LX172, LX173, LX176, LX178, LX186 & LX188 Lawn Tractors

TECHNICAL MANUAL

John Deere
Lawn & Grounds Care Division

TM1492 (31MAY96)

Litho in U.S.A



LX Series Lawn Tractor

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

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

- Table of Contents
- Specifications
- Component Location
- System Schematic
- Theory of Operation
- Troubleshooting Chart
- 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 tab symbol rather than a number. The groups and pages within a section will be consecutively numbered.

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

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.

Safety
Specifications and Information
Engine—Kawasaki
Engine—Kohler
Electrical
Power Train (Gear)
Power Train (Hydrostatic)
Steering
Brakes
Attachments
Miscellaneous
M

COPYRIGHT© 1996
JOHN DEERE HORICON WORKS
Horicon, Wisconsin
All rights reserved

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

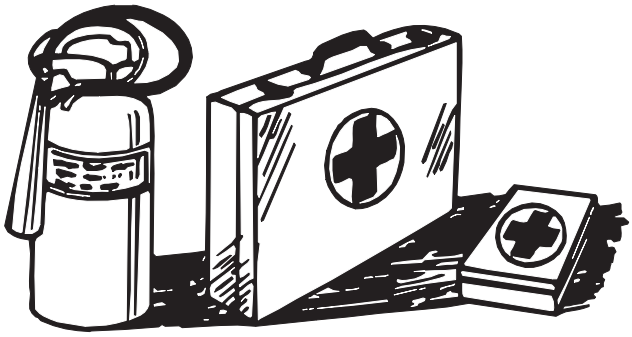


Replace missing or damaged safety signs. See the machine operator's manual for correct safety sign placement.

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.

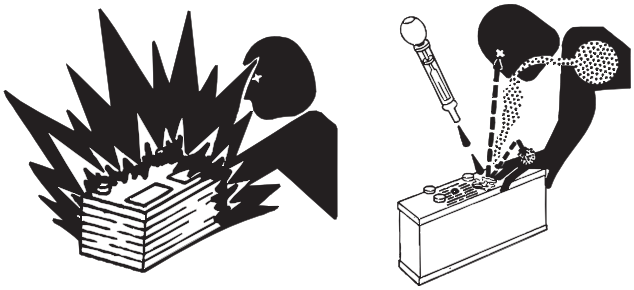
Do not store oily rags; they can ignite and burn spontaneously.

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 SAFE SERVICE PROCEDURES

Wear Protective Clothing

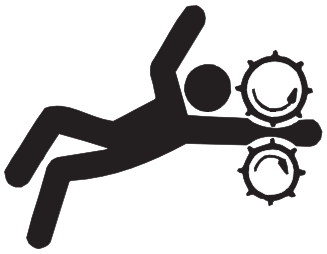


Wear close fitting clothing and safety equipment appropriate to the job.

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



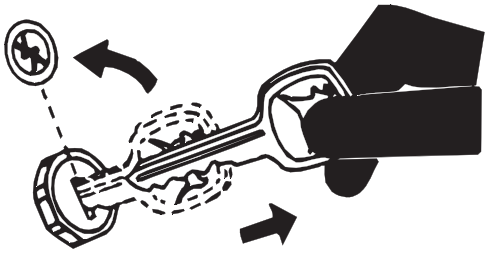
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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.

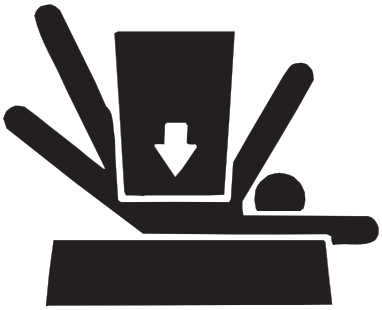
Park Machine Safely



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.

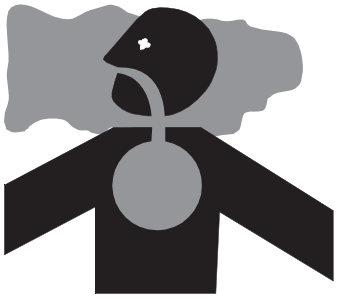
Using High Pressure Washers

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

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.

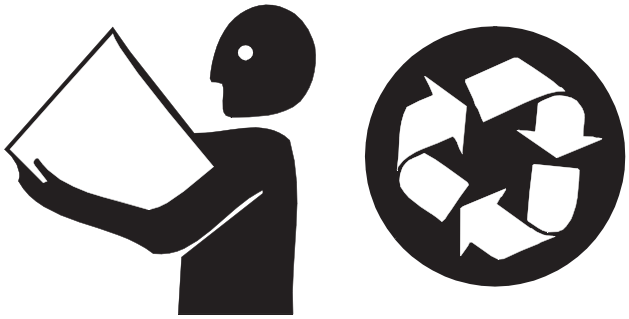
SERVICE COOLING SYSTEM SAFELY



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

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

HANDLE CHEMICAL PRODUCTS SAFELY



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

Page

SPECIFICATIONS AND GENERAL INFORMATION

GENERAL VEHICLE SPECIFICATIONS
VEHICLE SPECIFICATIONS 2-2
METRIC FASTENER TORQUE VALUES 2-7
INCH FASTENER TORQUE VALUES 2-8
GASOLINE
4-CYCLE ENGINES—NORTH AMERICA 2-9
GASOLINE STORAGE 2-9
4-CYCLE ENGINES—EUROPE 2-10
GASOLINE STORAGE 2-10
OILS AND LUBRICANTS
KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA 2-11
KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—EUROPE 2-12
KOHLER 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA 2-13
KOHLER 4-CYCLE GASOLINE ENGINE OIL—EUROPE 2-13
BREAK-IN 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA 2-14
BREAK-IN 4-CYCLE GASOLINE ENGINE OIL—EUROPE 2-15
HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA 2-16
HYDROSTATIC TRANSMISSION OIL—EUROPE 2-16
GEAR TRANSMISSION GREASE —NORTH AMERICA 2-17
GEAR TRANSMISSION GREASE—EUROPE 2-17
GREASE—NORTH AMERICA 2-18
GREASE—EUROPE 2-18
ANTI-CORROSION GREASE—NORTH AMERICA 2-19
ANTI-CORROSION GREASE—EUROPE 2-19
ALTERNATIVE LUBRICANTS 2-20
SYNTHETIC LUBRICANTS 2-20
LUBRICANT STORAGE 2-20
MIXING OF LUBRICANTS 2-20
OIL FILTERS 2-20
GASOLINE ENGINE COOLANT—NORTH AMERICA 2-21
GASOLINE ENGINE COOLANT DRAIN INTERVAL—NORTH AMERICA 2-21
GASOLINE ENGINE COOLANT—EUROPE 2-22
GASOLINE ENGINE COOLANT DRAIN INTERVAL—EUROPE 2-22
SERIAL NUMBER LOCATIONS
MACHINE IDENTIFICATION NUMBER 2-23
ENGINE SERIAL NUMBER—LX172, LX176 AND LX186 2-23
ENGINE SERIAL NUMBER—LX173 2-23
ENGINE SERIAL NUMBER—LX178 AND LX188 2-23
CARBURETOR SERIAL NUMBER—LX172, LX176 AND LX186 2-23
CARBURETOR PART NUMBER—LX173 (ONLY) 2-23
CARBURETOR SERIAL NUMBER—LX178 AND LX188 2-24
GEAR TRANSAXLE SERIAL NUMBER—LX172 AND LX173 2-24
HYDROSTATIC TRANSAXLE SERIAL NUMBER
—LX176, LX178, LX186 AND LX188 2-24
MOWER DECK SERIAL NUMBERS 2-24

GENERAL VEHICLE SPECIFICATIONS

ENGINE—LX172 AND LX176

Make	John Deere “K” Series
Type	Gasoline
Model	FC420V
Aspiration	Natural
Horsepower	10.4 kW (14 hp)
Cylinders	1
Displacement	423 mL (25.8 cu. in.)
Stroke/Cycle	4 Cycle
Bore	89 mm (3.500 in.)
Stroke	68 mm (2.68 in.)
Slow Idle	1550 ±75 rpm
Fast Idle	3350 ±50 rpm
Valving	Overhead Valves
Lubrication	Pressurized
Oil Filter	Full Flow Filter
Engine Oil Capacity (with filter)	1.50 L (3.2 U.S. pt)
Cooling System	Air Cooled
Air Cleaner	Two-stage with replaceable filter element
Muffler	Horizontal discharge below frame

ENGINE—LX173

Make	Kohler
Series	Command LT
Type	Gasoline
Model	CV15S
Aspiration	Natural
Horsepower	11.19 kW (15.0 hp)
Cylinders	1
Displacement	426 cc (26.0 cu. in.)
Stroke/Cycle	4 Cycle
Bore	90 mm (3.60 in.)
Stroke	67 mm (2.64 in.)
Slow Idle	1650 ±75 rpm
Fast Idle (Domestic)	3350 ±50 rpm
Valving	Overhead Valves
Lubrication	Pressurized
Oil Filter	Full Flow Filter (w/o By-Pass Valve)
Engine Oil Capacity (with filter)	1.8 L (1.9 U.S. qt)
Cooling System	Air Cooled
Air Cleaner	Paper with outer foam element
Muffler	Horizontal discharge below frame
Compression Release	Automatic/Centrifugal
Compression Ratio (Cranking)	2:1
Compression Ratio (Running)	8.5:1



ENGINE—LX178

Make	John Deere "K" Series
Type	Gasoline
Model	FD440V
Aspiration	Natural
Horsepower	11.1 kW (15 hp)
Cylinders	2 (V-twin)
Displacement	437 mL (26.7 cu. in.)
Stroke/Cycle	4 Cycle
Bore	67 mm (2.34 in.)
Stroke	62 mm (2.44 in.)
Slow Idle	1550 ±75 rpm
Fast Idle	3400 ±75 rpm
Valving	Overhead Valves
Lubrication	Pressurized
Oil Filter	Full Flow Filter
Engine Oil Capacity (with filter)	1.50 L (3.2 U.S. pt)
Cooling System	Liquid Cooled
Air Cleaner	Two-stage with replaceable filter element
Muffler	Horizontal discharge below frame

ENGINE—LX186

Make	John Deere "K" Series
Type	Gasoline
Model	FC540V
Aspiration	Natural
Horsepower	10.4 kW (14 hp)
Cylinders	1
Displacement	423 mL (25.8 cu. in.)
Stroke/Cycle	4 Cycle
Bore	89 mm (3.50 in.)
Stroke	68 mm (2.680 in.)
Slow Idle	1550 ±75 rpm
Fast Idle	3350 ±50 rpm
Valving	Overhead Valves
Lubrication	Pressurized
Oil Filter	Full Flow Filter
Engine Oil Capacity (with filter)	1.80 L (3.8 U.S. pt.)
Cooling System	Air Cooled
Air Cleaner	Two-stage with replaceable filter element
Muffler	Horizontal discharge below frame

ENGINE—LX188

Make	John Deere "K" Series
Type	Gasoline
Model	FD501V
Aspiration	Natural
Horsepower	12.6 kW (17 hp)
Cylinders	2 (V-twin)
Displacement	437 mL (26.7 cu. in.)
Stroke/Cycle	4 Cycle
Bore	67 mm (2.34 in.)
Stroke	62 mm (2.44 in.)
Slow Idle	1550 ±75 rpm
Fast Idle	3550 ±75 rpm
Valving	Overhead Valves
Lubrication	Pressurized
Oil Filter	Full Flow Filter
Engine Oil Capacity (with filter)	1.5 L (3.2 U.S. pt)
Cooling System	Liquid Cooled
Air Cleaner	Two-stage with replaceable filter element
Muffler	Horizontal discharge below frame

FUEL SYSTEM

Fuel Tank Location	Rear
Fuel Tank Capacity	9.5 L (2.5 U.S. gal)
Fuel (minimum octane)	Unleaded Gasoline, 87 Octane
Fuel Pump Location	
LX172, LX173, LX176 and LX186	On left-hand side of engine
LX178 and LX188	On front of engine
Fuel Delivery	Float-Type Side Draft Carburetor
Fuel Filter	Replaceable In-Line

ELECTRICAL

Ignition	Electronic Capacitor Discharge Ignition (CDI)
Type of Starter	Solenoid Shift
Charging System	Flywheel Alternator
Charging Capacity	
LX172/LX173/LX176/LX186	13 amp, Regulated
LX178/LX188	15 amp, Regulated
Battery Type	BCI Group, U1
Battery Voltage	12 V
Battery Reserve Capacity at 25 Amp	38 minutes
Battery Cold Cranking Amps at -18°C (0°F)	295 amps
Ignition Interlock Switches	Neutral Start—LX172/LX173 Brake—LX176/LX178/ LX186/LX188

PTO DRIVE

Type	V-Belt
Clutch Type	Engine-Mounted, Electric
Control	Switch on dash

POWER TRAIN

Drive Wheels . . . . . Rear
Transaxle Drive . . . . . Belt

Gear Transaxle—LX172/ LX173

Type . . . . . Gear Transaxle
Number of Speeds . . . . . 5 Forward, 1 Reverse
Travel Speeds at Full RPM
- 1st Gear . . . . . 2.6 km/h (1.6 mph)
- 2nd Gear . . . . . 4.1 km/h (2.5 mph)
- 3rd Gear . . . . . 6.1 km/h (3.8 mph)
- 4th Gear . . . . . 7.8 km/h (4.8 mph)
- 5th Gear . . . . . 9.2 km/h (5.7 mph)
- Reverse . . . . . 4.4 km/h (2.7 mph)

Transaxle Lubricant Capacity . . . . . 2.3 L (2.5 qt)
Lubricant Type . . . . . John Deere Non-Clay High-Temperature EP Grease

Hydrostatic Transaxle—LX176/ LX178/LX186/LX188

Type . . . . . Hydrostatic, Piston-Type Transaxle
Transaxle Filter . . . . . Replaceable, Internal
Travel Speeds at Full RPM
- Forward . . . . . 0—8.8 km/h (0—5.5 mph)
- Reverse . . . . . 0—4.0 km/h (0—2.5 mph)

Transaxle Lubricant Capacity . . . . . 3.4 L (7.2 U.S. qt)
Lubricant Type . . . . . John Deere TURF–GARD® 10W-30 Engine Oil

STEERING

Type . . . . . Sector and Pinion

BRAKES

Location . . . . . Transaxle
Type
- LX172/LX173 . . . . . External Disk, Single Pedal
- LX176/LX178/LX186/LX188 . . . . . External Band, Single Pedal

Park Brake
- LX172/LX173 . . . . . Right Pedal, Clutch Interlock
- LX176/LX178/LX186/LX188 . . . . . Right Pedal

IMPLEMENT LIFT

Lift System . . . . . Manual with Lift-Assist Spring
Lift Lever Location . . . . . Left-hand side of hood
Cutting Heights . . . . . 12.7—88.9 mm (12.7 mm increments)
. . . . . 0.5—3.5 in. (0.50 in. increments)

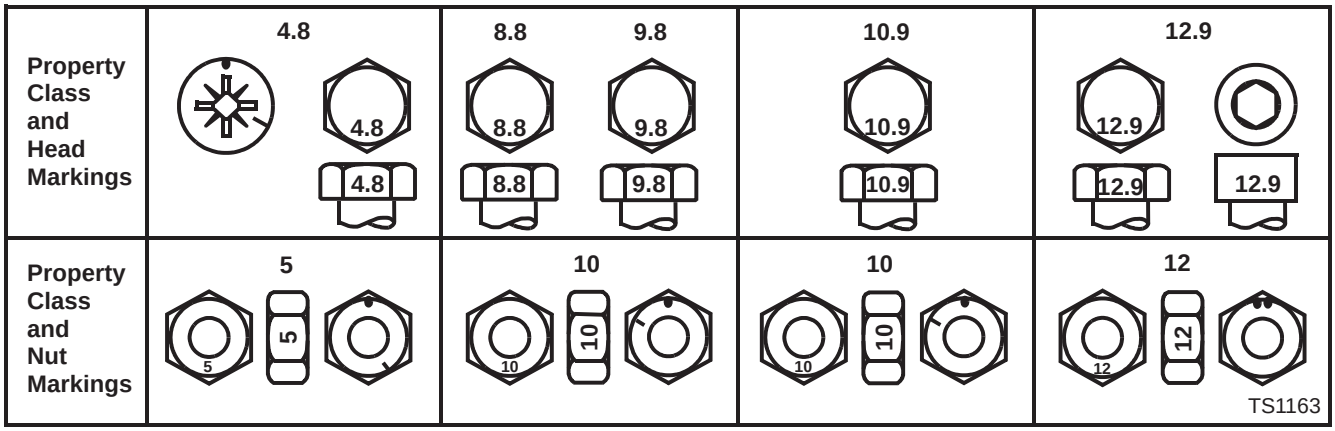
WEIGHTS AND DIMENSIONS

- Net Weight (no fuel) (estimated)
  - LX172/LX173
    - With 38-Inch Mower Deck . . . . . 238 kg (525 lb)
    - With 44-Inch Mower Deck . . . . . 245 kg (540 lb)
    - With 48-Inch Mower Deck . . . . . 254 kg (560 lb)
  - LX176
    - With 38-Inch Mower Deck . . . . . 243 kg (535 lb)
    - With 48-Inch Mower Deck . . . . . 259 kg (570 lb)
  - LX178
    - With 38-Inch Mower Deck . . . . . 245 kg (540 lb)
    - With 44-Inch Mower Deck . . . . . 261 kg (575 lb)
  - LX186/LX188
    - With 48-Inch Mower Deck . . . . . 268 kg (590 lb)
- Mower Deck Weight (estimated)
  - 38-Inch Mower Deck. . . . . 43 kg (95 lb)
  - 44-Inch Mower Deck. . . . . 49 kg (108 lb)
  - 48-Inch Mower Deck. . . . . 57 kg (125 lb)
- Overall Width (less mower deck)
  - LX172/LX173/LX176/LX178. . . . . 1.262 m (49.7 in.)
  - LX186/LX188 . . . . . 1.504 m (59.2 in.)
- Overall Width (with mower deck, discharge chute down)
  - With 38-Inch Mower Deck. . . . . 1.32 m (52 in.)
    - With Rear Bagger . . . . . 1.26 m (49.5 in.)
  - With 44-Inch Mower Deck. . . . . 1.163 m (45.7 in.)
  - With 48-Inch Mower Deck. . . . . 1.54 m (60.5 in.)
    - With Power Flow . . . . . 1.56 m (61.5 in.)
- Overall Height . . . . . 1.02 m (40.2 in.)
- Overall Length. . . . . 1.68 m (66.1 in.)
- Wheelbase . . . . . 1.165 m (45.9 in.)
- Turning Radius
  - Inside Rear Wheel . . . . . 0.508 m (20 in.)
  - Outside Front Wheel. . . . . 1.88 m (74 in.)

WHEELS AND TIRES

- Front . . . . . 15 x 6.00-6 in.
- Rear . . . . . 20 x 10.00-8 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	48	3.5	6	4.5	9	6.5	11	8.5	13	9.5	17	12	15	11.5	19	14.5
M8	12	8.5	15	11	22	16	28	20	32	24	40	30	37	28	47	35
M10	23	17	29	21	43	32	55	40	63	47	80	60	75	55	95	70
M12	40	29	50	37	75	55	95	70	110	80	140	105	130	95	165	120
M14	63	47	80	60	120	88	150	110	175	130	225	165	205	150	260	109
M16	100	73	125	92	190	140	240	175	275	200	350	225	320	240	400	300
M18	135	100	175	125	260	195	330	250	375	275	475	350	440	325	560	410
M20	190	140	240	180	375	275	475	350	530	400	675	500	625	460	800	580
M22	260	190	330	250	510	375	650	475	725	540	925	675	850	625	1075	800
M24	330	250	425	310	650	475	825	600	925	675	1150	850	1075	800	1350	1000
M27	490	360	625	450	950	700	1200	875	1350	1000	1700	1250	1600	1150	2000	1500
M30	675	490	850	625	1300	950	1650	1200	1850	1350	2300	1700	2150	1600	2700	2000
M33	900	675	1150	850	1750	1300	2200	1650	2500	1850	3150	2350	2900	2150	3700	2750
M36	1150	850	1450	1075	2250	1650	2850	2100	3200	2350	4050	3000	3750	2750	4750	3500

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

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

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

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

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

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

Reference: JDS—G200.

INCH FASTENER TORQUE VALUES

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

TS1162

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

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

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

Fasteners should be replaced with the same 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.

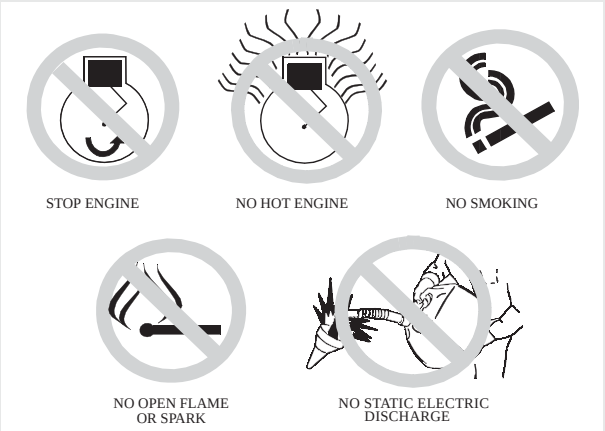
GASOLINE
4-CYCLE ENGINES—NORTH AMERICA

⚠ 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 bottom of filler neck only;**
- **be sure fill cap is tight after fueling;**
- **clean up any gas spills IMMEDIATELY;**
- **keep machine clean and in good repair–free of excess grease, oil, debris, and faulty or damaged parts;**
- **any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light.**

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

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

To avoid engine damage:

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

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

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



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.

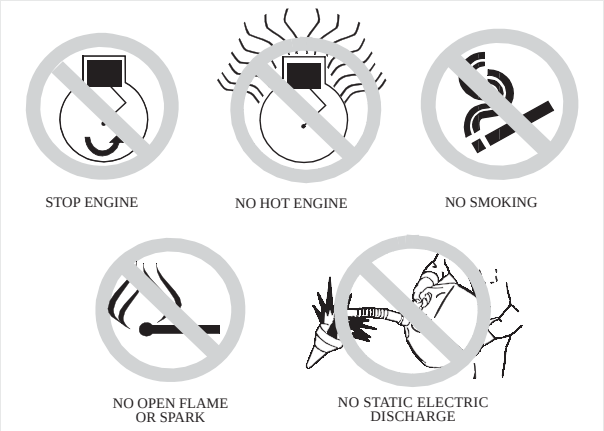
4–CYCLE ENGINES—EUROPE

⚠ 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 bottom of filler neck only;**
- **be sure fill cap is tight after fueling;**
- **clean up any gas spills IMMEDIATELY;**
- **keep machine clean and in good repair–free of excess grease, oil, debris, and faulty or damaged parts;**
- **any storage of machines with gas left in tank should be in an area that is well ventilated to prevent possible igniting of fumes by an open flame or spark, this includes any appliance with a pilot light.**

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

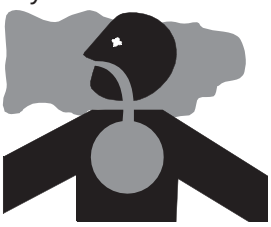
- **ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.**

To avoid engine damage:

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

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

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



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

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.

OILS AND LUBRICANTS

KAWASAKI 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**:

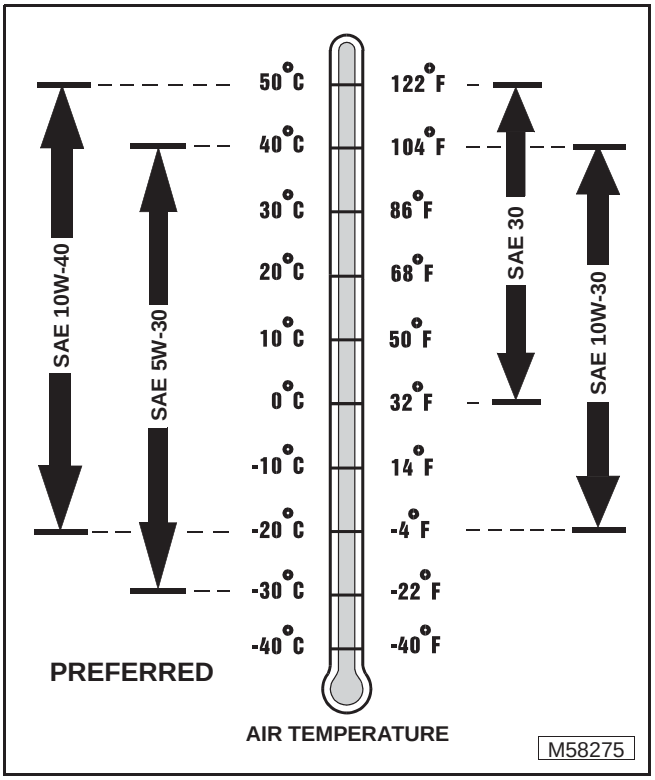
- **PLUS–4®—SAE 10W-40**;
- **TORQ–GARD SUPREME®—SAE 5W-30**.

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

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

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

- SAE 10W-40—API Service Classifications SG or higher;
- SAE 5W-30—API Service Classification SG or higher;
- SAE 10W-30—API Service Classifications SG or higher;
- SAE 30—API Service Classification SC or higher.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—EUROPE

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**:

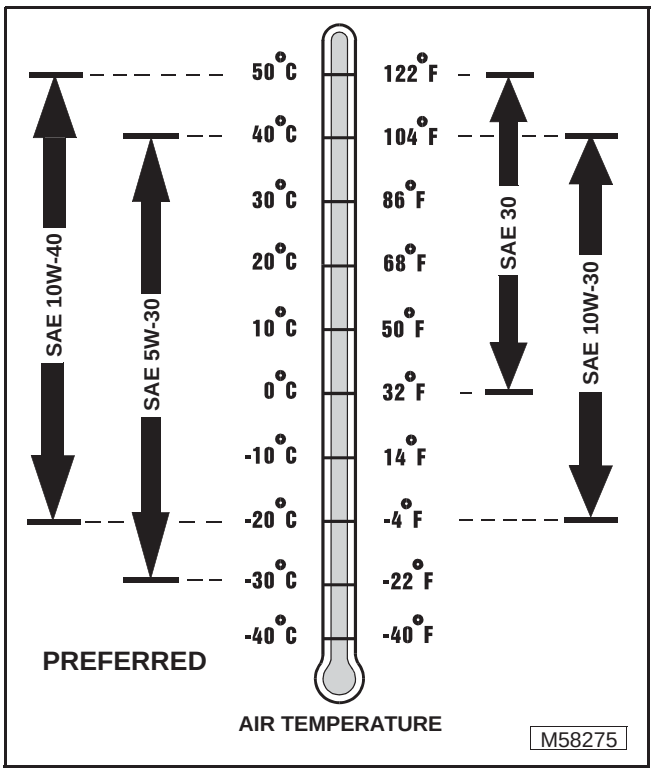
- **TORQ–GARD SUPREME®—SAE 10W-40;**
- **UNI–GARD™—SAE 10W-40;**
- **TORQ–GARD SUPREME®—SAE 5W-30;**
- **UNI–GARD™—SAE 5W-30.**

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

- **TORQ–GARD SUPREME®—SAE 10W-30;**
- **UNI–GARD™—SAE 10W-30;**
- **TORQ–GARD SUPREME®—SAE 30;**
- **UNI–GARD™—SAE 30.**

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

- CCMC Specifications G4 or higher.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

KOHLER 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**:

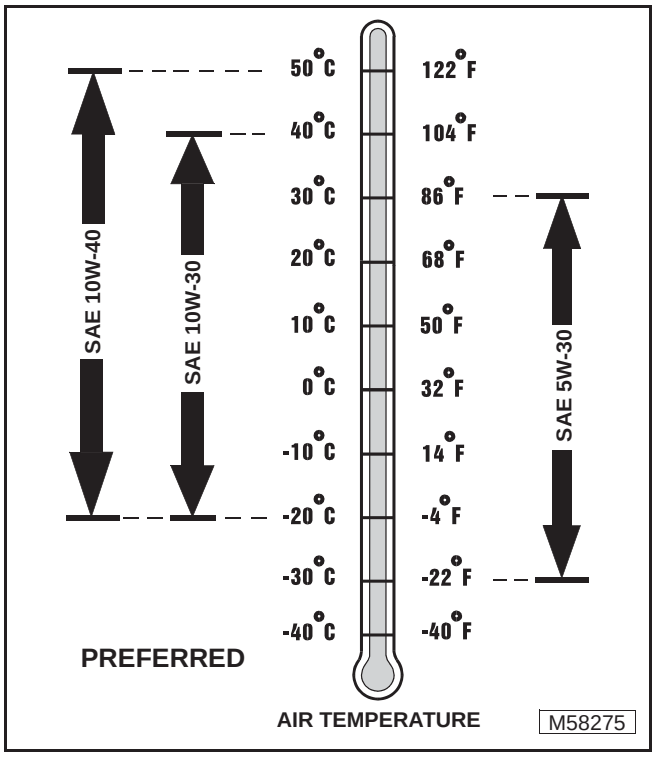
- **PLUS–4®—SAE 10W-40;**
- **TURF–GARD®—SAE 10W-30;**
- **PLUS–4®—SAE 10W-30**;

The following John Deere oil is **also recommended**, based on their specified temperature range:

- **TORQ–GARD SUPREME®—SAE 5W-30**.

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

- SAE 10W-40, 10W-30, or 5W-30—API Service Classifications SG or higher;



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

KOHLER 4-CYCLE GASOLINE ENGINE OIL—EUROPE

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**:

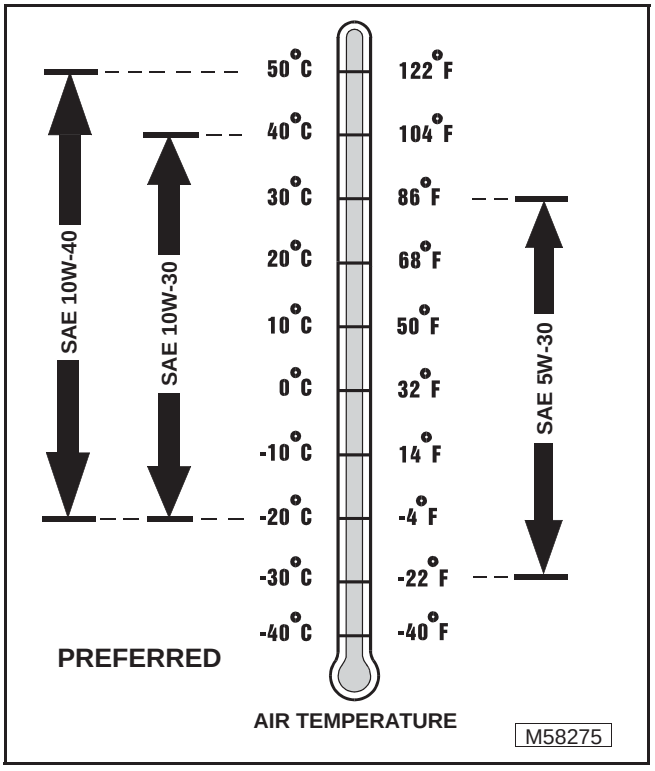
- **TORQ–GARD SUPREME®—SAE 10W-40;**
- **UNI–GARD™—SAE 10W-40;**
- **TORQ–GARD SUPREME®—SAE 10W-30;**
- **UNI–GARD™—SAE 10W-30.**

The following John Deere oil is **also recommended**, based on their specified temperature range:

- **TORQ–GARD SUPREME®—SAE 5W-30;**
- **UNI–GARD™—SAE 5W-30.**

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

- CCMC Specifications G4 or higher.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

BREAK-IN 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA

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

The following John Deere oil is **PREFERRED**:

- **BREAK–IN ENGINE OIL**.

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

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

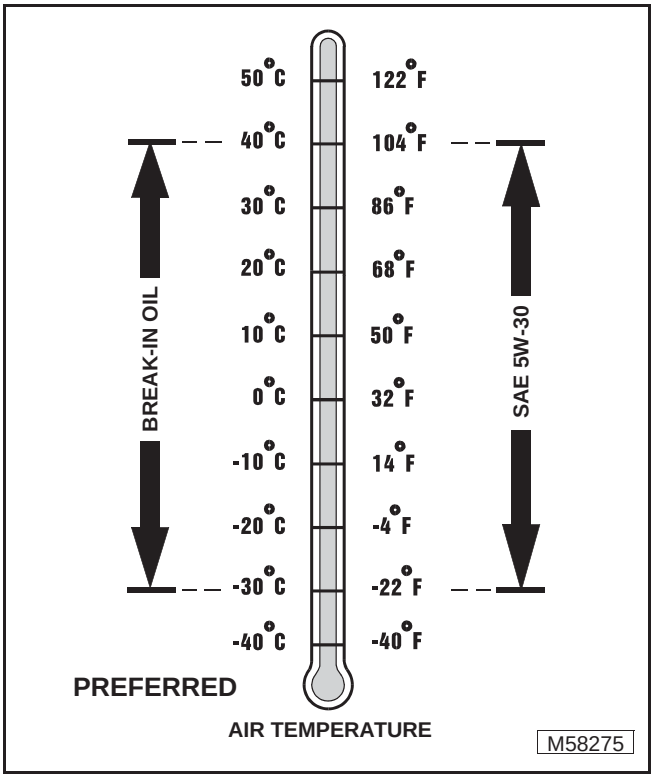
The following John Deere oil is **also recommended**:

- **TORQ–GARD SUPREME®—SAE 5W-30.**

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

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

IMPORTANT: After the break-in period, use the John Deere oil that is recommended for this engine.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL4 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

BREAK-IN 4-CYCLE GASOLINE ENGINE OIL—EUROPE

IMPORTANT: ONLY use a quality break-in oil in rebuilt or remanufactured engines for the first 5 hours (maximum) of operation. DO NOT use oils with heavier viscosity weights than SAE 5W-30 or oils meeting CCMC Specification G5—these oils will not allow rebuilt or remanufactured engines to break-in properly.

The following John Deere oil is **PREFERRED**:

- **BREAK–IN ENGINE OIL**.

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

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

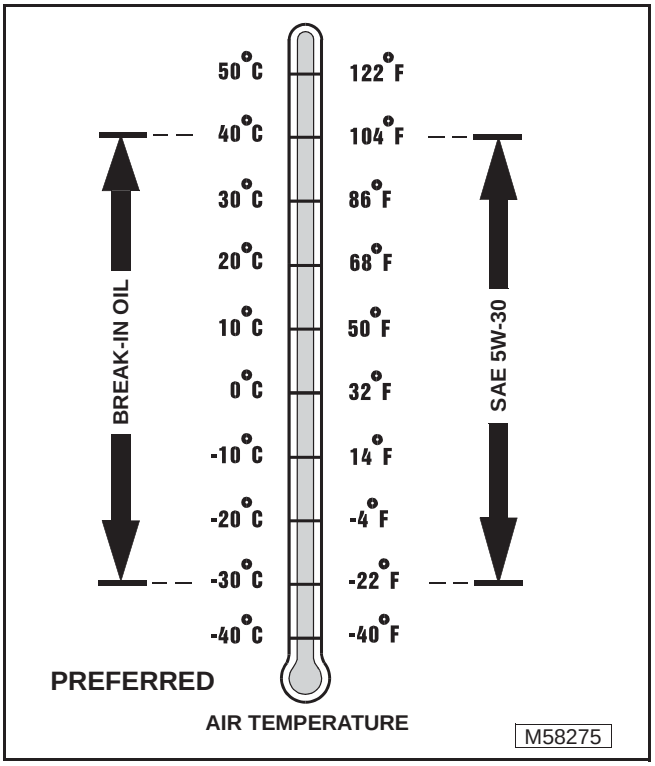
The following John Deere oil is **also recommended**:

- **TORQ–GARD SUPREME®—SAE 5W-30.**

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

- SAE 5W-30—CCMC Specification G4 or higher.

IMPORTANT: After the break-in period, use the John Deere oil that is specified for this engine.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL4 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

HYDROSTATIC TRANSMISSION OIL —NORTH AMERICA

Use the appropriate oil viscosity based on these air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature hydrostatic transmission failure.

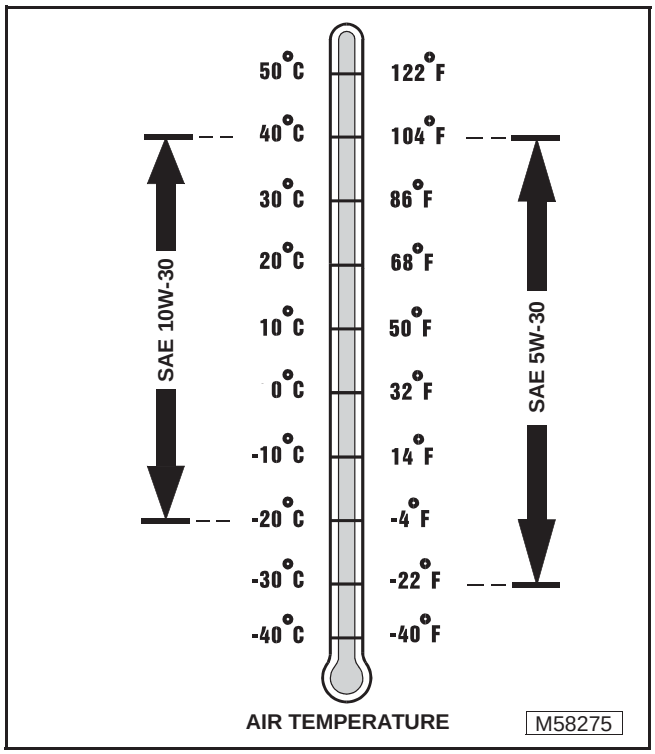
IMPORTANT: ONLY use a quality SAE 10W-30 or SAE 5W-30 engine oil in this transmission. Mixing of these two viscosity grade oils is permitted. DO NOT use BIO–HY–GARD® in this transmission.

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

- **TURF-GARD®—SAE 10W-30;**
- **PLUS-4®—SAE 10W-30.**
- **TORQ-GARD SUPREME®—SAE 5W-30.**

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

- API Service Classifications SG or higher.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

HYDROSTATIC TRANSMISSION OIL—EUROPE

Use the appropriate oil viscosity based on these air temperature ranges. Operating outside of these recommended oil air temperature ranges may cause premature hydrostatic transmission failure.

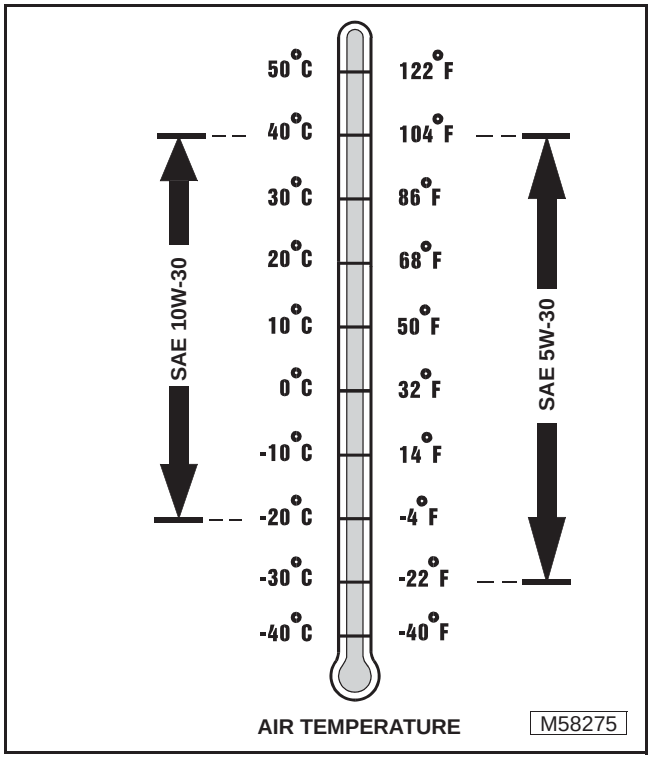
IMPORTANT: ONLY use a quality SAE 10W-30 or SAE 5W-30 engine oil in this transmission. Mixing of these two viscosity grade oils is permitted. DO NOT use BIO–HY–GARD® in this transmission.

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

- **TORQ-GARD SUPREME®—SAE 10W-30;**
- **TORQ-GARD SUPREME®—SAE 5W-30.**

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

- CCMC Specifications G4 or higher.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil for your customers:

- Module DX,ENOIL2 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

GEAR TRANSMISSION GREASE—NORTH AMERICA

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

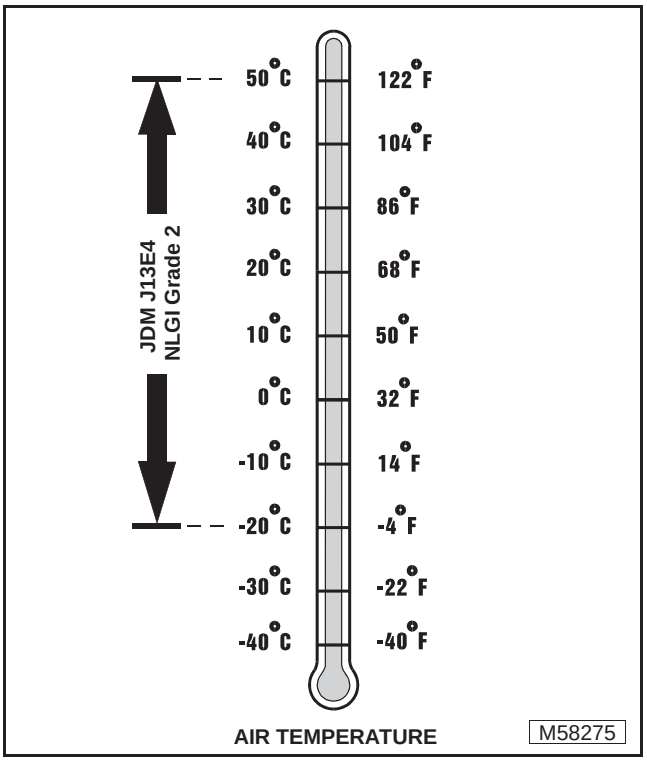
IMPORTANT: ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO–GREASE in this transmission.

The following John Deere gear grease is **PREFERRED**:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE® —JDM J13E4, NLGI Grade 2.**

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

- John Deere Standard JDM J13E4,
- NLGI Grade 2.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lubrication Sales Manual PI7032.

GEAR TRANSMISSION GREASE—EUROPE

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

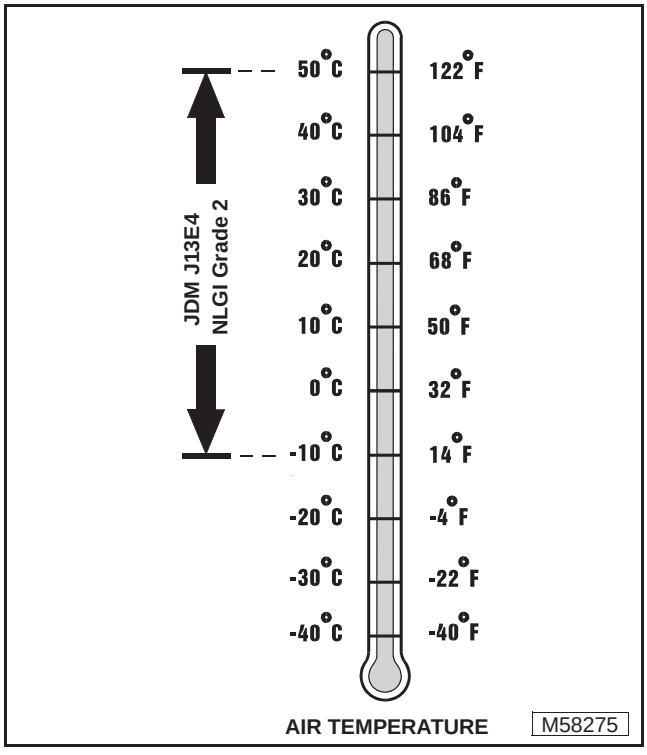
IMPORTANT: ONLY use a quality gear grease in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO–GREASE in this transmission.

The following John Deere gear grease is **PREFERRED**:

- **GREASE–GARD™—JDM J13E4, NLGI Grade 2.**

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

- John Deere Standard JDM J13E4,
- NLGI Grade 2.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

GREASE—NORTH AMERICA

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

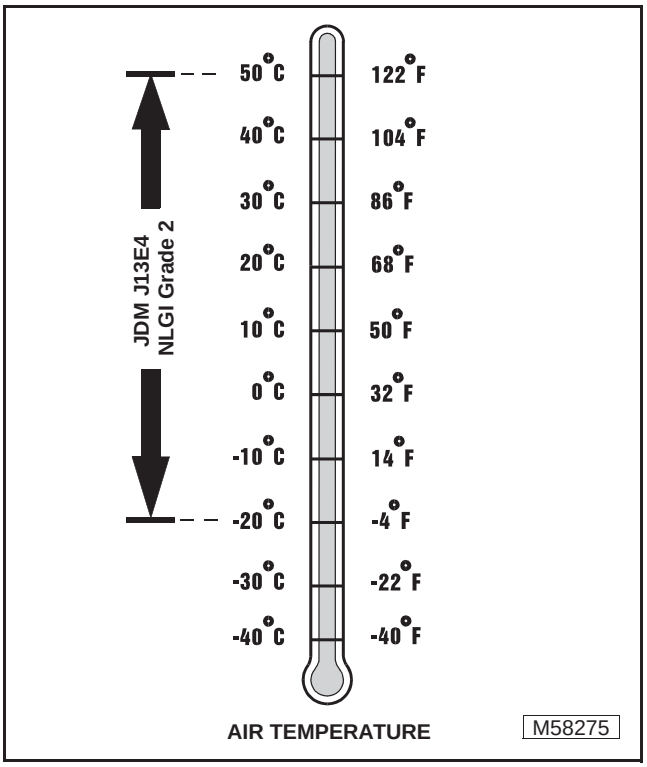
IMPORTANT: ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO–GREASE in this application.

The following John Deere grease is **PREFERRED**:

- **NON-CLAY HIGH-TEMPERATURE EP GREASE®—JDM J13E4, NLGI Grade 2.**

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- the Lubrication Sales Manual PI7032.

GREASE—EUROPE

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

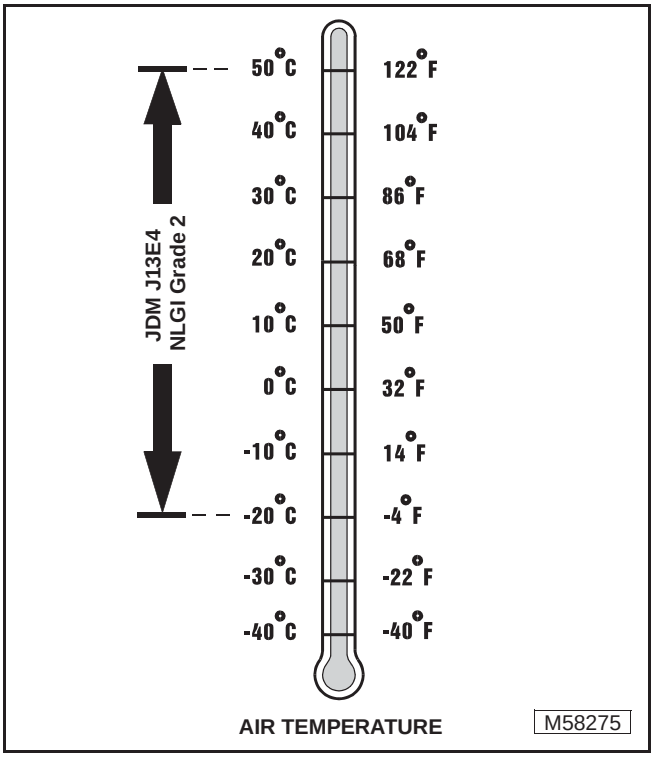
IMPORTANT: ONLY use a quality grease in this application. DO NOT mix any other greases in this application. DO NOT use any BIO–GREASE in this application.

The following John Deere grease is **PREFERRED**:

- **GREASE–GARD™—JDM J13E4, NLGI Grade 2.**

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

- John Deere Standard JDM J13E4, NLGI Grade 2.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

ANTI-CORROSION GREASE—NORTH AMERICA

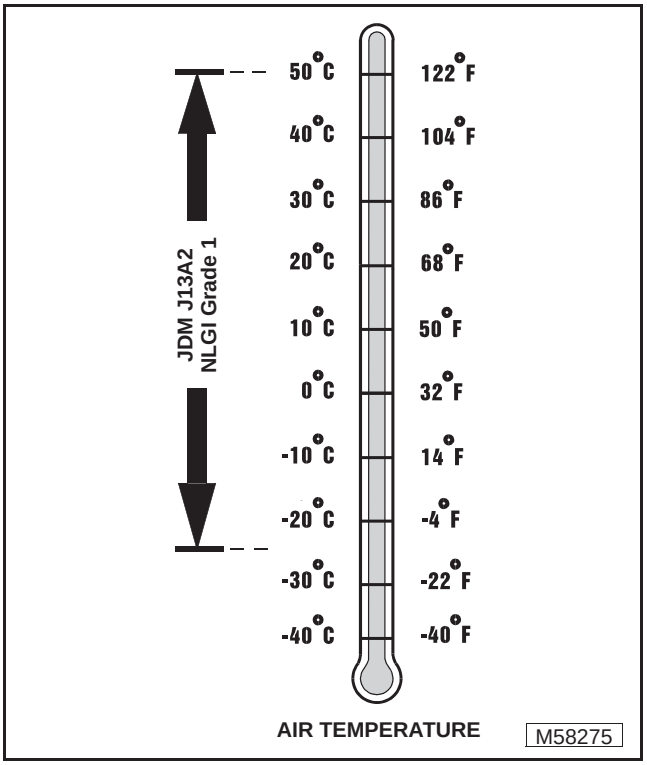
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

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.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- the Lubrication Sales Manual PI7032.

ANTI-CORROSION GREASE—EUROPE

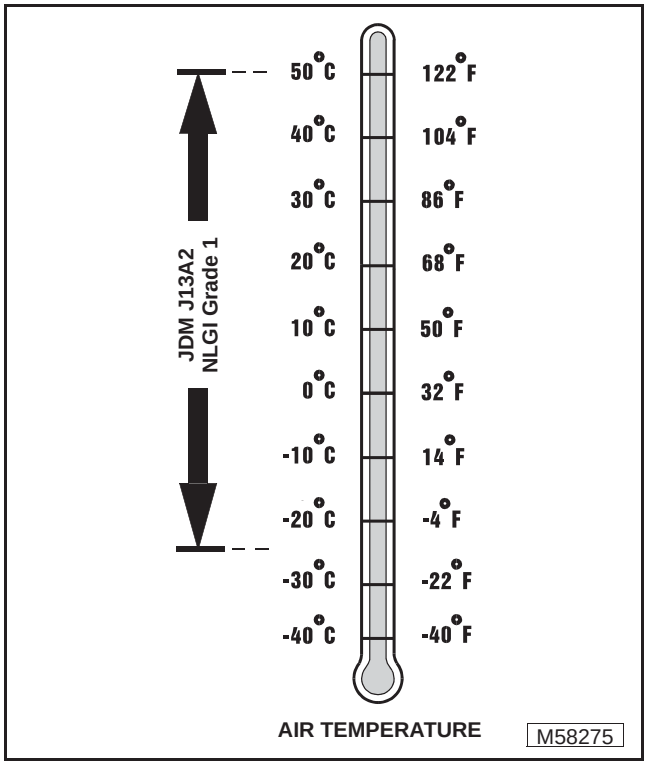
This anti-corrosion grease is formulated to provide the best protection against absorbing moisture, which is one of the major causes of corrosion. This grease is also superior in its resistance to separation and migration.

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.



John Deere Dealers: You may want to cross-reference the following publications to recommend the proper grease for your customers:

- Module DX,GREA1 in JDS–G135;
- Section 530, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide.

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.

John Deere Dealers: You may want to cross-reference the following publications to recommend the proper oil filter for your customers:

- Module DX,FILT in JDS–G135;
- Section 540, Lubricants & Hydraulics, of the John Deere Merchandise Sales Guide;
- Lawn & Grounds Care Tune-Up Guide PI672.

GASOLINE ENGINE COOLANT—NORTH AMERICA

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

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

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

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

The above preferred pre-diluted anti-freeze provides:

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

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

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

If either of above recommended engine coolants are available use any Automobile and Light Duty Engine Service **ethylene glycol base coolant**, meeting the following specification:

- ASTM D3306 (JDM H24C1).

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

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

Water Quality

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Max.	170 ppm (10 grns/gal)
Chloride (as Cl), Max.	40 ppm (2.5 grns/gal)
Sulfate (as SO_4), Max.	100 ppm (5.8 grns/gal)

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

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

GASOLINE ENGINE COOLANT DRAIN INTERVAL—NORTH AMERICA

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

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

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

GASOLINE ENGINE COOLANT—EUROPE

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

ONLY use a quality Automobile and Light Duty Engine Service **ethylene glycol base coolant**, meeting the following specification:

- ASTM D3306 (JDM H24C1).

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

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

Water Quality

Property	Requirements
Total Solids, Maximum	340 ppm (20 grns/gal)
Total Hardness, Max.	170 ppm (10 grns/gal)
Chloride (as Cl), Max.	40 ppm (2.5 grns/gal)
Sulfate (as SO_4), Max.	100 ppm (5.8 grns/gal)

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

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

GASOLINE ENGINE COOLANT DRAIN INTERVAL—EUROPE

If a quality Automobile and Light Duty Engine Service **ethylene glycol base coolant** is being used, drain and flush the cooling system and refill with fresh coolant mixture every **24 months or 2,000 hours** of operation, whichever comes first.

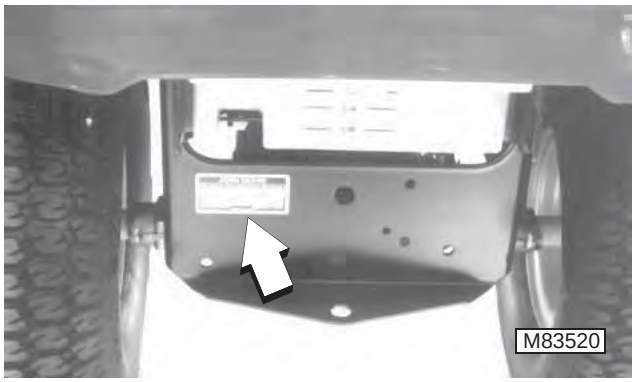
If a quality Automobile and Light Duty Engine Service coolant **is not** being used; drain, flush, and refill the cooling system according to instructions found on product container or in equipment operator's manual or technical manual.

SERIAL NUMBER LOCATION

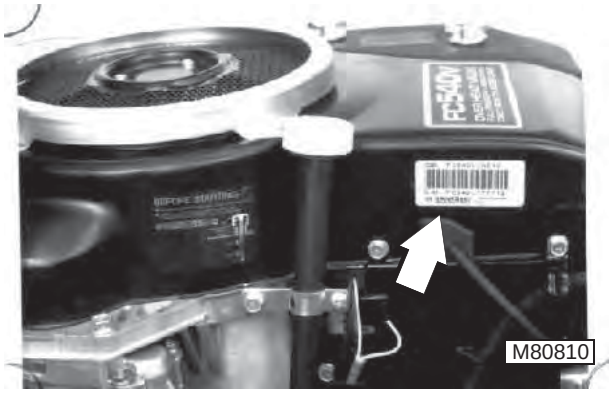
When ordering parts or submitting a warranty claim, it is IMPORTANT that the machine product identification number and component serial numbers are included.

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

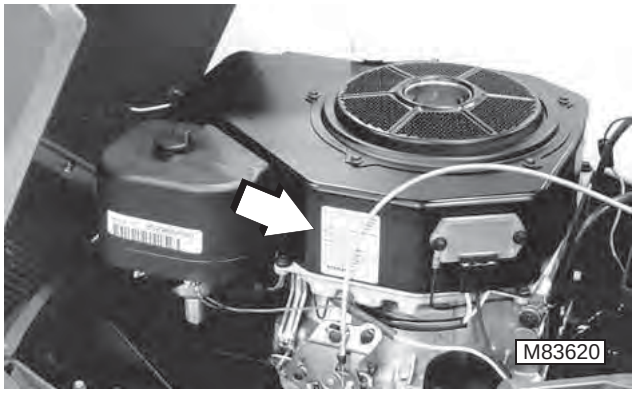
MACHINE IDENTIFICATION NUMBER



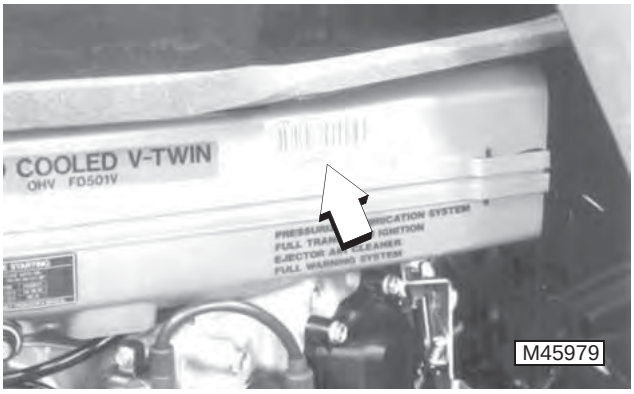
ENGINE SERIAL NUMBER—LX172, LX176 AND LX186



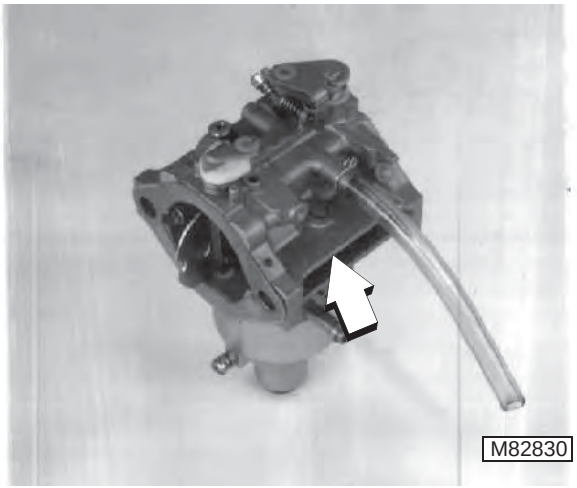
ENGINE SERIAL NUMBER—LX173



ENGINE SERIAL NUMBER—LX178 AND LX188



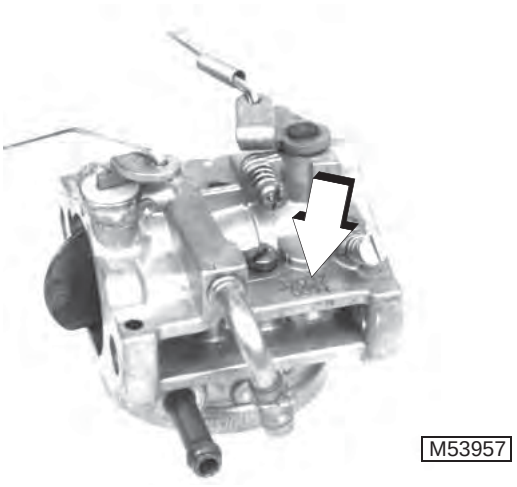
CARBURETOR SERIAL NUMBER—LX172, LX176 AND LX186



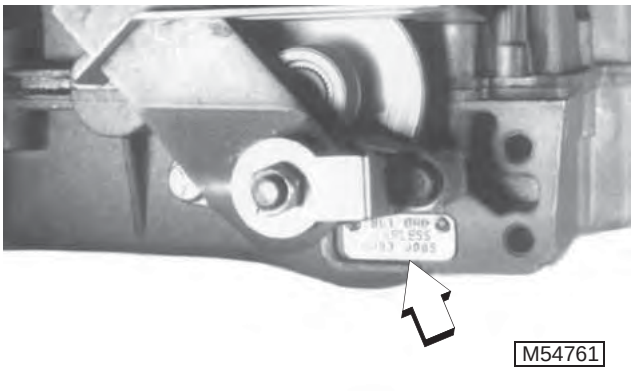
CARBURETOR PART NUMBER — LX173 (ONLY)



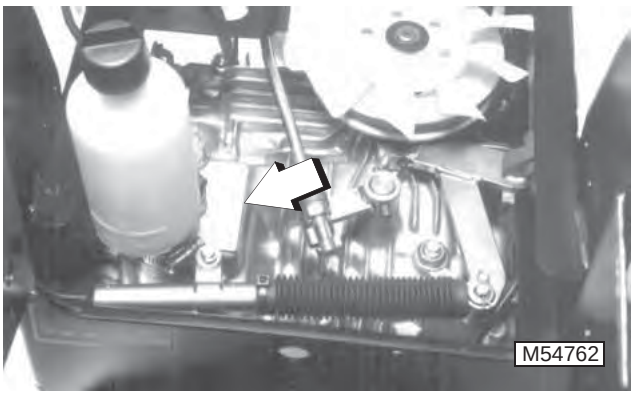
CARBURETOR SERIAL NUMBER—LX178 AND LX188



GEAR TRANSAXLE SERIAL NUMBER—LX172 AND LX173



HYDROSTATIC TRANSAXLE SERIAL NUMBER—LX176, LX178, LX186 AND LX188



MOWER DECK SERIAL NUMBER LOCATION

38 and 48-Inch Mower Decks



44-Inch Rear Discharge Mower Deck



CONTENTS

Page

ENGINE—KAWASAKI FC420V(LX172/LX176) / FC540V(LX186)

SPECIFICATIONS
- ENGINE DESIGNATION . . . 3-7
- TEST AND ADJUSTMENT SPECIFICATIONS . . . 3-7
- REPAIR SPECIFICATIONS . . . 3-7
- SPECIAL OR ESSENTIAL TOOLS . . . 3-12
- OTHER MATERIALS . . . 3-13
- SERVICE PARTS KITS . . . 3-13

COMPONENT LOCATION
- EXTERNAL ENGINE COMPONENTS . . . 3-14
- INTERNAL ENGINE COMPONENTS . . . 3-15
- OIL PUMP, BREATHER AND COMPRESSION RELEASE COMPONENTS . . . 3-16
- FUEL/AIR SYSTEM COMPONENTS . . . 3-17

THEORY OF OPERATION
- LUBRICATION SYSTEM OPERATION . . . 3-18
- COOLING SYSTEM OPERATION . . . 3-20

TROUBLESHOOTING
- TROUBLESHOOTING CHART . . . 3-22
- ENGINE TROUBLESHOOTING GUIDE . . . 3-24
- STARTER MOTOR TROUBLESHOOTING GUIDE . . . 3-28

TESTS AND ADJUSTMENTS
- THROTTLE CABLE TEST AND ADJUSTMENT . . . 3-29
- CHOKE PLATE TEST AND ADJUSTMENT . . . 3-29
- GOVERNOR ADJUSTMENT . . . 3-30
- FAST IDLE SPEED ADJUSTMENT . . . 3-31
- SLOW IDLE SPEED ADJUSTMENT—NON CARB/EPA ENGINES . . . 3-32
- SLOW IDLE SPEED ADJUSTMENT—CARB/EPA ENGINES . . . 3-32
- CYLINDER COMPRESSION PRESSURE TEST . . . 3-34
- VALVE CLEARANCE TEST AND ADJUSTMENT . . . 3-35
- AUTOMATIC COMPRESSION RELEASE (ACR) TEST . . . 3-35
- CRANKCASE VACUUM TEST . . . 3-36
- ENGINE OIL PRESSURE TEST . . . 3-37
- FUEL PUMP TESTS . . . 3-37
- SPARK TEST . . . 3-38
- SPARK PLUG GAP ADJUSTMENT . . . 3-39
- MAGNETO IGNITION COIL RESISTANCE TEST . . . 3-39
- IGNITOR MODULE TEST . . . 3-40
- MAGNETO IGNITION COIL WITH IGNITION MODULE RESISTANCE TEST . . . 3-40

REPAIR
- FUEL TANK . . . 3-41
- THROTTLE CONTROL LEVER AND CABLE . . . 3-41
- ENGINE . . . 3-42
- MUFFLER . . . 3-43



Page

REPAIR, continued

AIR CLEANER 3-43
CARBURETOR
- Removal/Installation 3-44
- Disassembly/Assembly 3-44
- Clean/Inspect/Rebuild 3-47

FUEL PUMP 3-47
BREATHER 3-47
BLOWER HOUSING
- Inspection/Replacement 3-48
- Flywheel Screen Adjustment 3-48

FLYWHEEL 3-48
ROCKER ARM ASSEMBLY
- Removal/Installation 3-49
- Inspection 3-49

CYLINDER HEAD AND VALVES
- Removal/Installation 3-49
- Disassembly/Assembly 3-50
- Inspection 3-51
- Valve Guide Replacement 3-52

ANALYZE VALVES 3-53
RECONDITION VALVE SEATS 3-54
LAP VALVES 3-54
CRANKCASE COVER 3-54
PISTON AND CONNECTING ROD
- Removal 3-55
- Installation 3-55
- Disassembly 3-55
- Assembly 3-56
- Inspection 3-56
- Check Piston Ring End Gap 3-58

ANALYZE PISTON RING WEAR 3-58
ANALYZE PISTON WEAR 3-60
CAMSHAFT AND TAPPETS
- Removal 3-61
- Installation 3-61
- Inspection 3-62

RECIPROCATING BALANCER
- Removal/Installation 3-63
- Disassembly/Assembly 3-63
- Inspection 3-64
- Bearing Replacement 3-64

crankshaft end play test 3-65
CRANKSHAFT AND MAIN BEARINGS
- Removal/Installation 3-65
- Inspection 3-65
- End Play Adjustment 3-66

Page

REPAIR, continued

CRANKSHAFT OIL SEALS 3-67
ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR 3-67
CYLINDER BLOCK
- Inspection 3-68
- Deglaze Cylinder Bore 3-68
- Rebore Cylinder Block 3-68

OIL PUMP
- Disassembly/Assembly 3-69
- Inspection 3-70

OIL FILTER MANIFOLD 3-71
GOVERNOR 3-71
GOVERNOR SHAFT 3-72
STATOR 3-72
MAGNETO IGNITION COIL
- Removal/Installation 3-72
- Air Gap Adjustment 3-73

IGNITOR MODULE 3-73
MAGNETO IGNITION COIL WITH IGNITOR MODULE
- Removal/Installation 3-73
- Air Gap Adjustment 3-73

STARTER
- Removal/Installation 3-74
- Analyze Condition 3-74
- Starter No-Load Amperage Draw and RPM Bench Tests 3-74
- Disassembly/Assembly 3-75
- Exploded View 3-75
- Inspection/Test 3-76

Page

ENGINE—KAWASAKI FD440V(LX178) / FD501V(LX188)

SPECIFICATIONS

ENGINE DESIGNATION 3-79
TEST AND ADJUSTMENT SPECIFICATIONS 3-79
REPAIR SPECIFICATIONS 3-80
SPECIAL OR ESSENTIAL TOOLS 3-82
OTHER MATERIALS 3-83
SERVICE PARTS KITS 3-83

COMPONENT LOCATION

EXTERIOR ENGINE COMPONENTS 3-85
INTERNAL ENGINE COMPONENTS 3-87
FUEL/AIR SYSTEM COMPONENTS 3-89

THEORY OF OPERATION

LUBRICATION SYSTEM OPERATION 3-90
COOLING SYSTEM OPERATION 3-92

TROUBLESHOOTING

TROUBLESHOOTING CHART 3-94
ENGINE TROUBLESHOOTING GUIDE 3-96
STARTER MOTOR TROUBLESHOOTING GUIDE 3-100

TESTS AND ADJUSTMENTS

THROTTLE CABLE TEST AND ADJUSTMENT 3-101
CHOKE PLATE TEST AND ADJUSTMENT 3-101
GOVERNOR ADJUSTMENT 3-102
FAST IDLE SPEED ADJUSTMENT 3-103
SLOW IDLE SPEED ADJUSTMENT NON CARB/EPA ENGINES 3-103
SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES 3-104
CYLINDER COMPRESSION PRESSURE TEST 3-105
VALVE CLEARANCE TEST AND ADJUSTMENT 3-106
CRANKCASE VACUUM TEST 3-107
ENGINE OIL PRESSURE TEST 3-108
FUEL PUMP TEST 3-108
SPARK TEST 3-110
SPARK PLUG GAP ADJUSTMENT 3-110
COOLING SYSTEM PRESSURE TEST 3-110
RADIATOR CAP PRESSURE TEST 3-111

REPAIR

FUEL TANK 3-112
THROTTLE CONTROL LEVER AND CABLE 3-112
ENGINE 3-112
MUFFLER 3-114
AIR CLEANER 3-114

Page

REPAIR, continued

CARBURETOR
- Removal/Installation . . . 3-115
- Disassembly/Assembly . . . 3-115
- Clean/Inspect/Rebuild . . . 3-118
- Float Level Adjustment . . . 3-118

INTAKE MANIFOLD
- Removal/Installation . . . 3-118
- Inspection . . . 3-119

FUEL PUMP
- Removal/Installation . . . 3-119
- Inspection . . . 3-119

RADIATOR
- Removal/Installation . . . 3-119
- Inspection . . . 3-120

COOLING FAN . . . 3-121
COOLING AIR DUCT . . . 3-121
THERMOSTAT
- Removal/Installation . . . 3-121
- Opening Test . . . 3-122

COOLANT PUMP
- Removal/Installation . . . 3-122
- Disassembly/Inspection/Assembly . . . 3-122

OVERFLOW RESERVOIR . . . 3-123
FLYWHEEL . . . 3-123
ROCKER ARM ASSEMBLY
- Removal/Installation . . . 3-124
- Inspection . . . 3-124

CYLINDER HEAD AND VALVES
- Removal/Installation . . . 3-124
- Disassembly/Assembly . . . 3-125
- Inspection/Replacement . . . 3-125

ANALYZE VALVES . . . 3-127
RECONDITION VALVE SEATS . . . 3-128
LAP VALVES . . . 3-128
CRANKCASE COVER . . . 3-129
PISTON AND CONNECTING ROD
- Removal . . . 3-129
- Installation . . . 3-129
- Disassembly . . . 3-130
- Assembly . . . 3-131
- Inspection . . . 3-131
- Check Piston Ring End Gap . . . 3-133

ANALYZE PISTON RING WEAR . . . 3-133
ANALYZE PISTON WEAR . . . 3-134



Page

REPAIR, continued

CAMSHAFT AND TAPPETS
- Removal/Installation . . . 3-135
- Inspection . . . 3-136

CRANKSHAFT AND MAIN BEARINGS
- Removal/Installation . . . 3-136
- Inspection . . . 3-137

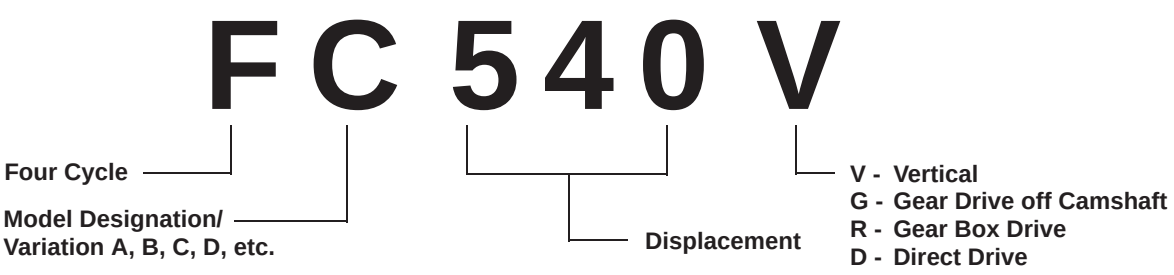
CRANKSHAFT OIL SEALS . . . 3-137
ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR . . . 3-137
CYLINDER BLOCK
- Inspection . . . 3-138
- Deglaze Cylinder Bore . . . 3-138
- Rebore Cylinder Block . . . 3-138

OIL PUMP
- Disassembly/Assembly . . . 3-139
- Inspection . . . 3-140

BREATHER . . . 3-141
GOVERNOR . . . 3-141
GOVERNOR SHAFT . . . 3-142
GOVERNOR SHAFT SEAL . . . 3-142
STATOR . . . 3-142
PULSER COILS . . . 3-142
IGNITION COILS . . . 3-143
IGNITION MODULE . . . 3-143
STARTER
- Removal/Installation . . . 3-143
- Analyze Condition . . . 3-143
- No-Load Amperage Draw and RPM Bench Tests . . . 3-144
- Disassembly/Assembly . . . 3-145
- Inspection/Test . . . 3-146

SPECIFICATIONS
ENGINE DESIGNATION

NOTE: LX172 and LX176 tractors use engine model number FC420V, LX186 tractor uses engine model number FC540V.



TEST AND ADJUSTMENT SPECIFICATIONS

SLOW Idle	
Carburetor SLOW Idle Stop Screw Setting	1450 ±75 rpm
Throttle Control Arm	
SLOW Idle Stop Screw Setting	1550 ±75 rpm
FAST Idle	3350 ±100 rpm
Cylinder Compression Pressure (Minimum)	483 kPa (71 psi)
Valve Clearance (Cold)	0.15 mm (0.006 in.)
Jam Nut Torque	20 N•m (180 lb-in.)
Valve Cover Cap Screw Torque	6 N•m (53 lb-in.)
Exhaust Valve ACR Movement (Minimum)	0.25 mm (0.010 in.)
Crankcase Vacuum (Minimum)	15 cm (6 in.) of water movement
Engine Oil Pressure (Minimum)	
FAST Idle (3350 ±100 rpm)	240 kPa (35 psi)
SLOW Idle (1550 ±75 rpm)	20.68 kPa (3 psi)
Fuel Pump Pressure (Minimum)	6.12 kPa (0.90 psi)
Fuel Pump Flow (Minimum)	
FC420V	55 mL/15 seconds (1.8 oz/15 seconds)
FC540V	65 mL/15 seconds (2.2 oz/15 seconds)
Crankshaft End Play	0.09—0.22 mm (0.004—0.009 in.)
Spark Plug Gap	0.76 mm (0.030 in.)
Spark Plug Torque	20 N•m (177 lb-in.)

REPAIR SPECIFICATIONS

Rock Arm Assembly	
Shaft O.D. (Minimum)	12.94 mm (0.509 in.)
Bearing I.D. (Maximum)	13.07 mm (0.515 in.)
Push Rod Bend (Maximum)	0.30 mm (0.012 in.)

REPAIR SPECIFICATIONS (Continued)

Cylinder Head and Valves
- Rocker Arm Cap Screw Torque . . . . . 10 N•m (89 lb-in.)
- Valve Adjustment Screw Jam Nut Torque. . . . . 20 N•m (180 lb-in.)
- Valve Cover Cap Screw Torque . . . . . 6 N•m (53 lb-in.)
- Cap Screw Torque in Sequence (Lubricated)
  - at 7 N•m (62 lb-in.) Increments
    - Initial Torque. . . . . 32 N•m (288 lb-in.)
    - Final Torque . . . . . 52 N•m (456 lb-in.)
- Spark Plug Torque . . . . . 20 N•m (177 lb-in.)
- Cylinder Head Distortion (Maximum) . . . . . 0.05 mm (0.002 in.)
- Valve Guide I.D. (Maximum)
  - FC420V . . . . . 7.015 mm (0.2762 in.)
  - FC540V . . . . . 7.07 mm (0.2780 in.)
- Valve Seating Surface . . . . . 1.10—1.46 mm (0.043—0.057 in.)
- Valve Spring Free Length (Minimum)
  - Early Model . . . . . 37.50 mm (1.476 in.)
  - Late Model. . . . . 35.50 mm (1.398 in.)
- Valve Margin (Minimum). . . . . 0.60 mm (0.024 in.)
- Valve Stem Bend (Maximum) . . . . . 0.03 mm (0.001 in.)
- Valve Guide Installation Depth
  - FC420V . . . . . 12 ±0.1 mm (0.472 ±0.004 in.)
  - FC540V . . . . . 9.5 ±0.1 mm (0.370 ±0.004 in.)
- Finished Valve Guide I.D. (Reamed) . . . . . 7.00—7.02 mm (0.275—0.276 in.)
- Valve Seat and Face Angle . . . . . 45°
- Valve Narrow Angle . . . . . 30°

Breather Air Gap . . . . . 1—2 mm (0.040—0.080 in.)

Crankcase Cover
- Oil Capacity (w/Filter) FC420V . . . . . 1.6 L (3.4 U.S. pt)
- Oil Capacity (w/Filter) FC540V . . . . . 1.9 L (4.0 U.S. pt)
- Mounting Cap Screw Torque . . . . . 26 N•m (230 lb-in.)

Piston Assembly
- Piston Ring Groove Side Clearance (Maximum)
  - Top Ring . . . . . 0.17 mm (0.007 in.)
  - Second Ring . . . . . 0.15 mm (0.006 in.)
  - Oil Ring . . . . . 0.20 mm (0.008 in.)
- Pin O.D. (Minimum)
  - Early Model . . . . . 21.98 mm (0.865 in.)
  - Late Model. . . . . 18.975 mm (0.747 in.)
- Pin Bore I.D. (Maximum)
  - Early Model . . . . . 22.04 mm (0.868 in.)
  - Late Model. . . . . 19.042 mm (0.7497 in.)
- Piston O.D.
  - Standard Piston. . . . . 88.83—88.864 mm (3.4885—3.4984 in.)
  - Oversize Piston 0.50 mm (0.020 in.) . . . . . 89.330—89.364 mm (3.517—3.518 in.)
- Cylinder Bore I.D.
  - Standard Size Bore
    - Standard. . . . . 88.98—89.00 mm (3.5031—3.5039 in.)
    - Wear Limit (Maximum) . . . . . 89.076 mm (3.5069 in.)
  - Oversize Bore—0.50 mm (0.020 in.)
    - Standard. . . . . 89.48—89.50 mm (3.5228—3.5236 in.)
    - Wear Limit (Maximum) . . . . . 89.576 mm (3.5266 in.)

REPAIR SPECIFICATIONS (Continued)

- Piston Assembly (Continued)
  - Piston-To-Cylinder Bore Clearance . . . . . 0.011—0.151 mm (0.0043—0.0059 in.)
  - Connecting Rod
    - Connecting Rod Cap Screw Torque . . . . . 20 N•m (177 lb-in.)
    - Crankshaft Bearing I.D. (Maximum)
      - Standard . . . . . 41.07 mm (1.617 in.)
      - Undersized . . . . . 40.56 mm (1.597 in.)
    - Piston Pin Bearing I.D. (Maximum)
      - Early Models . . . . . 22.06 mm (0.869 in.)
      - Late Models . . . . . 19.051 mm (0.750 in.)
  - Piston Rings
    - Ring Thickness—Top and Second Rings (Minimum) . . . . . 1.94 mm (0.076 in.)
    - Ring End Gap (Minimum) . . . . . 0.18 mm (0.007 in.)
    - Ring End Gap (Maximum)
      - Compression Rings—Top and Second
        - Early Model . . . . . 0.90 mm (0.035 in.)
        - Late Model . . . . . 1.50 mm (0.059 in.)
      - Oil Ring Side Rails . . . . . 1.30 mm (0.051 in.)
- Camshaft
  - End Journal O.D.—Cylinder Block (Minimum)
    - FC420V . . . . . 19.912 mm (0.7839 in.)
    - FC540V . . . . . 20.912 mm (0.8233 in.)
  - End Journal O.D.—Crankcase Cover (Minimum)
    - FC420V . . . . . 20.912 mm (0.8233 in.)
    - FC540V . . . . . 20.912 mm (0.8233 in.)
  - Lobe Height (Minimum)
    - FC420V . . . . . 36.75 mm (1.446 in.)
    - FC540V . . . . . 37.10 mm (1.461 in.)
  - Bearing I.D.—Cylinder Block (Maximum)
    - FC420V . . . . . 20.076 mm (0.7904 in.)
    - FC540V . . . . . 21.076 mm (0.8298 in.)
  - Bearing I.D.—Crankcase Cover (Maximum)
    - FC420V . . . . . 21.076 mm (0.8298 in.)
    - FC540V . . . . . 21.076 mm (0.8298 in.)
  - ACR Tappet Lift (Minimum) . . . . . 0.6 mm (0.024 in.)
  - ACR Disengagement . . . . . 600–900 rpm
- Reciprocating Balancer
  - Support Shaft Nut Torque . . . . . 7 N•m (65 lb-in.)
  - Link Rod
    - Journal O.D.—On Crankshaft (Minimum)
      - FC420V . . . . . 53.950 mm (2.1240 in.)
      - FC540V . . . . . 57.941 mm (2.2811 in.)
    - Small End I.D. (Maximum) . . . . . 12.601 mm (0.4961 in.)
    - Large End I.D. (Maximum)
      - FC420V . . . . . 54.121 mm (2.1307 in.)
      - FC540V . . . . . 58.153 mm (2.2895 in.)
    - Bearing Installation Depth Below Surface (Both Ends) . . . . . 1.0 mm (0.0394 in.)
  - Balancer Weight
    - Bearing I.D. (Maximum) . . . . . 26.097 mm (1.0274 in.)
    - Bearing Installation Depth (Below Surface) . . . . . 0.50 mm (0.0197 in.)
  - Support Shaft
    - Shaft O.D. (Minimum) . . . . . 25.927 (1.0208 in.)

REPAIR SPECIFICATIONS (Continued)

- Crankshaft
  - Total Indicated Runout (TIR) . . . . . 0.05 mm (0.002 in.)
  - Main Bearing Journal O.D.—Crankcase Cover Side (Minimum)
    - FC420V . . . . . 34.919 mm (1.3747 in.)
    - FC540V . . . . . 37.904 mm (1.4923 in.)
  - Main Bearing Journal O.D.—Cylinder Block Side (Minimum)
    - Both Engines . . . . . 34.945 mm (1.3757 in.)
  - Connecting Rod Journal O.D. (Minimum)
    - Standard . . . . . 40.928 mm (1.6113 in.)
    - Undersized . . . . . 40.47—40.48 mm (1.5932—1.5937 in.)
  - Crankcase Cover Crankshaft Bearing I.D. (Maximum)
    - FC420V . . . . . 35.069 mm (1.3807 in.)
    - FC540V . . . . . 38.056 mm (1.4983 in.)
  - Oil Seal Installation Depth
    - Both Sides/Both Engines . . . . . .flush with surface
- Oil Pump
  - Rotor Shaft O.D. (Minimum)
    - FC420V (Large O.D.) . . . . . 12.627 mm (0.4971 in.)
    - FC420V (Small O.D.) . . . . . 7.935 mm (0.3125 in.)
    - FC540V . . . . . 12.627 mm (0.4971 in.)
  - Rotor Shaft Bearing I.D. (Maximum)
    - FC420V (Oil Pump Cover) . . . . . 12.76 mm (0.5024 in.)
    - FC420V (Crankcase Cover) . . . . . 8.07 mm (0.3177 in.)
    - FC540V . . . . . 12.76 mm (0.5023 in.)
  - Outer Rotor
    - FC420V
      - Minimum Thickness . . . . . 11.92 mm (0.4692 in.)
      - Minimum O.D. . . . . 28.95 mm (1.1397 in.)
    - FC540V
      - Minimum Thickness . . . . . 9.92 mm (0.3905 in.)
      - Minimum O.D. . . . . 40.47 mm (1.5933 in.)
  - Outer Rotor Bearing Housing
    - FC420V
      - Maximum Depth . . . . . 12.14 mm (0.4779 in.)
      - Maximum I.D. . . . . 29.20 mm (1.1496 in.)
    - FC540V
      - Maximum Depth . . . . . 10.17 mm (0.4003 in.)
      - Maximum I.D. . . . . 40.77 mm (1.6051 in.)
  - Relief Valve Spring Free Length (Minimum) . . . . . 19.00 mm (0.7480 in.)
- Governor
  - Governor Mounting Shaft Height . . . . . 32.2—32.8 mm (1.267—1.291 in.)
  - Governor Lever Nut Torque . . . . . 7.8 N•m (69 lb-in.)
- Engine Mounting Cap Screw Torque . . . . . 34 N•m (300 lb-in.)
- Blower Housing To Flywheel Screen Gap (Minimum) . . . . . 1.5 mm (0.059 in.)
- Flywheel Screen To Cooling Fan Cap Screw Torque . . . . . 6 N•m (53 lb-in.)
- Cooling Fan To Flywheel Cap Screw Torque . . . . . 10 N•m (89 lb-in.)
- Flywheel Mounting Nut Torque
  - FC420V . . . . . 137 N•m (101 lb-ft)
  - FC540V . . . . . 172 N•m (127 lb-ft)
- Oil Drain Plug Torque . . . . . 23 N•m (200 lb-in.)

REPAIR SPECIFICATIONS (Continued)

Stator
- Cap Screw Torque . . . . . 6 N•m (53 lb-in.)

Ignitor Module
- FC420V-DS15 (FC420V —FC420VB50632)
- FC540V-DS15 (FC540V —FC540VA00384)
  - No Specifications. . . . . replace with known good ignitor module

Magneto Ignition Coil
- FC420V-DS10 (FC420V —FC420VB50632)
- FC540V-DS15 (FC540V —FC540VA00384)
  - Resistance Between Primary Lead and Core . . . . . 0.48—0.72 ohms
  - Resistance Between Plug Cap and Core . . . . . 10.9—16.3 K ohms
  - Air Gap . . . . . 0.30 mm (0.012 in.)
  - Cap Screw Torque. . . . . 6 N•m (53 lb-in.)

Magneto Ignition Coil With Ignitor Module
- FC420V-DS10 (FC420VB50633—)
- FC540V-DS15 (FC540VA00385—)
  - Resistance Between Primary Lead and Core . . . . . 0.48—0.72 ohms
  - Resistance Between Plug Cap and Core . . . . . 8.7—13.1 K ohms
  - Air Gap . . . . . 0.30 mm (0.012 in.)
  - Cap Screw Torque. . . . . 6 N•m (53 lb-in.)

Starter
- Maximum Amperage (No Load) . . . . . 50 amps at 6000 rpm
- Minimum Starter Brush Length
  - FC420V . . . . . 6 mm (0.240 in.)
  - FC540V . . . . . 10.5 mm (0.413 in.)
- Starter-To-Engine Mounting Cap Screw Torque . . . . . 16 N•m (140 lb-in.)

SPECIAL OR ESSENTIAL TOOLS

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

JT07270 Digital PulseTachometer
Used to check SLOW and FAST idle speeds and starter performance.

JDM59 Compression Gauge
Used to check engine compression.

JT05697 Manometer Kit
Contains #5 plug and the following:

- JT05703 Barb Fitting
  Used to connect U-tube manometer to engine for Crankcase Vacuum Test.
- JT05699 Line
  Used to connect U-tube manometer to engine for Crankcase Vacuum Test.
- JT05698 U-Tube Manometer
  Used to check crankshaft vacuum.

JT03503 Crankcase Vacuum Test Kit
Used to check crankcase vacuum.

JT05698 90° Elbow Fitting
Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.

JT03344 Pressure Gauge Assembly
Used to read engine oil pressure when performing Engine Oil Pressure Test.

JT03017 Hose Assembly
Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.

JDG356 Pressure Gauge
Used to check fuel pump performance.

D-05351ST Spark Tester
Used to check overall condition of ignition system.

JDM70 Valve Spring Compressor
Used to remove and install valve springs.

JDG504 Valve Guide Driver Tool
Used to replace valve guide bushings.

JT05712 Current Gun
Used to check starter performance.

OTHER MATERIALS

Number	Name	Use
M79292	MPG-2® Multipurpose Polymer Grease	Apply to engine crankshaft.
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol (or Kerosene)	Finish ream valve guides.
	Prussian Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	Mineral Spirits	Clean armature.
LOCTITE® PRODUCTS U.S./ Canadian/ LOCTITE No.		
TY9375/TY9480/592	Pipe Sealant with TEFLON®	Apply to threads of oil pressure switch.

SERVICE PARTS KITS

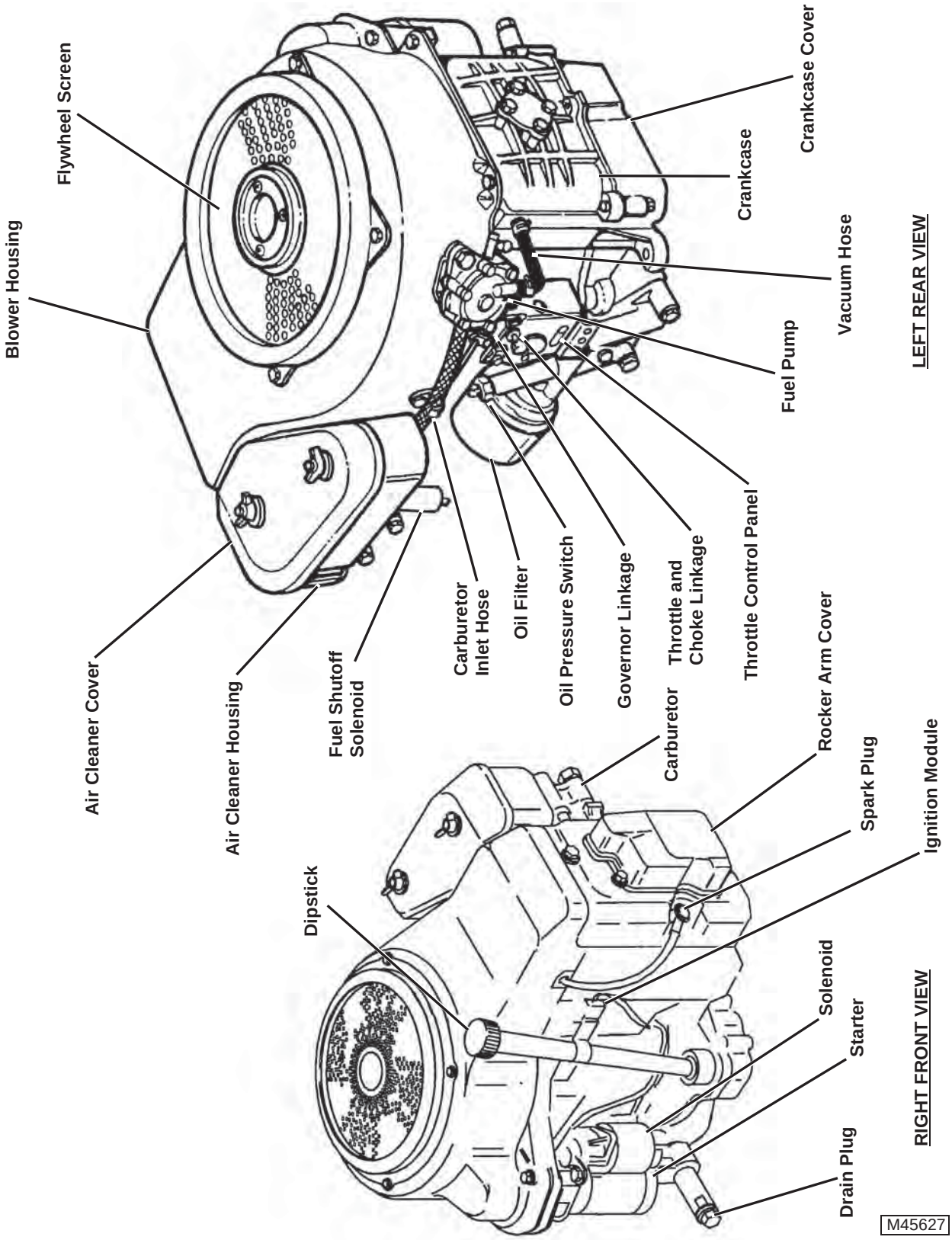
The following kits are available through your parts catalog:

- Fuel Pump Gasket Kit
- Carburetor
- Gasket Kit
- Vent Kit
- Jet Kit
- Choke Shaft Kit
- Throttle Shaft Kit
- Breather Valve Kit
- Air Cleaner Assembly
- Blower Housing Engine Cover Kit
- Flywheel Screen and Spacer Kit
- Dipstick Tube Kit
- Rocker Arm and Shaft Kit
- Intake Valve Kit
- Exhaust Valve Kit
- Camshaft and Tappet Kit
- Camshaft Axial Play Shim Kit
- Piston Ring Kit
- Oversized Piston
- Oversized Piston Ring Kit
- Undersized Connecting Rod
- Crankshaft End Play Shim Kit
- Cylinder Block
- Overhaul Gasket Kit
- Short Block Kit
- Oil Pump Kit
- Governor and Shaft Kit

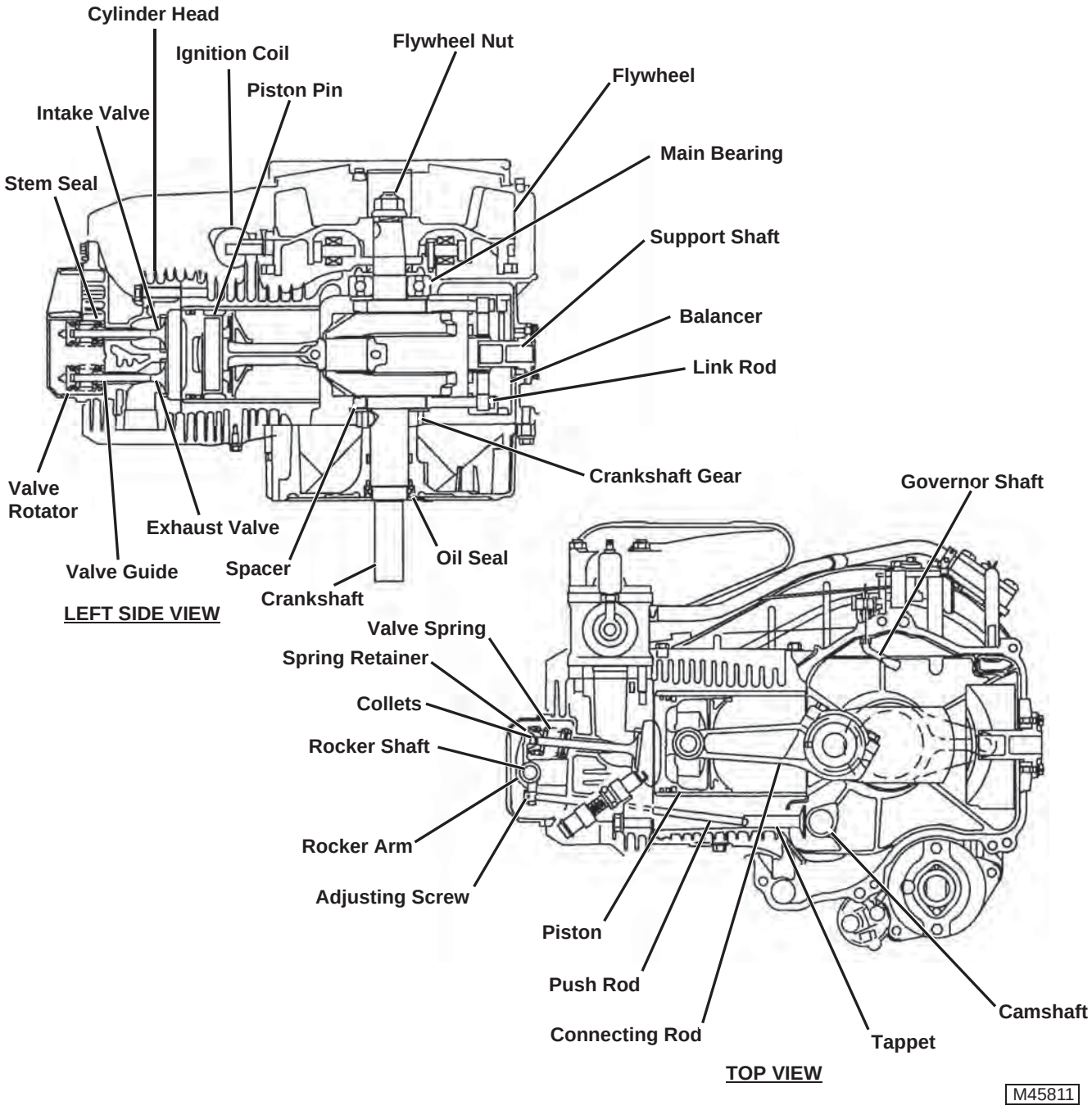
MPG-2® is a registered trademark of DuBois USA.
LOCTITE® is a registered trademark of the Loctite Corp.
SCOTCH-BRITE® is a registered trademark of the 3M Co.

COMPONENT LOCATION

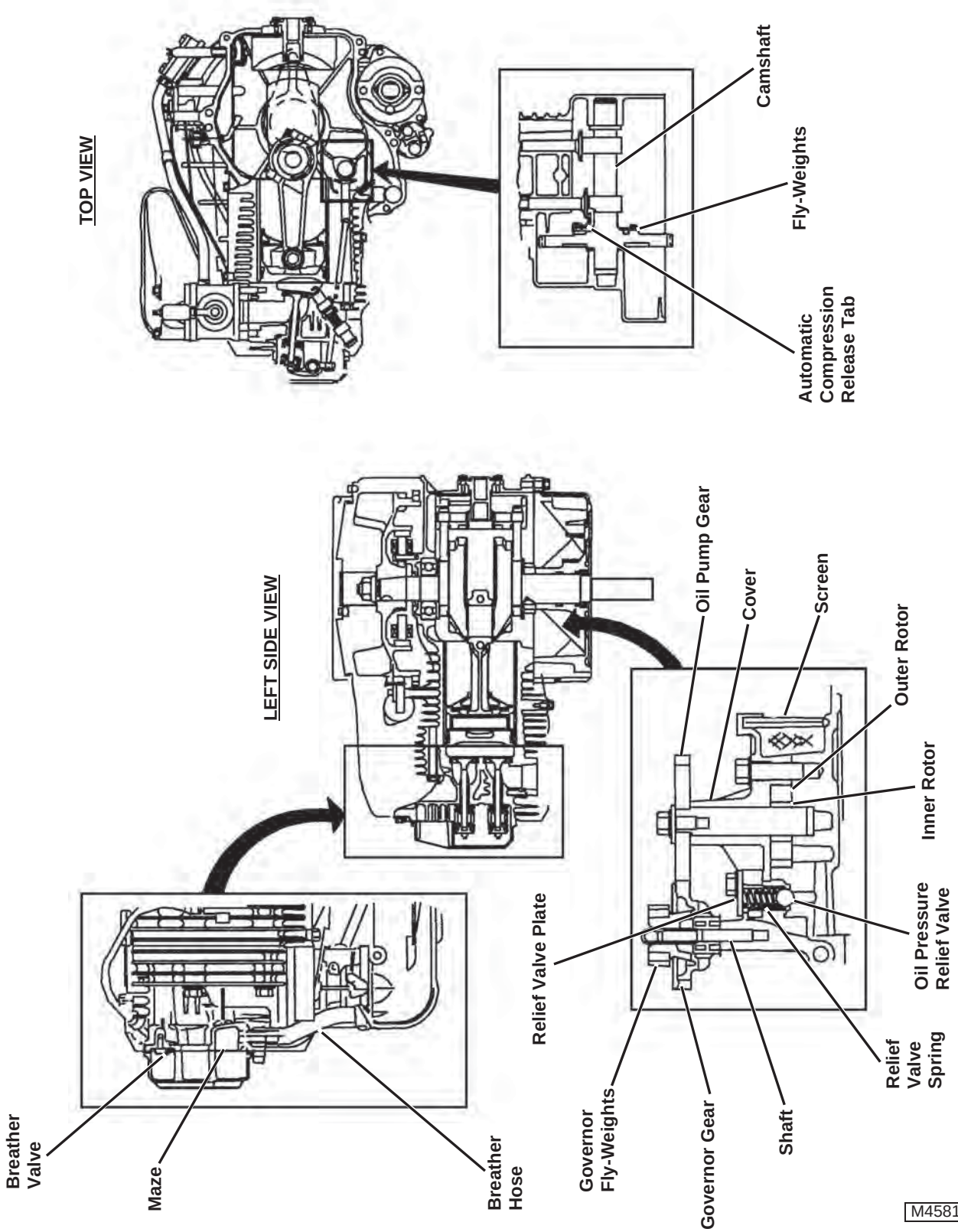
EXTERNAL ENGINE COMPONENTS



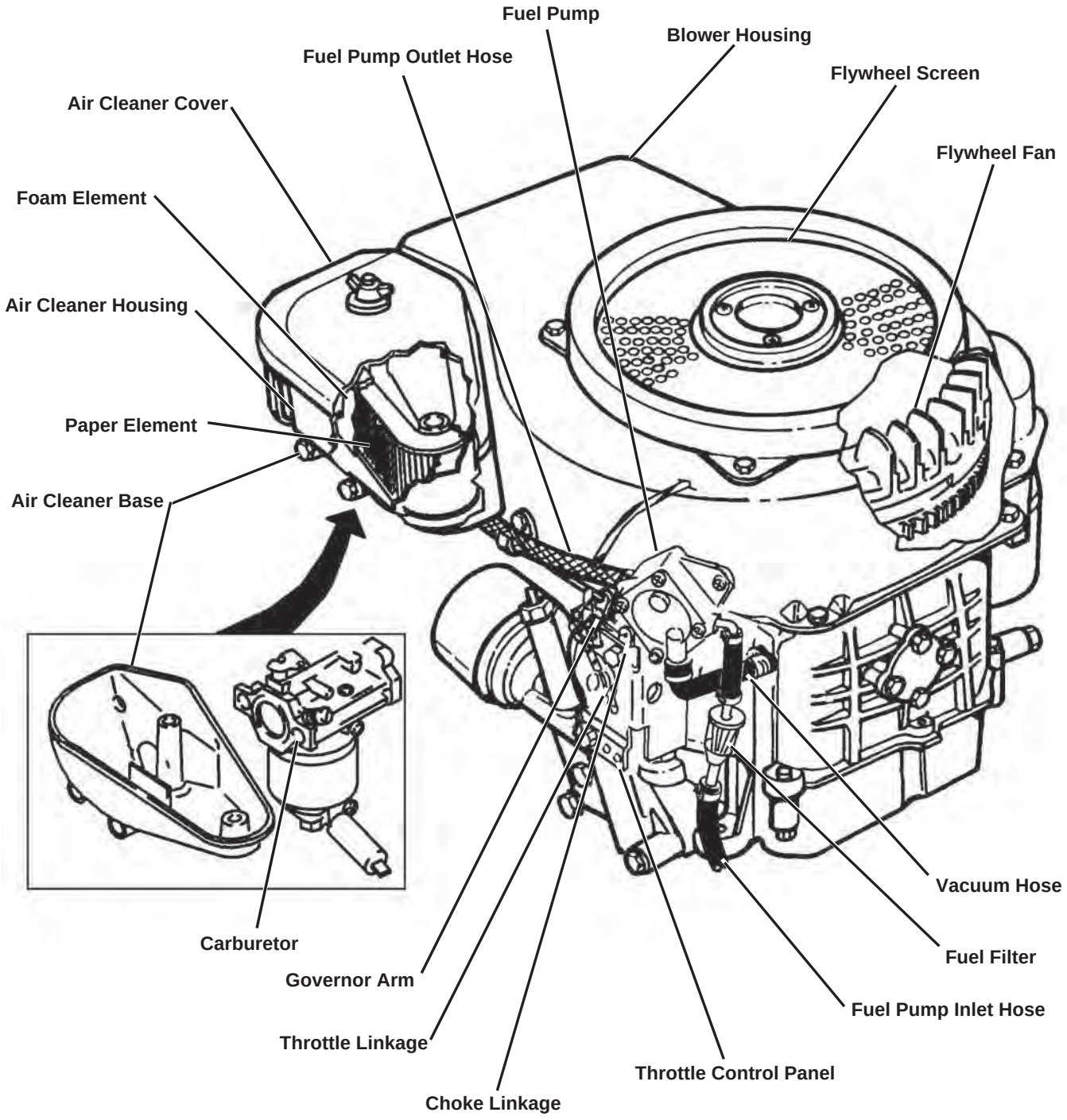
INTERNAL ENGINE COMPONENTS



OIL PUMP BREATHER AND COMPRESSION RELEASE COMPONENTS



FUEL/AIR SYSTEM COMPONENTS



LEFT REAR VIEW

M45665

THEORY OF OPERATION

LUBRICATION SYSTEM OPERATION

Function:

To provide pressurized oil to lubricate internal engine components.

Theory of Operation:

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

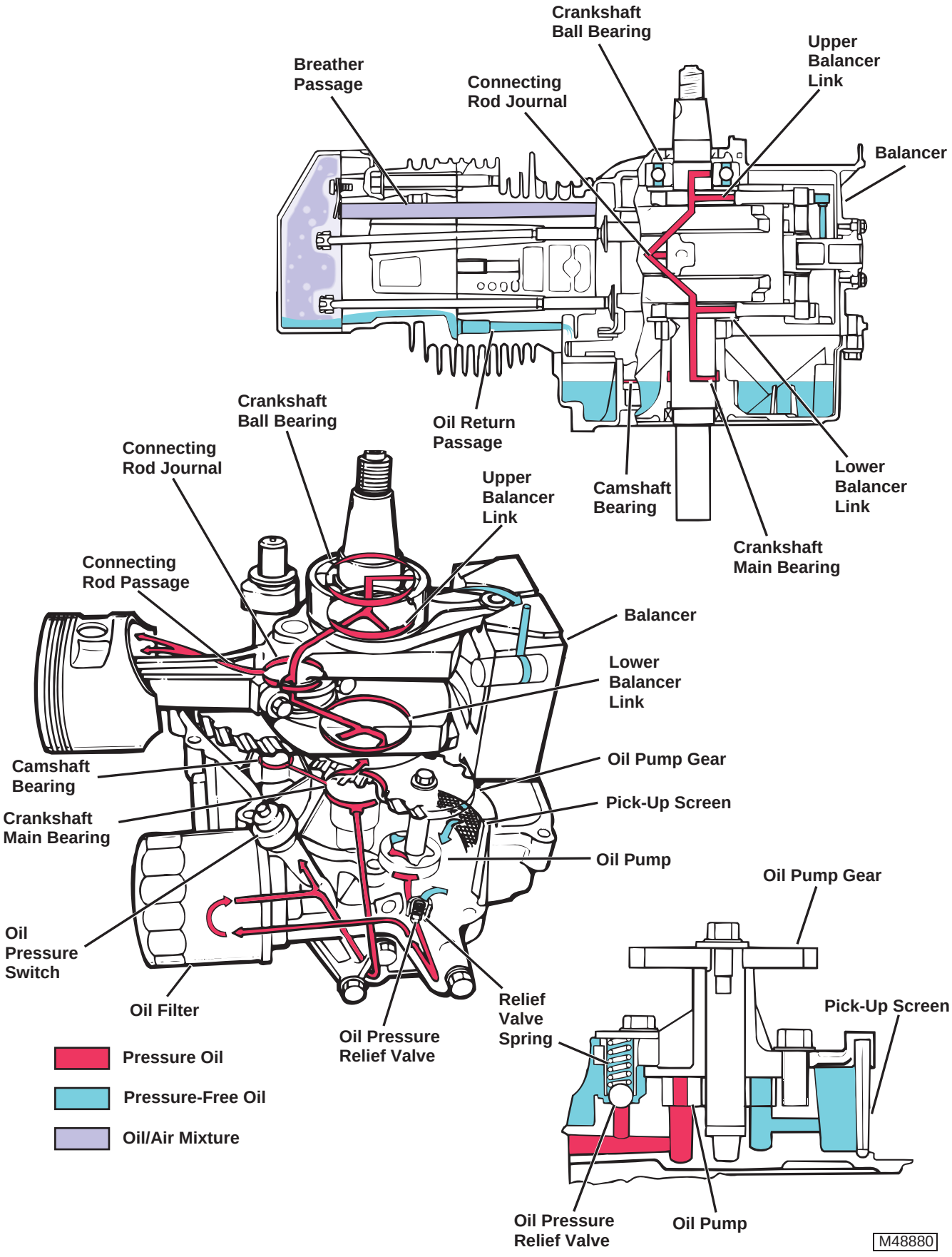
The oil pump draws oil from the sump through the pick-up screen. Pressure oil from the pump flows through the pump outlet passage past the oil pressure relief valve. The oil pressure relief valve limits the oil pressure to approximately 296 kPa (43 psi) and protects the oil pump from damage if an oil passage becomes blocked. If oil pressure exceeds 296 kPa (43 psi), the relief valve opens allowing oil to return to sump. Relief valve is not adjustable.

Pressure oil from the relief valve flows to the oil filter. The filter contains a bypass valve which opens if the element becomes plugged to ensure engine lubrication.

An oil pressure switch mounted in the oil filter manifold turns on a warning light if oil pressure is below 28 kPa (4 psi). Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (PTO side) and then to the camshaft bearing. Drilled passages in the crankshaft distribute oil from the main bearings to the lower balancer link, connecting rod journal, upper balancer link, and crankshaft ball bearing (flywheel side). A drilled passage in the connecting rods allow oil from the connecting rod journal to lubricate the piston and cylinder walls.

Pressure-free oil flowing out of the crankshaft ball bearing or upper balancer link also lubricates the balancer. A drilled passage in the top of the balancer allows oil to flow to the support shaft and balancer bushing.

The rocker arms, valves, and pushrods are lubricated by an oil/air mixture and carried to the rocker arm cover through the breather passage. The breather passage is located directly above the upper pushrod. The oil from the oil/air mixture is separated from the air through the breather maze and flows to the bottom of the cylinder head. This oil drains back to the sump through an oil return passage located in the bottom of the cylinder block directly under the lower pushrod.


Crankshaft Ball Bearing
Upper Balancer Link
Breather Passage
Connecting Rod Journal
Balancer
Oil Return Passage
Crankshaft Ball Bearing
Connecting Rod Journal
Upper Balancer Link
Camshaft Bearing
Lower Balancer Link
Crankshaft Main Bearing
Connecting Rod Passage
Balancer
Lower Balancer Link
Camshaft Bearing
Oil Pump Gear
Crankshaft Main Bearing
Pick-Up Screen
Oil Pump
Oil Pressure Switch
Oil Filter
Relief Valve Spring
Oil Pressure Relief Valve
Oil Pump Gear
Pick-Up Screen
Oil Pressure Relief Valve
Oil Pump
Pressure Oil
Pressure-Free Oil
Oil/Air Mixture
M48880

COOLING SYSTEM OPERATION

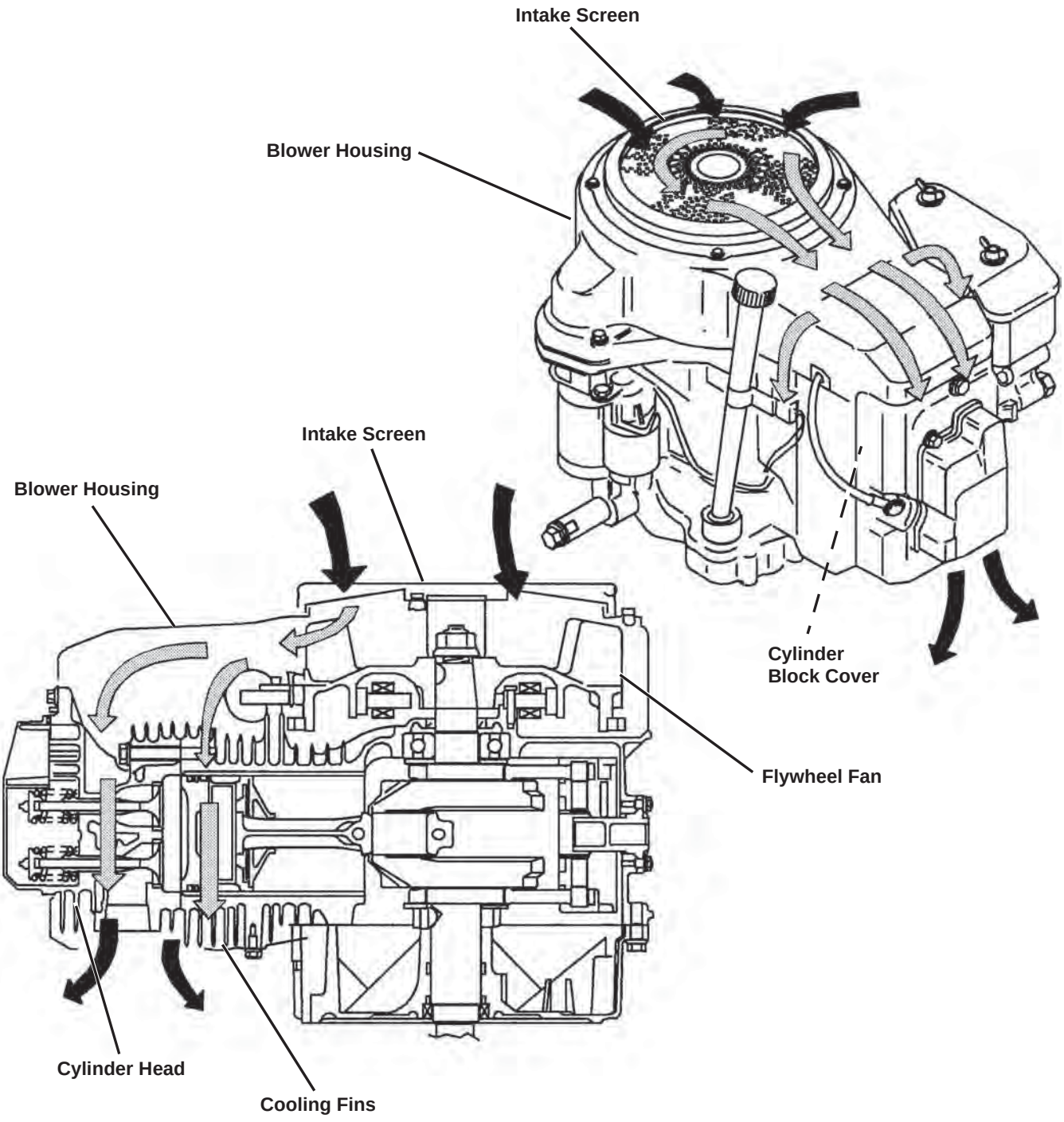
Function:

Remove heat from engine.

Theory of Operation:

The engine is air-cooled with air flow provided by a fan that is part of the flywheel. During operation, the fan draws air in through the intake screen. The intake screen rotates and cuts debris into small pieces to help prevent the cooling fins from plugging. The blower housing and cylinder block covers then direct the air flow past the cooling fins of the cylinder block and head. Most of the cooling air flows directly over the valve area. This increased cooling capacity in the valve area helps to minimize valve sticking and seat wear due to overheating. The cooling fins are cast into the engine block and cylinder head to increase their surface area to allow more of the heat generated by the engine to be transferred to the cooling air.

It is important that the intake screen remains free of debris for proper air flow. The engine covers should not be removed or altered, as cooling capacity will be reduced. Cylinder block and head cooling fins must remain clean to properly dissipate heat. Debris build-up on the intake screen or fins will affect the volume of air to the carburetor.


Intake Screen
Blower Housing
Intake Screen
Blower Housing
Cylinder
Block Cover
Flywheel Fan
Cylinder Head
Cooling Fins
M45628

TROUBLESHOOTING

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART

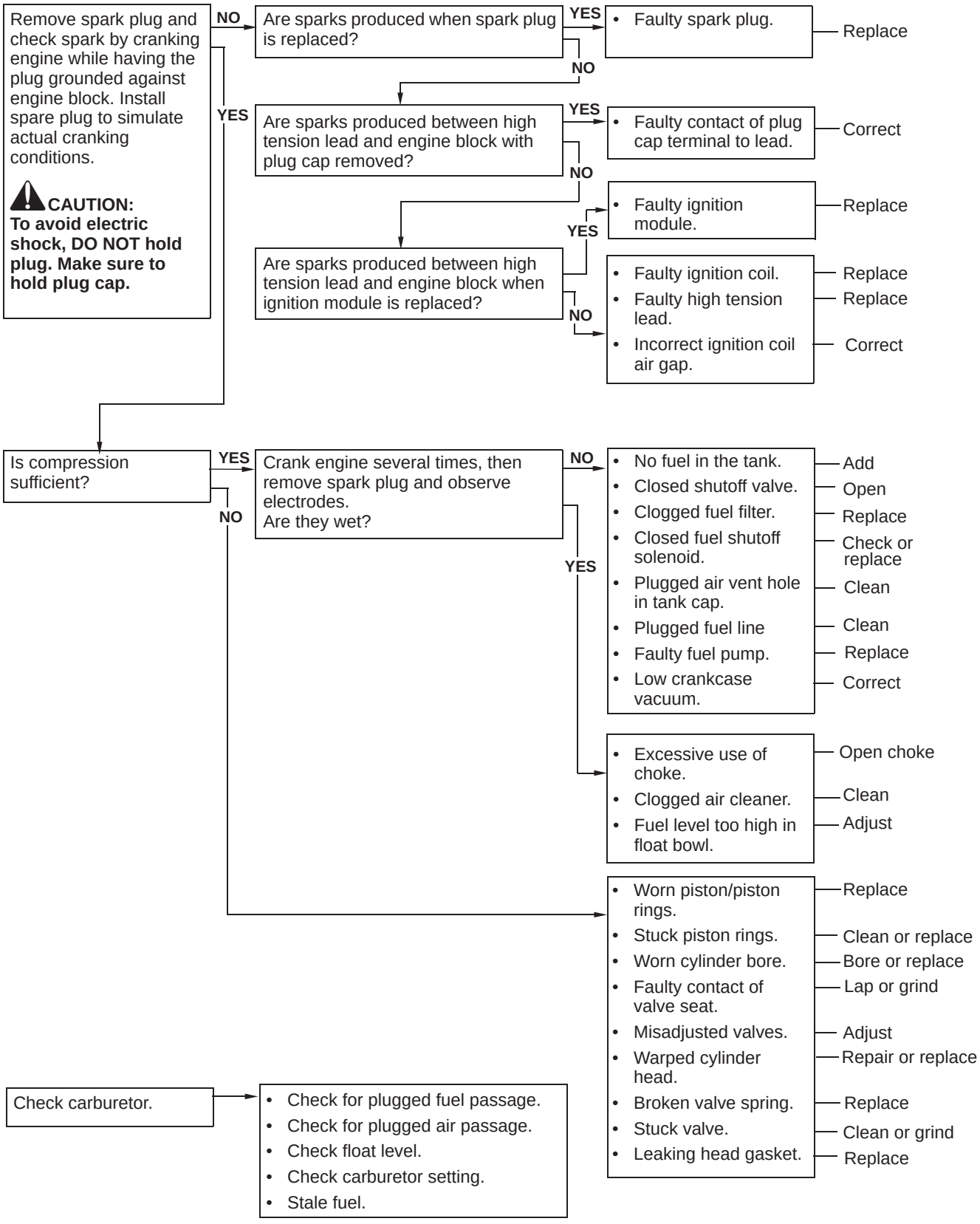
PROBLEM OR SYMPTOM / CHECK OR SOLUTION	Engine cranks but will not start or starts hard	Engine will not stay running, runs rough, or irratically	Engine dies frequently	Engine backfires (afterbang)	Engine surges, or has uneven or uncontrolled rpm	Engine has low power	Engine has no spark	Engine will not crank	Lack of fuel in carburetor	Engine floods	Exhaust smoke black or uses too much fuel	Exhaust smoke blue or has excessive oil consumption	Engine has low oil pressure	Fuel in oil	Engine overheats	Excessive engine noise or vibration
Spark plug fouled, defective, or gap not correct. Incorrect spark plug	●	●				●	●			●	●			●	●	
Defective ignition components	●	●	●	●	●	●	●			●	●			●		
Starter worn. Cranking rpm too slow	●							●								
Fuel filter or line restricted. Fuel pump weak, restricted, or leaking. Fuel stale, contains water, or wrong type	●	●	●	●	●	●			●		●	●				
Fuel pump not operating	●	●							●							
Air filter element(s) plugged, oil soaked, or restricted	●	●			●	●				●	●			●		
Choke, throttle, or governor linkage misadjusted. Carburetor misadjusted	●	●	●	●	●	●			●	●	●			●		
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets	●	●	●	●	●	●			●					●		
Carburetor, intake & exhaust manifold, or cylinder head gaskets leaking or damaged	●	●		●	●	●										●
Low compression from worn piston, rings, cylinder, valves or warped head	●	●				●						●		●		●

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART, continued

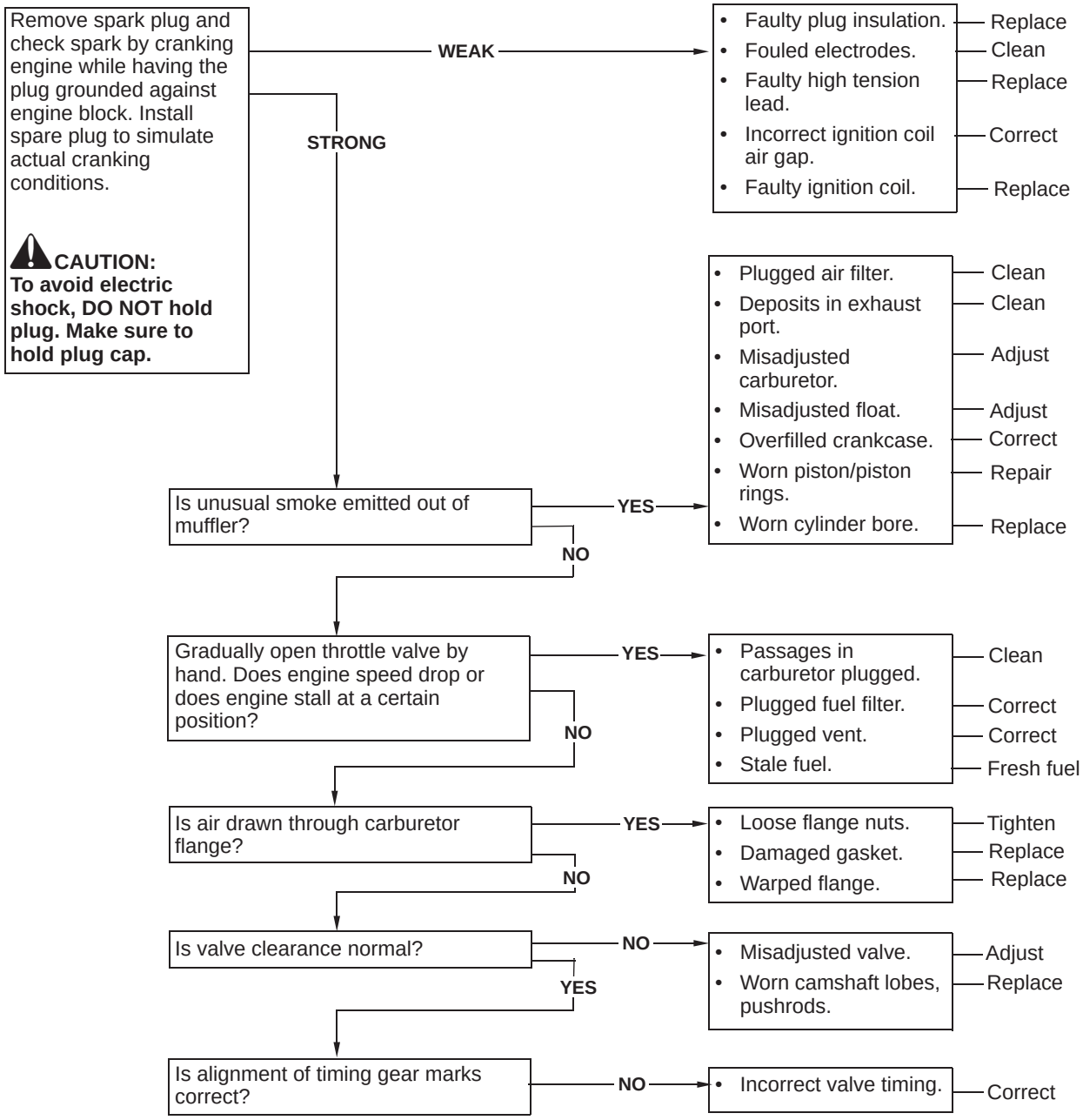
PROBLEM OR SYMPTOM / CHECK OR SOLUTION	Engine cranks but will not start or starts hard	Engine will not stay running, runs rough, or irratically	Engine dies frequently	Engine backfires (afterbang)	Engine surges, or has uneven or uncontrolled rpm	Engine has low power	Engine has no spark	Engine will not crank	Lack of fuel in carburetor	Engine floods	Exhaust smoke black or uses too much fuel	Exhaust smoke blue or has excessive oil consumption	Engine has low oil pressure	Fuel in oil	Engine overheats	Excessive engine noise or vibration
Valve clearance incorrect. Burned or warped valves and seats. Defective springs. Defective ACR.	●	●		●		●										●
Engine oil viscosity or level incorrect. Engine oil filter restricted												●	●		●	●
Engine gaskets or seals leaking	●	●		●	●	●						●	●			
Crankcase breather restricted, reed valve damaged, clearance incorrect, or drain hole plugged		●			●	●						●				
Valve guides or seals worn or leaking. Valve stems worn						●						●				
Worn, stuck, or broken piston rings. Cylinder bore worn. Check compression and vacuum	●	●				●						●				
Connecting rod or crankshaft bearings worn. Internal wear limits out of specification						●							●		●	●
Battery cables corroded or loose, or battery weak		●	●				●	●								
Clogged cooling fins or air intake screen															●	

ENGINE TROUBLESHOOTING GUIDE

Engine Hard To Start or Will Not Start



Engine Malfunctions at Low Speed



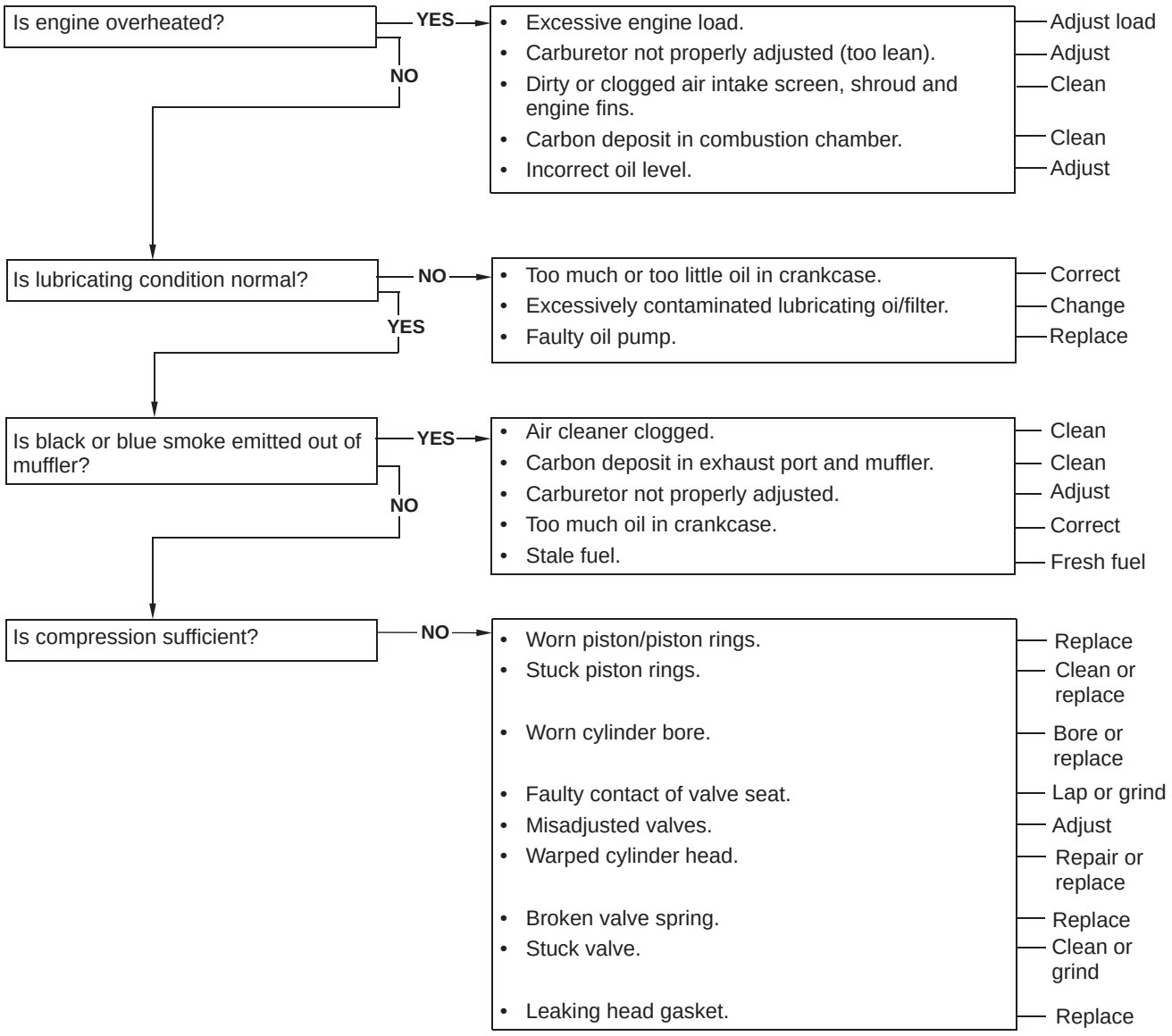
Engine Runs Erratically

Problem in fuel system (lack of fuel).	• Dust or water in fuel line or fuel filter.	Clean
	• Air or vapor lock in fuel line.	Remove
	• Plugged air vent in fuel tank cap.	Clean
	• Plugged air/fuel passages in carburetor.	Clean
	• Too little opening of carburetor pilot air-screw.	Correct
	• Stale fuel.	Fresh fuel
Problem in governor system.	• Incorrect governor linkage adjustment.	Correct
	• Faulty governor spring.	Replace
	• Governor gear assembly malfunction.	Check
Engine knocks.	• Stale fuel.	Fresh fuel
	• Excessive carbon deposit in engine.	Clean
	• Excessive engine load.	Adjust
	• Engine overheating.	See **Has Low Power**

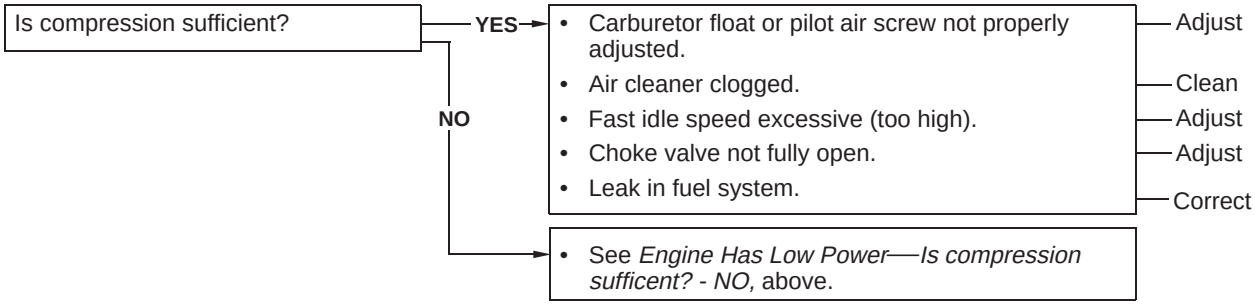
Oil Consumption Is Excessive

Is compression sufficient? **YES**	• Plugged oil ring groove.	Clean
	• High oil level.	Adjust
	• Worn valve stems and valve guides.	Replace
	• Oil leakage along governor shaft.	Replace
	• Oil seals leaking.	Replace
	• Head gasket leaking.	Replace
	• Drain plug leaking.	Retighten or replace
	• Breather valve clogged.	Clean
	• Drain-back hole in tappet chamber plugged.	Clean
	• Incorrect oil viscosity.	Change
NO	• Worn piston/piston rings.	Replace
	• Stuck piston rings.	Clean or replace
	• Worn cylinder bore.	Bore or replace
	• Faulty contact of valve seat.	Lap or grind
	• Misadjusted valves.	Adjust
	• Warped cylinder head.	Repair or replace
	• Broken valve spring.	Replace
	• Stuck valve.	Clean or grind
	• Leaking head gasket.	Replace

Engine Has Low Power



Fuel Consumption Is Excessive



STARTER MOTOR TROUBLESHOOTING GUIDE

1.Disconnect spark plug cap, and ground the cap terminal.

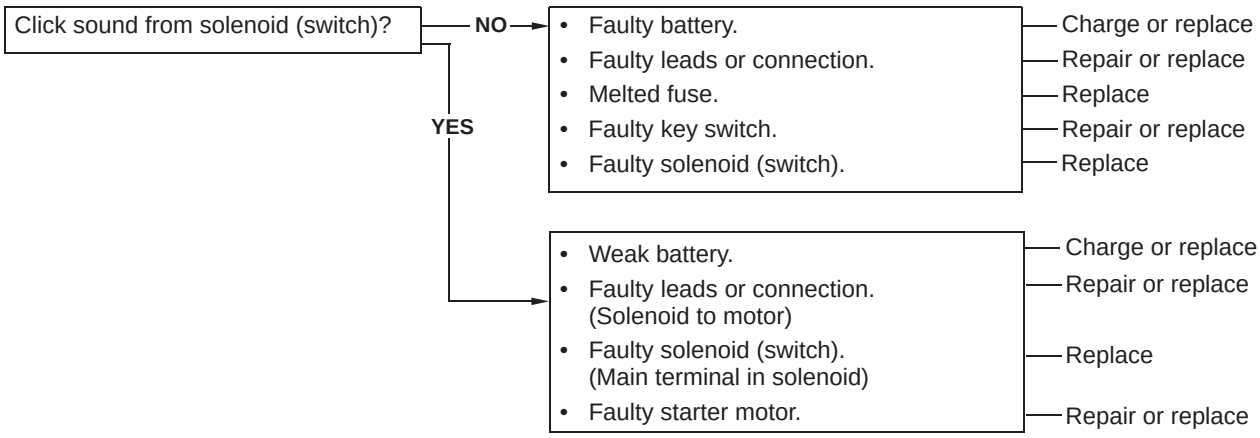
2.Turn key switch to “START” position and check condition.

⚠ CAUTION

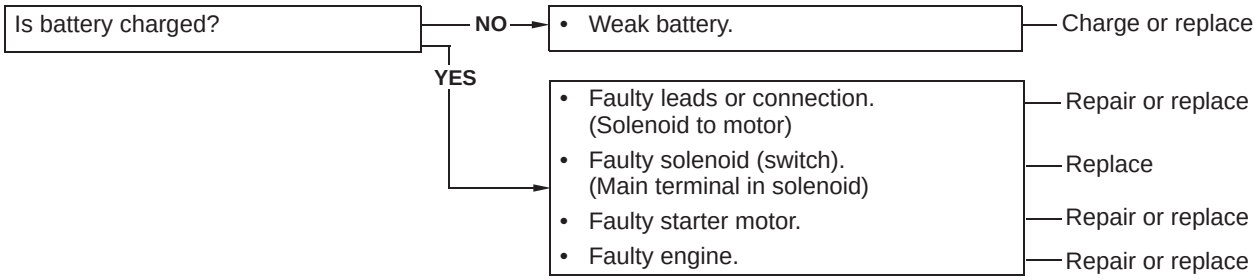
Engine may be cranked in this test. DO NOT touch any rotating parts of engine and equipment during test.

IMPORTANT: If starter does not stop when key switch is in off position, disconnect negative (-) lead from battery as soon as possible.

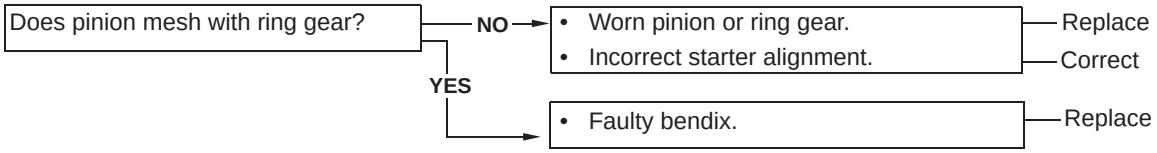
Starter Does Not Rotate



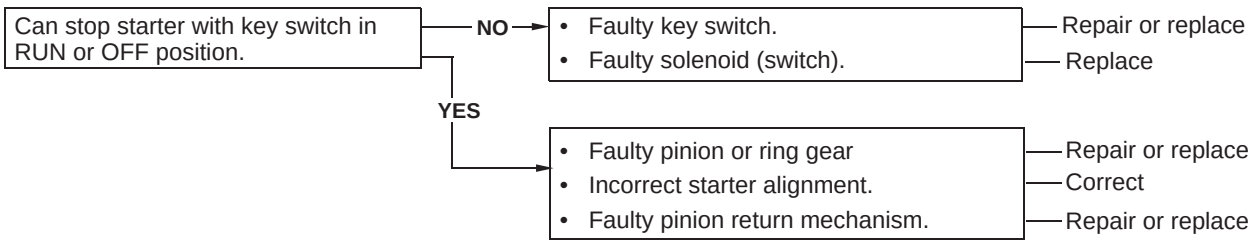
Starter Rotates Slowly



Starter Rotates But Can Not Crank Engine



Starter Does Not Stop With Key Switch In RUN or OFF Position



TESTS AND ADJUSTMENTS

THROTTLE CABLE TEST AND ADJUSTMENT

Reason:

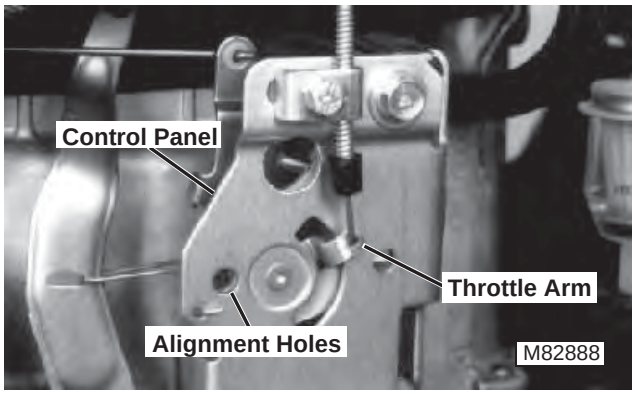
To make sure the throttle control lever obtains the full range of motion from SLOW idle, to FAST idle, and into FULL CHOKE position at the throttle control panel.

Equipment:

- 6 mm (15/64 in.) Drill Bit or
- 6 x 30 mm Flat Head Pin (45M7036)

Test Procedure:

1. Move throttle control lever from SLOW idle to FAST idle position. A solid "detent" should be felt to assure that the control lever is in the FAST idle position.



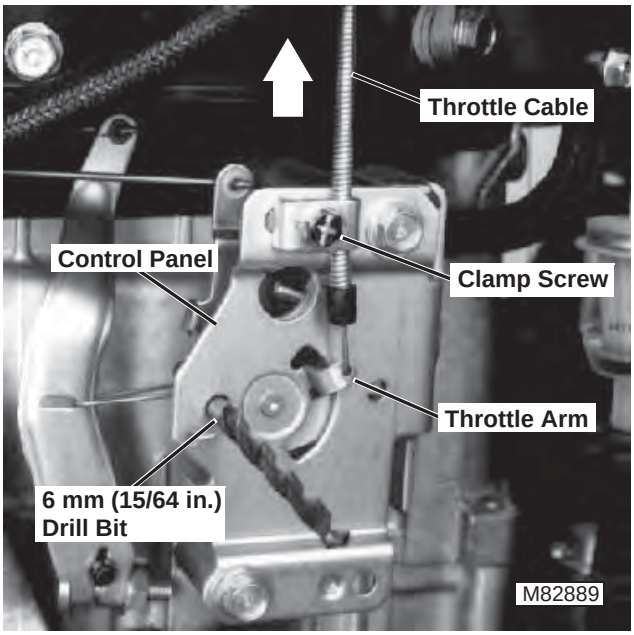
2. Check alignment holes in control panel and throttle arm. They MUST be in visual alignment.
3. Move throttle control lever into CHOKE position, then back into FAST idle position. Again, holes in control panel and throttle arm MUST be aligned.

Results:

- If holes align in FAST idle position, throttle cable is adjusted properly. Test and adjust choke plate. (See CHOKE PLATE TEST AND ADJUSTMENT.
- If holes DO NOT align in FAST idle position, perform following Adjustment Procedure.

Adjustment Procedure:

1. Move throttle control lever to FAST idle position.



2. Loosen clamp screw.
3. Align hole in throttle arm with hole in control panel. Insert a 6 mm (15/64 in.) drill bit or 6 x 30 mm flat head pin (45M7036) through holes to keep throttle arm from moving. Be sure drill bit or flat head pin is perpendicular to the control panel.
4. Pull throttle cable up (arrow) and tighten screw.
5. Remove drill bit.
6. Repeat test procedure.
7. Move throttle control lever through full range several times to be sure linkage is not binding.

CHOKE PLATE TEST AND ADJUSTMENT

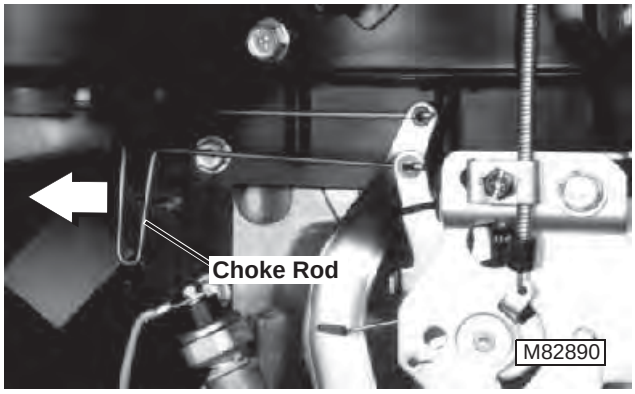
Reason:

To make sure that the choke plate is fully closed when the throttle control lever is in the FULL CHOKE position and completely opens choke plate at FAST idle position.

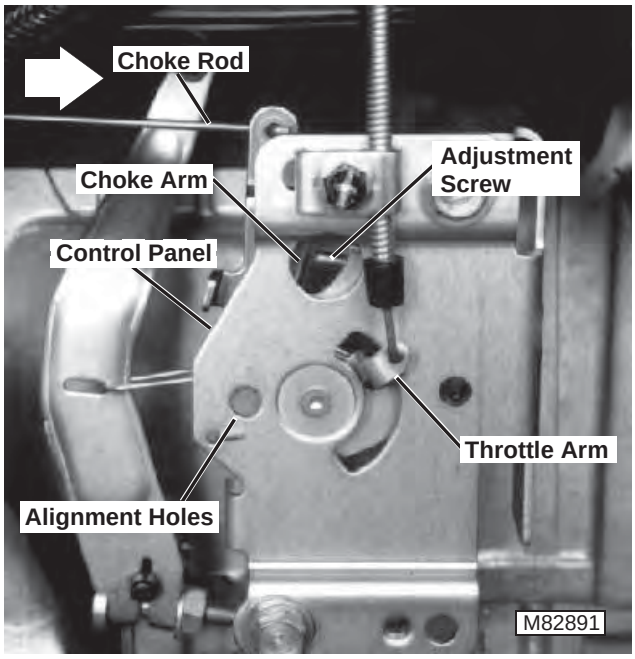
Test Procedure:

IMPORTANT: Check and adjust throttle cable before adjusting choke, to ensure accurate choke adjustment.

1. Check and adjust throttle cable.
2. Move throttle control lever to full CHOKE position.



3. Try to move choke rod toward carburetor (arrow). Choke rod should NOT move. If choke rod moves **forward**, the choke plate is not fully closed.
4. Move throttle control lever to FAST idle position.



5. Check holes in control panel and throttle arm. They MUST be in visual alignment. Check for gap between adjustment screw and choke arm.
6. Try to move choke rod toward control panel (arrow). Choke rod should NOT move. If choke rod moves **rearward**, the choke plate is not fully open.

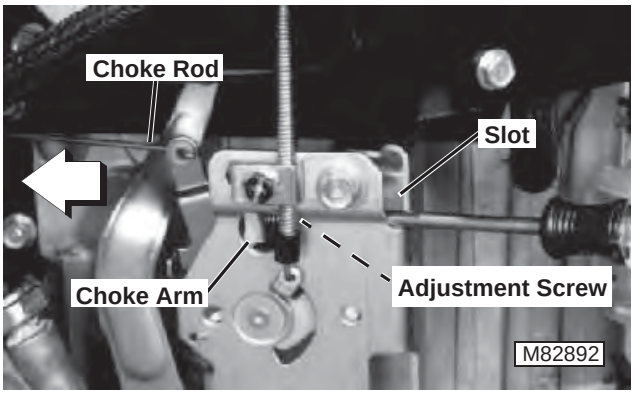
Results:

- If choke rod DOES NOT move in either direction with the throttle control lever in the specific positions, choke operation is properly adjusted.
- If choke rod DOES move in either direction with throttle control lever in the specific positions, perform following Adjustment Procedure.

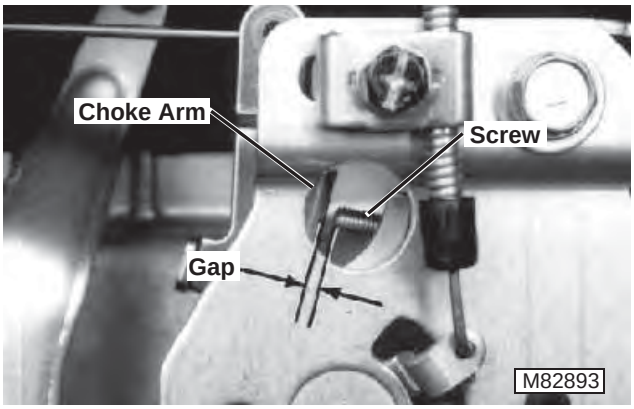
Adjustment Procedure:

If choke plate is not closed when the throttle control is in full choke position;

1. Move throttle control lever to full CHOKE position.



2. Push and hold choke rod forward (arrow) to close choke plate.
3. Insert a screwdriver through slot in control panel. Turn adjustment screw (on backside of control panel) clockwise until it is tight against choke arm.
4. Move throttle control lever to FAST idle position.



*NOTE: Amount of gap may vary from approximately **0.25—3.0 mm (0.01—0.12 in.)**.*

5. Check for gap between screw and choke arm. Amount of gap should be approximately **0.25—3.0 mm (0.01—0.12 in.)**.
6. Repeat Test Procedure.

GOVERNOR ADJUSTMENT

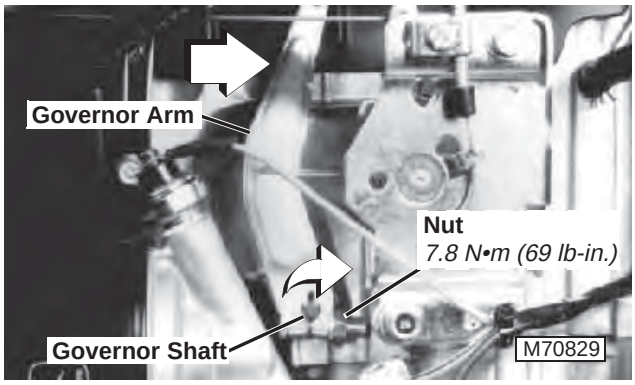
Reason:

To make sure the governor responds correctly at slow and fast idle.

Procedure:

NOTE: Adjust throttle cable and choke plate before adjusting governor linkage.

1. Adjust throttle cable and choke plate. (See THROTTLE CABLE and CHOKE PLATE TEST AND ADJUSTMENT on page 3-29.)
2. Move throttle lever to FAST idle position.



3. Loosen nut.
4. Hold governor arm in the full clockwise position (toward control panel). Turn the governor shaft clockwise to the end of its travel. Hold governor shaft and tighten nut to specifications.
5. Move throttle lever through full range to be sure linkage is not binding.

FAST IDLE SPEED ADJUSTMENT

Reason:

To set engine FAST idle speed.

Equipment:

- 6 mm (15/64 in.) Drill Bit or 6 x 30 mm Flat Head Pin (45M7036)
- JT07270 Digital Pulse Tachometer

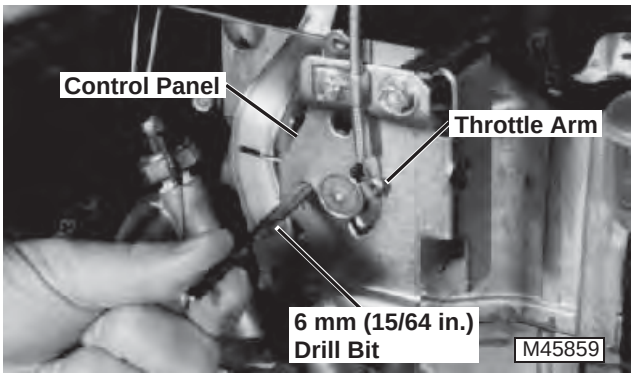
Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Raise engine hood.
4. Start and run engine at MEDIUM idle for 5 minutes to warm engine to normal operating temperature.

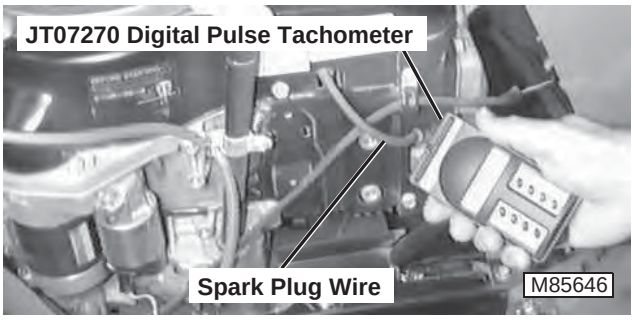
⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.

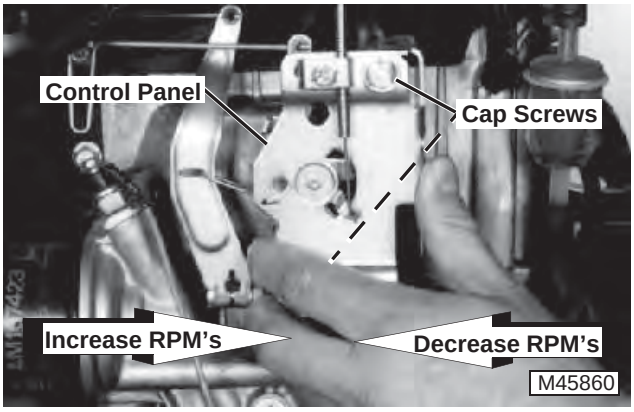
5. Move throttle control lever to FAST idle position.



6. Align hole in throttle arm with hole in throttle control panel. Insert a 6.0 mm (15/64 in.) drill bit or 6 x 30 mm flat head pin (45M7036) through holes to keep throttle arm from moving. Be sure bit or flat head pin are perpendicular to the throttle control panel.



7. Use a JT07270 Digital Pulse Tachometer at spark plug wire to set engine FAST idle speed at **3350 ± 100 rpm**.



Results:

- If FAST idle speed DOES NOT meet specifications:
  - Loosen throttle control panel cap screws.
  - Move throttle control panel rearward to increase rpm or forward to decrease rpm.
  - Hold throttle control panel motionless once specified rpm is found and tighten cap screws.
  - Check that hole in throttle arm aligns with hole in throttle control panel (see Step 6)—readjust throttle cable if holes are not in alignment.

SLOW IDLE SPEED ADJUSTMENT NON CARB/EPA ENGINES

NOTE: For engines WITHOUT California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Carburetors.

ENDING ENGINE SERIAL NUMBERS:

FC420V—ES10 . . . . . (FC420V –B78803)
FC540V—ES15 . . . . . (FC540V –A17447)

Reason:

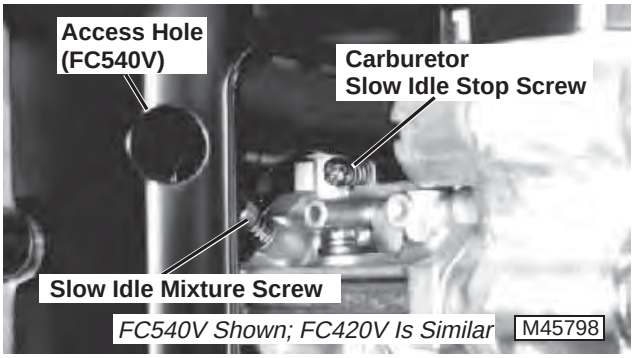
To set engine SLOW idle mixture and rpm.

Equipment:

- JT07270 Digital Pulse Tachometer

Procedure:

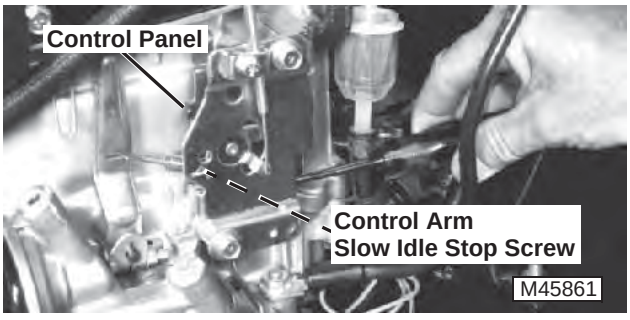
1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)



IMPORTANT: Forcing the slow idle mixture screw tight will damage the needle and seat.

NOTE: For access to SLOW idle mixture screw, insert screwdriver through hole in front shroud.

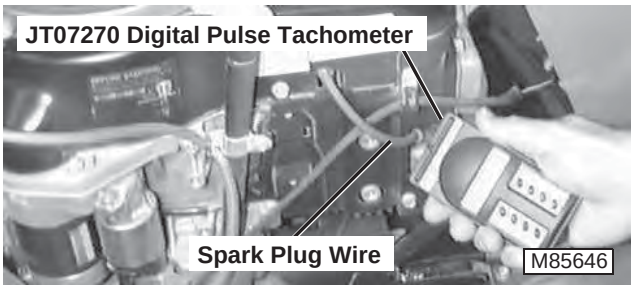
4. Turn SLOW idle mixture screw clockwise until lightly seated, then turn counterclockwise **1-3/8 turns (FC420V) or 1-1/2 turns (FC540V)**.



5. Put throttle lever in SLOW idle position and turn throttle control arm SLOW idle stop screw counterclockwise until it clears the throttle control panel by one full turn.
6. Start and run engine at MEDIUM idle for five minutes to warm engine to normal operating temperature.
7. Move throttle control lever to SLOW idle position..

⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.



8. Use a JT07270 Digital Pulse Tachometer at the spark plug wire to check engine rpm.
9. Adjust carburetor SLOW idle stop screw until SLOW idle speed is **1400 rpm,** removing any governor action.
10. Turn SLOW idle mixture screw clockwise until engine speed drops, note position.
11. Turn screw counterclockwise until engine speed increases and drops again, note position.
12. Turn SLOW idle mixture screw to midway between drop points, then turn screw counterclockwise an additional **1/4 turn (FC420V)** or **1/8 turn (FC540V)**.
13. Readjust carburetor SLOW idle stop screw to set carburetor SLOW idle speed at **1450 ± 75 rpm**.
14. Adjust throttle control arm SLOW idle stop screw to set the throttle SLOW idle speed at **1550 ± 75 rpm** (**100 rpm** above carburetor SLOW idle setting).

SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES

NOTE: For engines with California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Carburetors.

BEGINNING ENGINE SERIAL NUMBERS:

FC420V—ES10 . . . . . (FC420VB78804–)
FC540V—ES15 . . . . . (FC540VA17448–)

CARBURETOR PART NUMBERS:

FC420V—ES10 32350
FC540V—ES15 32297

ATTENTION!

DO NOT attempt to adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Reason:

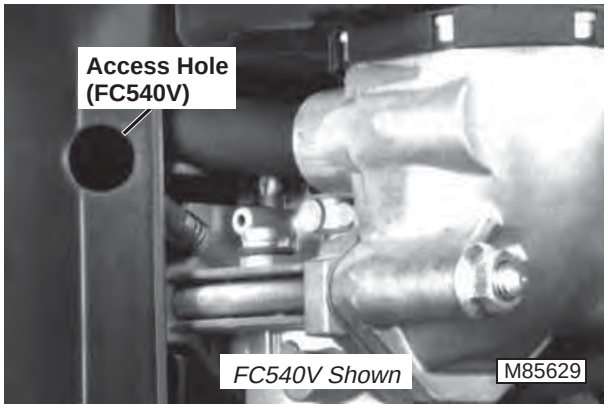
To set engine SLOW idle mixture and rpm. This ensures the engine meets the CARB/EPA emission requirements.

Equipment:

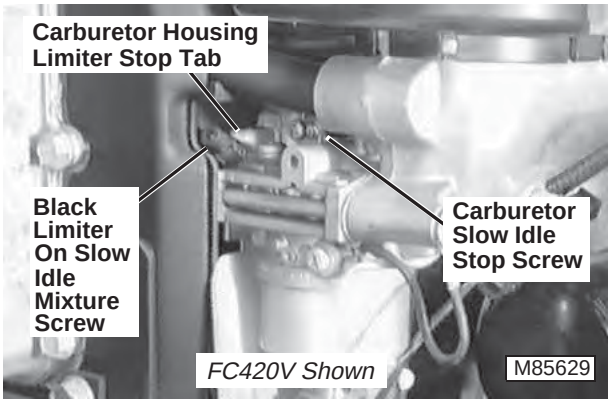
- JT07270 Digital Pulse Tachometer

Procedure:

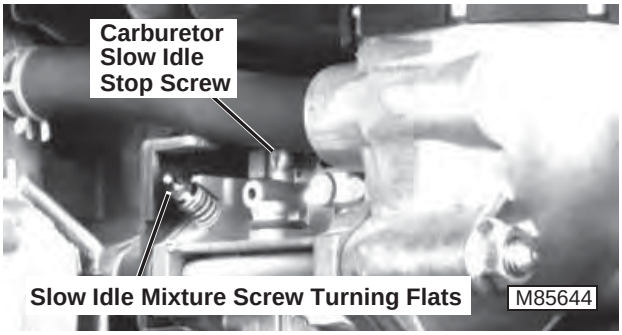
1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)



NOTE: On FC540V engines, SLOW idle mixture screw is accessed through front shroud hole. To remove and install black limiter on SLOW idle mixture screw, first remove front shroud.



4. Use screwdriver to carefully remove black limiter from SLOW idle mixture screw.

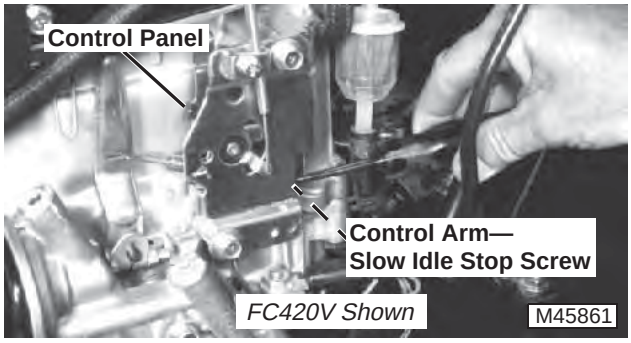


IMPORTANT: Forcing the slow idle mixture screw tight will damage the needle and seat.

5. Turn flats of SLOW idle mixture screw clockwise until lightly seated, then turn counterclockwise to following specifications:

Specifications:

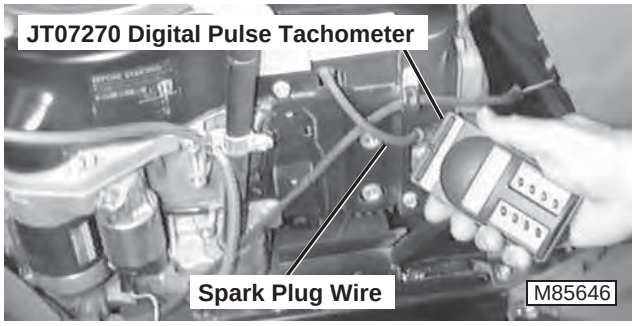
FC420V–ES10 . . . . . 1 7/16 Turns
FC540V–ES15 . . . . . 1 5/8 Turns



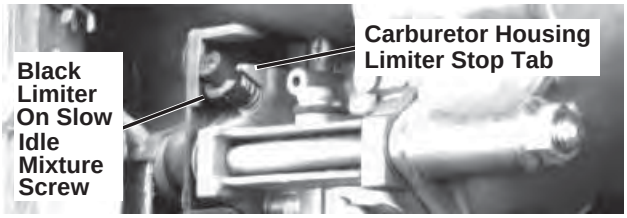
6. Put throttle lever in SLOW idle position and turn throttle control arm SLOW idle stop screw counterclockwise until it clears the throttle control panel by two turns.
7. Start and run engine at MEDIUM idle for five minutes to warm engine to normal operating temperature.
8. Move throttle control lever to SLOW idle position.

⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.



9. Use a JT07270 Digital Pulse Tachometer at the spark plug wire to check engine rpm.
10. Adjust carburetor SLOW idle stop screw until SLOW idle speed is **1400 rpm,** removing any governor action.
11. Turn SLOW idle mixture screw clockwise until engine speed drops, note position.
12. Turn screw counterclockwise until engine speed increases and drops again, note position.
13. Turn SLOW idle mixture screw to midway between drop points.



14. Without moving screw, carefully install black limiter on SLOW idle mixture screw so stops are centered on carburetor housing limiter stop tab. Now SLOW idle mixture screw can be fine tuned ONLY to limits allowed by black limiter cap.
15. Adjust carburetor SLOW idle stop screw to set carburetor SLOW idle speed at **1450 ± 75 rpm**.
16. Turn throttle control arm SLOW idle stop screw to set the SLOW idle speed at **1550 ± 75 rpm,** (**100 rpm** above carburetor SLOW idle speed).
17. Install front engine shroud (FC540V only).

CYLINDER COMPRESSION PRESSURE TEST

Reason:

To determine if the ACR mechanism is functioning properly.

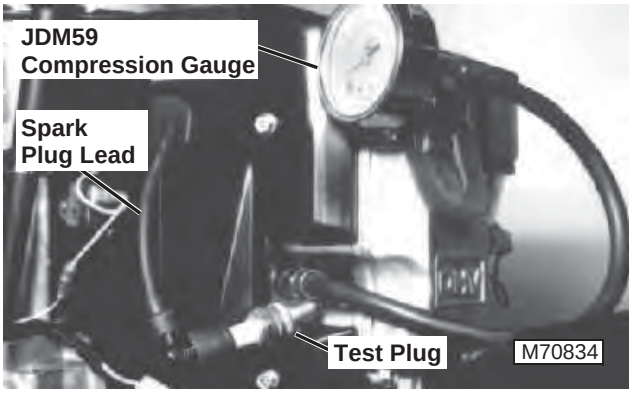
NOTE: A compression test on engines with ACR will not provide a good indication of the condition of the pistons, rings, cylinder walls, head gasket, and valves because the ACR mechanism is releasing compression pressure automatically.

Test Equipment:

- JDM59 Compression Gauge
- JDM-74A-5 Ignition Test Plug

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Raise or remove (optional) engine hood.



IMPORTANT: Spark Plug wire must be grounded or electronic ignition could be damaged.

3. Remove spark plug and ground spark plug lead to engine using JDM-74A-5 Ignition Test Plug.
4. Install JDM59 Compression Gauge.
5. Move throttle control lever to FAST idle position—throttle and choke plates must be fully open to obtain an accurate reading.

IMPORTANT: DO NOT overheat starting motor during test. Starter duty cycle is 5 seconds ON, 10 seconds OFF. Battery must be at a full state of charge—charge battery first, if necessary.

6. Crank engine until gauge needle settles out at its highest position.
7. Record pressure reading. **Minimum compression should be 483 kPa (71 psi)**.

Results:

- If compression is **above** 690 kPa (100 psi), the ACR is malfunctioning.
- If compression is **below** minimum specification, perform valve clearance test and adjustment and repeat test. (See VALVE CLEARANCE TEST AND ADJUSTMENT on next page.)

NOTE: Compression readings slightly below minimum specification are not a problem; however, compression readings 69 kPa (10 psi) or more below minimum specification may cause hard starting—especially at colder air temperatures.

If you have some reason to suspect bad rings, valves, or other internal engine components you should perform a cylinder leakdown test to better determine the state of their condition.

VALVE CLEARANCE TEST AND ADJUSTMENT

Reason:

To obtain the proper valve clearance that is critical for the valves to seat properly and for the automatic compression release to function properly.

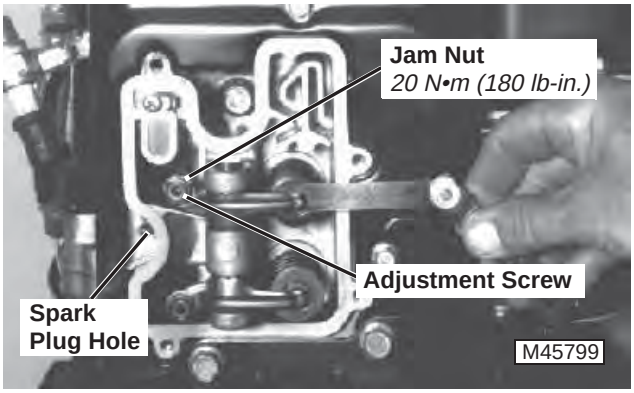
Equipment:

- Feeler Gauge (blade-type)

Procedure:

IMPORTANT: Perform valve clearance measurement or adjustment when engine is cold [15–30°C (60–85°F)]. Proper valve clearance is essential for the compression release system to function properly.

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise engine hood.
6. Remove and ground spark plug wire. Remove spark plug.
7. Remove valve cover.



8. Turn crankshaft until piston, visible in spark plug hole, is at Top Dead Center (TDC) of the compression stroke (both intake and exhaust valves will be closed).
9. Use a blade-type feeler gauge to measure valve clearance. Valve clearance should be **0.15 mm (0.006 in.)**.

Specifications:

Valve Clearance (cold) . . . . . 0.15 mm (0.006 in.)
Jam Nut Torque . . . . . 20 N•m (180 lb-in.)
Valve Cover
Cap Screw Torque . . . . . 6.0 N•m (53.0 lb-in.)
Spark Plug Torque . . . . . 20 N•m (177 lb-in.)

Results:

If valve clearance does not meet specifications, loosen the jam nut. Turn adjustment screw to adjust valve clearance to specifications. Hold screw and tighten nut to specifications. Check clearance again.

NOTE: BEFORE installing spark plug and valve cover, perform AUTOMATIC COMPRESSION RELEASE (ACR) TEST.

AUTOMATIC COMPRESSION RELEASE (ACR) TEST

Reason:

To determine if the ACR is opening the exhaust valve.

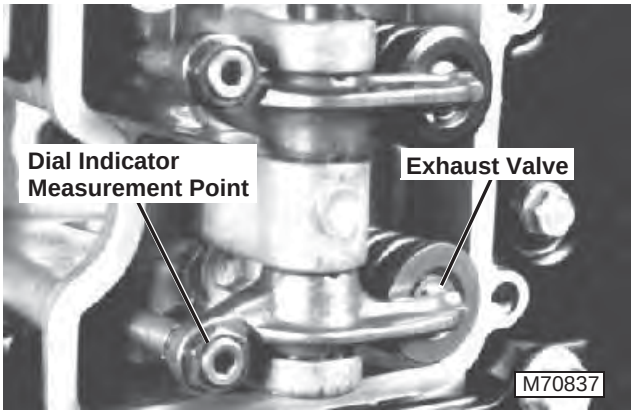
Test Equipment:

- Dial Indicator

Procedure:

IMPORTANT: Perform ACR movement measurement when engine is cold [15–30°C (60–85°F)]. Proper ACR movement is essential for the compression release system to operate correctly.

1. Immediately after adjusting valves, while rocker arm cover and spark plug are removed, rotate crankshaft slowly to observe ACR operation.



2. The exhaust valve must open (depress) briefly just after the intake valve closes.
3. Use a dial indicator to measure exhaust valve ACR movement. Minimum exhaust valve ACR movement should be **0.25 mm (0.010 in.)**.

Results:

- If the exhaust valve does not open or depress properly, the ACR tab is faulty.

CRANKCASE VACUUM TEST

Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil past the seals and gaskets and through the breather into the carburetor.

Test Equipment:

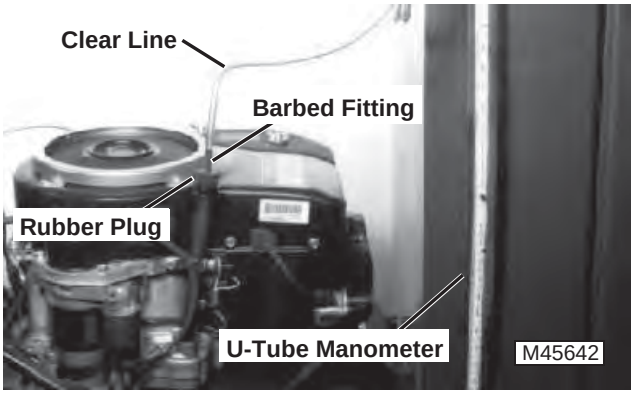
- JT05697 U-Tube Manometer Test Kit or
- JT03503 Crankcase Vacuum Test Kit

Procedure:

JT05697 U-Tube Manometer Test Kit—

1. Park machine on level surface.
2. Raise engine hood and remove dipstick.

IMPORTANT: Check oil fill cap and O-ring for cracks or damage, replace as necessary.



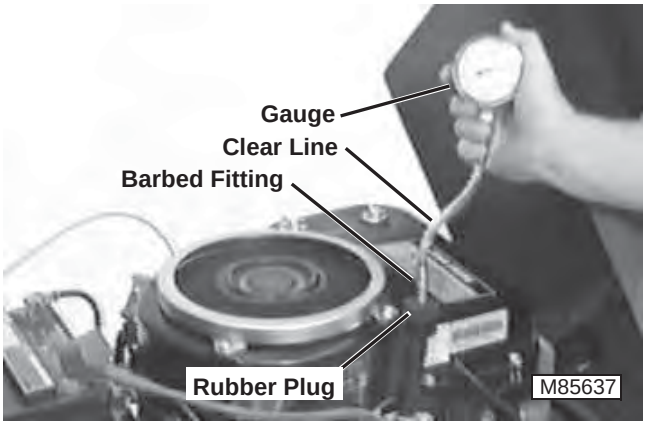
3. Install appropriate size rubber plug in dipstick tube.
4. Insert barbed fitting in rubber plug and connect clear line to barbed fitting.

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

DO NOT turn engine OFF until clear line has been disconnected from U-Tube Manometer.

5. Align ruler “zero” markings with top of water level in u-tube.
6. Start and run engine at FAST idle.
7. Connect clear line to open U-Tube Manometer spigot.
8. Record crankcase vacuum reading. Manometer should show a **minimum vacuum of 15 cm (6 in.) of water movement**.
9. Run engine at SLOW idle. **DO NOT TURN ENGINE OFF!**
10. Disconnect clear line from open manometer spigot.
11. Turn engine OFF.
12. Remove plug from dipstick tube and install dipstick.

JT03503 Crankcase Vacuum Test Kit—



1. Repeat Steps 1–4 in JT05697 test procedure.

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

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

2. Hold finger over rubber plug hole to keep oil from spraying out. Start engine and run at FAST idle.
3. Connect gauge, clear line, and barbed fitting to rubber plug.
4. Record crankcase vacuum reading. Gauge should show a **minimum vacuum of 15 cm (6 in.) of water movement**.
5. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
6. Move throttle to SLOW idle and turn engine OFF.
7. Remove rubber plug and install dipstick.

Results:

- If crankcase vacuum is BELOW specification, check the following:
  - Breather reed valve clearance and condition.
  - Breather port is obstructed.
  - Rings, piston, and cylinder bore for wear or damage.

ENGINE OIL PRESSURE TEST

Reason:

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

Test Equipment:

- JT03344 Pressure Gauge Assembly
- JT03017 Hose Assembly
- JT03338 90° Elbow Fitting

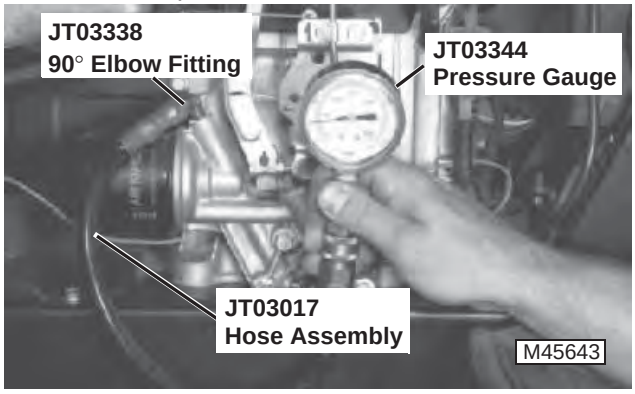
Procedure:

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise engine hood.

⚠ CAUTION

Engine components are HOT. Be careful not to touch while making adjustments.

6. Check engine oil level, bring level to full mark.
7. Disconnect oil pressure switch wiring lead and remove oil pressure switch.



8. Install JT03338 90° Elbow Fitting, JT03017 Hose Assembly and JT03344 Pressure Gauge Assembly.
9. Monitor oil pressure while cranking engine. If no or very low oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.

IMPORTANT: If pressure reading is below 69 kPa (10 psi) at FAST idle, STOP ENGINE IMMEDIATELY and determine cause.

10. Start and run engine at MEDIUM idle for five minutes to heat engine oil to normal operating temperature.
11. Run engine at FAST idle (3350 ± 100 rpm), then record oil pressure reading. Oil pressure should read a **minimum of 240 kPa (35 psi).**
12. Run engine at SLOW idle (1650 ± 75 rpm), then record oil pressure reading. Oil pressure should be a **minimum of 28 kPa (4 psi)**.

NOTE: Normal over-relief oil pressure is approximately 411 kPa (60 psi). Minimum oil pressure specification at FAST or SLOW idle indicates engine wear.

Results:

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

FUEL PUMP TESTS

Reason:

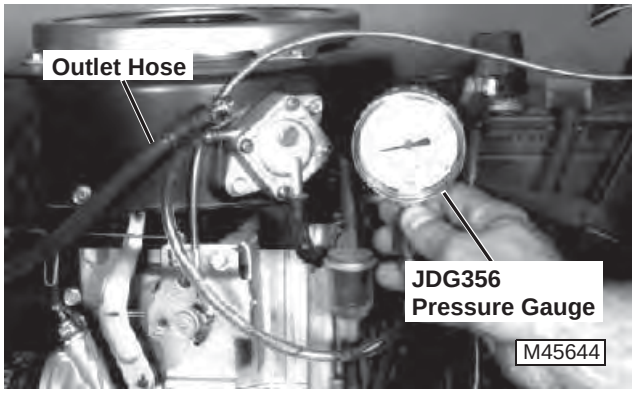
To check condition of fuel pump and determine fuel pressure and flow.

Test Equipment:

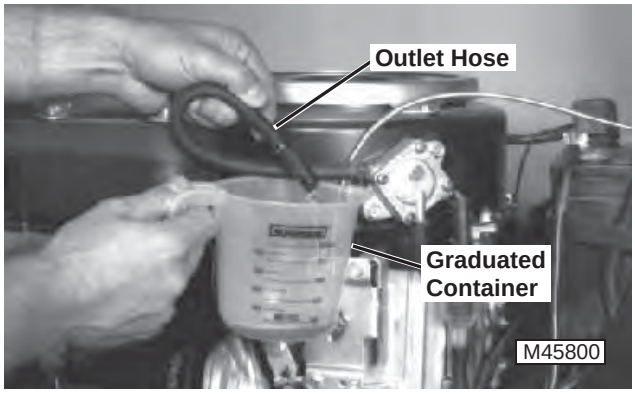
- JDG356 Pressure Gauge
- Graduated Container

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise engine hood.
6. Make sure fuel tank is at least 1/4 full with fresh fuel.
7. Start engine and run at SLOW idle (1650 ± 75 rpm) for one minute to fill carburetor with fuel.
8. Stop the engine.



9. Disconnect and plug fuel pump outlet hose.
10. Connect JDG356 Pressure Gauge hose to fuel pump outlet.
11. Start and run engine at FAST idle (3350 ±100 rpm) for 15 seconds. Minimum pressure should be **6.12 kPa (0.90 psi)**.
12. Stop engine.
13. Remove pressure gauge and connect fuel pump outlet hose to fuel pump.



14. Disconnect fuel pump outlet hose from carburetor and place it in graduated container.
15. Start and run engine at FAST idle (3350 ±100 rpm) for 15 seconds, then stop engine and record container measurement. Minimum flow should be **55 mL/15 seconds (1.8 oz./15 seconds)** for FC420V or **65 mL/15 seconds (2.2 oz./15 seconds)** for FC540V.

Results:

- If fuel pressure and/or flow does not meet specifications, check the following:
  - Fuel lines, filter, shut-off valve, and fuel tank cap for restrictions.
  - Clean and inspect fuel pump.

SPARK TEST

Reason:

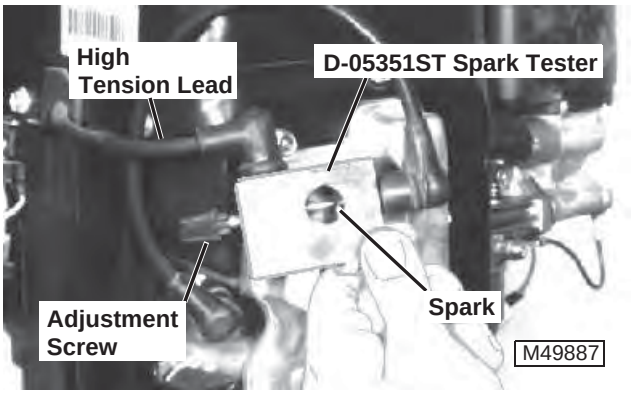
Check overall condition of ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Disengage PTO.
6. Raise engine hood.



7. Disconnect high tension lead from spark plug.
8. Connect D-05351ST Spark Tester to spark plug.
9. Connect high tension lead to Spark Tester.

IMPORTANT: Do not adjust Spark Tester gap beyond 5.0 mm (0.200 in.) (5 turns), as damage to ignition components could occur.

10. Adjust spark tester gap to **4.2 mm (0.166 in.) (4 turns)** with adjustment screw.
11. Move key switch to RUN position.
12. Spin engine with starter and watch spark at Spark Tester. If engine will start, watch spark with engine running. A steady, strong, blue spark should be observed.

Results:

- If spark is weak, or no spark is present, install a new spark plug and repeat test.
- If spark is still weak, or no spark is present, run tests on individual components to find the cause of the malfunction.

SPARK PLUG GAP ADJUSTMENT

Reason:

To ensure spark plug air gap is within specification.

Test Equipment:

- Wire Feeler Gauge

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.

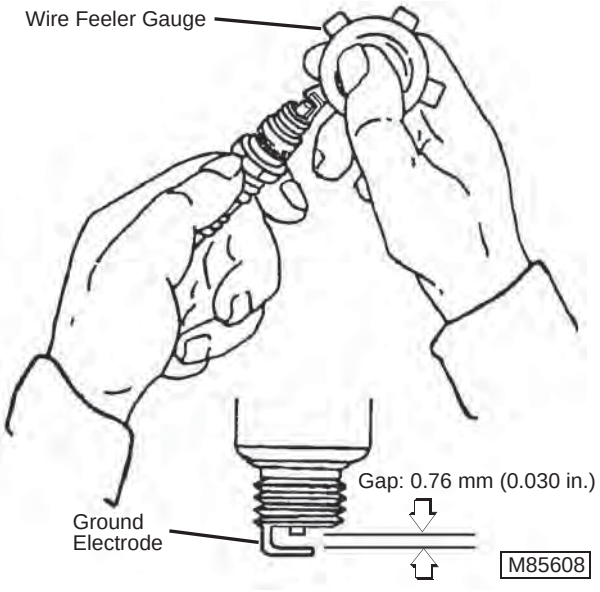
⚠ CAUTION

Engine components are HOT. Be careful not to touch, especially the exhaust pipe or muffler while making adjustments.

5. Remove spark plug.

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

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



8. Check spark plug gap using a wire feeler gauge. Set gap to **0.76 mm (0.030 in.)**.
9. Install and tighten spark plug to **20 N•m (177 lb-in.)**.

MAGNETO IGNITION COIL RESISTANCE TEST

ENDING ENGINE SERIAL NUMBERS:

FC420V-DS10 . . . . . (FC420V —B50632)
FC540V-DS15 . . . . . (FC540V —A00384)

Reason:

Test overall condition of magneto ignition coil.

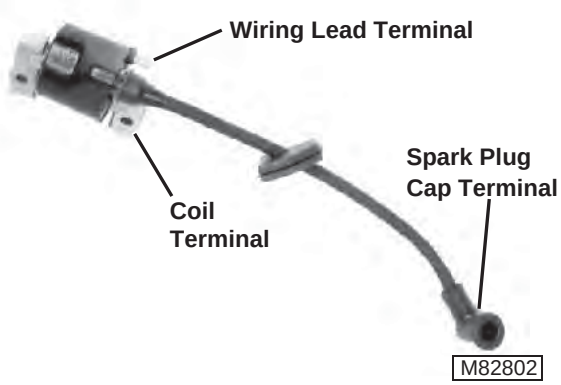
Test Equipment:

- JT05791 Digital Multimeter

Procedure:

NOTE: It is assumed that prior to performing this test, the air gap and power circuit up to the coil have been verified and are within specifications.

Coil removed from engine for clarity purposes only—it can be tested installed on the engine.



1. Measure resistance between wiring lead terminal and coil terminal. If resistance is **not within 0.48—0.72 ohms**, replace magneto ignition coil.
2. Measure resistance between spark plug cap terminal and coil terminal. If resistance is **not within 10.9—16.3 K ohms**, replace magneto ignition coil.

IGNITOR MODULE TEST

ENDING ENGINE SERIAL NUMBERS:

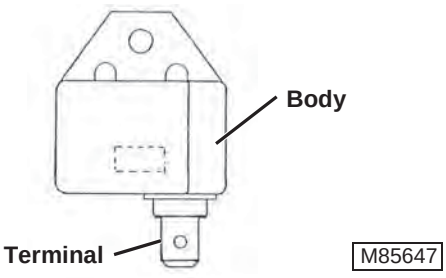
FC420V-DS10 . . . . . (FC420V —B50632)
FC540V-DS15 . . . . . (FC540V —A00384)

Reason:

Test condition of ignitor.

Procedure:

1. Be sure magneto ignition coil is good before proceeding with Step 2; otherwise, replacement ignitor module may be damaged. (See MAGNETO IGNITION COIL RESISTANCE TEST on previous page.



NOTE: Many electrical problems are due to poor connections or grounds. Inspect all connections and grounds to ensure good test results.

2. Inspect and clean ignitor module terminal and wiring lead spade connector.
3. Check that ignitor module body is properly grounded.
4. Start engine.

Results:

- If engine DOES NOT start, replace ignitor module with a known good one.
- If new ignitor module DOES NOT solve the problem, test all other ignition system components.

MAGNETO IGNITION COIL/IGNITOR MODULE RESISTANCE TEST

BEGINNING ENGINE SERIAL NUMBERS:

FC420V-DS10 . . . . . (FC420VB50633—)
FC540V-DS15 . . . . . (FC540VA00385—)

Reason:

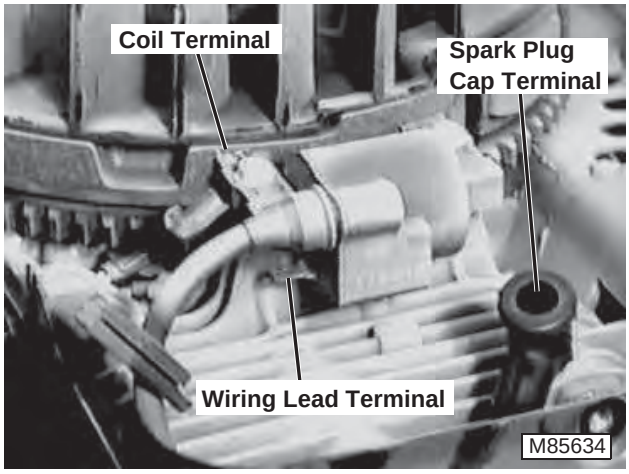
Test condition of magneto ignition coil/ignitor module.

Test Equipment:

- JT05791 Digital Multimeter

Procedure:

NOTE: It is assumed that prior to performing this test, the air gap and power circuit up to the coil have been verified and are within specifications.



1. Measure resistance between wiring lead terminal and core. If resistance is **not within 0.48—0.72 ohms**, replace magneto ignition coil/ignitor module.
2. Measure resistance between spark plug cap terminal and coil terminal. If resistance is **not within 8.7—13.1 K ohms**, replace magneto ignition coil/ignitor module.

NOTE: Magneto ignition coil/ignitor module will not retro-fit on earlier engines due to the reversed polarity of the flywheel magnet.

REPAIR

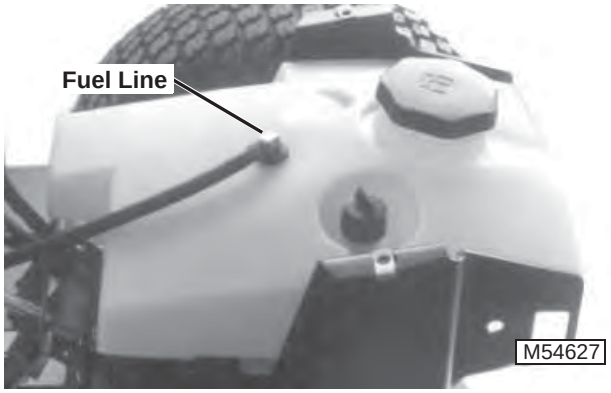
FUEL TANK

Removal/Installation

1. Lower mower deck to the ground.
2. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)

⚠ CAUTION

Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.



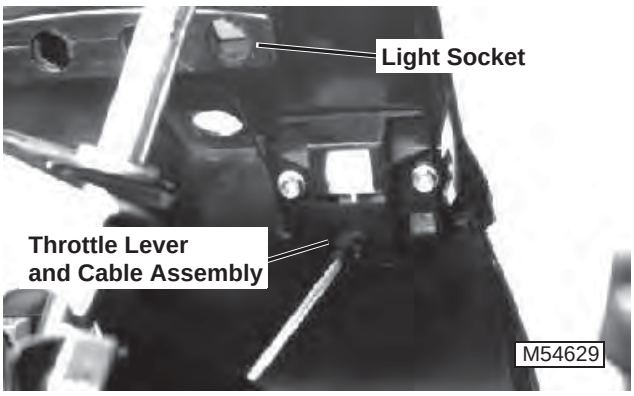
3. Disconnect fuel line.
4. Remove fuel tank.
5. Inspect fuel tank for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

THROTTLE CONTROL LEVER AND CABLE

Removal/Installation

1. Remove steering wheel. (See STEERING WHEEL—Removal/Installation on page 8-8.)
2. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)
3. Disconnect throttle control cable at engine.
4. Remove park brake lever and linkage. (See PARK BRAKE LEVER AND LINKAGE on page 9-19 and 9-21.)



5. Remove indicator lights from sockets.
6. Remove four cap screws and washers securing instrument panel.
7. Remove two cap screws and throttle control lever and cable assembly.

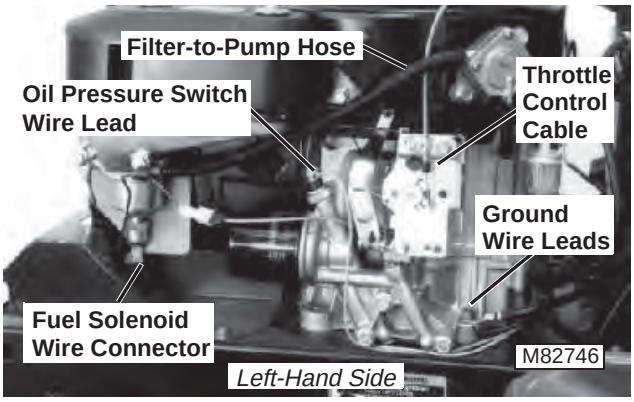
Installation is done in the reverse order of removal.

- Adjust throttle cable and choke plate. (See THROTTLE CABLE TEST AND ADJUSTMENT on page 3-29 and CHOKE PLATE TEST AND ADJUSTMENT on page 3-29.)

ENGINE

Removal/Installation

1. Remove muffler. (See MUFFLER—Removal/Installation on page 3-43.)
2. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
3. Disconnect negative (–) battery cable at battery.
4. Drain engine oil. Crankcase capacity with filter is approximately **1.6 L (3.4 U.S. pt)**.
5. Turn fuel shutoff valve to OFF position.

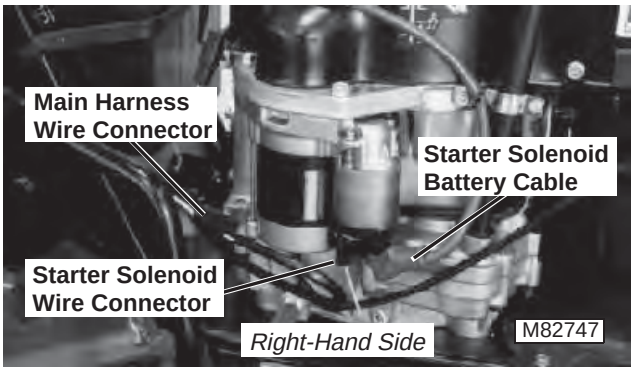


6. On left-hand side of engine, label and disconnect the following:
   - Fuel control solenoid wire connector.
   - Ground wire leads.
   - Oil pressure switch wire lead.
7. Remove fuel pump cover.

⚠ CAUTION

Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.

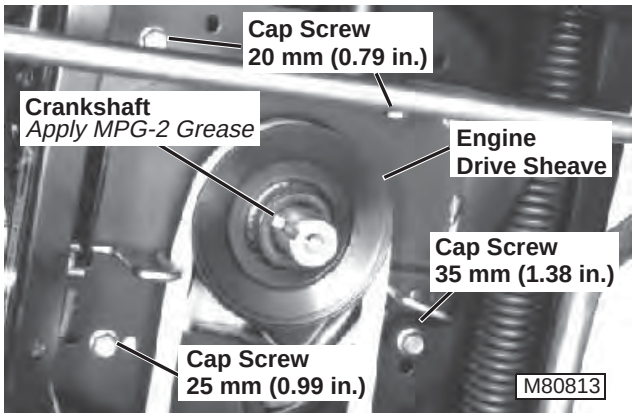
8. Disconnect fuel hose.
9. Disconnect throttle control cable.



10. Disconnect the following:
    - Starter solenoid wire connector.
    - Main harness wire connector.
    - Starter solenoid battery cable
11. Remove PTO clutch. (See ELECTRIC PTO CLUTCH—Removal/Installation on page 5-195.)

NOTE: Engage park brake to relieve tension from drive belt.

12. Engage park brake.



13. Remove engine drive sheave and key.
14. Remove cap screws.
15. Remove engine.

Installation is done in the reverse order of removal.

- Tighten engine mounting cap screws to **34 N•m (300 lb-in.)**.
- Apply MPG-2 grease to crankshaft before installing drive sheave and PTO clutch.
- Fill engine to proper level with oil of correct specifications. (See KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA on page 2-11 or KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—EUROPE on page 2-12.)
- Adjust throttle cable and choke plate. (See THROTTLE CABLE TEST AND ADJUSTMENT on page 3-29 and CHOKE PLATE TEST AND ADJUSTMENT on page 3-29.)
- LX172 Only—Install belt guide at right rear engine mounting cap screw.

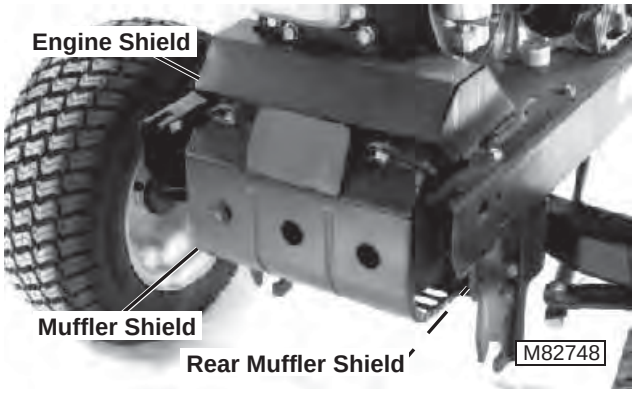
MUFFLER

Removal/Installation

1. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)

⚠ CAUTION

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



2. Remove heat shields.

NOTE: On FC420V equipped models it may be necessary to remove engine mount cap screws and raise engine to access muffler manifold cap screws.

3. Remove muffler and gasket, discard gasket.

Installation is done in the reverse order of removal.

- Use new gaskets for installation.

AIR CLEANER

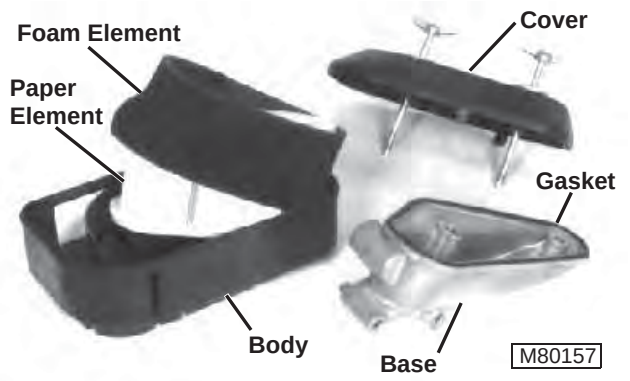
Service

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

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

NOTE: Replace elements yearly or every 25 hours.

1. Remove and disassemble air cleaner.



2. Wash foam element in detergent and warm water. Rinse element throughly to remove all traces of detergent. Squeeze out excess water—DO NOT wring out element. Let element air dry.
3. Apply 12—15 drops of clean engine oil to foam element. Squeeze out excess oil.

IMPORTANT: Do not clean paper element with solvent or compressed air.

4. Gently tap paper element to remove dust.
5. Inspect paper element.
   - Element is still usable if you can see light through it and element appears clean.
   - Replace if oily, dirty, or damaged in any way.
6. Inspect body, gasket and base for damage. Replace parts as necessary.
7. Assemble and install air cleaner.

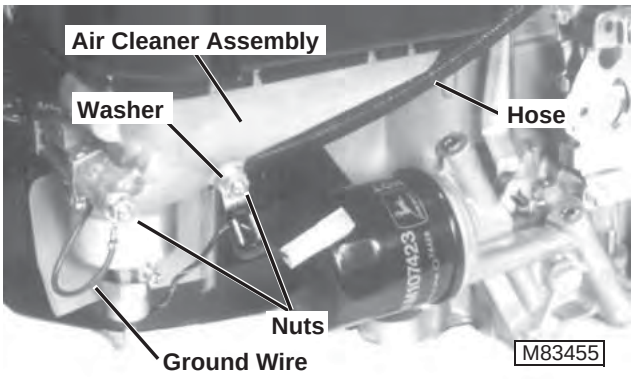
CARBURETOR

Removal/Installation

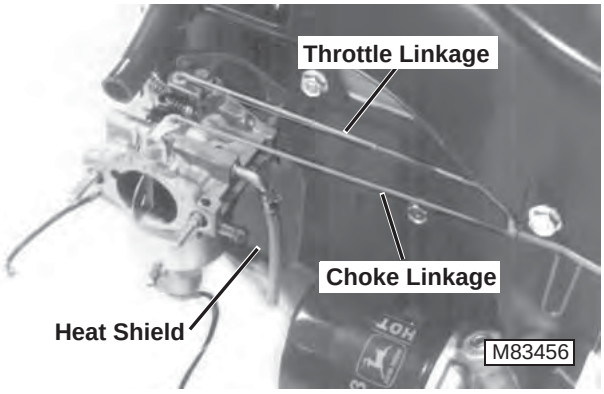
⚠ CAUTION

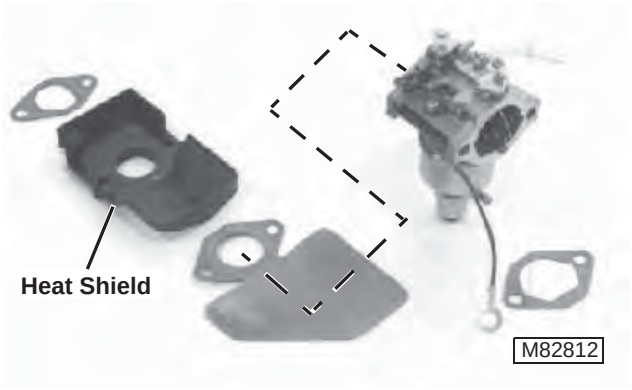
Gasoline is extremely flammable. Do not smoke. Always work in a ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

1. Drain fuel from carburetor.



2. Disconnect fuel hose.
3. Remove two nuts and washers.
4. Disconnect wire lead if carburetor is to be disassembled.
5. Remove air cleaner assembly. (See AIR CLEANER—Service on page 3-43.)





6. Separate carburetor from heat shield. Remove carburetor.
7. Disconnect choke and throttle control linkage.

Installation is done in the reverse order of removal.

- Use new gaskets when installaing.

Disassembly/Assembly

NOTE: For California Air Resources Board/ Enviornmental Protection Agency (CARB/EPA) Emissions Carburetors reference the following:

BEGINNING ENGINE SERIAL NUMBERS:
FC420V—ES10 . . . . . (FC420VB78804–)
FC540V—ES15 . . . . . (FC540VA17448–)

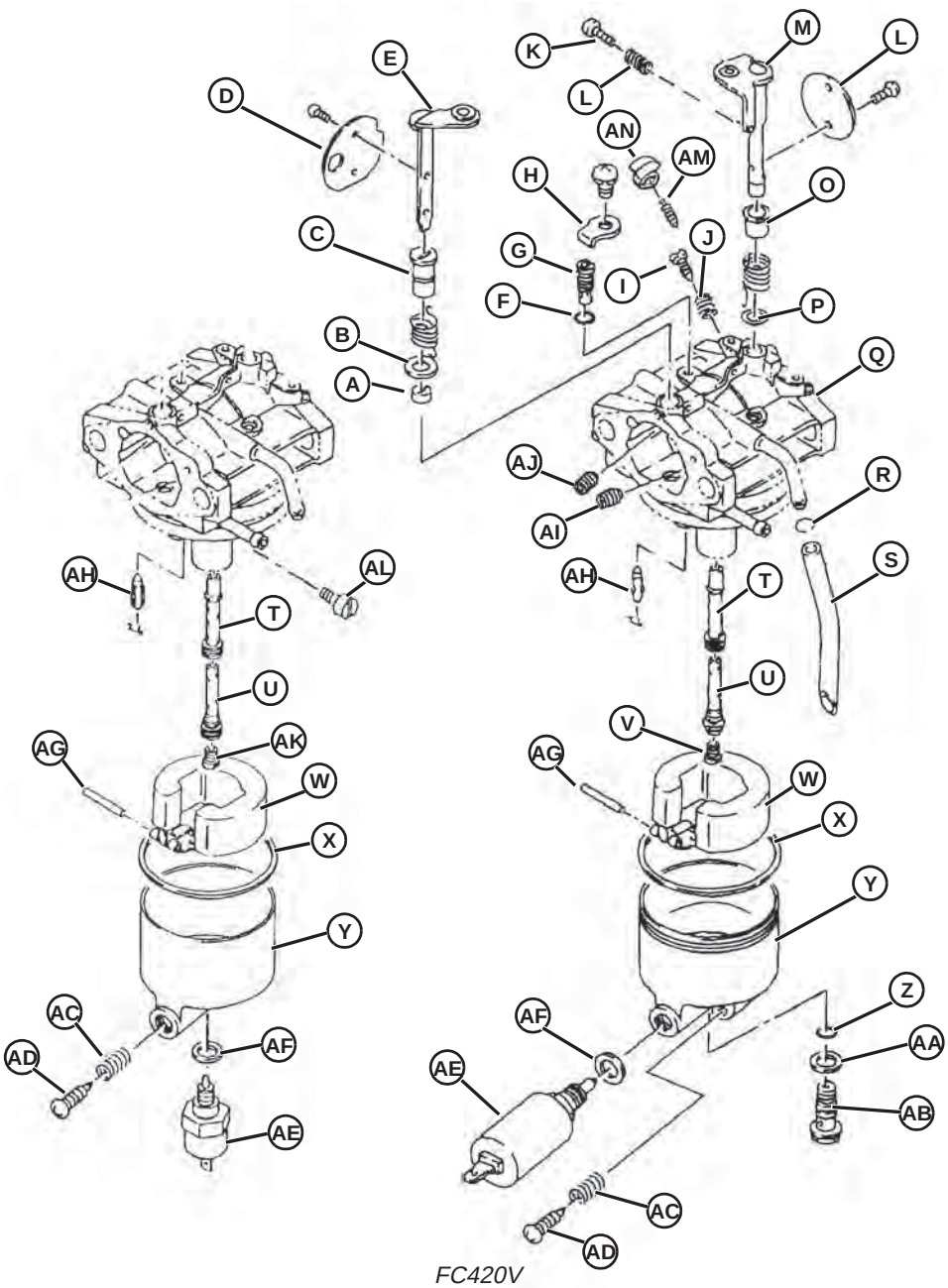
CARBURETOR PART NUMBERS:
FC420V—ES10 32350
FC540V—ES15 32297

ATTENTION!

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

IMPORTANT: There are a number of ball plugs on/ in the carburetor that should not be removed.

To remove float, use a long-nosed pliers on the deformed end of the float pin. DO NOT strike opposite end of pin. Damage to pin holder may result.

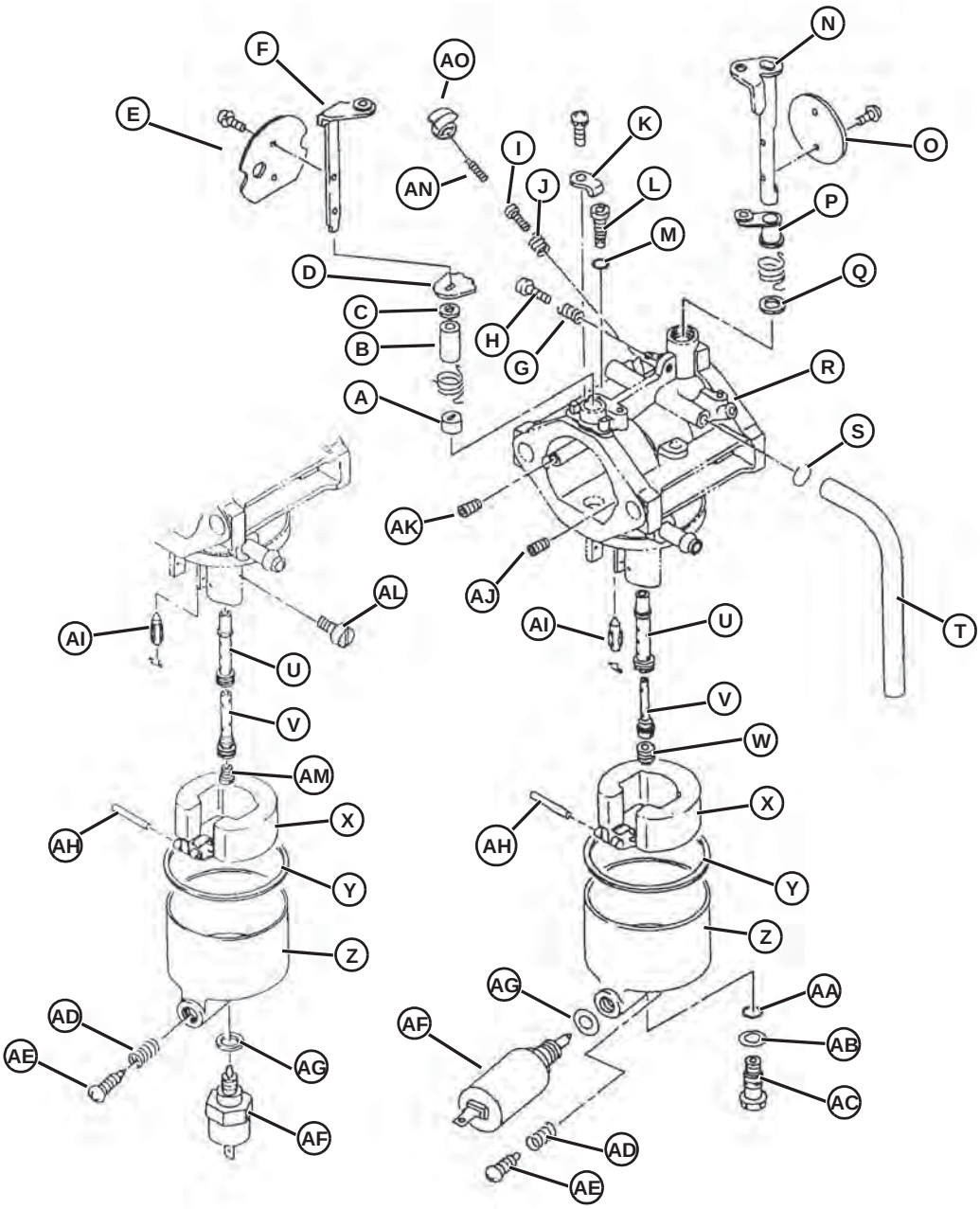


FC420V

A—Collar
B—Seal
C—Collar
D—Choke Plate
E—Choke Shaft
F—O-Ring
G—Pilot Jet-60
H—Plate
I—Slow Idle Mixture Screw
J—Spring
K—Slow Idle Stop Screw
L—Spring
M—Throttle Shaft
N—Throttle Plate
O—Ring
P—Seal
Q—Carburetor Body
R—Clamp
S—Hose
T—Main Nozzle
U—Bleed Pipe
V—Main Jet
W—Float
X—Gasket
Y—Float Chamber
Z—O-Ring
AA—Washer
AB—Plug
AC—Spring
AD—Drain Screw
AE—Fuel Shutoff Solenoid
AF—Washer
AG—Float Pin
AH—Needle Valve
AI—Main Air Jet
AJ—Pilot Air Jet
AK—Valve Seat
AL—Main Jet
AM—Slow Idle Mixture Screw (CARB/EPA)
AN—Black Limiter (CARB/EPA)

NOTE: Carburetor with vertical-mount fuel shutoff solenoid is used on engines with designation number BS10.

Carburetor with horizontal-mount fuel shutoff solenoid is used on engines with designation number AS10.



FC540V

A—Collar
B—Collar
C—Seal
D—Plate
E—Choke Plate
F—Choke Shaft
G—Spring
H—Slow Idle Stop Screw
I—Slow Idle Mixture Screw
J—Spring
K—Plate
L—Pilot Jet
M—O-Ring
N—Throttle Shaft
O—Throttle Plate
P—Ring
Q—Seal
R—Carburetor Body
S—Clamp
T—Hose
U—Main Nozzle
V—Bleed Pipe
W—Main Jet
X—Float
Y—Gasket
Z—Float Chamber
AA—O-Ring
AB—Washer
AC—Plug
AD—Spring
AE—Drain Screw
AF—Fuel Shutoff Solenoid
AG—Washer
AH—Float Pin
AI—Inlet Needle
AJ—Main Air Jet
AK—Pilot Air Jet
AL—Valve Seat
AM—Main Jet
AN—Slow Idle Mixture Screw (CARB/EPA)
AO—Black Limiter (CARB/EPA)

NOTE: Carburetor with vertical-mount fuel shutoff solenoid is used on engines with designation number AS10.

Carburetor with horizontal-mount fuel shutoff solenoid is used on engines with designation number AS00.

Clean/Inspect/Rebuild

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

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

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

⚠ CAUTION

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

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

2. Rinse carburetor parts in warm water and dry with compressed air. Do not use rags or paper to dry parts; lint can plug holes and passages in carburetor.
3. Inspect all parts for wear or damage. Replace parts as necessary.

NOTE: Float is plastic. The float cannot be adjusted. Replace if necessary.

Main jet high altitude kits are available.

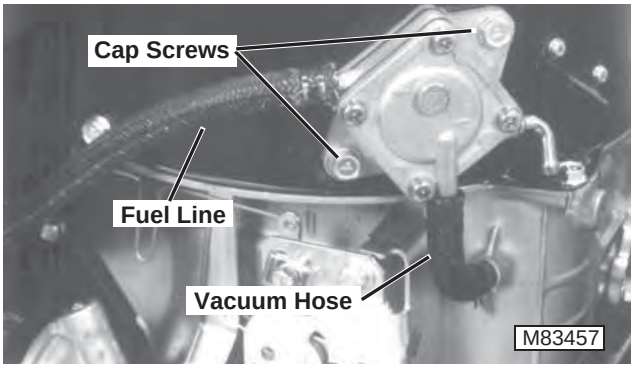
- Inspect the carburetor body for wear or damage. Verify all sealing surfaces and flanges are smooth and free of nicks or burrs. If worn or damaged, replace the float assembly and carburetor body as a set.
- Inspect the inlet needle for wear or damage. The tip should be smooth, without any grooves, scratches or cracks. If worn or damaged, replace the needle and carburetor body as a set.
- Inspect the idle mixture screw tapered end for wear or damage. Replace if necessary.

FUEL PUMP

Replacement

⚠ 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.



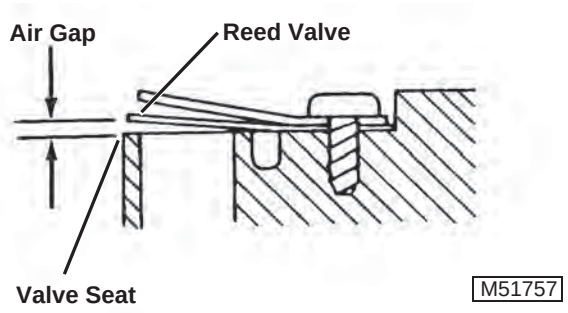
1. Disconnect fuel line and vacuum hose.
2. Remove cap screws.
3. Remove fuel pump and gasket.

Installation is done in the reverse order of removal.

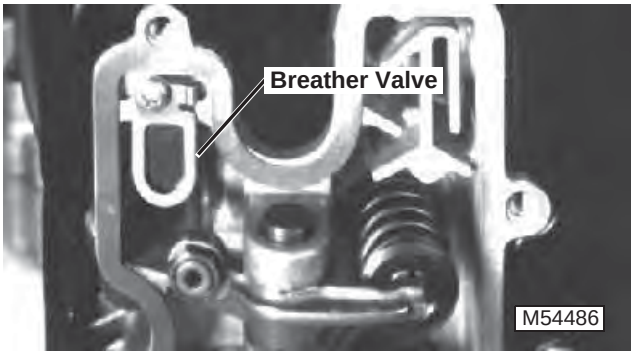
BREATHER

Inspection/Replacement

1. Remove valve cover. (See VALVE COVER ASSEMBLY—Removal/Installation on page 3-49.)



2. Measure air gap between reed valve and valve seat at valve tip. Air gap specification is **1—2 mm (0.040—0.080 in.)**. Replace if reed valve gap exceeds specifications.



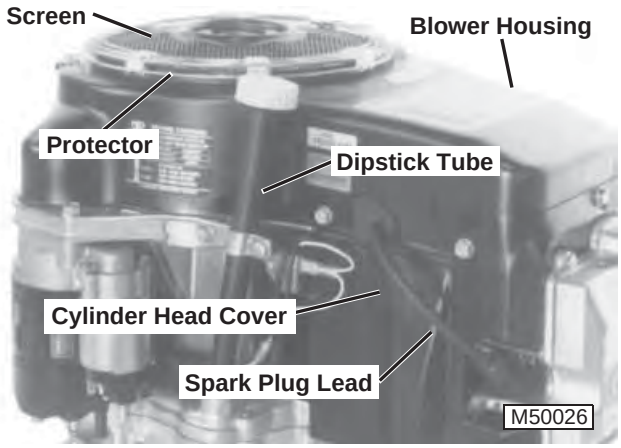
3. Remove breather valve assembly.
4. Inspect breather valve for sticking, binding, cracks or distortion. Replace breather valve if worn or damaged.
5. Inspect valve seating surface. Surface must be free of nicks or burrs.

Installation is done in the reverse order of removal.

- Tighten valve cover cap screws to **6 N•m (53 lb-in.)**.

BLOWER HOUSING

Inspection/Replacement

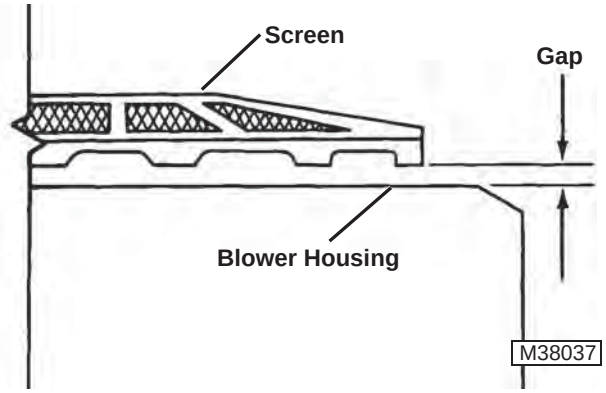


1. Disconnect spark plug lead.
2. Remove air cleaner assembly. (See AIR CLEANER—Service on page 3-43.)
3. Remove fuel pump. (See FUEL PUMP—Replacement on page 3-47.)
4. Remove cylinder head cover.
5. Remove dipstick tube.
6. Remove protector and screen.
7. Remove blower housing.

Installation is done in the reverse order of removal.

- Adjust flywheel screen. (See FLYWHEEL SCREEN ADJUSTMENT.)

Flywheel Screen Adjustment

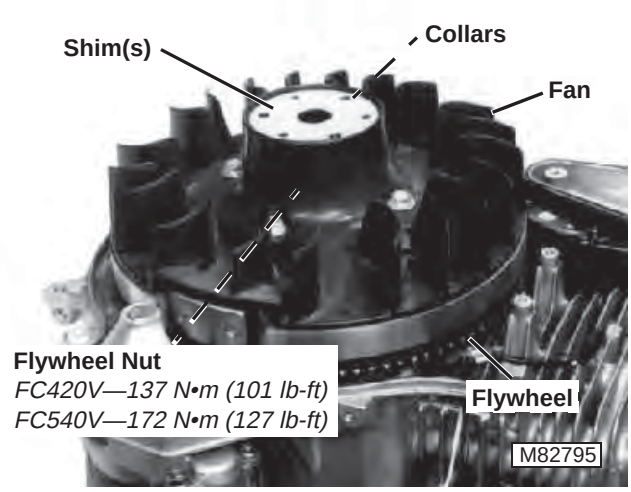


1. Adjust gap between bottom edge of screen and blower housing using spacers. Minimum gap is **1.5 mm (0.059 in.)**.
2. Tighten screen cap screws to **6 N•m (53 lb-in.)**.

FLYWHEEL

Removal/Installation

1. Remove blower housing. (See BLOWER HOUSING—Removal/Installation.)



2. Remove shim(s) and three collars.
3. Remove fan.
4. Hold flywheel and remove mounting nut.
5. Remove flywheel using a flywheel puller.

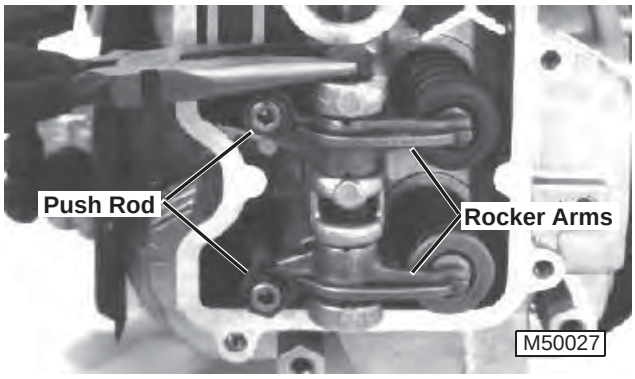
Installation is done in the reverse order of removal

- Tighten fan cap screws to **10 N•m (89 lb-in.)**.
- Tighten flywheel nut to specifications shown.
- Adjust coil air gap. (See MAGNETO IGNITION COIL on page 3-72 or MAGNETO IGNITION COIL WITH IGNITOR MODULE on page 3-73.)
- Test flywheel magnet. (See FLYWHEEL MAGNET TEST on page 5-185.)

ROCKER ARM ASSEMBLY

Removal/Installation

1. Remove valve cover.
2. Turn crankshaft until piston is at highest position on compression stroke (both intake and exhaust vavles will be closed).



3. Remove rocker shaft and arms.

IMPORTANT: Mark push rods for reassembly in original locations.

4. Remove push rods.
5. Inspect all parts for wear or damage. (See Inspection procedure.)

Installation is done in the reverse order of removal.

IMPORTANT: Align rocker arms over push rods during assembly.

- Adjust valve clearance. (See VALVE CLEARANCE TEST AND ADJUSTMENT on page 3-35.)

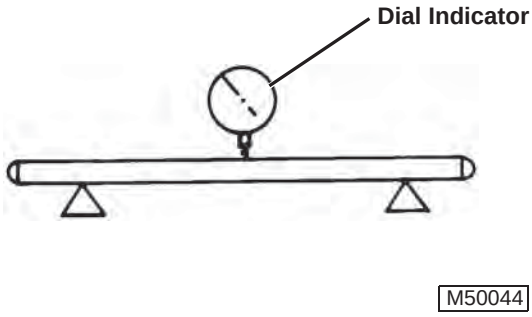
Inspection



- Measure outer diameter of rocker arm shaft. Replace if shaft diameter measures **less than 12.94 mm (0.509 in.)**.



- Measure inside diameter of rocker arm bearing. Replace bearing if inside diameter is **greater than 13.07 mm (0.515 in.)**.

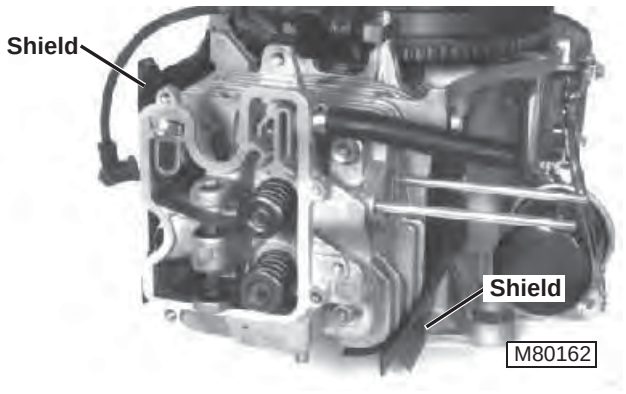


- Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is **greater than 0.30 mm (0.012 in.)**.

CYLINDER HEAD AND VALVES

Removal/Installation

1. Remove valve cover, rocker arm assembly, and push rods. (See ROCKER ARM ASSEMBLY—Removal/Installation.)
2. Remove blower housing. (See BLOWER HOUSING—Inspection/Replacement on page 3-48.)
3. Remove carburetor. (See CARBURETOR—Removal/Installation on page 3-44.)
4. Remove spark plug.



5. Remove shields.
6. Remove cylinder head assembly and gasket.
7. Disassemble and inspect cylinder head and valves. (See INSPECTION procedures on page 3-49.)

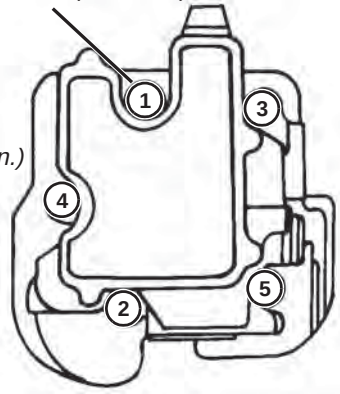
Installation is done in the reverse order of removal.

IMPORTANT: Gasket surfaces are coated with sealant. Do not damage surfaces or gasket during installation.

Torque should be applied in the sequence shown, at 7 N•m (62 lb-in.) increments, with an initial setting of 32 N•m (288 lb-in.) up to a final setting of 52 N•m (456 lb-in.).

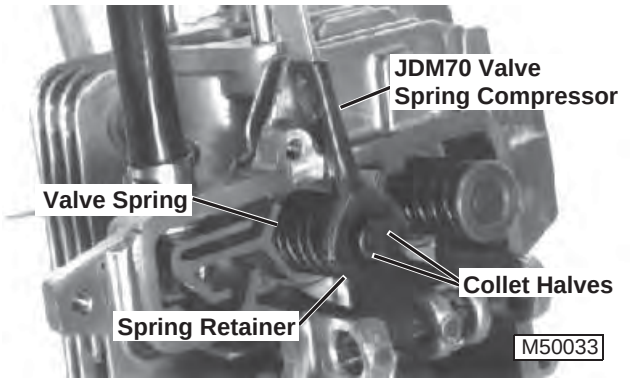
Cap Screws
Initial Torque: 32 N•m (288 lb-in.)
Final Torque: 52 N•m (456 lb-in.)

Spark Plug
20 N•m (177 lb-in.)



- Use new gaskets for installation.
- Adjust valve clearance. (See VALVE CLEARANCE TEST AND ADJUSTMENT on page 3-35.)

Disassembly/Assembly

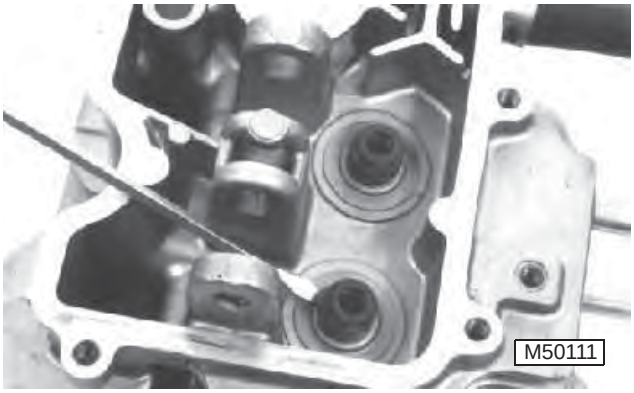


1. Compress intake valve spring with JDM70 Valve Spring Compressor and remove collet halves.
2. Remove spring retainer and spring.
3. Remove exhaust valve rotator with a magnet.
4. Support exhaust valve from below and press down on spring retainer.
5. Remove retainer, spring and valves.



IMPORTANT: Bottom spring retainer can only be removed with valve stem seal. Removal of retainer or seal damages stem seal. Inspect seal. If seal is not damaged, do not remove it.

6. If necessary to replace stem seal, remove with screwdriver.



7. Inspect springs, valves, guides and seals for wear or damage. (See Inspection/Replacement procedures.)

Assembly is done in the reverse order of disassembly.

Inspection

Cylinder Head:

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE® abrasive pads or an equivalent.

⚠ CAUTION

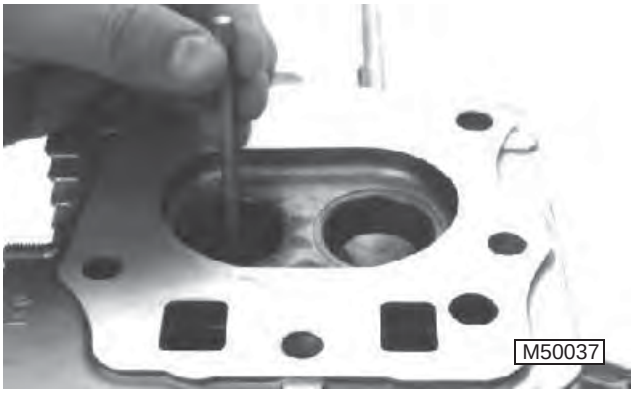
Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

2. Clean head with a suitable solvent and dry with compressed air.
3. Inspect head for cracks or broken cooling fins.
4. Inspect gasket surface for burrs and nicks.
5. Inspect head gasket for burns and traces of gas leakage. Replace if necessary.
6. Check that oil drainback passages are not plugged.



- Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is **more than 0.05 mm (0.002 in.)**.

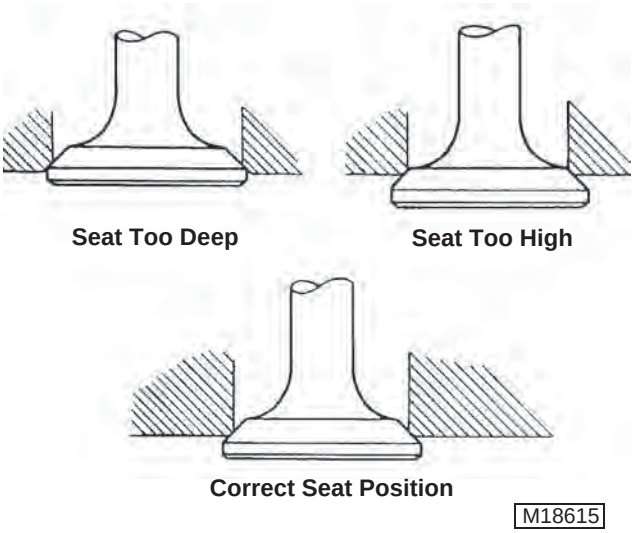
Valve Guides:



1. Clean inside of valve guides with valve guide cleaner.
2. Measure inside diameter of valve guide bushings. Replace bushing if inside diameter is **greater than 7.015 mm (0.2762 in.)—FC420V or 7.07 mm (0.278 in.)—FC540V**.

Valve Seats:

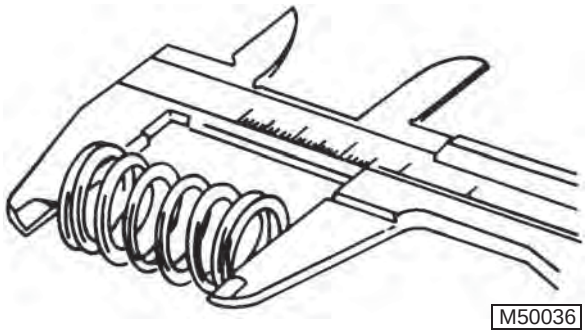
1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.



2. Check valve seating pattern for correct width and evenness all around. If valve seats width is not within **1.10—1.46 mm (0.043—0.057 in.)**, recondition valve seat. (See RECONDITION VALVE SEATS on page 3-54.)
3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. (See LAP VALVES on page 3-54.)

Valve Springs:

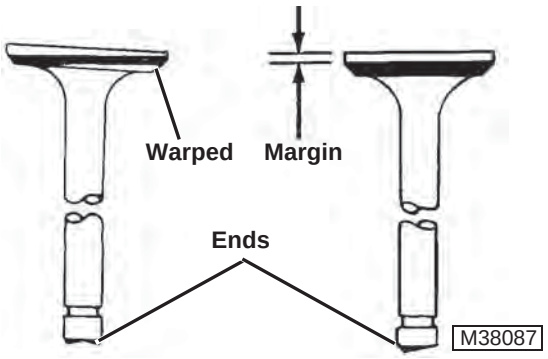
1. Inspect spring for pitting, rust, and burrs. Replace if necessary.



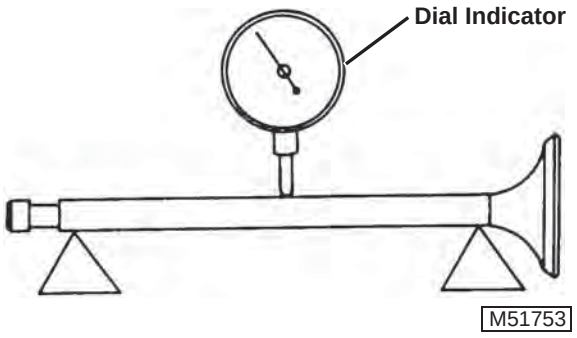
2. Measure spring free length. Replace spring if measurement is **less than 37.50 mm (1.476 in.)**.

Intake and Exhaust Valves:

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.
2. Inspect valve head, face, and stems for defects. Replace if necessary.



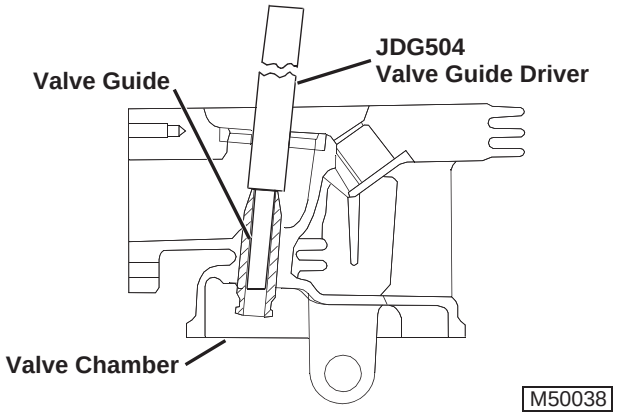
3. Replace warped valves or valves with **less than 0.60 mm (0.024 in.) margin**. Valve stem ends should be ground square before checking valve to tappet clearance.



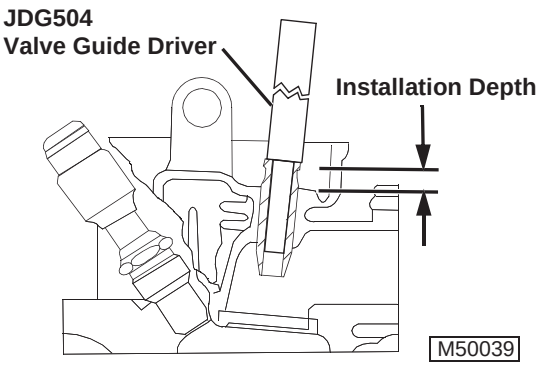
4. Check valve stem for bend using V-blocks and a dial indicator. Turn valve slowly and read variation on indicator. Replace if variation is **greater than 0.03 mm (0.001 in.)**.

Valve Guide Replacement

1. Place cylinder head so that valve seats face up.



2. Drive valve guide out through valve chamber using JDG504 Valve Guide Driver.
3. Clean carbon deposits from valve guide port.
4. Turn cylinder head over so that valve seats face down.



NOTE: A snap ring was used as an installation stop on early model engines. For those engines, drive guides in until snap ring bottoms out on casting.

5. Install new guide using JDG504 Valve Guide Driver. Drive guide to an installation depth of **12 ±0.1 mm (0.472 ±0.004 in.) for FC420V or 9.5 ±0.1 mm (0.370 ±0.004 in.) for FC540V**.
6. Finish reaming valve guides with Stanisol or kerosene lubricant and a **7 mm (0.2756 in.)** valve guide reamer. Turn reamer clockwise. Finished valve guide diameter should be **7.00—7.02 mm (0.275—2.76 in.)**.

ANALYZE VALVES



Lead deposits on the intake valve are caused by exhaust gas leakage past the valve. This indicates that the valve is not seating properly. Grind intake valve and re-face seat to correct this condition.

IMPORTANT: Do not grind the exhaust valve or valve life will be shortened.

NOTE: Be sure to reset valve-to-tappet clearance after grinding valves.



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

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

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



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

IMPORTANT: Do not run engine with blower housing removed.

Poor engine cooling due to dirt or obstructions is a common cause for overheating an engine and valves. Remove blower housing and clean the engine cooling fins.

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



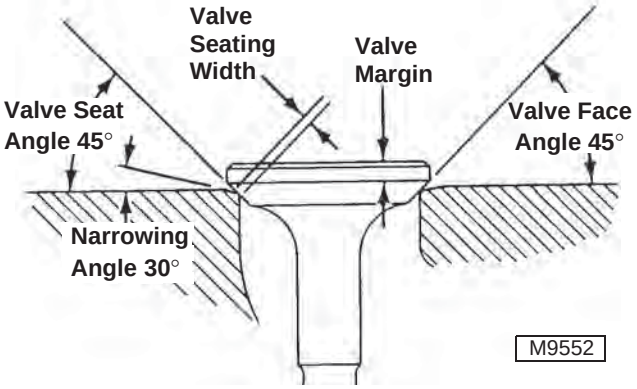
Using old or stale gasoline is a common cause for sticky valves.

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

Always use fresh gasoline. If the machine is to be stored, add an approved fuel strabilizer to the fuel, or drain fuel tank, lines, and carburetor before storing machine.

RECONDITION VALVE SEATS

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

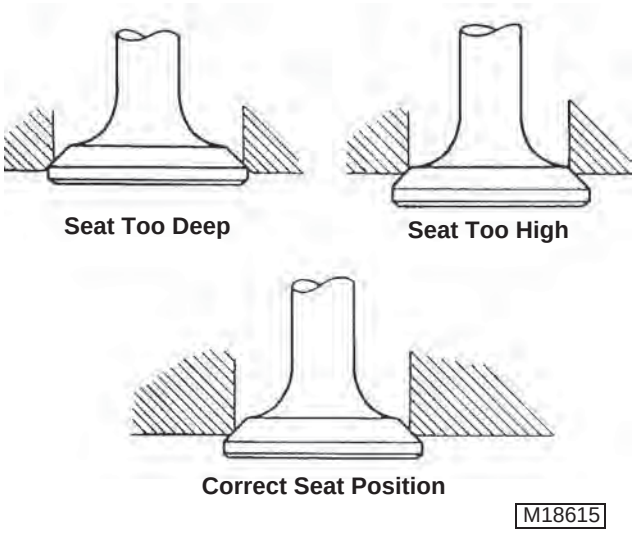


2. To recondition seat, cut at **45° angle** to clean up seat. Cut narrowing angle at **30°**. Finish cut at **45°** to establish valve seating surface width.
3. Cut valve seating surface as close as possible to specifications.

Specifications:

Valve Seating Width (Standard) . . . . . 1.10—1.46 mm (0.043—0.057 in.)
Valve Seat Angle . . . . . 45°
Valve Face Angle . . . . . 45°
Valve Margin . . . . . 0.060 mm (0.024 in.)
Valve Narrowing Angle . . . . . 30°

4. Lap valves to seats after re-facing. (See LAP VALVES.)



5. Center valve seat on the valve face.
6. Check seat for good contact using Prussian Blue Compound.

LAP VALVES

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

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



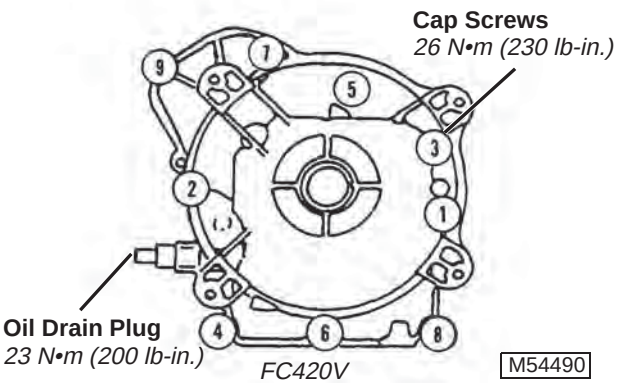
2. Grip top of valve with a vacuum cup tool and turn valve to lap valve to seat.
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
4. Wash all parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on valve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

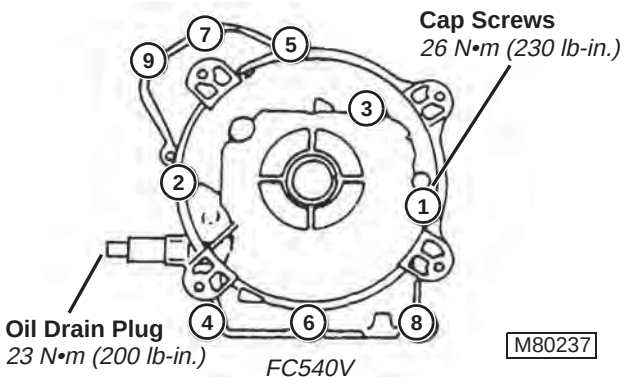
CRANKCASE COVER

Removal/Installation

1. Drain crankcase. Crankcase capacity (with filter) is approximately **1.6 L (3.4 U.S. pt)**.
2. Remove crankcase cover and gasket.
3. Clean crankcase and crankcase cover gasket surfaces.

Installation is done in the reverse order of removal.





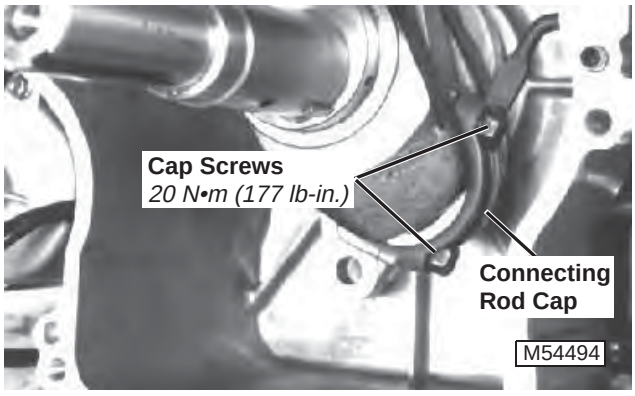
NOTE: Do not force cover. Gears must mesh for proper positioning.

- Use new gasket for installation.
- Tighten mounting cap screws in the sequence shown to **26 N•m (230 lb-in.).**
- Tigthen oil drain plug to **23 N•m (200 lb-in.).**

PISTON AND CONNECTING ROD

Removal

1. Remove cylinder head. (See CYLINDER HEAD—Removal/Installation on page 3-49.)
2. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)
3. Check cylinder bore for carbon and varnish ridges. These ridges can cause piston damage if not removed.
4. If necessary, remove ridge from top of cylinder bore using a ridge reamer.



5. Turn crankshaft to expose connecting rod end caps.
6. Remove cap screws and connecting rod cap.
7. Push piston and connecting rod assembly from cylinder bore.
8. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection procedures.)

Installation

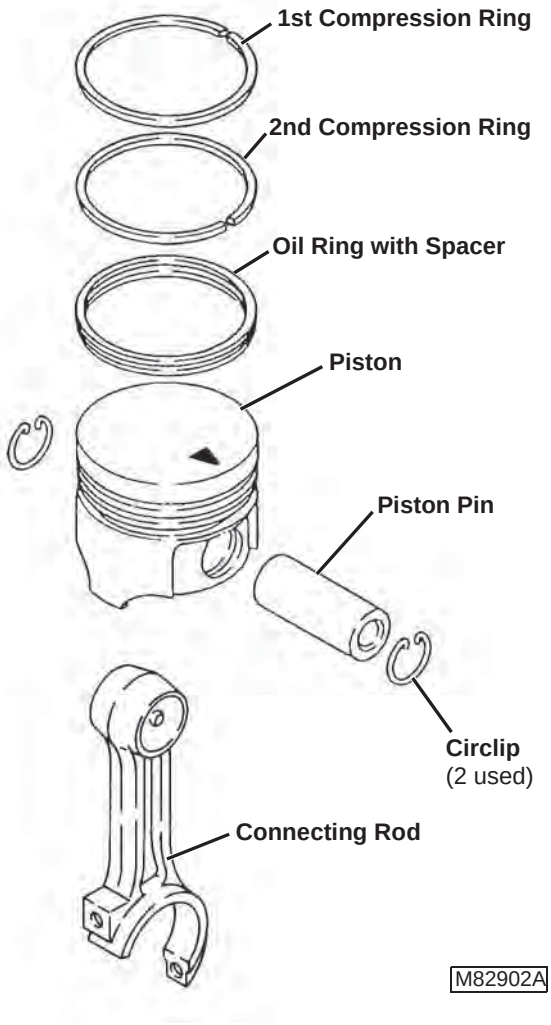
1. Deglaze cylinder bore. (See Deglaze Cylinder Bore on page 3-68.)
2. Stagger piston ring end gaps **180° apart**, but **DO NOT** align with oil ring side rail end caps.



3. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.
4. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
5. Install piston and connecting rod assembly in cylinder bore with engraved match mark/arrow on piston head facing the flywheel side of the engine.
6. Install connecting rod cap and cap screws. Tighten cap screws to **20 N•m (177 lb-in.)**.
7. Install crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)
8. Install cylinder head. (See CYLINDER HEAD—Removal/Installation on page 3-49.)

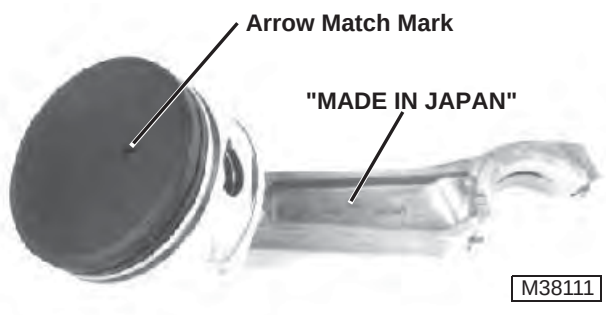
Disassembly

- Analyze piston and piston ring wear. (See ANALYZE PISTON WEAR on page 3-60 and ANALYZE PISTON RINGS WEAR on page 3-58.)
- Remove piston rings using a piston ring expander.
- Inspect all parts for wear or damage. Replace as necessary. (See Inspection procedures.)

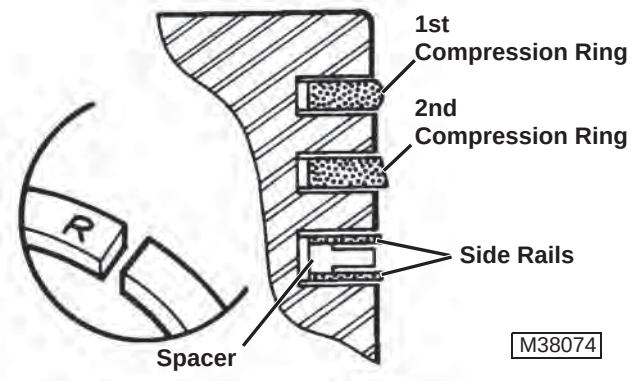


Assembly

- Apply a thin film of clean engine oil to piston pin and connecting rod bearing during assembly.



1. Align arrow match mark on piston head with "MADE IN JAPAN" on connecting rod, or if piston is marked with an "R" or "L", align the "R" or "L" on the piston with the Japanese character on the connecting rod.
2. Install piston pin and circlips.
3. Before installing rings on piston, check ring end gap in cylinder bore. (See Inspection—Piston Ring procedure on page 3-58.)



4. Install oil control and compression rings:

   Oil ring: Install spacer, then side rails. Align side rail end gaps **180° apart** in the position shown.

   Install 2nd compression ring in middle groove with letter mark (R or L) or other mark **facing up**. Ring should turn freely in groove. Turn ring until gap is **120° away from oil ring gap**.

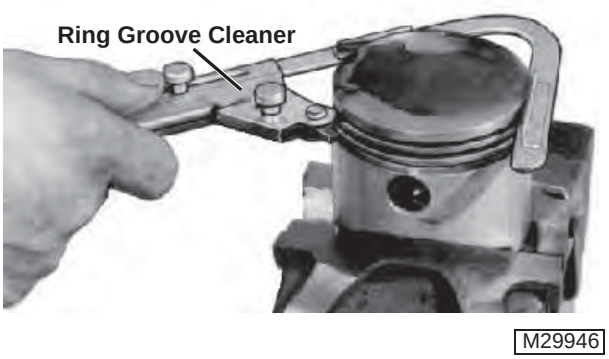
   Install 1st compression ring in top groove. Ring should turn freely in groove. Turn ring until gap is **120° away from second ring gap**.

Inspection

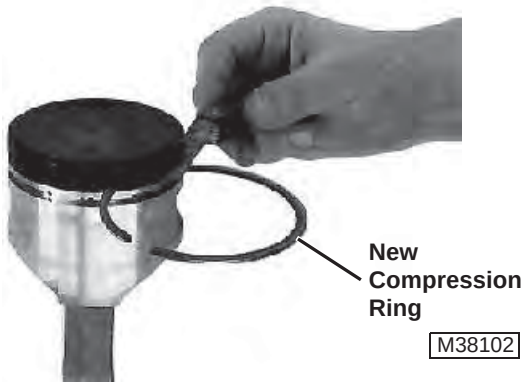
Piston:

IMPORTANT: Do not use a caustic cleaning solution or a wire brush to clean piston.

1. Remove all deposits from the piston.



2. Clean carbon from piston ring grooves with a ring groove cleaner. If cleaning tool is not available, break an old ring and use it to carefully clean groove.
3. Check that all oil return passages in grooves are open.
4. Inspect piston for scoring or fractures. Replace piston if damaged.

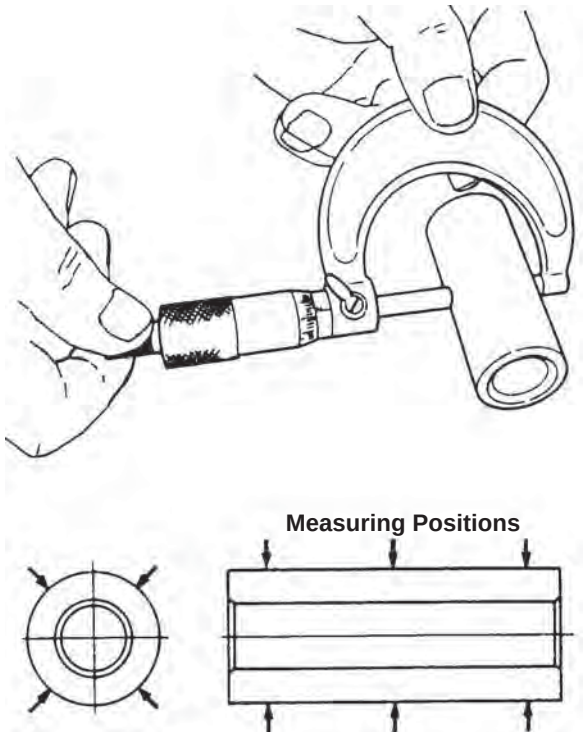


M38102

5. Using a new piston ring and feeler gauge, check ring grooves for wear, at several points around piston. Replace piston if clearance is **greater than** specifications.

Ring Groove Clearance Specifications (Maximum):

1st Compression Ring (Top) . . . . . 0.17 mm (0.007 in.)
2nd Compression Ring (Middle) . . . . . 0.15 mm (0.006 in.)
Oil Control Ring . . . . . 0.20 mm (0.008 in.)

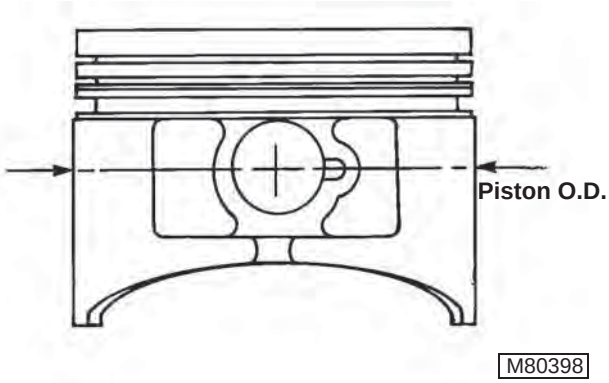


M82050A

6. Measure piston pin diameter at six places. Replace pin if any measurement is **less than 21.98 mm (0.865 in.) for early models or 18.975 mm (0.747 in.) for late models**.


M80427

7. Measure piston pin bore diameter in piston. Replace piston if measurement is **greater than 22.04 mm (0.868 in.) for early models or 19.042 mm (0.7497 in.) for late models**.



M80398

8. Measure piston O.D. perpendicular to piston pin bore. If piston diameter is less than specifications, install a new piston.

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

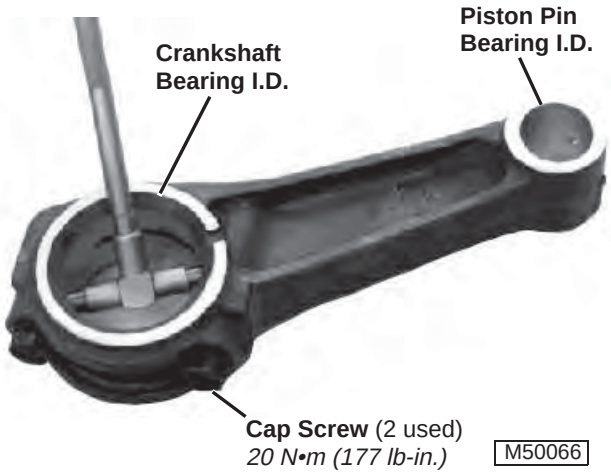
9. Measure cylinder bore diameter. (See CYLINDER BLOCK—Inspection on page 3-68.)
10. Subtract piston O.D. measurement from cylinder bore measurement to determine piston-to-cylinder bore clearance.
11. Replace piston and/or rebore cylinder block if not within specification.

Piston O.D. Specifications:

Standard Piston . . . . . 88.83—88.864 mm . . . . . (3.4885—3.4984 in.)
Oversize Piston
0.50 mm (0.020 in.) . . . . . 89.330—89.364 mm . . . . . (3.517—3.518 in.)
Piston-To-Cylinder Bore Clearance
. . . . . **0.011—0.151 mm (0.0043—0.0059 in.)**

Connecting Rod:

1. Analyze crankshaft and connecting rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR on page 3-67.)
2. Clean and inspect rod. Replace if scored.



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

*NOTE: If the engine has had a previous overhaul, an undersized connecting rod may have been installed. A **0.50 mm (0.020 in.) undersized rod** is available.*

4. Measure connecting rod crankshaft bearing inside diameter and piston pin bearing inside diameter. Replace connecting rod if either measurement is greater than specifications.

Connecting Rod Bearing I.D. (Maximum):

Crankshaft Bearing
Standard . . . . . 41.07 mm (1.617 in.)
Undersized . . . . . 40.56 mm (1.597 in.)
Piston Pin Bearing
Early Models . . . . . 22.06 mm (0.869 in.)
Late Models . . . . . 19.051 mm (0.750 in.)

Piston Rings:



1. Measure thickness of top and second compression rings at several places. Replace rings if thickness is **less than 1.94 mm (0.076 in.)**.
2. Check piston ring end gap:
   - Install compression ring using a piston to position it squarely in bore approximately **25.4 mm (1.0 in.)** down from top of cylinder.
   - Check end gap. Replace ring if end gap is **greater than** specifications.

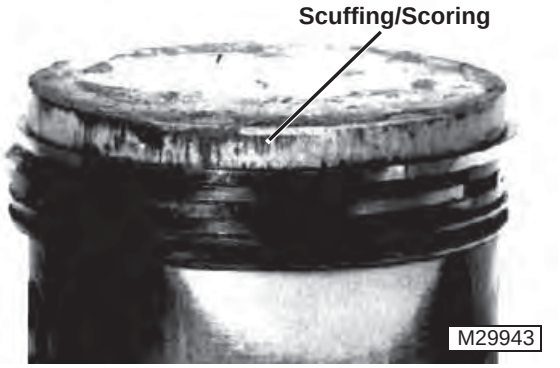
Ring End Gap Specifications:

Minimum End Gap . . . . . 0.18 mm (0.007 in.)
Maximum End Gap
Compression Rings (top and second)
Early Models . . . . . 0.90 mm (0.035 in.)
Late Models . . . . . 1.50 mm (0.059 in.)
Oil Control Rings
Side Rails . . . . . 1.30 mm (0.051 in.)

ANALYZE PISTON RING WEAR

Rings of the wrong size or rings having improper end gaps will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

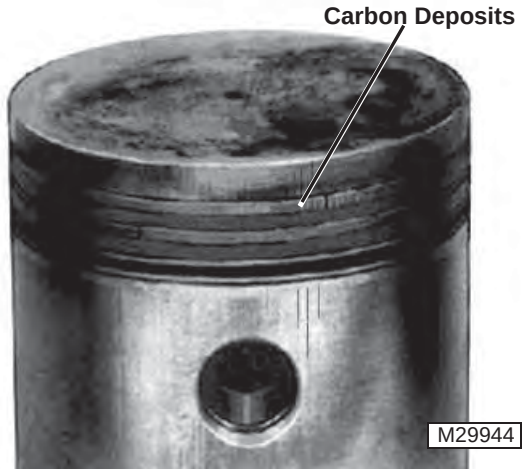
Ring end gaps should be staggered on the piston during installation. (See PISTON AND CONNECTING ROD on page 3-55.) End gaps in alignment can also cause oil consumption and blow-by.



Light scuffing or scoring of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston.

When this condition exists, it is due to one or more of the following probable causes:

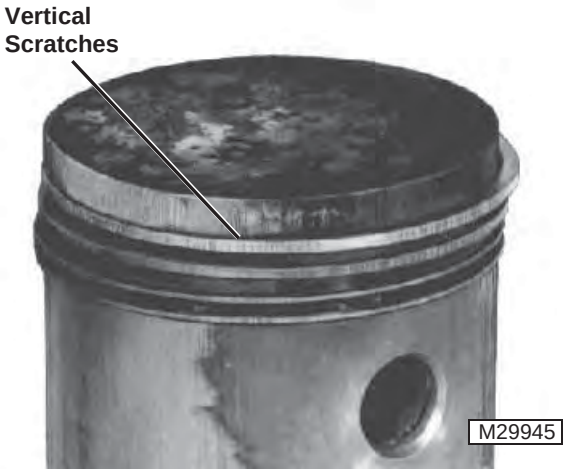
- Dirty cooling shroud and cylinder head.
- Lack of cylinder lubrication.
- Improper combustion.
- Wrong bearing or piston clearance.
- Too much oil in crankcase causing fluid friction.



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

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

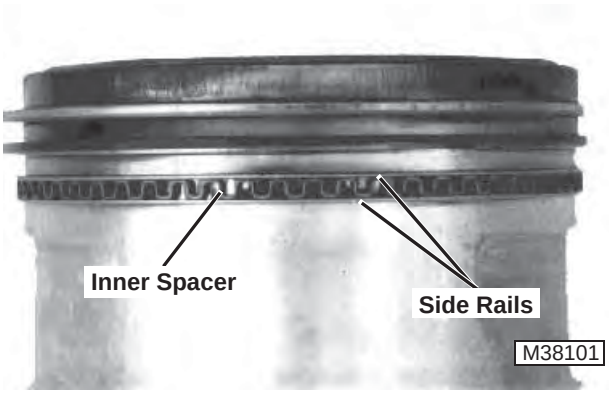
- Overloading.
- Incorrect ignition timing.
- Lean fuel mixture.
- Dirty cooling fins.
- Incorrect oil.
- Low oil supply.
- Stale fuel.



Vertical scratches across the piston rings are due to an abrasive in the engine. Abrasives may be airborne, may have been left in the engine during overhaul, or may be loose lead or carbon deposits.

When this condition exists, check for one or more of the following:

- Damaged, collapsed or improperly installed air filter.
- Loose connection or damaged gasket between air cleaner and carburetor.
- Air leak around carburetor-to-cylinder head gasket.
- Air leak around throttle shaft.
- Failure to properly clean cylinder bore after reconditioning engine.



Abrasive particles in engine oil cause scratches on side rails of oil control ring. Inner spacer wear or distortion may cause:

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

Increased oil consumption may be caused by:

- Worn side rails with low tension.
- Worn or distorted inner spacer.

ANALYZE PISTON WEAR

Detonation is abnormal combustion causing excessive temperature and pressure in the combustion chamber. Commonly called knock, spark knock, or timing knock, detonation occurs as the compressed fuel-air mixture ignites spontaneously to interrupt the normal ignition.


M29947

The following is a list of possible causes for detonation.

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



M30039

Pre-ignition is the igniting of the fuel-air mixture prior to regular ignition spark. Pre-ignition causes shock, resulting in pings, vibration, detonation and power loss. Severe damage to piston, rings and valves results from pre-ignition.

Check the following for causes of pre-ignition:

- Internal carbon deposits.
- Incorrect spark plug (high heat range).
- Broken ceramic in spark plug.
- Sharp edges on valves.
- Sharp edges in combustion chamber.



M29948

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

A cylinder bored at an angle to the crankshaft can also cause improper ring contact with the cylinder.

This condition causes:

- Rapid piston wear.
- Uneven piston wear.
- Excessive oil consumption.



M29949

A broken retaining ring caused the damage shown.

Retaining rings loosen or break due to:

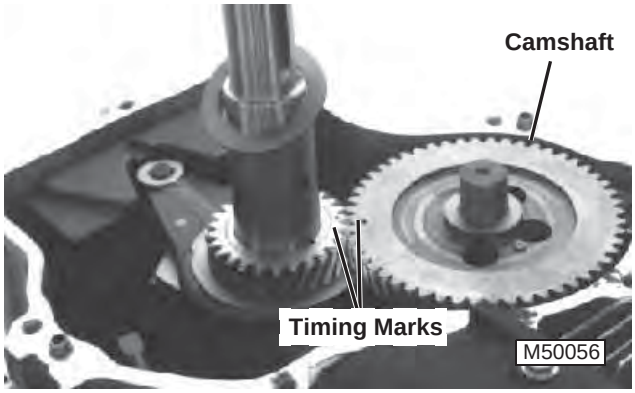
- Rod misalignment.
- Excessive crankshaft end play.
- Crankshaft journal taper.
- Weak retaining rings.
- Incorrectly installed retaining rings.

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

CAMSHAFT AND TAPPETS

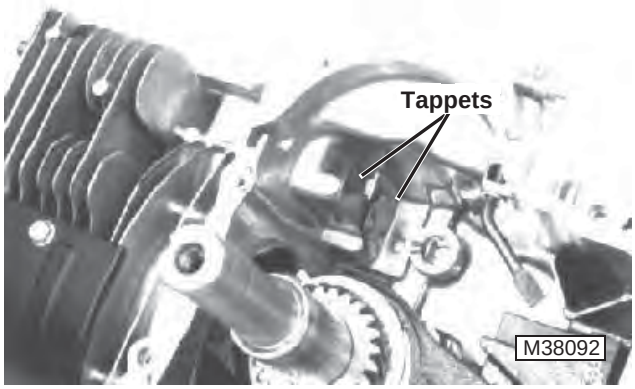
Removal

1. Remove crankshaft cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)



IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.

2. Rotate crankshaft until timing marks align.
3. Remove and inspect camshaft. (See Inspection procedures.)

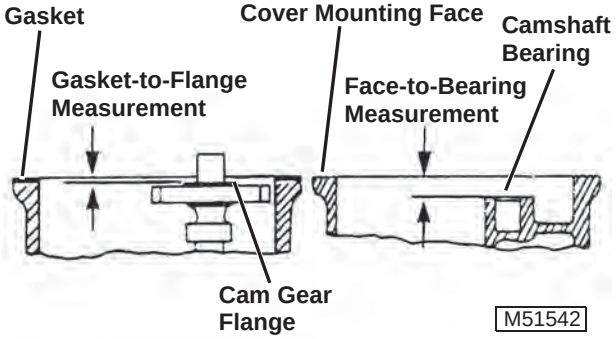


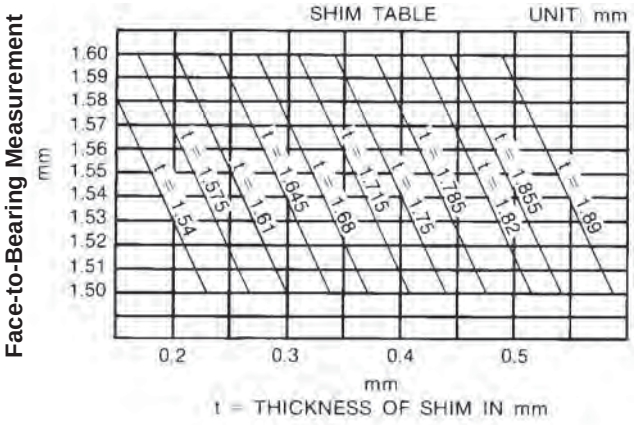
NOTE: Mark tappets so they can be installed in their original bores during assembly.

4. Remove and inspect tappets for wear or damage. Replace if necessary.

Installation

1. Apply a light coat of clean engine oil to tappets and bores and install tappets in original bores.
2. Apply a light coat of clean engine oil to camshaft lobes and journals.
3. Align timing mark with crankshaft and install camshaft.





Gasket-to-Flange Measurement

M51543

4. FC540V Only (Serial Number —014454) Check and adjust camshaft axial play.

*NOTE: Axial play of camshaft after adjustment should be **0.07—0.19 mm (0.0028—0.0075 in.)**.*

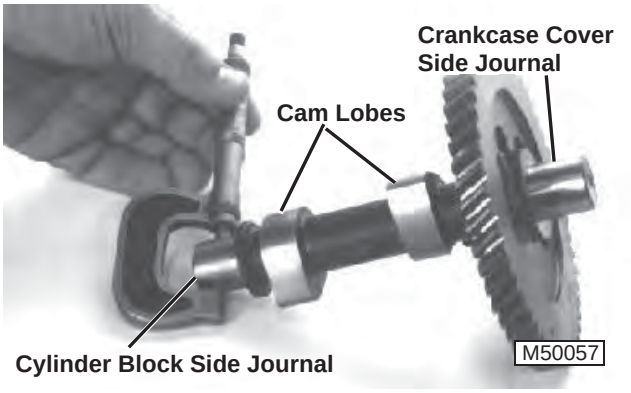
- With gasket installed on crankcase, measure from gasket surface to cam gear timing flange. Record this measurement.
- Measure from crankcase cover mounting face to camshaft bearing end. Record this measurement.
- Locate measurement on shim table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from table.
- Install shim to cam gear timing flange, with chamfered side of shim toward cam gear.

5. Install crankcase cover.

Inspection

1. Inspect camshaft for worn or broken teeth.

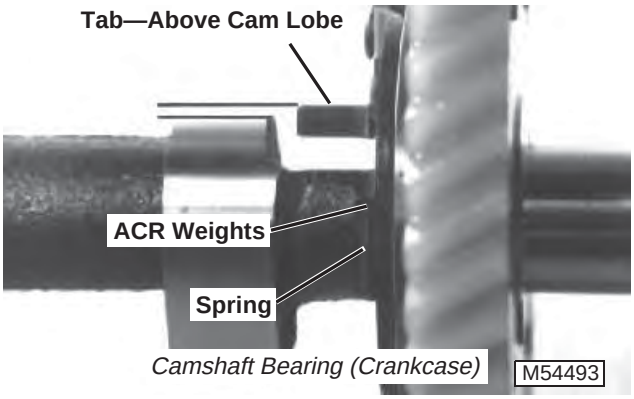
NOTE: Camshaft and tappets are a matched set. Replace both camshaft and tappets if necessary.



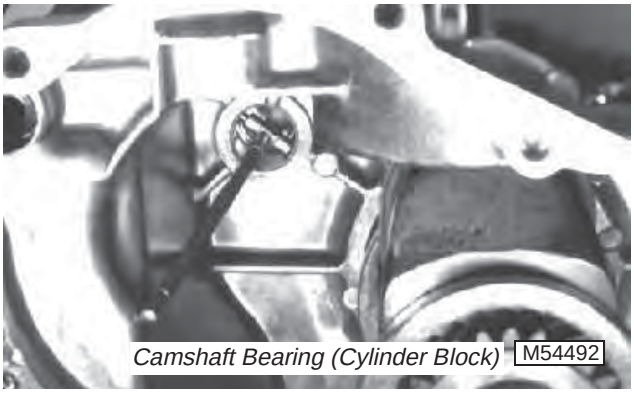
2. Measure cylinder block side journal, crankcase cover side journal and cam lobe height. Replace camshaft and tappets if any measurement is less than specifications.

Camshaft Specifications (Minimum):

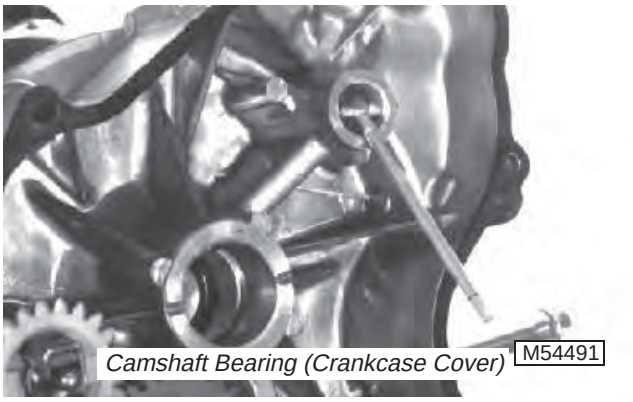
Crankcase Cover Side Journal
Both Engines . . . . . 20.912 mm (0.8233 in.)
Cylinder Block Side Journal
FC420V . . . . . 19.912 mm (0.7839 in.)
FC540V . . . . . 20.912 mm (0.8233 in.)
Cam Lobe Height
FC420V . . . . . 36.75 mm (1.447 in.)
FC540V . . . . . 37.10 mm (1.461 in.)



3. Inspect Automatic Compression Release (ACR) for damage.
4. Inspect spring for wear or damage. Replace if necessary.
5. Move weights by hand to check for proper operation.
6. Check that tab sits slightly above cam lobe when weights are released. Tab should drop below cam when weights are engaged.



7. Measure camshaft bearings in cylinder block. Replace block if inside diameter is **greater than 20.076 mm (0.7904 in.)—FC420V or 21.076 mm (0.8298 in.)—FC540V.**

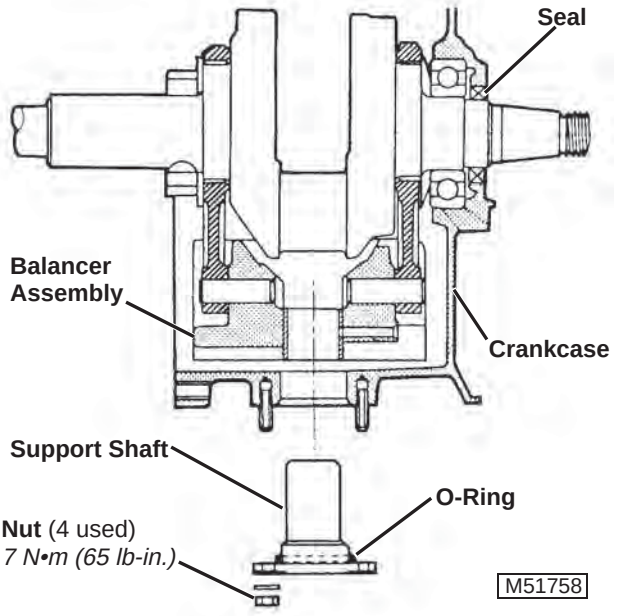


8. Measure camshaft bearings in crankcase cover. Replace cover if inside diameter is **greater than 21.076 mm (0.8298 in.)—both engines**.

RECIPROCATING BALANCER

Removal/Installation

1. Remove flywheel, camshaft and piston.

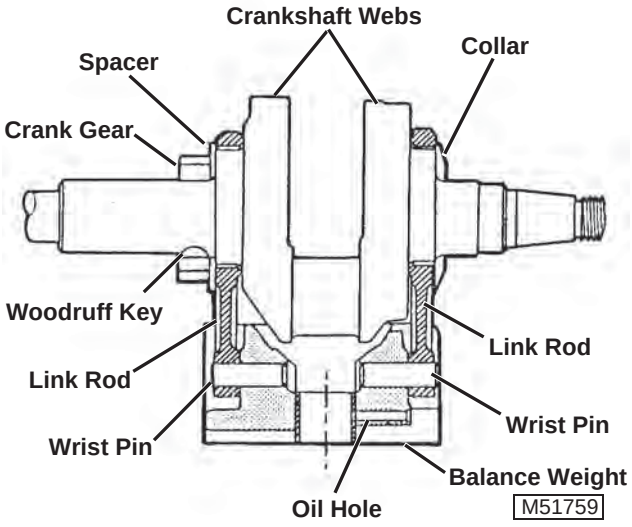


2. Remove four nuts, washers, support shaft and o-ring. Discard o-ring.
3. Remove crankshaft with balancer assembly from crankcase.
4. Remove and discard crankshaft oil seals from cylinder block and crankcase cover. (See CRANKCASE OIL SEAL—Cylinder Block and CRANKCASE OIL SEAL—Crankcase Cover replacement procedures on page 3-65.)
5. Inspect balancer assembly. (See Inspection Procedure on page 3-64.)

Installation is done in the reverse order of removal:

- Install new crankshaft oil seals. (See CRANKCASE OIL SEAL—Cylinder Block and CRANKCASE OIL SEAL—Crankcase Cover replacement procedures on page 3-65.)
- Cover keyway on flywheel end of crankshaft with tape to prevent damage to seal when installing assembly.
- Apply a light coat of clean engine oil on crankshaft bearing surfaces.
- Install new o-ring on support shaft.
- Tighten support shaft nuts to **7 N•m (65 lb-in.).**
- Adjust crankshaft end play. (See CRANKSHAFT AND MAIN BEARINGS—End Play Adjustment on page 3-66.)

Disassembly/Assembly



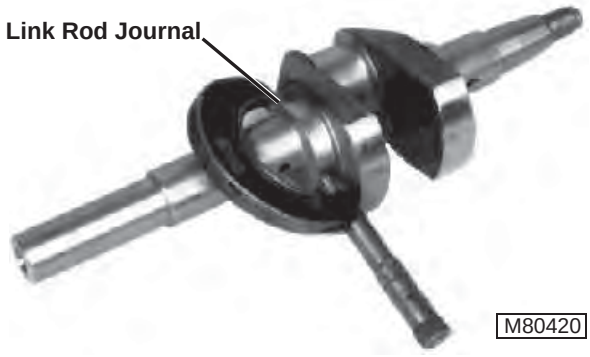
1. Remove collar, gear, key and spacer.
2. Remove link rods and crankshaft.
3. Inspect crankshaft. (See CRANKSHAFT AND MAIN BEARINGS—Inspection on page 3-65.)
4. Inspect balancer assembly. (See Inspection Procedure.)

Assembly is done in the reverse order of disassembly:

- Apply a light coat of clean engine oil on bearing surfaces.
- Install link rods with oil grooves away from crankwebs.
- Install balance weight to crankshaft with oil hole, if equipped, facing flywheel side.
- Install spacer with chamfered face toward link rod.
- Install collar with cone face away from link rod.

Inspection

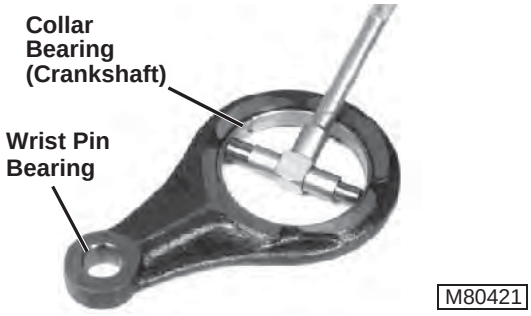
1. Clean and inspect all parts for obvious wear or damage. Replace parts as necessary.



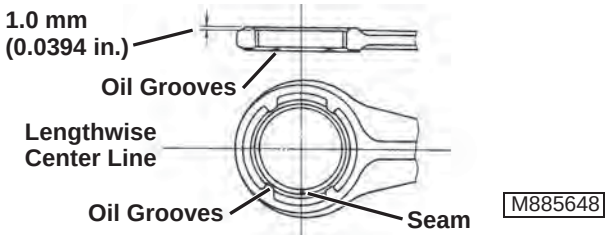
2. Measure link rod journal diameters on crankshaft. Replace crankshaft if diameters are **less than** specifications.

Minimum Link Rod Journal O.D.

FC420V . . . . . 53.950 mm (2.1240 in.)
FC540V . . . . . .57.941 mm (2.2811 in.)

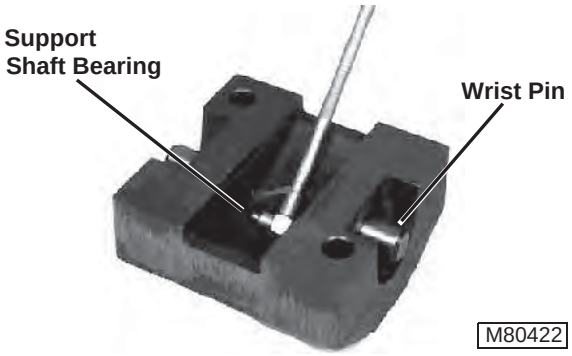


3. Measure inside diameter of link rod bearings. Replace link rod if either bearing is **greater than** specifications.



4. Install large end bearing from opposite side of oil grooves with seam at right angle to lengthwise center line.

Maximum Link Rod Bearing I.D.
Wrist Pin Bearing . . . . . 12.601 mm (0.4961 in.)
Collar Bearing (Crankshaft)
FC420V. . . . . 54.121 mm (2.1307 in.)
FC540V. . . . . 58.153 mm (2.2895 in.)
Bearing Installation Depth Below Surface:
Both Ends . . . . . 1.0 mm (0.0394 in.)

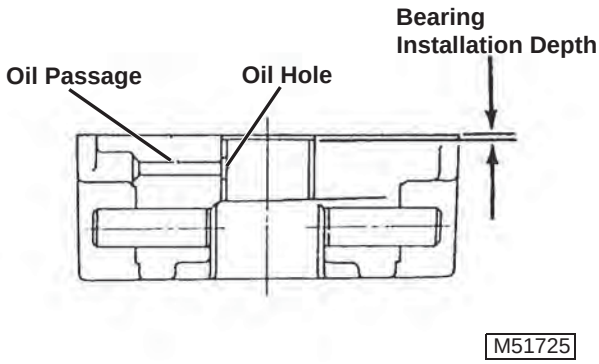


5. Measure support shaft bearing diameter. Replace bearing if measurement is **greater than 26.097 mm (1.0274 in.)**.
6. Inspect wrist pins for wear or damage.



7. Measure support shaft diameter. Replace shaft if diameter is **less than 25.927 mm (1.0208 in.)**.

Bearing Replacement



NOTE: Replace bearing using a driver set and a press.

1. Align oil hole in bearing with oil passage in weight.
2. Install bearing below surface to a depth of **0.50 mm (0.0197 in.)**.
3. Balancer oil passage installed to flywheel side.

CRANKSHAFT END PLAY TEST

Reason:

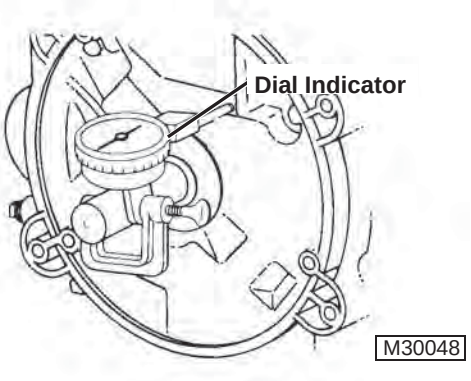
To ensure crankshaft or case halves are within wear tolerances.

Test Equipment:

- Dial Indicator

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move transaxle shift lever or forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 and 10-30.)
6. Remove PTO clutch assembly. (See PTO CLUTCH—Removal/Installation on page 5-195.)



7. Measure end play using a dial indicator. Move crankshaft in and out. Crankshaft end play specification is **0.09—0.22 mm (0.004—0.009 in.)**.

Results:

- If not within specifications, remove crankcase cover and adjust end play. (See CRANKSHAFT AND MAIN BEARINGS on page 3-63.)

CRANKSHAFT AND MAIN BEARING

Removal/Installation

1. Remove reciprocating balancer. (See RECIPROCATING BALANCER—Removal/Installation on page 3-63.)
2. Remove balancer from crankshaft.
3. Inspect crankshaft for wear or damage. (See Inspection procedures.)

Installation is done in the reverse order of removal.

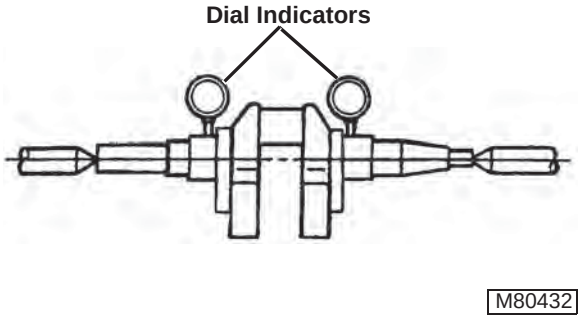
- Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
- Apply a light film of clean engine oil on crankshaft bearing surfaces before installation.
- Pack oil seals with lithium base grease.

Inspection

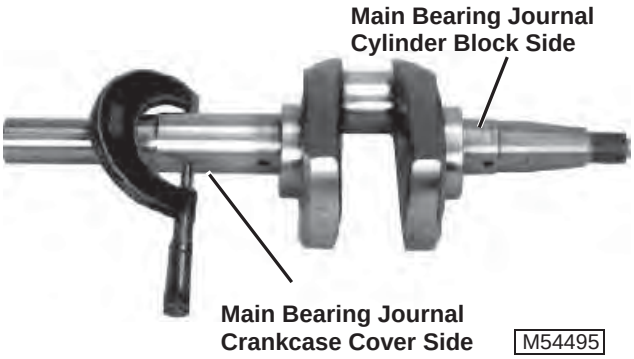
1. Analyze crankshaft and connecting rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR on page 3-67.)

IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.

2. Clean and inspect crankshaft. Replace if scratched, damaged or worn beyond specifications.

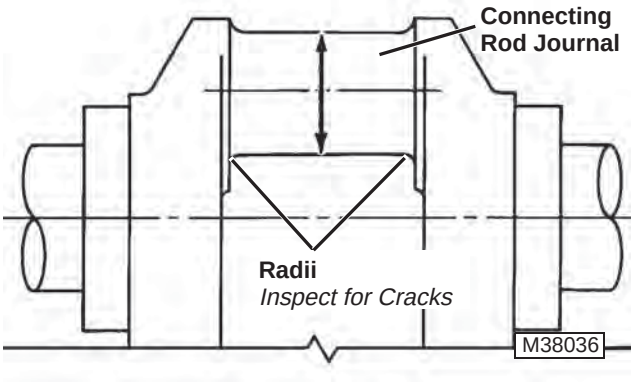


3. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators to measure maximum Total Indicated Runout (TIR). If runout exceeds **0.05 mm (0.002 in.)**, replace crankshaft.



4. Measure main bearing journal diameters. Replace crankshaft if either journal O.D. is **less than** specifications**.**

Crankshaft Main Bearing Journals (Minimum)
Crankcase Cover Side—
FC420V . . . . . 34.919 mm (1.3747 in.)
FC540V . . . . . 37.904 mm (1.4923 in.)
Cylinder Block Side—
Both Engines . . . . . 34.945 mm (1.3757 in.).



NOTE: If the engine has had a previous overhaul, the connecting rod journals may have been resized to accept an undersized rod. 0.50 mm (0.020 in.) undersized rod is available.

5. Measure connecting rod journal diameter and inspect journal radii for cracks. Replace crankshaft if any journal diameter is less than specifications.

Connecting Rod Journal O.D. (Minimum):

Standard . . . . . .40.928 mm (1.6113 in.)
Undersize . . . . . 40.47—40.48 mm
. . . . . (1.5932—1.5937 in.)

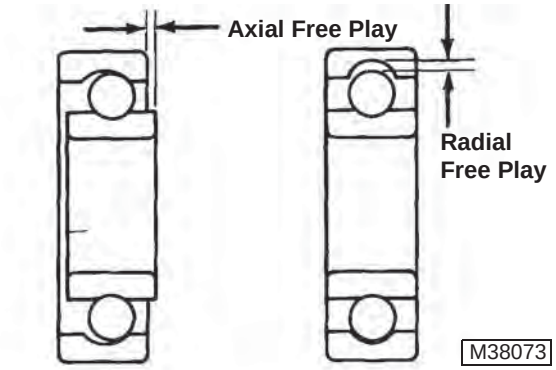


6. Measure crankshaft main bearing inside diameter in crankcase cover. Replace crankcase cover if bearing I.D. is greater than specifications.

Crankcase Cover Crankshaft Bearing I.D. (Maximum):

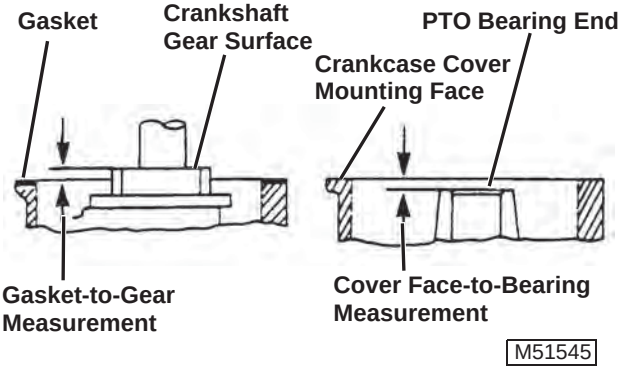
FC420V. . . . . 35.069 mm (1.3807 in.)
FC540V. . . . . 38.056 mm (1.4983 in.)

7. Inspect cylinder block crankshaft main ball bearing:
   - Remove oil seal.
   - Remove crankshaft bearing using appropriate driver set.
   - Thoroughly clean bearing in solvent. Dip bearing in light-weight oil.

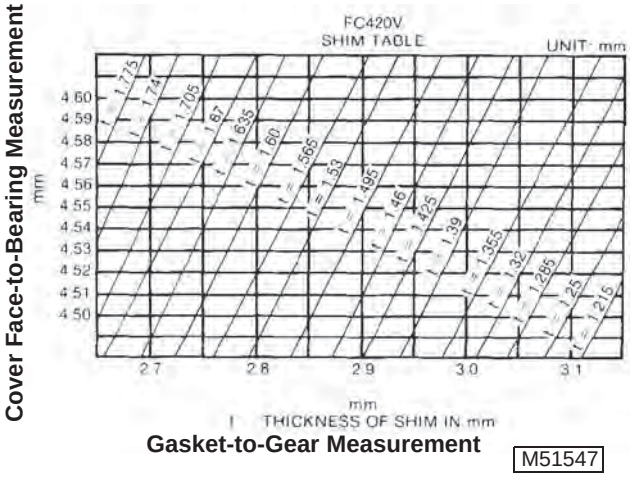


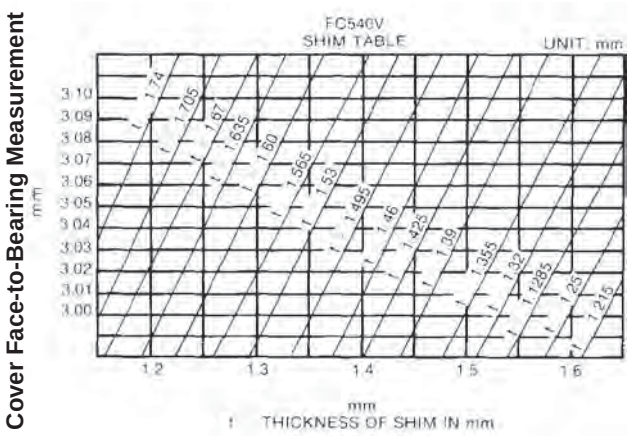
- Spin the bearing by hand and check for axial and radial free play. Replace the bearing if it is noisy or has too much free play.
- Install bearing flush to inside of crankcase.

End Play Adjustment



1. With gasket installed on crankcase, measure from gasket surface to crankshaft gear surface. Record measurement.
2. Measure from crankcase cover mounting face to PTO bearing end. Record measurement.



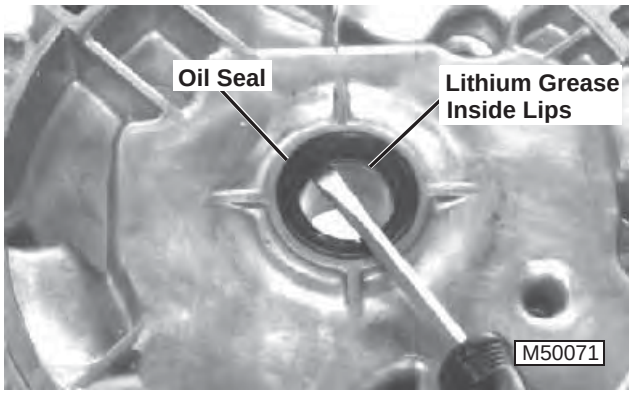


Gasket-to-Gear Measurement M51546

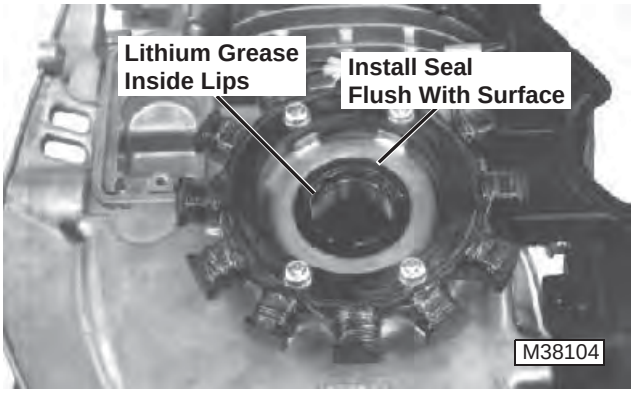
3. Locate measurement on table. Follow lines to where recorded measurements intersect. Choose the next smaller shim from the shim table.
4. Install shims on end of crankshaft.

CRANKSHAFT OIL SEALS

Replacement



1. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)
2. Remove worn or damaged seal using a screwdriver. DO NOT damage bore surfaces.
3. Pack lithium based grease inside lips of seals.
4. Install seal with spring-held seal lip toward inside of engine using appropriate driver set.
5. Press in seal to specification.



6. Remove crankshaft. (See CRANKSHAFT AND MAIN BEARING—Removal/Installation on page 3-65.)
7. Remove worn or damaged seal using a screwdriver. DO NOT damage bore surfaces.
8. Pack lithium based grease inside lips of seals.
9. Install seal with spring-held seal lip toward inside of engine using seal and driver set.
10. Press in seal to specification.

Oil Seal Installation Depth:

Both Sides/Both Engines . . . . . flush with surface

ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR

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

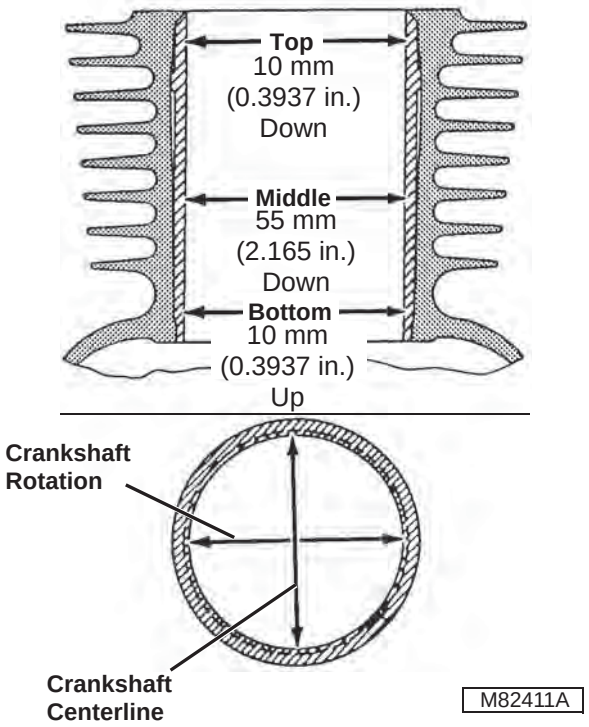
Lack of lubrication or improper lubrication can cause the connecting rod and cap to seize the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can also result from:

- Engine run low on oil or without oil.
- Engine run continually on too severe a slope for too long a time.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

CYLINDER BLOCK

Inspection



1. Clean block and check for cracks:
   - Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil.
   - Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol.
   - If crack is present, coating becomes discolored at the defective area.
   - Replace block if any cracks are found.
   - A bare block is available for service.
2. Measure cylinder bore diameter at three positions; **top—10 mm (0.3937 in.) from top of block**, **middle—55 mm (2.165 in.) from top of block**, and **bottom—10 mm (0.3937 in.) from bottom of cylinder**. At these three positions, measure, in both directions, along crankshaft centerline and direction of crankshaft rotation.

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

Cylinder Bore I.D.:

Standard Size Bore:

Standard . . . . . 88.980—89.000 mm
. . . . . (3.5031—3.5039 in.)
Wear Limit. . . . . 89.076 mm (3.5069 in.)

Oversize Bore—0.50 mm (0.020 in.):

Standard . . . . . 89.480—89.500 mm
. . . . . (3.5228—3.5236 in.)
Wear Limit. . . . . 89.576 mm (3.5266 in.)

3. If cylinder bore exceeds wear limit, rebore cylinder or replace cylinder block. (See Rebore Cylinder Block on this page.)

NOTE: If cylinders are rebored, oversize piston and rings must be installed.

Deglaze Cylinder Bore

1. Deglaze cylinder bore using a rigid hone with a coarse grit stone initially and fine grit stone for the final finish.
2. Use hone as instructed by manufacturer to obtain a 45° crosshatch pattern.

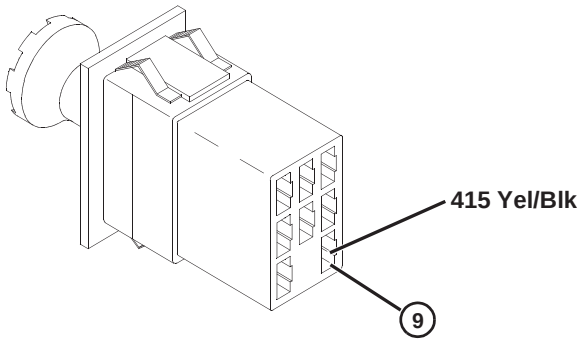
IMPORTANT: DO NOT use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

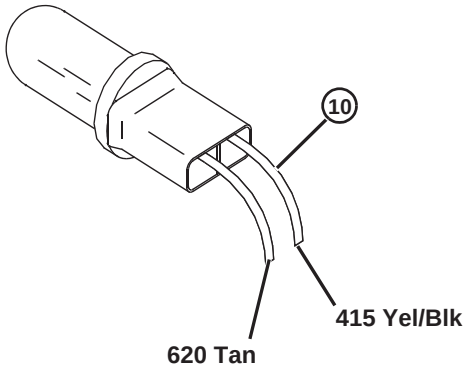
3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.
4. Dry cylinder and apply a light coat of clean engine oil.

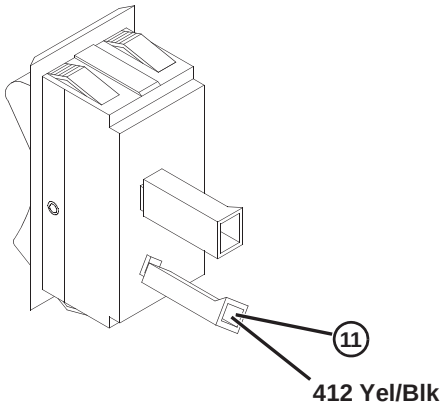
Rebore Cylinder Block

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

NOTE: The cylinder block can be rebored to use 0.50 mm (0.020 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use a drill press and honing tool. Rebore cylinder with honing tool to an initial (coarse grit stone) and a final (fine grit stone) bore according to below specifications.


415 Yel/Blk
9


10
415 Yel/Blk
620 Tan


11
412 Yel/Blk

CRANKING CIRCUIT OPERATION

Function:

The cranking system is used to energize the starting motor.

Operating Conditions:

- Key switch in START position.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- PTO switch in OFF position.

NOTE: The operator does not have to be in the seat (seat switch closed) to crank engine.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The starting motor is a solenoid shift design. The power circuit provides current to the key switch (S1) and protects the cranking circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the starter solenoid battery terminal, fusible link (F1) and key switch battery terminal. With the key switch in the START position, current flows to the 15-amp fuse (F3), and PTO switch (S4).

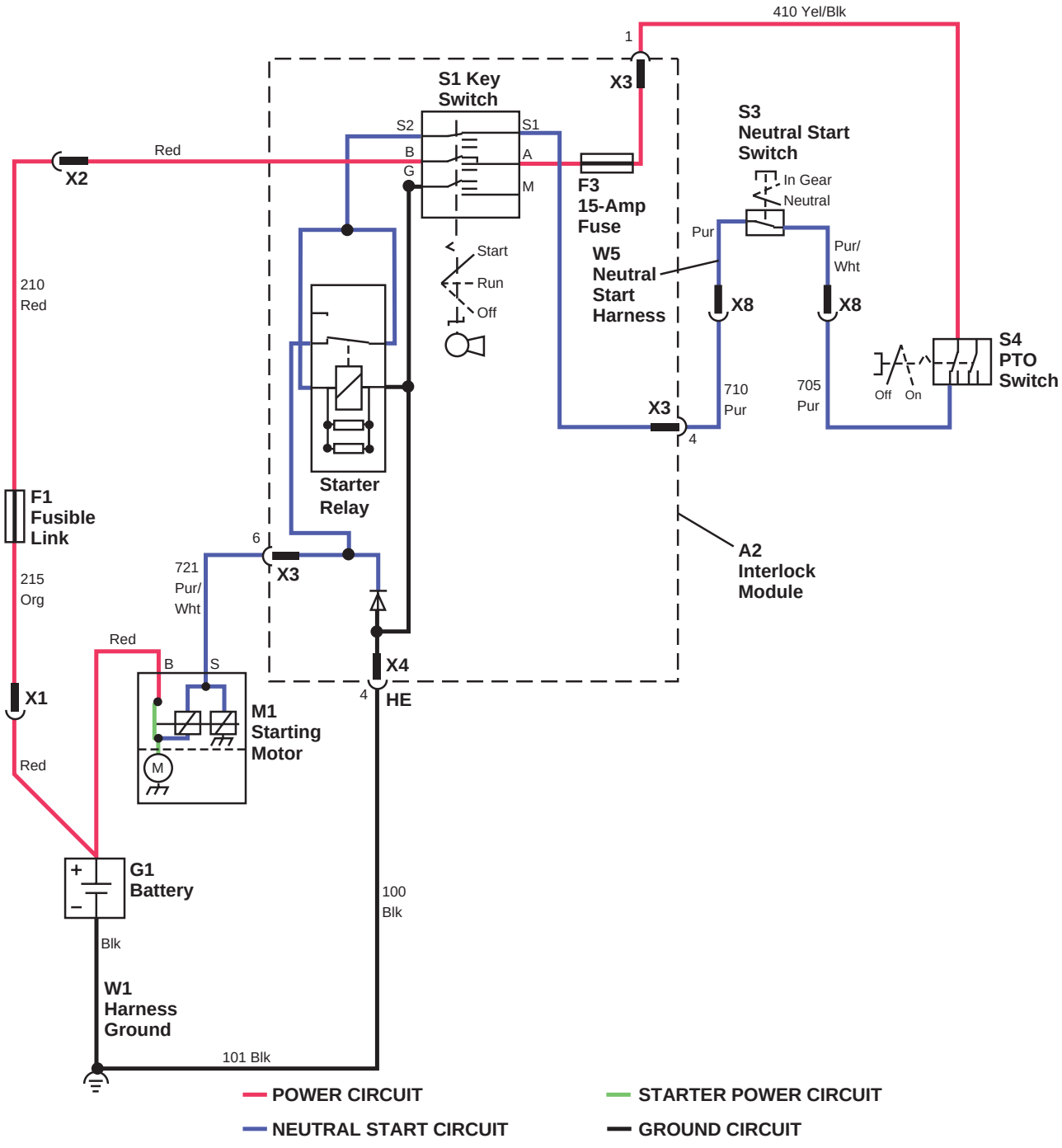
The PTO switch is used in the neutral start circuit to prevent the engine from cranking if the PTO is engaged. With the PTO switch closed (PTO disengaged), current flows to the neutral start switch (S3).

The neutral start switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral. The neutral start switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

With the neutral start switch closed, current flows to key switch S1-S2 terminals, to starter relay, to starter solenoid. The solenoid is engaged by current flowing through both pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in windings stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

CRANKING CIRCUIT OPERATION



MC83677

CRANKING CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid bolt—battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215 fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.

Test Conditions:

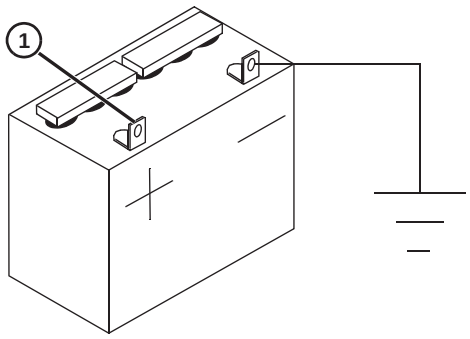
- Key switch in RUN position—engine not running.

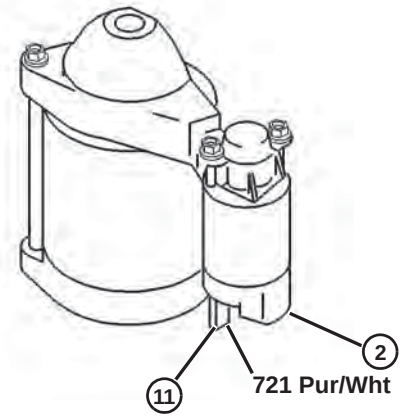
Test/Check Point	Normal	If Not Normal
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
5. PTO switch.	Battery voltage.	Test yellow/black wire No. 410 and connections.
6. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Neutral start switch.	Battery voltage.	Test purple wire No. 705 or purple/white wire—W5 harness.
8. Neutral start switch.	Battery voltage.	Test neutral start switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710 or purple wire—W5 harness and connections.

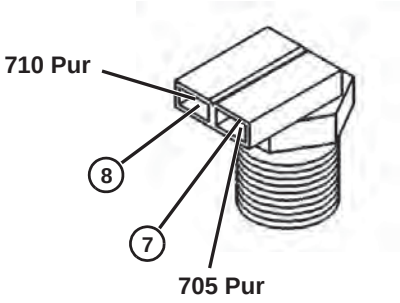
Test Conditions:

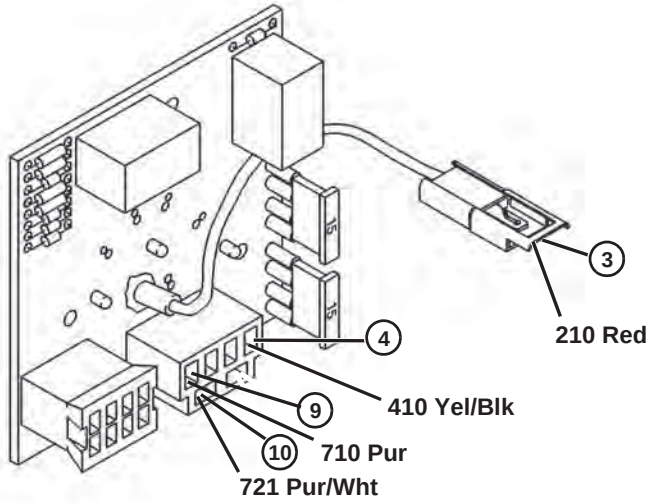
- Spark plug lead disconnected and grounded.
- Key switch in START position.

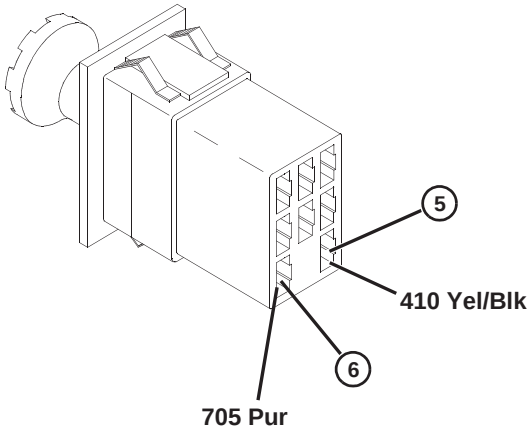
Test/Check Point	Normal	If Not Normal
10. Interlock module—terminal X3—6.	Battery voltage.	Replace interlock module.
11. Starter solenoid.	Battery voltage.	Check purple/white wire No. 721 and connections.


1


2
11
721 Pur/Wht


710 Pur
8
7
705 Pur


3
210 Red
4
9
410 Yel/Blk
10
710 Pur
721 Pur/Wht


5
410 Yel/Blk
6
705 Pur

IGNITION CIRCUIT OPERATION

Function:

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

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

  or
- PTO switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the ignition module (A1) and is not adjustable. The engine is shut off by grounding the ignition coil through the key switch (terminals M and G). The ignition coil is grounded (spark stopped) if the operator gets off the seat with the PTO or transmission engaged.

The ignition relay (K1) when energized by the neutral start circuit or seat switch circuit, eliminates a path to ground, therefore a spark cannot be produced. The power circuit provides current to the key switch (S1) and protects the ignition circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch (S1) in the START or RUN position, current flows to the 15-amp fuse, ignition relay, PTO switch (S4) and seat switch (S2).

The PTO switch is also used in the neutral start circuit to prevent the engine from starting if the PTO is engaged. With the PTO switch in the OFF position, current flows to the neutral start switch (S3).

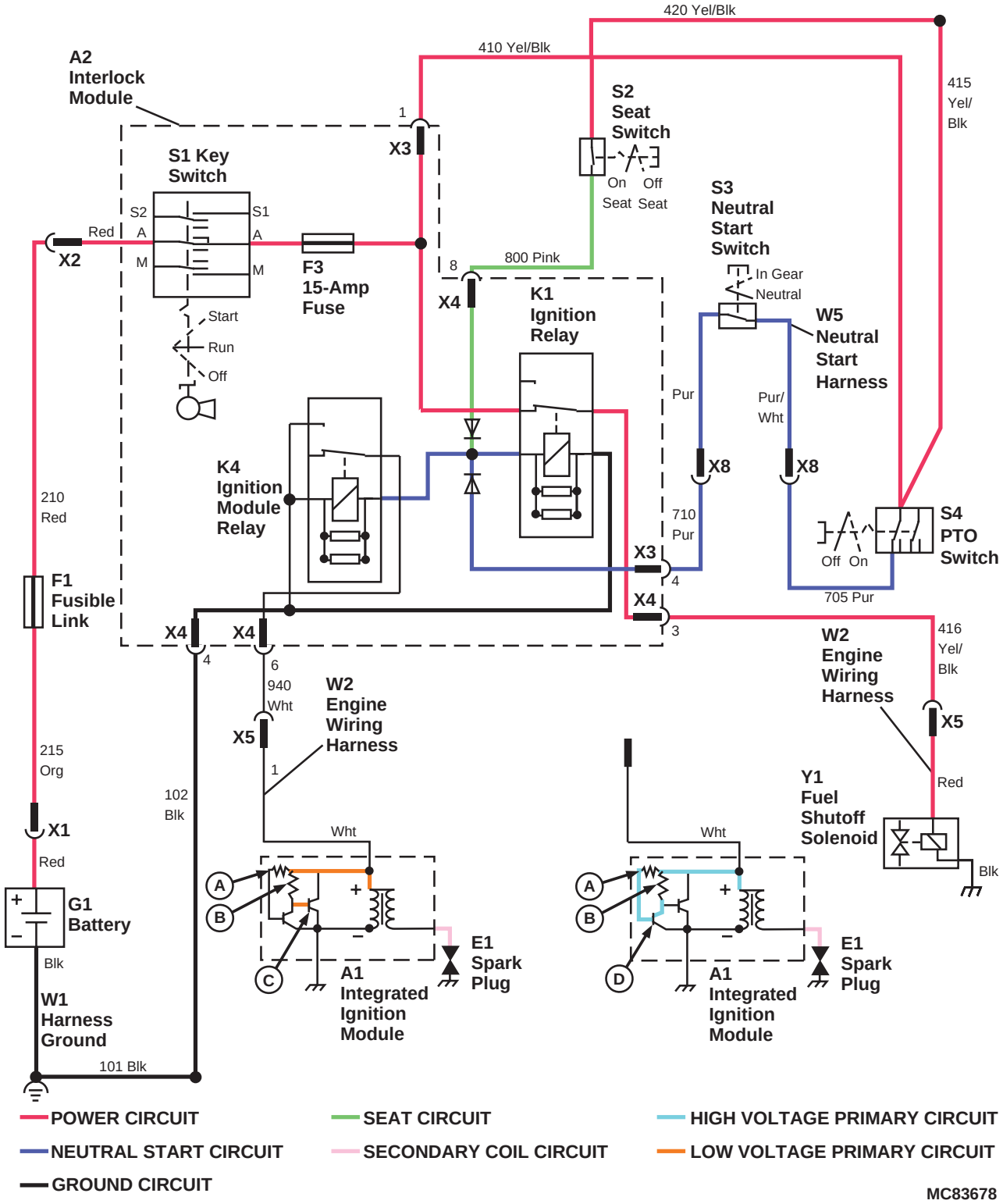
The neutral start switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral. The neutral start switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

With the neutral start switch closed, current flows to the ignition relay energizing the coil, closing the relay. Closing the relay breaks the path to ground for the ignition coil current and sends current to the fuel shutoff solenoid (Y1). An alternate current path is provided to keep ignition relay energized when the PTO is engaged or the transmission is engaged. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil keeping the relay energized.

As the flywheel turns, a magnet inthe flywheel starts to align with the ignition coil and produces current in the primary coil by electromagnetic induction. In the initial stage low voltage current is produced. The low voltage current flows to a transistor (C), and resistors (A and B) in the ignition module (A1). Resistor (A) has high resistance so current will flow through resistor (B) to transistor (C). The transistor base is energized which closes the transistor and provides a path to ground for ignition coil current flow.

In the spark stage (spark produced), the flywheel magnet is fully aligned with the ignition coil and high voltage (maximum) current is induced in the primary coil. The high voltage current can now flow through resistor (A) to transistor (D). The transistor base is energized which closes the transistor and provides a path to ground for current that was flowing to transistor base. With current no longer applied to transistor base, the transistor opens breaking the path to ground. The sudden reduction of current flow, induces high voltage current in the secondary coil. The high voltage current flows through the coil wire to the spark plug (E1). The voltage is now high enough to jump the spark plug gap and a spark is produced, igniting the fuel/air mixture in the cylinder.

IGNITION CIRCUIT OPERATION



IGNITION CIRCUIT OPERATION— ENGINE SHUTTING OFF

Function:

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

Operating Conditions:

- Key switch in STOP position.

  or

- Operator off seat with PTO engaged.

  or

- Operator off seat with transmission engaged.

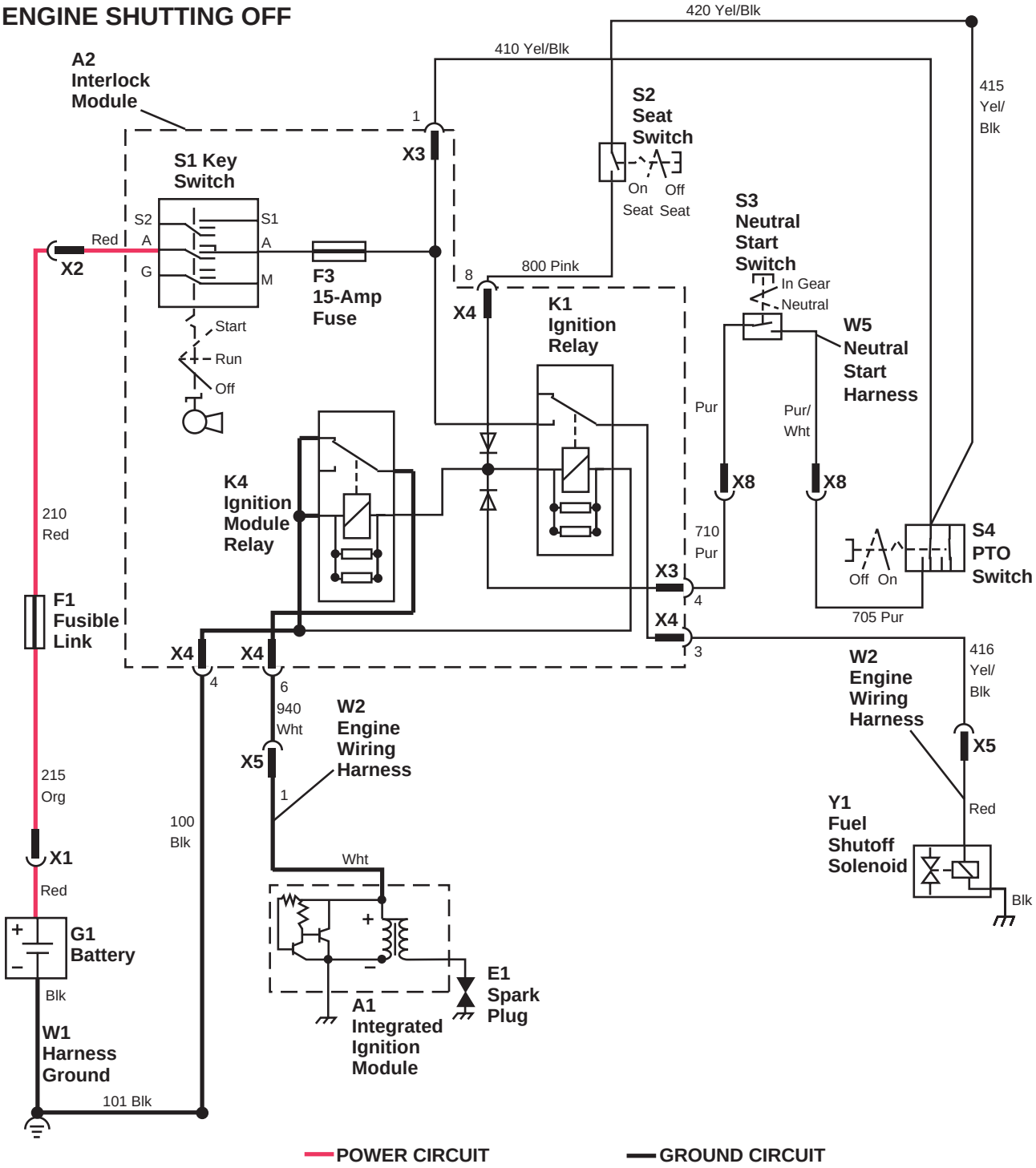
System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

When the key switch (S1) is turned to the STOP position, a path to ground through the key switch terminals M and G is provided for the integrated ignition module (A1) current. At the same time, the power circuit current flow is stopped at the key switch. The low voltage current produced in the primary coil of the ignition module (A1) flows to the key switch. It is easier for low voltage current to flow to the key switch, and to ground, than to flow through the ignition module transistors. Since no voltage is induced in the secondary coil, no spark occurs and the engine stops.

Whenever the ignition relay is de-energized, the fuel shutoff solenoid is also de-energized and fuel flow to the carburetor is stopped.

IGNITION CIRCUIT OPERATION— ENGINE SHUTTING OFF



MC83686

IGNITION CIRCUIT DIAGNOSIS

When diagnosing an ignition problem, isolate the magneto circuit from the ground circuit. If the engine will not start, check the magneto circuit first and then the ground circuit. If the engine will not shut off, check the ground circuit first. Remember the engine is stopped by grounding the ignition coil through either the key switch or ignition module relay. The ignition module relay must be energized to prevent the ignition coil from being grounded.

Test Conditions:

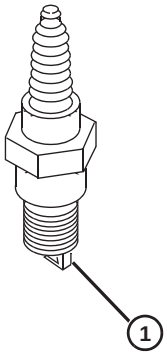
- Key switch in START position.
- PTO switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

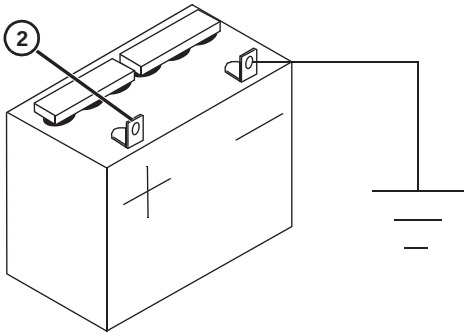
Test/Check Point	Normal	If Not Normal
1. Spark plug/spark tester.	Spark test indicateshot blue spark.	No spark present: Test ignition coil and ignition module. Check armature air gap, and flywheel magnets. Spark present: Check spark plug gap and condition of spark plug. If plug is good, continue testing ground circuit.

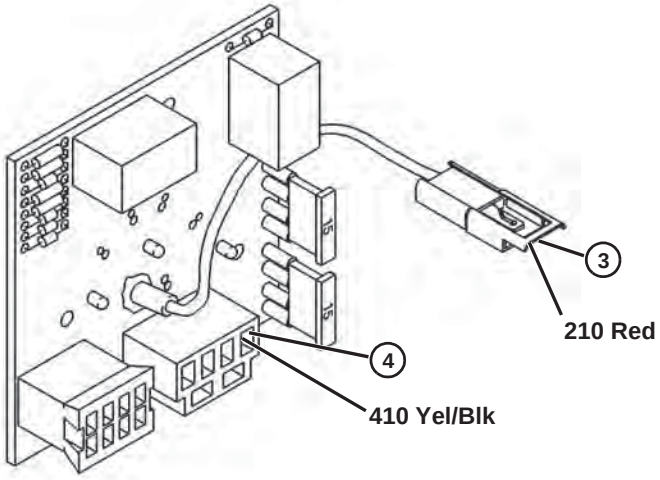
Test Conditions:

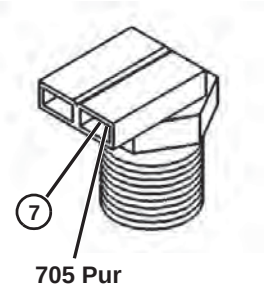
- Key switch in RUN position—engine not running.
- Operator on seat. (Seat switch CLOSED.)

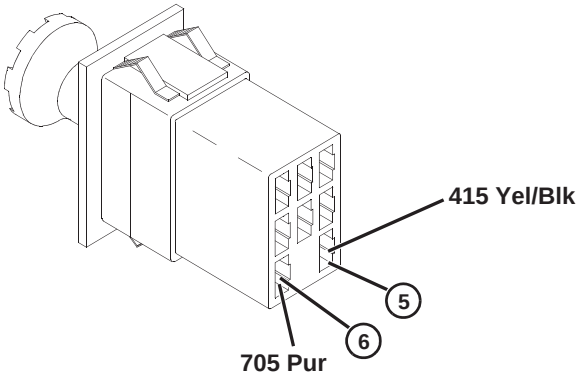
Test/Check Point	Normal	If Not Normal
2. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
5. PTO switch.	Battery voltage.	Check yellow/black wires No. 415 and 410 and connections.
6. PTO Switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Neutral start switch.	Battery voltage.	Check purple wire No. 705 or W5 harness—purple/white wire and connections. Neutral start switch—710 purple wire or W5 harness purple wire terminal. Test neutral start switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)


1


2


3
210 Red
4
410 Yel/Blk


7
705 Pur


415 Yel/Blk
5
6
705 Pur

IGNITION CIRCUIT DIAGNOSIS, continued

Test Conditions:

- Key switch in RUN position—engine not running.
- Operator on seat. (Seat switch CLOSED.)

Test/Check Point	Normal	If Not Normal
8. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710, W5 harness and connections.
9. Seat switch.	Battery voltage.	Check yellow/black wires No. 420, 415 and 410 and connections.
10. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
11. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.
12. Interlock module—terminal X4—3.	Battery voltage.	Replace interlock module.

Test Conditions:

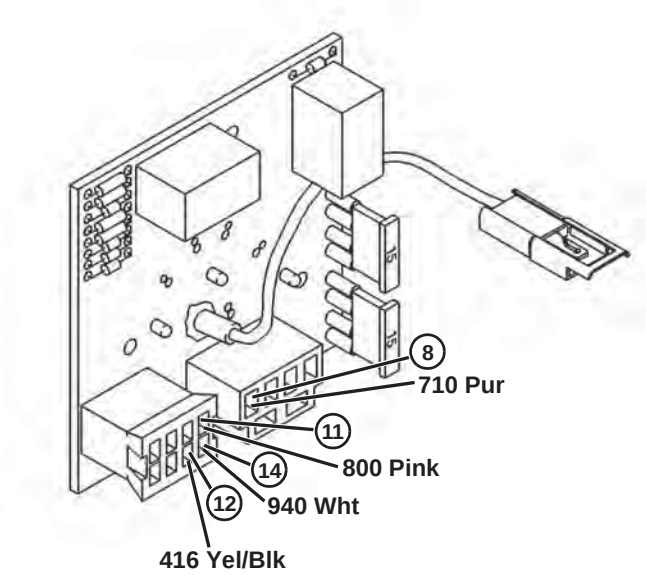
- Key switch in OFF position.

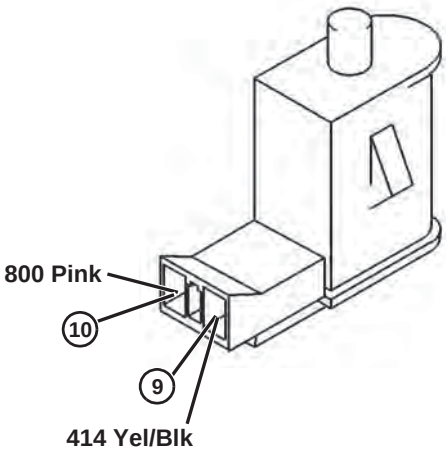
Test/Check Point	Normal	If Not Normal
13. Engine ground.	Maximum 0.1 ohms resistance.	Check battery negative cable and shielded ground connection.
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check black wires No. 100 and 101 and harness to engine ground connection.

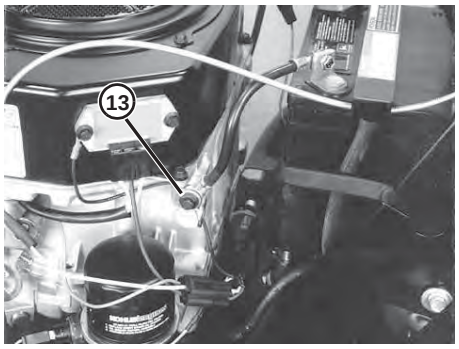
Test Conditions:

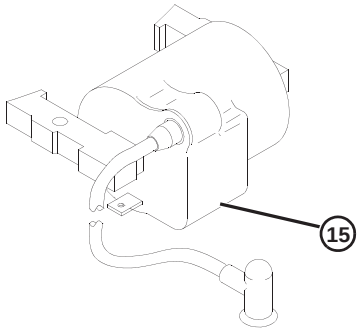
- Key switch in RUN position—engine not running.

Test/Check Point	Normal	If Not Normal
15. Ignition module—replace with a known good module.	Spark produced.	Replace ignition module. Check flywheel air gap and magnet.


8
710 Pur
11
14
800 Pink
12
940 Wht
416 Yel/Blk


800 Pink
10
9
414 Yel/Blk


13


15

CHARGING CIRCUIT OPERATION

Function:

To maintain battery voltage between 11.8 and 13.2 volts DC.

Operating Conditions:

- Key switch in RUN position.
- Engine running.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

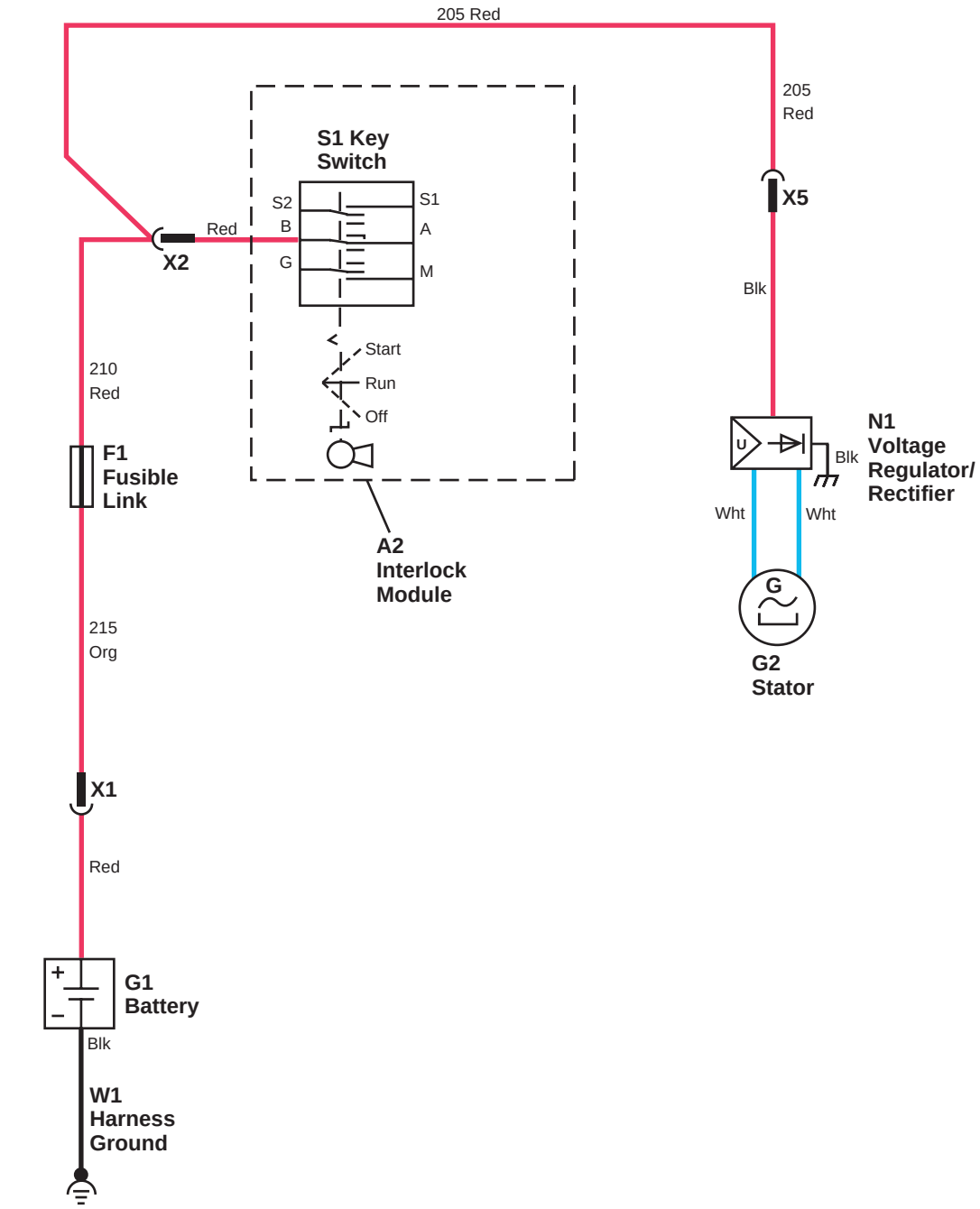
The charging system is a permanent magnet and stator design. Charging output is controlled by a regulator/rectifier.

The power/battery charging circuit provides current to the key switch (S1) and protects the charging circuit with a fusible link (F1). Current flows from battery (G1) positive (+) terminal to fusible link and regulator/rectifier (N1). The voltage sensing circuit in the regulator/rectifier allows it to monitor battery voltage.

As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC curent 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 to the battery to charge it through the power/battery charging circuit. When the battery is fully charged, the regulator stops current flow to the battery.

CHARGING CIRCUIT OPERATION



POWER/BATTERY CHARGING CIRCUIT
GROUND CIRCUIT
STATOR CIRCUIT

MC83679

CHARGING CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Voltage regulator/rectifier.	Battery voltage.	Check red wire No. 205 and connections.

Test Conditions:

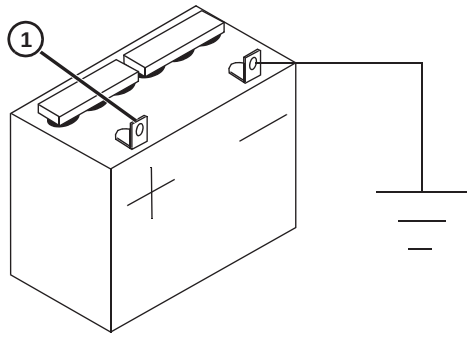
- Key switch in RUN position—engine not running.

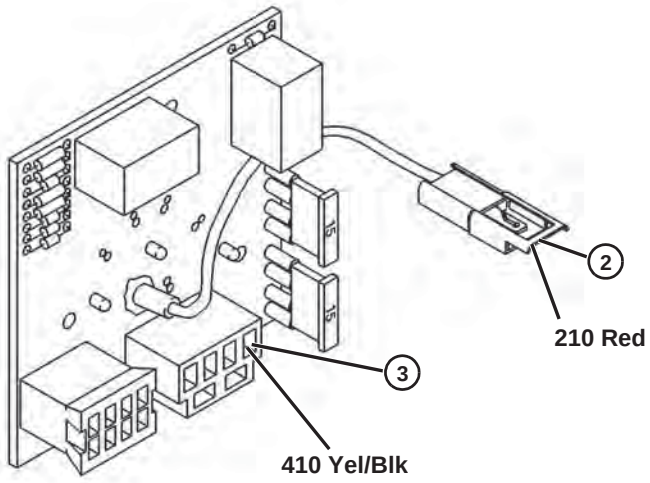
Test/Check Point	Normal	If Not Normal
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.

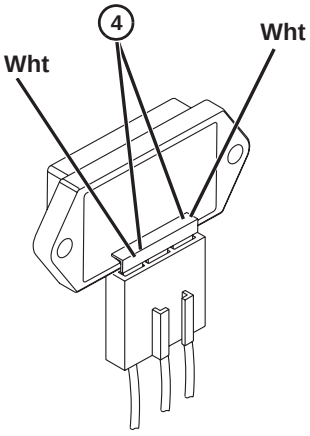
Test Conditions:

- Key switch in RUN position—engine running.

Test/Check Point	Normal	If Not Normal
5. Voltage regulator/rectifier connector (connector disconnected)—perform UNREGULATEDVOLTAGE OUTPUT TEST—LX173 on page 5-182.	Voltage output to specifications.	Check white wire from stator and connections. If OK, replace stator.
6. Voltage regulator/rectifier—perform REGULATED AMPERAGE OUTPUT TEST on page 5-179.	Regulated amperage to specification.	Perform UNREGULATED VOLTAGE OUTPUT TEST—LX173 on page 5-182.


1


2
210 Red
3
410 Yel/Blk


4
Wht
Wht

PTO CIRCUIT OPERATION—PTO OFF

Function:

To provide power to energize the PTO relay and clutch.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in OFF position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The PTO circuit uses a seat switch (S2), ignition relay (K1), and PTO relay (K2) to stop current flow to the PTO clutch (Y2) if the operator gets off the seat with the PTO engaged.

The power circuit provides current to the key switch (S1) and protects the PTO circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the RUN position, current flows to the ignition relay (K1), PTO switch (S4) and seat switch (S2). Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay can come from the neutral start or seat circuits and energizing current for the PTO relay must come from the PTO switch.

The PTO switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO switch is in the ON position. With the PTO switch OFF (PTO disengaged), current (Neutral Start Circuit) flows to the PTO relay coil energizing the relay. The PTO relay now has continuity across the relay.

The PTO switch is also used in the neutral start circuit to prevent the ignition relay from energizing if the PTO is engaged with the operator off the seat. With the PTO switch closed (PTO disengaged), current flows to the neutral start switch (S3).

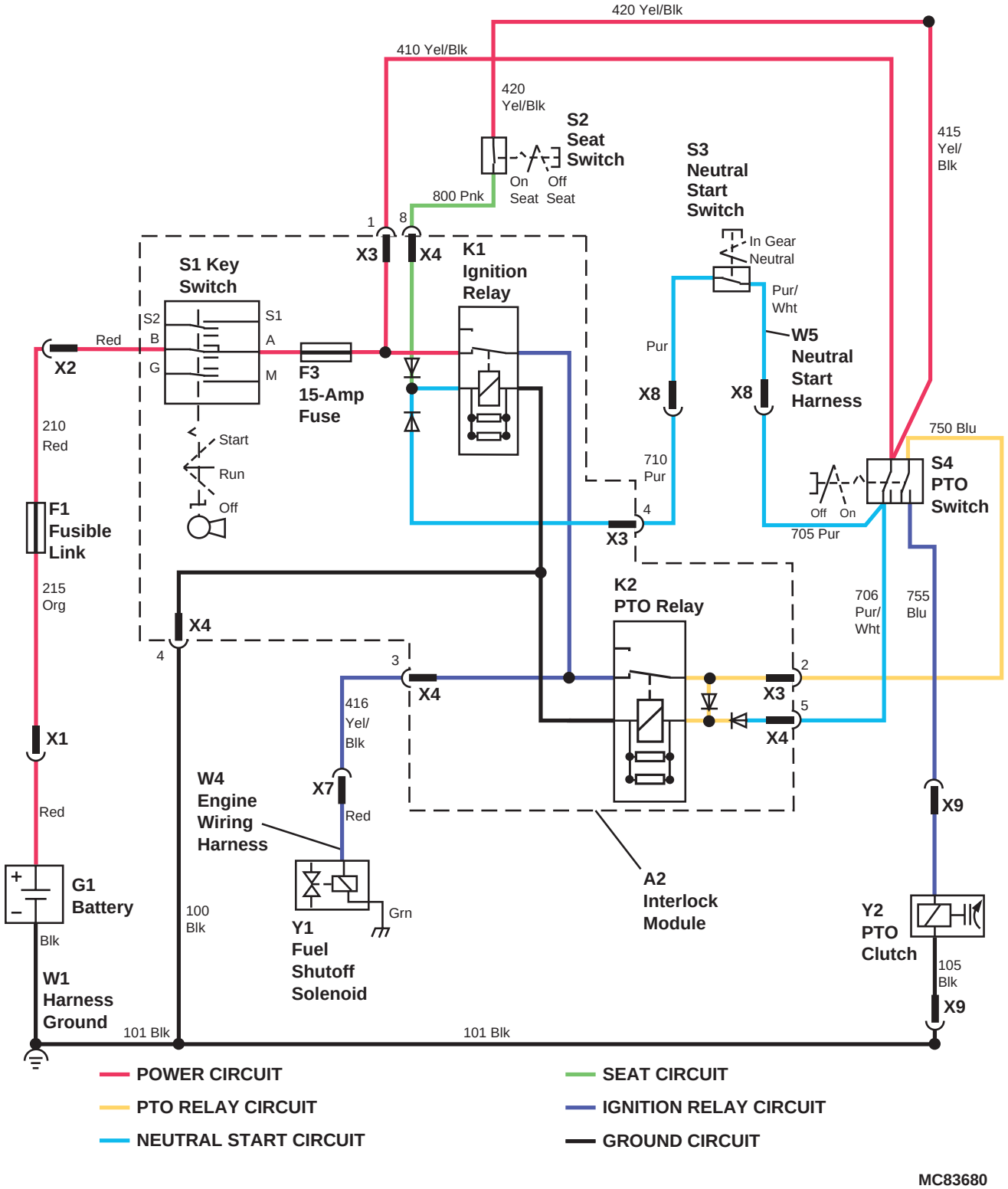
The neutral start switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral. The neutral start switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

With the neutral start switch closed, current (Neutral Start Circuit) flows to the ignition relay coil energizing the coil, closing the relay. Closing the relay sends ignition relay current to the PTO relay (Ignition Relay Circuit). PTO relay circuit current flows to the PTO switch and is available to operate the PTO clutch when the PTO switch is turned on.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged and the transmission is engaged. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil, keeping the relay energized.

The ground circuit provides a path to ground for the PTO and ignition relay coils.

PTO CIRCUIT OPERATION – PTO OFF



MC83680

PTO CIRCUIT OPERATION—PTO ON

Function:

To provide power to energize or de-energize the PTO clutch when desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in ON position.
- Operator on seat. (Seat switch CLOSED.)

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

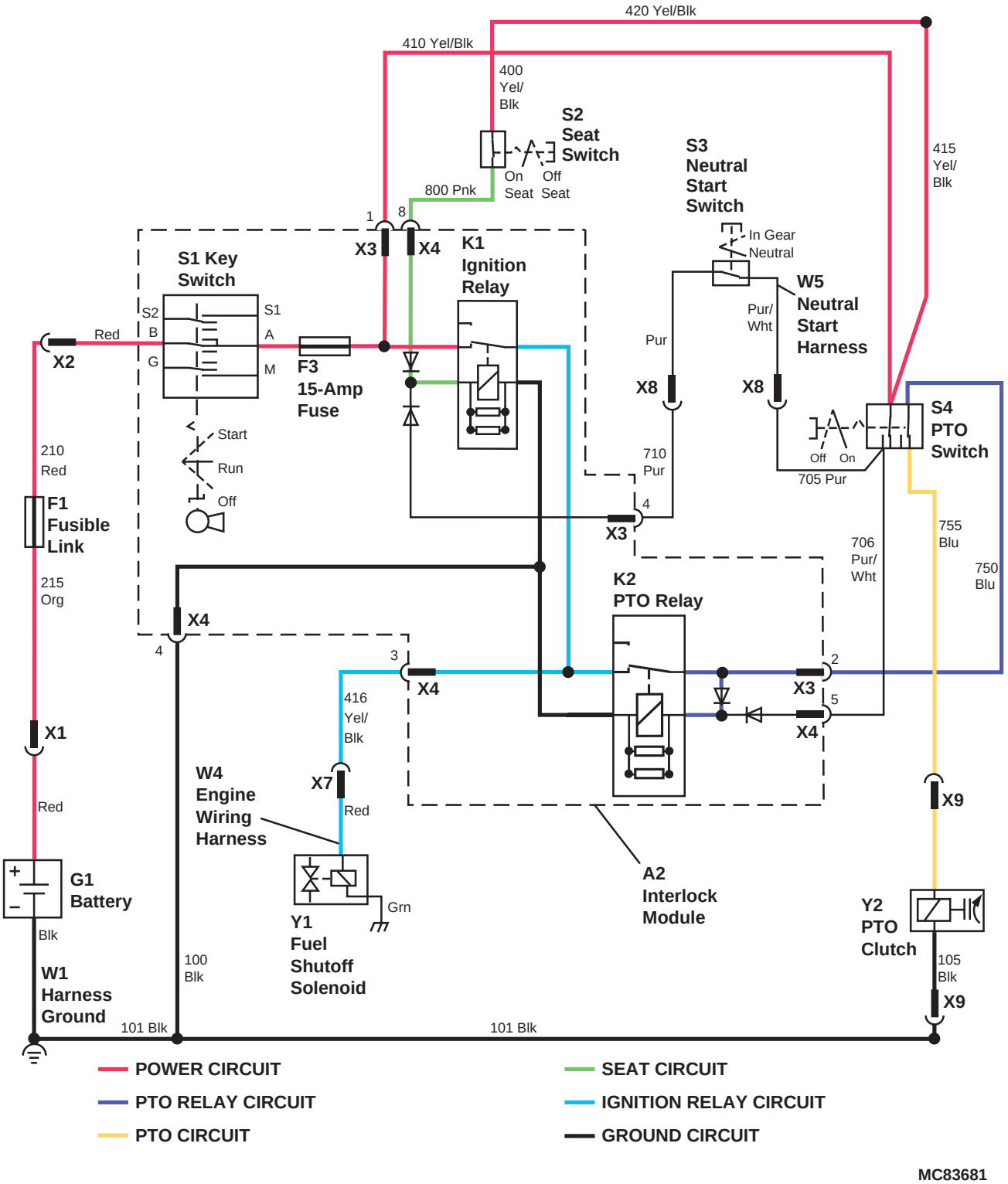
The PTO circuit uses a seat switch (S2), ignition relay (K1), and PTO relay (K2) to stop current flow to the PTO clutch (Y2), if the operator gets off the seat with the PTO engaged.

With the key switch (S1) in the RUN position and the PTO circuit energized, current flows the the PTO switch (S4) and is available to operate the PTO clutch when the PTO switch is moved the the ON position. When the PTO switch is moved to the ON position, current flows through the PTO switch (PTO Circuit) and energizes the PTO clutch. An alternate path for the PTO relay energizing current must be provided when the PTO switch is ON. With the PTO switch ON, the flow of current stops from the PTO switch to the PTO relay coil (PTO Relay Circuit). Since the PTO relay is already closed, the PTO relay coil receives energizing current from the Ignition Relay Circuit. Current flows across the PTO relay (contacts), keeping the relay energized.

With the PTO switch ON, current flow to the neutral start switch is stopped, so the seat circuit must keep the ignition relay energized. If the operator gets off the seat with the PTO switch ON, the seat switch (S2) de-energizes the ignition and PTO relays, which stops current flow to the PTO clutch.

The ground circuit provides a path to ground for the ignition and PTO relay coils and PTO clutch.

PTO CIRCUIT OPERATION – PTO ON



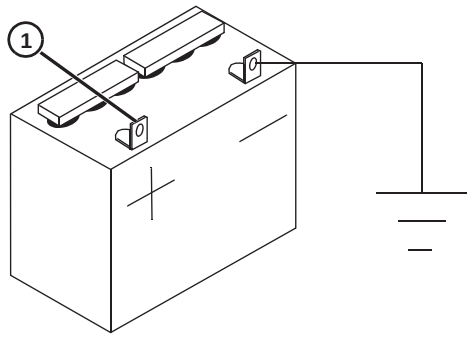
MC83681

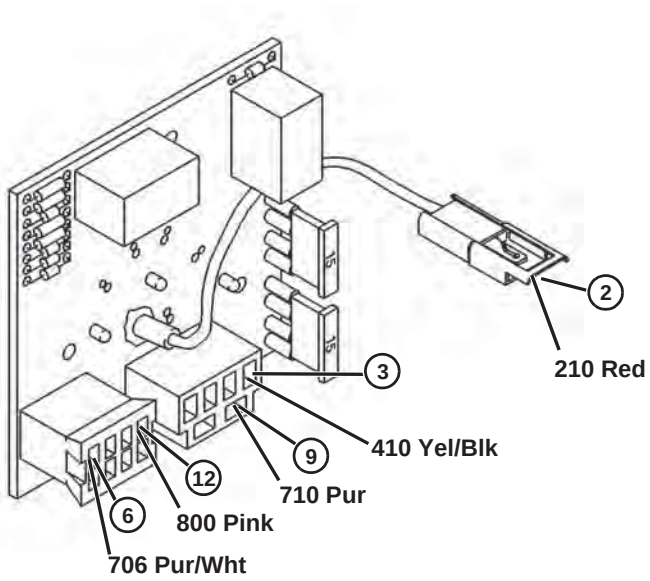
PTO CIRCUIT DIAGNOSIS

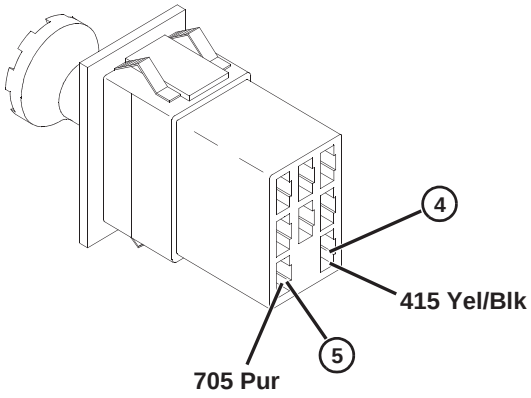
Test Conditions:

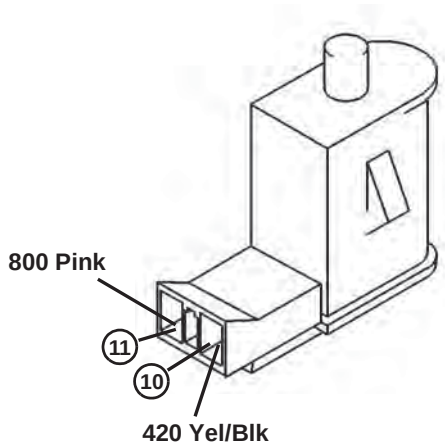
- Key switch in RUN position—engine not running.
- PTO switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- Operator on seat. (Seat switch CLOSED.)
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

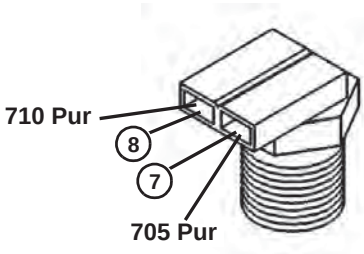
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Interlock module—terminal X4—5.	Battery voltage.	Check purple/white wire No. 706.
7. Neutral start switch.	Battery voltage.	Test purple wire No. 705 and connections. Check purple/white wire—W5 harness and connections.
8. Neutral start switch.	Battery voltage.	Test neutral start swith. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710 and connections.
10. Seat switch.	Battery voltage.	Test yellow/black wires No. 410, 415 and 420.
11. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
12. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.


1


2
210 Red
3
410 Yel/Blk
9
710 Pur
12
800 Pink
6
706 Pur/Wht


4
415 Yel/Blk
5
705 Pur


800 Pink
11
10
420 Yel/Blk


710 Pur
8
7
705 Pur

PTO CIRCUIT DIAGNOSIS, continued

Test Conditions:

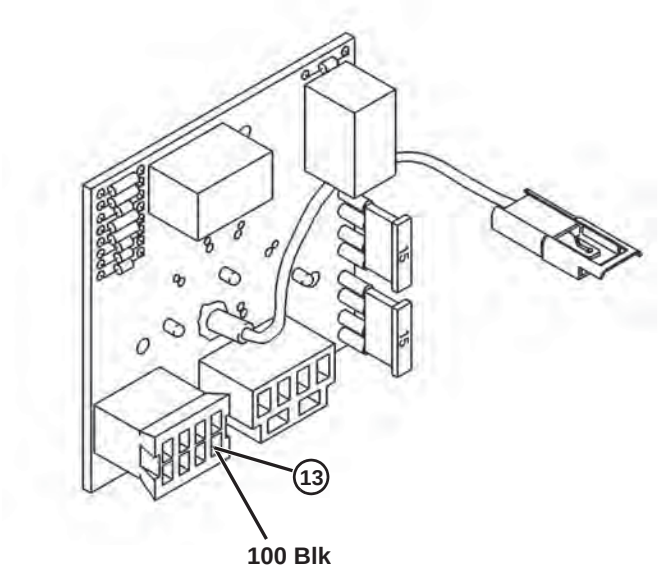
- Key switch in OFF position.

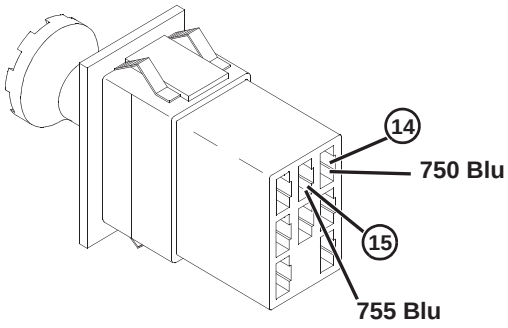
Test/Check Point	Normal	If Not Normal
13. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check black wires No. 100 and 101 and harness to engine ground connection.

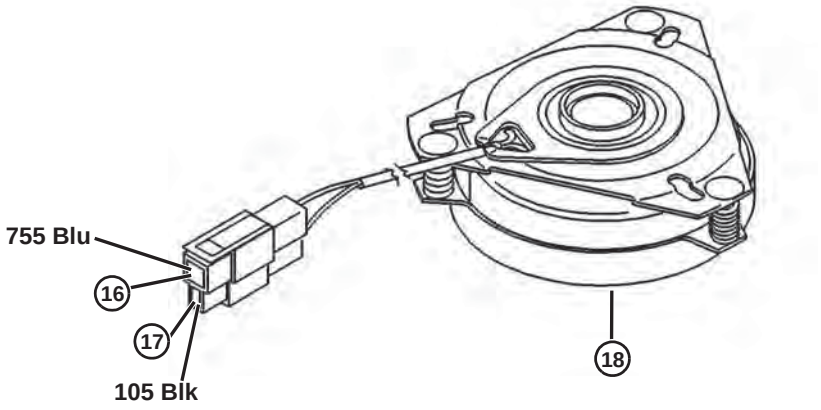
Test Conditions:

- Key switch in RUN position—engine not running.
- PTO switch in ON position.

Test/Check Point	Normal	If Not Normal
14. PTO switch.	Battery voltage.	Check blue wire No. 750 and connections. If OK, replace interlock module.
15. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
16. PTO clutch.	Battery voltage.	Check blue wire No. 755 and connections.
17. PTO clutch.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts: check PTO clutch ground circuit. 0 volts: test PTO clutch. (See PTO CLUTCH TEST on page 5-189.)
18. PTO clutch.	PTO clutch air gap within specification.	Adjust air gap. (See PTO CLUTCH ADJUSTMENT on page 5-193.)


13
100 Blk


14
750 Blu
15
755 Blu


755 Blu
16
17
105 Blk
18

LOW OIL PRESSURE LIGHT CIRCUIT OPERATION

Function:

To light the low oil pressure light to alert the operator that oil pressure is too low for continued operation.

Operating Conditions:

- Key switch in RUN position.
- Oil pressure switch CLOSED (engine OFF or low oil pressure).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

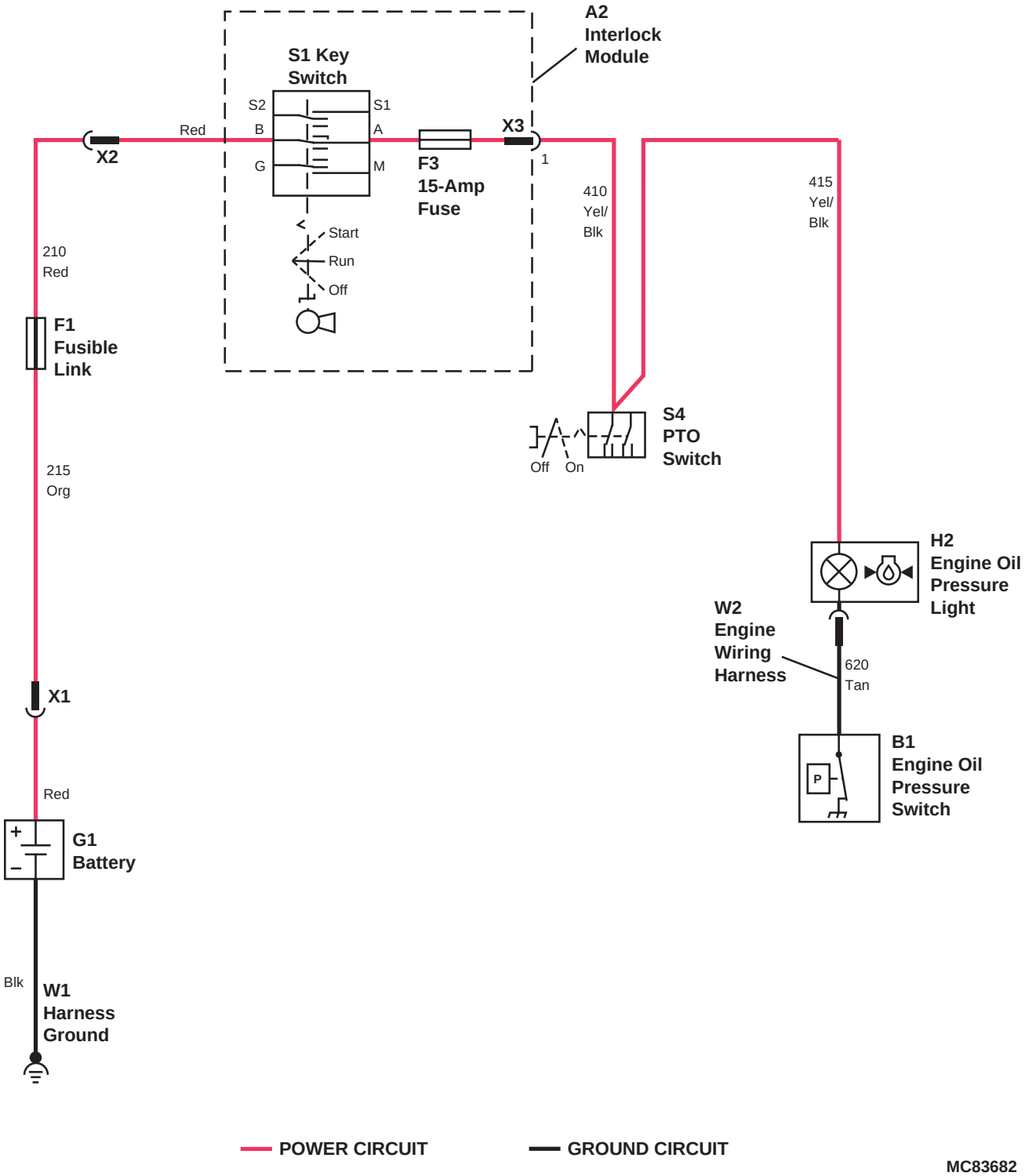
The low oil pressure light system uses a pressure activated switch to provide a path to ground for the oil pressure light. The switch is closed when engine oil pressure is at or below 28 kPa (4 psi).

The power circuit provides current to the key switch (S1) and protects the low oil pressure light circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the RUN position, current flows to the 15-amp fuse (F3) and the oil pressure light (H2).

If the engine is not running or oil pressure is at or below 28 kPa (4 psi), the oil pressure switch (B1) will be closed. The oil pressure switch completes the path to ground and the low oil pressure light comes ON. When the engine starts and oil pressure increases above 28 kPa (4 psi), the oil pressure switch opens, breaking the path to ground and the light goes out.

The ground circuit provides a path to ground through the oil pressure switch, for the oil pressure light.

LOW OIL PRESSURE LIGHT CIRCUIT OPERATION



LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- Engine oil pressure switch lead DISCONNECTED.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battey negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. Low oil pressure light.	Battery voltage.	Check yellow/black wires No. 410 and 415.
5. Low oil pressure switch.	Battery voltage.	Check tan wire 620, low oil pressure light and connections.

Test Conditions:

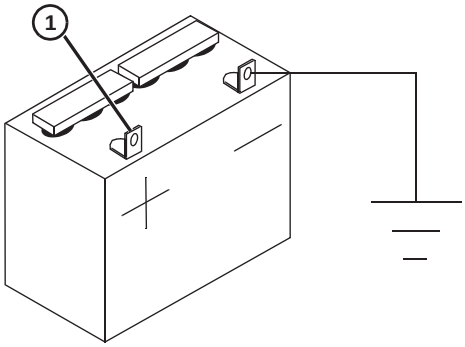
- Key switch in OFF position.

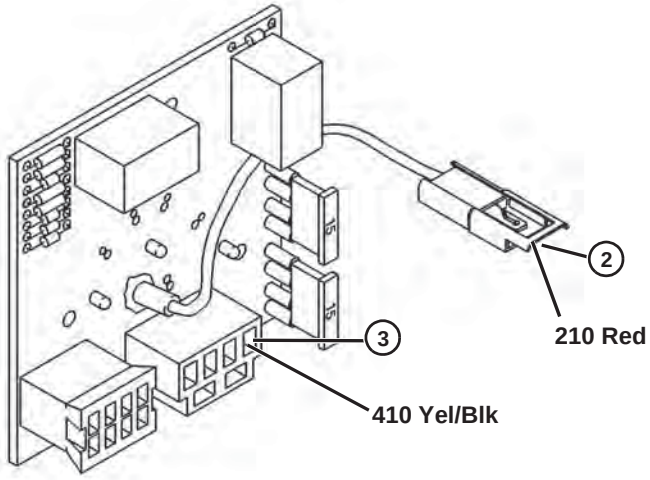
Test/Check Point	Normal	If Not Normal
6. Engine oil pressure switch.	Maximum 0.1 ohms resistance.	Check ground circuit. If OK, replace engine oil pressure switch.

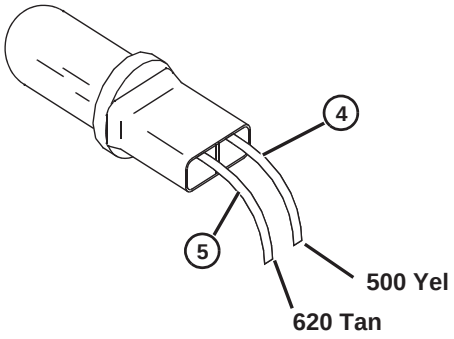
Test Conditions:

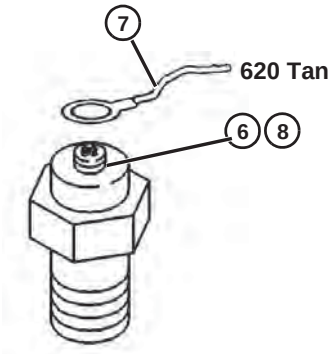
- Key switch in RUN position—engine running.

Test/Check Point	Normal	If Not Normal
7. Engine oil pressure switch.	Battery voltage.	Check tan wire No. 620 and connections.
8. Engine oil pressure switch.	No continuity to ground (maximum resistance).	Check engine oil pressure. (See ENGINE OIL PRESSURE TEST on page 4-25.) If OK, replace engine oil pressure switch.


1


2
210 Red
3
410 Yel/Blk


4
5
500 Yel
620 Tan


7
620 Tan
6
8

HEADLIGHT CIRCUIT OPERATION

Function:

To provide power to the headlights for illumination if desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- Headlight switch in ON position.

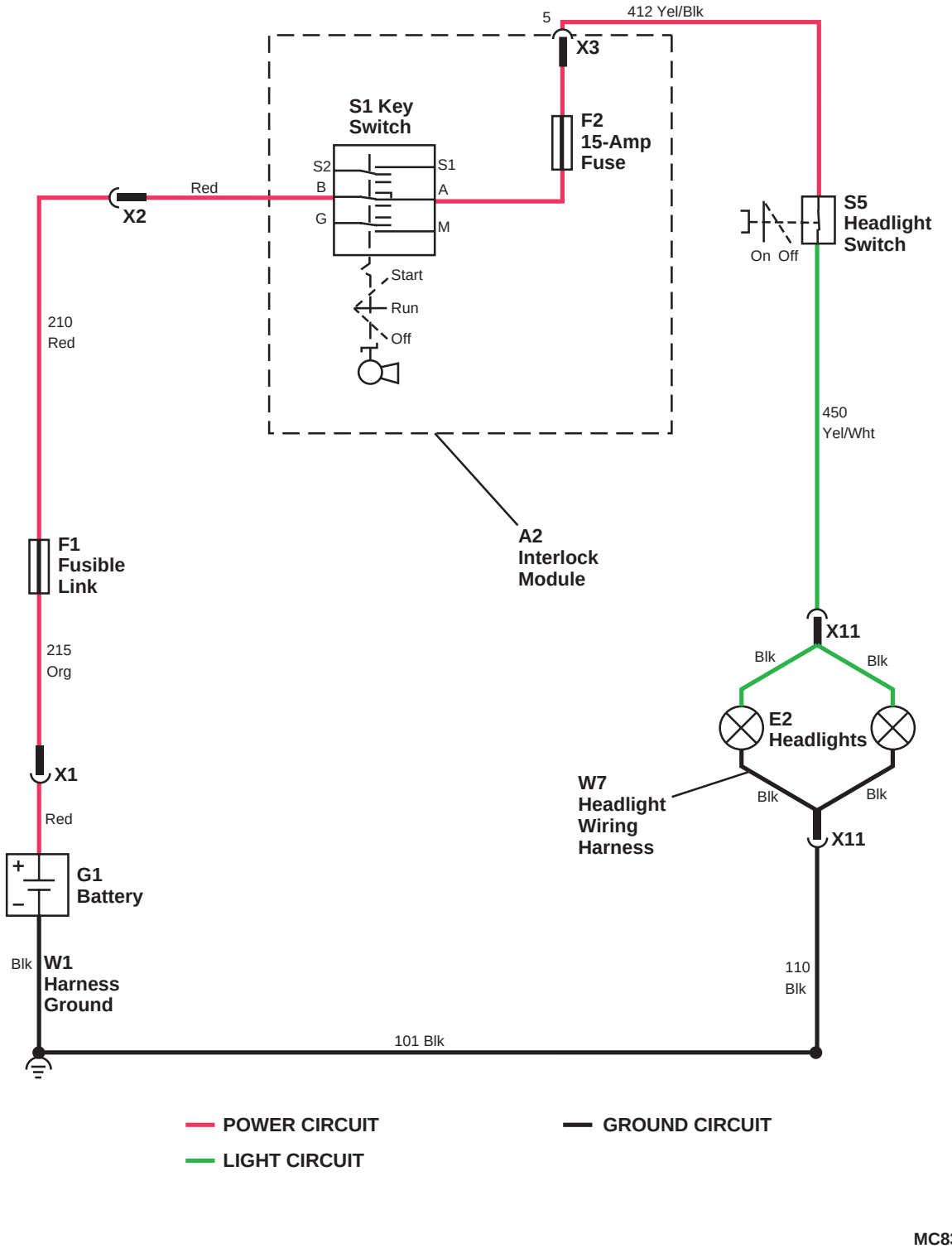
System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The power circuit provides current to the key switch (S1) and protects the circuit with a 15-amp fuse (F2). With the key switch in the RUN position, current flows from the battery (G1) positive (+) terminal to the fusible link (F1), key switch, 15-amp fuse (F2) and headlight switch (S5). With the headlight switch in the ON position, current flows to the headlights (E2) and illuminates the lamps.

The ground circuit provides a path to ground for the headlight.

HEADLIGHT CIRCUIT OPERATION



MC83683

HEADLIGHT CIRCUIT DIAGNOSIS

Test Conditions:

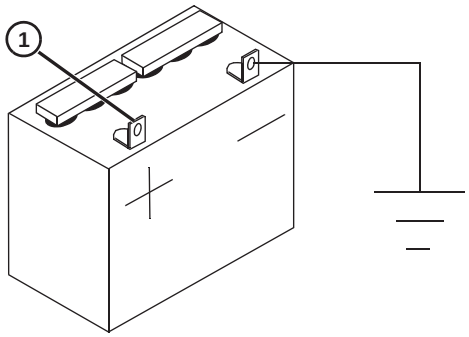
- Key switch in RUN position.
- Headlight switch in ON position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

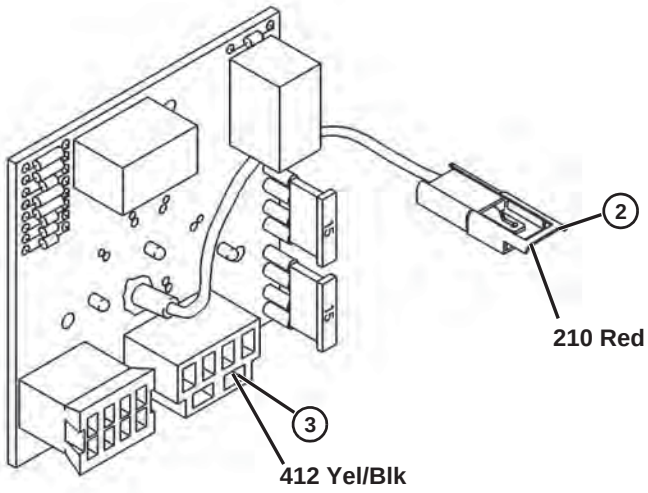
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—5.	Battery voltage.	Check fuse (F2), if OK, replace interlock module.
4. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412.
5. Headlight switch.	Battery voltage.	Test headlight switch. (See HEADLIGHT SWITCH TEST on page 5-190.)
6. Headlight connector.	Battery voltage.	Check yellow/white wire No. 450, black wires (from connector to headlights) and connections.
7. Headlights.	Headlights ON.	Test bulbs.

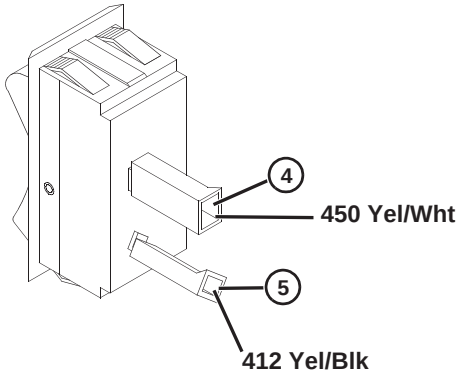
Test Conditions:

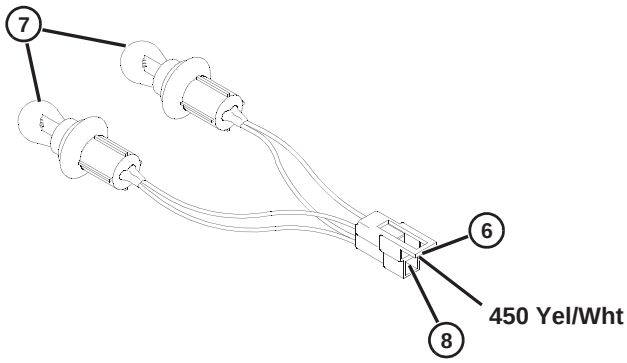
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
8. Headlight ground.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground, black wires 101 and 110, black wires (W7 headlight harness) and connections.


1


2
210 Red
3
412 Yel/Blk


4
450 Yel/Wht
5
412 Yel/Blk


7
6
450 Yel/Wht
8

FUEL SHUTOFF SOLENOID CIRCUIT OPERATION

Function:

To energize the fuel shutoff solenoid when the ignition relay is energized.

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- Transmission in NEUTRAL (neutral start switch CLOSED).

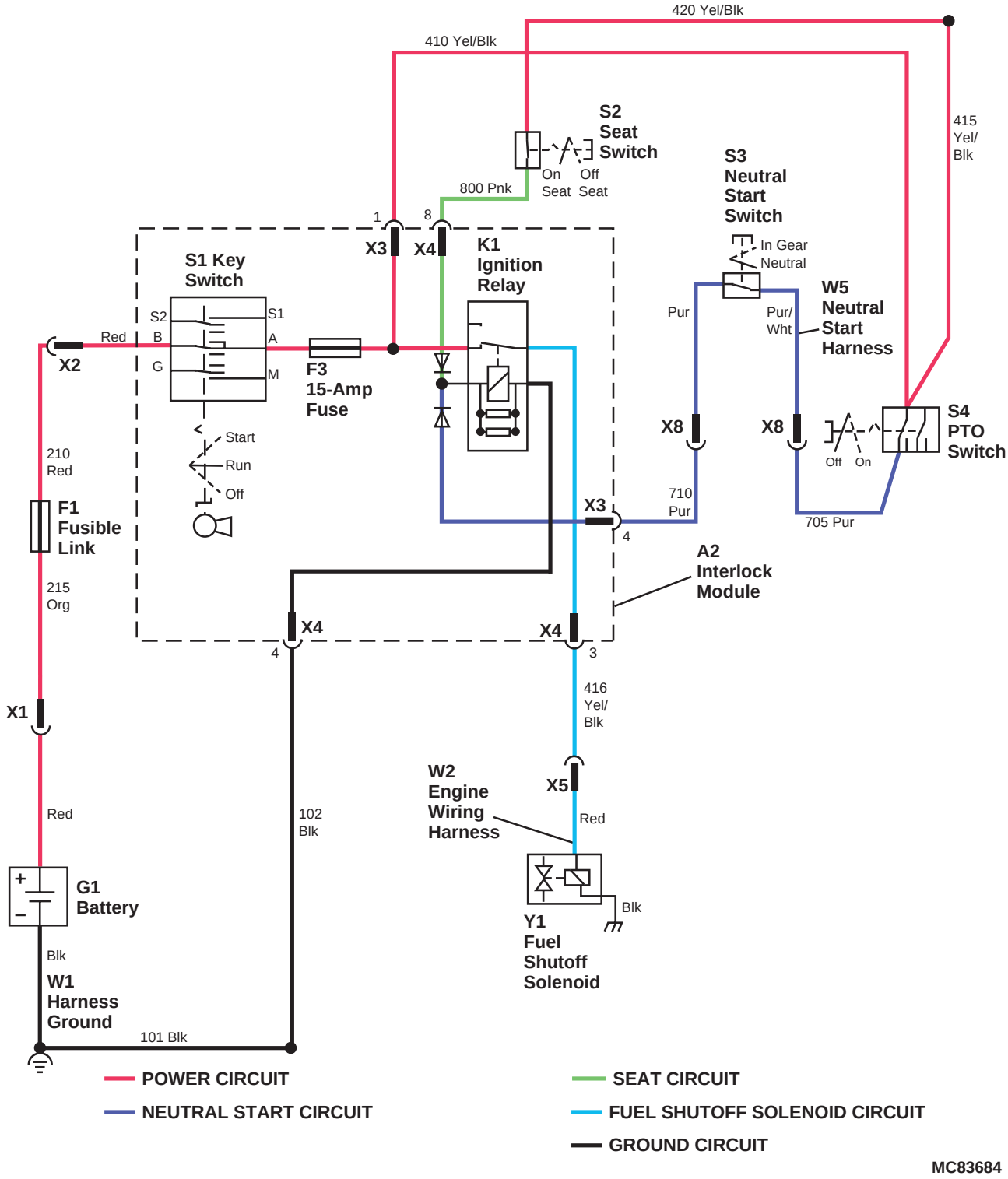
System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The fuel shutoff solenoid (Y1) uses an electro-magnetic coil to operate a plunger. The fuel shutoff solenoid plunger stops fuel flow in the carburetor bowl when the solenoid is de-energized. The ignition relay (K1) provides power to the fuel shutoff solenoid. When the ignition relay is de-energized, the fuel shutoff solenoid stops fuel flow at the same time the spark is stopped, helping to prevent backfire at engine shutdown.

The power circuit provides current to the key switch (S1), energizes the ignition relay circuit, and protects the fuel shutoff solenoid circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), and key switch. With the key switch in the RUN position, current flows to the 15-amp fuse (F3), ignition relay terminal, seat switch (S2) and PTO switch (S4). Current cannot flow to the fuel shutoff solenoid until the ignition relay is energized. The ignition relay coil is energized by current from the seat switch circuit or neutral start circuit.

FUEL SHUTOFF SOLENOID CIRCUIT OPERATION

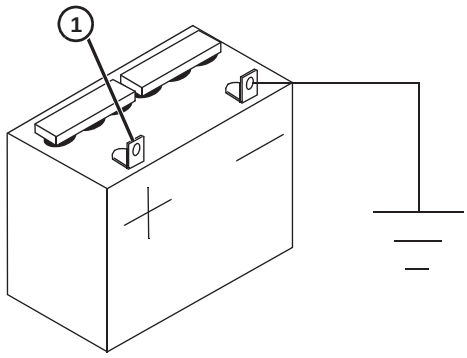


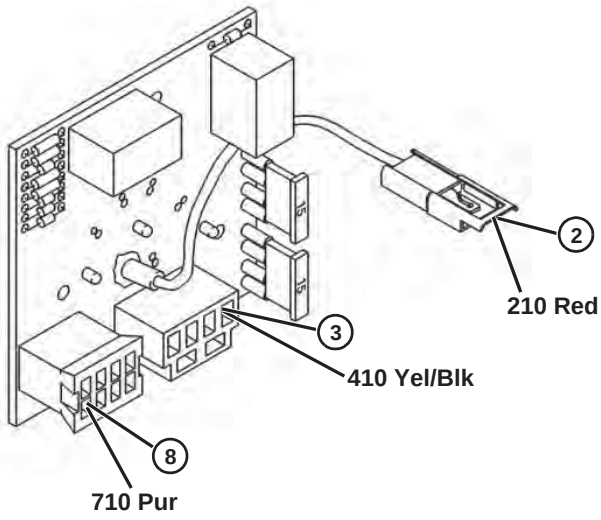
FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS

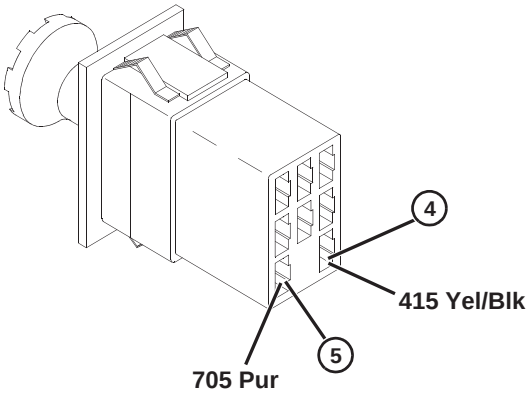
Test Conditions:

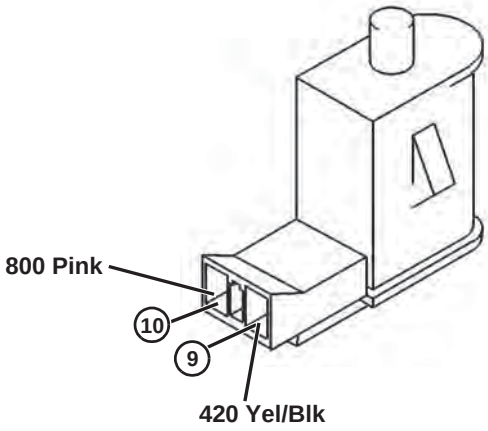
- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- Operator on seat. (Seat switch CLOSED.)
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

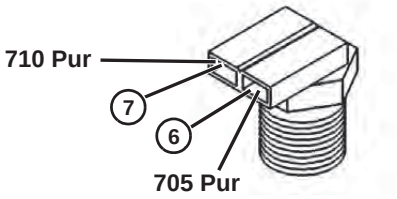
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Neutral start switch.	Battery voltage.	Check purple/black wire No. 705, W5 neutral start harness and connections.
7. Neutral start switch.	Battery voltage.	Test neutral start switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
8. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710, W5 neutral start harness and connections.
9. Seat switch.	Battery voltage.	Check yellow/black wires No. 410, 415 and 420 and connections.
10. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)


1


2
210 Red
3
410 Yel/Blk
8
710 Pur


4
415 Yel/Blk
705 Pur
5


800 Pink
10
9
420 Yel/Blk


710 Pur
7
6
705 Pur

FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS, continued

Test Conditions:

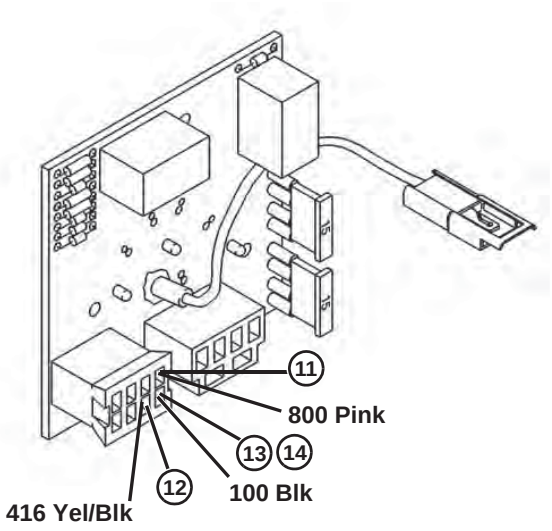
- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (neutral start switch CLOSED).
- Operator on seat. (Seat switch CLOSED).
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

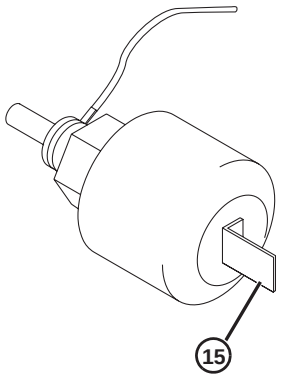
Test/Check Point	Normal	If Not Normal
11. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.
12. Interlock module—terminal X4—3.	Battery voltage.	Replace interlock module.
13. Fuel shutoff solenoid.	Battery voltage.	Check black/yellow wire No. 416, W2 engine wiring harness—red wire and connections. Check ground circuit. If OK, replace fuel shutoff solenoid.

Test Conditions:

- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground circuit and black wires 101 and 100.
15. Fuel shutoff solenoid (green wire).	Maximum 0.1 ohms	Check green wire (side of carburetor-to-carburetor mounting nut).

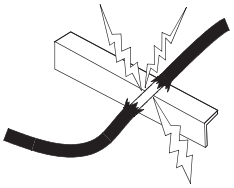

11
800 Pink
13
14
12
100 Blk
416 Yel/Blk


15

TESTS AND ADJUSTMENTS

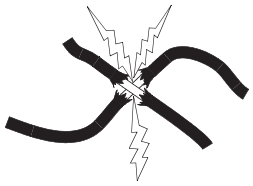
COMMON CIRCUIT TEST

Shorted/Grounded Circuit:



M85602

A shorted circuit on the ground side of a component (i.e., improper wire-to-wire or wire to ground contact) may result in improper component operation.



M85600

A shorted circuit on the power side of a component or contact of two power circuits (i.e., improper wire-to-wire or wire-to-ground contact) may result in blown fusible links and fuses.

To test for a shorted or improperly wired circuit:

1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until components stop operating.
4. Shorted or improper connections will be the last two wires disconnected.

High Resistance or Open Circuit:



M85601

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

1. Check all terminals and ground connections of the circuit for corrosion.
2. If terminals are not loose or corroded, the problem is in the component or wiring.

GROUND CIRCUIT TEST

Reason:

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

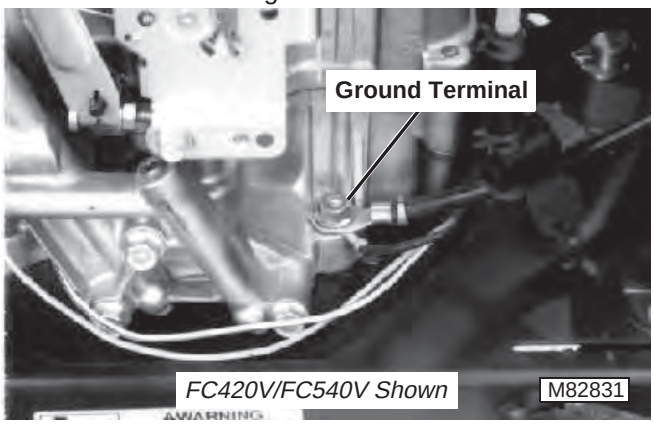
Equipment:

- Ohmmeter or Voltmeter

NOTE: The voltmeter method checks ground connections under load.

Procedure—OHMMETER METHOD:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.
6. Connect ohmmeter negative (black) lead to negative terminal of battery. Connect meter positive (red) lead to negative terminal of battery and record reading.



7. Connect ohmmeter red lead to ground terminal 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 ohms.** The problem is between the last two test points. If a problem is indicated, disconnect the wiring harness connector to isolate the wire or component and check resistance again. **Maximum allowable resistance in the circuit is 0.1 ohms.** Check both sides of the connectors closely, as disconnecting and connecting may temporarily solve problem.

Procedure—VOLTMETER METHOD:

1. Park machine on level surface.
2. Put transmission in NEUTRAL.
3. Engage park brake.
4. Turn key switch to RUN position.
5. Raise engine hood.
6. Connect voltmeter negative (black) lead to negative terminal of battery.
7. Connect voltmeter positive (red) lead to ground terminal of circuit or component to be tested. Be sure that component circuit is activated (key ON, switches CLOSED) so that voltage will be present at the component. Record voltage. **Voltage must be greater than 0, but less than 1 volt.** Some components will have a very small voltage reading on the ground side and still be operating correctly.

Results:

- If voltage is 0, the component is open.
- If voltage is greater than 1 volt, the ground circuit is bad. Check for open wiring, loose terminal wire crimps, poor connections, or corrosion in the ground circuit.

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 10—15 minutes. Get medical attention immediately.**

If acid is swallowed:

1. **Do not induce vomiting.**
2. **Then drink large amounts of milk of magnesia, beaten eggs, or vegetable oil.**
3. **Get medical attention immediately.**

Reason:

To check condition of battery and determine battery voltage.

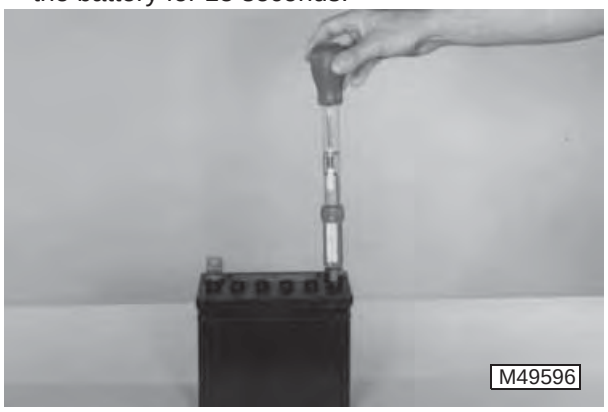
Equipment:

- Hydrometer
- Voltmeter or JT05685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Engage park brake.
4. Clean cable ends, battery terminals and top of battery. (See BATTERY—Cleaning on page 5-194.)
5. Remove battery to workbench. (See BATTERY—Removal/Installation on page 5-194.)
6. Inspect battery terminals and case for breakage or cracks.
7. Check electrolyte level in each battery cell. Add distilled water as needed. If water is added, charge battery for **20 minutes at 10 amps.**

8. Remove surface charge by placing a small load on the battery for 15 seconds.



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

Results:

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

10. 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 11.8 VDC, charge battery. (See CHARGE BATTERY on page 5-178.)
- If battery voltage is more than 13.2 VDC, test specific gravity (see step 9).

11. Install battery. (See BATTERY—Removal/ Installation on page 5-194.)

CHARGE BATTERY

Reason:

To increase battery charge after the battery has been discharged.

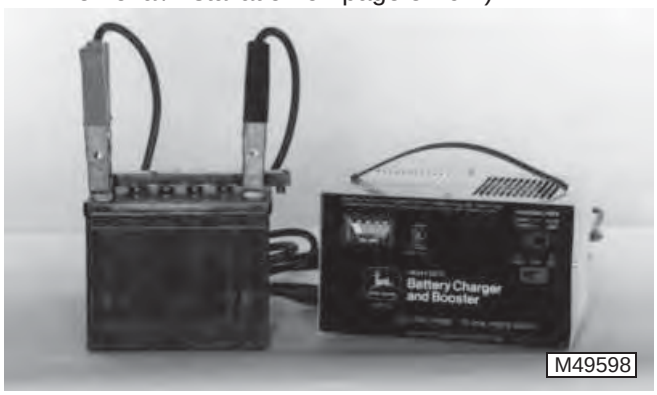
Equipment:

- Battery Charger (Variable Rate)

Procedure:

NOTE: See BATTERY TEST on page 5-177 before charging battery.

1. Park machine on level surface.
2. Turn key switch OFF.
3. Engage park brake.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench. (See BATTERY—Removal/Installation on page 5-194.)



6. Connect variable rate charger to battery.

NOTE: Maximum time at boost setting is 10 minutes. Allow an additional 5 minutes for each degree below 70° F.

7. 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.
8. Check if battery is accepting 10-amp charge rate after 10 minutes at boost setting.

Results:

- If battery WILL NOT accept 10-amp charge after 10 minutes at boost setting, replace battery;
- If battery is accepting 10-amp charge after 10 minutes at boost setting, and battery did NOT need water, go to steps 11 and 12;
- If battery is accepting 10-amp charge after 10 minutes at boost setting, but battery DID need water or all cells were BELOW 1.175, go to steps 9 and 10.

9. Set charger at 15—25 amps.

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

10. 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 11 and 12.

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).

11. Continue to charge battery until specific gravity is **1.230—1.265 points.**
12. Load test battery.
13. Install battery. (See BATTERY—Removal/Installation on page 5-194.)

LOAD TEST BATTERY

Reason:

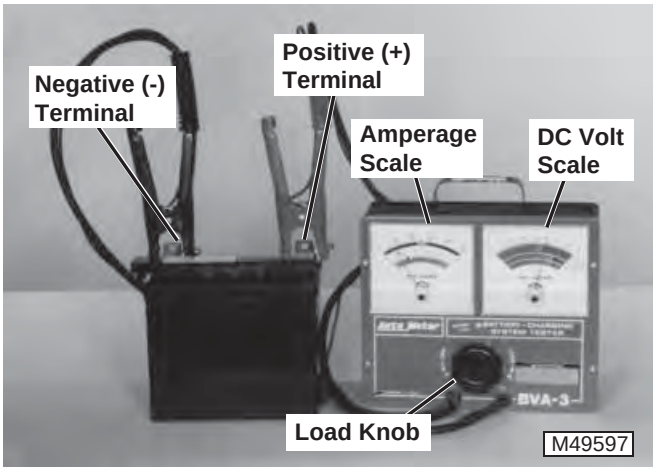
To check condition of battery under load.

Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL
4. Engage park brake.
5. Clean cable ends, battery terminals and top of battery. (See BATTERY—Cleaning on page 5-194.)
6. Remove battery to workbench. (See BATTERY—Removal/Installation on page 5-194.)



7. Turn load knob counterclockwise to OFF position.
8. Connect tester positive (red) cable to battery positive (+) terminal.
9. Connect tester negative (black) cable to battery negative (-) terminal.
10. Turn load knob of tester clockwise (in) until amperage reading is equal to:
    - cold cranking amperage rating of battery (use blue scale).

    -or-

    - three times ampere hour rating (use black scale).
11. Hold for 15 seconds and turn load knob of tester counterclockwise (out) into OFF position.
12. Repeat steps 10 and 11 above and read condition of battery at DC Volts scale.

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 AMPERAGE OUTPUT TEST

Reason:

To determine charging output of the regulator/rectifier.

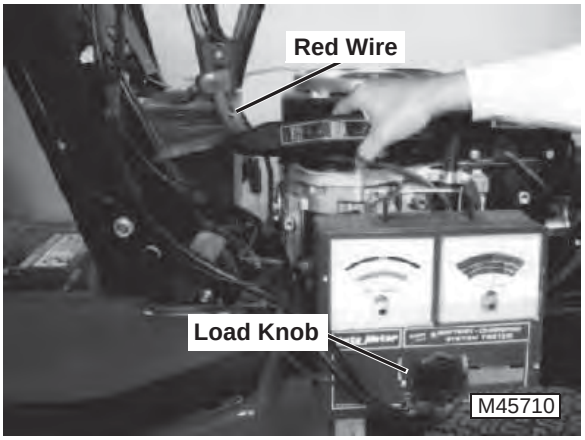
Test Equipment:

- JT05685 Battery Tester
- Current Gun or Ammeter

Procedure:

NOTE: The battery should be in good condition and fully charged before performing test. (See BATTERY TEST on page 5-177.)

1. Park machine on level surface.
2. Put transmission in NEUTRAL.
3. Engage park brake.
4. Turn key switch to OFF position.
5. Raise engine hood.



6. Connect ammeter in series with red wire or place current gun over wire.
7. Turn knob of battery tester to OFF position (fully counterclockwise).
8. Connect JT05685 Battery Tester to battery:
   - Connect tester positive (red) cable to battery positive (+) terminal.
   - Connect tester negative (black) to battery negative (-) terminal.

IMPORTANT: Perform this test as quickly as possible to prevent damage to electrical system components. DO NOT apply a full load to the battery for more than 10 seconds.

9. Start and run engine at fast idle.

Engine Fast Idle Speed:

Kawasaki Engines:

FC420V/FC540V.....(3350 ± 50 rpm)
FD440V... .....(3400 ± 75 rpm)
FD501V. .....(3350 ± 75 rpm)

Kohler Engine:

CV15S (3350 ± 50 rpm)

10. Turn load knob in (clockwise) until voltage reads 11 VDC.
11. Read and record amperage reading. Amperage should read a minimum of 13 amps at fast idle.
12. Turn load knob OFF (fully counterclockwise).

Results:

- If the amperage output is below minimum specification, perform UNREGULATED VOLTAGE OUTPUT TEST.
- If unregulated voltage output meets specifications and voltage and ground to the regulator/rectifier is verified, replace the regulator/rectifier.

REGULATED VOLTAGE OUTPUT TEST

Reason:

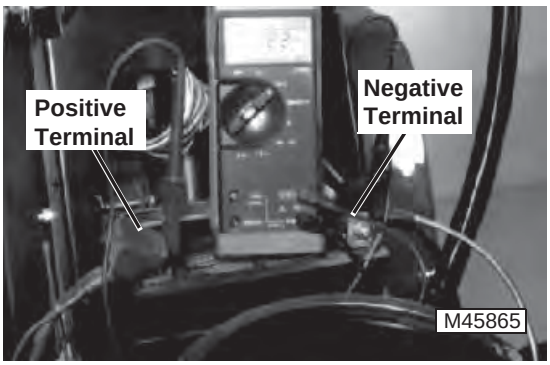
To determine regulated voltage output of the regulator/ rectifier.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.
6. Remove surface charge from battery by placing a small load on the battery for 15 seconds.
7. Set voltmeter for 25 or 50 DC volt scale.



8. Connect meter red lead to battery positive (+) terminal.
9. Connect meter black lead to battery negative (-) terminal.
10. Start and run engine at fast idle.

Engine Fast Idle Speeds:

Kawasaki Engines:

FC420V/FC540V..... (3350 ± 50 rpm)
FD440V... ..... (3400 ± 75 rpm)
FD501V. ..... (3350 ± 75 rpm)

Kohler Engine:

CV15S (3350 ± 50 rpm)

11. 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, test unregulated voltage output. (See UNREGULATED VOLTAGE OUTPUT TEST.)
- If the DC voltage goes above the maximum specification, replace the regulator/rectifier.

UNREGULATED VOLTAGE OUTPUT TEST—LX172/LX176/LX186/LX178/LX188

Reason:

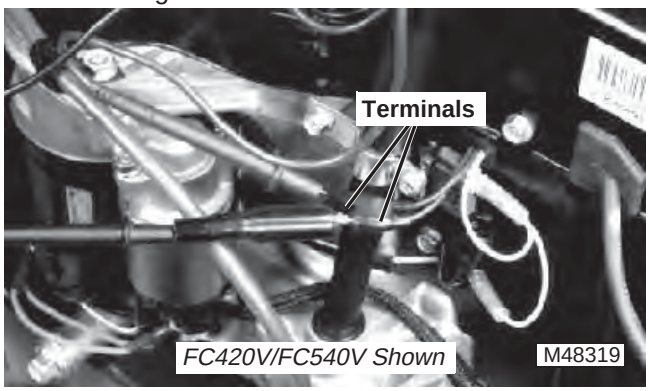
To measure stator voltage output to determine stator condition.

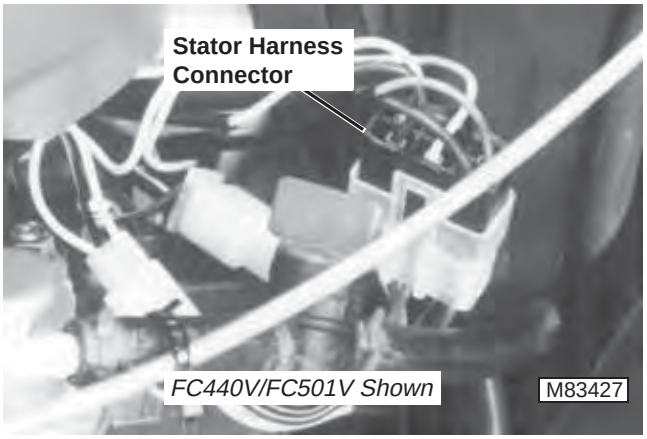
Test Equipment:

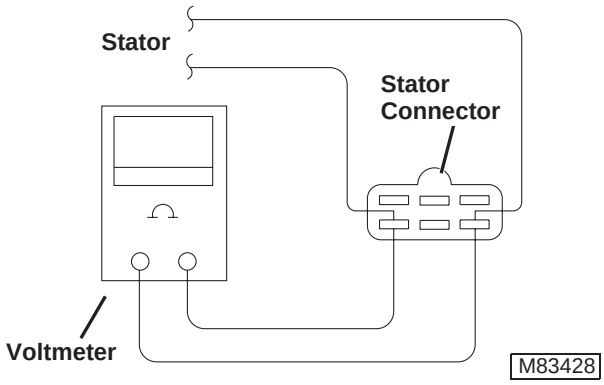
- Voltmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL
4. Engage park brake.
5. Raise engine hood.







6. Disconnect stator 2-pin connector (LX172/LX176/LX186) or 6-pin connector (LX178/LX188).
7. Set voltmeter to 50 volt AC scale.
8. Connect meter leads across terminals of connector.
9. Start and run engine at **fast idle.**

Engine Fast Idle Specifications:

FC420V/FC540V(3350 ± 50 rpm)
FD440V(3400 ± 75 rpm)
FD501 (3350 ± 75 rpm)

10. Measure stator output voltage.

Minimum Stator Output Voltage (AC):

LX172/LX17630 VAC
LX186 27 VAC
LX178/LX18826 VAC

Results:

- If voltage is less than specifications, test flywheel magnet (LX172/LX176/LX186) and then replace stator. (See FLYWHEEL MAGNET TEST on page 5-185.)

UNREGULATED VOLTAGE OUTPUT TEST—LX173

Reason:

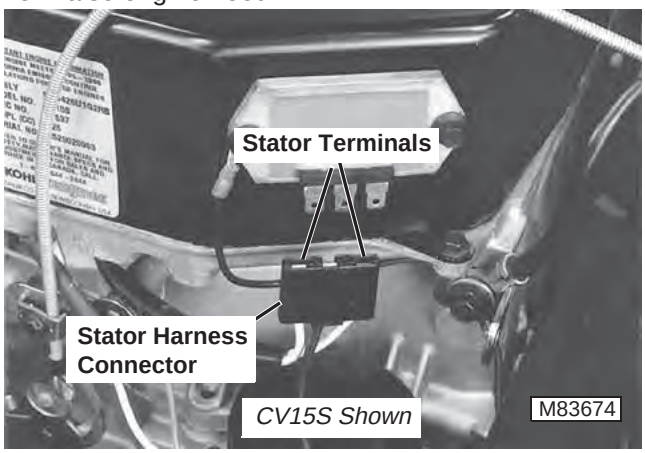
To measure stator voltage output to determine stator condition.

Test Equipment:

- Voltmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.



6. Disconnect voltage regulator/rectifier 3-pin connector.
7. Set voltmeter to 50 volt AC scale.
8. Connect meter leads across stator terminals (white wires).
9. Start and run engine at **fast idle (3350 ± 50 rpm).** Measure stator output voltage. Voltage should read a minimum of 30 VAC.

Results:

- If voltage is less than specifications, test flywheel magnet and then replace stator. (See FLYWHEEL MAGNET TEST on page 5-185.)

STATOR COIL RESISTANCE TEST—FD440V/FD501V

Reason:

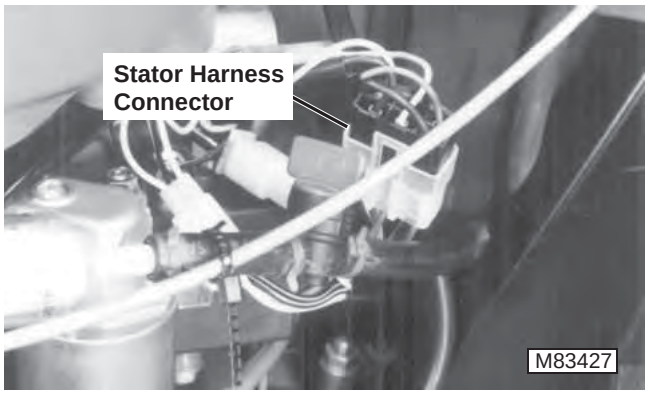
To determine resistance of the stator.

Test Equipment:

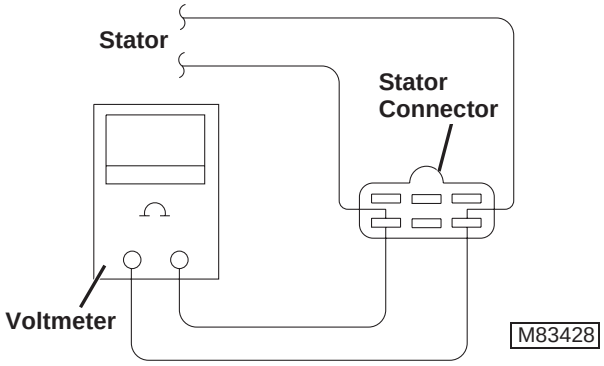
- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.



6. Disconnect stator harness connector.



7. Connect ohmmeter leads to stator connector terminals.
8. Read stator resistance. Stator resistance should read **0.1232—0.1848 ohms.**

Results:

- Replace stator if resistance is not within specifications.

STARTER SOLENOID TEST

Reason:

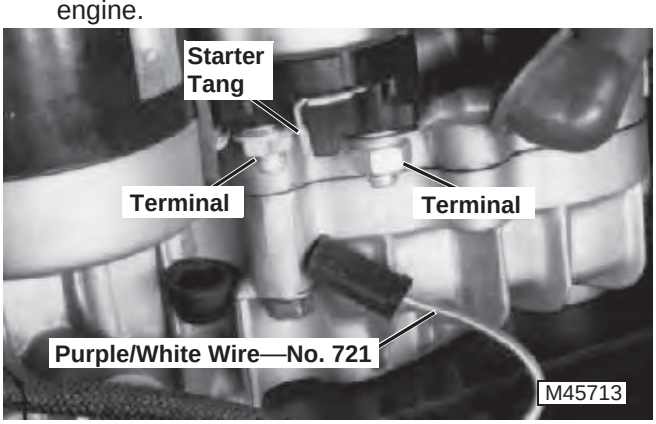
To determine if the starter solenoid or starter motor is defective.

Test Equipment:

- Jumper Wire

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.
6. Remove spark plug high tension lead and ground to engine.



7. Disconnect purple/white wire No. 721 from starter solenoid.
8. Connect jumper wire to positive battery terminal and briefly jump to starter tang.

Results:

- Starter runs: solenoid is good, check circuit wiring. (See CRANKING CIRCUIT DIAGNOSIS on page 5-48 [LX172/LX176/LX186], 5-94 [LX178/LX188] or 5-140 [LX173].)
- Starter does not run: go to step 9.

9. Remove red and black rubber boots from terminal.
10. Connect jumper wire between starter solenoid terminals.

Results:

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

STARTER LOADED AMPERAGE DRAW TEST—LX172/LX173/LX176/LX186

Reason:

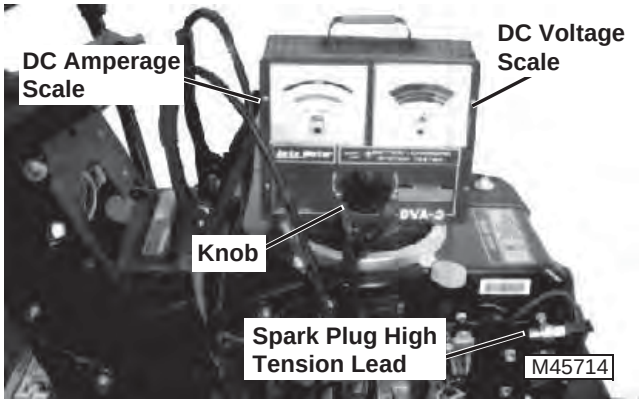
To determine the amperage required to crank the engine and check the starter motor operation under load.

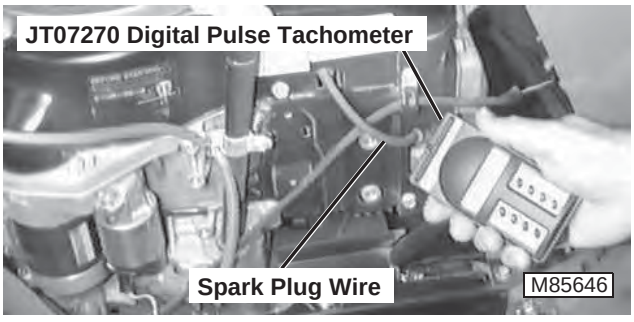
Test Equipment:

- JT05685 Battery Tester
- JT07270 Digital Pulse Tachometer

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Test system ground connections. (See GROUND CIRCUIT TEST on page 5-176.)
6. Test battery. (See BATTERY TEST on page 5-177.)





7. Turn knob of battery tester to OFF position (fully counterclockwise).
8. Connect red clamp of battery tester to positive (+) terminal of battery and black clamp to negative (-) terminal of battery.
9. Use a JT07270 Digital Pulse Tachometer at spark plug wire to monitor engine speed.

10. Remove spark plug high tension lead and ground to engine.
11. Crank engine and read voltage on DC voltage scale of battery tester and check engine rpm using JT07270 Digital Pulse Tachometer.
12. Turn key switch to OFF position.

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

13. Turn knob on Battery Tester clockwise until the DC voltage is the same as when cranking.
14. Read DC amperage on Battery Tester.

Maximum Starter Amperage Draw:

LX172/LX176/LX18685 amps at 500 rpm
LX173 180 amps at 225 rpm

Results:

- If amperage is above specifications, or cranking rpm is low, test starter no-load rpm and amperage. (See STARTER—No-Load Amperage Draw Test on page 3-74.)

STARTER LOADED AMPERAGE DRAW TEST—LX178/LX188

Reason:

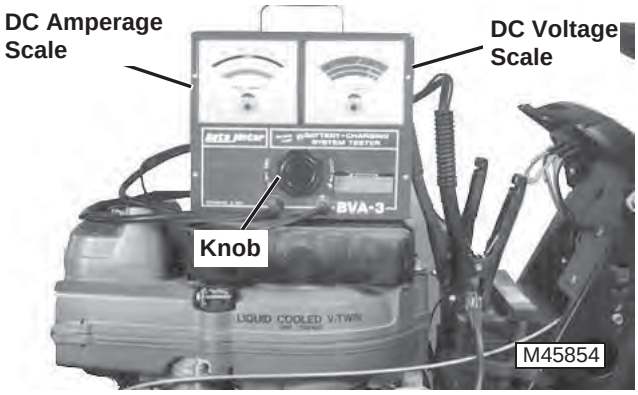
To determine the amperage required to crank the engine and check the starter motor operation under load.

Test Equipment:

- JT05685 Battery Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Put transmission in NEUTRAL.
4. Engage parking brake.
5. Test system ground connections. (See GROUND CIRCUIT TEST on page 5-176.)
6. Test battery. (See BATTERY TEST on page 5-177.)



7. Turn knob of battery tester fully counterclockwise to OFF position.
8. Connect positive (red) clamp of battery tester to positive (+) terminal of battery and negative (black) clamp to negative (-) terminal of battery.
9. Remove spark plug high tension leads and ground to engine.
10. Crank engine and read voltage on DC voltage scale of Battery Tester.
11. Turn key switch to OFF position.

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

12. Turn knob on Battery Tester clockwise until the DC voltage is the same as when cranking.
13. Read DC amperage on Battery Tester. **Maximum starter amperage draw should be 85 amps.**

Results:

- If amperage is above specifications, or cranking rpm is low, test starter no-load rpm and amperage. (See STARTER—No-Load Amperage Draw Test on page 3-144.)

IGNITION MODULE TEST—LX172/LX176/LX178/LX186/LX188

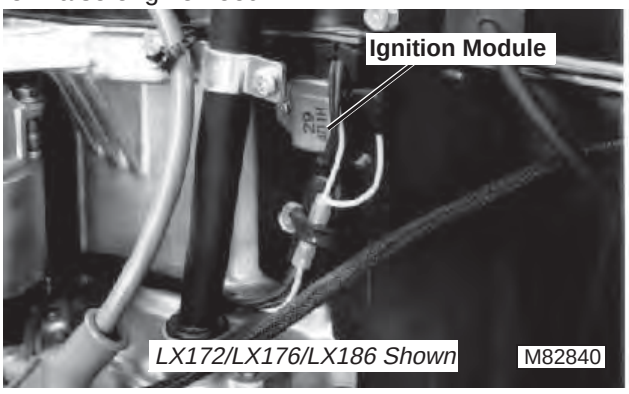
Reason:

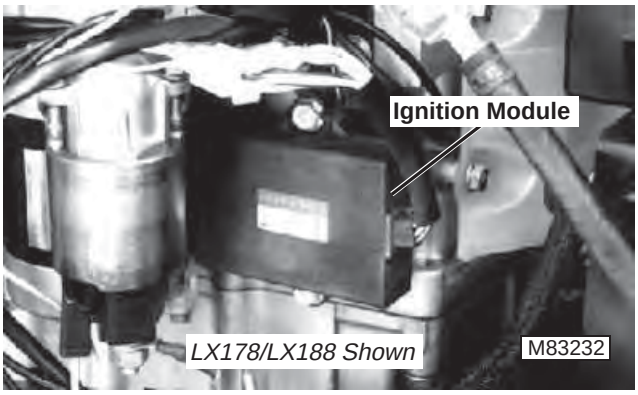
To determine if the ignition module is defective.

NOTE: Kawasaki engine model numbers FC420V (S.N. FC420VB05633—) and FC540V (S.N. FC540VA00385—) have the ignition module integrated with the ignition coil. This integrated coil cannot be used on older engines.

Procedure:

1. Park machine on level surface.
2. Put transmission in NEUTRAL.
3. Engage park brake.
4. Turn key switch to OFF position.
5. Raise engine hood.





6. The ignition module is very sensitive to the type of meter used to check resistance. Due to variations in meters, the best way to determine if the ignition module is good is to replace the questionable ignition module with a known good module.

Results:

- If the new ignition module does not solve the problem, check other ignition components.

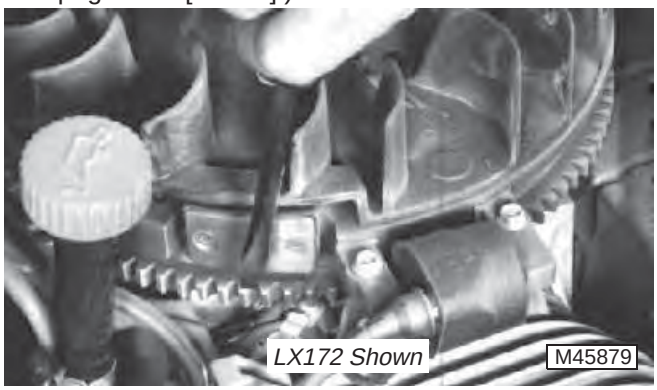
FLYWHEEL MAGNET TEST

Reason:

To make sure the flywheel magnet has enough force to induce current in the ignition coil.

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Remove blower housing—LX172/LX173/LX176/LX186. (See BLOWER HOUSING—Inspection/Replacement on page 3-48 [LX172/LX176/LX186] or BLOWER HOUSING—Removal/Installation on page 4-35 [LX173].)



6. Hold a steel tool about 25 mm (1.0 in.) from flywheel magnet. The tool should be attracted by the magnet.

Results:

- Replace the flywheel if the magnet does not attract tool.

IGNITION COIL TEST—LX172/LX176/LX186

Reason:

Check primary and secondary windings of ignition coil.

Test Equipment:

- Ohmmeter

Procedure:

This test requires removal of the blower housing. (See MAGNETO IGNITION COIL on page 3-72.) or MAGNETO IGNITION COIL WITH IGNITOR MODULE on page 3-73.)

IGNITION COIL TEST—LX178/LX188

Reason:

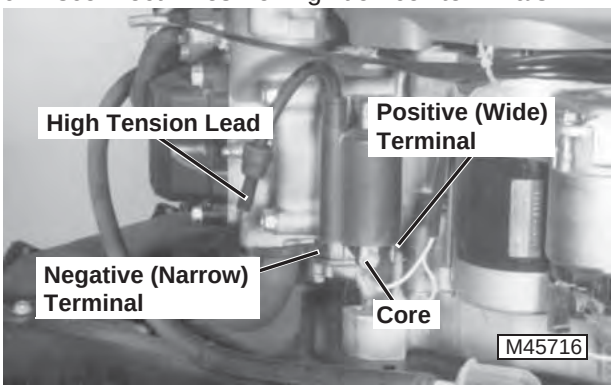
Check primary and secondary windings of ignition coil.

Test Equipment:

- Ohmmeter.

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.
6. Disconnect wires from ignition coil terminals.



7. Unscrew spark plug cap from high tension lead.
8. Set ohmmeter to 1x ohms scale.

Primary Windings:

NOTE: Resistance value may vary between ohmmeters.

9. Connect one ohmmeter lead to coil positive (+) (wide) terminal.
10. Connect other ohmmeter lead to coil negative (-) terminal.
11. Measure resistance across primary windings. Resistance should measure **3.4—4.6 ohms.**

Secondary Windings:

12. Set ohmmeter to 10Kx (10,000) ohms scale.
13. Connect one ohmmeter lead to coil positive (+) terminal.

NOTE: Test spark plug cap resistance before installing on high tension lead. (See SPARK PLUG CAP TEST on page 5-187.)

14. Connect other ohmmeter lead to high tension lead.
15. Measure resistance across secondary windings. Resistance should measure **10,400—15,600 ohms.**

Open Circuit Check:

16. Connect one ohmmeter lead to coil positive (+) terminal or coil negative (-) terminal.

NOTE: Do not connect ohmmeter lead to ignition coil mounting screws, as this will result in an inaccurate reading.

17. Connect other ohmmeter lead to coil core.
18. Measure resistance from primary leads to coil core. There should be no continuity (open circuit) between coil primary terminals and coil core.
19. Connect one ohmmeter lead to high tension lead.

NOTE: Do not connect ohmmeter lead to ignition coil mounting screws, as this will result in an inaccurate reading.

20. Connect other ohmmeter lead to coil core.
21. Measure resistance from high tension lead to coil core. There should be no continuity (open circuit) between high tension lead and coil core.
22. Repeat test procedures on other ignition coil.

Results:

- If the ohmmeter readings are not within specifications, replace coil.
- If ohmmeter readings are within specifications, the coil is probably good. If the system still does not perform properly after all checks/tests, replace coil with a known good coil.

PULSER COIL TEST—LX178/LX188

Reason:

To check if the pulser coil is operating properly.

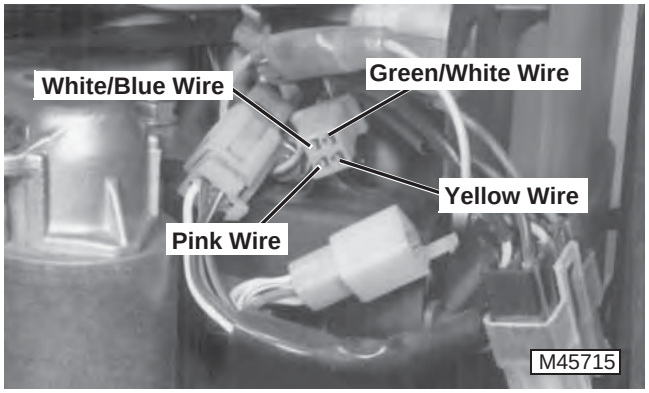
Test Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.

5. Raise engine hood.
6. Set ohmmeter to 1x ohms scale.
7. Separate pulser connector.



8. Connect one meter lead to blue/white wire. Connect other meter lead to pink wire.
9. Measure resistance. Resistance should measure **88—132 ohms.**
10. Connect one meter lead to green/white wire. Connect other meter lead to yellow wire.
11. Measure resistance. Resistance should measure **88—132 ohms.**

Results:

NOTE: Resistance values may vary between ohmmeters.

- If either pulser coil is out of specification, replace pulser coil/harness assembly.

SPARK PLUG CAP TEST—LX178/LX188

Reason:

To determine the resistance of the spark plug cap.

Test Equipment:

- Ohmmeter

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.
6. Unscrew spark plug cap from high tension lead.



7. Connect one meter lead to spark plug side of spark plug cap.
8. Connect other meter lead to high tension side of spark plug cap.
9. Measure resistance. Resistance should be within 10% of value marked on cap.

Results:

- If resistance is not within specifications, replace cap.

NEUTRAL START/BRAKE SWITCH TEST

NOTE: LX172/LX173 tractors use a gear transaxle and neutral start switch. LX176/LX178/LX186 and LX188 tractors use a hydrostatic transaxle and brake switch. Operation of switches is identical.

Reason:

To make sure that the neutral start/brake switch is operating properly.

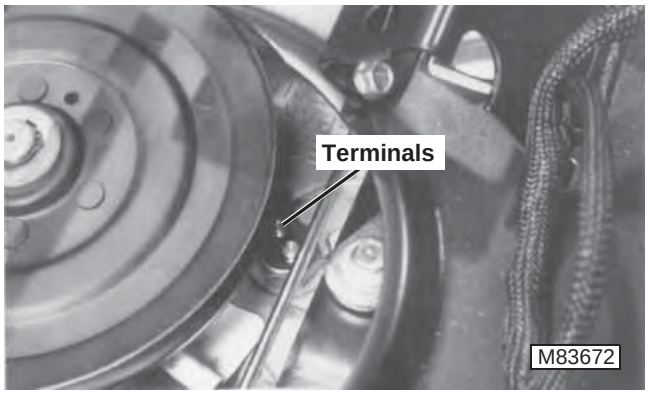
Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
6. Remove fuel tank. (See FUEL TANK—Removal/Installation on page 3-41 [LX172/LX176/LX186], page 3-112 [LX178/LX188] or page 4-28 [LX173].)
7. Disconnect neutral start/brake switch connector.

LX172/LX173:

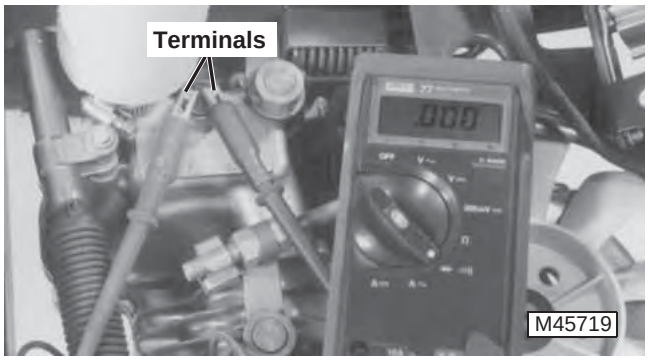


8. Check continuity across terminals. There should be continuity.
9. Place transmission in gear.
10. Check continuity across terminals. There should be no continuity.

Results:

- If continuity is not correct, check external linkage and repeat test.
- If after checking linkage, there is still no continuity when the transmission is in the NEUTRAL position, go to steps 14—16.

LX176/LX178/LX186/LX188:

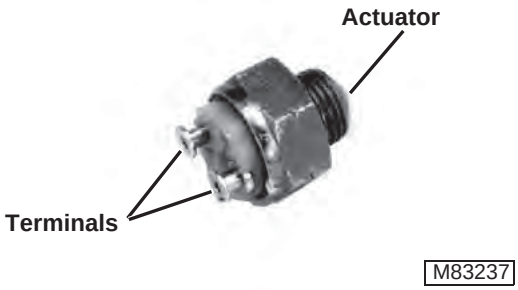


11. Check continuity across terminals. There should be continuity.
12. Release parking brake.
13. Check continuity across terminals. There should be no continuity.

Results:

- If continuity is not correct, check external brake linkage and repeat test.
- If after checking linkage, there is still no continuity when the transmission is in the NEUTRAL position, go to steps 14—16.

14. Remove switch from transmission.



15. Check continuity across terminals. There should be no continuity.
16. Depress actuator. Check continuity, there should be continuity across terminals with actuator depressed.

Results:

- If continuity is correct, check internal transmission linkage. (See TRANSAXLE—Disassembly/ Inspection on page 6-34 [LX172/LX173] or page 7-48 [LX176/LX178/LX186/LX188].)
- If continuity is not correct, replace switch.

PTO SWITCH TEST

Reason:

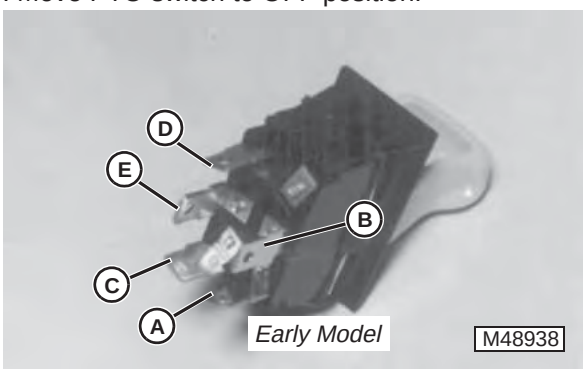
To verify terminal continuity is correct when in the ON and OFF positions.

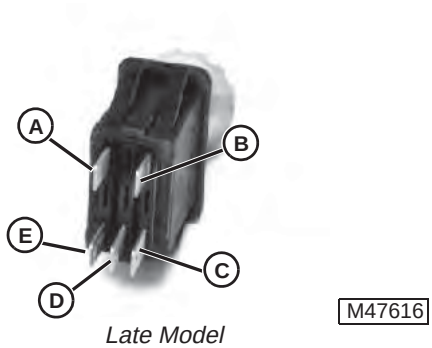
Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Disconnect PTO switch connector.
6. Move PTO switch to OFF position.





Late Model

7. Connect ohmmeter leads to terminals (A and B). There should be continuity.
8. Connect ohmmeter leads to terminals (C and E). There should be continuity.
9. Move PTO switch to ON position.
10. Connect ohmmeter leads to terminals (D and E). There should be continuity.

Results:

- If continuity is not correct, replace PTO switch.

PTO CLUTCH TEST

Reason:

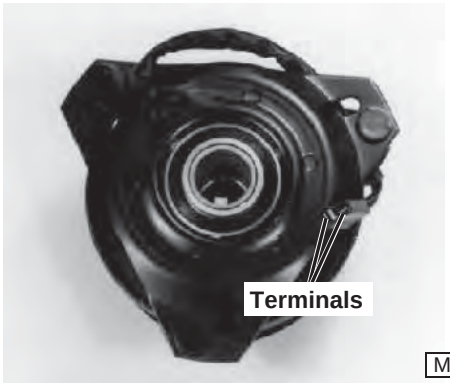
To check condition of PTO clutch coil and to check operation under load.

Test Equipment:

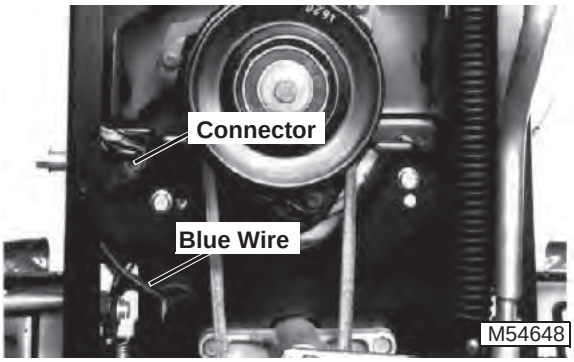
- Ohmmeter
- JT05712 Current Gun

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
6. Disconnect PTO clutch connector.
7. Set ohmmeter for 1x ohms scale.



8. Measure resistance across terminals. Resistance should measure **2.4—2.7 ohms.**



9. Connect PTO clutch connector.
10. Put JT05712 Current Gun over blue PTO clutch wire.
11. Start and run engine at **slow idle.**

Slow Idle Speed:

LX172/LX176/LX1861450 ± 75 rpm
LX178/LX1881550 ± 75 rpm

12. Turn the PTO switch to the ON position.
13. Measure PTO clutch current draw. The current draw should be approximately **4.84 amps.**

Results:

- If resistance does not meet specifications, replace the PTO clutch.
- Normal current draw is approximately **4.84 amps.** Low current draw will cause a weak PTO clutch. If the current draw is **less than 4 amps,** replace clutch.

SEAT SWITCH TEST

Reason:

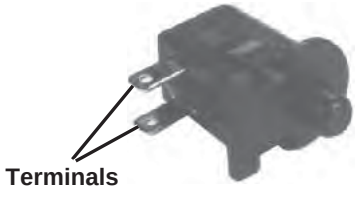
To verify continuity between seat switch terminals when operator is on the seat (plunger depressed).

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Disconnect seat switch connector.



M48379

6. Connect leads of ohmmeter or continuity tester to terminals of switch.
7. Set ohmmeter for 1x ohms scale.
8. Check continuity across switch terminals. There should be no continuity.
9. Depress plunger and check continuity across switch terminals. There should be continuity.

Results:

- If the seat switch does not have continuity with the operator on seat, check seat switch bracket and spring for damage.
- If the seat switch does not have continuity with plunger depressed, or continuity is not correct, replace the switch.

HEADLIGHT SWITCH TEST

Reason:

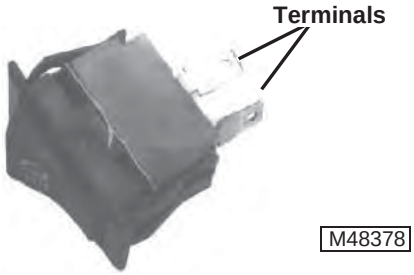
To verify headlight switch terminals have continuity when the headlight switch is ON.

Test Equipment:

- Ohmmeter or Continuity Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Disconnect headlight switch connector.



M48378

6. Connect ohmmeter leads to terminals of switch.
7. Set ohmmeter for 1x ohms scale.
8. Move headlight switch to the ON position and then the OFF position. Check continuity between terminals.

Results:

- If NO continuity with switch in ON position, replace switch.
- If continuity exists with switch in the OFF position, replace switch.

OIL PRESSURE SWITCH TEST

Reason:

To determine the proper operation of the oil pressure switch.

Test Equipment:

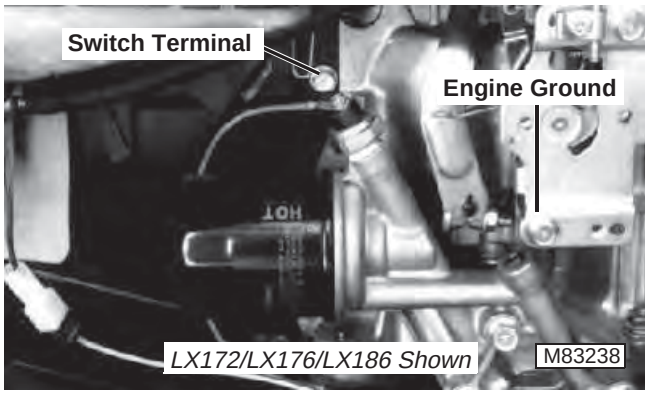
- Ohmmeter

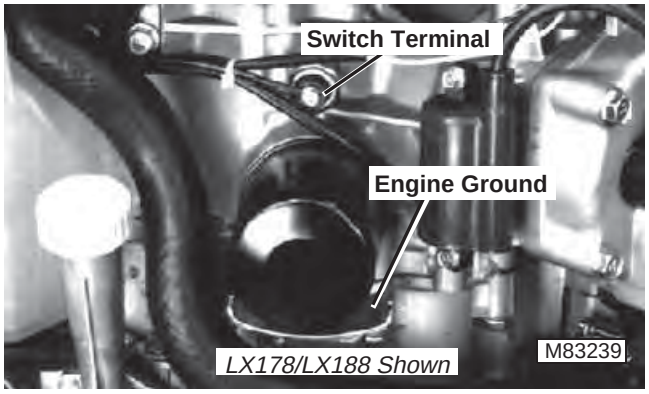
Procedure:

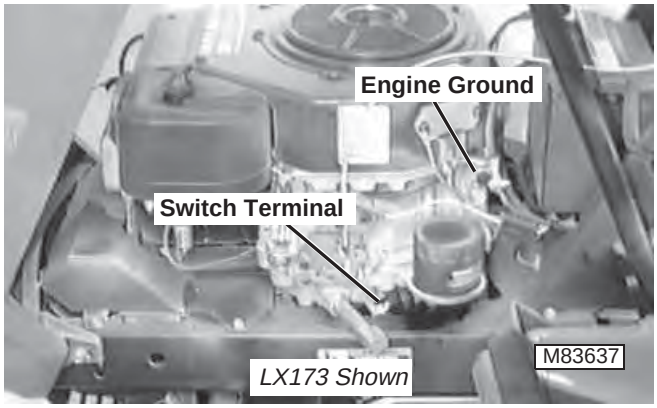
1. Park machine on level surface.
2. Turn key switch to OFF position.
3. Put transmission in NEUTRAL.
4. Engage park brake.
5. Raise engine hood.

IMPORTANT: Do not allow connector of wire to contact the engine or frame as there will be voltage at it during the test.

6. Disconnect wire from oil pressure switch.







7. Connect red ohmmeter lead to terminal of switch and black ohmmeter lead to engine block.
8. Set ohmmeter for 1x scale.
9. Measure resistance between terminal and engine block. There should be continuity between terminal and ground.
10. Start and run engine.
11. Measure resistance between terminal and engine block. There should be no continuity between terminal and ground.

Results:

- If switch does NOT have continuity to ground when the engine is not running, replace the switch.
- If the switch does have continuity to ground with the engine running, check engine oil pressure. (See ENGINE OIL PRESSURE TEST on page 3-37 [LX172/LX176/LX186], page 3-108 [LX178/LX188] or page 4-25 [LX173].) If the oil pressure is to specifications, replace the switch.

NOTE: Be sure to apply Pipe Sealant with TEFLON® to threads of switch anytime it is installed.

COOLANT TEMPERATURE SWITCH TEST—LX178/LX188

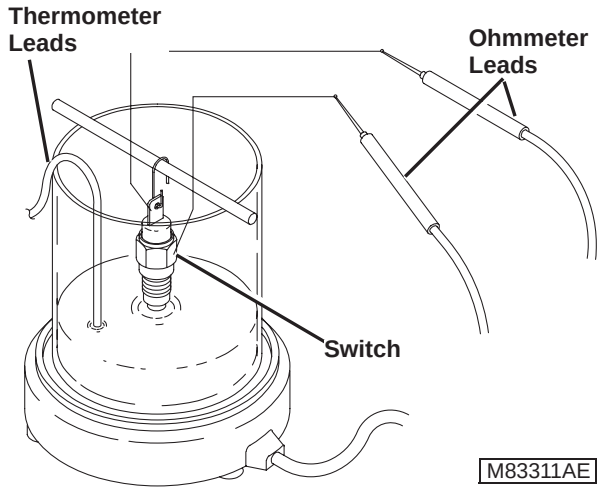
Reason:

To determine operating temperature of switch.

Test Equipment:

- Ohmmeter
- JT05800 Digital Thermometer
- Glass Container
- Heating Unit

Procedure:



1. Connect ohmmeter leads to switch terminal and body.
2. Suspend switch in a container of engine coolant solution.
3. Place digital thermometer lead in coolant.
4. Heat and stir the coolant. Observe temperature of coolant when continuity occurs. Coolant temperature should be 111°C (232°F).

Results:

- If continuity does not occur within specification, replace switch.

FUEL SHUTOFF SOLENOID TEST

Reason:

To determine if the fuel shut-off plunger retracts when the solenoid is energized.

Test Equipment:

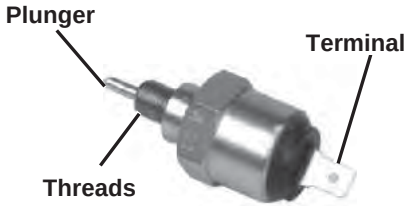
- 2 Jumper Wires

Procedure:

⚠ CAUTION

Keep gasoline away from sparks, flame, or hot engine parts or personal injury can result.

1. Remove drain screw and spring to drain gasoline from float bowl.
2. Disconnect fuel shut-off solenoid connector.
3. Remove fuel shut-off solenoid, washer and float bowl.



4. Connect a jumper wire from the battery positive (+) terminal to solenoid terminal.

NOTE: It may be necessary to push plunger inward slightly for plunger to retract.

5. Connect a jumper wire from the battery negative (-) terminal to solenoid threads. Plunger must retract when solenoid is energized.
6. Remove jumper wire from the battery negative (-) terminal. Plunger must extend.

Results:

- If plunger does not move, replace solenoid.

PTO CLUTCH ADJUSTMENT

Reason:

To set PTO clutch air gap at a specific dimension for proper operation.

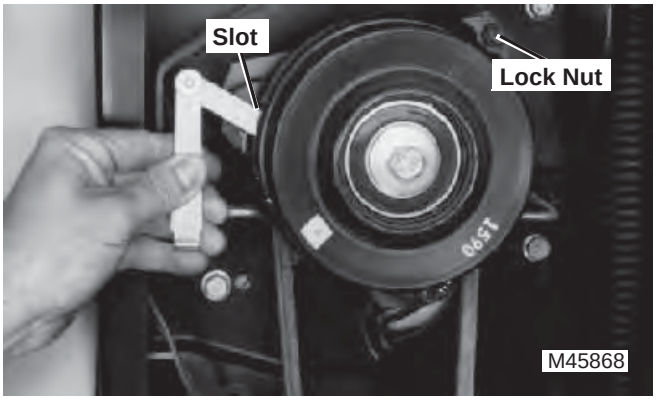
Equipment:

- 0.51 mm (0.020 in.) Feeler Gauge (Blade Type)

Procedure:

IMPORTANT: The adjustment/brake-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.

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move PTO switch to OFF position.
4. Put transmission in NEUTRAL.
5. Engage park brake.
6. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)



7. Insert 0.51 mm (0.020 in.) feeler gauge through slot in brake plate to check PTO clutch air gap. Gauge should be between clutch armature and rotor. Check air gap at all three slots.

IMPORTANT: DO NOT overtighten lock nuts.

8. If the air gap is not correct, adjust lock nut until the 0.51 mm (0.020 in.) feeler gauge begins to bind between the armature and rotor. Use a sweeping motion with feeler gauge while making this adjustment.
9. Repeat procedure on remaining nuts as necessary.
10. Engage and disengage the PTO clutch several times. Recheck adjustment.
11. Perform PTO Clutch Break-in procedure.

Break-in Procedure

1. Start and run engine at FAST idle.
2. With no load on clutch:
   - Put PTO switch in ON position (engage PTO clutch) and run for 10 seconds.
   - Put PTO switch in OFF position (disengage PTO clutch) and wait 10 seconds.
3. Repeat the procedure 12—15 cycles to properly burnish (break-in) the PTO clutch.
4. Recheck adjustment.

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.

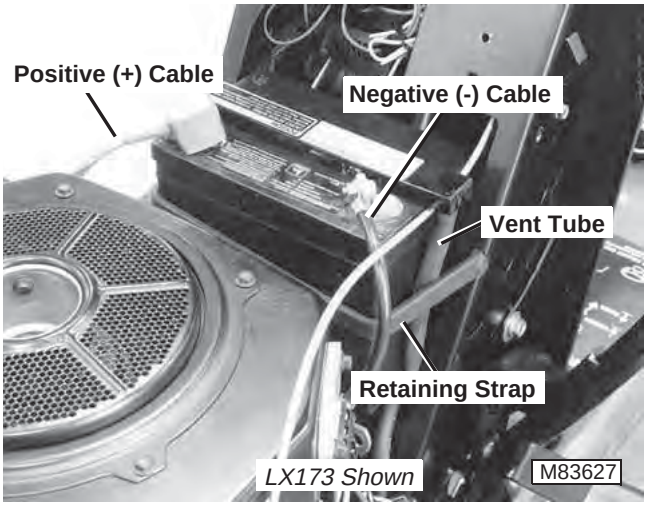
If you spill acid on yourself:

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. Raise engine hood.



2. Disconnect battery cables, negative (-) cable first.
3. Disconnect vent tube.
4. Remove retaining strap.
5. Remove battery.

Installation is done in the reverse order of removal.

- Clean battery if dirty. (See Cleaning procedure.)
- Insect battery terminals and case for breakage or cracks. Replace if needed.
- Test battery condition. (See BATTERY TEST on page 4-177.)
- Connect negative (-) cable last.

Cleaning

1. Remove battery from machine. (See Removal/ Installation procedure.)

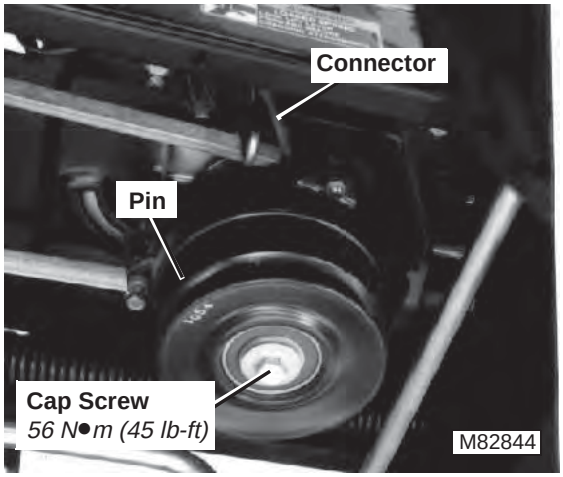
NOTE: Keep cleaning solution out of battery cells.

2. Clean battery, battery terminals, cable ends, bracket and battery box with 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 mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)



2. Disconnect wiring connector.
3. Remove cap screw, washer and PTO clutch.

Installation is done in the reverse order of removal.

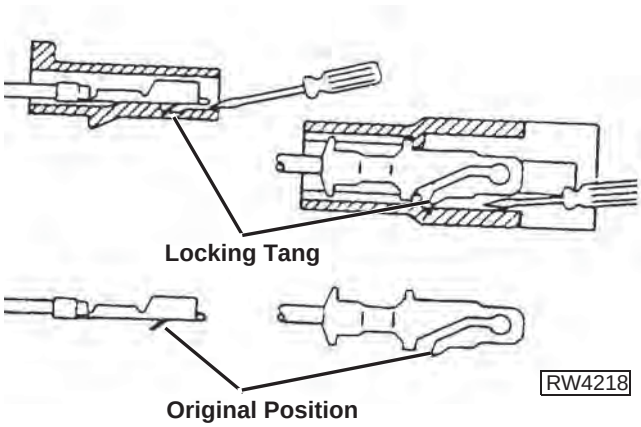
- Apply MPG-2® Multi-Purpose Grease to crankshaft before installing PTO clutch.
- Install clutch on crankshaft with pin through slot in coil housing.
- Install washer with concave side toward PTO clutch.

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.

- Adjust PTO clutch. (See PTO CLUTCH ADJUSTMENT on page 5-193.)

CONNECTOR BODY—BLADE TERMINALS

Replacement



Use a small screwdriver to depress locking tang terminal. Slide connector body off.

Be sure to bend locking tang back to its original position before installing connector body.

This page intentionally left blank.

CONTENTS

Page

POWER TRAIN—GEAR

SPECIFICATIONS
- ADJUSTMENT SPECIFICATIONS 6-3
- REPAIR SPECIFICATIONS 6-3
- OTHER MATERIALS 6-3
- SERVICE PARTS KITS 6-3

COMPONENT LOCATION AND OPERATION
- BELT DRIVE SYSTEM OPERATION—CLUTCH PEDAL DEPRESSED 6-4
- BELT DRIVE SYSTEM OPERATION—CLUTCH PEDAL RELEASED 6-5
- TRANSAXLE OPERATION—NEUTRAL 6-6
- TRANSAXLE OPERATION—FORWARD (1st—5th GEARS) 6-8
- TRANSAXLE OPERATION—REVERSE 6-10

TROUBLESHOOTING 6-13

DIAGNOSIS
- MACHINE WILL NOT MOVE IN FORWARD OR REVERSE 6-14
- MACHINE MOVES IN ONE DIRECTION ONLY OR DOESN'T MOVE IN ONE OR MORE GEARS 6-18
- LOSES POWER UNDER LOAD, BELT SLIPS, ERRATIC DRIVE 6-20
- JERKY AND AGGRESSIVE ENGAGEMENT 6-24
- SHIFTS HARD 6-26
- NOISY OPERATION 6-28

ADJUSTMENTS
- GEARSHIFT LEVER NEUTRAL ADJUSTMENT 6-32
- TRACTION DRIVE BELT TENSION ADJUSTMENT 6-32
- BELT GUIDE ADJUSTMENT 6-33

REPAIR
- TRANSAXLE
  - Removal/Installation 6-34
  - Disassembly/Inspection 6-34
  - Exploded View 6-36
  - Assembly 6-37
- SHIFT LEVER AND LINKAGE 6-42
- TRACTION DRIVE CLUTCH ASSEMBLY 6-43
- CLUTCH PEDAL AND LINKAGE 6-44
- TRACTION DRIVE BELT 6-45



This page intentionally left blank.

SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

Clutch Spring Assembly (dimension between caps) . . . . . 31—33 mm (1.2—1.3 in.)

REPAIR SPECIFICATIONS

Transaxle-to-Frame Nut Torque . . . . . 9 N•m (80 lb-in.)
Transaxle Case Cover-to-Case Cap Screw Torque . . . . . 12 N•m (100 lb-in.)
Transaxle Case Cover Inside Needle Bearing
(depth below inside case surface) . . . . . 3.8 mm (0.150 in.)
Pinion Gear Bearings (depth below each end of pinion gear) . . . . . 3.6 mm (0.142 in.)

OTHER MATERIALS

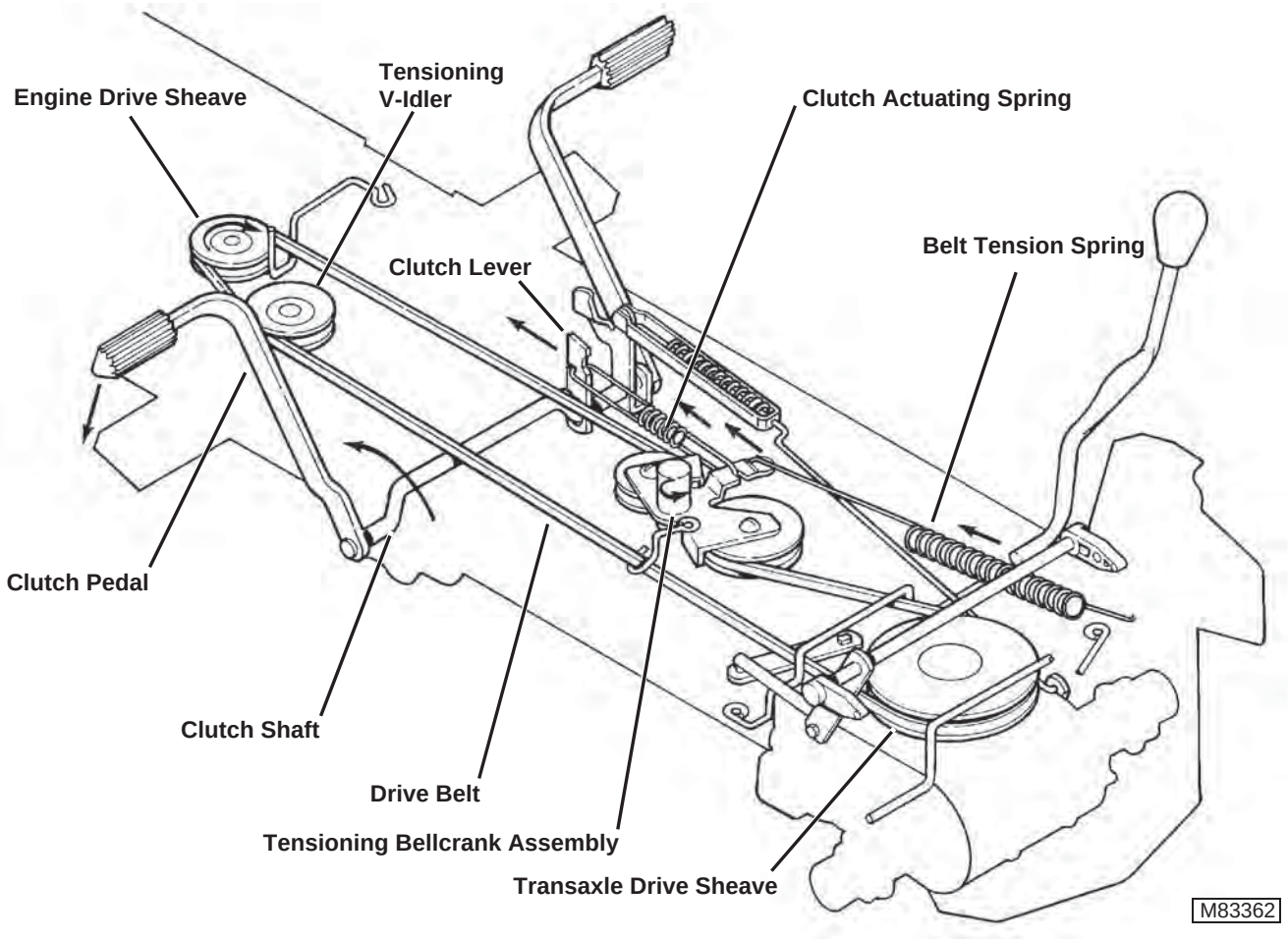
Number	Name	Use
TY6341	John Deere Non-Clay High-Temperature EP Grease	Apply to all internal parts of transaxle.

SERVICE PARTS KITS

• Differential Gear Kit

COMPONENT LOCATION AND OPERATION

BELT DRIVE SYSTEM OPERATION—CLUTCH PEDAL DEPRESSED



Function:

The function of the clutching system is to transfer power from the engine drive sheave through the drive belt and bellcrank tensioning assembly to the transaxle drive sheave. This system also allows the power to be interrupted in order to stop the tractor while in gear, change to a different gear, or push the unit when the engine is off.

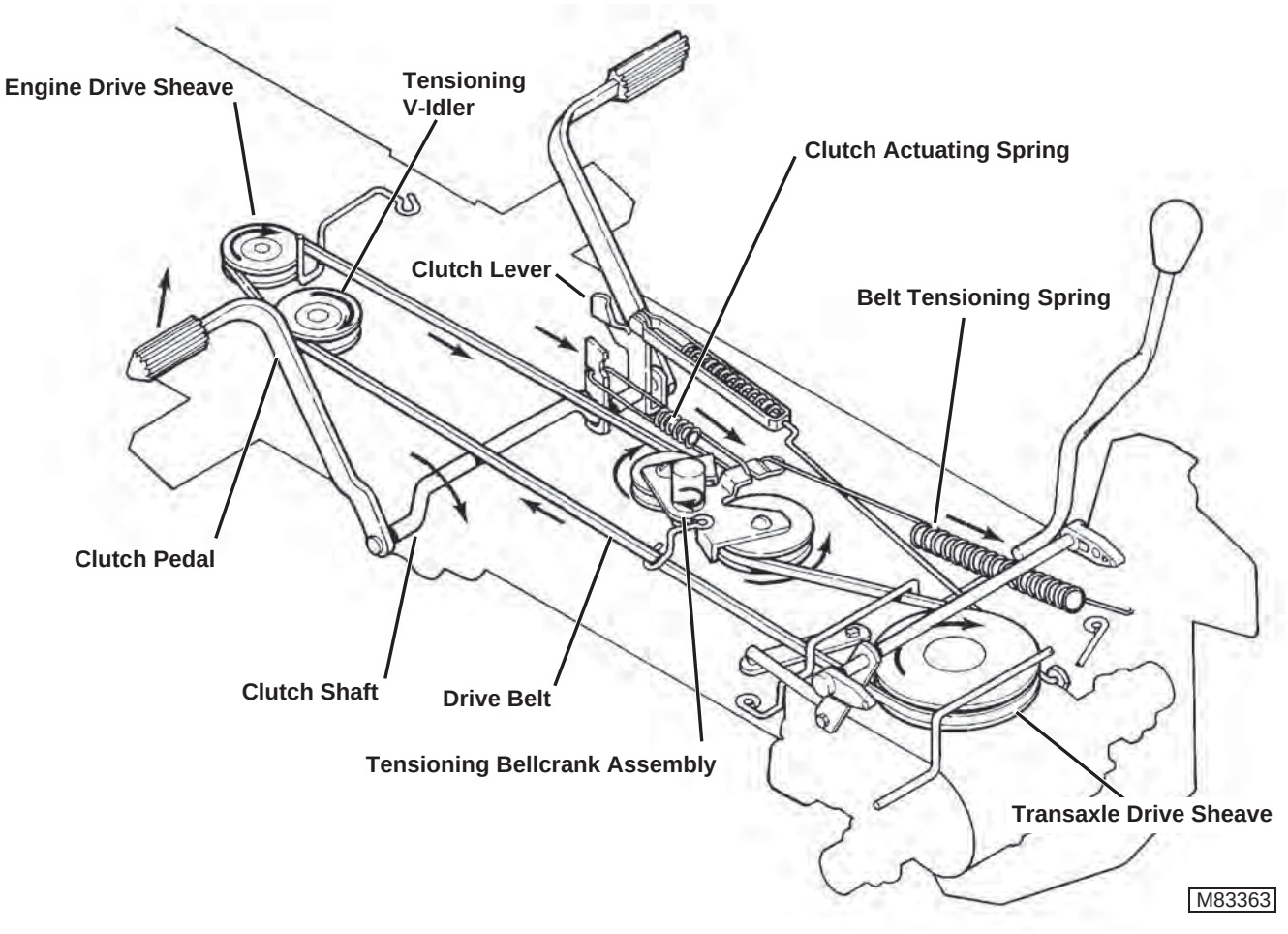
Theory of Operation:

As the clutch pedal is being fully depressed, the clutch shaft rotates. The arm welded to the clutch shaft pulls the clutch actuating spring forward. Initial movement of the pedal compresses the actuating spring; once compressed, it transfers forward movement into the rotating movement of the bellcrank tensioning assembly. As the bellcrank is rotated counterclockwise, drive belt tension is released. As the engine drive sheave rotates (engine running), power to the drive belt is interrupted due to slack now present in the drive belt.

As the bellcrank is rotated, the belt tension spring is stretched, building tension that is being felt and held by the operators left leg.

While the clutch is in the fully depressed position, the operator can shift the transaxle into any gear (forward, neutral, or reverse) or allow the tractor to be pushed while transaxle is in gear with the engine off.

BELT DRIVE SYSTEM OPERATION—CLUTCH PEDAL RELEASED



Function:

The function of this portion of the clutching system operation is to allow smooth engagement and transfer of power from the engine to the transaxle drive sheave.

Theory of Operation:

With the clutch pedal fully depressed, there is no tension on the drive belt; however, the belt tension spring has been stretched, building tension being felt and held by the operator's left leg. As the clutch pedal is gradually released, the force built up in the stretching of the belt tension spring is also gradually released. This allows the belt tension spring to contract, which rotates the bellcrank assembly clockwise and gradually applies tension to the drive belt. This allows power to be transferred from the rotating engine drive sheave through the drive belt to the transaxle drive sheave.

At the same time, the clockwise movement of the bellcrank tensioning assembly is transferred through the clutch actuating spring to the clutch shaft arm, clutch shaft, and clutch pedal; bringing the pedal back to the top of its travel as the operator removes his left foot from the clutch pedal.

TRANSAXLE OPERATION—NEUTRAL

Function:

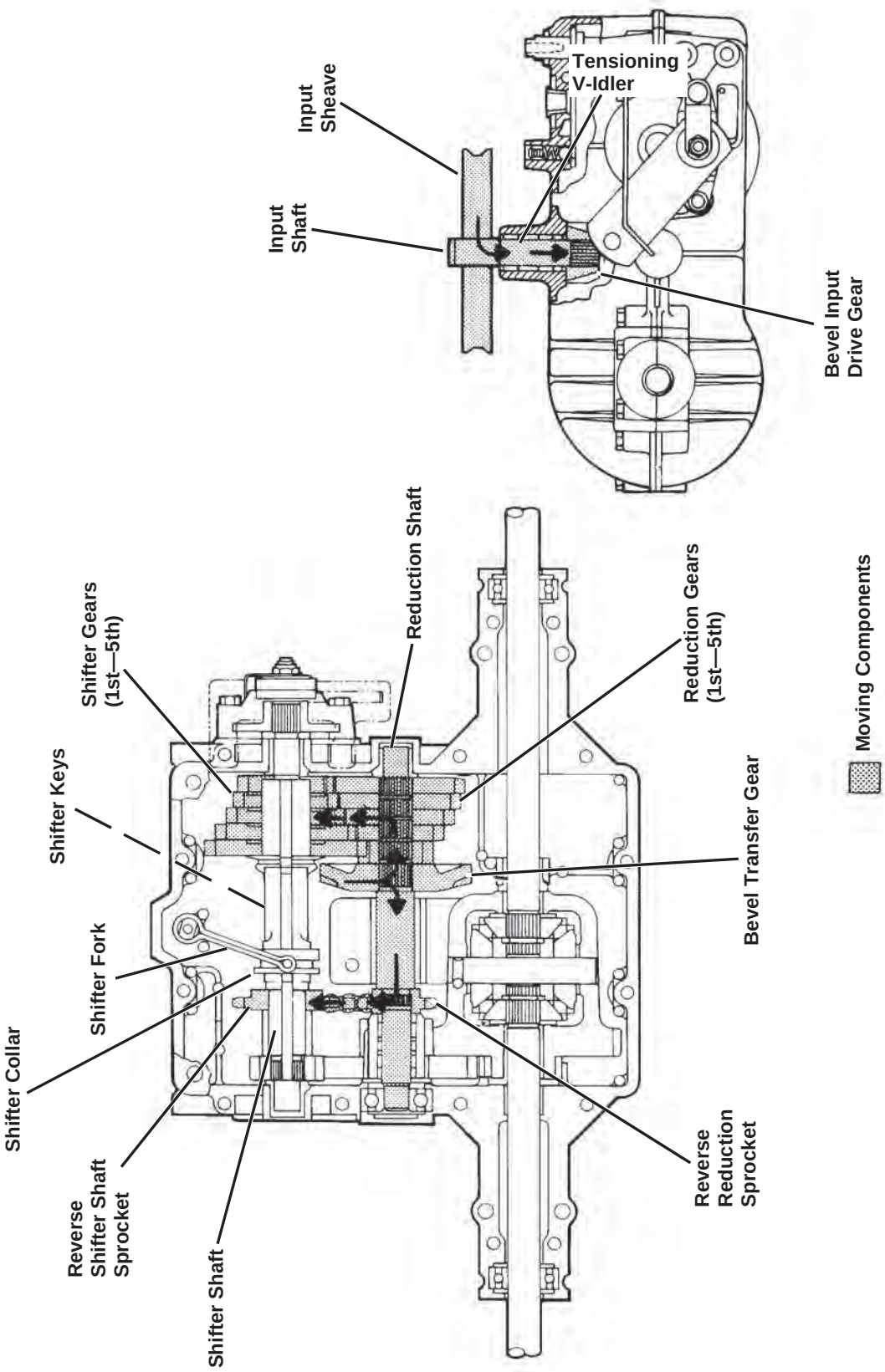
Neutral operation allows for the power transfer from the engine (engine running) to the transaxle to be interrupted inside the transaxle while the clutch pedal is disengaged (at rest at the top of its travel).

Theory of Operation:

The transaxle drive sheave is keyed to the input shaft. Splined to the shaft is the bevel input drive gear that engages the bevel transfer gear splined to the reduction shaft. Also splined to the reduction shaft are the 1st—5th reduction gears and the reverse reduction sprocket. Whenever the input shaft is turning, so are the 1st—5th reduction gears and the reverse reduction sprocket.

The 1st—5th shifter gears are in constant mesh with the 1st—5th reduction gears and are also turning in freewheeling fashion on the shifter shaft. The reverse shifter shaft sprocket is driven by the chain connected to the reverse reduction sprocket. When the shift lever is in neutral position, the shifter fork and collar places the shifter keys outside the shifter gears and the reverse shifter shaft sprocket, allowing them to spin freely on the shifter shaft.

The shifter shaft has 4 machined keyways that hold the shifter keys. These keys are retained by the shifter sliding collar and actuated by the shifter fork, which engages the keys into pockets of a selected shifter gear or the reverse sprocket. Only when engaged in the pockets of a shifter gear or reverse sprocket, is power transferred to the shifter shaft. In neutral, the shifter fork and collar places the keys outside the gears and reverse sprocket. Therefore, no power is transmitted to the shifter shaft and neutral freewheeling is maintained.


Input Sheave
Tensioning V-Idler
Input Shaft
Bevel Input Drive Gear
Reduction Shaft
Shifter Gears (1st—5th)
Reduction Gears (1st—5th)
Shifter Keys
Bevel Transfer Gear
Moving Components
Shifter Fork
Shifter Collar
Reverse Shifter Shaft Sprocket
Shifter Shaft
Reverse Reduction Sprocket

M83364

TRANSAXLE OPERATION—FORWARD (1st—5th GEARS)

Function:

Forward operation provides transfer of power (engine running) from the belt drive system through a specific transaxle shifter gear through the differential and out to the rear drive wheels, moving the tractor in a forward direction.

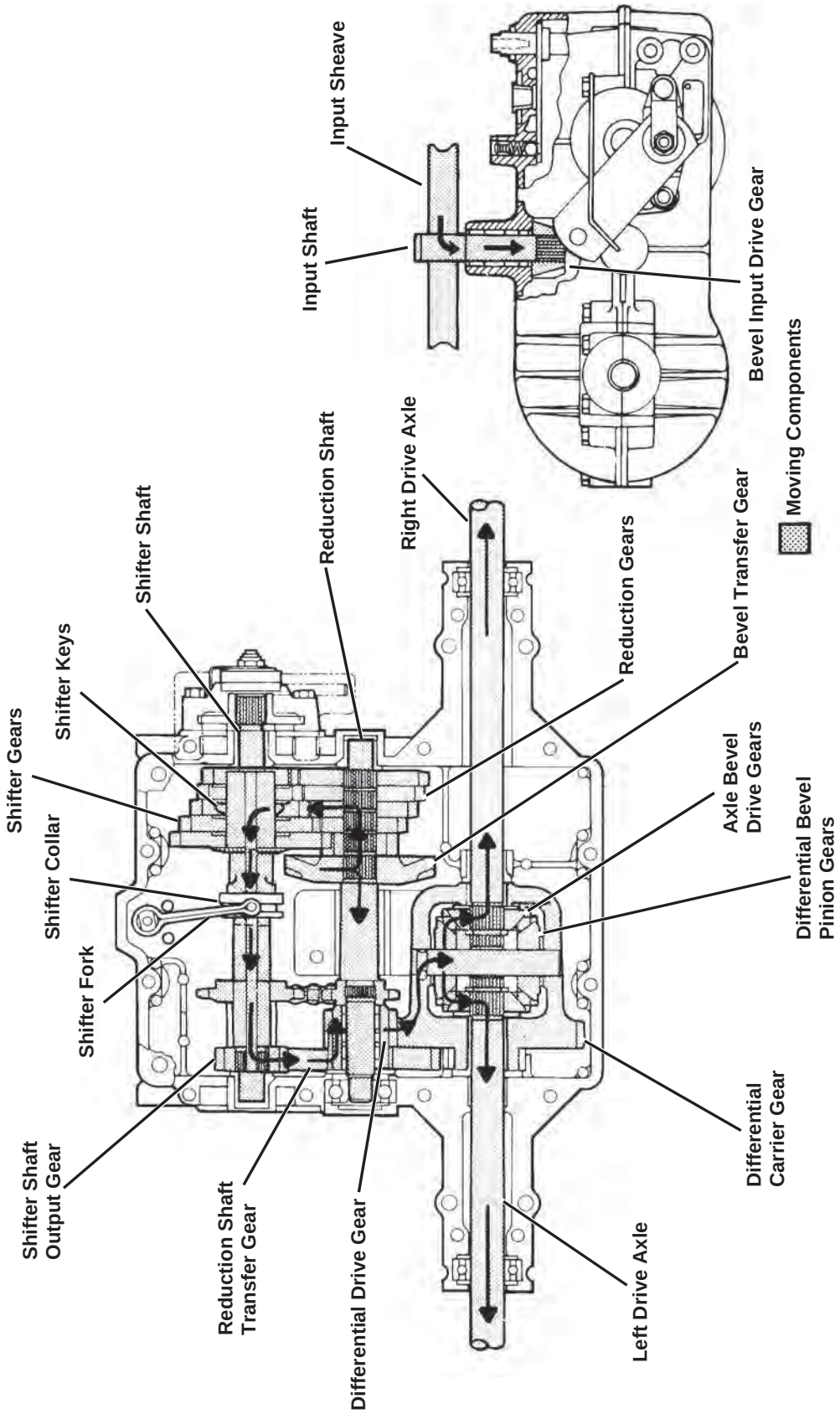
Theory of Operation:

The transaxle input sheave is keyed and fastened to the input shaft. Splined to the other end of the input shaft is the bevel input drive gear that drives the bevel transfer gear. The bevel transfer gear is splined to the reduction shaft along with 1st—5th reduction gears for and the reverse reduction sprocket. Whenever the input shaft turns, all the reduction gears and reverse sprocket turn also.

The shifter gears are in constant mesh with the reduction gears and spin freely on the shifter shaft. The shifter shaft has 4 machined keyways in which the shifter keys slide in and engage the pockets of the shifter gear selected. These keys are actuated by the shifter linkage that controls the internal shifter fork and shifter collar.

Once a gear is selected, power from the shifter gear is transferred to the shifter shaft through the shifter keys. The splined shifter shaft output gear transfers power to the reduction shaft transfer gear, which is an integral part of the differential drive gear that meshes with the differential carrier gear.

The differential carrier transfers power through the pinned differential bevel pinion gears. These pinion gears mesh with the axle bevel drive gears that are splined to the drive axles. Power finally is transfered out the drive axles to the keyed rear drive wheels that are retained by snap rings, moving the tractor in a forward direction at the desired ground speed.


Input Sheave
Input Shaft
Bevel Input Drive Gear
Moving Components
Shifter Shaft
Reduction Shaft
Right Drive Axle
Reduction Gears
Bevel Transfer Gear
Shifter Keys
Shifter Gears
Shifter Collar
Shifter Fork
Axle Bevel Drive Gears
Differential Bevel Pinion Gears
Shifter Shaft Output Gear
Reduction Shaft Transfer Gear
Differential Drive Gear
Left Drive Axle
Differential Carrier Gear
M45732

TRANSAXLE OPERATION—REVERSE

Function:

Reverse operation provides transfer of power (engine running) from the belt drive system through the internal chain drive reverse sprockets through the differential and out to the rear drive wheels, moving the tractor in a rearward direction.



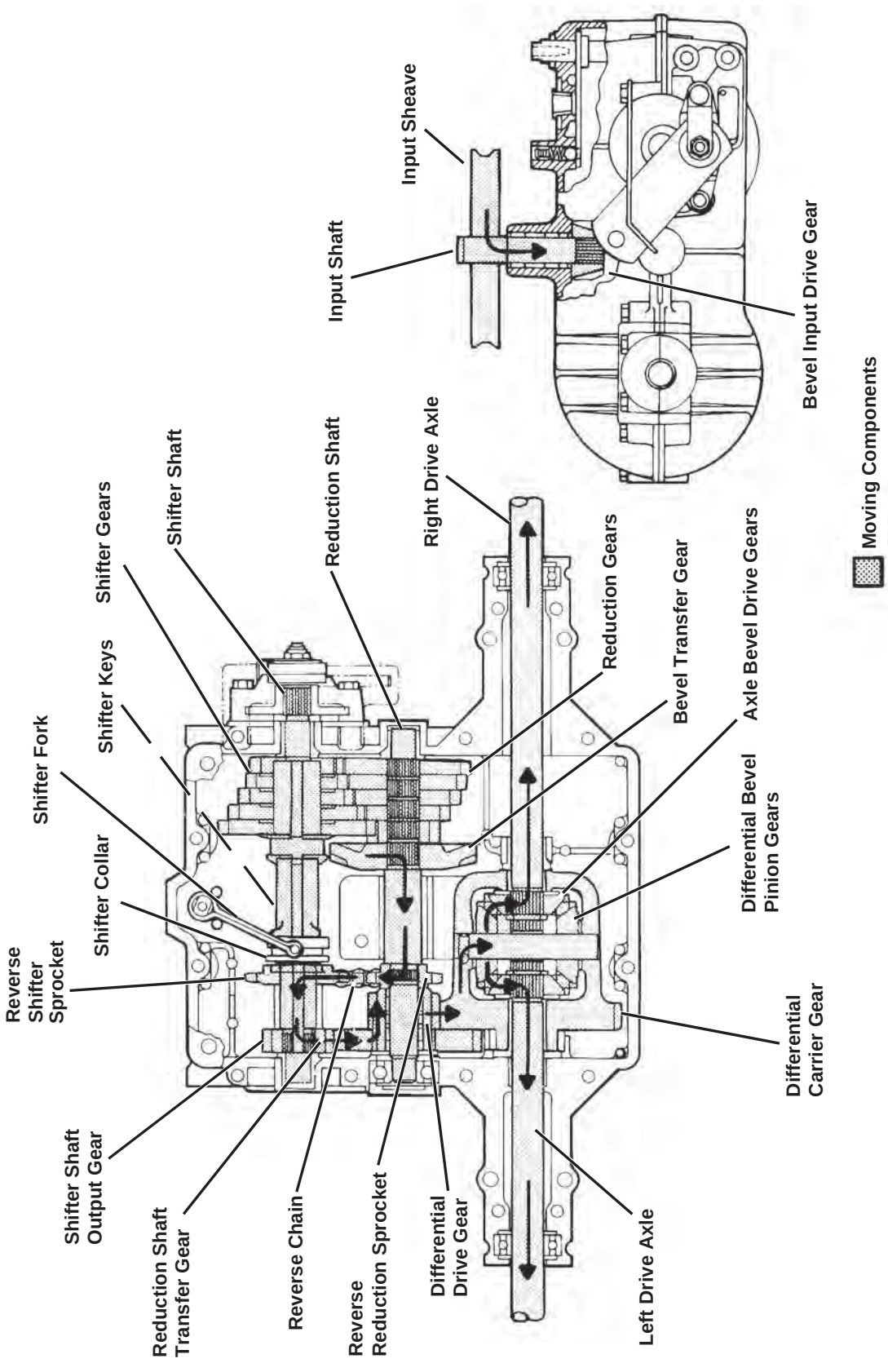
Theory of Operation:

The transaxle input sheave is keyed and fastened to the input shaft. Splined to the other end of the input shaft is the bevel input drive gear that drives the bevel transfer gear. The bevel transfer gear is splined to the reduction shaft along with 1st—5th reduction gears and the reverse reduction sprocket. Whenever the input shaft turns, all the reduction gears and reverse sprocket turn also. Even though the reduction gears mesh with the 1st—5th shifter gears, these shifter gears are only freewheeling on the shifter shaft when not selected.

A chain connects the reverse reduction sprocket to the reverse shifter sprocket, which spins freely on the shifter shaft when not selected.

Four shifter keys ride in machined keyways in the shifter shaft. When the transmission is shifted into reverse, the shifter fork and shifter collar move the keys into pockets in the reverse shifter sprocket. The sprocket transfers power through the keys to the shifter shaft which now turns in the reverse (opposite) direction. This transfers power to the splined shifter shaft gear, through the reduction shaft transfer gear and its integral differential drive gear, to the differential carrier gear.

The differential carrier transfers power through the pinned differential bevel pinion gears. These pinion gears mesh with the axle bevel drive gears that are splined to the drive axles. Power finally is transfered out the drive axles to the keyed rear drive wheels that are retained by snap rings, moving the tractor in a rearward direction.


Input Sheave
Input Shaft
Bevel Input Drive Gear
Moving Components
Right Drive Axle
Reduction Shaft
Shifter Shaft
Shifter Gears
Shifter Keys
Shifter Fork
Shifter Collar
Reverse Shifter Sprocket
Reduction Gears
Bevel Transfer Gear
Axle Bevel Drive Gears
Differential Bevel Pinion Gears
Differential Carrier Gear
Shifter Shaft Output Gear
Reduction Shaft Transfer Gear
Reverse Chain
Reverse Reduction Sprocket
Differential Drive Gear
Left Drive Axle
M45733



This page intentionally left blank

TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Machine will not move in forward or reverse.	Machine moves in one direction only or doesn't move in one or more gears.	Loses power under load, belt slips, erratic drive.	Jerky and aggressive engagement.	Shifts hard.	Noisy operation.
Brake linkage damaged.	●					●
Drive belt broken, worn, etc.	●		●			●
Wrong grease in transaxle.	●		●		●	●
Shift linkage out of adjustment or damaged.	●	●	●	●	●	●
Engine/transaxle sheaves worn or damaged.	●		●			●
Clutch pedal springs/linkage damaged.	●	●	●	●	●	●
Differential gears damaged.	●		●	●		●
Internal transaxle damage.	●	●	●	●	●	●
Belt tension out of adjustment.	●	●	●	●	●	●
Bellcrank assembly worn or damaged.	●		●		●	●
Belt guides worn or damaged.	●		●			●

DIAGNOSIS

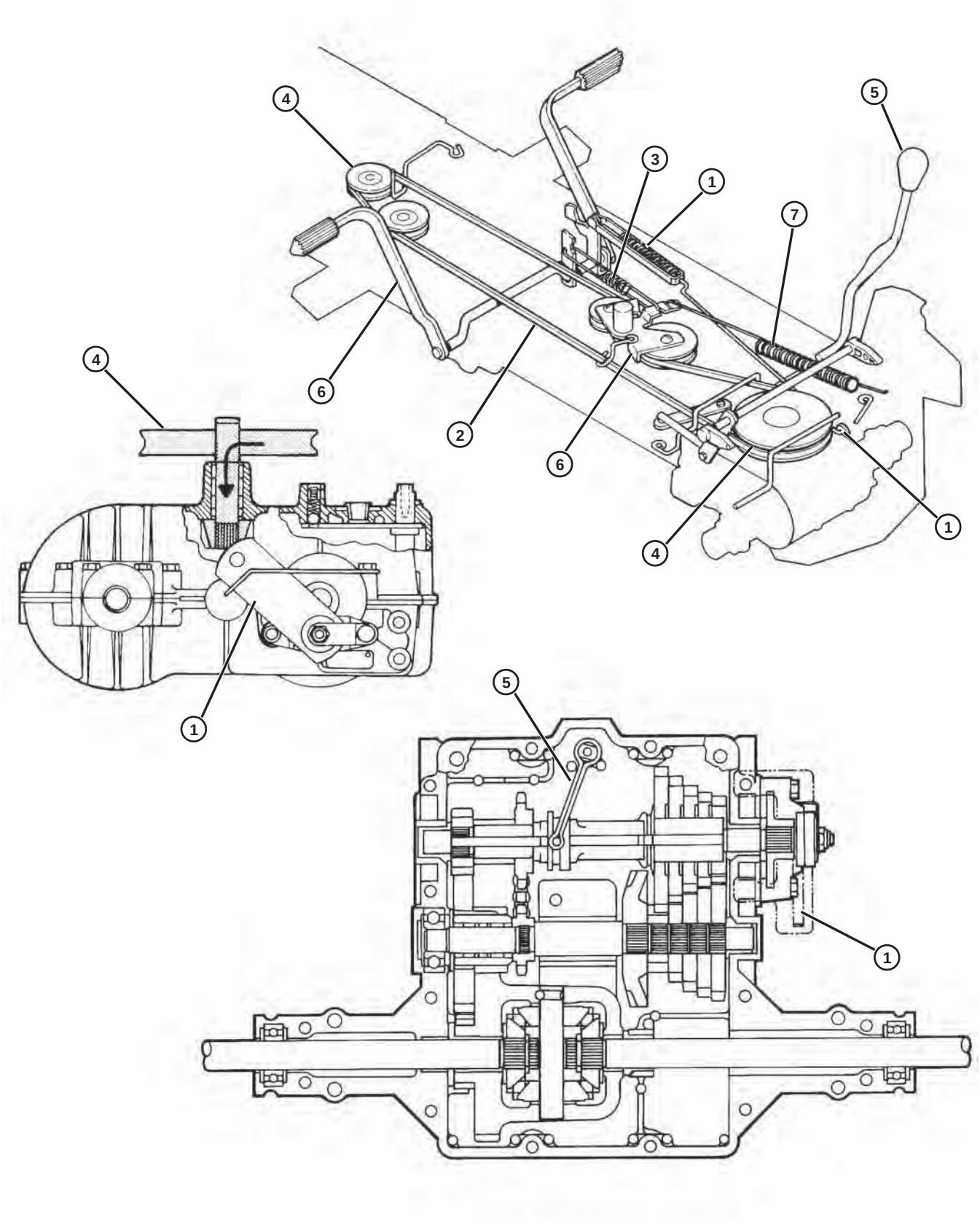
MACHINE WILL NOT MOVE IN FORWARD OR REVERSE

Test Conditions:

- Machine parked on a level surface.
- Wheels blocked.
- Park brake RELEASED.
- Key switch in STOP position.
- Transaxle in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Brake linkage and arm.	Moves freely.	Check linkage and adjustment. Check brake disk to shoe adjustment. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
2. Traction drive belt.	Not broken, worn, frayed, glazed or stretched.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 6-45.)
3. Belt tension—measured at clutch spring.	Spring coil length: 31—35 mm (1.2—1.3 in.).	Adjust belt tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.)
4. Engine and transaxle sheaves.	Tight on shafts, No damage to drive keys, not distorted. No evidence of belt riding in bottom of groove.	Replace damaged sheave and/or keys.
5. Shift lever and linkage.	Properly adjusted. Actuates transaxle into all gear ranges. Does not lock in any gear and shifts smoothly.	Adjust linkage. (See GEARSHIFT LEVER NEUTRAL ADJUSTMENT on page 6-32.)
6. Clutch pedal and bellcrank linkage.	Not binding or damaged.	Eliminate binding. Replace damaged or faulty components. (See CLUTCH PEDAL AND LINKAGE on page 6-44.)
7. Belt tensioning spring.	Spring holds bellcrank and belt in tension when clutch is disengaged. Not stretched or fatigued.	Replace stretched or fatigued spring.

Continued on page 6-16.



M85614

MACHINE WILL NOT MOVE IN FORWARD OR REVERSE, continued

Test Conditions:

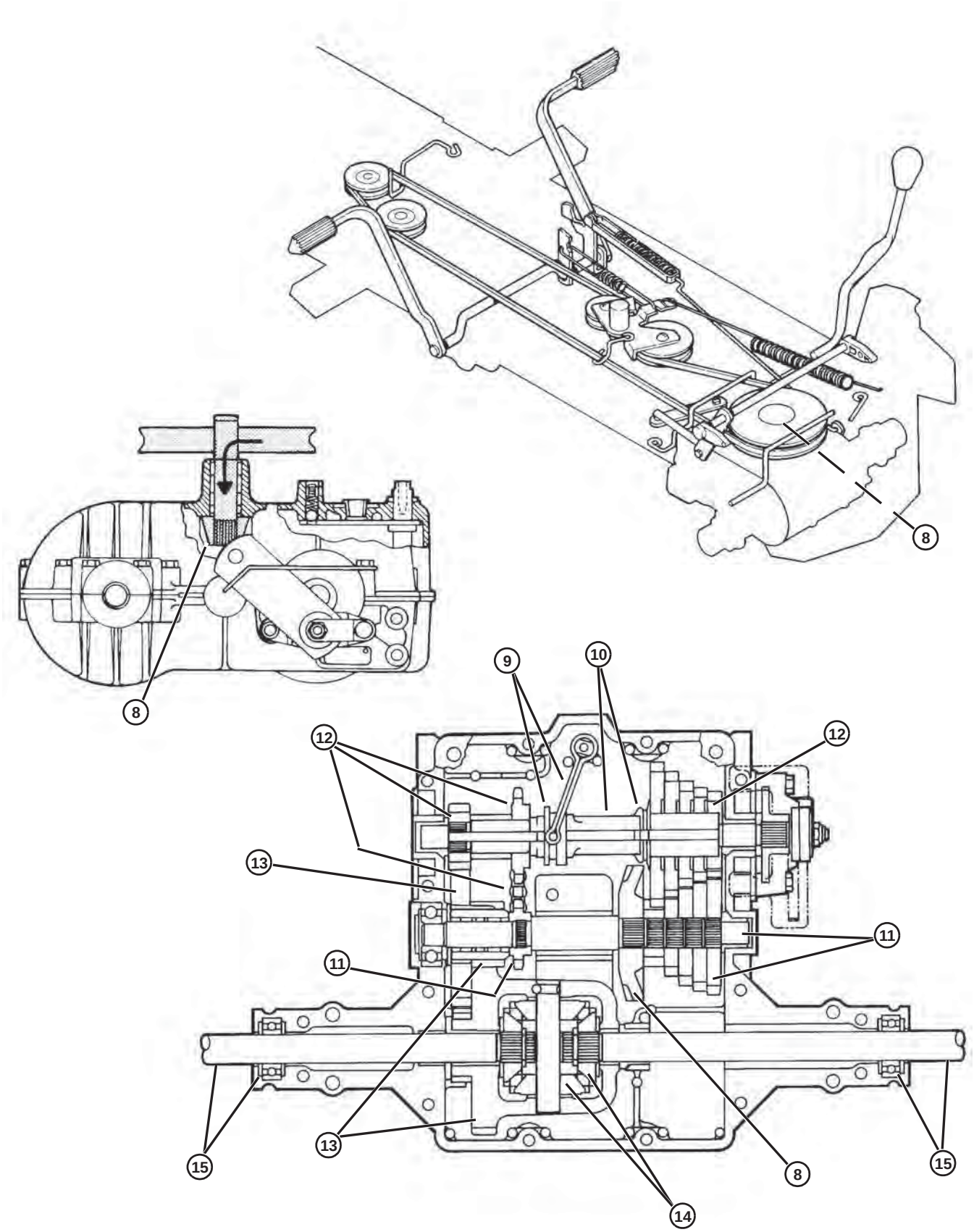
- Raise and support rear wheels off the ground and observe.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

OR

- Test drive on a level surface and up a 30° (or less) grade.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

Test/Check Point	Normal	If Not Normal
8. Input shaft bevel pinion and reduction shaft bevel gear.[a]	Gear teeth not chipped or worn. Splines not worn or striped. Positive engagement.	Replace damaged components. (See TRANSAXLE—Disassembly/ Inspection on page 6-34.)
9. Shifter fork and collar.[a]	Slide smoothly on shifter shaft. Positive detents felt in all gears. Not bent or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
10. Shifter shaft, keys, gears, and reverse sprocket.[a]	Positive and smooth operation in all gears. Engages positively in pockets of gears and sprocket. Not worn or damaged. Splines in good condition.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
11. Reduction shaft, gears and reverse sprocket.[a]	Positive and smooth operation in all gears. Splines not worn or damaged. Gear and sprocket teeth not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
12. Shifter shaft, drive gear, and reverse sprocket and chain.[a]	Positive and smooth operation in all gears. Not worn or damaged. Gear pockets not worn. Chain in good condition.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
13. Differential transfer drive gear and carrier gear.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
14. Differential bevel pinion gears and axle bevel drive gears and splines.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
15. Axle shafts, bushings, ball bearings, keys and keyways, and snap rings.[a]	Positive and smooth operation in all gears. Axles straight, not worn or damaged. Keys and keyways and snap rings in good shape.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)

[a] Requires removal of transaxle from machine and disassembly.


8
8
9
10
12
12
13
11
11
13
15
15
8
14
M85614

MACHINE MOVES IN ONE DIRECTION ONLY OR DOESN'T MOVE IN ONE OR MORE GEARS

Test Conditions:

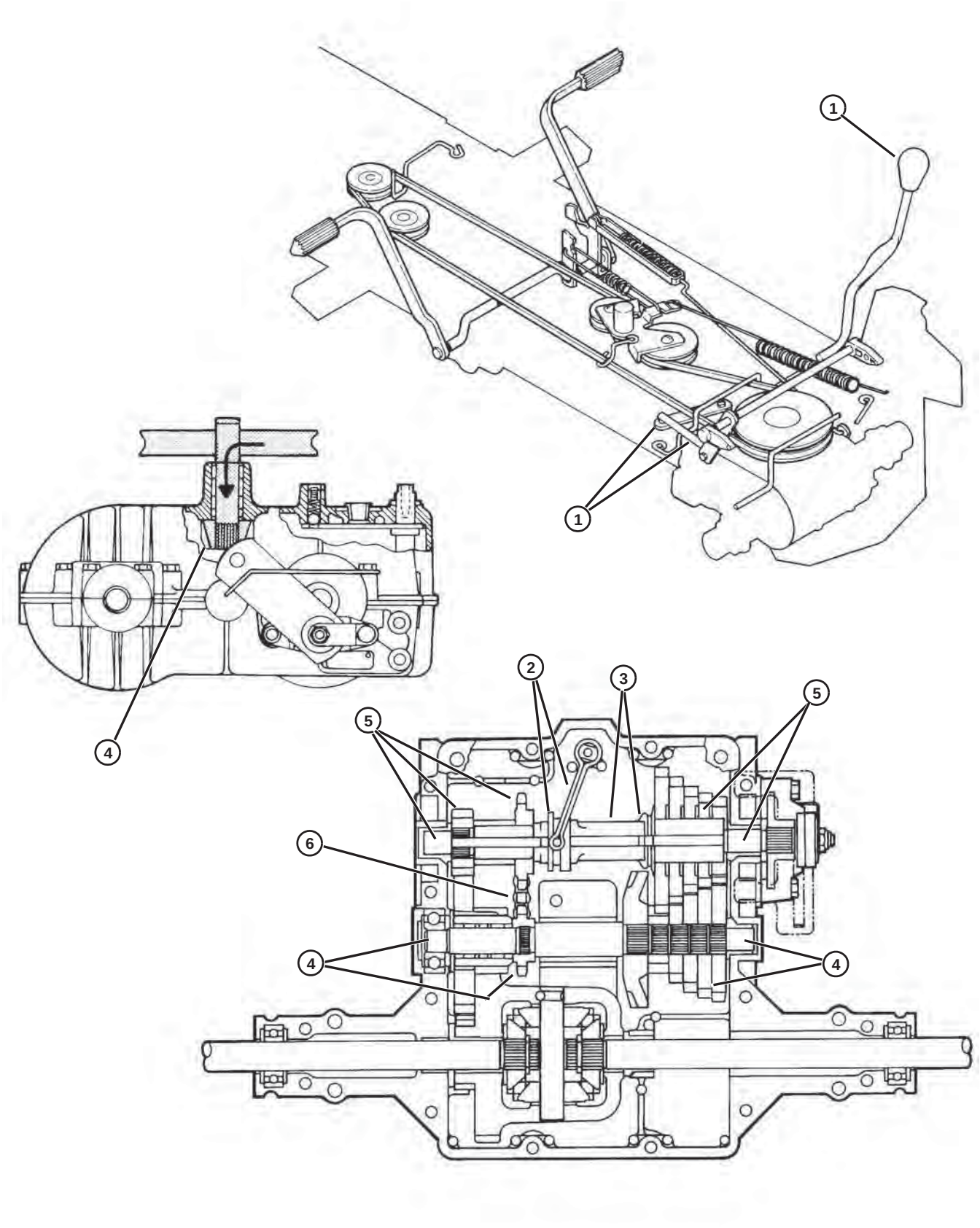
- Raise and support rear wheels off the ground and observe.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

OR

- Test drive on a level surface and up a 30° (or less) grade.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

Test/Check Point	Normal	If Not Normal
1. Shift lever and linkage.	Shift linkage moves freely; must actuate transaxle gear selector into all ranges and directions. Shift lever should not bottom in quadrant.	Adjust linkage. (See GEARSHIFT LEVER NEUTRAL ADJUSTMENT on page 6-32.)
	Linkage not worn or damaged.	Replace worn or faulty components. (See SHIFT LEVER AND LINKAGE on page 6-42.)
2. Shifter fork and collar.[a]	Positive detents felt in all gears. Slides smoothly. Not bent or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
3. Shifter shaft and keys.[a]	Positive and smooth operation in all gears. Not damaged or worn at ends. Tension when engaged in gear or sprocket pockets.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
4. Input shaft bevel pinion gear, reduction shaft bevel drive gear, reduction gears and reverse sprocket and splines.[a]	Positive and smooth operation in all gears. Splines not worn or damaged. Gear and sprocket teeth not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
5. Shifter shaft, gears and reverse sprocket.[a]	Positive and smooth operation in all gears. Gear and sprocket teeth not worn or damaged. Engagement pockets not worn.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
6. Reverse chain.[a]	Positive and smooth operation. Not worn or damaged, no excessive slack. Engages sprocket teeth. Does not ratchet on sprockets.	Replace chain. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)

[a] Requires removal of transaxle from machine and disassembly.



M85614

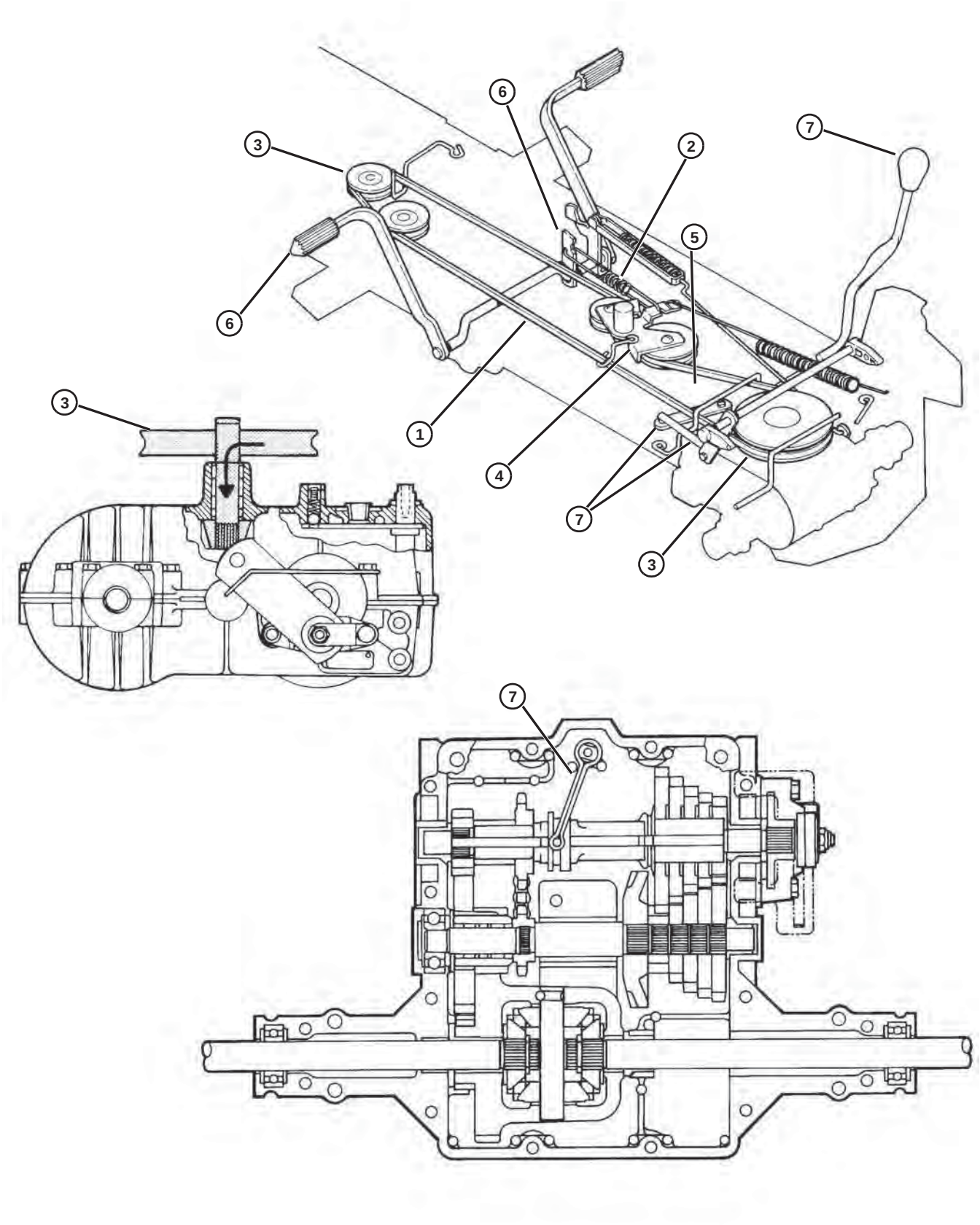
LOSES POWER UNDER LOAD, BELT SLIPS, ERRATIC DRIVE

Test Conditions:

- Machine parked on a level surface.
- Key switch in OFF position.
- Wheels blocked.
- Park brake RELEASED.
- Transaxle in NEUTRAL.
- Clutch pedal DISENGAGED.

Test/Check Point	Normal	If Not Normal
1. Traction drive belt.	Not worn, frayed, glazed or stretched. Routed correctly.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 6-45.)
2. Belt tension—measured at clutch spring.	Spring length: 31—35 mm (1.2—1.3 in.).	Adjust belt tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.)
3. Engine and transaxle sheaves.	Tight on shaft. No damage to drive keys, not distorted. No evidence of belt riding in bottom of groove.	Replace faulty sheave(s).
4. Bellcrank assembly.	Moves freely, does not bind, not bent or damaged.	Eliminate binding. Repair or replace damaged components. (See TRACTION DRIVE CLUTCH ASSEMBLY—Removal/Inspection/Installation on page 6-43.)
5. Belt tensioning spring.	Spring holds belt in tension when clutch is disengaged. Not stretched or fatigued.	Replace stretched or fatigued spring.
6. Clutch pedal and linkage.	Has complete travel. Not binding or damaged.	Eliminate binding. Replace damaged or faulty components. (See CLUTCH PEDAL AND LINKAGE on page 6-44.)
7. Shift lever and linkage.	Linkage not binding. Detents and linkage hold selected position.	Replace worn or faulty components. (See SHIFT LEVER AND LINKAGE on page 6-42.)

Continued on page 6-22.



M85614

LOSES POWER UNDER LOAD, BELT SLIPS, ERRATIC DRIVE, contined

Test Conditions:

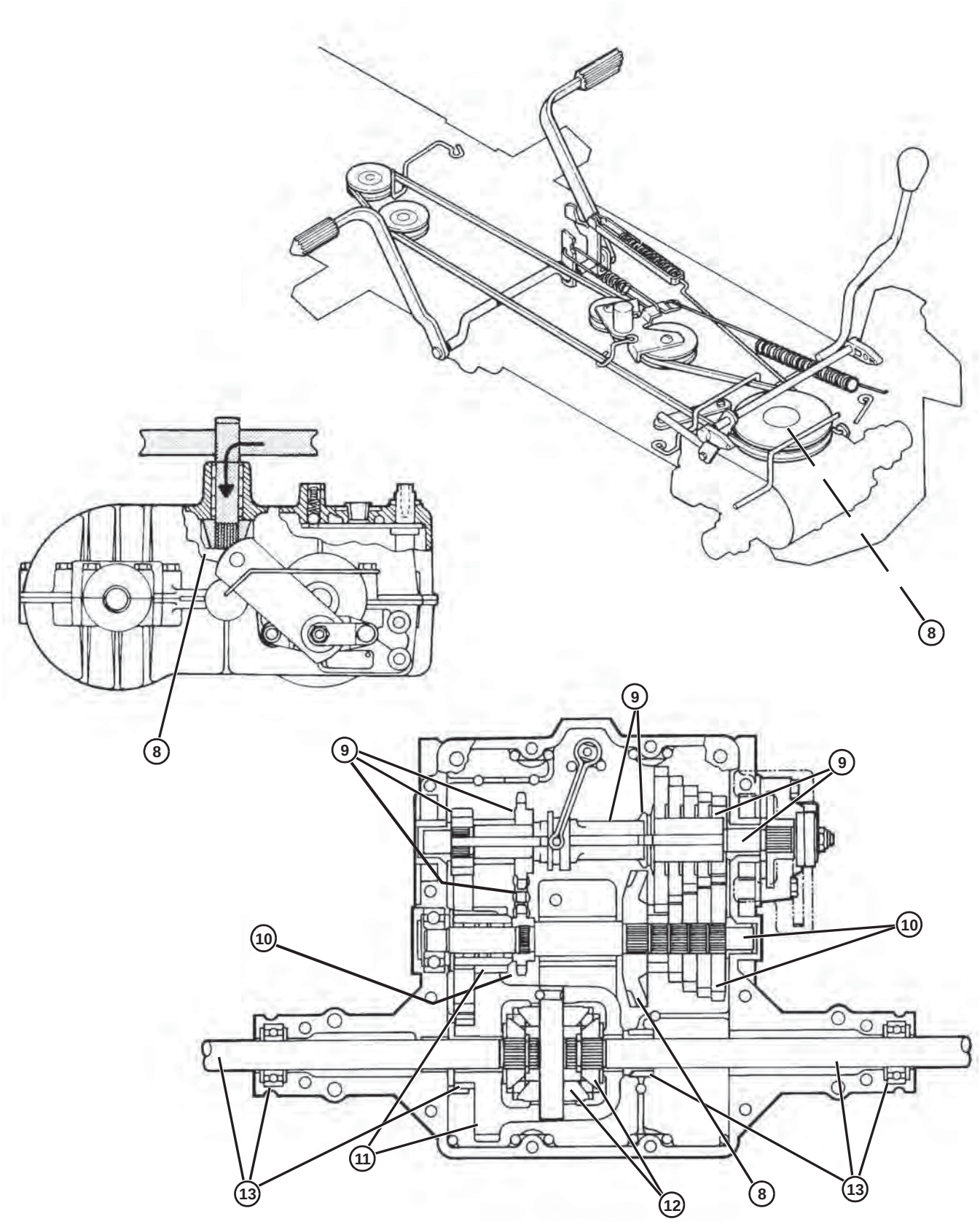
- Raise and support rear wheels off the ground and observe.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

OR

- Test drive on a level surface and up a 30° (or less) grade.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

Test/Check Point	Normal	If Not Normal
8. Input bevel pinion gear and reduction bevel gear.[a]	Gear teeth not chipped or worn. Positive engagement.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
9. Shifter shaft, keys, gears, and reverse sprocket and chain.[a]	Positive and smooth operation in all gears. Engages positively in pockets of gears and sprocket. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
10. Reduction shaft, gears and reverse sprocket.[a]	Positive and smooth operation in all gears. Splines not worn or damaged. Gear and sprocket teeth not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
11. Differential transfer drive gear and carrier gear.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
12. Differential bevel pinion gears and axle bevel gears and splines.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
13. Axle shafts, bushings, ball bearings, keys and keyways, and snap rings.[a]	Positive and smooth operation in all gears. Axles straight, not worn or damaged. Keys and keyways and snap rings in good shape.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)

[a] Requires removal of transaxle from machine and disassembly.



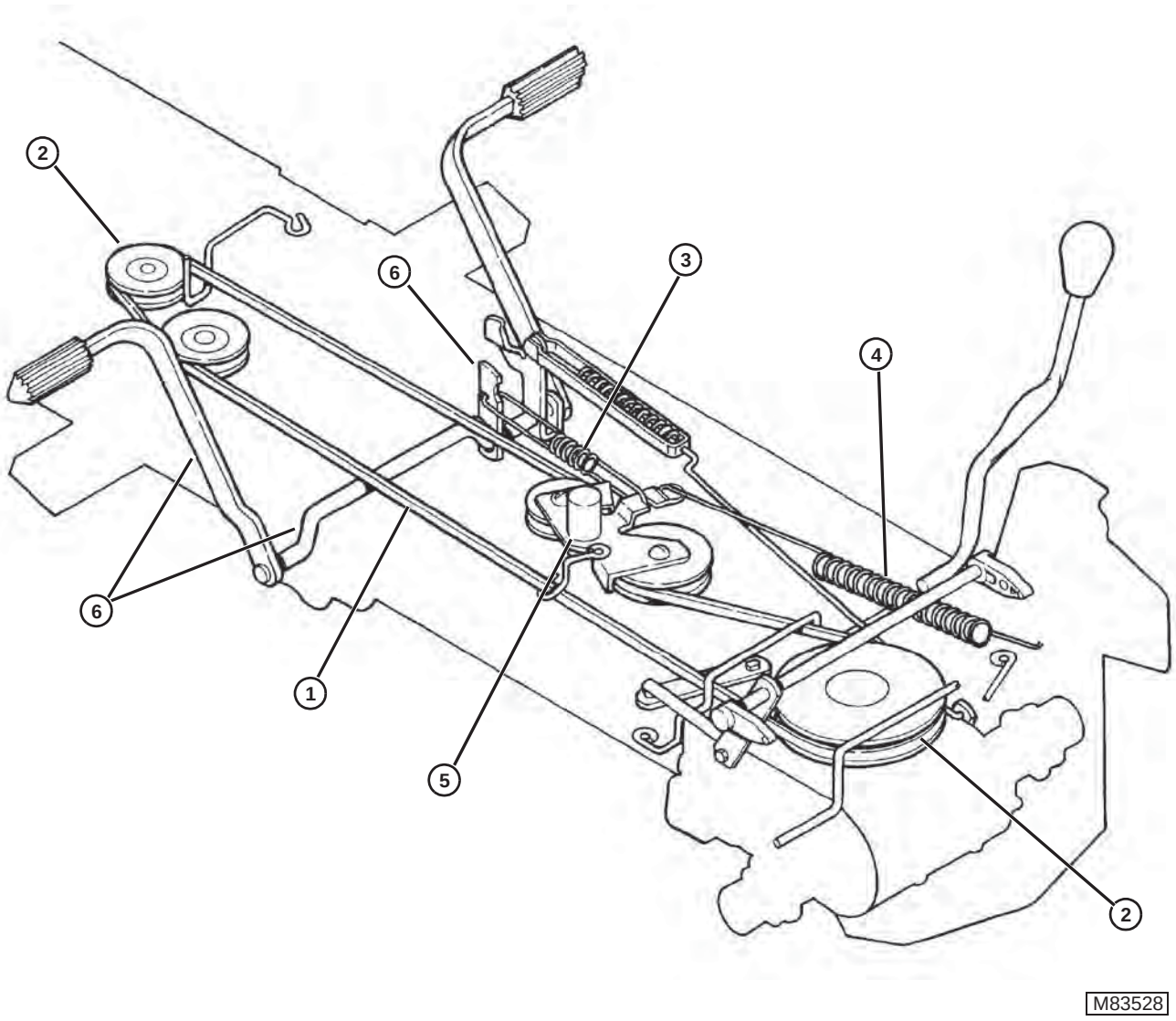
M85614

JERKY AND AGGRESSIVE ENGAGEMENT

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Transaxle in NEUTRAL.
- Clutch pedal DISENGAGED.

Test/Check Point	Normal	If Not Normal
1. Traction drive belt.	Correct belt for application. Belt in good condition, not glazed, worn, or frayed.	Install correct drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 6-45.)
2. Engine and transaxle sheaves.	Installed and functioning properly. Not distorted or damaged. V-groove clean and dry. Belt guides adjusted properly.	Clean or replace sheave(s). Properly adjust belt guides.
3. Belt tension—measured at clutch spring.	Spring length: 31—35 mm (1.2—1.3 in.). Not stretched or distorted.	Properly adjust belt tension or replace worn or damaged components. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.)
4. Belt tensioning spring.	Correct spring, installed correctly. Not stretched or distorted.	Replace spring.
5. Bellcrank assembly.	Moves freely through travel, does not bind, not distorted. Idlers operate smoothly and quietly.	Repair or replace bellcrank assembly. (See TRACTION DRIVE CLUTCH ASSEMBLY—Removal/Inspection/Installation on page 6-43.)
6. Clutch pedal, shaft, and arm.	Obatins full travel, does not bind. Not worn or distorted.	Eliminate binding. Replace damaged or faulty components. (See CLUTCH PEDAL AND LINKAGE on page 6-44.)


2
6
3
4
6
1
5
2
M83528

SHIFTS HARD

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Transaxle in NEUTRAL.
- Clutch pedal DISENGAGED.

Test/Check Point	Normal	If Not Normal
1. Shift lever and linkage.	Moves freely throughout normal travel.	Repair faulty components and adjust linkage. (See GEARSHIFT LEVER NEUTRAL ADJUSTMENT on page 6-32.)
2. Transaxle control arm.	Properly installed. Not worn or distorted.	Replace control arm.
3. Transaxle.	Filled with correct grease.	Fill transaxle with correct lubricant. (See GEAR TRANSMISSION GREASE—NORTH AMERICA on page 2-17 or GEAR TRANSMISSION GREASE—EUROPE on page 2-17.)

Test Conditions:

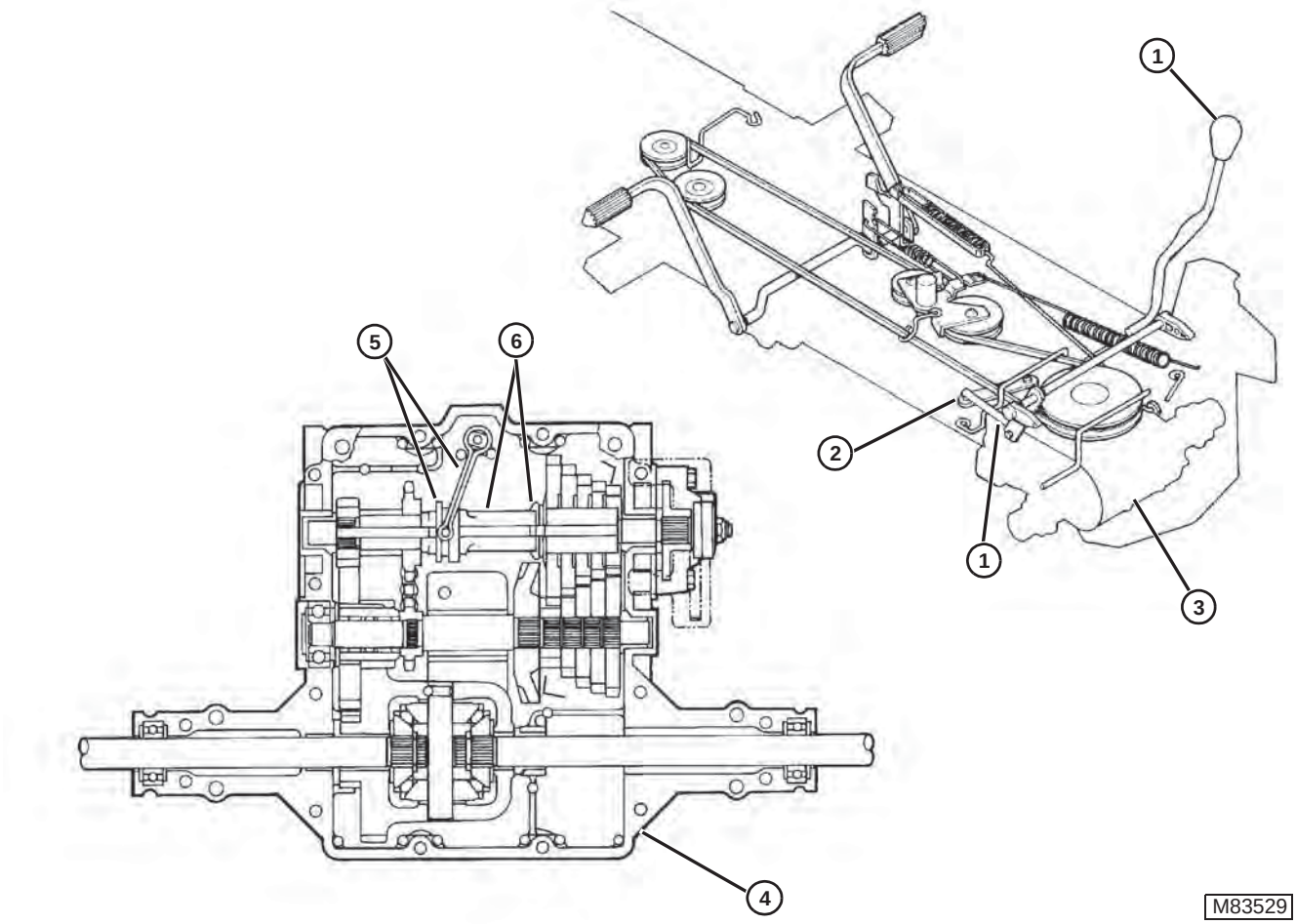
- Raise and support rear wheels off the ground and observe.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

OR

- Test drive on a level surface and up a 30° (or less) grade.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

Test/Check Point	Normal	If Not Normal
4. Transaxle.[a]	Internal components not rusty or damaged.	Clean or replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
5. Shifter fork and collar.[a]	Positive and smooth operation in all gears. Not binding, worn or damaged.	Eliminate binding, replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
6. Shifter shaft keys and keyways, gears, and reverse sprocket.[a]	Positive and smooth operation in all gears. Keys not worn, damaged, rusted or binding.	Replace keys. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)

[a] Requires removal of transaxle from machine and disassembly.


1
5
6
2
1
3
4
M83529

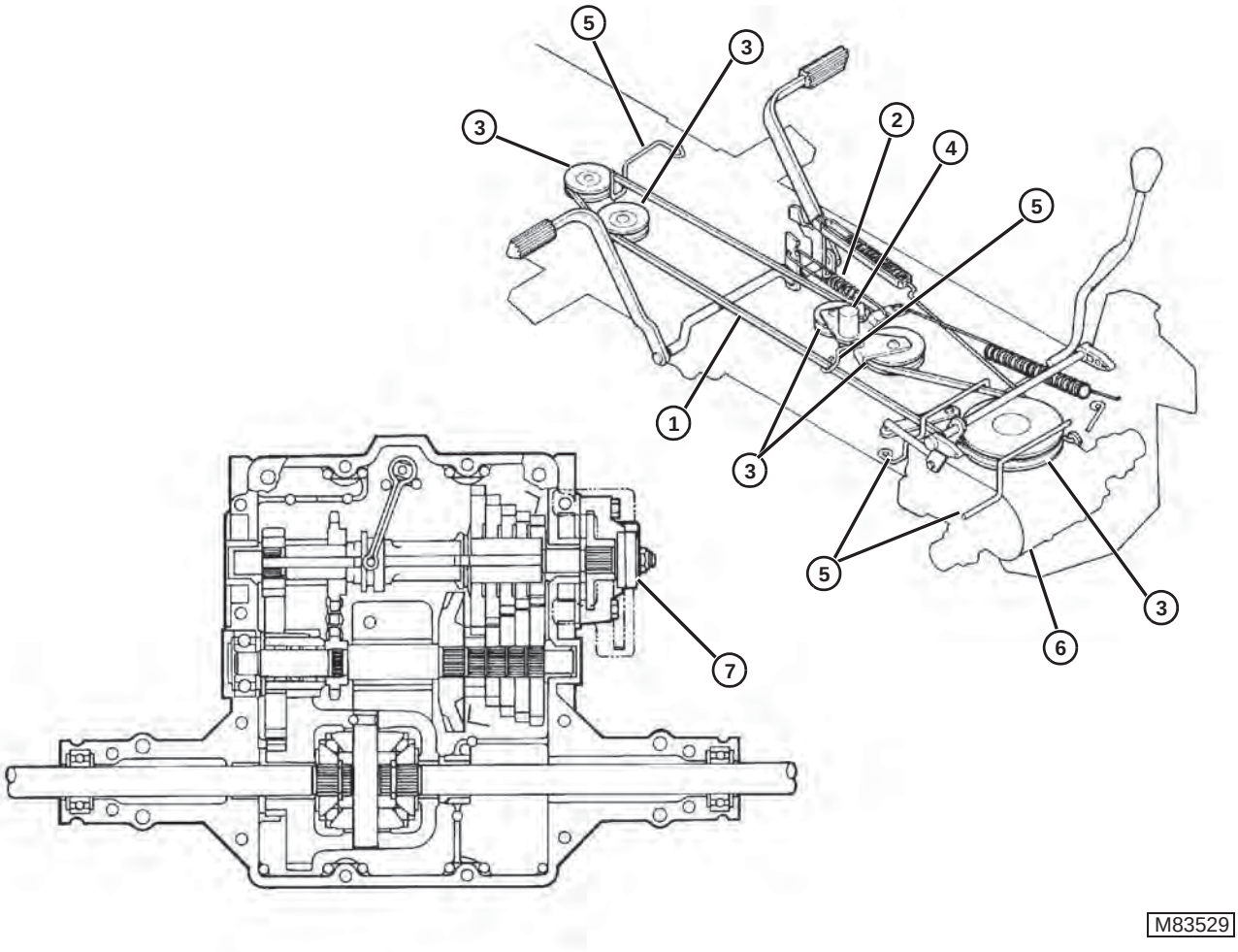
NOISY OPERATION

Test Conditions:

- Machine parked on a level surface.
- Key switch in STOP position.
- Transaxle in NEUTRAL.
- Clutch pedal DISENGAGED.

Test/Check Point	Normal	If Not Normal
1. Traction drive belt.	Not worn, frayed, glazed or stretched. Routed correctly.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 6-45.)
2. Belt tension.	Properly tensioned.	Perform TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.
3. Engine and transaxle sheaves, idlers.	Not distorted or damaged.	Replace faulty sheave(s) and/or idler(s).
4. Bellcrank assembly.	Moves freely, does not bind. Components not damaged.	Eliminate binding, replace worn or damaged components. (See TRACTION DRIVE CLUTCH ASSEMBLY—Removal/Inspection/Installation on page 6-43.)
5. Belt guides.	Installed correctly, not damaged.	Repair or replace belt guides.
6. Transaxle.	Filled to proper level with correct grease.	Fill transaxle with correct lubricant. (See GEAR TRANSMISSION GREASE—NORTH AMERICA on page 2-17 or GEAR TRANSMISSION GREASE—EUROPE on page 2-17.)
7. Brake assembly.	Adjusted to specifications.	Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
	Brake assembly not worn.	Repair or replace worn or damaged components. (See BRAKE ASSEMBLY—Removal/Inspection/Installation on page 9-23.)

Continued on page 6-30.


5
3
3
2
4
5
1
3
5
3
6
7
M83529

NOISY OPERATION, continued

Test Conditions:

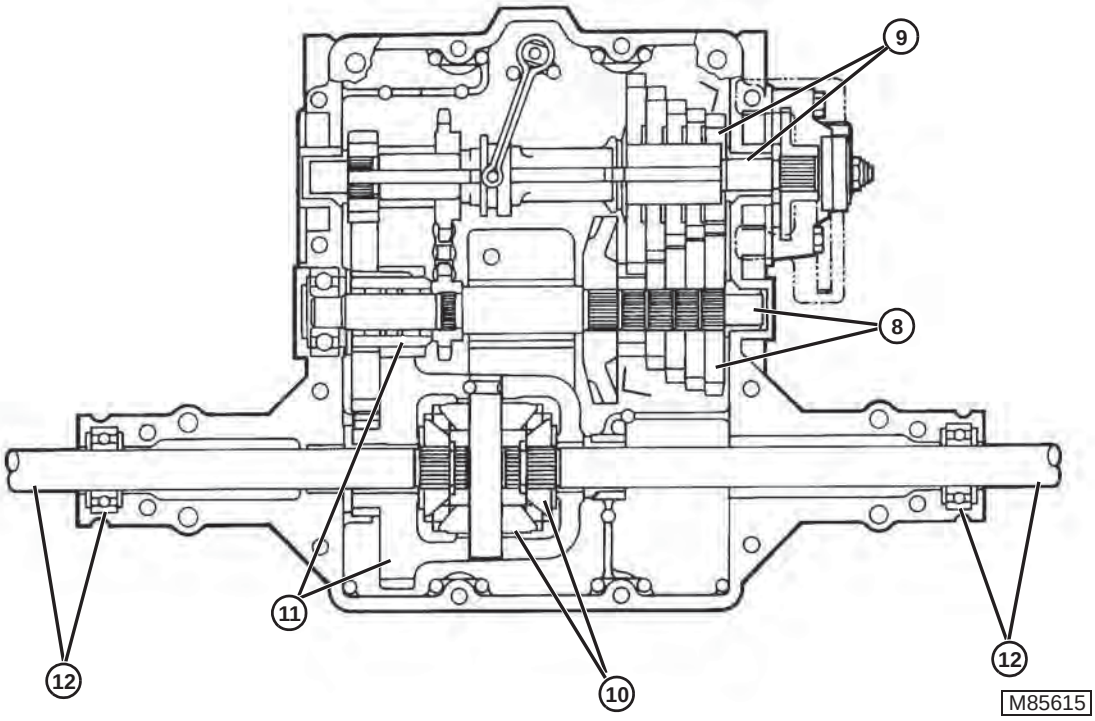
- Raise and support rear wheels off the ground and observe.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

OR

- Test drive on a level surface and up a 30° (or less) grade.
- Engine running at FAST idle.
- Operate machine in all gears to isolate the problem area.

Test/Check Point	Normal	If Not Normal
8. Reduction shaft, gears, sprocket and chain.[a]	Positive and smooth operation in all gears. Splines not worn or damaged. Gear and sprocket teeth and chain not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
9. Shifter shaft, gears, sprocket and chain.[a]	Positive and smooth operation in all gears. Not worn or damaged. Gear pockets not worn. Sprocket teeth and chain not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
10. Differential bevel pinion gears, bevel drive gears and splines.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
11. Differential transfer drive gear and carrier gear.[a]	Positive and smooth operation in all gears. Not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)
12. Axle shafts and ball bearings.[a]	Positive and smooth operation in all gears. Axles straight, not worn or damaged.	Replace worn or damaged components. (See TRANSAXLE—Disassembly/Inspection on page 6-34.)

[a] Requires removal of transaxle from machine and disassembly.


9
8
11
12
10
12
M85615

ADJUSTMENTS

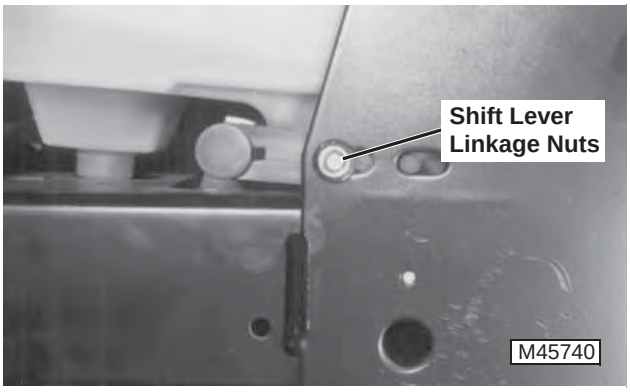
GEARSHIFT LEVER NEUTRAL ADJUSTMENT

Reason:

To ensure that the transaxle can achieve all ranges and directions available. It also ensures that the selector lever is coordinated with the markings on the shift quadrant.

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Transaxle in NEUTRAL.



4. Loosen shift lever linkage nuts located on each side of the frame behind the rear wheels.
5. Slide the bracket forward or rearward to position the gear selector lever in the center on the neutral slot on shift quadrant. Tighten nut.
6. Check that the gear selector lever will engage in all ranges and directions. If not, adjust the position of the lever slightly to achieve all gears.

Results:

- The gear selector lever should be in neutral position when the transaxle is in neutral.
- The transaxle should be able to achieve all speed ranges and direction selections, without bottoming the lever in the quadrant.

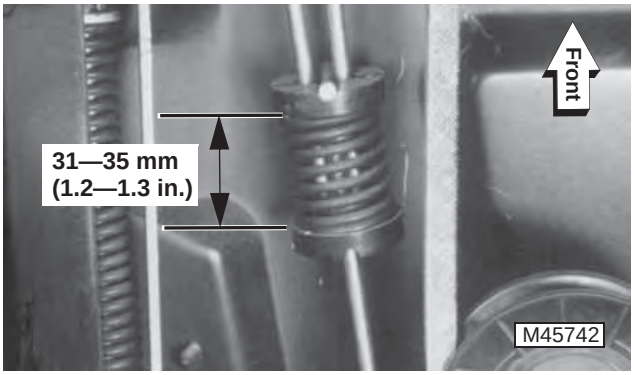
TRACTION DRIVE BELT TENSION ADJUSTMENT

Reason:

To maintained proper drive belt tension so belt does not slip and to position belt guides so that belt jumping is minimized.

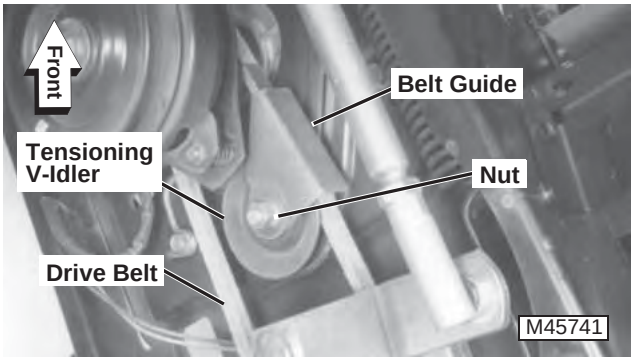
Procedure:

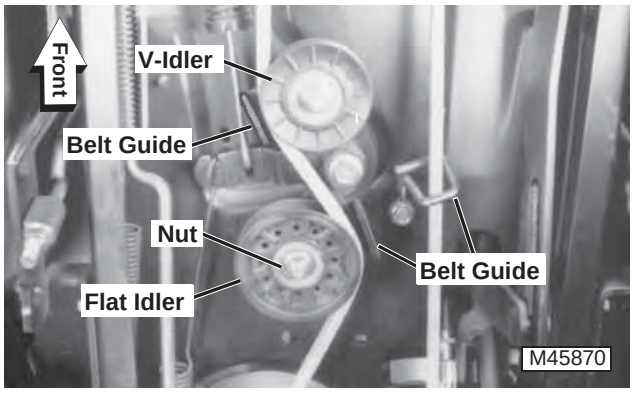
1. Park machine on level surface.
2. Turn key switch OFF.
3. Transaxle in NEUTRAL.
4. Park brake locked to release belt tension.
5. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)



6. Unlock park brake to tension drive belt.
7. Check that the belt is adjusted properly, the dimension between the cap lips on the ends of the clutch actuating spring should be **31–33 mm (1.2–1.3 in.)**.

LX172 (S.N. —43869):



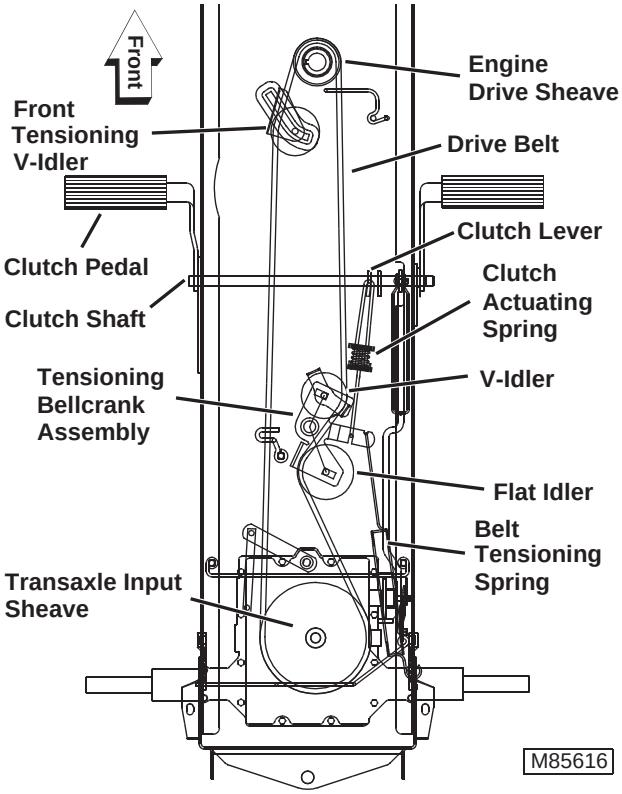


8. Lock park brake to release drive belt tension.
9. Move front (engine) tensioning v-idler outward and forward to increase belt tension and decrease clutch actuating spring caps dimension **or** move it

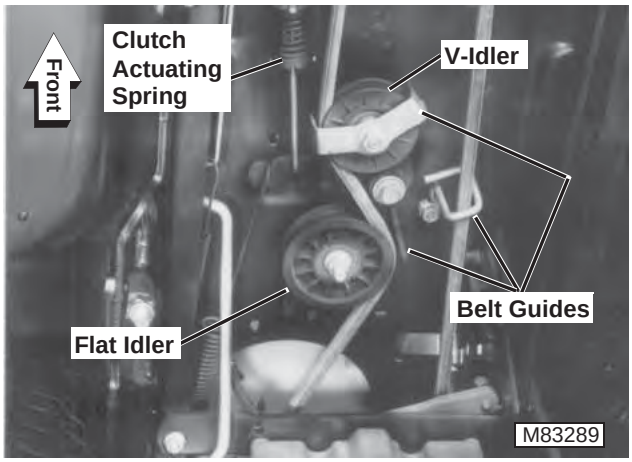
rearward and inward to decrease belt tension and increase clutch actuating spring caps dimension.

10. At the same time adjust v-idler belt guide so it is parallel with and approximately 3.2 mm (0.125 in.) away from belt and v-idler. Tighten fastening nut.
11. Unlock park brake to tension drive belt and remeasure clutch actuating spring cap lips dimension after each adjustment.
12. Repeat adjustment procedure until specified measurement is obtained or replace belt.

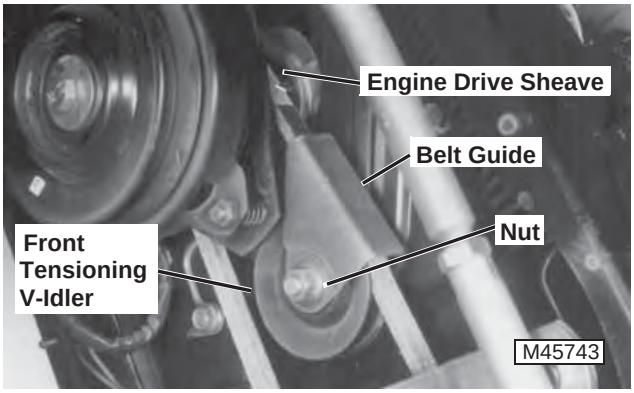
LX172 (S.N. 43870—) and LX173:



Top View



13. Lock park brake to release drive belt tension.
14. Position tensioning bellcrank assembly v-idler in the center of its slot and the flat idler to the end of its slot (towards belt guide). At the same time adjust belt guides so they are parallel with and approximately 3.2 mm (0.125 in.) away from belt and idlers. Tighten fastening nuts.



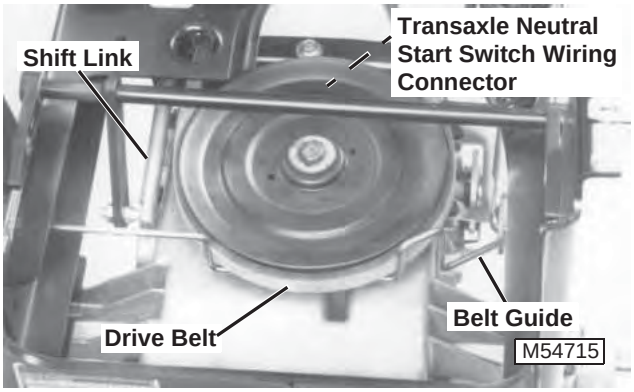
15. Move front (engine) tensioning v-idler outward and forward to increase belt tension and to decrease clutch actuating spring cap lips dimension **OR** move it rearward and inward to decrease belt tension and increase clutch actuating spring cap lips dimension.
16. If front (engine) tensioning v-idler is at the front end of its adjustment slot, the v-idler of the tensioning bellcrank assembly may also be used to adjust belt tension further—move v-idler toward the belt to increase belt tension and to decrease clutch actuating spring cap lips dimension.
17. Unlock park brake to tension drive belt and remeasure clutch actuating spring cap lips dimension after each adjustment.
18. Repeat adjustment procedure until specified measurement is obtained or replace belt.

REPAIR

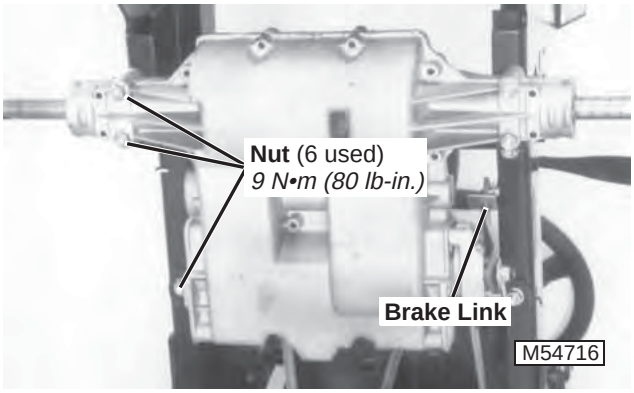
TRANSAXLE

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 6-45.)
3. Depress clutch pedal and lock park brake.
4. Safely lift the rear of the machine and place appropriate sized jackstands under both sides of frame.
5. Remove rear wheels. (See WHEELS—Removal/Installation on page 11-5.)



6. Remove belt guide.
7. Remove drive belt from driven sheave.
8. Disconnect shift link from transaxle.
9. Disconnect wiring connector.



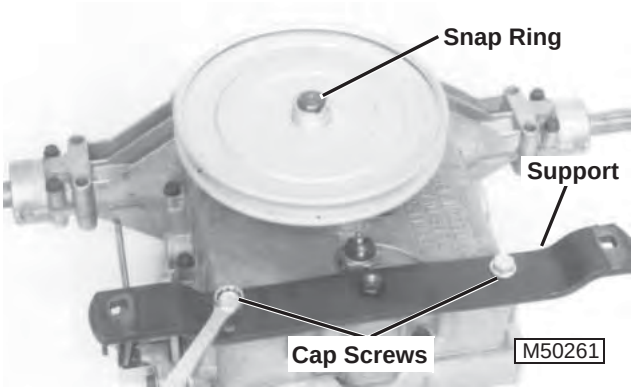
10. Disconnect brake link from transaxle.
11. Support transaxle with a floor jack.
12. Remove six nuts and transaxle.

Installation is done in the reverse order of removal.

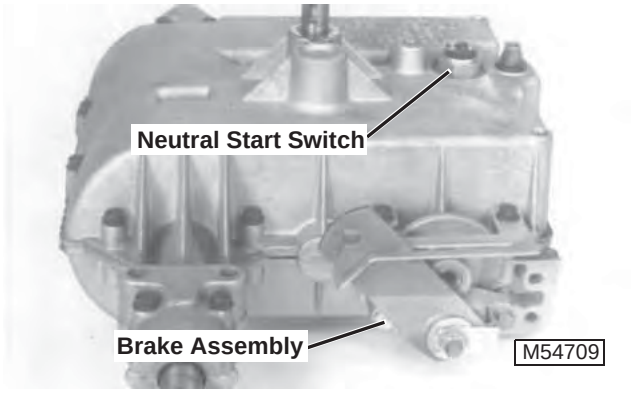
- Tighten mounting six nuts to **9 N•m (80 lb-in.)**.

Disassembly/Inspection

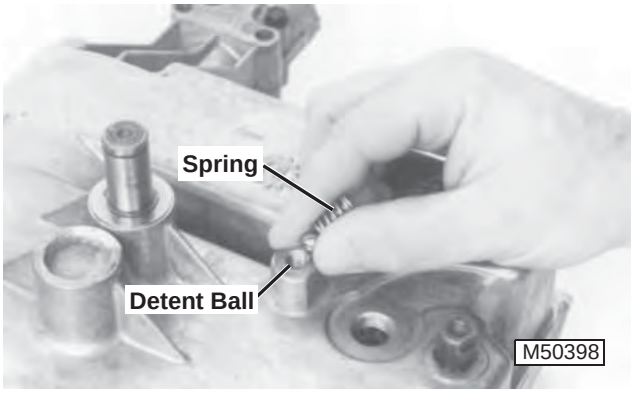
1. Thoroughly clean and dry the outside of the transaxle.



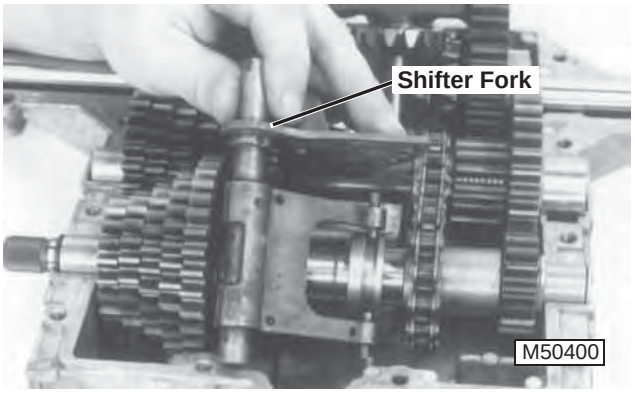
2. Remove cap screws and support.
3. Remove snap ring.
4. Remove transaxle drive sheave and key.



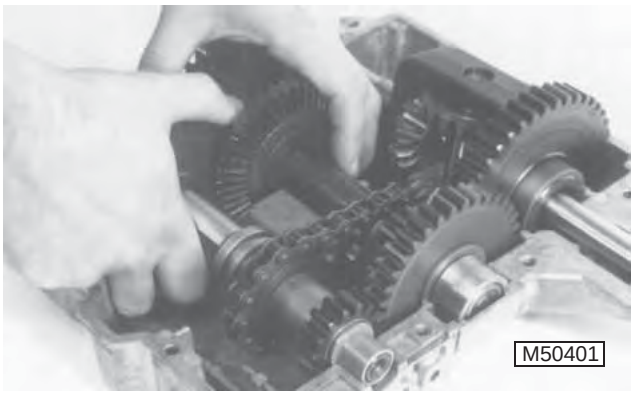
5. Remove neutral start switch.
6. Remove brake assembly. (See BRAKE ASSEMBLY—Removal/Installation on page 9-23.)



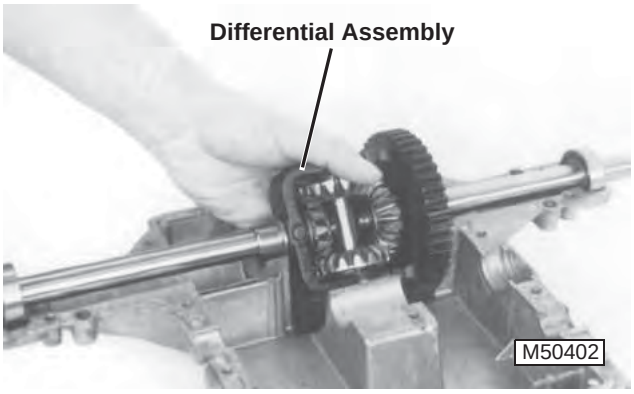
7. Remove Allen-head screw.
8. Remove spring and detent ball with a magnet.
9. Remove 17 cap screws. Tap sides of case with a plastic hammer to separate case halves.
10. Before removing any components, visually inspect and manually rotate bevel transfer gear of reduction shaft in all gears to find problem area(s).



11. Remove excess grease from cover and lower case using scraper and paper towels.
12. Remove shifter fork assembly.



13. Lift shifter shaft and reduction shaft assemblies out of case as a unit.



14. Remove differential assembly.

⚠ CAUTION

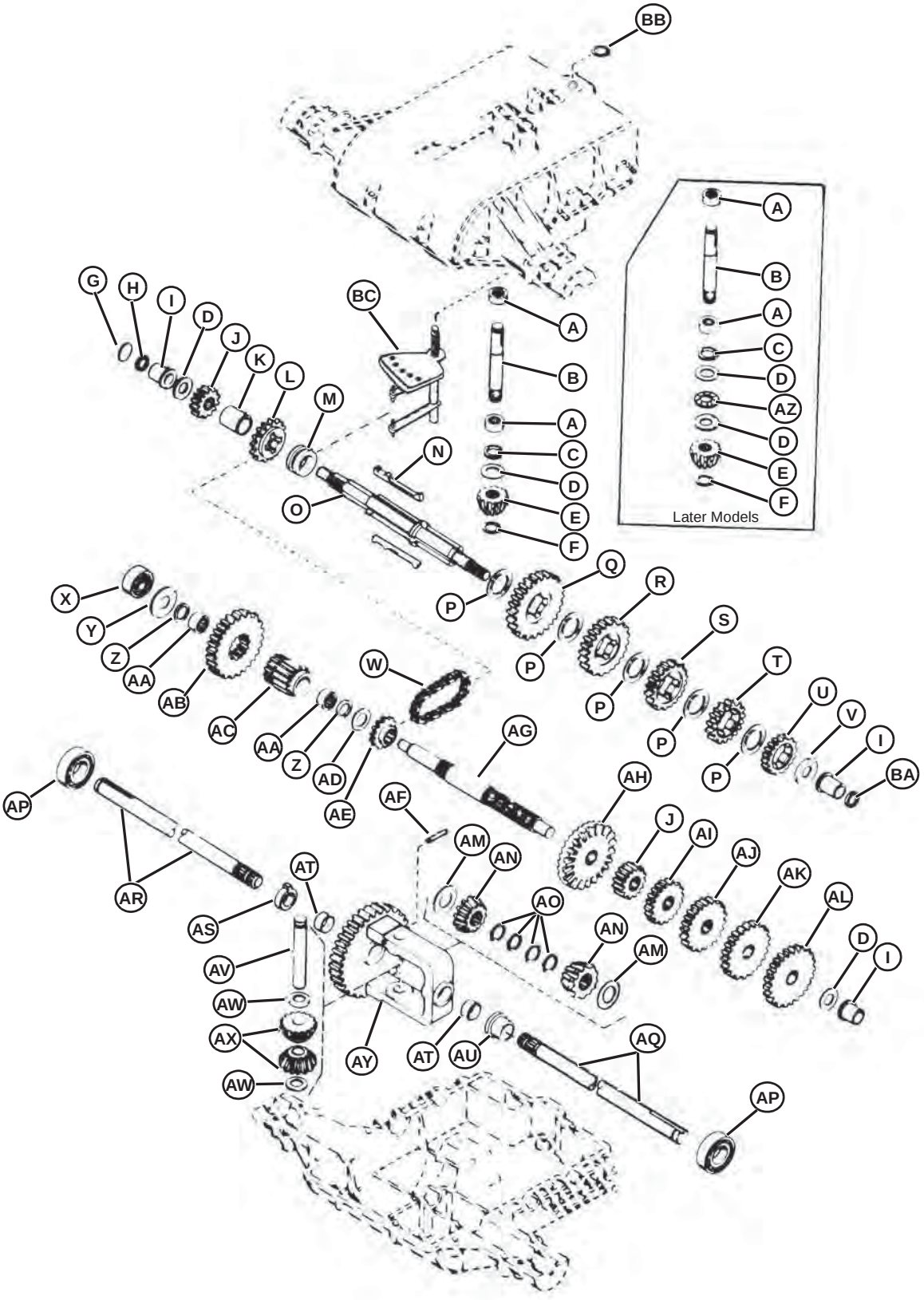
Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

NOTE: Remove bearings only if replacement is necessary.

Ball bearings (AP) are slip-fit. (See Exploded View on page 6-36.)

15. Inspect all bearings for wear or damage. Replace only if necessary.
    - Replace bearings (A) using a bearing, bushing and seal driver set. Install upper bearing flush with case surface. Install lower bearing 3.8 mm (0.150 in.) below inside surface of case cover.
    - Replace bearings (AA) using a bearing, bushing and seal driver set. Install bearings to a depth of 3.6 mm (0.142 in.) below top surface on each end.
16. Keeping assembly sequence in mind (see Exploded View on page 6-36), separate and arrange in-order all components for final cleaning and individual inspection. Replace chipped, cracked, worn, or damaged components.
17. Thoroughly clean all components and case halves with approved solvent and blow dry with less than 210 kPa (2 bar) (30 psi) compressed air.
18. Remove all remaining gasket material from case halves mating surfaces.
19. Inspect case halves for cracks, wear, or damage. Replace as necessary.

GEAR TRANSMISSION—EXPLODED VIEW



M54708

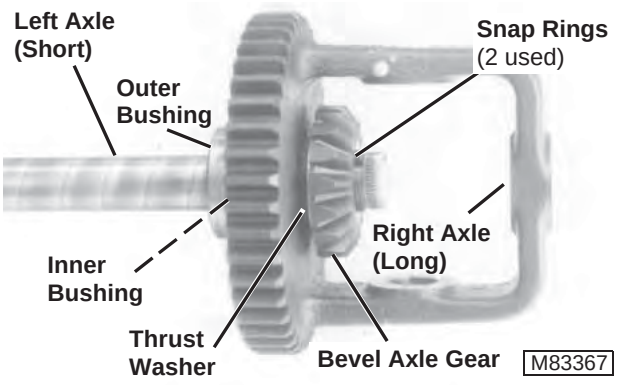
A—Needle Bearing (2 used)
B—Input Shaft
C—O-Ring
D—Washer (early—3 used) (late—4 used)
E—Bevel Pinion Gear (14T)
F—Snap Ring
G—Disk
H—Ring Seal (Early only)
I—Bushing (3 used)
J—Shifter Shaft Output Gear / Reduction Shaft First Gear (15T) (2 used)
K—Spacer
L—Shifter Shaft Reverse Sprocket (14T)
M—Shifter Collar
N—Shifter Key (early—2 used) (late—4 used)
O—Shift/Brake Shaft
P—Thrust Washer (5 used)
Q—Shifter Shaft First Gear (35T)
R—Shifter Shaft Second Gear (30T)
S—Shifter Shaft Third Gear (25T)
T—Shifter Shaft Forth Gear (22T)
U—Shifter Shaft Fifth Gear (19T)
V—Thrust Washer
W—Reverse Chain
X—Ball Bearing
Y—Washer
Z—O-Ring (2 used)
AA—Needle Bearing (2 used)
AB—Output Transfer Gear (35T)
AC—Output Transfer Pinion Gear (15T)
AD—Washer
AE—Reduction Shaft Reverse Sprocket (10T)
AF—Rolled Pin (for differential carrier housing pinion shaft)
AG—Reduction Shaft
AH—Reduction Shaft Input Bevel Gear (42T)
AI—Reduction Shaft Second Gear (20T)
AJ—Reduction Shaft Third Gear (25T)
AK—Reduction Shaft Forth Gear (28T)
AL—Reduction Shaft Fifth Gear (31T)
AM—Thrust Washers (2 used)
AN—Bevel Axle Gears (16T) (2 used)
AO—Snap Rings (4 used)
AP—Ball Bearing
AQ—Right Axle (Long)
AR—Left Axle (Short)
AS—Left Axle Outer Bushing
AT—Differential Carrier Housing Inner Bushings (2 used)
AU—Right Axle Outer Bushing
AV—Pinion Shaft
AW—Thrust Washers (2 used)
AX—Bevel Pinion Gears (16T) (2 used)
AY—Differential Carrier Housing and Ring Gear (43T)
AZ—Input Shaft Bevel Pinion Gear Thrust Bearing
BA—Ring Seal (end of brake shaft)
BB—Shifter Fork Shaft Seal
BC—Shifter Fork

Assembly

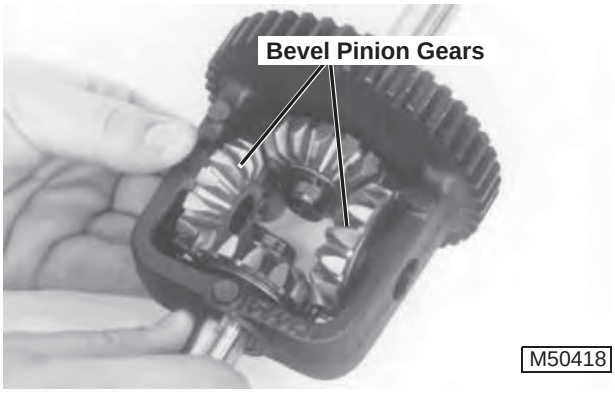
IMPORTANT: Always install new seals and O-rings. Damaged or used seals and O-rings will leak.

NOTE: Lubricate all seals and O-rings with petroleum jelly during assembly.

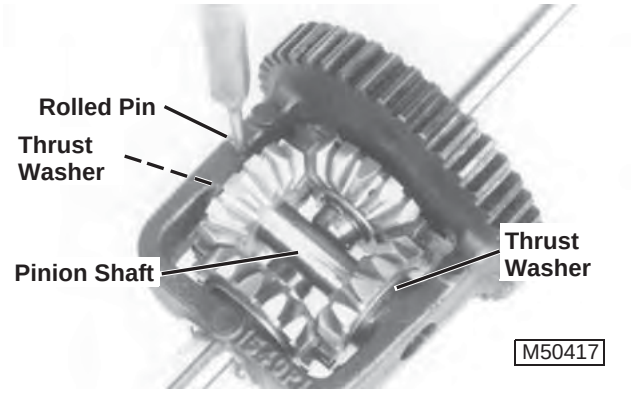
1. Apply John Deere Non-Clay High-Temperature EP Grease (or equivalent) to all mating surfaces of all internal parts before assembly. (See GEAR TRANSMISSION GREASE—NORTH AMERICA on page 2-17 or GEAR TRANSMISSION GREASE—EUROPE on page 2-17.)



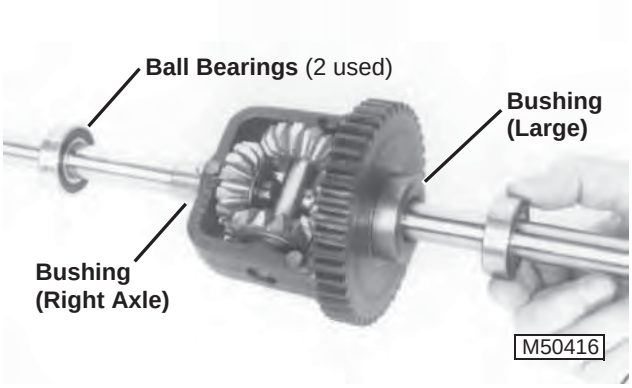
2. If differential carrier housing inner bushings are worn or damaged, they both must be pressed out and two new bushings pressed in.
3. Install left axle (short) in ring gear side of differential carrier housing.
4. Install thrust washer, bevel gear and snap rings.
5. Install right axle (long), thrust washer, bevel gear and snap rings in yoke end of differential carrier housing.



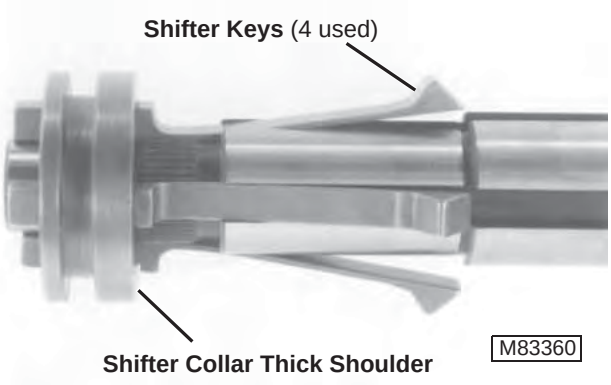
6. Install bevel pinion gears on opposite sides of differential carrier housing. Rotate axle to move pinion gears into alignment with pinion shaft holes.



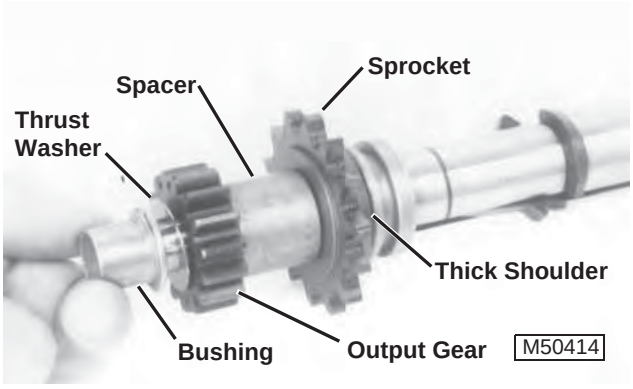
7. Insert thrust washers behind each pinion gear. Slide pinion shaft through differential carrier housing, thrust washers and pinion gears.
8. Install rolled pin to fasten pinion shaft to housing.



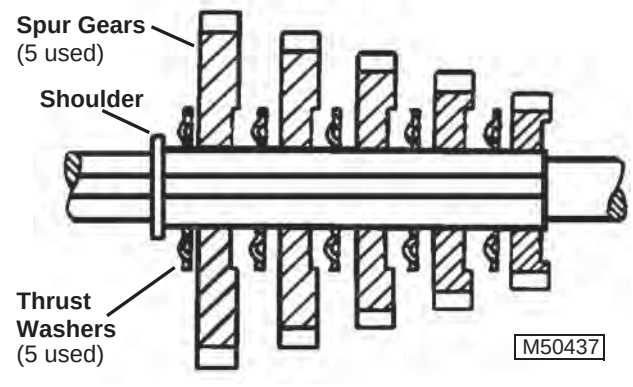
9. Install loose-fit outer bushings and ball bearings.



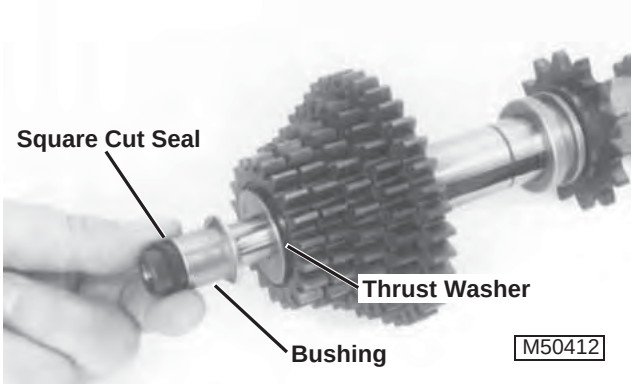
10. Position keys in keyways near end of shifter shaft and hold in place with heavy rubber band or plastic tie strap that can be cut when finished. Install shifter collar over key tabs with thicker shoulder of collar toward center of shaft. Slide collar and keys onto center of shaft.



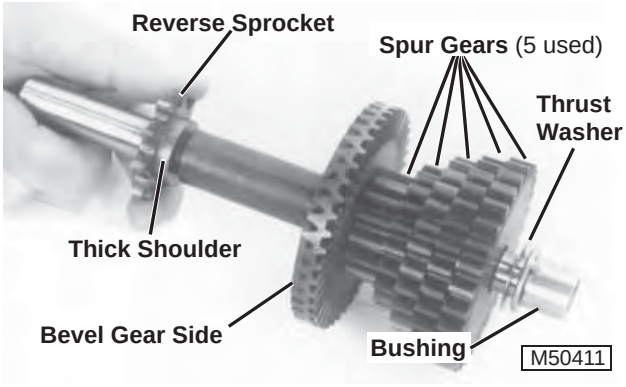
11. Install reverse sprocket with thicker shoulder toward shifter collar.
12. Install spacer, output gear, thrust washer and bushing.



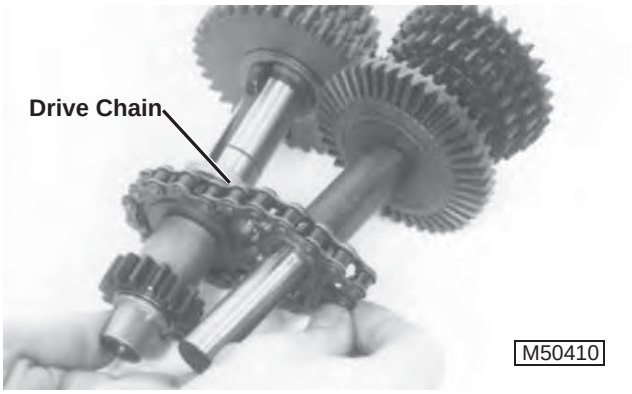
13. Install thrust washers and spur gears on shaft from brake splines end with raised side of thrust washers toward shoulder of shaft. Flat side of gears MUST BE toward shoulder.



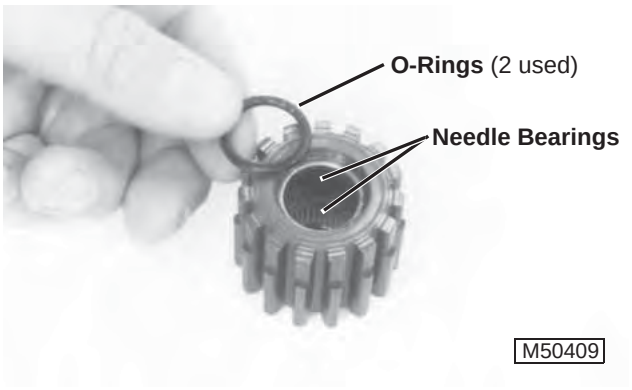
14. Put protective tape over brake splines to protect new seal from being damaged. Install thrust washer, bushing and square cut seal.



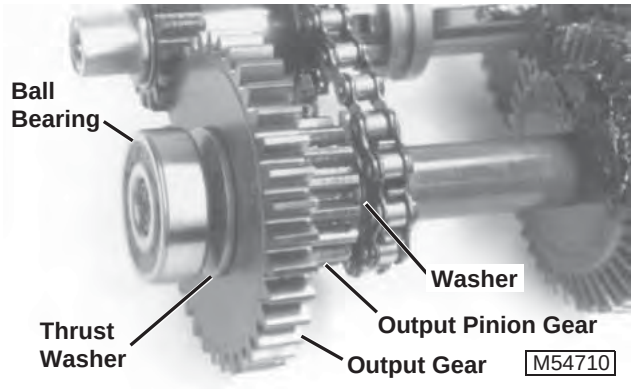
15. Install input bevel gear with bevel side toward center of reduction shaft. Install spur gears, smallest to largest, then thrust washer and bushing.
16. Install reverse sprocket with thick shoulder toward input bevel gear on opposite end of shaft.



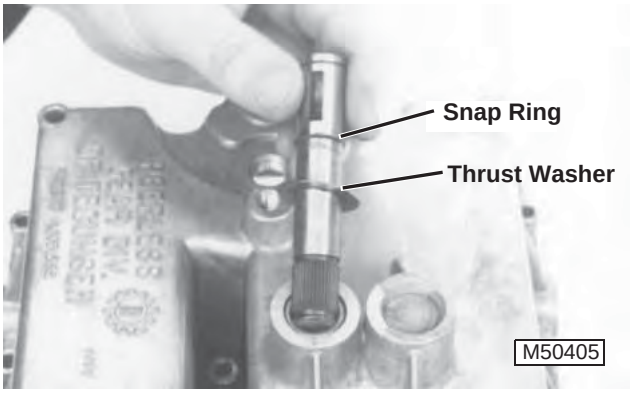
17. Overlap sprockets and angle shaft ends together to install drive chain.
18. Align reduction shaft and shifter shaft five gear sets.



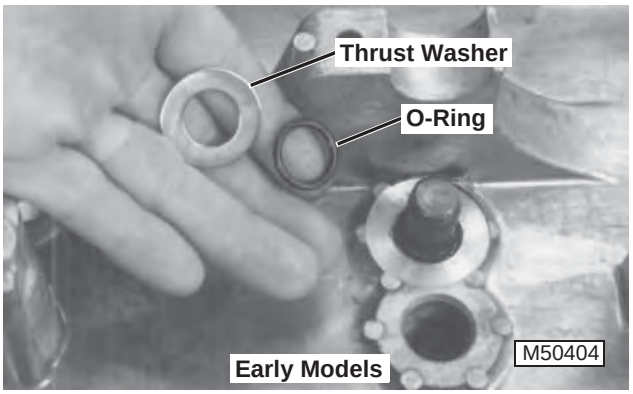
19. Put John Deere Non-Clay High-Temperature EP Grease (or equivalent) between needle bearings. Install O-rings in each end of output transfer pinion gear.



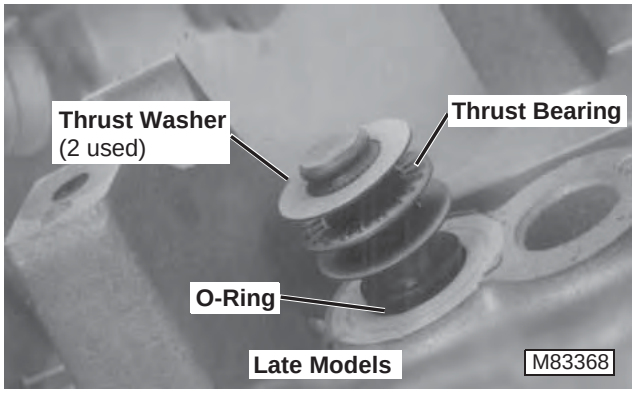
20. Install washer, output pinion gear, output gear, thrust washer and ball bearing (flush with end of shaft).



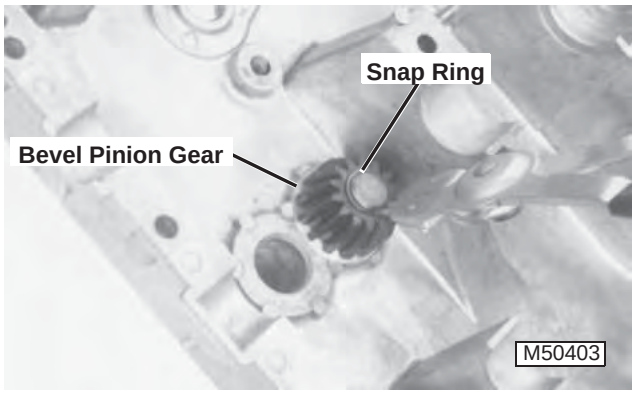
21. Install snap ring and thrust washer on input shaft. Install input shaft in cover (outside of cover).



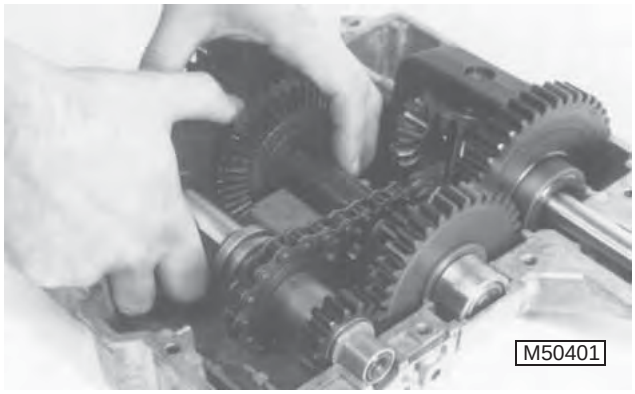
22. Put protective tape over splines to protect new o-ring from being damaged.
23. For early models, install O-ring first and then thrust washer on input shaft (inside of case). Remove tape.



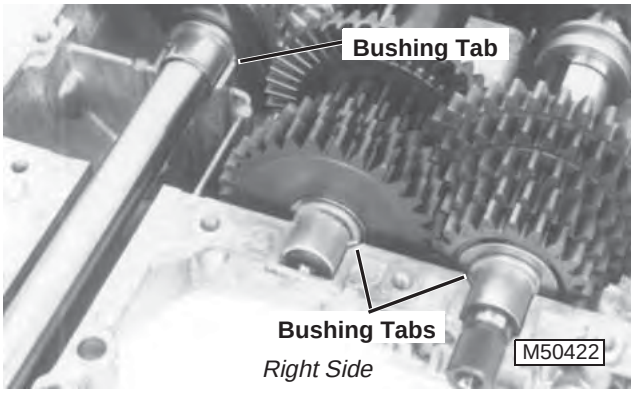
24. Put protective tape over splines to protect new o-ring from being damaged.
25. For late models, install O-ring, thrust washer, thrust bearing and thrust washer on input shaft (inside of case). Remove tape.

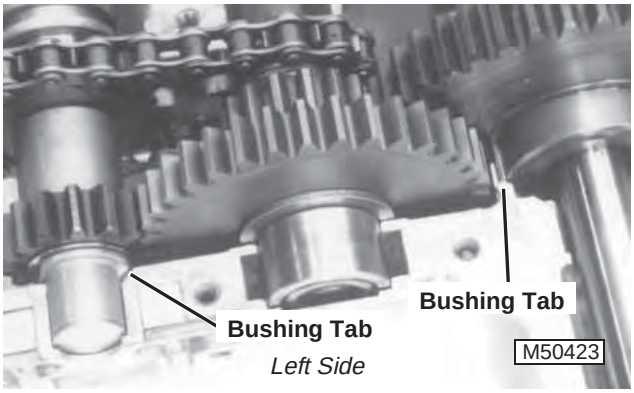


26. Install input bevel pinion gear and snap ring.

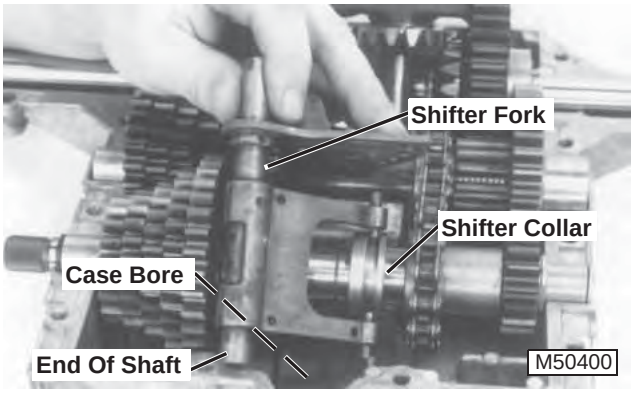


27. Coat appropriate case bearing surfaces with grease.
28. Install differential assembly in case.
29. Install shifter shaft/reduction shaft assembly in case.

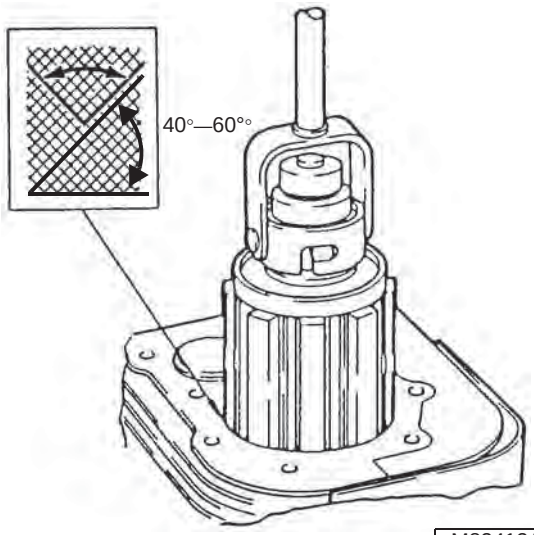




30. Make sure tabs on bushings are rotated into notches in case.



31. Coat end of shaft and case bore surfaces with grease.
32. Install shifter fork, putting pins in groove of shifter collar first, then rotate end of shaft into case bore.
33. Apply approximately 1.0 L (2.2 pt) of John Deere Non-Clay High-Temperature EP Grease (or equivalent) to all transaxle components and wear areas in the bottom half of the transaxle case.



M82412A

1. Align center of bore to drill press center.
2. Lower and raise hone until end extends **20—25 mm (0.75—1.0 in.)** past ends of cylinder.
3. Adjust hone stones until they contact narrowest point of cylinder walls.
4. Coat inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.
5. Run drill press between **200—250 rpm**. Move hone up and down in cylinder approximately **20 times per minute**.

NOTE: Measure bore when cylinder is cool.

6. Stop press and check cylinder diameter.

*NOTE: Finish should not be smooth. It should have a **40—60° cross-hatch pattern**.*

7. Check bore for size, taper and out-of-round.
8. If cylinder bores exceed wear limit, rebore cylinder or replace block.
9. Hone the cylinder an additional **0.007—0.009 mm (0.0003—0.0004 in.)** for final bore specifications. This allows for **0.020 mm (0.0008 in.) shrinkage** when cylinder cools.

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

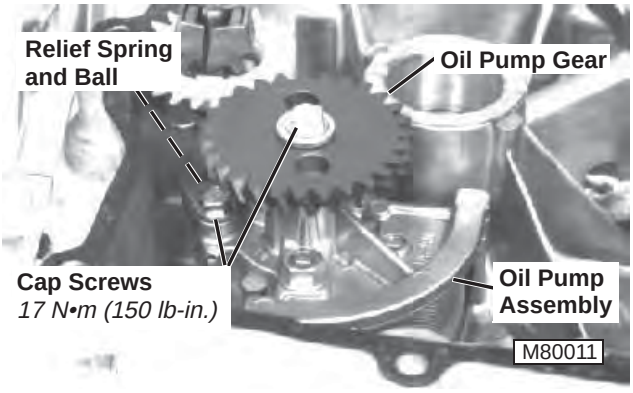
10. Clean cylinder walls using clean white rags and water. Continue to clean cylinder until white rags show no discoloration.
11. Dry cylinder.
12. Apply a light coat of clean engine oil.

OIL PUMP

Disassembly/Assembly

NOTE: FC540V shown. FC420V is similar.

1. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)



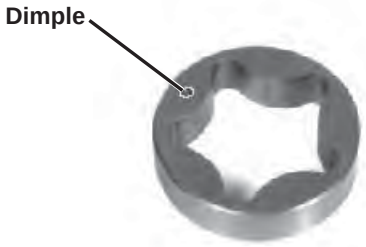
M80011

2. Remove oil pump gear.

IMPORTANT: Remove rotor shaft and oil pump cover to avoid damaging governor.

3. Remove oil pump assembly.
4. Remove relief spring and ball.
5. Inspect all parts for wear or damage. (See Inspection procedure on this page.)

Assembly is done in the reverse order of disassembly:



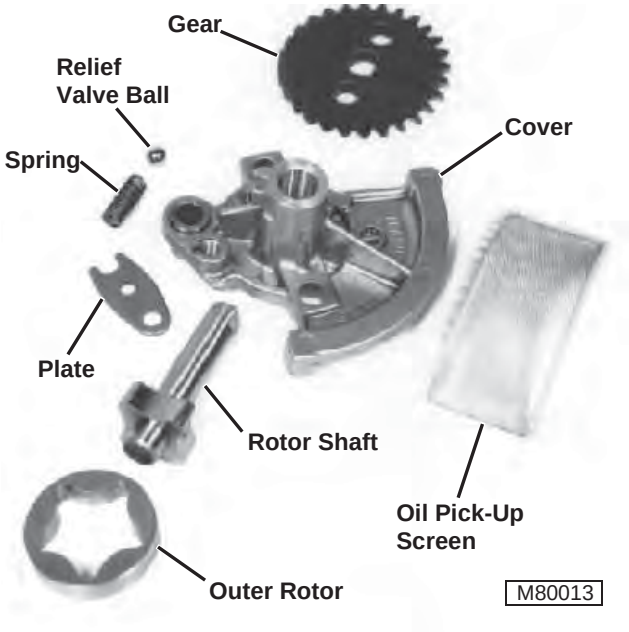
M80012

- Install outer rotor with dimple facing away from crankcase cover.
- Install oil pump gear with recess facing away from crankcase cover.

Oil PumpTorque Specifications:

Gear, Relief Spring, and Cover Cap Screws . . . . . 17 N•m (150 lb-in.)

Inspection



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



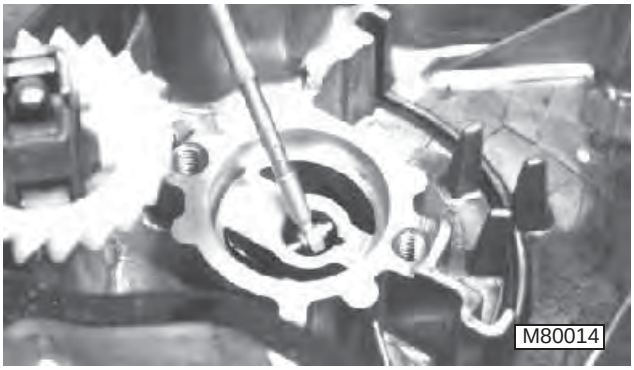
2. Measure rotor shaft diameter. Replace if shaft O.D. is less than specifications.

Minimum Rotor Shaft O.D.

FC420V (Large O.D.) . . . . . 12.627 mm (0.4971 in.)
FC420V (Small O.D.) . . . . . 7.935 mm (0.3125 in.)
FC540V . . . . . 12.627 mm (0.4971 in.)



3. Measure rotor shaft bearing in oil pump cover. Replace cover if bearing I.D. is greater than **12.76 mm (0.5024 in.)**.



4. Measure rotor shaft bearing in crankcase cover. Replace cover if bearing I.D. is greater than specifications.

Maximum Rotor Shaft Bearing I.D.:

FC420V . . . . . 8.07 mm (0.3177 in.)
FC540V . . . . . 12.76 mm (0.5023 in.)



5. Measure thickness of outer rotor. Replace if thickness is less than specifications.

Minimum Outer Rotor Thickness:

FC420V . . . . . .11.92 mm (0.4692 in.)
FC540V . . . . . 9.92 mm (0.3905 in.)



6. Measure outside diameter of outer rotor. Replace both outer rotor and shaft if O.D. is less than specifications.

Minimum Outer Rotor O.D.:

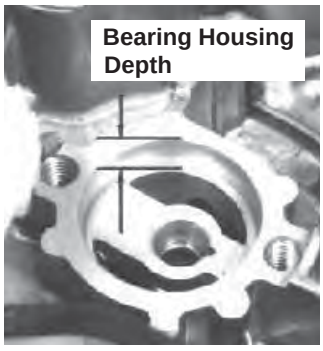
FC420V . . . . . 28.95 mm (1.1397 in.)
FC540V . . . . . 40.47 mm (1.5933 in.)



7. Measure inside diameter of rotor bearing. Replace crankcase cover if I.D is greater than specifications.

Maximum Rotor Bearing I.D.:

FC420V . . . . . 29.20 mm (1.1496 in.)
FC540V . . . . . 40.77 mm (1.6051 in.)



8. Measure outer rotor bearing housing depth. If depth is greater than specifications, replace oil pump housing (FC420V) or crankcase cover (FC540V).

Maximum Outer Rotor Bearing Housing Depth:

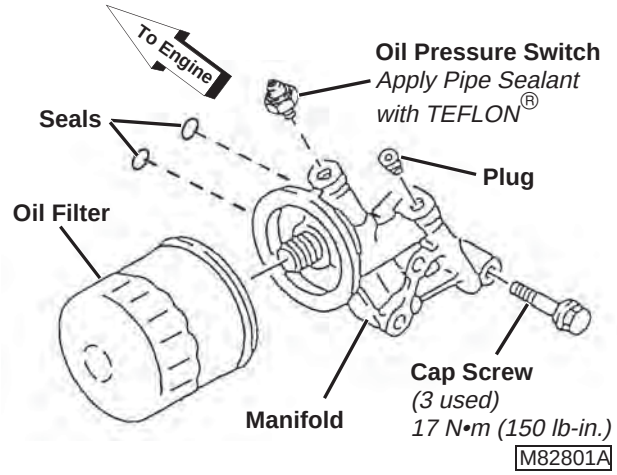
FC420V . . . . . 12.14 mm (0.4779 in.)
FC540V . . . . . 10.17 mm (0.4003 in.)



9. Measure relief valve spring. Replace spring if free length is **less than 19.00 mm (0.7480 in.)**.

OIL FILTER MANIFOLD

Removal/Installation



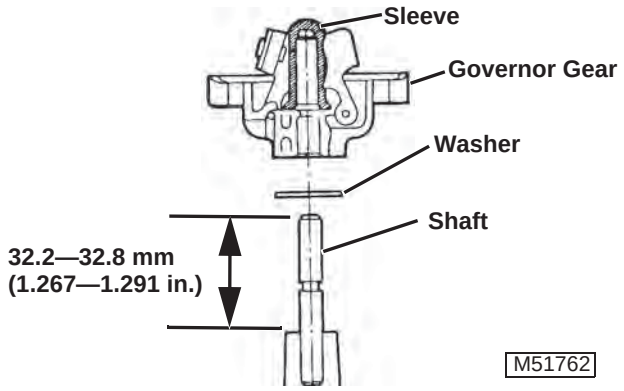
GOVERNOR

Inspection/Replacement

1. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)

IMPORTANT: DO NOT remove governor assembly or shaft unless damaged. Removal damages the gear assembly and entire assembly must be replaced.

2. Inspect governor for wear or damage. Replace entire assembly only when necessary.



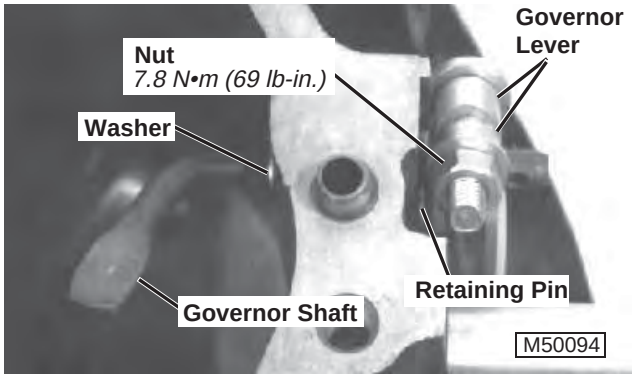
3. Use two screwdrivers to pry governor assembly from shaft. DO NOT damage crankcase sealing surfaces.
4. If shaft is removed, press shaft back into block until it protrudes **32.2—32.8 mm (1.267—1.291 in.)** above surface of opening.
5. Install sleeve into governor flyweights before gear assembly is installed onto shaft.
6. Install washer and governor assembly onto shaft.
7. Push down on assembly until it snaps into place.
8. Check assembly for freedom of movement.

GOVERNOR SHAFT

Inspection/Replacement

NOTE: It is not necessary to remove governor shaft unless damaged.

1. Remove crankshaft cover. (See CRANKCASE COVER—Removal/Installation on page 3-54.)
2. Inspect shaft for wear or damage. Replace entire assembly only when necessary.



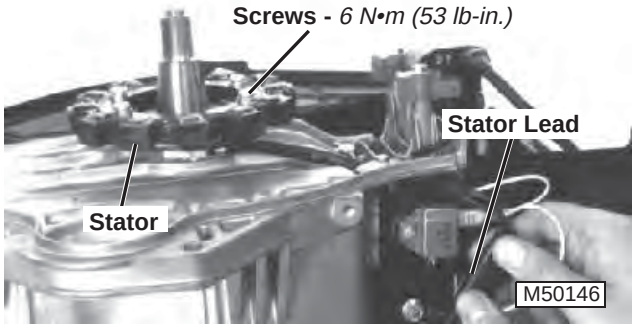
To replace governor shaft:

1. Scribe a mark across shaft and lever to aid in installation.
2. Loosen nut on lever.
3. Remove retaining pin, governor shaft and washer.
4. Install washer, shaft and retaining pin.
5. Align marks made during removal.
6. Tighten nut to **7.8 N•m (69 lb-in.)**.

STATOR

Removal/Installation

1. Remove flywheel. (See FLYWHEEL—Removal/Installation on page 3-48.)



2. Disconnect stator lead.
3. Remove screws and stator.

Installation is done in the reverse order of removal.

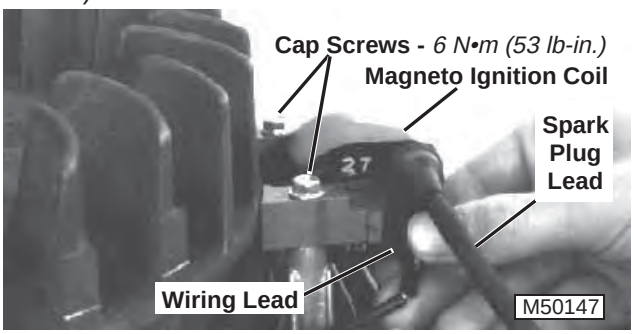
- Tighten stator cap screws to specification.

MAGNETO IGNITION COIL

ENDING ENGINE SERIAL NUMBERS:
(FC420V —B50632)
(FC540V —A00384)

Removal/Installation

1. Remove blower housing. (See BLOWER HOUSING—Inspection/Replacement on page 3-48.)

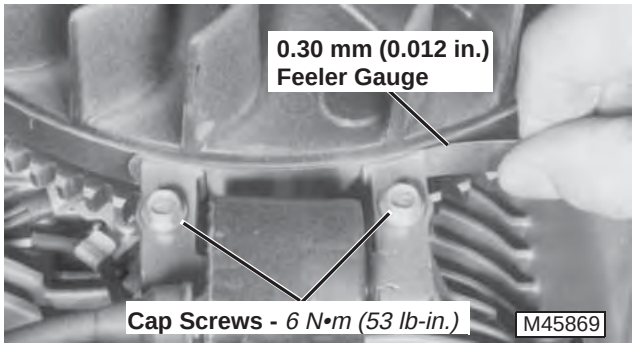


2. Disconnect spark plug high tension lead from plug.
3. Disconnect wiring lead.
4. Remove cap screws and magneto ignition coil.
5. Test magneto ignition coil resistance. (See MAGNETO IGNITION COIL RESISTANCE TEST on page 3-39.)

Installation is done in the reverse order of removal.

- Adjust coil air gap. (See Air Gap Adjustment on next page.)
- Tighten cap screws to specification.

Air Gap Adjustment

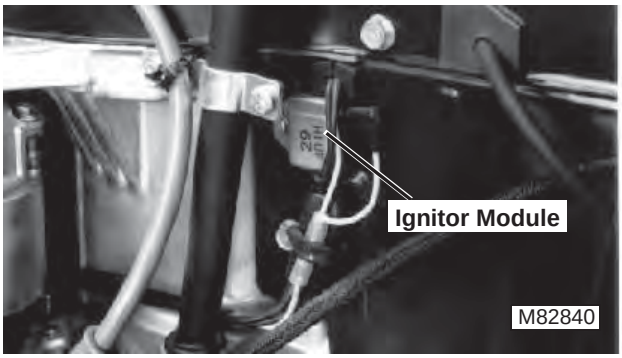


1. Turn flywheel magnet away from coil.
2. Loosen screws.
3. Insert a **0.30 mm (0.012 in.)** feeler gauge between flywheel and both coil terminals.
4. Push coil against feeler gauge and flywheel.
5. Hold coil motionless and tighten screws to specification.
6. Turn flywheel to remove feeler gauge.

IGNITOR MODULE

ENDING ENGINE SERIAL NUMBERS:
(FC420V —B50632)
(FC540V —A00384)

Replacement



NOTE: There is no way to test the ignitor module, if it is suspect, replace it with a know good ignitor module.

1. Disconnect wiring connector.
2. Remove cap screw to replace ignitor module.

Installation is done in the reverse order of removal.

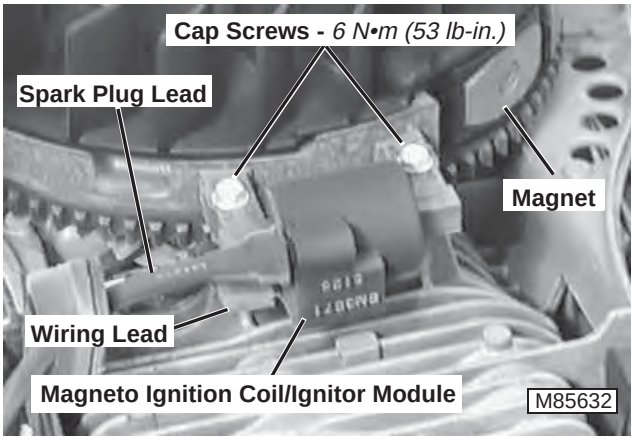
MAGNETO IGNITION COIL/IGNITOR MODULE

BEGINNING ENGINE SERIAL NUMBERS:
(FC420VB50633—)
(FC540VA00385—)

Removal/Installation

NOTE: Magneto ignition coil/ignitor module will not retro-fit on earlier engines due to the reversed polarity of the flywheel magnet.

1. Remove blower housing. (See BLOWER HOUSING—Inspection/Replacement on page 3-48.)

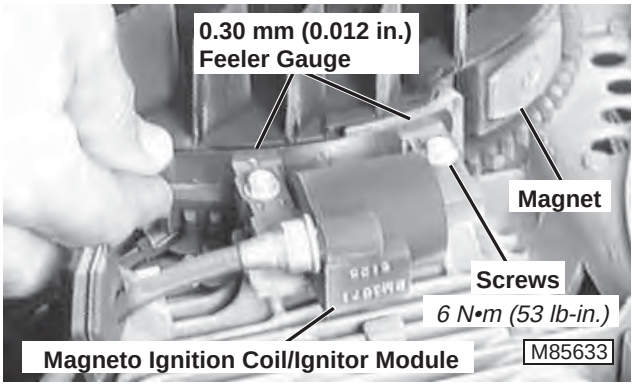


2. Disconnect spark plug high tension lead from plug.
3. Turn flywheel so magnet is clear of ignition coil.
4. Disconnect wiring lead.
5. Remove cap screws and ignition coil.
6. Test ignition coil resistance. (See MAGNETO IGNITION COIL/IGNITOR MODULE RESISTANCE TEST on page 3-40.)

Installation is done in the reverse order of removal.

- Adjust armature air gap. (See Air Gap Adjustment below.)

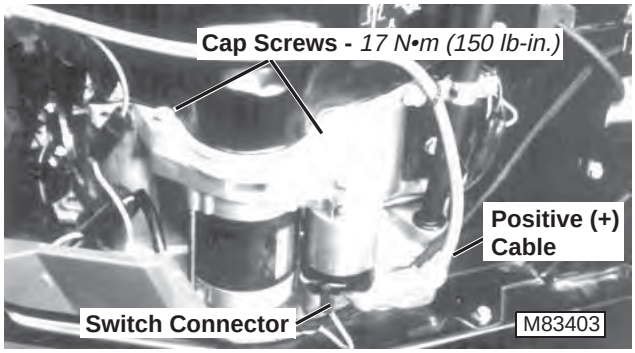
Air Gap Adjustment



1. Turn flywheel magnet away from ignition coil.
2. Loosen screws.
3. Insert a **0.30 mm (0.012 in.)** feeler gauge between flywheel and both ignition coil terminals.
4. Push ignition coil against feeler gauge and flywheel and tighten screws to specification.
5. Turn flywheel to remove feeler gauge.

STARTER

Removal/Installation



1. Disconnect negative (–) battery cable at the battery.
2. Remove switch connector and positive (+) battery cable.
3. Remove two cap screws and starter.

Installation is done in the reverse order of removal.

- Clean starter motor and engine mounting flange to ensure proper ground contact.
- Tighten cap screws to specification.

Torque Specification:
Starter Mounting Cap Screws . . . 17 N•m (150 lb-in.)

Analyze Condition

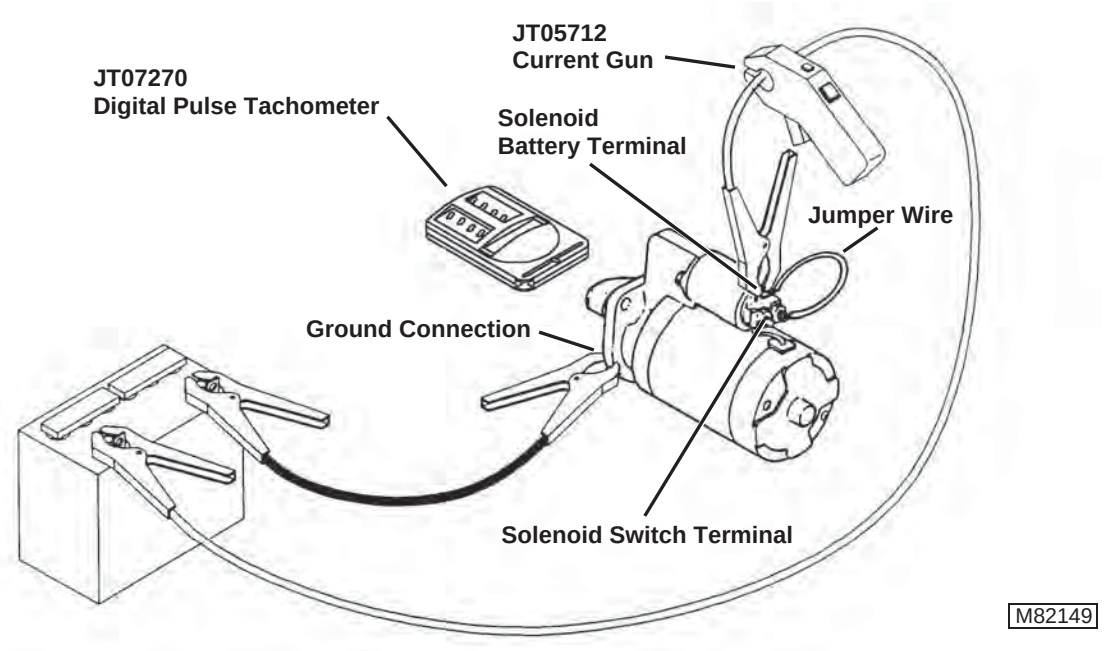
The starter overheats because of:

- Long cranking.
- Armature binding.

The starter operates poorly because of:

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

Starter No-Load Amperage Draw and RPM Bench Tests



Reason:

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

Test Equipment:

- JT05712 Current Gun
- JT07270 Digital Pulse Tachometer
- Jumper Cables
- Jumper Wire

Procedure:

IMPORTANT: Complete this test in 20 seconds or less to prevent starter damage.

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

1. Remove starter from engine and clamp in bench vise. (See STARTER–Removal/Installation.)
2. Connect jumper cables to a 12-volt battery.

3. Connect positive (+) cable to solenoid battery terminal.
4. Connect negative (–) cable to starter body.
5. Attach current gun to positive (+) cable.
6. Use a jumper wire to briefly connect solenoid battery terminal to solenoid switch terminal. Starter should engage and run.
7. Read and record starter amperage and rpm.

Results:

- If solenoid "clicks" or chatters and motor does not turn, replace solenoid.
- If pinion gear engages and motor doesn't turn, repair or replace starter motor.
- If starter engages and runs, but amperage is **more than 50 amps at 6000 rpm**, repair or replace starter.
- If free-running rpm is **less than 6000 rpm**, repair or replace starter.

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

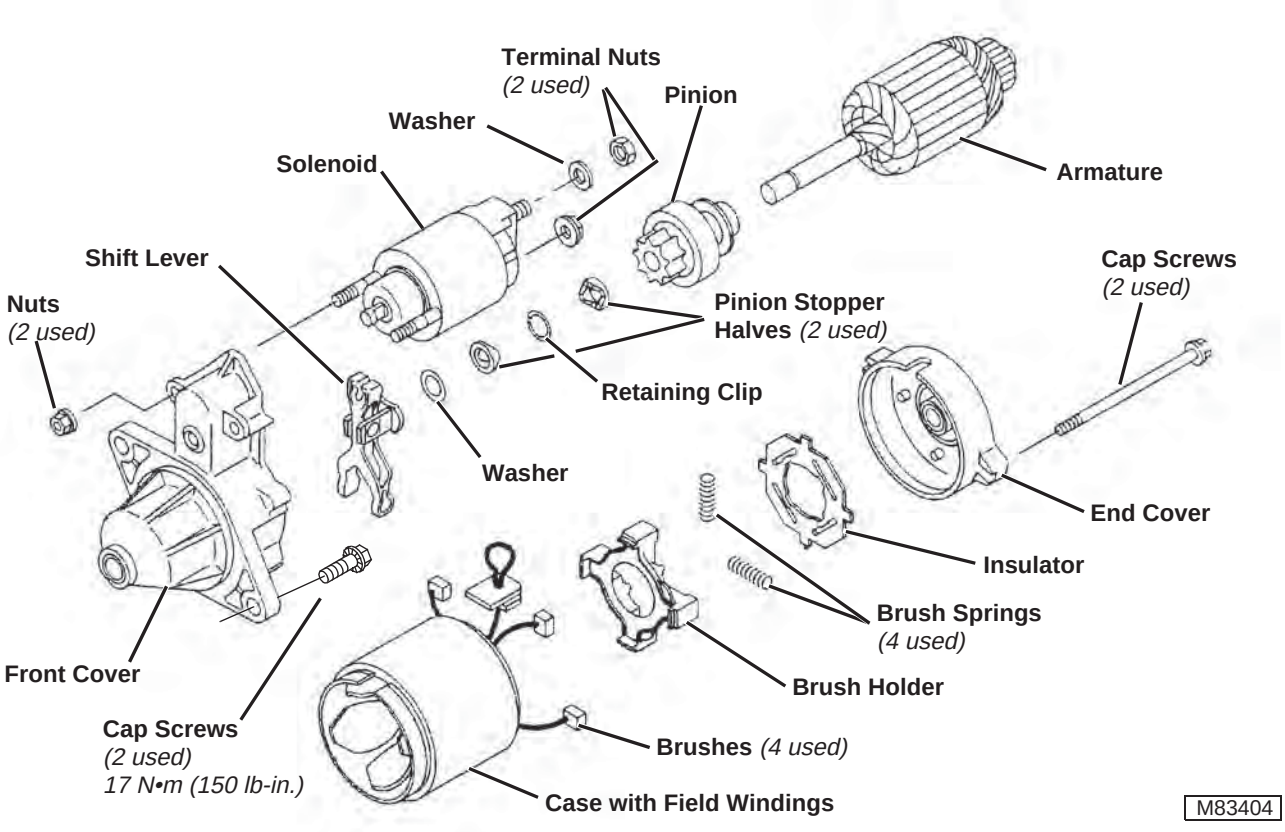
Disassembly/Assembly

1. Separate pinion stopper halves to remove retaining clip to remove starter drive.
2. Inspect parts for wear or damage. Replace parts as necessary.
3. Test solenoid, starter armature and brushes. (See Inspection/Test procedures.)

Assembly is done in the reverse order of disassembly.

- Apply a very light coating of multipurpose grease to:
  - Sliding surfaces of armature and solenoid shift lever pivots.
  - Armature shaft spline.
  - Points where shaft contacts cover.
- Always replace retaining clip with new one.

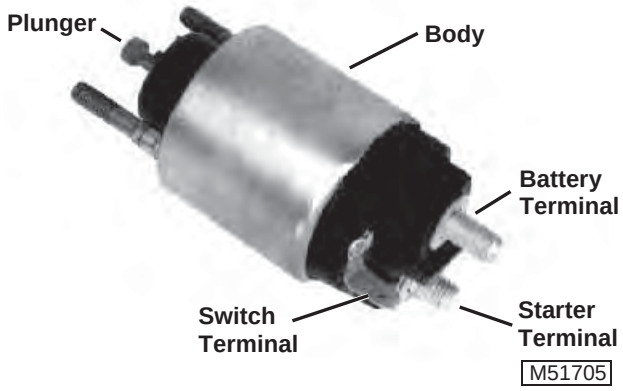
Starter Motor Exploded View



Inspection/Tests

Test Solenoid:

.

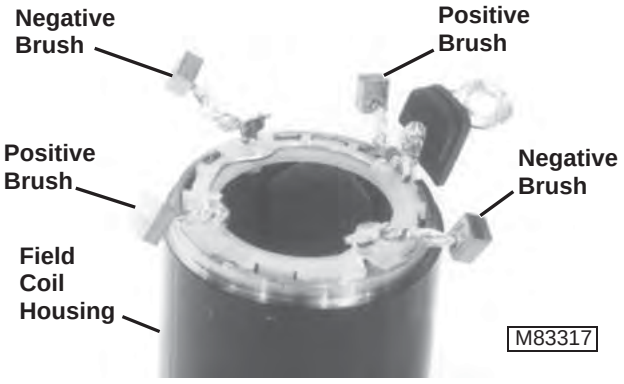


1. With plunger extended, check solenoid battery and starter terminals for continuity—there should be **no continuity**.
2. Depress plunger—there should be **continuity** when plunger is fully depressed.
3. Test for open circuits between starter terminal and switch terminal—there should be **no continuity**.
4. Test for open circuits between switch terminal and body—there should be **no continuity**.

Results:

- If solenoid fails any of above tests, it is defective and must be replaced.

Measure Brushes:

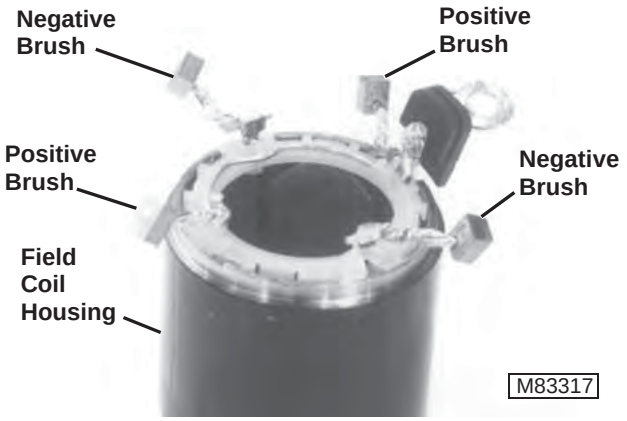


1. Measure brush lengths. If any one brush length is less than **6.0 mm (0.240 in.)** for FC420V or **10.5 mm (0.413 in.)** for FC540V. ALL brushes must be soldered to their leads.
2. Inspect brush springs for wear or damage.

Results:

- If one brush is bad, replace ALL brushes.
- If on spring is bad, replace ALL springs.

Test Brushes and Field Coil Housing Assembly:

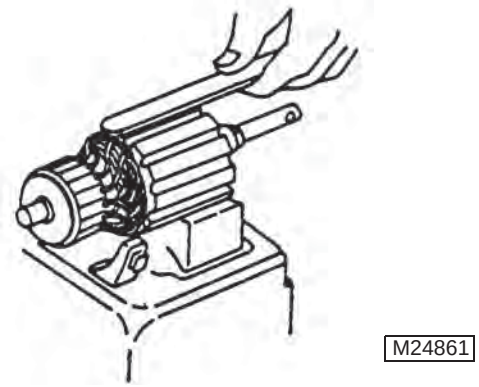


1. Test for continuity between positive brushes—there should be **continuity** between positive brushes.
2. Test for continuity between negative brushes (field coil) and bare metal area of housing—there should be **continuity** between negative brushes and bare metal area.
3. Test for continuity between positive brushes and bare metal area of housing—there should be **no continuity** between positive brushes and bare metal area **of the housing**.

Results:

- If assembly fails any of above tests, it is defective and must be replaced.

Test Starter Armature:



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

1. Test for short circuits by rotating armature on a growler while holding a hacksaw blade or steel strip on armature.
2. Watch Hacksaw blade, it will vibrate in areas of any short circuits.

NOTE: A shorted circuit most often occurs because of copper dust or filings between two commutator segments.

Results:

- If test indicates short circuit in windings, clean commutator of dust and filings. Test armature again.
- If re-test still indicates a short circuit, replace armature.

Test For Grounded Windings:



1. Use an ohmmeter or test light and touch probes on **each** commutator bar.
2. Armature windings are connected in parallel, so **each** commutator bar must be checked.

Results:

- If test indicates **continuity**, a winding is grounded and the armature must be replaced.

Test For Open Circuit Windings:



1. Use an ohmmeter or test light.
2. Touch probes on **two** different commutator bars.

Results:

- If test shows **high resistance** or **no continuity**, there is an open circuit and the armature must be replaced.

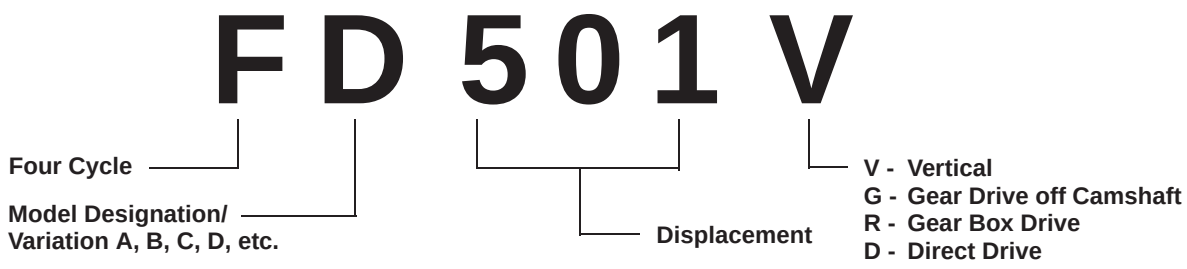


This page intentionally left blank.

SPECIFICATIONS

ENGINE DESIGNATION

NOTE: The LX178 tractor uses engine model number FD440V, LX188 uses engine model number FD501V.



TEST AND ADJUSTMENT SPECIFICATIONS

Slow Idle	1550 ±75 rpm
Fast Idle (FD440V)	3400 ±100 rpm
Fast Idle (FD501V)	3550 ±100 rpm
Choke Arm Gap	0.25–3.0 mm (0.01–0.12 in.)
Governor Arm Clamp Nut Torque	7.8 N•m (69 lb-in.)
Cylinders	
Compression Pressure (Minimum)	1171 kPa (170 psi)
Difference Between Cylinders (Maximum)	97 kPa (14 psi)
Valve Clearance (Cold)	0.15 mm (0.006 in.)
Jam Nut Torque	9 N•m (79 lb-in.)
Rocker Arm Cap Screw Torque	6 N•m (53 lb-in.)
Spark Plug Torque	17 N•m (150 lb-in.)
Crankcase Vacuum	1.27–38.1 cm (0.5–15.0 in.) of water movement
Engine Oil Pressure at Fast Idle (Minimum)	276 kPa (40 psi)
Engine Oil Pressure at Fast Idle (Maximum)—Relief Valve Pressure	296 kPa (43 psi)
Fuel Pump	
Pressure at Slow Idle (Minimum)	2.45 kPa (0.36 psi)
Flow Volume at Slow Idle (Minimum)	800 mL/60 seconds (0.8 qt/60 seconds)
Spark Plug Gap	0.6—0.7 mm (0.024—0.028 in.)
Cooling System	
Operating Pressure	
Minimum	90 kPa (13 psi)
Maximum	117 kPa (17 psi)
Radiator Cap Relief Pressure	73—103 kPa (10.6—14.9 psi)
Vacuum Valve	4.9 kPa (0.71 psi)
Coolant Temperature Switch Continuity (On)	107—113°C (225—235°F)
Capacity	2.10 L (2.2 U.S. qt)
Starter No Load Amperage Draw/RPM (Maximum)	50 amps at 6000 rpm

REPAIR SPECIFICATIONS

- Engine Mounting Cap Screw Torque . . . . . 34 N•m (300 lb-in.)
- Carburetor
  - Mounting Stud Nut Torque . . . . . 17 N•m (150 lb-in.)
  - Intake Elbow Mounting Cap Screw Torque . . . . . 8 N•m (71 lb-in.)
- Intake Manifold Mounting Cap Screw
  - Initial Torque . . . . . 3 N•m (27 lb-in.)
  - Final Torque . . . . . 6 N•m (53 lb-in.)
- Fuel Pump
  - Mounting Cap Screw Torque . . . . . 16 N•m (142 lb-in.)
  - Fuel Pump Push Rod Bend (Maximum) . . . . . 0.05 mm (0.002 in.)
- Cooling System
  - Cooling Fan Mounting Cap Screw Torque . . . . . 6 N•m (53 lb-in.)
  - Cooling Air Duct
    - Mounting Cap Screw Torque . . . . . 6 N•m (53 lb-in.)
    - Mounting Stud Torque . . . . . 6 N•m (53 lb-in.)
  - Thermostat
    - Begin Opening . . . . . 63–66°C (145–150°F)
    - Fully Open . . . . . 80°C (176°F)
  - Coolant Pump
    - Mounting Cap Screw Torque
      - Cover-to-Crankcase . . . . . 21 N•m (186 lb-in.)
      - Pump-to-Cover . . . . . 9 N•m (80 lb-in.)
    - Impeller Shaft O.D. (Minimum) . . . . . 9.935 mm (0.3911 in.)
    - Shaft Bore I.D. (Maximum) . . . . . 10.09 mm (0.397 in.)
  - Overflow Reservoir Mounting Cap Screw Torque . . . . . 4 N•m (35 lb-in.)
- Flywheel Mounting Nut Torque . . . . . 88 N•m (65 lb-ft)
- Rocker Arm Assembly
  - Shaft O.D. (Minimum) . . . . . 11.95 mm (0.470 in.)
  - Bearing I.D. (Maximum) . . . . . 12.07 mm (0.475 in.)
  - Maximum Push Rod Bend . . . . . 0.80 mm (0.031 in.)
  - Rocker Cover Cap Screw Torque . . . . . 5.9 N•m (52 lb-in.)
- Breather Reed Valve Tip Air Gap . . . . . 0.2 mm (0.008 in.)
- Cylinder Head
  - Cap Screw Torque (in Sequence)
    - Initial Torque . . . . . 13 N•m (115 lb-in.)
    - Final Torque . . . . . 21 N•m (186 lb-in.)
  - Spark Plug Torque . . . . . 17 N•m (150 lb-in.)
  - Cylinder Head Distortion (Maximum) . . . . . 0.06 mm (0.002 in.)
  - Valve Guide I.D. (Maximum) . . . . . 5.06 mm (0.199 in.)
  - Valve Seat Width . . . . . 0.5—1.1 mm (0.02—0.043 in.)
  - Valve Spring Free Length (Minimum) . . . . . 27.30 mm (1.074 in.)
- Intake and Exhaust Valves
  - Valve Stem I.D. (Minimum)
    - Intake . . . . . 4.93 mm (0.194 in.)
    - Exhaust . . . . . 4.92 mm (0.193 in.)
  - Valve Stem Bend (Maximum) . . . . . 0.03 mm (0.001 in.)
  - Valve Seating Surface (Standard) . . . . . 0.80 mm (0.031 in.)
  - Valve Seat and Face Angle . . . . . 45°
  - Valve Margin (Minimum) . . . . . 0.50 mm (0.020 in.)
  - Valve Narrow Angle . . . . . 30°

REPAIR SPECIFICATIONS, continued

- Crankcase Cover
  - Oil Capacity (W/Filter) . . . . . 1.8L (3.8 U.S. pt)
  - Mounting Cap Screw Torque . . . . . 21 N•m (186 lb-in.)
  - Oil Drain Plug Torque . . . . . 25 N•m (220 lb-in.)
- Piston Assembly
  - Piston Ring Side Clearance (Maximum)
    - Compression Ring Grooves . . . . . 0.10 mm (0.004 in.)
    - Oil Control Rings Groove . . . . . Not Measured
  - Piston Ring End Gap (Maximum)
    - Compression Rings . . . . . 1.00 mm (0.040 in.)
    - Oil Control Rings . . . . . Not Measured
  - Piston Pin
    - Pin O.D. (Minimum) . . . . . 15.98 mm (0.629 in.)
    - Bore I.D. (Maximum) . . . . . 16.04 mm (0.631 in.)
  - Piston O.D.
    - Standard Piston . . . . . 66.950—66.965 mm (2.6358—2.6364 in.)
    - Oversize Piston—0.50 mm (0.020 in.) . . . . 67.450—67.465 mm (2.655—2.656 in.)
    - Piston-to-Cylinder Bore Clearance . . . . . 0.015—0.150 mm (0.00059—0.00590 in.)
  - Cylinder Bore I.D.
    - Standard Size Bore
      - Standard . . . . . 66.980—67.000 mm (2.637—2.638 in.)
      - Wear Limit (Maximum) . . . . . 67.06 mm (2.639 in.)
    - Oversize Bore—0.50 mm (0.020 in.)
      - Standard . . . . . 67.48—67.50 mm (2.656—2.657 in.)
      - Wear Limit (Maximum) . . . . . 67.560 mm (2.659 in.)
  - Connecting Rod
    - Connecting Rod Bearing I.D. (Maximum)
      - Crankshaft Bearing . . . . . 31.06 mm (1.223 in.)
    - Piston Pin Bearing I.D. (Maximum) . . . . . 16.05 mm (0.632 in.)
    - Connecting Rod Cap Screw Torque . . . . . 12 N•m (106 lb-in.)
- Oil Pump
  - Mounting Cap Screw Torque . . . . . 7.8 N•m (69 lb-in.)
  - Rotor Shaft
    - Shaft O.D. (Minimum) . . . . . 10.92 mm (0.430 in.)
    - Shaft Bearing I.D. (Maximum) . . . . . 11.07 mm (0.436 in.)
  - Outer Rotor
    - Rotor O.D. (Minimum) . . . . . 40.43 mm (1.592 in.)
    - Bearing I.D. (Maximum) . . . . . 40.80 mm (1.606 in.)
    - Thickness (Maximum) . . . . . 9.83 mm (0.387 in.)
  - Inner and Outer Rotor Clearance (Maximum) . . . . . 0.3 mm (0.012 in.)
  - Pump Housing Depth (Maximum) . . . . . 10.23 mm (0.403 in.)
  - Spring Free Length (Minimum) . . . . . 19.00 mm (0.748 in.)
- Oil Pressure Sensor Continuity (On) . . . . . 98 kPa (14.2 psi)
- Oil Filter Bypass Valve Opening Pressure . . . . . 78.5–117.5 kPa (11.4–17.1 psi)
- Governor
  - Governor Mounting Shaft Height . . . . . 32.2—32.8 mm (1.267—1.291 in.)
  - Governor Lever-to-Shaft Position . . . . . 7 mm (0.276 in.) from end of shaft
  - Governor Shaft Seal Depth . . . . . 1 mm (0.040 in.) below crankcase surface
  - Governor Lever Nut Torque . . . . . 7.8 N•m (69 lb-in.)
- Starter
  - Maximum Amperage (No Load) . . . . . 50 amps at 6000 rpm
  - Starter Brush Length (Minimum) . . . . . 6 mm (0.240 in.)

SPECIAL OR ESSENTIAL TOOLS

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

JDM59 Compression Gauge
Used to check engine compression.

JT05697 Manometer Kit
Contains #5 plug and the following:

JT05703 Barb Fitting
Used to connect U-tube manometer to engine for Crankcase Vacuum Test.

JT05699 Line
Used to connect U-tube manometer to engine for Crankcase Vacuum Test.

JT05698 U-Tube Manometer
Used to check crankshaft vacuum.

JT03503 Crankcase Vacuum Test Kit
Used to check crankcase vacuum.

JT03344 Pressure Gauge Assembly
Used to read engine oil pressure when performing Engine Oil Pressure Test.

JT03017 Hose Assembly
Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.

JT03349 Connector
Used to connect pressure gauge to engine when performing Engine Oil Pressure Test.

JDG356 Pressure Gauge
Used to check fuel pump performance.

D-05351ST Spark Tester
Used to check overall condition of ignition system.

D05104ST Cooling System Pressure Pump
Used to check cooling system pressure.

JDG692 Radiator Pressure Test Kit (Adapters)
Used to adapt D05104ST Cooling System Pressure Pump to cooling system when performing Cooling System Pressure Test. Also used when performing Radiator Cap Pressure Test.

JDG472 Adaptor
Used to connect compressed air source to cylinder when performing Radiator Bubble Test.

JT05712 Current Gun
Used to check starter performance.

JT07270 Digital PulseTachometer
Used to check SLOW and FAST idle speeds and starter performance.

OTHER MATERIALS

Number	Name	Use
M7929	MPG-2® Multi-Purpose Polymer Grease	Apply to engine crankshaft.
LOCTITE® PRODUCTS U.S./ Canadian/ LOCTITE® No.		
T43512/ TY9473/ 242	Thread Lock and Sealer (Medium Strength)	Apply to threads of throttle and choke plate screws.
	SCOTCH-BRITE® Abrasive Sheets/pads	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol (or Kerosene)	Finish ream valve guides.
	Prussian Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	Mineral Spirits	Clean armature.

SERVICE PARTS KITS

The following kits are available through your parts catalog:

- Carburetor
- Gasket Kit
- Jet Kit
- Repair Kit
- Air Cleaner Bolt and Washer Kit
- Coolant Pump Gasket Kit
- Dipstick Tube Gasket Kit
- Rocker Arm and Shaft Kit
- Intake Valve Kit
- Exhaust Valve Kit
- Camshaft and Tappet Kit
- Piston Ring Kit (Standard)
- Piston Ring Kit (Oversize)
- Oversized Piston
- Overhaul Gasket Kit
- Engine Short Block Kit
- Oil Pump Kit
- Throttle Panel Kit
- Starter
- Brush Kit
- Clutch Kit

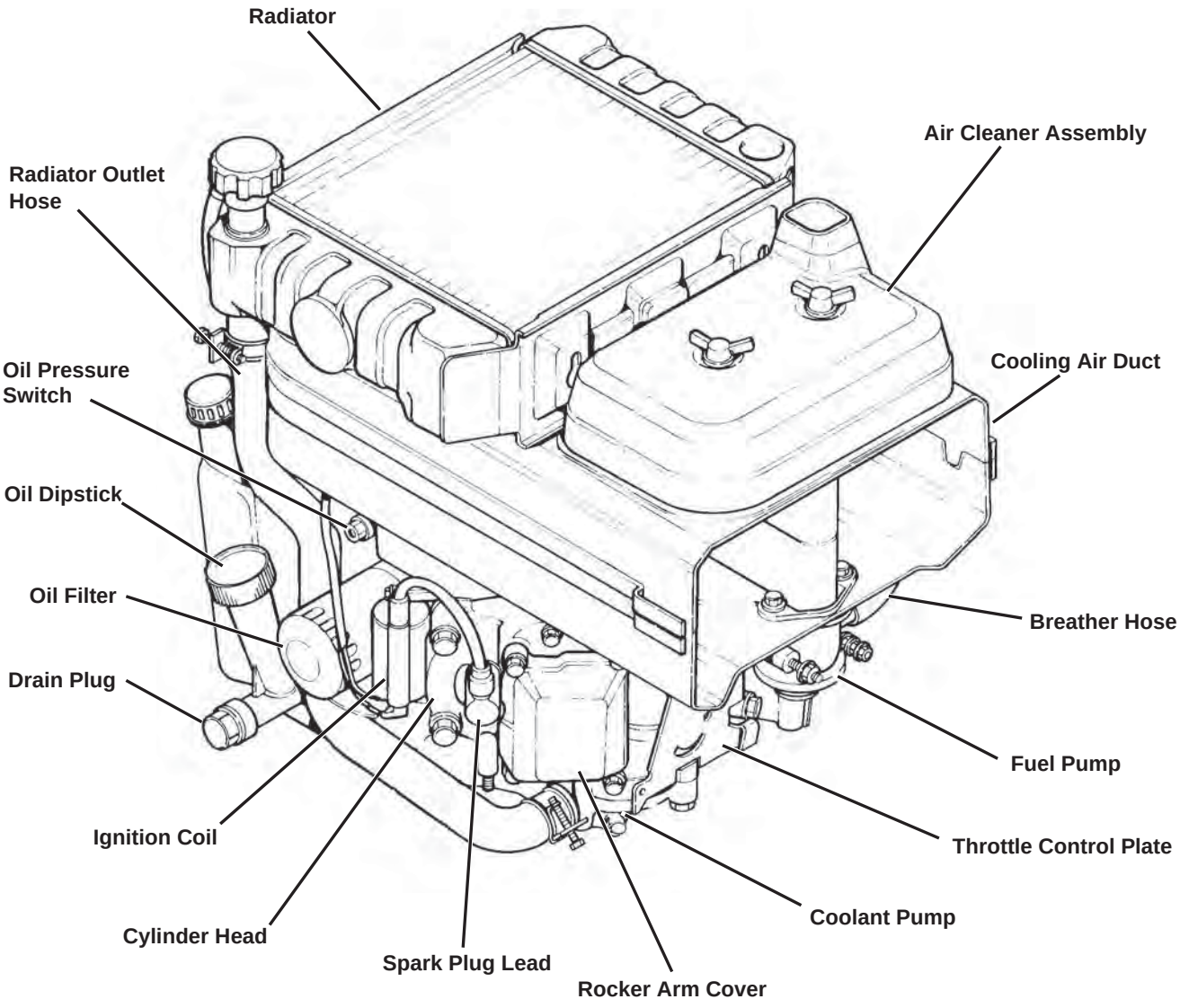
MPG-2® is a registered trademark of DuBois USA.
LOCTITE® is a registered trademark of the Loctite Corp.
SCOTCH-BRITE® is a register trademark of the 3M Co.



This page intentionally left blank.

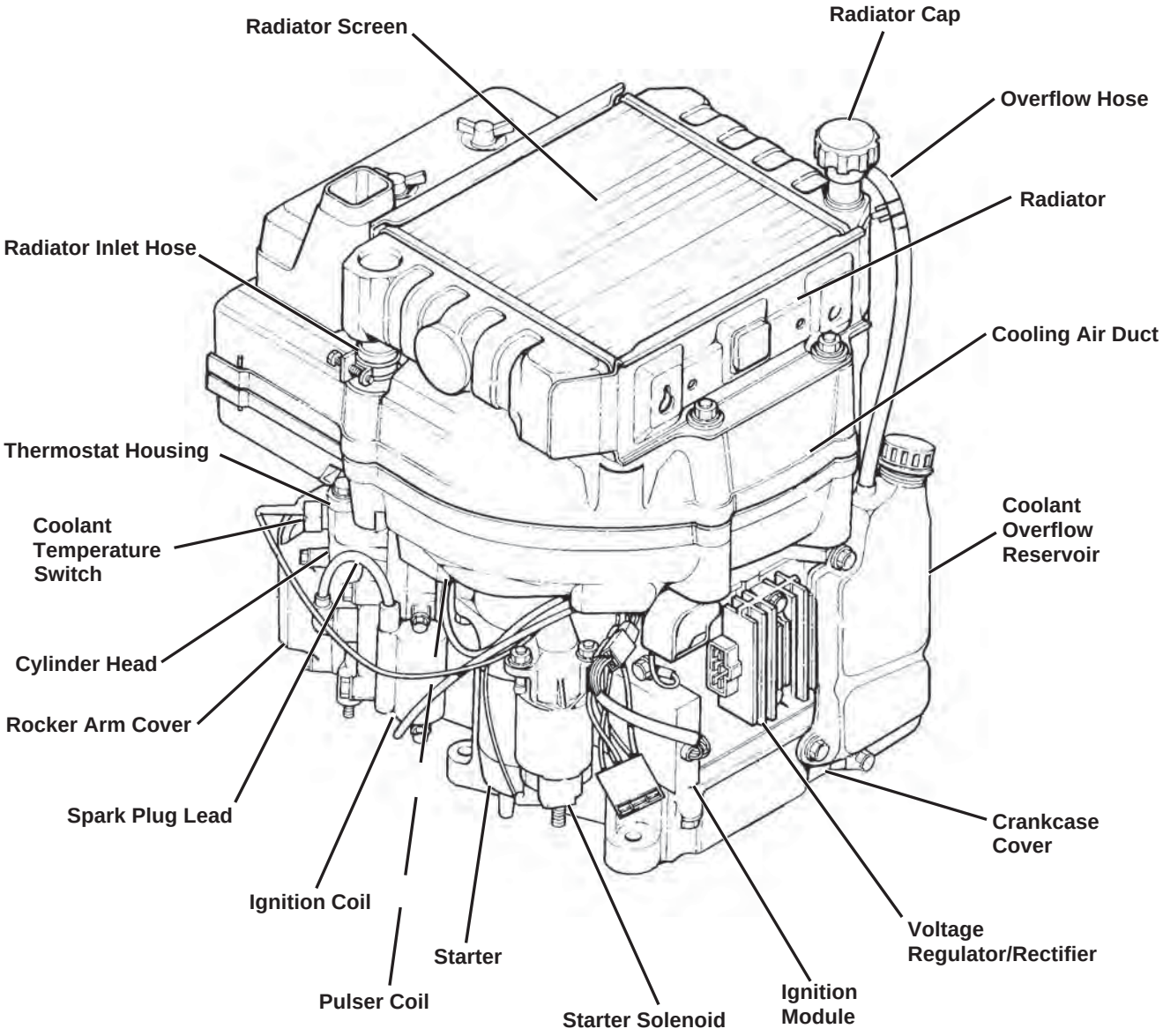
COMPONENT LOCATION

EXTERIOR ENGINE COMPONENTS



Right-Hand Side Shown

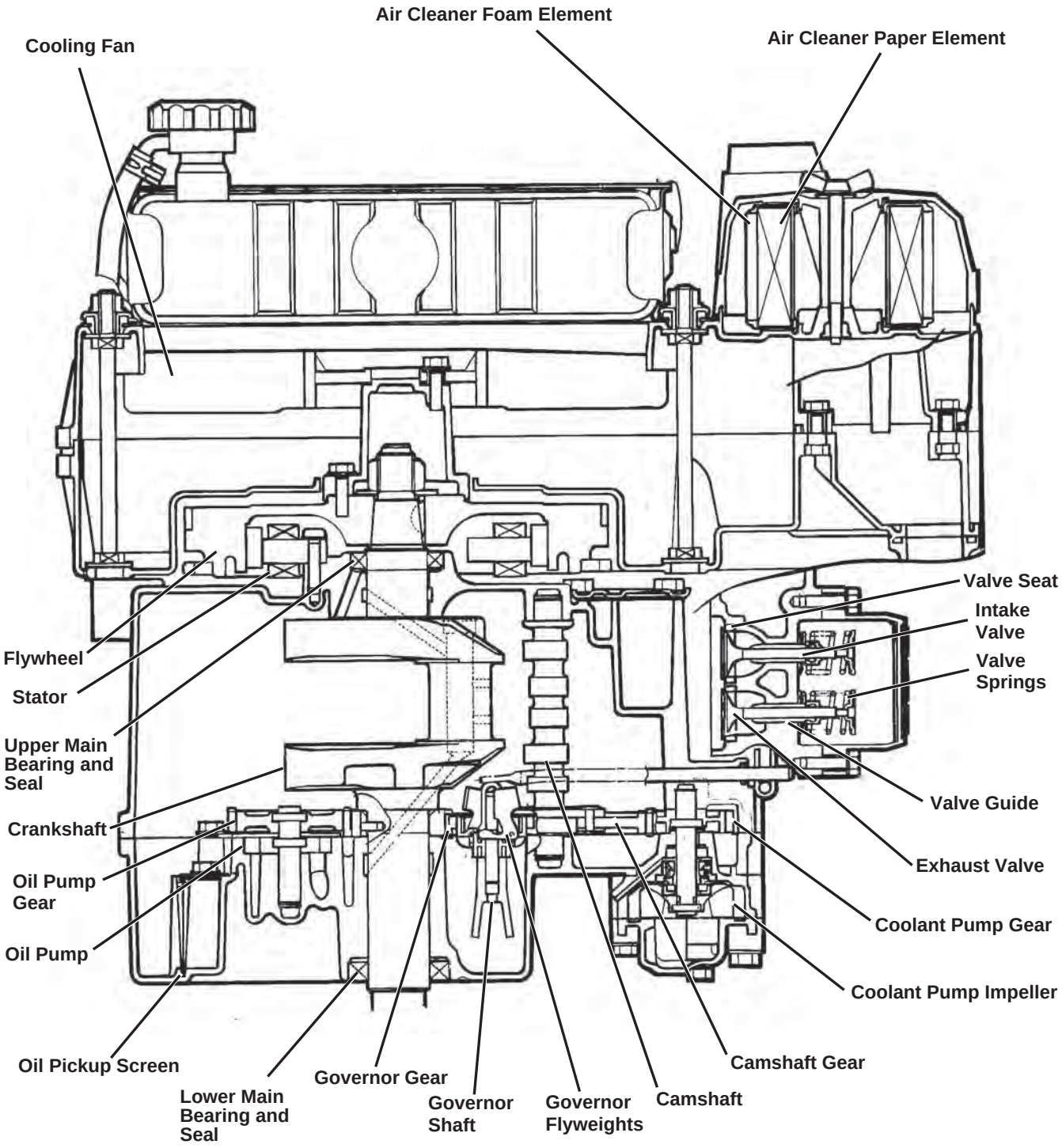
EXTERIOR ENGINE COMPONENTS, continued



Left-Hand Side Shown

M45645

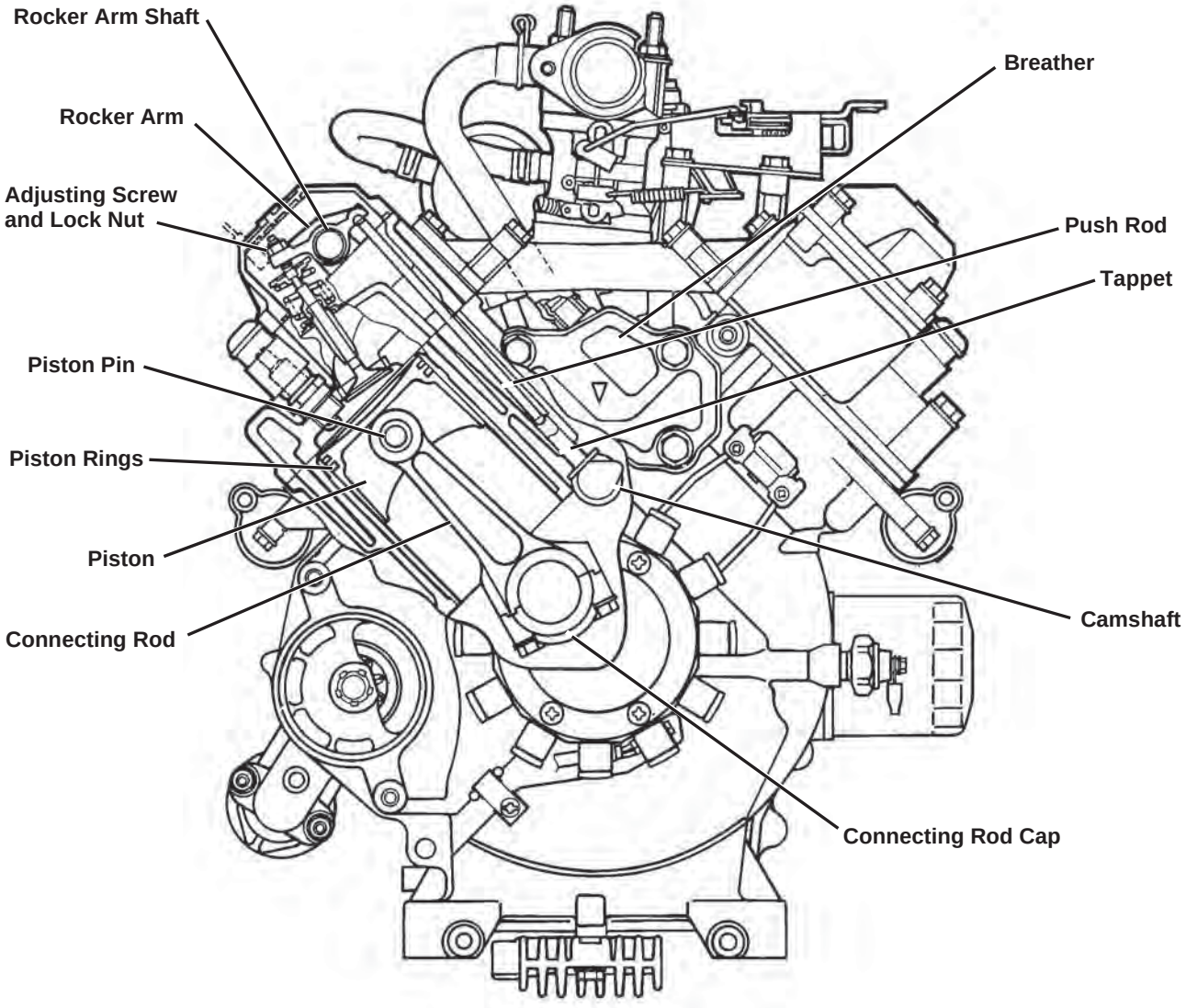
INTERNAL ENGINE COMPONENTS



Side View Cutaway

M45646

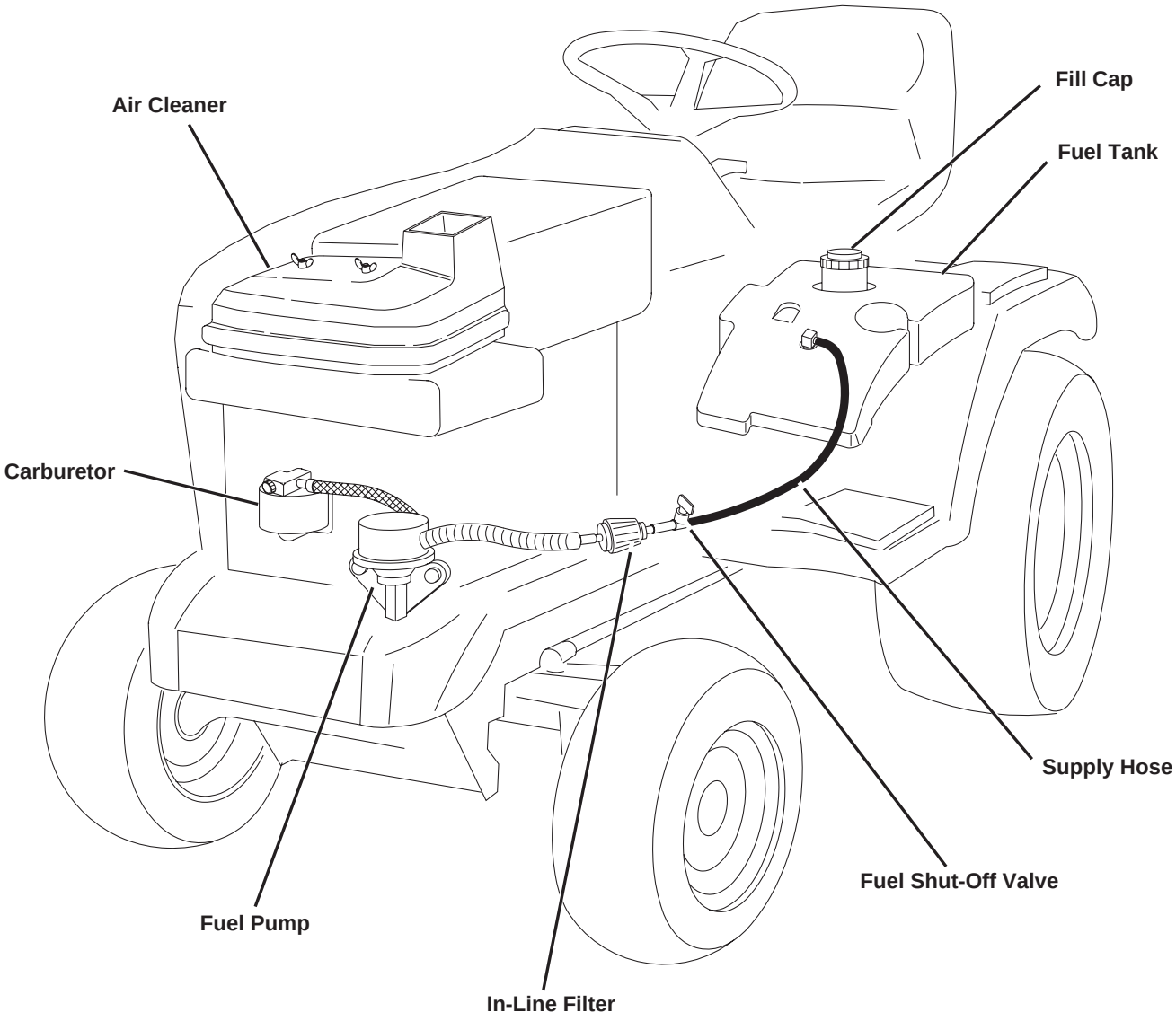
INTERNAL ENGINE COMPONENTS, continued



Top View Cutaway

M45647

FUEL/AIR SYSTEM COMPONENTS



THEORY OF OPERATION

LUBRICATION SYSTEM OPERATION

Function:

To provide pressurized oil to lubricate internal engine components.

Theory of Operation:

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

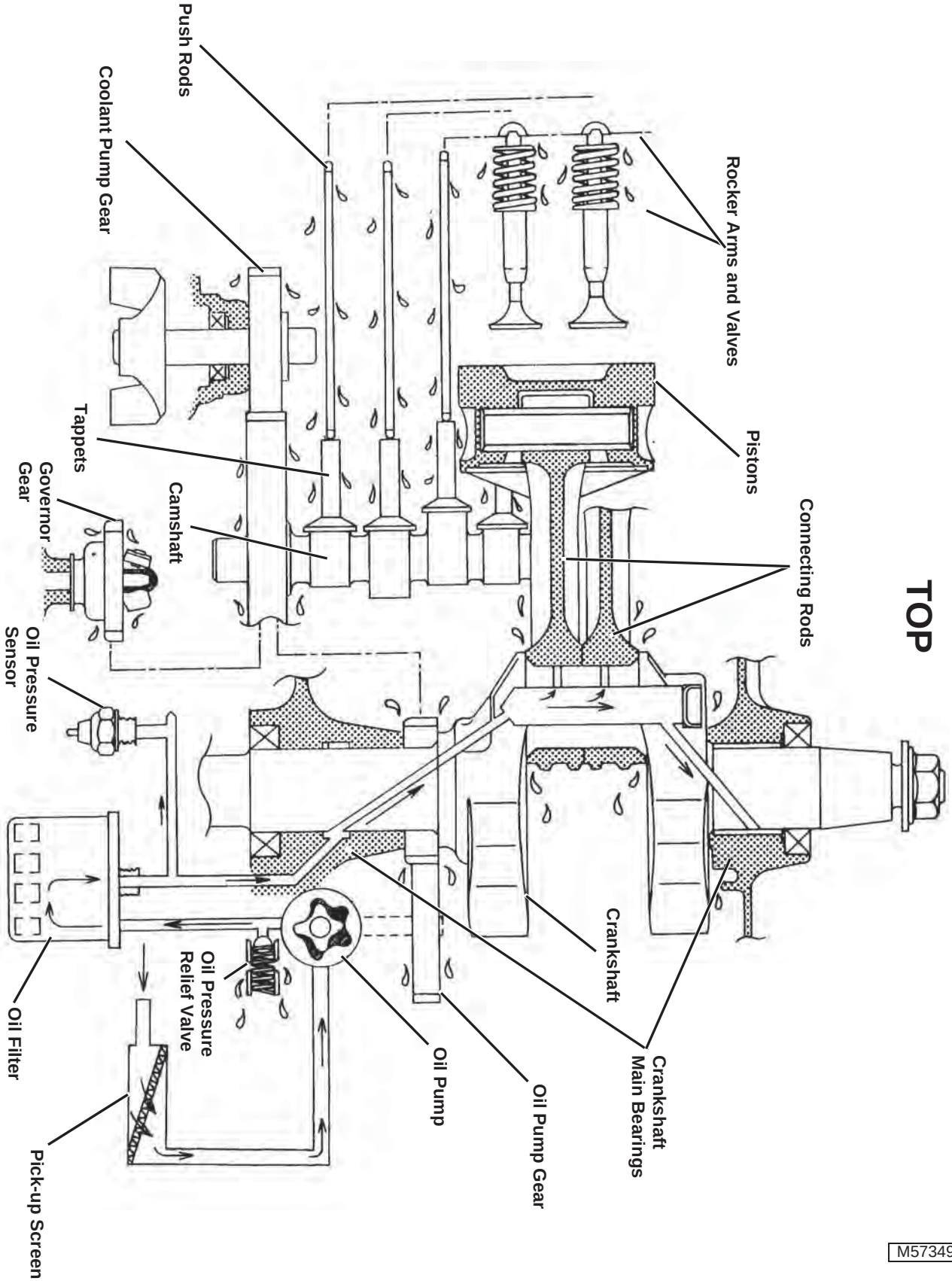
The oil pump draws oil from the sump through the pick-up screen. Pressure oil from the pump flows through the pump outlet passage past the oil pressure relief valve. The oil pressure relief valve limits the oil pressure to approximately 296 kPa (43 psi) and protects the oil pump from damage if an oil passage becomes blocked. If the oil pressure exceeds 296 kPa (43 psi), the relief valve opens allowing oil to return to the sump. The relief valve is not adjustable.

Pressure oil flows past the relief valve to the oil filter. The filter contains a bypass valve which opens at 78.5–117.5 kPa (11.4–17.1 psi) if the element becomes plugged to ensure engine lubrication.

An oil pressure switch mounted above the oil filter turns on a warning light if oil pressure is below 28 kPa (4 psi). Filtered pressure oil flows through a passage in the oil sump to the crankshaft main bearing (PTO side). Drilled passages in the crankshaft distribute oil from the main bearings to the connecting rod journals and crankshaft main bearings (flywheel side). A drilled passage in the connecting rods allows oil from the connecting rod journal to lubricate the piston and cylinder walls.

In the cylinder head, the rocker arms, valves, and pushrods are lubricated by an oil/air mixture carried through an upper lubrication passage from the breather chamber. As this oil/air mixture is swirled around the rocker arm chamber, the oil particles cling to the moving parts, lubricating them. Eventually these oil particles collect into a liquid state again in the lower portion of the rocker arm chamber. A small return passage is provided to return this liquid state oil back into the crankcase.

The camshaft gear, camshaft, tappets, coolant pump gear, governor gear, oil pump gear, and crankshaft gear are lubricated by oil splash generated by the internal moving parts during operation.


Push Rods
Coolant Pump Gear
Rocker Arms and Valves
Pistons
Tappets
Governor Gear
Camshaft
Connecting Rods
TOP
Oil Pressure Sensor
Crankshaft
Oil Pressure Relief Valve
Oil Filter
Oil Pump
Oil Pump Gear
Crankshaft Main Bearings
Pick-up Screen
M57349

COOLING SYSTEM OPERATION

Function:

Remove heat from engine.

Theory of Operation:

The engine is liquid-cooled and uses a pressurized, fin-type radiator, fan, coolant pump, and thermostat to regulate engine temperature. The cooling system is protected by a coolant temperature switch that activates a warning light on the dash if the engine temperature reaches 107–113°C (225–235°F). The coolant pump is driven by the camshaft gear.

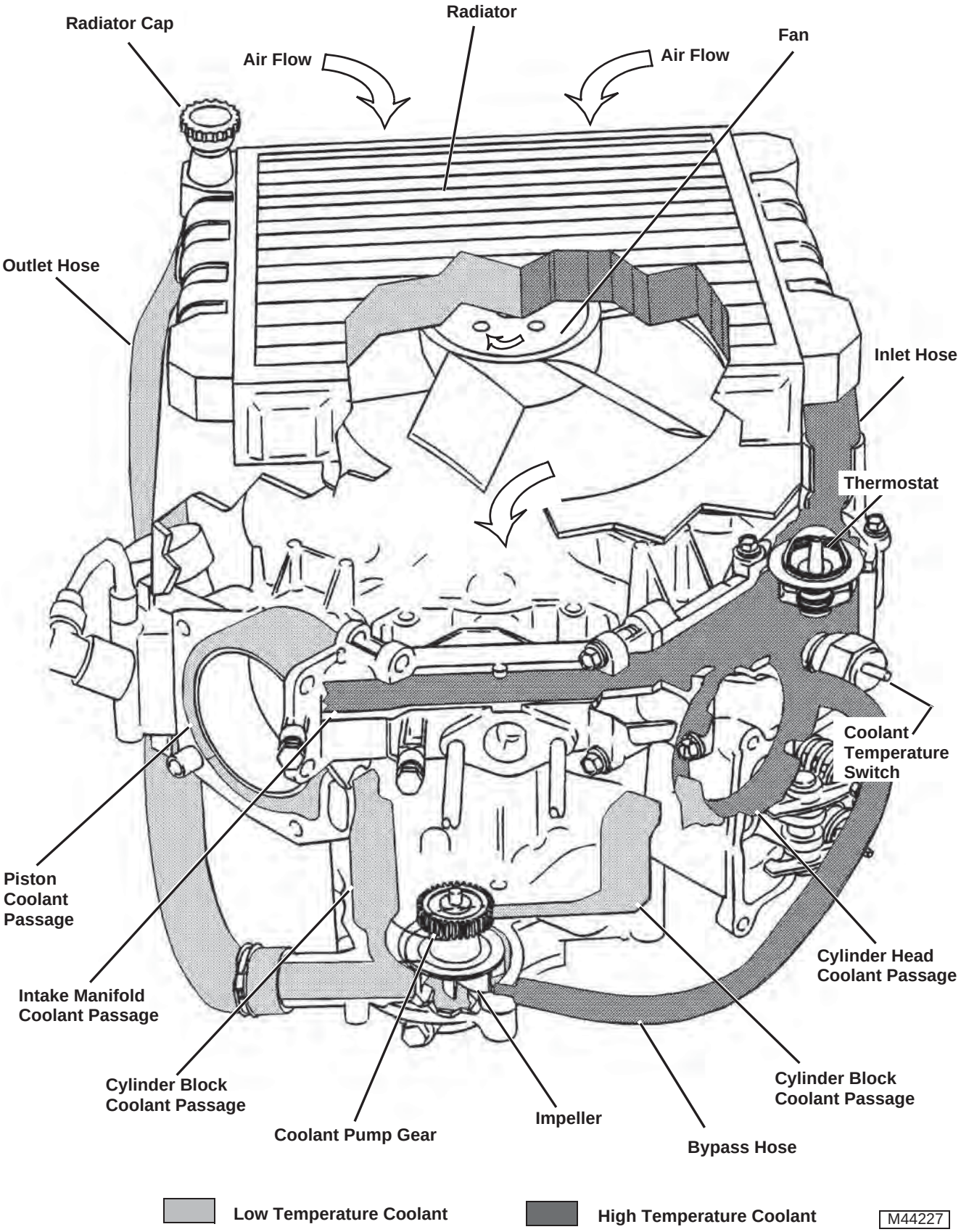
When the engine temperature is below 82°C (180°F), the thermostat is closed. When the thermostat is closed coolant flow into the radiator is stopped. The coolant pump must now draw coolant from the bypass hose which is between the cylinder head and coolant pump. The impeller forces the low temperature coolant through the cylinder block coolant passage to the piston coolant passage. Coolant flows around the piston coolant passage, and then through the right cylinder head, intake manifold, and left cylinder head to the bypass hose. The engine heat is transferred to the coolant and the coolant temperature increases. Since the high temperature coolant bypasses the radiator, the engine warms up to operating temperature quickly.

When the coolant temperature reaches 82°C (180°F), the thermostat begins to open and is fully open at 95°C (203°F). High temperature coolant from the left cylinder head flows through the thermostat to the radiator. The radiator is cooled by a radiator fan that is mounted to the flywheel. The radiator fan pulls air in from the top of the engine and downward through the radiator fins. The coolant temperature decreases as the coolant pump forces coolant into the radiator inlet and through the cooling fins to the radiator outlet.

With the thermostat open, the coolant pump draws low temperature coolant from the radiator through the radiator outlet hose instead of the bypass hose. The low temperature coolant is circulated through the engine to provide constant cooling.

A coolant temperature switch mounted in the left cylinder head activates a warning light on the dash if the coolant temperature should reach 107–113°C (225–235°F).

The radiator cap should maintain a constant pressure of 88 kPa (13 psi) inside the radiator which actually raises the boiling point of the coolant. The radiator cap contains a pressure valve and vacuum valve. When the coolant is hot and pressure is above 90 kPa (13 psi), the pressure valve opens allowing some coolant to flow to the overflow reservoir. After the engine has stopped, the coolant cools and the pressure inside the radiator decreases to create a partial vacuum. When vacuum pressure reaches 4.9 kPa (0.71 psi) the vacuum valve opens and some coolant flows from the overflow reservoir into the radiator, keeping it full.


Radiator Cap
Radiator
Air Flow
Air Flow
Fan
Outlet Hose
Inlet Hose
Thermostat
Coolant Temperature Switch
Piston Coolant Passage
Intake Manifold Coolant Passage
Cylinder Block Coolant Passage
Coolant Pump Gear
Impeller
Bypass Hose
Cylinder Head Coolant Passage
Cylinder Block Coolant Passage
Low Temperature Coolant
High Temperature Coolant
M44227

TROUBLESHOOTING

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART

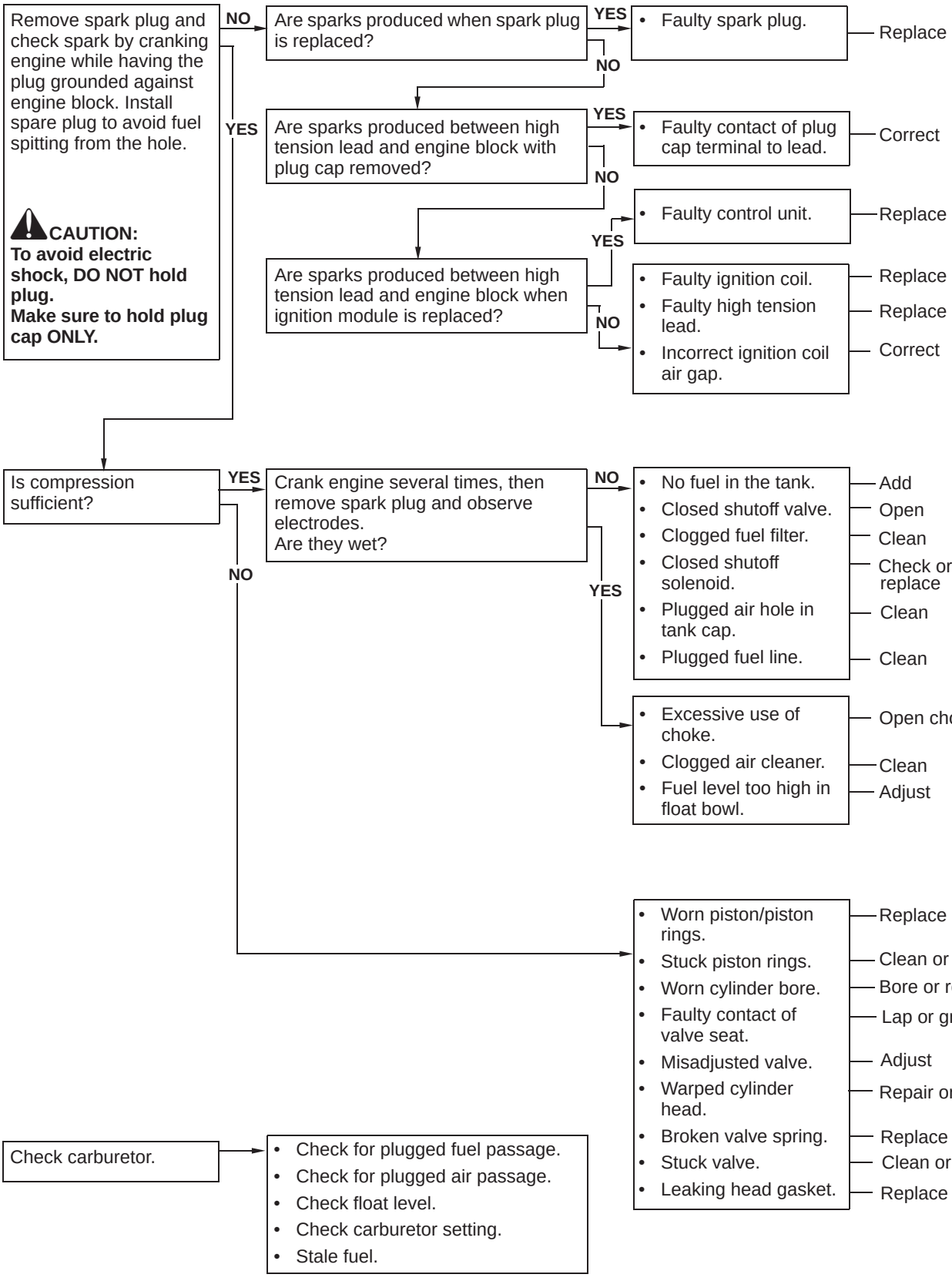
PROBLEM OR SYMPTOM / CHECK OR SOLUTION	Engine cranks but will not start or starts hard.	Engine will not stay running, runs rough, or irratic.	Engine dies frequently.	Engine backfires.	Engine surges, or has uneven or uncontrolled rpm.	Low or loses coolant.	Engine has low power.	Engine has no spark.	Engine will not crank.	Lack of fuel in carburetor.	Engine floods.	Exhaust smoke black or uses too much fuel.	Exhaust smoke blue or has excessive oil consumption.	Engine has low oil pressure.	Fuel in oil.	Engine overheats.	Excessive engine noise or vibration.
Spark plug fouled, defective, gap not correct or incorrect spark plug.	●	●	●				●	●			●	●	●		●	●	
Defective ignition components.	●	●	●	●	●		●	●			●	●			●		
Starter worn. Cranking rpm too slow.	●																
In-line fuel shutoff valve not open or fuel tank empty.	●	●								●							
Fuel filter or line restricted. Fuel pump restricted, or leaking.	●	●	●		●		●			●							
Fuel stale, contains water, or wrong type.	●	●	●		●		●					●					
Fuel pump not operating.	●	●	●		●		●			●							
Air filter element(s) plugged, oil soaked, or restricted.	●	●	●		●		●				●	●			●		
Choke, throttle, governor linkage or carburetor misadjusted.	●	●	●	●	●		●				●	●			●		
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets.	●	●	●		●		●				●	●			●		
Carburetor, intake manifold, or cylinder head gaskets leaking or damaged.	●	●	●	●	●		●									●	●
Low compression from worn piston, rings, cylinder, valves, low vacuum or warped head.	●	●	●		●		●						●		●		●

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART, continued

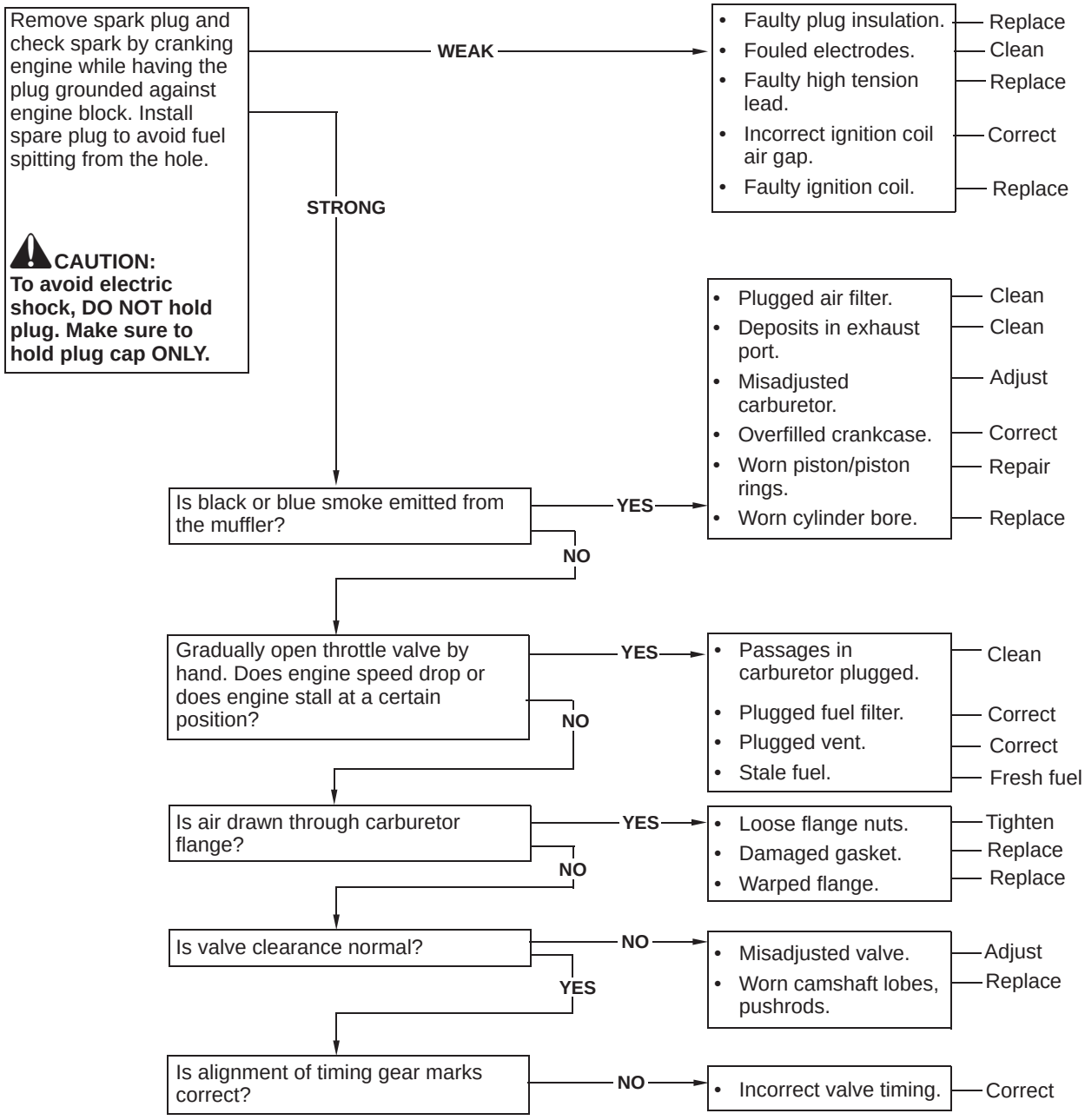
PROBLEM OR SYMPTOM / CHECK OR SOLUTION	Engine cranks but will not start or starts hard.	Engine will not stay running, runs rough, or irractic.	Engine stalls frequently.	Engine backfires.	Engine surges, or has uneven or uncontrolled rpm.	Low or loses coolant.	Engine has low power.	Engine has no spark.	Engine will not crank.	Lack of fuel in carburetor.	Engine floods.	Exhaust smoke black or uses too much fuel.	Exhaust smoke blue or has excessive oil consumption.	Engine has low oil pressure.	Fuel in oil.	Engine overheats.	Excessive engine noise or vibration.
Valve clearance incorrect. Burned or warped valves and seats. Defective springs. Defective ACR.	●	●	●	●	●		●				●	●			●	●	●
Engine oil viscosity or level incorrect. Engine oil filter restricted.	●								●				●	●		●	●
Engine gaskets or seals leaking.	●	●	●	●	●		●							●			●
Crankcase breather restricted, reed valve damaged, clearance incorrect, or drain hole plugged.	●	●	●		●		●						●			●	
Valve guides or seals worn or leaking. Valve stems worn.	●	●	●	●	●		●				●	●	●	●	●	●	●
Connecting rod or crankshaft bearings worn. Internal wear limits out of specification	●	●	●	●	●		●							●		●	●
Battery cables corroded or loose, or battery weak		●	●					●	●								
Clogged radiator and/or defective thermostat						●										●	
Weak coolant						●										●	
Coolant pump impeller																●	
Leak in cooling system						●										●	
Defective radiator cap						●										●	

ENGINE TROUBLESHOOTING GUIDE

Engine Hard To Start



Engine Malfunctions at Low Speed



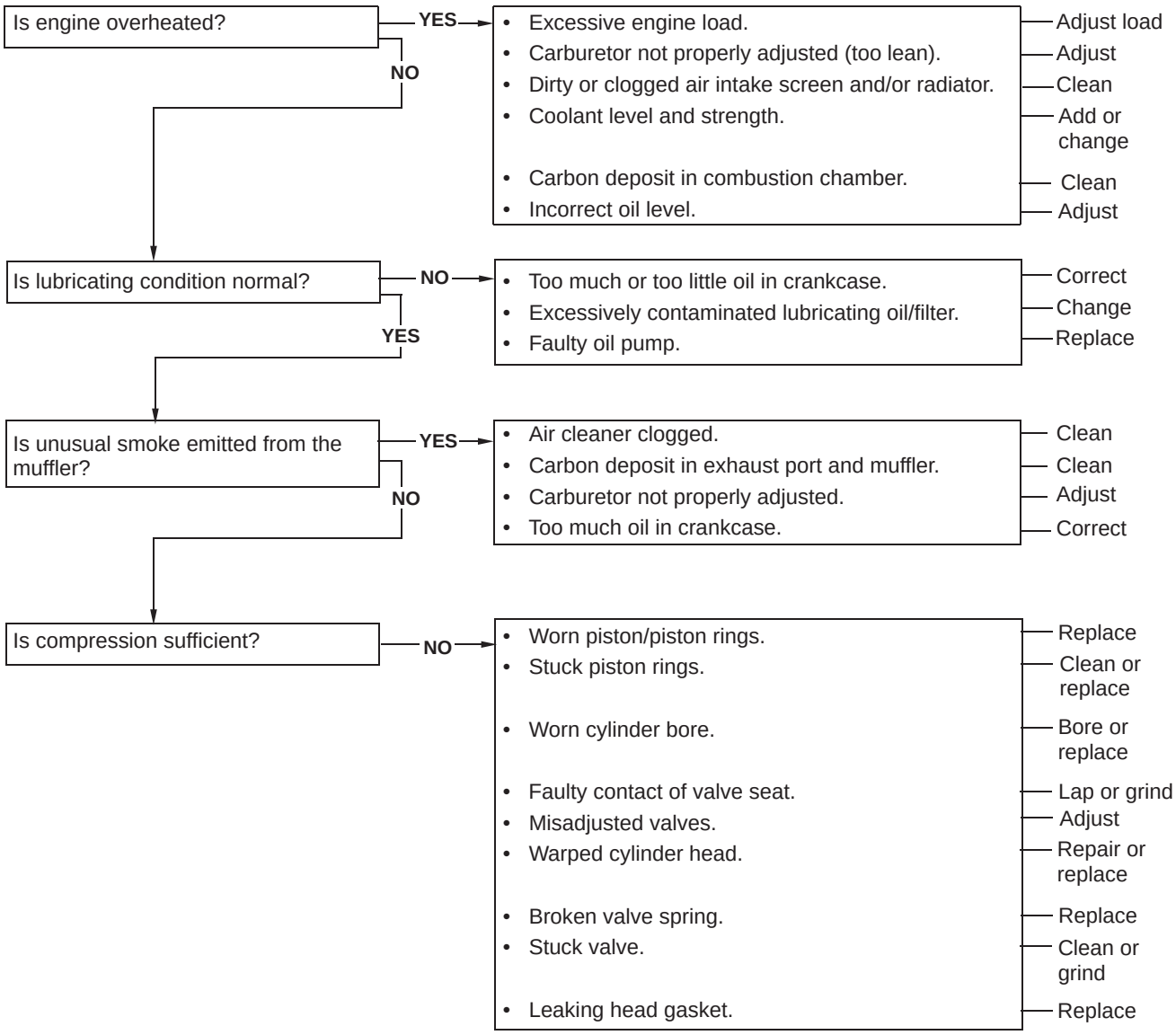
Engine Runs Erratically

Problem in fuel system (lack of fuel).	• Dust or water in fuel line or fuel filter.	— Clean
	• Air or vapor lock in fuel line.	— Remove
	• Plugged air vent in fuel tank cap.	— Clean
	• Plugged air/fuel passages in carburetor.	— Clean
	• Too little opening of carburetor pilot air-screw.	— Correct
	• Stale fuel.	— Fresh fuel
Problem in governor system.	• Incorrect governor linkage adjustment.	— Correct
	• Faulty governor spring.	— Replace
	• Governor gear assembly malfunction.	— Check
Engine knocks.	• Stale fuel.	— Fresh fuel
	• Excessive carbon deposit in engine.	— Clean
	• Excessive engine load.	— Adjust
	• Engine overheating.	— See **Has Low Power**

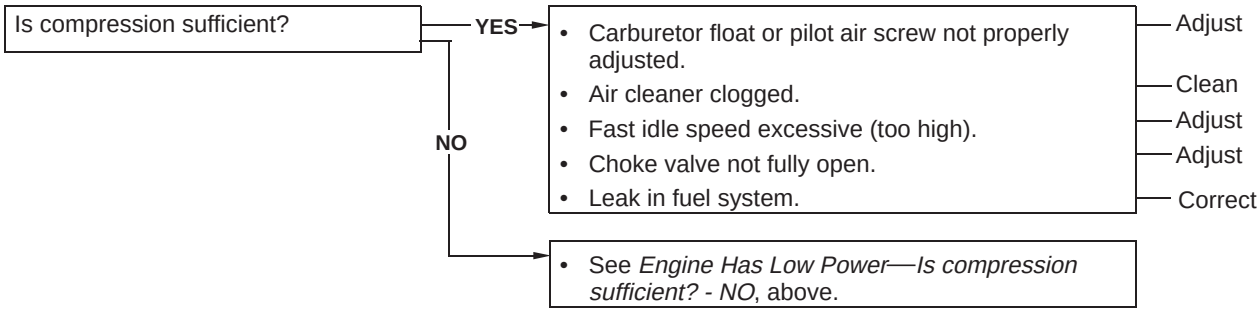
Oil Consumption Is Excessive

Is compression sufficient?	**YES**	• Plugged oil ring groove.	— Clean
		• High oil level.	— Adjust
		• Worn valve stems and valve guides.	— Replace
		• Oil leakage along governor shaft.	— Replace
		• Oil seals leaking.	— Replace
		• Head gasket leaking.	— Replace
		• Drain plug leaking.	— Retighten or replace
		• Breather valve clogged.	— Clean
		• Drain-back hole in tappet chamber plugged.	— Clean
		• Incorrect oil viscosity.	— Change
	NO	• Worn piston/piston rings.	— Replace
		• Stuck piston rings.	— Clean or replace
		• Worn cylinder bore.	— Bore or replace
		• Faulty contact of valve seat.	— Lap or grind
		• Misadjusted valves.	— Adjust
		• Warped cylinder head.	— Repair or replace
		• Broken valve spring.	— Replace
		• Stuck valve.	— Clean or grind
		• Leaking head gasket.	— Replace

Engine Has Low Power



Fuel Consumption Is Excessive



STARTER MOTOR TROUBLESHOOTING GUIDE

1.Disconnect spark plug cap, and ground the cap terminal.

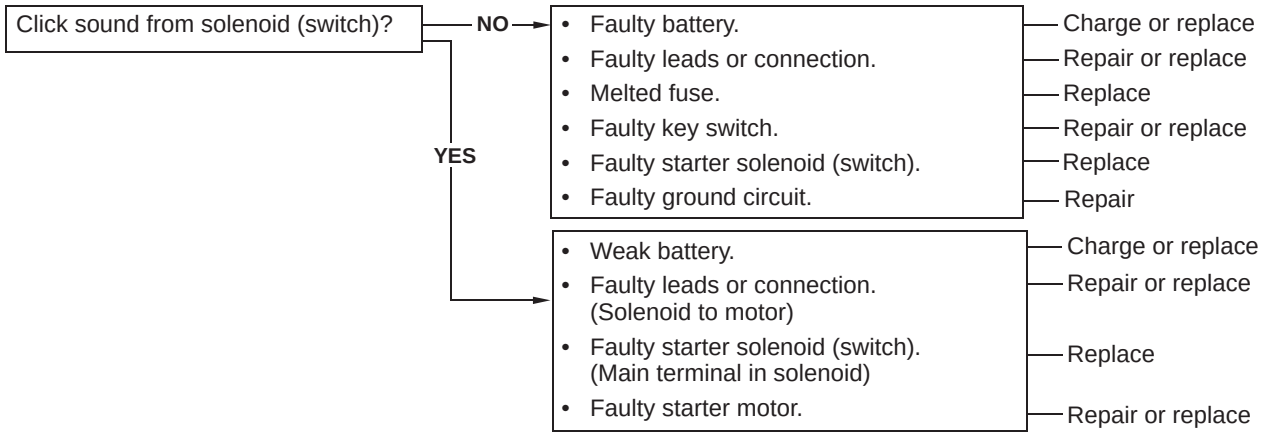
2.Turn key switch to START position and check starter condition.

⚠ CAUTION

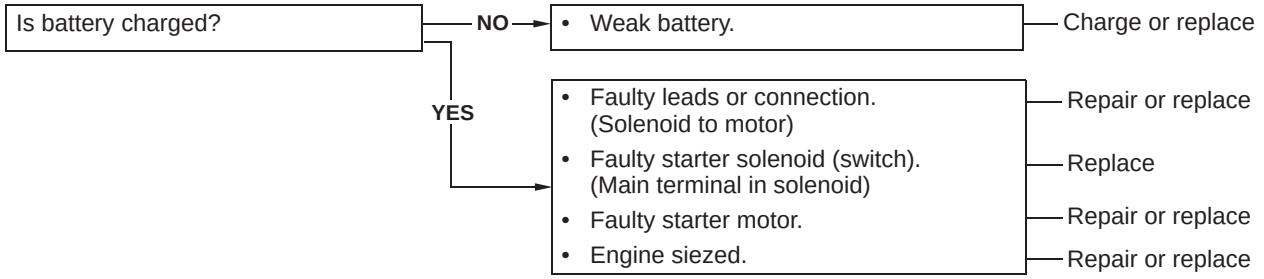
Engine may be cranked in this test. DO NOT touch any rotating parts of engine and equipment during test.

IMPORTANT: If starter does not stop when key switch is in off position, disconnect negative (–) lead from battery as soon as possible.

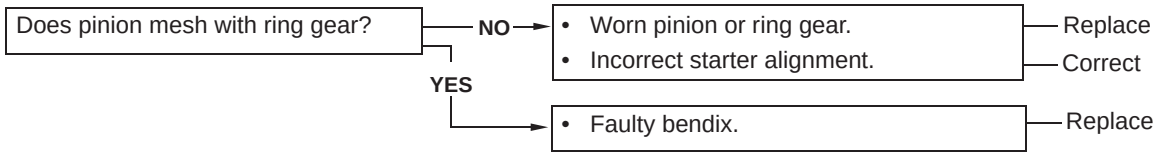
Starter Does Not Rotate



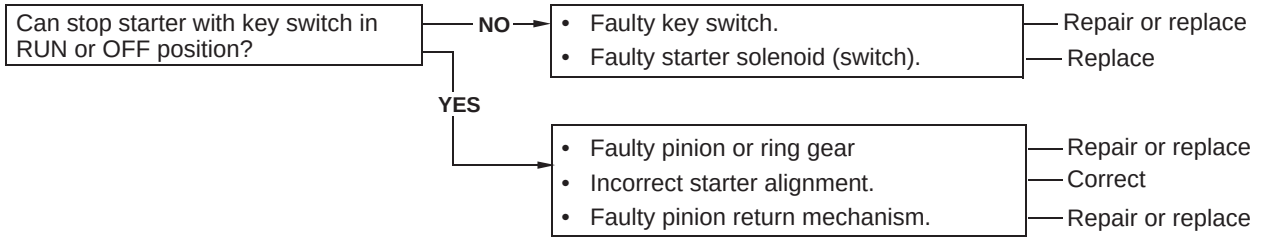
Starter Rotates Slowly



Starter Rotates But Can Not Crank Engine



Starter Does Not Stop With Key Switch In RUN or OFF Position



TESTS AND ADJUSTMENTS

THROTTLE CABLE TEST AND ADJUSTMENT

Reason:

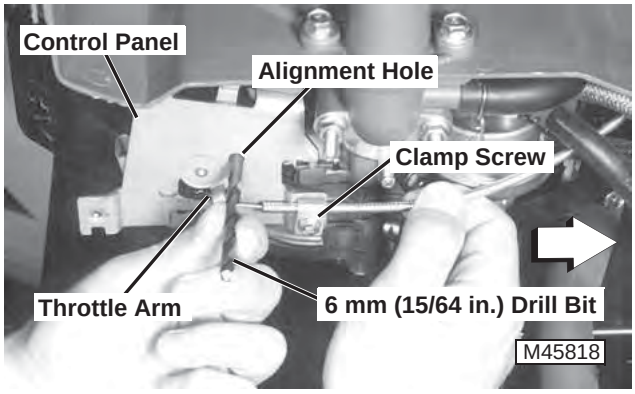
To make sure throttle cable has all slack remove, obtains full range of travel, and control lever contacts the slow idle stop at slow idle position.

Equipment:

- 6 mm (15/64 in.) Drill Bit or
- 6 x 30 mm Flat Head Pin (45M7036)

Test Procedure:

1. Remove hood and heat shield.
2. Move throttle control lever from SLOW idle to FAST idle position. A solid "detent" should be felt to assure that the control lever is in the FAST idle position.



3. Check holes in control panel and throttle arm. They MUST be in visual alignment.
4. Move throttle control lever into CHOKE position, then back into FAST idle position. Again, holes in control panel and throttle arm MUST be aligned.

Results:

- If holes align in positions, throttle cable is adjusted properly.
- If holes DO NOT align in either position, perform Adjustment Procedure.

Adjustment Procedure:

1. Move throttle control lever to FAST idle position.
2. Loosen clamp screw.
3. Align hole in throttle arm with hole in control panel. Insert a 6 mm (15/64 in.) drill bit or 6 x 30 mm flat head pin (45M7036) through holes to keep throttle arm from moving. Be sure drill bit is perpendicular to the control panel.
4. Pull throttle cable toward carburetor (arrow) and tighten screw.
5. Remove drill bit.
6. Repeat CHECK procedure.
7. Move throttle control lever through full range to be sure linkage is not binding.
8. Move throttle lever to the slow idle position. Be sure the throttle valve tab on the carburetor contacts the slow idle stop screw before the throttle lever bottoms out. (See SLOW IDLE SPEED ADJUSTMENT on page 3-103 or 3-104.)

CHOKE PLATE TEST AND ADJUSTMENT

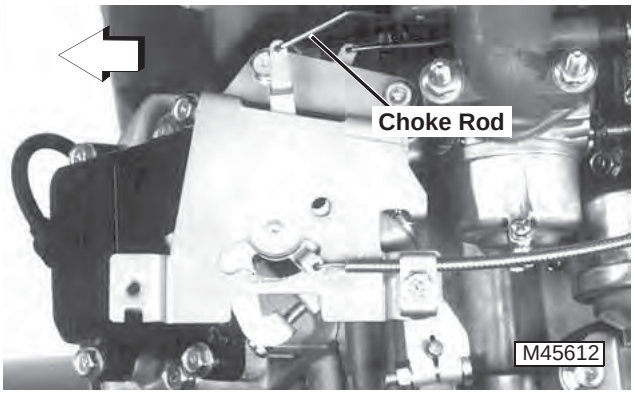
Reason:

To make sure that the choke plate is fully closed when the throttle control lever is in the full choke position and does not stay partially closed when the throttle control lever is in the fast idle position.

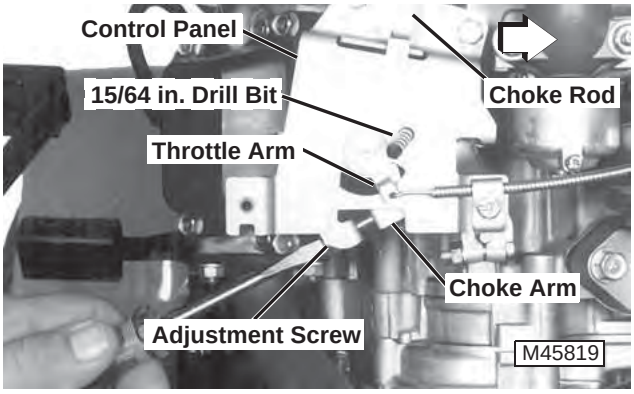
Test Procedure:

IMPORTANT: Check and adjust throttle cable before adjusting choke, to ensure accurate choke adjustment.

1. Check and adjust throttle cable.
2. Move throttle control lever to full CHOKE position.



3. Try to move choke rod away from carburetor (arrow). Choke rod should NOT move. If choke rod moves to the left, the choke plate is NOT fully closed.
4. Move throttle control lever to FAST idle position.



5. Check holes in control panel and throttle arm. They MUST be in visual alignment. Check for gap between adjustment screw and choke arm.
6. Try to move choke rod toward carburetor (arrow). Choke rod should not move. If choke rod moves to the **right**, the choke plate is not fully open.

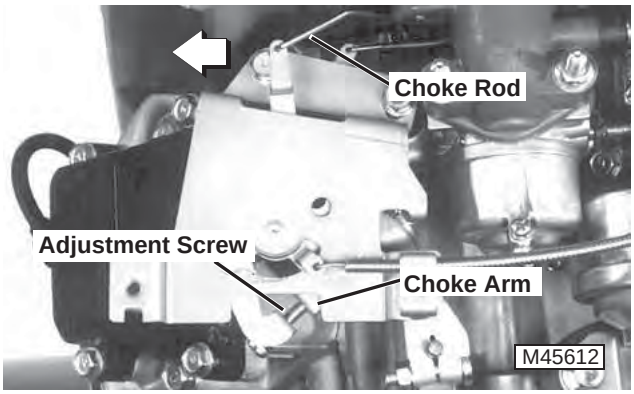
Results:

- If choke rod DOES NOT move in either direction with the throttle control lever in the specific positions, choke operation is functioning properly.
- If choke rod MOVES in either direction with throttle control lever in the specific positions, perform Adjustment Procedure.

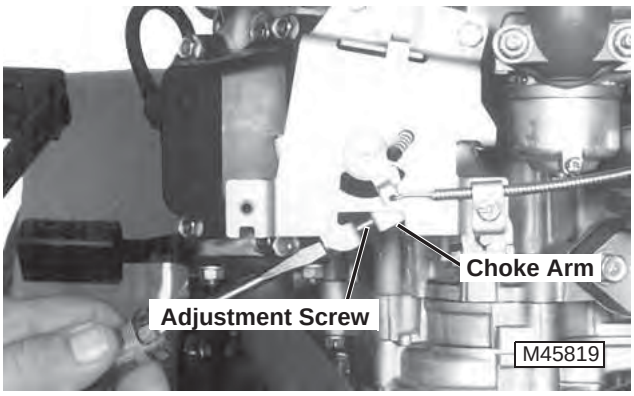
Adjustment Procedure:

If choke plate is not closed when the throttle control is in full choke position:

1. Move throttle control lever to full CHOKE position.



2. Push and hold choke rod away from carburetor (arrow) to close choke plate.
3. Turn adjustment screw (on backside of control panel) clockwise until it is tight against choke arm.
4. Move throttle control lever to FAST idle position.



*NOTE: Amount of gap may vary from approximately **0.25—3.0 mm (0.01—0.12 in.)**.*

5. Check for "gap" between adjustment screw and choke arm. Amount of gap should be approximately **0.25—3.0 mm (0.01—0.12 in.)**.
6. Repeat Test Procedure.

GOVERNOR ADJUSTMENT

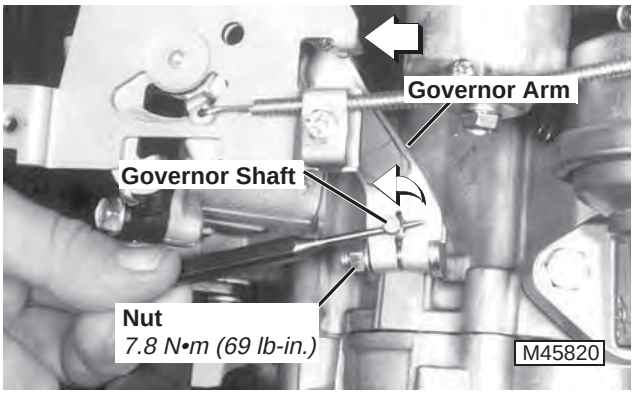
Reason:

To ensure proper operation of the governor.

Procedure:

*NOTE: Adjust throttle cable and choke plate **before** adjusting governor linkage.*

1. Adjust throttle cable and choke plate.
2. Move throttle lever to FAST idle position.



3. Loosen nut.
4. Hold governor arm fully counterclockwise.
5. Using a small pin, rotate shaft counterclockwise as far as it will go. Hold governor shaft and tighten nut to specification.
6. Move throttle lever through full range to be sure linkage is not binding.

FAST IDLE SPEED ADJUSTMENT

Reason:

To set engine fast idle speed.

Equipment:

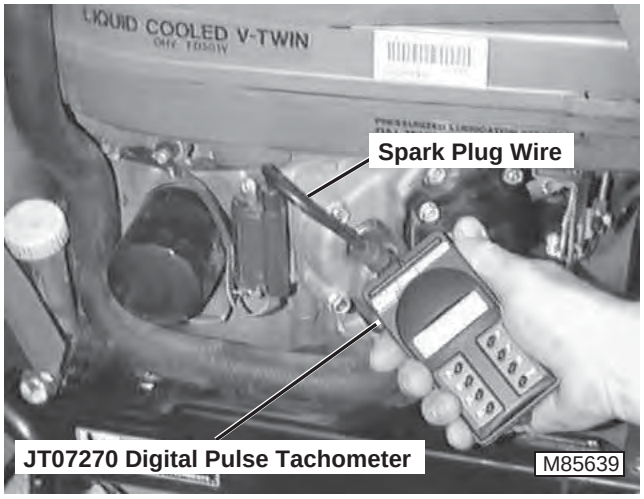
- 6 mm (15/64 in.) Drill Bit or
- 6 x 30 mm Flat Head Pin (45M7036)
- JT07270 Digital Pulse Tachometer

Procedure:

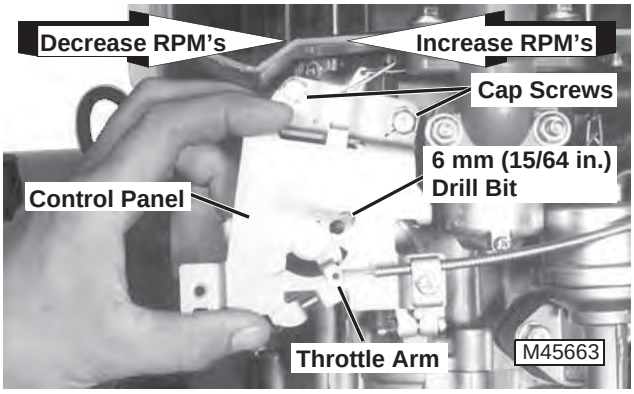
1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
4. Remove muffler heat shield.
5. Start and run engine at MEDIUM idle for 5 minutes.

⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.



6. Use JT07270 Digital Pulse Tachometer at spark plug wire.



7. Align hole in throttle arm with hole in throttle control panel. Insert a 6 mm (15/64 in.) drill bit or 6 x30 mm flat head pin (45M7036) through holes to keep throttle arm from moving. Be sure bit or pin is perpendicular to the throttle control panel.
8. Adjust engine rpm using JT07270 Digital Pulse Tachometer.

Specifications:

FAST Idle Speed Settings:

FD440V . . . . . 3400 ±100 rpm
FD501V . . . . . 3550 ±100 rpm

Results:

- If fast idle speed does not meet specifications:
- Loosen cap screws.
- Move throttle control panel away from carburetor to increase rpm or toward carburetor to decrease rpm.
- Hold throttle control panel and tighten cap screws.
- Remove drill bit.

SLOW IDLE SPEED ADJUSTMENT NON CARB/EPA ENGINES

NOTE: For engines WITHOUT California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Carburetors.

ENDING ENGINE SERIAL NUMBERS:
FD440V—CS00 . . . . . (FD440V —043352)
FD501V—CS00 . . . . . (FD501V —051078)

Reason:

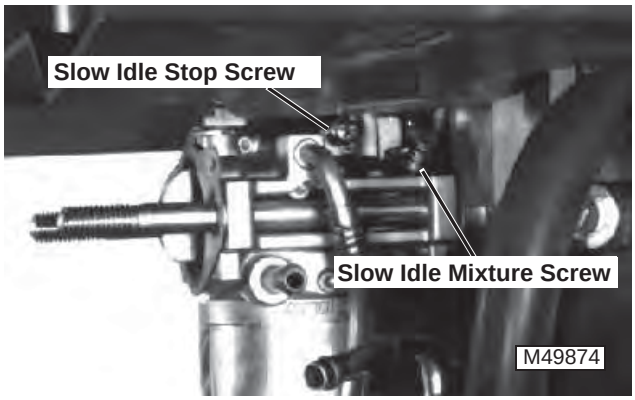
To properly adjust engine SLOW idle mixture and rpm settings.

Equipment:

- JT07270 Digital Pulse Tachometer

Procedure:

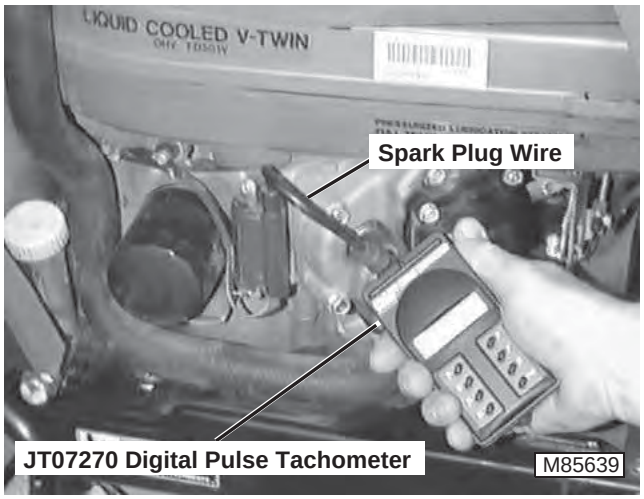
1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
4. Remove muffler heat shield.



IMPORTANT: Forcing the idle mixture screw tight will damage the needle and seat.

NOTE: Breather assembly and fuel line removed for clarity only. DO NOT remove for adjustment.

5. Turn SLOW idle mixture screw clockwise until lightly seated, then turn counterclockwise 1-1/8 turns (FD440V) or 1-3/8 turns (FD501V).
6. Start and run engine at MEDIUM idle for five minutes to obtain normal operating temperature.
7. Move throttle control lever to SLOW idle position.



8. Use JT07270 digital pulse tachometer at spark plug wire.
9. Turn SLOW idle stop screw until SLOW idle speed is **1400 rpm** to remove governor action.
10. Turn SLOW idle mixture screw clockwise until engine speed drops, note position.
11. Then turn screw counterclockwise until engine speed increases and begins to drop again, note position.
12. Turn SLOW idle mixture screw midway between drop points.
13. Use JT07270 digital pulse tachometer at spark plug wire to adjust SLOW idle mixture screw to a SLOW idle speed setting of **1450 ±75 rpm**.
14. Adjust SLOW idle stop screw to set carburetor SLOW idle speed at **1550 ±75 rpm** (**100 rpm** higher than SLOW idle mixture screw setting).
15. Install muffler heat shield and engine hood.

SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES

NOTE: For California Air Resources Board/ Environmental Protection Agency (CARB/EPA) Emissions Carburetors.

BEGINNING ENGINE SERIAL NUMBERS:

FD440V—CS00 . . . . . .(FD440V043353–)
FD501V—CS00 . . . . . .(FD501V051079–)

CARBURETOR PART NUMBERS:

FD440V—CS00 32361
FC501V—CS00 32362

ATTENTION!

DO NOT attempt to adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Reason:

To properly adjust engine SLOW idle mixture and rpm speed settings. This insures that engines with CARB/EPA Certified Emissions Carburetors meet the CARB/EPA emissions requirements.

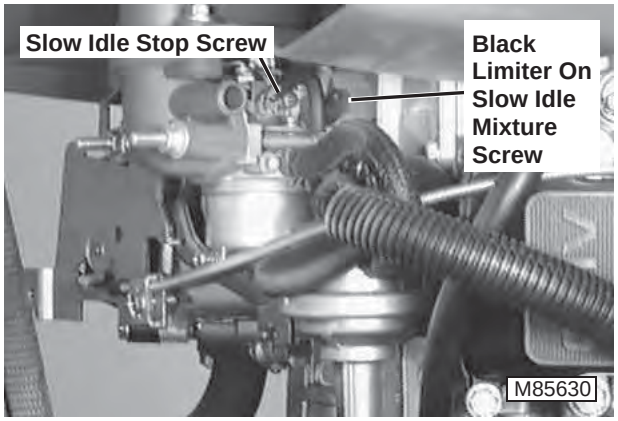
Equipment:

- JT07270 Digital Pulse Tachometer

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
4. Remove muffler heat shield.

NOTE: Breather assembly and fuel line removed for clarity only. DO NOT remove for adjustment.



5. Carefully remove black limiter from SLOW idle mixture screw.

IMPORTANT: Forcing the slow idle mixture screw tight will damage the needle and seat.

6. Turn flats of SLOW idle mixture screw clockwise until lightly seated, then turn counterclockwise to following specifications:

Specifications:

FD440V–CS00 . . . . . 1 11/16 Turns
FD501V–CS00 . . . . . 1 3/8 Turns

7. Start and run engine at MEDIUM idle for five minutes to obtain normal operating temperature.
8. Move throttle control lever to SLOW idle position.
9. Use JT07270 Digital Pulse Tachometer at spark plug wire to adjust carburetor SLOW idle stop screw until SLOW idle speed is set at **1400 rpm** to remove governor action.
10. Turn SLOW idle mixture screw clockwise until engine speed drops, note position.
11. Then turn screw counterclockwise until it increases and drops again, note position.
12. Turn screw clockwise again to midway between drop points.
13. Use JT07270 Digital Pulse Tachometer at spark plug wire to adjust SLOW idle mixture screw to a SLOW idle speed setting of **1450 ±75 rpm**.
14. Without moving screw, carefully install black limiter on SLOW idle mixture screw so limiter stops are centered on carburetor housing limiter stop tab. Now SLOW idle mixture screw can be fine tuned ONLY to limits allowed by black limiter cap.
15. Turn carburetor SLOW idle stop screw to a SLOW idle speed setting of **1550 ±75 rpm** (**100 rpm** higher than SLOW idle mixture screw).
16. Install muffler heat shield and engine hood.

CYLINDER COMPRESSION PRESSURE TEST

Reason:

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

NOTE: Unlike single cylinder engines, these two engines DO NOT have an ACR mechanism; therefore, this test will indicate actual compression readings.

Test Equipment:

- JDM59 Compression Gauge

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise or remove engine hood.

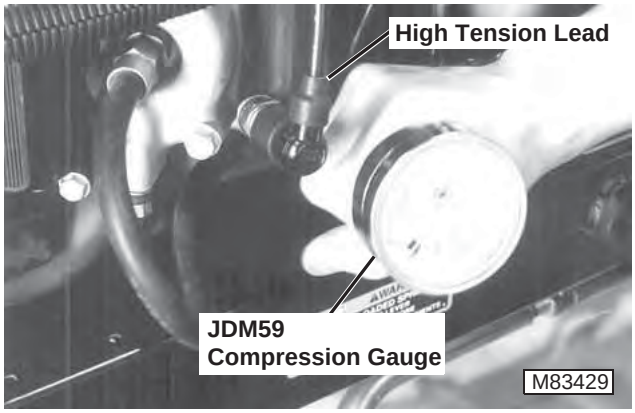
IMPORTANT: Proper valve adjustment is essential to obtain an accurate compression reading. Before performing cylinder compression pressure test, DO verify valve clearances while engine is cold [15–30°C (60–85°F)].

6. Verify valve clearances. (See VALVE CLEARANCE TEST AND ADJUSTMENT on page 3-106.)
7. Run engine for 5 minutes to bring engine to operating temperature.

⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.

8. Remove both spark plugs.



9. Install JDM59 Compression Gauge in one spark plug hole.
10. To protect ignition system, ground both spark plug wires or disconnect positive lead from both ignition coils.
11. Move throttle control lever to FAST idle position—carburetor throttle and choke plates must be fully open to obtain an accurate reading.

IMPORTANT: DO NOT overheat starting motor during test. Starter duty cycle is 5 seconds ON, 10 seconds OFF. Battery must be at a full state of charge—charge battery first, if necessary.

12. Crank engine until gauge needle settles out at its highest position.
13. Record pressure reading.
14. Repeat test for other cylinder and compare readings to specifications.

Specifications:

Minimum Compression . . . . . 1171 kPa (170 psi)
Maximum Difference between Cylinders . . . . . 97 kPa (14 psi)

Results:

NOTE: Above specifications are for an engine that has had sufficient time to allow rings to fully seat.

Compression that is lower than specifications on low hour machines (but relatively equal on both cylinders) does not indicate a problem.

- If compression reading is **below** minimum specification, squirt clean engine oil into cylinder and repeat test.
- If after retest compression pressure DOES NOT increase - check for leaking intake or exhaust valves, valve seats, or cylinder head gaskets. Replace parts as necessary.
- If after retest compression pressure INCREASES more than 138 kPa (20 psi)—check rings, pistons, and cylinder bores for broken rings, scoring, excessive wear, or other damage. Replace parts as necessary.

VALVE CLEARANCE TEST AND ADJUSTMENT

Reason:

To ensure proper opening and closing of the intake and exhaust valves.

Equipment:

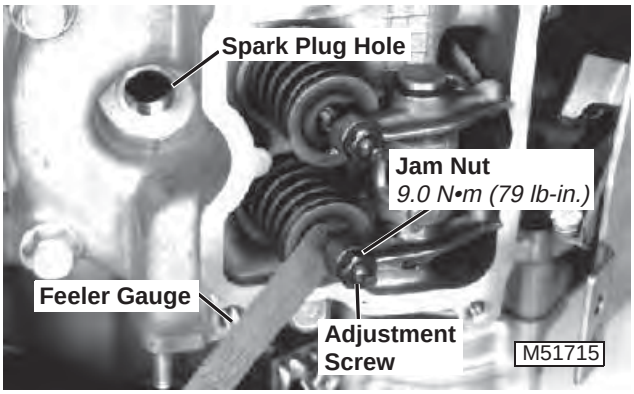
- Feeler Gauge (blade-type)

Procedure:

IMPORTANT: Make adjustment when engine is cold [15–30°C (60–85°F)].

NOTE: Check valve clearance for each cylinder separately.

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise engine hood.
6. Remove spark plugs.
7. Remove valve covers.



8. Turn crankshaft until piston, visible in spark plug hole, is at Top Dead Center (TDC) of the compression stroke (both intake and exhaust valves will be closed).
9. Use a blade-type feeler gauge to measure valve clearance. Valve clearance should be **0.15 mm (0.006 in.)**.

Specifications:

Valve Clearance (cold) . . . . . 0.15 mm (0.006 in.)
Jam Nut Torque . . . . . 9.0 N•m (79 lb-in.)
Valve Cover Cap Screw Torque . . . . . 6.0 N•m (53.0 lb-in.)
Spark Plug Torque . . . . . 20 N•m (177 lb-in.)

Results:

- If valve clearance DOES NOT meet specifications, loosen the jam nut. Turn adjustment screw to adjust valve clearance to specifications. Hold screw and tighten nut to specifications. Check clearance again.

CRANKCASE VACUUM TEST

Reason:

To check operation of the breather and condition of seals, gaskets, rings, pistons, and cylinder walls.

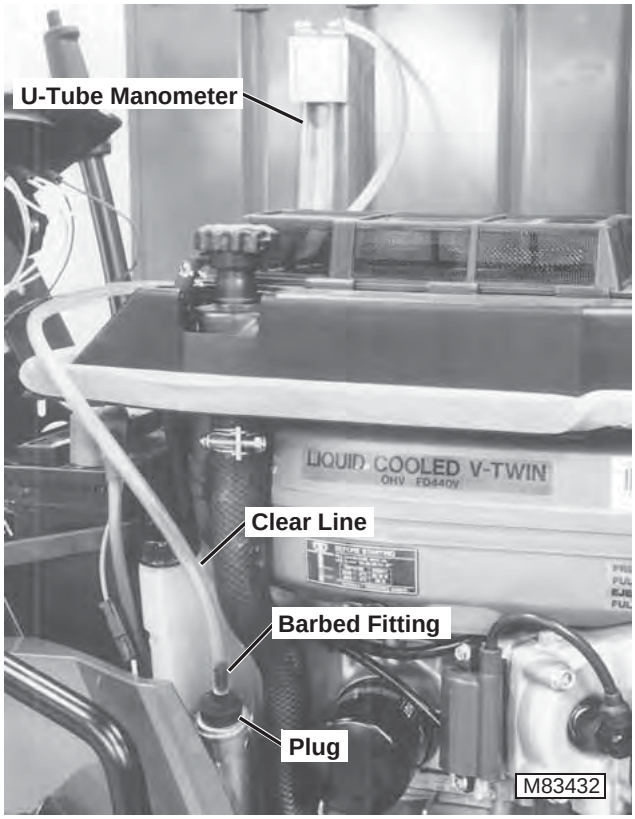
Test Equipment:

- JT05697 U-Tube Manometer Test Kit or
- JT03503 Crankcase Vacuum Test Kit

Procedure:

JT05697 U-Tube Manometer Test Kit—

1. Park machine on level surface.
2. Raise engine hood.



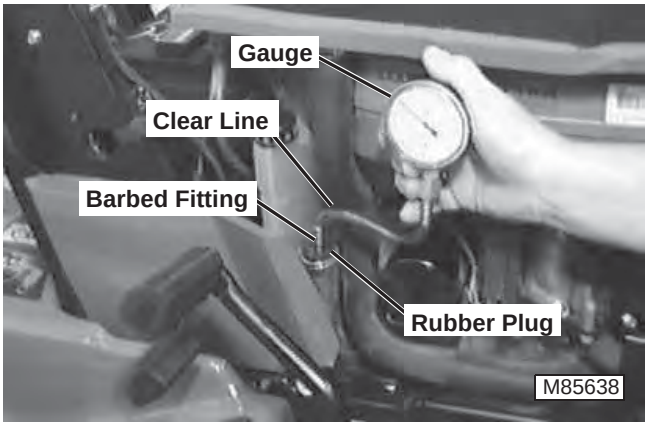
3. Remove dipstick and install appropriate size plug.
4. Insert large diameter end of barbed fitting into clear line.
5. Insert other end of barbed fitting into plug in dipstick tube.
6. Align ruler “zero” markings with top of water level in u-tube.

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

DO NOT turn engine OFF until line has been disconnected from Manometer.

7. Run engine at FAST idle.
8. Connect clear line to manometer.
9. Record crankcase vacuum reading. Manometer should show a **minimum of 15 cm (6 in.) of water movement**.
10. Run engine at SLOW idle. **DO NOT TURN ENGINE OFF!**
11. Disconnect line from Manometer.
12. Turn engine OFF.
13. Remove plug from dipstick tube and install dipstick.

JT03503 Crankcase Vacuum Test Kit—



1. Repeat Steps 1–3 in JT05697 test procedure.

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

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

2. Assemble gauge, clear line, and barbed fitting on workbench.
3. Hold finger over rubber plug hole to keep oil from spraying out. Start engine and run at FAST idle.
4. Connect gauge, clear line, and barbed fitting to rubber plug.
5. Record crankcase vacuum reading. Gauge should show a **minimum of 15 cm (6 in.) of vacuum**.

6. Disconnect barbed fitting, clear line, and gauge from rubber plug WHILE engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
7. Move throttle to SLOW idle and turn engine OFF.
8. Remove rubber plug and install dipstick.

Results:

- If crankcase vacuum is BELOW specification, check the following:
  - Breather reed valve clearance and condition.
  - Breather port is obstructed.
  - Rings, piston, and cylinder bore for wear or damage.

ENGINE OIL PRESSURE TEST

Reason:

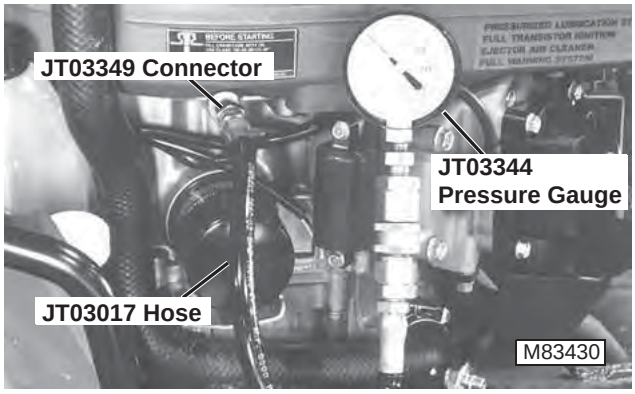
To verify if the engine has enough oil pressure to lubricate internal components.

Test Equipment:

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

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF. Allow engine to cool.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Raise engine hood.
6. Check engine oil level, bring level to full mark.
7. Disconnect oil pressure switch wiring lead.
8. Remove oil pressure switch.



9. Install JT03349 Connector.
10. Connect JT03017 Hose Assembly and JT03344 Pressure Gauge Assembly.
11. Monitor oil pressure while cranking engine. If no oil pressure is present, discontinue cranking engine. Determine and correct cause before running engine.

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

12. Start and run engine at Medium idle for five minutes to heat engine oil to normal operating temperature.

⚠ 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.

13. Run engine at FAST idle [**3400 ± 75 rpm (FD440V) or 3550 ± 75 rpm (FD501V)]** and check oil pressure. Gauge should read a **minimum oil pressure of 276 kPa (40 psi)**.

Results:

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

FUEL PUMP TESTS

Reason:

To check condition of fuel pump.

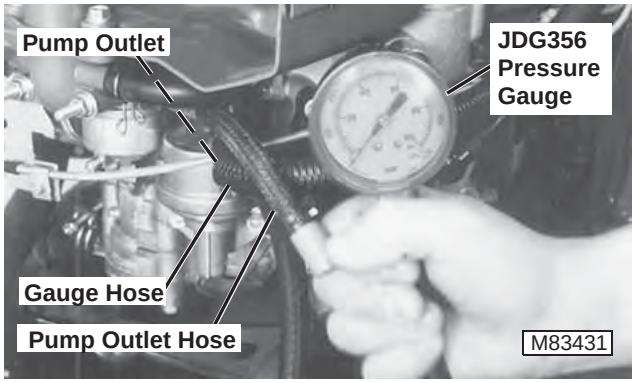
Test Equipment:

- JDG356 Pressure Gauge
- Graduated Container

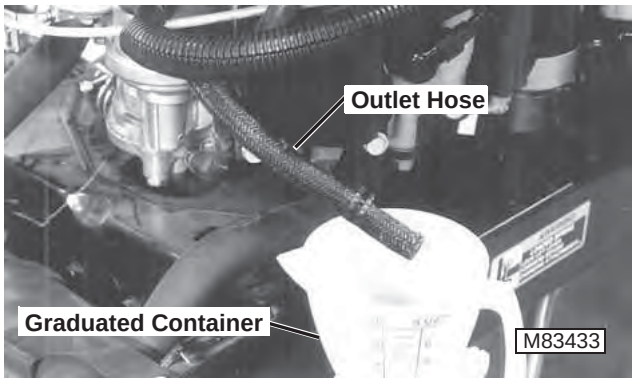
Procedure:

1. Park machine on level surface.
2. Move forward/reverse pedals to NEUTRAL position.
3. Engage park brake.
4. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)

5. Remove muffler heat shield.
6. Start engine and run at SLOW idle **(1550 ±75 rpm**) for one minute to fill carburetor with fuel.
7. Stop the engine.



8. Disconnect fuel pump outlet hose from fuel pump.
9. Connect JDG356 Pressure Gauge hose to fuel pump outlet.
10. Start and run engine at SLOW idle (1550 ± 75 rpm) for 15 seconds. **Minimum pressure should be 2.45 kPa (0.36 psi)**.
11. Stop engine and remove pressure gauge and connect fuel pump outlet hose to fuel pump outlet.



12. Disconnect fuel pump outlet hose from carburetor and place it in graduated container.
13. Start and run engine at SLOW idle (1550 ±75 rpm) for 60 seconds, then stop engine and record container measurement. **Minimum Flow should be 800 mL/60 seconds (0.8 qt/60 seconds)**.

Results:

- If fuel pressure and/or flow does not meet specifications, check the following:

- Fuel lines, filter, shut-off valve, and fuel tank cap for restrictions.
- Replace fuel pump.
- Check camshaft lobe and retest.

SPARK TEST

Reason:

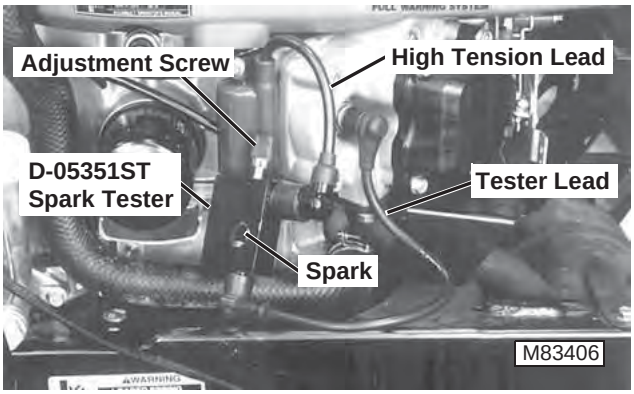
To check overall condition of ignition system.

Test Equipment:

- D-05351ST Spark Tester

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage park brake.
5. Disengage PTO.
6. Raise engine hood.



7. Disconnect high tension lead from spark plug.
8. Connect D-05351ST Spark Tester to spark plug.
9. Connect high tension lead to Spark Tester.

IMPORTANT: DO NOT adjust Spark Tester gap beyond 5.0 mm (0.200 in.) (5 turns), as damage to ignition components could occur.

10. Adjust spark tester gap to **4.2 mm (0.166 in.)** (4 turns) with adjustment screw.
11. Move key switch to RUN position.
12. Spin engine with starter and watch spark at Spark Tester. If engine will start, watch spark with engine running. A steady, strong, blue spark should be observed.

Results:

- If spark is weak, or no spark is present, install a new spark plug and repeat test.
- If spark is still weak, or no spark is present, run tests on individual components to find the cause of the malfunction.

SPARK PLUG GAP ADJUSTMENT

Test Equipment:

- Wire Feeler Gauge

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Move forward/reverse pedals to NEUTRAL position.
4. Engage park brake.

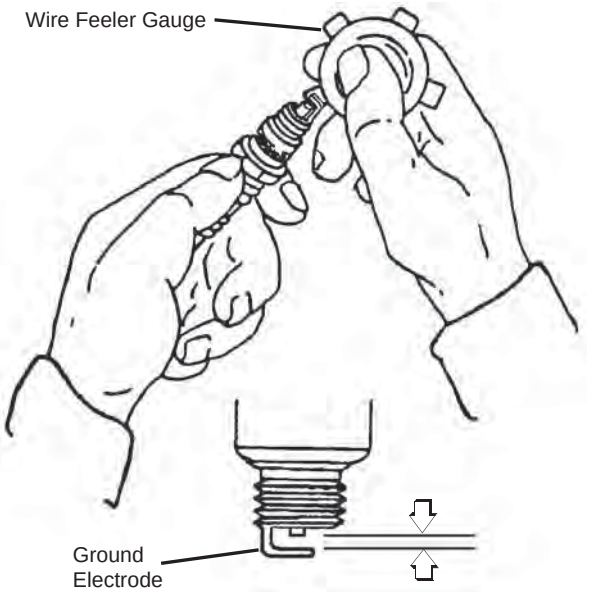
⚠ CAUTION

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

5. Remove spark plug.

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

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



8. Check spark plug gap using a wire feeler gauge.
9. Set gap to **0.6—0.7 mm (0.024—0.028 in.)**.
10. Install and tighten spark plug to **17N•m (150 lb-in.)**.

COOLING SYSTEM PRESSURE TEST

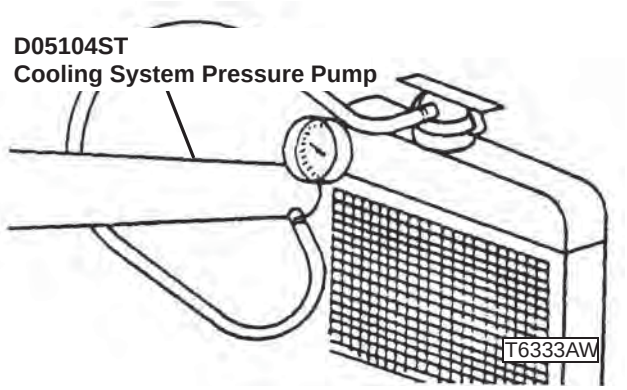
Reason:

To Inspect cooling system for leaks.

Test Equipment:

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

Procedure:



1. Remove radiator cap and attach D05104ST Cooling System Pressure Pump to radiator.

IMPORTANT: DO NOT exceed a maximum pressure of 117 kPa (17 psi) during test or damage to cooling system can occur.

2. Apply **90 kPa (13 psi) pressure** to cooling system. Pressure should hold steady for **minimum of 15 seconds**.

Results:

- Pressure should hold to specifications. If pressure decreases, check for leaks. Repair leaks or replace parts as necessary.
- If pressure test still indicates leakage after all external leaks have been stopped, a defective head gasket, cracked block, or cylinder head may be the cause.

RADIATOR CAP PRESSURE TEST

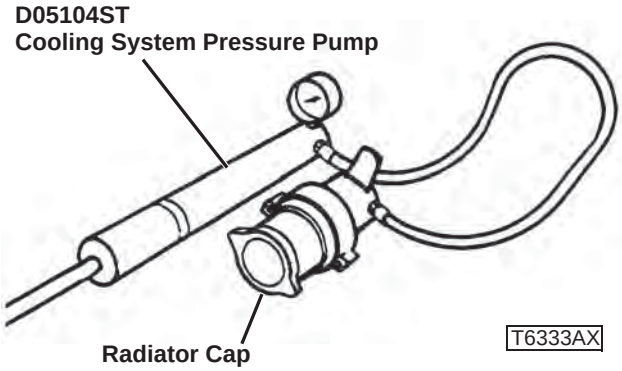
Reason:

To test radiator cap for operation in correct pressure range.

Test Equipment:

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

Procedure:



1. Wet sealing surfaces of radiator cap and install on D0510ST Cooling System Pressure Pump.
2. Apply pressure. Pressure valve in cap should open at **73—103 kPa (10.6—14.9 psi)**.

Results:

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

REPAIR

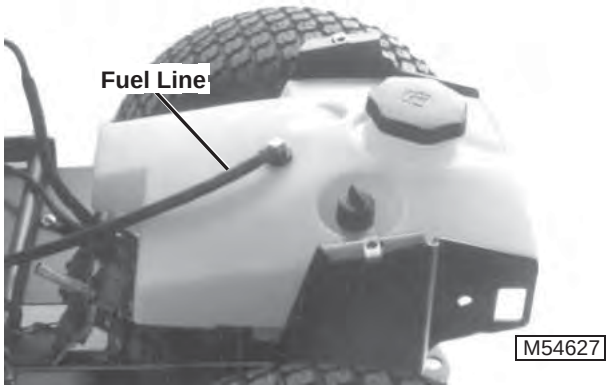
FUEL TANK

Removal/Installation

1. Lower mower deck to the ground.
2. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)

⚠ CAUTION

Gasoline vapor is explosive. DO NOT expose to spark or flame. Serious personal injury can result.



3. Disconnect fuel line.
4. Remove fuel tank.
5. Inspect fuel tank for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

THROTTLE CONTROL LEVER AND CABLE

Removal/Installation

1. Remove steering wheel. (See STEERING WHEEL—Removal/Installation on page 8-8.)
2. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)
3. Disconnect throttle control cable at engine.
4. Remove park brake lever and linkage. (See PARK BRAKE LEVER AND LINKAGE on page 9-25.)
5. Remove indicator lights from sockets.
6. Remove four cap screws and washers securing instrument panel.



7. Remove two cap screws and throttle control lever and cable assembly.

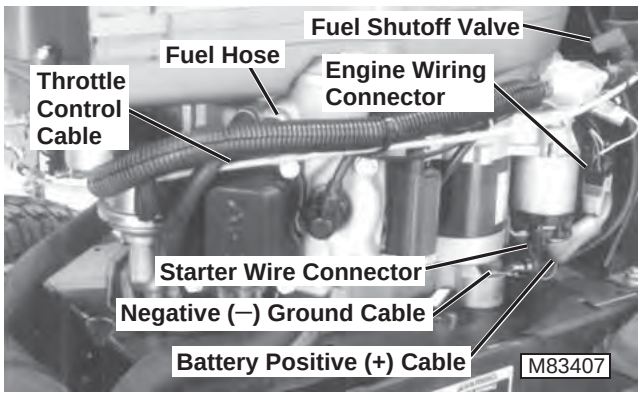
Installation is done in the reverse order of removal.

- Adjust throttle cable and choke plate. (See THROTTLE CABLE TEST AND ADJUSTMENT on page 3-101 and CHOKE PLATE TEST AND ADJUSTMENT on page 3-101.)

ENGINE

Removal/Installation

1. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
2. Disconnect negative (–) battery cable at battery.
3. Remove muffler. (See MUFFLER—Removal/Installation on page 3-114.)
4. Drain engine oil. Capacity is approximately **1.8 L (3.8 U.S. pt)**.
5. Turn fuel shutoff valve to OFF position.



Left-Hand Side

6. On left-hand side of engine, label and disconnect the following:
   - Engine wiring connector.
   - Positive (+) battery cable.
   - Negative (–) ground cable.
   - Starter wiring connector.

CAUTION

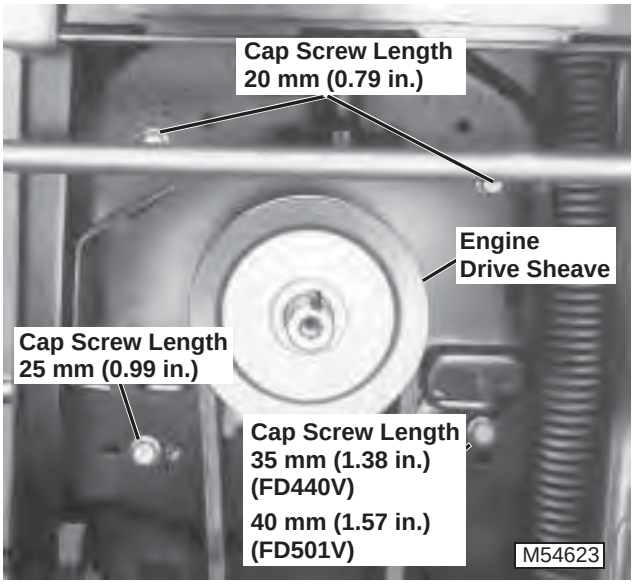
Gasoline vapor is explosive. Do not expose to spark or flame. Serious personal injury can result.

7. Disconnect fuel hose.
8. Disconnect throttle control cable.
9. On FD501V engine, disconnect fuel shutoff solenoid wiring connector.

CAUTION

Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

10. Loosen radiator cap to relieve pressure, then close tightly.
11. Disconnect bypass hose from cylinder head to drain cooling system. Capacity is approximately **2.1 L (2.2 qt.)**
12. Reconnect bypass hose.
13. Remove PTO clutch. (See ELECTRIC PTO CLUTCH—Removal/Installation on page 5-195.)



NOTE: Engage parking brake to relieve tension from drive belt.

14. Engage parking brake.
15. Remove engine drive sheave and key.
16. Remove cap screws.
17. Remove engine.

Installation is done in the reverse order of removal.

- Apply M79292—MPG-2® Multi-Purpose Polymer Grease by DuBois to engine crankshaft before installing PTO clutch.
- Tighten engine mounting cap screws to **34 N•m (300 lb-in.).**
- Fill engine to proper level with oil of correct specifications. (See KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA on page 2-11 or KAWASAKI 4-CYCLE GASOLINE ENGINE OIL—EUROPE on page 2-12.)
- Fill engine cooling system to proper level with coolant of correct specifications. (See GASOLINE ENGINE COOLANT—NORTH AMERICA on page 2-21 or GASOLINE ENGINE COOLANT—EUROPE on page 2-22.)
- Adjust throttle cable and choke plate. (See THROTTLE CABLE TEST AND ADJUSTMENT on page 3-101 and CHOKE PLATE TEST AND ADJUSTMENT on page 3-101.)

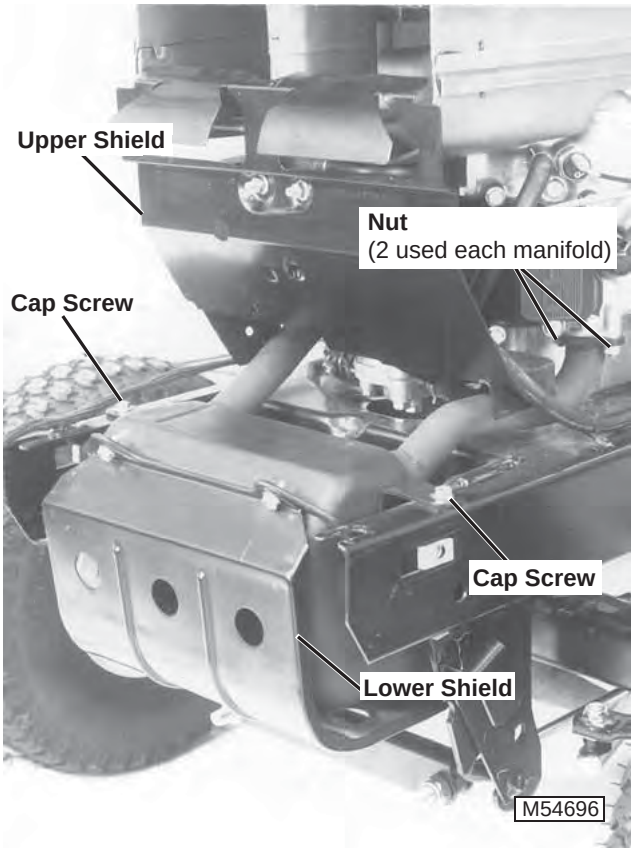
MUFFLER

Removal/Installation

1. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)

⚠ CAUTION

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



2. Remove upper and lower shields.
3. Remove cap screws.
4. Remove nuts and washers from both manifolds.
5. Remove muffler and gaskets. Discard gaskets

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Use standard torque values on this standard hardware.

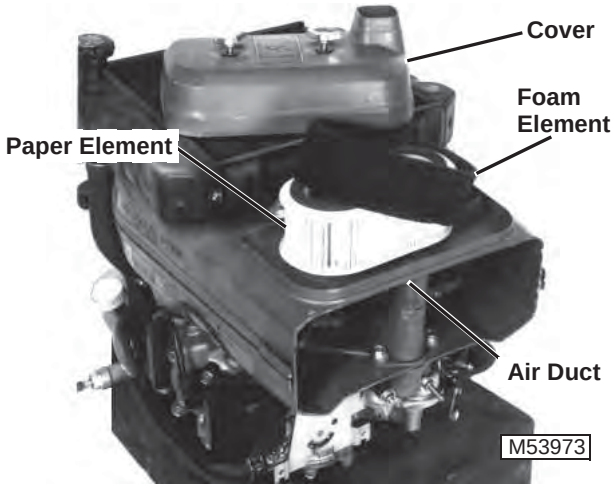
AIR CLEANER

Service

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

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

1. Remove and disassemble air cleaner.



2. Wash foam element in detergent and water. Dry element.
3. Apply 12—15 drops of clean engine oil to foam element. Squeeze out excess oil.

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

4. Gently tap paper element to remove dust.
5. Inspect paper element.
   - Element is still usable if you can see light through it and element appears clean.
   - Replace if oily, dirty, or damaged in any way.
6. Inspect cover and top half of air duct for damage. Replace parts as necessary.
7. Assemble and install air cleaner and cover.

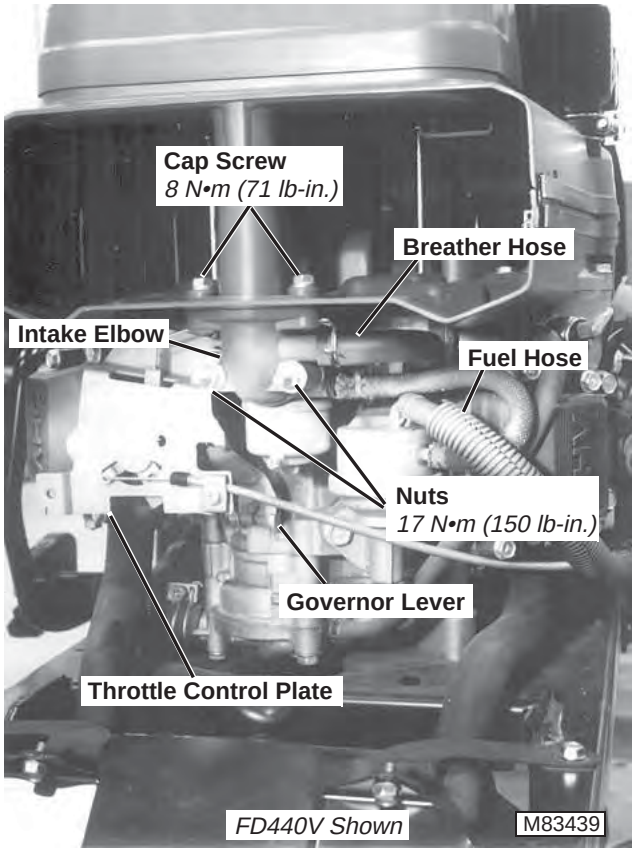
CARBURETOR

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. Drain fuel from carburetor. Wipe-up any spilled fuel IMMEDIATELY.



2. Disconnect breather hose.
3. Remove intake elbow and O-ring.
4. Remove throttle control plate.
5. FD501V Only—Disconnect fuel shutoff solenoid wiring connector.
6. Remove governor lever from governor shaft.
7. Disconnect fuel hose.
8. Remove carburetor and gasket.
9. Remove governor and throttle control plate linkage from carburetor.

Installation is done in the reverse order of removal.

- Adjust governor lever. (See GOVERNOR ADJUSTMENT on page 3-102.)
- Check throttle cable. (See THROTTLE CABLE TEST AND ADJUSTMENT on page 3-101.)
- Check choke plate. (See CHOKE PLATE TEST AND ADJUSTMENT on page 3-101.)
- Set FAST idle speed. (See FAST IDLE SPEED ADJUSTMENT on page 3-103.)
- Set SLOW idle speed. (See SLOW IDLE SPEED ADJUSTMENT NON CARB/EPA ENGINES on page 3-103 or SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES on page 3-104.)

Disassembly/Assembly

NOTE: For California Air Resources Board/ Environmental Protection Agency (CARB/EPA) Emissions Carburetors reference following engine serial numbers and carburetor part numbers:

BEGINNING ENGINE SERIAL NUMBERS:
FD440V—CS00 . . . . . (FD440V043353–)
FD501V—CS00 . . . . . .(FD501V051079–)

CARBURETOR PART NUMBERS:

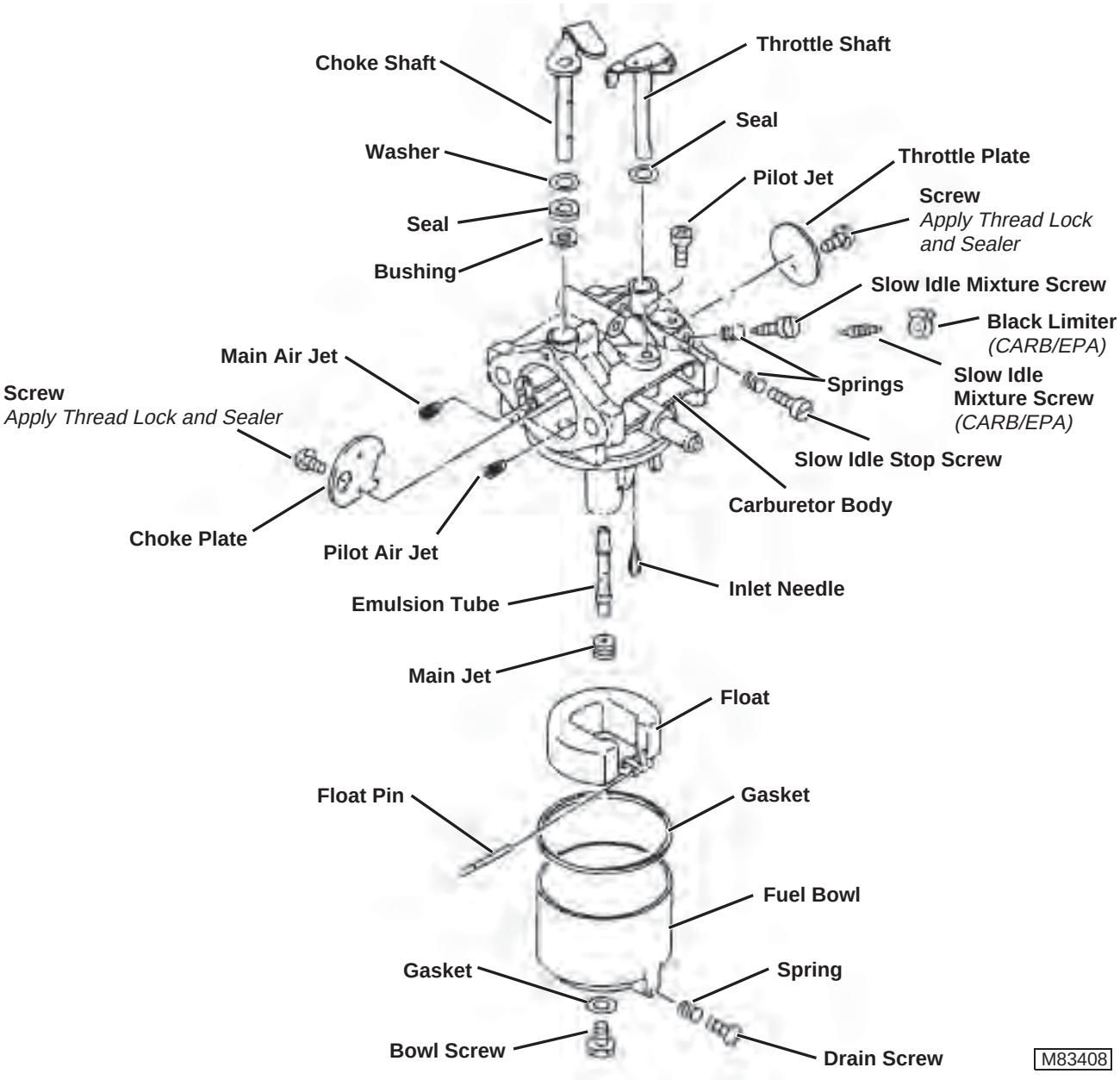
FD440V—CS00	**32361**
FC501V—CS00	**32362**

ATTENTION!

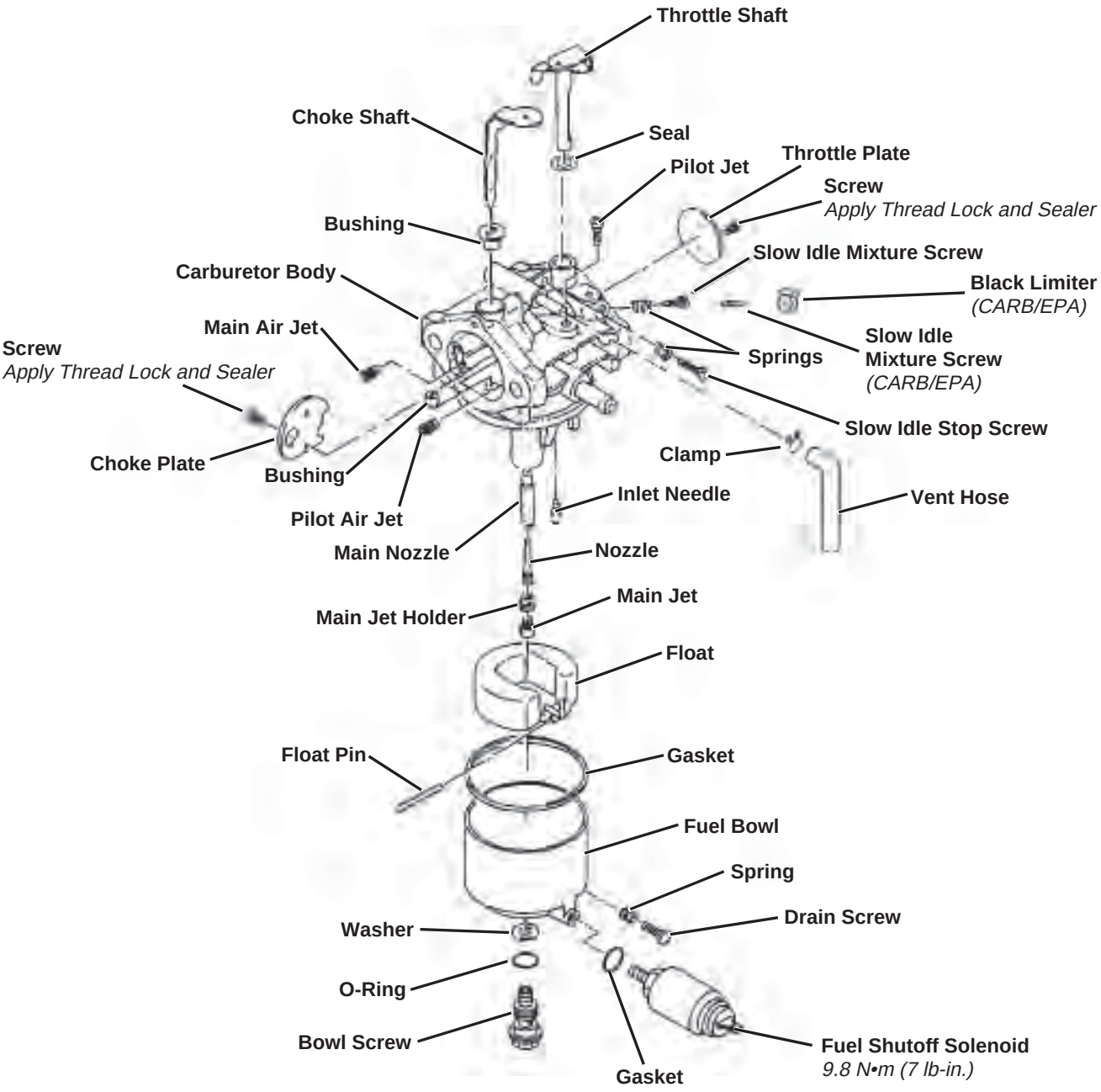
DO NOT attempt to adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

IMPORTANT: There are a number of ball plugs on/ in the carburetor that should not be removed.

To remove float, use a long-nosed pliers on the deformed end of the float pin. Do not strike opposite end of pin. Damage to pin holder may result.


Choke Shaft
Throttle Shaft
Seal
Washer
Throttle Plate
Pilot Jet
Screw
Apply Thread Lock and Sealer
Seal
Bushing
Slow Idle Mixture Screw
Black Limiter
(CARB/EPA)
Main Air Jet
Springs
Slow Idle Mixture Screw
(CARB/EPA)
Screw
Apply Thread Lock and Sealer
Slow Idle Stop Screw
Carburetor Body
Choke Plate
Pilot Air Jet
Inlet Needle
Emulsion Tube
Main Jet
Float
Float Pin
Gasket
Fuel Bowl
Gasket
Spring
Bowl Screw
Drain Screw
M83408

FD440V



FD501V

M83409

Clean/Inspect/Rebuild

ATTENTION!

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

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

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

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

⚠ CAUTION

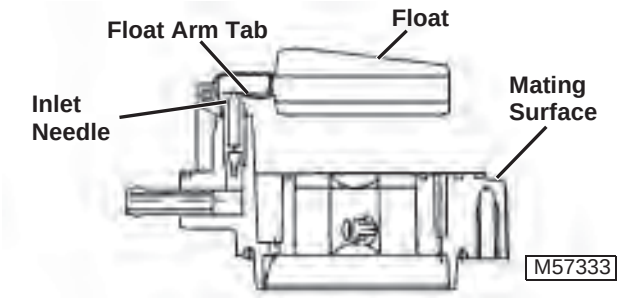
Reduce compressed air to less than 210 kPa (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

IMPORTANT: Rinse carburetor parts in warm water to neutralize corrosive action of cleaner on aluminum. Do not use rags or paper to dry parts; lint can plug holes and passages in carburetor.

2. Rinse carburetor parts in warm water and dry with compressed air. Do not use rags or paper to dry parts; lint can plug holes and passages in carburetor.
3. Inspect all parts for wear or damage.
   - Inspect the carburetor body for wear or damage. Verify all sealing surfaces and flanges are smooth and free of nicks or burrs. If worn or damaged, replace the float assembly and carburetor body as a set.
   - Inspect the inlet needle for wear or damage. The tip should be smooth, without any grooves, scratches or cracks. If worn or damaged, replace the needle and carburetor body as a set.
   - Inspect the SLOW idle mixture screw tapered end for wear or damage. Replace if necessary.
4. Turn the SLOW idle mixture screw in until it lightly seats and back it out the specified number of turns:
   - **FD440V—1-11/16 turns.**
   - **FD501V—1-3/8 turns.**
5. Install the choke plate with the metering hole toward the fuel inlet joint of the carburetor.
6. Verify that the float pin extends the same distance on both sides of the float hinge bracket when assembling the carburetor.
7. Verify that the throttle and choke valves move freely and that the shaft bosses are not elongated or worn. If shaft bosses have any of these conditions, replace the carburetor body.

Float Level Adjustment

NOTE: Plastic float is non-adjustable.

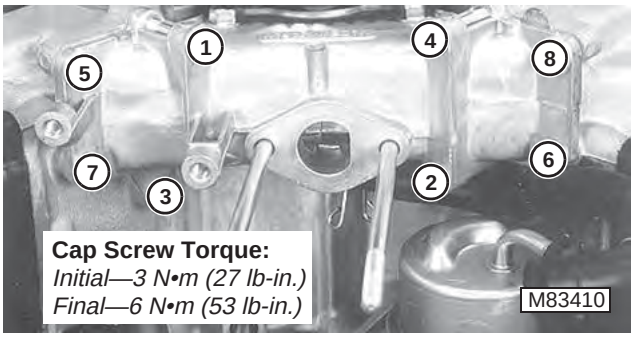


1. Adjust float level. Hold carburetor upside down at eye level with float assembly installed.
2. Gently support the float with a finger and lower it slowly until the float arm tab just touches the inlet needle. The float lower surface should be parallel with the body mating surface.
3. If necessary, bend float arm tab to adjust float level.

INTAKE MANIFOLD

Removal/Installation

1. Remove cooling air duct. (See COOLING AIR DUCT—Removal/Installation on page 3-121.)
2. Remove carburetor. (See CARBURETOR—Removal/Installation on page 3-115.)



IMPORTANT: To prevent warpage, loosen cap screws 1/4 turn at a time, in sequence shown until all cap screws are loose.

3. Loosen mounting cap screws in sequence shown.
4. Remove cap screws, intake manifold, and gaskets. Discard gaskets.

Installation is done in the reverse order of removal.

- Install new gaskets.
- Tighten cap screws in sequence to specifications.

Torque Specifications:

Initial Torque. . . . . 3 N•m (27 lb-in.)
Final Torque . . . . . 6 N•m (53 lb-in.)

Inspection

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

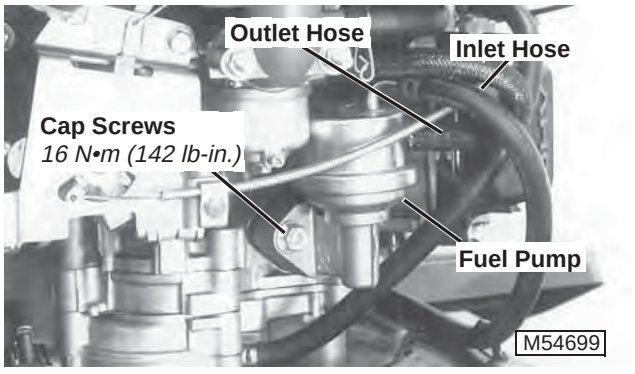
NOTE: Cracks not visible to the eye may be detected by coating the suspected area with a mixture of 25% kerosene and 75% light engine oil. Wipe area dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If crack is present, coating becomes discolored at the defective area. Replace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

FUEL PUMP

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.

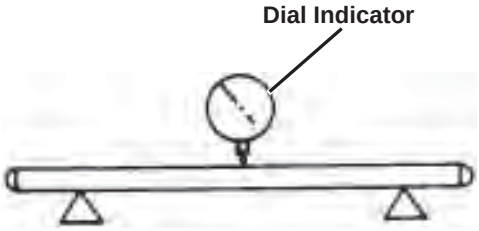


1. Disconnect outlet and inlet hoses. Wipe-up any spilled fuel IMMEDIATELY.
2. Remove cap screws.
3. Remove fuel pump, gaskets, insulator, and push rod.
4. Inspect all parts for wear or damage; replace if necessary. (See Inspection procedure.)

Installation is done in the reverse order of removal.

Inspection

- Inspect pump and insulator for wear or damage; replace if necessary.



- Turn rod slowly and inspect push rod for bend using V-blocks and a dial indicator. Replace if variation is greater than **0.05 mm (0.002 in.)**.

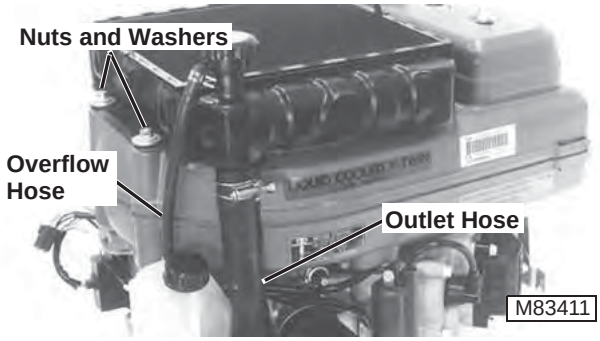
RADIATOR

Removal/Installation

⚠ CAUTION

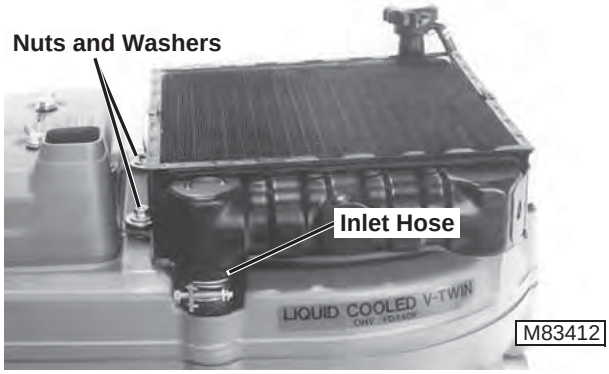
Explosive release of fluids from pressurized cooling system can cause serious burns. Shut off engine and allow to cool. Only remove filler cap when cool enough to touch with bare hands. Slowly loosen cap to first stop to relieve pressure before removing cap.

1. Loosen radiator cap to relieve pressure. Then close tightly.
2. Disconnect bypass hose from cylinder head to drain cooling system. Capacity is approximately **2.1 L (2.2 U.S. qt)**.
3. Reconnect bypass hose.



Right-Hand Side

4. Remove overflow hose from reservoir.
5. Disconnect outlet hose.
6. Remove nuts and washers.



Left-Hand Side

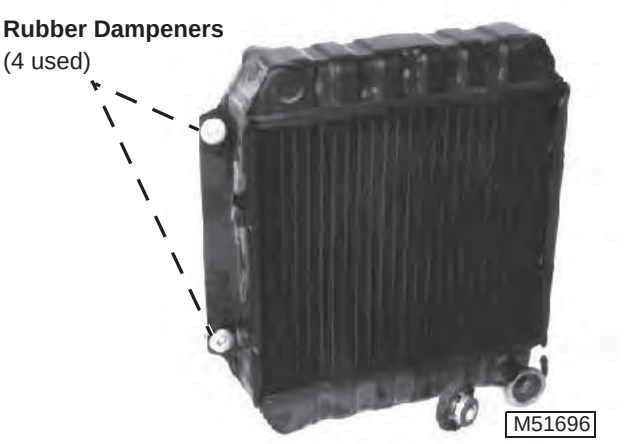
7. Disconnect inlet hose.
8. Remove nuts and washers.
9. Remove and inspect radiator. (See Inspection procedure.)

Installation is done in the reverse order of removal.

- Fill engine cooling system to proper level with coolant of correct specifications. (See GASOLINE ENGINE COOLANT—NORTH AMERICA on page 2-21 or GASOLINE ENGINE COOLANT—EUROPE on page 2-22.)

Inspection

Remove deflection screen.



- Inspect rubber dampeners for excessive wear or damage. Replace if necessary.

⚠ CAUTION

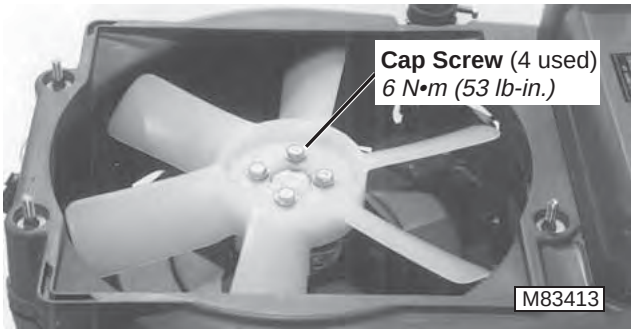
Reduce compressed air to less than 210 kPa (2 bar) (30 psi) when using for cleaning purposes. Clear area of bystanders, guard against flying chips, and wear personal protection equipment including eye protection.

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

COOLING FAN

Removal/Installation

1. Remove radiator. (See RADIATOR—Removal/Installation on page 3-119.)



2. Remove four cap screws and cooling fan.
3. Inspect fan for cracks, broken blades or other damage. Replace as necessary.

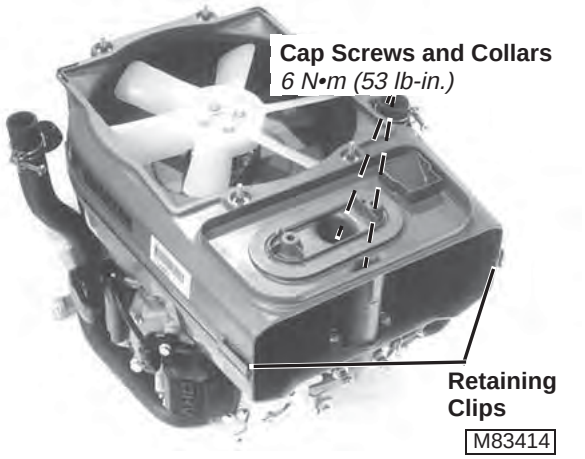
Installation is done in the reverse order of removal.

COOLING AIR DUCT

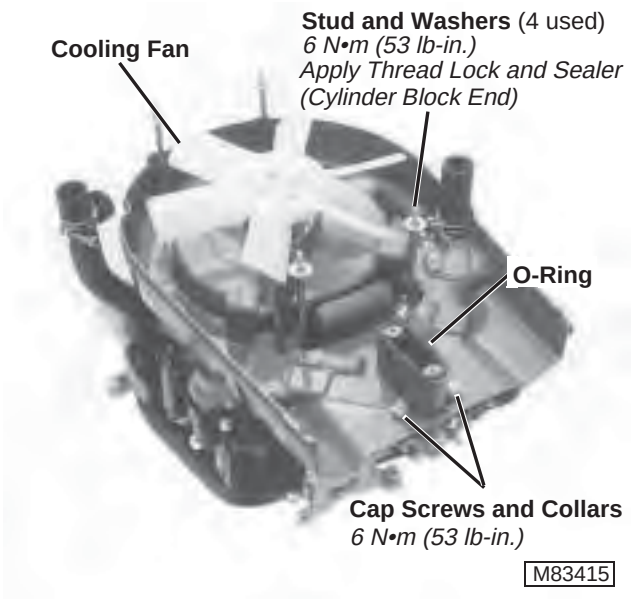
Removal/Installation

1. Remove radiator. (See RADIATOR—Removal/Installation on page 3-119.)
2. Remove air cleaner assembly. (See AIR CLEANER—Service on page 3-114.)

IMPORTANT: Remove cap screws and collars carefully. Parts may fall into the air intake.



3. Remove cap screws and collars.
4. Remove retaining clips.
5. Remove top half of air duct.



6. Remove cooling fan. (See COOLING FAN—Removal/Installation on page 3-121.)
7. Remove four studs and washers.
8. Remove cap screws and collars.
9. Remove lower half of air duct.

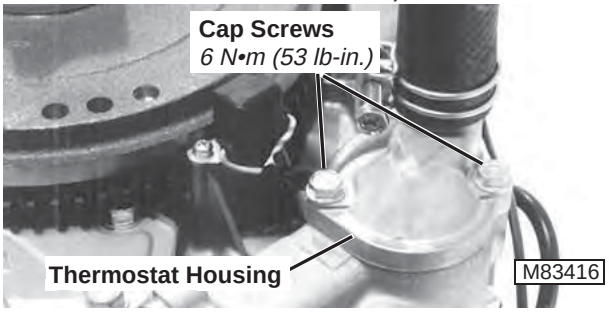
Installation is done in the reverse order of removal.

- Check condition of O-rings.
- Apply Thread Lock and Sealer (Medium Strength) to threads of stud (cylinder Block ends) and tighten to **6 N•m (53 lb-in.).**
- Tighten cap screws to **6 N•m (53 lb-in.).**

THERMOSTAT

Removal/Installation

1. Remove cooling air duct. (See COOLING AIR DUCT—Removal/Installation.)



2. Remove cap screws, housing, gasket, and thermostat. Discard gasket.
3. Clean gasket mating surface.
4. Test thermostat. (See Opening Test.)

Installation is done in the reverse order of removal.

- Use new gasket for installation.
- Tighten cap screws to **6 N•m (53 lb-in.).**

Opening Test

Reason:

To determine opening temperature of the thermostat.

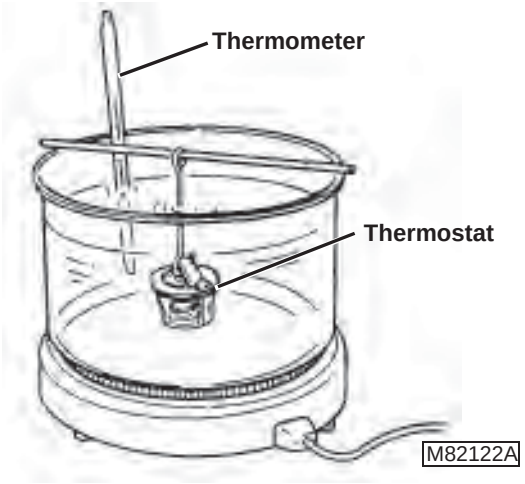
Test Equipment:

- Thermometer
- Glass Container
- Heating Unit

Procedure:

⚠ CAUTION

DO NOT allow thermostat or thermometer to rest against the side or bottom of the glass container when heating water. Thermometer or glass container may rupture if overheated.



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

Specifications:

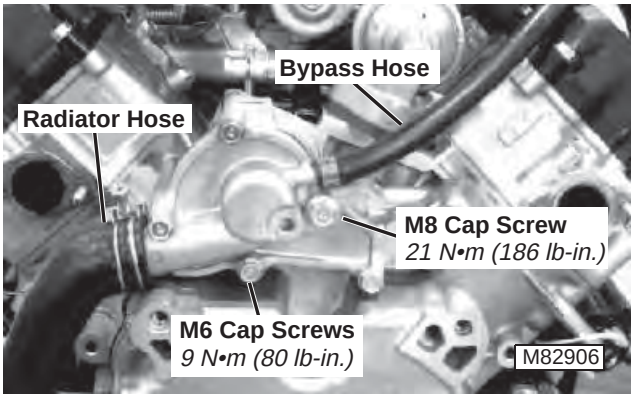
Begin Opening . . . . . 63–66°C (145–150°F)
Fully Open . . . . . 80°C (176°F)

Results:

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

COOLANT PUMP

Removal/Installation



NOTE: Note length and position of mounting cap screws to aid in installation.

1. Disconnect radiator and bypass hoses. Remove mounting cap screws, pump and gaskets.
2. Inspect all parts for wear or damage. (See Disassembly/Inspection procedure.)

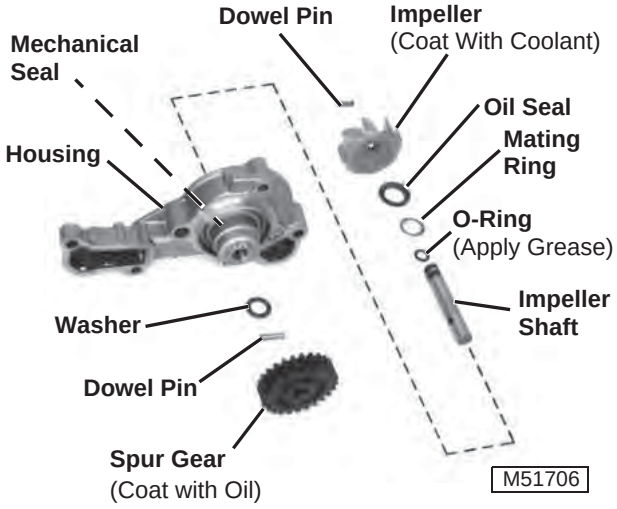
Installation is done in the reverse order of removal.

- Use new gaskets for installation.

NOTE: M8 cap screw goes through crankcase cover into crankcase.

Disassembly/Inspection/Assembly

IMPORTANT: Leakage from the coolant pump will drain into the engine block and could cause engine damage. If there is any doubt of the condition of the coolant pump, replace it as a complete assembly.



1. Remove spur gear using a puller.
2. Remove impeller assembly from housing. Disassemble impeller assembly.

NOTE: Mechanical seal is sealed in place and will be difficult to remove.

3. Drive old mechanical seal from housing.

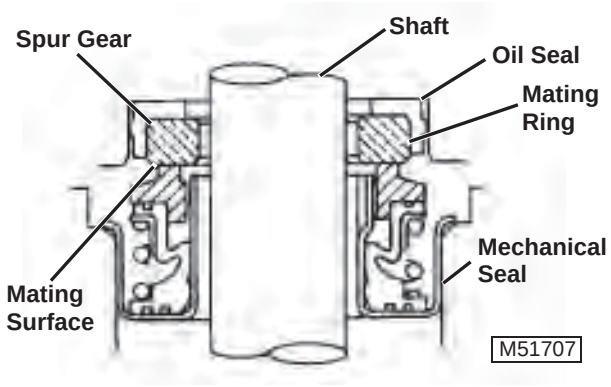


4. Measure outside diameter of impeller shaft. If shaft diameter is less than **9.94 mm (0.391 in.)**, or shows any signs of corrosion, replace shaft.



5. Measure inside diameter of impeller shaft bore in housing. Replace housing if shaft bore is greater than **10.09 mm (0.397 in.)**.

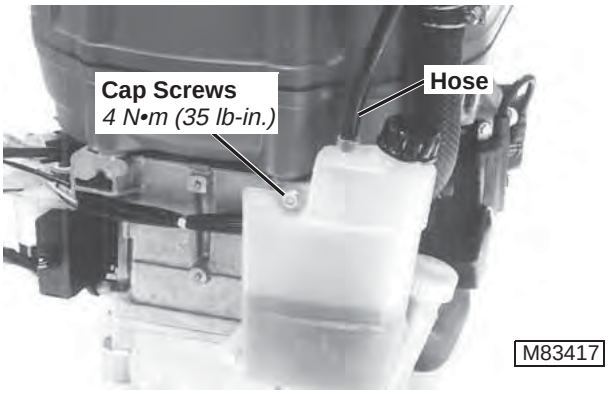
Assembly is done in the reverse order of disassembly.



- Install mechanical seal using special driver included in seal kit.

OVERFLOW RESERVOIR

Removal/Installation



1. Remove hose.
2. Remove cap screws and reservoir.

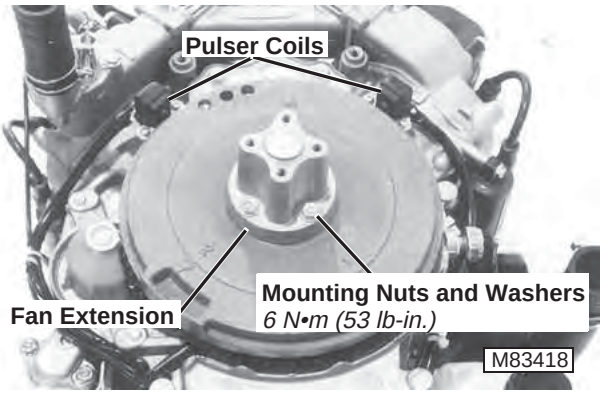
Installation is done in the reverse order of removal.

- Tighten cap screw to **4 N•m (35 lb-in.).**

FLYWHEEL

Removal/Installation

1. Remove cooling air duct. (See COOLING AIR DUCT—Removal/Installation on page 3-121.)



2. Move pulser coils away from flywheel.
3. Remove fan extension.
4. Hold flywheel and remove mounting nuts and washers.
5. Remove flywheel using a flywheel puller.

Installation is done in the reverse order of removal.

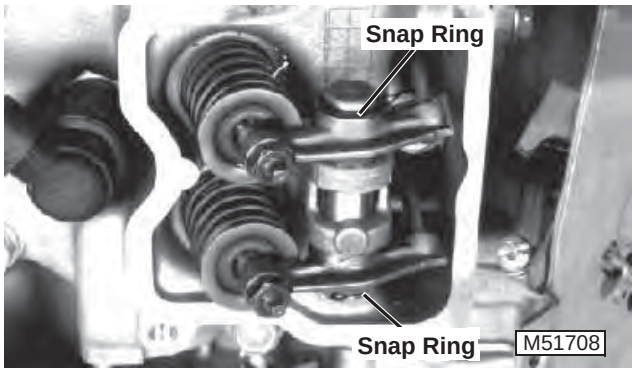
- Tighten mounting nuts to **6 N•m (53 lb-in.).**

ROCKER ARM ASSEMBLY

Removal/Installation

NOTE: The following procedures are done separately on both cylinder head assemblies.

1. Remove spark plug.
2. Remove rocker arm cover.
3. Turn crankshaft until piston is at highest position on compression stroke (both valves will be closed).



4. Remove snap rings, shaft and arms.

IMPORTANT: Mark push rods for reassembly in original locations.

5. Remove push rods.
6. Inspect all parts for wear or damage. (See Inspection procedure.)

Installation is done in the reverse order of removal.

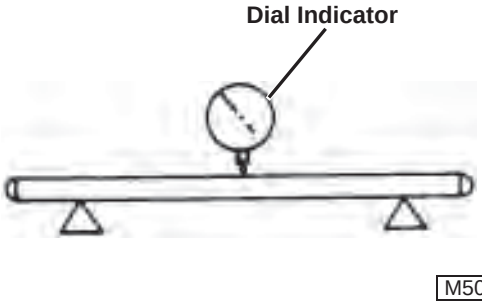
IMPORTANT: Be sure piston is at top dead center. Align rocker arms over push rods during assembly.

- Adjust valve clearance. (See VALVE CLEARANCE TEST AND ADJUSTMENT on page 3-106.)

Inspection



- Measure outer diameter of rocker arm shaft. Replace if shaft diameter measures **less than 11.95 mm (0.470 in.)**.
- Measure inner diameter of rocker arm bearing. Replace bearing if inside diameter is **greater than 12.07 mm (0.475 in.)**.



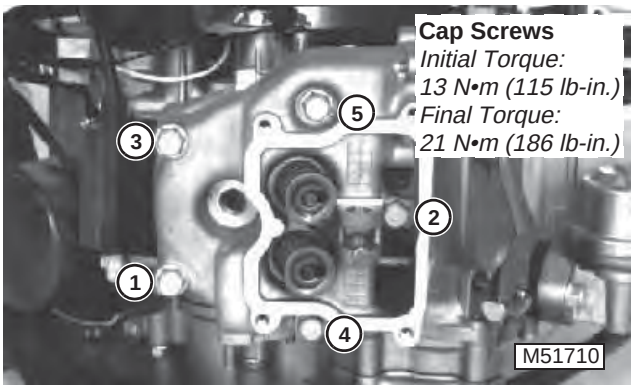
- Inspect push rod for bend using V-blocks and a dial indicator. Turn rod slowly and read variation on indicator. Replace if variation is **greater than 0.80 mm (0.031 in.)**.

CYLINDER HEAD AND VALVES

Removal/Installation

NOTE: Number one cylinder head shown. Number two cylinder head is the same except it has a thermostat housing, by-pass port, and a thermo-switch port.

1. Remove intake manifold. (See INTAKE MANIFOLD—Removal/Installation on page 3-118.)
2. Remove rocker arm cover, rocker arm assembly, and push rods. (See ROCKER ARM ASSEMBLY—Removal/Installation.)
3. Remove spark plug.



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

4. Remove cylinder head assembly and gasket.
5. Disassemble and inspect cylinder head and valves. (See Inspection procedures.)

Installation is done in the reverse order of removal.

- Use new gaskets for installation.

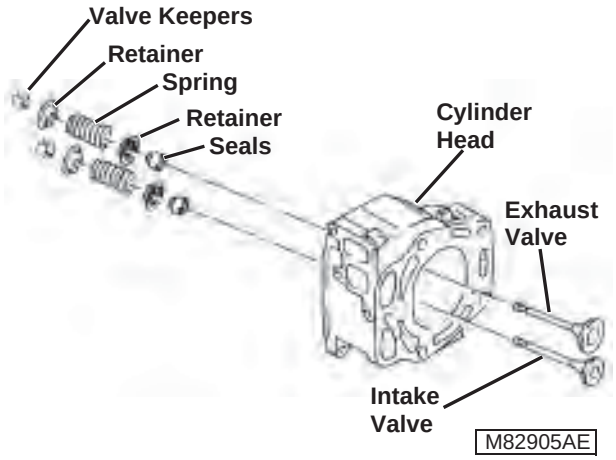
IMPORTANT: Torque should be applied in the sequence shown, in 3 N•m (27 lb-in.) increments. Install intake manifold before tightening cylinder head cap screws to final torque.

Torque Specifications:

Initial Torque . . . . . 13 N•m (115 lb-in.)
Final Torque . . . . . 21 N•m (186 lb-in.)
Spark Plug . . . . . 17 N•m (150 lb-in.)

- Adjust valve clearance. (See VALVE CLEARANCE TEST AND ADJUSTMENT on page 4-106.)

Disassembly/Assembly



- Inspect all parts for wear or damage. (See Inspection/Replacement procedures.)
- Intake and exhaust valve guides cannot be replaced; replace head if worn.

IMPORTANT: Bottom spring retainer can only be removed with valve stem seal. Removal of retainer or seal damages stem seal. Inspect seal. If seal is not damaged, do not remove it.

- If necessary to replace stem seal, remove with screwdriver.
- Apply clean engine oil on intake and exhaust valve stems during assembly.

Inspection/Replacement

Cylinder Head:

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE® abrasive pads or an 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.

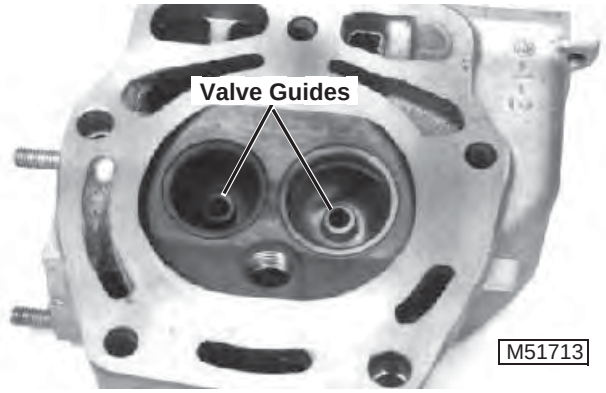
2. Clean head with a suitable solvent and dry with compressed air.
3. Inspect head for cracks or damage.
4. Inspect gasket surface for burrs and nicks.



5. Put cylinder head on a surface plate. Check for distortion at several points around the head using a feeler gauge. Replace head if distortion is **more than 0.06 mm (0.002 in.)**.

Valve Guides:

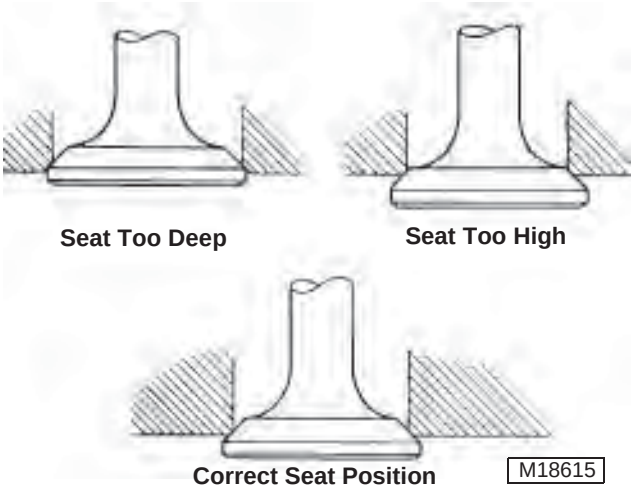
NOTE: Intake and exhaust valve guides cannot be replaced; replace head if worn.



1. Clean inside of valve guides with valve guide cleaner.
2. Measure inside diameter of valve guides. Replace cylinder head if inside diameter is **greater than 5.06 mm (0.199 in.)**.

Valve Seats:

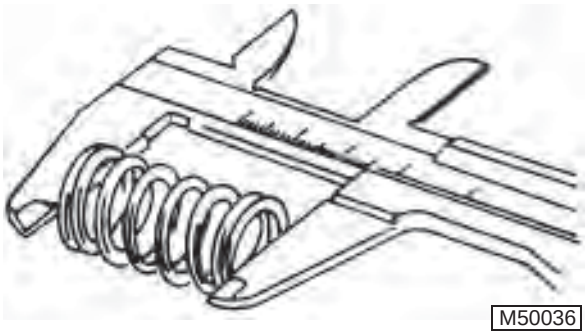
1. If valve seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.



2. Check valve seating pattern for correct width and evenness all around. If valve seat width is not within **0.5—1.1 mm (0.020—0.043 in.)**, recondition valve seat. (See RECONDITION VALVE SEATS on page 3-128.)
3. Lap valve after reconditioning with lapping compound and recheck valve seating surface for proper width and evenness of seating pattern. (See LAP VALVES on page 3-128.)

Valve Springs:

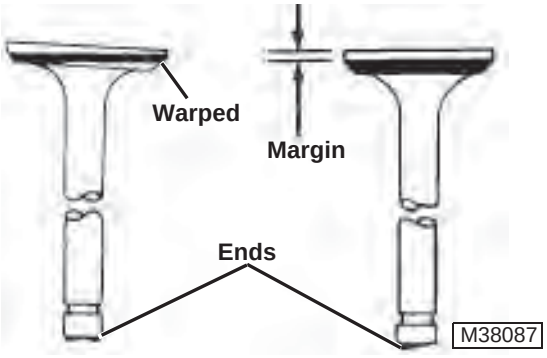
1. Inspect spring for pitting, rust, and burrs. Replace if necessary.



2. Measure spring free length. Replace spring if measurement is **less than 27.30 mm (1.074 in.)**.

Intake and Exhaust Valves:

1. Remove carbon from valve head, face, and stem with a power-operated wire brush. Be sure carbon is removed, not merely burnished.
2. Inspect valve head, face, and stems for defects. Replace if necessary.



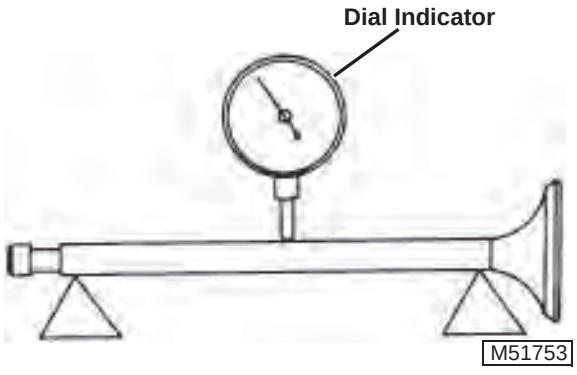
3. Replace warped valves or valves with **less than 0.50 mm (0.020 in.) margin**. Valve stem ends should be ground square before checking valve to tappet clearance.



4. Measure outside diameter of valve stem. Replace if diameter is **less than specifications**.

Minimum Valve Stem O.D. Specifications:

Intake . . . . . 4.93 mm (0.194 in.).
Exhaust . . . . . 4.92 mm (0.193 in.)



5. Check valve stem for bend using V-blocks and a dial indicator. Turn valve slowly and read variation on indicator. Replace if variation is **greater than 0.03 mm (0.001 in.)**.

ANALYZE VALVES



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

IMPORTANT: DO NOT grind the exhaust valve or life will be shortened.

Grind the intake valve and resurface the seat to correct this condition.

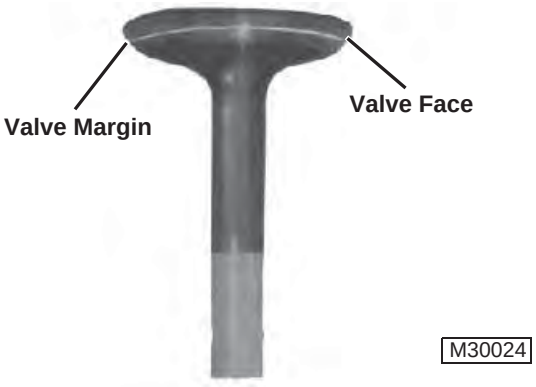
NOTE: Be sure to reset valve-to-tappet clearance after grinding valves.



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

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

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



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

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



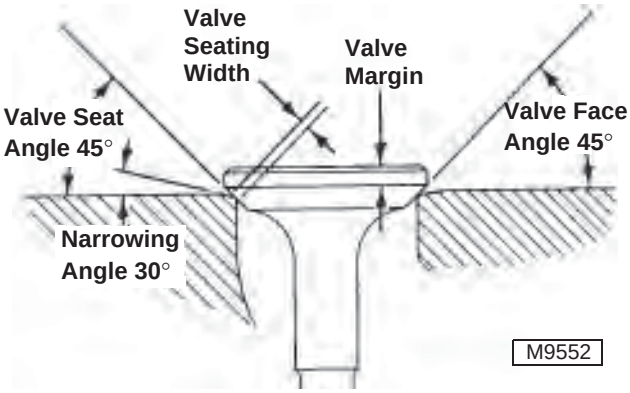
Using old or stale gasoline is a common cause for sticky valves.

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

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

RECONDITION VALVE SEATS

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

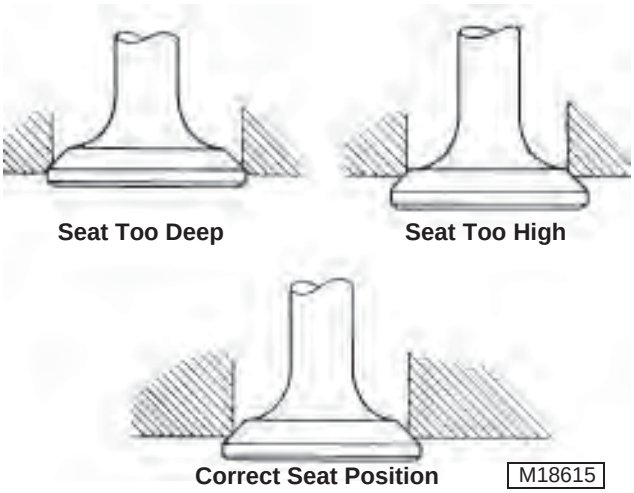


2. To recondition seat, cut at **45**° angle to clean up seat. Cut narrowing angle at **30**°. Finish cut at **45**° to establish seating surface width.
3. Cut valve seating surface as close as possible to specifications.

Specifications:

Valve Seating Surface (Standard) . . . . . 0.80 mm (0.031 in.)
Seat Width Tolerance . . . . . 0.50—1.10 mm (0.020—0.043 in.)
Valve Seat Angle . . . . . 45°
Valve Face Angle . . . . . 45°
Valve Margin (Minimum) . . . . . 0.050 mm (0.020 in.)
Valve Narrowing Angle . . . . . 30°

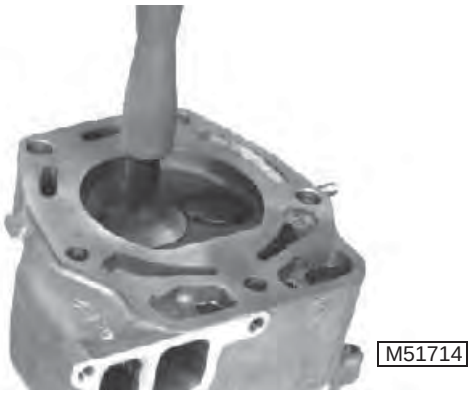
4. Lap valves to seats after re-facing. (See LAP VALVES.)
5. Center valve seat on the valve face.
6. Check seat for good contact using Prussian Blue Compound.



LAP VALVES

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

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



2. Grip top of valve with a vacuum cup tool and turn valve to lap valve to seat.
3. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface the valve face.

⚠ 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.

4. Wash all parts in solvent to remove lapping compound and dry parts with compressed air.
5. Check position of lap mark on valve face. Lap mark must be on or near the center of valve face.
6. Apply a light coat of clean engine oil to seat and valve to prevent rusting.

CRANKCASE COVER

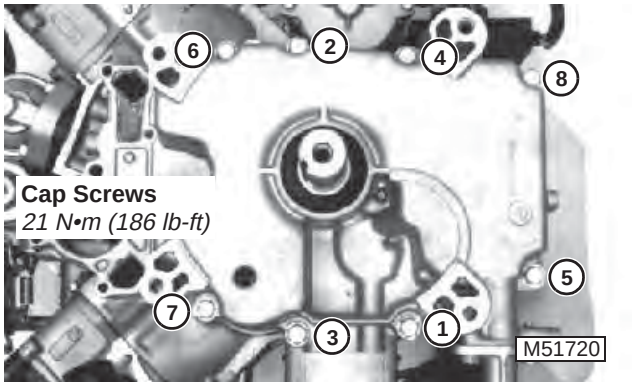
Removal/Installation

1. Drain oil from crankcase. Capacity is approximately **1.8 L (3.8 U.S. pt)** with filter.
2. Remove coolant pump. (See COOLANT PUMP—Removal/Installation on page 3-122.)
3. Remove eight cap screws, crankcase cover and gasket.
4. Clean crankcase and crankcase cover gasket surfaces.

Installation is done in the reverse order of removal.

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

- Use new gasket for installation.



- Tighten mounting cap screws using the sequence shown to **21 N•m (186 lb-ft).**
- Tighten oil drain plug to **25 N•m (221 lb-in.)**.

PISTON AND CONNECTING ROD

Removal

NOTE: No. 1 cylinder is the right-hand cylinder viewed from the flywheel. No. 2 cylinder is the left-hand cylinder viewed from the flywheel.

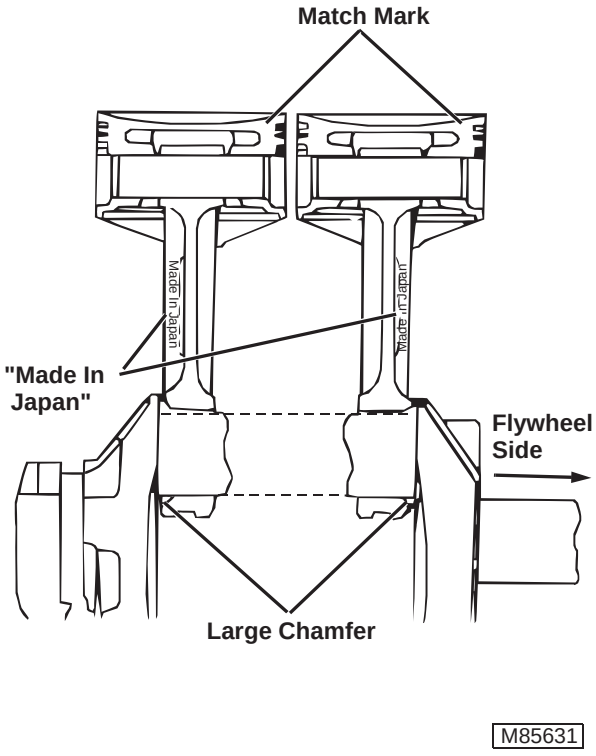
1. Remove cylinder head. (See CYLINDER HEAD AND VALVES—Removal/Installation on page 3-124.)
2. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation.)
3. Check cylinder bore for ridges which can cause piston damage if not removed. Remove ridge using a ridge reamer.
4. Turn crankshaft to expose connecting rod caps.



5. Remove connecting rod cap.
6. Push piston and connecting rod assembly from cylinder bore.
7. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection procedures.)

Installation

1. Deglaze cylinder bore. (See Deglaze Cylinder Bore on page 3-138.)
2. Stagger piston ring end gaps 180° apart, but do not align with oil ring side rail end caps.
3. Apply a light film of oil to piston and rings. Compress rings with a ring compressor.



IMPORTANT: Match mark on pistons must face flywheel. Large chamfer of connecting rods must be against crankshaft web (opposite each other).

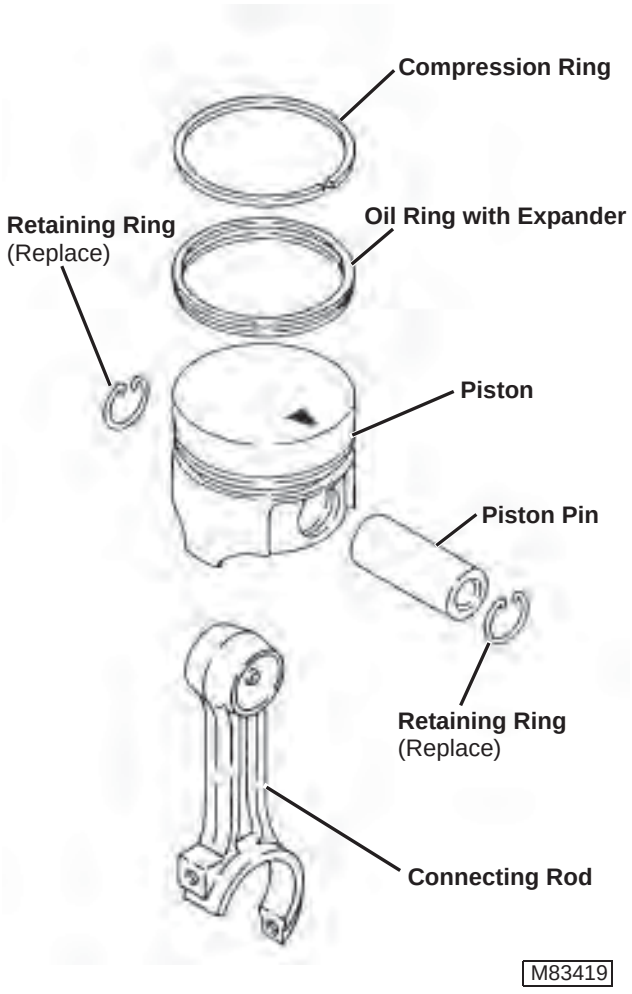
4. Install piston and connecting rod assembly in cylinder bore with arrow match mark on piston head facing the flywheel side of the engine.
5. Apply a light film of clean engine oil to cap bearing surface and cap screws. Install connecting rod cap with chamfer facing crank web. Tighten cap screws to **12 N•m (106 lb-in.)**.
6. Install crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-129.)
7. Install cylinder head. (See CYLINDER HEAD AND VALVES—Removal/Installation on page 3-124.)

Disassembly

IMPORTANT: Keep parts together as a set.

- Analyze piston and piston ring wear. (See ANALYZE PISTON WEAR on page 3-134 and ANALYZE PISTON RING WEAR on page 3-133.)
- Mark each piston and connecting rod to aid in assembly.
- Remove piston rings using a piston ring expander.
- Inspect all parts for wear or damage. Replace as necessary. (See Inspection procedures.)

IMPORTANT: DO NOT reuse piston pin retaining rings. Always use new for assembly.



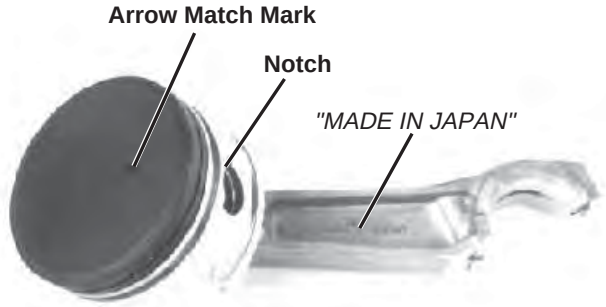
Assembly

- Apply a thin film of clean engine oil to piston pin and connecting rod bearing during assembly.

NOTE: With pistons installed, No. 1 piston is designated by the large chamfer on connecting rod facing toward flywheel.

No. 2 piston is designated by the large chamfer on the connecting rod facing away from flywheel.

The arrow match mark on both piston heads should point toward the flywheel.



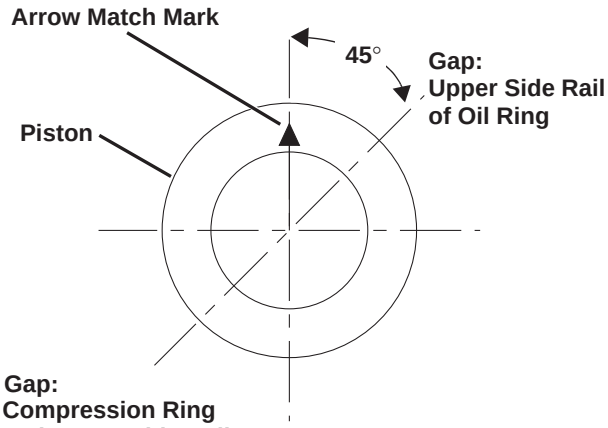
No. 1 Piston Shown M38111

1. Assemble pistons to connecting rods:
- No. 1 piston: Align arrow match mark on piston head with "MADE IN JAPAN" on connecting rod.
- No. 2 piston: Align arrow match mark on piston head opposite "MADE IN JAPAN" on connecting rod.

IMPORTANT: DO NOT reuse piston pin retaining rings.

Retaining ring gap must not align with notch at end of piston pin bore.

2. Install piston pin with new retaining rings.
3. Before installing rings on piston, check ring end gap in cylinder bore. (See Inspection—Piston Ring procedure.)



M83420

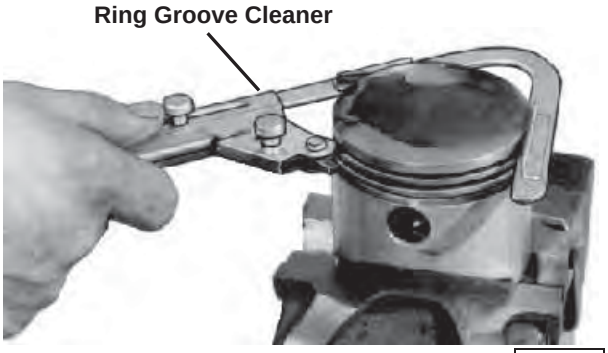
4. Install oil control and compression rings:
- Oil ring: Install spacer, then side rails. Align side rail end gaps 180° apart in the position shown.
- Install compression ring in groove with letter mark facing up. Ring should turn freely in groove. Turn ring until gap is positioned as shown.

Inspection

Piston:

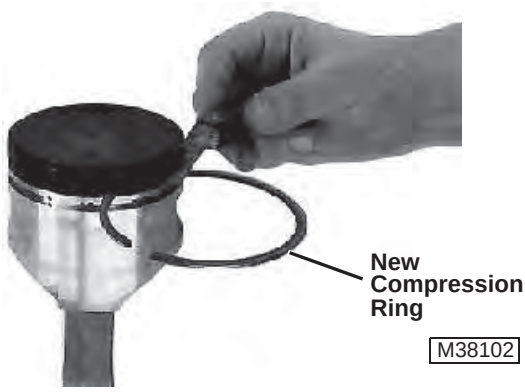
IMPORTANT: DO NOT use a caustic cleaning solution or a wire brush to clean piston.

1. Remove all deposits from the piston.



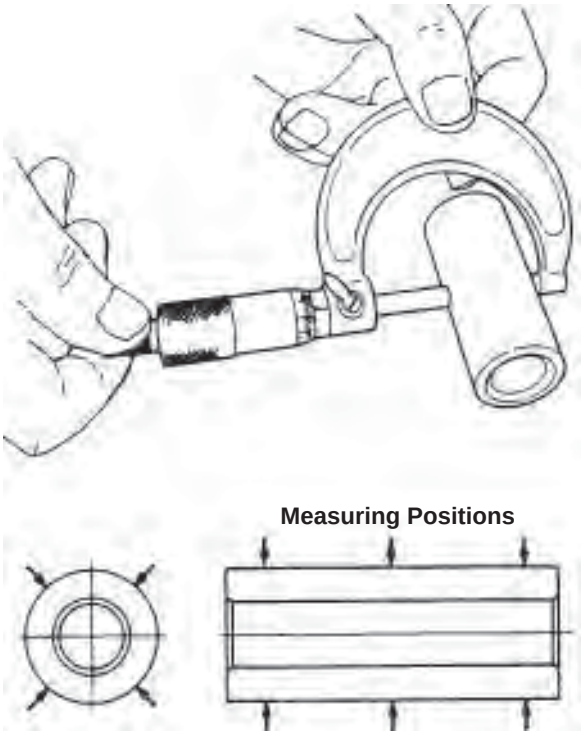
M29946

2. Clean carbon from piston ring grooves with a ring groove cleaner. If cleaning tool is not available, break an old ring and use it to carefully clean groove.
3. Check that all oil return passages in grooves are open.
4. Inspect piston for scoring or fractures. Replace piston if damaged.



NOTE: Oil control rings are not measured.

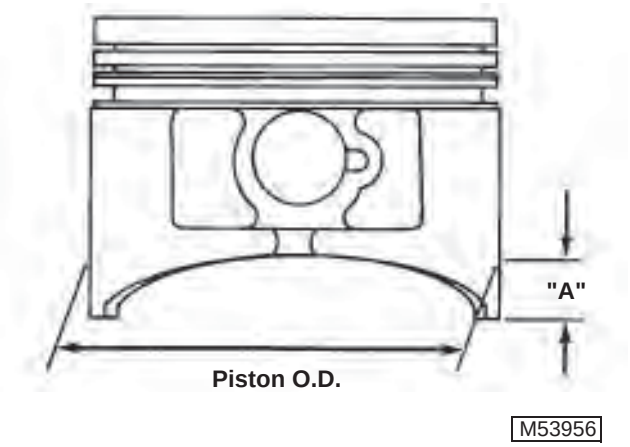
5. Using a new piston ring and feeler gauge, check top two ring grooves for wear, at several points around piston. Replace piston if clearance is **greater than 0.10 mm (0.004 in.)**. Oil ring groove is not measured, use visual check only.



6. Measure piston pin diameter at six places. Replace pin if measurement is **less than 15.98 mm (0.629 in.)**.



7. Measure piston pin bore diameter in piston. Replace piston if measurement is **greater than 16.04 mm (0.631 in.)**.



8. Measure piston O.D. perpendicular to piston pin at distance "A".

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

Piston Specifications:

Distance "A" . . . . . 13.5 mm (0.531)

Piston O.D.

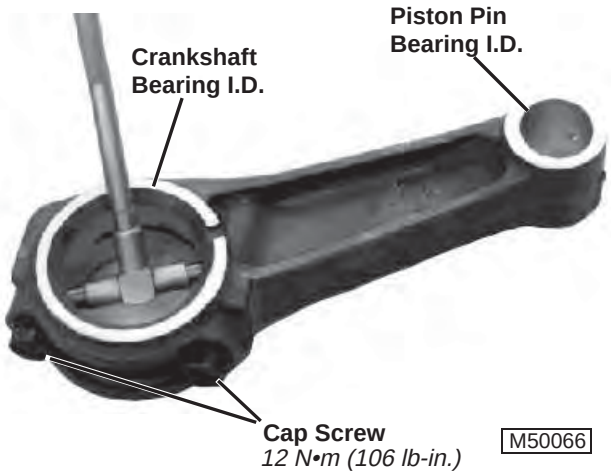
Standard Piston . . . . . 66.950—66.965 mm (2.6358—2.6364 in.)

Oversize Piston 0.50 mm (0.020 in.) . . . . . 67.45—067.465 mm (2.655—2.656 in.)

9. Measure cylinder bore diameter. (See CYLINDER BLOCK—Inspection on page 3-138.)
10. Subtract piston O.D. measurement from cylinder bore measurement to determine **piston-to-cylinder bore clearance**.
11. Replace piston and/or rebore cylinder block if not within **0.015—0.150 mm (0.00059—0.00590 in.)**.

Connecting Rod:

1. Analyze crankshaft and connecting rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR on page 3-137.)
2. Clean and inspect rod. Replace if scored.

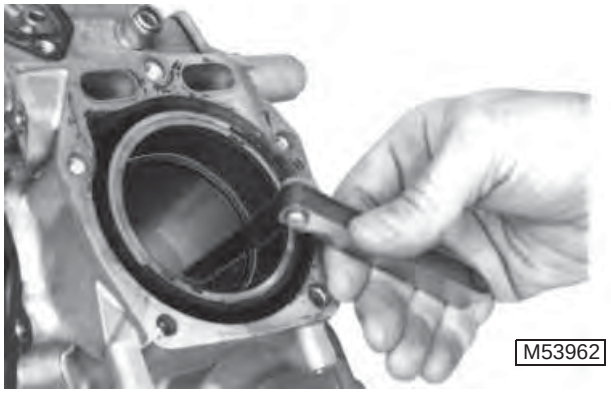


3. Install connecting rod cap. Tighten cap screws to **12 N•m (106 lb-in.)**.
4. Measure connecting rod crankshaft bearing diameter and piston pin bearing diameter. Replace connecting rod if either measurement is greater than specifications.

Connecting Rod Bearing I.D. (Maximum):

Crankshaft Bearing I.D. . . . . 31.06 mm (1.223 in.)
Piston Pin Bearing I.D. (Maximum) . . . . . 16.05 mm (0.632 in.)

Piston Rings:



NOTE: Oil control ring gap is not measured.

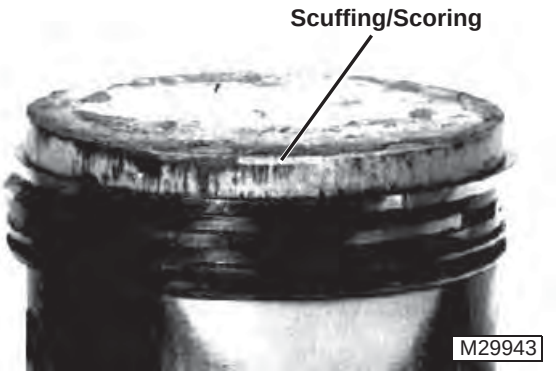
1. Check **piston ring end gap**:
   - Install compression rings individually using a piston to position it squarely in bore approximately **25.4 mm (1.0 in.)** down from top of cylinder.

   Check end gap with feeler gauge. Replace ring if end gap is **greater than 1.00 mm (0.040 in.)**.

ANALYZE PISTON RING WEAR

Rings of the wrong size or rings having improper end gaps will not conform to the shape of the cylinder. This results in high oil consumption and excessive blow-by.

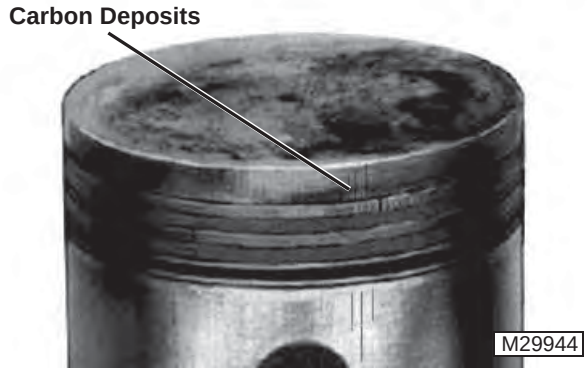
Ring end gaps should be staggered on the piston during installation. End gaps in alignment can also cause oil consumption and blow-by.



Light scuffing or scoring of both rings and piston occurs when unusually high friction and combustion temperatures approach the melting point of the piston.

When this condition exists, it is due to one or more of the following probable causes:

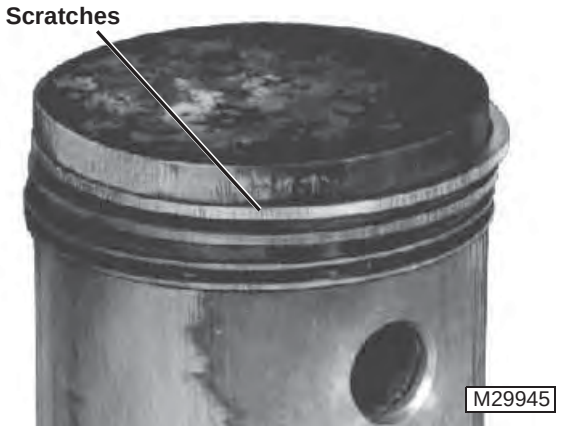
- Engine overheating.
- Lack of cylinder lubrication.
- Improper combustion.
- Wrong bearing or piston clearance.
- Too much oil in crankcase causing fluid friction.



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

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

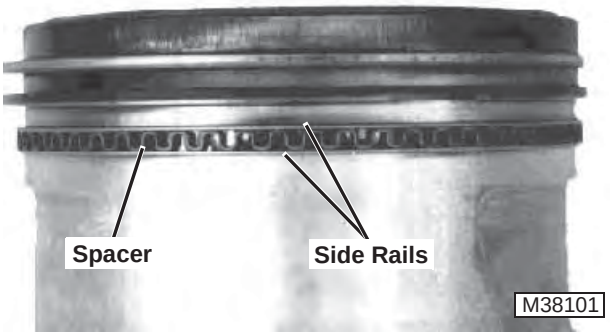
- Overheating
- Incorrect ignition timing.
- Lean fuel mixture.
- Incorrect oil.
- Low oil supply.
- Stale fuel.



Vertical scratches across the piston rings are due to an abrasive in the engine. Abrasives may be airborne, may have been left in the engine during overhaul, or may be loose lead or carbon deposits.

When this condition exists, check for one or more of the following:

- Damaged, collapsed or improperly installed air filter.
- Loose connection or damaged gasket between air cleaner and carburetor.
- Air leak around carburetor-to-cylinder head gasket.
- Air leak around throttle shaft, or choke shaft.
- Failure to properly clean cylinder bore after reconditioning engine.
- Air leak at breather hose.



Abrasive particles in engine oil cause scratches on side rails of oil control ring. Inner spacer wear or distortion may cause:

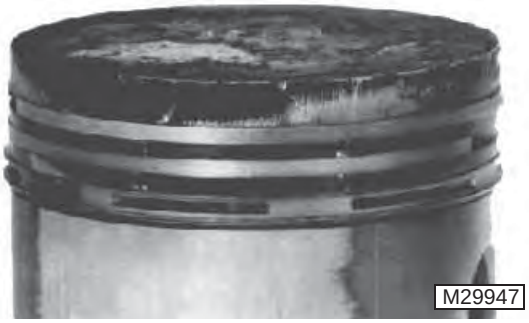
- High oil consumption.
- Increased deposits in combustion chamber.
- Sticking compression rings.

Increased oil consumption may be caused by:

- Worn side rails with low tension.
- Worn or distorted inner spacer.

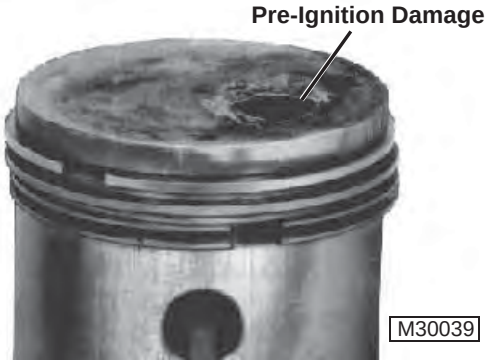
ANALYZE PISTON WEAR

Detonation is abnormal combustion causing excessive temperature and pressure in the combustion chamber. Commonly called knock, spark knock, or timing knock, detonation occurs as the compressed fuel-air mixture ignites spontaneously to interrupt the normal ignition.



The following is a list of possible causes for detonation.

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



Pre-ignition is the igniting of the fuel-air mixture prior to regular ignition spark. Pre-ignition causes shock, resulting in pings, vibration, detonation and power loss. Severe damage to piston, rings and valves results from pre-ignition.

Check the following for causes of pre-ignition:

- Internal carbon deposits.
- Incorrect spark plug (high heat range).
- Broken ceramic in spark plug.
- Sharp edges on valves.
- Sharp edges in combustion chamber.



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

A cylinder bored at an angle to the crankshaft can also cause improper ring contact with the cylinder.

This condition causes:

- Rapid piston wear.
- Uneven piston wear.
- Excessive oil consumption.



A broken retaining ring cased the damage shown.

Retaining rings loosen or break due to:

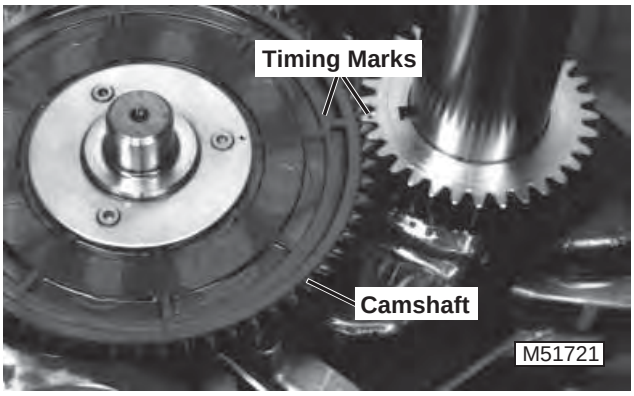
- Rod misalignment.
- Excessive crankshaft end play.
- Crankshaft journal taper.
- Weak retaining rings.
- Incorrectly installed retaining rings.

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

CAMSHAFT AND TAPPETS

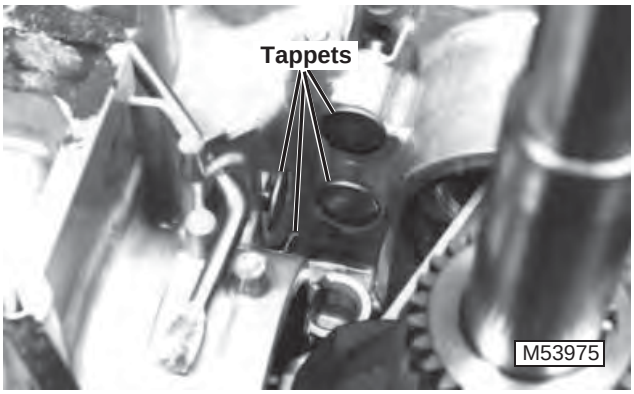
Removal/Installation

1. Remove fuel pump. (See FUEL PUMP—Removal/Installation on page 3-119.)
2. Remove rocker arm assemblies. (See ROCKER ARM ASSEMBLY—Removal/Installation on page 3-124.)
3. Remove crankshaft cover. (See CRANKCASE COVER—Removal/Installation on page 3-129.)



IMPORTANT: Align timing marks to prevent damage to tappets when removing camshaft.

4. Rotate crankshaft until timing marks align.
5. Remove and inspect camshaft. (See Inspection procedures.)



NOTE: Mark tappets so they can be installed in their original guides during assembly.

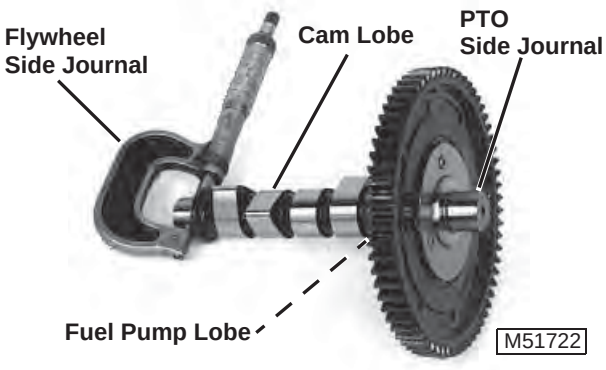
6. Remove and inspect tappets for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

- Align timing marks when installing camshaft.

Inspection

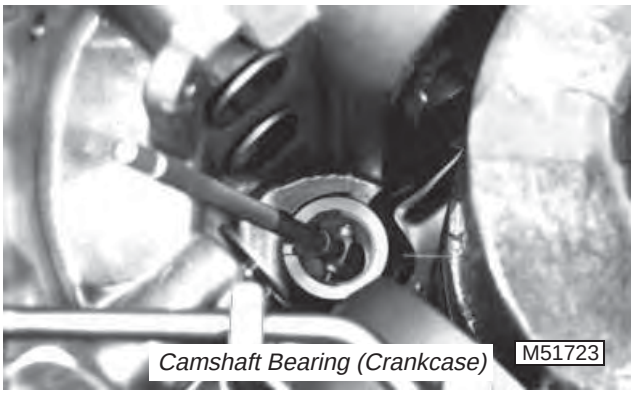
1. Inspect camshaft for worn or broken teeth.
2. Check for loose rivets holding the gear to camshaft. Replace camshaft if loose.



3. Measure flywheel side journal, PTO side journal, cam lobe height, and fuel pump lobe. Replace camshaft if any measurement is **less than** specifications.

Camshaft Specifications (Minimum):

PTO Side Journal . . . . . 13.91 mm (0.548 in.)
Flywheel Side Journal . . . . . 13.91 mm (0.548 in.)
Cam Lobe Height . . . . . 24.43 mm (0.962 in.)
Fuel Pump Lobe Height . . . . . 19.50 mm (0.760 in.)





4. Measure camshaft bearings in crankcase. Replace block if diameter is **greater than 14.07 mm (0.554 in.)**.
5. Measure camshaft bearings in crankcase cover. Replace cover if diameter is **greater than 14.05 mm (0.553 in.)**.

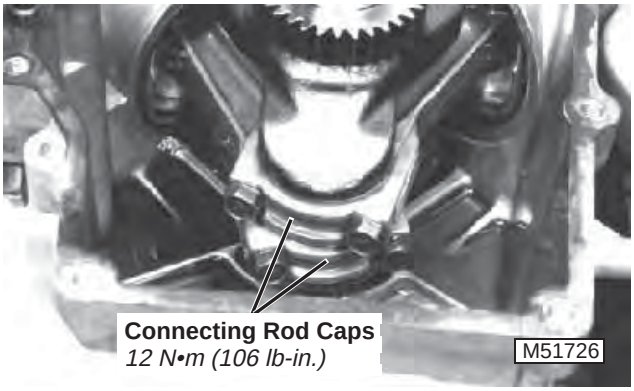
CRANKSHAFT AND MAIN BEARINGS

Removal/Installation

1. Remove flywheel. (See FLYWHEEL—Removal/Installation on page 3-118.)
2. Remove camshaft. (See CAMSHAFT AND TAPPETS—Removal/Installation on page 3-135.)

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

3. Mark connecting rod caps to aid in installation.



4. Remove connecting rod caps and push pistons to top of cylinder.
5. Remove crankshaft.
6. Inspect crankshaft for wear or damage. (See Inspection procedures.)

Installation is done in the reverse order of removal.

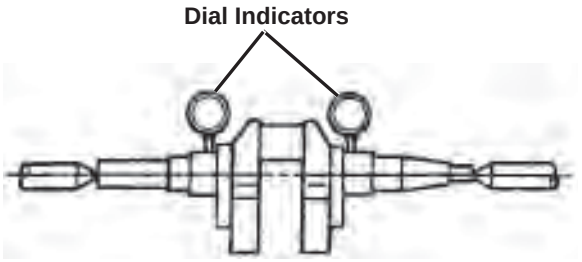
- Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
- Apply a light film of clean engine oil on crankshaft bearing surfaces before installation.
- Pack oil seals with lithium base grease.
- Install connecting rod caps.
- Tighten connecting rod cap screws to **12 N•m (106 lb-in.)**.

Inspection

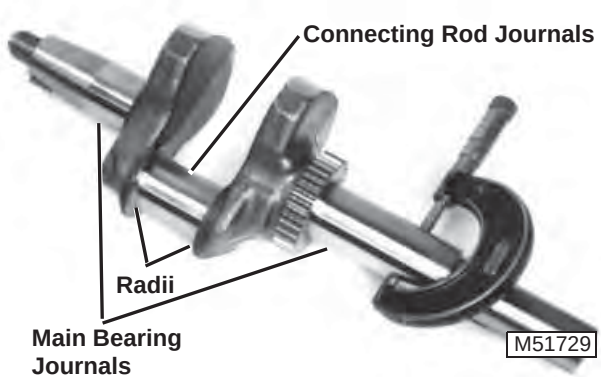
1. Analyze crankshaft and connecting rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR.)

IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.

2. Clean and inspect crankshaft. Replace if scratched, damaged or worn beyond specifications.

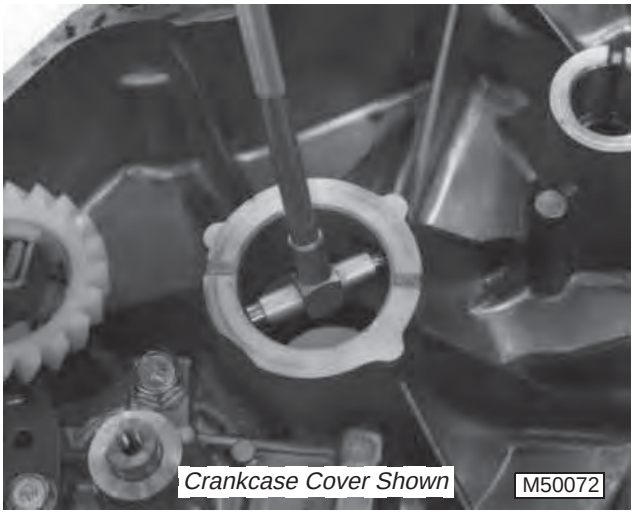


3. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators to measure maximum **Total Indicated Runout (TIR)**. If runout **exceeds 0.05 mm (0.002 in.)**, replace crankshaft.



4. Measure main bearing journal diameters. If either journal O.D. is **less than 29.92 mm (1.178 in.)**, replace crankshaft.
5. Measure connecting rod journal diameter. If journal is **less than 30.93 mm (1.218 in.)**, replace crankshaft. Inspect journal radii for cracks.

If any journal diameter is less than specifications, replace crankshaft.



6. Measure crankshaft main bearing diameter in crankcase and crankcase cover. Replace crankcase or crankcase cover if bearing I.D. is **greater than 30.09 mm (1.185 in.)**.

CRANKSHAFT OIL SEALS

Replacement

IMPORTANT: DO NOT scratch machined surface of bearings when removing seals.

Flywheel End: Remove crankshaft. (See CRANKSHAFT AND MAIN BEARINGS—Removal/Installation on page 3-136.)

PTO End: Remove crankshaft cover. (See CRANKCASE COVER—Removal/Installation on page 3-129.)

- Remove worn or damaged seals using a screwdriver. **DO NOT** damage machined surfaces.
- Install seals with lip toward inside of engine using a driver set. Press in seals until flush with flange surface.
- Pack lithium based grease inside lips of seals.

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 an incorrectly installed bearing cap.

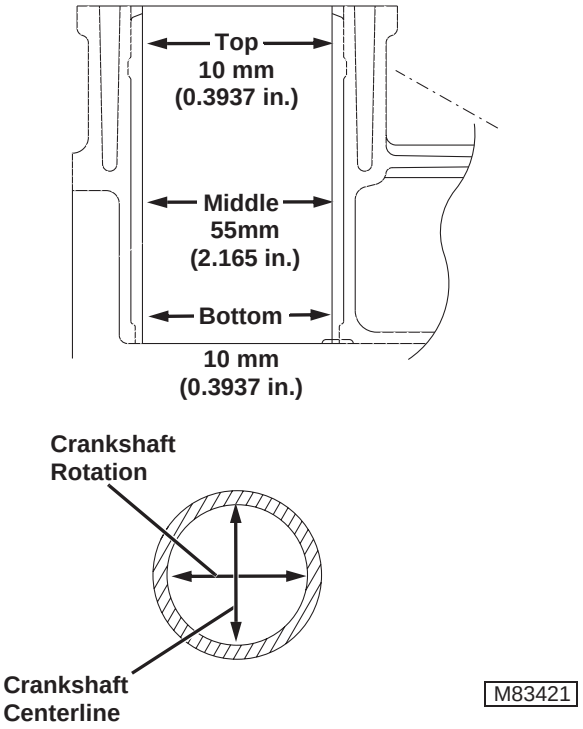
CYLINDER BLOCK

Inspection

1. Clean block and check for cracks.

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

A bare block is available for service.



2. Measure cylinder bore diameter at three positions:
   - **Top—10 mm (0.3937 in.) from top of block.**
   - **Middle—55 mm (2.165 in.) from top of block.**
   - **Bottom—10 mm (0.3937 in.) from bottom of cylinder.**

At these three positions, measure in both directions along crankshaft centerline and direction of crankshaft rotation.

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

Cylinder Bore I.D.:

Standard Size Bore:

Standard . . . . . 66.980—67.000 mm
. . . . . (2.637—2.638 in.)
Wear Limit. . . . . 67.06 mm (2.639 in.)

Oversized Bore—0.50 mm (0.020 in.):

Standard . . . . . 67.480—67.500 mm
. . . . . (2.656—2.657 in.)
Wear Limit. . . . . 67.560 mm (2.659 in.)

3. If cylinder bore exceeds wear limit, rebore cylinder or replace cylinder block. (See Rebore Cylinder Block.)

NOTE: If cylinders are rebored, oversize pistons and rings must be installed.

Deglaze Cylinder Bore

1. Deglaze cylinder bore using a rigid hone with a coarse grit stone initially and fine grit stone for the final finish.
2. Use hone as instructed by manufacture to obtain a 40° crosshatch pattern.

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

3. Clean cylinder walls using clean white rags and warm soapy water. Continue to clean cylinder until white rags show no discoloration.
4. Dry cylinder and apply a light coat of engine oil.

Rebore Cylinder Block

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

NOTE: The cylinder block can be rebored to use oversize pistons and rings—0.50 mm (0.020 in.). Have a reliable repair shop rebore the block, or use a drill press and honing tool. Rebore cylinder with honing tool to an initial (coarse grit stone) and a final (fine grit stone) bore according to below specifications. Align center of bore to drill press center.

5. Lower and raise hone until end extends **20—25 mm (0.75—1.0 in.)** past ends of cylinder.
6. Adjust hone stones until they contact narrowest point of cylinder walls.

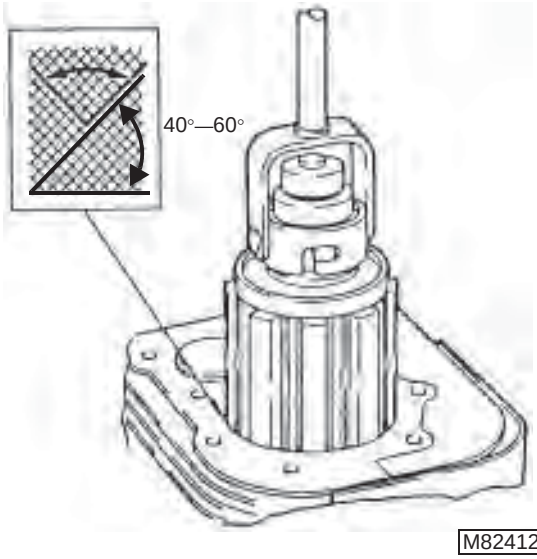
7. Coat inside of cylinder with honing oil. Turn hone by hand. Adjust if too tight.
8. Run drill press between **200—250 rpm**. Move hone up and down in cylinder approximately **20 times per minute**.

NOTE: Measure bore when cylinder is cool.

9. Stop press and check cylinder diameter.

*NOTE: Finish should not be smooth. It should have a **40—60° cross-hatch pattern**.*

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



M82412A

11. If cylinder bore exceeds wear limit, rebore cylinder or replace block.
12. Hone the cylinder an additional **0.007—0.009 mm (0.0003—0.0004 in.)** for final bore specifications. This allows for **0.020 mm (0.0008 in.)** shrinkage when cylinder cools.

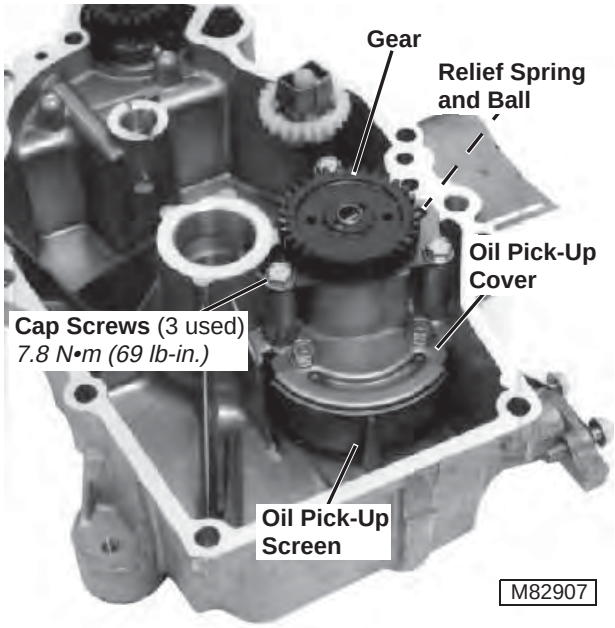
IMPORTANT: DO NOT use gasoline, kerosene, or commercial solvents to clean cylinder bores. Solvents will not remove all abrasives from cylinder walls.

13. Clean cylinder walls using clean white rags and water. Continue to clean cylinder until white rags show no discoloration.
14. Dry cylinder. Apply a light coat of clean engine oil.

OIL PUMP

Disassembly/Assembly

1. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-129.)



M82907

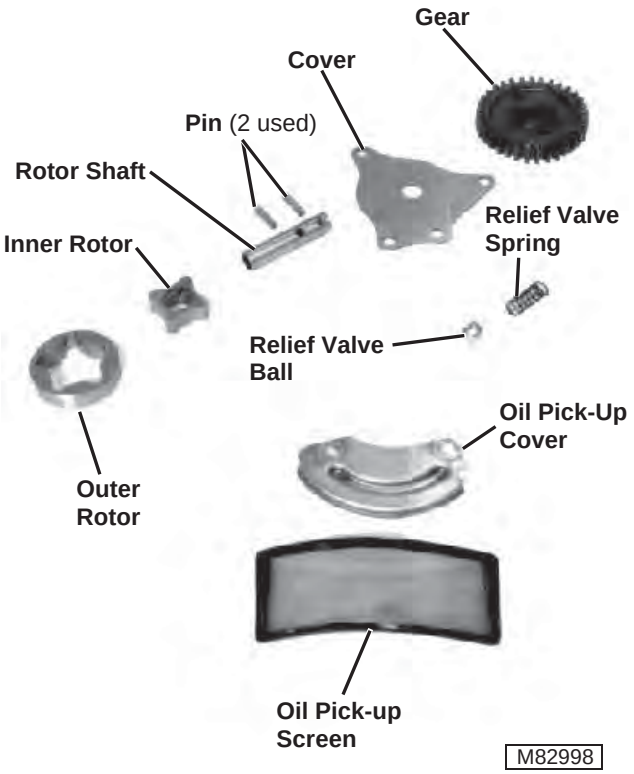
IMPORTANT: Oil pressure relief valve spring will be loose when oil pump assembly is removed.

2. Remove three cap screws and oil pump assembly.
3. Remove relief spring and ball.
4. Remove oil pick-up screen and cover.
5. Inspect all parts for wear. (See Inspection procedure.)

Assembly is done in the reverse order of disassembly.

- Fill rotor housing with engine oil for initial lubrication.
- Install oil pump assembly so that hole in the plate is centered over relief valve.
- Tighten cap screws to **7.8 N•m (69 lb-in.).**

Inspection



Inspect all parts for wear or damaged. Replace parts if necessary.

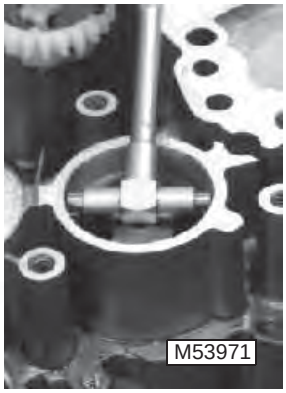




NOTE: Rotors and rotor shaft are replaced as a kit. If any of the parts show signs of wear or are scored, replace.

1. Measure rotor shaft diameter. If shaft O.D. is **less than 10.92 mm (0.430 in.)**, replace both shaft and outer rotor.
2. Measure rotor shaft bearing. If bearing I.D.s are **greater than 11.07 mm (0.436 in.)**, replace crankcase cover.





3. Measure outside diameter of outer rotor. If O.D. is **less than 40.43 mm (1.592 in.)**, replace both outer rotor and shaft.
4. Measure inside diameter of rotor bearing. If I.D. is **greater than 40.80 mm (1.606 in.)**, replace crankcase cover.





5. Measure thickness of outer rotor. If thickness is **less than 7.83 mm (0.308 in.)**, replace rotor.
6. Measure outer rotor bearing depth. If depth is **greater than 8.23 mm (0.324 in.)**, replace pump housing.
7. Measure inner and outer rotor clearance. If clearance is **greater than 0.3 mm (0.012 in.)**, replace both rotors.

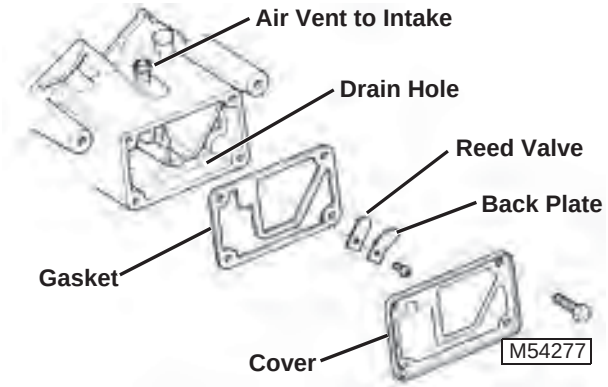


8. Measure relief valve spring. If free length is **less than 19.0 mm (0.748 in.)**, replace spring.

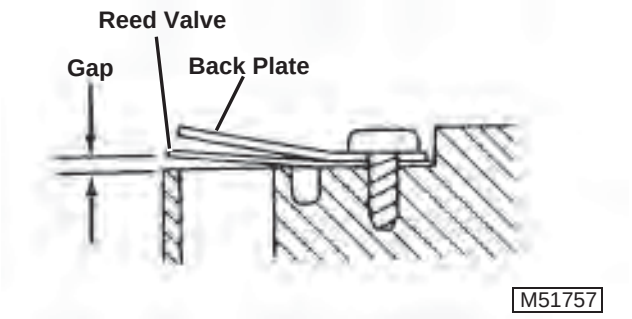
BREATHER

Inspection

1. Remove flywheel. (See FLYWHEEL—Removal/Installation on page 3-123.)



2. Remove breather cover and gasket. Discard gasket.
3. Check that drain hole in bottom of breather chamber is open.



4. Inspect reed valve for breakage, hairline cracks or distortion; replace if necessary.
5. Inspect back plate for damage or a rough contact surface; replace if necessary.
6. Check **reed valve tip air gap**. Gap should be **0.2 mm (0.008 in.)**. Replace reed valve if gap is greater than specifications.

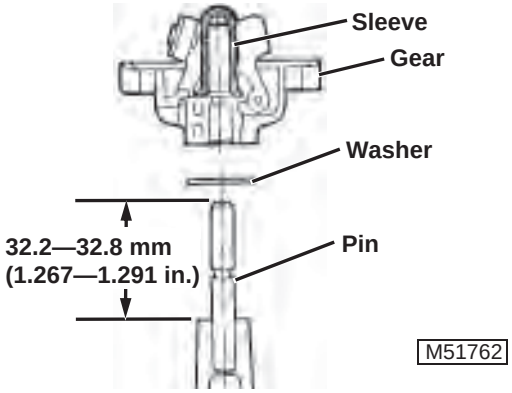
GOVERNOR

Inspection/Replacement

1. Remove crankcase cover. (See CRANKCASE COVER—Removal/Installation on page 3-129.)

IMPORTANT: Do not remove governor assembly or shaft unless damaged. Removal damages the assembly.

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



To replace governor:

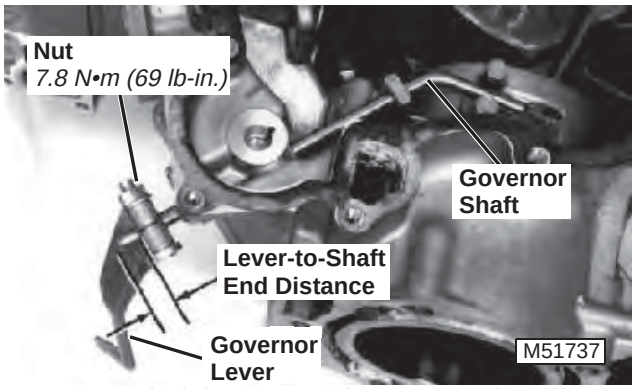
3. Use two screwdrivers to pry governor assembly from pin. DO NOT damage crankcase sealing surfaces.
   - If shaft is removed, press shaft back into block until it protrudes **32.2—32.8 mm (1.267—1.291 in.)**.
   - Install sleeve onto governor gear, properly engaging flyweights.
   - Install governor assembly onto shaft. Push down on assembly until it snaps into place. Check assembly for freedom of movement.

GOVERNOR SHAFT

Inspection/Replacement

NOTE: It is not necessary to remove governor shaft unless damaged.

1. Remove camshaft. (See CAMSHAFT AND TAPPETS—Removal/Installation on page 3-135.)



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

To replace governor shaft:

- Scribe a mark across shaft and lever to aid in installation.
- Loosen nut on lever.
- Remove lever and shaft.
- Install governor arm and align marks made during removal. Position lever **7 mm (0.276 in.)** from end of shaft.
- Tighten nut to **7.8 N•m (69 lb-in.).**

GOVERNOR SHAFT SEAL

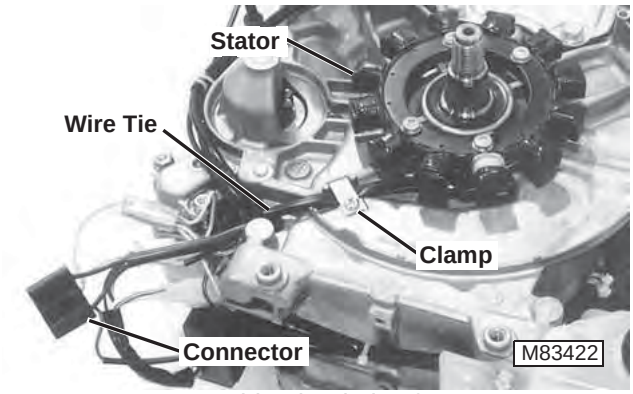
Replacement

1. Remove governor shaft. (See GOVERNOR SHAFT—Removal/Installation.)
2. Remove damaged seal using a screwdriver.
3. Install seal with lip toward engine using a driver set. Press in seal until **1.0 mm (0.040 in.) below crankcase surface**.

STATOR

Removal/Installation

1. Remove flywheel. (See FLYWHEEL—Removal/Installation on page 3-123.)
2. Cut wire tie from wiring harness.



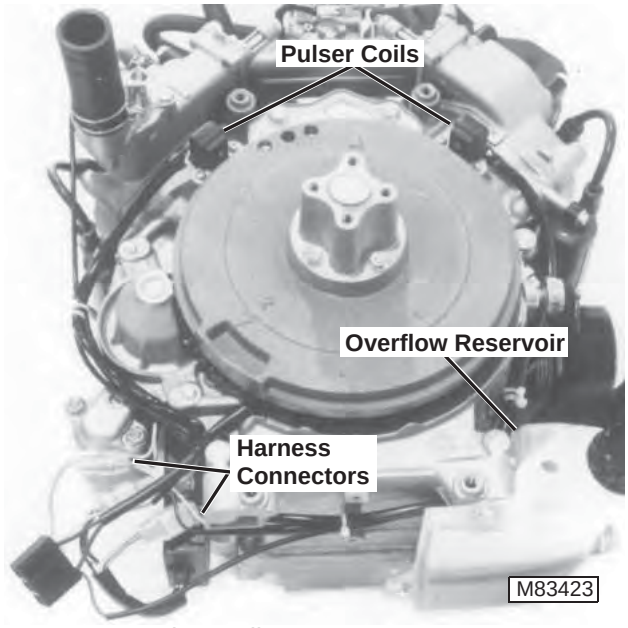
3. Remove stator wiring lead pins from connector.
4. Remove clamp.
5. Remove stator.

Installation is done in the reverse order of removal.

PULSER COILS

Replacement

1. Remove cooling air duct. (See COOLING AIR DUCT—Removal/Installation on page 3-121.)
2. Cut wire ties from wiring harness. Note wire routing and location of wire ties for installation.



3. Remove pulser coils.
4. Disconnect wiring harness connector.
5. Remove overflow reservoir, if necessary. (See OVERFLOW RESERVOIR—Removal/Installation on page 3-123.)

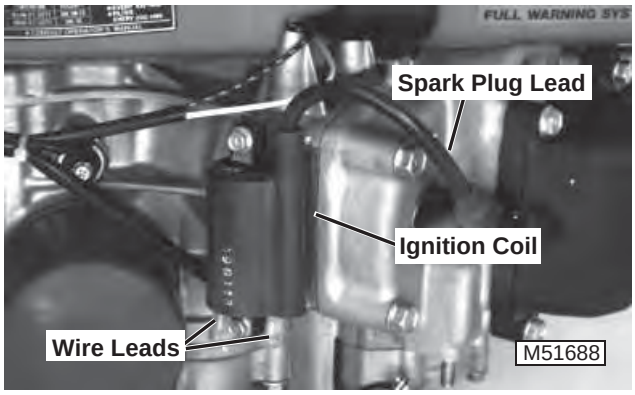
Installation is done in the reverse order of removal.

NOTE: Pulser coils are mounted in a fixed position. ***Air gap 0.35—1.13 mm (0.013—0.044 in.)****.*

- Install new wire ties where needed.

IGNITION COILS

Replacement

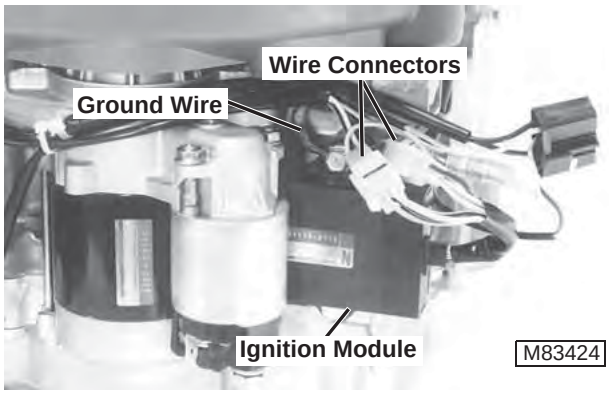


1. Disconnect wiring leads and spark plug lead.
2. Remove cap screws and coil.

Installation is done in the reverse order of removal.

IGNITION MODULE

Replacement



1. Disconnect wiring connectors.
2. Remove cap screws and ignition module.

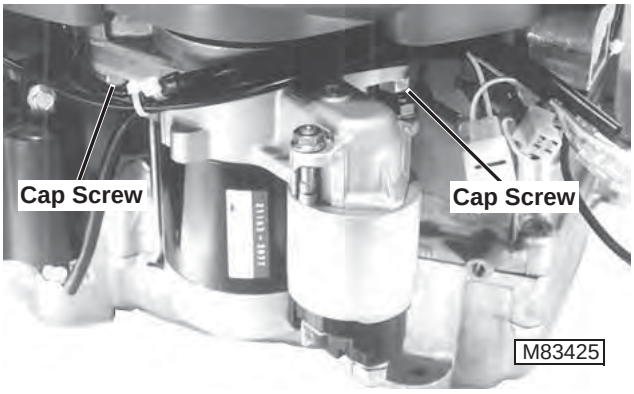
Installation is done in the reverse order of removal.

- When installing ignition module, put ground wire under cap screw.

STARTER

Removal/Installation

1. Remove ignition module. (See IGNITION MODULE—Replacement.)



2. Remove two cap screws and starter.

Installation is done in the reverse order of removal.

- Clean starter motor and engine mounting flange to ensure proper electrical contact.

Analyze Condition

The starter overheats because of:

- Long cranking.
- Armature binding.

The starter operates poorly because of:

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

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

Starter No-Load Amperage Draw and RPM Bench Tests

Reason:

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

Equipment:

- JT05712 Current Gun
- JT07270 Digital Pulse Tachometer
- Jumper Cables
- Jumper wire

Procedure:

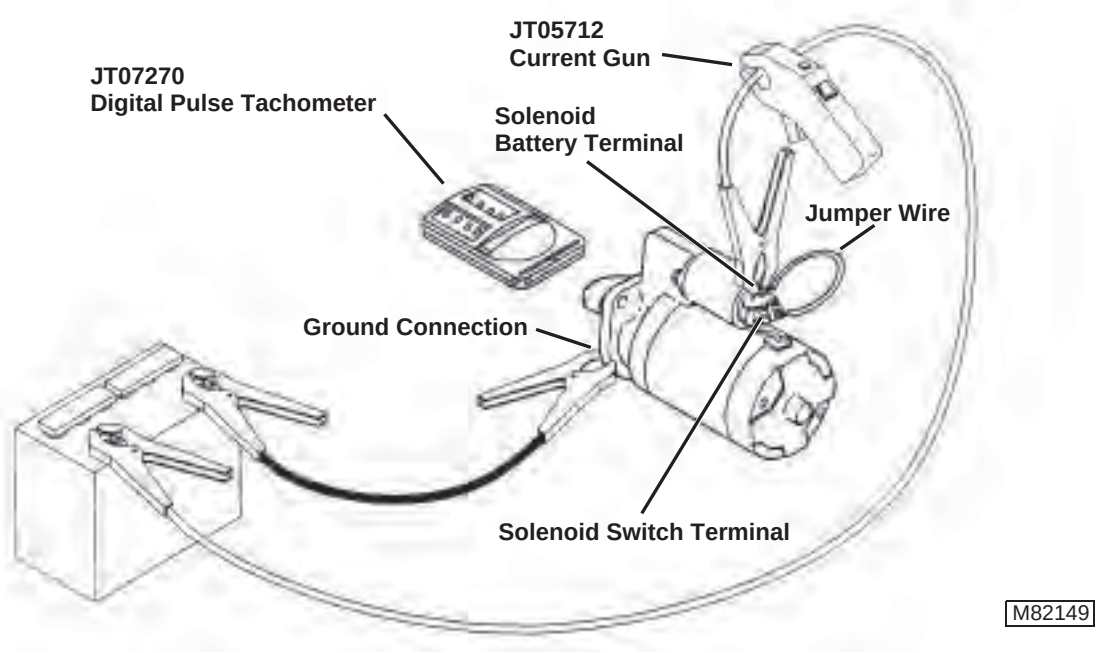
IMPORTANT: Complete this test in 20 seconds or less to prevent starter damage.

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

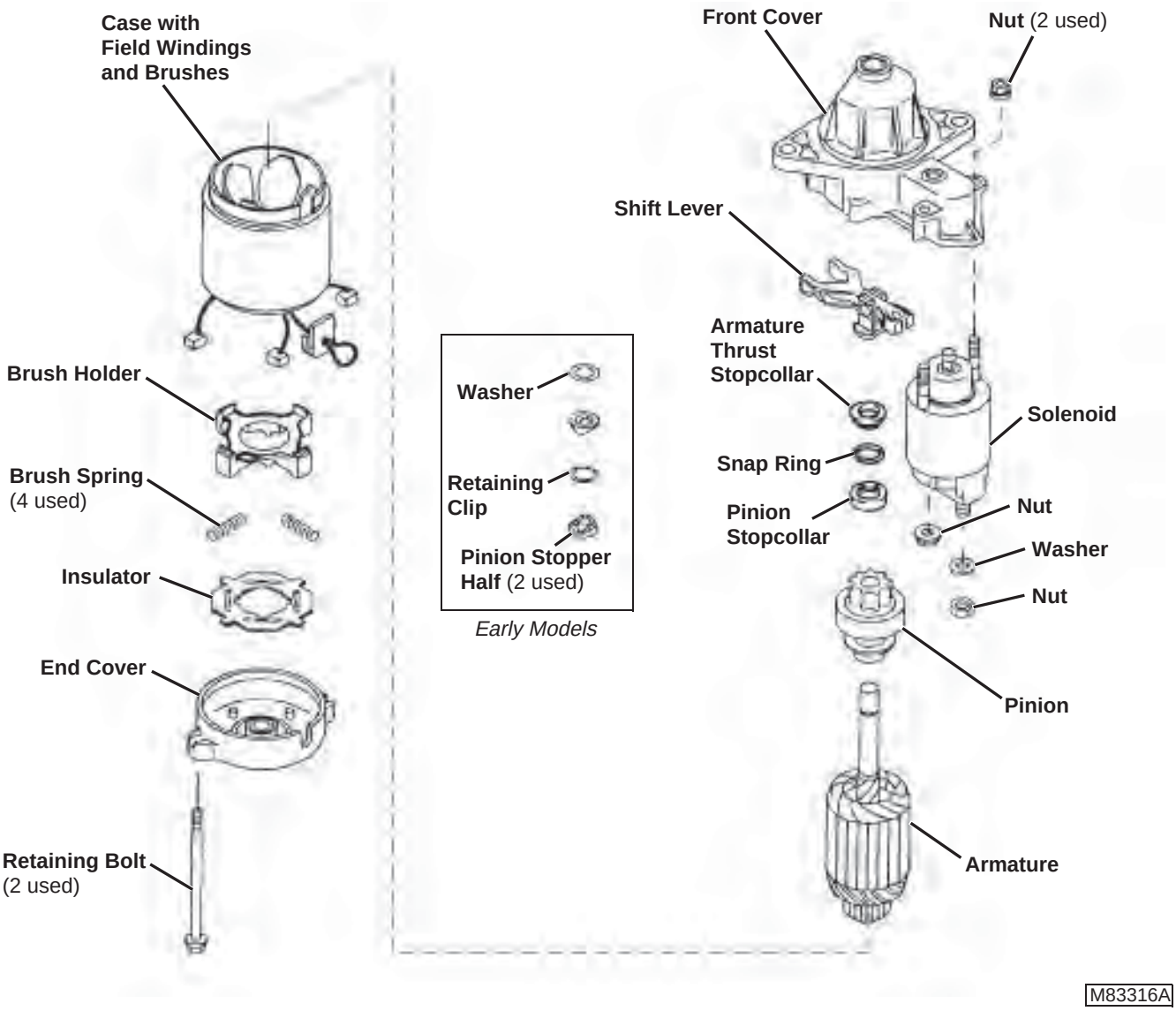
1. Remove starter from engine and clamp in bench vise. (See STARTER–Removal/Installation on page 3–143.)
2. Connect jumper cables to a 12-volt battery.
3. Connect positive (+) cable to solenoid battery terminal.
4. Connect negative (–) cable to starter body.
5. Attach Current Gun to positive (+) cable.
6. Use a jumper wire to briefly connect solenoid battery terminal to solenoid switch terminal. Starter should engage and run.
7. Read and record starter amperage and rpm.

Results:

- If solenoid "clicks" or chatters and motor does not turn, replace solenoid.
- If pinion gear engages and motor doesn't turn, repair or replace starter motor.
- If starter engages and runs, but amperage is **more than 50 Amps at 6000 rpm**, repair or replace starter.
- If free-running rpm is **less than 6000 rpm**, repair or replace starter.



Disassembly/Assembly



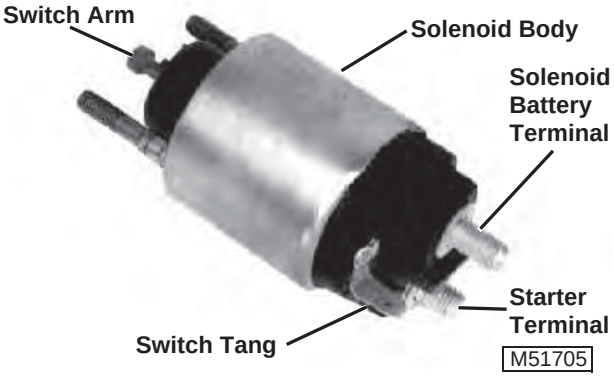
1. Mark body and covers to aid in alignment for assembly.
2. Separate pinion stopper halves to remove retaining clip to remove starter drive.
3. Inspect parts for wear or damage. Replace parts as necessary.
4. Test solenoid, starter armature and brushes. (See Inspection/Test procedures on page 3-146.)

Assembly is done in the reverse order of disassembly.

- Apply a very light coating of multipurpose grease to:
  - Sliding surfaces of armature and solenoid shift lever pivots.
  - Armature shaft spline.
  - Points where shaft contacts cover.
- Always replace retaining clip with new.

Inspection/Test

1. Measure brush lengths. If any one brush length is less than **6.0 mm (0.240 in.)**, replace all brushes. Brushes must be soldered to brush leads.
2. Inspect brush springs for wear or damage. Replace if necessary.



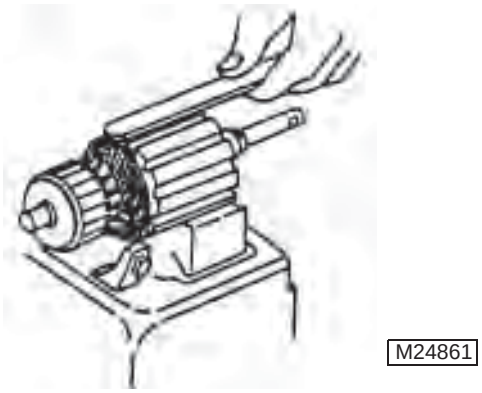
3. Test solenoid:
   - Check solenoid battery and starter terminals for continuity. There should be no continuity.
   - Depress switch arm. There should be continuity when arm is fully depressed.
   - Test for open circuits between starter terminal and switch tang. There should be no continuity.
   - Test for open circuits between switch tang and body. There should be no continuity.

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



4. Test brush/field coil housing assembly:
   - There should be continuity between positive brushes.
   - There should be continuity between negative (field coil) brushes and bare-metal area of the housing.
   - There should NOT be continuity between positive brushes and bare-metal areas of the housing.
5. Test Starter Armature:

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



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

NOTE: A shorted circuit most often occurs because of copper dust or filings between two commutator segments.

If test indicates shorted circuit windings, clean commutator of dust and filings. Check armature again. If test still indicates a short circuit, replace armature.



Test for grounded windings using an ohmmeter or test light.

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

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



Test for open circuit windings using an ohmmeter or test light.

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



This page intentionally left blank.

CONTENTS

Page

ENGINE—KOHLER CV15S(LX173)

SPECIFICATIONS
ENGINE DESIGNATION 4-4
TEST AND ADJUSTMENT SPECIFICATIONS 4-4
REPAIR SPECIFICATIONS 4-5
SPECIAL OR ESSENTIAL TOOLS 4-9
OTHER MATERIALS 4-10
SERVICE PARTS KITS 4-10

TROUBLESHOOTING
TROUBLESHOOTING CHART 4-11
ENGINE TROUBLESHOOTING GUIDE 4-13
STARTER MOTOR TROUBLESHOOTING GUIDE 4-17

TESTS AND ADJUSTMENTS
THROTTLE CABLE ADJUSTMENT 4-18
CHOKE ADJUSTMENT 4-18
GOVERNOR ADJUSTMENT 4-19
FAST IDLE SPEED ADJUSTMENT 4-19
SLOW IDLE SPEED ADJUSTMENT 4-20
CYLINDER COMPRESSION TEST 4-21
CYLIDER LEAKDOWN TEST 4-21
AUTOMATIC COMPRESSION RELEASE (A.C.R.) TEST 4-23
CRANKCASE VACUUM TEST 4-24
ENGINE OIL PRESSURE TEST 4-25
FUEL PUMP TEST 4-26
SPARK PLUG GAP ADJUSTMENT 4-27

REPAIR
FUEL TANK 4-28
THROTTLE CONTROL LEVER AND CABLE ASSEMBLY 4-28
ENGINE 4-29
MUFFLER 4-30
AIR CLEANER 4-31
CARBURETOR
Removal/Installation 4-32
Clean/Inspect/Rebuild 4-32
SELF-RELIEVING CHOKE 4-33
FUEL PUMP 4-34
BREATHER 4-35
BLOWER HOUSING 4-35
FLYWHEEL 4-36
ROCKER ARM COVER 4-36
ROCKER ARMS 4-37
INSPECT PUSH ROD 4-37

Page

REPAIR, continued

CYLINDER HEAD AND VALVES
Removal/Installation 4-37
Disassembly/Assembly 4-38
Inspection 4-38
ANALYZE VALVES 4-40
RECONDITION VALVE SEATS 4-41
LAP VALVES 4-41
OIL PAN
Removal 4-41
Installation 4-42
Seal Replacement 4-42
CAMSHAFT
Removal/Installation 4-43
Inspection 4-43
HYDRAULIC VALVE LIFTERS
Removal/Installation 4-44
Inspection 4-44
BALANCER SHAFT
Removal/Installation 4-45
Inspection 4-45
PISTON AND CONNECTING ROD
Removal 4-46
Installation 4-46
Disassembly 4-47
Inspection 4-47
Assembly 4-49
ANALYZE PISTON RING WEAR 4-50
ANALYZE PISTON WEAR
Detonation 4-51
Pre-Ignition 4-51
Improper Rod And Piston Alignment 4-52
Cylinder Bored Improperly 4-52
ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR 4-52
CRANKSHAFT AND MAIN BEARING
Removal/Installation 4-52
Inspection 4-52
CRANKCASE OIL SEAL 4-54
ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR 4-54

Page

REPAIR, continued

CYLINDER BLOCK
- Inspection 4-54
- Deglaze Cylinder Bore 4-55
- Rebore Cylinder Block 4-55

OIL PICKUP 4-56

OIL PUMP
- Relief Valve Inspection 4-56
- Removal/Inspection/Installation 4-56

GOVERNOR
- Removal/Installation 4-57
- Inspection 4-57

ARMATURE WITH COIL
- Removal/Installation 4-58
- Air Gap Adjustment. 4-58

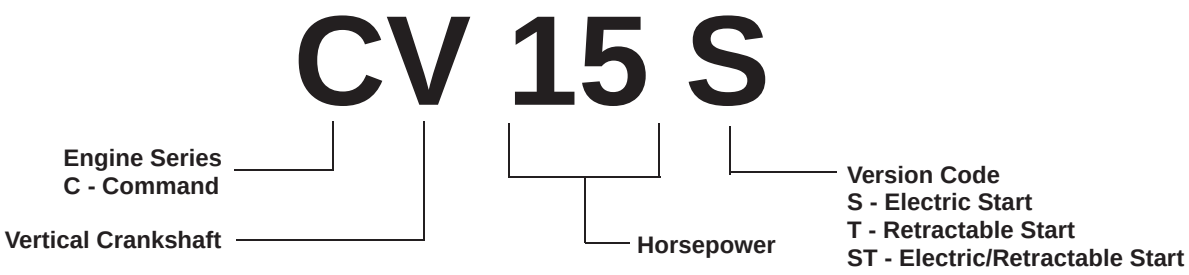
STATOR. 4-59

STARTER
- Removal/Installation 4-59
- Analyze Condition. 4-59
- Replace Bendix Drive 4-60
- Replace Brushes 4-60
- Inspection/Test 4-61

VOLTAGE REGULATOR/RECTIFIER 4-61

SPECIFICATIONS

ENGINE DESIGNATION



TEST AND ADJUSTMENT SPECIFICATIONS

Engine
Carburetor/Throttle
- Slow Idle Speed (Carburetor) . . . . . 1550 ±75 rpm
- Slow Idle Speed (Throttle Control Arm) . . . . . 1650 ±75 rpm
- Fast Idle Speed . . . . . 3350 ±100 rpm
- Throttle Plate Cap Screw Torque
  - New (Thread Forming) . . . . . 10.7 N•m (95 lb-in.)
  - Reused . . . . . 7.3 N•m (65 lb-in.)
- Governor Arm Clamp Nut Torque . . . . . 10 N•m (89 lb-in.)

Fuel Pump
- Pressure (cranking rpm for 3–5 seconds) (Minimum) . . . . . 6.12 kPa (0.9 psi)
- Flow (cranking rpm for 15 seconds) (Minimum) . . . . . 30 ml (1.0 U.S. oz)
- Cap Screw Torque
  - New (Thread Forming) . . . . . 9.0 N•m (80 lb-in.)
  - Reused . . . . . 7.3 N•m (65 lb-in.)
- Oil Capacity (With Filter) . . . . . 1.8 L (1.9 U.S. qt) (3.8 U.S. pt)
- Oil Filter Torque . . . . . 5.7–9.0 N•m (50–80 lb-in.)
- Oil Filter Drain Plug Torque . . . . . 7.3–9.0 N•m (65–80 lb-in.)
- Crankcase Oil Drain Plug Torque . . . . . 13.6 N•m (120 lb-in.)
- Oil Pressure (Approximate)
  - FAST Idle Relief (Maximum) . . . . . 413.7 kPa (60 psi)
  - FAST Idle (Minimum) . . . . . 103.4 kPa (15 psi)
  - SLOW Idle (Minimum) . . . . . 20.7–34.5 kPa (3–5 psi)
- Oil Pressure Switch Continuity (On) . . . . . 20.7–34.5 kPa (3–5 psi)
- Oil Pressure Switch Torque . . . . . 7.9 N•m (70 lb-in.)
- Valve Adjustment . . . . . None (hydraulic lifters)
- Crankcase Vacuum (3350 rpm at operating temperature)
  (Minimum) . . . . . 1.27–38.1 cm (0.5–15.0 in.) of water movement
- Automatic Compression Release Minimum Lift (Engine Cold) . . . . 0.25 mm (0.01 in.)
- Cylinder Compression
  - Normal . . . . . 551.6 kPa (80 psi)
  - Minimum . . . . . 344.7 kPa (50 psi)

Ignition Module
- Air Gap . . . . . 0.203–0.305 mm (0.008–0.012 in.)
- Cap Screw Torque
  - New (Thread Forming) . . . . . 6.2 N•m (55 lb-in.)
  - Reused . . . . . 4.0 N•m (35 lb-in.)

TEST AND ADJUSTMENT SPECIFICATIONS (Continued)

Spark Plug
- Gap . . . . . 1.02 mm (0.040 in.)
- Torque . . . . . 40 N•m (354 lb-in.)

REPAIR SPECIFICATIONS

- Engine Mounting Cap Screw Torque . . . . . 34 N•m (300 lb-in.)
- Muffler Nut Torque . . . . . 24.4 N•m (216 lb-in.)
- Air Cleaner Housing Nut Torque . . . . . 9.9 N•m (88 lb-in.)
- Carburetor
  - Throttle and Choke Plate Cap Screw Torque . . . . . 0.9–1.4 N•m (8–12 lb-in.)
  - Fuel Shutoff Solenoid Torque . . . . . 5.6 N•m (50 lb-in.)
  - Float Bowl Nut Torque . . . . . 5.1–6.2 N•m (45–55 lb-in.)
- Flywheel
  - Fan Cap Screw Torque . . . . . 9.9 N•m (88 lb-in.)
  - Flywheel Cap Screw Torque . . . . . 66.4 N•m (49 lb-ft.)
- Rocker Arm Assembly
  - Rocker Arm Cover Cap Screw Torque (in Sequence)
    - New (Thread Forming) . . . . . 10.7 N•m (95 lb-in.)
    - Reused . . . . . 7.3 N•m (65 lb-in.)
  - Rocker Arms Rocker Pivot Cap Screw Torque . . . . . 14 N•m (124 lb-in.)
  - Rocker Shaft O.D.
    - Standard . . . . . 15.90–15.85 mm (0.626–0.624 in.)
      - Wear Limit (Minimum) . . . . . 15.73 mm (0.619 in.)
  - Rocker Arm Bearing I.D.
    - Standard . . . . . 15.837–16.127 mm (0.6235–0.6349 in.)
      - Wear Limit (Maximum) . . . . . 16.13 mm (0.635 in.)
  - Push Rods Bend (Maximum) . . . . . 0.76 mm (0.03 in.)
- Cylinder Head and Valves
  - Cap Screw Torque (in Sequence)
    - Initial . . . . . 20 N•m (177 lb-in.)
    - Final . . . . . 40.7 N•m (360 lb-in.)
  - Cylinder Head Flatness (Maximum) . . . . . 0.076 mm (0.003 in.)
  - Intake Valve Guide I.D.:
    - Standard . . . . . 7.038–7.058 mm (0.2771–0.2779 in.)
      - Wear Limit (Maximum) . . . . . 7.134 mm (0.2809 in.)
    - Oversize . . . . . 7.288–7.308 mm (0.287–0.288 in.)
      - Wear Limit (Maximum) . . . . . 7.384 mm (0.291 in.)
  - Intake Valve Stem O.D.:
    - Standard . . . . . 6.982–7.000 mm (0.275–0.276 in.)
    - Oversize . . . . . 7.232–7.250 mm (0.284–0.285 in.)
  - Exhaust Valve Guide I.D.
    - Standard . . . . . 7.038–7.058 mm (0.2771–0.2779 in.)
      - Wear Limit (Maximum) . . . . . 7.159 mm (0.2819 in.)
    - Oversize . . . . . 7.238–7.308 mm (0.285–0.288 in.)
      - Wear Limit (Maximum) . . . . . 7.409 mm (0.301 in.)
  - Exhaust Valve Stem O.D.:
    - Standard . . . . . 6.970–6.988 mm (0.274–0.275 in.)
    - Oversize . . . . . 7.220–7.238 mm (0.284–0.285 in.)

REPAIR SPECIFICATIONS (Continued)

Cylinder Head and Valves, continued
- Valve Stem-to-Guide Clearance (Maximum)
  - Intake . . . . . 0.038–0.076 mm (0.0015–0.0030 in.)
  - Exhaust . . . . . 0.050–0.088 mm (0.0020–0.0035 in.)
- Valve Margin (Minimum) . . . . . 1.5 mm (0.059 in.)
- Valve Stem Bend (Maximum) . . . . . 0.076 mm (0.003 in.)
- Valve Seat Angle (Intake and Exhaust) . . . . . 89°
- Valve Face Angle (Intake and Exhaust) . . . . . 45°
- Valve Lift (Minimum)
  - Intake . . . . . 8.9 mm (0.353 in.)
  - Exhaust . . . . . 9.14 mm (0.360 in.)

Crankcase Cover
- Mounting Cap Screw Torque (in Sequence) . . . . . 24.4 N•m (216 lb-in.)
- Crankshaft Seal Installation Depth . . . . . .2.49–2.98 mm (0.098–0.117 in.) . . . . . or until its top surface is flush with machined bore opening

Camshaft
- Journal O.D.
  - Standard . . . . . 19.962–19.975 mm (0.7859–0.7864 in.)
    - Wear Limit (Minimum) . . . . . 19.959 mm (0.7858 in.)
- Bearing Bore I.D. (Crankcase and Crankcase Cover)
  - Standard . . . . . 20.000–20.025 mm (0.7874–0.7884 in.)
    - Wear Limit (Maximum) . . . . . 20.038 mm (0.7889 in.)
- Clearance . . . . . 0.025–0.063 mm (0.0010–0.0025 in.)
- End Play (with shims) . . . . . 0.076–0.127 mm (0.003–0.005 in.)

Hydraulic Valve Lifters
- Lifter-to-Bore Clearance . . . . . 0.0124–0.0501 mm (0.0005–0.0020 in.)

Balancer Shaft Assembly
- Balance Shaft Bearing O.D.
  - Standard . . . . . 19.962–19.975 mm (0.7859–7864 in.)
    - Wear Limit (Minimum) . . . . . 19.959 mm (0.7858 in.)
- Bearing Bore I.D. (Crancase and Crankcase Cover)
  - Standard . . . . . 20.000–20.025 mm (0.7874–0.7884 in.)
    - Wear Limit (Maximum) . . . . . 20.038 mm (0.7889 in.)
- Clearance . . . . . 0.025–0.063 mm (0.0009–0.0025 in.)
- End Play (Free) . . . . . 0.0575–0.3625 mm (0.0023–0.0143 in.)

Connecting Rod
- Cap Screw Torque
  - Step Down Shank Bolt . . . . . 14.7 N•m (130 lb-in.)
- Crankshaft Clearance (Big End)
  - Standard . . . . . 0.030–0.055 mm (0.0012–0.0022 in.)
    - Wear Limit (Maximum) . . . . . 0.07 mm (0.0025 in.)
  - Side . . . . . 0.18–0.41 mm (0.007–0.016 in.)
- Piston Pin Clearance (Small End) . . . . . .0.015–0.028 mm (0.0006–0.0011 in.)
- Piston Pin End I.D.
  - Standard . . . . . 19.015–19.023 mm (0.7486–0.7489 in.)
    - Wear Limit (Maximum) . . . . . 19.036 mm (0.7495 in.)

REPAIR SPECIFICATIONS (Continued)

Cylinder Bore, Piston and Rings
- Cylinder Bore I.D.
  - Standard . . . . . 90.000–90.025 mm (3.5433–3.5443 in.)
    - Wear Limit (Maximum) . . . . . 90.63 mm (3.5681 in.)
  - Out-of-Round (Maximum) . . . . . 0.12 mm (0.0047 in.)
  - Taper (Maximum) . . . . . 0.05 mm (0.0020 in.)
- Piston-To-Pin Clearance . . . . . 0.006–0.017 mm (0.0002–0.0007 in.)
- Piston Pin Bore I.D.
  - Standard . . . . . 19.006–19.012 mm (0.7483–0.7485 in.)
    - Wear Limit (Maximum) . . . . . 19.025 mm (0.7490 in.)
- Piston Pin O.D.
  - Standard . . . . . 18.995–19.000 mm (0.7478–0.7480 in.)
    - Wear Limit (Minimum) . . . . . 18.994 mm (0.74779 in.)
- Top Compression Ring-To-Groove Side Clearance . . . . . 0.060–0.105 mm (0.0024–0.0041 in.)
- Middle Compression Ring-To-Groove Side Clearance . . . . . 0.040–0.085 mm (0.0016–0.0034 in.)
- Oil Control Ring-To-Groove Side Clearance . . . . . 0.176–0.026 mm (0.0069–0.0010 in.)
- Top and Center Compression Ring End Gap
  - Standard . . . . . 0.26–0.51 mm (0.010–0.020 in.)
  - Used Bore Wear Limit (Maximum) . . . . . 0.77 mm (0.030 in.)
- Piston Thrust Face O.D.
  - Standard . . . . . 89.951–89.969 mm (3.5413–3.5420 in.)
    - Wear Limit (Minimum) . . . . . 89.824 mm (3.5363 in.)
- Piston Thrust Face-To-Cylinder Bore Clearance
  - Standard . . . . . 0.031–0.043 mm (0.0012–0.0016 in.)

Crankshaft
- End Play (Free) . . . . . 0.0575–0.4925 mm (0.0023–0.0194 in.)
- Crankshaft Bore I.D. (Cylinder Block Half)
  - Standard . . . . . 44.965–45.003 mm (1.7703–1.7718 in.)
    - Wear Limit (Maximum) . . . . . 45.016 mm (1.7723 in.)
  - Clearance (Standard) . . . . . 0.03–0.09 mm (0.0012–0.0035 in.)
- Crankshaft Bore (Crankcase Cover Half)
  - Standard . . . . . 44.965–45.003 mm (1.7703–1.7718 in.)
    - Wear Limit (Maximum) . . . . . 45.016 mm (1.7723 in.)
  - Clearance (Standard) . . . . . 0.03–0.09 mm (0.0012–0.0035 in.)
- Main Bearing Journal O.D. (Flywheel End)
  - Standard . . . . . 44.913–44.935 mm (1.7682–1.7691 in.)
    - Wear Limit (Minimum) . . . . . 44.84 mm (1.765 in.)
  - Taper (Maximum) . . . . . 0.022 mm (0.0009 in.)
  - Out-of-Round (Maximum) . . . . . 0.025 mm (0.0010 in.)
  - Running Clearance (Maximum) . . . . . 0.03–0.08 mm (0.0012–0.0031 in.)
- Main Bearing Journal O.D. (Crankcase Cover End)
  - Standard . . . . . 41.915–41.935 mm (1.6502–1.6510 in.)
    - Wear Limit (Minimum) . . . . . 41.86 mm (1.648 in.)
  - Taper (Maximum) . . . . . 0.020 mm (0.0008 in.)
  - Out-of-Round (Maximum) . . . . . 0.025 mm (0.0010 in.)
  - Running Clearance (Maximum) . . . . . 0.03–0.08 mm (0.0012–0.0031 in.)

REPAIR SPECIFICATIONS (Continued)

- Crankshaft, continued
  - Connecting Rod Journal O.D.
    - Standard . . . . . 38.958–38.970 mm (1.5338–1.5343 in.)
      - Wear Limit (Minimum) . . . . . 38.94 mm (1.5328 in.)
    - Taper (Maximum) . . . . . 0.012 mm (0.0005 in.)
    - Out-of-Round (Maximum) . . . . . 0.025 mm (0.0010 in.)
  - Crankshaft Total Indicated Runout (TIR)
    - PTO End (In Engine) . . . . . 0.15 mm (0.0059 in.)
    - Entire Crankshaft (On Bench V-Blocks) . . . . . 0.10 mm (0.0039 in.)
- Oil Pump Assembly
  - Oil Pump Cover Screw
    - New (Thread Forming) . . . . . 6.2 N•m (55 lb-in.)
    - Reused . . . . . 4.0 N•m (35 lb-in.)
  - Oil Pump Relief Valve Spring Free Length . . . . . 25.1968 mm (0.992 in.)
  - Oil Pump Cover To Rotor Clearance . . . . . 0.076 mm (0.003 in.)
- Governor Assembly
  - Governor Control Panel Screw . . . . . 9.9 N•m (88 lb-in.)
  - Crankcase Control Arm Cross Shaft Bore I.D.
    - Standard . . . . . 6.025–6.050 mm (0.2372–0.2382 in.)
      - Wear Limit (Maximum) . . . . . 6.063 mm (0.2387 in.)
  - Control Arm Cross Shaft O.D.
    - Standard . . . . . 5.975–6.000 mm (0.2352–0.2362 in.)
      - Wear Limit (Minimum) . . . . . 5.962 mm (0.2347 in.)
    - Crankcase Bore-To-Cross Shaft Clearance . . 0.025–0.075 mm (0.0010–0.0030 in.)
  - Gear Shaft O.D.
    - Standard . . . . . 5.990–6.000 mm (0.2358–0.2362 in.)
      - Wear Limit (Minimum) . . . . . 5.977 mm (0.2353 in.)
    - Gear Shaft-To-Gear Bore Clearance . . . . . 0.015–0.140 mm (0.0006–0.0055 in.)
  - Gear Shaft Installation Depth . . . . . 32.639–32.842 mm (1.285–1.293 in.)
- Stator
  - Cap Screw Torque . . . . . 4.0 N•m (35 lb-in.)
- Starter
  - Mounting Cap Screw Torque . . . . . 24 N•m (216 lb-in.)

SPECIAL OR ESSENTIAL TOOLS

NOTE: Order tools according to information given in the U.S. SERVICEGARD™ Catalog or in the European Microfiche Tool Catalog (MTC). Some tools may be available from a local supplier

JT07270 Digital PulseTachometer
Used to test SLOW and FAST idle speeds and starter performance.

JDM59 Compression Gauge
Used to test engine compression.

JDM74A5 Spark Plug Ground
Used to ground ignition system to prevent engine from accidentally starting during various tests.

45M7036 Pin
Used to hold throttle arm when adjusting carburetor.

Dial Indicator
Used to measure push rods and valves for bending. Also used to measure crankshaft end play.

D20020WI Standard Size Valve Guide Reamer (7.05 mm)
Used to clean or size valve guide to original size.

JDG705 Oversize Valve Guide Reamer (7.25 mm)
Used to bore valve guides to proper size for oversize valves.

JDM70 Valve Spring Compressor.
Used to remove and install valve springs

JT05697 U-Tube Manometer Kit
Used to test crankcase vacuum. Contains #5 plug and the following:

JT05703 Barb Fitting
Used to connect U-tube manometer to engine for Crankcase Vacuum Test.

JT05699 Line
Used to connect U-tube manometer to engine for Crankcase Vacuum Test.

JT05698 U-Tube Manometer
Used to test crankshaft vacuum.

JT03503 Crankcase Vacuum Test Kit
Used to test crankcase vacuum.

AMT122553 Oil Pressure Test Kit.
Used to perform Oil Pressure Test.

OTHER MATERIALS

Number	Name	Use
M79292	MPG-2® Multipurpose Polymer Grease	Apply to engine crankshaft.
	SCOTCH-BRITE® Abrasive Sheets/Pads	Clean cylinder head.
	Valve Guide Cleaner	Clean valve guides.
	Stanisol (or Kerosene)	Finish ream valve guides.
	Prussian Blue Compound	Check valve seat contact.
	Lithium Base Grease	Pack oil seals.
	Zinc Oxide/Wood Alcohol	Check block for cracks.
	Mineral Spirits	Clean armature.
	Valve Lap Compound	Lap valves.
LOCTITE® PRODUCTS U.S./ Canadian/ LOCTITE No.		
TY15130/N/A/395	Form-in-Place Gasket	Apply to rocker arm cover mating surfaces.

SERVICE PARTS KITS

The following kits are available through your parts catalog:

- Camshaft Shim Kit
- Oversize Piston and Ring Kits
- Undersize Connecting Rod
- Oil Pressure Test Kit.

MPG-2® is a registered trademark of DuBois USA.
LOCTITE® is a registered trademark of the Loctite Corp.
SCOTCH-BRITE® is a registered trademark of the 3M Co.

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 irratically	Engine dies frequently	Engine backfires (afterbang)	Engine surges, or has uneven or uncontrolled rpm	Engine has low power	Engine has no spark	Engine will not crank	Lack of fuel in carburetor	Engine floods	Exhaust smoke black or uses too much fuel	Exhaust smoke blue or has excessive oil consumption	Engine has low oil pressure	Fuel in oil	Engine overheats	Excessive engine noise or vibration
Spark plug fouled, defective, or gap not correct. Incorrect spark plug.	●	●				●	●			●	●			●	●	
Defective ignition components.	●	●	●	●	●	●	●			●	●			●		
Starter worn. Cranking rpm too slow.	●							●								
Fuel filter or line restricted. Fuel pump weak, restricted, or leaking. Fuel stale, contains water, or wrong type.	●	●	●	●	●	●			●		●	●				
Fuel pump not operating.	●	●							●							
Air filter element(s) plugged, oil soaked, or restricted.	●	●			●	●				●	●			●		
Choke, throttle, or governor linkage misadjusted. Carburetor misadjusted.	●	●	●	●	●	●			●	●	●			●		
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets.	●	●	●	●	●	●			●					●		
Carburetor, intake & exhaust manifolds, or cylinder head gaskets leaking or damaged.	●	●		●	●	●										●
Low compression from worn piston, rings, cylinder, valves or warped head.	●	●				●						●		●		●

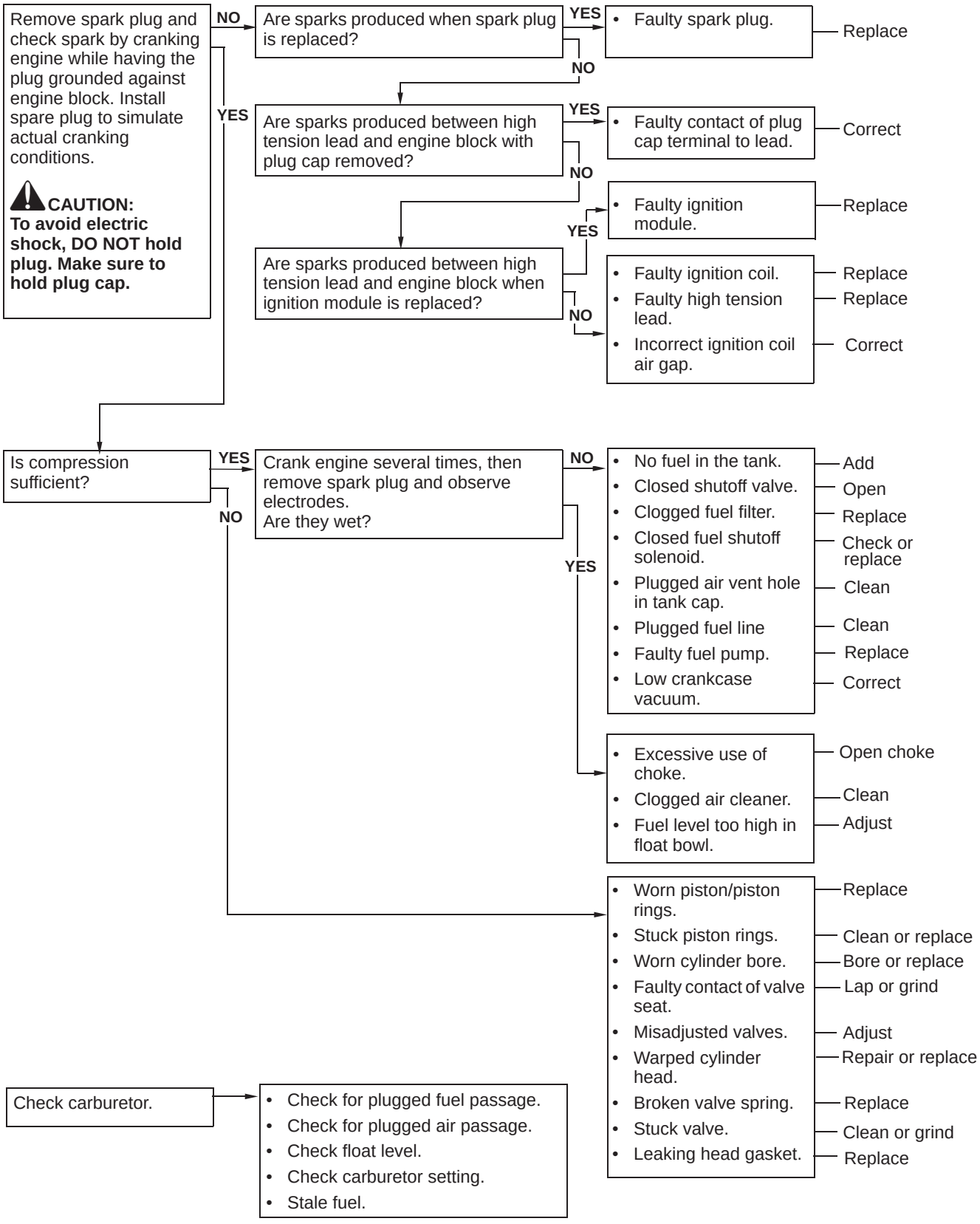
Continued on next page.

ENGINE AND FUEL SYSTEM TROUBLESHOOTING CHART (Continued)

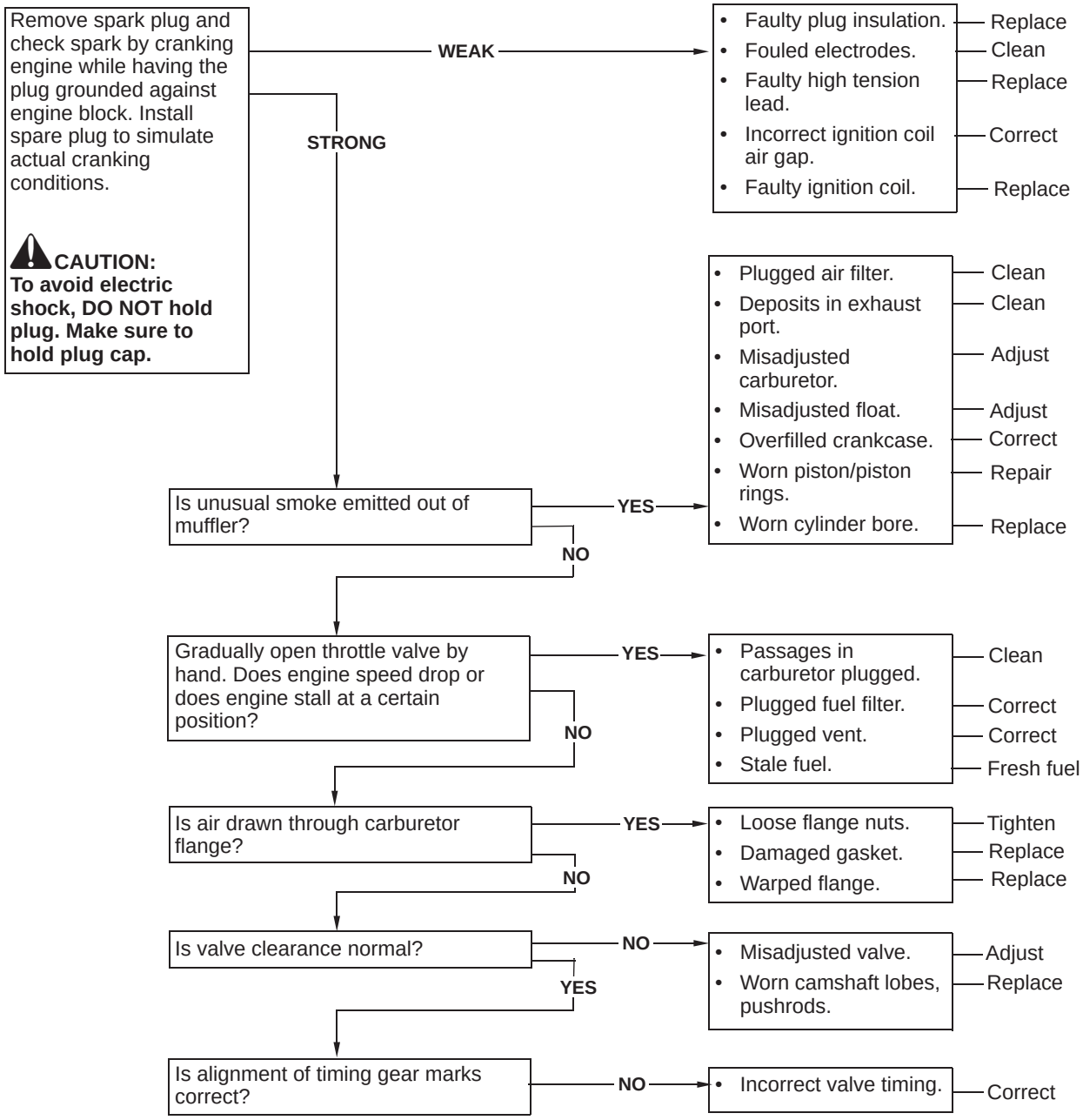
PROBLEM OR SYMPTOM / CHECK OR SOLUTION	Engine cranks but will not start or starts hard	Engine will not stay running, runs rough, or irratically	Engine dies frequently	Engine backfires (afterbang)	Engine surges, or has uneven or uncontrolled rpm	Engine has low power	Engine has no spark	Engine will not crank	Lack of fuel in carburetor	Engine floods	Exhaust smoke black or uses too much fuel	Exhaust smoke blue or has excessive oil consumption	Engine has low oil pressure	Fuel in oil	Engine overheats	Excessive engine noise or vibration
Valve clearance incorrect. Burned or warped valves and seats. Defective springs. Defective ACR.	●	●		●		●										
Engine oil viscosity or level incorrect. Engine oil filter restricted.												●	●		●	●
Engine gaskets or seals leaking.	●	●		●	●	●						●	●			●
Crankcase breather restricted, reed valve damaged, clearance incorrect, or drain hole plugged.		●			●	●						●				
Valve guides or seals worn or leaking. Valve stems worn.	●					●						●				
Worn, stuck, or broken piston rings. Cylinder bore worn. Check compression and vacuum.	●	●				●						●				
Connecting rod or crankshaft bearings worn. Internal wear limits out of specification.						●							●		●	●
Battery cables corroded or loose, or battery weak.		●	●				●	●								
Clogged cooling fins or air intake screen.															●	

ENGINE TROUBLESHOOTING GUIDE

Engine Hard To Start or Will Not Start



Engine Malfunctions at Low Speed



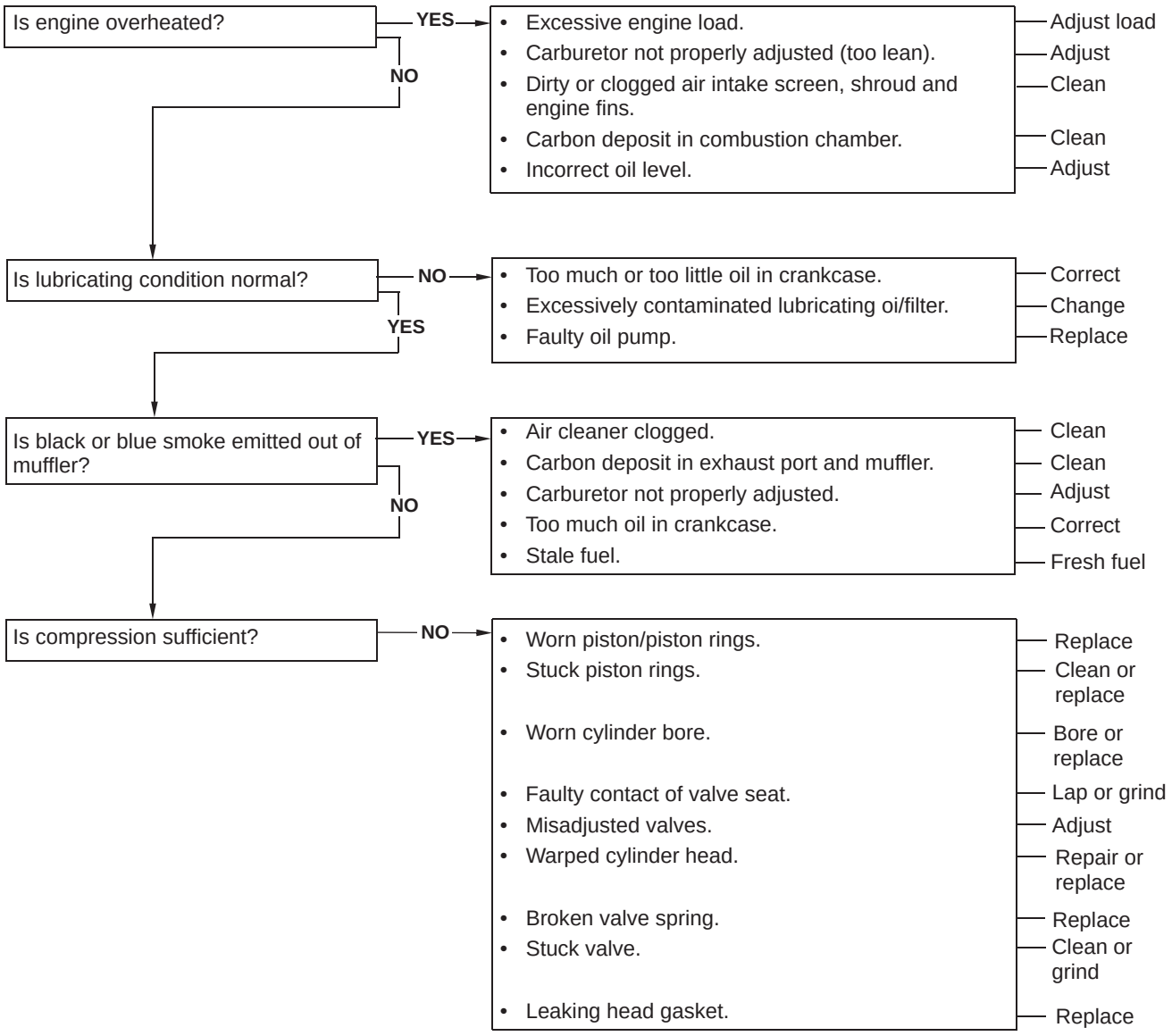
Engine Runs Erratically

Problem in fuel system (lack of fuel).	• Dust or water in fuel line or fuel filter.	Clean
	• Air or vapor lock in fuel line.	Remove
	• Plugged air vent in fuel tank cap.	Clean
	• Plugged air/fuel passages in carburetor.	Clean
	• Too little opening of carburetor pilot air-screw.	Correct
	• Stale fuel.	Fresh fuel
Problem in governor system.	• Incorrect governor linkage adjustment.	Correct
	• Faulty governor spring.	Replace
	• Governor gear assembly malfunction.	Check
Engine knocks.	• Stale fuel.	Fresh fuel
	• Excessive carbon deposit in engine.	Clean
	• Excessive engine load.	Adjust
	• Engine overheating.	See **Has Low Power**

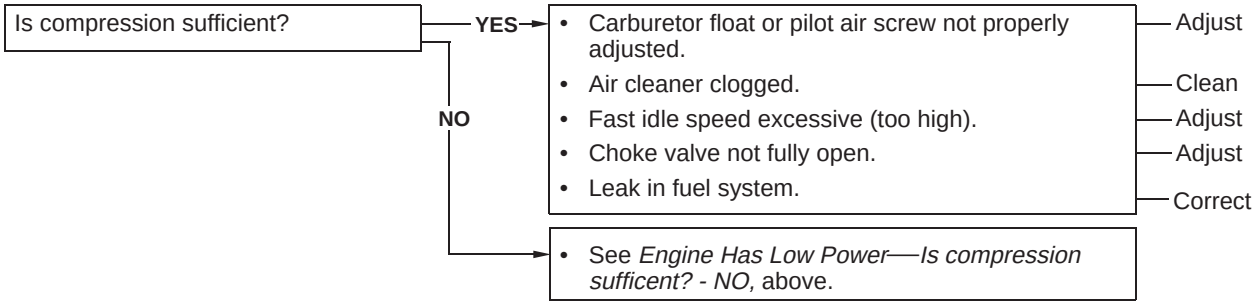
Oil Consumption Is Excessive

Is compression sufficient? **YES**	• Plugged oil ring groove.	Clean
	• High oil level.	Adjust
	• Worn valve stems and valve guides.	Replace
	• Oil leakage along governor shaft.	Replace
	• Oil seals leaking.	Replace
	• Head gasket leaking.	Replace
	• Drain plug leaking.	Retighten or replace
	• Breather valve clogged.	Clean
	• Drain-back hole in tappet chamber plugged.	Clean
	• Incorrect oil viscosity.	Change
NO	• Worn piston/piston rings.	Replace
	• Stuck piston rings.	Clean or replace
	• Worn cylinder bore.	Bore or replace
	• Faulty contact of valve seat.	Lap or grind
	• Misadjusted valves.	Adjust
	• Warped cylinder head.	Repair or replace
	• Broken valve spring.	Replace
	• Stuck valve.	Clean or grind
	• Leaking head gasket.	Replace

Engine Has Low Power



Fuel Consumption Is Excessive



STARTER MOTOR TROUBLESHOOTING GUIDE

1.Disconnect spark plug cap, and ground the cap terminal.

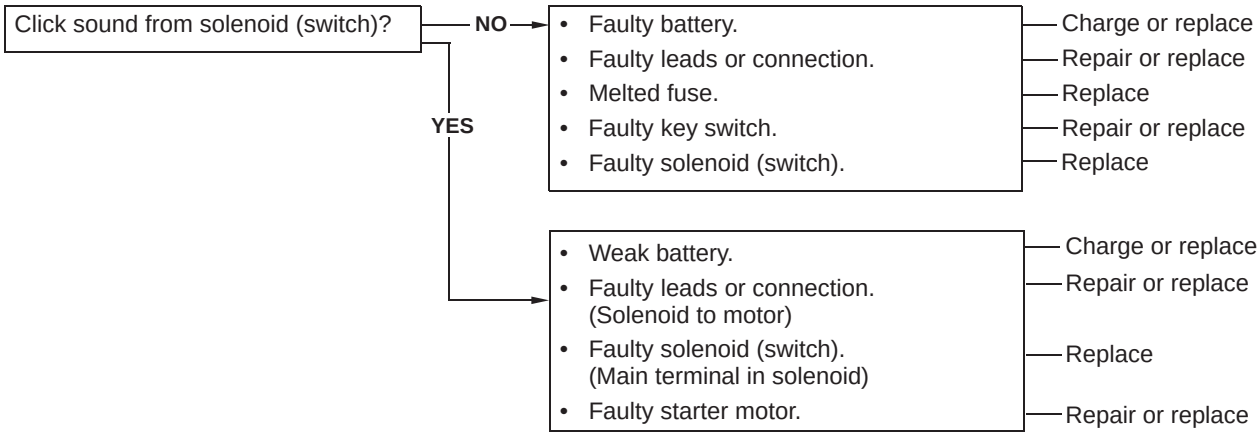
2.Turn key switch to “START” position and check condition.

⚠ CAUTION

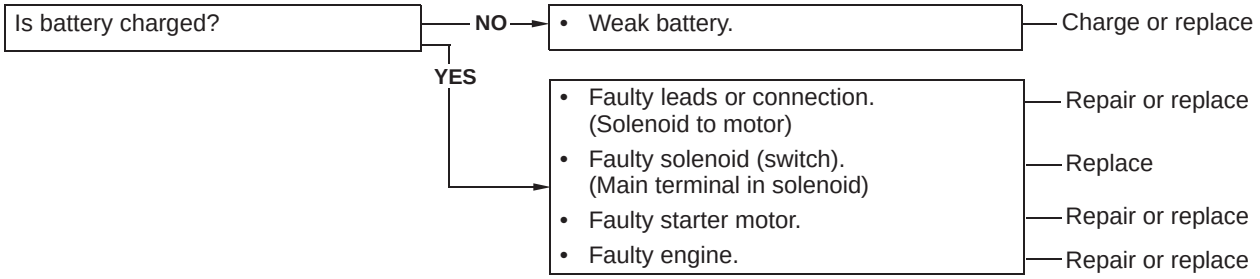
Engine may be cranked in this test. DO NOT touch any rotating parts of engine and equipment during test.

IMPORTANT: If starter does not stop when key switch is in off position, disconnect negative (-) lead from battery as soon as possible.

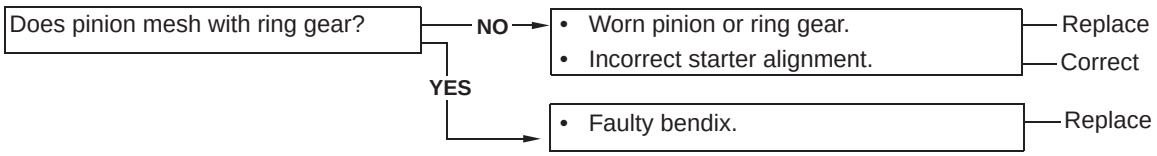
Starter Does Not Rotate



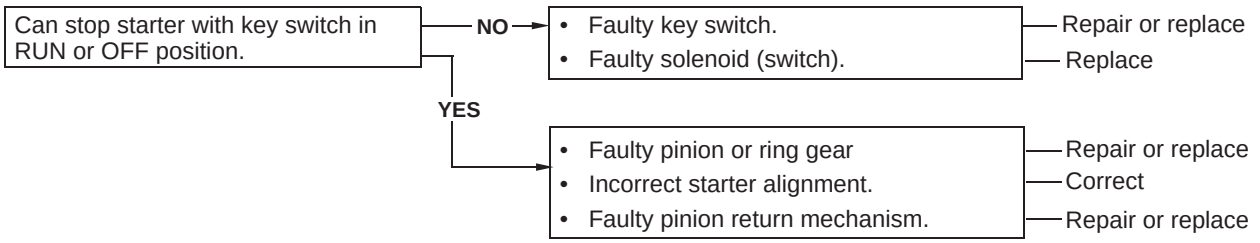
Starter Rotates Slowly



Starter Rotates But Can Not Crank Engine



Starter Does Not Stop With Key Switch In RUN or OFF Position



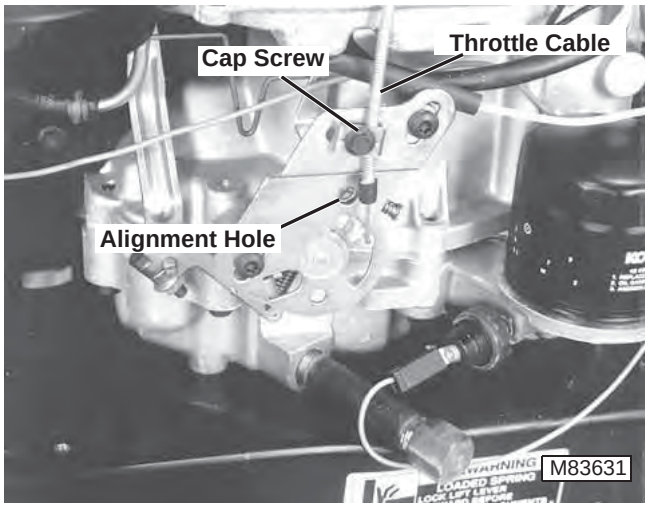
TESTS AND ADJUSTMENTS

THROTTLE CABLE ADJUSTMENT

Reason:

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

Procedure:



1. Move throttle lever to FAST idle position.
2. Loosen clamp cap screw.
3. Adjust throttle cable up or down to align hole in throttle control arm with hole in throttle control plate.
4. Tighten clamp cap screw.
5. Move throttle lever to the FULL choke position. Make sure throttle lever is held up against throttle plate. Choke should be fully closed.
6. Move throttle lever through full range to be sure linkage is not binding.

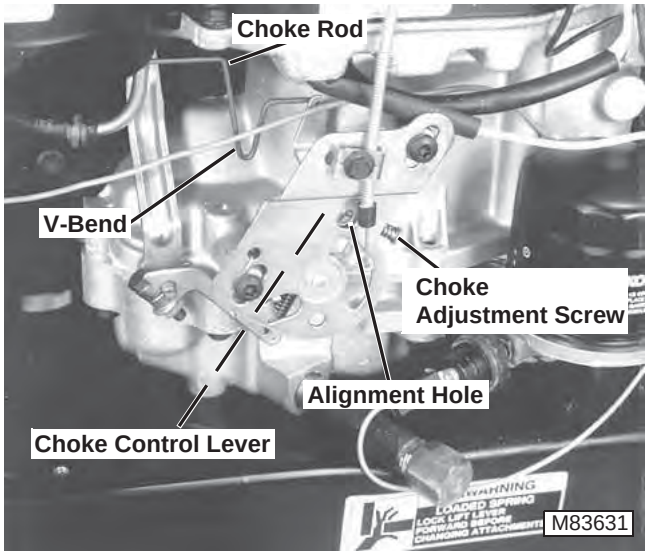
CHOKE ADJUSTMENT

Reason:

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

Procedure:

NOTE: Adjust throttle cable before adjusting choke.



1. Move throttle lever to CHOKE position then back to FAST idle position.
2. See if alignment hole in throttle control lever is aligned with hole in throttle control plate; if not, adjust throttle cable until they are in alignment. (See THROTTLE CABLE ADJUSTMENT on this page.)
3. Turn choke adjustment screw counterclockwise until screw DOES NOT contact the choke control lever by one full turn.
4. Now turn screw clockwise until screw just touches the choke control lever.
5. Move throttle lever to FULL choke position.
6. Try to move choke rod forward—**choke rod should not move**. If the choke rod moves forward, the choke plate is NOT fully closed. Turn choke adjustment screw clockwise further until the choke plate is fully closed.
7. Move throttle lever through full range of motion to be sure choke linkage is NOT binding.

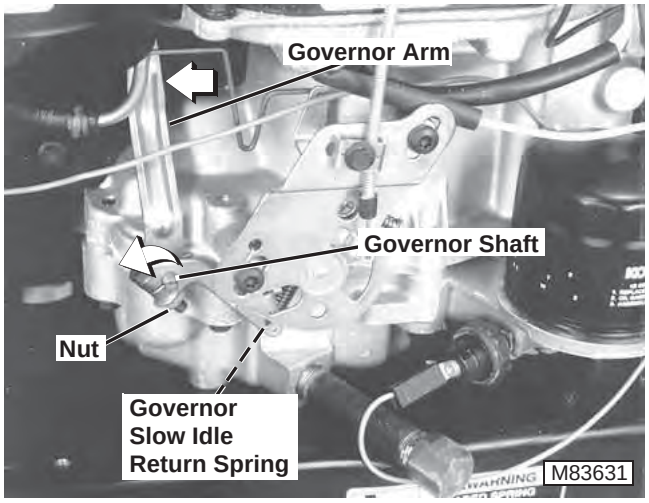
GOVERNOR ADJUSTMENT

Reason:

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

Procedure:

NOTE: Adjust throttle cable before adjusting governor linkage.



1. Adjust throttle cable.
2. Move throttle lever to FAST idle position.
3. Governor SLOW idle return spring should be installed in hole closest to governor shaft.
4. Loosen governor arm clamp nut.
5. Hold top of governor arm toward carburetor until it stops.
6. Turn governor shaft counterclockwise until it stops.
7. Hold governor arm and shaft motionless while you tighten clamp nut to **10 N•m (89 lb-in.)**.
8. Governor spring should be installed in the hole closest to governor shaft.
9. Move throttle lever through full range to be sure linkage is NOT binding.
10. If governor is NOT responding properly, replace spring and readjust FAST idle speed.
11. If above procedure DOES NOT correct the problem, repair governor. (See GOVERNOR—Inspection on page 4-57.)

FAST IDLE SPEED ADJUSTMENT

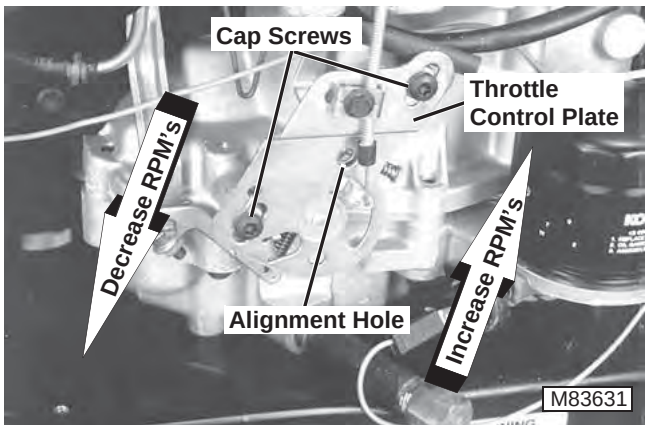
Reason:

To set engine FAST idle rpm.

Equipment:

- JT07270 Digital Pulse Tachometer

Procedure:



1. Start and run engine at MEDIUM idle for five minutes to bring engine up to normal operating temperature.

⚠ CAUTION

Engine will be HOT. Be careful not to burn skin.

2. Move throttle lever to FAST idle position.
3. See if alignment hole in throttle control lever is aligned with hole in throttle control plate; if not, adjust throttle cable until they are in alignment. (See THROTTLE CABLE ADJUSTMENT on this page.)



4. Use a JT07270 Digital Pulse Tachometer to check engine rpm at spark plug wire. FAST idle speed should be **3350 ±100 rpm**.

Results:

- If FAST idle speed DOES NOT meet the specifications, loosen plate cap screws.
- Move throttle control plate upward to increase rpm or downward to decrease rpm.
- Hold the throttle control plate motionless while you tighten cap screws to **10.7 N•m (95 lb-in.) in new block or 7.3 N•m (65 lb-in.) in reused block**.

SLOW IDLE SPEED ADJUSTMENT

NOTE: For engines with California Air Resources Board/Environmental Protection Agency (CARB/EPA) Emissions Carburetors.

BEGINNING ENGINE SERIAL NUMBER:

CV15S—41537 . . . . . ALL

ATTENTION!

DO NOT attempt to adjust the carburetor unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

Reason:

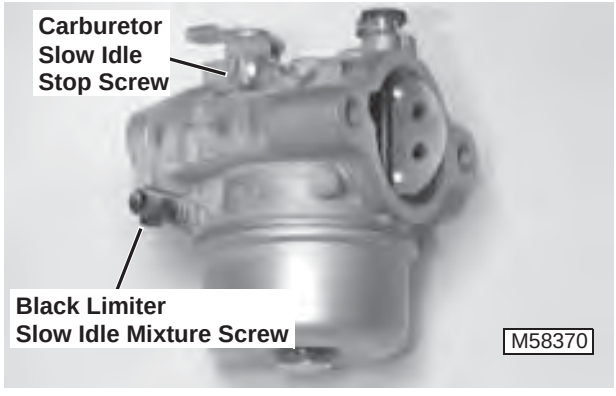
To set engine SLOW idle mixture and rpm. This insures the engine meets the CARB/EPA emissions requirements.

Equipment:

- JT07270 Digital Pulse Tachometer

NOTE: For high altitude operation above 4000 feet, use high altitude carburetor kit, service part number AM123427 to prevent over rich fuel mixture and black exhaust smoke.

Procedure:



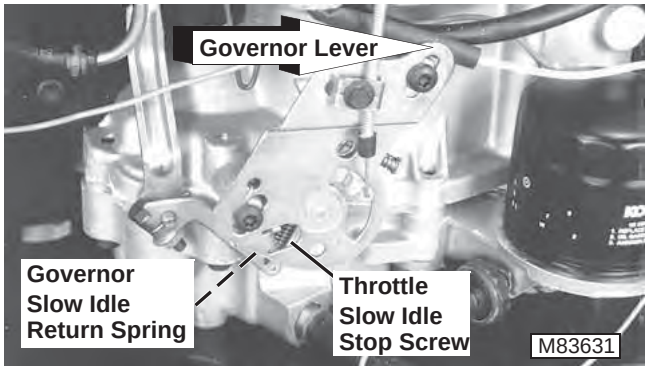
1. Carefully remove black limiter from SLOW idle mixture screw.

IMPORTANT: Forcing the slow idle mixture screw tight will damage the needle and seat.

2. Turn SLOW idle mixture screw clockwise until lightly seated, then turn counterclockwise 1 turn.
3. Start and run engine at MEDIUM idle for 5 minutes to obtain operating temperature.
4. Move throttle lever to SLOW idle position.

⚠ CAUTION

Engine will be HOT. Be careful not to burn hands.



5. Governor SLOW idle return spring should be installed in hole closest to governor shaft.
6. Turn throttle control arm SLOW idle stop screw counterclockwise until it DOES NOT contact the throttle control arm by one full turn.
7. Turn carburetor SLOW idle mixture screw clockwise until engine speed drops, note position.
8. Turn SLOW idle mixture screw counterclockwise until engine speed increases and then drops again, note position.
9. Turn SLOW idle mixture screw to midpoint between engine speed drop points.
10. Without moving screw, carefully install black limiter onto SLOW idle mixture screw so stops are centered on carburetor housing stop tab. Black limiter allows for only 1/8 turn in either direction which will meet CARB/EPA emissions standards.



11. Use JT07270 Digital Pulse Tachometer at spark plug wire to check engine SLOW idle speed.
12. Hold governor lever away from carburetor as far as it will go. Turn carburetor SLOW idle stop screw in either direction until specified SLOW idle speed of **1550 ±75 rpm** is reached.
13. Release governor lever and turn throttle control arm SLOW idle stop screw clockwise to set throttle SLOW idle speed at **1650 ±75 rpm** (**100 rpm** higher than carburetor setting).

CYLINDER COMPRESSION TEST

Reason:

To determine if the automatic compression release mechanism (ACR) is functioning properly or if piston, rings, cylinder walls, valves, head flatness and/or gasket could be defective.

Test Equipment:

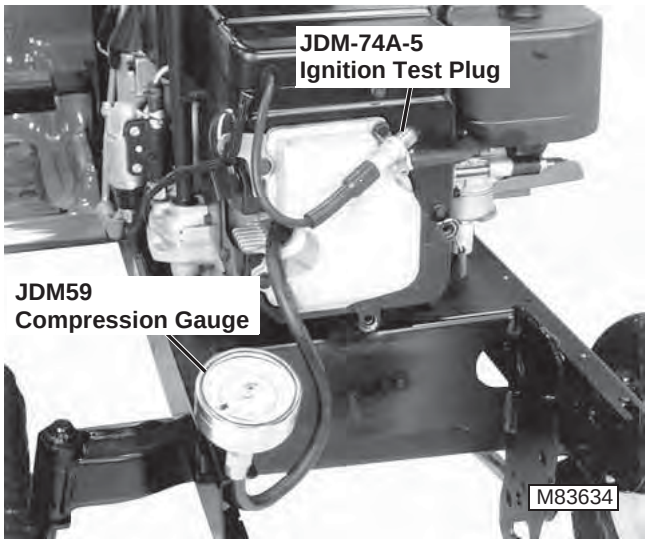
- JDM59 Compression Gauge
- JDM-74A-5 Ignition Test Plug

Procedure:

1. Park machine in a well ventilated area and run engine at MEDIUM idle for five minutes to bring engine to operating temperature.
2. Turn key switch OFF.

⚠ 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.



IMPORTANT: Spark plug wire must be grounded or electronic ignition could be damaged.

3. Remove hood. (See ENGINE HOOD—Removal/ Installation on page 11-5.)
4. Disconnect spark plug wire and ground it with a JDM-74A-5 Ignition Test Plug.
5. Remove spark plug and install JDM-59 Compression Gauge.
6. Move the throttle control lever to FAST idle position.

NOTE: Starter minimum cranking speed is 300–400 rpm.

7. Crank engine for three to five compression strokes—record compression reading.
8. Install hood. (See ENGINE HOOD—Removal/ Installation on page 11-5.)

Specifications:

Cylinder Compression

Maximum . . . . . 551.6 kPa (80 psi)
Minimum . . . . . 345 kPa (50 psi).

Results:

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

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

- If compression is **above** specifications, ACR mechanism or hydraulic valve lifters are defective.
- If compression is **below** specifications, perform the following Cylinder Leakdown Test.

CYLINDER LEAKDOWN TEST

Reason:

To determine the condition of the piston, rings, cylinder wall, head flatness, gasket, or intake and exhaust valves.

Test Equipment:

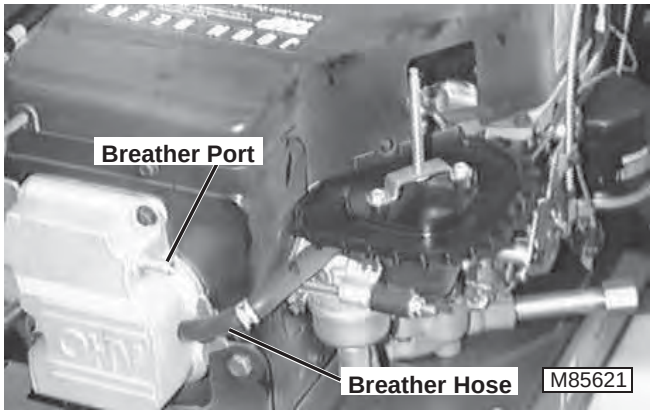
- JT03502 Cylinder Leakdown Test Kit
- JDM-74A-5 Ignition Test Plug

Procedure:

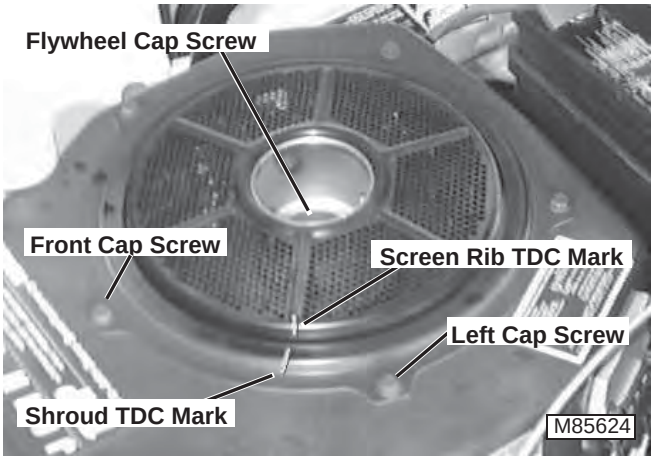
1. Park machine in a well ventilated area and run engine at MEDIUM idle for five minutes to bring engine to operating temperature.
2. Turn key switch OFF.
3. Remove hood. (See ENGINE HOOD—Removal/ Installation on page 11-5.)

⚠ CAUTION

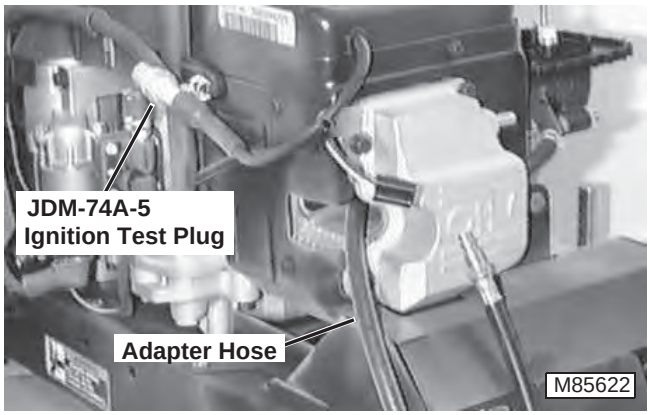
Engine components are HOT. DO NOT touch with bare skin, especially the exhaust pipe or muffler while making test.



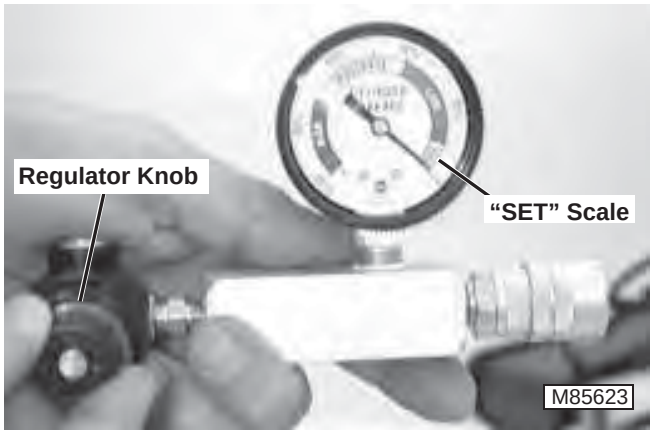
4. Disconnect crankcase breather hose from valve cover breather port and remove air cleaner element from engine so you can listen for air leaks.



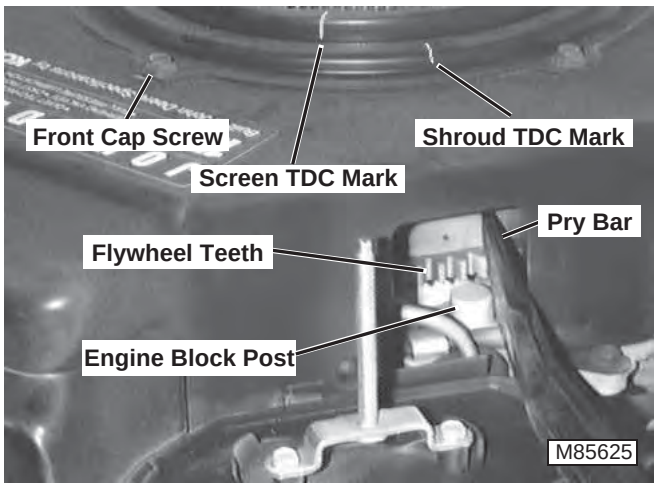
5. Use flywheel mounting cap screw to turn flywheel and find approximate top dead center (TDC) of the compression stroke.
6. Remove spark plug and put a wooden dowel on top of piston to find actual TDC of the compression stroke. Then mark flywheel screen rib and shroud as shown between front and left shroud cap screws.



7. Ground ignition high tension lead using JDM-74A-5 Ignition Test Plug to protect ignition system and install test kit adapter hose into spark plug hole

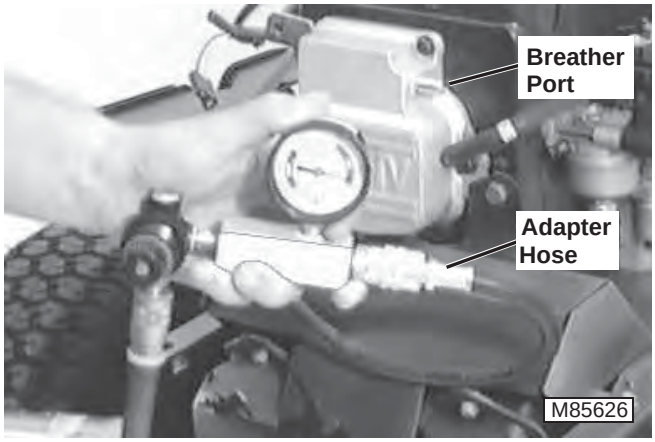


8. First turn regulator knob on tester OFF (fully counterclockwise) then attach appropriate air source to coupler below black regulator valve.
9. Gradually turn regulator knob clockwise until needle aligns with "zero" of the yellow "SET" scale.



10. Turn flywheel clockwise until screen TDC mark is between shroud TDC mark and front cap screw.

IMPORTANT: Have a helper put a wide blade pry bar between two flywheel teeth and up against engine block post and firmly wedge the pry bar against edge of shroud opening. This must be done properly to prevent piston and crankshaft from turning in a clockwise direction when compressed air is applied.



NOTE: A slight air leak from the breather port is normal as air escapes from the crankcase through the oil drainback hole in the head and breather valve.

11. Connect adapter hose to tester. Watch and record gauge reading while listening for excessive air leaks at carburetor intake, crankcase breather port, and exhaust outlet. Pressure should hold steady or reduce only slightly and only a faint air leak should be heard at the breather port.
12. Remove test equipment and install spark plug.
13. Install hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)

Results:

- Air Leaks—
  Carburetor:
  slight . . . "low-to-moderate" wear to intake valve
  excessive. . . . . intake valve bad, fix or replace
  Crankcase Breather:
  slight (normal). . . . . .ok
  excessive . . . . . rings or cylinder wall bad,
  . . . . . replace rings and hone cylinder,
  . . . . . or use short block
  Exhaust Outlet:
  slight . . . "low-to-moderate" wear to intake valve
  excessive. . . . .exhaust valve bad, fix or replace
- Gauge Color Codes—
  Green (low) . . . . . .compression good
  Yellow (moderate) . . . . . .compression borderline
  Red (high) . . . . . .compression bad

AUTOMATIC COMPRESSION RELEASE (ACR) TEST

Reason:

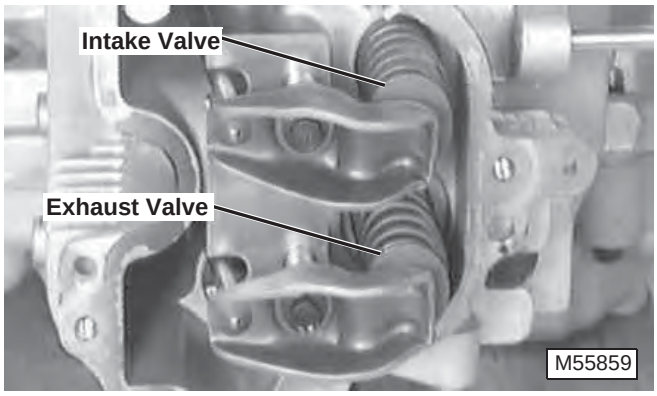
To determine if the automatic compression release is opening the exhaust valve properly.

Equipment:

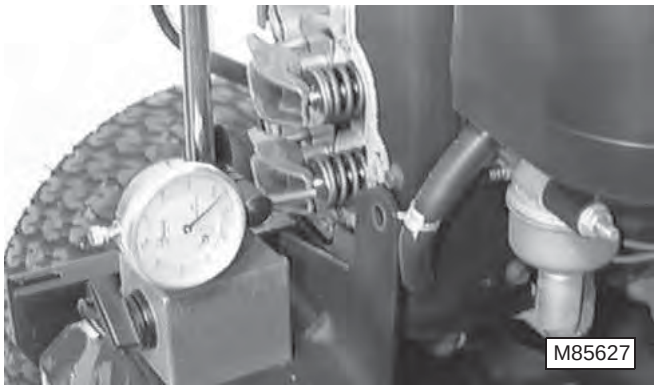
- JDM-74A-5 Ignition Test Plug
- Dial Indicator With Magnetic Base

Procedure:

1. Park machine and allow engine to cool.
2. Remove hood.
3. Remove rocker arm cover. (See ROCKER ARM COVER—Removal/Installation on page 4-36.)
4. Remove spark plug and use JDM-74A-5 Ignition Test Plug to ground high tension lead to protect ignition system while turning flywheel.



5. Use flywheel mounting cap screw to turn flywheel clockwise until intake valve opens fully.
6. Then slowly turn flywheel clockwise further to observe that the automatic compression release mechanism (ACR) on camshaft is functioning:
   - the exhaust valve must begin to open as the intake valve is nearing its closed position,
   - the exhaust valve must continue to open for a distance after the intake valve is fully closed,
   - the exhaust valve must return to its fully closed position as the flywheel is turned clockwise further.



7. Use a dial indicator on flat of spring washer to measure exhaust valve ACR movement.
8. Repeat Steps 5 and 6.
9. **Minimum** exhaust valve ACR movement should be **0.76–1.02 mm (0.030–0.040 in.)**.
10. Remove dial indicator and base and install rocker arm cover. (See ROCKER ARM COVER—Removal/Installation on page 4-36.)

11. Remove test plug, install spark plug [tighten spark plug to **40 N•m (354 lb-in.)],** and install hood.

Results:

- If the exhaust valve **DOES NOT** open beyond the minimum specification, the ACR mechanism is faulty and camshaft assembly must be replaced. (See CAMSHAFT—Removal/Installation on page 4-42.)

CRANKCASE VACUUM TEST

Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil past the seals and gaskets and through the breather into the carburetor.

Test Equipment:

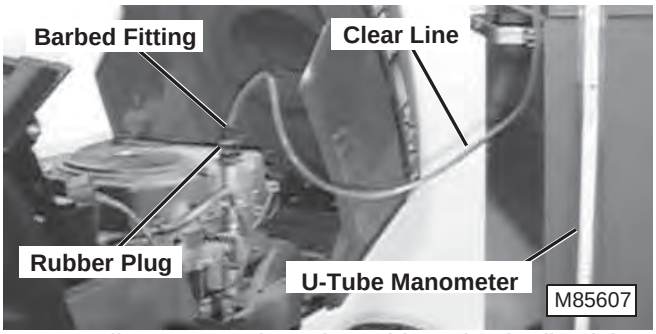
- JT05697 U-Tube Manometer Test Kit or
- JT03503 Crankcase Vacuum Test Kit

Procedure:

JT05697 U-Tube Manometer Test Kit—

1. Park machine on level surface.
2. Raise engine hood and remove dipstick.

IMPORTANT: Check oil fill tube, dipstick cap and O-ring for cracks or damage, replace as necessary.

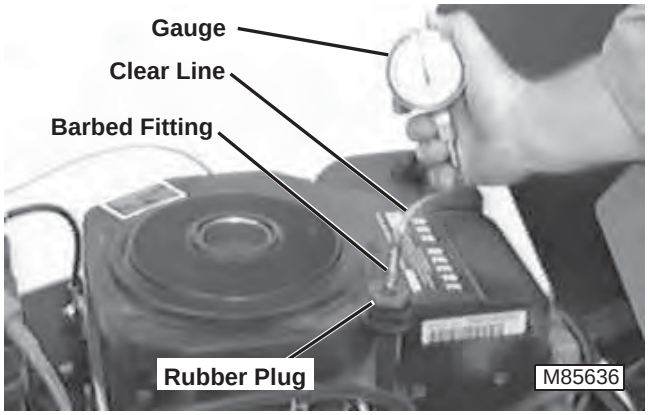


3. Install an appropriate size rubber plug in dipstick tube.
4. Insert barbed fitting in rubber plug and connect clear line to barbed fitting.

IMPORTANT: DO NOT make connection between U-Tube Manometer and clear line BEFORE engine is running or fluid in manometer could be drawn into crankcase. DO NOT turn engine OFF until clear line has been disconnected from U-Tube Manometer.

5. Start and run engine at SLOW idle.
6. Connect clear line to open U-Tube Manometer spigot.
7. Run engine at FAST idle.
8. Record crankcase vacuum reading. Manometer should show a **minimum vacuum of 10.2 cm (4.0 in.) of water movement**.
9. Run engine at SLOW idle. **DO NOT TURN ENGINE OFF!**
10. Disconnect clear line from open manometer spigot.
11. Turn engine OFF.
12. Remove plug from dipstick tube and install dipstick.

JT03503 Crankcase Vacuum Test Kit—



1. Repeat Steps 1–3 in JT05697 test procedure.
2. Assemble gauge, clear line, and barbed fitting on workbench.

IMPORTANT: DO NOT make connection between test gauge assembly and rubber plug BEFORE engine is running at FAST idle or gauge damage may result. After test reading is made, DO disconnect test gauge assembly WHILE engine is running at FAST idle to prevent gauge damage.

3. Hold finger over rubber plug hole to keep oil from spraying out. Start engine and run at FAST idle.
4. Connect gauge, clear line, and barbed fitting to rubber plug.
5. Record crankcase vacuum reading. Gauge should show a **minimum vacuum of 10.2 cm (4.0 in.)**.
6. Disconnect barbed fitting, clear line, and gauge from rubber plug while engine is running at FAST idle. Hold finger over rubber plug hole to keep oil from spraying out.
7. Move throttle to SLOW idle and turn engine OFF.
8. Remove rubber plug and install dipstick.

Results:

- If crankcase vacuum is BELOW specification, check the following:
  - Breather reed valve clearance and condition.
  - Seals and gaskets for leakage.
  - Rocker arm cover O-ring for leakage.
  - Valve and valve seats for wear or damage.
  - Head warpage.
  - Rings, piston, and cylinder bore for wear or damage.

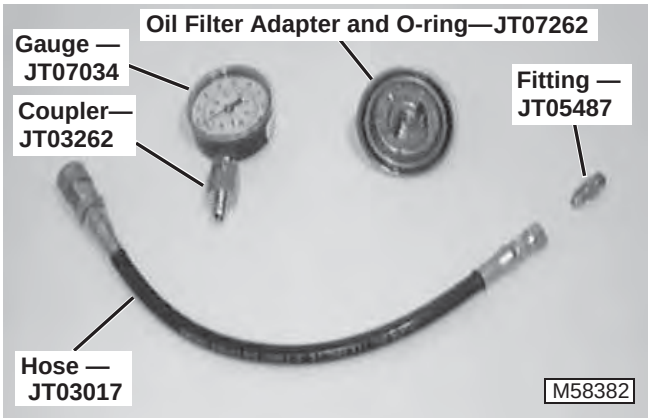
ENGINE OIL PRESSURE TEST

Reason:

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

Test Equipment:

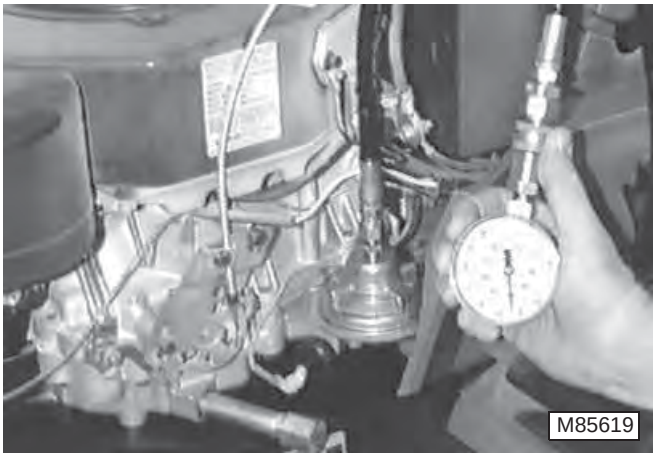
- JT07262 Oil Pressure Test Kit
- JT05487 Fitting
- JT03017 Hose
- JT03262 Coupler
- JT07034 Gauge



NOTE: SERVICEGARD™ Oil Pressure Test Kit (JT07262) only includes the oil filter adapter and o-ring. The hose (JT03017), gauge (JT07034), coupler (JT03262), and fitting (JT05487) are found in other SERVICEGARD test kits. The non-tapered threaded end of fitting (JT05487) matches the oil pressure switch port on Kohler engines.

Procedure:

At Oil Filter Base:



1. Park machine on level surface, turn key switch OFF, and allow engine to cool.
2. Remove oil filter. Use a piece of cardboard or a plastic bag to channel filter oil into drain pan.
3. Wipe filter flange clean and install pressure test kit to oil filter flange.
4. Check engine oil level, bring level to full mark.
5. Monitor oil pressure during cranking, if oil pressure is **below 28 kPa (4 psi)—STOP engine immediately** and correct cause before continuing.
6. Start and run engine at MEDIUM idle for five minutes to bring engine to operating temperature.

⚠ CAUTION

Engine components are HOT. DO NOT touch with bare skin while making test. Wear protective eye glasses and clothing.

*NOTE: Oil pump pressure relief valve opens at approximately **411 kPa (60 psi)**. Minimum specification indicates engine wear. Oil pressure switch turns on warning light when oil pressure falls to approximately **28 kPa (4 psi)**.*

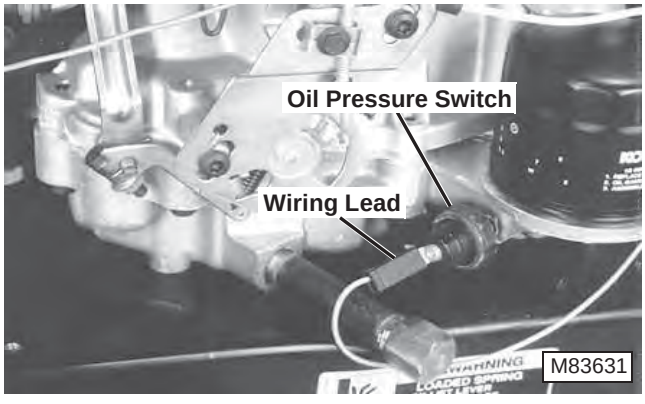
7. Record oil pressure at FAST idle **(3350 ±50 rpm)**.
8. Record oil pressure at SLOW idle **(1650 ±75 rpm)**.
9. STOP engine and allow to cool.
10. Remove test equipment and install new oil filter.
11. Run engine for 30 seconds, STOP engine, and check crankcase oil level—bring to full mark before operating.

SPECIFICATIONS:

Oil Pressure (Approximate)

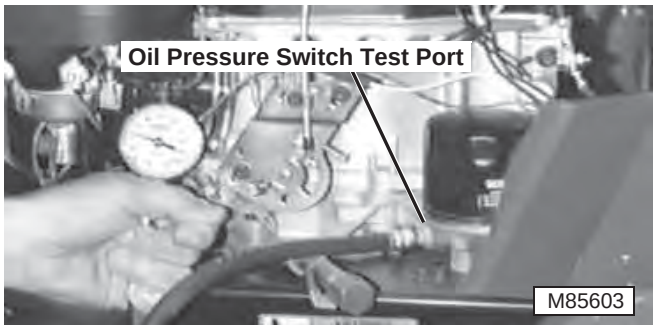
FAST Idle Relief (maximum) . . 413.7 kPa (60 psi)
FAST Idle (minimum) . . . . . 103.4 kPa (15 psi)
SLOW Idle (minimum) . . . . . 28 kPa (4 psi)

At Pressure Switch Port:



1. Park machine on level surface, turn key switch OFF, and allow engine to cool.

2. Check engine oil level, bring level to full mark.
3. Use a shop cloth to catch any oil spillage.
4. Disconnect oil pressure switch wiring lead.
5. Remove oil pressure switch and quickly install oil pressure test hose into test port.
6. Quick couple test gauge onto test hose.
7. Check crankcase oil level, bring to full mark before testing.



8. Monitor oil pressure during cranking, if oil pressure is **below 28 kPa (4 psi)—STOP engine immediately** and correct cause before continuing.
9. Start and warm engine to operating temperature.

⚠ CAUTION

Engine components are HOT. DO NOT touch with bare skin while making test. Wear protective eye glasses and clothing.

*NOTE: Oil pump pressure relief valve opens at approximately **413.7 kPa (60 psi)**. Oil pressure switch turns on warning light when oil pressure falls to approximately **28 kPa (4 psi)**.*

10. Record oil pressure at FAST idle **(3350 ± 50 rpm)**.
11. Record oil pressure at SLOW idle **(1650 ±75 rpm).**
12. STOP engine and allow to cool.
13. Remove test equipment, install oil pressure switch **[tighten to 7.9 N•m (70 lb-in.)]**, connect wiring lead, and check crankcase oil level—bring to full mark before operating.

SPECIFICATIONS:

Oil Pressure (Approximate)

FAST Idle Relief (maximum) . . 413.7 kPa (60 psi)
FAST Idle (minimum) . . . . . 103.4 kPa (15 psi)
SLOW Idle (minimum) . . . . . 28 kPa (4 psi)

Results:

- If FAST idle pressure is **above maximum** specification: check oil passages for restrictions and oil relief valve for incorrect spring tension or stuck closed.
- If FAST idle pressure is **below minimum** specification: check oil pump wear, relief valve for weak spring or stuck open, pickup plugged, or crankshaft bearings and seals for leaks or wear.
- If SLOW idle pressure is **above minimum** specification, but warning is **ON**: check oil pressure switch for defects or incorrect rating.
- If SLOW idle pressure is **below minimum** specification, but warning light is **NOT ON**: check for major restrictions, internal engine wear, or oil pressure switch is defective.

FUEL PUMP TESTS

Reason:

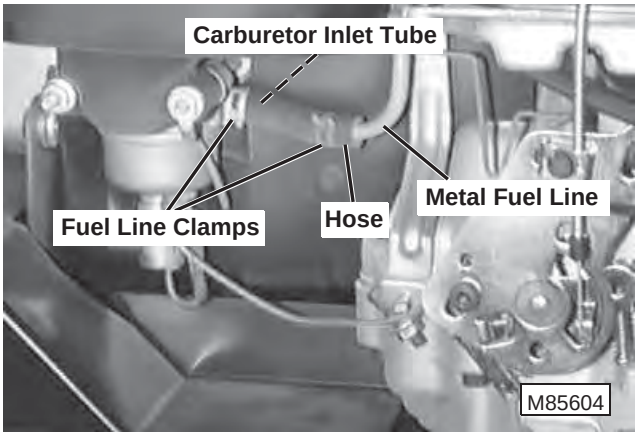
To determine fuel pump pressure and flow to the carburetor.

Test Equipment:

- JDG356 Pressure Gauge
- JDM-74A-5 Ignition Test Plug
- Graduated Container

Procedure:

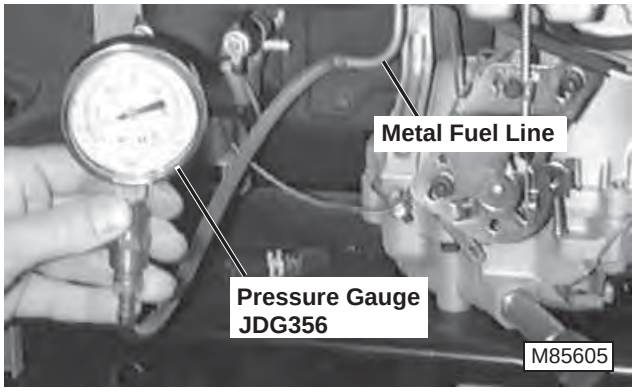
1. Park machine on level surface.
2. STOP engine and allow to cool.
3. Check for sufficient volume of fuel in tank to perform test.
4. Disconnect spark plug wire and ground it with a JDM-74A-5 Ignition Test Plug. This prevents damage to ignition system while cranking engine during test.



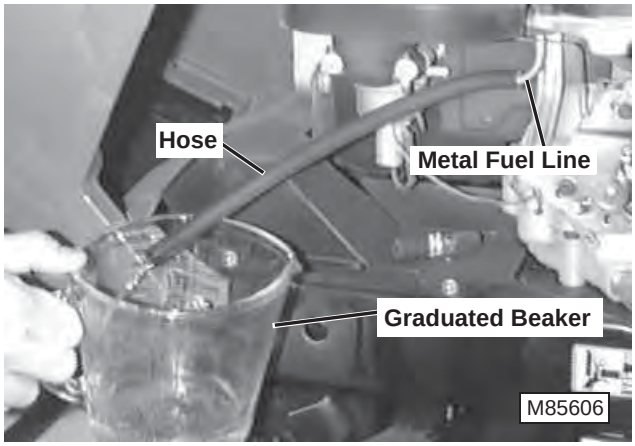
⚠ CAUTION

Gasoline is extremely flammable. DO NOT SMOKE. Always work in a well ventilated area away from open flame or spark producing equipment; this includes equipment that utilizes pilot lights.

5. On left side of engine, put a shop cloth below carburetor inlet to soak up any escaping fuel.
6. Slide fuel line clamps to right off the hose.
7. Disconnect hose from carburetor inlet tube and metal fuel line, respectively. Wipe up any spilled fuel **immediately**.



8. Connect JDG356 Pressure Gauge hose to metal fuel line.
9. Crank engine for 3–5 seconds only. Record pressure, **minimum** pressure should be **6.12 kPa (0.90 psi)**. Turn key switch OFF.



10. Remove pressure test equipment and install a long piece fuel hose onto metal fuel line and a large graduated beaker.
11. Crank engine for 15 seconds only; otherwise**,** starter may be damaged. Record flow, **minimum** flow should be **30 ml (1.0 U.S. oz).**
12. Remove test equipment, reconnect hose to metal fuel line then carburetor inlet tube, fasten with fuel line clamps, and reconnect spark plug lead.

Results:

- If fuel pump pressure and flow **DO meet** specifications, check carburetor inlet tube, inlet needle, and float for proper function, obstructions, varnish/sticking conditions, or other problems. (See CARBURETOR—Removal/Installation and Clean/Inspect/Rebuild on page 4-32.).
- If fuel pump pressure or flow **DO NOT meet** specifications, check fuel lines, in-line filter, fuel tank, pickup tube, and fill cap vent for restrictions and retest.
- If after retest fuel pump pressure or flow **DO NOT meet** specifications, replace fuel pump. (See FUEL PUMP—Replacement on page 4-34.)

SPARK PLUG GAP ADJUSTMENT

Test Equipment:

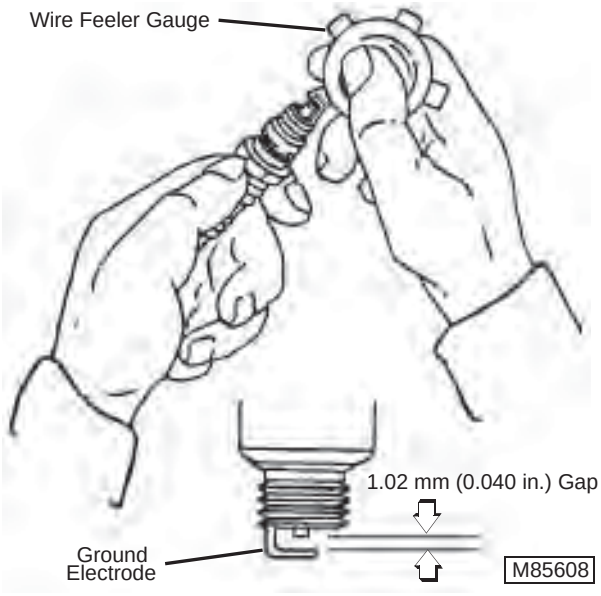
- Wire Feeler Gauge

Procedure:

1. Park machine, turn key switch OFF, and allow engine to cool.
2. Remove spark plug

IMPORTANT: DO NOT clean spark plug with sand paper 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 wire feeler gauge. Set gap to **1.02 mm (0.040 in.)**.
6. Install and tighten spark plug to **40 N•m (354 lb-in.)**.

REPAIR

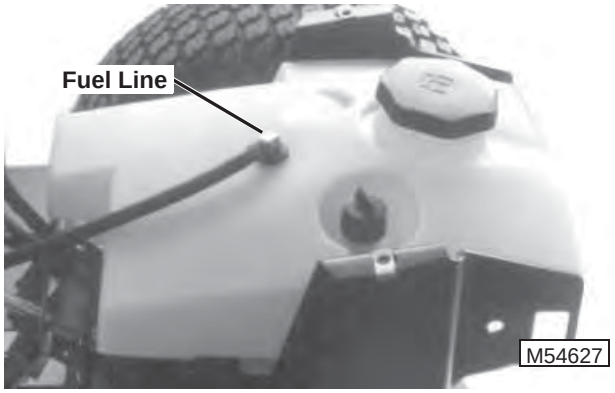
FUEL TANK

Removal/Installation

1. Lower mower deck to the ground.
2. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)

CAUTION

Gasoline vapor is explosive. DO NOT expose to spark or flame. Serious personal injury can result.



3. Disconnect fuel line.
4. Remove fuel tank.
5. Inspect fuel tank for wear or damage. Replace if necessary.

Installation is done in the reverse order of removal.

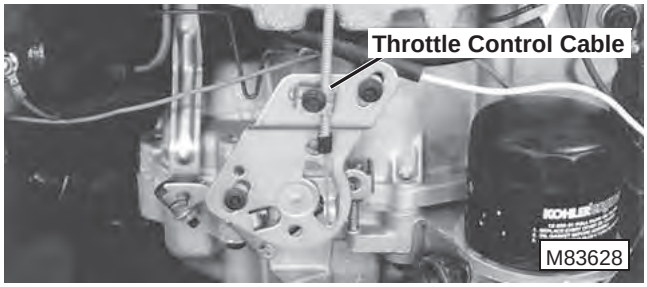
THROTTLE CONTROL LEVER AND CABLE ASSEMBLY

Removal/Installation

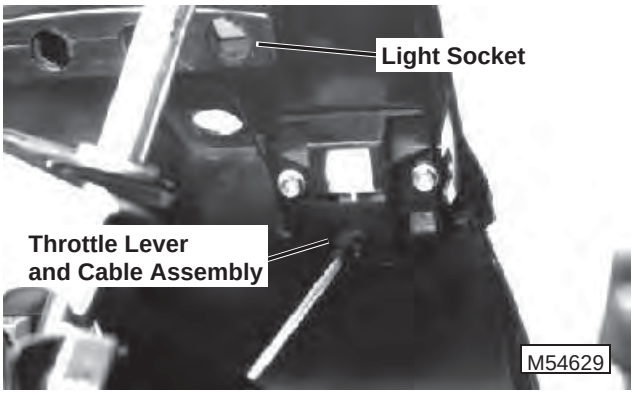
1. Remove steering wheel. (See STEERING WHEEL—Removal/Installation on page 8-8.)
2. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)



3. Remove green plastic side panels from both sides.



4. Disconnect throttle control cable at engine.
5. Remove park brake lever and linkage. (See PARK BRAKE LEVER AND LINKAGE on page 9-24.)



6. Remove oil pressure indicator light from socket.
7. Remove four cap screws and washers securing instrument panel.
8. Remove two cap screws and throttle control lever and cable assembly.

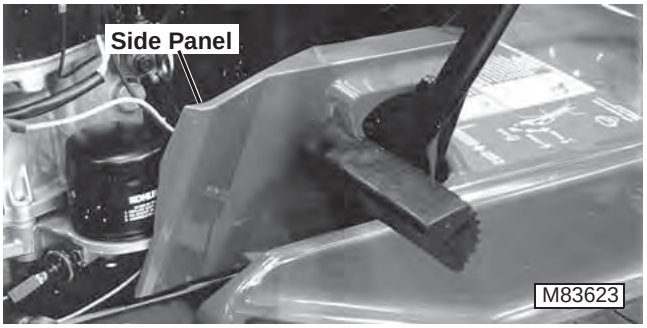
Installation is done in the reverse order of removal.

- Adjust throttle cable and choke plate. (See THROTTLE CABLE ADJUSTMENT on page 4-18 and CHOKE ADJUSTMENT on page 4-18.)

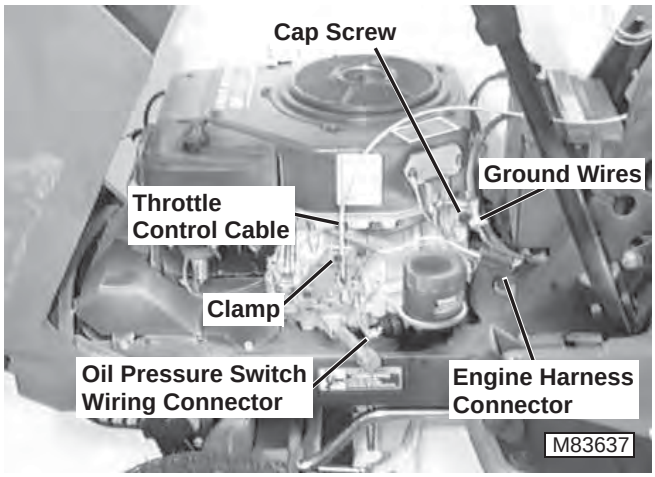
ENGINE

Removal/Installation

1. Disconnect negative (–) battery cable at battery.
2. Remove mower deck.
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
4. Remove muffler. (See MUFFLER—Removal/Installation on page 4-30.)
5. Drain engine oil. **Capacity with filter** is approximately **1.8 L (1.9 U.S. qt) (3.8 U.S. pt).**

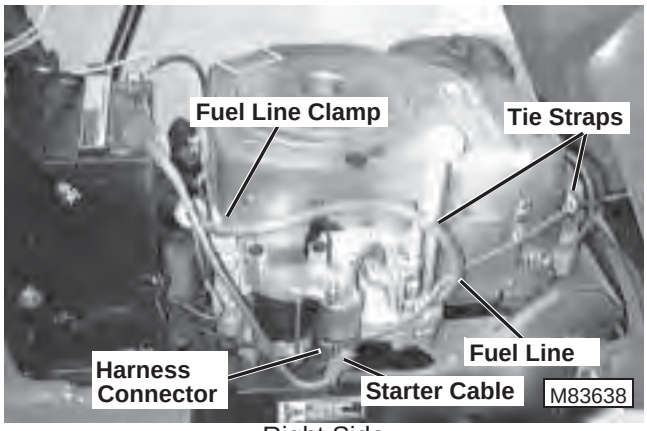


6. Remove green plastic side panels from both sides.



Left Side

7. Disconnect oil pressure switch wiring connector.
8. Disconnect engine harness connector.
9. Remove cap screw to remove angle bracket and ground wires.
10. Loosen clamp and disconnect throttle control cable.



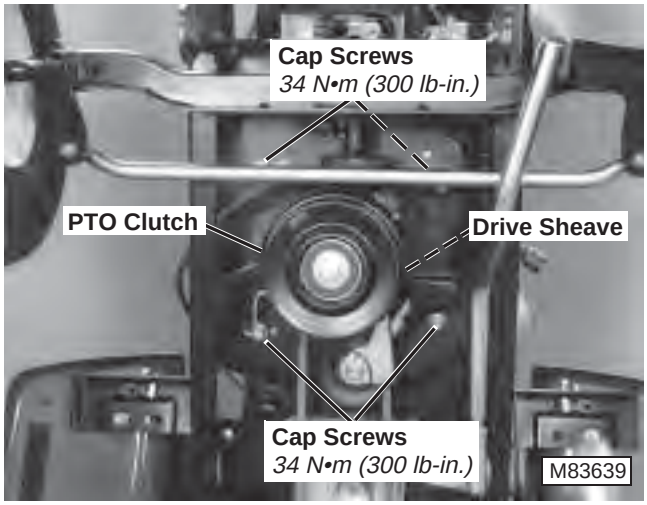
Right Side

11. Remove tie straps and fuel line clamp. Pull headlight harness away from engine.

⚠ 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.

12. Disconnect fuel line at fuel pump and drain fuel. Wipe-up spilled fuel IMMEDIATELY.
13. Disconnect starter cable and harness connector.



14. Remove PTO clutch. (See ELECTRIC PTO CLUTCH—Removal/Installation on page 5-195.).
15. Remove drive sheave.
16. Remove four cap screws and remove engine.

Installation is done in the reverse order of removal:

- Tighten engine mounting cap screws to **34 N•m (300 lb-in.)**.
- Tighten muffler mounting nuts to **24.4 N•m (216 lb-in.)**.

—Continued on next page.

NOTE: If the engine has been rebuilt (cylinder rebored or deglazed, etc.), break-in oil should be used for the first 5 hours (maximum) of operation. (See BREAK-IN ENGINE OIL—NORTH AMERICA on page 2-14, or *BREAK-IN ENGINE OIL—EUROPE on page 2-15.)*

- Fill engine to proper level with oil of correct specifications. (See KOHLER 4-CYCLE GASOLINE ENGINE OIL—NORTH AMERICA on page 2-13 or KOHLER 4-CYCLE GASOLINE ENGINE OIL—EUROPE on page 2-13.)
- Apply DuBois MPG-2® Multi-Purpose Grease—M79292 to engine crankshaft before installing engine drive sheave and PTO clutch.
- Install engine drive sheave and PTO clutch. (See ELECTRIC PTO CLUTCH—Removal/Installation on page 5-195.)
- Adjust throttle cable. (See THROTTLE CABLE ADJUSTMENT on page 4-18.)

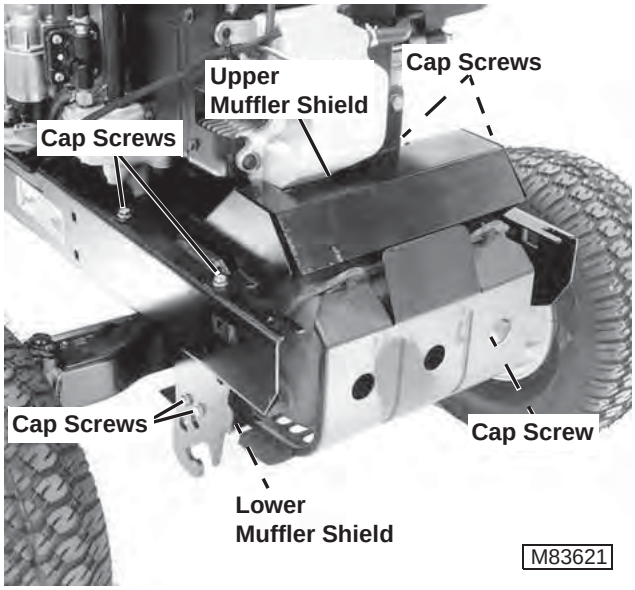
MUFFLER

Removal/Installation

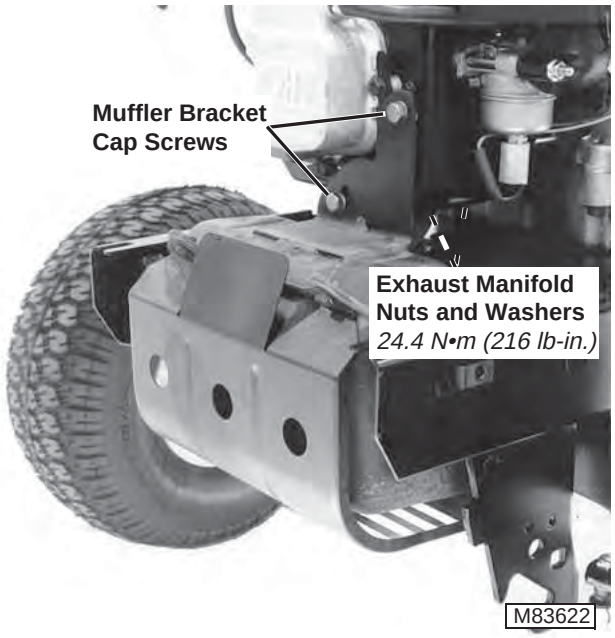
1. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)

⚠ CAUTION

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



2. Remove four cap screws and upper muffler shield.
3. Remove three cap screw and lower muffler shield.



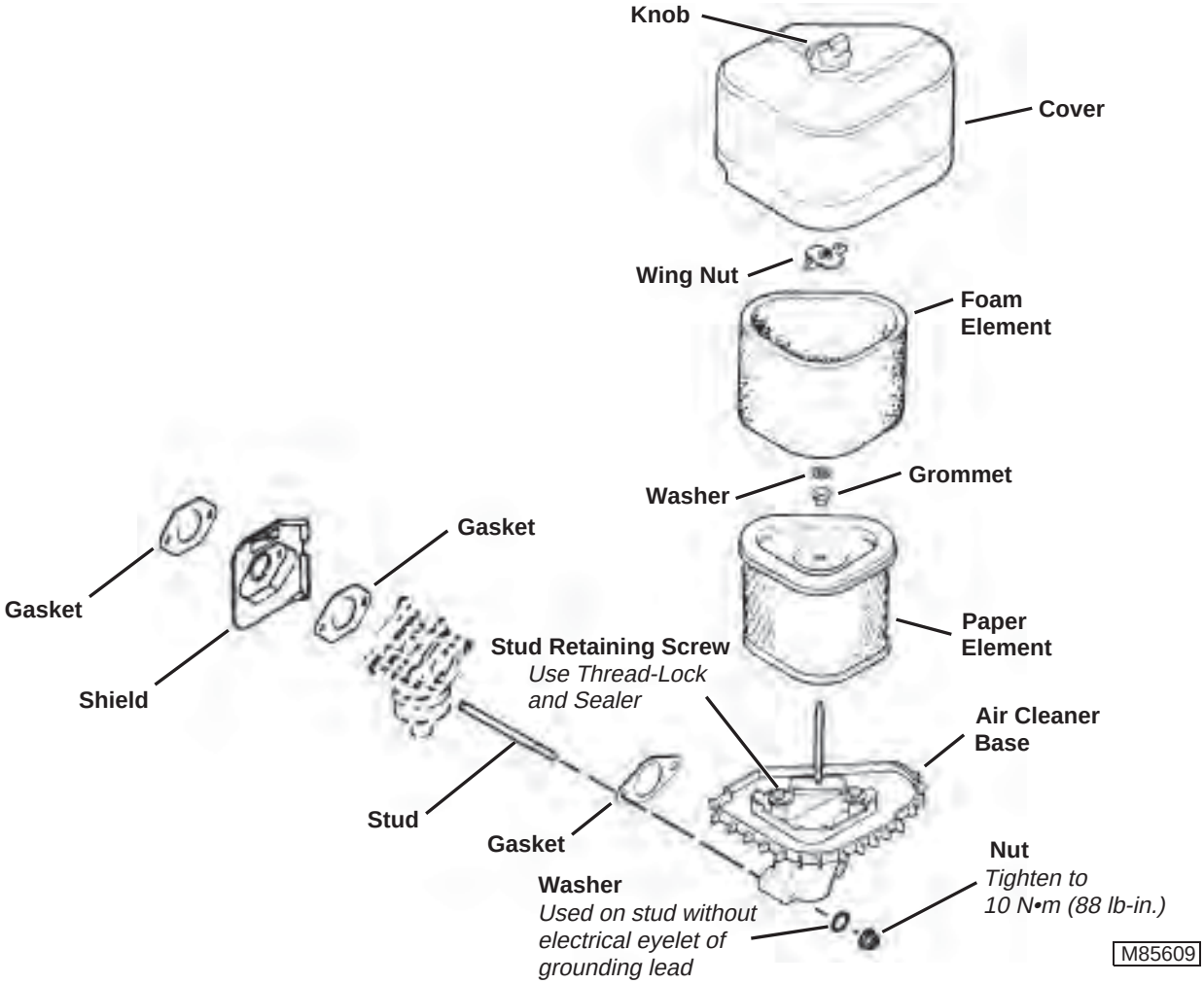
4. Remove exhaust manifold nuts and washers.
5. Remove muffler bracket cap screws.
6. Remove muffler and gasket.

Installation is done in the reverse order of removal.

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

AIR CLEANER

Service



IMPORTANT: Carefully remove air cleaner cover and elements. Inspect inside paper element and intake passage for signs of dust. If present, replace elements and perform engine compression and/or cylinder leakdown tests or inspect engine for internal damage.

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

NOTE: Replace elements yearly or every 25 hours.

1. Remove and disassemble air cleaner.
2. Wash foam element in detergent and warm water. Rinse element thoroughly to remove all traces of detergent. Squeeze out excess water—DO NOT ring out element. Let element air dry.
3. Apply 12—15 drops of clean engine oil to foam element. Squeeze out excess oil.

IMPORTANT: Do not clean paper element with solvent or compressed air.

4. Gently tap paper element to remove dust.
5. Inspect paper element.
   - Element is still usable if you can see light through it and element appears clean.
   - Replace if oily, dirty, or damaged in any way.
6. Inspect body, gasket and base for damage. Replace parts as necessary.

IMPORTANT: Grommet must be in place to prevent dirt ingestion.

7. Assemble and install air cleaner.
8. Tighten air cleaner housing nuts to **10 N•m (88 lb-in.)**.

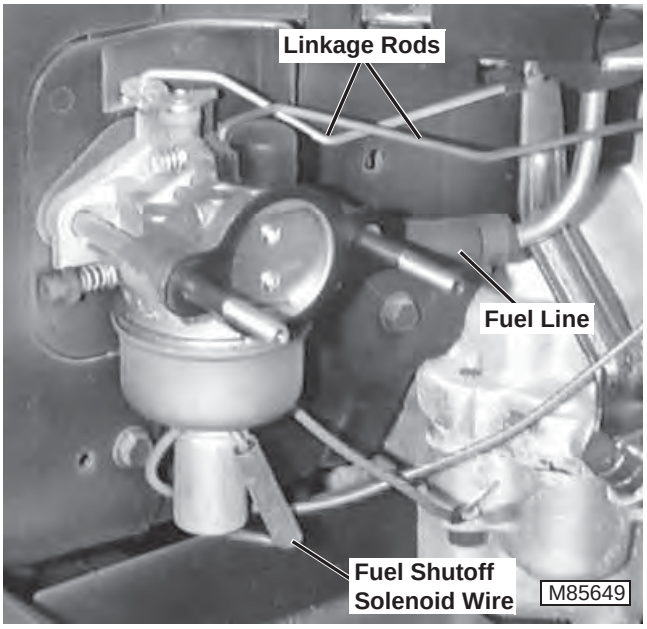
CARBURETOR

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. Drain fuel from carburetor.
2. Remove air cleaner assembly. (See AIR CLEANER—Service on page 4-31.)



3. Pinch fuel line to block fuel flow, then disconnect and plug fuel line.
4. Disconnect fuel shutoff solenoid wire and linkage rods from carburetor levers to remove carburetor.

Installation is done in the reverse order of removal.

- Use new gaskets for installation.
- Tighten air cleaner housing nuts to **10 N•m (88 lb-in.)**.
- Adjust carburetor. (See SLOW IDLE SPEED ADJUSTMENT on page 4-20 and FAST IDLE SPEED ADJUSTMENT on page 4-19.)
- Adjust choke. (See CHOKE ADJUSTMENT on page 4-18.)

Clean/Inspect/Rebuild

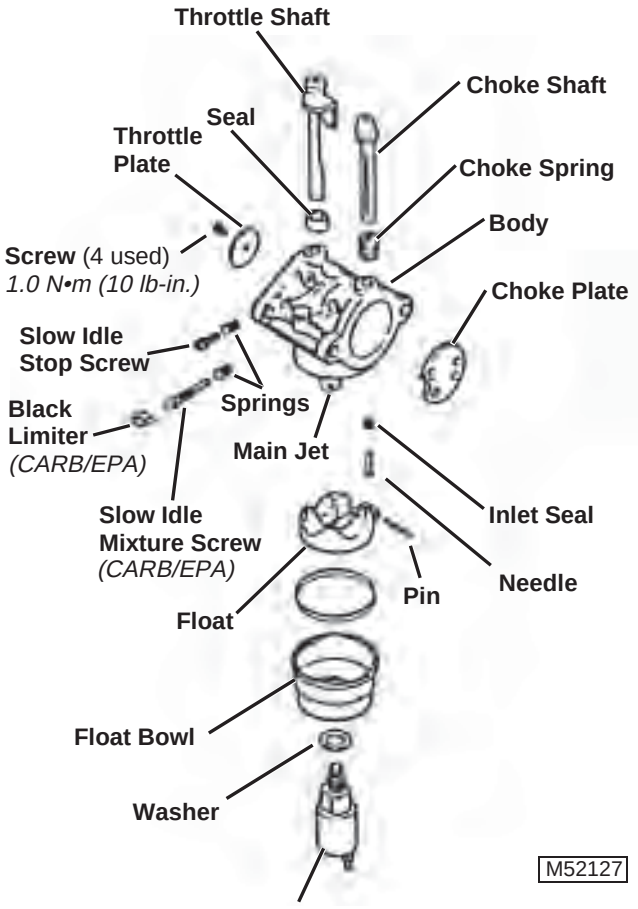
NOTE: For California Air Resources Board/ Environmental Protection Agency (CARB/EPA) Emissions Carburetors reference the following:

BEGINNING ENGINE SERIAL NUMBER:

CV15S—41537

ATTENTION!

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



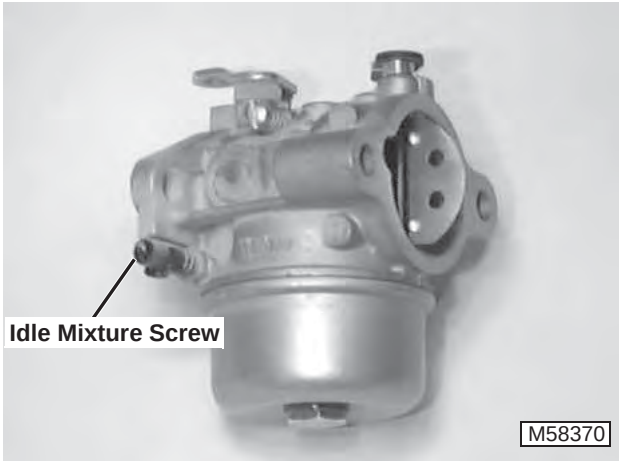
1. Disassemble bowl, float, inlet needle, slow idle mixture screw and spring.

IMPORTANT: Further disassembly of carburetor is not required for general cleaning. Further disassembly will require replacing parts with new parts. DO NOT soak carburetor in carburetor cleaner when fiber, rubber or foam gaskets are still installed. Cleaner may damage these components.

2. Clean carburetor using pressurized carburetor cleaner and compressed air. Clean out all passages.
3. DO NOT remove idle port welch plug unless absolutely necessary. To remove, pierce with sharp tool. Clean chamber. Install new plug using a flat tool about the same size as plug. Flatten plug but do not force below the surface of the cavity.
4. If inlet seat was leaking or damaged it can be replaced by pulling it out with a drill bit or screw. Always replace with new parts. Press in new seat until it bottoms in bore.
5. If throttle and choke plates were removed, use a high strength thread lock and sealer on the small retaining screws. Install screws slightly loose. Apply pressure on shafts to center plates in bore, then tighten screws to **1 N•m (10 lb-in.)**.

NOTE: High altitude jet is available.

6. Main jet can be pressed out. Replace with new jet. Press new jet in until flush with surface.
7. Low idle mixture screw has a precision taper. If screw is grooved, bent or broken, this may indicate seat damage and carburetor may need to be replaced.
8. On standard carburetors, to set preliminary adjustment for idle mixture screw—**turn clockwise until LIGHTLY seated and back-out (counterclockwise) one full turn**.



New Emissions Carburetor

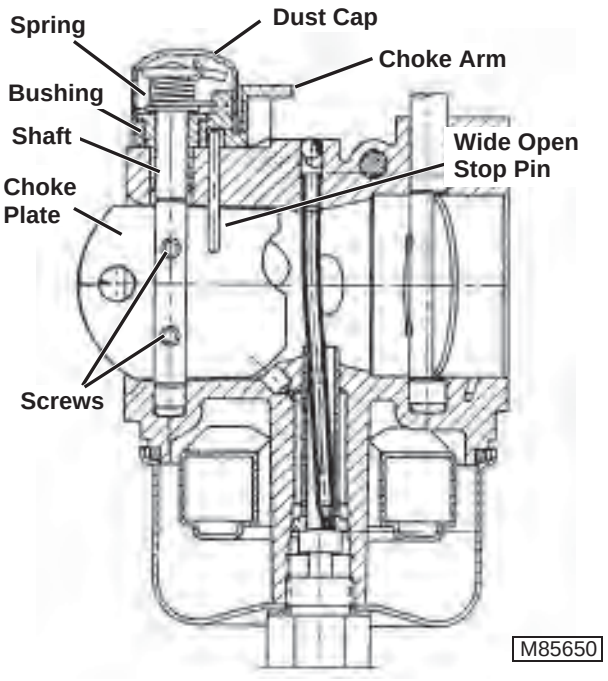
9. On new emissions carburetors, no preliminary adjustment is required for idle mixture screw, this is pre-set by manufacturer—**only turn screw (limited to maximum 1/4 turn in either direction) until specified slow idle speed is obtained.**
10. Perform Slow Idle Speed Adjustment. (See SLOW IDLE SPEED ADJUSTMENT on page 4-20.)

SELF-RELIEVING CHOKE

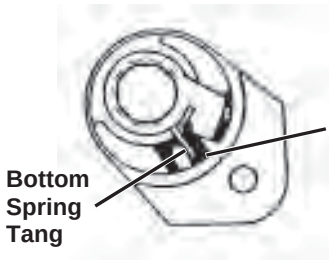
Replacement

⚠ CAUTION

Spring is under high tension, wear protective eye glasses or safety shield before attempting to remove and install spring.

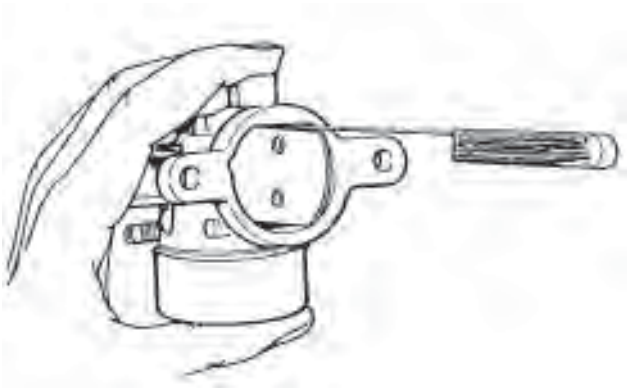


1. Remove and discard dust cover.
2. Remove and discard choke plate and screws.
3. Remove and discard choke shaft and spring.
4. Remove and discard bushing using a blind hole puller or No. 3—4 mm (5/32 in.) screw extractor by clamping extractor in a vise and turning carburetor onto extractor; then while pulling on carburetor, lightly tap casting with rubber hammer.
5. Thoroughly clean carburetor body.
6. Install new bushing onto new lever and align slot in bottom of lever over the wide open stop pin.
7. For proper alignment of upper bushing and lower shaft hole use a 4.76 mm (3/16 in.) drill blank to align bushing as it is pressed into casting until it bottoms out.



Top View—Choke Lever

8. Install choke shaft and spring assembly with bottom spring tang installed in second notch from the right.



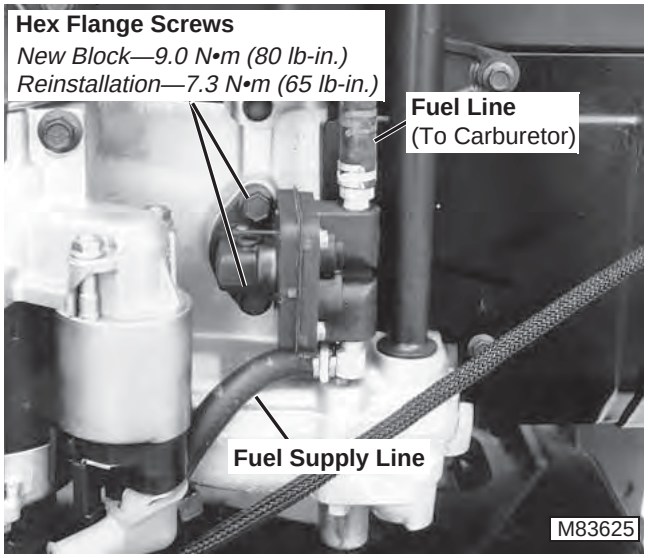
9. Apply John Deere Thread Lock and Sealer (medium strength), TY9370 or T43512, to cap screws.
10. Loosely install choke plate onto choke shaft.
11. Align choke plate with a **0.25 mm (0.010 in.)** feeler gauge between top right edge of choke plate and venturi bore.
12. Then, while pushing down on top of choke shaft, tighten screws to **1 N•m (10 lb-in.)**.
13. Test choke mechanism as follows:
    - using choke lever close choke plate—choke lever and choke plate should move in unison;
    - while holding choke lever in closed position, push on long side of choke plate—it should open then spring closed freely;
    - move choke lever into wide open position—choke plate should be against wide open stop pin.
14. Install new dust cover until it snaps into place.
15. Install carburetor on engine and recheck choke system for freedom of movement as follows:
    - move wire link into choke (fully closed) position and then release it—wire link should move freely in both directions.

FUEL PUMP

Replacement

⚠ 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. Pinch fuel line to block fuel flow, then disconnect fuel supply line.
2. Disconnect fuel pump-to-carburetor fuel line.
3. Remove cap screws and fuel pump.

Installation is done in the reverse order of removal.

IMPORTANT: Make sure fuel pump lever is positioned to the RIGHT of the camshaft (when looking at fuel pump mounting pad). Incorrect installation may result in fuel pump and engine damage.

- Use new gaskets for installation.
- Tighten hex flange screws to specifications.

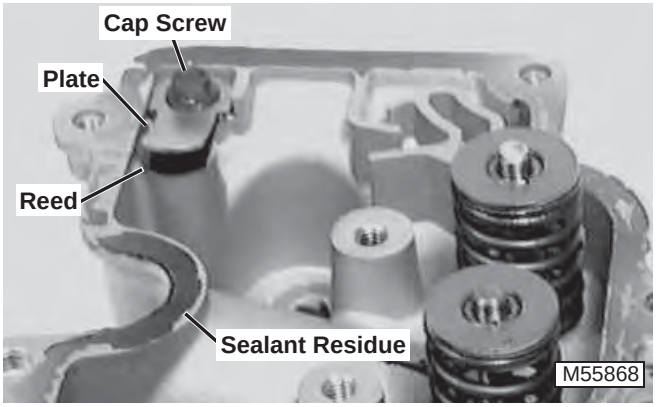
Fuel Pump Hex Flange Screw Torque

New Block . . . . . 9.0 N•m (80 lb-in.)
Reused Block . . . . . 7.8 N•m (65 lb-in.)

BREATHER

Inspect

1. Remove rocker arm cover. (See ROCKER ARM COVER—Removal/Installation on page 4-36.)



1. Remove cap screw, plate, and reed.
2. Check that breather opening is clear.
3. Replace reed if it does not lie flat on casting.
4. Clean mating surface of any sealant residue.
5. Install rocker arm cover. (See ROCKER ARM COVER—Removal/Installation on page 4-36.)

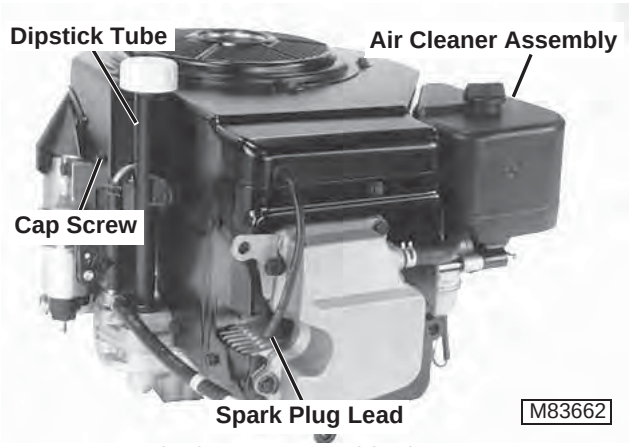
BLOWER HOUSING

Removal/Installation

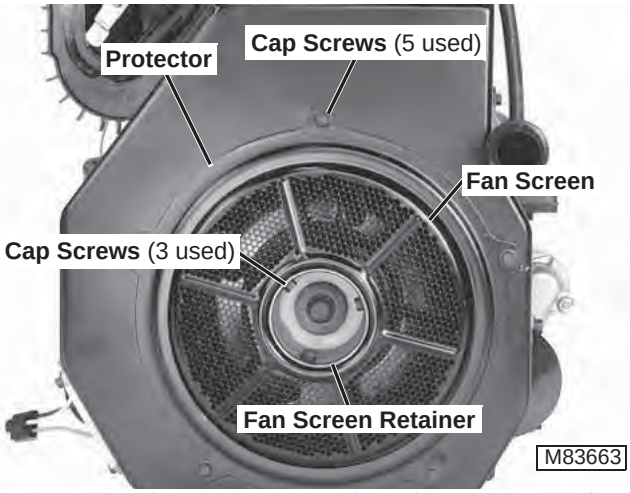
NOTE: Blower housing can be removed without removing engine from the machine.

IMPORTANT: Disconnect battery negative (–) cable (if engine is still in machine) to prevent damage to voltage regulator/rectifier.

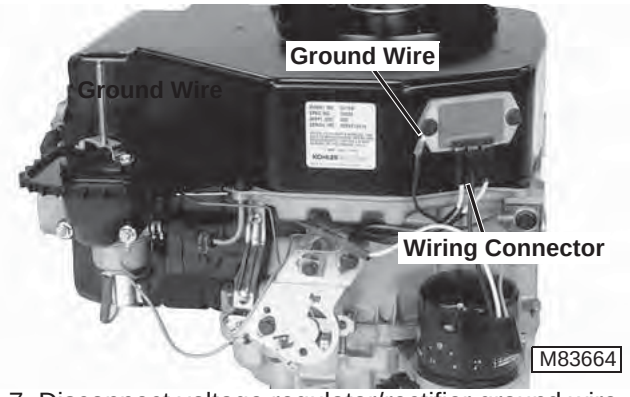
1. Disconnect battery negative (–) cable.



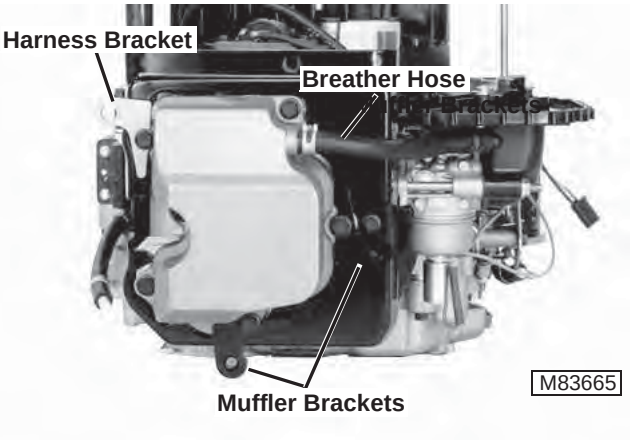
2. Remove air cleaner assembly. (See AIR CLEANER—Service on page 4-31.)
1. Disconnect spark plug lead.
2. Remove dipstick tube.
3. Remove cap screw.



4. Remove three cap screws from fan screen retainer.
5. Remove five cap screws and fan screen and protector.
6. Remove blower housing.



7. Disconnect voltage regulator/rectifier ground wire and wiring connector.



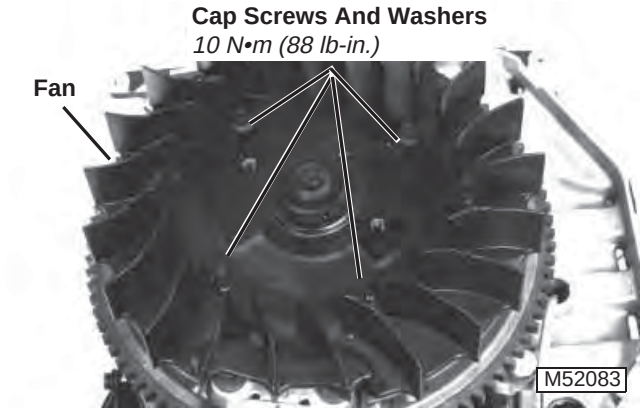
8. Remove muffler brackets.
9. Remove harness bracket.
10. Disconnect breather hose.
11. Remove cylinder head covers.

Installation is done in the reverse order of removal.

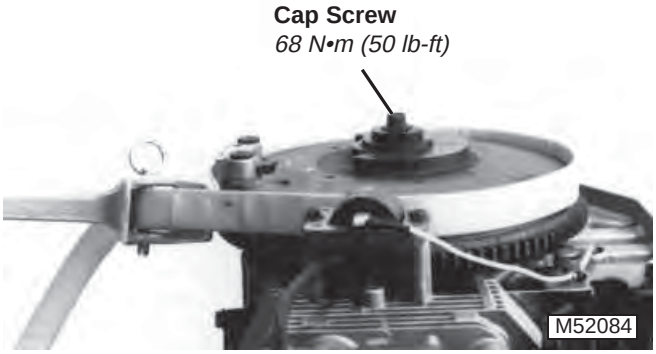
FLYWHEEL

Removal/Installation

1. Remove blower housing. (See BLOWER HOUSING—Removal/Installation on page 4-35.)



2. Remove four fan cap screws and washers and fan.



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

3. Hold flywheel with strap wrench. Remove cap screw.



4. Remove flywheel using a puller.

NOTE: Flywheel and magnets are not serviceable.

5. Inspect flywheel for cracks, chips, and broken teeth. Replace as necessary.
6. Inspect for sheared or partially sheared key, replace as necessary.

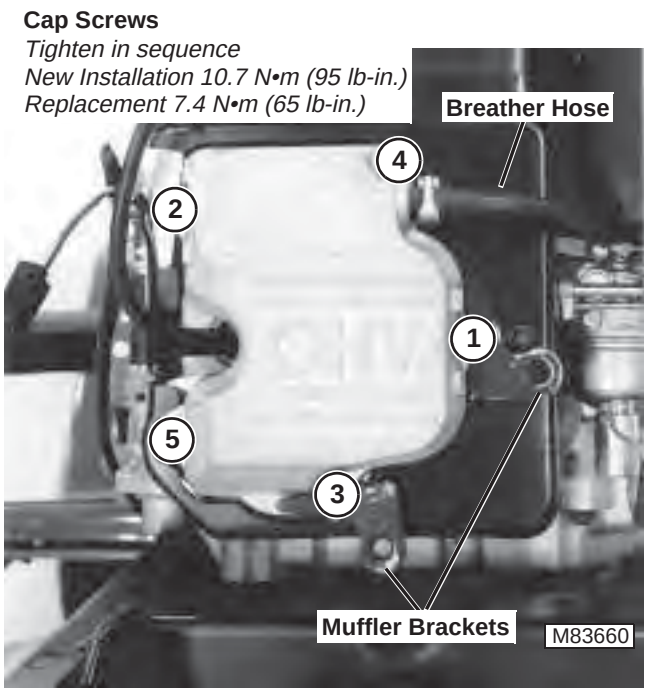
Installation is done in the reverse order of removal.

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.

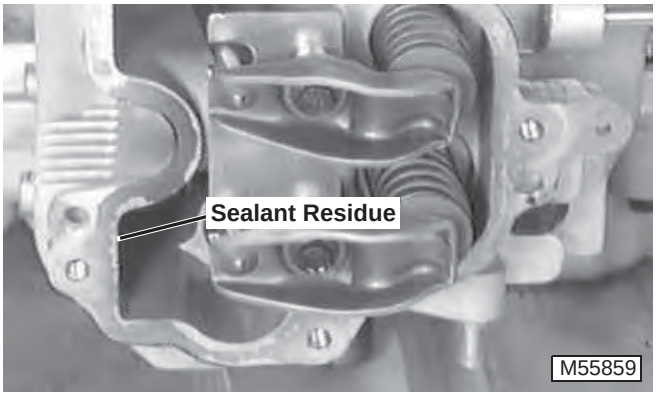
- Hold flywheel with strap wrench. Tighten cap screw to **68 N•m (50 lb-ft)**.
- Tighten fan cap screws to **10 N•m (88 lb-in.)**
- Check ignition module air gap. (see ARMATURE-WITH-COIL—Air Gap Adjustment on page 4-58.)

ROCKER ARM COVER

Removal/Installation



1. Disconnect breather hose.
2. Remove five caps screws, muffler brackets and rocker arm cover.



3. Clean mating surface of any sealant residue.

Installation is done in the reverse order of removal.

- Apply TY15130 John Deere Form-in-Place Gasket to mating surfaces.
- Tighten rocker cover cap screws, in sequence illustrated to specifications.

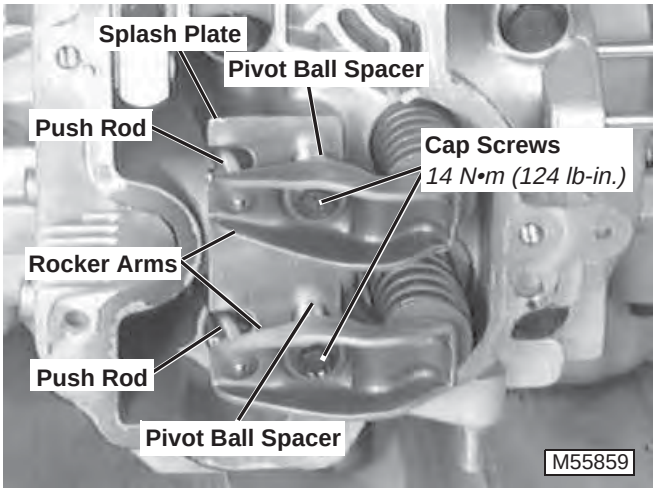
Rocker Arm Cover Cap Screw Torque

New Installation . . . . . 10.7 N•m (95 lb-in.).
Reinstallation . . . . . 7.4 N•m (65 lb-in.).

ROCKER ARMS

Removal/Installation

1. Remove rocker arm cover. (See ROCKER ARM COVER—Removal/Installation on page 4-36.)



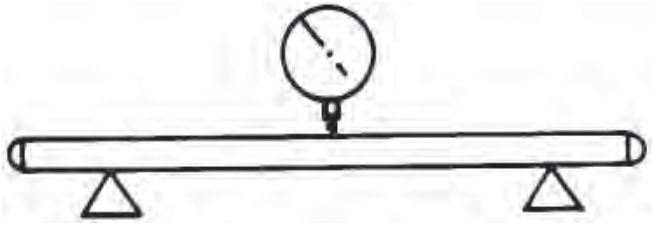
IMPORTANT: Mark push rods for assembly in original locations.

2. Remove cap screws and pivot ball spacers.
3. Remove rocker arms.
4. Remove push rods.
5. Remove splash plate.
6. Inspect and replace components as necessary.

Install components in reverse order of removal.

- Tighten rocker pivot bolts to **14 N•m (124 lb-in.)**.

INSPECT PUSH ROD



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

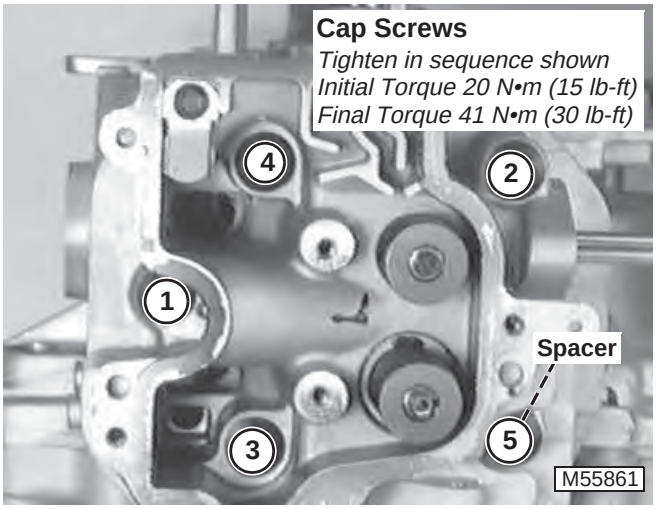
CYLINDER HEAD AND VALVES

Removal/Installation

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

NOTE: Cylinder head can be serviced without removing engine from tractor.

1. Remove blower housing. (See BLOWER HOUSING—Removal/Installation on page 4-35.)
2. Remove rocker arms. (See ROCKER ARM—Removal/Installation on page 4-37.)
3. Remove spark plug.



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

4. Remove cap screws in sequence shown, spacer and cylinder head. Discard gasket and clean head and block.

Installation is done in reverse order of removal.

IMPORTANT: Before installing head, rotate the piston to Top Dead Center of the compression stroke (crankshaft PTO keyway will be in 12 o'clock position). Failure to position piston correctly could result in damage to lifters and push rods.

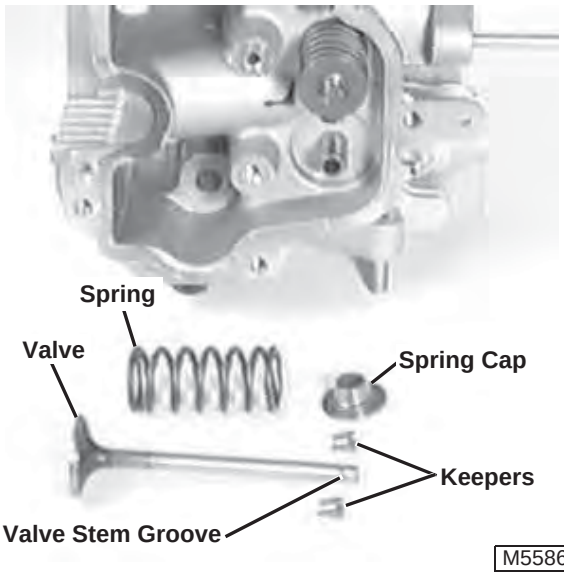
- Install new gasket.
- Tighten spark plug to **20 N•m (15 lb-ft)**.
- Tighten cylinder head cap screws in sequence to specifications.

Torque Specifications

Initial Torque . . . . . 20 N•m (15 lb-ft)
Final Torque . . . . . 41 N•m (30 lb-ft)

- Install rocker arm cover. (See ROCKER ARM—Removal/Installation on page 4-37.)
- Install blower housing. (See BLOWER HOUSING—Removal/Installation on page 4-35.)

Disassembly/Assembly



IMPORTANT: Make sure keepers are seated in valve stem groove.

1. Compress intake and exhaust springs using an appropriate size spring compressor.
2. Remove keepers, spring caps, springs, and valves.
3. Install valve components.
4. Compress spring and install keepers in grooves.
5. Inspect all parts for wear or damage. (See Inspection procedures.)

Assembly is done in reverse order of disassembly.

NOTE: Valve stem seal is used on intake valve. DO NOT reuse old seal if removed.

- Install new valve stem seal on intake valve.

Inspection

Cylinder Head:

1. Remove carbon deposits and clean gasket surface with SCOTCH-BRITE® abrasive or equivalent.
2. Inspect head for cracks or damage. Make sure oil drain port is open.



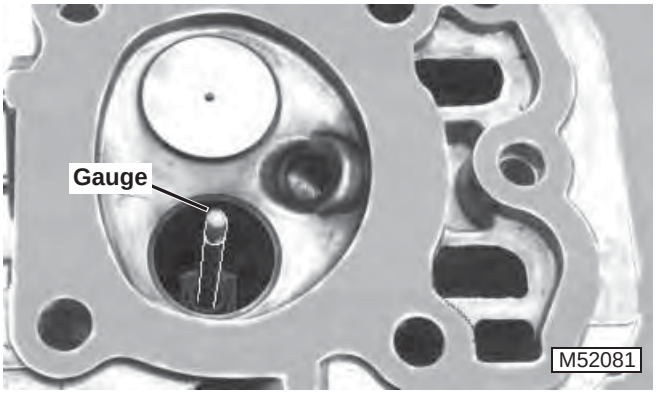
Put head on a **flat** surface plate. Check for distortion at several points with a feeler gauge. Replace head if distortion is **more than 0.076 mm (0.003 in.)**

Valve Guides:

NOTE: Valve guides cannot be replaced, but if worn can be reamed to 0.25 mm (0.010 in.) oversize. Replace cylinder head if guides are worn beyond oversize wear limit.

If guides have been reamed, oversized valves must be installed.

1. Clean inside of valve guide. Standard valve guide reamer (D20020WI) can be used.



2. Measure inside diameter of guide with gauge.

IMPORTANT: If guide is reamed oversized, an oversize valve must be installed.

3. If valve guide is worn beyond standard wear limit, ream guide using JDG705 Oversize Reaming Tool. If guide is worn beyond oversize wear limit, replace cylinder head.

Valve Guide I.D. Specifications:

Intake Guide:

Standard . . . 7.038—7.058 mm (0.277—0.278 in.)
Standard (Wear Limit) . . . . . 7.134 mm (0.281 in.)
Oversize . . . . 7.283—7.308 mm (0.287—0.288 in.)
Oversize (Wear Limit) . . . . . 7.384 mm (0.291 in.)

Exhaust Guide:

Standard . . . . 7.038—7.058 mm (0.277—0.278 in.)
Standard (Wear Limit) . . . . . 7.159 mm (0.282 in.)
Oversize . . . . 7.238—7.308 mm (0.285—0.288 in.)
Oversize (Wear Limit) . . . . . 7.409 mm (0.301 in.)



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

NOTE: An 0.25 mm (0.010 in.) oversize is available.

5. Measure outside diameter of valve stem at several points wear stem moves in guide.

Valve Stem O.D. Specifications:

Intake Valve:

Standard . . . 6.982—7.000 mm (0.275—0.276 in.)
Oversize . . . . 7.232—7.250 mm (0.284—0.285 in.)

Exhaust Valve:

Standard . . . . 6.970—6.988 mm (0.274—0.275 in.)
Oversize . . . . 7.220—7.238 mm (0.284—0.285 in.)

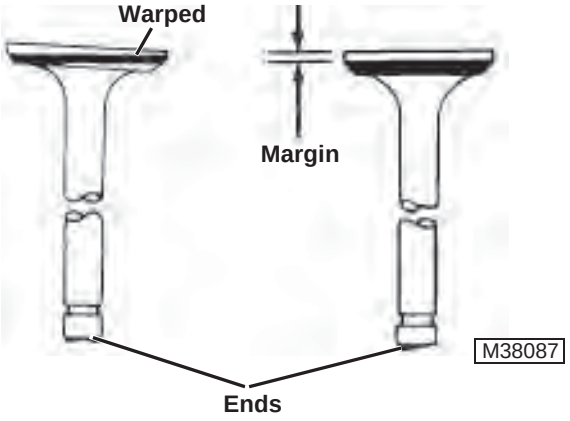
6. Subtract valve stem O.D. (use largest O.D.) from valve guide I.D. to find valve stem-to-guide clearance. Replace valve if stem-to-guide clearance is too great.

Valve Stem-to-Guide Clearance:

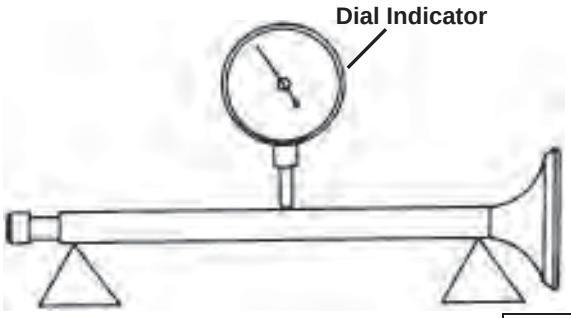
Intake . . . . . 0.038—7.076 mm (0.0015—0.003 in.)
Exhaust . . . 0.050—0.088 mm (0.0020—0.0035 in.)

Intake and Exhaust Valves:

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



3. Replace warped valves or valves with a margin **less than 1.5 mm (0.059 in.)**. Valve stem ends should be square, not worn uneven as shown.



M51753

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



M29934

Lead deposits 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.

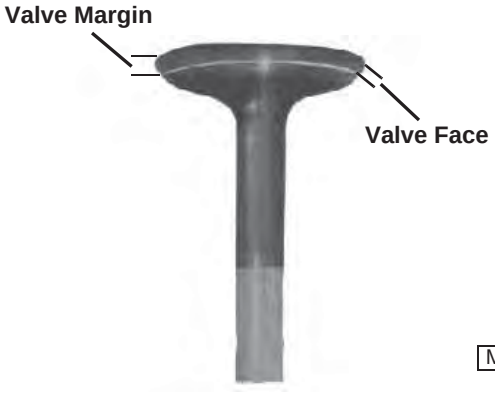
Use unleaded fuel to prevent lead deposits.



M5563

Valve stem corrosion 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.



M30024

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 and face. 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.



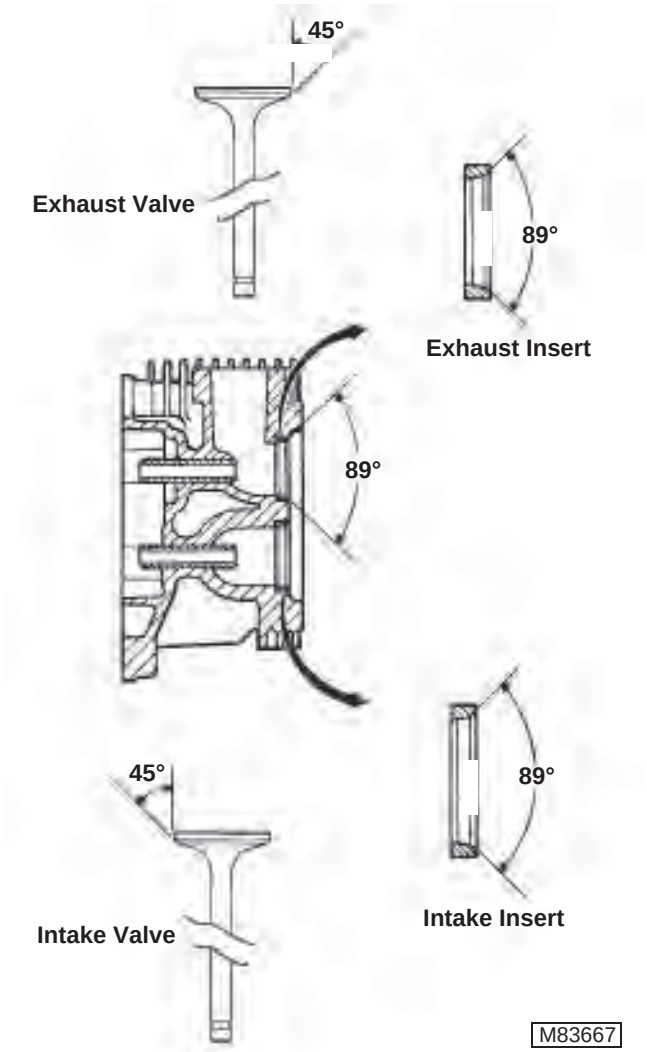
M29936

Use of old or stale gasoline can cause valves to stick.

Gummy deposits 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



1. Inspect valve seats for wear or damage. If seats are loose, warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be re-faced using a seat cutter.
2. Reface pitted or worn seats as shown. Cut valve seating as close as possible to specifications.
3. Lap valves to seats after re-facing. (See LAP VALVES.)
4. Check seat for good contact using Prussian Blue Compound.

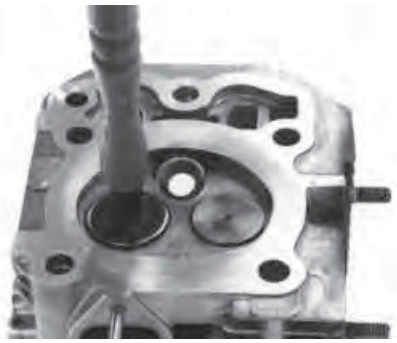
Specifications:

Valve Seat Angle . . . . . 89°
Valve Face Angle . . . . . 45°

LAP VALVES

IMPORTANT: Valves and seats should be lapped if they do not make good contact.

1. Apply light coat of lapping compound to valve face.

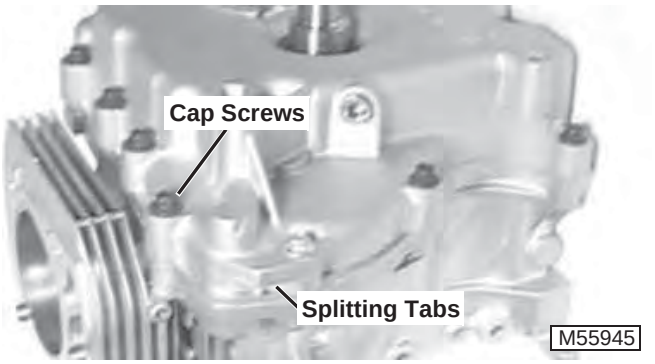


2. Grip top of valve with a vacuum cup tool and turn valve to lap valve to seat.
3. Lift valve from seat every 8 strokes. Lap until a uniform ring appears around surface of valve face.
4. Wash parts in solvent to remove lapping compound. Dry parts.
5. Check position of lap mark on face–lap mark must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

OIL PAN

Removal

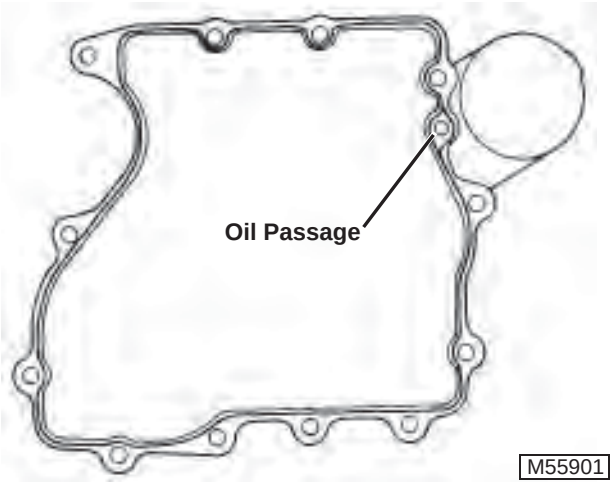
1. Drain engine oil. Capacity with filter is approximately **1.8 L (1.9 U.S. qt)**



NOTE: Do not pry on gasket surface when removing oil pan from crankcase.

1. Remove 12 cap screws.
2. Pry oil pan from crankcase using flat blade screwdriver on splitting tabs.
3. Clean mating surfaces of crankcase and oil pan.
4. Replace crankshaft seals. (See OIL PAN—Seal Replacement.

Installation

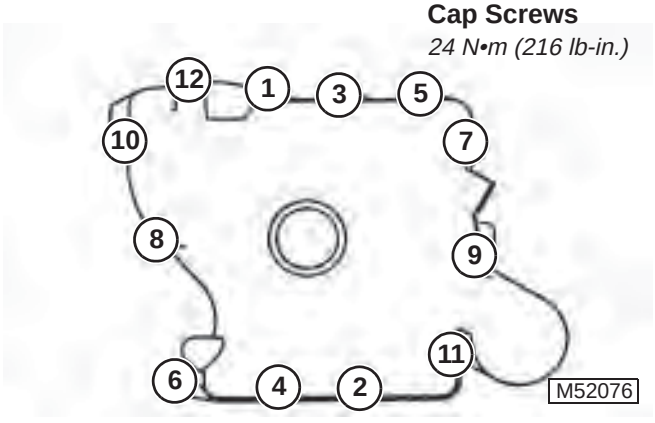


IMPORTANT: DO NOT get TY15130 John Deere Form-in-Place Gasket in oil passage. Apply just enough to seal both sides of oil passage when case halves are fastened together.

1. Apply 1.6 mm (1/16 in.) bead of TY15130 John Deere Form-in-Place Gasket to oil pan flange. DO NOT block oil passage.
2. Apply grease to inside lip of crankshaft main bearing seal.
3. Install oil pan over crankshaft carefully to avoid damaging main bearing seal.

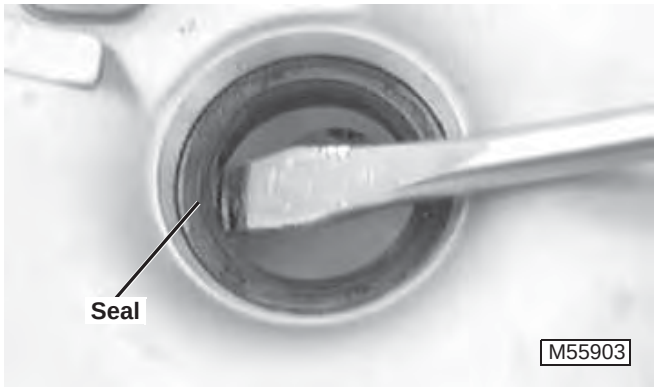
IMPORTANT: Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pan.

4. Install oil pan onto crankcase.



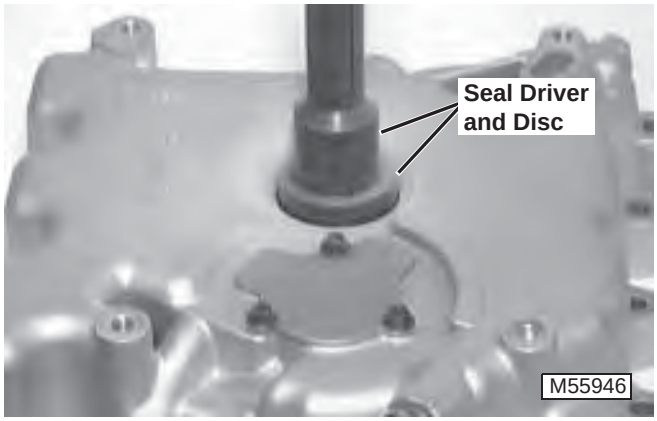
5. Tighten oil pan cap screws in sequence shown to **24 N•m (216 lb-in.).**

Seal Replacement



IMPORTANT: DO NOT damage pan bore when removing seal.

1. Remove and discard seal.
2. When replacing crankshaft seals, apply a thin film of LOCTITE® 598 (or equivalent) to the outside diameter of seal.



3. Apply grease to inside lip of seal to aid installation.
3. Using a suitable seal driver and disc, install new oil seal to **2.49—2.98 mm (0.098—0.117 in.) or until its top surface is flush with machined bore opening**.

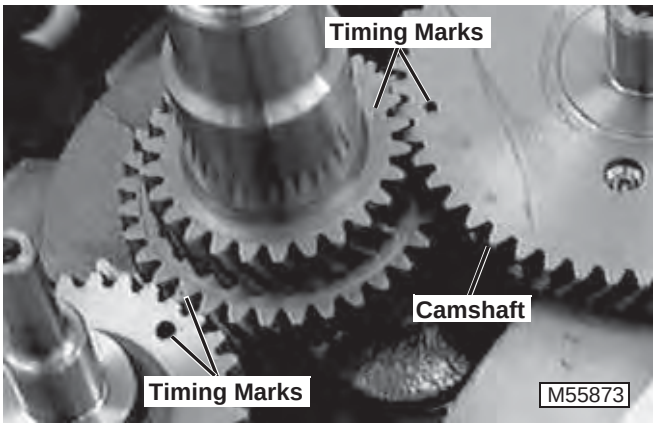
IMPORTANT: Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pan.

4. Install oil pan. (See OIL PAN—Installation.)

CAMSHAFT

Removal/Installation

1. Remove cylinder head. (See CYLINDER HEAD—Removal/Installation on page 4-37.)
2. Remove oil pan. (See OIL PAN—Removal/Installation on page 4-41.)

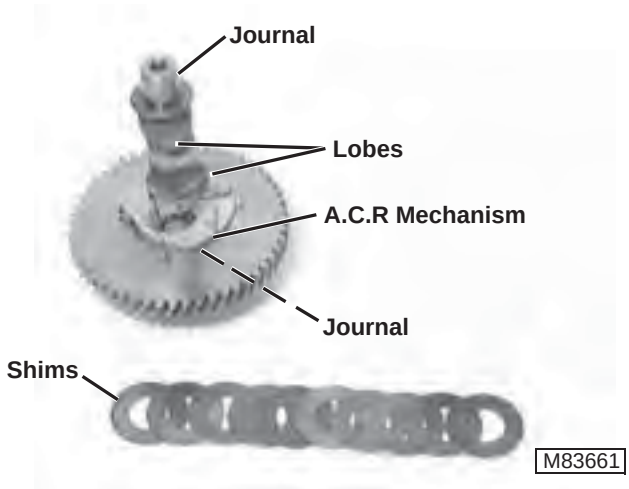


3. Rotate crankshaft to align two sets of marks.
4. Remove camshaft.
5. Inspect camshaft closely, replace as necessary.
6. Coat entire camshaft with clean engine oil.

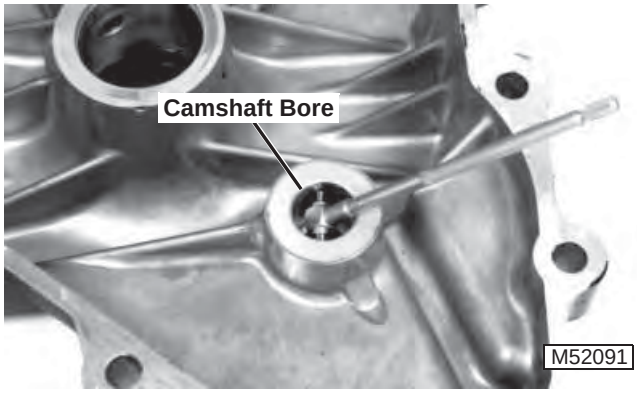
Installation is done in reverse order of removal.

- Install camshaft with four timing marks aligned.
- Check camshaft end play. (See End Play Check and Adjustment procedure.)

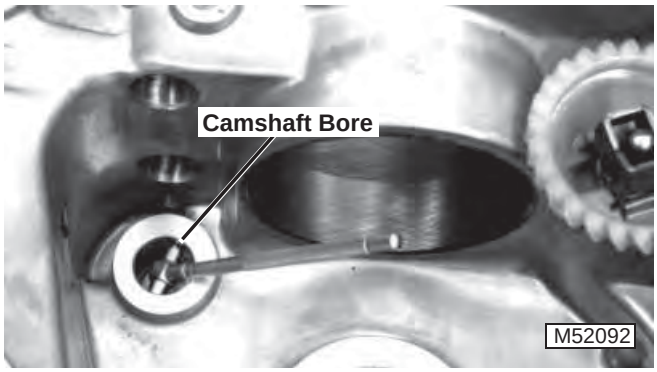
Inspection



1. Inspect camshaft for worn or broken teeth.
2. Measure journals at both ends. Replace camshaft if outside diameter measures **less than 19.959 mm (0.7858 in.)**.
3. Inspect lobes for wear or damage. Replace camshaft if lobes show excessive wear.
4. Inspect A.C.R. mechanism. Replace spring if necessary and check that weight moves freely.



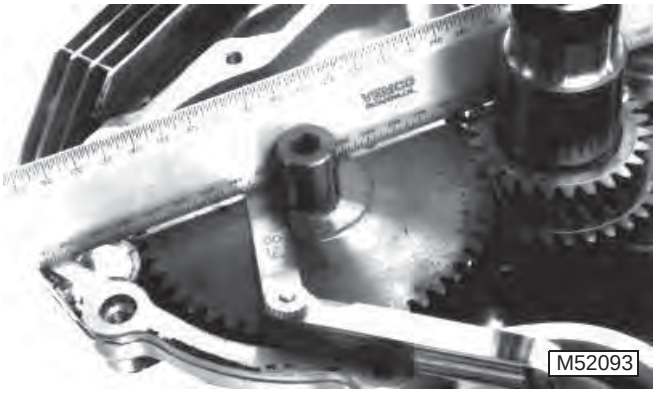
5. Measure camshaft bore in oil pan. Replace oil pan if inside diameter is **greater than 20.038 mm (0.7889 in.)**
6. Subtract journal O.D. from bore I.D. to determine clearance with camshaft journal. Replace camshaft and oil pan if clearance is **greater than 0.025—0.063 mm (0.0010—0.0025 in.)**.



7. Measure camshaft bore in crankcase. Replace block if inside diameter is **greater than 20.038 mm (0.7889 in.)**.

Subtract journal O.D. from bore I.D. to determine clearance with camshaft journal. Replace camshaft and block if clearance is **greater than 0.025—0.063 mm (0.0010—0.0025 in.)**

1. Check that camshaft is seated in crankcase bore.



2. Place a straightedge across crankcase mounting surfaces.
3. Measure play between camshaft and straight edge (spanning crankcase) using flat feeler gauge.
4. Use shims from Shim Kit as necessary until end play is within specification.

Camshaft End Play Specification (with shims) (Maximum) . . 0.076—0.127 mm (0.003—0.005 in.)

Shim Thickness Range:

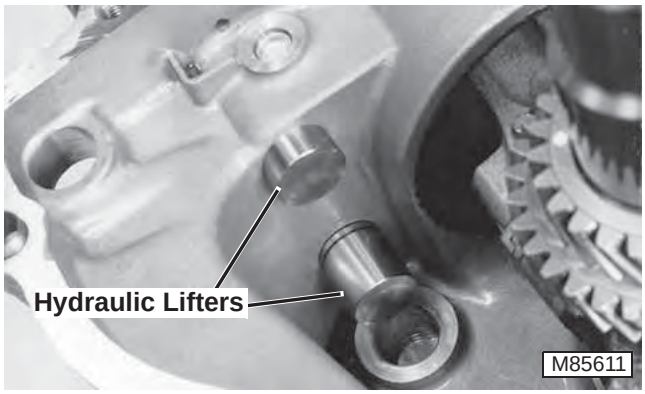
White . . . . . 0.692–0.730 mm (0.0273–0.0288 in.)
Blue . . . . . 0.743–0.781 mm (0.0293–0.0308 in.)
Red . . . . . 0.794–0.832 mm (0.0313–0.0328 in.)
Yellow . . . . . 0.845–0.883 mm (0.0333–0.0348 in.)
Green. . . . . 0.895–0.994 mm (0.0352–0.0368 in.)
Gray. . . . . 0.946–0.984 mm (0.0373–0.0388 in.)
Black . . . . . 0.997–1.035 mm (0.0393–0.0408 in.)

HYDRAULIC VALVE LIFTERS

Removal/Installation

1. Remove camshaft. (See CAMSHAFT—Removal/Installation on page 4-43.)

IMPORTANT: Used lifters are mated to their original camshaft lobes. Mark them for installation in the correct bore.



2. Remove lifters.
3. Inspect lifters for wear, replace as necessary.

Installation is done in reverse order of removal.

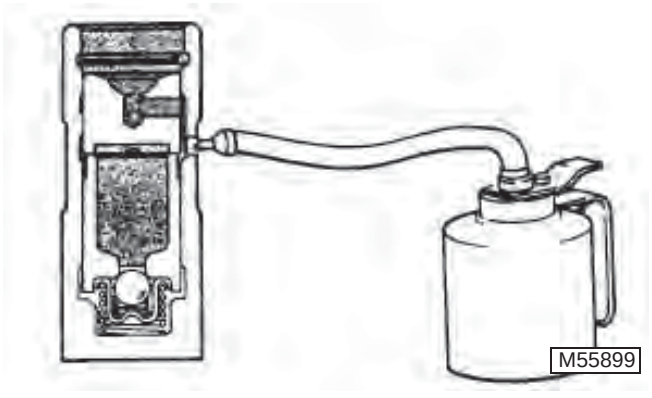
- Apply a light coat of clean engine oil to lifters and install in correct bore.

Inspection

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

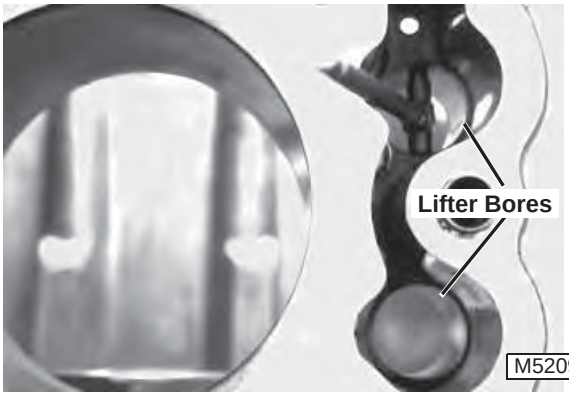


1. Inspect lifter face for wear. Face should be flat and smooth.
2. Use push rod to depress plunger. Plunger should offer resistance but move smoothly.
3. Check that oil hole is clear to inner piston.
4. Measure outside diameter of lifter.
5. Replace lifters that are worn or damaged.



NOTE: When installing new lifters, make sure lifters are full of oil. Submerse lifters in oil and use old push rod to pump lifter several times to purge air and fill with oil, or force oil into lifter with oil can (shown above), until lifter feels solid. Reassemble engine and allow 10 minutes for lifters to bleed down. Crank engine over by

hand and check for compression. If no compression exists or engine cannot be turned, lifters have not bled down, and may have trapped air inside. Wait 10 minutes more to allow lifters to bleed down.

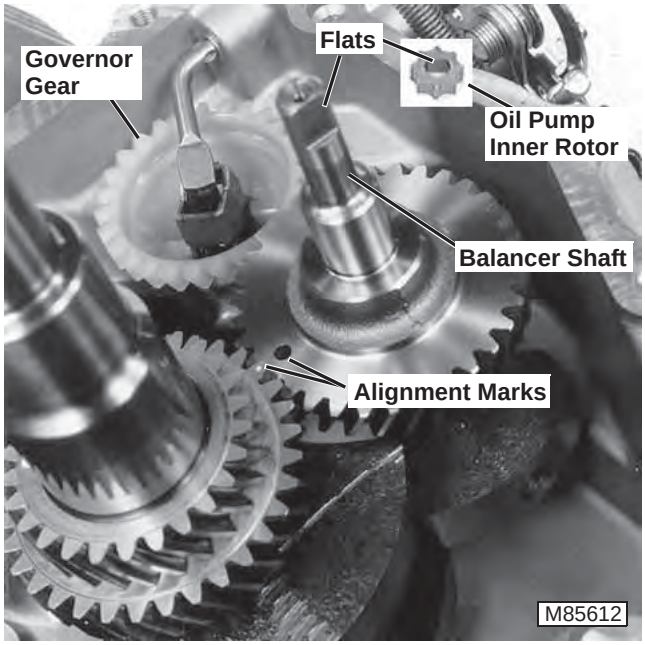


6. Measure inside diameter of crankcase lifter bore.
7. Subtract lifter O.D. from bore I.D. to determine lifter-to-bore clearance. Replace components as necessary if clearance is **greater than 0.0124—0.0501 mm (0.0005—0.0020 in.)**.

BALANCER SHAFT

Removal/Installation

1. Remove oil pan. (See OIL PAN—Removal/Installation on page 4-41.)

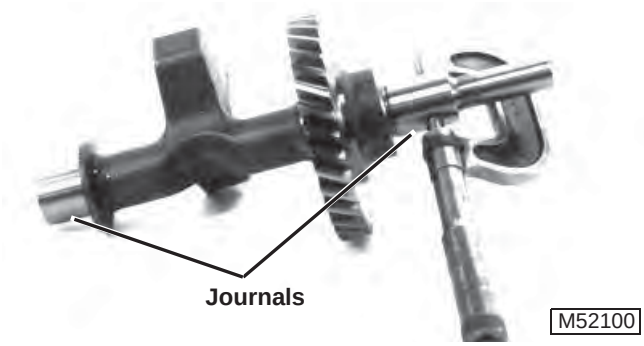


1. Align marks on balancer shaft and crankshaft.
2. Remove balancer shaft.
3. Inspect balancer shaft, replace as necessary.

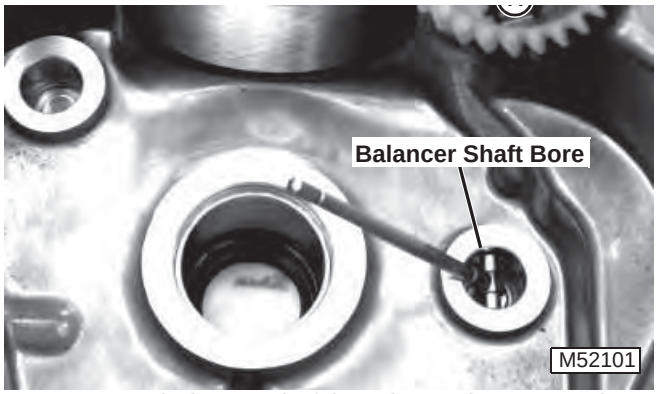
Installation is done in reverse order of removal:

- Align marks and install balancer shaft so it also aligns with governor gear.
- When installing oil pan, align flat of balancer shaft with bore flat of oil pump inner rotor gear.

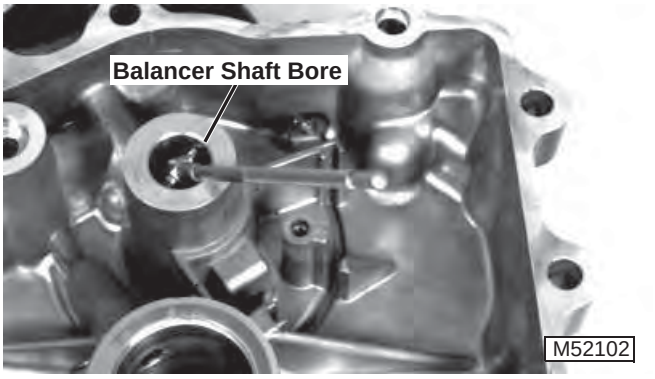
Inspection



1. Inspect shaft for cracks and broken teeth. Replace shaft if cracked or damaged.
2. Measure journals. Replace balancer shaft if journal outside diameter is **less than 19.959 mm (0.7858 in.)**.



3. Measure balancer shaft bore in crankcase. Replace block if inside diameter is **greater than 20.038 mm (0.7889 in.).**
4. Subtract journal O.D. from bore I.D. to determine clearance with balancer shaft journal. Replace balancer shaft and block if clearance is **greater than 0.025—0.063 mm (0.0009—0.0025 in.)**.



5. Measure balancer shaft bore in oil pan. Replace oil pan if inside diameter is **greater than 20.038 mm (0.7889 in.)**
6. Subtract journal O.D. from bore I.D. to determine clearance with balancer shaft journal. Replace balancer shaft and oil pan if clearance is greater than **0.025—0.063 mm (0.0009—0.0025 in.)**.

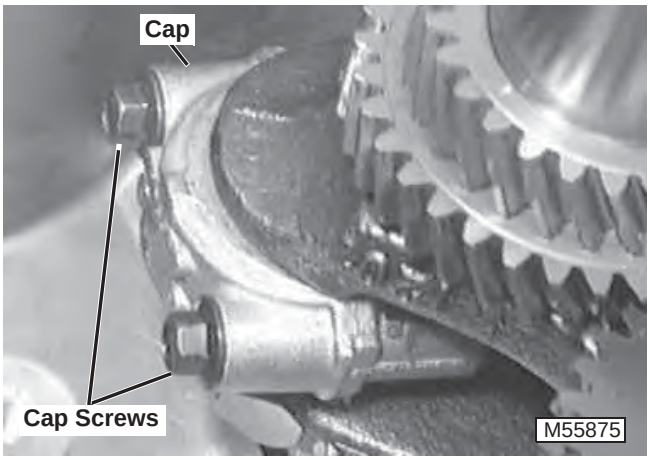
PISTON AND CONNECTING ROD

Removal

1. Remove balancer shaft. (See BALANCER SHAFT—Removal/Installation on page 4-45.)
1. Remove camshaft. (See CAMSHAFT—Removal/ Installation on page 4-43.)

IMPORTANT: Remove carbon ridge, if present, from cylinder before removing piston.

2. Remove carbon ridge, if present at top of cylinder, using a ridge reamer.



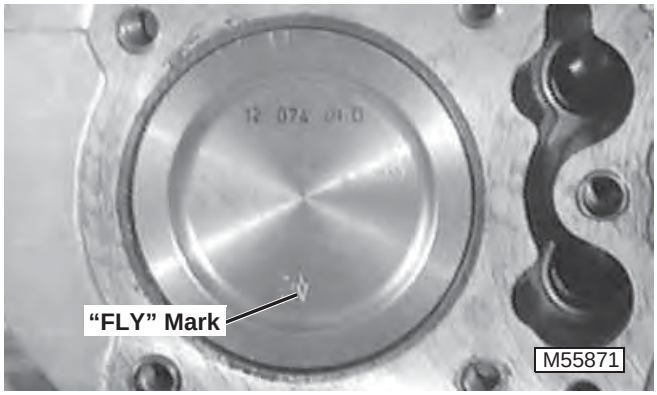
3. Remove cap screws to remove cap from connecting rod.
4. Remove piston assembly through top of cylinder.
5. Disassemble and inspect all parts for wear or damage. (See Disassembly and Inspection procedures.)

Installation

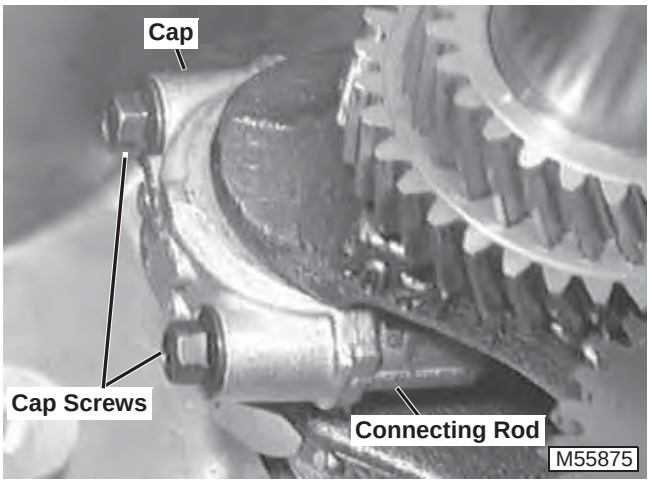
1. Install piston rings so piston ring end gaps are staggered 120° apart.
2. Coat cylinder, piston skirt, rod, and cap bearing surfaces with clean engine oil.



3. Compress rings with ring compressor tool.



4. Install piston with "FLY" mark toward flywheel side of crankcase. Use wooden dowel to push piston into bore.



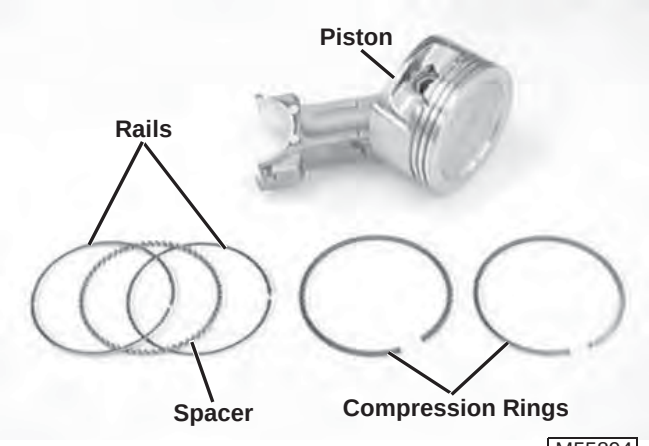
5. Fasten connecting rod and cap to crankshaft.
6. Tighten cap screws to specification.

Cap Screw Torque:

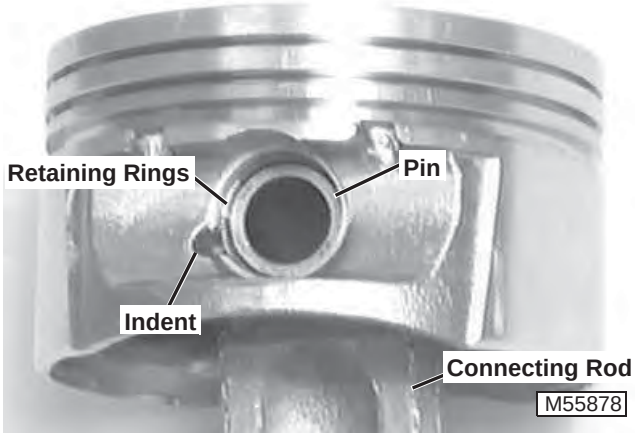
M8 Step–Down Shank . . . . . 14.6 N•m (130 lb-in.)

7. Check connecting rod-to-crankshaft side clearance. Replace connecting rod if side clearance is greater than **0.18—0.41 mm (0.007—0.016 in.)**.
8. Install balancer shaft. (See BALANCER SHAFT—Removal/Installation on page 4-45.)
9. Install camshaft. (See CAMSHAFT—Removal/Installation on page 4-43.)
10. Install oil pan. (See OIL PAN—Removal/Installation on page 4-41.)
11. Install cylinder head. (See CYLINDER HEAD—Removal/Installation on page 4-37.)

Disassembly



1. Remove compression rings from piston using ring expander.
2. Remove rails.
3. Remove spacer.



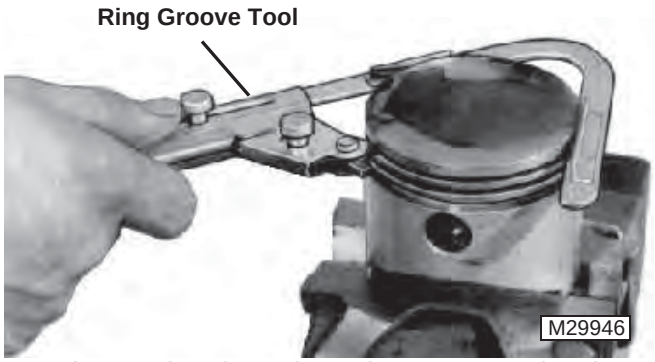
4. Remove retaining rings by prying at indent.
5. Use wooden dowel to remove pin from piston and connecting rod. (See Inspection procedures.)
6. Analyze piston ring wear. (See ANALYZE PISTON RING WEAR on page 4-50.)
7. Analyze piston wear. (See ANALYZE PISTON WEAR on page 4-51.)

Inspection

Piston:

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

1. Remove all deposits from the piston.



2. Clean carbon from piston ring grooves using ring groove tool. If a 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.



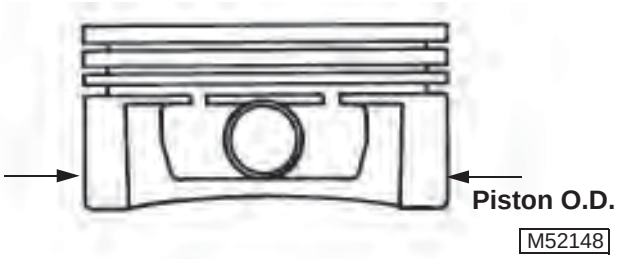
4. Measure piston ring clearance as shown at several points around piston.
5. Replace piston if measurements exceed clearance specifications.

Ring Groove Clearance Specifications:

1st Compression Ring (Top)
. . . . . 0.060—0.105 mm (0.0024—0.0041 in.)

Middle Compression Ring
. . . . . 0.040—0.085 mm (0.0016—0.0034 in.)

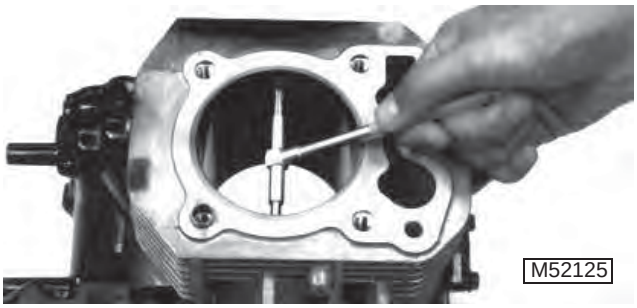
Oil Control Ring
. . . . . 0.176—0.026 mm (0.0069—0.0010 in.)



6. Measure diameter of piston at a point 6 mm (0.25 in.) from skirt bottom and perpendicular to piston pin. Replace piston if outside diameter is **less than 89.824 mm (3.5363 in.)**.



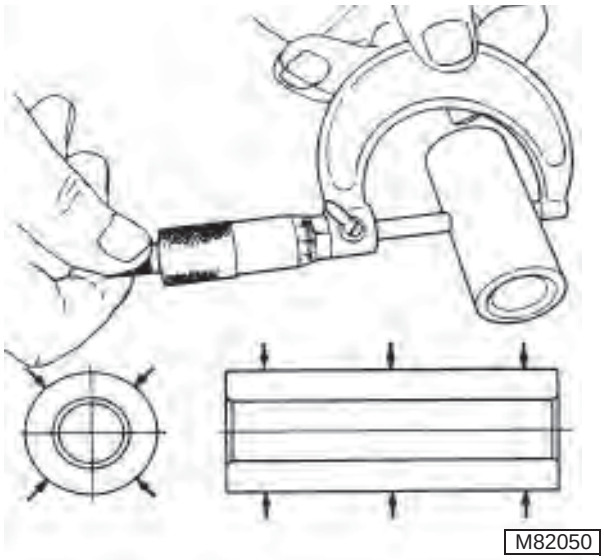
Measure piston pin bore diameter in piston. Replace piston if inside diameter is **greater than 19.025 mm (0.7490 in.)**



7. Measure cylinder bore.
8. Replace piston and/or rebore cylinder block if not within specifications.

Piston Specifications:

Thrust Face to Cylinder Bore Clearance (New)
. . . . . 0.031—0.043 mm (0.0012—0.0016 in.)

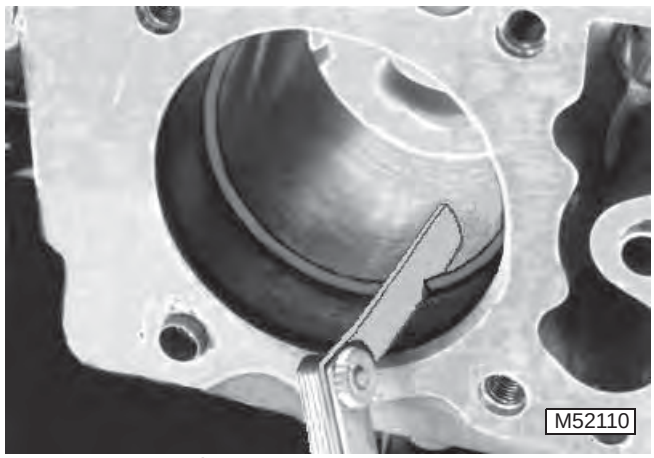


9. Measure piston pin outside diameter at six places. Replace pin if measurement is **less than 18.994 mm (0.7477 in.)**.

Piston Rings:

IMPORTANT: If new rings are to be installed, deglaze cylinder so rings will seat properly. (See Deglaze Cylinder Bore on page 4-55.)

1. Use a clean or new piston to push piston compression ring squarely into bore, to a point where it normally runs.

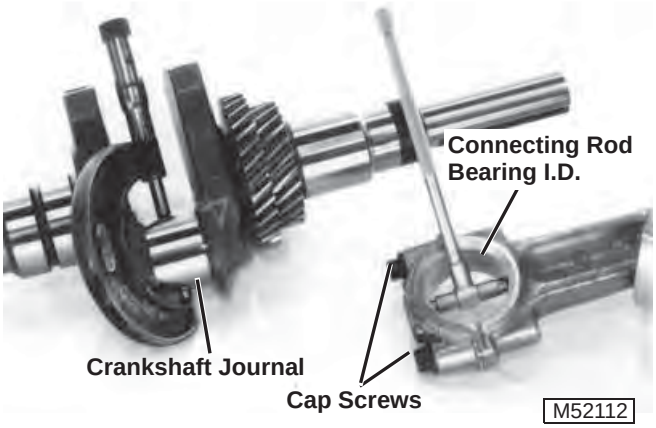


2. Measure end gap.
3. Remove ring and file ends squarely until gap meets specification. Rings with too large a gap must be replaced. If one piston ring needs replaced, all must be replaced as a set.

Specifications:

Piston Ring End Gap (New Bore)
. . . . . 0.26—0.51 mm (0.010—0.020)
Piston Ring End Gap (Used Bore)
(Maximum) . . . . . 0.77 mm (0.030 in.)

Connecting Rod:



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

1. Tighten cap screws to specification.
2. Measure inside diameter of connecting rod.
3. Measure outside diameter of crankshaft journal.
4. Determine connecting rod-to-crankshaft clearance.

Replace parts that are not within specifications.

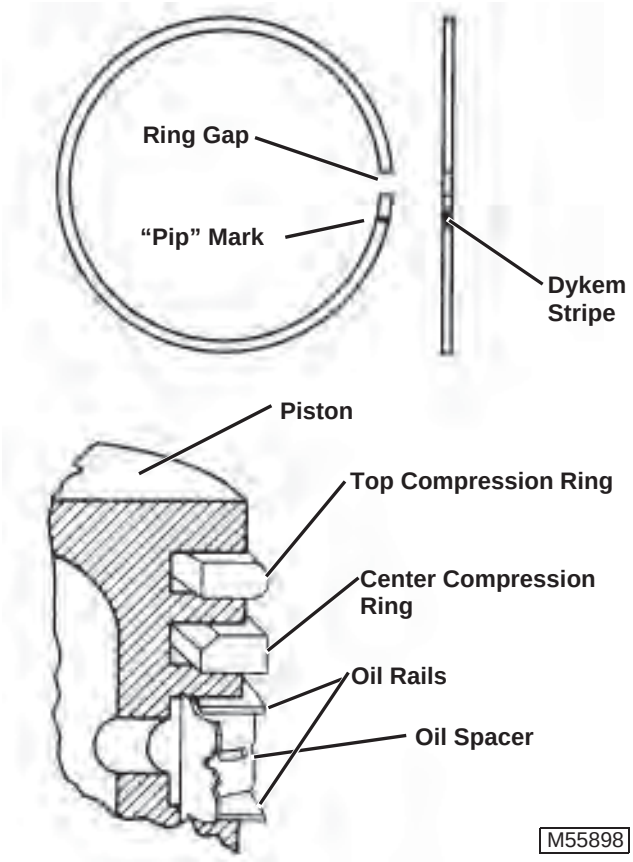
Crankshaft Specifications:

Connecting Rod Journal O.D.
New . . . . 38.958—38.970 mm (1.5338—1.5343 in.)
Wear Limit. . . . . 38.94 mm (1.5328 in.)
Taper (maximum) . . . . . 0.012 mm (0.0005 in.)
Out-Of-Round (max). . . . . 0.025 mm (0.0010 in.)
Crankshaft-to-Connecting Rod Clearance
New . . . . . 0.030—0.055 mm (0.0012—0.0022 in.)
Wear Limit. . . . . (0.07 mm (0.0025)

Connecting Rod Specifications:
Piston Pin End I.D.
New . . . . 19.015—19.023 mm (0.7486—0.7489 in.)
Wear Limit. . . . . 19.036 mm (0.7495 in.)
Connecting Rod Cap Screws Torque
8mm Step Down Shank . . . . 14.6 N•m (130 lb-in.)

Assembly

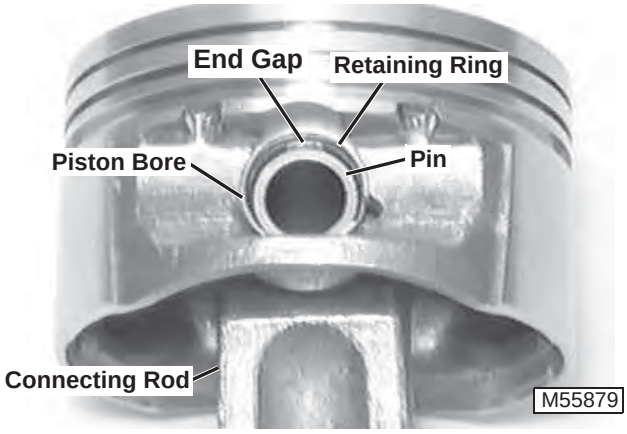
IMPORTANT: Side of ring marked TOP faces top of piston with Dykem stripe to left of end gap. Top compression ring has a blue Dykem stripe. Bottom compression ring has a pink Dykem stripe.



1. Install rings as shown on piston using ring expander.
   - 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 gasp of oil rails 180° apart.
   - Rings should turn freely in grooves.

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

Connecting rod is symmetrical and requires no special orientation to the piston.



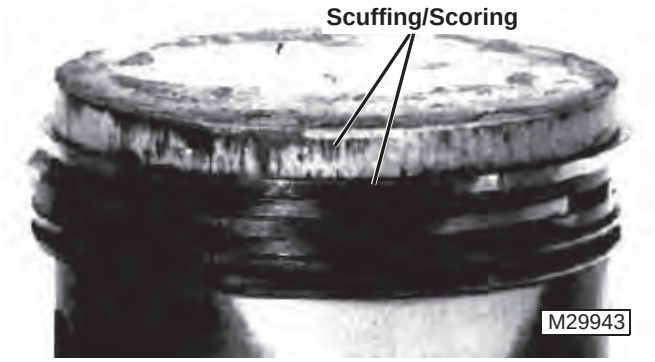
IMPORTANT: Retaining rings should be installed with end gap pointing up.

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

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.

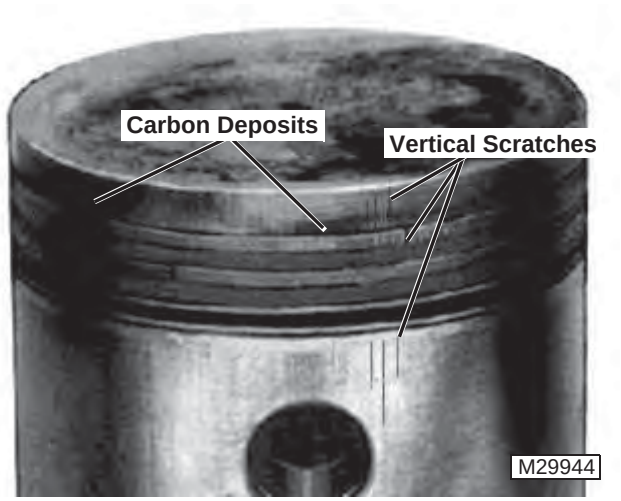
Ring end gaps should be staggered on the piston during installation. End gaps in alignment can also cause oil consumption and blowby.



Light scuffing or scoring 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 to form in the piston grooves making the rings stick. When this happens, excessive oil consumption and blowby will occur.

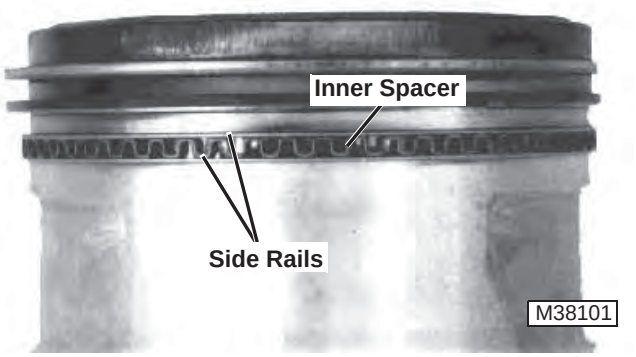
Engine overheating and ring sticking is usually caused by one or more of the following:

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

Vertical scratches 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.

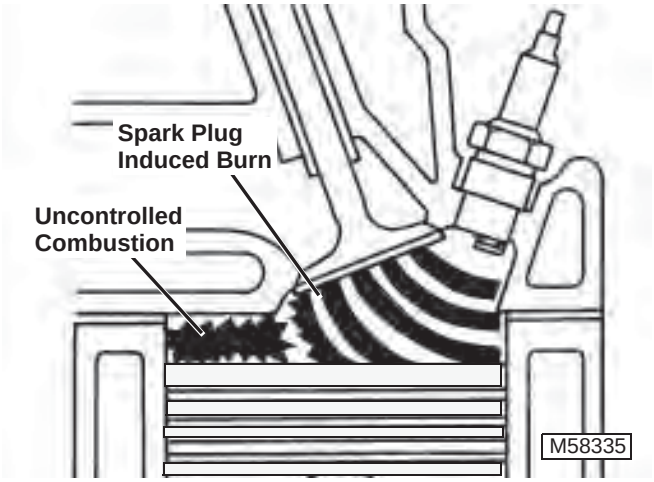


Abrasive particles in engine oil cause scratches on side rails of oil control ring. If inner spacer of oil control ring is worn or distorted it may cause:

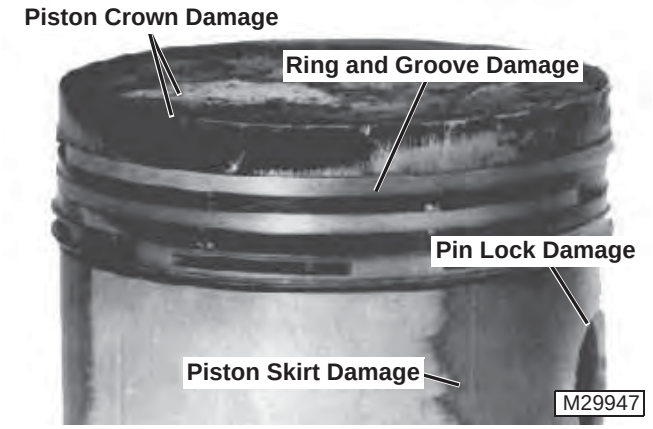
- Increased or high oil consumption.
- Increased deposits in combustion chamber.
- Sticking compression rings.

ANALYZE PISTON WEAR

Detonation



Detonation is uncontrolled combustion 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, causing a loud explosion and extreme shockwave.



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

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 pings, vibration, and power loss. Severe damage 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 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 caused the damage 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.

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.

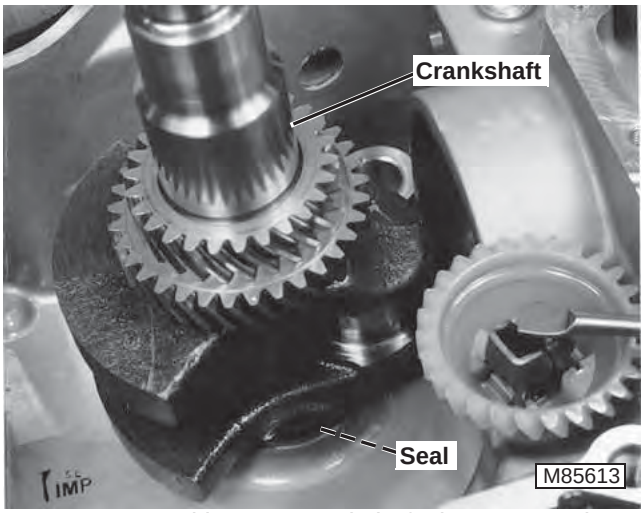
Crankshaft and connecting rod damage can also result from:

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

CRANKSHAFT AND MAIN BEARINGS

Removal/Installation

1. Remove camshaft and balancer assemblies.



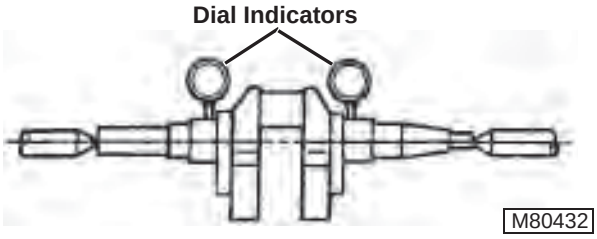
2. Remove and inspect crankshaft. (See Inspection procedure.)
3. Install new seals in crankcase and oil pan.
4. Install crankshaft carefully, DO NOT damage seals.

Inspection

1. Analyze crankshaft and connecting rod wear. (See ANALYZE CRANKSHAFT AND CONNECTING ROD WEAR on page 4-54.)

IMPORTANT: A bent crankshaft must be replaced; it cannot be straightened.

2. Clean and inspect crankshaft. Replace if scratched, damaged or worn beyond specifications.

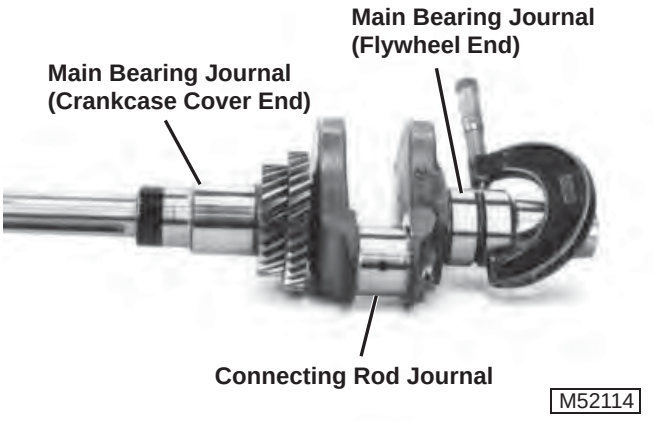


In alignment jig:

3. Place crankshaft into an alignment jig and slowly rotate crankshaft. Use dial indicators to measure maximum Total Indicated Runout (TIR). If runout exceeds **0.100 mm (0.0039 in.)**, replace crankshaft.

In engine:

4. Rotate crankshaft slowly. Measure TIR at oil pan end of crankshaft using dial indicator. If runout exceeds **0.15 mm (0.0059 in.)**, replace crankshaft.



5. Measure main bearing and connecting rod journals. Replace crankshaft if bent, damaged, or not within specifications.

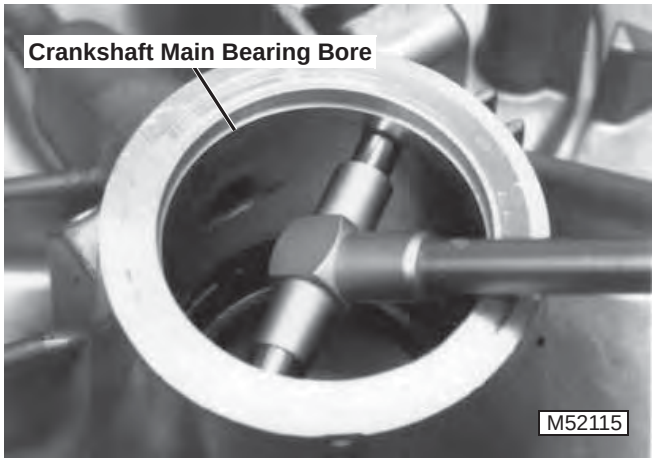
Crankshaft Bearing Journal Specifications:

Crankcase Cover End Main Journal O.D.:
New . . . . 41.915—41.935 mm (1.6502—1.6510 in.)
Wear Limit. . . . . 41.86 mm (1.648 in.)
Taper (Maximum) . . . . . 0.020 mm (0.0008 in.)
Out-of-Round (Maximum) . 0.025 mm (0.0010 in.)

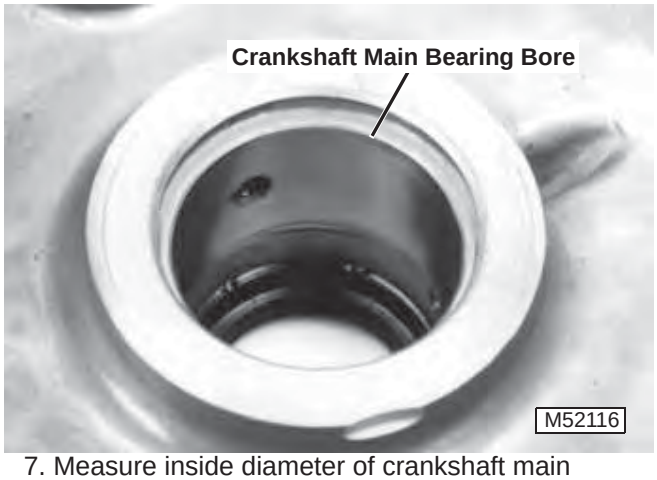
Flywheel End Main Journal O.D.:
New . . . . 44.913—44.935 mm (1.7682—1.7691 in.)
Wear Limit. . . . . 44.84 mm (1.765 in.)
Taper (Maximum) . . . . . 0.022 mm (0.0009 in.)
Out-of-Round (Maximum) . 0.025 mm (0.0010 in.)

Connecting Rod Journal O.D.:
New . . . . 38.958—38.970 mm (1.5338—1.5343 in.)
Wear Limit. . . . . 38.94 mm (1.5328 in.)
Taper (Maximum) . . . . . 0.012 mm (0.0005 in.)
Out-of-Round (Maximum) . 0.025 mm (0.0010 in.)

Running Clearance (Maximum) . . . . . 0.03–0.08 mm . . . . . (0.0012–0.0031 in.)



6. Measure inside diameter of crankshaft main bearing bore in crankcase cover. Replace cover if inside diameter is greater than 47.98—48.03 mm (1.889—1.891 in.).

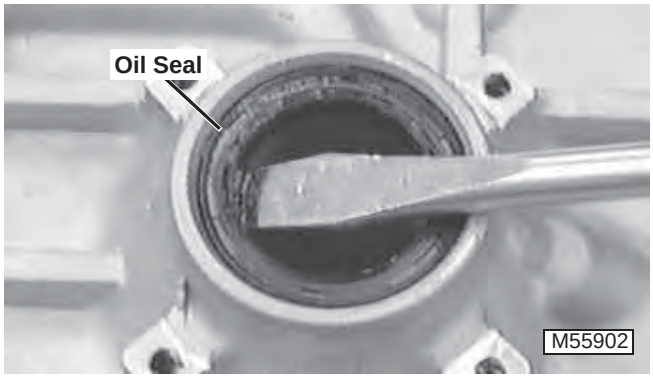


7. Measure inside diameter of crankshaft main bearing bore in crankcase. Replace block if inside diameter is **greater than 47.98—48.03 mm (1.889—1.891 in.)**.

8. Subtract crankshaft main journal O.D.'s from their respective bore I.D.'s to determine if running clearance is within specifications. Replace parts if clearance is **greater than 0.03—0.08 mm (0.0012—0.0031 in.)**.

CRANKCASE OIL SEAL

Replacement



IMPORTANT: DO NOT damage crankcase bore when removing seal.

1. Remove and discard crankcase oil seal.
2. When replacing crankshaft seals, apply a thin film of LOCTITE® 598 or equivalent to the outside diameter of seal.
3. Using a suitable driver and disc, install new oil seal to **4.0 mm (0.157 in.) or until top surface is flush with machined bore opening**.

IMPORTANT: Coat inside seal lip with grease to aid installation. Install crankshaft carefully to avoid damaging seal.

4. Carefully install crankshaft seal.

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:

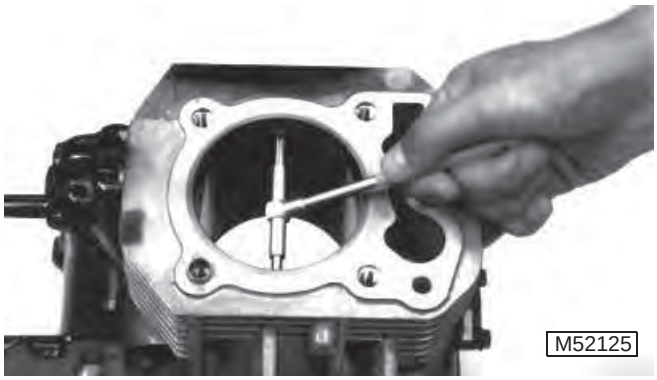
- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

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. Replace block if any cracks are found.



5. Measure cylinder bore inside diameter at six places; two measurements 90° apart at top, middle, and bottom of ring travel.
6. Measure piston outside diameter perpendicular to piston pin bore.

NOTE: Pistons and rings are available 0.25 and 0.50 mm (0.010 and 0.020 in.) oversize.

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

Cylinder Bore I.D.:

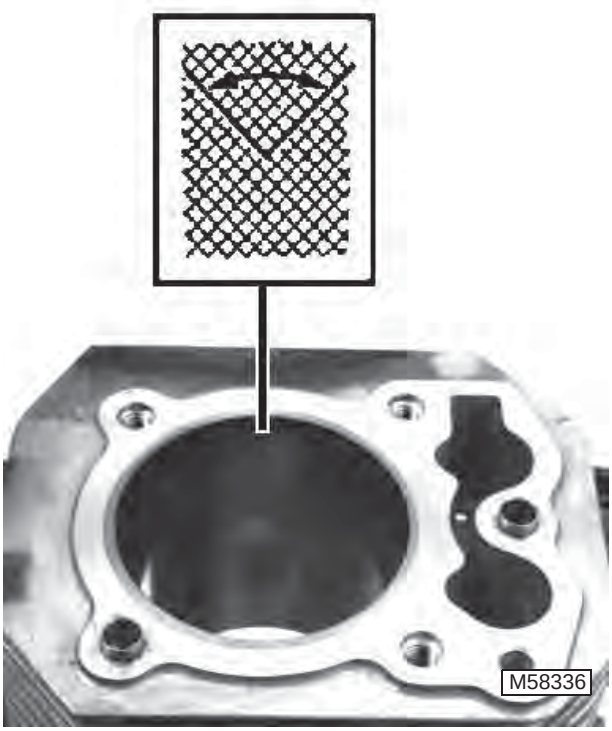
New . . . . . 90.000-90.025 mm (3.5433-3.5443 in.)
Wear Limit. . . . . 90.63 mm (3.5681 in.)
Out-of-Round (maximum) . . . . 0.12 mm (0.0047 in.)
Taper (maximum) . . . . . 0.05 mm (0.0020 in.)
Piston-to-Cylinder Clearance . . . . . 0.031-0.043 mm (0.0012-0.0016 in.)

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.


HONE1


M58336

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 clean engine oil.

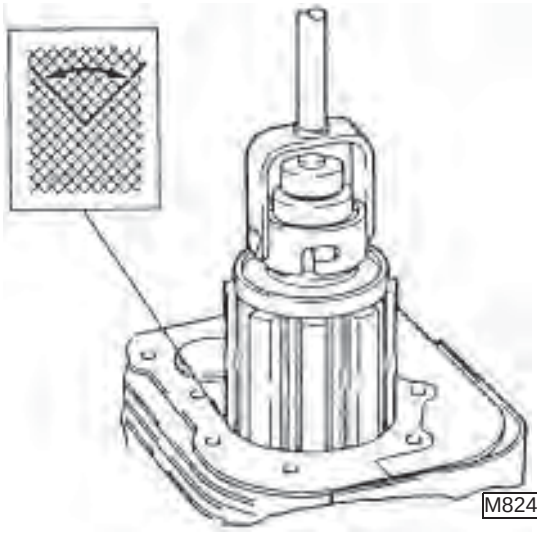
Rebore Cylinder Block

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

NOTE: The cylinder block can be rebored to use 0.50 mm (0.020 in.) oversize pistons and rings. Have a reliable repair shop rebore the block, or use a drill press and honing tool.

Rebore cylinder with a coarse grit stone honing tool to initial bore specifications and a fine grit stone to final bore specifications.

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 grit hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.


M82412a

5. Run drill press at about **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 **0.06 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 fine grit finish stones 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 solvents to clean cylinder bore. Solvents will not remove metal particles produced during honing.

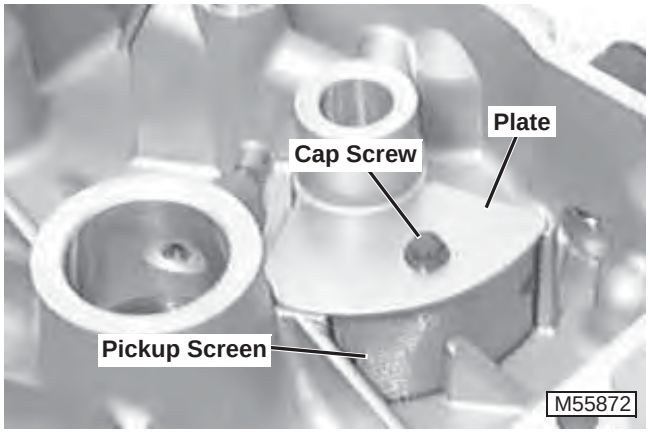
11. Clean cylinder thoroughly using warm soapy water until clean white cloths show no discoloration.
12. Dry cylinder. Apply a light coat of clean engine oil to appropriate mating surfaces.

Specifications:

Oversize Limits
Initial . . . . . 0.25 mm (0.010 in.)
Final . . . . . 0.50 mm (0.020 in.)
Drill Speed . . . . . .250 rpm
Hone Cycles . . . . . .60 per minute
Bore Crosshatch Pattern. . . . . 23—33°
Initial Bore Size—Coarse Stone
. . . . . Until within 0.06 mm (0.0025 in.) of desired bore size
Secondary Bore Size—Burnish Stone
. . . . . Until within 0.13 mm (0.0005 in.) of desired bore size
Final Bore Size—Finish Stone
. . . . . Using 220—280 grit finishing stones bore to desired size

OIL PICKUP

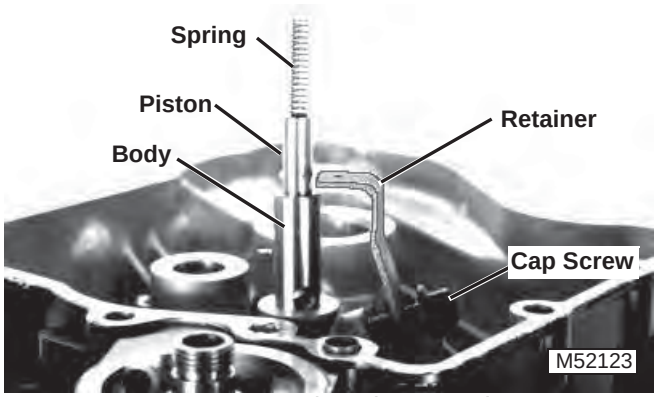
inspection



1. Remove cap screw and plate to remove pickup screen.
2. Clean screen with approved solvent. Replace if damaged.
3. Install screen, plate and cap screw.
4. Install oil pan. (See OIL PAN—Removal/Installation on page 4-41.)

OIL PUMP

Relief Valve Inspection

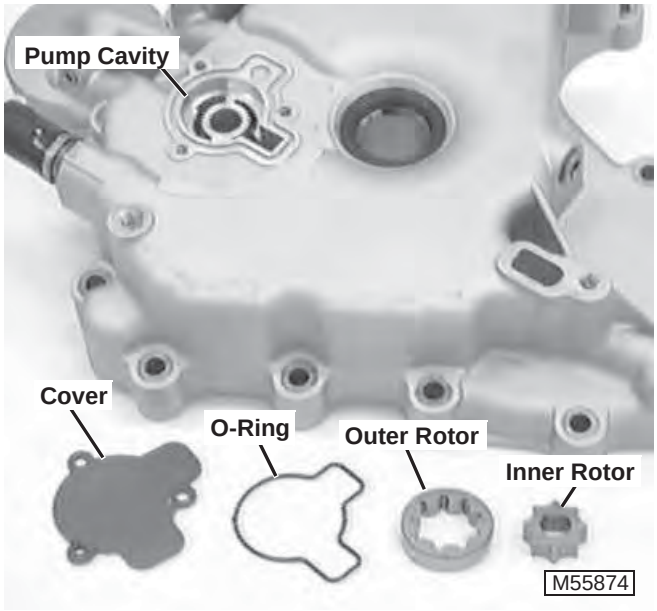


1. Loosen cap screw and retainer to gain access to individual components.
2. Remove and measure spring, replace if not to specification.

Specification:
Relief Valve Spring Free Length
. . . . . 25.1968 mm (0.992 in.)

3. Inspect spring, piston and body. Replace parts that are damaged or worn.
4. Install components with retainer and cap screw.
5. Install oil pan. (See OIL PAN—Removal/Installation on page 4-41.)

Removal/Inspection/Installation



1. Remove cover, O-ring, pump outer rotor and pump inner rotor.
2. Inspect rotor, pump, and inside surface of cavity for scoring, discoloration, and wear.
3. Replace parts as necessary.
4. Lubricate cavity and inner and outer rotors with engine oil. Install in cavity.

5. Install O-ring and cover. Tighten cap screws to specification.

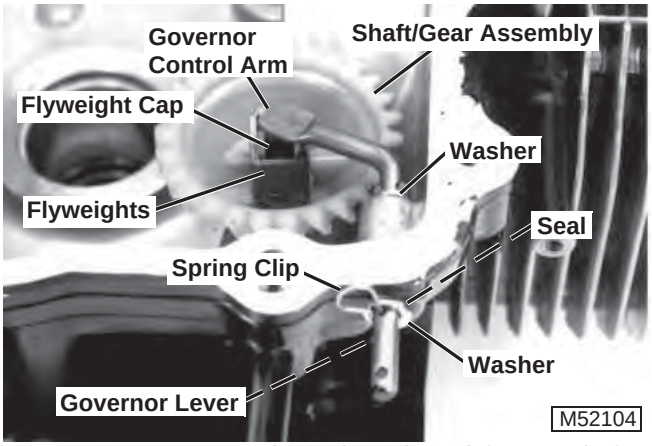
Oil Pump Cover Cap Screw Torque Specification:

New Oil Pan (Thread Forming) . . 6.2 N•m (55 lb-in.)
Used Oil Pan (Threads Cut) . . . . 4.0 N•m (35 lb-in.)

Oil Pump Cover-to-Rotor Clearance:. . . . . 0.076 mm (0.003 in.)

GOVERNOR

Removal/Installation



1. Remove governor lever (not shown) from end of control arm.
2. Remove spring clip, washers and governor control arm from inside of crankcase.
3. Remove and discard seal.

NOTE: Check governor shaft/gear assembly, if plastic gear, flyweight assembly, flyweight cap, and/or shaft are damaged, the complete assembly must be replaced.

4. Inspect governor shaft/gear assembly, replace as necessary.

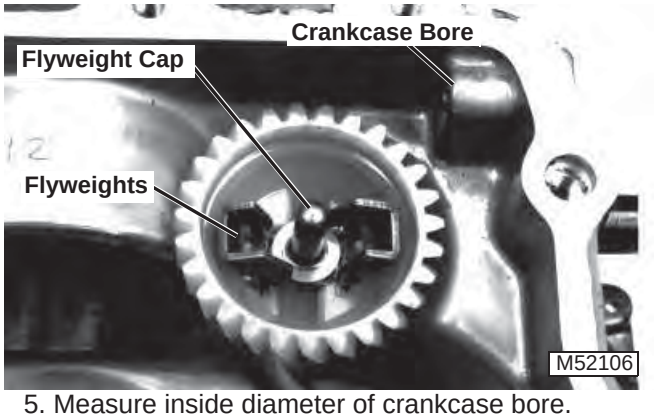
Installation is done in the reverse order of removal.

- Install new seal using suitable driver.

Inspection



Measure outside diameter of control arm shaft. Replace shaft if outside diameter is **less than 5.962 mm (0.2347 in.)**

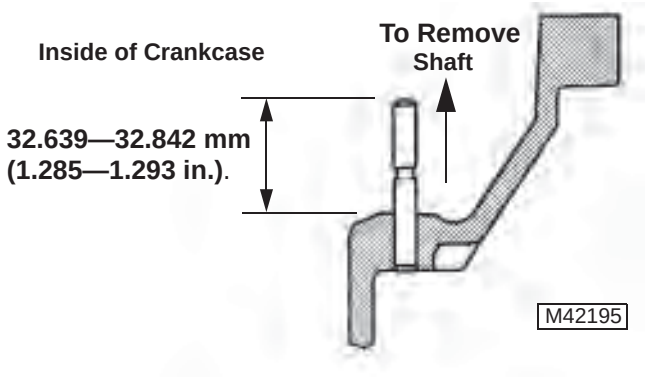


5. Measure inside diameter of crankcase bore. Replace block if inside diameter is **greater than 6.063 mm (0.2387 in.)**.
6. Subtract governor shaft O.D. from bore I.D. to determine control arm shaft-to-bore clearance. Replace governor shaft if clearance is **greater than 0.025—0.075 mm (0.0010—0.0030 in.)**.

IMPORTANT: DO NOT remove governor shaft unless it is to be replaced. Removal causes damage.

7. Inspect flyweights for proper operation and free movement. Replace governor shaft/gear assembly as necessary.
8. Measure outside diameter of governor shaft. Replace shaft if O.D. is **less than 5.977 mm (0.2353 in.)**.

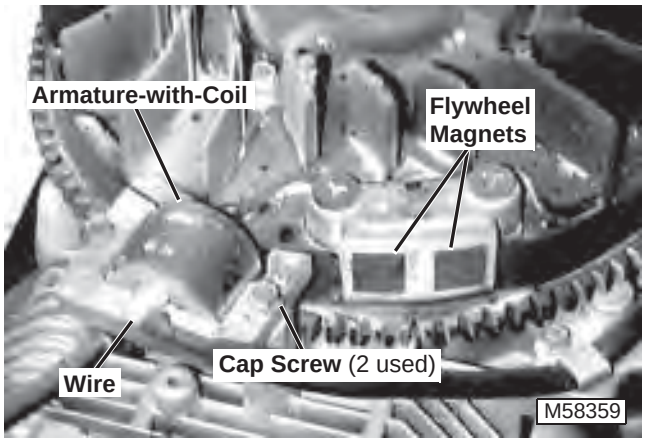
IMPORTANT: DO NOT remove governor shaft with vise-grips or pliers, damage to case may result.



9. With a small punch, CAREFULLY drive governor shaft toward **inside** of crankcase to remove it.
10. From **inside** of crankcase, install new governor shaft/gear assembly by pressing or lightly tapping shaft into crankcase bore until **top of shaft is 32.639—32.842 mm (1.285—1.293 in.) above inside surface**.

ARMATURE-WITH-COIL

Removal/Installation

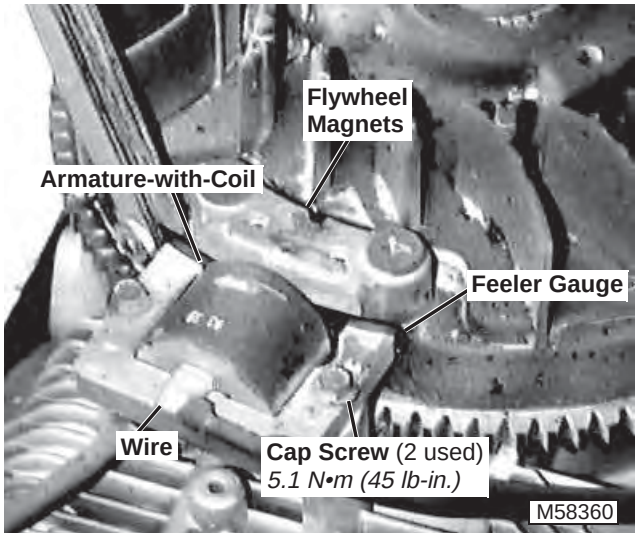


1. Turn flywheel magnets away from armature-with-coil.
2. Disconnect wire from terminal.
3. Remove cap screws and armature-with-coil.

Installation is done in the reverse order of removal.

- Install armature-with coil loosely. Rotate magnet away from module mount.
- Adjust armature air gap. (See Air Gap Adjustment.)

Air Gap Adjustment



1. Align flywheel magnet with mounting posts for armature.

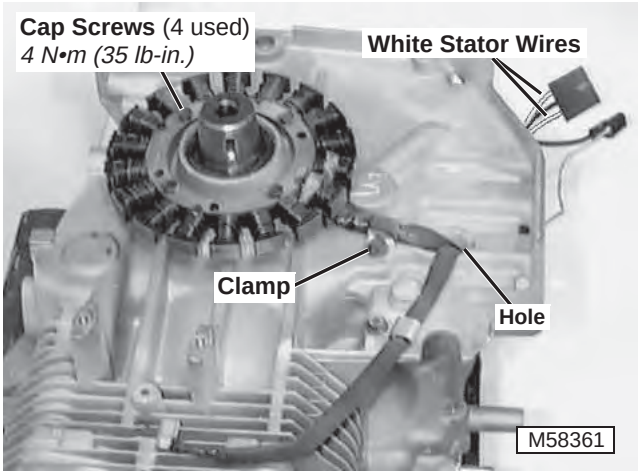
IMPORTANT: BE SURE flywheel magnets are centered on armature-with-coil so all three polls of the armature are properly gapped from the flywheel magnet.

2. Place **0.25 mm (0.01 in.)** feeler gauge blade or shim stock across magnet face.
3. Position armature-with coil so all three polls mate with feeler gauge blade and its two mounting holes align with mounting posts.
4. Install and tighten cap screws to **5.1 N•m (45 lb-in.)**.
5. Remove feeler gauge and connect wire to terminal.

STATOR

Removal/Installation

1. Remove armature-with-coil. (See ARMATURE-WITH-COIL on page 4-58.)
2. Remove flywheel. (See FLYWHEEL—Removal/Installation on page 4-36)



3. Remove two white stator wires from connector.
4. Remove clamp.
5. Remove cap screws and stator.
6. Inspect for damage.

Installation is done in the reverse order of removal.

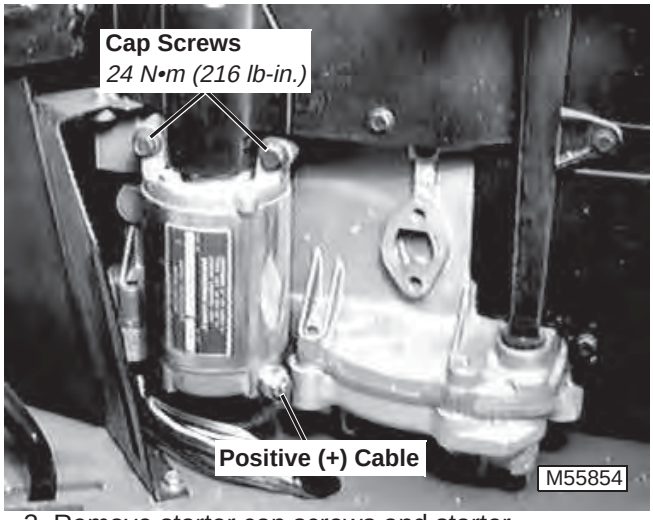
- Tighten cap screws to **4 N•m (35 lb-in.)**.
- Install armature-with coil loosely. DO NOT tighten cap screws.
- Adjust armature air gap. (See Air Gap Adjustment on page 4-58.)

STARTER

Removal/Installation

NOTE: Disconnect negative (–) *battery cable first.*

1. Disconnect negative (–) battery cable at the battery.
2. Disconnect positive (+) cable from starter.



3. Remove starter cap screws and starter.

Installation is done in the reverse order of removal.

NOTE: Connect negative (–) *battery cable last.*

- Tighten cap screws to **24 N•m (216 lb-in.)**.
- Clean all battery cable connections before installing cable.

Analyze Condition

The starter overheats because of:

- Long cranking.
- Armature binding.

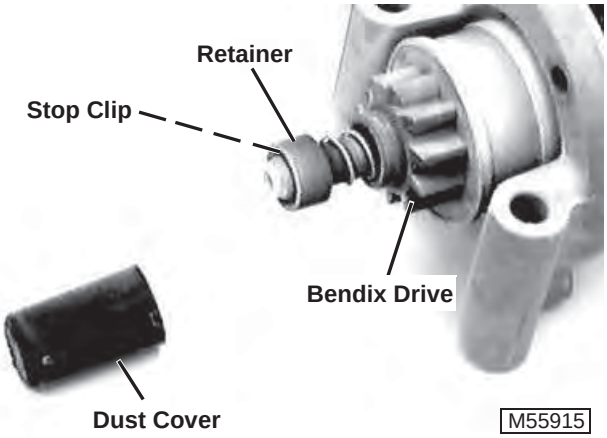
The starter operates poorly because of:

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

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

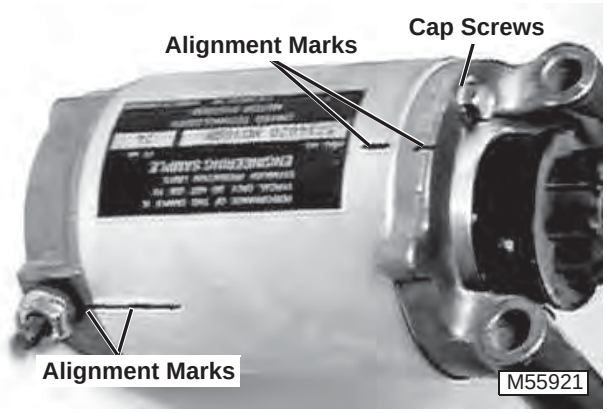
Replace Bendix Drive

Replace drive if drive fails to engage flywheel or kicks out repeatedly before engine starts.



1. Remove dust cover.
2. Compress retainer and remove stop clip.
3. Disassemble bendix drive.
4. Inspect and replace with new Bendix Drive Kit.

Replace Brushes

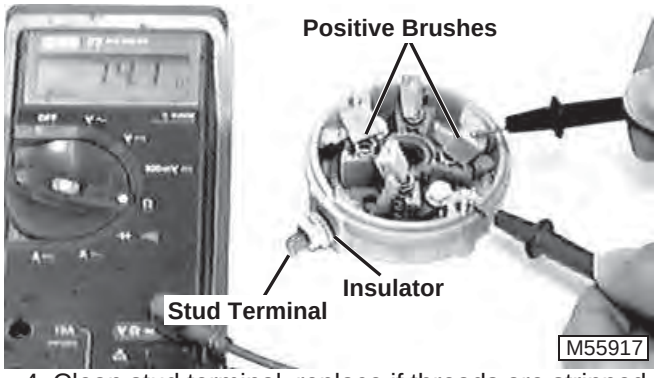


NOTE: Highlight upper and lower alignment marks on frame and end caps to aid assembly. Permanent magnets are part of frame. If frame or magnets are damaged replace frame. Always test armature anytime starter is disassembled. (See Inspection/Test procedures.)

1. Remove long cap screws then separate top end cap and armature from frame and bottom end cap (brush holder).
2. Clean commutator of armature with a coarse, lint free cloth. DO NOT use emery cloth. If commutator is badly grooved, turn it down on a lathe or replace it.



3. Clean negative brushes contact point with end cap. Using Ohmmeter, check for **continuity** with end cap. Replace negative brushes if **no continuity** is indicated.



4. Clean stud terminal, replace if threads are stripped or if it is corroded.
5. Replace insulator if cracked.
6. Clean positive brushes contact point with end cap. Using Ohmmeter, check for **no continuity** between positive brushes and end cap, and also between stud terminal and end cap. Replace positive brushes if **continuity** is indicated.
7. Align upper highlighted markings and carefully assemble top end cap and armature into frame.

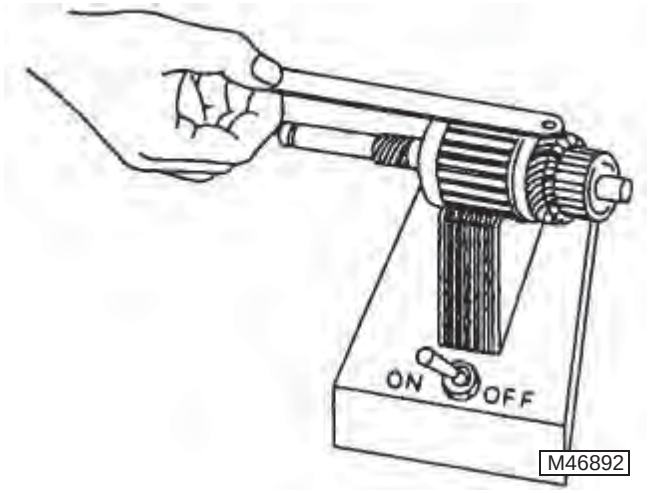


8. Compress brushes into brush holders of bottom end cap using two thin screw drivers or tongue depressors.
9. Align lower highlighted markings and carefully assemble starter so brushes are positioned against commutator of armature.
10. Carefully remove screwdrivers without allowing brushes to dislodge from holders of bottom end cap as assembly goes together.
11. Install long cap screws and tighten them evenly.

Inspection/Test

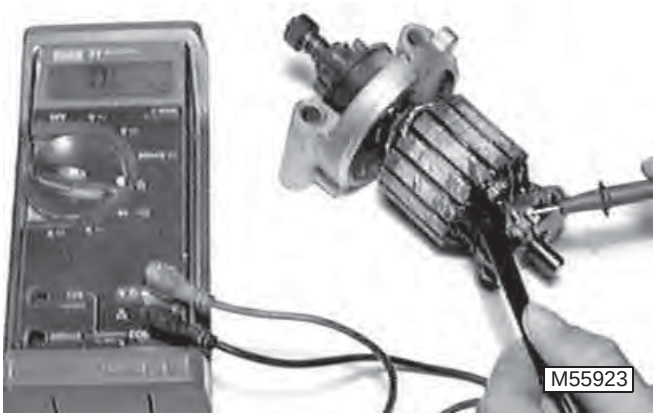
IMPORTANT: DO NOT clean armature with solvent. It can damage insulation on windings. Use mineral spirits and a clean brush

1. Clean commutator of armature with a coarse, lint free cloth. DO NOT use emery cloth. If commutator is badly grooved, turn it down on a lathe or replace it.
2. Check for short circuits with a growler.

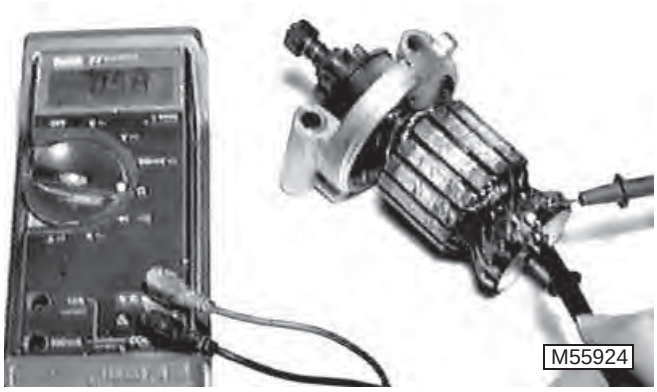


3. Rotate armature on growler while holding a steel strip (e.g. hacksaw blade) on armature. Strip will vibrate in area of short.

NOTE: Shorts between bars are sometimes caused by dirt or copper between bars.
If test indicates short circuited windings, clean and recheck. If still faulty, replace armature.



4. Check for grounded windings with an ohmmeter or test light. If any **continuity** is indicated, winding is grounded and armature must be replaced.



NOTE: Armature windings are connected in parallel, each bar must be tested.

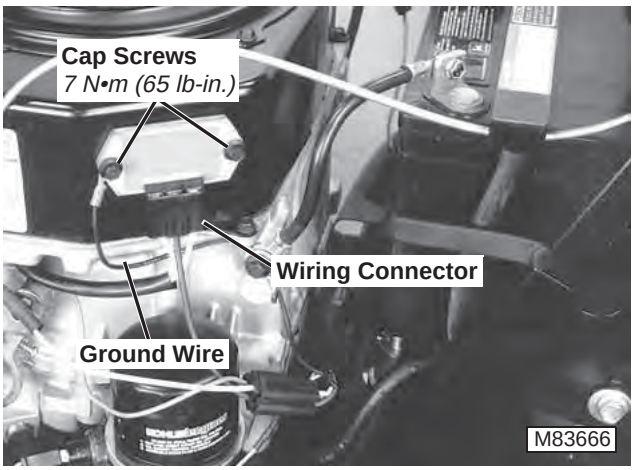
5. Check for open windings with an ohmmeter or test light. If **no continuity** is indicated, there is an open circuit and armature must be replaced.

VOLTAGE REGULATOR/RECTIFIER

Removal/Installation

IMPORTANT: Disconnect battery negative (–) cable (if engine is still in machine) to prevent damage to voltage regulator/rectifier.

1. Disconnect battery negative (–) cable.



2. Disconnect wiring harness connector.
3. Remove cap screws and ground wire.
4. Remove voltage regulator/rectifier.

Installation is done in the reverse order of removal.

- Tighten cap screws to **7 N•m (65 lb-in.)**.



This page intentionally left blank.

CONTENTS

Page

ELECTRICAL

SPECIFICATIONS
- TEST AND ADJUSTMENT SPECIFICATIONS 5-4
- REPAIR SPECIFICATIONS 5-5
- SPECIAL OR ESSENTIAL TOOLS 5-5
- OTHER MATERIALS 5-5

THEORY AND DIAGNOSTIC INFORMATION
- READING ELECTRICAL SCHEMATICS 5-6
- THEORY OF OPERATION INFORMATION 5-8
- DIAGNOSTIC INFORMATION 5-8
- WIRE COLOR ABBREVIATION CHART 5-8

COMPONENT LOCATION
- ELECTRICAL COMPONENTS—LX172/LX173/LX176/LX186 5-9
- ELECTRICAL COMPONENTS—LX178/LX188 5-10

ELECTRICAL SCHEMATICS
- ELECTRICAL SCHEMATIC—LX172/LX176/LX186 5-11
- ELECTRICAL SCHEMATIC—LX178/LX188 5-12
- ELECTRICAL SCHEMATIC—LX173 5-13

ELECTRICAL WIRING HARNESSES
- W1 MAIN WIRING HARNESS—LX172/LX176/LX186 5-14
- WIRING HARNESS—LX172/LX176/LX186 5-15
- ELECTRICAL CONNECTORS—LX172/LX176/LX186 5-17
- W1 MAIN WIRING HARNESS—LX178/LX188 5-23
- WIRING HARNESS—LX178/LX188 5-24
- ELECTRICAL CONNECTORS—LX178/LX188 5-25
- W1 MAIN WIRING HARNESS—LX173 5-31
- WIRING HARNESS—LX173 5-32
- ELECTRICAL CONNECTORS—LX173 5-33

TROUBLESHOOTING
- ELECTRICAL SYSTEM
  - TROUBLESHOOTING CHART—LX172/LX173/LX176/LX186 5-37
- TROUBLESHOOTING CHART—LX178/LX188 5-38

CIRCUIT OPERATION AND DIAGNOSIS—LX172/LX176/LX186
- POWER CIRCUIT OPERATION 5-40
- POWER CIRCUIT DIAGNOSIS 5-42
- CRANKING CIRCUIT OPERATION 5-46
- CRANKING CIRCUIT DIAGNOSIS 5-48
- IGNITION CIRCUIT OPERATION—EARLY MODELS 5-50
- IGNITION CIRCUIT OPERATION—LATE MODELS 5-52
- IGNITION CIRCUIT OPERATION—ENGINE SHUTTING OFF 5-54
- IGNITION CIRCUIT DIAGNOSIS 5-56
- CHARGING CIRCUIT OPERATION 5-60
- CHARGING CIRCUIT DIAGNOSIS 5-62

Page

CIRCUIT OPERATION AND DIAGNOSIS—LX172/LX176/LX186, continued

PTO CIRCUIT OPERATION—PTO OFF 5-64
PTO CIRCUIT OPERATION—PTO ON 5-66
PTO CIRCUIT DIAGNOSIS 5-68
LOW OIL PRESSURE LIGHT CIRCUIT OPERATION 5-72
LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS 5-74
HEADLIGHT CIRCUIT OPERATION 5-76
HEADLIGHT CIRCUIT DIAGNOSIS 5-78
FUEL SHUTOFF SOLENOID CIRCUIT OPERATION 5-80
FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS 5-82

CIRCUIT OPERATION AND DIAGNOSIS—LX178/LX188

POWER CIRCUIT OPERATION 5-86
POWER CIRCUIT DIAGNOSIS 5-88
CRANKING CIRCUIT OPERATION 5-92
CRANKING CIRCUIT DIAGNOSIS 5-94
IGNITION CIRCUIT OPERATION 5-96
IGNITION CIRCUIT DIAGNOSIS 5-98
CHARGING CIRCUIT OPERATION 5-102
CHARGING CIRCUIT DIAGNOSIS 5-104
PTO CIRCUIT OPERATION—PTO OFF 5-106
PTO CIRCUIT OPERATION—PTO ON 5-108
PTO CIRCUIT DIAGNOSIS 5-110
LOW OIL PRESSURE LIGHT CIRCUIT OPERATION 5-114
LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS 5-116
COOLANT TEMPERATURE WARNING LIGHT CIRCUIT OPERATION 5-118
COOLANT TEMPERATURE WARNING LIGHT CIRCUIT DIAGNOSIS 5-120
HEADLIGHT CIRCUIT OPERATION 5-122
HEADLIGHT CIRCUIT DIAGNOSIS 5-124
FUEL SHUTOFF SOLENOID CIRCUIT OPERATION—LX188 5-126
FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS—LX188 5-128

CIRCUIT OPERATION AND DIAGNOSIS—LX173

POWER CIRCUIT OPERATION 5-132
POWER CIRCUIT DIAGNOSIS 5-134
CRANKING CIRCUIT OPERATION 5-138
CRANKING CIRCUIT DIAGNOSIS 5-140
IGNITION CIRCUIT OPERATION 5-142
IGNITION CIRCUIT OPERATION—ENGINE SHUTTING OFF 5-144
IGNITION CIRCUIT DIAGNOSIS 5-146
CHARGING CIRCUIT OPERATION 5-150
CHARGING CIRCUIT DIAGNOSIS 5-152
PTO CIRCUIT OPERATION—PTO OFF 5-154
PTO CIRCUIT OPERATION—PTO ON 5-156
PTO CIRCUIT DIAGNOSIS 5-158

Page

CIRCUIT OPERATION AND DIAGNOSIS—LX173, continued

LOW OIL PRESSURE LIGHT CIRCUIT OPERATION 5-162
LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS. 5-164
HEADLIGHT CIRCUIT OPERATION. 5-166
HEADLIGHT CIRCUIT DIAGNOSIS 5-168
FUEL SHUTOFF SOLENOID CIRCUIT OPERATION. 5-170
FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS 5-172

TESTS AND ADJUSTMENTS

COMMON CIRCUIT TEST 5-176
GROUND CIRCUIT TEST. 5-176
BATTERY TEST 5-177
CHARGE BATTERY 5-178
BATTERY LOAD TEST 5-179
REGULATED AMPERAGE OUTPUT TEST 5-179
REGULATED VOLTAGE OUTPUT TEST 5-180
UNREGULATED VOLTAGE OUTPUT TEST
—LX172/LX176/LX186/XL178/LX188 5-181
UNREGULATED VOLTAGE OUTPUT TEST—LX173 5-182
STATOR COIL RESISTANCE TEST—FD440V/FD501V. 5-182
STARTER SOLENOID TEST 5-183
STARTER LOADED AMPERAGE
DRAW TEST—LX172/LX173/LX176/LX186 5-183
STARTER LOADED AMPERAGE
DRAW TEST—LX178/LX188. 5-184
IGNITION MODULE TEST—LX172/LX176/LX178/XL186/LX188. 5-185
FLYWHEEL MAGNET TEST—LX172/LX173/LX176/LX186. 5-185
IGNITION COIL TEST—LX172/LX176/LX186 5-185
IGNITION COIL TEST—LX178/LX188 5-186
PULSER COIL TEST—LX178/LX188 5-186
SPARK PLUG CAP TEST—LX178/LX188 5-187
NEUTRAL START/BRAKE SWITCH TEST. 5-187
PTO SWITCH TEST 5-188
PTO CLUTCH TEST 5-189
SEAT SWITCH TEST 5-190
HEADLIGHT SWITCH TEST. 5-190
OIL PRESSURE SWITCH TEST. 5-191
COOLANT TEMPERATURE SWITCH TEST—LX178/LX188. 5-192
FUEL SHUTOFF SOLENOID TEST 5-192
PTO CLUTCH ADJUSTMENT. 5-193

REPAIR

BATTERY
Removal/Installation 5-194
Cleaning 5-194
ELECTRIC PTO CLUTCH. 5-195
CONNECTOR BODY—BLADE TERMINALS 5-195

SPECIFICATIONS

TEST AND ADJUSTMENT SPECIFICATIONS

Maximum Ground Circuit Resistance . . . . . 0.1 ohms

Battery

Minimum Specific Gravity . . . . . 1.225 with less than 50 point variation between cells
Minimum Voltage. . . . . .12.4 volts
Cold Cranking Amps. . . . . 295 amps at −18°C (0°F)
13 amps at 13.5—15 volts
LX173 . . . . . 160 amps at −18°C (0°F)

Starter

Maximum Amperage (No-load) . . . . . 50 amps at 6000 rpm
Maximum Amperage (Load) . . . . . 85 amps at 500 rpm
Maximum Amperage (Load) LX173 . . . . . 180 amps at 225 rpm

Stator

Minimum Unregulated Voltage Output:
LX172 and LX176 (FC420V) . . . . . .30 volts AC at 3350 ±50 rpm
LX173 (CV15S-41537) . . . . . .28 volts AC at 3350 ±50 rpm
LX186 (FC540V). . . . . .27 volts AC at 3350 ±50 rpm
LX178 (FD440V)/LX188 (FD501V). . . . . 26 volts AC at 3000 rpm
Resistance . . . . . .0.1232—0.1848 ohms

Ignition Coil

Air Gap:
LX172/LX176 (FC420V) . . . . . .0.3 mm (0.012 in.)
LX173 (CV15S-41537) . . . . . .0.3 mm (0.012 in.)
LX186 (FC540V). . . . . .0.3 mm (0.012 in.)
LX172/LX176 (FC420V)/LX186 (FC540V):
Primary Lead to Core Resistance. . . . . .0.4—0.8 ohms
Spark Plug Lead and Core Resistance. . . . . .8.7—13.1 ohms
LX178 (FD440V)/LX188 (FD501V):
Primary Coil Resistance . . . . . .3.4—4.6 ohms
Secondary Coil Resistance. . . . . .10,400—15,600 ohms
Core Insulation Resistance. . . . . infinite
LX173 (CV15S-41537):
Primary Coil Resistance . . . . . .5—1000 ohms
Secondary (Plug Wire and Core) Resistance . . . . . .7.9—10.85 Kohms

Spark Plug

Gap . . . . . .0.76 mm (0.030 in.)
Gap (LX173) . . . . . .1.0 mm (0.040 in.)

Pulser Coil—LX178 (FD440V)/LX188 (FD501V)

Resistance . . . . . .88—132 ohms

PTO Clutch

Air Gap . . . . . 0.51 mm (0.020 in.)
Resistance . . . . . 2.4—2.7 ohms
Current Draw (approximate) . . . . . 4.84 amps
Minimum Current Draw . . . . . .4 amps
LX173 (CV15S-41537):
Coil Resistance . . . . . 3—10 ohms
Current Draw . . . . . 3.5 amps

Coolant Temperature Switch—LX178/LX188

Closing Temperature . . . . . 111°C (232°F)

REPAIR SPECIFICATIONS

PTO Cap Screw Torque . . . . . 56 N•m (45 lb-ft)
Spark Plug Torque . . . . . 25 N•m (18 lb-ft)

SPECIAL OR ESSENTIAL TOOLS

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

JT05685 Battery Tester
Test battery performance.

JT05719 Photo Tachometer
Used to check engine rpm.

OTHER MATERIALS

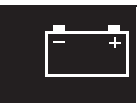
Number	Name	Use
M79292	MPG-2® Multipurpose Polymer Grease	Apply to engine crankshaft.
LOCTITE® PRODUCTS U.S./ Canadian/ LOCTITE® No.		
TY9375/ TY9480/592	Pipe Sealant with TEFLON®	Apply to threads of oil pressure switch.
TY15130/N/A/395	Form-in-Place Gasket	Seals coolant temperature sensor in engine—LX178/LX188.

MPG-2® is a registered trademark of DuBois USA.
LOCTITE® is a registered trademark of the Loctite Corp.
TEFLON® is a registered trademark of the DuPont Co.

THEORY AND DIAGNOSTIC INFORMATION

READING ELECTRICAL SCHEMATICS

The electrical 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.



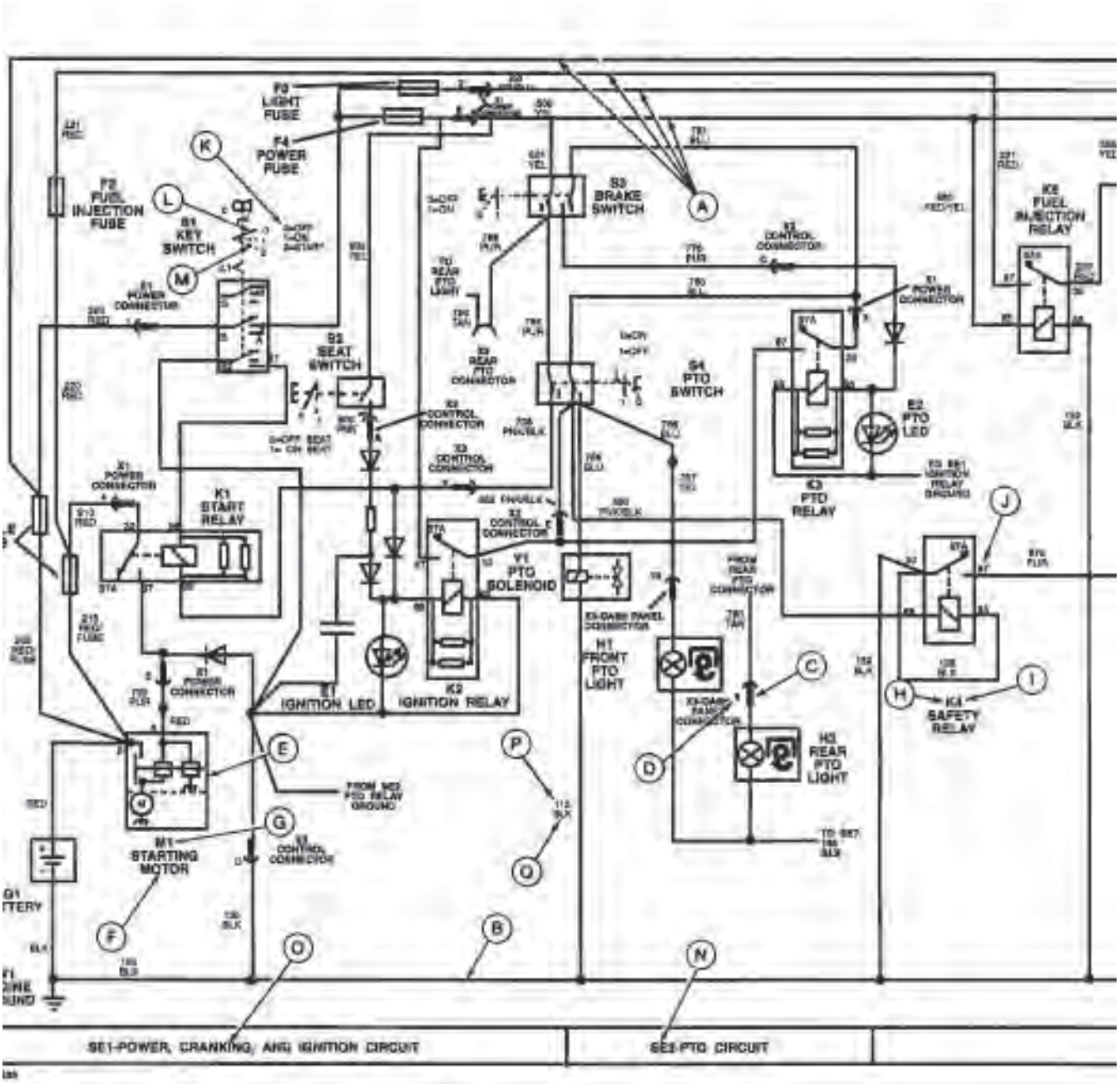
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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 dashed 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.

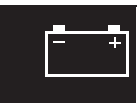
The same component name and identification code are used consistently throughout all diagrams in this section. Components can be easily cross-referenced.


F3 LIGHT FUSE
F4 POWER FUSE
F2 FUEL INJECTION FUSE
B1 KEY SWITCH
S3 BRAKE SWITCH
K6 FUEL INJECTION RELAY
S2 SEAT SWITCH
S4 PTO SWITCH
K3 PTO RELAY
E2 PTO LED
K1 START RELAY
Y1 PTO SOLENOID
E1 IGNITION LED
K2 IGNITION RELAY
H1 FRONT PTO LIGHT
H3 REAR PTO LIGHT
K4 SAFETY RELAY
M1 STARTING MOTOR
SE1-POWER, CRANKING, AND IGNITION CIRCUIT
SE2-PTO CIRCUIT

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 schematic and only shows 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 operating position, with power, or battery positive, into them across the top, and 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:

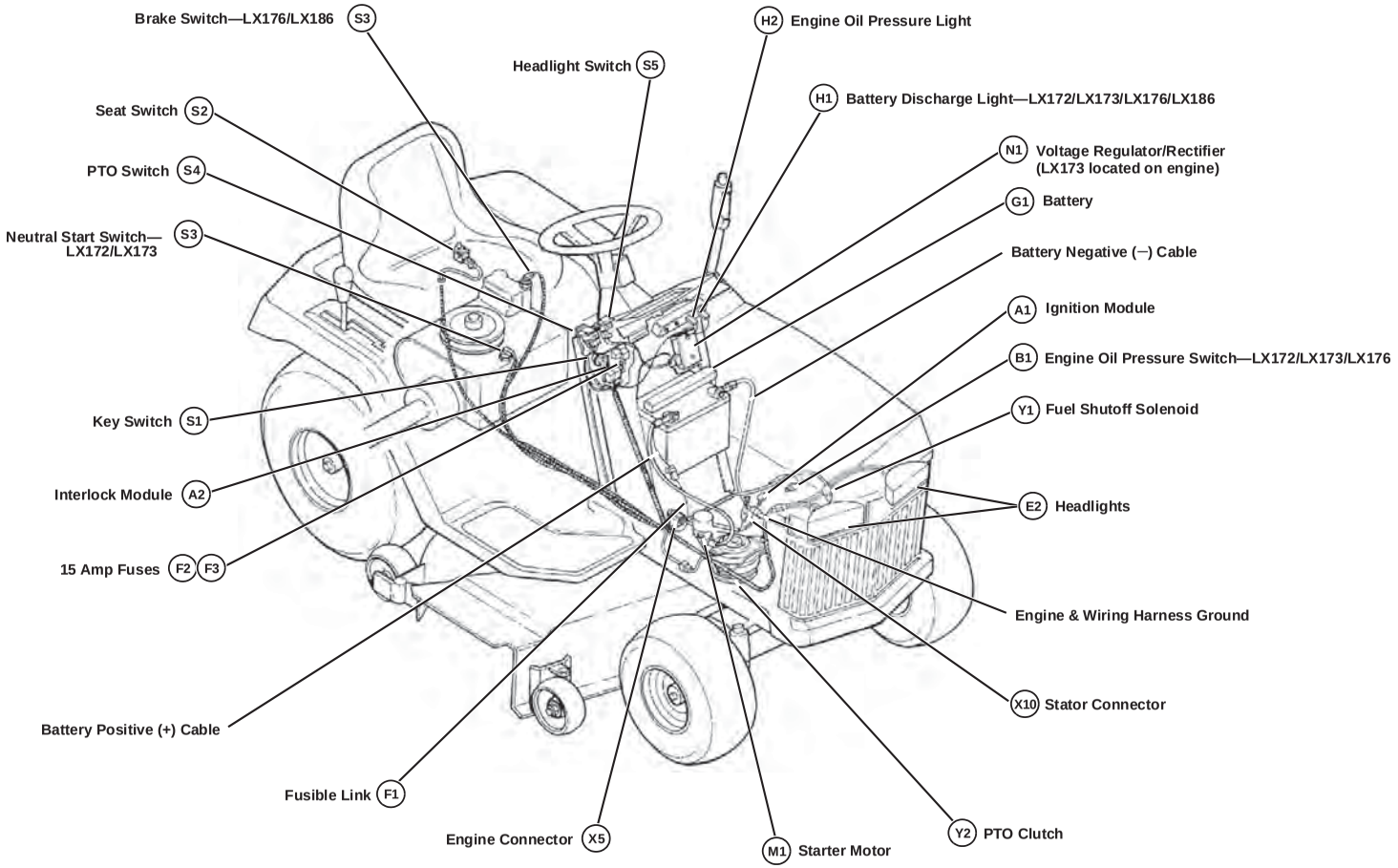
- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading obtained is not correct

When performing the test or check, be sure to set your mower 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 test 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 mower components. The key number on the art matches the number in the "TEST LOCATION" column and the arrow points to the exact point where the test is to be made.

WIRE COLOR ABBREVIATION CHART

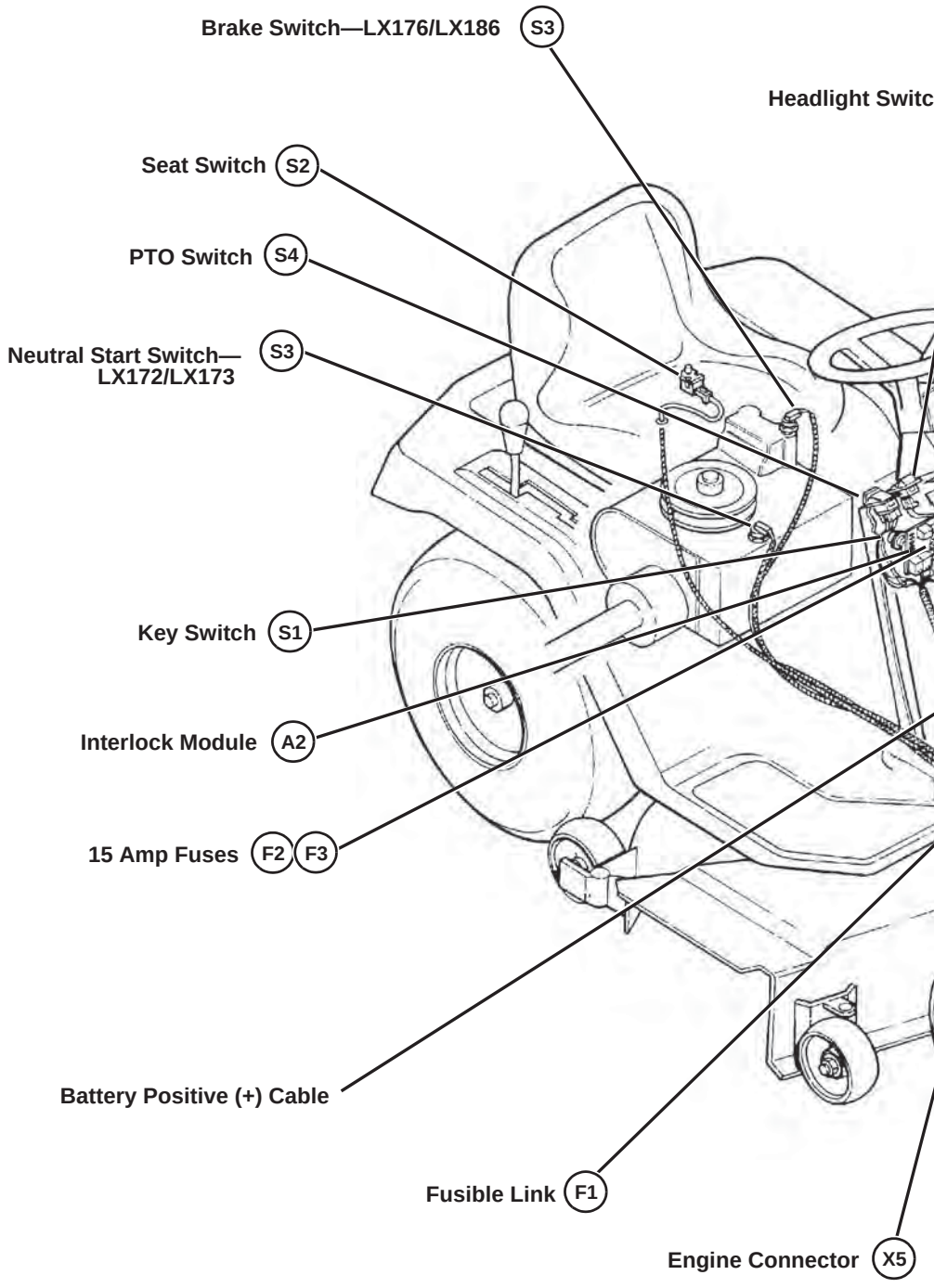
Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Rust	Rust
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Dk Blu	Dark Blue
Dk Brn/Lt Grn	Dark Brown/Light Green
Dk Brn/Red	Dark Brown/Red
Dk Brn/Yel	Dark Brown/Yellow
Dk Grn	Dark Green
Lt Blu	Light Blue
Lt Grn	Light Green
Grn/Wht	Green/White
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

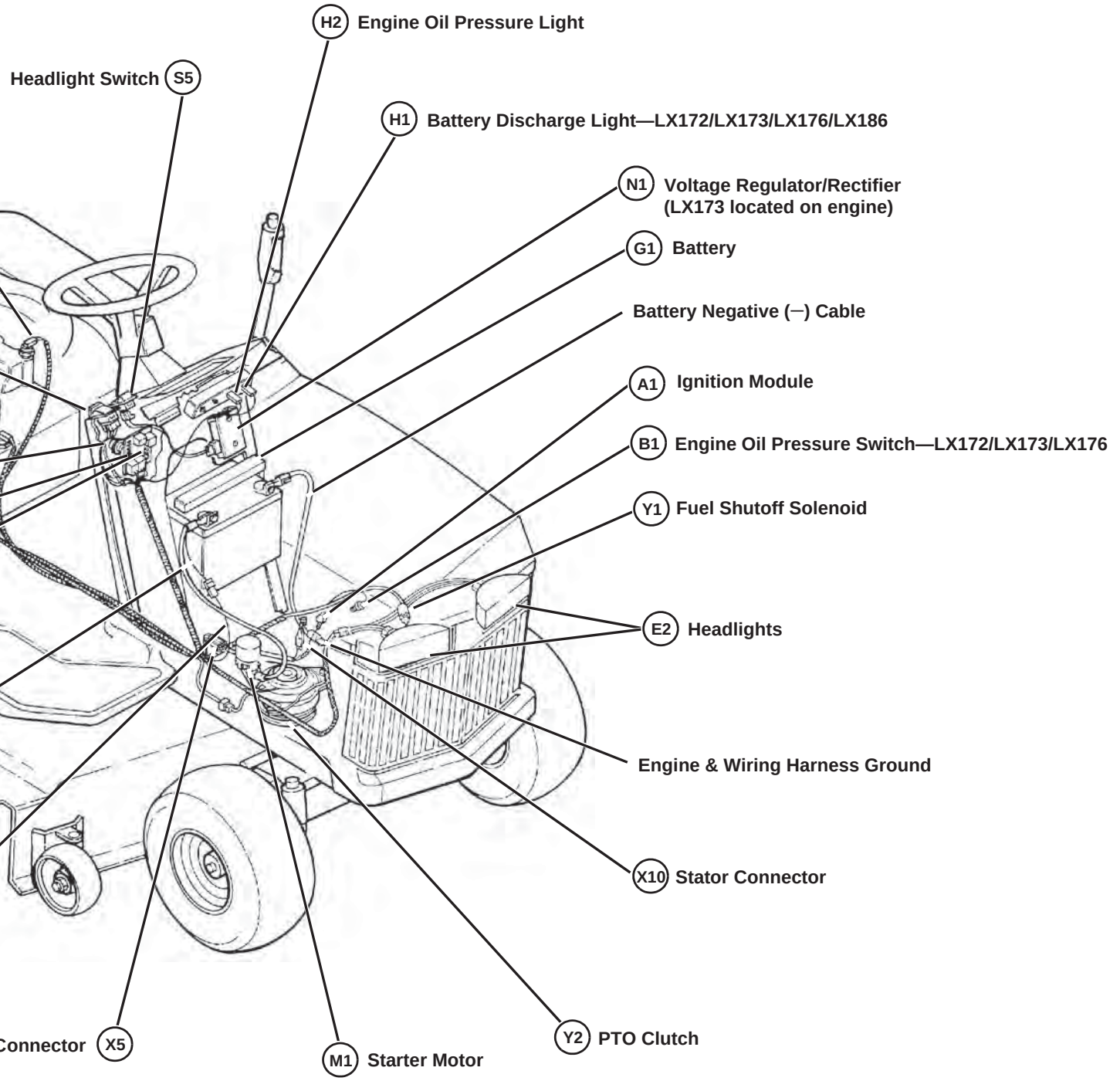
ELECTRICAL COMPONENTS—LX172/LX173/LX176/LX186



M83248

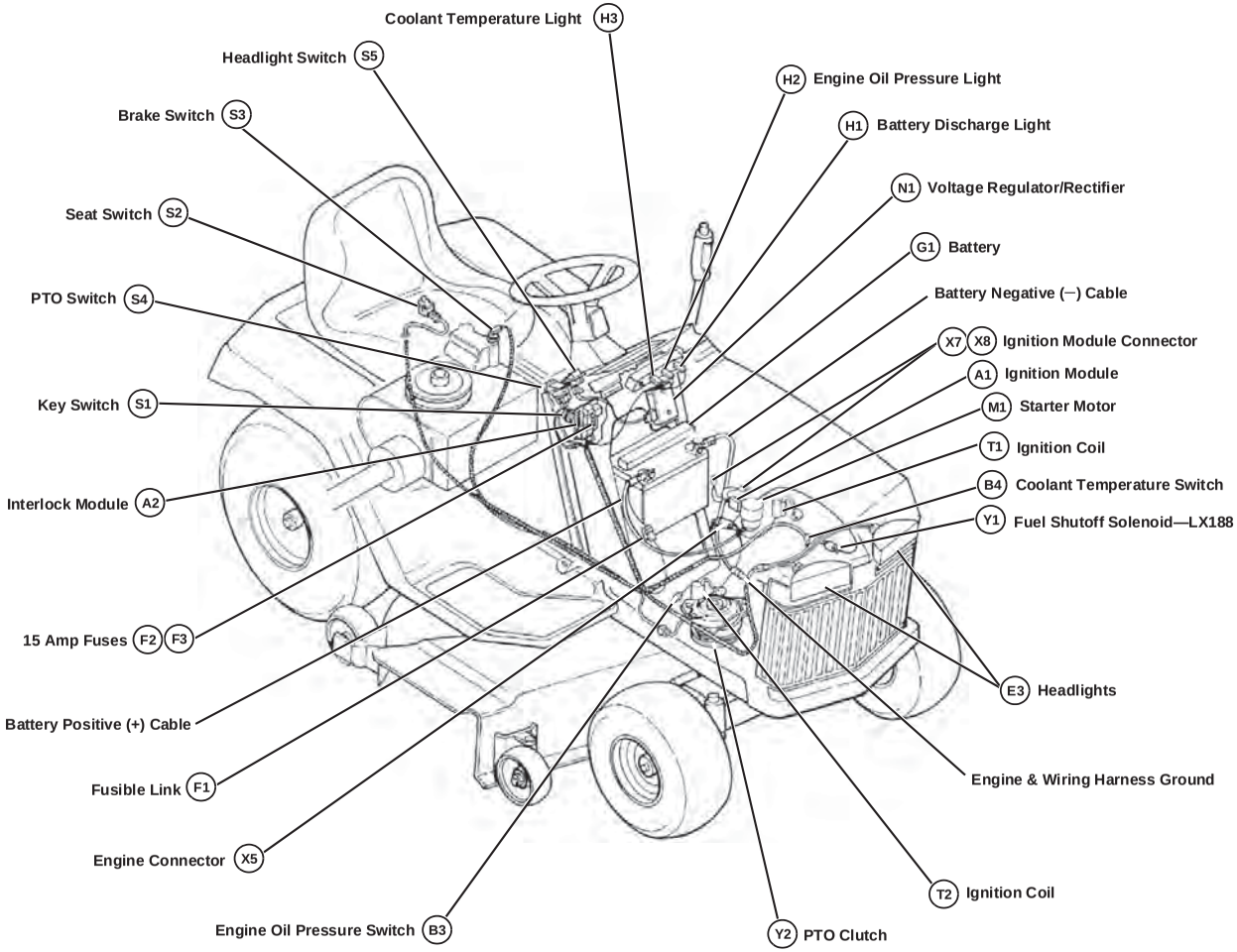
ELECTRICAL COMPONENTS—LX172/LX173/LX176/LX186




H2 Engine Oil Pressure Light
Headlight Switch S5
H1 Battery Discharge Light—LX172/LX173/LX176/LX186
N1 Voltage Regulator/Rectifier
(LX173 located on engine)
G1 Battery
Battery Negative (—) Cable
A1 Ignition Module
B1 Engine Oil Pressure Switch—LX172/LX173/LX176
Y1 Fuel Shutoff Solenoid
E2 Headlights
Engine & Wiring Harness Ground
X10 Stator Connector
Connector X5
M1 Starter Motor
Y2 PTO Clutch

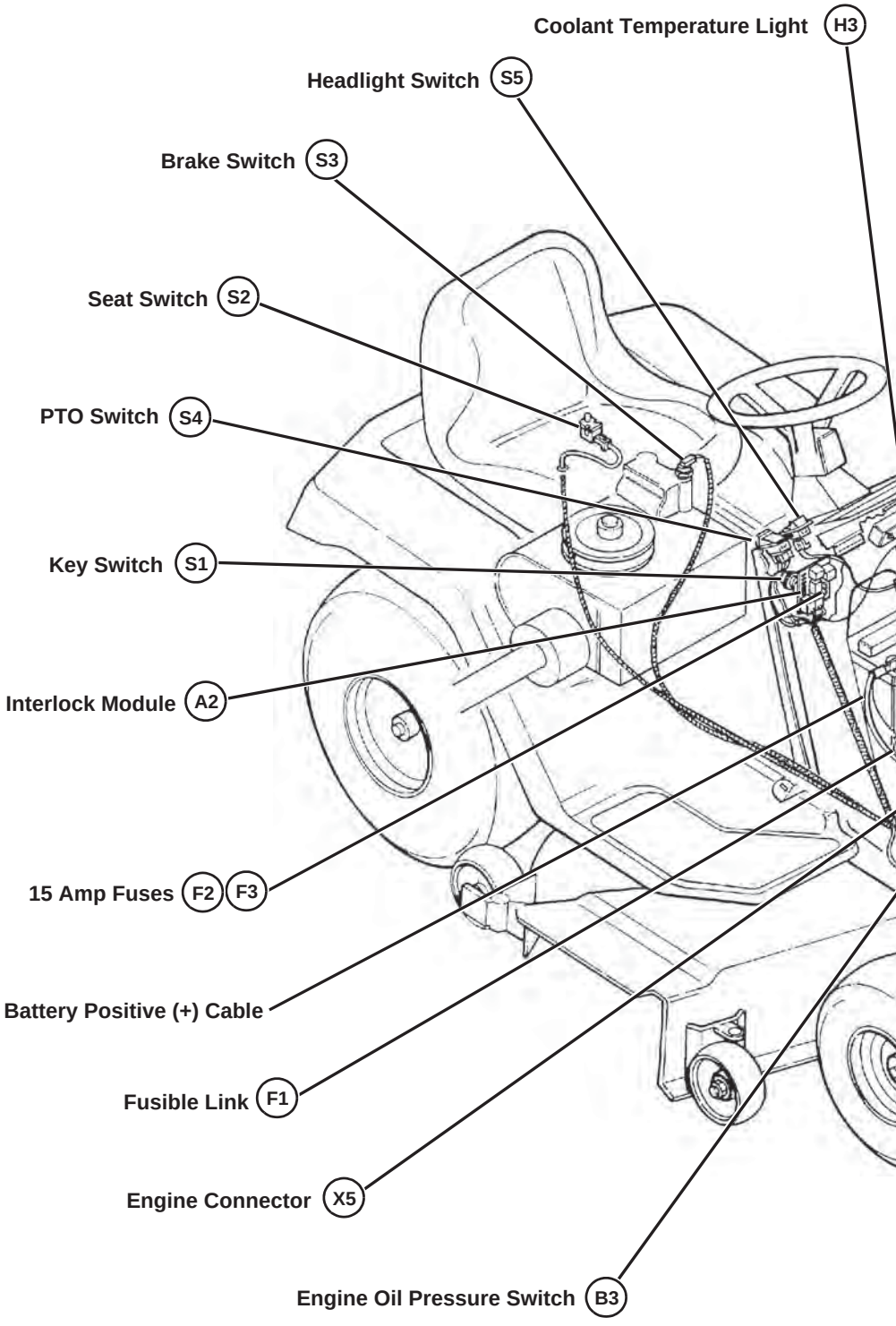
M83248

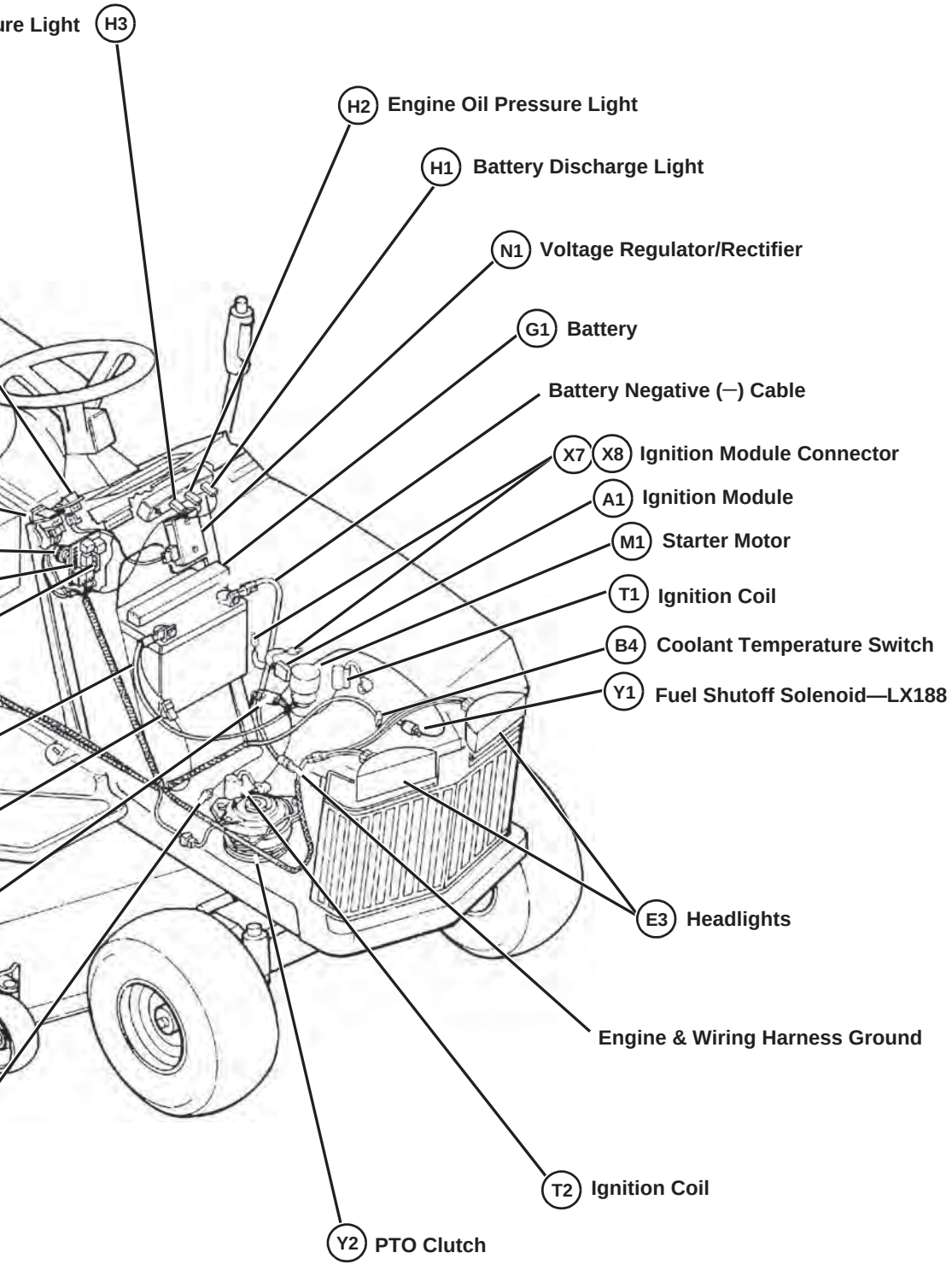
ELECTRICAL COMPONENTS—LX178/LX188



M83249

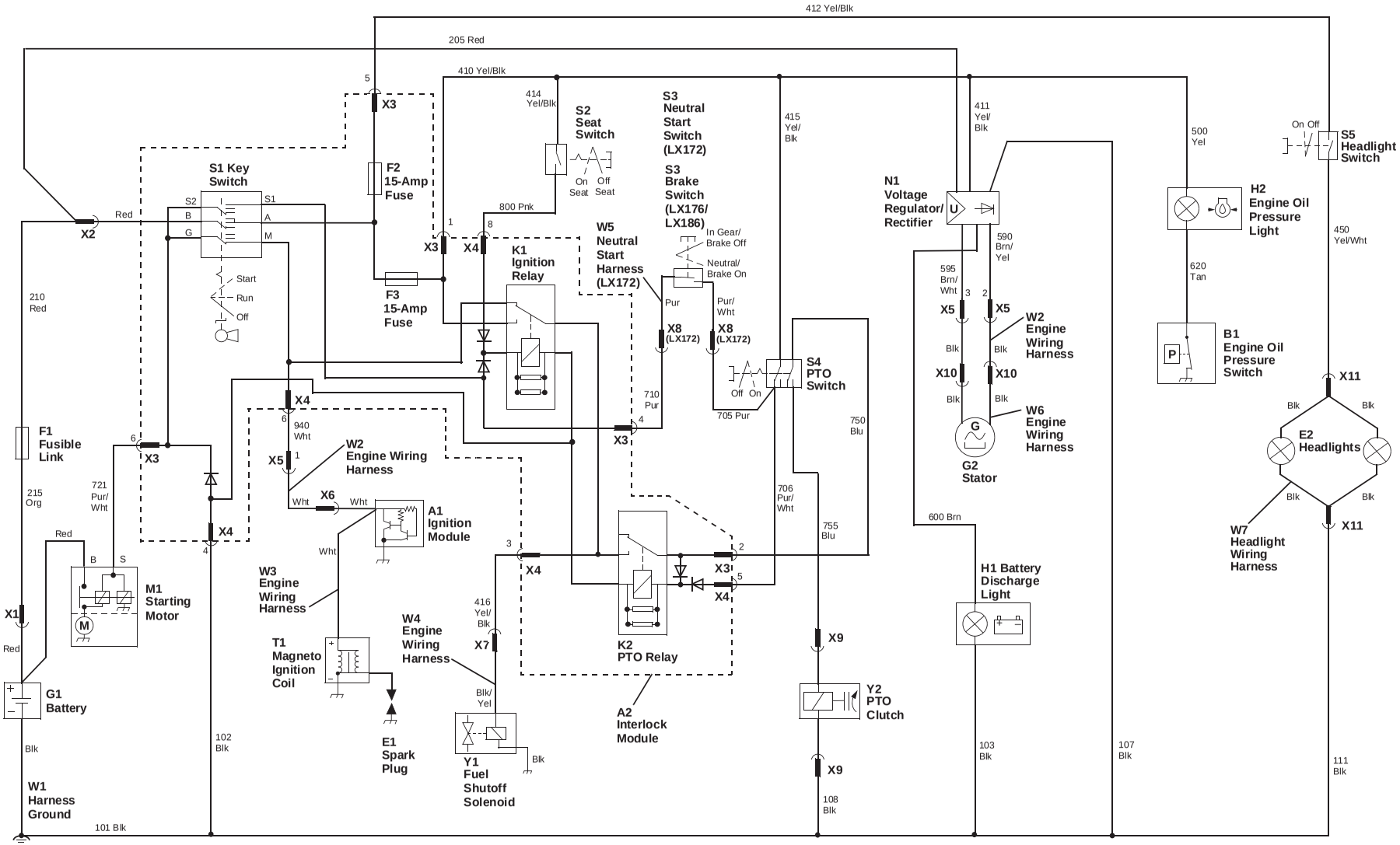
ELECTRICAL COMPONENTS—LX178/LX188




ure Light H3
H2 Engine Oil Pressure Light
H1 Battery Discharge Light
N1 Voltage Regulator/Rectifier
G1 Battery
Battery Negative (–) Cable
X7 X8 Ignition Module Connector
A1 Ignition Module
M1 Starter Motor
T1 Ignition Coil
B4 Coolant Temperature Switch
Y1 Fuel Shutoff Solenoid—LX188
E3 Headlights
Engine & Wiring Harness Ground
T2 Ignition Coil
Y2 PTO Clutch

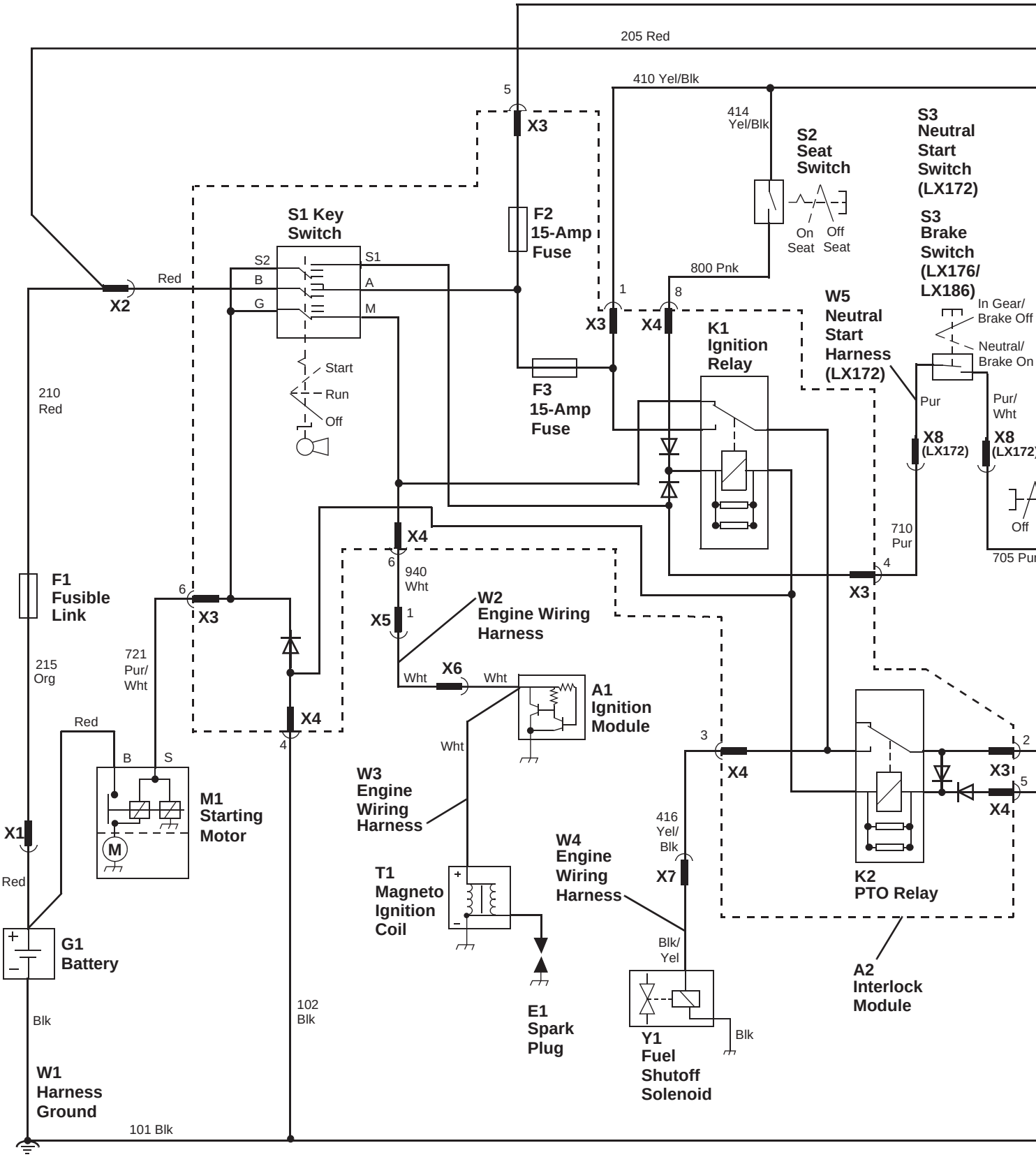
M83249

ELECTRICAL SCHEMATIC—LX172/LX176/LX186

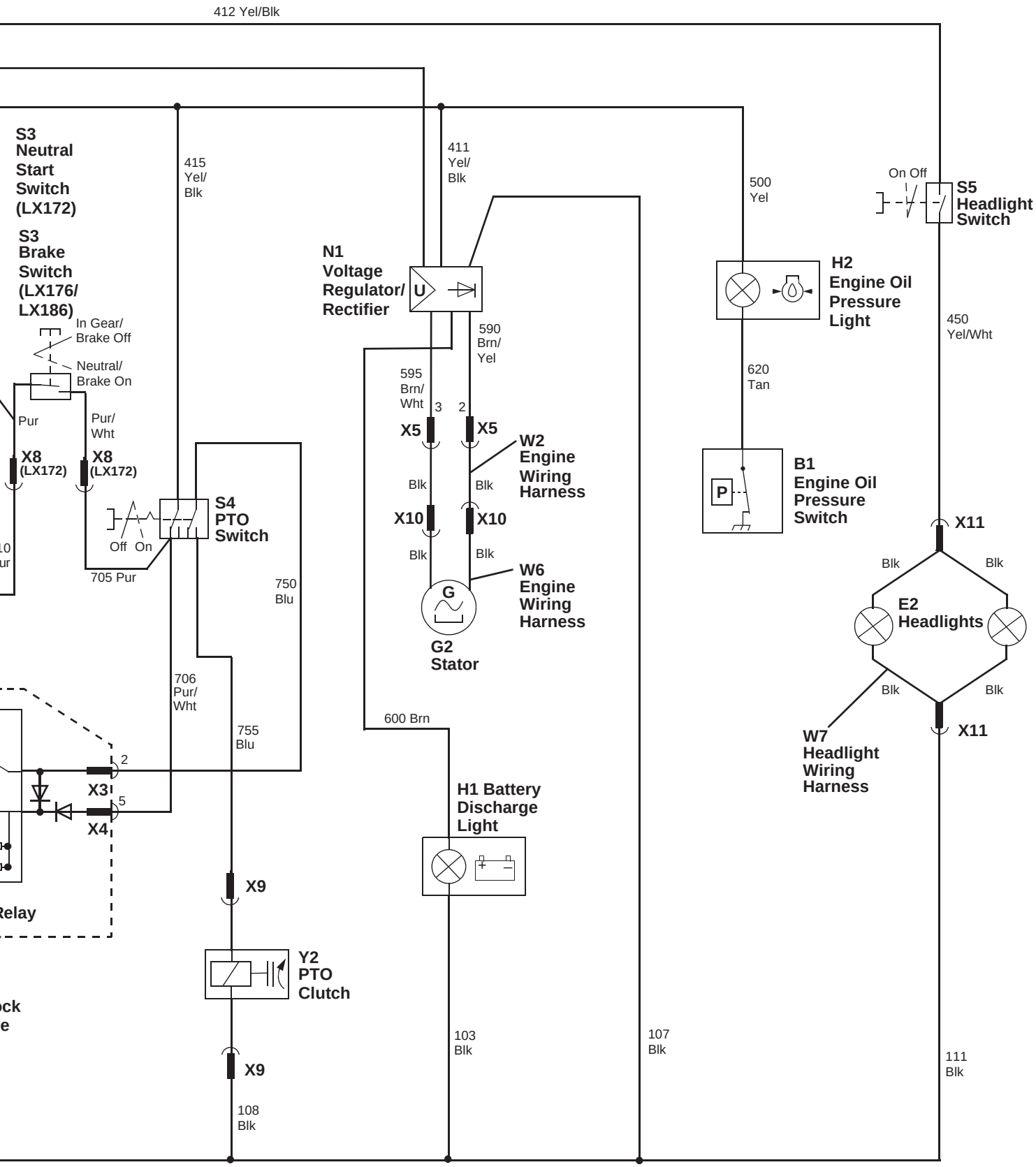


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and Interlock Circuit	SE4-Charge Circuit	SE5-Engine Oil Pressure Circuit	SE6-Light Circuit

ELECTRICAL SCHEMATIC—LX172/LX176/LX186

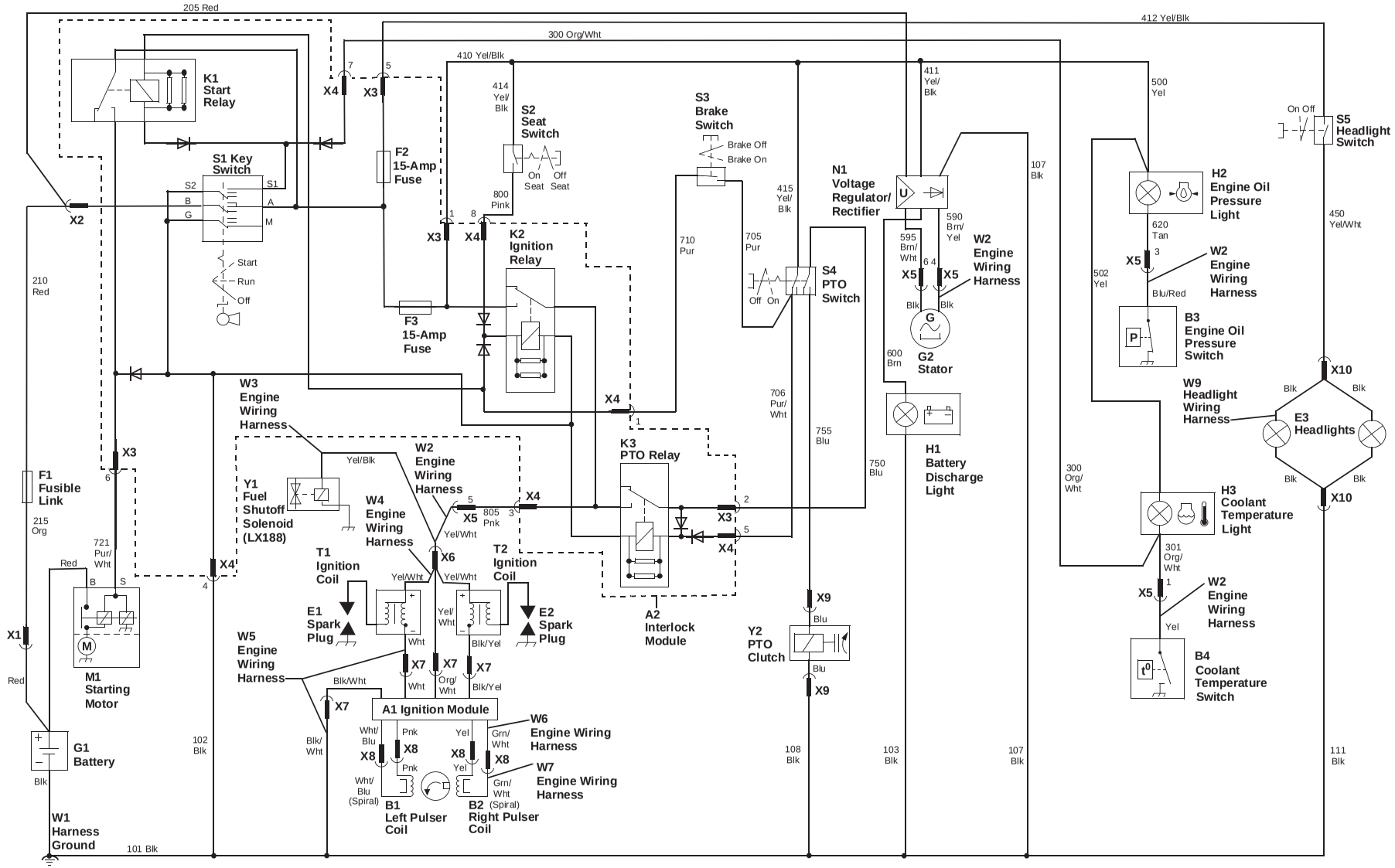


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and



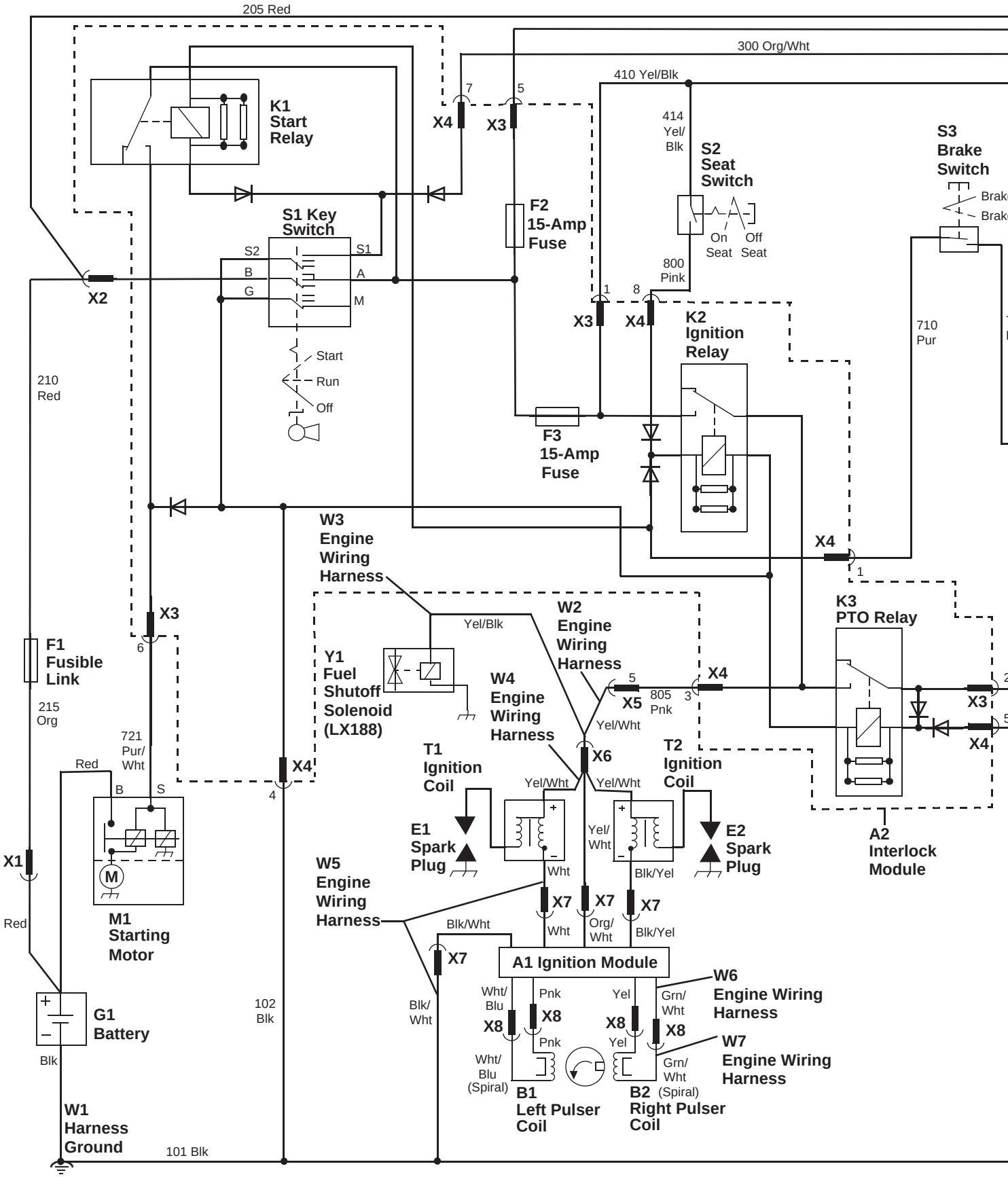
SE3-PTO and Interlock Circuit	SE4-Charge Circuit	SE5-Engine Oil Pressure Circuit	SE6-Light Circuit

ELECTRICAL SCHEMATIC—LX178/LX188

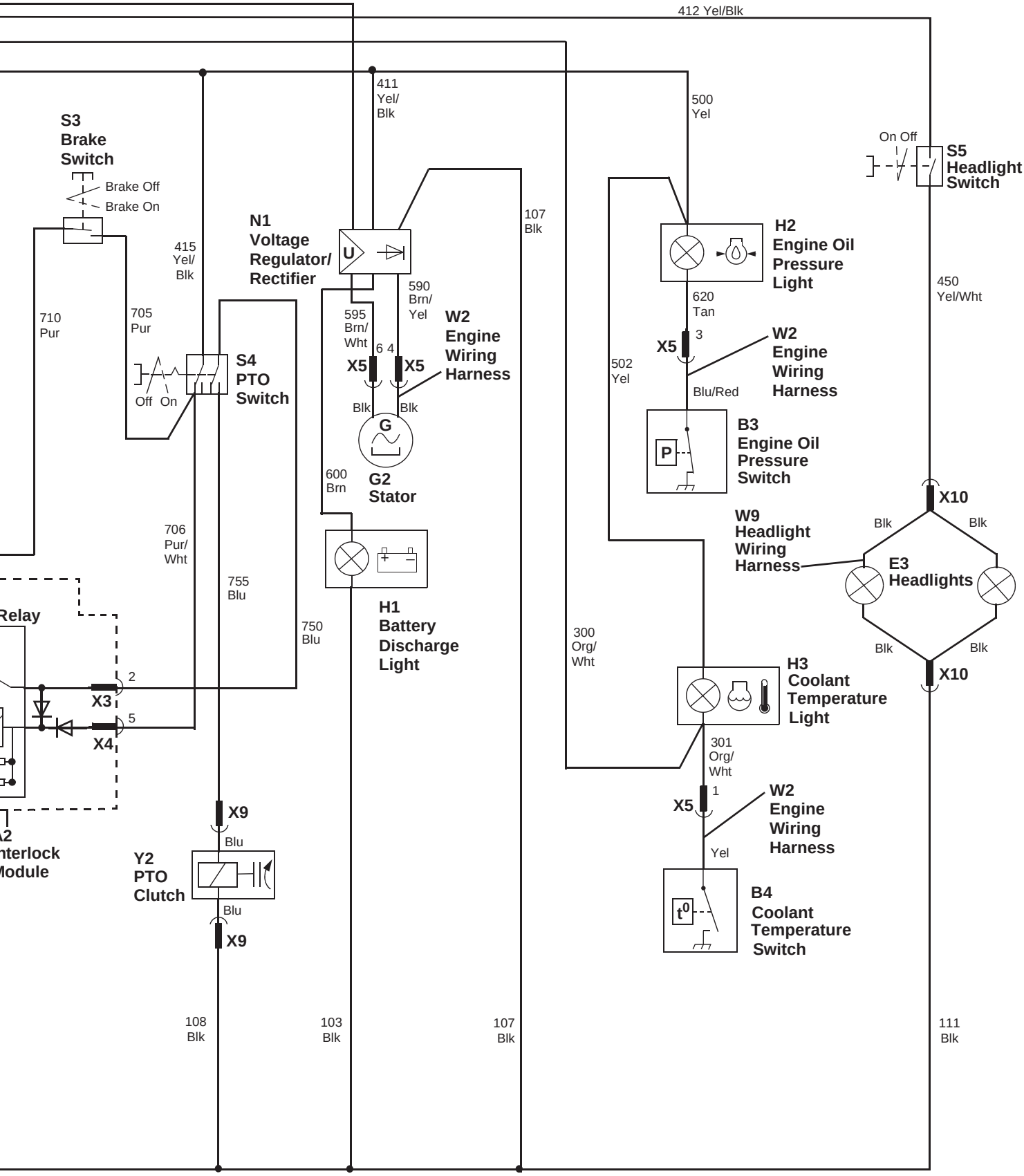


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and Interlock Circuit	SE4-Charge Circuit	SE5-Oil Pressure and Coolant Temp. Circuit	SE6-Light Circuit

ELECTRICAL SCHEMATIC—LX178/LX188

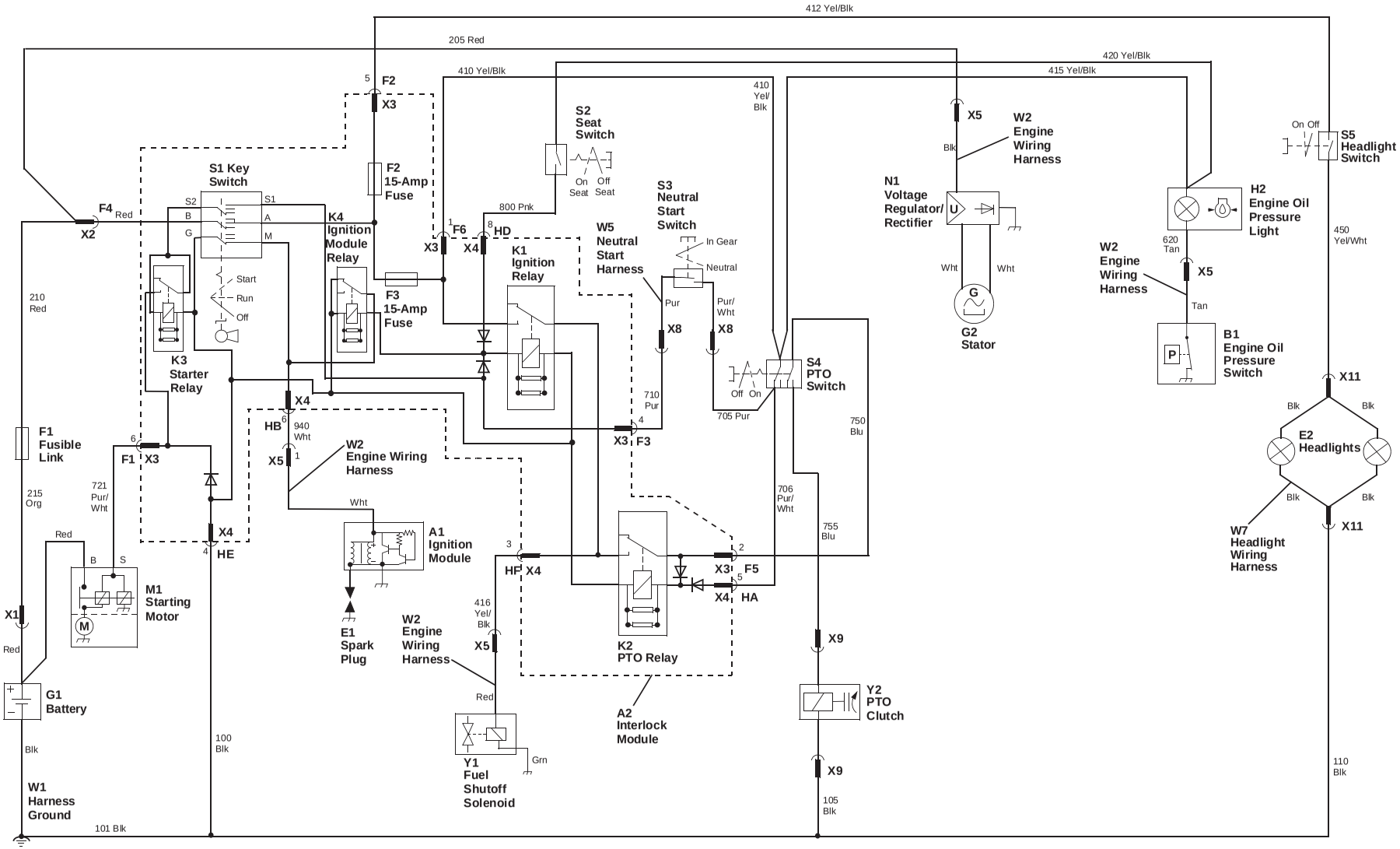


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and Interlock C



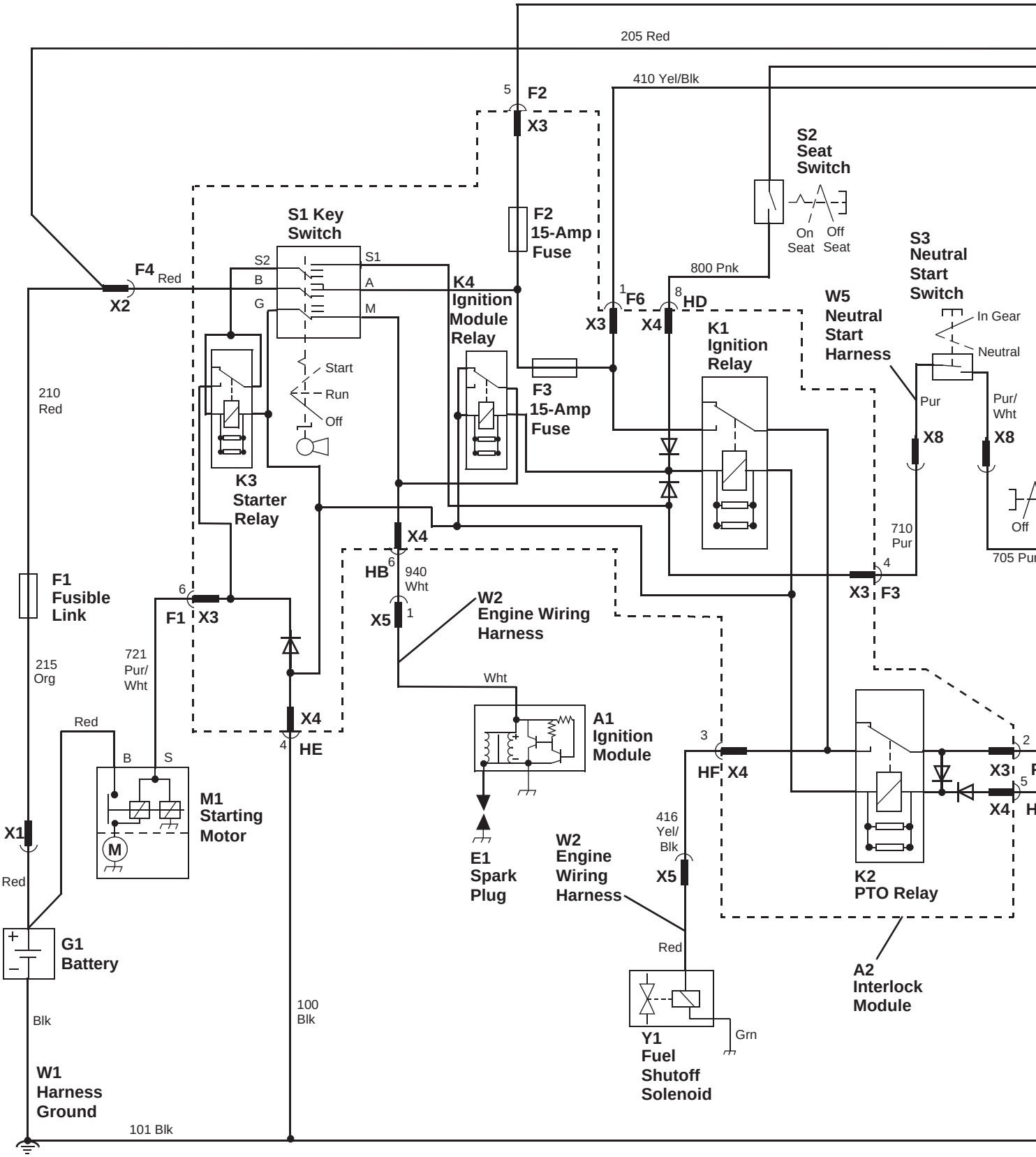
TO and Interlock Circuit	SE4-Charge Circuit	SE5-Oil Pressure and Coolant Temp. Circuit	SE6-Light Circuit

ELECTRICAL SCHEMATIC—LX173

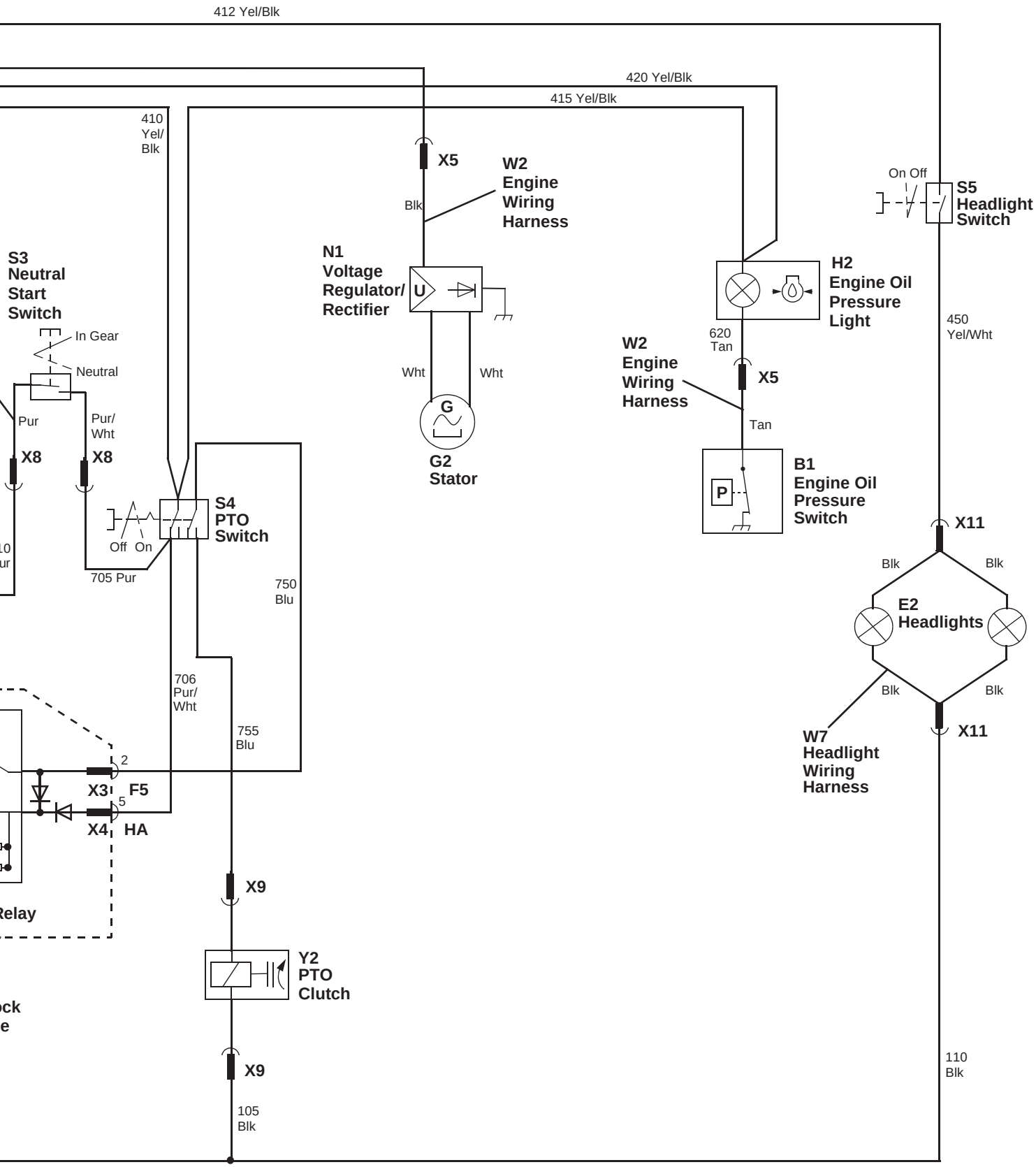


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and Interlock Circuit	SE4-Charge Circuit	SE5-Engine Oil Pressure Circuit	SE6-Light Circuit

ELECTRICAL SCHEMATIC—LX173

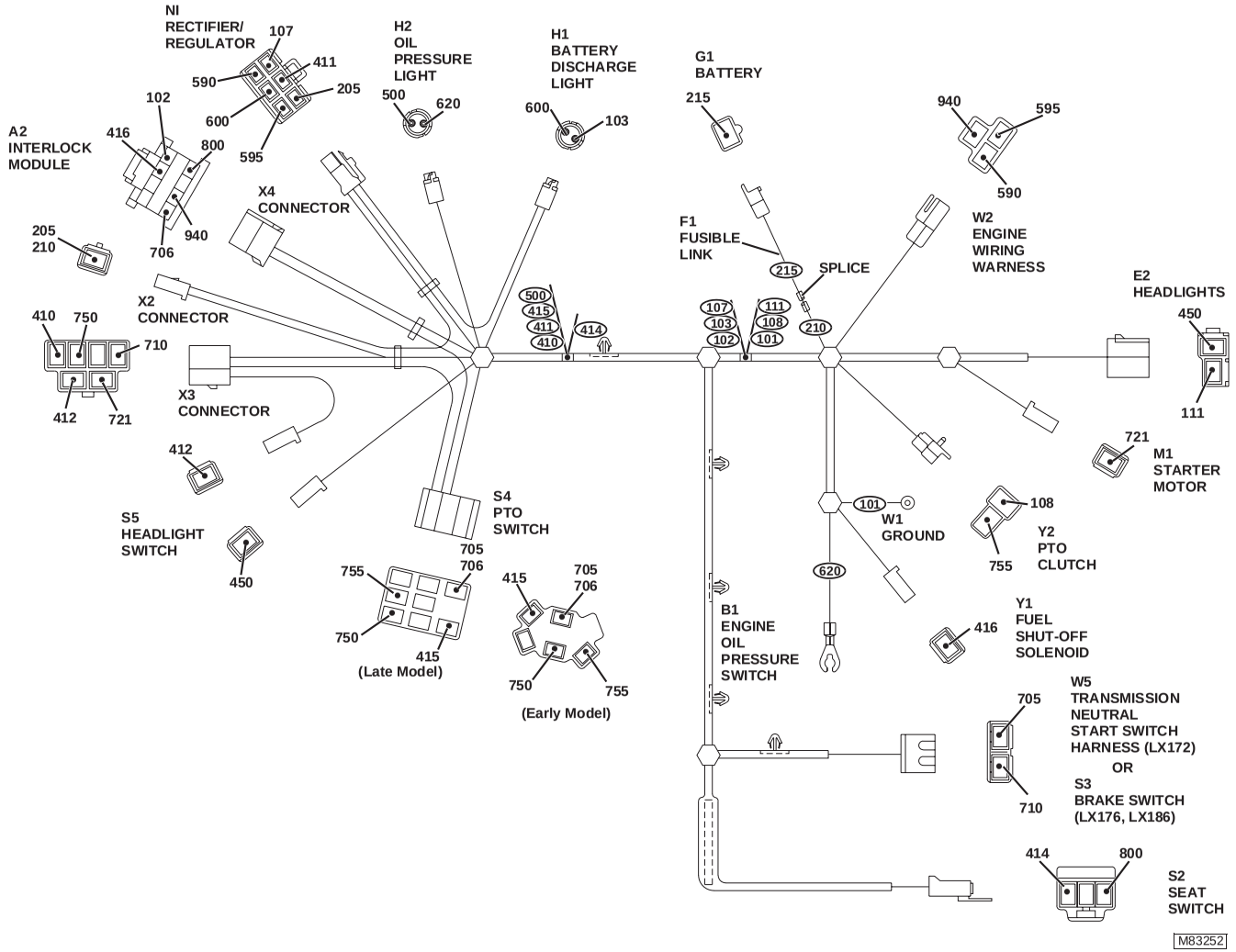


SE1-Power and Starting Circuit	SE2-Ignition and Fuel Shutoff Circuit	SE3-PTO and



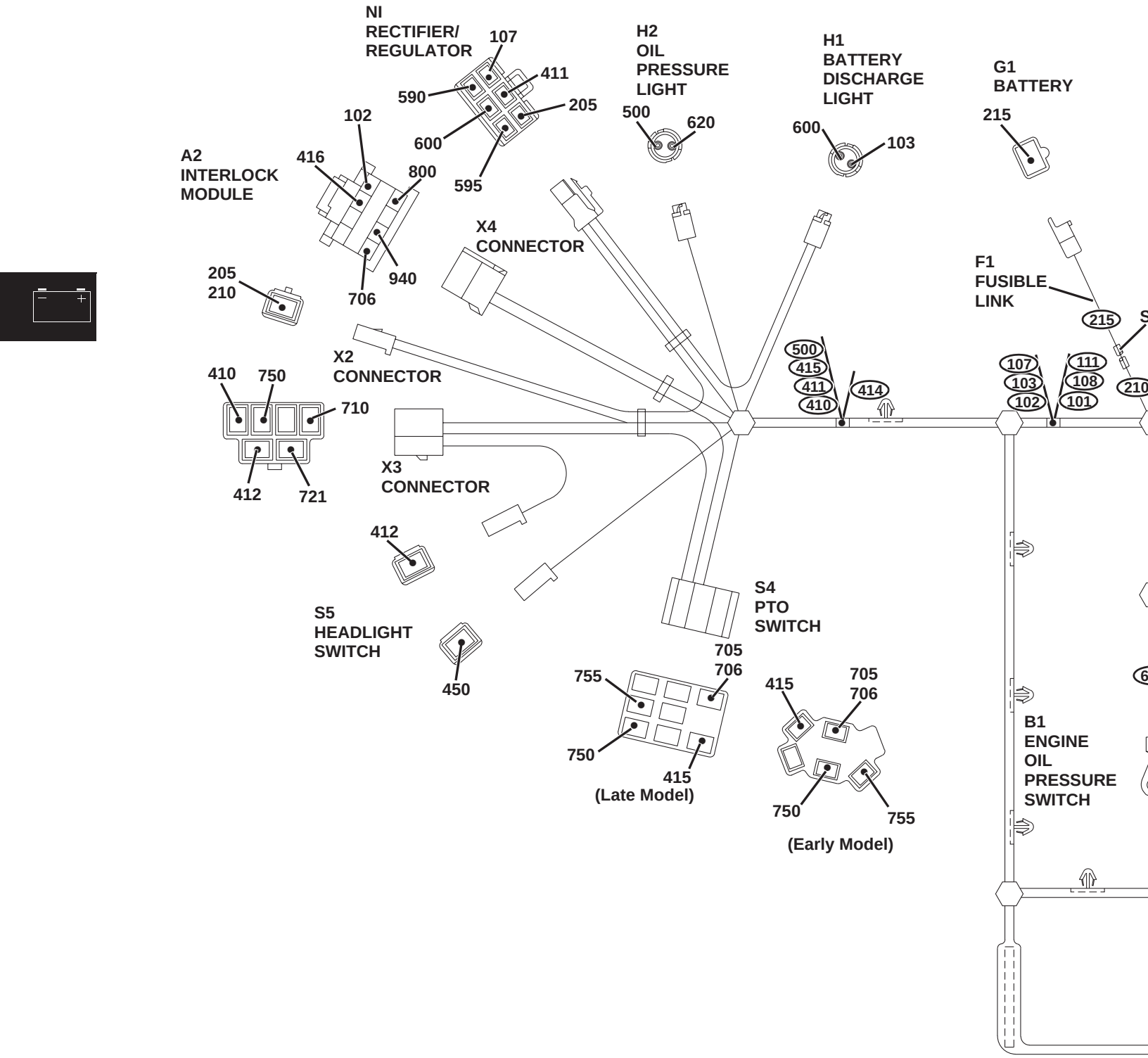
SE3-PTO and Interlock Circuit	SE4-Charge Circuit	SE5-Engine Oil Pressure Circuit	SE6-Light Circuit

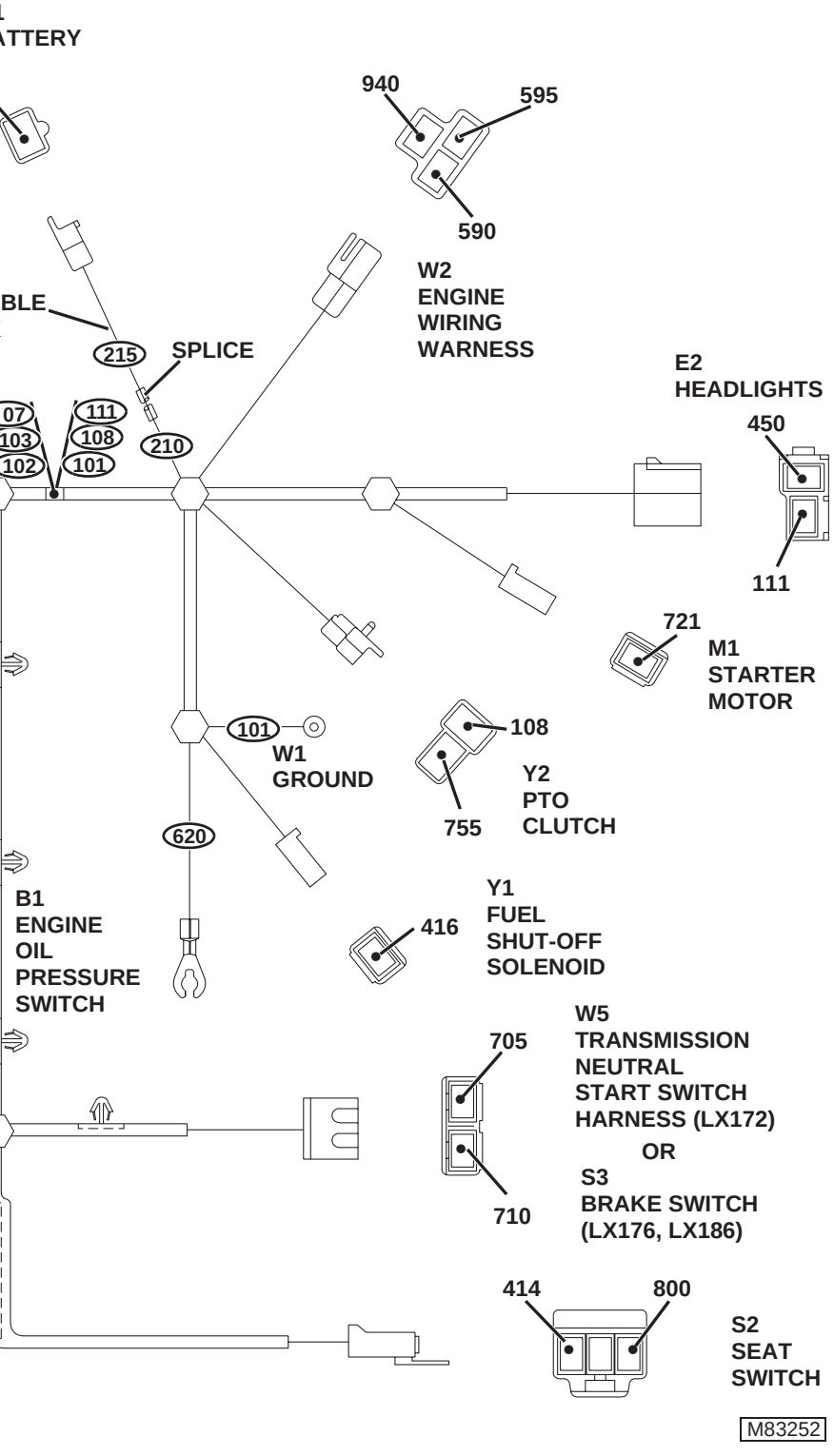
W1 MAIN WIRING HARNESS—LX172/LX176/LX186



No.	mm² (GA)	Color
101	2.0 (14)	Black
102	0.8 (18)	Black
103	0.8 (18)	Black
107	1.0 (16)	Black
108	0.8 (18)	Black
111	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Orange
410	1.0 (16)	Yellow/Black
411	0.8 (18)	Yellow/Black
412	0.8 (18)	Yellow/Black
414	0.8 (18)	Yellow/Black
415	1.0 (16)	Yellow/Black
416	0.8 (18)	Yellow/Black
450	0.8 (18)	Yellow/White
500	0.8 (18)	Yellow
590	2.0 (14)	Brown/Yellow
595	2.0 (14)	Brown/White
600	0.8 (18)	Brown
620	0.8 (18)	Tan
705	1.0 (16)	Purple
706	0.8 (18)	Purple/White
710	1.0 (16)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	0.8 (18)	Blue
800	0.8 (18)	Pink
940	0.8 (18)	White

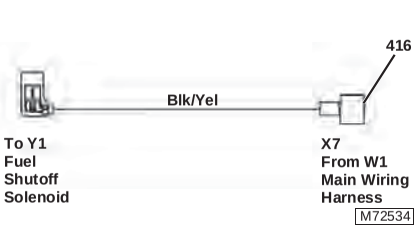
W1 MAIN WIRING HARNESS—LX172/LX176/LX186

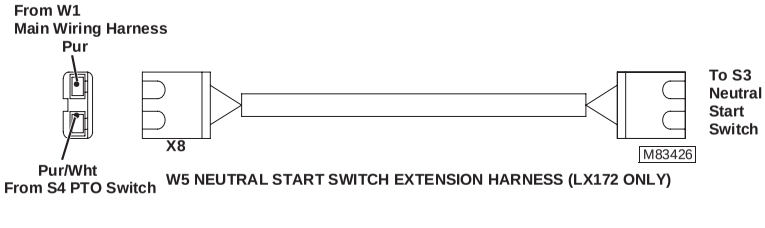




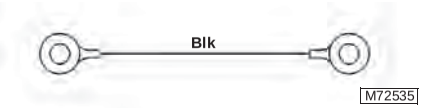
No.	mm^2 (GA)	Color
101	2.0 (14)	Black
102	0.8 (18)	Black
103	0.8 (18)	Black
107	1.0 (16)	Black
108	0.8 (18)	Black
111	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Orange
410	1.0 (16)	Yellow/Black
411	0.8 (18)	Yellow/Black
412	0.8 (18)	Yellow/Black
414	0.8 (18)	Yellow/Black
415	1.0 (16)	Yellow/Black
416	0.8 (18)	Yellow/Black
450	0.8 (18)	Yellow/White
500	0.8 (18)	Yellow
590	2.0 (14)	Brown/Yellow
595	2.0 (14)	Brown/White
600	0.8 (18)	Brown
620	0.8 (18)	Tan
705	1.0 (16)	Purple
706	0.8 (18)	Purple/White
710	1.0 (16)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	0.8 (18)	Blue
800	0.8 (18)	Pink
940	0.8 (18)	White

WIRING HARNESSES—LX172/LX176/LX186

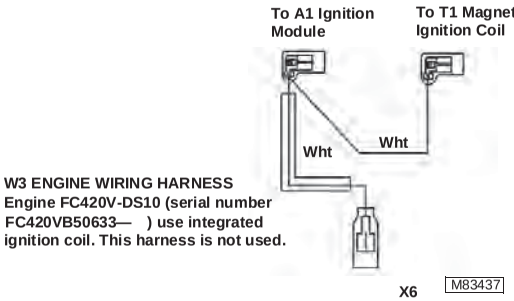




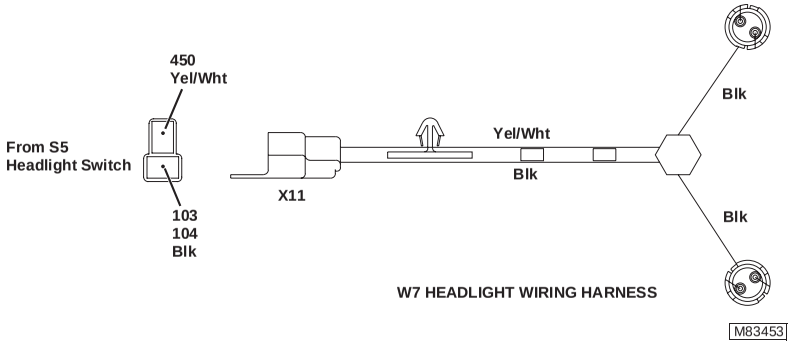
W5 NEUTRAL START SWITCH EXTENSION HARNESS (LX172 ONLY)



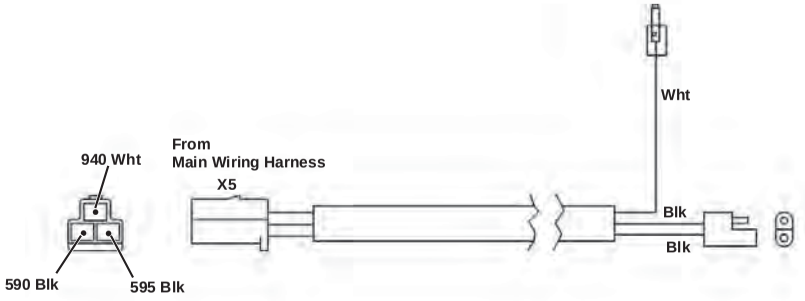
FUEL SHUTOFF GROUND WIRE



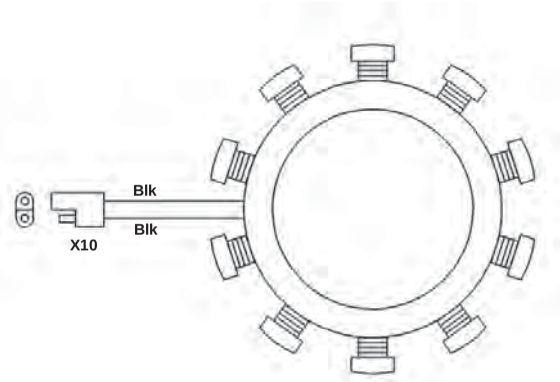
W3 ENGINE WIRING HARNESS
Engine FC420V-DS10 (serial number FC420VB50633—) use integrated ignition coil. This harness is not used.



W7 HEADLIGHT WIRING HARNESS

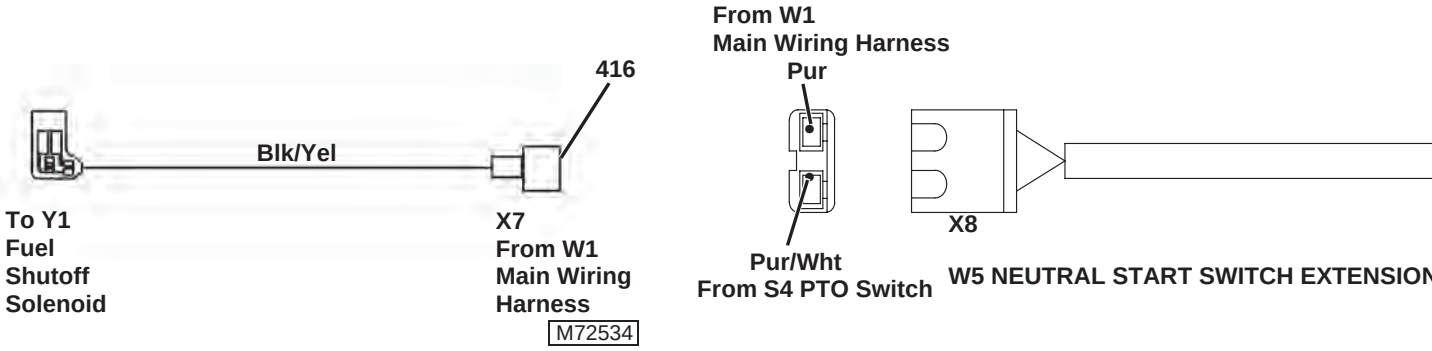


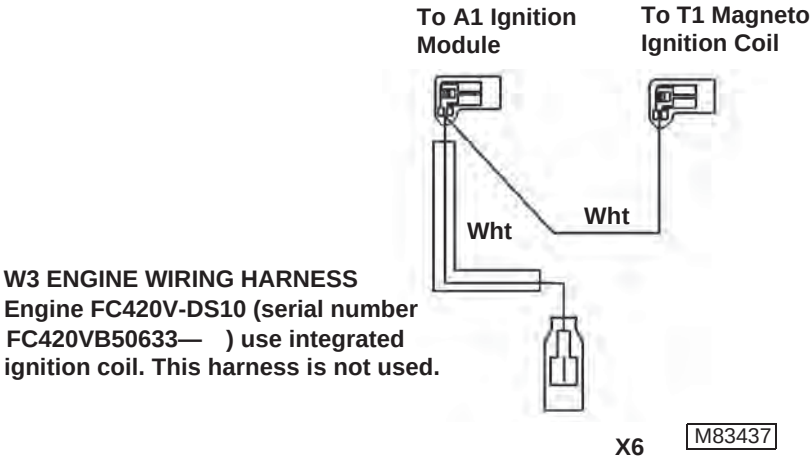
W2 ENGINE WIRING HARNESS

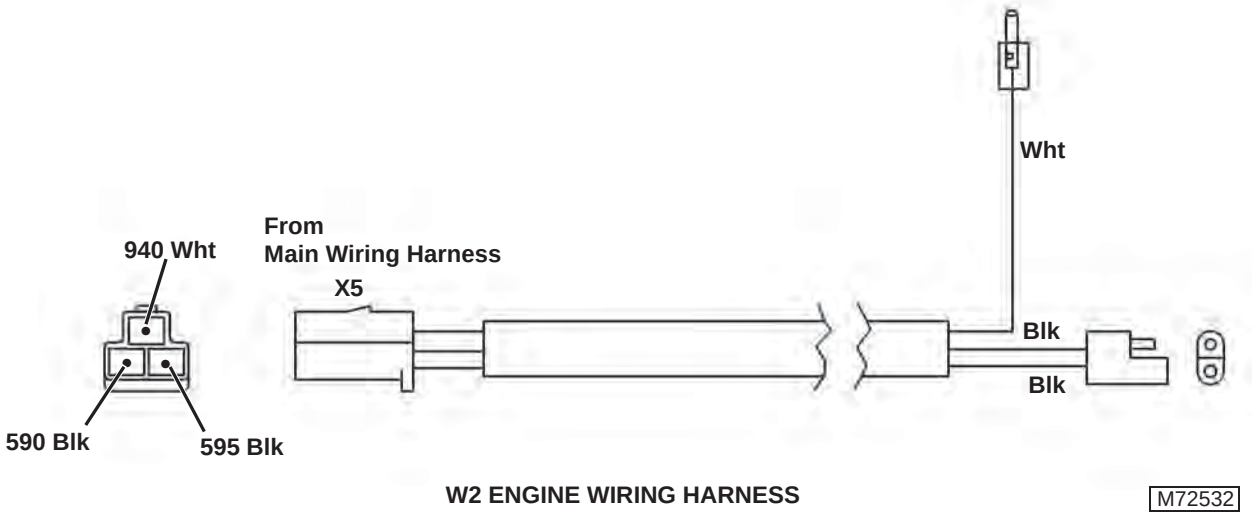


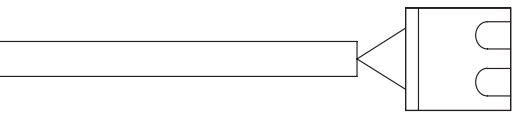
W5 ENGINE WIRING HARNESS

WIRING HARNESSES—LX172/LX176/LX186









M83426

ITCH EXTENSION HARNESS (LX172 ONLY)

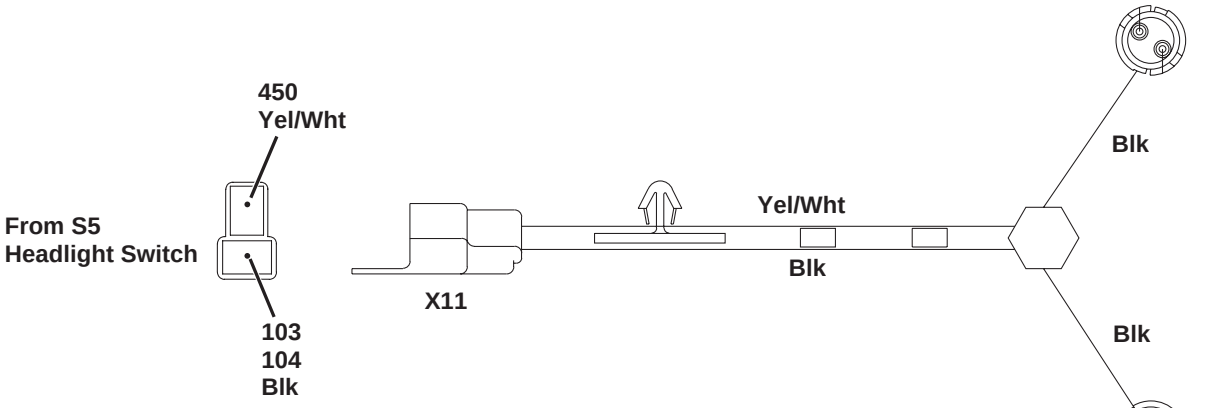


M72535

FUEL SHUTOFF GROUND WIRE

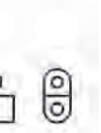
Magneto
n Coil

M83437

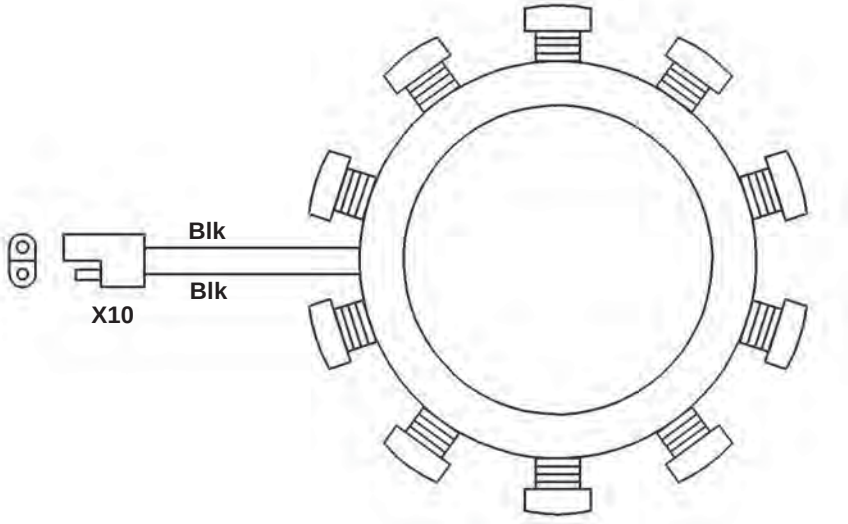


W7 HEADLIGHT WIRING HARNESS

M83453



M72532



M72533

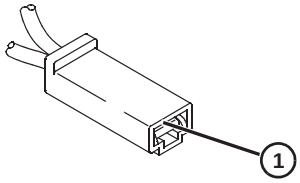
W5 ENGINE WIRING HARNESS

This page intentionally left blank.

ELECTRICAL CONNECTORS—LX172/LX176/LX186

A2 INTERLOCK MODULE—X2 CONNECTOR

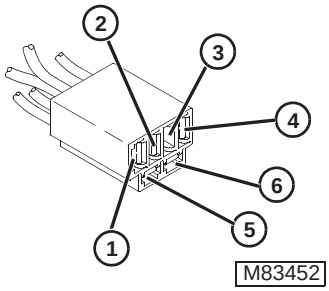
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	205	Red/1.0 (16)	N1
1	210	Red/2.0 (14)	F1



M83434

A2 INTERLOCK MODULE—X3 CONNECTOR

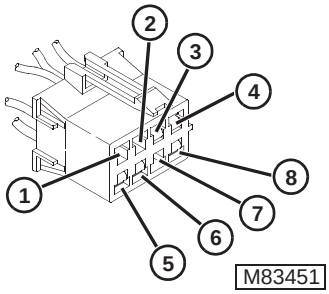
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	410	Yel/Blk/1.0 (16)	W1 Splice
2	750	Blu/0.8 (18)	S4
3	Not Used	-	-
4	710	Pur/1.0 (16)	X11 or S3
5	412	Yel/Blk/0.8 (18)	S5
6	721	Pur/Wht/1.0 (16)	M1



M83452

A2 INTERLOCK MODULE—X4 CONNECTOR

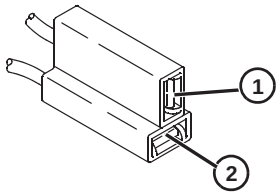
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	Not Used	-	-
2	Not Used	-	-
3	416	Yel/Blk/0.8 (18)	Y1
4	102	Blk/0.8 (18)	W1 Splice
5	706	Pur/Wht/0.8 (18)	S4
6	940	Wht/0.8 (18)	W2
7	Not Used	-	-
8	800	Pnk/0.8 (18)	S2



M83451

E2 HEADLIGHTS—X11 CONNECTOR

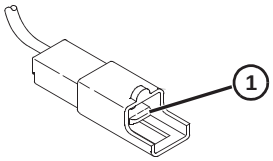
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	111	Blk/0.8 (18)	W1 Splice
2	450	Yel/Wht/0.8 (18)	S5



M83443

G1 BATTERY—X1 CONNECTOR

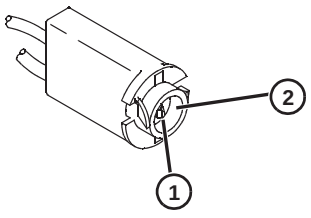
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	215	Org/0.8 (18)	F1 Splice



M83442

H1 BATTERY DISCHARGE LIGHT CONNECTOR

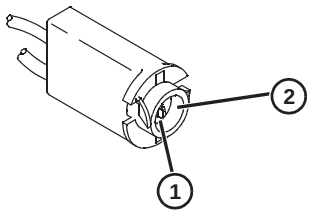
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	600	Brn/0.8 (18)	N1
2	103	Blk/0.8 (18)	W1 Splice



M83441

H2 OIL PRESSURE LIGHT CONNECTOR

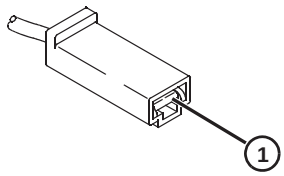
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	500	Yel/0.8 (18)	W1 Splice
2	620	Tan/0.8 (18)	B1



M83441

M1 STARTING MOTOR CONNECTOR

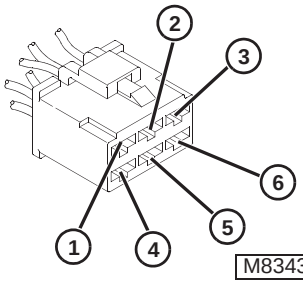
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	721	Pur/Wht/1.0 (16)	X3



M83445

N1 RECTIFIER/REGULATOR CONNECTOR

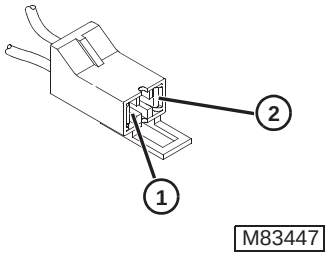
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	107	Blk/2.0 (14)	W1 Splice
2	411	Yel/Blk/0.8 (18)	W1 Splice
3	205	Red/1.0 (16)	X1
4	590	Brn/Yel/2.0 (14)	W2
5	600	Brn/0.8 (18)	H1
6	595	Brn/Wht/2.0 (14)	W2



M83438

S2 SEAT SWITCH CONNECTOR

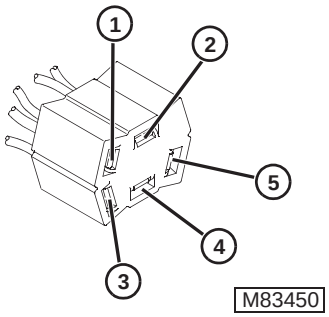
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	414	Yel/Blk/0.8 (18)	W1 Splice
2	800	Pnk/0.8 (18)	X4



M83447

S4 PTO SWITCH CONNECTOR (Early Model)

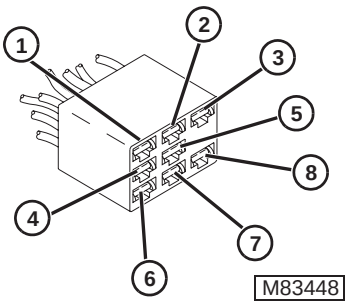
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	415	Yel/Blk/1.0 (16)	W1 Splice
2	705	Pur/1.0 (16)	S3
2	706	Pur/Wht/0.8 (18)	X4
3	Not Used	-	-
4	750	Blu/0.8 (18)	X3
5	755	Blu/0.8 (18)	Y2



M83450

S4 PTO SWITCH CONNECTOR (Late Model)

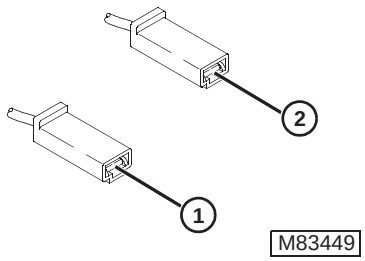
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	Not Used	-	-
2	Not Used	-	-
3	705	Pur/1.0 (16)	S3
3	706	Pur/Wht/0.8 (18)	X4
4	755	Blu/0.8 (18)	Y2
5	Not Used	-	-
6	750	Blu/0.8 (18)	X3
7	Not Used	-	-
8	415	Yel/Blk/1.0 (16)	W1 Splice



M83448

S5 HEADLIGHT SWITCH CONNECTORS

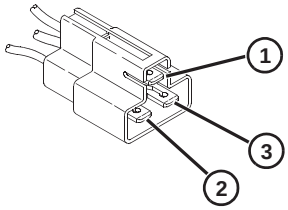
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	412	Yel/Blk/0.8 (18)	X3
2	450	Yel/Wht/0.8 (18)	X9



M83449

W2 ENGINE WIRING HARNESS—X5 CONNECTOR

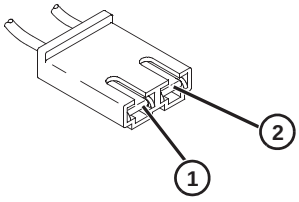
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	940	Wht/0.8 (18)	X4
2	590	Brn/Yel/2.0 (14)	N1
3	595	Brn/Wht/2.0 (14)	N1



M83458

S3 NEUTRAL START SWITCH/BRAKE SWITCH CONNECTOR

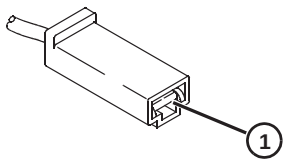
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	710	Pur/1.0 (16)	X3
2	705	Pur/1.0 (16)	S4



M83446

Y1 FUEL SHUT-OFF SOLENOID—X7 CONNECTOR

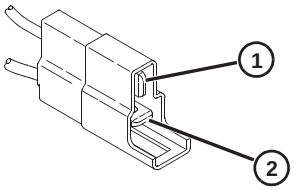
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	416	Yel/Blk/0.8 (18)	X4



M83445

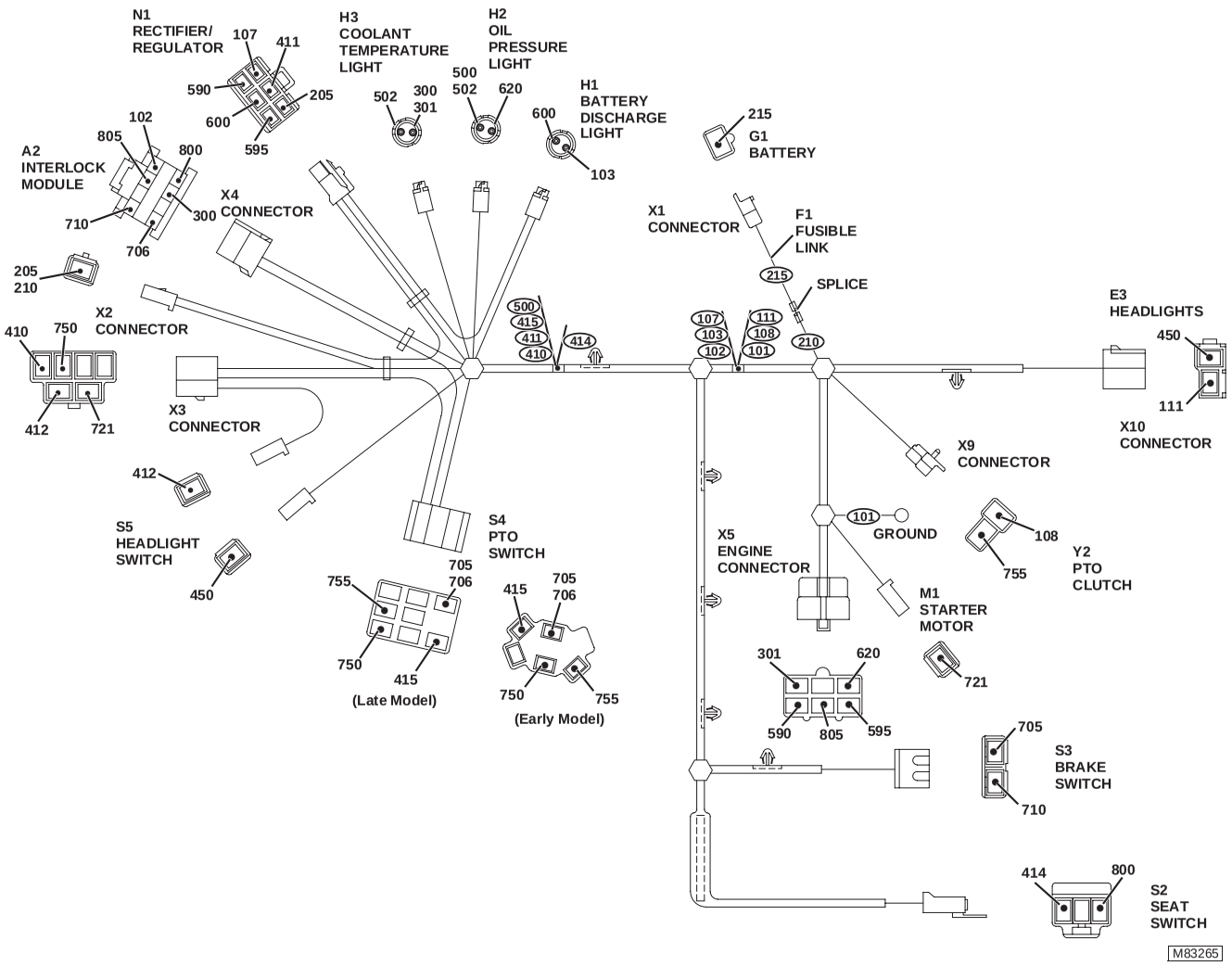
Y2 PTO CLUTCH—X9 CONNECTOR

Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	755	Blu/0.8 (18)	S4
2	108	Blk/0.8 (18)	W1 Splice



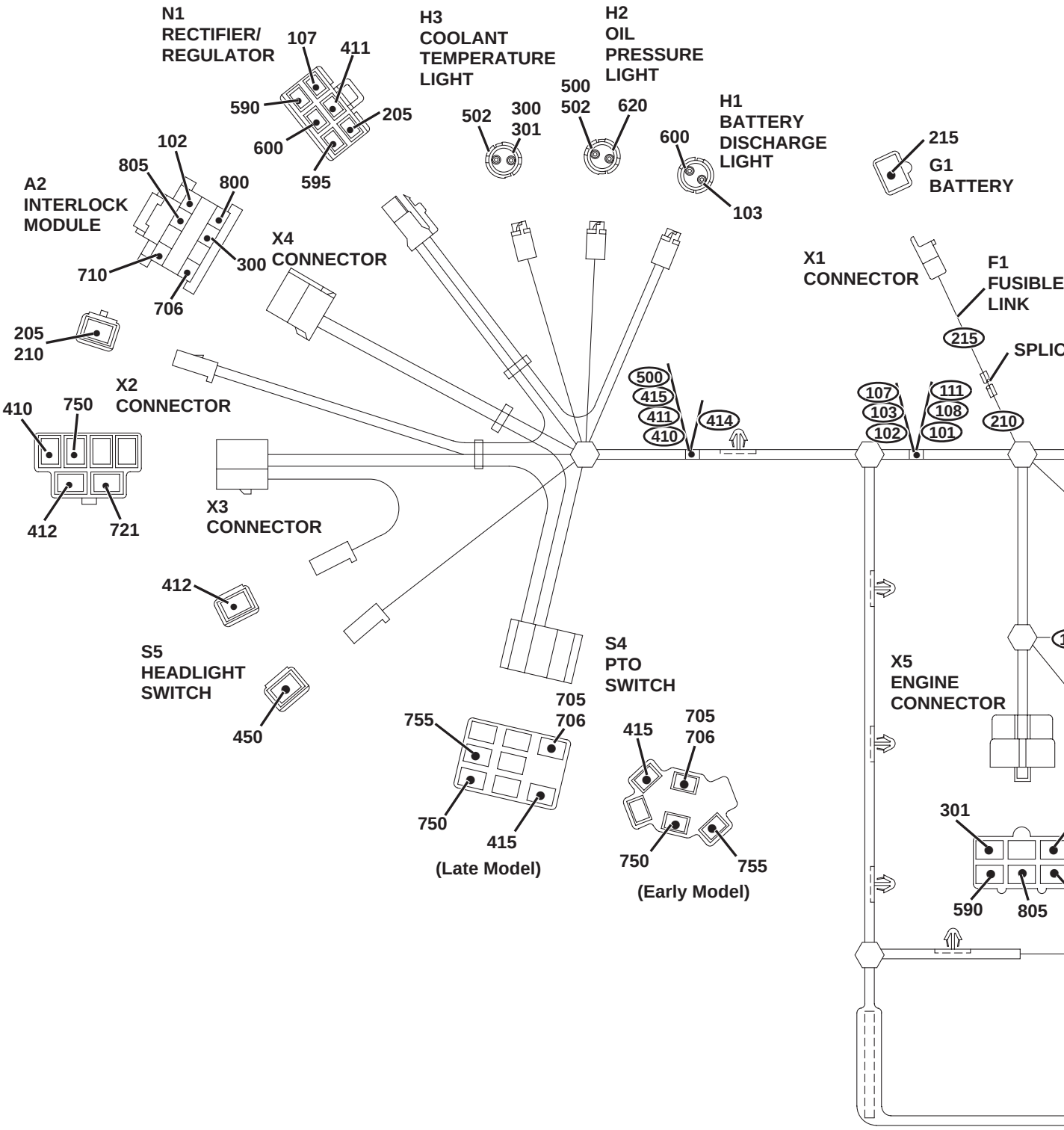
M83444

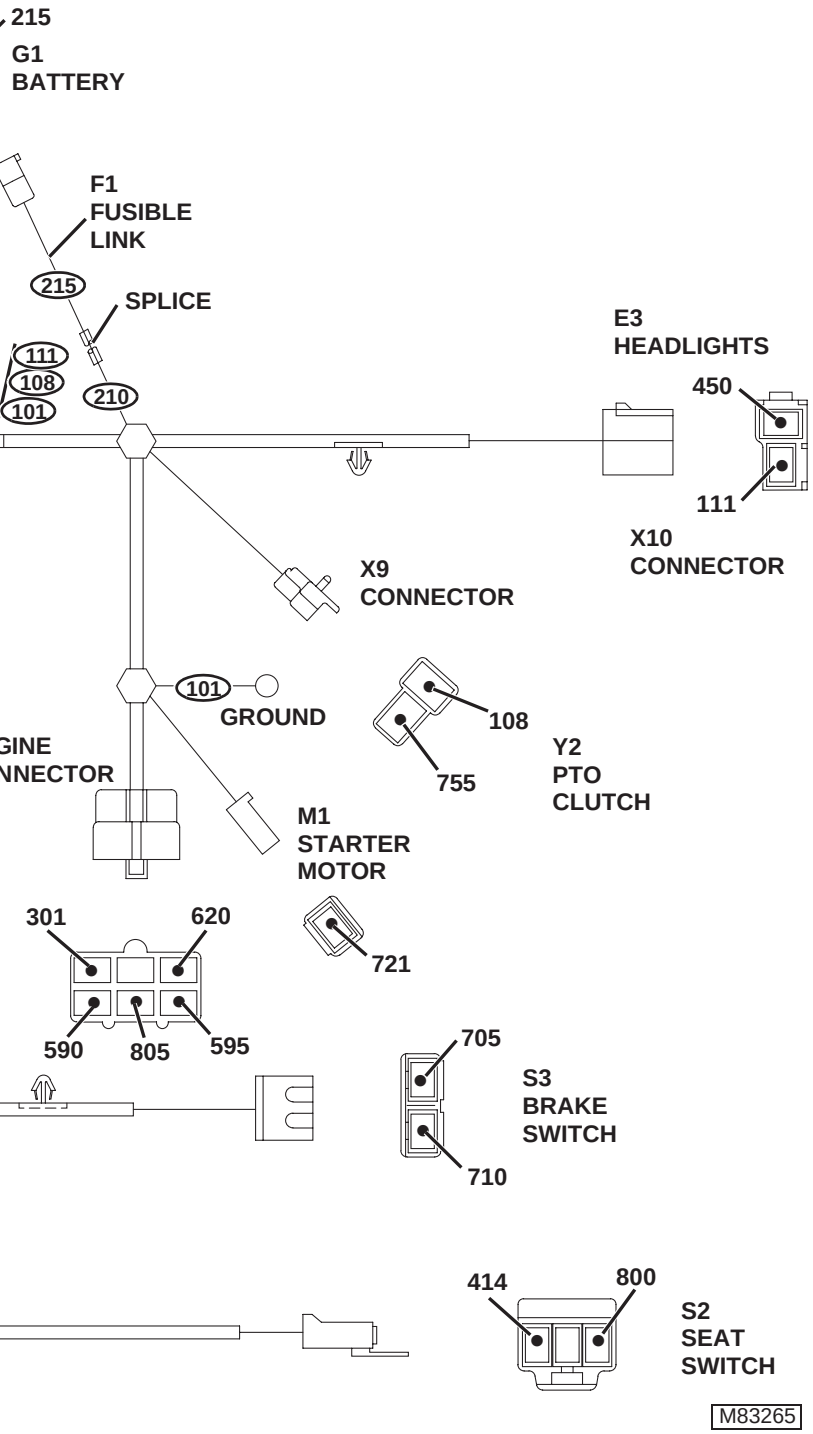
W1 MAIN WIRING HARNESS—LX178/LX188



No.	mm² (GA)	Color
101	2.0 (14)	Black
102	0.8 (18)	Black
103	0.8 (18)	Black
107	1.0 (16)	Black
108	0.8 (18)	Black
111	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Orange
300	0.8 (18)	Orange/White
301	0.8 (18)	Orange/White
410	1.0 (16)	Yellow/Black
411	0.8 (18)	Yellow/Black
412	0.8 (18)	Yellow/Black
414	0.8 (18)	Yellow/Black
415	0.8 (18)	Yellow/Black
450	0.8 (18)	Yellow/White
500	0.8 (18)	Yellow
502	0.8 (18)	Yellow
590	2.0 (14)	Brown/Yellow
595	2.0 (14)	Brown/White
600	0.8 (18)	Brown
620	0.8 (18)	Tan
705	0.8 (18)	Purple
706	0.8 (18)	Purple/White
710	0.8 (18)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	0.8 (18)	Blue
800	0.8 (18)	Pink
805	0.8 (18)	Pink

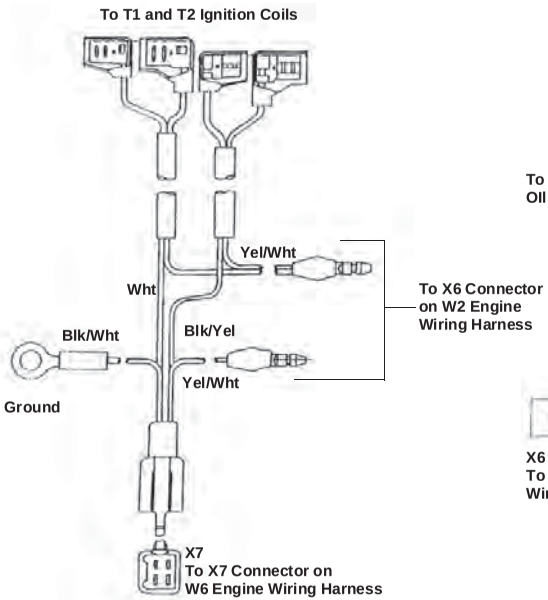
W1 MAIN WIRING HARNESS—LX178/LX188





No.	mm^2 (GA)	Color
101	2.0 (14)	Black
102	0.8 (18)	Black
103	0.8 (18)	Black
107	1.0 (16)	Black
108	0.8 (18)	Black
111	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Orange
300	0.8 (18)	Orange/White
301	0.8 (18)	Orange/White
410	1.0 (16)	Yellow/Black
411	0.8 (18)	Yellow/Black
412	0.8 (18)	Yellow/Black
414	0.8 (18)	Yellow/Black
415	0.8 (18)	Yellow/Black
450	0.8 (18)	Yellow/White
500	0.8 (18)	Yellow
502	0.8 (18)	Yellow
590	2.0 (14)	Brown/Yellow
595	2.0 (14)	Brown/White
600	0.8 (18)	Brown
620	0.8 (18)	Tan
705	0.8 (18)	Purple
706	0.8 (18)	Purple/White
710	0.8 (18)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	0.8 (18)	Blue
800	0.8 (18)	Pink
805	0.8 (18)	Pink

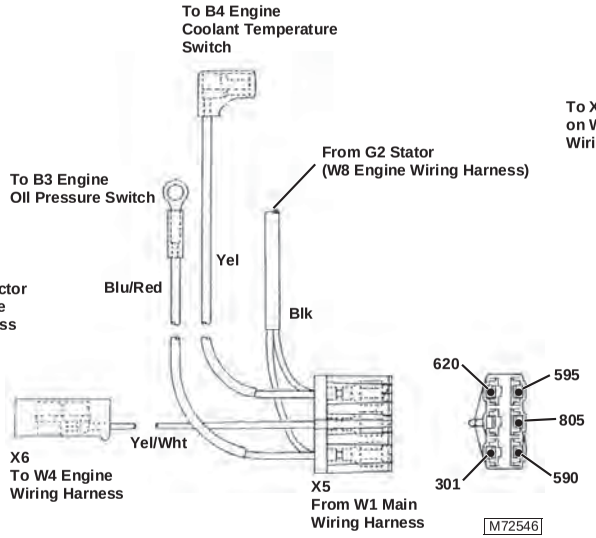
WIRING HARNESSES—LX178/LX188



W4 ENGINE WIRING HARNESS



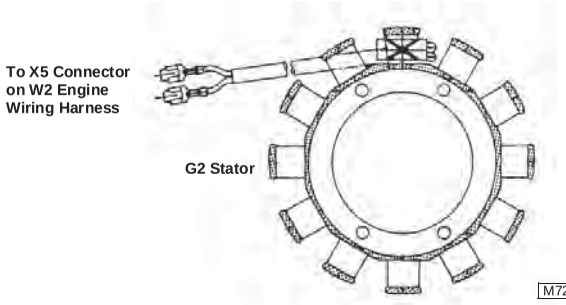
FUEL SHUTOFF SOLENOID GROUND WIRE (LX188 ONLY)



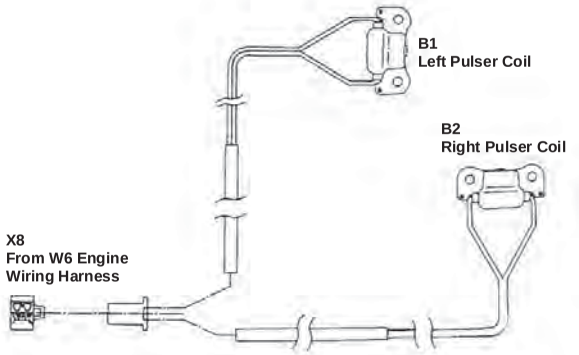
W2 ENGINE WIRING HARNESS



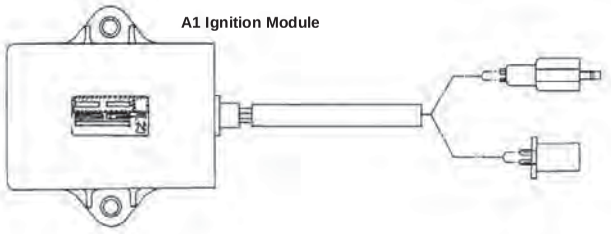
W3 ENGINE WIRING HARNESS (LX188 ONLY)



W8 ENGINE WIRING HARNESS



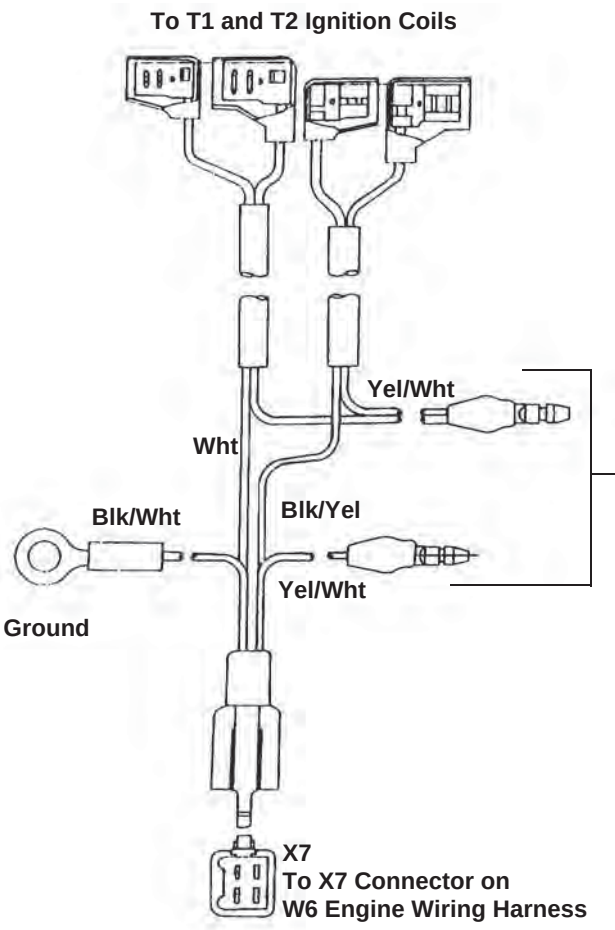
W7 ENGINE WIRING HARNESS



W6 ENGINE WIRING HARNESS

W9 HEADLIGHT WIRING HARNESS

WIRING HARNESSES—LX178/LX188



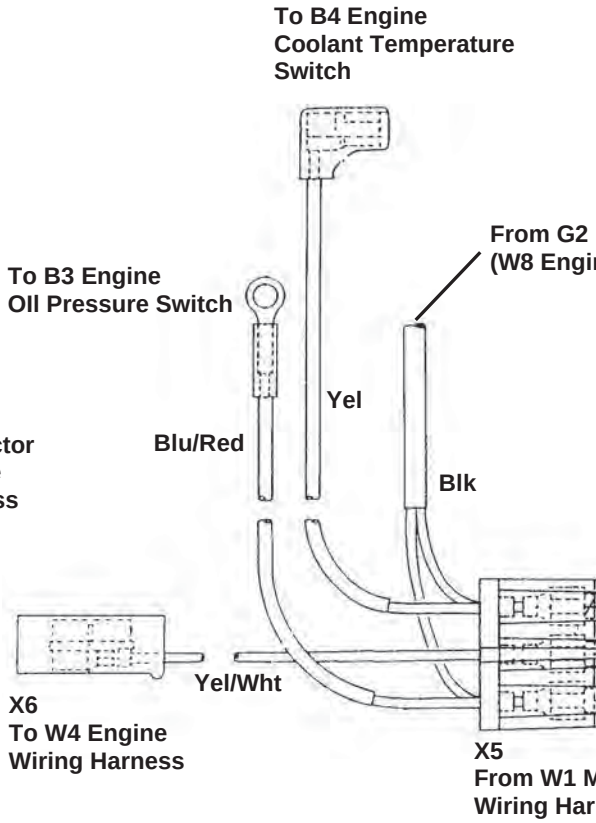
W4 ENGINE WIRING HARNESS

M72547



M72535

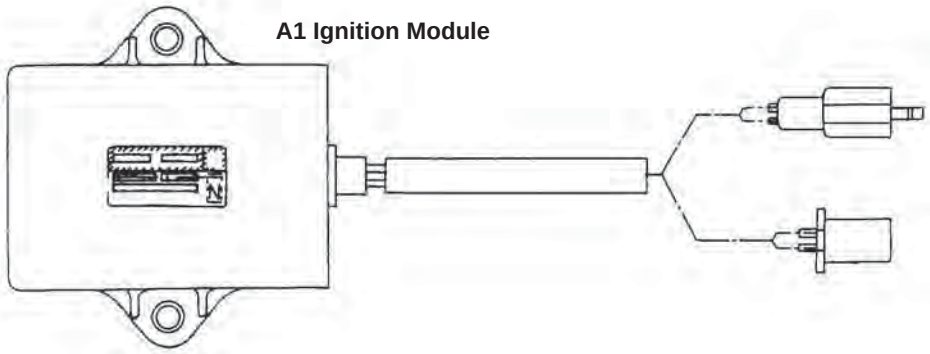
FUEL SHUTOFF SOLENOID GROUND WIRE (LX188 ONLY)



W2 ENGINE WIRING HARNES



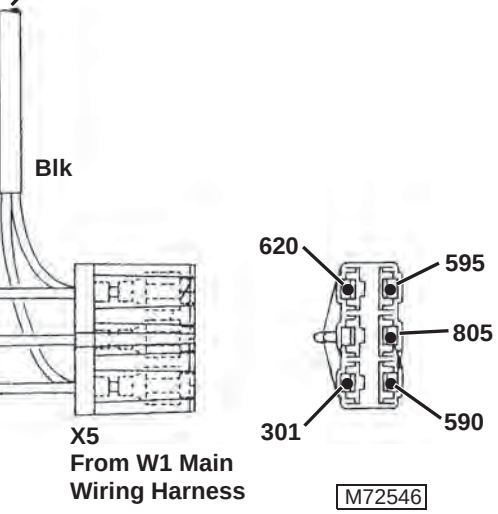
W3 ENGINE WIRING HARNE



W6 ENGINE WIRING HARNESS

M72548

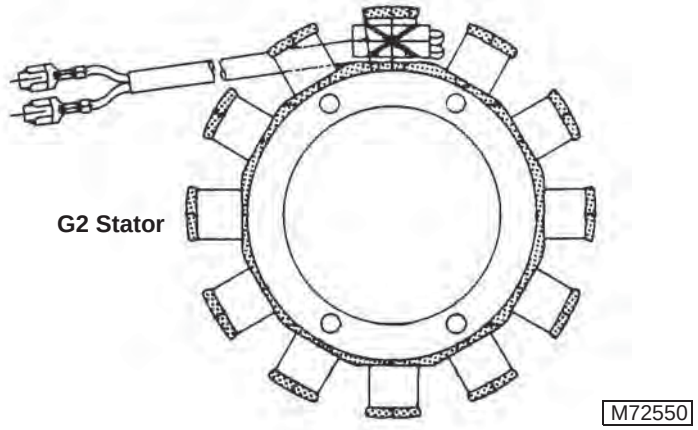
ne
mperature



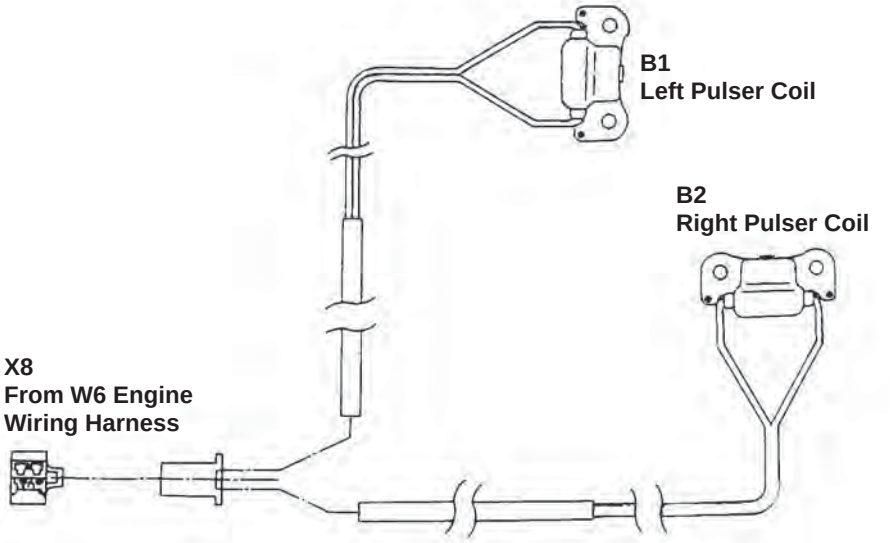
WIRING HARNESS



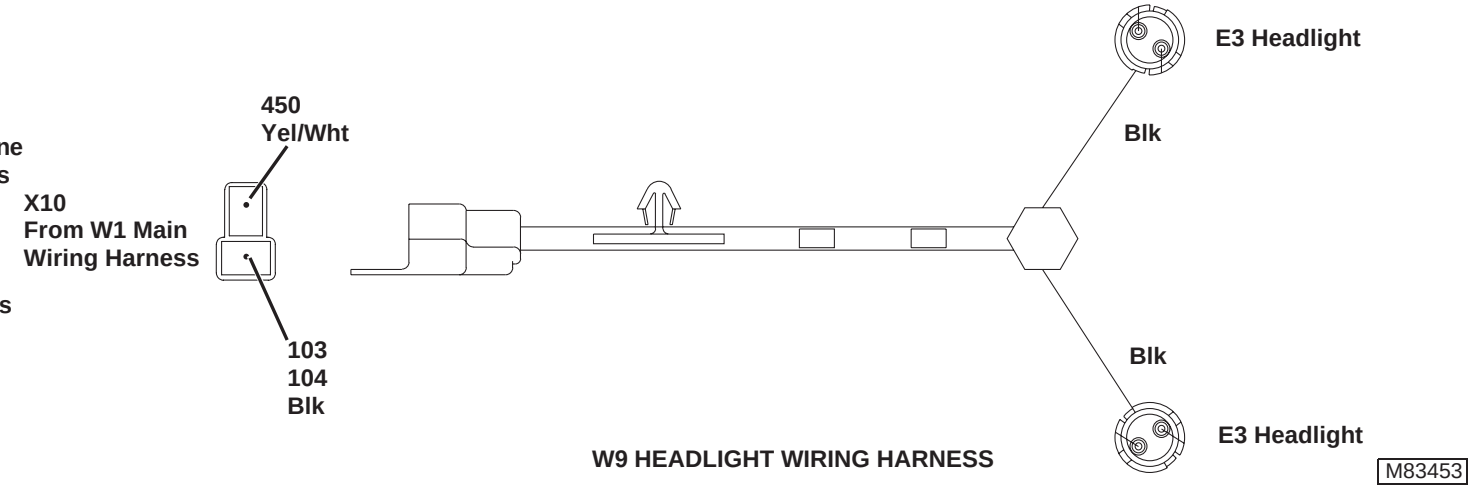
E WIRING HARNESS (LX188 ONLY)



W8 ENGINE WIRING HARNESS



W7 ENGINE WIRING HARNESS

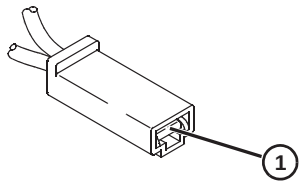


W9 HEADLIGHT WIRING HARNESS

ELECTRICAL CONNECTORS—LX178/LX188

A2 INTERLOCK MODULE—X2 CONNECTOR

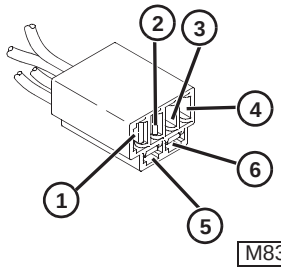
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	205	Red/1.0 (16)	N1
1	210	Red/2.0 (14)	F1



M83434

A2 INTERLOCK MODULE—X3 CONNECTOR

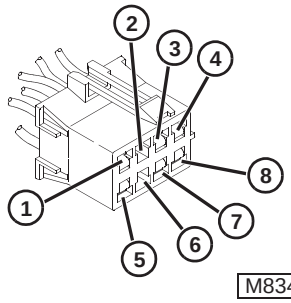
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	410	Yel/Blk/1.0 (16)	W1 Splice
2	750	Blu/0.8 (18)	S4
3	Not Used	-	-
4	Not Used	-	-
5	412	Yel/Blk/0.8 (18)	S5
6	721	Pur/wht/1.0 (16)	M1



M83435

A2 INTERLOCK MODULE—X4 CONNECTOR

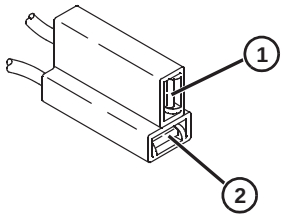
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	710	Pur/0.8 (18)	S3
2	Not Used	-	-
3	805	Pnk/0.8 (18)	X8
4	102	Blk/0.8 (18)	W1 Splice
5	706	Pur/Wht/0.8 (18)	S4
6	Not Used	-	-
7	300	Org/Wht/0.8 (18)	H3
8	800	Pnk/0.8 (18)	S2



M83439

E3 HEADLIGHTS—X10 CONNECTOR

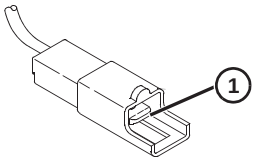
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	111	Blk/0.8 (18)	W1 Splice
2	450	Yel/Wht/0.8 (18)	S5



M83443

G1 BATTERY—X1 CONNECTOR

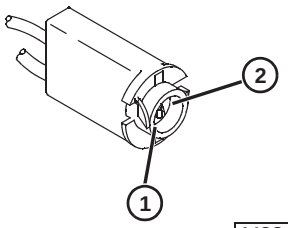
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	215	Org/0.8 (18)	F1 Splice



M83442

H1 BATTERY DISCHARGE LIGHT CONNECTOR

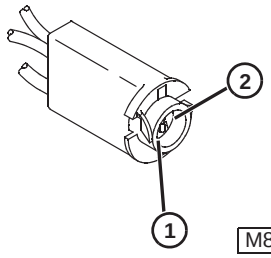
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	600	Brn/0.8 (18)	N1
2	103	Blk/0.8 (18)	W1 Splice



M83441

H2 OIL PRESSURE LIGHT CONNECTOR

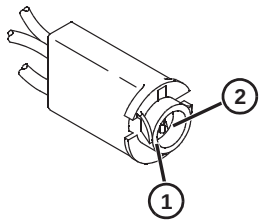
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	500	Yel/0.8 (18)	W1 Splice
1	502	Yel/0.8 (18)	H3
2	620	Tan/0.8 (18)	X8



M83436

H3 COOLANT TEMPERATURE LIGHT CONNECTOR

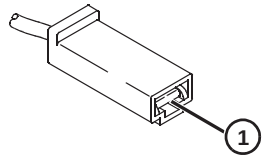
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	502	Yel/0.8 (18)	H2
2	300	Org/Wht/0.8 (18)	X4
2	301	Org/Wht/0.8 (18)	X8



M83436

M1 STARTING MOTOR CONNECTOR

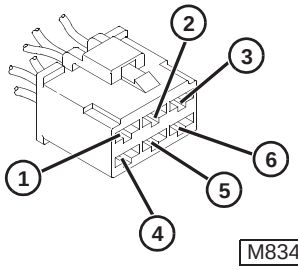
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	721	Pur/Wht/1.0 (18)	X3



M83445

N1 RECTIFIER/REGULATOR CONNECTOR

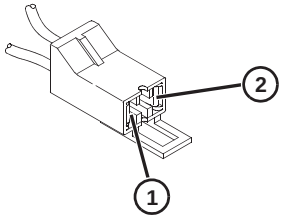
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	107	Blk/2.0 (14)	W1 Splice
2	411	Yel/Blk/0.8 (18)	W1 Splice
3	205	Red/1.0 (16)	X1
4	590	Brn/Yel/2.0 (14)	X8
5	600	Brn/0.8 (18)	H1
6	595	Brn/Wht/2.0 (14)	X8



M83438

S2 SEAT SWITCH CONNECTOR

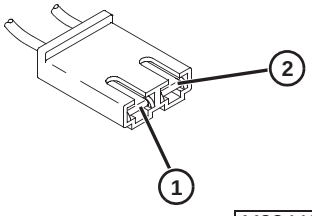
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	414	Yel/Blk/0.8 (18)	W1 Splice
2	800	Pnk/0.8 (18)	X4



M83447

S3 BRAKE SWITCH CONNECTOR

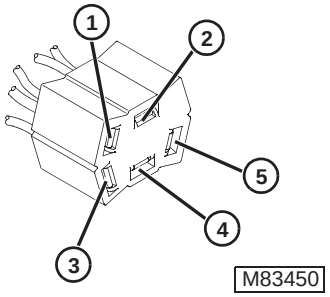
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	710	Pur/0.8 (18)	X4
2	705	Pur/0.8 (18)	S4



M83446

S4 PTO SWITCH CONNECTOR (Early Model)

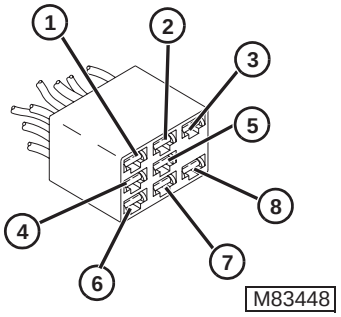
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	415	Yel/Blk/0.8 (18)	W1 Splice
2	705	Pur/0.8 (18)	S3
2	706	Pur/Wht/0.8 (18)	X4
3	Not Used	-	-
4	750	Blu/0.8 (18)	X3
5	755	Blu/0.8 (18)	Y2



M83450

S4 PTO SWITCH CONNECTOR (Late Model)

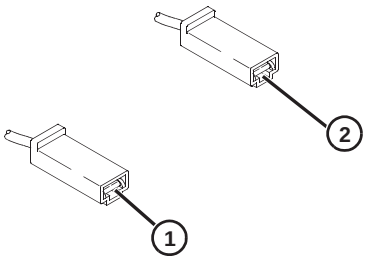
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	Not Used	-	-
2	Not Used	-	-
3	705	Pur/0.8 (18)	S3
3	706	Pur/Wht/0.8 (18)	X4
4	755	Blu/0.8 (18)	Y2
5	Not Used	-	-
6	750	Blu/0.8 (18)	X3
7	Not Used	-	-
8	415	Yel/Blk/0.8 (18)	W1 Splice



M83448

S5 HEADLIGHT SWITCH CONNECTOR

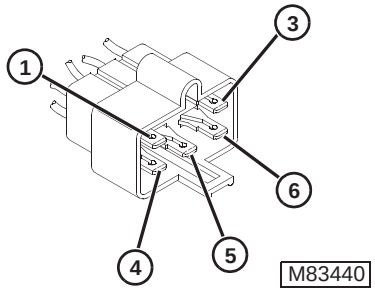
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	412	Yel/Blk/0.8 (18)	X3
2	450	Yel/Wht/0.8 (18)	E3



M83449

W2 ENGINE WIRING HARNESS—X5 CONNECTOR

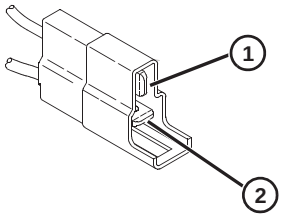
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	301	Org/Wht/0.8 (18)	H3
2	Not Used	-	-
3	620	Tan/0.8 (18)	H2
4	590	Brn/Yel/2.0 (14)	N1
5	805	Pnk/0.8 (18)	X4
6	595	Brn/Wht/2.0 (14)	N1



M83440

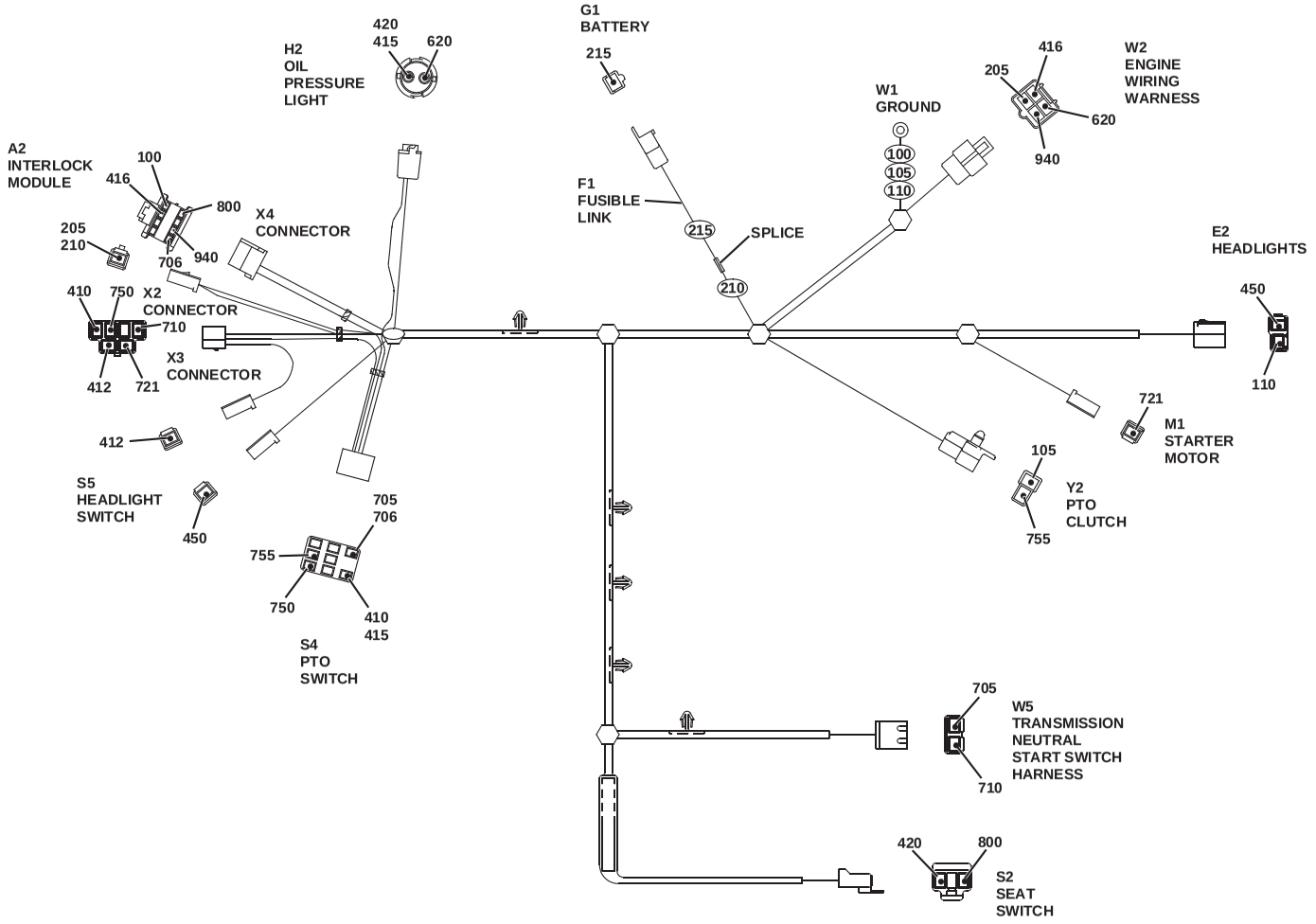
Y2 PTO CLUTCH—X9 CONNECTOR

Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	755	Blu/0.8 (18)	S4
2	108	Blk/0.8 (18)	W1 Splice



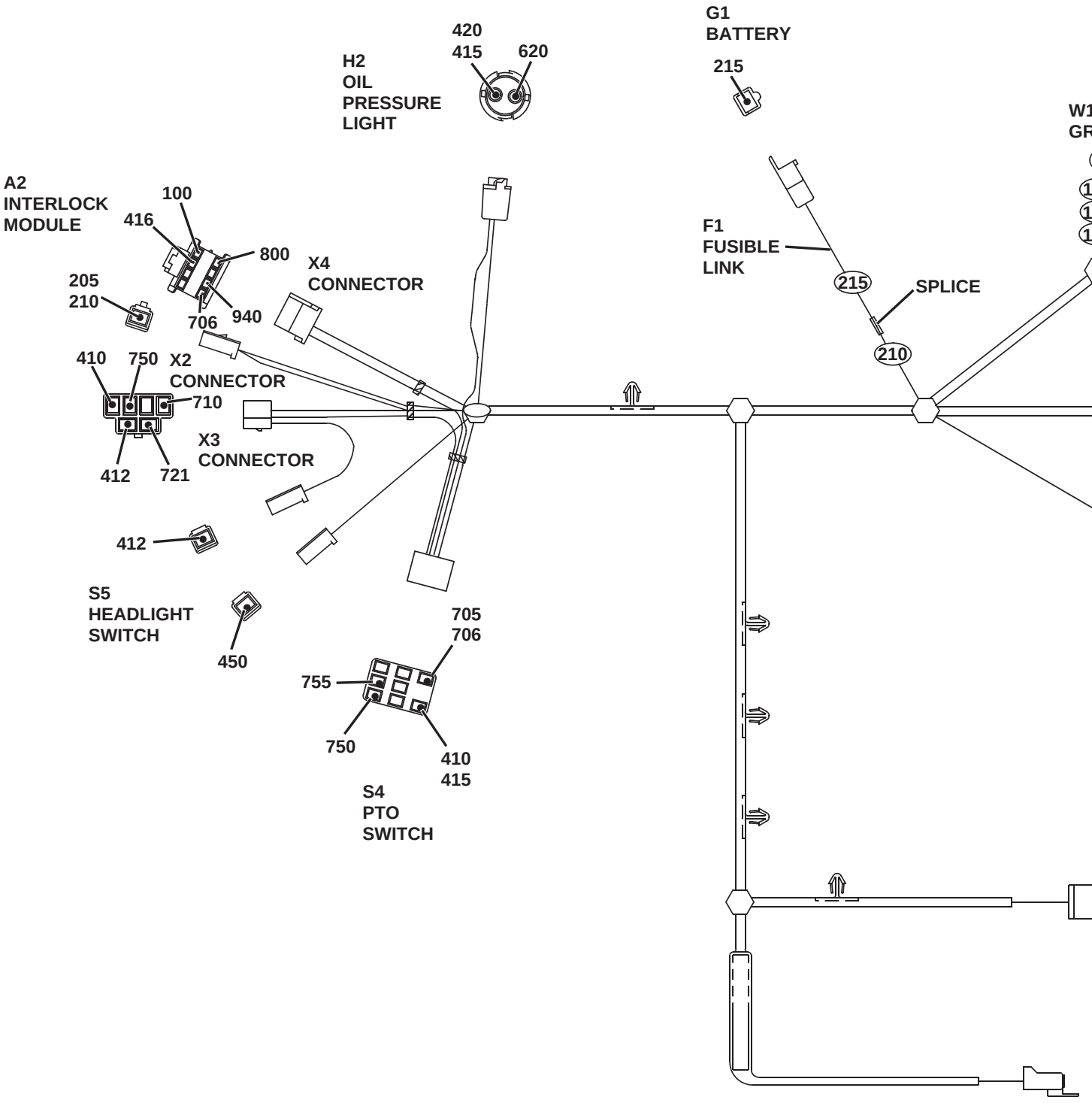
M83444

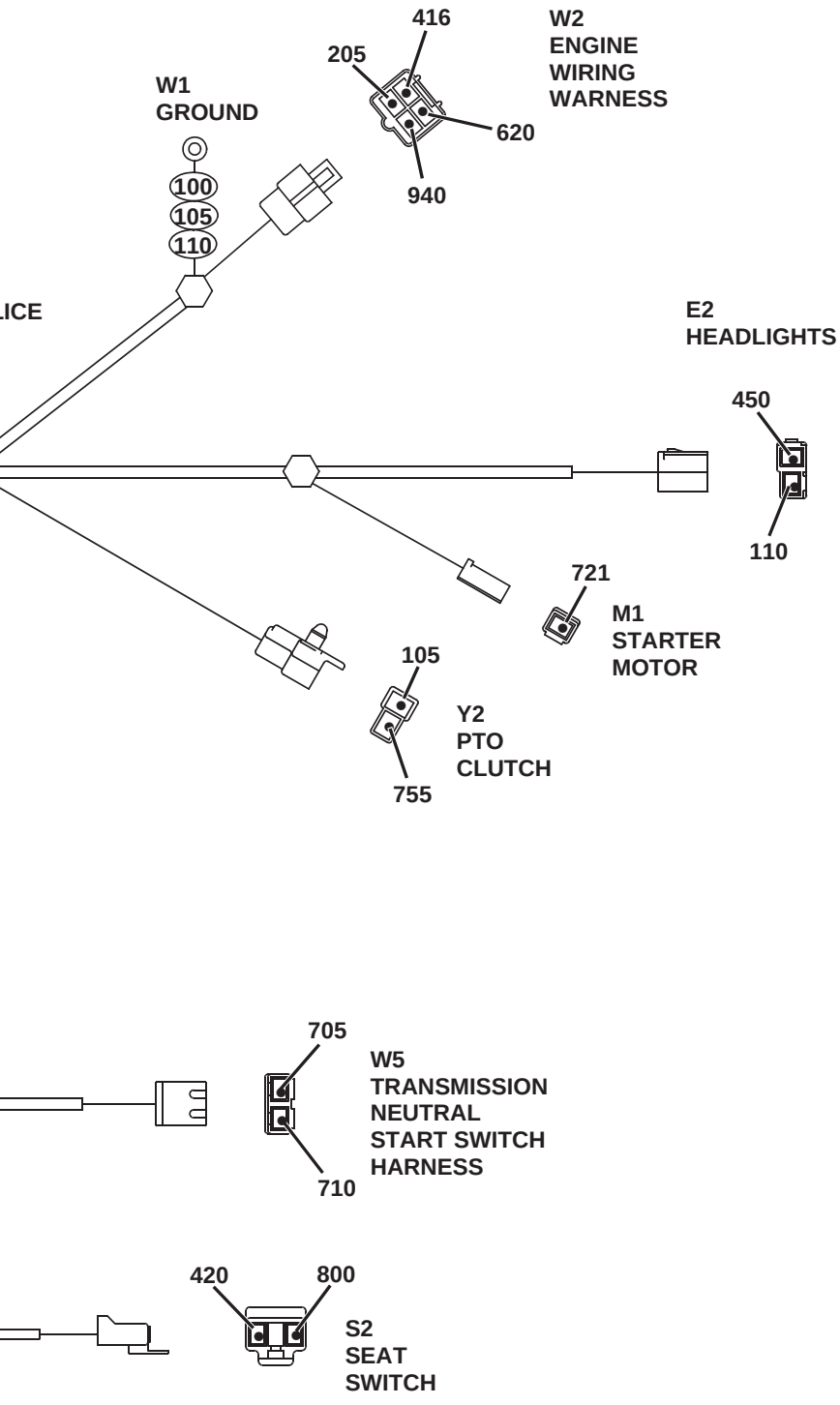
W1 MAIN WIRING HARNESS—LX173



No.	mm² (GA)	Color
100	0.8 (18)	Black
105	2.0 (14)	Black
110	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Fusible Link
410	1.0 (16)	Yellow/Black
412	0.8 (18)	Yellow/Black
415	1.0 (16)	Yellow/Black
416	0.8 (18)	Yellow/Black
420	1.0 (16)	Yellow/Black
450	0.8 (18)	Yellow/White
620	0.8 (18)	Tan
705	1.0 (16)	Purple
706	0.8 (18)	Purple/White
710	1.0 (16)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	2.0 (14)	Blue
800	0.8 (18)	Pink
940	0.8 (18)	White

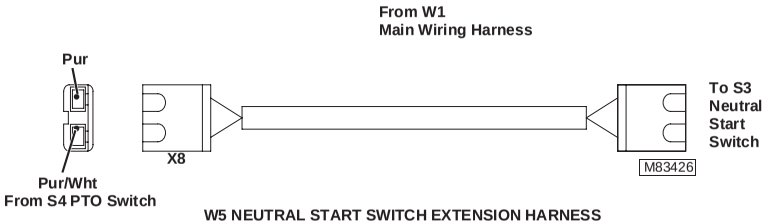
W1 MAIN WIRING HARNESS—LX173





No.	mm^2 (GA)	Color
100	0.8 (18)	Black
105	2.0 (14)	Black
110	0.8 (18)	Black
205	1.0 (16)	Red
210	2.0 (14)	Red
215	0.8 (18)	Fusible Link
410	1.0 (16)	Yellow/Black
412	0.8 (18)	Yellow/Black
415	1.0 (16)	Yellow/Black
416	0.8 (18)	Yellow/Black
420	1.0 (16)	Yellow/Black
450	0.8 (18)	Yellow/White
620	0.8 (18)	Tan
705	1.0 (16)	Purple
706	0.8 (18)	Purple/White
710	1.0 (16)	Purple
721	1.0 (16)	Purple/White
750	0.8 (18)	Blue
755	2.0 (14)	Blue
800	0.8 (18)	Pink
940	0.8 (18)	White

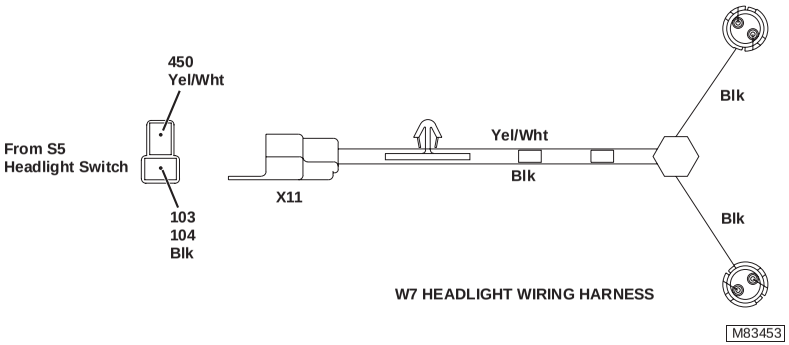
WIRING HARNESSES—LX173



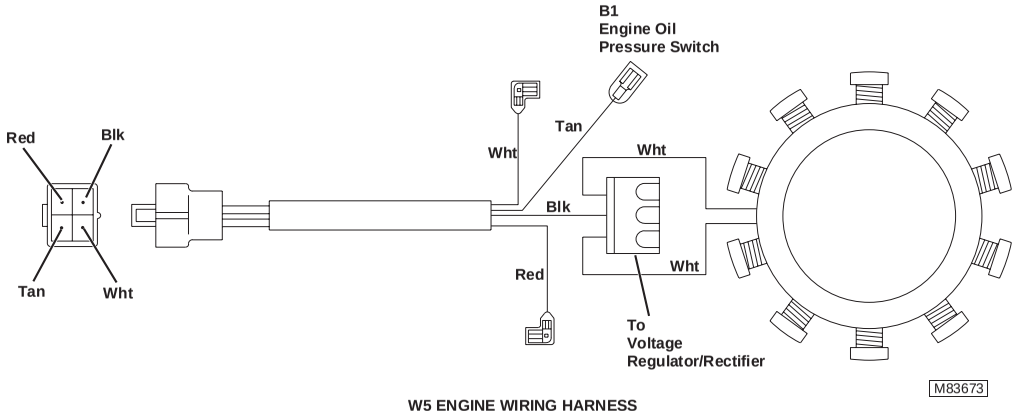
W5 NEUTRAL START SWITCH EXTENSION HARNESS



FUEL SHUTOFF GROUND WIRE

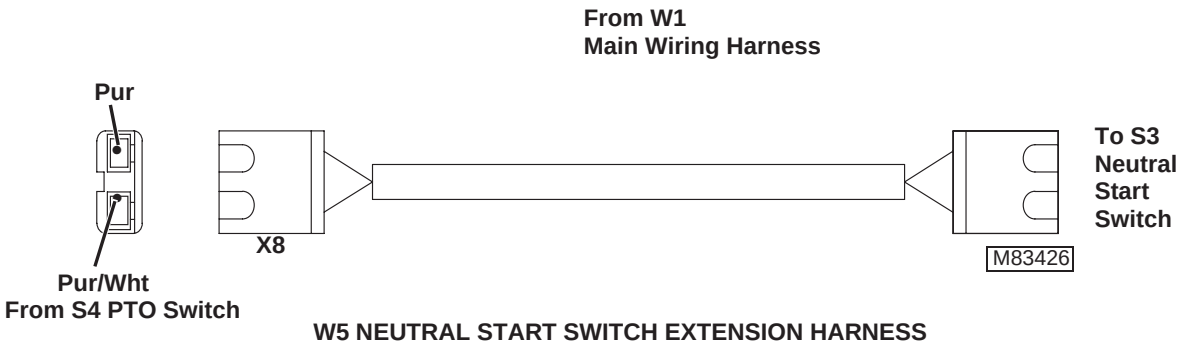


W7 HEADLIGHT WIRING HARNESS

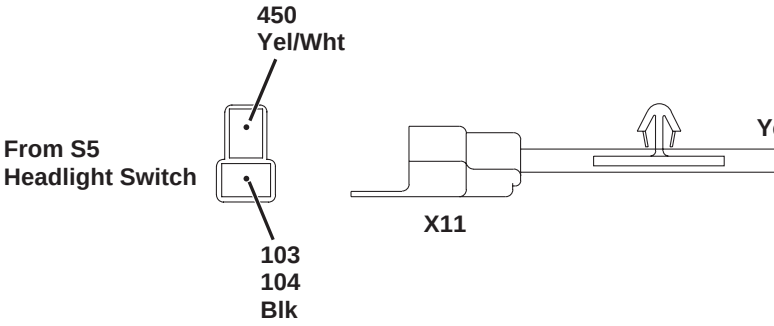


W5 ENGINE WIRING HARNESS

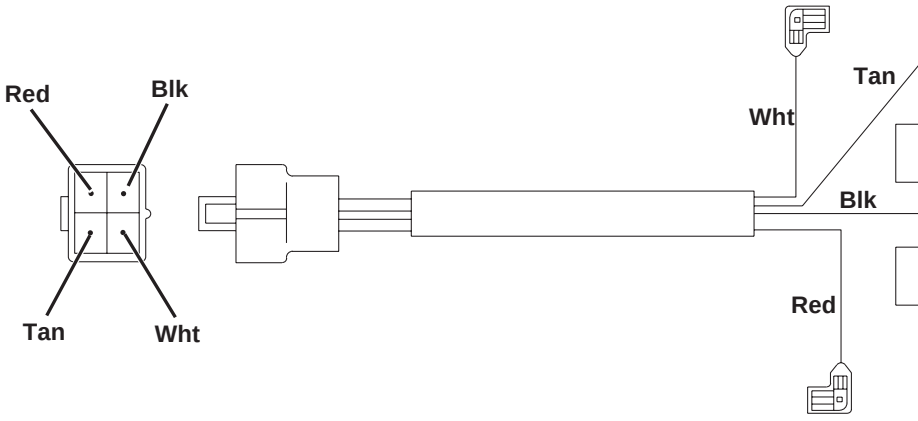
WIRING HARNESSES—LX173



W5 NEUTRAL START SWITCH EXTENSION HARNESS



W7 HEADLIGH

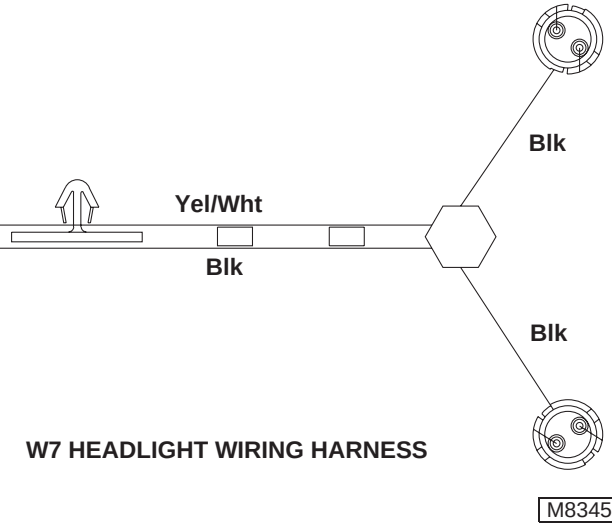


W5 ENGINE WIRING HAR

o S3
eutral
tart
witch

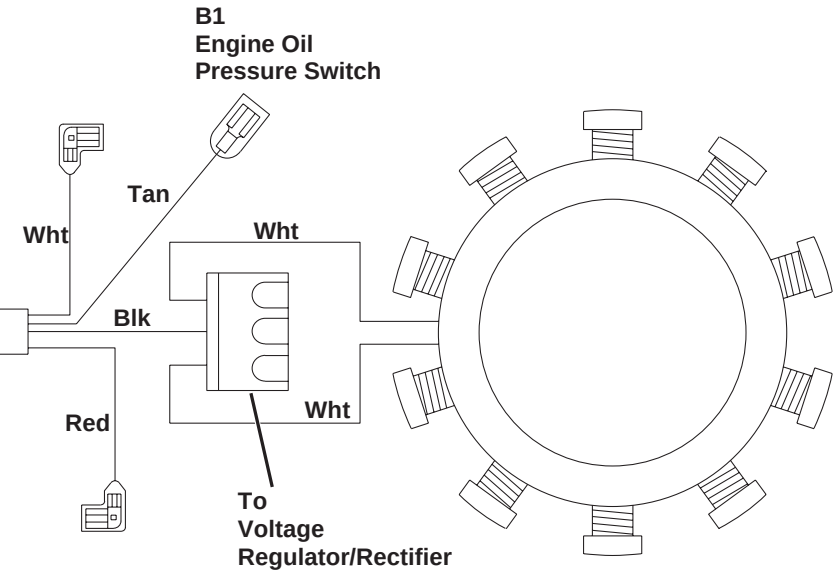


FUEL SHUTOFF GROUND WIRE



W7 HEADLIGHT WIRING HARNESS

M83453



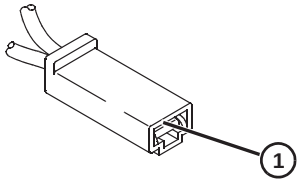
M83673

NE WIRING HARNESS

ELECTRICAL CONNECTORS—LX173

A2 INTERLOCK MODULE—X2 CONNECTOR

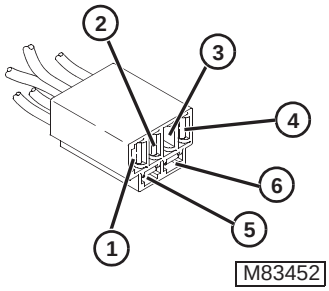
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	205	Red/1.0 (16)	N1
1	210	Red/2.0 (14)	F4



M83434

A2 INTERLOCK MODULE—X3 CONNECTOR

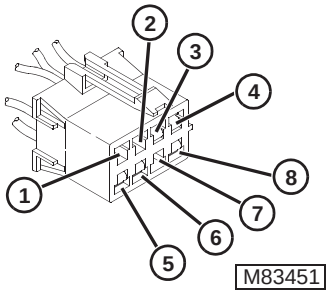
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	410	Yel/Blk/1.0 (16)	W1 Splice
2	750	Blu/0.8 (18)	S4
3	Not Used	-	-
4	710	Pur/1.0 (16)	S3
5	412	Yel/Blk/0.8 (18)	S5
6	721	Pur/Wht/1.0 (16)	M1



M83452

A2 INTERLOCK MODULE—X4 CONNECTOR

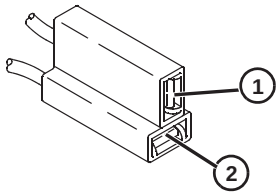
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	Not Used	-	-
2	Not Used	-	-
3	416	Yel/Blk/0.8 (18)	Y1
4	100	Blk/0.8 (18)	W1 Splice
5	706	Pur/Wht/0.8 (18)	S4
6	940	Wht/0.8 (18)	W2
7	Not Used	-	-
8	800	Pnk/0.8 (18)	S2



M83451

E2 HEADLIGHTS—X11 CONNECTOR

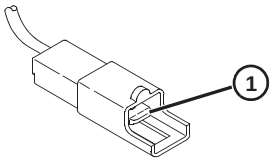
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	110	Blk/0.8 (18)	W1 Splice
2	450	Yel/Wht/0.8 (18)	S5



M83443

G1 BATTERY—X1 CONNECTOR

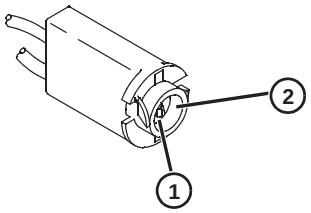
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	215	Org/0.8 (18)	F1 Splice



M83442

H2 OIL PRESSURE LIGHT CONNECTOR

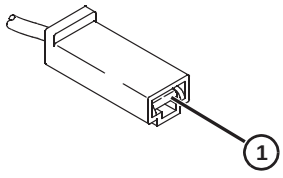
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	415	Yel/Blk/1.0 (16)	W1 Splice
	420	Yel/Blk/1.0 (16)	W1 Splice
2	620	Tan/0.8 (18)	W2



M83441

M1 STARTING MOTOR CONNECTOR

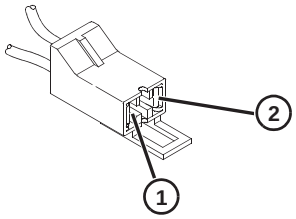
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	721	Pur/Wht/1.0 (16)	X3



M83445

S2 SEAT SWITCH CONNECTOR

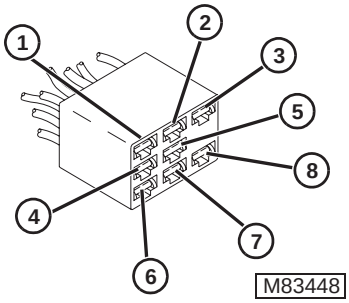
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	420	Yel/Blk/0.8 (18)	W1 Splice
2	800	Pnk/0.8 (18)	X4



M83447

S4 PTO SWITCH CONNECTOR

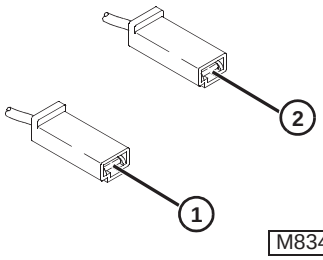
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	Not Used	-	-
2	Not Used	-	-
3	705	Pur/1.0 (16)	S3
3	706	Pur/Wht/0.8 (18)	X4
4	755	Blu/0.8 (18)	Y2
5	Not Used	-	-
6	750	Blu/0.8 (18)	X3
7	Not Used	-	-
8	415	Yel/Blk/1.0 (16)	W1 Splice



M83448

S5 HEADLIGHT SWITCH CONNECTORS

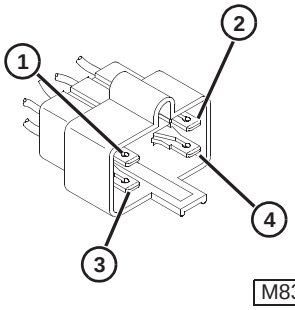
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	412	Yel/Blk/0.8 (18)	X3
2	450	Yel/Wht/0.8 (18)	X11



M83449

W2 ENGINE WIRING HARNESS—X5 CONNECTOR

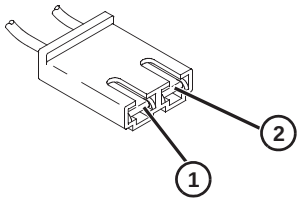
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	940	Wht/0.8 (18)	X4
2	205	Red/1.0 (16)	F4
3	620	Tan/0.8 (18)	H2
4	416	Yel/Blk/0.8 (18)	X4



M83458

S3 NEUTRAL START SWITCH CONNECTOR

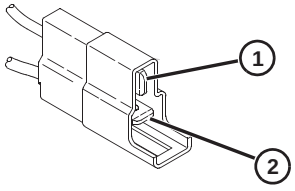
Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	710	Pur/1.0 (16)	X3
2	705	Pur/1.0 (16)	S4



M83446

Y2 PTO CLUTCH—X9 CONNECTOR

Terminal Number	Circuit Number	Wire Color/Size mm^2 (Gauge)	Circuit Termination Points
1	755	Blu/0.8 (18)	S4
2	105	Blk/0.8 (18)	W1 Splice



M83444

TROUBLESHOOTING

ELECTRICAL SYSTEM TROUBLESHOOTING CHART— LX172/LX173/LX176/LX186

Problem or Symptom / Check or Solution	Starter cranking problems.	Engine cranks but will not start.	No spark.	Engine will not shut off.	Improper component operating with switch.	Battery goes dead, discharges or overcharges.	Oil light problem.	Discharge light problem.	Instrument light problem.	Headlight problems.
See power circuit diagnosis.	●									
See cranking circuit diagnosis.	●									
Check ground circuit.	●	●								
Test battery and battery connections.	●									
See ignition circuit diagnosis.		●	●	●						
See charging circuit diagnosis.						●		●		
See instrument circuit diagnosis.							●	●	●	
Check for shorted circuit.				●	●					
See headlight circuit diagnosis.										●
See fuel shutoff solenoid circuit diagnosis.		●								

ELECTRICAL SYSTEM TROUBLESHOOTING CHART—LX178/LX188

Problem or Symptom / Check or Solution	Starter cranking problems.	Engine cranks but will not start.	No spark.	Engine will not shut off.	Improper component operating with switch.	Battery goes dead, discharges or overcharges.	Oil light problem.	Discharge light problem.	Coolant light problem.	Instrument light problem.	Headlight problems.
See power circuit diagnosis.	●										
See cranking circuit diagnosis.	●										
Check ground circuit.	●	●									
Test battery and battery connections.	●										
See ignition circuit diagnosis.		●	●	●							
See charging circuit diagnosis.						●		●			
See instrument circuit diagnosis.							●	●	●	●	
Check for shorted circuit.				●	●						
See headlight circuit diagnosis.											●
See fuel shutoff solenoid circuit (LX188 Only).		●									



This page intentionally left blank.

CIRCUIT OPERATION AND DIAGNOSIS—LX172/LX176/LX186

POWER CIRCUIT OPERATION

Unswitched Power Circuit

Function:

Provides unswitched power to the primary circuit whenever the battery is connected. This circuit is protected by the fusible link. This link is a short length of wire which is designed to protect the main wiring harness and will fail if current load becomes excessive.



Operating Conditions, Unswitched Circuits:

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

- Battery positive (+) terminal.
- Battery terminal of starter solenoid.
- Battery terminal of key switch.
- Battery terminal of voltage regulator/rectifier.

The positive battery cable connects the battery (G1) to the starter solenoid. The battery cables must be in good condition for the electrical system to function properly.

Switched Power Circuit:

Function:

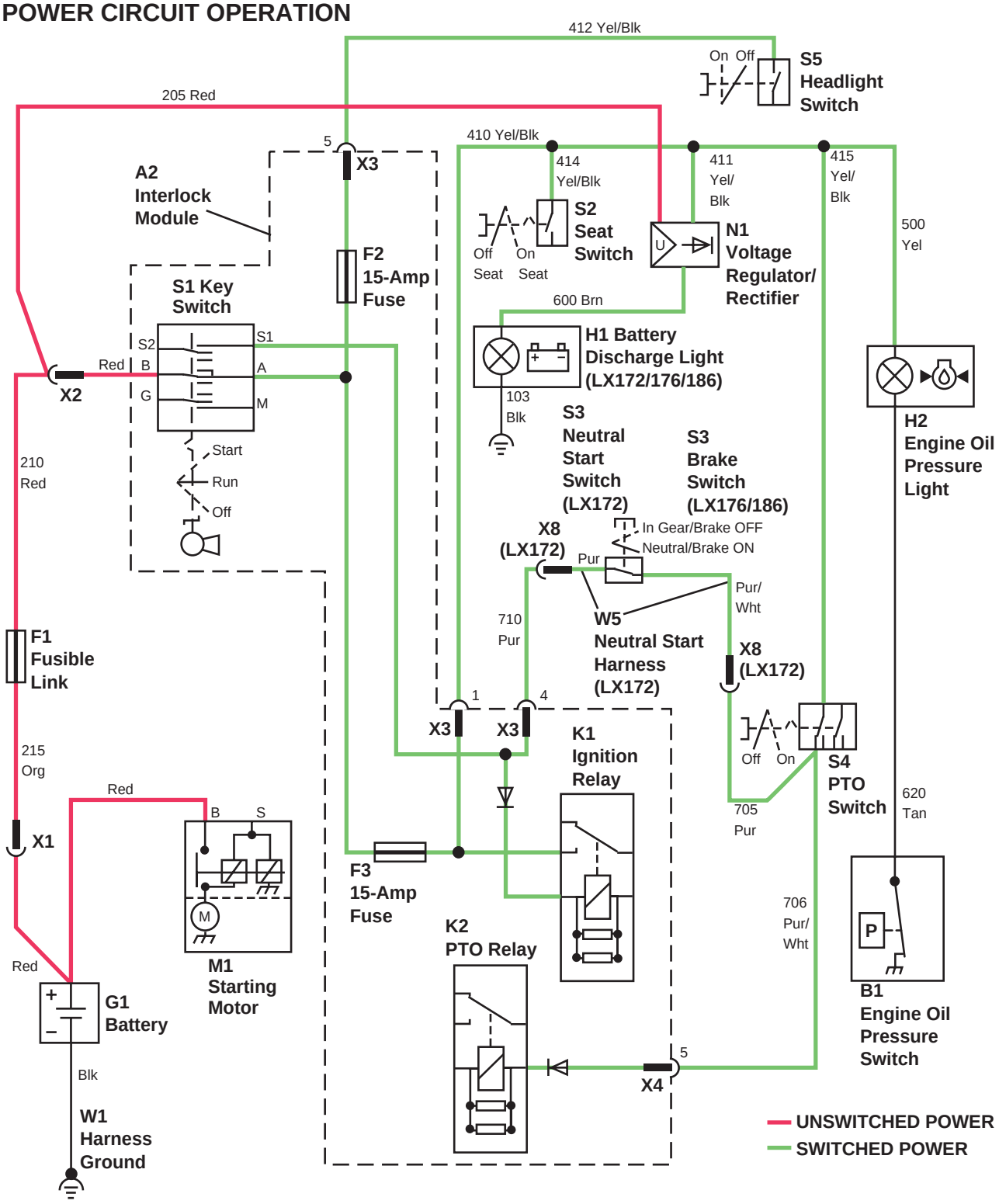
Provides switched power to the primary machine operating components by means of a key switch. In addition to the fusible link, this circuit is protected by two 15-amp fuses.

Operating Conditions, Switched Circuits:

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

- All Unswitched Locations.
- A2 Interlock Module:
  - F2 and F3 Fuse Terminals.
  - X3 Connector—Terminals 1 and 5.
- S2 Seat Switch—Yellow/Black wire.
- PTO Switch—Yellow/Black wire.
- S5 Headlight Switch—Yellow/Black wire.
- N1 Voltage Regulator/Rectifier.
- H1 Battery Discharge Light—Brown/White wire.
- H2 Oil Pressure Light—Yellow wire.
- B1 Engine Oil Pressure Switch—Tan wire.
- S3 Neutral Start/Brake Switch—Purple wire terminal.
- N1 Voltage Regulator/Rectifier.

POWER CIRCUIT OPERATION



M83253P

POWER CIRCUIT DIAGNOSIS

Test Conditions:

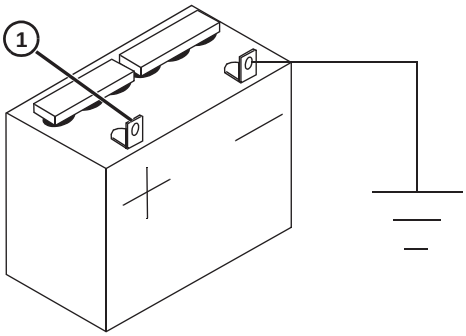
- Park brake ENGAGED.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on battery (+) terminal.
- Check connection(s) for corrosion and looseness when checking/testing.

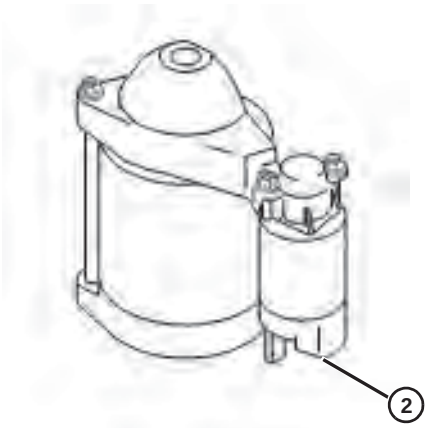
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid to motor bolt—battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Voltage regulator/rectifier—battery terminal.	Battery voltage.	Check red wire No. 205 and connections.

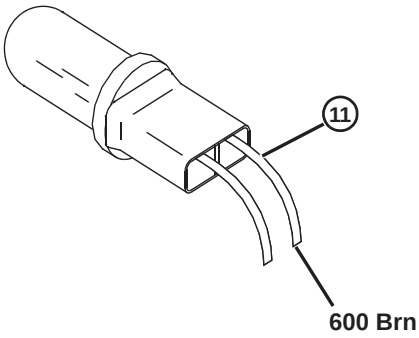
Test Conditions:

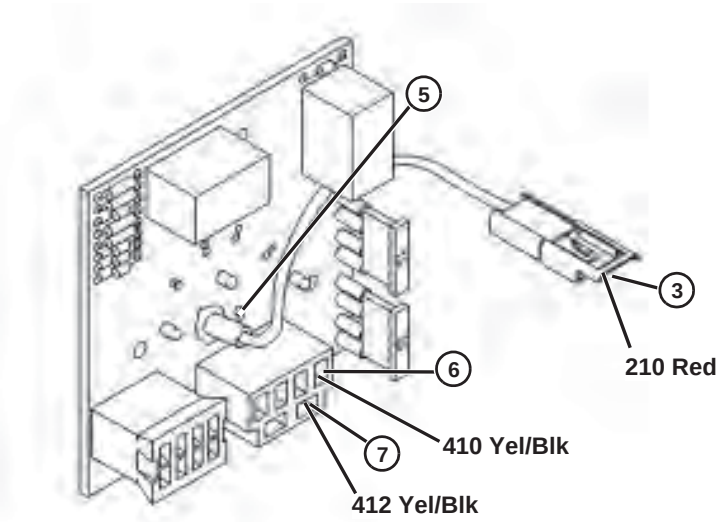
- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (LX172) or park brake engaged (LX176/LX186). (Neutral start/brake switch CLOSED.)

Test/Check Point	Normal	If Not Normal
5. Key switch—"A" terminal.	Battery voltage.	Replace interlock module.
6. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
7. Interlock module—terminals X3—5.	Battery voltage.	Check fuse (F2), if OK, replace interlock module.
8. Voltage regulator/rectifier—battery terminal.	Battery voltage.	Check red wire No. 205 and connections.
9. Voltage regulator/rectifier.	Battery voltage.	Check yellow/black wires No. 410 and 411 (X3 to N1) and connections.
10. Seat switch.	Battery voltage.	Check yellow/black wire No. 414 (X3 to S2) and connections.
11. Battery discharge light.	Light is ON. Battery voltage.	Check brown wire No. 600 and connections.



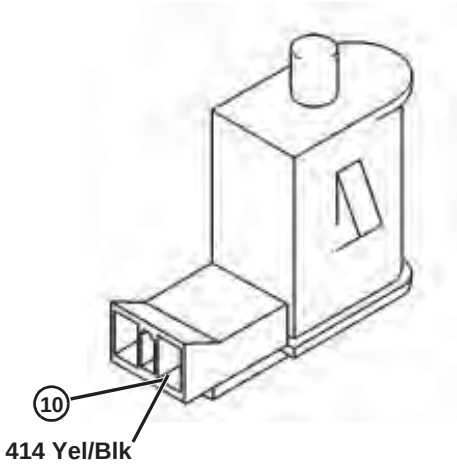


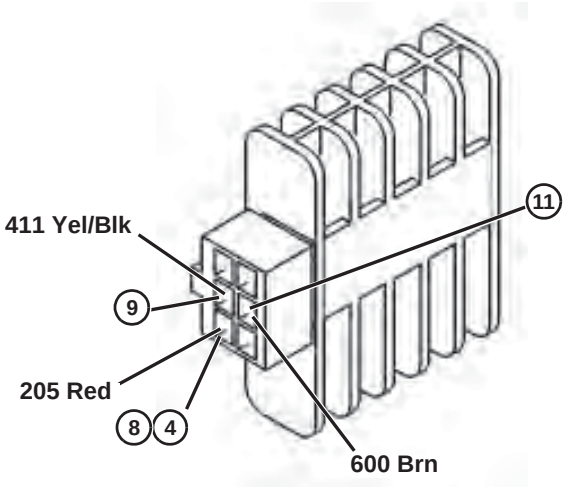




A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



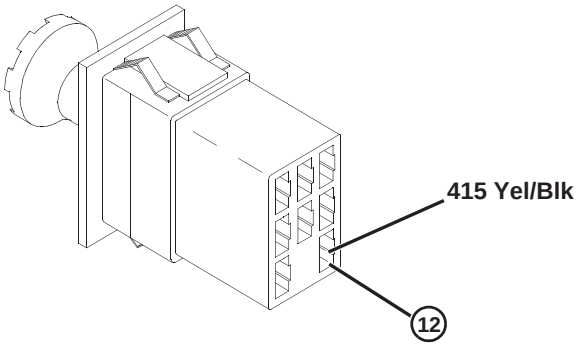


POWER CIRCUIT DIAGNOSIS, continued

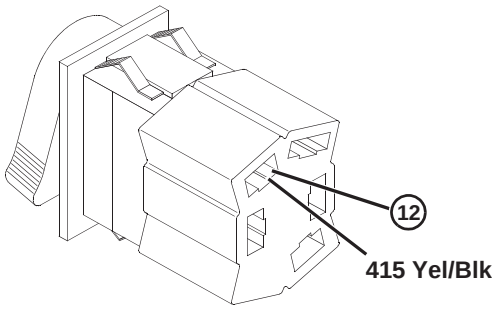
Test Conditions:

- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (LX172) or park brake engaged (LX176/LX186). (Neutral start/brake switch CLOSED.)

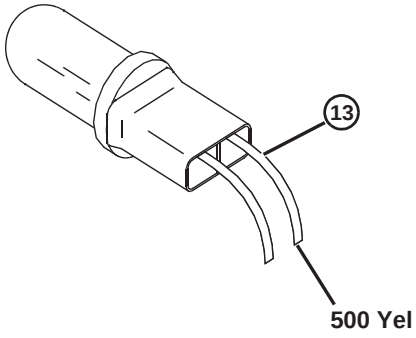
Test/Check Point	Normal	If Not Normal
12. PTO switch.	Battery voltage.	Check yellow/black wire No. 410 and 415 and connections.
13. Engine oil pressure light.	Light is ON. Battery voltage.	Check yellow wire No. 500, yellow/ black wire No. 410 and connections.
14. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412 (X3 to S5).

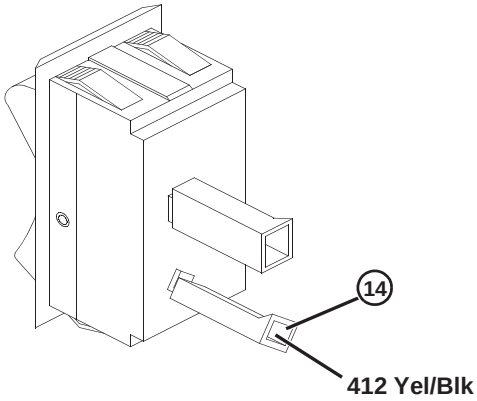


S4 PTO Switch (Late Model)



S4 PTO Switch (Early Model)





CRANKING CIRCUIT OPERATION

Function:

The cranking system is used to energize the starting motor.

NOTE: LX172 tractors use a manual shift transaxle and neutral start switch. LX176 and LX186 tractors use a hydrostatic transaxle and brake switch. System operation is identical.

Operating Conditions:

- Key switch in START position.
- LX172—Transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—Park brake engaged (brake switch CLOSED).
- PTO switch in OFF position.

NOTE: The operator does not have to be in the seat (seat switch closed) to crank engine.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The starting motor is a solenoid shift design. The power circuit provides current to the key switch (S1) and protects the cranking circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the starter solenoid battery terminal, fusible link (F1) and key switch battery terminal. With the key switch in the START position, current flows to the 15-amp fuse (F3), and PTO switch (S4).

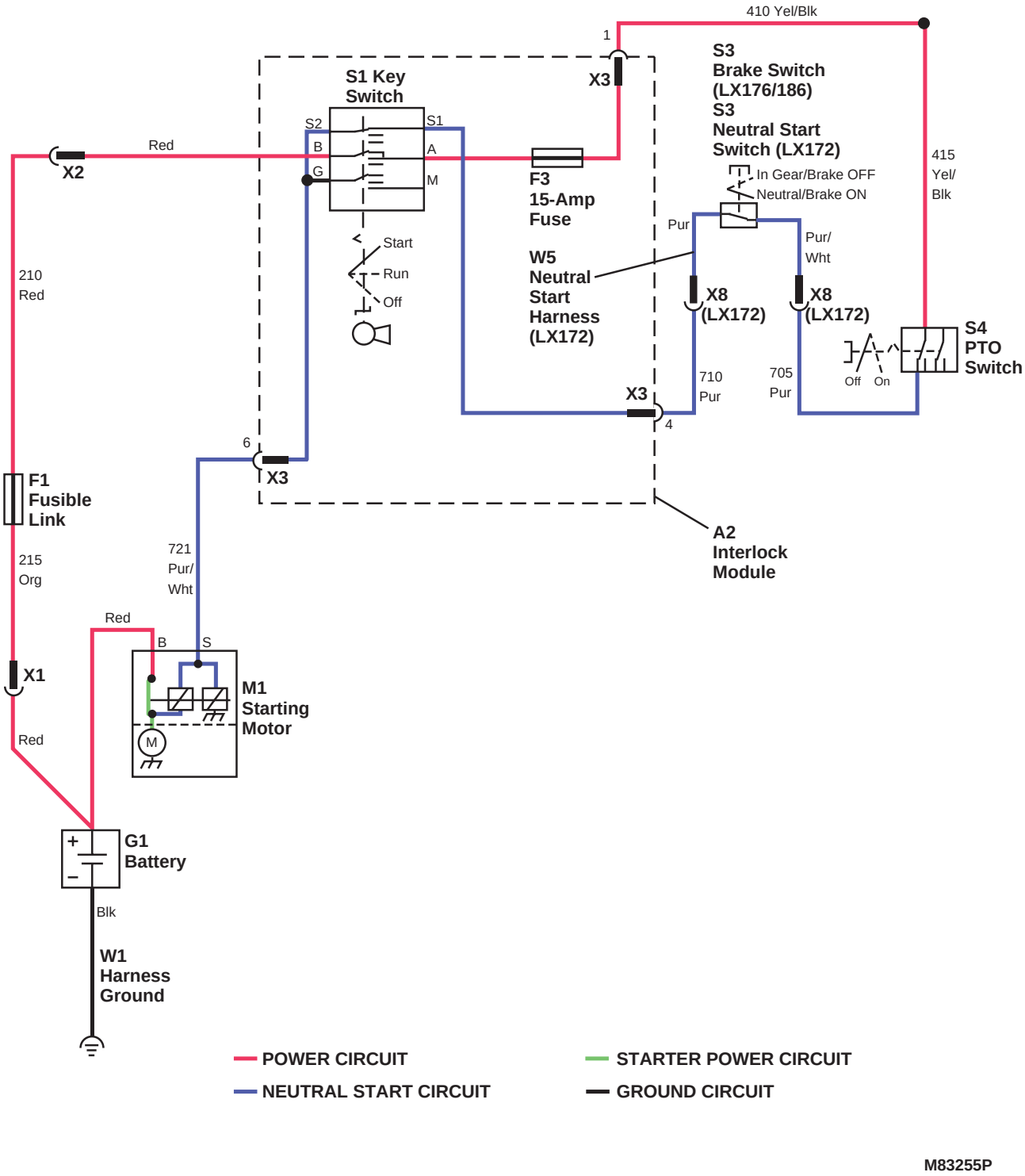
The PTO switch is used in the neutral start circuit to prevent the engine from cranking if the PTO is engaged. With the PTO switch closed (PTO disengaged), current flows to the neutral start/brake switch (S3).

The neutral start/brake switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral (LX172) or by the brake actuator linkage when the parking brake is engaged (transmission is automatically shifted into NEUTRAL) (LX176 and LX186). The neutral start/brake switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

With the neutral start/brake switch closed, current flows to the key switch S1-S2 terminals and starter solenoid, engaging the solenoid. The solenoid is engaged by current flowing through both pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in windings stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

CRANKING CIRCUIT OPERATION



M83255P

CRANKING CIRCUIT DIAGNOSIS

Test Conditions:

- Key Switch in STOP position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid bolt—battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.

Test Conditions:

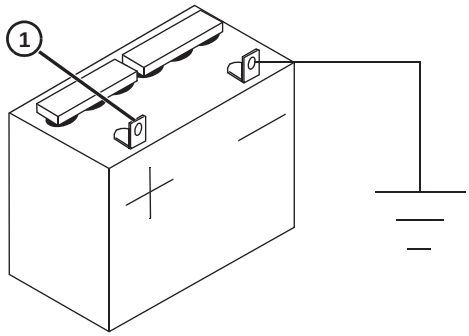
- Key switch in RUN position—engine not running.

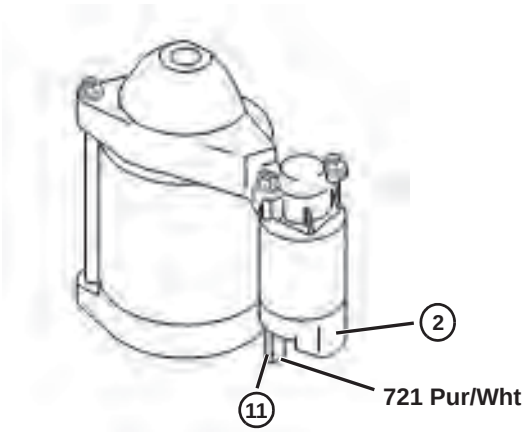
Test/Check Point	Normal	If Not Normal
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
5. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415 and connections.
6. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Neutral start/brake switch.	Battery voltage.	Test purple wire No. 705 or purple/white wire—W5 harness.
8. Neutral start/brake switch.	Battery voltage.	Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710 or purple wire—W5 harness and connections.

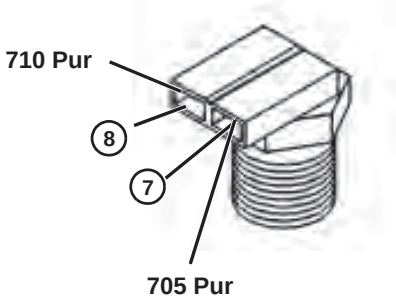
Test Conditions:

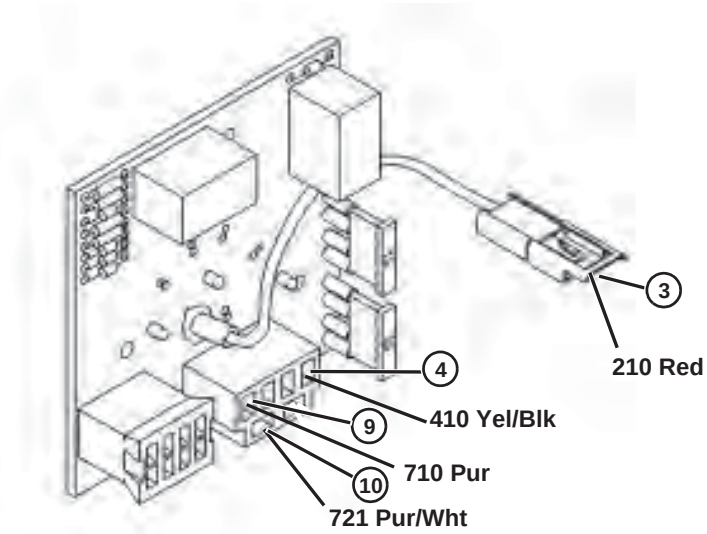
- Spark plug lead disconnected and grounded.
- Key switch in START positon.

Test/Check Point	Normal	If Not Normal
10. Interlock module—terminal X3—6.	Battery voltage.	Replace interlock module.
11. Starter solenoid.	Battery voltage.	Check purple/white wire No. 721 and connections.



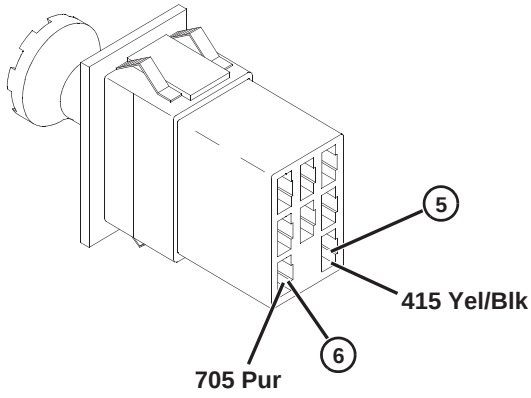




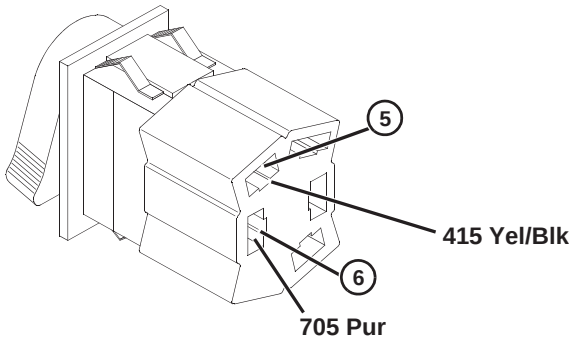


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



S4 PTO Switch (Late Model)



S4 PTO Switch (Early Model)

IGNITION CIRCUIT OPERATION—EARLY MODEL

Function:

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

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).

System Operation:

NOTE: LX172 tractors use a manual shift transaxle and neutral start switch. LX176 and LX186 Tractors use a hydrostatic transaxle and brake switch. System operation is identical.

The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness. The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the ignition module (A1) and is not adjustable. The engine is shut off by grounding the ignition coil through the key switch (terminals M and G) and the ignition relay (K1). The ignition coil is grounded (spark stopped) if the operator gets off the seat with the PTO or transmission engaged.

The ignition relay (K1) when energized by the neutral start circuit or seat switch circuit, eliminates a path to ground, therefore a spark cannot be produced. The power circuit provides current to the key switch (S1) and protects the ignition circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch (S1) in the START or RUN position, current flows to the 15-amp fuse, ignition relay, seat switch (S2) and PTO) switch (S4).

The PTO switch is also used in the neutral start circuit to prevent the engine from starting if the PTO is engaged. With the PTO switch in the OFF position, current flows to the neutral start/brake switch (S3).

The neutral start/brake switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral (LX172) or by the brake actuator linkage when the parking brake is engaged (transmission is automatically shifted into NEUTRAL) (LX176 and LX186). The neutral start/brake switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

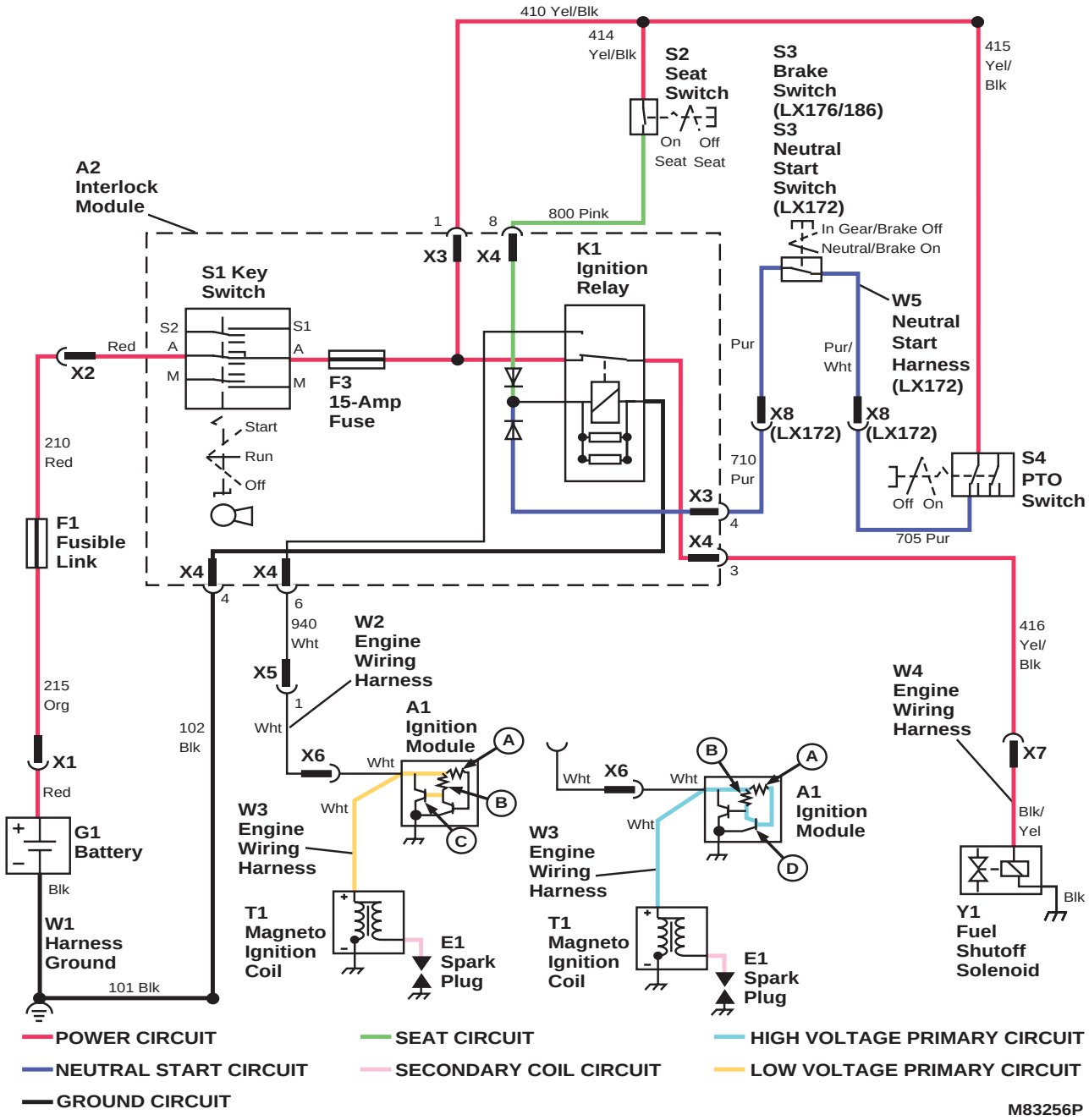
With the neutral start/brake switch closed, current flows to the ignition relay energizing the coil, closing the relay. Closing the relay breaks the path to ground for the ignition coil current and sends current to the fuel shutoff solenoid (Y1). An alternate current path is provided to keep ignition relay energized when the PTO is engaged, the transmission is engaged, or the brake pedal is not depressed. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil keeping the relay energized.

As the flywheel turns, a magnet in the flywheel starts to align with the ignition coil and produces current in the primary coil by electromagnetic induction. In the initial stage low voltage current is produced. The low voltage current flows to a transistor (C), and resistors (A and B) in the ignition module (A1). Resistor (A) has high resistance so current will flow through resistor (B) to transistor (C). The transistor base is energized which closes the transistor and provides a path to ground for ignition coil current flow.

In the spark stage (spark produced), the flywheel magnet is fully aligned with the ignition coil and high voltage (maximum) current is induced in the primary coil. The high voltage current can now flow through resistor (A) to transistor (D). The transistor base is energized which closes the transistor and provides a path to ground for current that was flowing to transistor base. With current no longer applied to transistor base, the transistor opens breaking the path to ground. The sudden reduction of current flow, induces high voltage current in the secondary coil. The high voltage current flows through the coil wire to the spark plug (E1). The voltage is now high enough to jump the spark plug gap and a spark is produced, igniting the fuel/air mixture in the cylinder.

NOTE: Late model engines incorporate an integrated Ignition Module (A1). This module can not be used on earlier engines.

IGNITION CIRCUIT OPERATION



IGNITION CIRCUIT OPERATION—LATE MODEL

Function:

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

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).

System Operation:

NOTE: LX172 tractors use a manual shift transaxle and neutral start switch. LX176 and LX186 Tractors use a hydrostatic transaxle and brake switch. System operation is identical.

The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The ignition system is a transistor-controlled magneto design. Ignition timing is controlled by the ignition module (A1) and is not adjustable. The engine is shut off by grounding the ignition coil through the key switch (terminals M and G) and the ignition relay (K1). The ignition coil is grounded (spark stopped) if the operator gets off the seat with the PTO or transmission engaged.

The ignition relay (K1) when energized by the neutral start circuit or seat switch circuit, eliminates a path to ground, therefore a spark cannot be produced. The power circuit provides current to the key switch (S1) and protects the ignition circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch (S1) in the START or RUN position, current flows to the 15-amp fuse, ignition relay, seat switch (S2) and PTO switch (S4).

The PTO switch is also used in the neutral start circuit to prevent the engine from starting if the PTO is engaged. With the PTO switch in the OFF position, current flows to the neutral start/brake switch (S3).

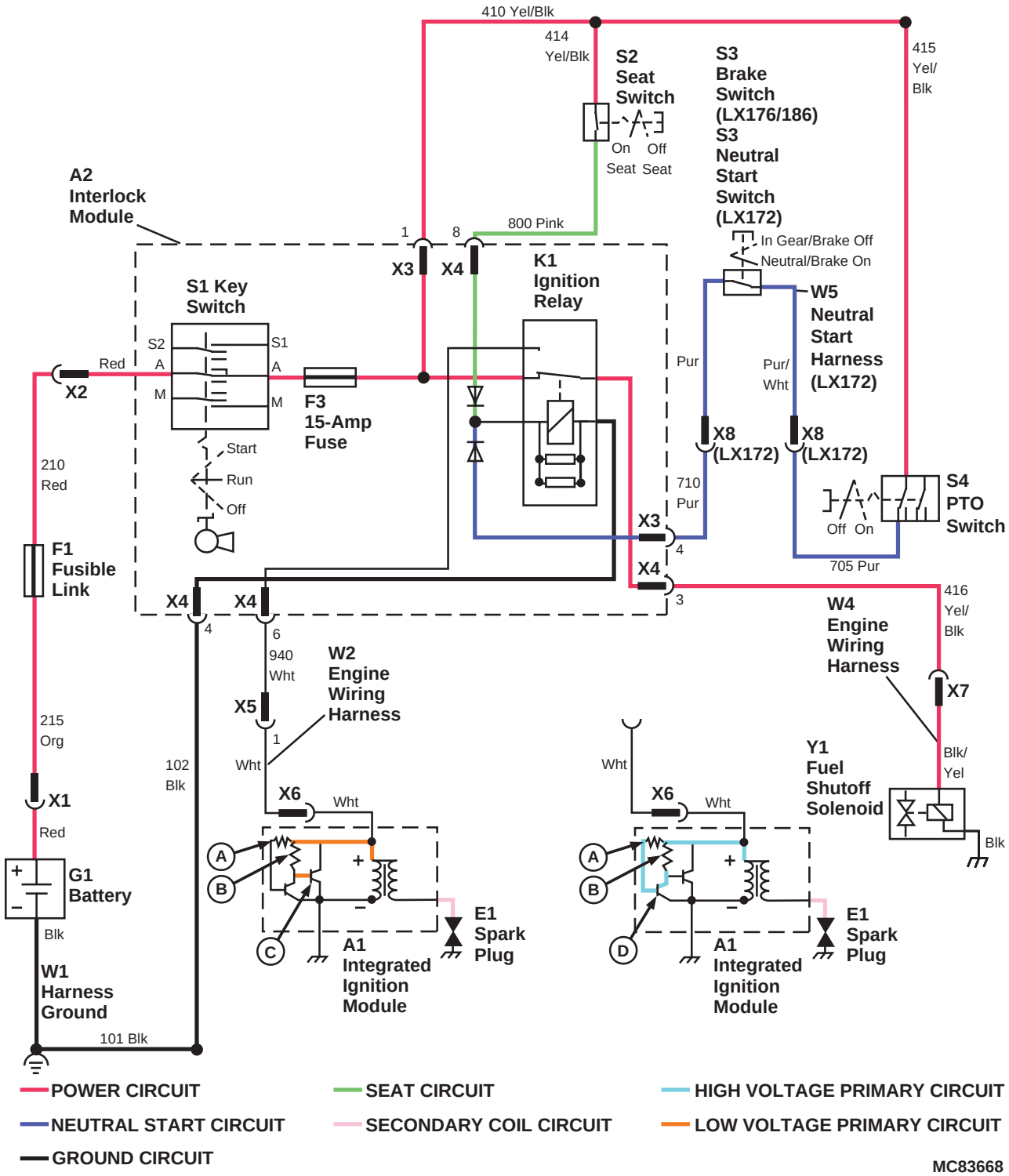
The neutral start/brake switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral (LX172) or by the brake actuator linkage when the parking brake is engaged (transmission is automatically shifted into NEUTRAL) (LX176 and LX186). The neutral start/brake switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged.

With the neutral start/brake switch closed, current flows to the ignition relay energizing the coil, closing the relay. Closing the relay breaks the path to ground for the ignition coil current and sends current to the fuel shutoff solenoid (Y1). An alternate current path is provided to keep ignition relay energized when the PTO is engaged, the transmission is engaged, or the brake pedal is not depressed. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil keeping the relay energized.

As the flywheel turns, a magnet in the flywheel starts to align with the ignition coil and produces current in the primary coil by electromagnetic induction. In the initial stage low voltage current is produced. The low voltage current flows to a transistor (C), and resistors (A and B) in the ignition module (A1). Resistor (A) has high resistance so current will flow through resistor (B) to transistor (C). The transistor base is energized which closes the transistor and provides a path to ground for ignition coil current flow.

In the spark stage (spark produced), the flywheel magnet is fully aligned with the ignition coil and high voltage (maximum) current is induced in the primary coil. The high voltage current can now flow through resistor (A) to transistor (D). The transistor base is energized which closes the transistor and provides a path to ground for current that was flowing to transistor base. With current no longer applied to transistor base, the transistor opens breaking the path to ground. The sudden reduction of current flow, induces high voltage current in the secondary coil. The high voltage current flows through the coil wire to the spark plug (E1). The voltage is now high enough to jump the spark plug gap and a spark is produced, igniting the fuel/air mixture in the cylinder.

IGNITION CIRCUIT OPERATION



IGNITION CIRCUIT OPERATION—ENGINE SHUTTING OFF

Function:

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

Operating Conditions:

- Key switch in STOP position.

  or

- Operator off seat with PTO engaged.

  or

- Operator off seat with transmission engaged (LX172) or brake released (LX176/LX186).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

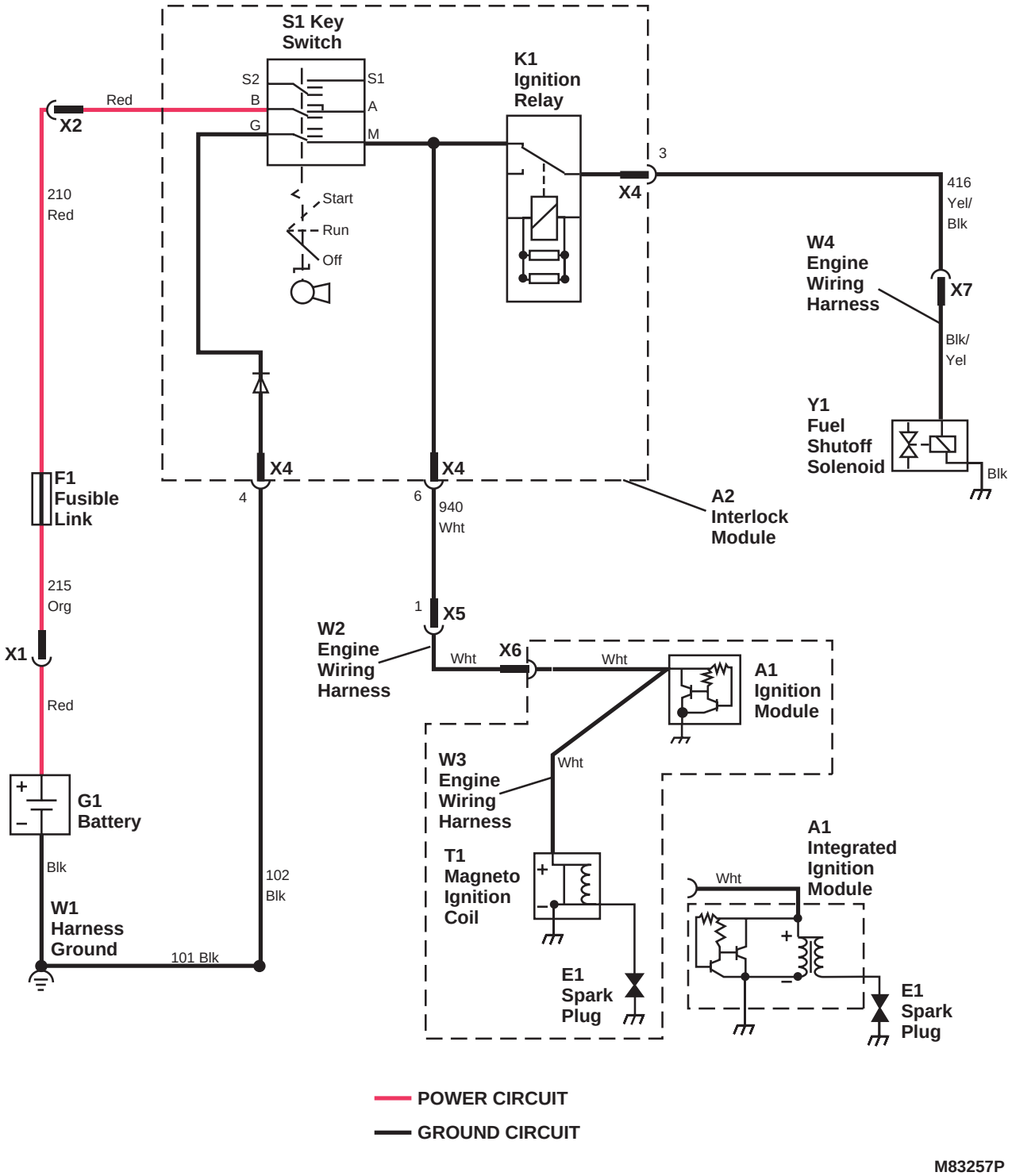
When the key switch (S1) is turned to the STOP position, a path to ground through key switch terminals M and G is provided for the magneto ignition coil (T1) current. At the same time, the power circuit current flow is stopped at the key switch. The low voltage current produced in the primary coil of the ignition coil flows to the ignition module (A1) and key switch. It is easier for low voltage current to flow to the key switch, and then through the diode to ground, than to flow through the ignition module transistors. Since no voltage is induced in the secondary coil, no spark occurs and the engine stops.

A second path to ground is provided for the ignition coil current through the ignition relay (K1) terminals. The ignition relay coil is energized by current from the seat switch or neutral start circuit. If the operator gets off the seat (seat switch opens) with the PTO engaged or with the transmission engaged/brake released, current flow to the ignition relay coil is stopped. The low voltage current produced in the primary coil of the magneto ignition coil flows to the ignition module (A1) and ignition relay terminal. The ignition relay coil de-energizes and grounds ignition coil current through the ignition relay terminals and fuel shutoff solenoid.

Whenever the ignition relay is de-energized, the fuel shutoff solenoid is also de-energized and fuel flow to the carburetor is stopped.

NOTE: Late model engines incorporate an integrated Ignition Module (A1). This module can not be used on earlier engines.

IGNITION CIRCUIT OPERATION - ENGINE SHUTTING OFF



M83257P

IGNITION CIRCUIT DIAGNOSIS

When diagnosing an ignition problem, isolate the magneto circuit from the ground circuit by separating the engine connector (X5). If the engine will not start, check the magneto circuit first and then the ground circuit. If the engine will not shut off, check the ground circuit first. Remember the engine is stopped by grounding the ignition coil through either key switch or ignition relay. The ignition relay must be energized to prevent the ignition coil from being grounded.

Test Conditions:

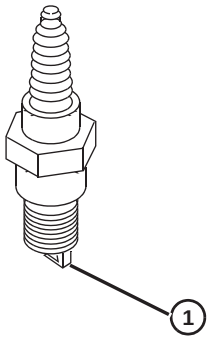
- Key switch in START position.
- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).
- Engine connector (X5) DISCONNECTED.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

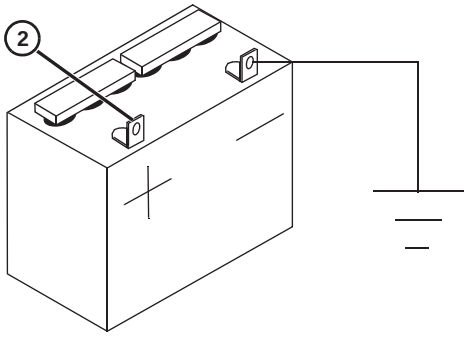
Test/Check Point	Normal	If Not Normal
1. Spark plug/spark tester. (Perform SPARK TEST on page 3-38.)	Spark test indicates hot blue spark.	No spark present: Test ignition coil and ignition module. Check armature air gap, and flywheel magnets. Spark present: Check spark plug gap and condition of spark plug. If plug is good, continue testing ground circuit.

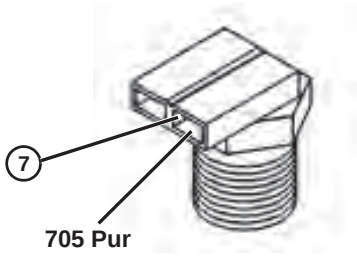
Test Conditions:

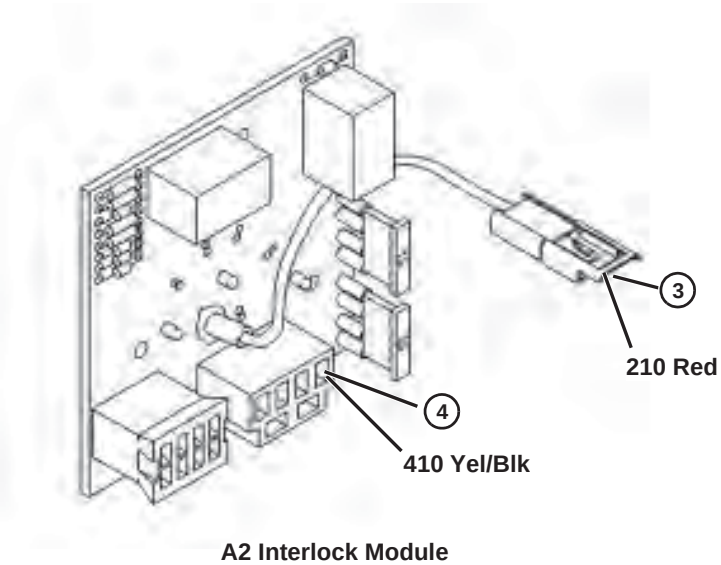
- Key switch in RUN position—engine not running.
- Engine connector (X5) CONNECTED.
- Operator on seat. (Seat switch CLOSED.)

Test/Check Point	Normal	If Not Normal
2. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
5. PTO switch.	Battery voltage.	Check yellow/black wires No. 415 and 410 and connections.
6. PTO Switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Neutral start/brake switch.	Battery voltage.	Check purple wire No. 705 or W5 harness—purple/white wire and connections. Neutral start/brake switch—710 purple wire or W5 harness purple wire terminal. Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)



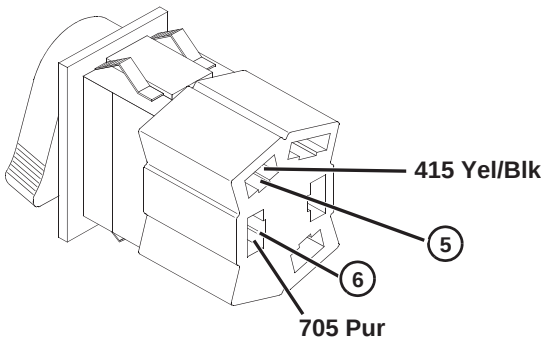




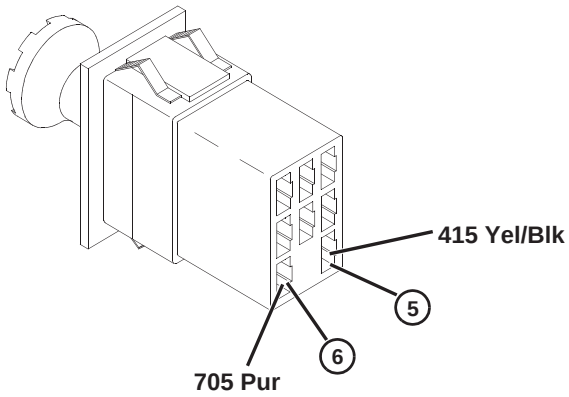


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



S4 PTO Switch (Early Model)



S4 PTO Switch (Late Model)

IGNITION CIRCUIT DIAGNOSIS, continued

Test Conditions:

- Key switch in RUN position—engine not running.
- Engine connector (X5) CONNECTED.
- Operator on seat. (Seat switch CLOSED).

Test/Check Point	Normal	If Not Normal
8. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710, W5 harness and connections.
9. Seat switch.	Battery voltage.	Check yellow/black wires No. 414 and 410 and connections.
10. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
11. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.
12. Interlock module—terminal X4—3.	Battery voltage.	Replace interlock module.

Test Conditions:

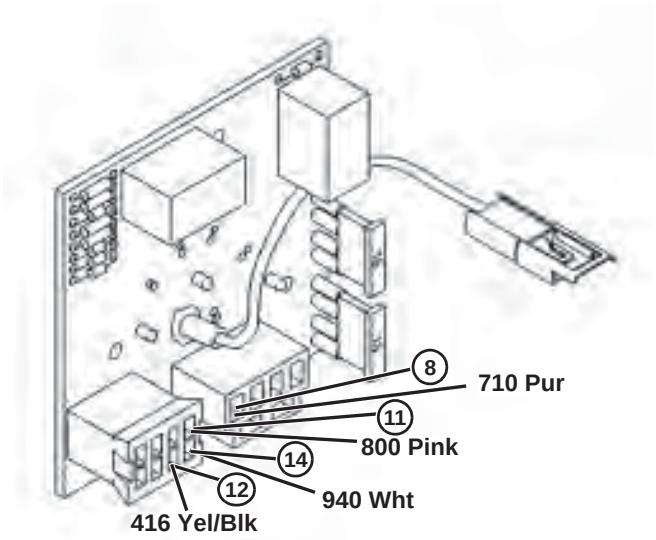
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
13. Engine ground.	Maximum 0.1 ohms resistance.	Check battery negative cable and shielded ground connections.
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check black wires No. 101 and 102 and harness to engine ground connection.
15. Ignition module.	Maximum 0.1 ohms resistance.	Check ignition module-to-engine connection. Replace ignition module.

Test Conditions:

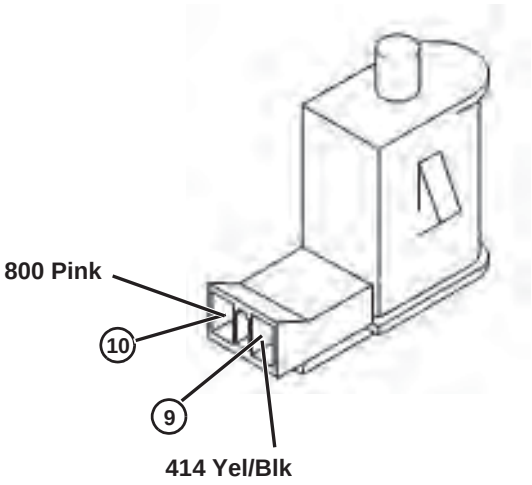
- Key switch in RUN position—engine not running.

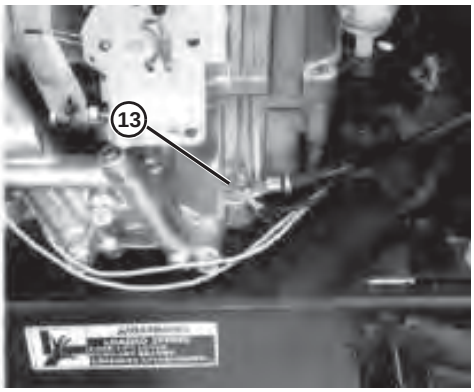
Test/Check Point	Normal	If Not Normal
16. Ignition module.	Battery voltage.	Check white wires and connections, if OK, replace ignition module.
17. Ignition module—replace with a known good module.	Spark produced.	Replace ignition module. Check flywheel air gap and magnet.

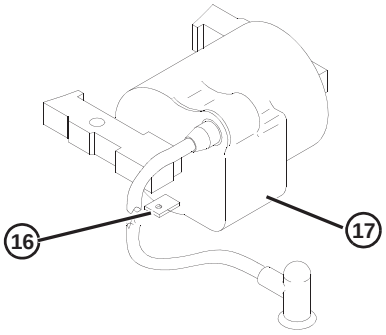


A2 Interlock Module

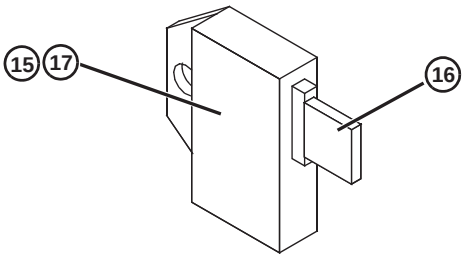
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.







A1 Integrated Ignition Module



A1 Ignition Module

CHARGING CIRCUIT OPERATION

Function:

To maintain battery voltage between 11.8 and 13.2 volts DC.

Operating Conditions:

- Key switch in RUN position.
- Engine running.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The charging system is a permanent magnet and stator design. Charging output is controlled by a regulator/rectifier. A battery discharge light warns the operator if the stator stops charging. The battery discharge light circuit monitors stator output, not battery voltage.

The power/battery charging circuit provides current to the key switch (S1) and protects the charging circuit with a fusible link (F1). With the key switch in the RUN position, current flows from battery (G1) positive (+) terminal to fusible link, key switch, 15-amp fuse (F3), and regulator/rectifier (N1). The voltage sensing circuit allows the regulator/rectifier to monitor battery voltage.

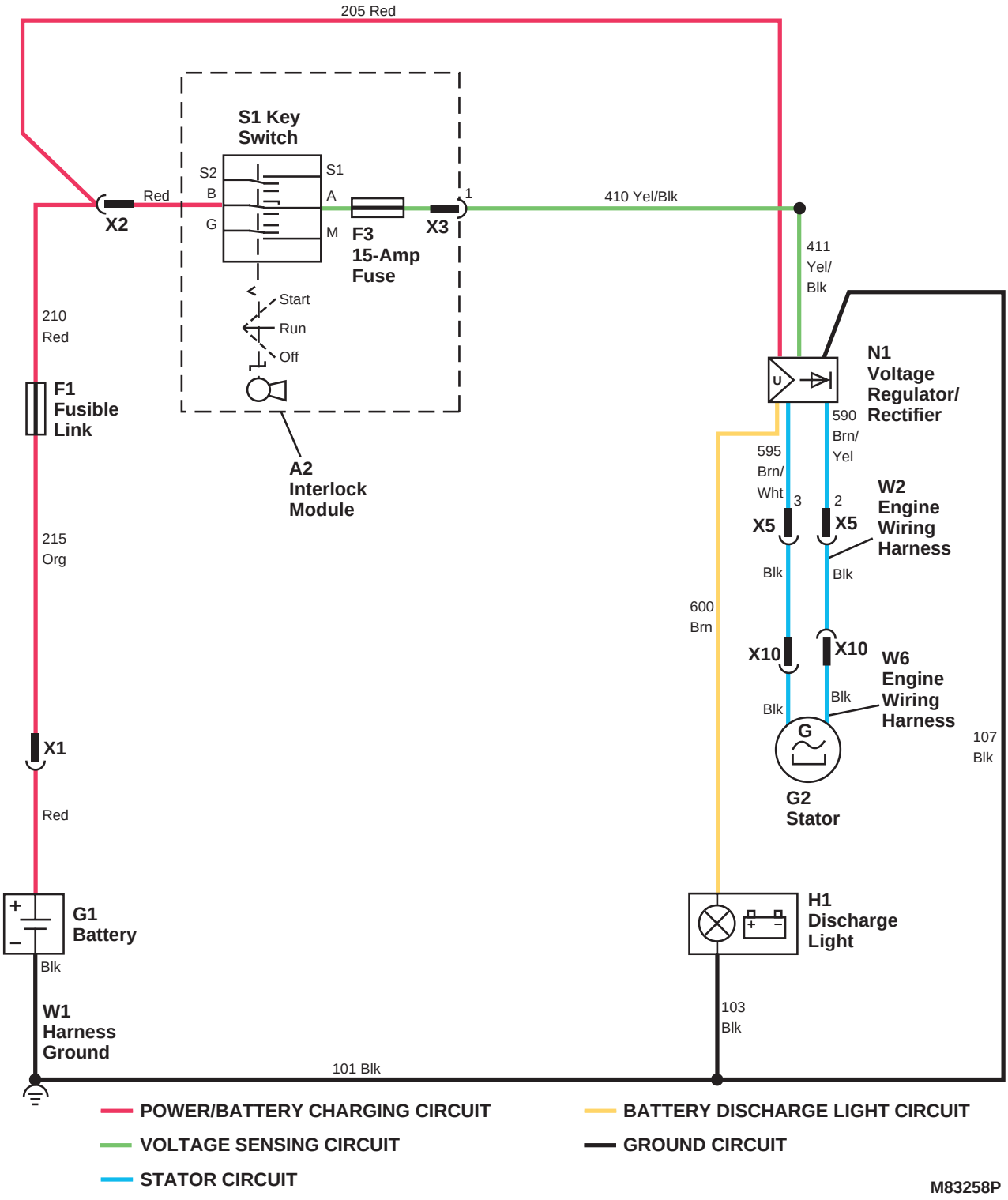
As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the regulator/rectifier. The regulator/rectifier converts the AC current to DC current needed to charge the battery.

If the battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the power/battery charging circuit. When the battery is fully charged, the regulator stops current flow to the battery.

If stator output current to the regulator/rectifier stops, the regulator/rectifier provides current to the battery discharge light (H1) to illuminate the light.

The ground circuit provides a path to ground for the regulator/rectifier.

CHARGING CIRCUIT OPERATION



CHARGING CIRCUIT DIAGNOSIS

- Key switch in STOP position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
18. Battery positive (+) terminal.	1.11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
19. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
20. Voltage regulator/rectifier.	Battery voltage.	Check red wire No. 205, and connections.
21. Voltage regulator/rectifier.	Maximum 0.1 ohms resistance.	Check battery negative cable, shielded ground, black wires No. 101 and 102.
22. Discharge light.	Maximum 0.1 ohms resistance.	Check black wires No. 101 and 103.

Test Conditions:

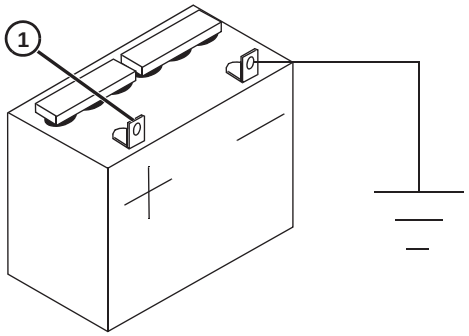
- Key switch in RUN position—engine not running.

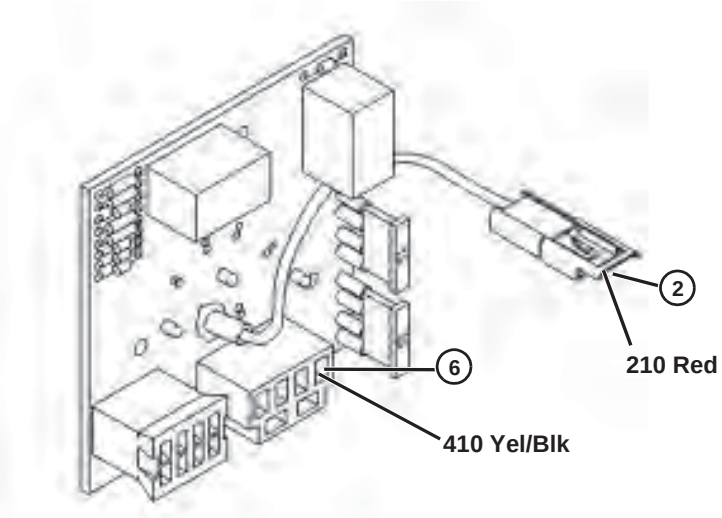
Test/Check Point	Normal	If Not Normal
23. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
24. Voltage regulator/rectifier.	Battery voltage.	Check brown wire No. 600 and connections. If OK, replace voltage regulator/rectifier.
25. Voltage regulator/rectifier.	Battery voltage.	Check yellow/black wires No. 410 and 411 and connections.
26. Discharge light.	Battery voltage.	Check brown wire No. 600 and connections. If OK, replace discharge light.

Test Conditions:

- Key switch in RUN position—engine running.

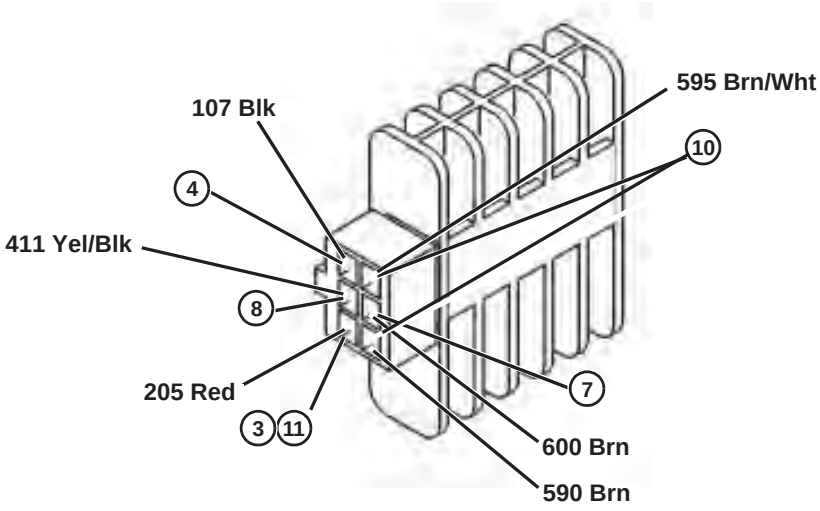
Test/Check Point	Normal	If Not Normal
27. Stator connector—perform UNREGULATED VOLTAGE OUTPUT TEST on page 5-181.	Voltage output to specifications.	Check brown/white wire No. 595, brown/yellow wire No. 590 and black wires. If OK, replace voltage regulator/rectifier.
28. Voltage regulator/rectifier—perform REGULATED AMPERAGE OUTPUT TEST on page 5-179.	Regulated amperage to specification.	Perform UNREGULATED VOLTAGE OUTPUT TEST on page 5-181.

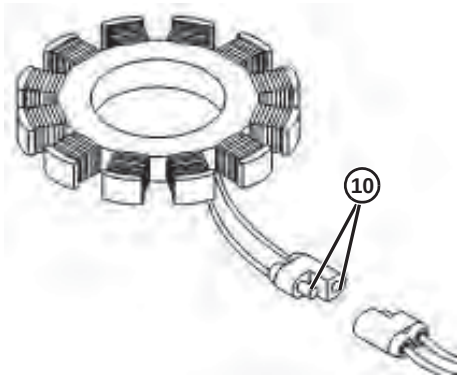


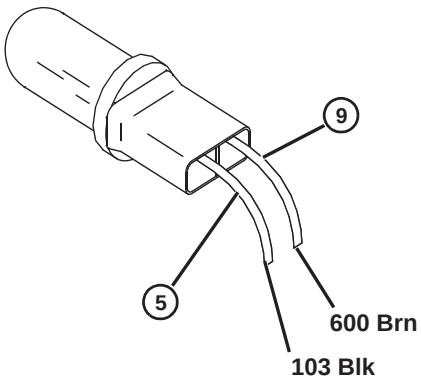


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.







PTO CIRCUIT OPERATION—PTO OFF

Function:

To provide power to energize the PTO relay and clutch.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in OFF position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The PTO circuit uses a seat switch (S2), ignition relay (K1), and PTO relay (K2) to stop current flow to the PTO clutch (Y2) if the operator gets off the seat with the PTO engaged.

The power circuit provides current to the key switch (S1) and protects the PTO circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the RUN position, current flows to the ignition relay (K1), seat switch (S2) and PTO switch (S4). Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay can come from the neutral start or seat circuits and energizing current for the PTO relay must come from the PTO switch.

The PTO switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO switch is in the ON position. With the PTO switch OFF (PTO disengaged), current (Neutral Start Circuit) flows to the PTO relay coil energizing the relay. The PTO relay now has continuity across the relay.

The PTO switch is also used in the neutral start circuit to prevent the ignition relay from energizing if the PTO is engaged with the operator off the seat. With the PTO switch closed (PTO disengaged), current flows to the neutral start/brake switch (S3).

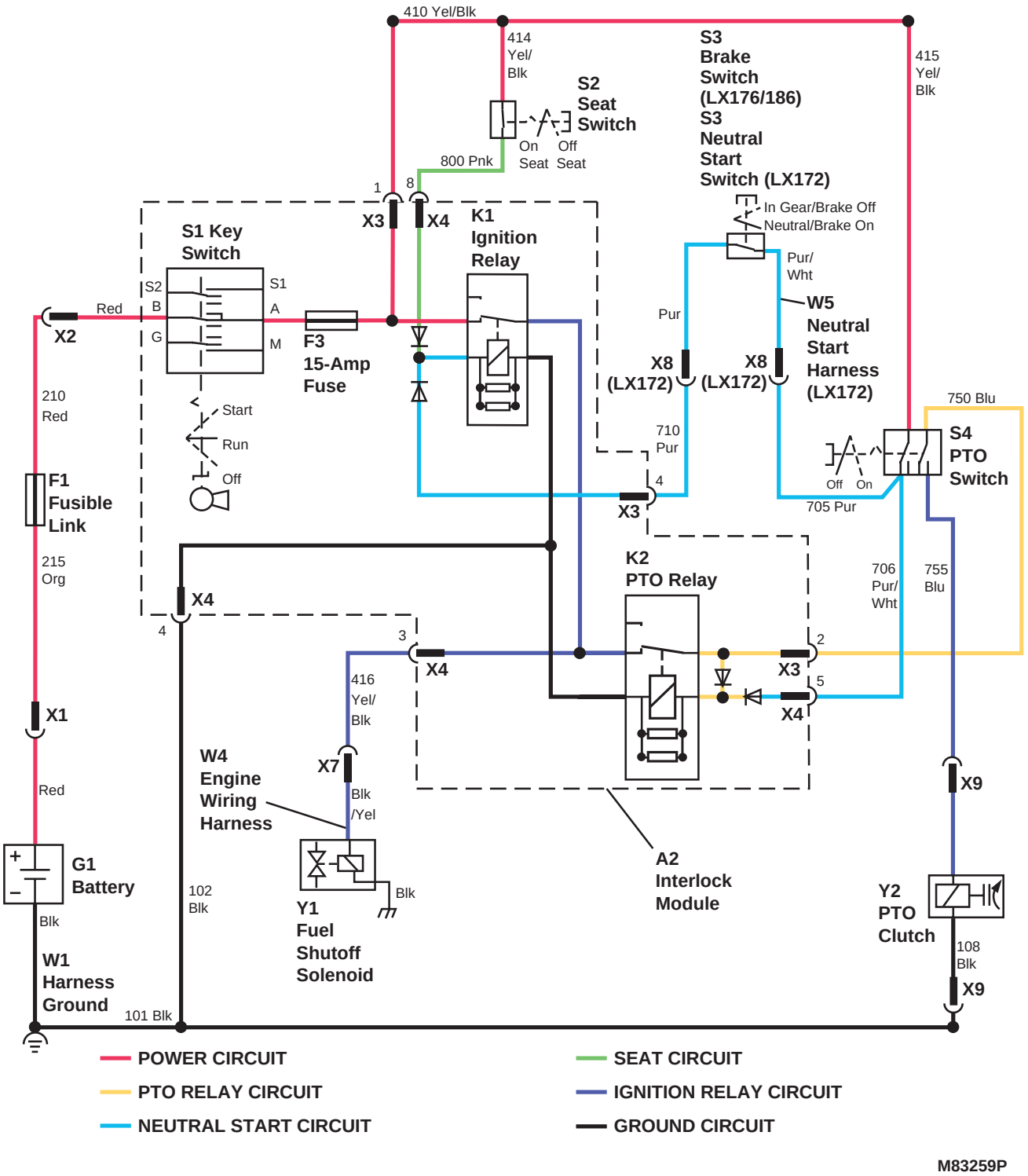
The neutral start/brake switch is located on the top of the transaxle and is activated by the shift actuator linkage as the transmission is placed in neutral (LX172) or by the brake actuator linkage when the parking brake is engaged (transmission is automatically shifted into NEUTRAL) (LX176 and LX186). The neutral start/brake switch is used in the neutral start circuit to prevent the engine from cranking if the transmission is engaged with the operator off the seat.

With the neutral start/brake switch closed, current (Neutral Start Circuit) flows to the ignition relay coil energizing the coil, closing the relay. Closing the relay sends ignition relay current to the PTO relay (Ignition Relay Circuit). PTO relay circuit current flows to the PTO switch and is available to operate the PTO clutch when the PTO switch is turned ON.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged and the transmission is engaged. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil, keeping the relay energized.

The ground circuit provides a path to ground for the PTO and ignition relay coils.

PTO CIRCUIT OPERATION – PTO OFF



M83259P

PTO CIRCUIT OPERATION—PTO ON

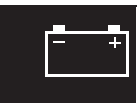
Function:

To provide power to energize or de-energize the PTO clutch when desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in ON position.
- Operator on seat. (Seat switch CLOSED.)

System Operation:



NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

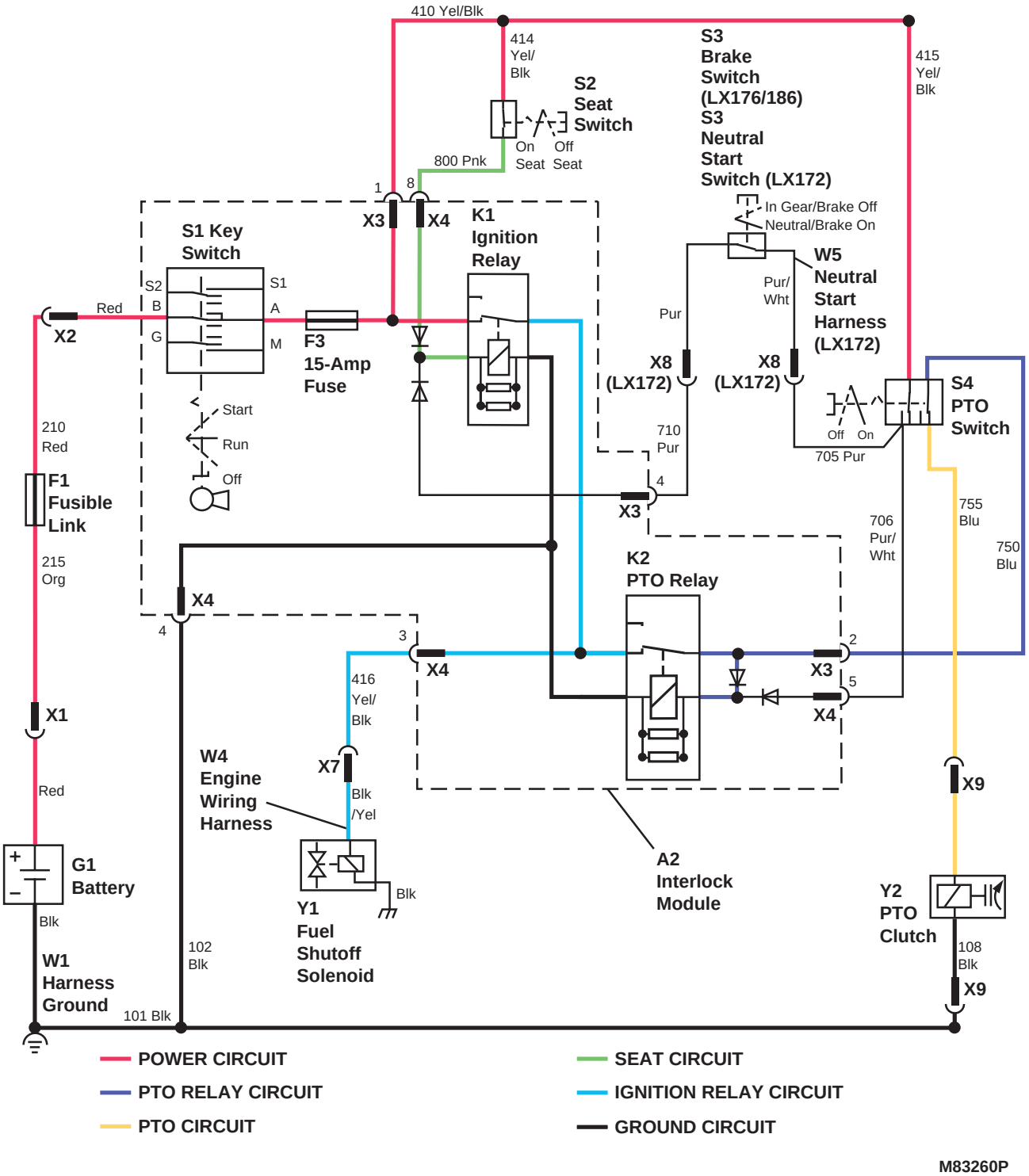
The PTO circuit uses a seat switch (S2), ignition relay (K1), and PTO relay (K2) to stop current flow to the PTO clutch (Y2) if the operator gets off the seat with the PTO engaged.

With the key switch (S1) in the RUN position and the PTO circuit energized, current flows to the PTO switch (S4) and is available to operate the PTO clutch when the PTO switch is moved to the ON position. When the PTO switch is moved to the ON position, current flows through the PTO switch (PTO Circuit) and energizes the PTO clutch. An alternate path for the PTO relay energizing current must be provided when the PTO switch is ON. With the PTO switch ON, the flow of current stops from the PTO switch to the PTO relay coil (PTO Relay Circuit). Since the PTO relay is already closed, the PTO relay coil receives energizing current from the Ignition Relay Circuit. Current flows across the PTO relay (contacts), keeping the relay energized.

With the PTO switch ON, current flow to the neutral start/brake switch is stopped, so the seat circuit must keep the ignition relay energized. If the operator gets off the seat with the PTO switch ON, the seat switch (S2) de-energizes the ignition and PTO relays, which stops current flow to the PTO clutch.

The ground circuit provides a path to ground for the ignition and PTO relay coils and PTO clutch.

PTO CIRCUIT OPERATION – PTO ON

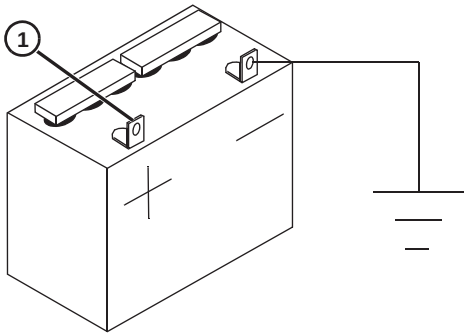


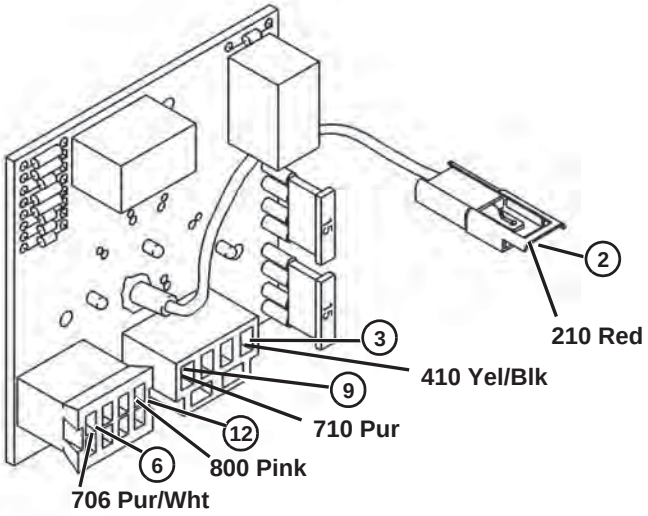
PTO CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).
- Operator on seat. (Seat switch CLOSED.)
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

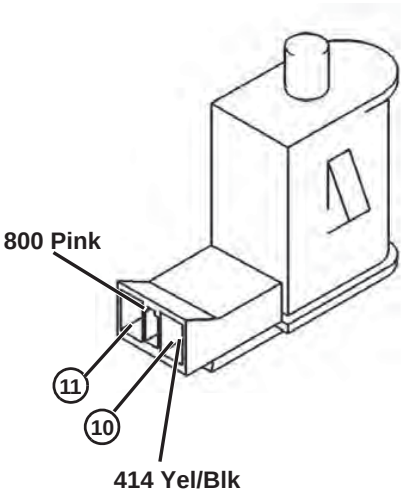
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Interlock module—terminal X4—5.	Battery voltage.	Check purple/white wire No. 706.
7. Neutral start/brake switch.	Battery voltage.	Test purple wire No. 705 and connections. Check purple/white wire—W5 harness and connections (LX172).
8. Neutral start/brake switch.	Battery voltage.	Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710 and connections.
10. Seat switch.	Battery voltage.	Test yellow/black wires No. 410 and 414.
11. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
12. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.

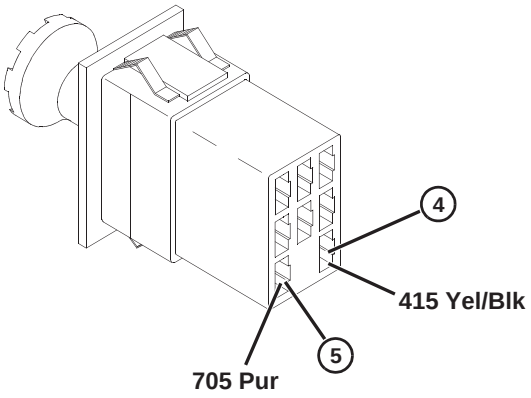




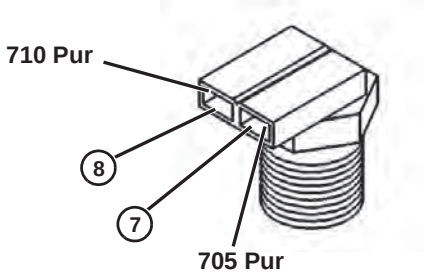
A2 Interlock Module

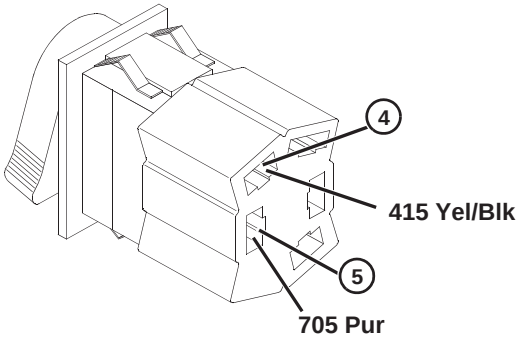
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





S4 PTO Switch (Late Model)





S4 PTO Switch (Early Model)

PTO CIRCUIT DIAGNOSIS, continued

Test Conditions:

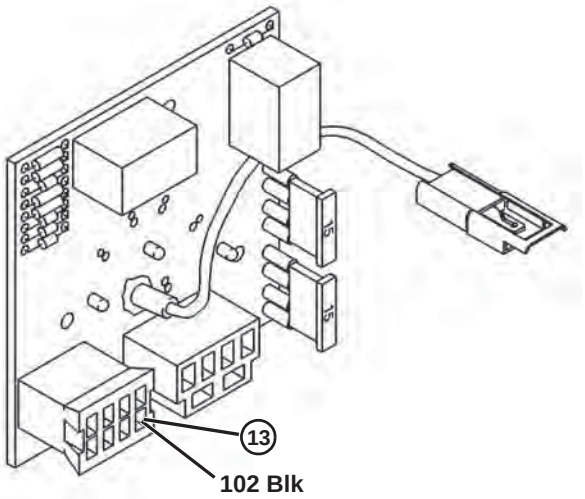
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
13. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check black wires No. 101 and 102 and harness to engine ground connection.

Test Conditions:

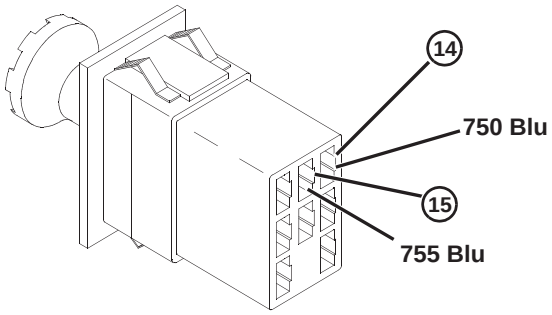
- Key switch in RUN position—engine not running.
- PTO switch in ON position.

Test/Check Point	Normal	If Not Normal
14. PTO switch.	Battery voltage.	Check blue wire No. 750 and connections. If OK, replace interlock module.
15. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
16. PTO clutch.	Battery voltage.	Check blue wire No. 755 and connections.
17. PTO clutch.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts: check PTO clutch ground circuit. 0 volts: test PTO clutch. (See PTO CLUTCH TEST on page 5-189.)
18. PTO clutch.	PTO clutch air gap within specification.	Adjust air gap. (See PTO CLUTCH ADJUSTMENT on page 5-193.)

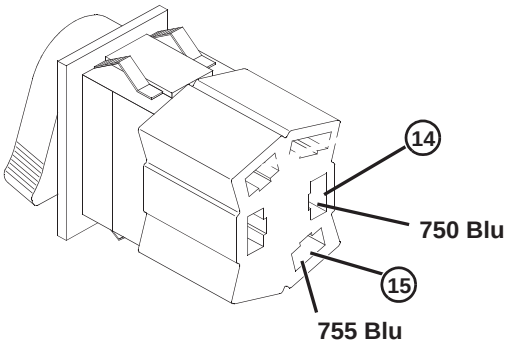


A2 Interlock Module

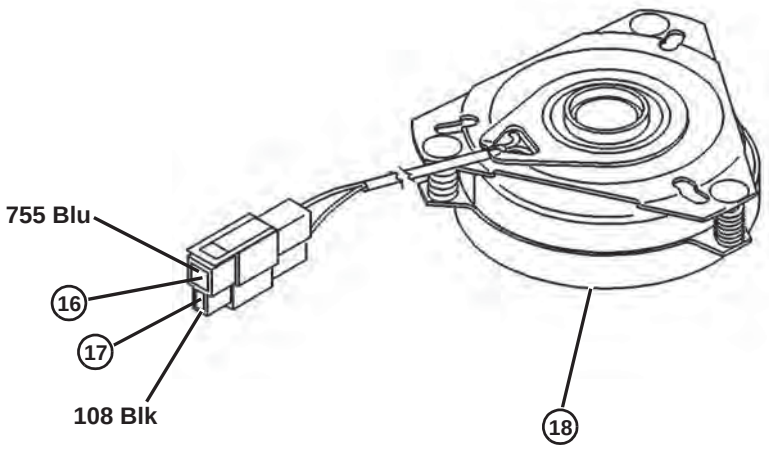
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



S4 PTO Switch (Late Model)



S4 PTO Switch (Early Model)



LOW OIL PRESSURE LIGHT CIRCUIT OPERATION

Function:

To light the low oil pressure light to alert the operator that oil pressure is too low for continued operation.

Operating Conditions:

- Key switch in RUN position.
- Oil pressure switch CLOSED (engine OFF or low oil pressure).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

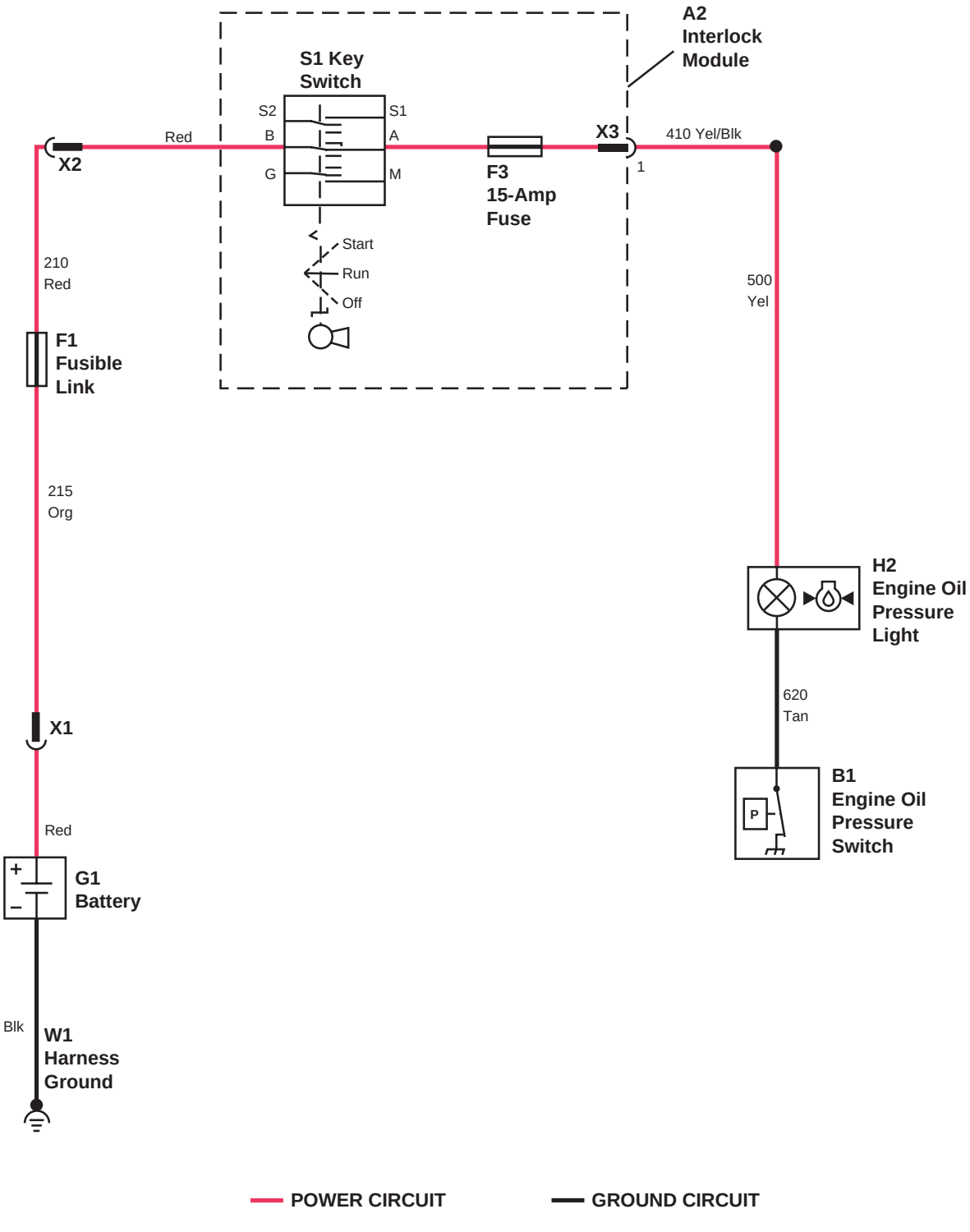
The low oil pressure light system uses a pressure activated switch to provide a path to ground for the oil pressure light. The switch is closed when engine oil pressure is at or below 28 kPa (4 psi).

The power circuit provides current to the key switch (S1) and protects the low oil pressure light circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the RUN position, current flows to the 15-amp fuse (F3) and the oil pressure light (H2).

If the engine is not running or oil pressure is at or below 28 kPa (4 psi), the oil pressure switch (B1) will be closed. The oil pressure switch completes the path to ground and the low oil pressure light comes ON. When the engine starts and oil pressure increases above 28 kPa (4 psi), the oil pressure switch opens, breaking the path to ground and the light goes out.

The ground circuit provides a path to ground through the oil pressure switch, for the oil pressure light.

LOW OIL PRESSURE LIGHT CIRCUIT OPERATION



M83262P

LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- Engine oil pressure switch lead DISCONNECTED.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. Low oil pressure light.	Battery voltage.	Check yellow/black wire No. 410 and yellow wire No. 500.
5. Low oil pressure switch.	Battery voltage.	Check tan wire 620, low oil pressure light and connections.

Test Conditions:

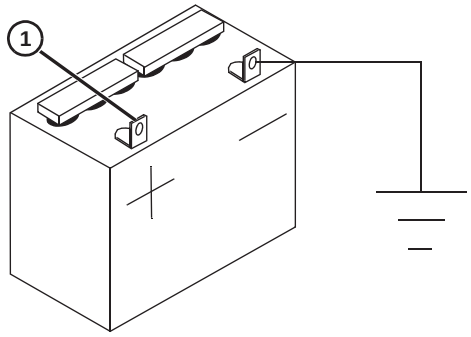
- Key switch in STOP position.

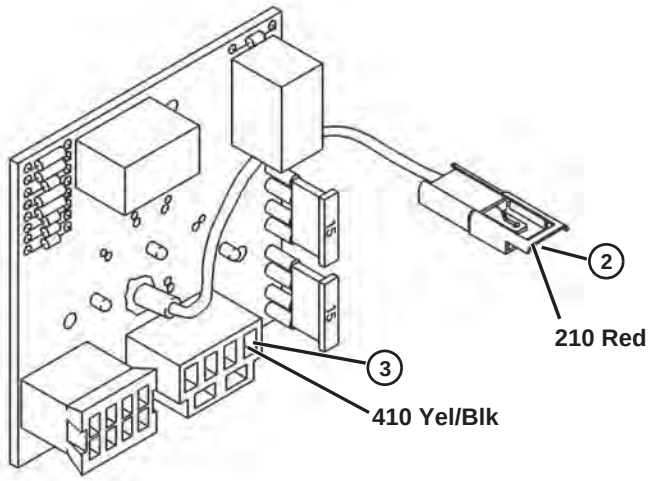
Test/Check Point	Normal	If Not Normal
6. Engine oil pressure switch.	Maximum 0.1 ohms resistance.	Check ground circuit. If OK, replace engine oil pressure switch.

Test Conditions:

- Key switch in RUN position—engine running.

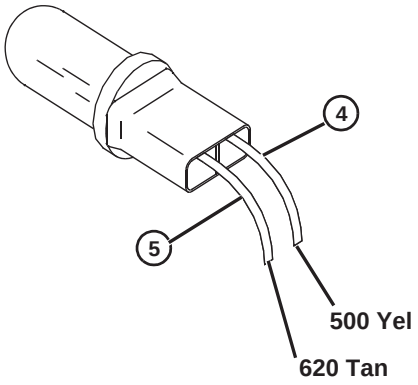
Test/Check Point	Normal	If Not Normal
7. Engine oil pressure switch.	Battery voltage.	Check tan wire No. 620 and connections.
8. Engine oil pressure switch.	No continuity to ground (maximum resistance).	Check engine oil pressure. (See ENGINE OIL PRESSURE TEST on page 3-37.) If OK, replace engine oil pressure switch.

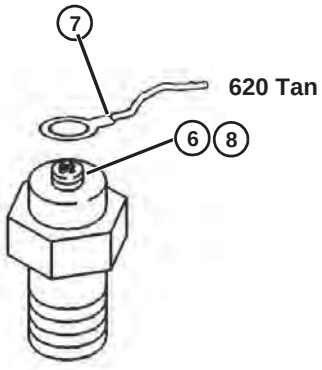




A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





HEADLIGHT CIRCUIT OPERATION

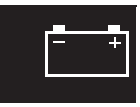
Function:

To provide power to the headlights for illumination if desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- Headlight switch in ON position.

System Operation:

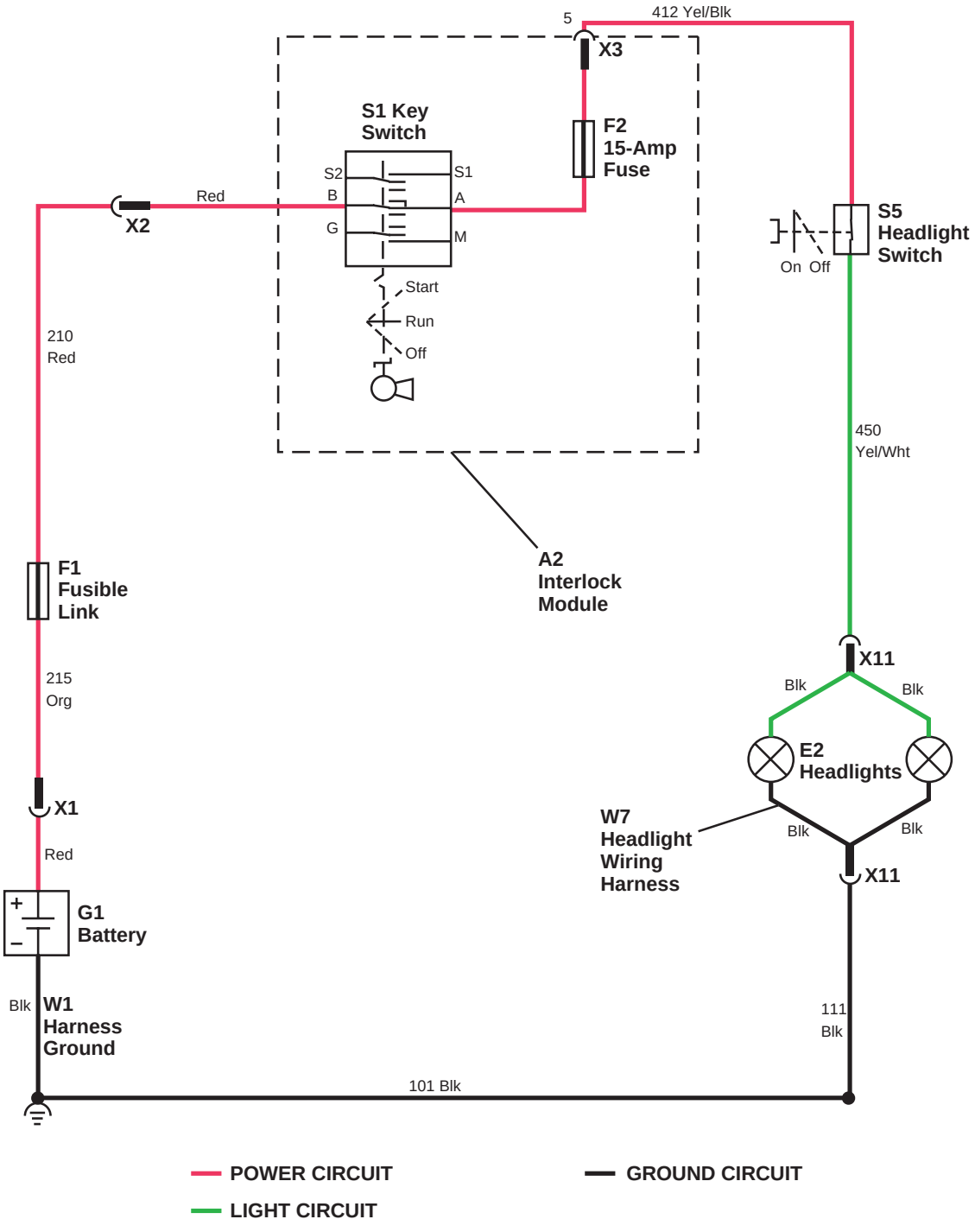


NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The power circuit provides current to the key switch (S1) and protects the circuit with a 15-amp fuse (F2). With the key switch in the RUN position, current flows from the battery (G1) positive (+) terminal to the fusible link (F1), key switch, 15-amp fuse (F2) and headlight switch (S5). With the headlight switch in the ON position, current flows to the headlights (E2) and illuminates the lamps.

The ground circuit provides a path to ground for the headlight.

HEADLIGHT CIRCUIT OPERATION



M83263P

HEADLIGHT CIRCUIT DIAGNOSIS

Test Conditions:

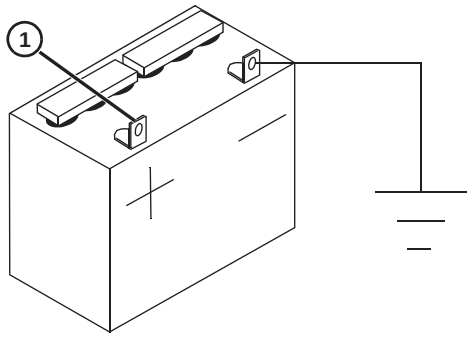
- Key switch in RUN position.
- Headlight switch in ON position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

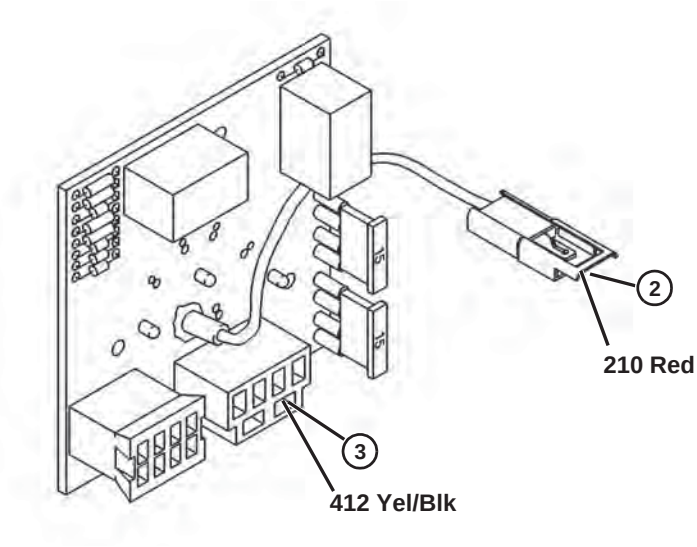
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—5.	Battery voltage.	Check fuse (F2), if OK, replace interlock module.
4. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412.
5. Headlight switch.	Battery voltage.	Test headlight switch. (See HEADLIGHT SWITCH TEST on page 5-190.)
6. Headlight connector.	Battery voltage.	Check yellow/white wire No. 450, black wires (from connector to headlights) and connections.
7. Headlights.	Headlights ON.	Test bulbs.

Test Conditions:

- Key switch in OFF position.

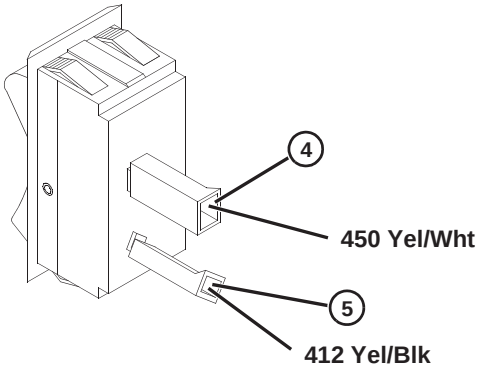
Test/Check Point	Normal	If Not Normal
8. Headlight ground.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground, black wires 101 and 111, black wires (W8 headlight harness) and connections.

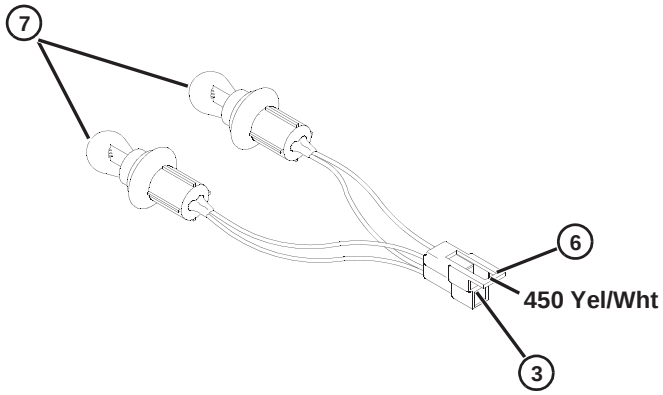




A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





FUEL SHUTOFF SOLENOID CIRCUIT OPERATION

Function:

To energize the fuel shutoff solenoid when the ignition relay is energized.

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).

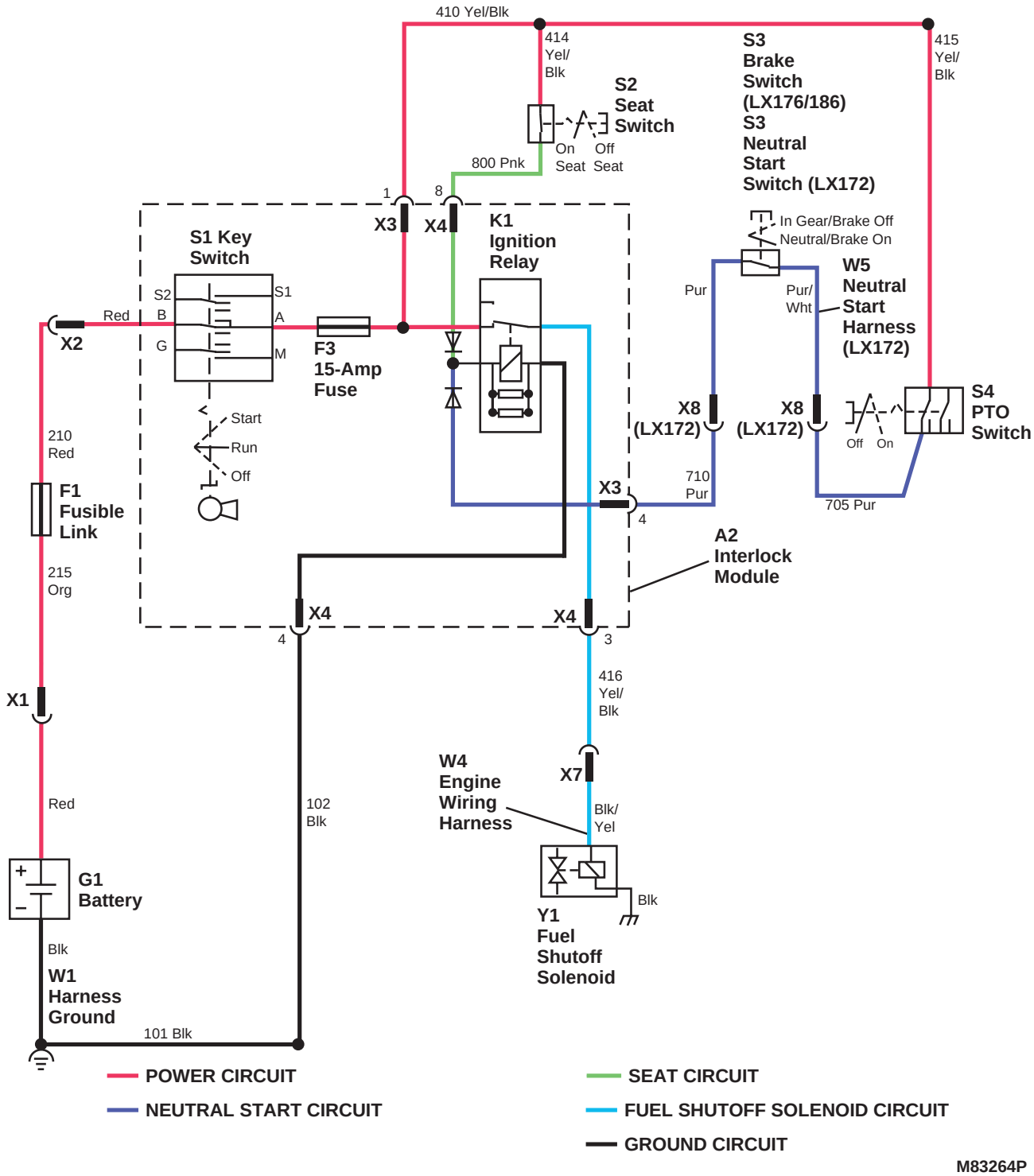
System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The fuel shutoff Solenoid (Y1) uses an electro-magnetic coil to operate a plunger. The fuel shutoff solenoid plunger stops fuel flow in the carburetor bowl when the solenoid is de-energized. The ignition relay (K1) provides power to the fuel shutoff solenoid. When the ignition relay is de-energized, the fuel shutoff solenoid stops fuel flow at the same time the spark is stopped, helping to prevent backfire at engine shutdown.

The power circuit provides current to the key switch (S1), energizes the ignition relay circuit, and protects the fuel shutoff solenoid circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), and key switch. With the key switch in the RUN position, current flows to the 15-amp fuse (F3), ignition relay terminal, seat switch (S2) and PTO switch (S4). Current cannot flow to the fuel shutoff solenoid until the ignition relay is energized. The ignition relay coil is energized by current from the seat switch circuit or neutral start circuit.

FUEL SHUTOFF SOLENOID CIRCUIT OPERATION

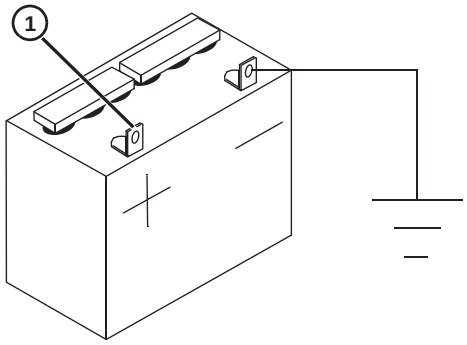


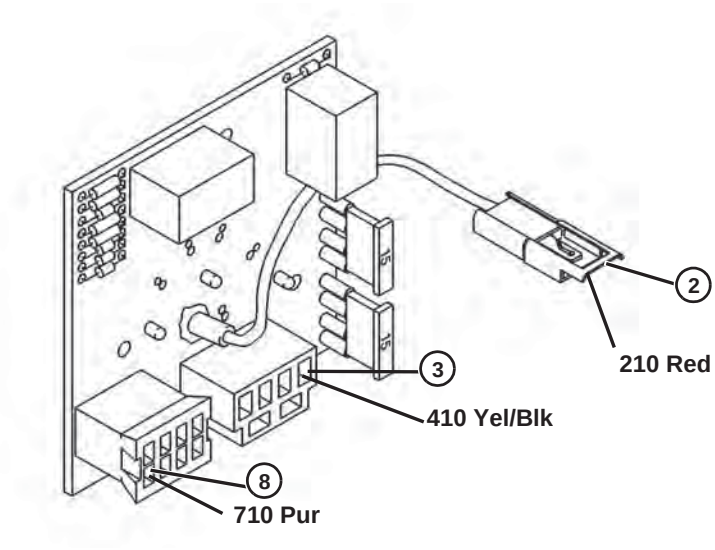
FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).
- Operator on seat. (Seat switch CLOSED.)
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

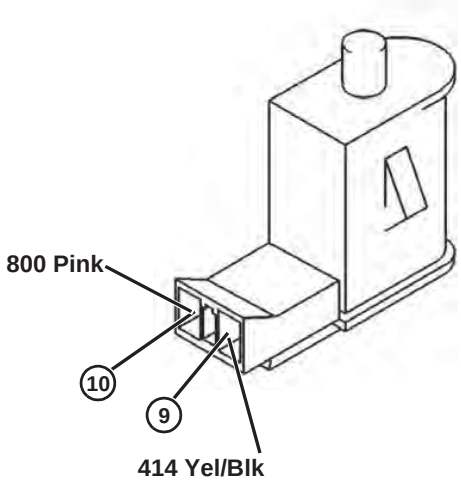
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Neutral start/brake switch.	Battery voltage.	Check purple/black wire No. 705, W5 neutral start harness and connections.
7. Neutral start/brake switch.	Battery voltage.	Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
8. Interlock module—terminal X3—4.	Battery voltage.	Check purple wire No. 710, W5 neutral start harness and connections.
9. Seat switch.	Battery voltage.	Check yellow/black wires No. 410 and 441 and connections.
10. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)

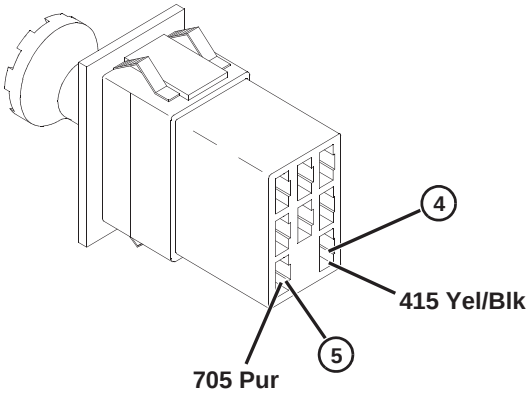




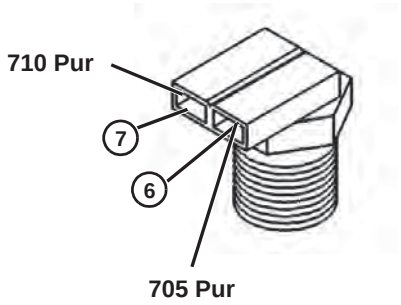
A2 Interlock Module

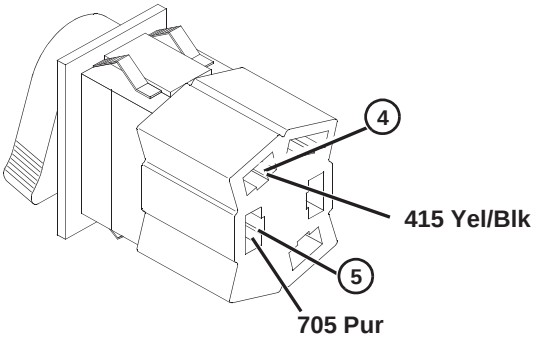
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





S4 PTO Switch (Late Model)





S4 PTO Switch (Early Model)

FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS, continued

Test Conditions:

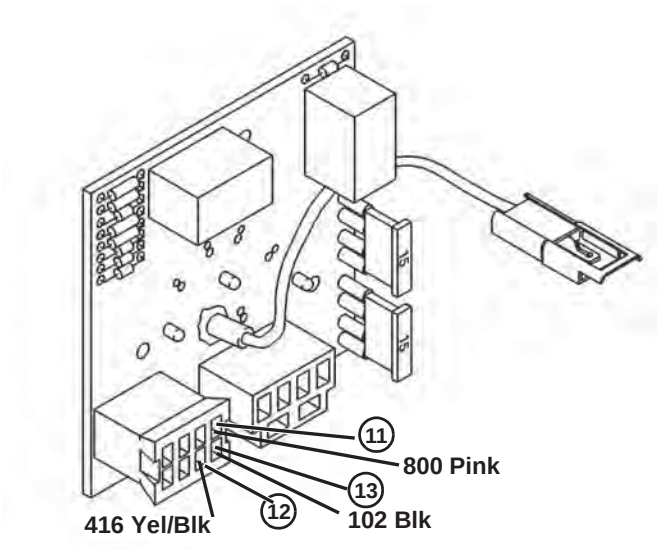
- Key switch in RUN position—engine not running.
- LX172—transmission in NEUTRAL (neutral start switch CLOSED).
- LX176/LX186—park brake ENGAGED (brake switch CLOSED).
- Operator on seat. (Seat switch CLOSED.)
- PTO switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
11. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.
12. Interlock module—terminal X4—3.	Battery voltage.	Replace interlock module.
13. Fuel shutoff solenoid.	Battery voltage.	Check black/yellow wire No. 416, W4 engine wiring harness—yellow/black wire and connections. Check ground circuit. If OK, replace fuel shutoff solenoid.

Test Conditions:

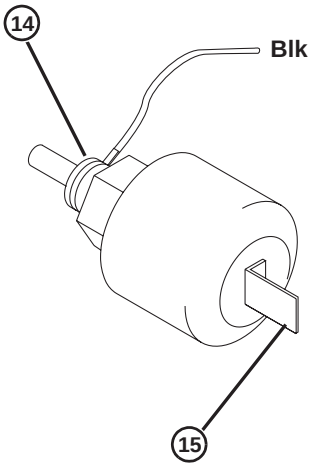
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground circuit and black wires 101 and 102.
15. Fuel shutoff solenoid (black wire).	Maximum 0.1 ohms resistance.	Check black wire (side of carburetor-to-carburetor mounting nut).



A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



CIRCUIT OPERATION AND DIAGNOSIS—LX178/LX188

POWER CIRCUIT OPERATION

Unswitched Power Circuit

Function:

Provides unswitched power to the primary machine operating components whenever the battery is connected. This circuit is protected by the fusible link. This link is a short length of wire that is designed to protect the main wiring harness and will fail if current load becomes excessive.

Operating Conditions, Unswitched Circuits:

Voltage should be present at the following locations with the key switch in the "OFF" position:

- Battery positive (+) terminal.
- Battery terminal of starter solenoid.
- "B" terminal of key switch.
- Battery terminal of voltage regulator/rectifier.

The positive battery cable connects the battery to the starter solenoid. The battery cables must be in good working condition in order for the electrical system to function properly.

Switched Power Circuit

Function:

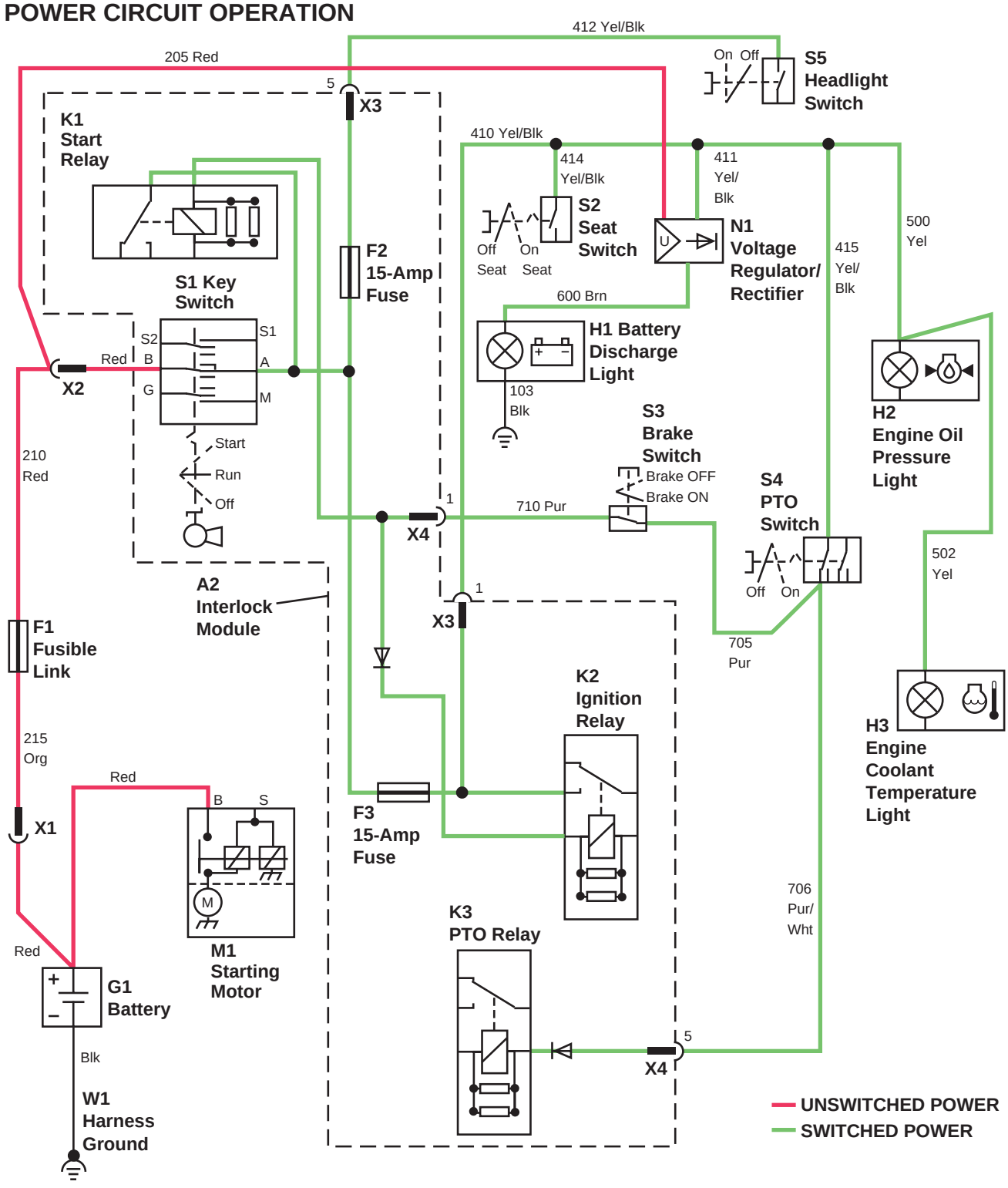
Provides switched power to the primary machine operating components by means of the key switch. In addition to the fusible link, this circuit is protected by two 15-amp fuses.

Operating Conditions, Switched Power:

Voltage should be present at the following locations with the key switch in the "RUN" position:

- All Unswitched Locations.
- A2 Interlock Module:
  - Terminals "1" and "5" of X3 connector.
  - Terminals "1" and "5" of X4 connector.
- S5 Headlight Switch.
- S2 Seat Switch.
- N1 Voltage Regulator/Rectifier—Yellow/Black wire terminal.
- S4 PTO Switch:
  - Yellow/Black wire terminal.
  - Purple wire terminal.
  - Purple/White wire terminal.
- H2 Engine Oil Pressure Light—Yellow wire terminal.
- H3 Engine Coolant Temperature Light.
- B3 Engine Oil Pressure Switch—Tan wire terminal.
- S3 Brake Switch—Purple wire terminal.
- H1 Battery Discharge Light—Brown wire terminal.

POWER CIRCUIT OPERATION



M83266P

POWER CIRCUIT DIAGNOSIS

Test Conditions:

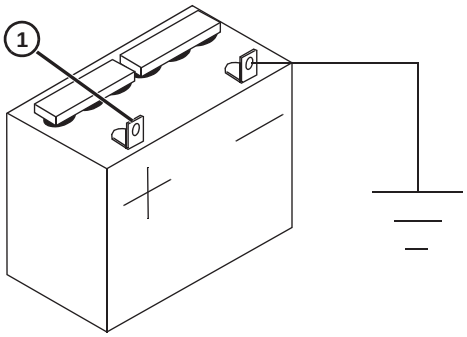
- Park brake ENGAGED. (Brake switch CLOSED.)
- Key Switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on battery (+) terminal.
- Check connection(s) for corrosion and looseness when checking/testing.

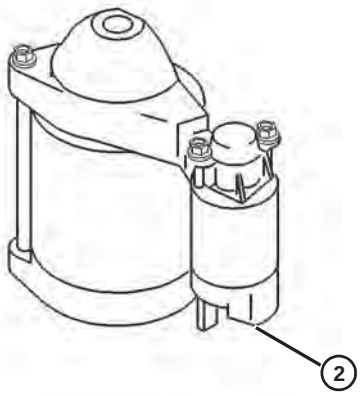
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid to motor bolt—battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Voltage regulator/rectifier—battery terminal.	Battery voltage.	Check red wire No. 205 and connections.

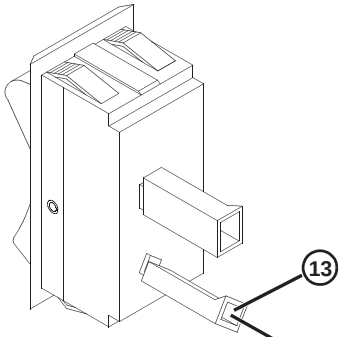
Test Conditions:

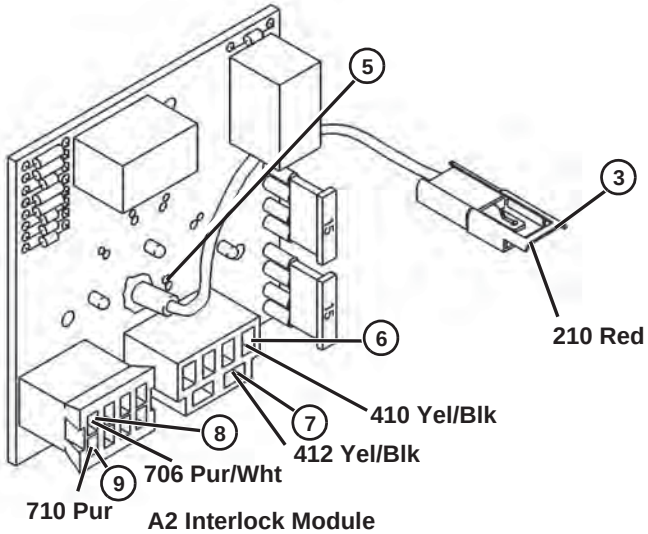
- Key switch in RUN position.

Test/Check Point	Normal	If Not Normal
5. Key switch—"A" terminal.	Battery voltage.	Replace interlock module.
6. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
7. Interlock module—terminal X3—5.	Battery voltage.	Check fuse (F2).
8. Interlock module—terminal X4—5.	Battery voltage.	Check yellow/black wire No. 415, PTO switch and purple/white wire No. 706.
9. Interlock module—terminal X4—1.	Battery voltage.	Check purple wire No. 705, brake switch and purple wire No. 710.
10. Voltage regulator/rectifier.	Battery voltage.	Check red wire No. 205 (X2 to N1).
11. Voltage regulator/rectifier.	Battery voltage.	Check yellow/black wire No. 411 (X3—1 to N1).
12. Seat switch.	Battery voltage.	Check yellow/black wire No,. 414 (X3—1 to S2).
13. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412 (X3—5 to S5).

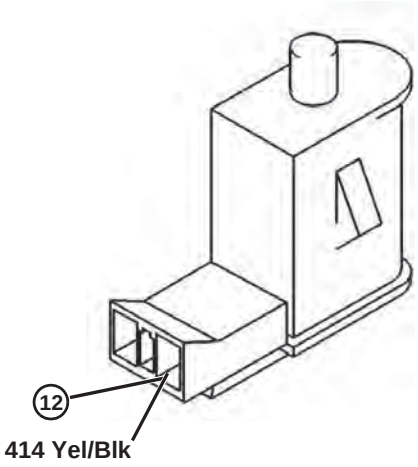


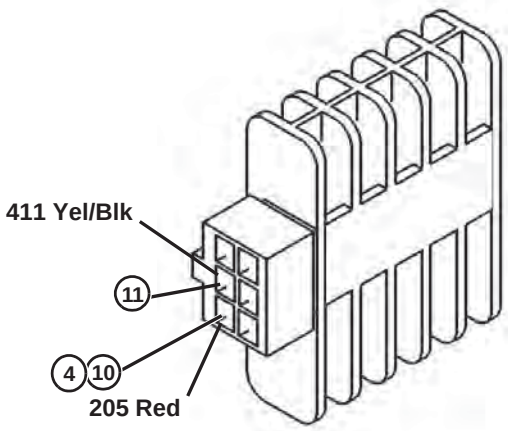






NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two seperate relays, as shown, or a single dual relay



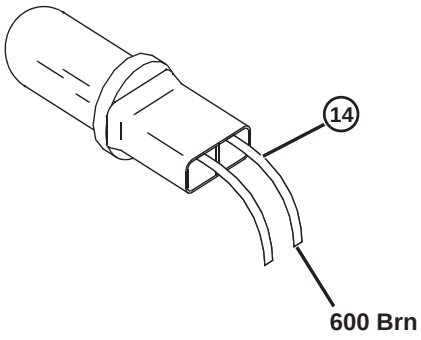


POWER CIRCUIT DIAGNOSIS, continued

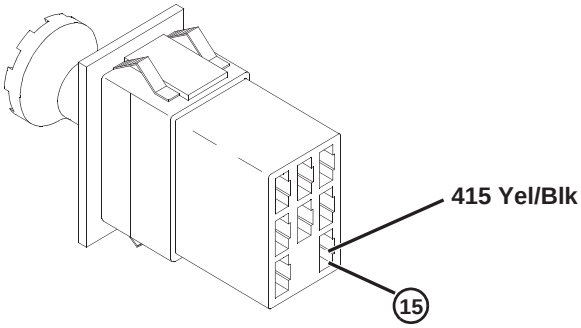
Test Conditions:

- Key switch in RUN position.

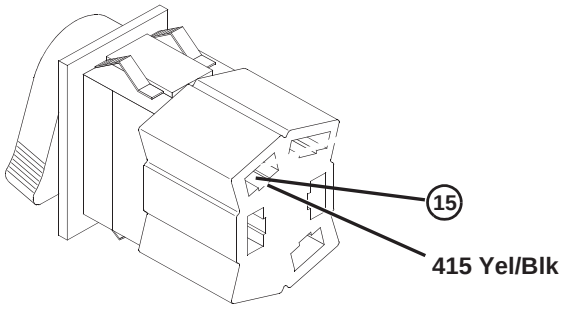
Test/Check Point	Normal	If Not Normal
14. Discharge light.	Light is ON.	Check brown wire No. 600 (N1 to H1).
15. PTO Switch.	Battery voltage.	Check yellow/black wires No. 415, purple wire No. 705 and purple/ white wire No. 706.
16. Engine oil pressure light.	Light is ON.	Check yellow wire No. 500 (X3—1 to H2).
17. Engine coolant temperature light—yellow wire No. 502.	Battery voltage.	Check yellow wire No. 502.



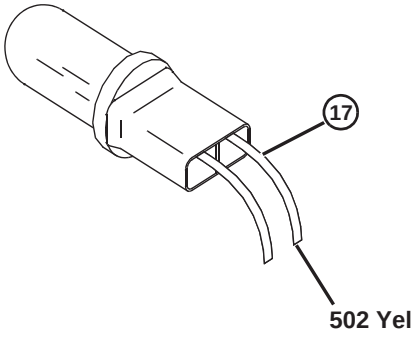
H1 Battery Discharge Light



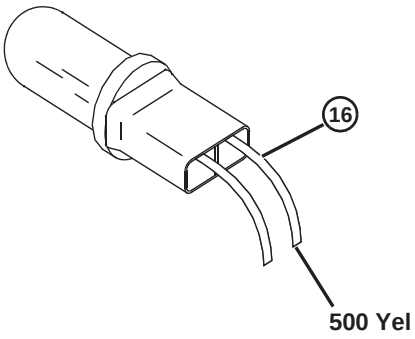
S4 PTO Switch (Late Model)



S4 PTO Switch (Early Model)



H3 Engine Coolant Temperature Light



H2 Engine Oil Pressure Light

CRANKING CIRCUIT OPERATION

Function:

The cranking system is used to energize the starting motor.

Operating Conditions:

- Key switch in START position.
- Park brake ENGAGED. (Brake switch CLOSED.)
- PTO switch in OFF position.

NOTE: The operator does not have to be in the seat (seat switch closed) to crank engine.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15- amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The starting motor is a solenoid shift design. The power circuit provides current to the key switch (S1) and protects the cranking circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the starter solenoid battery terminal, fusible link (F1) and key switch battery terminal. With the key switch in the START position, current flows to the 15-amp fuse (F3), PTO switch and start relay (K1) contacts.

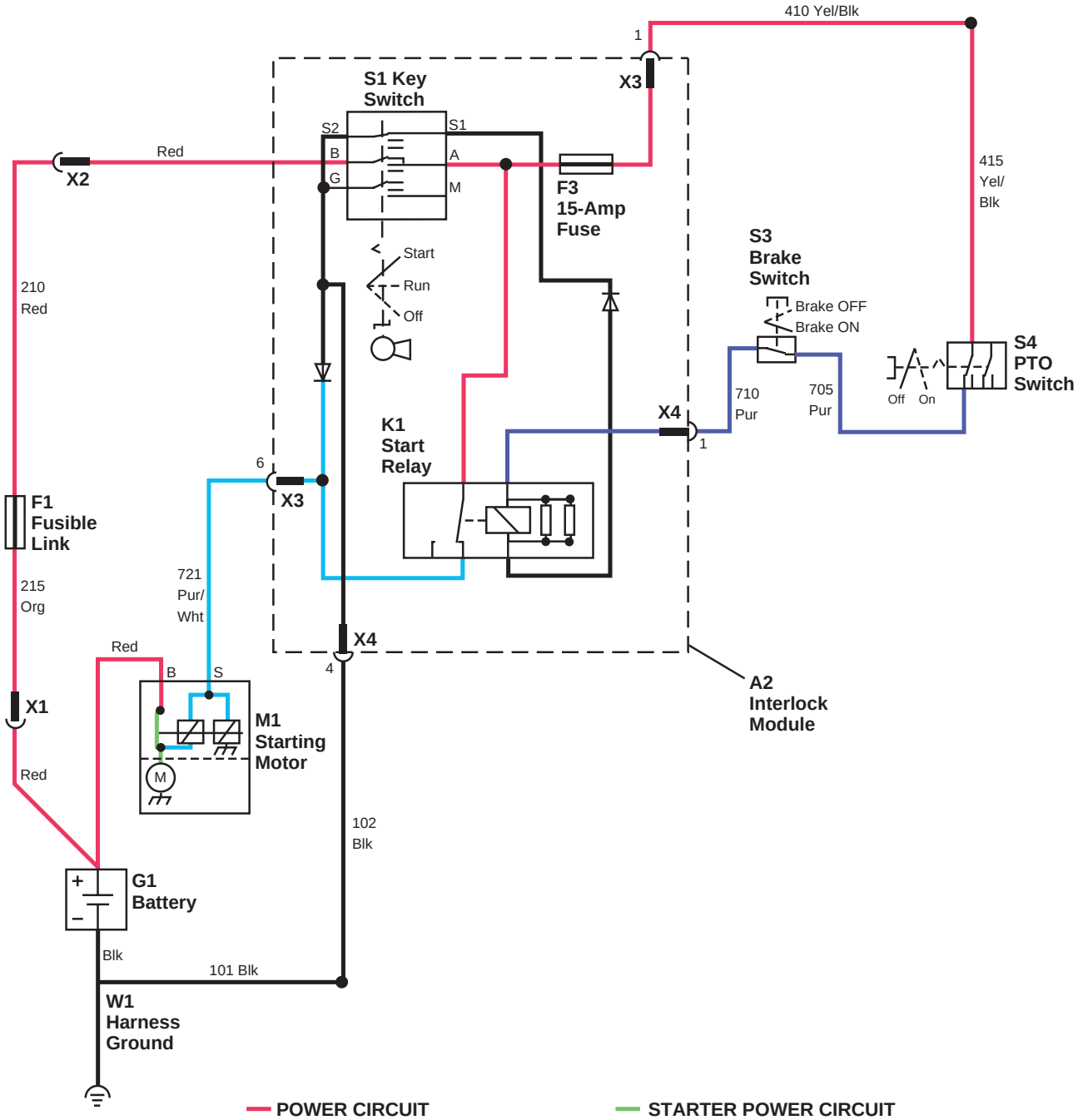
The PTO switch is used in the neutral start circuit to prevent the engine from cranking if the PTO is engaged. With the PTO switch closed (PTO disengaged), current flows to the brake switch (S3).

The brake switch is located on the top of the transmission directly over the internal brake lever. When the brake is engaged (transmission is automatically shifted into NEUTRAL), the brake actuator linkage closes the brake switch. The brake switch is used in the neutral start circuit to prevent the engine from cranking if the brake pedal is not depressed.

With the brake switch closed, current flows to start relay (K1) (Neutral Start Circuit). The solenoid energizes when the ground circuit is completed through the S1 and S2 terminals and the key switch. Current then flows to the starter solenoid (Starter Relay Circuit), engaging the solenoid. The solenoid is engaged by current flowing through both pull-in and hold-in windings, pulling the plunger inward. The plunger closes the solenoid main contacts. When the main contacts are closed, both ends of the pull-in windings have the same voltage so current through the pull-in windings stops. Current continues through the hold-in windings, keeping the solenoid engaged.

With the solenoid main contacts closed, high current from the battery flows across the main contacts to the starter motor (M1) causing it to turn.

CRANKING CIRCUIT OPERATION



M83267P

CRANKING CIRCUIT DIAGNOSIS

Test Conditions:

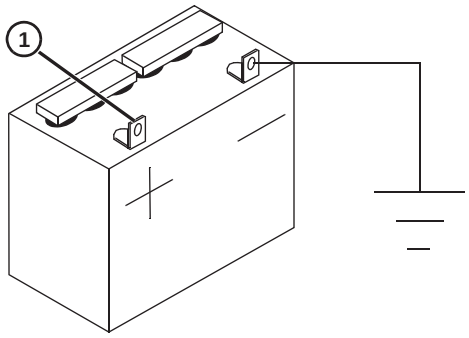
- Park brake ENGAGED. (Brake switch CLOSED.)
- PTO switch in OFF position.
- Key switch in RUN position—engine not running.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

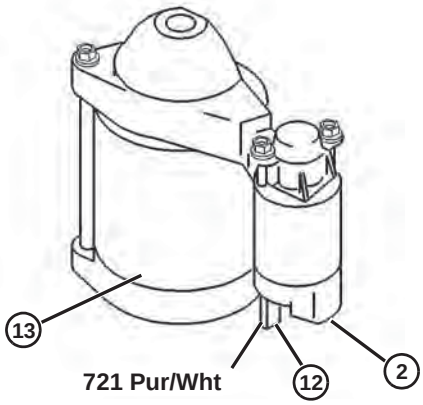
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid—battery terminal.	Battery voltage.	Check battery positive (+) cable and clamp. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace Interlock Module.
5. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
6. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Brake switch.	Battery voltage.	Test purple wire No. 705.
8. Brake switch.	Battery voltage.	Test brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X4—1.	Battery voltage.	Check purple wire No. 710.

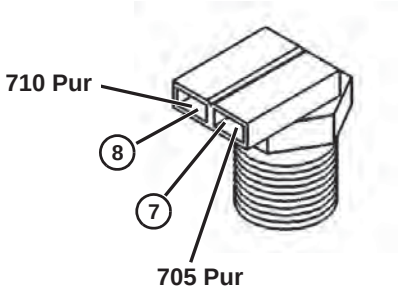
Test Conditions:

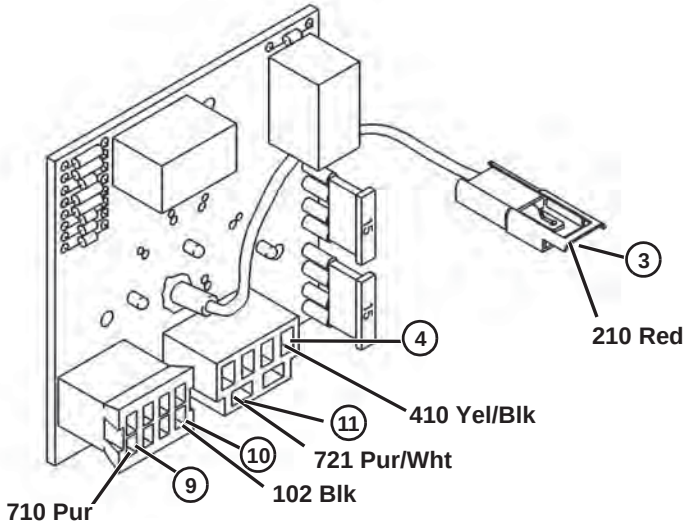
- Spark plug leads disconnected and grounded.
- Key switch in START position.

Test/Check Point	Normal	If Not Normal
10. Interlock module—terminal X4—4.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts—check Interlock Module ground circuit. 0 volts—replace Interlock Module.
11. Interlock module—terminal X3—6.	Battery voltage.	Replace Interlock Module.
12. Starter solenoid—terminal S.	Battery voltage.	Test purple/white wire No. 721.
13. Starter motor.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts—check starter motor and engine ground circuit. 0 volts—test starter solenoid and motor. (See STARTER SOLENOID TEST on page 5-183 and STARTER—Inspection/Test on page 3-146.)



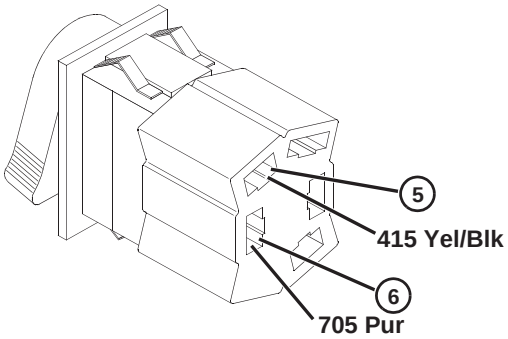




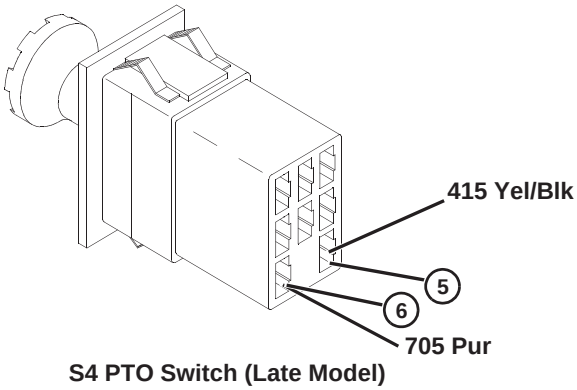


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two seperate relays, as shown, or a single dual relay



S4 PTO Switch (Early Model)



S4 PTO Switch (Late Model)

IGNITION CIRCUIT OPERATION

Function:

At the correct time, supplies a spark that ignites the fuel/air mixture in the engine.

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch in OFF position.
- Park brake ENGAGED (brake switch CLOSED).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The engine is equipped with a solid state, transistorized, battery ignition system and has no moving parts. The power circuit provides current to the key switch (S1) and protects the ignition circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the START or RUN position, current flows to the 15-amp fuse, ignition relay (K2), seat switch (S2) (Power Circuit), voltage regulator/rectifier (N1) and PTO switch (S4).

The PTO switch is also used in the neutral start circuit to prevent the engine from starting if the PTO is ON (engaged). With the PTO switch closed (PTO disengaged), current flows to the brake switch (S3).

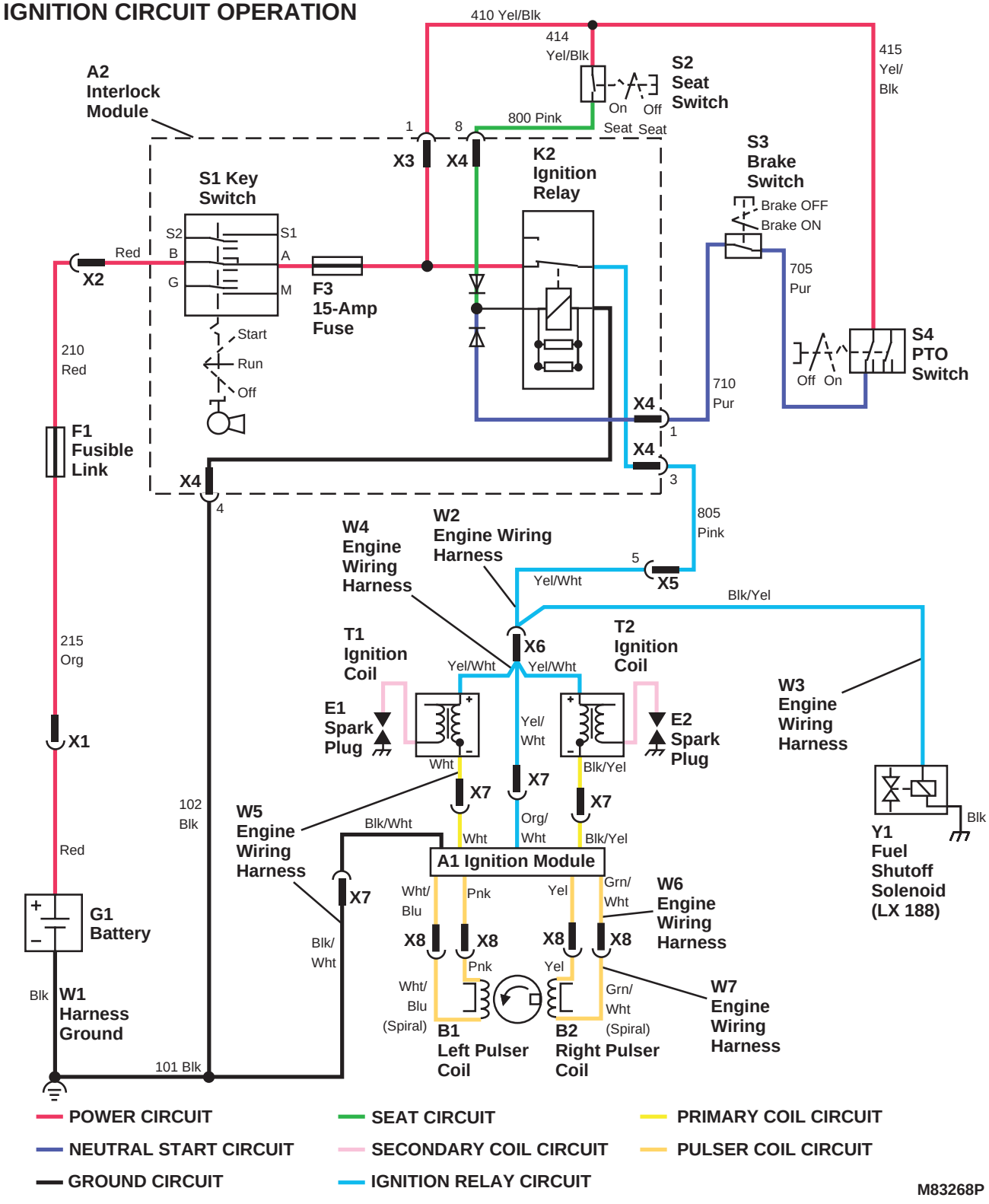
The brake switch is located on the top of the transmission and is activated by the brake actuator linkage. When the parking brake is engaged the transmission is automatically shifted into NEUTRAL, the brake actuator linkage closes the brake switch. The brake switch is used in the neutral start circuit to prevent the engine from energizing if the brake pedal is not depressed.

With the brake switch or seat switch closed, current flows to the ignition relay coil (Neutral Start Circuit) energizing the coil, closing the relay. Current is then supplied to energize the system. The triggering signals are generated as an extended segment on the outside edge of the flywheel moves past each of the pulser coils (B1 and B2). These triggering signals are transferred to the ignition module (A1). The ignition module acts as an electronic switch controlling the timing of the flow of current (Ignition Circuit) to the primary windings of the Ignition coils (T1 and T2).

The ignition coils consist of iron cores with 2 sets of wires wound around them. The primary windings are connected to the ignition module. The secondary windings are connected to the spark plugs (E1 and E2) through high tension leads. There are many more windings in the secondary windings of the coils than in the primary windings.

As the flywheel rotates prior to the spark plugs firing, the ignition module allows current from the battery to the primary windings of the ignition coils. When a signal from the pulser coil is received at the ignition module, current flow to the primary winding is stopped. As the voltage in the primary winding drops from battery voltage to 0 volts, a strong magnetic field is created around the wires of both the primary and secondary windings. This strong magnetic field generates a voltage in the secondary windings of the coil. The voltage generated in the secondary windings is much higher than the battery voltage that was applied to the primary windings due to the greater number of windings. The high voltage of the secondary windings creates a spark at the spark plug (E1 or E2).

IGNITION CIRCUIT OPERATION



IGNITION CIRCUIT DIAGNOSIS

Test Conditions:

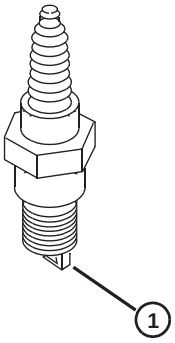
- Park brake ENGAGED. (Brake switch CLOSED.)
- PTO switch in OFF position.
- Spark plug leads disconnected and grounded.
- Key switch in START position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

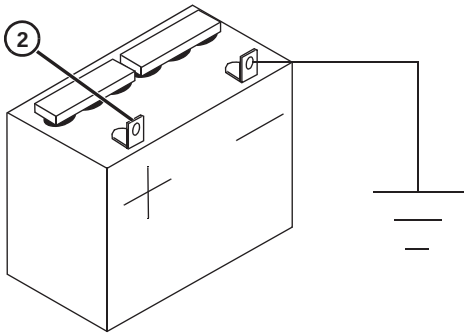
Test/Check Point	Normal	If Not Normal
1. Spark plug/Spark Tester.	Spark test indicates hot blue spark.	No spark present: test ignition coils and ignition module. Spark present: check spark plug gap and condition of spark plug. If plugs are good, continue testing ground circuit.

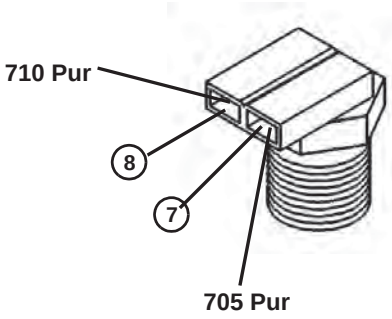
Test Conditions:

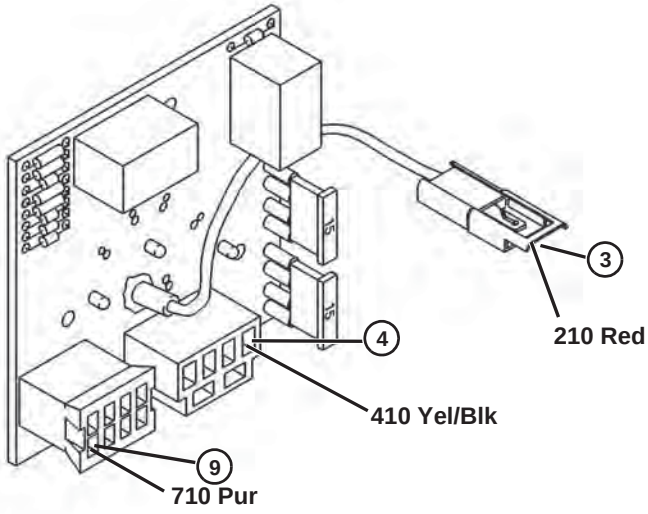
- Key switch in RUN position (engine not running).

Test/Check Point	Normal	If Not Normal
2. Battery positive (+) terminal	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace Interlock Module.
5. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
6. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
7. Brake switch.	Battery voltage.	Test purple wire No. 705.
8. Brake switch.	Battery voltage.	Test brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X4—1.	Battery voltage.	Check purple wire No. 710.



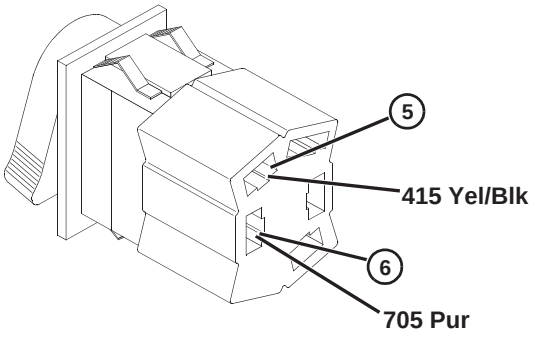




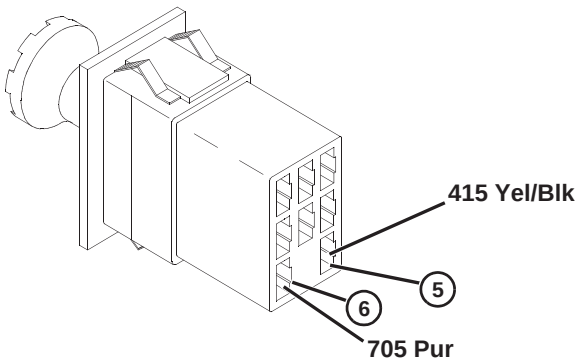


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



S4 PTO Switch (Early Model)



S4 PTO Switch (Late Model)

IGNITION CIRCUIT DIAGNOSIS, continued

Test Conditions:

- Seat switch depressed or jumper wire installed in connector.

Test/Check Point	Normal	If Not Normal
10. Seat switch.	Battery voltage.	Test yellow/black wires No. 410 and 414.
11. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
12. Interlock module—terminal X4—8.	Battery voltage.	Test pink wire No. 800.

Test Conditions:

- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
13. Engine ground.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable and shielded engine ground connection.
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check black wires No. 101 and 102.
15. Ignition module.	Maximum 0.2 ohms resistance.	Check black/white wire and ground connection.
16. Ignition coil-resistance.	Primary—3.4—4.6 ohms. Core—infinite (open circuit).	Secondary—10.4—15.6 K ohms. Replace ignition coil (T1 or T2).

Test Conditions:

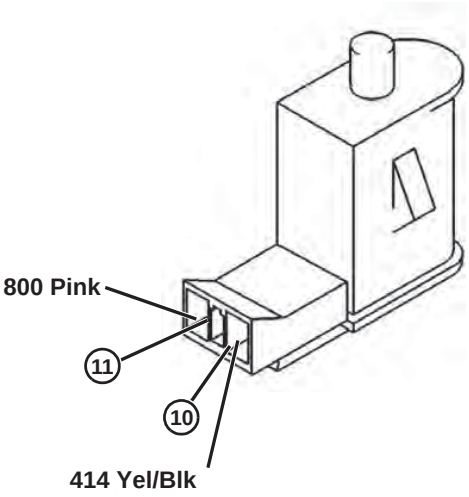
- Plug leads disconnected and grounded.
- Key switch in START position.
- Meter set for AC voltage for step 17.
- Voltage test light connected to battery negative (-) terminal (checking for current pulses) for step 18.

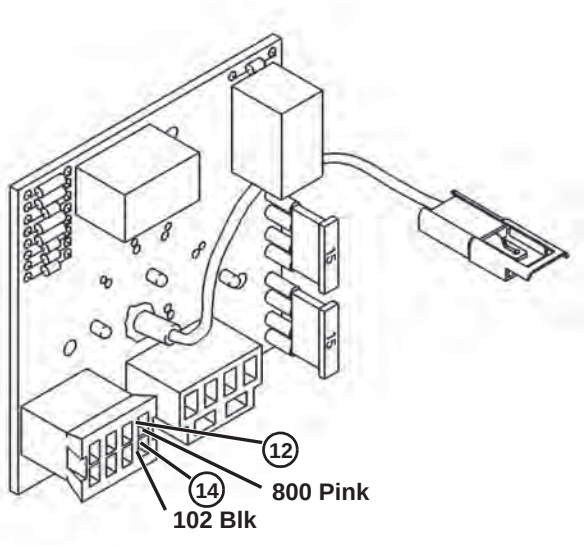
Test/Check Point	Normal	If Not Normal
17. Left and right pulser coils white/blue and pink leads. then green/white and yellow leads.	0.1—1 VAC.	Check pulser coil connections and test pluser coil resistance.
18. Ignition coil negative (-) terminal.	Rapidly flashing light, not steady glow.	Flashing light—check ignition module, go to step 19. Light steady glow—check ignition coil ground circuit.

Test Conditions:

- Key switch in RUN position.

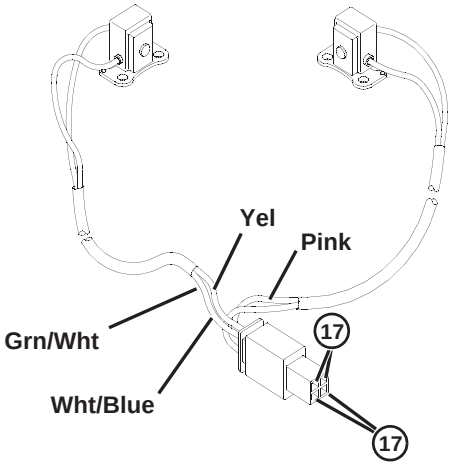
Test/Check Point	Normal	If Not Normal
19. Ignition module.	Battery voltage.	Check white and black/yellow wires, if OK, replace ignition module.
20. Ignition module.	Spark produced.	Replace ignition module (A1).

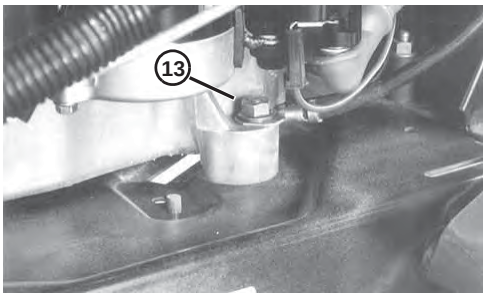


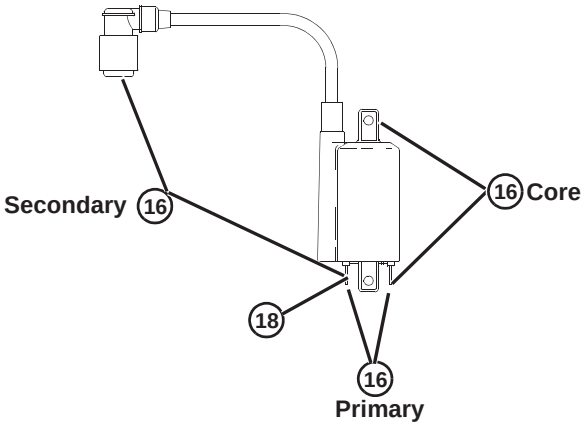


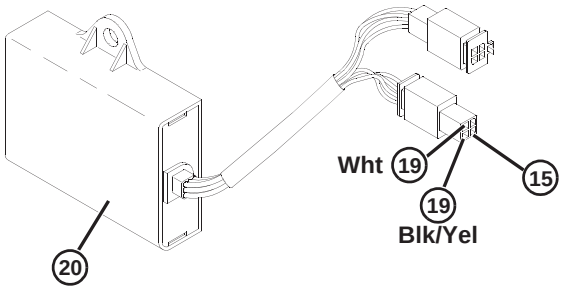
A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.









CHARGING CIRCUIT OPERATION

Function:

To maintain battery voltage between 11.8 and 13.2 volts DC.

Operating Conditions:

- Key switch in RUN position.
- Engine running.

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The charging system is a permanent magnet and stator design. Charging output is controlled by a regulator/rectifier. A battery discharge light warns the operator if the stator stops charging. The battery discharge light circuit monitors stator output, not battery voltage.

The power/battery charging circuit provides current to the key switch (S1) and protects the charging circuit with a fusible line (F1). With the key switch in the RUN position, current flows from battery (G1) positive (+) terminal to fusible link, key switch, 15-amp fuse (F3), and regulator/rectifier (N1). The voltage sensing circuit allows the regulator/rectifier to monitor battery voltage.

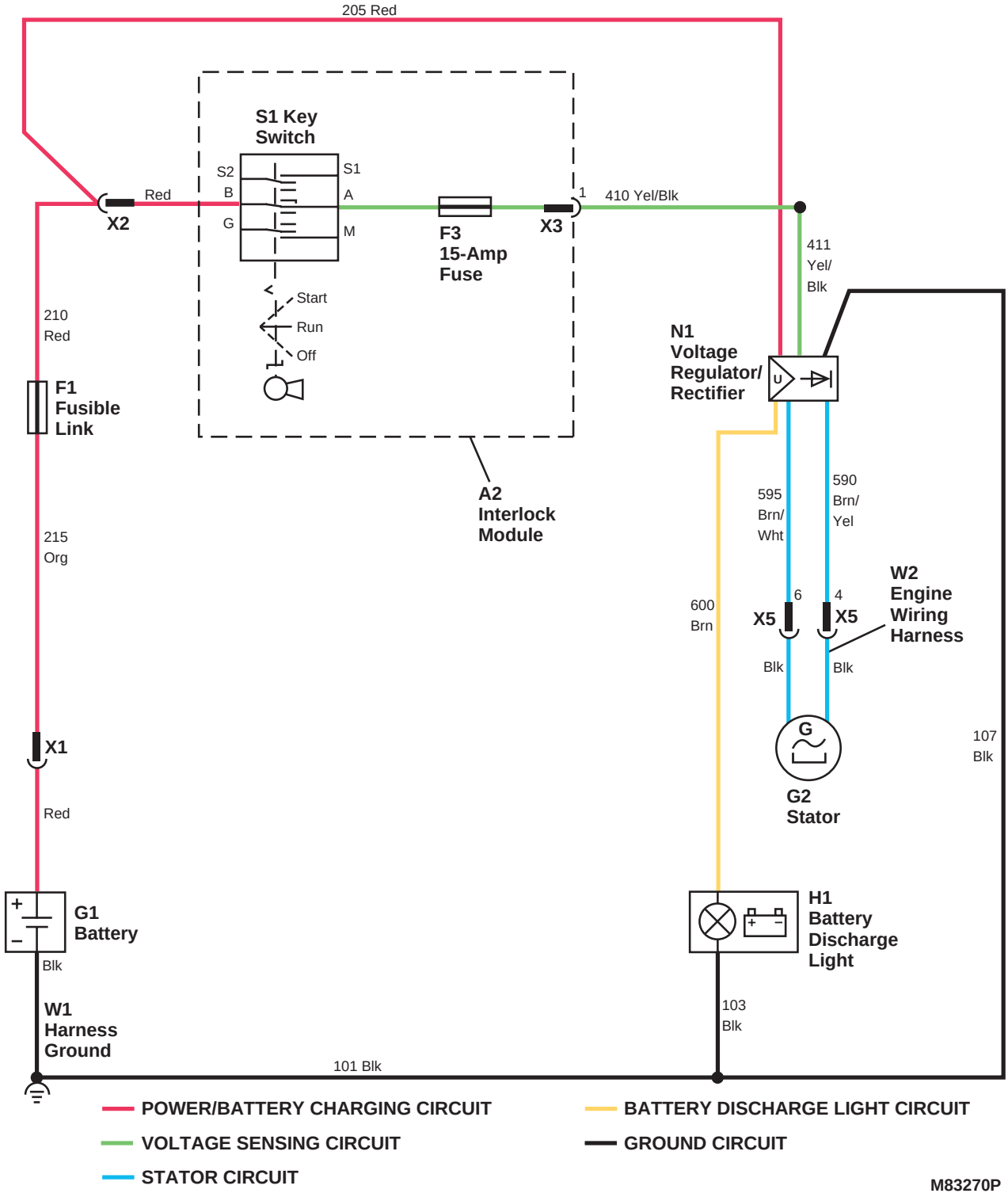
As the flywheel turns, a permanent magnet located in the flywheel induces AC current in the stator (G2) windings. The AC current flows to the regulator/rectifier. The regulator/rectifier converts the AC current to DC current needed to charge the battery.

If the battery voltage is low, the regulator/rectifier allows DC current to flow to the battery to charge it through the power/battery charging circuit. When the battery is fully charged, the regulator stops current flow to the battery.

If stator output current to the regulator/rectifier stops, the regulator/rectifier provides current to the battery discharge light (H1) to illuminate the light.

The ground circuit provides a path to ground for the regulator/rectifier and battery discharge light.

CHARGING CIRCUIT OPERATION



CHARGING CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in OFF position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Voltage regulator/rectifier.	Battery voltage.	Check red wire No. 205, and connections.
4. Voltage regulator/rectifier.	Maximum 0.1 ohms resistance.	Check battery negative cable, shielded ground, black wires No. 101 and 107.
5. Discharge light.	Maximum 0.1 ohms resistance.	Check black wires No. 103.

Test Conditions:

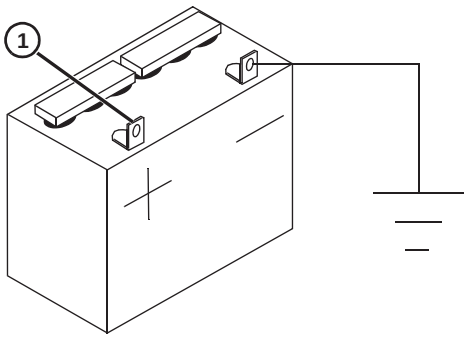
- Key switch in RUN position—engine not running.

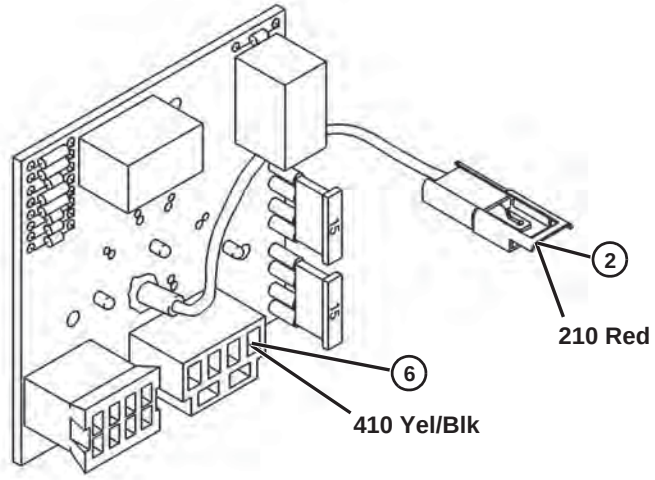
Test/Check Point	Normal	If Not Normal
6. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
7. Voltage regulator/rectifier.	Battery voltage.	Check yellow/black wire No. 410 and 411 and connections.
8. Discharge light.	Battery voltage.	Check brown wire No. 600 and connections.

Test Conditions:

- Key switch in RUN position—engine running.

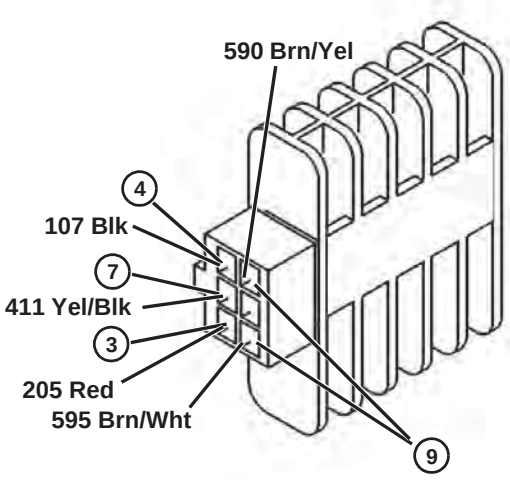
Test/Check Point	Normal	If Not Normal
9. Stator connector. (Perform UNREGULATED VOLTAGE OUTPUT TEST.)	Voltage output to specifications. Regulated amperage to specification.	Check brown/white wire No. 595, brown/yellow wire No. 590 and black wires. If OK, replace voltage regulator/rectifier. Voltage regulator/rectifier—red wire No. 205. (Perform Regulated Amperage Test.) See UNREGULATED VOLTAGE OUTPUT TEST on page 5-181.

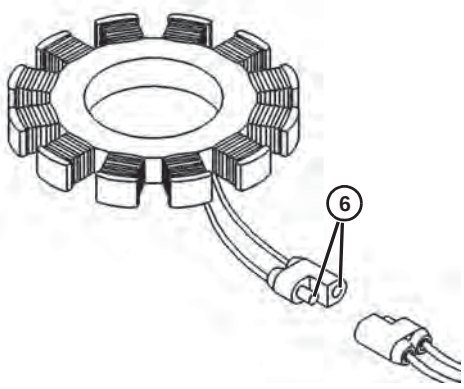


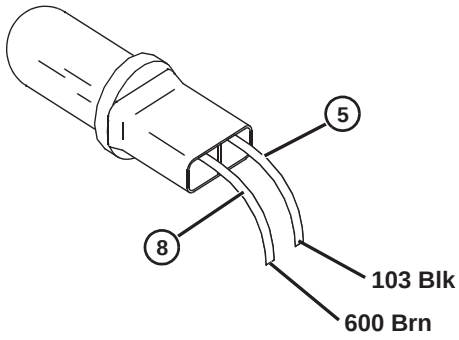


A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.







PTO CIRCUIT OPERATION—PTO OFF

Function:

To provide power to energize the PTO relay and clutch.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in OFF position.
- Operator on seat. (Seat switch CLOSED.)

or

- PTO switch OFF.
- Park brake ENGAGED. (Brake switch CLOSED.)

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The PTO circuit uses a seat switch (S2), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO clutch (Y2), if the operator gets off the seat with the PTO engaged.

The power circuit provides current to the key switch (S1) and protects the PTO circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch battery terminal. With the key switch in the RUN position, current flows to the ignition relay (K2), seat switch (S2) and PTO switch (S4). Current cannot flow to the PTO relay until the ignition relay is energized. Energizing current for the ignition relay must come from the neutral start circuit, and energizing current for the PTO relay must come from the PTO switch.

The PTO switch is used in the PTO safety circuit to prevent the PTO relay from energizing if the PTO switch is in the ON position. With the PTO switch OFF (PTO disengaged), current flows to the PTO relay coil energizing the relay.

The PTO switch is also used in the neutral start circuit to prevent the ignition relay from energizing if the PTO is engaged with the operator off the seat. With the PTO switch closed (PTO disengaged), current flows to the brake switch (S3).

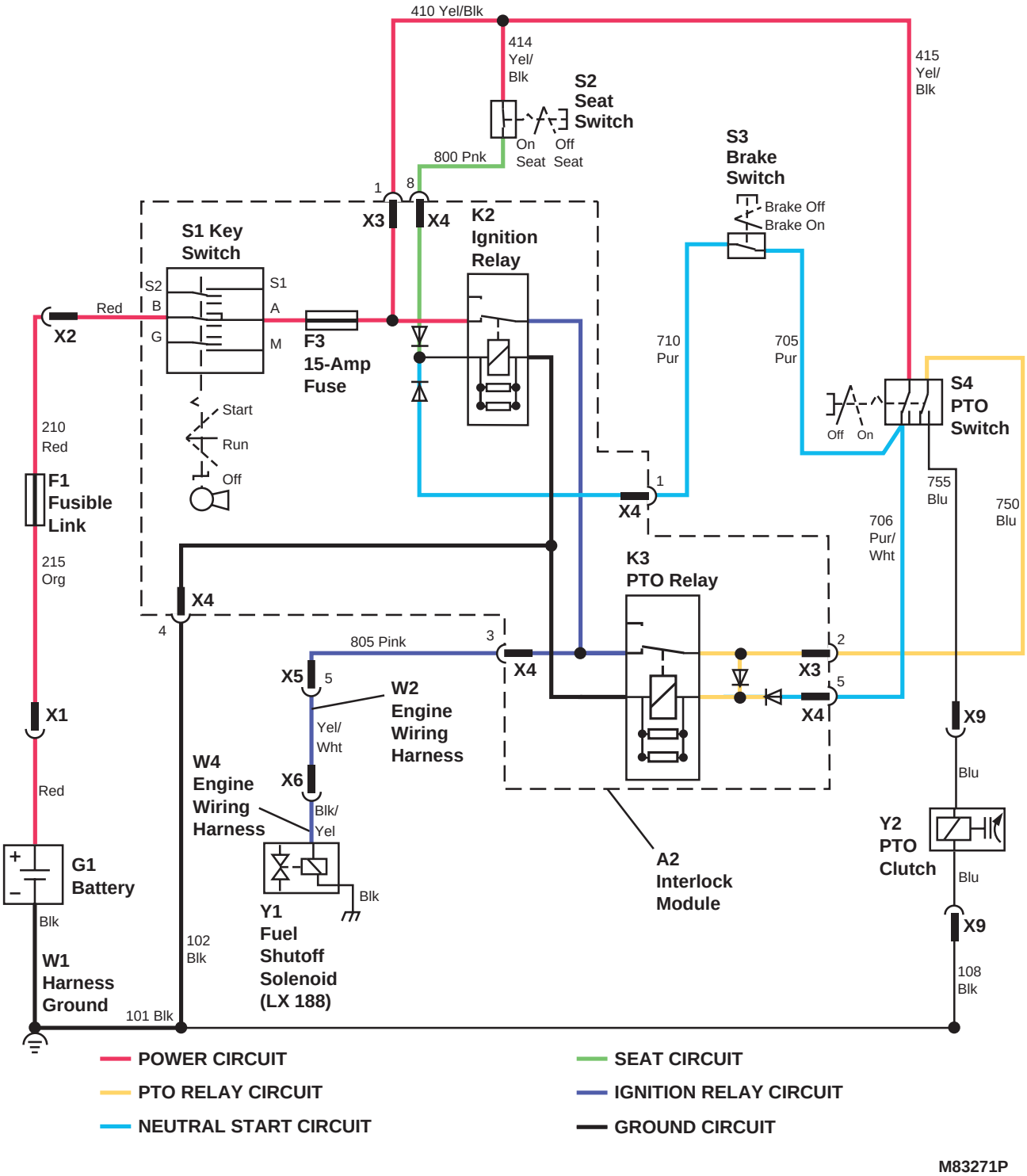
The brake switch is located on the top of the transmission and is activated by the brake actuator linkage. When the park brake is engaged the transmission is automatically shifted into neutral, the brake actuator linkage closes the brake switch. The brake switch is used in the neutral start circuit to prevent the ignition relay from energizing if the brake pedal is not depressed with the operator off the seat.

With the brake switch, current flows to the ignition relay coil energizing the coil, closing the relay. Closing the relay sends ignition relay current to the PTO relay. PTO relay current now flows to the PTO switch and is available to operate the PTO clutch when the PTO switch is turned ON.

An alternate current path is provided to keep the ignition relay energized when the PTO is engaged or the brake pedal is not depressed. With the operator on the seat, the seat switch (S2) is closed and current flows to the ignition relay coil, keeping the relay energized.

The ground circuit provides a path to ground for the PTO and ignition relay coils.

PTO CIRCUIT OPERATION – PTO OFF



M83271P

PTO CIRCUIT OPERATION—PTO ON

Function:

To provide power to energize or de-energize the PTO clutch when desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- PTO switch in ON position.
- Operator on seat. (Seat switch CLOSED.)

System Operations:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

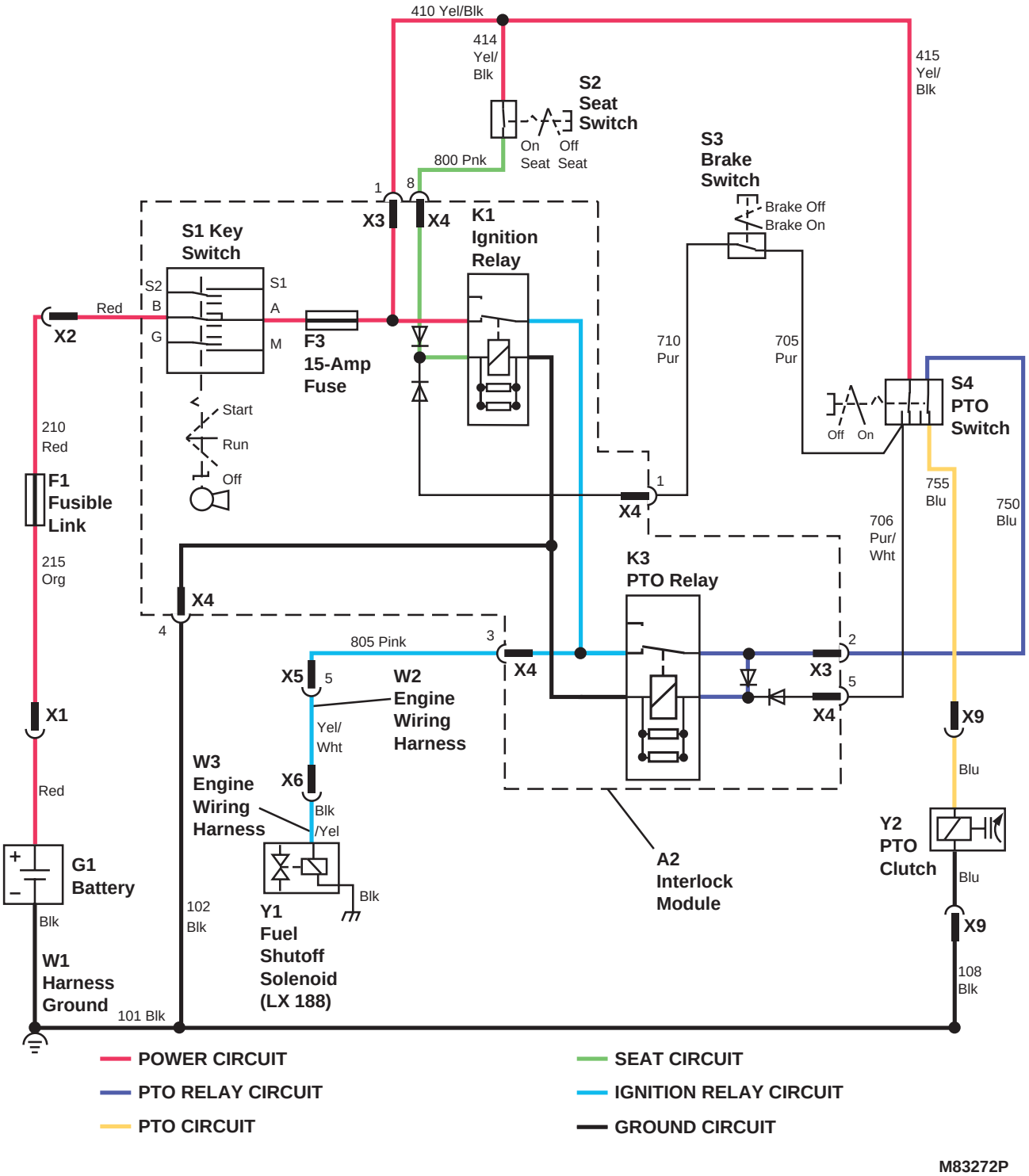
The PTO circuit uses a seat switch (S2), ignition relay (K2), and PTO relay (K3) to stop current flow to the PTO clutch (Y2), if the operator gets off the seat with the PTO engaged.

With the key switch (S1) in the RUN position and the PTO circuit energized, current flows to the PTO switch (S4) and is available to operate the PTO clutch when the PTO switch is moved to the ON position. When the PTO switch is moved to the ON position, current flows through the PTO switch and energizes the PTO clutch. An alternate path for the PTO relay energizing current must be provided when the PTO switch is in the ON position. With the PTO switch ON, circuit 706 purple/white wire no longer has power which stops current flow from the PTO switch to the PTO relay coil. Since the PTO relay contacts are closed, the PTO relay coil receives energizing current from the ignition relay. Current flows through the PTO contacts to the PTO switch and a diode is used to provide a hold-in path for the PTO coil.

With the PTO switch ON, current flow to the brake switch is stopped, so the seat circuit must keep the ignition relay energized. The seat switch (S2) de-energizes the ignition and PTO relays, which stops current flow to the PTO clutch if the operator gets off the seat with the PTO switch ON.

The ground circuit provides a path to ground for the ignition and PTO relay coils and PTO clutch.

PTO CIRCUIT OPERATION – PTO ON



M83272P

PTO CIRCUIT DIAGNOSIS

Test Conditions:

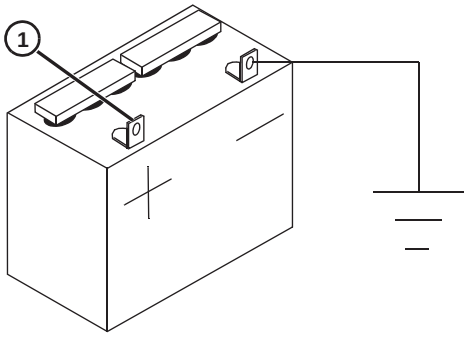
- Key switch in RUN position—engine not running.
- PTO switch in OFF position.
- Park brake engaged. (Brake switch CLOSED.)
- Operator on seat. (Seat switch CLOSED.)
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

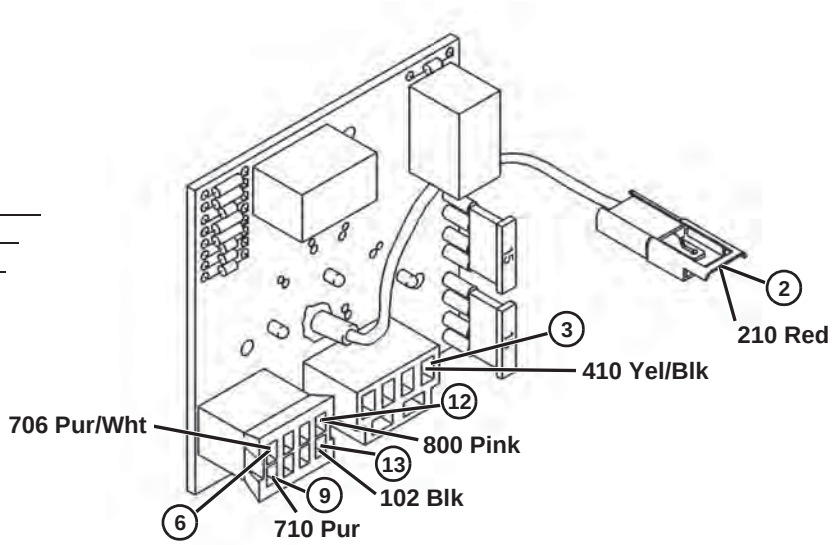
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Interlock module—terminal X4—5.	Battery voltage.	Check purple/white wire No. 706.
7. Brake switch.	Battery voltage.	Test purple wire No. 705.
8. Brake switch.	Battery voltage.	Test brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
9. Interlock module—terminal X4—1.	Battery voltage.	Check purple wire No. 710 and connections.
10. Seat switch.	Battery voltage.	Test yellow/black wires No. 414.
11. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)
12. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800 and connections.

Test Conditions:

- Key switch on OFF position.

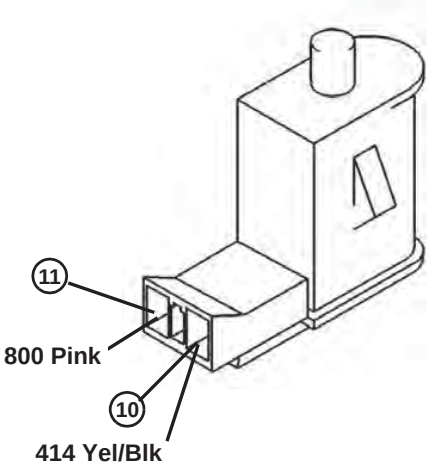
Test/Check Point	Normal	If Not Normal
13. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground, and black wires No. 101 and 102.

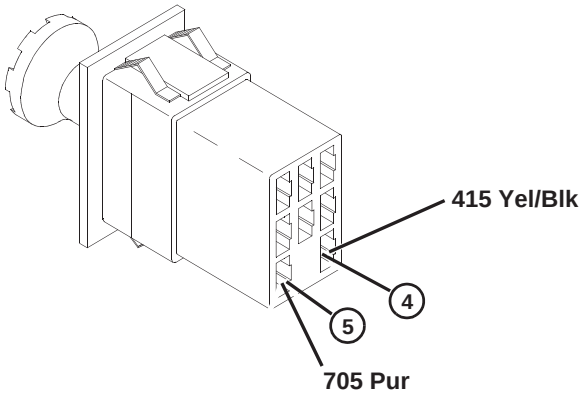




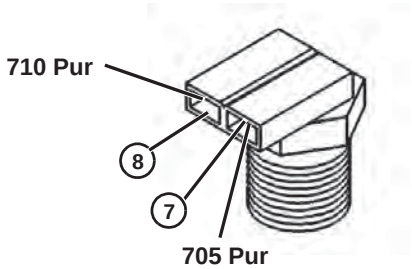
A2 Interlock Module

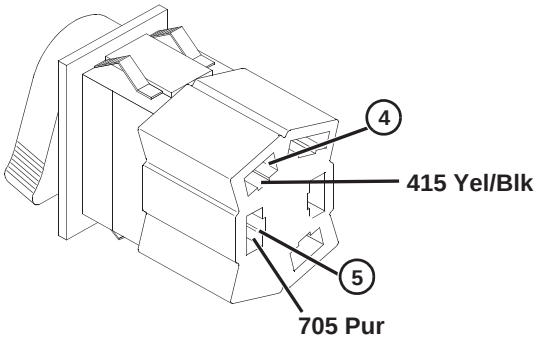
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





S4 PTO Switch (Late Model)





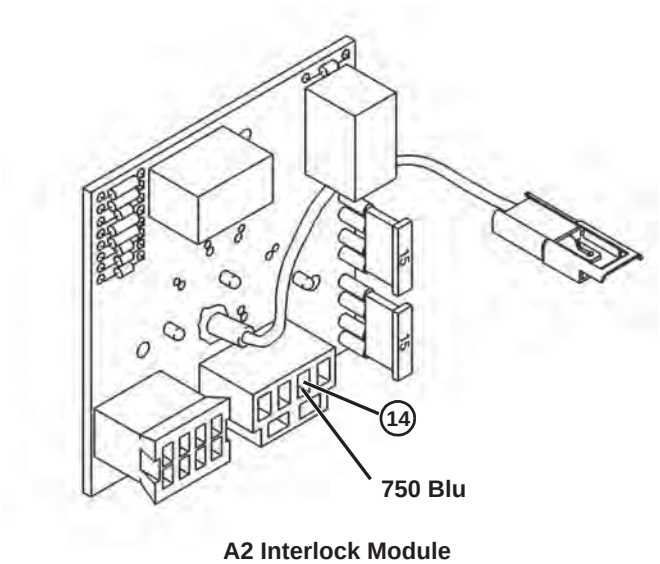
S4 PTO Switch (Early Model)

PTO CIRCUIT DIAGNOSIS, continued

Test Conditions:

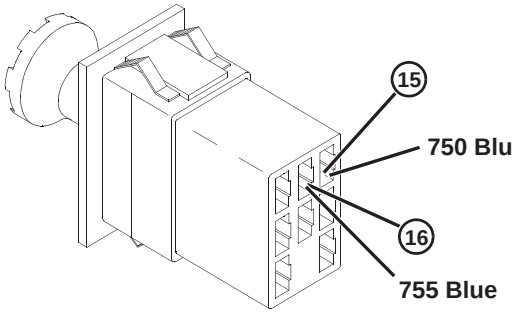
- Key switch in STOP position.
- PTO switch in ON position.

Test/Check Point	Normal	If Not Normal
14. Interlock module—terminal X3—2.	Battery voltage.	Replace interlock module (A2).
15. PTO switch.	Battery voltage.	Check blue wire No. 750 and connections.
16. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
17. PTO clutch.	Battery voltage.	Check blue wire No. 755 and connections.
18. PTO clutch.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts: check PTO clutch ground circuit. 0 volts: test PTO clutch. (See PTO CLUTCH TEST on page 5-189.)
19. PTO clutch.	PTO clutch air gap within specification.	Adjust air gap. (See PTO CLUTCH ADJUSTMENT on page 5-193.)

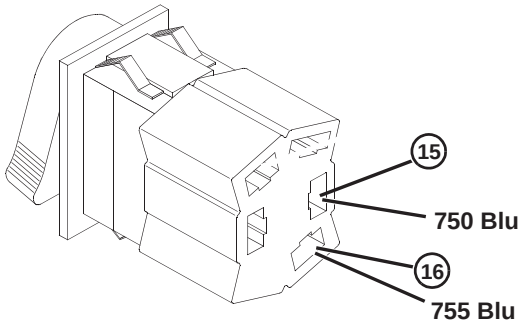


A2 Interlock Module

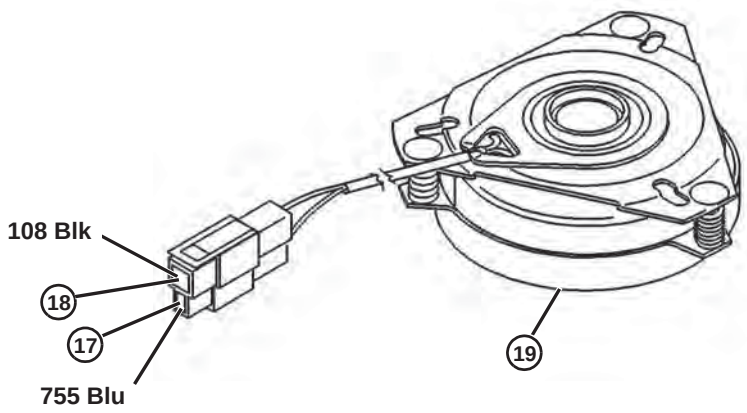
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



S4 PTO Switch (Late Model)



S4 PTO Switch (Early Model)



LOW OIL PRESSURE LIGHT CIRCUIT OPERATION

Function:

To light the low oil pressure light to alert the operator that oil pressure is too low for continued operation.

Operating Conditions:

- Key switch in RUN position.
- Oil pressure switch CLOSED (engine OFF or low oil pressure).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

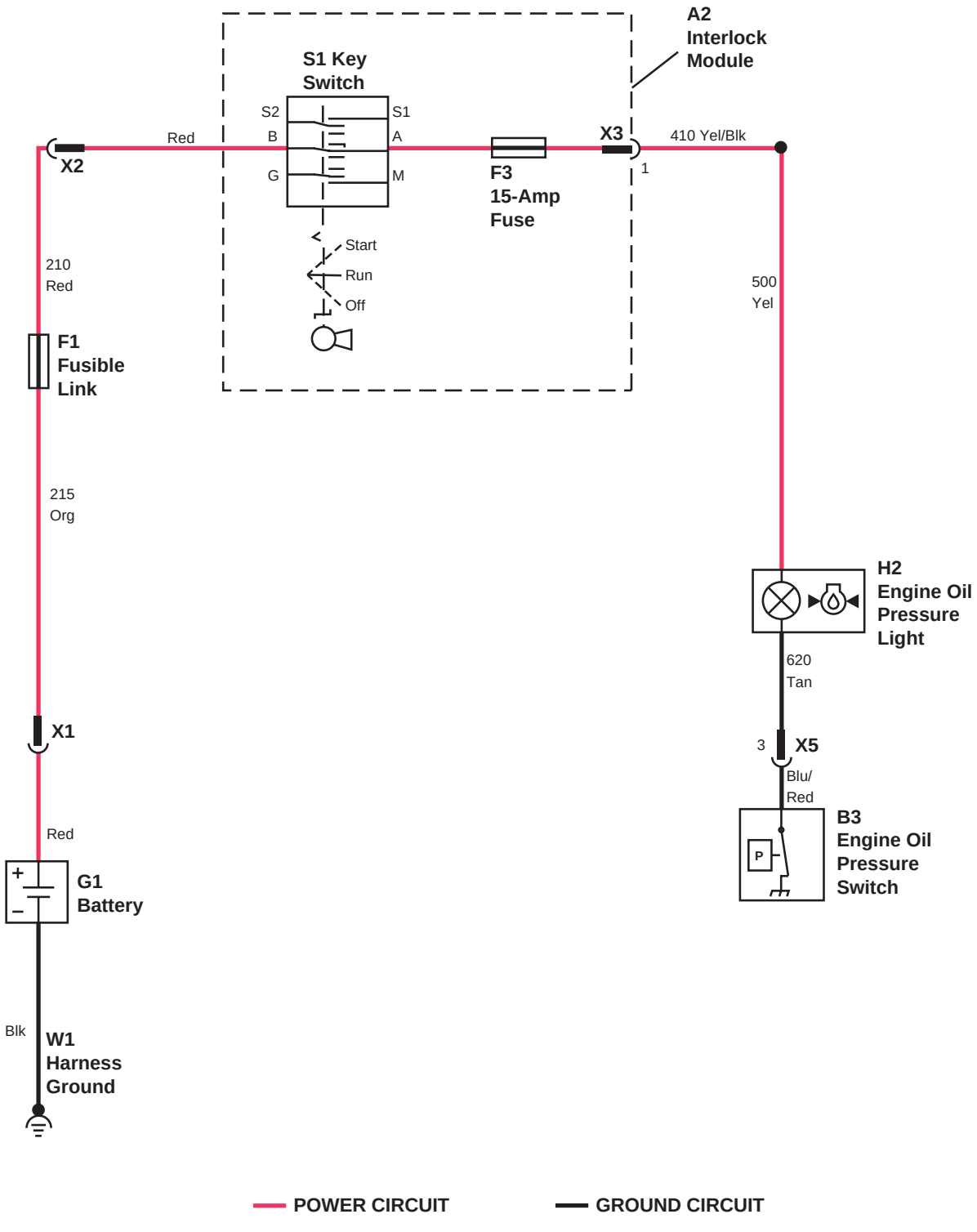
The low oil pressure light system uses a pressure activated switch to provide a path to ground for the oil pressure light. The switch is closed when engine oil pressure is at or below 28 kPa (4 psi).

The power circuit provides current to the key switch (S1) and protects the low oil pressure light circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch battery terminal. With the key switch in the RUN position, current flows to the 15-amp fuse (F3) and the oil pressure light (H2).

If the engine is not running or oil pressure is at or below 28 kPa (4 psi), the oil pressure switch (B3) will be closed. The oil pressure switch completes the path to ground and the low oil pressure light comes ON. When the engine starts and oil pressure increases above 28 kPa (4 psi), the oil pressure switch opens, breaking the path to ground and the light goes out.

The ground circuit provides a path to ground through the oil pressure switch, for the oil pressure light.

LOW OIL PRESSURE LIGHT CIRCUIT OPERATION



M83274P

LOW OIL PRESSURE LIGHT CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- Engine oil pressure switch lead disconnected.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. Low oil pressure light.	Battery voltage.	Check yellow/black wire No. 410 and yellow wire No. 500.
5. Low oil pressure light.	Greater than 0—less than 0.2 volts.	Greater than 0.2 volts—check tan wire No. 620, blue/red wire and connections. 0 volts—check low oil pressure light bulb.

Test Conditions:

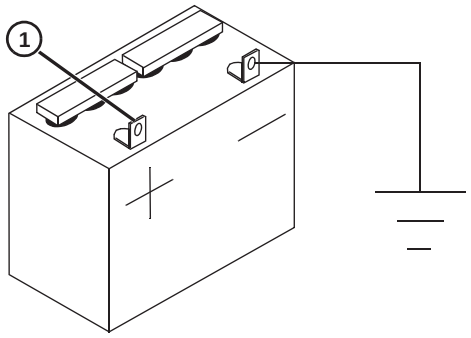
- Key switch in OFF position.

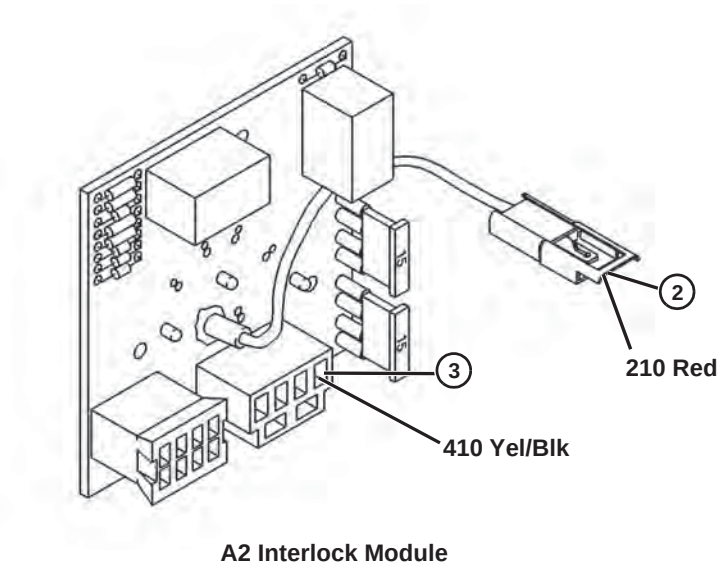
Test/Check Point	Normal	If Not Normal
6. Engine oil pressure switch.	Maximum 0.1 ohms resistance.	Check ground circuit, if OK, replace engine oil pressure switch.

Test Conditions:

- Key switch in RUN position—engine running.

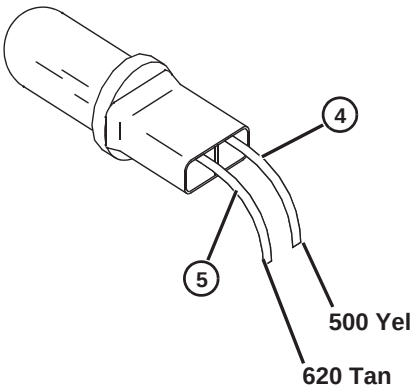
Test/Check Point	Normal	If Not Normal
7. Engine oil pressure switch.	No continuity to ground (maximum resistance).	Perform ENGINE OIL PRESSURE TEST on page 3-108. If OK, replace oil pressure switch.

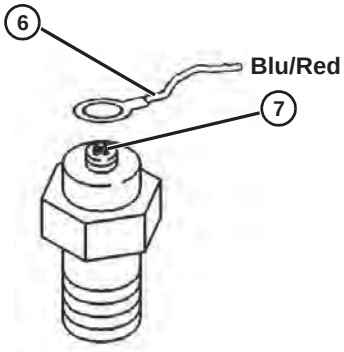




A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





COOLANT TEMPERATURE LIGHT CIRCUIT OPERATION

Function:

To light the coolant temperature light to alert the operator that the engine coolant temperature exceeds normal operating temperature.

Operating Conditions:

- Plug leads disconnected and grounded.
- Key switch in START position.

or

- Key switch in RUN position.
- Engine coolant switch CLOSED (high coolant temperature).

System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

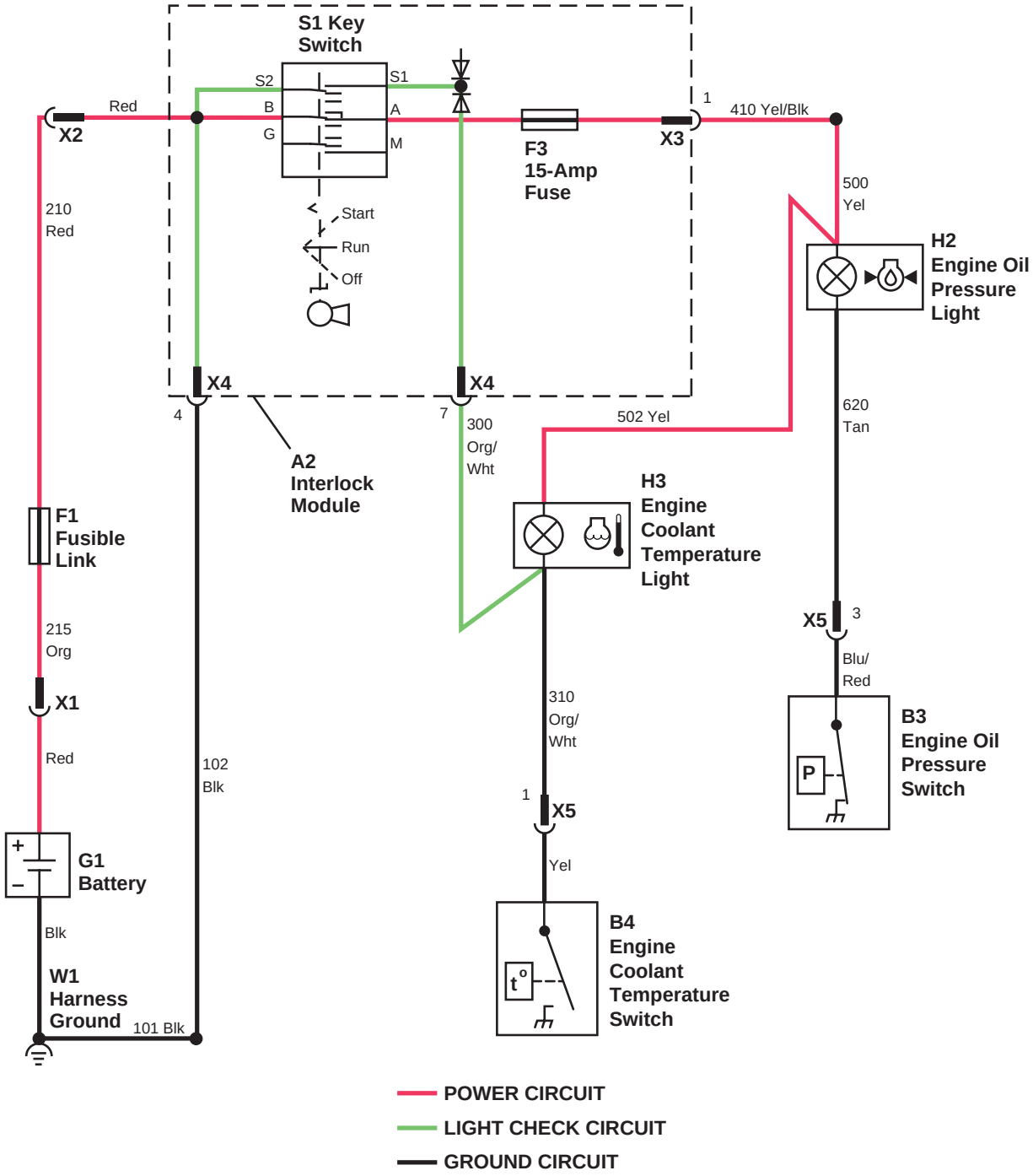
The coolant temperature light system uses a thermal activated switch to provide a path to ground for the coolant temperature light. The switch is closed when engine coolant temperature is at or above 111°C (232°F).

The power circuit provides current to the key switch (S1) and protects the coolant temperature light circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1) and key switch. With the key switch in the START or RUN position, current flows to the 15-amp fuse (F3), low oil pressure light (H2), and coolant temperature light (H3).

If the engine coolant temperature exceeds 111°C (232°F) the coolant temperature switch (B4) will close. The coolant temperature switch completes the path to ground and the coolant temperature light comes ON. When the engine coolant temperature is below 111°C (232°F), the coolant temperature switch opens, breaking the path to ground and the light goes out.

Normally the coolant temperature switch is always open when the engine is operating at normal temperature and the coolant temperature lamp is not ON. A coolant temperature light check circuit through the key switch is used to verify operation of the coolant temperature light. When the key switch is in the START position, current from the coolant temperature light flows to the key switch terminals S1 and S2 and to ground lighting the light. A diode in the coolant temperature light check circuit prevents current flow to the start relay.

COOLANT TEMPERATURE LIGHT CIRCUIT OPERATION



M83275P

COOLANT TEMPERATURE LIGHT CIRCUIT DIAGNOSIS

Test Conditions:

- Key switch in RUN position—engine not running.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. Oil pressure light.	Battery voltage.	Check yellow/black wire No. 410 and yellow wire No. 500.
5. Engine coolant temperature light.	Light is OFF. Battery voltage.	Check yellow wire No. 502.
6. Engine coolant temperature light.	Battery voltage.	Test bulb.
7. Engine coolant temperature switch.	Battery voltage.	Check orange/white wire No. 301 and yellow wire (W2 engine wiring harness) and connections.
8. Interlock module—terminal X4—7.	Battery voltage.	Check orange/white wire No. 300 and connections.

Test Conditions:

- Key switch in OFF position.
- Engine at room temperature.

Test/Check Point	Normal	If Not Normal
9. Engine coolant temperature switch.	No continuity to ground (maximum resistance).	Replace engine coolant temperature switch.

Test Conditions:

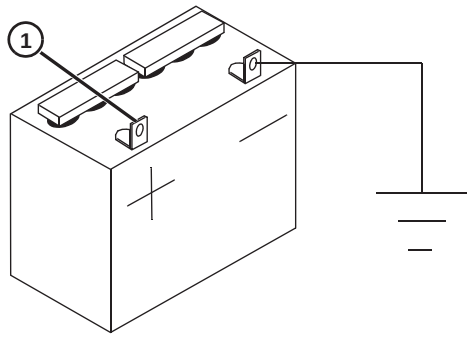
- Plug leads disconnected and grounded.
- Key switch in START position.

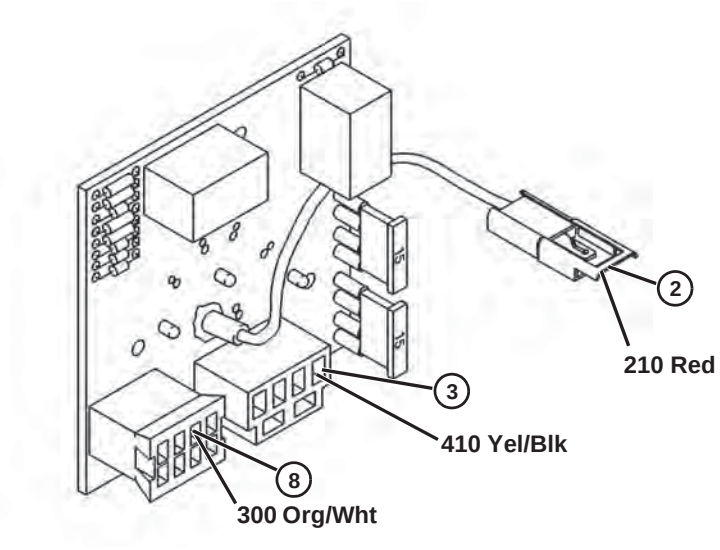
Test/Check Point	Normal	If Not Normal
10. Engine coolant temperature light.	Light is ON. Battery voltage.	Check ground circuit, if OK, replace light bulb.

Test Conditions:

- Battery positive (+) cable disconnected.
- Key switch in START position.

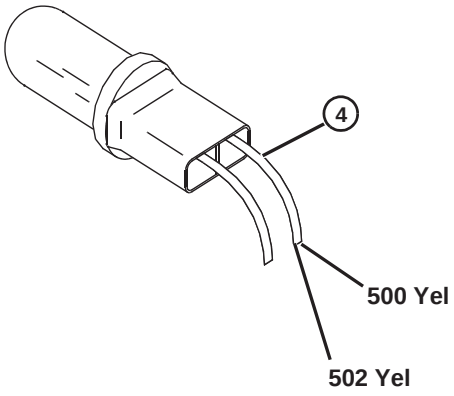
Test/Check Point	Normal	If Not Normal
11. Engine coolant temperature light.	Maximum 0.1 ohms resistance.	Check orange/white wire No. 300, battery negative (-) cable, shielded ground, black wires No. 101 and 102 and connections. If OK, replace interlock module.



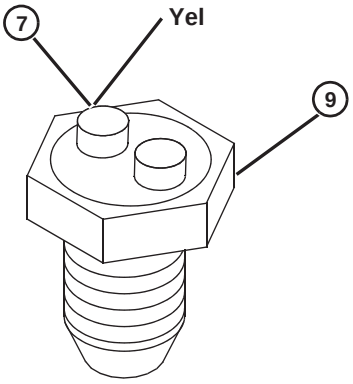


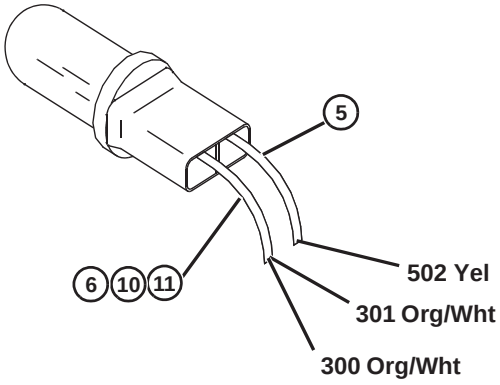
A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



H2 Engine Oil Pressure Light





H3 Engine Coolant Temperature Light

HEADLIGHT CIRCUIT OPERATION

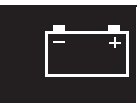
Function:

To provide power to the headlights for illumination if desired by the operator.

Operating Conditions:

- Key switch in RUN position.
- Headlight switch in ON position.

System Operation:

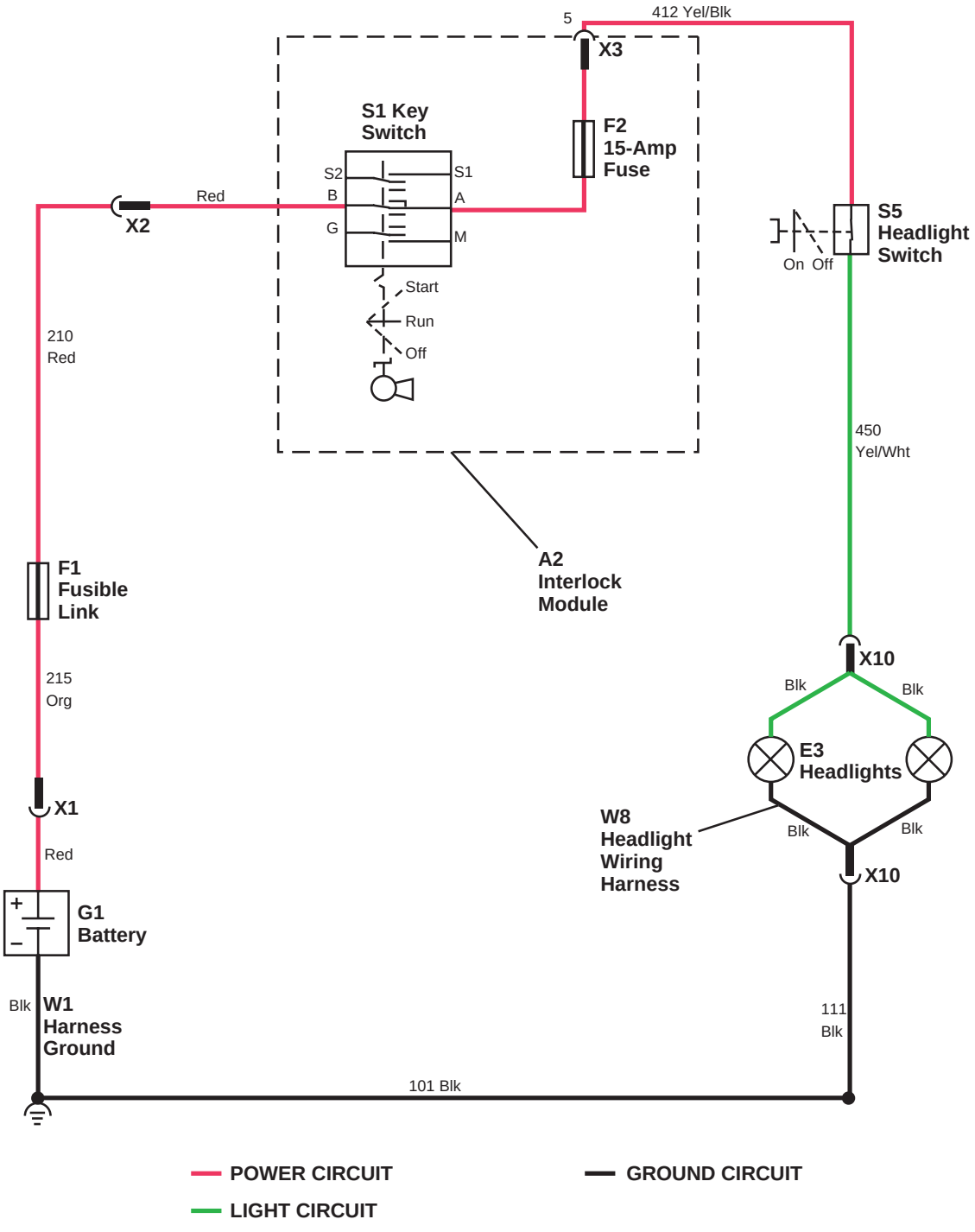


NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The power circuit provides current to the key switch (S1) and protects the circuit with a 15-amp fuse (F2). With the key switch in the RUN position, current flows from the battery (G1) positive (+) terminal to the fusible link (F1), key switch battery terminal, 15-amp fuse (F2) and headlight switch (S5). With the headlight switch in the ON position, current flows to the headlights (E3) and illuminates the lamps.

The ground circuit provides a path to ground for the headlight.

HEADLIGHT CIRCUIT OPERATION



M83277P

HEADLIGHT CIRCUIT DIAGNOSIS

Test Conditions:

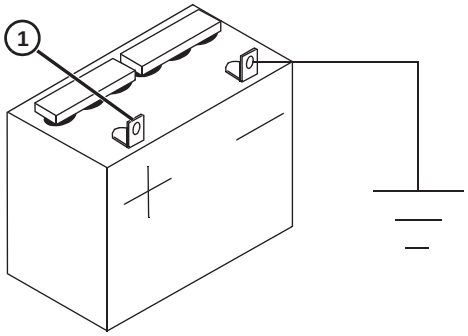
- Key switch in RUN position—engine not running.
- Headlight switch in ON position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

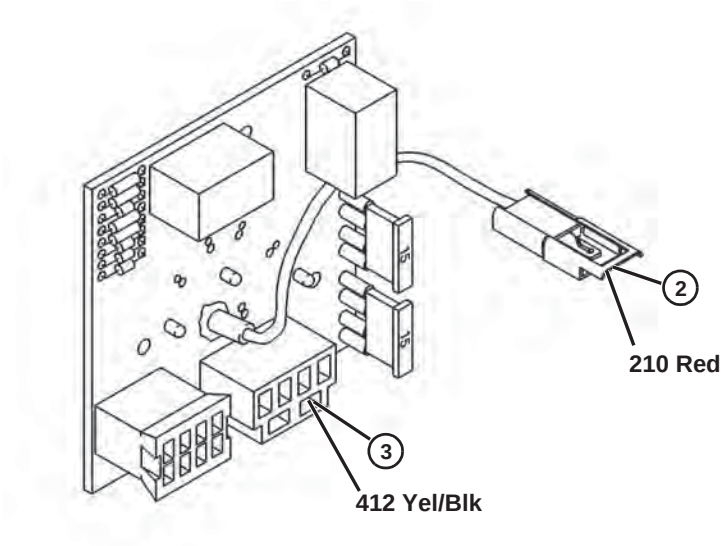
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—5.	Battery voltage.	Check fuse (F2), if OK, replace interlock module.
4. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412.
5. Headlight switch.	Battery voltage.	Test headlight switch. (See HEADLIGHT SWITCH TEST on page 5-190.)
6. Headlight connector.	Battery voltage.	Check yellow/white wire No. 450, black wires (from connector to headlights) and connections.
7. Headlights.	Headlights ON.	Test bulbs.

Test Conditions:

- Key switch in OFF position.

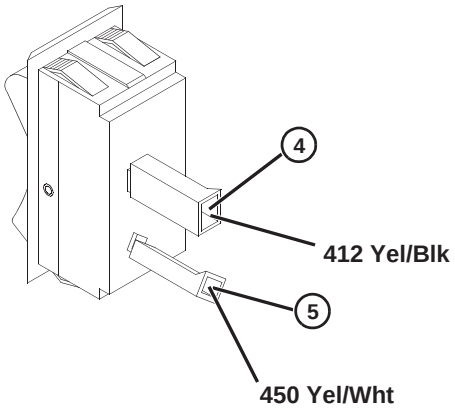
Test/Check Point	Normal	If Not Normal
8. Headlight ground.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground, black wires 101 and 111, black wires (W8 headlight harness) and connections.

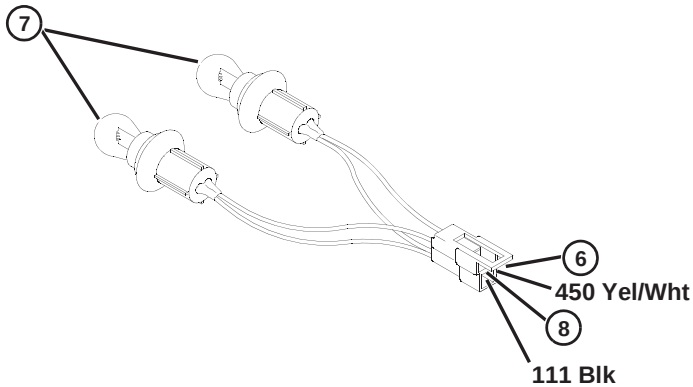




A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





FUEL SHUTOFF SOLENOID CIRCUIT OPERATION—LX188

Function:

To energize the fuel shutoff solenoid when the ignition relay is energized.

Operating Conditions:

- Key switch in START or RUN position.
- Operator on seat. (Seat switch CLOSED).

or

- PTO switch in OFF position.
- Park brake ENGAGED (brake switch CLOSED).

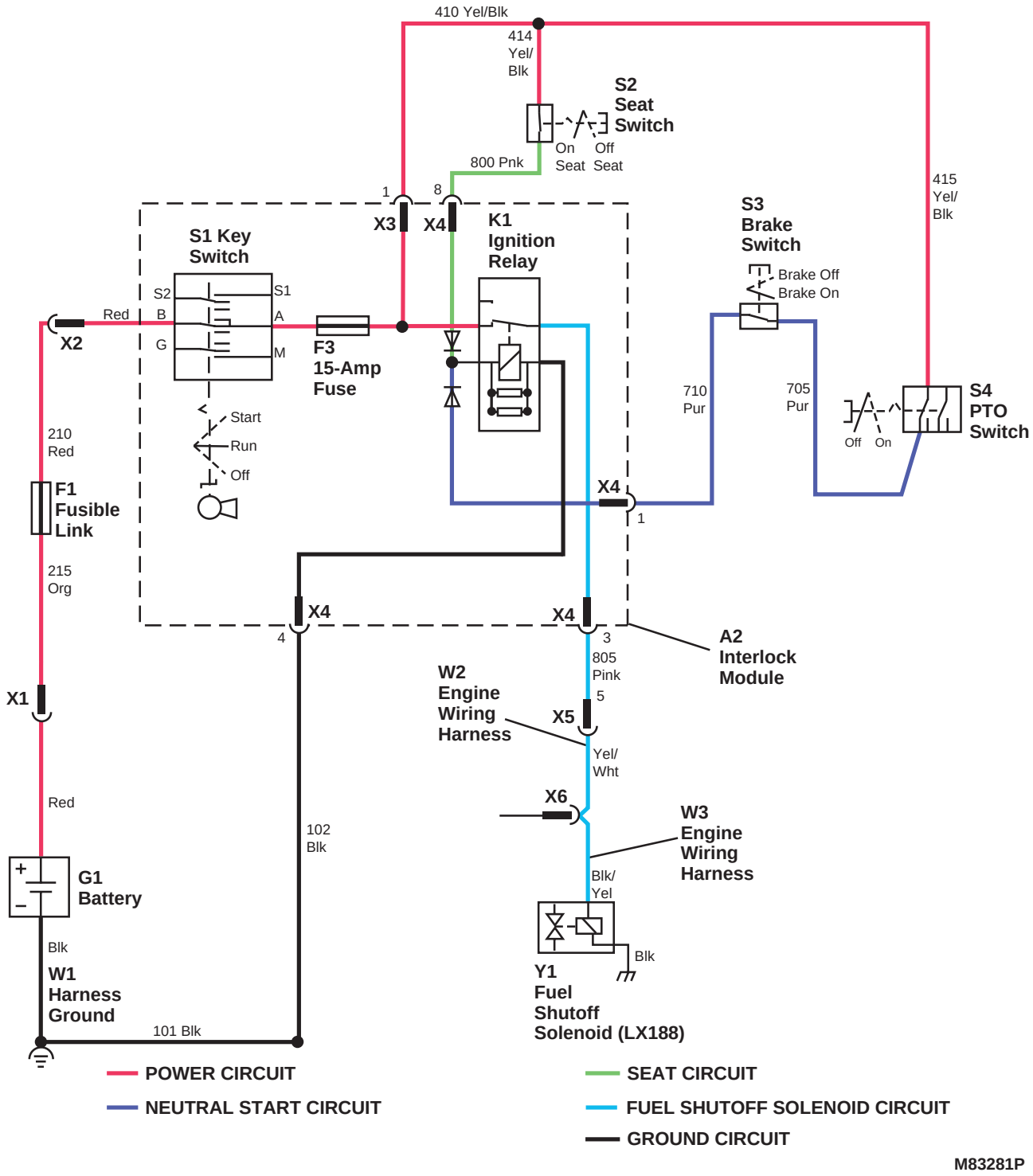
System Operation:

NOTE: The key switch and 15-amp fuse terminals are mounted on a printed circuit board (A2 Interlock Module). The components are solid state and are not serviced separately except for the 15-amp fuses. Lines within dashed border of the Interlock Module (A2) are circuit paths on the circuit board and are not wires in the harness.

The fuel shutoff solenoid (Y1) uses an electro-magnetic coil to operate a plunger. The fuel shutoff solenoid plunger stops fuel flow in the carburetor bowl when the solenoid is de-energized. The ignition relay (K1) provides power to the fuel shutoff solenoid. When the ignition relay is de-energized, the fuel shutoff solenoid stops fuel flow at the same time the spark is stopped, helping to prevent backfire at engine shutdown.

The power circuit provides current to the key switch (S1), energizes the ignition relay circuit, and protects the fuel shutoff solenoid circuit with a 15-amp fuse (F3). Current flows from the battery (G1) positive (+) terminal to the fusible link (F1), and key switch. With the key switch in the RUN position, current flows to the 15-amp fuse (F3), ignition relay terminal, seat switch (S2) and PTO switch (S4). Current cannot flow to the fuel shutoff solenoid until the ignition relay is energized. The ignition relay coil is energized by current from the seat switch or neutral start circuit.

FUEL SHUTOFF SOLENOID CIRCUIT OPERATION — LX188



M83281P

FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS—LX188

Test Conditions:

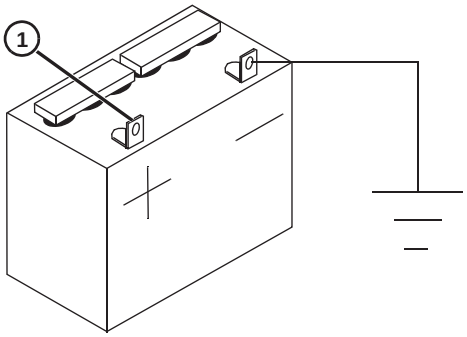
- PTO switch in OFF position.
- Key switch in RUN position.
- Check connection(s) for corrosion and looseness when checking/testing.
- Meter negative (-) lead on battery negative (-) terminal.

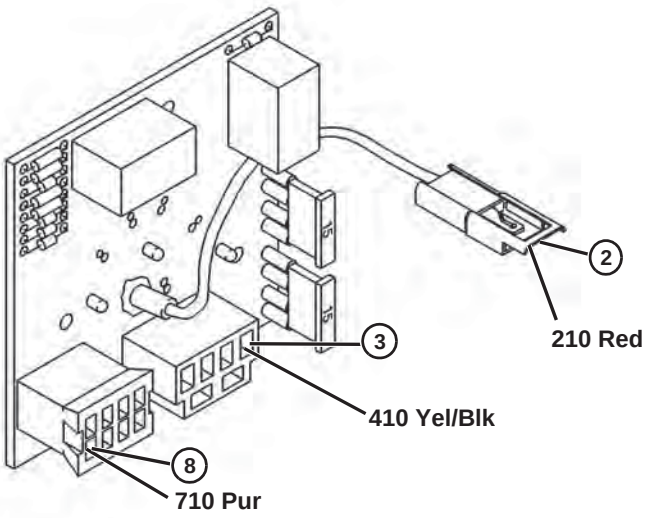
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
3. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
4. PTO switch.	Battery voltage.	Test yellow/black wires No. 410 and 415.
5. PTO switch.	Battery voltage.	Test PTO switch. (See PTO SWITCH TEST on page 5-188.)
6. Brake switch.	Battery voltage.	Test purple wire No. 705.
7. Brake switch.	Battery voltage.	Test brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
8. Interlock module—terminal X4—1.	Battery voltage.	Check purple wire No. 710.
9. Seat switch.	Battery voltage.	Check yellow/black wires No. 410 and 414 and connections.

Test Conditions:

- Operator on seat (seat switch CLOSED) or jumper wire installed in connector.
- PTO switch in ON position.

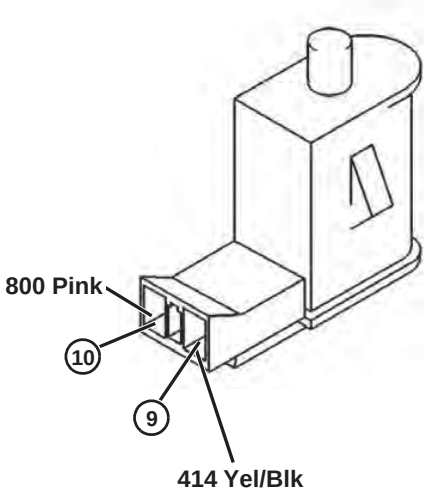
Test/Check Point	Normal	If Not Normal
10. Seat switch.	Battery voltage.	Test seat switch. (See SEAT SWITCH TEST on page 5-190.)

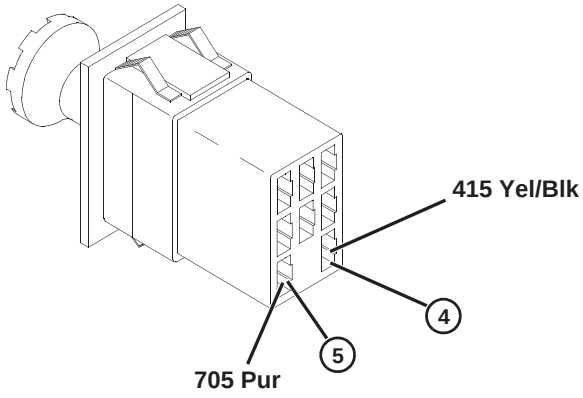




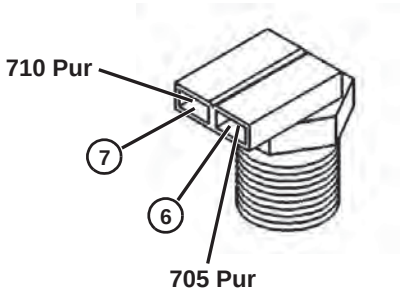
A2 Interlock Module

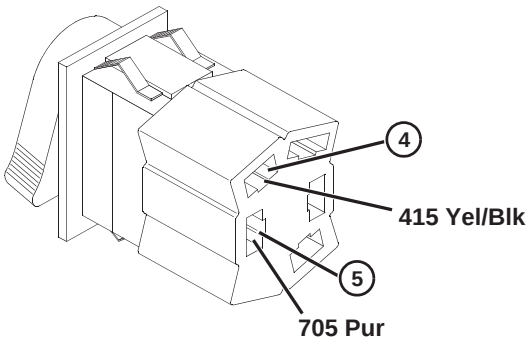
NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.





S4 PTO Switch (Late Model)





S4 PTO Switch (Early Model)

FUEL SHUTOFF SOLENOID CIRCUIT DIAGNOSIS—LX188, continued

Test Conditions:

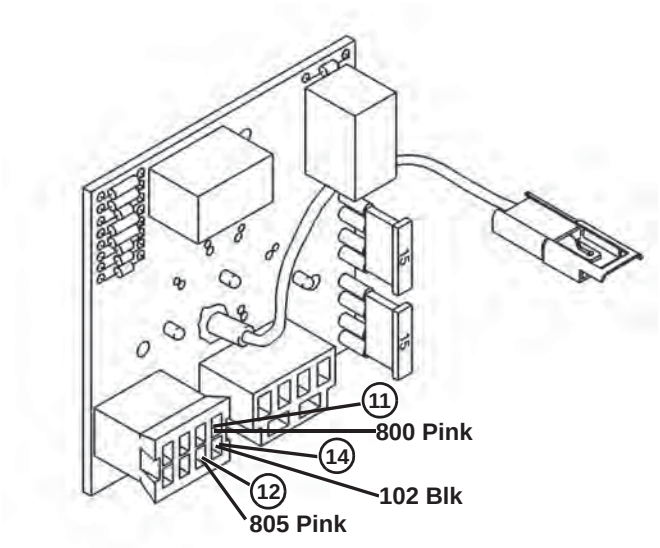
- Operator on seat (seat switch CLOSED) or jumper wire installed in connector.
- PTO switch in ON position.

Test/Check Point	Normal	If Not Normal
11. Interlock module—terminal X4—8.	Battery voltage.	Check pink wire No. 800.
12. Interlock module—terminal X4—3.	Battery voltage.	Replace interlock module.
13. Fuel shutoff solenoid.	Battery voltage.	Check pink wire No. 805, yellow/white wire and black/yellow wires (W2 engine harness) and connections.

Test Conditions:

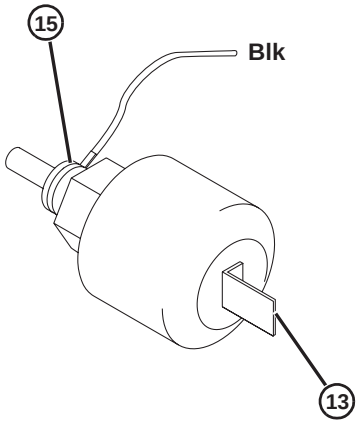
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
14. Interlock module—terminal X4—4.	Maximum 0.1 ohms resistance.	Check battery negative (-) cable, shielded ground, black wires 101 and 102 and connections.
15. Fuel shutoff solenoid.	Maximum 0.1 ohms resistance.	Check black wire (fuel solenoid ground).



A2 Interlock Module

NOTE: Relay configuration on A2 Interlock Module may vary per machine. Module may be equipped with either two separate relays, as shown, or a single dual relay.



CIRCUIT OPERATION AND DIAGNOSIS—LX173

POWER CIRCUIT OPERATION

Unswitched Power Circuit

Function:

Provides unswitched power to the primary circuit whenever the battery is connected. This circuit is protected by the fusible link. This link is a short length of wire which is designed to protect the main wiring harness and will fail if current load becomes excessive.

Operating Conditions, Unswitched Circuits:

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

- Battery positive (+) terminal.
- Battery terminal of starter solenoid.
- Battery terminal of key switch.
- Battery terminal of voltage regulator/rectifier.

The positive battery cable connects the battery (G1) to the starter solenoid. The battery cables must be in good condition for the electrical system to function properly.

Switched Power Circuit

Function:

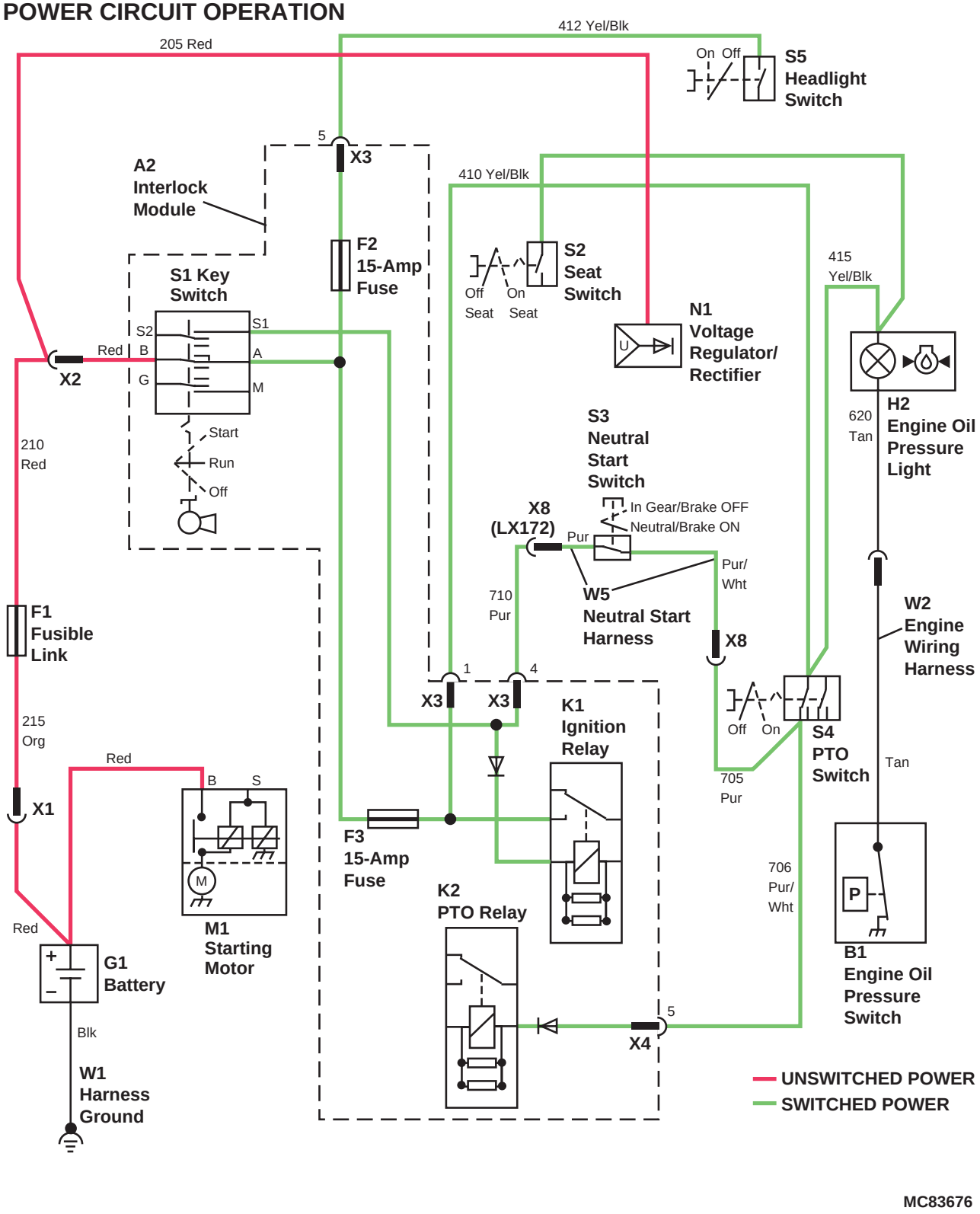
Provides switched power to the primary machine operating components by means of a key switch. In addition to the fusible link, this circuit is protected by two 15-amp fuses.

Operating Conditions, Switched Circuits:

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

- All Unswitched Locations.
- A2 Interlock Module:
  - F2 and F3 Fuse Terminals.
  - X3 Connector—Terminals 1 and 5.
- S2 Seat Switch—Yellow/Black Wire.
- PTO Switch—Yellow/Black Wire.
- S5 Headlight Switch—Yellow/Black Wire.
- H2 Oil Pressure Light—Yellow/Black Wire.
- B1 Engine Oil Pressure Switch—Tan Wire.
- S3 Neutral Start Switch—Purple Wire Terminal.

POWER CIRCUIT OPERATION



MC83676

POWER CIRCUIT DIAGNOSIS

Test Conditions:

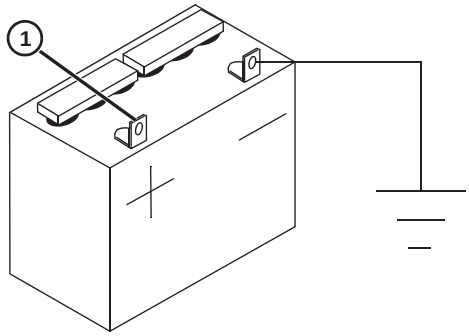
- Park brake ENGAGED.
- Key switch in OFF position.
- Meter negative (-) lead on battery negative (-) terminal.
- Meter positive (+) lead on battery (+) terminal.
- Check connection(s) for corrosion and looseness when checking/testing.

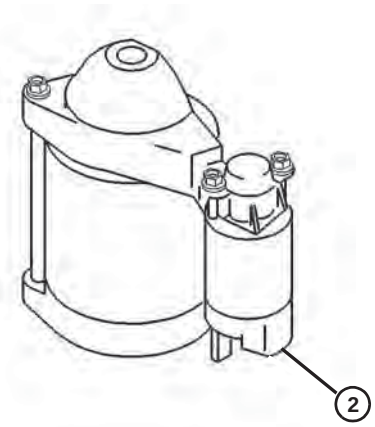
Test/Check Point	Normal	If Not Normal
1. Battery positive (+) terminal.	11.8—13.2 volts.	Test battery. (See BATTERY TEST on page 5-177.)
2. Starter solenoid to motor bolt—battery terminal.	Battery voltage.	Check battery cables and clamps. Clean and tighten connections.
3. Interlock module—connector X2.	Battery voltage.	Check orange wire No. 215, fusible link (F1), red wire No. 210 and red wire (X2 to key switch). Check connections.
4. Voltage regulator/rectifier—battery terminal.	Battery voltage.	Check red wire No. 205, black wire and connections.

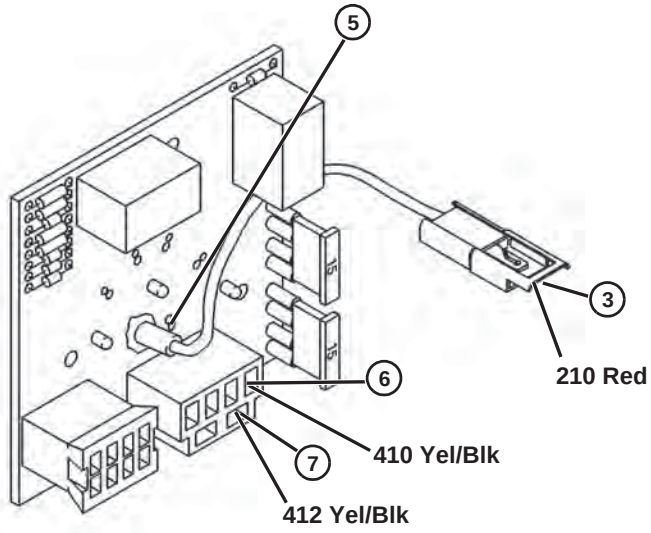
Test Conditions:

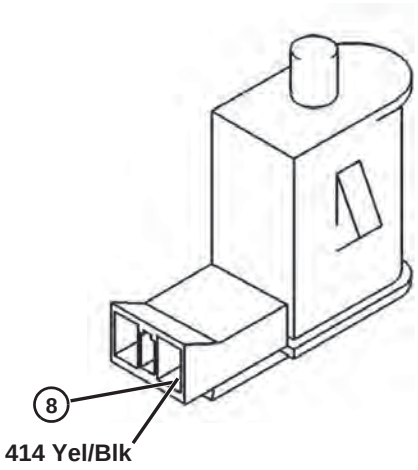
- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (Neutral start switch CLOSED).

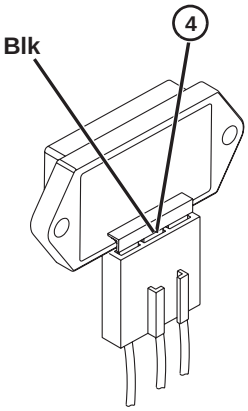
Test/Check Point	Normal	If Not Normal
5. Key switch—"A" terminal.	Battery voltage.	Replace interlock module.
6. Interlock module—terminal X3—1.	Battery voltage.	Check fuse (F3), if OK, replace interlock module.
7. Interlock module—terminals X3—5.	Battery voltage.	Check fuse (F2), if OK, replace interlock module.
8. Seat switch.	Battery voltage.	Check yellow/black wires No. 410, 415 and 420 (X3 to S2) and connections.


1


2


5
3
210 Red
6
410 Yel/Blk
7
412 Yel/Blk


8
414 Yel/Blk

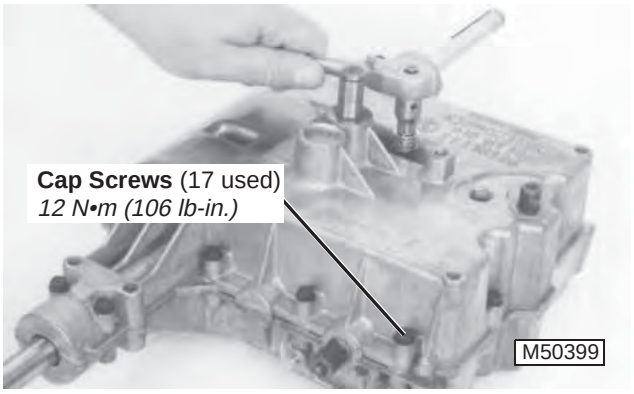

Blk
4

POWER CIRCUIT DIAGNOSIS, continued

Test Conditions:

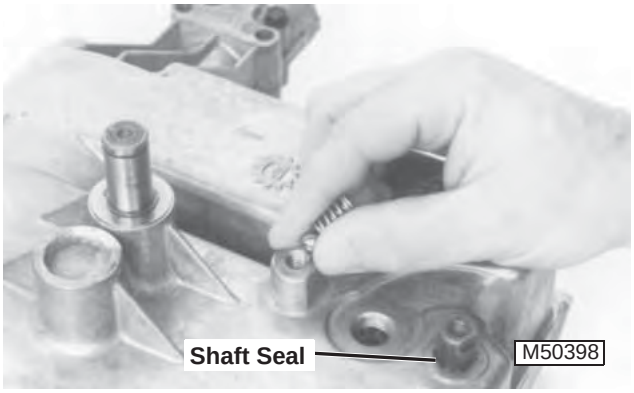
- Key switch in RUN position—engine not running.
- Transmission in NEUTRAL (Neutral start switch CLOSED.)

Test/Check Point	Normal	If Not Normal
9. PTO switch.	Battery voltage.	Check yellow/black wires No. 410 and 415 and connections.
10. Engine oil pressure light.	Light is ON. Battery voltage.	Check yellow/black wires No. 415, 410, tan wire No. 620 and connections.
11. Headlight switch.	Battery voltage.	Check yellow/black wire No. 412 (X3 to S5).

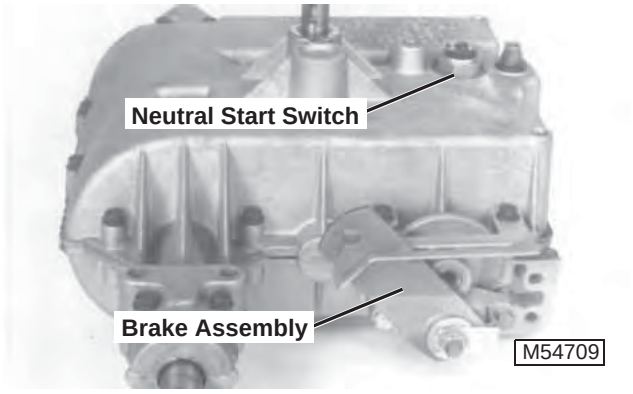


NOTE: New transaxle cases have untapped bolt holes. Use self-tapping cap screws when assembling.

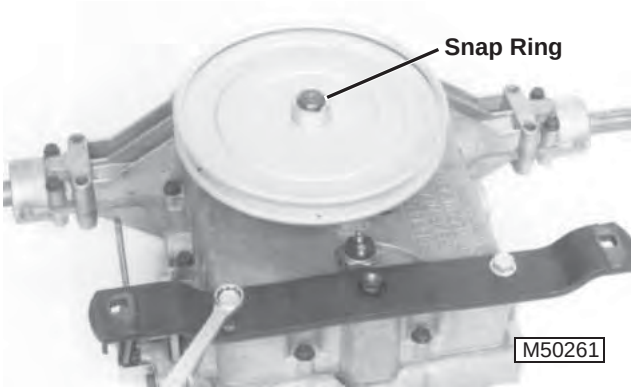
34. Align shifter fork shaft with cover hole and install cover. Tighten 17 cap screws to **12 N•m (106 lb-in.)**.



35. Install new shifter fork shaft seal until it contacts case surface.
36. Install detent ball, spring and Allen-head screw. Tighten screw one turn below flush with case cover.

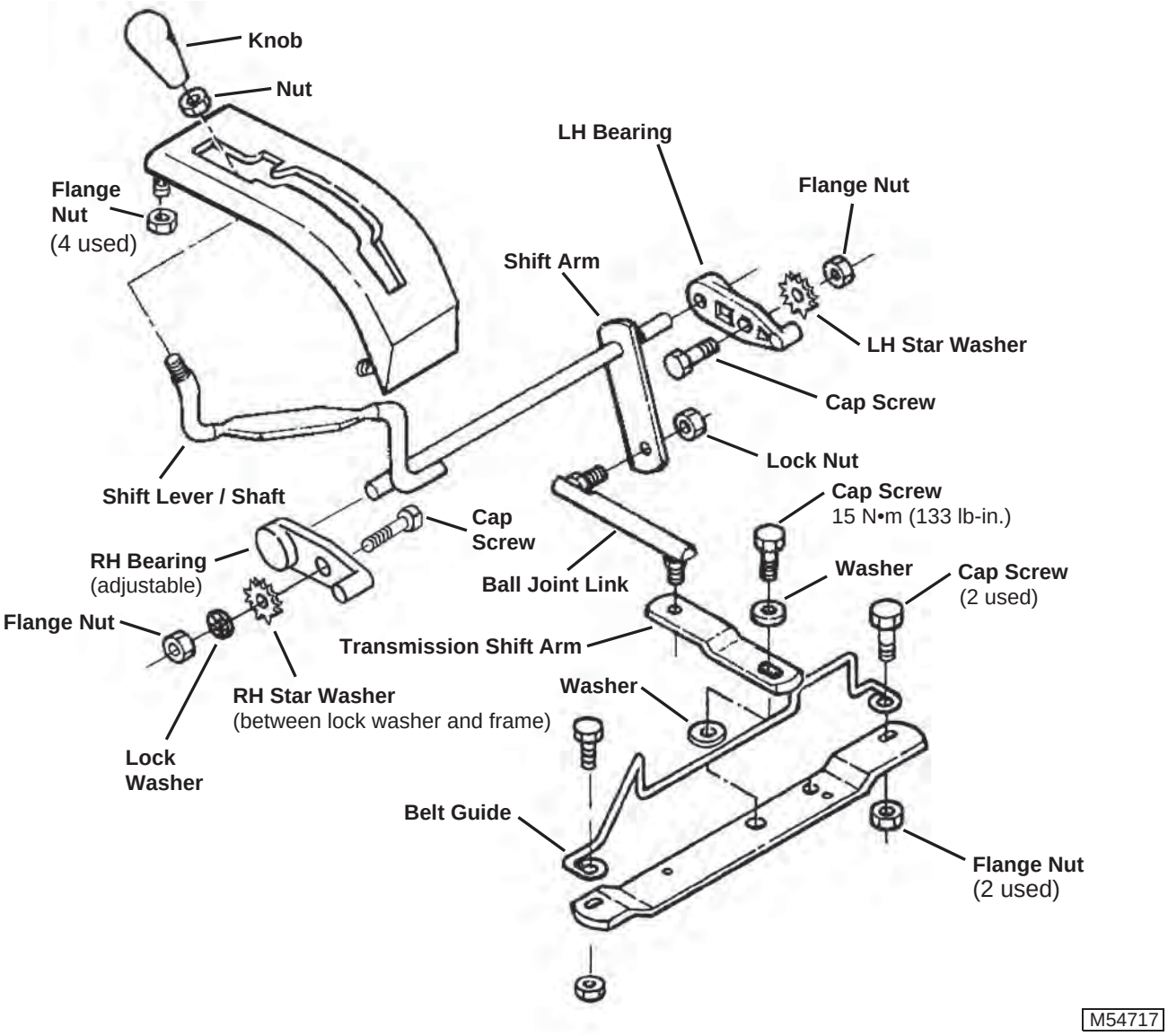


37. Install neutral start switch. DO NOT over tighten.
38. Install brake assembly. (See BRAKE ASSEMBLY —Removal/Inspection/Installation on page 9-23.)



39. Install key, transaxle drive sheave, and snap ring.
40. Install mounting support bracket. Tighten cap screws to **27 N•m (240 lb-in.)**.

SHIFT LEVER AND LINKAGE



Removal/Inspection/Installation

1. Remove fuel tank. (See FUEL TANK—Removal/ Installation on page 3-41 or 4-28.)
2. Inspect parts for wear or damage. Replace parts as necessary.

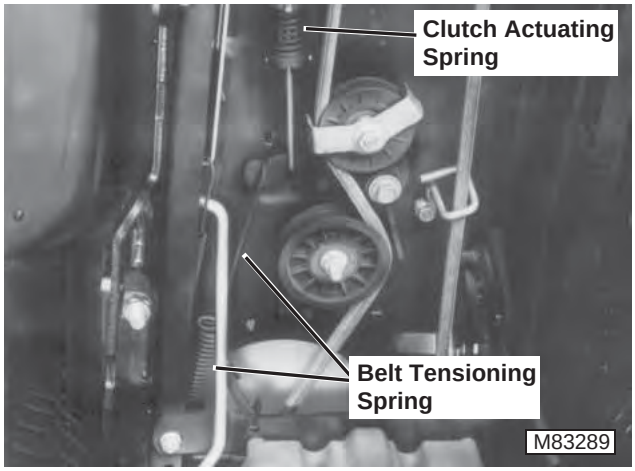
Installation is done in the reverse order of removal:

- Adjust shift lever linkage. (See GEARSHIFT LEVER NEUTRAL ADJUSTMENT on page 6-32.)

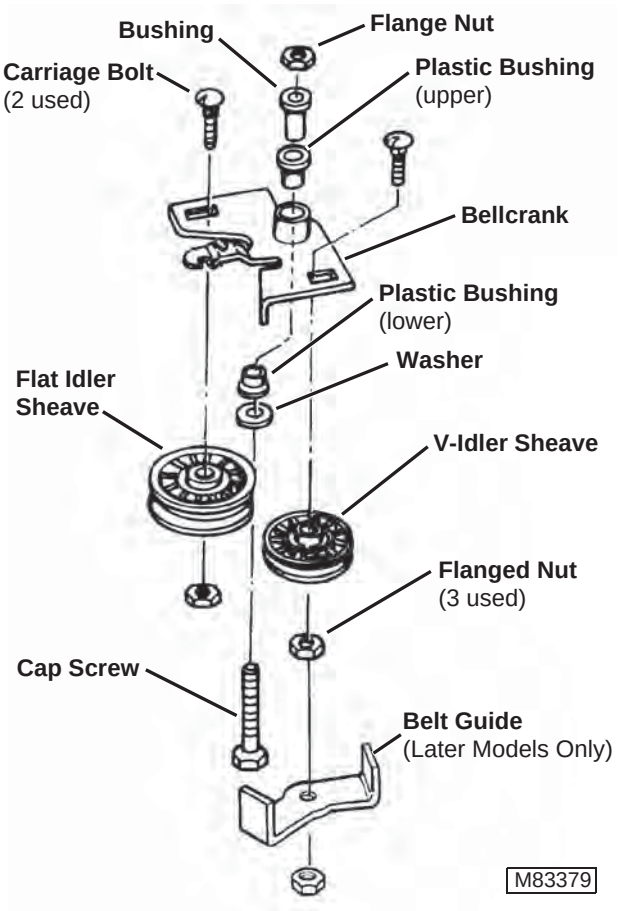
TRACTION DRIVE CLUTCH ASSEMBLY

Removal/Inspection/Installation

1. Remove:
   - Mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
   - Fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)



2. Disconnect clutch actuating spring and belt tension spring.
3. Remove drive belt. (See TRACTION DRIVE BELT–Removal/Installation on page 6–45.)

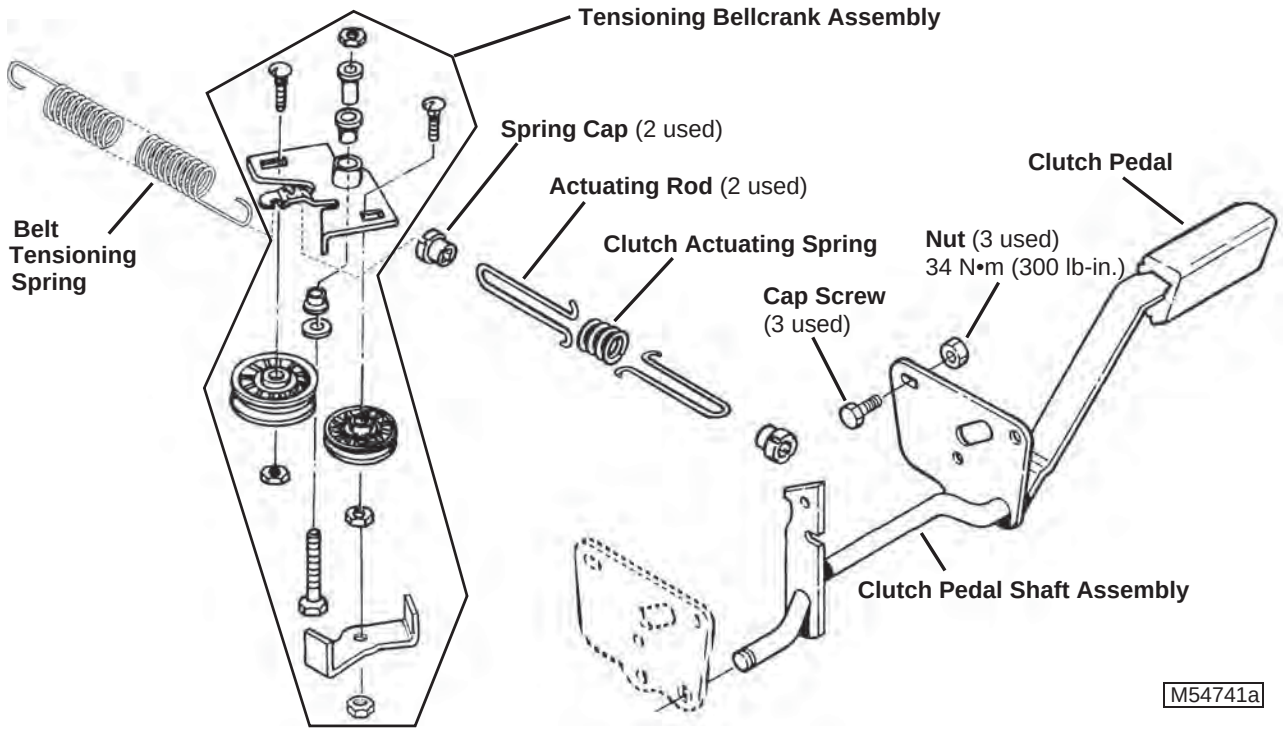


4. Remove:
   - Flat idler sheave.
   - V-idler sheave.
   - Bellcrank.
   - Bushings.
5. Inspect all parts for wear or damage. Replace parts as necessary.

Installation is done in the reverse order of removal:

- Adjust belt tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32 and TRACTION DRIVE BELT, Removal/Installation on page 6-45.)
- Adjust belt guides. (See BELT GUIDE ADJUSTMENT on page 6-33.)

CLUTCH PEDAL AND LINKAGE



Removal/Inspection/Installation

1. Remove:
   - Mower deck. (See MOWER DECK—Removal/ Installation on page 10-15, 10-21 or 10-30.)
   - Fender deck. (See FENDER DECK—Removal/ Installation on page 11-6.)
   - Drive belt. (See TRACTION DRIVE BELT, Remove/Installation on page 6-45.)
   - Brake pedal assembly. (See BRAKE PEDAL— Removal/Inspection/Installation on page 9-22.)
2. Inspect all parts for wear or damage.
3. Replace parts as necessary.

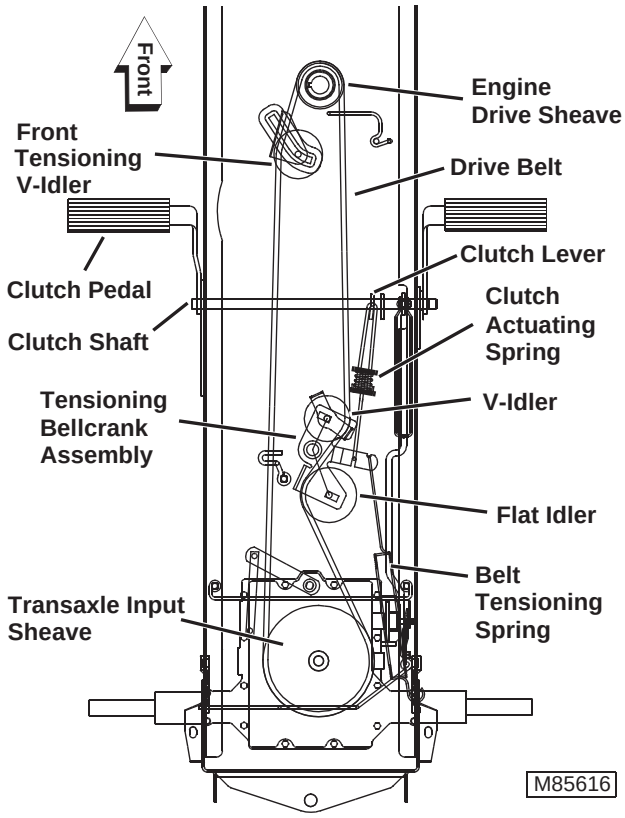
Installation is done in the reverse order of removal:

- Install drive belt. (See TRACTION DRIVE BELT, Remove/Installation on page 6-45.)
- Adjust traction drive belt. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.
- Adjust belt guides. (See BELT GUIDE ADJUSTMENT on page 6-33.)

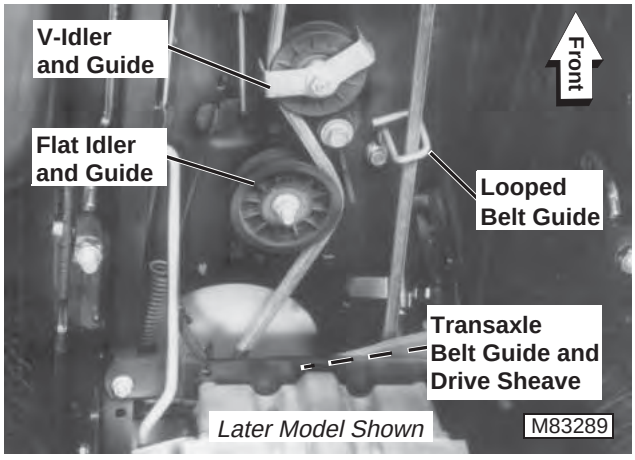
TRACTION DRIVE BELT

Removal/Installation

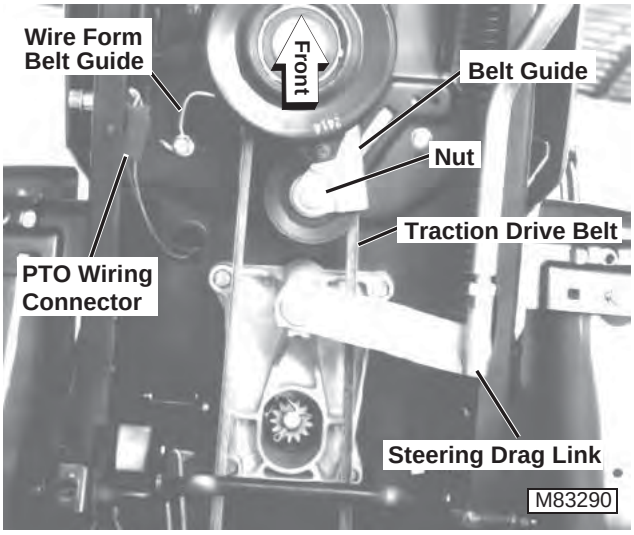
1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Lock parking brake to release belt tension.



Top View



3. Loosen transaxle belt guide.
4. Remove belt from transaxle drive sheave.
5. Remove belt from looped belt guide.
6. **Early models**—remove V-idler.
   Late models—remove guide only.
7. Loosen flat idler and guide to remove belt.



8. Remove front tensioning v-idler nut to remove belt guide.
9. Remove wire form belt guide.
10. Disconnect PTO wiring connector.
11. Disconnect steering drag link from steering arm.
12. Replace traction drive belt.

Installation is done in the reverse order of removal:

- Adjust belt tension. (Also see TRACTION DRIVE BELT TENSION ADJUSTMENT on page 6-32.)



This page intentionally left blank.

CONTENTS

Page

POWER TRAIN—HYDROSTATIC

SPECIFICATIONS
- ADJUSTMENT SPECIFICATIONS 7-2
- REPAIR SPECIFICATIONS 7-2
- OTHER MATERIALS 7-2
- SERVICE PARTS KITS 7-3
- TRANSAXLE IDENTIFICATION 7-3

JIC HYDRAULIC CIRCUIT SYMBOLS 7-4

HYDRAULIC/HYDROSTATIC SCHEMATIC 7-6

COMPONENT LOCATION AND OPERATION
- TRACTION DRIVE BELT SYSTEM OPERATION 7-7
- PEDAL CONTROL SYSTEM OPERATION 7-8
- BRAKE LINKAGE/DRIVE BELT DISENGAGEMENT PEDAL CONTROL SYSTEM OPERATION 7-9
- HYDROSTATIC SYSTEM OPERATION 7-10
- TRANSAXLE OPERATION—GEAR POWER FLOW 7-12
- TRANSAXLE OPERATION—HYDROSTATIC CONTROL LINKAGE 7-13

TROUBLESHOOTING 7-14

DIAGNOSIS
- MACHINE WILL NOT MOVE FORWARD OR REVERSE 7-16
- NOISY OPERATION 7-20
- MACHINE CREEPS 7-22
- MACHINE MOVES IN ONE DIRECTION ONLY 7-24
- ERRATIC SPEED 7-26
- MACHINE DOES NOT ACHIEVE FULL GROUND SPEED 7-30
- MACHINE IS TOO AGGRESSIVE IN FORWARD OR REVERSE 7-34
- PARK BRAKE DOES NOT HOLD MACHINE ON HILL 7-36
- BRAKE SWITCH WILL NOT ENGAGE 7-38
- FREEWHEEL VALVE WILL NOT WORK 7-40
- FREEWHEEL VALVE WILL NOT STAY OPEN WITH ENGINE OFF 7-42

ADJUSTMENTS
- HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE 7-43
- NEUTRAL CREEP ADJUSTMENT 7-43
- PEDAL HEIGHT ADJUSTMENT 7-44
- TRACTION DRIVE BELT TENSION ADJUSTMENT 7-45
- BELT GUIDE ADJUSTMENT 7-46

REPAIR
- HYDROSTATIC TRANSAXLE
  - Removal/Installation 7-47
  - Disassembly/Inspection 7-48
  - Assembly 7-52
- CONTROL PEDALS AND LINKAGE—FORWARD 7-59
- CONTROL PEDALS AND LINKAGE—REVERSE 7-60
- TRACTION DRIVE BELT 7-61
- TRACTION DRIVE BELT TENSIONER ASSEMBLY 7-62

SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

Forward Pedal-to-Frame Height . . . . . 76—80 mm (3.00—3.10 in.)

REPAIR SPECIFICATIONS

Transaxle Oil Capacity . . . . . 3.4 L (7.2 U.S. pt)
Transaxle-to-Frame Mounting Nut Torque . . . . . 27 N•m (20 lb-ft)
Reverse Pedal Set Screw Torque . . . . . 2.3 N•m (20 lb-in.)
Drain Plug Torque . . . . . 14.7 N•m (130 lb-in.)
Center Case Cap Screw Torque . . . . . 43 N•m (32 lb-ft)
Case Half Cap Screw Torque
- Same Case . . . . . 24 N•m (17 lb-ft)
- New Case . . . . . 29 N•m (21 lb-ft)

Final Pinion
- Bushing I.D. (Maximum) . . . . . 15.13 mm (0.596 in.)
- Shaft O.D. (Minimum) . . . . . 14.97 mm (0.589 in.)
- Bushing/Shaft Clearance (Maximum) . . . . . 0.50 mm (0.020 in.)

Differential Gears
- Pinion Gear I.D. (Maximum) . . . . . 15.03 mm (0.592 in.)
- Pinion Shaft O.D. (Minimum). . . . . 14.99 mm (0.590 in.)
- Pinion Gear/Shaft Clearance (Maximum) . . . . . 0.50 mm (0.020 in.)

Axle Shafts
- Bushing I.D. (Maximum) . . . . . 22.15 mm (0.872 in.)
- Axle Shaft O.D. (Minimum) . . . . . 21.98 mm (0.865 in.)
- Axle Shaft/Bushing Clearance (Maximum) . . . . . 0.50 mm (0.020 in.)

Swash Plate/Shift Block Clearance
- Standard . . . . . 0.01—0.11 mm (0.0004—0.004 in.)
- Wear Limit . . . . . 0.15 mm (0.006 in.)
- Swash Plate Plain Bearing Thickness (Minimum). . . . . 1.30 mm (0.051 in.)

Center Case Cap Screw Torque . . . . . 43 N•m (32 lb-in.)

OTHER MATERIALS

LOCTITE® PRODUCTS
U.S./
Canadian/
LOCTITE No.

Number	Name	Use
TY9375/ TY9480/ 592	Pipe Sealant with TEFLON®	Seal pipe plug.
TY6305/ TY9485/ 764	Clean and Cure Primer	Clean transaxle case mating surfaces.
TY6304/ TY9484/ 518	Flexible Sealant	Seal transaxle case.

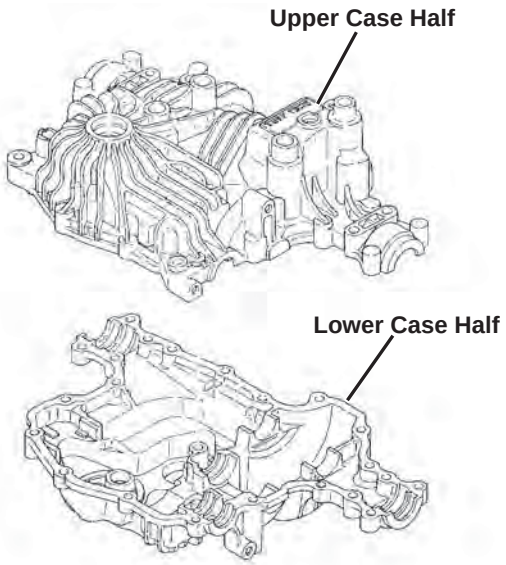
LOCTITE® is a registered trademark of the Loctite Corp.
TEFLON® is a registered trademark of the DuPont Co.

SERVICE PARTS KITS

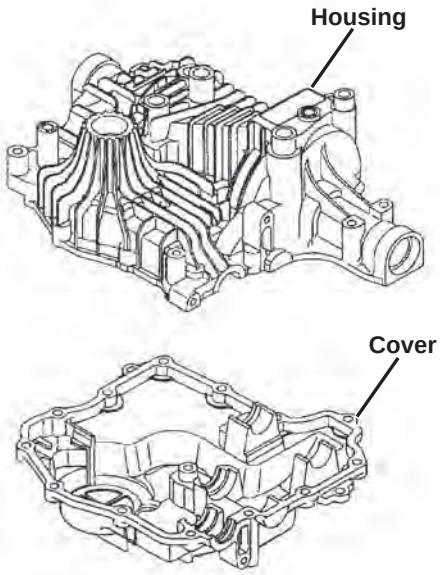
The following kits are available through your parts catalog:

- Pedal and Linkage Bushing Kit

TRANSAXLE IDENTIFICATION



K60 Transaxle M83441



K61 Transaxle M83446

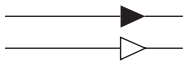
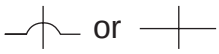
Two versions of the hydrostatic transaxle are used in the LX series lawn tractors:

- Early models use a Model K60 transaxle, and can be identified by the case split into upper and lower case halves.
- Later models use a Model K61 transaxle, and can be identified by the case being split into a housing and cover.

The operation of both transaxles is the same, with only slight differences in the disassembly/assembly procedures.

JIC HYDRAULIC CIRCUIT SYMBOLS

LINES

1		Working (Main) Lines
2		Pilot Control Lines
3		Drain Line
4		Hydraulic / Pneumatic } Flow Direction
5		Crossing Lines
6		Joining Lines
7		Flexible Line

PUMPS

8		Fixed Displacement
9		Variable Displacement

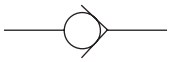
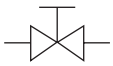
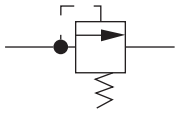
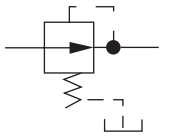
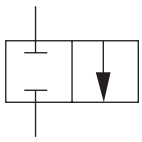
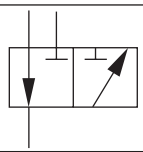
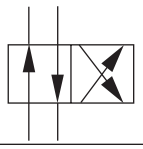
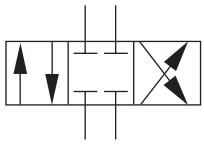
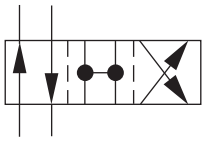
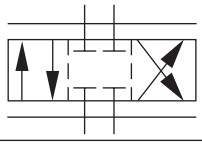
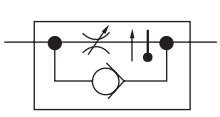
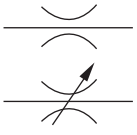
MOTORS

10		Fixed Displacement
11		Variable Displacement

RESERVOIR

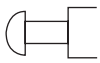
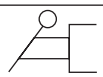
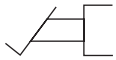
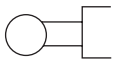
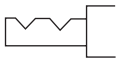
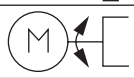
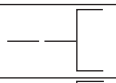
12		Vented Reservoir
13		Pressurized Reservoir
14		Reservoir Return -Above Fluid Level
15		Reservoir Return -Below Fluid Level

VALVES

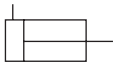
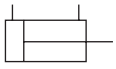
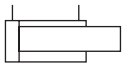
16		Check Valve
17		Manual On/Off Valve
19		Pressure Relief Valve
20		Pressure Reduction Valve
21		Two Position, Two Connection Valve
22		Two Position, Three Connection Valve
23		Two Position, Four Connection Valve
24		Three Position, Four Connection Valve
25		Two Position, Four Connection Valve with Transmission
26		Three Position, Four Connection Valve with Infinite Positioning
27		Adjustable Flow Control Valve (Temperature and Pressure Compensated)
18		Fixed / Variable } Orifice

M82612AE

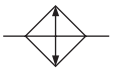
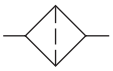
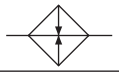
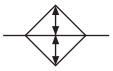
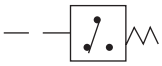
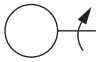
VALVE OPERATORS

28		Spring
29		Manual
30		Push Button
31		Push/Pull Lever
32		Pedal or Treadle
33		Mechanical
34		Detents
35		Pressure Compensated
36		Solenoid-Single Winding
37		Reversing Motor
38		Pilot Pressure -Remote Supply
39		Pilot Pressure -Internal Supply

CYLINDERS

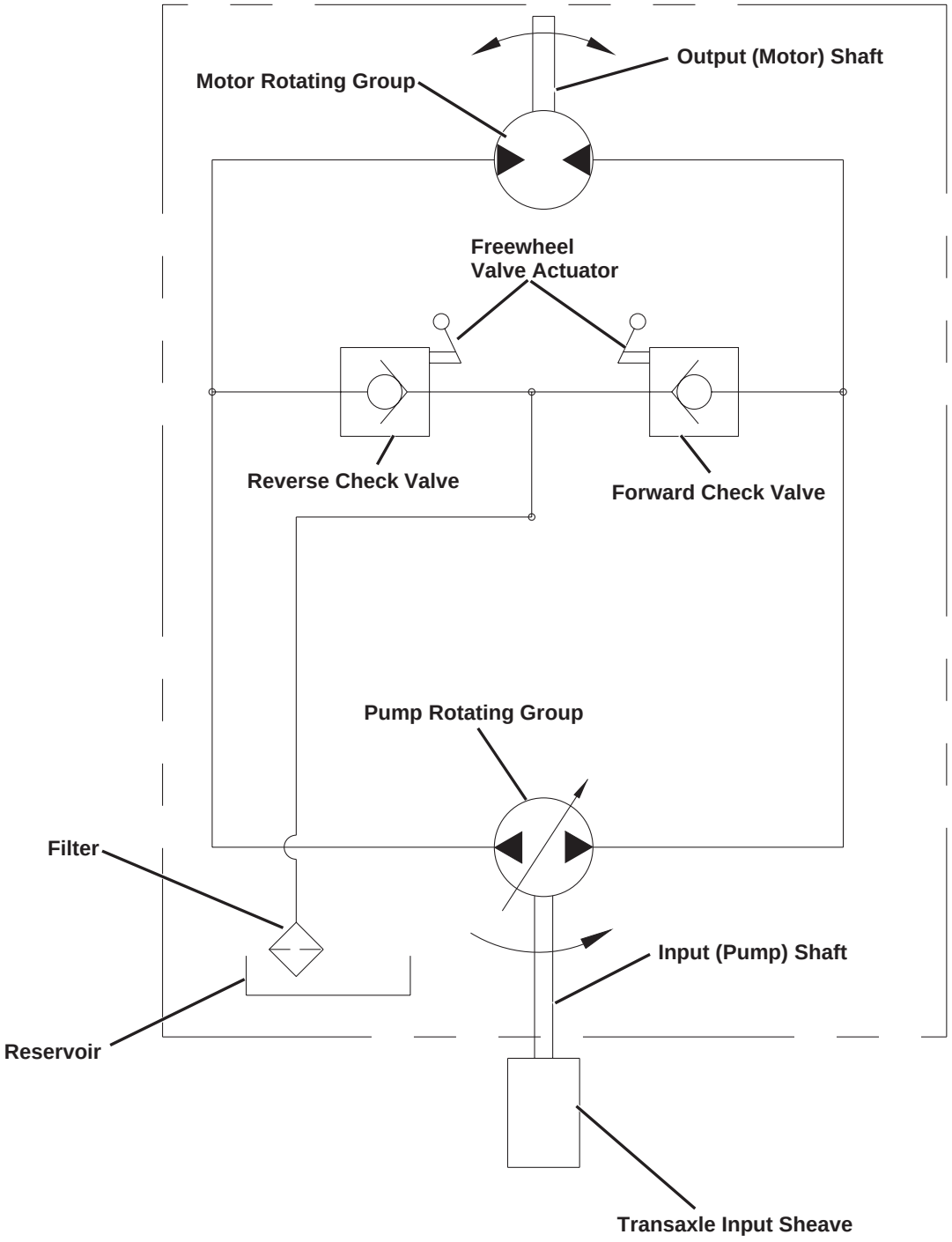
40		Single Acting
41		Double Acting, Single Rod
42		Double Acting, Double Rod
43		Double Acting, Adj. Cushion, Extend Only
44		Double Acting, Differential Piston

MISCELLANEOUS

45		Cooler
46		Filter, Strainer
47		Heater
48		Temperature Controller
49		Pressure Switch
50		Pressure Indicator
51		Temperature Indicator
52		Pressure Compensated
53		Variable Component (Symbol Thru Component)
54		Plug, Test Port, Pressure Supply Test
55		Gas Charged Accumulator
56		Spring Loaded Accumulator
57		Electric Motor
58		Shaft Rotation (Arrow on Near Side of Shaft)
59		Component Outline

M82613AE

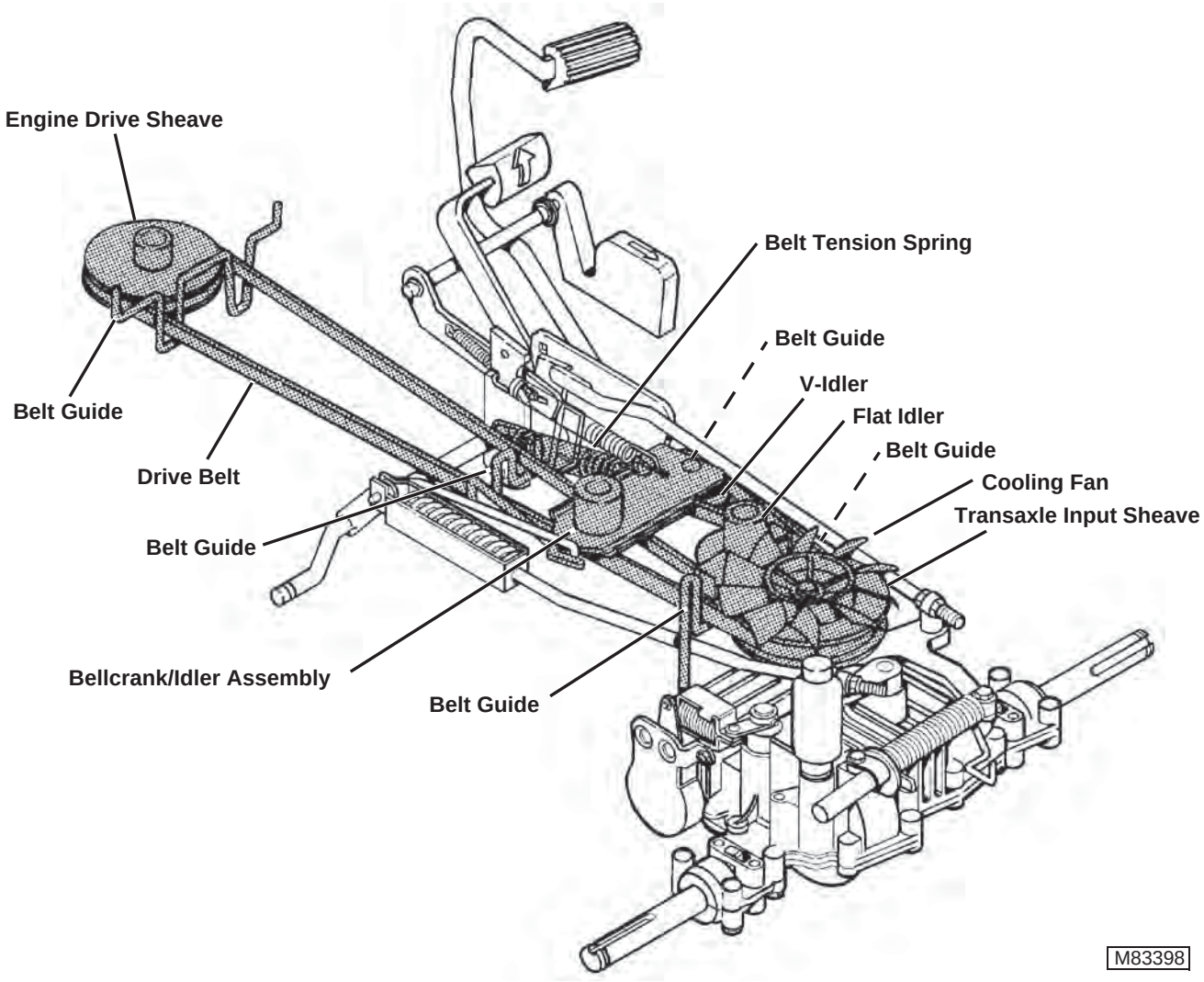
HYDRAULIC/HYDROSTATIC SCHEMATIC



M83530

COMPONENT LOCATION AND OPERATION

TRACTION DRIVE BELT SYSTEM OPERATION



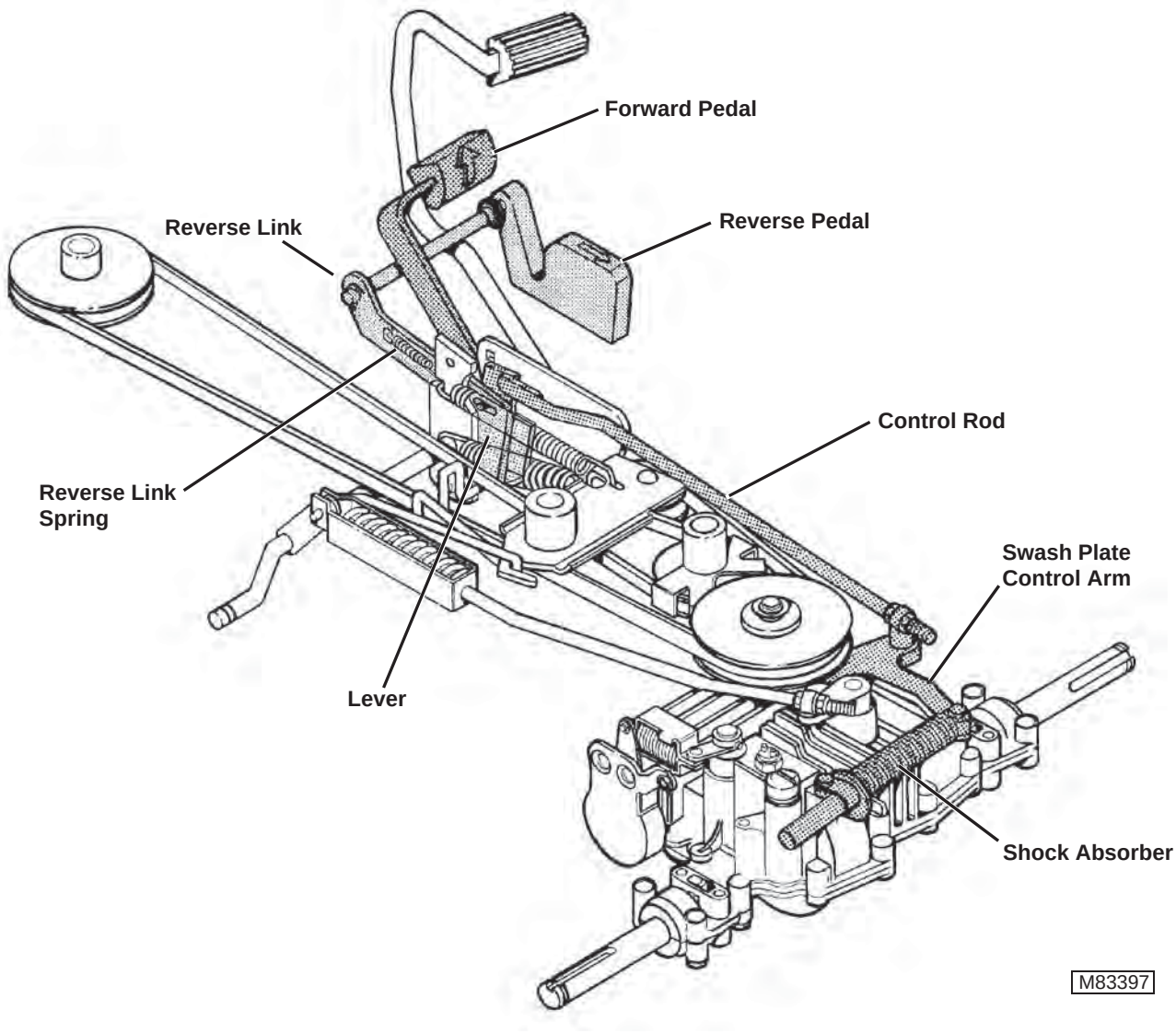
Function:

The function of the drive belt system is to transfer power from the engine to the transaxle.

Theory of Operation:

The engine drive sheave is keyed to the engine crankshaft. Power is transferred through the drive belt to the transaxle input sheave. Belt tension is maintained by the bellcrank/idler assembly and belt tension spring. Belt tension is adjusted by moving the idler in its slotted mounting hole. Belt guides keep the belt in the correct position and reduce unwanted vibration. The cooling fan helps cool transaxle by forcing blown air down over transaxle, lowering lubricant temperature

PEDAL CONTROL SYSTEM OPERATION



Function:

The pedal control system actuates the mechanism within the transaxle for forward and reverse machine movement.

Theory of Operation:

Neutral

When neither the forward or reverse pedals are depressed, the internal neutral return spring of the hydrostatic transmission positions the pump variable displacement swash plate into a flat, zero displacement relationship with the pump cylinder block rotating group. No pressure or rotation is generated between the pump and motor rotation groups. Foot control linkage return springs aid in returning and holding neutral position.

Forward

When the forward pedal is depressed, the lever which is part of the forward pedal assembly rotates toward the front of the machine. As the lever moves, the control rod connected to the lever and the hydrostatic control arm also moves forward. This causes the transaxle to shift into forward drive.

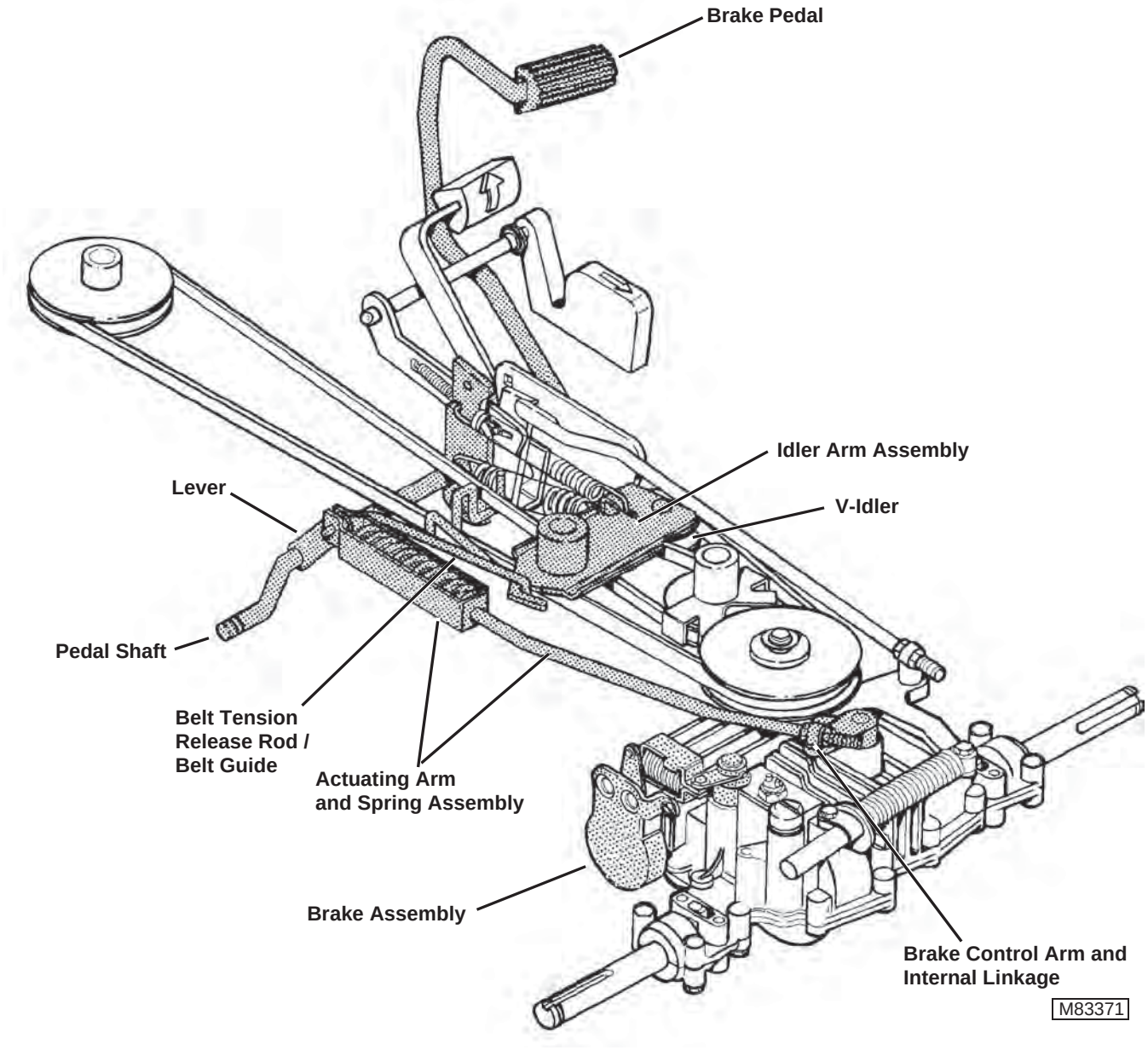
The reverse link spring is tensioned slightly to aid in keeping the reverse link from vibrating in its no-motion slot while the forward pedal is engaged.

Reverse

The reverse pedal is connected to the lever by the reverse link. As the reverse pedal is depressed, the reverse link, lever and control rod are driven toward the rear of the machine. This causes the transmission to shift into reverse drive.

When the forward/reverse pedals are released, the transmission is returned to the neutral position by a swash plate linkage neutral return spring located inside the transaxle. This motion is dampened by the shock absorber to eliminate sudden jerks.

BRAKE LINKAGE/DRIVE BELT DISENGAGEMENT PEDAL CONTROL SYSTEM OPERATION



Function:

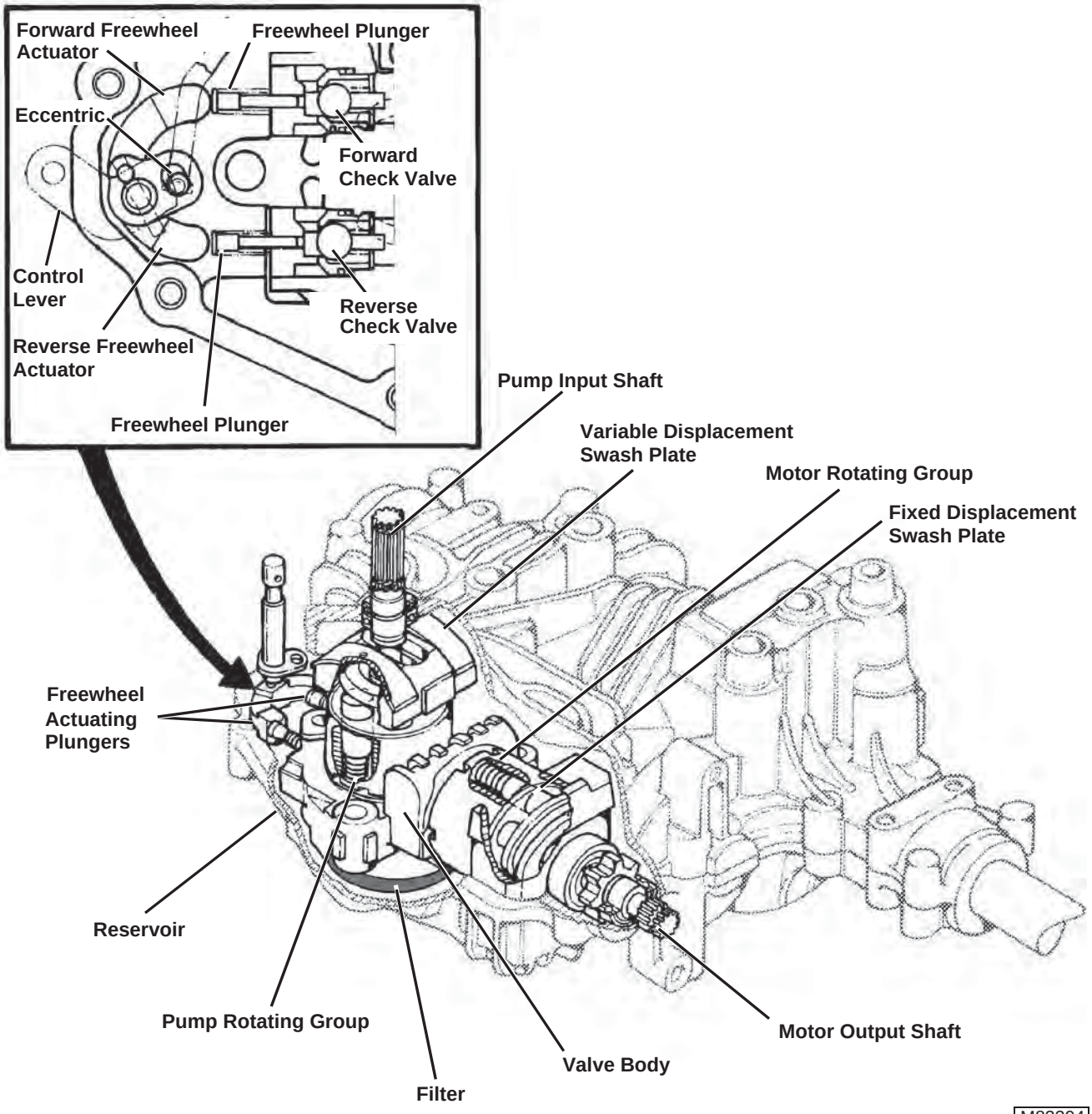
To stop machine motion and disengage power from the engine to the transaxle.

Theory of Operation:

When the brake pedal is depressed it rotates the pedal shaft and lever forward. Attached to the lever is the belt tension release rod and belt guide. Movement of the lever is transferred to the rod which engages the end of the slot in the idler arm assembly. Continued movement pulls the left side of the idler arm forward and disengages drive belt tension of the v-idler.

Also attached to the lever is the brake actuating rod and spring assembly. Movement of the lever is transferred through the rod to the transaxle brake control arm and internal linkage to the external brake assembly for machine braking action.

HYDROSTATIC SYSTEM OPERATION



Function:

Transfers power from the input sheave to the gear drive components of the transaxle. It also provides infinitely variable speed and torque within a range in forward and reverse direction.

Theory of Operation:

As the pump input shaft is turned by the traction drive belt and input sheave, it also turns the pump rotating group. The pump rotating group is a axial piston design with a variable displacement swash plate. It draws pressure-free oil from the reservoir through the filter and supplies oil to the hydrostatic motor. The motor rotating group is a bi-directional axial piston design with a fixed position swash plate and converts hydraulic energy into rotary motion. This rotary motion of the motor output shaft is the beginning of the gear power flow.

Freewheel

When the freewheel valve control lever is engaged, this rotates the eccentric, moving the actuator. The actuator moves the freewheel valve plungers against the forward/reverse check valves. This forces the check valves off their seats and allows oil to flow from both sides of the motor to the reservoir. Normally the motor would have excessive resistance to movement due to dynamic braking of the hydrostatic closed loop.

Neutral

With the transmission in the neutral position, springs in the pump cylinder block force the pump pistons against the variable displacement swash plate which is parallel to the pump body. With the swash plate parallel to the pump body, there is no reciprocating motion of the pistons; therefore no oil is pumped to the motor rotating group. Both directional check valves are closed because there is no demand for oil in the pump. The pump is in a zero displacement position and the machine remains stationary.

Forward

As the direction control arm is moved to the forward position this angles the variable displacement swash plate within the transaxle.

Springs inside the pistons force them against the swash plate. As the pistons rotate and follow the contour of the swash plate they move outward drawing oil into their bores. As the pistons continue to rotate, the swash plate angle forces the pistons back into the bores and displaces the oil through porting in the valve body.

High pressure oil from the pump forces the forward check valve closed and supplies high pressure oil to the drive motor rotating group.

The motor rotating group works in conjunction with a fixed displacement swash plate. Oil enters the piston bore through a port in the valve plate at a point where the piston is compressed in its bore.

As the oil fills the piston bore, the piston is forced out and follows the contour of the fixed swash plate. This creates the rotary motion in the motor rotating group for forward drive. Oil pressure within these components is directly proportional to the load encountered. This is known as the high pressure side.

As the motor continues to rotate, its pistons are compressed by the fixed angle of the swash plate and oil is forced from the piston bores into the other port within the valve body. There is minimal oil pressure from the pump back to the motor and this is referred to as the low pressure side.

Reverse

As the direction control arm is moved to the reverse position, the variable displacement swash plate is moved from the neutral position (parallel to the pump body) to a reverse angle position. Springs inside the cylinder bores force the pistons against the swash plate. As the pistons rotate and follow the contour of the swash plate they move outward, drawing oil into their bores. As the pistons continue to rotate, the swash plate angle forces the pistons back into the bores, forcing oil out of the bores through the valve plate.

High pressure oil from the pump forces the reverse check valve closed and supplies high pressure oil to the drive motor rotating group. Oil enters the piston bore at a point where the piston is compressed. As the oil fills the piston bore, the piston is forced out and follows the contour of the swash plate. This causes the motor rotating group to rotate, but in the opposite, reverse direction.

The piston continues to expand in its bore and follow the fixed angle swash plate until it is no longer aligned with the delivery port of the valve body. Since oil is no longer being displaced to the piston, it no longer adds to the rotary motion of the motor. But, pistons next in line to it are now filling with oil, so the motion is continued.

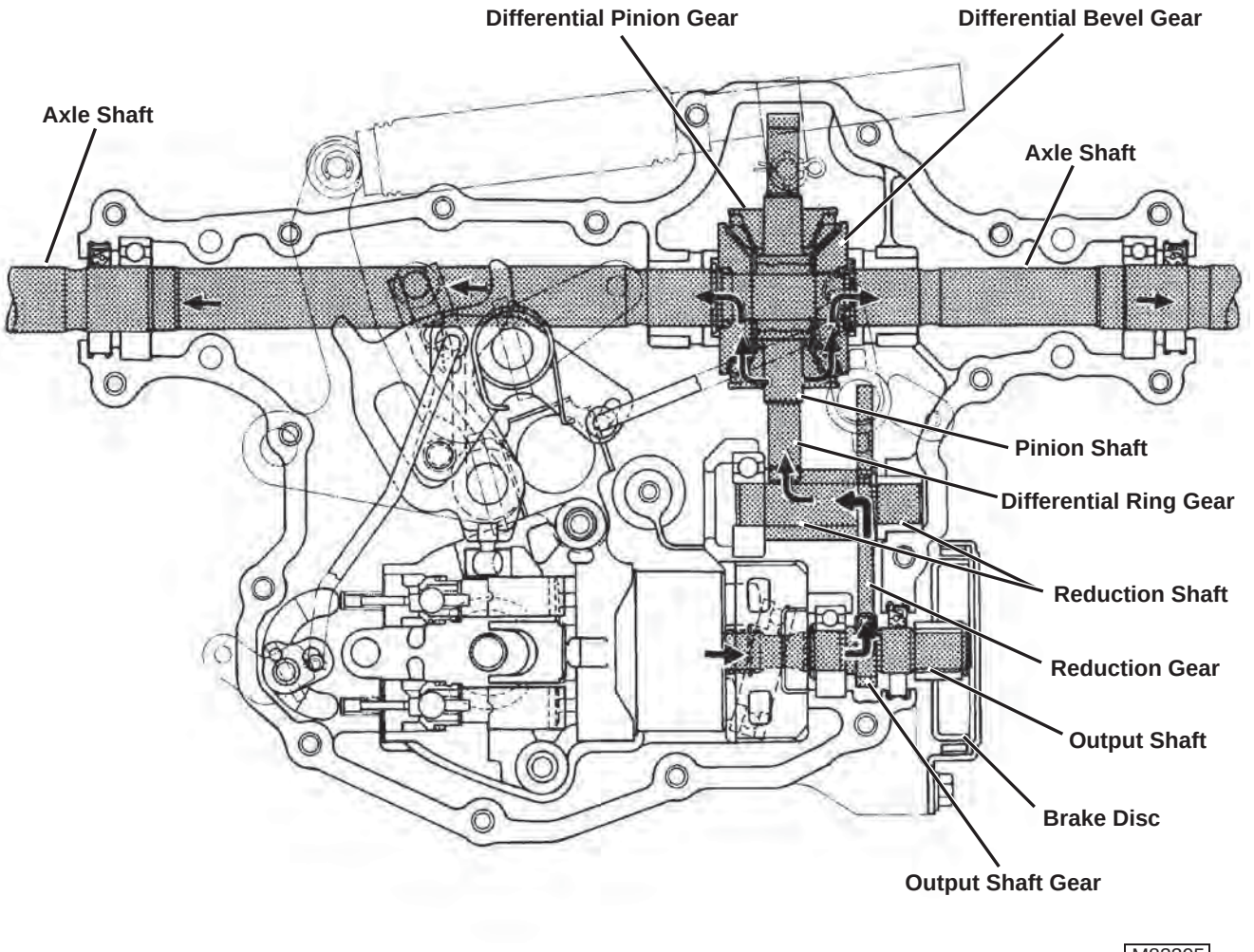
As the motor continues to rotate, the piston is now forced back into its bore by the fixed angle swash plate. As this is happening the piston is in alignment with the return port in the valve body and oil is directed back into the suction side of the pump.

The oil path from the pump to the motor is known as the high pressure side because oil pressure builds, depending on the system load. The oil path from the motor back to the pump is known as the low pressure side. From forward drive to reverse drive these two paths switch, which gives opposite rotation to the motor.

A certain amount of oil is lost from the pump and motor rotating groups. This is due to normal leakage or may be caused by component wear. Since this oil is recirculated there needs to be a means of replacing it. This is accomplished by the directional check valves.

When in reverse, the reverse check valve is closed due to high pressure oil forcing it against the seat. The forward check valve will open to sump if the pump demands oil on the low pressure side of the closed loop.

TRANSAXLE OPERATION—GEAR POWER FLOW



Function:

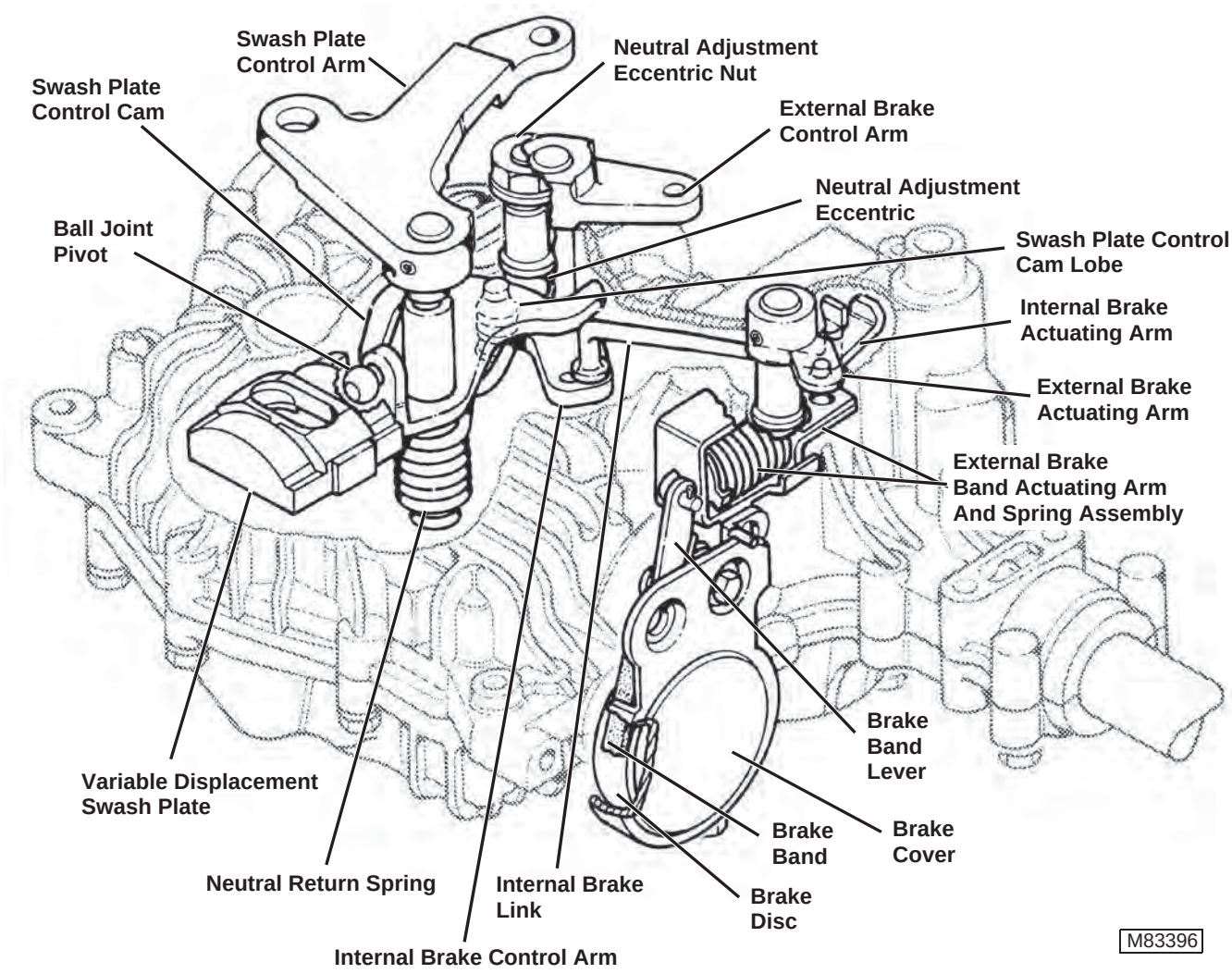
The gear components transfer power from the hydrostatic transaxle components of the transaxle out the drive axles to the drive wheels. They also provide a means of making turns with differential action for smooth operation.

Theory of Operation:

The output shaft and output shaft gear are splined to the hydrostatic motor. Power from the motor is transferred to the shaft. The output shaft gear meshes with the reduction gear which drives the reduction shaft. The reduction shaft drives the differential ring gear. Power is transferred from the ring gear to the differential pinion shaft and differential pinion gears. The differential bevel gears are splined to the axle shafts and transfer power directly out to the drive wheels.

Splined to the end of the motor output shaft is the brake disc of the brake assembly.

TRANSAXLE OPERATION—HYDROSTATIC AND BRAKE CONTROL LINKAGE



Function:

The function of the internal hydrostatic/brake linkage is to control the movement of the variable displacement swash plate to include forward, reverse, return to neutral, true neutral, and in emergency situations stop motor output shaft and drive axle rotation.

Theory of Operation:

When the swash plate control arm is moved to the forward position, this moves the swash plate control cam an equal amount. Part of the control cam is a ball joint pivot that is connected to the variable position swash plate. Movement from the ball joint pivot is induced into the swash plate which allows the pump piston to reciprocate.

When force is removed from the swash plate control arm the swash plate returns to the neutral position. The neutral return spring applies pressure on the lobe that is attached to the swash plate control cam. This forces the control cam back to the neutral position.

When in neutral, the lobe on the swash plate control cam is retained between the two legs of the torsion spring. The spring legs rest on the neutral adjustment eccentric. The neutral adjustment eccentric, when turned, moves the spring legs and swash plate control cam lobe to obtain true neutral. The neutral adjustment eccentric is held in place by a nut.

When the brake pedal is depressed, the brake linkage rotates the external and internal brake control arms forward. The internal brake link pulls the internal brake actuating arm to the right (counterclockwise) rotating the external brake actuating arm reward, compressing the spring of the external brake band actuating arm and spring assembly. This action rotates the brake band lever and tightens the brake band around the brake disc which is splined to the motor output shaft, stopping axle rotation. As the brake pedal is released, the spring expands and relaxes band tension, allowing the motor output shaft to rotate and transfer power to the differential, drive axles, and rear wheels.

TROUBLESHOOTING

POWER TRAIN TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Machine will not move forward or reverse.	Transmission noisy.	Machine creeps.	Machine moves in one direction only.	Erratic speed.	Machine does not achieve full ground speed.	Machine is too aggressive in forward or reverse.	Park brake does not hold machine on hill.	Brake switch will not engage.	Freewheel valve will not work.	Freewheel valve will not stay open with engine off.
Oil level low.	●	●			●	●					
Temperature too cold.		●	●			●					
Wrong oil/incorrect viscosity.		●	●			●					
Control linkage out of adjustment or damaged.	●		●	●		●			●		
Brake linkage damaged.	●	●			●	●		●	●		
Defective brake switch.									●		
Park brake engaged.	●	●				●					
Traction drive belt broken, worn, etc.	●				●	●					
Air in system.		●			●	●					
Internal oil filter plugged.	●	●			●	●					
Cooling fan broken. Oil too hot.						●					
Debris/trash on transmission. Oil too hot.						●			●		
Water in oil.		●			●						
Shock absorber binding/damaged.	●		●	●		●	●		●		
Neutral eccentric out of adjustment.			●								
Control arm roll pin broken.	●		●			●					

Continued on next page.

POWER TRAIN TROUBLESHOOTING CHART, continued

Problem or Symptom / Check or Solution	Machine will not move forward or reverse.	Transmission noisy.	Machine creeps.	Machine moves in one direction only.	Erratic speed.	Machine does not achieve full ground speed.	Machine is too aggressive in forward or reverse.	Park brake does not hold machine on hill.	Brake switch will not engage.	Freewheel valve will not work.	Freewheel valve will not stay open with engine off.
Control arm broken. [a]	●		●	●		●					
Internal transmission damage (pump or motor). [a]	●	●			●	●					
Input shaft broken. [a]	●										
Freewheel linkage stuck or damaged. [a]	●	●			●	●				●	●
Reverse check valve stuck open. [a]	●			●	●	●					
Forward check valve stuck open. [a]	●			●	●	●					
Motor shaft damaged. [a]	●				●			●			
Motor shaft gear damaged. [a]	●				●			●			
Final drive pinion damaged. [a]	●	●			●			●			
Final ring gear damaged. [a]	●	●			●			●			
Differential gears damaged. [a]	●							●			
Axle shaft damaged. [a]	●							●			

[a] Requires removal of transmission from machine and disassembly.

DIAGNOSIS

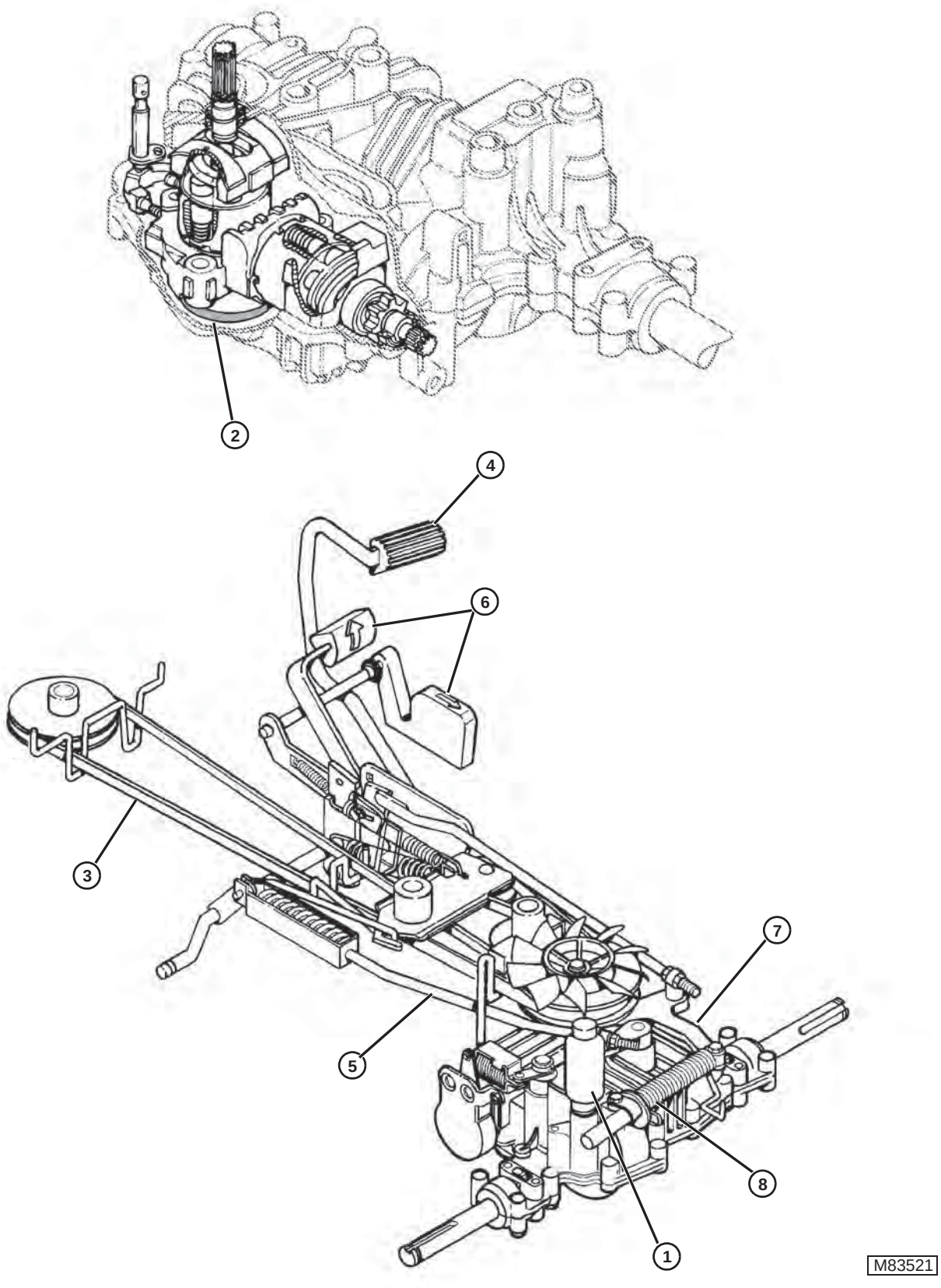
MACHINE WILL NOT MOVE FORWARD OR REVERSE

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle reservoir.	Hydraulic oil at full mark.	Fill reservoir to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
2. Hydrostatic oil filter.	Clean, free of debris, not plugged.	Replace filter.
3. Traction drive belt.	Properly tensioned.	Adjust tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 7-45.)
	Not broken, worn, frayed, glazed or stretched.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 7-61.)
4. Park brake.	Brake not depressed and locked.	Release park brake.
5. Brake linkage.	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)
	Brake rod and lever not damaged or binding.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-25.)
6. Forward/reverse pedal linkage.	Linkage properly adjusted.	Adjust linkage. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)
	Linkage moves freely, not damaged.	Eliminate binding, replace faulty or damaged components. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59 and CONTROL PEDALS AND LINKAGE—REVERSE on page 7-60.)
7. Control arm.	Not damaged. Roll pin not broken or missing.	Replace control arm. Replace roll pin.
8. Shock absorber.	Not binding or damaged.	Replace shock absorber.

Continued on page 7-18.



NOTE: K60 Transaxle shown. K61 similar.

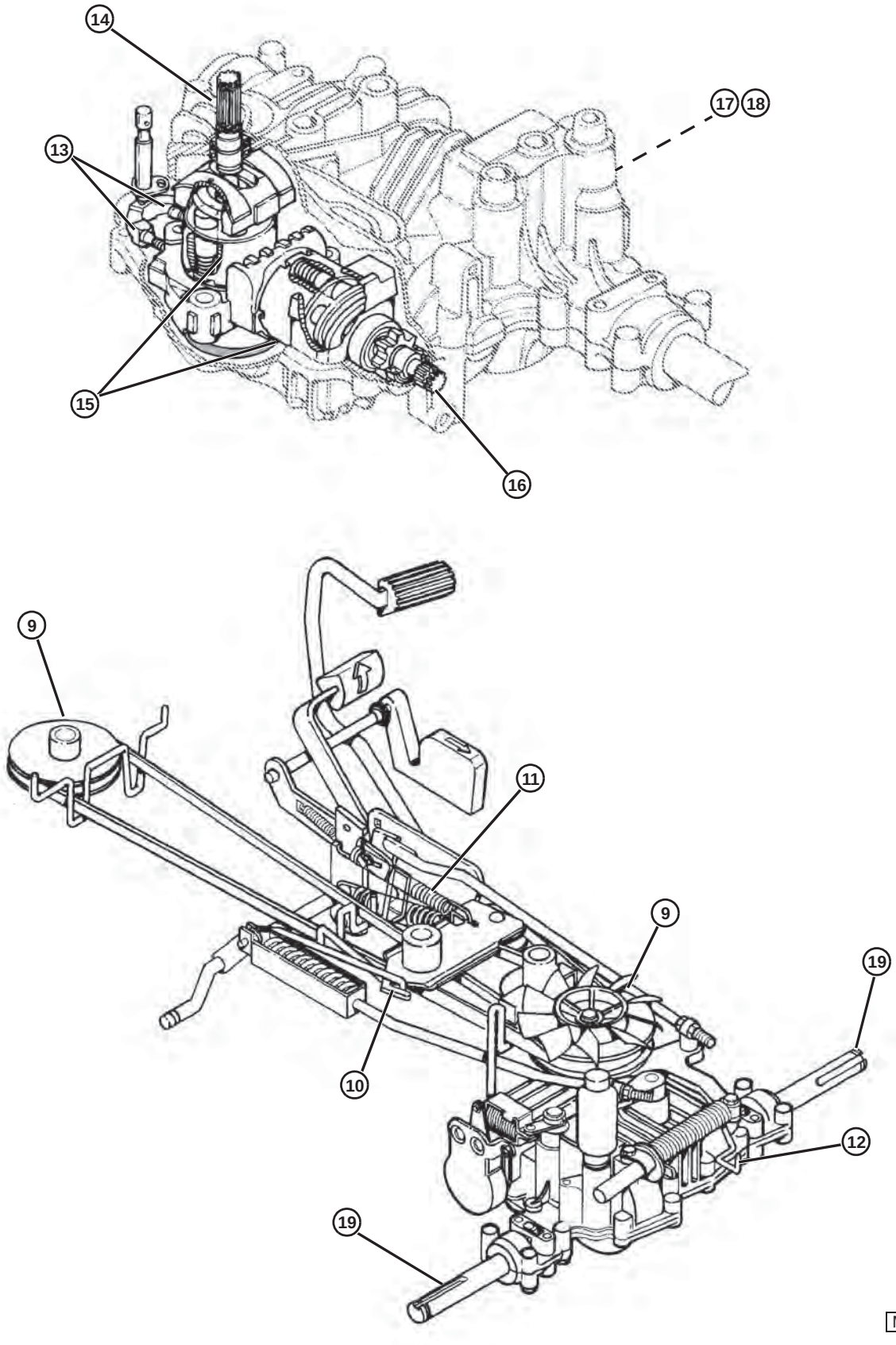
MACHINE WILL NOT MOVE FORWARD OR REVERSE, continued

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
9. Engine/transaxle drive sheaves.	No damage to drive keys or keyways, sheave intact with no evidence of wear at bottom of sheave.	Replace sheaves or keys.
10. Idler arm assembly.	Pivots freely, no wear in bearing.	Lubricate and/or replace assembly.
11. Belt idler assembly tension spring.	Maintains tension on drive belt, not stretched or damaged.	Replace tensioning spring.
12. Freewheel linkage. [a]	Components move freely. Components not damaged.	Eliminate binding and/or replace damaged components. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
13. Forward/reverse check valves and seat assemblies. [a]	Balls and seats not deformed, damaged, or stuck in bores, sealing properly.	Clean, free up valves or replace forward/reverse check valve components, plungers and springs. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
14. Input (pump) shaft. [a]	Splines not worn or damaged, positively engaged in pump.	Correct engagement or replace shaft. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
15. Pump/motor rotating groups. [a]	No scoring on valve body interface, no scoring on pistons.	Replace rotating groups and valve body. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
16. Motor output shaft with gear. [a]	Shaft with gear not worn or damaged.	Replace shaft. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
17. Final pinion and ring gear. [a]	Pinion and gear not damaged or worn.	Replace damaged or worn components. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
18. Differential gears. [a]	Gears not damaged.	Replace gears. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
19. Axle shafts. [a]	Shafts not damaged.	Replace axle shafts. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

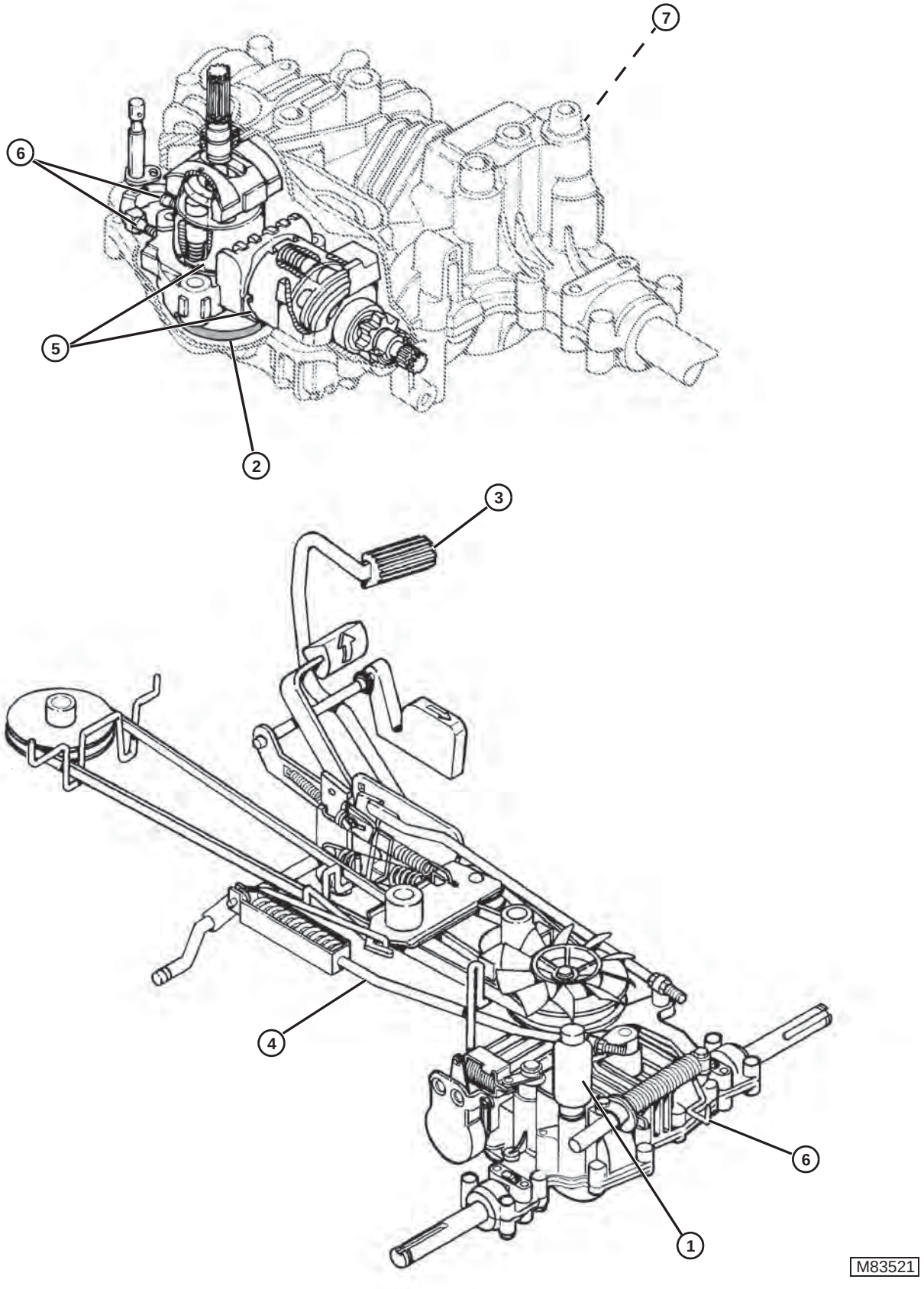
NOISY OPERATION

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle reservoir.	Hydraulic oil at full mark. Oil at room temperature. Check cold.	Fill reservoir to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
	Oil not contaminated, no water in oil.	Drain transaxle and fill to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
	Hydraulic oil clean and not foamy (no air in system).	Bleed air from system. (See HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE on page 7-43.)
2. Hydrostatic oil filter.	Clean, free of debris, not plugged.	Replace filter.
3. Park brake.	Brake not depressed and locked.	Release park brake.
4. Brake linkage.	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT on page 9-21.)
	Brake rod and lever not damaged or binding.	Eliminate binding and/or replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-25.)
5. Pump/motor rotating groups. [a]	No scoring on valve body interface, no scoring on pistons.	Replace rotating groups and valve body. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
6. Freewheel linkage and check valves. [a]	Components move freely. Components not damaged.	Clean, free up valves or replace plungers and springs. Replace linkage. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
7. Final pinion and ring gear. [a]	Pinion and gear not damaged or worn.	Replace damaged or worn components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

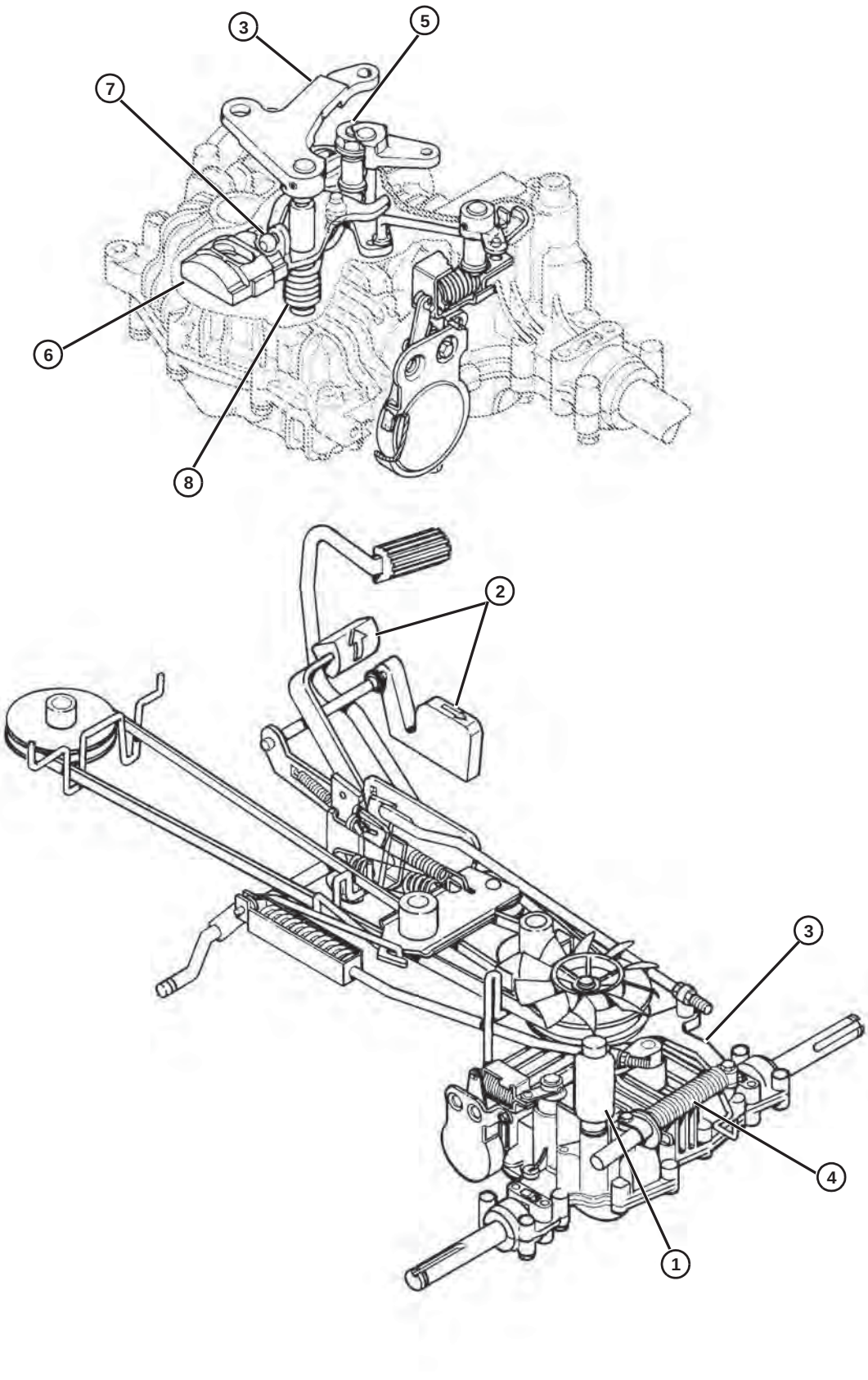
MACHINE CREEPS

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle reservoir.	Hydraulic oil at full mark. Oil at room temperature. Check cold.	Fill reservoir to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
2. Forward/reverse pedal linkage.	Linkage properly adjusted.	Adjust linkage. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)
	Linkage moves freely, not damaged.	Eliminate binding, replace faulty or damaged components. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59 and CONTROL PEDALS AND LINKAGE—REVERSE on page 7-60.)
3. Control arm.	Control arm not damaged. Roll pin not broken or missing.	Replace control arm. Replace roll pin.
4. Shock absorber.	Not binding or damaged.	Eliminate binding and/or replace shock absorber.
5. Neutral eccentric.	Properly adjusted for no wheel movement at fast idle, one wheel off the ground.	Adjust neutral eccentric. (See NEUTRAL CREEP ADJUSTMENT on page 7-43.)
6. Variable position swash plate. [a]	Ball joint, shift blocks, cradle bearings not worn or damaged, thrust washers and bearings not binding.	Replace damaged or worn components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
7. Swash plate pivot ball and control lever. [a]	Pivot ball and socket not bent or worn.	Replace swash plate control arm. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
8. Neutral return spring. [a]	Returns swash plate to neutral when forward/reverse pedals released. Not fatigued or damaged.	Replace spring. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

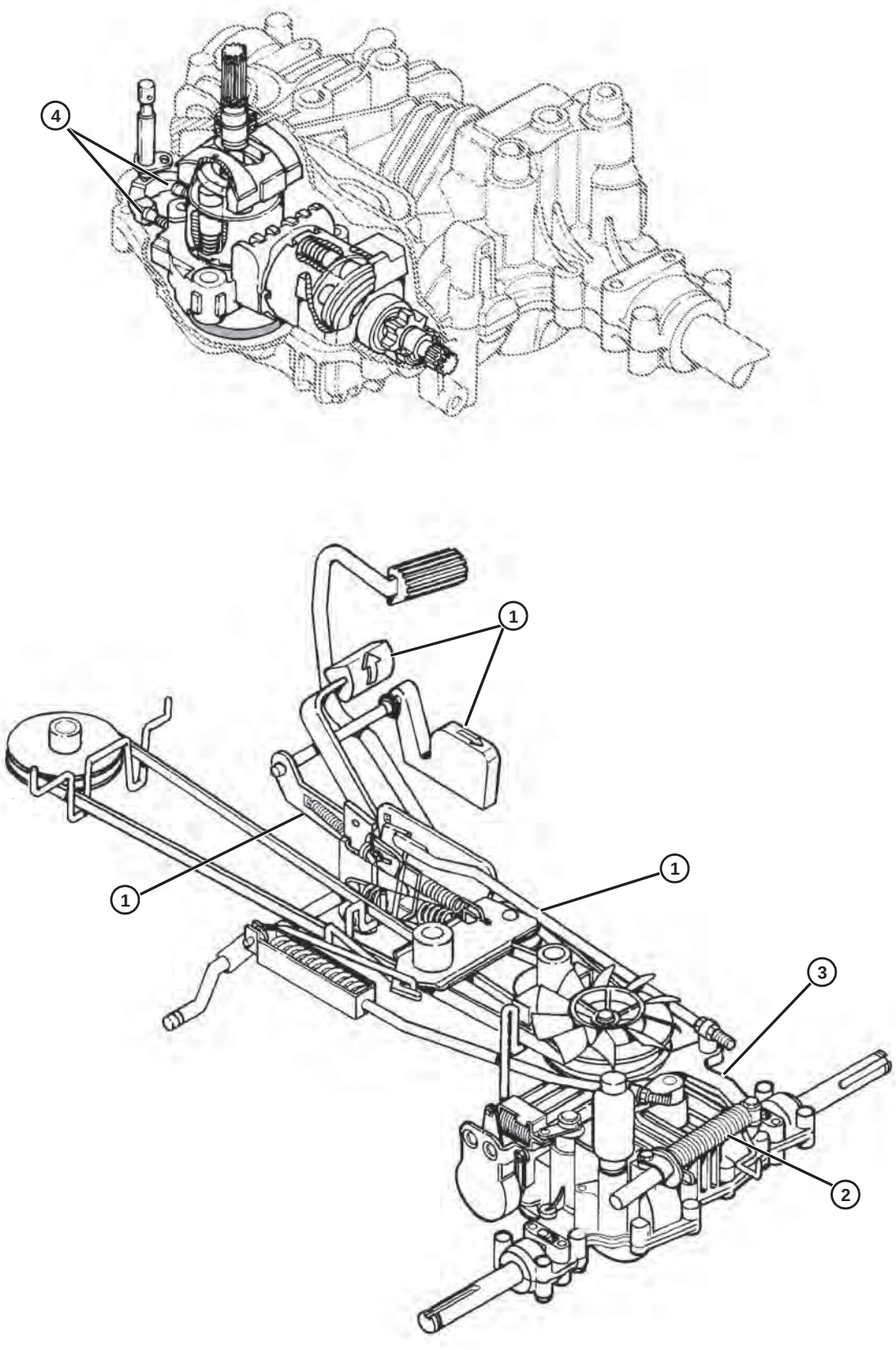
MACHINE MOVES IN ONE DIRECTION ONLY

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Forward/reverse pedal linkage.	Linkage properly adjusted.	Adjust linkage. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)
	Linkage moves freely, not damaged.	Eliminate binding, replace faulty or damaged components. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59 and CONTROL PEDALS AND LINKAGE—REVERSE on page 7-60.)
2. Shock absorber.	Not binding or damaged.	Eliminate binding and/or replace shock absorber.
3. Control arm.	Control arm not damaged.	Replace control arm.
4. Reverse check valve. [a]	Moves freely, not stuck in open position.	Clean, unstick and/or replace check valve components. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transmission shown. K61 similar.

ERRATIC SPEED

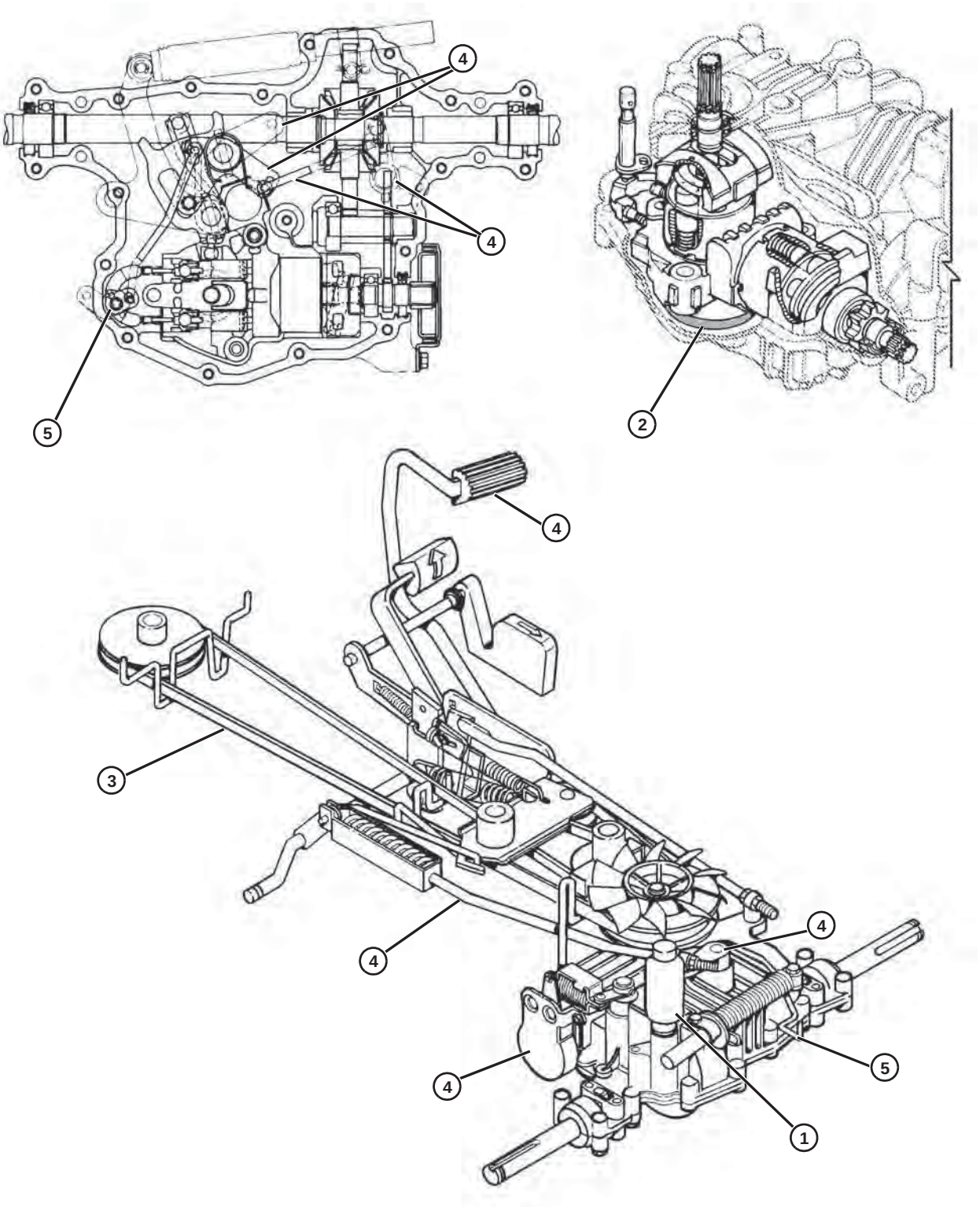
Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle reservoir.	Hydraulic oil at full mark. Oil at room temperature. Check cold.	Fill reservoir to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
	Oil not contaminated, no water in oil.	Drain transaxle and fill to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
	Hydraulic oil clean and not foamy (no air in system).	Bleed air from system. (See HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE on page 7-43.)
2. Hydrostatic oil filter.	Clean, free of debris, not plugged.	Replace filter.
3. Traction drive belt.	Properly tensioned.	Adjust tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 7-45.)
	Not broken, worn, frayed, glazed or stretched.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 7-61.)
4. Brake pedal and linkage.	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)
	Brake rod and lever not damaged or binding.	Eliminate binding and/or replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-25.)
5. Freewheel linkage. [a]	Components move freely. Components not damaged.	Clean, free up valves or replace forward/reverse check valve components, plungers and springs. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

Continued on page 7-28.

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

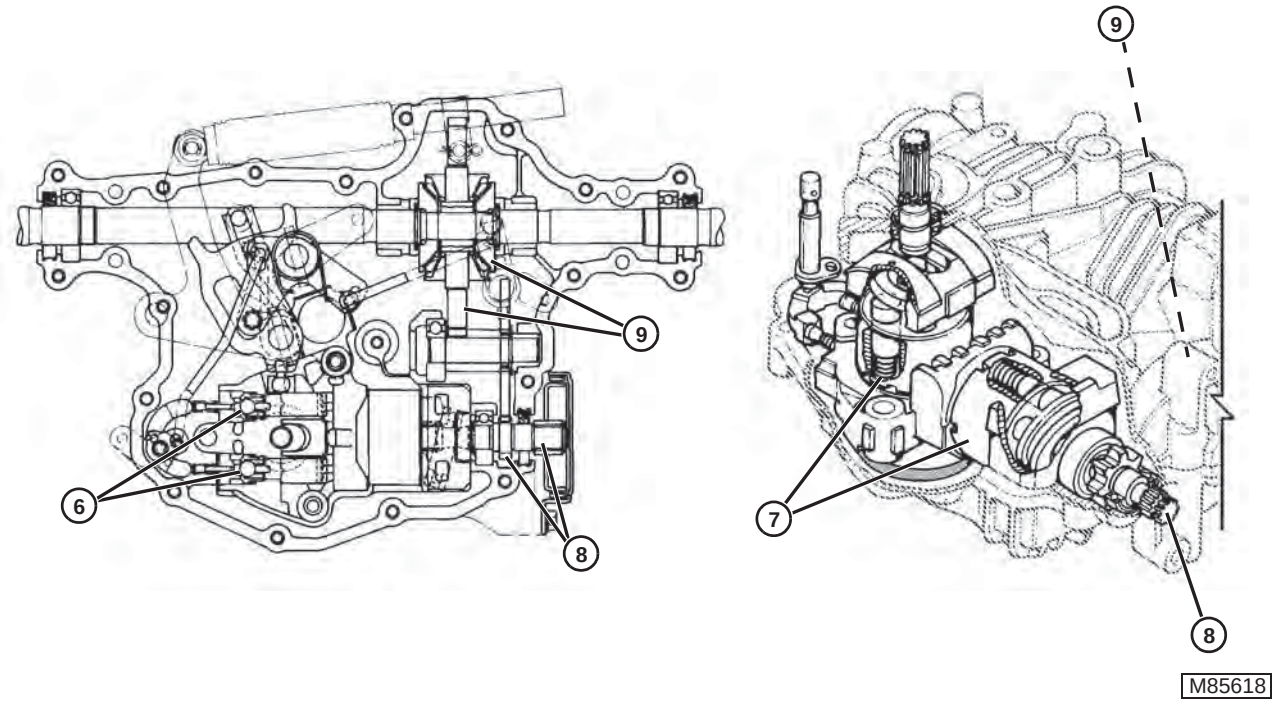
ERRATIC SPEED, continued

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
6. Forward/reverse check valves and seat assemblies. [a]	Ball and seats not deformed, damaged, or stuck in bores, sealing properly.	Replace directional check valve components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
7. Pump/motor rotating groups. [a]	No scoring on valve body interface, no scoring on pistons.	Replace rotating groups and valve body. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
8. Motor output shaft with gear. [a]	Shaft with gear not worn or damaged.	Replace shaft. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
9. Final drive pinion and differential ring gear assembly. [a]	Pinion and differential ring gear assembly not worn or damaged.	Replace worn or damaged components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

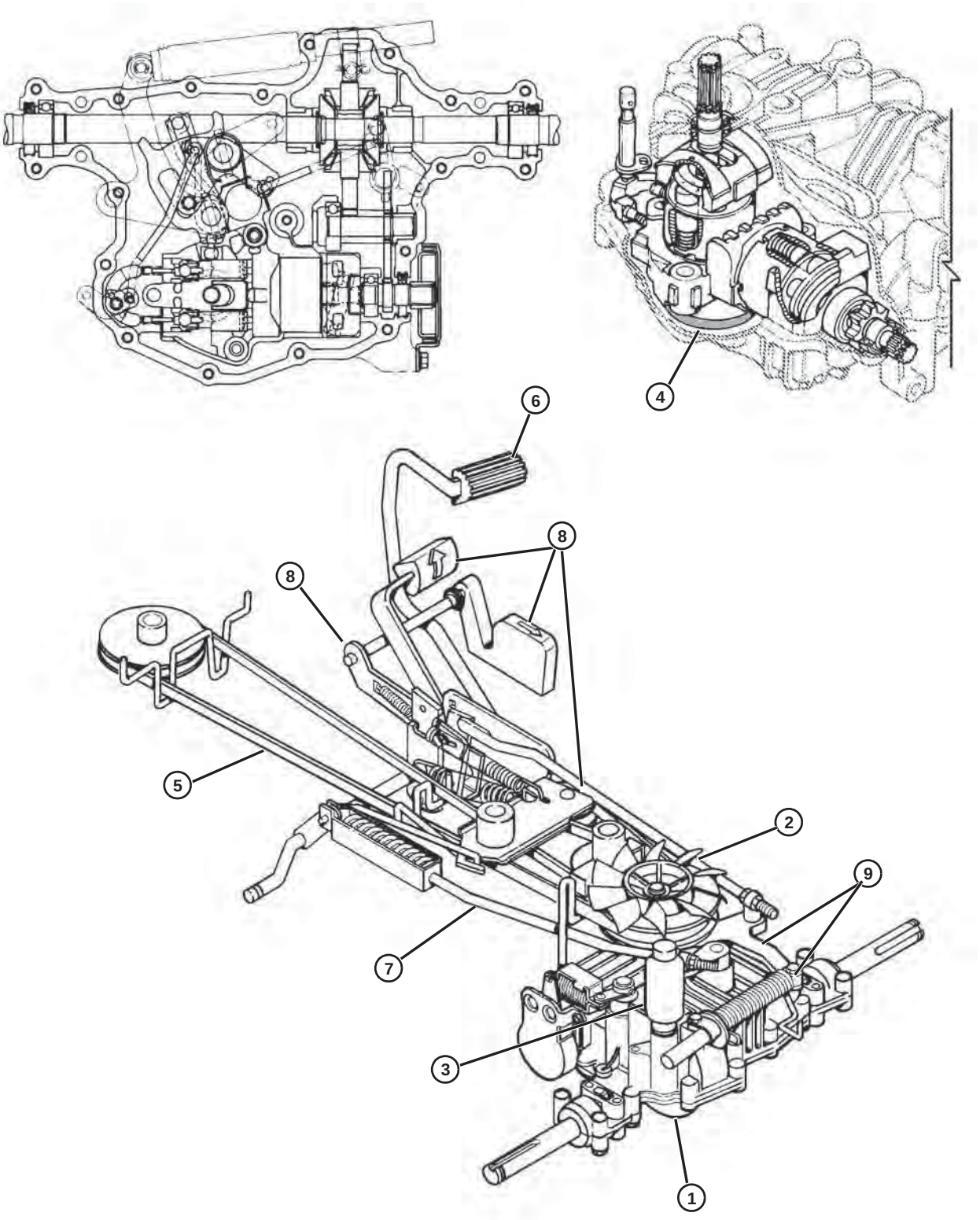
MACHINE DOES NOT ACHIEVE FULL GROUND SPEED

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle.	Transaxle free of debris.	Remove debris from transaxle.
2. Cooling fan.	Not damaged.	Replace cooling fan.
3. Hydrostatic transaxle reservoir.	Hydraulic oil at full mark. Oil at room temperature. Check cold.	Fill reservoir to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
	Hydraulic oil clean and not foamy (no air in system).	Bleed air from system. (See HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE on page 7-43.)
4. Hydrostatic oil filter.	Clean, free of debris, not plugged.	Replace filter.
5. Traction drive belt.	Properly tensioned.	Adjust tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 7-45.)
	Not worn, frayed, glazed or stretched.	Replace traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 7-61.)
6. Park brake.	Brake not depressed and locked.	Release park brake.
7. Brake linkage.	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)
	Brake rod and lever not damaged or binding.	Eliminate binding and/or replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-25.)
8. Forward/reverse pedal linkage.	Linkage properly adjusted.	Adjust linkage. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.).
	Linkage moves freely, not damaged.	Eliminate binding, replace faulty or damaged components. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59 and CONTROL PEDALS AND LINKAGE—REVERSE on page 7-60.)
9. Swash plate control arm and shock absorber.	Not binding or damaged. Roll pin not broken or missing.	Replace faulty or damaged components. Replace roll pin.

Continued on page 7-32.



NOTE: K60 Transaxle shown. K61 similar.

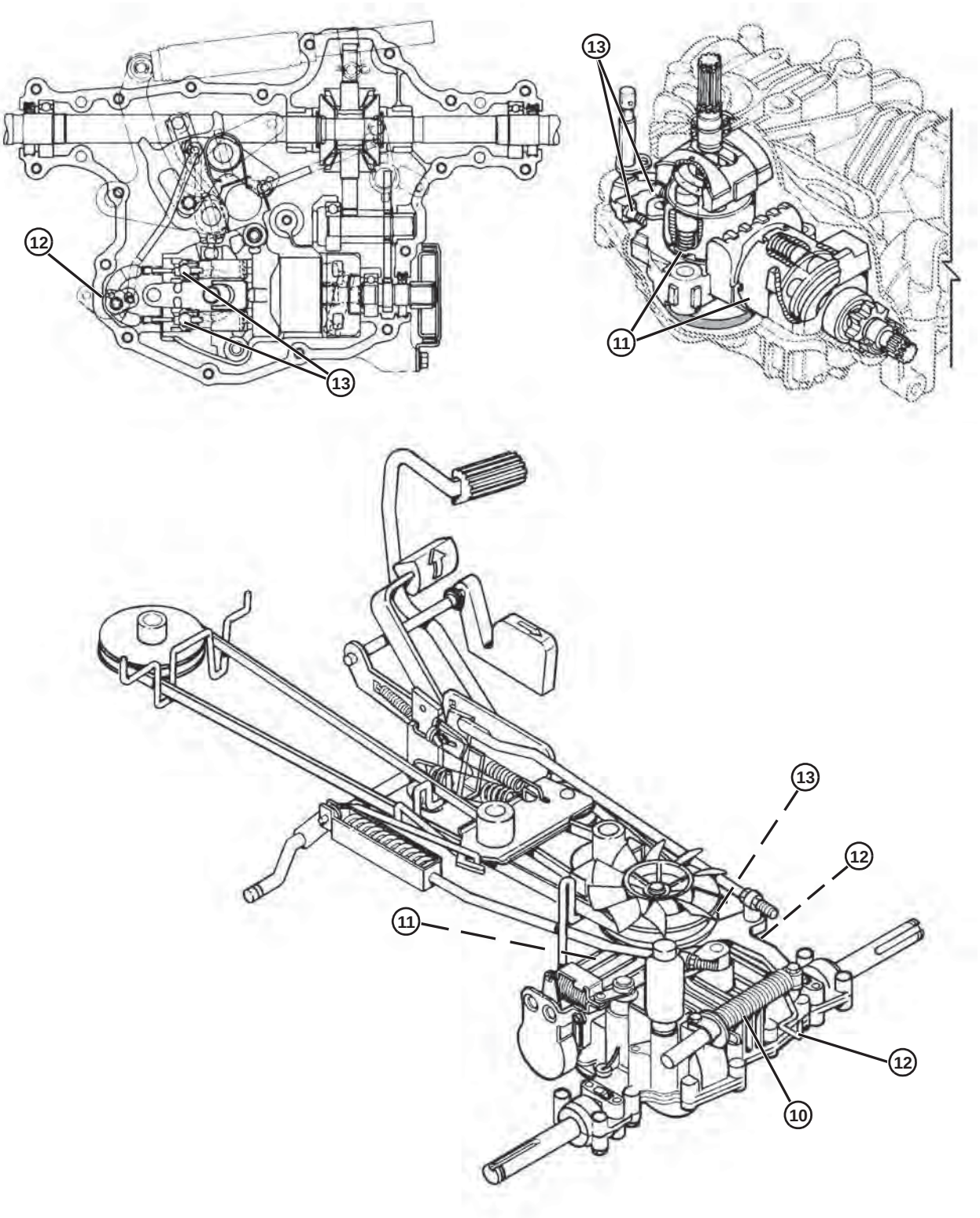
MACHINE DOES NOT ACHIEVE FULL GROUND SPEED, continued

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
10. Shock absorber.	Not binding or damaged.	Replace shock absorber.
11. Pump/motor rotating groups. [a]	No scoring on valve body interface, no scoring on pistons.	Replace scored parts of rotating groups and valve body. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
12. Freewheel linkage. [a]	Components move freely. Components not damaged.	Eliminate binding and/or replace damaged components. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
13. Forward/reverse check valves and seat assemblies. [a]	Move freely, not stuck in open position.	Clean, unstick and/or replace check valve components, plungers and springs. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



NOTE: K60 Transaxle shown. K61 similar.

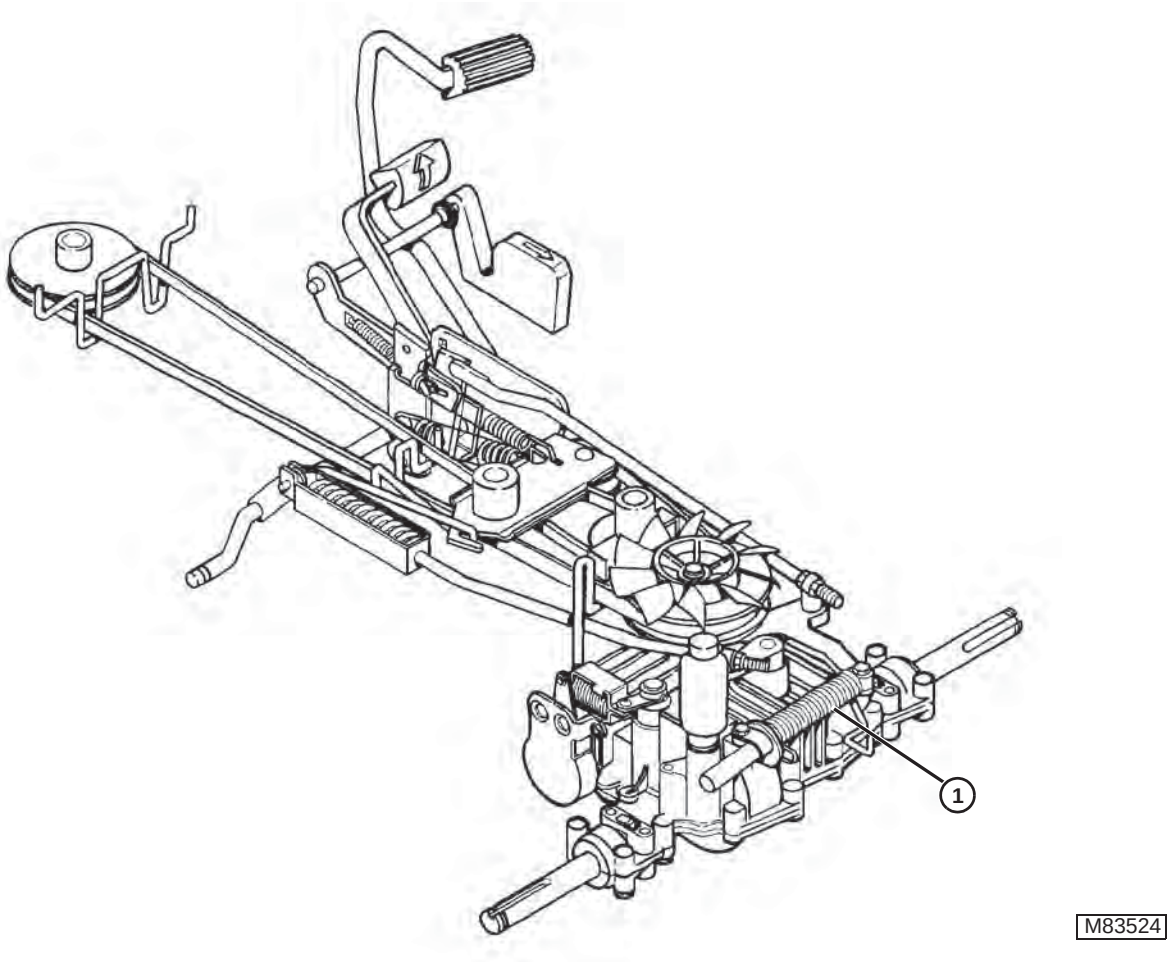
MACHINE IS TOO AGGRESSIVE IN FORWARD OR REVERSE

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Shock absorber.	Not binding or damaged.	Replace shock absorber.





NOTE: K60 Transaxle shown. K61 similar.

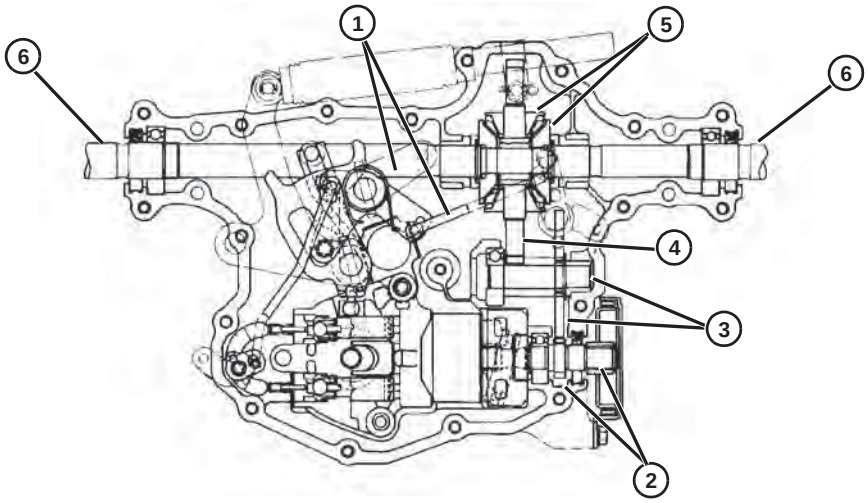
PARK BRAKE DOES NOT HOLD MACHINE ON HILL

Test Conditions:

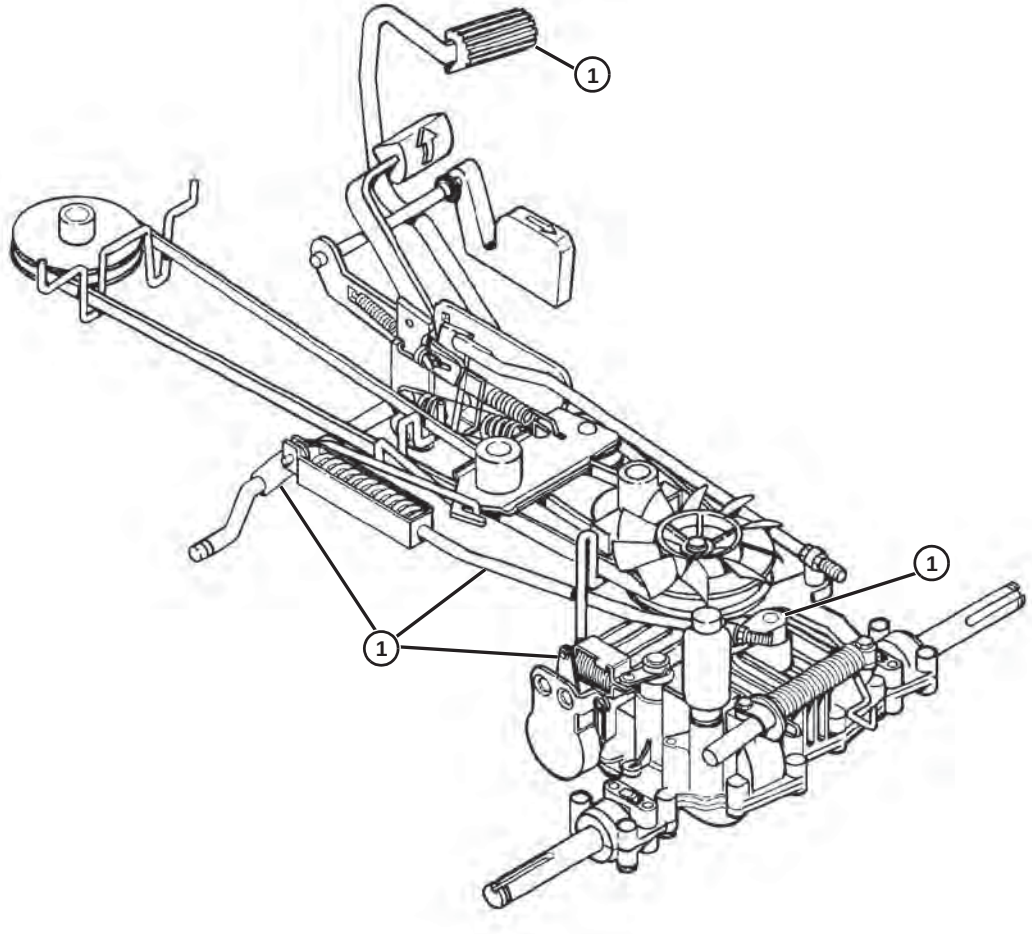
- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Brake pedal, internal/external linkage and brake band assembly.	Brake pedal linkage, internal/ external components, brake band not damaged, worn, or binding.	Eliminate binding and/or replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-25.)
		If internal problem, remove transaxle, disassemble/inspect/ replace damaged components/and install. (See HYDROSTATIC TRANSAXLE—Removal/ Installation on page 7-47, Disassembly/Inspection on page 7-48, and Assembly on page 7-52.)
2. Motor output shaft with gear. [a]	Shaft with gear not worn or damaged.	Replace shaft. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
3. Reduction shaft and gear. [a]	Shaft and gear not worn or damaged.	Replace worn or damaged components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
4. Final pinion and ring gear. [a]	Pinion and gear not damaged or worn.	Replace damaged or worn components. (See HYDROSTATIC TRANSAXLE—Disassembly/ Inspection on page 7-48.)
5. Differential gears. [a]	Gears not damaged.	Replace gears. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)
6. Axle shafts. [a]	Shafts not damaged.	Replace axle shafts. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



M83525



M83524

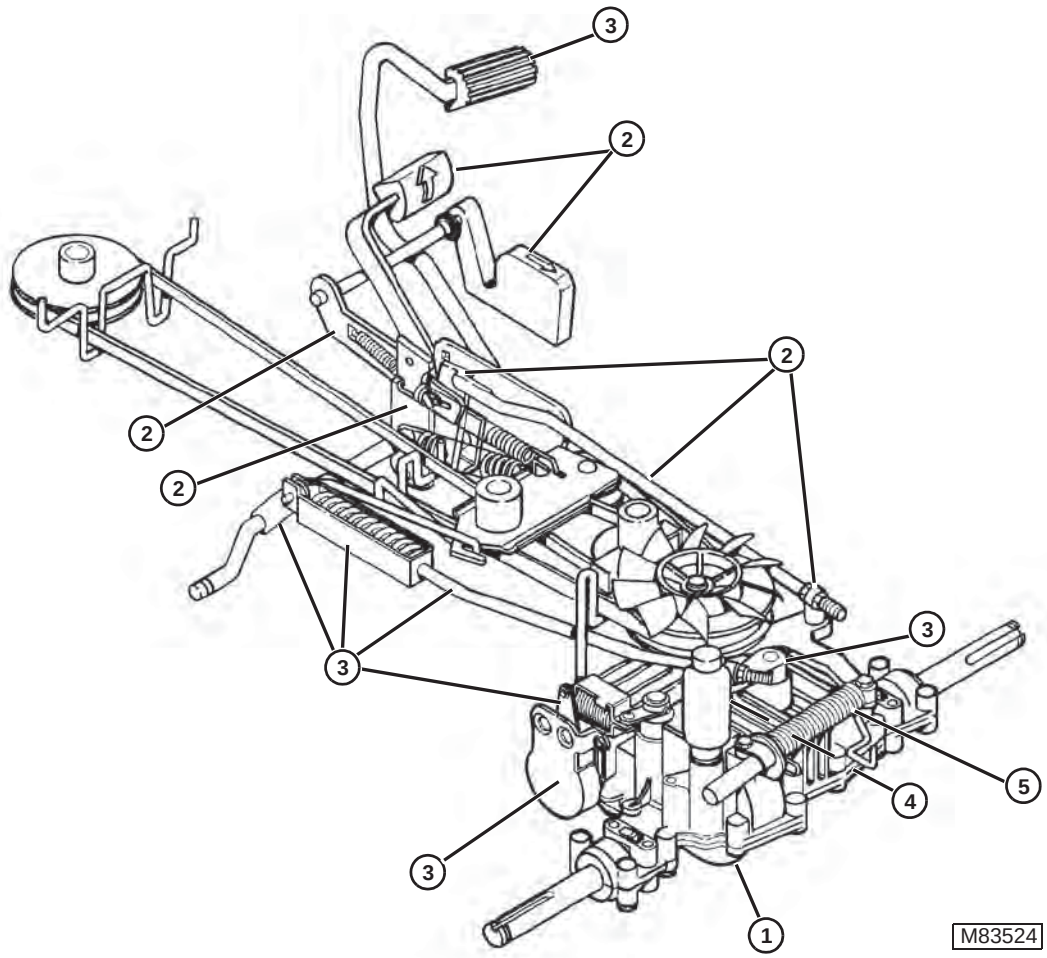
NOTE: K60 Transaxle shown. K61 similar.

BRAKE SWITCH WILL NOT ENGAGE

Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Hydrostatic transaxle.	Transaxle free of debris.	Remove debris from transaxle.
2. Forward/reverse pedal linkage.	Linkage properly adjusted.	Adjust linkage. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)
	Linkage moves freely, not damaged.	Eliminate binding, replace faulty or damaged components. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59 and CONTROL PEDALS AND LINKAGE—REVERSE on page 7-60.)
3. Brake linkage.	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)
	Brake rod and lever not damaged or binding.	Eliminate binding and/or replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/Installation on page 9-26.)
4. Brake switch.	Continuity through switch with park brake engaged.	Replace brake switch.
5. Shock absorber.	Not binding or damaged.	Replace shock absorber.



NOTE: K60 Transaxle shown. K61 similar.

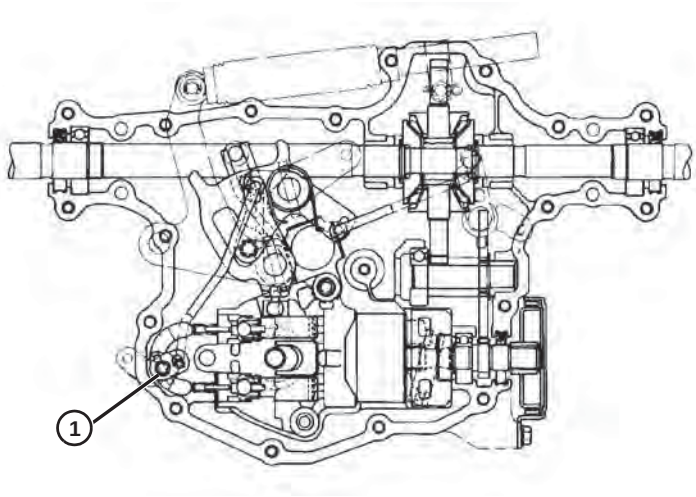
FREEWHEEL VALVE WILL NOT WORK

Test Conditions:

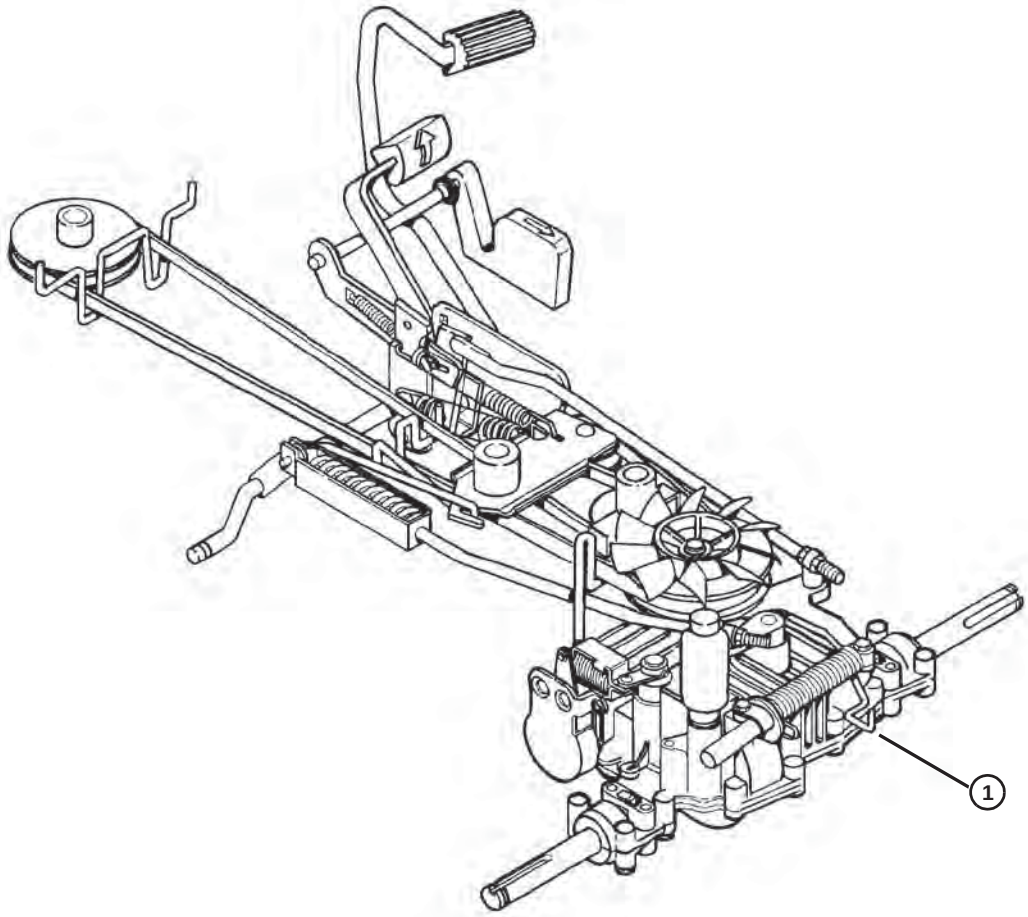
- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Freewheel linkage and valves.[a]	Components move freely. Components not damaged.	Clean, unstick valves and/or replace damaged components. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transaxle from machine and disassembly.



M83525



M83524

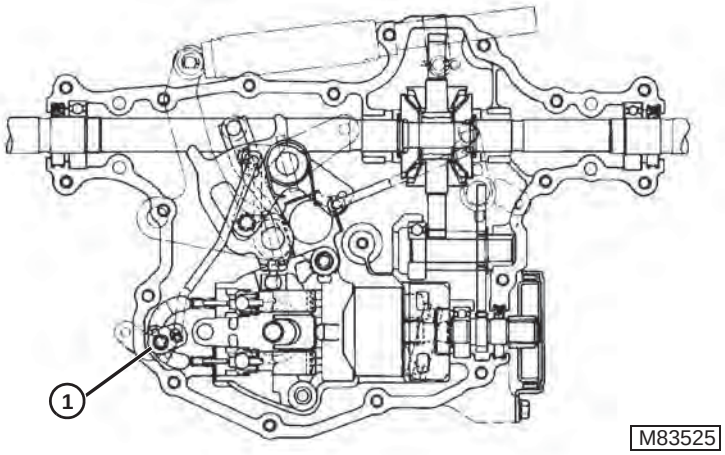
NOTE: K60 Transaxle shown. K61 similar.

FREEWHEEL VALVE WILL NOT STAY OPEN WITH ENGINE OFF

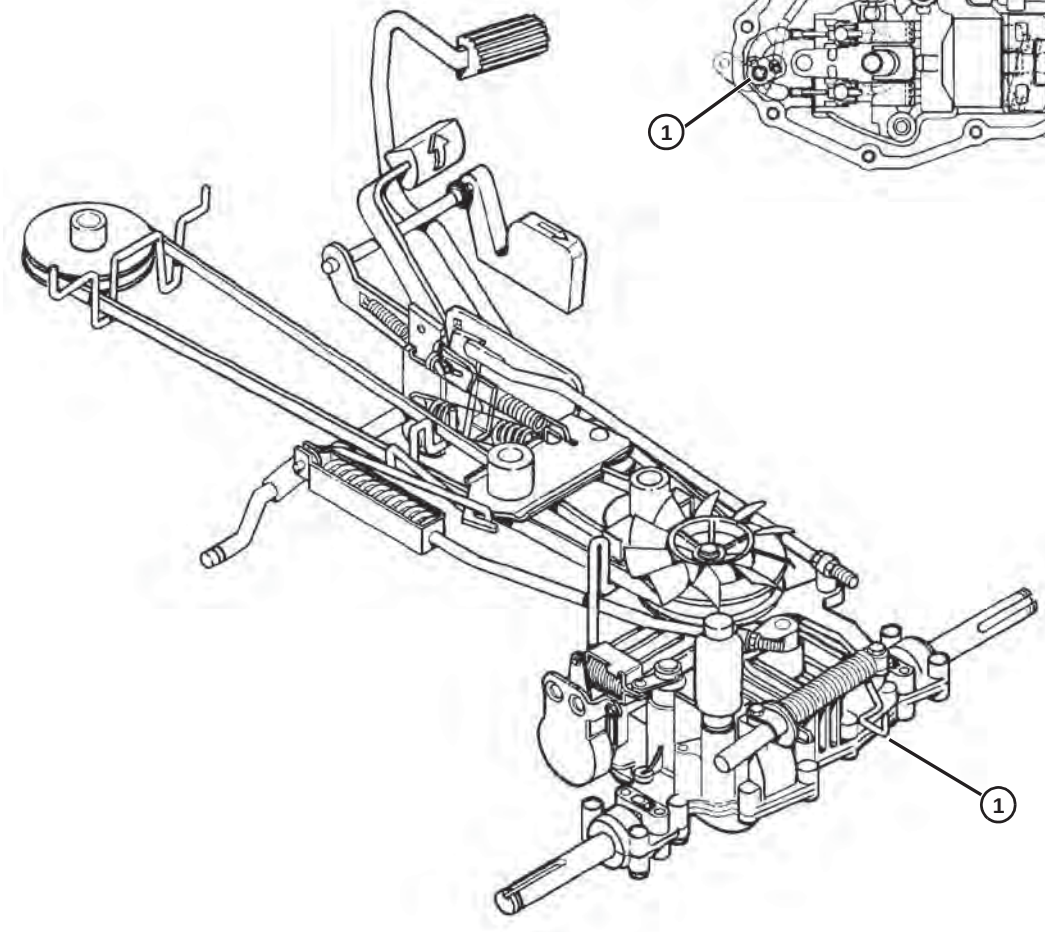
Test Conditions:

- Machine parked on level surface.
- Key switch in STOP position.
- Park brake DISENGAGED.
- Transmission in NEUTRAL.

Test/Check Point	Normal	If Not Normal
1. Freewheel lever/linkage.	Transaxle free of debris. Lever/linkage moves freely.	Remove debris and clean area. Repair or replace binding linkage. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)



M83525



M83524

NOTE: K60 Transaxle shown. K61 similar.

ADJUSTMENTS

HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE

Reason:

This procedure is performed to eliminate air from the hydrostatic transaxle after repair or leakage of the transaxle.

Procedure:

Check hydrostatic transaxle oil reservoir oil level. If necessary, fill to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)

1. Raise rear wheels off the ground. Support rear axles with jack stands.
2. Start and run engine at SLOW idle.

⚠ CAUTION

Keep hands away from transaxle cooling fan and wheels during procedure or fingers can be injured.

3. While alternately depressing the forward and reverse pedals, engage and disengage the freewheel valve lever. Continue this procedure until the rear wheels start to rotate. This step may take 5 to 10 minutes to perform.
4. Lower the machine to the ground.
5. With control pedals in neutral, push the machine forward and then rearward to turn the motor rotating group.
6. Start and run the engine at FAST idle.
7. Quickly depress and release the forward and reverse pedals until the machine moves without hesitation.

Results:

- Machine moves without hesitation when forward or reverse pedals are depressed.

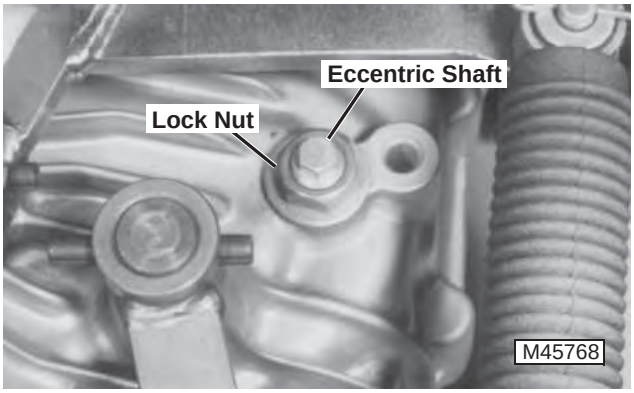
NEUTRAL CREEP ADJUSTMENT

Reason:

If the machine creeps forward or backward with the forward/reverse pedals in the neutral position, parking brake released, and the engine running, the neutral eccentric must be adjusted.

Procedure:

1. Park machine on level surface.
2. Turn key switch to STOP position.
3. Move forward/reverse pedals to NEUTRAL position. Engage park brake.
4. Lift rear of machine until wheels are just barely off the ground and support machine with jackstands.
5. Remove seat and fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)



6. Pull fuel tank forward to gain access to eccentric.

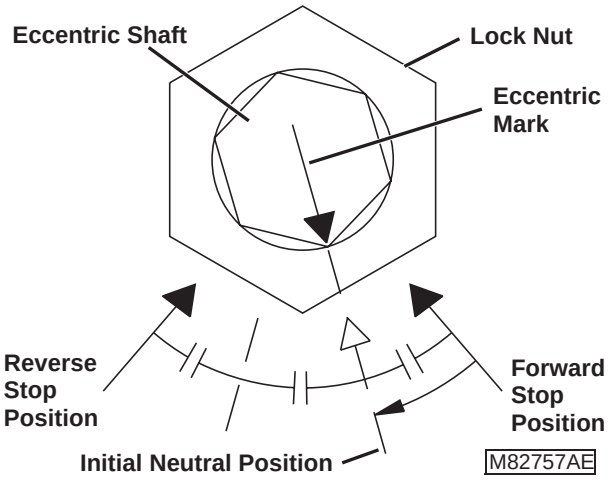
⚠ CAUTION

Keep hands away from transaxle cooling fan and wheels during procedure or fingers can be injured.

NOTE: Engine will not start with seat switch disconnected. Use a jumper wire to by-pass switch.

7. Start and run engine at FAST idle.

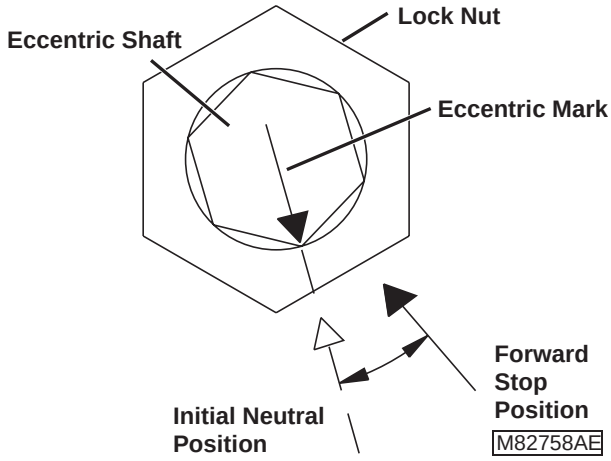
NOTE: If axle shafts do not rotate in reverse after turning the eccentric shaft one full turn, see steps 15—17.



8. Loosen lock nut and turn the eccentric shaft clockwise until the axle shaft rotates in reverse. Mark the top of the eccentric shaft for position.
9. Turn the eccentric shaft slowly counterclockwise until the axle shaft stops. Mark the transaxle case as the reverse stop position.
10. Turn the eccentric shaft slowly counterclockwise until the axle shaft rotates forward.
11. Turn the eccentric shaft clockwise until the axle shaft stops. Mark the transaxle case as the forward stop position.
12. Turn the eccentric shaft slowly clockwise until the mark is approximately 1/3 the distance between the forward and reverse stop positions initial neutral position.
13. Hold eccentric shaft with wrench and tighten locknut.

If the axle shafts do not rotate in reverse although the eccentric shaft has been turned one full turn, adjust neutral as follows:

14. Turn eccentric shaft counterclockwise until axle shafts rotate forward.



15. Turn eccentric shaft clockwise until the axle shaft stops. Mark the top of the eccentric shaft and transaxle case.
16. Turn the eccentric shaft clockwise approximately 8° from forward stop position.
17. Hold eccentric shaft with wrench and tighten locknut.

PEDAL HEIGHT ADJUSTMENT

Reason:

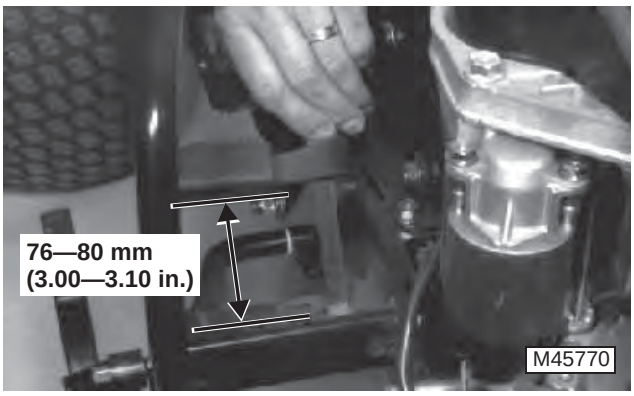
To insure full travel speeds in forward and reverse directions. This also insures that the transaxle swash plate and control arm will not act as a mechanical stop for the pedal linkage.

Procedure:

1. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)
2. Pull fuel tank forward to gain access to the adjustment.



3. Loosen control rod end retaining nuts.



4. With transmission in neutral, adjust the position of control rod end, until distance between the forward pedal arm and the frame is within specifications.
5. Tighten retaining nuts.

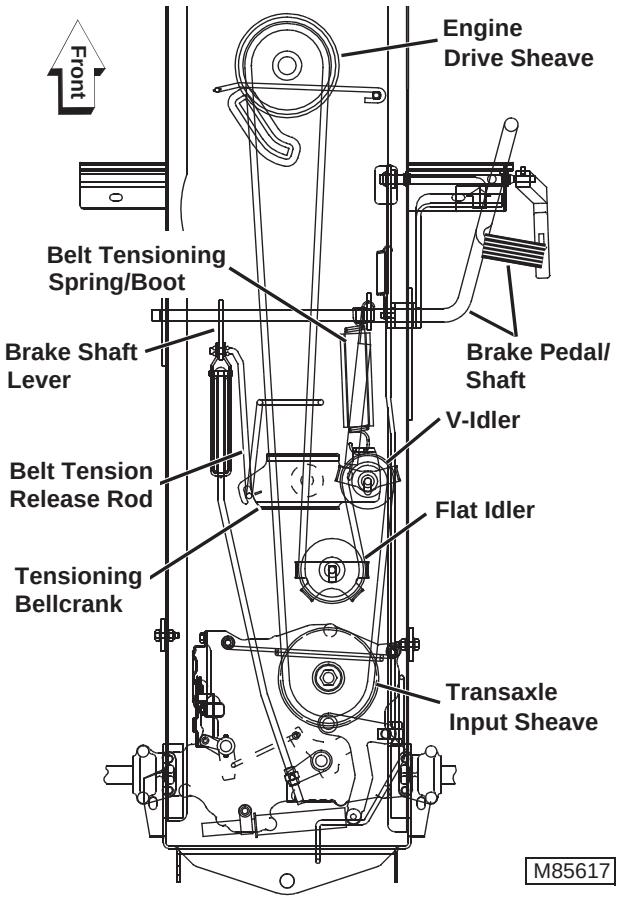
TRACTION DRIVE BELT TENSION ADJUSTMENT

Reason:

To provide proper traction belt tension to keep the belt from slipping and to position the guides so that belt jumping is minimized.

Procedure:

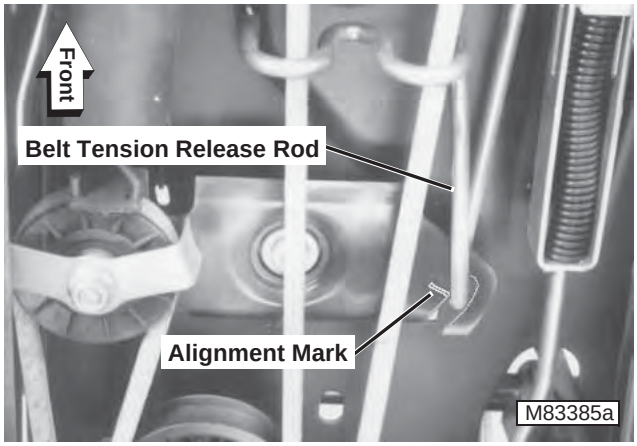
1. Park the machine on a level surface.
2. Turn key switch to STOP position.
3. Move forward/reverse pedals to NEUTRAL position and engage park brake.
4. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)



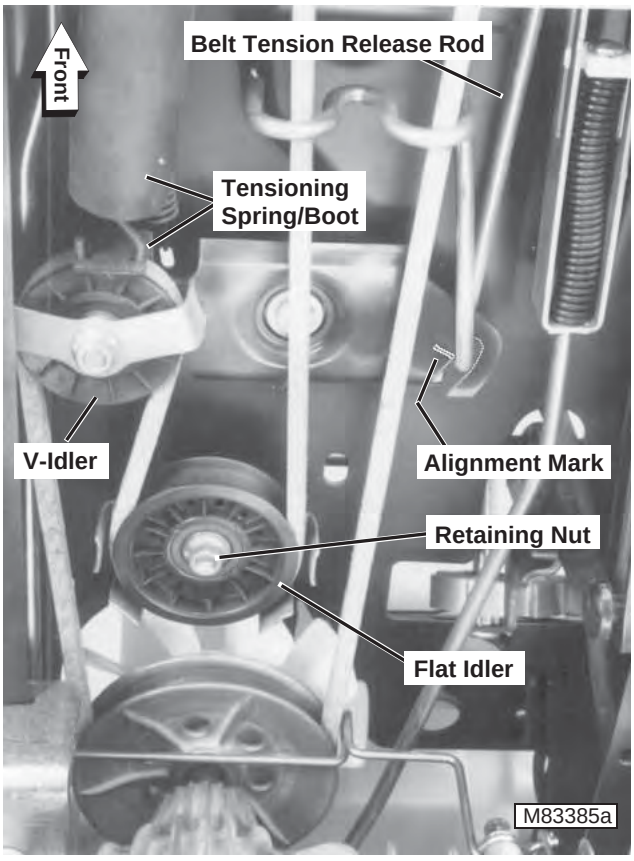
Top View

NOTE: Slide flat idler to the rear of the tractor to increase belt tension and to the front of the tractor to decrease belt tension.

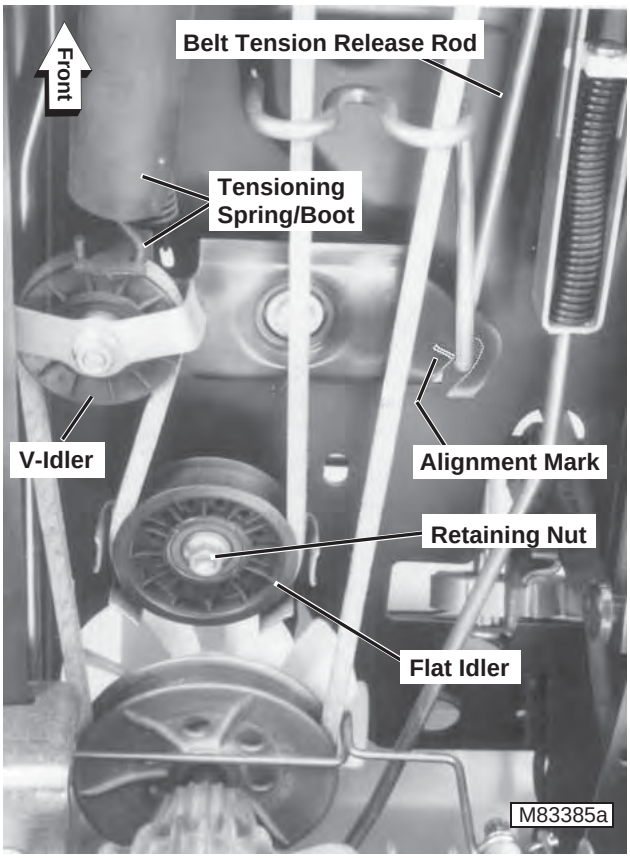
*If alignment mark on tensioning bellcrank is not clearly visible, measure **16 mm (0.63 in.)** from open end of slot to center of belt tension release rod.*



5. Release park brake to apply tension to traction drive belt.
6. Check for proper adjustment between alignment mark of the tensioning bellcrank arm and belt tension release rod—**mark should be centered on rod,** as shown:
   - if mark is off the rod toward the front of the tractor, belt tension is too tight
   - if mark is off the rod toward the rear of the tractor, belt tension is too loose.



7. Engage park brake to release belt tension.
8. Position tensioning bellcrank v-idler fully forward in it's slot and at the same time adjust it's belt guide so it is parallel with and approximately 3.2 mm (0.125 in.) away from belt and v-idler.



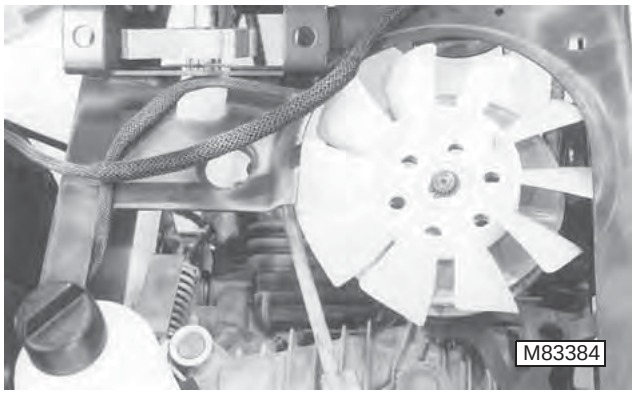
9. At short increments, adjust flat idler position, engaging and disengaging park brake with each incremental adjustment, until alignment mark on the bellcrank idler arm aligns with the center of the belt tension release rod, as shown.
10. When adjusting flat idler, adjust belt guide at the same time so it is parallel with and approximately 3.2 mm (0.125 in.) away from belt and v-idler.
11. Recycle park brake several times and recheck alignment of mark and rod with park brake disengaged. Readjust flat idler and belt guide as necessary until alignment is assured.

REPAIR

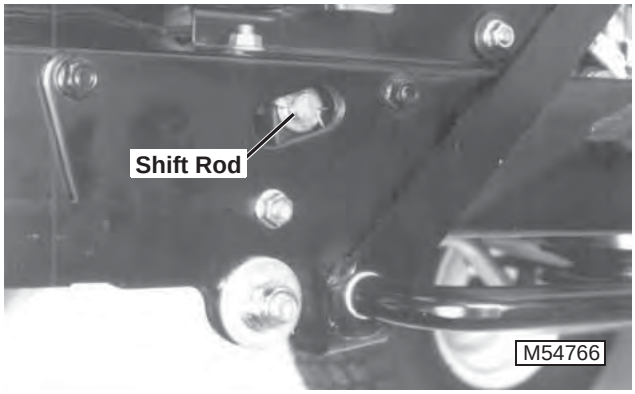
HYDROSTATIC TRANSAXLE

Removal/Installation

1. Set park brake.
2. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
3. Remove fuel tank. (See FUEL TANK—Removal/Installation on page 3-41, 3-112 or 4-28.)
4. Remove rear wheels. (See WHEELS—Removal/Installation on page 11-5.)



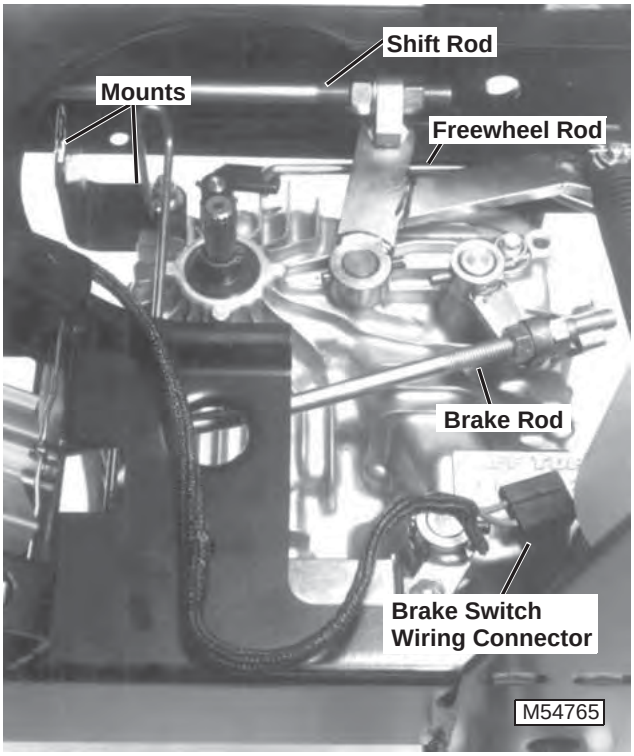
5. Remove snap ring, washer, wave washer and fan.
6. Remove traction drive belt.
7. Remove sheave.
8. Release park brake.



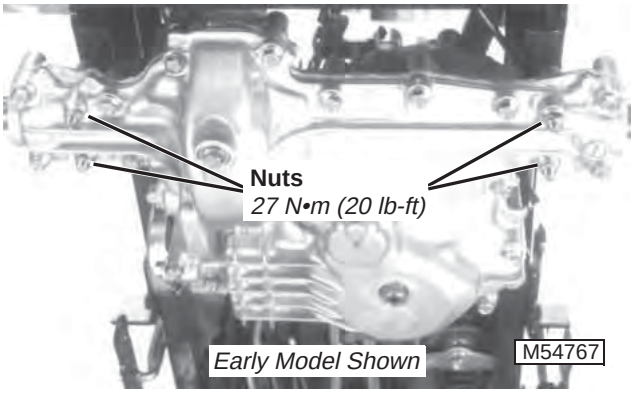
9. Disconnect shift rod.

NOTE: Transaxle oil capacity is 3.4 L (7.2 pt).

10. If transaxle is to repaired, drain transaxle.



11. Disconnect shift and brake rods.
12. Disconnect brake switch wiring connector.
13. Support transaxle with a floor jack.
14. Disconnect mount(s) from frame. Early models use one slotted mount (RH side). Later models use two mounts attached to frame.



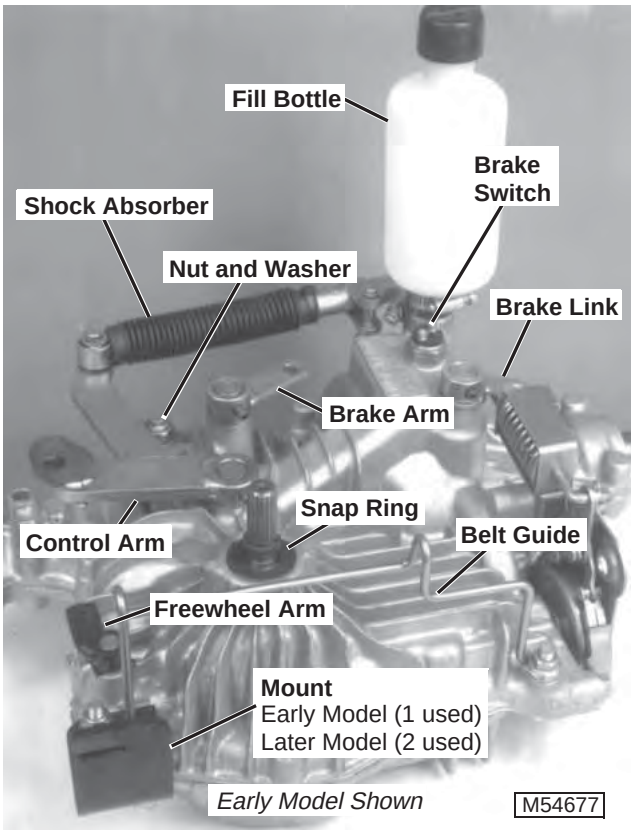
15. Remove nuts.
16. Lower transaxle.
17. Disconnect free wheel rod.
18. Remove transaxle.

Installation is done in the reverse order of removal.

- Fill transaxle to correct level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)

Disassembly/Inspection

1. Thoroughly clean the outside of the transaxle.



2. Remove bottle and hose.
3. Remove brake switch.
4. Remove brake assembly. (See BRAKE ASSEMBLY—Removal/Installation on page 9-26.)

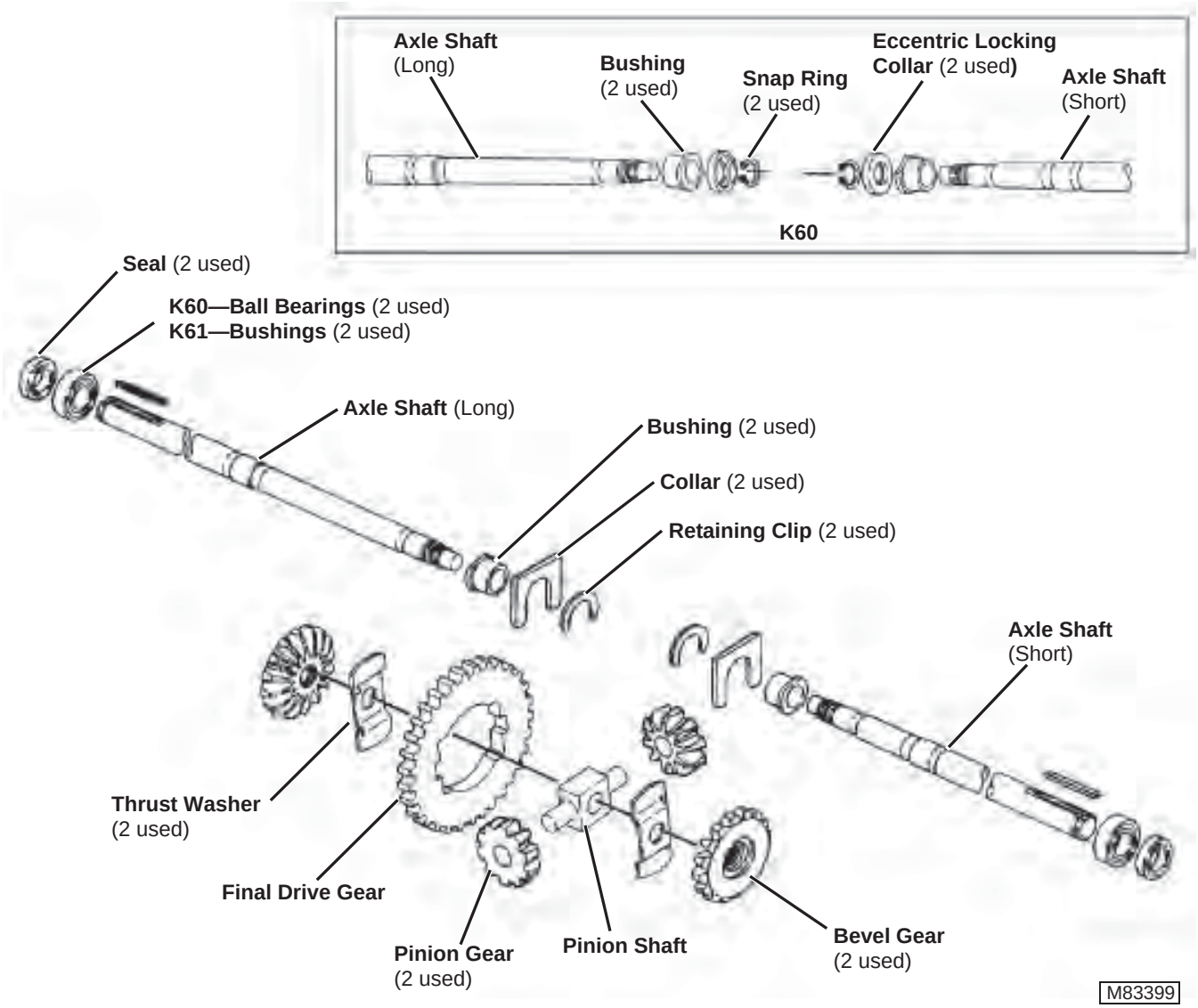
NOTE: Early models use one mount, later models use two mounts.

5. Remove belt guide and mount(s).
6. Remove snap ring.
7. Remove shock absorber.
8. Remove swash plate control arm, brake arm and freewheel arm.
9. Remove nut and washer.
10. Turn transaxle over.
11. Remove transaxle case cap screws and separate case halves (K60) or remove cover (K61).

NOTE: K61 Transaxle—Axle shafts must be removed before differential gear set can be removed.

K61 Transaxle—Axle shaft seals are press-fit in transaxle housing. Do not remove unless replacement is necessary.

12. Remove differential gear assembly as a unit.



NOTE: Ball bearings (K60) and axle bushings (K61) are slip-fit.

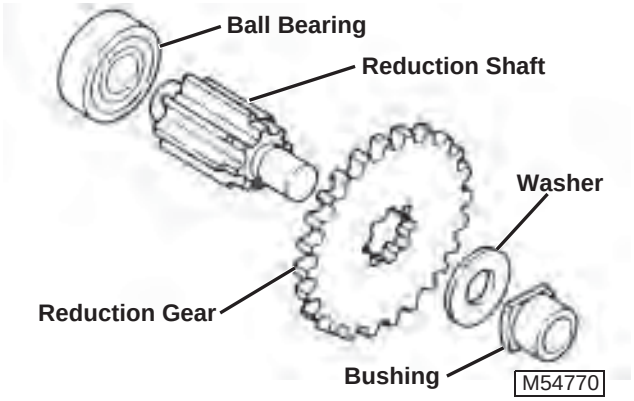
13. Disassemble parts as shown.
14. Inspect all parts for wear or damage. Replace parts as necessary.



15. Measure I.D. of pinion gears. Replace if measurement is **greater than 15.03 mm (0.592 in.)**.
16. Measure O.D. of pinion shaft. Replace if measurement is **less than 14.99 mm (0.590 in.)**.
17. Subtract pinion shaft O.D. from pinion gear I.D. to find clearance. Replace parts if clearance is **greater than 0.50 mm (0.020 in.)**.



18. Measure I.D. of bushings. Replace if measurement is **greater than 22.15 mm (0.872 in.)**.
19. Measure O.D. of axle shafts. Replace if measurement is **less than 21.98 mm (0.865 in.)**.
20. Subtract axle shaft O.D. from bushing I.D. to find clearance. Replace parts if clearance is **greater than 0.50 mm (0.020 in.)**.
21. Remove reduction shaft assembly.

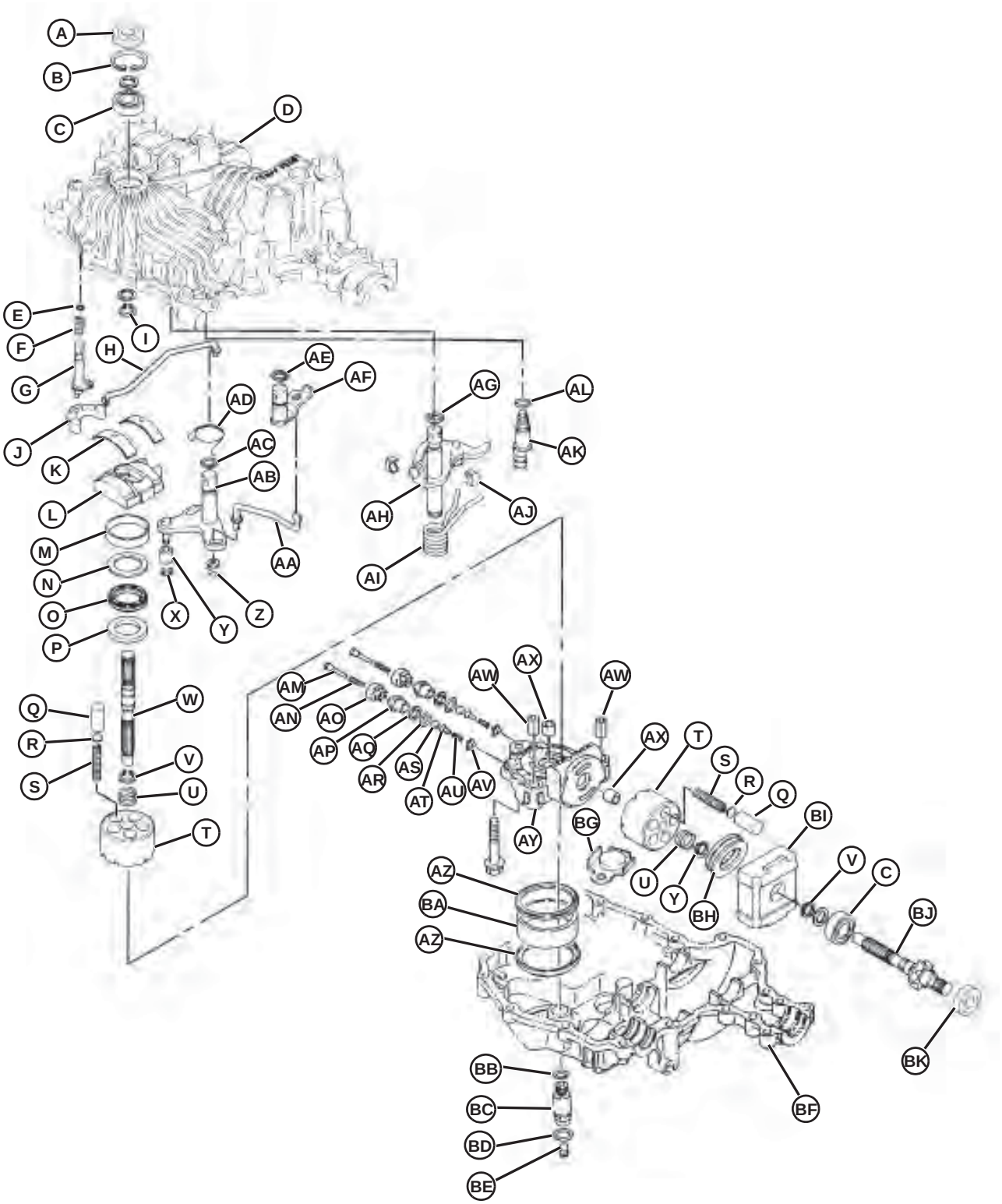


22. Remove ball bearing, bushing, washer and reduction gear from reduction shaft.
23. Inspect all parts for wear or damage. Replace parts as necessary.



24. Measure I.D. of bushings. Replace if measurement is **greater than 15.13 mm (0.596 in.)**.
25. Measure O.D. of reduction shaft. Replace if measurement is **less than 14.97 mm (0.589 in.)**.
26. Subtract reduction shaft O.D. from bushing I.D. to find clearance. Replace parts if clearance is **greater than 0.50 mm (0.020 in.)**.

A—Seal
B—Snap Ring
C—Ball Bearing
D—Top Case Half
E—O-Ring
F—Spring
G—Freewheel Lever Shaft
H—Rod
I—Snap Ring
J—Check Valve Arm
K—Plain Bearing
L—Variable Position Swash Plate
M—Sleeve
N—Plate
O—Roller Bearing
P—Plate
Q—Piston (12 used)
R—Disk (12 used)
S—Spring (12 used)
T—Cylinder Block
U—Spring
V—Snap Ring
W—Input (Pump) Shaft
X—E-Clip
Y—Roller
Z—Clip
AA—Brake Rod
AB—Brake Lever
AC—O-Ring
AD—Guide Spring
AE—O-Ring
AF—Brake Shaft
AG—O-Ring
AH—Swash Plate Control Cam
AI—Neutral Return Spring
AJ—Shift Block (2 used)
AK—Neutral Adjustment Eccentric Shaft
AL—O-Ring
AM—Actuating Plunger (2 used)
AN—Spring (2 used)
AO—Valve Cap (2 used)
AP—Valve Body (2 used)
AQ—Back-Up Ring (2 used)
AR—O-Ring (2 used)
AS—Ball (2 used)
AT— Seat (2 used)
AU—Spring (2 used)
AV—Spring Guide (2 used)
AW—Pin (2 used)
AX—Bushing
AY—Valve Body
AZ—Gasket
BA—Filter
BB—O-Ring
BC—Fill Port
BD—O-Ring
BE—Pipe Plug
BF—Case Half—K60 (Cover—K61)
BG—Magnet
BH—Bearing Assembly
BI—Fixed Position Swash Plate
BJ—Output (Motor) Shaft
BK—Seal



K60 Shown

M54659

IMPORTANT: Parts (AM—AP) and (AS—AV) are not interchangeable. Mark parts to ensure assembly in original bore.

Be careful not to scratch or nick mating surfaces of parts (T, AY and BI).

NOTE: Bearings (C) are press-fit. Remove bearings only if replacement is necessary.

27. Disassemble parts (A—BK).
28. Inspect all parts for wear or damage. Replace parts as necessary.
29. Replace bearings (C) using a piece of pipe and a press.


M54773

30. Measure plain bearings. Replace if bearing thickness is **less than 1.30 mm (0.051 in.)**.

IMPORTANT: Absolute cleanliness is essential when working on transaxle. Contamination can result in serious damage or inadequate operation.

DO NOT use shop towels or rags to dry clean parts. Lint will clog passages in hydrostatic system and cause damage.

⚠ 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.

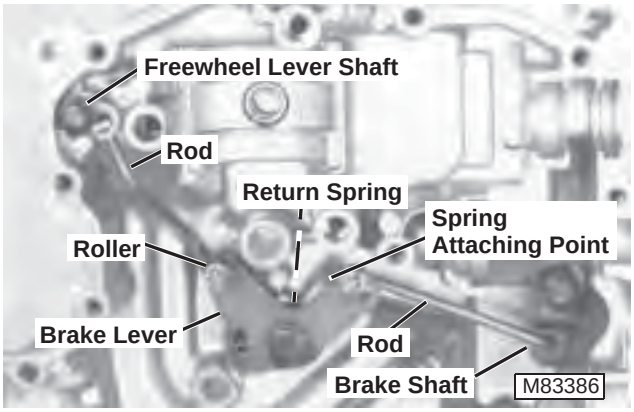
31. Clean all metal parts with solvent and blow dry with compressed air.
32. Inspect case halves for wear or damage. Replace as necessary.

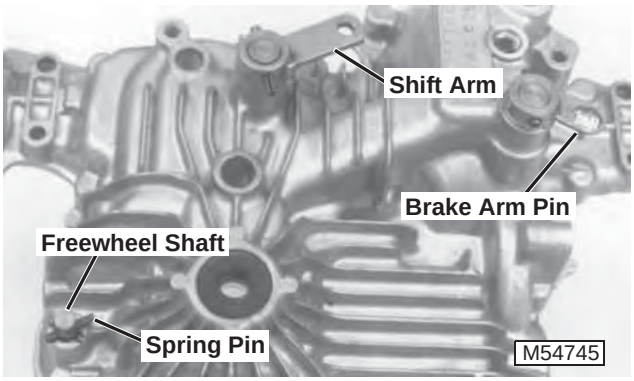
Assembly

IMPORTANT: Always use new seals and O-rings. Damaged or used parts will leak.

NOTE: Lubricate all seals and O-rings with petroleum jelly during assembly.

Apply clean SAE 10W30 engine oil to all internal parts during assembly.





1. Install O-ring and rod on brake shaft.

NOTE: Apply a light coat of multipurpose grease to the shaft bore in the top case.

2. Install brake shaft in top case half.
3. Install spring, O-ring and rod on freewheel shaft.

NOTE: Apply a light coat of multipurpose grease to the shaft bore in the top case.

4. Install freewheel shaft in top case half.
5. Install brake arm with pin facing case. Secure with roll pin.
6. Install roll pin in hole of freewheel shaft closest to case.

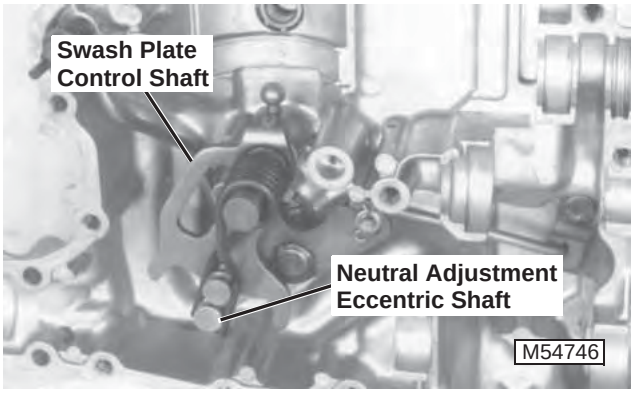
7. Install O-ring and return spring on brake lever shaft.

NOTE: Apply a light coat of multipurpose grease to the shaft bore in the top case.

8. Install brake lever in case half.
9. Connect brake shaft rod and freewheel rods to brake lever as shown. Secure brake shaft rod with washer and retaining clip.

NOTE: Shaft should protrude slightly above shift arm. Check that the return spring is not pinched between the case half and shaft, and is hooked on lever at the spring attaching point.

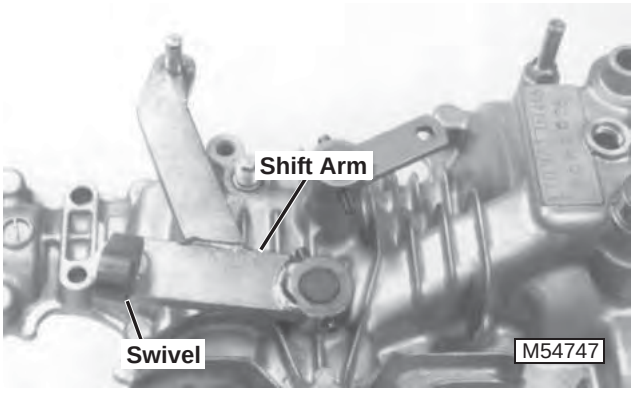
10. Install roll pin and shift arm.
11. Install roller and E-clip.



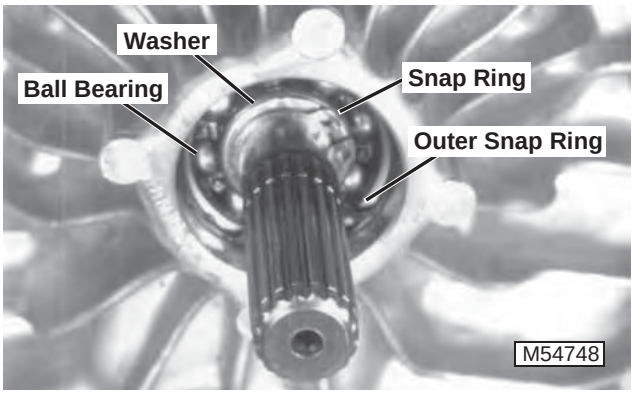
12. Install O-rings and shafts.

NOTE: Apply a light coat of multipurpose grease to the shaft bores in the top case.

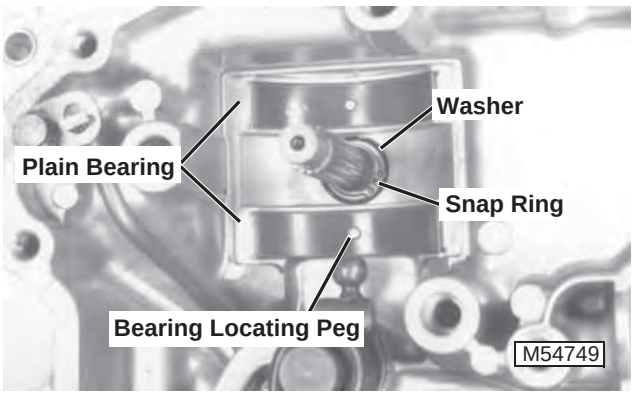
13. Insert neutral adjustment eccentric shaft between spring ends. Install swash plate control and neutral adjustment eccentric shafts in case as an assembly.



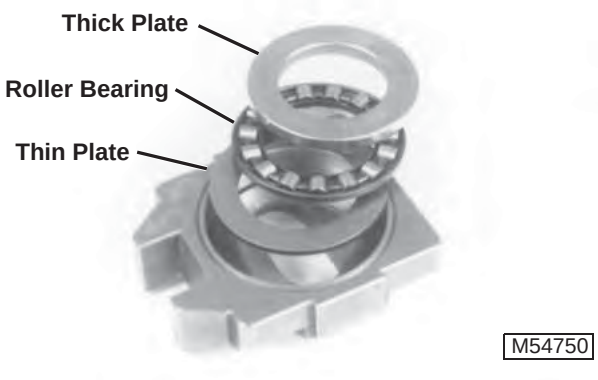
14. Install shift arm. Secure with roll pin.
15. Install swivel and bushing.



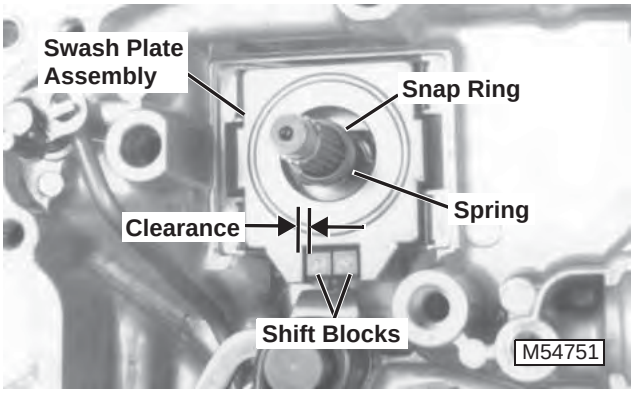
16. Press bearing in until seated.
17. Install outer snap ring.
18. Install washer.
19. Install snap ring on input shaft.
20. Press input shaft through bearing until seated against snap ring.



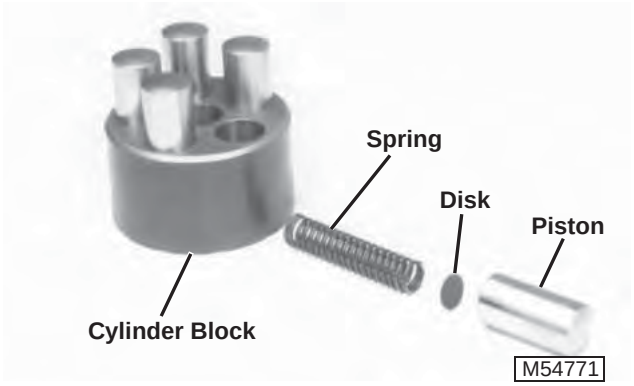
21. Install washer and snap ring.
22. Install bearings. Check that bearings are seated on pegs.



23. Install plates and roller bearing as shown.

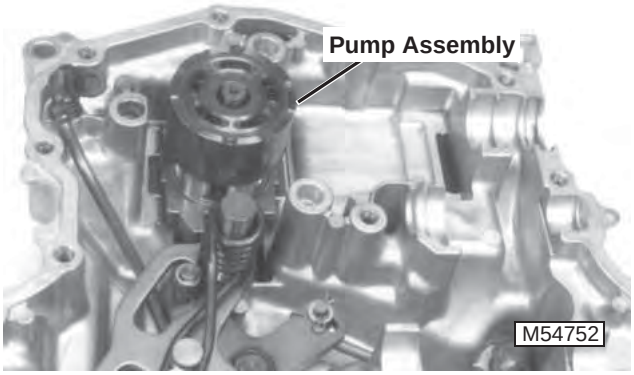


24. Apply a small amount of petroleum jelly to shift blocks to hold blocks in place. Install blocks on control shaft.
25. Install swash plate assembly in upper case.
26. Install snap ring and spring.
27. Measure clearance between swash plate and shift blocks. If measurement is greater than 0.30 mm (0.010 in.), replace both shift blocks and swash plate.

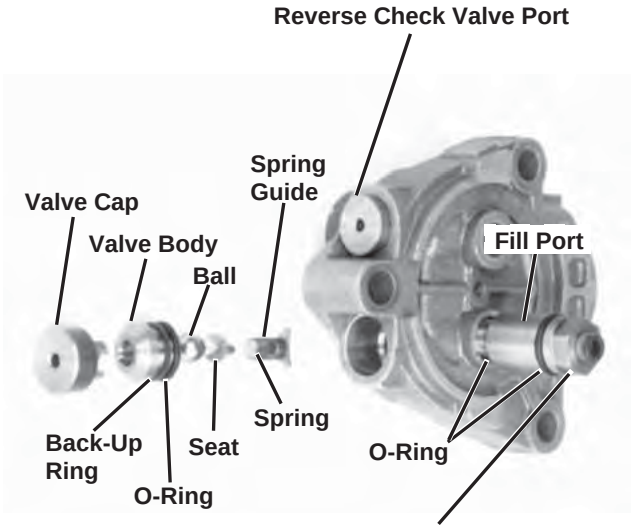


IMPORTANT: Install pistons into the same bore as removed from.

28. Install spring, disk and pistons in their original bore in cylinder block.



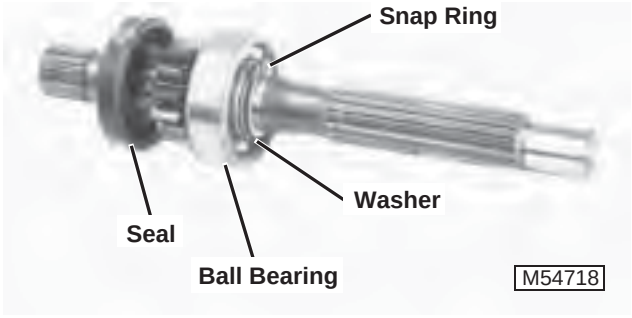
29. Install pump assembly on output (motor) shaft.



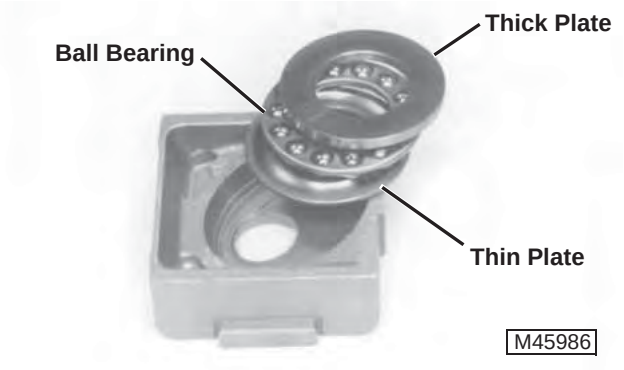


IMPORTANT: Valve body with orifice must be installed in reverse check valve port.

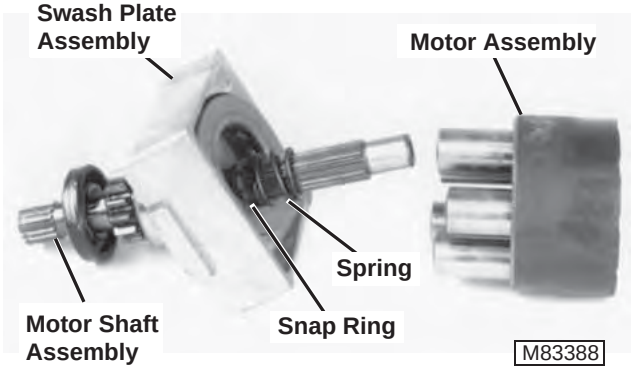
30. Install valve cap, valve body, ball, seat, spring guide, back-up ring, O-ring and spring in valve body.
31. Install O-rings on fill port.
32. Install fill port in valve body.
33. Apply Pipe Sealant with TEFLON® (or equivalent) to threads of pipe plug. Install pipe plug.



34. Press bearing onto motor shaft.
35. Install washer and snap ring.
36. Install seal with open side facing bearing.



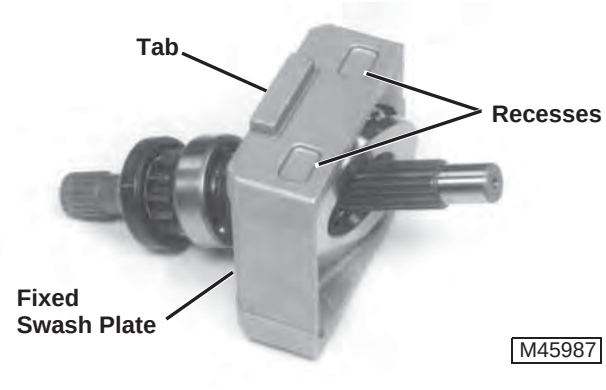
37. Install thin plate in retaining block with flat side toward retainer.
38. Install ball bearing, scalloped side facing toward retainer.
39. Install thick plate with flat side facing away from retainer.



40. Install motor shaft assembly in swash plate assembly.
41. Install snap ring.
42. Install spring.

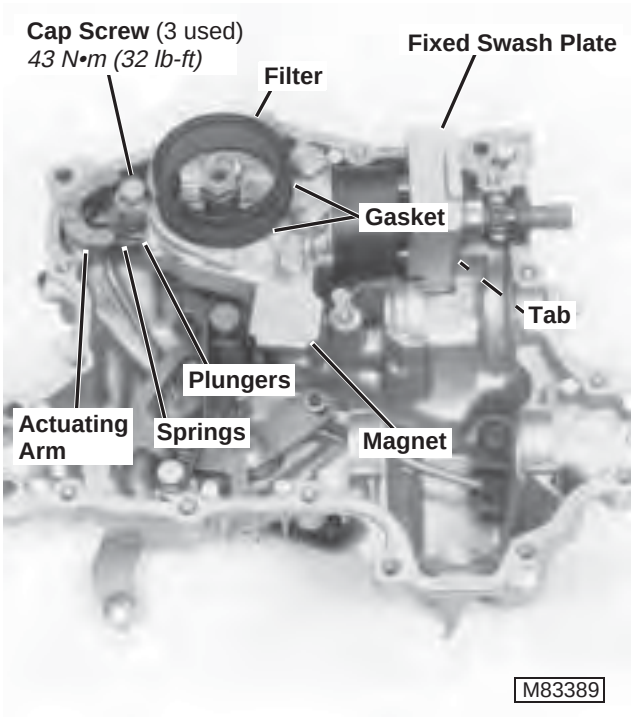
NOTE: When installing motor assembly onto motor shaft, hold pistons to prevent them from falling into case.

43. Install motor assembly on shaft.



IMPORTANT: Fixed swash plate must be installed with recesses facing downward. Incorrect installation will result in improper operation of transaxle.

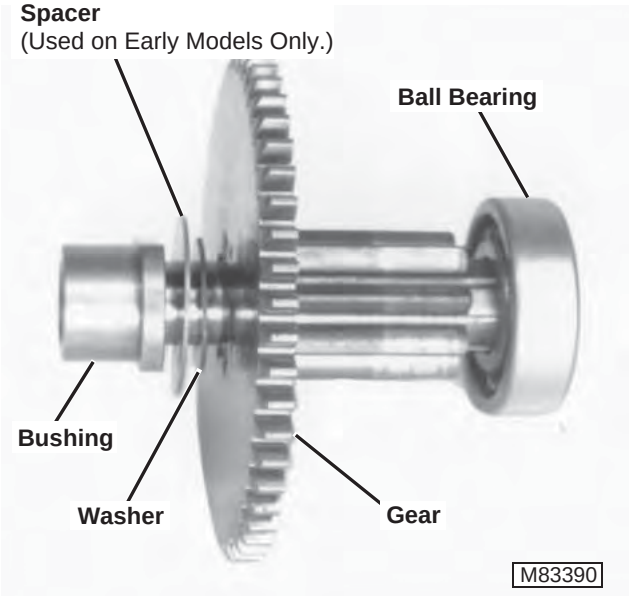
44. Install center case and motor assembly in top case half. Check that tab on bottom of fixed swash plates is in slot of the top case half.



45. Install magnet and cap screws. Tighten cap screws evenly to draw the assembly into place.
46. Install springs and plungers.
47. Install arm with slot in arm facing toward case half.

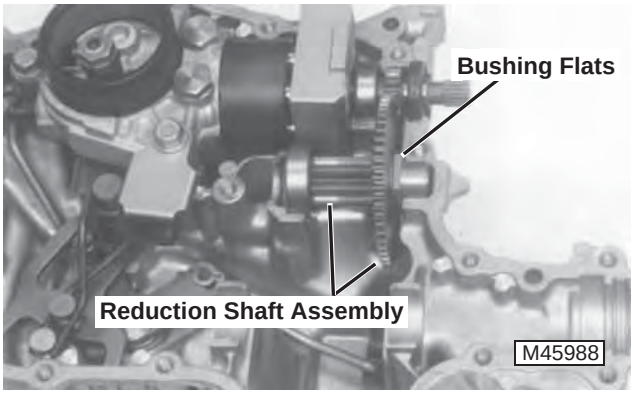
NOTE: Replace filter whenever transaxle is opened.

48. Install gaskets and new filter.

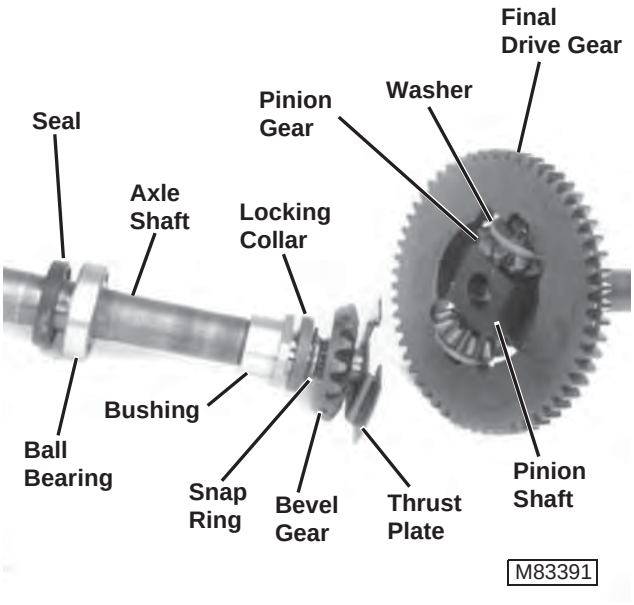


49. Install parts on reduction gear shaft.

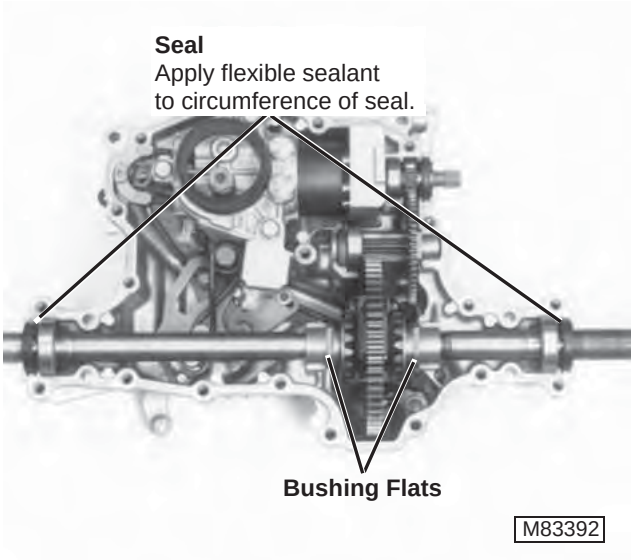
NOTE: Steps (50—55) are for K60 transaxles only.



50. Install reduction shaft assembly. Be sure that bushing flats face case halves.

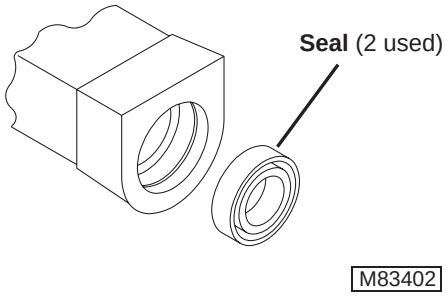


51. Install seal, ball bearing, bushing, locking collar, bevel gear, thrust plate and snap ring on each axle shaft.
52. Install pinion shaft, pinion gears and washers in final drive gear.



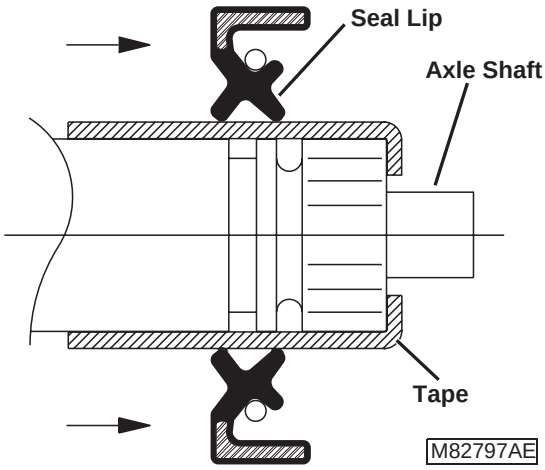
53. Apply John Deere Flexible Sealant (or equivalent) to outer circumference of axle seals.
54. Install differential assembly in case half.
55. Check that axles turn smoothly and that bushing flats face case halves.

NOTE: Steps (56—64) are for K61 transaxles only.

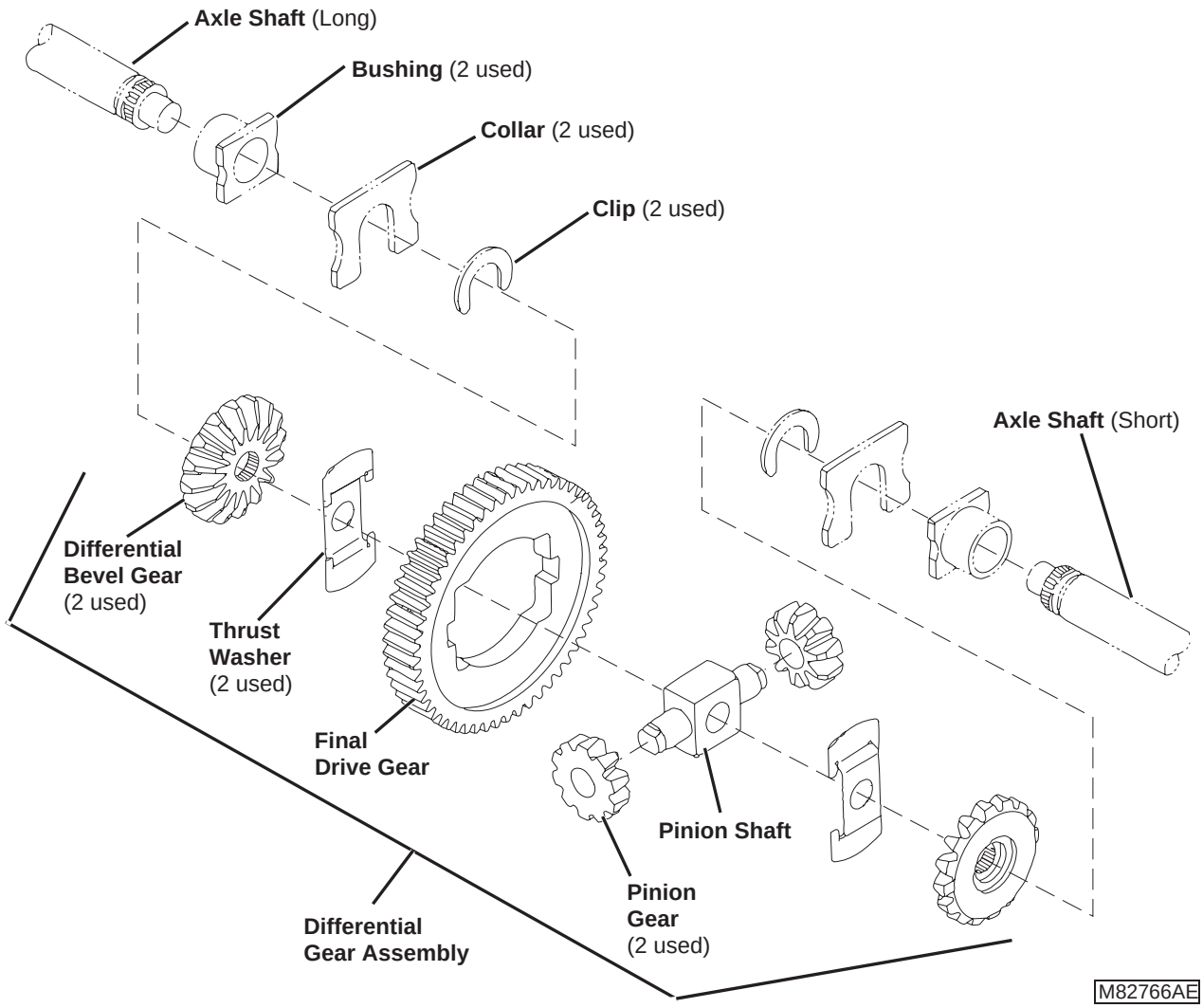


56. Install axle shaft seals in top case half using a seal driver. Drive to shoulder in housing.

IMPORTANT: Apply multipurpose grease to lips of seal and tape ends of axle shaft to prevent damage during axle installation.

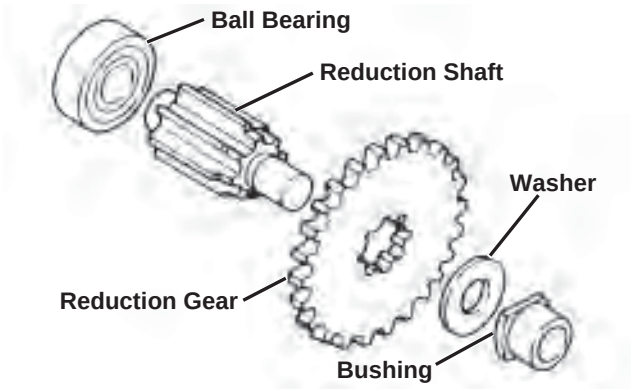


57. Apply tape to ends of axle shaft and install axles.



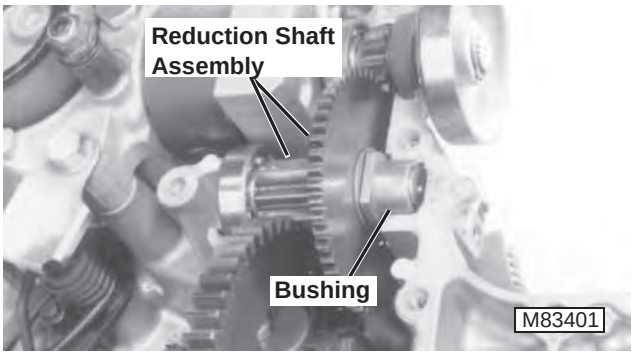
NOTE: Push axle shafts into bushing so that the ends do not extend past bushing.

58. Install bushings in top case half.
59. Assemble differential gear assembly.
60. Install differential gear assembly into case and push axle shafts into side differential bevel gears.
61. Install ring on each side of differential gear assembly.
62. Install collar between ring and bushing on each side of differential gear assembly.

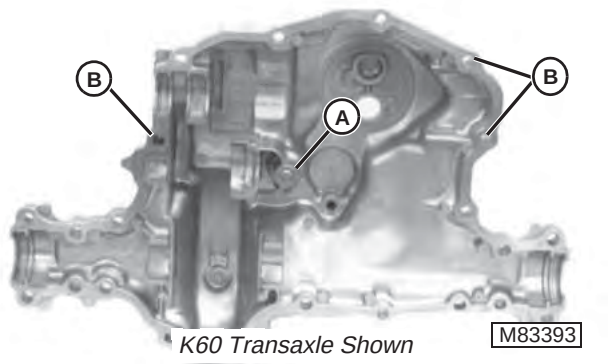


Reduction Shaft Assembly

63. Assemble reduction shaft assembly.



64. Install reduction shaft assembly in top case half. Make sure that bushing flats face case halves.



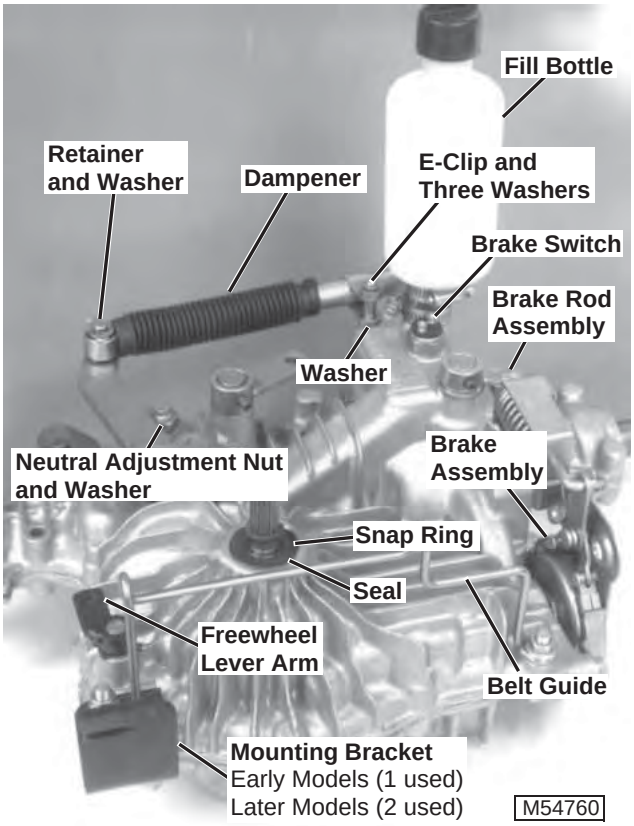
K60 Transaxle Shown

NOTE: Apply sealant to area "A" before assembly.

65. Clean mating surfaces of transaxle case halves using Clean and Cure Primer. Apply a light coat of Flexible Sealant or equivalent to top and bottom case halves.

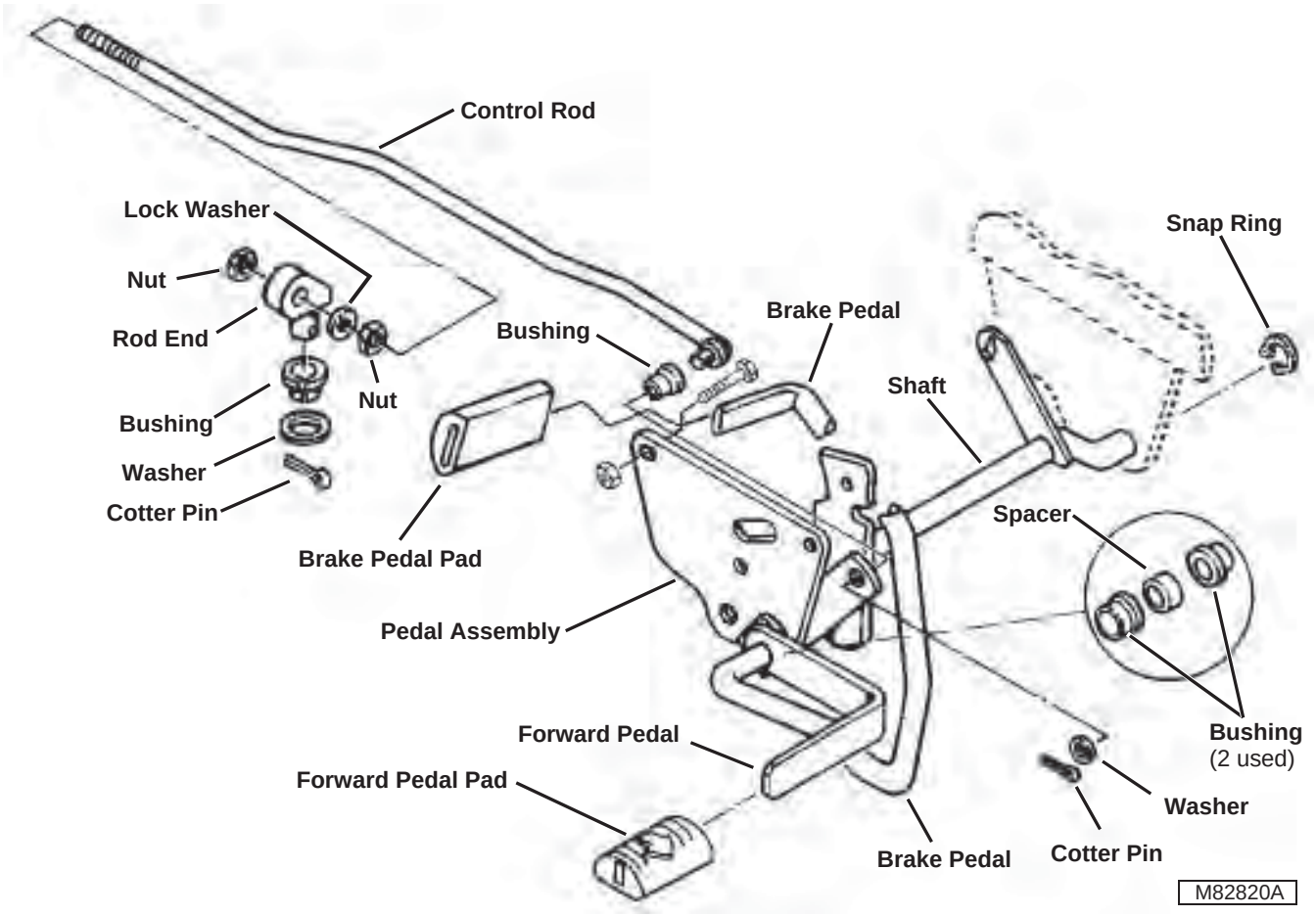
NOTE: Install longer cap screws at points "B".

66. Assemble transaxle case halves. Install cap screws and tighten to **24 N•m (212 lb-in.)** in same case or **29 N•m (257 lb-in.)** in new case.



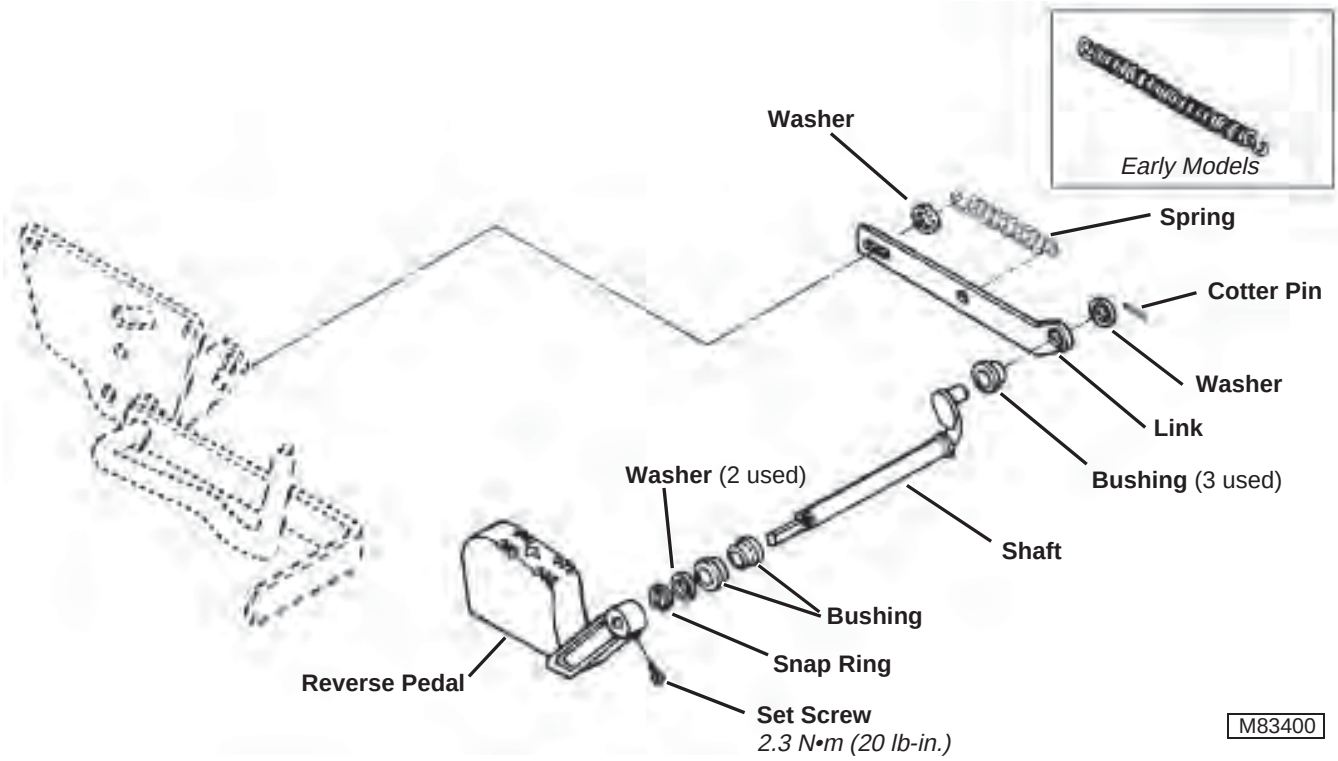
67. Install all parts as shown.
68. Install brake assembly. (See BRAKE ASSEMBLY—Removal/Installation on page 9-26.)
69. Fill transaxle to proper level with specified oil. (See HYDROSTATIC TRANSMISSION OIL—NORTH AMERICA on page 2-16 or HYDROSTATIC TRANSMISSION OIL—EUROPE on page 2-16.)
70. Install transaxle. (See HYDROSTATIC TRANSAXLE—Removal/Installation on page 7-47.)
71. Bleed air from transaxle. (See HYDROSTATIC TRANSAXLE BLEEDING PROCEDURE on page 7-43.)
72. Adjust transmission for neutral creep. (See NEUTRAL CREEP ADJUSTMENT on page 7-43.)
73. Adjust brake shoe actuator. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)

CONTROL PEDALS AND LINKAGE—FORWARD



1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove fuel tank. (See FUEL TANK—Removal/Installation on page 3-41, 3-112 or 4-28.)
3. Inspect all parts for wear or damage. Replace parts as necessary.
4. Adjust linkage and pedal height. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)

CONTROL PEDALS AND LINKAGE—REVERSE

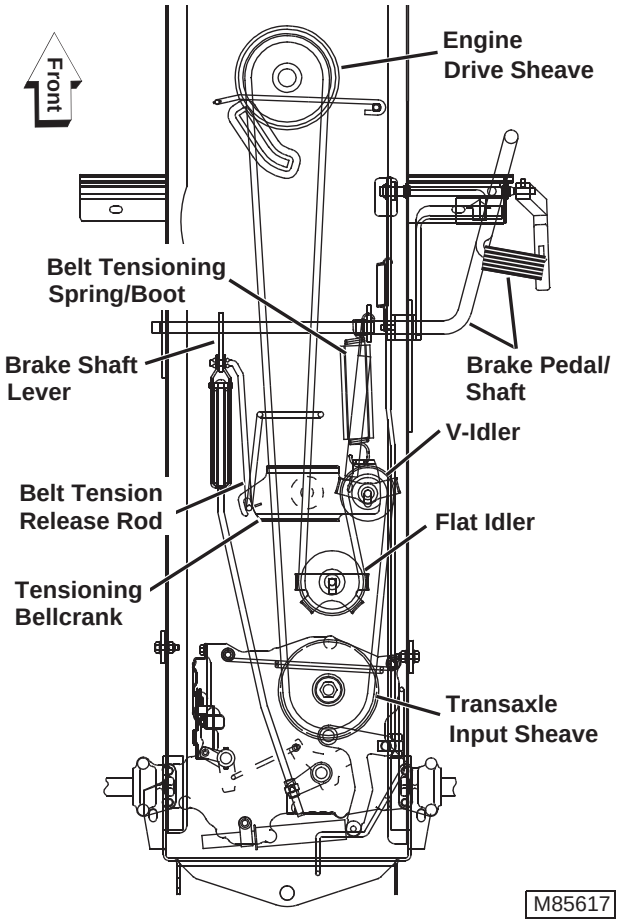


- Inspect all parts for wear or damage. Replace parts as necessary.
- Adjust linkage and pedal height. (See PEDAL HEIGHT ADJUSTMENT on page 7-44.)

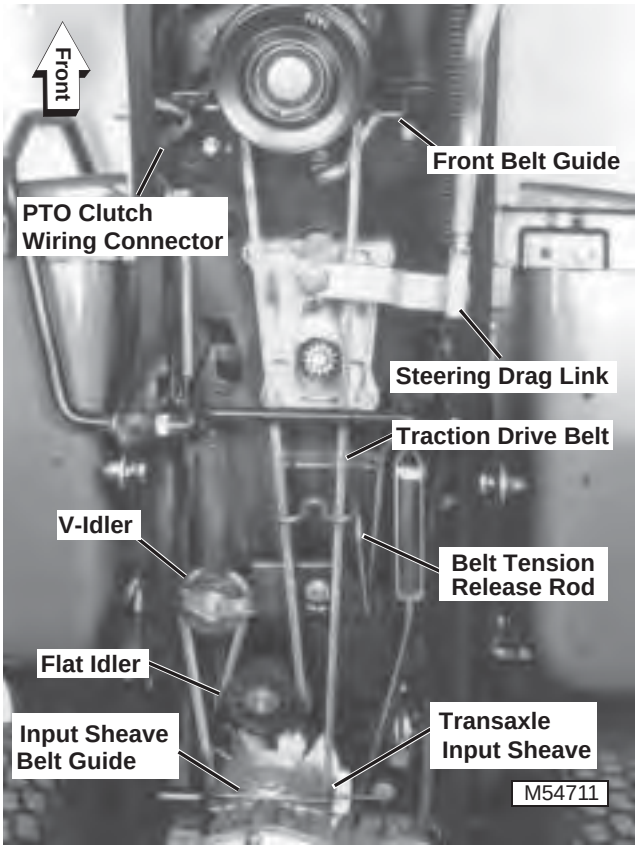
TRACTION DRIVE BELT

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Set park brake to release belt tension.



Top View



3. Remove flat idler.
4. Remove v-idler belt guide.
5. Remove transaxle input sheave belt guide and remove drive belt from sheave.
6. Remove belt from belt tension release rod.
7. Disconnect PTO clutch wiring connector.
8. Remove front belt guide.
9. Disconnect steering drag link.
10. Remove drive belt.

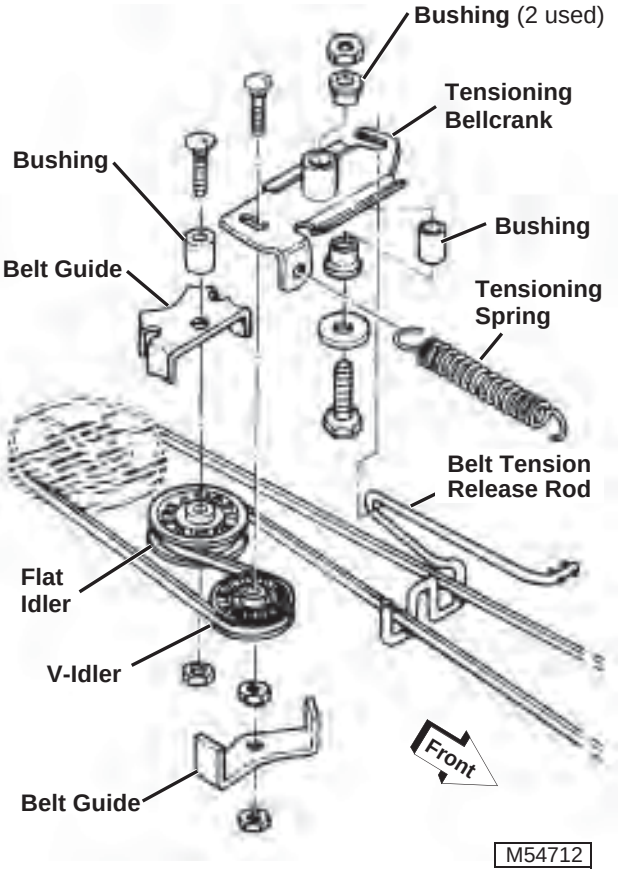
Installation is done in the reverse order of removal.

- Adjust belt tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 7-45.)

TRACTION DRIVE BELT TENSIONER ASSEMBLY

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)
3. Remove traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on previous page 7-61.)



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

Installation is done in the reverse order of removal.

- Install traction drive belt. (See TRACTION DRIVE BELT—Removal/Installation on page 7-61.)
- Adjust belt tension. (See TRACTION DRIVE BELT TENSION ADJUSTMENT on page 7-45.)

CONTENTS

Page

STEERING

SPECIFICATIONS
REPAIR SPECIFICATIONS 8-2
COMPONENT LOCATION AND OPERATION 8-3
TROUBLESHOOTING 8-4
DIAGNOSIS 8-5
ADJUSTMENTS
DRAG LINK ADJUSTMENT 8-7
REPAIR
STEERING WHEEL 8-8
STEERING SHAFT 8-8
STEERING SECTOR ASSEMBLY 8-10



SPECIFICATIONS

REPAIR SPECIFICATIONS

Drag Link

Drag Link Nut Torque	30 N•m (22 lb-ft)

COMPONENT LOCATION AND OPERATION

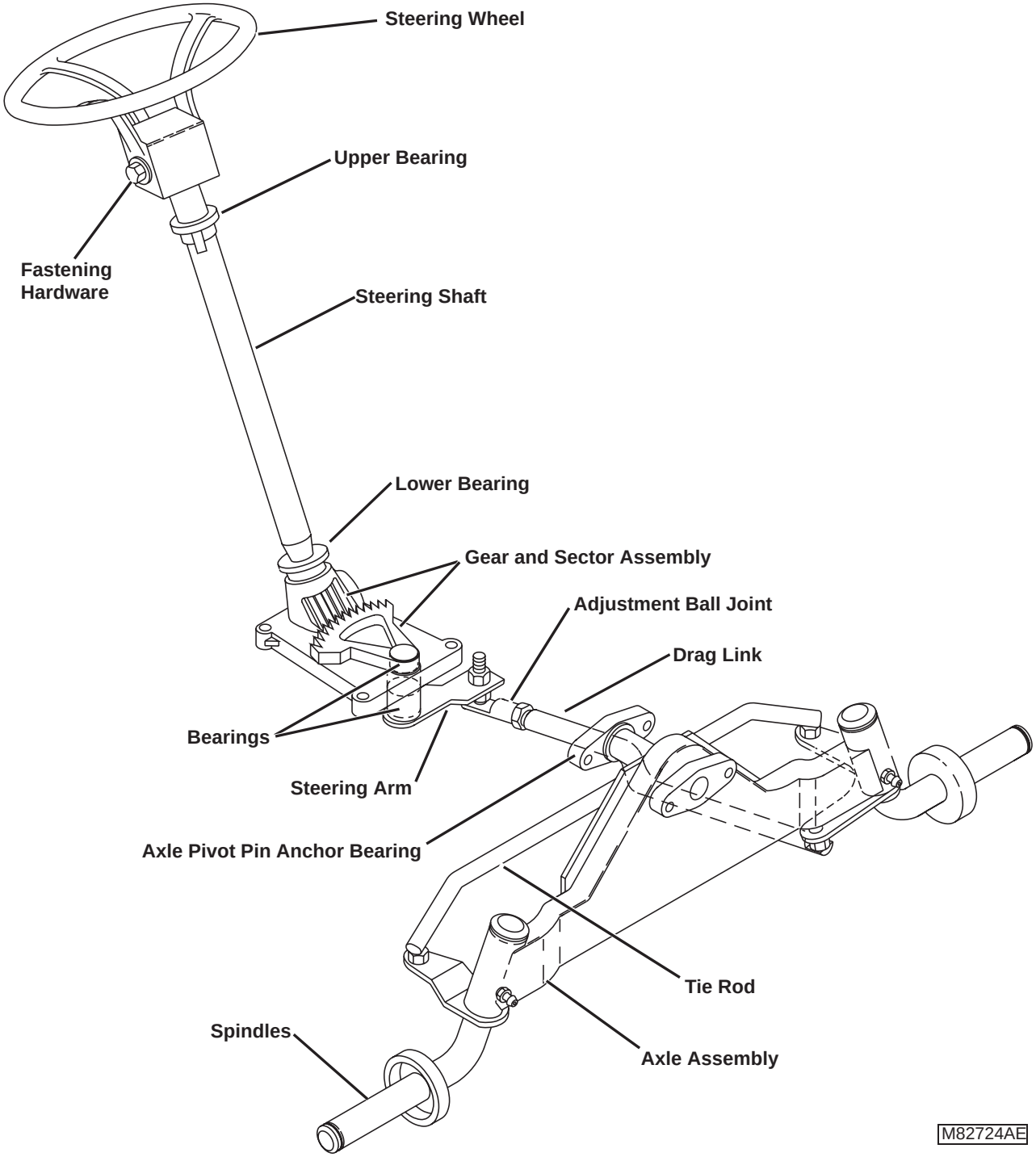
STEERING SYSTEM OPERATION

Function:

To allow the operator to change machine travel direction.

Theory of Operation:

As the steering wheel is turned, the steering shaft and gear rotate. The steering gear meshes with the sector gear, causing the sector gear and steering arm to rotate. As the steering arm moves, the drag link is moved (forward—left turn, backward—right turn) causing the spindle to rotate. Since the spindles are connected by the tie rod both spindles are turned at the same time.



TROUBLESHOOTING

STEERING SYSTEM TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Steering wander.	Lash (lost motion) at steering wheel.	Steering wheel turns farther in one direction.	Wheels won't track straight.
Steering wheel loose on shaft.	●	●		●
Steering linkage components loose or worn.	●	●		●
Gear and/or sector teeth worn or damaged.	●	●		
Drag link out of adjustment.			●	
Tie rod bent or out of adjustment.				●

DIAGNOSIS

STEERING WANDER

NOTE: Before checking for a steering problem, make sure that tire inflation is correct, front ballasting is not excessive, and front implement is properly installed.

Test Conditions:

- Machine parked on a level surface.
- Park brake ENGAGED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Gear and sector assembly.	Teeth not worn or damaged. Not binding	Replace gear and sector assembly. Check bushings. (See STEERING SECTOR ASSEMBLY—Removal/ Inspection/Installation on page 8-10)
2. Tie rod.	Not binding, damaged, bent, or worn.	Replace tie rod.

LASH (LOST MOTION) AT STEERING WHEEL

NOTE: Before checking for a steering problem, make sure that tire inflation is correct, front ballasting is not excessive, and front implement is properly installed.

Test Conditions:

- Machine parked on a level surface.
- Park brake ENGAGED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Steering wheel.	Wheel securely mounted to shaft.	Tighten.
2. Steering linkage.	Linkage not loose, worn or damaged.	Tighten, repair or replace linkage.
3. Gear and sector assembly.	Teeth not worn or damaged. Not binding.	Replace gear and sector assembly. Check bushings. (See STEERING SECTOR ASSEMBLY—Removal/ Inspection/Installation on page 8-10)
4. Tie rod.	Not worn.	Replace tie rod.

STEERING WHEEL TURNS FARTHER IN ONE DIRECTION

NOTE: Before checking for a steering problem, make sure that tire inflation is correct, front ballasting is not excessive, and front implement is properly installed.

Test Conditions:

- Machine parked on a level surface.
- Park brake ENGAGED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Drag link.	Drag link properly adjusted.	Adjust drag link. (See DRAG LINK ADJUSTMENT on page 8-7.)

WHEELS WON'T TRACK STRAIGHT

NOTE: Before checking for a steering problem, make sure that tire inflation is correct, front ballasting is not excessive, and front implement is properly installed.

Test Conditions:

- Machine parked on a level surface.
- Park brake ENGAGED.
- Front axle raised safely off ground.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Tie rod.	Tie rod not bent or damaged.	Replace bent or damaged components.

ADJUSTMENTS

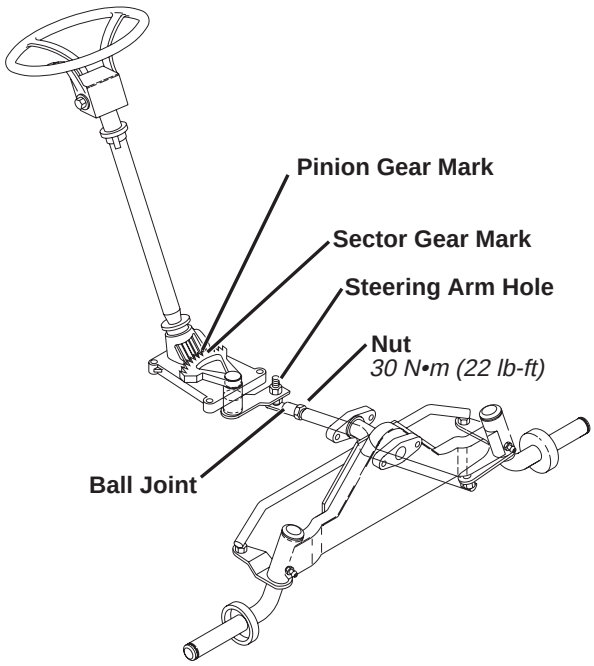
DRAG LINK ADJUSTMENT

Reason:

To adjust the steering linkage so that wheels are straight ahead.

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Place transmission is in NEUTRAL position.
4. Engage park brake.



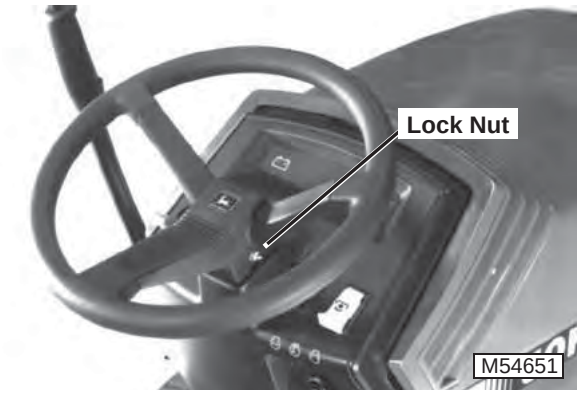
M82821AE

5. Disconnect drag link ball joint.
6. Align sector gear mark with pinion gear mark.
7. Put wheels in straight forward position.
8. Loosen nut. Turn drag link ball joint until stud aligns with the hole in the steering arm. Tighten nut.
9. Connect drag link ball joint. Tighten nut to **30 N•m (22 lb-ft)**.
10. Turn steering wheel to the full left position and check that the sector gear contacts the stop before the tie rod hits the axle.
11. Repeat check for full right turn. Adjust drag link slightly if tie rod contacts axle.

REPAIR

STEERING WHEEL

Removal/Installation



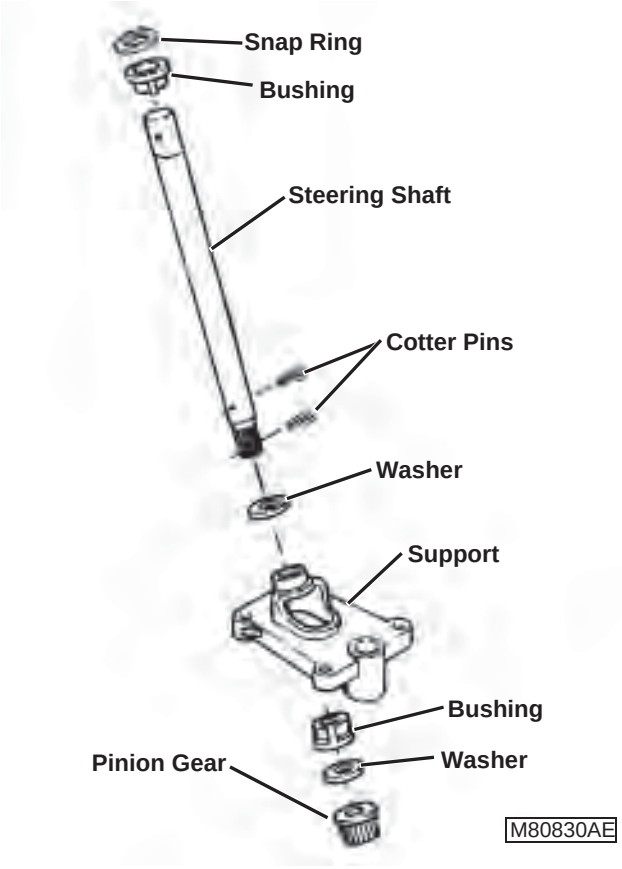
1. Remove lock nut.
2. Drive shoulder bolt out of steering wheel.
3. Remove steering wheel.

Installation is done in the reverse order of removal.

STEERING SHAFT

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove steering wheel.
3. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)



NOTE: Turn shaft to gain clearance to cotter pin.

4. Remove cotter pins.
5. Remove pinion gear and washer.
6. Loosen four instrument panel mounting cap screws.

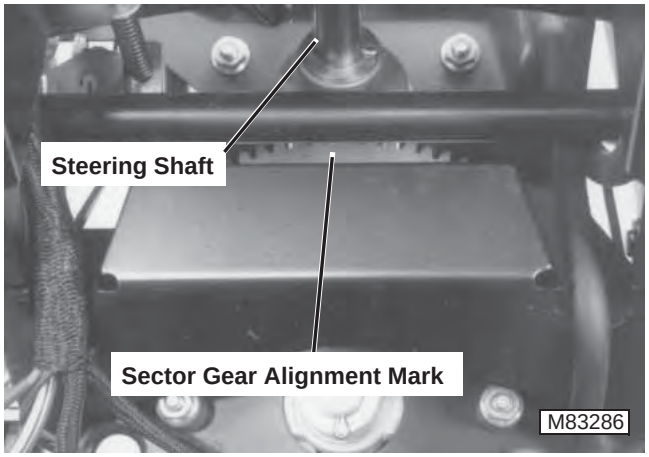
NOTE: Some force is required for the snap ring to pass through panel.

7. Remove steering shaft through top of the instrument panel.

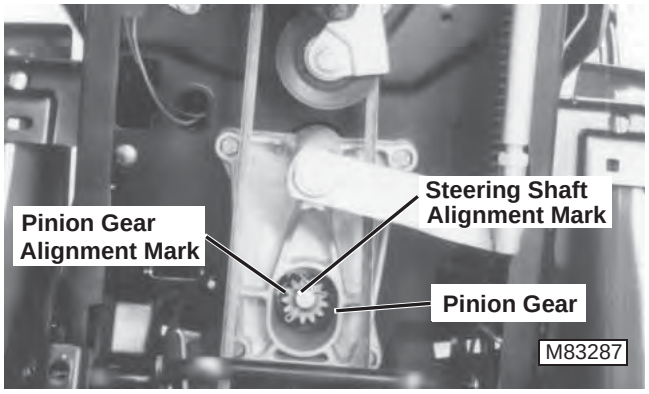
NOTE: Bushings are slip fit.

8. Inspect all parts for wear or damage. Replace parts as necessary.
   - If pinion gear requires replacement, also replace steering sector.
   - If support requires replacement, remove steering sector assembly.

Installation is done in the reverse order of removal.



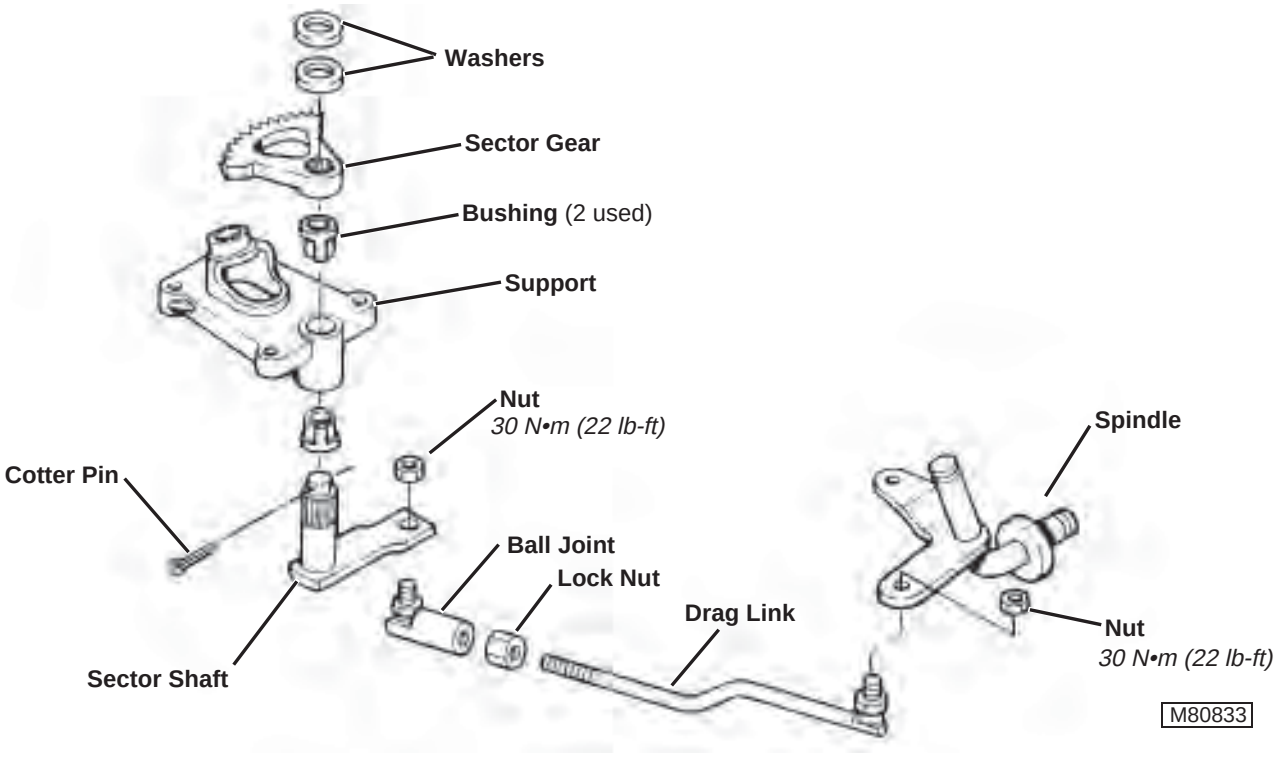
- Check that front wheels are straight and sector gear alignment mark is centered with steering shaft.



- When installing pinion gear, align pinion gear, steering shaft and sector gear alignment marks.

STEERING SECTOR ASSEMBLY

Removal/Inspection/Installation



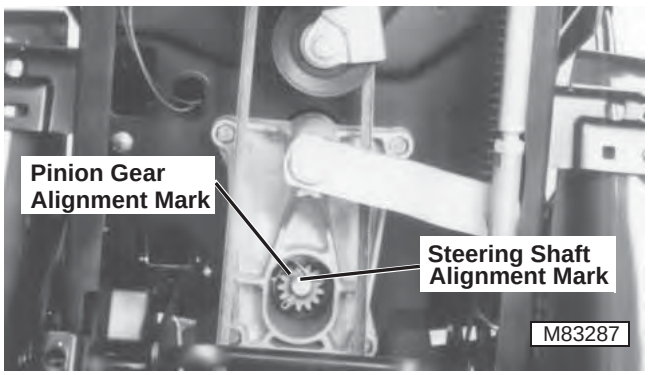
1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)

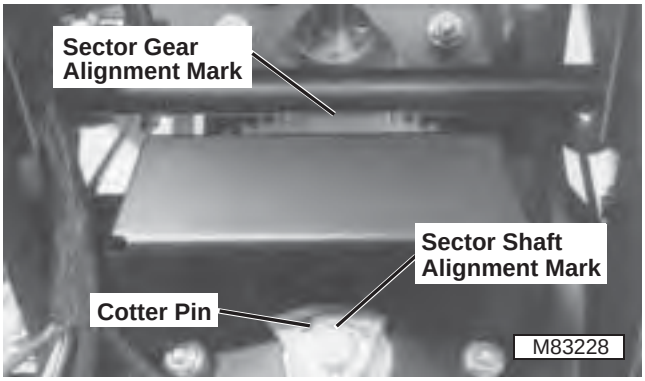
NOTE: Bushings are slip fit.

3. Inspect all parts for wear or damage. Replace parts as necessary.
   - If sector gear requires replacement, also replace pinion gear.
   - If support requires replacement, remove steering shaft.

Installation is done in the reverse order of removal.

- Tighten drag link retainer nuts to **30 N•m (22 lb-ft)**.





- Do not bend cotter pin in place until pinion gear, steering shaft, sector gear and sector shaft alignment marks are aligned.
- Adjust drag link. (See DRAG LINK ADJUSTMENT, page 8-7.)

CONTENTS

Page

BRAKES

SPECIFICATIONS
ADJUSTMENT SPECIFICATIONS 9-3
REPAIR SPECIFICATIONS 9-3
SERVICE PARTS KITS 9-3
OTHER MATERIALS 9-3
COMPONENT LOCATION AND OPERATION—LX172/LX173
BRAKE SYSTEM OPERATION 9-4
COMPONENT LOCATION AND OPERATION—LX176/LX178/LX186/LX188
EXTERNAL BRAKE LINKAGE OPERATION 9-5
INTERNAL BRAKE LINKAGE OPERATION 9-6
TROUBLESHOOTING—LX172/LX173 9-7
DIAGNOSIS—LX172/LX173
LACK OF DRIVE—BOTH DIRECTIONS 9-8
BRAKES DO NOT ENGAGE WHEN PEDAL DEPRESSED 9-9
PARK BRAKE DOES NOT HOLD MACHINE ON HILL 9-10
NOISY OPERATION 9-11
TROUBLESHOOTING—LX176/LX178/LX186/LX188 9-12
DIAGNOSIS—LX176/LX178/LX186/LX188
MACHINE WILL NOT MOVE IN FORWARD OR REVERSE 9-13
BRAKES DO NOT ENGAGE WHEN PEDAL DEPRESSED 9-14
PARK BRAKE DOES NOT HOLD MACHINE ON HILL 9-15
NOISY OPERATION 9-15
ERRATIC SPEED 9-16
MACHINE DOES NOT ACHIEVE FULL GROUND SPEED 9-16
MACHINE WILL NOT MOVE IN FORWARD OR IS SLOW IN FORWARD 9-17
MACHINE IS SLOW IN REVERSE 9-18
BRAKE SWITCH DOES NOT ENGAGE WHEN BRAKE PEDAL IS DEPRESSED 9-19
ENGINE CAN BE STARTED WITHOUT DEPRESSING BRAKE PEDAL 9-20
ADJUSTMENTS
BRAKE ADJUSTMENT—LX172/LX173 9-21
BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 9-21



Page

REPAIR—LX172/LX173
BRAKE LINKAGE 9-22
BRAKE PEDAL ASSEMBLY 9-22
BRAKE ASSEMBLY 9-23
PARK BRAKE LEVER AND LINKAGE 9-24
REPAIR—LX176/LX178/LX186/LX188
BRAKE PEDAL AND LINKAGE 9-25
BRAKE ASSEMBLY 9-26
PARK BRAKE LEVER AND LINKAGE 9-26

SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

LX172/LX173

Brake Pad Clearance . . . . . 0.13 mm (0.005 in.)

REPAIR SPECIFICATIONS

LX172/LX173

Brake Holder Cap Screw Torque. . . . . 10 N•m (95 lb-in.)

SERVICE PARTS KITS

The following kits are available through your parts catalog:

LX176/LX178/LX186/LX188

- Brake Linkage Bushing Kit

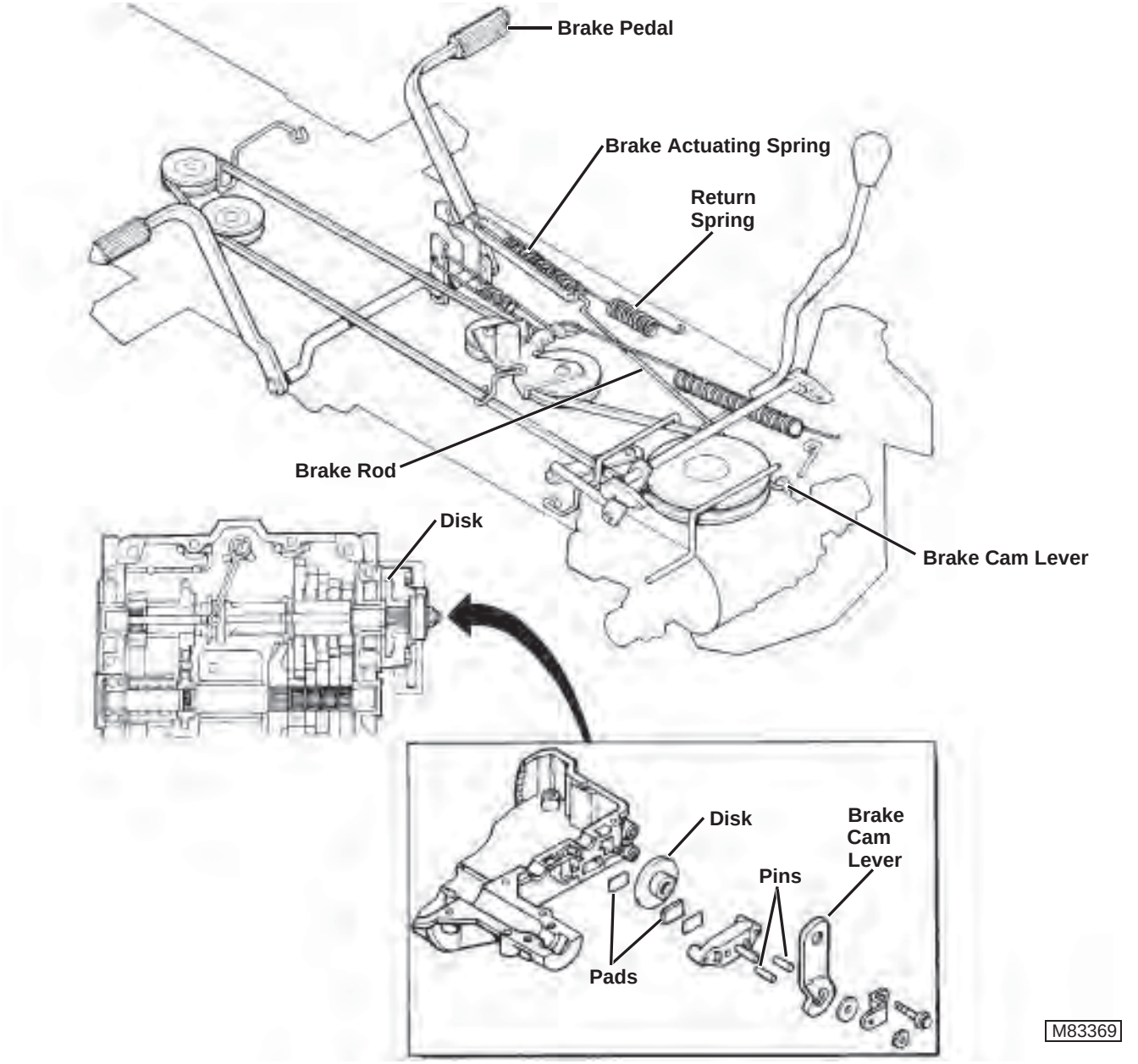
OTHER MATERIALS

Number	Name	Use
TY6431	John Deere LUBRIPLATE® Lubricant	Apply to brake shaft and pins.

® LUBRIPLATE is a registered trademark of Fiske Brothers Refining Co.

COMPONENT LOCATION AND OPERATION—LX172/LX173

BRAKE SYSTEM OPERATION



Function:

To slow down or stop the machine.

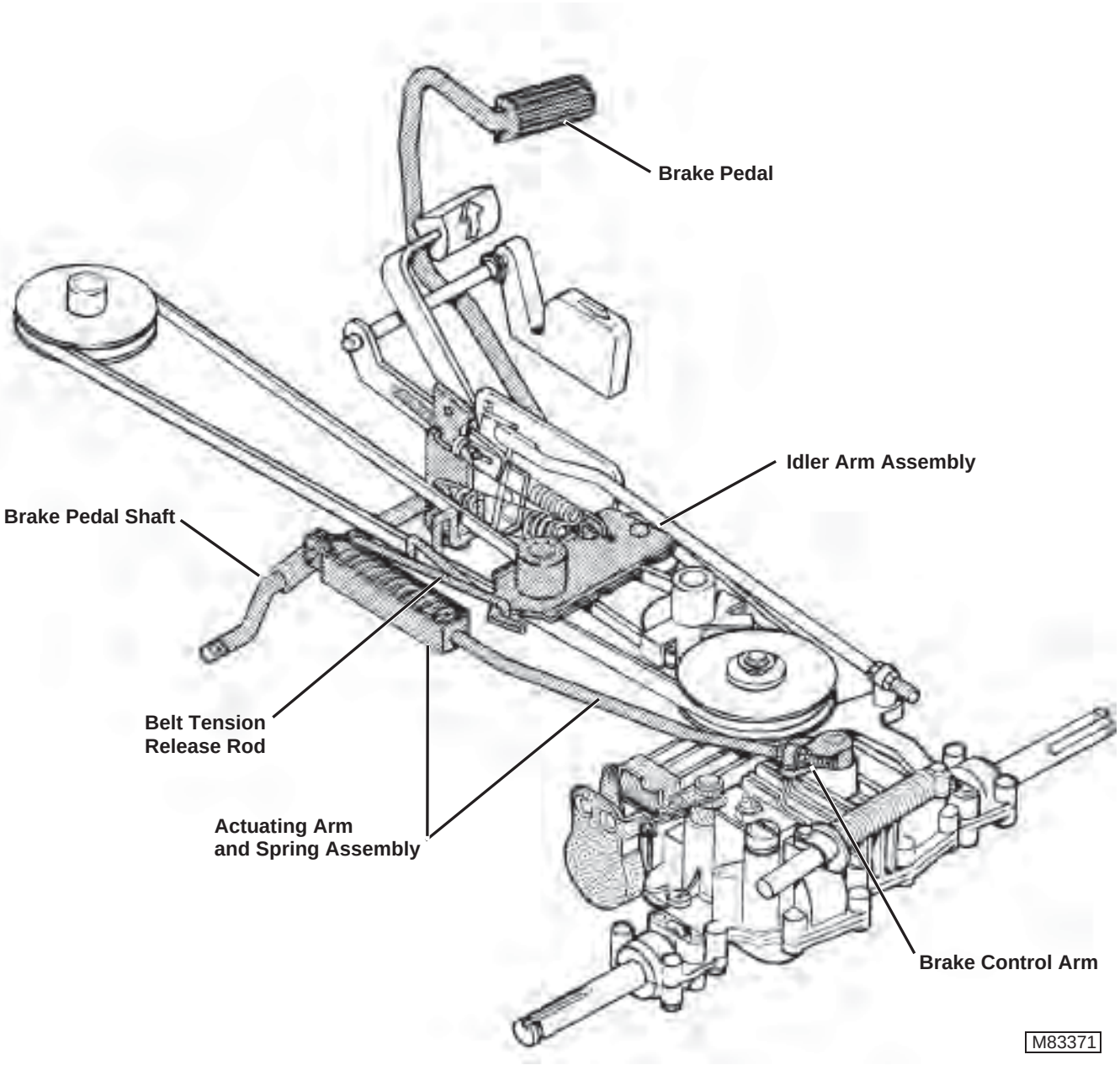
Theory of Operation:

The brake system is mounted on the transaxle. When the brake pedal is depressed, the brake actuating spring assembly moves forward which starts to compress the spring. The spring force pulls the brake rod forward and rotates the brake cam lever at the adjuster nut. There is a cam stamped into the lever. The cam forces pins to press against the outer brake pad, which presses the brake disk against the inner brake pad and the friction stops the unit. The brake disk is splined to the shifter shaft.

When the brake pedal is released, the return spring pulls the brake linkage to the disengaged position.

COMPONENT LOCATION AND OPERATION—LX176/LX178/LX186/LX188

EXTERNAL BRAKE LINKAGE OPERATION



Function:

To stop machine motion and disengage power from the engine to the transmission.

Theory of Operation:

When the brake pedal is depressed, it rotates the brake pedal shaft forward. Attached to the shaft is the belt tension release rod. Movement of the shaft is transferred to the rod which engages the end of the slot in the idler arm assembly. Continued movement pulls the left side of the idler arm forward and disengages drive belt tension.

Also attached to the brake pedal shaft is the brake actuating arm and spring assembly. Movement of the lever is transferred through the rod to the transmission brake actuator arm to provide braking action.

INTERNAL BRAKE LINKAGE OPERATION

Function:

The internal linkage performs multiple functions. First it applies the transaxle brake which is used as a park or emergency brake. Through the same linkage it activates the neutral start switch which necessitates having the brake applied in order to crank and start the engine. Along with these two functions the forward/reverse pedals are locked in place (neutral) and the freewheel valve is deactivated if it was previously engaged.

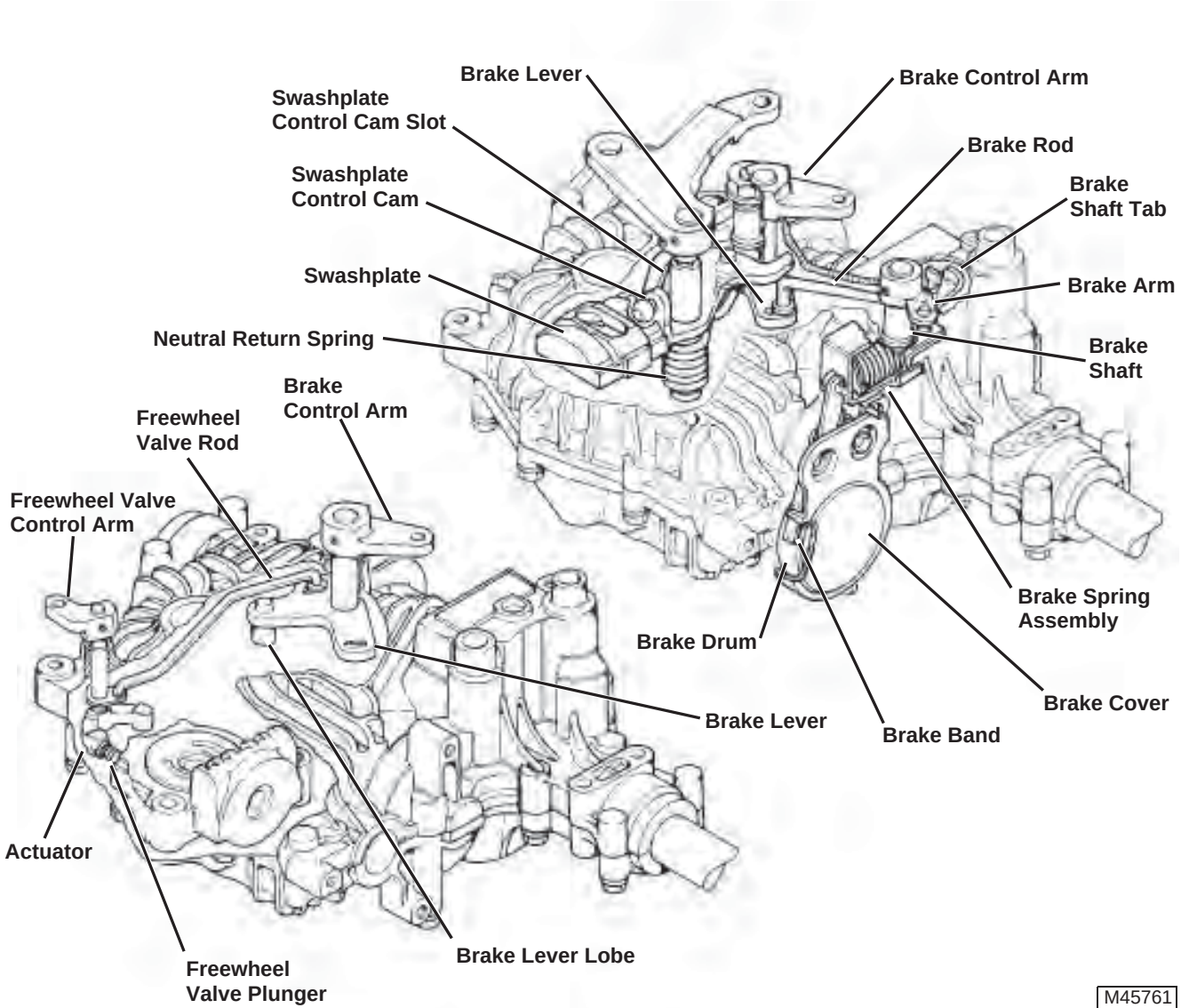
Theory of Operation:

When the brake pedal is applied, the external linkage pulls the brake control arm forward and rotates the brake lever. The motion is transferred to the brake rod which rotates the brake shaft. The brake shaft protrudes through the top of the case and is attached to the brake arm. As the brake arm rotates, it actuates the brake spring assembly. The brake link assembly allows only a limited amount of force to be applied to the brake band for braking action. The band encompasses the brake drum that is splined to the hydrostatic motor output shaft and this action stops the machine.

Without the brake applied, a tab on the brake shaft contacts the neutral start switch and interrupts the current flow in the cranking circuit. When the brake is applied, the tab no longer contacts the switch and the starting circuit can be activated.

At the same time, a lobe on the brake lever acts upon the cam slot profile of the swashplate control cam and locks the hydrostatic control linkage in place (neutral).

When the hydrostatic freewheel valve is activated, the brake rod is pulled to the end of the slot in the brake lever. When the brake is applied, the rod rotates the freewheel valve shaft and actuator and deactivates the freewheel valve plungers.



K60 Transaxle Shown

TROUBLESHOOTING—LX172/LX173

BRAKE SYSTEM TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Lack of drive in both directions.	Brakes do not engage when pedal is depressed.	Park brake does not hold machine on hill.	Noisy operation.
Brake linkage damaged or binding.	●	●	●	●
Brake actuating spring damaged or binding.		●	●	
Brake return spring damaged or binding.	●			●
Brake pads binding or worn.	●	●	●	●
Brake disk splines damaged or worn.		●	●	
Brake caliper pins and lever binding or damaged.	●	●	●	●

DIAGNOSIS—LX172/LX173

LACK OF DRIVE—BOTH DIRECTIONS

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in any gear.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Linkage not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE LINKAGE—Removal/Inspection/ Installation on page 9-22.)
2. Brake pads.	Pads not binding or worn. Adjusted properly.	Replace pads. Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
3. Caliper pins and lever.	Pins and lever not binding or bent.	Repair or replace components as necessary. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
4. Brake return spring.	Returns brake pedal and linkage to rest position when pedal is released. Not stretched or damaged.	Replace stretched or damaged spring.

BRAKES DO NOT ENGAGE WHEN PEDAL DEPRESSED

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in any gear.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Linkage not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE LINKAGE—Removal/Inspection/ Installation on page 9-22.)
2. Brake pads.	Pads not binding or worn. Adjusted properly.	Replace pads. Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
3. Brake disk.	Splines between disk and shifter not damaged or worn.	Replace brake disk. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
4. Caliper pins and lever.	Pins and lever not binding or bent.	Repair or replace components as necessary. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
5. Brake actuating spring.	Spring not damaged or weak when pedal depressed.	Replace spring.

PARK BRAKE DOES NOT HOLD MACHINE ON HILL

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in any gear.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Linkage not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE LINKAGE—Removal/Inspection/ Installation on page 9-22.)
2. Brake pads.	Adjusted properly.	Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
	Pads not binding or worn.	Replace pads. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
3. Brake disk.	Splines between disk and shifter not damaged or worn.	Replace brake disk. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
4. Caliper pins and lever.	Pins and lever not binding or bent.	Repair or replace components as necessary. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
5. Brake actuating spring.	Spring not damaged or weak when pedal depressed.	Replace spring.

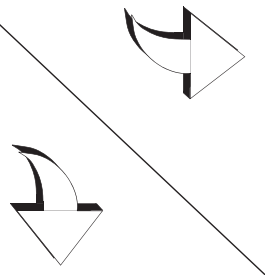
NOISY OPERATION

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in any gear.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake pads.	Adjusted properly.	Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)
	Pads not binding or worn.	Replace pads. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
2. Caliper pins and lever.	Pins and lever not binding or bent.	Repair or replace components as necessary. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-23.)
3. Brake linkage.	Linkage not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE LINKAGE—Removal/Inspection/ Installation on page 9-22.)
4. Brake return spring.	Returns brake pedal and linkage to rest position when pedal is released. Not stretched or damaged.	Replace stretched or damaged spring.

TROUBLESHOOTING—LX176/LX178/LX186/LX188

Problem or Symptom / Check or Solution 	Machine will not move in forward or reverse.	Brakes do not engage when pedal depressed.	Park brake does not hold machine on a hill.	Noisy operation.	Erratic speed.	Machine does not achieve full ground speed.	Machine will not move in forward or is slow in forward.	Machine is slow in reverse.	Brake switch does not engage when depressing brake pedal.	Engine can be started without depressing brake pedal.
Park brake engaged.	●			●			●	●		
Brake linkage damaged.	●	●	●	●	●	●	●	●	●	●
Brake linkage out of adjustment.		●	●	●	●	●	●	●	●	●
Belt idler assembly return spring weak or damaged.	●					●	●	●		
Brake return spring weak or broken.						●	●	●	●	
Brake band damaged or worn.		●	●							
Brake drum damaged or worn.		●	●							
Internal brake actuator lever damaged or worn.		●							●	●
Faulty brake switch.									●	●
Belt tension release rod.	●					●	●	●		

DIAGNOSIS—LX176/LX178/LX186/LX188

MACHINE WILL NOT MOVE IN FORWARD OR REVERSE

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Park brake.	Pedal depressed and linkage not locked.	Release park brake.
2. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
3. Traction drive belt tensioner assembly return spring.	Spring returns idler assembly to tension traction drive belt when brake pedal is released.	Replace stretched or broken spring. (See TRACTION DRIVE BELT TENSIONER ASSEMBLY—Removal/Inspection/Installation on page 7-62.)
4. Traction drive belt tension release rod.	Rod not binding, worn or damaged.	Replace rod. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59.)

BRAKES DO NOT ENGAGE WHEN PEDAL DEPRESSED

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
2. Brake band.	Band not binding, worn or damaged.	Replace brake band. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-26.)
3. Brake drum.	Drum not binding, worn or damaged.	Replace brake drum. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-26.)
4. Internal brake actuator lever[a].	Engages brake actuator plate when brakes applied.	Replace if worn or damaged. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transmission from machine and disassembly.

PARK BRAKE DOES NOT HOLD MACHINE ON HILL

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-21.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
2. Brake band.	Band not binding, worn or damaged.	Replace brake band. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-26.)
3. Brake drum.	Drum not binding, worn or damaged.	Replace brake drum. (See BRAKE ASSEMBLY—Removal/Inspection/ Installation on page 9-26.)

NOISY OPERATION

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Park brake.	Pedal depressed and linkage not locked.	Release park brake.
2. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)

ERRATIC SPEED

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)

MACHINE DOES NOT ACHIEVE FULL GROUND SPEED

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
2. Traction drive belt tensioner assembly return spring.	Spring returns idler assembly to tension traction drive belt when brake pedal is released.	Replace stretched or broken spring. (See TRACTION DRIVE BELT TENSIONER ASSEMBLY— Removal/Inspection/Installation on page 7-62.)
3. Brake return spring.	Returns brake pedal and linkage to rest position when brake pedal is released.	Replace stretched or damaged spring. (See BRAKE PEDAL AND LINKAGE—Removal/Inspection/ Installation on page 9-25.)
4. Traction drive belt tension release rod.	Rod not binding, worn or damaged.	Replace rod. (See CONTROL PEDALS AND LINKAGE— FORWARD on page 7-59.)

MACHINE WILL NOT MOVE IN FORWARD OR IS SLOW IN FORWARD

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Park brake.	Pedal depressed and linkage not locked.	Release park brake.
2. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
3. Traction drive belt tensioner assembly return spring.	Spring returns idler assembly to tension traction drive belt when brake pedal is released.	Replace stretched or broken spring. (See TRACTION DRIVE BELT TENSIONER ASSEMBLY—Removal/Inspection/Installation on page 7-62.)
4. Brake return spring.	Returns brake pedal and linkage to rest position when brake pedal is released.	Replace stretched or damaged spring.
5. Traction drive belt tension release rod.	Rod not binding, worn or damaged.	Replace rod. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59.)

MACHINE IS SLOW IN REVERSE

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Park brake.	Pedal depressed and linkage not locked.	Release park brake.
2. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
3. Traction drive belt tensioner assembly return spring.	Spring returns idler assembly to tension traction drive belt when brake pedal is released.	Replace stretched or broken spring. (See TRACTION DRIVE BELT TENSIONER ASSEMBLY—Removal/Inspection/Installation on page 7-62.)
4. Brake return spring.	Returns brake pedal and linkage to rest position when brake pedal is released.	Replace stretched or damaged spring.
5. Traction drive belt tension release rod.	Rod not binding, worn or damaged.	Replace rod. (See CONTROL PEDALS AND LINKAGE—FORWARD on page 7-59.)

BRAKE SWITCH DOES NOT ENGAGE WHEN BRAKE PEDAL IS DEPRESSED

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
2. Brake return spring.	Returns brake pedal and linkage to rest position when brake pedal is released.	Replace stretched or damaged spring.
3. Neutral start/brake switch.	Continuity across terminals when activated by linkage.	Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
4. Internal brake actuator lever[a].	Engages brake actuator plate when brakes applied.	Replace if worn or damaged. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transmission from machine and disassembly.

ENGINE CAN BE STARTED WITHOUT DEPRESSING BRAKE PEDAL

Test Conditions:

- Machine parked on level surface.
- Park brake DISENGAGED.
- Transaxle in NEUTRAL.
- Key switch in OFF position.

Test/Check Point	Normal	If Not Normal
1. Brake linkage.	Brake rod, control lever, linkage and spring assembly not binding or damaged.	Eliminate binding, replace damaged components. (See BRAKE PEDAL AND LINKAGE—Removal/ Inspection/Installation on page 9-25.)
	Brake linkage properly adjusted.	Adjust brake linkage. (See BRAKE ADJUSTMENT—LX176/LX178/ LX186/LX188 on page 9-21.)
2. Neutral start/brake switch.	Continuity across terminals when activated by linkage.	Test neutral start/brake switch. (See NEUTRAL START/BRAKE SWITCH TEST on page 5-187.)
3. Internal brake actuator lever[a].	Engages brake actuator plate when brakes applied.	Replace if worn or damaged. (See HYDROSTATIC TRANSAXLE—Disassembly/Inspection on page 7-48.)

[a] Requires removal of transmission from machine and disassembly.

ADJUSTMENTS

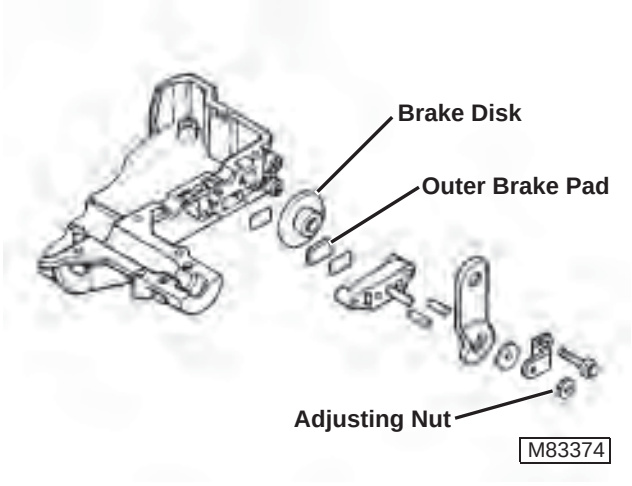
BRAKE ADJUSTMENT—LX172/ LX173

Reason:

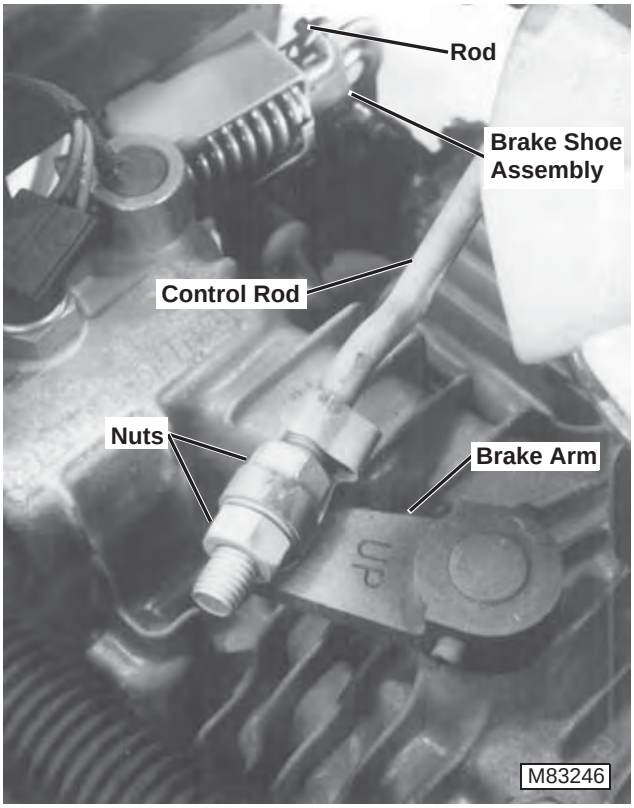
To ensure proper brake operation.

Procedure:

1. Park machine on level surface.
2. Turn key switch OFF.
3. Place transmission in NEUTRAL position.
4. Block wheels to prevent machine from moving.



5. Check linkage, pads and disk for wear, binding or dirt.
6. Adjust nut to get **0.13 mm (0.005 in.)** clearance between outer brake pad and brake disk.



6. Disconnect control rod from brake arm.
7. Disconnect rod from brake shoe assembly.
8. Hold brake arm all the way rearward and adjust the length of the rod so that it slips easily into the hole in the brake shoe actuator.
9. Hold brake arm all the way rearward and adjust nuts so that the control rod pin slips easily into the hole in the brake arm.

BRAKE ADJUSTMENT—LX176/ LX178/LX186/LX188

Reason:

To ensure proper brake pedal travel and synchronize brake shoe engagement with linkage movement within the transaxle.

Procedure:

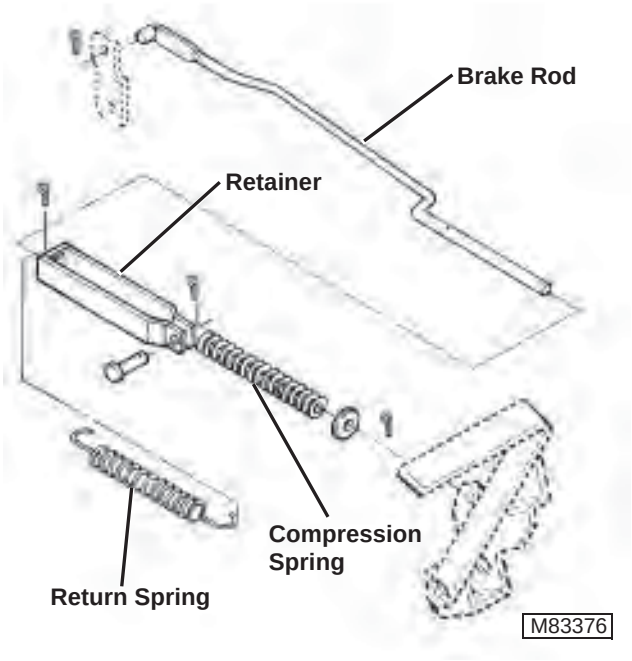
1. Park machine on level surface.
2. Turn key switch OFF.
3. Place transmission in NEUTRAL position.
4. Block wheels to prevent machine from moving.
5. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)

REPAIR—LX172/LX173

BRAKE LINKAGE

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove right rear wheel. (See WHEELS—Removal/Installation on page 11-5.)



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

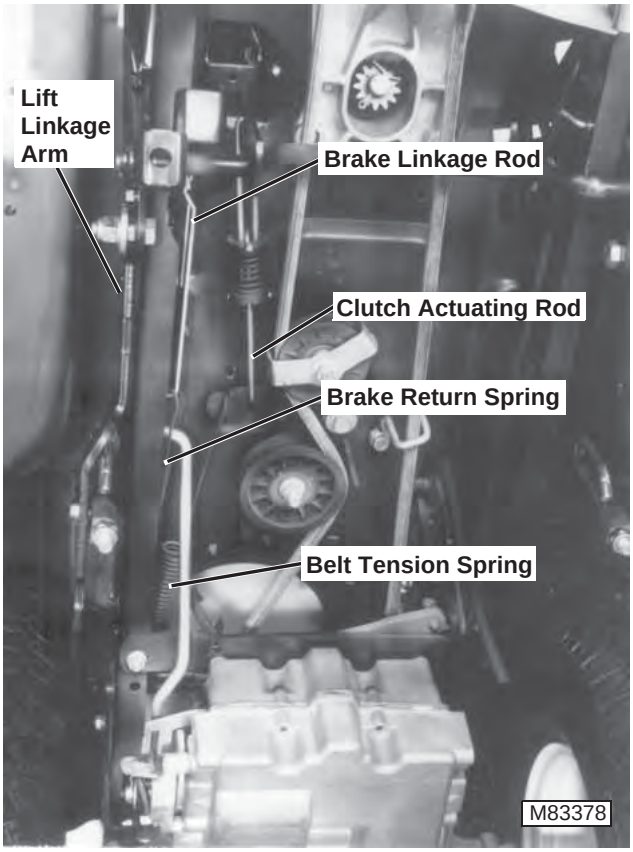
Installation is done in the reverse order of removal.

- Adjust brakes. (See BRAKE ADJUSTMENT on page 9-21.)

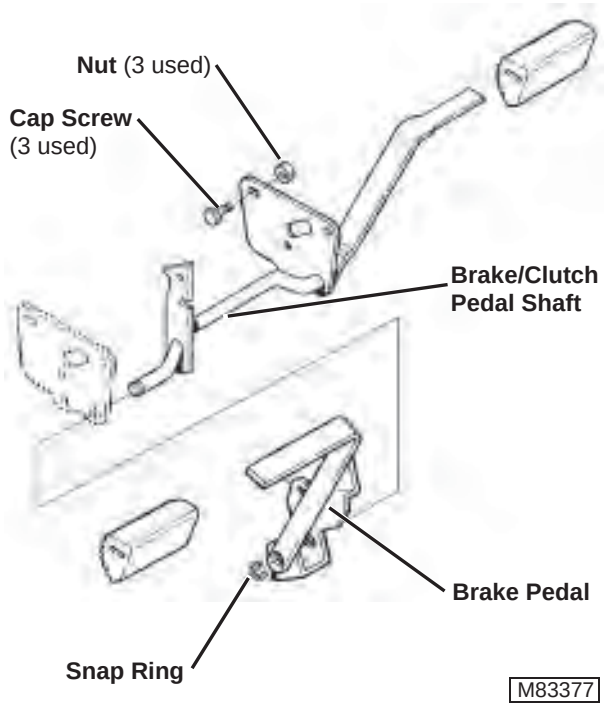
BRAKE PEDAL ASSEMBLY

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)
3. Remove right rear wheel. (See WHEELS—Removal/Installation on page 11-5.)



4. Disconnect:
   - Belt tension spring.
   - Clutch actuating rod.
   - Brake return spring.
   - Brake linkage rod.
   - Left-hand lift linkage arm.



5. Remove snap ring.
6. Remove cap screws and nuts.
7. Remove brake/clutch pedal shaft and brake pedal.
8. Inspect all parts for wear or damage. Replace parts as necessary.

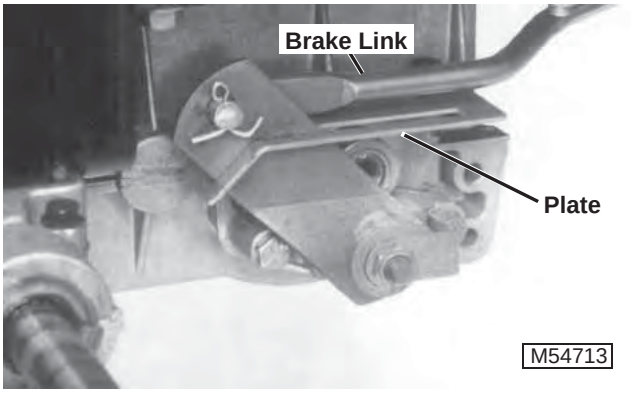
Installation is done in the reverse order of removal.

- Adjust brakes. (See BRAKE ADJUSTMENT on page 9-21.)

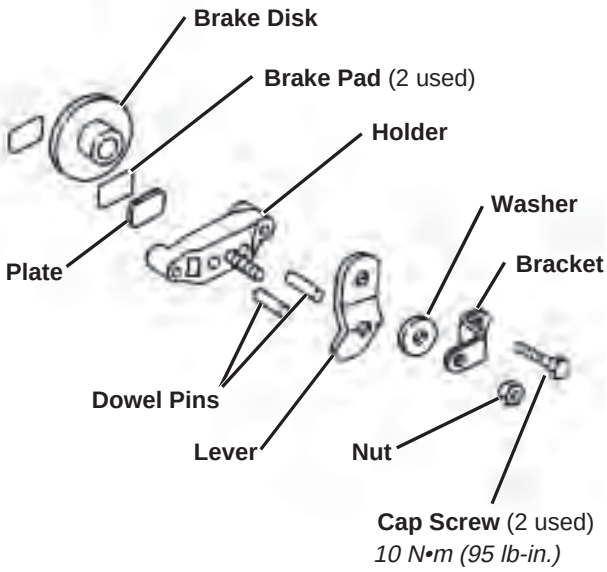
BRAKE ASSEMBLY

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15,10-21 and 10-30.)
2. Remove rear wheel. (See WHEELS—Removal/Installation on page 11-5.)



3. Disconnect brake link.
4. Remove plate.



5. Disassemble brakes.
6. Inspect all parts for wear or damage. Replace parts as necessary.

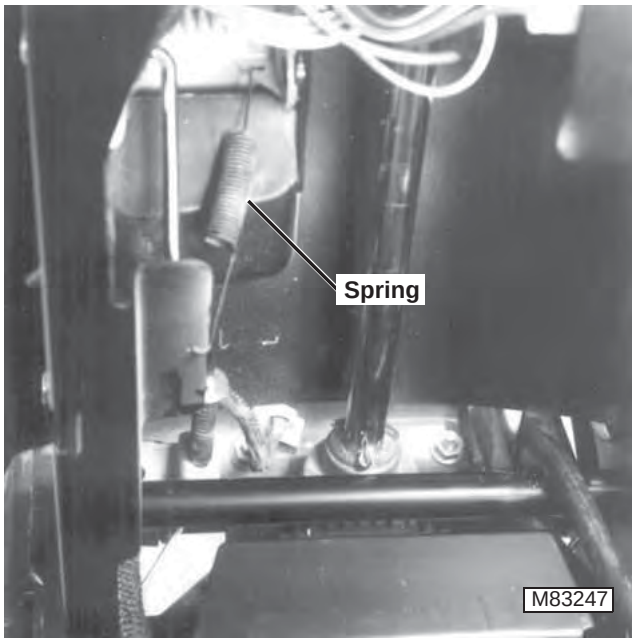
Installation is done in the reverse order of removal.

- Replace brake pads if less than **6 mm (0.250 in.)**.
- Apply a light coat of John Deere LUBRIPLATE® lubricant or equivalent to brake shaft dowel pins and washer.
- Tighten cap screws to **10 N•m (95 lb-in.)**.
- Adjust brakes. (See BRAKE ADJUSTMENT—LX172/LX173 on page 9-21.)

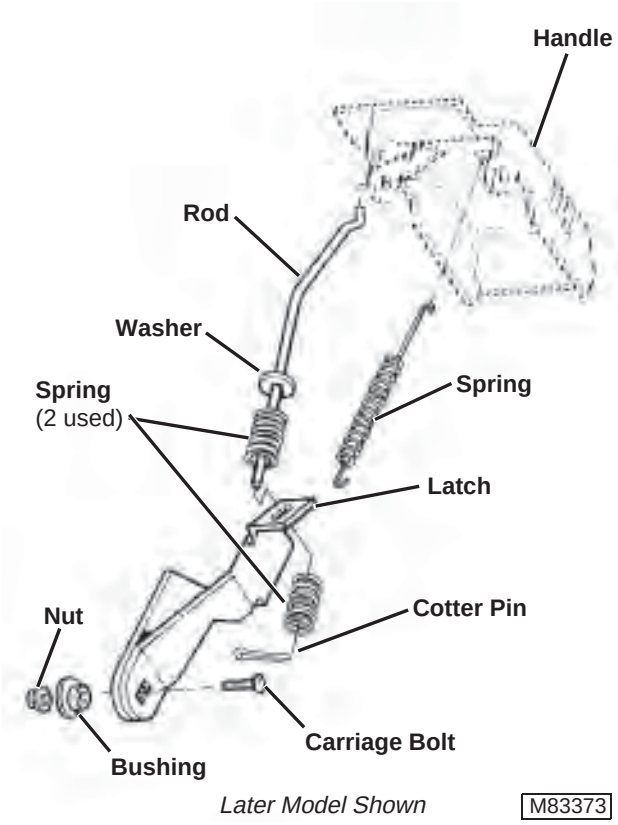
PARK BRAKE LEVER AND LINKAGE

Removal/Inspection/Installation

1. Remove battery. (See BATTERY—Removal/ Installation on page 5-194.)
2. Remove right pedestal panel.



3. Remove spring.



4. Remove carriage bolt, nut and bushing.
5. Remove brake handle.
6. Early models—Remove latch and rod.
   Later models—Remove cotter pin, springs and rod.
7. Inspect all parts for wear or damage. Replace parts as necessary.

Installation is done in the reverse order of removal.

REPAIR—LX176/LX178/LX186/LX188

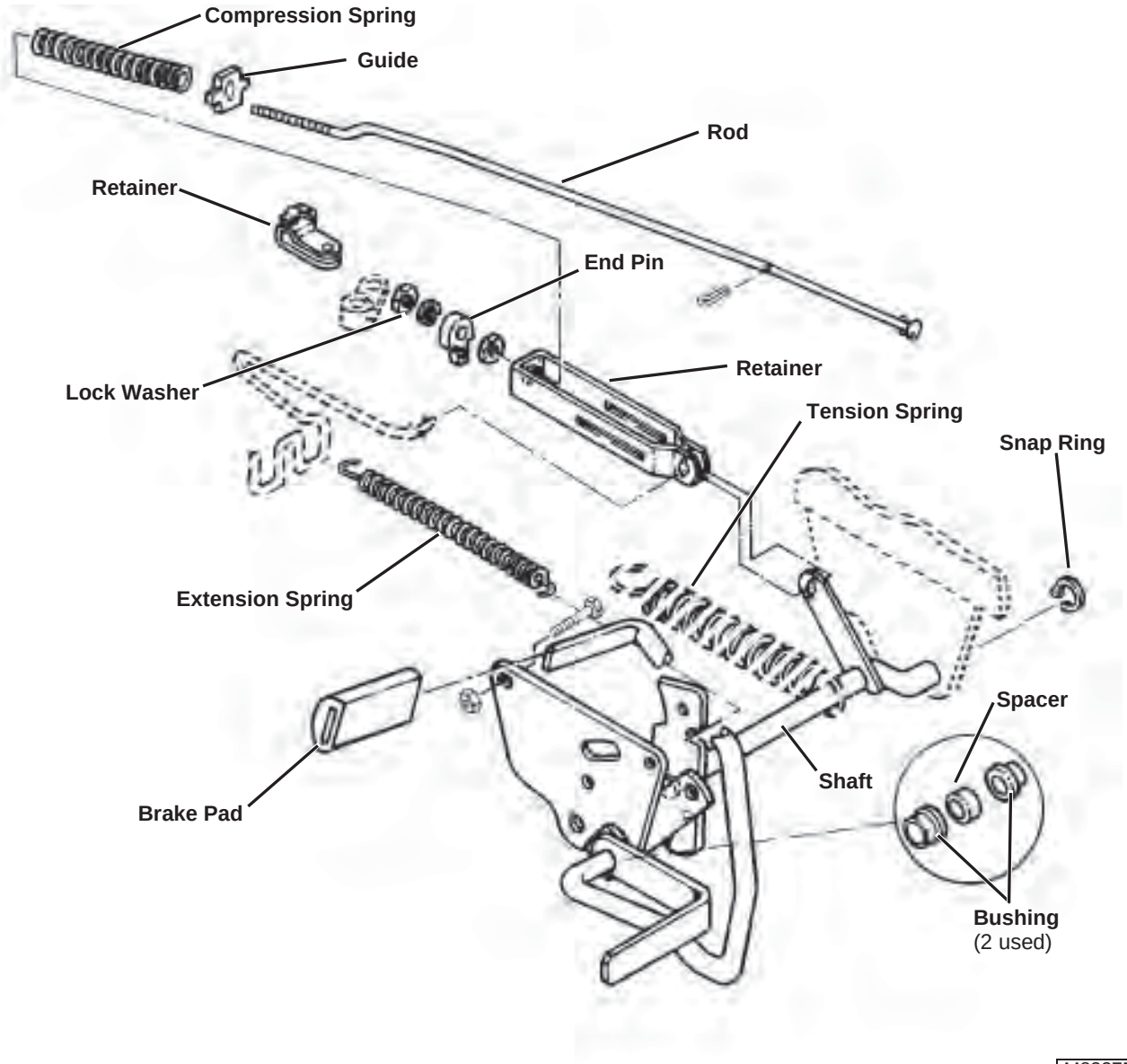
BRAKE PEDAL AND LINKAGE

Removal/Inspection/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove fuel tank. (See FUEL TANK—Removal/Installation on pages 3-41 or 3-112.)
3. Inspect all parts for wear or damage. Replace parts as necessary.

Installation is done in the reverse order of removal.

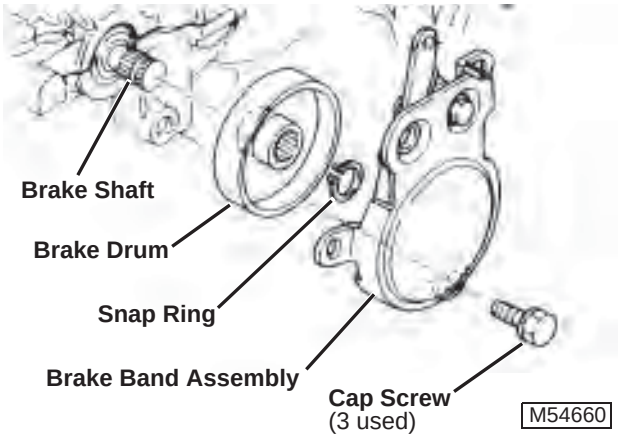
- Adjust brakes. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)



BRAKE ASSEMBLY

Removal/Inspection/Installation

1. Remove left rear wheel. (See WHEELS—Removal/ Installation on page 11-5.)



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

Installation is done in the reverse order of removal.

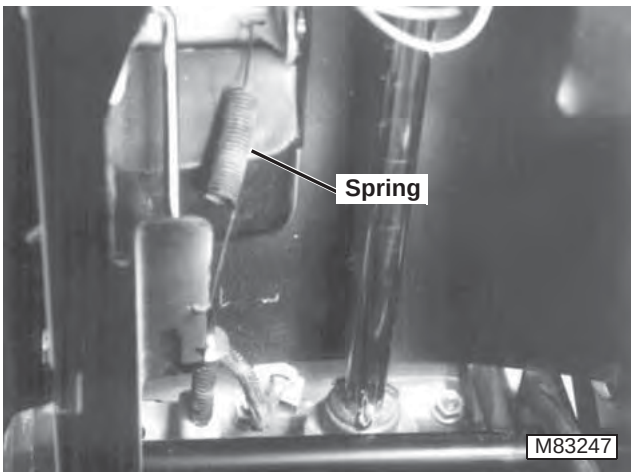
- Apply a light coat of John Deere LUBRIPLATE® lubricant or equivalent to splines of shaft.
- Adjust brakes. (See BRAKE ADJUSTMENT—LX176/LX178/LX186/LX188 on page 9-21.)

NOTE: The remainder of the brake components are internal to the transaxle. See hydrostatic TRANSAXLE—Disassembly/Inspection on page 7-48 for inspection and repair of these components.

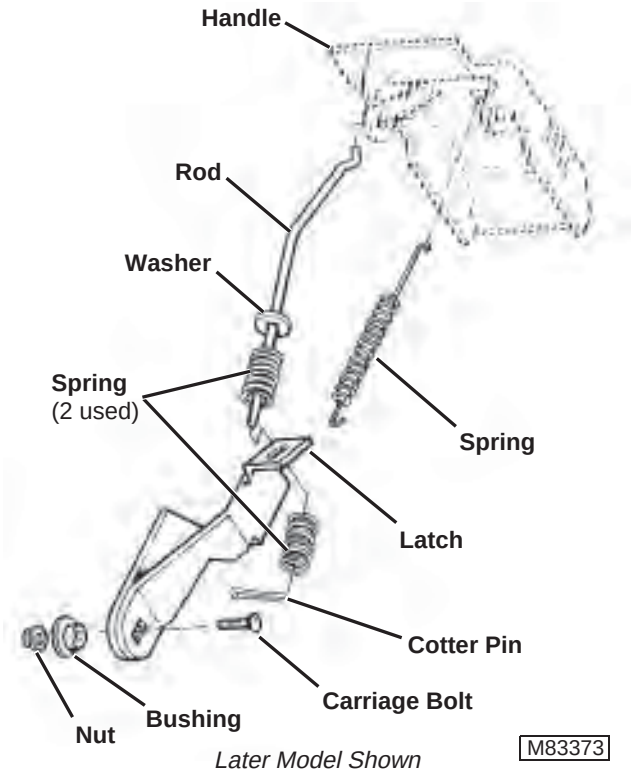
PARK BRAKE LEVER AND LINKAGE

Removal/Inspection/Installation

1. Remove battery. (See BATTERY—Removal/ Installation on page 5-194.)
2. Remove right pedestal panel.



3. Remove spring.



Later Model Shown

4. Remove carriage bolt, nut and bushing.
5. Remove brake handle.
6. Early models—Remove latch and rod.
   Later models—Remove cotter pin, springs and rod.
7. Inspect all parts for wear or damage. Replace parts as necessary.

Installation is done in the reverse order of removal.

CONTENTS

Page

ATTACHMENTS

SPECIFICATIONS
ADJUSTMENT SPECIFICATIONS 10-3
REPAIR SPECIFICATIONS 10-3
SPECIAL OR ESSENTIAL TOOLS 10-4
SERVICE PARTS KITS 10-4
COMPONENT LOCATION
38-INCH MOWER DECK. 10-5
44-INCH REAR DISCHARGE MOWER DECK 10-6
48-INCH MOWER DECK. 10-7
TROUBLESHOOTING 10-8
DIAGNOSIS
MOWER DRIVE CHECKS. 10-9
MOWER DECK WILL NOT RUN. 10-11
MOWER DECK VIBRATES 10-12
CUTS UNEVENLY. 10-12
ADJUSTMENTS
MOWER LEVEL SIDE-TO-SIDE 10-13
MOWER LEVEL FRONT-TO-REAR 10-14
REPAIR—38-INCH MOWER DECK
MOWER DECK 10-15
OVERALL VIEW 10-16
DRAFT ARMS AND GAUGE WHEELS. 10-17
IDLERS AND SHEAVES 10-18
SPINDLES
Removal/Installation 10-19
Disassembly/Assembly 10-19
MOWER DRIVE BELT. 10-19
MOWER BLADES
Removal/Installation 10-20
Sharpen. 10-20
Balance 10-20
REPAIR—44-INCH REAR DISCHARGE MOWER DECK
MOWER DECK 10-21
OVERALL VIEW 10-22
DRAFT ARMS AND GAUGE WHEELS. 10-23
IDLERS AND SHEAVES 10-24
SPINDLES
Removal/Installation 10-25
Disassembly/Inspection 10-25
Cross Section 10-26
Assembly. 10-27
MOWER DRIVE BELT. 10-28

Page

REPAIR—44-INCH REAR DISCHARGE MOWER DECK, Continued

MOWER BLADES
- Removal/Installation 10-29
- Sharpen 10-29
- Balance 10-29

REPAIR—48-INCH MOWER DECK

MOWER DECK 10-30
OVERALL VIEW 10-31
DRAFT ARMS 10-32
GAUGE WHEELS 10-33
IDLERS AND SHEAVES 10-34
SPINDLES
- Removal/Installation 10-36
- Disassembly/Inspection 10-36
- Cross Section 10-37
- Assembly 10-37

MOWER DRIVE BELT 10-39
MOWER BLADES
- Removal/Installation 10-39
- Sharpen 10-40
- Balance 10-40

SPECIFICATIONS

ADJUSTMENT SPECIFICATIONS

Side-to-Side Blade Height Difference (Maximum) . . . . . 3 mm (0.125 in.)
Front-to-Rear Blade Height Difference
38 and 48-Inch . . . . . 3—10 mm (0.125—0.375 in.) front lower than rear
44-Inch . . . . . 0—6 mm (0—0.250 in.) front lower than rear

REPAIR SPECIFICATIONS

38-Inch Mower Deck

Spindle
Mounting Nut Torque . . . . . 26 N•m (230 lb-in.)
Sheave Nut Torque . . . . . 140 N•m (103 lb-ft)
Blade
Blade Cap Screw Torque . . . . . 75 N•m (55 lb-ft)
Cutting Edge Width . . . . . 0.40 mm (0.016 in.)

44-Inch Rear Discharge Mower Deck

Spindle
Mounting Nut Torque . . . . . 26 N•m (230 lb-in.)
Sheave Nut Torque . . . . . 163 N•m (120 lb-ft)
Lower Seal Installation Position . . . . . 7.8 mm (0.31 in.) below hub flange
Blade
Blade Cap Screw Torque . . . . . 68 N•m (50 lb-ft)
Cutting Edge Width . . . . . 0.40 mm (0.016 in.)

48-Inch Mower Deck

Gauge Wheels
Roller Shaft Nut Torque . . . . . 30 N•m (22 lb-ft)
Idlers and Sheaves
Jack Sheave Nut Torque . . . . . 136 N•m (100 lb-ft)
Tensioning Idler Sheave Nut Torque . . . . . 27 N•m (20 lb-ft)
Spindle
Mounting Nut Torque . . . . . 26 N•m (230 lb-in.)
Sheave Nut Torque . . . . . 163 N•m (120 lb-ft)
Lower Seal Installation Position . . . . . 7.8 mm (0.31 in.) below hub flange
Blade
Blade Cap Screw Torque . . . . . 68 N•m (50 lb-ft)
Cutting Edge Width . . . . . 0.40 mm (0.016 in.)

SPECIAL OR ESSENTIAL TOOLS

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

TY15272 Blade Height Gauge
Use to check mower side-to-side level.

SERVICE PARTS KITS

The following kits are available through your parts catalog:

38-Inch Mower Deck

- Rear Draft Pin Kit
- Gauge Wheel Kit
- Jack Sheave Kit
- Front Draft Rod Kit

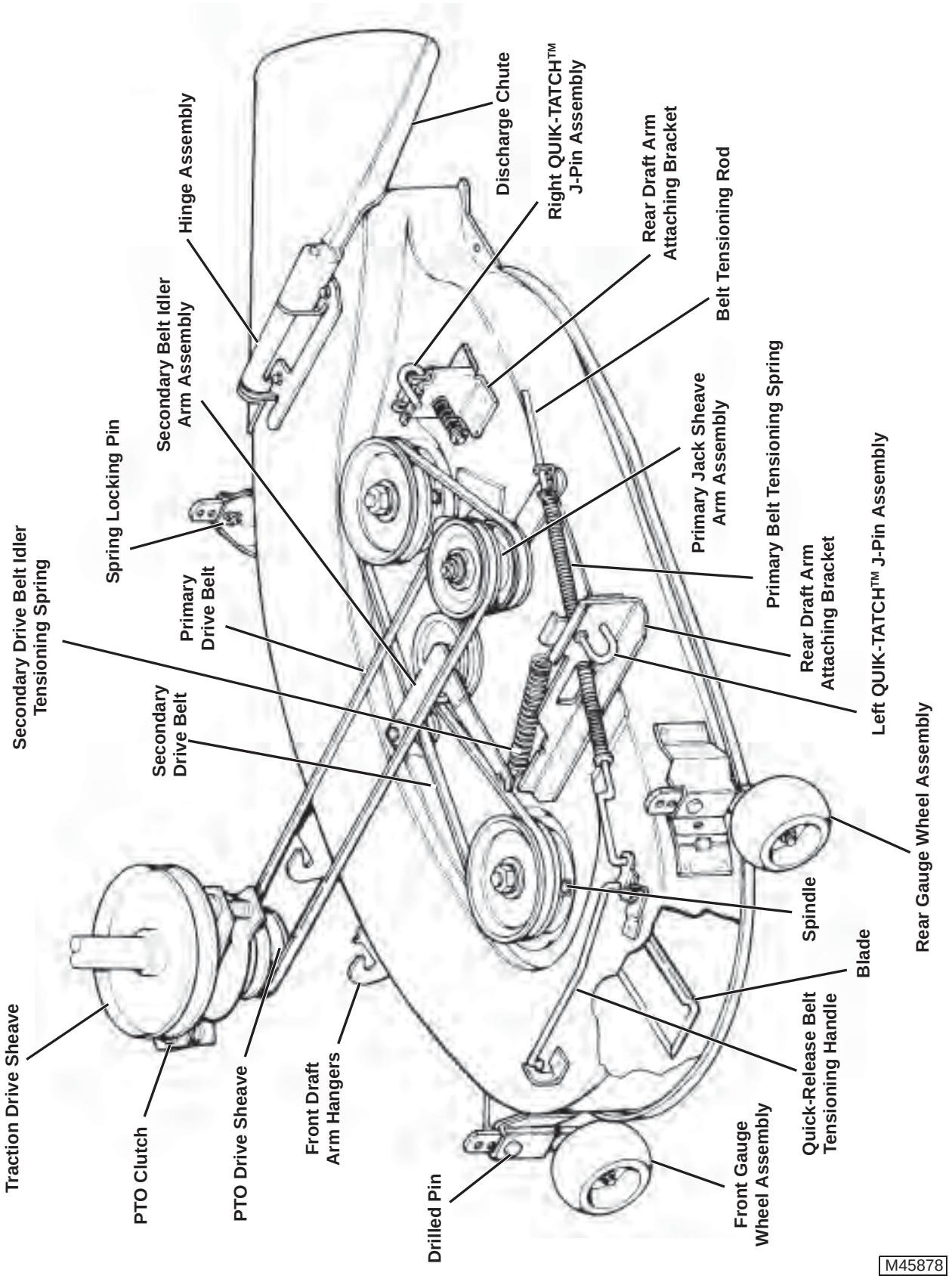
44-Inch Rear Discharge Mower Deck

- QUIK-TATCH™ J-Pin Kit
- Spindle Bearing Replacement Kit
- Spindle Housing Kit
- Tensioner Assembly Kit
- Gauge Wheel Kit

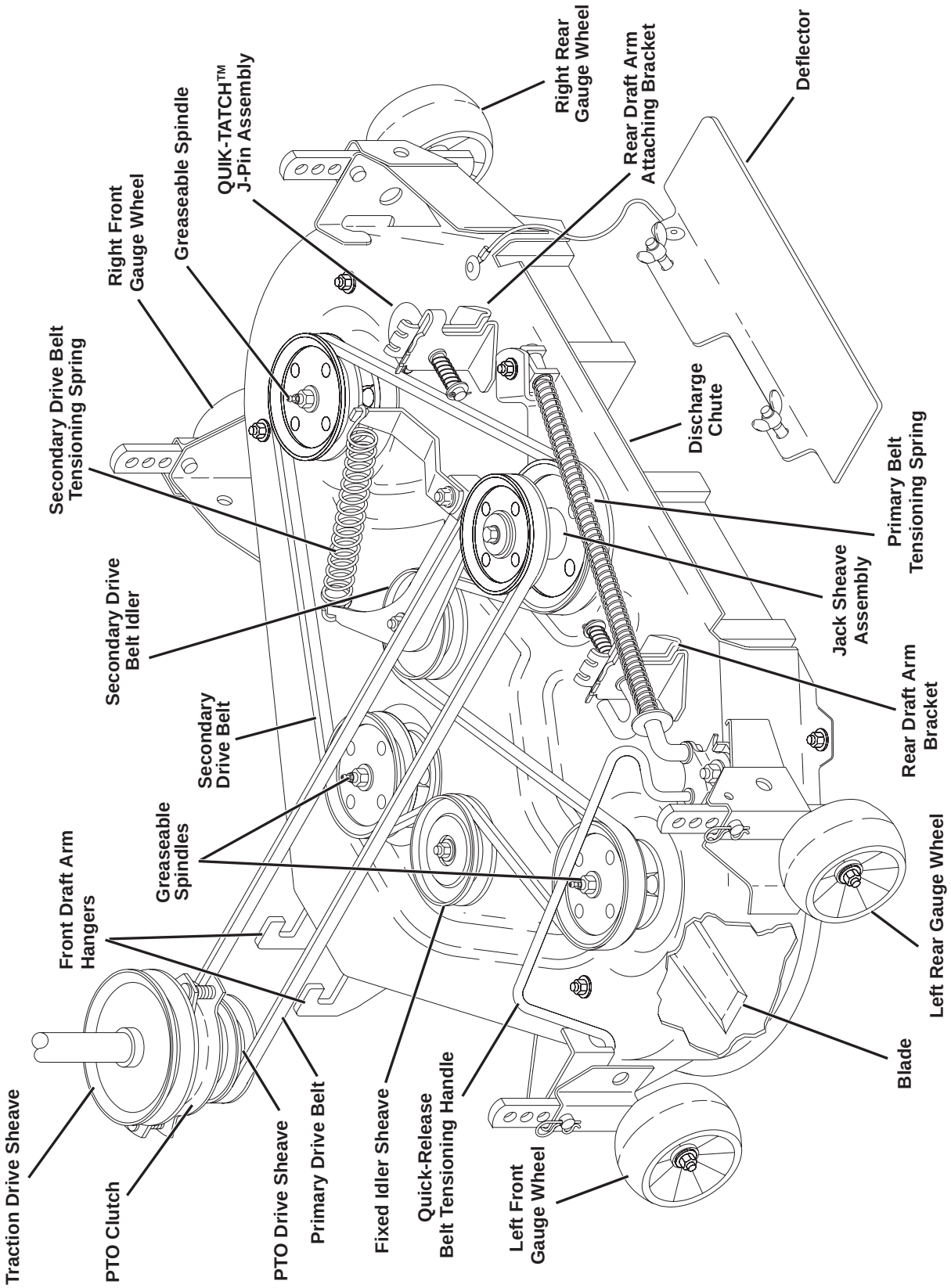
48-Inch Mower Deck

- QUIK-TATCH™ J-Pin Kit
- Bushing Replacement Kit
- Spindle Bearing Kit
- Rear Draft Kit
- Gauge Wheel Kit

COMPONENT LOCATION
38-INCH MOWER DECK COMPONENTS

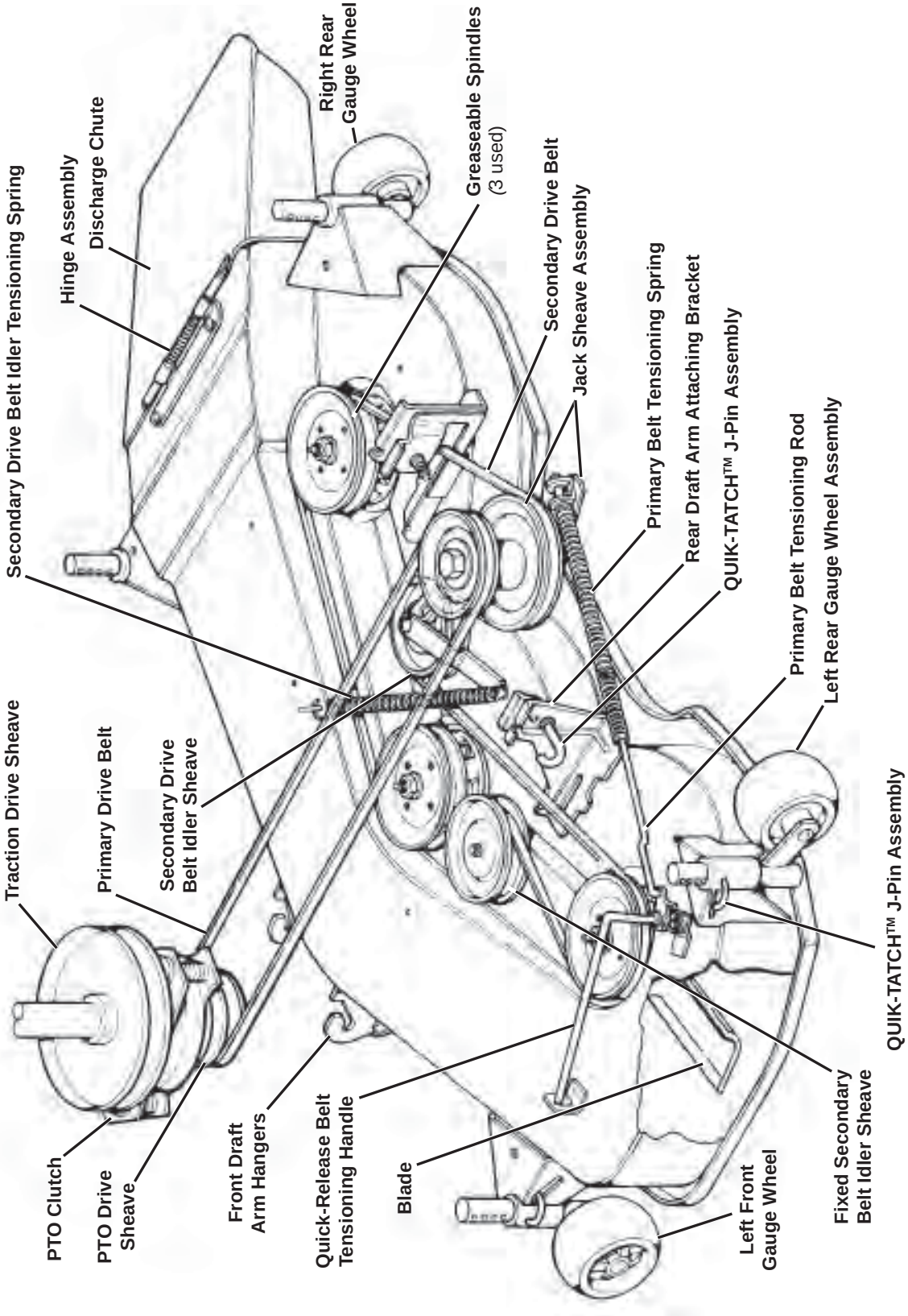


44-INCH REAR DISCHARGE MOWER DECK COMPONENTS



M82730AE

48-INCH MOWER DECK COMPONENTS



M45782

TROUBLESHOOTING

MOWER DECK TROUBLESHOOTING CHART

Problem or Symptom / Check or Solution	Mower deck will not run.	Mower deck vibrates.	Cuts unevenly	Belt squeals.
PTO clutch and sheave will not engage.	●			
Primary drive belt broken, worn, frayed, glazed, stretched or wrong belt.	●	●		●
Secondary drive belt broken, worn, frayed, glazed, stretched or wrong belt.	●	●		●
Primary belt Quick-Release belt tensioning handle not locked in place, weak spring, spring unhooked or broken.	●			●
Secondary drive belt tensioning spring weak, unhooked or broken.	●	●		●
Blades out of balance.		●		
Blades bent.		●	●	
Blade level side-to-side out of adjustment.			●	
Blade level front-to-rear out of adjustment.			●	
Blades dull.			●	
Gauge wheels not adjusted correctly.			●	
Drive sheaves and idlers loose, damaged, dry or locked-up.	●	●	●	●

DIAGNOSIS

MOWER DRIVE CHECKS

Test Conditions:

- Machine parked on a clean, level surface.
- PTO disengaged.
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
1. PTO clutch and drive sheave.	Tight on crankshaft and key not damaged or missing. Air gap properly adjusted. Belt on sheave. Sheave not binding, damaged or worn. Sheave angle matching belt angle.	Tighten cap screw. Replace key. Repair and adjust as needed. Install belt. Replace sheave. Check jack sheave and PTO sheave.
2. Primary drive belt.	Correct belt installed. Not damaged, worn, or broken. Not turned over.	Replace belt.
3. Jack sheave.	Belt on sheave. Sheave not binding, damaged or worn. Sheave angle matching belt angle. Nut at correct torque.	Install belt. Replace sheave and bearing. Check jack sheave and PTO sheave. Tighten nut to specifications.
4. Primary belt tension spring and rod	Not damaged, worn or weak. Belt tensioning handle in tension position.	Replace spring or rod. Move to tension position.
5. Jack sheave arm.	Not binding, damaged or worn.	Replace jack sheave arm.
6. Secondary drive belt.	Correct belt installed Not damaged, worn or broken. Not turned over.	Replace belt.
7. Secondary drive belt tensioning spring.	Not damaged, worn or weak.	Replace spring.
8. Secondary drive belt idler and pivot arm.	Not binding, damaged or worn. Belt in place. Pivot arm not bent, locating idler parallel to belt.	Replace idler. Install belt. Replace pivot arm.
9. Fixed idler—44 and 48-inch only.	Not binding, damaged or worn. Belt in place.	Replace idler. Install belt.
10. Spindle sheave.	Tight on spindle and key in place. Not damaged or bent. Running straight. Belt on sheave. Sheave angle matches belt angle.	Tighten nut and install key as needed. Repair, or replace as needed. Install belt. Replace sheave. Install belt.
11. Spindle and housing.	Bearings not failed, full of grease. Blade tight on spindle.	Replace as needed, fill with grease. Tighten hardware to specifications.

MOWER DRIVE CHECKS, continued

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
12. Blade.	Not bent, worn or damaged. Sharp and balanced. Level side-to-side. Correctly adjusted front-to-rear.	Replace blade and tighten to specifications. Sharpen and balance. Adjust. Adjust.
13. Mower deck lift linkage.	Mounting hardware tight, not worn or binding.	Tighten or replace as needed.
14. Engine.	Check that engine is running at correct rpm.	Adjust engine fast idle and governor. Check engine adjustments and condition. Inform operator that engine should be running at fast idle when mowing.

Test Conditions:

- Machine parked on a clean, level surface, away from people and objects.
- Engine at operating temperature.
- Engine running at FAST idle.
- Perform PTO clutch break-in procedure.

Test/Check Point	Normal	If Not Normal
15. PTO clutch and drive sheave.	Functioning properly.	Repair or replace components.
16. Mower deck.	Operating smoothly without any unusual noises and stops quickly.	Slowly reduce rpm and listen for problem area—stop PTO and engine, repair or replace faulty components.

MOWER DECK WILL NOT RUN

Test Conditions:

- Machine parked on a clean, level surface.
- PTO disengaged.
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
1. PTO clutch and drive sheave.	PTO circuit operating properly. Tight on crankshaft and key not damaged or missing. Air gap properly adjusted. Belt on sheave. Sheave not binding, damaged or worn.	Test PTO circuit. (See PTO CIRCUIT DIAGNOSIS on pages 5-68 [LX172/LX176/LX186], 5-110 [LX178/LX188] or 5-158 [LX173]) Tighten cap screw. Replace key. Repair and adjust as needed. Install belt. Replace sheave.
2. Primary drive belt.	Correct belt installed. Not damaged, worn, or broken. Not turned over.	Replace with correct belt.
3. Jack sheave.	Belt on sheave. Sheave not bent or locked.	Install belt. Replace jack sheave.
4. Primary belt tension spring and rod.	Not damaged, worn, or weak. Belt tensioning handle in tension position.	Replace spring or rod. Move to tension position.
5. Secondary drive belt.	Correct belt installed. Not damaged, worn, or broken. Not turned over.	Replace with correct belt.
6. Secondary drive belt tensioning spring.	Not damaged, worn, or weak.	Replace spring.
7. Secondary drive belt idler.	Belt in place. Idler not bent or locked up.	Install belt. Replace idler.
8. Spindles and drive sheaves.	Belt in place. Spindles and drive sheaves not bent or locked up.	Install correct belt. Replace spindles and drive sheaves.



MOWER DECK VIBRATES

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
1. PTO clutch and drive sheave.	Sheave angle matching belt angle.	Check jack sheave and PTO sheave.
2. Jack sheave.	Sheave not binding, damaged or worn, Sheave angle matching belt angle. Nut at correct torque.	Replace sheave and bearing. Check jack sheave and PTO sheave. Tighten nut to specifications.
3. Jack sheave arm.	Not damaged, binding or worn.	Replace jack sheave arm.
4. Secondary drive belt idler and pivot arm.	Not damaged, binding or worn. Pivot arm not bent, locating idler parallel to belt.	Replace idler. Replace pivot arm.
5. Fixed idler—44- and 48-inch only.	Not binding, damaged or worn.	Replace idler.
6. Spindle sheave.	Tight on spindle and key in place. Not damaged or bent. Running straight. Sheave angle matches belt angle.	Tighten nut and install key as needed. Repair or replace as needed. Replace sheave.
7. Spindle and housing.	Bearings not failed. Blade tight on spindle.	Replace as needed. Tighten hardware to specifications.
8. Blade.	Not bent, worn or damaged.	Replace blade. Balance blade.

CUTS UNEVENLY

Test Conditions:

- Machine parked on a level surface.
- PTO disengaged.
- Key switch in STOP position.

Test/Check Point	Normal	If Not Normal
1. Blade.	Sharp. Level side-to-side. Correctly adjusted front-to-back.	Sharpen. Adjust. Adjust.
2. Mower deck lift linkage.	Mounting hardware tight, not worn.	Tighten or replace as needed.
3. Engine.	Check that engine is running at correct rpm.	Adjust engine fast idle and governor. Check engine adjustments and condition. Inform operator that engine should be running at fast idle when mowing.

ADJUSTMENTS

MOWER LEVEL SIDE-TO-SIDE

Reason:

To set mower deck for an even side-to-side cut.

Equipment:

- TY15272 Blade Height Gauge

Procedure:

CAUTION

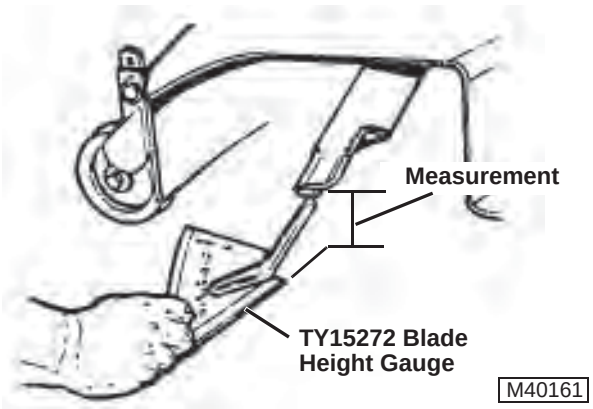
Before you adjust the mower, stop engine and remove ignition key.

1. Disengage PTO.
2. Park machine on a hard, level surface.
3. Turn key switch OFF.
4. Move forward/reverse pedals to NEUTRAL position.
5. Engage park brake.
6. Check for correct tire pressures and measure wheel rim height (same between rear and between front) to be sure machine is level.
7. Raise gauge wheels to highest setting, so they are not on the ground during leveling.

CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.

8. Rotate blade by hand to check for bent blade or spindle.
9. Set mower at the cutting height that will be used.
10. Set mower blade ends toward outside edges of mower deck.



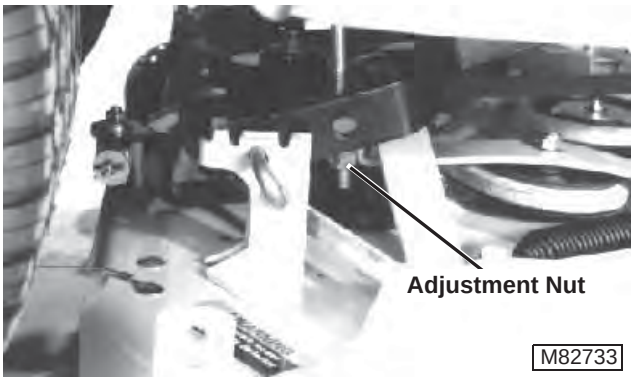
11. Using a TY15272 Blade Height Gauge, measure distance of outside tips of blade to floor surface. The maximum blade outside tip-to-outside tip height difference should be **3 mm (0.125 in.)**.

Results:

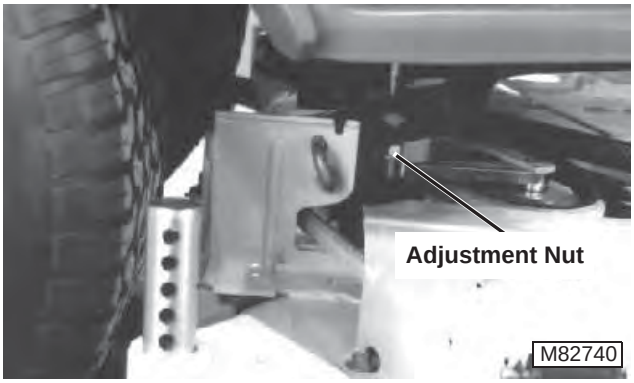
NOTE: Adjustable lift links are on both sides of the mower. Cutting height can closely match knob setting by using adjustment on both sides. DO NOT adjust deck too high or it will not lock in the transport (upper) position.



38-Inch Mower Deck



44-Inch Rear Discharge Mower Deck



48-Inch Mower Deck

- If the mower side-to-side height difference is greater than specifications, adjust lift link on right side of mower. Turn adjustment nut:
  - Clockwise to raise right side of mower.
  - Counterclockwise to lower right side.

MOWER LEVEL FRONT-TO-REAR

Reason:

To set the mower blade for the best cut and most efficient operation.

Equipment:

- TY15272 Blade Height Gauge

Procedure:

⚠ CAUTION

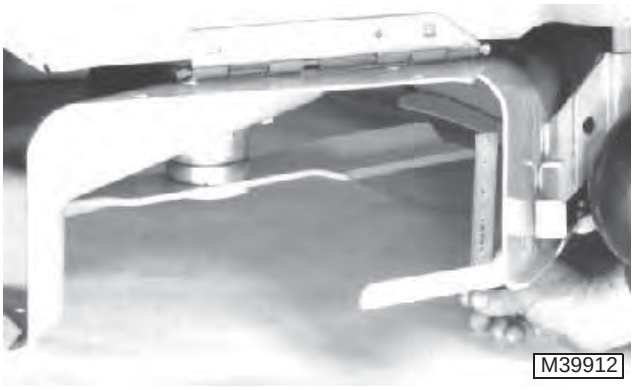
Before you adjust the mower, stop engine and remove ignition key.

1. Disengage PTO.
2. Park machine on a hard, level surface.
3. Turn key switch OFF.
4. Move forward/reverse pedals to NEUTRAL position.
5. Engage park brake.
6. Check for correct tire pressures and measure wheel rim height (same between rear and between front) to be sure machine is level.
7. Raise gauge wheels to highest setting so they are not on the ground during leveling process.

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury

8. Rotate blade by hand to check for bent blade or spindle.
9. Set mower at the cutting height that will be used.
10. Set mower blades parallel to the center axis of machine.



11. Use TY15272 Blade Height Gauge or a small ruler to measure front blade tip to ground and measure rear blade tip to ground. The front end of the blade should measure lower than the rear.

Specifications:

Front-to-Rear Blade Height Difference

38-, 48-Inch Deck . . . . . .3—10 mm (0.125—0.375 in.) front lower than rear

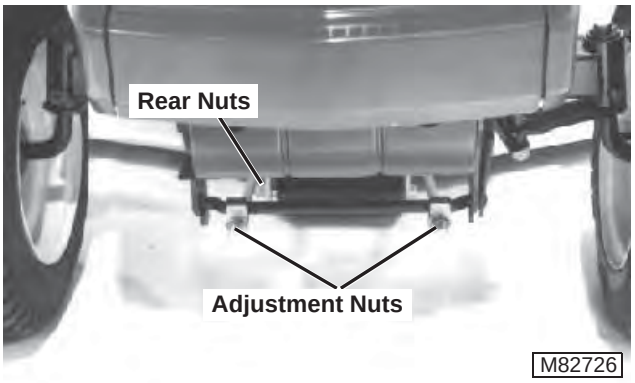
44-Inch Rear Discharge Deck . . . . . .0—6 mm (0—0.250 in.) front lower than rear

Results:

- If the blade front-to-rear height difference is out of specification, adjust as follows.

NOTE: On 38- and 48-inch decks, bagger performance is generally greater when the front-to-rear adjustment is at the maximum end of specifications.

Adjustment Procedure:



- Loosen REAR nuts on front draft rod.
- Turn FRONT adjustment nuts clockwise to raise front of mower deck or counterclockwise to lower front of mower deck.
- Tighten REAR nuts after adjustment is completed.

REPAIR—38-INCH MOWER DECK

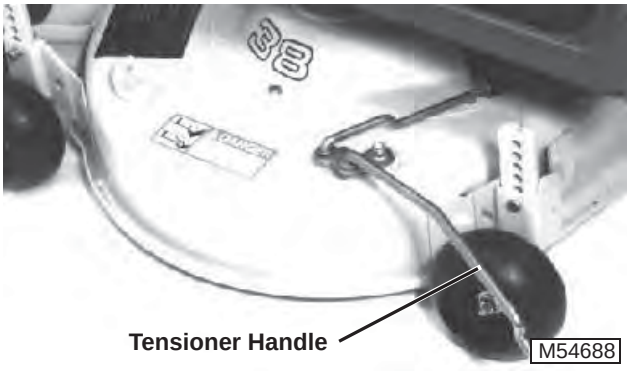
MOWER DECK

Removal/Installation

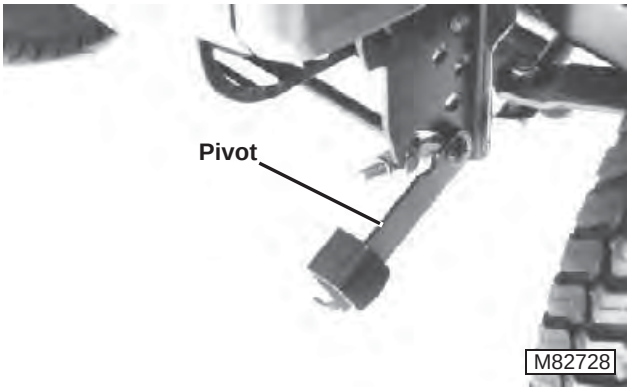
CAUTION

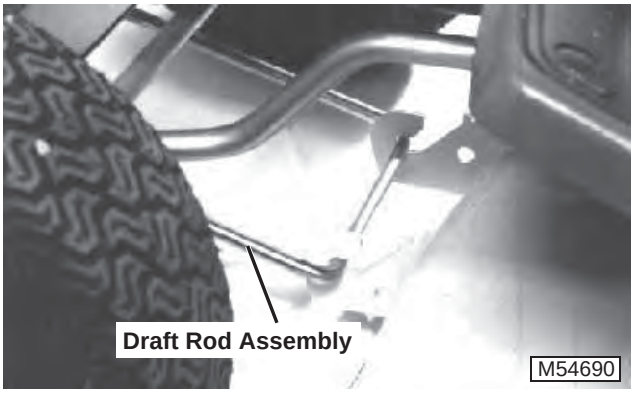
STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever all the way back.
2. Turn mower depth control knob to blank mark.
3. Move lift lever all the way forward to lock in DOWN position.



4. Disconnect tensioner handle from bracket and pull handle out to relieve belt tension.
5. Remove drive belt from PTO and mower jack sheave.





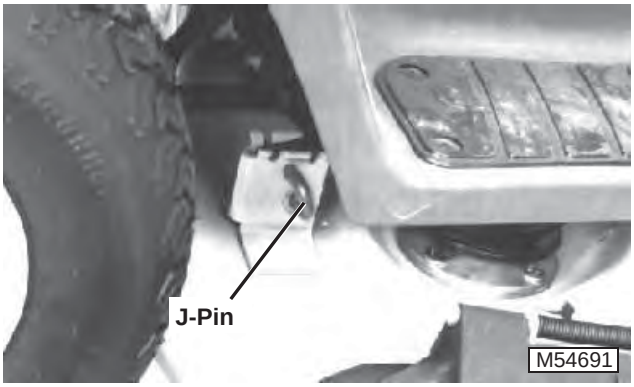
6. Pull out and push down on pivot to disconnect front draft rod assembly. Remove draft rod assembly from machine.

CAUTION

Do not remove mower deck until lift lever is moved forward in locked-down position. Spring pressure on rear draft arms could cause injury when mower deck is disconnected.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins

.



7. Pull out J-pin on each side of mower deck and turn pin to unlock position.

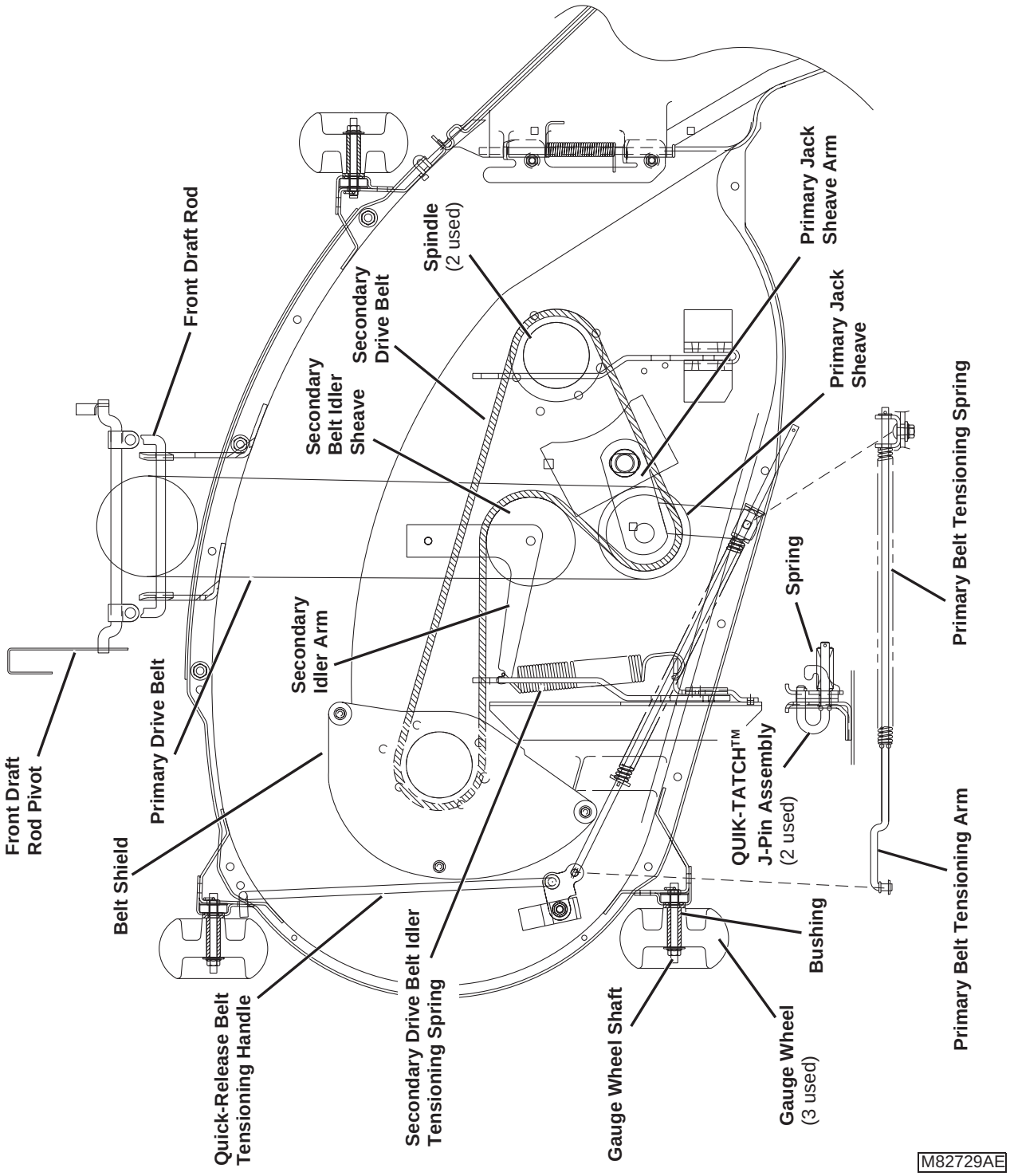
CAUTION

Lift lever is spring loaded and will snap rearward when lever is released from locked-down position, with no attachment on machine.

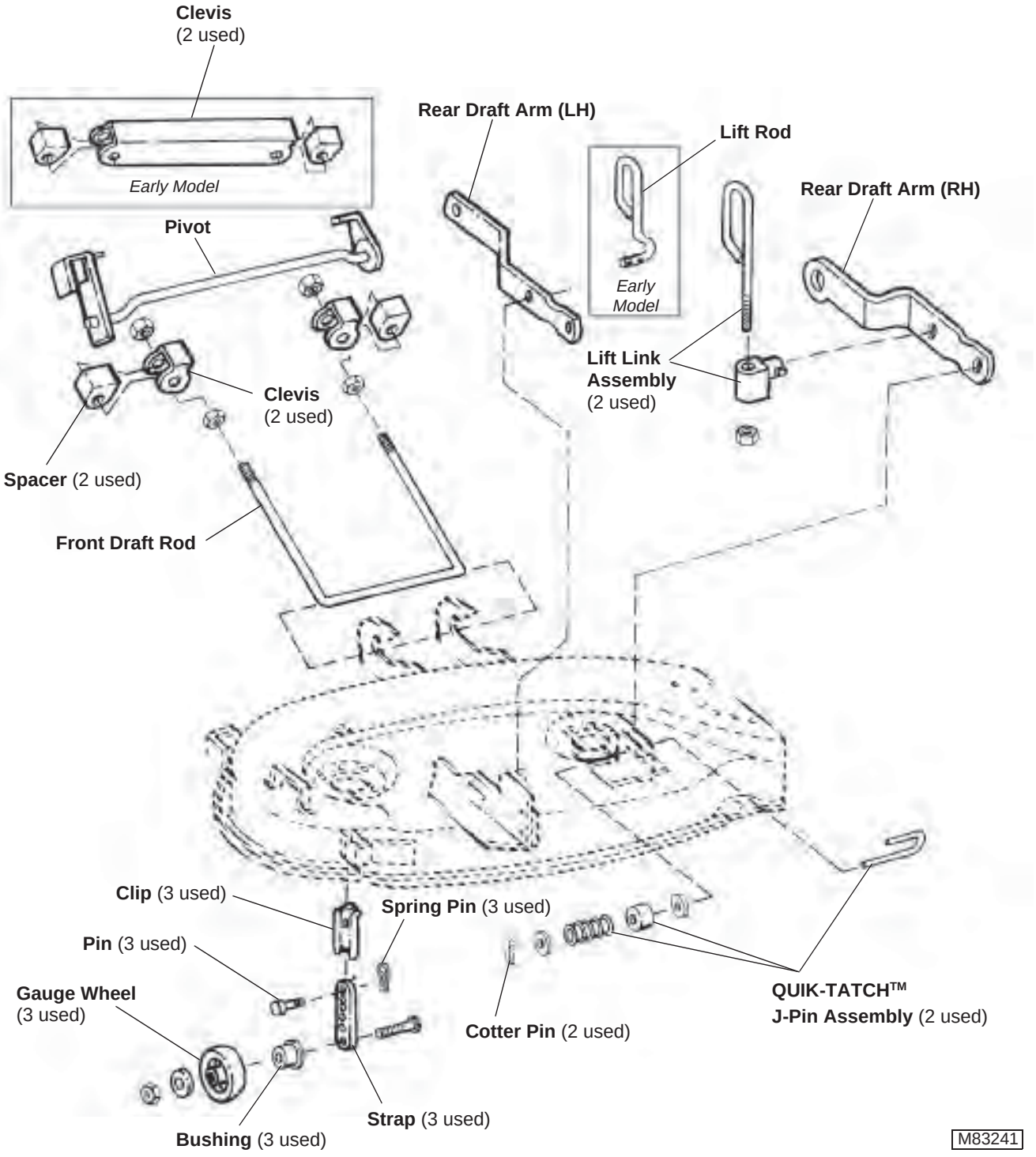
8. Pull lift lever all the way back.
9. Slide mower deck out the right side of the machine.

Installation is done in the reverse order of removal.

OVERALL VIEW



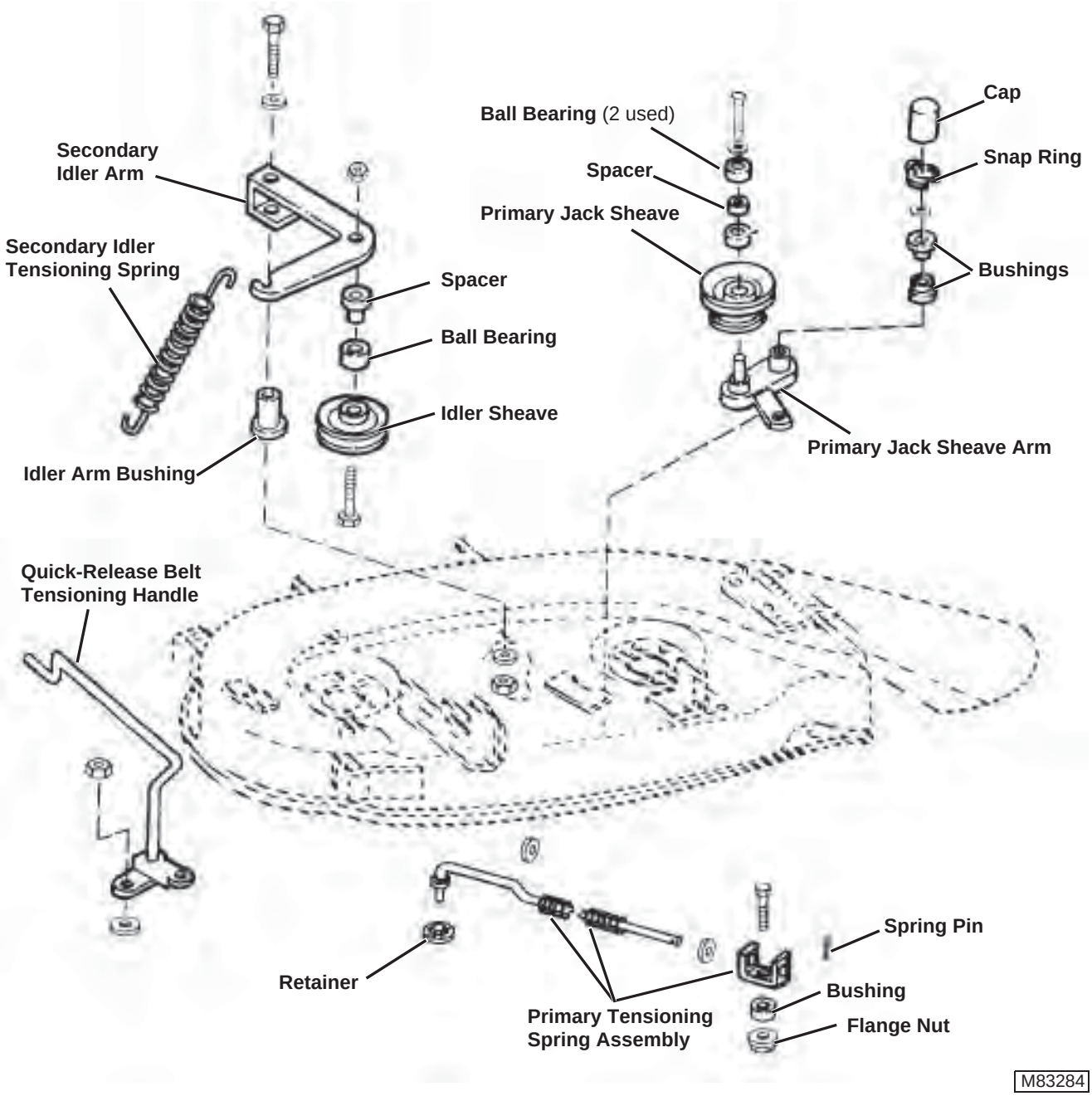
DRAFT ARMS AND GAUGE WHEELS



NOTE: On early models only, one lift link assembly is used. Lift rod is connected to opposite draft arm.

- Check mower deck side-to-side and front-to-rear adjustment after assembly. (See MOWER LEVEL SIDE-TO-SIDE adjustment on page 10-13 and MOWER LEVEL FRONT-TO-REAR adjustment on page10-14.)

IDLERS AND SHEAVES



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

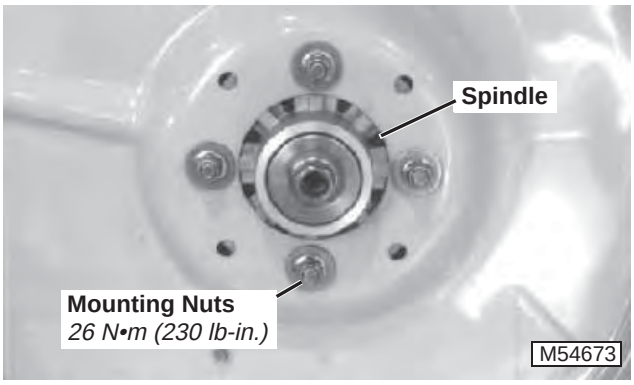
NOTE: Bearings are press-fit in primary jack sheave. Remove bearings only if replacement is necessary.

- Inspect jack sheave bearings for wear or damage. Replace if necessary:
  - Remove one jack sheave bearing from either end using a punch.
  - Remove jack sheave spacer and remaining bearing using a driver set.
  - Install new bearings tight against shoulders of primary jack sheave using a press.

SPINDLES

Removal/Installation

1. Remove mower blade. (See MOWER BLADES—Removal/Installation on page 10-20.)
2. Remove mower drive belt. (See MOWER DRIVE BELT—Removal/Installation.)

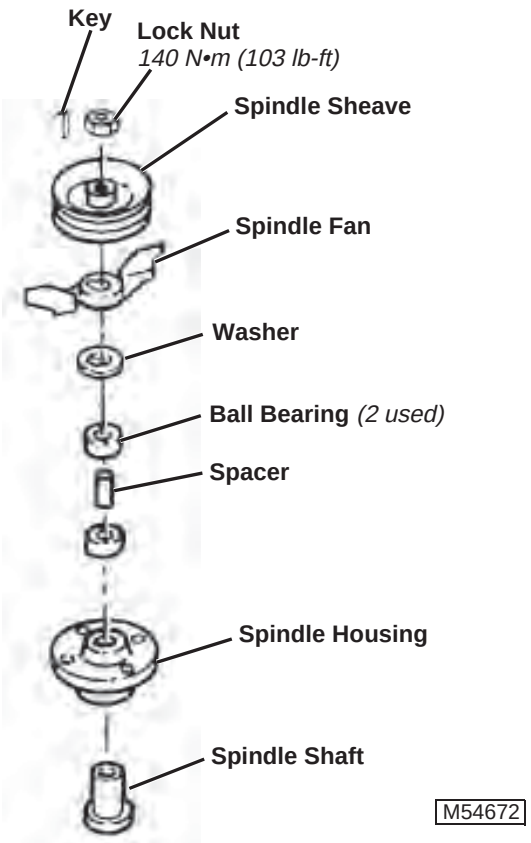


3. Remove four nuts, washers and spindle.
4. Make repairs as necessary. (See Disassembly/Assembly procedures.)

Installation is done in the reverse order of removal.

- Tighten spindle mounting nuts to **26 N•m (230 lb-in.)**.

Disassembly/Assembly



1. Remove key, lock nut, sheave, fan and washer.

NOTE: Spindle shaft and bearings are press-fit in housing. Remove bearings only if replacement is necessary.

2. Remove spindle shaft using a driver set and press.
3. Replace bearings and spacer, if necessary, using a driver set and press.
4. Inspect all parts for wear or damage. Replace parts as necessary.

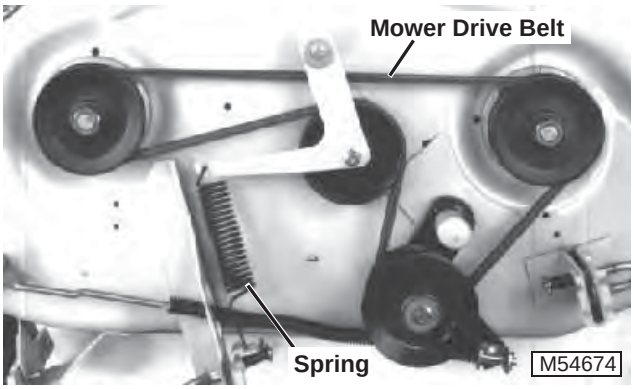
Installation is done in the reverse order of removal.

- Apply multipurpose grease to lubrication fitting in spindle housing.
- Tighten spindle sheave lock nut to **140 N•m (103 lb-ft)**.

MOWER DRIVE BELT

Removal/Installation

1. Remove mower deck.(See MOWER DECK—Removal/Installation on page 10-15.)
2. Remove belt cover.



3. Remove spring.
4. Remove mower drive belt.

Installation is done in the reverse order of removal.

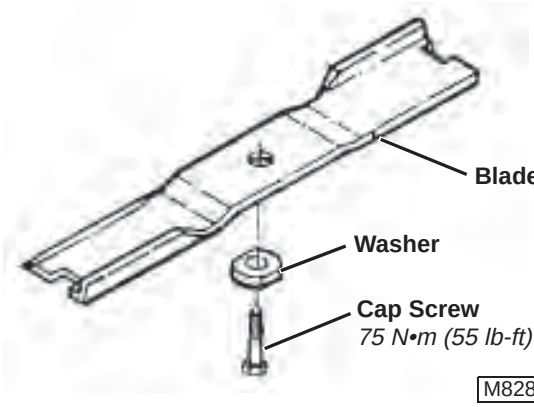
MOWER BLADES

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15.)

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.



2. Remove cap screw, washer and blade.
3. Inspect blade for cracks, wear or damage. Replace blade if necessary.
4. Sharpen and balance as necessary.

Installation is done in the reverse order of removal.

IMPORTANT: On early model decks, make sure that hole in washer is aligned with spindle. On late model decks, make sure that concave side of washer faces blade.

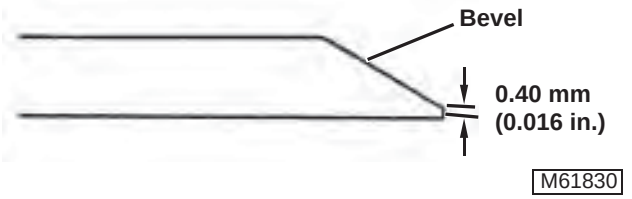
- Install blade with bent tips up.
- Tighten cap screw to **75 N•m (55 lb-ft)**.

Sharpen

⚠ CAUTION

Wear goggles and gloves when sharpening blade.

1. Sharpen blades using grinder, file or power sharpener.



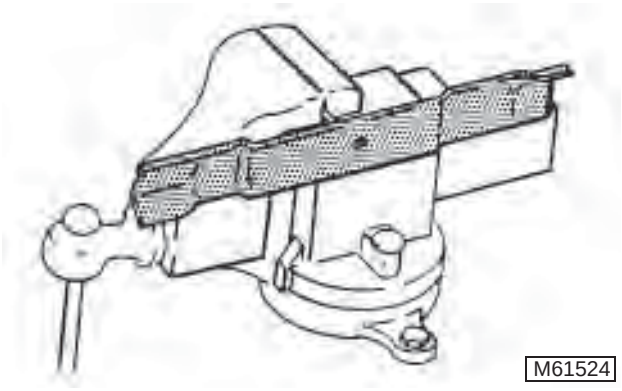
2. Do not alter original bevel. Blade should have **0.40 mm (0.016 in.) cutting edge** rather than a razor-type edge.
3. Balance blades.

Balance

⚠ CAUTION

Wear gloves when handling blade.

1. Clean blade.



2. Put blade on nail in vise or vertical wall stud.
3. Turn blade to HORIZONTAL position. If the blade is not balanced, the heavy end will drop.
4. Grind bevel of heavy end. Do not change blade bevel.

REPAIR—44-INCH REAR DISCHARGE MOWER DECK

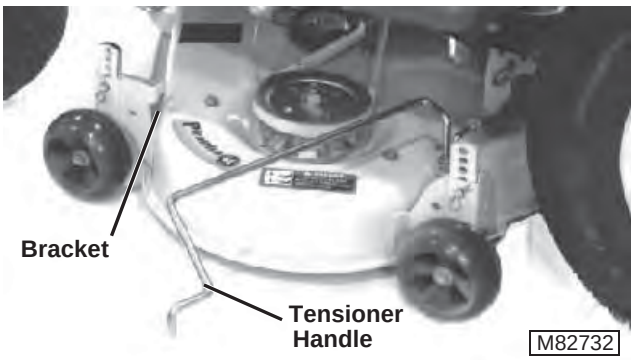
MOWER DECK

Removal/Installation

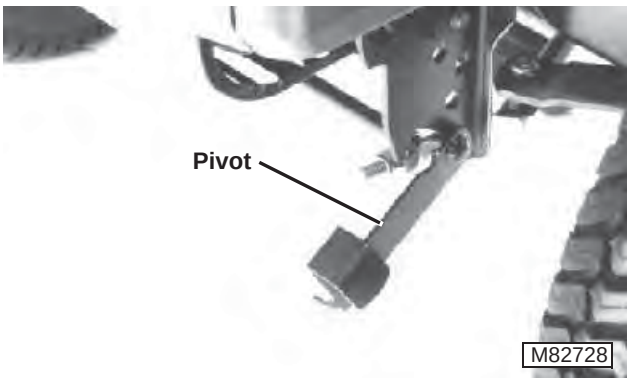
⚠ CAUTION

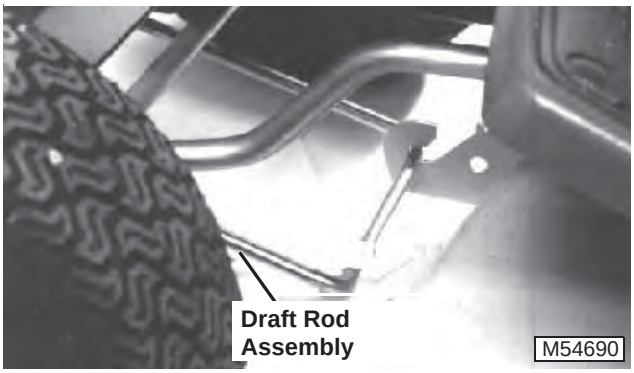
STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever all the way back.
2. Turn mower depth control knob to blank mark.
3. Move lift lever all the way forward to lock in DOWN position.



4. Disconnect tensioner handle from bracket. Pull handle out to relieve belt tension.
5. Remove drive belt from PTO and mower jack sheave.



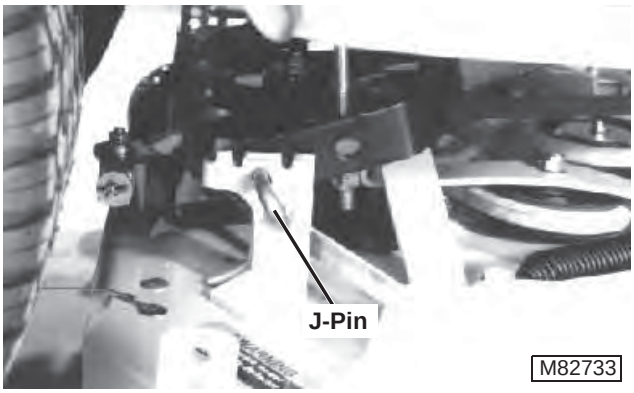


6. Pull out and push down on pivot to disconnect front draft rod assembly. Remove draft rod assembly from machine.

⚠ CAUTION

Do not remove mower deck until lift lever is moved forward in locked-down position. Spring pressure on rear draft arms could cause injury when mower deck is disconnected.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



7. Pull out J-pin on each side of mower deck and turn pin to unlock position.

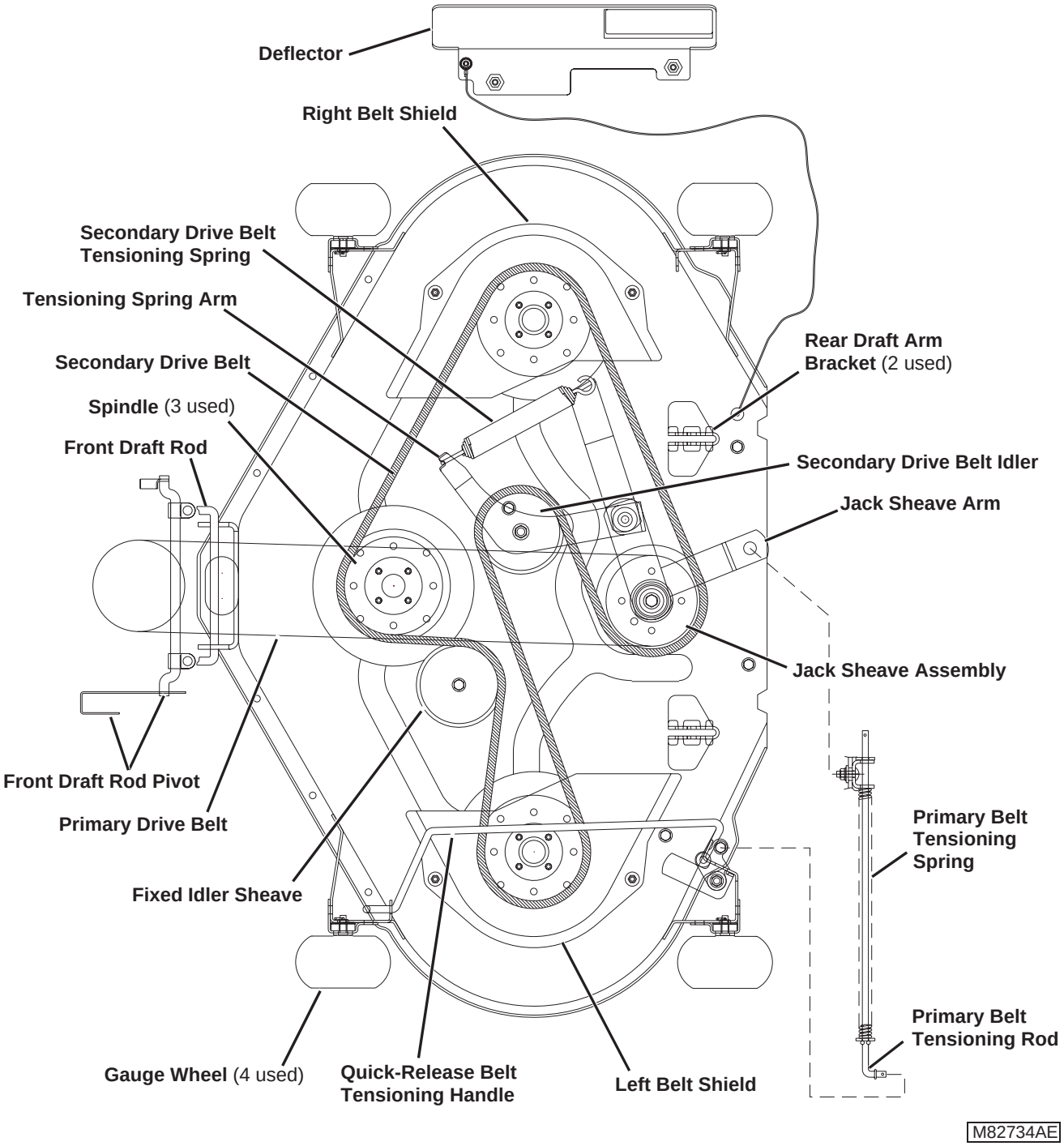
⚠ CAUTION

Lift lever is spring loaded and will snap rearward when lever is released from locked-down position, with no attachment on machine.

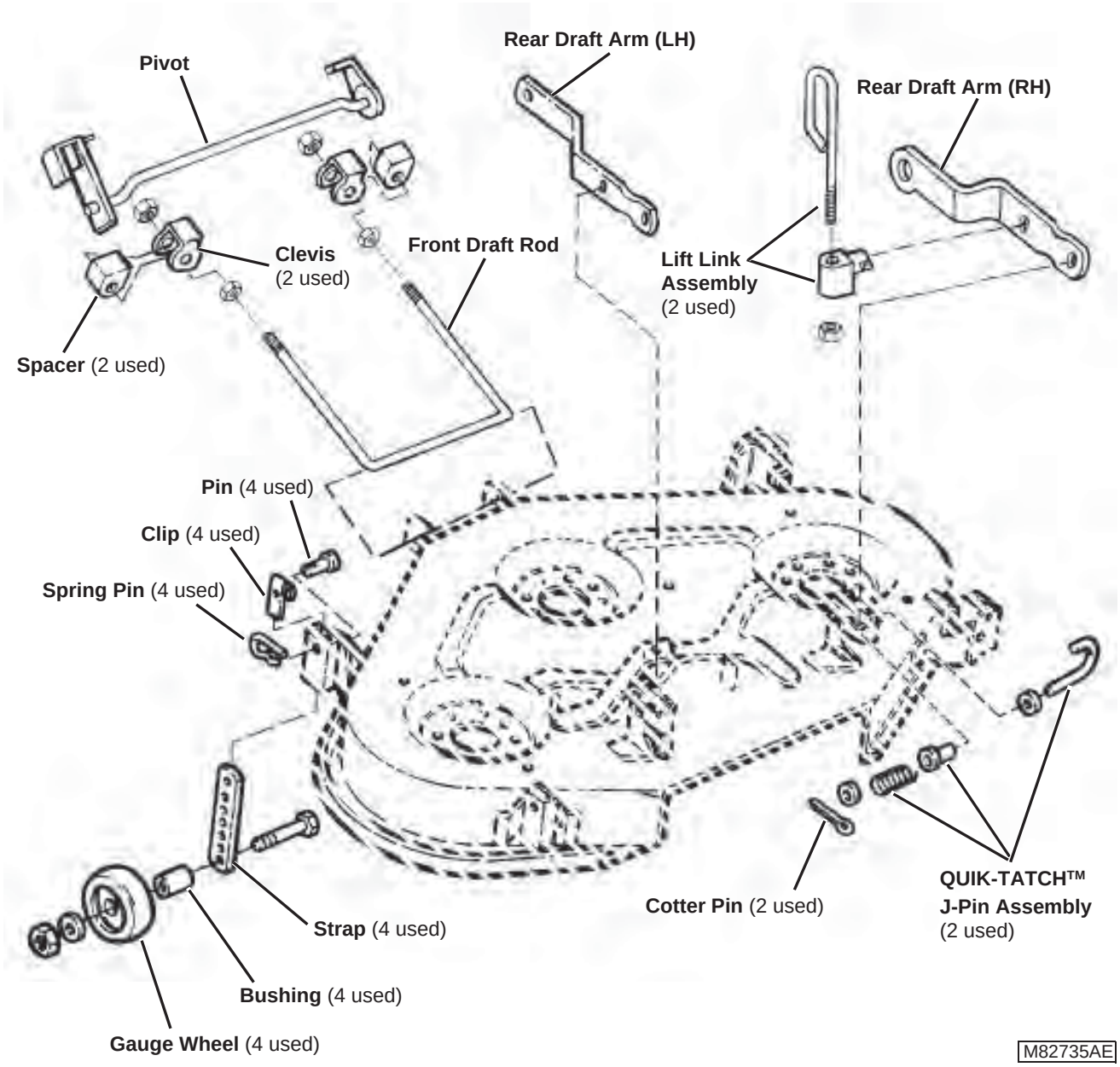
8. Pull lift lever all the way back.
9. Slide mower deck out the right side of the machine.

Installation is done in the reverse order of removal.

OVERALL VIEW



DRAFT ARMS AND GAUGE WHEELS



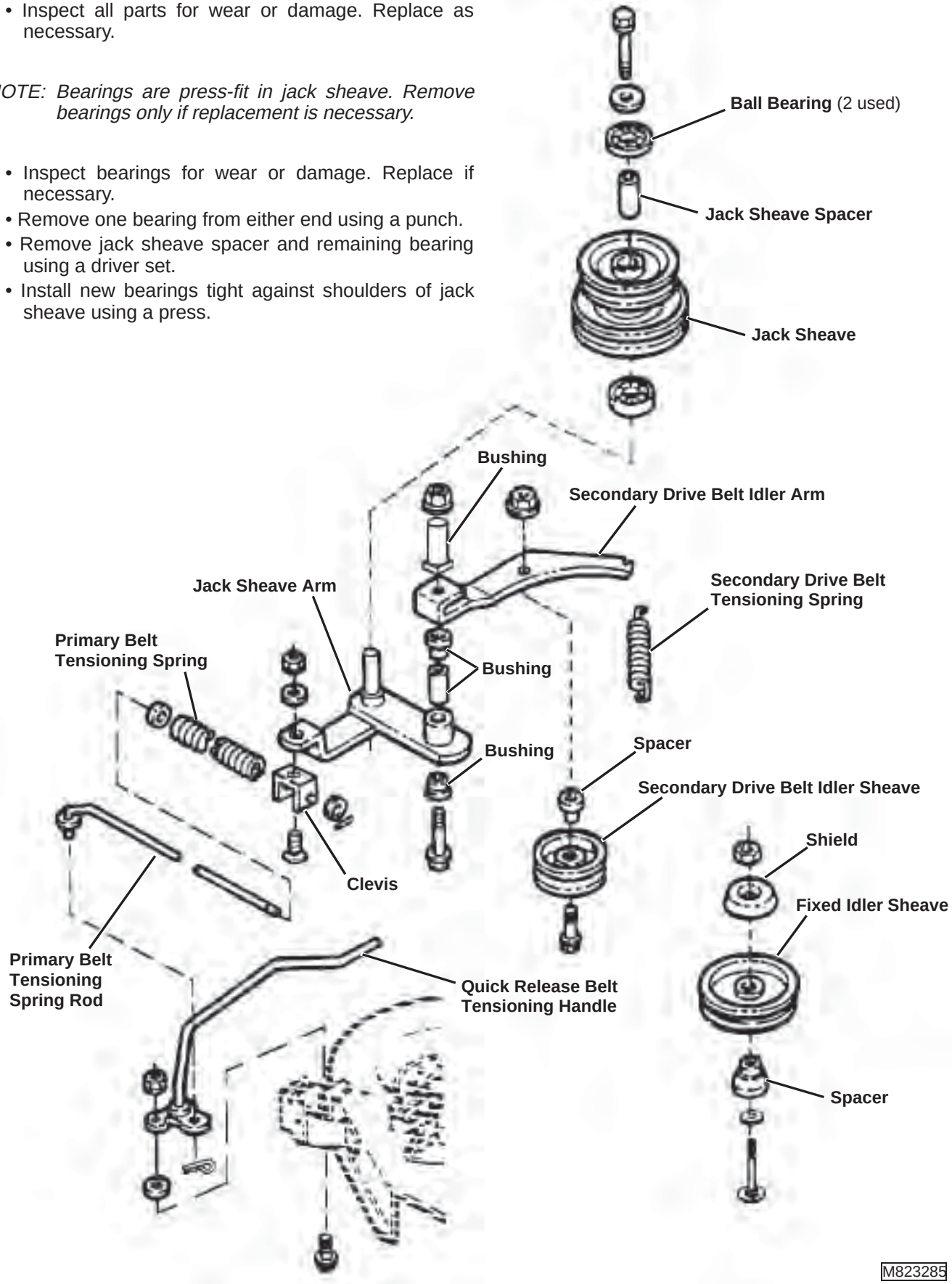
- Inspect all parts for wear or damage. Replace as necessary.
- Check mower deck side-to-side and front-to-rear adjustment after assembly. (See MOWER LEVEL SIDE-TO-SIDE adjustment on page 10-13 and MOWER LEVEL FRONT-TO-REAR adjustment on page 10-14.)

IDLERS AND SHEAVES

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

NOTE: Bearings are press-fit in jack sheave. Remove bearings only if replacement is necessary.

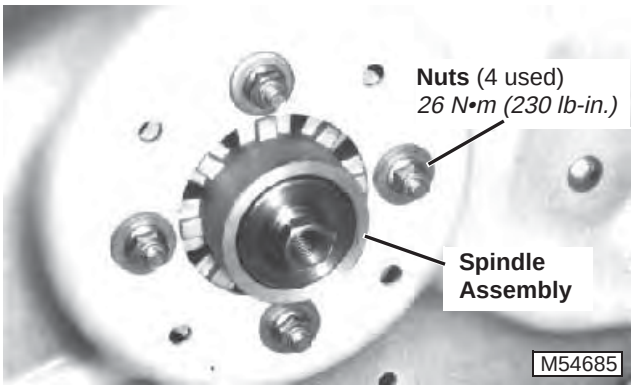
- Inspect bearings for wear or damage. Replace if necessary.
- Remove one bearing from either end using a punch.
- Remove jack sheave spacer and remaining bearing using a driver set.
- Install new bearings tight against shoulders of jack sheave using a press.



SPINDLES

Removal/Installation

1. Remove mower blade(s). (See MOWER BLADES—Removal/Installation on page 10-29.)
2. Remove mower drive belt. (See MOWER DRIVE BELT—Removal/Installation on page 10-28.)



3. Remove four nuts, washers, and spindle assembly.
4. Make repairs as necessary. (See Disassembly/Inspection procedure.)

Installation is done in the reverse order of removal.

- Tighten spindle mounting nuts to **26 N•m (230 lb-in.).**

Disassembly/Inspection

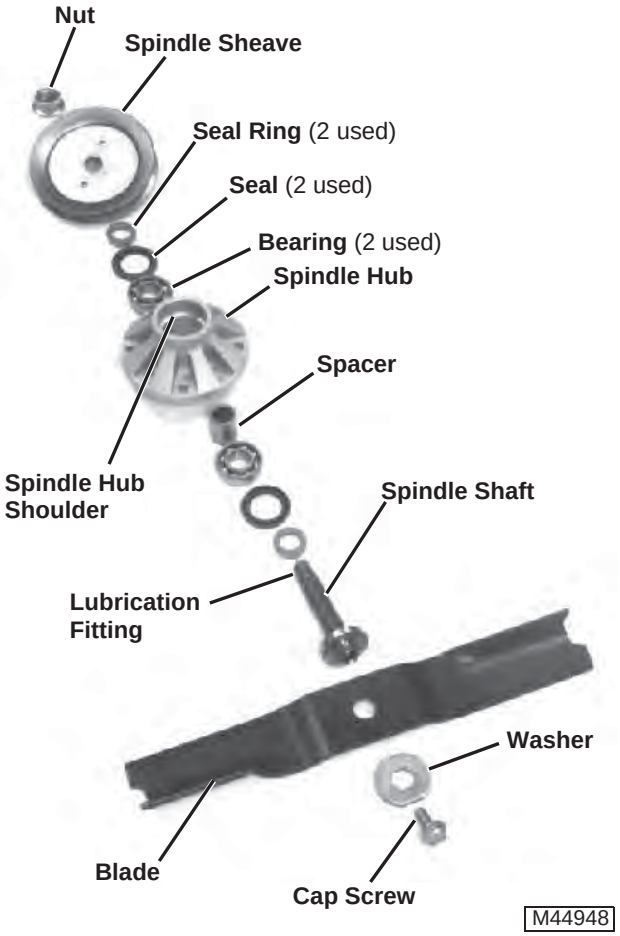
⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.

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.

NOTE: Two blade configurations are available:
Mulching - Two blades.
Rear Discharge - One blade and a spacer.

1. Install blades or spacer and blade, washer, and cap screw on spindle shaft. On late model decks, make sure that the concave side of the washer faces the blade. On early model decks, make sure that hole in washer is aligned with hexagon portion of spindle. If only the nut or spindle sheave need to be replaced, and the spindle is still in the deck, use a block of wood to prevent the blade from turning. If spindle is not in the deck, put blade in a soft jaw vise. Tighten cap screw to **122 N•m (90 lb-ft)**.



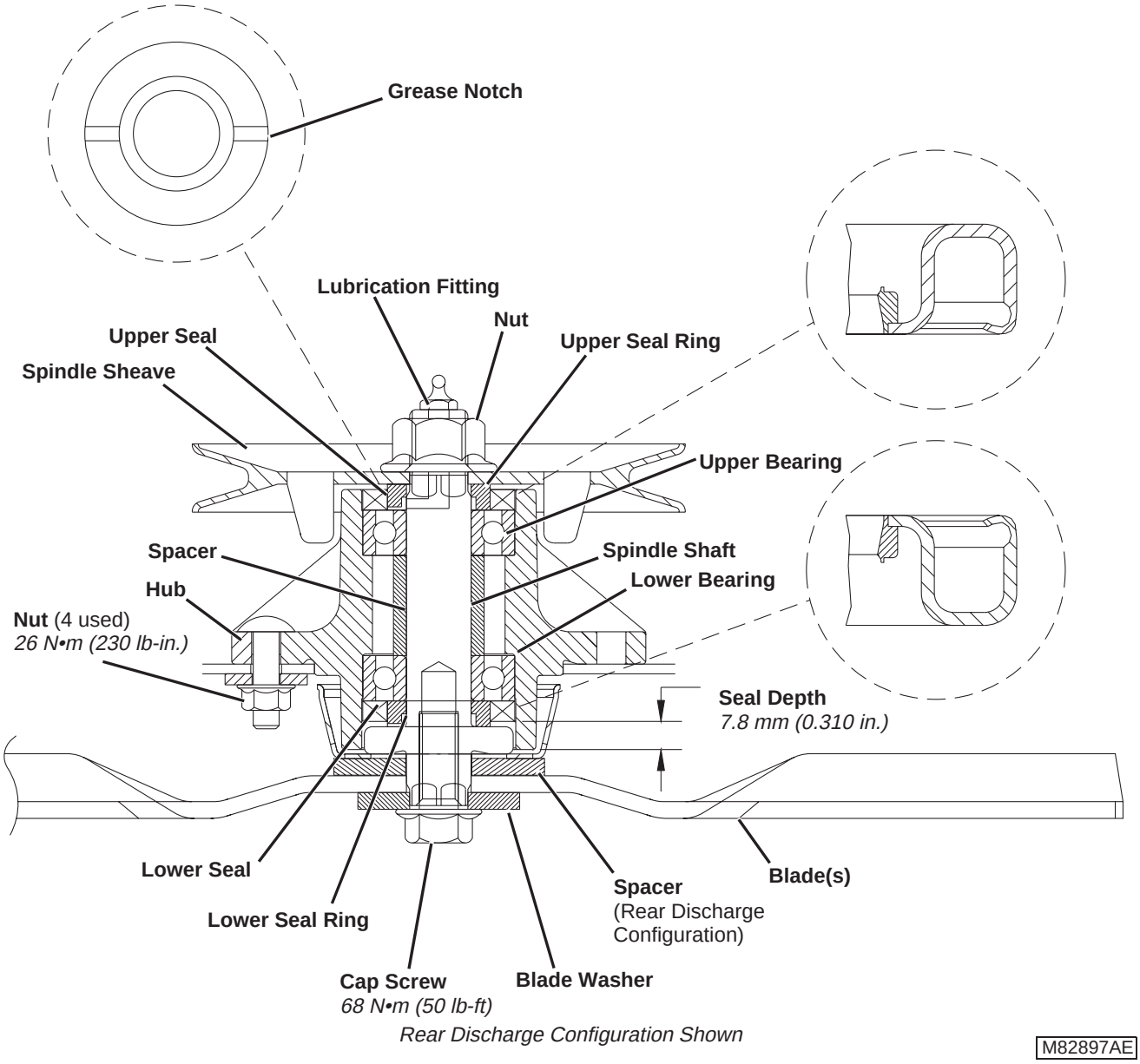
Rear Discharge Configuration Shown

2. Hold the blade with a vise or a block of wood. Remove nut, spindle sheave, and lubrication fitting.
3. Remove cap screw, washer, blade and spacer or blades.
4. Pull spindle shaft out of spindle hub.
5. Remove seal rings, noting location of notched side.

NOTE: Remove bearings only if replacement is necessary.

6. Bearings are seated against hub shoulder and cannot be removed with a press. Remove seals and bearings using a punch.
7. Remove spacer.
8. Inspect all parts for wear or damage. Replace parts as necessary.

Cross Section



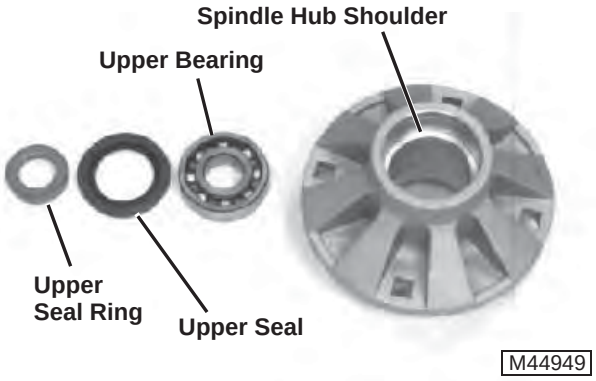
Rear Discharge Configuration Shown

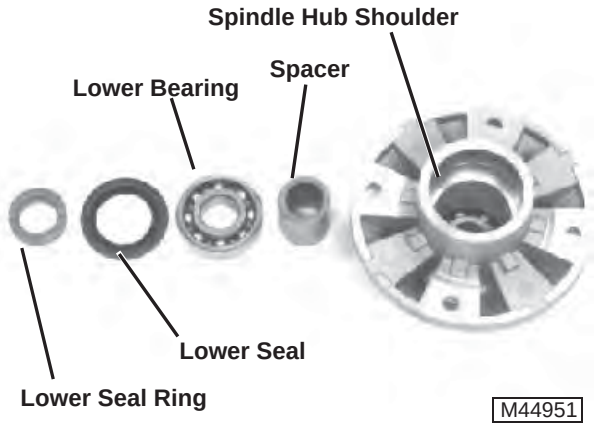
NOTE: Upper seal ring is installed with grease notch facing toward upper bearing.

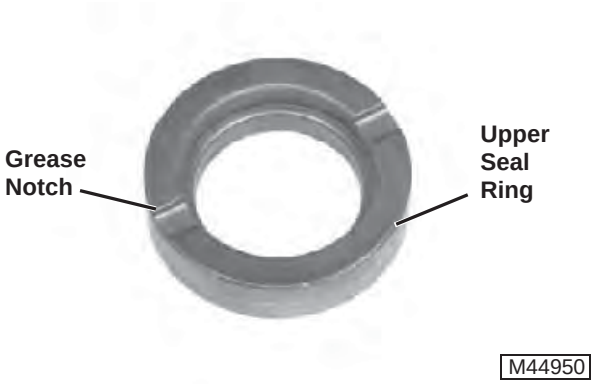
Two blade configurations are available:

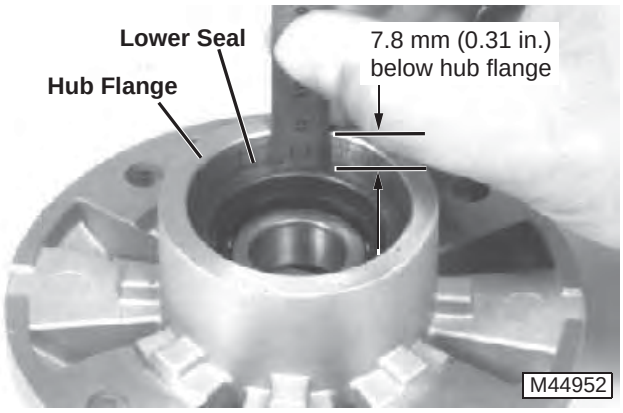
Mulching—Two blades.
Rear Discharge—One blade and a spacer.

Assembly





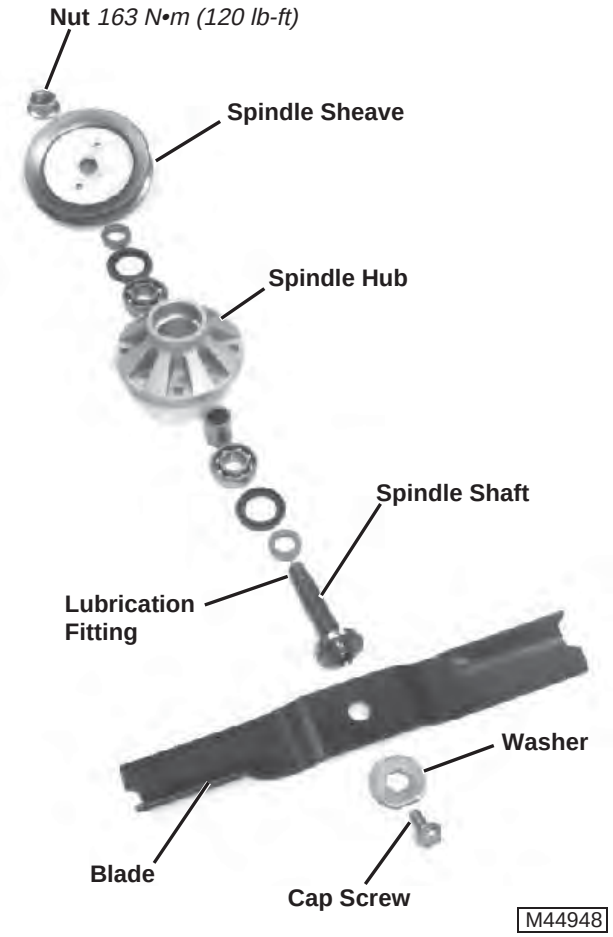




1. Install upper bearing tight against spindle hub shoulder using a 1-13/16 in. disk and press.
2. Install upper seal with lip toward bearing, tight against bearing using a 1-13/16 in. disk and press.
3. Install upper seal ring, with grease notch toward bearing, inside seal lip.
4. Install spacer.

IMPORTANT: Do not press lower bearing tight against hub shoulder. The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

5. Install lower bearing in hub using a 1-13/16 in. disk and press, just enough so the lower seal can be installed.
6. Install lower seal with lip toward bearing using a 1-13/16 in. disk and a press.
7. Install lower seal ring, with grease notch away from bearing, inside seal lip.



8.Install spindle shaft.

IMPORTANT: Do not install hexagon end of spindle shaft in a vise to install spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.

9. Install blades or spacer and blade, washer, and cap screw on spindle shaft. On late model decks, make sure that the concave side of washer faces the blade. On early model decks, make sure that the hole in washer is aligned with hexagon portion of spindle.

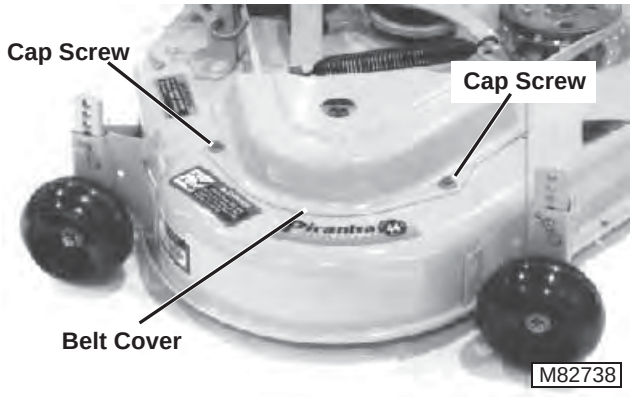
IMPORTANT: Make sure the hexagon shaped hole in spindle sheave is aligned with the hexagon portion of the spindle shaft.

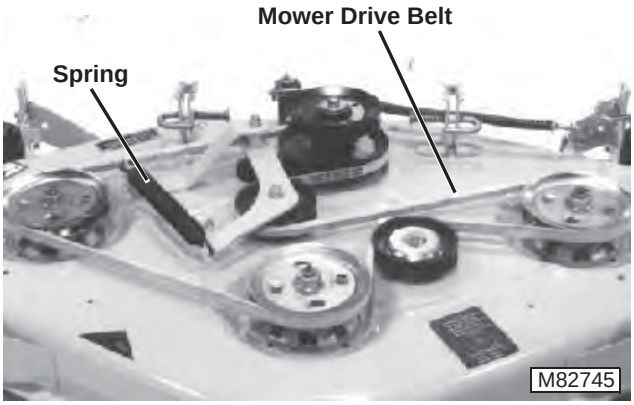
10. Hold the blade with a soft-jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave, nut, and lubrication fitting.
11. Remove cap screw, washer, blade and spacer or blades.
12. Lubricate spindle with multipurpose grease at lubrication fitting.

MOWER DRIVE BELT

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-21.)





2. Remove cap screws and belt cover.

NOTE: Right-hand side shown. Left-hand side similar.

3. Remove spring using a spring puller.
4. Remove mower drive belt.

Installation is done in the reverse order of removal.

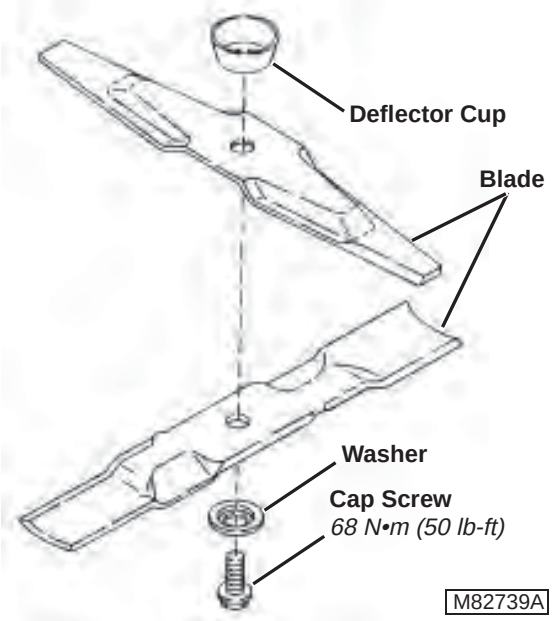
MOWER BLADE(S)

Removal/Installation

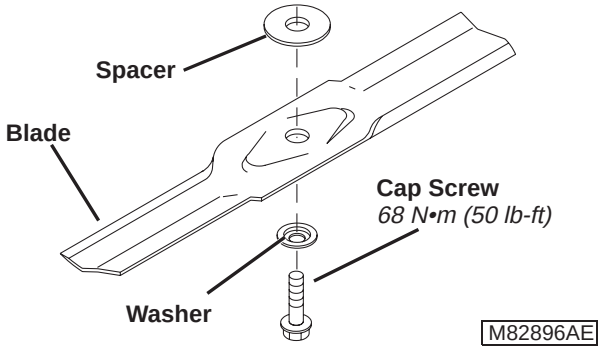
1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-21.)

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.



Mulching Configuration



Rear Discharge Configuration

2. Remove cap screw, washer, blade(s), spacer, if equipped, and cup.
3. Inspect blade(s) for cracks, wear or damage. Replace if necessary.
4. Sharpen and balance as necessary.

Installation is done in the reverse order of removal.

IMPORTANT: Make sure deflector cup is in place between spindle and blades. On late model decks, make sure that the concave side of washer faces the blade. On early model decks, make sure that hole in washer is aligned with hexagon portion of spindle.

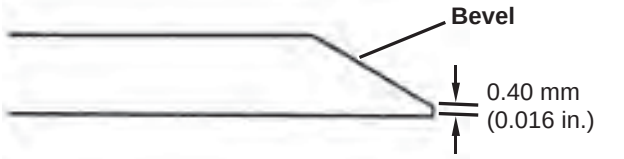
- Install blade with bent tips up.
- Tighten cap screw to **68 N•m (50 lb-ft).**

Sharpen

⚠ CAUTION

Wear goggles and gloves when sharpening blade.

1. Sharpen blade using grinder, file or power sharpener.



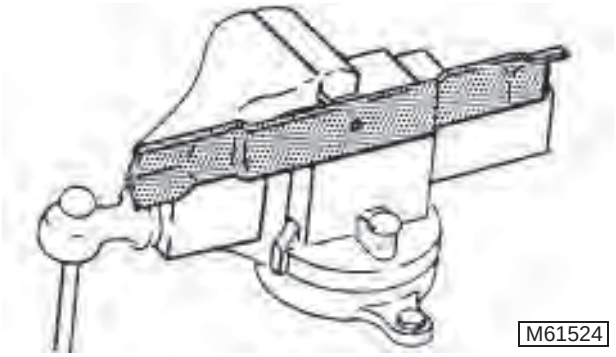
2. Do not alter original bevel. Blade should have **0.40 mm (0.016 in.)** cutting edge rather than a razor-type edge.
3. Balance blade.

Balance

⚠ CAUTION

Wear gloves when handling blade.

1. Clean blade.



2. Put blade on nail in vise or vertical wall stud.
3. Turn blade to HORIZONTAL position. If the blade is not balanced, the heavy end will drop.
4. Grind bevel of heavy end. Do not change blade bevel.

REPAIR—48-INCH MOWER DECK

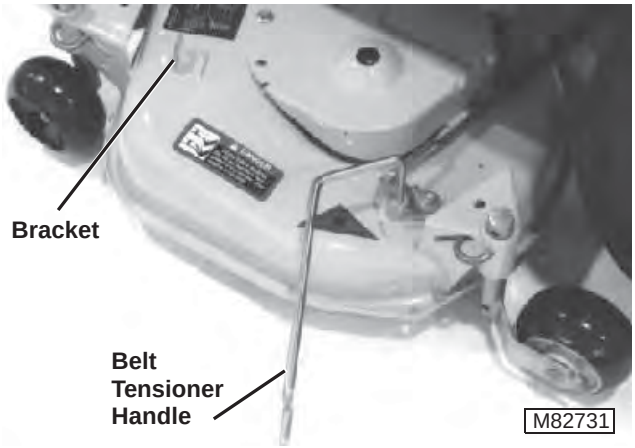
MOWER DECK

Removal/Installation

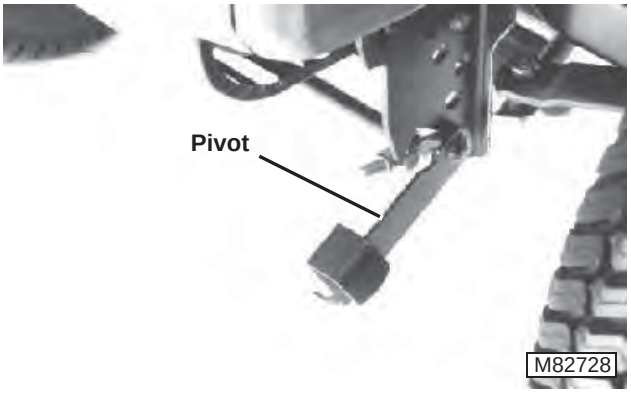
CAUTION

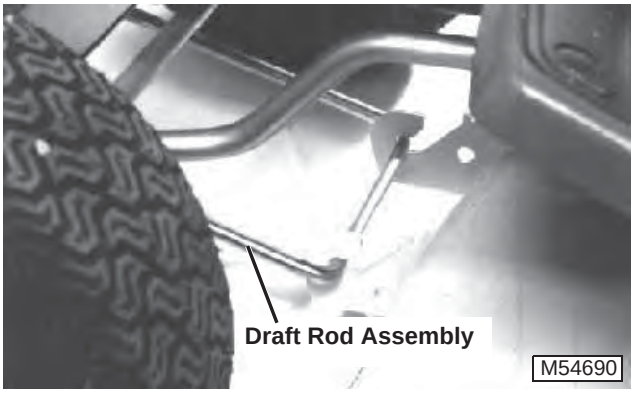
STOP engine. Remove ignition key. Wait for all moving parts to STOP.

1. Pull lift lever all the way back.
2. Turn mower depth control knob to blank mark.
3. Move lift lever all the way forward to lock in DOWN position.



4. Disconnect tensioner handle from bracket. Pull handle out to relieve belt tension.
5. Remove drive belt from PTO and mower jack sheave.



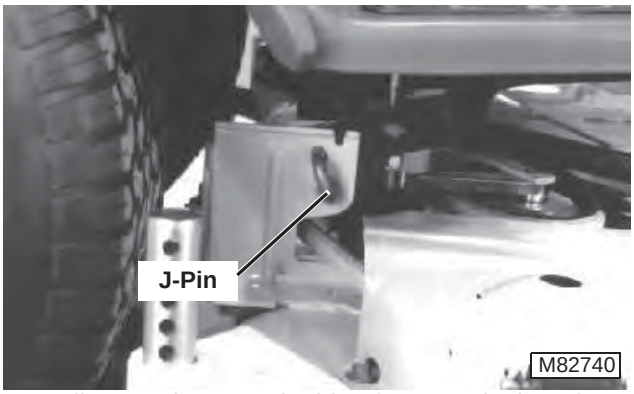


6. Pull out and push down on pivot to disconnect front draft rod assembly. Remove draft rod assembly from machine.

CAUTION

Do not remove mower deck until lift lever is moved forward in locked-down position. Spring pressure on rear draft arms could cause injury when mower deck is disconnected.

NOTE: It may be necessary to lift up on rear of mower deck to pull out J-pins.



7. Pull out J-pin on each side of mower deck and turn pin to unlock position.

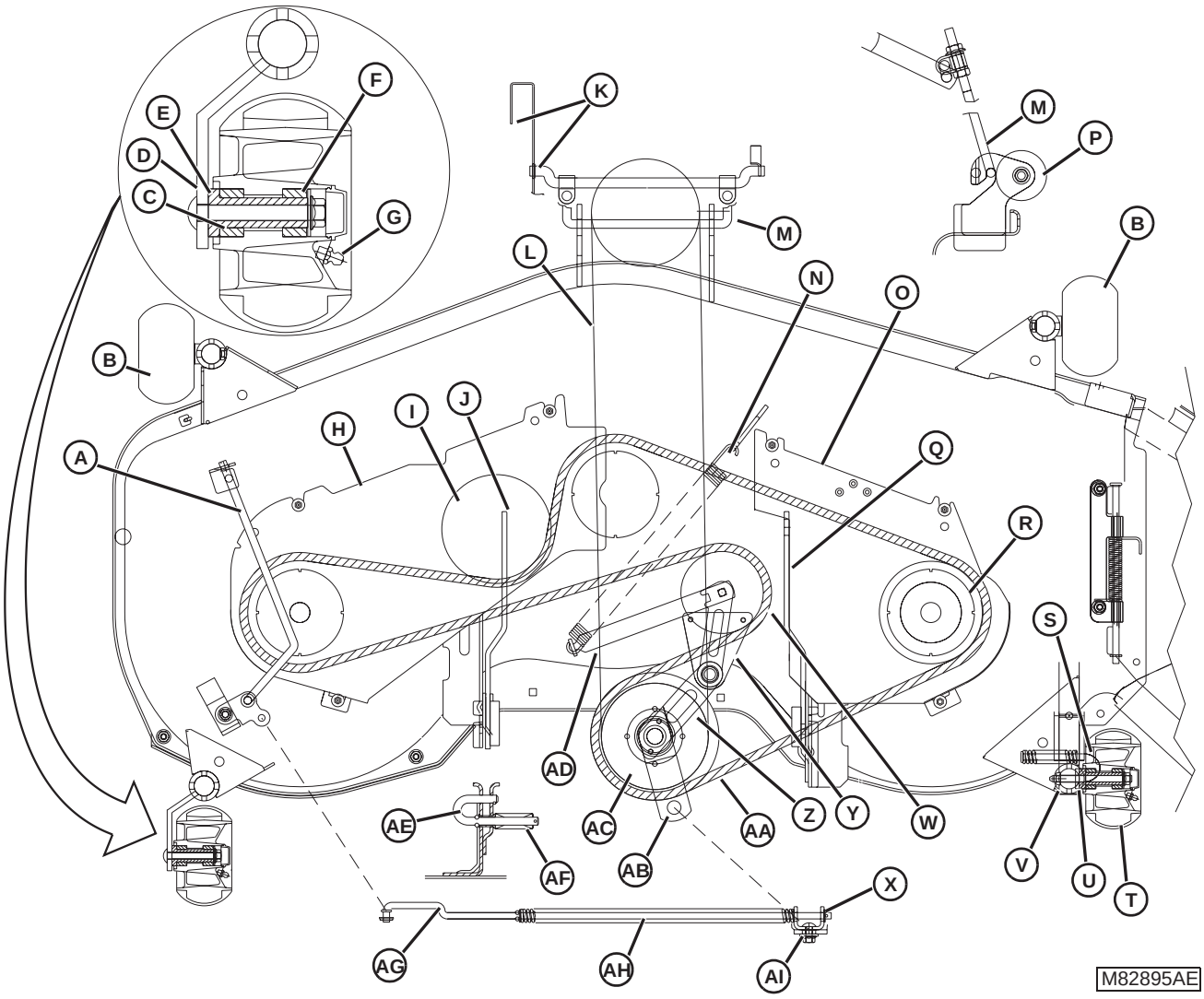
CAUTION

Lift lever is spring loaded and will snap rearward when lever is released from locked-down position, with no attachment on machine.

8. Pull lift lever all the way back.
9. Slide mower deck out the right side of the machine.

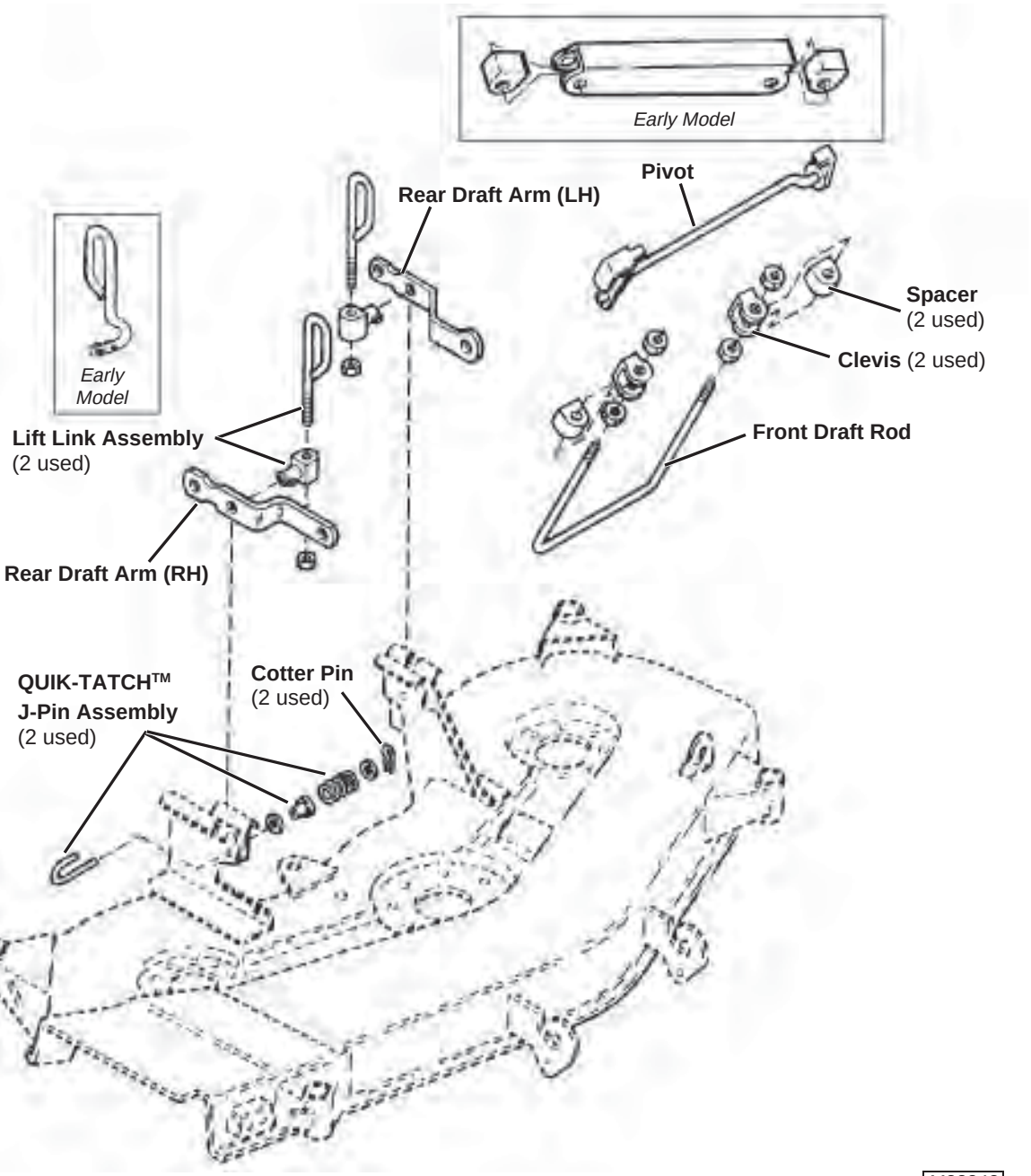
Installation is done in the reverse order of removal.

OVERALL VIEW



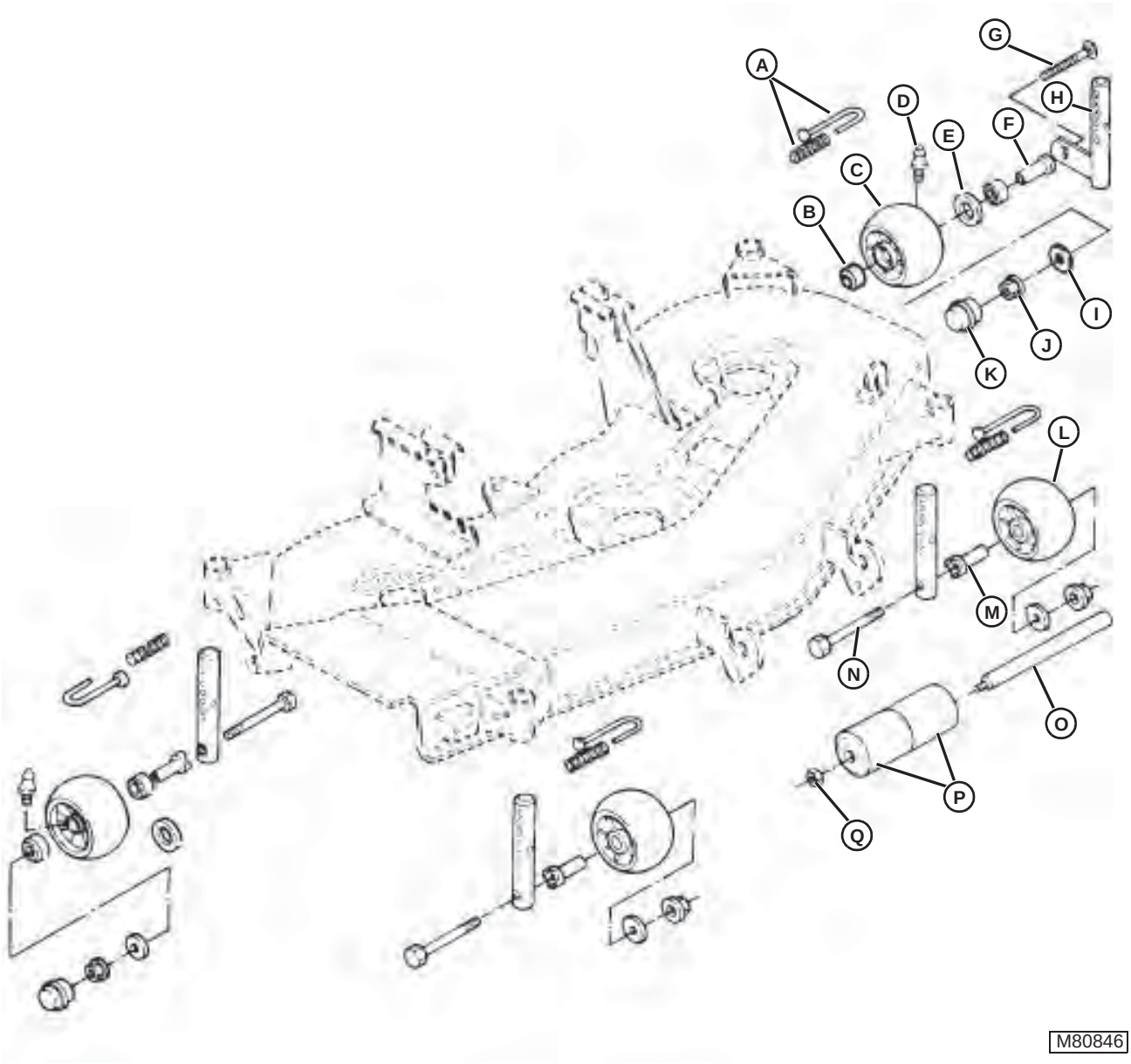
A—Quick Release Belt Tensioning Handle
B—Front Gauge Wheel (2 used)
C—Seal
D—Gauge Wheel Arm
E—Bushing
F—Bushing
G—Grease Fitting
H—Left Belt Shield
I—Fixed Idler Sheave
J—Left Rear Draft Arm
K—Front Draft Rod Pivot
L—Primary Drive Belt
M—Front Draft Rod
N—Secondary Drive Belt Idler Tensioning Spring
O—Right Belt Shield
P—Front Rollers
Q—Right Rear Draft Arm
R—Spindle (3 used)
S—QUIK-TATCH™ J-Pin Assembly
T—Rear Gauge Wheel (2 used)
U—Bushing (3 used)
V—Gauge Wheel Shaft (Bolt)
W—Secondary Drive Belt Idler Sheave
X—Clevis
Y—Secondary Idler Sheave Arm
Z—Jack Sheave Arm
AA—Secondary Drive Belt
AB—Jack Sheave Tensioning Arm
AC—Jack Sheave
AD—Tensioning Spring Arm
AE—QUIK-TATCH™ J-Pin Assembly
AF—Spring
AG—Primary Belt Tensioning Rod
AH—Primary Belt Tensioning Spring
AI—Bushing

DRAFT ARMS



- Check mower deck side-to-side and front-to-rear adjustment after assembly. (See MOWER LEVEL SIDE-TO-SIDE adjustment on page 10-13 and MOWER LEVEL FRONT-TO-REAR adjustment on page 10-14.)

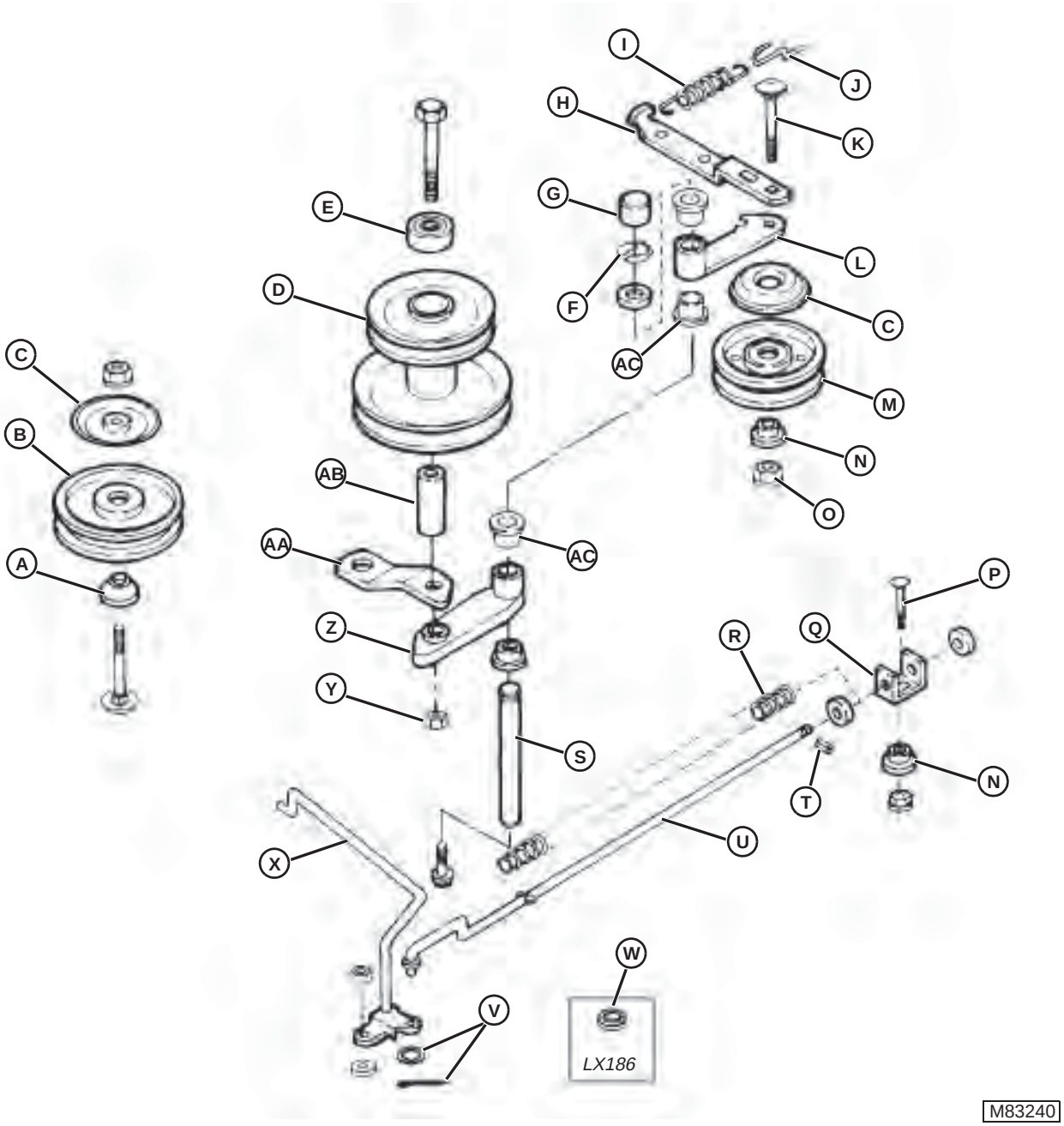
GAUGE WHEELS



A—QUIK-TATCH™ J-Pin Assembly (4 used)
B—Bushing (4 used)
C—Rear Gauge Wheel (2 used)
D—Grease Fitting (2 used)
E—Seal (2 used)
F—Bushing
G—Carriage Bolt
H—Gauge Wheel Arm
I—Washer (4 used)
J—Flange Nut (4 used)
K—Cap
L—Front Gauge Wheel (2 used)
M—Bushing (3 used)
N—Gauge Wheel Shaft (3 used)
O—Roller Shaft
P—Front Rollers
Q—Nut

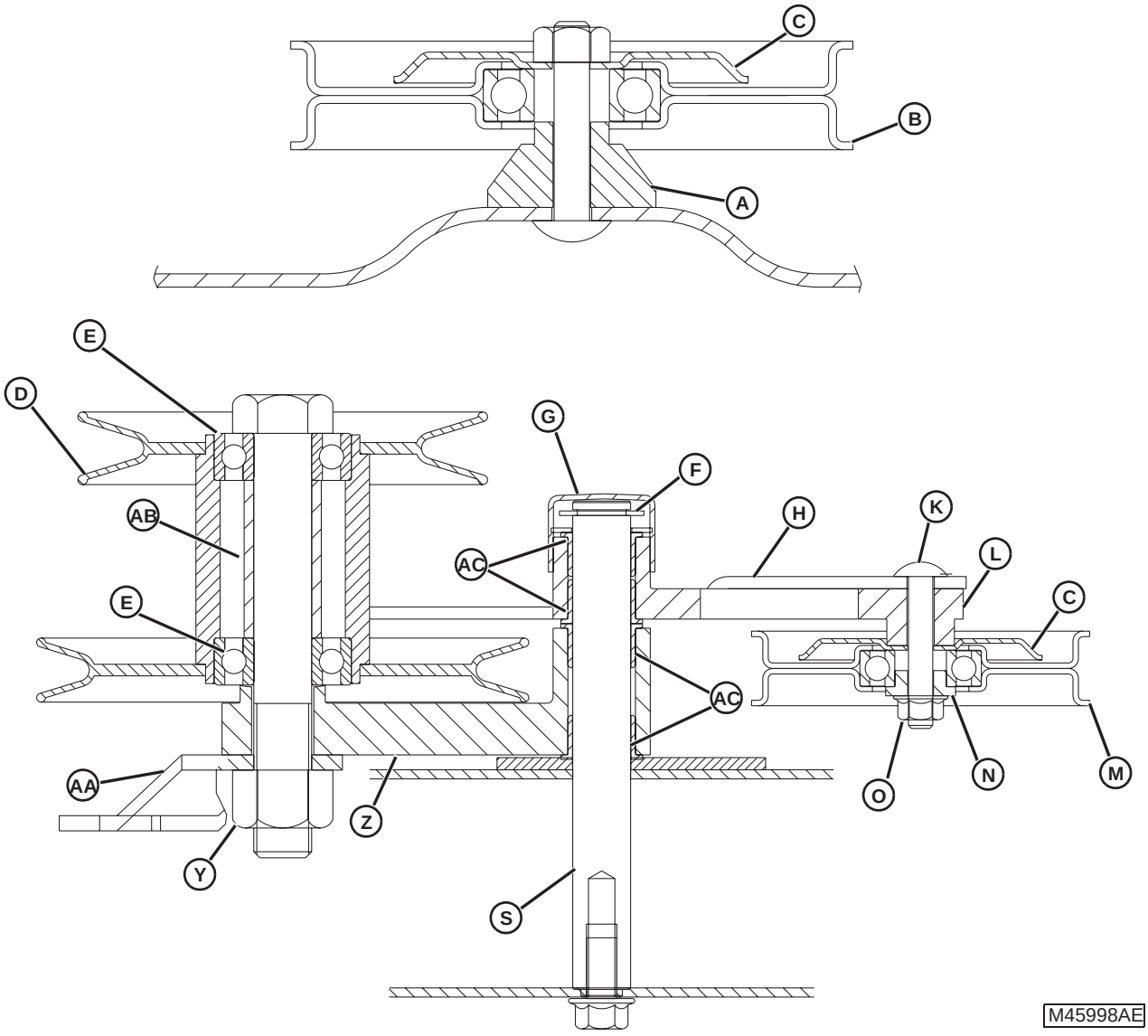
- Inspect all parts for wear or damage. Replace parts if necessary.
- Apply multipurpose grease to grease fittings (D).
- Tighten roller shaft nut (Q) to **30 N•m (22 lb-ft)**.

IDLERS AND SHEAVES



M83240

A—Spacer
B—Fixed Idler Sheave
C—Shield
D—Jack Sheave
E—Ball Bearing (2 used)
F—Snap Ring
G—Plug
H—Tensioning Spring Arm (Secondary)
I—Tensioning Idler Sheave Spring
J—Hook
K—Carriage Bolt
L—Tensioning Idler Sheave Arm (Secondary)
M—Tensioning Idler Sheave
N—Bushing
O—Nut
P—Carriage Bolt
Q—Clevis
R—Primary Belt Tensioning Spring
S—Shaft
T—Spring Pin
U—Primary Belt Tensioning Rod
V—Cotter Pin and Washer
W—Clip
X—Quick Release Belt Tensioning Handle
Y—Nut
Z—Jack Sheave Arm
AA—Jack Sheave Tensioning Arm
AB—Spacer
AC—Bushing (4 used)



- Inspect all parts for wear or damage. Replace parts if necessary.

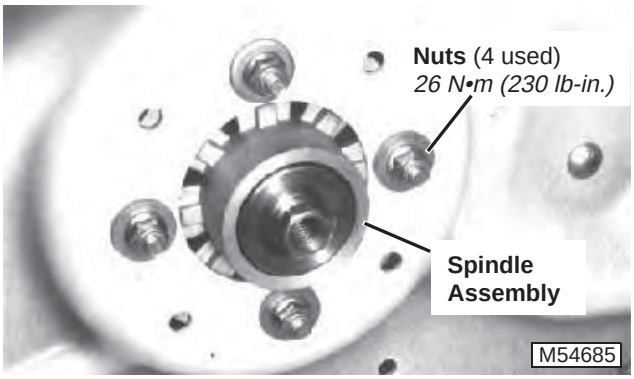
NOTE: Bearings (E) are press-fit in jack sheave (D). Remove bearings only if replacement is necessary.

- Inspect bearings (E) for wear or damage. Replace if necessary:
  - Remove one bearing (E) from either end, using a punch.
  - Remove spacer (AB) and remaining bearing using a driver set.
  - Install new bearings tight against shoulders of jack sheave (D) using a press.
- Tighten jack sheave nut (Y) to **136 N•m (100 lb-ft)**.
- Tighten tensioning idler sheave nut (O) to **27 N•m (20 lb-ft)**.

SPINDLES

Removal/Installation

1. Remove mower blade. (See MOWER BLADES—Removal/Installation on page 10-39.)
2. Remove mower drive belt. (See MOWER DRIVE BELT—Removal/Installation on page 10-39.)



3. Remove four nuts and washers and spindle assembly.
4. Make repairs as necessary. (See Disassembly/Inspection procedure.)

Installation is done in the reverse order of removal.

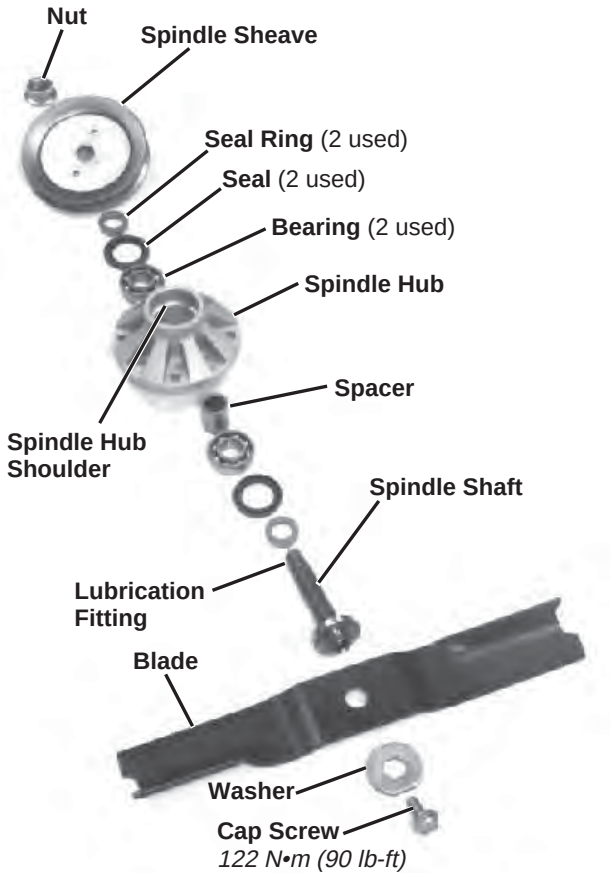
- Tighten spindle mounting nuts to **26 N•m (230 lb-in.).**

Disassembly/Inspection

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.

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.

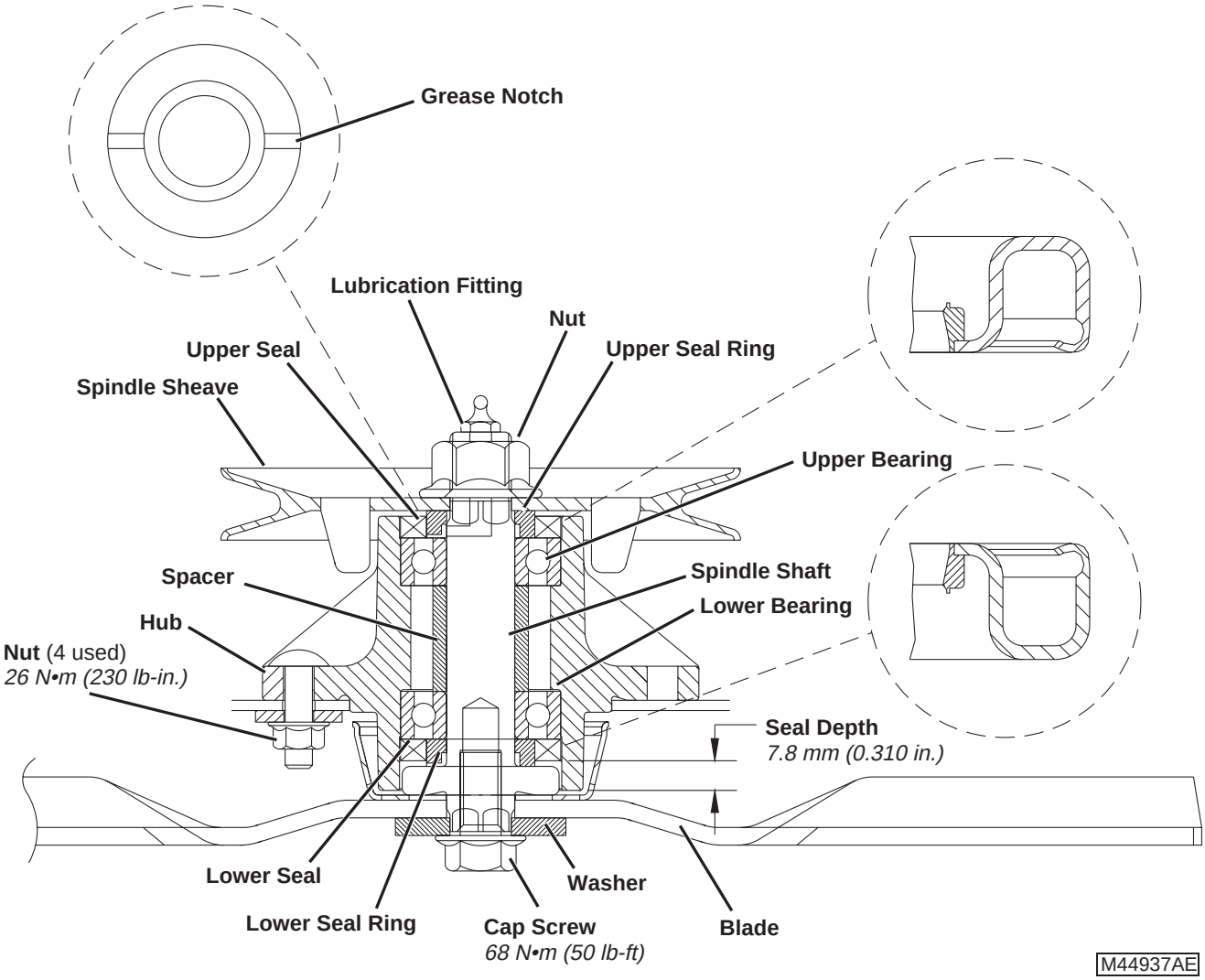


1. Install blade, washer, and cap screw on spindle shaft. On early model decks, make sure that hole in washer is aligned with hexagon portion of spindle. If only the nut or spindle sheave need to be replaced, and the spindle is still in the deck, use a block of wood to prevent the blade from turning. If spindle is not in the deck, put blade in a soft-jaw vise. Tighten cap screw to specifications.
2. Hold the blade with a vise or a block of wood. Remove nut, spindle sheave, and lubrication fitting.
3. Remove cap screw, washer and blade.
4. Pull spindle shaft out of spindle hub.
5. Remove seal rings, noting location of notched side.

NOTE: Remove bearings only if replacement is necessary.

6. Bearings are seated against spindle hub shoulder and cannot be removed with a press. Remove seals and bearings using a punch.
7. Remove spacer.
8. Inspect all parts for wear or damage. Replace parts as necessary.

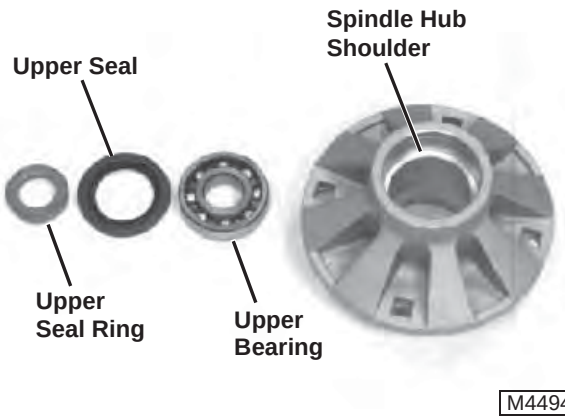
Cross Section



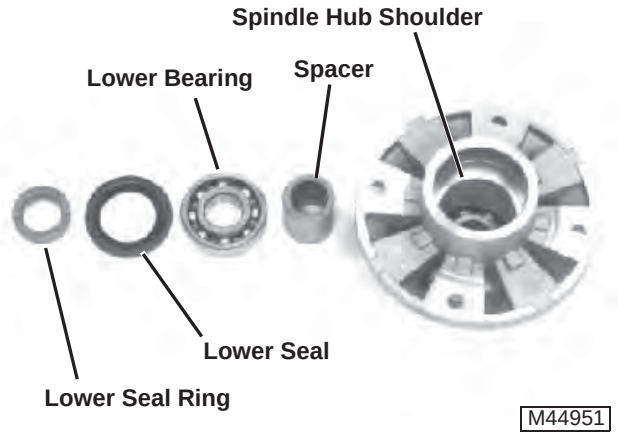
Assembly

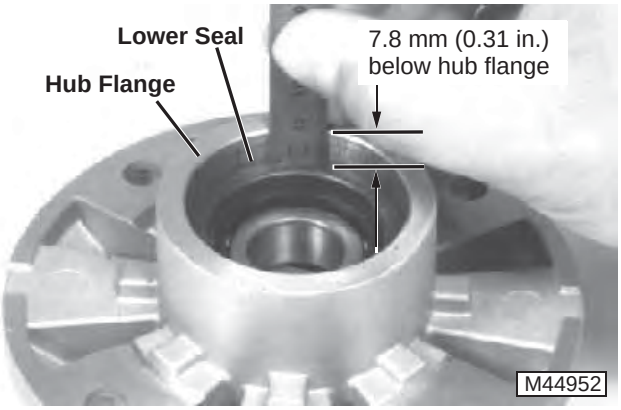
NOTE: Upper seal ring is installed with grease notch facing toward upper bearing.





1. Install upper bearing tight against spindle hub shoulder using a 1-13/16 in. disk and press.
2. Install upper seal with lip toward bearing, tight against bearing using a 1-13/16 in. disk and press.
3. Install upper seal ring, with grease notch toward bearing, inside seal lip.

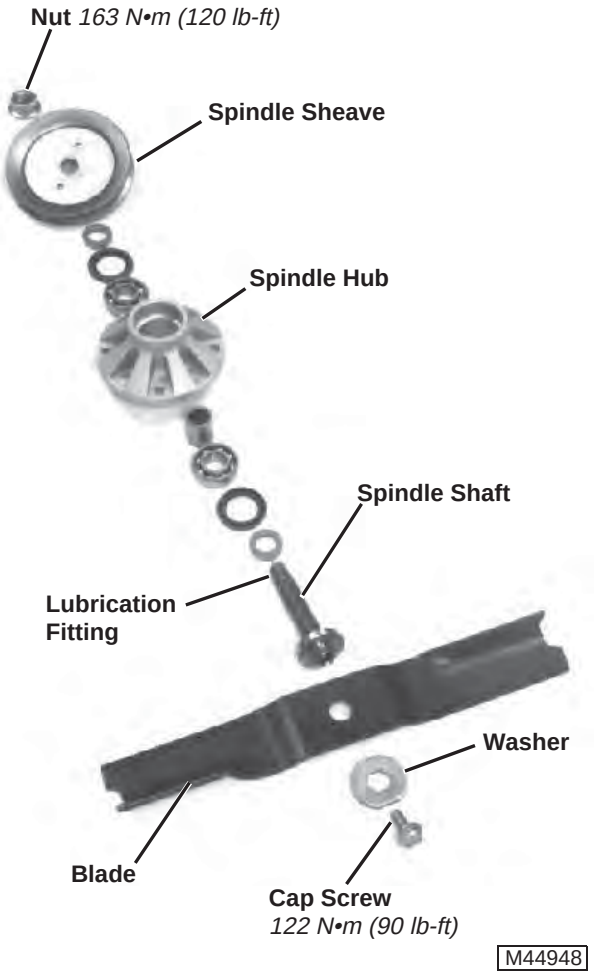




4.Install spacer.

IMPORTANT: Do not press lower bearing tight against spindle hub shoulder. The bearing and seal must be installed to a specific dimension for proper sealing of spindle.

5. Install lower bearing in hub using a 1-13/16 in. disk and press, just enough so the lower seal can be installed.
6. Install lower seal with lip toward bearing using a 1-13/16 in. disk and a press.
7. Install lower seal ring, with grease notch away from bearing, inside seal lip.



8.Install spindle shaft.

IMPORTANT: Do not install hexagon end of spindle shaft in a vise to install spindle sheave nut. The hexagon end of the spindle shaft will be damaged resulting in improper blade operation.

9. Install blade, washer, and cap screw on spindle shaft. On early model decks, make sure that hole in washer is aligned with hexagon portion of spindle. Tighten cap screw.

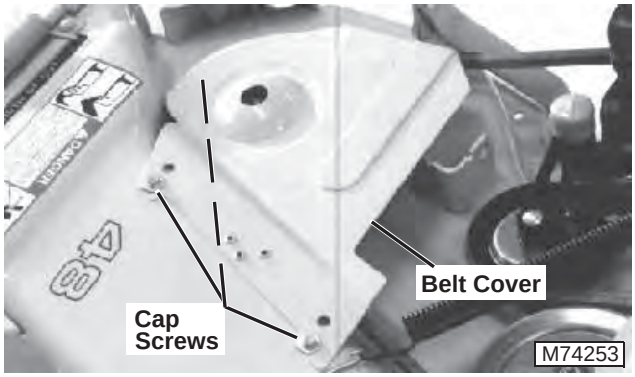
IMPORTANT: Make sure the hexagon shaped hole in spindle sheave is aligned with the hexagon portion of the spindle shaft.

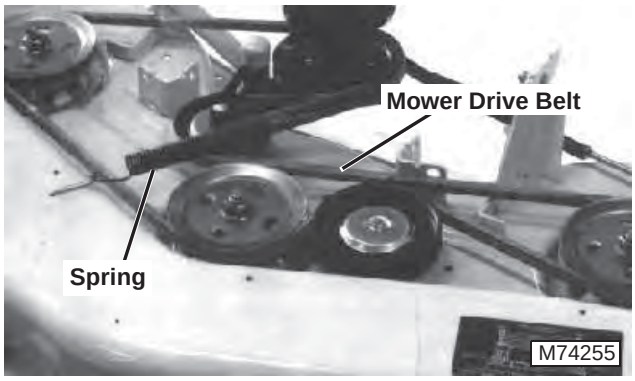
10. Hold the blade with a soft-jaw vise or if spindle is in the mower deck, with a block of wood. Install spindle sheave, nut, and lubrication fitting. Tighten nut to **163 N•m (120 lb-ft).**
11. Remove cap screw, washer and blade.
12. Lubricate spindle with multipurpose grease at lubrication fitting.

MOWER DRIVE BELT

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-30.)





2. Remove cap screws and belt cover.

NOTE: Right-hand side shown. Left-hand side similar.

3. Disconnect spring using a spring puller.
4. Replace mower drive belt.

Installation is done in the reverse order of removal.

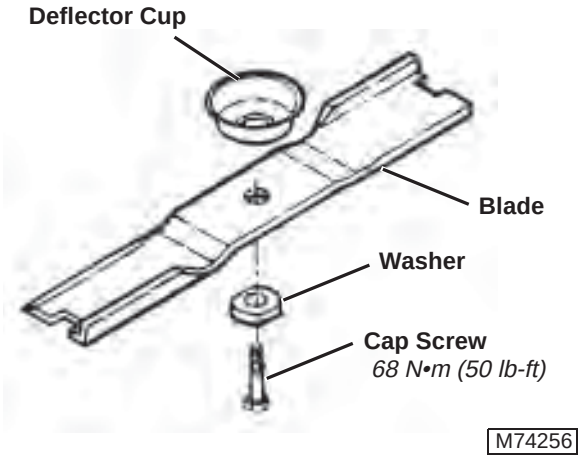
MOWER BLADES

Removal/Installation

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-30.)

⚠ CAUTION

Wear gloves or wrap blade with rag to prevent personal injury.



2. Remove cap screw, washer and blade.
3. Inspect blade for cracks, wear or damage. Replace blade if necessary.
4. Sharpen and balance as necessary.

Installation is done in the reverse order of removal.

IMPORTANT: Make sure deflector cup is in place between spindle and blade. On early model decks, make sure that hexagon shaped hole in washer is aligned with hexagon portion of the spindle.

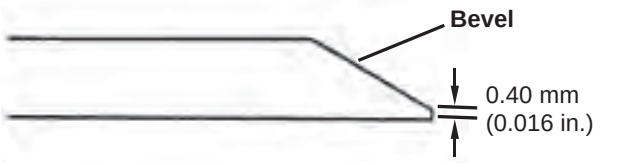
- Install blade with bent tips up.
- Tighten cap screw to **68 N•m (50 lb-ft).**

Sharpen

CAUTION

Wear goggles and gloves when sharpening blade.

1. Sharpen blade using grinder, file or power sharpener.



M61830

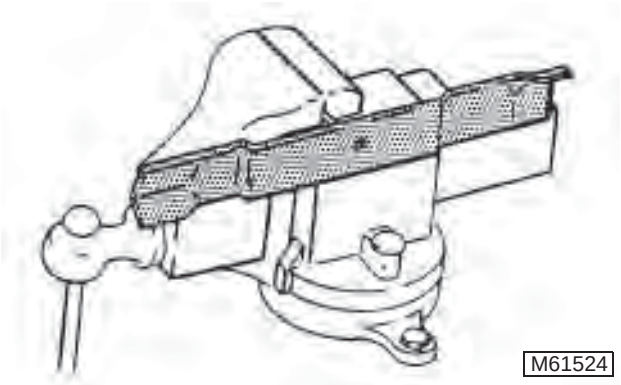
2. Do not alter original bevel. Blade should have **0.40 mm (0.016 in.)** cutting edge rather than a razor-type edge.
3. Balance blade.

Balance

CAUTION

Wear gloves when handling blade.

1. Clean blade.



M61524

2. Put blade on nail in vise or vertical wall stud.
3. Turn blade to HORIZONTAL position. If the blade is not balanced, the heavy end will drop.
4. Grind bevel of heavy end. Do not change blade bevel.

CONTENTS

Page

MISCELLANEOUS

SPECIFICATIONS
- REPAIR SPECIFICATIONS 11-2
- SERVICE PARTS KITS 11-2

COMPONENT LOCATION AND OPERATION
- LIFT ASSIST AND DEPTH STOP OPERATION 11-3

REPAIR
- FRONT AXLE 11-4
- SPINDLE SHAFTS
  - Removal/Inspection/Installation 11-4
  - Bushing Replacement 11-4
- WHEELS
  - Removal/installation 11-5
  - Front Wheel Bearings Inspection/Replacement 11-5
- ENGINE HOOD
  - Removal/installation 11-5
  - Hood Adjustment 11-6
- SEAT AND SUPPORT 11-6
- FENDER DECK 11-6
- MOWER DECK LIFT LINKAGE
  - Lift Lever and Linkage 11-6
  - Height Adjuster 11-7

M

SPECIFICATIONS

REPAIR SPECIFICATIONS

Pivot Anchor Cap Screw Torque	25 N•m (228 lb-in.)
Tie Rod Lock Nut Torque	23 N•m (200 lb-in.)
Drag Link Lock Nut Torque	37 N•m (27 lb-ft)

SERVICE PARTS KITS

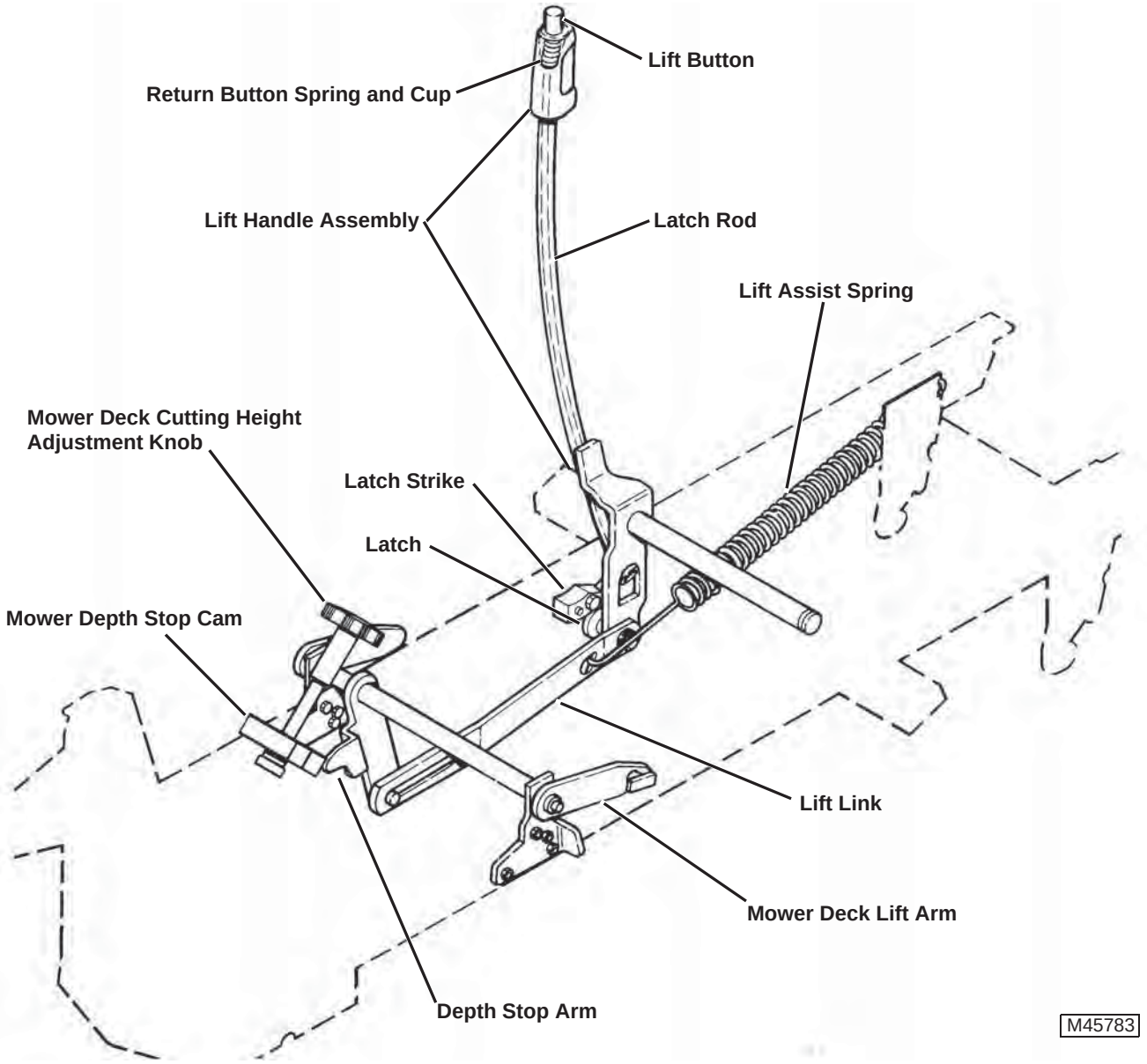
The following kits are available through your parts catalog:

- Lift Grip Kit
- Lift Latch Kit
- Height Control Kit

M

COMPONENT LOCATION AND OPERATION

LIFT ASSIST AND DEPTH STOP OPERATION



Function:

To counterbalance the weight of the attachment to reduce operator effort.

Theory of Operation:

As the lift lever is pulled rearward (to raise attachment), it pulls the lift link forward. The lift link is attached to the lift shaft. The lift shaft rotates forward raising the lift arms and attachment. Also attached to the lift link is the lift assist spring. Spring tension helps pull the link forward, reducing the effort required to lift the attachment. The lift handle locks in the fully raised position with a latch and strike.

When the lift handle is lowered, the lift arms lower the attachment until the depth stop arm on the lift shaft contacts the depth stop cam. The depth stop cam has different cam heights which are selected by using the cutting height knob. This allows the attachment to return to a specific height each time the attachment is lowered.

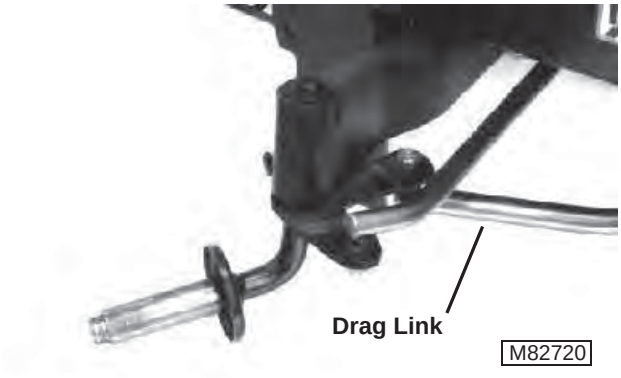
The lift assist spring can be locked out by pushing the lift handle fully forward. A slot in the lift link allows the lift shaft and arms that hold the attachment to move without any effect from the lift assist spring. This results in full implement weight on the ground.

REPAIR

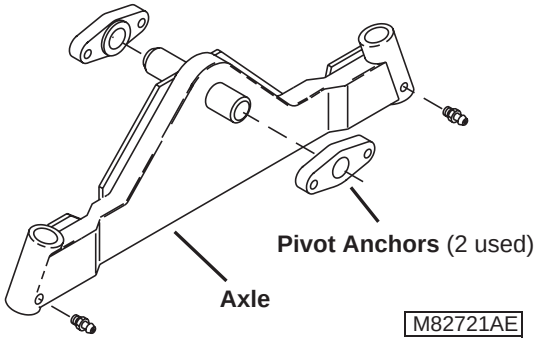
FRONT AXLE

Removal/Installation

1. Remove muffler. (See MUFFLER—Removal/Installation on page 3-43, 3-114 or 4-30.)
2. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
3. Remove PTO clutch. (See ELECTRIC PTO CLUTCH—Removal/Installation on page 5-195.)
4. Remove crankshaft drive sheave.
5. Remove front wheels. (See WHEELS—Removal/Installation on page11-5.)



6. Disconnect drag link.



7. Remove pivot anchor cap screws. Turn pivot anchors onto pivot shaft.
8. Remove axle.

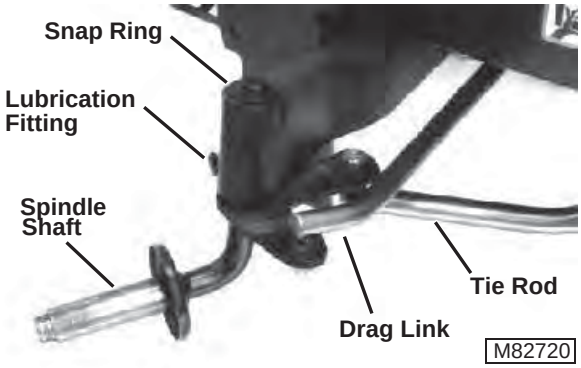
Installation is done in the reverse order of removal.

- Turn pivot anchors out until axle is secure and fore/aft movement is eliminated.
- Tighten pivot anchor cap screws to **25 N•m (228 lb-in.)**.
- Tighten drag link lock nuts to **37 N•m (27 lb-ft)**.

SPINDLE SHAFTS

Removal/Inspection/Installation

1. Raise and support machine.
2. Remove front wheel. (See WHEELS—Removal/Installation on page 11-5.)

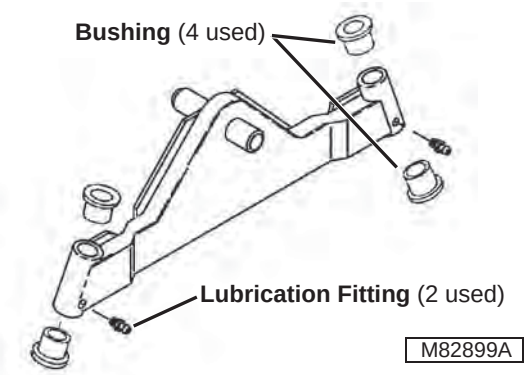


3. Left-hand spindle: disconnect drag link.
4. Disconnect tie rod.
5. Remove snap ring and spindle shaft.
6. Inspect spindle shaft and bearing for wear or damage. Replace parts if necessary.
7. Inspect bushings for wear or damage. Replace if necessary, see Bushing Replacement.

Installation is done in the reverse order of removal.

- Tighten tie rod lock nut to **23 N•m (200 lb-in.)**.
- Tighten drag link lock nut to **37 N•m (27 lb-ft)**.
- Apply multipurpose grease to lubrication fittings.

Bushing Replacement



- Inspect bushings for wear or damage.
- Bushings are press-fit. Replace using a bushing driver set.
- Apply multipurpose grease to lubrication fittings.

M

WHEELS

Removal/Installation

1. Lift machine high enough to remove weight from wheels. Place jackstands under machine frame.
2. Remove hub cap.



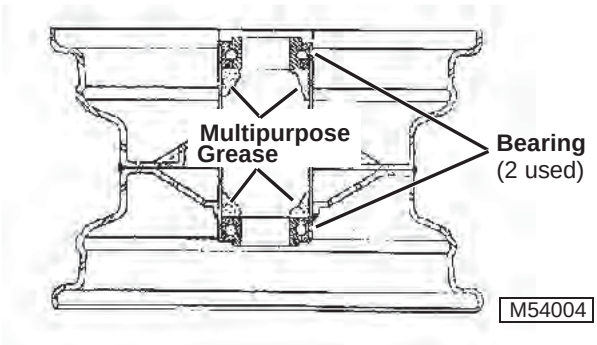
3. Remove snap ring, washer and wheel.
4. Inspect front wheel bearings. Replace if necessary. (See Front Wheel Bearings Inspection/ Replacement.)

Installation is done in the reverse order of removal.

- Install front wheels with valve stems facing toward machine.
- Install rear wheels with valve stems facing away from machine.

Front Wheel Bearings Inspection/ Replacement

NOTE: Remove bearings only if replacement is necessary.



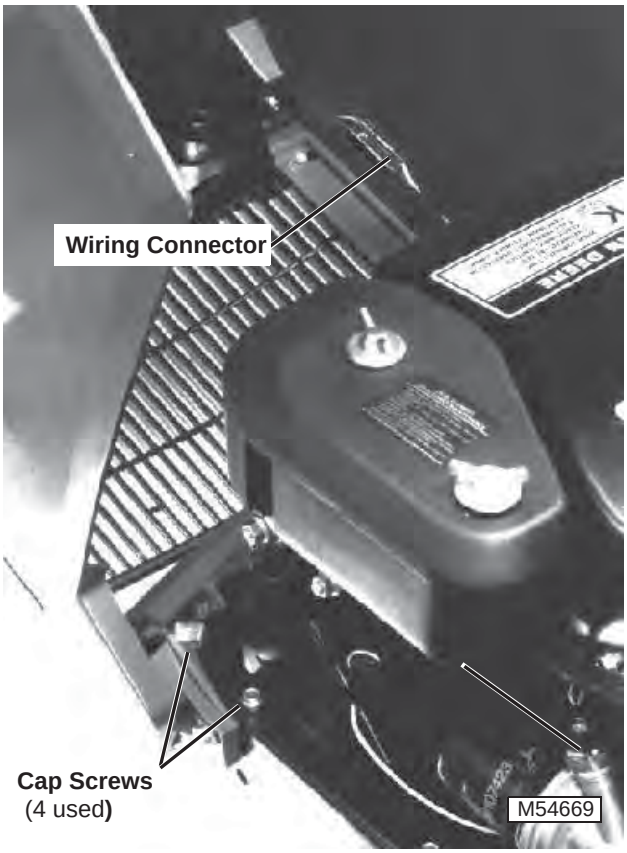
Inspect bearings for wear or damage. Replace if necessary.

- Remove one bearing using a slide hammer and inside puller.
- Remove bearing on opposite end using a bearing, bushing and seal driver set and a press.
- Install bearings flush to wheel hub.
- Pack areas with multipurpose grease.

ENGINE HOOD

Removal/Installation

1. Raise hood.



2. Disconnect wiring connector.
3. Remove cap screws on both sides of machine.
4. Remove engine hood.

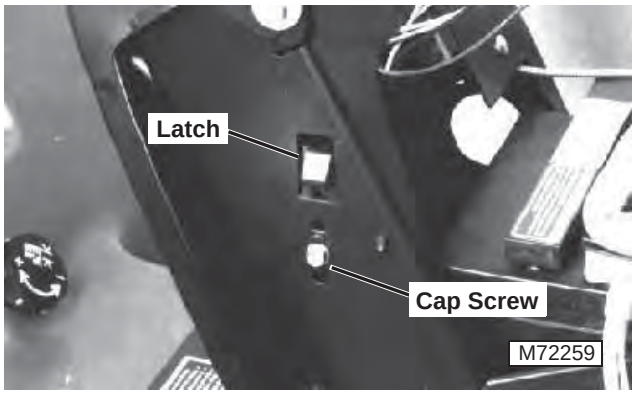
Installation is done in the reverse order of removal.

- Adjust hood if necessary. (See Hood Adjustment on page 11-6.)

M

Hood Adjustment

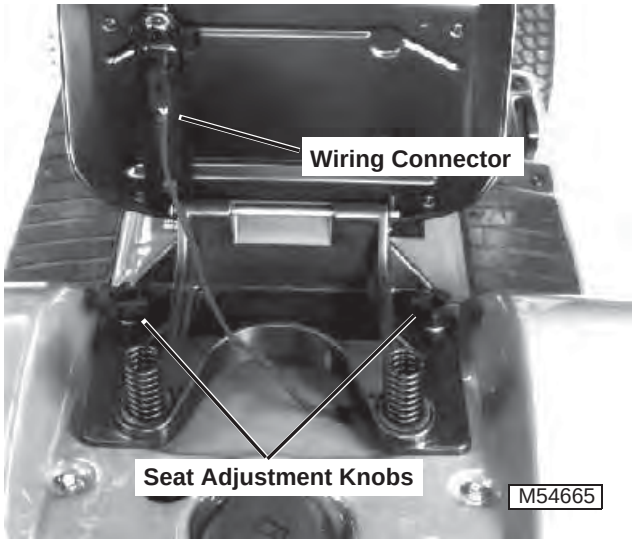
1. Loosen cap screw on both sides of machine.



2. Move latch for proper adjustment.
3. Tighten cap screw.

SEAT AND SUPPORT

Removal/Installation



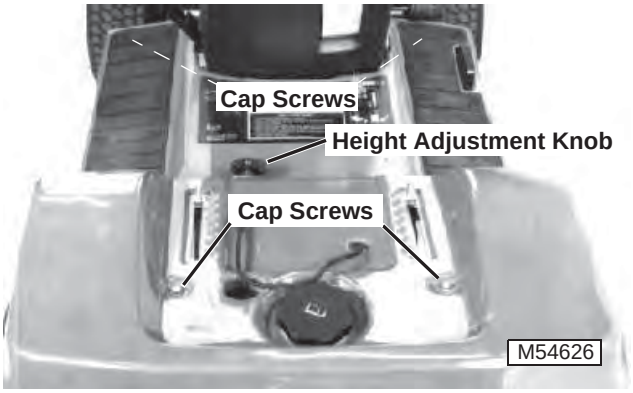
1. Lift seat and disconnect wiring connector.
2. Remove seat adjustment knobs.
3. Remove seat and support.

Installation is done in the reverse order of removal.

FENDER DECK

Removal/Installation

1. Remove seat and support. (See SEAT AND SUPPORT—Removal/Installation.)



2. Remove height adjustment knob.
3. Remove gear shift knob (LX172/LX173).
4. Remove cap screws.
5. Remove fender deck.

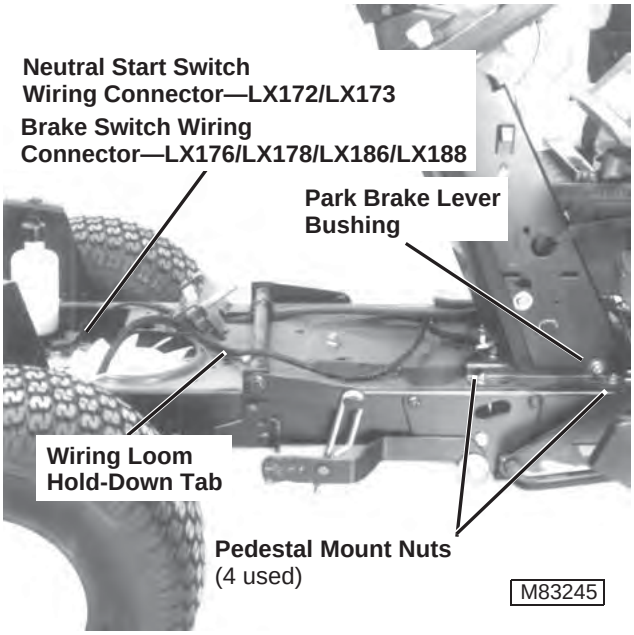
Installation is done in the reverse order of removal.

MOWER DECK LIFT LINKAGE

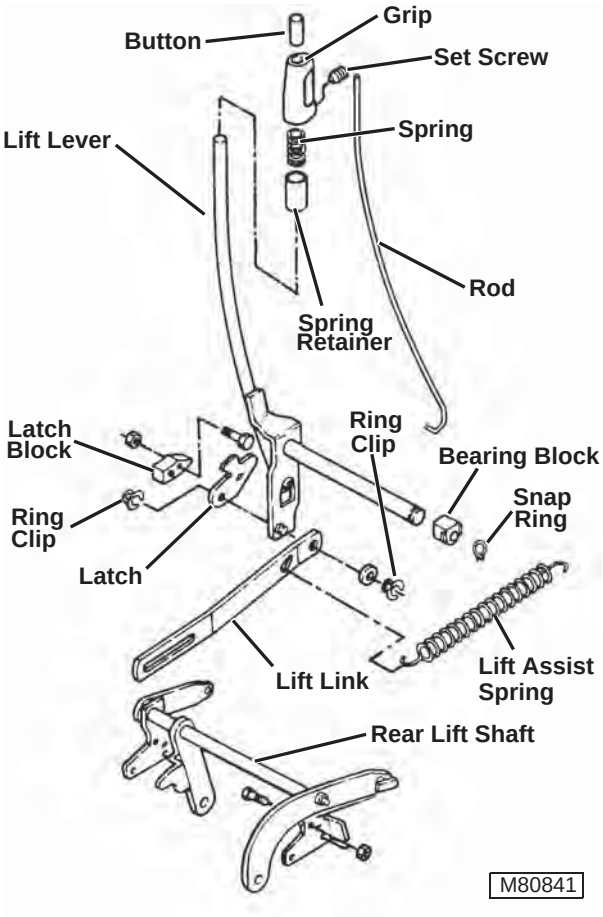
Lift Lever and Linkage

1. Remove mower deck. (See MOWER DECK—Removal/Installation on page 10-15, 10-21 or 10-30.)
2. Remove fuel tank. (See FUEL TANK—Removal/Installation on page 3-41, 3-112 or 4-28.)
3. Remove engine hood. (See ENGINE HOOD—Removal/Installation on page 11-5.)
4. Remove battery. (See BATTERY—Removal/Installation on page 5-194.)

M



5. Remove cotter pin from steering shaft at pinion gear.
6. Remove park brake lever bushing.
7. Remove four pedestal mounting nuts.
8. Disconnect wiring connector and loom hold-down tab.

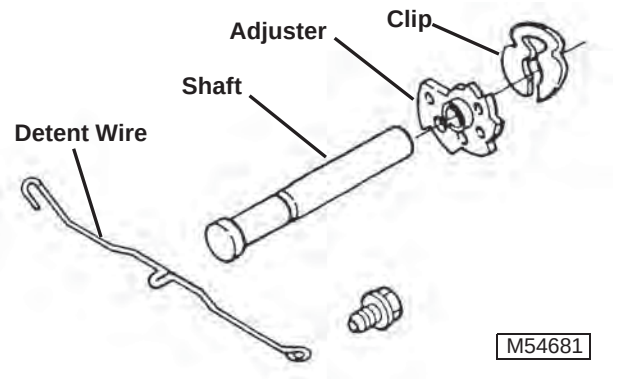


9. Remove lift assist spring from machine frame.
10. Inspect all parts for wear or damage. Replace parts as necessary.

Installation is done in the reverse order of removal.

Height Adjuster

- Remove fender deck. (See FENDER DECK—Removal/Installation on page 11-6.)



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

Installation is done in the reverse order of removal.

M

M

This page intentionally left blank.

A

Air Cleaner
- LX173 4-31
- LX172/LX176/LX186 3-43
- LX178/LX188 3-114

Alternative Lubricants 2-20
Anti-Corrosion Grease
- North America 2-19
- Europe 2-19

Armature-with-Coil—Kohler (CV15S)
- Air Gap Adjustment 4-58
- Removal/Installation 4-58

Automatic Compression Release (A.C.R.) Test
- LX172/LX176/LX186 3-35
- LX173 3-23

B

Balancer Shaft—Kohler (CV15S)
- Inspection 4-45
- Removal/Installation 4-45

Battery
- Charge 5-178
- Load Test 5-179
- Test 5-177

Belt Drive System Operation—LX172/LX173
- Clutch Pedal Depressed 6-4
- Clutch Pedal Released 6-5

Blower Housing—Kawasaki (FC420V/FC540V)
- Flywheel Screen Adjustment 3-48
- Inspection/Replacement 3-48

Blower Housing—Kohler (CV15S)
- Removal/Installation 4-35

Brake Adjustment
- LX172/LX173 9-21
- LX176/LX178/LX186/LX188 9-21

Brake Assembly, Repair
- LX172/LX173 9-23
- LX176/LX178/LX186/LX188 9-26

Brake Linkage—LX172/LX173 9-22
Brake Linkage—LX176/LX178/LX186/LX188
- External Operation 9-5
- Internal Operation 9-6

Brake Pedal and Linkage
- LX176/LX178/LX186/LX188 9-25

Brake Pedal Assembly—LX172/LX173 9-22
Brake System Operation—LX172/LX173 9-4
Brake System Troubleshooting Chart
- LX176/LX178/LX186/LX188 9-12
- LX172/LX173 9-7

Brakes—LX172/LX173
- Adjustment Specifications 9-3
- Diagnosis 9-8
- Repair Specifications 9-3

Brakes—LX176/LX178/LX186/LX188
- Diagnosis 9-13

Break-In Engine Oil
- 4-Cycle Gasoline—Europe 2-15
- 4-Cycle Gasoline—North America 2-14

Breather
- Kawasaki (FC420V/FC540V) 3-47
- Kawasaki (FD440V/FD501V) 3-141

Breather Components
- Kawasaki (FC420V) 3-16
- Kawasaki (FC540V) 3-16

Breather—Kohler (CV15S)
- Inspect 4-35

C

Camshaft and Tappets—Kawasaki (FC420V/FC540V)
- Inspection 3-62
- Installation 3-61
- Removal 3-61

Camshaft and Tappets—Kawasaki (FD440V/FD501V)
- Inspection 3-136
- Removal/Installation 3-135

Camshaft—Kohler (CV15S)
- Inspection 4-43
- Removal/Installation 4-43

CARB/EPA Engines—LX178/LX188
- Slow Idle Speed Adjustment 3-104

CARB/ERP Engines—LX172/LX176/LX188
- Slow Idle Speed Adjustment 3-32

Carburetor—Kawasaki (FC420V/FC540V)
- Clean/Inspect/Rebuild 3-47
- Disassembly/Assembly 3-44
- Removal/Installation 3-44

Carburetor—Kawasaki (FD440V/FD501V)
- Clean/Inspect/Rebuild 3-118
- Disassembly/Assembly 3-115
- Float Level Adjustment 3-118
- Removal/Installation 3-115

Carburetor—Kohler (CV15S)
- Clean/Inspect/Rebuild 4-32
- Removal/Installation 4-32

Charging Circuit Diagnosis
- LX172/LX176/LX186 5-62
- LX173 5-152
- LX178/LX188 5-104

Charging Circuit Operation
- LX172/LX176/LX186 5-60
- LX173 5-150
- LX178/LX188 5-102

Choke Adjustment—LX173 418
Choke Plate, Test and Adjustment
- LX172/LX176/LX186 3-29
- LX178/LX188 3-101

Clutch Pedal and Linkage—LX172/LX173 . . . 6-44
Common Circuit Test 5-176
Compression Pressure Test
- LX172/LX176/LX186 3-34
- LX178/LX188 3-105

Compression Release Components
- Kawasaki (FC420V) 3-16
- Kawasaki (FC540V) 3-16

Connector Body—Blade Terminal 195
Control Pedals and Linkage—
LX176/LX178/LX186/LX188
- Forward 7-59
- Reverse 7-60

Coolant
- Engine—Europe 2-22

Coolant Drain Interval
- Engine—Europe 2-22
- Engine—North America 2-21

Coolant Pump—Kawasaki (FD440V/FD501V)
Disassembly/Inspection/Assembly 3-122
Removal/Installation 3-122
Coolant Temperature Light Circuit—LX178/LX188
Diagnosis. 5-120
Operation. 5-118
Coolant Temperature Switch Test—
LX178/LX188 5-192
Cooling Air Duct—Kawasaki (FD440V/FD501V) 5-121
Cooling Fan—Kawasaki (FD440V/FD501V) . . 5-121
Cooling System Operation
Kawasaki (FC420V) 3-20
Kawasaki (FC540V) 3-20
Cooling System—LX178/LX188
Pressure Test 5-110
Operation 5-92
Crankcase Cover
Kawasaki (FC420V/FC540V) 3-54
Kawasaki (FD440V/FD501V) 3-129
Crankcase Oil Seal—Kohler (CV15S)
Replacement 4-54
Crankcase Vacuum Test
LX172/LX176/LX186 3-36
LX173 4-24
LX178/LX188 3-107
Cranking Circuit Diagnosis
LX172LX176LX186 5-48
LX173 5-140
LX178/LX188 5-94
Cranking Circuit Operation
LX172/LX176/LX186 5-46
LX173 5-138
LX178/LX188 5-92
Crankshaft and Connecting Rod, Analyze Wear
Kawasaki (FC420V/FC540V) 3-67
Kawasaki (FD440V/FD501V) 3-137
Kohler (CV15S) 4-52
Crankshaft and Main Bearing—Kohler (CV15S)
Removal/Installation 4-52
Crankshaft and Main Bearings—
Kawasaki (FC420V/FC540V)
End Play Adjustment 3-66
Inspection 3-65
Removal/Installation 3-65
Crankshaft and Main Bearings—
Kawasaki (FD440V/FD501V)
Inspection 3-137
Removal/Installation 3-136
Crankshaft and Main Bearings—Kohler (CV15S)
Inspection 4-52
Crankshaft End Play Test
LX172/LX176/LX186 3-65
Crankshaft Oil Seals—
Kawasaki (FC420V/FC540V)
Flywheel End 3-67
Crankshaft Oil Seals—
Kawasaki (FD440V/FD501V) 3-137
Cylinder Block—Kawasaki (FC420V/FC540V)
Deglaze 3-68
Inspection 3-68
Rebore 3-68
Cylinder Block—Kawasaki (FD440V/FD501V)
Deglaze 3-138
Inspection 3-138
Rebore 3-138
Cylinder Block—Kohler (CV15S)
Deglaze Cylinder Bore 4-55
Inspection 4-54
Rebore Cylinder 4-55
Cylinder Compression Test—LX173 4-21
Cylinder Head and Valves—
Kawasaki (FC420V/FC540V)
Disassembly/Assembly 3-50
Inspection 3-51
Removal/Installation 3-49
Valve Guide Replacement 3-52
Cylinder Head and Valves—
Kawasaki (FD440V/FD501V)
Disassembly/Assembly 3-125
Inspection/Replacement 3-125
Removal/Installation 3-124
Cylinder Leakdown Test—LX173 4-21

D

Draft Arms
38-Inch Deck 10-17
44-Inch Deck 10-23
48-Inch Deck 10-32
Drag Link Adjustment 8-7
Drive Belt Tensioner Assembly
LX176/LX178/LX186/LX188 7-62

E

Electrical
Reading Electrical Schematics 5-6
Repair Specifications 5-5
Test and Adjustment Specifications 5-4
Wire Color Abbreviation Chart 5-8
Electrical Components
LX172/LX173/LX176/LX186 5-9
LX178/LX188 5-10
Electrical Connectors
LX172/LX176/LX186 5-17
LX173 5-33
LX178/LX188 5-25
Electrical Schematic
LX172/LX176/LX186 5-11
LX173 5-13
LX178/LX188 5-12
Electrical System Troubleshooting Chart
LX172/LX173/LX176/LX186 5-37
LX178/LX188 5-38
Engine Coolant Drain Interval
Europe 2-22
North America 2-21
Engine Coolant
Europe 2-22
North America 2-21
Engine Hood
Adjustment 11-6
Removal/Installation 11-5

Engine Oil
Kawasaki—Europe 2-12
Kawasaki—North America 2-11
Kohler—Europe 2-13
Kohler—North America 2-13
Engine Oil Pressure Test
LX172/LX176/LX186 3-37
LX173 4-25
LX178/LX188 3-108
Engine Tests & Adjustments—LX173 4-18
Engine, Removal/Installation
LX172/LX176/LX186 3-42
LX178/LX188 3-112
LX173 4-29
Engine—Kawasaki (FC420V)
Automatic Compression Release Test . . . 3-35
Breather Components 3-16
Compression Release Components 3-16
Cooling System Operation 3-20
Crankcase Vacuum Test 3-36
Crankshaft End Play Test 3-65
Cylinder Compression Test 3-34
Designation 3-7
External Components 3-14
Fuel/Air System Components 3-17
Internal Components 3-15
Lubrication System Operation 3-18
Oil Pressure Test 3-37
Oil Pump Components 3-16
Removal/Installation 3-42
Repair Specifications 3-7
Serial Number Location 3-23
Spark Plug Gap Adjustment 3-39
Test and Adjustment Specifications 3-7
Troubleshooting Chart 3-22
Troubleshooting Guide 3-24
Valve Clearance Test and Adjustment . . . 3-35
Engine—Kawasaki (FC540V)
Automatic Compression Release Test . . . 3-35
Breather Components 3-16
Compression Release Components 3-16
Cooling System Operation 3-20
Crankcase Vacuum Test 3-36
Crankshaft End Play Test 3-65
Cylinder Compression Test 3-34
Designation 3-7
External Components 3-14
Fuel/Air System Components 3-17
Internal Components 3-15
Lubrication System Operation 3-18
Oil Pressure Test 3-37
Oil Pump Components 3-16
Removal/Installation 3-42
Repair Specifications 3-7
Serial Number Location 3-23
Spark Plug Gap Adjustment 3-39
Test and Adjustment Specifications 3-7
Troubleshooting Chart 3-22
Troubleshooting Guide 3-24
Valve Clearance Test and Adjustment . . . 3-35
Engine—Kawasaki (FD440V)
Cooling System Operation 3-92
Cooling System Pressure Test 3-110
Crankcase Vacuum Test 3-107
Cylinder Compression Pressure Test 3-105
Designation 3-79
Exterior Components 3-85
Internal Components 3-87
Lubrication System Operation 3-90
Oil Pressure Test 3-108
Radiator Cap Pressure Test 3-111
Removal/Installation 3-112
Repair Specifications 3-80
Serial Number Location 3-23
Spark Plug Gap Adjustment 3-110
Test and Adjustment Specifications 3-79
Troubleshooting Chart 3-94
Troubleshooting Guide 3-96
Valve Clearance Check and Adjustment . 3-106
Engine—Kawasaki (FD501V)
Cooling System Operation 3-92
Cooling System Pressure Test 3-110
Crankcase Vacuum Test 3-107
Cylinder Compression Pressure Test 3-105
Designation 3-79
External Components 3-85
Internal Components 3-87
Lubrication System Operation 3-90
Oil Pressure Test 3-108
Radiator Cap Pressure Test 3-111
Removal/Installation 3-112
Repair Specifications 3-80
Serial Number Location 3-23
Spark Plug Gap Adjustment 3-110
Test and Adjustment Specifications 3-79
Troubleshooting Chart 3-94
Troubleshooting Guide 3-96
Valve Clearance Check and Adjustment . 3-106
Engine—Kohler (CV15S)
Crankcase Vacuum Test 4-24
Cylinder Compression Test 4-21
Cylinder Leakdown Test 4-21
Designation 4-4
Engine Oil Pressure Test 4-25
Repair Specifications 4-5
Serial Number Location 4-23
Spark Plug Gap Adjustment 4-27
Test and Adjustment Specifications 4-4
Troubleshooting Chart 4-11
Troubleshooting Guide 4-13
Exploded View, Gear Transaxle 6-36
External Engine Components
Kawasaki (FD440V) 3-85
Kawasaki (FD501V) 3-85
Kawasaki (FC420V) 3-14
Kawasaki (FC540V) 3-14

F

Fender Deck 11-6
Flywheel
Kawasaki (FC420V/FC540V) 3-48
Kawasaki (FD440V/FD501V) 3-123
Flywheel Magnet Test 5-185

Flywheel—Kohler (CV15S)
Removal/Installation 4-36
Front Axle 11-4
Front Wheel
Bearing Inspection/Replacement 11-5
Fuel Pump Test
LX178/LX188 3-108
LX172/LX176/LX186 3-37
LX173 4-26
Fuel Pump—Kawasaki (FC420/FC540V)
Replacement 3-47
Fuel Pump—Kawasaki (FD440V/FD501V)
Inspection 3-119
Removal/Installation 3-119
Fuel Pump—Kohler (CV15S)
Replacement 4-34
Fuel Shutoff Solenoid Circuit Diagnosis
LX172/LX176/LX186 5-82
LX173 5-172
LX188 5-128
Fuel Shutoff Solenoid Circuit Operation
LX172/LX176/LX186 5-80
LX173 5-170
LX188 5-126
Fuel Shutoff Solenoid Test 5-192
Fuel System Components
LX178/LX188 3-89
Fuel Tank
LX172/LX1767/LX186 3-41
LX173 4-28
LX178/LX188 3-112
Fuel/Air System Components
Kawasaki (FC420V) 3-17
Kawasaki (FC540V) 3-17

G

Gasoline Specifications
4-Cycle Engines—Europe 2-10
4-Cycle Engines—North America 2-9
Gasoline Storage 2- 9
Gauge Wheels
38-Inch Deck 10-17
44-Inch Deck 10-23
48-Inch Deck 10-33
Gear Transaxle Serial Number Location 2-24
Gear Transaxle Operation—LX172/LX173
Forward 6-8
Neutral 6-6
Reverse 6-10
Gear Transmission Grease
Europe 2-17
North America 2-17
Gearshift Lever Neutral Adjustment—
LX172/LX173 6-32
Governor Shaft
Kawasaki (FC420V/FC540V) 3-72
Kawasaki (FD440V/FD501) 3-142
Governor Shaft Seal—
Kawasaki (FD440V/FD501V) 3-142
Governor—Kawasaki (FC420V/FC540V)
Inspection/Replacement 3-71
Governor—Kawasaki (FD440V/FD501V)
Adjustment 3-102
Inspection/Replacement 3-141
Governor—Kohler (CV15S)
Adjustment 4-19
Inspection 4-57
Removal/Installation 4-57
Governor—LX172/LX176/LX186
Adjustment 3-30
Grease
Europe 2-18
North America 2-18
Ground Circuit Test
Ohmmeter Method 5-176
Voltmeter Method 5-177

H

Head and Valves—Kohler (CV15S)
Disassembly/Assembly 4-38
Inspection 4-38
Removal/Installation 4-37
Headlight Circuit Diagnosis
LX172/LX176/LX186 5-78
LX173 5-168
LX178/LX188 5-124
Headlight Circuit Operation
LX172/LX176/LX186 5-76
LX173 5-166
LX178/LX188 5-122
Headlight Switch Test 5-190
Height Adjuster 10-7
Hydraulic Lifters—Kohler (CV15S)
Inspection 4-44
Removal/Installation 4-44
Hydraulic/Hydrostatic Schematic 7-6
Hydrostatic Transaxle LX176/LX178/LX186/LX188
Gear Power Flow 7-12
Serial Number Location 2-24
Assembly 7-52
Bleeding Procedure 7-43
Control Linkage Operation 7-13
Disassembly/Inspection 7-48
Hydrostatic System Operation 7-10
Identification 7-3
Neutral Creep Adjustment 7-43
Removal/Installation 7-47
Hydrostatic Transmission Oil
Europe 2-16
North America 2-16

I

Idle Speed Adjustment—LX172/LX176/LX186
Fast 3-31
Idle Speed Adjustment—LX173
Fast 4-19
Slow 4-20
Idle Speed Adjustment—LX178/LX188
Fast 3-103
Idlers and Sheaves
38-Inch Deck 10-18
44-Inch Deck 10-24
48-Inch Deck 10-34

Ignition Circuit Diagnosis
LX172/LX176/LX186 5-56
LX173 5-146
LX178/LX188 5-98
Ignition Circuit Operation
LX173 5-142
LX178/LX188 5-96
Ignition Circuit Operation—Early Model
LX172/LX176/LX186 5-50
Ignition Circuit Operation—Engine Shutting OFF
LX172/LX176/LX186 5-54
Ignition Circuit Operation—Late Model
LX172/LX176/LX186 5-52
Ignition Coil Test
LX172/LX176/LX186 5-185
LX178/LX188 5-186
Ignition Coils—Kawasaki (FD440V/FD501V) . 3-143
Ignition Module
Kawasaki (FC420V/FC540V) 3-73
Kawasaki (FD440V/FD501V) 3-143
Ignition Module Test
LX172/LX176/LX178/LX186/LX188 5-185
Inch Fastener Torque Values 2-8
Inspect Push Rod—Kohler (CV15S) 4-37
Intake Manifold—Kawasaki (FD440V/FD501V)
Inspection 3-119
Removal/Installation 3-118
Integrated Ignition Coil Resistance Test 3-40
Internal Engine Components
Kawasaki (FC420V) 3-15
Kawasaki (FC540V) 3-15
Kawasaki (FD440V). 3-87
Kawasaki (FD501V) 3-87

J

JIC Hydraulic Circuit Symbols 7-4

L

Lift Assist and Depth Stop
Component Location and Operation 11-3
Low Oil Pressure Light Circuit Diagnosis
LX172/LX176/LX186 5-74
LX173 5-164
LX178/LX188 5-116
Low Oil Pressure Light Circuit Operation
LX172/LX176/LX186 5-72
LX173 5-162
LX178/LX188 5-114
Lubricants
Alternative 2-20
Mixing 2-20
Storage 2-20
Synthetic 2-20
Lubrication System Operation
Kawasaki (FC420V) 3-18
Kawasaki (FC540V) 3-18
Kawasaki (FD440V/FD501V) 3-90

M

Machine Identification Number Location 2-23
Magneto Ignition Coil Resistance Test 3-39
Magneto Ignition Coil With Ignitor Module—
Kawasaki (FC420V/FC540V)
Removal/Installation 3-73
Magneto Ignition Coil—Kawasaki (FC420V/FC540V)
Air Gap Adjustment 3-73
Removal/Installation 3-72
Resistance Test 3-39
Resistance Test (with ingnition module) . . 3-40
Metric Fastener Torque Values 2-7
Mixing of Lubricants 2-20
Mower Blades—38-Inch Deck
Balance 10-20
Removal/Installation 10-20
Sharpen 10-20
Mower Blades—44-Inch Deck
Balance 10-29
Removal/Installation 10-29
Sharpen 10-29
Mower Blades—48-Inch Deck
Balance 10-40
Removal/Installation 10-39
Sharpen 10-40
Mower Deck
Troubleshooting Chart 10-8
Mower Deck Adjustments
Mower Level Front-to-Rear 10-14
Mower Level Side-to-Side 10-13
Mower Deck Lift Linkage 11-6
Mower Deck—38-Inch
Adjustment Specifications 10-3
Component Location 5 10-
Diagnosis 10-9
Overall View 10-16
Removal/Installation 10-15
Repair Specifications 10-3
Mower Deck—44-Inch Rear Discharge
Adjustment Specifications 10-3
Component Location 10-6
Diagnosis 10-9
Overall View 10-22
Removal/Installation 10-21
Repair Specifications 10-3
Mower Deck—48-Inch
Adjustment Specifications 10-3
Component Location 10-7
Diagnosis 10-9
Overall View 10-31
Removal/Installation 10-30
Repair Specifications 10-3
Mower Drive Belt
38-Inch Deck 10-19
44-Inch Deck 10-28
48-Inch Deck 10-39
Muffler, Removal/Installation
LX172/LX176/LX186 3-43
LX173 4-30
LX178/LX188 3-114

N

Neutral Start/Brake Switch Test 5-187
Non CARB/EPA Engines—LX172/LX176/LX186
Slow Idle Speed Adjustment 3-32
Non CARB/EPA Engines—LX178/LX188
Slow Idle Speed Adjustment 3-103

O

Oil Filter Manifold—Kawasaki (FC420V/FC540V) 3-71
Oil Filters 2-20
Oil Pan—Kohler (CV15S)
Install 4-42
Remove 4-41
Seal Replacement 4-42
Oil Pickup—Kohler (CV15S)
Inspection 4-56
Oil Pressure Switch Test 5-191
Oil Pump Components
Kawasaki (FC420V) 3-16
Kawasaki (FC540V) 3-16
Oil Pump—Kawasaki (FC420V/FC540V)
Disassembly/Assembly 3-69
Inspection 3-70
Oil Pump—Kawasaki (FD440V/FD501V)
Disassembly/Assembly 3-139
Inspection 3-140
Oil Pump—Kohler (CV15S)
Relief Valve Inspection 4-56
Removal/Inspection/Installation 4-56
Overflow Reservoir—
Kawasaki (FD440V/FD501V) 3-123

P

Park Brake Lever and Linkage
LX172/LX173 9-24
LX176/LX178/LX186/LX188 9-26
Pedal Control System Operation
LX176/LX178/LX186/LX188 7-8
Pedal Height Adjustment—
LX176/LX178/LX186/LX188 7-44
Piston and Connecting Rod—
Kawasaki (FC420V/FC540V)
Assembly 3-56
Disassembly 3-55
Inspection 3-56
Installation 3-55
Removal 3-55
Piston and Connecting Rod—
Kawasaki (FD440V/FD501)
Installation 3-129
Assembly 3-131
Disassembly 3-130
Inspection 3-131
Removal 3-129
Piston and Connecting Rod—Kohler (CV15S)
Assembly 4-49
Disassembly 4-47
Installation 4-46
Removal 4-46
Inspection 4-47
Piston Ring, Analyze Wear
Kawasaki (FC420V/FC540V) 3-58
Kawasaki (FD440V/FD501V) 3-133
Kohler (CV15S) 4-50
Piston, Analyze Wear
Kawasaki (FC420V/FC540V) 3-60
Kawasaki (FD440V/FD501V) 3-134
Kohler (CV15S) 4-51
Power Circuit Diagnosis
LX172/LX176/LX186 5-42
LX173 5-134
LX178/LX188 5-88
Power Circuit Operation
LX172/LX176/LX186 5-40
LX173 5-132
LX178/LX188 5-86
Power Train—LX172/LX173
Adjustment Specifications 6-3
Diagnosis 6-14
Repair Specifications 6-3
Troubleshooting Chart 6-13
Power Train—LX176/LX178/LX186/LX188
Adjustment Specifications 7-2
Diagnosis 7-16
Repair Specifications 7-2
Troubleshooting Chart 7-14
PTO Circuit Diagnosis
LX172/LX176/LX186 5-68
LX173 5-158
LX178/LX188 5-110
PTO Circuit Operation—PTO OFF
LX172/LX176/LX186 5-64
LX173 5-154
LX178/LX188 5-106
PTO Circuit Operation—PTO ON
LX172/LX176/LX186 5-66
LX173 5-156
LX178/LX188 5-108
PTO Clutch
Adjustment 5-193
Removal/Installation 5-195
Test 5-189
PTO Switch Test 5-188
Pulser Coil Test—LX178/LX188 5-186
Pulser Coils—Kawasaki (FD440V/FD501V)
Replacement 3-142

R

Radiator Cap Pressure Test
LX178/LX188 3-111
Radiator—Kawasaki (FD440V/FD501V)
Inspection 3-120
Removal/Installation 3-119
Reciprocating Balancer—Kawasaki (FC420V/FC540V)
Bearing Replacement 3-64
Disassembly/Assembly 3-63
Inspection 3-64
Removal/Installation 3-63
Regulated Amperage Output Test 5-179
Regulated Voltage Output Test 5-180
Rocker Arm Assembly—Kawasaki (FC420V/FC540V)
Inspection 3-49
Removal/Installation 3-49
Rocker Arm Assembly—Kawasaki (FD440V/FD501V)
Inspection 3-124
Removal/Installation 3-124
Rocker Arm Cover—Kohler (CV15S)
Removal/Installation 4-36
Rocker Arms—Kohler (CV15S)
Removal/Installation 4-37

S

Seat and Support 11-6
Seat Switch Test 5-190
Shift Lever and Linkage—LX172/LX173 6-42
Spark Plug Cap Test—LX178/LX188 5-187
Spark Plug Gap Adjustment
LX/172/LX176/LX186 3-39
LX/173 4-27
LX178/LX188 3-110
Spark Test
LX172/LX176/LX186 3-38
LX178/LX188 3-109
Spindle Shafts
Bushing Replacement 11-4
Removal/Inspection/Installation 11-4
Spindles—38-Inch Deck
Disassembly/Assembly 10-19
Removal/Installation 10-19
Spindles—44-Inch Deck
Assembly 10-27
Cross Section 10-26
Disassembly/Inspection 10-25
Removal/Installation 10-25
Spindles—48-Inch Deck
Assembly 10-37
Cross Section 10-37
Disassembly/Inspection 10-36
Removal/Installation 10-36
Starter Loaded Amperage Draw Test
LX172/LX173/LX176/LX186 5-183
LX178/LX188 5-184
Starter Motor—Kawasaki (FC420V)
Troubleshooting Guide 3-28
Starter Motor—Kawasaki (FC540V)
Troubleshooting Guide 3-28
Starter Motor—Kohler (CV15S)
Troubleshooting Guide 4-17
Starter Solenoid Test 5-183
Starter—Kawasaki (FC420V/FC540V)
Analyze Condition 3-74
Disassembly/Assembly 3-75
Exploded View 3-75
Inspection/Tests 3-76
No-Load Amperage Draw
and RPM Bench Tests 5-144
Removal/Installation 3-74
Starter—Kawasaki (FD440V/FD501V)
Analyze Condition 3-143
Disassembly/Assembly 3-145
Inspection/Test 3-146
No-Load Amperage and RPM Bench Test 3-144
Removal/Installation 3-143
Troubleshooting Guide 3-100
Starter—Kohler (CV15S)
Analyze Condition 4-59
Inspection/Test 4-61
Removal/Installation 4-59
Replace Bendix Drive 4-60
Replace Brushes 4-60
Stator Coil Resistance Test—
FD440V/FD501V 5-182
Stator, Removal/Installation
Kawasaki (FC420V/FC540V) 72
Kawasaki (FD440V/FD501V) 142
Stator—Kohler (CV15S)
Removal/Installation 4-59
Steering Sector Assembly 8-10
Steering Shaft
Removal/Inspection/Installation 8-8
Steering System
Adjustment 8-7
Component Location and Operation 8-3
Diagnosis 8-5
Repair Specifications 8-2
Troubleshooting Chart 8-4
Steering Wheel, Removal/Installation 8-8
Synthetic Lubricants 2-20

T

Thermostat—Kawasaki (FD440V/FD501V)
Opening Test 3-122
Removal/Installation 3-121
Throttle Cable Adjustment—LX173 4-18
Throttle Cable—LX172/LX176/LX186
Removal/Installation 3-41
Test and Adjustment 3-29
Throttle Cable—LX173
Removal/Installation 4-28
Throttle Cable—LX178/LX188
Removal/Installation 3-112
Test and Adjustment 3-101
Torque Values
Inch Fastener 2-8
Metric Fastener 2-7
Traction Drive Belt
LX172/LX173 6-45
LX176/LX178/LX186/LX188 7-61
Traction Drive Belt System Operation
LX176/LX178/LX186/LX188 7-7
Traction Drive Belt Tension Adjustment
LX172/LX173 6-32
LX176/LX178/LX186/LX188 7-45
Traction Drive Clutch Assembly—
LX172/LX173 6-43
Transaxle—LX172/LX173
Assembly 6-37
Disassembly/Inspection 6-34
Exploded View 6-36
Removal/Installation 6-34
Troubleshooting Chart (Engine)
Kawasaki (FC420V) 3-22
Kawasaki (FC540V) 3-22
Kawasaki (FD440V) 3-94
Kawasaki (FD501V) 3-94
Kohler (CV15S) 4-11
Troubleshooting Guide (Engine)
Kawasaki (FC420V) 3-24
Kawasaki (FC540V) 3-24
Kawasaki (FD440V) 3-96
Kawasaki (FD501V) 3-96
Kohler (CV15S) 4-13

U

Unregulated Voltage Output Test
LX172/LX176/LX186/LX178/LX188 5-181
LX173 5-182

V

Valve Clearance, Check and Adjustment
LX178/LX188 3-106
Valve Seats, Recondition
Kawasaki (FC420V/FC540V) 3-54
Kawasaki (FD440V/FD501V) 3-128
Valves, Analyze
Kawasaki (FC420V/FC540V) 3-53
Kawasaki (FD440V/FD501V) 3-127
Kohler (CV15S) 4-40
Valves, Lap
Kawasaki (FC420V/FC540V) 3-54
Kawasaki (FD440V/FD501V) 3-128
Kohler (CV15S) 4-41
Valve Seats, Recondition Kohler (CV15S) . . . 4-41
Voltage Regulator/Rectifier—LX173 4-61

W

Wheels 5
Wiring Harness—Engine
LX173 5-32
LX178/LX188 5-24
Wiring Harnesses—Engine
LX172/LX176/LX186 5-15
Wiring Harness—Main
LX172/LX176/LX186 5-14
LX173 5-31
LX178/LX188 5-23