GS25, GS30, GS45, GS75 HD45, HD75, Commercial Walk–Behind Mowers

TECHNICAL MANUAL

John Deere
Worldwide Commercial and
Consumer Equipment Division

TM1598 (01Nov97)
Replaces TM1598 (01Mar97)
And TM1598 (01Jul96)

Litho in U.S.A

GS75 Gear
54 in. Commercial
Walk-Behind Mower

GS45 Gear
48 in Commercial
Walk-Behind Mower

GS30 Gear
36 in. Commmercial
Walk-Behind Mower

GS25 Gear
36 in. Commmercial
Walk-Behind Mower

HD45 Hydrostatic
36 in. Commmercial
Walk-Behind Mower

HD75 Hydrostatic
54 in. Commmercial
Walk-Behind Mower

CSM5335

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

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

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

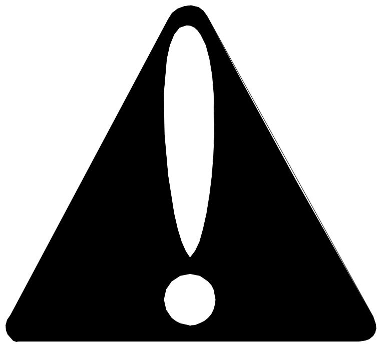
Note: Depending on the particular section or system being covered, not all of the above groups may be used.

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

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

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.

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.

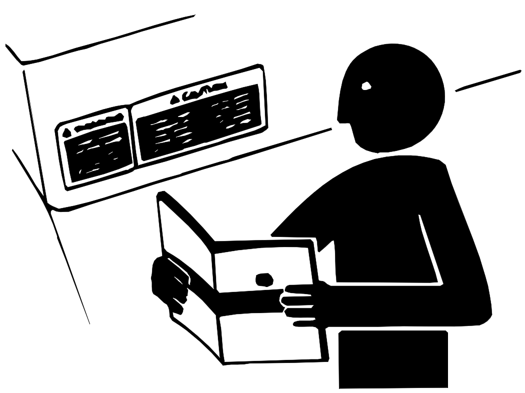
Follow recommended precautions and safe servicing practices.

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.

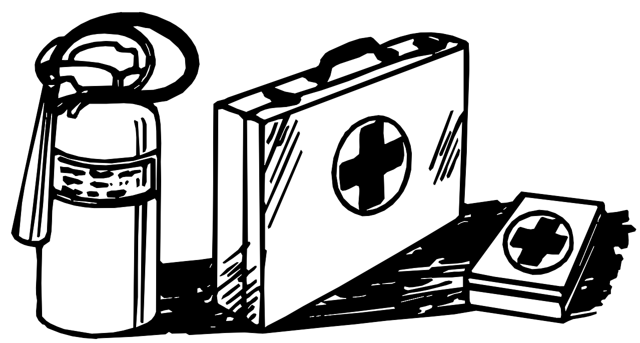
REPLACE SAFETY SIGNS



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.

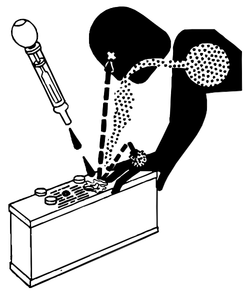
Do not store oily rags; they can ignite and burn spontaneously.

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.
1. Wearing eye protection and rubber gloves.
1. Avoiding breathing fumes when electrolyte is added.
1. Avoiding spilling or dripping electrolyte.
1. Use proper jump start procedure.

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

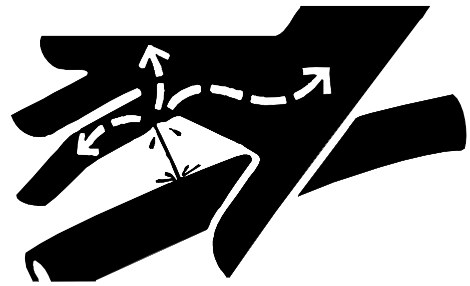
1. Flush your skin with water.
1. Apply baking soda or lime to help neutralize the acid.
1. Flush your eyes with water for 10_15 minutes.
1. Get medical attention immediately.

- **If acid is swallowed:**

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

USE CARE AROUND HIGH-PRESSURE FLUID LINES

Avoid High-pressure Fluids



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

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

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

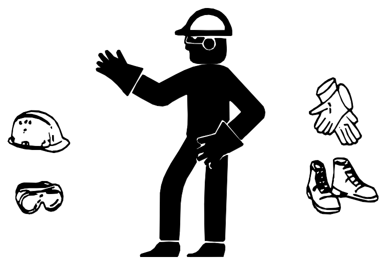
If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result. Doctors unfamiliar with this type of injury should reference a knowledgeable medical source. Such information is available from Deere & Company Medical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

Avoid Heating Near Pressurized Fluid Lines

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

USE SAFE SERVICE PROCEDURES

Wear Protective Clothing

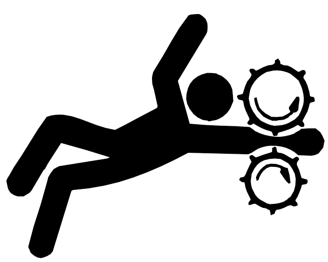


Wear close fitting clothing and safety equipment appropriate to the job.

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

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

Service Machines Safely



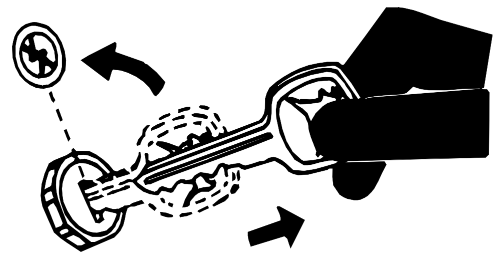
Tie long hair behind your head. Do not wear a necktie, scarf, loose clothing, or necklace when you work near machine tools or moving parts. If these items were to get caught, severe injury could result.

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

Use Proper Tools

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

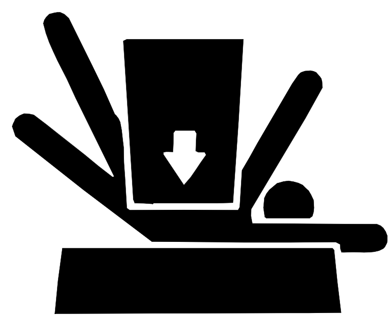
Park Machine Safely



Before working on the machine:

1. Lower all equipment to the ground.
1. Stop the engine and remove the key.
1. Disconnect the battery ground strap.
1. 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.
1. Make sure you have all necessary tools to do your job.
1. Have the right parts on hand.
1. Read all instructions thoroughly; do not attempt shortcuts.

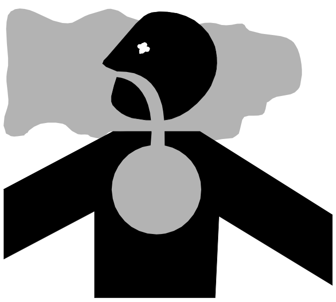
Using High Pressure Washers

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

Illuminate Work Area Safely

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

Work In Ventilated Area



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

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

WARNING: California Proposition 65 Warning

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

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

Remove Paint Before Welding Or Heating

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

Avoid Harmful Asbestos Dust

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

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

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

SERVICE TIRES SAFELY

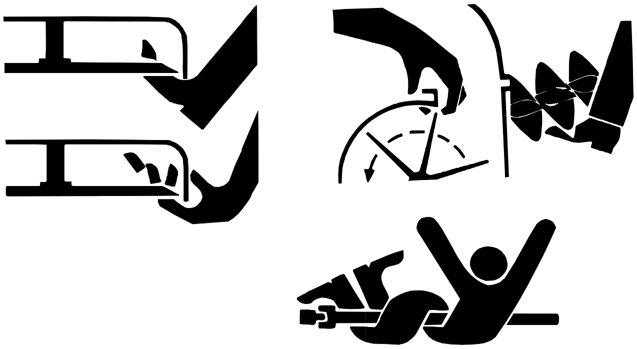
Explosive separation of a tire and rim parts can cause serious injury or death.

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

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

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

AVOID INJURY FROM ROTATING BLADES, AUGERS AND PTO SHAFTS



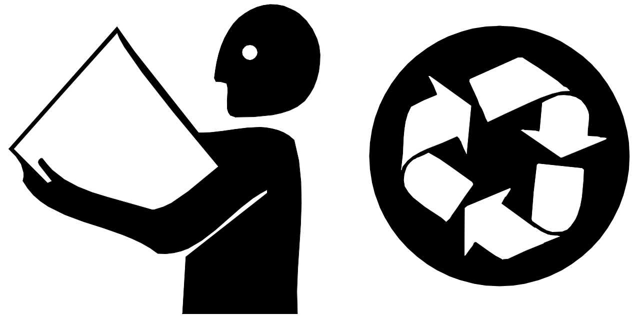
Keep hands and feet away while machine is running. Shut off power to service, lubricate or remove mower blades, augers or PTO shafts.

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.

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SPECIFICATIONS & INFORMATION

SPECIFICATIONS

ENGINE

	GS25	GS30	GS45, HD45	GS75, HD75
Horsepower	9.3 Kw (12.5 hp)	9.7 Kw (13 hp)	10.5 Kw (14 hp)	12.7 Kw (17 hp)
Model number	FC401V-BS05	CV13S	FC420V-AS19	FC540V-AS17
Manufacturer	Kawasaki	Kohler	Kawasaki	Kawasaki
Displacement	423 cc (25.8 cu. in.)	398 cc (24.3 cu. in.)	423 cc (25.8 cu. in.)	535 cc (32.6 cu. in.)
No. of cylinders	One	One	One	One
Fast idle speed	3350 ± 100 rpm	3350 ± 100 rpm	3350 ± 100 rpm	3350 ± 100 rpm
Slow idle speed	1450 ± 75 rpm	1550 ± 75 rpm	1450 ± 75 rpm	1450 ± 75 rpm
Ignition	Solid state electronic	Solid state electronic	Solid state electronic	Solid state electronic
Crankcase capacity without oil filter	1.3 L (2.8 U.S. pt.)	1.9 L (4 U.S. pt.)	1.3 L (2.8 U.S. pt.)	1.6 L (3.4 U.S. pt.)
Crankcase capacity with oil filter	1.5 L (3.17 U.S. pt.)		1.6 L (3.4 U.S. pt.)	1.9 L (4.0 U.S pt.)
Oil filter	Standard	Standard	Standard	Standard
Type of fuel	Regular grade leaded or lead-free	Regular grade leaded or lead-free	Regular grade leaded or lead-free	Regular grade leaded or lead-free
Air cleaner	Dual stage	Dual stage	Dual stage	Dual stage
Governor	Mechanical	Mechanical	Mechanical	Mechanical
Fuel tank capacity	19 L (5.0 U.S. gal.)	19 L (5.0 U.S. gal.)	19 L (5.0 U.S. gal.)	19 L (5.0 U.S. gal.)

POWER TRAIN—GEAR

	GS25	GS30	GS45	GS75
Transmission	Dana, 5-speed with reverse	Dana, 5-speed with reverse	Dana, 5-speed with reverse	Dana, 5-speed with reverse
Shift mechanism	Enclosed gear with keys	Enclosed gear with keys	Enclosed gear with keys	Enclosed gear with keys
Brakes	Band	Band	Band	Band
Axle	Solid axle, 25 mm (1 in.) diameter, with grease lubricated roller bearings in wheels			
Drive wheels	330 x 165 mm (13 x 6.5 in.)	330 x 165 mm (13 x 6.5 in.)	330 x 165 mm (13 x 6.5 in.)	330 x 165 mm (13 x 6.5 in.)
Ground speeds:				
Forward speeds	5	5	5	5
Reverse Speeds	1	1	1	1
Forward Speed range	2.9 to 9.6 km/h (1.8 to 5.9 mph)	2.9 to 9.6 km/h (1.8 to 5.9 mph)	2.9 to 9.6 km/h (1.8 to 5.9 mph)	2.9 to 9.6 km/h (1.8 to 5.9 mph)
Reverse Speed Range	1.2 km/h (0.75 mph)	1.2 km/h (0.75 mph)	1.2 km/h (0.75 mph)	1.2 km/h (0.75 mph)

POWER TRAIN—HYDROSTATIC

	HD45	HD75
Transmission	Eaton 778	Eaton 778
	Unitized, Infinitely variable, dual hydrostatic transaxles with reverse, and brakes.	
Shift mechanism	Hydrostatic lever for forward, individual turn levers for right, left, and reverse.	
Brakes	Internal wet disk	Internal wet disk
Axle	Individual left and right side axles with wheel flanges, roller bearings mounted inside transaxle and splash lubricated.	
Drive wheels	406 x 165 mm (16 x 6.5 in.)	406 x 165 mm (16 x 6.5 in.)
Forward Speed range	0 to 8.1 km/h (0 to 6 mph)	0 to 8.1 km/h (0 to 6 mph)
Reverse Speed Range	0 to 1.6 km/h (0 to 1 mph)	0 to 1.6 km/h (0 to 1 mph)

MOWER DECKS

	914 mm (36 in.)	914 mm (36 in.)	1219 mm (48 in.)	1372 mm (54 in.)
Deck material	10-gauge steel, fabricated	10-gauge steel, fabricated	11-gauge steel, one-piece stamped	11-gauge steel, one-piece stamped
Blades	Two, 472 mm (18.6 in.)	Two, 472 mm (18.6 in.)	Three, 422 mm (16.6 in.)	Three, 472 mm (18.6 in.)
Blade drive	V-belt and timed cogged belt	V-belt and timed cogged belt	V-belt with self-adjusting idler	V-belt with self-adjusting idler
Cutting heights	19 to 114 mm (3/4 to 4-1/2in.)	19 to 114 mm (3/4 to 4-1/2in.)	25 to 127 mm (1 to 5 in.)	25 to 127 mm (1 to 5 in.)
Weight (Mower deck only)	83.9 Kg (185 lb)	83.9 Kg (185 lb)	83.5 Kg (184 lb)	87.4 Kg (193 lb)

GENERAL

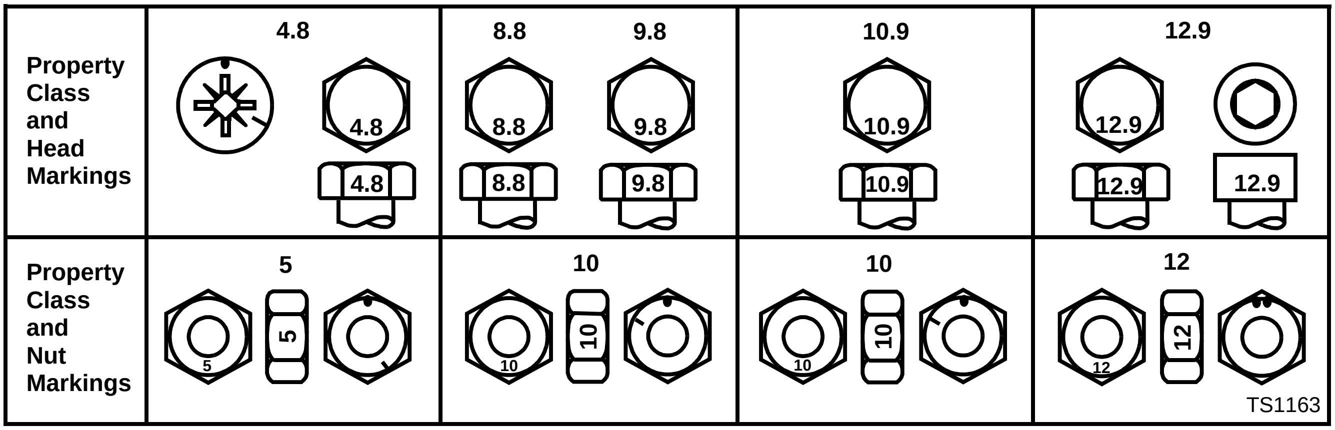
Caster wheels	228 x 89 mm (9 x 3.5 in.)	228 x 89 mm (9 x 3.5 in.)	228 x 89 mm (9 x 3.5 in.)	228 x 89 mm (9 x 3.5 in.)

DIMENSIONS

	GS25	GS30	GS45	GS75
Overall height	1041 mm (41 in.)	1041 mm (41 in.)	1041 mm (41 in.)	1041 mm (41 in.)
Overall length	2032 mm (80 in.)	2032 mm (80 in.)	2032 mm (80 in.)	2032 mm (80 in.)
Overall width	927 mm (36.5 in.)	927 mm (36.5 in.)	1308 mm (51.5 in.)	1460 mm (57.5 in.)
Traction Unit Weight (Without deck)		124.7 Kg (275 lb)	124.7 Kg (275 lb)	136.8 Kg (302 lb)

	HD45	HD75
Overall height	1118 mm (44 in.)	1118 mm (44 in.)
Overall length	1981 mm (78 in.)	1981 mm (78 in.)
Traction Unit Weight (Without deck)	146.1 Kg (322 lb)	162.5 Kg (358 lb)

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.

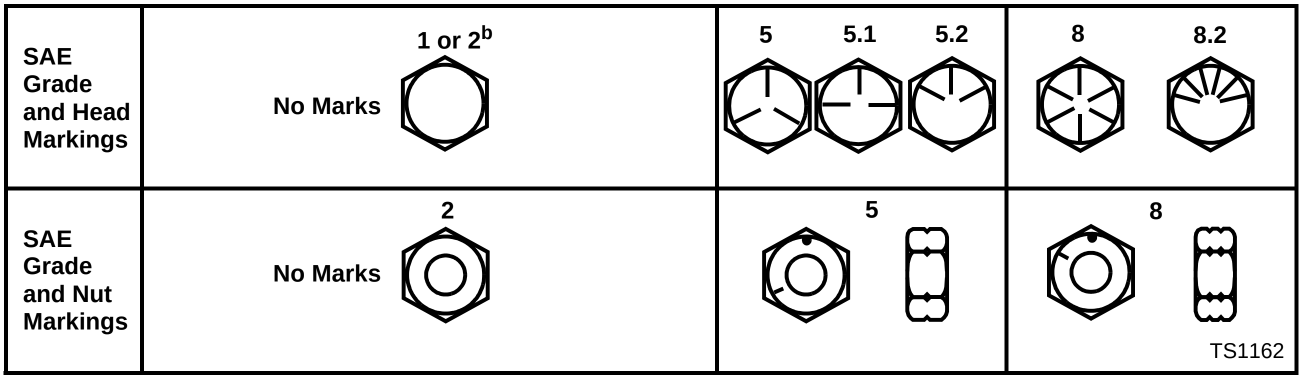
When bolt and nut combination fasteners are used, torque values should be applied to the **NUT** instead of the bolt head.

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



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

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

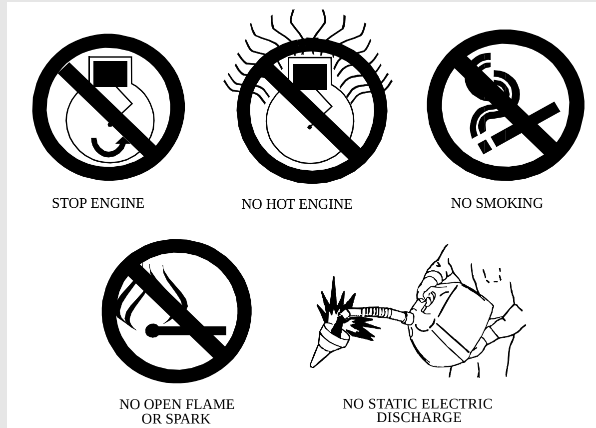
[a] *"Lubricated" means coated with a lubricant such as engine oil, or fasteners with phosphate and oil coatings. "Dry" means plain or zinc plated (yellow dichromate - Specification JDS117) without any lubrication.*

[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.*

GASOLINE—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:

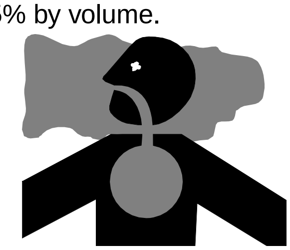
- **ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.**

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

California Proposition 65 Warning: Gasoline engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

GASOLINE STORAGE

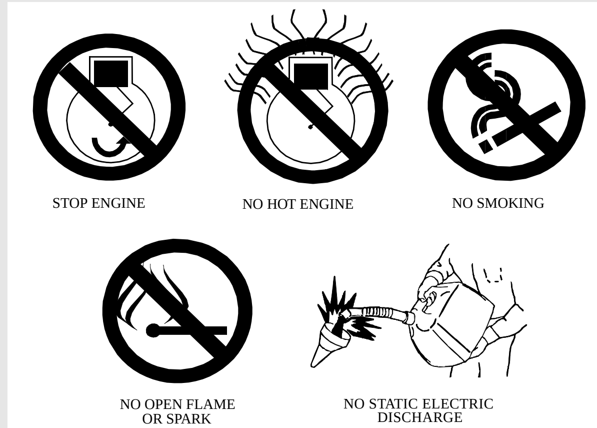
IMPORTANT: Keep all dirt, scale, water or other foreign material out of gasoline.

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,equivalent to the gasoline. **BE SURE** to follow directions on container and to properly discard empty container.

GASOLINE—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:

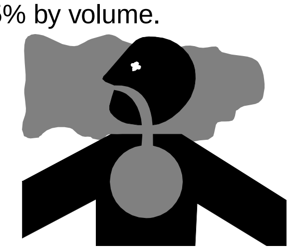
- **ONLY use a clean, approved POLYETHYLENE PLASTIC fuel container and funnel WITHOUT any metal screen or filter.**

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.

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**:

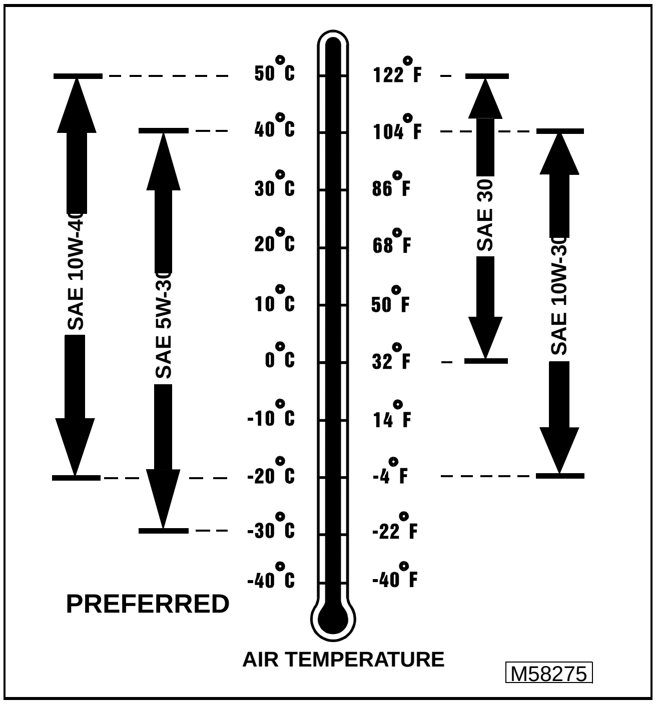
- **PLUS–4®—SAE 10W-40**;
- **TORQ–GARD SUPREME®—SAE 5W-30**.

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

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**:

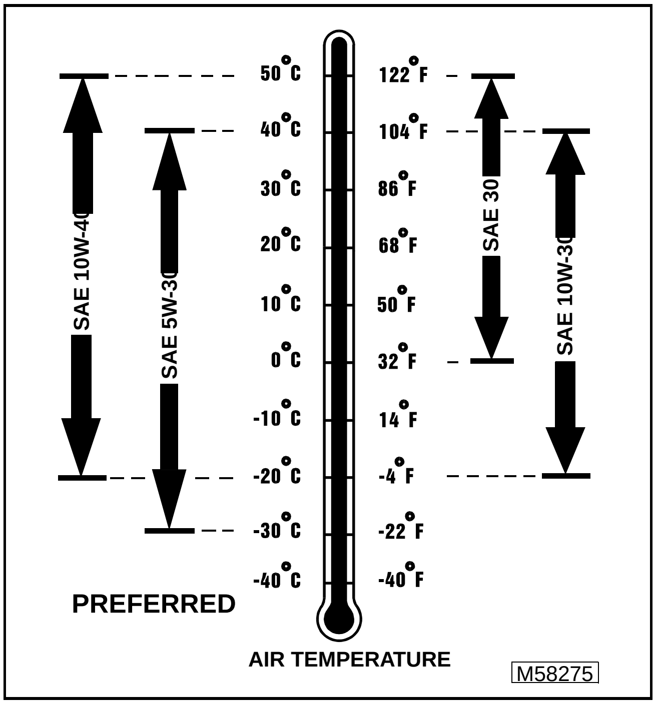
- **TORQ–GARD SUPREME®—SAE 10W-40;**
- **UNI–GARD™—SAE 10W-40;**
- **TORQ–GARD SUPREME®—SAE 5W-30;**
- **UNI–GARD™—SAE 5W-30.**

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 Specification 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 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.

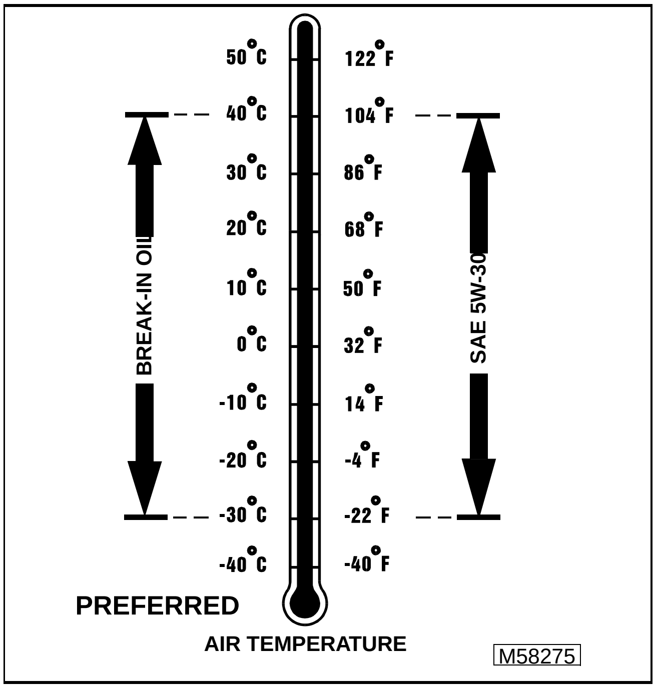
The following John Deere oil is **also recommended**:

- **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 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.

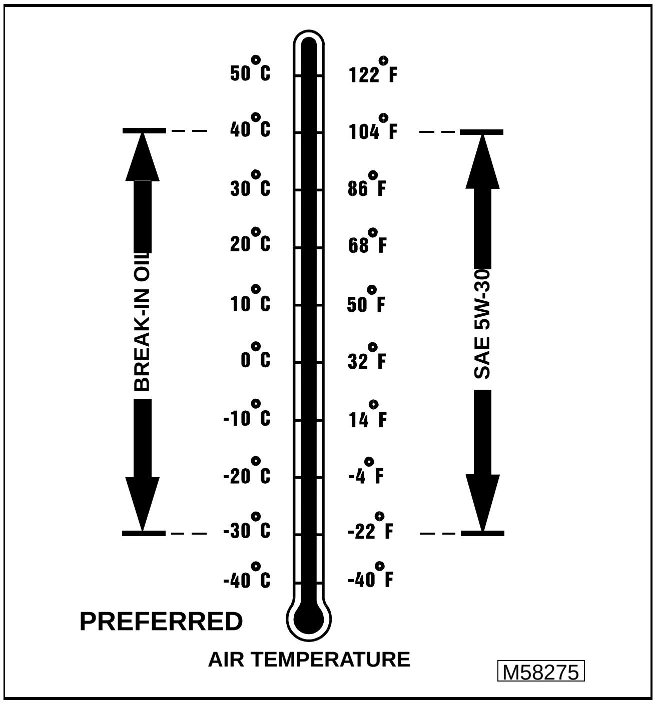
The following John Deere oil is **also recommended**:

- **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.

TRANSMISSION GREASE—GEAR

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 these specified greases in this transmission. DO NOT mix any other greases in this transmission. DO NOT use any BIO–GREASE in this transmission.

ONLY use the following **PREFERRED** grease as the **input shaft needle bearing** lubricant:

- **Unirex N3 Grease®—M120263.**

Other greases may be used as the input shaft needle bearing lubricant if they meet or exceed the following specification:

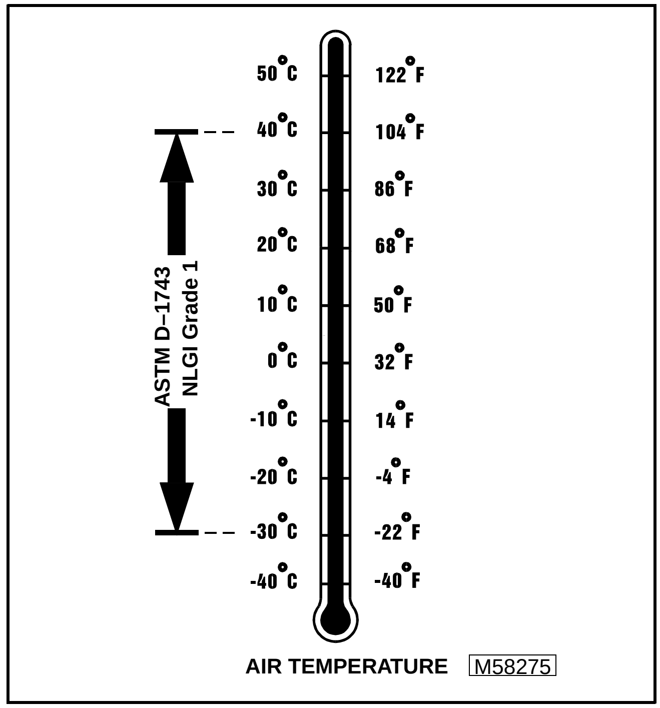
- ASTM D–1743, NLGI Grade 1.

ONLY use the following **PREFERRED** grease as the **gear housing** lubricant:

- **Shell Darina D Grease®—AM119608.**

Other greases may be used as the gear housing lubricant if they meet or exceed the following specification:

- ASTM D–1743, 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;
- Lubrication Sales Manual PI7032.

HYDROSTATIC TRANSAXLE OIL—NORTH AMERICA

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

Use recommended oil viscosity based on the expected air temperature range during the service interval.

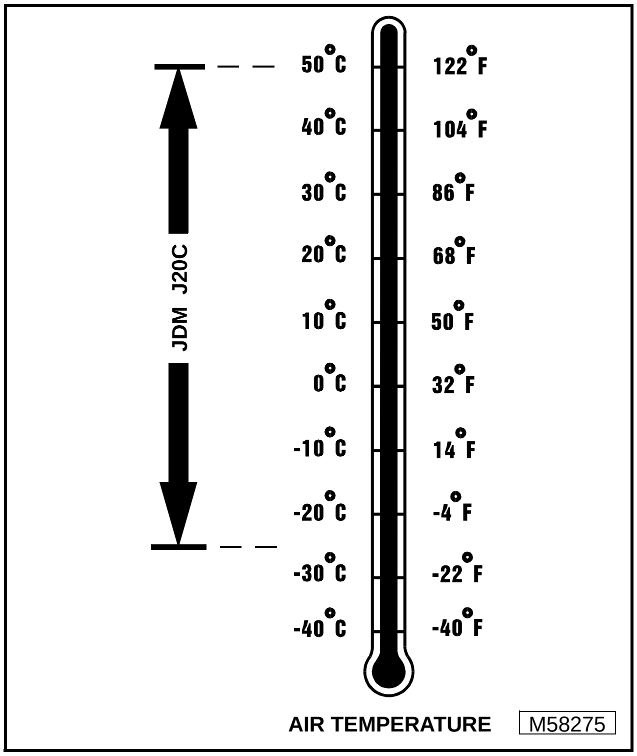
The following John Deere transmission and hydraulic oil is **PREFERRED**:

- **HY–GARD® — JDM J20C.**
- **TURF-GARD® — SAE 10W-30;**
- **PLUS-4® — SAE 10W-30;**

TORQ-GARD SUPREME® SAE 30.Other oils may be used if above recommended John Deere oil is not available, provided they meet the following specification:

- **John Deere Standard JDM J20C.**

IMPORTANT: If minimum air temperature should fall below -25°C (-13°F), the transmission oil must be heated to at least five degrees above the lower limit before start-up or transmission may be damaged. For prolonged operation under heavy load in air temperatures above 50°C (122°F) reduce service interval by 50%.



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

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

NOTE: Disregard the John Deere All Weather Hydrostatic Fluid (JDM J21A) listing—it has been eliminated from the specification.

HYDROSTATIC TRANSAXLE OIL—EUROPE

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

The following John Deere transmission and hydraulic oil is **PREFERRED**:

- **HY–GARD®—JDM J20C.**

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

- **John Deere Standard JDM J20C.**

IMPORTANT: If minimum air temperature should fall below -25°C (-13°F), the transmission oil must be heated to at least five degrees above the lower limit before start-up or transmission may be damaged. For prolonged operation under heavy load in air temperatures above 50°C (122°F) reduce service interval by 50%.

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

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

NOTE: Disregard the John Deere All Weather Hydrostatic Fluid (JDM J21A) listing—it has been eliminated from the specification.

ANTI-CORROSION GREASE SPECIFICATIONS

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

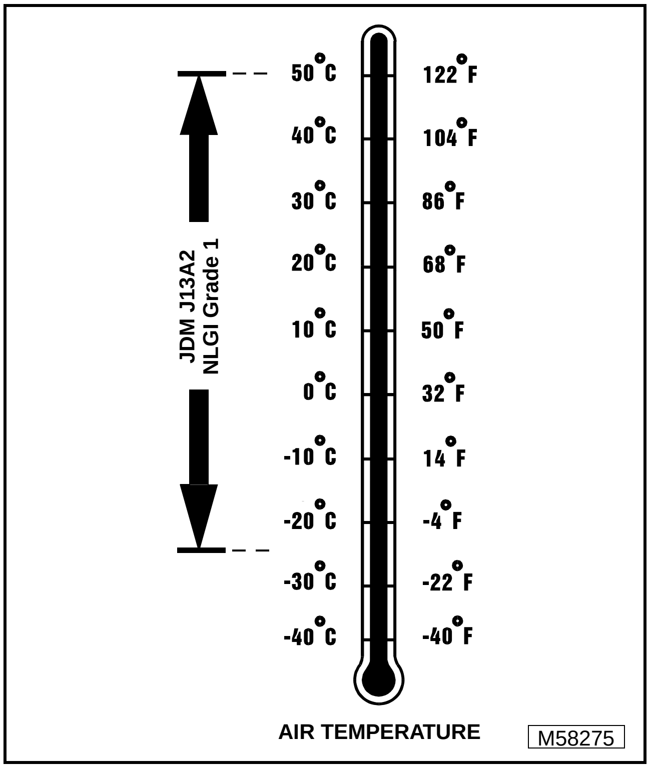
The following anti-corrosion grease is **PREFERRED**:

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

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

- John Deere Standard JDM J13A2, NLGI Grade 1.

**IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control.
DO NOT substitute any other grease for electrical connector corrosion control.**



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.

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.

SERIAL NUMBER INFORMATION

When working on machines or components that are covered by warranty, it is IMPORTANT that you include the machine's Product Identification Number and the component serial number on the warranty claim form.

The location of component serial number plates are shown below.

PRODUCT IDENTIFICATION NUMBER LOCATION

M76605

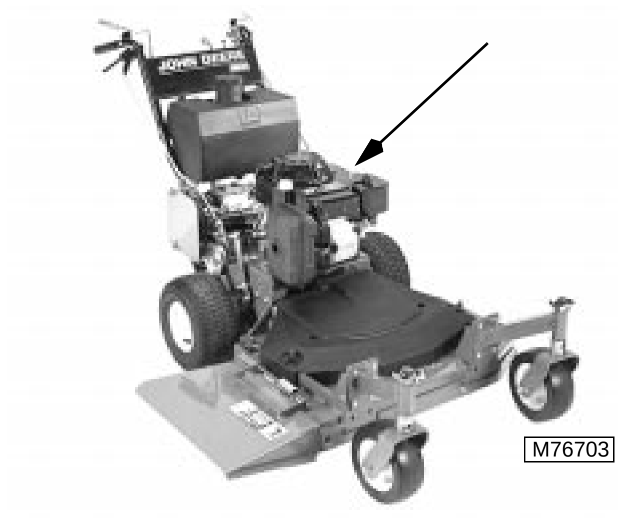
The Commercial Walk-Behind Power Unit Product Identification Number is located on the right hand side of the drive train housing.

ENGINE SERIAL NUMBER LOCATION - KAWASAKI ENGINES

M76703

The engine serial number is located on the Fan Housing opposite the engine head.

ENGINE SERIAL NUMBER LOCATION -KOHLER ENGINE



M76703

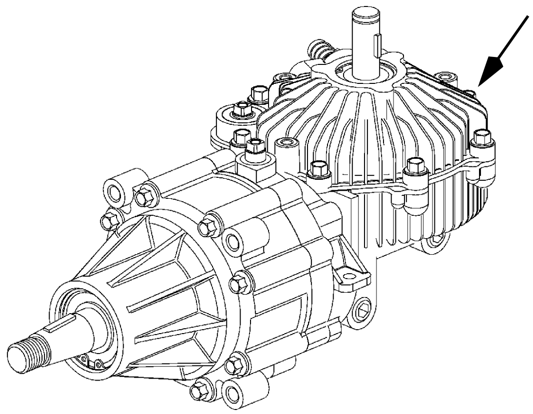
The engine serial number is located on the Fan Housing next to the carburetor intake air filter cover.

GEAR TRANSMISSION SERIAL NUMBER LOCATION

M76703

The gear transmission serial number is located on the transmission housing web.

HYDROSTATIC TRANSAXLE SERIAL NUMBER LOCATION

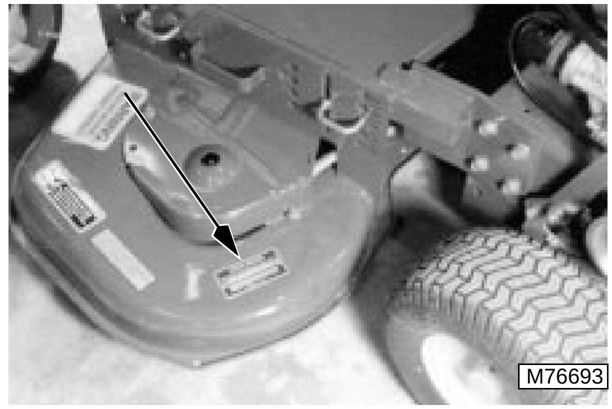


The hydrostatic transaxle serial number tag is bolted to the inside edge of the transaxle case, and can be seen from the rear of the mower deck.

MOWER DECK SERIAL NUMBER LOCATION—36 INCH

The Mower Deck Product Identification Number is located on the left hand side of the mower deck.

MOWER DECK SERIAL NUMBER LOCATION—48/54 INCH



The Mower Deck Product Identification Number is located on the left hand side of the mower deck.

CONTENTS

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KAWASAKI ENGINES

SPECIFICATIONS

TEST AND ADJUSTMENT SPECIFICATIONS—KAWASAKI ENGINES

Valves

Valve Clearance . . . . 0.15 mm (0.006 in.)

Flywheel And Breather

Breather Air Gap . . . . 1—2 mm (0.040—0.080 in.)
Minimum Flywheel Screen Gap . . . . 1.50 mm (0.059 in.)
Crankcase Vacuum @ 3350 rpm . . . . 25 cm (10 in.) water

Automatic Compression Release (ACR)

Minimum Exhaust Valve Movement . . . . 0.25 mm (0.010 in.)

Lubrication System

Oil Capacity With Filter
  FC401V-BS05 & FC420V-AS19 & AS21 . . . . 1.5 L (3.17 pt.)
  FC540V-AS17 & AS18 . . . . 1.9 L (4.0 pt.)
Without Filter
  FC401V-BS05 & FC420V-AS19 & AS21 . . . . 1.3 L (2.75 pt.)
  FC540V-AS17 & AS18 . . . . 1.6 L (3.38 pt.)

Oil Pump

Minimum Oil Pressure @ 3350 rpm . . . . 240 kPa (35 psi)

Fuel Pump

Fuel Pump Pressure Minimum . . . . 6.21 kPa (0.9 psi)
Minimum Flow In 15 seconds @3350 Engine rpm
  FC401V-BS05 & FC420V-AS19 & AS21 . . . . 80 mL (2.7 oz.)
  FC540V-AS17 & AS18 . . . . 90 mL (3 oz.)

Ignition And Charging System

Ignition Coil With Module Air Gap . . . . 0.30 mm (0.012 in.)
Spark Plug Gap . . . . 0.76 mm (0.030 in.)

Fuel/Air System

Throttle Lever Stop Gap . . . . 2—4 mm (0.080—0.160 in.)
Choke Cable Clearance (Knob To Plastic Boot . . . . 2—3 mm (0.080—0.120 in.)

Operating Specifications

Slow Idle Speed . . . . 1450±75 rpm
Fast Idle Speed (No Load) . . . . 3350±100 rpm
Direction of Rotation . . . . Counterclockwise, Facing PTO Shaft

REPAIR SPECIFICATIONS

Valve

Intake Valve Lift (W/ Clearance set at 0.00)	8.99 mm (0.354 in.)
Exhaust Valve Lift (W/ Clearance set at 0.00)	8.99 mm (0.354 in.)
Valve Guide I.D.	
Min.	7.00 mm (0.275 in.)
Max.	7.02 mm (0.276 in.)
Replace if over.	7.07 mm (0.278 in.)
Valve Seating Surface	1.00—1.46 mm (0.039—0.057 in.)
Valve Seat and Face Angle	45°
Minimum Valve Margin	0.60 mm (0.020 in.)
Valve Narrowing Angle	30°
Intake Valve Stem O.D.	Min. 6.93 mm (0.272 in.)
	Max. 6.99 mm (0.275 in.)
Exhaust Valve Stem O.D.	Min. 6.91 mm (0.272 in.)
	Max. 6.98 mm (0.275 in.)
Maximum Valve Stem Bend	0.03 mm (0.001 in.)

Valve Guide

Valve Guide I.D.	
Min.	7.00 mm (0.275 in.)
Max.	7.02 mm (0.276 in.)
Replace if over.	7.07 mm (0.278 in.)
Installed Height	
FC401V-BS05, FC420V-AS19 & AS21	12.0±0.1 mm (0.472±0.004 in.)
FC540V-AS17 & AS18	9.5±0.1 mm (0.374±0.004 in.)

Rocker Arm

Minimum Shaft O.D.	12.94 mm (0.509 in.)
Maximum Rocker Arm Bore I.D.	13.07 mm (0.515 in.)

Push Rod

Maximum Bend	0.30 mm (0.012 in.)

Springs:

Minimum Spring Free Length	37.50 mm (1.476 in.)
Squareness	2.39 mm (0.090 in.)

Cylinder Head

Cylinder Head Flatness	0.05 mm (0.002 in.)

Governor

Shaft Height (From Block)	32.2—32.8 mm (1.267—1.291 in.)

Camshaft And Tappets

- Camshaft Minimum End Journal O.D.
  - PTO Side . . . . . 20.91 mm (0.823 in.)
  - Flywheel Side . . . . . 19.91 mm (0.784 in.)
- Minimum Lobe Height . . . . . 36.75 mm (1.446 in.)
- Maximum Bearing I.D. FC401V-BS05 & FC420V-AS19 & AS21
  - Crankcase . . . . . 20.08 mm (0.790 in.)
  - Crankcase Cover . . . . . 21.08 mm (0.830 in.)
- Maximum Bearing I.D. FC540V-AS17 & AS18
  - Crankcase . . . . . 21.08 mm (0.830 in.)
  - Crankcase Cover . . . . . 21.08 mm (0.830 in.)

Balancers

- Link Rod FC401V-BS05 & FC420V-AS19 & AS21
  - Minimum Journal O.D. . . . . . 53.95 mm (2.124 in.)
  - Maximum Small End I.D. . . . . . 12.60 mm (0.475 in.)
  - Maximum Large End I.D. . . . . . 54.12 mm (2.132 in.)
  - Bushing Depth . . . . . 1.00 mm (0.020 in.)
- Link Rod FC540V-AS17 & AS18
  - Minimum Journal O.D. . . . . . 57.94mm (2.281 in.)
  - Maximum Small End I.D. . . . . . 12.60 mm (0.475 in.)
  - Maximum Large End I.D. . . . . . 58.15 mm (2.289 in.)
  - Bushing Depth . . . . . 1.00 mm (0.040 in.)
- Balancer Weight
  - Maximum Bearing I.D. . . . . . 26.10 mm (1.027 in.)
  - Bushing Depth . . . . . 0.50 mm (0.02 in.)
- Support Shaft Minimum Shaft O.D. . . . . . 25.93 mm (1.021 in.)

Piston

- Piston O.D. . . . . . 88.83—88.86 mm (3.488—3.498 in.)
- Maximum Ring Groove Clearance
  - Top Ring . . . . . 0.17 mm (0.007 in.)
  - Second Ring . . . . . 0.15 mm (0.006 in.)
  - Oil Ring . . . . . 0.20 mm (0.008 in.)
- Minimum Ring End Gap . . . . . 0.18 mm (0.007 in.)
- Maximum Ring End Gap
  - Compression Rings . . . . . 0.90 mm (0.035 in.)
  - Oil Ring . . . . . 1.30 mm (0.051 in.)
- Minimum Pin O.D. . . . . . 18.98 mm (0.747 in.)
- Maximum Pin Bore I.D. . . . . . 19.06 mm (0.750 in.)
- Maximum Piston-to-Piston Pin Clearance . . . . . 0.06 mm (0.002 in.)

Connecting Rod

- Maximum Crankshaft Bearing I.D.. . . . . . 41.07 mm (1.617 in.)
- Maximum Piston Pin Bearing I.D. . . . . . 19.06 mm (0.750 in.)
- Maximum Connecting Rod-to-Piston Pin Clearance . . . . . 0.06 mm (0.002 in.)
- Maximum Connecting Rod-to-Crankpin Clearance . . . . . 0.14 mm (0.006 in.)

Crankshaft

- Minimum Main Bearing Journal O.D - PTO Side.
  - FC401V-BS05 & FC420V-AS19 & AS21 . . . . 34.91 mm (1.374 in.)
  - FC540V-AS17 & AS18 . . . . 37.90 mm (1.492 in.)
- Minimum Main Bearing Journal O.D - Flywheel Side (All) . . . . 34.94 mm (1.376 in.)
- Minimum Connecting Rod Journal O.D. . . . . 40.93 mm (1.611 in.)
- Maximum Crankcase Cover Plain Bearing I.D.
  - FC401V-BS05 & FC420V-AS19 & AS21 . . . . 35.06 mm (1.380 in.)
  - FC540V-AS17 & AS18 . . . . 38.06 mm (1.498 in.)
- Maximum T.I.R. . . . . 0.05 mm (0.002 in.)
- End Play . . . . 0.09—0.22 mm (0.004—0.009 in.)

Cylinder Block

- Cylinder Bore
  - Standard Cylinder Bore I.D . . . . 88.98—89.00 mm (3.500—3.504 in.)
  - Maximum Cylinder Bore I.D. . . . . 89.08 mm (3.507 in.)
- Maximum Out Of Round . . . . 0.06 mm (0.002 in.)
- Rebore Cylinder
  - Oversize: 0.25 mm (0.010 in.) . . . . 89.21—89.23 mm (3.512—3.513 in.)
  - Oversize: 0.50 mm (0.020 in.) . . . . 89.46—89.48 mm (3.522—3.523 in.)
  - Oversize: 0.75 mm (0.030 in.) . . . . 89.71—89.73 mm (3.532—3.533 in.)
- Final Honed Cylinder Bore
  - Oversize: 0.25 mm (0.010 in.) . . . . 89.23—89.25 mm (3.513—3.514 in.)
  - Oversize: 0.50 mm (0.020 in.) . . . . 89.48—89.50 mm (3.523—3.524 in.)
  - Oversize: 0.75 mm (0.030 in.) . . . . 89.73—89.75 mm (3.533—3.534 in.)
- Compression . . . . 483 kPa (71 psi)

Oil Pump

- Minimum Rotor Shaft O.D.
  - Large O.D. . . . . 12.63 mm (0.497 in.)
  - Small O.D. . . . . 7.94 mm (0.313 in.)
- Maximum Rotor Shaft Bearing I.D.
  - Oil Pump Cover . . . . 12.76 mm (0.502 in.)
  - Crankcase Cover. . . . . 8.07 mm (0.318 in.)
- Outer Rotor Thickness Max.
  - FC401V-BS05 & FC420V-AS19 & AS21 . . . . 11.92 mm (0.469 in.)
  - FC540V-AS17 & AS18 . . . . 9.92 mm (0.391 in.)
- Outer Rotor Housing I.D. Max.
  - FC401V-BS05 & FC420V-AS19 & AS21 . . . . 29.2 mm (1.150 in.)
  - FC540V-AS17 & AS18 . . . . 40.72 mm (1.603 in.)
- Outer Rotor O.D. Max.
  - FC401V-BS05 & FC420V-AS19 & AS21 . . . . 28.95 mm (1.140 in.)
  - FC540V-AS17 & AS18 . . . . 40.47 mm (1.593 in.)
- Minimum Valve Spring Free Length . . . . 19.00 mm (0.750 in.)

Carburetor

- Float to jet holder . . . . 13.5—15.5 mm (0.531—0.610 in.)

Starting Motor

- Minimum Brush Length . . . . 10.5 mm (0.413in.)

TORQUE SPECIFICATIONS

Rocker Arm Stud	7 N•m (62 lb-in.)
Cylinder Head Cap Screw (Lubricated)	
Initial Torque	32 N•m (24 lb-in.)
Final Torque	52 N•m (38 lb-in.)
Spark Plug	20 N•m (15 lb-ft)
Flywheel Nut	
FC401V-BS05 & FC420V-AS19 & AS21	137 N•m (101 lb-ft)
FC540V-AS17 & AS18	172 N•m (127 lb-ft)
Connecting Rod Cap Screw	20 N•m (177 lb-in.)
Tappets Cap Screw	26 N•m (19 lb-ft)
Balancer Bushing Screw	7.3 N•m (65 lb-in.)
Crankcase Cover Cap Screw	26 N•m4 (19 lb-ft)
Engine Mounting Cap Screws	57 N•m (42 lb-ft)

ESSENTIAL TOOLS

NOTE: Order tools from your SERVICE-GARD™ Catalog. Some tools may be available from a local supplier.

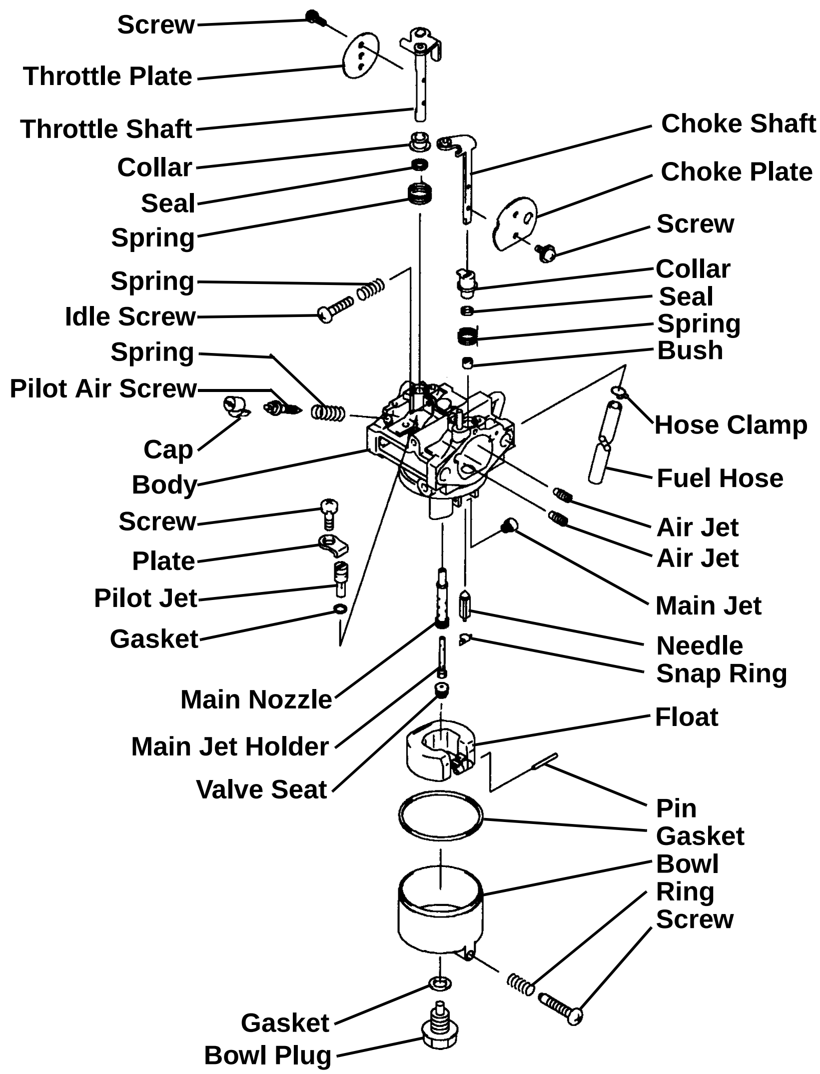
Number	Name	Use
JDG504	Valve Guide Driver	Remove and install valve guides
JDM70	Valve Spring Compressor	Compress valve springs
JDG356	Pressure Gauge	Test fuel pump pressure
JTO7270	Digital Pulse Tachometer	Determine engine RPM
JDM59	Compression Gauge	Engine compression
JTO5791	Digital Multimeter	Electrical tests
D05351ST	Spark Tester	Test spark

OTHER MATERIAL

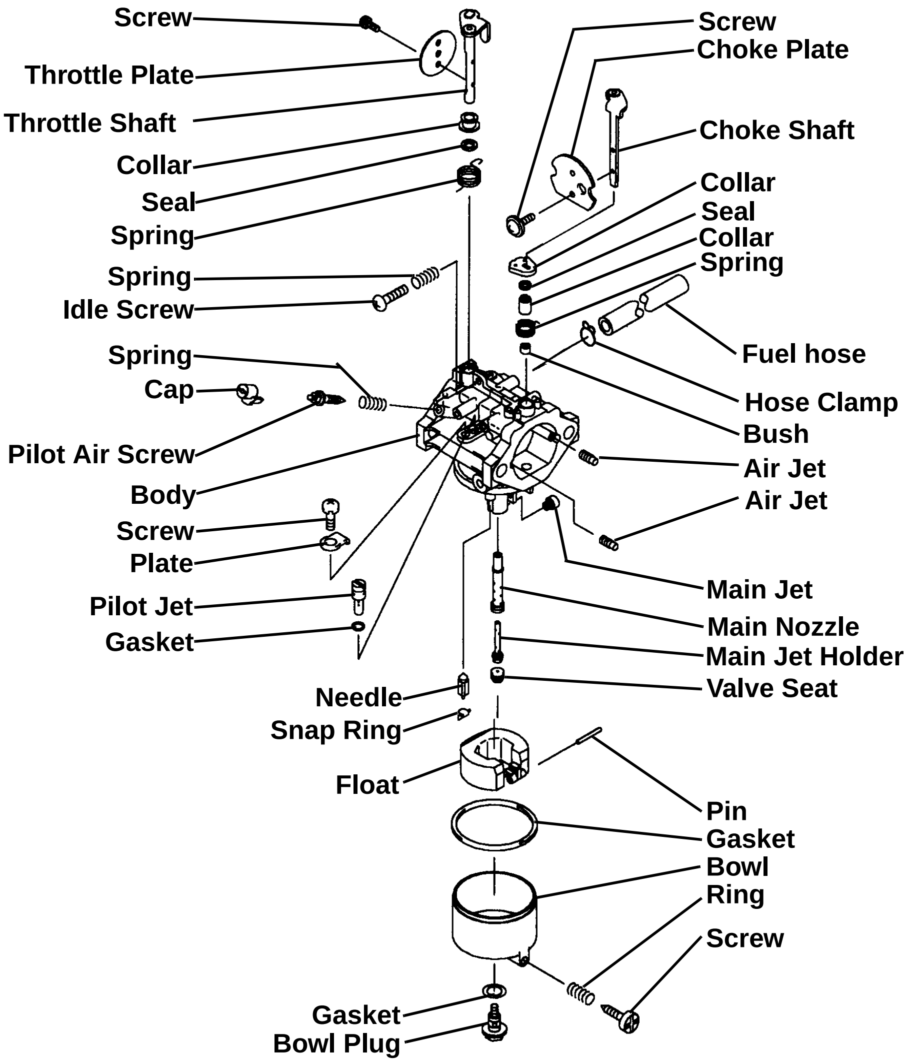
Number	Name	Use
Local Supplier	SCOTCH-BRITE Abrasive Sheets/Pads	Clean cylinder head
Local Supplier	Valve Guide Cleaner	Clean valve guides
Local Supplier	Stanisol (or Kerosene)	Finish ream valve guide
Local Supplier	Prussian Blue Compound	Check valve seat contact
Local Supplier	Valve Lapping Compound	Lap valves
Local Supplier	200/300 Grit Stone	Deglaze/hone cylinders

COMPONENT LOCATION

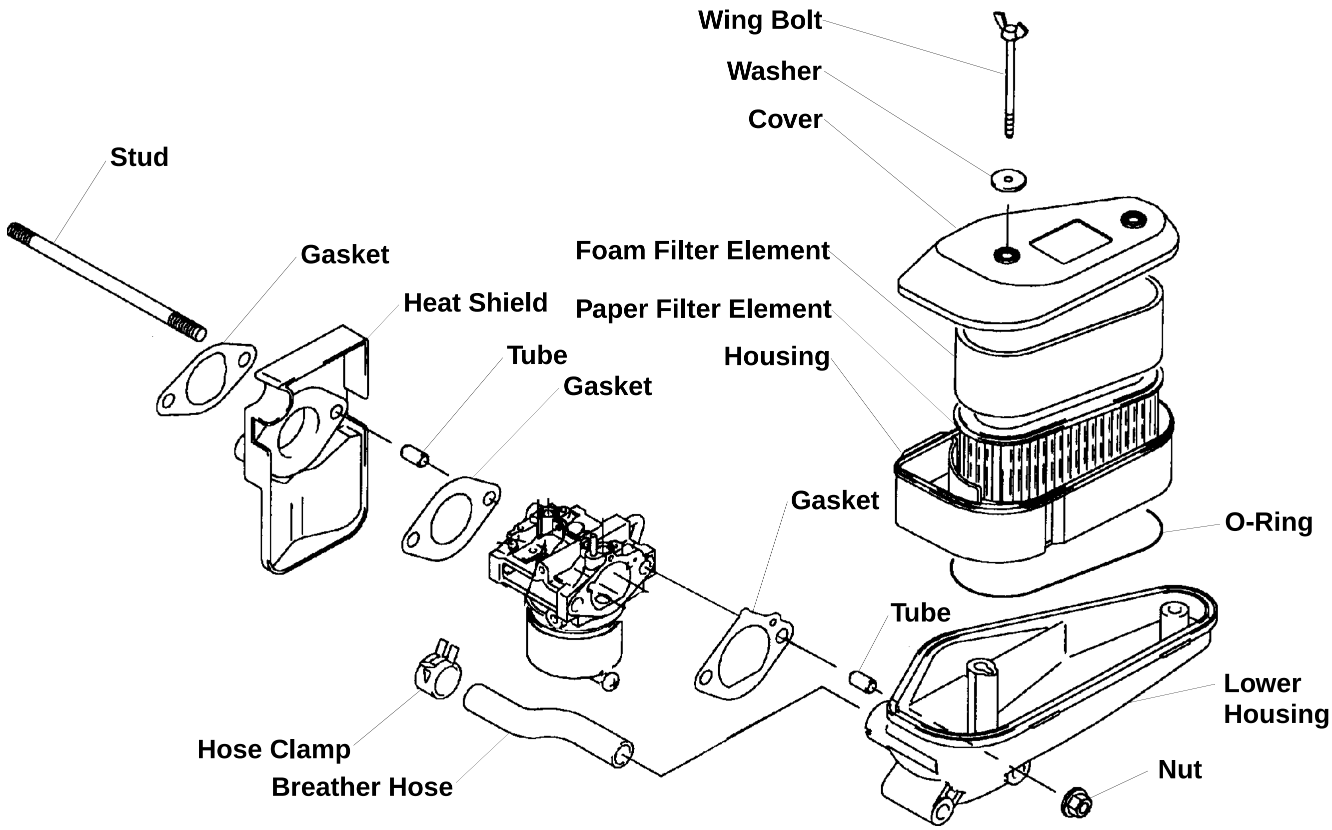
CARBURETOR COMPONENT LOCATION–FC401V-BS05, FC420V-AS19 & 21



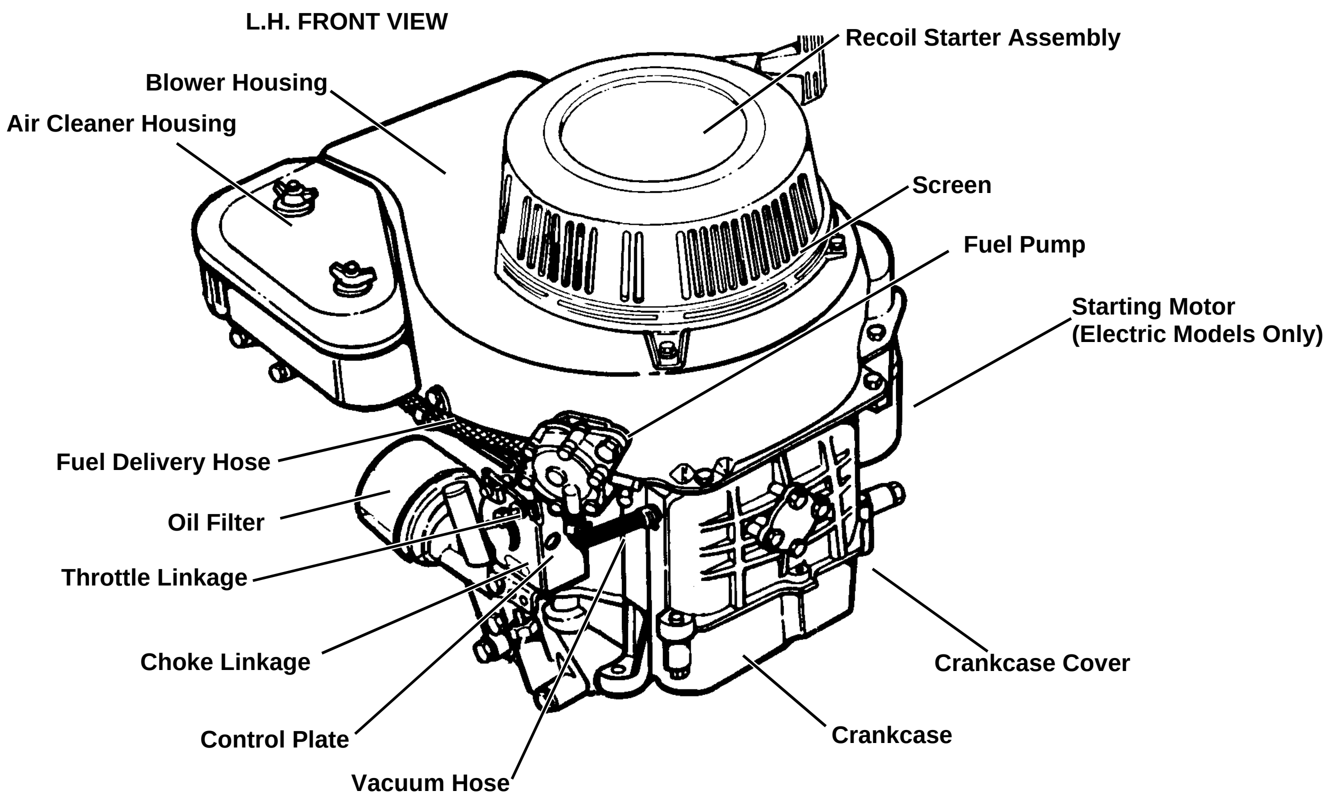
CARBURETOR COMPONENT LOCATION—FC540V-AS17 & AS18

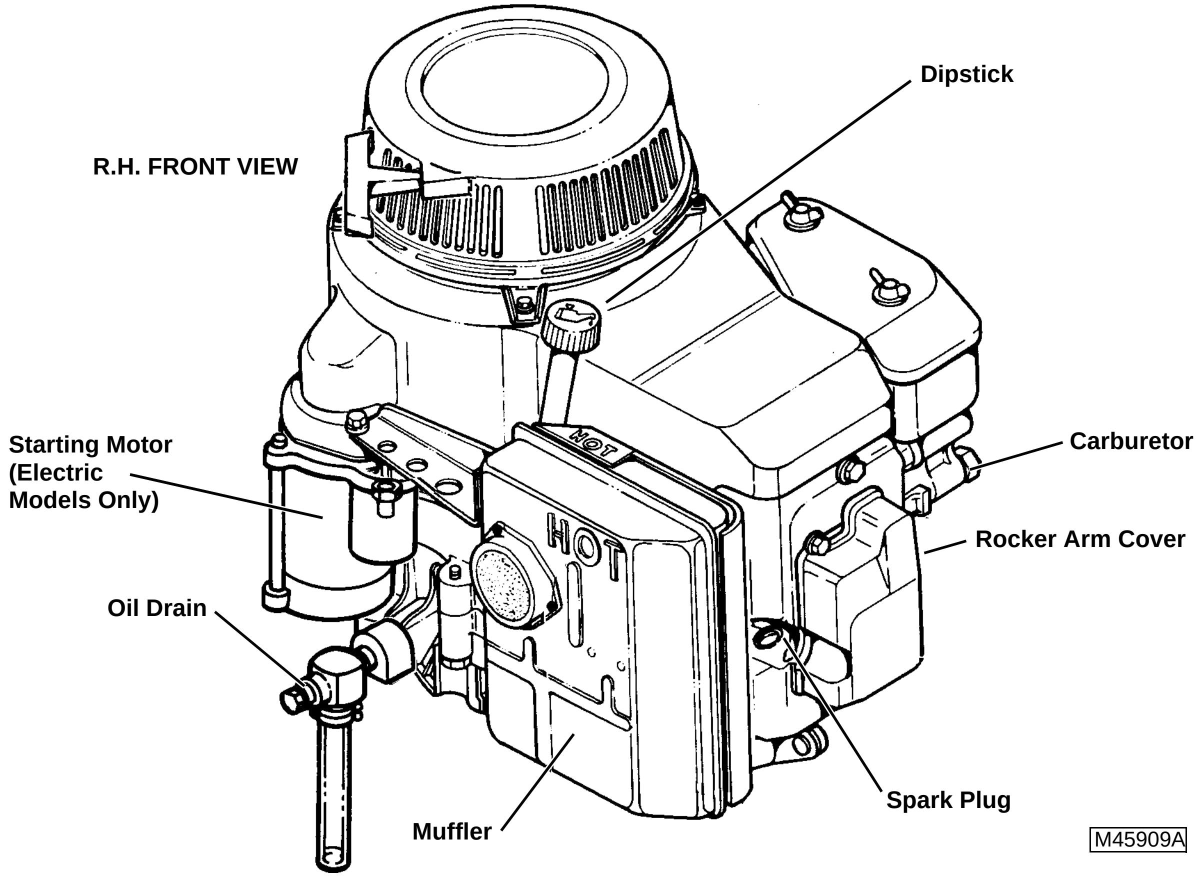


INTAKE SYSTEM COMPONENT LOCATION—ALL

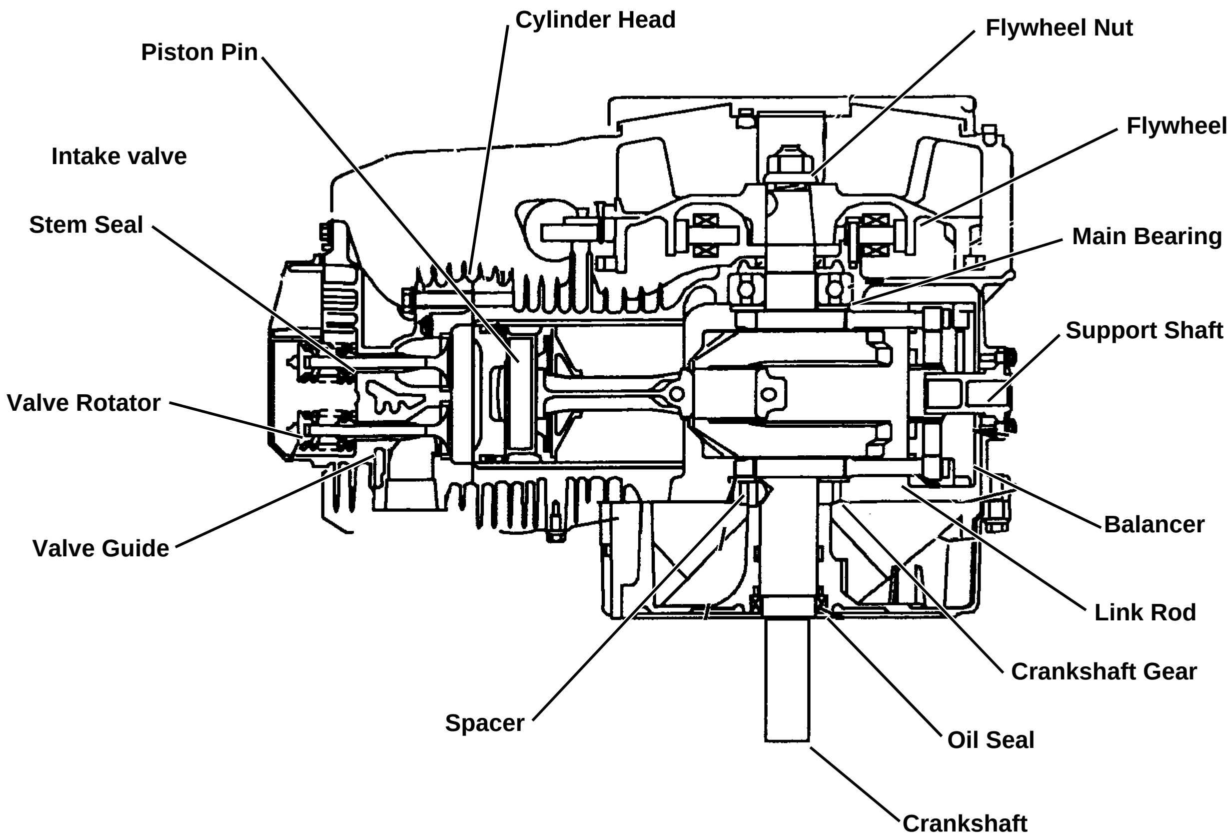


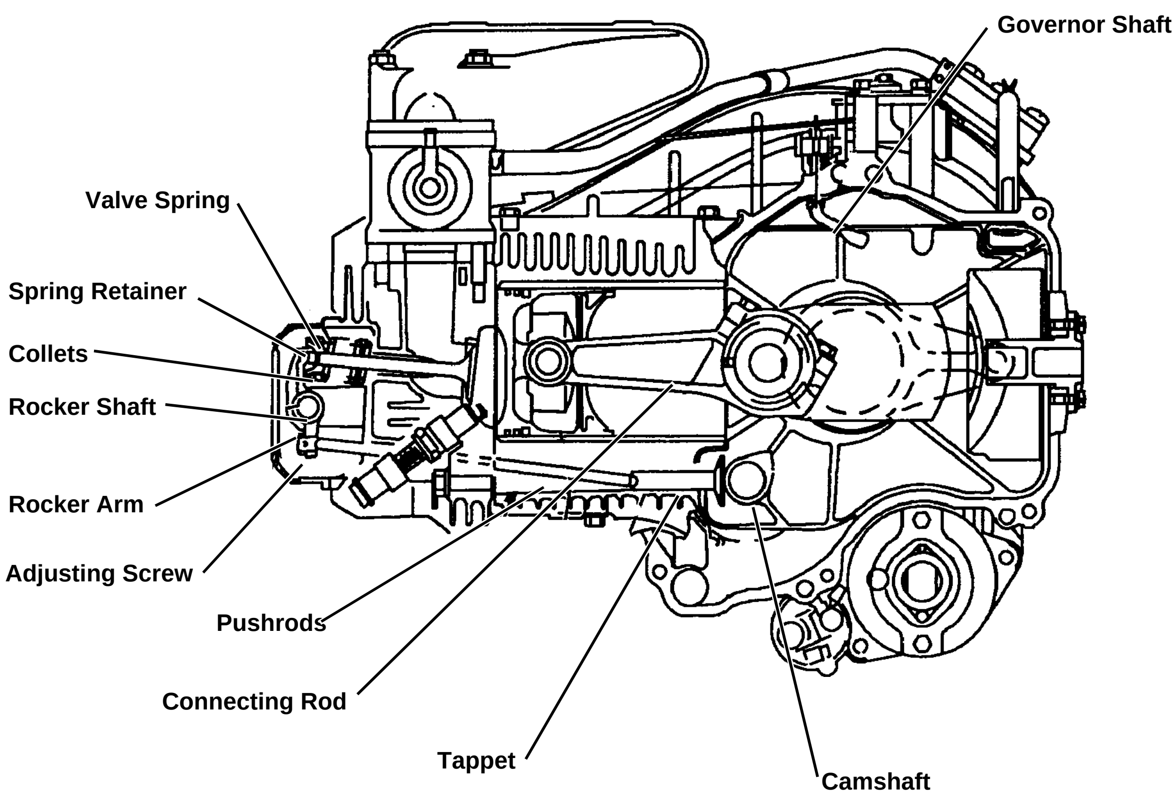
ENGINE - EXTERNAL COMPONENT LOCATION



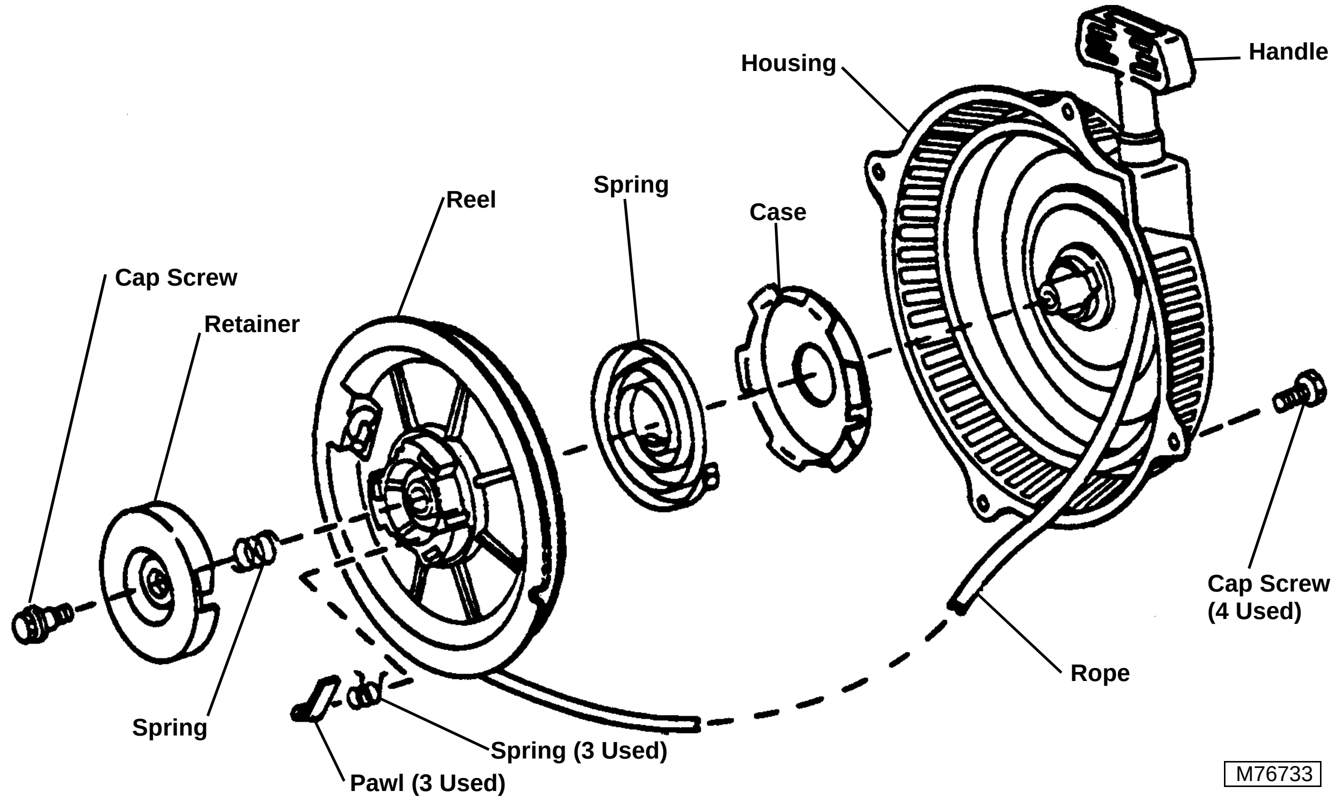


ENGINE - INTERNAL COMPONENT LOCATION

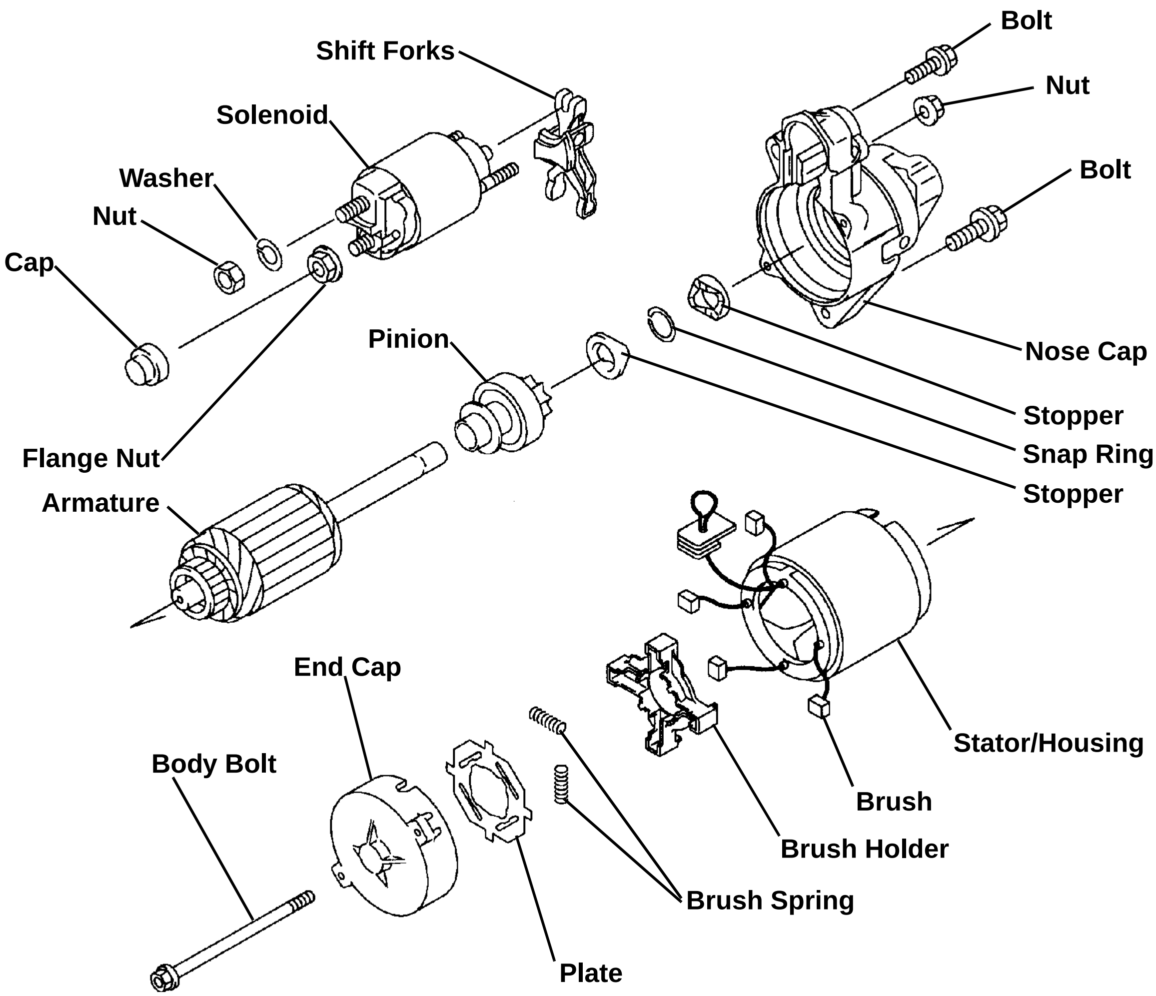




RECOIL STARTER COMPONENT LOCATION



ELECTRIC STARTER COMPONENT LOCATION



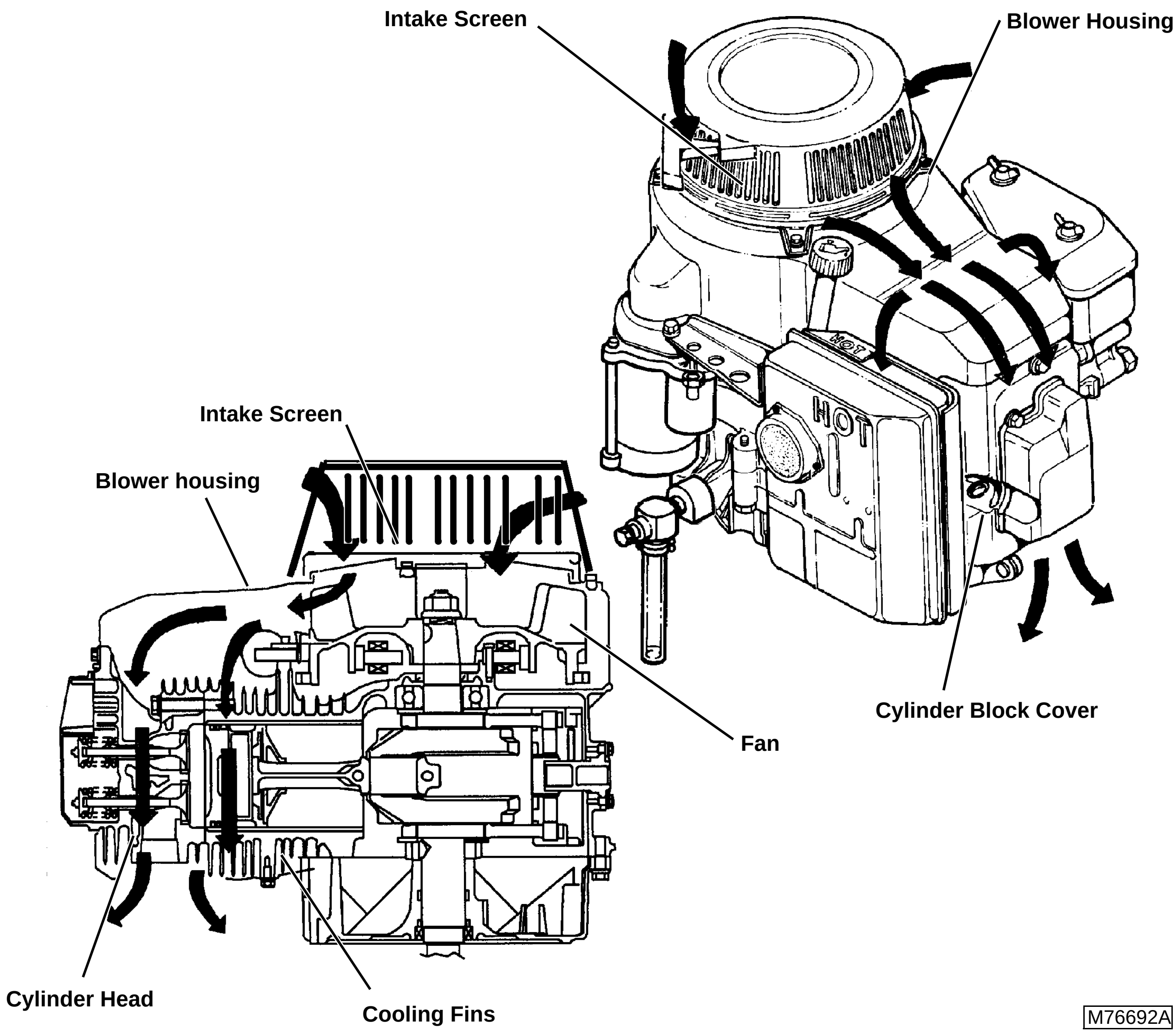
THEORY OF OPERATION

COOLING SYSTEM OPERATION

The engine is air cooled with air flow provided by a fan that is mounted on the flywheel. During operation the fan draws air in through the intake screen and delivers it, through the blower housing, to the cooling fins surrounding the cylinder and head.

The intake screen rotates with the fan and cuts debris into fine pieces helping to keep the cooling fins clear.

It is important that the intake screen remains open for proper air flow. The engine shroud should never be altered or removed, as cooling capacity will be affected. Cylinder block and cylinder head cooling fins must remain clean and open to properly dissipate heat.



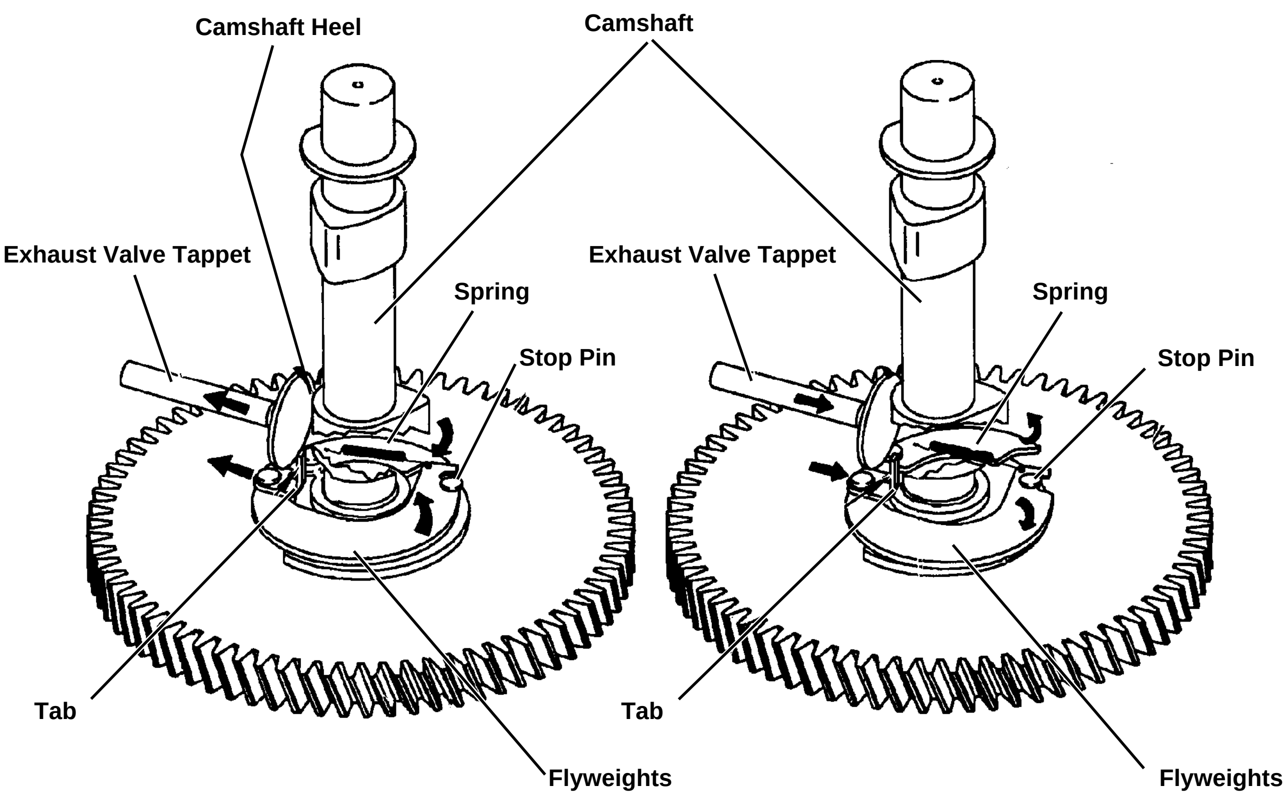
AUTOMATIC COMPRESSION RELEASE (ACR) OPERATION

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

The ACR consist of a pair of camshaft mounted flyweights, tab and spring. The ACR is attached to the camshaft and has limited serviceability.

The ACR is “engaged” at starting engine rpm. During low rpm operation the spring pulls the flyweights together, which moves the tab into interference with the exhaust valve lifter. The interference causes the exhaust valve to lift slightly as the engine rotates, thus keeping compression low and allowing the engine to turn over with less resistance.

After the engine starts, the ACR automatically “disengages.” As engine rpm increases the flyweights swing out and overcome the force of the spring. As the flyweights rotate, the tab moves toward the camshaft until it no longer contacts the exhaust valve tappet. The engine will now run with normal operating compression. (A stop pin is provided to limit the travel of the flyweights.)



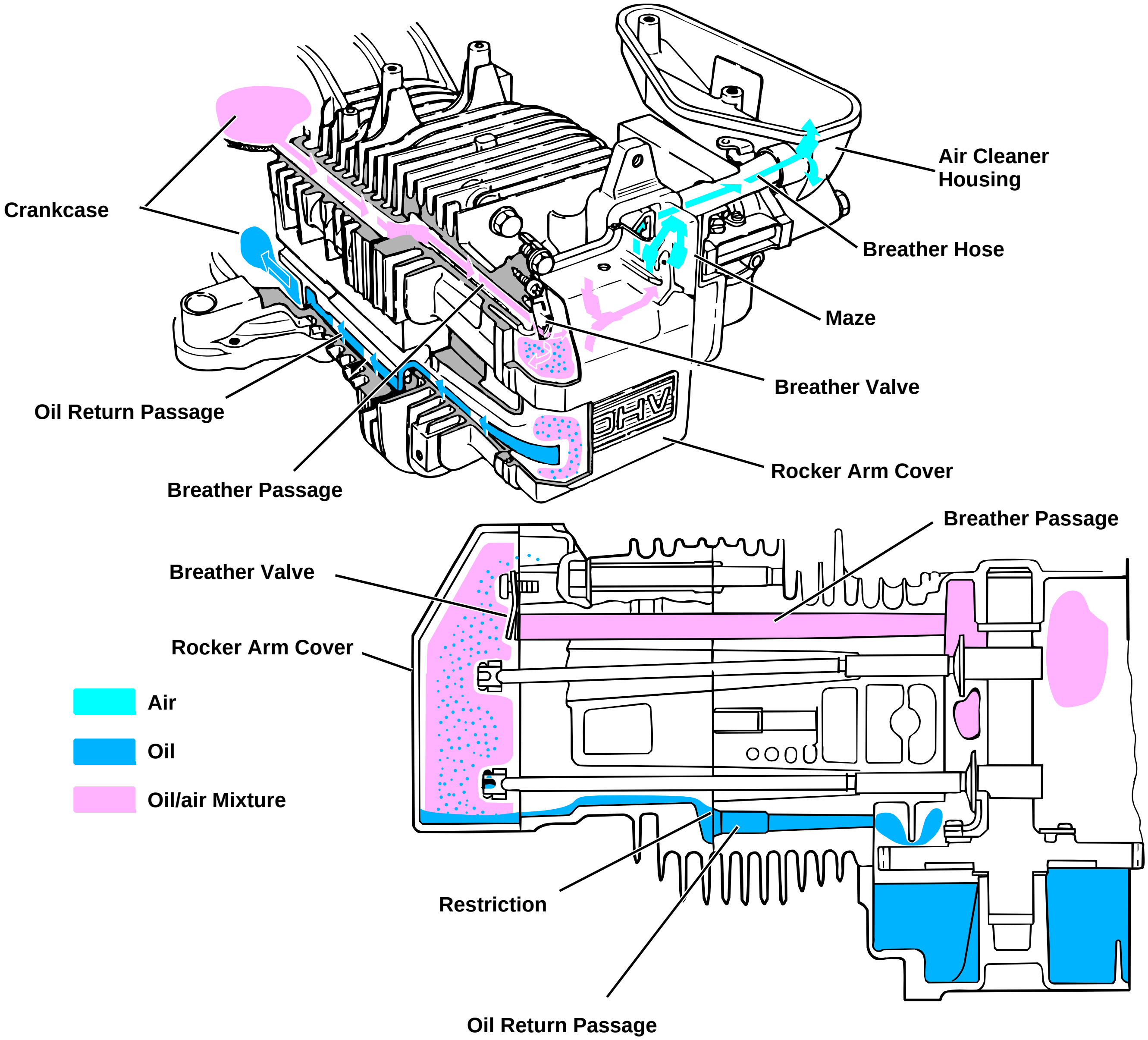
ENGINE CRANKING ENGINE RUNNING

M76691

CRANKCASE BREATHER SYSTEM OPERATION

The engine is equipped with a breather system that allows air to escape easily from the engine, but restricts air coming in. As the piston moves downward during power and intake strokes, the volume of the crankcase decreases. To prevent a build up of pressure, oil laden air flows though the breather passage and valve into the rocker arm cover. In order to prevent excess oil loss the air is routed through a maze in the rocker arm cover where the oil separates out. The non-oily air then passes through a breather hose and into the air cleaner housing. The separated oil lubricates the valve train and returns to the crankcase through the oil return passage.

When the piston moves upward during compression and exhaust strokes, the volume of the crankcase increases. Crankcase vacuum increases and closes the breather valve preventing air flow into the crankcase. A restriction in the oil return passage also helps to limit air flow into the crankcase. The result is that a small vacuum is maintained in the crankcase.



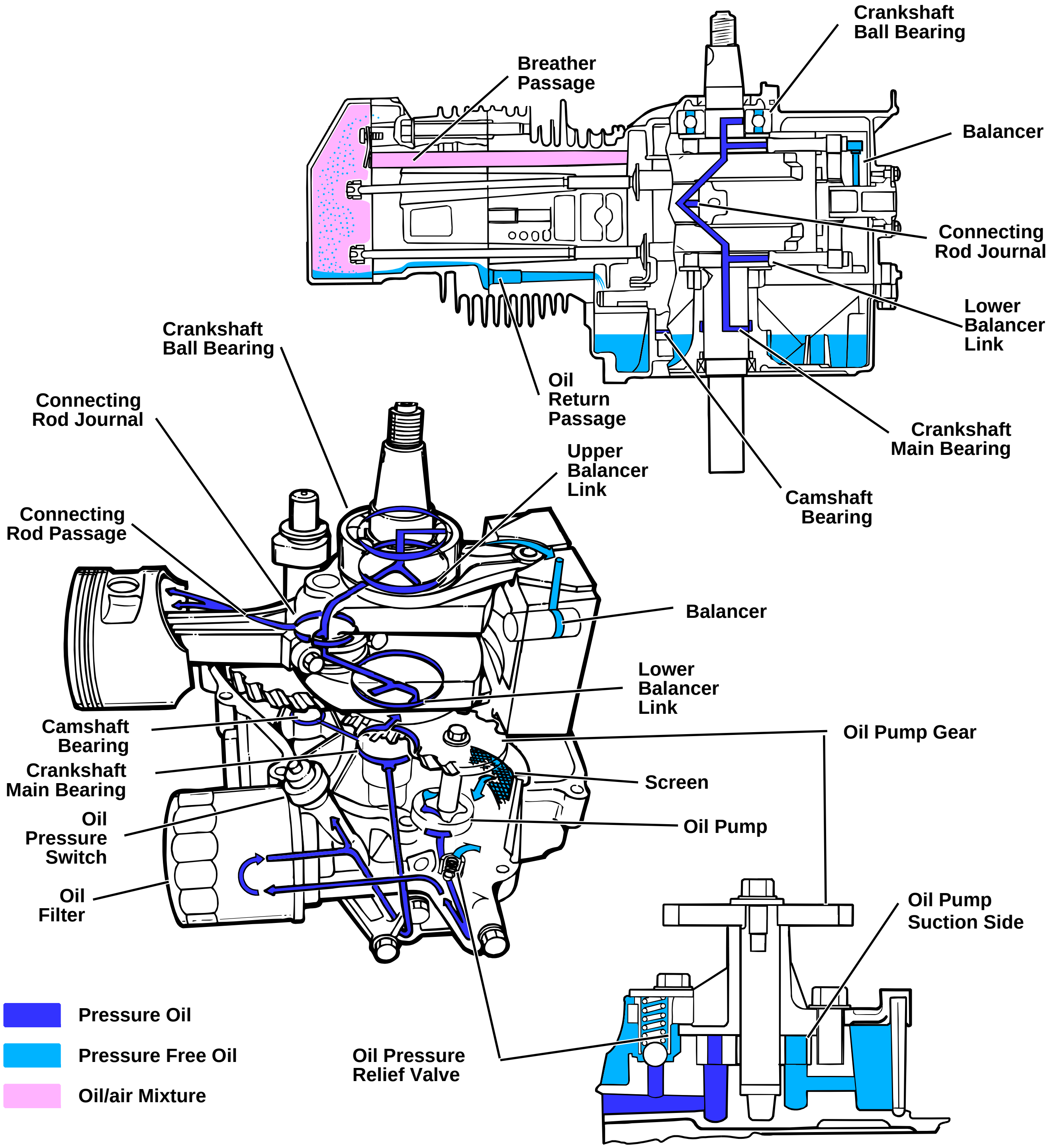
LUBRICATION SYSTEM OPERATION

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

The oil pump draws oil from the sump through a pick up screen. Pressurized oil flows from the pump to a pressure relief valve that limits the oil pressure to approximately 296 kPa (43 psi). Relief oil is vented back to the sump.

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

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



FUEL SYSTEM OPERATION

Fuel is stored in fuel tank with vented cap. Fuel is drawn from the tank, through a fuel shutoff valve and paper element fuel filter, by a vacuum operated pump mounted on the outside of the blower housing. The pump supplies fuel to the carburetor at approximately 6kPa (1psi).

The fuel pump is a pressure/vacuum operated diaphragm pump. The pump operates using the changes in vacuum that occur in the crankcase during engine operation. As the engine piston moves upward a vacuum is created in the crankcase, due to the operation of the breather system. A hose transfers this vacuum to the fuel pump when air is drawn out of the air chamber and the pump diaphragm is pulled into the chamber, towards the cover, which creates a suction in the pump fuel chamber which opens the suction valve and draws fuel from the fuel filter through the fuel inlet.

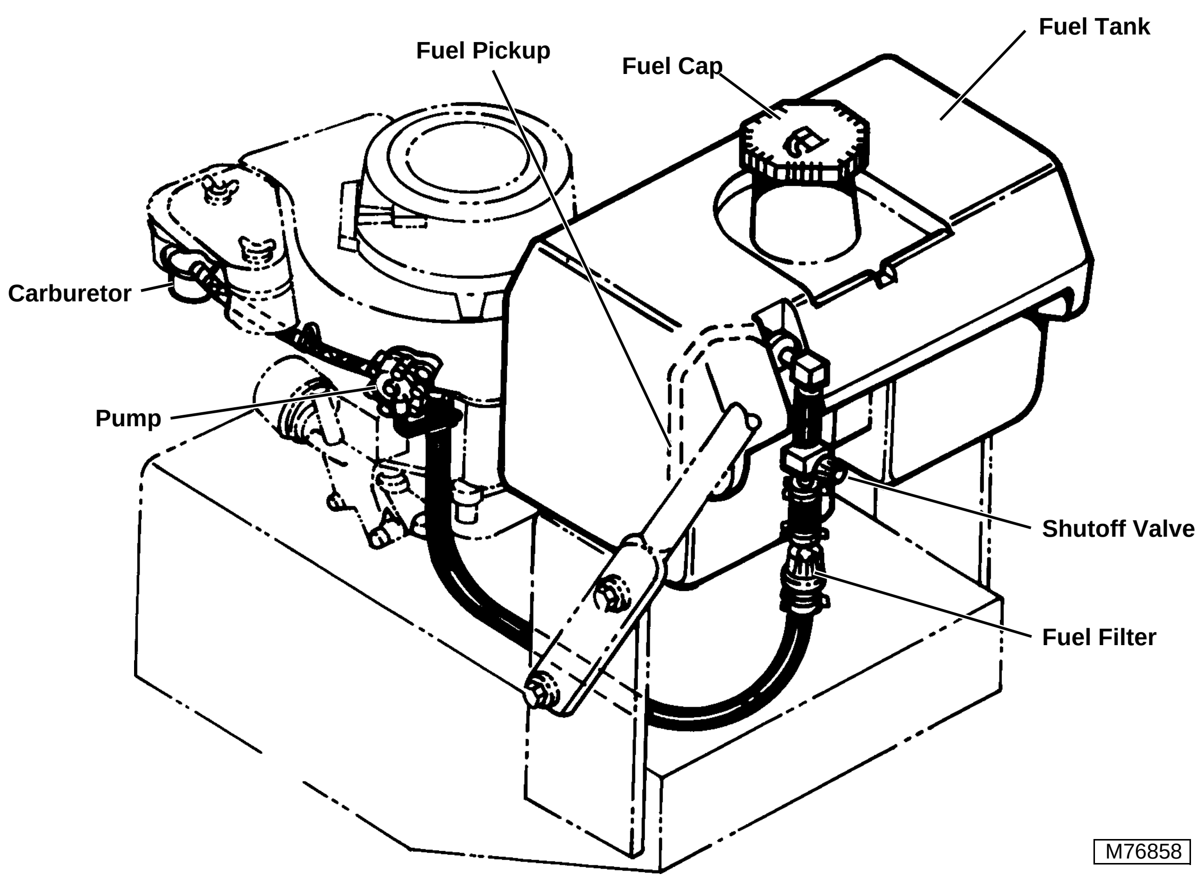
When the engine piston moves downward a slight pressure is created in the crankcase. Air is forced into the air chamber and the pump diaphragm is pushed away from the cover. This produces pressure in the pump chamber. The pressure closes the suction valve and open the pressure valve and forces fuel into the outlet chamber and to the carburetor.

The vent in the cover allows the pump diaphragm to return to a neutral position when the fuel pump is not operating.

Fuel flows into the carburetor through the inlet needle and seat assembly into the float bowl of the carburetor. The inlet needle is connected to the float. As the fuel level, and the float, rise, the inlet needle rises and restrict the flow of fuel to the float bowl. As the engine runs and draws fuel through the main and pilot jets the level in the float bowl, and the attached needle, lowers, which allows more fuel to enter the fuel bowl thus keeping a constant level of fuel in the carburetor.

The main jet circuit controls the fuel supply at all engine speeds. As engine speed, and/or load, increases (as controlled by the governor) the butterfly valve located in the throttle body opens allowing more air flow through the carburetor. A venturi in the throttle body creates a pressure differential which draws fuel through the main nozzle. The main jet, located and the inlet of the main nozzle, has a fixed orifice and is not adjustable. However main jets, with different orifices, are available for operation at other than sea level. The main jet meters the amount of fuel drawn into the engine. The main air jet meters the amount of air that will be mixed with the fuel, in the main nozzle before being drawn into the engine.

An Idle circuit is also provided to allow a richer condition at idle to allow the engine to run at RPM that are too low for the main jet circuit to operate efficiently.



TROUBLESHOOTING

CARBURETION TROUBLESHOOTING

Problem or Symptom → / Check or Solution ↓	Hard Starting	Fuel Leak at Carburetor	Engine Floods	Will Not Idle	Rich Idle	Idles with Needle Closed	Hunts / Erratic Idle	Idles Fast-Lean	Will Not Accelerate	Over Rich Acceleration	Hesitates	Will Not Run At High Speed	Low Power	Hunts at High Speed	Runs With Needle Closed	Engine Overspeeds
Plugged Air Filter	●			●	●				●	●		●	●			
Leaky Carb Gasket				●			●	●			●					●
Throttle Or Choke Shafts Worn	●			●			●	●					●	●		●
Choke Not Functioning Properly	●															
Plugged Atmospheric Vent		●	●													
Air Bleed Restricted	●			●	●		●		●		●			●		
Damaged Or Leaky O-Ring		●					●	●						●		●
Plugged Tank Filter Or Vent	●								●		●	●	●			
Fuel Pick-up Restricted	●			●			●		●		●	●		●		
Idle Port Restricted				●			●									
Damaged Adjustment Needles	●			●	●	●	●		●			●	●	●	●	●
Incorrect Float Height			●				●		●	●			●	●		
Main Nozzle Restricted	●								●		●	●	●	●		
Dirty, Stuck Needle and Seat	●	●	●										●			
Fuel Inlet Plugged	●			●			●						●	●		

ENGINE TROUBLESHOOTING

Problem or Symptom → / Check or Solution ↓	Engine cranks but will not start or starts hard	Engine won't stay running, runs rough or irregularly	Engine stalls frequently	Engine backfires	Engine surges–has uneven or uncontrolled rpm	Engine misses	Engine has low power under load	Engine has no spark	Engine will not crank	Exhaust smoke black, engine floods or burns rich	Exhaust smoke blue or excessive oil consumption	Engine has low oil pressure	Engine overheats	Engine overheats	Excessive engine noise or vibration
Spark plug fouled, defective, or gap not correct. Incorrect spark plug. Inspect/test.	●	●	●												
Defective ignition components. Inspect/test.	●	●	●	●	●	●	●		●			●	●		●
Starting motor worn or defective. Cranking rpm too slow, cables corroded, battery weak or defective. ACR not functioning properly. Move throttle to wide-open.	●	●	●		●	●	●	●	●			●			●
Tank outlet restricted or plugged, shut-off valve not fully open, fuel filter or line restricted. Fuel stale, contains water, or wrong type.	●	●	●	●		●		●			●		●	●	
Air filter element plugged, oil soaked, or restricted.	●	●	●		●	●			●	●					●
Choke, throttle, or governor linkage worn or misadjusted. Carburetor set too rich.	●	●	●	●	●	●			●			●			●
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets or adjusted too lean.	●	●	●	●	●	●		●	●			●	●		●
Carburetor, intake manifold, or cylinder head gaskets leaking or damaged.	●	●	●	●	●	●						●			●

Problem or Symptom / Check or Solution	Engine cranks but will not start or starts hard	Engine won't stay running, runs rough or irregularly	Engine stalls frequently	Engine backfires	Engine surges–has uneven or uncontrolled rpm	Engine misses	Engine has low power under load	Engine has no spark	Engine will not crank	Exhaust smoke black, engine floods or burns rich	Exhaust smoke blue or excessive oil consumption	Engine has low oil pressure	Engine overheats	Engine overheats	Excessive engine noise or vibration
Valve clearance incorrect. Burned or warped valves and seats. Defective springs.	●	●	●	●	●	●				●	●	●	●	●	●
Low compression from worn piston, rings, cylinder, valves or warped head.	●	●	●		●	●							●	●	●
Engine oil viscosity or level incorrect. Engine oil filter restricted. Oil pump worn or passages obstructed.	●	●			●	●							●	●	●
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.	●	●	●		●	●				●	●	●	●	●	●
Engine mounting hardware loose, broken, or missing.						●					●		●	●	

ENGINE TROUBLESHOOTING GUIDE

ENGINE HARD TO START

Remove spark plug and check spark by cranking engine while having the plug grounded against engine block. Install spare plug to avoid fuel spitting from the hole. See “SPARK TEST” on page 45.

CAUTION:
To avoid electric shock, do not hold plug. Make sure to hold plug cap.

- NO → Are sparks produced when spark plug is replaced?
  - YES → • Faulty spark plug. — Replace
  - NO → Are sparks produced between high tension lead and engine block with plug cap removed?
    - YES → • Faulty contact of plug cap terminal to lead. — Correct
    - NO → Are sparks produced between high tension lead and engine block when control unit is replaced?
      - YES → • Faulty control unit. — Replace
      - NO →
        - Faulty ignition coil with module. — Replace
        - Faulty high tension lead. — Replace
        - Incorrect ignition coil with module air gap. See “IGNITION COIL WITH MODULE AIR GAP ADJUSTMENT” on page 43. — Correct
        - Demagnetized flywheel. — Replace
- YES → Is compression sufficient? See “CYLINDER COMPRESSION TEST” on page 36.
  - YES → Crank engine several times, then remove spark plug and observe electrodes. Are they wet?
    - NO →
      - No fuel in the tank. — Add
      - Closed shutoff valve. — Open
      - Clogged fuel filter. — Clean
      - Closed shutoff solenoid. — Check or replace
      - Plugged air hole in tank cap. — Clean
      - Plugged fuel line. — Clean
    - YES →
      - Excessive use of choke. — Open choke
      - Clogged air cleaner. — Clean
      - Fuel level too high in float bowl. — Adjust
  - NO →
    - Worn piston/piston rings. — Replace
    - Stuck piston rings. — Clean or replace
    - Worn cylinder bore. — Bore or replace
    - Insufficient cylinder head tightening. — Retighten
    - Faulty contact of valve seat. — Lap or grind
    - Misadjusted valve. — Adjust
    - Warped cylinder head. — Repair or replace
    - Broken valve spring. — Replace
    - Stuck valve. — Clean or grind
    - Leaking head gasket. — Replace

Check carburetor. →
- Check for plugged fuel passage.
- Check for plugged air passage.
- Check float level.
- Check carburetor setting.

ENGINE MALFUNCTIONS AT LOW SPEED

Remove spark plug and check spark by cranking engine while having the plug grounded against engine block. Install spare plug to avoid fuel spitting from the hole.

CAUTION:
To avoid electric shock, do not hold plug. Make sure to hold plug cap.

WEAK →

- Faulty plug insulation. — Replace
- Fouled electrodes. — Clean
- Faulty high tension lead. — Replace
- Incorrect ignition coil air gap. — Correct
- Faulty ignition coil. — Replace

STRONG ↓

Is unusual smoke emitted out of muffler?

YES →

- Plugged air filter. — Clean
- Deposits in exhaust port. — Clean
- Misadjusted carburetor. — Adjust
- Overfilled crankcase. — Correct
- Worn piston/piston rings. — Repair
- Worn cylinder bore. — Replace
- Defective breather valve. — Correct

NO ↓

Gradually open throttle valve by hand. Does engine speed drop or does engine stall at a certain position?

YES →

- Passages in carburetor plugged. — Clean

NO ↓

Is air drawn through carburetor flange?

YES →

- Loose flange nuts. — Tighten
- Damaged gasket. — Replace
- Warped flange. — Replace

NO ↓

Is valve clearance normal? See “VALVE CLEARANCE ADJUSTMENT” on page 31.

NO →

- Misadjusted valve. — Adjust
- Worn camshaft lobes, pushrods. — Replace

YES ↓

Is alignment of timing gear marks correct?

NO →

- Incorrect valve timing. — Correct

ENGINE RUNS ERRATICALLY

Problem in fuel system (lack of fuel).	• Fuel pump not functioning. See “FUEL PUMP TEST” on page 32.	Test
	• Dust or water in fuel pipe 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
Problem in governor system.	• Incorrect governor linkage adjustment. See “GOVERNOR ADJUSTMENT” on page 35.	Correct
	• Faulty governor spring.	Replace
	• Governor gear assembly malfunction.	Check
Engine knocks.	• Stale fuel.	Change
	• Excessive carbon deposit in engine.	Clean
	• Excessive engine load.	Adjust
	• Engine overheating.	See **Has Low Power**

OIL CONSUMPTION IS EXCESSIVE

Is compression sufficient? See “CYLINDER COMPRESSION TEST” on page 36.

YES →

• Plugged oil ring groove.	Clean
• High oil level.	Adjust
• Worn valve stems and valve guides.	Replace
• Oil leakage along	Replace
• Governor Shaft.	Replace
• Oil seals leaking.	Replace
• Head gasket leaking.	Retighten or replace
• Drain plug leaking.	Retighten or replace
• Breather valve clogged.	Clean
• Drain-back hole in tappet chamber plugged.	Clean
• Incorrect oil viscosity.	Change

NO →

• Same as **Hard To Start**.

ENGINE HAS LOW POWER

Is engine overheated?

YES →

• Excessive engine load.	Adjust load
• Carburetor not properly adjusted (too lean).	Adjust
• Dirty or clogged air intake screen, shroud and engine fins.	Clean
• Carbon deposit in combustion chamber.	Clean
• Incorrect oil level.	Adjust

NO ↓

Is lubricating condition normal? See "OIL PRESSURE TEST" on page 38.

NO →

• Too much or too little oil in crankcase.	Correct
• Excessively contaminated lubricating oil/filter.	Change
• Faulty oil pump.	Replace

YES ↓

Is unusual smoke emitted out of muffler?

YES →

• Air cleaner clogged.	Clean
• Carbon deposit in exhaust port and muffler.	Clean
• Carburetor not properly adjusted.	Adjust
• Too much oil in crankcase.	Correct

NO ↓

Is compression sufficient? See "CYLINDER COMPRESSION TEST" on page 36.

NO →

• Same as **Hard To Start**.

FUEL CONSUMPTION IS EXCESSIVE

Is compression sufficient? See "CYLINDER COMPRESSION TEST" on page 36.

YES →

• Carburetor float or pilot air screw not properly adjusted.	Adjust
• Air cleaner clogged.	Clean
• High idling speed. See "FAST IDLE SPEED ADJUSTMENT" on page 35.	Adjust
• Choke valve not fully open. See "CHOKE ADJUSTMENT" on page 34.	Adjust

NO →

• Same as **Hard To Start**.

STARTING MOTOR TROUBLESHOOTING GUIDE

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

1. Turn engine switch to "START" position and check condition.

CAUTION

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

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

STARTING MOTOR DOES NOT ROTATE

Click sound from solenoid (switch)?

NO

• Faulty battery.	Charge or replace
• Faulty leads or connection.	Repair or replace
• Melted fuse.	Replace
• Faulty engine switch.	Repair or replace
• Faulty solenoid (switch).	Replace

YES

• Weak battery.	Charge or replace
• Faulty leads or connection. (Solenoid to motor)	Repair or replace
• Faulty solenoid (switch). (Main terminal in solenoid)	Replace
• Faulty starting motor.	Repair or replace

STARTING MOTOR ROTATES SLOWLY

Is battery normal and charged? See "BATTERY TEST" on page 52 in ELECTRICAL SECTION.

NO

• Weak battery.	Charge or replace

YES

• Faulty leads or connection. (Solenoid to motor)	Repair or replace
• Faulty solenoid (switch). (Main terminal in solenoid)	Replace
• Faulty starting motor.	Repair or replace
• Faulty engine.	Repair or replace

STARTING MOTOR ROTATES BUT CAN NOT CRANK ENGINE

Does pinion mesh with ring gear?

NO

• Worn pinion or ring gear.	Replace
• Incorrect starter alignment.	Correct

YES

• Faulty clutch.	Replace

STARTING MOTOR DOES NOT STOP WITH KEY SWITCH IN OFF POSITION

Can stop starter with key switch in off position.

NO

• Faulty engine switch.	Repair or replace
• Faulty solenoid (switch).	Replace

YES

• Faulty pinion or ring gear	Repair or replace
• Incorrect starter alignment.	Correct
• Faulty pinion return mechanism.	Repair or replace

TESTS AND ADJUSTMENTS

FLYWHEEL SCREEN ADJUSTMENT

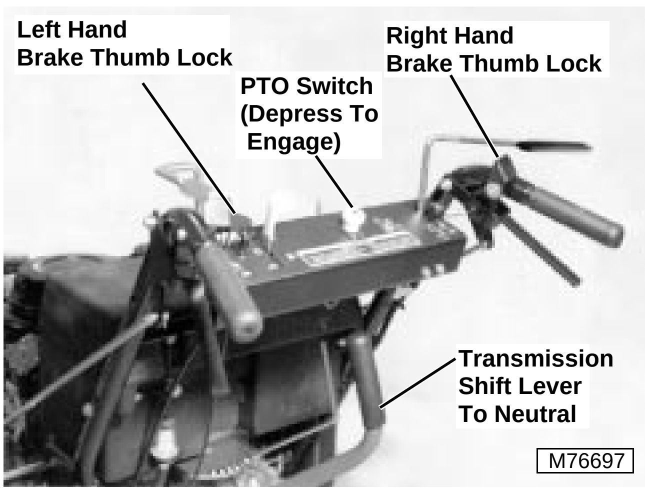
Reason:

To insure that there is sufficient gap between the flywheel screen and the blower housing.

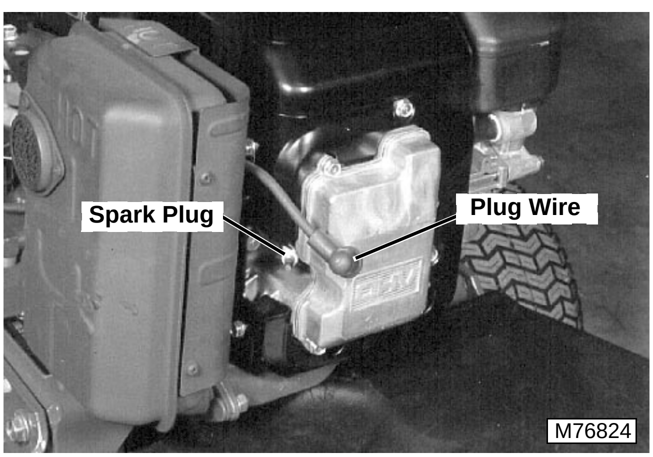
Equipment:

- Feeler Gage 1.5 mm (0.059in.)

Procedure:

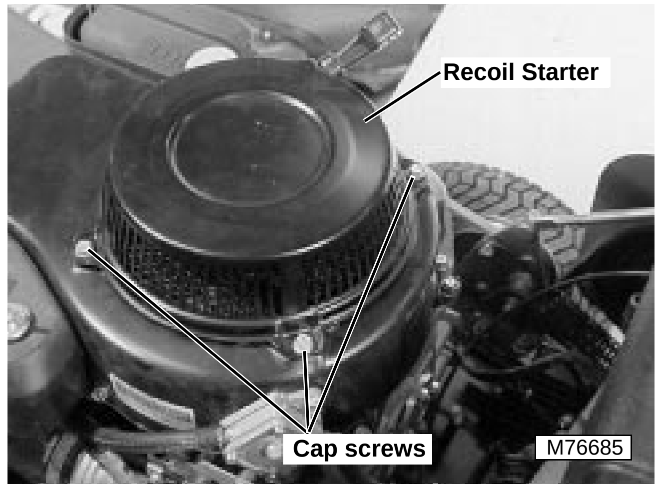


1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.

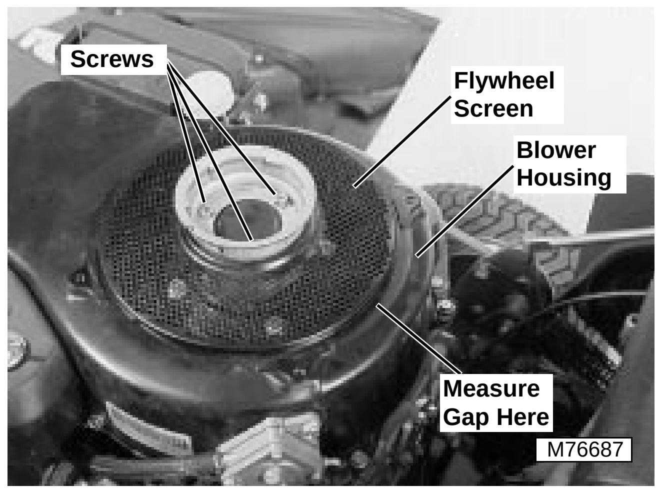


1. Disconnect spark plug wire and ground.

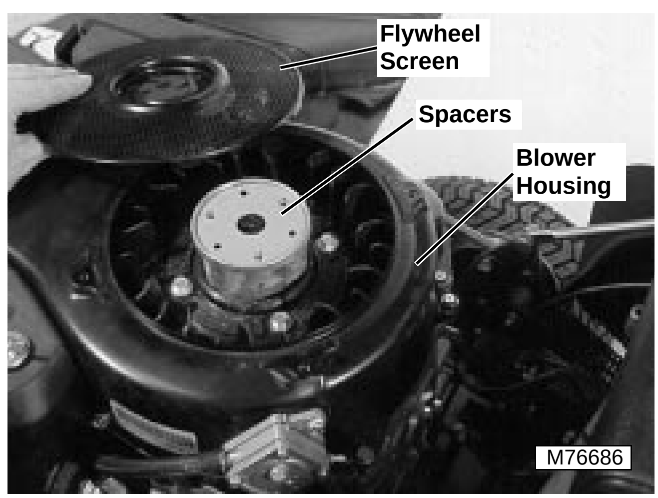
IMPORTANT: Spark plug wire must be grounded or electronic ignition could be damaged.



2. Remove four cap screws securing recoil starter to engine. Remove recoil starter.



3. Check gap between flywheel screen and blower housing. If gap is less than **1.5 mm (0.059 in.)** remove three screws securing starter pawl bracket to flywheel. Remove bracket and flywheel screen.



4. Add or subtract spacers below flywheel screen to adjust gap between flywheel screen and blower housing to **1.5 mm (0.059 in.)**.
5. Replace screen on spacer and shims.
6. Place starter pawl bracket on flywheel screen and secure with three socket head screws.
7. Replace recoil starter and secure with four (4) cap screws.

VALVE CLEARANCE ADJUSTMENT

Reason:

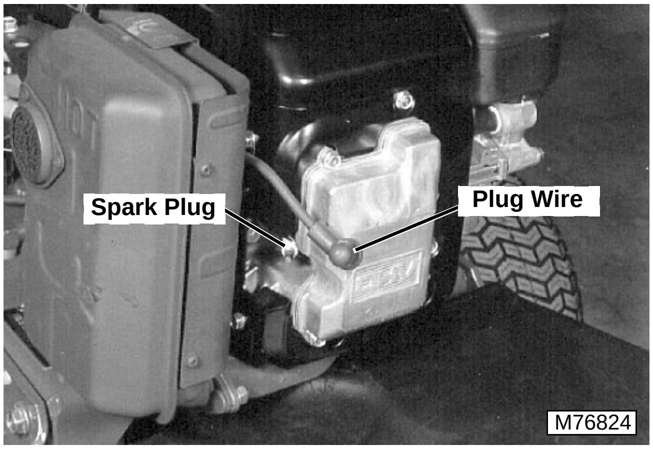
To insure that there is sufficient gap between the valve and the rocker arm.

Equipment:

- Feeler Gage 0.15 mm (0.006in.)

Procedure:

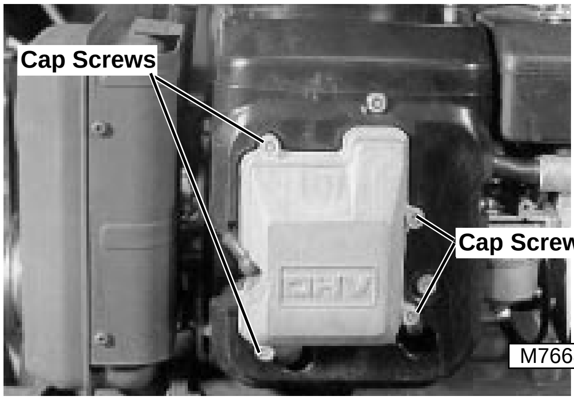
IMPORTANT: Perform valve clearance measurement or adjustment when engine is COLD which means engine operating temperature has reached normal shop temperature of 15-30°C (60-85°F). Proper valve clearance is essential for the engine to operate properly



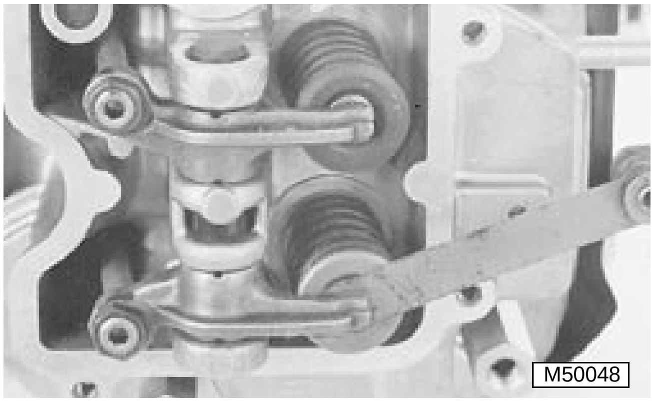
1. Disconnect spark plug wire and ground.

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

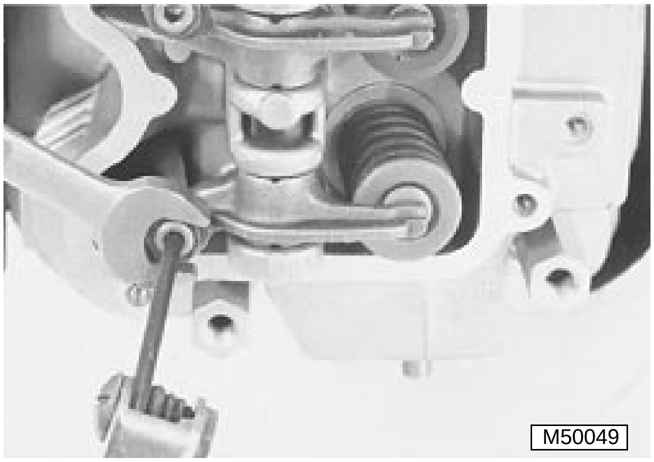
2. Remove spark plug to allow engine to turn over easily.



3. Remove four cap screws securing valve cover to block.
4. Turn crankshaft until piston is at highest position in compression stroke.



5. Measure clearance.



6. If necessary, adjust clearance to **0.15 mm (0.006 in.)**
7. Replace Valve Cover.

FUEL PUMP TEST

Reason:

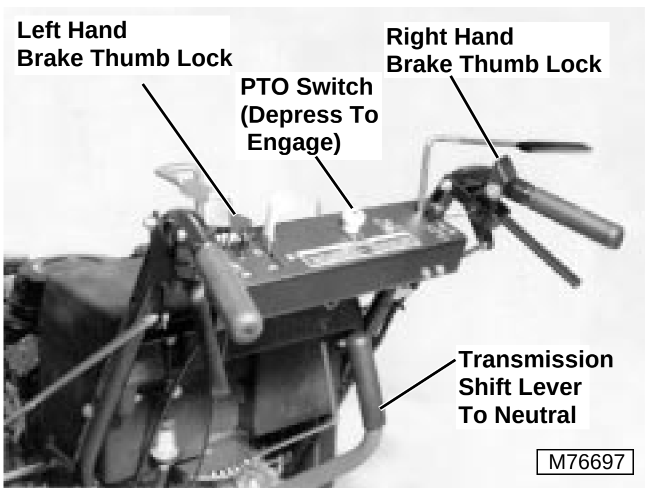
To check condition of fuel pump and determine fuel pressure.

Equipment:

- JDG356 Pressure Gauge
- Graduated Container

Procedure:

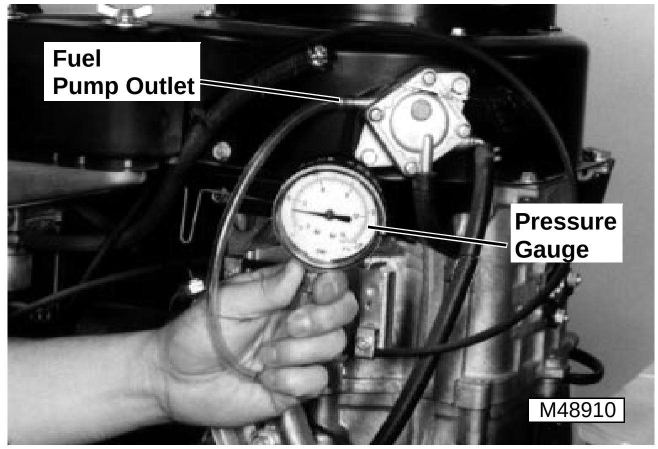
NOTE: Battery removed for clarity of photo. If necessary, pull battery outward until test can be made.



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Start and run engine at SLOW idle for 1 minute to fill carburetor with fuel.
3. Stop the engine.

CAUTION

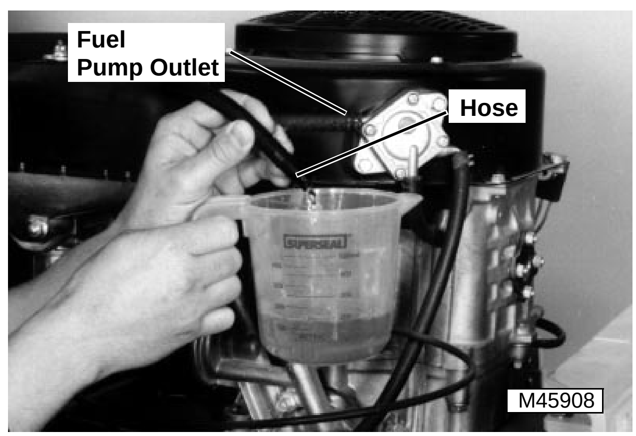
Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.



4. Disconnect fuel pump outlet hose and plug end of hose.
5. Connect JDG356 Pressure Gauge to fuel pump outlet.
6. Start and run engine at fast idle for 15 seconds, then record pressure reading.
7. Stop engine.

CAUTION

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



8. Remove pressure gauge and connect fuel pump outlet hose.
9. Connect one end of a short length of fuel hose to fuel pump outlet and put other end in a graduated container.
10. Start and run engine at fast idle for 15 seconds, then stop the engine and record container measurement.
11. Remove plug from end of fuel hose and reconnect to fuel pump outlet.

Specifications:

Minimum pressure . . . . 6.12 kPa (0.9 psi)
Minimum flow:
FC401V-BS05 and FC420V-AS19. 80 mL/15 seconds (2.7 oz/15 seconds)
FC540V-AS17 . . . . 90 mL/15 seconds (3 oz/15 seconds)
Engine speed . . . . .3350 rpm

Results:

If fuel pump pressure or flow does not meet the specifications, check the following:

- Fuel lines, filter, shutoff valve, and fuel tank cap for restrictions
- Check crankcase vacuum
- Repair or replace fuel pump

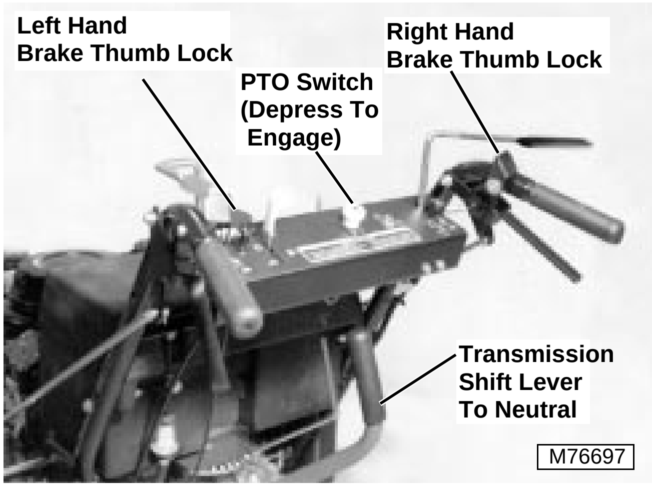
THROTTLE CABLE ADJUSTMENT

Reason:

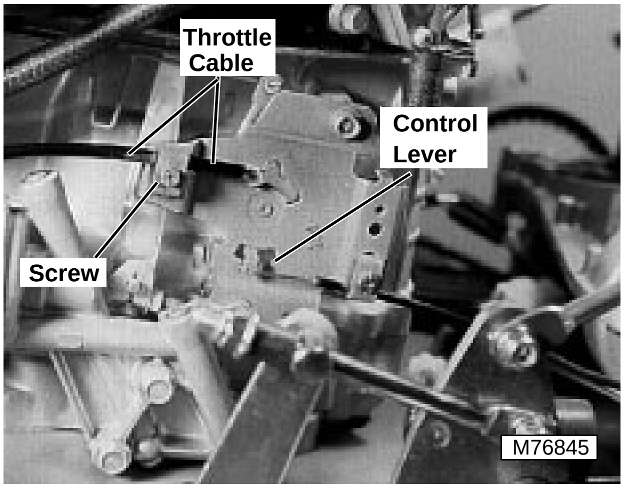
To make sure the throttle control lever contacts the slow idle stop at slow idle and the fast idle stop at fast idle.

Procedure:

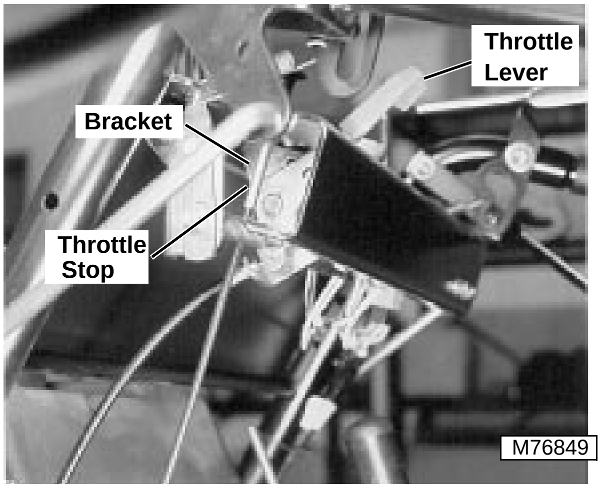
NOTE: Adjust slow idle speed before adjusting throttle cable. *See "SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES" on page 39.*



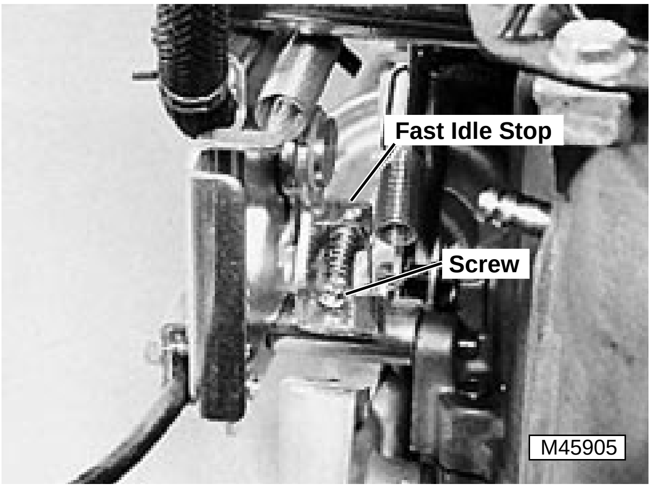
1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Loosen screw.



3. Move throttle lever to the slow idle position until the throttle lever stop is **2-4 mm (0.080-0.160 in.)** away from bracket.
4. Push throttle cable forward to remove slack and tighten screw.



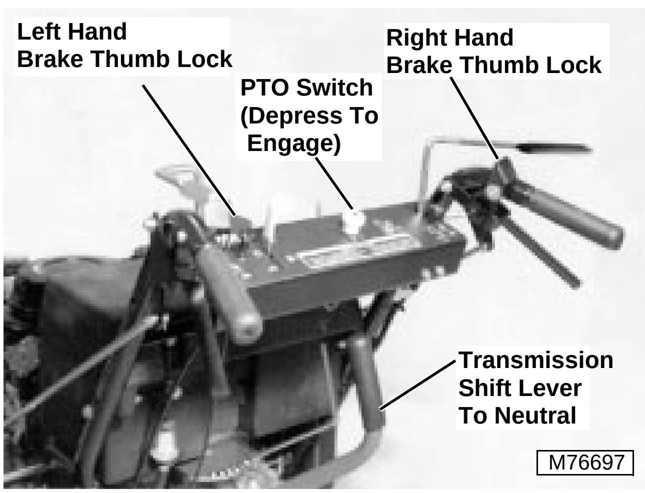
5. Move throttle lever to the fast idle position. Be sure the throttle control lever contacts the control lever plate (fast idle stop). Also be sure the throttle control lever does not contact the throttle cable housing.
6. Move throttle lever to the slow idle position. Be sure the throttle control lever screw contacts the control lever plate.
7. Move throttle lever through full range to be sure linkage is not binding.

CHOKE ADJUSTMENT

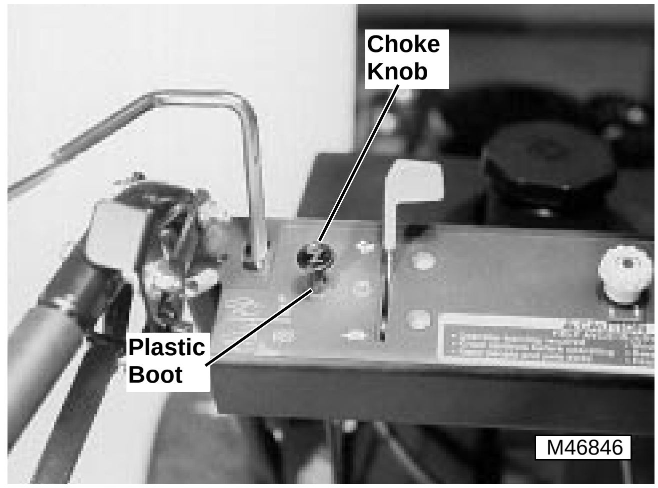
Reason:

To make sure the choke plate is fully closed when the choke knob is in the choke position.

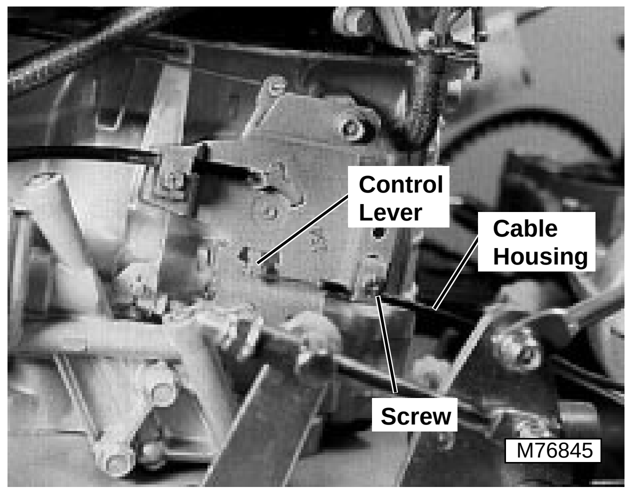
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Make sure that choke control knob is fully depressed.



3. Loosen screw.
4. Hold choke control lever in the full open position. Adjust the choke cable housing until there is **2—3 mm (0.08—0.12 in.)** clearance between choke knob and plastic boot with knob pushed inward.
5. Hold choke cable and tighten screw.
6. Pull choke knob out to full choke position. Be sure choke plate is fully closed.
7. Move choke knob in and out several times to be sure linkage is not binding.

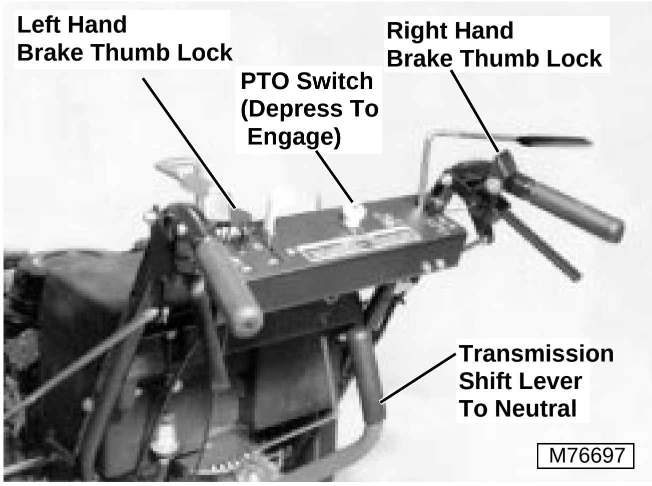
GOVERNOR ADJUSTMENT

Reason:

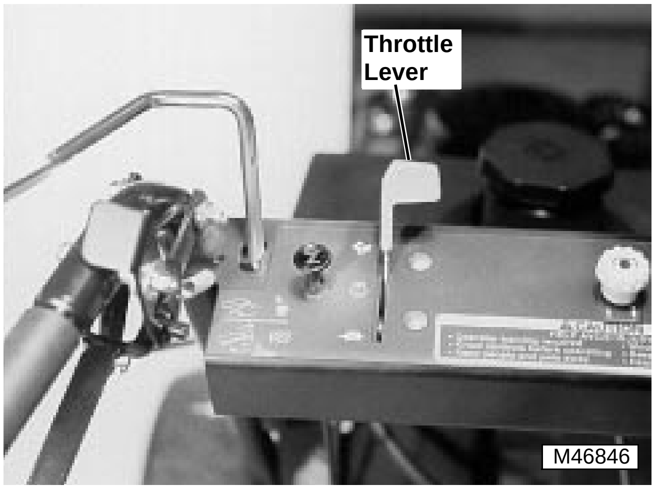
To make sure the governor shaft contacts the flyweight plunger when the engine is stopped.

NOTE: Adjust throttle cable before adjusting governor linkage. Battery removed for clarity of photo. If necessary, pull battery outward until adjustment can be made.

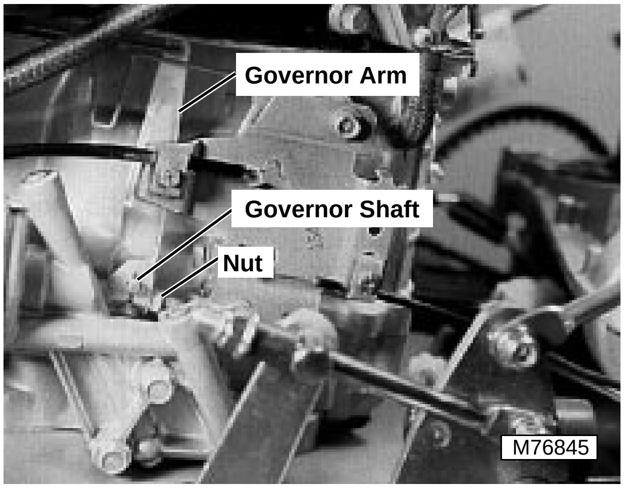
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Move throttle lever to fast idle position.



3. Loosen nut.
4. Hold governor arm in the full upright right position. Turn governor shaft clockwise until governor shaft stops. Hold governor arm and governor shaft in position and tighten nut.
5. Move throttle lever through full range to be sure linkage is not binding.

FAST IDLE SPEED ADJUSTMENT

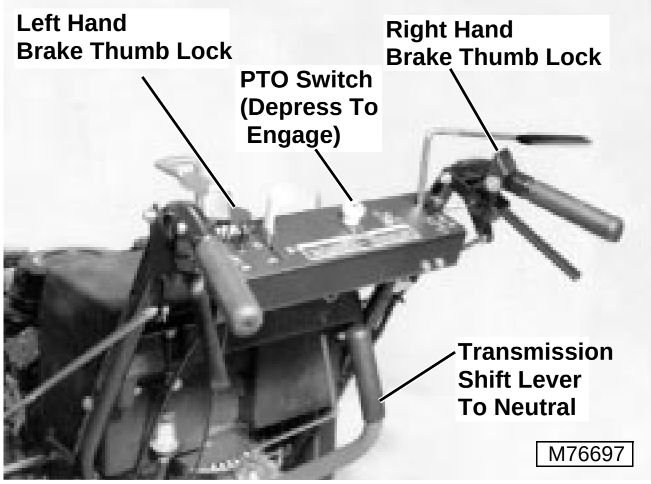
Reason:

To set engine fast idle rpm.

Equipment:

- JTO7270 Digital Pulse Tachometer

Procedure:



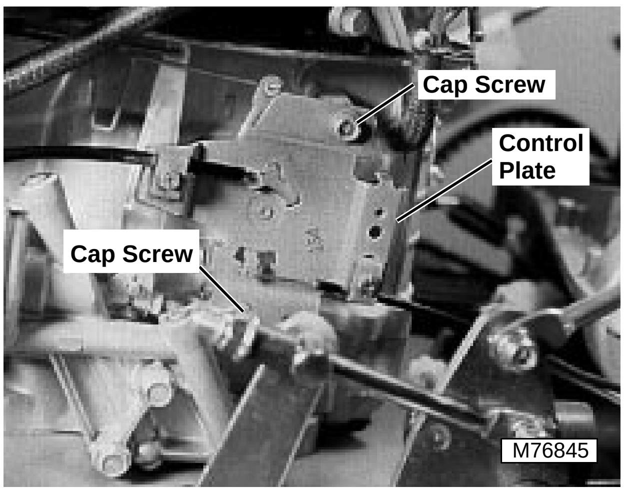
1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Start and run engine at MEDIUM idle for five minutes.

> **⚠ CAUTION**
>
> **Engine will be HOT. Be careful not to burn hands**

3. Move throttle control lever to fast idle position.
4. Use tachometer to check engine rpm.

Specifications:

Fast idle (No Load). . . . . 3350±100 rpm



Results:

- If fast idle speed does not meet the specifications, loosen cap screws.
- Move throttle control plate forward to increase rpm or rearward to decrease rpm until fast idle speed matches specifications above.
- Hold the throttle control plate and tighten cap screws.

CYLINDER COMPRESSION TEST

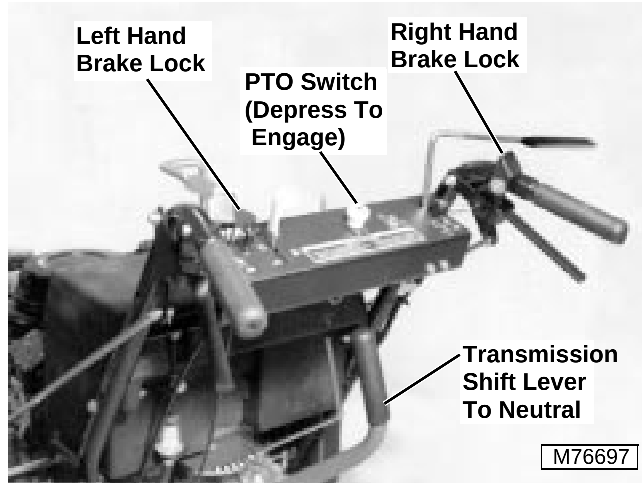
Reason:

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

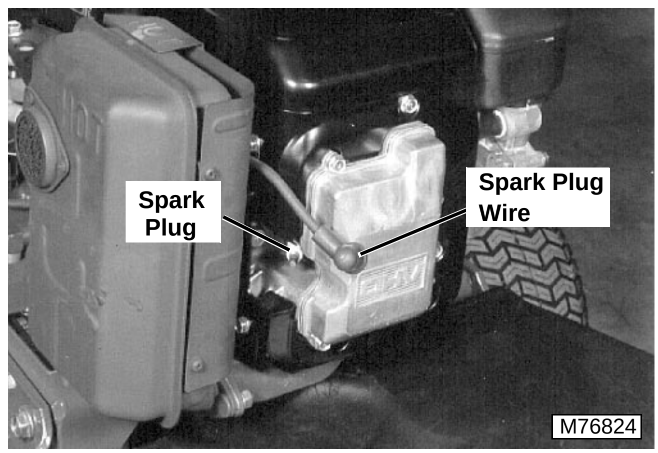
Equipment:

- JDM-59 Compression Gauge

Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and locks.

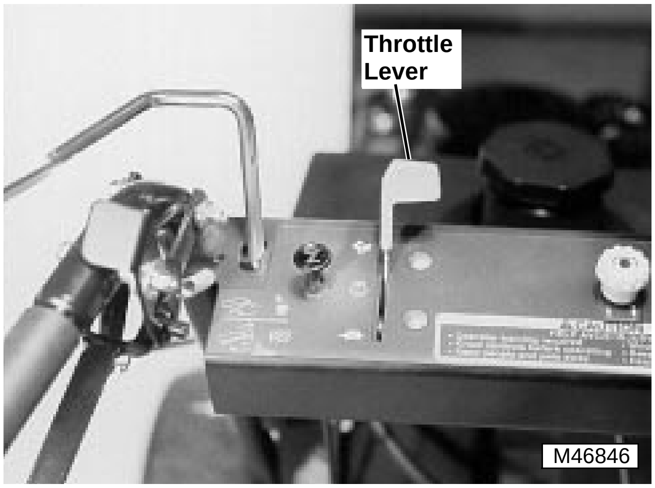


2. Disconnect and ground spark plug wire.

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

3. Remove spark plug and install JDM-59 Compression Gauge.

IMPORTANT: For best accuracy, test compression when engine is COLD which means engine operating temperature has reached normal shop temperature of 15-30 degrees C (60-85 degrees F).



4. Move throttle lever to fast idle position.

IMPORTANT: Throttle "must" be fully open to get an accurate compression test.

5. Crank engine and record compression reading.

Specifications:

Minimum Compression . . . . .483 kPa (71 psi).

Results:

- If compression is low, perform the compression leak check.

COMPRESSION LEAK CHECK

Reason:

To verify the source of the compression leak.

Equipment:

- JDM-59 Compression Gauge

Procedure:

1. Remove compression gauge.
2. Put clean engine oil on piston rings through spark plug hole.
3. Repeat cylinder compression test procedure.

Results:

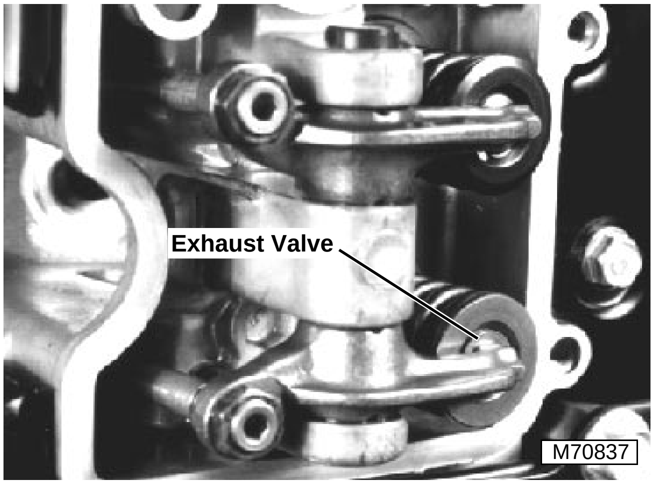
- IF COMPRESSION PRESSURE INCREASES, check rings, piston and cylinder bore for broken rings, scoring, wear or damage. Replace as necessary.
- IF COMPRESSION PRESSURE IS STILL LOW, check for leaking intake or exhaust valves, valve seal or cylinder head gasket. Replace as necessary.

AUTOMATIC COMPRESSION RELEASE (ACR) CHECK

Reason:

To determine if the ACR is opening the exhaust valve.

Procedure:



NOTE: Always perform valve adjustment before checking ACR.

1. Immediately after adjusting the valves, while valve cover and spark plugs 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.

Specifications:

Minimum exhaust valve ACR movement. . . . . 0.25 mm (0.010 in.)

Results:

- If the exhaust valve does not open or depress properly, the automatic compression release tab is faulty. See "AUTOMATIC COMPRESSION RELEASE (ACR) INSPECTION" on page 63.

CRANKCASE VACUUM TEST

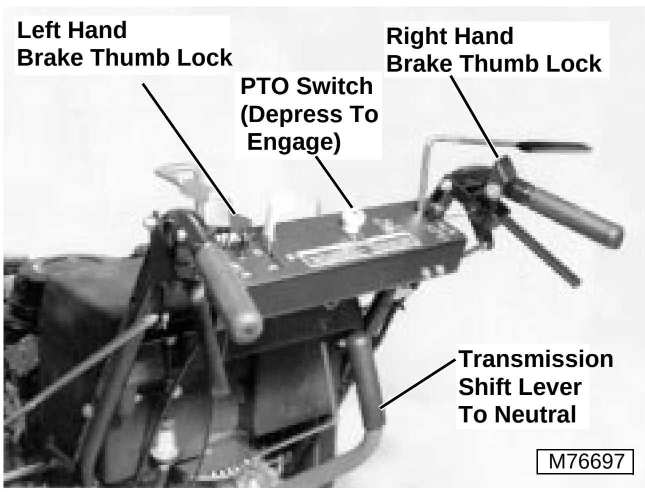
Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil leakage past the seals and gaskets and affect fuel pump operation.

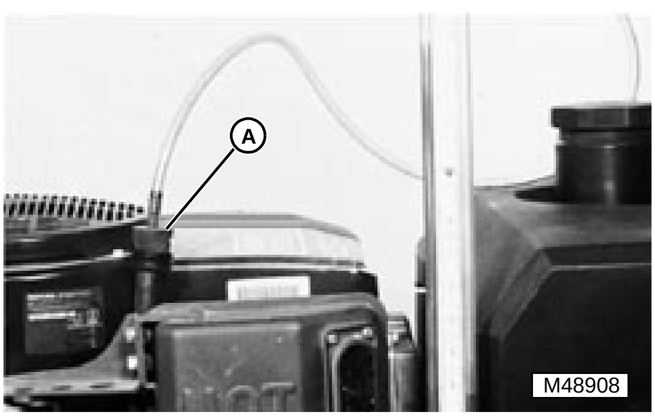
Equipment:

- AHT8741-F66 Plug (A)
- JTO5703 Barb Fitting (B)
- JTO5699 Line (C)
- JTO5698 U-Tube Manometer (D)

Connections:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Remove dipstick.



3. Put plug (A) in dipstick hole.
4. Finish making test connections from JTO5697 U-Tube Manometer Kit.
5. Close manometer vent.

Procedure:

IMPORTANT: Keep the vent side of manometer closed until the engine is running or fluid in manometer will be sucked into crankcase.

1. Start and run engine at fast idle.
2. Open manometer vent and record crankcase vacuum reading.
3. Close manometer vent and stop engine.

Specifications:

Minimum crankcase vacuum . . 25 cm (10 in.) water
Engine speed . . . . .3350 rpm

Results:

If crankcase vacuum does not meet specifications, check the following:

- Breather reed valve clearance and condition
- Seals and gaskets for leakage
- Fuel pump vacuum hose leakage
- Rocker arm cover O-ring for leakage
- Rings, piston and cylinder bore for wear or damage

OIL PRESSURE TEST

Reason:

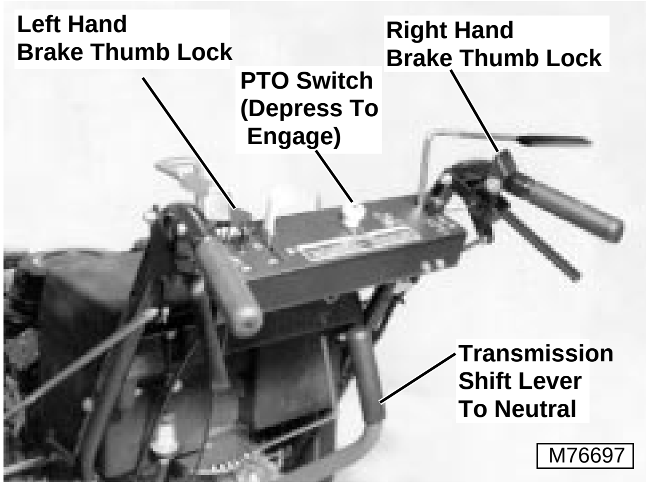
To be sure engine has enough oil pressure to lubricate the internal components.

Equipment:

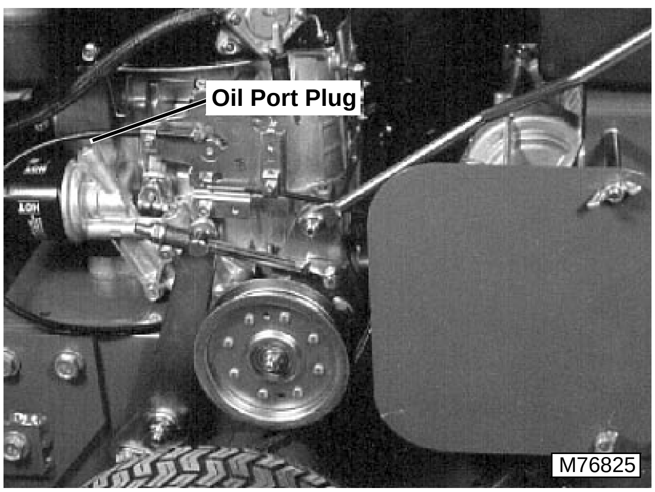
- JTO3338 90 degree Elbow Fitting
- JTO3017 Test Hose
- JTO3344 Gauge, 2000 kPa (300 psi)

Connections:

NOTE: Battery removed for clarity of photo. If necessary, pull battery outward until test can be made.



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Check engine oil level.



3. Remove oil pressure port plug.
4. Make test connections with elbow fitting, hose, and gauge.
5. Start and run engine at MEDIUM idle for 5 minutes to heat engine oil to normal operating temperature.

Procedure:

1. Start and run engine at fast idle.
2. Record oil pressure reading.

Specifications:

Minimum oil pressure . . . . 240 kPa (35 psi)
Engine speed . . . . .3250—3450 rpm

Results:

If oil pressure does not meet the specifications, inspect or replace the following:

- Oil pressure relief valve for damage
- Oil pump worn or damaged
- Suction screen plugged
- Oil filter plugged
- Oil passages plugged

SLOW IDLE SPEED ADJUSTMENT CARB/EPA ENGINES

FC401V-BS05 . . . . S/N(FC401VA08732 -)
FC420V-AS19 . . . . S/N(FC420VC03992 -)
FC540V-AS17 . . . . S/N(FC540VA27926 -)

Carburetor Part Number:

FC401V-BS05 32455
FC420V-AS19 32453
FC540V-AS17 32296

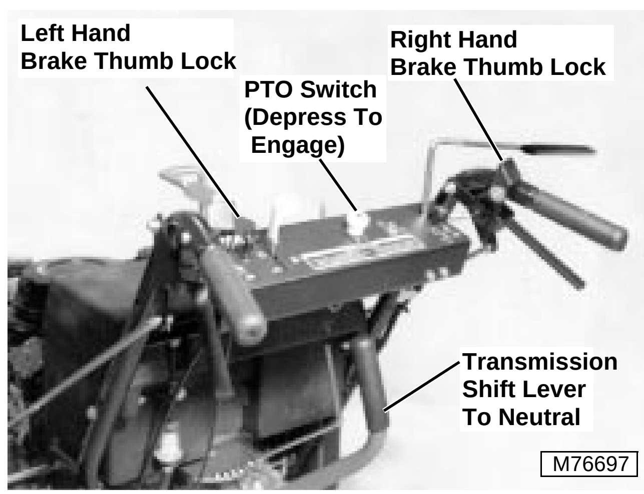
Reason:

To set engine slow idle rpm.

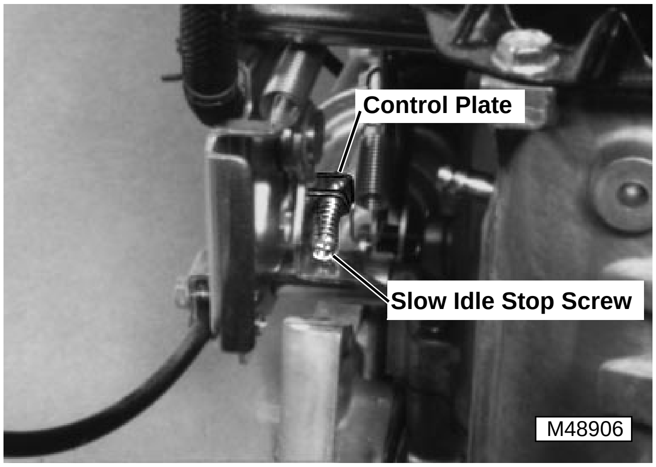
Equipment:

- JTO7270 Digital Pulse Tachometer

Procedure:



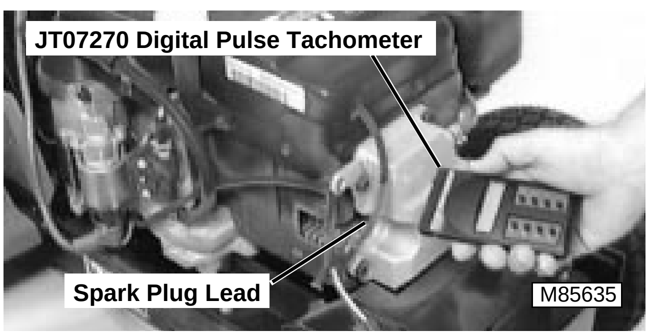
1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



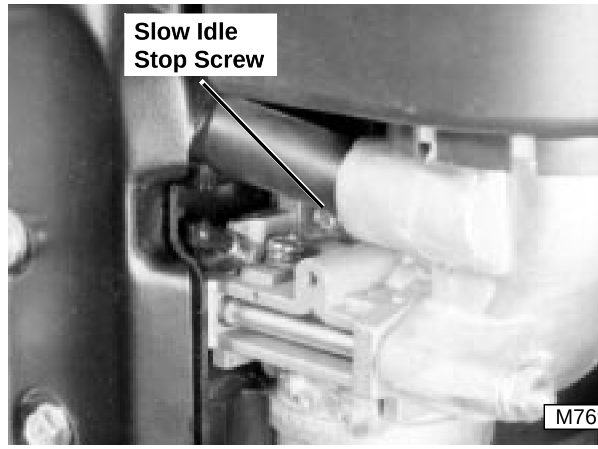
2. Turn SLOW idle stop screw on throttle control lever counterclockwise until it does not contact the throttle control plate.
3. Start engine and run at MEDIUM idle for 5 minutes.
4. Move throttle lever to SLOW idle position.

⚠ CAUTION

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



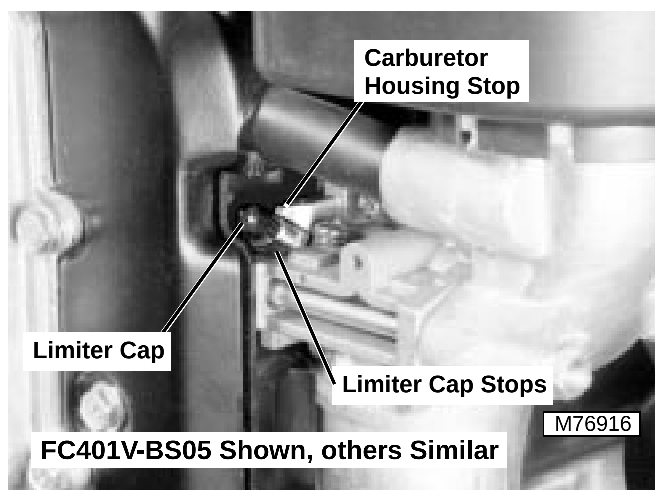
5. Check engine rpm with JT07270 Digital Pulse Tachometer.



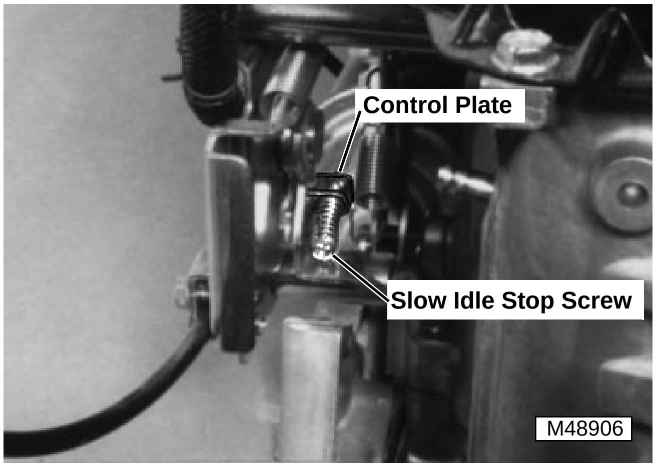
6. Turn slow idle stop screw on carburetor until slow idle speed is **1450 ±75 rpm.**

ATTENTION!

DO NOT remove the cap on the idle mixture screw unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.



7. Rotate idle mixture screw back and forth between limiter cap stops until smoothest idle is obtained.



8. Turn slow idle stop screw on throttle control arm until slow idle speed is **1550±75 rpm**.
9. Adjust throttle cable. See “THROTTLE CABLE ADJUSTMENT” on page 33.

SLOW IDLE MIXTURE ADJUSTMENT CARB/EPA ENGINES

FC401V-BS05 . . . . S/N(FC401VA08732 -)
FC420V-AS19 . . . . S/N(FC420VC03992 -)
FC540V-AS17 . . . . S/N(FC540VA27926 -)

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

Carburetor Part Number:

FC401V-BS05 32455
FC420V-AS19 32453
FC540V-AS17 32296

ATTENTION!

Do not attempt to adjust the slow idle mixture screw unless you are a factory trained technician with authorization to service CARB/EPA Certified engines.

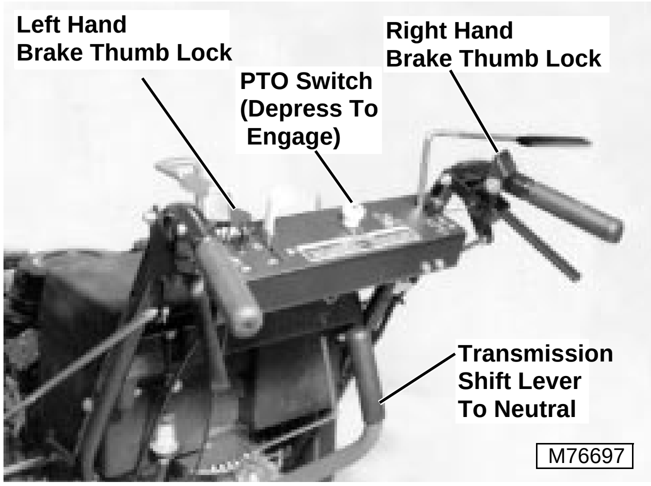
Reason:

To set engine slow idle mixture and rpm. This insures the engine meets CARB/EPA emissions requirements.

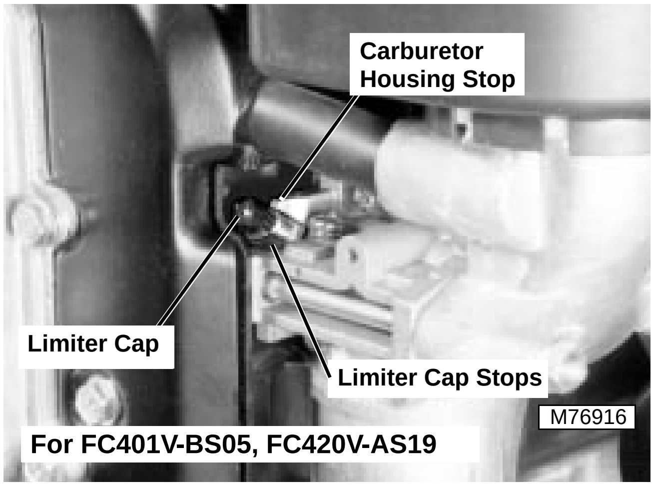
Equipment:

- JTO7270 Digital Pulse Tachometer

Procedure:

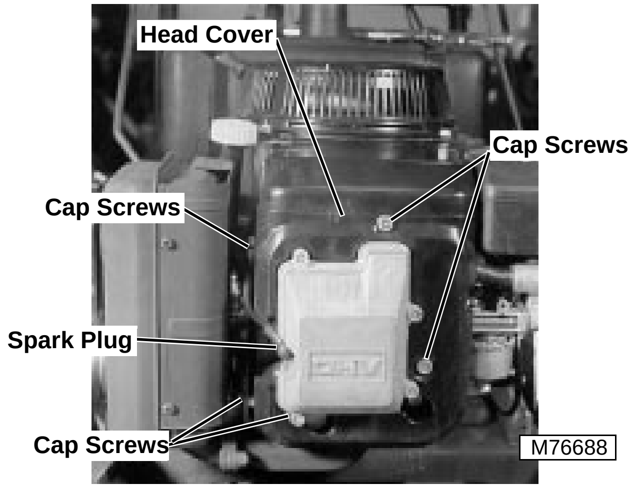


1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.

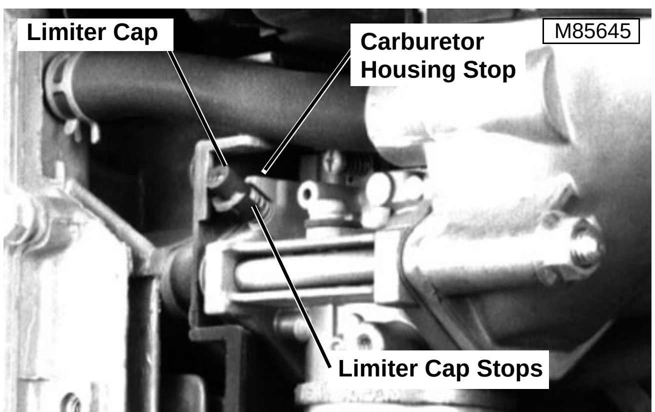


For FC401V-BS05, FC420V-AS19

2. On **FC401V-BS05, FC420V-AS19**, use screwdriver to pry off limiter cap from slow idle mixture screw.

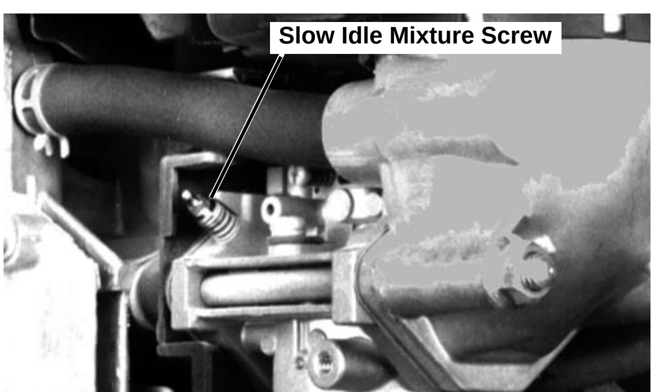


3. On **FC540V-AS17** head cover must be removed prior to removal of the idle screw cap. To remove head cover:
• Disconnect spark plug.
• Remove five (5) cap screws securing head cover.
• Remove cover.



FC540V-AS17 Shown With Head Cover Removed

4. Use screwdriver to pry off limiter cap from slow idle mixture screw.



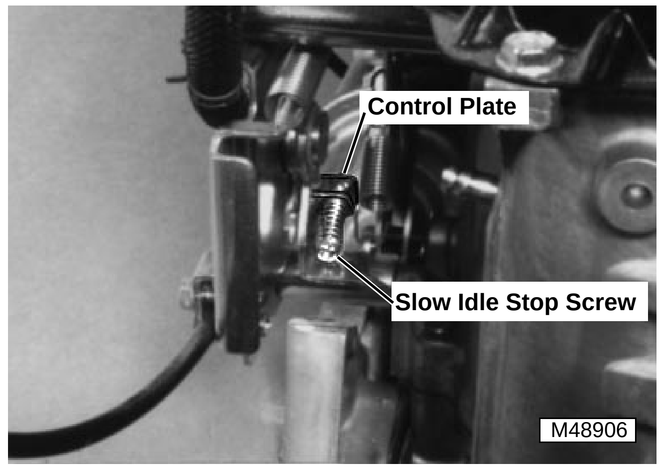
FC540V-AS17 Shown, Others Similar

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

5. Turn slow idle mixture screw clockwise until lightly seated, then turn counterclockwise to specification.

Specifications:

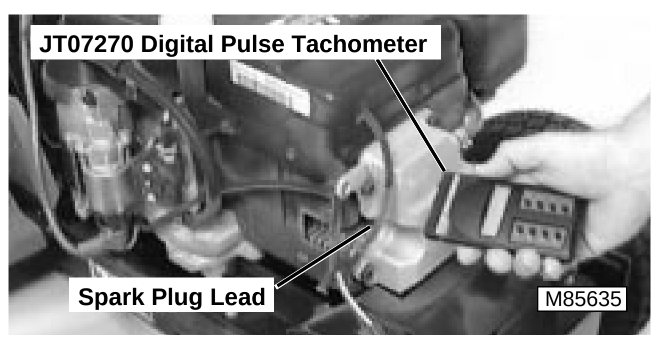
FC401V-BS05, FC420V-AS19 . . . . 1-7/16 Turns
FC540V-AS17 . . . . 1-5/8 Turns



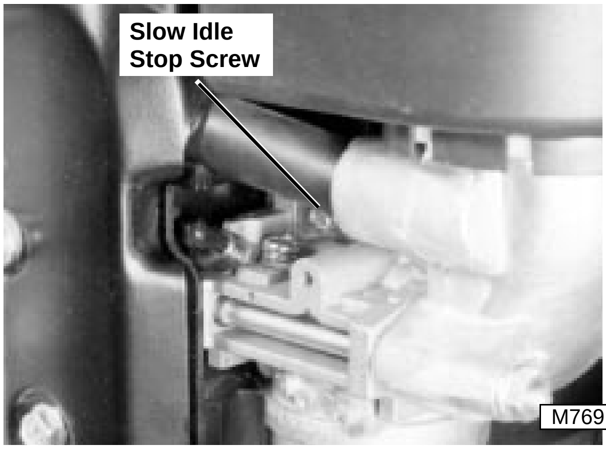
6. Turn SLOW idle stop screw on throttle control lever counterclockwise until it does not contact the throttle control plate.
7. Start engine and run at MEDIUM idle for 5 minutes.
8. Move throttle lever to SLOW idle position.

⚠ CAUTION

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

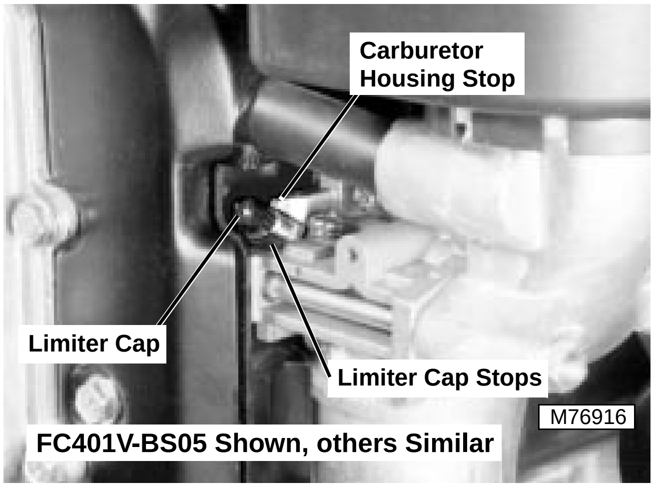


9. Check engine rpm with JT07270 Digital Pulse Tachometer.



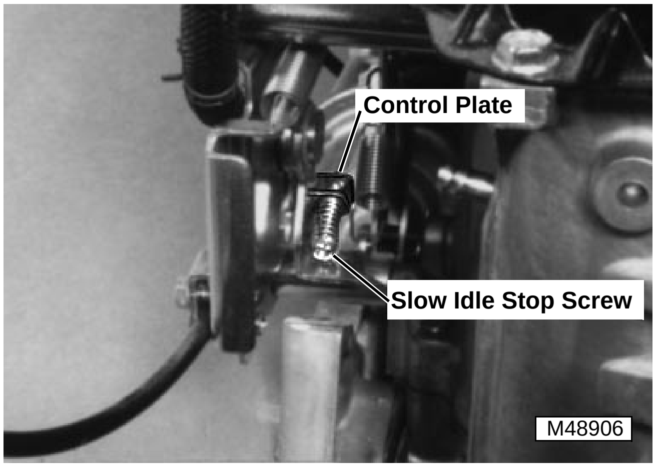
10. Turn slow idle stop screw on carburetor until slow idle speed is **1450 ±75 rpm.**
11. Turn slow idle mixture screw clockwise until engine speed drops, then counterclockwise until engine speed increases and begins to drop again.
12. 10. Turn slow idle mixture screw clockwise for highest engine speed.

IMPORTANT: DO NOT allow slow idle mixture screw to rotate during installation of limiter cap!

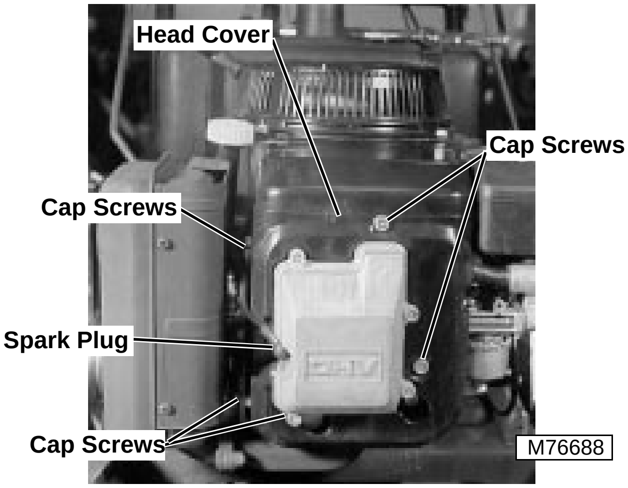


FC401V-BS05 Shown, others Similar

13. Center LIMITER CAP stop(s) between CARBURETOR HOUSING stop and install limiter cap onto slow idle mixture screw.



14. Turn slow idle stop screw on throttle control arm until slow idle speed is **1550±75 rpm**.



15. On **FC540V-AS17** replace head cover and secure with five (5) cap screws removed previously. Connect spark plug.
16. Adjust throttle cable. See “THROTTLE CABLE ADJUSTMENT” on page 33.

IGNITION COIL WITH MODULE AIR GAP ADJUSTMENT

Reason:

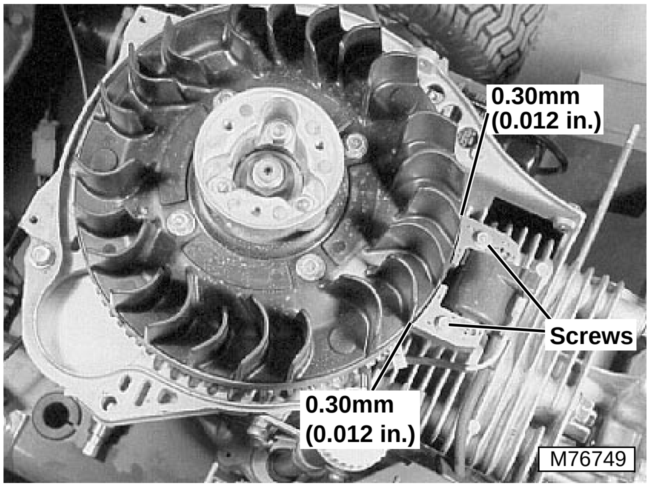
To insure that the gap between the ignition coil with module and the flywheel are correct.

Equipment:

• Feeler Gage 0.30 mm (0.012 in.)

Procedure:

1. Turn flywheel magnet away from armature.



2. Loosen screws.
3. Insert a **0.30 mm (0.012 in.)** feeler gauge between flywheel and **both** legs of armature.
4. Press armature tight to gage.
5. Tighten screws. Turn flywheel to remove gauge.

IGNITION COIL WITH MODULE TEST

Reason:

To determine the condition of the integrated ignition coil with module.

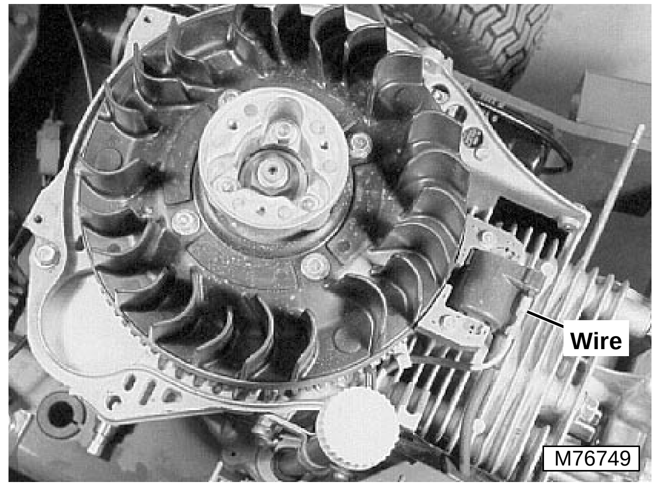
Equipment:

• JTO5791 Digital Multimeter

Procedure:

NOTE: This procedure will eliminate possible causes in a logical order eliminating the easiest components to test and the easiest procedures to accomplish first. After each step is accomplished check for a good spark before going to the next step.

1. Test or replace spark plug. See “SPARK TEST” on page 45.
2. Test or replace spark plug cap. Resistance value is marked on cap.



3. Disconnect the white wire from the ignition coil with module and test for a spark.
4. Replace the ignition coil with module with a known good one and test for spark.
5. Check air gap at the flywheel and adjust if necessary. See “IGNITION COIL WITH MODULE AIR GAP ADJUSTMENT” on page 43.

Results:

• If the engine starts or produces a spark after the white wire is disconnected check the wiring and ignition switch for a short to ground.
• If the engine fails to start or produce a spark when the ignition coil with module is replaced, either the air gap is not set properly or the flywheel has the wrong polarity. Reset air gap and/or replace flywheel.

SPARK PLUG GAP ADJUSTMENT

Reason:

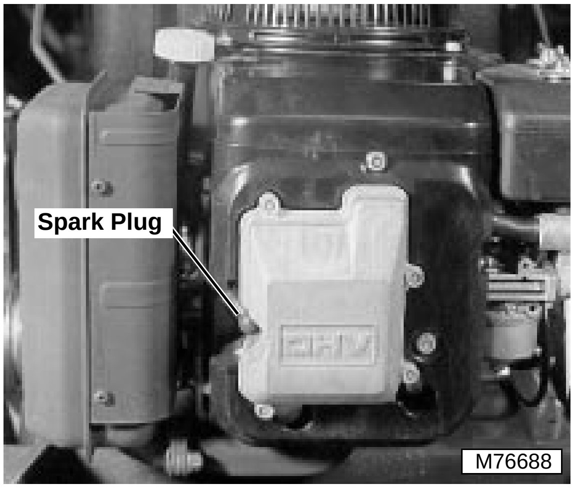
To insure that the gap between the ignition coil with module and the flywheel are correct.

Equipment:

• Feeler Gage 0.76 mm (0.030 in.)

Procedure:

1. Stop engine and let it cool.



2. Disconnect spark plug wire and remove plug.
3. Inspect the plug. If plug is damaged, replace it.
4. Remove excess carbon with a wire brush.
5. Use a wire type gauge to check gap. Adjust gap to **0.76 mm (0.030 in)**.
6. Install and tighten plug to **20 N•m (15 lb-ft).**
7. Connect plug wire.

SPARK TEST

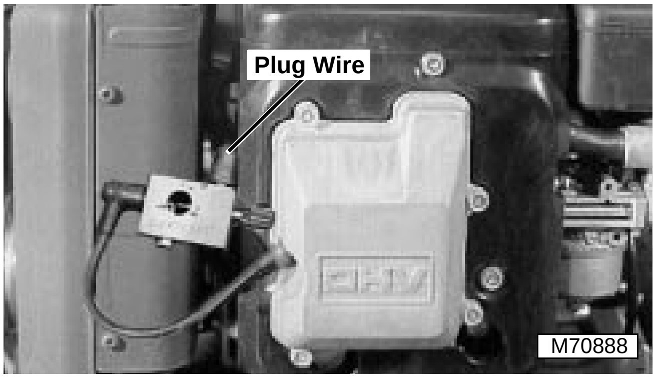
Reason:

The spark test should be performed to determine the quality of spark produced by the ignition coil with module. The module air gap must be properly set, and the flywheel magnets in good condition. There are no repairable components in the ignition coil with module. If it fails the test, replace it.

Equipment

- D05351ST Spark Tester

Procedure:



1. Disconnect spark plug wire.
2. Install a spark tester on plug wire.
3. Set gap at **1.5 mm (0.062 in.)**.
4. Crank engine and check spark. Engine should produce a hot, “blue” spark. If a weak yellow spark is produced, the ignition coil with module may be faulty.

REPAIR

ENGINE REMOVAL

1. Drain engine oil.

Oil Capacity:

With Filter:

FC401V-BS05, FC420V-AS19 & AS21 1.5 L (3.17 pt.)

FC540V-AS17 & AS18 . . . . 1.9 L (4.00 pt.)

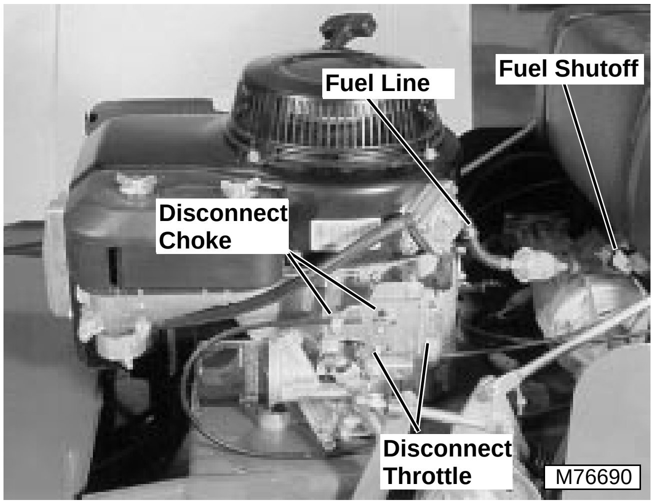
Without Filter:

FC401V-BS05, FC420V-AS19 & AS21 1.3 L (2.75 pt.)

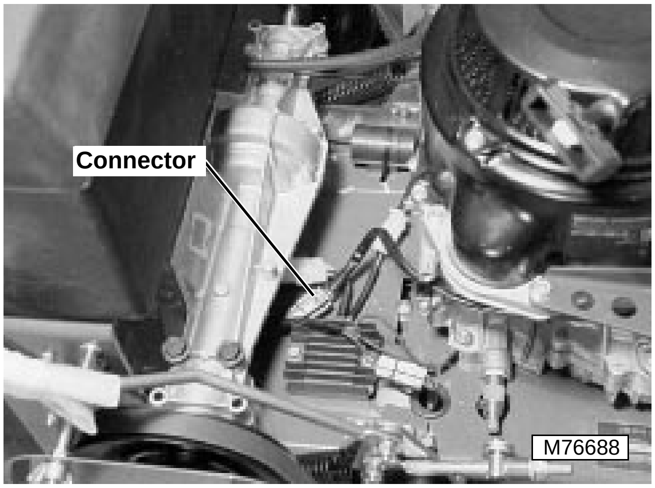
FC540V-AS17 & AS18 . . . . 1.6 L (3.38 pt.)

CAUTION

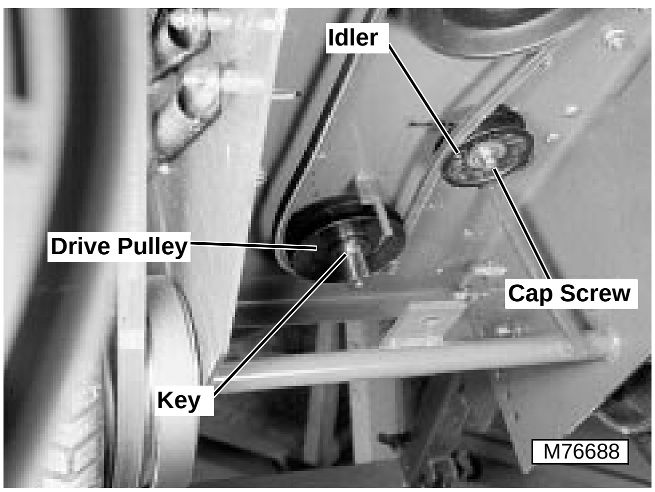
Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.



2. Turn off fuel valve. Disconnect and plug fuel line.
3. Disconnect throttle and choke controls.



4. Disconnect engine electrical connector.
5. Remove accessory drive belt.
6. Remove electric clutch. See “PTO CLUTCH REMOVAL” on page 61 in ELECTRICAL SECTION.



7. Loosen retaining cap screw for idler and remove drive belt.
8. Remove drive pulley and key from engine output shaft.
9. Remove four cap screws securing engine to frame.

CAUTION

Engine is heavy. Use proper lifting techniques to remove engine from frame. Serious personal injury can result.

10. Remove engine.

ENGINE INSTALLATION

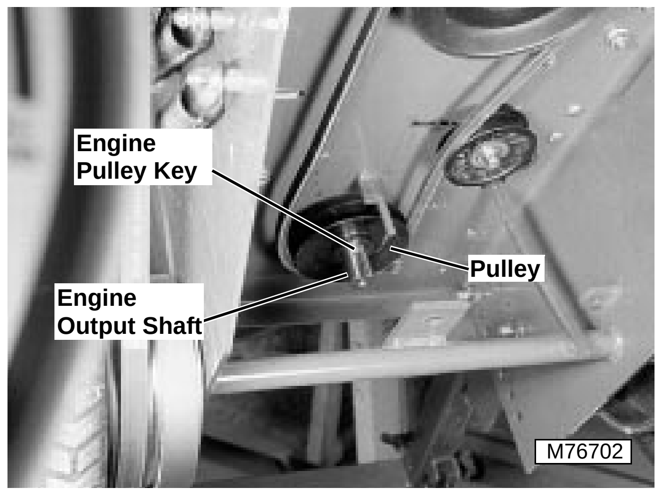
CAUTION

Engine is heavy. Use proper lifting techniques to remove engine from frame. Serious personal injury can result.

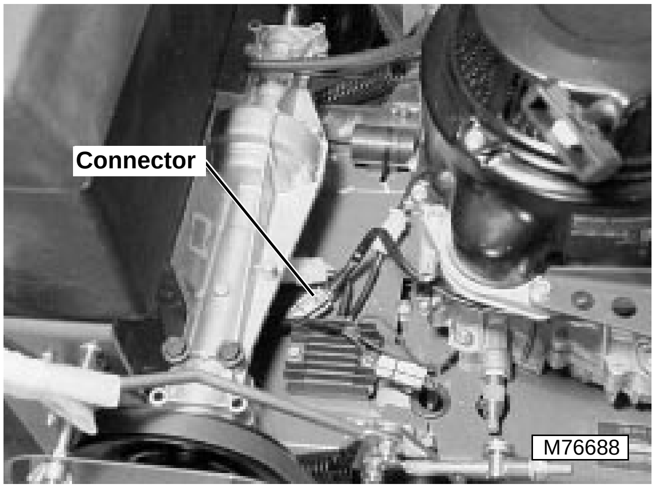
1. Place engine on frame. Align mounting holes and secure with four (4) cap screws. Tighten to specification:

Torque Specifications:

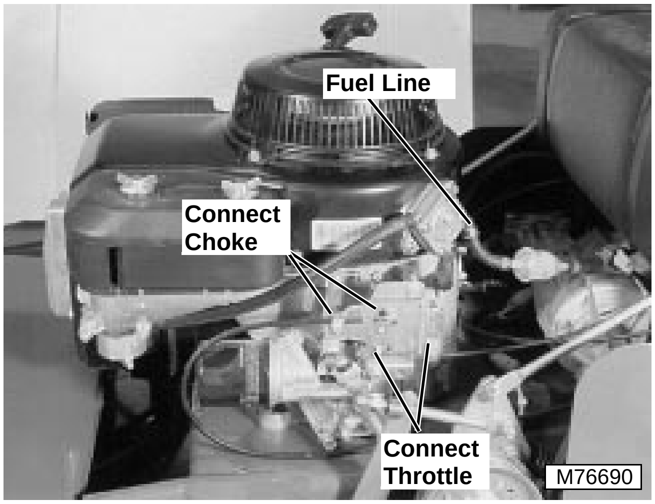
Engine mounting cap screws . . . . . 57 N•m (42 lb-ft)



1. Apply NEVER-SEEZ lubricant to engine output shaft.
2. Install key and pulley.
3. Install drive belt.
4. Adjust drive belt tension.
5. Install electric clutch. See “PTO CLUTCH INSTALLATION” on page 62 in ELECTRICAL SECTION.



6. Connect engine electrical connector.

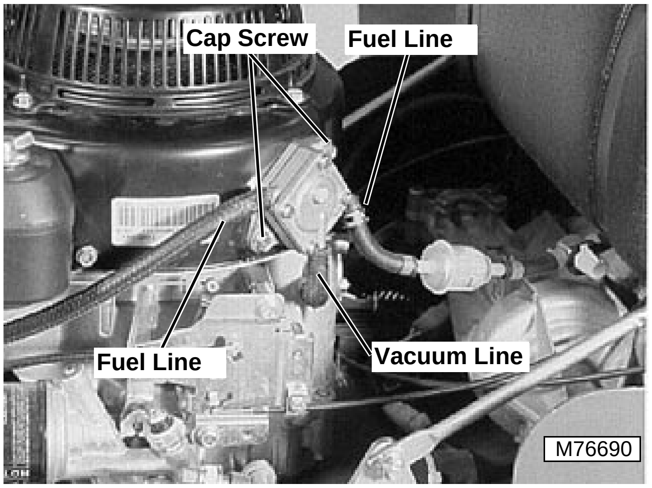


7. Connect throttle and choke controls.
8. Connect and plug fuel line. Turn on fuel valve.
9. Check engine oil and top off or fill if necessary.

FUEL PUMP REMOVAL & INSTALLATION

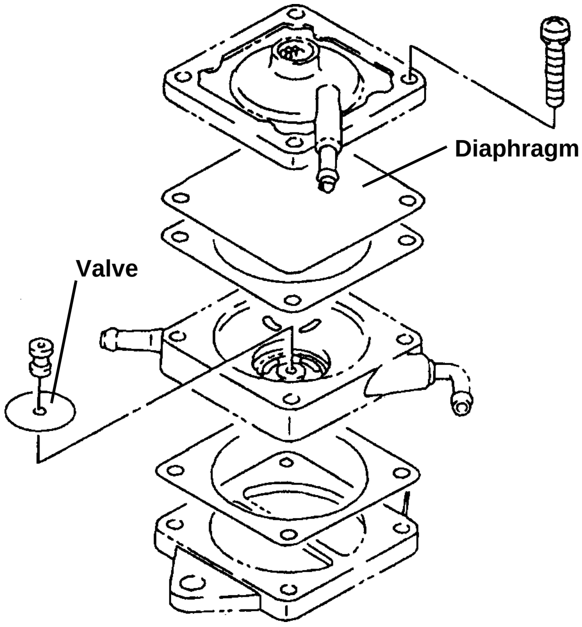
> **CAUTION**
>
> **Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Disconnect spark plug.



2. Turn off fuel valve. Disconnect vacuum line and fuel lines. Close all openings using caps and plugs.
3. Remove two (2) cap screws securing fuel pump to side of engine. Remove fuel pump.

NOTE: Fuel pump components are not seviceable separately. If inspection detects damaged components entire fuel pump must be replaced.



4. Inspect pump for wear or damage. Pay special attention to diaphragm and valve. If any damage is noted replace pump.
5. Installation of fuel pump is reverse of removal.
6. Connect vacuum and fuel lines.

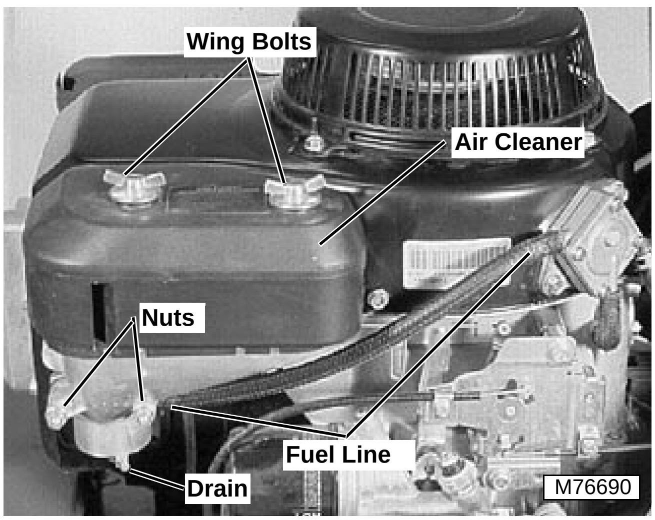
CARBURETOR REMOVAL

1. Disconnect spark plug.

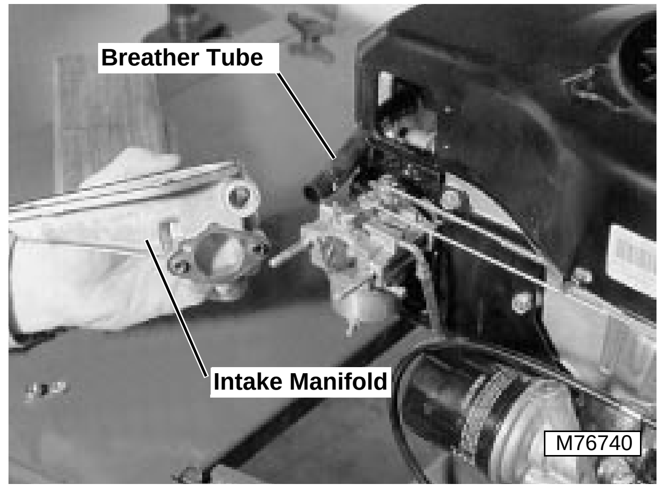
CAUTION

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

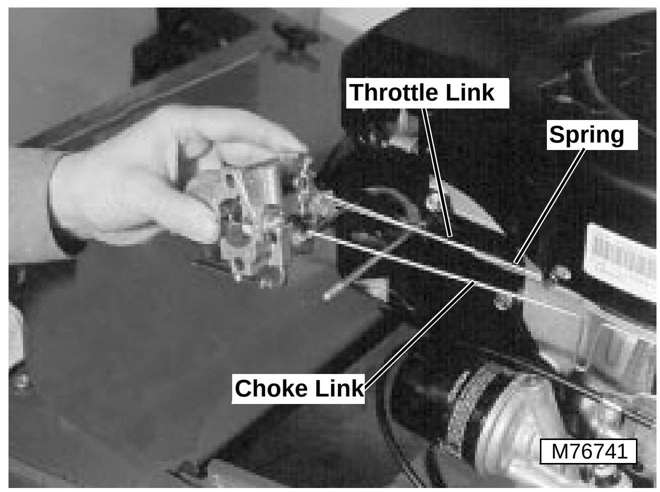
NOTE: Carburetor removal is similar for all engines. Model FC401V-BS05 shown.



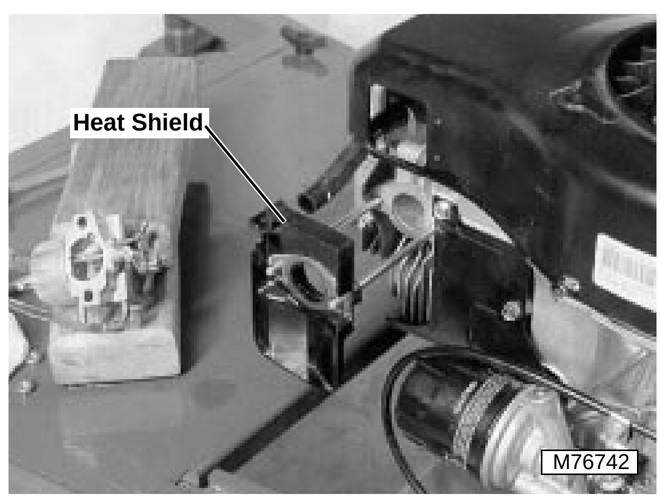
2. Turn off fuel valve. Disconnect fuel line at carburetor. Drain fuel from carburetor, into an approved container, by loosening drain screw in bottom of bowl.
3. Remove air cleaner assembly.
4. Remove two nuts securing intake manifold to carburetor.



5. Separate intake manifold from carburetor and breather tube.



6. While removing carburetor disconnect throttle spring and remove throttle linkage and choke linkage.



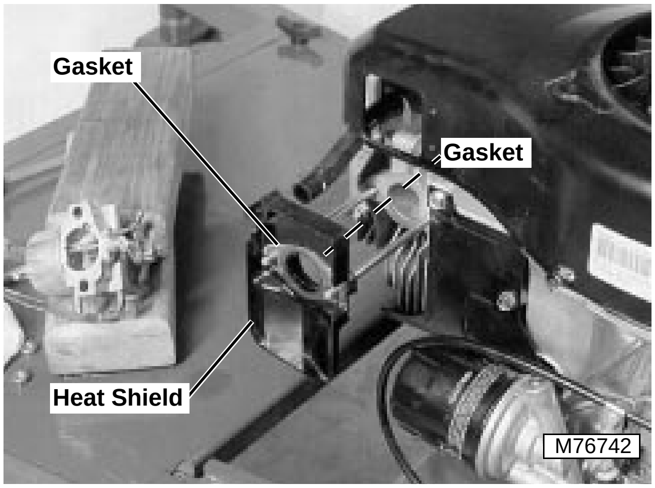
7. Remove heat shield and gaskets.
8. Make repairs as necessary. See “CARBURETOR DISASSEMBLY, CLEAN, INSPECT AND ASSEMBLY” on page 50.

CARBURETOR INSTALLATION

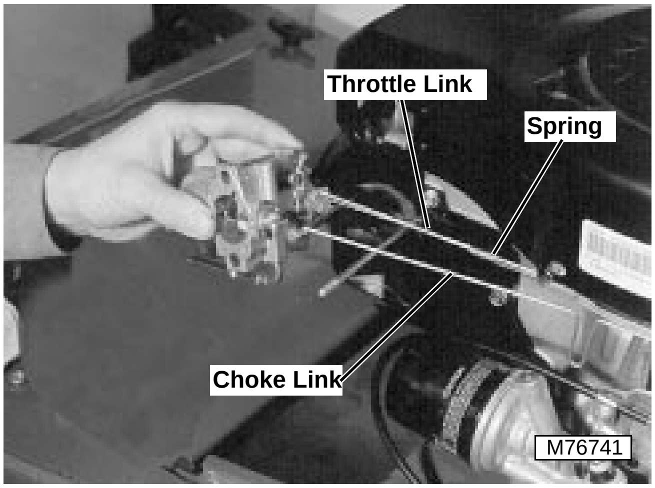
CAUTION

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

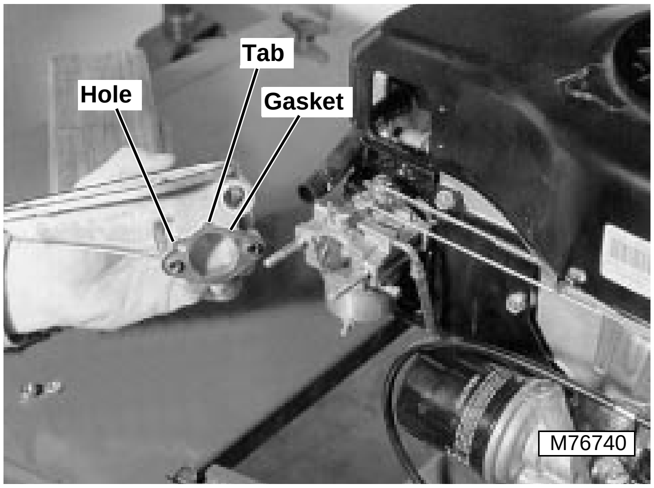
NOTE: Carburetor installation is similar for all engines. Model FC401V-BS05 shown.



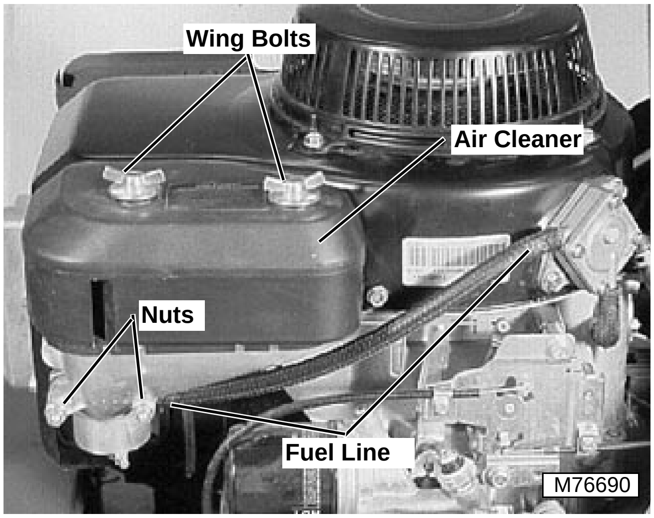
1. Place a gasket on either side of heat shield and install heat shield on studs.



2. Connect throttle link, throttle spring, choke linkage and install carburetor.



3. Install gasket with hole pointing toward fuel inlet side of carburetor and tab pointing up.
4. Install intake manifold and secure with two (2) flange nuts.



5. Install air cleaner assembly and secure with wing bolts.
6. Connect fuel hose.

CARBURETOR DISASSEMBLY, CLEAN, INSPECT AND ASSEMBLY

ATTENTION!

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

CAUTION

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

NOTE: Carburetor disassembly is similar for all engines.

See "CARBURETOR COMPONENT LOCATION–FC401V-BS05, FC420V-AS19 & 21" on page 10.,
—or—
"CARBURETOR COMPONENT LOCATION—FC540V-AS17 & AS18" on page 11.

IMPORTANT: To remove float, use a long nosed pliers on deformed end of float pivot pin.

DO NOT strike opposite end of pin. Damage to pin holder may result.
DO NOT clean holes or passages with small drill bits or wire.

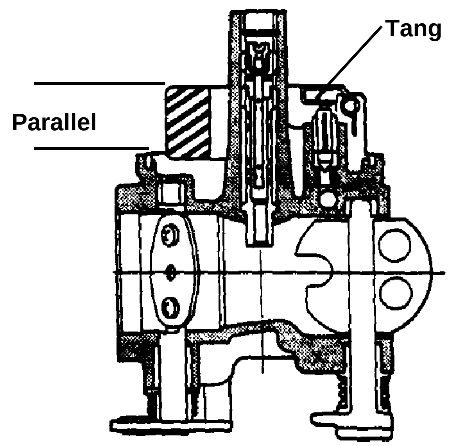
1. Soak carburetor body and all parts, except gaskets and plastic rings, in carburetor cleaning solvent for 1/2 hour maximum.
2. Spray all passages with a carburetor cleaning spray to verify that all internal passages are open.

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

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

NOTE: Main jet high altitude kits are available.

IMPORTANT: Do not push on float or inlet needle valve when adjusting float level.



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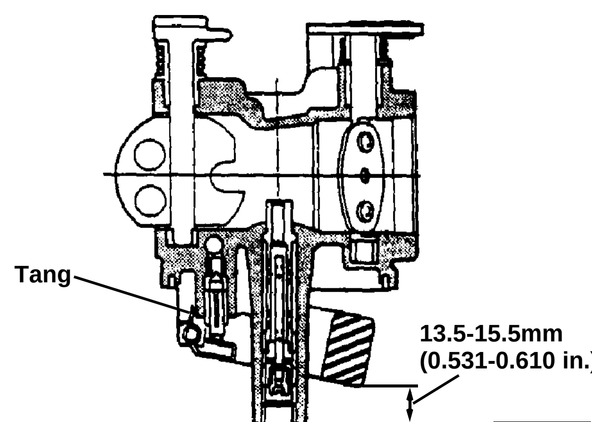
5. Turn carburetor body upside down and check to insure that float is parallel with body. If not, carefully bend needle valve tang in required direction to bring float parallel to body.



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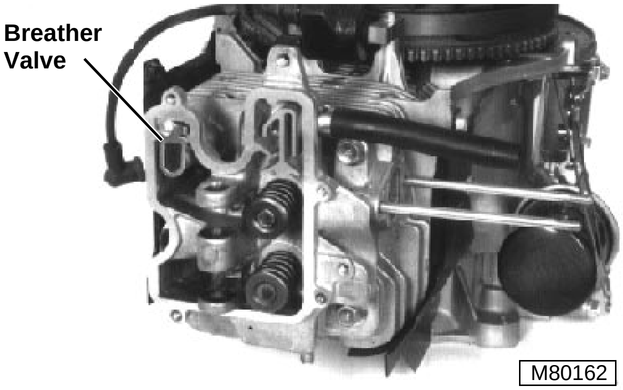
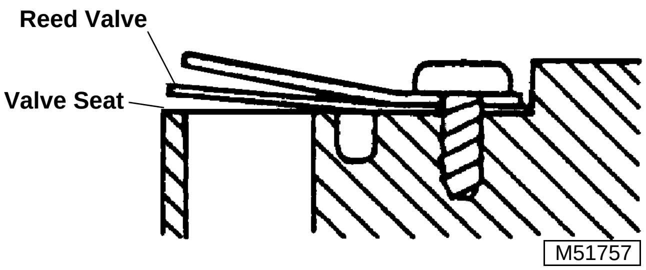
6. Invert carburetor, float down, and check dimension between bottom of float and end of jet holder. If not **13.5—15.5 mm (0.531—0.610 in.)** adjust by bending stop tang.

BREATHER REMOVAL, INSPECTION & REPLACEMENT

NOTE: Breather is located in cylinder head of engine.

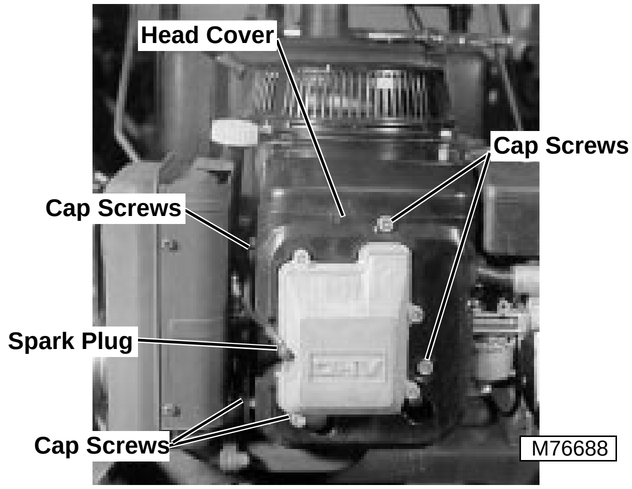
1. Remove rocker arm cover. See “ROCKER ARM ASSEMBLY REMOVAL & INSTALLATION” on page 52.



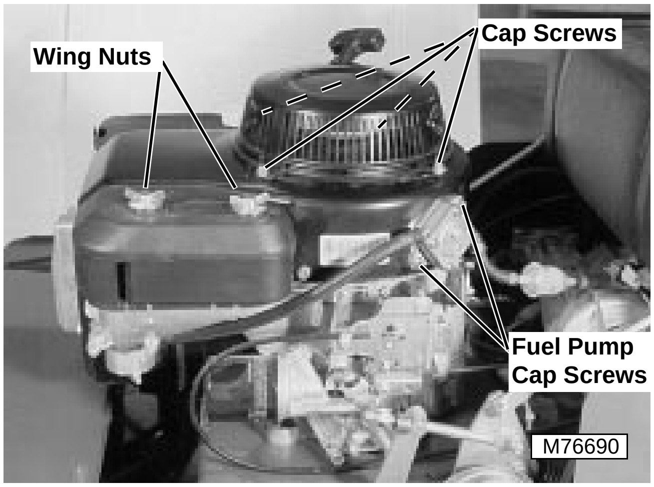


2. Measure air gap between reed valve and valve seat at valve tip. Replace reed valve if gap exceeds **2 mm (0.080 in.)**
3. Remove breather valve.
4. Inspect breather for sticking, binding, cracks or distortion. Replace breather if worn or damaged.
5. Inspect valve seating surface. Surface must be free of nicks or burrs.
6. Install breather assembly and cover, if equipped.

BLOWER HOUSING REMOVAL & INSTALLATION



1. Disconnect spark plug.
2. Remove five (5) cap screws securing head cover. Remove cover.



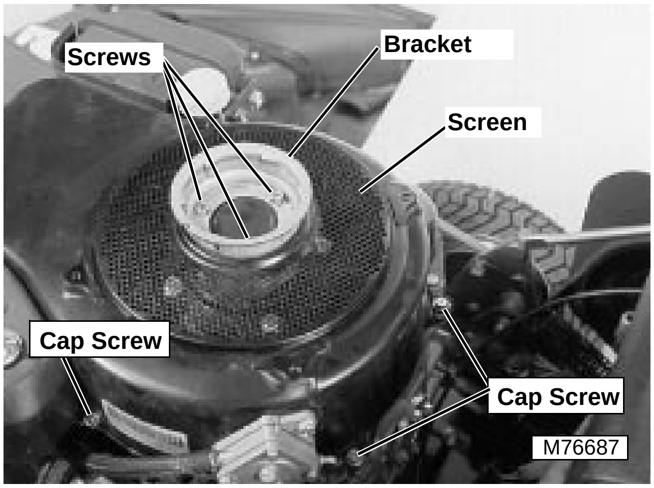
3. Remove wing nuts securing air cleaner. Remove air cleaner

CAUTION

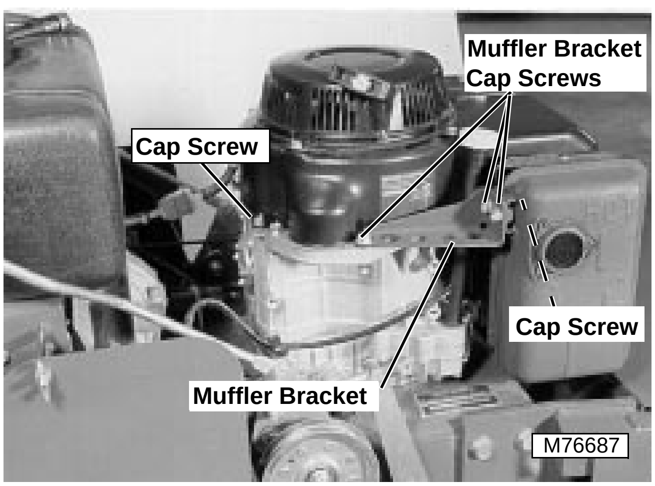
Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.

NOTE: It is not necessary to remove fuel lines from Fuel pump to complete this procedure.

4. Remove two cap screws securing fuel pump to housing. Move fuel pump away from housing.
5. Remove four cap screws securing pull starter to engine. Remove pull starter assembly.

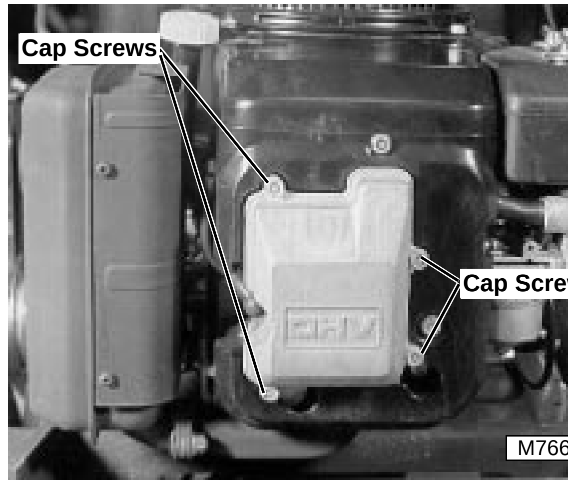


6. Remove three screws securing bracket to flywheel standoff bracket. Remove bracket and flywheel screen. Take care not to loose shims under bracket.

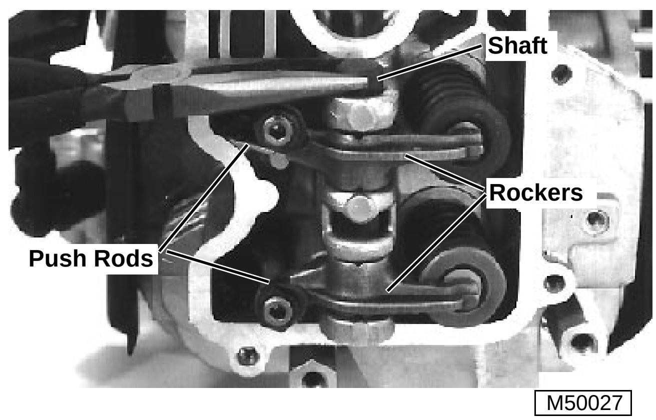


7. Remove cap screws securing muffler bracket to engine. Remove bracket.
8. Remove remaining cap screws securing blower housing to engine. Remove blower housing.
9. Clean inside of blower housing, between engine fins and flywheel screen.
10. Install blower housing, screen and protector.
11. Adjust flywheel screen. See “FLYWHEEL SCREEN ADJUSTMENT” on page 30.
12. Install cylinder head cover and muffler bracket.
13. Install fuel pump
14. Install air cleaner.

ROCKER ARM ASSEMBLY REMOVAL & INSTALLATION



1. Remove four cap screws securing valve cover to block. Remove cover.
2. Turn crankshaft until piston is at highest position in compression stroke.



3. Remove rocker shaft and arms.

IMPORTANT: Mark push rods for reassembly in original locations.

4. Remove push rods.

IMPORTANT: Align rocker arms over push rods during assembly.

5. Install push rods and rocker arm assemblies.
6. Check valve clearance. See “VALVE CLEARANCE ADJUSTMENT” on page 31.

Torque Specifications:

Rocker Arm Studs . . . . 7 N•m (62 lb-in.)

ROCKER ARM ASSEMBLY INSPECTION

Measure outside diameter of rocker shaft and inside diameter of rocker arm bearing. Replace if not according to specifications.

Specifications:

Minimum Shaft OD.

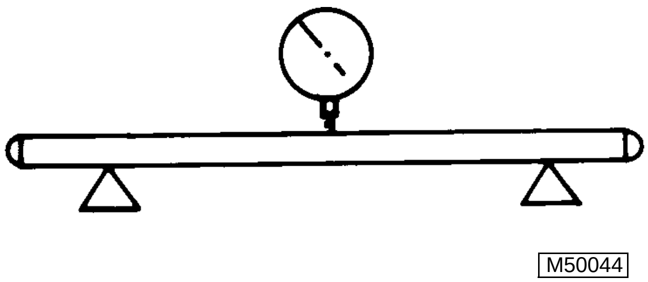
All Models . . . . 12.94 mm (0.509 in.)

Maximum Arm I.D.

All Models . . . . 13.07 mm (0.515 in.)

PUSH ROD INSPECTION

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 specification.

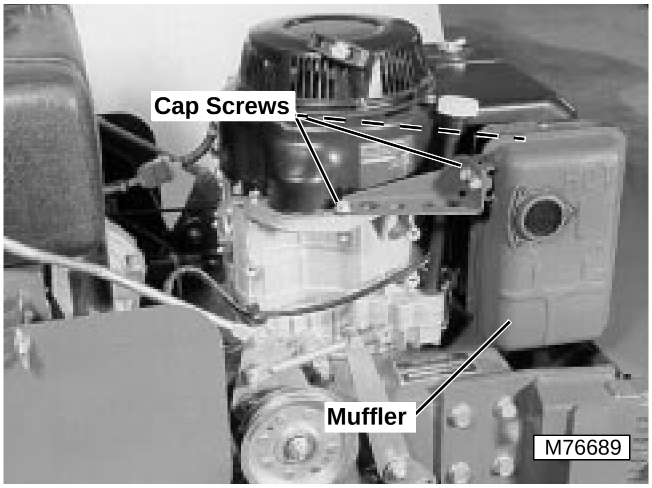


Push Rod Bend Specifications (Max):

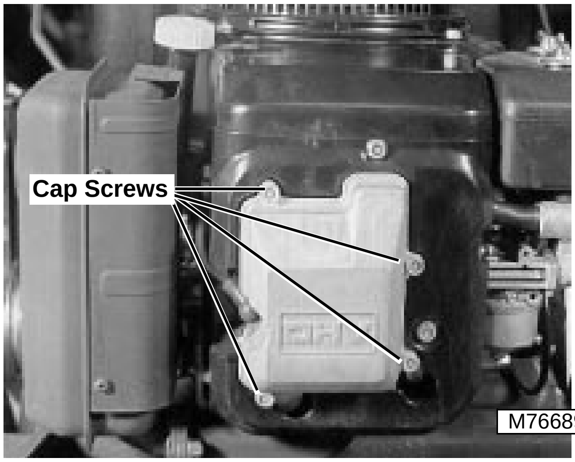
All Models . . . . 0.30 mm (0.012 in.)

CYLINDER HEAD REMOVAL

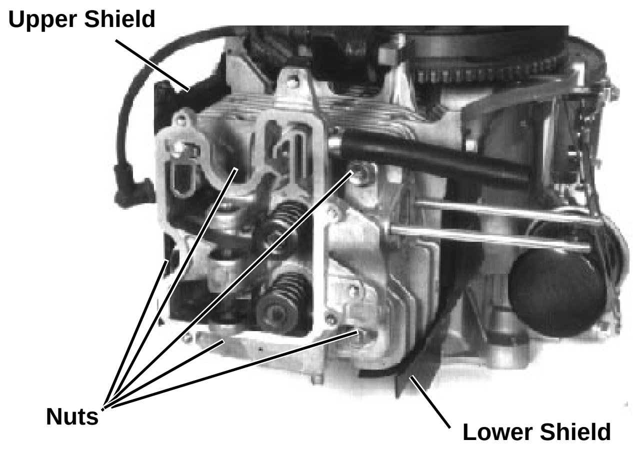
1. Turn crankshaft until piston is at highest position in compression stroke.
2. Remove blower housing/engine cover. See "BLOWER HOUSING REMOVAL & INSTALLATION" on page 51.
3. Remove carburetor. See "CARBURETOR REMOVAL" on page 48.



4. Remove muffler and shields.



5. Remove spark plug.
6. Remove four cap screws securing rocker cover.



7. Remove upper and lower shields.
8. Remove nuts, spacers and/or washers.
9. Remove cylinder head assembly.

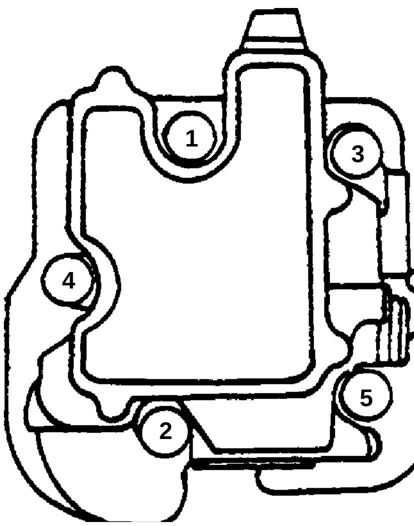
CYLINDER HEAD INSTALLATION

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

1. Turn crankshaft until piston is at highest position in compression stroke.
2. Apply a light film of oil to fasteners.

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

3. Install new head gasket.
4. Install cylinder head assembly tighten fasteners finger tight.



M50046

5. Tighten cap screws and nuts in sequence shown. Tighten to initial torque specifications.
6. Continue in sequence **7 N•m (5 lb-ft)** at a time until final torque is as specified.
7. Install spark plug and tighten to specification.
8. Assemble push rods, and rocker assembly. See “ROCKER ARM ASSEMBLY REMOVAL & INSTALLATION” on page 52.
9. Check valve clearance. See “VALVE CLEARANCE ADJUSTMENT” on page 31.

Torque Specifications:

Initial	**32 N•m (24 lb-ft.)**
Final	**52 N•m (38 lb-ft.)**
Spark Plug	**20 N•m (177 lb-in.)**

CYLINDER HEAD INSPECTION

1. Remove carbon deposits from combustion chamber and gasket surface using SCOTCH-BRITE abrasive pads or an equivalent.
2. Clean head with solvent.
3. Inspect for cracks and/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.


M52080

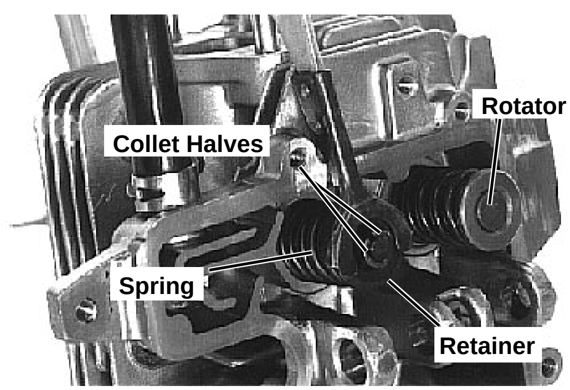
6. Put head on a **flat** surface plate. Check for distortion at several points with a feeler gauge. Replace head if distorted beyond specification.

Cylinder Head Flatness:

All Models	**0.05 mm (0.002 in.)**

VALVES AND SPRINGS REMOVAL AND INSTALLATION

1. Remove rocker arm assembly. See “ROCKER ARM ASSEMBLY REMOVAL & INSTALLATION” on page 52.
2. Remove cylinder head. See “CYLINDER HEAD REMOVAL” on page 53.



M50033

3. Compress intake valve spring with JDM-70 Valve Spring Compressor and remove collet halves.
4. Remove spring retainer and spring.
5. Remove exhaust valve rotator with a magnet.
6. Support exhaust valve from below and press down on spring retainer.
7. Remove retainer, spring and valves.

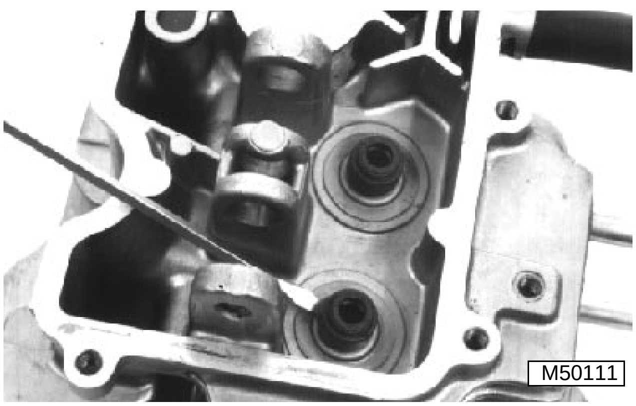
NOTE: If valves are removed from head valve stem seals will be damaged and must be replaced.

8. Replace stem seals. (See below.)
9. Inspect springs, valves, guides and seats. See “VALVE SPRING INSPECTION” on page 55.
10. Lubricate valve stems with engine oil.
11. Install components in reverse order.

VALVE STEM SEAL REPLACEMENT

1. Remove valves and springs. (See above.)

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.

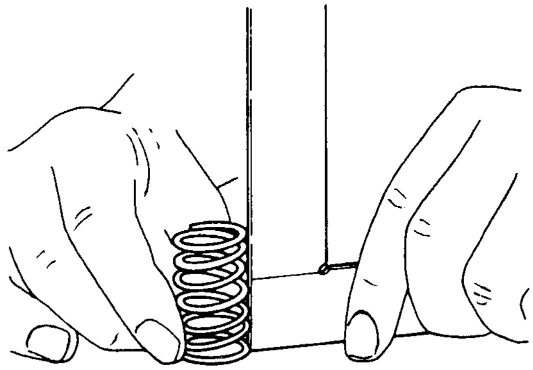


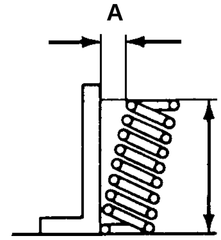
M50111

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

VALVE SPRING INSPECTION

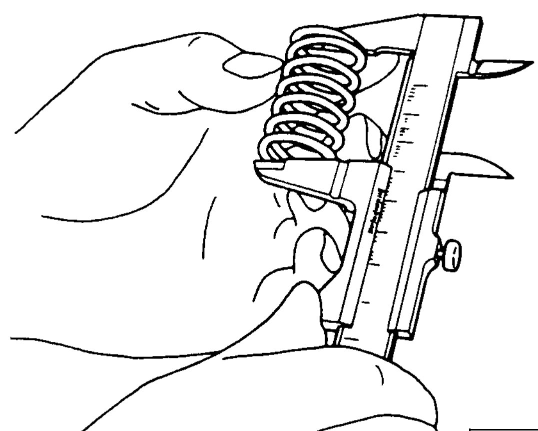
1. Clean and inspect valve springs. Replace if cracked or broken.





M82035A

2. Inspect valve spring for squareness on a surface plate. Turn spring and measure space between top spring coil and square (A). Replace spring if not in within specifications.



M82034A

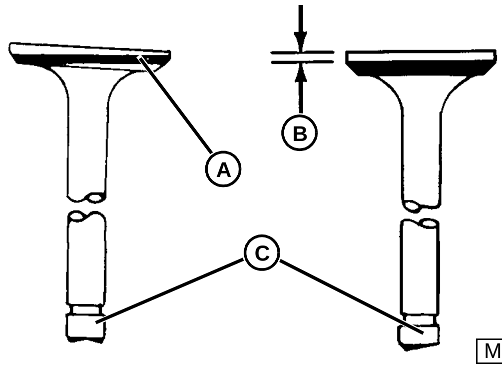
3. Measure free length of valve spring. Replace valve spring if not within specifications.

Valve Spring Specifications:

Squareness Tolerance . . . . 2.39 mm (0.090 in.)
Free Length. . . . . 37.5 mm (1.476 in.)

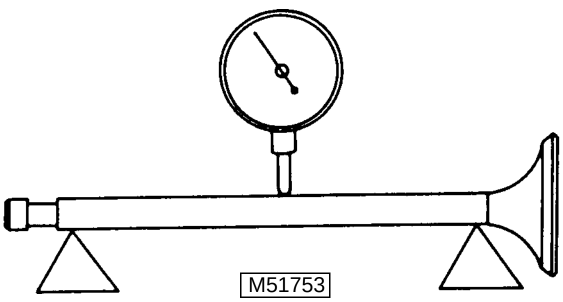
VALVE INSPECTION

1. Remove carbon from valve head, face, and stem.
2. Check valve for cracks or damage.

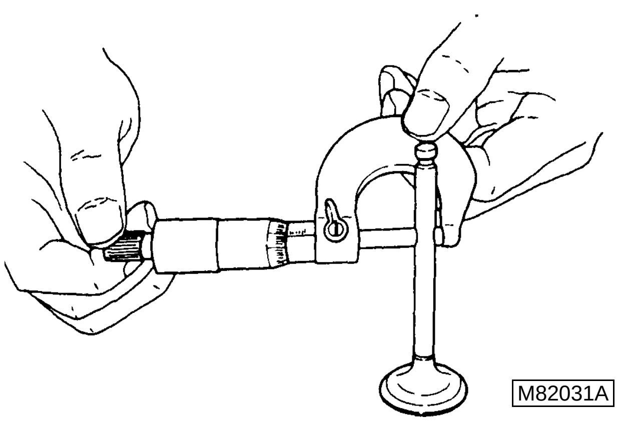


M38087

3. Replace warped valves (A) or valves with less than serviceable margin (B). Valve stem ends (C) should be square, not worn uneven as shown.


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 **0.03 mm (0.001 in.).**


M82031A

5. Measure valve stem diameter in several places. Replace valve if measurement exceeds specifications.

Minimum Intake Valve Stem OD:

Standard . . . . 6.93 mm (0.273 in.)

Minimum Exhaust Valve Stem OD:

Standard . . . . 6.91 mm (0.272 in.)

VALVE ANALYZE


M29934

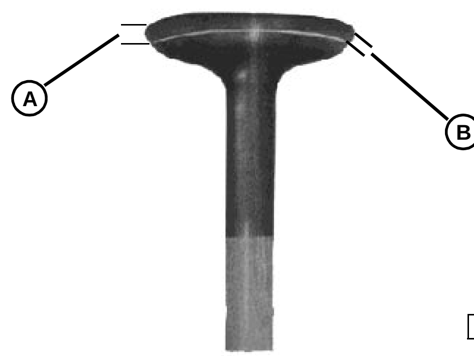
Lead deposits on the intake valve are caused by exhaust gas leakage past the valve when using leaded gasoline. Grind intake valve and reface valve seat to correct this condition.

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.

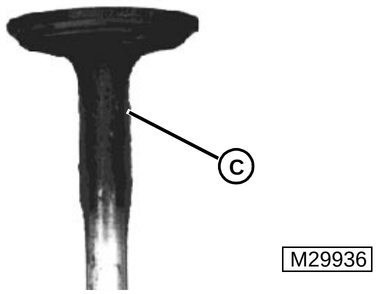
Fogging of combustion chamber with oil before storage helps prevent corrosion. Replace badly corroded valves.



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 (A) and face angle (B). 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 lifter, lean fuel-air mixture, or incorrect spark plug.



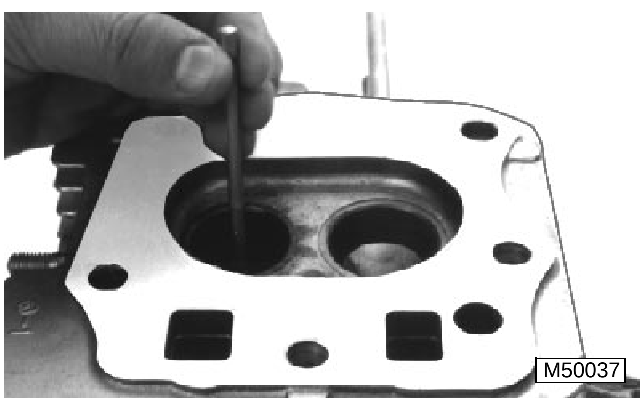
Use of old or stale gasoline can cause valves to stick.

Gummy deposits (C) 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.

VALVE GUIDE INSPECTION

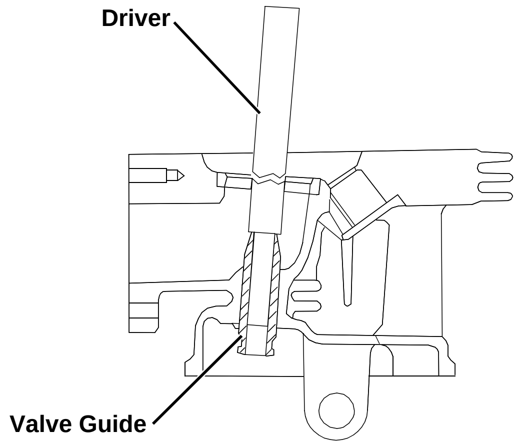
Clean inside of valve guides with valve guide cleaner.



Measure inside diameter of valve guides. Replace Guide if inside diameter is greater than **7.07 mm (0.278 in.)**

VALVE GUIDE REPLACEMENT

1. Remove head from engine. See “CYLINDER HEAD REMOVAL” on page 53.
2. Remove valves from head. See “VALVES AND SPRINGS REMOVAL AND INSTALLATION” on page 54.

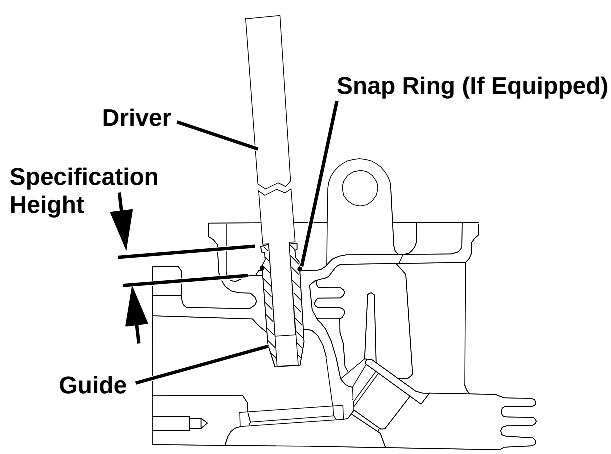


1. Drive valve guide bushing into valve chamber using JDG-504 Valve Guide Driver.
2. Clean carbon deposits from valve guide port.

NOTE: Early model engine valve guides were equipped with a snap ring on the O.D. of the valve guide to use as an assembly aid. This snap ring may or may not be used on the engine you have. If not present it may be installed or left off as desired and the valve stem installed to the height specified.

3. Install snap ring, if equipped, onto new valve guide.
4. Place head on a flat clean support plate.

IMPORTANT: Be careful not to damage gasket surface of head while installing valve guides.

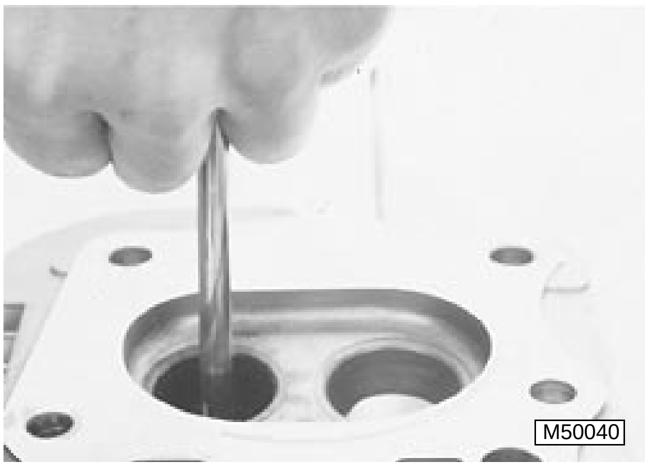


5. Coat outside surface of valve guide with a light coat of engine oil.

6. Install new valve guide with valve guide driver. Drive in from valve chamber side until valve guide head protrudes per specification or snap ring just seats on head.

Valve Guide Installed Height Specification:

FC401V-BS05, FC420V-AS19 & AS21 . . 12.0±0.1 mm (0.472±0.004 in.)
FC540V-AS17 & AS18 9.5±0.1 mm (0.374±0.004 in.)



7. Finish ream valve guide bushings with Stanisol or kerosene lubricant and a **7 mm** valve guide reamer. Turn reamer clockwise.
8. Thoroughly clean valve area before assembly.

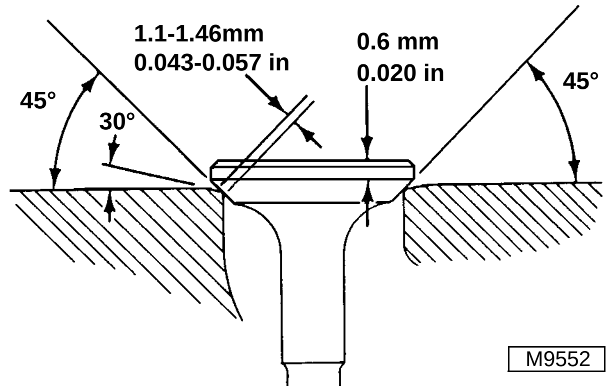
IMPORTANT: Valve seat and valve should always be resurfaced after replacing valve guide.

Finished I.D. Specifications:

Valve Guide. . . . . 7—7.02 mm (0.275—0.276 in.)

VALVE SEAT RECONDITIONING

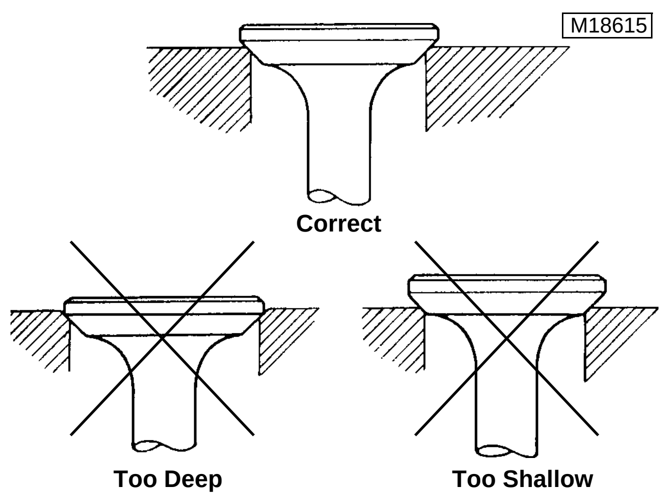
1. Inspect valve seats for damage. If seats are warped or distorted beyond reconditioning, replace cylinder head. Pitted or worn seats can be refaced using a seat cutter.



2. To recondition valve seat, cut at 45° angle to clean up seat. Cut narrowing angle at 30°. Finish cut at 45° to establish seating surface width.
3. Cut valve seat surface as close as possible to specifications.
4. Lap valves to seats after refacing. See “LAP VALVES” on page 59.

Specifications:

Valve Seating Surface . . . . 1.1—1.46 mm (0.043—0.057 in.)
Valve Seat Angle . . . . 45°
Valve Face Angle . . . . 45°
Seat Narrowing Angle . . . . 30°
Valve Margin . . . . 0.60 mm (0.020 in.)

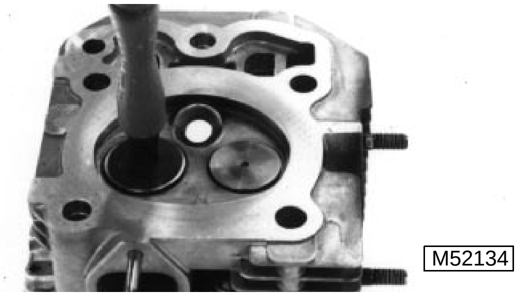


IMPORTANT: Center valve seat on the valve face.

5. Check seat for good contact using Prussian blue compound.

LAP VALVES

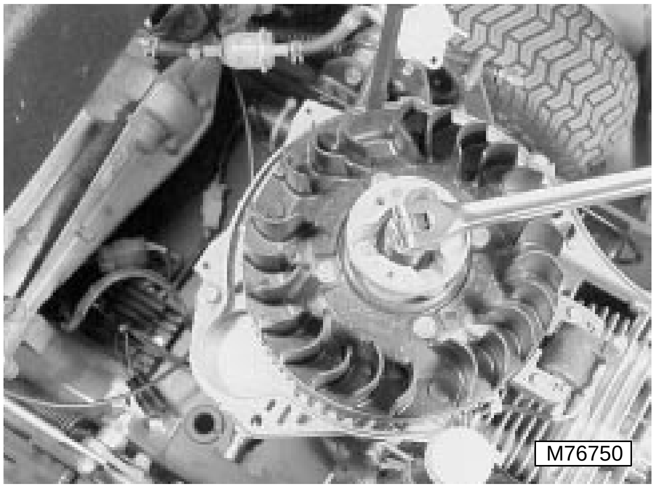
IMPORTANT: Valves and seats should be lapped if they do not make good contact.



1. If seat does not make proper contact, lap the valve into the seat.
2. Apply small amount of fine lapping compound to face of valve.
3. Grip top of valve with a vacuum cup tool. Turn valve to lap valve to seat.
4. Lift valve from seat every 8 to 10 strokes. Lap until a uniform ring appears around the surface of the valve face.
5. Wash all parts in solvent to remove lapping compound. Dry parts.
6. Check position of lap mark on valve face. Lap mark must be on or near center of valve face.
7. Check valve clearance. (See this group.)

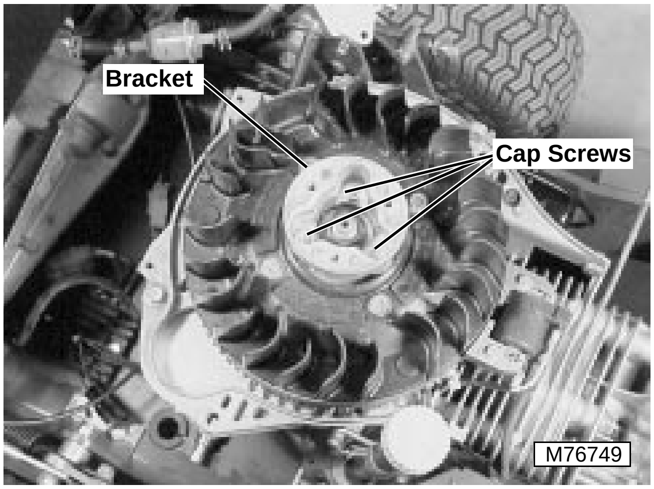
FLYWHEEL REMOVAL AND INSTALLATION

1. Remove engine blower housing. See “BLOWER HOUSING REMOVAL & INSTALLATION” on page 51.



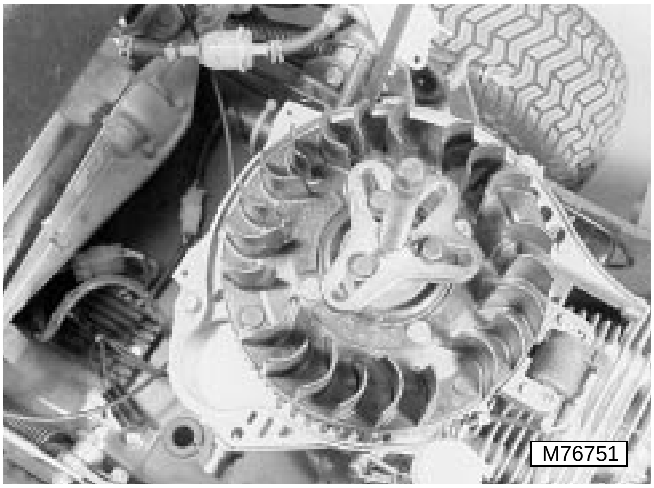
2. Remove flywheel nut. Use strap wrench around flywheel.

IMPORTANT: Insure that strap wrench is placed below fan vanes. Vanes are plastic and will break.



3. Remove three cap screws securing bracket to flywheel.

IMPORTANT: DO NOT remove flywheel using jaw type puller on outside diameter of flywheel. Flywheel warping or breakage could result from use of wrong puller.



4. Remove flywheel with a flywheel puller or a gear puller.
5. Inspect flywheel for damage. Check magnets on inside of flywheel. Check ring gear teeth. If any damage is found, replace flywheel.

6. Install flywheel, bracket, washer and nut. Tighten nut to specifications.

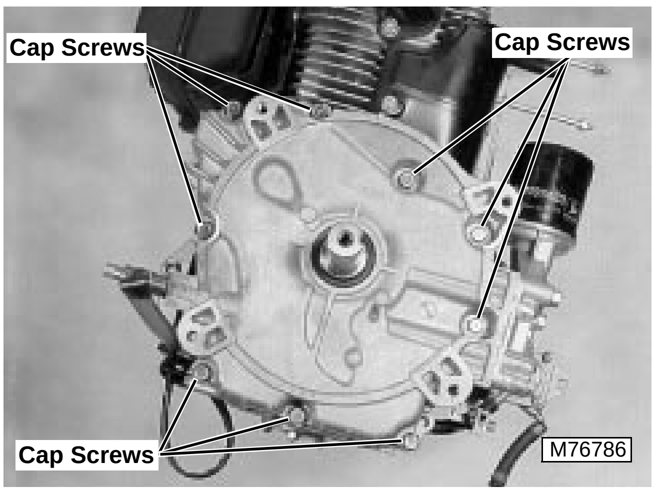
Torque Specifications:

FC401V-BS05, FC420V-AS19&21 137 N•m (101 lb-ft.)
FC540V-AS17 & AS18 . . . . 172 N•m (127 lb-ft.)

7. Adjust armature air gap. See “IGNITION COIL WITH MODULE AIR GAP ADJUSTMENT” on page 43.

CRANKCASE COVER REMOVAL

1. Remove engine from machine. See “ENGINE REMOVAL” on page 45.



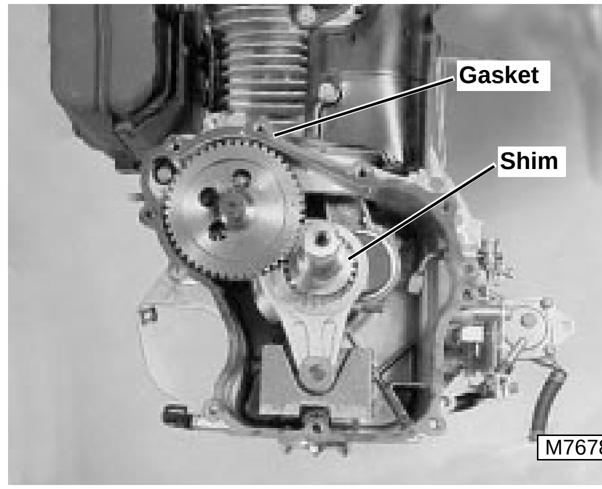
2. Remove rust and burr from edge of PTO shaft step with steel wool or fine cut file.
3. Remove cap screws securing cover to block.

CAUTION

Crankcase and cover are aluminum. Do Not use steel hammer or steel tools to separate cover from case. If sealing surface is scratched or cover is bent during removal it must be replaced.

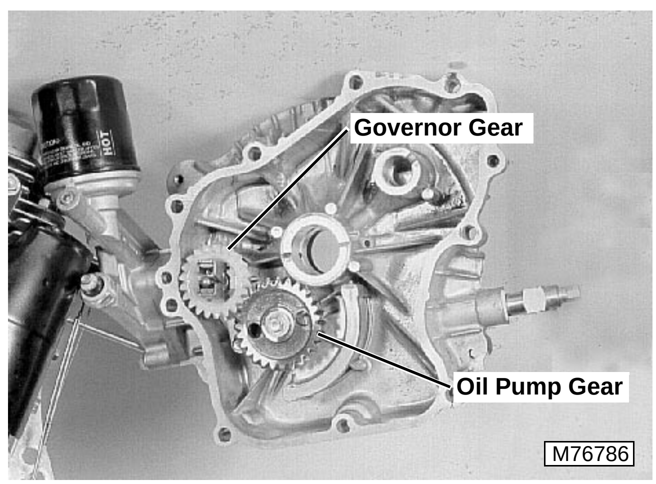
4. Remove crankcase cover by tapping cover with a soft face mallet.

CRANKCASE COVER INSTALLATION



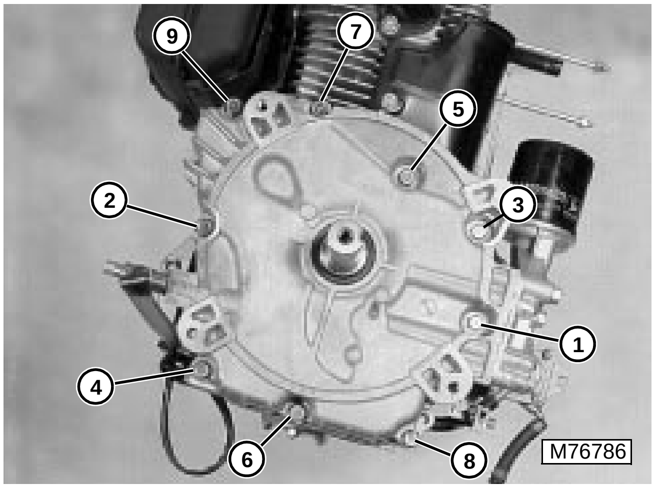
1. Clean gasket surface and place new gasket on crankcase cover.
2. Replace crankcase cover seal if required. See “CRANKCASE COVER SEAL” on page 61.
3. Pack grease into oil seal.
4. Coat light film of engine oil on bearings. Make sure governor weights are closed.

NOTE: Make sure shim is on crankshaft.



5. Make sure governor gear and oil pump gear are properly aligned to mesh with drive gear when installing cover.

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

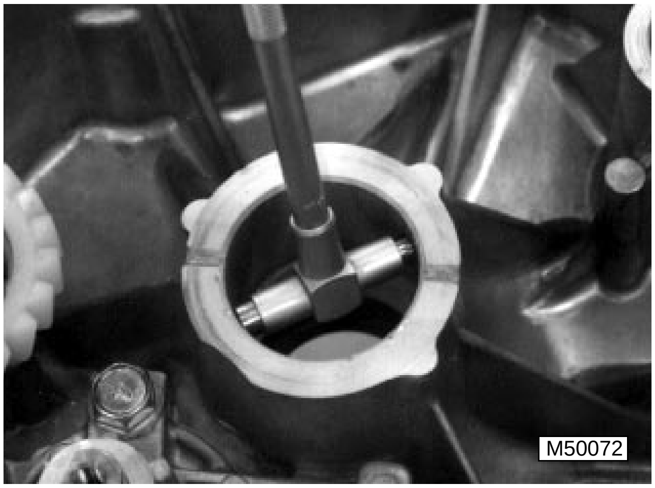


6. Install cover and gasket and tighten cap screws using the sequence shown. Evenly torque cap screws to **26 N•m (19 lb-ft).**

NOTE: Any time the cover is removed crankshaft end play should be checked and/or adjusted. See "CRANKSHAFT END PLAY ADJUSTMENT" on page 71.

CRANKCASE PLAIN BEARINGS

NOTE: Plain bearings, in crankcase cover, are not replaceable bearings. Entire crankcase cover must be replaced if bearings are bad.



1. Measure crankshaft bearing in crankcase cover. Replace cover if diameter is greater than specifications.

Crankcase Cover Bearing I.D. for Crankshaft Specifications (Max):

FC401V-BS05 . . . . 35.07 mm (1.381 in.)
FC420V-AS19 & AS21 . . . . 35.07 mm (1.381 in.)
FC540V-AS17 & AS18 . . . . 38.06 mm (1.498 in.)

2. Measure camshaft bearing in crankcase cover. Replace cover if diameter is greater than specifications.

Crankcase Cover Bearing I.D. for Camshaft Specifications (Max):

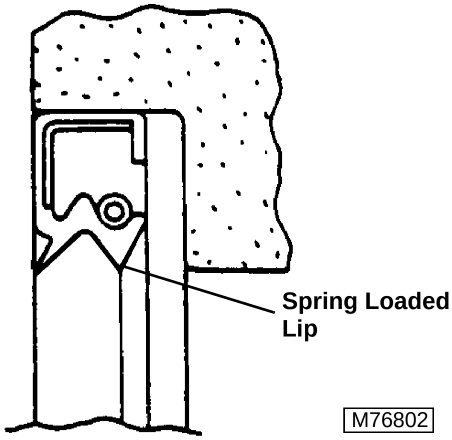
FC401V-BS05 . . . . 21.08 mm (0.830 in.)
FC420V-AS19 & AS21 . . . . 21.08 mm (0.830 in.)
FC540V-AS17 & AS18 . . . . 21.08 mm (0.830 in.)

CRANKCASE COVER SEAL

NOTE: Pack lithium base grease in new or used seals.

1. Inspect oil seals in crankcase cover. Replace if worn or damaged.

2. Remove worn or damaged seals with a screwdriver. (PTO end shown)



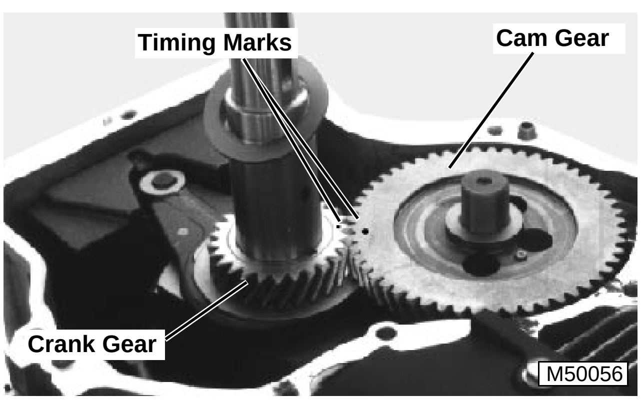
3. Install seal with spring loaded lip to inside of engine. Press seal in until flush with hub.

*NOTE: On and FC540V-AS17 engines, press in seal to **0.50 mm (0.20 in.)**, below crankcase cover flange surface.*

CAMSHAFT REMOVAL AND INSTALLATION

1. Remove crankcase cover. See “CRANKCASE COVER REMOVAL” on page 60.

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



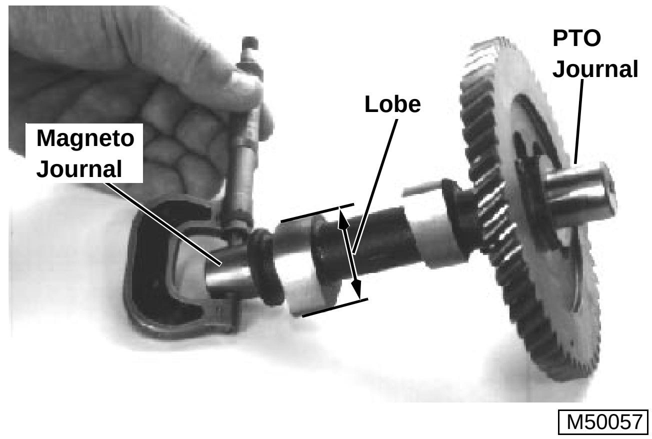
2. Rotate crankshaft until timing marks on crankshaft gear and camshaft gear align.
3. Remove camshaft gear with camshaft.
4. Inspect camshaft. (See next section.)

NOTE: Install tappets prior to installing camshaft. Take great care not to damage cam lobes on tappets when installing cam.

5. Align timing marks and install camshaft.

CAMSHAFT INSPECTION

1. Inspect camshaft for worn or broken teeth. If found, replace camshaft.



2. Measure PTO side journal, magneto side journal, and lobes. Replace camshaft if **less** than specifications.

Specifications (Min):

FC401V-BS05 & FC420V-AS19 & AS21

PTO Side Journal . . . . 20.91 mm (0.823 in.)
Magneto Side Journal . . . . 19.91 mm (0.784 in.)
Cam Lobes . . . . 36.75 mm (1.447 in.)

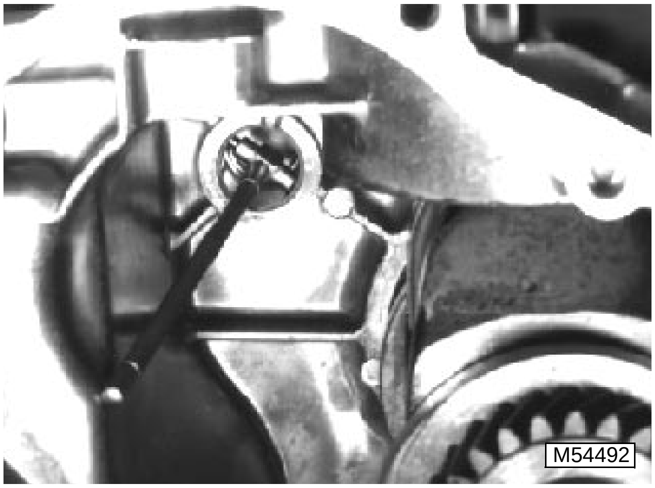
FC540V-AS17 & AS18

PTO Side Journal . . . . 20.91 mm (0.823 in.)
Magneto Side Journal . . . . 20.91 mm (0.823 in.)
Cam Lobes . . . . 37.10 mm (1.461 in.)

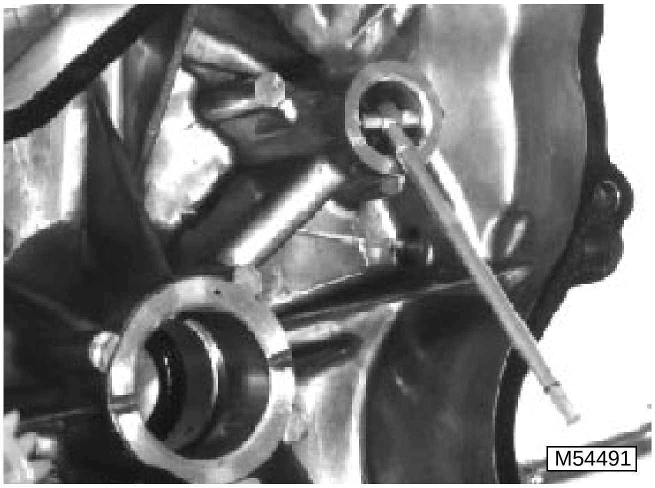
NOTE: Both cam lobes, intake and exhaust, have the same specifications.

CAMSHAFT BEARINGS

NOTE: Bearings are not replaceable.



1. Measure camshaft bearings in cylinder block.



2. Measure camshaft bearings in crankcase cover.
3. Replace block or cover if diameter is greater than specification.

Specifications (Max):

FC401V-BS05 & FC420V-AS19 & AS21

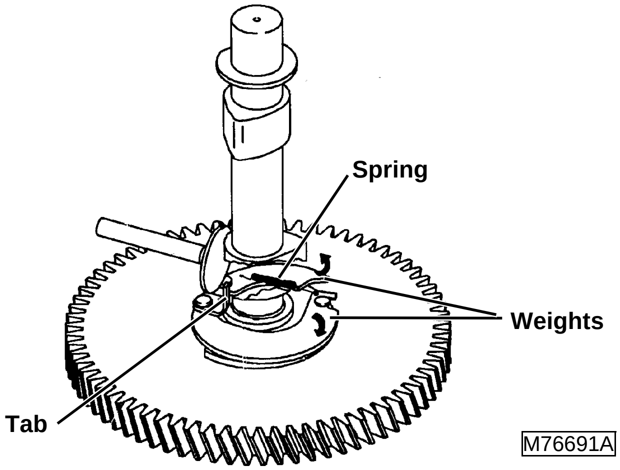
Cylinder Block Bearing . . . . . . 20.08 mm (0.790 in.)
Crankcase Cover Bearing . . . . 21.08 mm (0.830 in.)

FC540V-AS17 & AS18

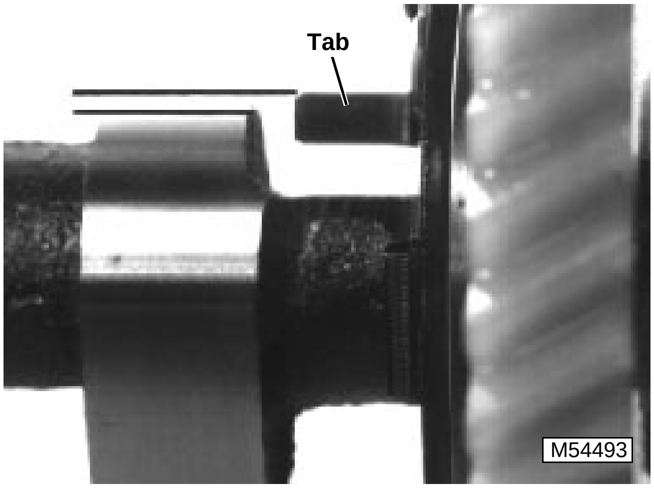
Cylinder Block Bearing . . . . . . 21.08 mm (0.830 in.)
Crankcase Cover Bearing . . . . 21.08 mm (0.830 in.)

AUTOMATIC COMPRESSION RELEASE (ACR) INSPECTION

1. Remove camshaft. See “CAMSHAFT REMOVAL AND INSTALLATION” on page 62.



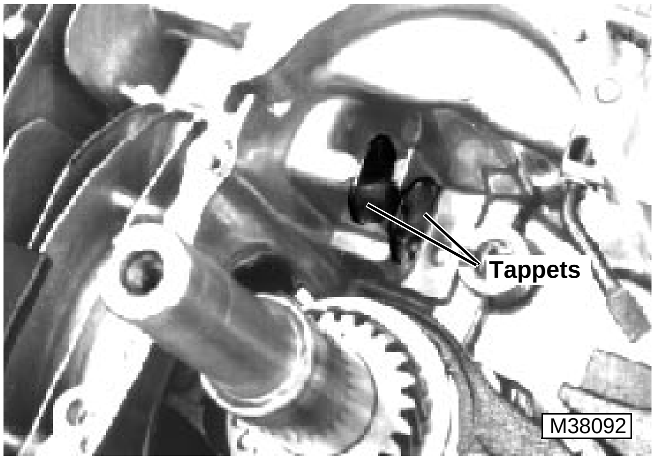
2. Inspect automatic compression release mechanism (ACR) for damage.
3. Inspect spring. Replace if worn or damaged.
4. Move weight(s) by hand to check for proper operation.



5. Check that tab sits slightly above cam lobe when weights are released. Tab should drop below cam when weights are operated.
6. Replace ACR if it does not operate properly.

TAPPETS REMOVAL AND INSTALLATION

1. Remove camshaft. See “CAMSHAFT REMOVAL AND INSTALLATION” on page 62.

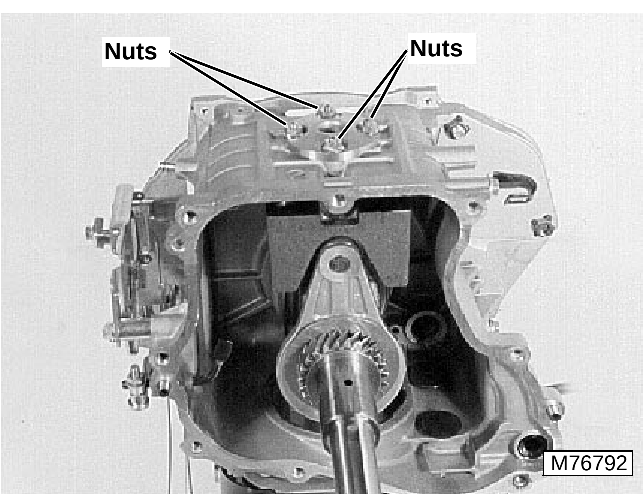


NOTE: *Mark tappets so they can be installed in their original guides during assembly.*

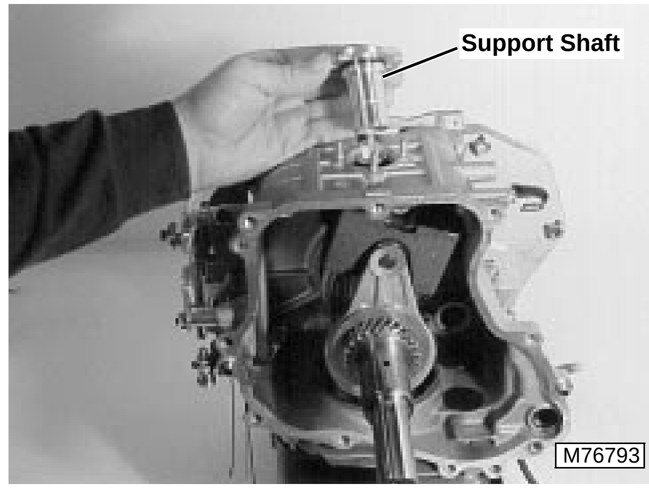
2. Remove tappets.
3. Inspect tappets for wear or damage. Replace if necessary.
4. Apply clean engine oil to tappets and bores.
5. Install tappets in original positions.
6. Install camshaft.

BALANCER REMOVAL AND INSTALLATION

1. Remove flywheel. See “FLYWHEEL REMOVAL AND INSTALLATION” on page 59.
2. Remove camshaft. See “CAMSHAFT REMOVAL AND INSTALLATION” on page 62.
3. Remove piston. See “REMOVE PISTON AND CONNECTING ROD” on page 66.



4. Remove four nuts securing support shaft.



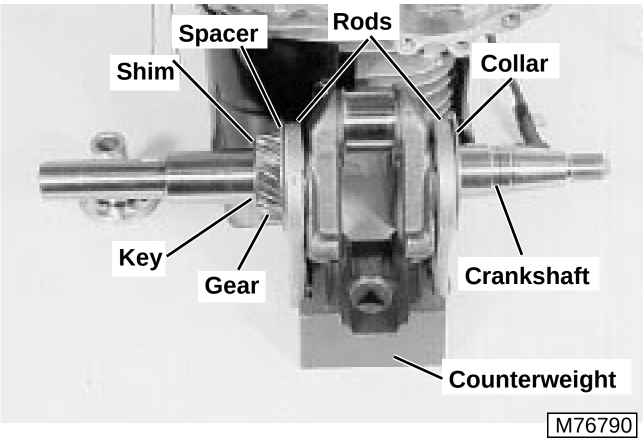
5. Remove support shaft.

CAUTION

Crank and balancer assembly is heavy and balancer assembly will rotate around crank freely. Use care in removing crank and balancer from block to avoid crushing fingers.

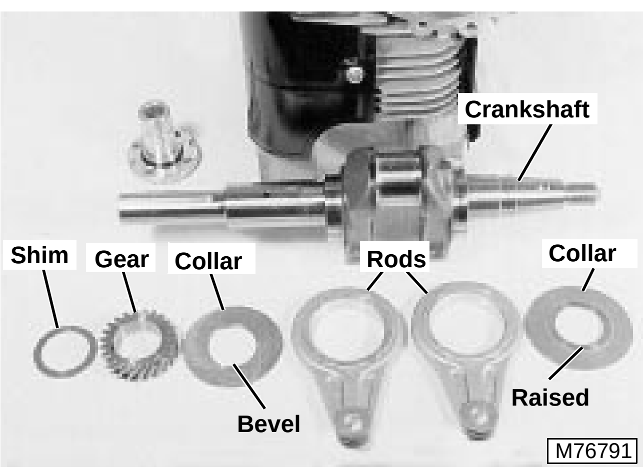
6. CAREFULLY remove crankshaft with balancer assembly.
7. Disassemble and inspect balancer assembly. See “BALANCER DISASSEMBLY AND ASSEMBLY” on page 65.
8. Inspect oil seals.
9. Cover keyway on flywheel end of crankshaft with tape to prevent damage to seal when installing assembly.
10. Put light film of oil on crankshaft bearing surfaces.
11. Install balancer assembly with crankshaft into crankcase.
12. Align balancer weight in crankcase and install support shaft. Secure with four nuts.

BALANCER DISASSEMBLY AND ASSEMBLY



1. Remove collar, shim, gear, spacer, and key.
2. Remove rods, counterweight and crankshaft.
3. Inspect crankshaft. See “INSPECT CRANKSHAFT” on page 69.
4. Inspect balancer assembly. See “BALANCER INSPECTION” on page 65.
5. Put a light film of oil on bearing surfaces.

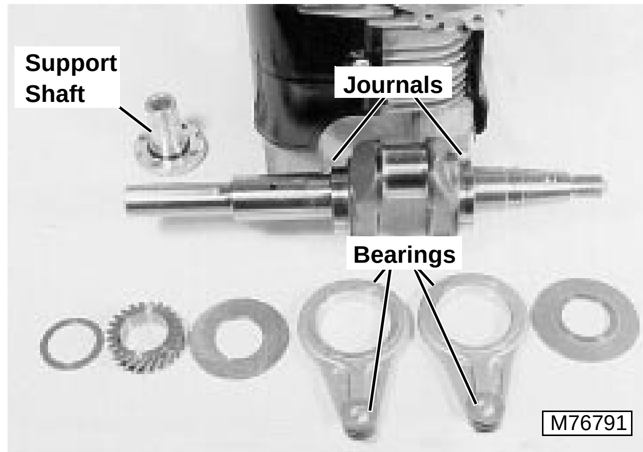
NOTE: Link rods are symmetrical and may be installed either way.



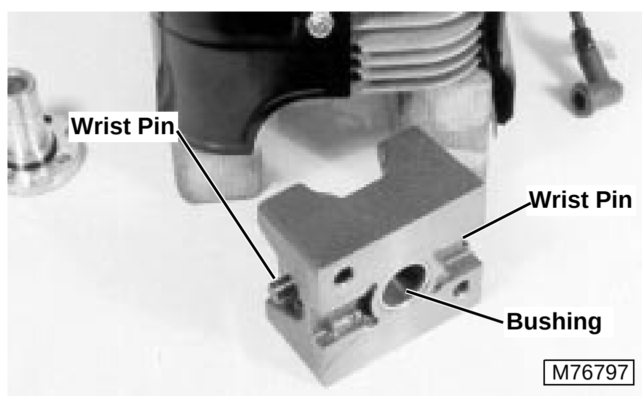
6. Slide link rods on crankshaft journals.
7. Install balance weight to link rods with oil hole, if equipped, facing flywheel side.
8. Install collar with bevel on inside of hole towards link rod. Install collar with smooth raised surface toward flywheel.
9. Install key in slot in crankshaft.
10. Install gear with timing mark facing away from crank journal.
11. Install shim.

BALANCER INSPECTION

Clean and inspect all parts for wear or damage. Replace parts, if necessary.



12. Measure crankshaft journals. Replace crankshaft if diameter is less than specifications.
13. Measure inside diameter of bearings. Replace link rod if greater than specifications.
14. Measure support shaft diameter. Replace shaft if diameter is less than specification.



15. Measure inside diameter of support shaft bushing. If bushing is greater than specifications, replace bushing. See next section.
16. Inspect wrist pins for any damage. If necessary, replace weight.

Balancer Link Rod Specifications:

Link Rod Crankshaft Journal O.D. (Min.)
FC401V-BS05, FC420V-AS19 53.95 mm (2.124 in.)
FC540V-AS17 & AS18. . . . . . 57.94 mm (2.281 in.)

Link Rod Large End I.D. (Max.)
FC401V-BS05, FC420V-AS19 54.12 mm (2.131 in.)
FC540V-AS17 & AS18. . . . . . 58.15 mm (2.289 in.)

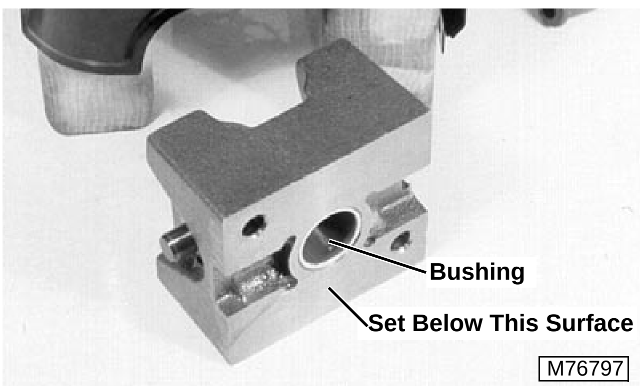
Link Rod Small End I.D. (Max.)
All. . . . . 12.06 mm (0.475 in.)

Support Shaft O.D. (Min)
All. . . . . 25.93 mm (1.021 in.)

Support Shaft Bearing I.D. (Max.)
All. . . . . 26.10 mm (1.027 in.)

BALANCER BUSHINGS REPLACEMENT

NOTE: Remove bushings with a bearing driver or a press.



1. Remove bushing.
2. Align oil hole, if equipped, in bushing and oil passage in weight.
3. Install bushing below surface to specifications.

Specifications:

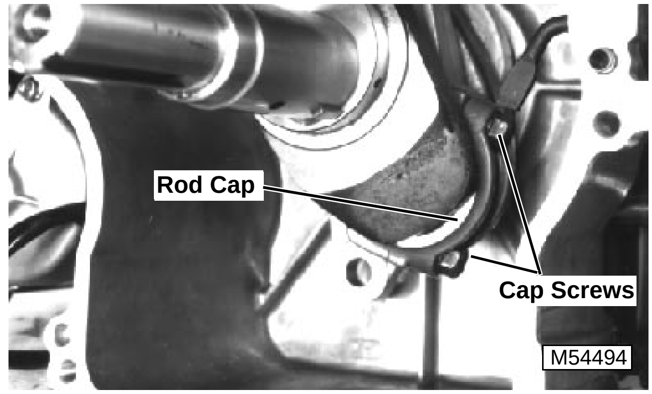
Bushing Depth (D)

FC401V-BS05, FC420V-AS19. . . . 0.50 mm (0.20 in.)

FC540V-AS17 . . . . 1.00 mm (0.40 in.)

REMOVE PISTON AND CONNECTING ROD

1. Remove cylinder head. See “CYLINDER HEAD REMOVAL” on page 53.
2. Remove crankcase cover. See “CRANKCASE COVER REMOVAL” on page 60.
3. Remove carbon and varnish from top of cylinder bore with a ridge reamer.



4. Remove cap screws.
5. Remove connecting rod cap.
6. Push piston and connecting rod from cylinder bore.
7. Inspect piston, piston rings and connecting rod. See “PISTON INSPECTION” on page 67. See “INSPECT CONNECTING ROD” on page 69.

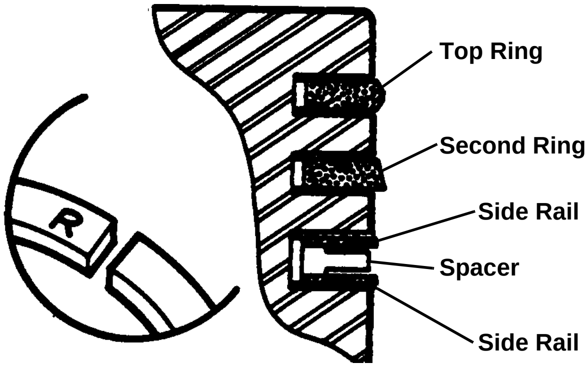
PISTON INSTALLATION

1. Stagger piston ring end gaps 180^{o} apart, but do not align with side rail end gaps.

2. Compress rings with a ring compressor.
3. Apply a light film of oil to cylinder bore, connecting rod bearing surface and cap screws.
4. Install piston assembly in cylinder bore with engraved match mark/arrow on piston head facing flywheel side of engine.
5. Install connecting rod cap, oil splasher, if equipped and locking plate, if equipped. Tighten cap screws to **20 N•m (177 lb-in.)**

PISTON RINGS REMOVAL AND INSTALLATION

1. Remove piston rings with a piston ring expander.
2. Inspect piston. Clean piston ring grooves.
3. Check piston ring end gap. (See below.)



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4. Install top ring and second ring with R or NPR mark facing up. Rings should turn freely in grooves.
5. On all engines, oil ring is an assembly. Install spacer, then side rails. Put side rail end gaps 180^{o} apart.

CHECK PISTON RING END GAP

NOTE: Before installing rings on piston, check end gap in cylinder bore.

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1. Install each ring squarely in bore approximately **25.4 mm (1.0 in.)** down from top of cylinder.
2. Check end gap. Replace ring if end gap is more than specifications.

Piston Ring End Gap Specifications:

Min. Ring Gap All Rings . . . . . . 0.18 mm (0.007 in.)

Max. Ring Gap

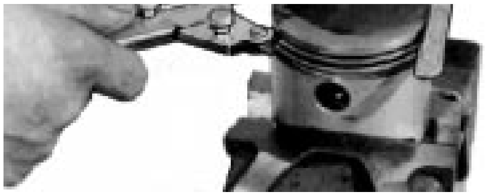
Compression Rings . . . . 0.90 mm (0.035 in.)
Oil Ring Side Rails . . . . 1.30 mm (0.051 in.)

PISTON INSPECTION

1. Remove piston rings. (See this group.)

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

2. Remove all deposits from the piston.



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

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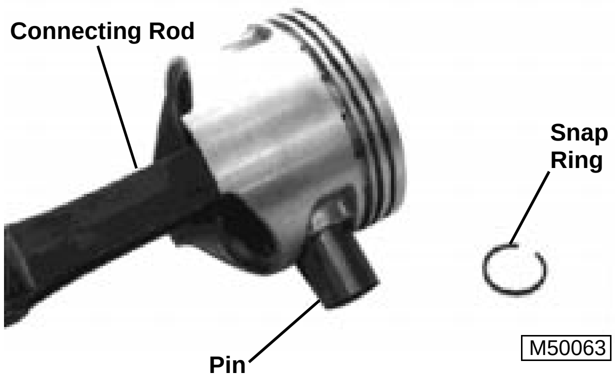
6. Check ring grooves for wear at several points around piston. Replace piston if clearance is greater than specification.

Piston Ring Groove Specifications Max.:

Top Ring	**0.17 mm (0.007 in.)**
Second Ring	**0.15 mm (0.006 in.)**
Oil Control Ring	**0.20 mm (0.008 in.)**



7. Remove snap ring, piston pin and connecting rod.

8. Measure piston pin outer diameter. Replace if less than specification.

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

Piston Pin Specifications:

Piston Pin O.D. (Min.).	**18.98 mm (0.747 in.)**
Piston Pin Bore I.D. (MAX) . . .	**19.06 mm (0.750 in.)**

CRANKSHAFT AND CONNECTING ROD WEAR INSPECTION

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

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

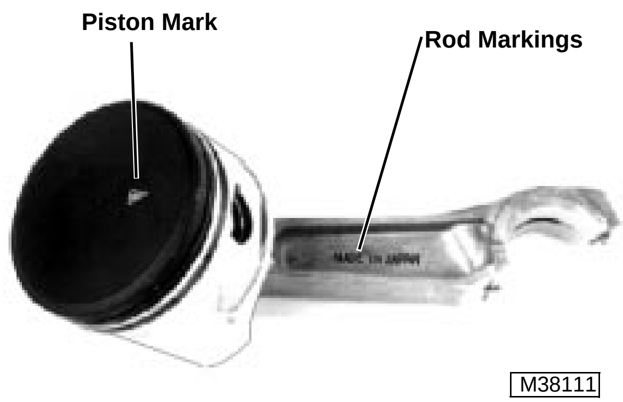
When the rod and cap seize to the crankshaft, the connecting rod and piston may both break causing other internal damage. Inspect block carefully before rebuilding engine.

Crankshaft and connecting rod damage can result from:

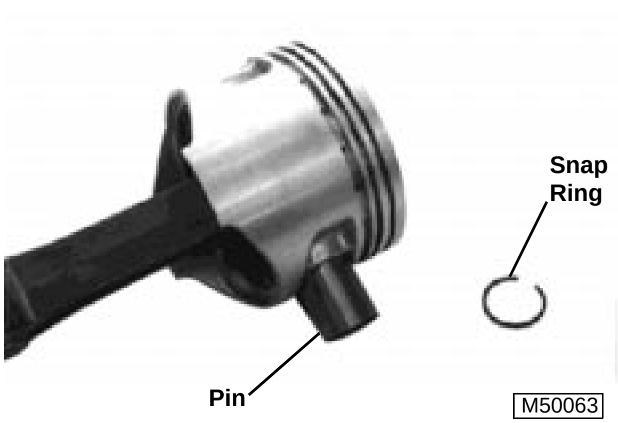
- Engine run low on oil or without oil.
- Oil not changed regularly.
- Bearing cap installed incorrectly.

PISTON-TO-ROD ASSEMBLY

1. Apply a light film of engine oil to piston pin and connecting rod bearing.



2. Align arrow match mark on piston head with MADE IN JAPAN on connecting rod web, or if piston is marked with “R” and “L”, alight the “R” on the piston with the Japanese characters on the rod web.



3. Install pin in piston and rod. Secure with snap ring at each end.

INSPECT CONNECTING ROD

1. Install connecting rod cap. Tighten to **20 N•m (177 lb-in.)**
2. Clean and inspect rod. Replace if scored.
3. Measure connecting rod crankshaft bearing and piston bearing. Replace connecting rod if either measurement is greater than specifications.

Connecting Rod Bearing I.D. Specifications (Max):

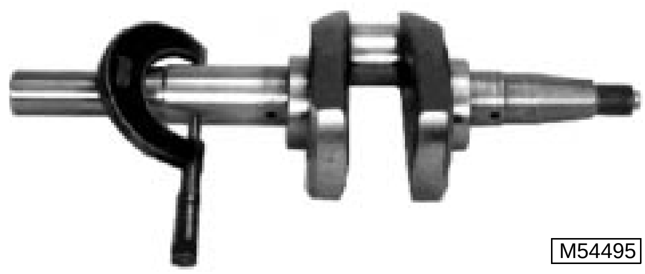
Crankshaft Bearing . . . . 41.07 mm (1.617 in.)
Piston Pin Bearing . . . . 19.06 mm (0.750 in.)

INSPECT CRANKSHAFT

1. Remove Crankshaft. See “BALANCER REMOVAL AND INSTALLATION” on page 64.
2. Remove balancer.

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

3. Check crankshaft alignment (T.I.R.). See “CHECK CRANKSHAFT ALIGNMENT (TIR)” on page 70.
4. Clean and inspect crankshaft. Replace or grind if bearing surfaces are scratched or damaged.



5. Measure crankshaft main bearing journals and connecting rod journal. Replace crankshaft if measurements are less than specifications.

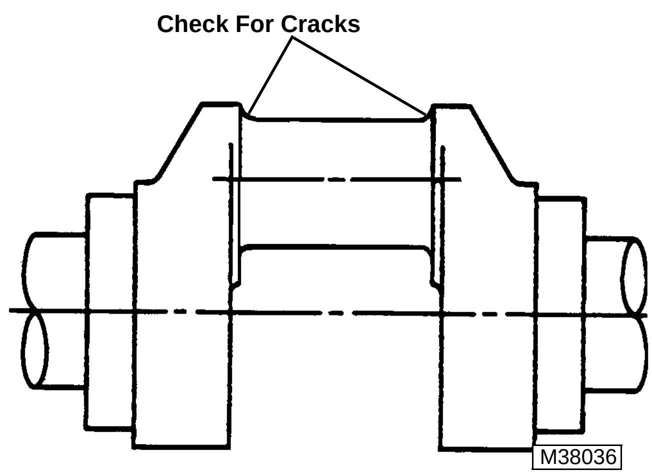
Crankshaft Specifications (Min):

FC401V-BS05 & FC420V-AS19 & AS21:

Main Bearing PTO Side . . . . . . 34.92 mm (1.375 in.)
Main Bearing Flywheel Side . . 34.94 mm (1.376 in.)
Connecting Rod Journal . . . . . 40.93 mm (1.611 in.)

FC540V-AS17 & AS18:

Main Bearing PTO Side . . . . . . 37.90 mm (1.492 in.)
Main Bearing Flywheel Side . . 34.94 mm (1.376 in.)
Connecting Rod Journal . . . . . 40.93 mm (1.611 in.)

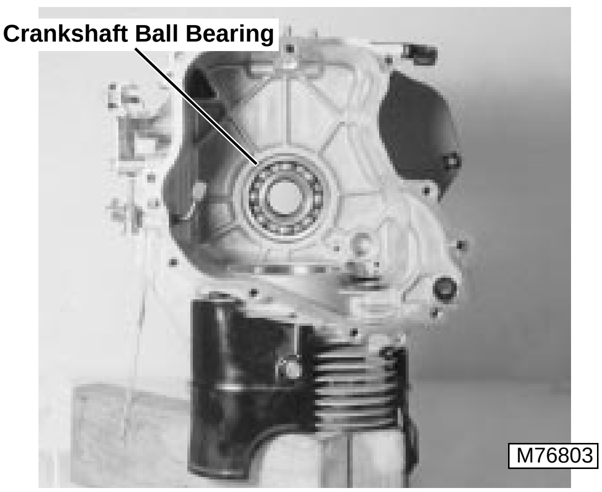


NOTE: Connecting rod journal can be resized to accept undersized rod. Have grinding done by a reliable repair shop. Before sending crankshaft for grinding, inspect journal radii for cracks.

6. Cover keyway on flywheel end of crankshaft with tape to prevent seal damage when installing crankshaft.
7. Put a light film of oil on crankshaft bearing surfaces.
8. Pack grease in oil seals and install crankshaft. See "BALANCER REMOVAL AND INSTALLATION" on page 64.

CRANKSHAFT BALL BEARING REPLACEMENT

IMPORTANT: DO NOT remove ball bearing from engine case unless it requires replacement. Inspection can take place with bearing in case.

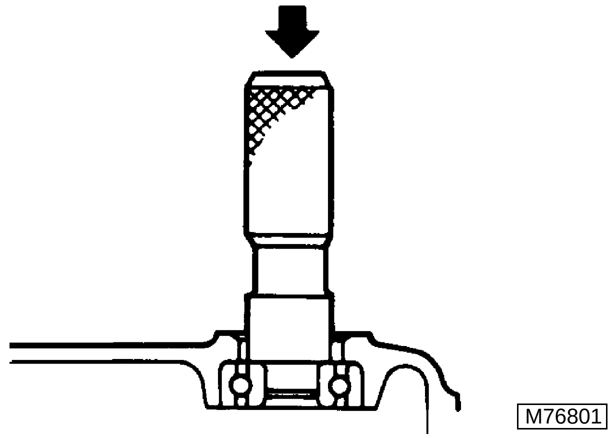


1. Thoroughly clean bearing in solvent. Dip bearing in light weight oil.
2. Spin the bearing by hand and check for **ANY** roughness or axial and/or radial free play. Replace bearing as required.

CAUTION

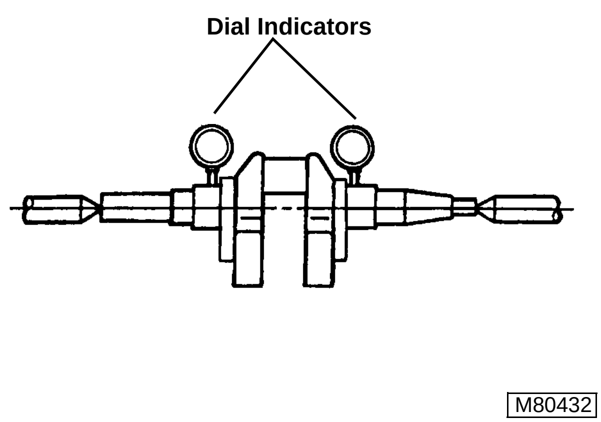
Engine case is aluminum. Insure that case is properly supported during bearing removal and installation to prevent warping or cracking case.

3. Remove oil seal from outside of case using screwdriver. Discard seal.



4. Use suitable bearing driver to remove ball bearing to inside of case.
5. Clean case bearing surfaces and lightly oil.
6. Using a bearing driver install new bearing and seal.
7. Reassemble crank and case and set end play. See "CRANKSHAFT END PLAY ADJUSTMENT" on page 71.

CHECK CRANKSHAFT ALIGNMENT (TIR)

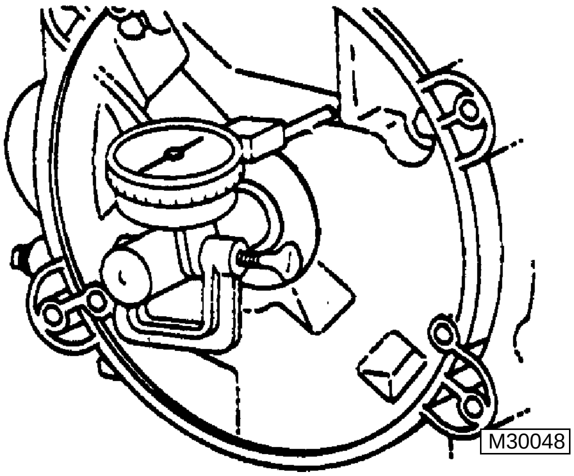


Place crankshaft into an alignment jig and rotate crankshaft slowly. Use dial indicators to measure maximum total indicated runout (TIR). If not according to specification, replace crankshaft.

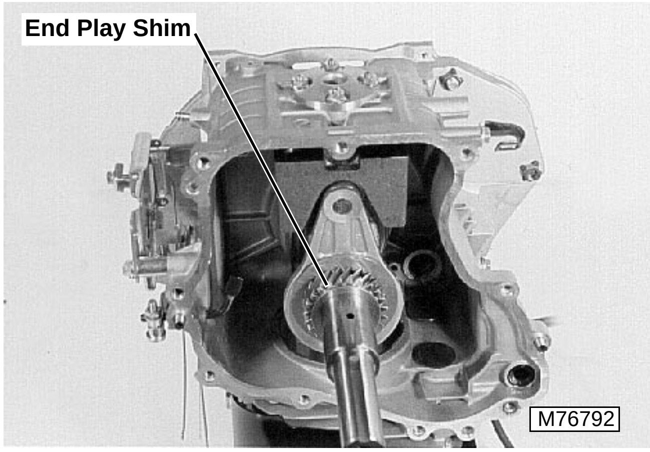
TIR Specifications (Max):
All Models . . . . 0.05 mm (0.002 in.)

CRANKSHAFT END PLAY ADJUSTMENT

NOTE: Crankshaft end play should be checked and/or adjusted whenever the case cover has been removed.
Always use new gasket when reassembling cover.



1. Install crankshaft, cover gasket and cover.
2. Set up dial indicator and push crankshaft fully into case.
3. Zero dial indicator. Pull crankshaft as far out of case as it will move and record difference in reading on dial indicator.



4. If play is not within specifications remove crankcase cover and replace shim.

Crankshaft End Play Specifications:

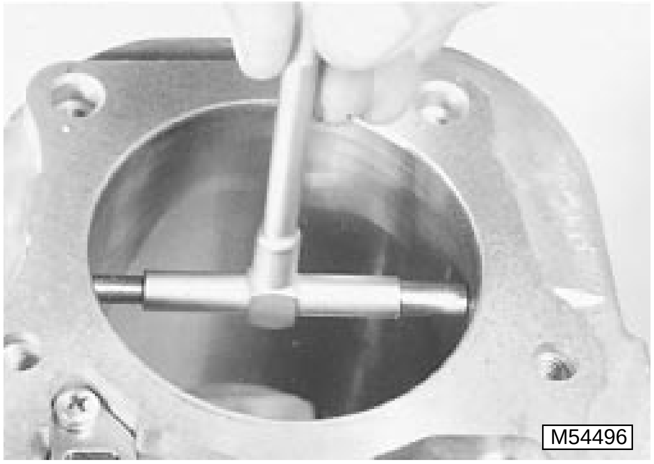
All Models . . . . 0.09—0.22 mm (0.004—0.009 in.)

5. If shim required falls between available shims choose the next smaller shim.
6. Install shim on PTO shaft.
7. Recheck end play.

BLOCK INSPECTION

1. Clean and check block for cracks.
2. 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.
3. 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.

NOTE: A bare block is available for service.



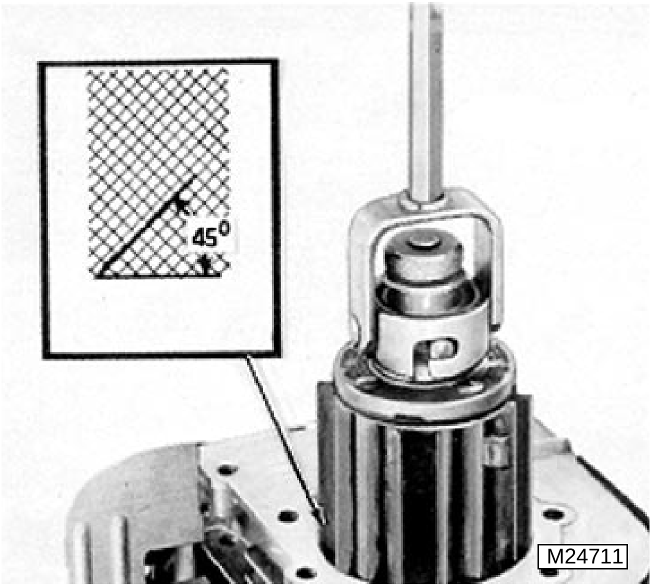
4. Measure cylinder bore parallel with crankshaft and right angles to crankshaft to top and bottom of ring travel.
5. If cylinder bore exceeds wear limit, replace cylinder block or rebore cylinder. (See this group.)

NOTE: If cylinder is rebored, oversize piston and rings must be installed.

Cylinder Bore Specifications:

Standard . . . . . . 88.90—89.00 mm (3.500—3.504 in.)
Wear Limit. . . . . 89.08 mm (3.507 in.)
Out Of Round . . . . 0.06 mm (0.002 in.)

DEGLAZE CYLINDER BORE



1. Deglaze cylinder bore using a rigid hone with a **220 to 300 grit** stone.
2. Use hone as instructed by manufacturer to obtain **45°** crosshatch pattern as shown.

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 water. Continue to clean cylinder until white rags show no discoloration.

REBORE CYLINDER BLOCK

NOTE: The cylinder block can be rebored to use ***0.25, 0.50 or 0.75 mm (0.010, 0.020 or 0.030 in.)*** *oversize pistons and rings. Have a reliable repair shop rebore the block, or use a drill press and honing tool.*

1. Rebore cylinder with a honing tool to initial and final bore specifications.
2. Align center of bore to press center. Set the press to operate from **200—250 rpm**.
3. Lower and raise hone until ends extend **20—25 mm (0.75—1.0 in.)** past ends of cylinder.
4. Turn adjusting nut on hone until stones contact cylinder wall at narrowest point.
5. Coat inside of cylinder with honing oil. Turn hone by hand. If you cannot turn it, hone is too tight.
6. Start drill press. Move hone up and down in cylinder approximately **20 times** per minute.
7. Check cylinder diameter regularly during honing. Stop press before measuring. Remove hone from cylinder.

NOTE: Finish should not be smooth, but have a ***40—60°*** *crosshatch pattern.*

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

Initial Cylinder Oversize Bore Specifications:

Oversize: 0.25 mm (0.010 in.)
. . . . 89.21–89.23 mm (3.512–3.513 in.)

Oversize: 0.50 mm (0.020 in.)
. . . . 89.46–89.48 mm (3.522–3.523 in.)

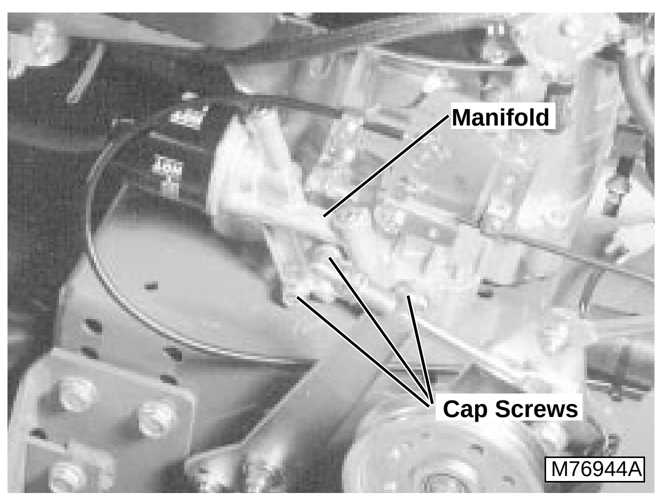
Oversize: 0.75 mm (0.030 in.)
. . . . 89.71–89.73 mm (3.532–3.533 in.)

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

IMPORTANT: DO NOT use gasoline or commercial solvents to clean cylinder bores. Solvents will not remove metal particles produced during honing.

9. Clean the cylinder thoroughly using soap, warm water and clean rags. Continue to clean cylinder until white rags show no discoloration.
10. Dry the cylinder. Apply engine oil to cylinder wall.

OIL FILTER MANIFOLD REMOVAL AND INSTALLATION



1. Remove and discard oil filter.

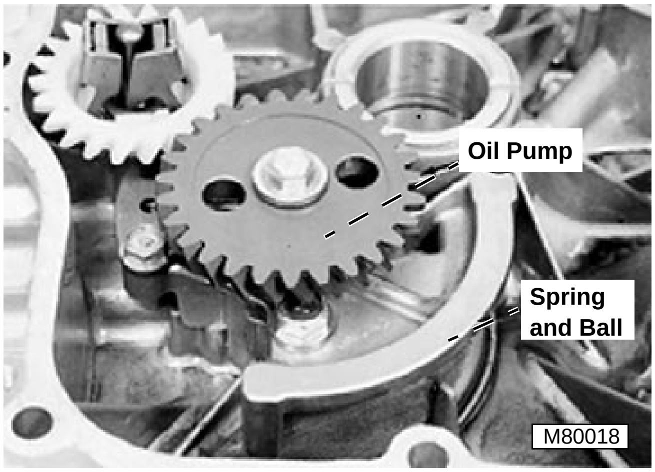
2. Remove three (3) cap screws securing manifold to block.
3. Inspect oil passages for clogs. Clean if needed.

4. Inspect rubber gaskets. Replace if worn or damaged.
5. Install new filter and manifold.

OIL PUMP REMOVAL AND INSTALLATION

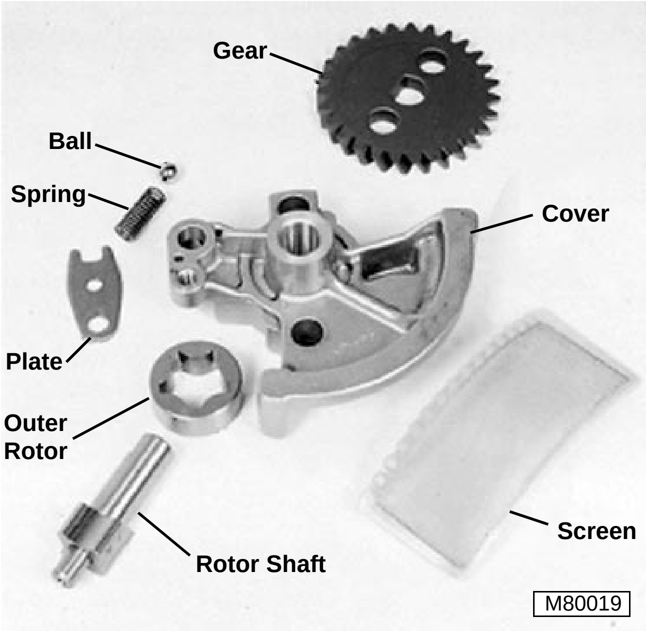
1. Remove crankcase cover. See “CRANKCASE COVER REMOVAL” on page 60.
2. Remove oil pump gear.

IMPORTANT: Remove rotor shaft and oil pump cover together to avoid damaging governor.

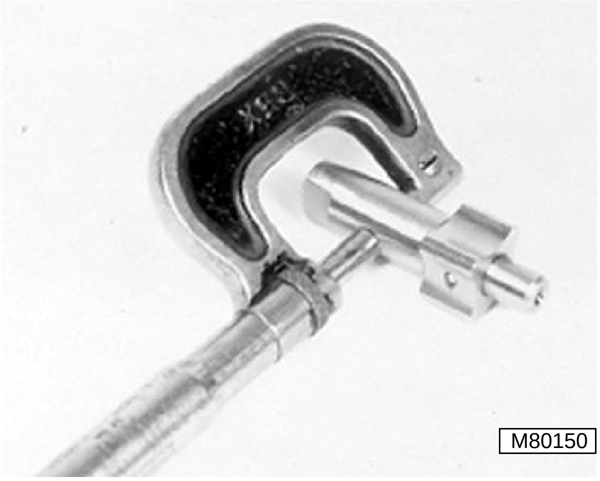


3. Remove oil pump assembly.
4. Remove relief spring and ball.
5. Inspect all parts. (See next.)
6. Install oil pump assembly.
7. Replace cover. See “CRANKCASE COVER INSTALLATION” on page 60.

OIL PUMP INSPECTION



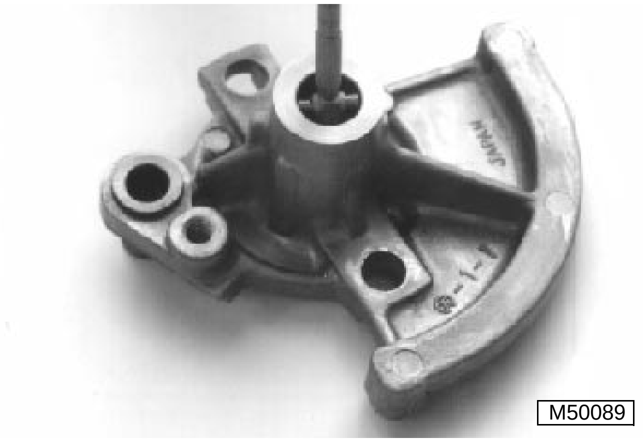
1. Inspect all parts. Replace if worn or damaged.



2. Measure pump rotor shaft. Replace if less than specifications:

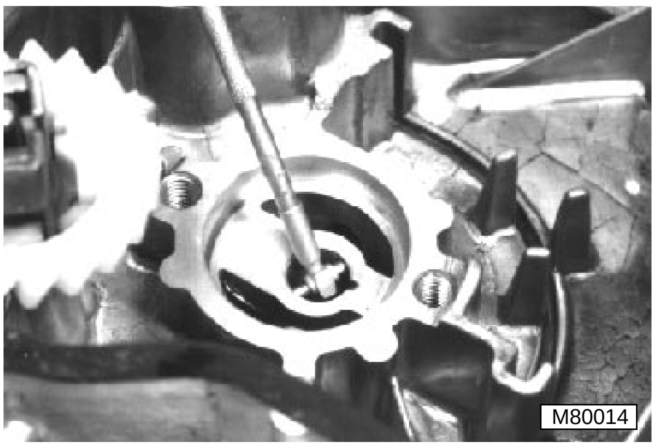
Oil Pump Shaft Specifications:

Large Shaft Diameter . . . . 12.63 mm (0.497 in.)
Small Shaft Diameter . . . . 7.94 mm (0.313 in.)



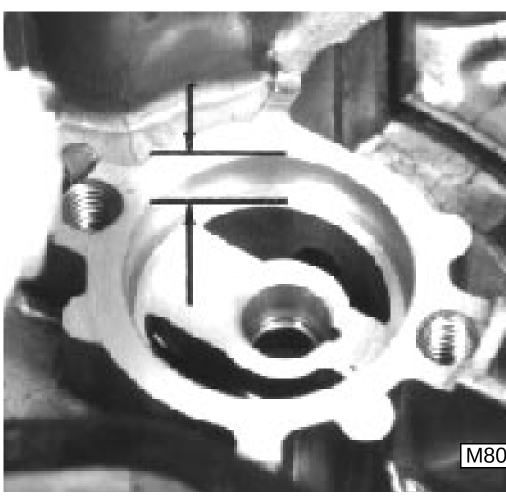
M50089

3. Measure pump cover bearing. Replace cover if greater than **12.76 mm (0.502 in.)**



M80014

4. Measure crankcase cover oil pump bearing. Replace cover if greater than **8.07 mm (0.318 in.).**

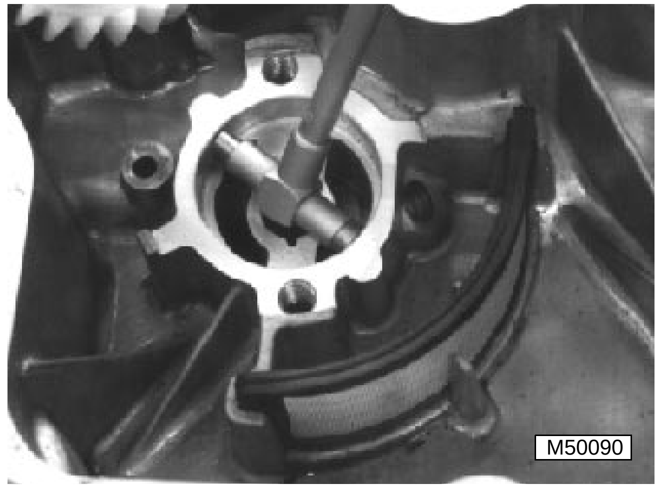


M800152

5. Measure outer rotor bearing depth. Replace crankcase cover if greater than specification.

Oil Pump Rotor Bearing Depth Specifications:

FC401V-BS05, FC420V-AS19 . . 12.14 mm (0.478 in.)
FC540V-AS17 & AS18 . . . . 10.17 mm (0.401 in.)

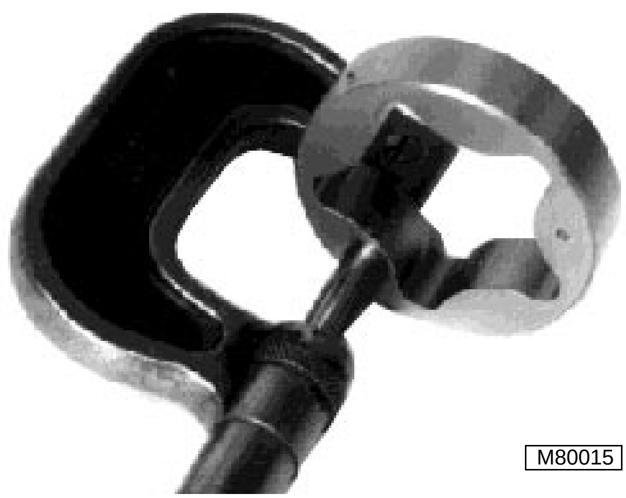


M50090

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

Rotor Housing I.D. Specification:

FC401V-BS05, FC420V-AS19 . . . 29.2 mm (1.150 in.)
FC540V-AS17 & AS18 . . . . 40.72 mm (1.603 in.)



M80015

7. Measure thickness of outer rotor. Replace BOTH outer rotor and shaft if less than specification.

Outer Rotor Thickness Specifications:

FC401V-BS05, FC420V-AS19 . . 11.92 mm (0.469 in.)
FC540V-AS17 . . . . 9.92 mm (0.391 in.)


M80017

8. Measure outside diameter of outer rotor. Replace BOTH outer rotor and shaft if less than specification

Outer Rotor O.D. Specification:

FC401V-BS05, FC420V-AS19 . . 28.95 mm (1.140 in.)
FC540V-AS17 . . . . 40.47 mm (1.593 in.)

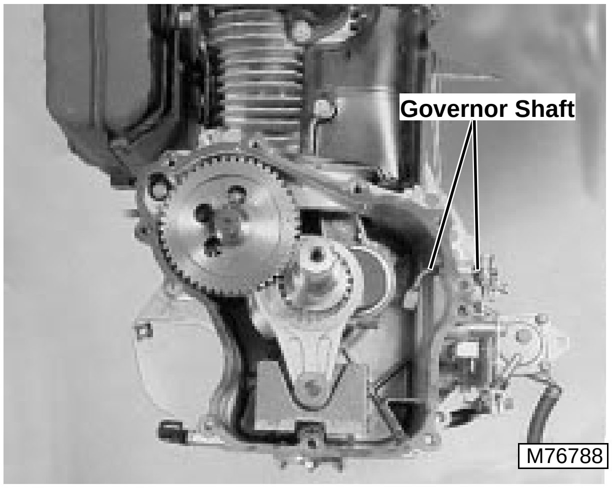

M50083

9. Measure relief valve spring. Replace if length is less than **19.00 mm (0.750 in.)**

GOVERNOR SHAFT INSPECT AND REPLACE

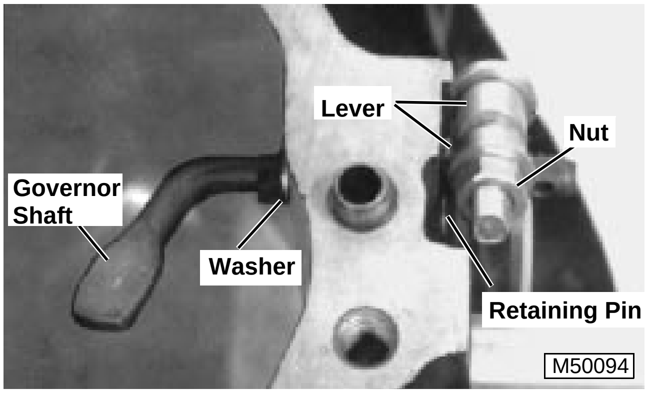
NOTE: It is not necessary to remove governor shaft unless damaged.

1. Remove crankcase cover. See “CRANKCASE COVER REMOVAL” on page 60.



M76788

2. Inspect governor shaft. Replace if damaged.



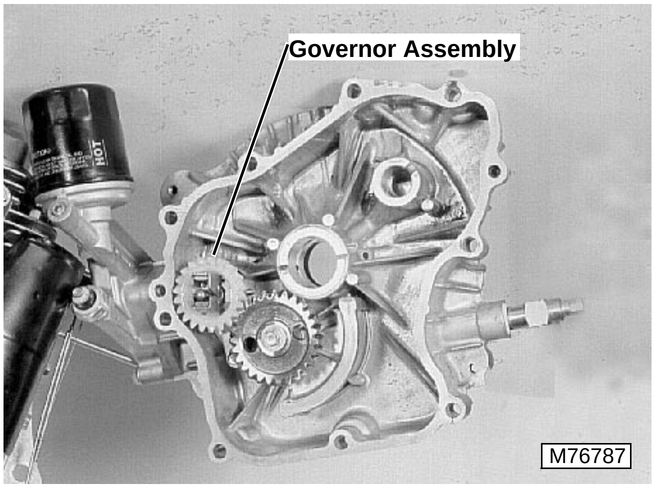
M50094

3. To replace governor shaft, loosen nut on lever.
4. Remove retaining pin, governor shaft and washer.
5. Install washer, shaft and retaining pin. Tighten nut.

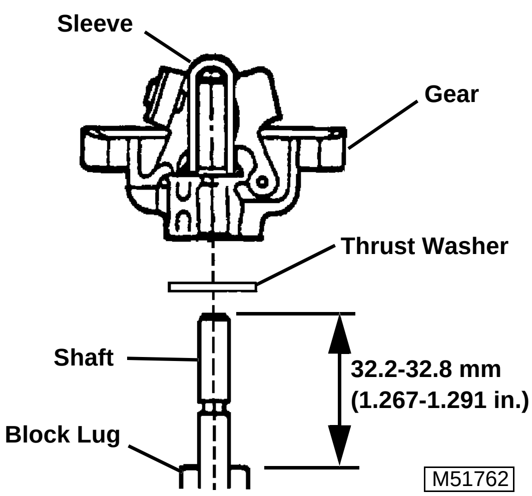
GOVERNOR REMOVAL AND INSTALLATION

IMPORTANT: Removal damages governor. If governor does not need replacement not, do not remove.

1. Remove crankcase cover. See “CRANKCASE COVER REMOVAL” on page 60.



2. Inspect governor. If necessary to replace, remove with screwdriver.



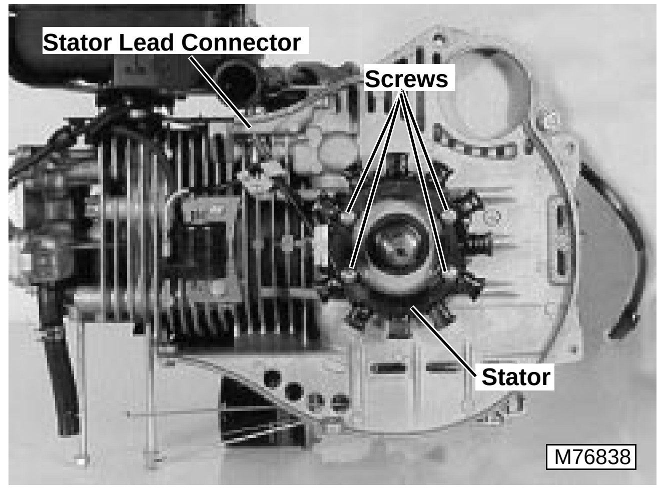
3. If removed, press shaft back into block lug until it protrudes **32.2—32.8 mm (1.267—1.291 in.).**

NOTE: Assemble sleeve and gear before installing assembly on shaft.

4. Install sleeve into governor gear.
5. Place thrust washer on shaft.
6. Install governor assembly onto shaft. Push down on assembly until it snaps into place.
7. Check for free rotation of governor assembly on shaft after assembly

STATOR REMOVAL AND INSTALLATION

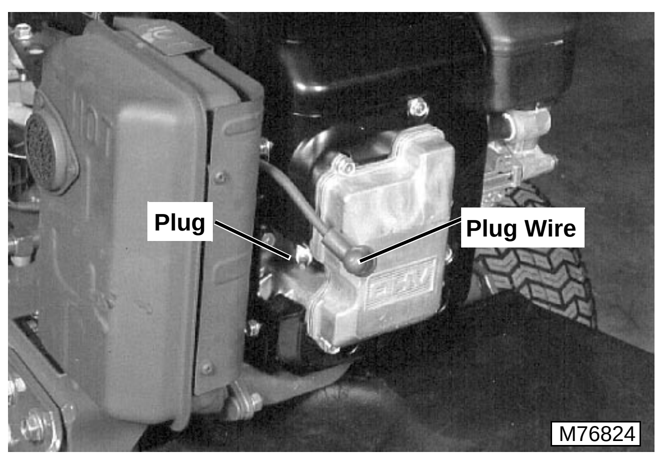
1. Remove flywheel. See “FLYWHEEL REMOVAL AND INSTALLATION” on page 59.



2. Disconnect stator leads at connector.
3. Remove screws and stator.
4. Install stator and connect stator lead.

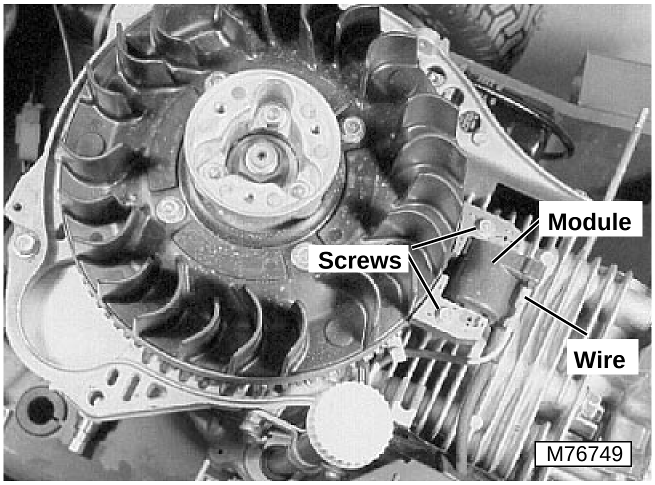
IGNITION COIL WITH MODULE REMOVAL AND INSTALLATION

1. Remove carburetor. See “CARBURETOR REMOVAL” on page 48.
2. Remove blower housing. See “BLOWER HOUSING REMOVAL & INSTALLATION” on page 51.



1. Disconnect spark plug wire and ground.

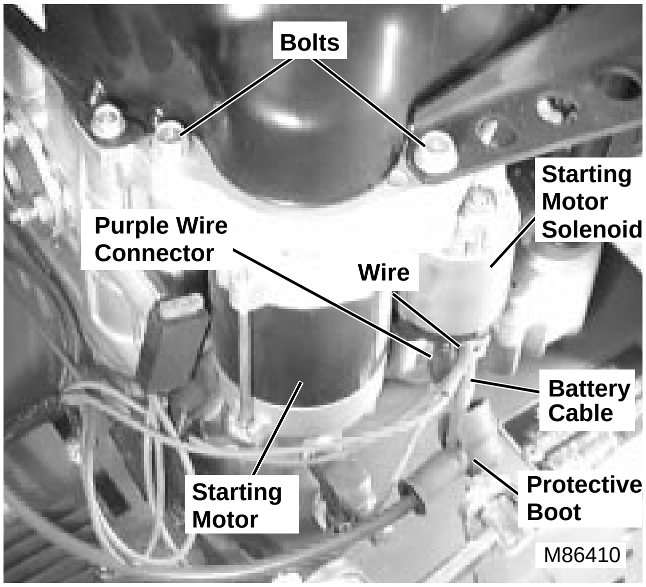
IMPORTANT: Spark plug wire must be grounded or electronic ignition could be damaged.



2. Disconnect wire.
3. Remove screws and ignition coil with module.
4. Install ignition coil with module loosely and connect wire.
5. Adjust ignition coil with module air gap. See “IGNITION COIL WITH MODULE AIR GAP ADJUSTMENT” on page 43.
6. Replace blower housing. See “BLOWER HOUSING REMOVAL & INSTALLATION” on page 51.
7. Replace carburetor. See “CARBURETOR REMOVAL” on page 48.

STARTING MOTOR REMOVAL

1. Disconnect battery.



2. Disconnect purple wire connector from spade on starting motor solenoid.
3. Remove protective boot from stud. Remove nut from stud.
4. Mark wires and remove wire and the positive battery cable from stud.
5. Remove bolts and remove starting motor from engine.
6. Install in reverse order.

STARTING MOTOR PROBLEM DIAGNOSIS

1. The starting motor overheats because of:
   • Long cranking.
   • Armature binding.
2. The starting motor operates poorly because of:
   • Armature binding.
   • Dirty or damaged starting motor drive.
   • Badly worn brushes or weak brush springs.
   • Excessive voltage drop in cranking system.
   • Battery or wiring defective.
   • Shorts, opens, or grounds in armature.

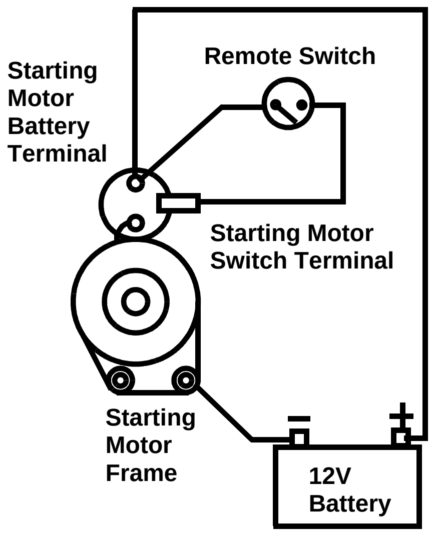
NOTE: Starting motor repair is limited to brushes, end caps, and starting motor drive. Fields in starting motor are permanent magnets and are not serviceable. If housing or armature is damaged, replace starting motor assembly.

STARTING MOTOR BENCH TEST

Perform bench test before disassembling starting motor to determine cause of problem.

IMPORTANT: Never operate motor longer than 20 seconds. Allow at least two minutes for cooling and battery recovery before operating again. Overheating, caused by excessive operation, will seriously damage starting motor.

1. Remove starting motor from engine.



2. Connect 12-volt battery to starting motor battery terminal and starting motor frame using heavy duty cables.
3. Connect remote start switch between switch terminal and battery terminal.

NOTE: A short piece of wire with a small clip on the end will allow a more positive connection at the switch terminal.

When switch is activated, starting motor should engage and run.

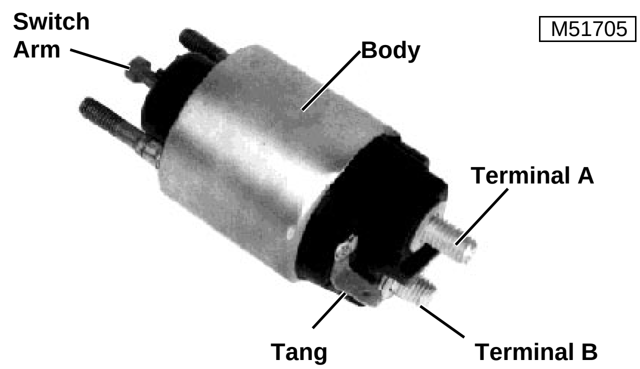
- IF SOLENOID CHATTERS: hold-in winding is open-circuited.
- IF NOTHING HAPPENS: either the solenoid pull-in winding is open-circuited or mechanical parts are sticking.
- IF SOLENOID ENGAGES - BUT MOTOR DOES NOT RUN: check solenoid switch continuity, brushes, armature and field windings.

Solenoid cannot be repaired, replace it.

SOLENOID TEST

NOTE: If bench test indicated solenoid problems, use an ohmmeter or test light to check solenoid.

Test is similar for all units.



1. Test solenoid terminals (A and B) for continuity. There should be no continuity.
2. Depress switch arm. There should be continuity when arm is fully depressed.
3. Test for open circuits between terminal (B) and tang. There should be continuity.
4. Test for open circuits between tang and body. There should be continuity.

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

STARTING MOTOR ROTATION TEST

1. Remove starting motor from engine.
2. Rotate armature.

If armature does not rotate freely, armature may be bent or bearings may be worn. Disassemble and inspect starting motor. (See this group.)

STARTING MOTOR DISASSEMBLY/ASSEMBLY

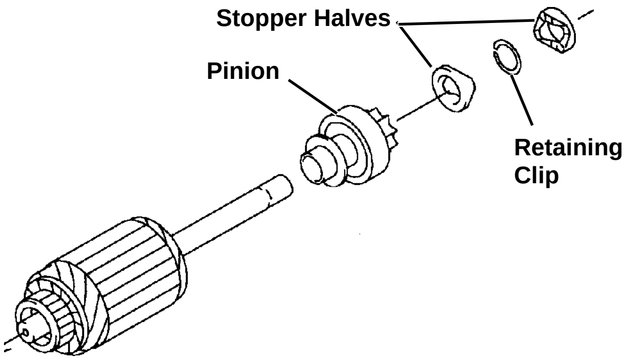
Mark body and covers for correct alignment during reassembly.

1. Separate pinion stopper halves to remove retaining clip.
2. Inspect starting motor parts for wear or damage.
3. Measure brushes. Test starting motor armature and brushes. (See this group.)
4. Apply multipurpose grease to:
   - sliding surfaces of armature and solenoid shift lever
   - armature shaft spline
   - points where shaft contacts cover
5. Assemble starting motor.

STARTING MOTOR INSPECTION

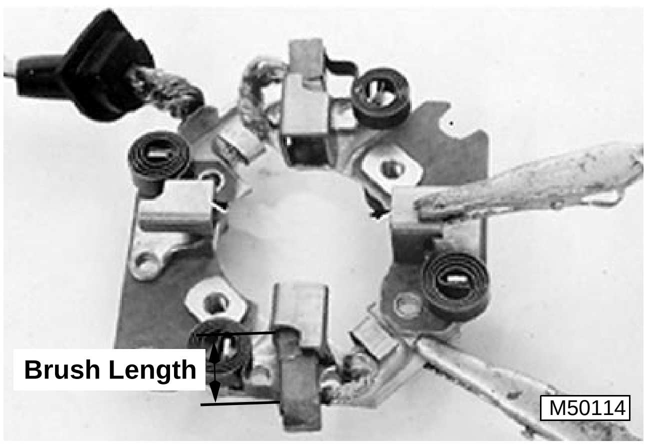
1. Mark body and covers for correct alignment during reassembly

.



M76861

2. Push pinion stopper halves toward pinion to remove retaining clip.
3. Inspect starting motor parts for wear or damage.



M50114

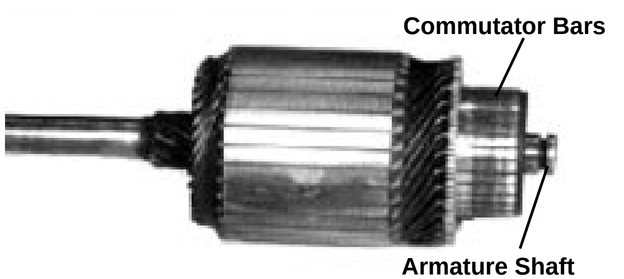
4. Measure brush lengths. Minimum brush length is **10.5 mm (0.413 in.)**. Brushes are not individually serviceable. If brushes are worn replace entire brush holder assembly.

NOTE: Test brush holder using an ohmmeter or test light.

5. Test brush holder:
   • Touch one probe of tester to negative brush holder and other probe to field brush holder. If there is continuity, replace the brush holder.
6. Inspect springs for wear or damage. Springs are not individually serviceable. If springs are damaged replace entire brush holder assembly.

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

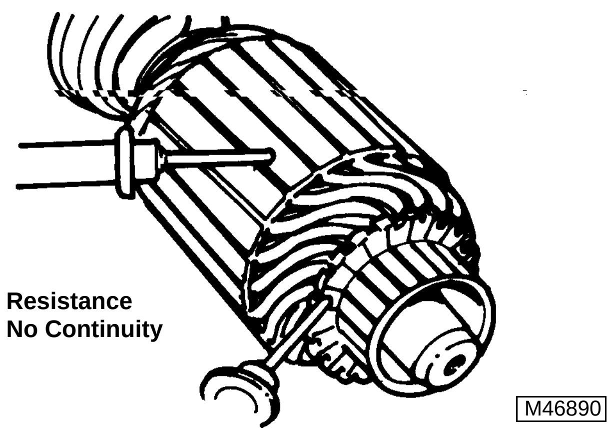
7. Inspect armature. Look for signs of dragging against pole shoes.



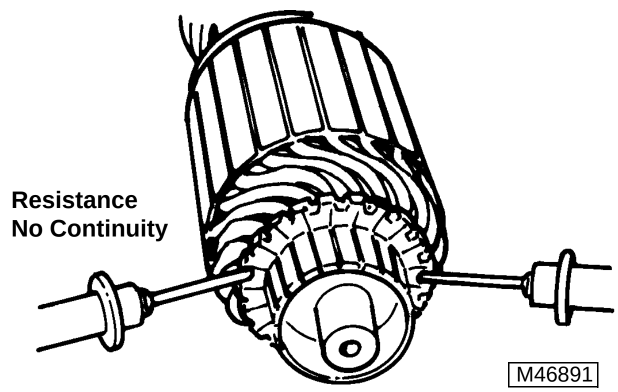
M82246

8. Inspect commutator. Look for roughness, burned bars, or any material which might cause short circuits between bars. If necessary, clean and touch up with 400 sandpaper. NEVER use emery cloth. Clean all dust from armature when finished. Test for grounded windings using an ohmmeter or test light.
9. Armature windings are connected in parallel, so each commutator bar must be checked.
10. If the test shows continuity, a winding is grounded and the armature must be replaced.
11. Test for open circuits in the windings. If the test shows no continuity, the armature has an open circuit and must be replaced

.



M46890



M46891

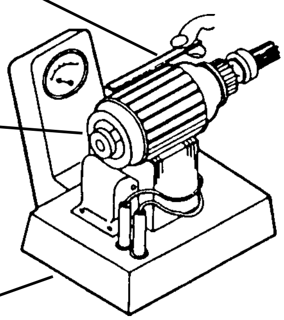
NOTE: Test armature windings using an ohmmeter or test light.

12. Test for grounded windings:
    Touch probes on one commutator bar and armature shaft. Armature windings are connected in series, so only one commutator bar needs to be checked.

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

13. Test for open circuited windings:
    Touch probes on two different commutator bars.

If test shows no continuity, there is an open circuit and the armature must be replaced.



14. Test for short circuited windings using a growler.
    Put armature in a growler and hold a hacksaw blade above each slot while slowly rotating armature.

If coil is shorted, the blade will vibrate on the slot.

NOTE: A short circuit most often occurs because of copper dust or filings between two commutator segments.

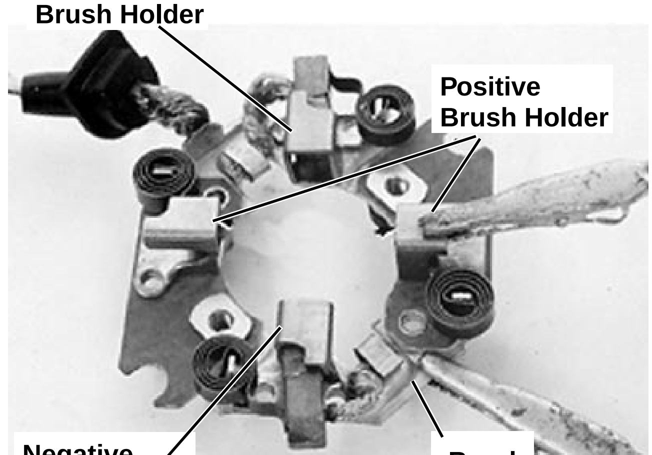
15. If test indicates short circuited windings, clean the commutator of dust and filings. Check the armature again. If the test still indicates a short circuit, replace the armature.

NOTE: Field uses permanent magnets which are not serviceable. Visually inspect for broken magnets or damage to housing.

16. If rpm was slow and armature tests are normal, replace the field coil assembly.
17. Apply multipurpose grease to:
    - Sliding surfaces of armature and solenoid shift lever
    - Armature shaft spline
    - Points where shaft contacts cover
18. Assemble and install starting motor.

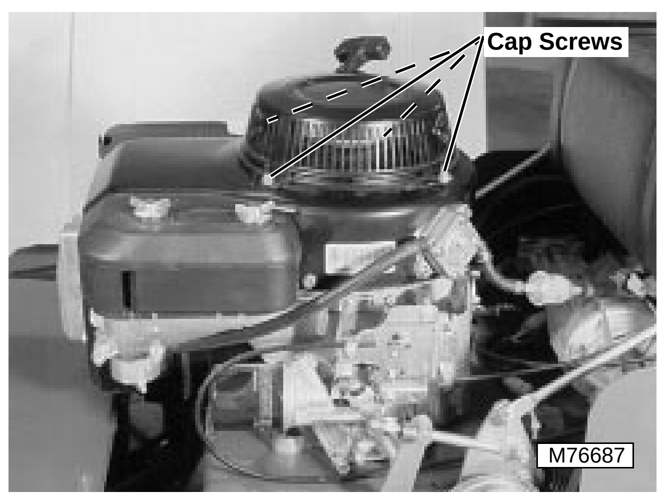
STARTING MOTOR FIELD COIL TEST

NOTE: Continuity tests are similar for all units.



1. Test for continuity between each positive brush holder and brush plate. Replace brush holder assembly if there is **NO** continuity.
2. Test for continuity between each negative brush holder and brush plate. Replace brush holder assembly if there **IS** continuity.

RECOIL STARTER DISASSEMBLY



1. Remove four cap screws securing recoil starter assembly to engine. Remove recoil starter assembly.

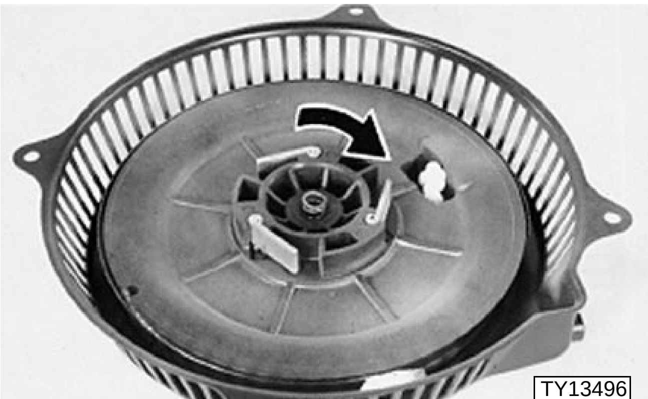
TY13495

2. Pull handle out about 30 cm (1 ft.). Tie knot (A) to prevent rope from winding back onto reel.
3. Pry knot (B) out of handle and untie.
4. Remove handle from rope.
5. While holding reel with thumb, untie knot (A). Slowly release reel tension. Do not let rope get wedged between reel and housing.
6. Remove screw (C) and ratchet cover.

CAUTION

Spring is wound under great tension in reel or spring case. DO NOT let spring fly loose! Hold spring firmly in place while replacing.

Spring edges may be rough and sharp! Wear gloves and protective goggles for remaining steps

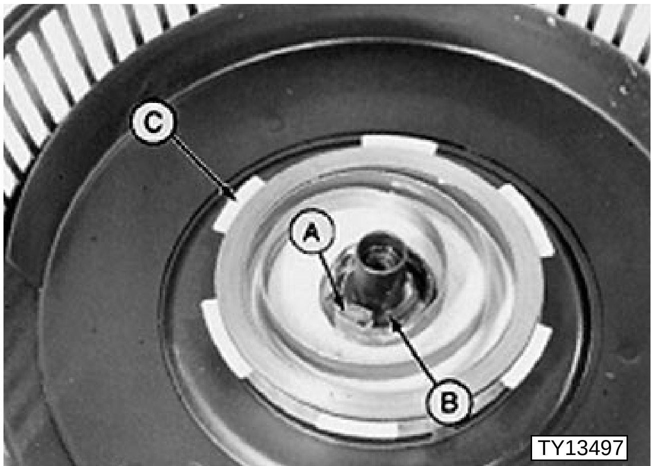


TY13496

7. Turn the reel clockwise until **NO** spring tension can be felt.

CAUTION

Spring is still under great pressure inside case. Use care to avoid personal injury.



TY13497

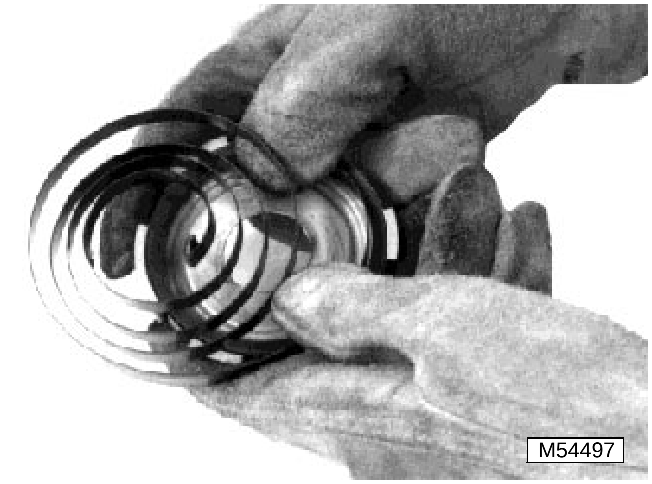
8. On all engines, spring is stored in spring case in housing. Lift reel straight up so spring remains seated in housing.
9. On engines with spring case (C), carefully unhook spring tang (A) from catch (B).
10. Remove spring case from housing.
11. Inspect and replace all damaged or worn parts.

RECOIL STARTER SPRING REPLACEMENT

CAUTION

Spring is wound under great tension in reel or spring case. DO NOT let spring fly loose! Hold spring firmly in place while replacing.

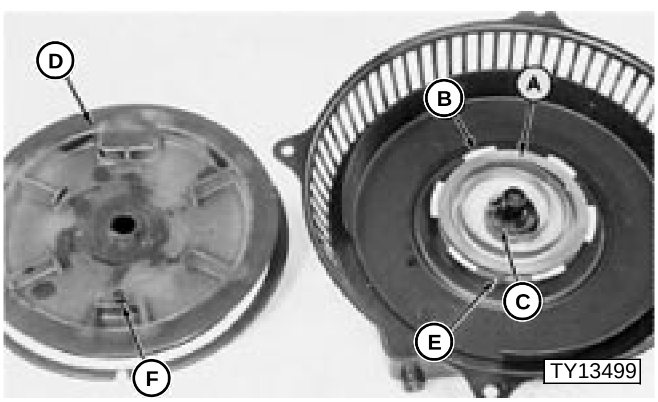
Spring edges may be rough and sharp! Wear gloves and protective goggles for remaining steps



1. Working from the center out, carefully unwind spring from spring case or reel.
2. Hook outside spring tang in reel or case. Wind spring into reel or spring case, working toward center.

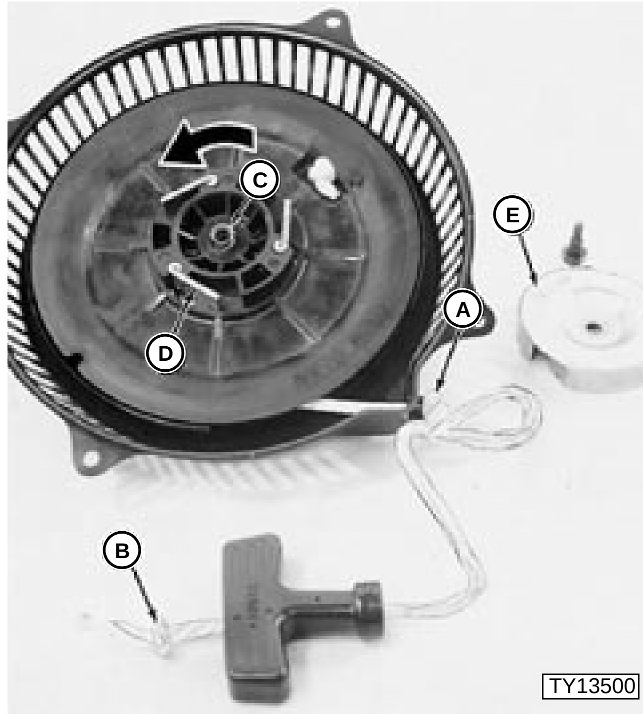
RECOIL STARTER ASSEMBLY

NOTE: Refer to "RECOIL STARTER COMPONENT LOCATION" on page 15 for general component location.

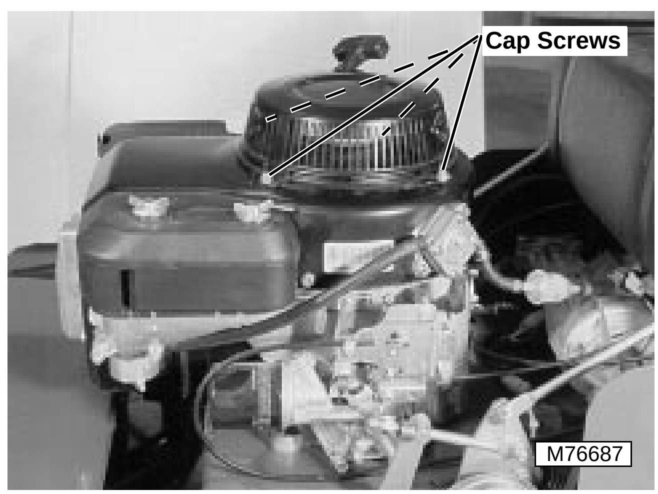


1. Wind rope counterclockwise onto reel.
2. On engines with a spring case (B), place spring case into housing with spring tang over catch (C).
3. Install reel in spring case, with round peg (F) aligned with end of spring (E).
4. Turn reel counterclockwise until you feel tang hook on catch.
5. Turn reel two turns counterclockwise to pre-load spring

.



6. While holding reel to keep it from unwinding, feed end of rope through hole. Tie knot (A) to hold rope.
7. Install handle and secure with knob (B).
8. Remove knot (A).
9. Install spring (C) and ratchet cover (E) with opening(s) in cover over pawl(s) (D). Check for free movement of pawls.
10. Pull rope to check for proper operation.



11. Place starter assembly on engine and secure with four (4) cap screws.

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KOHLER ENGINE

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SPECIFICATIONS - KOHLER ENGINE

TEST AND ADJUSTMENT SPECIFICATIONS

Engine:

Valve Adjustment . . . . None (hydraulic lifters)
Oil Pressure (Minimum at 1250 rpm) . . . . 124 kPa (18 psi)
Compression Pressure (Minimum At Operating Temperature) . . . . 345 kPa (50 psi)
Crankcase Vacuum (Minimum At Operating Temp.) . . . 102 mm (4 in.) Water Movement
ACR Minimum Lift (Engine Cold) . . . . 0.25 mm (0.01 in.)

Fuel/Air System:

Carburetor Slow Idle Mixture Screw Initial Setting . . . . 1 Turn
Slow Idle Speed . . . . 1550 ±75 rpm
Fast Idle Speed . . . . 3350 ±100 rpm

REPAIR SPECIFICATIONS

Cylinder Head:

Cylinder Head Flatness (Maximum Warpage) . . . . 0.076 mm (0.003 in.)

Push Rod:

Maximum Bend . . . . 0.76 mm (0.030 in.)

Valves and Valve Lifters:

Hydraulic Lifter Clearance . . . . 0.01 - 0.05 mm (0.0005 - 0.002 in.)
Intake Valve-to-Guide Clearance . . . . 0.04 - 0.07 mm (0.0015 - 0.003 in.)
Intake Valve Stem OD . . . . 6.98 - 7.00 mm (0.274 - 0.275 in.)
Exhaust Valve Stem OD . . . . 6.97 - 6.98 mm (0.274 - 0.275)
Exhaust Valve-to-Guide Clearance . . . . 0.05 - 0.09 mm (0.002 - 0.003 in.)
Intake Valve Guide ID:
  New . . . . 7.04 -7.06 mm (0.277 - 0.278 in.)
  Maximum . . . . 7.13 mm (0.281 in.)
Exhaust Valve Guide ID:
  New . . . . 7.04 - 7.06 mm (0.277 - 0.278 in.)
  Maximum . . . . 7.16 mm (0.282 in.)
Valve Guide Reamer:
  Standard . . . . 7.05 mm (0.277in.)
  Oversize (0.25 mm) . . . . 7.30 mm (0.287 in.)
Intake Valve Lift (Minimum—Engine Cold) . . . . 8.96 mm (0.353 in.)
Exhaust Valve Lift (Minimum—Engine Cold) . . . . 9.14 mm (0.360 in.)
Valve Face Angle . . . . 45°
Valve Seat Angle 44.5

Crankshaft:

- End Play ..... 0.0575 - 0.4925 mm (0.0023 - 0.0194 in.)
- Crankshaft Bore (Crankcase Half) ID:
  - New ..... 44.965 - 45.003 mm (1.7703 - 1.7718 in.)
  - Maximum ..... 45.016 mm (1.7723 in.)
  - Clearance (New) ..... 0.03 - 0.09 mm (0.0012 - 0.0035 in.)
- Crankshaft Bore (Oil Pan Half):
  - New ..... 44.965 - 45.003 mm (1.7703 - 1.7718 in.)
  - Maximum ..... 45.016 mm (1.7723 in.)
  - Clearance (New) ..... 0.03 - 0.09 mm (0.0012 - 0.0035 in.)
- Flywheel Main Bearing Journal OD:
  - New ..... 44.913 - 44.935 mm (1.7682 - 1.7691 in.)
  - Minimum ..... 44.84 mm (1.765 in.)
  - Maximum Taper ..... 0.022 mm (0.0009 in.)
  - Maximum Out-of-Round ..... 0.025 mm (0.0010 in.)
- Oil Pan Main Bearing Journal OD:
  - New ..... 41.915 - 41.935 mm (1.6502 - 1.6510 in.)
  - Minimum ..... 41.86 mm (1.648 in.)
  - Maximum Taper ..... 0.020 mm (0.0008 in.)
  - Maximum Out-of-Round ..... 0.025 mm (0.0010 in.)
- Connecting Rod Journal OD:
  - New ..... 38.958 - 38.970 mm (1.5338 - 1.5343 in.)
  - Minimum ..... 38.94 mm (1.5328 in.)
  - Maximum Taper ..... 0.012 mm (0.0005 in.)
  - Maximum Out-of-Round ..... 0.025 mm (0.0010 in.)
- Crankshaft Total Indicated Runout (TIR):
  - PTO End (In Engine) ..... 0.15 mm (0.0059 in.)
  - Entire Crankshaft (In Bench V-Blocks) ..... 0.10 mm (0.0039 in.)

Camshaft:

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

Balance Shaft:

- End Play ..... 0.0575 - 0.3625 mm (0.0023 - 0.0143 in.)
- Clearance ..... 0.025 - 0.063 mm (0.0009 - 0.0025 in.)
- Bore ID:
  - New ..... 20.000 - 20.025 mm (0.7874 - 0.7884 in.)
  - Maximum ..... 20.038 mm (0.7889 in.)
- Balance Shaft Bearing OD:
  - New ..... 19.962 - 19.975 mm (0.7859 - 7864 in.)
  - Minimum ..... 19.959 mm (0.7858 in.)

Cylinder Bore, Piston and Rings:

Cylinder Bore ID:
- New .... 87.00 - 87.02 mm (3.425 - 3.426 in.)
- Maximum .... 87.06 mm (3.428 in.)
- Maximum Out-of-Round .... 0.12 mm (0.005 in.)
- Maximum Taper .... 0.05 mm (0.002 in.)

Piston-To-Pin Clearance .... 0.006 - 0.017 mm (0.0002 - 0.0007 in.)

Piston Pin Bore ID:
- New .... 19.006 - 19.012 mm (0.7483 - 0.7485 in.)
- Maximum .... 19.025 mm (0.749 in.)

Piston Pin OD:
- New .... 18.995 - 19.000 mm (0.7478 - 0.7480 in.)
- Minimum .... 18.994 mm (0.74779 in.)

Top Compression Ring Groove
- Side Clearance .... 0.04 - 0.10 mm (0.002 - 0.004 in.)

Middle Compression Ring Groove
- Side Clearance .... 0.04 - 0.07 mm (0.002 - 0.003 in.)

Oil Control Ring Groove
- Side Clearance .... 0.55 - 0.68 mm (0.022 - 0.027 in.)

Top and Center Compression Ring End Gap
- New Bore .... 0.3 - 0.5 mm (0.012 - 0.020 in.)
- Used Bore (Maximum) .... 0.77 mm (0.030 in.)

Piston Thrust Face OD:
- New .... 86.94 - 86.96 mm (3.423 - 3.424 in.)
- Minimum .... 86.81 mm (3.418 in.)

Connecting Rod:

Crankpin End Clearance
- New .... 0.03 - 0.05 mm (0.001 - 0.002 in.)
- Maximum .... 0.07 mm (0.003 in.)
- Side .... 0.18 - 0.41 mm (0.007 - 0.016 in.)

Piston Pin Clearance .... 0.01 - 0.03 mm (0.0006 - 0.001 in.)

Piston Pin End ID:
- New .... 19.01 - 19.02 mm (0.748 - 0.749 in.)
- Maximum .... 19.04 mm (0.750 in.)

Governor:

Crankcase Cross Shaft Bore ID:
- New .... 6.02 - 6.05 mm (0.237 - 0.238 in.)
- Maximum .... 6.06 mm (0.239 in.)

Cross Shaft OD:
- New .... 5.97 - 6.00 mm (0.235 - 0.236 in.)
- Minimum .... 5.96 mm (0.233 in.)

Crankcase Bore-To-Cross Shaft Clearance .... 0.02 - 0.07 mm (0.001 - 0.003 in.)

Gear Shaft OD:
- New .... 5.99 - 6.00 mm (0.235 - 0.236 in.)
- Minimum .... 5.98 mm (0.235 in.)

Gear Shaft-To- Gear Bore Clearance .... 0.01 - 0.14 mm (0.0006 - 0.005 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.)

TORQUE SPECIFICATION

Air Cleaner Base Nut	9.9 N•m (88 lb-in.)
Cylinder Head Cap Screw	41 N•m (30 lb-ft.)
Connecting Rod Cap Screw (SN: –2307007167)	22.6 N•m (200 lb-in.)
Con. Rod Cap Screw (SN: 2307007168–2402399999)	14.6 N•m (130 lb-in.)
Connecting Rod Cap Screw (SN: 2402400000–)	11.3 N•m (100 lb-in.)
Fan Cap Screw	9.9 N•m (88 lb-in.)
Flywheel Cap Screw	68 N•m (50 lb-ft.)
Fuel Pump/Cover Screw	7.3 - 9.0 N•m (65 - 85 lb-in.)
Fuel Bowl Nut	4.0 N•m (35 lb-in.)
Governor Control Panel Screw	9.9 N•m (88 lb-in.)
Ignition Module Screw	4.0 - 6.2 N•m (35 - 55 lb-in.)
Muffler Nut	24.4 N•m (216 lb-in.)
Oil Filter	5.7 - 9.0 N•m (50 - 80 lb-in.)
Oil Filter Drain Plug	7.3 9.0 N•m (65 - 80 lb-in.)
Oil Pan Cap Screw	24.4 N•m (216 lb-in.)
Oil Pump Cover Screw	4.0 - 6.2 N•m (35 - 55 lb-in.)
Rocker Arm Pivot Cap Screw	14 N•m (124 lb-in.)
Spark Plug	38 - 43.4 N•m (28 - 32 lb-ft.)
Stator Cap Screw	4.0 N•m (35 lb-in.)
Valve Cover Cap Screw	7.4 N•m (65 lb-in.)

ESSENTIAL TOOLS

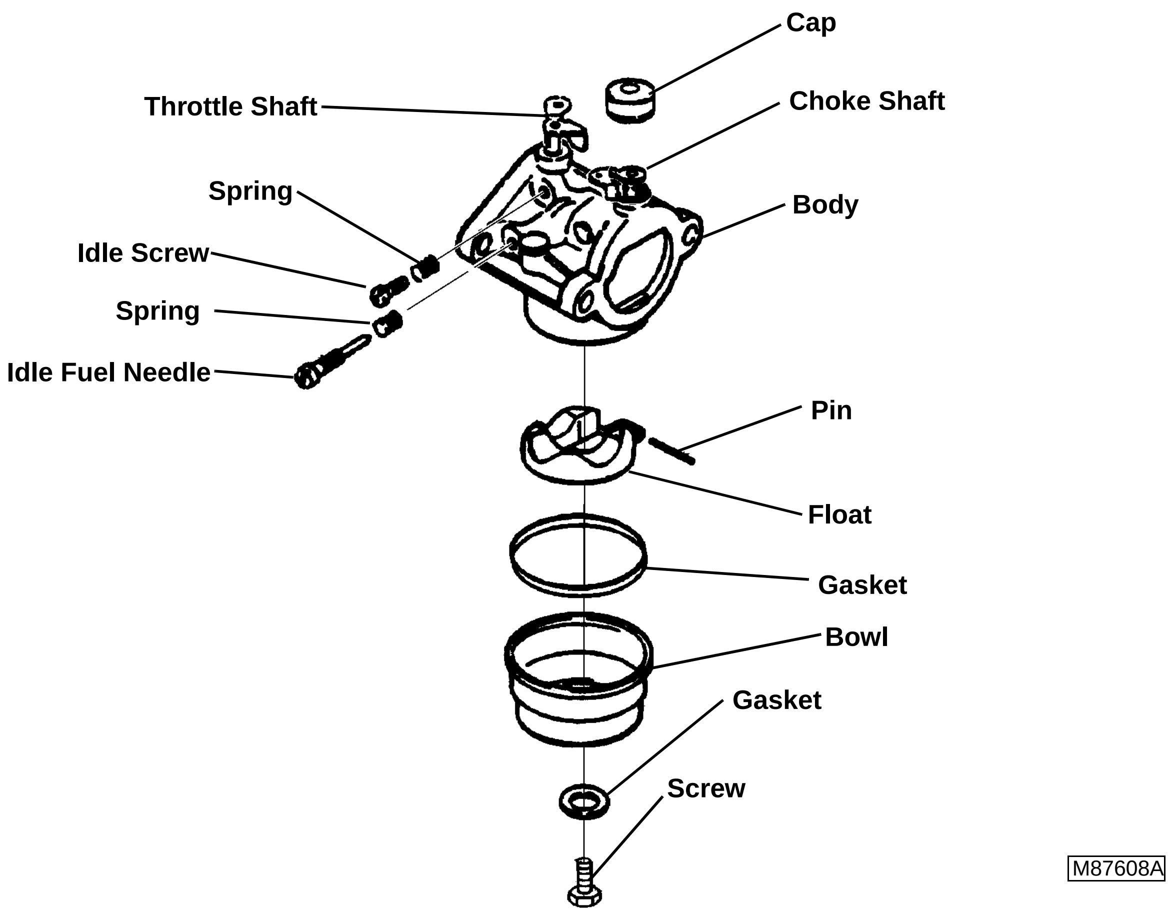
NOTE: Order tools from your SERVICE-GARD™ Catalog. Some tools may be available from a local supplier.

Number	Name	Use
JDM70	Valve Spring Compressor	Compress valve springs
JDG356	Pressure Gauge	Test fuel pump pressure
JTO7270	Digital Pulse Tachometer	Determine engine RPM
JDM59	Compression Gauge	Engine compression
JTO5791	Digital Multimeter	Electrical tests
D05351ST	Spark Tester	Test spark
Local Supplier	200/300 Grit Stone	Deglaze/hone cylinders

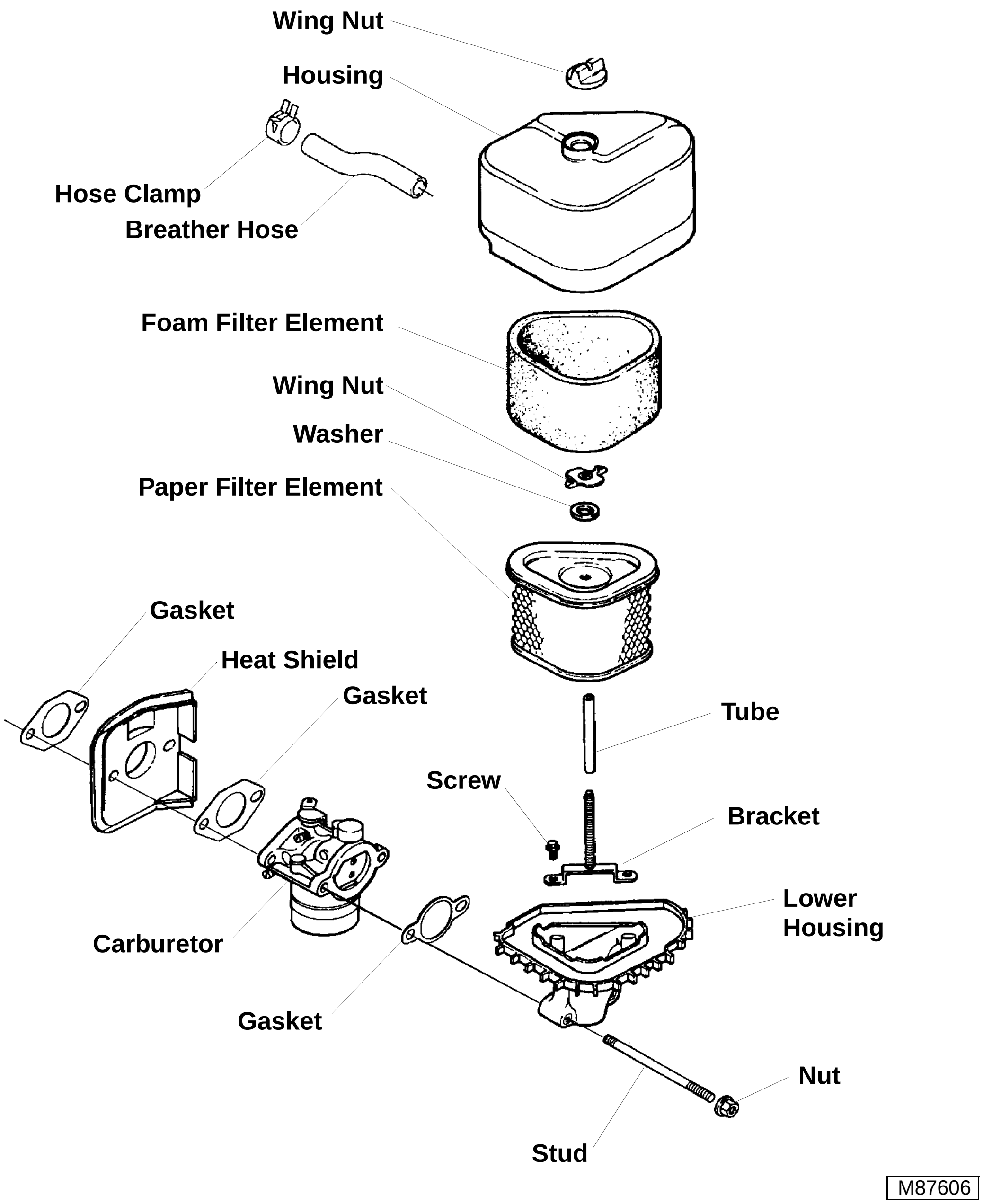
OTHER MATERIAL

Number	Name	Use
Local Supplier	SCOTCH-BRITE Abrasive Sheets/Pads	Clean cylinder head
Local Supplier	Valve Guide Cleaner	Clean valve guides
Local Supplier	Stanisol (or Kerosene)	Finish ream valve guide
Local Supplier	Prussian Blue Compound	Check valve seat contact
Local Supplier	Valve Lapping Compound	Lap valves

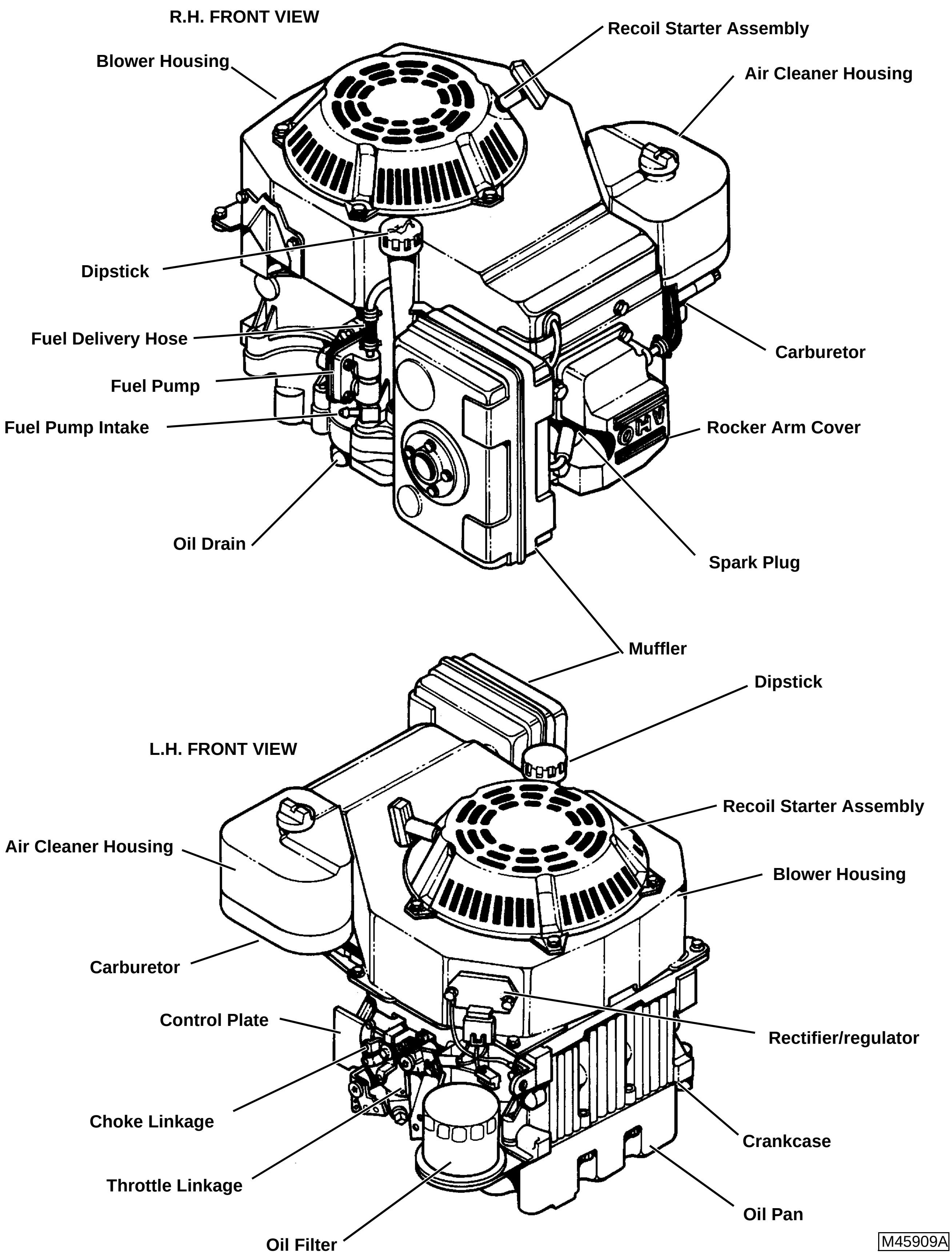
CARBURETOR COMPONENT LOCATION



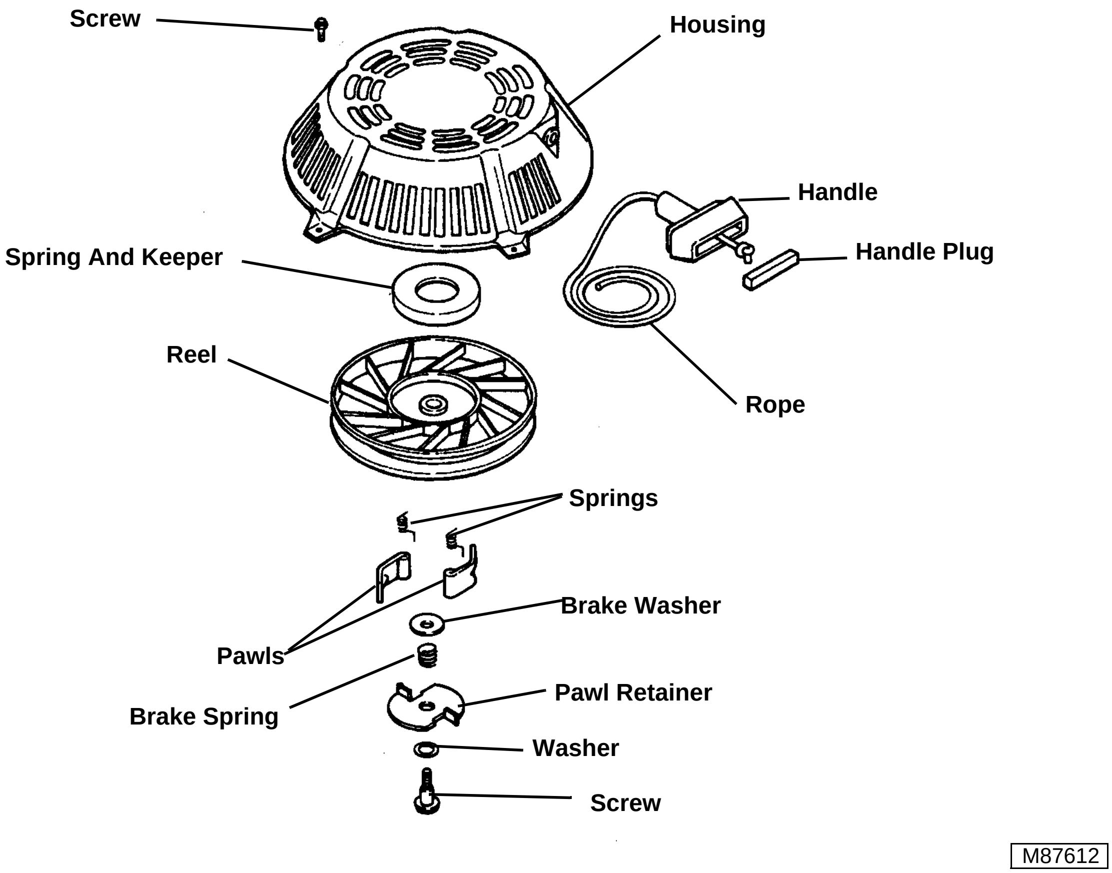
INTAKE SYSTEM COMPONENT LOCATION



ENGINE - EXTERNAL COMPONENT LOCATION



RECOIL STARTER COMPONENT LOCATION



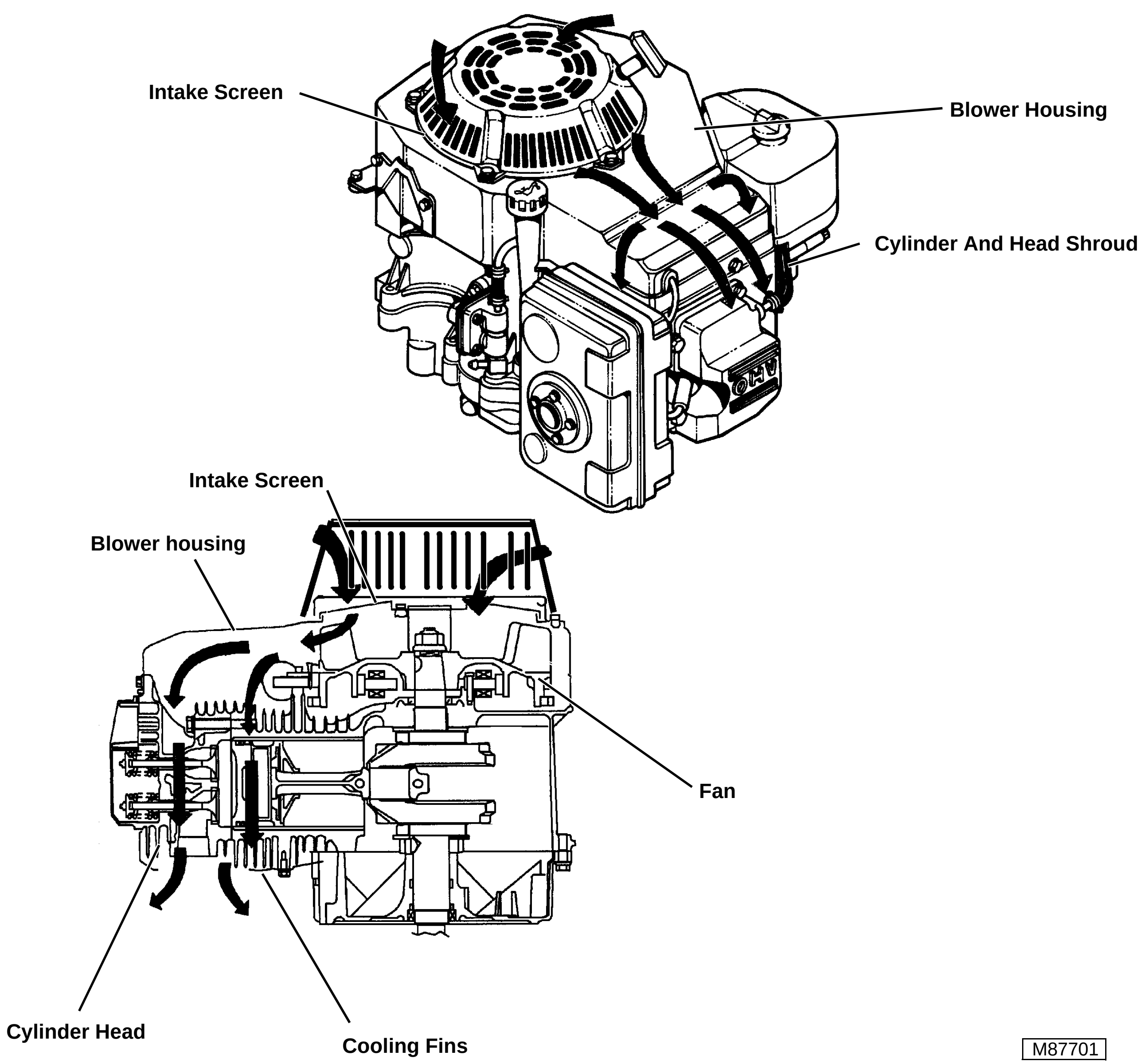
THEORY OF OPERATION

COOLING SYSTEM OPERATION

The engine is air cooled with air flow provided by a fan that is mounted on the flywheel. During operation the fan draws air in through the intake screen and delivers it, through the blower housing, to the cooling fins surrounding the cylinder and head.

The intake screen rotates with the fan and cuts debris into fine pieces helping to keep the cooling fins clear.

It is important that the intake screen remains open for proper air flow. The engine shroud should never be altered or removed, as cooling capacity will be affected. Cylinder block and cylinder head cooling fins must remain clean and open to properly dissipate heat.



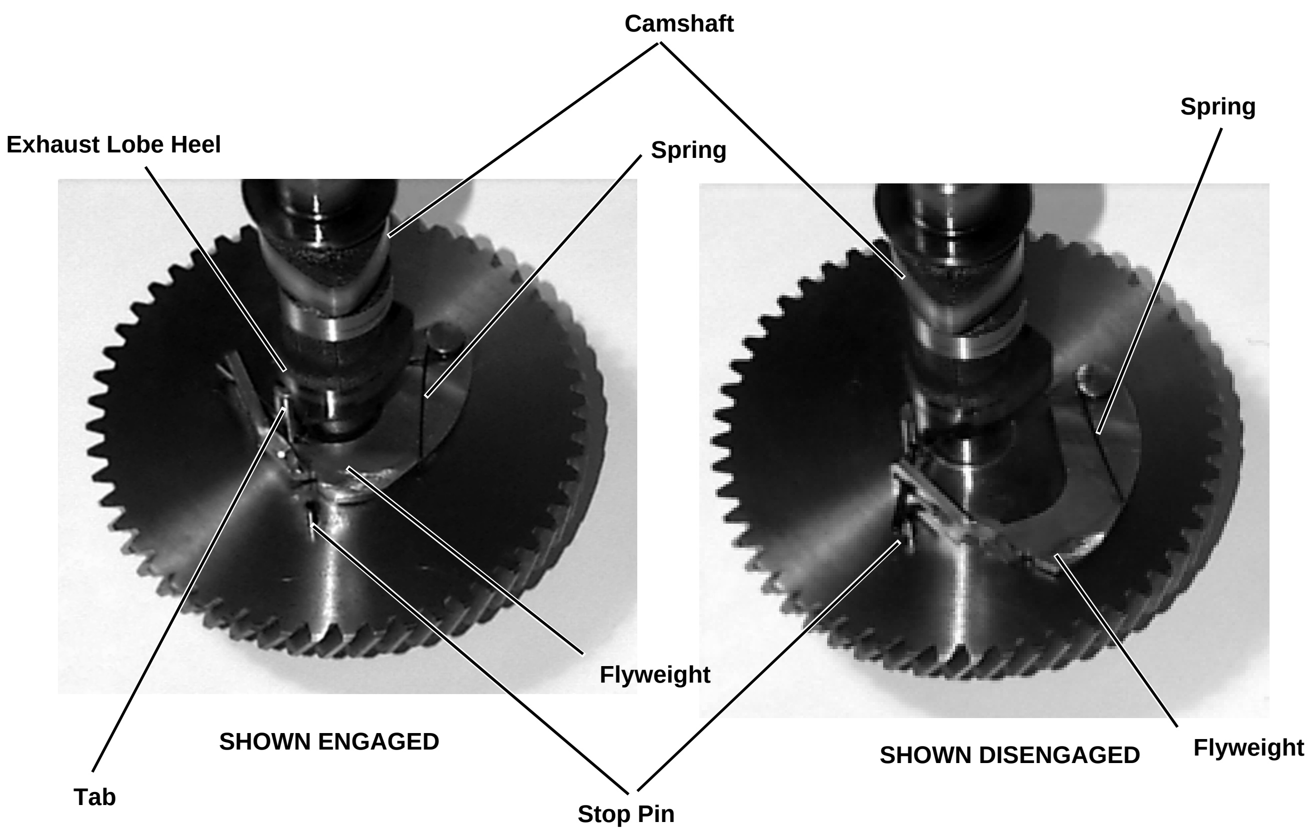
AUTOMATIC COMPRESSION RELEASE (ACR) OPERATION

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

The ACR consist of a camshaft mounted flyweight, tab and spring. The ACR is attached to the camshaft and has limited serviceability.

The ACR is “engaged” at starting engine rpm. During low rpm operation the spring pulls the flyweight towards the camshaft, which rotates the tab into interference with the exhaust valve lifter. The interference causes the exhaust valve to lift slightly as the engine rotates, thus keeping compression low and allowing the engine to turn over with less resistance.

After the engine starts, the ACR automatically “disengages.” As engine rpm increases the flyweight swings out and overcomes the force of the spring. As the flyweight rotates, the tab rotates toward the camshaft until it no longer contacts the exhaust valve lifter. The engine will now run with normal operating compression. (A stop pin is provided to limit the travel of the flyweight.)



SHOWN ENGAGED

SHOWN DISENGAGED

FUEL SYSTEM OPERATION

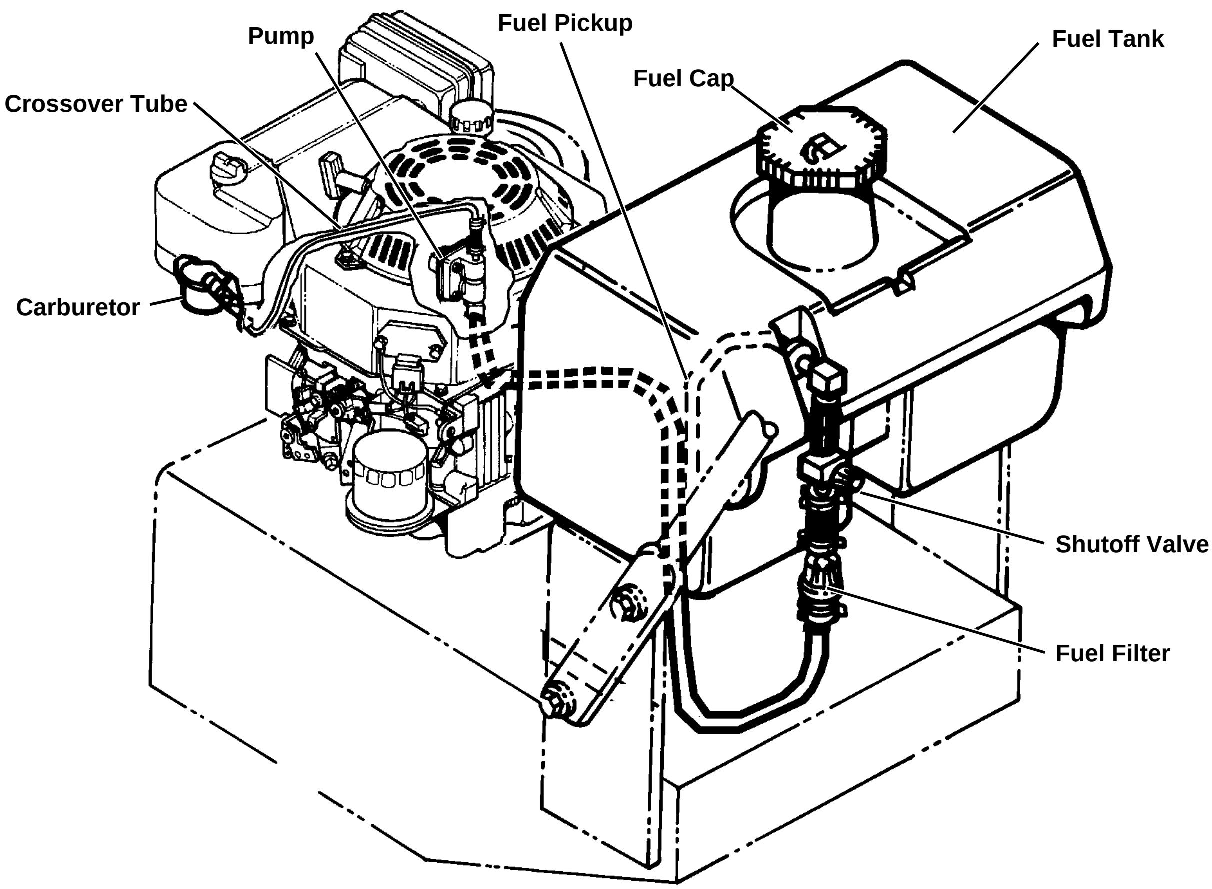
Fuel is stored in fuel tank with vented cap. Fuel is drawn from the tank, through a fuel shutoff valve and paper element fuel filter, by a mechanically operated pump mounted on the outside of the cylinder block. The pump supplies fuel to the carburetor.

The fuel pump is a mechanically operated diaphragm pump. The pump is operated by a lever which rides on a special lobe on the engine camshaft. The lever transmits a pumping action to the diaphragm inside the pump body. On the downward stroke of the diaphragm, fuel is drawn in through the inlet check valve. On the upward stroke of the diaphragm, fuel is forced out through the outlet check valve and to the carburetor.

Fuel flows into the carburetor through the inlet needle and seat assembly into the float bowl of the carburetor. The inlet needle is connected to the float. As the fuel level, and the float, rise, the inlet needle rises and restrict the flow of fuel to the float bowl. As the engine runs and draws fuel through the main and pilot jets the level in the float bowl, and the attached needle, lowers, which allows more fuel to enter the fuel bowl thus keeping a constant level of fuel in the carburetor.

The main jet circuit controls the fuel supply at all engine speeds. As engine speed, and/or load, increases (as controlled by the governor) the butterfly valve located in the throttle body opens allowing more air flow through the carburetor. A venturi in the throttle body creates a pressure differential which draws fuel through the main nozzle. The main jet, located and the inlet of the main nozzle, has a fixed orifice and is not adjustable. However main jets, with different orifices, are available for operation at other than sea level. The main jet meters the amount of fuel drawn into the engine. The main air jet meters the amount of air that will be mixed with the fuel, in the main nozzle before being drawn into the engine.

An Idle circuit is also provided to allow a richer condition at idle to allow the engine to run at RPM that are too low for the main jet circuit to operate efficiently.



TROUBLESHOOTING

CARBURETION TROUBLESHOOTING

Problem or Symptom / Check or Solution	Hard Starting	Fuel Leak at Carburetor	Engine Floods	Will Not Idle	Rich Idle	Idles with Needle Closed	Hunts / Erratic Idle	Idles Fast-Lean	Will Not Accelerate	Over Rich Acceleration	Hesitates	Will Not Run At High Speed	Low Power	Hunts at High Speed	Runs With Needle Closed	Engine Overspeeds
Plugged Air Filter	●			●	●				●	●		●	●			
Leaky Carb Gasket				●			●	●			●					●
Throttle Or Choke Shafts Worn	●			●			●	●					●	●		●
Choke Not Functioning Properly	●															
Plugged Atmospheric Vent		●	●													
Air Bleed Restricted	●			●	●		●		●		●			●		
Damaged Or Leaky O-Ring		●					●	●						●		●
Plugged Tank Filter Or Vent	●								●		●	●	●			
Fuel Pickup Restricted	●			●			●		●		●	●		●		
Idle Port Restricted				●			●									
Damaged Adjustment Needles	●			●	●	●	●		●			●	●	●	●	●
Incorrect Float Height			●				●		●	●			●	●		
Main Nozzle Restricted	●								●		●	●	●	●		
Dirty, Stuck Needle and Seat	●	●	●										●			
Fuel Inlet Plugged	●			●			●						●	●		

ENGINE TROUBLESHOOTING

Problem or Symptom / Check or Solution	Engine cranks but will not start or starts hard	Engine won't stay running, runs rough or irregularly	Engine stalls frequently	Engine backfires	Engine surges–has uneven or uncontrolled rpm	Engine misses	Engine has low power under load	Engine has no spark	Engine will not crank	Exhaust smoke black, engine floods or burns rich	Exhaust smoke blue or excessive oil consumption	Engine has low oil pressure	Engine overheats	Engine overheats	Excessive engine noise or vibration
Spark plug fouled, defective, or gap not correct. Incorrect spark plug. Inspect/test.	●	●	●												
Defective ignition components. Inspect/test.	●	●	●	●	●	●	●		●			●	●		●
Starting motor worn or defective. Cranking rpm too slow, cables corroded, battery weak or defective. ACR not functioning properly. Move throttle to wide-open.	●	●	●		●	●	●	●	●			●			●
Tank outlet restricted or plugged, shutoff valve not fully open, fuel filter or line restricted. Fuel stale, contains water, or wrong type.	●	●	●	●		●		●			●		●	●	
Air filter element plugged, oil soaked, or restricted.	●	●	●		●	●			●	●					●
Choke, throttle, or governor linkage worn or misadjusted. Carburetor set too rich.	●	●	●	●	●	●			●			●			●
Carburetor worn, contaminated with debris or varnish. Passages plugged. Wrong jets or adjusted too lean.	●	●	●	●	●	●		●	●			●	●		●
Carburetor, intake manifold, or cylinder head gaskets leaking or damaged.	●	●	●	●	●	●						●			●

Problem or Symptom / Check or Solution	Engine cranks but will not start or starts hard	Engine won't stay running, runs rough or irregularly	Engine stalls frequently	Engine backfires	Engine surges–has uneven or uncontrolled rpm	Engine misses	Engine has low power under load	Engine has no spark	Engine will not crank	Exhaust smoke black, engine floods or burns rich	Exhaust smoke blue or excessive oil consumption	Engine has low oil pressure	Engine overheats	Engine overheats	Excessive engine noise or vibration
Valve clearance incorrect. Burned or warped valves and seats. Defective springs.	●	●	●	●	●	●				●	●	●	●	●	●
Low compression from worn piston, rings, cylinder, valves or warped head.	●	●	●		●	●							●	●	●
Engine oil viscosity or level incorrect. Engine oil filter restricted. Oil pump worn or passages obstructed.	●	●			●	●							●	●	●
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.	●	●	●		●	●				●	●	●	●	●	●
Engine mounting hardware loose, broken, or missing.						●					●		●	●	

ENGINE TROUBLESHOOTING GUIDE

ENGINE HARD TO START

Remove spark plug and check spark by cranking engine while having the plug grounded against engine block. Install spare plug to avoid fuel spitting from the hole. See "SPARK TEST" on page 35.

CAUTION:
To avoid electric shock, do not hold plug. Make sure to hold plug cap.

- NO → Are sparks produced when spark plug is replaced?
  - YES →
    - Faulty spark plug. — Replace
  - NO → Are sparks produced between high tension lead and engine block with plug cap removed?
    - YES →
      - Faulty contact of plug cap terminal to lead. — Correct
    - NO → Are sparks produced between high tension lead and engine block when control unit is replaced?
      - YES →
        - Faulty control unit. — Replace
      - NO →
        - Faulty ignition coil with module. — Replace
        - Faulty high tension lead. — Replace
        - Incorrect ignition coil with module air gap. See "IGNITION COIL AIR GAP ADJUSTMENT" on page 36. — Correct
        - Demagnetized flywheel. — Replace
- YES → Is compression sufficient? See "CYLINDER COMPRESSION TEST" on page 28.
  - YES → Crank engine several times, then remove spark plug and observe electrodes. Are they wet?
    - NO →
      - No fuel in the tank. — Add
      - Closed shutoff valve. — Open
      - Clogged fuel filter. — Clean
      - Closed shutoff solenoid. — Check or replace
      - Plugged air hole in tank cap. — Clean
      - Plugged fuel line. — Clean
    - YES →
      - Excessive use of choke. — Open choke
      - Clogged air cleaner. — Clean
      - Fuel level too high in float bowl. — Adjust
  - NO →
    - Worn piston/piston rings. — Replace
    - Stuck piston rings. — Clean or replace
    - Worn cylinder bore. — Bore or replace
    - Insufficient cylinder head tightening. — Retighten
    - Faulty contact of valve seat. — Lap or grind
    - Misadjusted valve. — Adjust
    - Warped cylinder head. — Repair or replace
    - Broken valve spring. — Replace
    - Stuck valve. — Clean or grind
    - Leaking head gasket. — Replace

Check carburetor. →

- Check for plugged fuel passage.
- Check for plugged air passage.
- Check float level.
- Check carburetor setting.

ENGINE MALFUNCTIONS AT LOW SPEED

Remove spark plug and check spark by cranking engine while having the plug grounded against engine block. Install spare plug to avoid fuel spitting from the hole.

⚠ CAUTION:
To avoid electric shock, do not hold plug. Make sure to hold plug cap.

WEAK →

- Faulty plug insulation. — Replace
- Fouled electrodes. — Clean
- Faulty high tension lead. — Replace
- Incorrect ignition coil air gap. — Correct
- Faulty ignition coil. — Replace

STRONG ↓

Is unusual smoke emitted out of muffler?

YES →

- Plugged air filter. — Clean
- Deposits in exhaust port. — Clean
- Misadjusted carburetor. — Adjust
- Overfilled crankcase. — Correct
- Worn piston/piston rings. — Repair
- Worn cylinder bore. — Replace
- Defective breather valve. — Correct

NO ↓

Gradually open throttle valve by hand. Does engine speed drop or does engine stall at a certain position?

YES →

- Passages in carburetor plugged. — Clean

NO ↓

Is air drawn through carburetor flange?

YES →

- Loose flange nuts. — Tighten
- Damaged gasket. — Replace
- Warped flange. — Replace

NO ↓

Are hydraulic lifters working correctly?

NO →

- Collapsed lifter. — Replace
- Worn camshaft lobes, pushrods. — Replace

YES ↓

Is alignment of timing gear marks correct?

NO →

- Incorrect valve timing. — Correct

ENGINE RUNS ERRATICALLY

Problem	Possible cause	Action
Problem in fuel system (lack of fuel).	• Fuel pump not functioning. See “FUEL PUMP TEST” on page 34.	Test
	• Dust or water in fuel pipe 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
Problem in governor system.	• Incorrect governor linkage adjustment. See “GOVERNOR ADJUSTMENT” on page 24.	Correct
	• Faulty governor spring.	Replace
	• Governor gear assembly malfunction.	Check
Engine knocks.	• Stale fuel.	Change
	• Excessive carbon deposit in engine.	Clean
	• Excessive engine load.	Adjust
	• Engine overheating.	See **Has Low Power**

OIL CONSUMPTION IS EXCESSIVE

Is compression sufficient? See “CYLINDER COMPRESSION TEST” on page 28.

YES

Possible cause	Action
• Plugged oil ring groove.	Clean
• High oil level.	Adjust
• Worn valve stems and valve guides.	Replace
• Oil leakage along	Replace
• Governor Shaft Oil seals leaking.	Replace
• Head gasket leaking.	Replace
• Drain plug leaking.	Retighten or replace
• Breather valve clogged.	Clean
• Drainback hole in tappet chamber plugged.	Clean
• Incorrect oil viscosity.	Change

NO

• Same as **Hard To Start**.

ENGINE HAS LOW POWER

Is engine overheated?

YES →

- Excessive engine load. — Adjust load
- Carburetor not properly adjusted (too lean). — Adjust
- Dirty or clogged air intake screen, shroud and engine fins. — Clean
- Carbon deposit in combustion chamber. — Clean
- Incorrect oil level. — Adjust

NO ↓

Is lubricating condition normal?

NO →

- Too much or too little oil in crankcase. — Correct
- Excessively contaminated lubricating oil/filter. — Change
- Faulty oil pump. — Replace

YES ↓

Is unusual smoke emitted out of muffler?

YES →

- Air cleaner clogged. — Clean
- Carbon deposit in exhaust port and muffler. — Clean
- Carburetor not properly adjusted. — Adjust
- Too much oil in crankcase. — Correct

NO ↓

Is compression sufficient? See “CYLINDER COMPRESSION TEST” on page 28.

NO →

- Same as **Hard To Start**.

FUEL CONSUMPTION IS EXCESSIVE

Is compression sufficient? See “CYLINDER COMPRESSION TEST” on page 28.

YES →

- Carburetor float or pilot air screw not properly adjusted. — Adjust
- Air cleaner clogged. — Clean
- High idling speed. See “FAST IDLE SPEED ADJUSTMENT” on page 25. — Adjust
- Choke valve not fully open. See “CHOKE ADJUSTMENT” on page 24. — Adjust

NO →

- Same as **Hard To Start**.

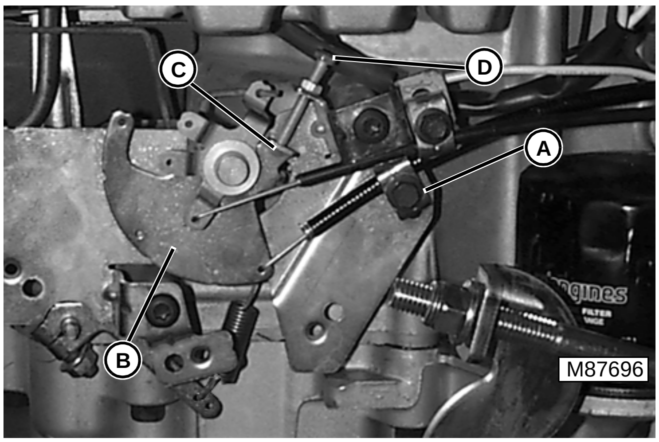
TESTS AND ADJUSTMENTS

THROTTLE CABLE ADJUSTMENT

Reason:

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

Procedure:



1. Loosen the cable clamp screw (A) on the engine control plate.
2. Move throttle lever to FAST idle position. Then move the throttle lever back 4.75 mm (0.187 in.)
3. Rotate throttle plate counter clockwise, pulling cable through cable clamp, until it stops against high speed idle screw (D). Tighten cable clamp screw (A)
4. Move throttle lever to the slow position, then to full speed. Make sure throttle lever stop (C) is held up against high speed idle screw (D).
5. Set fast idle speed. See “FAST IDLE SPEED ADJUSTMENT” on page 25.

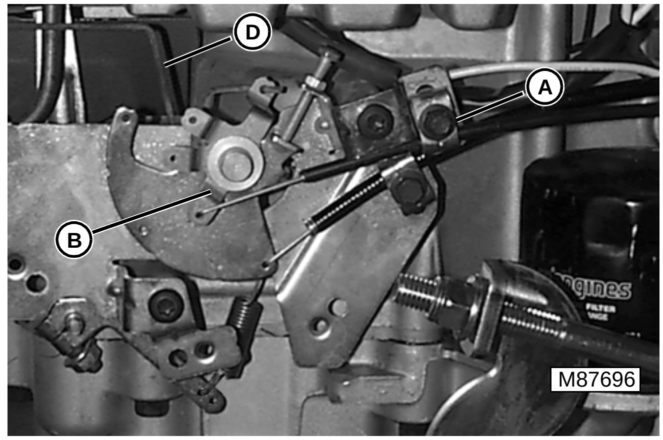
CHOKE ADJUSTMENT

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. Loosen the cable clamp screw (A) on the engine control plate
2. Pull out choke lever to CHOKE position Then push the choke lever in 4.75 mm (0.187 in.).
3. Move choke plate (B) counterclockwise, pulling cable through cable clamp, as far as possible. Tighten cable clamp screw (A)
4. Try to move choke rod (D) forward (choke rod should not move). If the choke rod moves forward, the choke plate is not fully closed. Carefully bend the choke rod at Vee bend until the choke plate is fully closed.
5. Move choke lever through entire range while watching to make sure choke linkage is not binding.

GOVERNOR ADJUSTMENT

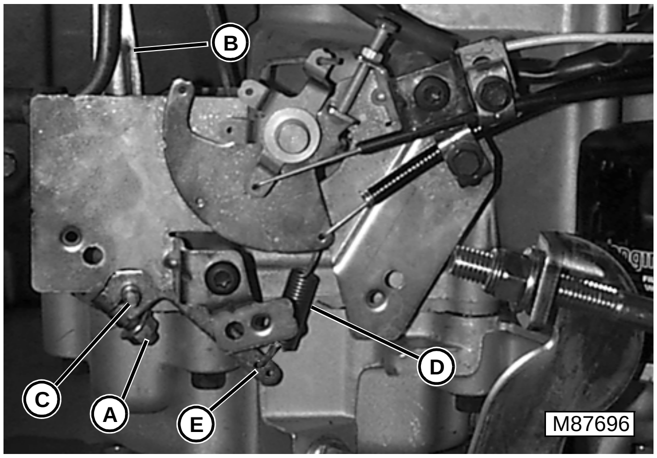
Reason:

To make sure the initial setting on the governor lever is correct and to insure correct operation of the governor.

NOTE: Adjust throttle cable before adjusting governor linkage.

Procedure:

1. Move throttle lever to FAST idle position.



2. Loosen nut (A).
3. Hold top of governor arm (B) toward carburetor. Turn governor shaft (C) counter-clockwise until it stops. Hold governor shaft and tighten nut (A).
4. Move throttle lever through full range to be sure linkage is not binding.
5. Governor spring (D) should be installed in the hole (E) closest to governor shaft. If governor is not responding properly, replace spring and readjust fast idle speed. If spring did not correct the problem, repair governor.

FAST IDLE SPEED ADJUSTMENT

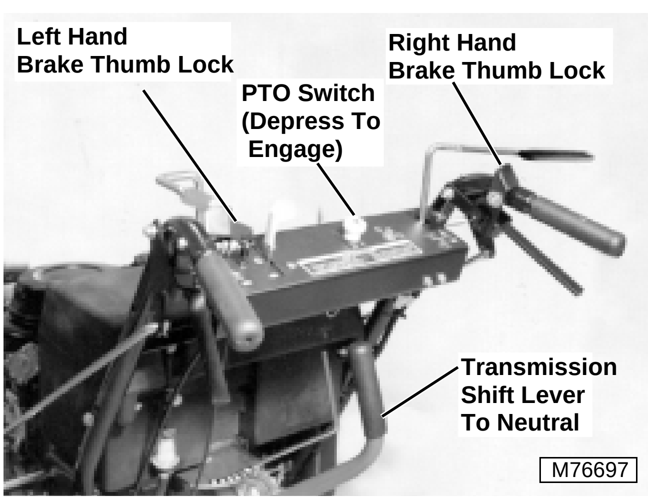
Reason:

To set engine fast idle rpm.

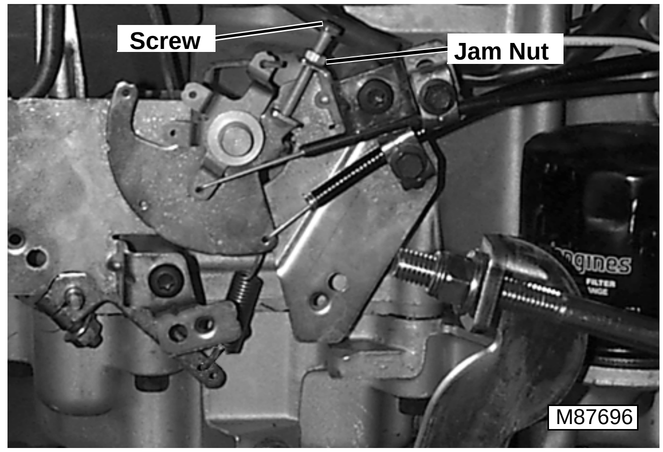
Equipment:

- JTO7270 Digital Pulse Tachometer

Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Start and run engine at MEDIUM idle for five minutes.

> **CAUTION**
>
> **Engine will be HOT. Be careful not to burn skin.**

3. Move throttle lever to FAST idle position.
4. Use JTO7270 Digital Pulse Tachometer to check engine rpm.

Specifications:

Fast idle speed setting . . . . 3350 ± 100 rpm
Control panel screw torque. . . . . 9.9 N•m (88 lb-in.)

Results:

- If fast idle speed does not meet the specifications, loosen jam nut.
- Turn screw counter clockwise to increase rpm or clockwise to decrease rpm.
- Hold screw and tighten jam nut.

SLOW IDLE SPEED ADJUSTMENT

Reason:

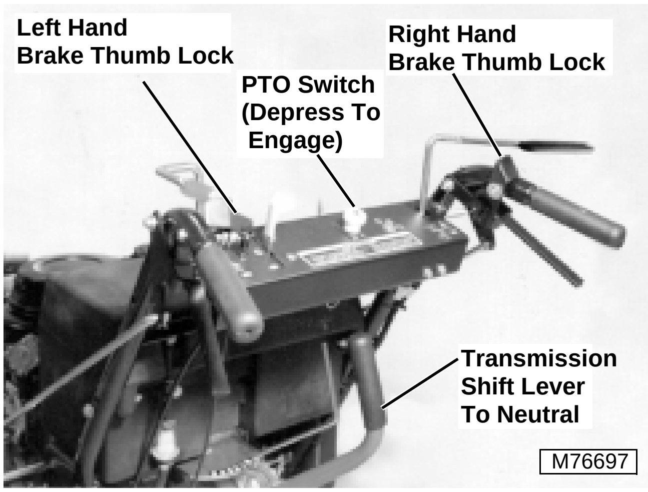
To set engine SLOW idle rpm.

Equipment:

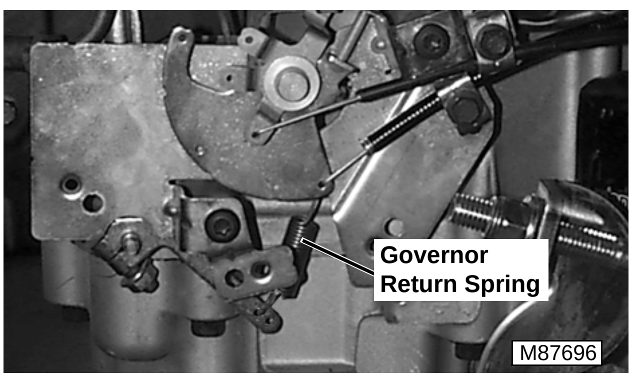
- JT07270 Digital Pulse Tachometer

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.

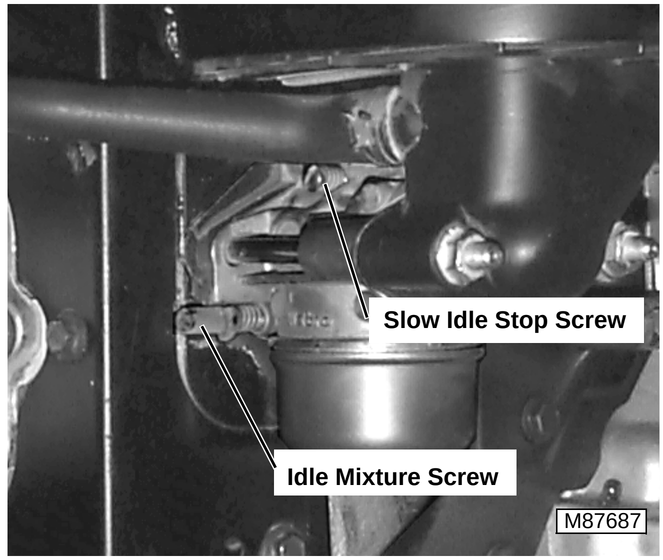
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Governor return spring should be installed in hole closest to governor shaft. If not correct and adjust governor. See "GOVERNOR ADJUSTMENT" on page 24.



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. Use JT07270 Digital Pulse Tachometer at spark plug wire to check engine slow idle speed.
6. 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 is reached.

ATTENTION!

DO NOT remove the black cap on the idle mixture screw unless you are a factory trained technician with authorization to service CARB/EPA Certified Emissions Carburetors.

7. Turn carburetor idle mixture screw back and forth between its two stops until the best idle is achieved.

Specifications:

SLOW idle speed . . . . 1550 ± 75 rpm

SLOW IDLE MIXTURE ADJUSTMENT

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

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:

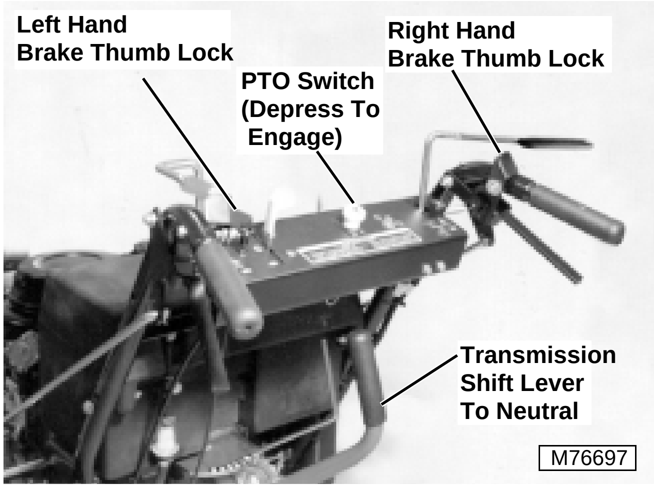
To set engine SLOW idle mixture and rpm. This insures the engine meets the CARB/EPA emissions requirements.

Equipment:

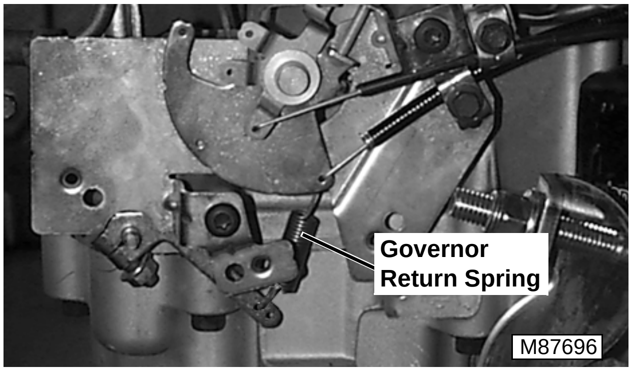
- JT07270 Digital Pulse Tachometer

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.

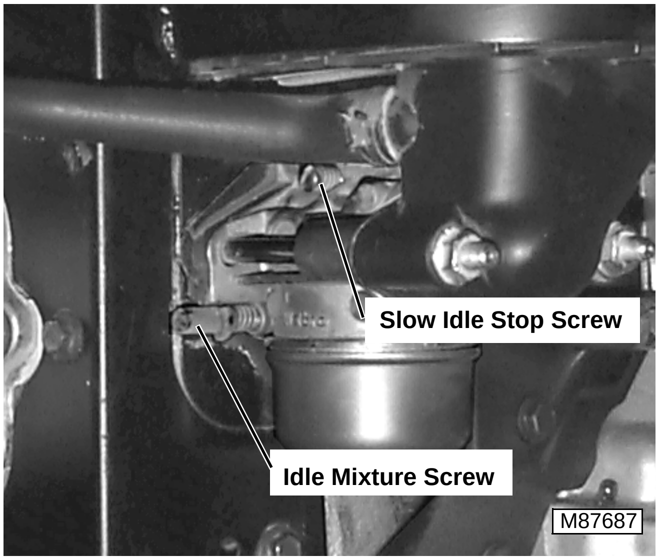
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



2. Governor return spring should be installed in hole closest to governor shaft. If not correct and adjust governor. See “GOVERNOR ADJUSTMENT” on page 24.



3. Carefully remove black limiter from idle mixture screw.

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

4. Turn idle mixture screw clockwise until lightly seated, then turn counterclockwise 1 turn.
5. Start and run engine at MEDIUM idle for 5 minutes to obtain operating temperature.
6. Move throttle lever to slow idle position.

CAUTION

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

7. Turn carburetor idle mixture screw clockwise until engine speed drops, note position.
8. Turn idle mixture screw counterclockwise until engine speed increases and then drops again, note position.
9. Turn idle mixture screw to midpoint between engine speed drop points.
10. Without moving screw, carefully install black limiter onto 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 is reached.

Specifications:

SLOW idle stop screw setting. . . . . . 1550 ± 75 rpm

CYLINDER COMPRESSION TEST

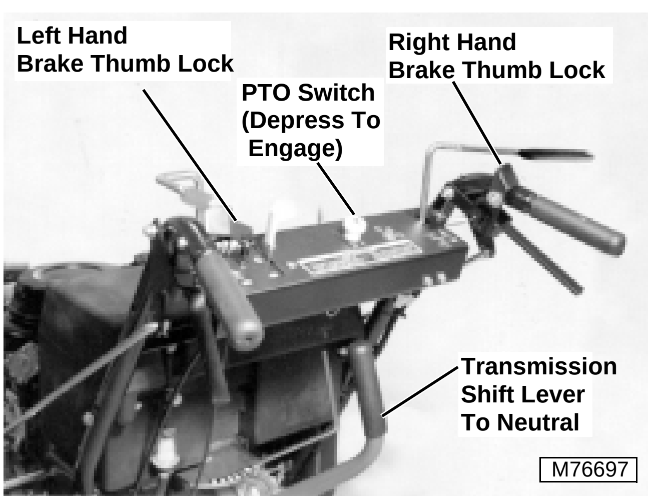
Reason:

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

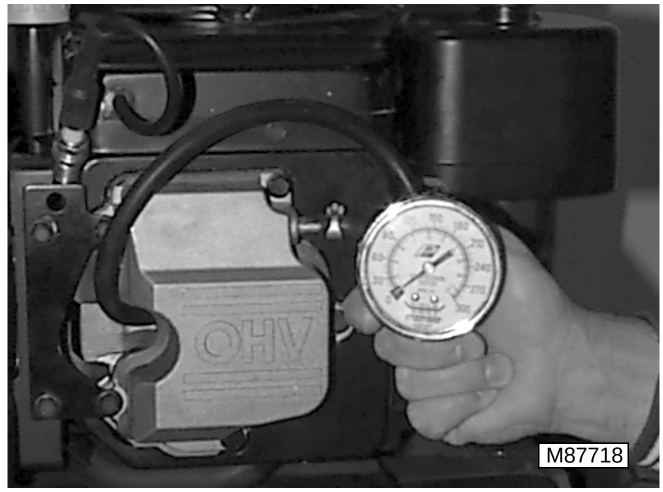
Equipment:

- JDM-59 Compression Gauge
- JDM-74A-5 Spark Plug Ground

Connections:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.



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

2. Disconnect and ground spark plug wire using JDM-74A-5 Spark Plug Ground.
3. Remove spark plug and install JDM-59 Compression Gauge.

Procedure:

1. Move the throttle lever to FAST idle position.
2. Crank engine and record compression reading.

Specifications:

Minimum

m Compression . . . . 345 kPa (50 psi).

Results:

- If compression is low, put clean engine oil on piston rings through spark plug hole. Repeat cylinder compression test.

Results:

- IF COMPRESSION PRESSURE INCREASES: check rings, piston and cylinder bore for broken rings, scoring, wear, or damage. Replace as necessary.
- IF COMPRESSION PRESSURE IS STILL LOW: check for leaking intake or exhaust valves, valve seal, or cylinder head gasket. Replace as necessary.

CYLINDER LEAKDOWN TEST

Reason:

To determine the condition of the piston, rings, cylinder wall, head flatness, gasket, or intake and exhaust valves.

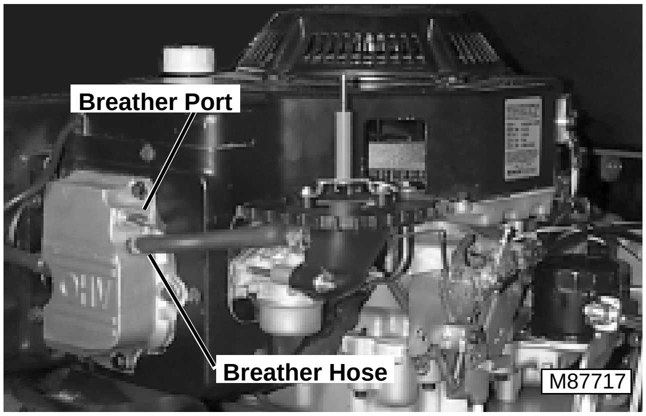
Test Equipment:

- JT03502 Cylinder Leakdown Test Kit
- JDM-74A-5 Ignition Test Plug

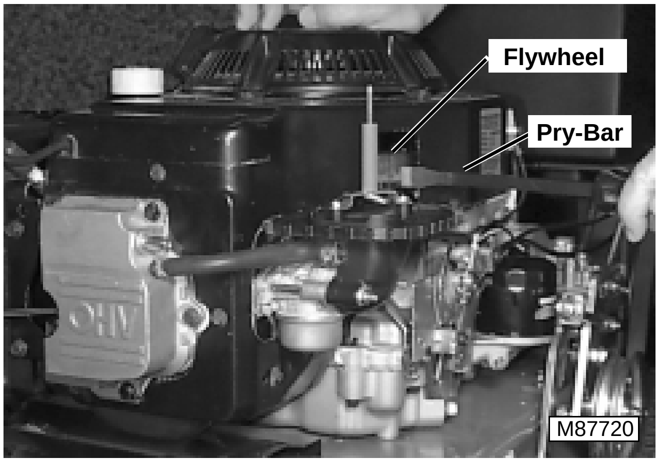
Procedure:

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.

> **CAUTION**
>
> **Engine components are HOT. DO NOT touch with bare skin, especially the exhaust pipe or muffler while making test.**

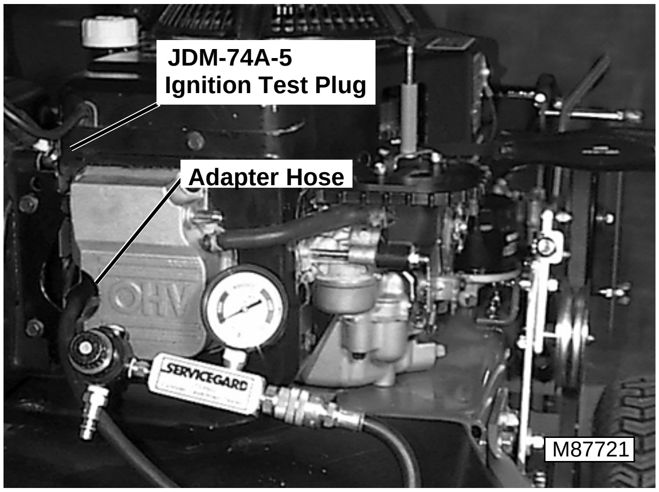


3. Disconnect crankcase breather hose from valve cover breather port and remove air cleaner element from engine so you can listen for air leaks.



4. Use pull starter to turn flywheel and find approximate top dead center (TDC) of the compression stroke.
5. Remove spark plug and put a wooden dowel on top of piston to find actual TDC of the compression stroke.

NOTE: A pry-bar inserted in the intake opening in the blower shroud can be used to move the flywheel back and forth making it easier to find exact TDC. Once found, mark flywheel with indelible marker or paint to identify tooth that lines up with engine post at TDC to make it easier to find.



6. 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

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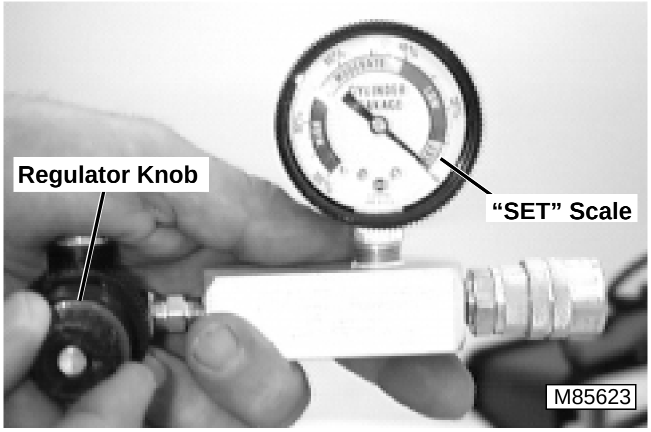
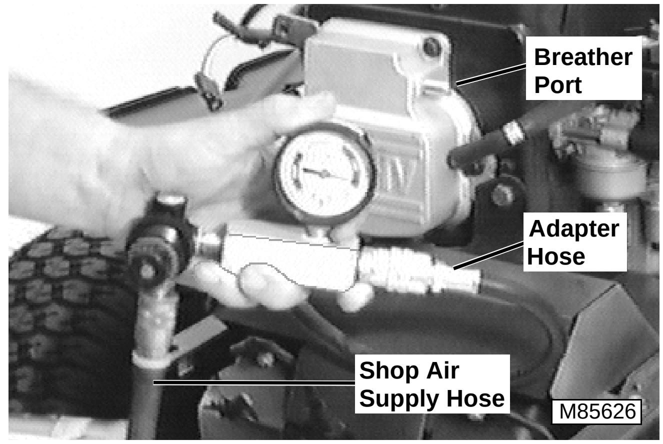
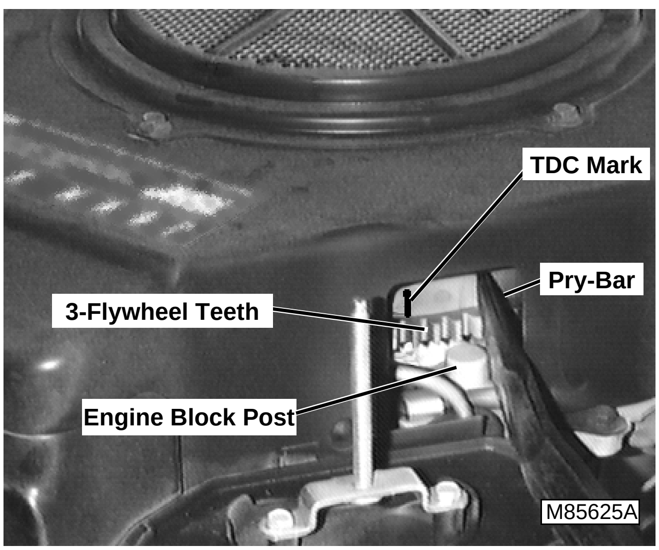




7. First turn regulator knob on tester OFF (fully counterclockwise) then attach appropriate air source to coupler below black regulator valve.

NOTE: A minimum 80 psi air supply must be used for this test.

8. Gradually turn regulator knob clockwise until needle aligns with "zero" of the yellow "SET" scale.



9. With a wide blade pry-bar move flywheel 3 teeth in the clockwise direction to insure the compression release mechanism is not activated.

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.

10. 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.
11. Remove test equipment and install spark plug.

Results:

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 exhaust 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) CHECK

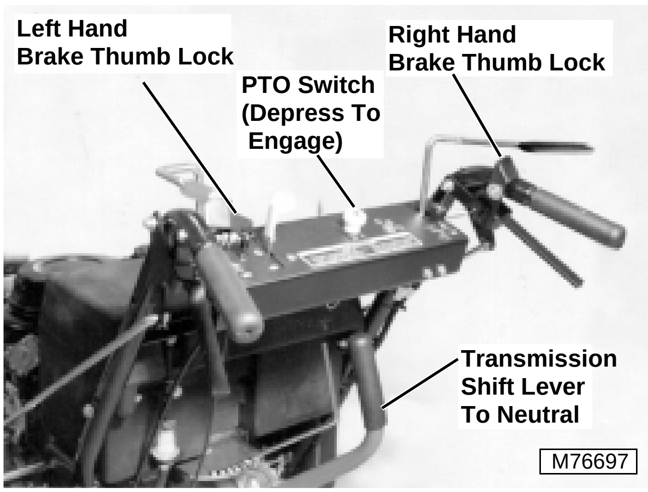
Reason:

To determine if the automatic compression release is opening the exhaust valve.

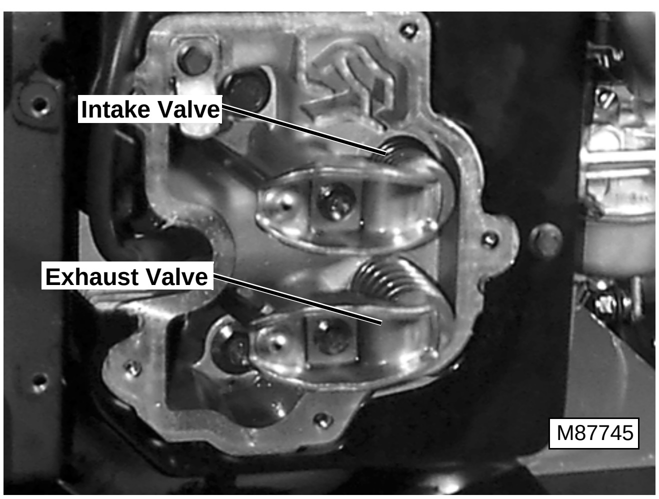
Equipment:

- Dial Indicator With Magnetic Base
- JDM-74A-5 Ignition Test Plug

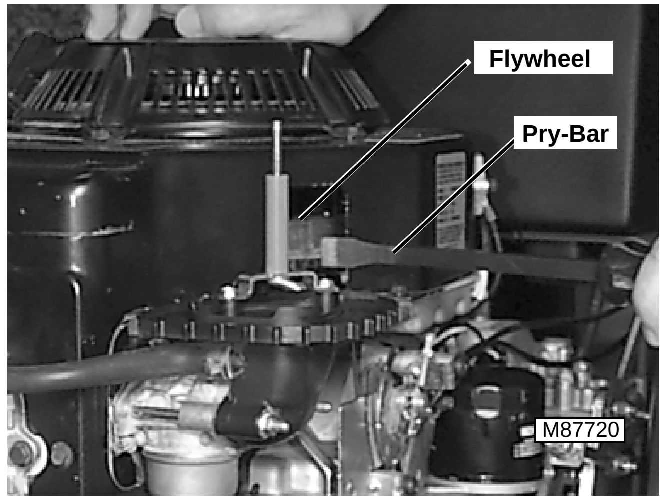
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Remove rocker arm cover. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 42.
3. Remove spark plug and use JDM-74A-5 Ignition Test Plug to ground high tension lead to protect ignition system while turning flywheel.

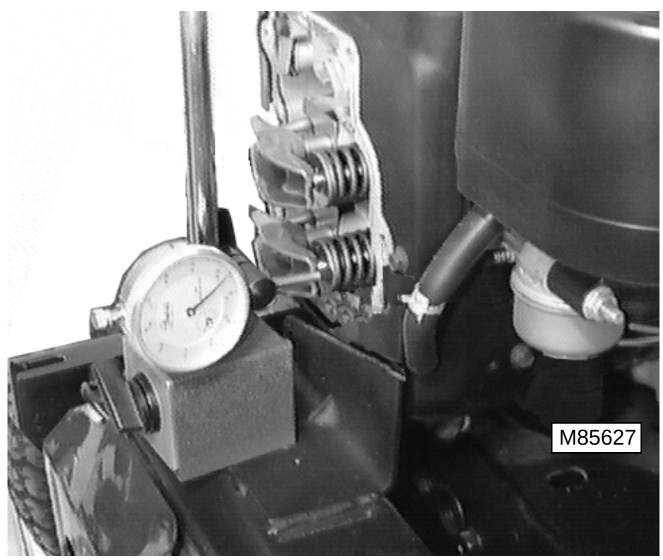


4. Use pull starter to turn flywheel clockwise until intake valve opens fully.



NOTE: A pry-bar inserted in the intake opening in the blower shroud can be used to move the flywheel back and forth.

5. 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.



6. Use a dial indicator on flat of spring retainer to measure exhaust valve ACR movement.
7. Repeat Steps 5 and 6.

8. **Minimum** exhaust valve ACR movement should be **0.76–1.02 mm (0.030–0.040 in.)**.
9. Remove dial indicator and base and install rocker arm cover. See “CYLINDER HEAD REMOVAL AND INSTALLATION” on page 42.
10. Remove test plug, install spark plug [tighten spark plug to **40 N•m (354 lb-in.)**

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 AND INSTALLATION” on page 51.

CRANKCASE VACUUM TEST

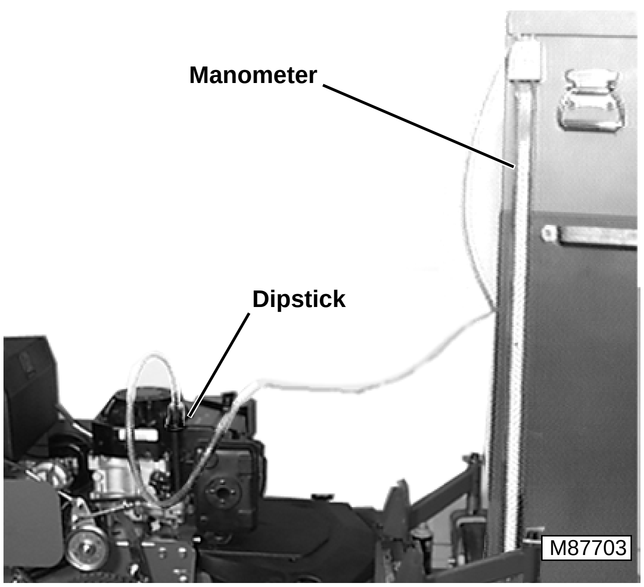
Reason:

To measure the amount of crankcase vacuum, which ensures the crankcase is not pressurized. A pressurized crankcase will force oil leakage past the seals.

Equipment:

- JTO5697 U-Tube Manometer Kit

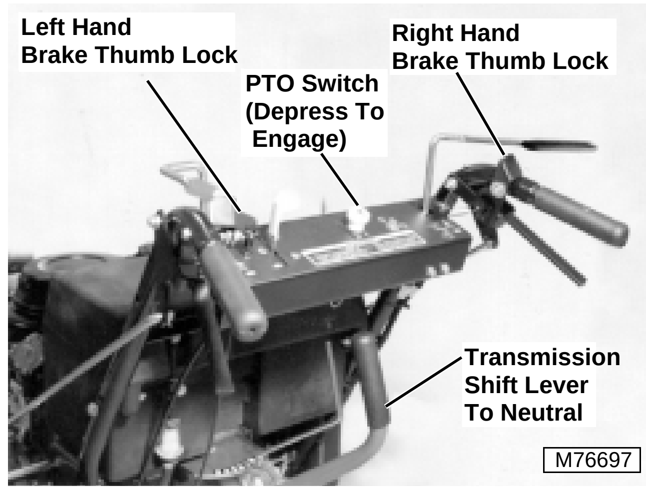
Connections:



1. Remove dipstick.
2. Seal dipstick hole with correct size plug.
3. Finish making test connections from JTO5697 U-Tube Manometer Kit.
4. Close manometer vent.

Procedure:

IMPORTANT: Keep the vent side of manometer closed until the engine is running or fluid in manometer will be sucked into crankcase.



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Start and run engine at fast idle.
3. Open manometer vent and record crankcase vacuum reading.
4. Close manometer vent and stop engine.

Specifications:

Minimum crankcase vacuum at fast idle . . . . 10.2 cm (4 in. water)

Results:

If crankcase vacuum does not meet specifications, check the following:

- Breather reed valve clearance and condition
- Seals and gaskets for leakage
- Rocker arm cover O-ring for leakage
- Rings, piston, and cylinder bore for wear or damage

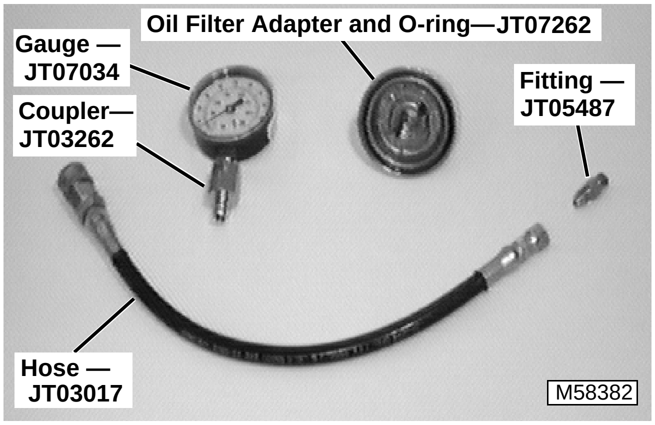
OIL PRESSURE TEST

Reason:

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

Test Equipment:

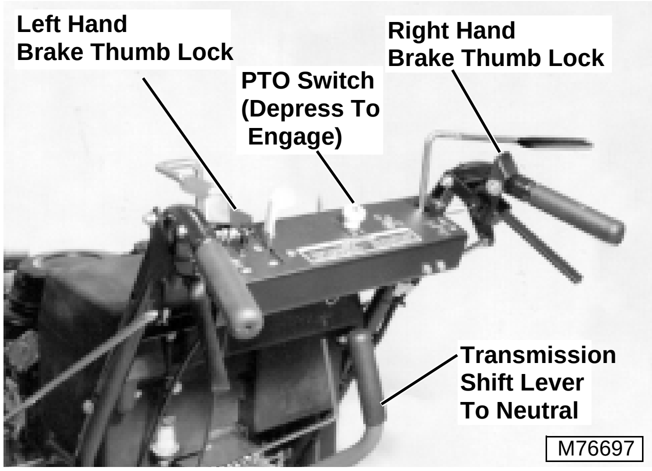
- JT07262 Oil Pressure Test Adapter w/ O-ring (required ONLY on engines without test ports)
- JT05487 Fitting
- JT03017 Hose
- JT03262 Coupler
- JT07034 Gauge



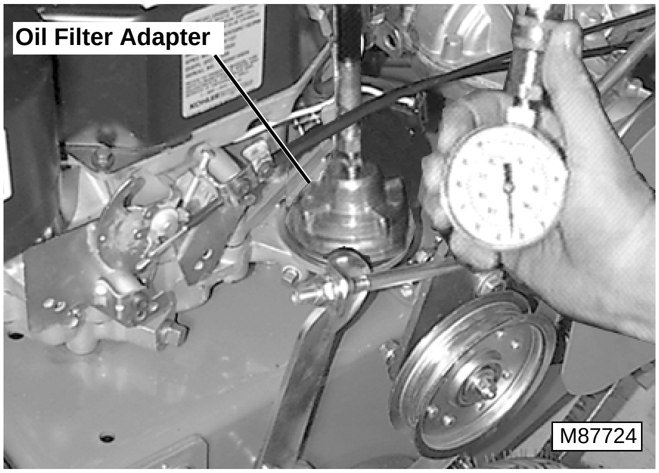
NOTE: SERVICEGARD™ Oil Pressure Test Kit (JT07262) only includes the oil filter adapter and O-ring. The hose (JT03017), gauge (JT07034), coupler (JT03262), and fitting (JT05487) are found in other SERVICEGARD test kits. The non-tapered threaded end of fitting (JT05487) matches the oil pressure port on Kohler engines.

Connections:

For Engines Without Pressure Port:

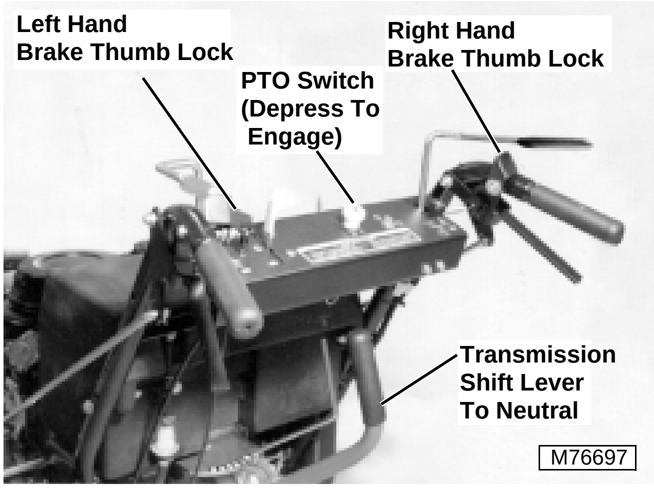


1. Park machine on level surface, turn key switch OFF, and allow engine to cool. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.

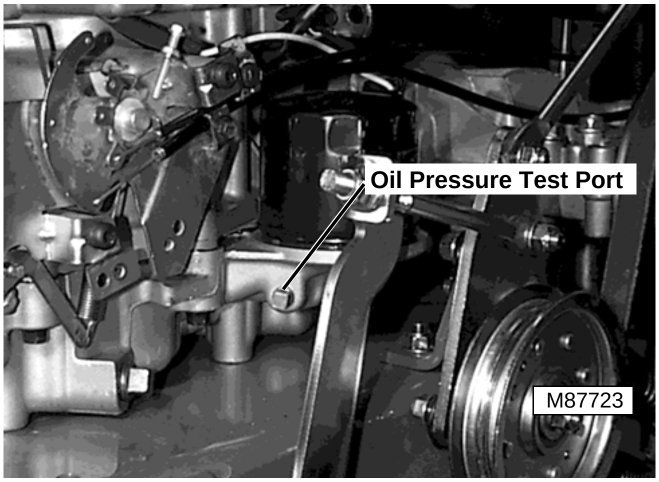


2. Remove oil filter.
3. Wipe filter flange clean and install oil filter adapter JTO7262 in place of oil filter. Assemble fitting, coupler, hose, and gage.
4. Check engine oil level, bring level to full mark.

For Engines With Pressure Port:



1. Park machine on level surface, turn key switch OFF, and allow engine to cool. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Use a shop cloth to catch any oil spillage.



3. Remove plug from oil pressure test port and install fitting (JT05487) into test port.
4. Assemble fitting, coupler, hose, and gage.
5. Check crankcase oil level, bring to full mark before testing.

Procedure:

1. Monitor oil pressure during cranking, if oil pressure is **below 28 kPa (4 psi)—STOP engine immediately** and correct cause before continuing.
2. 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.**

3. Oil pump pressure relief valve opens at approximately ***411 kPa (60 psi)***. Minimum specification indicates engine wear. Record oil pressure at FAST idle **(3350 ±100 rpm)**.
4. Record oil pressure at SLOW idle **(1550 ±75 rpm)**.
5. STOP engine and allow to cool.
6. Remove test equipment and install new oil filter.
7. 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)**

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 **below minimum** specification: check for major restrictions, internal engine wear.

FUEL PUMP TEST

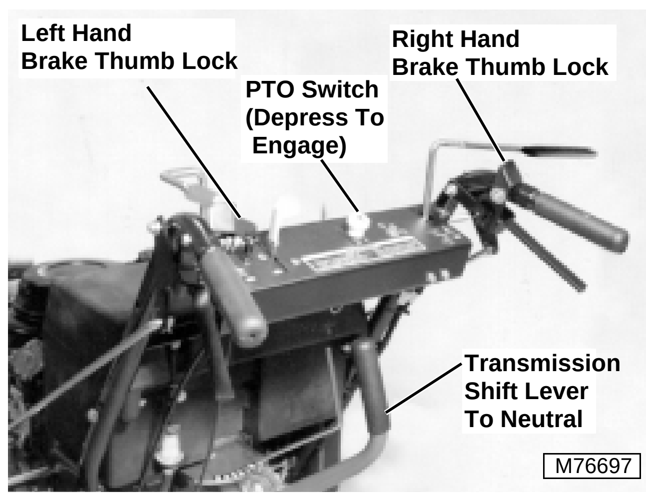
Reason:

To check condition of fuel pump and determine fuel pressure.

Equipment:

- JDG356 Pressure Gauge
- Graduated Container

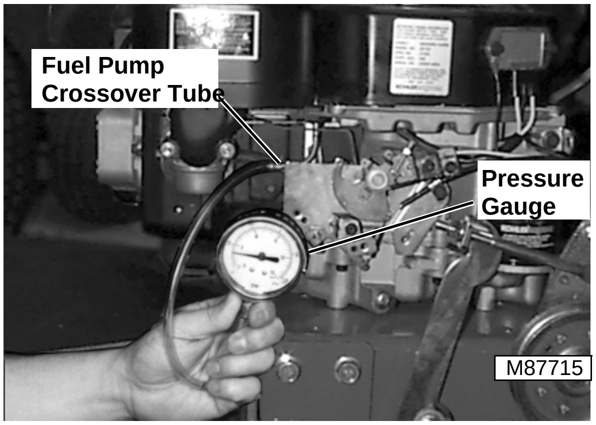
Procedure:



1. Move transmission shift lever to neutral position. Disengage PTO. Engage **both** brakes and thumb locks.
2. Start and run engine at SLOW idle for 1 minute to fill carburetor with fuel.
3. Stop the engine.

⚠ CAUTION

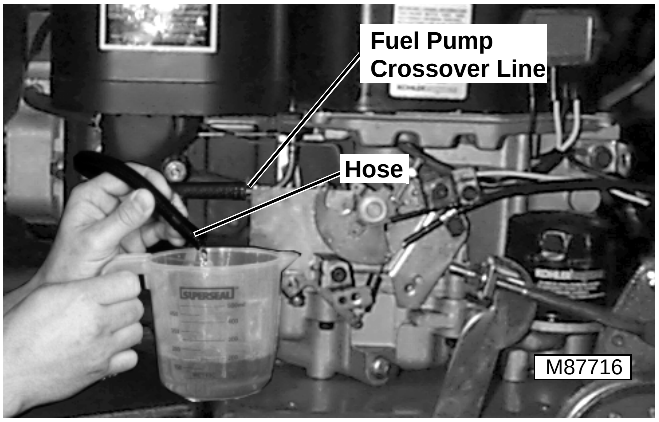
Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.



4. Disconnect hose from fuel pump crossover tube (near carburetor) and connect JDG356 Pressure Gauge to fuel pump crossover tube.
5. Start and run engine at fast idle for 15 seconds, then record pressure reading.
6. Stop engine.

⚠ CAUTION

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



7. Remove pressure gauge and hose.
8. Connect one end of a short length of fuel hose to fuel pump crossover tube and put other end in a graduated container.
9. Start and run engine at fast idle for 15 seconds, then stop the engine and record container measurement.
10. Remove hose from fuel pump crossover tube and reconnect hose from carburetor to fuel pump crossover tube.

Specifications:

Minimum pressure . . . . 6.12 kPa (0.9 psi)
Minimum flow: . . . . 30 mL/15 seconds (1 oz/15 seconds))
Engine speed . . . . 3350±100 rpm

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.
- 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 REMOVAL & INSTALLATION” on page 40.

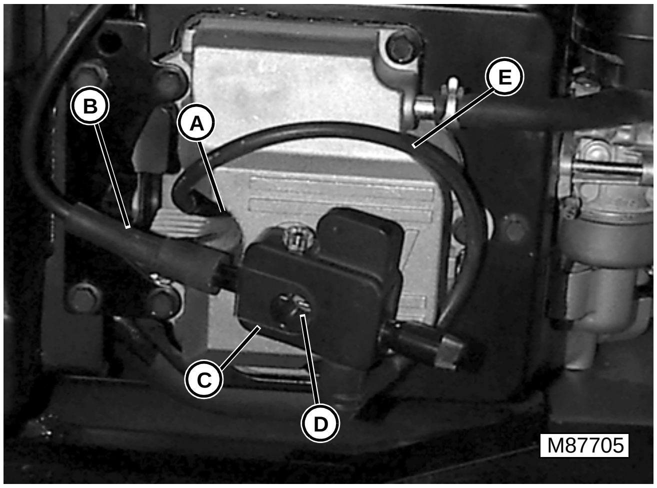
SPARK TEST

Reason:

To determine condition of ignition system.

Equipment:

- D-05351ST Spark Tester



Connections:

1. Remove ignition module high tension lead (B) from spark plug (A).
2. Connect spark tester lead (E) to spark plug (A).
3. Connect high tension lead (B) to tester (C).

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

4. Adjust spark tester gag (D) to **4.2 mm (0.166 in.)** with screw (C).

Procedure:

1. Crank or start engine. Watch spark at tester gap.

Results:

- Steady, strong, blue spark - ignition is good. If engine will not start, check fuel supply and engine compression.
- If spark is weak, or no spark, install a new spark plug.
- If spark is still weak or still no spark, See "IGNITION COIL AIR GAP ADJUSTMENT" on page 36. and/or See "IGNITION COIL TEST" on page 37.

Specification:

Spark Plug Gap . . . . 1.0 mm (0.040 in.)
Spark Plug Torque . . . . .38 - 43.4 N•m (28 - 32 lb-ft.)

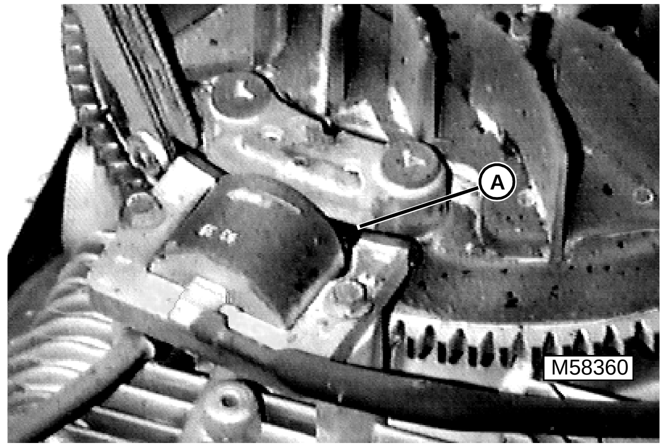
IGNITION COIL AIR GAP ADJUSTMENT

Reason:

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

Equipment:

- 0.25 mm (0.010 in.) feeler gauge



Connections:

1. Put transaxle in neutral.
2. Put key switch in OFF position.
3. Remove blower housing.

Procedure:

1. Turn flywheel magnet away from ignition module.
2. Loosen ignition module mounting screws and hold module as far back as possible.
3. Turn flywheel magnet so it is centered on ignition module.
4. Insert **0.25 mm (0.01 in.)** feeler gauge (A) between flywheel magnet and all three ignition module polls. Allow module to draw against feeler gauge (A) and flywheel magnet.
5. Hold module coil in this position and tighten mounting screws to specification.
6. Turn flywheel to remove feeler gauge.
7. Install blower housing.

Specifications:

Ignition module air gap . . . . 0.25 mm (0.010 in.)

Ignition Module
Cap Screws. . . . . 4.0–6.2 N•m (35–55 lb-in.)

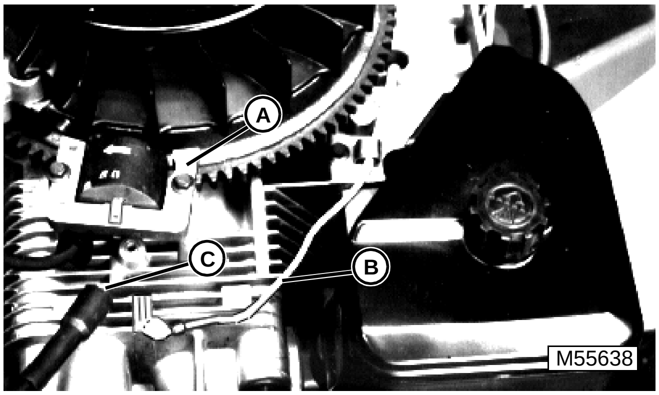
IGNITION COIL TEST

Reason:

To determine condition of ignition coil windings.

Equipment:

• Ohmmeter



Procedure:

1. Put transaxle in neutral. Put key switch in off position.
2. Remove spark plug cap from spark plug wire.
3. Disconnect primary lead wire.
4. Measure resistance between primary lead (B) and core (A). Reverse meter leads and check resistance again.
5. Measure resistance between spark plug lead (C) and core (A).

Specifications:

Primary lead and core resistance:
One direction . . . . .5-1000 ohms
Other direction (Minimum) . . . . 30 K ohms
Spark plug lead and core resistance . . . . .7.9-10.85 K ohms

Results:

• If resistance does not meet specifications, replace the ignition module.

FLYWHEEL MAGNETS TESTS

Reason:

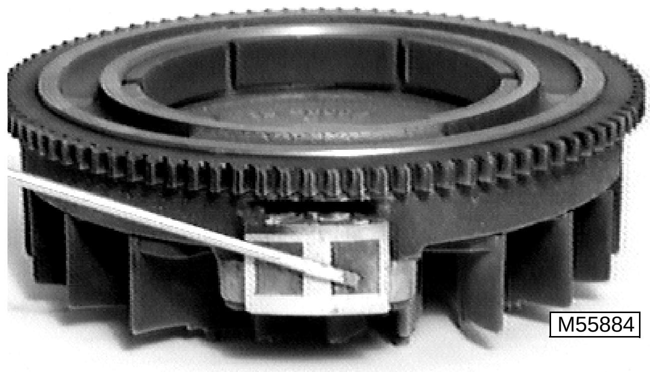
To make sure flywheel magnet(s) have enough force to induce current in ignition coil and stator.

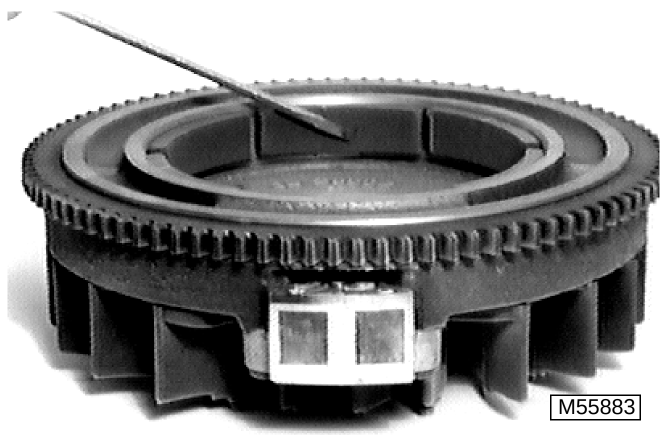
Equipment:

• Screwdriver.

Procedure:

1. Park machine on level surface and turn key switch OFF.
2. Shift lever in NEUTRAL and park brake LOCKED.
3. Remove flywheel housing and flywheel from engine.





4. Place screwdriver about 25 MM (1 in.) from magnets.

Results:

• If screwdriver pulled into magnet, flywheel is good.
• If screwdriver NOT pulled into magnet, flywheel is bad and should be replaced.

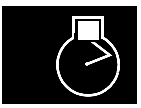
SPARK PLUG GAP ADJUSTMENT

Test Equipment:

• Wire Feeler Gauge

Procedure:

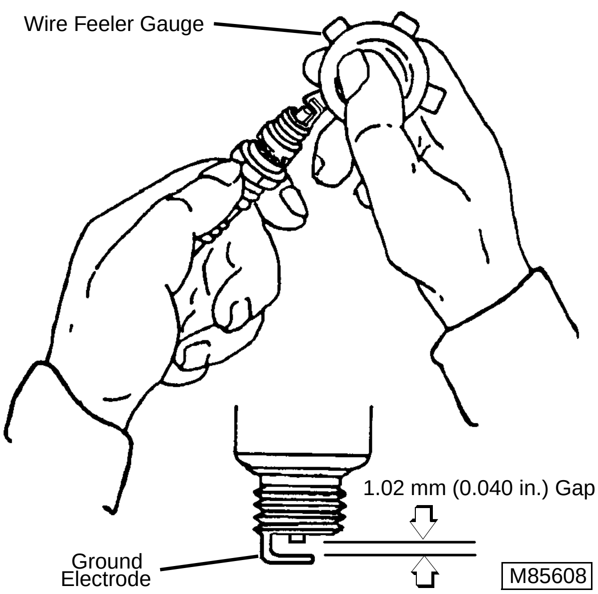
1. Park machine, turn key switch OFF, and allow engine to cool.
2. Remove spark plug



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.)**.

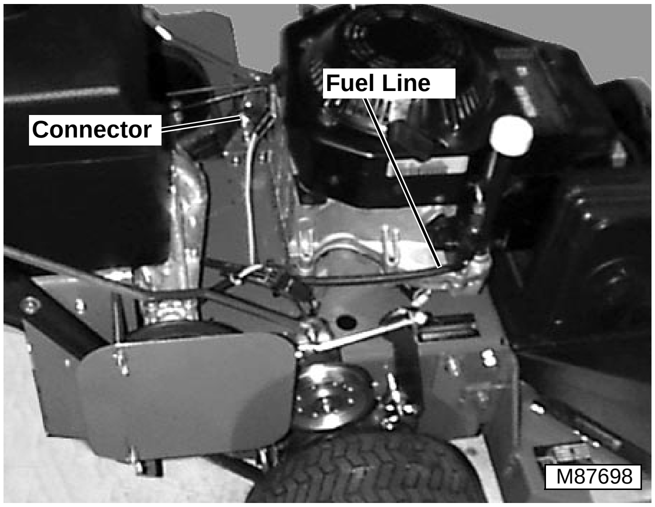
REPAIR

ENGINE REMOVAL

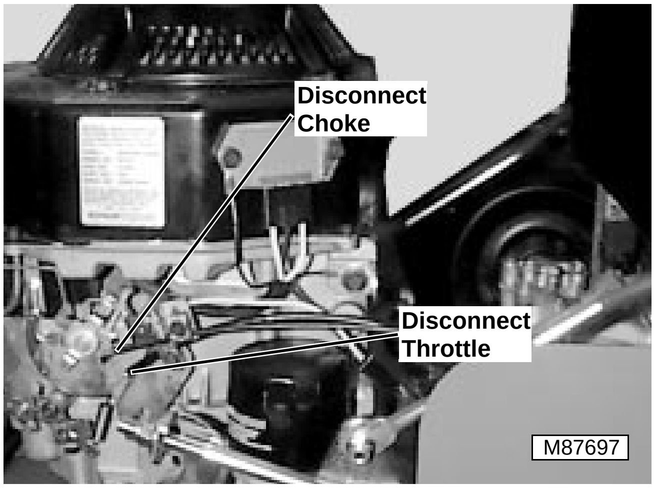
1. Drain engine oil.

Oil Capacity With Filter . . . . 1.8 L (1.9 U.S. qt)

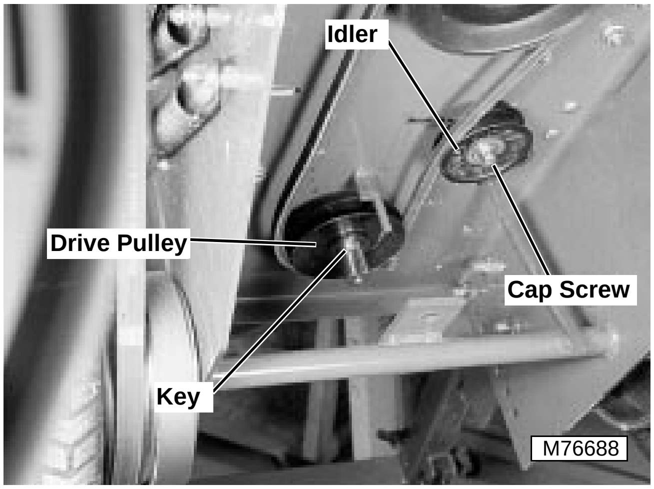
> **CAUTION**
>
> **Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.**



2. Turn off fuel valve. Disconnect fuel line at fuel pump and plug.
3. Disconnect engine electrical connector.



4. Disconnect throttle and choke controls.
5. Remove accessory drive belt.
6. Remove electric clutch. See “PTO CLUTCH REMOVAL” on page 61 in ELECTRICAL SECTION.



7. Loosen retaining cap screw for idler and remove drive belt.
8. Remove drive pulley and key from engine output shaft.
9. Remove four cap screws securing engine to frame.

> **CAUTION**
>
> **Engine is heavy. Use proper lifting techniques to remove engine from frame. Serious personal injury can result.**

10. Remove engine.

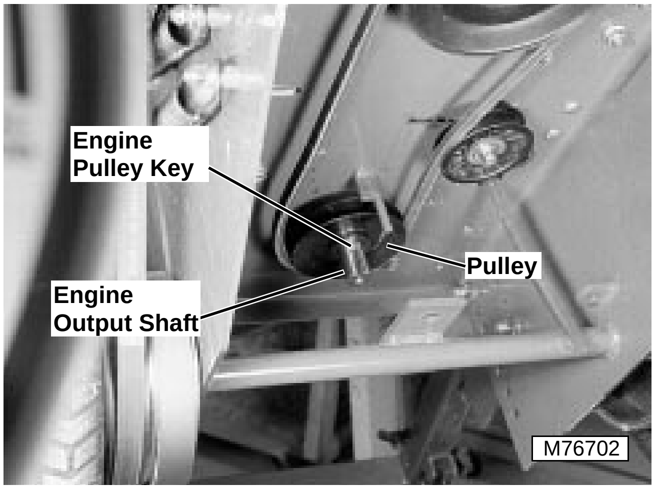
ENGINE INSTALLATION

> **CAUTION**
>
> **Engine is heavy. Use proper lifting techniques to remove engine from frame. Serious personal injury can result.**

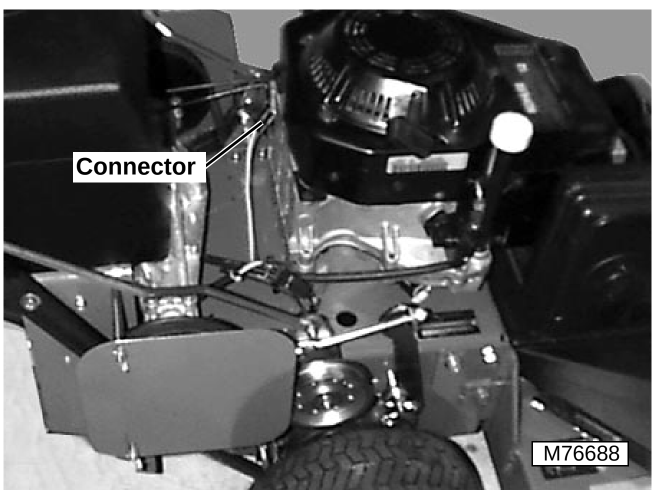
1. Place engine on frame. Align mounting holes and secure with four (4) cap screws. Tighten to specification:

Torque Specifications:

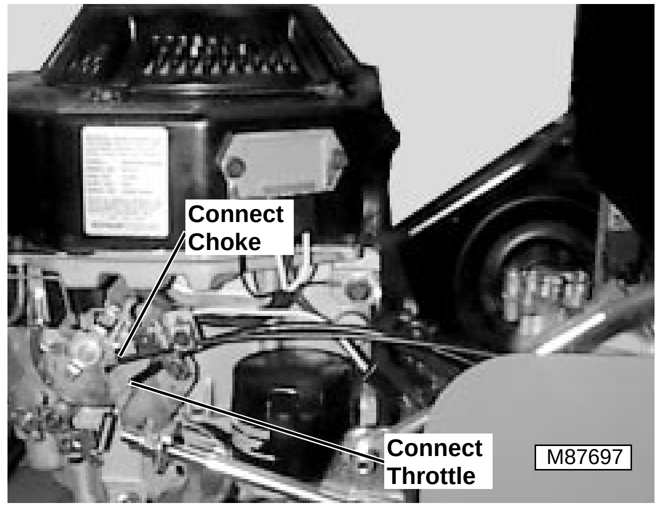
Engine mounting cap screws . . . . . 57 N•m (42 lb-ft)



1. Apply NEVER-SEEZ lubricant to engine output shaft.
2. Install key and pulley.
3. Install drive belt.
4. Adjust drive belt tension.
5. Install electric clutch. See “PTO CLUTCH INSTALLATION” on page 62 in ELECTRICAL SECTION.



6. Connect engine electrical connector.



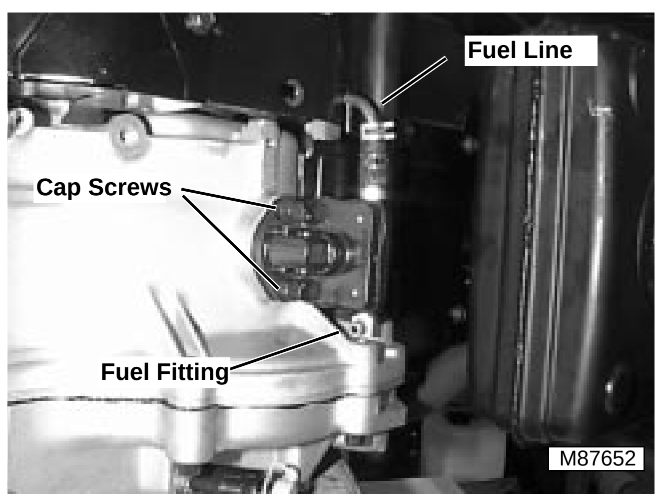
7. Connect throttle and choke controls. See “THROTTLE CABLE ADJUSTMENT” on page 24. See “CHOKE ADJUSTMENT” on page 24.
8. Connect fuel line. Turn on fuel valve.
9. Check engine oil and top off or fill if necessary.

FUEL PUMP REMOVAL & INSTALLATION

Removal:

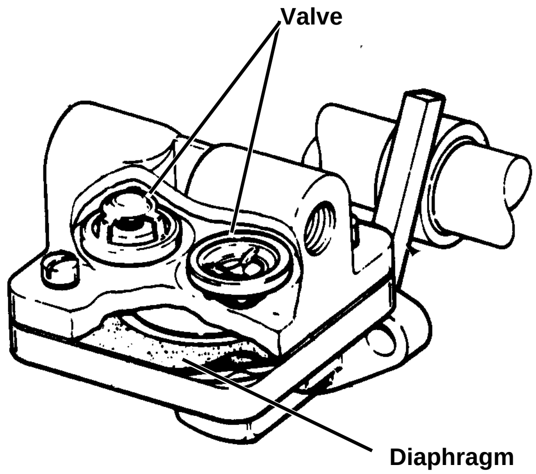
> ## ⚠ CAUTION
>
> **Gasoline is explosive. Do not expose to spark or flame. Serious personal injury can result.**

1. Disconnect spark plug.



2. Turn off fuel valve. Disconnect fuel lines. Close all openings using caps and plugs.
3. Remove two (2) cap screws securing fuel pump to side of engine. Remove fuel pump.

NOTE: Fuel pump components are not seviceable separately. If inspection detects damaged components entire fuel pump must be replaced.

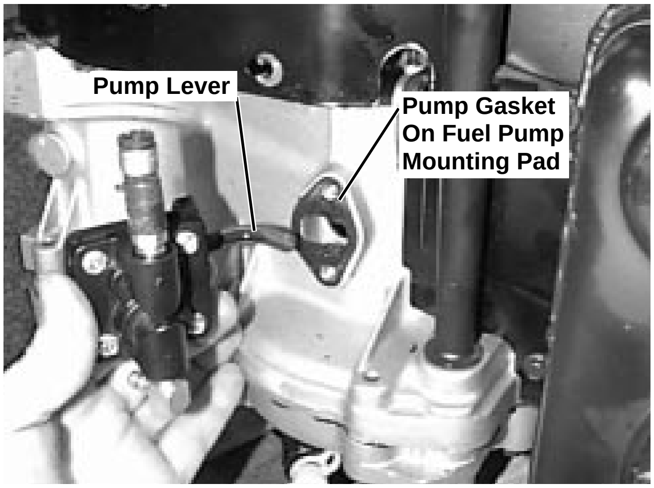


4. Inspect pump for wear or damage. Pay special attention to diaphragm and valves. If any damage is noted replace pump.

Installation:

NOTE: Do Not reuse gasket between fuel pump and engine block.

5. If fittings were removed use Permatex® Aviation Perm-A-Gasket on threads before replacing fittings. Turn fitting into the pump **6 full turns**; continue turning the fittings in the same direction until the desired position is reached.



IMPORTANT: Make sure the fuel pump lever is positioned to the right of the camshaft (When looking at the fuel pump mounting pad on engine block). Damage to the fuel pump, and subsequent severe engine damage could result if the lever is positioned to the left of the camshaft.

6. Place new gasket between fuel pump and engine block and secure pump with two hex flange screws. Torque to specifications.

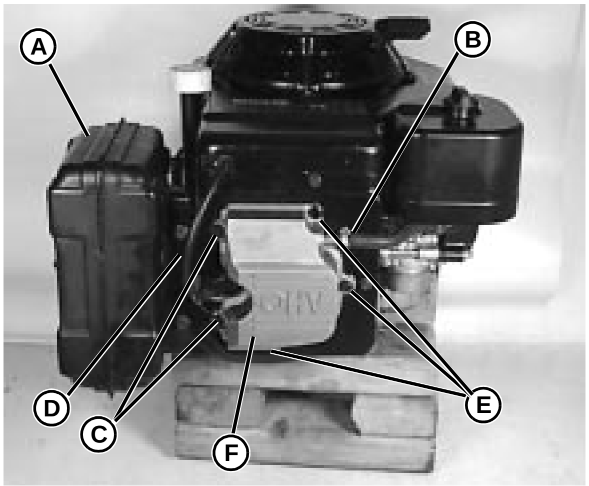
Specifications:

First Time Installation On New Short Block. . . . . 9 N•m (80 lb-in.)

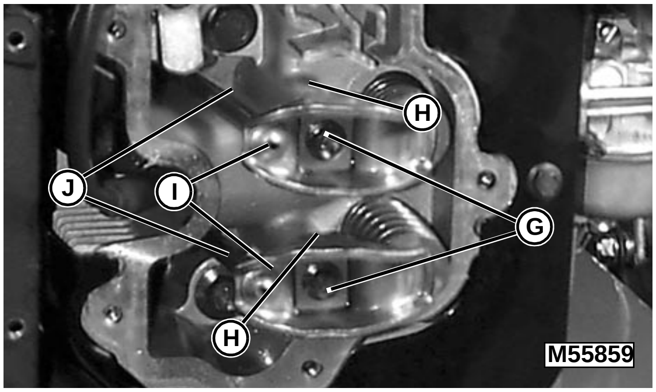
All Reinstallations . . . . 7.3 N•m (65 lb-in.)

7. Connect vacuum and fuel lines.

ROCKER ARMS REMOVAL AND INSTALLATION



1. Remove muffler (A).
2. Disconnect breather hose(B) from valve cover,
3. Remove two valve cover cap screws (C) securing muffler bracket (D) to head.
4. Remove remaining valve cover cap screws (E) and remove valve cover (F).



IMPORTANT: Mark push rods for assembly in original locations.

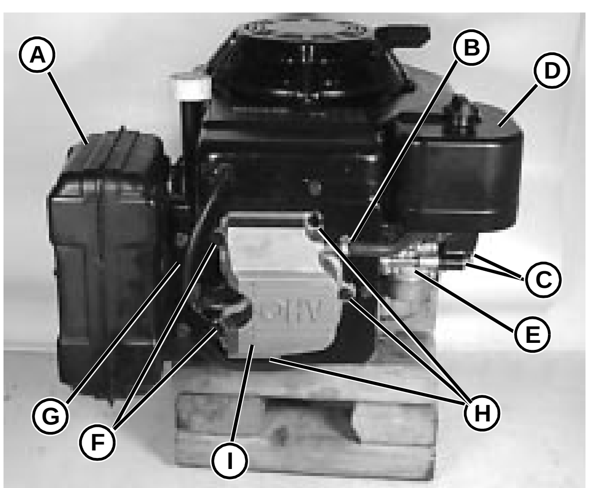
5. Remove cap screws (G) and pivot ball spacers (H).
6. Remove rocker arms (I).
7. Remove push rods (J).
8. Inspect and replace components as necessary.
9. Install components in reverse order of removal.

Specification:

Rocker Pivot Bolts . . . . 14 N•m (124 lb-in.)

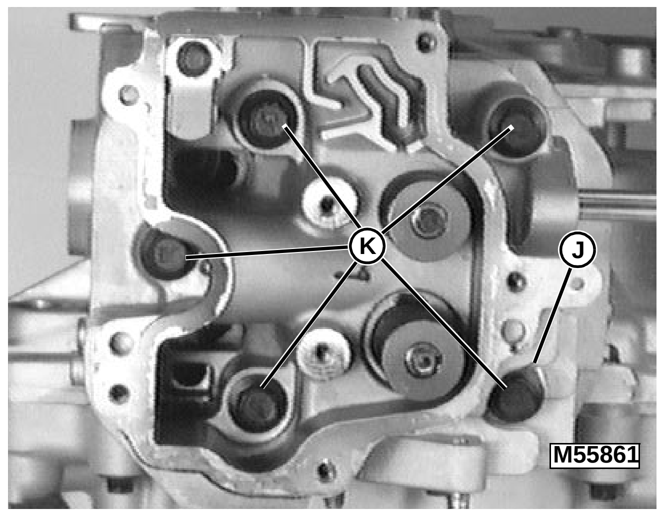
CYLINDER HEAD REMOVAL AND INSTALLATION

Removal:



1. Remove muffler (A).
2. Disconnect breather hose(B) from valve cover, Remove two (2) flange nuts (C) securing carburetor filter box (D) and carburetor (E) to head and remove carburetor.
3. Remove two valve cover cap screws (F) securing muffler bracket (G) to head.
4. Remove remaining valve cover cap screws (H) and remove valve cover (I).
5. Remove screws securing head shroud. Remove shroud.
6. Remove rocker arms and push rods. See “ROCKER ARMS REMOVAL AND INSTALLATION” on page 41.

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



NOTE: Location of spacer (J) under lower right hand cap screw.

7. Remove cap screws (K), spacer (J) and cylinder head. Discard gasket, clean cylinder head and engine block mating surfaces.

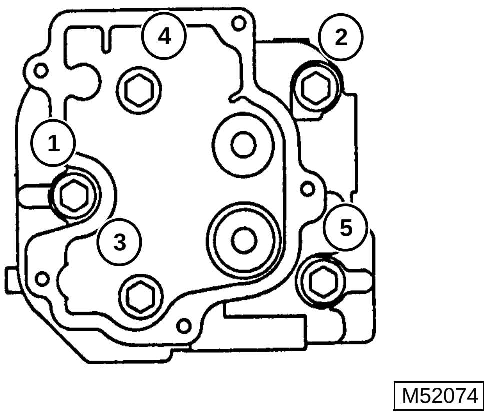
NOTE: Do not scrape surfaces when cleaning as this will damage the aluminium surface and could cause leaks. The use of a gasket removing solvent is recommended.

Installation:

NOTE: Proper care and procedure must be taken to avoid damage to lifters or push rods. Before proceeding, rotate piston to top dead center

(TDC) on the compression stroke of the engine. Crankshaft PTO keyway will be in the 12 o'clock position.

1. Install new cylinder head gasket.
2. Place cylinder head on block and secure with five (5) cap screws (K) making sure the spacer (J) is under the lower right hand capscrew (closest to exhaust port).

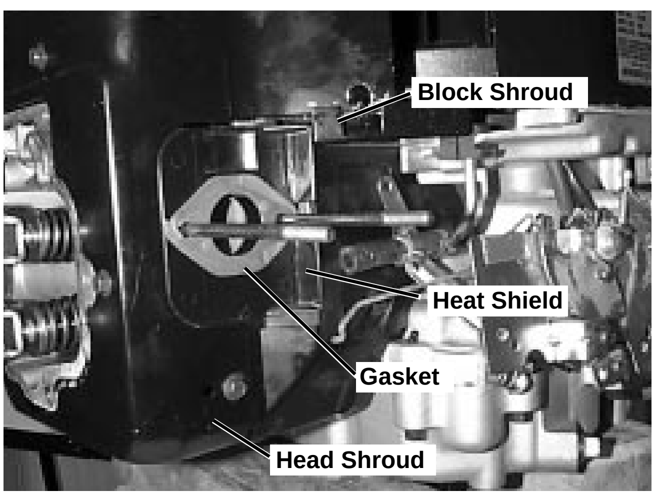


3. Torque cylinder head cap screws in 7 N•m (5 lb-ft) increments in sequence illustrated.

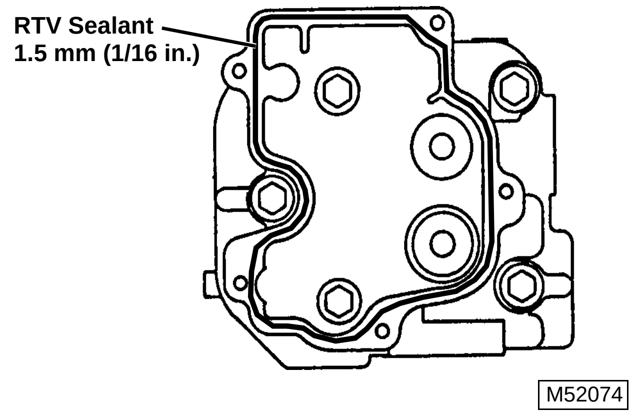
Specification:

Cylinder Head Cap Screws . . . . 41 N•m (30 lb-ft)

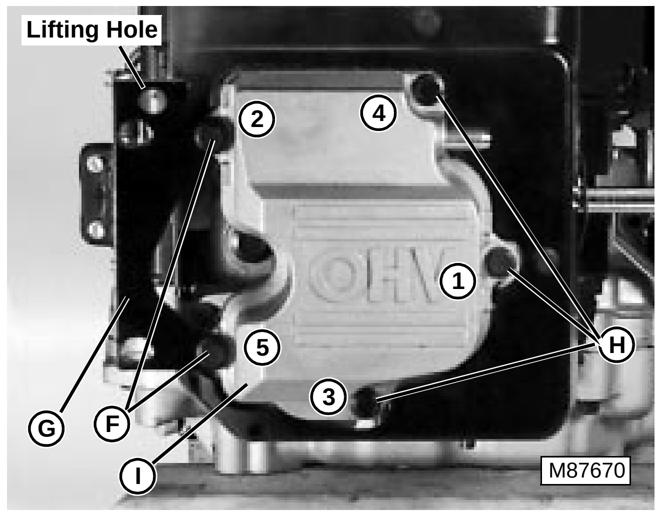
4. Install push rods and rocker arms. See "ROCKER ARMS REMOVAL AND INSTALLATION" on page 41.



5. Place new gasket on intake port and place carburetor heat shield in position. Place second new intake gasket over heat shield.
6. Install head shroud taking care that heat shield is in correct position BEHIND both block shroud and head shroud.



7. Apply a 1.5mm (1/16 in.) bead of RTV sealant to the cylinder head.

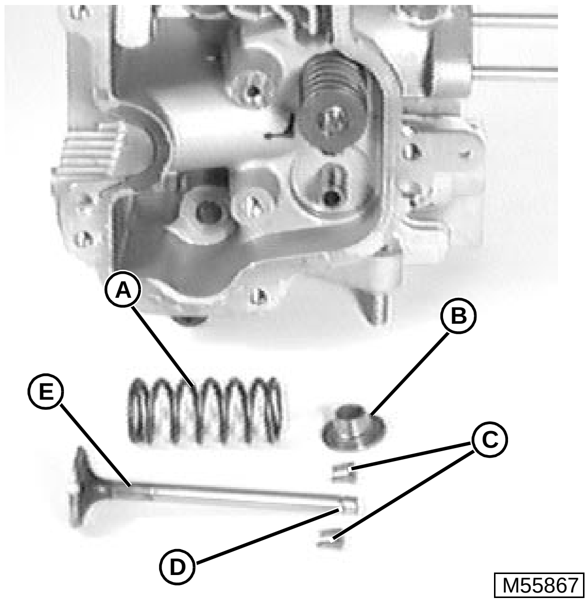


8. Place valve cover (I) on head, taking care not to smear RTV, and secure with cap screws (H).
9. Place the muffler bracket (G) (lifting hole up) in position and secure with cap screws (F).
10. Tighten valve cover cap screws (F & H), in sequence illustrated, to specifications.
11. Install muffler, using new gasket.
12. Install carburetor and filter box, secure with two flange head nuts.
13. Place breather hose on fitting in valve cover.
14. Reinstall engine. See "ENGINE INSTALLATION" on page 39.

Specification:

Valve Cover Cap Screws
First Time Installation
on New Cylinder Head . . . . . . 10.7 N•m (95 lb-in.)
All Reinstallations . . . . 7.3 N•m (65 lb-in.

VALVES AND SPRINGS REMOVAL AND INSTALLATION



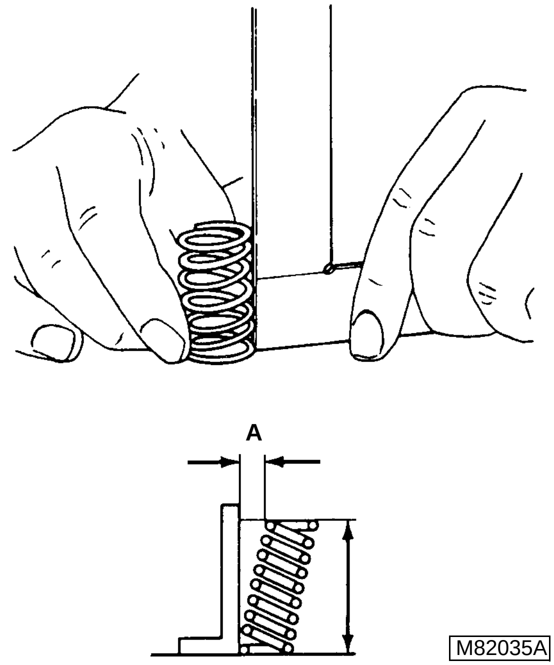
IMPORTANT: Make sure keepers are seated in valve stem groove (D).

1. Compress intake and exhaust springs using an appropriate size spring compressor.
2. Remove keepers (C), spring caps (B), springs (A), and valves (E).
3. Install valve components.
4. Compress spring and install keepers in grooves (D).
5. Install rocker arm assembly and cylinder head in reverse order.

IMPORTANT: Valves are equipped with a valve stem seals. Always use a new seals when valves are removed from cylinder head. The seals should also be replaced if deteriorated or damaged in any way. NEVER reuse an old seals.

VALVE SPRING INSPECTION

1. Clean and inspect valve springs. Replace if cracked or broken.



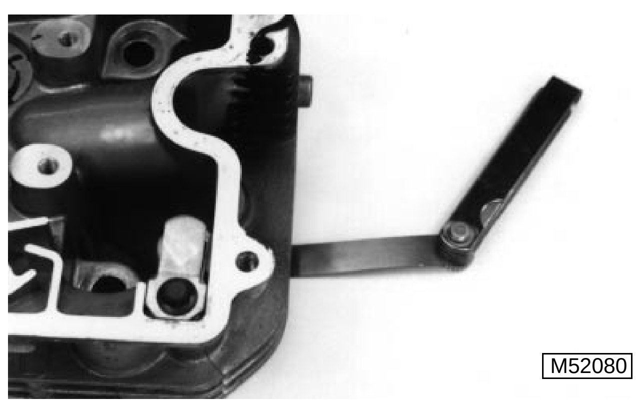
2. Inspect valve spring for squareness on a surface plate. Turn spring and measure space between top spring coil and square (A). Replace spring if not in within specifications.

Valve Spring Specifications:

Squareness Tolerance . . . . 2.39 mm (0.090 in.)

CYLINDER HEAD INSPECTION

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.

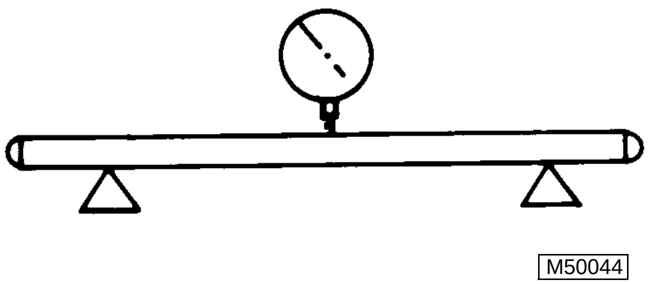


3. Put head on a flat surface plate. Check for distortion at several points with a feeler gauge. Replace head if distorted beyond specification.

Specification:

Cylinder Head Distortion (maximum)
. . . . . 0.076 mm (0.003 in.)

PUSH ROD INSPECTION

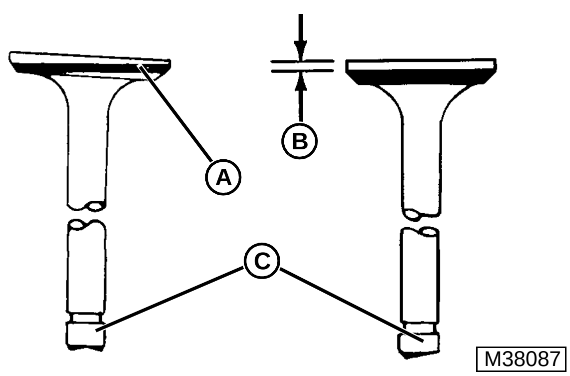


Specification:

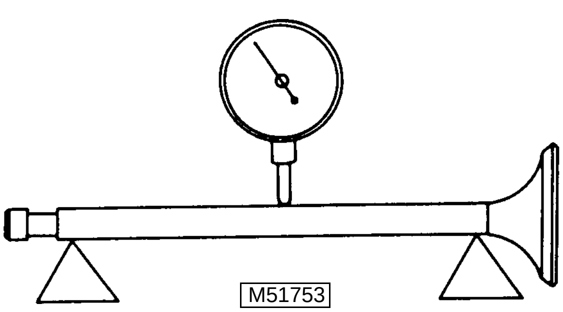
Push Rod Bend (maximum) . . . 0.76 mm (0.030 in.)

VALVE INSPECTION

1. Remove carbon from valve head, face, and stem.
2. Check valve for cracks or damage.



3. Replace warped valves (A) or valves with less than serviceable margin (B). Valve stem ends (C) should be square, not worn uneven as shown.



4. Inspect valve stems for bends using V-blocks and dial indicator. Turn valve slowly and read variation. Replace if variation is greater than specification.

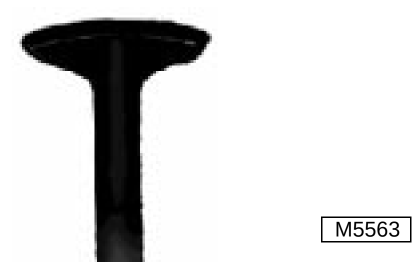
Specification:

Valve Stem Bend (maximum)
. . . . . 0.076 mm (0.003 in.)

VALVE ANALYSIS

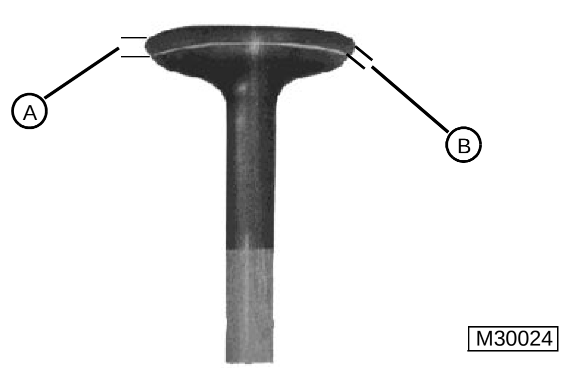
Lead deposits on the intake valve are caused by exhaust gas leakage past the valve when using leaded gasoline. Grind intake valve and reface valve seat to correct this condition.

Use unleaded fuel to prevent lead deposits.



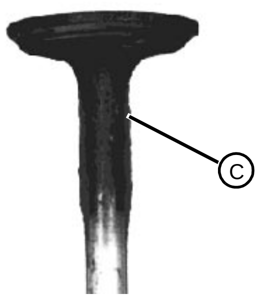
Valve stem corrosion is caused by moisture in the engine which occurs during hot engine cool-down periods or during storage.

Fogging of combustion chamber with oil before storage helps prevent corrosion. Replace badly corroded valves.



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 (A) and face angle (B). 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.



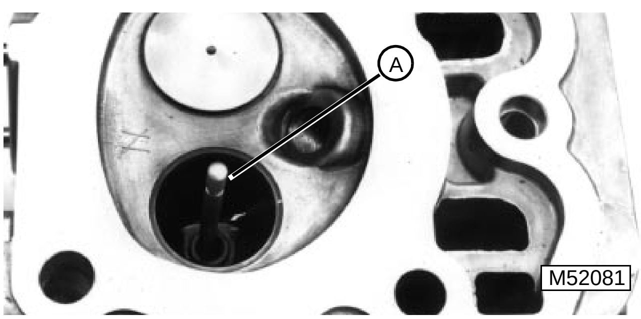
Use of old or stale gasoline can cause valves to stick.

Gummy deposits (C) can build up on valve and can also gum carburetor, requiring cleaning.

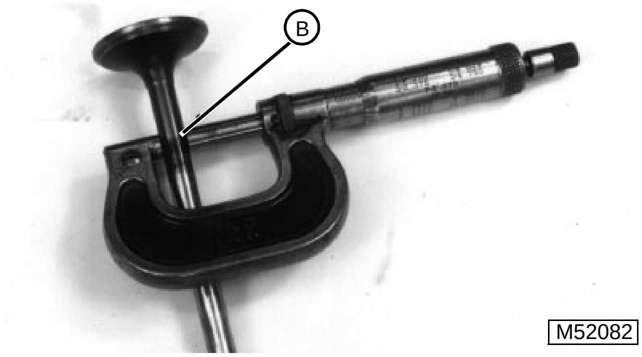
Always use fresh gasoline of 87 octane rating or higher. Drain fuel tank, lines, and carburetor before storage.

VALVE GUIDES INSPECTION

1. Clean inside of valve guide. Standard valve guide reamer (D20020WI) can be used.



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



3. Measure outside diameter of valve stem (B).
4. An oversize valve is available. Replace valve if stem-to-guide clearance is too great.

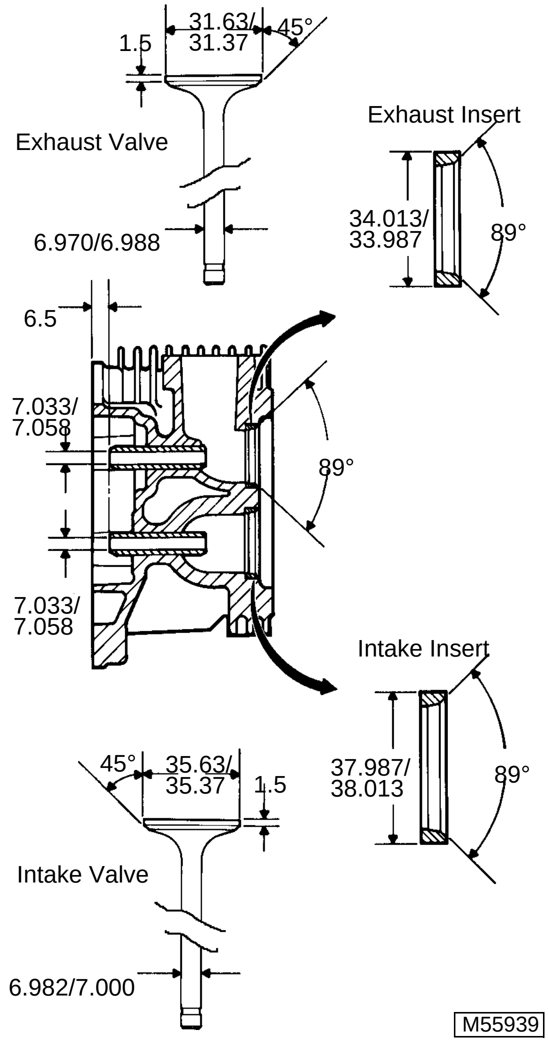
IMPORTANT: If guide is reamed oversized, an oversize valve must be installed.

5. Use oversize reaming tool (JDG705) to ream guide, if necessary.
6. Replace cylinder head if inside diameter of guide is greater than oversize specification.

Specifications:

Valve Guide Ream (standard)
. . . . . 7.05 mm (0.278 in.)
Valve Guide Ream (oversize)
. . . . . 7.30 mm (0.287 in.)
Intake Stem-to-Guide Clearance
. . . . 0.38—0.07 mm (0.001—0.003 in.)
Intake Guide (Maximum Wear)
. . . . . 7.134 mm (0.2809 in.)
Exhaust Stem-to-Guide Clearance
. . . . 0.05—0.088 mm (0.002—0.0035 in.)
Exhaust Guide (Maximum Wear)
. . . . . 7.159 mm (0.2819 in.)

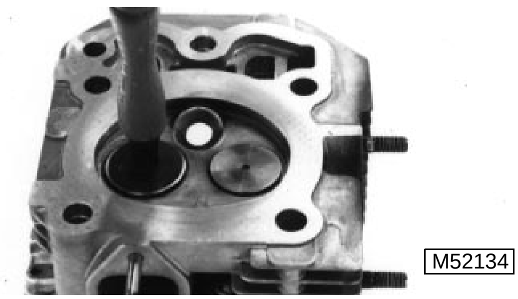
RECONDITION VALVE SEATS



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

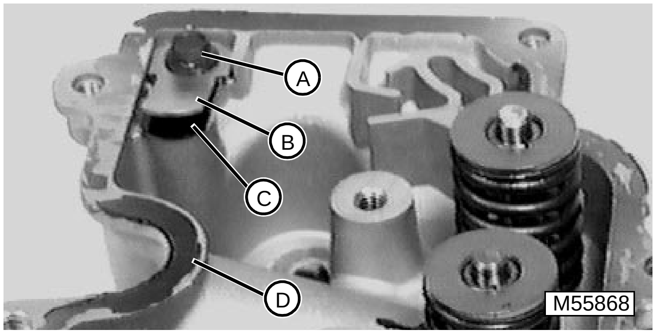
LAP VALVES

IMPORTANT: Valves and seats should be lapped if they do not make good contact.



1. Apply light coat of lapping compound to valve face, then turn valve in seat using vacuum cup tool.
2. Check valve every 8 strokes until a uniform ring appears around surface of valve face.
3. Wash parts in solvent to remove lapping compound.
4. Check position of lap mark on face–lap mark must be on or near center of valve face.

BREATHER INSPECTION

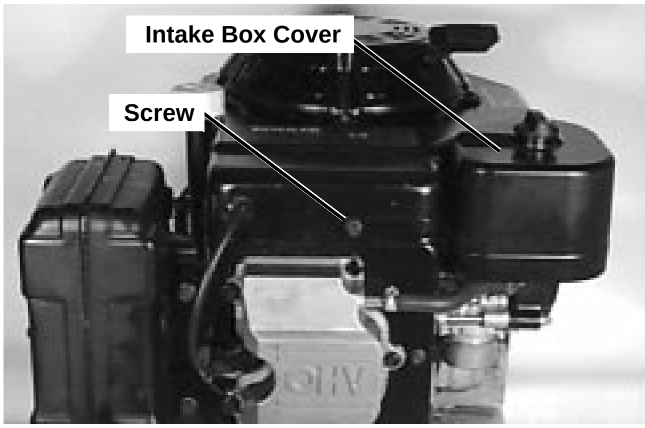


1. Remove cap screw (A), plate (B), and reed (C).
2. Check that breather opening is clear.
3. Replace reed if it does not lie flat on casting.
4. Clean mating surface of any sealant residue (D).

BLOWER HOUSING REMOVAL AND INSTALLATION

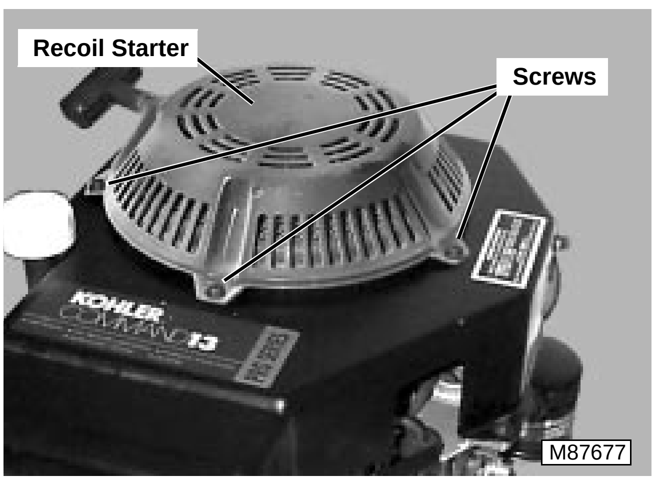
NOTE: Blower housing can be removed without removing engine from the machine.

Removal:

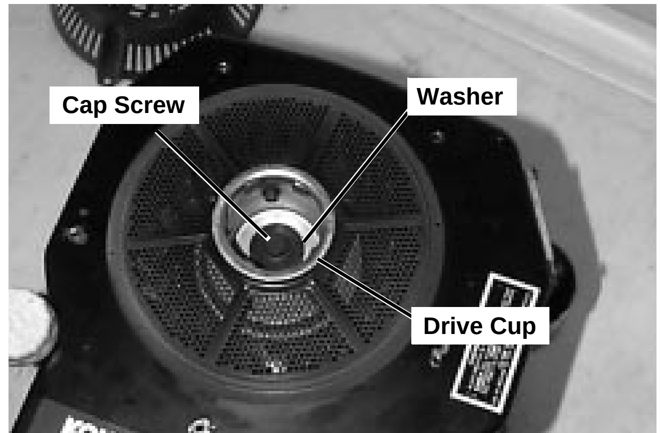


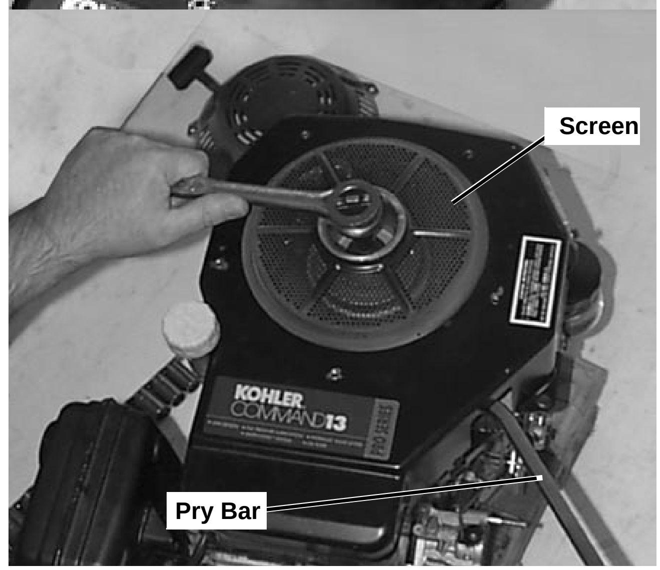
1. Remove intake box cover (A) and intake filter assembly.
2. Remove screw securing front of blower housing to block

NOTE: It is not necessary to remove carburetor or muffler in order to remove blower housing.

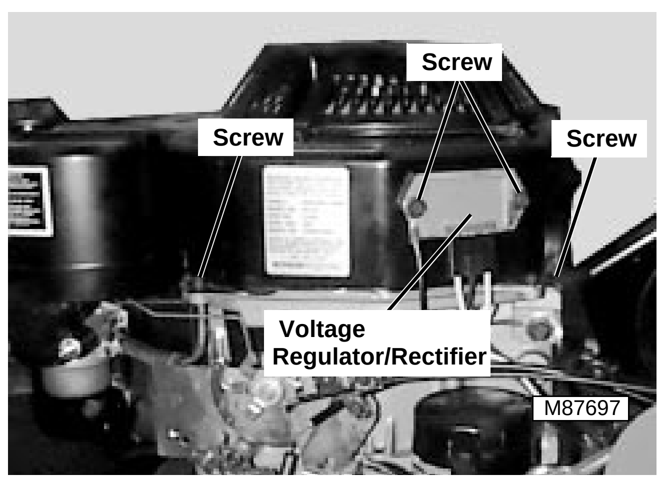


3. Remove five (5) screws securing recoil starter to blower housing. Remove recoil starter assembly.



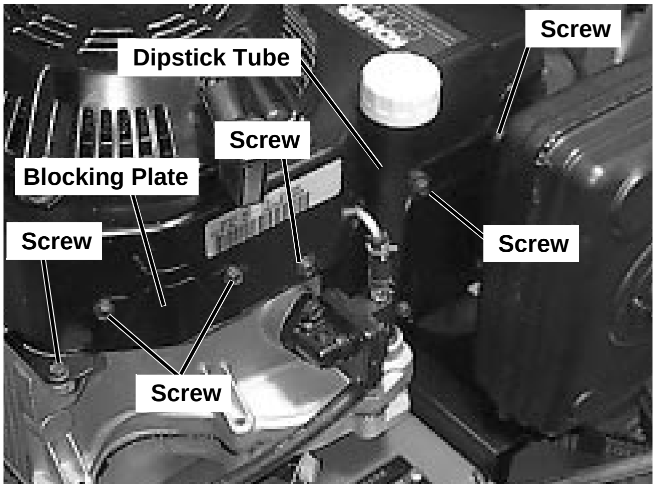


4. Remove cap screw and washer from bottom of drive cup by blocking flywheel with pry bar inserted into opening for carburetor intake. Remove drive cup, screw, washer, cup and screen.



5. Remove two screws securing voltage regulator/rectifier to blower housing. Move voltage regulator/rectifier out of the way.

6. Remove two screws securing left side of blower housing to engine block.



7. Remove screw securing dipstick tube to blower housing. Remove dipstick tube.
8. Remove two cap screws securing blocking plate to blower housing.
9. Remove four cap screws securing right side of blower housing to block.
10. Remove Blower housing.

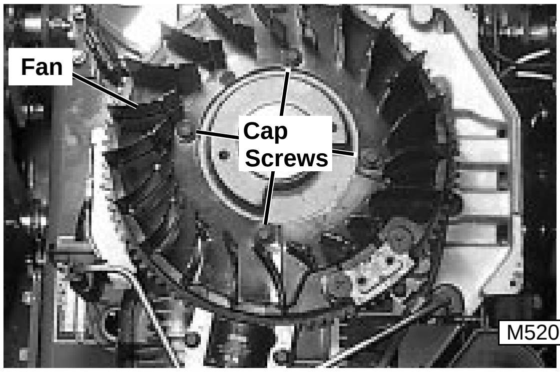
Installation is done in the reverse order of removal.

Specification:

Flywheel Cap Screw. . . . . 68 N•m (50 lb-ft).

FLYWHEEL REMOVE AND INSTALL

1. Remove blower housing. See “BLOWER HOUSING REMOVAL AND INSTALLATION” on page 47.



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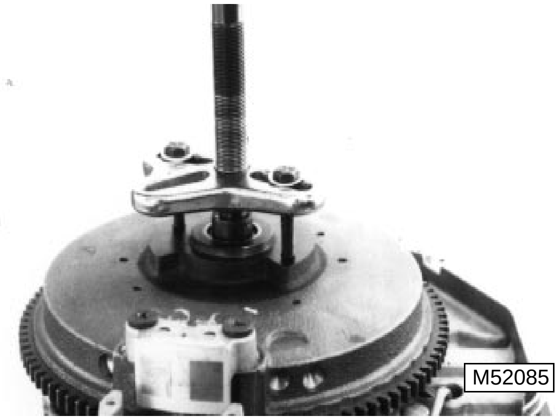
2. If fan requires removal from flywheel, remove four fan cap screws and washers and fan.



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3. Remove flywheel using a puller.

NOTE: Ring gear and magnets are not serviceable. If either are damaged entire flywheel must be replaced.

4. Inspect flywheel for cracks, chips, and broken teeth. Replace as necessary.
5. Inspect for sheared or partially sheared key, replace as necessary.

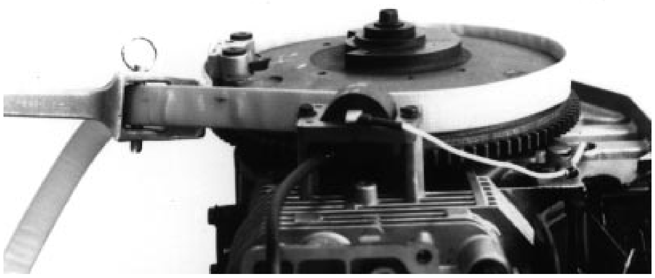
Installation:

IMPORTANT: Check that crankshaft end and flywheel hub are clean and free of lubricant, and flywheel key is installed properly in keyway.

⚠ CAUTION

Improperly installed flywheel can cause machine damage and serious personal injury

1. Install key and flywheel on crankshaft.



2. Hold flywheel with strap wrench. Place plain washer and capscrew in crankshaft and tighten cap screw to specification to set flywheel on crankshaft. Remove capscrew and washer.
3. Check ignition module air gap. See “IGNITION COIL AIR GAP ADJUSTMENT” on page 36.
4. Install fan on flywheel, if removed, and secure with four (4) cap screws and washers. Tighten to specification.
5. Install blower housing sheet metal taking care that heat shield is in correct position BEHIND both block shroud and head shroud. See “BLOWER HOUSING REMOVAL AND INSTALLATION” on page 47.

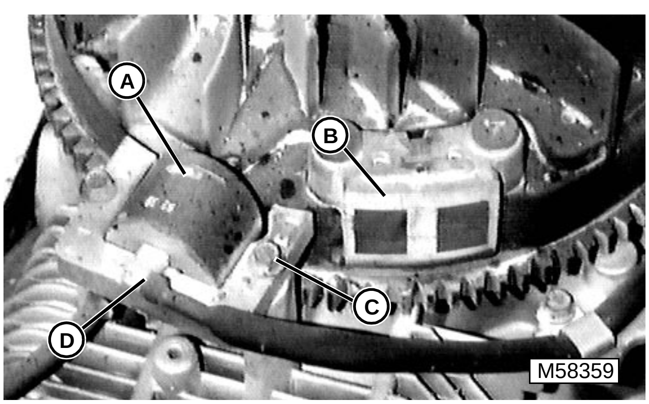
Specification:

Flywheel Cap Screw. . . . . 68 N•m (50 lb-ft).
Fan Cap Screws . . . . 9.9 N•m (88 lb-in.)

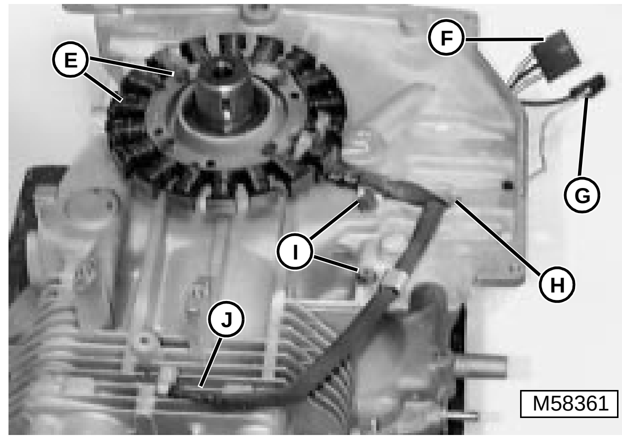
STATOR AND IGNITION COIL REMOVE AND INSTALL

Removal:

1. Remove blower housing. See “FLYWHEEL REMOVE AND INSTALL” on page 49. (Steps 1 to 7.)



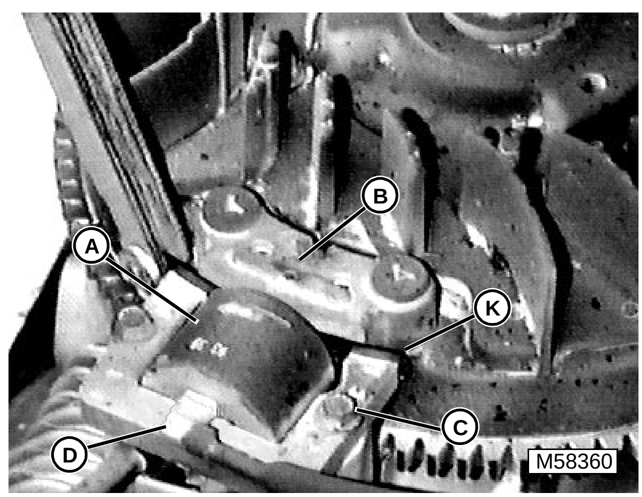
1. Turn flywheel magnet (B) away from ignition module (A).
2. Disconnect wire (D) from terminal.
3. Remove cap screws (C) and ignition module.
4. Remove flywheel See “FLYWHEEL REMOVE AND INSTALL” on page 49.



5. Remove two white stator wires from connector (F).
6. Remove clamps (G).
7. Remove cap screws and stator (E).
8. Inspect for damage.

Installation:

1. Thread stator wires through hole in crankcase and install in connector. Fasten clamps.
2. Install stator. Tighten cap screws to specification.
3. Install flywheel and tighten cap screw to specification See “FLYWHEEL REMOVE AND INSTALL” on page 49.
4. Rotate magnet away from module mount. Install module loosely.



5. Align flywheel magnet (B) with mounting posts for ignition module.
6. Place **0.25 mm (0.01 in.)** feeler gauge blade (K) or shim stock across magnet face.

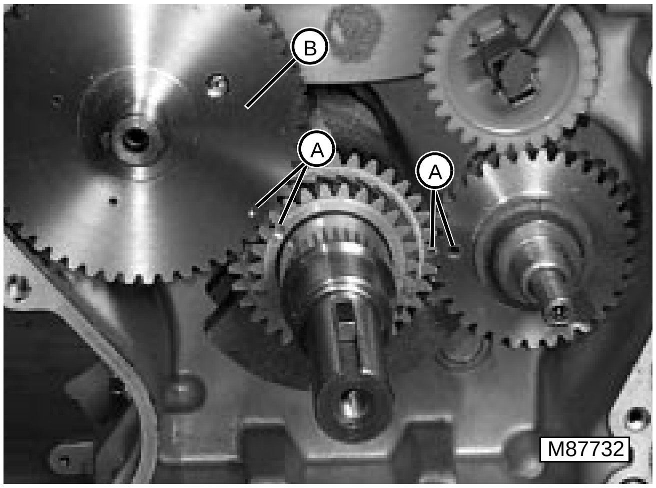
IMPORTANT: BE SURE flywheel magnet (B) is centered on ignition module (A) so all three polls of the ignition module are properly gapped from the flywheel magnet.

7. Position ignition module (A) so all three polls mate with feeler gauge blade (K) and its two mounting holes align with mounting posts.
8. Install and tighten cap screws to specification.
9. Remove feeler gauge and connect wire (D) to terminal.

Specifications:

Ignition Module Air Gap . . . . 0.25mm (0.01 in.)
Ignition Module Cap Screws
. . . . . 4.0–6.2 N•m (35–55 lb-in.)
Stator Cap Screws . . . . 4 N•m (35 lb-in.)
Flywheel Cap Screw. . . . . 68 N•m (50 lb-ft)

CAMSHAFT REMOVAL AND INSTALLATION

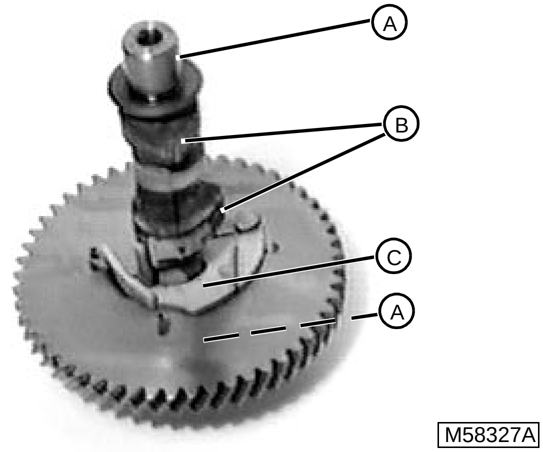


1. Remove oil pan. See “OIL PAN REMOVAL AND INSTALLATION” on page 63.
2. Rotate crankshaft to align two sets of marks (A).
3. Remove camshaft (B).
4. Inspect camshaft closely, replace as necessary. See “CAMSHAFT INSPECTION” on page 51.
5. Coat entire camshaft with engine oil.
6. Install camshaft with four timing marks (A) aligned.
7. Check camshaft end play. See “CAMSHAFT END PLAY” on page 52.

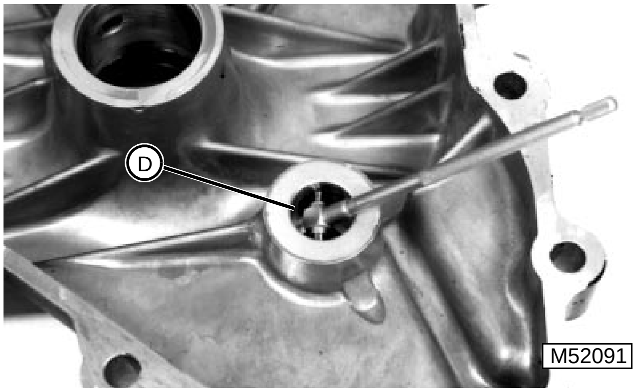
IMPORTANT: If oil pan does not seat fully on block DO NOT force it down. STOP and find out why it does not seat properly.

8. Align flat surface of balancer shaft with bore flat of oil pump inner rotor gear as you install oil pan. See “OIL PAN REMOVAL AND INSTALLATION” on page 63.

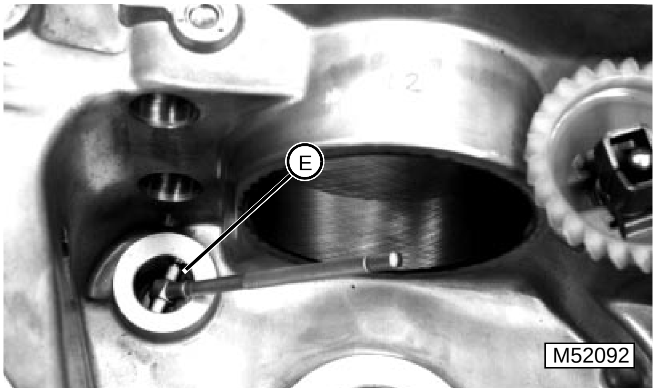
CAMSHAFT INSPECTION



1. Inspect camshaft for worn or broken teeth.
2. Measure journals (A). Replace camshaft if measurements do not meet specifications.
3. Inspect lobes (B). Replace camshaft if lobes show excessive wear.
4. Inspect ACR mechanism (C). Replace spring if necessary and check that weight moves freely.



5. Measure camshaft bore (D) in oil pan.
6. Subtract journal OD from bore ID to determine clearance with camshaft journal. Replace if not within specifications.



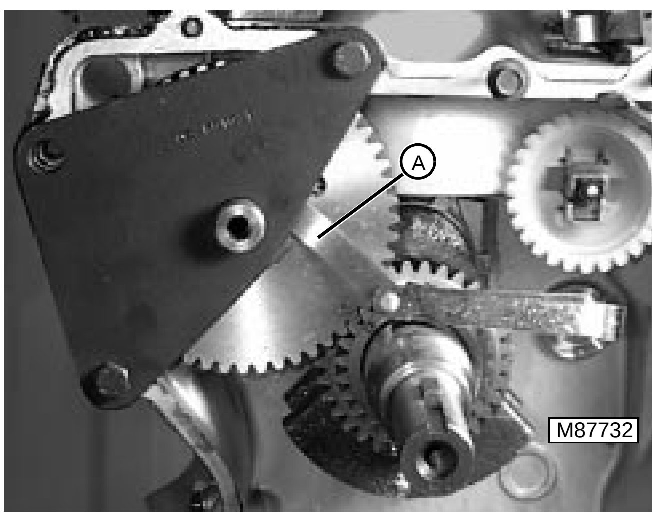
7. Measure camshaft bore (E) in crankcase.
8. Subtract journal OD from bore ID to determine clearance with camshaft journal. Replace if not within specification.

Specifications:

Camshaft Journal (A) OD (minimum) . . . . 19.96 mm (0.786 in.)
Oil Pan Bore (D) to Camshaft Clearance (maximum) . . . . . . 0.08 mm (0.003 in.)
Crankcase Bore (E) to Camshaft Clearance (maximum) . . . . . . 0.08 mm (0.003 in.)

CAMSHAFT END PLAY

1. Check that camshaft is seated in crankcase bore.



2. Install special tool on case locator and cam bearing surface. Secure to case with two bolts supplied with tool.
3. Measure play (A) between camshaft thrust bearing surface and special tool using feeler gauge.
4. Use shims from Shim Kit as necessary until end play is within specification.

Specification:

Camshaft End Play (with shim) (maximum) . . . . 0.07—0.13 mm(0.003—0.005 in.)

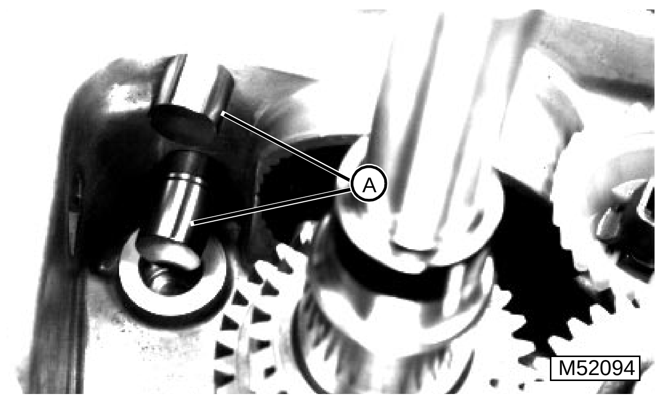
Shim Thickness Range:

White	**0.69–0.73 mm (0.027–0.029 in.)**
Blue	**0.74–0.78 mm (0.029–0.031 in.)**
Red	**0.79–0.83 mm (0.031–0.033 in.)**
Yellow	**0.84–0.88 mm (0.033–0.035 in.)**
Green	**0.89–0.99 mm (0.035–0.037 in.)**
Gray	**0.95–0.98 mm (0.037–0.039 in.)**
Black	**1.00–1.03 mm (0.039–0.041 in.)**

HYDRAULIC VALVE LIFTERS REMOVAL AND INSTALLATION

1. Remove camshaft. See “CAMSHAFT REMOVAL AND INSTALLATION” on page 51.

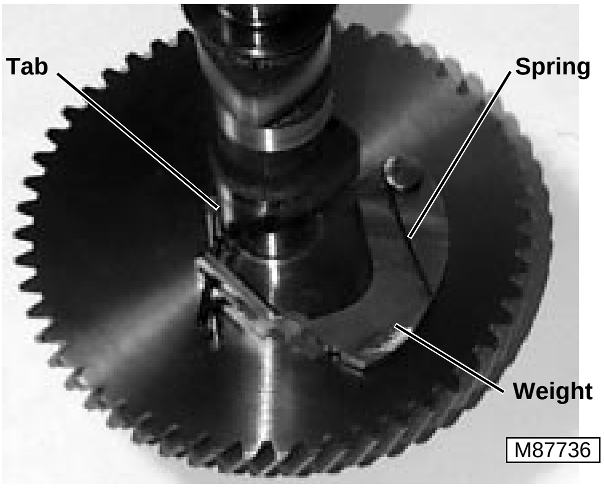
IMPORTANT: Used lifters are mated to their camshaft lobes. Mark them for installation in the correct bore.



2. Remove lifters (A).
3. Inspect lifters for wear, replace as necessary.
4. Coat lifters with engine oil and install in correct bore.
5. Install camshaft.

AUTOMATIC COMPRESSION RELEASE (ACR) INSPECTION

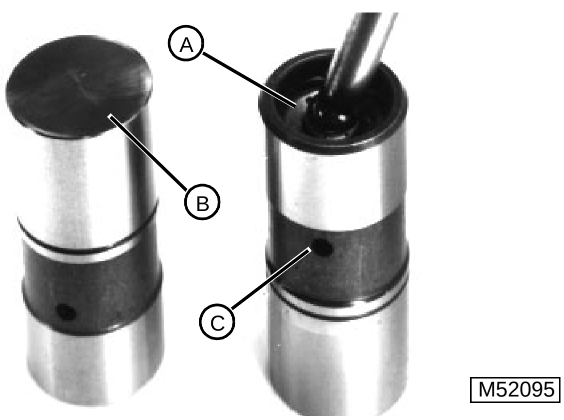
1. Remove camshaft. See “CAMSHAFT REMOVAL AND INSTALLATION” on page 51.



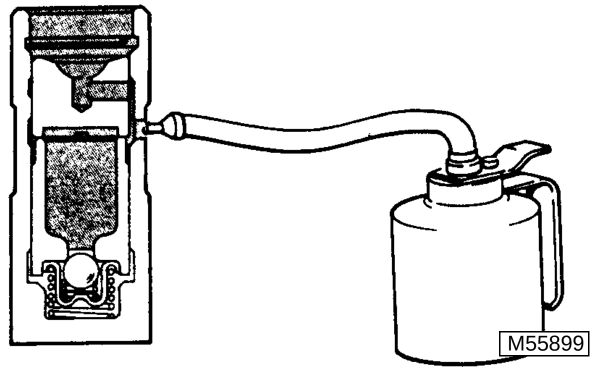
2. Inspect automatic compression release mechanism (ACR) for damage.
3. Inspect spring. Replace if worn or damaged.
4. Move weight(s) by hand to check for proper operation.
5. Check that tab sits slightly above cam lobe when weights are released. Tab should drop below cam when weights are operated.
6. Replace camshaft if ACR does not operate properly.

HYDRAULIC VALVE LIFTERS INSPECTION

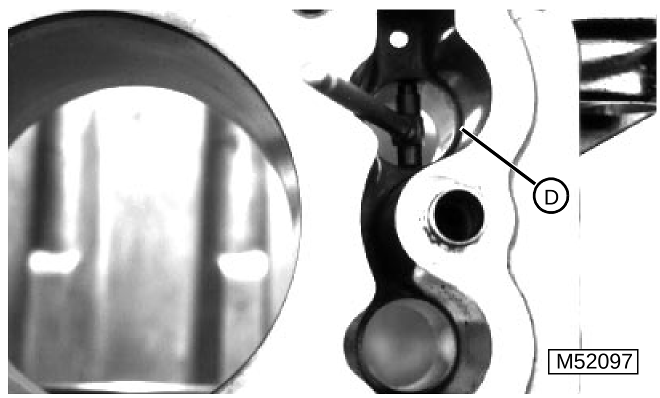
IMPORTANT: Damaged or worn lifters usually indicate a damaged camshaft. Check camshaft before replacing lifters. Always replace lifters when replacing camshaft.



1. Inspect lifter face (B) for wear. Face should be flat and smooth.
2. Use push rod to depress plunger (A). Plunger should offer resistance but move smoothly.
3. Check that oil hole (C) is clear to inner piston.
4. Measure outside diameter of lifter.
5. Replace lifters that are worn or damaged.



NOTE: When installing new lifters, make sure lifters are full of oil. Submerse lifters in oil. Use old push rod to depress lifter several times to purge air and fill with oil or force oil into lifter with oil can.

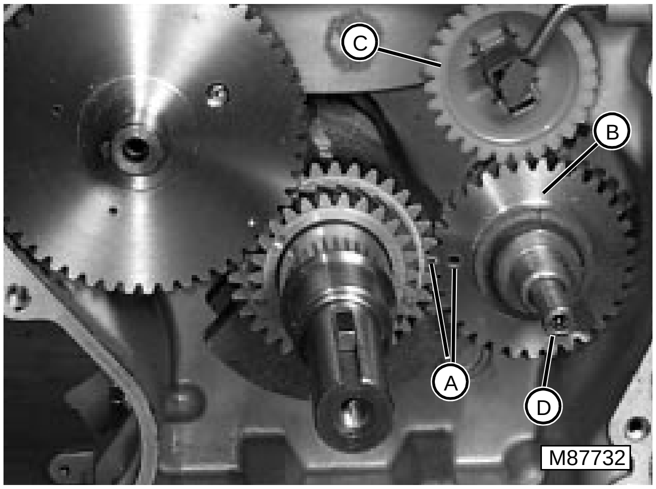


6. Measure inside diameter of crankcase lifter bore (D).
7. Subtract lifter OD from bore ID to determine if clearance is not within specification. Replace components as necessary.

Specification:

Valve Lifter To Bore Clearance (maximum)
. . . . 0.0124—0.05 mm (0.0005—0.002 in.)

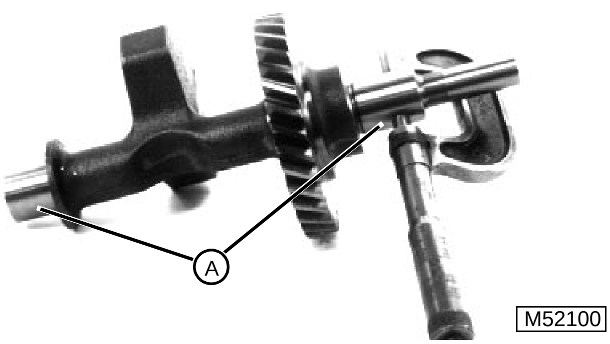
BALANCER SHAFT REMOVAL AND INSTALLATION



1. Align marks (A) on balancer shaft and crankshaft.
2. Remove balancer shaft (B).
3. Inspect balancer shaft, replace as necessary.
4. Align marks (A) and install balancer shaft (B) so it also aligns with governor gear (C).
5. Remember, when installing oil pan, be sure to align flat (D) of balancer shaft with bore flat of oil pump inner rotor gear.

IMPORTANT: If oil pan does not seat fully on block DO NOT force it down. STOP and find out why it does not seat properly.

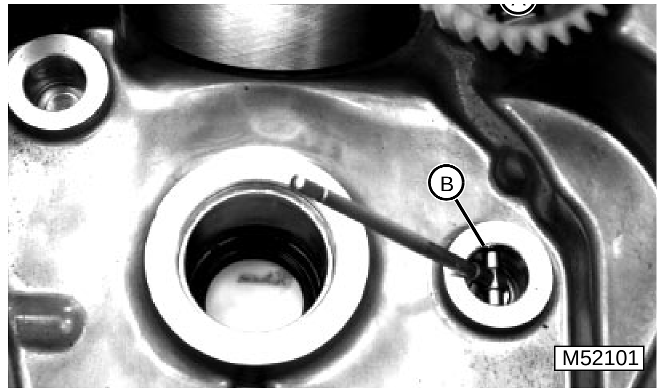
BALANCER SHAFT INSPECTION



1. Inspect shaft for cracks and broken teeth. Replace shaft if cracked or damaged.
2. Measure journals (A). Replace if not within specification.

Specification:

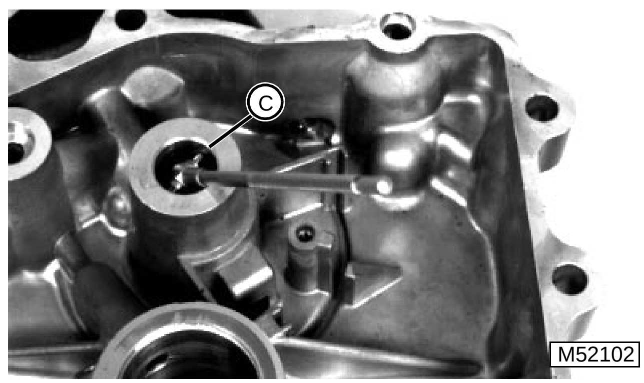
Balancer Shaft Journal OD (minimum)
. . . . . 19.959 mm (0.7858 in.)



3. Measure balancer shaft bore (B) in crankcase.
4. Subtract journal OD from bore ID to determine clearance with balancer shaft journal. Replace crankcase if measurements are not within specifications.

Specifications:

Balancer Shaft Bore ID (Crankcase) (maximum)
. . . . . 20.04 mm (0.789 in.)
Shaft to Crankcase Bore Clearance (maximum)
. . . . 0.03—0.06 mm (0.001—0.002 in.)



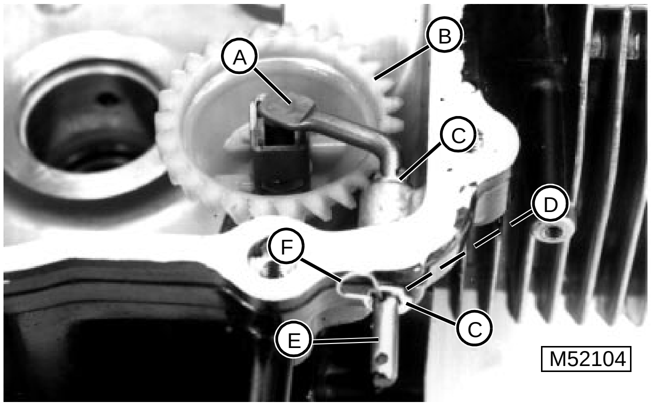
5. Measure balancer shaft bore (C) in oil pan.
6. Determine clearance with balancer shaft journal. Replace oil pan if measurements not within specifications.

Specifications:

Balancer Shaft Bore ID.—Oil Pan (maximum)
. . . . . 20.04 mm (0.789 in.)
Shaft to Bore Clearance—Oil Pan (maximum)
. . . . 0.03—0.06 mm (0.001—0.002 in.)

GOVERNOR REMOVAL AND INSTALLATION

NOTE: The plastic governor gear is held onto the governor gear shaft by small molded tabs in the gear. When the gear is removed from the shaft these tabs are destroyed. This will require replacement of the gear; therefore, remove the gear only if absolutely necessary (such as when boring, doing major engine rebuilding, etc.).



1. Remove governor lever (not shown) from end of control arm (E).
2. Remove spring clip (F), washers (C), and governor control arm (A) from inside of crankcase.
3. Remove and discard seal (D).

NOTE: DO NOT remove governor gear assembly unless replacing. Check governor shaft/gear assembly, if plastic gear, flyweight assembly, flyweight cap, and/or shaft are damaged, the complete assembly must be replaced.

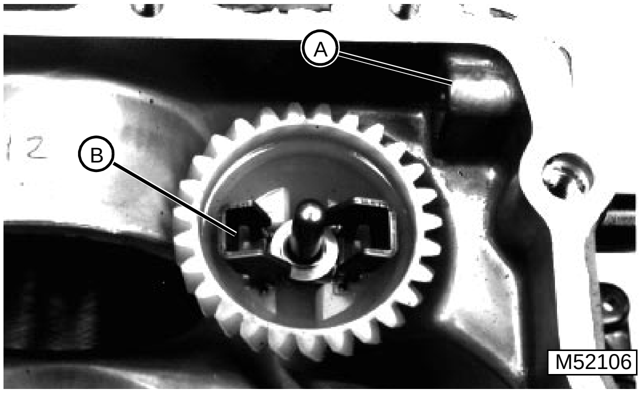
4. Inspect governor shaft/gear assembly (B), replace as necessary. See "GOVERNOR CONTROL ARM AND SHAFT/GEAR ASSEMBLY INSPECTION" on page 55.
5. Install governor shaft/gear assembly.
6. Install new seal (D) using suitable driver.
7. Install control arm, washers, and clip.
8. Install lever (not shown).

GOVERNOR CONTROL ARM AND SHAFT/GEAR ASSEMBLY INSPECTION

1. Measure outside diameter of control arm shaft. Replace if not within specification.

Specification:

Governor Control Arm Diameter (minimum)
. . . . . 5.96 mm (0.235 in.)



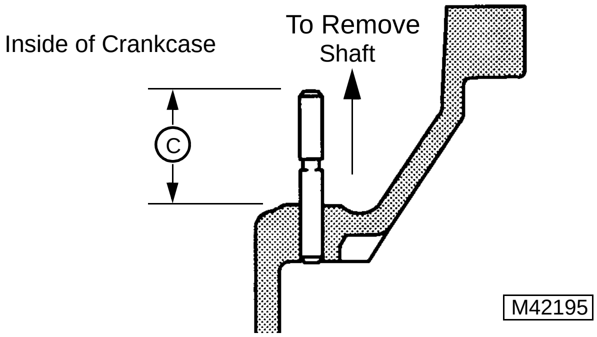
2. Measure inside diameter of crankcase bore (A).
3. Determine governor control arm shaft-to- bore clearance. Replace governor shaft/gear assembly as necessary.

Specification:

Shaft to Bore Clearance (maximum)
. . . . . 0.05 mm (0.002 in.)

4. Inspect flyweights (B) for proper operation and free movement. Replace governor shaft/gear assembly as necessary.

IMPORTANT: DO NOT remove governor shaft with vise-grips or pliers, damage to case may result.



5. With a small punch, CAREFULLY drive governor shaft toward inside of crankcase to remove it.
6. From inside of crankcase, install new governor shaft/gear assembly by pressing or lightly tapping shaft into crankcase bore to specified height (C).

Specifications:

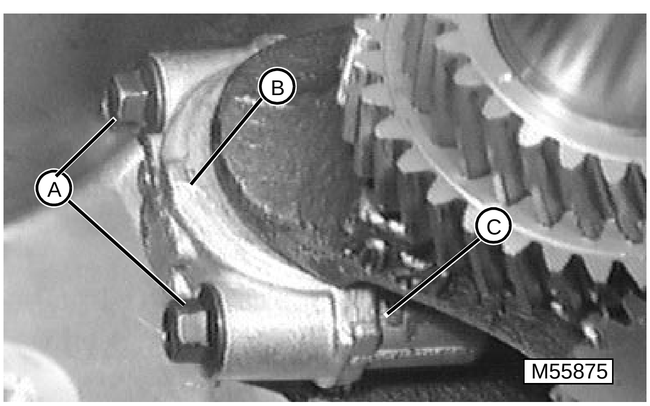
Governor shaft height (C)
. . . . 32.639—32.842 mm (1.285—1.293 in.)
Governor Shaft Diameter (minimum)
. . . . 5.99—6.0 mm (0.2358—0.2362 in.)

PISTON REMOVAL

1. Remove balance shaft, and camshaft.

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.

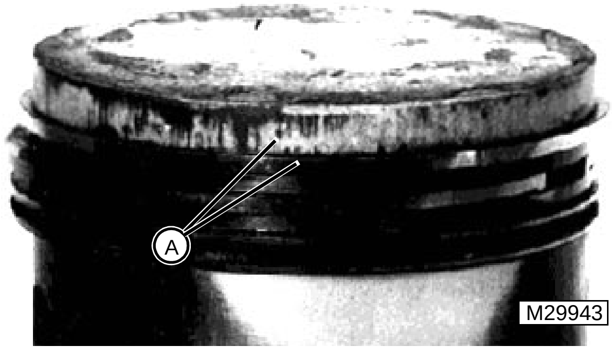


3. Remove cap screws (A) to remove cap (B) from connecting rod (C).
4. Remove piston assembly through top of cylinder.
5. Inspect piston assembly, see following two topics.

PISTON RING WEAR ANALYZE

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

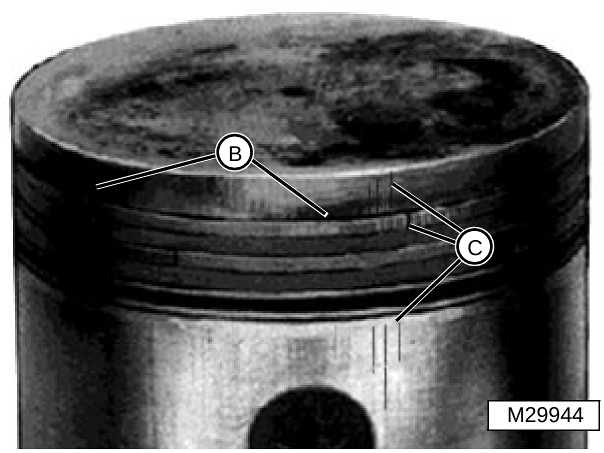
Ring end gaps should be staggered on the piston during installation. End gaps in alignment can also cause oil consumption and blowby.



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

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

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



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

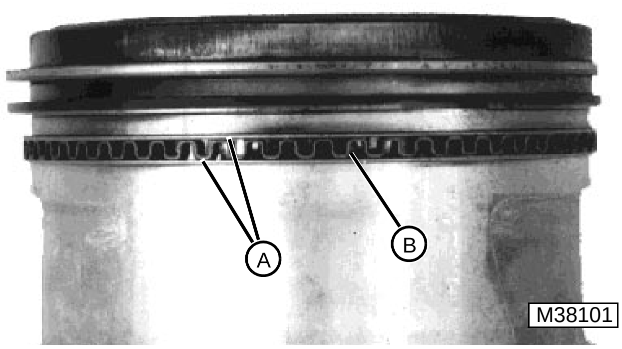
Engine overheating and ring sticking is usually caused by one or more of the following:

1. Overloading.
2. Incorrect ignition timing.
3. Lean fuel mixture.
4. Dirty cooling fins.
5. Incorrect oil.
6. Low oil supply.
7. Stale fuel.

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

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

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

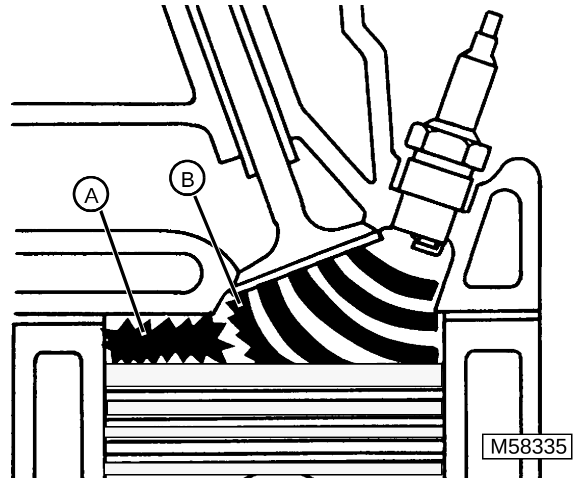


Abrasive particles in engine oil cause scratches on side rails (A) of oil control ring. If inner spacer (B) of oil control ring is worn or distorted it may cause:

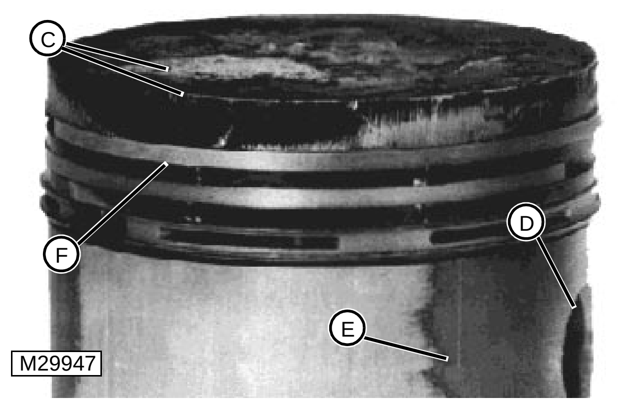
• Increased or high oil consumption.
• Increased deposits in combustion chamber.
• Sticking compression rings.

PISTON WEAR ANALYZE

DETONATION—



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



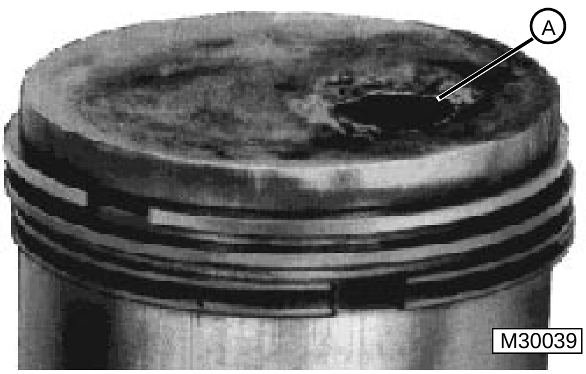
This detonation shockwave (“hammering”) of the piston inside the cylinder causes damage to piston crown (C), top ring and groove (F), piston side skirts (E), and pin locks (D).

The following is a list of possible causes for detonation:

1. Lean fuel mixture.
2. Low octane fuel.
3. Advanced ignition timing.
4. Engine lugging.
5. Buildup of carbon deposits on piston or cylinder head, causing excessive compression.

6. Wrong cylinder head or excessive milling of head increasing compression ratio.

PRE-IGNITION—

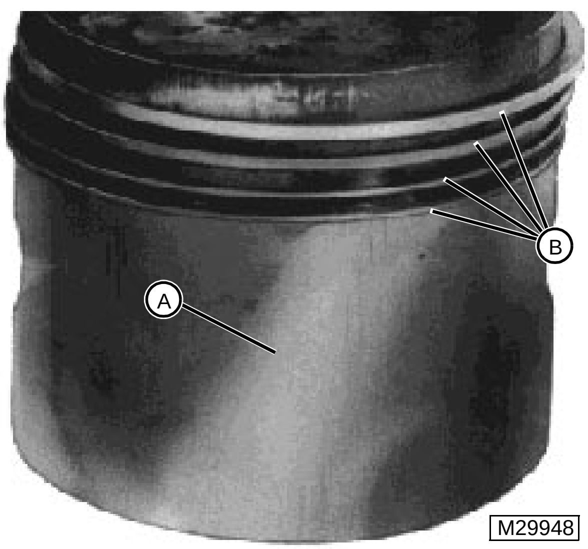


Pre-ignition is the igniting of the fuel-air mixture prior to proper ignition spark. Pre-ignition causes internal shock, resulting in pings, vibration, and power loss. Severe damage is caused to the piston crown (A), rings, and valves results from pre-ignition.

Check the following for causes of pre-ignition:

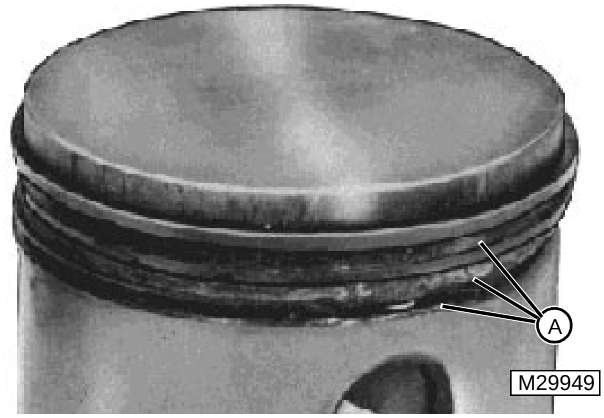
1. Hot internal carbon deposits.
2. Incorrect spark plug (high heat range).
3. Broken ceramic insulation of spark plug.
4. Hot sharp edges on valves.

IMPROPER ROD AND PISTON ALIGNMENT—



Check rod and piston alignment when piston shows a diagonal wear pattern (A) 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 (B).

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:

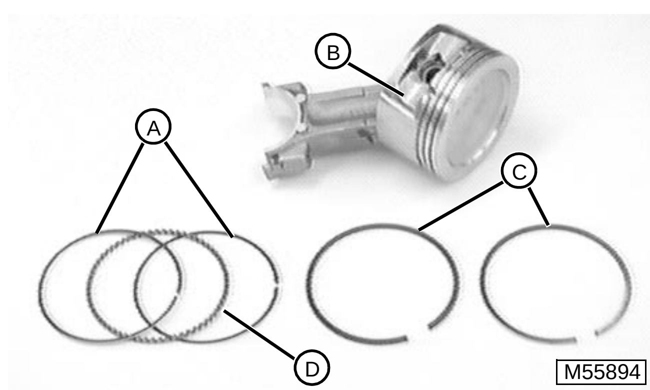
1. Rapid and uneven piston ring wear.
2. Rapid and uneven piston wear.
3. Loose or broken piston pin retaining rings.
4. Excessive oil consumption.

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

1. Rod misalignment.
2. Excessive crankshaft end play.
3. Crankshaft journal taper.
4. Weak piston pin retaining rings.
5. Incorrectly installed piston pin retaining rings.

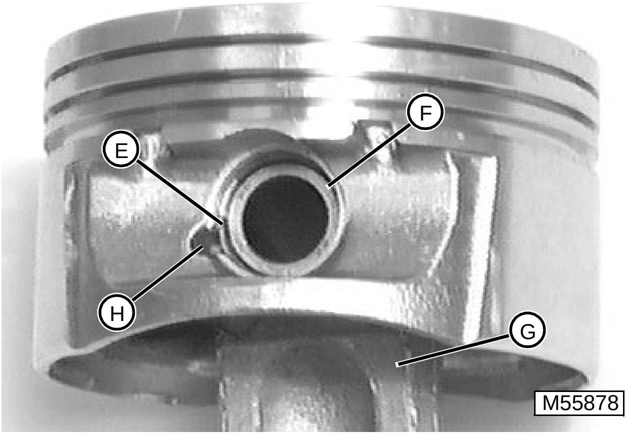
Inertia can also cause a broken piston pin retaining ring to beat out the piston and cylinder, causing extensive damage.

PISTON DISASSEMBLE



1. Remove compression rings (C) from piston (B) using ring expander.
2. Remove rails (A).

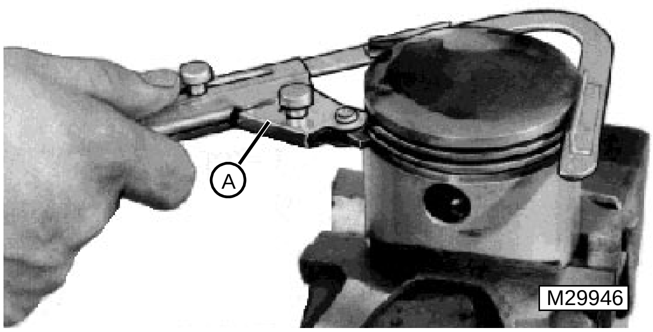
3. Remove spacer (D).



4. Remove retaining rings (E) by prying at indent (H).
5. Use wooden dowel to remove pin (F) from piston and connecting rod (G).
6. Inspect parts.

PISTON INSPECTION

1. Carefully remove piston rings.



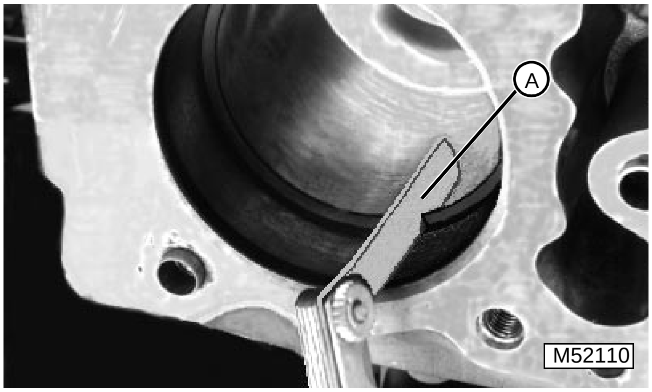
IMPORTANT: Do not use caustic cleaners or wire brush to clean aluminum piston. Piston damage can result.

2. Clean piston. Inspect for scoring or fractures.
3. Clean carbon from grooves using ring groove tool (A).

PISTON RING END GAP

IMPORTANT: If new rings are to be installed, deglaze cylinder so rings will seat properly. (See Deglaze Cylinder Bore, later in this section.)

1. Use a clean or new piston to push piston compression ring squarely into bore, to a point where it normally runs.

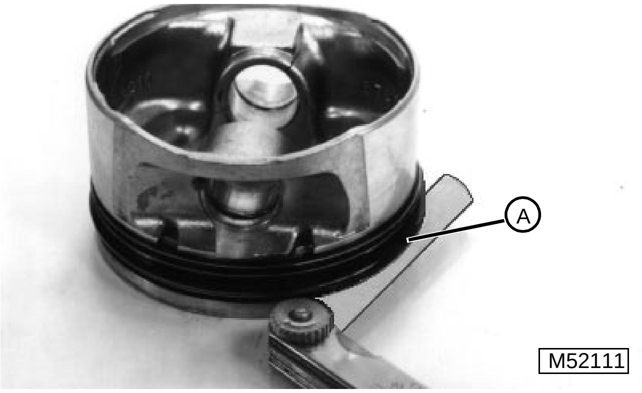


2. Measure end gap (A).
3. Remove ring and file ends squarely until gap meets specification. Rings with too large a gap must be replaced. If one piston ring needs to be replaced, all must be replaced as a set.

Specifications:

Piston Ring End Gap (standard)
. . . . 0.3—0.5 mm (0.012—0.020 in.)
Piston Ring End Gap (maximum)
. . . . . 0.77 mm (0.030 in.)

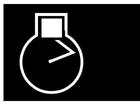
PISTON RING SIDE CLEARANCE



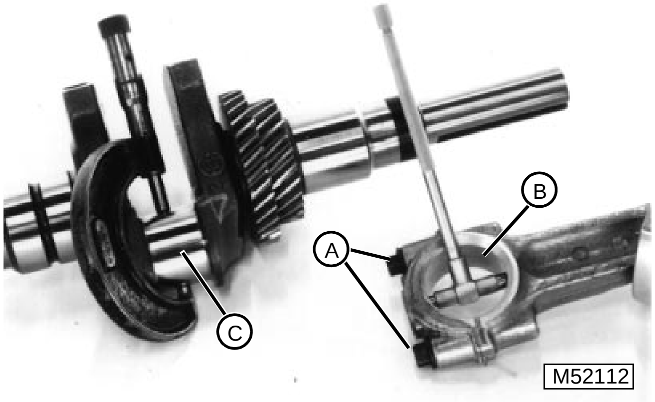
1. Measure piston ring side clearance (A) as shown at several points around piston.
2. Replace piston if measurements exceed clearance specifications.

Specifications:

Top Compression Ring
. . . . 0.040—0.105 mm (0.002—0.004 in.)
Bottom Compression Ring
. . . . 0.040—0.072 mm (0.002—0.003 in.)
Oil Control Ring
. . . . 0.551—0.675 mm (0.022—0.027 in.)



PISTON MEASUREMENT



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

1. Tighten cap screws (A) to specification.
2. Measure inside diameter of connecting rod (B).
3. Measure outside diameter of crankshaft journal (C).
4. Determine connecting rod-to-crankshaft clearance.

Replace parts that are not within specifications.

Specifications:

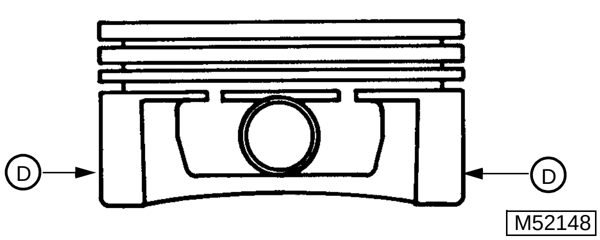
CrankshaftConnectingRodJournalOutsideDiameter
38.96—38.97 mm (1.5338—1.5342 in.)
Maximum Wear Limit . . . . . . 38.94 mm (1.533 in.)
Taper (maximum) . . . . 0.012 mm (0.0005 in.)
Out-Of-Round . . . . 0.03 mm (0.001 in.)

Clearance to Connecting Rod
. . . . 0.030—0.055 mm (0.001—0.0025 in.)
Maximum Wear Clearance. . . . (0.07 mm (0.0025)

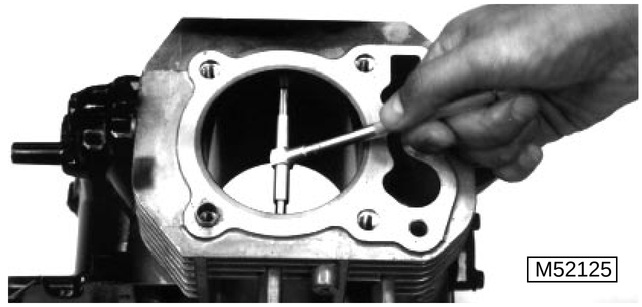
Piston Pin end ID.
. . . . 19.015—19.023 mm (0.7486—0.7489 in.)
Maximum Wear . . . . 19.036 mm (0.7495 in.)

Piston Pin OD.
. . . . 18.995—19.00 mm (0.7478—0.7480 in.)
Maximum Wear . . . . 18.994 mm (0.7477 in.)

Connecting Rod Cap Screws
. . . . . 22.6 N•m (200 lb-in.)



5. Measure diameter of piston at point (D). Point (D) is 6 mm (0.25 in.) from skirt bottom and perpendicular to piston pin.



6. Measure cylinder bore.
7. Replace piston and/or rebore cylinder block if not within specifications.

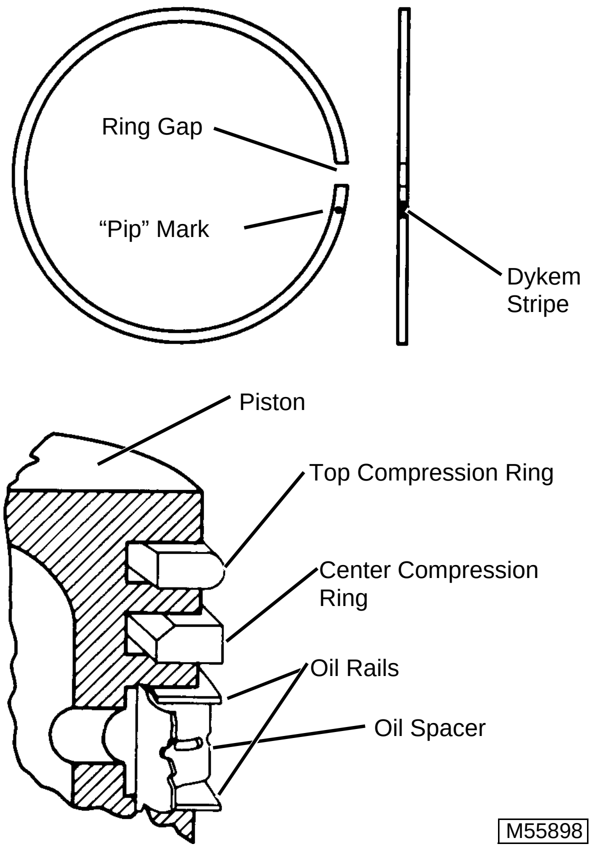
Specifications:

Piston to Cylinder Bore Clearance
(maximum) . . . . 0.20 mm (0.008 in.)

Piston Pin Bore ID.
. . . . 19.006—19.012 mm (0.7483—0.7485 in.)
(maximum wear . . . . 19.025 mm (0.749 in.)

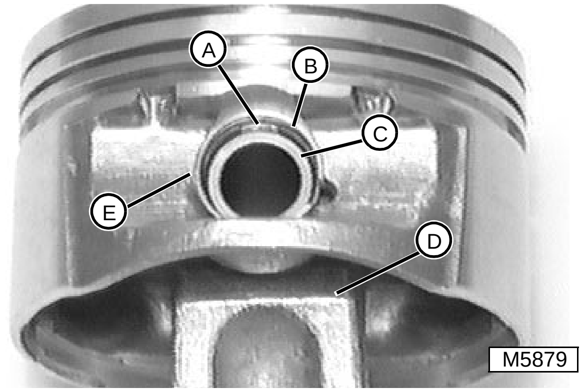
PISTON ASSEMBLY

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 stripe to left of ring gap.
- Install oil ring spacer first. Make sure that its ends do not overlap.
- Stagger end gaps of oil rails 180° apart.
- Rings should turn freely in grooves.

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

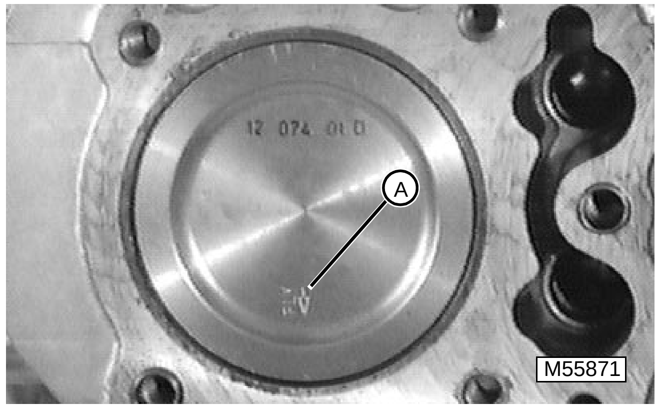


IMPORTANT: Retaining rings (B) should be installed with end gap (A) pointing up.

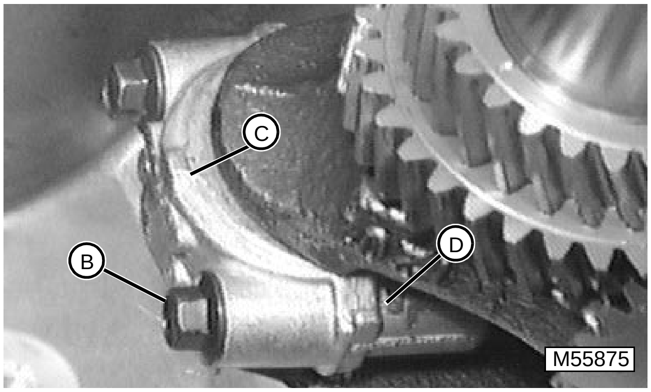
2. Install one piston pin retaining ring (B) in groove of piston bore (E).
3. Install pin (C) through piston bore (E) and connecting rod (D). Pin should install easily with thumb pressure.
4. Install remaining retaining ring (B) in opposite side.

PISTON INSTALLATION

1. Install piston rings so piston ring end gaps are staggered 120° apart.
2. Compress rings with ring compressor tool.
3. Coat cylinder, piston skirt, rod, and cap bearing surfaces with oil.



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



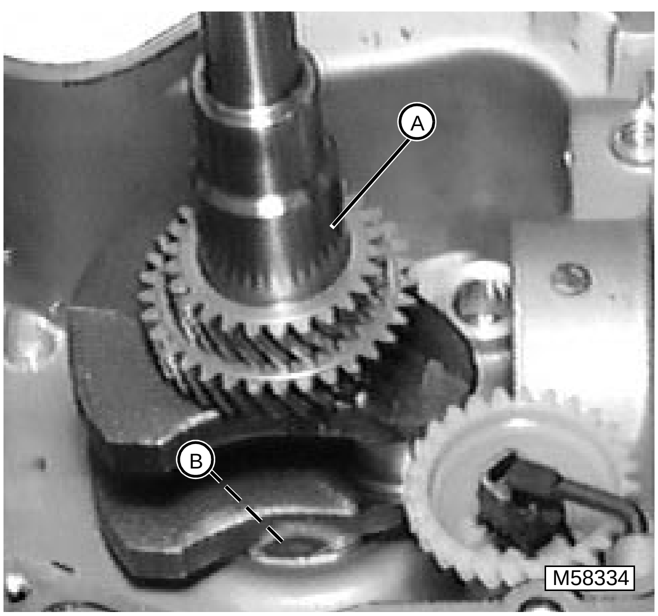
5. Fasten connecting rod (D) and cap (C) to crankshaft.
6. Tighten cap screws (B) to specification.
7. Check connecting rod to crankshaft side clearance. Replace if not within specification.
8. Install balance shaft, camshaft, oil pan, and cylinder head. See appropriate procedures in this section.

Specifications:

Connecting Rod Cap Screw Torque
. . . . . 11.3 N•m (100 lb-in.)
Connecting Rod Side Clearance
. . . . 0.18—0.41 mm (0.007—0.016 in.)

CRANKSHAFT REMOVAL AND INSTALLATION

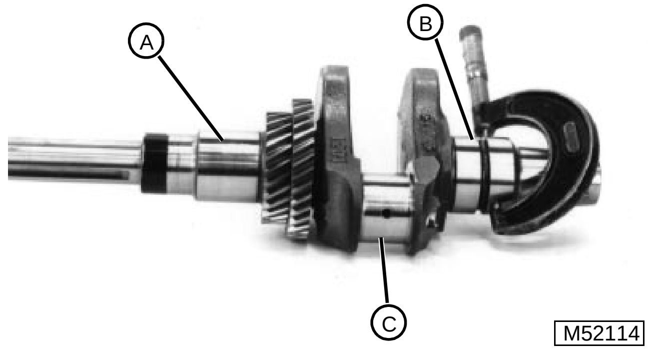
1. Remove camshaft and balancer assemblies.



2. Remove and inspect crankshaft (A).
3. Install new seals (B) in crankcase and oil pan.
4. Install crankshaft carefully, DO NOT damage seals.

CRANKSHAFT AND MAIN BEARINGS INSPECTION

1. Inspect for cracks or chipped teeth.

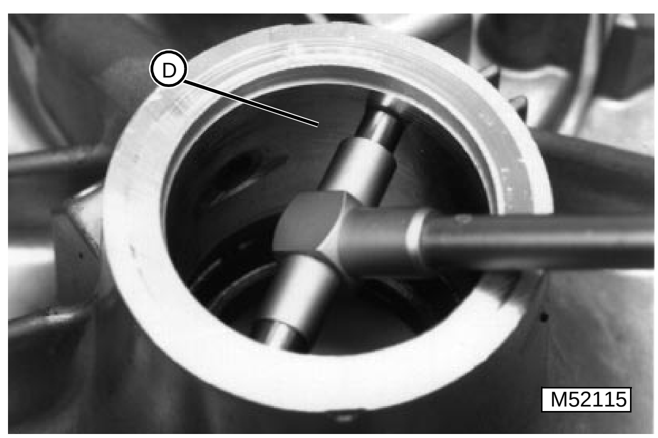


2. Check crankshaft alignment. See “CRANKSHAFT ALIGNMENT” on page 63.
3. Measure journals (A), (B), and (C).

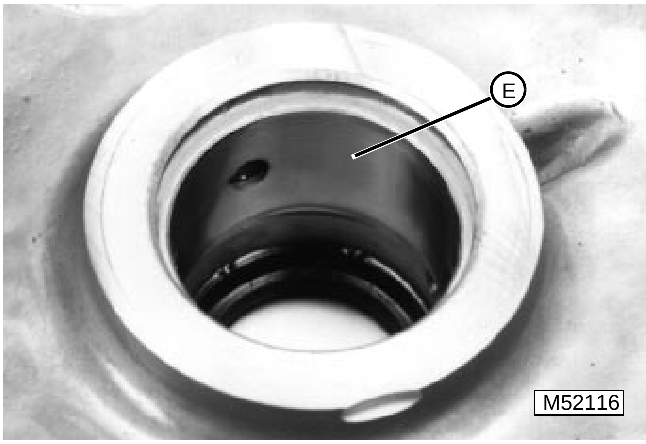
Replace crankshaft if bent, damaged, or not within specifications.

Specifications:

(A) Crankshaft Bearing Journal OD (Oil Pan End)
. . . . 41.92—41.94 mm (1.650—1.651 in.)
Taper (maximum) . . . . 0.020 mm (0.0007 in.)
Out-of-Round (maximum) . . 0.025 mm (0.001 in.)
(B) Crankshaft Bearing Journal OD (Flywheel End)
. . . . 41.913—41.935 m (1.7682—1.7691 in.)
Taper (maximum) . . . . 0.022 mm (0.0009 in.)
Out-of-Round (maximum) . . 0.025 mm (0.001 in.)
(C) Crankshaft Connecting Rod Journal OD . . . . . .
. . . . 38.97—38.96 mm (1.5342—1.5337 in.)
Taper (maximum) . . . . 0.012 mm (0.0004 in.)
Out-of-Round (maximum) . . . 0.03 mm (0.001 in.)



4. Measure inside diameter of crankshaft main bearing bore (D) in oil pan.



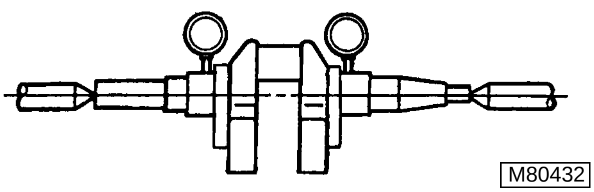
5. Measure inside diameter of crankshaft main bearing bore (E) in crankcase.
6. Subtract journal OD from bore ID to determine if clearance is within specifications. Replace parts if not within specifications.

Specifications:

Crankshaft Main Bearing Bore ID For Oil Pan and Crankcase 47.98—48.03 mm (1.889—1.891 in.)

Main Bearing Bore-to-Crankshaft Clearance. 0.03—0.09 mm (0.001—0.004 in.)

CRANKSHAFT ALIGNMENT



In alignment jig:

- Rotate crankshaft slowly. Dial indicators (A) measure maximum Total Indicated Runout (TIR).

In engine:

- Rotate crankshaft slowly. Measure TIR at oil pan end of crankshaft using dial indicator.

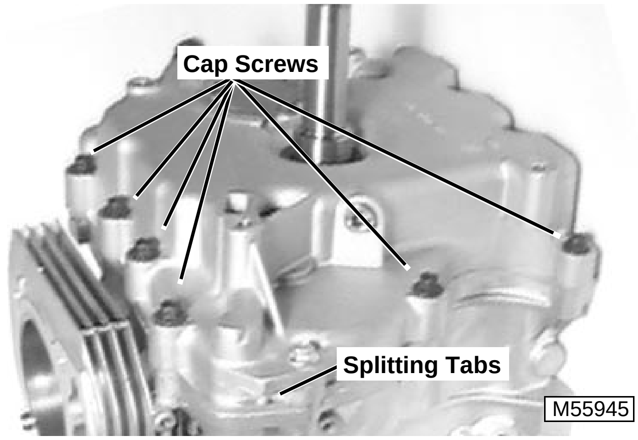
Replace crankshaft if not within specification.

Specifications:

Crankshaft Maximum TIR
In Alignment Jig . . . . 0.10 mm (0.004 in.)
In Engine . . . . 0.15 mm (0.006 in.)

OIL PAN REMOVAL AND INSTALLATION

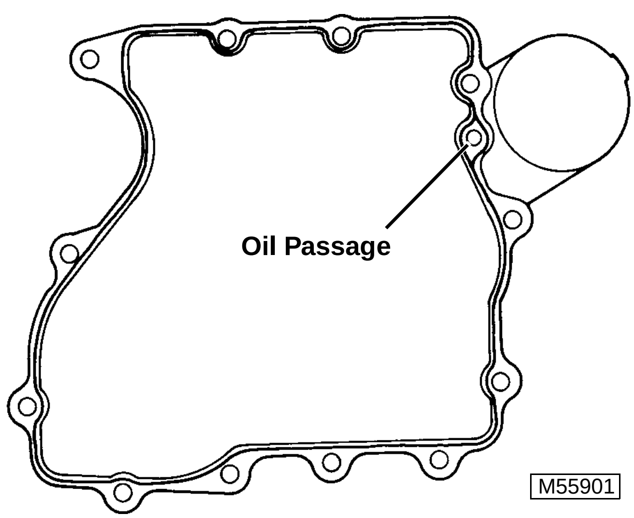
Removal:



IMPORTANT: Do not pry on gasket surface when removing oil pan from crankcase.

1. Remove 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 CRANKSHAFT SEAL REMOVAL AND INSTALLATION” on page 64. See “CRANKSHAFT OIL SEAL REMOVAL AND INSTALLATION” on page 65.

Installation:



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

1. Apply 1.6 mm (1/16 in.) bead of RTV silicone sealant to oil pan flange. DO NOT block oil passage.
2. Apply grease to inside lip of crankshaft main bearing seal.

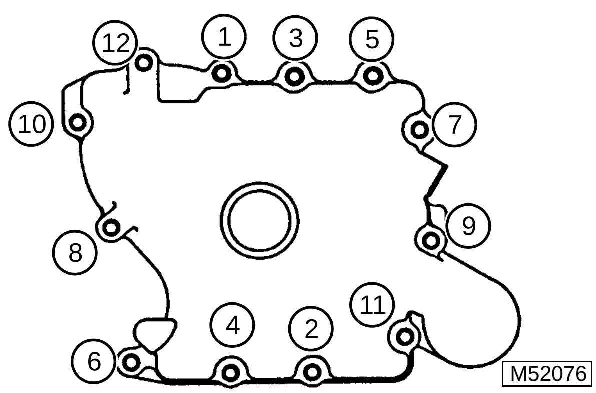
IMPORTANT: Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pan.

NOTE: Removal of oil pump before installing oil pan will make installation of oil pan easier. *See “OIL PUMP REMOVAL AND INSTALLATION” on page 66.*

3. Install oil pan over crankshaft carefully to avoid damaging crankshaft bearing seal.

IMPORTANT: If oil pan does not seat fully on block DO NOT force it down. STOP and find out why it does not seat properly.

4. Install oil pan onto crankcase.

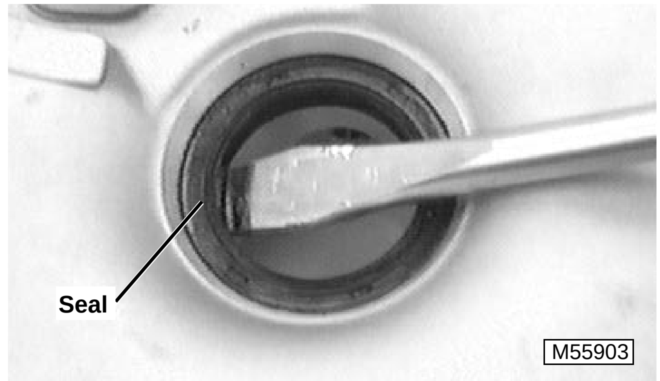


5. In sequence shown, tighten oil pan cap screws to specification.

Specification:

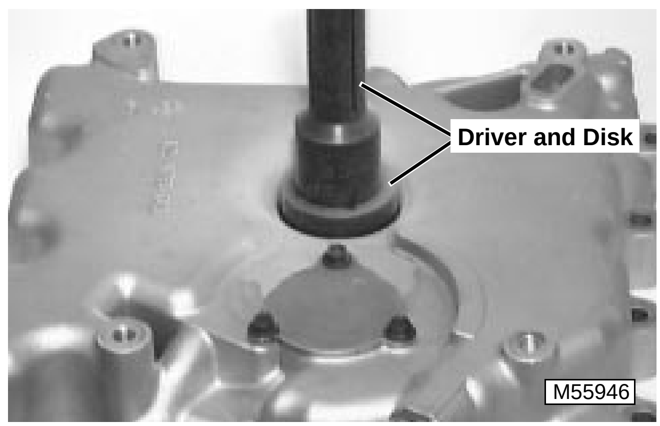
Oil Pan Cap Screws . . . . 24 N•m (216 lb-in.).

OIL PAN CRANKSHAFT SEAL REMOVAL AND INSTALLATION



IMPORTANT: DO NOT damage seal 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 OD of seal.



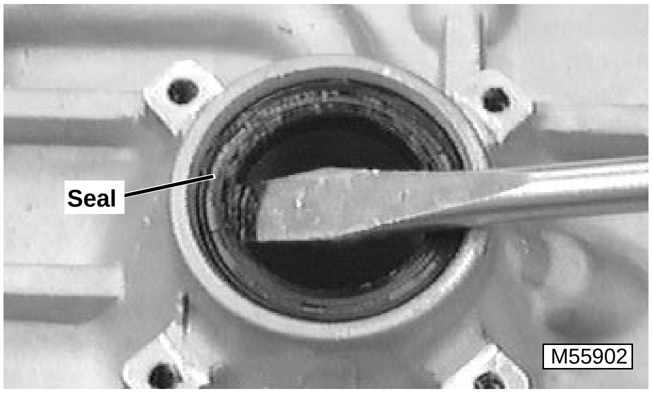
3. Using a suitable driver and disc, install new oil seal to specification.

Specification:

Oil Pan Seal Depth

. . . . 2.49—2.98 mm (0.098—0.117 in.) or until its top surface is flush with machined bore opening.

CRANKSHAFT OIL SEAL REMOVAL AND INSTALLATION



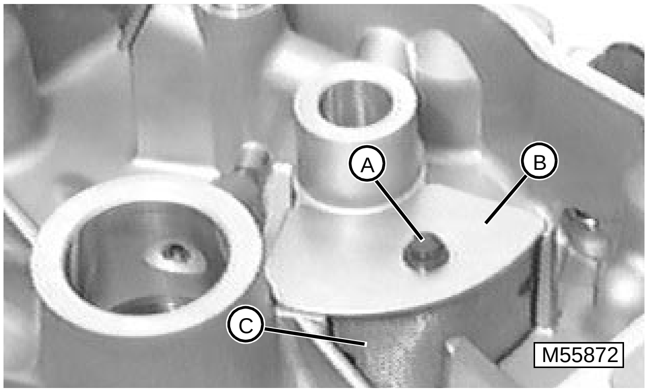
IMPORTANT: DO NOT damage crankcase seal bore when removing seal.

1. Remove and discard crankcase seal.
2. When replacing crankshaft seal, apply a thin film of LOCTITE® 598 or equivalent to the OD of seal.
3. Using a suitable driver and disc, install new oil seal to specification.

Specification:

Crankcase Seal Depth
. . . . . 4.0 mm (0.157 in.)
or until its top surface is flush with machined bore opening.

OIL PICKUP INSPECTION

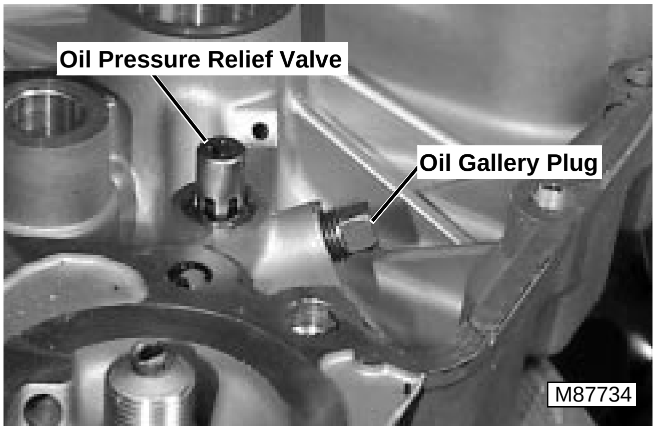


1. Remove cap screw (A) and plate (B) to remove pickup screen (C).
2. Clean screen with approved solvent. Replace if damaged.
3. Install screen, plate, and cap screw.

OIL PRESSURE RELIEF VALVE REMOVAL AND INSTALLATION

NOTE: There are no serviceable components in the oil pressure relief valve (A). Entire valve assembly must be replaced if it test bad. See "OIL PRESSURE TEST" on page 33.

IMPORTANT: If pressure relief valve (A) is remove a new valve must be installed. DO NOT reinstall old valve.

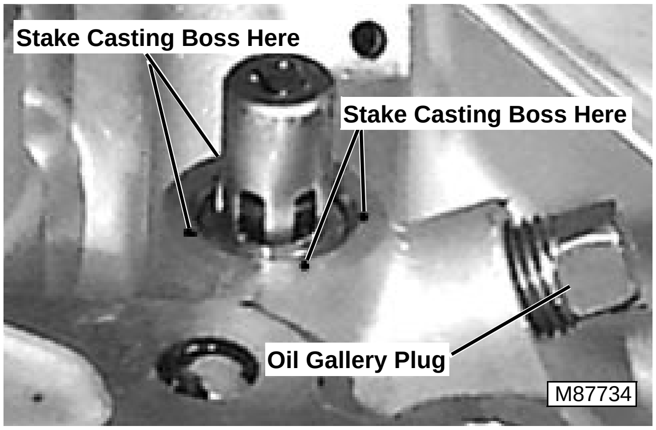


1. Remove Oil Pan. See "OIL PAN REMOVAL AND INSTALLATION" on page 63.
2. Using 1/2" deep socket with an extension, or 1/2" I.D. metal tubing, slid over relief valve carefully remove valve by rocking valve out of pocket.
3. Remove oil gallery plug.
4. Inspect and clean the oil pressure relief valve pocket and oil galley as required.

IMPORTANT: Oil pressure relief valve is constructed of very thin material. DO NOT use excessive force when installing valve or casing may distort and valve will not work correctly.

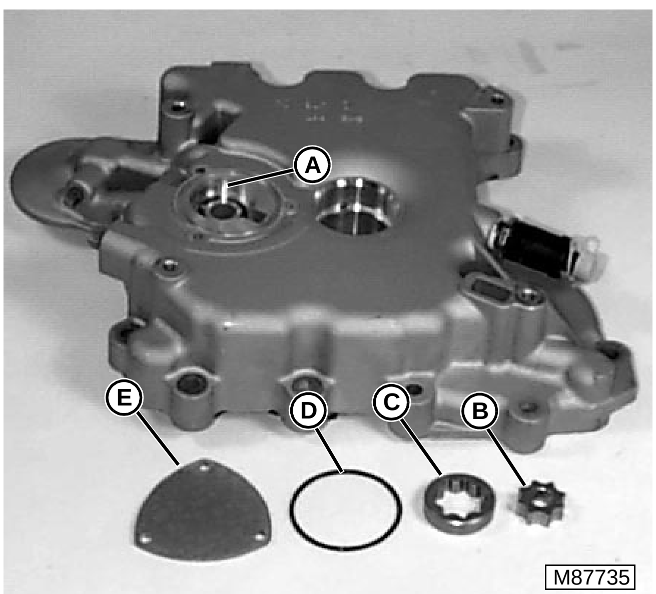
IMPORTANT: DO NOT use Locktite®, liquid gasket, or Silicone sealant (RTV) when installing valve. If valve is not a press fit in pocket, replace oil pan.

5. Install new valve using a piece of thin wall metal tubing or deep socket with slightly smaller O.D. than oil pressure relief valve base, press or tap valve into oil pressure relief valve pocket until it bottoms.



6. Stake the casting boss with a center punch in 3 or 4 locations near the inner edge of the oil pressure relief valve pocket to lock the oil pressure relief valve in place.
7. Reinstall oil gallery plug.
8. Reinstall Oil Pan. See “OIL PAN REMOVAL AND INSTALLATION” on page 63.

OIL PUMP REMOVAL AND INSTALLATION



1. Remove cover (E), O-ring (D), pump outer rotor (C), and pump inner rotor (B).
2. Inspect rotor, pump, and inside surface of cavity (A) for scoring, discoloration, and wear.
3. Replace parts as necessary.
4. Lubricate parts (A, B, and C) with engine oil. Install in cavity.

IMPORTANT: Be sure to align flats of balancer shaft and oil pump inner rotor when installing oil pump.

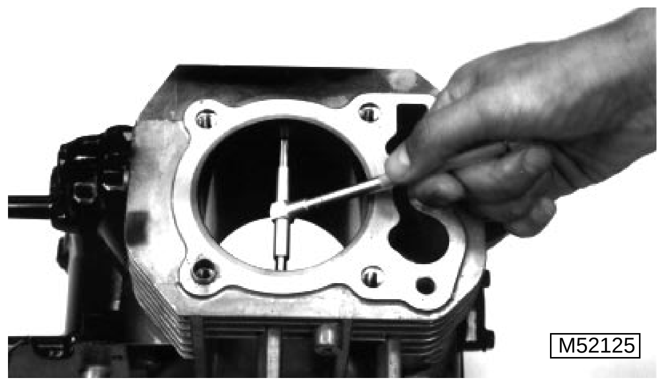
5. Install O-ring and cover. Tighten cap screws to specification.

Specification:

Pump Cover Cap Screws. . . . . 0.076 mm (0.003 in.)

BLOCK INSPECTION

1. Clean and check block for cracks.
2. 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.
3. 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.
4. 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.

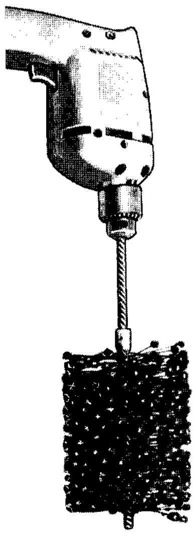
Specifications:

Piston Thrust Face to Cylinder Bore
Clearance (maximum) . . . . . . 0.21 mm (0.008 in.)
Clearance (standard)
. . . . 0.041—0.044 mm(0.0016—0.0017 in.)
Cylinder Bore Inside Diameter
New . . . . 87.0—87.03 mm (3.425—3.426 in.)
Used (maximum) . . . . 87.06 mm (3.428 in.)
Out-of-Round (maximum) . . . 0.12 mm (0.005 in.)
Taper (maximum) . . . . 0.05 mm (0.002 in.)

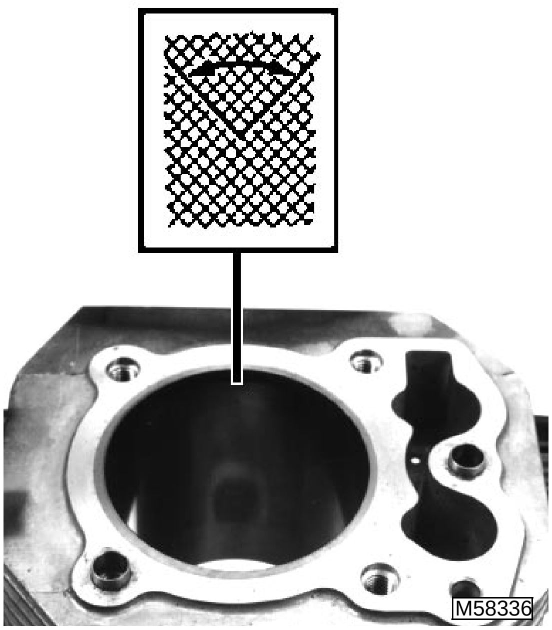
CYLINDER BORE DEGLAZE

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



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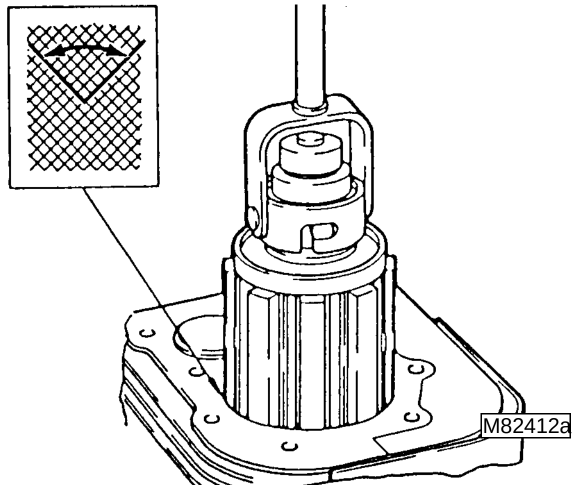
2. Deglaze cylinder bore using flex-hone to obtain 23—33° crosshatch pattern.
3. Clean abrasive residue from cylinder using warm soapy water until clean white rags show no discoloration.
4. Dry cylinder and apply engine oil.

Specification:

Deglaze Crosshatch Pattern . . . . 23—33°

CYLINDER BLOCK REBORE

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



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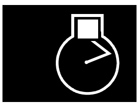
NOTE: The cylinder block can only be rebored to use 0.25 and 0.50 mm (0.010 and 0.020 in.) oversize pistons and rings.

1. Align center of bore to drill press center.
2. Adjust hone so lower end is even with lower end of cylinder bore.
3. Adjust coarse hone stones until they contact narrowest point of cylinder.
4. Coat cylinder with honing oil. Hone should turn by hand. Adjust if too tight.
5. Run drill press at 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 finish stones (200—300 grit) to final size.
10. Allow cylinder to cool completely; then, measure for new piston-to-cylinder bore running clearance, taper, and out-of-round.

IMPORTANT: Do not use solvents to clean cylinder bore. Solvents will not remove metal particles produced during honing.

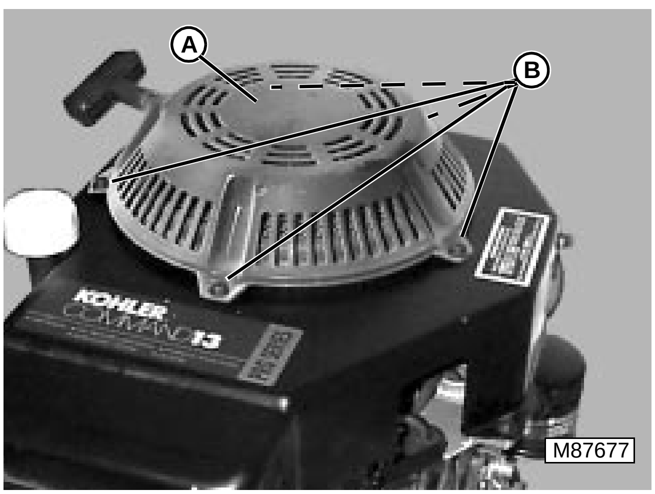


11. Clean cylinder thoroughly using warm soapy water until clean white cloths show no discoloration.
12. Dry cylinder completely and apply thin coat of engine oil to appropriate mating surfaces.

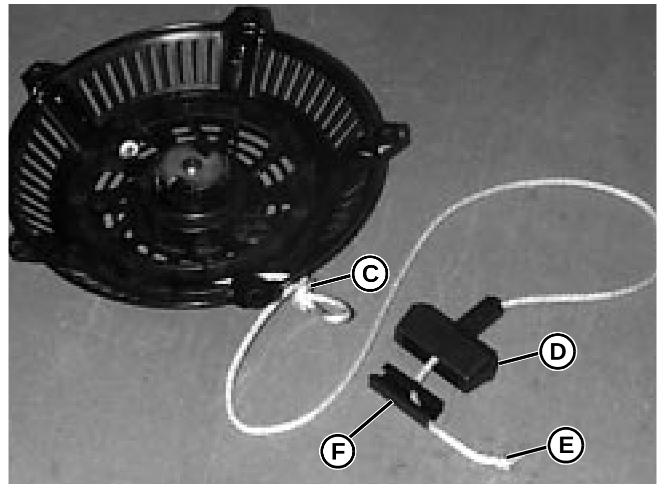
Specifications:

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 200—300 grit finishing stones bore to desired size

RECOIL STARTER DISASSEMBLY



1. Remove five (5) screws (B) securing recoil starter (A) to blower housing. Remove recoil starter assembly.



2. Pull handle out about 30 cm (1 ft.). Tie knot (C) to prevent rope from winding back onto reel.
3. Pry metal clip (F) out of handle (D) and untie or cut knot (E) off handle end of rope. Remove metal clip and handle from rope.

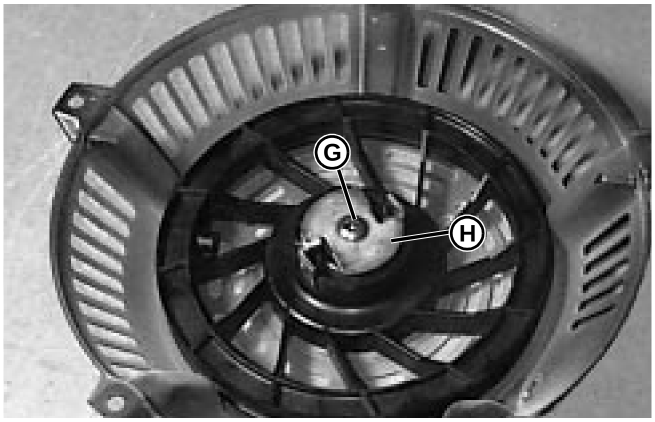
CAUTION

Spring is wound under great tension in reel or spring case. DO NOT let spring fly loose! Hold spring firmly in place while replacing.

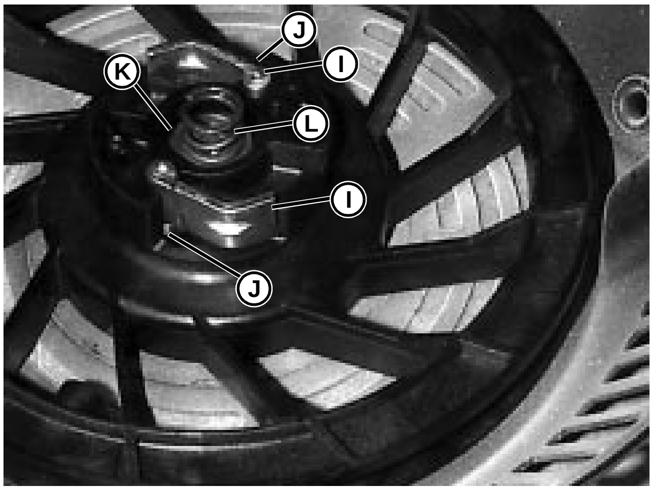
Spring edges may be rough and sharp! Wear gloves and protective goggles for remaining steps

4. Turn the reel clockwise until **NO** spring tension can be felt.
5. While holding reel with thumb, untie knot (C). Slowly allow reel to rotate to release spring tension. Do not let rope get wedged between reel and housing.

NOTE: Carefully note location of washers (K), two (2), and spring (L) under pawl retainer when removing screw (G).



6. Remove screw (G) and pawl retainer (H).

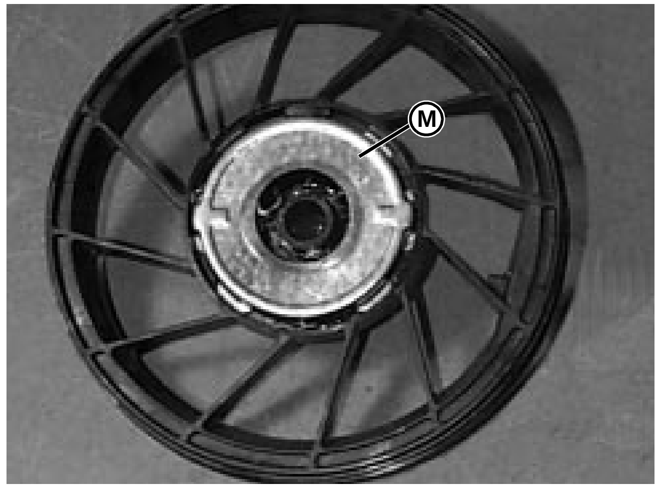


7. Remove pawls (I) and pawl springs (J).

⚠ CAUTION

Spring is still under great pressure inside case. Use care to avoid personal injury.

8. While supporting reel with one hand turn housing, and reel, over (right side up) and remove reel, with spring housing.



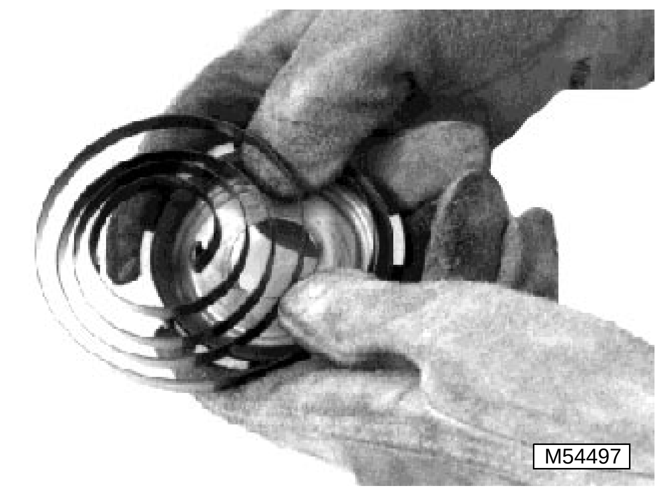
9. Carefully remove spring case (M) from reel.
10. Inspect and replace all damaged or worn parts.

RECOIL STARTER SPRING REPLACEMENT

⚠ CAUTION

Spring is wound under great tension in reel or spring case. DO NOT let spring fly loose! Hold spring firmly in place while replacing.

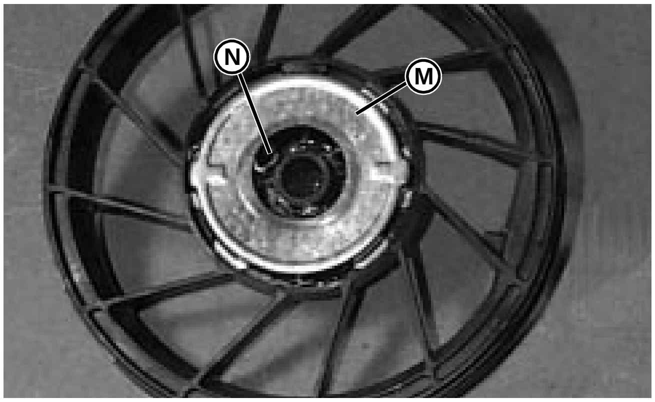
Spring edges may be rough and sharp! Wear gloves and protective goggles for remaining steps



1. Working from the center out, carefully unwind spring from spring case or reel.
2. Hook outside spring tang in reel or case. Wind spring into reel or spring case, working toward center.

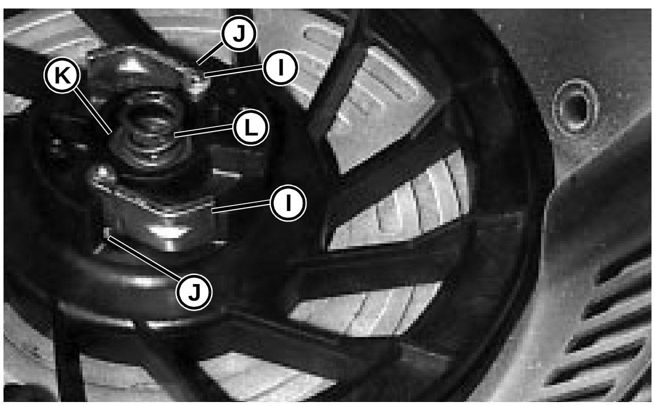
RECOIL STARTER ASSEMBLY

NOTE: Refer to “RECOIL STARTER COMPONENT LOCATION” on page 13 for general component location.

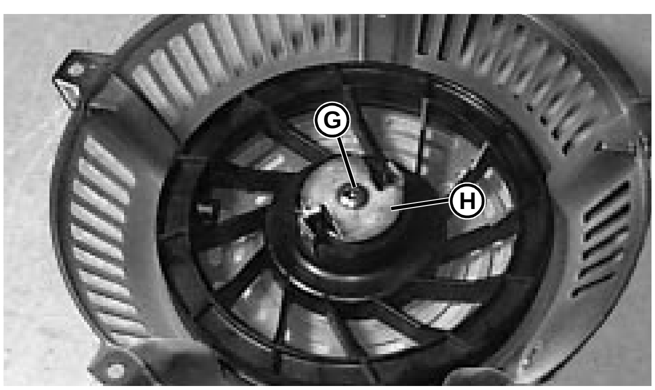


1. Place spring housing (M) into reel with spring tang (N) over reel center hub.
2. Place recoil housing starter on reel, turn upside down and turn reel counterclockwise until drops down on hub and you feel spring tang (N) hook on catch.

.



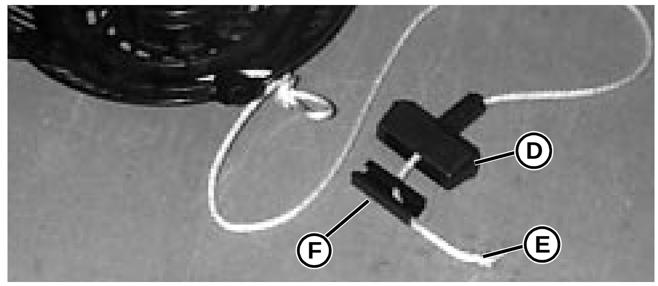
3. Assemble pawl springs (J) and pawls (I) in reel making sure springs hold pawls towards center of reel.
4. place washer (K) with small hole in recess in reel followed by spring (L) and washer with large hole.



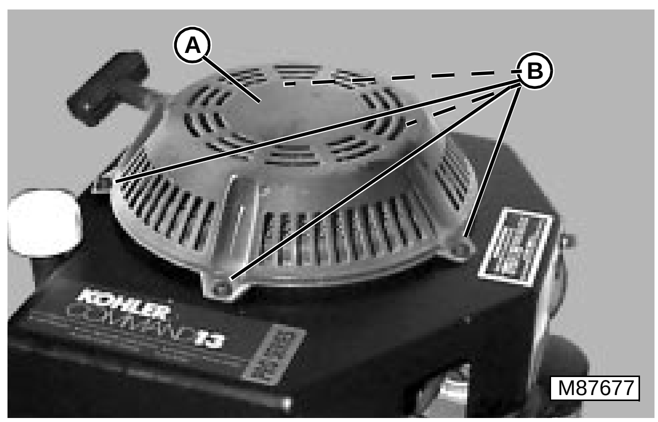
5. Place pawl retainer (H), with tabs to the inside of the pawls, and secure with screw (G).

IMPORTANT: Rotate reel back and forth approximately 1/4 turn to make sure reel rotates freely and both pawls extend when reel is rotated counterclockwise and retract when reel is rotated clockwise.

6. Turn reel approximately six turns counterclockwise to pre-load spring.
7. Turn reel clockwise slightly until rope holes in reel and housing line up.



8. Have assistant install handle (D), (E), (F), on one end of starter rope and thread other end of starter rope through hole in housing and hole in reel. Tie knot in end of starter rope.
9. Allow reel to rotate slowly until handle is against housing.
10. Pull rope to check for proper operation.



11. Place recoil starter (A) on engine. Secure with five (5) screws (B).

CONTENTS

SPECIFICATIONS

ELECTRICAL SPECIFICATIONS, KAWASAKI ENGINES

Charging System	Flywheel/Electronic Alternator
Ignition System	Integrated Electronic Module
Charging Capacity	13 amp (regulated)
Spark Plug	Champion RN11YC
Spark Plug Gap	0.76 mm (0.030 in.)
Battery Type	BCI Group, U1
Battery Reserve Capacity	23 min. at 25 amp
Battery Cold Cranking Amp	25 amp at 27° C (0° F) for 20 minutes
Battery Specific Gravity	Above 1.225 Points
Starting Motor Type	Bendix Inertia Drive

ELECTRICAL SPECIFICATIONS, KOHLER ENGINE

Charging System	Flywheel/Electronic Alternator
Ignition System	Electronic Magneto
Charging Capacity	15 amp (regulated)
Spark Plug	Champion RC12YC
Spark Plug Gap	12.02 mm (0.040 in.)

PTO CLUTCH

Type	Electric (Manufactured by Warner)

REPAIR SPECIFICATIONS

PTO Clutch Air Gap	0.51 mm (0.020 in.)

TORQUE SPECIFICATIONS

PTO Clutch Cap Screw	56 N•m (45 lb-ft.)
Idler Arm to Deck Cap Screw	11-24 N•m (8-18 lb-ft)

ESSENTIAL TOOLS

Number	Name	Use
JDG374	Soldering Iron	Diode replacement
JTO5712	Current Gun	Test PTO clutch and voltage regulator/rectifier output
JTO5685	Battery Tester	Test battery condition
JTO5791	Digital Multimeter	Various electrical tests

READING ELECTRICAL SCHEMATICS

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

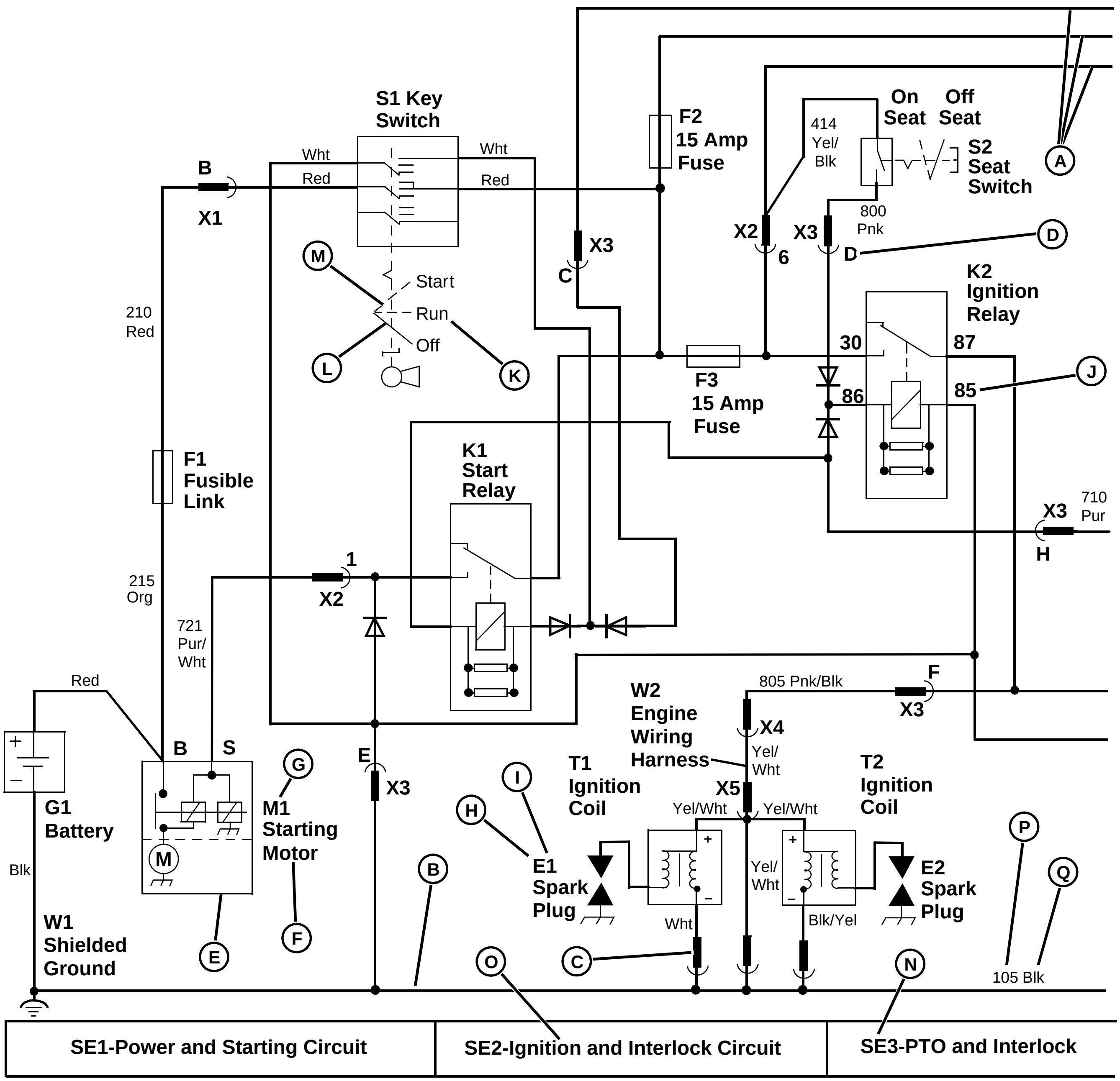
Each component is shown by a symbol (E), its name (F), and an identification code (G). The identification code contains a device identifying letter (H) and number (I).

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

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

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

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



OPERATION AND DIAGNOSIS

THEORY OF OPERATION INFORMATION

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

DIAGNOSTIC INFORMATION

The diagnostic procedures is used to test the complete circuit regardless of the problem or complaint. Select a symptom or system from the quick check or troubleshooting chart and follow the test procedures under that heading.

The diagnostic procedure lists:

- Test conditions
- Test sequence
- Test location
- Normal reading
- Check or test to perform if reading is not normal

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

WIRE COLOR ABBREVIATION CHART

Blk	Black
Blu	Blue
Brn	Brown
Grn	Green
Gry	Gray
Org	Orange
Pnk	Pink
Pur	Purple
Red	Red
Tan	Tan
Wht	White
Yel	Yellow
Blk/Wht	Black/White
Blu/Wht	Blue/White
Brn/Wht	Brown/White
Brn/Yel	Brown/Yellow
Dk Blu	Dark Blue
Dk Brn/lt. Grn	Dark Brown/light Green
Dk Brn/Red	Dark Brown/Red
Dk Brn/Yel	Dark Brown/Yellow
Dk Grn	Dark Green
Lt Blu	Light Blue
Lt Grn	Light Green
Org/Wht	Orange/White
Pnk/Blk	Pink/Black
Pur/Wht	Purple/White
Red/Blk	Red/Black
Red/Wht	Red/White
Wht/Blk	White/Black
Wht/Red	White/Red
Yel/Blk	Yellow/Black
Yel/Red	Yellow/Red
Yel/Wht	Yellow/White

CONDUCTORS FOR 12 VOLT CIRCUITS

STRANDED CONDUCTORS FOR 12 VOLT CIRCUITS						
SAE WIRE SIZE (GAUGE)	20	18	16	14	12	10
METRIC WIRE SIZE (MM)	0.5	0.8	1.0	2.0	3.0	5.0
TYPICAL STRANDING	7 X 28	16 X 30	19 X 29	19 X 27	19 X 25	19 X 23
MINIMUM CONDUCTOR AREA IN CIRCULAR MILS	1072	1537	2336	3702	5833	9343

ELECTRICAL SCHEMATIC AND WIRING HARNESS LEGEND

C1—Ignition Capacitor

E1—Spark Plug

F1—25A Fuse

G1—Battery

G2—Stator

K1—Start Relay

K2—Magneto Relay, Electric Start

K3—Initialization Relay

K4—Magneto Relay, Recoil Start

N1—Voltage Regulator/Rectifier, Kawasaki Engines

N2—Delta Module

N3—Voltage Regulator/Rectifier, Kohler Engine

M1—Starting Motor

P1—Hour Meter

S1—Key Switch

S2—PTO Switch

S3—Operator Presence Switch

S4— Neutral Start Switch

T1— Ignition Coil w/ Module

T2— Ignition Coil

V1—Diode

V2—Diode

V3—Diode

V4—Diode

W1—Ground

W2—Engine Wiring Harness, Kawasaki Engine

W3—Main Wiring Harness, Electric Start

W4—Main Wiring Harness, Recoil Start, Kawasaki Engine

W5—Ignition Wiring Harness, Kawasaki Engines

W6—Main Wiring Harness, Recoil Start, Kohler Engine

W7—Engine Ignition Coil Wire Harness, Kohler Engine

W8—Ignition Wiring Harness, Kohler Engine

Y1—PTO Clutch

Connectors:

X1—W2 to W3 Wiring Harness

X2—W2 to W4 Wiring Harness

X3—W2 to W5 Wiring Harness

X4—W2 to G2 Stator

X5—W3 to N1 Voltage Regulator/Rectifier

X6—W4 to N1 Voltage Regulator/Rectifier

X7—W3 Wiring Harness to Y1 PTO Clutch

X8—W4 Wiring Harness to Y1 PTO Clutch

X9—W3 Wiring Harness to Optional Hour Meter

X10—W4 Wiring Harness to Optional Hour Meter

X11—C1 Capacitor to N1 Voltage Regulator/Rectifier

X12—G2 Stator to N3 Voltage Regulator/Rectifier

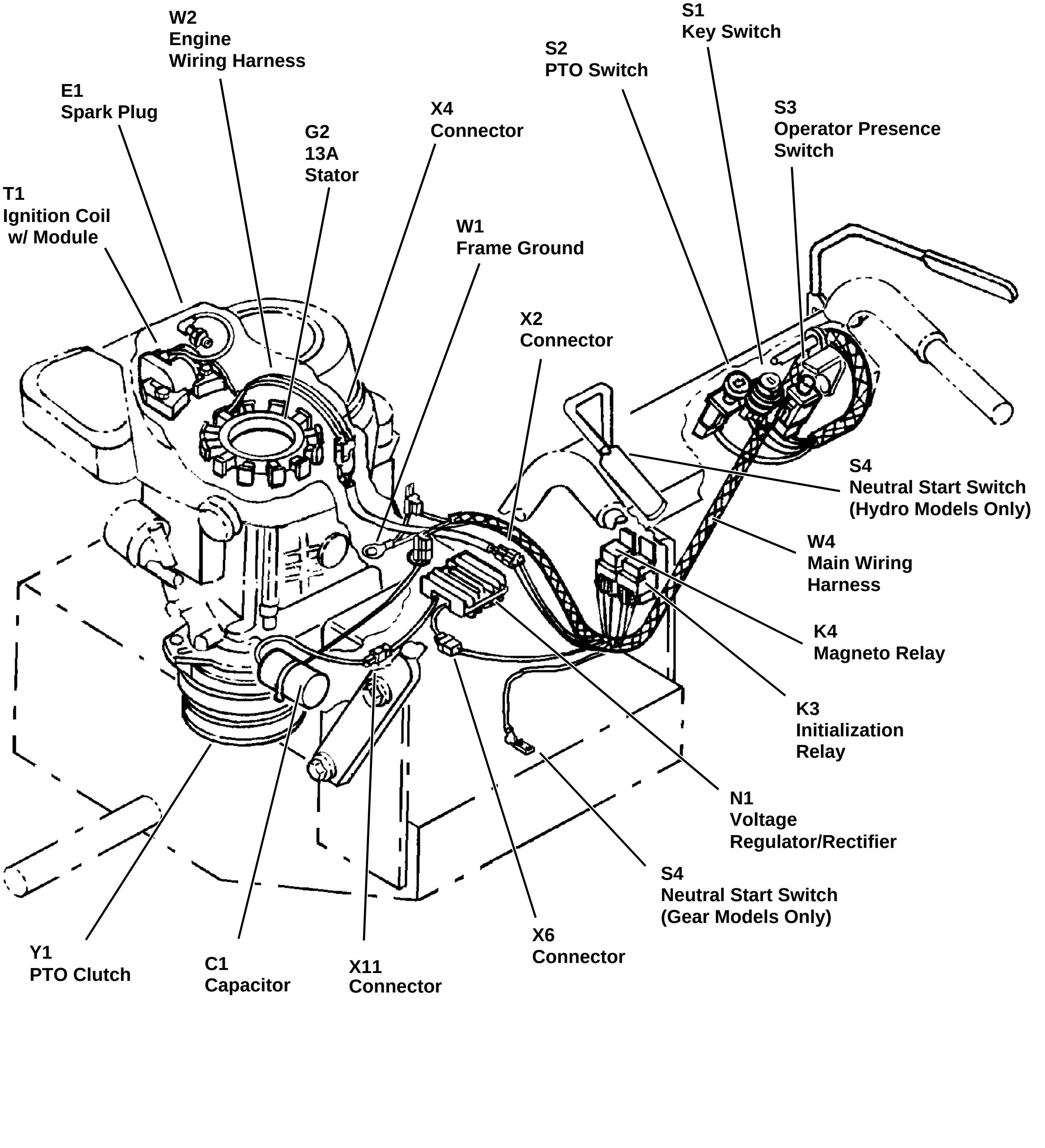
X13—W8 Wiring Harness to W6 Wiring Harness

X14—W6 Wiring Harness to Optional Hour Meter

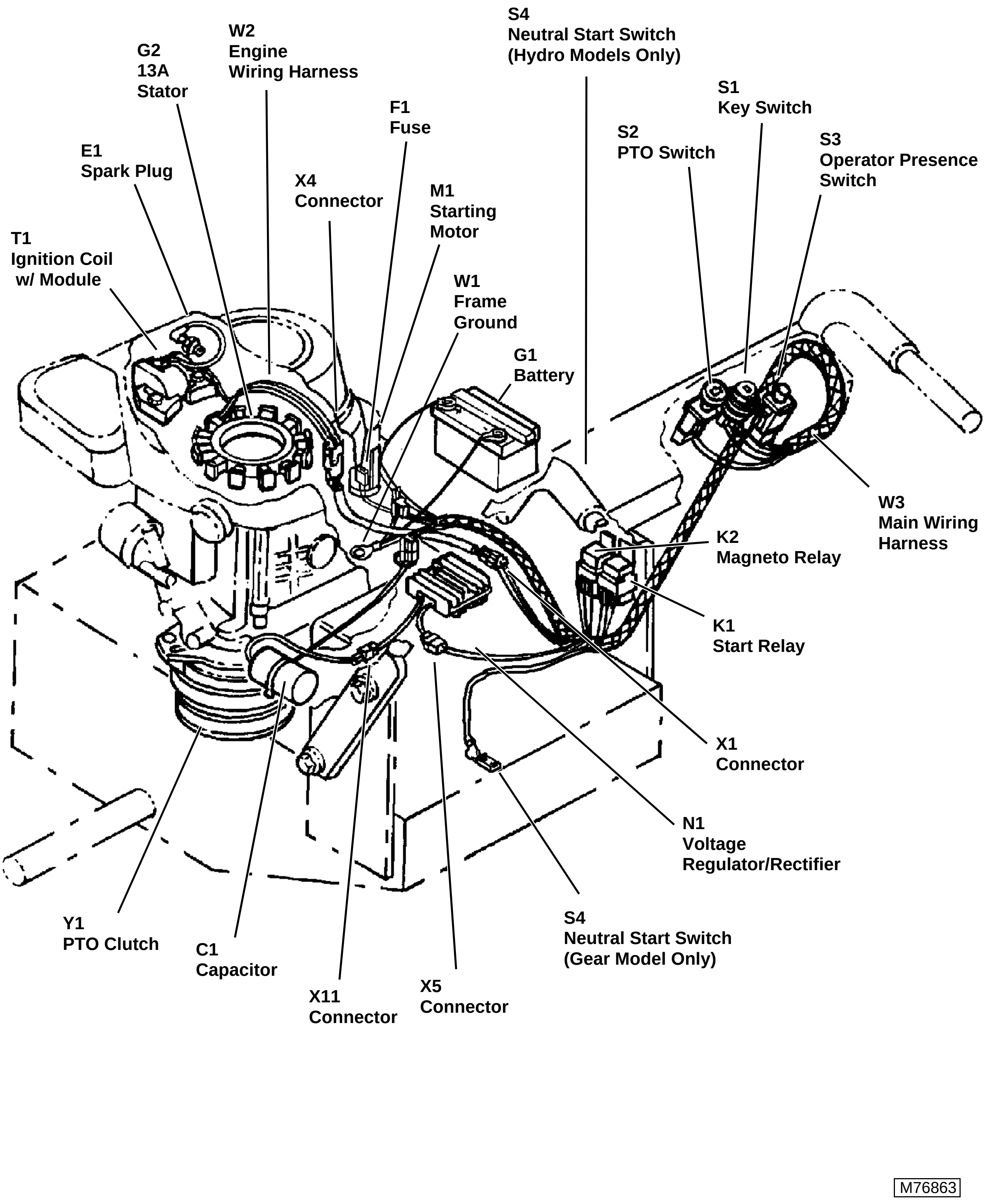
X15—W6 Wiring Harness to Y1 PTO Clutch

COMPONENT LOCATION

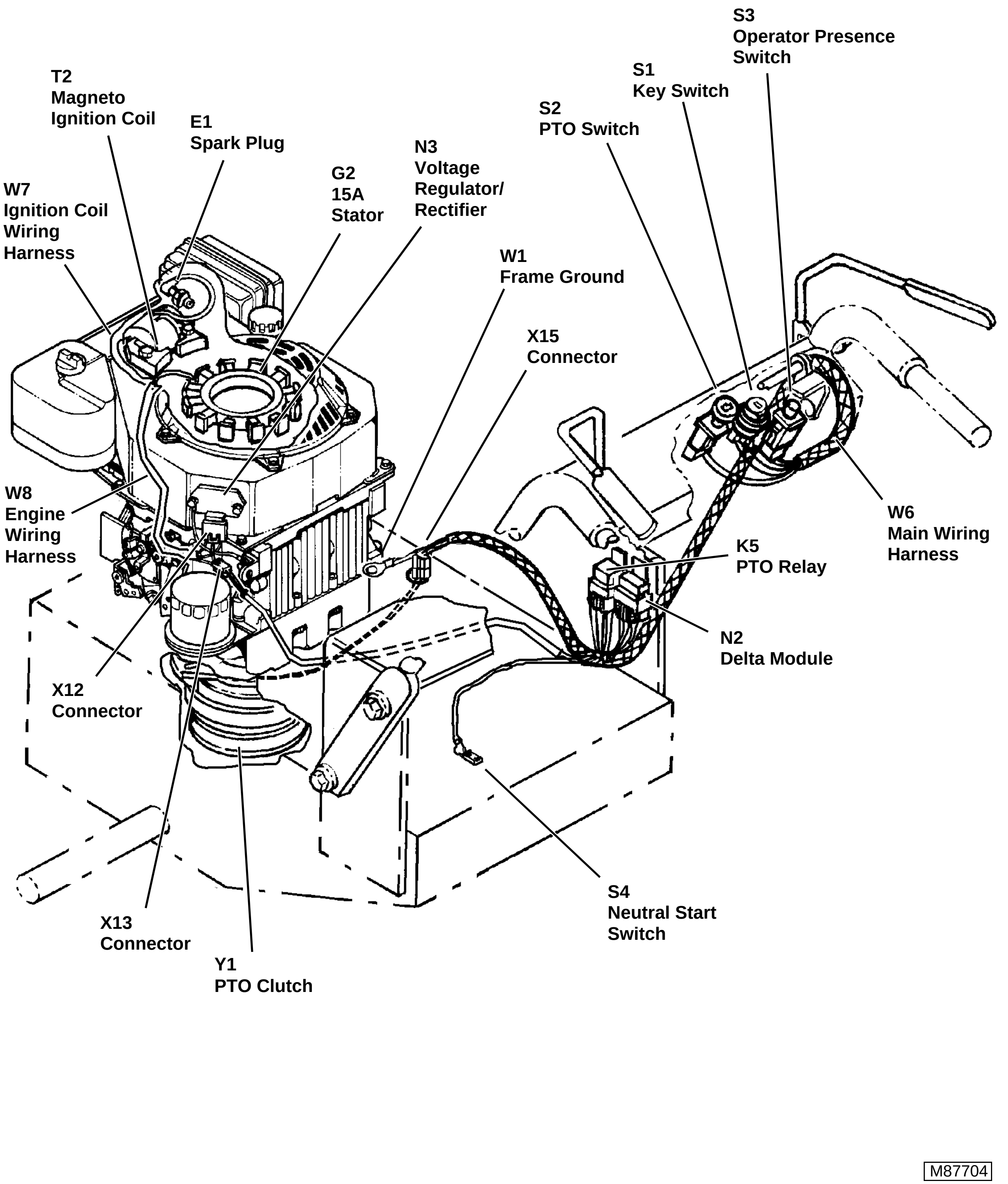
RECOIL START COMPONENT LOCATION—KAWASAKI ENGINES



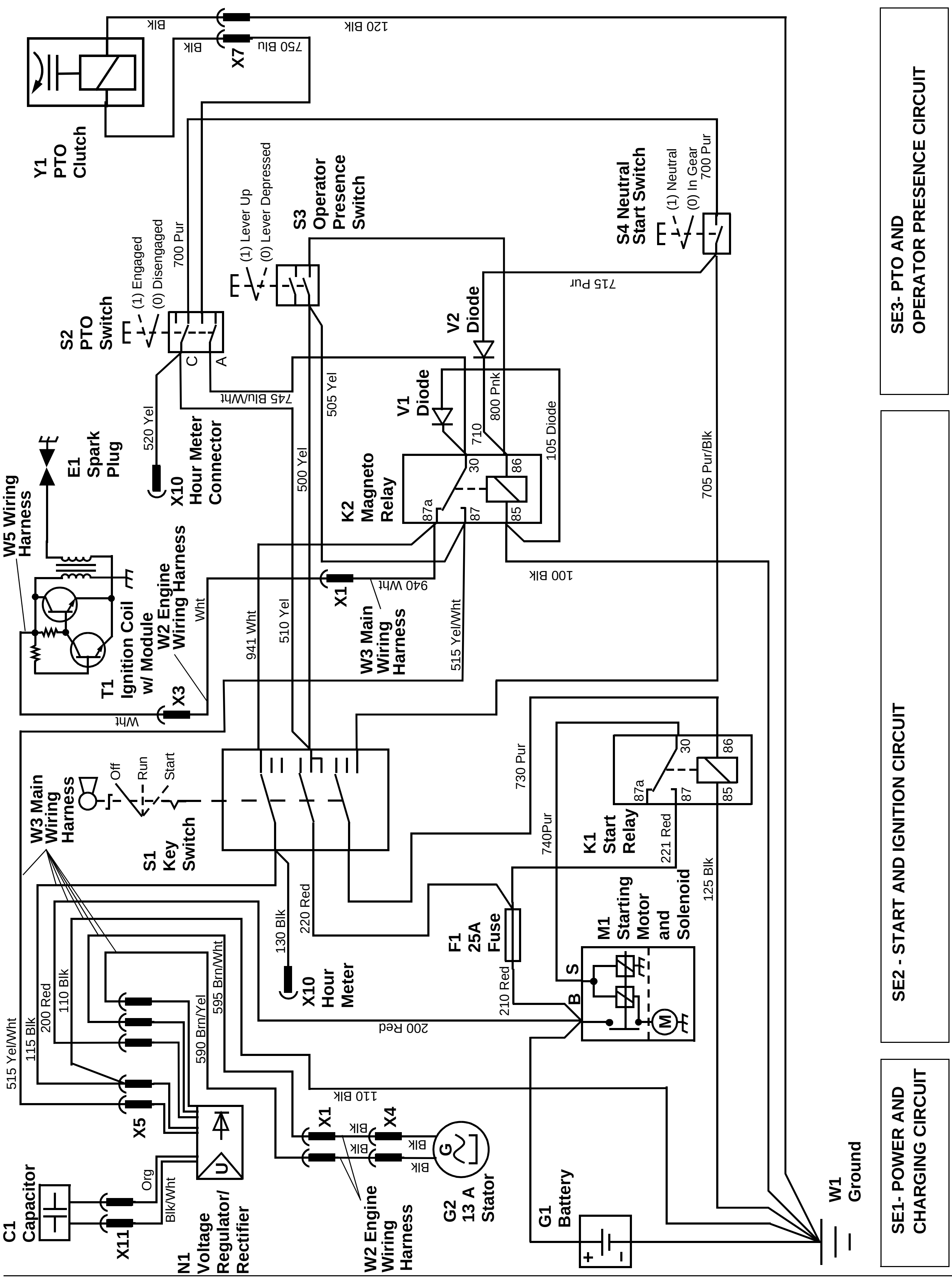
ELECTRIC START COMPONENT LOCATION—KAWASAKI ENGINES



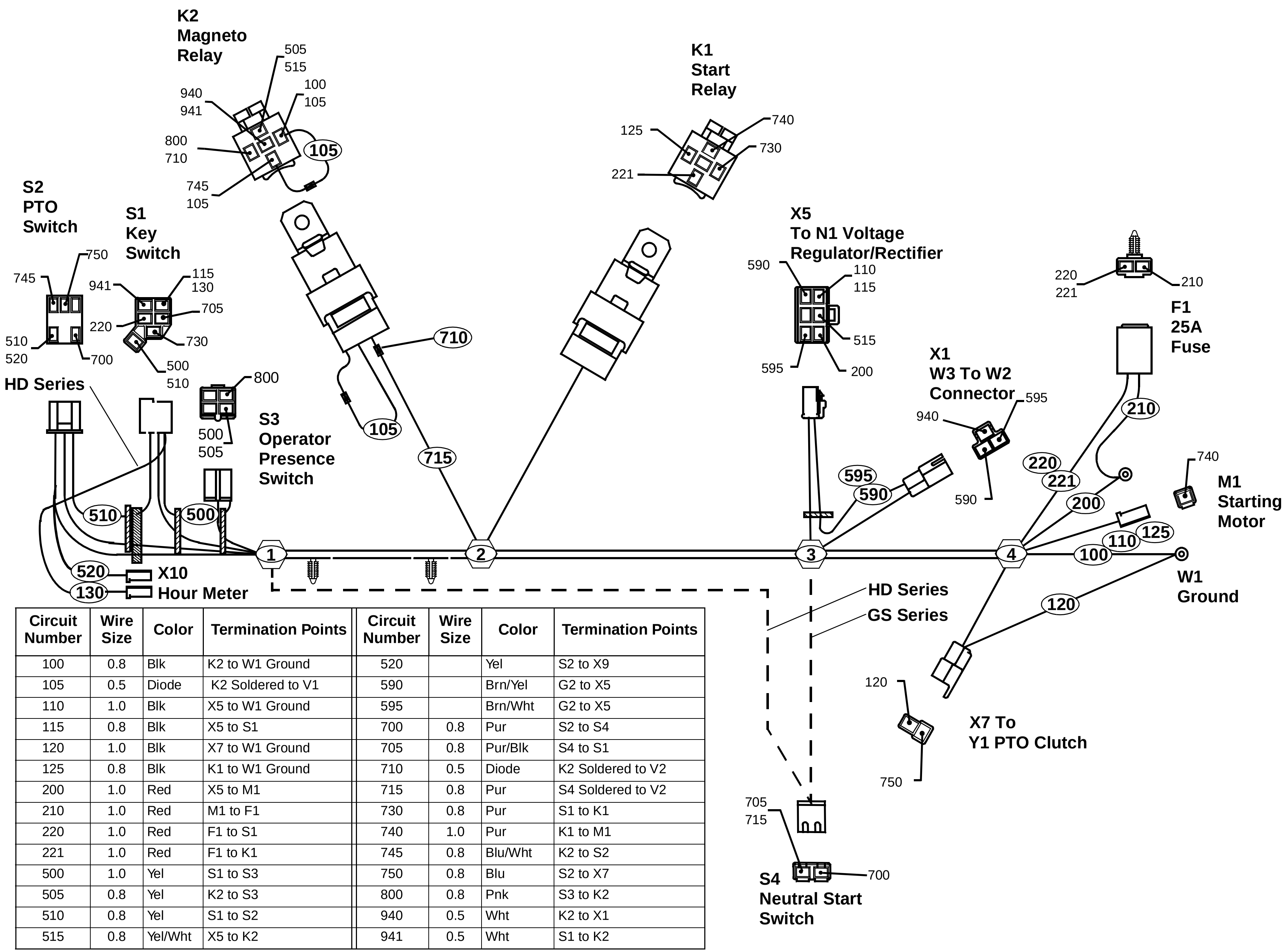
RECOIL START COMPONENT LOCATION—KOHLER ENGINE



ELECTRICAL SCHEMATIC—ELECTRIC START, KAWASAKI ENGINE

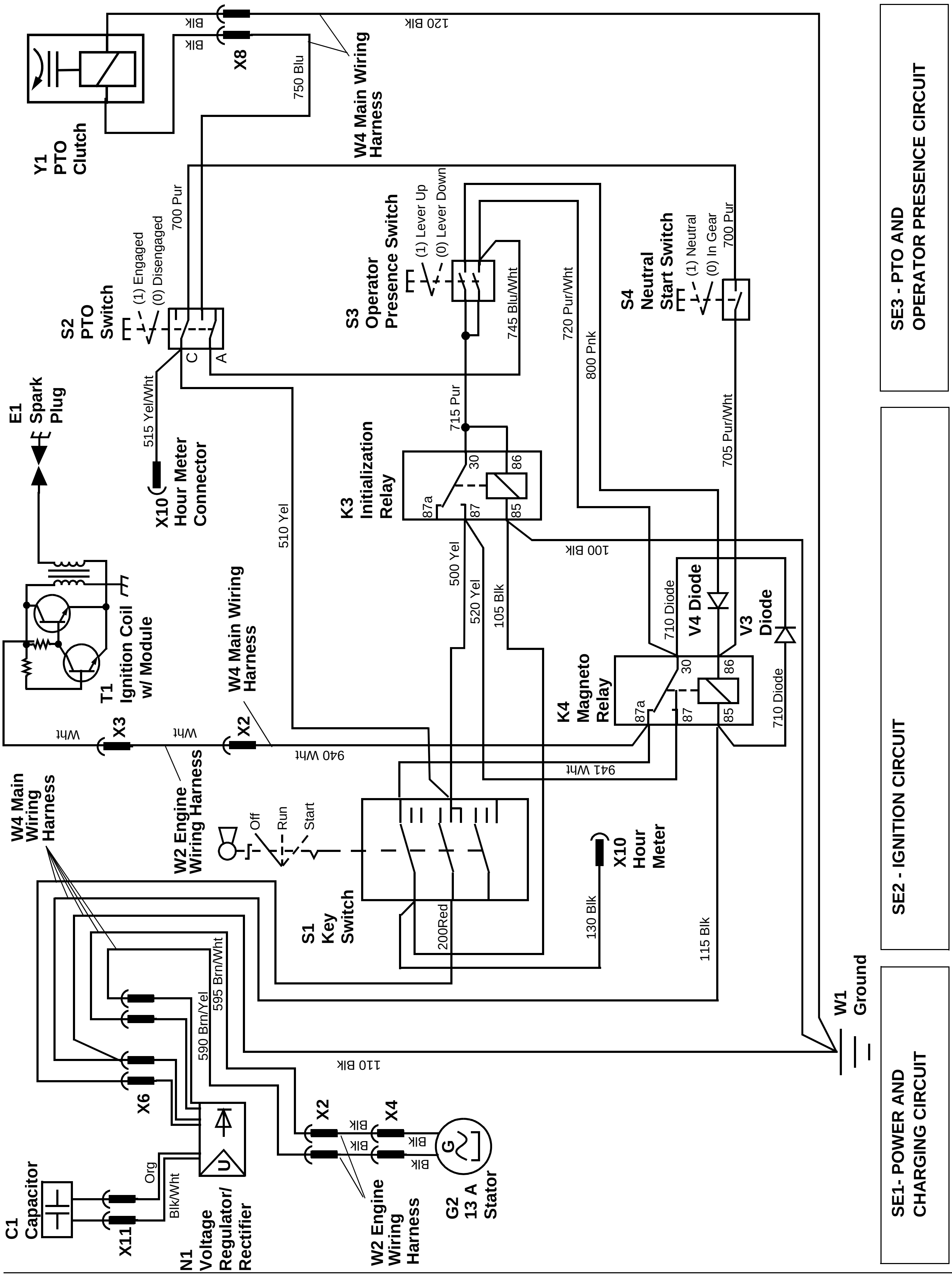


W3 MAIN WIRING HARNESS— ELECTRIC START, KAWASAKI ENGINE

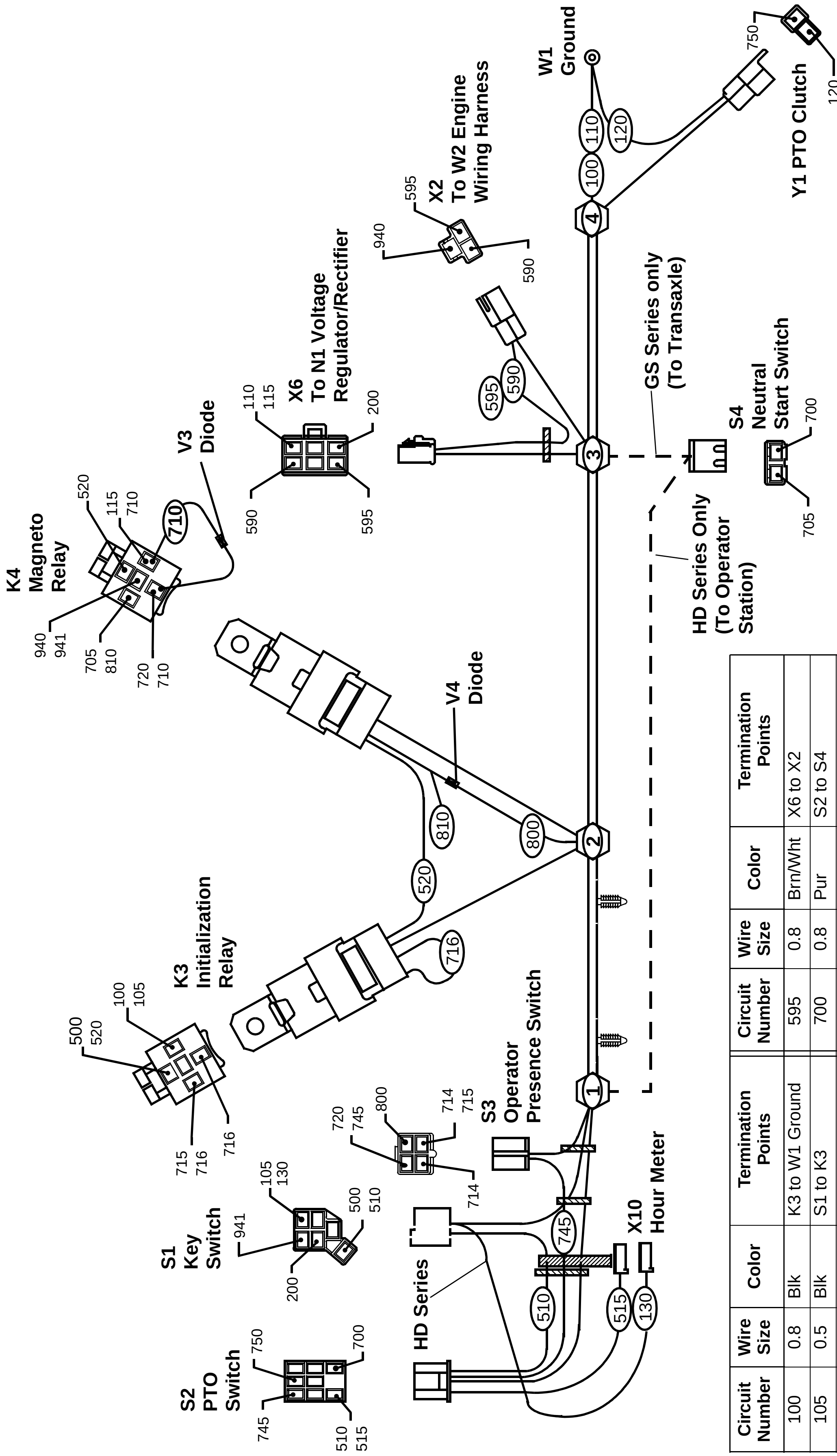


Circuit Number	Wire Size	Color	Termination Points	Circuit Number	Wire Size	Color	Termination Points
100	0.8	Blk	K2 to W1 Ground	520		Yel	S2 to X9
105	0.5	Diode	K2 Soldered to V1	590		Brn/Yel	G2 to X5
110	1.0	Blk	X5 to W1 Ground	595		Brn/Wht	G2 to X5
115	0.8	Blk	X5 to S1	700	0.8	Pur	S2 to S4
120	1.0	Blk	X7 to W1 Ground	705	0.8	Pur/Blk	S4 to S1
125	0.8	Blk	K1 to W1 Ground	710	0.5	Diode	K2 Soldered to V2
200	1.0	Red	X5 to M1	715	0.8	Pur	S4 Soldered to V2
210	1.0	Red	M1 to F1	730	0.8	Pur	S1 to K1
220	1.0	Red	F1 to S1	740	1.0	Pur	K1 to M1
221	1.0	Red	F1 to K1	745	0.8	Blu/Wht	K2 to S2
500	1.0	Yel	S1 to S3	750	0.8	Blu	S2 to X7
505	0.8	Yel	K2 to S3	800	0.8	Pnk	S3 to K2
510	0.8	Yel	S1 to S2	940	0.5	Wht	K2 to X1
515	0.8	Yel/Wht	X5 to K2	941	0.5	Wht	S1 to K2

ELECTRICAL SCHEMATIC—RECOIL START, KAWASAKI ENGINE

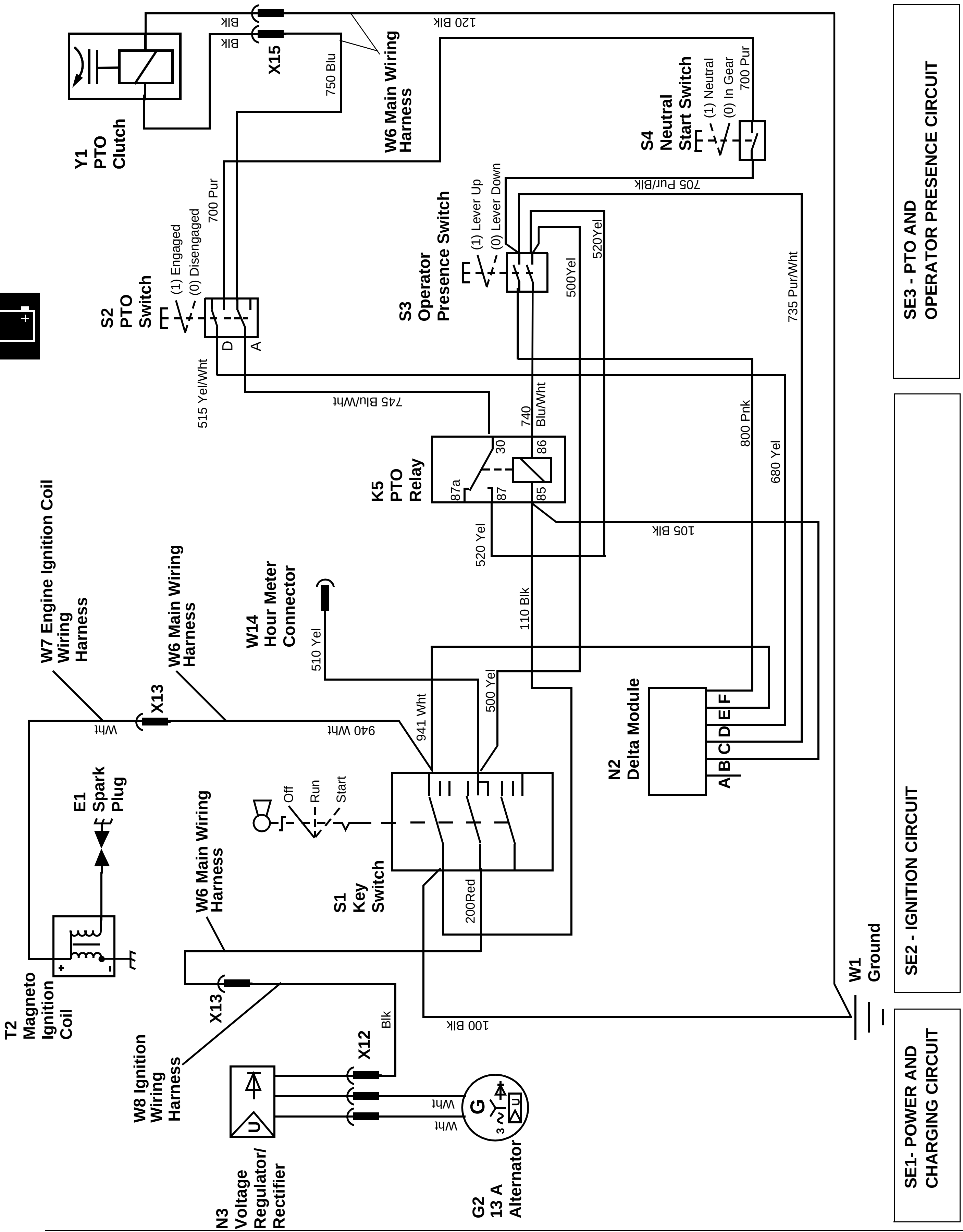


W4 MAIN WIRING HARNESS- RECOIL START, KAWASAKI ENGINE

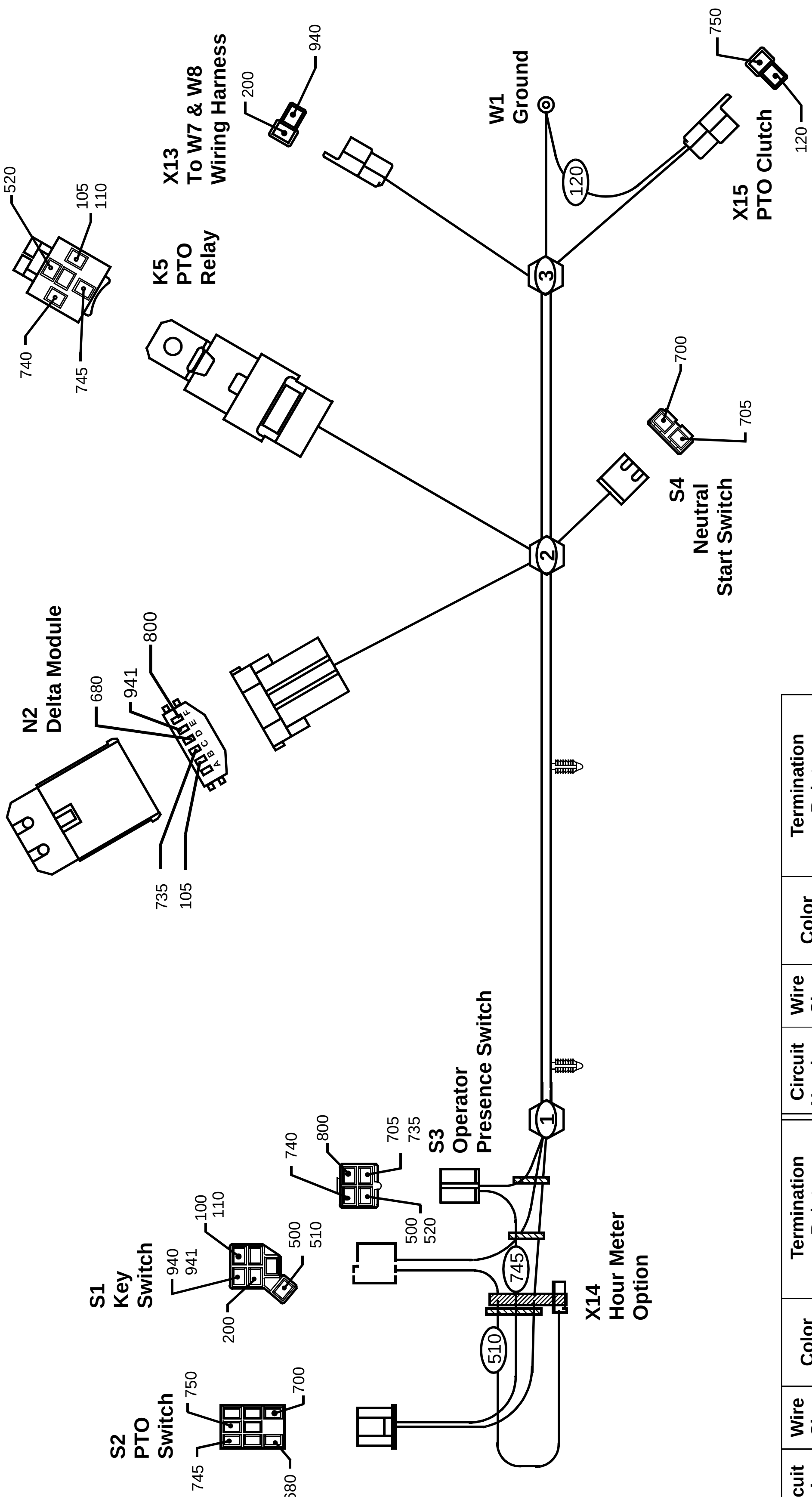


Circuit Number	Wire Size	Color	Termination Points
100	0.8	Blk	K3 to W1 Ground
105	0.5	Blk	S1 to K3
110	1.0	Blk	X6 to W1 Ground
115	0.8	Blk	X6 to K4
120	1.0	Blk	X8 to W1 Ground
200	1.0	Red	X6 to S1
500	1.0	Yel	S1 to K3
510	0.8	Yel	S1 to S2
515	0.8	Yel/Wht	S2 to X10
520		Yel	K4 to K3
590	0.8	Brn/Yel	X6 to X2
595	0.8	Brn/Wht	X6 to X2
700	0.8	Pur	S2 to S4
705	0.8	Pur/Blk	S4 to K4
710	0.5	Diode	K4 Soldered to K4
715	0.8	Pur	S3 to K3
720	0.8	Pur/Wht	S3 to K4
750	0.8	Blu	S2 to X8
800	0.8	Pnk	S3 to K4
940	0.5	Wht	K4 to X2
941	0.5	Wht	S1 to K4

ELECTRICAL SCHEMATIC—RECOIL START, KOHLER ENGINE

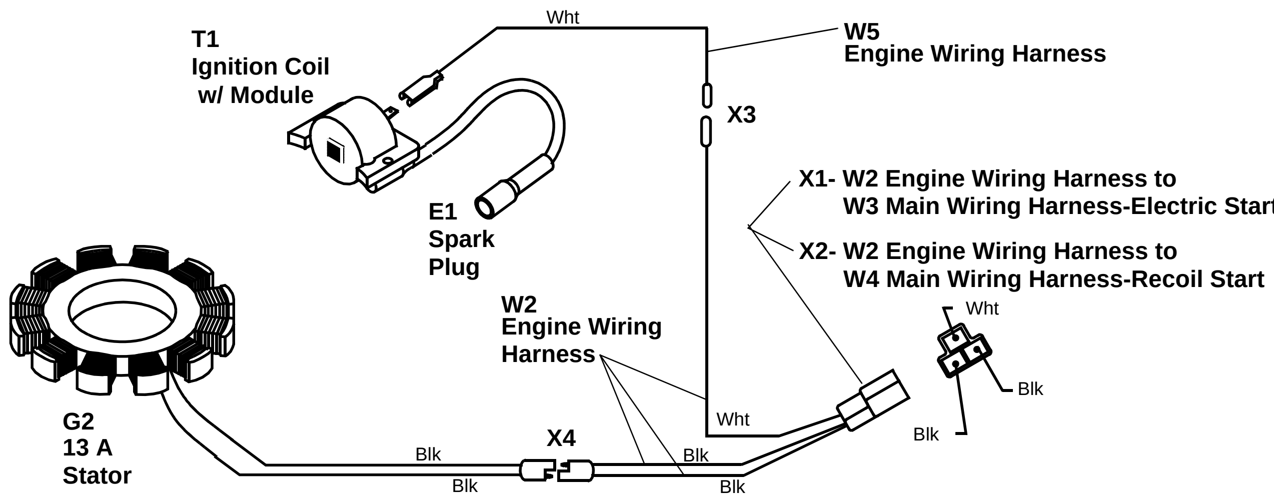


W6 MAIN WIRING HARNESS- RECOIL START, KOHLER ENGINE

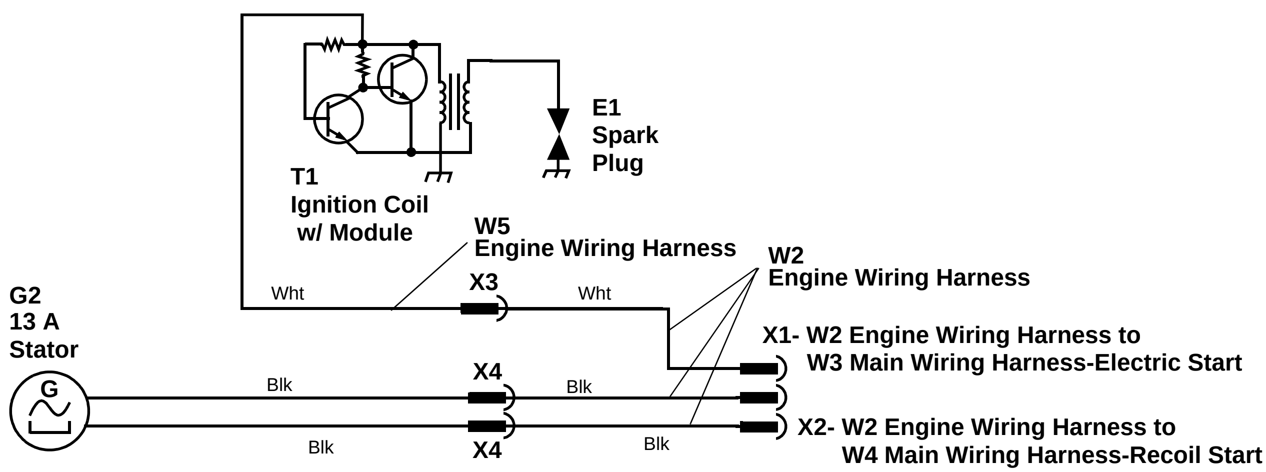


Circuit Number	Wire Size	Color	Termination Points
100	0.8	Blk	S1 to W1 Ground
105	0.8	Blk	N2 to K5
110	0.8	Blk	S1 to W1 Ground
120	1.0	Blk	X15 to W1 Ground
200	1.0	Red	S1 to X13
500	0.8	Yel	S1 to S3
510	0.8	Yel	S1 to X14
680	0.8	Yel	S2 to N2
700	0.8	Pur	S2 to S4
705	0.8	Pur/Blk	S4 to S3
735	0.8	Pur/Wht	S3 to N2
740	0.8	Blu/Wht	S3 toK5
750	0.8	Blu	S2 to X15
800	0.8	Pnk	S3 to N2
940	0.5	Wht	S1 to X13
941	0.5	Wht	S1 to N2

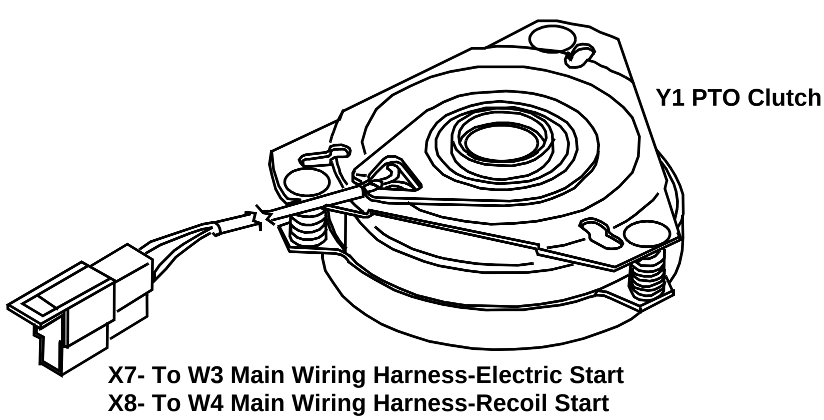
WIRING HARNESSES—KAWASAKI ENGINE



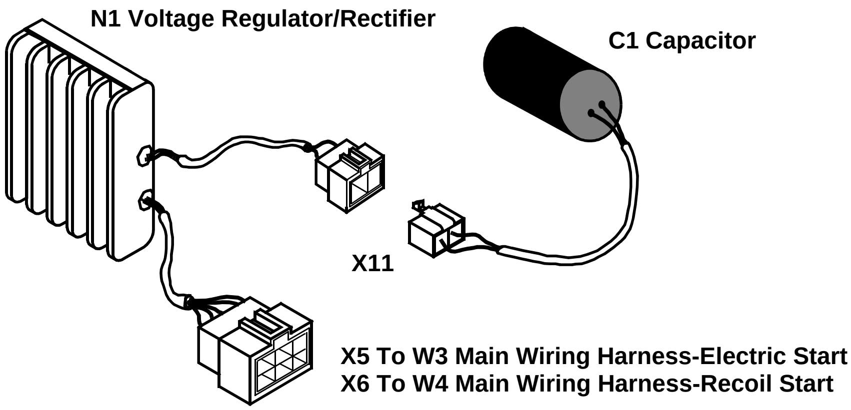
ELECTRICAL SCHEMATIC—KAWASAKI ENGINE HARNESS



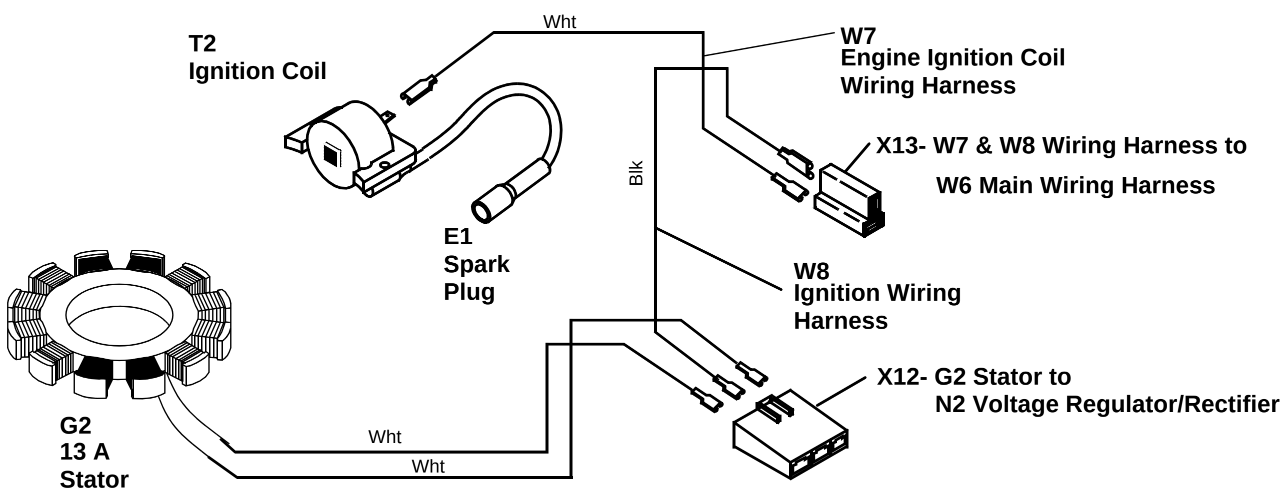
Y1 PTO CLUTCH WIRING HARNESS



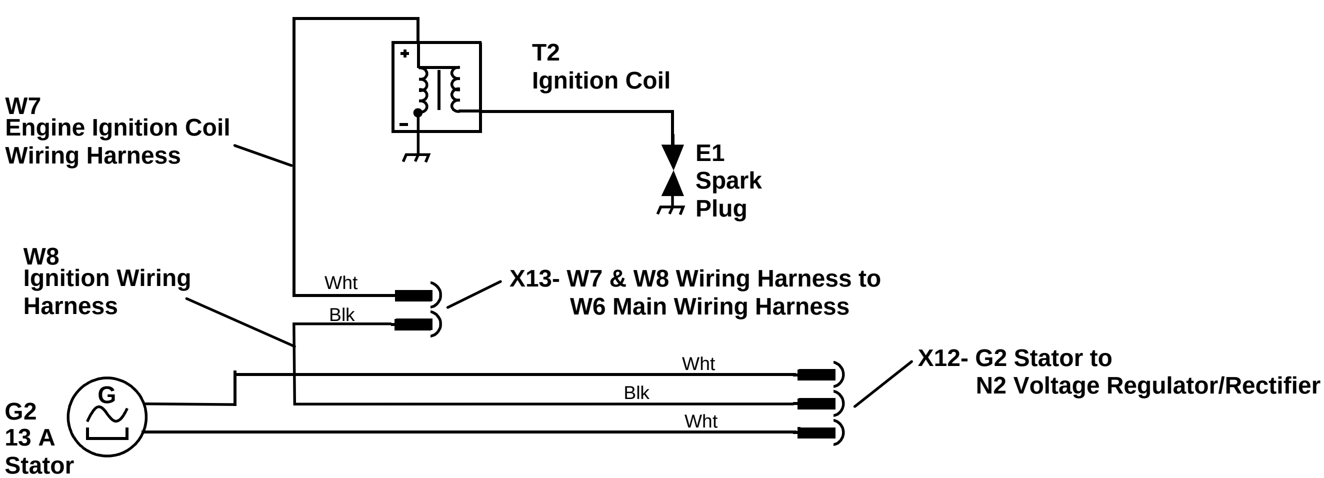
VOLTAGE REGULATOR/RECTIFIER HARNESS—KAWASAKI ENGINES



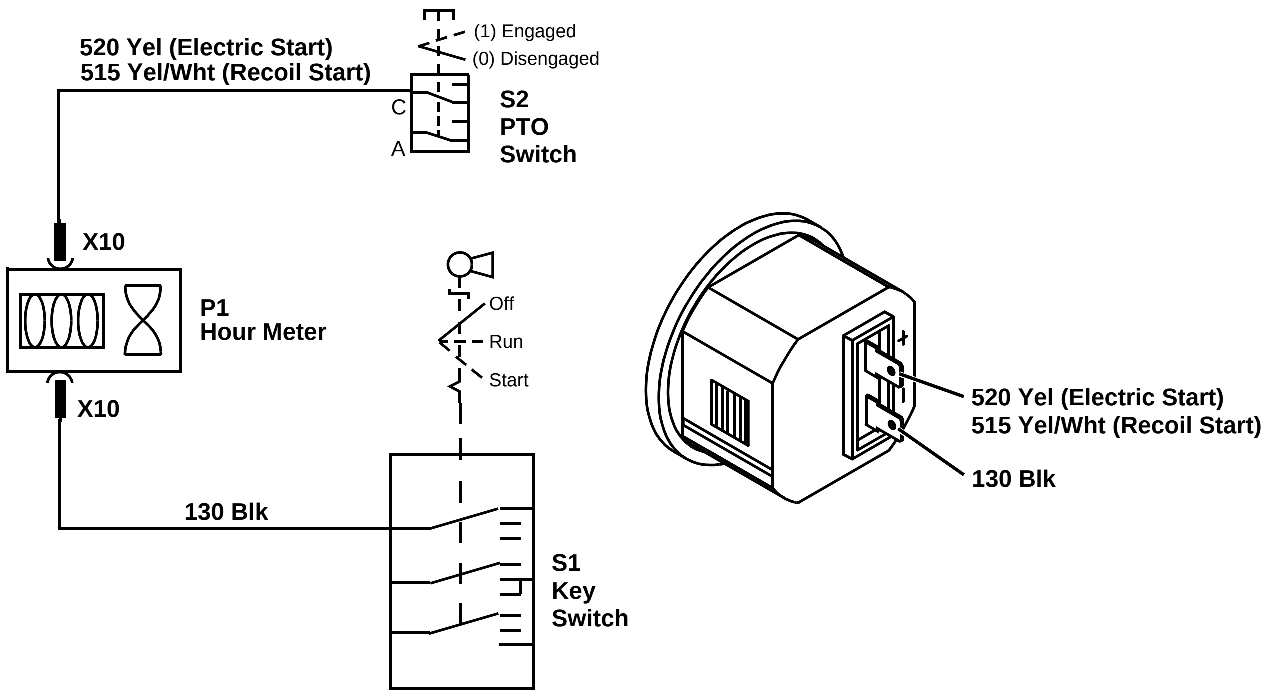
WIRING HARNESSES—KOHLER ENGINE



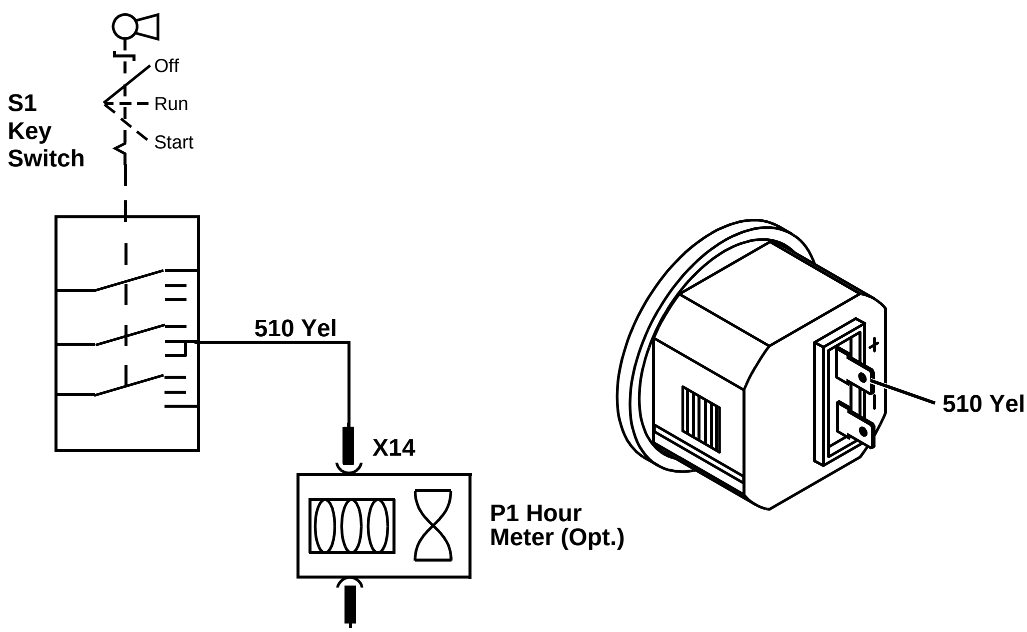
ELECTRICAL SCHEMATIC—KOHLER ENGINE HARNESS



HOUR METER—KAWASAKI



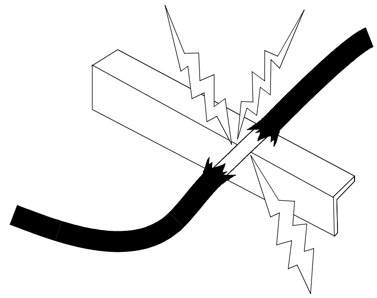
HOUR METER (OPT.)—KOHLER



TROUBLESHOOTING

Check or Solution / Problem or Symptom	Engine Will Not Crank (Electric start only)	Engine Cranks But Will Not Start (Electric start only)	Engine Cranks But Will Not Start (Recoil start only)	Engine Cranks Slowly (Electric start only)	Engine Stops When shifted into gear	Engine Stops When PTO Switch Is Engaged	Cutting Unit Will Not Operate	Engine Does Not stop when Operator Presence levers are released when unit is shifted into gear
15 amp fuse defective, check fuse	●							
Defective key switch	●	●					●	●
Transmission not in neutral or neutral start switch is defective	●		●					●
Magneto relay defective	●	●	●			●		●
Starting motor defective	●							
Start relay defective (electric start only)	●	●						
Ignition Coil w/ module defective		●	●					
Initialization relay defective (recoil start only)			●		●			
Loose or dirty electrical connections	●	●	●	●	●	●	●	
Diode defective								●
PTO switch or wiring defective		●	●		●	●	●	
Operator presence switch defective					●	●	●	●
Battery weak or discharged	●	●		●			●	
Defective starting motor solenoid	●							
PTO clutch defective							●	

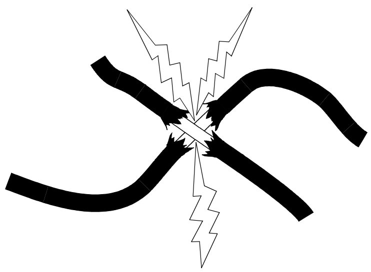
COMMON CIRCUIT TESTS



Shorted Circuit:

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

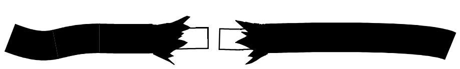
1. Turn component switch ON.
2. Start at the controlling switch of the component that should not be operating.
3. Follow the circuit and disconnect wires at connectors until component stops operating.
4. Shorted or improper connections will be the last two wires disconnected.



High Resistance or Open Circuit:

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

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



Grounded Circuit:

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

CRANKING CIRCUIT OPERATION—ELECTRIC START

Function:

The cranking system is used to energize the starting motor.

Operating Conditions:

In order to crank the engine; the key switch must be in the START position, the transmission must be in NEUTRAL, and the PTO switch must be OFF. The operator DOES NOT have to be present to crank the engine.

Theory of Operation:

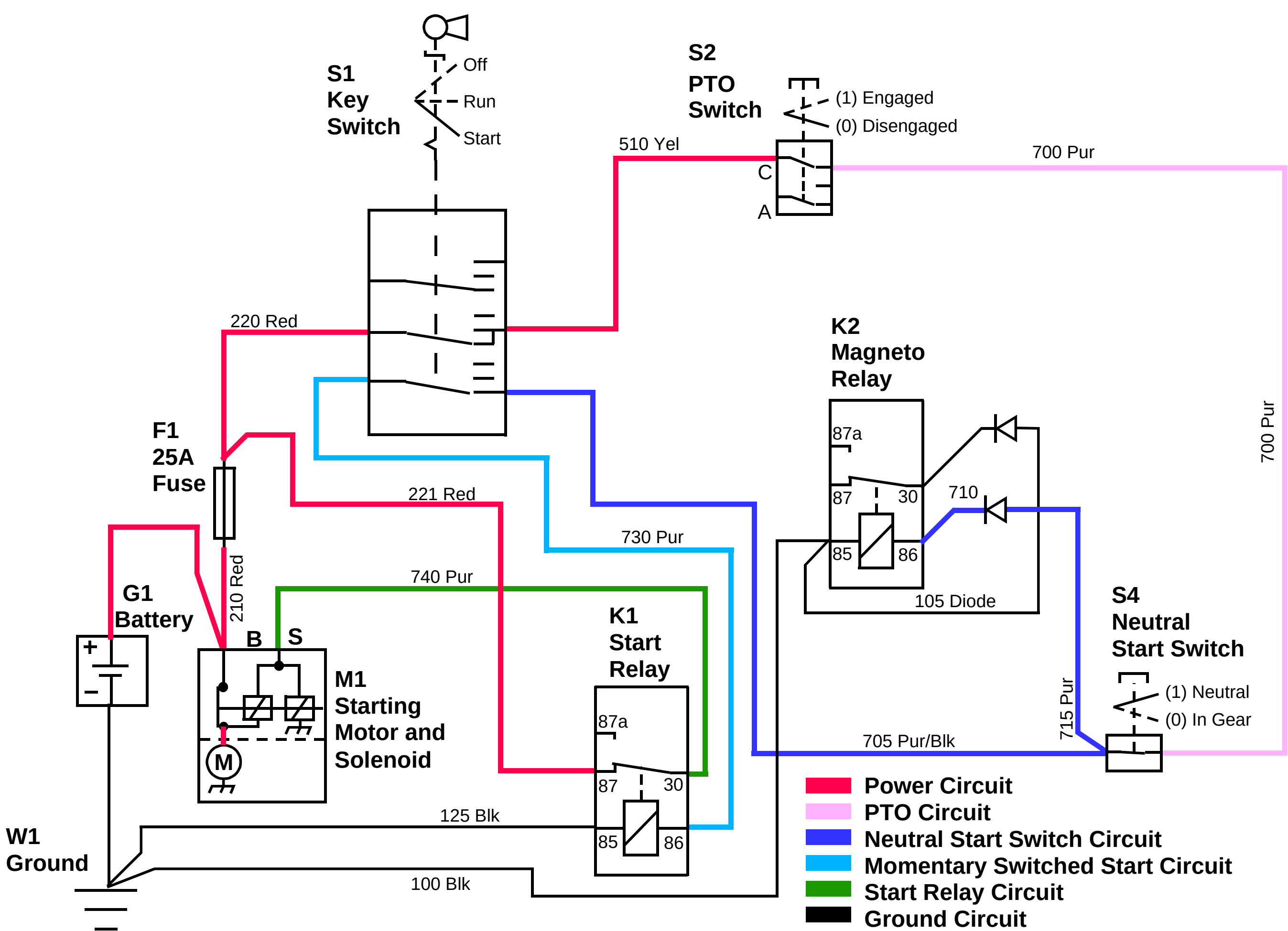
The starting motor has a separate internal solenoid. Current flows from the battery (G1) positive terminal to the starting solenoid terminal on the starter (M1), fuse (F1), and key switch (S1).

When the key switch is in the RUN position, current passes through the key switch, and to the PTO switch (S2). If the PTO switch is disengaged (closed), power flows through the PTO switch to the neutral start switch (S4). If PTO switch is not disengaged (open), the unit will not start.

If the transmission is in neutral, the neutral start switch (S4) is depressed (closed), and power flows through the neutral start switch to the pull-in coil of the magneto relay (K4). If the transmission is in gear, the neutral start switch will be open, and the engine will not start.

The neutral start switch, if closed, will also supply power back to the key switch, so that when the key switch is turned to the start position, power will flow to the pull-in coil of the start relay (K1), which energizes the the pull-in coils of the starter solenoid.

The starter solenoid pulls-in and closes the large main starter terminals, supplying high battery current to the starting motor (M1). The rotation of the motor engages the starter bendix drive with the engine flywheel, cranking the engine until the ignition circuit fires (see Ignition Circuit Operation), igniting the fuel/air mixture and starting the engine. Once the engine starts, the operator releases the key switch (S1) to the run position. This breaks the current flow to the starting solenoid, cutting off high battery current to the starting motor.



CRANKING CIRCUIT DIAGNOSIS—ELECTRIC START

Test Conditions:

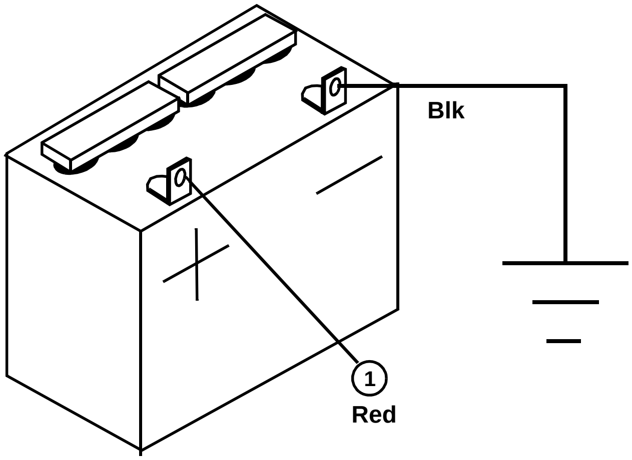
- Transmission in NEUTRAL
- PTO switch DISENGAGED
- Key switch in RUN position
- Meter positive (+) lead on numbered test point
- Meter negative (—) lead on battery negative (—) terminal

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8-13.2 volts	Test battery.
2. Key switch 220 Red wire and starting motor solenoid terminal 210 Red wire	Battery voltage	Check battery cable connection, fuse (F1), and 220 Red wires. Replace as necessary.

Test Conditions:

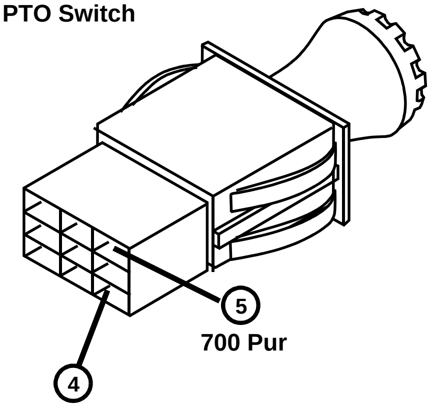
- Key switch in START position

Test/Check Point	Normal	If Not Normal
3. Key switch 510 Yel wire	Battery voltage	Replace key switch.
4. PTO switch 510 Yel wire	Battery voltage	Replace 510 Yel wire.
5. PTO switch terminal E (700 Pur wire)	Battery voltage	Replace PTO switch.
6. Neutral start switch 700 Pur wire	Battery voltage	Replace 700 Pur wire.
7. Neutral start switch 705 Pur/Blk wire	Battery voltage	Replace neutral start switch
8. Key switch 705 Pur/Blk wire	Battery voltage	Replace 705 Pur/Blk wire.
9. Key switch 730 Pur wire	Battery voltage	Replace key switch.
10. Starter relay terminal 86 (730 Pur wire)	Battery voltage	Replace 730 Pur wire.
11. Starter relay ground terminal - 125 Blk wire	Greater than 0 - less than 0.2 volts	Greater than 0.2 volts: Check starting solenoid ground circuit 125 Blk wire. 0 volts: Replace solenoid.
12. Starter relay terminal 87 (221 Red wire)	Battery voltage	Check fuse F1. Clean battery terminals. Replace 221 Red wire.
13. Starter relay terminal 30 (740 Pur wire)	Battery voltage	Replace starter relay.
14. Starter solenoid terminal S (740 Pur wire)	Battery voltage	Replace 740 Pur wire. If solenoid still does not engage suspect solenoid ground. Check engine ground, replace solenoid.

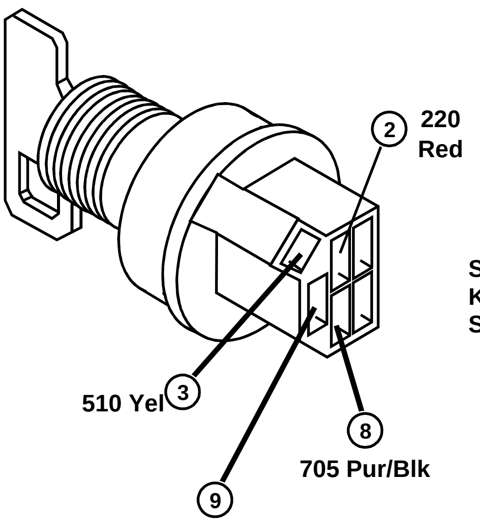


G1 Battery

S2
PTO Switch

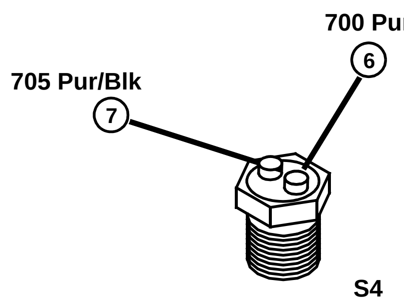


510 Yel



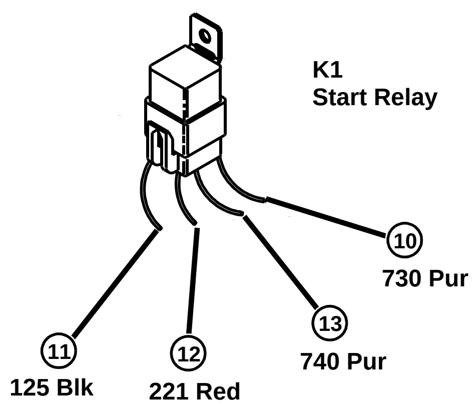
730Pur

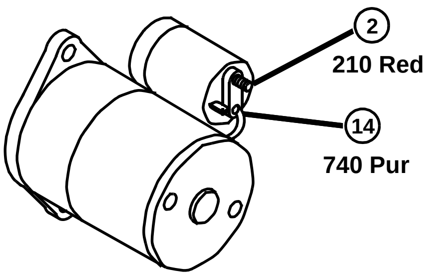
S1
Key
Switch



S4
Neutral Start
Switch

K1
Start Relay





M1
Starting Motor

IGNITION CIRCUIT OPERATION—ELECTRIC START

Function:

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

Operating Conditions:

To produce a spark, the key switch (S1) must be in the start or run position. Either the pto switch must be off, and/or the operator presence switch must be depressed for the engine to continue running. If the pto switch is off, the neutral start switch must also indicate that the transmission is in neutral.

Theory of Operation:

The ignition system is an electronic magneto design. Ignition timing is controlled by the ignition module (T1) and is not adjustable.

Battery (G1) current is routed through the main battery cable, to the “B” terminal of the starting motor and solenoid (M1). Battery current is also always present at 25 Amp Fuse (F1), 220 Red wire to key switch, and 200 Red wire to Voltage Regulator/Rectifier (N1).

When the key switch is in the run position, the key switch eliminates one of the paths to ground that would prevent ignition: W1 ground, 110 Blk, 115 Blk, through key switch, 941 Wht to Magneto Relay (K2), and 940 Wht to ignition coil current.

When the key switch is in the run position, current passes through the key switch (S1), and to the pto switch (S2).

If the pto switch is disengaged (closed), power flows through the pto switch to the neutral start switch (S4). If pto switch is not disengaged (open), the unit will not start, but will continue to run, if already running, as long as the operator presence lever is depressed.

If the neutral start switch indicates that the transmission is in neutral (switch closed), power flows through the neutral start switch to the magneto relay coil (K4). If the neutral start switch is open, indicating that the transmission is in gear, the unit will not start, but will continue to run, if already running, as long as the operator presence lever is depressed.

Upon activation of the magneto relay coil the second path to ground - established through circuit 710 diode, 115 Blk, 110 Blk to W1 ground - is removed from terminal 87A Thus allowing spark to be generated by the ignition coil (T1).

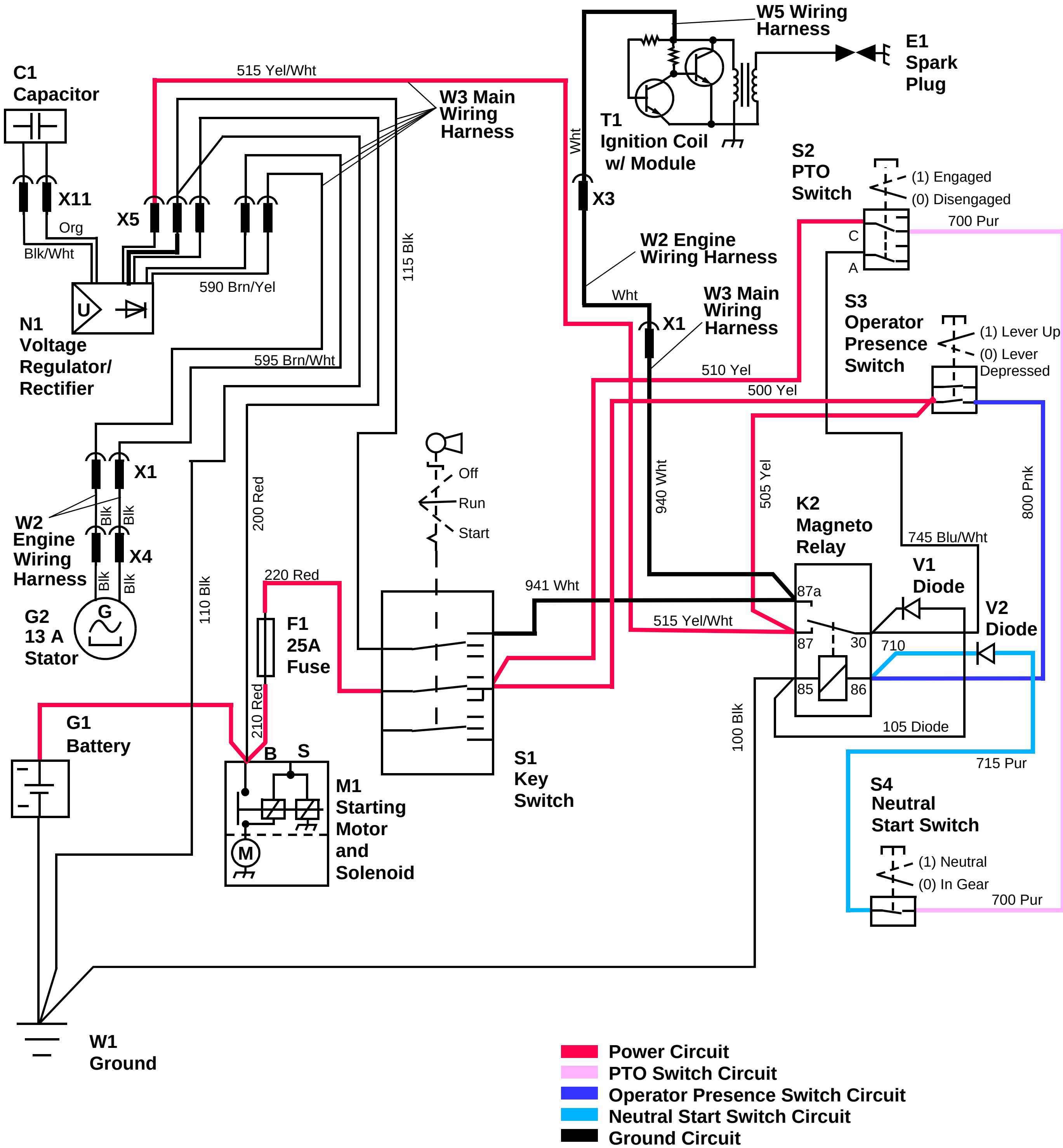
As the flywheel turns in the cranking circuit, a magnet in the flywheel, produces current in the primary coil of the ignition module (T1) by electromagnetic induction. When the primary current builds to its highest level, the ignition module (T1) induces high voltage current into the secondary coil. This high voltage current then flows to the spark plug (E1) and jumps the spark plug gap and ignites the fuel/air mixture, causing the engine to start and run.

The operator presence lever (switch) must be depressed before the pto switch is engaged and/or the transmission is placed in neutral. Failure to depress the operator presence lever before engagement of pto switch and/or transmission neutral switch will cause engine to stop running.

The engine can be stopped in either of two ways:

- Primary shut-off is controlled by turning the key switch (S1) to the off position, which grounds the 940 Wht circuit of the ignition coil w/module, stopping the engine. The ground path takes the following route: Ignition coil wire 940 Wht to terminal 87a of magneto relay (K2), 941 Wht to key switch (S1), through key switch to 115 Blk to Voltage regulator/rectifier (N1), 110 Blk to W1 ground.
- The engine will also be shut-off if the operator releases or fails to engage the operator presence levers before the pto switch is engaged, or puts the transmission in gear. In this circuit, current flows from key switch (S1), through wire 510 Yel to the pto switch, through 700 Pur wire to the neutral start switch (S4), which, when transmission is in gear (switch open), interrupts current in wire 800 Pnk to the magneto relay. This returns the magneto relay to its normal position, which provides a ground circuit to terminal 30 of the magneto relay from ground W1 through wires 100 Blk, and 105 Diode. This provides a ground through the magneto relay, from terminal 30 to terminal 87a, to wire 940 Wht which is connected to the ignition coil w/ Module. This provides a path to ground and terminates spark generation.

IGNITION CIRCUIT OPERATION—ELECTRIC START



IGNITION CIRCUIT DIAGNOSIS—ELECTRIC START

When diagnosing an ignition problem, isolate ignition coil w/ module circuit from ground circuit by separating engine connector X1. If engine will not start check ignition coil w/ module circuit first and then check ground circuit. If engine will not shut-off, check ground circuit. Remember engine is stopped by grounding ignition coil w/ module through key switch, operator presence switch or PTO switch.

Test Conditions:

- Transmission in NEUTRAL
- PTO switch DISENGAGED
- Key switch in RUN position
- Spark plug lead connected to D05351ST Tester
- Meter positive (+) lead on numbered test point
- Meter negative (—) lead on engine ground

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8-13.2 volts	Test battery.
2. Key switch 220 Red wire and Starting Solenoid 210 Red wire	Battery voltage	Check battery cable connection, fuse and 220 Red wires. Replace as necessary.
3. Spark plug	Spark test indicates hot blue spark	Test ignition module. Check armature air gap, and flywheel magnets.
4. Engine connector 940 Wht wire	Infinite resistance	Check for shorted 940/941 Wht wires. Check for faulty key switch. Check for faulty PTO switch.

Test Conditions:

- S1 Key switch in OFF position
- Operator presence lever released

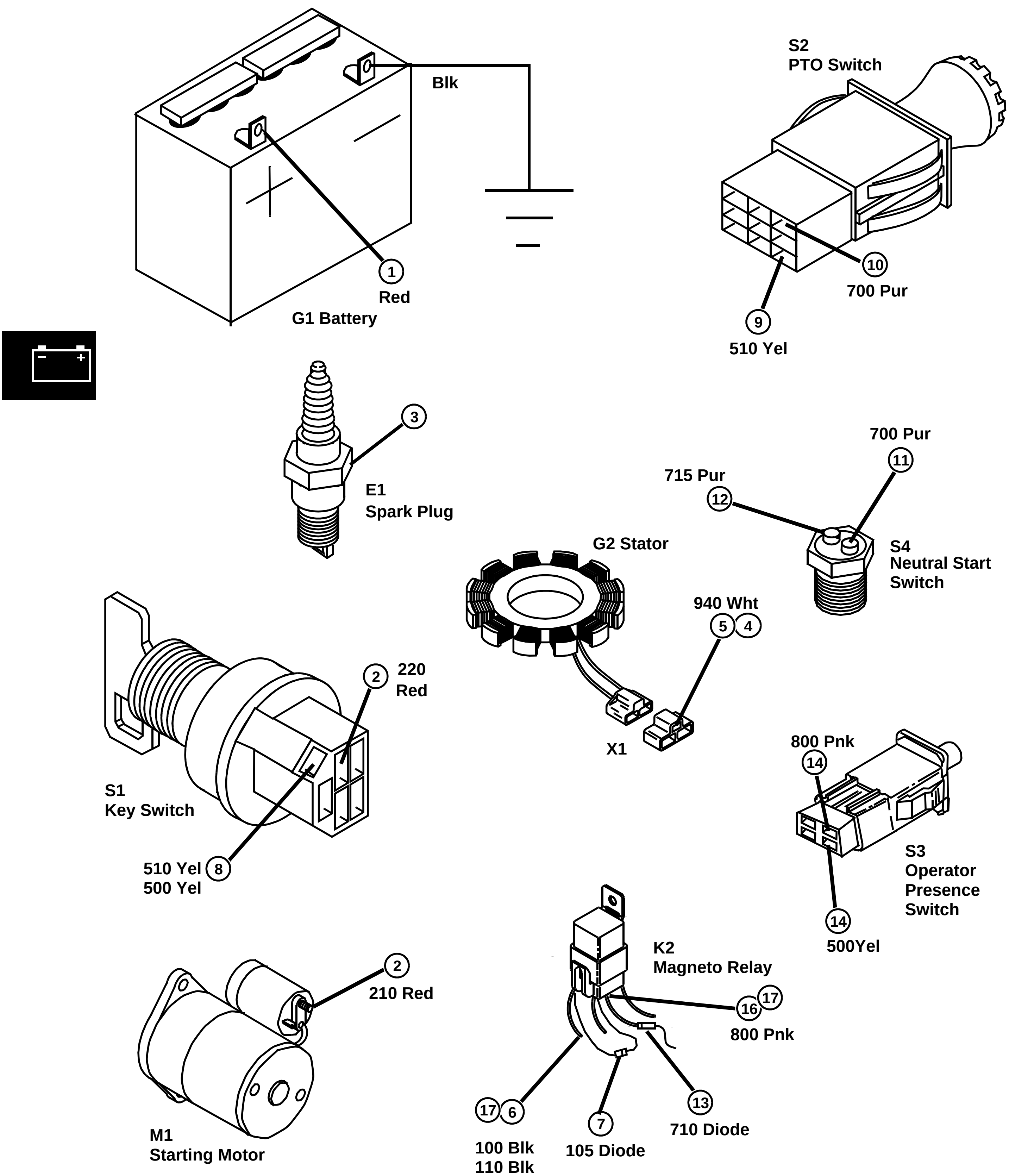
Test/Check Point	Normal	If Not Normal
5. Engine connector 940 Wht wire	Maximum 0.1 ohm	Check for open 940/941Wht wires. Check for open 115/110 Blk wires.
6. Magneto relay 100 Blk	Ground	Replace 100 Blk wire.
7. Magneto relay 105 Diode	Pass current in one direction only. See “DIODE TEST” on page 56.	Replace 105 Diode wire and/or V1 Diode.

Test Conditions:

- S1 Key switch in RUN position
- Operator presence lever DEPRESSED
- PTO switch DISENGAGED
- Transmission in NEUTRAL

8. Key switch 500/510 Yel wire	Battery voltage	Replace key switch.
9. PTO switch 510 Yel wires	Battery voltage	Replace 510 Yel wire.
10. PTO switch 700 Pur wire	Battery voltage	Replace PTO switch.
11. Neutral start switch 700 Pur wire	Battery voltage	Replace 700 Pur wire.
12. Neutral start switch 715 Pur wire	Battery voltage	Replace neutral start switch.

Test/Check Point	Normal	If Not Normal
13. Magneto relay – 710 Diode	Pass Current in one direction only. See “DIODE TEST” on page 56.	Replace diode.
14. Operator presence switch – 500 Yel wire	Battery voltage	Replace 500 Yel wire.
15. Operator presence switch – 800 Pnk wire	Battery voltage	Replace operator presence switch.
16. Magneto relay – 800 Pnk wire	Battery voltage	Replace 800 Pnk wire.
17. Magneto relay	If current present at 800 Pnk and ground 100 Blk, Check: Good relay should “click” and continuity should change from terminal 30 - 87A to 30 - 87.	Replace magneto relay.


Blk
1
Red
G1 Battery
S2
PTO Switch
10
700 Pur
9
510 Yel
3
E1
Spark Plug
700 Pur
11
715 Pur
12
S4
Neutral Start
Switch
G2 Stator
940 Wht
5 4
2 220
Red
X1
S1
Key Switch
510 Yel 8
500 Yel
800 Pnk
14
S3
Operator
Presence
Switch
14
500Yel
K2
Magneto Relay
2
210 Red
16 17
800 Pnk
13
710 Diode
17 6
100 Blk
110 Blk
7
105 Diode
M1
Starting Motor

CHARGING CIRCUIT OPERATION—KAWASAKI ENGINES

Function:

To provide electricity to operate electrical system and to maintain battery voltage between 11.8 and 13.2 volts, if equipped.

Operating Conditions:

The engine must be running for the charging system to operate.

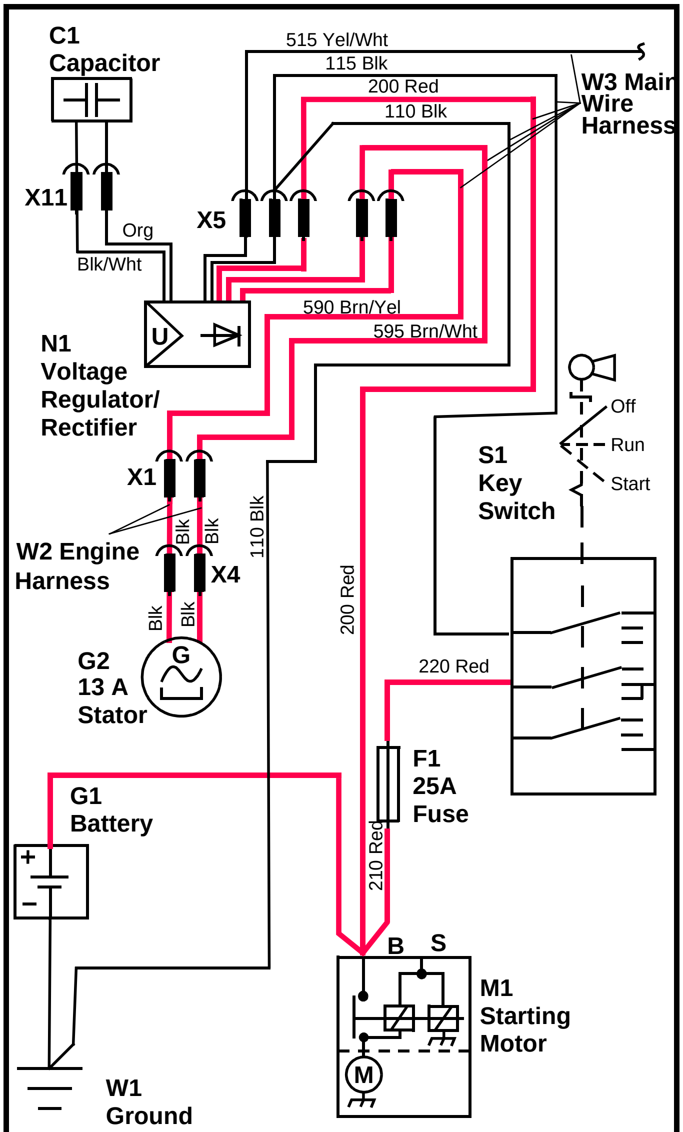
Theory of Operation:

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

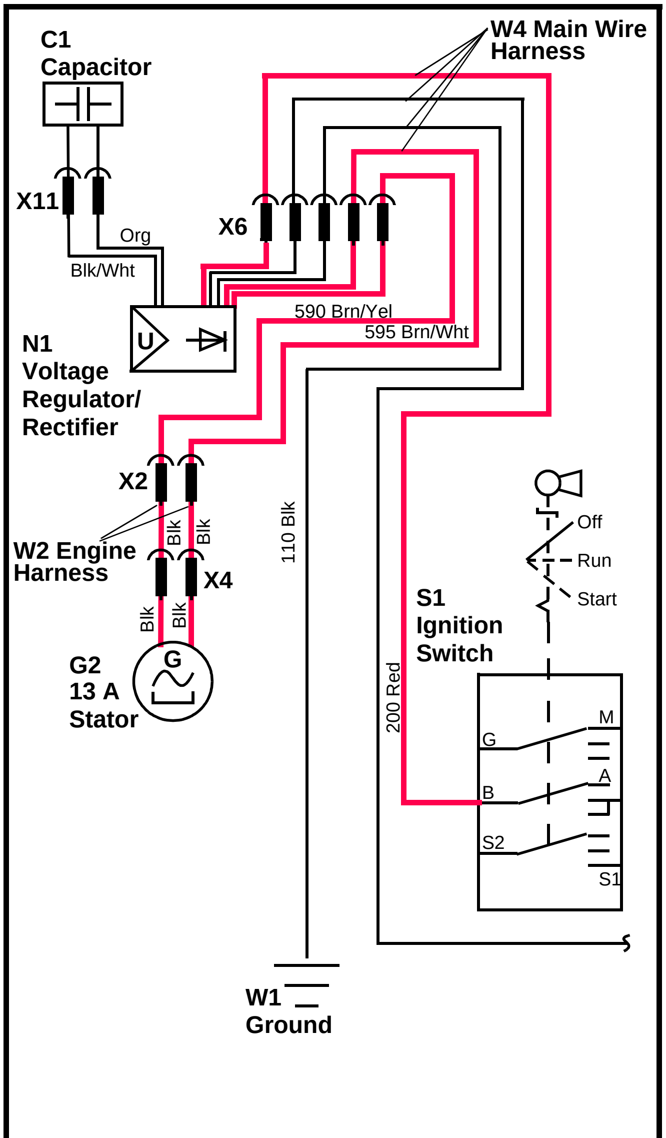
The key switch (S1) must be in the RUN position and the engine running for the charging circuit to be fully operational.

As the flywheel turns, several permanent magnets (located on the inside lip of the flywheel) induce AC current in the stator (G2) windings. The AC current flows through two wires to the voltage regulator/rectifier (N1). The voltage regulator/rectifier converts AC current to DC current needed to run the electrical systems and charge the battery (G1), if equipped.

The battery (G1) voltage is sensed by the voltage regulator/rectifier (N1) through the positive battery cable (red), and the 200 Red wire between the starting solenoid (K1) and voltage regulator/rectifier. If battery voltage is low, rectified DC current is released to charge the battery. When the battery is fully charged, the voltage regulator/rectifier stops the flow of DC current to the battery.



ELECTRIC START, BATTERY EQUIPPED MODELS



RECOIL START MODELS

CHARGING CIRCUIT DIAGNOSIS—KAWASAKI ENGINES

Test Conditions:

- Transmission in neutral, park brakes ON
- Voltage regulator/rectifier connector (X5 electric start motor, X6 recoil start motors) disconnected
- Key switch in RUN position
- Engine running at fast idle - 3350+/- 100 RPM
- Meter negative (-) lead on battery negative (-) terminal
- Meter positive (+) lead on numbered test point

Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8-13.2 volts	Test battery.
2. Engine connector from 590 Brn/Yel to 595 Brn/Wht	Minimum unregulated voltage output - FC401V, FC420V — 27 VAC FC540V — 30 VAC	Check flywheel magnets, if OK replace stator.
3. Rectifier connector 110 Blk wire	Ground	Check ground connection. Check/Replace 110 Blk wire.

Test Conditions:

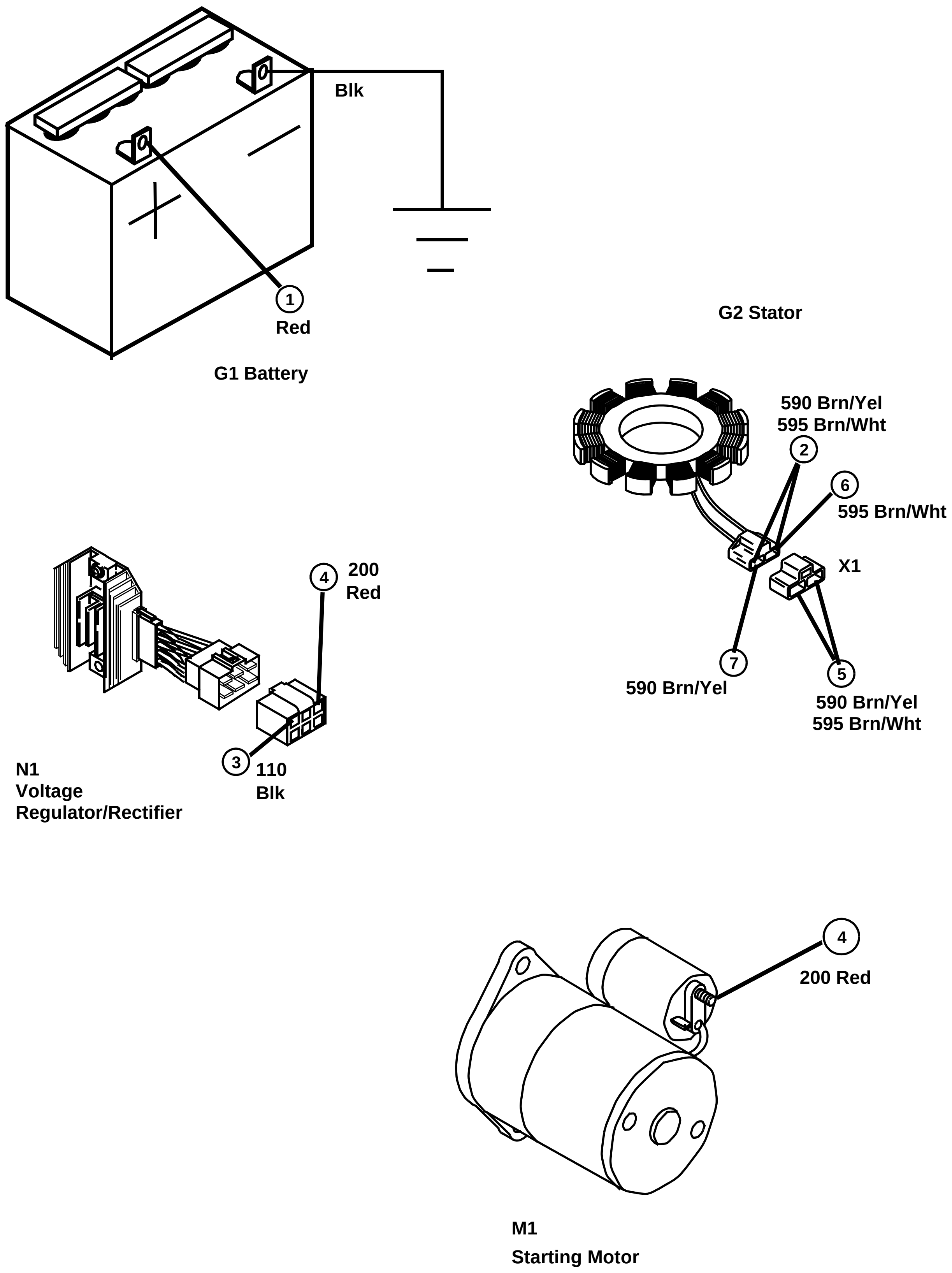
- Connect voltage regulator/rectifier connector (X5 electric start motor, X6 recoil start motors).

Test/Check Point	Normal	If Not Normal
4. Voltage regulator/rectifier to starting motor 200 Red wire	Battery voltage	Check battery positive cable connections, and 200 Red wire for breaks. Replace as required.
5. Engine connector from 590 Brn/Yel to 595 Brn/Wht	Minimum regulated output - 13 amps at 12.2-14.7 volts Voltage must stay below 14.7 volts	Clean and grease plug contacts with DuBois MPG-2®, retest. If not normal, replace voltage regulator/rectifier.

Test Conditions:

- Stop engine. Key switch in OFF position
- Disconnect engine connector X1

Test/Check Point	Normal	If Not Normal
6. Engine connector 595 Brn/Wht	Infinite resistance to ground	Check stator for short to ground. Replace stator.
7. Engine connector 590 Brn/Yel	Infinite resistance to ground	Check stator for short to ground. Replace stator.


Blk
1
Red
G1 Battery
G2 Stator
590 Brn/Yel
595 Brn/Wht
2
6
595 Brn/Wht
X1
7
590 Brn/Yel
5
590 Brn/Yel
595 Brn/Wht
4
200
Red
3
110
Blk
N1
Voltage
Regulator/Rectifier
4
200 Red
M1
Starting Motor

IGNITION CIRCUIT OPERATION—RECOIL START, KAWASAKI ENGINE

Function:

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

Operating Conditions:

To produce a spark, the key switch (S1) must be in the run position. The PTO switch must be off, and the neutral start switch must be in neutral.

Theory of Operation:

The ignition system is an electronic magneto design. Ignition timing is controlled by the ignition coil w/ module (T1) and is not adjustable.

Enough current is stored in the capacitor (C1) to charge the system and facilitate starting. It is not necessary to have a fully charged capacitor to start the system. Current is supplied from capacitor and/or the stator through voltage regulator/rectifier (N1) to key switch (S1) through the 200 red wire.

When the key switch is in the run position, the key switch eliminates one of the paths to ground, (W1 ground, 110 Blk, 115 Blk to key switch) for ignition current.

When the key switch is in the run position current passes through the key switch, and to the PTO switch (S2).

If the PTO switch is disengaged (open), power flows through the PTO switch to the neutral start switch (S4). If PTO switch is not disengaged the unit will not start.

If the neutral start switch indicates that the transmission is in neutral, switch closed, power flows through the neutral start switch to the magneto relay coil (K4). If the neutral start switch is open, indicating that the transmission is in gear, the unit will not start.

Upon activation of the magneto relay coil the second path to ground (established through circuit 710 diode, 115 Blk, 110 Blk to W1 ground) is removed from terminal 87A Thus allowing spark to be generated by the ignition coil w/ module (T1).

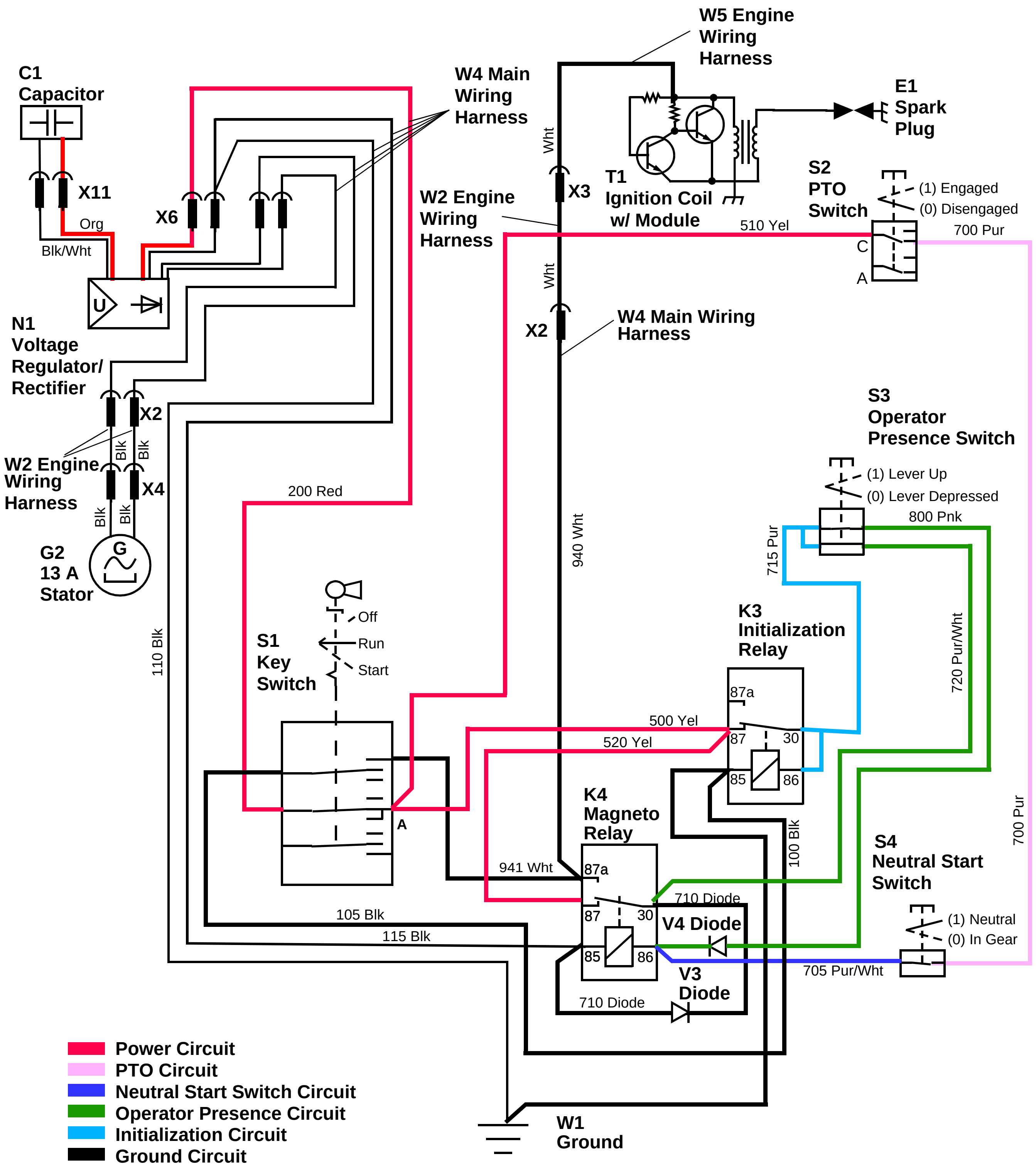
As the flywheel turns in the cranking circuit, a magnet in the flywheel produces current in the primary coil of the ignition coil w/ module (T1) by electromagnetic induction. When the primary current builds to its highest level, the ignition coil w/ module (T1) induces high voltage current into the secondary coil. This high voltage current then flows to the spark plug (E1) and jumps the spark plug gap and ignites the fuel/air mixture, causing the engine to start and run.

Also, once the engine is running and the magneto relay is held closed, a continuous supply of current from terminal “A” on the key switch through wire 500 Yel, 520 Yel to terminal “87” magneto relay, which is closed. Current flows through the magneto relay terminals “87”—”30”, through 720 Pur/Wht wire to the operator presence switch. Once the operator presence switch is depressed, current flows through the operator presence switch, latches the initialization relay, and provides power through wire 715 Pur, 800 Pnk, diode (V4), and wire 810 Pnk, to hold the magneto relay open during operation.

The engine can be stopped in either of two ways:

- Primary shut-off is controlled by turning the key switch to the off position, which establishes a ground at wire 941 Wht, - W1 ground, 110 Blk, 105 Blk to key switch. This provides a ground circuit to terminal 87a of the magneto relay and to wire 940 Wht which is connected to the ignition coil w/ module. This provides a path to ground and terminates spark generation.
- The engine will also be stopped if the operator releases the operator presence levers while the PTO switch is engaged and/or the transmission is in gear. In this circuit holding current is interrupted from key switch terminal “A” through wire 500 Yel, terminal “87” initialization relay, which is closed, wire 715 Pur, operator presence switch, 720 Pur/ Wht, 800 Pnk, diode (V4) and wire 810 Pnk. This provides a ground circuit to terminal 30 of the magneto relay from a ground through wires 110 Blk, voltage regulator/Rectifier, 115 Blk, and 710 diode. This provides a ground through the magneto relay from terminal 30 to terminal 87a of and to wire 940 Wht which is connected to the ignition coil w/ module. This provides a path to ground and terminates spark generation.

IGNITION CIRCUIT OPERATION—RECOIL START, KAWASAKI ENGINE



- Power Circuit
- PTO Circuit
- Neutral Start Switch Circuit
- Operator Presence Circuit
- Initialization Circuit
- Ground Circuit

IGNITION CIRCUIT DIAGNOSIS—RECOIL START, KAWASAKI ENGINE

When diagnosing an ignition problem, isolate magneto circuit from the ground circuit by separating engine connector (X2). If engine will not start, check the magneto circuit first. If the engine will not shutoff, check ground circuit. Remember the engine is stopped by grounding the ignition coil w/ module through the key switch, or magneto relay.

Test Conditions:

- Transmission in NEUTRAL
- PTO switch DISENGAGED
- Key switch in RUN position
- Spark plug lead connected to D05351ST Tester
- Meter positive (+) lead on numbered test point
- Meter negative (—) lead on engine ground

Test/Check Point	Normal	If Not Normal
1. Key switch 220 Red wire and starting solenoid 210 Red wire	11.8-13.2 volts	Check battery cable connection, fuse and 220 Red wires. Replace as necessary.
2. Spark plug	Spark test indicates hot blue spark	Test ignition coil w/ module. Check armature air gap, and flywheel magnets.
3. Engine connector 940 Wht wire	Infinite resistance	Check for shorted 940/941 Wht wires. Check for faulty key switch. Check for faulty PTO switch.

Test Conditions:

- Key switch in OFF position
- Operator presence lever released

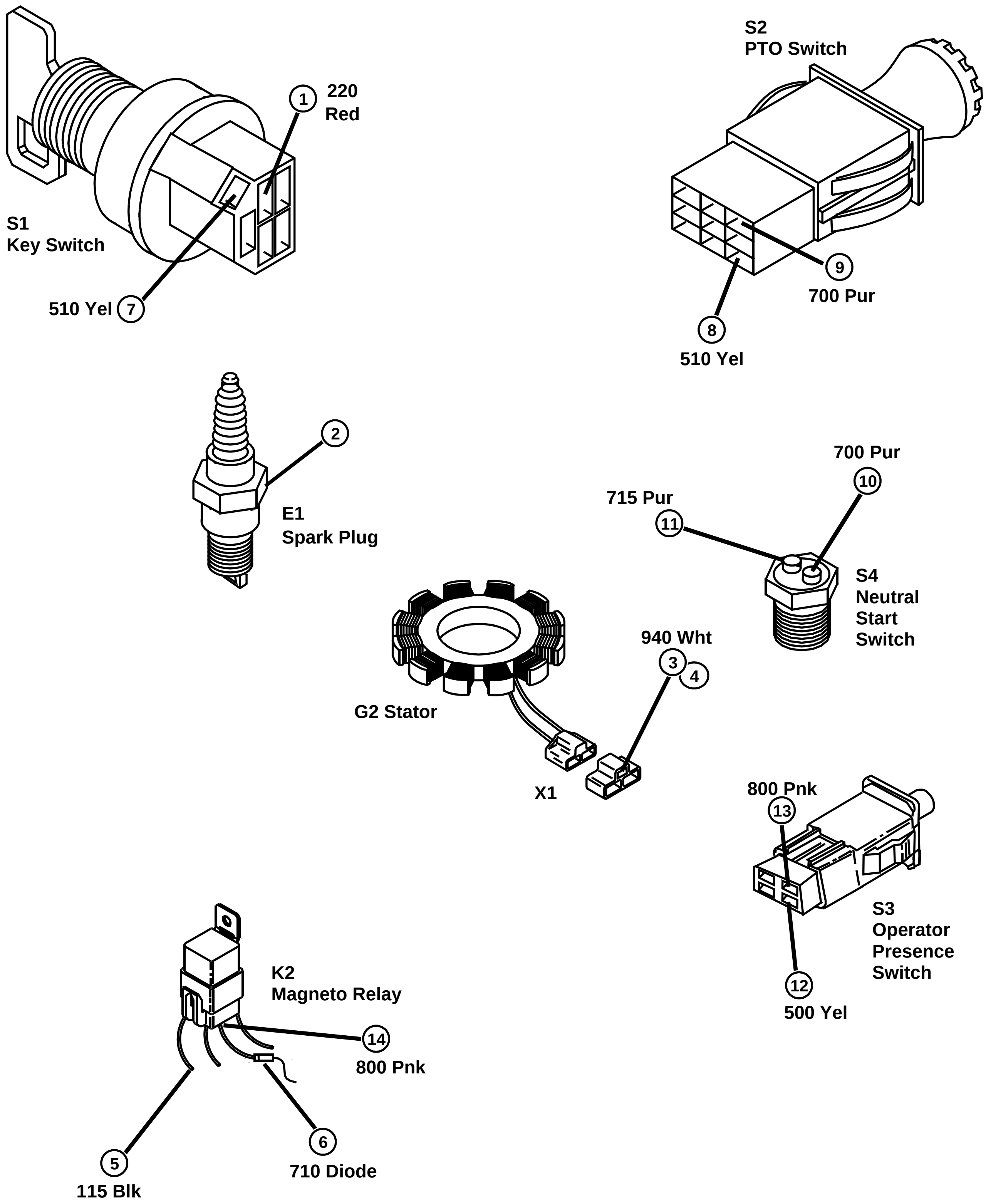
Test/Check Point	Normal	If Not Normal
4. Engine connector 940 Wht wire	Maximum 0.1 ohm	Check for open 940 Wht wire. Check for open 110 Blk wires.
5. Magneto relay 115 Blk	Ground	Replace 115 Blk wire.
6. Magneto relay 710 Diode	Pass current in one direction only. See “DIODE TEST” on page 56.	Replace 710 diode.

IGNITION CIRCUIT DIAGNOSIS—RECOIL START, KAWASAKI ENGINE

Test Conditions:

- Key switch in RUN position
- PTO switch disengaged
- Operator presence lever depressed
- Transmission in NEUTRAL

Test/Check Point	Normal	If Not Normal
7. Key switch 510 Yel wire	11.8-13.2 volts	Replace key switch.
8. PTO switch 510 Yel wires	11.8-13.2 volts	Replace 510 Yel wire.
9. PTO switch 00 Pur wire	11.8-13.2 volts	Replace PTO switch.
10. Neutral start switch – 700 Pur wire	11.8-13.2 volts	Replace 700 Pur wire.
11. Neutral start switch 705 Pur/ Wht wire	11.8-13.2 volts	Replace neutral start switch.
12. Operator presence switch 500 Yel wire	Battery voltage	Replace 500 Yel wire.
13. Operator presence switch 800 Pnk wire	Battery voltage	Replace operator presence switch.
14. Magneto relay 800 Pnk wire	Battery voltage	Replace 800 Pnk wire.
15. Magneto relay	If current present at 800 Pnk and ground 100 Blk, good relay should “click” and continuity should change from terminal 30 - 87A to 30 - 87.	Test/Replace magneto relay. See “RELAY TESTS” on page 57.


S1
Key Switch
1 220 Red
7 510 Yel
S2
PTO Switch
9 700 Pur
8 510 Yel
2
E1
Spark Plug
700 Pur
10
715 Pur
11
S4
Neutral
Start
Switch
940 Wht
3 4
G2 Stator
X1
800 Pnk
13
S3
Operator
Presence
Switch
12
500 Yel
K2
Magneto Relay
14
800 Pnk
6
710 Diode
5
115 Blk

PTO CIRCUITS OPERATION—ELECTRIC START, KAWASAKI ENGINES

Function:

To provide power to energize the PTO clutch.

Operating Conditions:

The key switch (S1) must be in the run position, the operator presence lever (S3) must be depressed and the PTO switch (S2) must be engaged. Engine does not have to be running for the PTO clutch to engage.

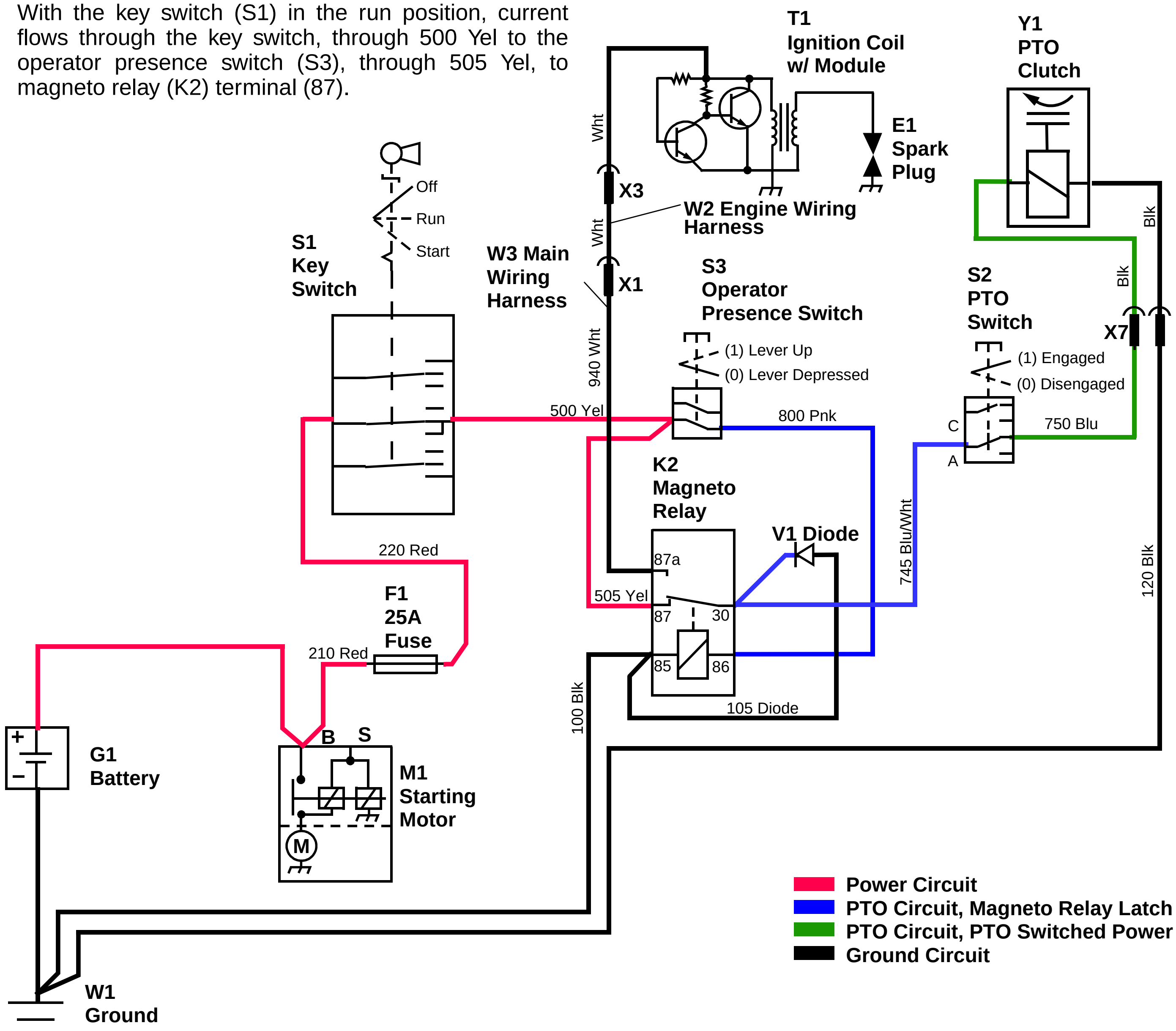
Theory of Operation:

Current flows from the battery (G1) positive terminal to the key switch (S1) through the starting motor (M1) connection point, 210 Red wire, 25A fuse (F1), and 220 Red wire.

With the key switch (S1) in the run position, current flows through the key switch, through 500 Yel to the operator presence switch (S3), through 505 Yel, to magneto relay (K2) terminal (87).

When the operator presence switch is depressed, current flows through the switch, through 800 Pnk to energize the magneto relay, completing the circuit from terminal (87) to terminal (30). Current then flows through wire 745 Blu/Wht to terminal (A) of the PTO switch (S2). If the PTO switch is energized (pulled out), current flows through the switch, to wire 750 Blu, which passes current to energize the PTO clutch (Y1) windings. The energized PTO clutch magnet pulls the PTO clutch brake away from the sheave plate, allowing the sheave plate to turn with the engine crankshaft.

If the operator releases the operator presence levers, the circuit is broken and the magneto relay will de-energize and release the PTO clutch. When the magneto relay is de-energized, a path to ground is established through 105 diode for the ignition circuit, and the engine will stop running. Once the engine has stopped running, the PTO switch (S2) must be pushed into the off position before the cranking circuit can be engaged to restart the engine.



PTO CIRCUIT DIAGNOSIS—ELECTRIC START, KAWASAKI ENGINES

Test Conditions:

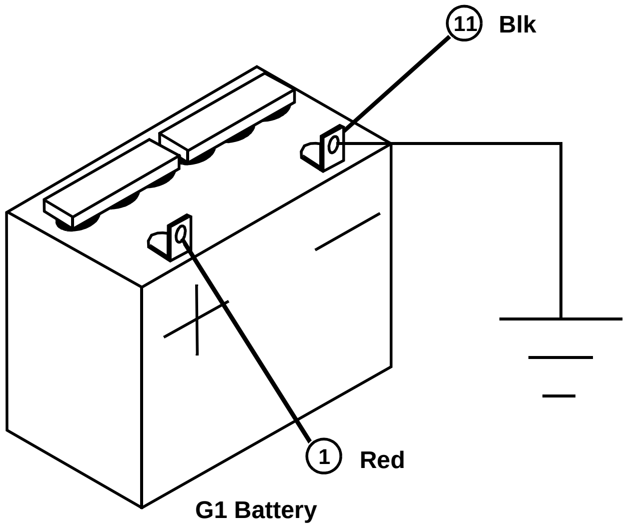
- Transmission in NEUTRAL
- Operator Presence Switch ENGAGED
- PTO switch ON (engaged)
- All electrical connectors connected in proper place.
- Key switch in RUN position
- Meter negative (—) lead on battery negative (—) terminal
- Meter positive (+) lead on numbered test point

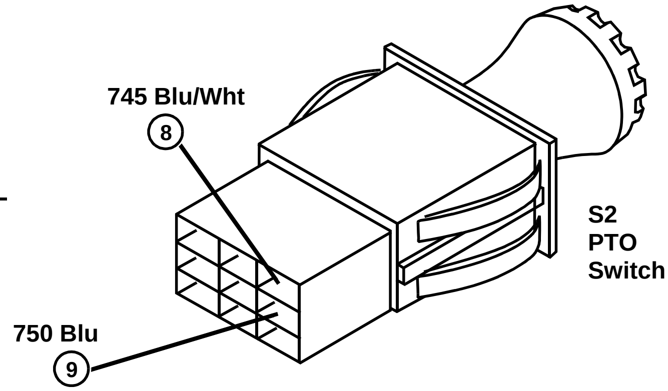
Test/Check Point	Normal	If Not Normal
1. Battery positive terminal	11.8-13.2 volts	Test battery.
2. Key switch 220 Red wire	Battery voltage	Check battery cable (red) connection, fuse 210 Red and 220 Red wire. Replace as required.
3. Key switch 500Yel wire	Battery voltage	Replace key switch (S1).
4. Operator presence switch 500 Yel wire	Battery voltage	Test 500 Yel wire. Replace as required.
5. Operator presence switch 800 Pnk wire	Battery voltage	Replace operator presence switch.
6. Magneto relay terminal 86 (800 Pnk wire)	Battery voltage	Test 800 Pnk wire. Replace as required.
7. Magneto relay terminal 30 (754 Blu/Wht wire)	Battery voltage	Replace magneto relay.
8. PTO switch 754 Blu/Wht wire	Battery voltage	Test 754 Blu/Wht wire. Replace as required.
9. PTO switch 750 Blu wire	Battery voltage	Replace PTO switch.
10. PTO clutch 750 Blu wire	Battery voltage	Test 750 Blu wire. Replace as required.

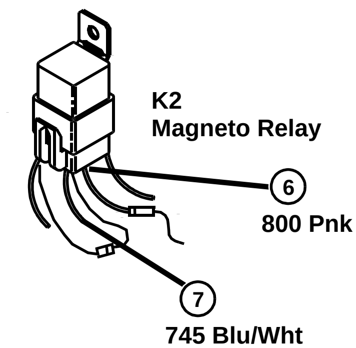
Test Conditions:

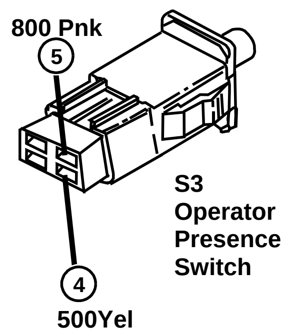
- Key switch in OFF position
- Disconnect PTO clutch harness connector X7

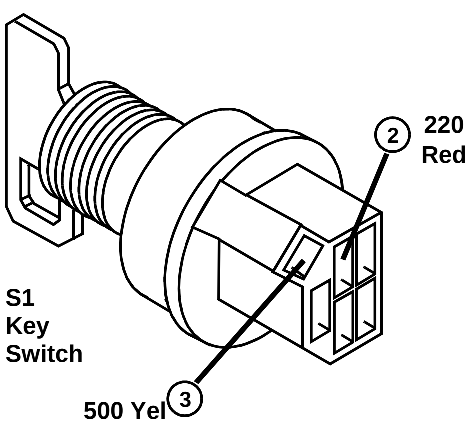
Test/Check Point	Normal	If Not Normal
11. PTO clutch 125 Blk wire	Maximum 0.1 ohm	Check PTO clutch, 125 Blk wire engine ground circuit, and battery negative cable ground connection.
12. Across PTO clutch terminals	Resistance between 3 and 10 ohms	If less than 3 or greater than 10 ohms resistance: Replace PTO clutch.

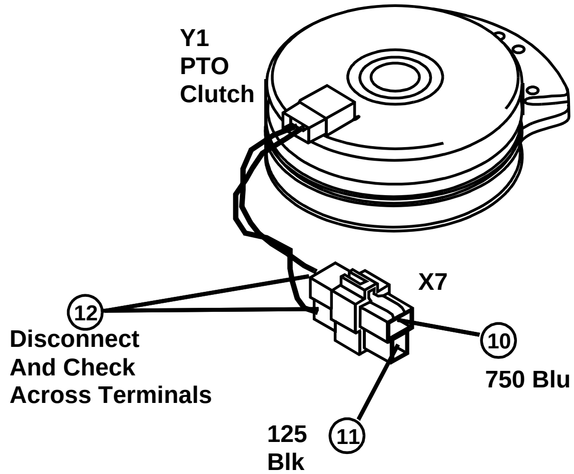

11 Blk
1 Red
G1 Battery


745 Blu/Wht
8
S2
PTO
Switch
750 Blu
9


K2
Magneto Relay
6
800 Pnk
7
745 Blu/Wht


800 Pnk
5
S3
Operator
Presence
Switch
4
500Yel


2 220
Red
S1
Key
Switch
500 Yel 3


Y1
PTO
Clutch
X7
12
Disconnect
And Check
Across Terminals
10
750 Blu
125
Blk
11

PTO CIRCUIT OPERATION—RECOIL START, KAWASAKI ENGINE

Function:

To provide power to energize the PTO clutch.

Operating Conditions:

The key switch (S1) must be in the run position, the operator presence lever (S3) must be depressed, the PTO switch (S2) must be engaged, and the engine must be running.

Theory of Operation:

Power to energize the PTO clutch is only available to the PTO switch when the engine is running and the operator presence switch is depressed.

Current flows from the voltage regulator/rectifier (N1) through 200 Red wire to the key switch (S1) terminal B.

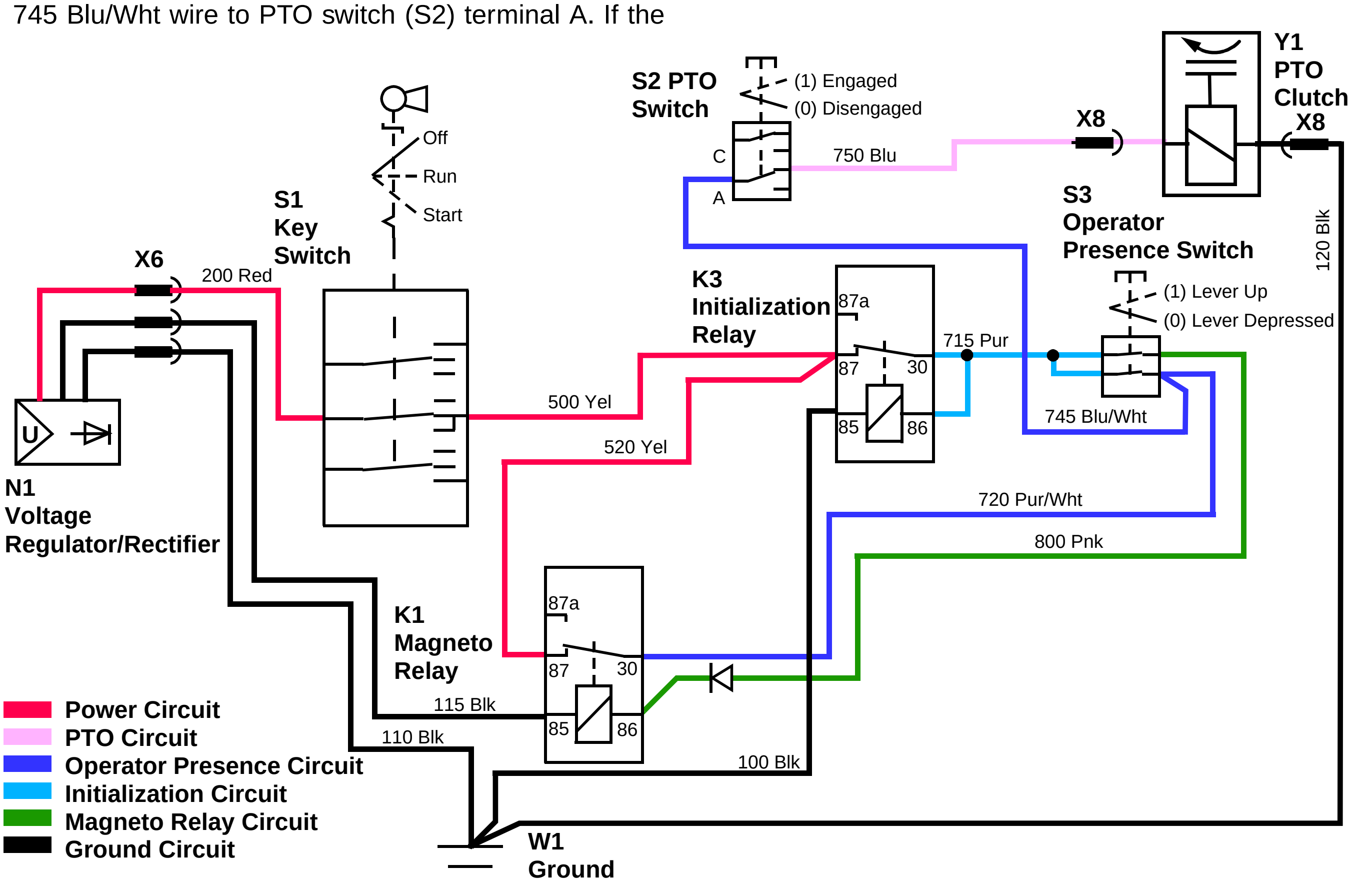
With the key switch (S1) in the run position, current flows through the 500 Yel wire to initialization relay (K3) terminal 87. Current also flows from initialization relay terminal 87 through 520 Yel wire to magneto relay (K1) terminal 87.

With the engine running, a current path has been established that closes the magneto relay, thus allowing current to flow from contact 30 through 720 Pur/Wht wire to the operator presence switch, through 745 Blu/Wht wire to PTO switch (S2) terminal A. If the PTO switch is engaged without first depressing the operator presence levers, the current path to the magneto relay will be broken and the engine will stop running. If the transmission is engaged without first depressing the operator presence levers, the current path to the magneto relay will be broken and the engine will stop running.

If the operator presence levers are depressed, current will flow through the operator presence switch and establish a latch circuit through the initialization relay which will provide power through the 800 Pnk wire, to hold closed the magneto relay as long as the operator presence lever is depressed.

Once the above parameters are met, the PTO switch may be energized (pulled out) and current will flow through the PTO switch to wire 750 Blu, which passes current to energize the PTO clutch (Y1) windings. The energized PTO clutch magnet pulls the PTO clutch brake away from the sheave plate, allowing the sheave plate to turn with the engine crankshaft.

If the operator releases the operator presence levers, the circuit is broken, and a path to ground is established, through terminal 87a magneto relay, for the ignition circuit, and the engine stops running (See IGNITION CIRCUIT OPERATION—RECOIL START, KAWASAKI ENGINE, on page 5-32). Once the engine has stopped running, the PTO switch must be pushed into the off position, and the transmission must be returned to neutral before the ignition circuit is re-established, enabling the operator to start the engine.



PTO CIRCUIT DIAGNOSIS—RECOIL START, KAWASAKI ENGINE

Test Conditions:

- Transmission in Neutral
- Operator presence switch released
- PTO switch OFF
- Engine running at fast idle - 3350 ± 100 rpm
- All electrical connectors connected in proper place
- Key switch in RUN position
- Meter negative (—) lead on battery negative (—) terminal
- Meter positive (+) lead on numbered test point

Test/Check Point	Normal	If Not Normal
1. Key switch 220 Red wire	12.2-14.7 volts	Test 220 Red wire. Replace as required.
2. Key switch 500 Yel wire	12.2-14.7 volts	Replace key switch (S1).
3. Initialization relay 500 Yel wire	12.2-14.7 volts	Test 500Yel wire. Replace as required.
4. Magneto relay terminal 87 (520 Yel wire)	12.2-14.7 volts	Test 520Yel wire. Replace as required.
5. Magneto relay terminal 30 (720 Pur/Wht wire)	12.2-14.7 volts	Check to make sure relay is pulled in. Test relay. Replace as required.
6. Operator presence switch 720 Pur/Wht wire	12.2-14.7 volts	Test 720 Pur/Wht wire. Replace as required.
7. PTO switch 745 Blu/Wht wire	12.2-14.7 volts	Test 745 Blu/Wht wire. Replace as required.

Test Conditions:

- Operator presence switch depressed
- PTO switch engaged

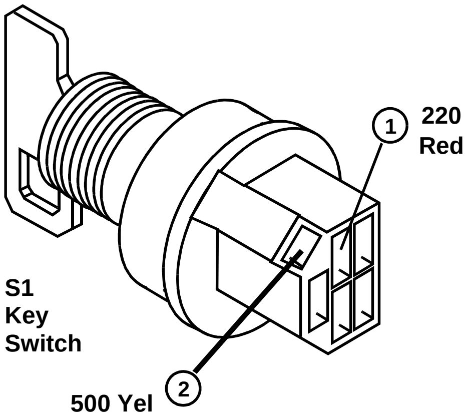
Test/Check Point	Normal	If Not Normal
8. PTO switch 750 Blu wire	12.2-14.7 volts	Replace PTO switch.
9. PTO clutch 750 Blu wire	12.2-14.7 volts	Test 750 Blu wire. Replace as required.
10. Operator presence switch 715 Pur wire	12.2-14.7 volts	Test operator presence switch. Replace as required.
11. Initialization relay	Engaged	Test 715 Pur wire. Test relay. Replace as required.
12. Magneto relay 810 Pnk wire	12.2-14.7 volts - Relay engaged	Test 810 Pnk wire. Test relay. Replace as required.

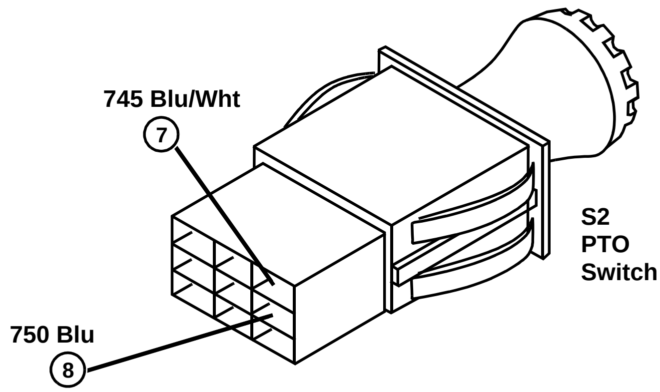
PTO CIRCUIT DIAGNOSIS—RECOIL START CONTINUED

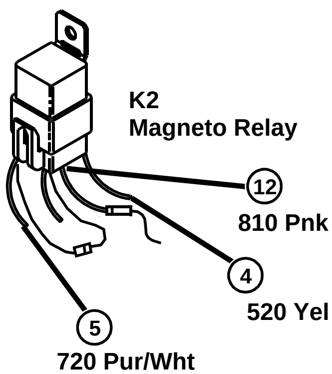
Test Conditions:

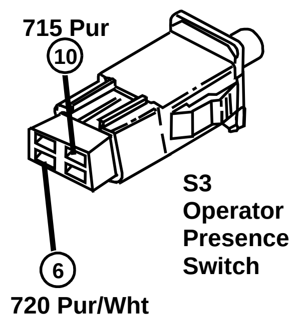
- Key switch in OFF position
- Operator presence switch released
- Engine NOT running
- Disconnect PTO clutch harness connector X8

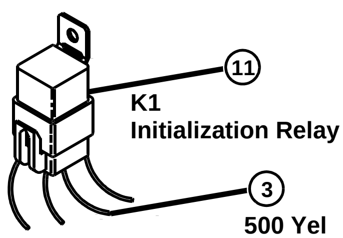
Test/Check Point	Normal	If Not Normal
13. PTO clutch 125 Blk wire	Maximum 0.1 ohm	Check PTO clutch 125 Blk wire, engine ground circuit, and battery negative cable ground connection.
14. Across PTO clutch terminals	Resistance between 3 and 10 ohms	If less than 3 or greater than 10 ohms resistance: Replace PTO clutch.

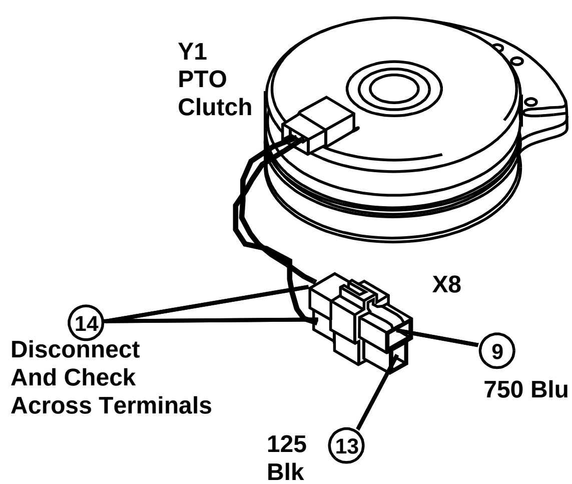

1
220
Red
S1
Key
Switch
2
500 Yel


745 Blu/Wht
7
S2
PTO
Switch
750 Blu
8


K2
Magneto Relay
12
810 Pnk
4
520 Yel
5
720 Pur/Wht


715 Pur
10
S3
Operator
Presence
Switch
6
720 Pur/Wht


11
K1
Initialization Relay
3
500 Yel


Y1
PTO
Clutch
X8
14
Disconnect
And Check
Across Terminals
9
750 Blu
125
Blk
13

IGNITION CIRCUIT OPERATION—RECOIL START, KOHLER ENGINE

Function:

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

Operating Conditions:

To produce a spark, the key switch (S1) must be in the RUN position. The PTO switch must be off, and the neutral start switch must be in neutral.

Theory of Operation:

The ignition system is an electronic magneto design. Ignition timing is controlled by the magneto and is not adjustable.

When the key switch is in the RUN position, the key switch eliminates one of the paths to ground, (W1 ground, 100 Blk to key switch) for ignition current.

This unit is equipped with a Delta Systems Ignition Control Module (Delta Module) which monitors the PTO switch (S2), neutral start switch (S4) and operator presence switch (S3). Depending on position of these switches the Delta Module makes or breaks a circuit from the magneto ignition coil 940/941 Wht wires through the Delta Module to ground through wires 105/110/100 Blk.

In order for the engine to start, the PTO switch must be disengaged, switch pushed down, and the neutral start switch must indicate the transmission is in neutral, switch closed. If these two conditions are met the Delta Module opens the second path to ground and will allow a spark to be generated by the ignition coil (T2).

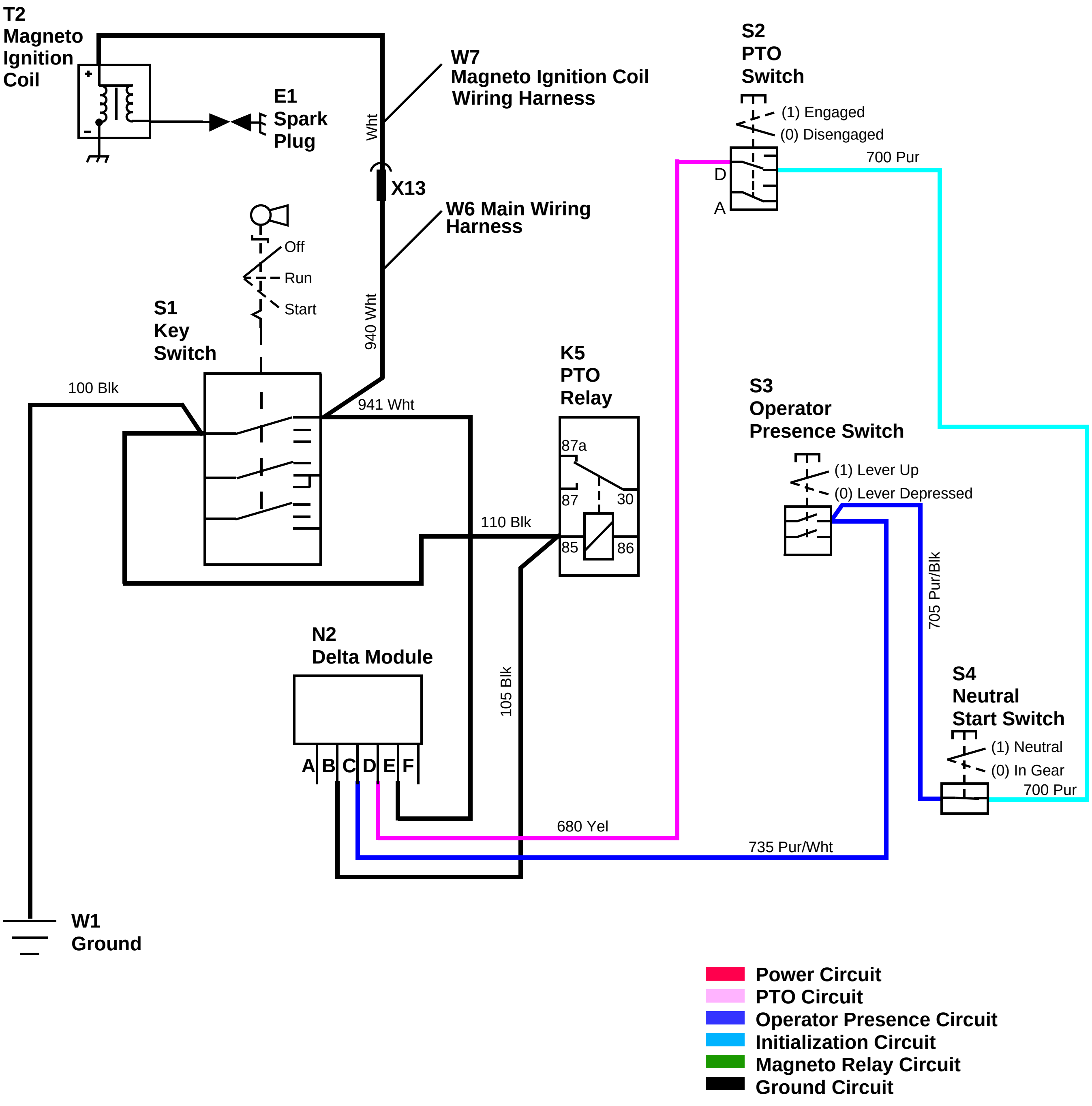
As the flywheel turns during cranking, a magnet on the flywheel produces current in the primary coil of the ignition coil (T2) by electromagnetic induction. When the primary current builds to its highest level, the ignition coil induces high voltage current into the secondary coil. This high voltage current then flows to the spark plug (E1) and jumps the spark plug gap and ignites the fuel/air mixture, causing the engine to start and run.

The engine will remain running as long as the transmission is in neutral and the PTO switch remains closed - or the operator presence switch is depressed. Once the operator presence switch is depressed the transmission can be shifted into gear and the PTO can be engaged and the engine will continue to run. If the operator presence switch is released while the transmission, and/or the PTO are engaged, the engine will stop running.

The engine can be stopped in either of two ways:

- Primary shut-off is controlled by turning the key switch to the off position, which establishes a ground through the key switch between 100 Blk and 941 Wht to the ignition coil. This provides a path to ground and terminates spark generation.
- The engine will also be stopped if the operator releases the operator presence levers while the PTO switch is engaged and/or the transmission is in gear. This interrupts the signal from the Delta module, which closes, and provides an internal ground through the Delta Module, connecting 105 Blk wire to 941/940 Wht wires, which are connected to the ignition coil. This provides a path to ground and terminates spark generation.

IGNITION CIRCUIT OPERATION—RECOIL START, KOHLER ENGINE



IGNITION CIRCUIT TEST POINTS—KOHLER ENGINE

When diagnosing an ignition problem, isolate magneto circuit from ground circuit by separating engine connector. If engine will not start check magneto circuit first and then check ground circuit. If engine will not shut off, check ground circuit. Remember engine is stopped by grounding ignition coil through either key switch, or the Delta Module through the operator presence switch, the transmission neutral start switch and PTO switch.

Test Conditions:

- Transmission in NEUTRAL
- Brake ENGAGED
- Key switch in RUN position
- PTO switch OFF (Disengaged)
- Engine connector X13 disconnected
- Spark plug lead connected to D05351ST Tester

Test/Check Point	Normal	If Not Normal
1. Spark plug	Spark test indicates hot blue spark	Replace ignition coil
		Check ignition coil air gap, and flywheel magnets

Test Conditions:

- Meter positive (+) lead on numbered test point
- Meter negative (—) lead on engine ground

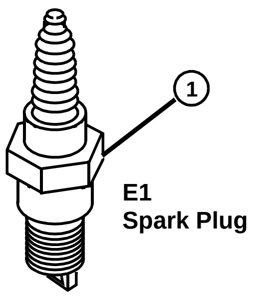
Test/Check Point	Normal	If Not Normal
2. Engine connector 940 white wire	Infinite resistance	Check for shorted 940/941 Wht wires
		Check for faulty key switch
		Check for faulty PTO switch
		Replace Delta Module
3. Delta module 105 Blk wire	Maximum 0.1 ohms	Check for open 100/110/105 Blk wires

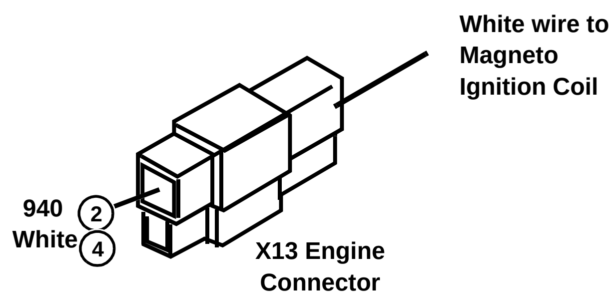
Test Conditions:

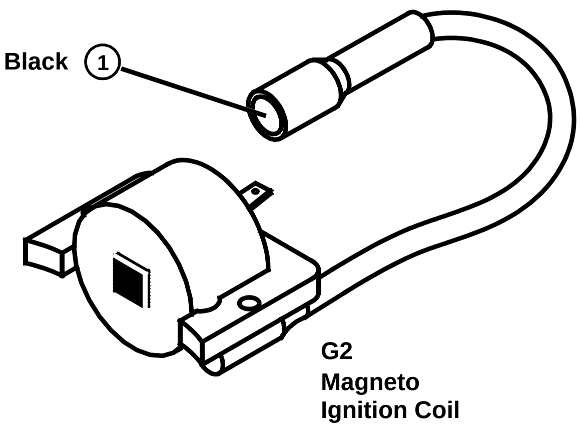
- Key switch in OFF position

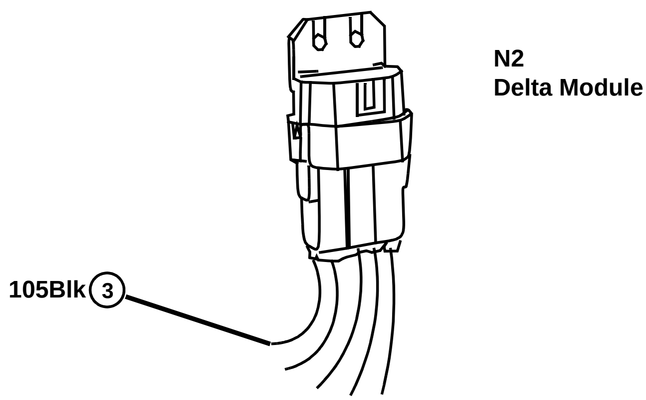
Test/Check Point	Normal	If Not Normal
4. Engine connector 940 white wire	Maximum 0.1 ohms	Check for open 940/941/942 Wht wires
		Check for open 100/110/105 Blk wires
		Replace Delta Module

IGNITION CIRCUIT TEST POINTS—KOHLER ENGINE









PTO CIRCUIT OPERATION—RECOIL START, KOHLER ENGINE

Function:

To provide power to energize the PTO clutch.

Operating Conditions:

The key switch (S1) must be in the run position, the operator presence lever (S3) must be depressed, the PTO switch (S2) must be engaged, and the engine must be running.

Theory of Operation:

Power to energize the PTO clutch is only available to the PTO switch when the engine is running and the operator presence switch is depressed.

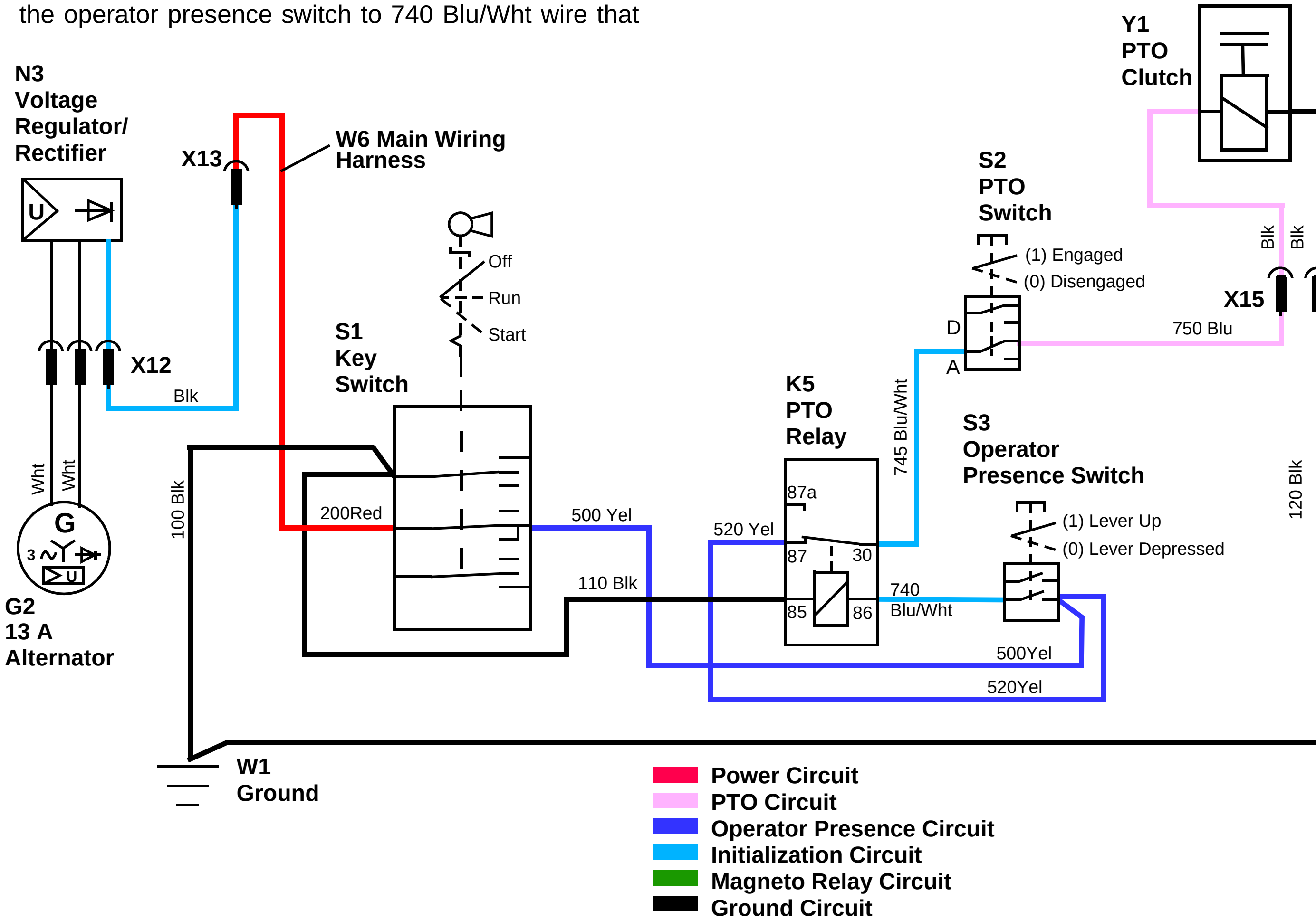
Current flows from the voltage regulator/rectifier (N3) through 200 Red wire to the key switch (S1).

With the key switch (S1) in the run position, current flows through the 500 Yel wire, to the operator presence switch and 520 Yel wire to PTO relay (K5) terminal 87.

With the engine running, and the operator presence switch depressed, a current path is established through the operator presence switch to 740 Blu/Wht wire that closes the PTO relay, thus allowing current to flow from contact 87 to contact 30 and then through 745 Blu/Wht wire to the PTO switch (S2) terminal A. If the PTO switch is engaged without first depressing the operator presence levers, the current path to the Delta Module will be broken and the engine will stop running. If the transmission is engaged without first depressing the operator presence levers, the current path to the Delta Module will be broken and the engine will stop running. See “IGNITION CIRCUIT OPERATION—RECOIL START, KOHLER ENGINE” on page 45.

Once the above parameters are met, the PTO switch may be energized (pulled out) and current will flow through the PTO switch to wire 750 Blu, which passes current to energize the PTO clutch (Y1) windings. The energized PTO clutch magnet pulls the PTO clutch brake away from the sheave plate, allowing the sheave plate to turn with the engine crankshaft.

If the operator releases the operator presence levers, the circuit is broken, and PTO relay is de-energized, terminating the power connection to 745 Blu/Wht wire. At the same time the current path to the Delta Module will be broken and the engine will stop running. Once the engine has stopped running, the PTO switch must be pushed into the off position, and the transmission must be returned to neutral before the ignition circuit is re-established, enabling the operator to start the engine.



PTO CIRCUIT DIAGNOSIS—RECOIL START, KOHLER ENGINE

Test Conditions:

- Transmission in NEUTRAL
- Operator presence switch OFF
- PTO switch OFF
- Engine running at fast idle - 3350 +/- 100 rpm
- All electrical connectors connected in proper place
- Key switch in RUN position
- Meter negative (—) lead on vehicle ground
- Meter positive (+) lead on numbered test point

Test/Check Point	Normal	If Not Normal
1. Voltage regulator/rectifier Blk wire	12.2-14.7 volts	Test voltage regulator/rectifier. Replace as required.
2. Key switch 200 Red wire	12.2-14.7 volts	Test 220 Red wire, engine connector X13 and/or Blk wire from voltage regulator/rectifier. Replace as required.
3. Key switch 500 Yel wire	12.2-14.7 volts	Test key switch (S1). Replace as required
4. Operator presence switch 500 Yel wire	12.2-14.7 volts	Test 500Yel wire. Replace as required.
5. PTO relay terminal 87 (520 Yel wire)	12.2-14.7 volts	Test 520Yel wire. Replace as required.

Test Conditions:

- Operator presence switch depressed
- PTO switch engaged

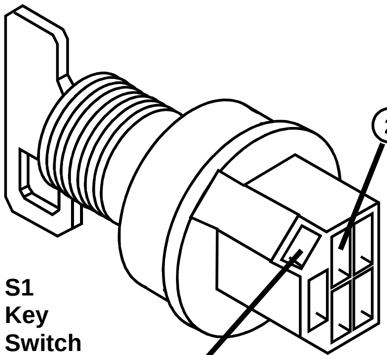
Test/Check Point	Normal	If Not Normal
6. Operator presence switch 740 Blu/Wht wire	12.2-14.7 volts	Test operator presence switch. Replace as required.
7. PTO relay terminal 86 (740 Blu/Wht wire)	12.2-14.7 volts	Test 740 Blu/Wht wire. Replace as required.
8. PTO relay terminal 30 (745 Blu/Wht wire)	12.2-14.7 volts	Test PTO relay. Replace as required.
9. PTO switch 745 Blu/Wht wire	12.2-14.7 volts	Test 745 Blu/Wht wire. Replace as required.
10. PTO switch 750 Blu wire	12.2-14.7 volts	Test PTO switch. Replace as required.
11. X15 PTO clutch connector 750 Blu wire.	12.2-14.7 volts	Test 700Pur wire. Replace as required.

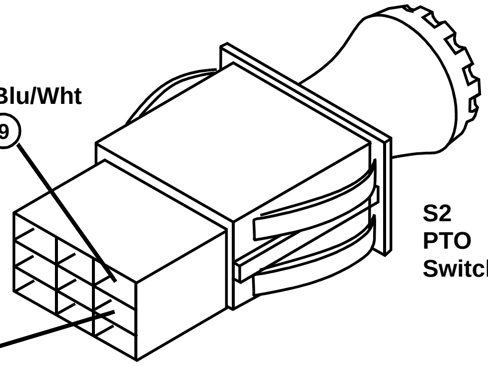
PTO CIRCUIT DIAGNOSIS—RECOIL START CONTINUED

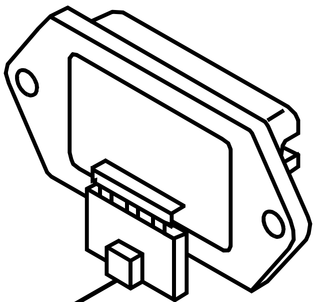
Test Conditions:

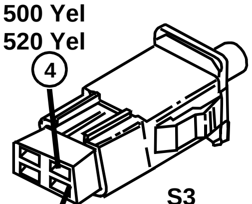
- Key switch in OFF position
- Operator presence switch released
- Engine NOT running
- Disconnect PTO clutch harness connector X15

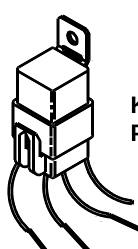
Test/Check Point	Normal	If Not Normal
12. PTO clutch 120 Blk wire	Maximum 0.1 ohm	Check PTO clutch 120 Blk wire, engine ground circuit, and ground connection.
13. Across PTO clutch terminals	Resistance between 3 and 10 ohms	If less than 3 or greater than 10 ohms resistance: Replace PTO clutch.

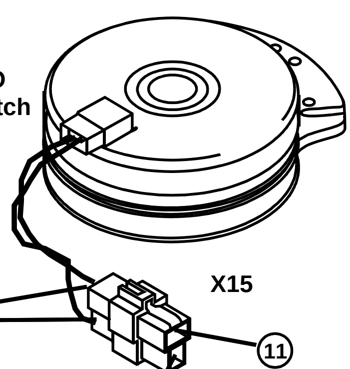

2
200
Red
S1
Key
Switch
3
500 Yel


745 Blu/Wht
9
S2
PTO
Switch
750 Blu
10


1
Black
N3
Voltage
Regulator/Rectifier


500 Yel
520 Yel
4
S3
Operator
Presence
Switch
6
740 Blu/Wht


K5
PTO Relay
7
740 Blu/Wht
8
745 Blu/Wht
5
520 Yel


Y1
PTO
Clutch
X15
13
Disconnect
And Check
Across Terminals
11
750 Blu
Connector
125
Blk
12

TESTS AND ADJUSTMENTS

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

Reason:

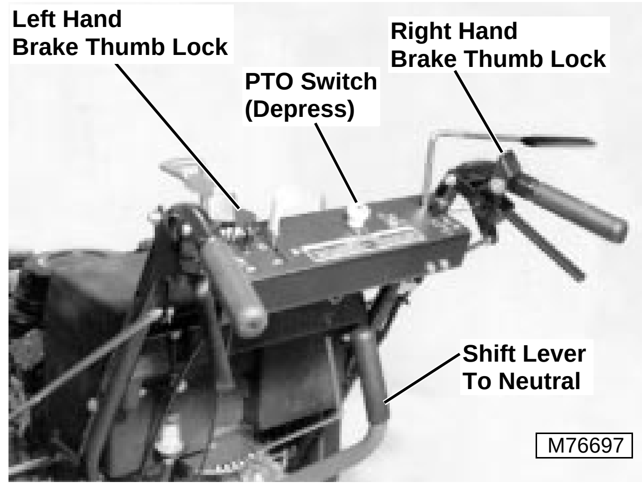
To check condition of battery and determine battery voltage.

Equipment:

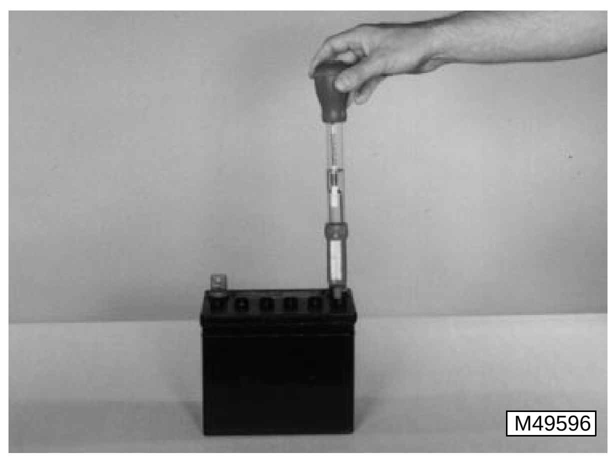
- Hydrometer
- Voltmeter or JTO5685 Battery Tester

Procedure:

1. Park machine on level surface.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.
6. Inspect battery terminals and case for breakage or cracks.
7. Check electrolyte level in each battery cell. Add clean, soft water as needed. If water is added, charge battery for **20 minutes at 10 amps**.
8. Remove surface charge by placing a small load on the battery for 15 seconds.



9. Use an 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 JTO5685 Battery Tester to check for a **minimum battery voltage of 12.4 volts**.

Results:

- If battery voltage is **less than 12.4 VDC**, charge battery (see Charge Battery).
- If battery voltage is **more than 12.4 VDC**, test specific gravity (see Step 9).

11. Install battery.

BATTERY CHARGING

Reason:

To increase battery charge after the battery has been discharged.

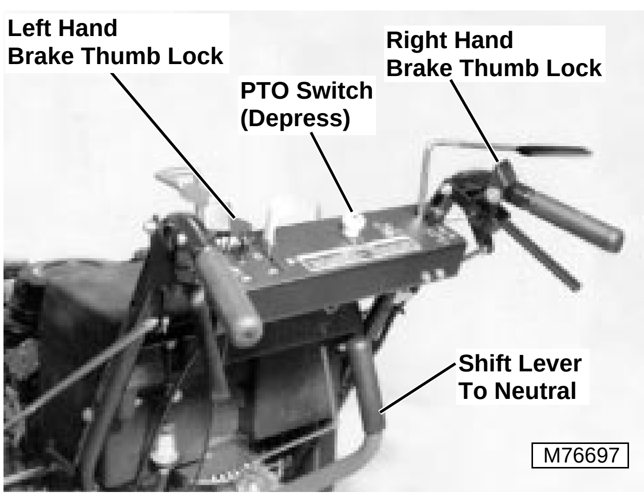
Equipment:

- Battery charger (variable rate)

Procedure:

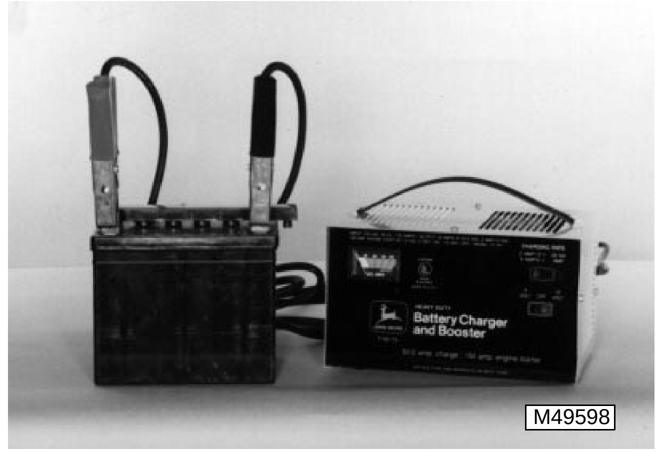
NOTE: See BATTERY TEST before charging battery.

1. Park machine on level surface.



M76697

2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Clean cable ends, battery terminals and top of battery.
5. Remove battery to workbench.



M49598

6. Connect variable rate charger to battery.
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 9 and 10.
- 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 Step 10 and 11.

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.

BATTERY LOAD TEST

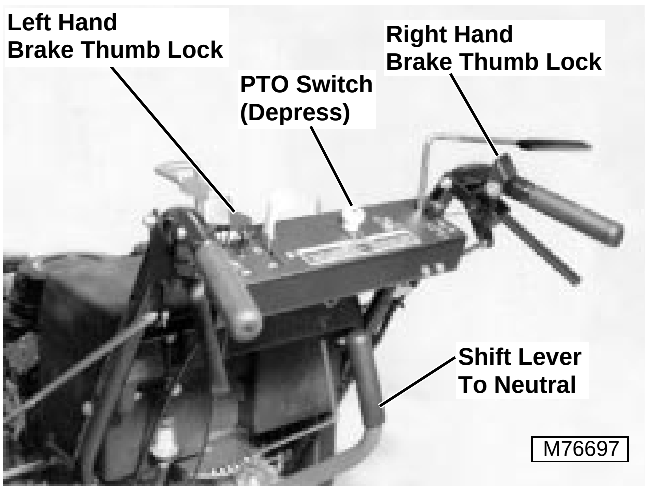
Reason:

To check condition of battery under load.

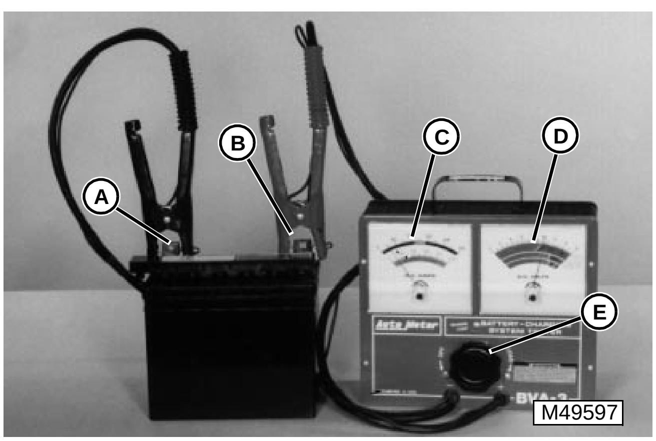
Equipment:

- JTO5685 Battery Tester

Procedure:



14. Put transmission in neutral. Disengage PTO.
15. Engage traction control levers and set **both** park brake thumb locks.
16. Clean cable ends, battery terminals and top of battery.
17. Remove battery.



18. Turn load knob (E) counterclockwise to OFF position.
19. Connect tester positive (red) cable to battery positive (+) terminal (B).
20. Connect tester negative (black) cable to battery negative (-) terminal (A).
21. Turn load knob (E) of tester clockwise (in) until amperage reading (C) is equal to:
   - Cold cranking amperage rating of battery (use blue scale).

   or

   - Three times ampere hour rating (use black scale).
22. Hold for 15 seconds and turn load knob (E) of tester counterclockwise to OFF position.
23. Repeat Steps 8 and 9 above and read condition of battery at DC Volts scale (D).

Results:

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

UNREGULATED VOLTAGE OUTPUT TEST—KAWASAKI ENGINES

Reason:

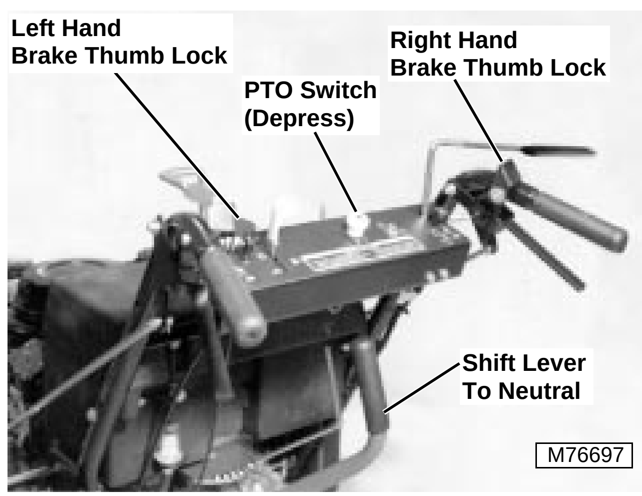
To measure stator voltage output to determine stator condition.

Equipment:

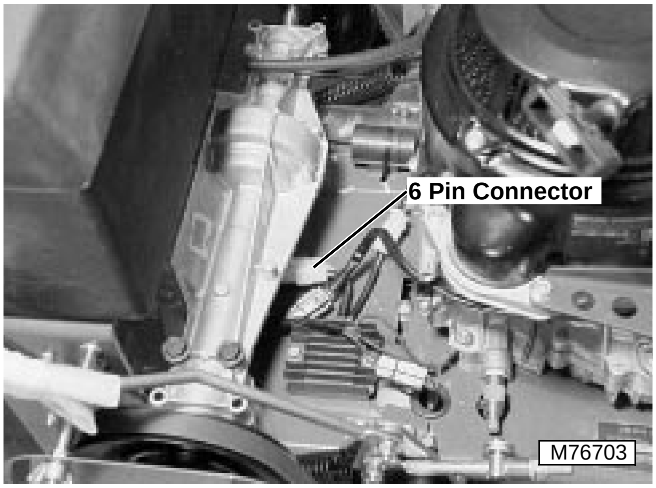
- JTO5791 Digital Multimeter

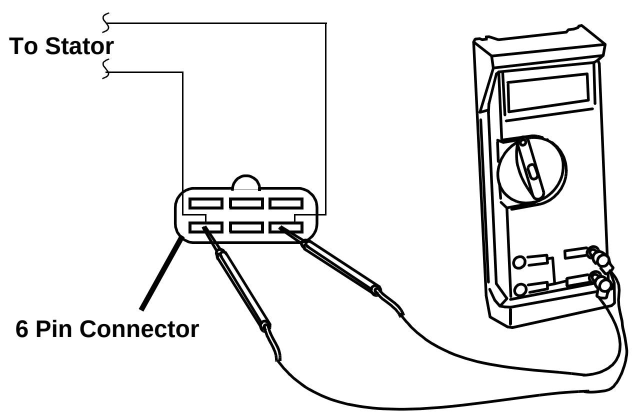
Procedure:

1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Remove key from switch.





5. Disconnect stator 6-pin connector.
6. Set voltmeter to 50 volt AC scale.
7. Connect meter leads across terminals of connector.
8. Start and run engine at fast idle.
9. Measure stator output voltage.

Specifications:

FC420V/FC540V . . . . 3350 ± 50 rpm
Minimum Stator Output Voltage (AC) . . . . . . 26 VAC

Results:

- If voltage is less than specifications, test flywheel magnet and then replace stator.

UNREGULATED VOLTAGE OUTPUT TEST—KOHLER ENGINE

Reason:

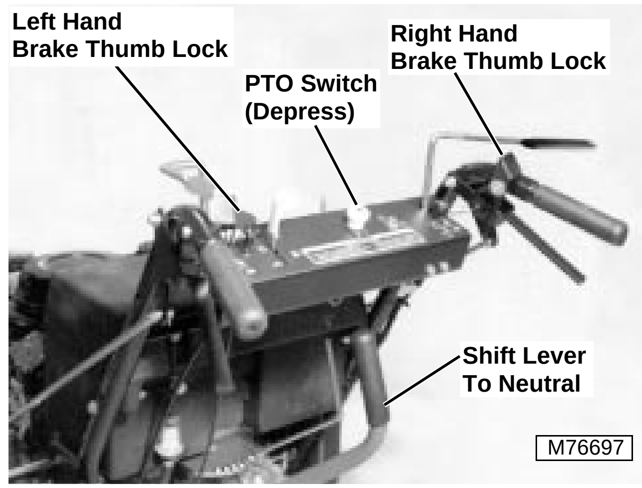
To measure stator voltage output to determine stator condition.

Equipment:

- JTO5791 Digital Multimeter

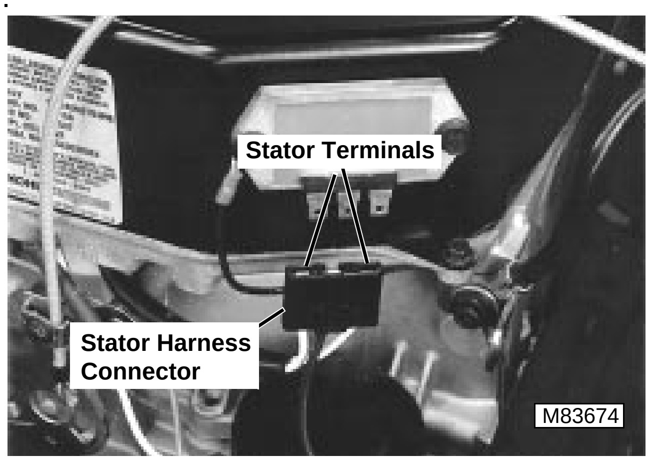
Procedure:

1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Remove key from switch.

.



5. Disconnect voltage regulator/rectifier 3-pin connector.
6. Set voltmeter to 50 volt AC scale.
7. Connect meter leads across stator terminals (white wires).
8. 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 MAGNETS TESTS” on page 37 of ENGINE SECTION.

KEY SWITCH TEST

Reason:

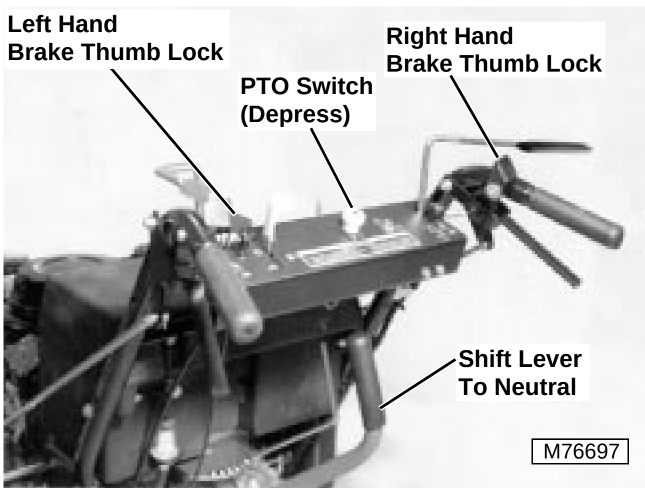
To insure that key switch terminals have continuity in all key switch positions.

Equipment:

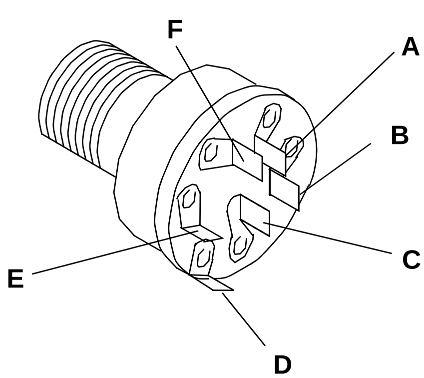
- JTO5791 Digital Multimeter

Procedure:

1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Remove key from switch.
5. Remove nut securing switch in control panel.
6. Remove switch out the bottom of the control panel.
7. Disconnect switch from wiring harness connector.



8. Check for continuity using JTO5791 Digital Multimeter and following table:

Key Switch Continuity

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

Results:

If switch fails any of the above continuity tests, replace switch.

IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control. DO NOT substitute any other grease for electrical connector corrosion control.

DIODE TEST

Reason:

To insure that diodes are passing current in only one direction.

Equipment:

- JTO5791 Digital Multimeter
- JDG374 Soldering Iron

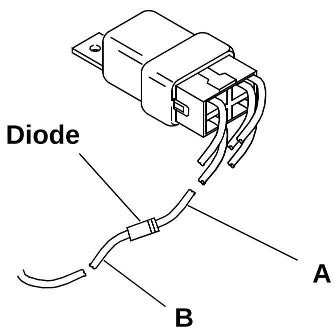
Procedure:

1. Remove shrink tube from diode to be tested.

IMPORTANT: DO NOT use AC resistance type soldering gun to unsolder/solder diodes. Current flux and/or magnetic field generated by this type of gun can damage diode.

NOTE: Orientation of diode. Diode must be installed in correct direction.

2. Unsolder the diode from the electrical harness using JDG374 Soldering Iron.



3. Using an ohmmeter, connect the black test lead to A and the Red test lead to B, and check continuity.
4. Reverse the test leads and check continuity.
5. Re-solder diode in harness. Replace shrink tube.

Results:

1. If continuity is noted in both steps 3 & 4, the diode is defective and must be replaced.
2. If continuity is noted in only one direction diode is good.

DELTA MODULE

The Delta Module contains no serviceable components.

Because of complex internal microcircuitry there are no reliable test that can be performed on this unit. If the delta module is suspected to be bad, replace it with a known good module.

Whenever the wiring harness is disconnected from the delta module, be sure to pack electrical connector with approved dielectric grease before reassembly.

IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control. DO NOT substitute any other grease for electrical connector corrosion control.

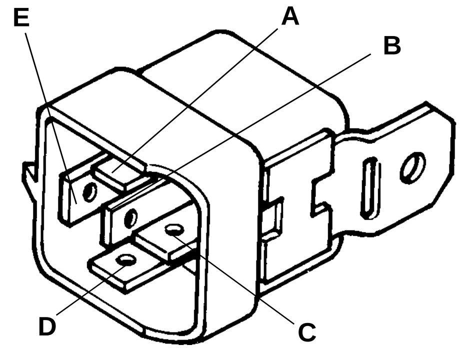
RELAY TESTS

NOTE: All relays are identical and are tested the same way.

Equipment:

- JTO5791 Digital Multimeter

Procedure:



M56509

1. Remove relay to be tested from the vehicle.

NOTE: Relays are factory sealed with Silicone sealant. Separate relay from base with care so as not to damage relay or base.

2. Using a 12V battery and test leads, connect the battery POS (+) lead to terminal (A) and the battery NEG (-) lead to terminal (D).
3. With the relay energized, check for continuity between (C) and (E) terminals.
4. Replace the relay if it fails this test.
5. Remove the battery test leads and check that there is continuity between (C) and (B).

Results:

If relay fails to show conitiuity in steps 3 and 5 above, replace relay.

IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control. DO NOT substitute any other grease for electrical connector corrosion control.

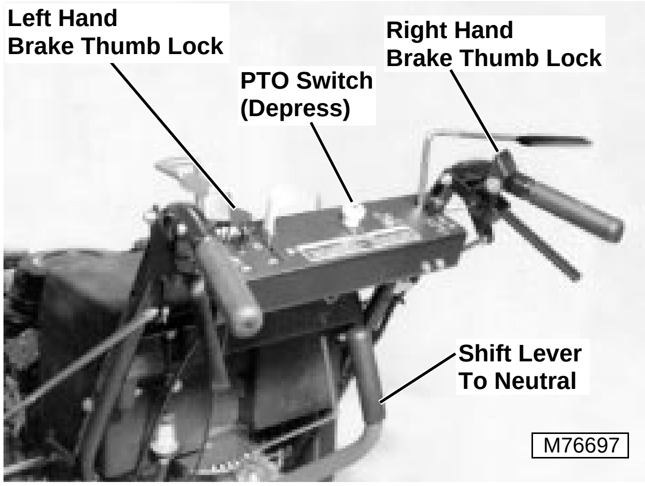
NEUTRAL START SWITCH TEST—GS MODELS

Tools Needed:

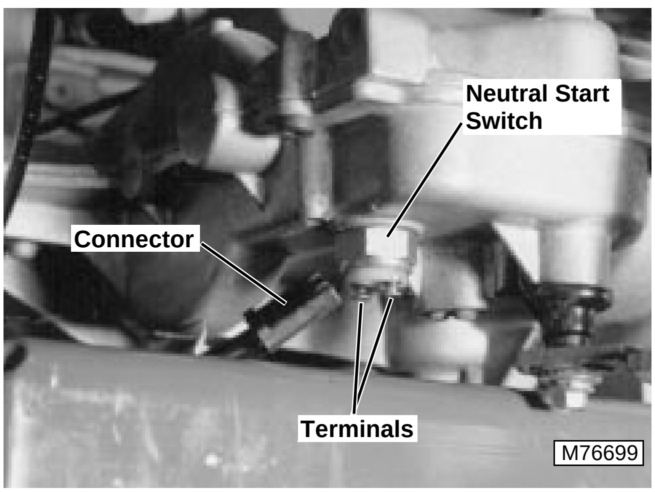
- JTO5791 Digital Multimeter

Procedure:

1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Put key switch in off position, remove key.
5. Disconnect spark plug wire.



6. Disconnect transmission neutral start switch wiring harness connector.
7. Check for continuity across terminals (transmission in neutral).
8. Shift transmission into gear. Check for **NO** continuity across terminals.

Results:

- Switch should have continuity only when the transmission is in neutral. If otherwise, replace switch.
- If replacement switch does not correct problem, check for wear in transmission shift linkage - This will require that transmission be disassembled.

IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control.
DO NOT substitute any other grease for electrical connector corrosion control.

OPERATOR PRESENCE SWITCH TEST

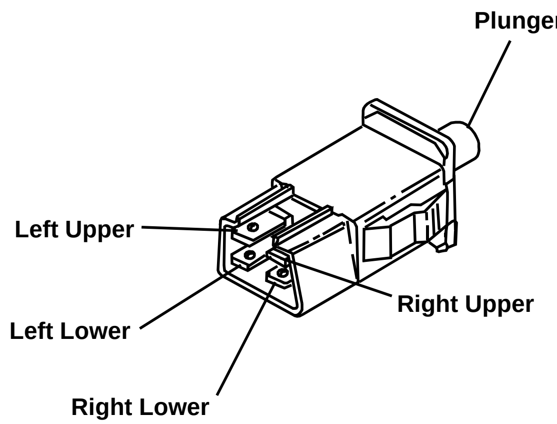
Reason:

To insure that operator presence switch terminals have correct continuity.

Equipment:

- JTO5791 Digital Multimeter

Procedure:



1. Remove the switch and inspect the plunger for flat spots and freedom of movement. Replace the switch if plunger end is rough, worn or if plunger does not move smoothly.
2. Using an ohmmeter, place one lead of the ohmmeter on the right lower terminal and touch the other lead to the right upper terminal (looking at the end of the terminal end of the switch, see illustration). The ohmmeter **Should Not** show continuity until the switch is actuated (plunger depressed). Continuity should be indicated until the plunger is released. If not, replace switch.
3. Place one lead to the left lower terminal and touch the other lead to the left upper terminal (looking at the end of the terminal end of the switch, see illustration). The ohmmeter **Should Not** show continuity until the switch is actuated (plunger depressed). Continuity should be indicated until the plunger is released. If not, replace switch.
4. There should NEVER be continuity between both upper or both lower terminals.

Results:

If switch fails any of the above tests replace switch.

**IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control.
DO NOT substitute any other grease for electrical connector corrosion control.**

PTO CLUTCH TEST

Reason:

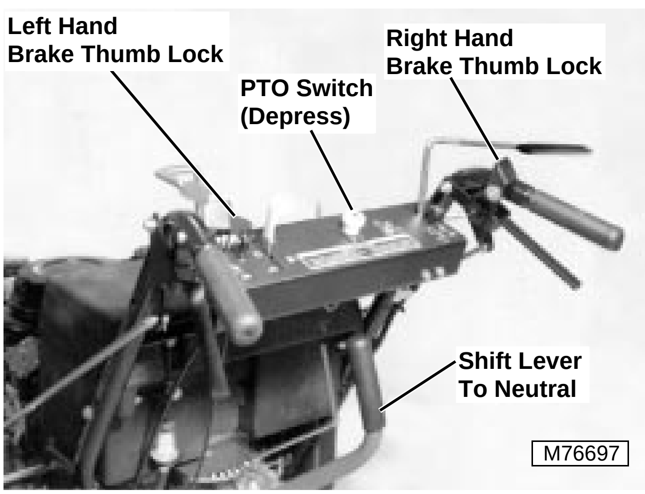
To check condition of PTO clutch coil and to check operation under load.

Equipment:

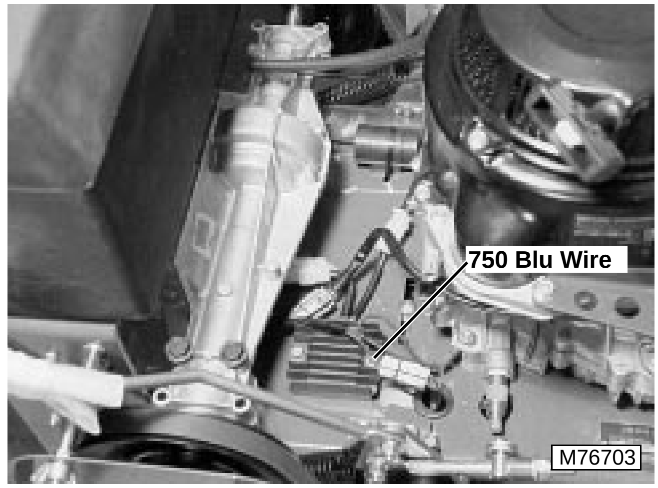
- JTO 5712 Current Gun

Procedure:

1. Park mower in a clear flat area.



2. Put transmission in neutral.
3. Disengage PTO.
4. Engage traction control levers and set **both** park brake thumb locks.



5. Put current gun over PTO clutch 750 Blu wire.
6. Start engine and run at slow idle.
7. Engage the PTO switch.
8. Depress operator levers.
9. Measure PTO clutch current draw.

Results:

Minimum PTO clutch current draw should be **4 amps**.

NOTE: Low current will cause weak PTO engagement. If current draw is low, replace clutch.

PTO CLUTCH ADJUSTMENT

Reason:

To set initial PTO clutch air gap at a specific dimension and check blade stop time.

Equipment:

- 0.51 mm (0.020 in.) Feeler Gauge
- Stop Watch

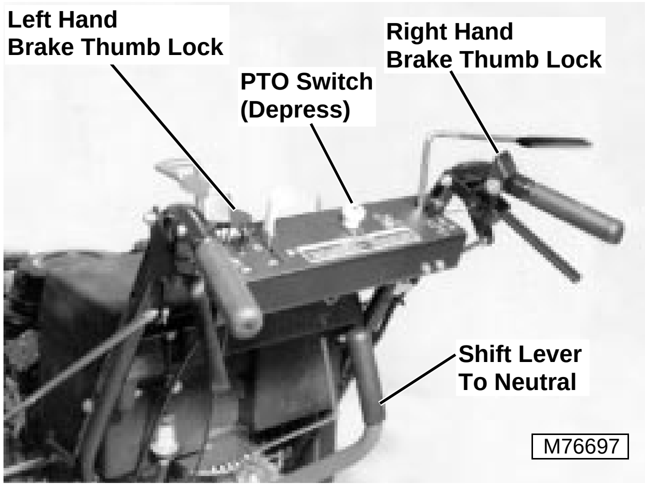
Procedure:

IMPORTANT: If a new PTO clutch has been installed it must be “broken in” before unit is put in service. To break-in a new clutch:

- Start engine and push throttle lever to full throttle position.
- With no load on mower, engage PTO and allow mower to run for 10 seconds. Disengage PTO and wait 10 seconds.
- Repeat the above step for 12 to 15 cycles

• The PTO clutch is now properly broken in.

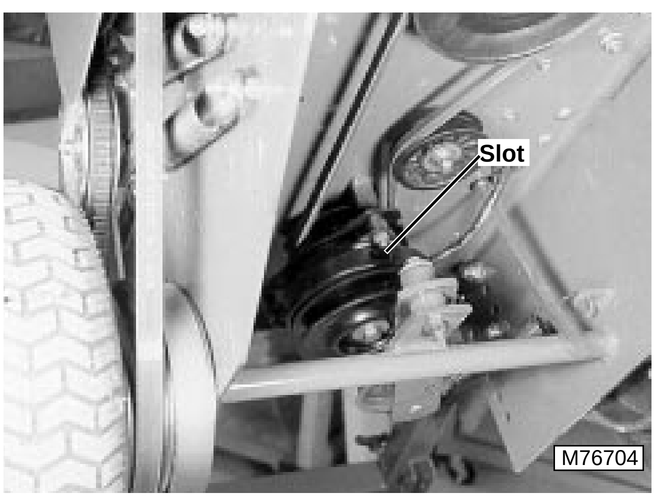
1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Put key switch in off position, remove key.
5. Disconnect spark plug wire.

NOTE: The PTO clutch air gap dimension is an initial setting only. Use blade stop time to make final PTO clutch air gap adjustment.

> **⚠ CAUTION**
>
> **Turn engine off, remove key, and disconnect spark plug before performing any adjustment on PTO clutch!**



6. 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.
7. Check air gap at all three slots.
8. Adjust air gap by moving nuts in required direction.
9. Reconnect spark plug.
10. Start and run the engine at half throttle.
11. Engage PTO switch.
12. Depress the operator levers.
13. Watch the mower drive belt to determine blade stop time. Time the interval between depressing the PTO switch and belt stopping. (It may be easier to have someone else time while the operator runs the machine.)

Results:

- Belt should stop in **less** than **six (6) seconds**. If belt does not stop in specified time turn all three adjusting nuts IN 1/4 turn and recheck belt stop time.
- If belt stops in **less** than **three (3) seconds**, turn all three nuts OUT 1/4 turn and recheck belt stop time.

Engage and disengage the PTO clutch several times. Recheck adjustment.

PTO SWITCH TEST

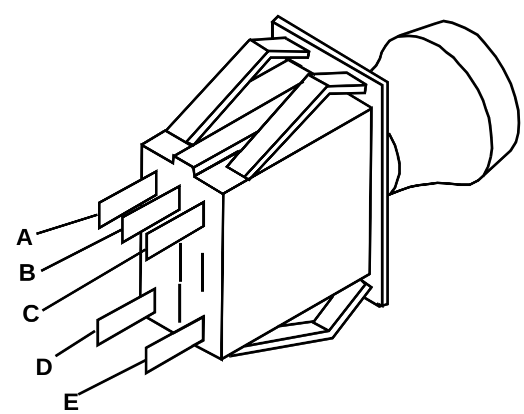
Reason:

To ensure terminal continuity is correct in the on and off positions.

Equipment:

- JTO5791 Digital Multimeter

Procedure:



1. Remove the PTO switch and perform the following tests with an ohmmeter.
2. With the switch OFF (pushed in), check for continuity between (A and C) and (D and E).
3. With the switch ON (pulled out), check for continuity between (B and C).

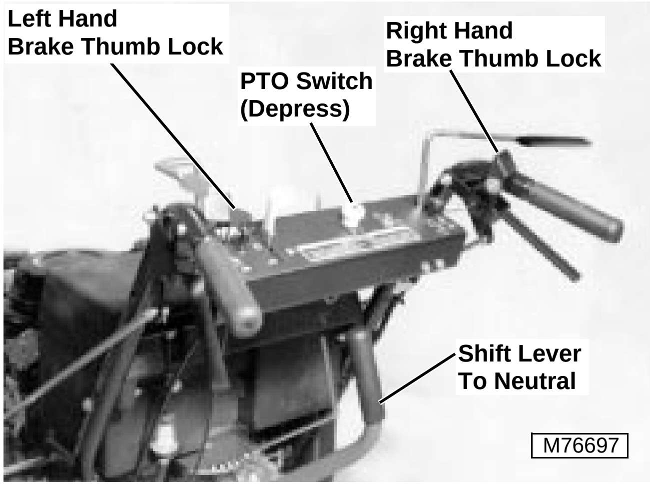
Results:

If the PTO switch should have continuity in all of the above tests. If PTO switch fails to show continuity in any of the above tests, replace it.

REPAIR

PTO CLUTCH REMOVAL

1. Park mower in a clear flat area.



2. Put transmission in neutral. Disengage PTO.
3. Engage traction control levers and set **both** park brake thumb locks.
4. Put key switch in off position, remove key.

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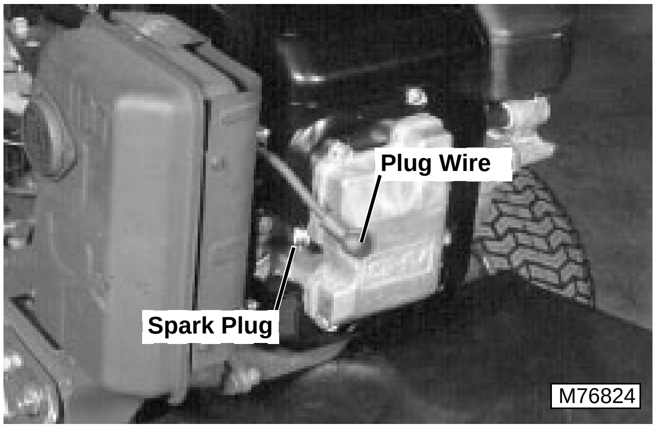


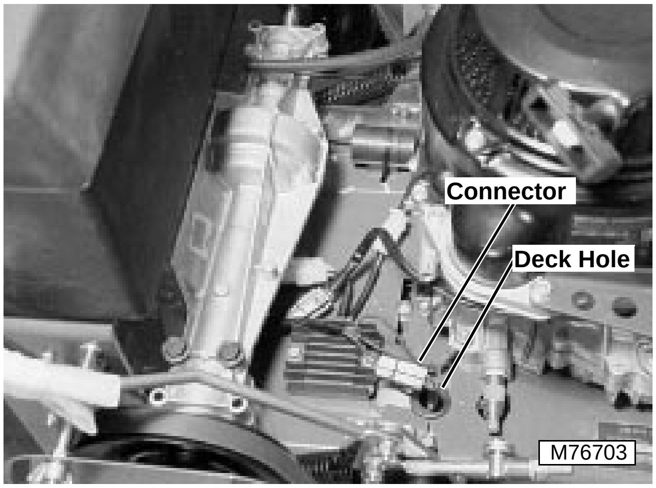
1. Disconnect spark plug wire and ground.

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

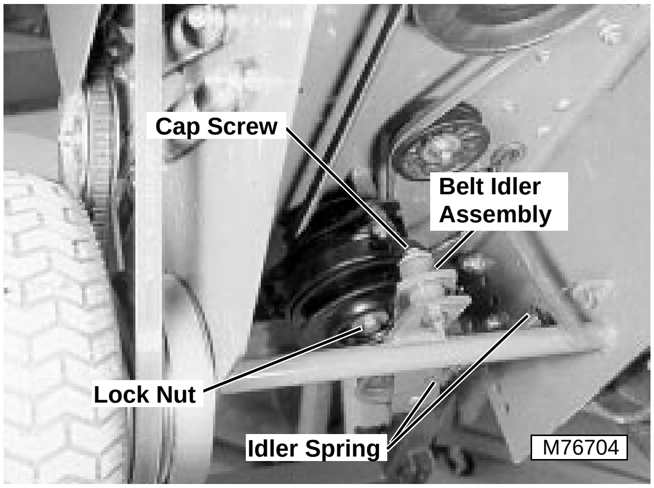
CAUTION

Turn engine off, remove key, and disconnect spark plug before performing any work on PTO clutch!

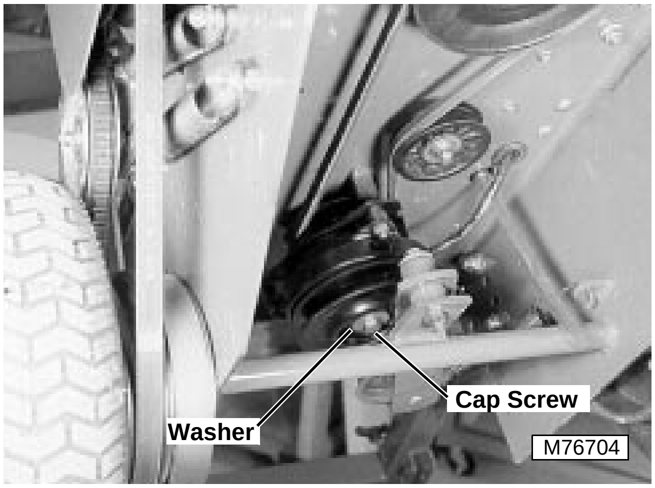
2. Remove deck drive belt. See "PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS" on page 14 of ATTACHMENT SECTION. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24 of ATTACHMENT SECTION.



3. Disconnect PTO electrical connector. Push end of connector through hole in deck.



4. From the underside of the power unit disconnect the idler spring.
5. Remove idler pivot cap screw and lock nut. Remove belt idler assembly.
6. Remove accessory belt from electric PTO clutch pulley.

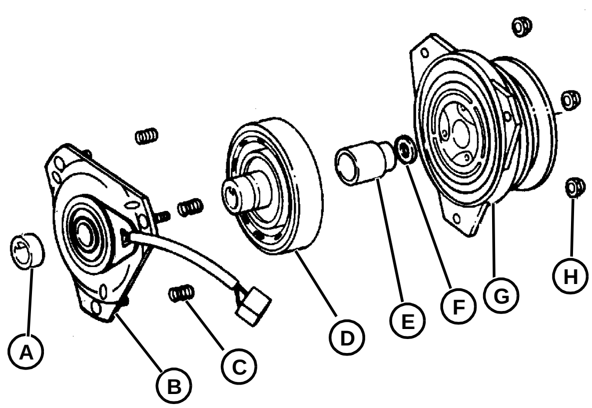


7. Remove cap screw, washer, and PTO clutch.

PTO CLUTCH DISASSEMBLY/ ASSEMBLY

NOTE: PTO clutch is serviced as an assembly. If components other than springs (C) and nuts (H) are damaged the entire PTO must be replaced.

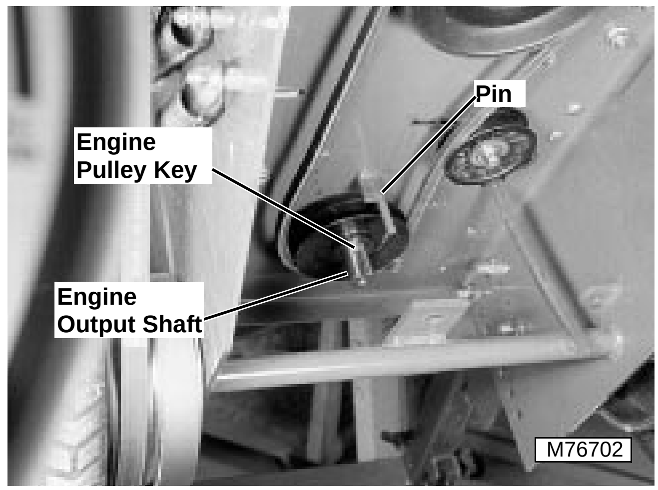
Key in rotor (D) is a machined feature of rotor, not a separate component.



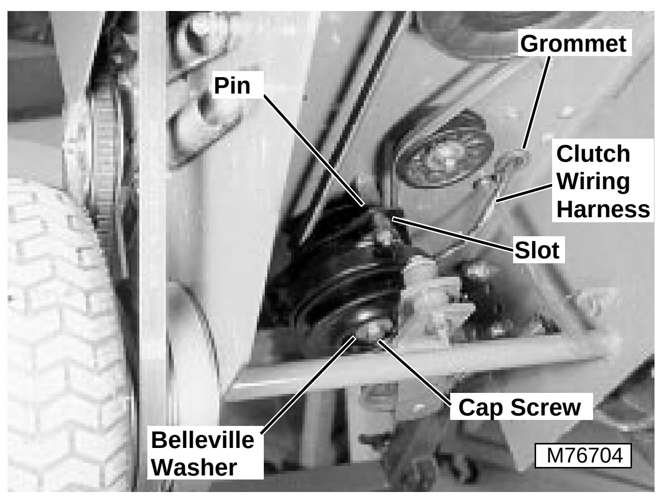
1. Remove nuts (H).
2. Remove parts (C, E, F, and G).
3. Inspect Rotor (D), spacer retainer (A) and electric coil (B). If damaged replace entire clutch.
4. Assemble In reverse order.
5. Adjust air gap. See "PTO CLUTCH ADJUSTMENT" on page 59.

PTO CLUTCH INSTALLATION

NOTE: Before installing clutch, ensure that key in drive belt engine pulley has not fallen out.



1. Apply NEVER-SEEZ lubricant to engine output shaft.



2. Install PTO clutch on shaft with pin through slot in coil housing.

CAUTION

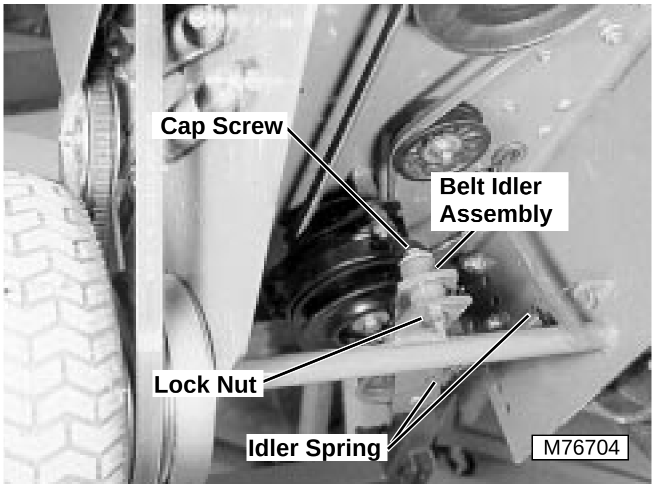
The washer for PTO clutch retention is a Belleville cupped washer and MUST be installed correctly, with the cup towards the blade.

Failure to install washer correctly will allow the PTO clutch to come loose and will result in serious injury to the operator or bystanders.

3. Install washer and cap screw. Tighten cap screw to **56 N•m (45 lb-ft.)**

IMPORTANT: Use only DuBois MPG-2® for electrical connector corrosion control. DO NOT substitute any other grease for electrical connector corrosion control.

4. Push wiring connector through grommet in frame, apply DuBois MPG-2Q® grease to connector and connect to wiring harness.



5. Install belt idler assembly and secure with cap screw and lock nut. Torque to 11-24 N•m (8-18 lb-ft)
6. Install accessory drive belt. See "PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS" on page 14 of ATTACHMENT SECTION. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24 of ATTACHMENT SECTION.
7. Adjust PTO clutch. See "PTO CLUTCH ADJUSTMENT" on page 59.

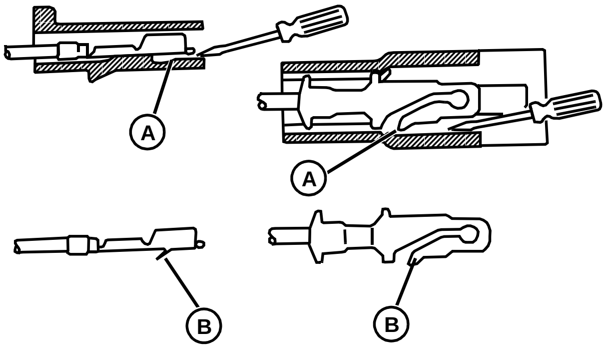
IMPORTANT: If a new PTO clutch has been installed it must be "broken in" before unit is put in service. To break-in a new clutch:

- Start engine and push throttle lever to full throttle position.
- With no load on mower, engage PTO and allow mower to run for 10 seconds. Disengage PTO and wait 10 seconds.
- Repeat the above step for 12 to 15 cycles.
- The PTO clutch is now properly broken in.

8. Re-adjust PTO clutch.
   See "PTO CLUTCH ADJUSTMENT" on page 59.

CONNECTOR BODY—BLADE TERMINALS

Replacement



Use a small screwdriver to depress locking tang (A) terminal. Slide connector body off.

Be sure to bend locking tang back to its original position (B) before installing connector body.

NOTES

CONTENTS

Page

SPECIFICATIONS

5-SPEED TRANSMISSION SPECIFICATIONS

Dimensions:

Overall Transmission Width (end-to-end output shafts)	540.21 mm (21.268 in.)
Overall Housing Width	433.58 mm (17.070 in.)
Overall Housing Length (front-to-rear)	272.03 mm (10.710 in.)
Overall Height (top of input shaft-to-bottom case)	184.66 mm (7.270 in.)
Overall Housing Height (top case-to-bottom case)	154.18 mm (6.070 in.)

Gear Teeth:

Bevel Pinion Gear (input shaft)	14
Drive Shaft:	
Bevel Drive Gear	42
Drive Sprocket Gear	9
1st Gear	15
2nd Gear	20
3rd Gear	25
4th Gear	28
5th Gear	31
Spur Gear	14

Intermediate Shaft:

Drive Sprocket Gear	18
1st Gear	35
2nd Gear	30
3rd Gear	25
4th Gear	22
5th Gear	19
Combination Gear (idler shaft)	12 and 35

ENGINE TO TRANSMISSION DRIVE BELT

Effective Length (New)	1168.4 mm (46 in.)
Top Width (New)	13.1 mm (0.52 in.)
Bottom Width (New)	7.5 mm (0.30 in.)
Depth (New)	8.8 mm (0.35 in.)

TRACTION DRIVE BELT

Effective Length (New)	1282.4 mm (50.5 in.)
Top Width (New)	16.2 mm (0.64 in.)
Bottom Width (New)	9.2 mm (0.36 in.)
Depth (New)	13.4 mm (0.53 in.)

LUBRICATION

Grease Type	Shell Darina® D
Capacity (grease)	638 g (1.406 lbs)
Input Shaft Needle Bearings—	
Grease Type	Unirex® N3
Capacity (grease)	2.27 g (0.005 lbs)
Overall Weight (with grease)	14.2 kg (31.3 lbs)

GROUND SPEEDS

Domestic Ground Speeds (at FAST idle—3350 rpm) and Gear Ratios:
- 1st Gear . . . . 2.4 km/hr (1.5 mph)
- 2nd Gear . . . . 4.0 km/hr (2.5 mph)
- 3rd Gear . . . . 5.6 km/hr (3.5 mph)
- 4th Gear . . . . 7.2 km/hr (4.5 mph)
- 5th Gear . . . . 9.3 km/hr (5.8 mph)
- Reverse . . . . 2.9 km/hr (1.8 mph)

Export Ground Speeds (at FAST idle—2700 rpm) and Gear Ratios:
- 1st Gear . . . . 1.9 km/hr (1.2 mph)
- 2nd Gear . . . . 3.2 km/hr (2.0 mph)
- 3rd Gear . . . . 4.5 km/hr (2.8 mph)
- 4th Gear . . . . 5.8 km/hr (3.6 mph)
- 5th Gear . . . . 7.5 km/hr (4.7 mph)
- Reverse . . . . 2.3 km/hr (1.5 mph)

REPAIR SPECIFICATIONS

Input Shaft:

Pinion Gear to Snap Ring Gap . . . . 0.25 mm (0.010 in.) or less

Shim Set:
- Wear Limit . . . . Replace if broken or damaged

Washers:
- Thickness . . . . 1.17±0.13 mm (0.046±0.005 in.)

Intermediate Shaft:

Assembly End Play . . . . 0.00—0.25 mm (0.00—0.010 in.)

Flange Bearing:
- Wear Limit . . . . Replace if broken or damaged

Shim:
- Wear Limit . . . . Replace if broken or damaged

Spacer:
- Wear Limit . . . . Replace if broken or damaged

Washer:

Wear Limit . . . . Replace if broken or damaged

Idler Shaft:

Combination Gear End Play . . . . 0.33—0.63 mm (0.013 —0.026 in.)

Washers:
- Wear Limit . . . . Replace if broken or damaged

Spacer:
- Wear Limit . . . . Replace if broken or damaged

Shim:
- Wear Limit . . . . Replace if broken or damaged

Drive Shaft:

Flange Bearings:
Wear Limit . . . . Replace if broken or damaged
Drive Shaft Gear Stack Height . . . . 61.61—61.79 mm (2.426—2.433 in.)
Spacers:
Wear Limit . . . . Replace if broken or damaged
Shim:
Wear Limit . . . . Replace if broken or damaged
Washers:
Wear Limit . . . . Replace if broken or damaged

L.H. And R.H Transmission Output Shafts:

Transmission Output Shafts End Play . . . . 0.18—0.38 mm (0.007—0.015 in.)
Washers:
Wear Limit . . . . Replace if broken or damaged
Shims:
Wear Limit . . . . Replace if broken or damaged
Gear Cross Shaft:
Wear Limit . . . . Replace if broken or damaged

TORQUE SPECIFICATIONS

Detent Ball and Spring Set Screws . . . . Flush Only
Rear Axle Cap Screws and
Nuts to Frame . . . . 20.3 N•m (15 lb-ft)
Shift Arm to Transmission Shaft Cap Screw . . . . 14.9 N•m (11 lb-ft)
Shift Arm Clamp Cap Screw . . . . 47.5—61.0 N•m (35—45 lb-ft)
Shift Lever to Shift Arm Cap Screws . . . . 27.1 N•m (20 lb-ft)
Shift Linkage Lock Nut . . . . 15 N•m (11 lb-ft)
Torque Strap to Frame . . . . 27.1 N•m (20 lb-ft)
Transmission Housing Cap Screws . . . . 9 —10 N•m (80 —90 lb-in.)
Transmission to Frame Cap Screws . . . . 61 N•m (45 lb-ft)
Transmission Input Driven Sheave Retaining Cap Screw 61.0—94.9 N•m (45—70 lb-ft)
Transmission Output Drive Sheave Retaining Cap Screw 61.0—94.9 N•m (45—70 lb-ft)
Idler Cap Screw . . . . 27.1—40 N•m (20—30 lb-ft)
Brake Pivot Cap Screw . . . . 27.1—40 N•m (20—30 lb-ft)
Neutral Start Switch . . . . 21—27 N•m (15—20 lb-ft)
Idler Arm to Deck Lock Nut . . . . 11—24 N•m (8-18 lb-ft)
Drive Wheel Mounting Bolt . . . . 44 N•m (33 lb-ft)

LUBRICATION SPECIFICATIONS

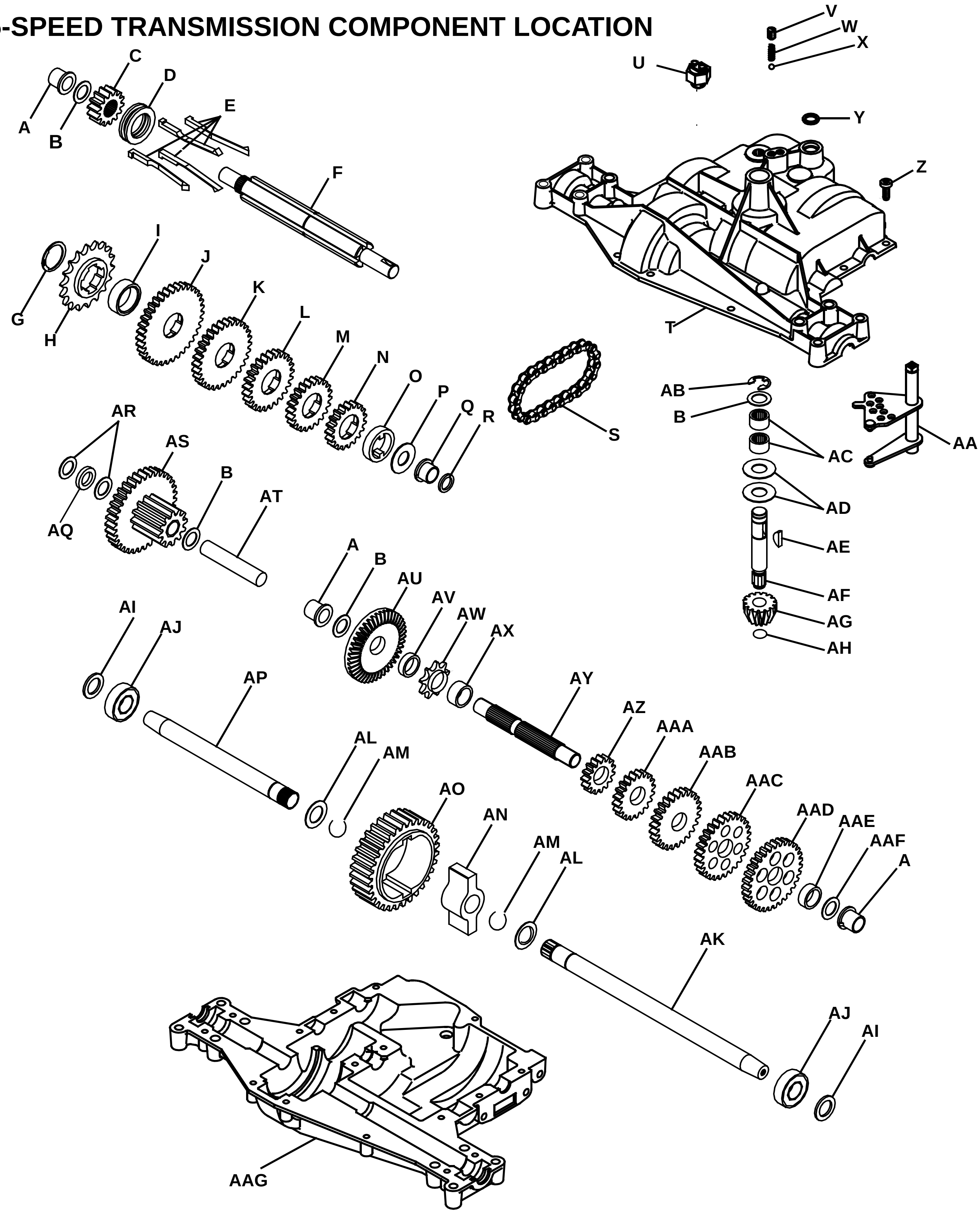
Engine Output Shaft . . . . John Deere Never-Seez®
Engine Traction Drive Sheave . . . . John Deere Never-Seez®
PTO Clutch Assembly . . . . John Deere Never-Seez®
Input Shaft Needle Bearings Grease . . . . Unirex® N3 Grease Only
Transmission Housing Grease . . . . Shell Darina® D Grease Only

OTHER MATERIALS

Transmission Sealant . . . . John Deere Form-In-Place Gasket Silicone Sealant

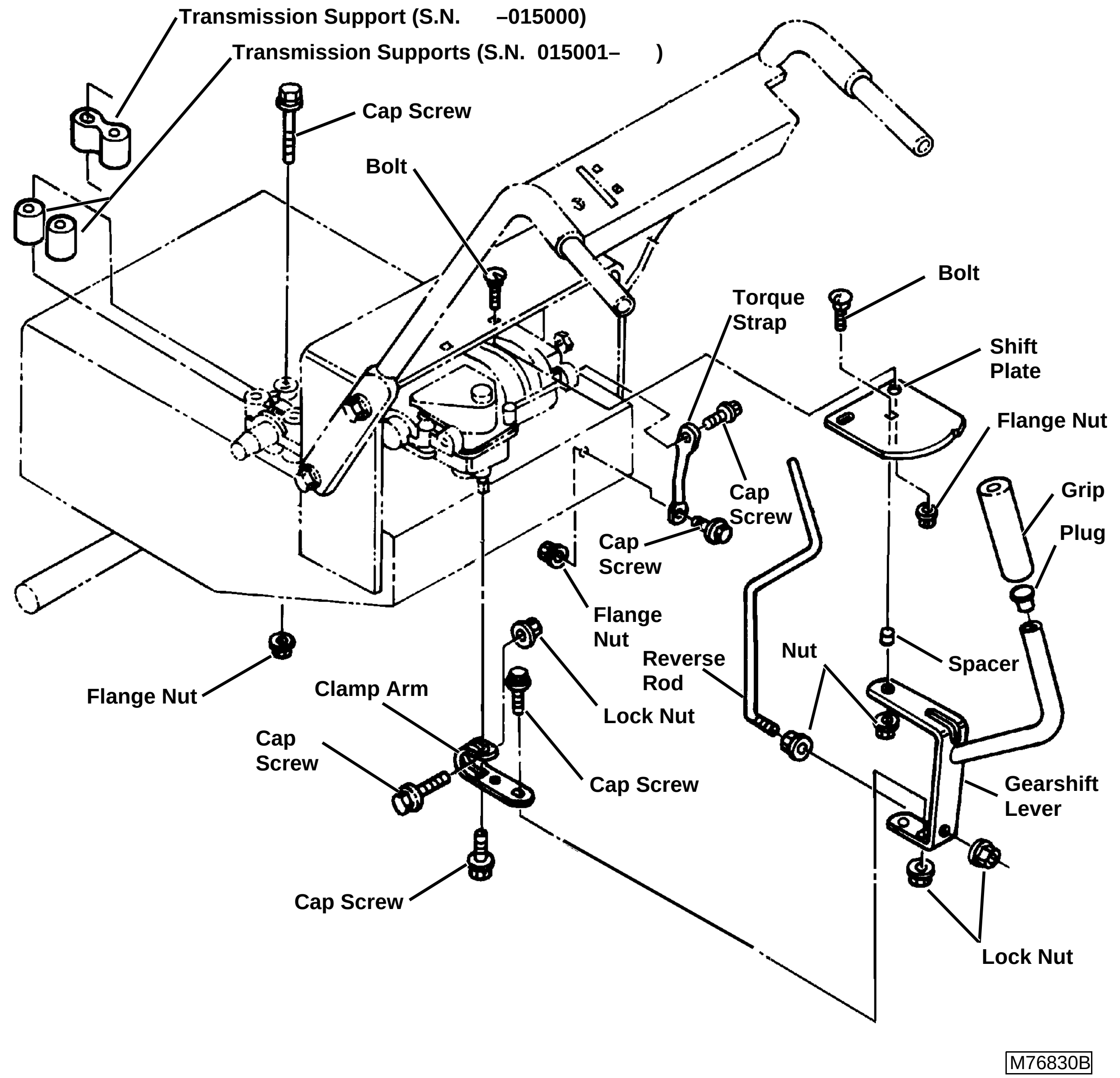
COMPONENT LOCATION

5-SPEED TRANSMISSION COMPONENT LOCATION

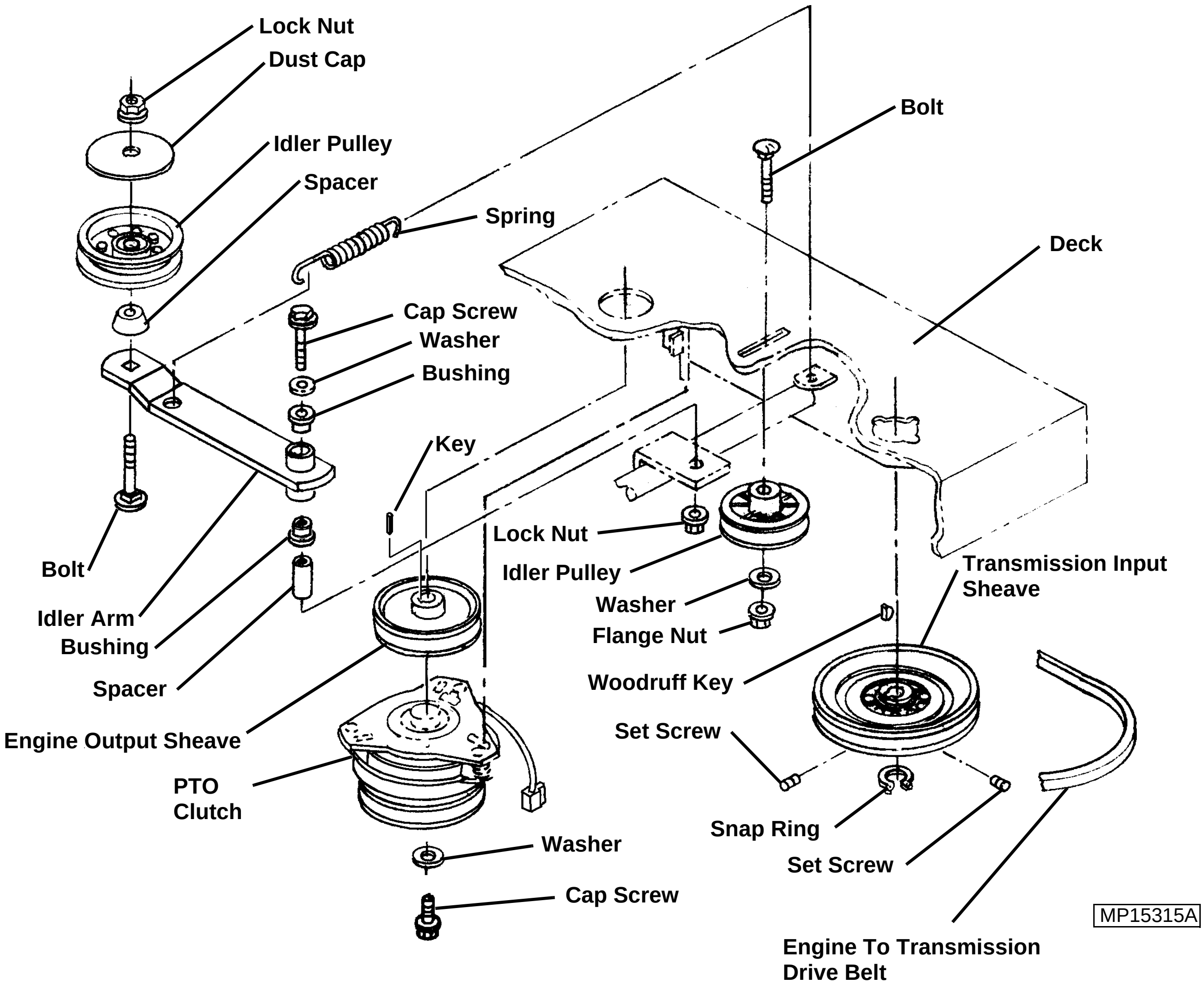


A. Flange Bearings
B. Shim Set
C. Spur Gear, 14T
D. Clutch Collar
E. Clutch Key Kit
F. Intermediate Shaft
G. Retaining Ring
H. Sprocket 18T
I. Spacer
J. Gear 31T
K. Gear 28T
L. Gear 25T
M. Gear 20T
N. Gear 15T
O. Spacer
P. Washer
Q. Flange Bearing
R. Oil Seal
S. Chain 22 Pitch
T. Upper Housing
U. Neutral Start Switch
V. Detent Set Screw
W. Detent Spring
X. Detent Ball
Y. Seal
Z. TORX® Head Cap Screw
AA. Shifter Shaft Assembly
AB. Snap Ring
AC. Input Shaft Bearing
AD. Washer
AE. Woodruff Key
AF. Input Shaft
AG. Pinion Gear
AH. Snap Ring
AI. Neoprene Washer
AJ. Ball Bearing
AK. R.H. Transmission Output Shaft
AL. Shim Set
AM. Retaining Ring
AN. Ring Gear Cross
AO. Ring Gear
AP. L.H. Transmission Output Shaft
AQ. Spacer
AR. Washer
AS. Combination Gear, 12T & 35T
AT. Idler Shaft
AU. Bevel Gear
AV. Spacer
AW. Sprocket 9T
AX. Spacer
AY. Drive Shaft
AZ. Gear Set, 19T
AAA. Gear 22T
AAB. Gear 25T
AAC. Gear Set, 30T
AAD. Gear 35T
AAE. Spacer
AAF. Washer
AAG. Lower Housing

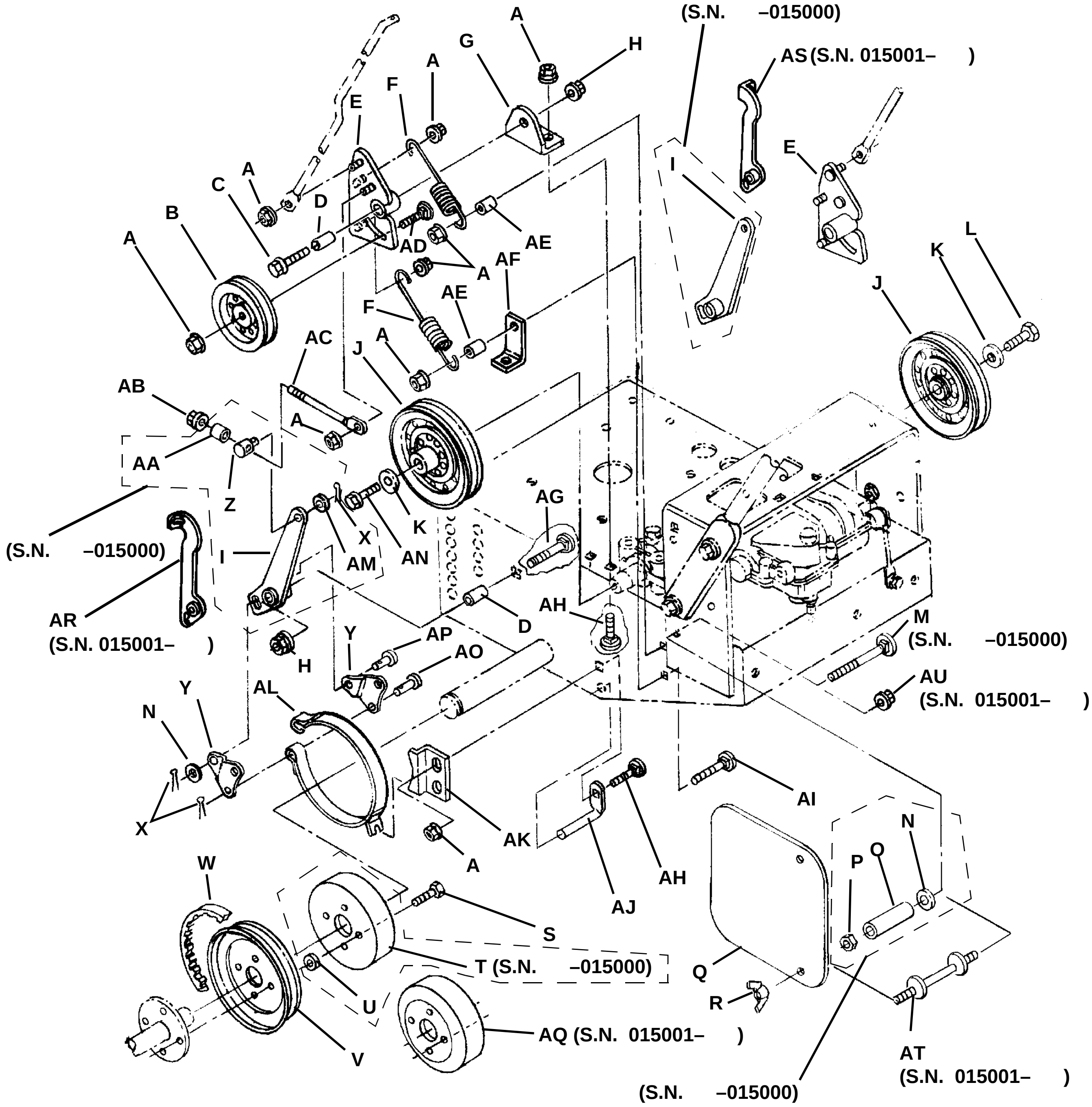
SHIFT LEVER COMPONENT LOCATION



TRANSMISSION BELT DRIVE COMPONENT LOCATION



TRACTION DRIVE COMPONENT LOCATION

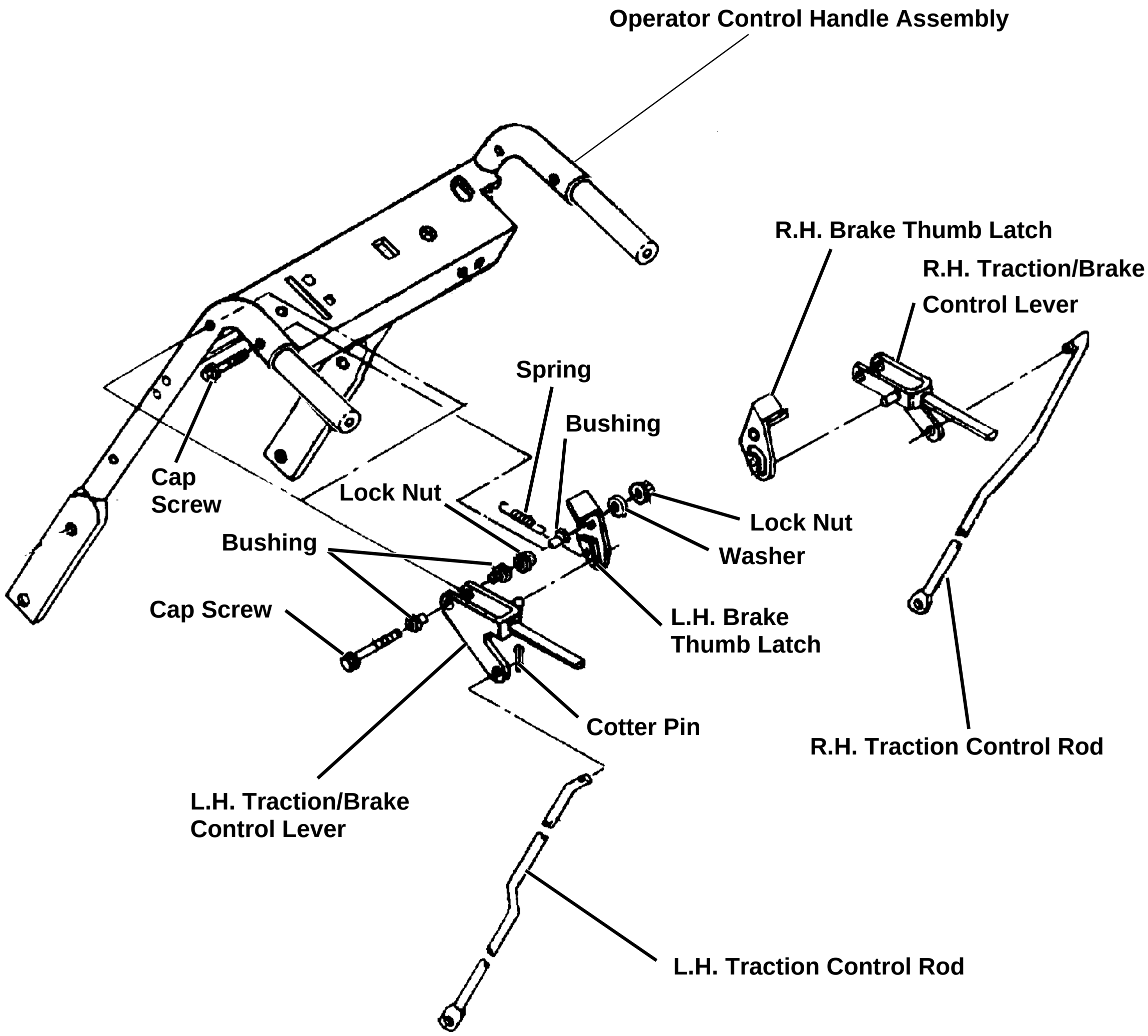


M87750

A. Nut
B. Idler Pulley
C. Capscrew
D. Spacer
E. Idler Arm
F. Spring
G. Bracket
H. Nut
I. Link (S.N. —015000)
J. Transmission Output Drive Sheave
K. Washer
L. Cap Screw, L.H. Thread
M. Carriage Bolt (S.N. —015000)
N. Washer (S.N. —015000)
O. Spacer (S.N. —015000)
P. Nut (S.N. —015000)
Q. Belt Guard
R. Wing Nut
S. Cap Screw
T. Brake Drum (S.N. —015000)
U. Spacer
V. Wheel Drive Sheave
W. Traction Drive Belt
X. Cotter Pin
Y. Brake Plate
Z. Fitting (S.N. —015000)

AA. Spacer (S.N. —015000)
AB. Nut
AC. Brake Rod
AD. Carriage Bolt
AE. Spacer
AF. Bracket
AG. Carriage Bolt
AH. Carriage Bolt
AI. Carriage Bolt
AJ. Stop Rod
AK. Guide Plate
AL. Brake Band
AM. Washer
AN. Capscrew
AO. Pin
AP. Pin
AQ. Brake Drum (S.N. 015001—)
AR. Link, Left Hand (S.N. 015001—)
AS. Link, Right Hand (S.N. 015001—)
AT. Stud (S.N. 015001—)
AU. Nut (S.N. 015001—)

TRACTION DRIVE CONTROLS COMPONENT LOCATION



THEORY OF OPERATION

TRANSMISSION OPERATION

Function:

The transmission distributes power received from the engine, via the engine to transmission drive belt, into the transmission gear matrix, and out the transmission output shaft to the transmission output sheaves. The transmission provides a gear selection of five forward speeds and one reverse speed.

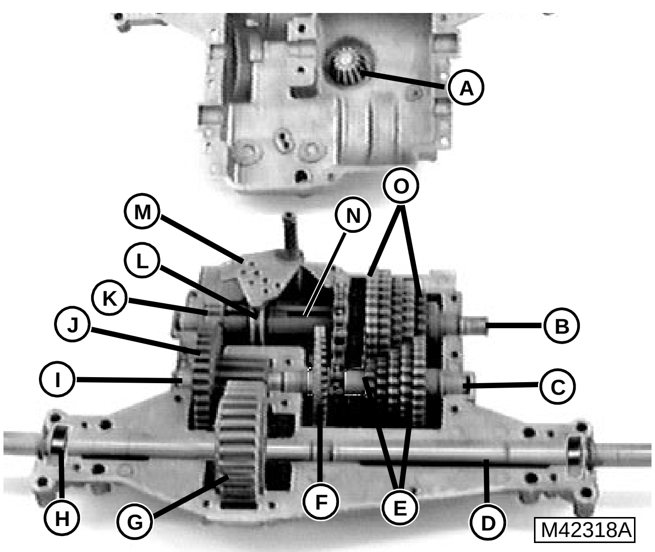
It also provides the means to interrupt the flow of power to the wheels when shifted into neutral.

Major Components:

- Transmission input sheave
- Input shaft and pinion gear
- Bevel gear, drive shaft with small chain sprocket, and drive gears
- Chain to transfer power from the drive shaft to the intermediate shaft
- Intermediate shaft with large drive chain sprocket/ reverse gear, shifter fork, shift collar, shift keys, and transfer gears
- Idler shaft and combination gear
- Transmission output shafts with ring gear and ring gear cross
- Transmission output sheaves

Forward:

With engine running the transmission input sheave turns in a clockwise direction. The input sheave is keyed to the input shaft and is retained by a snap-ring and two set screws.

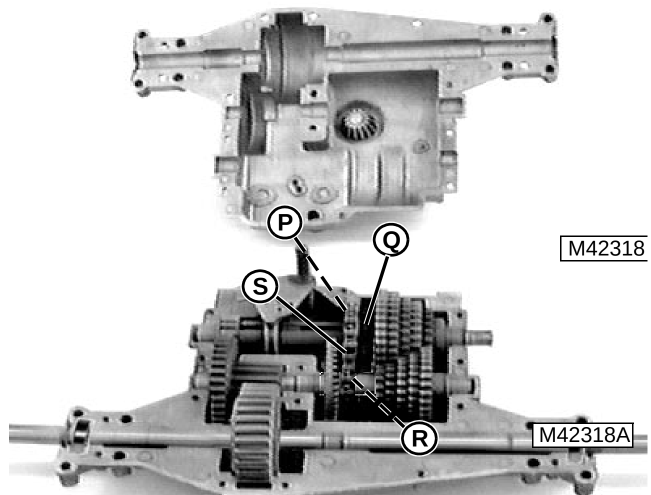


The pinion gear (A), which is splined to the input shaft and retained by a snap ring, drives the beveled gear (F). The beveled gear is splined to the drive shaft (C), as are the five forward drive gears (E).

A forward gear is selected when the operator moves the shift lever. The shift lever moves the shifter fork (M), shift collar (L), and shift keys (N) into one of the selected five transfer gears (O). The selected gear is now keyed to the intermediate shaft (B). Power is transferred by the selected gear (O) on the right side of the shaft to the left-side, splined spur gear (K).

The spur gear (K) drives the combination gear (J), which transfers power into the ring gear (G). Power is transferred by the ring gear cross to both transmission output shafts (D & H). The transmission output shafts transmit power to the to the drive sheaves mounted on the outboard end of the transmission output shafts.

Reverse:



When the operator shifts the shift lever into reverse, the shifter fork (M), and shift collar (L), engage the shift keys (N) to the large drive chain sprocket (P). Power, which enters through pinion gear (A) and is transferred through drive shaft (C) to the small sprocket (R) and then through chain (S) to the large sprocket (P) which turns in the opposite direction as the free-wheeling transfer gears (O). Because the large drive chain sprocket (P) has been engaged by the shift keys (N), the shaft (B) turns in the reverse direction and transfers power through the left side spur gear (K).

The spur gear (K) drives the combination gear (J), which transfers power into the ring gear (G). Power is transferred by the ring gear cross to both transmission output shafts (D & H). The transmission output shafts transmit power to the to the drive sheaves mounted on the outboard end of the transmission output shafts.

Neutral:

When the operator moves the shift lever into neutral position, the shifter fork (M) places the shift keys (N) under the free-floating spacer (Q). This position does not allow power to be transmitted to the intermediate shaft (B), and the drive shaft.

BELT DRIVE SYSTEM OPERATION

Function:

There are two belt drive systems incorporated in this unit.

The first belt drive system transfers power from the engine to the 5-speed transmission.

Major Components:

- Engine Output Sheave
- Engine To Transmission Drive Belt
- Transmission Input Sheave
- Idler Pulley

The second belt drive system, or traction drive, transfers power from the 5-speed transmission to each rear wheel individually. This system also incorporates a brake system which controls steering.

Major Components:

- Transmission Output Sheaves
- Traction Drive Belts
- Wheel Sheaves
- Brakes
- Traction Idlers
- Traction/Brake Control Levers
- Brake Thumb Latch (Auto-Release)

Theory of Operation:

NOTE: The following operation description assumes that the operator is depressing the operator presence levers and the engine is running. Only the L.H. side is shown in the illustration.

Power from the engine is transferred to the transmission through the engine to transmission drive belt. The engine to transmission drive belt runs from the engine output sheave, over the drive belt idler/adjuster and to the transmission input sheave. This system runs continuously whenever the engine is running.

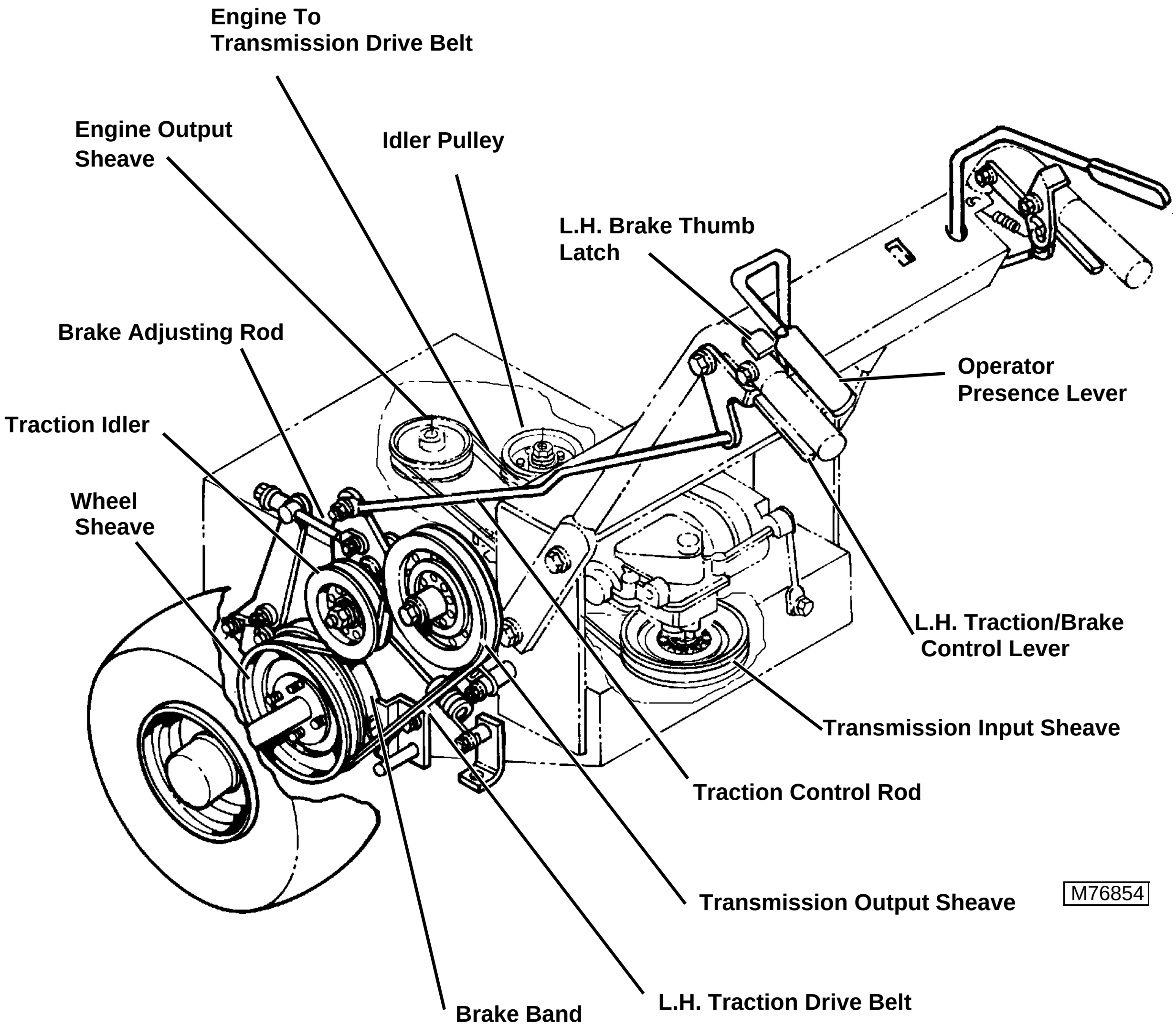
Once a gear has been selected and the operator releases the traction/brake control levers, simultaneously the brake bands release the brake drums and allow the traction idlers to apply tension to the traction drive belts, which in turn drive the wheel sheaves which are attached to the wheels.

Steering is accomplished by engaging one or the other of the traction/brake control levers. As an example, when the L.H. traction/brake lever is engaged, it simultaneously reduces drive traction on the L.H. traction drive belt and engages the band brake on the L.H. wheel. This provides a speed differential between the L.H. and R.H. wheels and causes the machine to pivot around the L.H. wheel.

Braking is accomplished by simultaneously engaging both traction/brake control levers. This simultaneously removes tension on both L.H. and R.H. traction drive belts and engages both L.H. and R.H. brakes.

NOTE: If the operator presence levers are released while the transmission is in gear the engine will stop running.

BELT DRIVE SYSTEM OPERATION - CONTINUED



TROUBLESHOOTING

Problem or Symptom / Check or Solution	Belt jumping off or slapping	Lack of drive in forward or reverse	Looses power under load, belt slips, or erratic drive	Jerky or aggressive engagement	Cannot get all forward gears	No reverse	Jumps out of gear or must hold into gear	Hard shifting	Noisy operation	Leaking grease	Brakes will not stop machine	Thumb latch brake locks will not prevent machine movement	Neutral detent not aligned to stop
Belt sheaves, idler, out of adjustment, worn, or damaged—tighten, replace, or adjust properly.	●	●	●	●	●	●			●		●	●	
Belt worn, frayed, glazed, or stretched—Check idler adjustment. Replace belt if required.	●	●	●	●	●	●			●				
Clutch/brake linkage out of adjustment—adjust properly.	●	●	●	●				●	●		●	●	
Clutch/brake components worn, bent, or broken—replace and adjust properly.	●	●	●	●	●	●		●	●		●	●	
Shift lever bent, worn, out of adjustment, or broken—replace or adjust properly.					●	●	●	●					●
Input sheave, input shaft, and transmission output shaft keys or keyways worn or damaged—replace.		●	●	●					●		●		
Internal components worn, stripped, or broken—replace necessary components.		●	●	●	●	●	●	●	●		●		
Transmission housing halves worn or broken—replace halves.		●	●	●	●	●		●	●	●			

Check or Solution \ Problem or Symptom	Belt jumping off or slapping	Lack of drive in forward or reverse	Looses power under load, belt slips, or erratic drive	Jerky or aggressive engagement	Cannot get all forward gears	No reverse	Jumps out of gear or must hold into gear	Hard shifting	Noisy operation	Leaking grease	Brakes will not stop machine	Thumb latch brake locks will not prevent machine movement	Neutral detent not aligned to stop
Incorrect type or volume of lubricant used—replace with correct type and volume.			●	●	●	●	●	●	●	●			
Intermediate shaft or transmission output shaft seals worn or damaged—replace seals.			●		●	●	●	●	●	●			
Transmission cap screws loose or housing holes stripped—tighten or replace housing half.		●	●		●	●	●	●	●	●			
Poor application of transmission housing halves sealant—replace sealant properly.										●			
Incorrect type sealant—replace with proper sealant.										●			
Transmission output sheaves slipping on shaft. Remove sheave, clean taper on shaft and sheave and reinstall. Torque properly.		●	●	●		●							
Install Reverse Assist Kit.						●							

DIAGNOSIS

DRIVE TRAIN

Test Conditions:

- Mower on level surface
- Engine OFF
- Front wheels blocked
- Rear wheels raised off surface with mower properly supported.

Test/Check Point	Normal	If Not Normal
1. Drive belts (All)	Belt in good condition; not glazed, split, unraveled, or stretched.	Replace drive belt.
2. Sheaves, idler, and belt guides (All)	Sheaves, idlers and guides in good condition.	Replace any loose, worn, or damaged components.
	Guides installed, properly adjusted and tight.	Adjust and tighten.
3. Brake assembly	Brakes not worn or binding.	Repair, adjust linkage, or replace as needed.
4. Brake drum	Not bent, damaged or out of round.	Replace drum.
5. Internal transmission components	Shifts smoothly, and obtains all gears.	Repair or replace components as needed.
6. Exterior of transmission housing	No cracks, leaks, or loose hardware.	Tighten hardware.
		Repair or replace as needed.
7. Tires, wheels and axles	Driving tires have same radii.	Match tires for same radii.
	Wheels not bent or out of round.	Replace wheels.
	Keys, keyways and snap rings in good shape and seated correctly.	Repair or replace as needed.

DRIVE TRAIN - CONTINUED

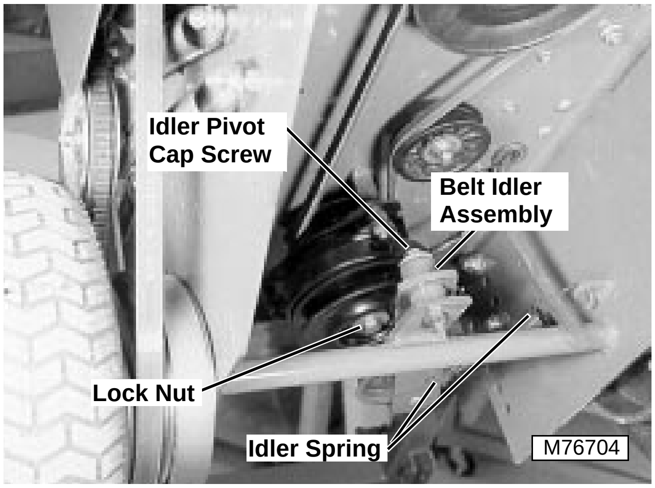
Test Conditions:

- Engine running at slow idle and fast idle
- Engine at operating temperature

Test/Check Point	Normal	If Not Normal
1. Running in test area	Engine running smoothly throughout throttle range.	Adjust or tune engine.
2. Drive belts, sheaves, idlers, and belt guides (All)	Belts not squealing or vibrating.	Check belt condition.
		Check adjustment and condition of idlers and guides.
		Check clutch/brake linkage adjustment and condition.
		Replace components as needed.
3. Shift transmission through all five speeds and reverse	Shifting is smooth and all gears obtained.	Check transmission internal components. Repair or replace as needed.
	Constant speed is maintained.	Check belt condition.
		Check adjustment and condition of idlers and guides.
		Check clutch/brake linkage adjustment and condition.
		Check transmission internal components.
		Check brake components.
		Check axles, wheels and tires.
		Replace components as needed.

REPAIR

PTO DRIVE BELT IDLER ARM R&R—GEAR DRIVE



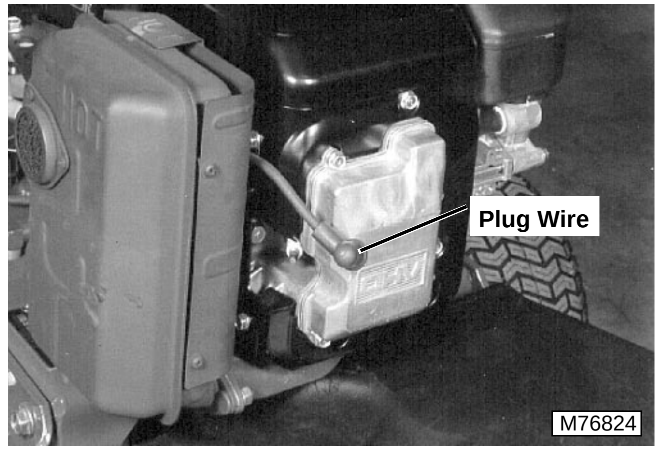
1. From the underside of the power unit disconnect the idler spring.
2. Remove idler pivot cap screw. Remove attachment belt idler assembly.

1. Install belt idler assembly and secure with cap screw and lock nut. Torque to 11-24 N•m(8-18 lb-ft).
2. Attach idler spring to idler arm and frame.

TRANSMISSION DRIVE BELT REMOVAL/ INSPECTION/ INSTALLATION

Removal:

1. Park mower on level surface.
2. Safely raise and block mower to gain easy access to underside of frame.



1. Disconnect spark plug wire and ground.

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

2. Remove the attachment belt from the PTO clutch. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14 in ATTACHMENT SECTION. See “IDLER PULLEY REMOVAL / INSTALLATION-48/54INCH” on page 26 in ATTACHMENT SECTION.

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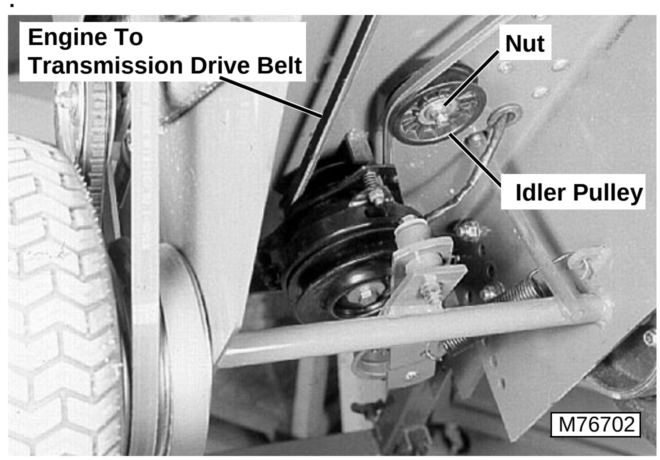

3. Loosen the nut securing the idler pulley to the frame. Move idler pulley to relieve tension from the engine to transmission drive belt.
4. Remove the engine to transmission drive belt.

Inspection:

Examine engine to transmission drive belt to determine if it is worn, stretched, cracked, frayed, or damaged beyond the point of continued use.

Installation:

Installation of the engine to transmission drive belt is the reverse of removal.

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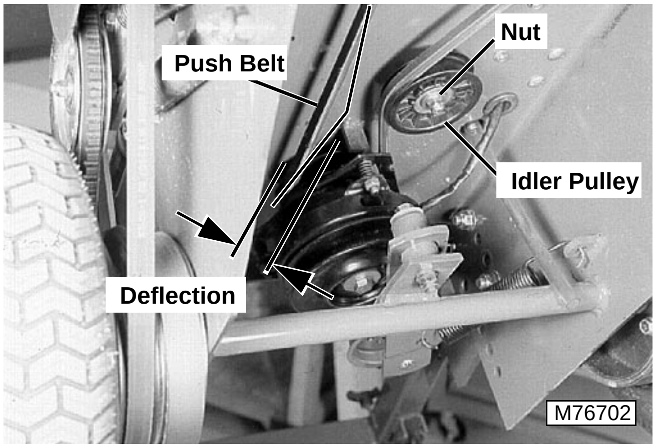

5. Push idler pulley against belt with approximately **16 kg (35 lbs)** force and tighten nut to **27.1—40 N•m (20—30 lb-ft).**

NOTE: To check for proper belt tension push on belt opposite idler pulley and measure belt deflection. Properly adjusted belt will not deflect over ***13 mm (0.500 in.).***

TRACTION DRIVE BELT- REMOVAL AND INSTALLATION

1. Park mower on level surface.
2. Safely raise and block mower to gain easy access to underside of frame.

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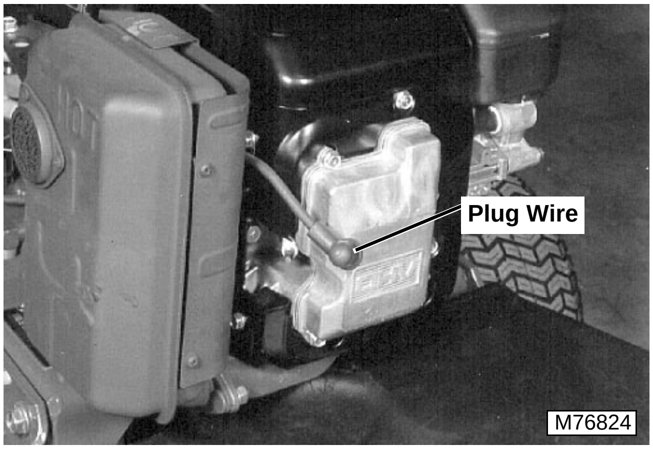
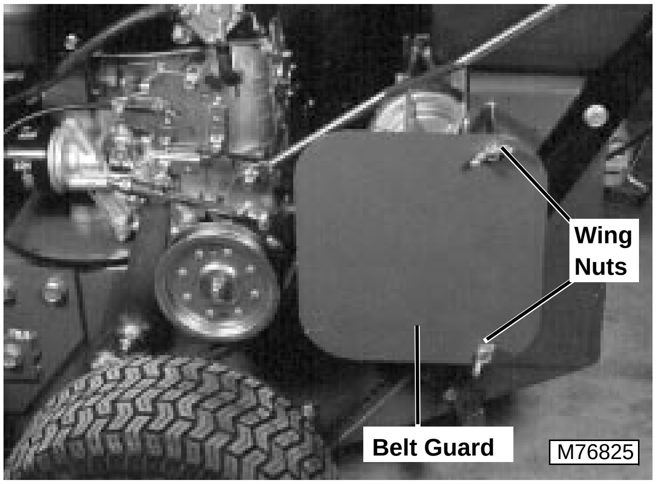
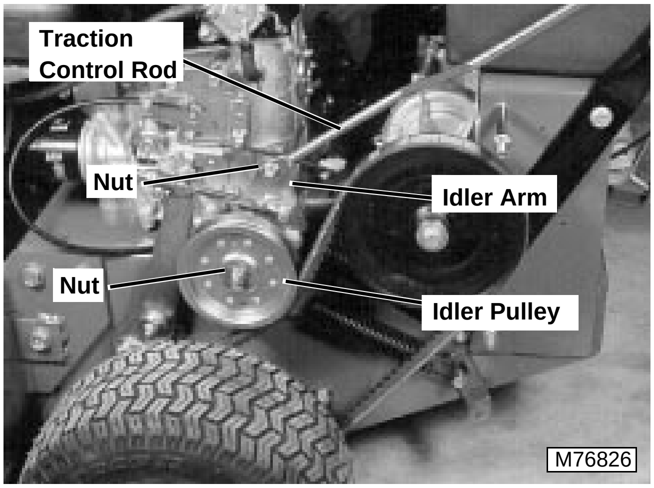


3. Disconnect spark plug wire and ground.

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



4. Remove wing nuts and belt guard.



5. Remove nut securing traction control rod to idler arm to relieve some of the spring tension.
6. Loosen nut securing idler pulleys to idler arm to relieve additional spring and belt tension.
7. Remove traction belt.

NOTE: The wheels and tires do not have to be removed to remove the belts.

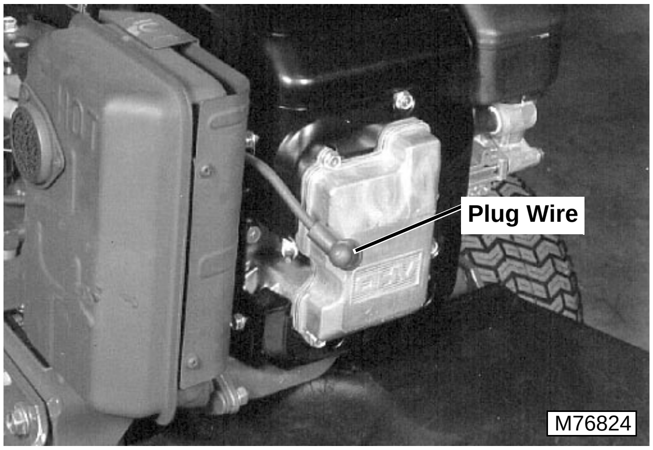
Installation:

Installation of the traction drive belt is the reverse of removal.

- Adjust traction drive belt. See “TRACTION DRIVE BELT ADJUSTMENT” on page 35.

TRANSMISSION OUTPUT SHEAVE REMOVAL AND INSTALLATION

1. Park mower on level surface.
2. Safely raise and block mower to gain easy access to underside of frame.

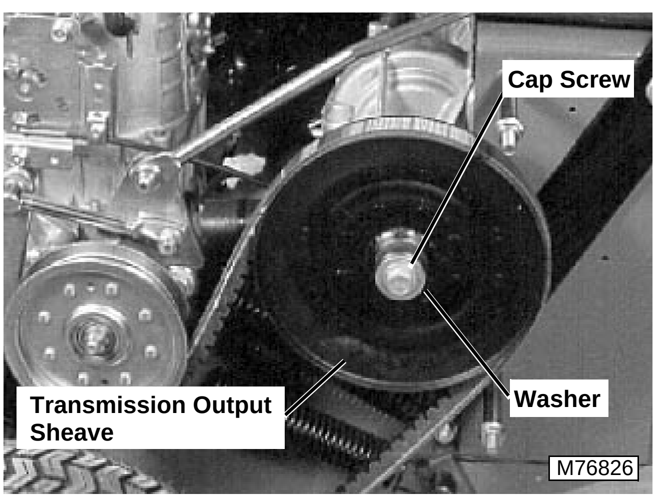


1. Disconnect spark plug wire and ground.

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

2. Remove traction drive belt. See “TRACTION DRIVE BELT- REMOVAL AND INSTALLATION” on page 21.

IMPORTANT: From the operator position of the machine, the right side of the machine uses LEFT HAND threads on the transmission output sheave retaining cap screw.



3. Remove the cap screw and washer retaining the transmission output sheave.

NOTE: The transmission output sheaves are threaded to facilitate removal. Thread the appropriate size cap screw into the threaded end of the sheave to press off the sheave and belt.

4. Remove the transmission output sheave.

Installation:

IMPORTANT: Tapered end of transmission output shaft and matching internal taper on sheave must be absolutely free of any grease, oil, and dirt before assembly!

1. Clean tapered end of transmission output shaft with a non oily cleaner and dry thoroughly.
2. Clean tapered bore of sheave with a non oily cleaner and dry thoroughly.
3. Install sheave on transmission output shaft taking care to insure that the taper is correctly oriented. Secure with washer and cap screw. Torque to **61.0—94.9 N•m (45—70 lb-ft).**
4. Install traction drive belt. See “TRACTION DRIVE BELT- REMOVAL AND INSTALLATION” on page 21.

TRANSMISSION REMOVAL / INSTALLATION

1. Remove the mower deck drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14 in ATTACHMENT SECTION. Or See “DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH” on page 24 in ATTACHMENT SECTION.
2. Remove the traction drive belts. See “TRACTION DRIVE BELT- REMOVAL AND INSTALLATION” on page 21.

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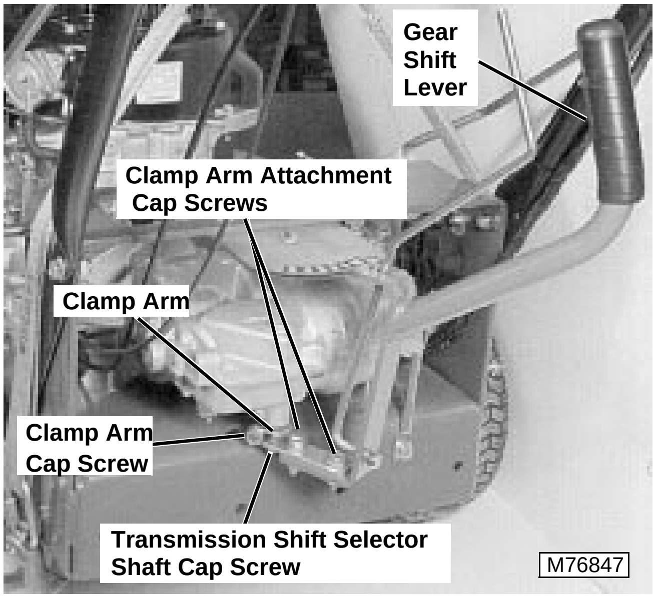
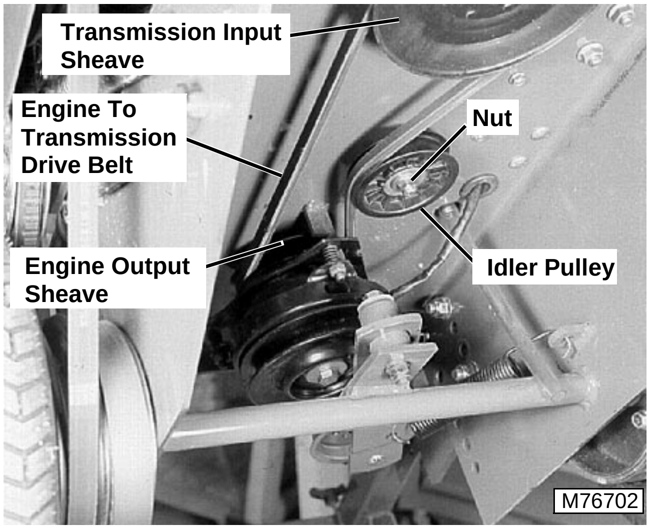
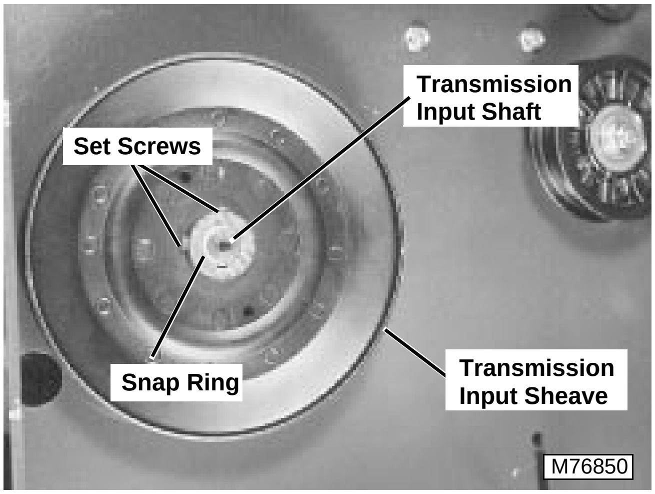


3. Loosen cap screw on clamp arm.
4. Remove cap screw securing clamp arm to transmission shift selector shaft.
5. Remove two (2) clamp arm attachment cap screws.
6. Remove clamp arm from transmission shift selector shaft and gear shift lever.

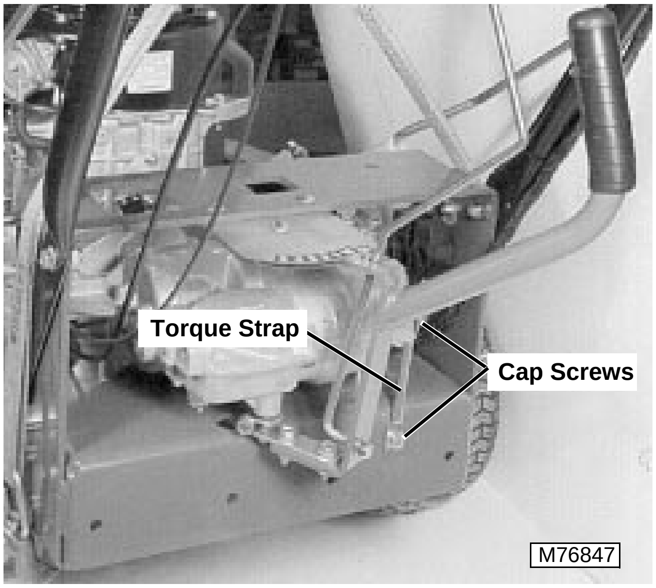


7. Loosen nut securing idler pulley to frame.
8. Remove engine to transmission drive belt from engine output sheave and transmission input sheave.

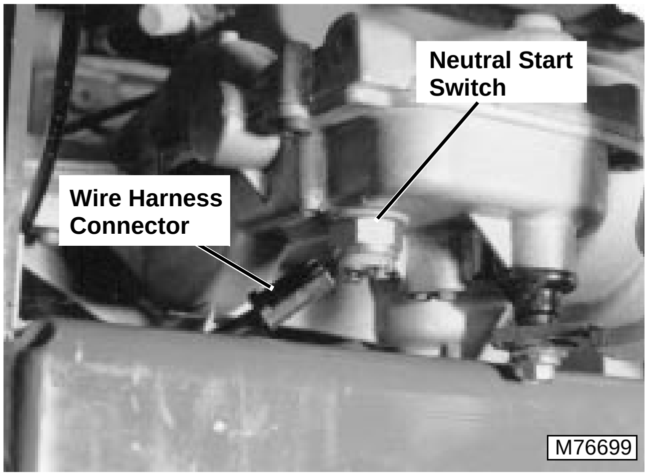
.



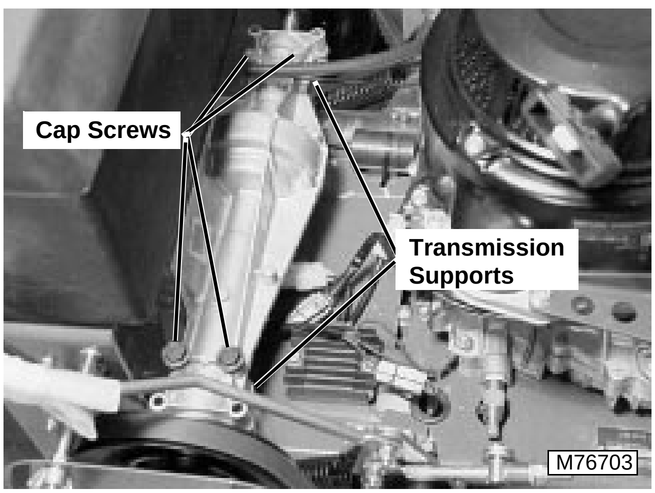
9. Remove snap ring and two set screws from transmission input sheave. Remove transmission input sheave from keyed transmission input shaft.
10. Remove key from transmission input shaft. Inspect key for damage and, if in good condition, retain key for reassembly.



11. Remove the two (2) cap screws securing torque strap to the frame and the transmission.



12. Disconnect the wire harness connector from the neutral start switch on the bottom of the transmission.
13. Loosen mounting cap screws for fuel tank. Move tank aside slightly.



14. Remove caps screws securing transmission to frame. Remove transmission supports from under transmission.

NOTE: Machines prior to S.N. 015000 have two (2) one piece transmission supports. Machines after S.N. 015001 have two (2) tubes supporting each side of transmission (total of four tubes).

CAUTION

Transmission is heavy. Get help and use proper lifting procedures when removing transmission from frame.

15. Carefully remove the transmission from frame.

Installation:

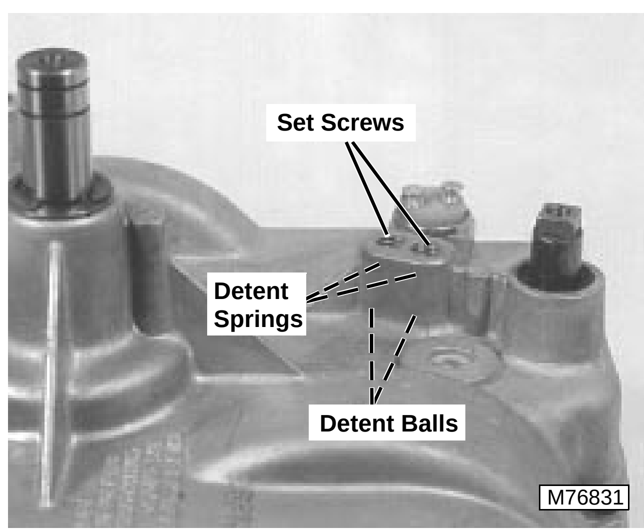
1. Install transmission in reverse order of removal.
2. Tighten mounting hardware to the following specifications:

Specifications:

Transmission To Frame Cap Screws. . . . . 61 N•m (45 lb-ft)
Torque Strap To Frame Cap Screws . . . . . . 27.1 N•m (20 lb-ft)
Shift Arm To Shift Selector Shaft Cap Screws. . . . . 14.9 N•m (11 lb-ft)
Shift Arm Clamp Cap Screw . . . . 47.5 N•m (35 lb-ft)
Shift Lever To Shift Arm Cap Screws . . 27.1 N•m (20 lb-ft)

TRANSMISSION DISASSEMBLY

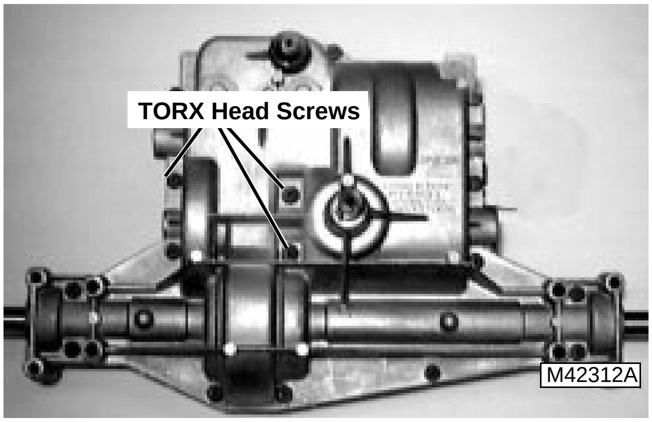
IMPORTANT: Pay attention to the orientation of all components. Mark them if necessary. This will aid assembly.



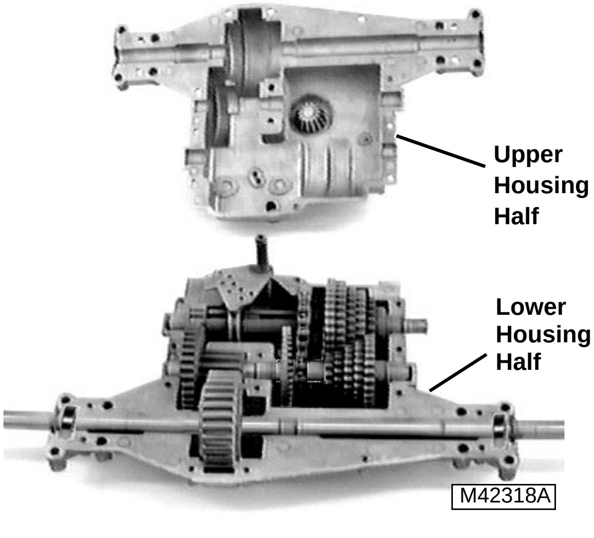
1. Remove both set screws and detent springs.

IMPORTANT: DO NOT drop or lose detent balls.

2. Use a magnet or place a shop cloth over holes and turn transmission upside-down to catch both detent balls in cloth.
3. Inspect detent balls and springs for wear or damage. Replace components as necessary, but do not install until assembly.

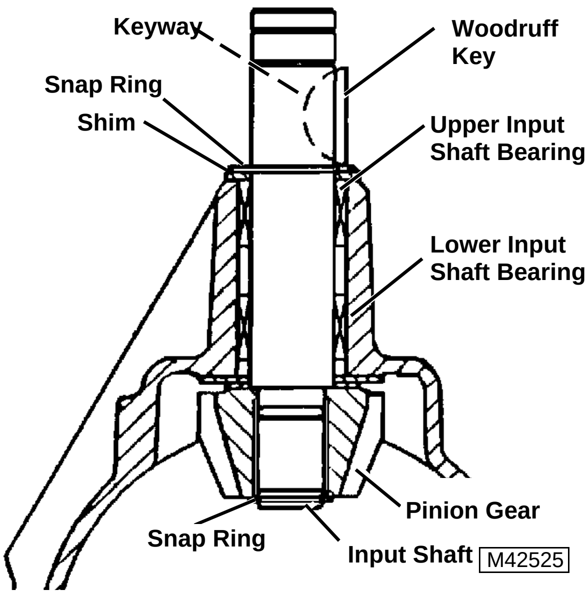


4. Remove all 16 transmission TORX™ head screws.



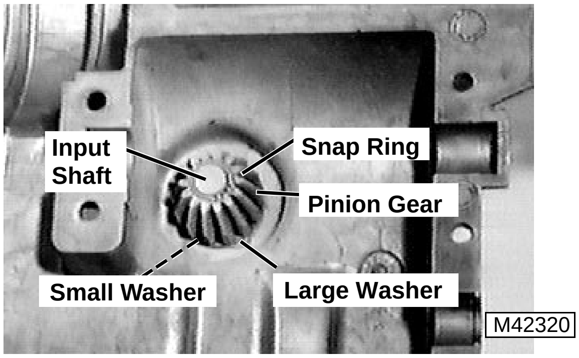
5. Carefully separate transmission housing into upper and lower housing halves.
6. Inspect overall condition of components without removing any of them. Replace worn or damaged components.
7. Remove most of the grease before removing any components.

INPUT SHAFT INSPECTION/ ADJUSTMENT



1. Visually check overall condition of assembly, including the woodruff key and keyway.
2. Check condition of pinion gear. Look for wear, pitting, broken teeth, etc.
3. Rotate/spin input shaft. Listen for noisy bearings and feel for smooth rotation.
4. Use a feeler gauge to measure end play gap between pinion gear and snap ring. Gap should be **0.25 mm (0.010 in.) or less**.
5. If end play is not within specification, shim thickness needs to be changed and/or worn components must be replaced.

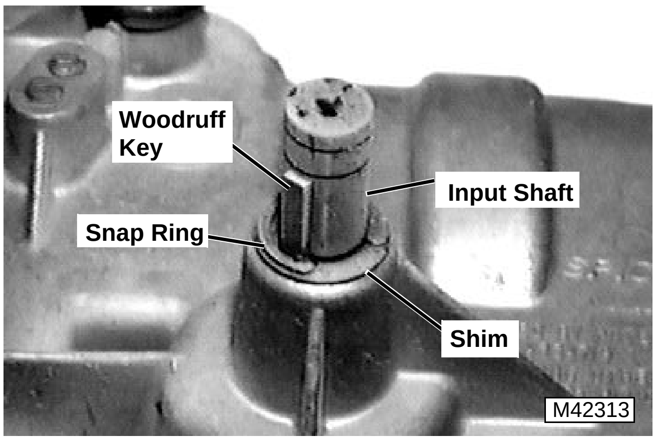
INPUT SHAFT DISASSEMBLY



1. Remove snap ring, pinion gear, small washer, and large washer from input shaft.

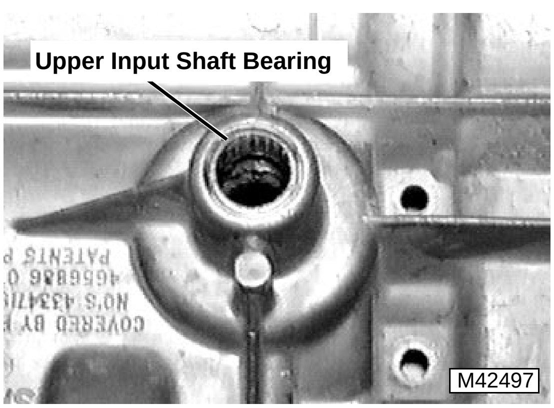
NOTE: Input shaft may fall out of the upper housing half when the snap ring is removed. Use caution not to lose any parts when the shaft is removed.

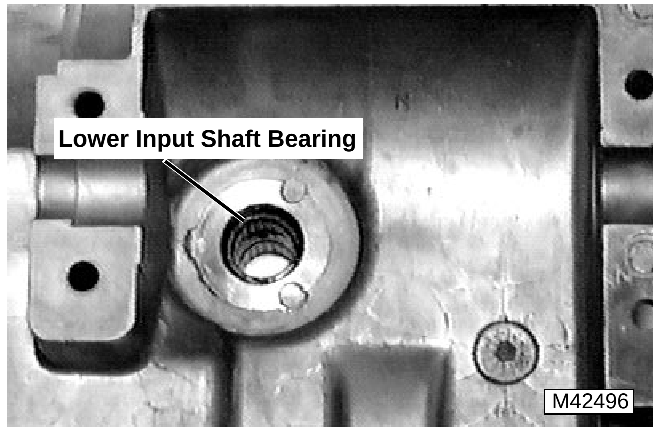
NOTE: Original equipment washers have different outside diameters. The washers in the repair kit have the same outside diameter.



2. Turn upper housing half over.
3. Remove woodruff key, snap ring, and shim from input shaft. Check for and remove any burrs on shaft with a fine cut file.
4. Remove input shaft from inside of housing.

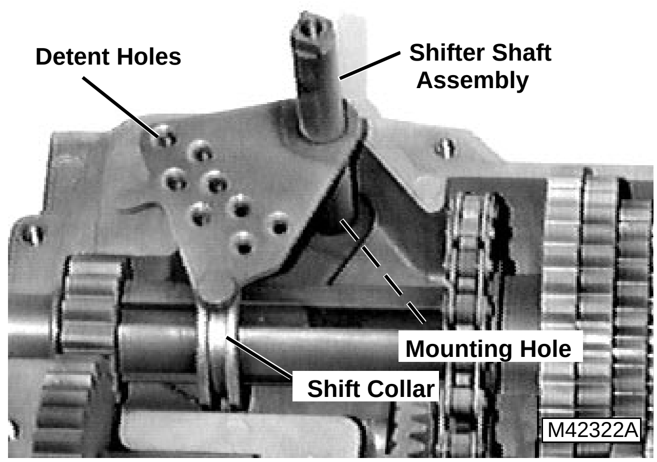
IMPORTANT: DO NOT scratch or deform upper housing half bore if bearings are removed.



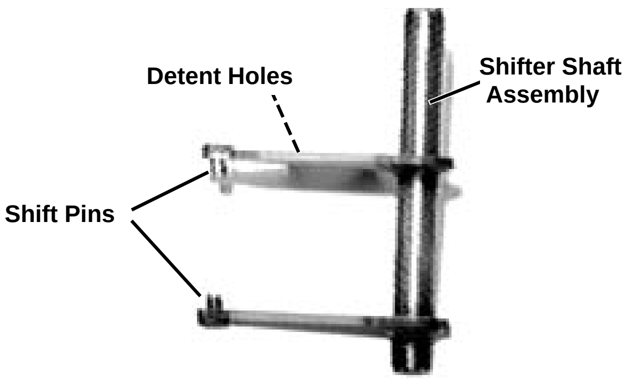


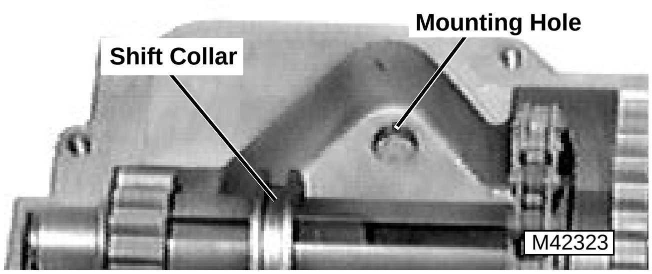
5. Without removing input shaft bearings visually inspect condition of input shaft bearings.
6. Replace input shaft bearings only if damaged or worn. If replacement is necessary, carefully remove input shaft bearings without damaging the bore.
7. Clean and inspect bore. If scratched or deformed, replace upper housing half.

SHIFTER SHAFT DISASSEMBLY



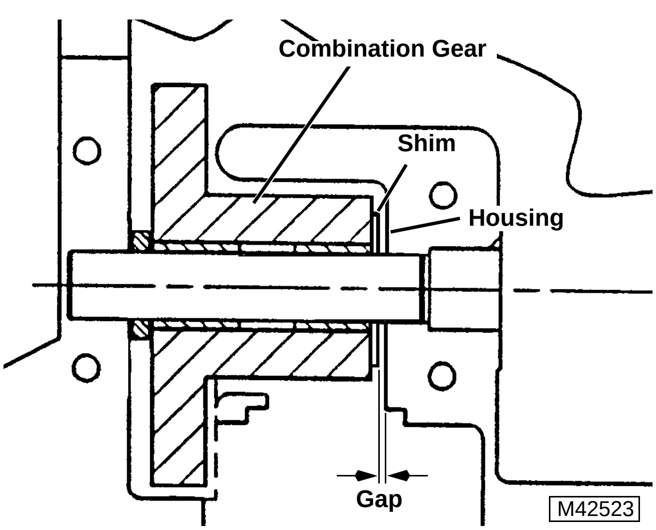
1. Lift shifter shaft assembly from mounting hole and disengage from groove in shift collar.





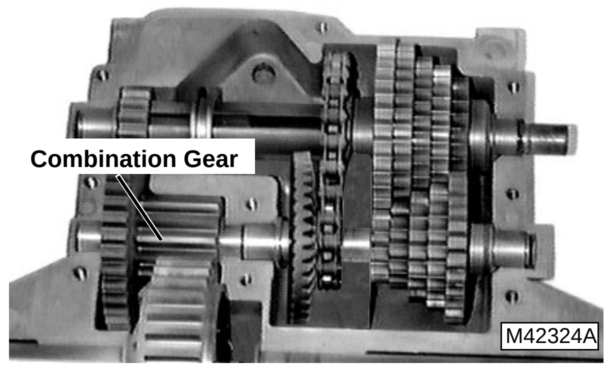
2. Clean shifter shaft assembly once removed.
3. Inspect condition of detent holes, shift pins, overall shifter shaft assembly, mounting hole, and shift collar.
4. If any part of shifter shaft assembly is worn or damaged, replace it; including the detent balls, detent springs, and set screws.
5. If mounting hole is worn or damaged, replace the housing half.
6. If shift collar is worn or damaged, replace it when intermediate shaft assembly is disassembled.

COMBINATION GEAR END PLAY ADJUSTMENT

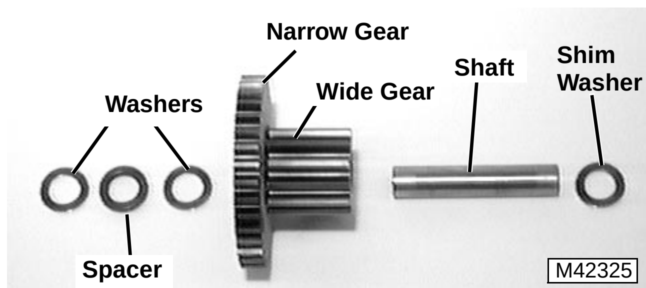


1. Visually check overall condition of assembly, including shaft and bushings, gears for wear, pitting, broken teeth, etc.
2. Use a feeler gauge to measure gap between end surface of shim pack and surface of housing half. Gap should be **0.33—0.66 mm (0.013—0.026 in.).**
3. If end play is not within specifications, shim pack thickness and/or worn components must be replaced.

COMBINATION GEAR DISASSEMBLY



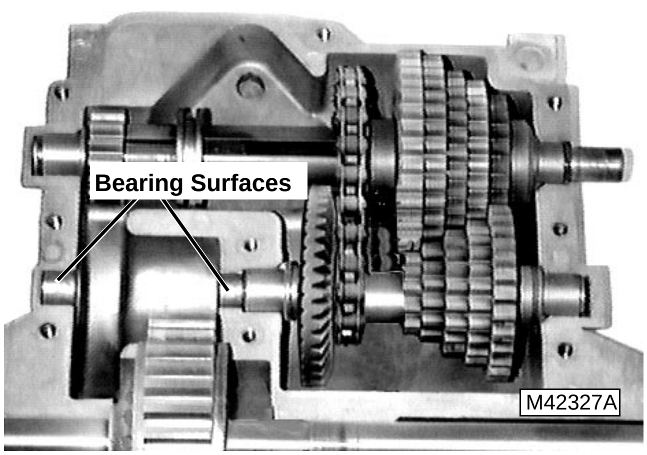
1. Lift idler combination gear assembly from lower housing half.
2. Mark components for orientation before disassembly. Clean components individually once disassembled.



3. Separate and inspect assembly components:
- Shim(s) should not be scored or discolored (burnt)
- Spacer should not be scored or discolored (burnt)
- Narrow combination gear should have **35** good teeth and wide gear should have **12** good teeth, not scored or discolored (burnt)
- Idler shaft should be smooth and not scored, pitted, or discolored (burnt)
- Shim washer(s) are serviced as a set

M42326

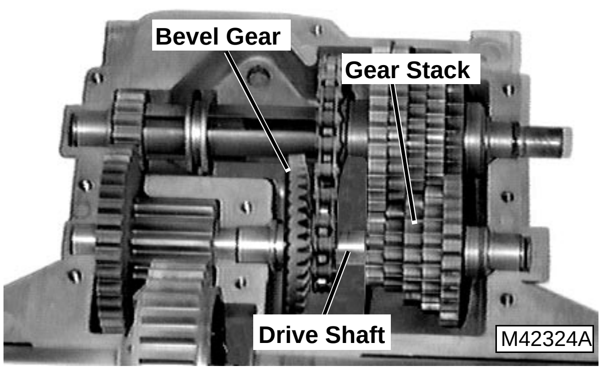
- Combination gear and bearings are serviced as a set. **DO NOT** remove bearings. Bearings should not be scored or discolored (burnt). They should roll freely and without roughness. If not, replace entire combination gear assembly. Replacement gear has bearings pre-installed, with special grease. A new shaft is recommended whenever the combination gear is replaced.



M42327A

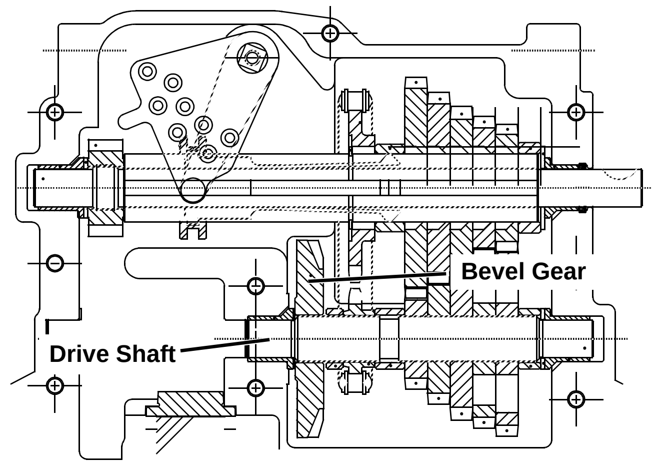
4. Inspect lower and upper housing combination shaft bearing surfaces for excessive scoring or wear. Replace housing halves as necessary.

DRIVE SHAFT AND GEAR STACK INSPECTION

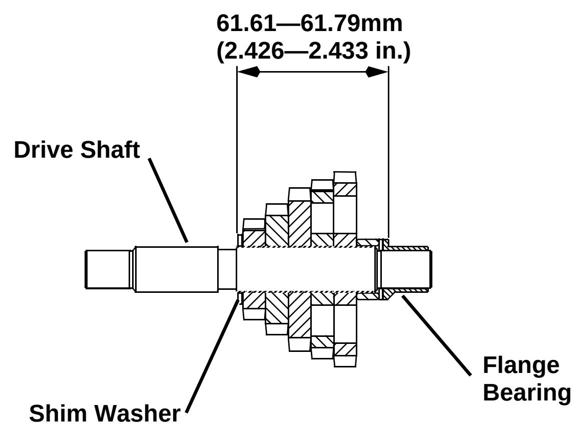


M42324A

1. Visually check overall condition of assemblies, including gears for wear, pitting, broken teeth, etc. Replace as required.

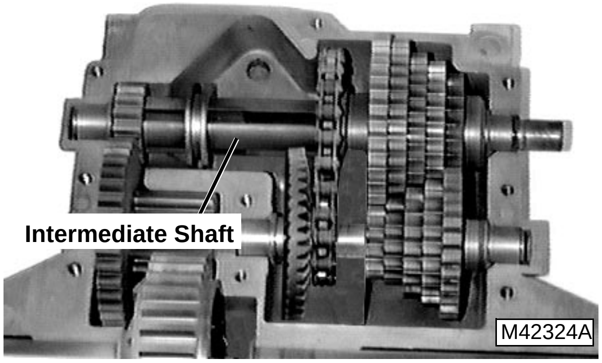


2. To check the drive shaft gear stack height remove the drive shaft assembly from the housing and remove the bevel gear from the drive shaft. See “DRIVE SHAFT ASSEMBLY” on page 31.

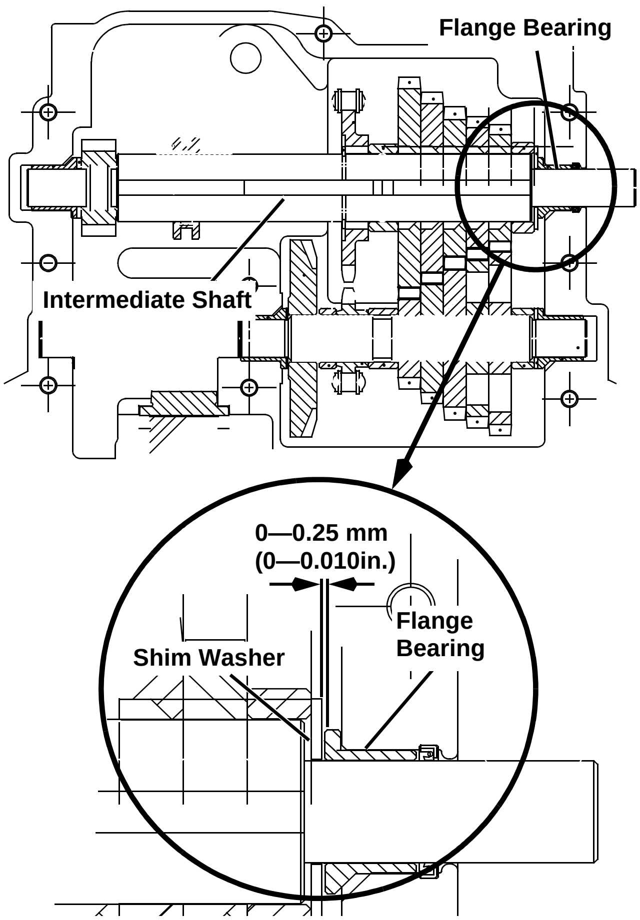


3. Put a caliper over the shim washer and the lip of the right side flange bearing. The caliper should read **61.61—61.79 mm (2.426—2.433 in.)**.
4. If end play is not within specification, shim washer needs to be changed and/or worn components need to be replaced.

INTERMEDIATE SHAFT END PLAY ADJUSTMENT

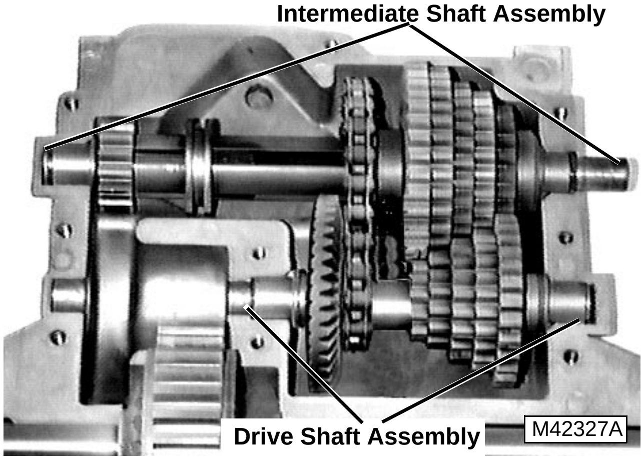


1. Visually check overall condition of assemblies, including gears for wear, pitting, broken teeth, etc. Replace as required.



2. Use a feeler gauge to measure end play gap between end surface of flange bearing and washer. Gap should be **0—0.25 mm (0—0.010 in.)**.
3. If end play is not within specification, change shim washer and/or replace worn components.

DRIVE/INTERMEDIATE SHAFT ASSEMBLIES - DISASSEMBLE



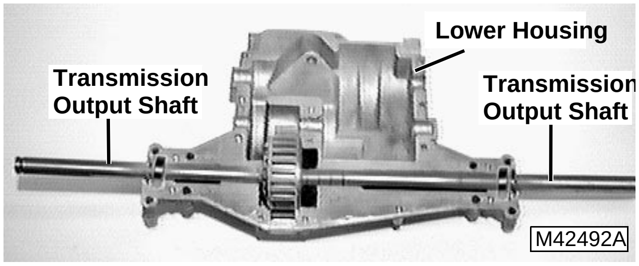
1. Lift both drive shaft and intermediate shaft assemblies out together.
2. Carefully remove drive shaft assembly components from drive shaft. Mark components to help keep orientation.
3. Clean components individually once disassembled.
4. Inspect each component closely for wear, scoring, cracks, chips, and broken teeth or splines.
5. Do the same for the intermediate shaft and its components.
6. Replace components as necessary.

IMPORTANT: Remember gears are in matched sets and both gears must be replaced, even if only one gear in a set is damaged.

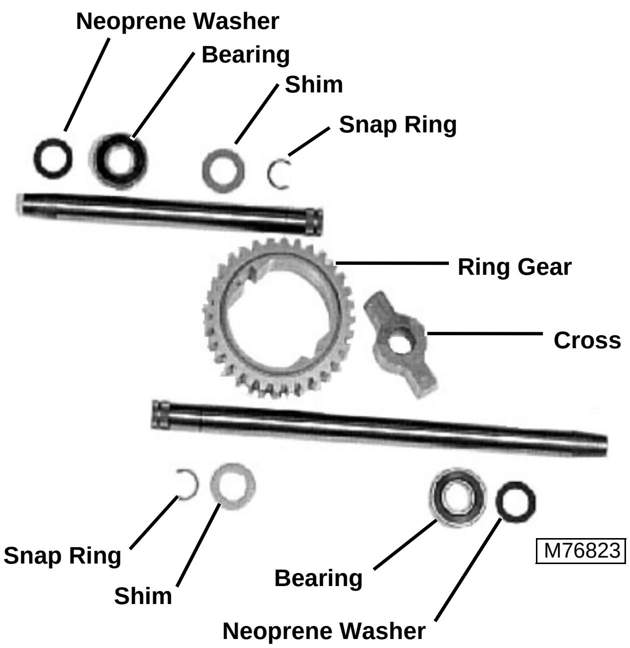
NOTE: Shim washers are serviced as a set.

7. Check end play. See “DRIVE SHAFT AND GEAR STACK INSPECTION” on page 28. See “INTERMEDIATE SHAFT END PLAY ADJUSTMENT” on page 29.

TRANSMISSION OUTPUT SHAFTS REMOVAL AND DISASSEMBLY



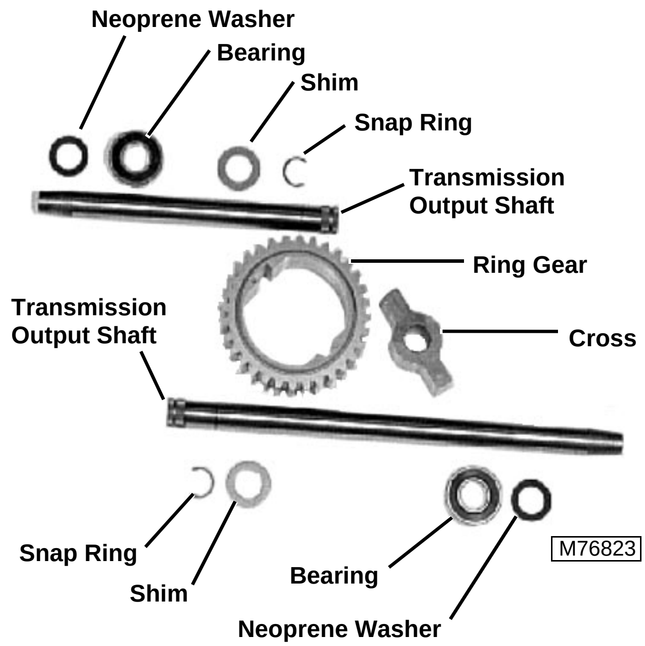
1. Remove the transmission output shafts from the lower housing half.



2. Carefully remove transmission output shaft assembly components from ring gear and cross. Mark all components for proper orientation.
3. Clean all components. Be sure to remove all sealant material from upper and lower housing halves.
4. Inspect each component (especially upper and lower housing halves) closely for wear, scoring, cracks, chips, or discoloration (burnt). Replace components as necessary.
5. Replace neoprene washers **every time** transmission housing has been separated.

TRANSMISSION ASSEMBLY

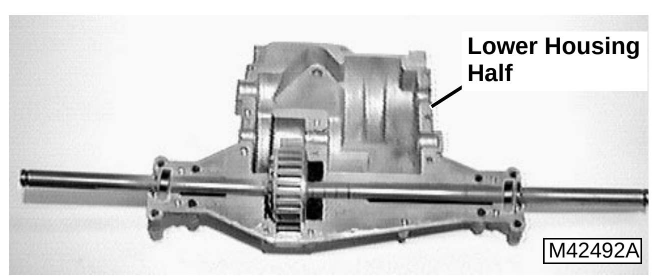
IMPORTANT: Pay close attention to proper order and orientation of all components.



1. Assemble snap ring and shim on inboard end of each transmission output shaft.
2. Install splined end of transmission output shafts into splines of cross.

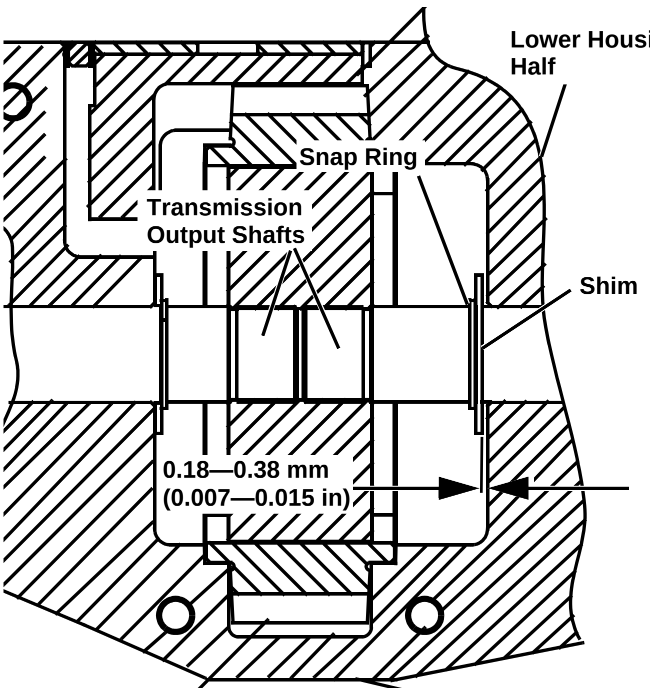
NOTE: Shim washer should be on the “Outboard” side of the snap ring, not next to the cross. See “TRANSMISSION OUTPUT SHAFT END PLAY ADJUSTMENT” on page 31.

3. Align slots in ring gear with tabs on cross and slide the ring gear onto the cross.
4. Install bearing and neoprene washer on each transmission output shafts.



5. Install the transmission output shaft assembly into lower housing half.

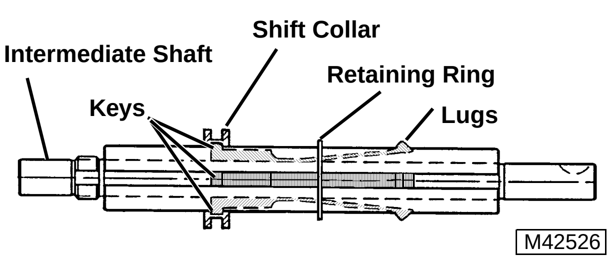
TRANSMISSION OUTPUT SHAFT END PLAY ADJUSTMENT



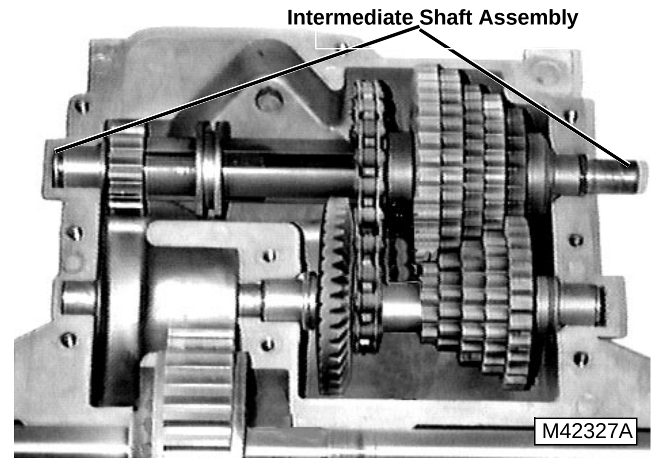
1. Push transmission output shaft/ring gear assembly to left until all end play is on side to be measured.
2. Measure end play gap between shim and side of lower housing half. End play should be **0.18—0.38 mm (0.007—0.015 in).** If not within specification, remove transmission output shaft and change shim until end play is within specification.

INTERMEDIATE SHAFT ASSEMBLY

NOTE: Intermediate shaft and drive shaft must be assembled together before installation in lower case housing.



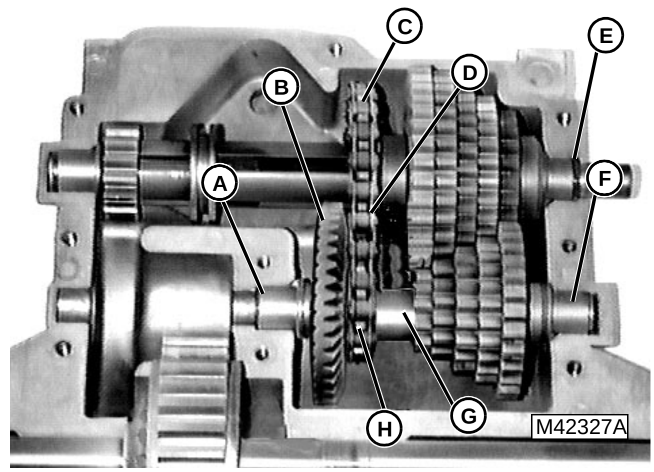
1. Install retaining ring onto intermediate shaft groove.
2. Install four keys in grooves of the intermediate shaft and hold them so internal shift collar anchors will seat in internal groove of collar as it is installed on the shaft.
3. Slide shift collar and keys against retaining ring and compress locking ramps/lugs to clear retaining ring.



4. Install the remaining intermediate shaft components to the shaft in their proper order.

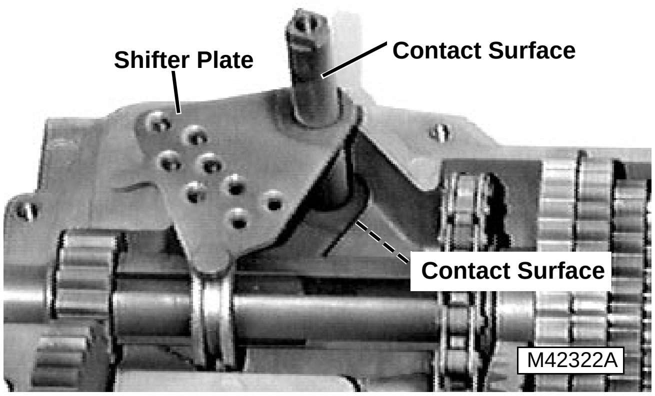
DRIVE SHAFT ASSEMBLY

NOTE: Intermediate shaft and drive shaft must be assembled together before installing into lower case housing.



1. Install drive shaft (G) components starting with small sprocket (H). Long flange of small sprocket (H) faces bevel drive gear (B).
2. Assemble drive chain (D) on sprockets (C) and (H)
3. Install flange bearings (A) and (C) with flange facing inside.
4. If not already done, set gear stack height. See "DRIVE SHAFT AND GEAR STACK INSPECTION" on page 28.

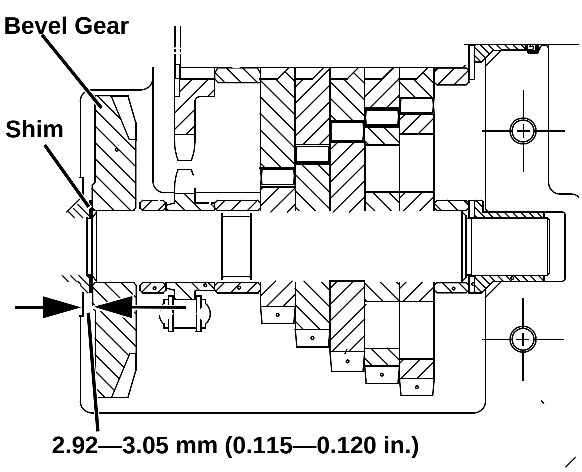
5. Set drive shaft end play, See “DRIVE SHAFT END PLAY ADJUSTMENT” on page 32.



6. Apply John Deere Never-Seez® to top surface of shifter plate and contact portions of shifter shaft with housing halves.
7. Install shifter fork assembly.

DRIVE SHAFT END PLAY ADJUSTMENT

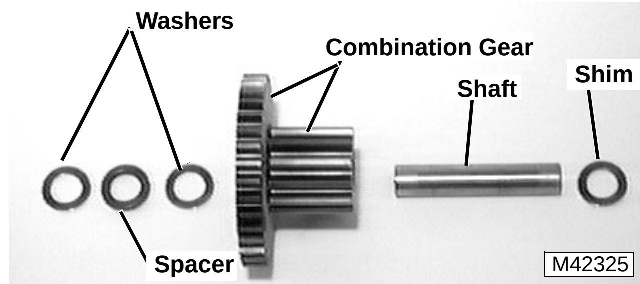
1. Before setting drive shaft end play, drive shaft gear stack height must be set. See “DRIVE SHAFT AND GEAR STACK INSPECTION” on page 28.



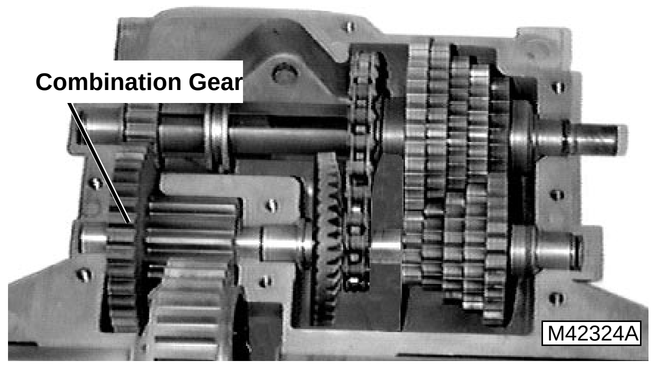
1. Reassemble the bevel gear to the drive shaft.
2. Measure the end play between the bevel gear hub face and the transmission housing. End play should be between **2.92—3.05 mm (0.115—0.120 in.)**.
3. If end play is not within specification, change shim thickness to obtain the correct specification.

NOTE: This procedure is required to correctly establish the input pinion gear to bevel gear mesh.

IDLER COMBINATION GEAR ASSEMBLY



1. Install components on idler shaft in order shown:

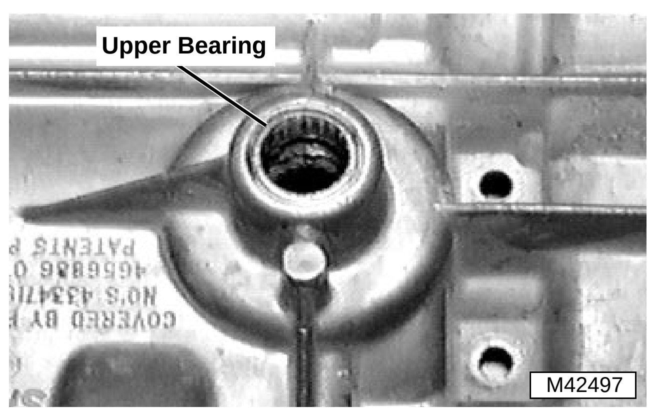


2. Install combination gear assembly into lower housing half.
3. Set end play of combination gear assembly. See “COMBINATION GEAR END PLAY ADJUSTMENT” on page 27.

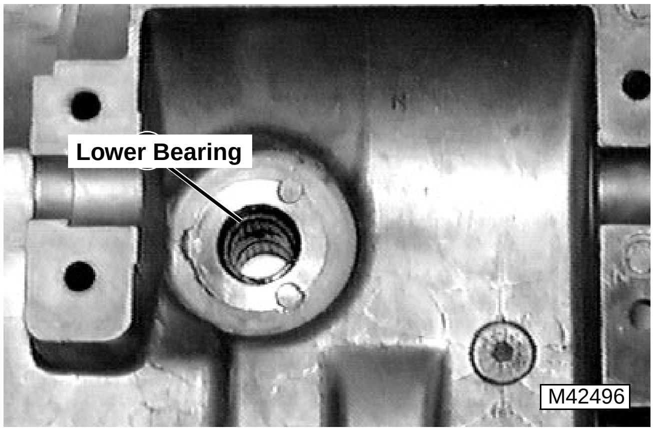
INPUT SHAFT INSTALLATION

1. Pack bearings with Unirex® N-3 grease before installing.

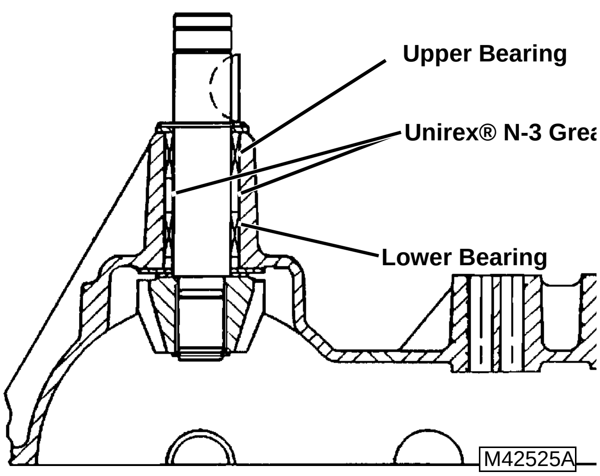
IMPORTANT: DO NOT scratch or deform housing bearing bore when installing bearings



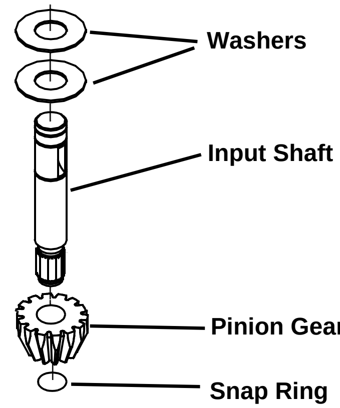
2. Install upper bearing with flat side of bearing (with lettering) toward outside of housing. Press into bore until **flush—0.76 mm (flush—0.030 in.)** recessed from outside bore opening face.



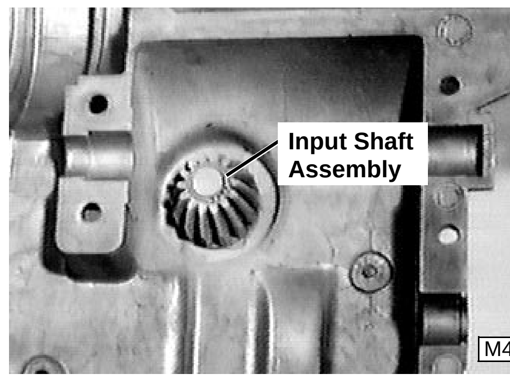
3. Install lower bearing with flat side of bearing (with lettering) toward inside of housing. Press into bore until **flush—0.76 mm (flush—0.030 in.)** from inside bore opening.



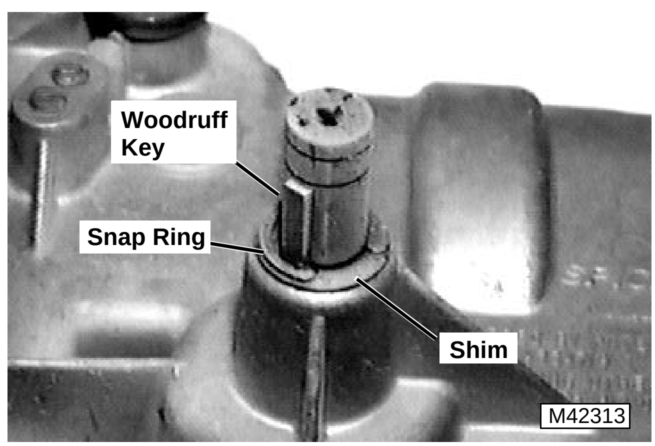
4. Pack needle bearings and gap between bearings with Unirex® N-3 grease before installing input shaft.



5. Install pinion gear on input shaft. Retain with snap ring.
6. Place two washers on input shaft, next to pinion gear.

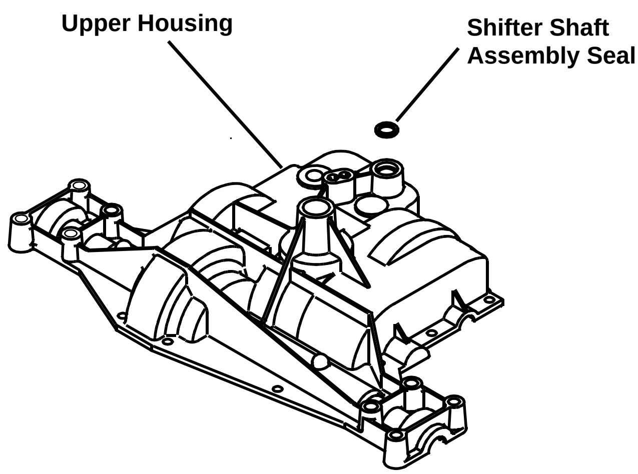


7. Install input shaft assembly into bearings from inner side of upper housing. Keyway should be on outside of housing.

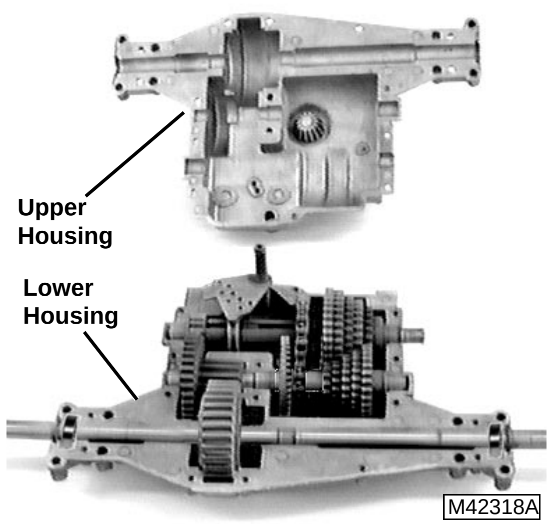


8. Install shim and secure input shaft with snap ring.
9. Turn housing half over and set end play. See “INPUT SHAFT INSPECTION/ADJUSTMENT” on page 25.
10. Install woodruff key in shaft keyway.

TRANSMISSION HOUSING ASSEMBLY



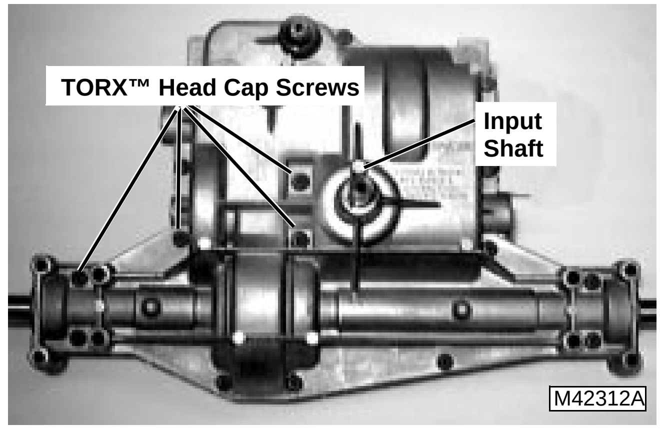
1. Inspect shifter shaft assembly seal and replace, if necessary.



2. Pack upper housing and lower housing with **638 g (1.4 lbs)** of Shell Darina® D grease.
3. Apply John Deere Form-In-Place Gasket Silicone Sealant to lower housing mating surface.

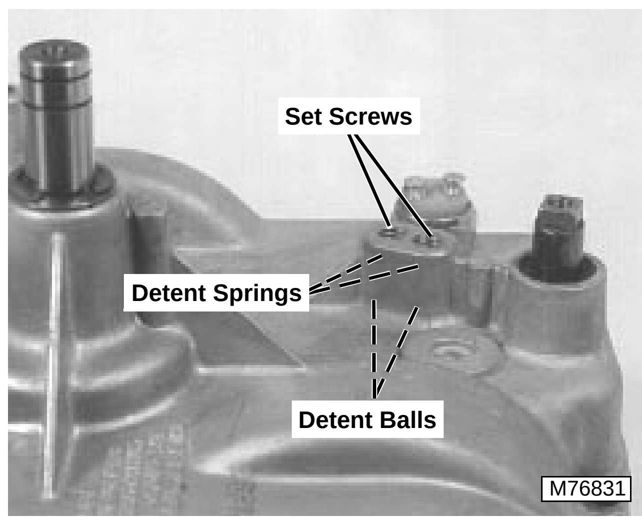
*NOTE: **BE SURE** sealant **DOES NOT** contact any gear, shaft, or bearing surfaces.*

4. Apply silicone all around housing cutouts where intermediate shaft flange bearing sets into upper and lower housing halves.



5. Align lower and upper housing halves together. **Be sure** shaft seals are seated correctly. You may have to turn input shaft slightly to insure proper gear mesh.
6. Install 16 TORX™ head transmission cap screws and torque to **9.03—10.2 N•m (80—90 lb-in.).**

SHIFTER DETENT INSTALLATION



IMPORTANT: DO NOT drop or lose detent balls (F).

1. Coat detent balls and detent springs with John Deere Never-Seez and install in housing bores.

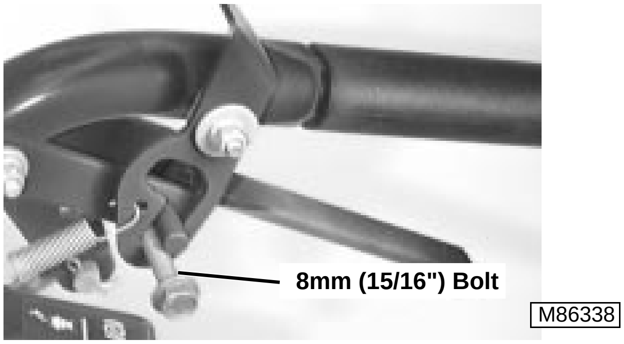
NOTE: New set screws are coated to assist in sealing the opening from moisture and to prevent the set screws from vibrating loose. If not replacing set screws use Loctite® or equivalent.

2. Install and tighten set screws until they are flush with top of mounting hole surface.

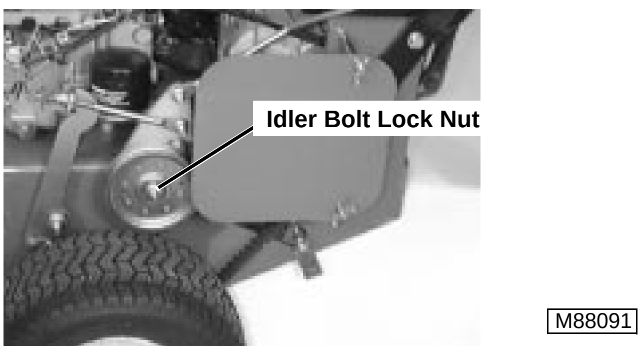
TRACTION DRIVE BELT ADJUSTMENT

IMPORTANT: Due to belt stretching, the tension on the drive wheel belts should be checked and adjusted after the first 25 hours of use.

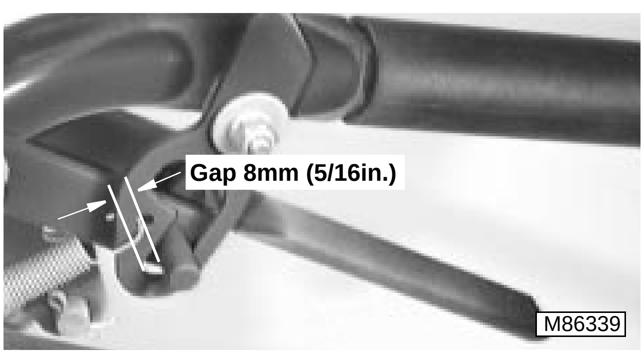
For best overall performance always adjust both left and right drive wheel belts equally.



1. Install something that is approximately 8 mm (5/16 in) in diameter – such as a 8 mm bolt - in between the brake lever stud and the brake thumb lock.



2. Loosen idler bolt lock nut.
3. Move idler to tighten drive belt.
4. Tighten idler bolt lock nut to **27.1—40 N•m (20—30 lb-ft)**.



5. Remove bolt used as a spacer between brake lever stud and the brake lever lock.

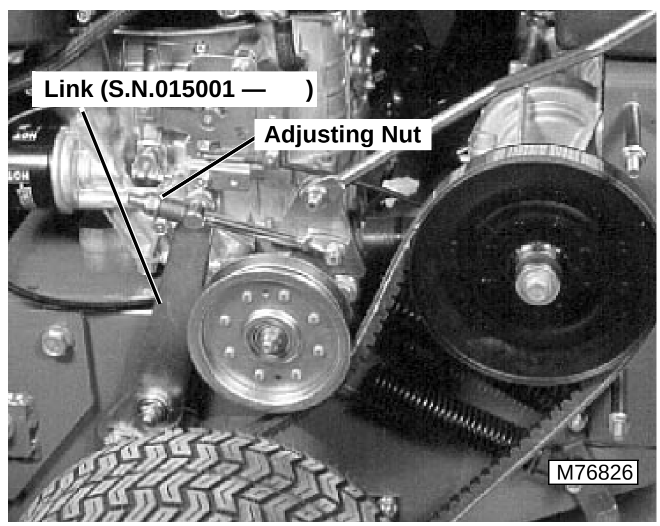
NOTE: If gap is less than 6mm (1/4 in.) the vehicle's traction may be restricted.
If gap is greater than 12 mm (1/2 in.) the belt may not declutch, when the brakes are applied.

6. A properly adjusted drive belt will show a gap of approximately 8 mm (5/16 in) between the brake lever stud and the brake lever lock.
7. Repeat Steps 1–6 until drive belt is properly adjusted.
8. Repeat procedure on the second drive belt.
9. Start engine. Unit should not move.
10. Set transmission in first gear. Release park brake. Unit should drive forward evenly.

IMPORTANT: With the traction drive/brake control levers engaged the belt should slip sufficiently to prevent the mower from moving. Belt should not show signs of getting excessively hot - Friction burning.

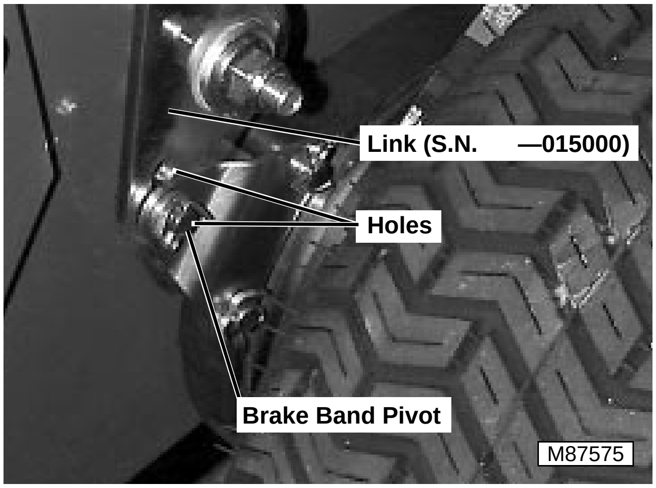
BRAKE ADJUSTMENT

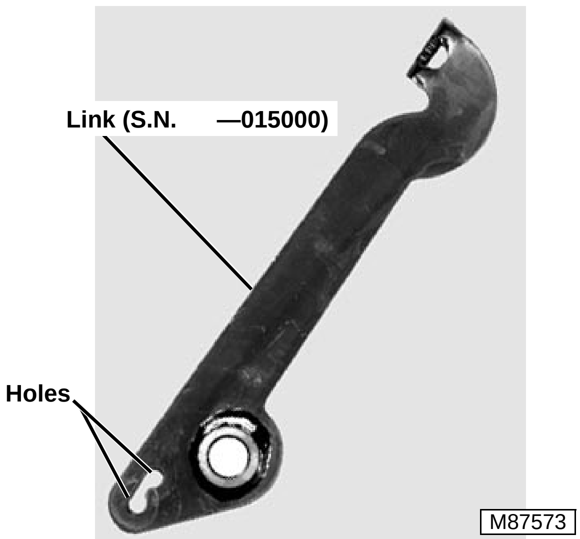
IMPORTANT: Due to initial brake wear and brake material being seated, the brakes should be checked and adjusted after the first 25 hours of use



1. Adjust brake by turning adjusting nut:
- To increase brake tension tighten adjusting nut.
- To decrease brake tension loosen adjusting nut.

NOTE: (S.N. —015000) Links have a second attachment hole for the brake band pivot. If threads on adjuster do not give correct brake engagement move pivot to second hole.

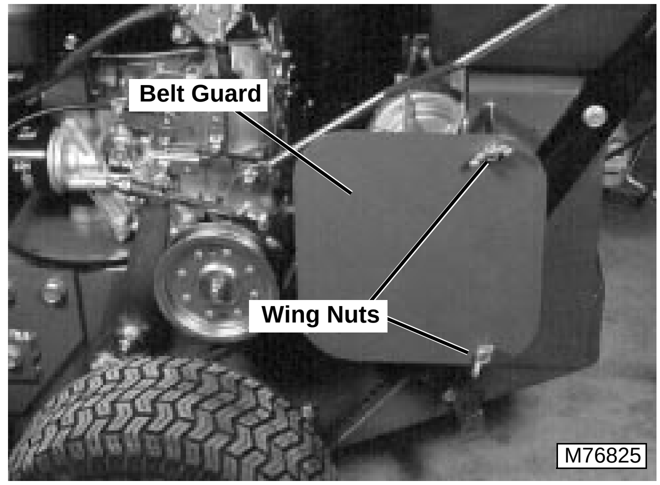




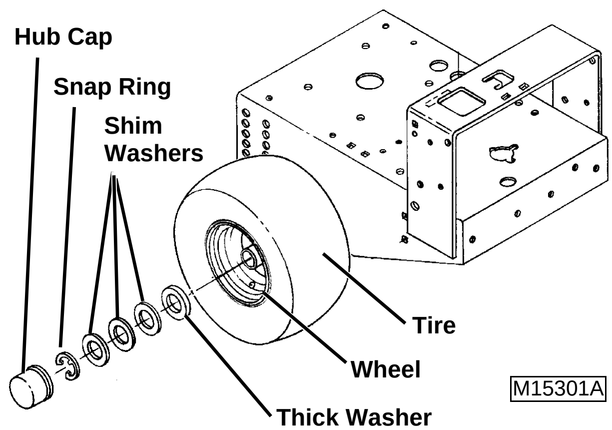
2. Adjust the brakes to provide a maximum of friction when the brake thumb latch is engaged. With the brake thumb latch engaged the mower should not move.
3. On mowers after (S.N. —015000) the brake band pivot can be moved to the second hole to increase range of braking motion.
4. When the brake thumb latch is released and brake controls are released the brake should not drag.
5. Repeat procedure on the remaining brake.
6. Replace any brake band and/or drum that will not hold the machine when properly adjusted.

DRIVE WHEEL REMOVAL

1. Position mower on a level, flat surface
2. Disconnect spark plug wire.
3. Jack up and support power unit.

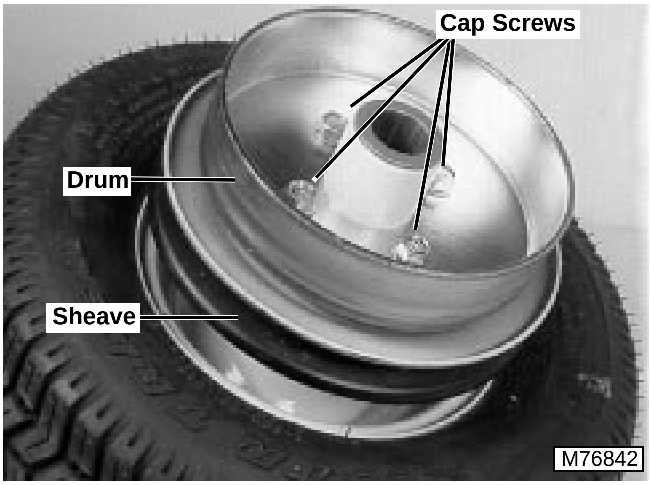


4. Remove belt guard and traction drive belt. See "TRACTION DRIVE BELT- REMOVAL AND INSTALLATION" on page 21.

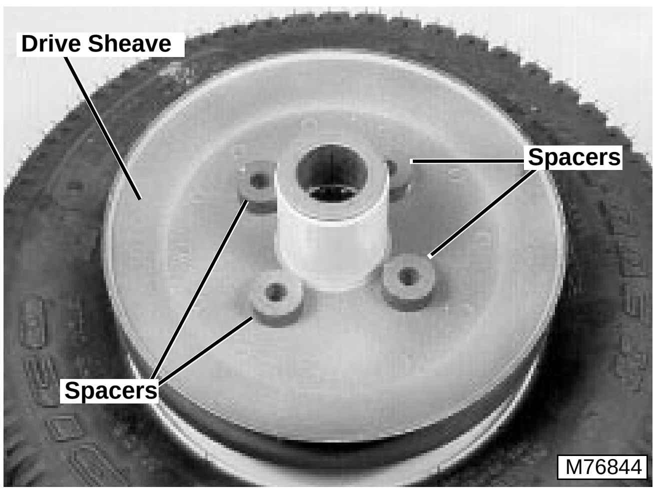


5. Remove hub cap from wheel.
6. Remove snap ring from axle.
7. Remove shim washers and thick washer from axle.
8. Slide wheel, drum and sheave from axle.

DRIVE WHEEL DISASSEMBLY



1. Remove four mounting cap screws.
2. Lift drum from wheel axle housing.
3. *Drive assemblies after SN#015001 do not use spacers between the new design drum (deeper center dish) and the drive sheave.*

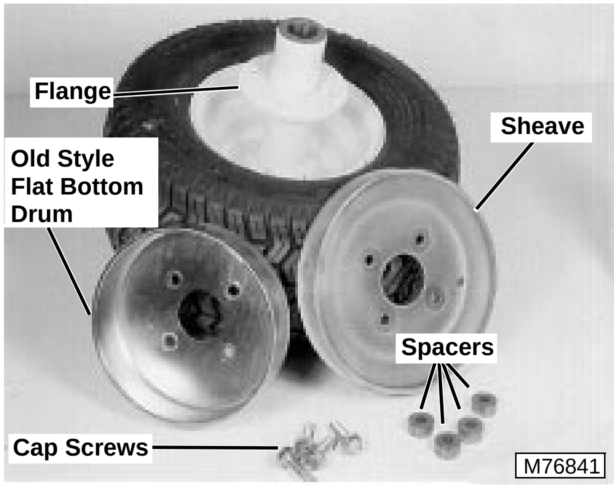


4. Remove four spacers and retain.
5. Remove drive sheave.

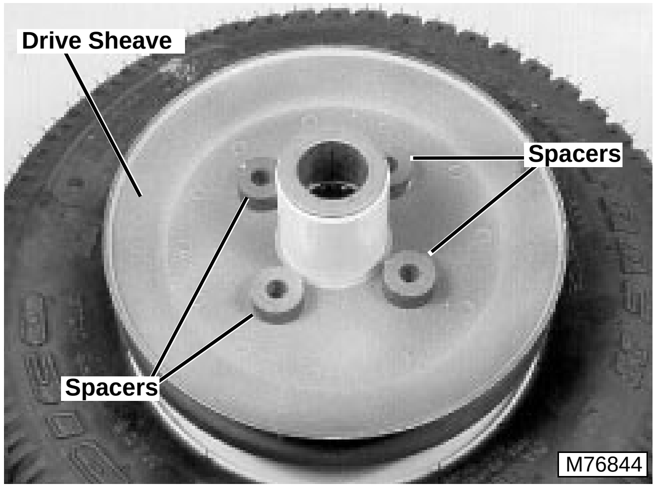
DRIVE WHEEL ASSEMBLY

NOTE: Drive assemblies after SN#015001 do not use spacers between the new design drum (deeper center dish) and the drive sheave. New style drums can be used on earlier units if spacers are left out.

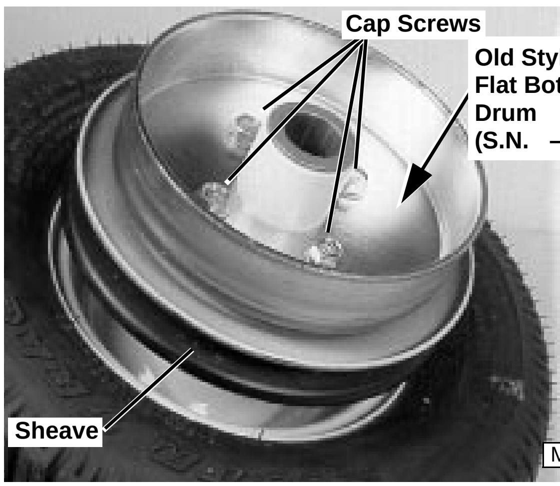
IMPORTANT: DO NOT use spacers with new deep dish drums.

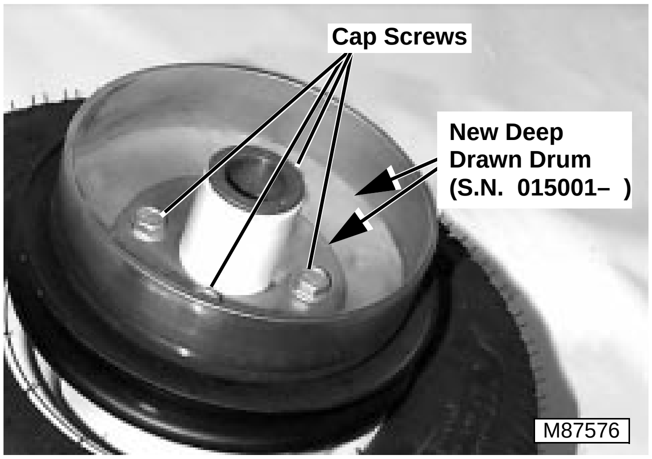


1. Place drive sheave on flange.



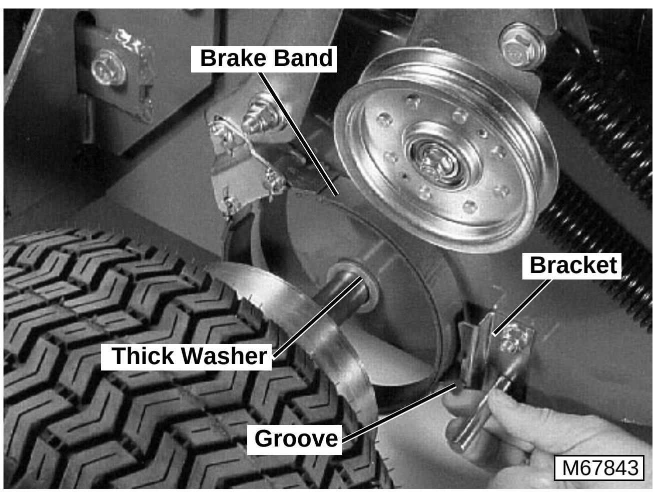
2. Position spacers, if required, on sheave over mount holes.
3. Align brake drum with spacers, drive sheave and mounting holes in flange.



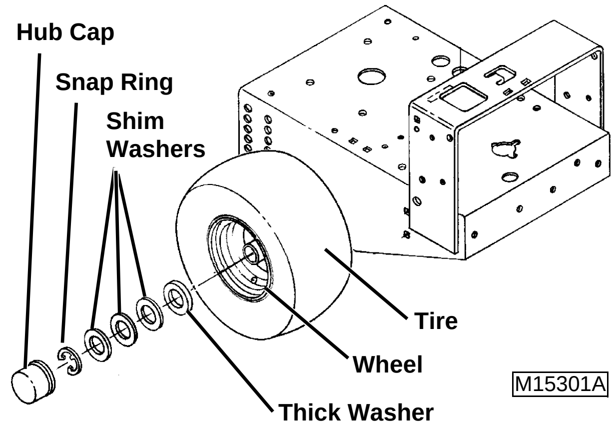


4. Install mounting cap screws and torque to **44 N•m (33 lb-ft).**

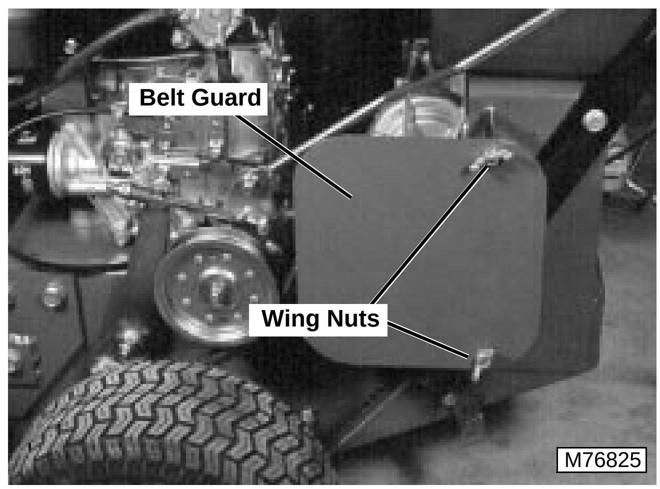
DRIVE WHEEL INSTALLATION



1. Install one THICK washer on axle.
2. Slide wheel assembly over axle only far enough to support its weight.
3. Align brake band groove in bracket.
4. Gently slide wheel assembly on axle until brake drum starts to engage the brake band.
5. Check that band fits over drum.
6. Push wheel assembly until it is seated on axle.
7. Rotate wheel slightly and check for any dragging of brake assembly.



8. Install second THICK washer, next to wheel. Add shim washers as needed to take up clearance between thick washer and snap ring. Install snap ring and hub cap on end of axle.
9. Install and adjust traction drive belt. See “TRACTION DRIVE BELT ADJUSTMENT” on page 35.



10. Reinstall belt guard.
11. Lower mower to floor.

CONTENTS

HYDROSTATIC TRANSAXLE SPECIFICATIONS

General Specifications

Maximum Operating Temperature . . . . 82° C (180° F)
Input Shaft Rotation . . . . Clockwise
Output Shaft Rotation . . . . Clockwise

Dimensions

Input Shaft Diameter . . . . 17 mm (0.669 in.)
Input Shaft Woodruff Key Dimension . . . . 4.763 x 15.875 mm (0.1875 x 0.6250 in.)
Output Shaft Diameter . . . . 25 mm (0.984 in.)
Output Shaft Woodruff Key Dimension . . . . 6.299 x 25.4 mm (0.2480 x 1.000 in.)
Reservoir-to-Transaxle Hose Inside Diameter. . . . . 15.88 mm (0.625 in)

Gear Tooth Count

Ring Gear 54T
First Sun Gear. 18T
Primary Carrier 18T
First Planet Gear 18T
Second Sun Gear 18T
Second Planet Gear 18T

TRANSMISSION DRIVE BELT

Effective Length (New) . . . . 914.4 mm (36 in.)
Top Width (New) . . . . 12.45 mm (0.49 in.)

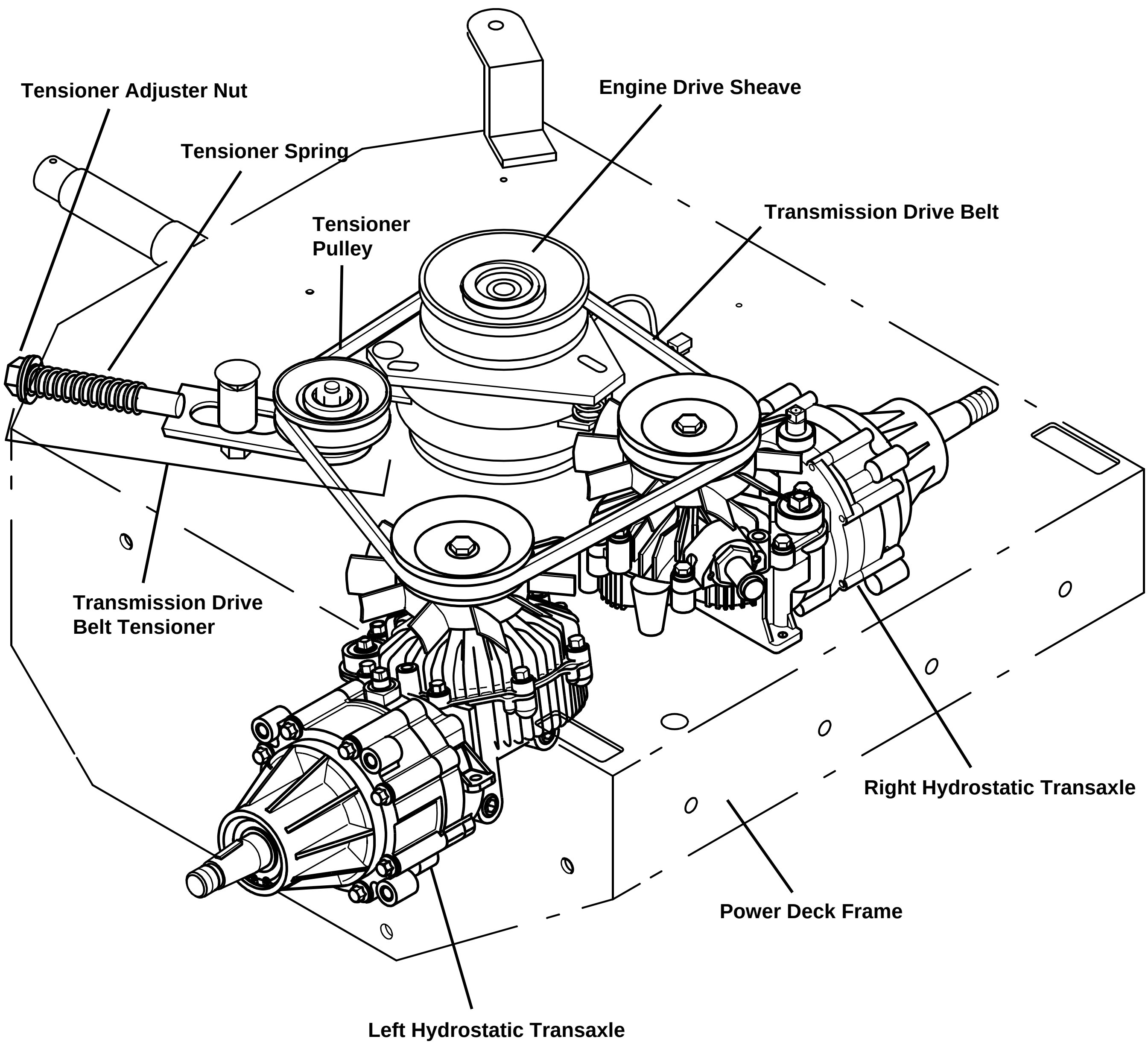
GROUND SPEEDS

(Measured at Fast Idle—3350 RPM Engine Speed)
Forward . . . . 0–9.7 kph (0–6 mph)
Reverse . . . . 0–1.6 kph (0–1 mph)

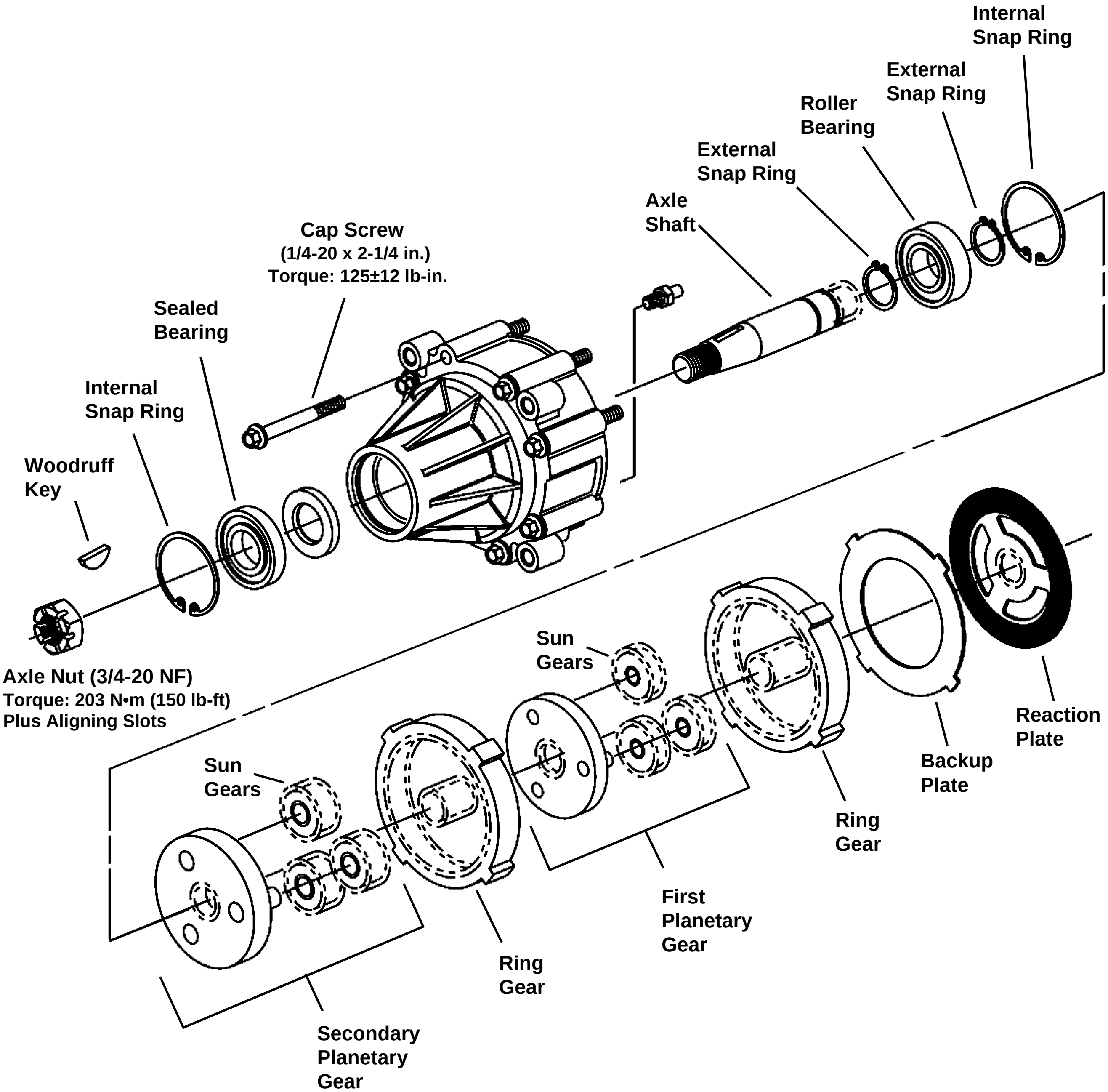
TORQUE SPECIFICATIONS

Plastic Reservoir Cover. . . . . 100±10 lb-in.
Suction Line Hose Nipple (From Reservoir) . . . . 44±4 lb-in.
Pump Cover Mounting Cap Screws . . . . 165±16.5 lb-in.
Brake Housing Cap Screws (Inside Transaxle) . . . . 165±16.5 lb-in.
Transaxle Drain Plug (use loctite) . . . . 28±3 lb-in.
Axle Housing-to-Transaxle Case Cap Screws. . . . . 125±12.5 lb-in.
Slotted Axle Nut . . . . . 203 N•m (150 lb-ft) minimum, plus torque required to align slot.
Transaxle-to-Power Deck Mounting Self-Tapping Cap Screws . . . . . 20 N•m (177 lb-in.)

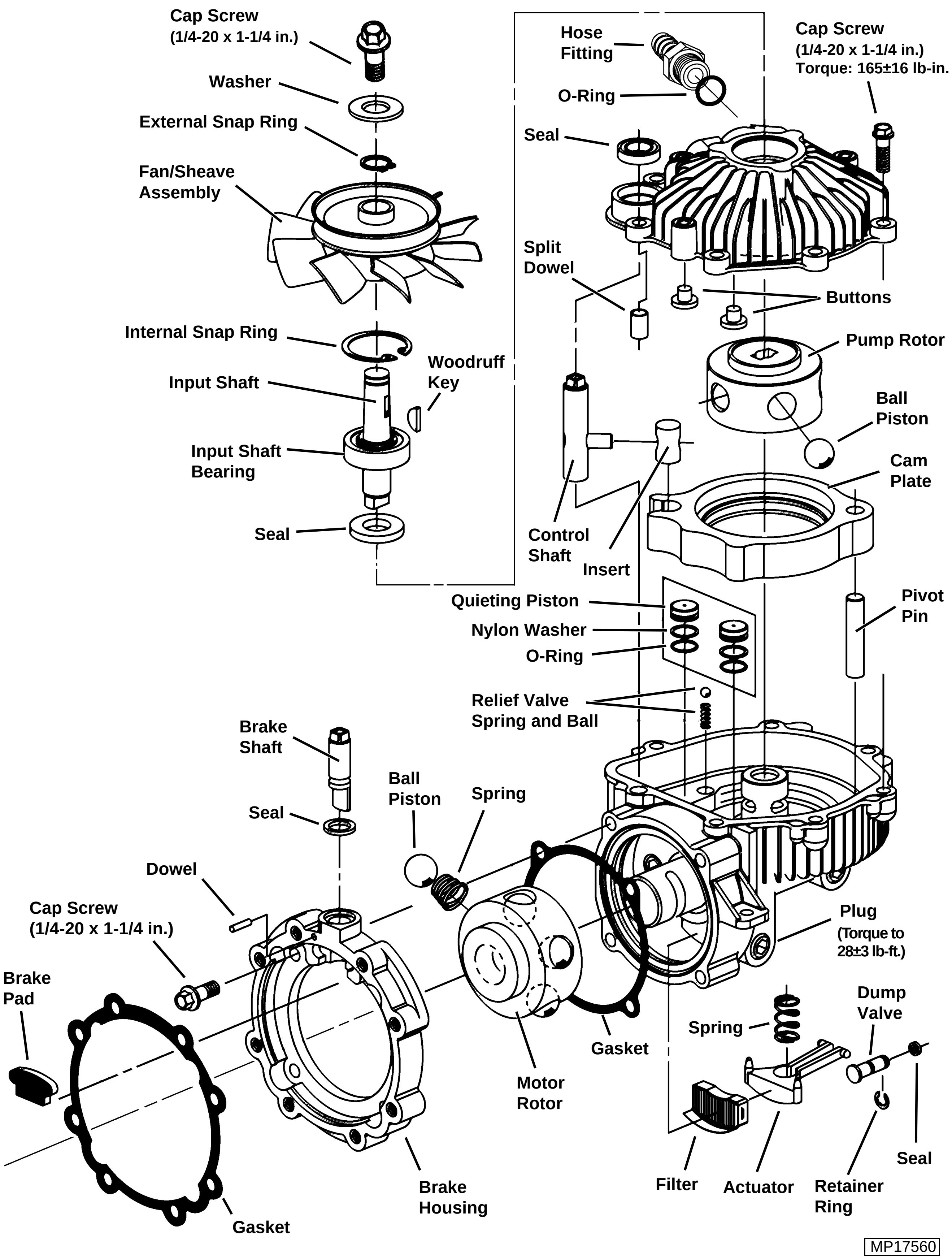
HYDROSTATIC TRANSAXLE COMPONENT LOCATION



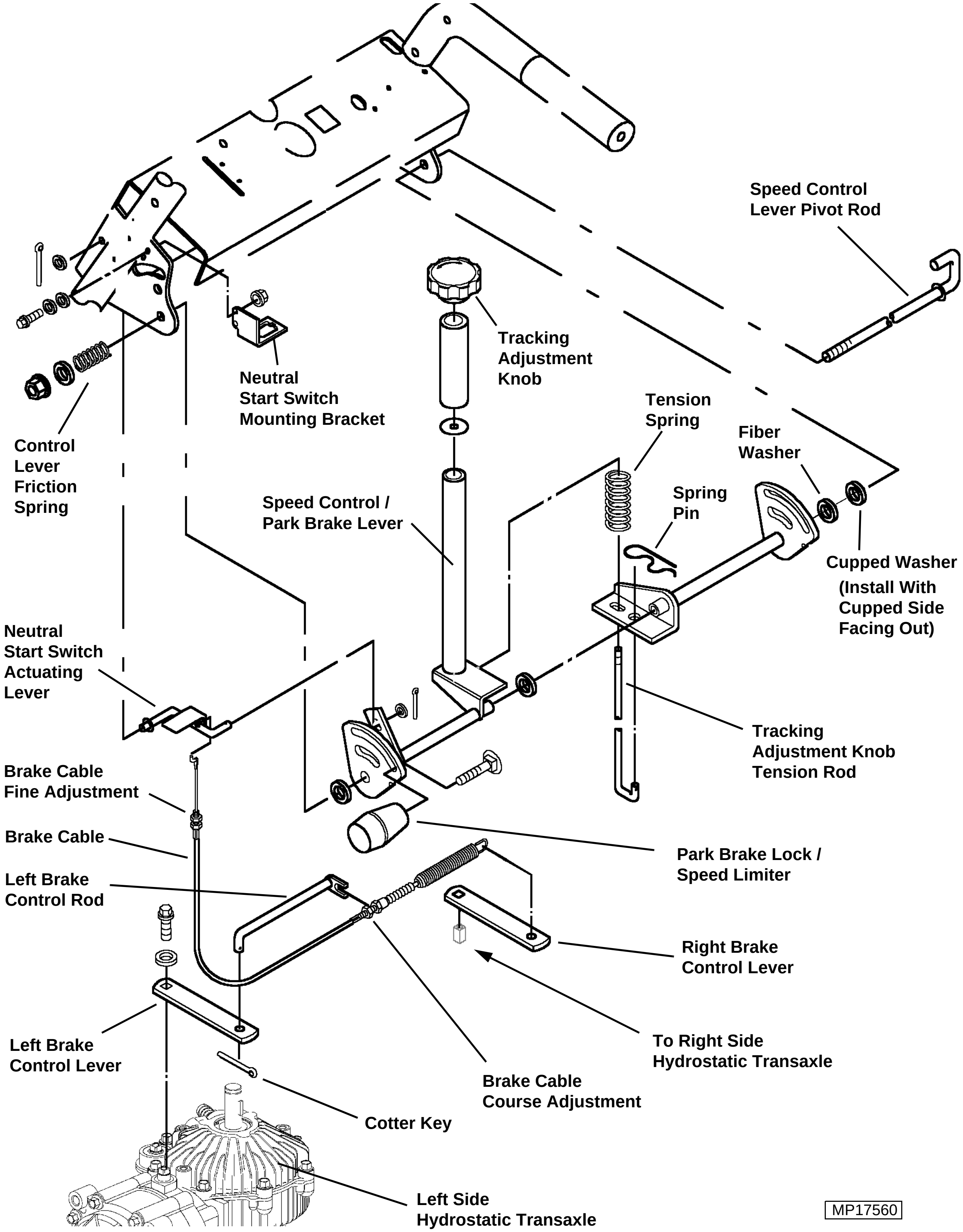
HYDROSTATIC TRANSAXLE COMPONENT LOCATION



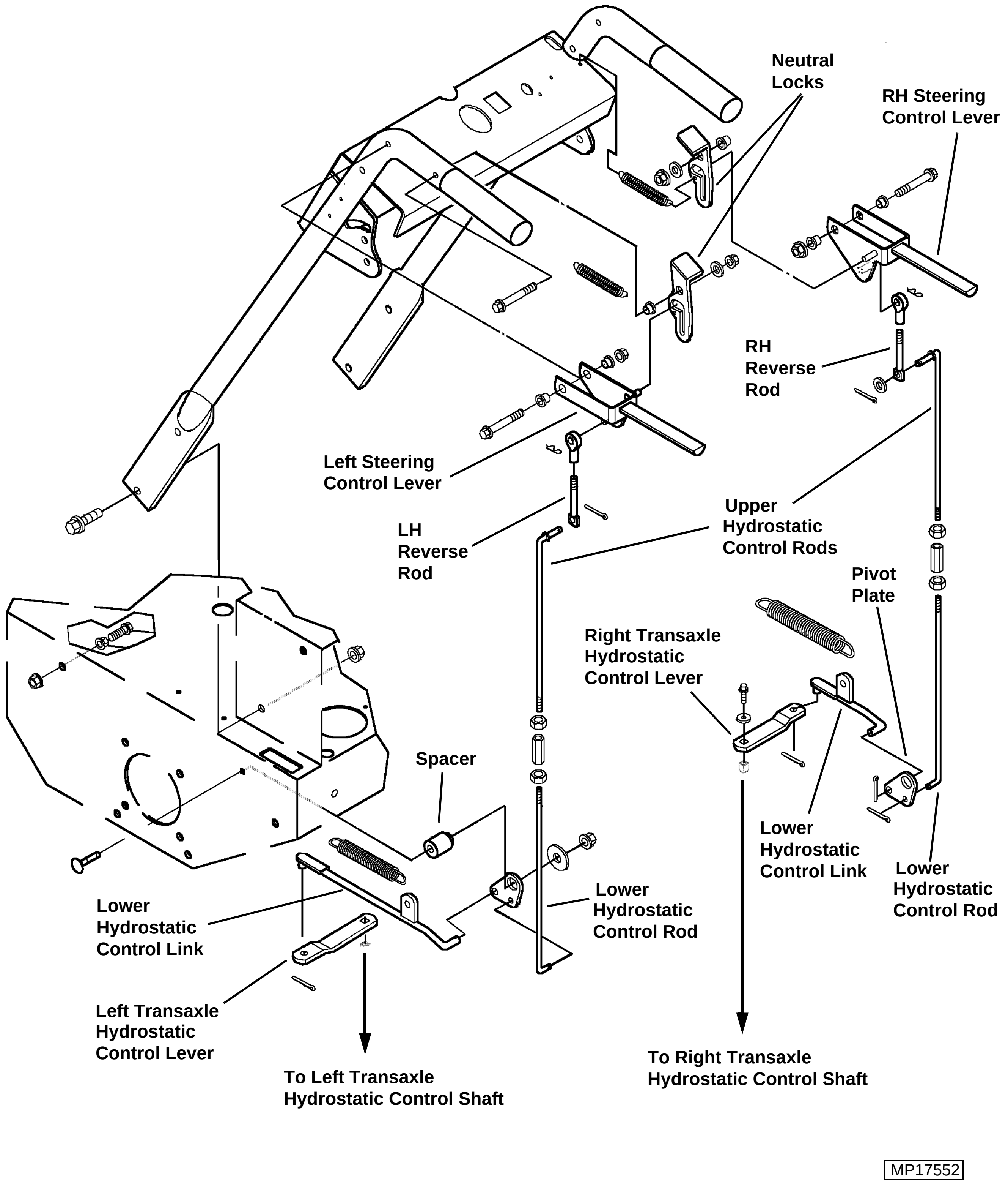
HYDROSTATIC TRANSAXLE COMPONENT LOCATION



HYDROSTATIC CONTROLS COMPONENT LOCATION



HYDROSTATIC CONTROLS COMPONENT LOCATION



TROUBLESHOOTING CHART

Check or Solution / Problem or Symptom	Vehicle Will Not Track In A Straight Line	Excessive Noise When Transaxle is Engaged (Forward or Reverse)	Vehicle Will Not Move Forward	Vehicle Will Not Move In Reverse	Speed Control Won't Move or Slips	Brakes Do Not Hold On A Hill	Vehicle Will Not Return To Neutral	Engine Shuts Off When Speed Control Lever Is Moved Forward	Vehicle Will Not Obtain Full Speed	Vehicle Creeps
Brake Cable Adjustment Too Tight		●	●	●					●	
Brake Cable Adjustment Too Loose						●				●
Low Hydrostatic Oil Level or Cavitation In Transaxle	●	●	●	●						
Hydrostatic Control Linkage Out Of Adjustment	●						●		●	●
Left or Right Reverse Rods Out Of Adjustment	●			●					●	
Hydrostatic Control Rod Friction Adjustment Not Correct	●				●					
Transaxle Free Wheeling Valve(s) In Engaged (Pulled Out) Position			●	●					●	
Transmission Drive Belt Slipping		●	●	●					●	
Engine Drive Sheave Key Sheared		●	●	●						
Transmission Being Overloaded		●							●	
Operator Presence Linkage Bent								●		
Tire Pressure Unequal	●									

THEORY OF OPERATION

TRANSMISSION OPERATION

Function:

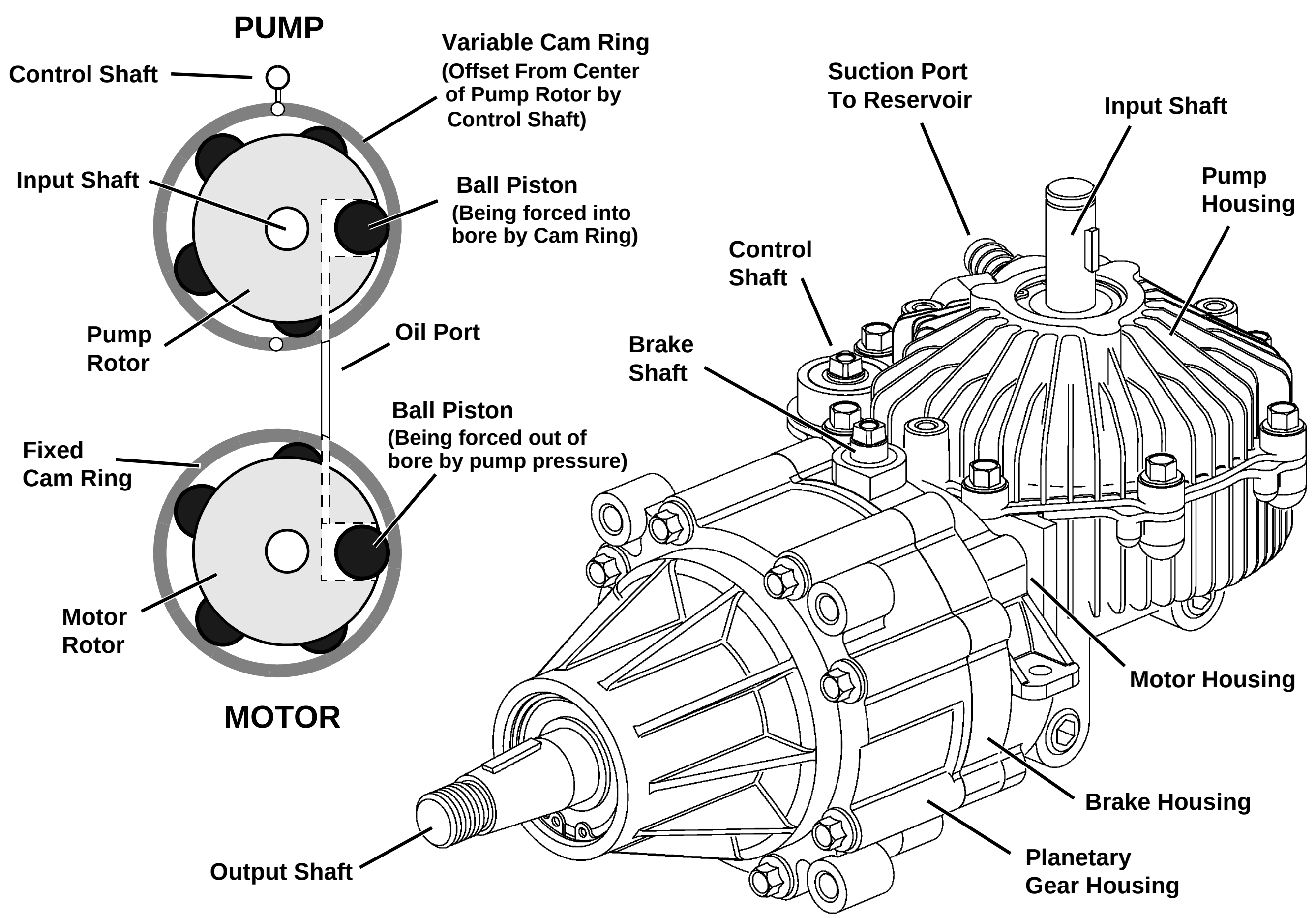
Eaton Model 778 Right Angle Transaxles are used to transmit forward and reverse power to the drive wheels. Two separate transaxles are used, one for each drive wheel. The transaxles are sealed and contain no internal serviceable parts, so disassembly is not recommended. External case seals are available through service parts, and it is recommended to check the Parts Catalog before attempting transaxle service.

Power from the engine is transmitted through the engine drive sheave, to the transmission drive belt, and into both the left and right transaxle input sheaves. The input sheaves turn the input shafts of the transaxles, driving the internal hydrostatic pumps.

The hydrostatic pump is a ball piston type, with a variable cam ring. When in neutral, the cam ring is centered on the rotation of pump rotor. As the input shaft turns the pump rotor, the ball pistons follow the race of the cam ring, and remain centered in the bore of the piston. When the control shaft is turned, the cam ring is moved off center from the pump rotor. The ball pistons continue to follow the race of the cam ring, and are now forced into and out of the pump rotor bores. This action forces oil to be pumped to one port to the motor, and suction created in the other port, providing power to drive the hydrostatic motor. If the cam ring is moved off center of the pump rotor in the opposite direction, the motor will be driven in reverse.

The hydrostatic motor is also a ball piston type, but its center axle is off center from the cam ring race. As pressure is directed to the motor, the ball pistons are forced outward in the motor bore, causing the rotor to spin. The cam race is fixed into the transmission housing, so the rotation of the motor rotor is directed to the planetary drive, turning the drive wheel axle.

The brake housing is located between planetary gear housing and the motor housing. The brakes are wet disk style and controlled by the brake shaft. The brake is only used for parking when the speed control lever is returned to neutral. The brake pads and disks are not serviceable, and no attempt should be made to open the transaxle.



DIAGNOSTICS

Test Conditions:

- Mower sitting on level ground, outdoors, in a area clear of obstructions and large enough to run mower at full ground speed and slow turn tests.
- Free wheeling levers fully forward (unlocked position).
- Transmission drive belt tension checked and adjusted.
- Hydrostatic reservoirs full of oil.
- Neutral thumb lock levers OFF
- .Speed control / park brake lever pulled fully back (neutral position).

Test/Check Point	Normal	If Not Normal
1. Pull out choke and start engine. Push in choke.	Engine starts and idles.	Neutral start switch actuating lever is not contacting switch plunger under left side of operator's control panel. Manually depress switch and try to restart. See Electrical Section for circuit testing. See Brake Cable Adjustment (this section) for lever repair.
2. Lower operator presence bail and move speed control lever forward one inch.	Engine continues to run. Mower begins to move forward.	Engine stops-operator presence linkage is not contacting switch plunger under right side of operator's control panel. Manually depress switch plunger and retest. See Electrical section for circuit testing. See Miscellaneous Section for repair. Brake cable may be too tight. Adjust Brake
3. Move speed control lever from full back (neutral) position to full forward (high speed) position while tracking path of mower.	Mower will track differently as engine speed and ground speed changes. Tracking control knob should be able to compensate within one turn of the tracking control knob.	If tracking control knob does not compensate correctly, linkage may be out of adjustment (See "HYDROSTATIC CONTROL LINKAGE ADJUSTMENT" on page 11.)
1. Move speed control lever to full back (neutral / park brake) position.	Mower does not creep in neutral.	See Hydrostatic Control Linkage Adjustment. See Park Brake Adjustment.
1. With speed control lever in full back (neutral) position, lock neutral thumb lock levers in the forward position.	Moving the speed control lever forward does not cause the drive wheels to turn.	Mower creeps forward, See Hydrostatic Control Linkage Adjustment.
1. With speed control lever moved forward one inch, pull in both LH and RH steering control levers (reverse).	Mower tracks in a straight line in reverse.	Mower doesn't move, or pulls to one side, See Hydrostatic Control Linkage Adjustment

TESTS AND ADJUSTMENTS

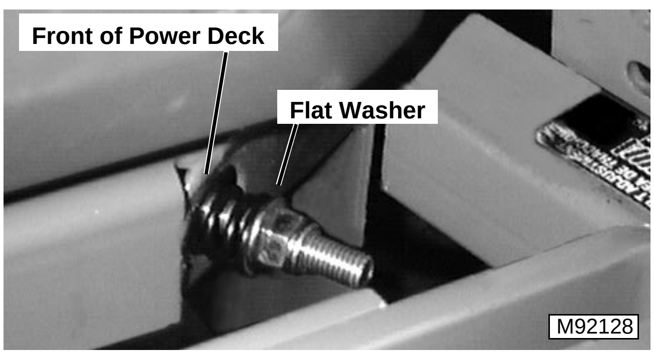
TRANSMISSION DRIVE BELT TENSION ADJUSTMENT

Reason:

Due to belt stretching, the tension on the transmission drive belt should be adjusted after the first 25 hours of use.

NOTE: Do not over tension the drive belt. Excess belt tension can cause transmission damage. Inadequate drive belt tension can cause loss of traction drive.
The engine drive pulley should be checked for oil and grease anytime the drive belt is serviced.

Inspection:



1. Check tension of transmission drive belt by measuring distance between the back of the flat washer and the front of the power unit deck.
2. As the drive belt stretches, the distance between the flat washer and power deck will increase.
3. When the distance between washer and the power unit reaches 17 mm (0.669 in.) or greater, an adjustment is needed.
4. Tighten adjustment nut to increase spring tension, or loosen nut to decrease spring tension.
5. Adjust to 14-16 mm (0.551 – 0.630 in.)

HYDROSTATIC CONTROL LINKAGE ADJUSTMENT

Reason:

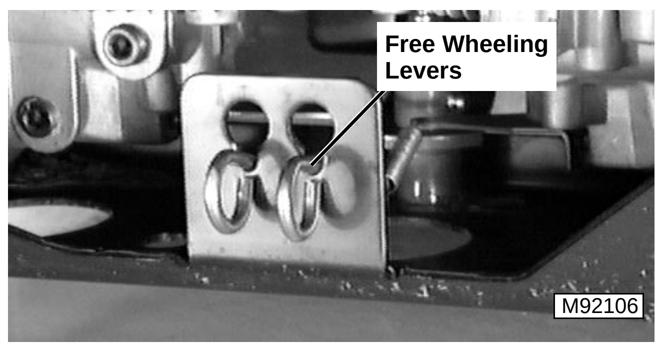
To adjust the control linkages for the hydrostatic transaxles to produce full power, not creep in neutral, and allow the mower to track in a straight line in forward and reverse.

Equipment:

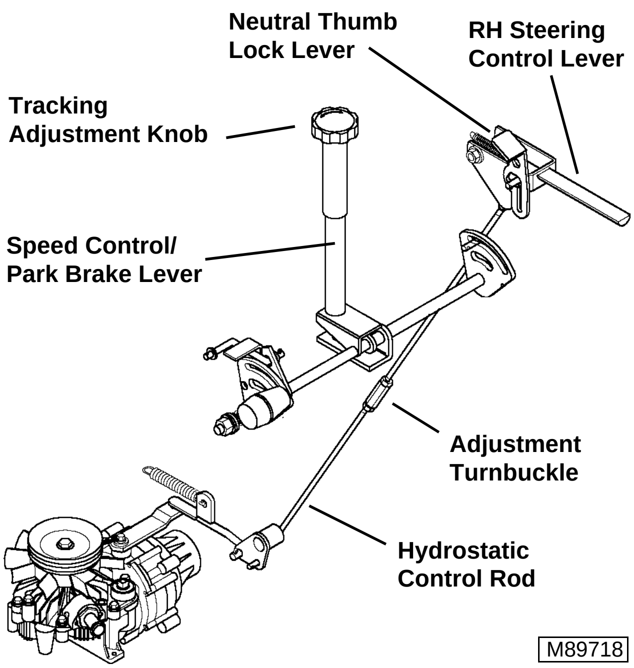
- Two 1/2” open end wrenches
- Wheel Chocks and Jack Stands

Procedure:

1. Park mower on level surface. Place speed control lever in full back (NEUTRAL) position.
2. Turn PTO off. (Push PTO switch IN).
3. Check belt tension on transmission drive belt. (See “TRANSMISSION DRIVE BELT TENSION ADJUSTMENT” on page 11.)
4. Check oil level in hydrostatic reservoirs. (See “HYDROSTATIC SYSTEM BLEEDING” on page 19.)



5. Move free wheeling lever handles IN so springs are slack. Check that free wheeling valve piston rods into transaxle are moving freely in their bore.
6. Start engine and move throttle control to the fast idle ( ) position.

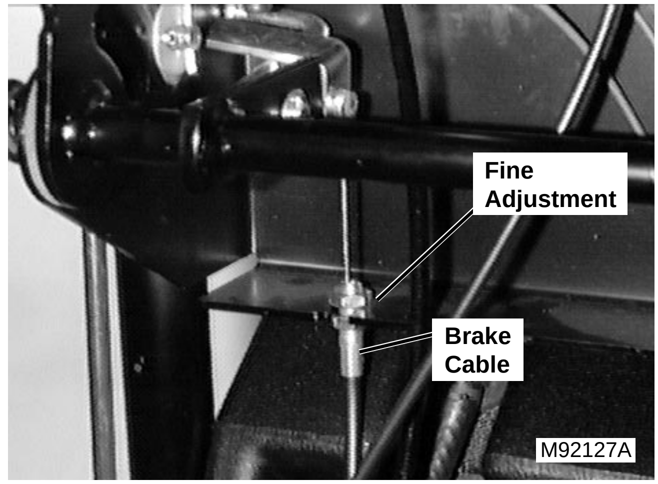


7. Pull up steering control levers and engage neutral thumb locks.
8. Push speed control lever forward 25 mm (1 in.).
9. If drive wheels begin to creep, an adjustment is required.
10. Pull speed control lever back to the PARK (Ⓟ) position. Stop engine.

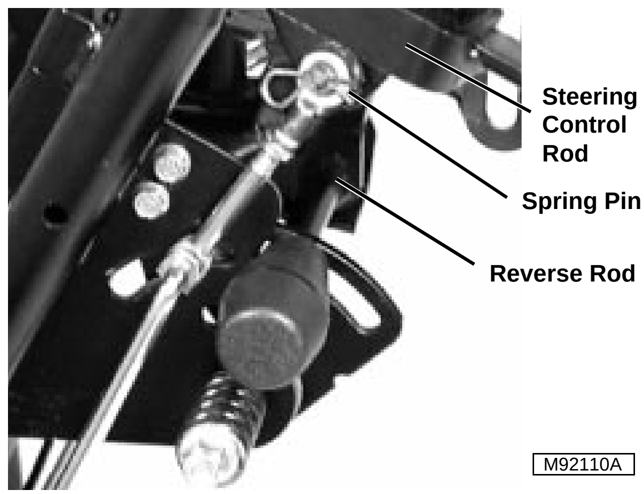
⚠ CAUTION

Engine will be run and transmission engaged while mower is supported by jack stands. Stand clear of drive wheels while running. Keep hands and feet clear of all moving parts. Always use jack stands. Be prepared to stop engine at all times. Never engage PTO while mower is raised.

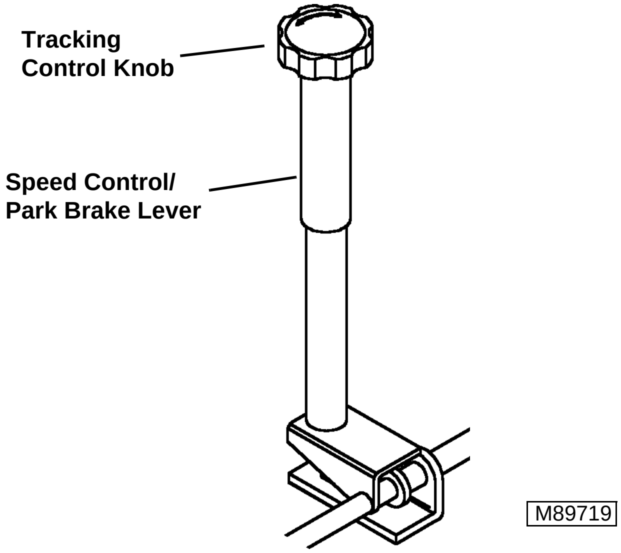
11. Block caster wheels front and rear. Raise power deck drive wheels off of ground and use jack stands under rear of power deck to support frame.



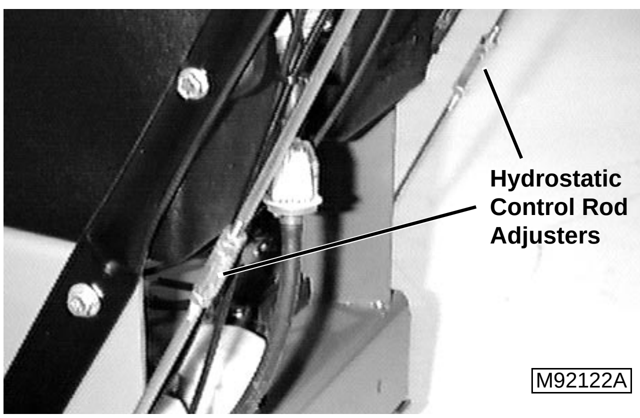
12. Loosen park brake cable fine adjustment nuts on bottom of operator control station, and pull cable from it’s mounting bracket.



13. Remove spring pin and washer holding reverse rod to steering control lever from left and right side.



14. Turn tracking control knob in clockwise until it stops, then back out two turns. Cycle speed control lever a few times to allow spring to take up play in linkage.



15. Loosen upper and lower lock nuts on left and right side hydrostatic control rod turnbuckles.
16. Pull speed control lever to full rearward (neutral) position, and check that PTO switch is in OFF position.

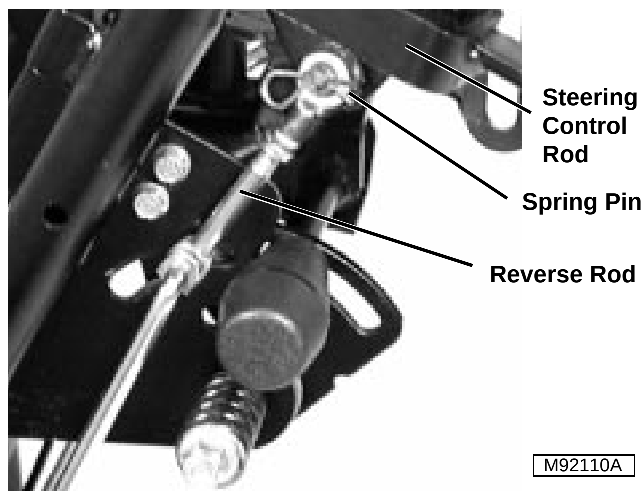
> **⚠ CAUTION**
>
> **Help prevent personal injury. It is important that the mower be supported off the ground. Do not operate the mower any longer than necessary with the operator presence bail tied off.**

17. Tie one of the operator presence bails down to the handlebars with tape, wire, or rubber band.
18. Start engine and set throttle at high idle () position. Run engine approximately 5 minutes to warm hydrostatic oil.
19. Adjust turnbuckles on hydrostatic control rods so drive wheels just begin to rotate in reverse.
20. Cycle speed control lever fully forward and back two times, then recheck that drive wheels are still just starting to rotate in reverse.
21. Tighten lock nuts on turnbuckles.
22. Cycle speed control lever fully forward and back two times, and recheck that drive wheels have a slight rearward rotation when speed control is in neutral (Ⓟ) position.

Neutral Thumb Lock Adjustment:

IMPORTANT: Perform the Hydrostatic Control Linkage Adjustment <u>before</u> perfoming this adjustment.

1. Continue this adjustment from the Hydrostatic Control Linkage Adjustment above with the following conditions :
   Mower on stands, brake cable fine adjustment removed, speed control lever in full back (Ⓟ) position, engine running.

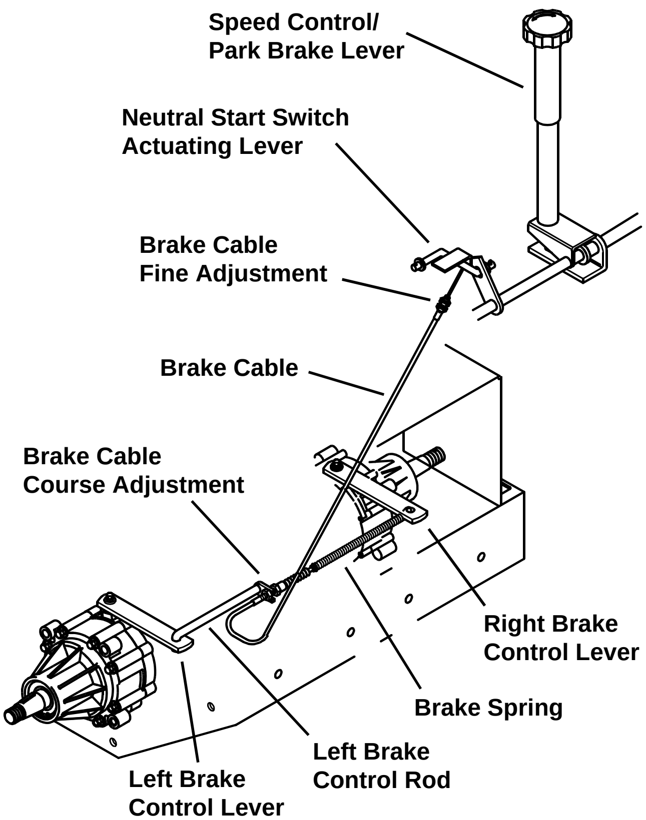


2. Attach reverse rods to turn control levers on left and right sides. Install washers and spring pins.
3. Push speed control lever to full forward position.
4. Cycle steering control levers up and down 2 times.
5. Engage left and right side neutral thumb locks.
6. Set throttle to the fast idle () position. Drive wheels should be turning slightly in reverse. If not, continue with next step.
7. To increase wheel speed in reverse direction, shorten reverse rod.
   To decrease wheel speed in reverse direction, lenghten reverse rod.
8. Cycle turn control levers to eliminate play in linkage after each adjustment. Repeat adjust as necessary to obtain slight rotation in reverse.
9. Stop engine.
10. Release operator presence lever bail, install and adjust park brake cable. (See next page.)

PARK BRAKE CABLE ADJUSTMENT

Reason:

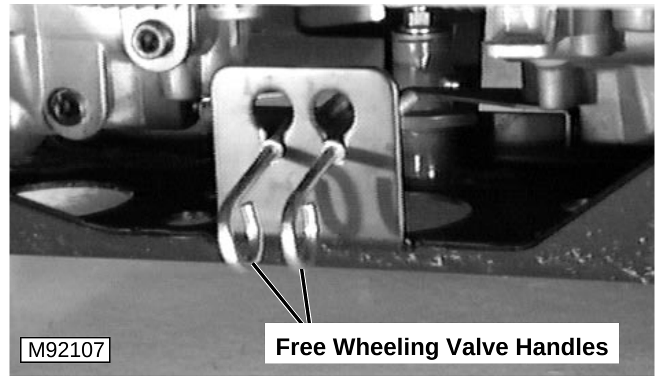
The park brake should be checked and adjusted after the first 25 hours of use, and anytime after the hydrostatic control linkage is adjusted, to be sure the brakes will hold the mower from rolling while the speed control/park brake lever is in the full rearward (neutral) position. A park brake that is adjusted too tightly could damage the transmission or cause premature brake wear.



Testing Brakes:

1. Park mower on a hard level surface.

2. Pull speed control lever fully back to the neutral / park position.

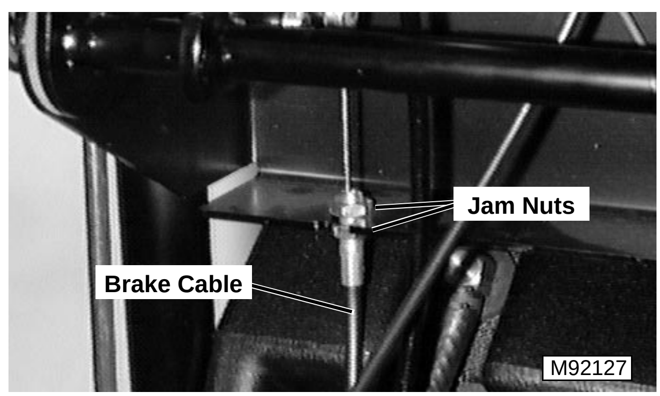


3. Pull free wheeling levers back and latch into free wheeling position (as shown above).
4. Push and pull the machine on the pavement. The drive wheels should skid. If not, adjust brakes.
5. Release free wheeling valves.
6. Start engine.
7. Move speed control lever forward approximately 25 mm (1 in.). Drive wheels should begin to move forward with no excessive strain on transaxle from dragging brakes. If an audible whine is heard and/ or mower does not move, adjust brakes.

Adjust Brakes: Fine Adjustment:

NOTE: *Use fine adjustment for brake adjustments. Course adjustment is only used after fine adjustment has reached the end of it's travel.*

1. Pull speed control back to neutral/brake position.

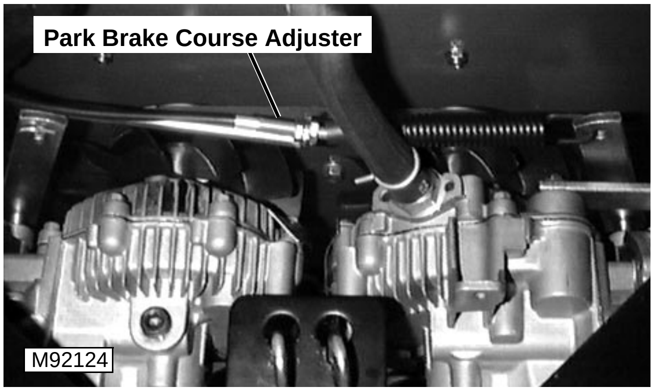


2. Loosen jam nuts on brake cable fine adjuster (under left side of operator's station).
   - To decrease brake tension, turn bottom jam nut down.
   - To increase brake tension, turn bottom jam nut up.
3. Tighten upper jam nut.
4. Check adjustment by testing brakes.

Adjust Brakes: Course Adjustment:

NOTE: *Use fine adjuster (see above) until it has reached the end of it's travel, then use the course adjuster to bring the fine adjuster back into range.*

1. Pull speed control lever back to the neutral/park brake (Ⓟ) position.
2. Loosen fine adjuster jam nuts and turn bottom nut down to bottom of fine adjuster threads.



3. Locate park brake course adjustment under rear of mower deck.
4. Loosen jam nuts and turn both nuts to the right 6 mm (1/4 in.) on the brake cable. Tighten jam nuts.
5. Return to the park brake fine adjustment. Make a fine adjustment and tighten jam nuts.
6. Test and readjust as necessary.

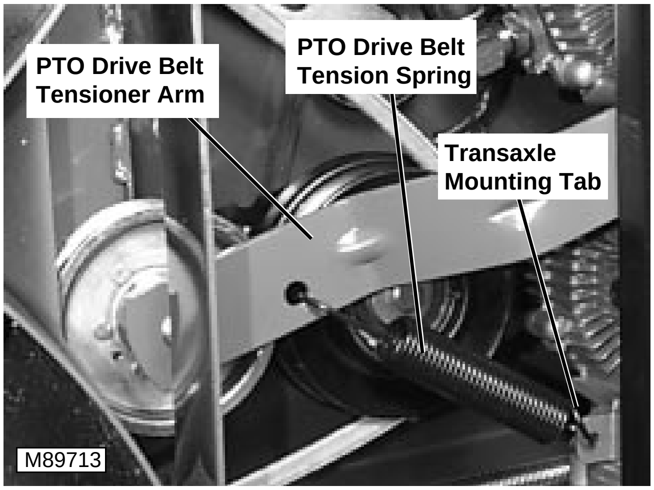
REPAIR

TRANSMISSION DRIVE BELT REMOVAL & INSTALLATION

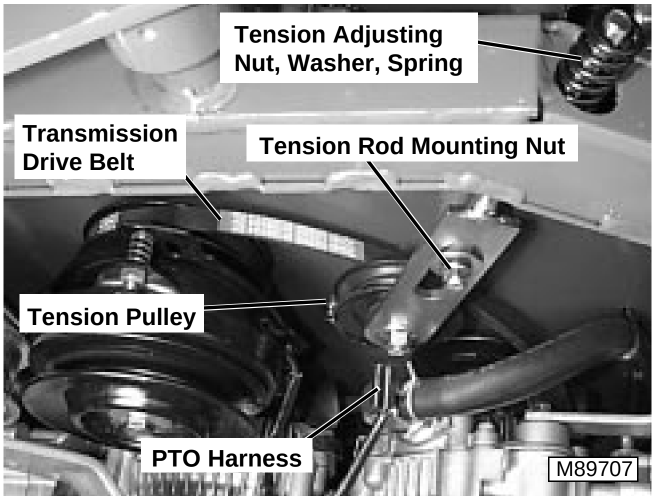
NOTE: *While the transaxle drive belt may be replaced with the mower deck attached, it is recommended that the deck be removed to gain easier access to the underside of the frame.*

Removal:

1. Park machine on level surface. Block drive wheels.
2. Remove PTO drive belt. (See "PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS" on page 14 in ATTACHMENT SECTION.)
3. Remove mower deck. (See "DECK REMOVAL-36 INCH" on page 20 in ATTACHMENT SECTION.)
4. Lay power deck back with frame resting on ground to that transmission drive belt can be accessed.



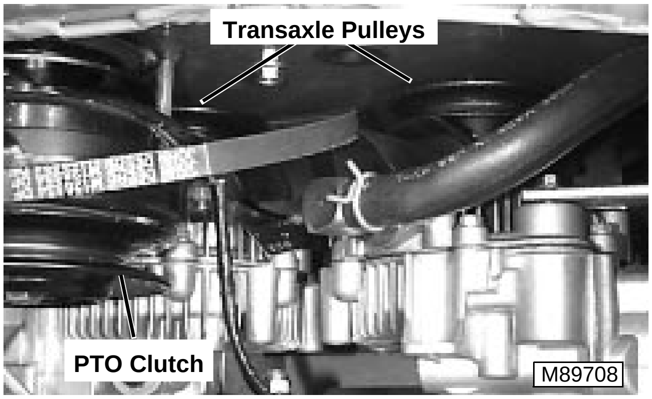
5. Remove PTO drive belt tension spring from tensioner arm and tab on transaxle.



6. Loosen tension on transmission drive belt by loosening tension adjusting nut. Remove nut, washer, and spring, from tension rod.
7. Loosen tension rod mounting nut enough to allow transmission drive belt to pass through tension pulley and frame.
8. Pull drive belt off of tension pulley, transaxle pulleys, and engine drive sheave. Remove belt from mower.

Installation:

1. Installation is the reverse of removal. Clean all grease from top of engine drive sheave and PTO clutch before belt installation.



2. Install belt up over PTO electric harness, and electric clutch.

NOTE: *Be careful not to damage belt when pushing between transaxle pulleys and power deck frame.*

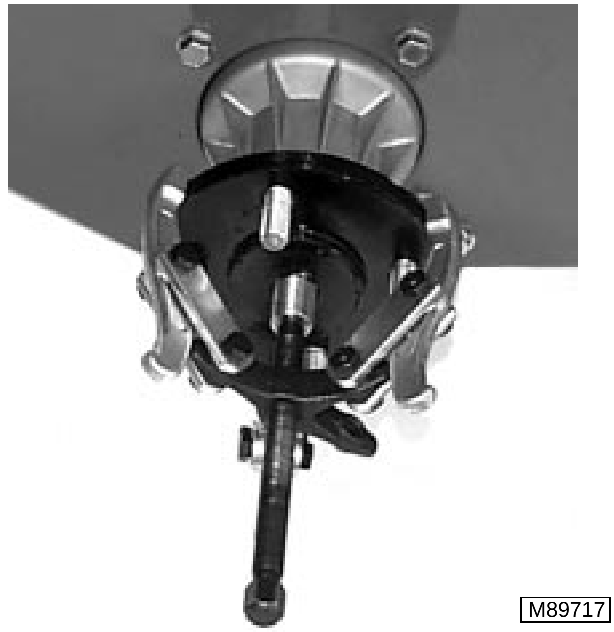
3. Push belt between transaxle pulleys and power deck frame using pry bar or other suitable tool. Push belt into center of transaxle pulleys before installing belt into tensioner pulley.
4. Tighten tensioner mounting hardware. Install tensioner spring, washer, and adjusting nut. Adjust belt tension. (See “TRANSMISSION DRIVE BELT TENSION ADJUSTMENT” on page 11.)
5. Install PTO drive belt tensioner spring into hole in tensioner arm, and tab on front of right side transaxle housing.
6. Install mower deck.
7. Install PTO drive belt.

DRIVE WHEEL HUB REMOVAL & INSTALLATION

Removal:

NOTE: *If transaxle or transmission guard will be removed after removing drive wheel hub, support power deck under green painted frame to allow access to transmission guard mounting screws.*

1. Park mower on level surface. Support frame using blocks or stands. (See note above).
2. Remove lug nuts holding drive wheels to mounting studs on hub. Remove drive wheel from hub.
3. Remove cotter key holding axle nut to axle shaft. Remove axle nut and washer.

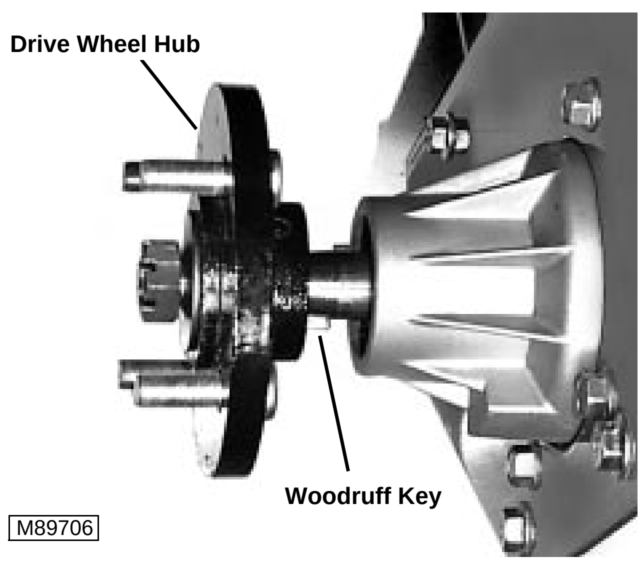


CAUTION

Axle hub can fly off of axle shaft suddenly and violently when puller is tightened. Always wear safety glasses and protect hands and body from flying parts before turning in screw on puller.

4. Install a puller onto hub and into center of axle shaft. Turn in puller screw until tight, then advance screw in small steps while tapping on side of hub with plastic dead-blow hammer.
5. Remove hub from axle shaft. Remove woodruff key from axle shaft.

Installation:



1. Inspect axle shaft, inside bore of hub, and woodruff key for burrs, corrosion, or excessive wear of taper. Check woodruff key for wear. Replace hub if worn.

IMPORTANT: <u>DO</u> <u>NOT</u> coat taper of axle shaft or hub with oil or grease when installing.

2. Place woodruff key into slot on axle shaft. Line up keyway in hub with woodruff key on axle shaft. Install hub, washer, and slotted nut onto axle shaft.
3. Torque axle nut to specification below, then torque any additional amount needed to align slots in axle nut with drilled cotter key hole in axle shaft.

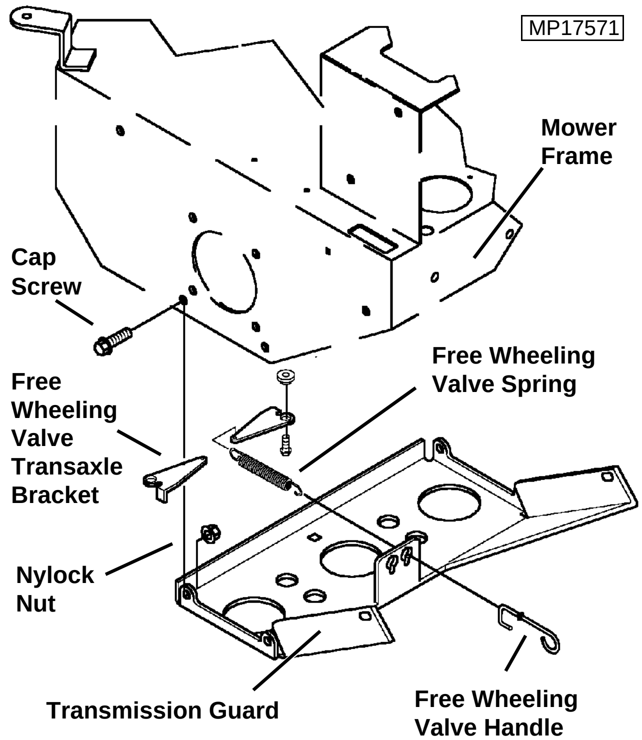
Axle Nut Torque Specification. . . .203 N•m (150 lb-ft) Plus Additional Torque To Line Up Slots In Axle Nut

4. Install cotter key through axle nut and shaft.
5. Install drive wheel and lug nuts.

TRANSMISSION GUARD REMOVAL & INSTALLATION

Removal:

1. Remove PTO drive belt.
2. Remove mower deck. (See “DECK REMOVAL-36 INCH” on page 20 in ATTACHMENT SECTION.)
3. Roll power deck back until frame is resting on ground. Remove PTO belt tensioner arm spring from tensioner arm and right transaxle.
4. Remove two front cap screws and nuts holding transmission guard to power deck.
5. Roll power deck forward until it is resting on mower deck pinion bearing cap.



6. Remove the two free wheeling springs from the transaxle brackets, and pull the free wheeling valve handles from the keyholes in the transmission guard. The handles will need to be rotated down to be removed from the keyhole.
7. Remove four remaining cap screws and nuts holding transmission guard to power deck.
8. Lower the transmission guard down out of the mower frame.

Installation:

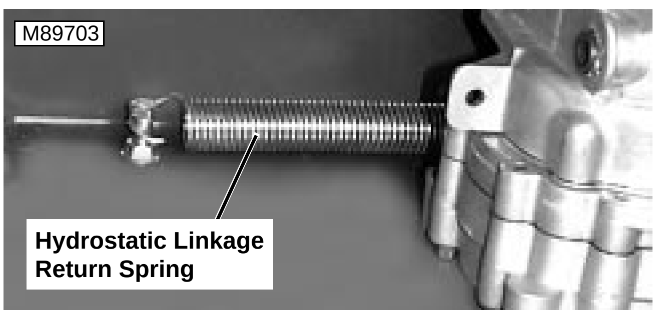
1. Installation is the reverse of removal. Make sure PTO tensioner sheave is free from grease or oil before installation.
2. Place transmission guard under mower frame with PTO tensioner arm outstretched towards front of mower.
3. Fit up transmission guard lining up mounting holes. Install four flange head cap screw through mower deck and transmission guard, and secure with nylock nuts on inside of frame.
4. Install left and right transaxle free wheeling valve control handles and springs the same as removed.
5. Roll power deck back and install two remaining transmission guard mounting cap screws and nuts from front of frame.

HYDROSTATIC TRANSMISSION REMOVAL & INSTALLATION

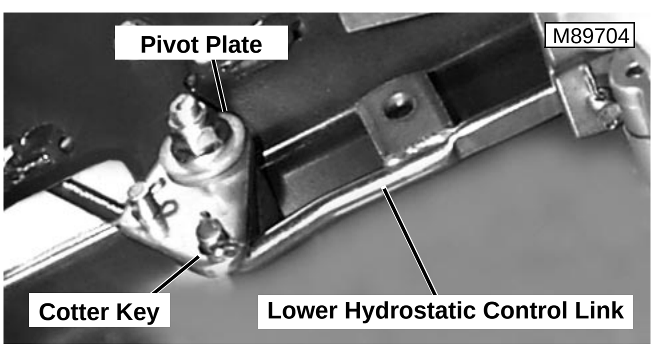
NOTE: *Service of transaxle is limited to replacement of case seals. If transaxle is worn beyond service limits, it must be replaced. No internal components are available.*
Service transaxle is suppiled with reservoir and hose attached, and fully charged with oil.

Removal:

1. Park mower on level surface. Remove mower deck. (See “DECK REMOVAL-36 INCH” on page 20 in ATTACHMENT SECTION.)
2. Remove transmission guard. (See “TRANSMISSION GUARD REMOVAL & INSTALLATION” on page 17.)
3. Remove hydrostatic drive belt. (See “TRANSMISSION DRIVE BELT REMOVAL & INSTALLATION” on page 15.)
4. Remove drive wheel(s) and hub(s) from transaxle being removed. (See “DRIVE WHEEL HUB REMOVAL & INSTALLATION” on page 16.)

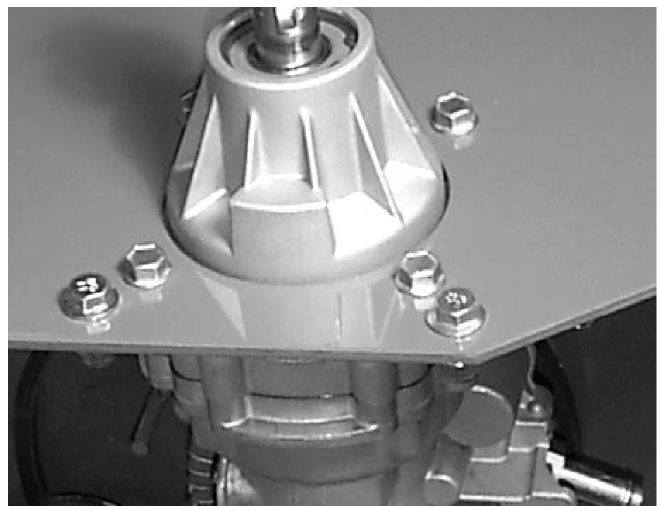


5. Remove hydrostatic linkage return spring from lower hydrostatic control link and frame.



6. Remove cotter key from lower hydrostatic control link, and remove end of rod from hole in pivot plate.

7. Remove cotter key from left brake control rod. Remove rod from brake control lever. Unhook spring from right brake control lever and tie brake cable assembly back away from work area.
8. Remove four cap screws and nuts holding reservoir to power deck frame.



9. While supporting transaxle, remove four self-tapping cap screws holding transaxle to mower deck. Carefully remove transaxle and reservoir as an assembly from power deck frame.

Installation:

1. Installation is in reverse order of removal. Clean oil and grease from transaxle input pulley before installing.

NOTE: *Allways keep reservoir above transaxle during installation to allow any air trapped in transaxle to rise out of hose and into reservoir.*

2. Align transaxle in mower deck frame and secure with four self-tapping cap screws.

Transaxle Mounting Cap Screw
Torque Specification . . . . 20 N•m (177 lb-in.)

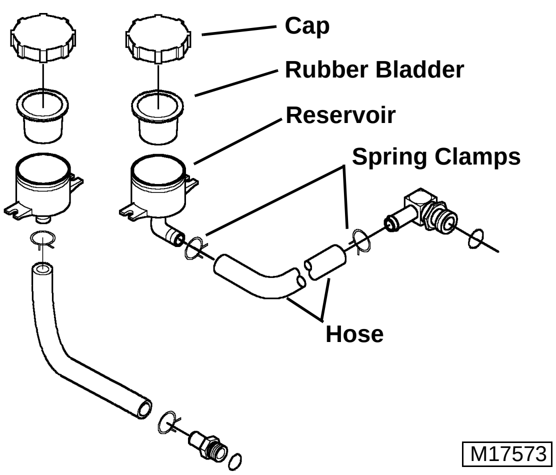
3. Install reservoir into power deck and secure with four cap screws and nuts. Do not overtighten.
4. Install lower hydrostatic control link and cotter key.

5. Install brake control rod and cotter key.
6. Install hydrostatic linkage return spring.
7. Install drive wheel hub and drive wheel. (See “DRIVE WHEEL HUB REMOVAL & INSTALLATION” on page 16.)
8. Install transmission drive belt (See “TRANSMISSION DRIVE BELT REMOVAL & INSTALLATION” on page 15.)
9. Install transmission guard and PTO drive belt tensioner spring. (See “TRANSMISSION GUARD REMOVAL & INSTALLATION” on page 17.)
10. Install mower deck. (See “DECK INSTALLATION-36 INCH” on page 21 in ATTACHMENT SECTION.)

HYDROSTATIC RESERVOIR REMOVAL & REPLACEMENT

Removal:

1. Park mower on level surface. Allow hydrostatic system to cool.
2. Remove filler cap from reservoir being serviced. Remove rubber bladder.



3. Place drain pan under bottom of reservoir. Remove spring clamp on hose below reservoir and pull hose from reservoir fitting. Drain oil.
4. Remove reservoir mounting nuts and screws. Remove reservoir from bottom of mower deck.

Installation:

1. Install a hose clamp to each end of hose, and install hose to reservoir.
2. Install reservoir to power deck. Do not overtighten mounting screw on plastic tab of reservoir.
3. Attach hose to reservoir and secure with hose clamp.
4. Fill reservoir <u>VERY</u> <u>SLOWLY</u> to allow air to escape from top of transaxle and hose. (See Hydrostatic System Bleeding).

HYDROSTATIC SYSTEM BLEEDING

IMPORTANT: Prevent contamination of hydraulic oil. Do not open the hydraulic oil reservoir caps unless absolutely necessary. Oil level can be checked by looking through translucent neck of filler neck. Do not overfill oil reservoirs. Oil expands during operation and could overflow.

Service parts transaxle is supplied with reservoir attached, and hydrostatic system fully charged.

1. Fill unit slowly with oil to allow time for oil to escape. Do not install rubber bladder at this time.
2. Jack rear of mower deck up and support with drive wheels off ground.
3. Start engine and run with no load until transaxle reaches operating temperature (five minutes).
4. Move hydrostatic speed control forward and run drive wheels for five minutes. Return to neutral and stop engine. Allow transaxle to cool.
5. Top off reservoir oil level as needed.
6. Repeat step six as many times as needed to stop air bubbles from rising up in reservoirs.
7. Lower mower to ground and drive in forward and reverse. Any excessive noise or loss of power may be caused by cavitation of air in that transaxle. Repeat step six as needed. Replace rubber bladders and reservoir cap.

CONTENTS

Page

ATTACHMENTS

SPECIFICATIONS

REPAIR SPECIFICATIONS

Spindle Top Bearing Recess Dimension-48/54 Inch Deck . . . . 7.8 mm (0.307in.)
Maximum Distance Blade Tips To Balancer Track . . . . .1.5 mm (0.059-in.)

TORQUE SPECIFICATIONS

Idler Arm Compression Spring Jam Nuts . . . . 55 N•m (40 lb-ft)
Blade to Spindle Shaft Cap Screw-36 Inch Deck . . . . 122 N•m (90 lb-ft)
Blade to Spindle Shaft Cap Screw-48/54 Inch Deck. . . . . 68 N•m (50 lb-ft)
Drive Sheave to Spindle Shaft-36 Inch Deck . . . . 190 N•m (140 lb-ft)
Drive Sheave to Spindle Shaft-48/54 Inch Deck . . . . 163 N•m (120 lb-ft)
Spindle Housing to Mower Deck-36/48/54 Inch Decks . . . . 26 N•m (19 lb-ft)
Idler Arm Pivot Securing Nut-48/54 Inch Deck . . . . 12 N•m (9 lb-ft)
Mower Deck Support Frame Cap Screws-36/48/54 Inch Decks . . . . 140 N•m (105 lb-ft)

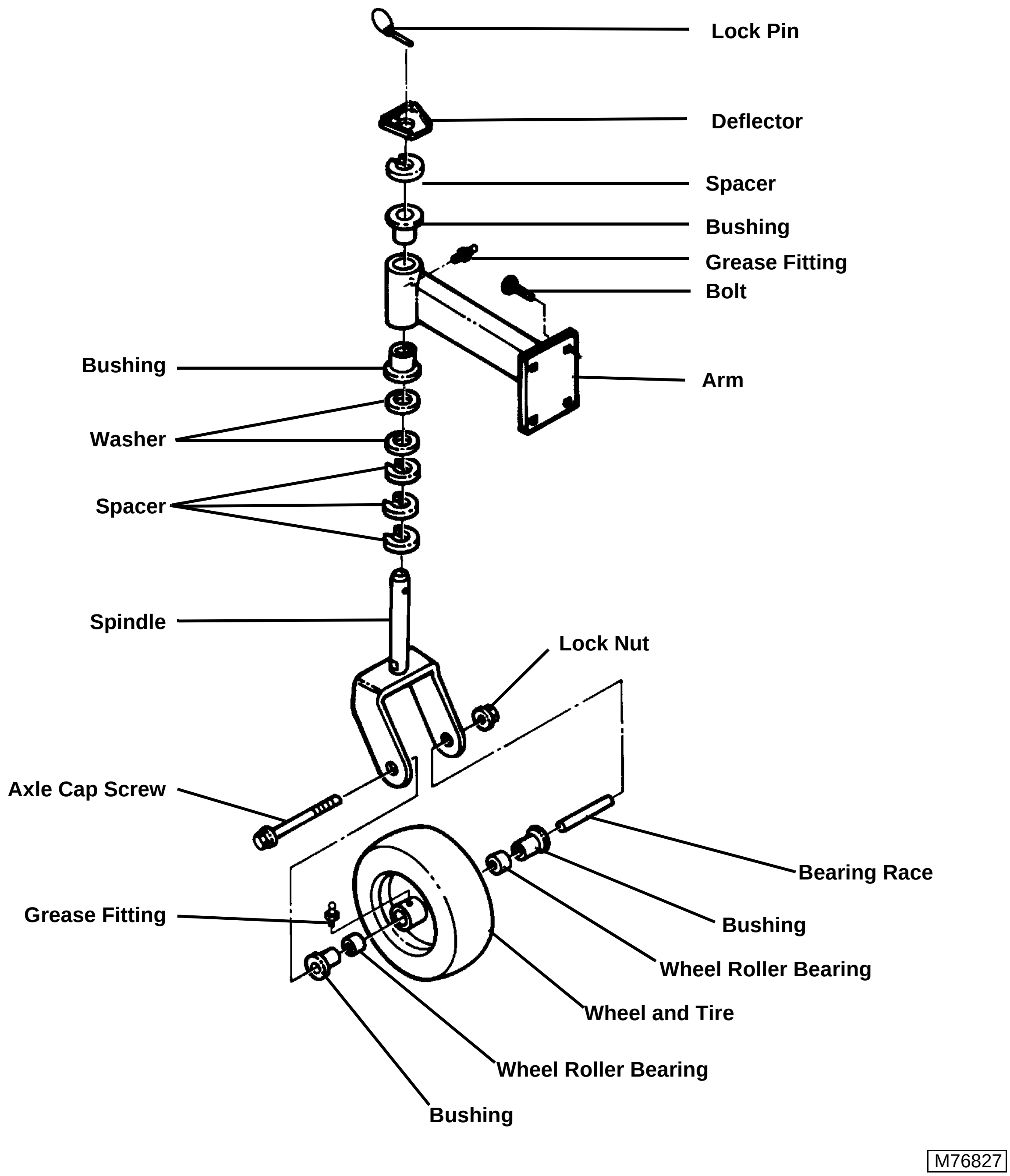
ESSENTIAL TOOLS

NOTE: Order tools from your SERVICE-GARD™ Catalog. Some tools may be available from a local supplier.

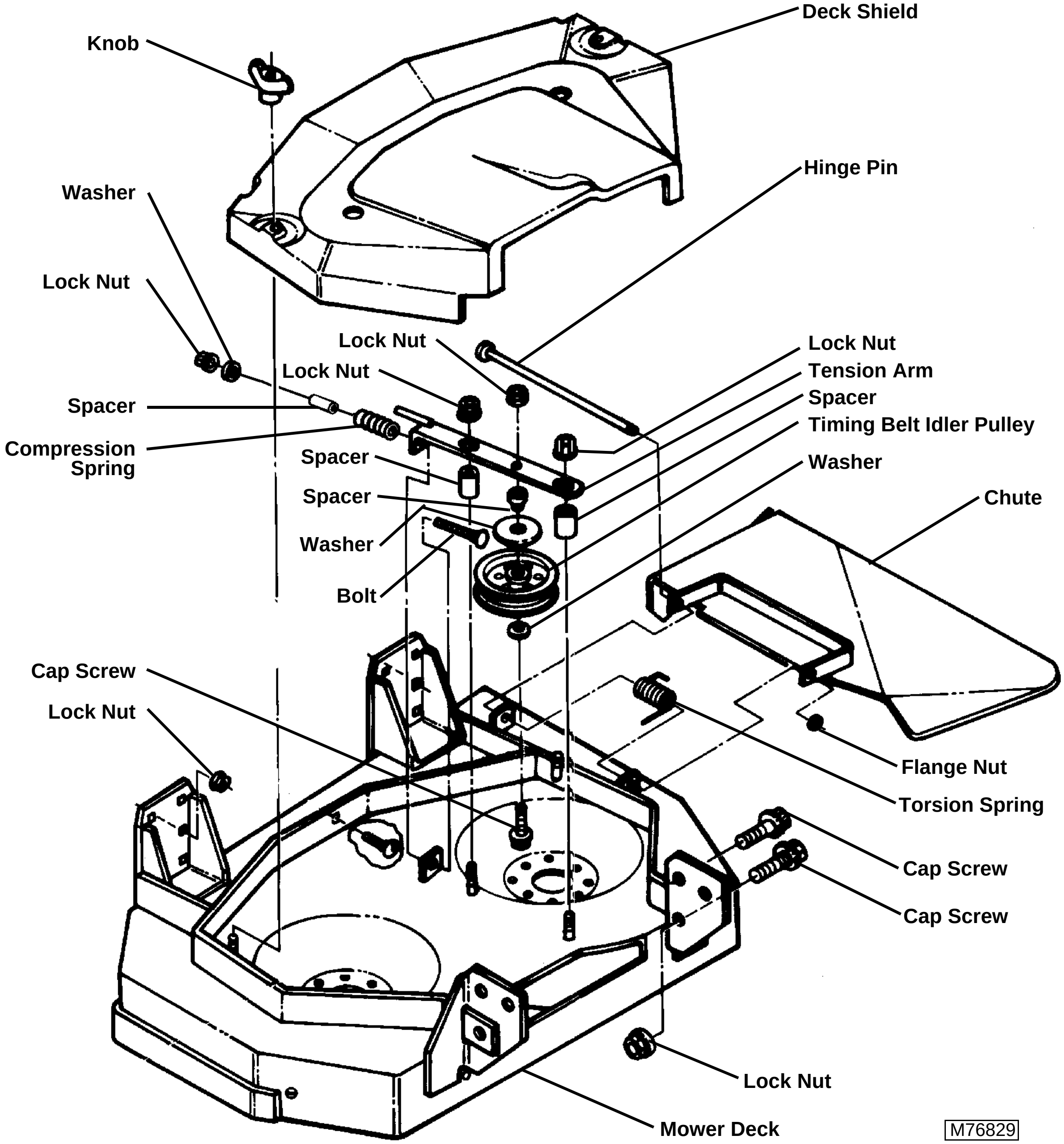
Number	Name	Use
DO1210AA	Slide Hammer	Remove wheel bushings
JTO7076	Rotary Blade Balancer	Balance Mower Blades

COMPONENT LOCATION

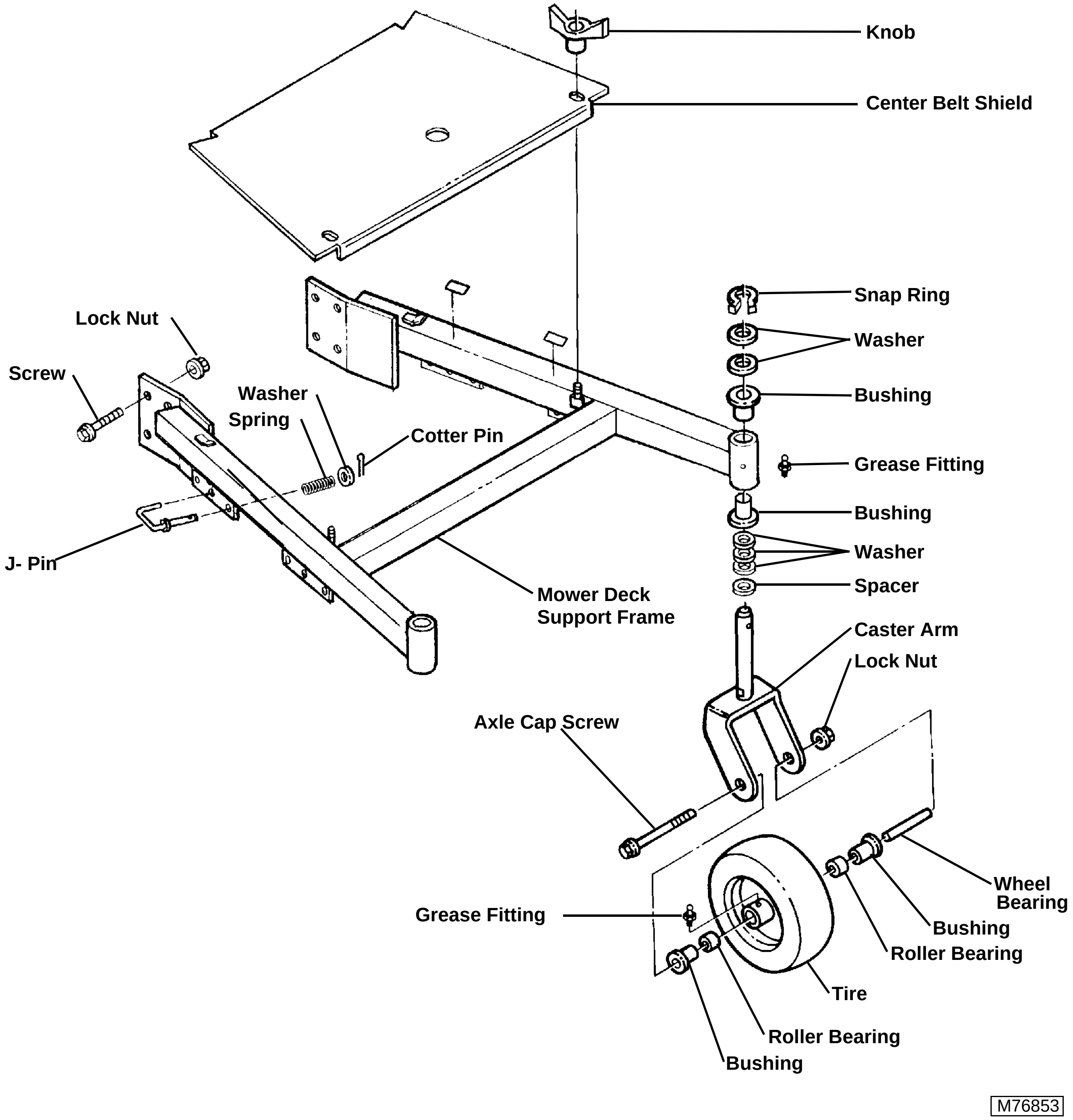
MOWER DECK CASTERS – 36 INCH GEAR DRIVE MODELS



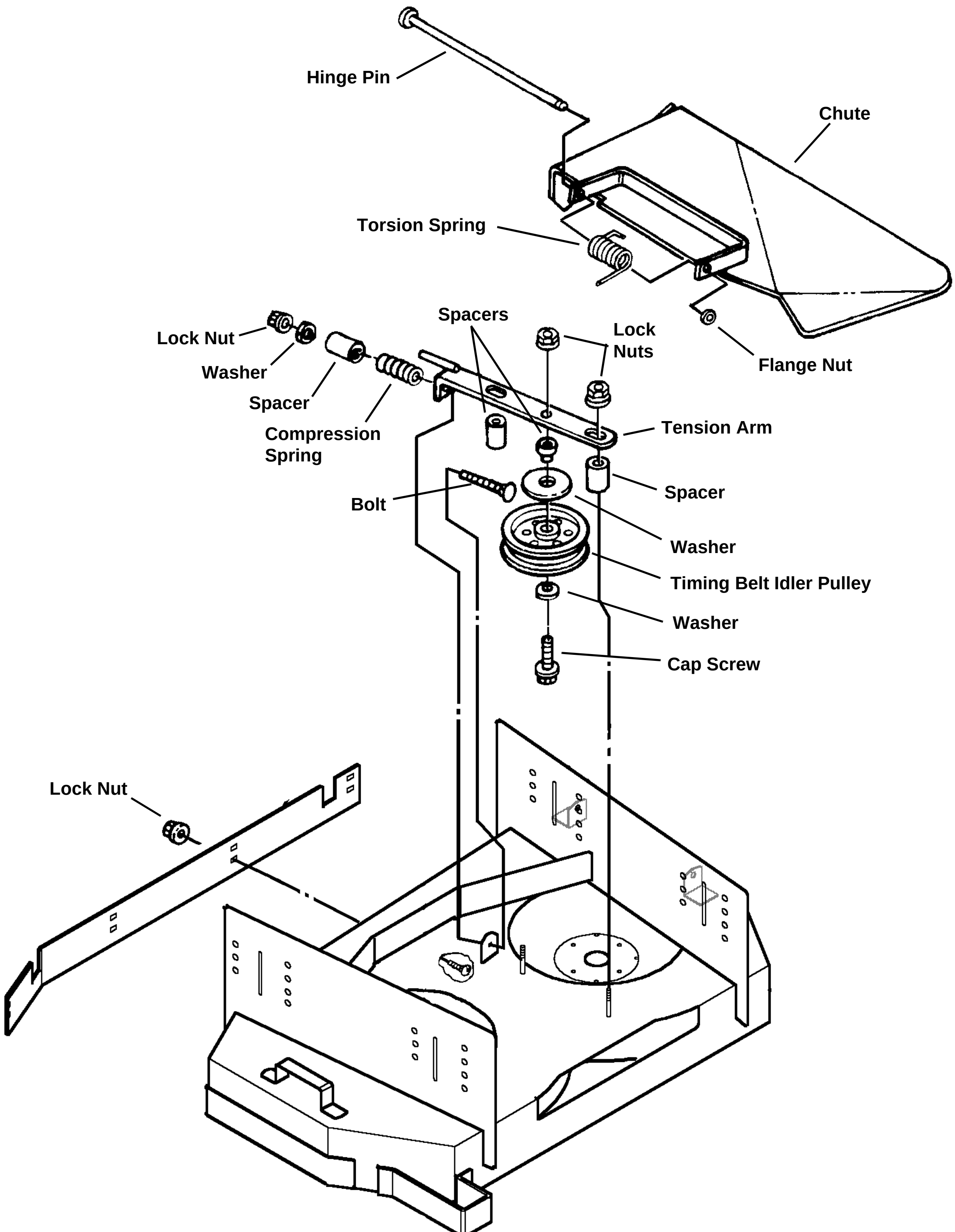
MOWER DECK – 36 INCH GEAR DRIVE MODELS



MOWER DECK SUPPORT FRAME–48/54 INCH GEAR DRIVE MODELS



MOWER DECK–36 INCH HYDROSTATIC DRIVE MODELS



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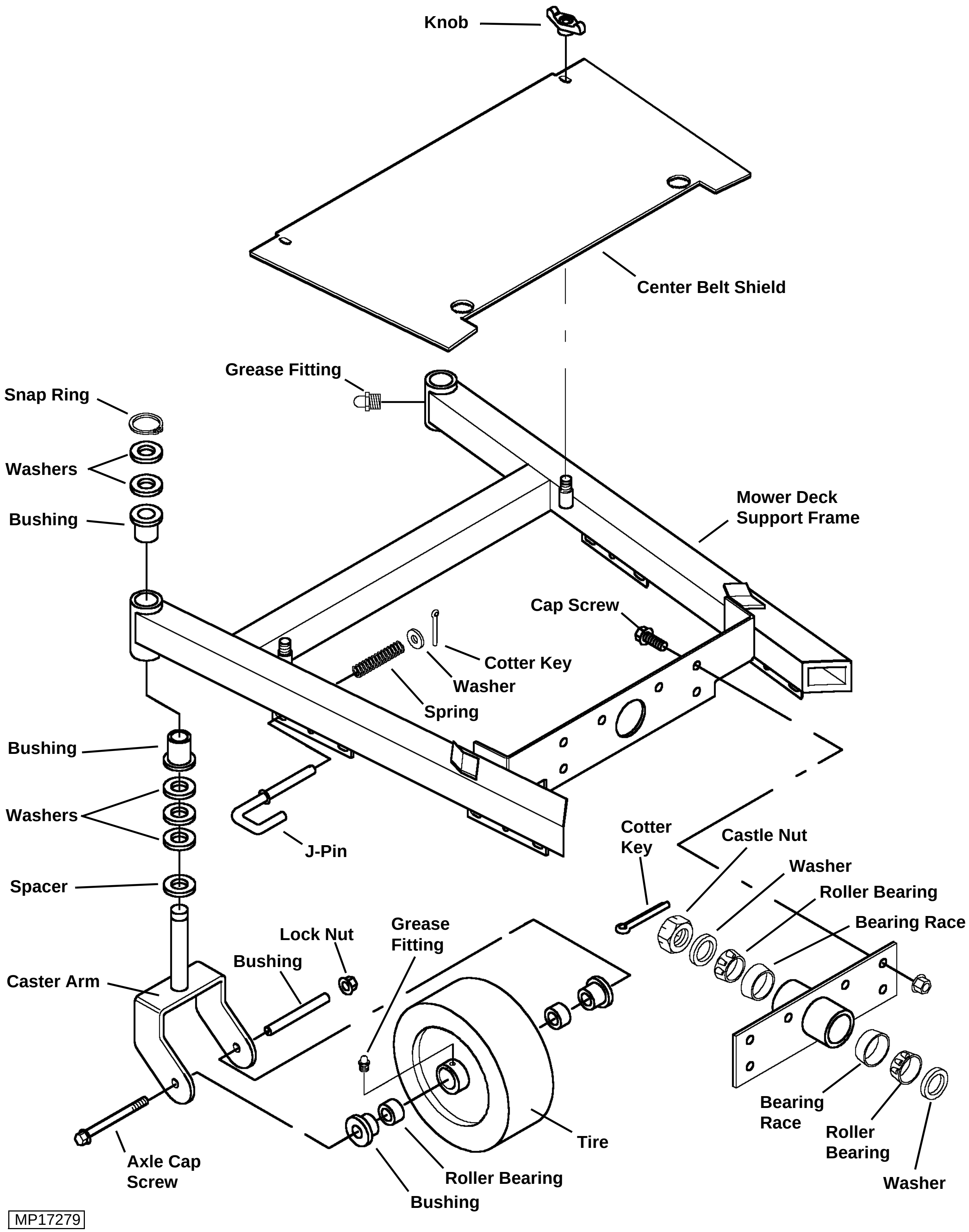
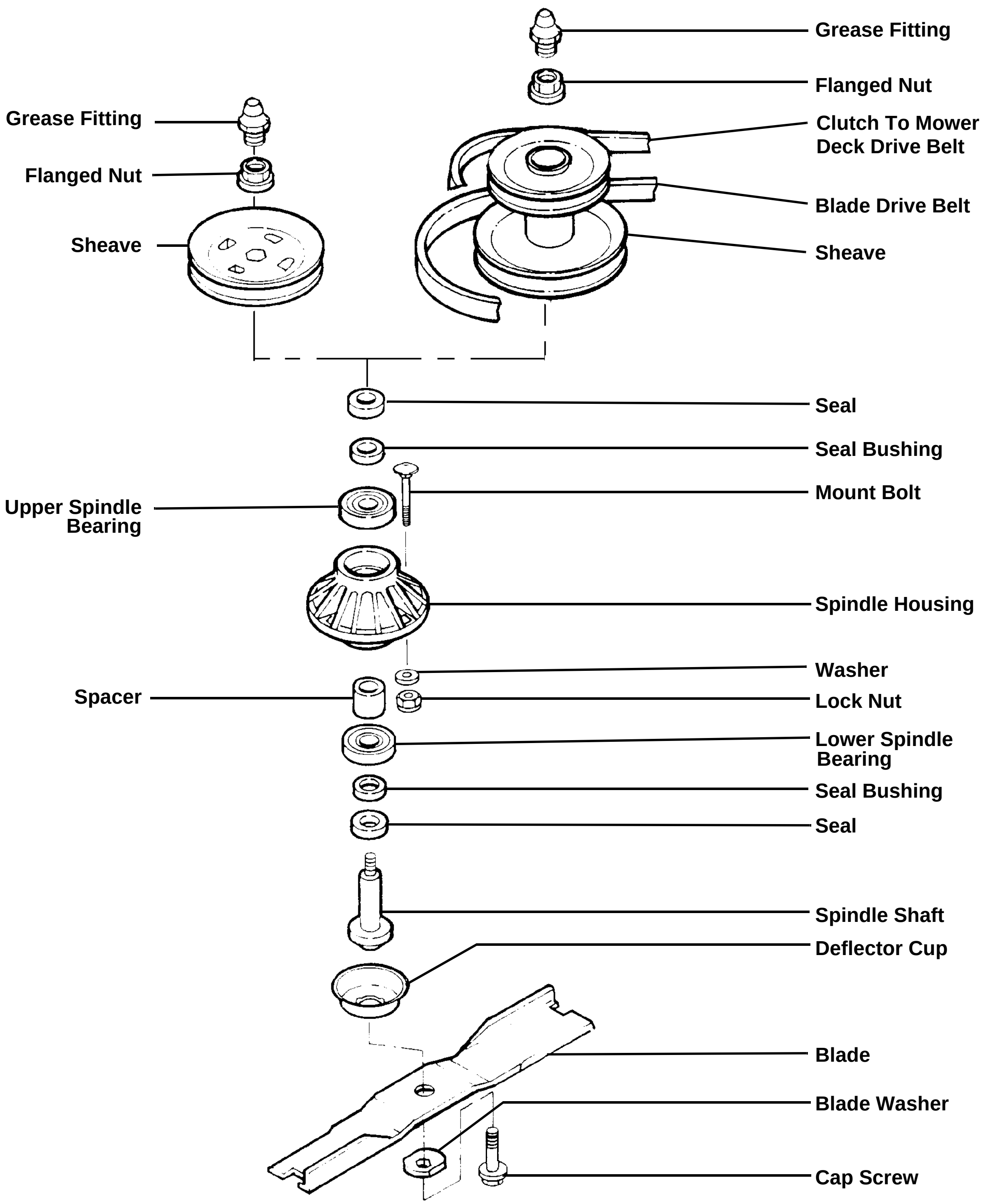
MOWER DECK SUPPORT FRAME–ALL HYDROSTATIC MODELS



SPINDLES–48/54 INCH–ALL MODELS



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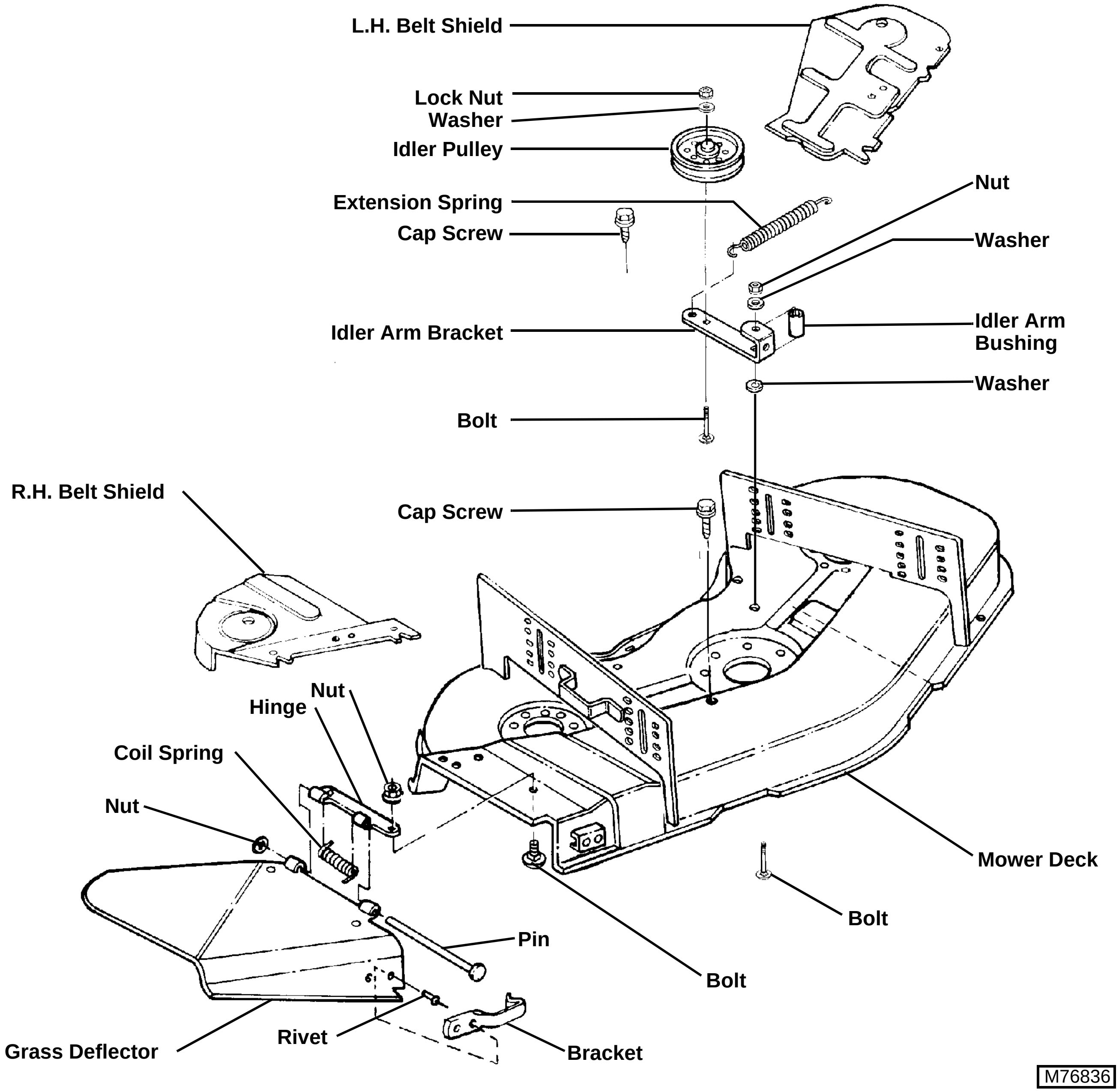
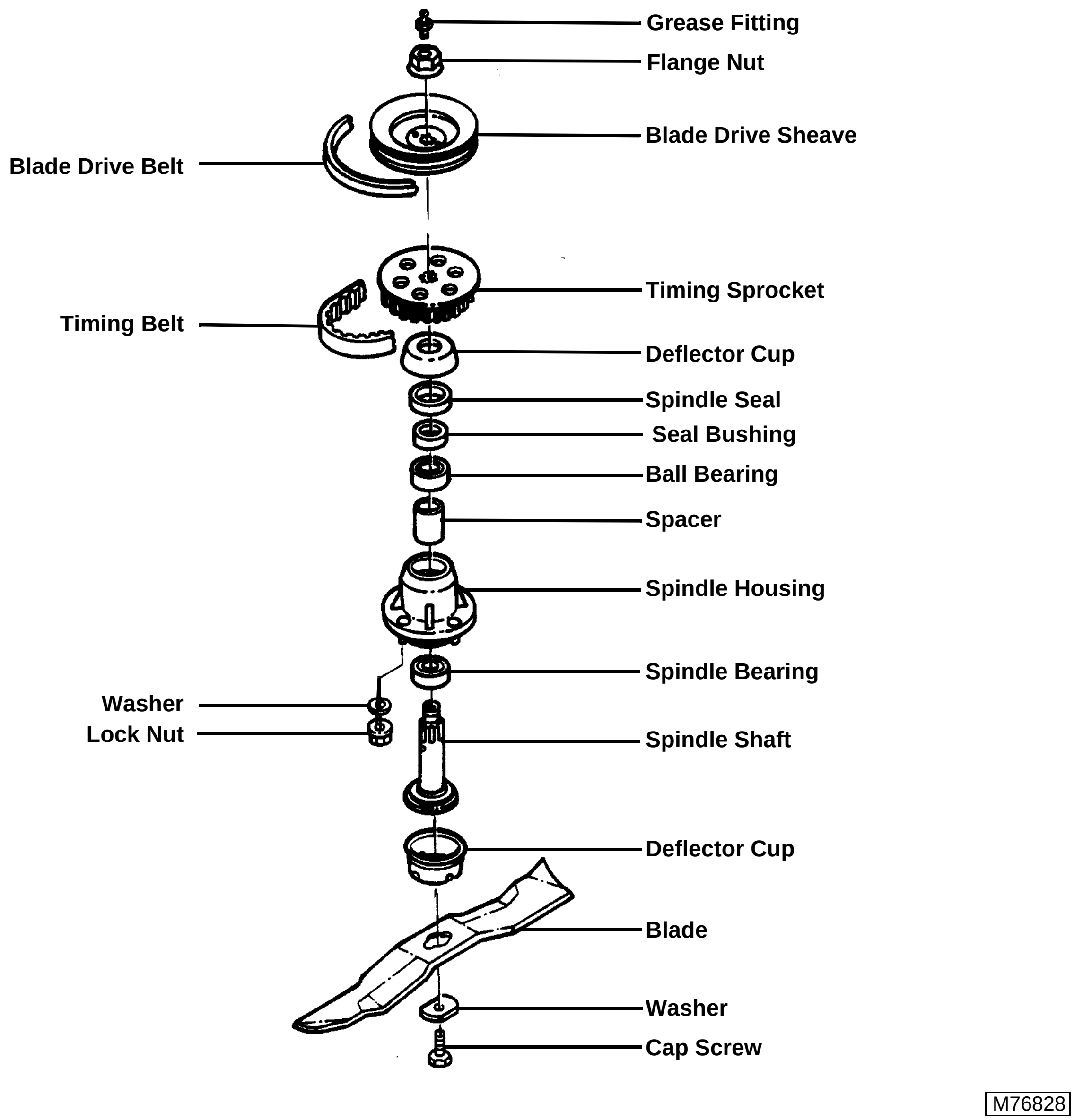
MOWER DECK–48/54 INCH–ALL MODELS



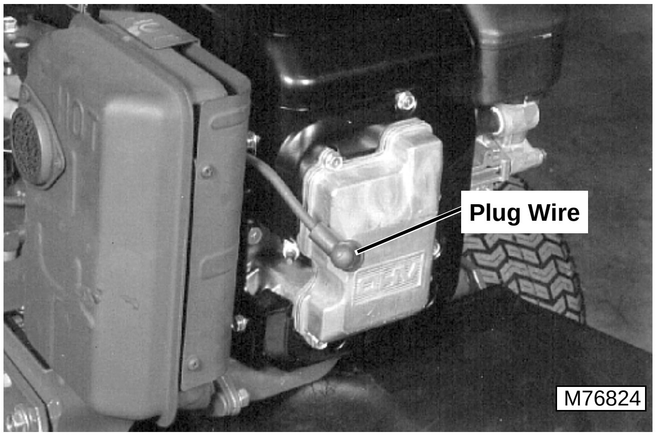
SPINDLES–36 INCH–ALL MODELS



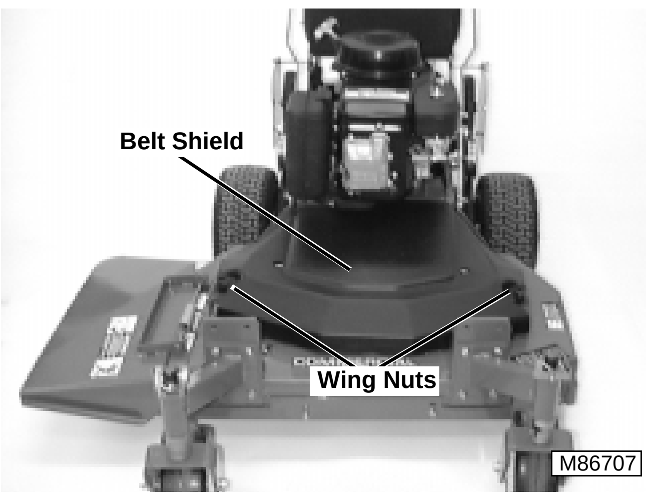
REPAIR

MOWER POSITIONING FOR MAINTENANCE-36 INCH

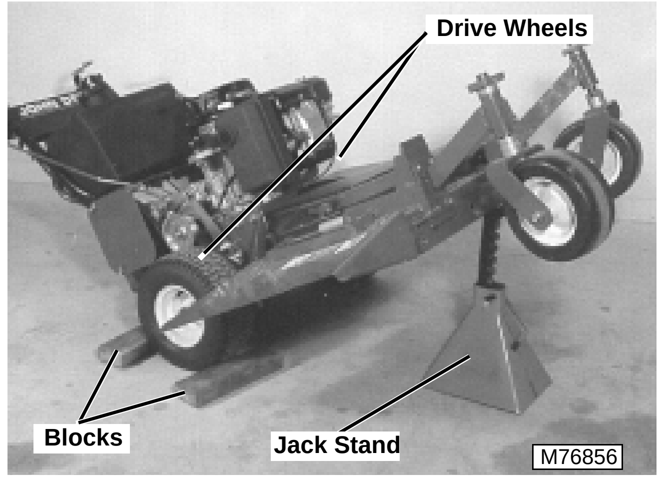
1. Position mower on a solid, level surface.



2. Disconnect spark plug wire.
3. Ensure fuel level is less than 1/2 tank.



4. Remove both wing nuts.
5. Remove belt shield.



6. Block both drive wheels.
7. Raise front of unit approximately 18 inches. Support mower deck with jack stand or other suitable support.

BLADE REMOVAL/INSTALLATION-36 INCH

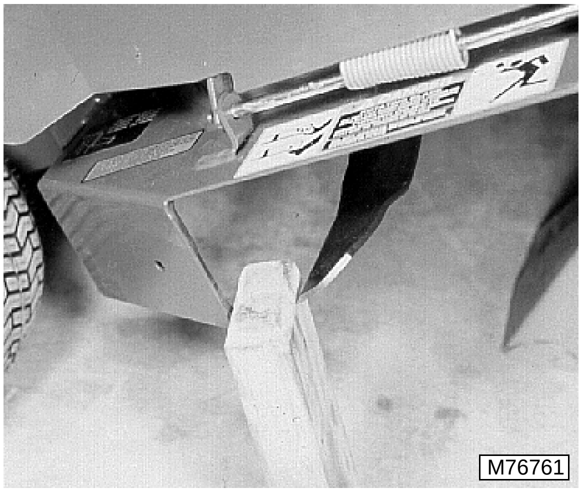
CAUTION

Blades Are Sharp. Always Wear Gloves Or Wrap Blades With A Rag To Prevent Personal Injury.

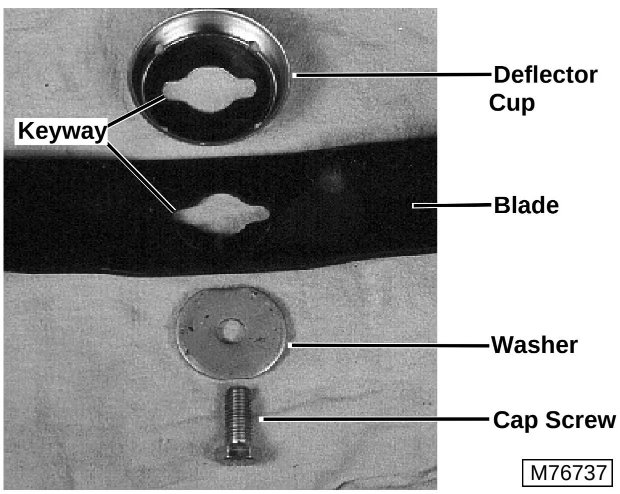
IMPORTANT: If blade timing is disturbed See "TIMING BELT QUICK CHECK-36 INCH" on page 14.

Removal:

1. Position mower for blade maintenance. See "MOWER POSITIONING FOR MAINTENANCE-36 INCH" on page 11.



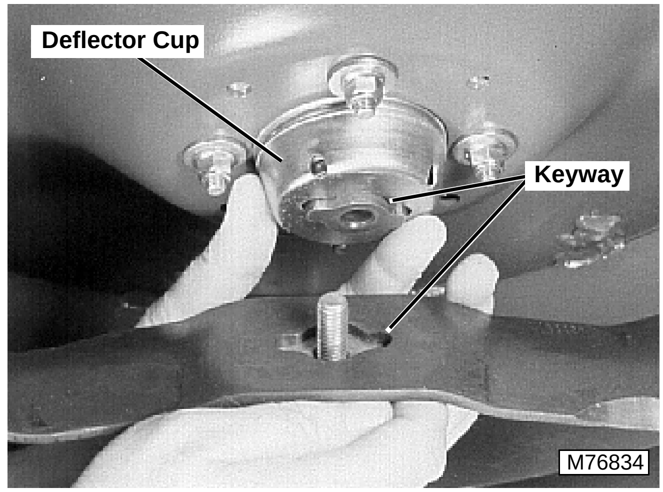
2. Block blade using a suitable piece of wood.



NOTE: The deflector cup and blade are keyed to the spindle shaft.

3. Remove cap screw, washer, blade and deflector.
4. Check blade for bends, gouges and dullness. Sharpen blade and replace parts as required.

Installation:



1. Hold deflector cup over keyway in spindle shaft.
2. Position blade on spindle shaft.

NOTE: Be certain to index deflector cup and blade key holes to spindle key.

3. Install washer and cap screw.
4. Block blade and torque cap screw to **122 N•m (90 lb-ft).**

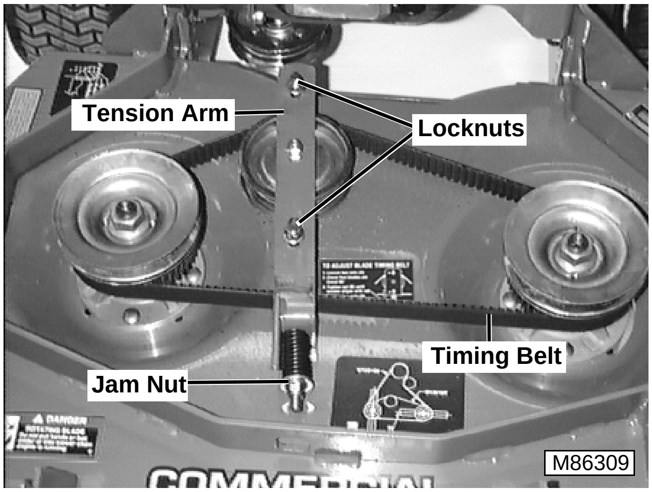
IMPORTANT: Remove piece of wood being used to stop blade rotation.

5. Check blade timing. See “TIMING BELT QUICK CHECK-36 INCH” on page 14.

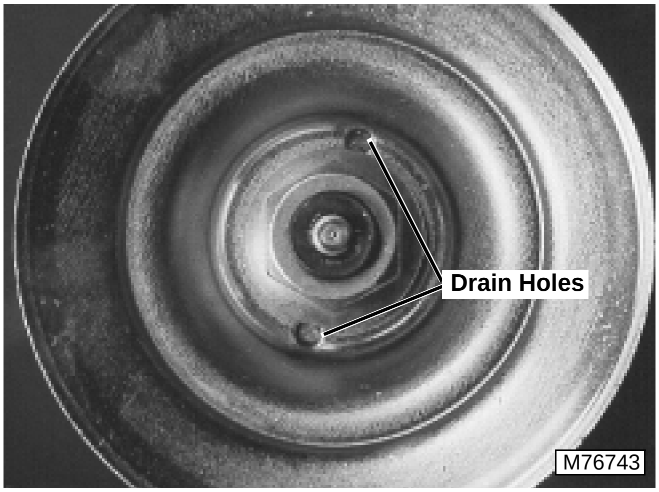
TIMING BELT REMOVAL/INSTALLATION-36 INCH

Removal:

1. Remove belt shield. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.
2. Remove drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14. or See “PTO DRIVE BELT R&R—36 INCH HYDROSTATIC MODELS” on page 15.

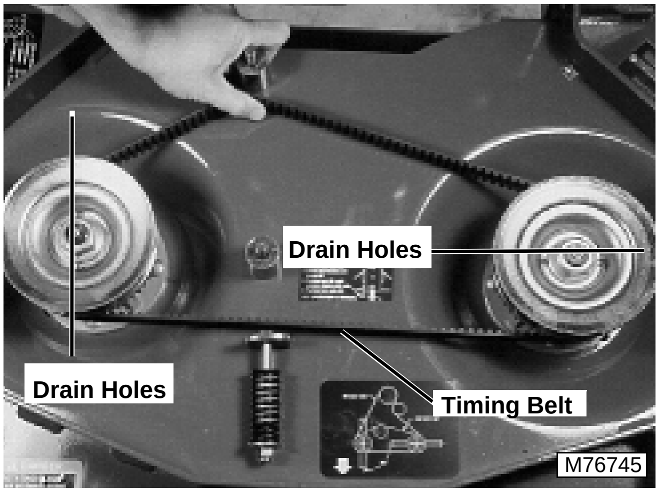


3. Loosen two locknuts on top of the tension arm. Do not remove at this time.
4. Back spring loaded jam nut out to end of threaded shaft.
5. Remove two locknuts and tension arm.
6. Remove timing belt.



IMPORTANT: Drain holes in the drive sheaves indicate the orientation of the mower blades.

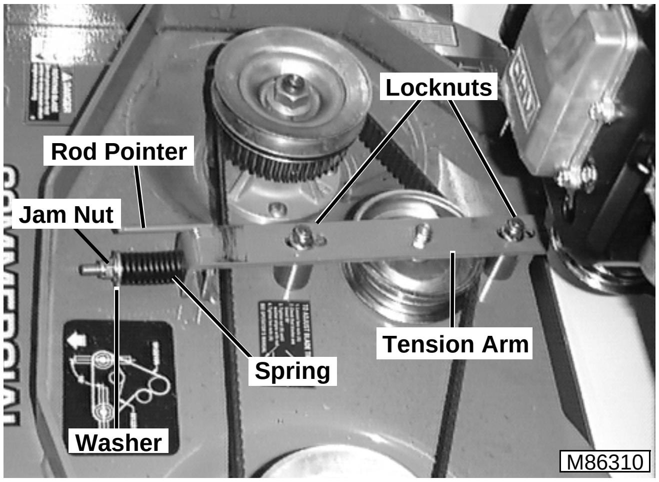
> **⚠ CAUTION**
>
> **Due to mower blade overlap, it is possible for blades to collide if blade timing is not set correctly.**



IMPORTANT: Proper blade orientation exists when one set of drain holes is positioned 90° in relation to the other set.

Installation:

1. Position drive sheaves so that one set of drain holes is oriented front-to-back and the other set is oriented left-to-right.
2. Install new mower deck timing belt and take up slack in the front run of the belt.
3. Recheck drain hole orientation and make necessary adjustments by skipping or adding a tooth on the timing sprocket to belt positioning.
4. Repeat steps 2 and 3 as required.



5. Place tension arm into position and install locknuts finger tight.
6. Ensure that belt rides in the center of the idler pulley.
7. Be sure tension arm is free to travel under the locknuts.
8. Recheck blade orientation.
9. Tighten jam nut to compress spring until washer is even with the end of rod pointer.

10. Tighten locknuts to **55 N•m (40 lb-ft).**

IMPORTANT: Locknuts MUST be tightened to hold idler arm in place.

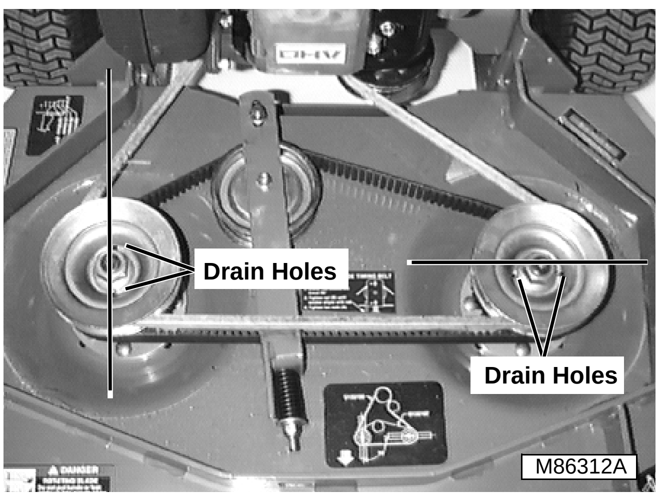
11. Install clutch to mower deck drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14. or
12. Replace belt shield.

TIMING BELT QUICK CHECK-36 INCH

CAUTION

Due to mower blade overlap, it is possible for blades to collide if blade timing is not set properly.

1. Remove belt shield. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.



IMPORTANT: A properly timed mower deck must have one blade oriented 90° to the other blade. Due to belt stretching, tension on the timing belt should be adjusted after first 25 hrs. of use and at 100 hr. intervals afterward.

2. For a quick check on blade timing, sheave drain holes should be oriented **90°** to each other.
3. If necessary, adjust mower deck timing. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14.
4. Install belt shield.

PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS

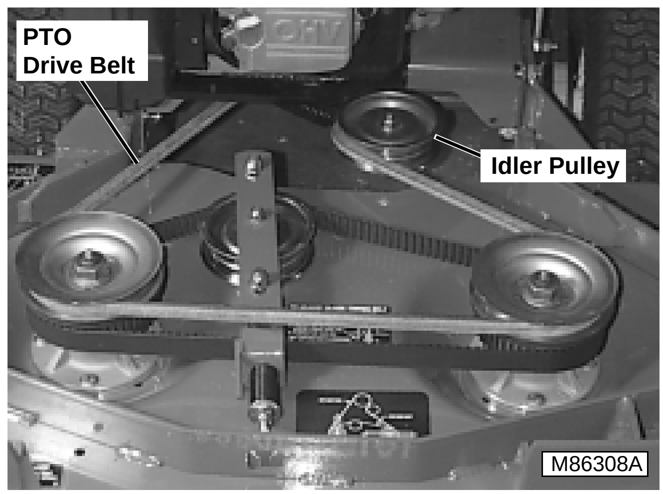
Removal:

1. Remove belt shield. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.

CAUTION

Idler pulley is under strong spring tension. Wear gloves and use caution when performing following steps!

Be aware of possible pinch point between idler pulley and clutch drive sheave.



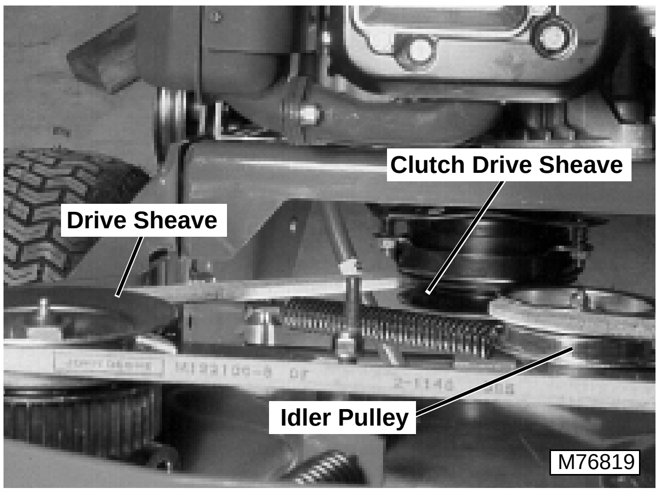
2. Pull spring loaded idler to loosen belt tension.
3. Remove PTO drive belt.
4. Check for frayed and broken fibers.
5. Look for excessive stretching.
6. Replace unserviceable belt.
7. Check blade timing. See “TIMING BELT QUICK CHECK-36 INCH” on page 14.

Installation:

⚠ CAUTION

Idler pulley is under strong spring tension. Wear gloves and use caution when performing following steps!

Be aware of possible pinch point between Idler pulley and clutch drive sheave.

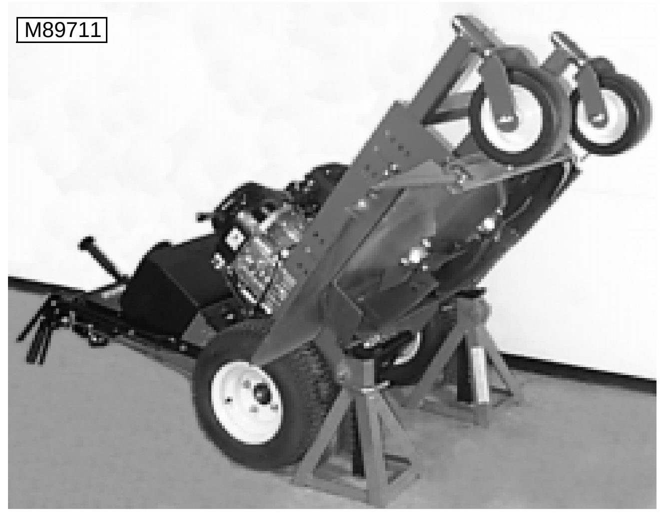


1. Position belt in groove of clutch drive sheave.
2. While holding belt in groove of clutch drive sheave, pull belt into grooves of spindle drive sheaves.
3. Pull idler pulley against spring tension and position so that back of drive belt rides inside of idler pulley.

PTO DRIVE BELT R&R—36 INCH HYDROSTATIC MODELS

NOTE: It is not necessary to remove mower deck to remove & install PTO drive belt.

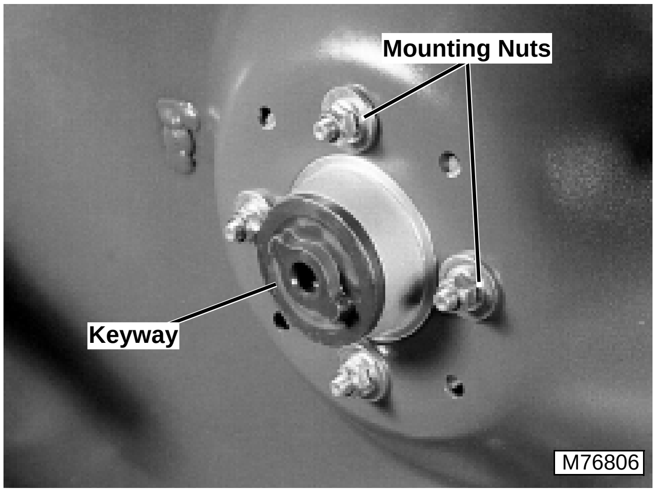
1. Park mower on level surface, pull hydrostatic control lever back to engage transaxle brakes, block drive wheels.
1. Remove mower deck belt shield.



2. Raise mower deck up and support rear of deck frame with jack stands.
3. Pull PTO drive belt tensioner arm to the left to relieve tension on belt. Pull drive belt down out of the path of the idler sheave, and allow idler arm to swing to the right and come to rest against mower deck frame.
4. Remove PTO belt from mower deck spindle sheaves, then from PTO clutch pulley.
5. Remove belt from mower.
6. Clean spindle sheaves and PTO clutch pulley of grease and oil. Inspect belt for wear.
7. Install belt over PTO clutch pulley first, then over spindle sheaves.
8. Pull PTO drive belt tensioner to the left beyond belt, and allow to come to rest against back of PTO drive belt.
9. Lower mower off of jack stands.

BLADE SPINDLE REMOVAL-36 INCH

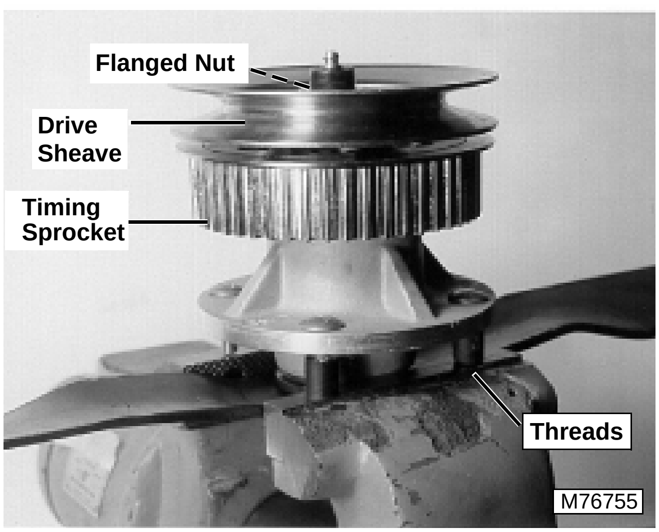
1. Remove belt shield.See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.
2. Remove drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14.
3. Remove timing belt. See “TIMING BELT REMOVAL/INSTALLATION-36 INCH” on page 12.
4. Position mower. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.
5. Remove mower blade. See “BLADE REMOVAL/INSTALLATION-36 INCH” on page 11.



6. Remove four spindle mounting nuts on lower side of mower deck.
7. Extract spindle housing assembly from top of deck.

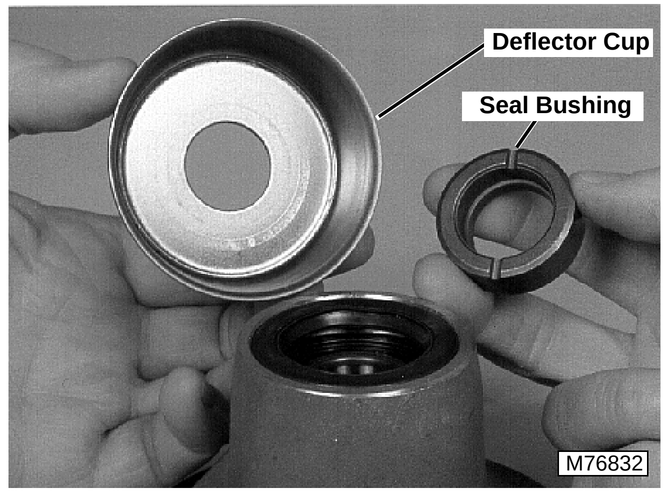
BLADE SPINDLE DISASSEMBLY-36 INCH

1. Mount blade on spindle shaft and tighten finger tight. Blade orientation is immaterial because this is used as an aid for disassembly.

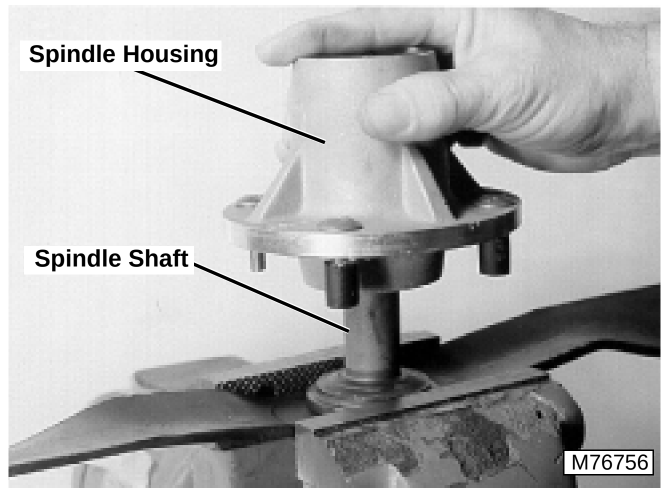


NOTE: Cut a short length of rubber hose and place over threads of housing mount bolts.

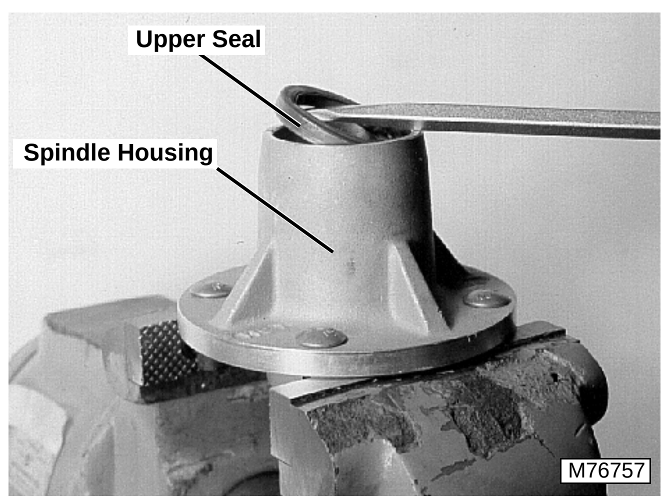
2. Clamp blade in vise, being careful not to damage threads on housing mount bolts.
3. Remove flanged nut from top of spindle shaft.
4. Remove drive sheave and timing sprocket from spindle shaft.



5. Remove deflector cup and seal bushing.

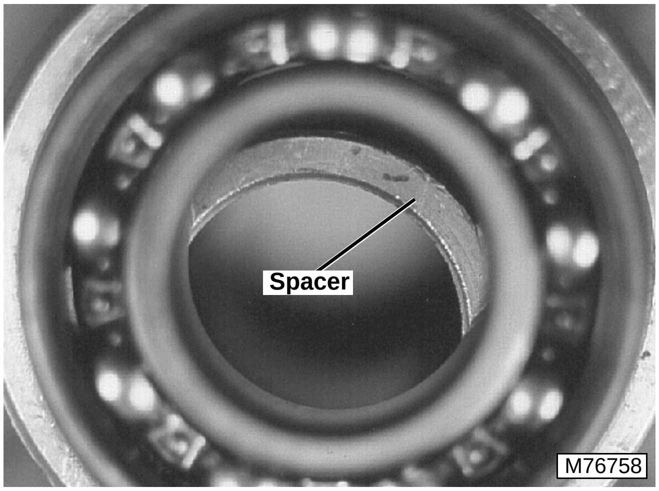


6. Remove spindle housing from spindle shaft.
7. Remove blade and spindle shaft from vise.
8. Remove blade from spindle shaft.



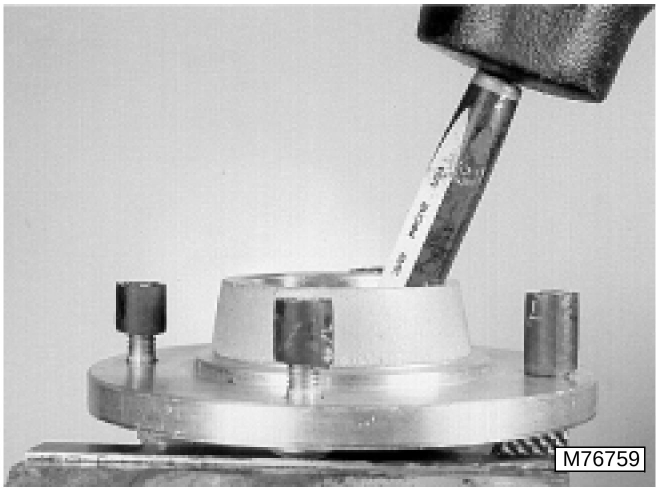
9. Pry the upper seal from spindle housing.

IMPORTANT: Take care not to "cock" bearing when removing. Spindle housing is aluminum and can be damaged by driving the bearings out unevenly.

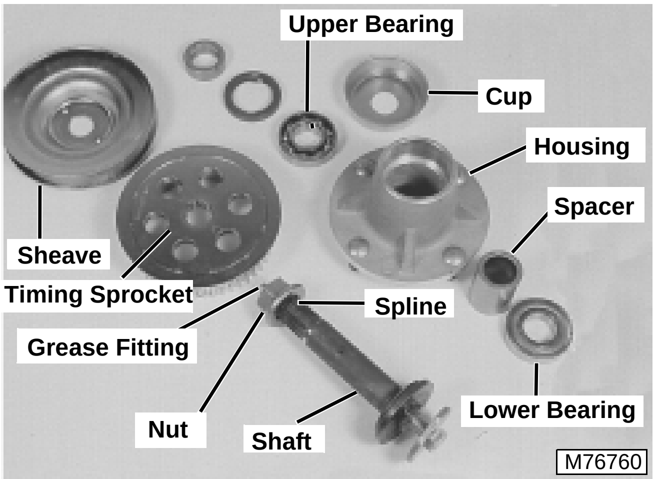


10. Pry inner spacer so that it is slightly to one side. With a long drift tap lower bearing evenly and work lower bearing out of spindle housing.

NOTE: As the bearing moves, the spacer will become increasingly free.



11. Turn the spindle housing over. Evenly drive upper bearing until it drops free of housing.
12. Clean spindle housing and other components in approved solvent.



13. Check for discolored or broken bearings.
14. Look for cracked or damaged spindle housing.
15. Verify that deflector cup is not dented or damaged.
16. Inspect for stripped threads on the spindle shaft.
17. Insure that spindle shaft is straight.
18. See that spline on spindle shaft is not galled.
19. Test for obstructed grease fitting.
20. Check splines on timing sprocket for wear.
21. Examine drive sheave for dents and bends.
22. Check spindle mount bolts for damaged threads or bent.
23. Check for roughness on the upper bearing seal bushing.
24. Inspect flanged nut for damage.
25. Replace any damaged or unserviceable components.

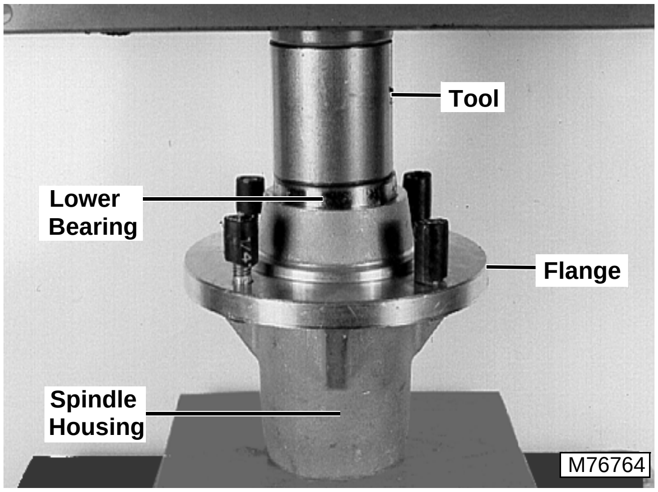
BLADE SPINDLE ASSEMBLY-36 INCH

1. Ensure that all components are new or in a serviceable condition.

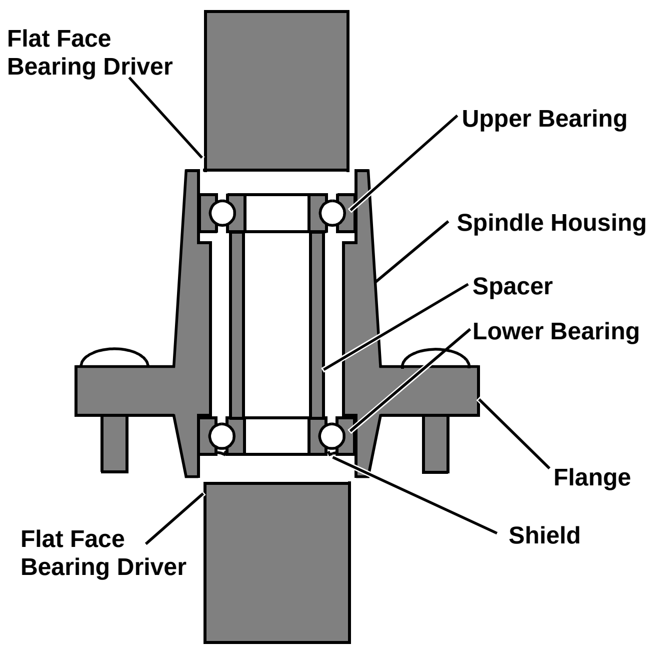
IMPORTANT: Take care not to "cock" bearing when installing. Spindle housing is aluminum and can be damaged by driving the bearings in unevenly.

2. Coat outer surface of lower bearing with grease.

NOTE: The lower bearing has a single shield on one side of the bearing. This bearing should be installed with seal facing out of the bore of the flange (blade) end of the spindle housing.



3. Place lower bearing, with shield facing out, in spindle housing and press until the bearing is seated on shoulder of the spindle housing.



4. Turn housing over.
5. Install spacer.

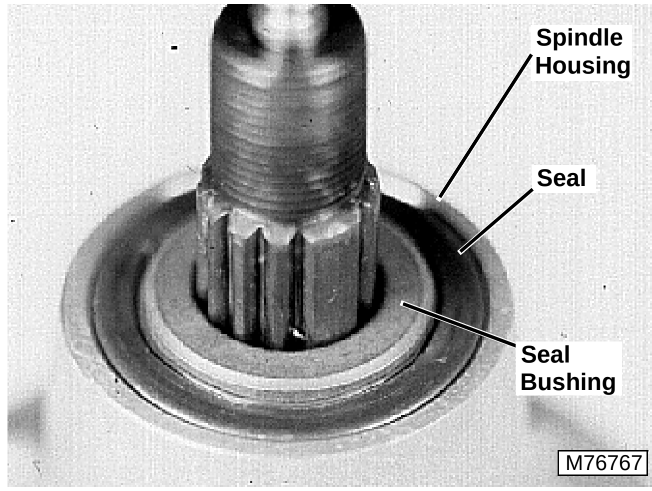
IMPORTANT: Lower Bearing MUST be supported on both inner and outer race when upper bearing is being pressed in place.

Upper bearing Must be pressed in place with a FLAT face driver that will press evenly on BOTH inner and outer bearing race.

Failure to use proper procedure and tooling will result in accelerated bearing wear.

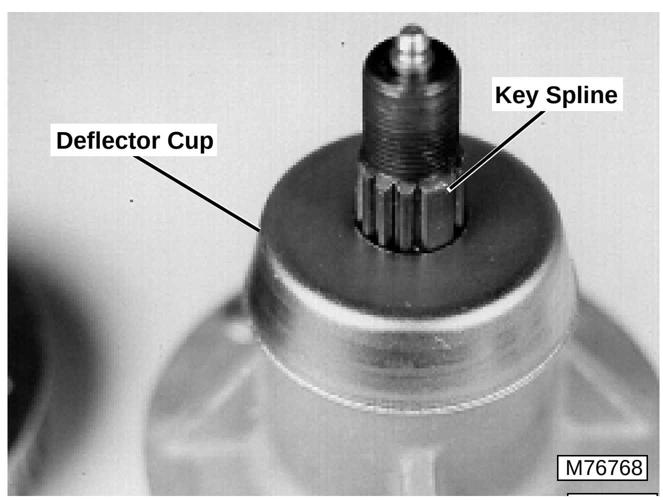
Take care NOT to crush spacer.

6. Coat surface of upper bearing with light coat of grease and press into housing until inner bearing race comes into contact with spacer.



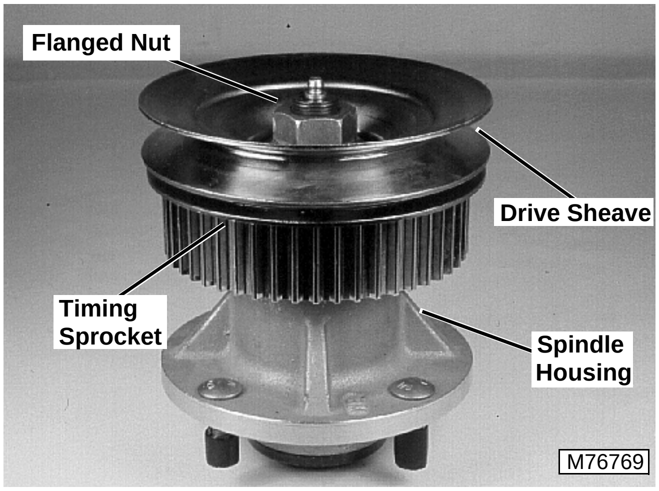
NOTE: Apply a light coating of grease to the inside and outside seal surfaces to protect seal lips and facilitate installation.

7. Press seal into housing until flush with outside face of spindle housing.
8. Install the seal bushing so that the smooth side is facing up.
9. Install spindle shaft.



10. Install the deflector cup over the spindle and housing.

NOTE: Be certain to index the timing sprocket and drive sheave correctly to the key spline of the spindle shaft.



11. Install timing sprocket with flanged side up.
12. Install drive sheave.
13. Install flanged nut and tighten to **163 N•m (120 lb-ft).**

BLADE SPINDLE HOUSING INSTALLATION-36 INCH

1. If not already done, position mower for maintenance. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.
2. Install housing assembly on deck.
3. Torque mounting bolt nuts to **26 N•m (19 lb-ft).**
4. Install mower blade. See “BLADE REMOVAL/INSTALLATION-36 INCH” on page 11.
5. Lower mower to normal position.
6. Install timing belt. See “TIMING BELT REMOVAL/INSTALLATION-36 INCH” on page 12.

IMPORTANT: Lubricate both mower spindles with John Deere Moly High Temperature EP Grease or equivalent.

CASTER REMOVAL / INSTALLATION-36 INCH

Removal:

1. Position mower for maintenance. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11.

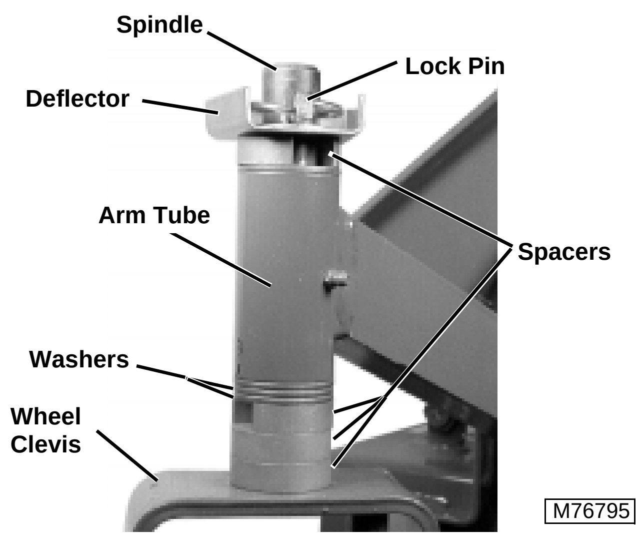
NOTE: Belts and shields do not need to be removed.

⚠ CAUTION

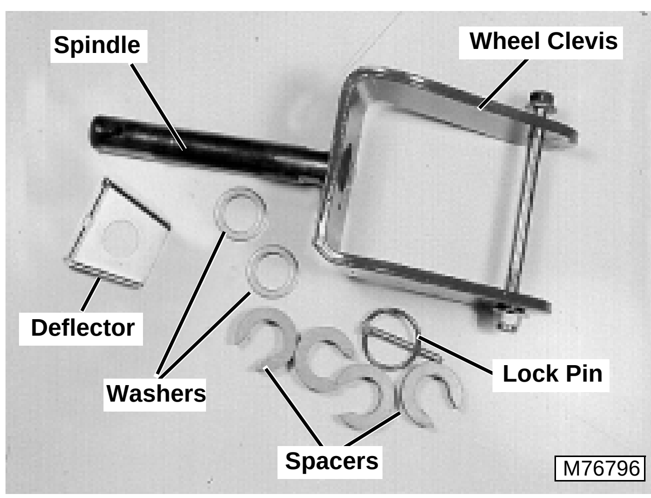
Caster assembly is heavy and may slide out of frame tube when lock pin is removed if not properly supported!

Wheel clevis will rotate around wheel when spindle is removed from frame tube and create pinch points.

2. If required, remove wheel. See “WHEEL REMOVAL-ALL” on page 33.



3. Remove lock pin, deflector, and extra spacers and/or washers from spindle.
4. Lower caster assembly down through arm tube.



5. Clean associated areas of grease and dirt.
6. Inspect for cracked welds.
7. Check tightness of bushings.
8. Look for hole elongation in bushings.
9. Clear grease fittings.
10. Check squareness of wheel clevis with spindle arm.

Installation:

1. Arrange spacers and washers on spindle as needed to achieve the required height. See “CASTER ARM INSTALLATION-36 INCH GEAR DRIVE MODELS” on page 22.

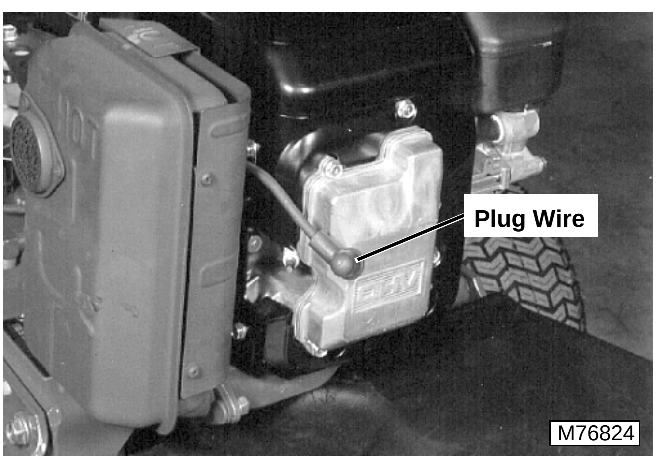
NOTE: Washers are provided for “fine” tuning height.

2. Install spindle arm, with spacers and washers, into arm tube. Place extra spacers and/or washers on spindle and secure with deflector and lock pin.
3. Install wheel. See “WHEEL INSTALLATION-ALL” on page 34.
4. Lower mower to ground.
5. Check to make sure deck is parallel to the ground and that both caster wheels contact the ground.
6. Connect spark plug.

DECK REMOVAL-36 INCH

Removal:

> **CAUTION**
>
> **Decks are heavy. use proper lifting procedures to avoid personal injury.**

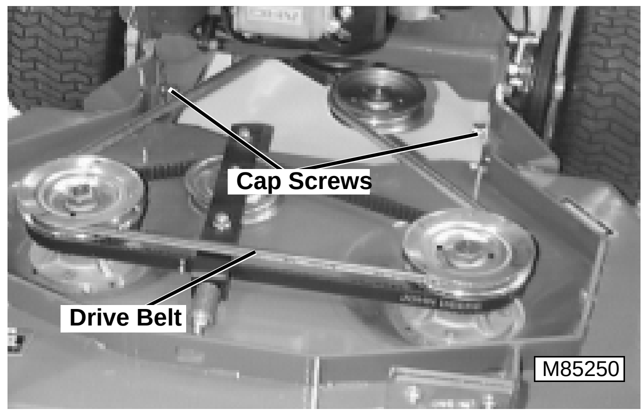


1. Disconnect spark plug wire.

Gear Drive Models:

2. Remove PTO drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14.

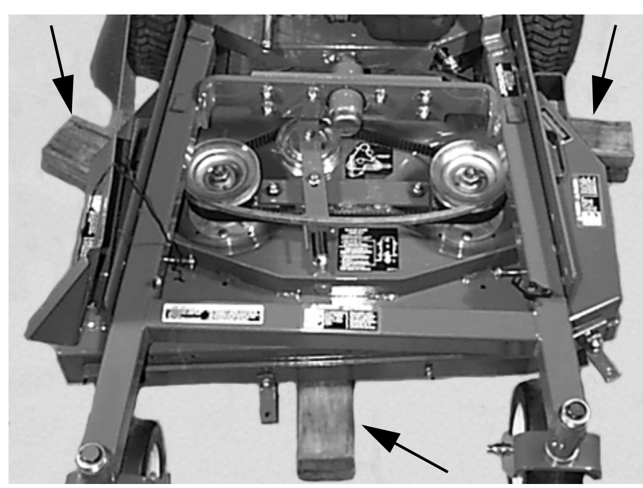
> **CAUTION**
>
> **Use care in removal of cap screws securing power unit to mower deck assembly. Once removed the power unit will become overbalanced and fall backwards onto the operator handles. It is recommended that two (2) people perform this operation, one to handle the deck and one to handle the power unit.**



3. Loosen (do not remove) cap screws on left and right side of power unit frame.
4. Work deck and power unit in opposite up and down motion - to loosen deck to power unit attachment point - then carefully remove cap screws.
5. Separate deck from power unit.

Hydrostatic Models:

1. Remove PTO See “PTO DRIVE BELT R&R—36 INCH HYDROSTATIC MODELS” on page 15.



2. Place a wood block under each rear corner of mower deck, and one in center front.

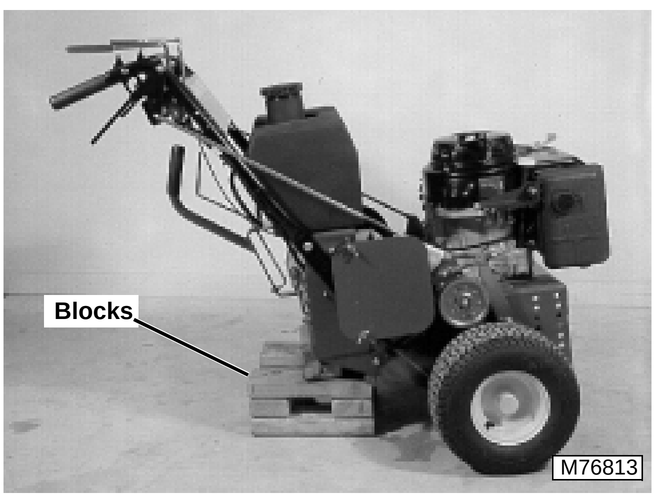
⚠ CAUTION

When mower deck mounting cap screws are removed, the power deck becomes free and can fall back suddenly. Do not move the power deck after the mounting bolts until power deck is being supported

3. Remove six cap screws and nylock nuts holding mower deck to power deck. Allow the mower deck to lower onto wood blocks as cap screws are removed.
4. Pull free wheeling levers out and lock in the free wheeling position.
5. Move hydrostatic speed control lever forward to release park brake.
6. Roll power deck back away from mower deck.

DECK INSTALLATION-36 INCH

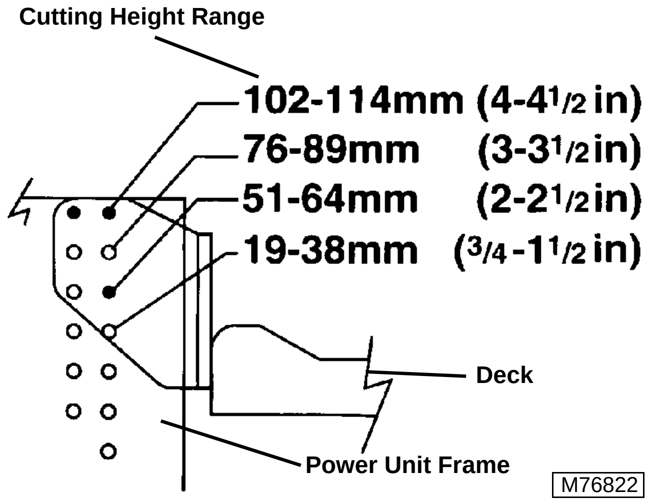
Gear Drive Models:



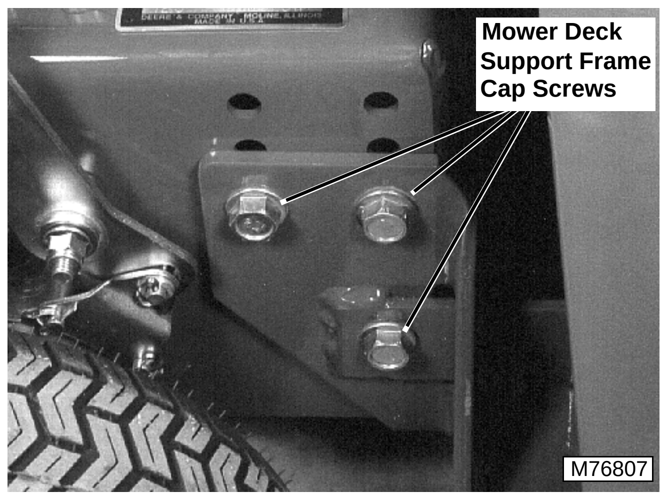
1. Support power unit with jack stand, blocks or other safe suitable means.

IMPORTANT: Blade cutting height is determined when mower deck is attached to power unit.

NOTE: For purposes of instruction, a cutting height range of 2.5 inch and lower has been selected. When installing deck in the field, refer to criteria outlined below.



2. Select the desired blade cutting height range.



3. Loosely install mower deck support caps screws in holes appropriate to cutting height range selection.
4. Tighten deck attaching cap screws to **140 N•m (105 lb-ft)**.
5. Install caster arms. See “CASTER ARM INSTALLATION-36 INCH GEAR DRIVE MODELS” on page 22.
6. Install drive belt. See “PTO DRIVE BELT R & R—36 INCH GEAR DRIVE MODELS” on page 14.
7. Connect spark plug lead.

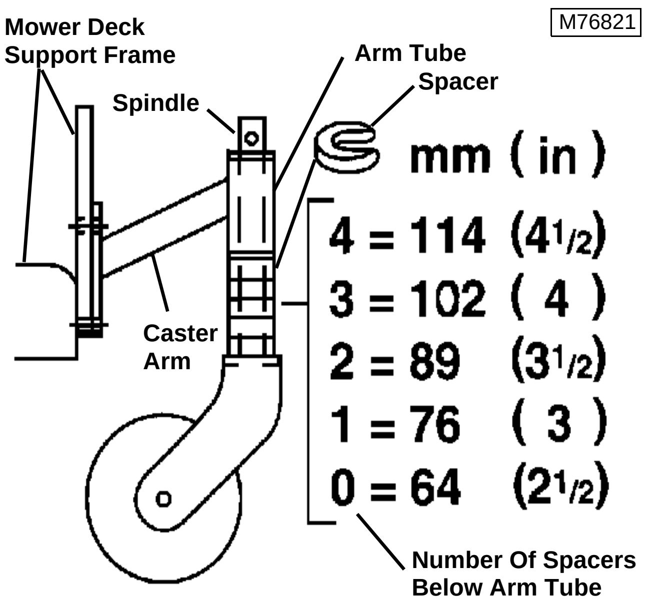
Hydrostatic Models:

1. Support deck on wooden blocks as shown in Removal section. See “DECK REMOVAL-36 INCH” on page 20.
2. Move power deck pinion up to mower deck mounting flange, and install six mounting cap screws.

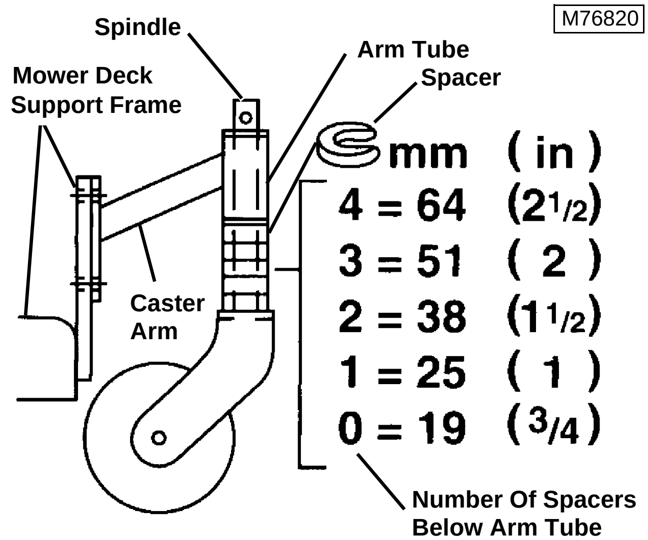
3. Install PTO drive belt. See “PTO DRIVE BELT R&R—36 INCH HYDROSTATIC MODELS” on page 15.

CASTER ARM INSTALLATION-36 INCH GEAR DRIVE MODELS

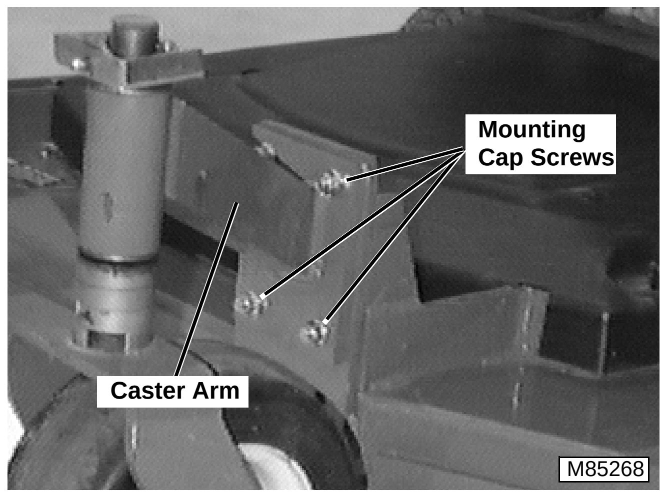
NOTE: Cutting height adjustment range is determined by position of caster arm on mower deck support frame. (Upper or lower range) Specific individual heights within range are determined by positioning spacers and washers below arm tube.



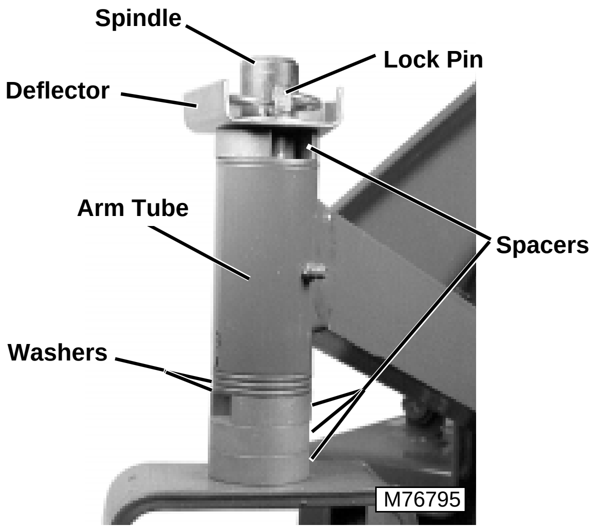
2.5 INCH AND HIGHER CUTTING HEIGHT



2.5 INCH AND LOWER CUTTING HEIGHT



1. Select cutting range.
2. Remove caster arm mounting cap screws.
3. Locate caster arm in position, upper or lower, to give adjustment range required.
4. Install mounting cap screws.



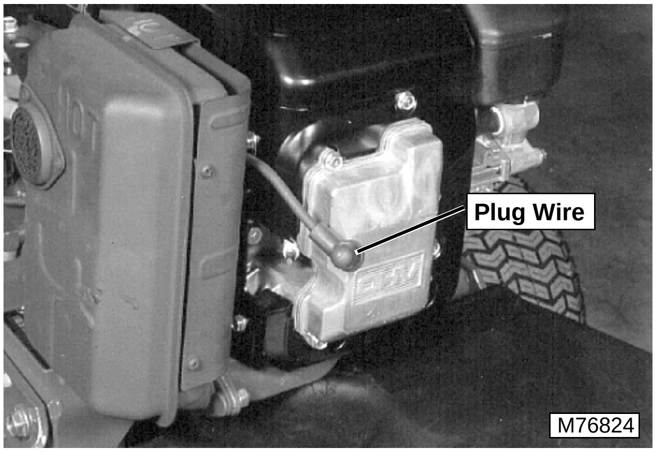
5. Remove lock pin, guard, and extra spacers and/or washers from spindle.
6. Lower caster assembly down through arm tube.
7. Arrange spacers and washers on spindle as needed to achieve the required height.

NOTE: Washers are provided for "fine" tuning height from side to side. It may be necessary to have one or more washers on one side than the other in order to level the deck.

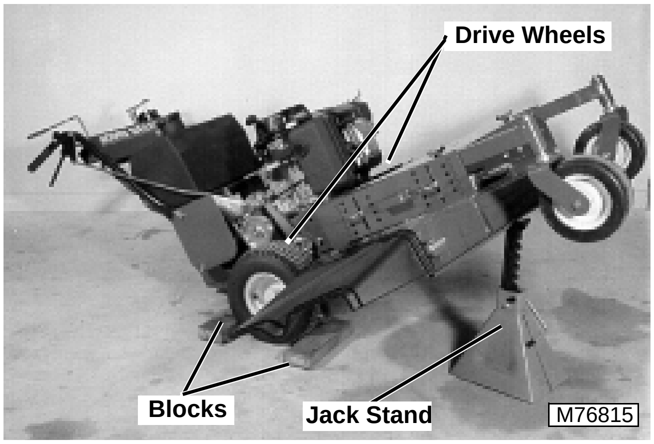
8. Install spindle arm, with spacers and washers, into arm tube. Place extra spacers and/or washers on spindle and secure with shield and lock pin.

MOWER POSITIONING FOR MAINTENANCE-48/54 INCH

1. Position mower on a level flat surface.



2. Disconnect spark plug wire.
3. Ensure that fuel tank is no more than half full.



4. Block both drive wheels.
5. Raise front of unit approximately 18 inches. Support mower deck with jack stand or other suitable support.

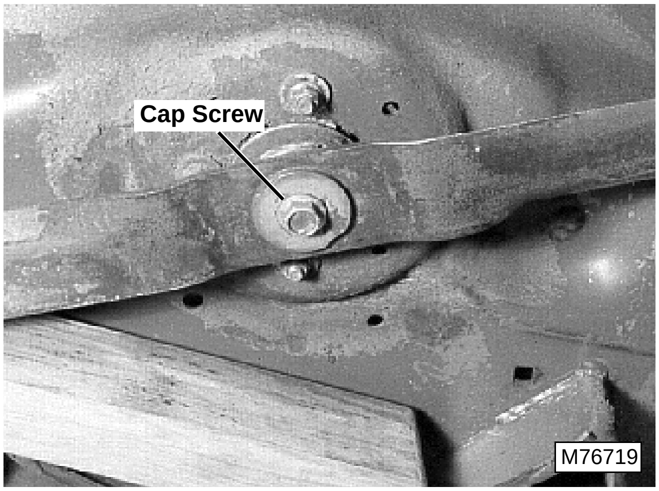
BLADE REMOVAL / INSTALLATION-48/54 INCH

⚠ CAUTION

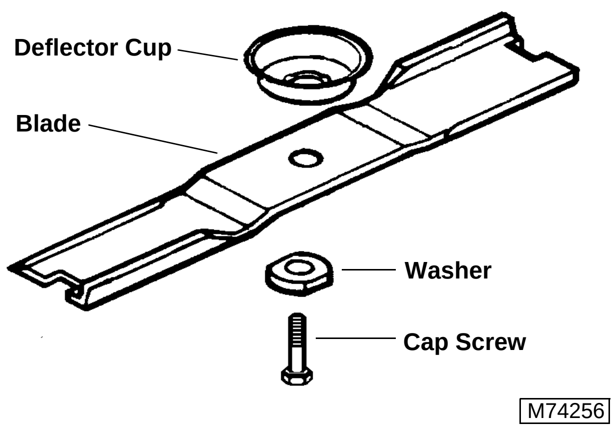
Blades are sharp. wear gloves or wrap blade with rag to prevent personal injury.

Removal:

1. Position mower for blade maintenance. See "MOWER POSITIONING FOR MAINTENANCE-48/54 INCH" on page 23.

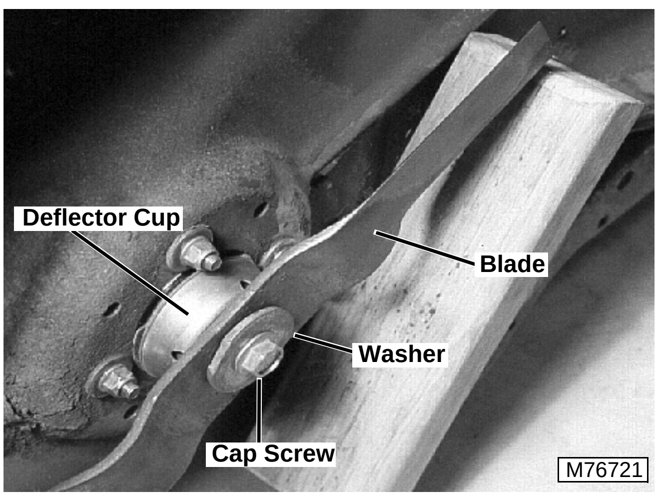


2. Block blade using a suitable piece of wood.



3. Remove cap screw and washer from spindle shaft.
4. Remove blade.
5. Remove deflector cup.
6. Repeat this procedure for the other two blade assemblies, as required.

Installation:



1. Block blade using a suitable piece of wood.
2. Install deflector cup so that it rests flush on face of spindle.

CAUTION

The washer for blade retention is a Bellville Cupped washer and MUST be installed correctly, with the cup towards the blade.

The washer has two indentations that show the proper orientation. BE CERTAIN the indentations face AWAY from the mower blade for correct installation.

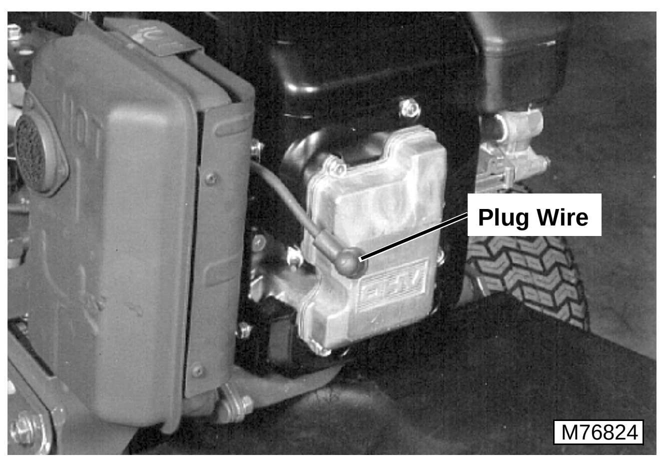
Failure to install washer correctly will allow the blade to come loose and will result in serious injury to the operator or bystanders.

3. Install blade and washer, with convex side up.
4. Install cap screw and tighten to **68 N•m (50 lb-ft).**

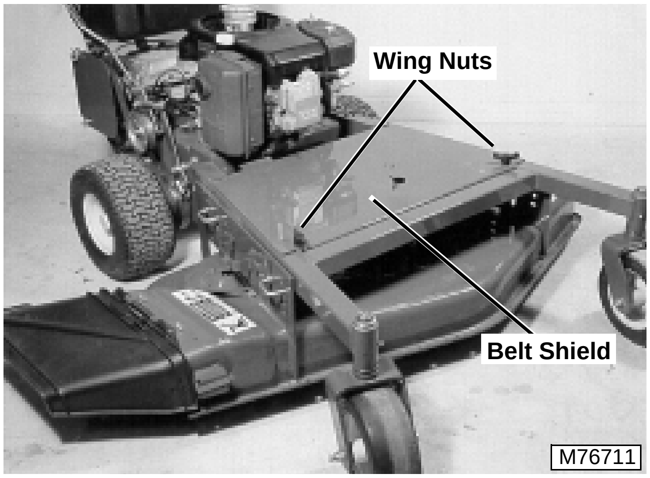
IMPORTANT: Remove piece of wood being used to stop blade rotation.

DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH

Removal:



1. Disconnect spark plug wire.

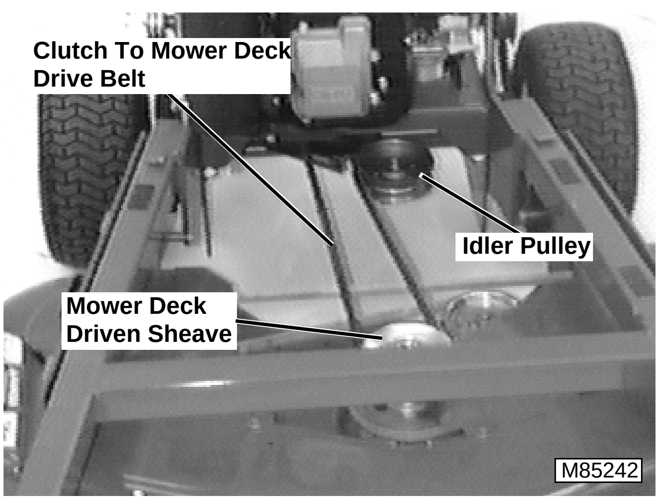


2. Remove wing nuts on belt shield.
3. Remove belt shield from mower deck support frame.

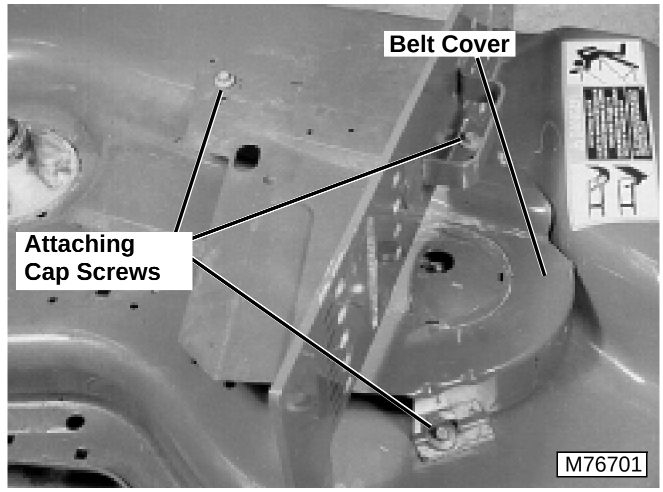
⚠ CAUTION

Idler pulley is under strong spring tension. Wear gloves and use caution when performing following steps!

Be aware of possible pinch point between Idler pulley and clutch drive sheave



4. Pull spring loaded idler pulley to remove tension on clutch to mower deck drive belt.
5. While holding idler pulley back, remove clutch to mower deck drive belt from contact with idler pulley.
6. Remove clutch to mower deck drive belt from driven sheave on mower deck.

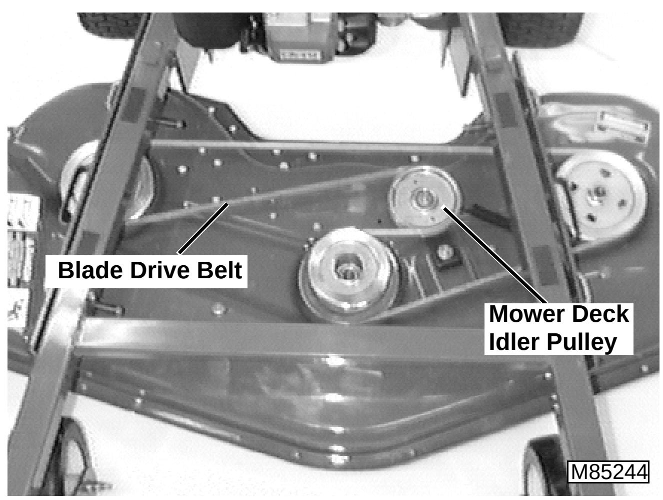


NOTE: Belt cover installation shown above is typical.

7. Loosen (do not remove) belt cover attaching cap screws.
8. Slide belt cover to rear and remove.

⚠ CAUTION

Mower deck Idler pulley is under strong spring tension. Wear gloves and use caution when performing following steps!

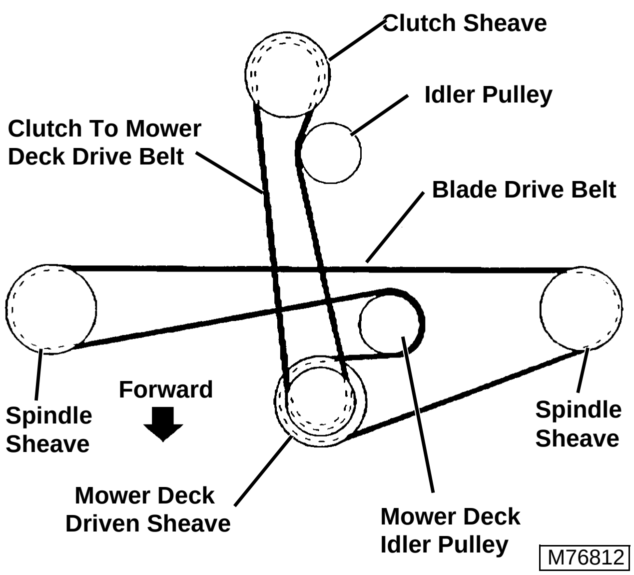


9. Pull spring loaded mower deck idler pulley to remove tension on blade drive belt. Remove blade drive belt from mower deck idler pulley.

10. Remove mower deck drive belt from blade drive sheaves.
11. Be sure belt has not been friction burned.
12. Check for cracks and deterioration.
13. Look for frayed and loose fibers.
14. Insure belt has not stretched excessively.
15. Replace any worn or defective belts.

Installation:

> ⚠ **CAUTION**
>
> **Idler pulleys are under strong spring tension. Wear gloves and use caution when performing following steps!**
>
> **Be aware of possible pinch point between Idler pulley and clutch drive sheave.**

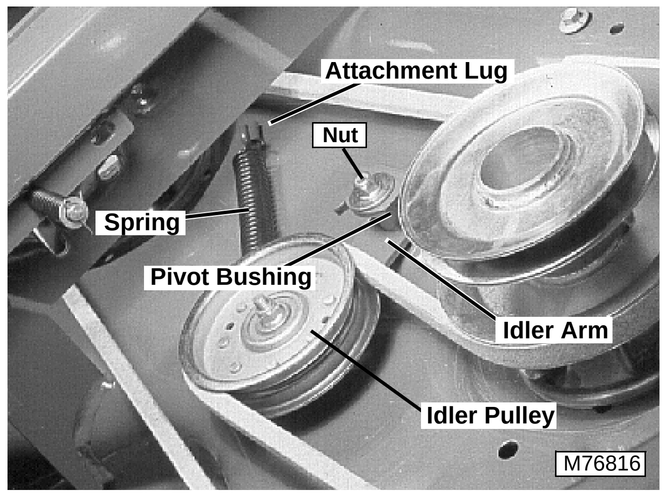


1. Position blade belt in grooves of spindle sheaves.
2. Pull mower deck idler pulley against spring tension until back of blade belt lines up with center of deck idler pulley. Slowly release deck idler pulley until full contact is made with blade belt.
3. Place clutch to mower deck drive belt in groove of clutch drive sheave and groove in center mower deck driven sheave.
4. Pull spring loaded idler and position clutch to mower deck drive belt so it rides in center of spring loaded idler. Slowly release spring loaded idler until full contact is made with clutch to mower deck drive belt.
5. Double check to make sure that both belt are seated correctly in sheaves and run in center of respective idler pulley.
6. Replace belt covers.
7. Attach spark plug.

IDLER PULLEY REMOVAL / INSTALLATION-48/54INCH

Removal:

1. Remove drive belt. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24.



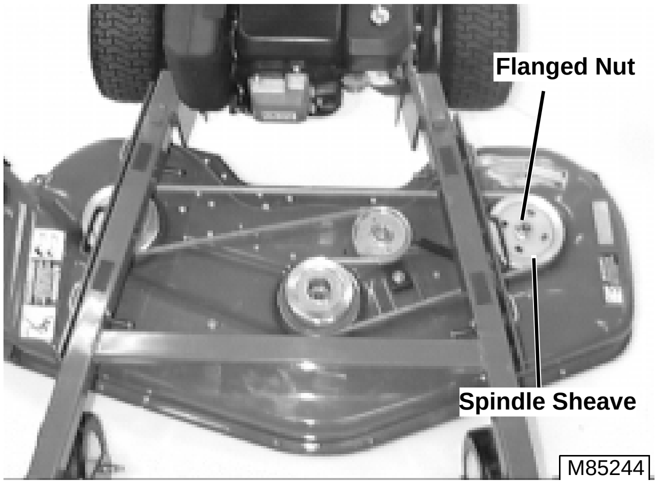
2. Remove spring from idler arm and attachment lug on deck.
3. Loosen nut on pivot of idler arm.
4. Remove nut, cap screw and idler arm.

Installation:

1. Position idler arm, cap screw and pivot on deck.
2. To prevent crushing of pivot bushing, install nut and torque to **12 N•m (9 lb-ft).**
3. Attach spring to attachment lug and idler arm.

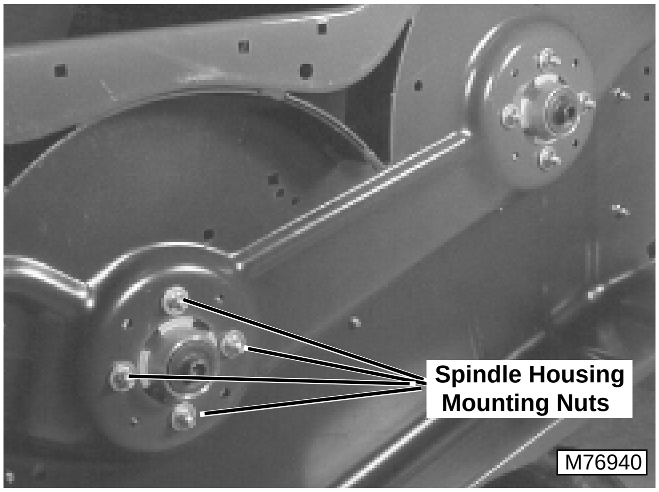
BLADE SPINDLE REMOVAL-48/54 INCH

1. Position mower. See "MOWER POSITIONING FOR MAINTENANCE-48/54 INCH" on page 23.
2. Remove mower drive belts. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24.



3. Use wooden block on inside of mower housing to prevent blade from rotating and loosen (do not remove) flanged nut securing spindle sheave to spindle.
4. Remove appropriate mower blade. See “BLADE REMOVAL / INSTALLATION-48/54 INCH” on page 23.
5. Remove flanged nut, spindle sheave. Lower spindle shaft through spindle housing.

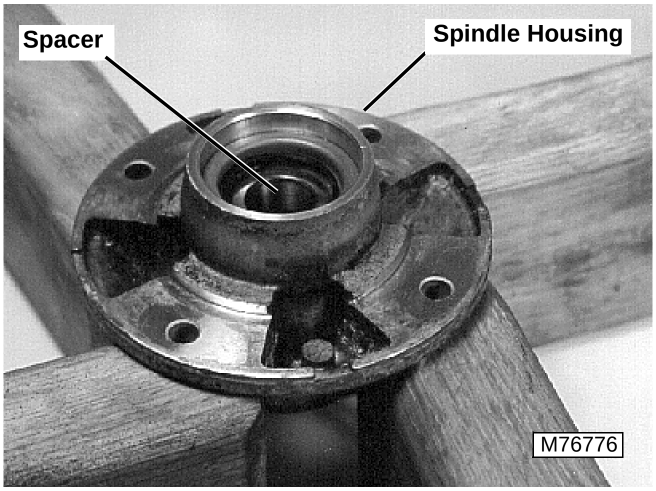
NOTE: *If spindle shaft will not come out of spindle housing the entire unit can be removed from the top of the mower deck once the spindle housing nuts have been removed.*



6. Remove spindle housing mounting nuts and washers.
7. Extract spindle housing from top side of mower deck.

BLADE SPINDLE DISASSEMBLY-48/54INCH

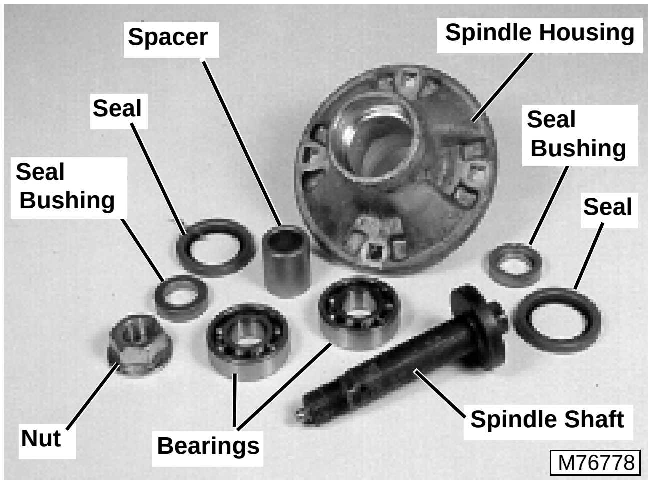
IMPORTANT: Take care not to “cock” bearing when removing. Spindle housing is aluminum and can be damaged by driving the bearings out unevenly.



1. Support spindle housing assembly.
2. Slide spacer to one side, exposing inner race of lower bearing.

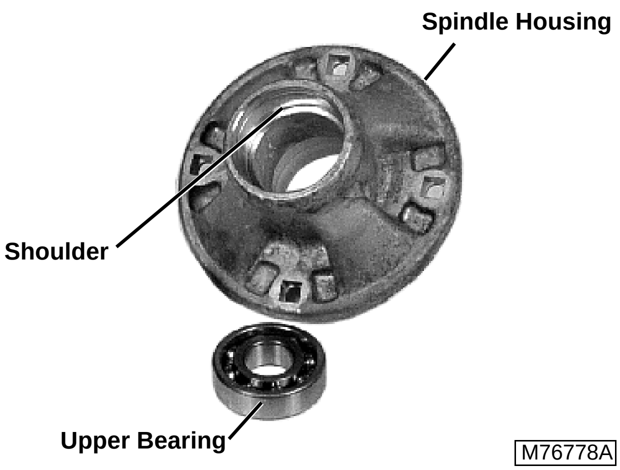
NOTE: *Removal of lower bearing may damage bearing. Carefully inspect lower bearing for damage and/or replace bearing with new bearing.*

3. Drive bearing and seal until bearing, seal and spacer drop clear of housing assembly.
4. Turn housing over and drive other bearing and seal until they drop free.
5. Clean all parts in an approved solvent.

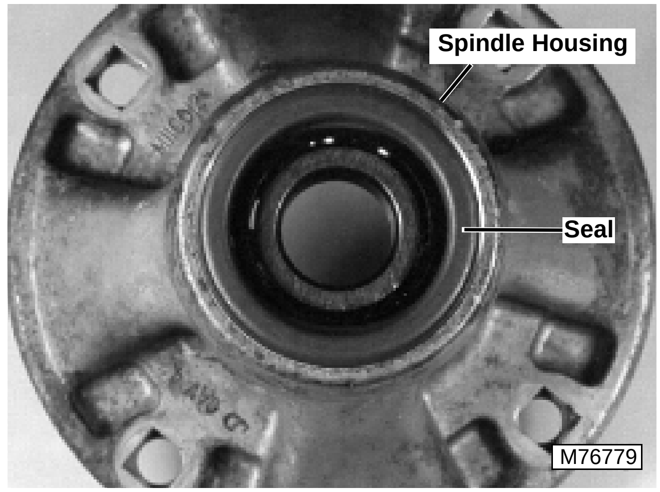


6. Look for cracks in spindle housing webs.
7. Check for discoloration of bearing cages and races.
8. Feel bearing rotation and ensure smoothness.
9. Verify spindle shaft is straight.
10. Examine threads on spindle shaft.
11. Clear lubrication holes in spindle shaft.
12. Be sure cap screw threads in spindle are serviceable.
13. Make sure grease fitting is clear.
14. Replace any damaged or unserviceable components.

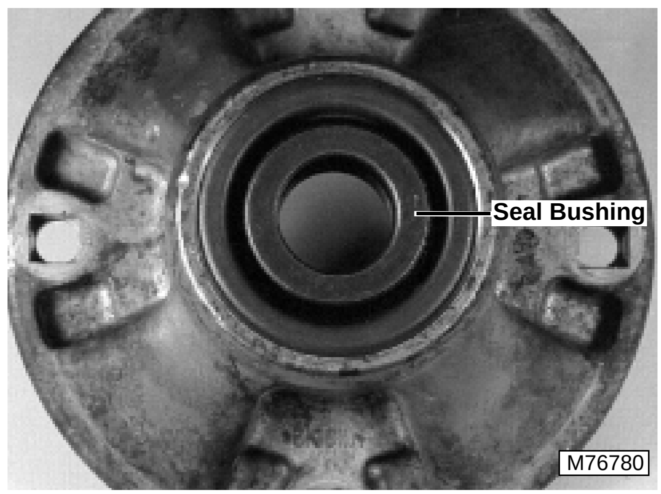
BLADE SPINDLE ASSEMBLY-48/54INCH



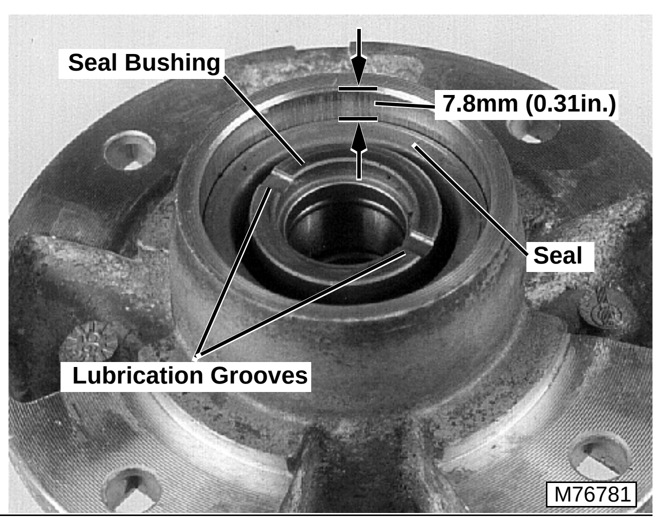
1. Lightly coat upper bearing with grease and install upper bearing tight against shoulder of spindle housing.



2. Coat seal with grease and install seal until flush with top of housing. Note correct seal orientation with lip facing bearing.

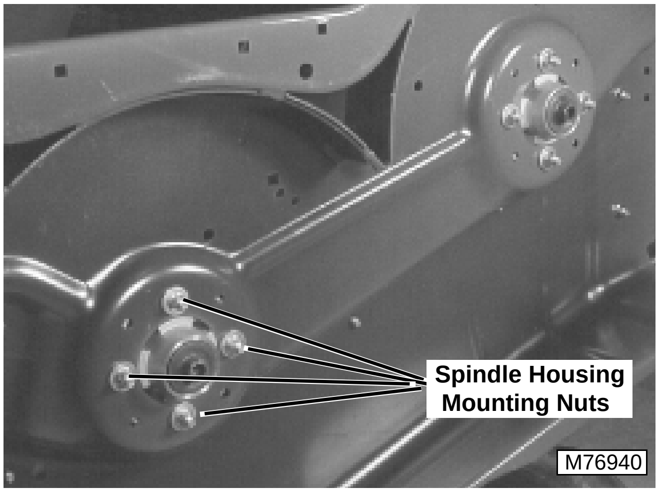


3. Install upper seal bushing with smooth side facing away from bearing.
4. Turn housing over.

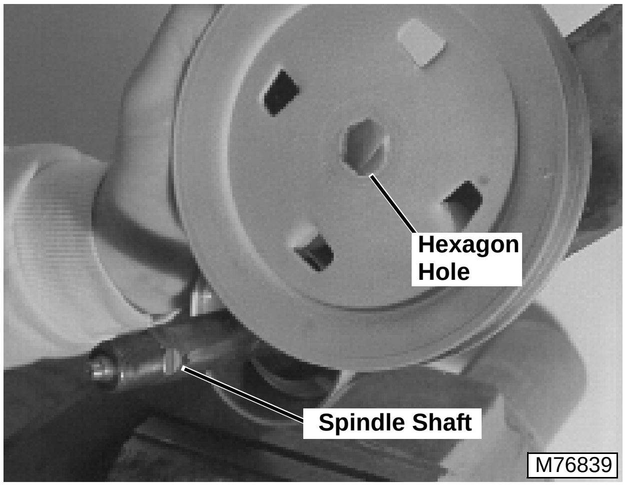


5. Place spacer in spindle housing
6. Press bearing and seal into housing together until top of seal is **7.8 mm (0.31 in.)** below top of spindle housing.
7. Install lower seal bushing with lubrication grooves away from bearing.
8. Install spindle shaft.

BLADE SPINDLE INSTALLATION-48/54 INCH



1. Place spindle housing in appropriate hole in mower deck. Secure with washers, locknuts and spindle housing mounting nuts.
2. Torque nuts to **26 N•m (19 lb-ft).**



IMPORTANT: Make sure that the hexagon hole in the spindle sheave is in alignment with hexagon portion of spindle shaft.

3. Install drive sheave and flanged nut.
4. Torque flanged nut to **163 N•m (120 lb-ft)**
5. Lubricate spindle with John Deere Moly High Temperature EP Grease or an equivalent.
6. Install blade. See "BLADE REMOVAL / INSTALLATION-48/54 INCH" on page 23.
7. Install belts. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24.

CASTER REMOVAL / INSTALLATION-48/54 INCH

Removal:

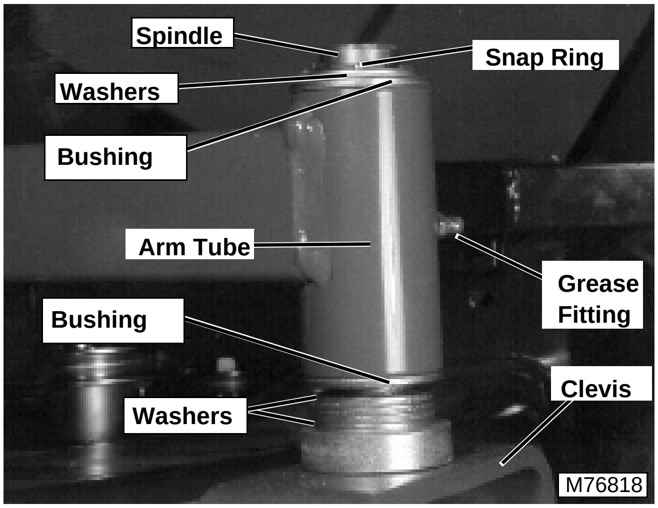
1. Position Mower. See "MOWER POSITIONING FOR MAINTENANCE-48/54 INCH" on page 23.

CAUTION

Caster assembly is heavy and may slide out of frame tube when lock pin is removed if not properly supported!

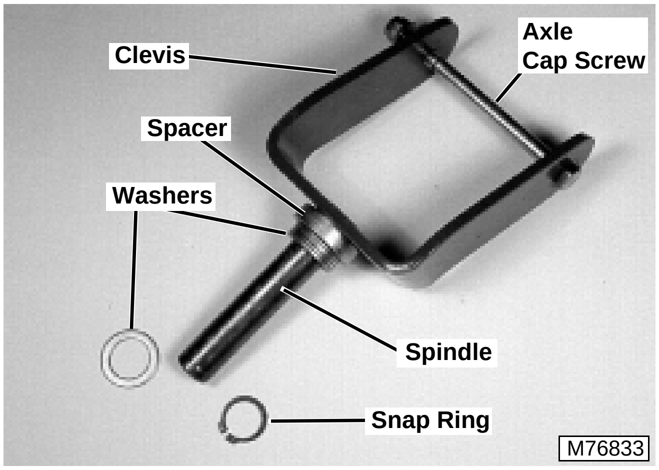
Wheel clevis will rotate around wheel when spindle is removed from frame tube and create pinch points.

2. Remove wheel if required. See "WHEEL REMOVAL-ALL" on page 33.



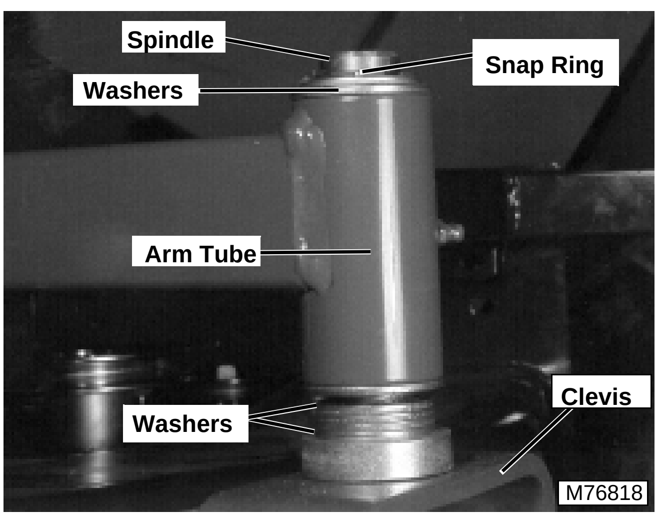
3. Take note of the number and location of washers under snap ring and on top of the wheel clevis.
4. Remove snap ring from spindle and any washers that are located above the arm tube.
5. Lower caster assembly through arm tube.

6. Clean associated areas of grease and dirt.
7. Look at arm tube and frame welds for any cracks or bends.
8. Insure that bushings in the arm tube are free from elongation and are tight in their mounts.
9. Clear grease fitting.



10. Check that spindle weld is not cracked at the wheel clevis.
11. Be sure that spindle is not bent.
12. Verify that wheel clevis is square, in relation to the wheel axle.
13. Wipe components clear of dirt and other contaminants.

Installation:



1. Place correct number of washers on spindle.
2. Slide spindle through arm tube.
3. Place remaining washers on spindle.
4. Install snap ring.
5. Return mower to ground.
6. Check to make sure both casters are touching the ground evenly.
7. Attach spark plug lead.

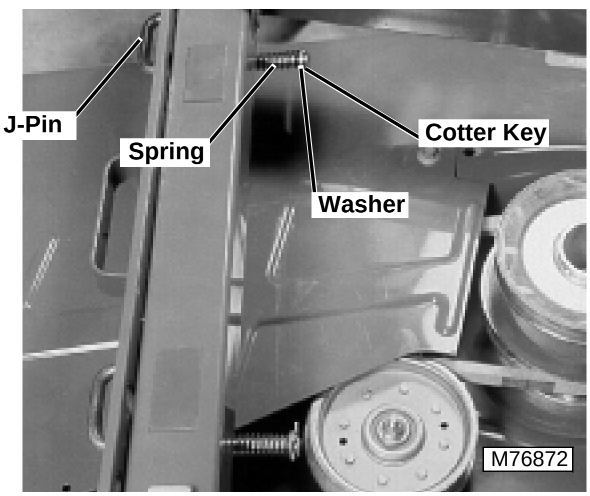
DECK REMOVAL / INSTALLATION-48/54 INCH GEAR DRIVE MODELS

Removal:

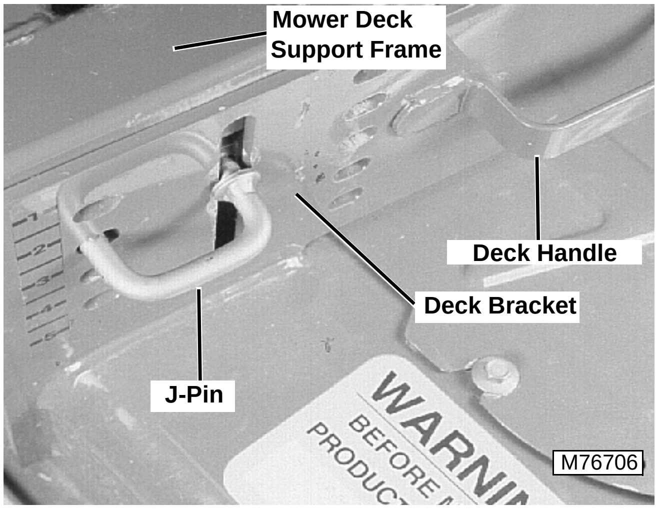
1. Remove belt shield. See "MOWER POSITIONING FOR MAINTENANCE-48/54 INCH" on page 23.
2. Remove clutch to deck drive belt. See "DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH" on page 24.

NOTE: It is only necessary to remove the clutch to mower deck drive belt to remove the deck.

3. Support mower deck with blocks or other safe suitable method.

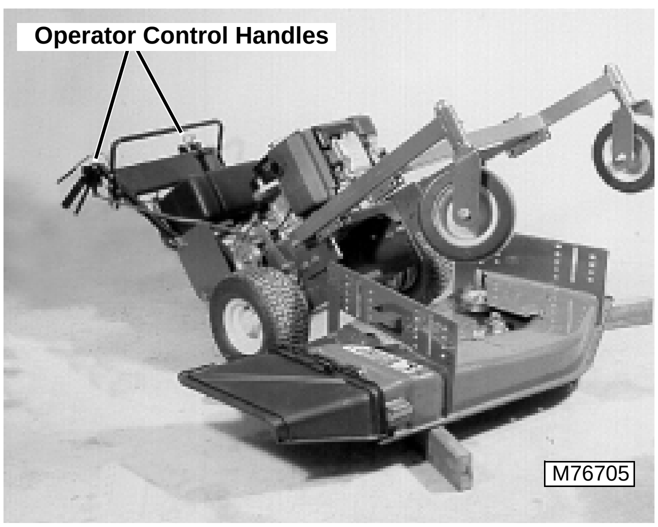


4. Remove cotter key, washer and spring from all four J-pins.



5. Pull all four J-pins from the frame and the deck brackets.

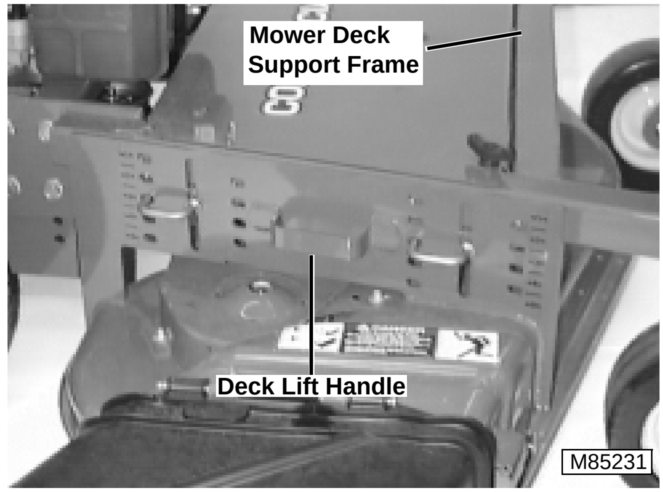
NOTE: It may be necessary to relieve tension on the J-pins by pulling up slightly on the deck handles



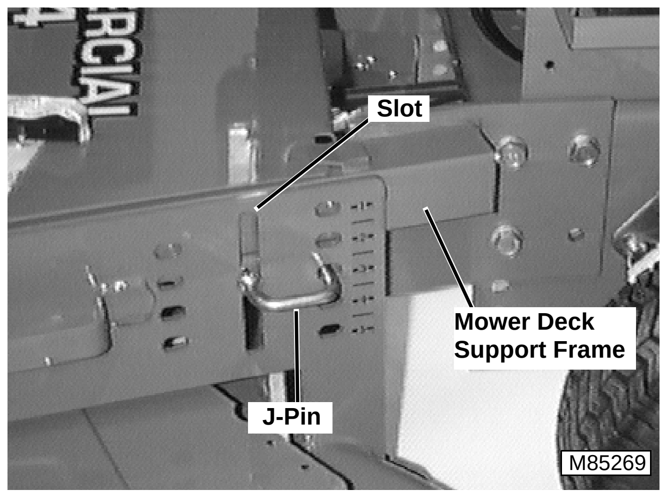
6. Push down on operator control handles, raising the front caster wheels above the mower deck.
7. Pull power unit clear of deck.

Installation:

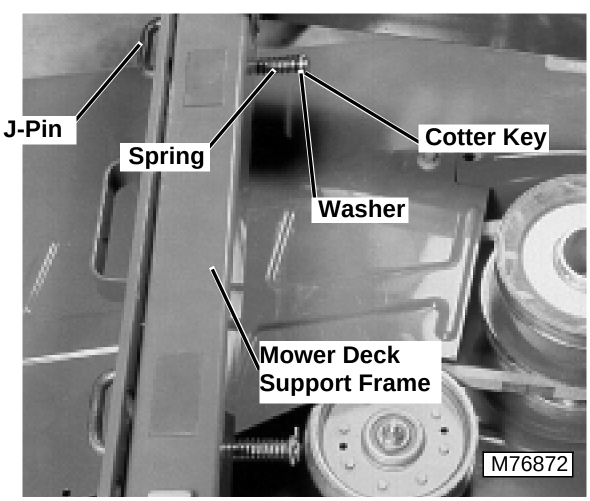
1. Position mower assembly so that mower deck support frame fits inside mower deck frame.
2. Select desired cutting height.



3. Grip deck lift handle and raise deck to selected position.



4. Push long end of J-pin through slot on deck bracket and the center mounting hole on mower deck support frame.
5. Repeat for all four pins.

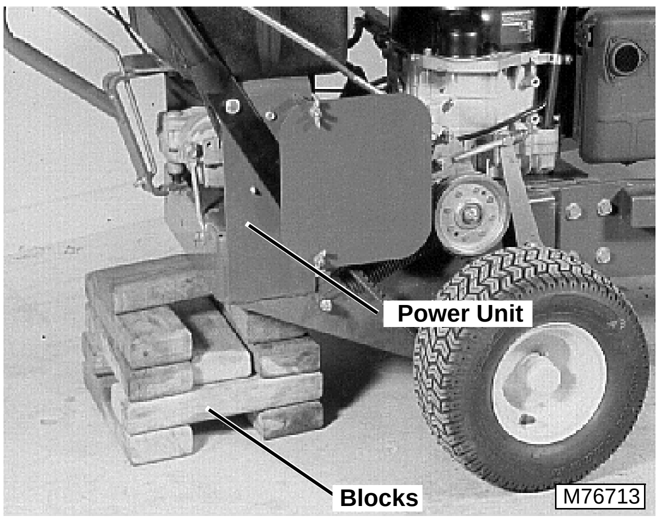


6. Install spring, washer and cotter key to each J-pin.
7. Install drive belt. See “DRIVE BELT REMOVAL / INSTALLATION-48/54 INCH” on page 24.

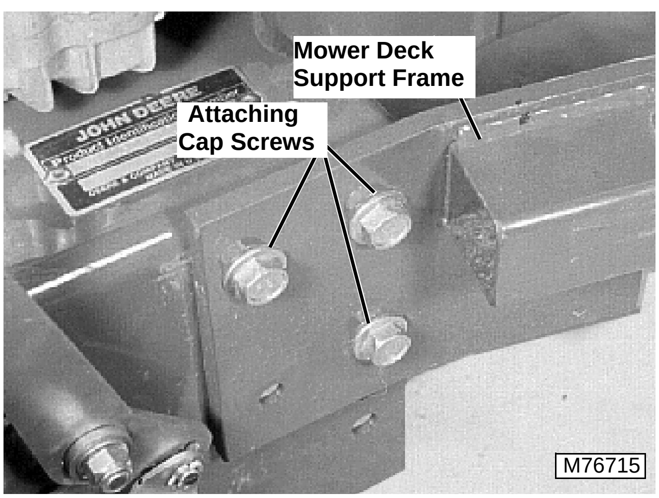
MOWER DECK SUPPORT FRAME REMOVAL/INSTALLATION-48/54 INCH

Removal:

1. Remove mower deck. See “DECK REMOVAL / INSTALLATION-48/54 INCH GEAR DRIVE MODELS” on page 30.



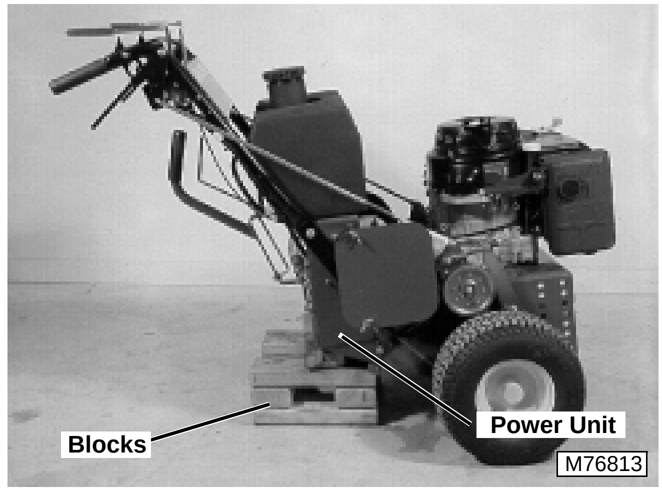
2. Support power unit with blocks or other safe suitable method.



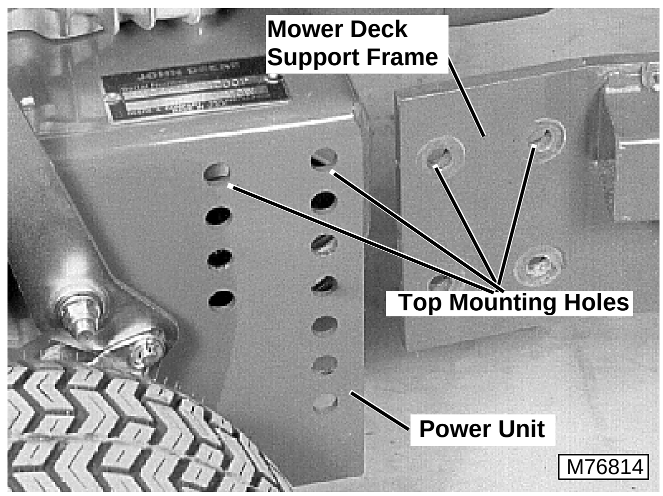
3. Loosen (do not remove) all of the mower deck support frame cap screws.
4. Remove attaching cap screws and separate the power unit from the mower deck support frame.

Installation:

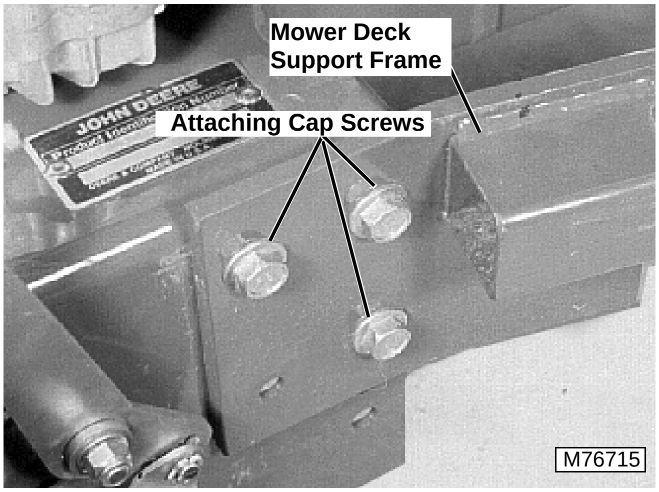
1. Position power unit on a level flat surface.



2. Support power unit with blocks or other suitable safe method.
3. Remove spark plug lead if not already done.



4. Align top holes of mower deck support frame with top holes of power unit. Install two cap screws in top holes on each side and loosely install nuts on cap screws.



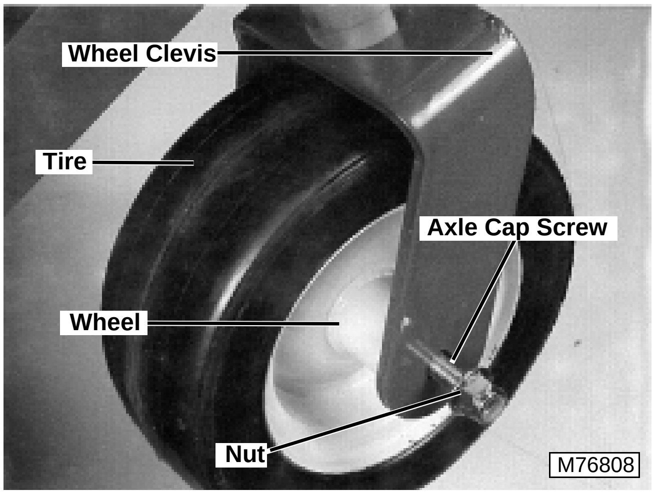
5. Install third cap screw on each side by tilting power unit or mower deck support frame slightly to align holes. Place nut on cap screw.
6. Tighten all mower deck support frame cap screws to **140 N•m (105 lb-ft)**.

WHEEL REMOVAL-ALL

Removal:

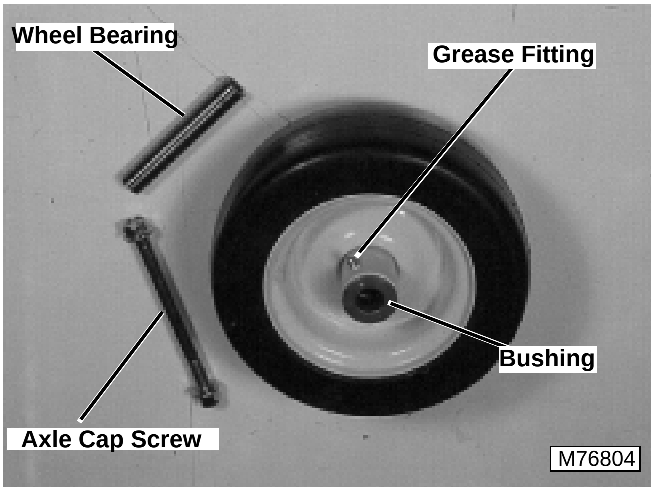
1. Position mower for blade maintenance. See “MOWER POSITIONING FOR MAINTENANCE-36 INCH” on page 11. or See “MOWER POSITIONING FOR MAINTENANCE-48/54 INCH” on page 23.

NOTE: Belt shields do not need to be removed.



2. While supporting wheel assembly, remove nut and slide axle cap screw out of clevis.
3. Remove wheel.
4. Clean wheel assembly.

NOTE: Some petro-based solvents will dissolve rubber. Use Approved Cleaners Only.



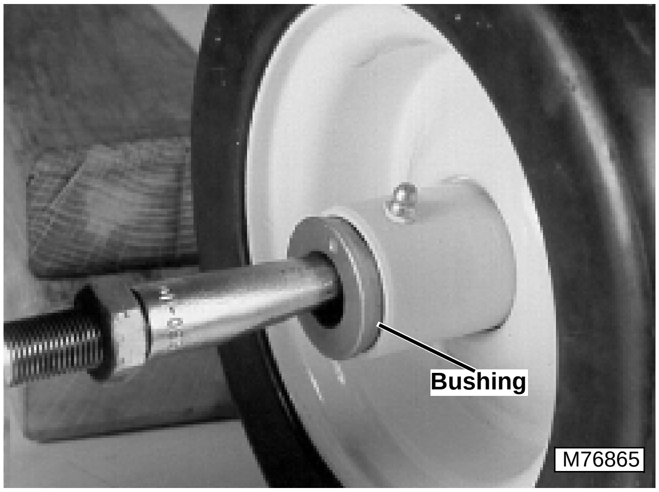
5. Slide wheel bearing from wheel.
6. Check wheel bearing for corrosion or damage to the running surface. Replace as required.
7. Inspect wheel bushings for any visual signs of hole elongation or fretting wear.
8. Look inside wheel hub to ensure all roller bearings are present, and that bearing cage is not damaged.
9. Insure that grease fitting is clear.
10. Be sure that hard rubber tire is free of large nicks or tears and is securely attached to metal wheel.

WHEEL DISASSEMBLY / ASSEMBLY-ALL

NOTE: Some petro-based solvents will dissolve rubber. Use Approved Cleaners Only.

Disassembly:

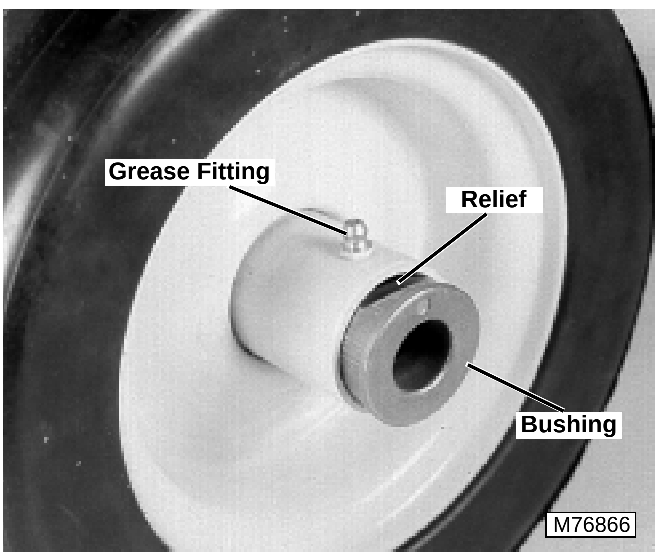
1. Clean wheel assembly of all grease.



2. Pull bushing from wheel using a blind hole puller and DO1210AA slide hammer or equivalent.
3. Remove roller bearings from wheel.
4. Turn wheel over and pull remaining bushing.
5. Replace worn or damaged parts, as required.

Assembly:

1. Place wheel on flat and solid surface.

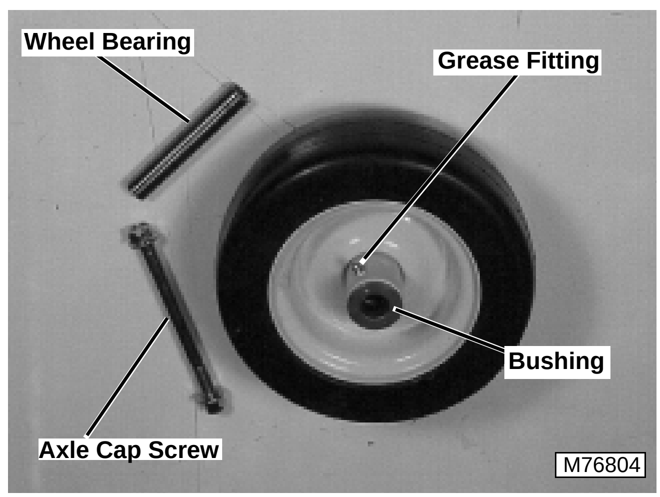


2. Align the relief on the outer bushing (indicated by a dot on the flange) with the grease fitting in the wheel.

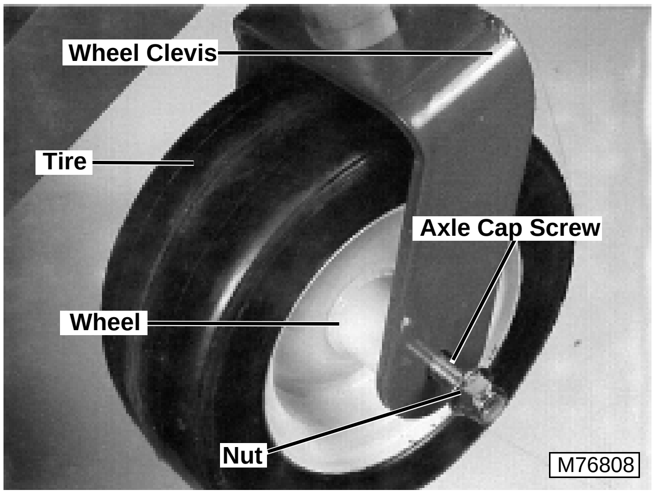
3. Drive bushing into wheel until it is seated.
4. Turn wheel over and install both roller bearings.
5. Drive remaining bushing into wheel until it is seated.

WHEEL INSTALLATION-ALL

1. Be sure that all dirt and traces of cleaning solvent have been removed.



2. Coat wheel bearing with a thin coat of grease.
3. Insert wheel bearing into wheel.



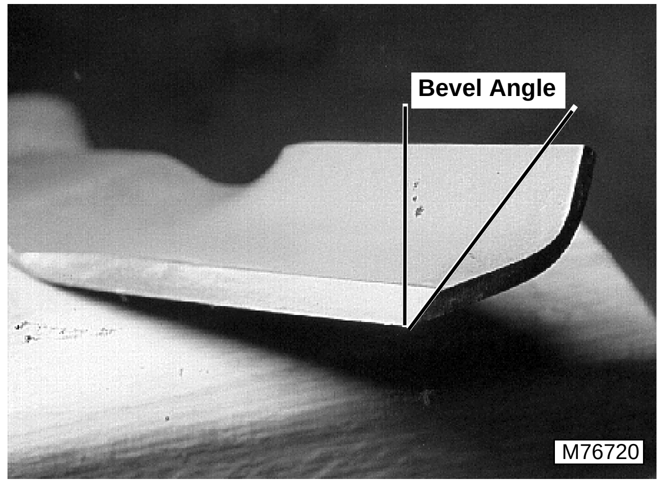
4. Position wheel assembly between clevis halves.
5. Install axle cap screw and thread nut finger tight.
6. Lubricate wheel assembly at grease fitting until a small amount of grease is visible at wheel clevis.
7. Tighten nut.
8. Check wheel assembly to make sure it turns freely.
9. Return mower to ground. Check to make sure both tires touch the ground evenly. If not adjust shims. See “CASTER REMOVAL / INSTALLATION-36 INCH” on page 19. See “CASTER REMOVAL / INSTALLATION-48/54 INCH” on page 29.

BLADES SHARPEN / BALANCE-ALL

⚠ CAUTION

Blades are sharp. wear gloves or wrap blades with rag to prevent personal injury.

1. Check cutting edge of blade and remove any large nicks or damaged areas.
2. Blades can be sharpened using a hand file, grinding wheel, or power sharpener



3. Do not alter blade bevel angle.

NOTE: A balanced blade will greatly improve the life of the deck spindles and ease operator strain.

4. Remove any accumulated grass / dirt with scraper or wire brush and wipe blade clean.

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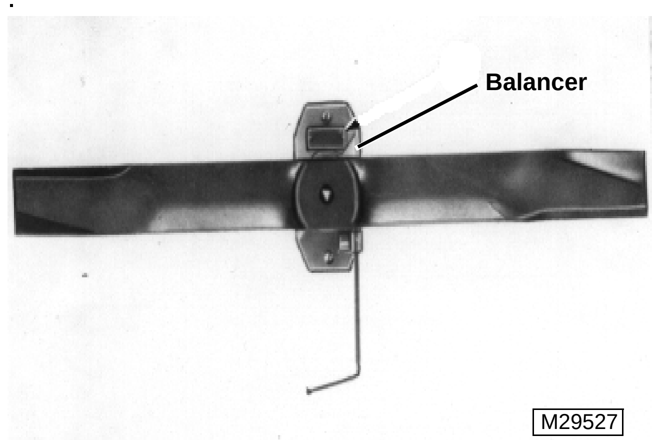
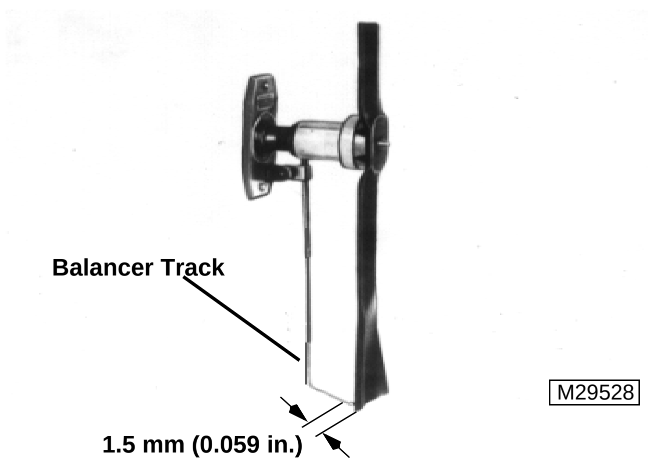


5. Set blade on JT07076 Rotary Blade Balancer and turn blade to the horizontal position.



6. If blade is not balanced, heavy end will drop.
7. Lightly grind bevel of the heavy end, WITHOUT changing the original angle of blade.
8. Recheck balance.
9. Adjust balancer track to just touch blade tip.
10. Turn blade to opposite tip.
11. Blade should also touch in same way.

IMPORTANT: If difference between blade tips and balancer track measures over 1.5 mm (0.059-in.), install new blade.

CONTENTS

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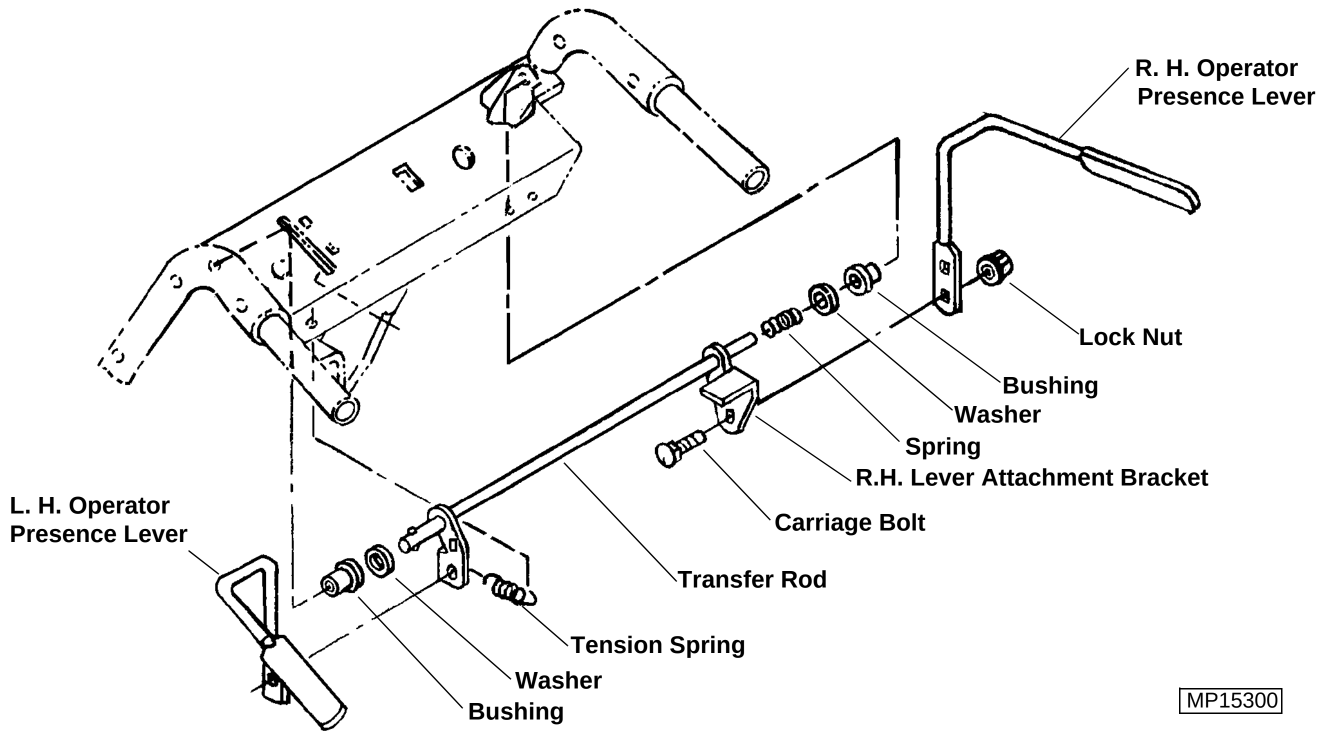
MISCELLANEOUS

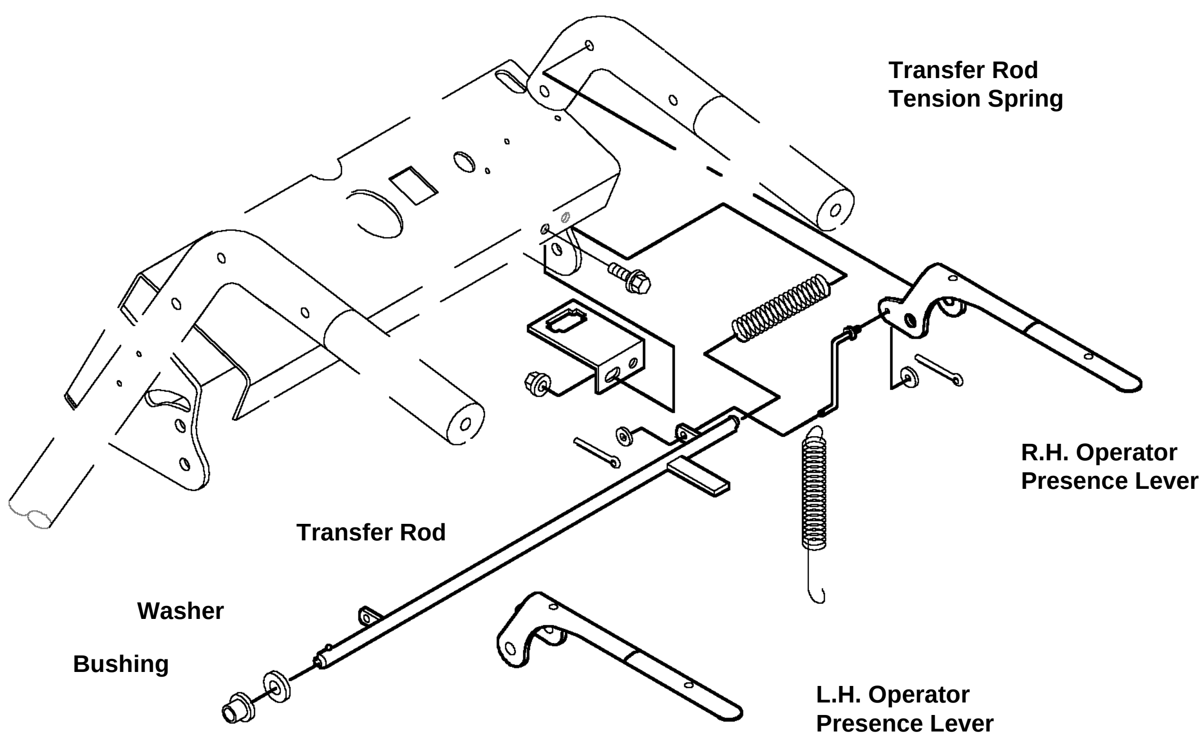
M

OPERATOR PRESENCE SYSTEM

COMPONENT LOCATION—GEAR DRIVE MODELS



COMPONENT LOCATION—HYDROSTATIC MODELS



M

THEORY OF OPERATION:

The operator presence levers engage the operator presence switch when the levers are depressed. Both L.H. and R.H. operator presence levers are attached to the transfer rod. The operator presence switch is normally open and the operator presence levers are normally held in an upright position by a tension spring that acts on the transfer rod. When either or both levers are depressed, the transfer rod pivots and the R.H. lever attachment bracket portion of the transfer rod closes the operator presence switch. Should the levers be released the spring tension pulls on the transfer rod, raising the levers and opening the operator presence switch.

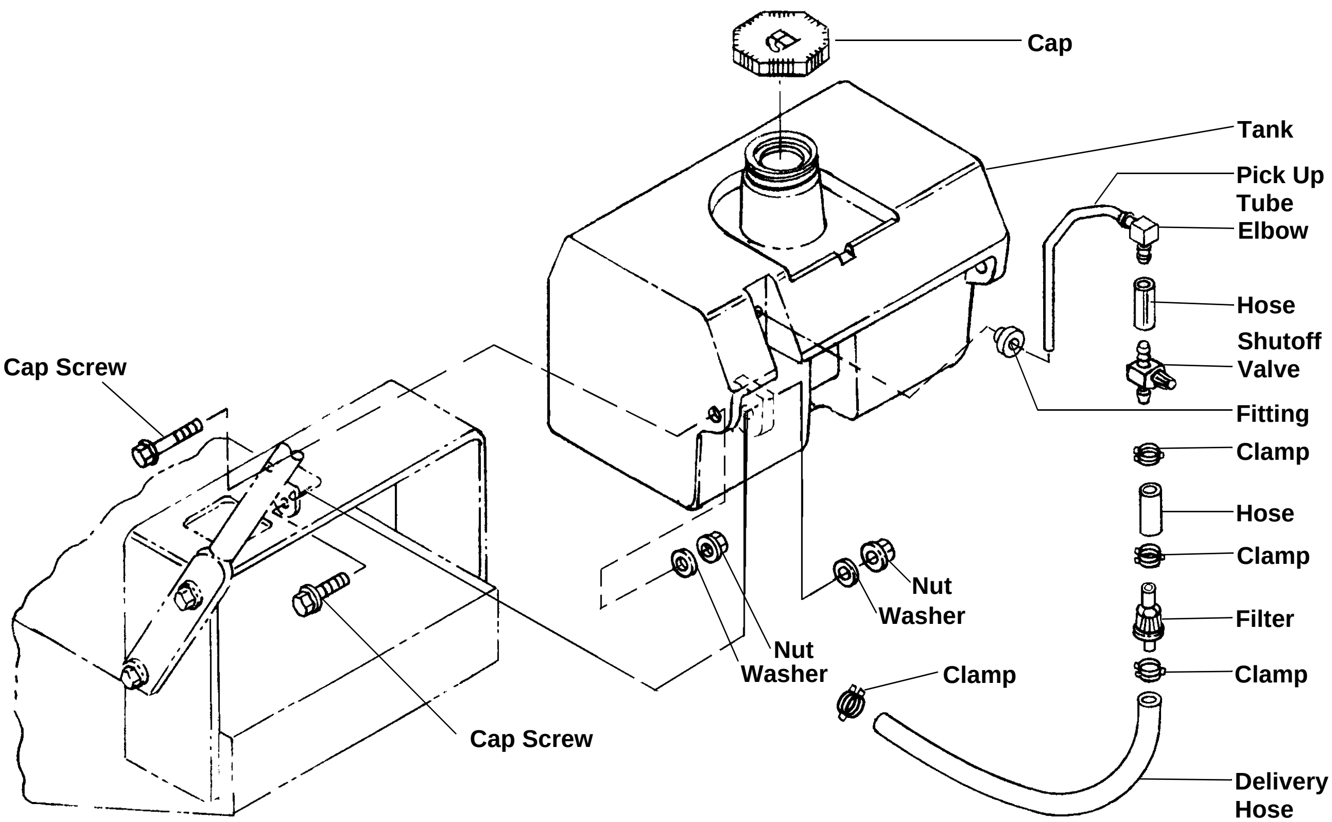
TESTS & ADUSTMENTS:

Check the operation of the levers for smooth operation. The operator presence switch engagement can be verified by listening for an audible “click”, or testing for continuity as described in the Electrical Section of this manual. See “OPERATOR PRESENCE SWITCH TEST” on page 58 of ELECTRICAL SECTION.

M

FUEL TANK

COMPONENT LOCATION



THEORY OF OPERATION:

The fuel tank is a plastic, one piece molded design which is bolted to the frame in three places. The cap is vented to the atmosphere. Fuel is delivered to the engine fuel pump via the pick up tube and delivery hose. A fuel shutoff valve is provided in the delivery line as well as a disposable paper element filter.

TESTS & ADJUSTENTS:

Visually inspect fuel filter for debris. Check for flow. If filter is plugged, replace. Check for collapsed lines. Check shut off valve to insure that it is operating correctly. If mower has been drained of all fuel, system may be completely dry and have to be primed. Fill fuel tank, replace cap, open fuel valve, and hold an air hose over the small vent hole in the cap while watching fuel level in fuel filter. Charge system with air until fuel begins to flow. It is not necessary to completly fill fuel filter with fuel.

M

A

B

C

D

M

N

O

P

R

U

V

W