SINGLE CYLINDER OHV Air Cooled Engines

Repair Manual

103M00, 104M00

YOU.POWERED.

Foreword

This manual was written to assist engine technicians and service personnel with the maintenance and repair procedures for Briggs & Stratton® engines. It assumes that persons using this manual have been properly trained and are familiar with the service procedures for these products, including the proper use of required tools and the application of appropriate safety practices. Persons untrained or unfamiliar with these procedures or products should not attempt to perform such work.

Proper maintenance and repair is important to safe, reliable operation of all engines and engine-driven systems. The maintenance, troubleshooting, and repair procedures described in this manual are appropriate for the Briggs & Stratton engines described herein. Alternative methods or procedures may pose risks to both personal safety and engine reliability and are not endorsed or recommended by Briggs & Stratton.

All information, illustrations, and specifications contained in this manual were based on the data available at the time of publication. Briggs & Stratton Corporation reserves the right to change, alter, or otherwise improve the product or the product manuals at any time without prior notice.

Briggs & Stratton offers two complementary publications to enhance understanding of engine technology, maintenance, and repair. However, neither publication is a substitute for a recognized training program for engine technicians.

- For consumers, *Small Engine and Equipment Maintenance Guide* (Part No. CE8155) provides a comprehensive overview of how small air-cooled engines work, basic troubleshooting, and step-by-step maintenance procedures.
- For engine technicians and consumers alike, an in-depth study of engine theory and operation can be found in the textbook *Small Engines* (Part No. CE8020).

Both publications can be purchased at BRIGGSandSTRATTON.COM or through a local Briggs & Stratton Authorized Service Dealer.

This engine repair manual includes the following engine models:

- MODEL 103M00
- MODEL 104M00

NOTE: Some models have limited service parts. Review the *Illustrated Parts List* for part availability before conducting any service work.

NOTE: The images in this document are representative and may differ according to model.

HOW TO USE THIS MANUAL

Besides describing the service maintenance tasks and the intervals at which they are to be performed, two basic levels of service are presented in this manual: engine top end service and engine bottom end service. The manner in which these instructions are used depends upon the tasks to be performed and the level of disassembly required.

Remove External Assemblies

To prepare the engine for service, whether top or bottom end, first see *SECTION 4 - REMOVE EXTERNAL ASSEMBLIES* to remove the air cleaner, fuel tank, carburetor, etc. The order in which the topics are presented is the order in which the assemblies are most easily removed from the engine.

Top End Service

If servicing only cylinder head components, see *SECTION 5 - DISASSEMBLE ENGINE, TOP END DISASSEMBLY,* and then proceed to *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, CYLINDER HEAD.* When cylinder head service is complete, see *SECTION 7 - ASSEMBLE ENGINE, TOP END ASSEMBLY.*

Bottom End Service

If servicing bottom end components, such as the piston, connecting rod, crankshaft, etc., first see *SECTION 5 - DISASSEMBLE ENGINE, TOP END DISASSEMBLY,* and then proceed to *BOTTOM END DISASSEMBLY* in the same section. When finished, move to *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES,* and see *PISTON AND CONNECTING ROD; FLYWHEEL, CRANKSHAFT AND CAMSHAFT;* and *CRANKCASE AND CRANKCASE COVER,* for all service instructions. When bottom end service is complete, see *SECTION 7 - ASSEMBLE ENGINE, BOTTOM END ASSEMBLY,* and then proceed to *TOP END ASSEMBLY* in the same section.

Install External Assemblies

When the top and bottom ends of the engine are assembled, see *SECTION 8 - INSTALL EXTERNAL ASSEMBLIES* to complete the project. The order in which the topics are presented is the order in which the assemblies are most easily installed on the engine. These instructions also include any cleaning, inspection, or adjustments that may be recommended.

SECTION1 - SAFETY AND GENERAL INFORMATION

1

This manual contains safety information that will:

- Make you aware of hazards associated with engines.
- Inform you of the risk of injury associated with those hazards.
- Instruct you how to avoid or reduce the risk of injury.

Safety Alert Symbol and Signal Words

The safety alert symbol (⚠) is used to identify safety information about hazards that can result in personal injury. A signal word (DANGER, WARNING, or CAUTION) is used with the alert symbol to indicate the likelihood and the potential severity of injury. In addition, a hazard symbol may be used to represent the type of hazard.

⚠ **DANGER** indicates a hazard which, if not avoided, **will result in death or serious injury**.

⚠ **WARNING** indicates a hazard which, if not avoided, **could result in death or serious injury**.

⚠ **CAUTION** indicates a hazard which, if not avoided, **could result in minor or moderate injury**.

NOTICE indicates a situation that **could result in damage to the product**.

Hazard Symbols and Meanings

Symbol	Meaning	Symbol	Meaning
	Safety information about hazards that can result in personal injury.		Read and understand the Operator's Manual before operating or servicing the unit.
	Fire hazard		Explosion hazard
	Shock hazard		Explosion hazard
	Hot surface hazard		Toxic fume hazard
	Amputation hazard - moving parts		Chemical hazard
	Kickback hazard		Thrown object hazard - wear eye protection
	Amputation hazard - entanglement		

General Safety Messages

Prior to work, read and understand the section(s) of this manual that pertain to the job. Follow all safety warnings.

- Always use fresh gasoline. Stale fuel can cause gum deposits in the carburetor and cause leakage, flow restrictions, or other problems.
- Check fuel lines and fittings frequently for cracks or leaks and replace if necessary.

⚠ **WARNING**

Before attempting to service this equipment, read and understand this manual and the operating instructions of the engine and the equipment.

⚠ **WARNING**

Failure to follow instructions could result in serious injury (including paralysis) and even death.

⚠ **WARNING**

Battery post, terminals, and related accessories contain lead and lead compounds - chemicals known to the State of California to cause cancer and reproductive harm. Wash hands after handling.

⚠ **WARNING**

Certain components in this product and its related accessories contain chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm. Wash hands after handling.

⚠ **WARNING**

Briggs & Stratton Engines are not designed for and are not to be used to power: fun-karts; go-karts; children's, recreational, or sport all-terrain vehicles (ATVs); motorbikes; hovercraft; aircraft products; or vehicles used in competitive events not sanctioned by Briggs & Stratton. For information about competitive racing products, see www.briggsracing.com. For use with utility and side-by-side ATVs, please contact Briggs & Stratton Power Application Center, 1-866-927-3349. Improper engine application may result in serious injury or death.

⚠ **WARNING**

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

WARNING

Fuel and its vapors are extremely flammable and explosive which could cause burns, fire or explosion resulting in death or serious injury.

When Adding Fuel

- Turn engine OFF and let engine cool at least 2 minutes before removing the fuel cap. Loosen cap slowly to relieve pressure in tank.
- Fill fuel tank outdoors or in well-ventilated area.
- Do not overfill fuel tank. To allow for expansion of the fuel, do not fill above the bottom of the fuel tank neck.
- Keep fuel away from sparks, open flames, pilot lights, heat, and other ignition sources.
- Check fuel lines, tank, cap, and fittings frequently for cracks or leaks. Replace if necessary.
- If fuel spills, wait until it evaporates before starting engine.
- Do not light a cigarette or smoke.

When Starting Engine

- Ensure that spark plug, muffler, fuel cap and air cleaner (if equipped) are in place and secured.
- Do not crank engine with spark plug removed.
- If engine floods, set choke (if equipped) to OPEN / RUN position, move throttle (if equipped) to FAST position and crank until engine starts.

When Operating Equipment

- Do not operate this product inside any building, carport, porch, mobile equipment, marine applications, or enclosure.
- Do not tip engine or equipment at angle which causes fuel to spill.
- Do not choke the carburetor to stop engine.
- Never start or run the engine with the air cleaner assembly (if equipped) or the air filter (if equipped) removed.

When Changing Oil

- If you drain the oil from the oil fill hole (not recommended), the fuel tank must be empty or fuel can leak out and result in a fire or explosion.

When Tipping Unit for Maintenance

- When performing maintenance that requires the unit to be tipped, the fuel tank, if mounted on the engine, must be empty or fuel can leak out and result in a fire or explosion.

When Transporting Equipment

- Transport/move/repair with fuel tank EMPTY or with fuel shutoff valve OFF.
- Do not tip engine or equipment at angle which causes fuel to spill.
- Disconnect spark plug wire.

When Storing Fuel or Equipment with Fuel In Tank

- Store away from furnaces, stoves, water heaters, clothes dryers, or other appliances that have pilot lights or other ignition source because they could ignite fuel vapors.

WARNING

Starting engine creates sparking which could ignite nearby flammable gases causing explosion or fire resulting in death or serious injury.

- If there is natural or LP gas leakage in the area, do not start engine.
- Do not use pressurized starting fluids because vapors are flammable.

WARNING

POISONOUS GAS HAZARD. Engine exhaust contains carbon monoxide, a poisonous gas that could kill you in minutes. You CANNOT see it, smell it, or taste it. Even if you do not smell exhaust fumes, you could still be exposed to carbon monoxide gas. If you start to feel sick, dizzy, or weak while using this product, get to fresh air RIGHT AWAY. See a doctor. You may have carbon monoxide poisoning.

- Operate this product ONLY outside far away from windows, doors and vents to reduce the risk of carbon monoxide gas from accumulating and potentially being drawn towards occupied spaces.
- Install battery-operated carbon monoxide alarms or plug-in carbon monoxide alarms with battery back-up according to the manufacturer's instructions. Smoke alarms cannot detect carbon monoxide gas.
- DO NOT run this product inside homes, garages, basements, crawlspaces, sheds, or other partially-enclosed spaces even if using fans or opening doors and windows for ventilation. Carbon monoxide can quickly build up in these spaces and can linger for hours, even after this product has shut off.
- ALWAYS place this product downwind and point the engine exhaust away from occupied spaces.

WARNING 

Starter cord kickback (rapid retraction) will pull hand and arm toward engine faster than you can let go which could cause broken bones, fractures, bruises, or sprains resulting in serious injury.

- When starting engine, pull the starter cord slowly until resistance is felt and then pull rapidly to avoid kickback.
- Remove all external equipment / engine loads before starting engine.
- Direct-coupled equipment components such as, but not limited to, blades, impellers, pulleys, sprockets, etc., must be securely attached.

WARNING 

Rotating parts could entangle hands, feet, hair, clothing, or accessories resulting in serious injury.

- NEVER operate equipment without protective housing or covers in place.
- DO NOT wear loose clothing, jewelry or anything that could become entangled in the equipment.
- Tie up long hair and remove jewelry.
- Keep hands and feet away from rotating parts.

WARNING 

Running engines produce heat. Engine parts, especially mufflers, become extremely hot which could cause severe thermal burns or catching fire to combustible debris, such as leaves, grass, brush, etc., resulting in serious injury.

- Allow muffler, engine cylinder and fins to cool before touching.
- Remove accumulated debris from muffler area and cylinder area.
- It is a violation of California Public Resource Code, Section 4442, to use or operate the engine on any forest-covered, brush-covered, or grass-covered land unless the exhaust system is equipped with a spark arrester, as defined in Section 4442, maintained in effective working order. Other states or federal jurisdictions may have similar laws. Contact the original equipment manufacturer, retailer, or dealer to obtain a spark arrester designed for the exhaust system installed on this engine.

WARNING 

Unintentional sparking could cause fire or electric shock resulting in death or serious injury.

Unintentional start-up could result in entanglement, traumatic amputation, or laceration.

Before performing adjustments or repairs:

- Disconnect the spark plug wire and keep it away from the spark plug.
- Disconnect battery at negative terminal (only engines with electric start.)
- Use only correct tools.
- Do not tamper with governor spring, links or other parts to increase engine speed.
- Replacement parts must be of the same design and installed in the same position as the original parts. Other parts may not perform as well, may damage the unit, and may result in injury.
- Do not strike the flywheel with a hammer or hard object because the flywheel may later shatter during operation.

When testing for spark:

- Use approved spark plug tester.
- Do not check for spark with spark plug removed.

WARNING 

Charging batteries produce hydrogen gas which could cause explosion resulting in death or serious injury.

- Do not store or charge a battery near an open flame or device that utilizes a pilot light or can create a spark.

WARNING 

Damaged, worn, or loose fuel components can leak fuel which could cause explosion or fire resulting in death or serious injury.

- All fuel components should be in good condition and properly maintained.
- Repairs should only be made with factory approved parts.
- Repair work should be done by a qualified technician.
- Flexible supply lines should be checked regularly to make sure they are in good condition.

WARNING

Prolonged or repeated contact with used motor oil could cause injury.

- Used motor oil has been shown to cause skin cancer in certain laboratory animals.
- Thoroughly wash exposed areas with soap and water.

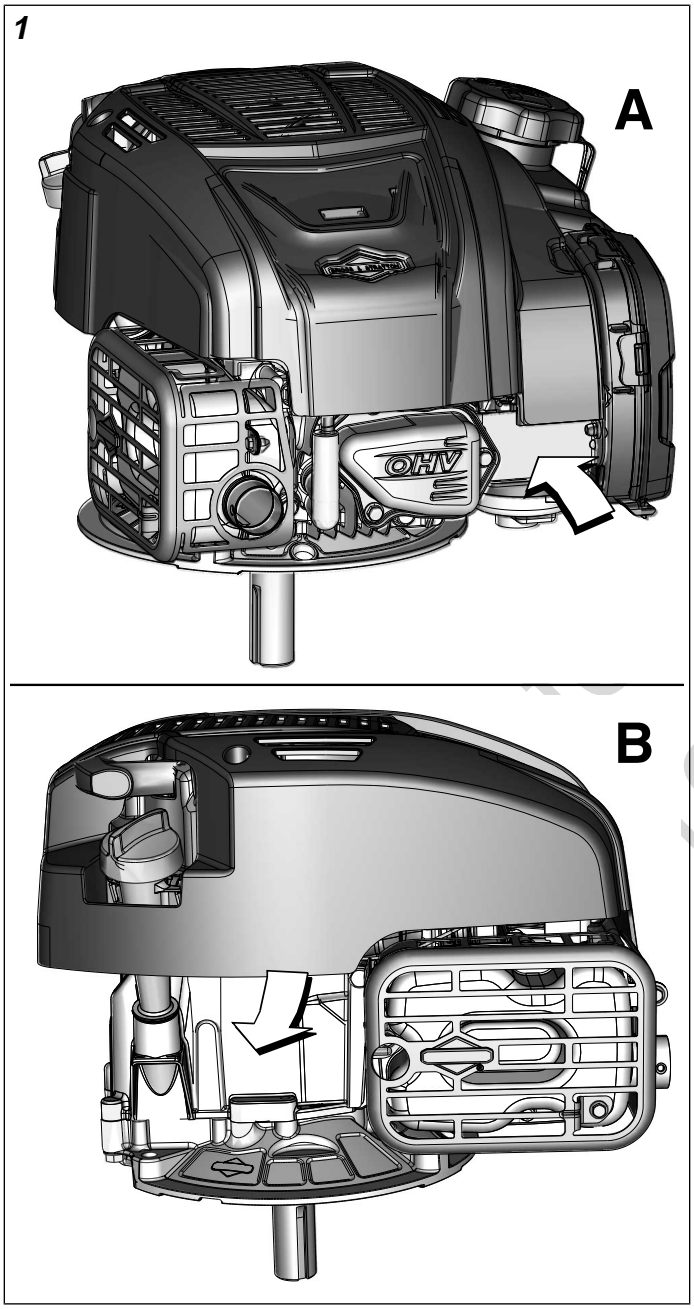
NOTICE

Failure to follow instructions could result in property damage.

Engine Identification

See Figure 1. The engine identification is either stamped on the carburetor mounting bracket (**A**) or laser etched on the crankcase (**B**).

1



Fuel Recommendations

Fuel must meet these requirements:

- Clean, fresh, unleaded gasoline.
- A minimum of 87 octane / 87 AKI (91 RON). For high altitude use, see below.
- Gasoline with up to 10% ethanol (gasohol) is acceptable.

NOTICE Do not use unapproved gasolines, such as E15 and E85. Do not mix oil in gasoline or modify the engine to run on alternate fuels. Use of unapproved fuels will cause damage to engine components, **which will not be covered under warranty**.

To protect the fuel system from gum formation, mix a fuel stabilizer into the fuel. See **Storage**. All fuel is not the same. If starting or performance problems occur, change fuel providers or change brands. This engine is certified to operate on gasoline. The emissions control system for this engine is EM (Engine Modifications).

High Altitude

At altitudes over 5,000 feet (1524 meters), a minimum 85 octane / 85 AKI (89 RON) gasoline is acceptable.

For carbureted engines, high altitude adjustment is required to remain emissions compliant. Operation without this adjustment will cause decreased performance, increased fuel consumption, and increased emissions. Contact a Briggs & Stratton Authorized Service Dealer for high altitude adjustment information. Operation of the engine at altitudes below 2,500 feet (762 meters) with the high altitude adjustment is not recommended.

For Electronic Fuel Injection (EFI) engines, no high altitude adjustment is necessary.

Oil Recommendations

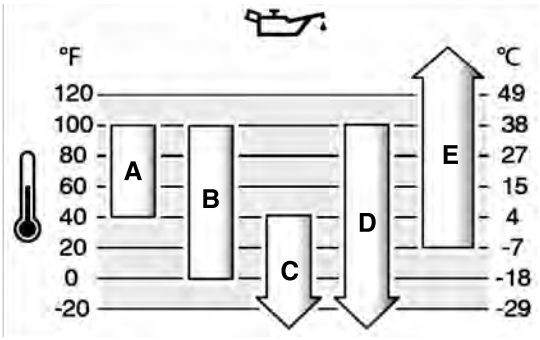
Oil Capacity: See the ***Specifications*** section.

NOTICE
This engine was shipped from Briggs & Stratton without oil. Equipment manufacturers or dealers may have added oil to the engine. Before you start the engine for the first time, make sure to check the oil level and add oil according to the instructions in this manual. If you start the engine without oil, it will be damaged beyond repair and will not be covered under warranty.

We recommend the use of Briggs & Stratton® Warranty Certified oils for best performance. Other high-quality detergent oils are acceptable if classified for service SF, SG, SH, SJ or higher. Do not use special additives.

Outdoor temperatures determine the proper oil viscosity for the engine. Use the chart to select the best viscosity for the

outdoor temperature range expected. Engines on most outdoor power equipment operate well with 5W-30 Synthetic oil. For equipment operated in hot temperatures, Vanguard™ 15W-50 Synthetic oil provides the best protection.



A	**SAE 30 -** Below 40 °F (4 °C) the use of SAE 30 will result in hard starting.
B	**10W-30 -** Above 80 °F (27 °C) the use of 10W-30 may cause increased oil consumption. Check oil level more frequently.
C	**5W-30**
D	**Synthetic 5W-30**
E	**Vanguard™ Synthetic 15W-50**

Storage

Fuel can become stale when stored over 30 days. Stale fuel causes acid and gum deposits to form in the fuel system or on essential carburetor parts. To keep fuel fresh, use **Briggs & Stratton® Advanced Formula Fuel Treatment & Stabilizer**, available wherever Briggs & Stratton genuine service parts are sold.

There is no need to drain gasoline from the engine if a fuel stabilizer is added according to instructions. Run the engine for 2 minutes to circulate the stabilizer throughout the fuel system before storage. If gasoline in the engine has not been treated with a fuel stabilizer, it must be drained into an approved container. Run the engine until it stops from lack of fuel. The use of a fuel stabilizer in the storage container is recommended to maintain freshness.

SECTION 2 – MAINTENANCE

2

Maintenance Schedule

First 5 Hours
• Change Engine Oil (Not required on **Just Check & Add™** models)
Every 8 Hours or Daily
• Check Engine Oil Level • Clean Muffler, Rewind Starter Finger Guard, and Controls
Every 25 Hours or Annually
• Clean Air Filter and Pre-Cleaner †
Every 50 Hours or Annually
• Clean/Inspect Muffler and Spark Arrester • Change Engine Oil (Not required on **Just Check & Add™** models)
Annually
• Replace Air Filter and Pre-Cleaner † • Clean/Gap/Replace Spark Plug • Clean Air Cooling System † • Check/Adjust Valve Clearance ‡

† Clean more often in dusty conditions or when airborne debris is present.
‡ Not required unless engine performance problems are noted.

Change Engine Oil

1. Start and run engine until fuel tank is empty.

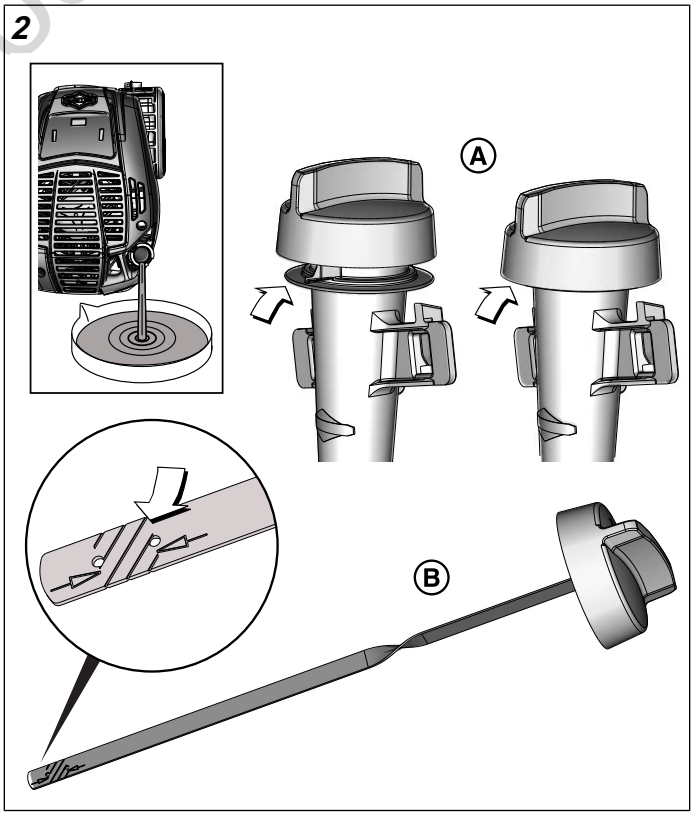
WARNING

Failure to completely empty fuel tank will result in fuel leakage when engine is tilted to drain oil. Gasoline and its vapors are extremely flammable and highly explosive. Inadequate safety precautions can cause fire or explosion resulting in death or serious injury.

2. Allow engine to cool before handling.
3. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.
4. Place engine on a flat, level surface.
5. Remove all dirt and debris from around the oil fill cap and dipstick tube.
6. Remove dipstick from the dipstick tube.
7. With the spark plug side of the engine up, carefully pour oil out the dipstick tube and into an approved container. See inset of Figure 2.
8. Slowly pour **15 ounces** (444 ml) of the recommended type of oil into the dipstick tube. Do NOT OVERFILL.

   NOTE: See *Section 1 - Safety and General Information, General Information, Oil Recommendations.*
9. Wipe dipstick with a clean, lint free cloth.
10. See A of Figure 2. Slowly insert dipstick until oil fill cap contacts collar on dipstick tube.
11. Slowly remove dipstick.
12. See B of Figure 2. Verify that oil level is on the cross hatch pattern at or near the high mark.

    NOTE: Observe oil level on both sides of the dipstick. The lower level of the two readings is the correct oil level measurement.
13. Add oil as necessary until oil level is at or near the high mark. Do NOT OVERFILL.
14. Install dipstick into dipstick tube. Tighten oil fill cap.
15. Install spark plug wire onto spark plug terminal.
16. Start and run engine. Check for oil leaks while engine is running.
17. Dispose of used oil at a proper waste disposal or recycling center.



Check Engine Oil Level

1. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.
2. Place engine on a flat, level surface.
3. Remove all dirt and debris from around the oil fill cap and dipstick tube.
4. Remove dipstick from the dipstick tube.
5. Wipe dipstick with a clean, lint free cloth.
6. See A of Figure 2. Slowly insert dipstick until oil fill cap contacts collar on dipstick tube.

   NOTE: The most accurate oil level readings are obtained when the engine is cold.
7. Slowly remove dipstick.
8. See B of Figure 2. Verify that oil level is on the cross hatch pattern at or near the high mark.

   NOTE: Observe oil level on both sides of the dipstick. The lower level of the two readings is the correct oil level measurement.
9. Add oil as necessary until oil level is at or near the high mark. Do NOT OVERFILL.

   NOTE: See *Section 1 - Safety and General Information, General Information, Oil Recommendations.*
10. Install dipstick into dipstick tube. Tighten oil fill cap.
11. Install spark plug wire onto spark plug terminal.

Clean Muffler, Rewind Starter Finger Guard, and Controls

NOTE: Proper cleaning reduces the risk of engine damage due to overheating and ignition of accumulated debris.

NOTE: Avoid using high pressure compressed air, which can force dirt and debris deeper into engine cavities and crevices. Do not use a pressurized water spray as water intrusion can contaminate both oil and fuel systems and lead to corrosion.

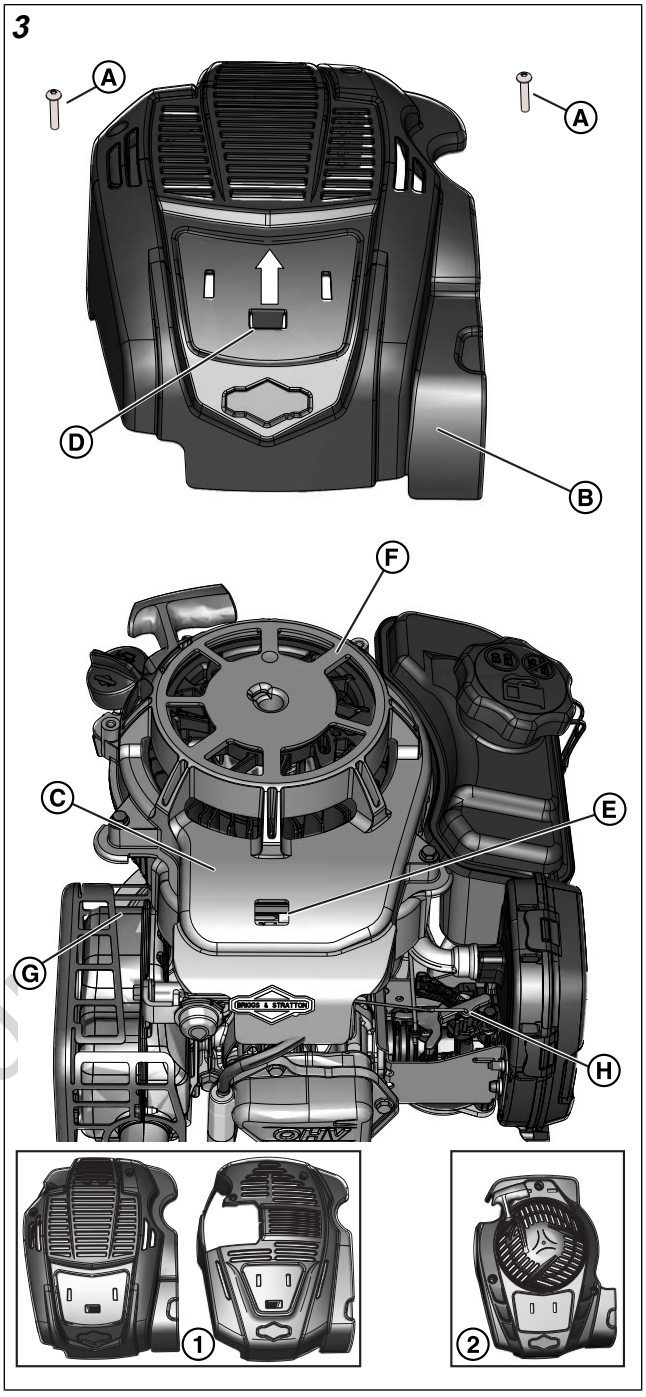
1. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.

   NOTE: See insets of Figure 3. If equipped with static cover (**1**), move to step 2. If equipped with rewind starter housing (**2**), proceed to step 3.
2. Remove static cover as follows:

   A. If equipped, pull tabs on cover insert (decorative trim) from slots in static cover.

   B. Remove knob on choke shaft, if equipped.

3



   C. Remove two TORX screws (**A**) to release static cover (**B**) from blower housing (**C**).

   D. Push static cover forward (up) to disengage latch (**D**) from catch (**E**) on blower housing.
3. Remove rewind starter housing as follows:

   A. Remove three hex flange shoulder screws to release rewind starter housing from blower scroll.

   B. If equipped, disconnect two socket spade terminals from rocker stop switch.

CAUTION

The edges of the blower scroll may be sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

4. Thoroughly clean rewind starter finger guard (**F**), if equipped, and muffler (**G**). Carefully clean governor links, springs, and controls (**H**). Proceed as follows:
   A. Remove all loose debris by hand.
   B. Remove dust and dirt with a soft bristle brush and a portable hand held vacuum.
   C. Gently scrape away stubborn accumulations of dirt and other deposits using a plastic putty knife or stiff bristle brush.
   D. Apply a light solvent to bristle brush to loosen and remove grit and oily residue, if necessary.
5. Verify that all combustible debris is removed from area around and behind muffler.
6. Verify that governor links, springs, and controls move freely without sticking, binding, or contacting blower scroll, fuel tank, or other engine parts.

   NOTE: If equipped with static guard, move to step 7. If equipped with rewind starter housing, proceed to step 8.
7. Install static cover as follows:
   A. Position static cover on blower housing.
   B. Push static cover rearward (down) to engage latch with catch on blower housing.
   C. Install two TORX screws to fasten static cover to blower housing. Alternately tighten screws to **12-18 lb-in** (1.4-2.0 N-m).
   D. Install knob on choke shaft, if equipped.
   E. If equipped, push tabs on cover insert (decorative trim) into slots in static cover.
8. Install rewind starter housing as follows:
   A. If equipped, connect two socket spade terminals to rocker stop switch.
   B. Loosely install three hex flange shoulder screws to fasten blower housing to blower scroll.

      NOTE: To ensure that pawls evenly engage flywheel starter cup, pull starter rope, tighten hex flange screws until snug, and then release starter rope.
   C. Alternately tighten hex flange screws to **30-40 lb-in** (3.4-4.5 N-m).
9. Install spark plug wire onto spark plug terminal.

Clean/Replace Air Filter and Pre-Cleaner

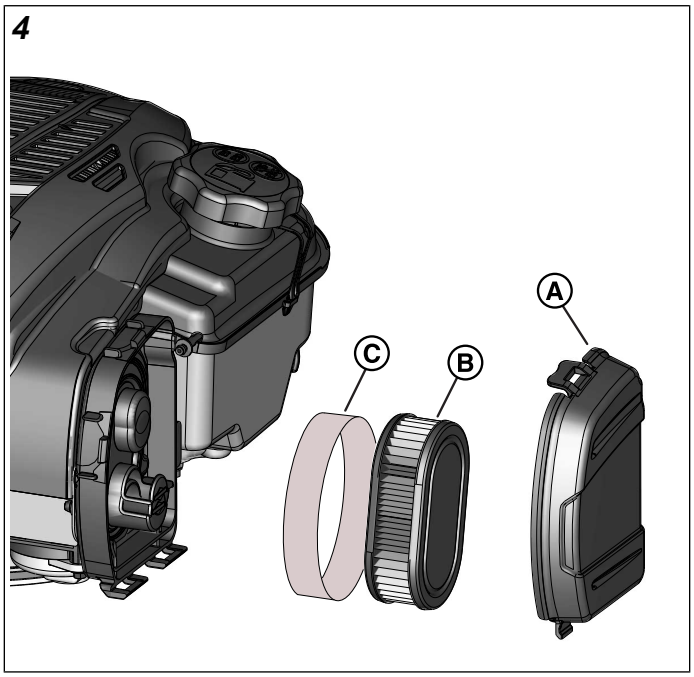
1. See Figure 4. Pull latch to disengage air cleaner cover (**A**), and then rotate cover to release tabs from slots in air cleaner base.

   NOTE: Exercise care to keep dust and dirt out of carburetor. Inadequate precautions can result in engine damage.
2. Remove air filter cartridge (**B**) from air cleaner base.
3. Remove foam pre-cleaner (**C**) from air filter cartridge.
4. Gently tap air filter cartridge on a hard surface to loosen dirt and debris. Carefully brush and/or vacuum air filter cartridge as necessary.

   NOTE: Use of pressurized air or solvents will damage foam pre-cleaner and air filter cartridge.
5. Gently wash foam pre-cleaner in warm, soapy water. Thoroughly rinse with clean water and allow to air dry completely. Do not oil pre-cleaner.
6. Carefully inspect foam pre-cleaner and air filter cartridge. Replace parts if they cannot be adequately cleaned or if any damage is observed.
7. Install foam pre-cleaner onto air filter cartridge.
8. Place air filter cartridge with foam pre-cleaner onto air cleaner base.
9. Insert tabs on air cleaner cover into slots in air cleaner base, and then rotate cover until latch fully engages.

   NOTE: Slot in air cleaner cover captures EVAP tube from fuel tank on some models.

4

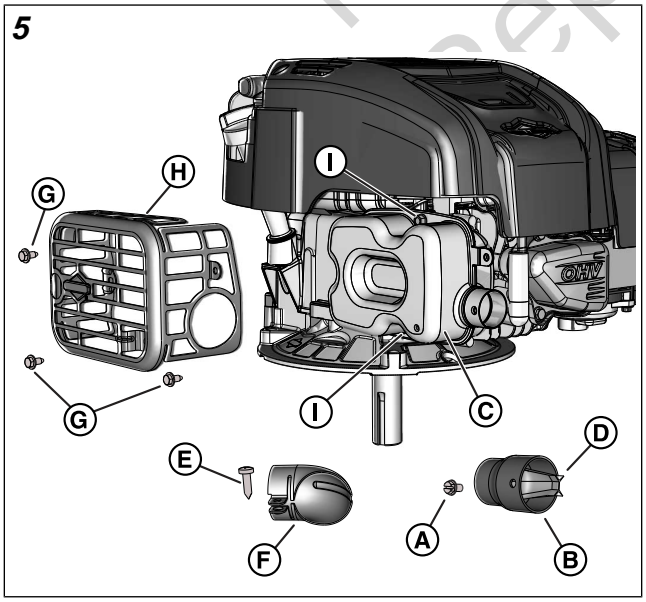


Clean/Inspect Muffler and Spark Arrester

NOTE: Avoid using high pressure compressed air, which can force dirt and debris deeper into engine cavities and crevices. Do not use a pressurized water spray as water intrusion can contaminate both oil and fuel systems and lead to corrosion.

1. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent contact with spark plug terminal.
2. If equipped, inspect spark arrester for dirt, debris, and carbon buildup. Proceed as follows:
   A. See Figure 5. Remove screw (**A**) to release spark arrester (**B**) from muffler (**C**).
   B. Remove screening element (**D**) from spark arrester.
   C. Gently clean screening element with a stiff bristle brush. If carbon buildup is present, soak or spray with Carburetor Cleaner (Part No. 100042). Blow dry from the inside-out with low pressure compressed air. Exercise caution to avoid bending or puncturing screening element. Replace screening element if it cannot be adequately cleaned or if any damage is observed.
3. If equipped, remove screw (**E**) to release muffler deflector (**F**) from muffler.
4. Remove three hex flange screws (**G**) to release guard (**H**) from muffler.
5. Clean area around and behind muffler. Proceed as follows:
   A. Remove all loose debris by hand.
   B. Remove dust and dirt with a soft bristle brush and a portable hand held vacuum.

5



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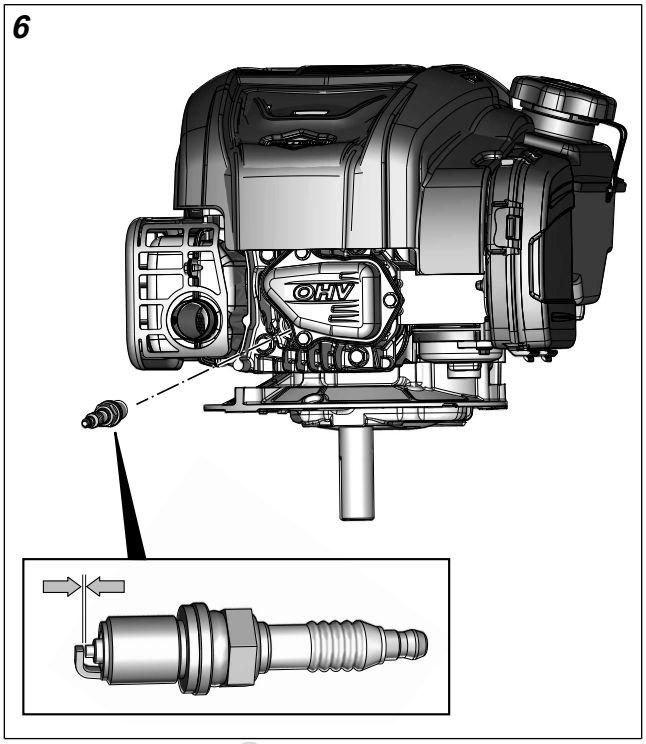


   C. Gently scrape away stubborn accumulations of dirt and other deposits using a plastic putty knife or stiff bristle brush.
   D. Apply a light solvent to bristle brush to loosen and remove grit and oily residue, if necessary.
6. Inspect muffler for holes, split seams, cracked welds, loose internal parts, corrosion, and other damage. Replace parts as necessary.
7. Verify that two hex flange screws (**I**) to exhaust flange are tightened to **55-65 lb-in** (6.2-7.3 N-m).
8. Install three hex flange screws to fasten guard to muffler. Tighten screws to **20-30 lb-in** (2.3-3.4 N-m).
9. If equipped, install spark arrester as follows:
   A. Install screening element into spark arrester.
   B. Install screw to fasten spark arrester to muffler. Tighten screw to **71-124 lb-in** (8-14 N-m).
10. If equipped, install screw to fasten muffler deflector to muffler. Tighten screw to **8-12 lb-in** (0.9-1.4 N-m).
11. Install spark plug wire onto spark plug terminal.

Clean/Gap/Replace Spark Plug

NOTE: Spark plugs have different thread lengths and heat ranges. Always use the specified replacement spark plug or engine damage can occur.

NOTE: Some localities require use of a special resistor type spark plug to suppress ignition noise. If the engine was originally equipped with a resistor type spark plug, be sure to use the same replacement spark plug.

1. Remove spark plug wire from spark plug terminal.
2. Thoroughly clean area around spark plug to keep dirt and debris out of combustion chamber.
3. Remove spark plug from cylinder head using the 5/8 inch Spark Plug Wrench (Part No. 19576S).
4. Check condition of threads in cylinder head. If necessary, soften deposits with penetrating oil and clean out with a thread chaser.
5. Clean spark plug using a wire brush and commercial solvent. Do not bead blast spark plug. Obtain **new** spark plug if electrode is pitted or burned, or if porcelain is cracked.
6. See Figure 6. Using a feeler gauge, verify spark plug gap is **0.030 inches** (0.76 mm). If necessary, adjust gap by carefully bending ground electrode.
7. Finger tighten spark plug into cylinder head, and then tighten to **140-200 lb-in** (15.8-22.6 N-m).
8. Install spark plug wire onto spark plug terminal.

Clean Air Cooling System

NOTE: Proper cleaning reduces the risk of engine damage due to overheating and ignition of accumulated debris.

NOTE: Avoid using high pressure compressed air, which can force dirt and debris deeper into engine cavities and crevices. Do not use a pressurized water spray as water intrusion can contaminate both oil and fuel systems and lead to corrosion.

1. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.

   NOTE: See insets of Figure 7. If equipped with static cover (**1**), move to step 2. If equipped with rewind starter housing (**2**), proceed to step 3.
2. Remove static cover as follows:
   A. If equipped, pull tabs on cover insert (decorative trim) from slots in static cover.
   B. Remove knob on choke shaft, if equipped.
   C. Remove two TORX screws (**A**) to release static cover (**B**) from blower housing (**C**).
   D. Push static cover forward (up) to disengage latch (**D**) from catch (**E**) on blower housing.
   E. Remove three hex flange shoulder screws (**F**) to release blower housing from blower scroll (**G**).
3. Remove rewind starter housing as follows:
   A. Remove three hex flange shoulder screws to release rewind starter housing from blower scroll.
   B. If equipped, disconnect two socket spade terminals from rocker stop switch.

CAUTION

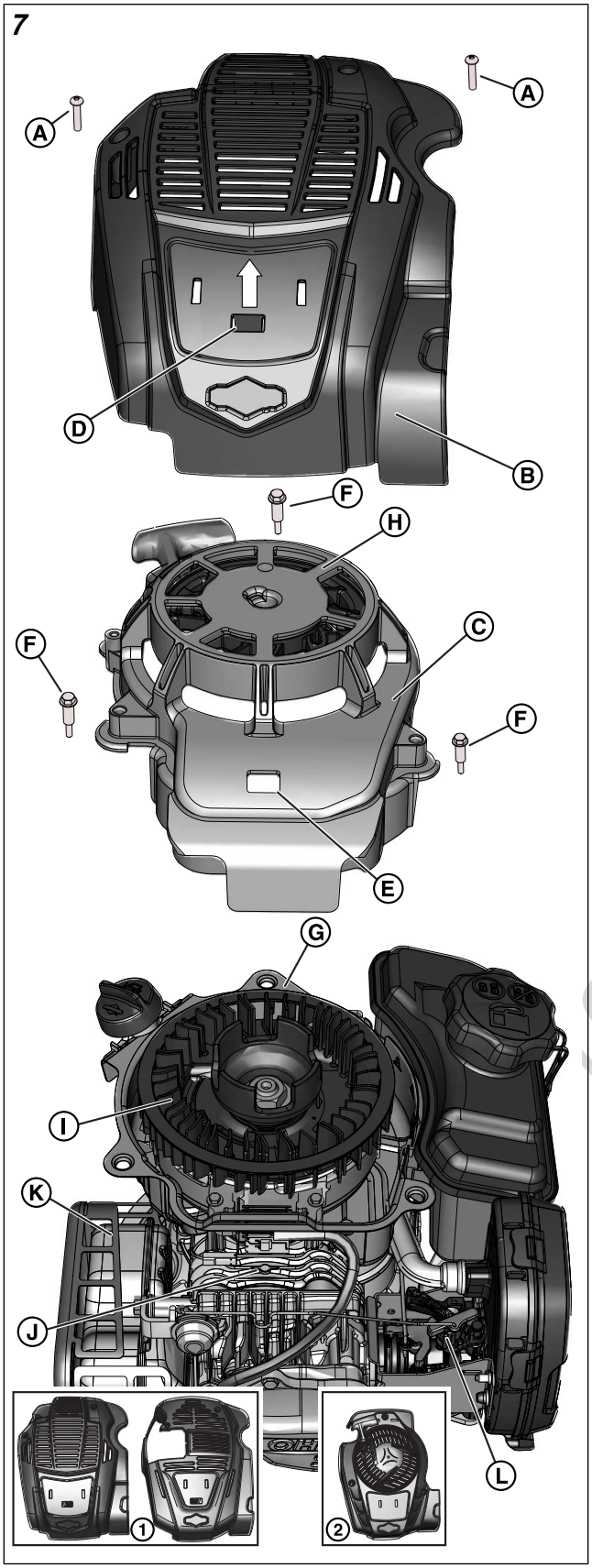
The edges of the blower scroll may be sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

4. Thoroughly clean the rewind starter finger guard (**H**), flywheel fan (**I**), and cylinder cooling fins (**J**) as follows:
   A. Remove all loose debris by hand.
   B. Remove dust and dirt with a soft bristle brush and a portable hand held vacuum.
   C. Gently scrape away stubborn accumulations of dirt and other deposits using a plastic putty knife or stiff bristle brush.
   D. Apply a light solvent to bristle brush to loosen and remove grit and oily residue, if necessary.
5. Verify that all combustible debris is removed from area around and behind muffler (**K**).
6. Verify that governor links, springs, and controls (**L**) move freely without sticking, binding, or contacting blower scroll, fuel tank, or other engine parts.

   NOTE: If equipped with static guard, move to step 7. If equipped with rewind starter housing, proceed to step 8.
7. Install static cover as follows:
   A. Loosely install three hex flange shoulder screws to fasten blower housing to blower scroll.

      NOTE: To ensure that pawls evenly engage flywheel starter cup on engines equipped with rewind starter, pull starter rope, tighten hex flange screws until snug, and then release starter rope.
   B. Alternately tighten hex flange screws to **30-40 lb-in** (3.4-4.5 N-m).
   C. Position static cover on blower housing.
   D. Push static cover rearward (down) to engage latch with catch on blower housing.
   E. Install two TORX screws to fasten static cover to blower housing. Alternately tighten screws to **12-18 lb-in** (1.4-2.0 N-m).
   F. Install knob on choke shaft, if equipped.
   G. If equipped, push tabs on cover insert (decorative trim) into slots in static cover.
8. Install rewind starter housing as follows:
   A. If equipped, connect two socket spade terminals to rocker stop switch.

7



B. Loosely install three hex flange shoulder screws to fasten rewind starter housing to blower scroll.

NOTE: To ensure that pawls evenly engage flywheel starter cup, pull starter rope, tighten hex flange screws until snug, and then release starter rope.

C. Alternately tighten hex flange screws to **30-40 lb-in** (3.4-4.5 N-m).

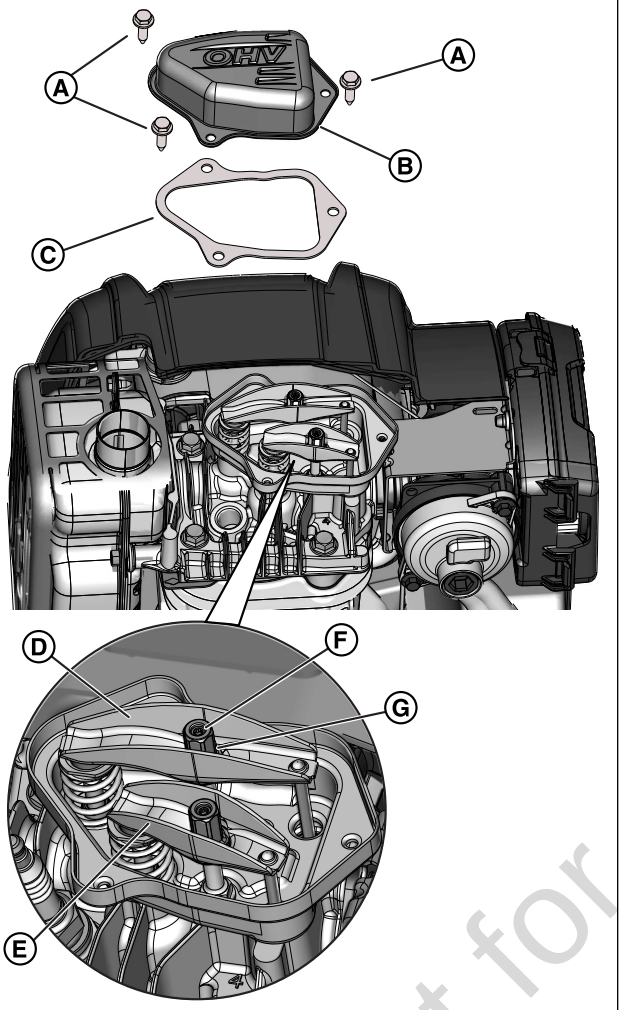
9. Install spark plug wire onto spark plug terminal.

Check/Adjust Valve Clearance

NOTE: For best results, check valve clearance with the engine cold.

1. Remove spark plug wire from spark plug terminal.
2. Thoroughly clean area around spark plug to keep dust and dirt out of the combustion chamber.
3. Remove spark plug from cylinder head using the 5/8 inch Spark Plug Wrench (Part No. 19576S).
4. See Figure 8. Remove three hex flange screws (**A**) to release valve cover (**B**) from cylinder head plate.
5. Remove and discard valve cover gasket (**C**).
6. Move piston **1/4 inch** (6 mm) past Top Dead Center (TDC) of the compression stroke. Proceed as follows:
   A. While rotating flywheel end of crankshaft by hand in the direction of engine rotation, watch the rocker arms to determine the action of the valves. After the exhaust valve (**D**) closes, the intake valve (**E**) begins to open.
   B. When the intake valve closes (so that both valves are closed with the rocker arms loose), insert a wooden dowel through the spark plug hole until seated at the top of the piston.
   C. Rotate engine in the same direction until the piston pushes the wooden dowel to its highest point. This is TDC of the compression stroke.
   D. Place a mark on the wooden dowel that is even with the machined surface at the top of the spark plug hole. Make a second mark **1/4 inch** (6 mm) above the first.
   E. Rotate engine in the same direction until the second mark on the wooden dowel is even with the machined surface at the top of the spark plug hole. Remove wooden dowel.
7. Insert feeler gauge between rocker arm and exhaust valve stem. Verify that exhaust valve clearance is **0.004-0.008 inches** (0.10-0.20 mm).
8. If adjustment is necessary to obtain proper clearance, proceed as follows:
   A. Loosen set screw (**F**) and turn rocker ball nut (**G**) as necessary.

8



B. Holding rocker ball nut to prevent rotation, tighten set screw to **19-25 lb-in** (2.1-2.8 N-m).

C. Check valve clearance again to verify that rocker ball did not move when set screw was tightened.

9. Insert feeler gauge between rocker arm and intake valve stem. Verify that intake valve clearance is **0.004-0.008 inches** (0.10-0.20 mm). If adjustment is necessary, see step 8.
10. Remove old gasket material from valve cover and cylinder head plate flanges. Gasket material left on sealing surfaces will cause leaks.
11. Install **new** valve cover gasket onto valve cover.
12. Start three hex flange screws to fasten valve cover to cylinder head plate. Alternately tighten screws to **45-55 lb-in** (5.0-6.2 N-m).
13. Install spark plug into cylinder head and finger tighten until snug. Tighten spark plug to **140-200 lb-in** (15.8-22.6 N-m).
14. Install spark plug wire onto spark plug terminal.

SECTION 3 – TROUBLESHOOTING/SPECIAL TOOLS

General Complaints

Most complaints concerning engine operation include one or more of the following:

- Will not start
- Hard starting
- Lack of power
- Runs rough
- Vibration
- Overheating
- High oil consumption

Equipment Check

What often appears to be a problem with the engine may actually be the result of faulty equipment.

No Start or Hard Start

- Loose belt or blade
- Cranking under load
- Misadjusted controls
- Improperly operating low oil sensor system

Engine Will Not Stop

- Equipment stop switch not functioning
- Engine ground wire damaged or disconnected

Vibration

- Bent cutter blades
- Loose spindles and couplings
- Bent/broken deck or weldments
- Bent crankshaft
- Loose equipment mounting bolts
- Damaged or worn belts and pulleys
- Out of balance impeller

Power Loss

- Bind or drag in moving parts of equipment
- Grass build-up under deck
- No lubrication in equipment gear box
- Excessive belt tension

Systems Check

Once equipment sources are ruled out, most symptoms can be traced to one or more of the following. Perform these checks in the order listed.

1. Ignition
2. Carburetion
3. Compression

Check Ignition

1. Move to step 2 if engine does not start. If engine runs, but misses, move to step 9.

Engine Does Not Start

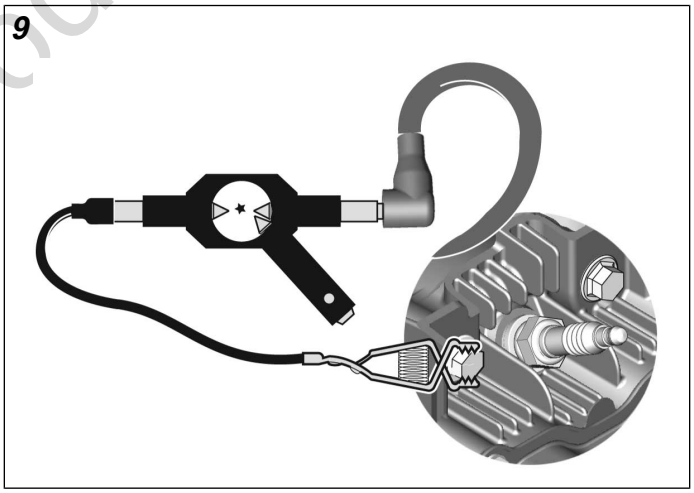
2. Verify that engine oil level is within the cross hatch pattern on the dipstick.
3. Obtain Ignition Tester (Part No. 19368).
4. Remove spark plug wire from spark plug terminal.
5. See Figure 9. Install free end of spark plug wire onto inline tester prong. Install tester alligator clip onto good engine ground.

WARNING

Be sure there is no fuel or fuel vapors present which, if spark ignited, can cause a fire or explosion resulting in death or serious injury.

6. Move throttle control lever to FAST.
7. Pull rewind starter rope (or activate electric starter, if equipped). If spark jumps the tester gap, the ignition system is functioning satisfactorily.
8. If spark is not present, move to step 15.

9



Engine Runs But Misses

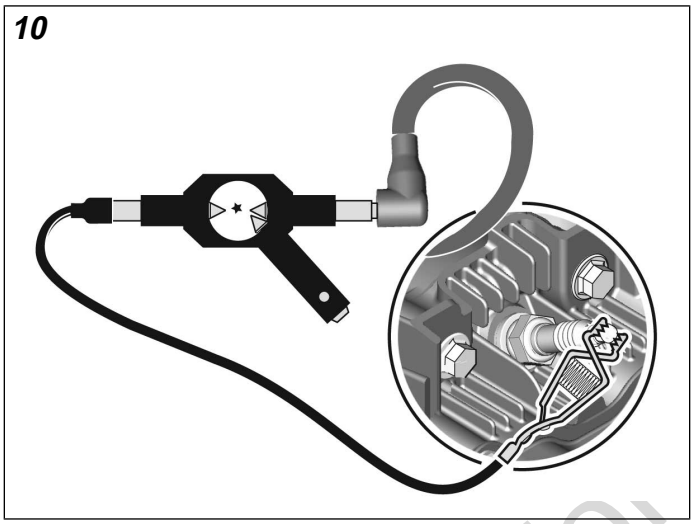
9. Obtain Ignition Tester (Part No. 19368).
10. Remove spark plug wire from spark plug terminal.
11. See Figure 10. Install free end of spark plug wire onto inline tester prong. Install tester alligator clip onto spark plug terminal.

WARNING

Be sure there is no fuel or fuel vapors present which, if spark ignited, can cause a fire or explosion resulting in death or serious injury.

12. Move throttle control lever to FAST.
13. Pull rewind starter rope (or activate electric starter, if equipped). If spark jumps the tester gap, install a **new** spark plug.
14. If spark is not present, move to step 15.

10



15. If spark is not present, look for:
    - Improperly operating low oil sensor system
    - Shorted equipment or engine stop switch wire
    - Incorrect armature air gap
    - Armature failure

Check Carburetion

1. Verify that fuel tank has an ample supply of fresh, clean gasoline.
2. Verify that fuel valve is positioned to ON, if equipped, and that fuel flows freely through the fuel line. If fuel flow is slow or fails to flow, check for plugged fuel cap vent, fuel line restriction, or plugged fuel filter.
3. Verify that throttle and choke controls are clean and properly adjusted.
4. If engine cranks, but will not start, remove and inspect the spark plug.
5. A wet spark plug may indicate:
    - Over choking
    - Excessively rich fuel mixture
    - Water in fuel
    - Carburetor float needle valve stuck open
    - Plugged air cleaner
    - Fouled spark plug
6. A dry spark plug may indicate:
    - Leaking carburetor or intake manifold gaskets
    - Gummy or dirty carburetor, fuel filter, fuel lines, or fuel tank
    - Carburetor float needle valve stuck closed

    NOTE: To determine if the fuel is getting to the combustion chamber through the carburetor, remove the spark plug and pour a small quantity of gasoline through the spark plug hole. Install the spark plug and crank the engine. If the engine fires a few times and then stops, look for the same conditions as those listed for a dry spark plug.

Check Compression

Engine Does Not Start

1. Obtain Leakdown Tester (Part No. 19545).
2. Follow the instructions provided with the tester to check the sealing capabilities of compression components.

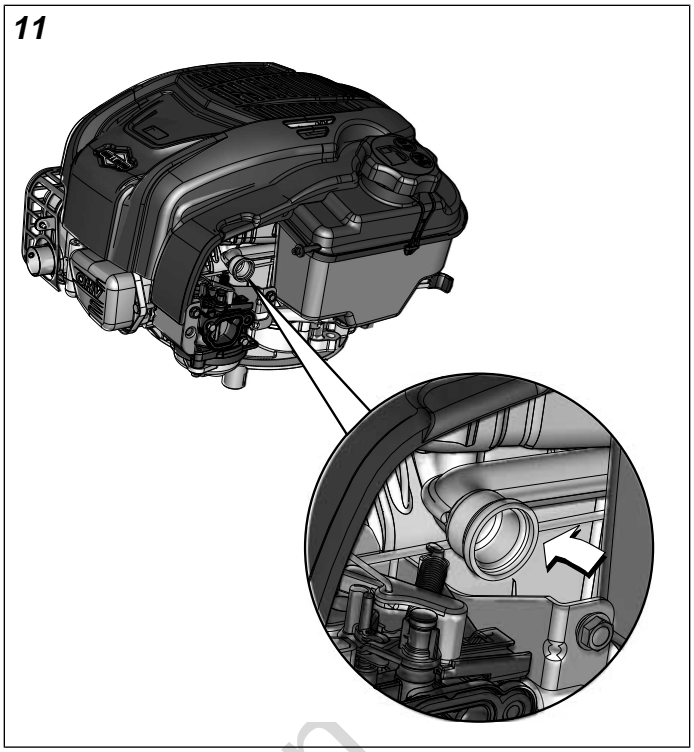
    NOTE: Any air leaks at the tester connections and fittings will adversely affect test results.
3. The sound of air flow:
    - between the cylinder and cylinder head indicates the cylinder head gasket is leaking.
    - from the carburetor indicates air is leaking past the intake valve and valve seat.
    - from the exhaust system indicates air is leaking past the exhaust valve and valve seat.
    - from the breather tube or oil fill dipstick tube indicates air is leaking past the piston rings.
4. The likely causes of poor compression are:
    - Loose cylinder head screws
    - Damaged cylinder head gasket
    - Burned valves, burned valve seats, and/or loose valve seats
    - Insufficient tappet clearance
    - Warped cylinder head
    - Warped valve stems
    - Worn cylinder bore and/or piston rings
    - Broken connecting rod

Check Crankcase Breather

Engine Does Not Start

1. See Figure 11. Gently blow air into breather hose to verify that there is no air flow through the breather reed assembly.

2. Apply vacuum or draw air out through the breather hose to verify that air flows freely through breather reed assembly.
3. If air flow has no resistance when blowing or is restricted under vacuum, replace the breather reed assembly.



SPECIAL TOOLS

1. Piston Ring Compressor (Part No. 19070)
2. Valve Lapping Tool (Part No. 19258)
3. Piston Ring Expander (Part No. 19340)
4. Ignition Tester (Part No. 19368)
5. Torque Wrench (Part No. 19393)
6. Tang Adjusting Tool (Part No. 19480)
7. Telescoping Gauge (Part No. 19485)
8. Dial Bore Gauge (Part No. 19487)
9. Leakdown Tester (Part No. 19545)
10. Master Seat Cutter Kit (Part No. 19547)
11. Spark Plug Wrench (Part No. 19576S)
12. Digital Tachometer/Hour Meter (Part No. 19598)
13. Digital Multimeter (Part No. 19602)
14. Dial Caliper (Part No. 19609)
15. Flywheel Puller (Part No. 19619)
16. Fuel Hose Remover (Part No. 19620)
17. Valve Lapping Compound (Part No. 94150)
18. Carburetor Cleaner (Part No. 100042)
19. Silicone Sealant (Part No. 100106)
20. Armature Air Gap Gauge (Part No. CE5121)

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SECTION 4 – REMOVE EXTERNAL ASSEMBLIES

Preliminary Instructions

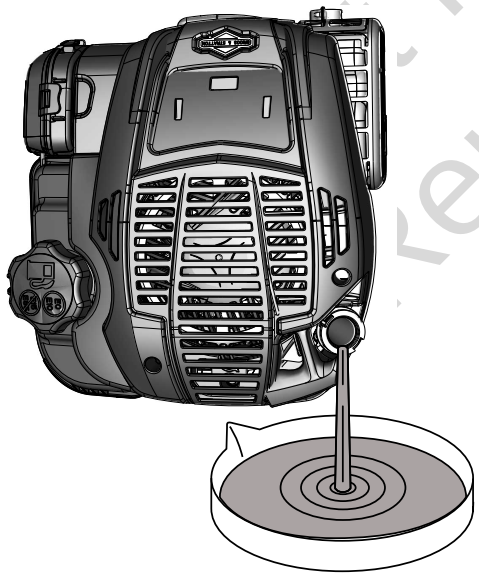
1. Start and run engine until fuel tank is empty.

WARNING

Failure to completely empty fuel tank will result in fuel leakage when engine is tilted to drain oil. Gasoline and its vapors are extremely flammable and highly explosive. Inadequate safety precautions can cause fire or explosion resulting in death or serious injury.

2. Allow engine to cool before handling.
3. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.
4. Remove dipstick from the dipstick tube.
5. See Figure 13. With the spark plug side of the engine up, carefully pour oil out the dipstick tube and into an approved container.
6. Dispose of used oil at a proper waste disposal or recycling center.

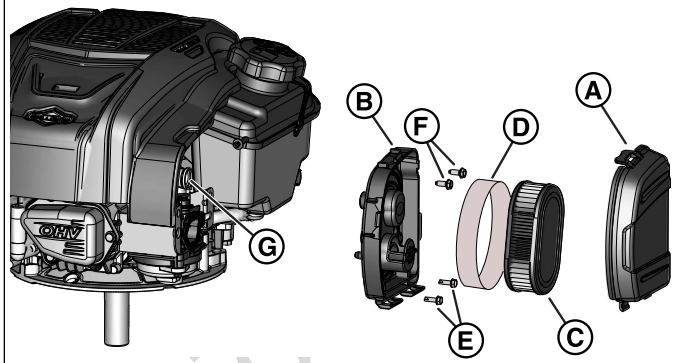
13



Air Cleaner

1. See Figure 14. Pull latch to disengage air cleaner cover (**A**), and then rotate cover to release tabs from slots in air cleaner base (**B**).
2. Remove air filter cartridge (**C**) from air cleaner base.
3. Remove foam pre-cleaner (**D**) from air filter cartridge.
4. Remove two inside hex flange screws (**E**) to release air cleaner base from carburetor.
5. Remove two outside hex flange screws (**F**) to release air cleaner base from carburetor mounting bracket.
6. Remove breather tube (**G**) from port on air cleaner base.

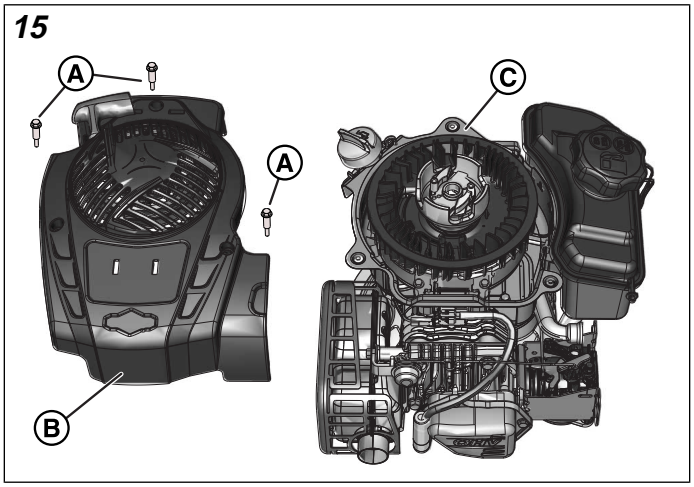
14



Rewind Starter Housing (If Equipped)

1. See Figure 15. Remove three hex flange shoulder screws (**A**) to release rewind starter housing (**B**) from blower scroll (**C**).
2. If equipped, disconnect two socket spade terminals from rocker stop switch.

15

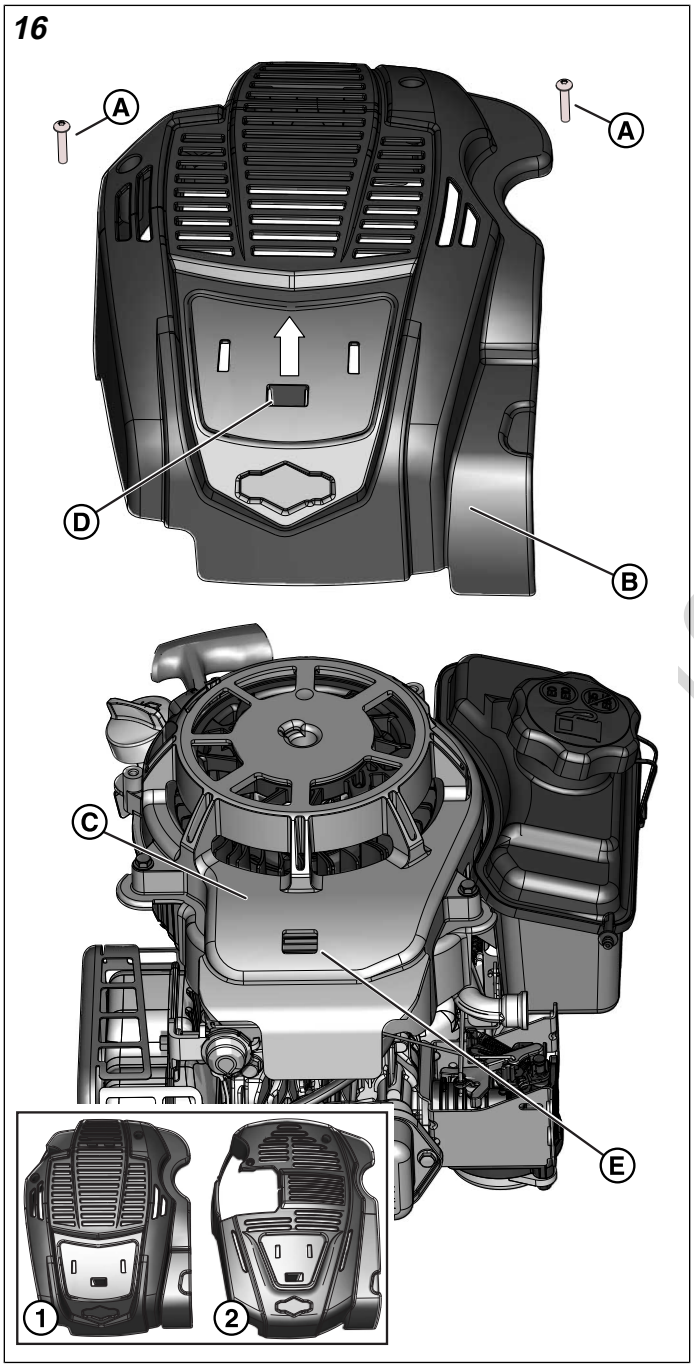


Static Cover (If Equipped)

NOTE: See inset of Figure 16. The appearance of the static cover differs depending upon whether the engine is equipped with a rewind starter (**1**) or battery pack (**2**).

1. If equipped, pull tabs on cover insert (decorative trim) from slots in static cover.
2. Remove knob on choke shaft, if equipped.
3. Remove two TORX screws (**A**) to release static cover (**B**) from blower housing (**C**).
4. Push static cover forward (up) to disengage latch (**D**) from catch (**E**) on blower housing.

16



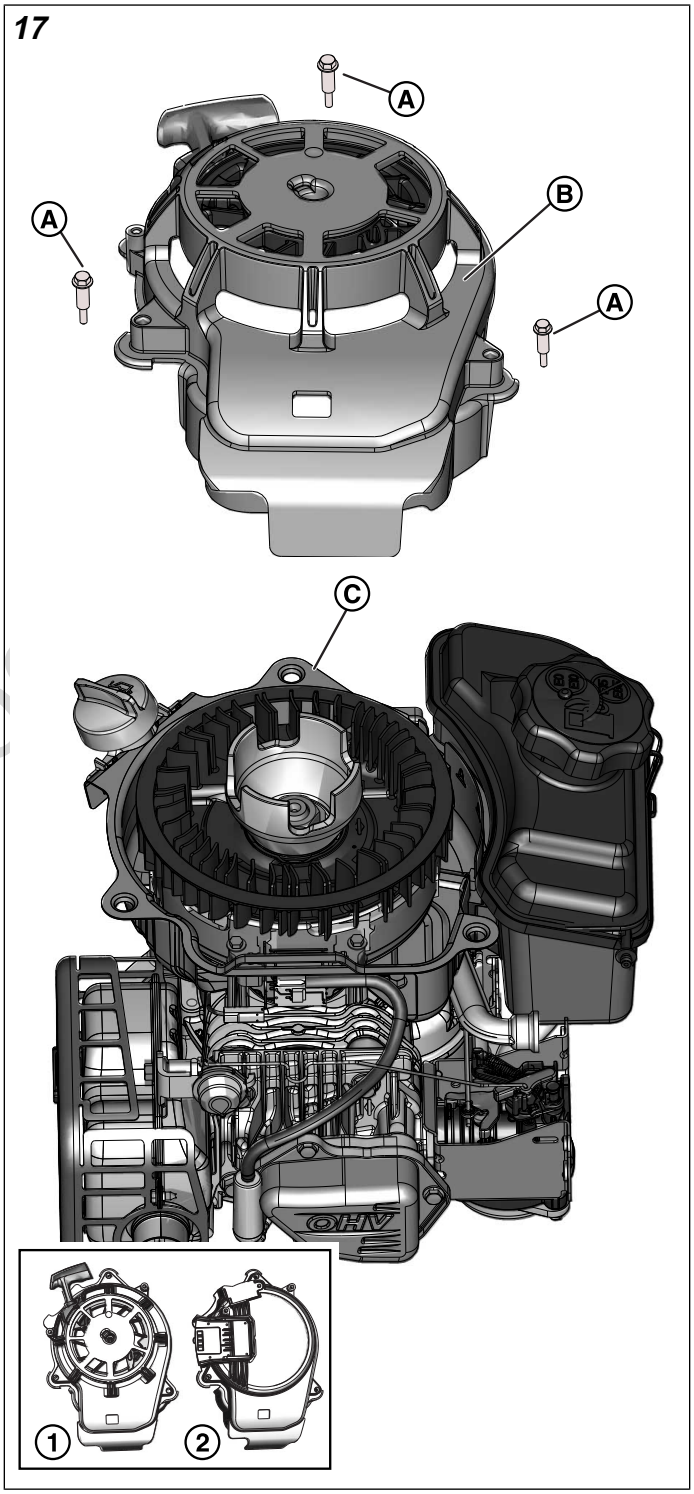
Blower Housing (If Equipped)

NOTE: See inset of Figure 17. The appearance of the blower housing differs depending upon whether the engine is equipped with a rewind starter (**1**) or battery pack (**2**).

NOTE: If equipped with starter motor, see *Starter Motor* in this section before proceeding.

1. Remove three hex flange shoulder screws (**A**) to release blower housing (**B**) from blower scroll (**C**).

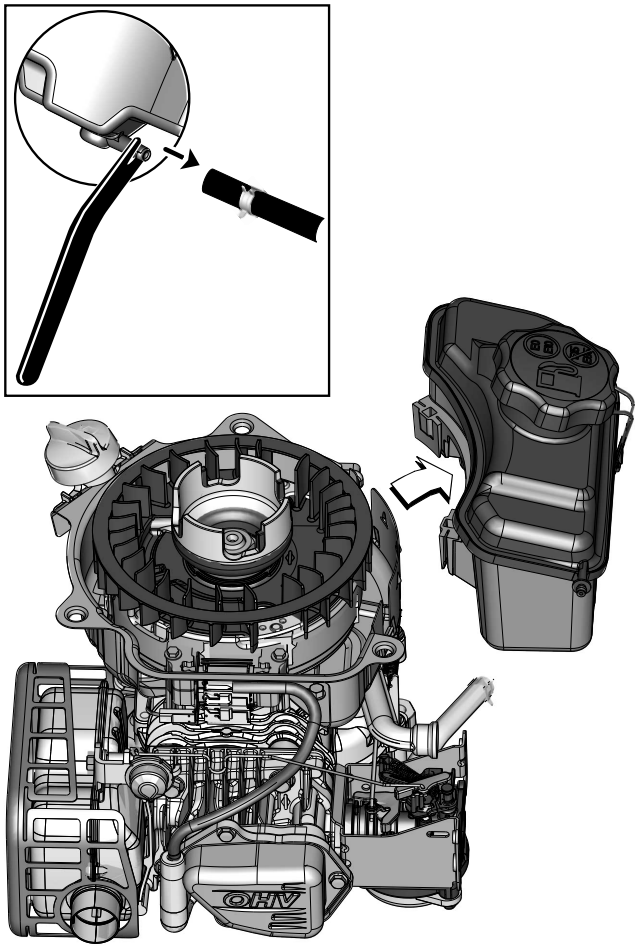
17



Fuel Tank

1. Squeeze tangs and move hose clamp away from fuel tank fitting.
2. Remove hose from fitting. For best results, use Fuel Hose Remover (Part No. 19620) as shown in inset of Figure 18.
3. Remove fuel tank disengaging two tabs on tank from slots on blower scroll.

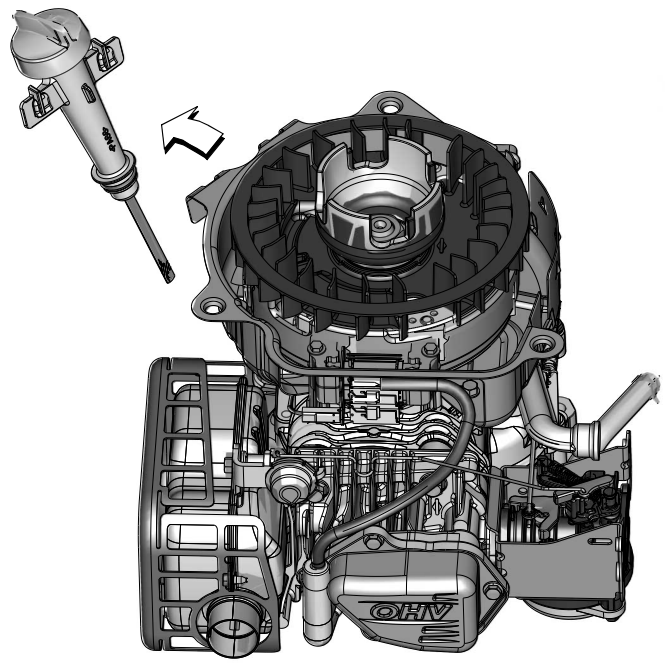
18



Oil Dipstick Tube/Dipstick

1. See Figure 19. Remove oil dipstick tube with dipstick from crankcase disengaging two slots on tube from tabs on blower scroll.

19



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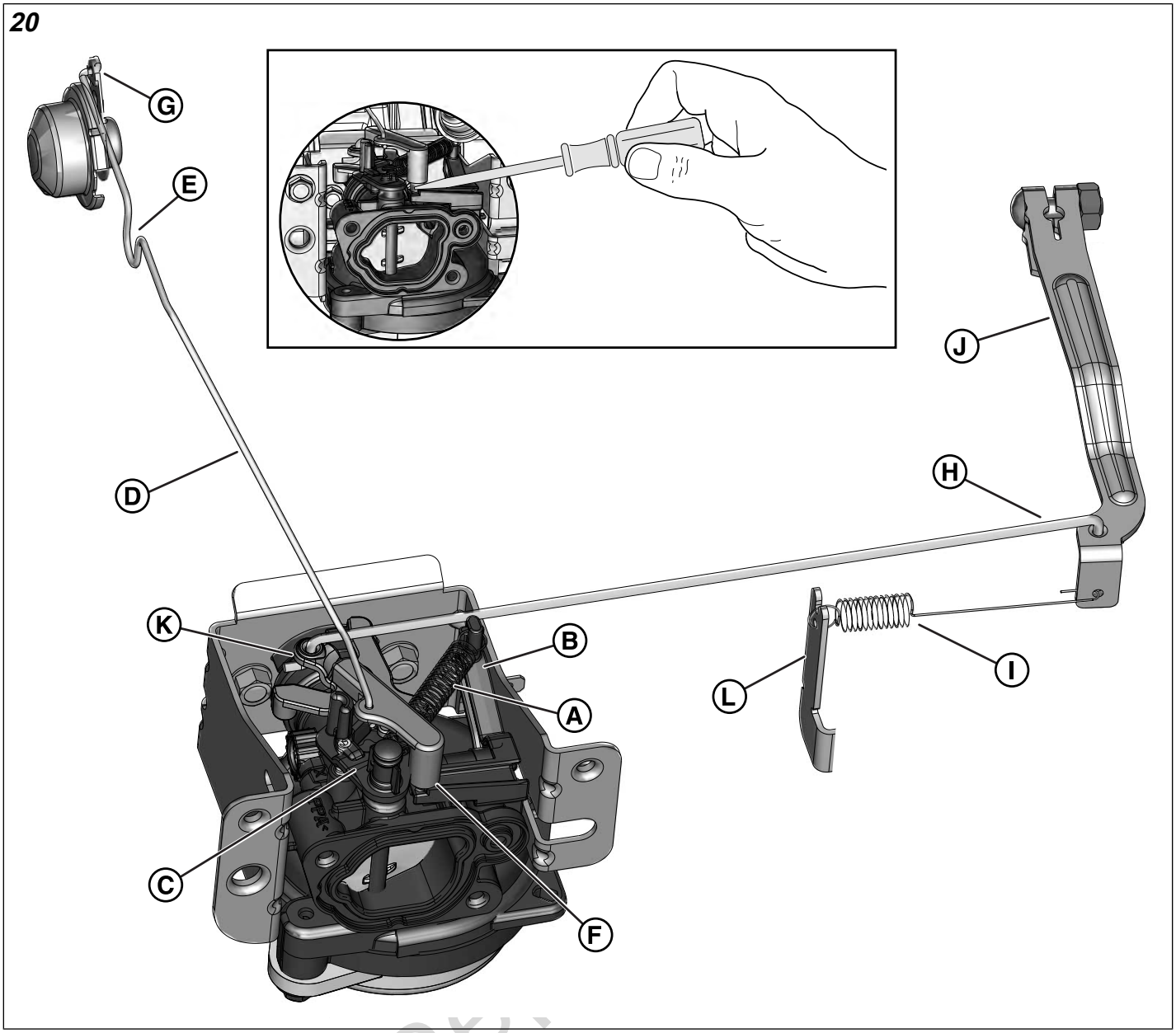


Carburetor/Governor Lever

NOTE: If *ReadyStart*® carburetor, begin at step 1. If *manual choke* carburetor, start at step 4.

1. See Figure 20. Remove choke return spring (**A**) between anchor spring arm (**B**) and choke lever bracket (**C**).

   NOTE: Exercise care to avoid bending, kinking, or stretching choke spring and choke link (**D**).

   NOTE: The horseshoe bend (**E**) in the choke link allows the length to be adjusted for proper starting. Exercise care to avoid either lengthening or shortening the link.

2. Inserting a small flat blade screwdriver between thermostatic lever (**F**) and anchor spring, gently pry upward while twisting slightly to release thermostatic lever from anchor spring shaft. See inset of Figure 20.
3. Remove choke link from muffler thermostat lever (**G**).
4. Gently rotate carburetor back and forth while slowly removing it from the carburetor spacer.

   NOTE: Exercise care to avoid bending, kinking, or stretching governor link (**H**) and governor spring (**I**).

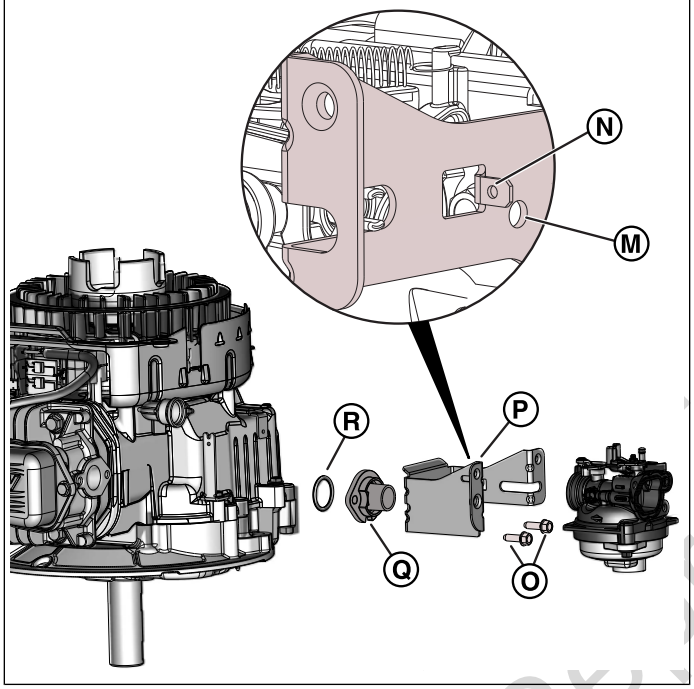
5. Remove governor link from governor lever (**J**) and throttle lever bracket (**K**).
6. Remove governor spring from governor lever and speed control bracket (**L**).
7. Remove carburetor.
8. See Figure 21. If equipped, proceed as follows:

A. Release speed control stop switch wire from wire clip, and remove anchor on clip from hole (**M**) in mounting bracket.

B. Release rocker stop switch ground wire from hole (**N**) in mounting bracket tab. Release ground wire from wire clip, and remove anchor on clip from hole in mounting bracket.

9. Remove two hex flange screws (**O**) to release mounting bracket (**P**) and carburetor spacer (**Q**) from cylinder head.
10. Remove carburetor spacer from mounting bracket.
11. Remove O-ring (**R**) from carburetor spacer. Discard O-ring.

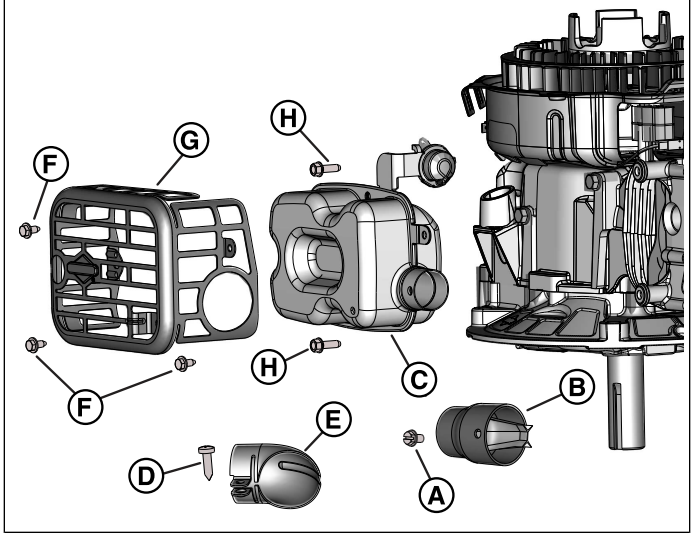
21



Muffler

1. See Figure 22. If equipped, remove screw (**A**) to release spark arrester (**B**) from muffler (**C**).
2. If equipped, remove screw (**D**) to release muffler deflector (**E**) from muffler.
3. Remove three hex flange screws (**F**) to release muffler guard (**G**).
4. Remove two hex flange screws (**H**) to release muffler from cylinder head.

22



Speed Control Bracket

1. If equipped with stop wire, proceed as follows:

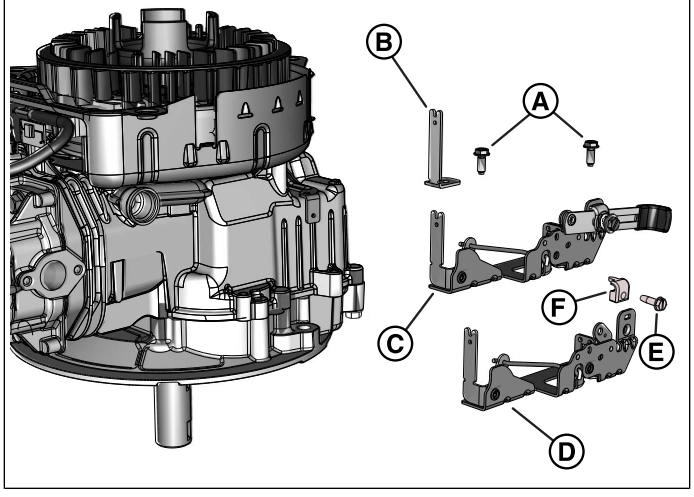
   A. Depress stop switch tab on speed control bracket, and then straighten and remove stop wire.

   B. Draw stop wire below speed control bracket, and then over to armature.

   NOTE: If equipped with a dual lead stop wire with a one-place connector, release wire from clip and remove clip from rib of crankcase. Draw wire below blower scroll to area of armature.

   C. Disconnect socket housing from armature spade terminal.

23



2. See Figure 23. Remove hex flange screw(s) (**A**) to release fixed speed control bracket (**B**), manual speed control bracket (**C**), or variable speed control bracket (**D**) from crankcase mounting boss(es).

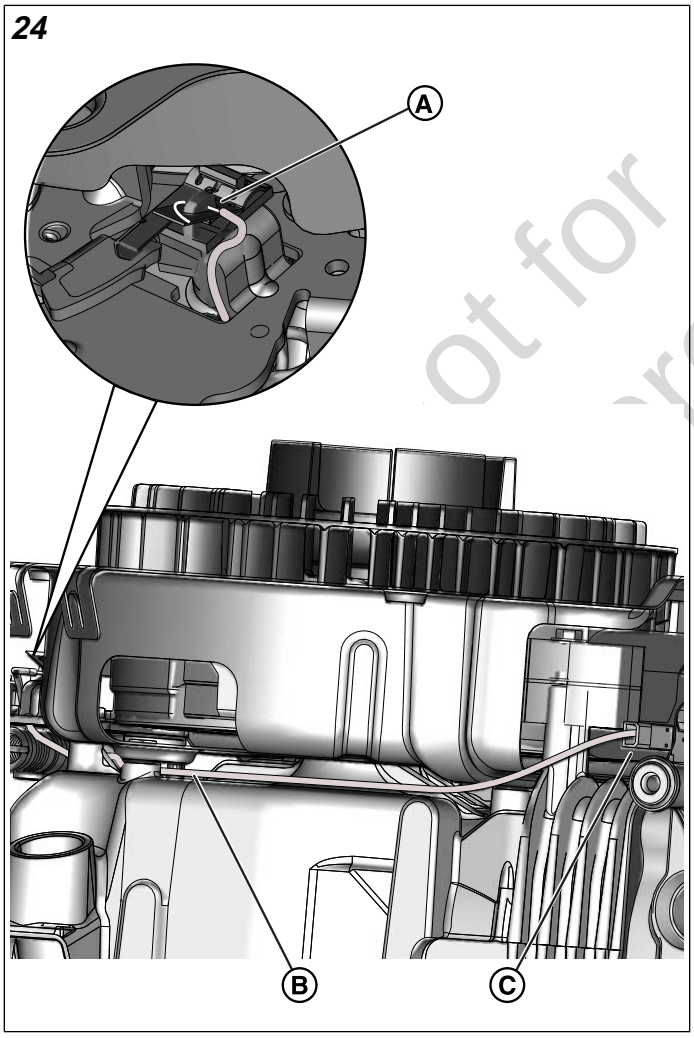
   NOTE: If variable speed bracket, remove hex flange screw (**E**) to release throttle cable bracket (**F**).

Flywheel Brake

1. See Figure 24. Depress stop switch tab (**A**) on flywheel brake, and then straighten and remove stop wire.

   NOTE: If equipped with a single or dual lead stop wire with a one-place connector, release wire from clip and remove clip from rib of crankcase.
2. Draw stop wire(s) below blower scroll (**B**) to area of armature and disconnect socket housing (**C**) from armature spade terminal.
3. See Figure 25. Disconnect spring (**D**) from flywheel brake tab.

24



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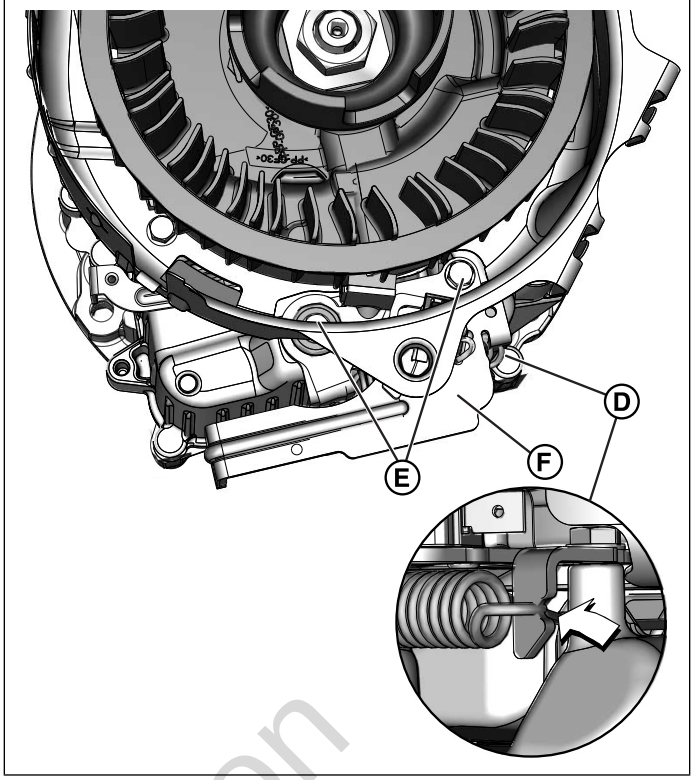
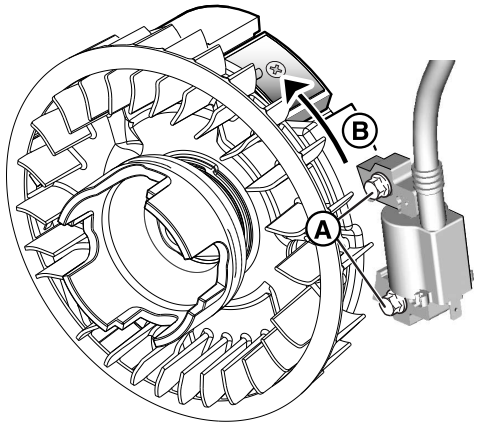


4. Remove two hex flange screws (**E**) to release flywheel brake (**F**) from crankcase.

Armature

1. See Figure 26. Loosen two hex flange screws (**A**) and rotate flywheel to move magnet (**B**) away from armature legs.
2. Remove hex flange screws to release armature from crankcase.

26



Starter Motor (If Equipped)

1. Proceed as follows:

   NOTE: If configuration differs from that described below, take note of all wire routing and electrical connections to ensure proper installation at time of assembly.

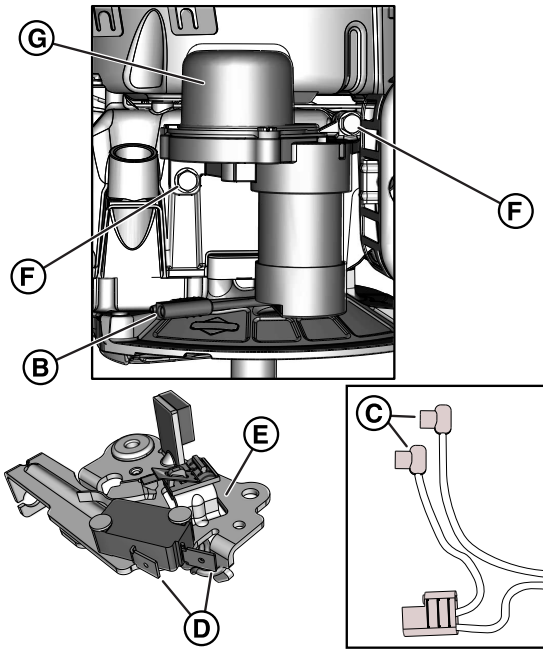
Brake Wire Routing

1. See Figure 27. Disconnect two-place wire harness connector (**A**) from starter motor connector (**B**).
2. Disconnect two 90° connectors (**C**) from micro switch terminals (**D**) on flywheel brake (**E**).
3. Remove two hex flange screws (**F**) to release starter motor (**G**) from crankcase.

Bail Start Wire Routing

1. See Figure 28. Disconnect white one-place connector (**A**) from armature wire connector.
2. Disconnect two 90° connectors (**B**) from micro switch terminals (**C**) on flywheel brake (**D**).
3. Disconnect three-place connector (**E**) between bail start module (**F**) and wire block (**G**).
4. Remove TORX screw (**H**) to release bail start module from blower housing.
5. Disconnect two-place connector (**I**) from starter motor connector.
6. Remove wire block from blower housing terminals.
7. Remove two hex flange screws to release starter motor from crankcase.

27



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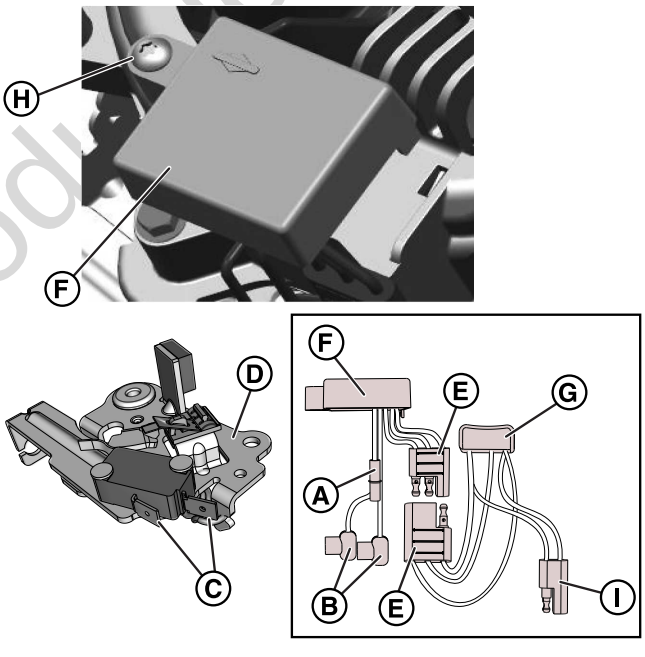

SECTION 5 – DISASSEMBLE ENGINE

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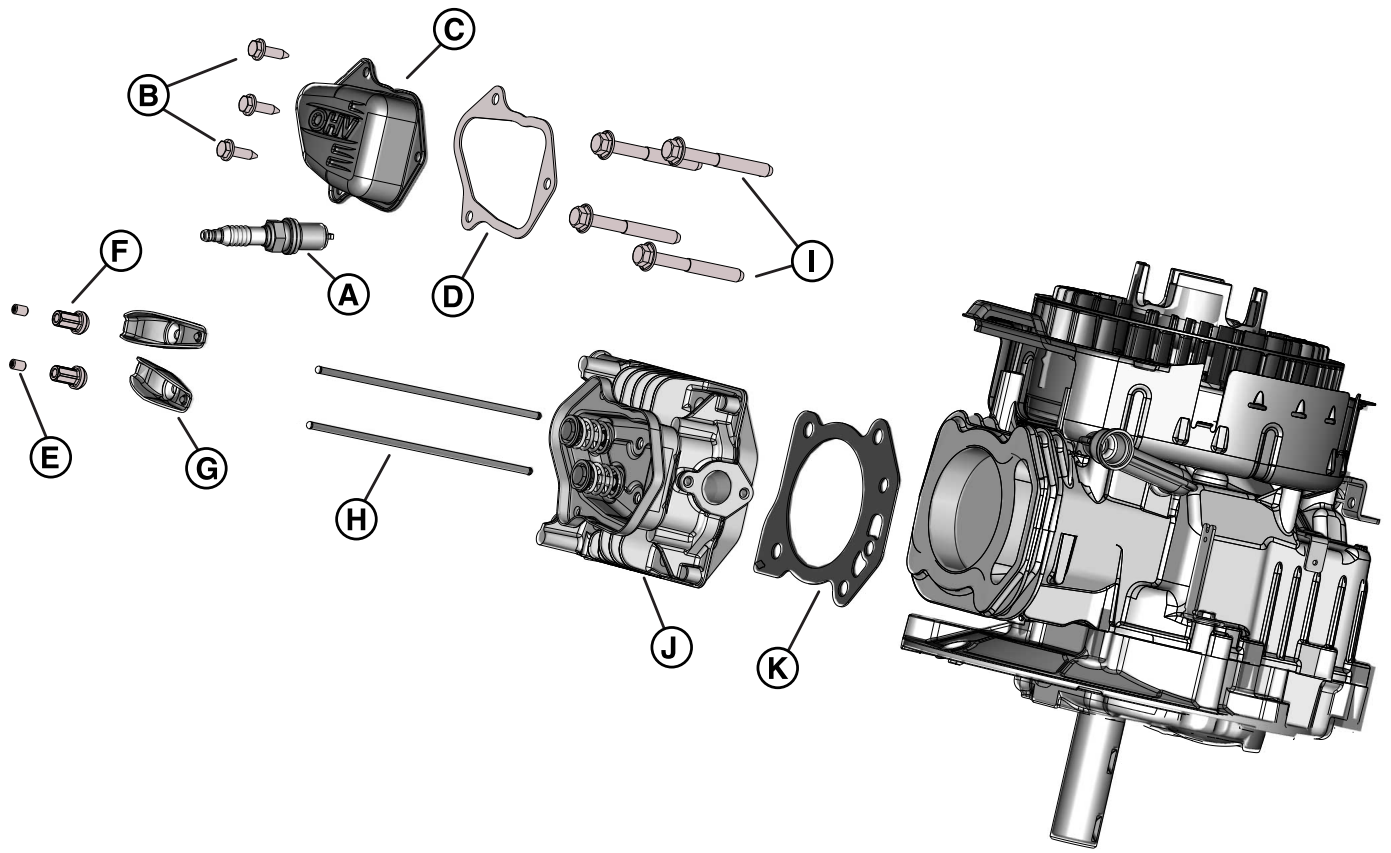

1. See *SECTION 4 - REMOVE EXTERNAL ASSEMBLIES.*
2. Thoroughly clean exterior surfaces of engine prior to disassembly. Proceed as follows:

   NOTE: Dirt caked on cooling fins and other areas can fall into cylinder bore or stick to subassemblies as parts are removed. Abrasive particles can damage machined surfaces and plug oil passageways.

   A. Remove all loose debris by hand.
   B. Remove dust and dirt with a soft bristle brush and a portable hand held vacuum.
   C. Gently scrape away stubborn accumulations of dirt and other deposits using a plastic putty knife or stiff bristle brush.
   D. Apply a light solvent to bristle brush to loosen and remove grit and oily residue, if necessary.

3. Thoroughly clean area around spark plug to keep dirt and debris out of combustion chamber.
4. See Figure 29. Remove spark plug (**A**) from cylinder head using the 5/8 inch Spark Plug Wrench (Part No. 19576S).
5. Remove three hex flange screws (**B**) to release valve cover (**C**) from cylinder head plate.
6. Remove and discard valve cover gasket (**D**).
7. Move piston **1/4 inch** (6 mm) past Top Dead Center (TDC) of the compression stroke. Proceed as follows:

   NOTE: Disassembly with the valve train loaded can result in bent push rods.

   A. While rotating flywheel end of crankshaft by hand in the direction of engine rotation, watch the rocker arms to determine the action of the valves. After the exhaust valve closes, the intake valve begins to open.
   B. When the intake valve closes (so that both valves are closed with the rocker arms loose), insert a wooden dowel through the spark plug hole until seated at the top of the piston.

C. Rotate engine in the same direction until the piston pushes the wooden dowel to its highest point. This is TDC of the compression stroke.

D. Place a mark on the wooden dowel that is even with the machined surface at the top of the spark plug hole. Make a second mark **1/4 inch** (6 mm) above the first.

E. Rotate engine in the same direction until the second mark on the wooden dowel is even with the machined surface at the top of the spark plug hole. Remove wooden dowel.

8. Remove set screws (**E**) from rocker balls (**F**). Remove rocker balls and rocker arms (**G**) from rocker arm studs.
9. Remove the intake and exhaust push rods (**H**).
10. Remove four cylinder head screws (**I**) from cylinder head.
11. Remove cylinder head (**J**) from cylinder deck.
12. Remove and discard the cylinder head gasket (**K**).
13. See *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, CYLINDER HEAD.*

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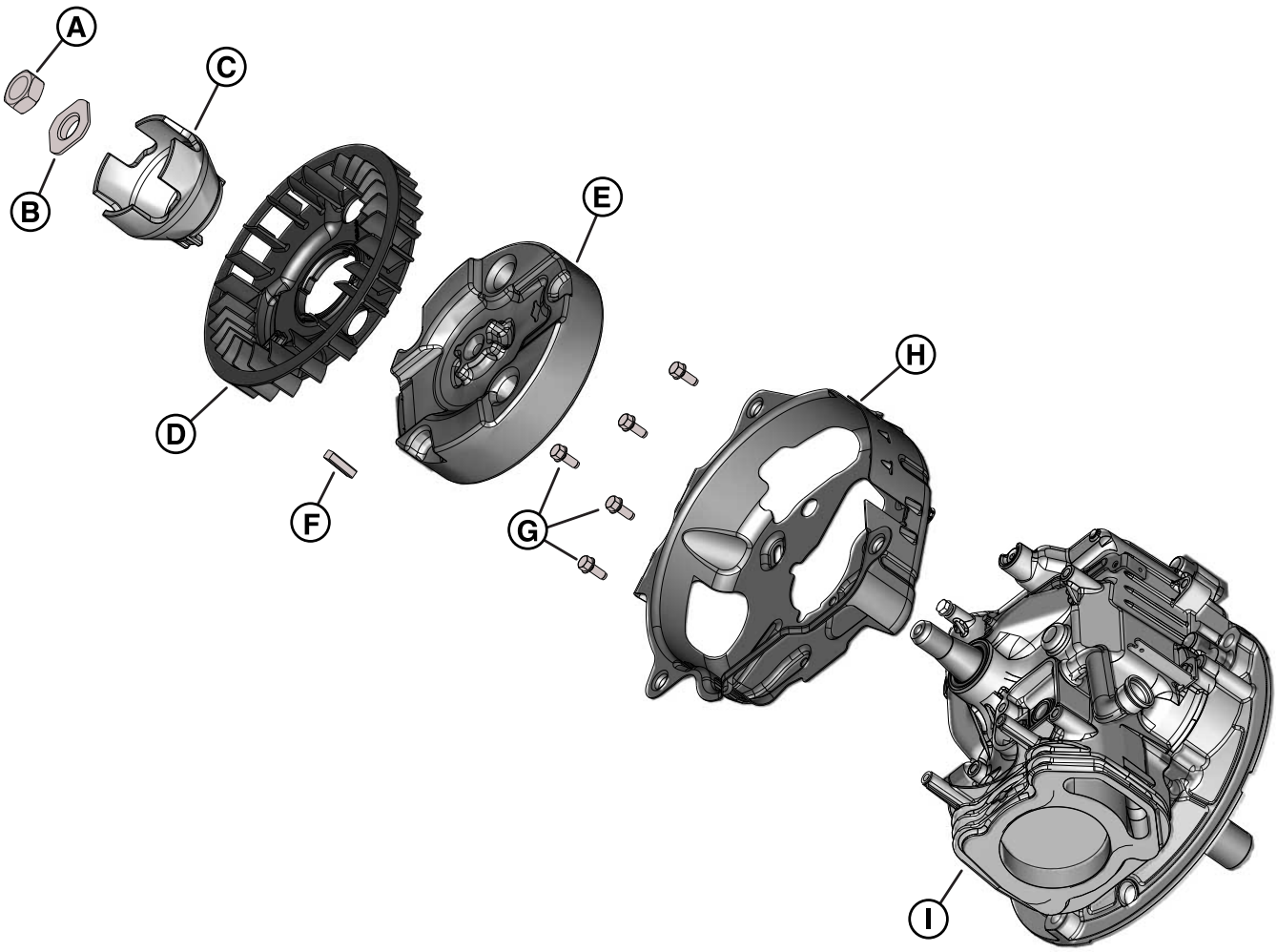

1. See *TOP END DISASSEMBLY* in this section.
2. See Figure 30. Loosen flywheel nut (**A**) as follows:

   NOTE: DO NOT use an air impact wrench to loosen flywheel nut or thread damage may occur.

   A. Obtain the Flywheel Puller (Part No. 19619), a 1/2 inch drive breaker bar, and a 1/2 inch rachet with a 15/16 inch socket.

   B. See Figure 31. With the lip on the puller facing up (**A**), insert the 3/4 inch bolts through the two slotted holes. On opposite side of puller, thread the hex nuts down the bolts until light contact is made with puller.

   C. Insert the threaded ends of the 3/4 inch bolts into the two holes in the flywheel fan and flywheel (**B**).

   D. Insert joint of breaker bar into square shaped hole at top of puller (**C**).

   E. While holding the breaker bar to prevent movement of puller, use the rachet with 15/16 inch socket to loosen the flywheel nut (**D**).

3. See Figure 30. Remove flywheel nut, puller, spacer (**B**), starter cup (**C**), and fan (**D**).
4. Using Flywheel Puller (Part No. 19619), remove flywheel (**E**) as follows:

   A. Obtain the two 3/8 inch bolts. Thread the hex nuts down the bolts until each is just below the flange head.

   B. See Figure 31. Turn the puller over with the lip facing down (**E**), and set the head of one of the installed 3/4 inch bolts on the end of the crankshaft.

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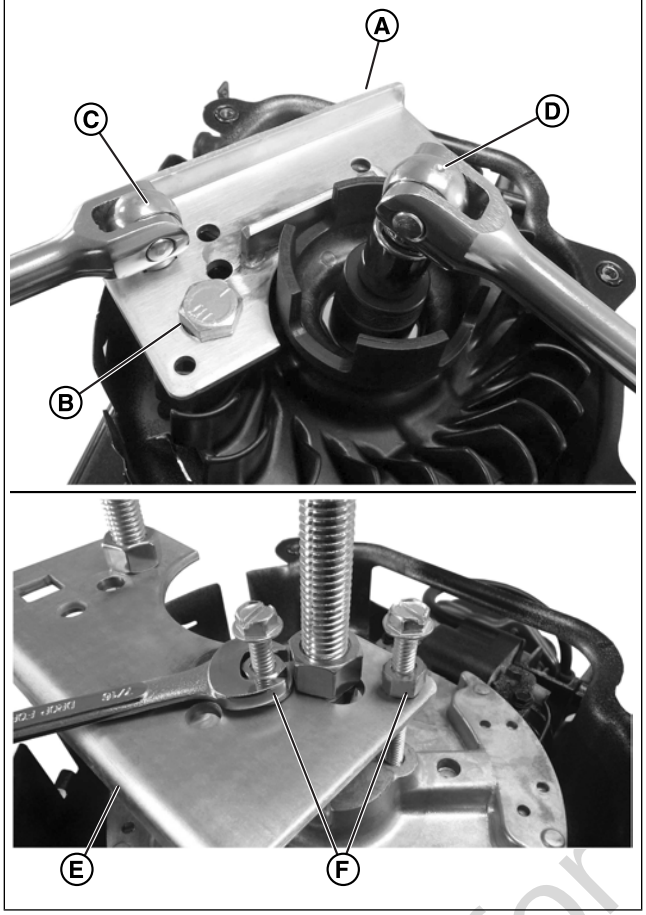


C. Slide the two 3/8 inch bolts through the adjacent holes in the puller and engage the threaded holes in the flywheel. Alternately tighten each bolt an equal number of turns until positive engagement is obtained (a minimum of eight threads).

D. Turn the hex nut on each 3/8 inch bolt until it contacts the puller.

E. Alternately tighten the hex nut on each 3/8 inch bolt in small increments until the flywheel is free (**F**).

5. Remove the flywheel. Remove puller from flywheel.
6. See Figure 30. Remove key (**F**) from keyway on flywheel taper.

CAUTION

The edges of the blower scroll may be sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

7. Remove the blower scroll as follows:

   A. Remove five hex flange screws (**G**) to release blower scroll (**H**) from crankcase (**I**).

   NOTE: The blower scroll serves as the cover for the crankcase breather and is sealed by a non-hardening sealant. It is necessary to overcome the resistance of the sealant to remove the blower scroll.

   B. See Figure 32. Locate the raised boss just beneath the blower scroll (**A**) adjacent to the breather tube.

   C. Insert a suitable prying tool between the top of the boss and the bottom of the blower scroll (**B**).

   D. Gently pry the blower scroll upward until free.

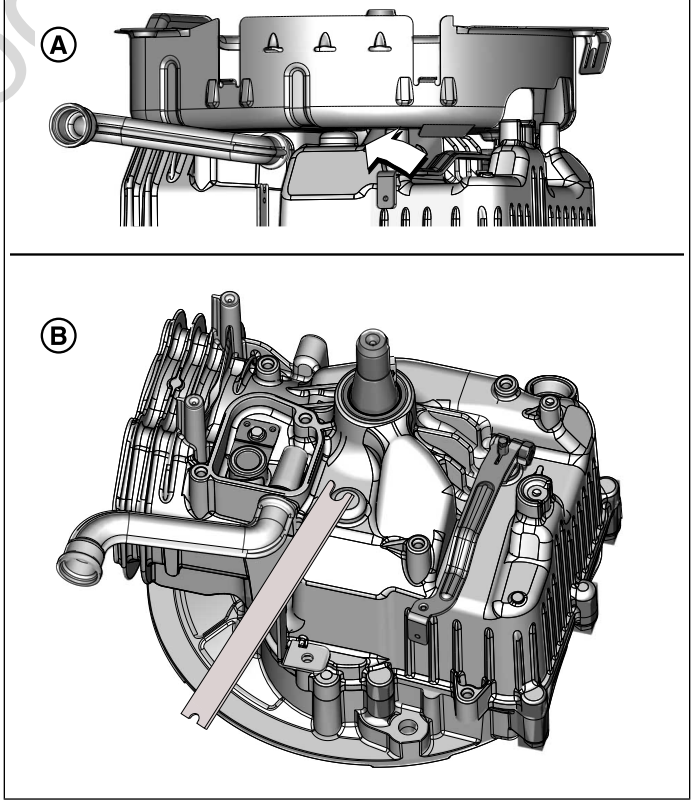
   NOTE: The Fuel Hose Remover (Part No. 19620) may be used with satisfactory results.

8. See Figure 33. Remove seven hex flange screws (**A**) to release crankcase cover (**B**).

   NOTE: If crankcase cover sticks, use a soft hammer to lightly tap area adjacent to two locating pins (see arrows).

9. Remove and discard crankcase cover gasket (**C**).
10. Remove locating pins (**D**) from crankcase (**E**) and set aside.
11. See Figure 34. Remove oil slinger (**A**) from camshaft.
12. See Figure 35. Rotate crankshaft (**A**) to align timing marks (**B**) on crankshaft gear tooth and camshaft gear root.

32



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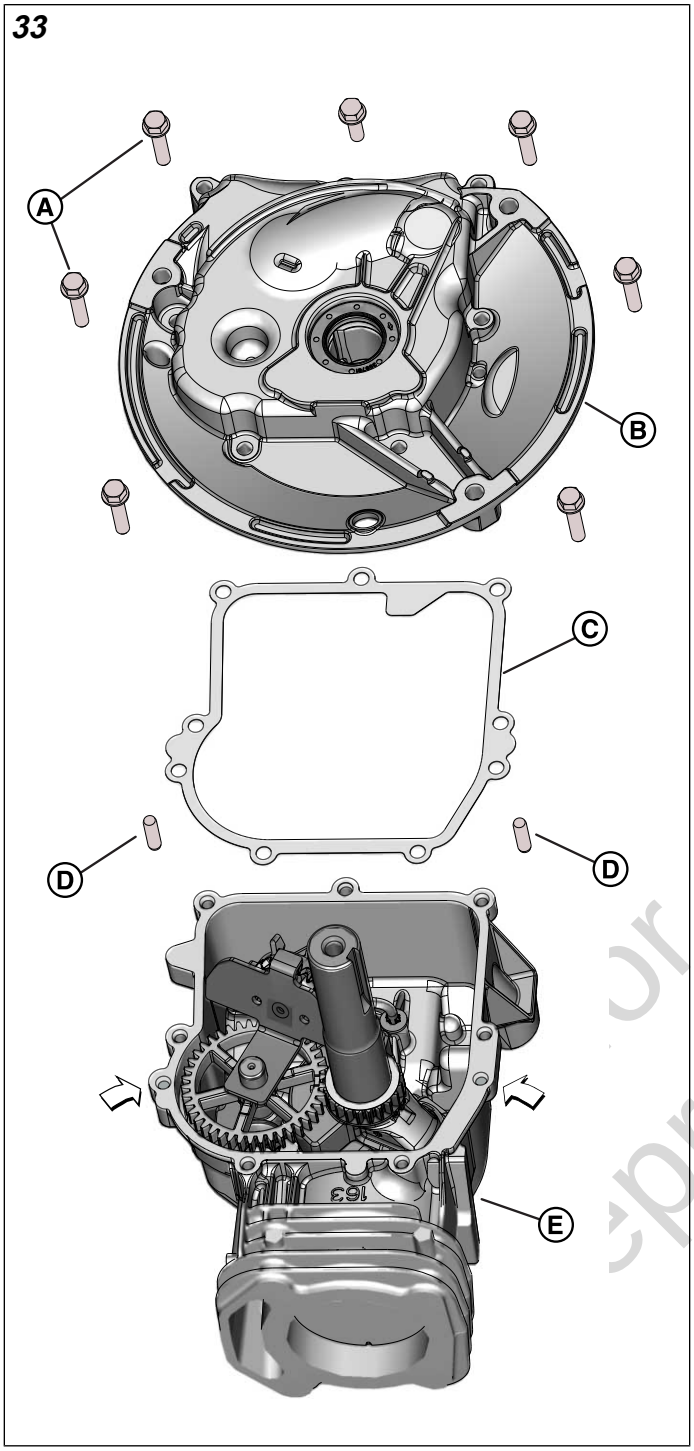

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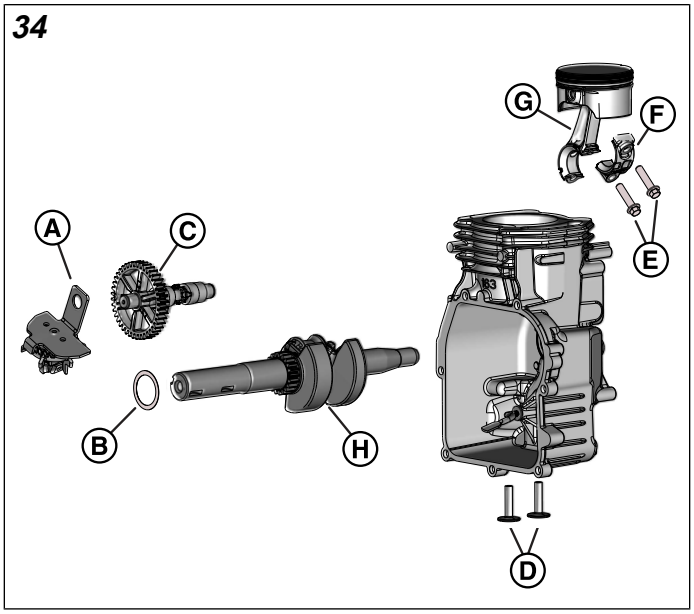

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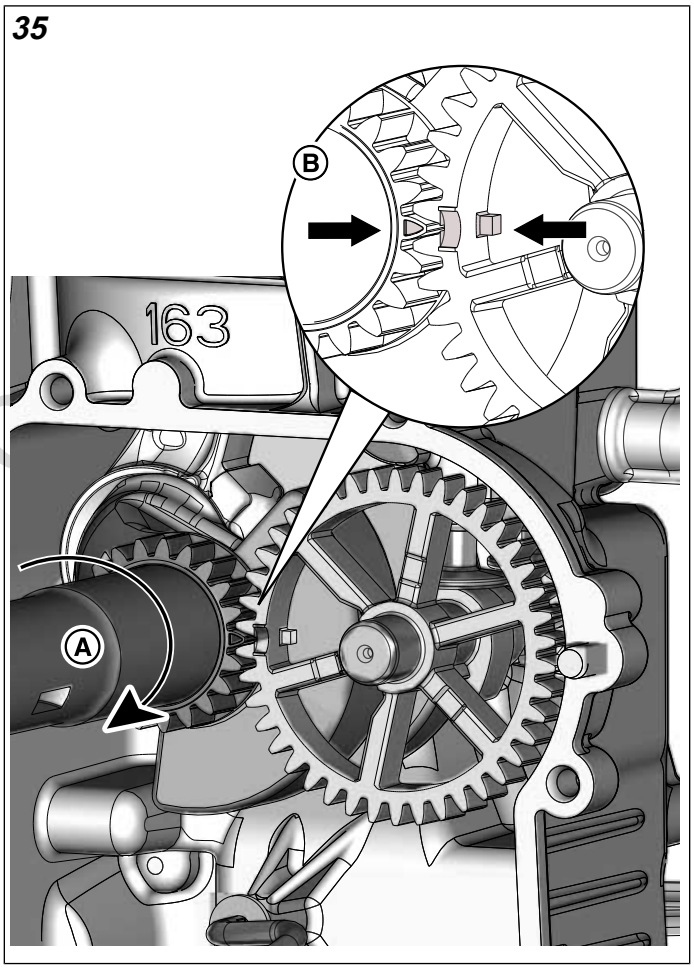

NOTE: Tappets are now clear of the camshaft lobes.

13. See Figure 34. Remove shim (**B**) from crankshaft.
14. Remove camshaft (**C**) from bearing bore in crankcase.
15. Remove tappets (**D**) from tappet bores. Tag each tappet as it is removed, so that it can be installed in its original location when the engine is assembled.
16. Rotate crankshaft until piston is at the bottom of its stroke.
17. See Figure 36. Use a plastic scraper to carefully remove carbon ridge at top of cylinder bore.

    NOTE: Failure to remove carbon ridge can result in piston ring breakage.

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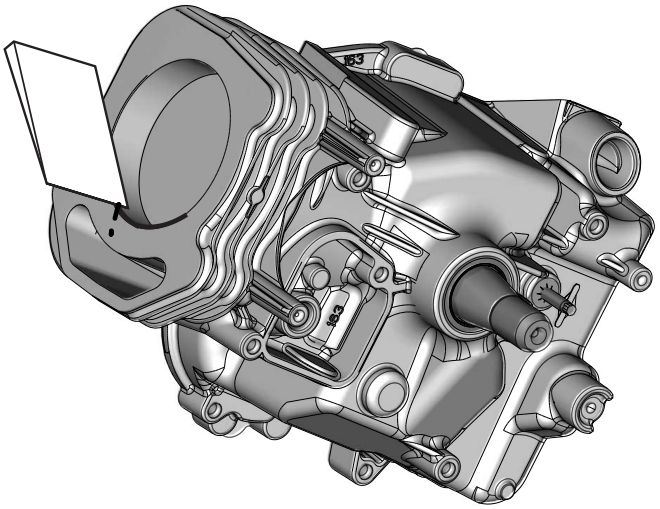

18. Rotate crankshaft as necessary to obtain best access to connecting rod cap screws.
19. See Figure 34. Remove two hex flange screws (**E**) to release connecting rod cap (**F**) from connecting rod (**G**).
20. Remove connecting rod and piston assembly from cylinder bore.
21. Remove crankshaft (**H**) from crankcase.
22. See the following topics under *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES:*
    - *PISTON AND CONNECTING ROD*
    - *FLYWHEEL, CRANKSHAFT AND CAMSHAFT*
    - *CRANKCASE AND CRANKCASE COVER.*

SECTION 6 – SERVICE ENGINE SUBASSEMBLIES

Disassembly

1. See Figure 37. Pack shop towels into the combustion chamber and place cylinder head on bench with the combustion chamber side down.
2. Remove exhaust valve as follows:
   A. See Figure 38. Remove valve cap (**A**).
   B. Using thumb pressure, press down on valve spring retainer (**B**) to disengage from valve stem groove. Guide valve stem into larger offset hole in valve spring retainer and then relieve valve spring tension as shown in Figure 37.
   C. Remove valve spring retainer and valve spring (**C**).
   D. Remove valve (**D**) from valve guide.
   E. Mark the bottom of the valve to identify it as the exhaust valve. Bag the valve, valve cap, valve spring retainer, and valve spring, so that all parts can be installed in their original locations at time of assembly.
3. Remove intake valve as follows:
   A. Remove valve cap (**E**).

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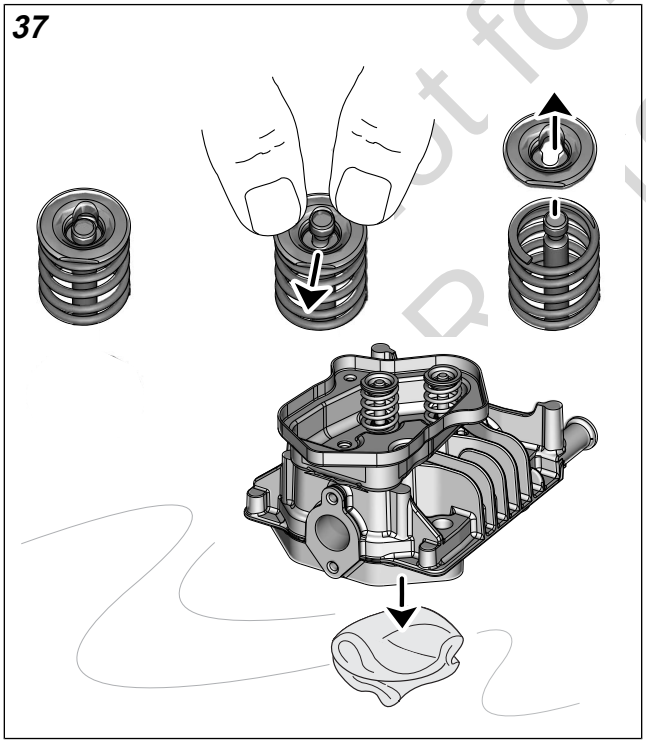

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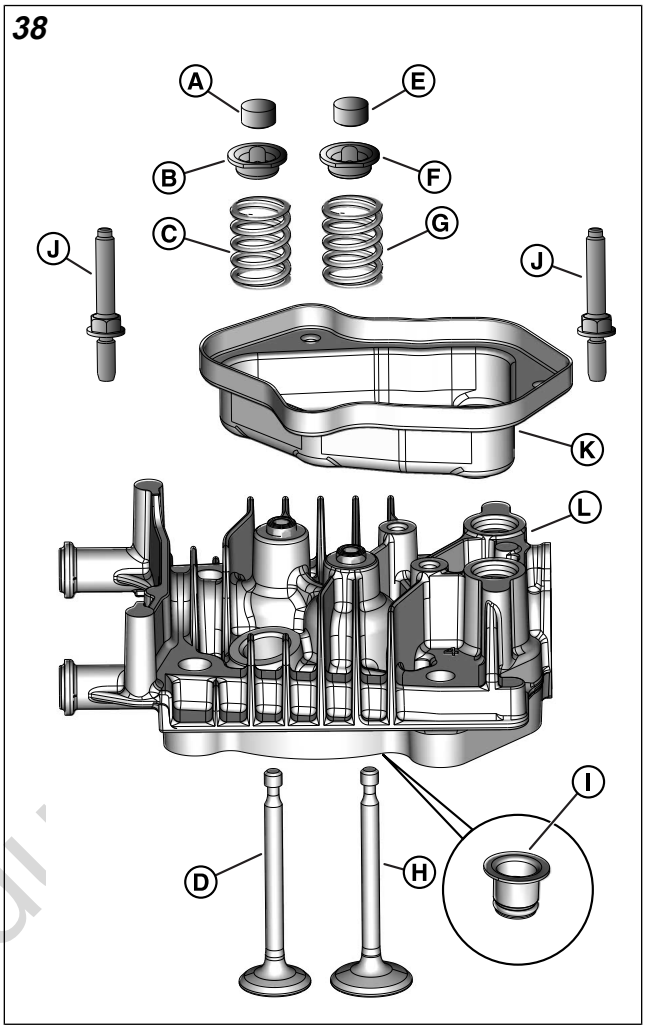

B. Using thumb pressure, press down on valve spring retainer (**F**) to disengage from valve stem groove. Guide valve stem into larger offset hole in valve spring retainer and then relieve valve spring tension as shown in Figure 37.
C. Remove valve spring retainer and valve spring (**G**).
D. Inspect valve spring retainer groove for burrs that could damage the valve stem seal during valve removal. Remove any slight burrs with a fine-tooth file. Lightly lubricate valve spring retainer groove with clean engine oil, and then remove valve (**H**) from valve guide.

   NOTE: Carefully inspect valve stem seal (**I**) for nicks, cuts, cracks, or general deterioration. Remove and discard valve stem seal if any damage is observed. Gently grip the seal with a pliers and pull using a twisting motion.

E. Mark the bottom of the valve to identify it as the intake valve. Bag the valve, valve cap, valve spring retainer, and valve spring, so that all parts can be installed in their original locations at time of assembly.

F. For thorough cleaning, or if cylinder head plate is damaged or leaking, remove rocker arm studs (**J**), and then remove cylinder head plate (**K**) from cylinder head (**L**).

Cleaning

1. See Figure 39. Using a plastic scraping tool, carefully remove old gasket material from the cylinder head. Gasket material left on sealing surfaces will cause leaks.
2. Remove all carbon deposits from combustion chamber and machined surfaces of cylinder head. Exercise caution to avoid removing any metal material. For best results, use an air tool with a **worn** fine wire brush. Scraping may result in scratches or nicks.

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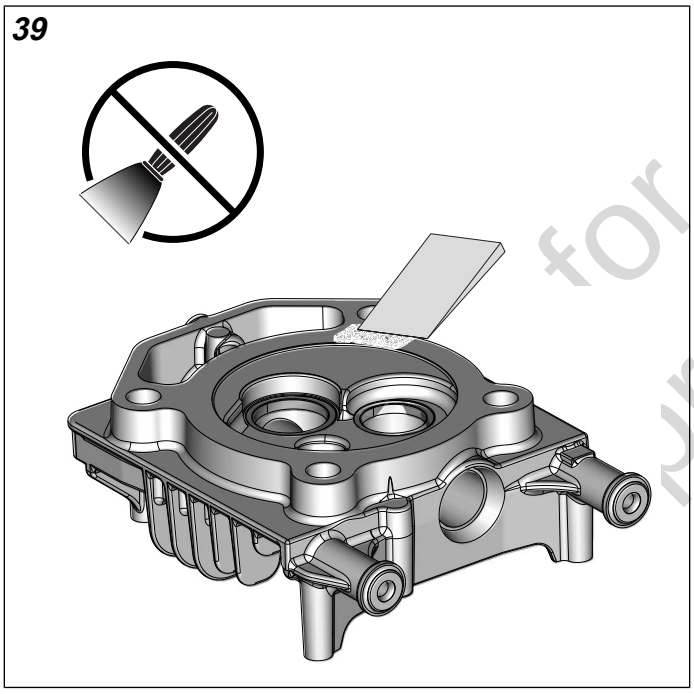

3. To soften stubborn deposits, soak the cylinder head in a suitable chemical solution or other carbon and gum dissolving agent. Repeat steps 1-2 as necessary.

   NOTE: Do not use glass or sand to bead blast surfaces exposed to the engine oil. Bead blasting materials become lodged in the pores of the casting where they cannot be removed through ordinary cleaning methods. Only after the engine is put to use will heat expansion cause this material to be released, and the resulting oil contamination will accelerate wear and lead to engine failure.

4. Thoroughly clean the cylinder head, valves, valve springs, valve spring retainers, valve caps, tappets, pushrods, and rocker arms in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water. Blow dry with low pressure compressed air.

Inspection

Cylinder Head

1. Check for scratches and nicks on all gasket sealing surfaces.
2. Check condition of spark plug threads. If necessary, soften deposits with penetrating oil and clean out with a thread chaser.

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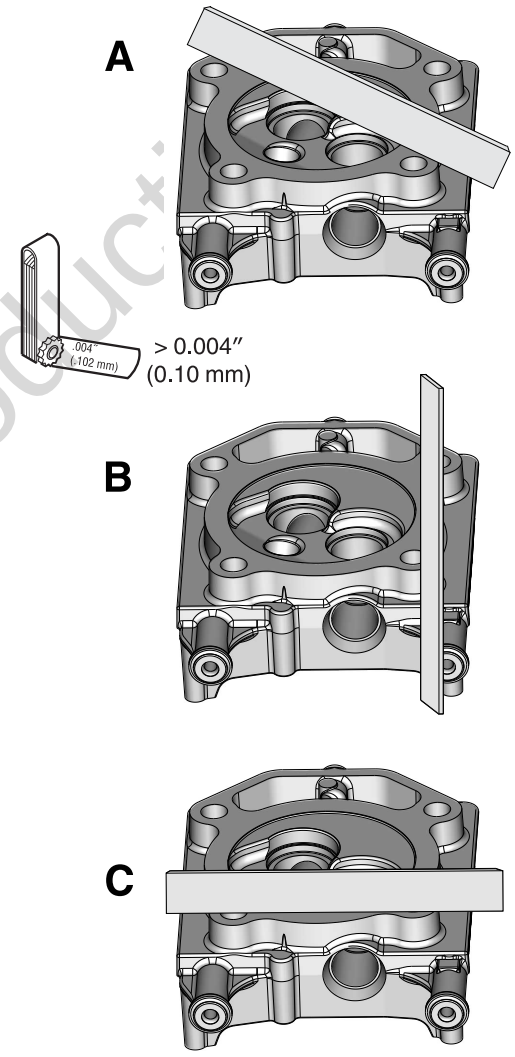


3. Check the cylinder head to cylinder mating surface for warpage or distortion. Discard the cylinder head if any low spot is **0.004 inches** (0.10 mm) or more. Proceed as follows:
   A. See A of Figure 40. With the combustion chamber side facing up, set a straightedge diagonally across the length of the cylinder head gasket surface.
   B. Slide a feeler gauge beneath the straightedge to check for warpage.
   C. Check the opposite diagonal to verify that the gasket surface is flat.
   D. See B of Figure 40. Set a straightedge vertically across the length of the cylinder head gasket surface. Use feeler gauge to check for warpage. Repeat step on opposite side.
   E. See C of Figure 40. Set a straightedge horizontally across the length of the cylinder head gasket surface. Use feeler gauge to check for warpage. Repeat step on opposite side.
4. Visually inspect the cylinder head for cracks or discoloration due to excessive heat. Replace cylinder head if either of these conditions are found.
5. Verify that breather hole, and intake and exhaust ports are clean and open.

Valve Guides

1. Inspect external surface of valve guides for cracks (particularly the combustion chamber side). Replace the cylinder head if cracks are found.
2. To verify cleanliness, lightly hone bore using a suitable valve guide hone and then scrub with a valve guide cleaning brush to remove any dirt or debris.
3. Measure the inside diameter using an inside ball micrometer or plug gauge. Replace the cylinder head if the measurement is **0.203 inches** (5.16 mm) or more.

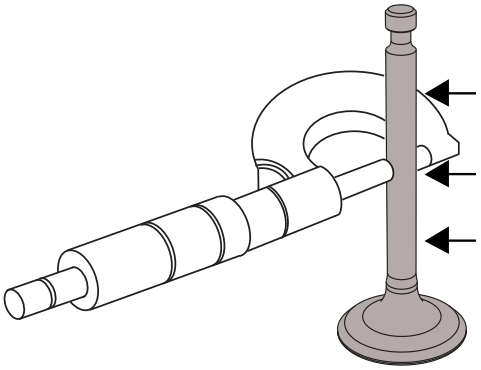
Valve Seats

1. Inspect valve seats for cracking, chipping or burning. Replace cylinder head if any of these conditions are found or if either valve seat is loose.

Valves

1. Replace the valve if bent or if there is evidence of burning or cracking.
2. Inspect the end of the valve stem for pitting or uneven wear. Replace the valve if either of these conditions are found.

41



3. Inspect the valve stem retainer groove for burrs, damage or excessive wear. Remove burrs with a fine tooth file if found.
4. Polish the valve stem with fine emery cloth or steel wool to remove carbon buildup.
5. See Figure 41. Measure the top, center and bottom of the intake valve stem using an outside micrometer. Replace the intake valve if any measurement is **0.191 inches** (4.84 mm) or less.
6. Measure the top, center and bottom of the exhaust valve stem. Replace the exhaust valve if any measurement is **0.191 inches** (4.84 mm) or less.
7. Hold each valve against a worn wire wheel in a bench grinder to remove all carbon deposits from the valve head and face, but exercise caution to avoid removing any metal material.
8. Inspect intake valve face and seat. If only minimal wear is found, lap the valve face and seat as follows:
   A. Obtain fine Valve Lapping Compound (Part No. 94150).
   B. Apply lapping compound sparingly around the entire valve face and valve seat.
   C. Lightly lubricate the valve guide and valve stem with clean engine oil.
   D. See A of Figure 42. From the bottom of the cylinder head, insert the valve stem into the valve guide.
   E. Push on bottom of valve until it contacts the valve seat.
   F. Obtain the Valve Lapping Tool (Part No. 19258).
   G. See B of Figure 42. Attach suction cup at end of tool to valve head. Holding shank of tool between the palms of both hands, oscillate the tool approximately 20° back and forth a few times.
   H. Remove valve from the cylinder head and thoroughly clean the valve face and valve seat of any lapping compound. Use a clean rag dipped in mineral spirits for good results.

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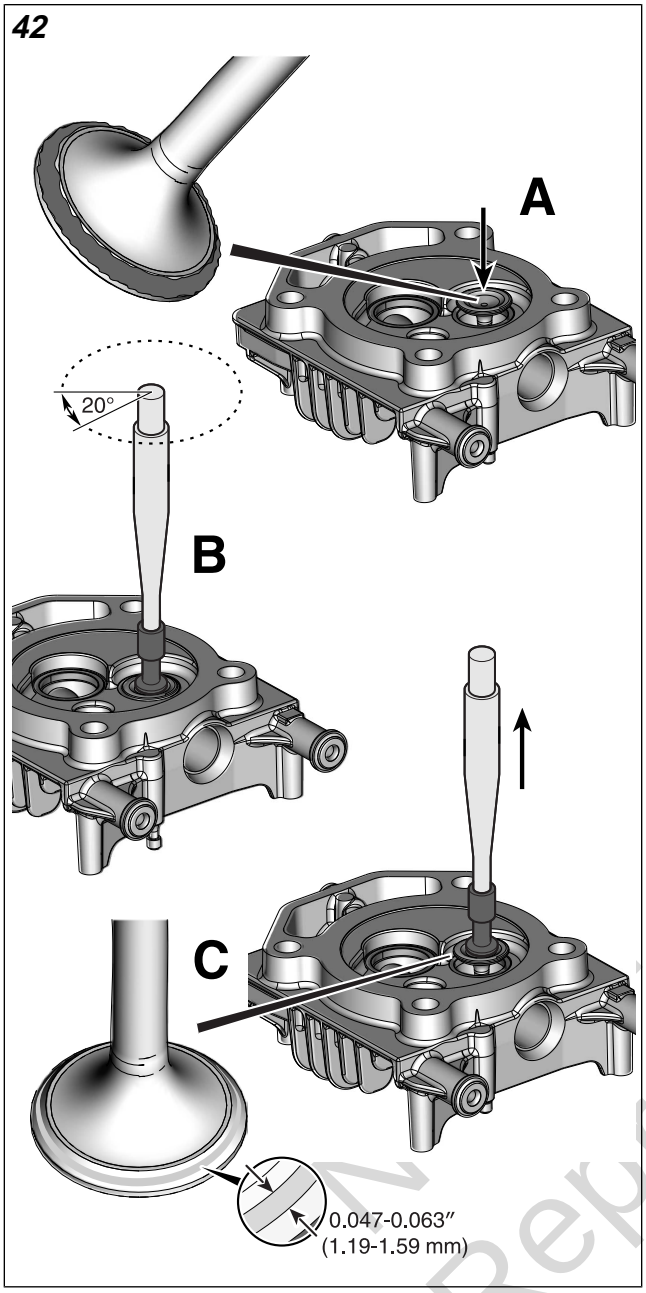

I. See C of Figure 42. Carefully inspect the seating surface on the valve face. A properly lapped valve shows a gray, frosty seating surface located near the center of the valve face. Verify that the lapped surface extends evenly and completely around the entire valve face with a contact area **0.047-0.063 inches** (1.19-1.59 mm) wide.

Carefully inspect the seating surface on the valve seat. The valve seat should also show an unbroken lapped finish of uniform width.

9. If the desired results are not observed, obtain the Master Seat Cutter Kit (Part No. 19547) and proceed as follows:

NOTE: Carefully read manufacturer's directions for proper assembly and use of tool.

A. Install the proper sized pilot in the valve guide.

NOTE: Do not drop the cutter onto the valve seat during installation or removal, as the blades may cause seat damage that requires additional cutting.

NOTE: Applying too much pressure or rotating the cutter too fast will produce chatter marks that adversely affect sealing integrity. Rotate the cutter slowly, so that it takes about three seconds to make one complete rotation.

B. See Figure 43. Install the 60° cutter on the pilot to make the bottom-narrowing cut. Rotate the cutter three of four turns, so that it cuts all the way around the valve seat.

C. Install the 31° cutter to make the top-narrowing cut.

D. Install the 46° base angle cutter and cut the seat contact area until it is approximately **0.047-0.063 inches** (1.19-1.59 mm) wide.

E. Use low pressure compressed air to thoroughly remove all cutting chips and metal shavings. Remove pilot from valve guide.

F. Lap the valve face and seat a second time to verify location and width of the seat contact area.

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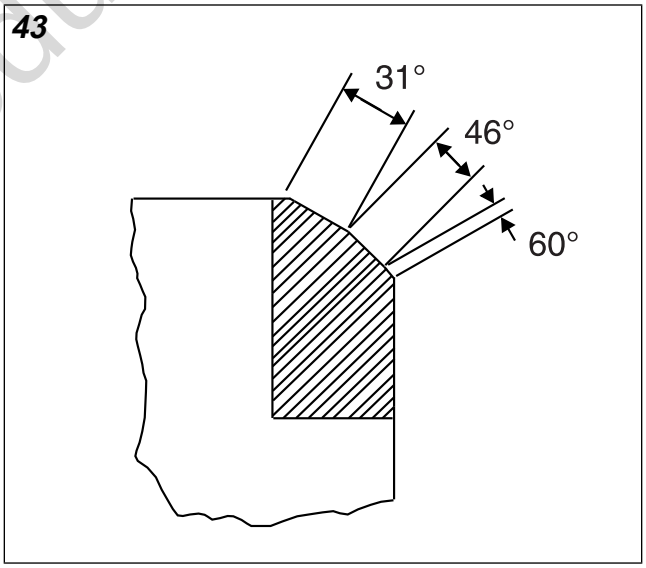


G. If the seat contact area is too narrow, recut using the 46° base angle cutter.

H. If the seat contact area is too wide, repeat steps 9(B) and 9(C).

10. Perform steps 8-9 on the exhaust valve.

Valve Springs

1. Inspect valve springs for broken or discolored coils. Replace springs if either of these conditions are found.
2. Set the intake and exhaust valve springs on a level surface and use a straightedge to check for proper squareness and equivalent height. Too much height may correspond to a reduction in spring pressure which results in sluggish valve action.

Valve Spring Retainers

1. Inspect parts for rust pits or corrosion. Replace as necessary.
2. Inspect inside diameter for damage or excessive wear. Center must be well defined without distortion.

Tappets, Push Rods, and Rocker Arms

1. Inspect tappet sockets for signs of scuffing, pitting or general wear.
2. Tappet faces may appear to have smooth surfaces, but still have concave wear. Hold a straight edge across the tappet face. Any concave wear found on the tappet faces may also indicate worn camshaft lobes.
3. Roll push rods on a flat surface to determine if they are bent. Replace push rods that are bent, dented, broken or discolored. Replace the push rod if the ball ends show signs of excessive wear or damage. For best practices, replace push rods in pairs.
4. Check rocker arms for uneven wear or pitting where contact is made with the valve stem tips. Check for concave wear where rocker arms contact the push rod ends. Replace the rocker arm if excessive wear is found at either location, or if pitted, deformed, or scored.

Assembly

1. See Figure 44. If cylinder head plate (**A**) was removed for thorough cleaning, or if it was damaged or leaking, proceed as follows:

   A. Verify that mating surfaces of cylinder head and cylinder head plate are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.

WARNING

Vapors of silicone sealant are flammable. Keep away from heat, sparks, flame, and other ignition sources. Use in a well ventilated area. Keep container closed when product is not in use. Inadequate safety precautions can cause a fire or explosion resulting in death or serious injury.

CAUTION

Contact with vapors of silicone sealant can cause eye irritation and/or respiratory tract discomfort. Direct contact with uncured product can cause skin irritation. Wear appropriate personal protection, and wash thoroughly after handling.

   B. Apply a bead of Silicone Sealant (Part No. 100106) around each hole in the cylinder head plate. Bead must be a continuous closed loop.

      NOTE: Cylinder head plate must be installed within five minutes of sealant application. If time limit is exceeded, remove sealant and reapply.

   C. Place cylinder head plate onto cylinder head (**B**).

   D. Install rocker arm studs (**C**) through cylinder head plate and into cylinder head. Alternately tighten rocker arm studs to **40-60 lb-in** (4.5-6.8 N-m).

2. Install exhaust valve (**D**) assembly as follows:

   A. Apply a suitable engine assembly lube to the valve stem.

      NOTE: If the valves were not tagged during disassembly, remember that the exhaust valve always has the smaller valve face diameter.

   B. From the bottom of the cylinder head, insert the valve stem into the valve guide.

   C. To distribute the assembly lube evenly around the valve stem and guide, hand spin the valve as it is installed. Work the valve back and forth in the bore to verify that it slides smoothly and seats properly.

   D. Using a suitable degreaser, thoroughly clean valve face, valve guide, and end of valve stem of any excess assembly lube.

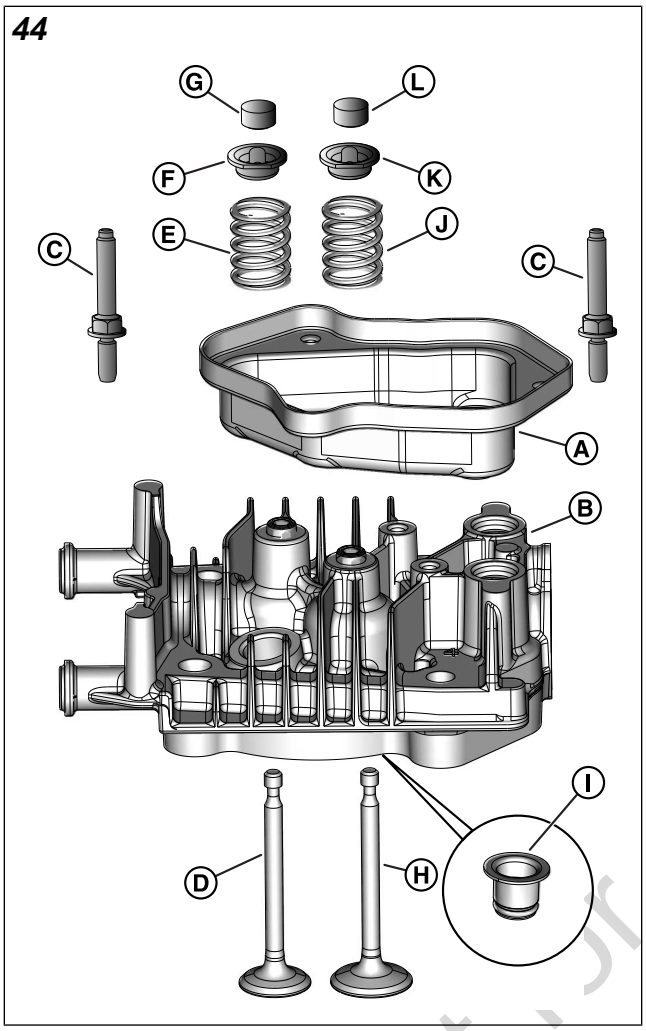
   E. Install valve spring (**E**) over the valve stem and valve guide.

   F. Set the valve spring retainer (**F**) on top of the valve spring. Using thumbs to compress valve spring, guide the end of the valve stem through the larger offset hole in the valve spring retainer. Continue pressing down until the smaller center hole engages the valve stem groove.

   G. Verify that the axis of the valve spring is parallel to the valve stem. A slanting or leaning valve spring will result in premature valve guide wear.

   H. Lightly tap the end of the valve stem once or twice with a soft mallet to ensure that valve spring retainer is tightly seated in the valve stem groove.

   I. Install valve cap (**G**) on end of valve stem.



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3. See Figure 44. Install intake valve (**H**) assembly as follows:

NOTE: To install **new** valve stem seal (**I**), lightly lubricate inside diameter with clean engine oil, and place over valve guide. Obtain the appropriately sized socket or seal installation tool, and using a small hammer, gently tap end of tool until seal lightly bottoms on cylinder head.

A. Apply a suitable engine assembly lube to the valve stem.

B. From the bottom of the cylinder head, insert the valve stem into the valve guide.

C. To distribute the assembly lube evenly around the valve stem and guide, hand spin the valve as it is installed. Work the valve back and forth in the bore to verify that it slides smoothly and seats properly.

D. Using a suitable degreaser, thoroughly clean valve face, valve guide, and end of valve stem of any excess assembly lube.

E. Install valve spring (**J**) over the valve stem and valve guide.

F. Set the valve spring retainer (**K**) on top of the valve spring. Using thumbs to compress valve spring, guide the end of the valve stem through the larger offset hole in the valve spring retainer. Continue pressing down until the smaller center hole engages the valve stem groove.

G. Verify that the axis of the valve spring is parallel to the valve stem. A slanting or leaning valve spring will result in premature valve guide wear.

H. Lightly tap the end of the valve stem once or twice with a soft mallet to ensure that valve spring retainer is tightly seated in the valve stem groove.

I. Install valve cap (**L**) on end of valve stem.

4. Cover the cylinder head to protect it from dust and dirt until time of installation.

Disassembly

1. See Figure 45. Insert small pick into pick lock groove and pull piston pin lock ring out of pin boss groove. Discard lock ring.

CAUTION

Always wear proper eye protection when removing piston pin lock ring. Slippage can propel the ring with enough force to cause eye injury.

2. Push piston pin toward open pin boss to remove from piston and upper connecting rod.
3. Obtain the Piston Ring Expander (Part No. 19340).

CAUTION

Always wear proper eye protection when removing compression and oil wiper rings. Slippage may propel the ring with enough force to cause eye injury.

4. See Figure 46. Remove compression ring from the top ring groove.

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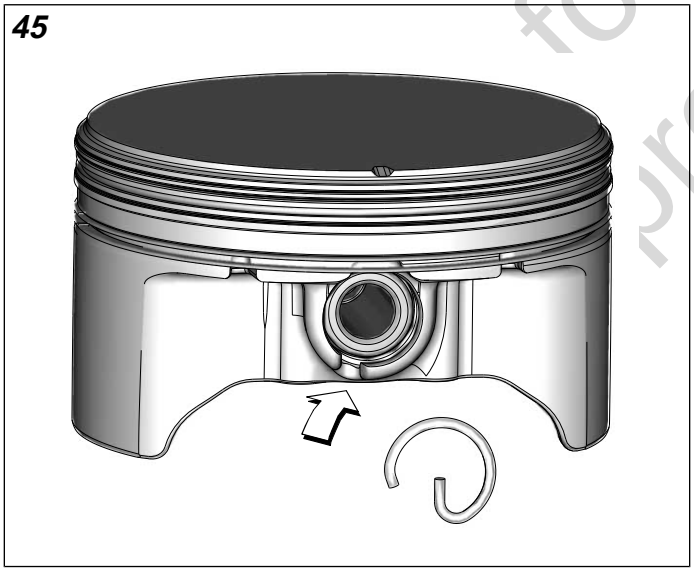

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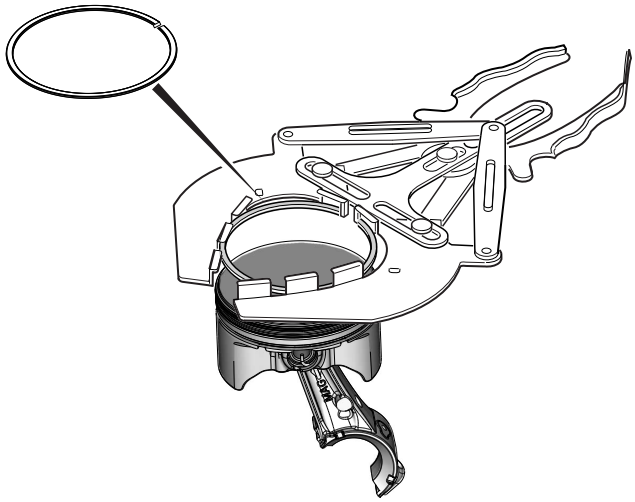
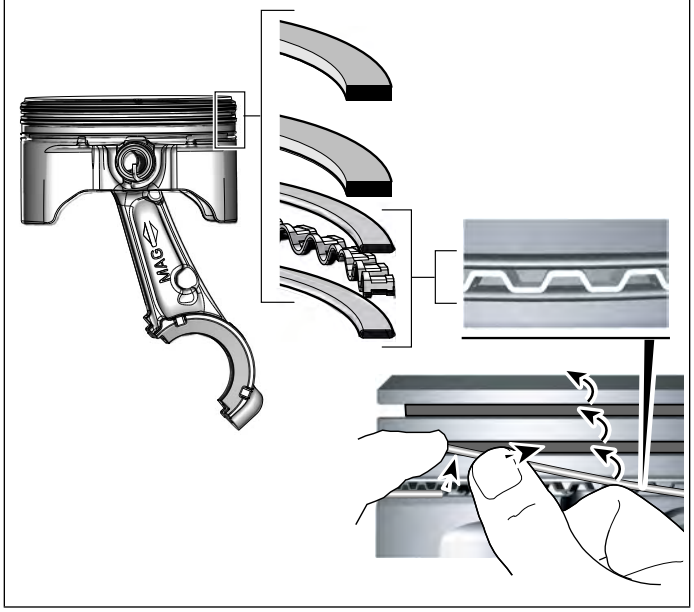


5. Remove oil wiper ring from the middle ring groove.
6. Remove oil control ring from the bottom ring groove. Proceed as follows:
   - Remove the expander spring.
   - See Figure 47. Spiral or wind the upper steel rail from the bottom ring groove into the middle ring groove. Repeat action to move the rail into the top ring groove and then off the piston.
   - Repeat above step to remove the lower steel rail.

47



Cleaning

Piston

1. Do not sand blast or glass bead blast piston. Bead blasting rounds the ring lands and will result in high oil consumption and blow-by of exhaust gases. Blow-by of exhaust gases contaminates the engine oil supply, and reduces engine efficiency by weakening the combustion seal necessary for efficient transfer of energy to the piston.
2. To remove all carbon and combustion deposits, soak the piston in a special detergent that will not corrode aluminum. Maintain the temperature of the cleaning solution well below 212° F. (100° C.).
3. Thoroughly rinse the piston and dry with moisture free compressed air.
4. Thoroughly clean the three piston ring grooves of all carbon deposits. A broken compression ring properly ground to a sharp chisel-like edge can be used for this purpose.
5. Verify that the piston pin lock ring groove is clean and free of dirt and grime.
6. Clean oil drain back holes leading from the oil control ring groove to the underside of the piston crown. Use a soft bristle brush and compressed air to ensure cleanliness. Do not use a wire brush or the holes may be enlarged.
7. If present, verify that set of oil drain back holes at top of piston skirt are clean and open.

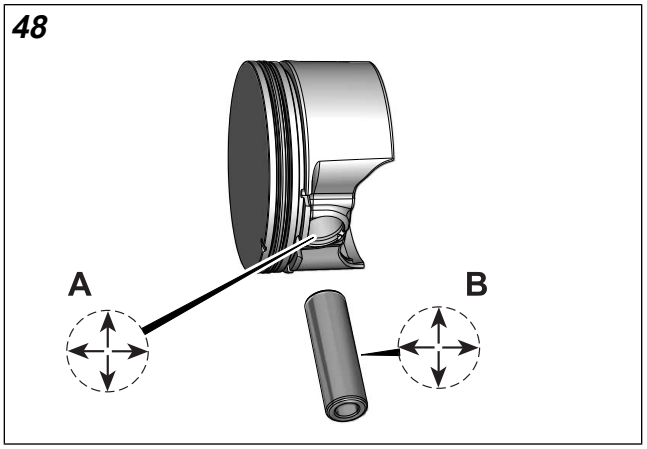
Connecting Rod

1. Thoroughly clean parts in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water.
2. Blow dry with low pressure compressed air.
3. Verify that oil holes in connecting rod shank and at top of piston pin bore are clean and open.

Inspection

Piston and Pin

1. Carefully inspect the piston for damage or excessive wear. Proceed as follows:
   A. Inspect the piston for cracks. Pay special attention to the area around the pin bores and oil drain back holes beneath the piston crown.
   B. Check piston for cracked, broken or bent ring lands.



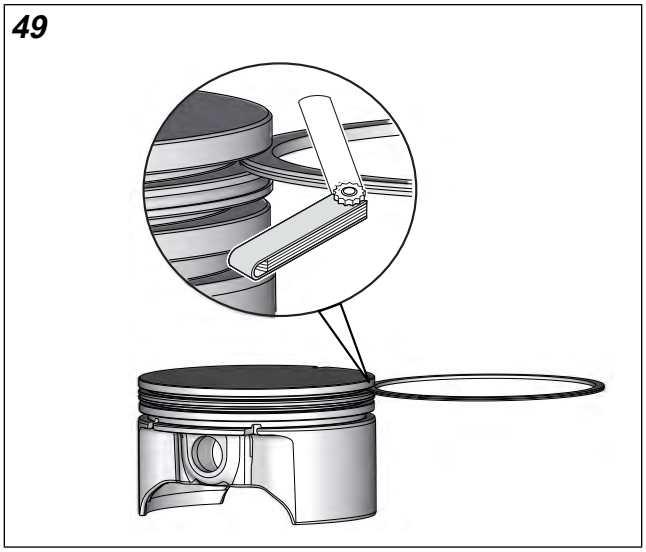
   C. Check piston skirt for cracks, gouges, deep scratches or heavy scoring.
   D. Check piston head for evidence of burning, etching or melting.
   E. Look for marks or imprints caused by contact with valves.

NOTE: A piston with superficial wear marks, minor scratching or mild scoring may continue to be used.

2. Lightly oil a good piston pin and insert it into the piston pin bore to feel for proper fitment. The pin should slide in and out without binding, but also without pivoting or rocking.
3. See A of Figure 48. Using an inside micrometer or dial vernier caliper, measure the piston pin bore diameter at two locations- parallel and perpendicular to the crankshaft. Replace the piston if either measurement is **0.493 inches** (12.521 mm) or more.
4. See B of Figure 48. Using an outside micrometer, measure the outside diameter of the piston pin at two locations- parallel and perpendicular to the crankshaft. Replace piston pin if either measurement is **0.489 inches** (12.408 mm) or less.
5. Run your index finger around the edge of the piston crown to feel for dings, nicks or burrs. Lightly file the edge of the crown to remove any defects.
6. Measure the piston ring side clearance as follows:

NOTE: Worn ring grooves result in high oil consumption and blow-by of exhaust gases. Blow-by of exhaust gases contaminates the engine oil supply, and reduces engine efficiency by weakening the combustion seal necessary for efficient transfer of energy to the piston.

   A. See Figure 49. Insert the edge of a **new** compression ring into the top piston ring groove. Insert a feeler gauge between the upper surface of the ring and the ring land.



B. Since the grooves wear unevenly, repeat this check at several locations around the piston ring groove circumference.

C. Discard the piston if any measurement is **0.011 inches** (0.279 mm) or more.

NOTE: Only the top compression ring side clearance needs to be checked.

Piston Rings

NOTE: Always use **new** piston rings. Recondition (deglaze) or resize (hone) cylinder before installing new rings.

1. Before placing each ring on the piston, perform the following check.

   NOTE: Insufficient ring end gap may cause the ends to abut at engine operating temperatures, resulting in ring breakage, cylinder scuffing and/or piston seizure. Excessive ring end gap results in high oil consumption and blow-by of exhaust gases. Blow-by of exhaust gases contaminates the engine oil supply, and reduces engine efficiency by weakening the combustion seal necessary for efficient transfer of energy to the piston.

   A. Obtain **new** top compression ring.

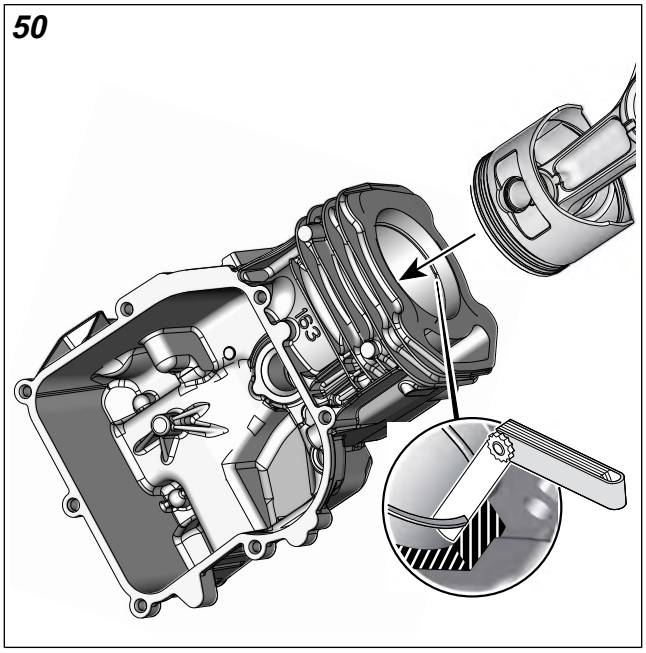
   B. See Figure 50. Insert ring approximately one inch (25.4 mm) into cylinder bore.

   C. Square ring in the bore using the top of the piston.

   D. Measure the ring end gap with a feeler gauge.

   E. Do not use the top compression ring if the end gap is **0.039 inches** (0.989 mm) or more.

   F. Repeat steps 1(B) thru 1(D) using **new** middle oil wiper ring. Do not use the ring if the end gap is **0.066 inches** (1.674 mm) or more.

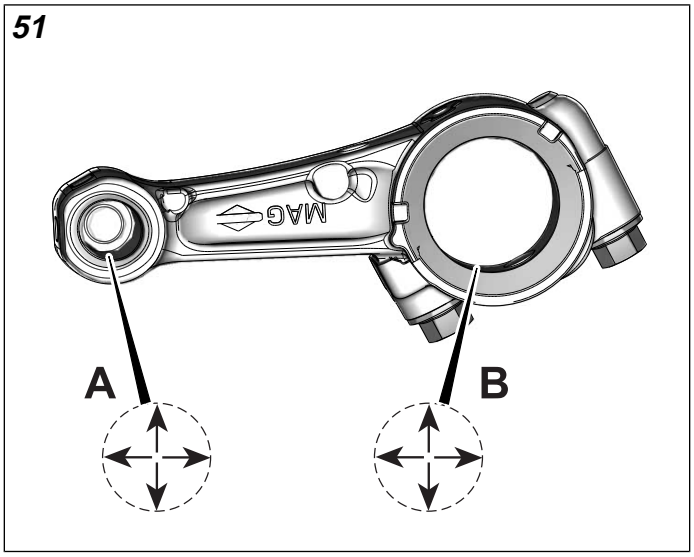


G. Repeat steps 1(B) thru 1(D) using rails of **new** oil control ring. Do not use the ring if the end gaps are **0.065 inches** (1.652 mm) or more.

Connecting Rod

1. Inspect the connecting rod for cracks, twisting or bending.
2. Inspect bearing surfaces for scratches or scoring.

   NOTE: Replace connecting rod and cap if any of the above conditions are found. Always replace connecting rod and cap as an assembly.



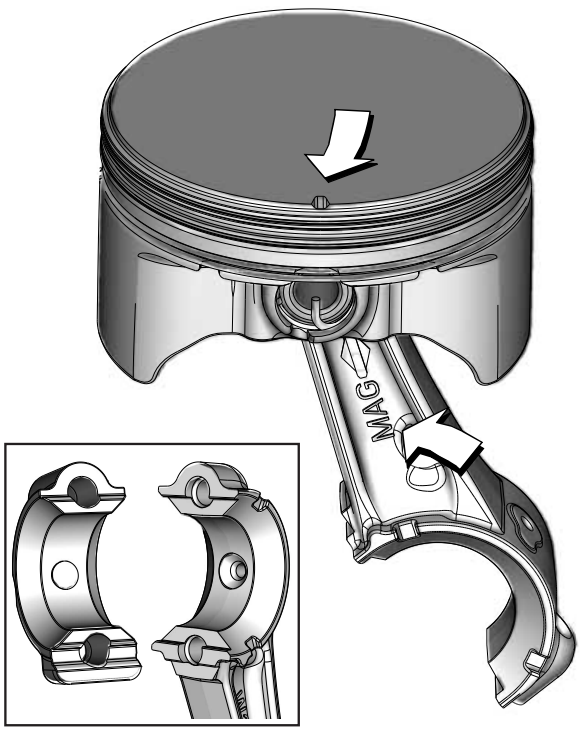
3. Start two hex flange screws to fasten connecting rod cap to connecting rod. Alternately tighten screws to **90-105 lb-in** (10.2-11.9 N-m).

   NOTE: See inset of Figure 52. The contoured mating surfaces allow the connecting rod and cap to fit only one way.
4. Obtain Telescoping Gauge (Part No. 19485) and inside micrometer or plug gauge.
5. See A of Figure 51. Measure piston pin bearing bore diameter at two locations- parallel and perpendicular to the crankshaft. Replace connecting rod if either measurement is **0.493 inches** (12.518 mm) or more.
6. See B of Figure 51. Measure the crank pin bearing bore diameter at two locations- parallel and perpendicular to the crankshaft. Replace the connecting rod if either measurement is **1.003 inches** (25.465 mm) or more.
7. Remove two hex flange screws to release connecting rod cap.

Assembly

1. Apply clean engine oil to piston pin, piston pin bosses, and upper connecting rod bearing.
2. See Figure 52. Place piston over connecting rod end, so that the notch on the piston crown is on the same side as the word **MAG** on the connecting rod shank.

52



3. Insert piston pin through piston pin bore and upper connecting rod bearing. Push pin until it contacts opposite pin boss.

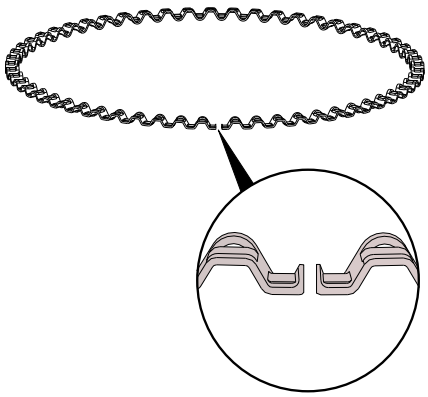
   NOTE: Do not reuse piston pin lock ring after it has been removed. The lock ring may weaken or become distorted during removal causing it to break or dislodge during engine operation.
4. Install **new** piston pin lock ring into pin bore groove, so that end of the lock ring is 90° from the pick lock groove. Exercise care to avoid kinking, stretching, or distorting lock ring. Verify that lock ring is fully seated in the groove.

CAUTION

Always wear proper eye protection when installing piston pin lock ring. Slippage can propel the ring with enough force to cause eye injury.

5. Use compressed air to remove any dirt or dust that may have settled in the oil drain back holes and piston ring grooves.
6. Apply clean engine oil to three piston ring grooves.
7. Install the oil control ring into the bottom ring groove. Proceed as follows:
   - See Figure 53. Install expander spring, so that the gap ends point toward the piston crown.
   - See Figure 54. Spiral bottom oil rail into space below expander spring.
   - Spiral top oil rail into space above expander spring.

53



8. Obtain the Piston Ring Expander (Part No. 19340).

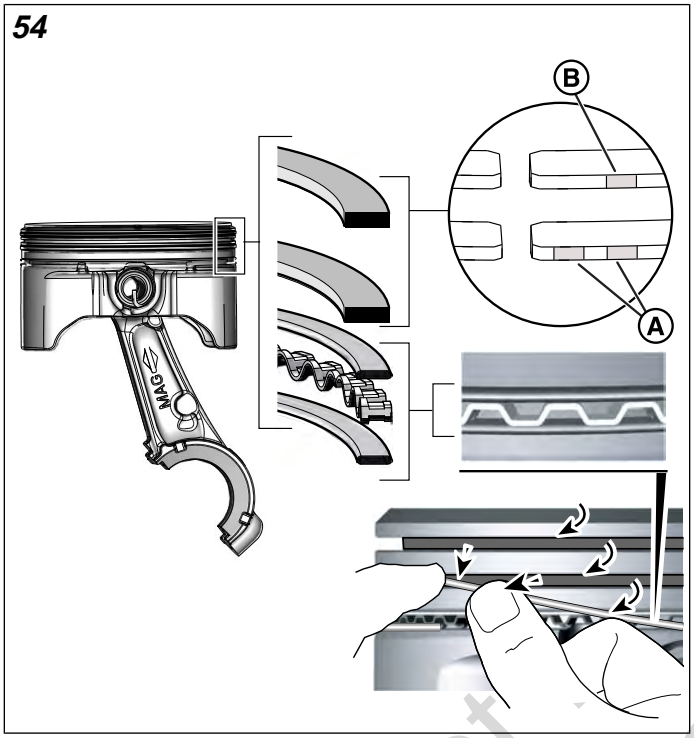
   NOTE: Always use the piston ring expander to prevent excessive ring twist and expansion. Over expansion may cause the ring to crack opposite the ring gap. Damaged or distorted rings result in blow-by of exhaust

gases, increased oil consumption, and lower service life of valves and other components.

CAUTION

Always wear proper eye protection when installing compression and oil wiper rings. Slippage may propel the ring with enough force to cause eye injury.

54



9. See inset of Figure 54. Carefully install the oil wiper ring **(A)** into the middle ring groove, so that the two painted marks are to the right of the ring end gap.

   NOTE: Installing the oil wiper ring upside down will cause oil to be scraped up into the combustion chamber resulting in excessive oil consumption and lower service life on valves and other components.

10. Carefully install the compression ring **(B)** into the top ring groove, so that the single painted mark is to the right of the ring end gap.

11. Rotate piston rings using the palms of both hands. Verify that the rings rotate freely without sticking.

12. Stagger the ring end gaps around the piston. Proceed as follows:

    A. See Figure 55. Rotate expander spring, so that the gap is positioned at the front of the piston (**A**).

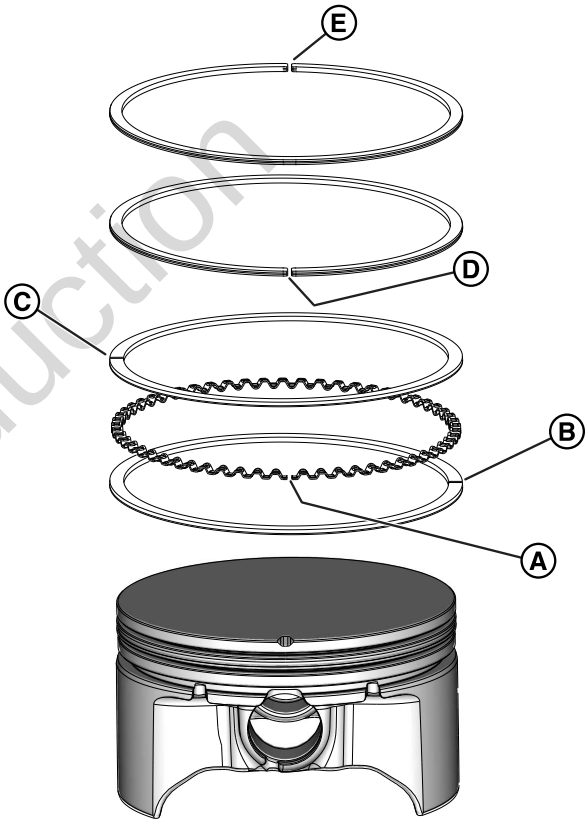
    B. Rotate bottom oil rail to position the gap 90° from the gap in the expander spring (**B**).

    C. Rotate top oil rail to position the gap 180° from the gap in the bottom oil rail (**C**).

    D. Rotate the middle oil wiper ring to align the gap with the gap in the expander spring (**D**).

    E. Rotate the top oil compression ring to position the gap 180° from the gap in the oil wiper ring (**E**).

55



Cleaning

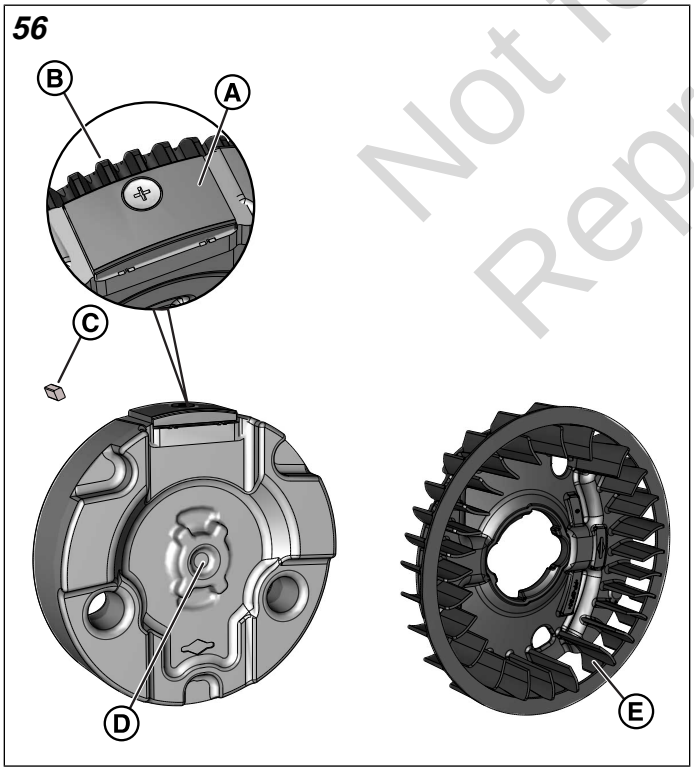
1. Thoroughly clean parts in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water.
2. Blow dry with low pressure compressed air.

Inspection

Flywheel

1. See Figure 56. Inspect flywheel magnet (**A**) for cracks, chips, or other damage. Check magnet for looseness.
2. If engine is equipped with electric start, check flywheel ring gear (**B**) for worn, cracked, chipped, or missing teeth.
3. Inspect flywheel key (**C**) for partial or complete shearing. Replace key if any damage is found.
4. Inspect flywheel keyway (**D**) for damage or distortion.
5. Inspect flywheel taper for scoring, scratches, cracks, or burrs. Remove any slight burrs with a fine-tooth file.
6. Inspect flywheel fan (**E**) for bent, cracked, chipped, or broken fins.

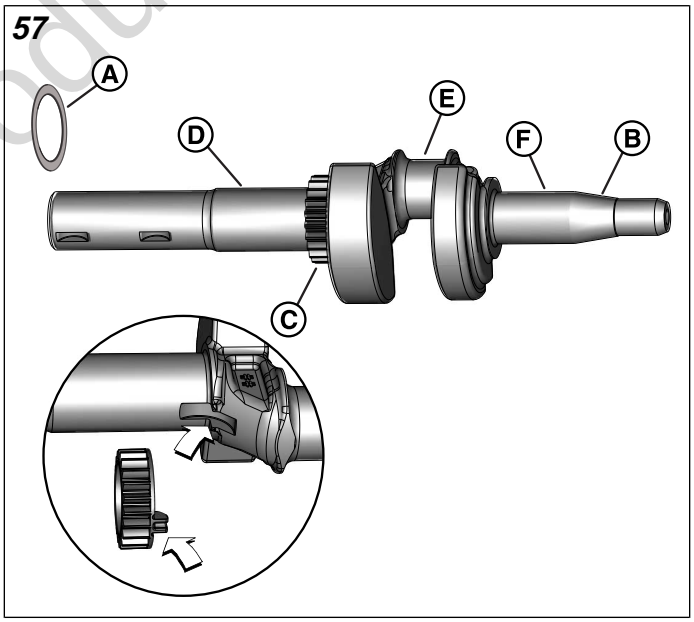
56



Crankshaft

1. See Figure 57. Inspect shim (**A**) for tears, holes, nicks, or other damage. Replace as necessary.
2. Inspect keyway (**B**) for damage or distortion.
3. Check crankshaft gear (**C**) for worn, cracked, chipped, or missing teeth. Remove gear from crankshaft and inspect index tab for damage. See inset of Figure 57.
4. Inspect crankshaft for straightness. DO NOT attempt to straighten bent crankshafts.
5. Inspect crankshaft taper for burrs, rust or other damage. Remove any slight burrs with a fine-tooth file.
6. Inspect crankshaft PTO bearing journal (**D**), crankpin journal (**E**), and MAG bearing journal (**F**) for scoring.
7. Using an outside micrometer, measure the crankpin journal diameter. Replace the crankshaft if measurement is **0.996 inches** (25.299 mm) or less.
8. Measure the MAG bearing journal diameter. Replace the crankshaft if measurement is **0.872 inches** (22.155 mm) or less.
9. Measure the PTO bearing journal diameter. Replace the crankshaft if measurement is **1.06 inches** (26.917 mm) or less.

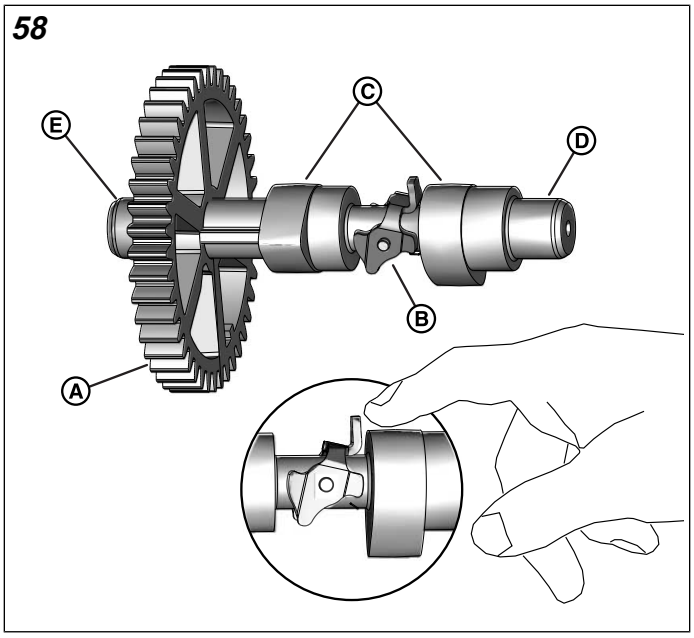
57



Camshaft

1. See Figure 58. Check camshaft gear (**A**) for worn, cracked, chipped, or missing teeth.
2. Inspect yoke and yoke spring on Mechanical Compression Release (MCR) mechanism (**B**) for damage or distortion.
3. Check operation of yoke. Gently push yoke release to the OPEN position, and then verify that it returns to the CLOSED position when released. See inset of Figure 58.

58



4. Check camshaft lobes (**C**) for scratching, scoring, or excessive wear.
5. Check MAG bearing journal (**D**) and PTO bearing journal (**E**) for scratching or scoring.
6. Using an outside micrometer, measure the MAG bearing journal and PTO bearing journal diameters. Replace the camshaft if either measurement is **0.497 inches** (12.625 mm) or less.

Disassembly

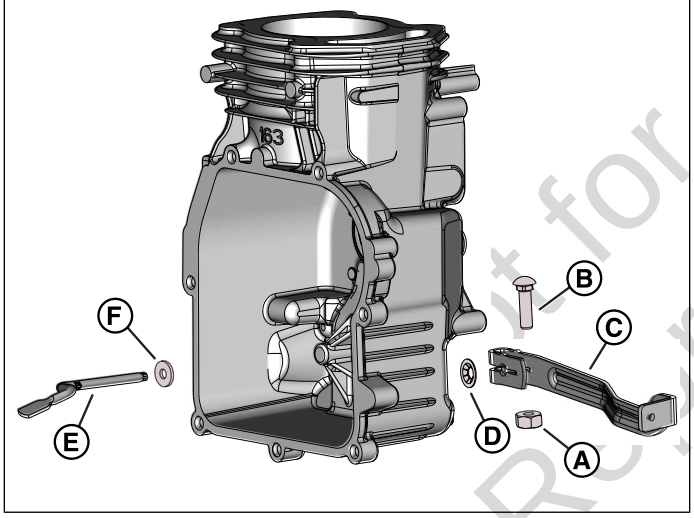
Crankcase

Governor Lever/Governor Crank

1. See Figure 59. Remove hex nut (**A**) from carriage bolt (**B**) on governor lever (**C**). Use a flat blade screwdriver to pry apart clamp end of governor lever and remove from governor crank.

   NOTE: Clamp end of governor lever is distorted during installation and removal. Discard governor lever, hex nut, and carriage bolt.
2. Remove push nut (**D**) from governor crank.
3. Remove governor crank (**E**) and flat washer (**F**) from inside crankcase.

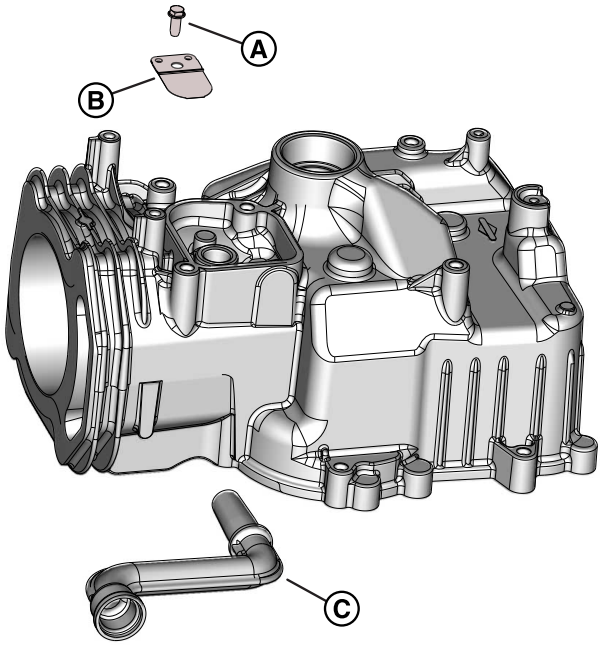
59



Crankcase Breather

1. See Figure 60. Remove hex flange screw (**A**) to release breather reed assembly (**B**) from crankcase.
2. Remove breather tube (**C**).

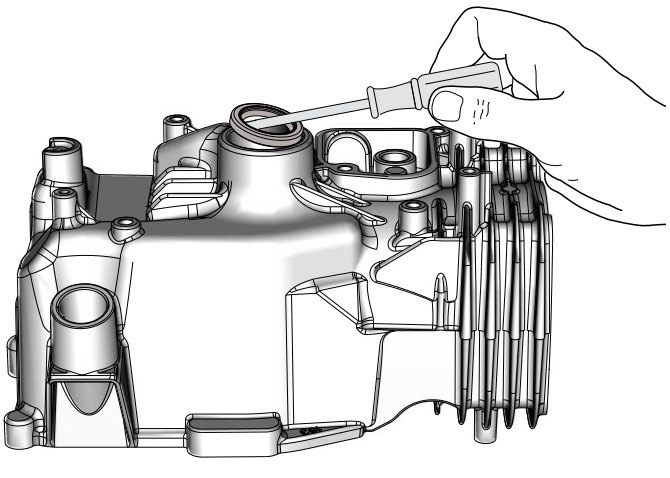
60



MAG Oil Seal

1. See Figure 61. Remove and discard oil seal from crankcase bearing bore. Exercise care to avoid scratching bearing bore during removal.

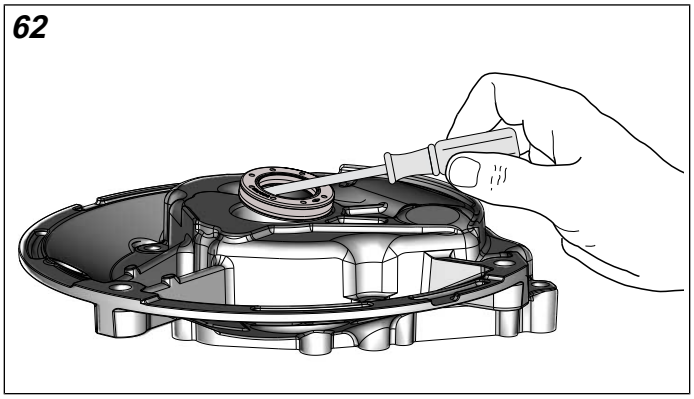
61



Crankcase Cover

PTO Oil Seal

1. See Figure 62. Remove and discard oil seal from crankcase cover bearing bore. Exercise care to avoid scratching bearing bore during removal.



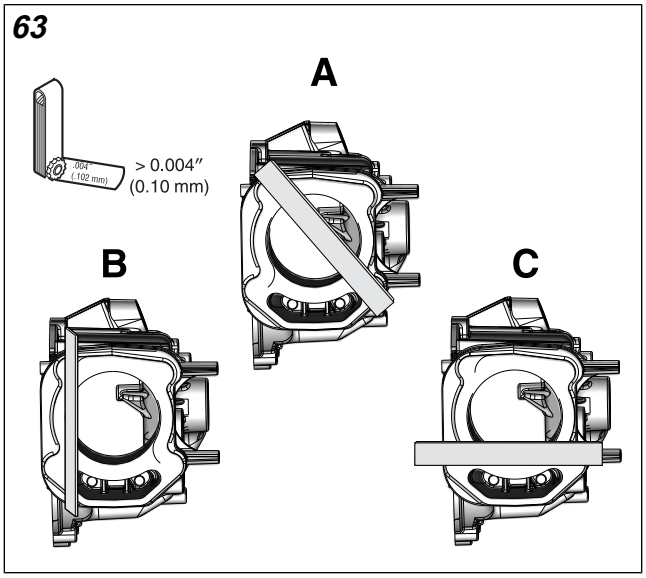
Cleaning

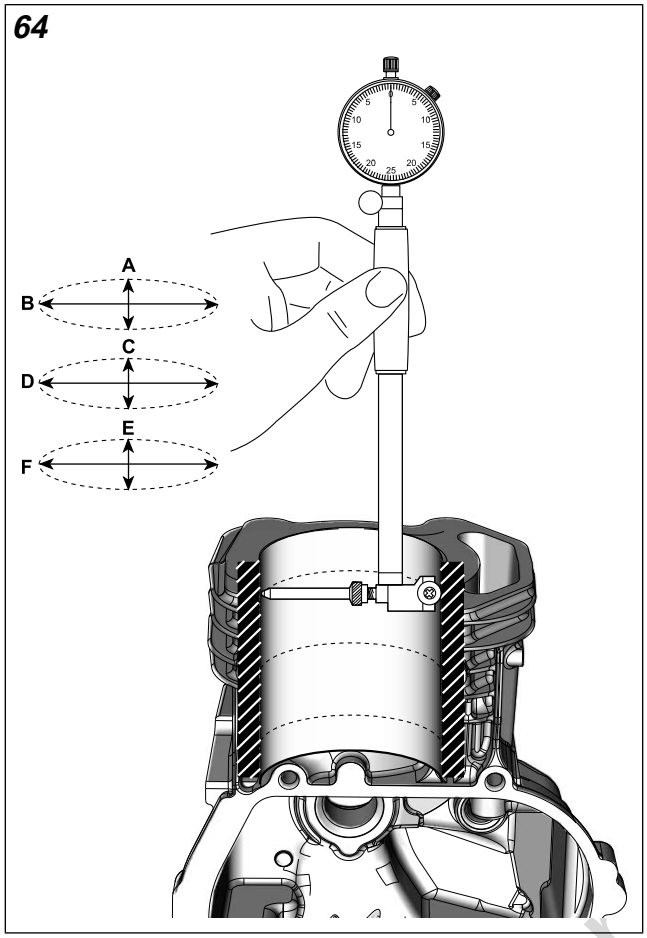
1. Using a plastic scraping tool, carefully remove old gasket material from the crankcase and crankcase cover flanges. Gasket material left on sealing surfaces will cause leaks.
2. Remove all carbon deposits from machined surfaces. Exercise caution to avoid removing any metal material. For best results, use an air tool with a **worn** wire brush. Scraping may result in scratches or nicks.
3. To soften stubborn deposits, soak the crankcase and crankcase cover in a suitable chemical solution or other carbon and gum dissolving agent. Repeat steps 1-2 as necessary.
4. Thoroughly clean the crankcase and crankcase cover in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water. Blow dry with low pressure compressed air.

Inspection

1. Using an inside micrometer, check the crankcase and the crankcase cover camshaft bearing bores for wear. Replace either part if measurement is **0.504 inches** (12.788 mm) or more.
2. Check the crankcase for cracks or broken cooling fins. Check the crankcase cover for cracks. Replace parts as necessary.
3. Check for scratches and nicks on all gasket sealing surfaces. Use a fine-tooth file to carefully remove any nicks or burrs found.
4. Check the crankcase and crankcase cover for stripped threads.

   NOTE: Stripped threads can sometimes be repaired using a helicoil, but replace parts if thread damage is severe or present at multiple locations.
5. Inspect the cylinder bore for defects or damage in the ring travel area. Replace crankcase if the cylinder is severely scored, scuffed, scratched, burnt, or gouged.
6. Using Magnaflux Dye Penetrant, inspect the cylinder bore for cracks. If no cracks are found, thoroughly wash cylinder to remove traces of dye.
7. Check the cylinder to cylinder head mating surface for warpage or distortion. Discard the crankcase if any low spot is **0.004 inches** (0.10 mm) or more. Proceed as follows:
   A. See A of Figure 63. Set a straightedge diagonally across the length of the cylinder intersecting the upper and lower corners of the gasket surface.
   B. Slide a feeler gauge beneath the straightedge to check for warpage.
   C. Check the opposite diagonal to verify that the gasket surface is flat.
   D. See B of Figure 63. Set a straightedge vertically across the length of the cylinder gasket surface. Use feeler gauge to check for warpage. Repeat step on opposite side.
   E. See C of Figure 63. Set a straightedge horizontally across the length of the cylinder gasket surface. Use feeler gauge to check for warpage. Repeat step on opposite side.





64

8. Repeat the 6 point check outlined under step 7 to check for warpage or distortion of the crankcase to crankcase cover mating surfaces. Be sure to check both crankcase and crankcase cover. Discard the crankcase or crankcase cover if any low spot is **0.004 inches** (0.10 mm) or more.
9. Obtain the Dial Bore Gauge (Part No. 19487) to check the cylinder bore for out-of-round and taper. Proceed as follows:

   NOTE: If the Dial Bore Gauge is not available, use the Telescoping Gauge (Part No. 19485) and Dial Caliper (Part No. 19609).

   A. See Figure 64. At the top of the piston ring travel zone, measure the cylinder bore diameter at two locations- parallel and perpendicular to the crankshaft (A-B). Write the readings down.
   B. Repeat the two measurements at the center of the piston ring travel zone (C-D).
   C. Repeat the two measurements again at a point below the piston ring travel zone (E-F).
   D. If the two measurements at the top, middle or bottom of the bore vary by more than **0.0015 inches** (0.04 mm), then the cylinder is out-of-round.
   E. If the top, middle and bottom bore diameters, either parallel (A-C-E) or perpendicular (B-D-F) to the crankshaft, vary by more than **0.003 inches** (0.08 mm), then the cylinder is excessively worn (or tapered).
   F. Replace the cylinder if worn beyond the service limits described under steps 9(D) and 9(E).

Clean Crankcase and Cylinder Bore

1. Thoroughly wash crankcase and cylinder bore with a non-volatile cleaning solution or solvent.
2. To loosen all abrasive particles and residual grit, thoroughly scrub cylinder bore with a stiff bristle brush using liquid dishwashing soap and hot water.
3. Thoroughly rinse cylinder bore with hot running water.
4. Repeat washing and rinsing until all traces of dirt and grit are gone. Continue cleaning until a clean cloth shows no evidence of dirt or debris.
5. Hot rinse the crankcase and dry with moisture free compressed air.
6. Verify that tappet and bearing bores, oil drain holes, breather passage, and all threaded holes are completely clean and free of dirt and grit.
7. Lightly lubricate cylinder bore with clean engine oil.

Assembly

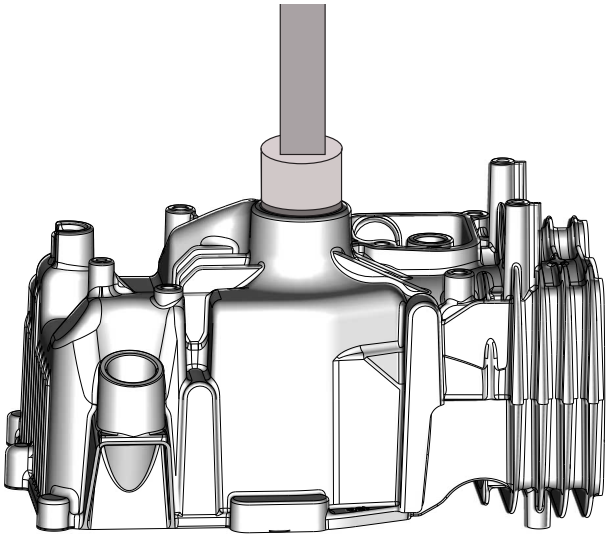
Crankcase

MAG Oil Seal

1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. With the outside facing upward, support crankcase on wooden blocks on deck of arbor press.
3. Apply a thin film of clean engine oil to oil seal bore and OD of **new** oil seal.
4. Verify that oil seal lip garter spring is not broken or missing.
5. Place oil seal into bearing bore.

6. Place suitable oil seal driver on outside edge of oil seal.
7. See Figure 65. Center oil seal driver under ram.
8. See Figure 66. Slowly apply pressure to oil seal driver until oil seal is at a depth of **Flush +/- 0.010 inches** (Flush +/- 0.25 mm).

65



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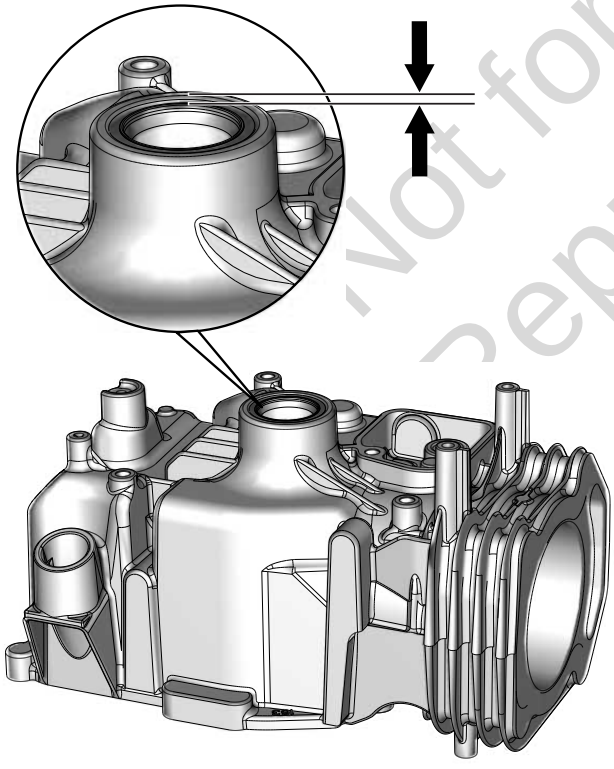
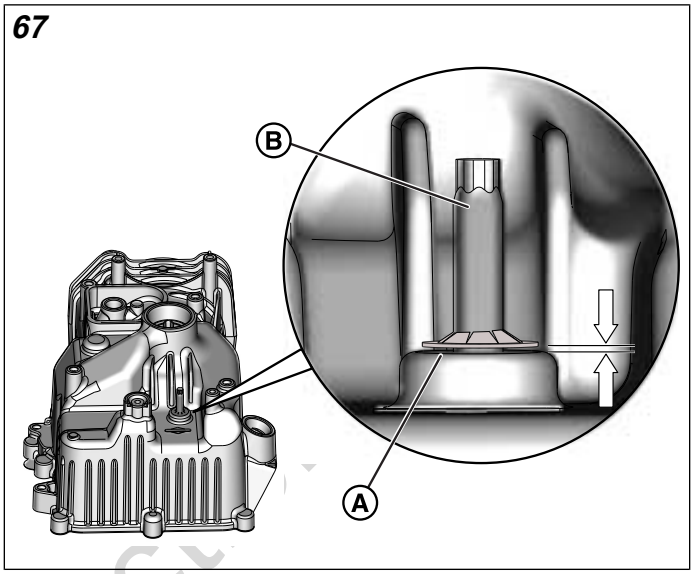


Governor Crank/Governor Lever

1. From inside crankcase, insert governor crank with flat washer thru hole at top of crankcase.
2. See Figure 67. At top of crankcase, work push nut (**A**) down governor crank (**B**) until bottom of push nut is **0.002-0.015 inches** (0.05-0.38 mm) from top of crankcase boss.
3. Verify that governor crank rotates freely without sticking.

67



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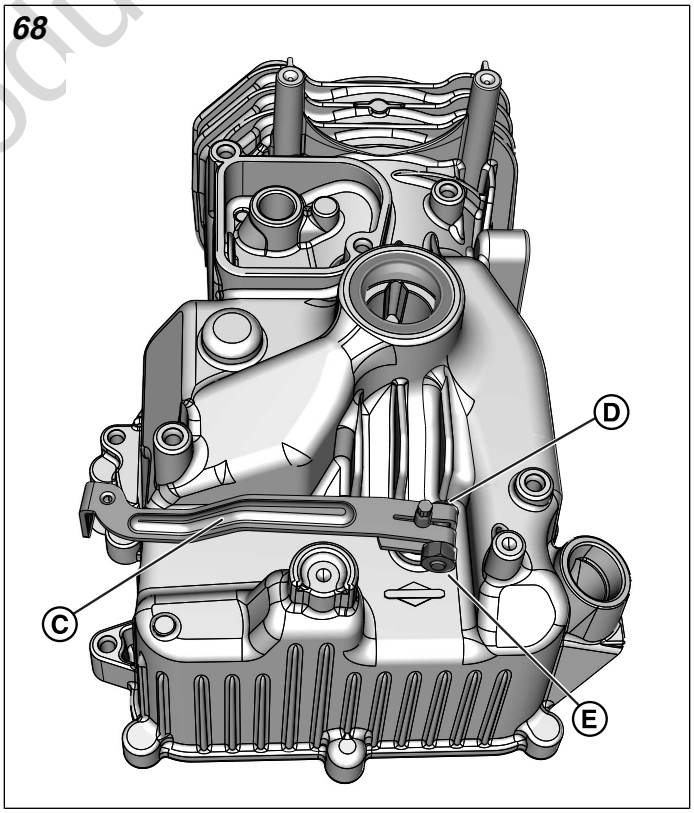
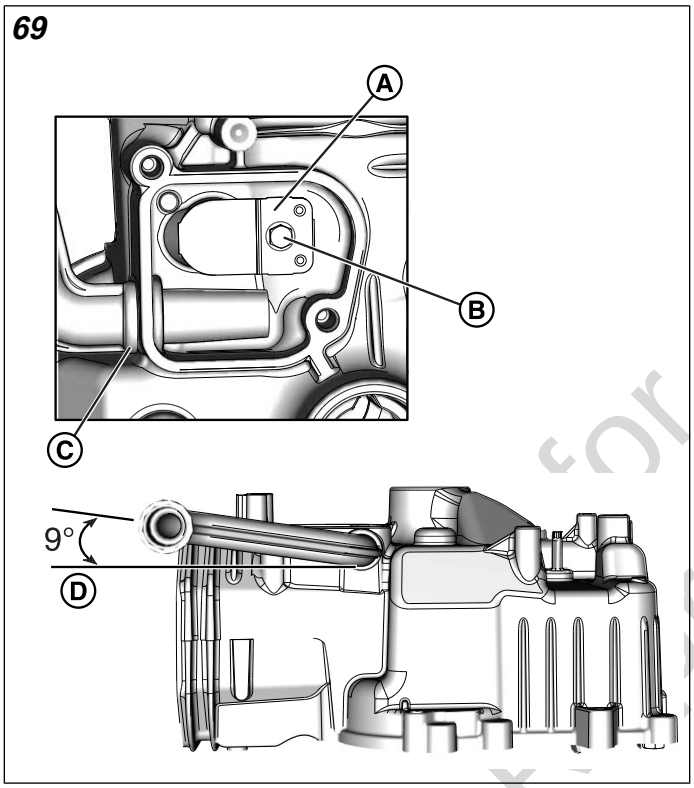


4. See Figure 68. Install governor lever (**C**) onto governor crank.
5. Install carriage bolt (**D**) onto governor lever and start hex nut (**E**), but do not tighten at this time.

Crankcase Breather

1. See Figure 69. Install breather reed assembly to crankcase with the backing plate out (**A**). Install hex flange screw (**B**) and tighten to **30-40 lb-in** (3.4-4.5 N-m).
2. Install breather tube, so that the outer ring (**C**) contacts the crankcase. Rotate breather tube approximately 9° (**D**) to ensure proper alignment with air cleaner base.

69

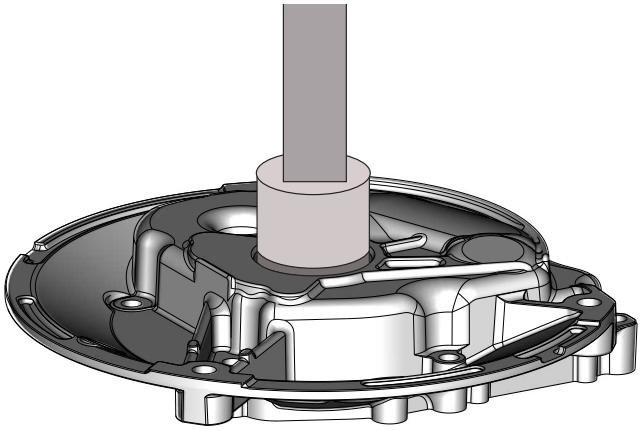


Crankcase Cover

PTO Oil Seal

1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. With the outside facing upward, support crankcase cover on wooden blocks on deck of arbor press.
3. Apply a thin film of clean engine oil to oil seal bore and OD of **new** oil seal.
4. Verify that oil seal lip garter spring is not broken or missing.
5. Place oil seal into bearing bore.
6. Place suitable oil seal driver on outside edge of oil seal.
7. See Figure 70. Center oil seal driver under ram.
8. See Figure 71. Slowly apply pressure to oil seal driver until oil seal is at a depth of **0.175-0.225 inches** (4.45-5.71 mm).

70



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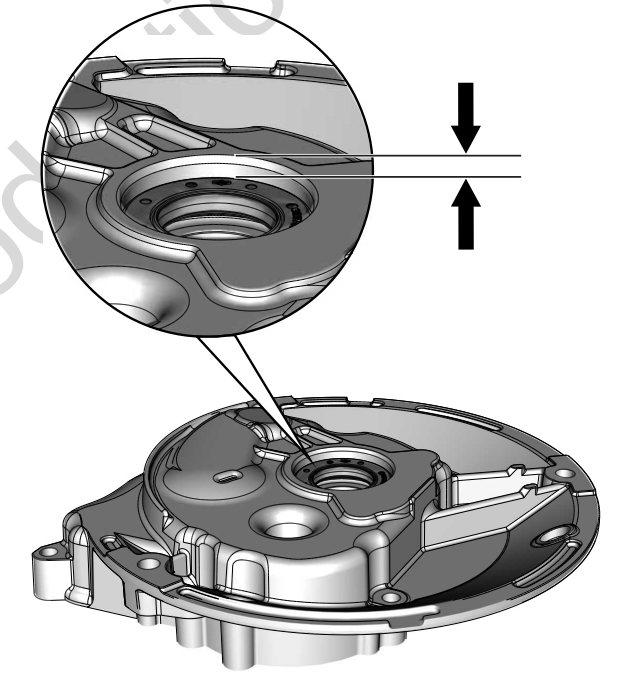


SECTION 7 – ASSEMBLE ENGINE

7

1. Apply a thin film of clean engine oil to MAG bearing oil seal lip.
2. Thoroughly lubricate crankshaft MAG bearing journal and PTO bearing journal with clean engine oil.
3. Lubricate crank pin with General Lithium Grease.
4. Install oil seal protector sleeve over crankshaft taper.

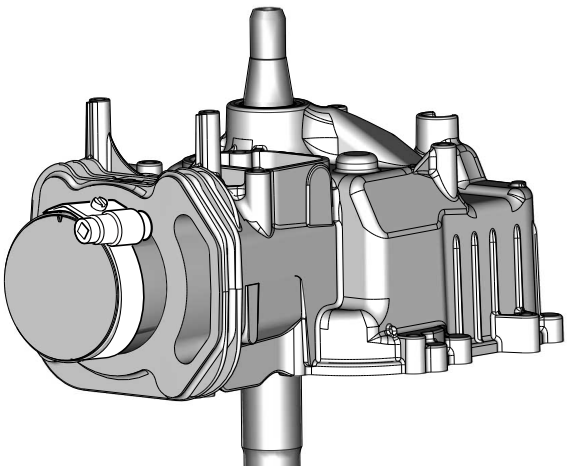
   NOTE: If oil seal protector sleeve is not available, tightly wrap keyway with black electrical tape.
5. Carefully install crankshaft into crankcase positioning MAG bearing journal in MAG bearing.
6. Remove oil seal protector sleeve (or black electrical tape) from crankshaft taper.
7. Rotate crankshaft until crank pin journal is at the bottom of its stroke.
8. Verify that piston ring end gaps are properly staggered. See *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, PISTON AND CONNECTING ROD, ASSEMBLY,* step 12.
9. Obtain the Piston Ring Compressor (Part No.19070), and proceed as follows:

CAUTION

The edges of the piston ring compressor are sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

A. Using tool wrench, unwind sleeve of piston ring compressor. Do not unwind sleeve too far or tool damage will occur.

72



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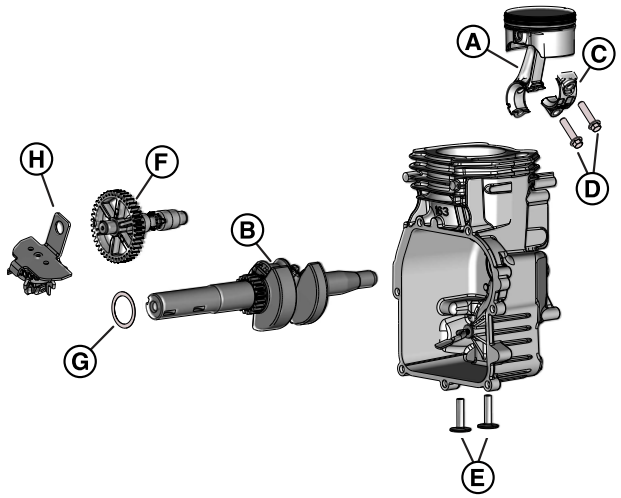


B. Apply clean engine oil to piston rings, piston skirt, cylinder bore, and inside wall of Piston Ring Compressor.

C. With notch on piston crown pointing toward the MAG bearing side, start piston and connecting rod assembly into cylinder bore.

D. See Figure 72. Slide compressor sleeve over piston, and using tool wrench, tighten to compress piston rings into piston ring grooves.

E. Verify that all piston rings are captured and compressed, but that compressor sleeve is still loose enough to be rotated.

F. Gently tap on the top edge of the compressor sleeve to be sure the bottom edge is in full contact with cylinder deck.

G. Apply steady pressure to piston crown to slide piston from compressor sleeve into cylinder bore.

NOTE: Do not hammer piston into cylinder bore or piston rings may be damaged. If piston travel is stopped before it completely enters the cylinder bore, then retract the piston, reset the piston ring compressor sleeve, and try again.

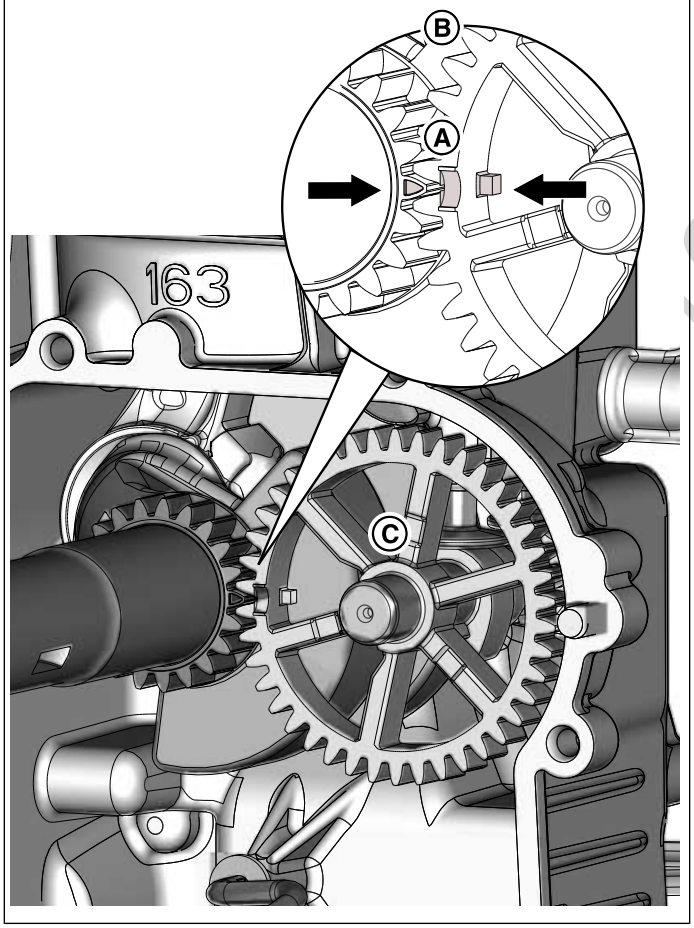
10. See Figure 73. With connecting rod (**A**) positioned on crank pin journal (**B**), install connecting rod cap (**C**).
11. Start two hex flange screws (**D**) to fasten connecting rod cap to connecting rod. Starting with the screw closest to the piston, tighten screws to **90-105 lb-in** (10.2-11.9 N-m).
12. Rotate crankshaft two revolutions to be sure crankshaft, connecting rod, and piston move freely without binding.
13. Move connecting rod sideways to verify clearance on each side of crankpin journal.

14. Check operation of yoke on Mechanical Compression Release (MCR) mechanism on camshaft gear.

    NOTE: Gently push yoke release to the OPEN position, and then verify that it returns to the CLOSED position when released.

15. Thoroughly lubricate tappet bores and tappet shafts with clean engine oil.
16. Install tappets (**E**) into tappet bores. Be sure to install each tappet in the same bore from which it was removed.
17. Lubricate the camshaft MAG bearing journal, camshaft lobes, and camshaft bearing bore in crankcase with clean engine oil.
18. See Figure 74. Verify that tappets are clear of camshaft lobes, and install camshaft into bearing bore aligning timing mark on camshaft gear root with timing mark on crankshaft gear tooth (**A**).
19. See Figure 73. Slide shim (**G**) down crankshaft until it contacts crankshaft gear.
20. See Figure 74. Lubricate the camshaft and crankshaft gear mesh (**B**) with clean engine oil.

74



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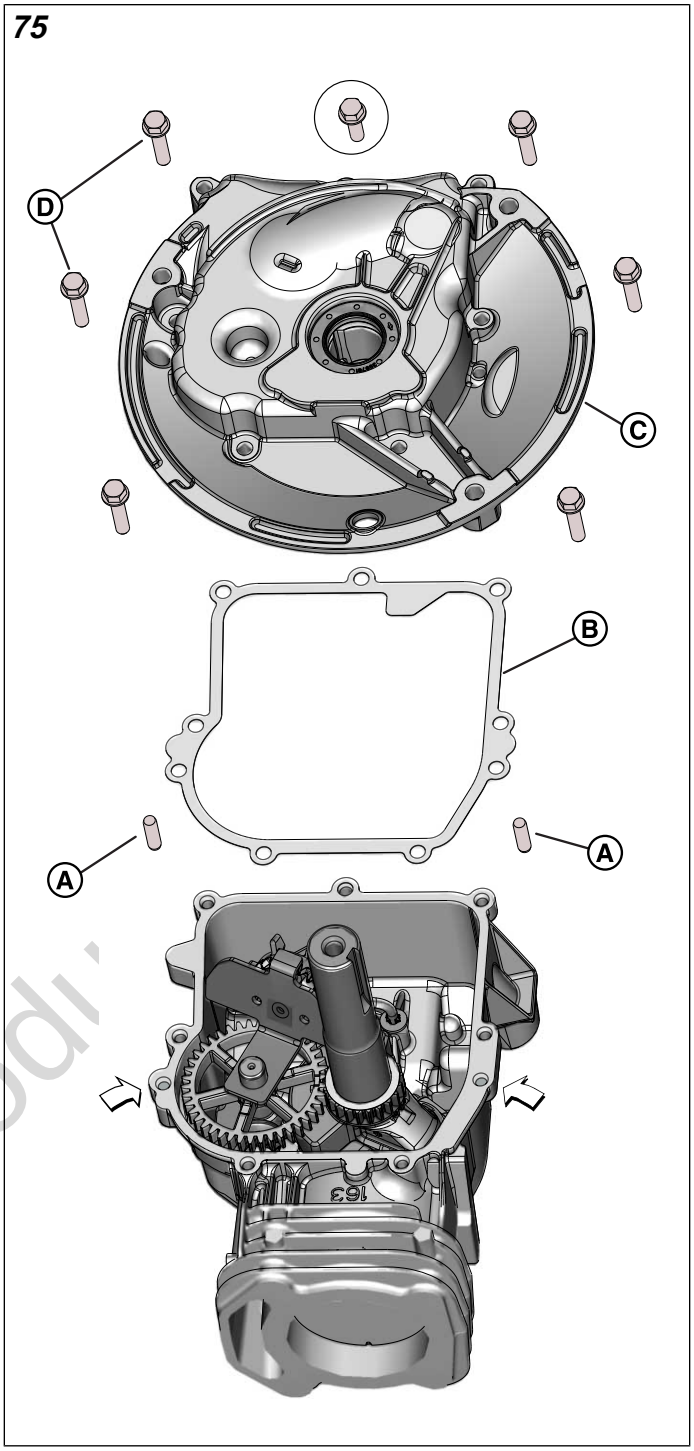
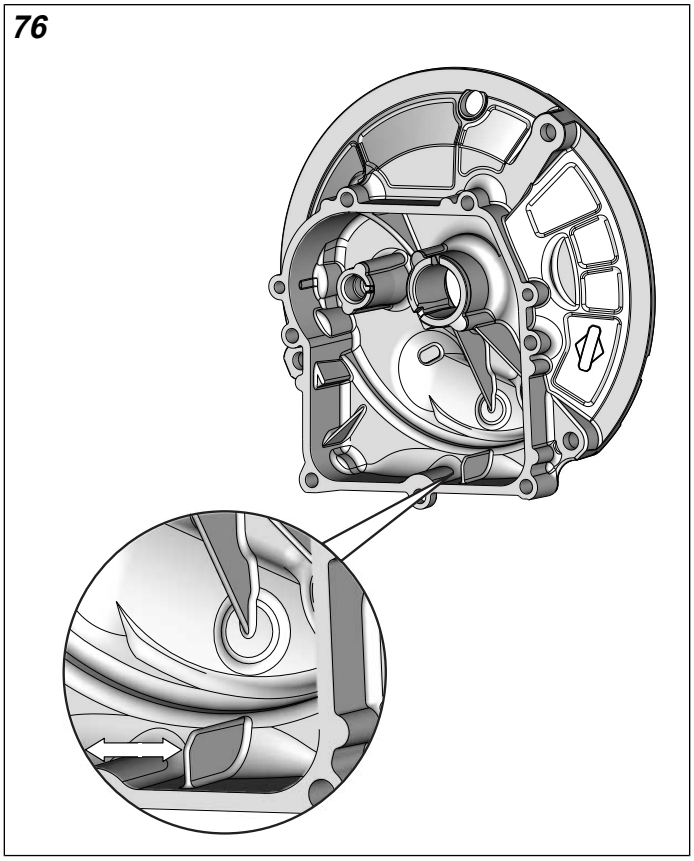


21. Lubricate the camshaft PTO bearing journal (**C**), and camshaft bearing bore in crankcase cover with clean engine oil.
22. See Figure 73. Install oil slinger (**H**) onto camshaft (**F**).
23. Verify that mating surfaces of crankcase and crankcase cover are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.
24. See Figure 75. Verify two locating pins (**A**) are present on crankcase flange (see arrows). Install **new** locating pins if damaged or missing.

76



7

25. Install **new** crankcase cover gasket (**B**) onto locating pins.
26. Install oil seal protector sleeve on crankshaft.

    NOTE: If oil seal protector sleeve is not available, tightly wrap keyway with black electrical tape.
27. Apply a thin film of clean engine oil to PTO bearing oil seal lip.
28. Rotate oil slinger, so that cup is in contact with paddle on governor crank.

    NOTE: Governor crank must be positioned between oil slinger and rib on inside of crankcase cover after cover installation. See Figure 76.
29. See Figure 75. Install crankcase cover (**C**) onto locating pins.
30. Remove oil seal protector sleeve (or black electrical tape) from keyway on crankshaft.
31. Start seven hex flange screws (**D**) to fasten crankcase cover to crankcase. Proceed as follows:

    NOTE: Install the short self-tapping screw in the center hole below the threaded bosses used for mounting of the flywheel brake. See screw circled in Figure 75.

    NOTE: Verify cleanliness of crankcase cover screws. Friction caused by dirt will result in a false torque reading.

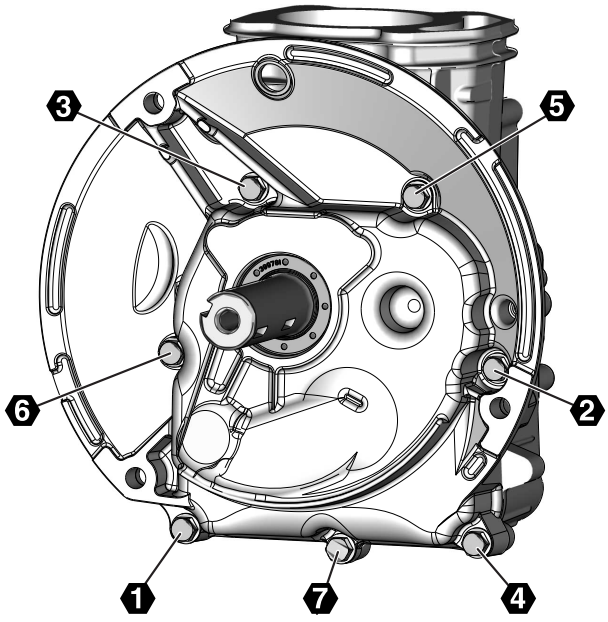
    A. Tighten screws to **32-38 lb-in** (3.6-4.3 N-m) using the sequence shown in Figure 77.
    B. Tighten screws to **64-76 lb-in** (7.2-8.6 N-m) using the sequence shown.
    C. Final tighten screws to **95-115 lb-in** (10.7-13.0 N-m) using the sequence shown.

    NOTE: Failure to step-torque screws in the proper sequence may result in gasket leaks or cause the crankcase cover to warp.

32. Rotate crankshaft to check for binding.
33. Check crankshaft end play as follows:

    A. Mount base of dial indicator to crankcase or crankcase cover.
    B. Set the indicator contact point on the end of the crankshaft.
    C. Firmly push opposite end of crankshaft as far as it will go while rotating it back and forth.
    D. While still pushing on crankshaft, zero dial indicator gauge.
    E. Firmly pull crankshaft as far as it will go while rotating it back and forth.
    F. While still pulling on crankshaft, note the reading of the dial indicator gauge.
    G. Verify that end play is **0.002-0.040 inches** (0.05-1.02 mm).

77



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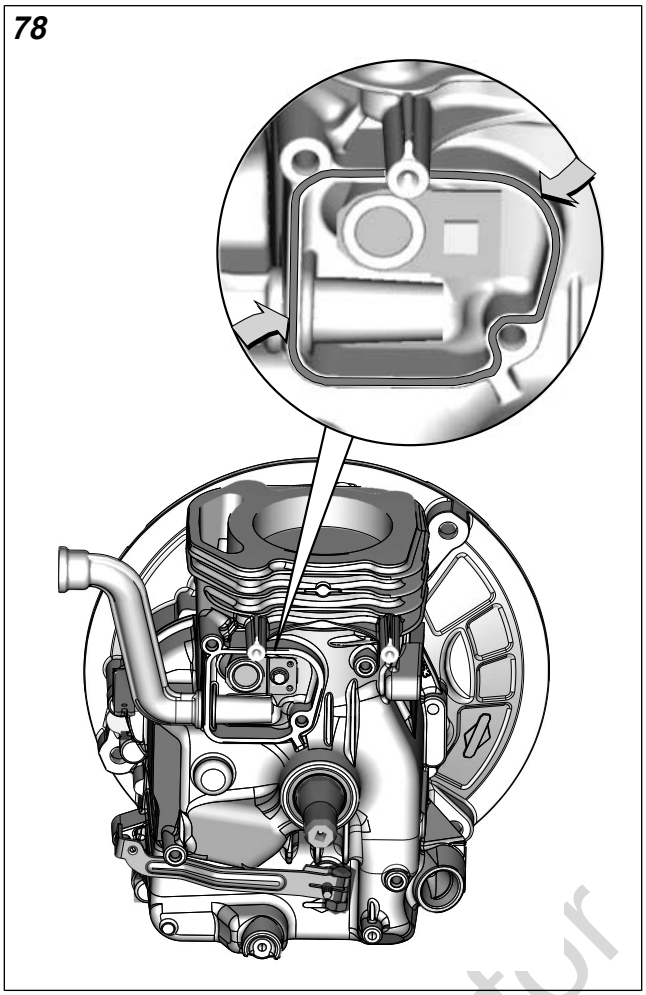

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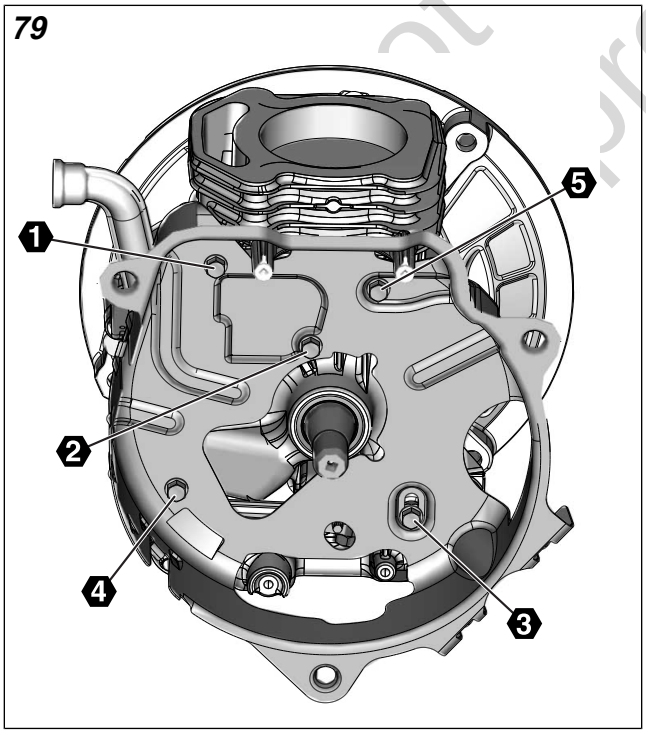


H. Repeat the procedure to verify the reading.

I. If end play is not within specification, replace the crankcase cover or add or remove shims as necessary.

WARNING

Vapors of silicone sealant are flammable. Keep away from heat, sparks, flame, and other ignition sources. Use in a well ventilated area. Keep container closed when product is not in use. Inadequate safety precautions can cause a fire or explosion resulting in death or serious injury.

CAUTION

Contact with vapors of silicone sealant can cause eye irritation and/or respiratory tract discomfort. Direct contact with uncured product can cause skin irritation. Wear appropriate personal protection, and wash thoroughly after handling.

34. See Figure 78. Apply a bead of Silicone Sealant (Part No. 100106) to the crankcase breather chamber flange. Bead must be a continuous closed loop as shown.

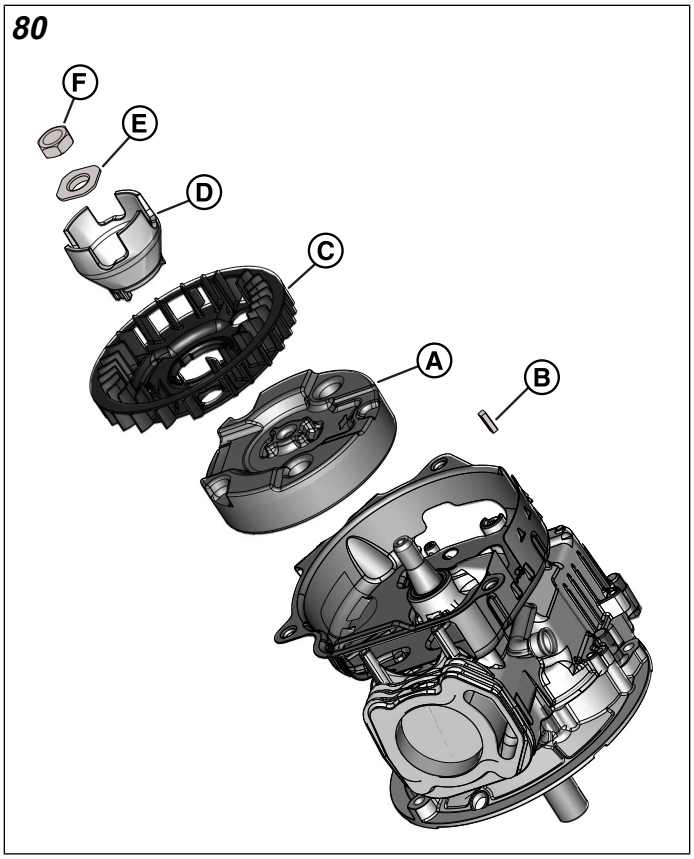
CAUTION

The edges of the blower scroll may be sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

35. See Figure 79. Place blower scroll onto crankcase. Install five hex flange screws and tighten to **55-65 lb-in** (6.2-7.3 N-m) in the sequence shown.
36. Verify that flywheel and crankshaft tapers are free of grease, oil, dust, and dirt. Verify that keyways are clean and completely free of dirt and grit.
37. See Figure 80. Install flywheel (**A**) over crankshaft taper.
38. Align the flywheel and crankshaft keyways and insert key (**B**). Verify that flywheel fits tightly without wobbling.
39. Install flywheel fan (**C**) onto flywheel.

    NOTE: Rotate flywheel fan slightly to ensure that two large pegs fully engage blind holes in flywheel.
40. Install starter cup (**D**).

80



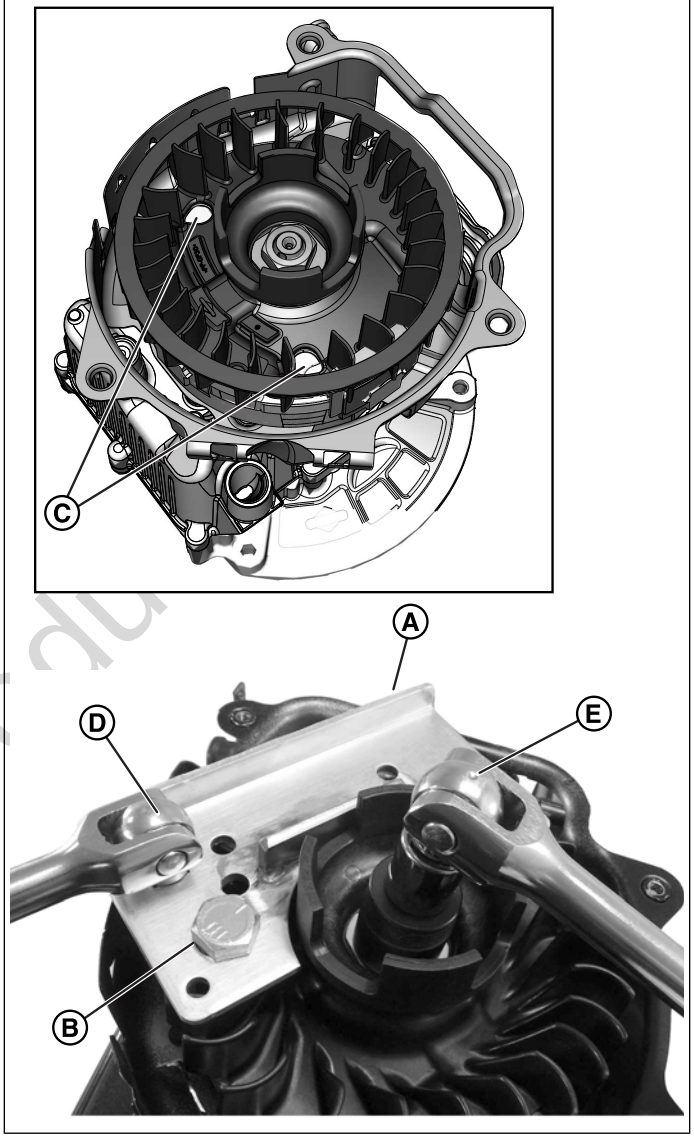
41. Install spacer (**E**) and flywheel nut (**F**). Hand tighten flywheel nut, so that spacer, starter cup, flywheel fan, and flywheel remain fully engaged.
42. Tighten flywheel nut as follows:

    NOTE: DO NOT use an air impact wrench to tighten flywheel nut or thread damage may occur.

    A. Obtain the Flywheel Puller (Part No. 19619), a 1/2 inch drive breaker bar, and a 1/2 inch rachet with a 15/16 inch socket.
    B. See Figure 81. With the lip on the puller facing up (**A**), insert the 3/4 inch bolts through the two slotted holes. On opposite side of puller, thread the hex nuts down the bolts until light contact is made with puller.
    C. Insert the threaded ends of the 3/4 inch bolts (**B**) into the two holes in the flywheel fan and flywheel (**C**).
    D. Insert joint of breaker bar into square shaped hole at top of puller (**D**).
    E. While holding the breaker bar to prevent movement of puller, use the rachet with 15/16 inch socket (**E**) to tighten the flywheel nut to **55-65 lb-ft** (74.6-88.1 N-m).
    F. Remove puller from flywheel.

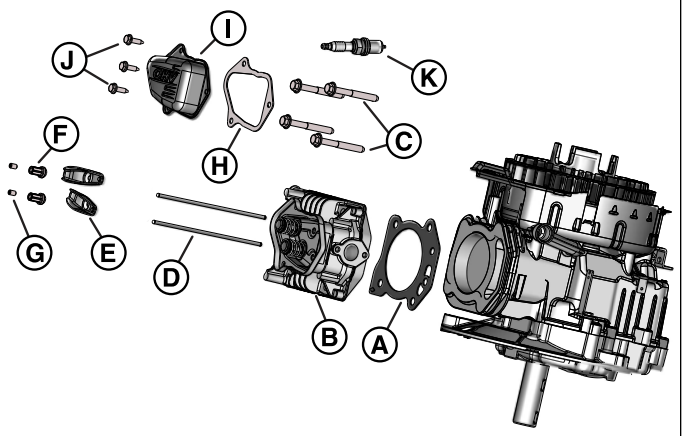
43. See *TOP END ASSEMBLY* in this section.

81



1. Verify that mating surfaces of cylinder and cylinder head are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.
2. See Figure 82. Install **new** cylinder head gasket (**A**) onto cylinder deck.

82

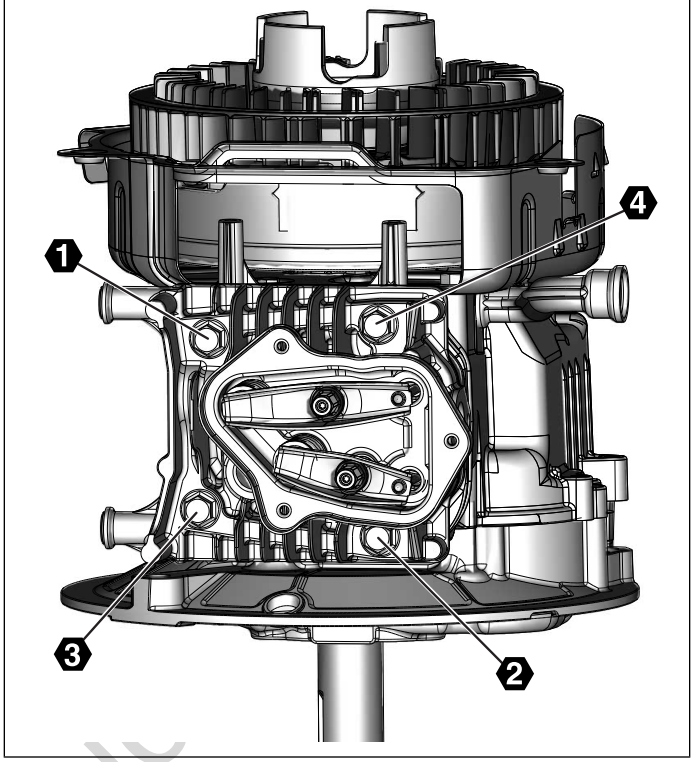


3. Install cylinder head (**B**).
4. Start four cylinder head screws (**C**) and hand tighten until snug.

   NOTE: Verify cleanliness of cylinder head screws. Friction caused by dirt will result in a false torque reading.
5. Tighten cylinder head screws as follows:
   A. Tighten screws to **40-47 lb-in** (4.5-5.3 N-m) using the sequence shown in Figure 83.
   B. Tighten screws to **80-94 lb-in** (9.0-10.6 N-m) using the sequence shown.
   C. Final tighten screws to **120-140 lb-in** (13.6-15.8 N-m) using the sequence shown.

   NOTE: Failure to step-torque screws in the proper sequence may result in gasket leaks or cause the cylinder head to warp.
6. See Figure 82. Insert push rods (**D**) through cylinder head plate and cylinder head to engage valve tappets. Rotate push rods as shown in Figure 84 to be sure that ball ends are seated in valve tappet sockets.

83



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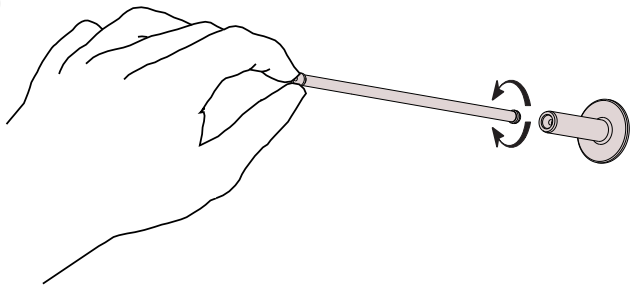

7. See Figure 82. Install rocker arms (**E**) and rocker balls (**F**) onto rocker arm studs. Start set screws (**G**) into rocker balls.
8. Tighten rocker ball nuts to obtain zero clearance between rocker arms and valve stem tips.
9. Slowly rotate crankshaft to verify proper movement of push rods and rocker arms.
10. Adjust valve clearance. See *SECTION 2 - MAINTENANCE, CHECK/ADJUST VALVE CLEARANCE,* steps 6-9.

11. Verify that mating surfaces of cylinder head plate and valve cover are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.
12. Install **new** valve cover gasket (**H**) onto valve cover (**I**).
13. Start three hex flange screws (**J**) to fasten valve cover to cylinder head plate. Alternately tighten screws to **45-55 lb-in** (5.0-6.2 N-m).
14. Install spark plug (**K**) into cylinder head and finger tighten until snug. Tighten spark plug to **140-200 lb-in** (15.8-22.6 N-m) using the 5/8 inch Spark Plug Wrench (Part No. 19576S).

    NOTE: Do not install spark plug wire onto spark plug terminal at this time.
15. See *SECTION 8 - INSTALL EXTERNAL ASSEMBLIES.*

SECTION 8 – INSTALL EXTERNAL ASSEMBLIES

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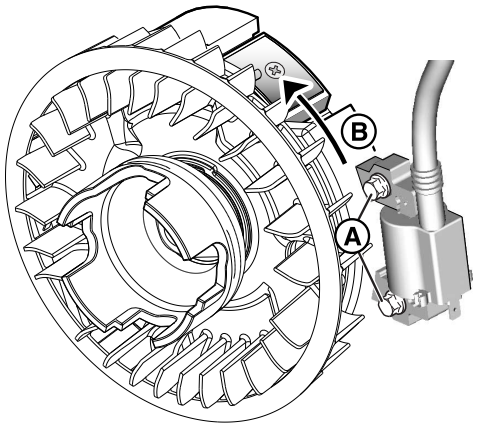
Armature

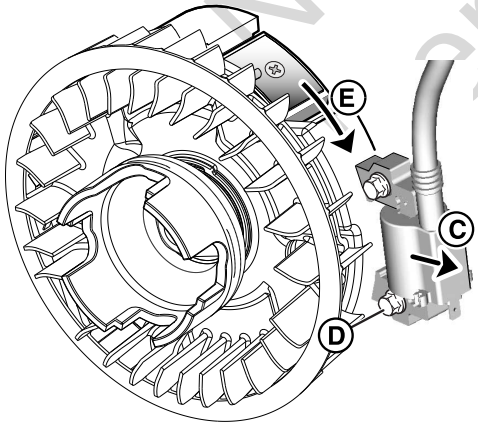
1. See Figure 85. Loosely install two hex flange screws (**A**) to fasten armature to crankcase.

85



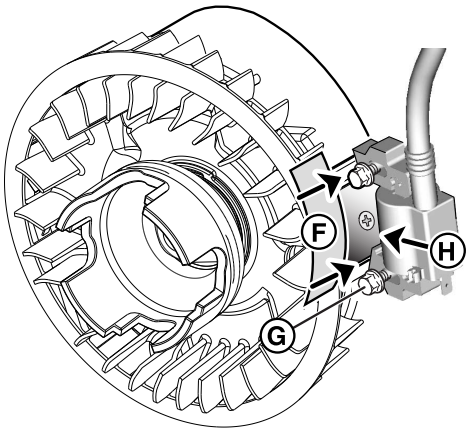
2. Rotate flywheel to move magnet away from armature legs (**B**).
3. See Figure 86. Slide armature (**C**) away from flywheel.
4. Tighten bottom hex flange screw (**D**) until snug.
5. Rotate flywheel, so that magnet is aligned with armature legs (**E**).

86



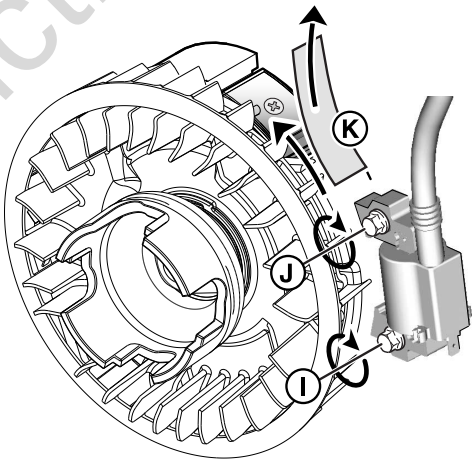
6. See Figure 87. Insert Armature Air Gap Gauge (Part No. CE5121) (**F**) between flywheel and armature legs. To set air gap to **0.006-0.014 inches** (0.15-0.36 mm), loosen bottom hex flange screw (**G**) to allow magnet to pull armature legs (**H**) against gauge.

87



7. See Figure 88. Tighten bottom hex flange screw (**I**) and top hex flange screw (**J**) to **20-35 lb-in** (2.3-4 N-m).
8. Rotate flywheel to remove gauge (**K**).

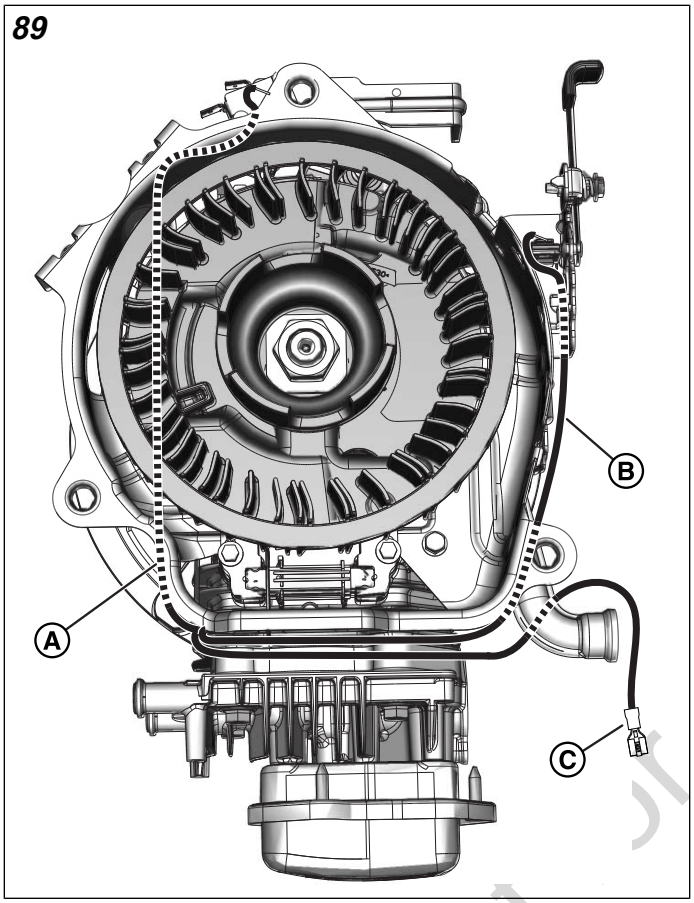
88



9. See Figure 89. Install stop switch wire as follows:
   A. **Flywheel Brake Bracket:** Connect socket housing of 10 inch (254 mm) stop wire to armature spade terminal. Draw free end of wire (**A**) below blower scroll to area of flywheel brake.
   B. **Speed Control Bracket:** Connect socket housing of 15 inch (381 mm) stop wire to armature spade terminal. Route free end of wire (**B**) below armature and breather tube to area of speed control bracket.

C. **Rocker Stop Switch:** Connect socket housing of 13 inch (330 mm) stop wire to armature spade terminal. Route free end of wire (**C**) below armature and breather tube.

89



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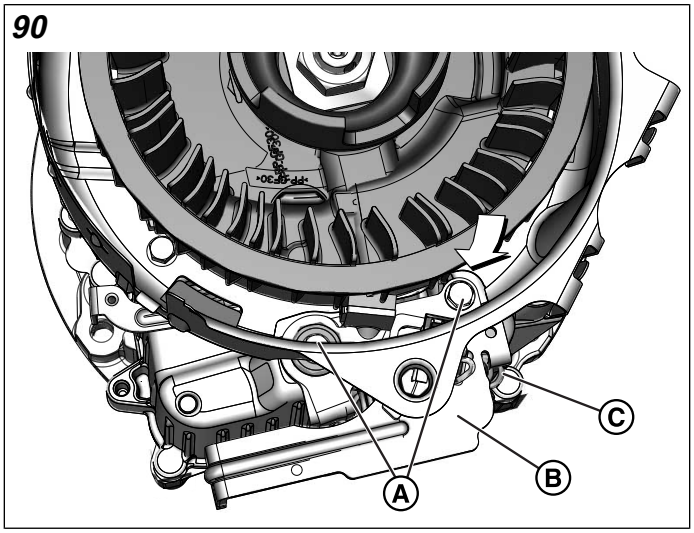

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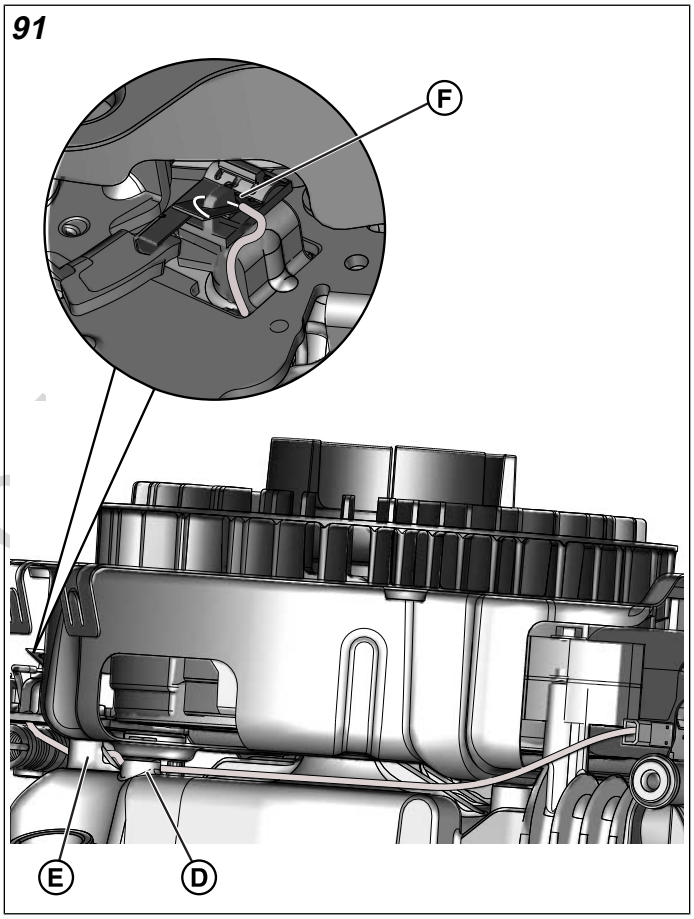


Flywheel Brake

1. See Figure 90. Install two hex flange screws (**A**) to fasten flywheel brake (**B**) to crankcase bosses. Alternately tighten screws to **25-40 lb-in** (2.8-4.5 N-m).

   NOTE: Install the shorter screw into the smaller boss (see arrow).
2. Connect spring (**C**) to flywheel brake tab.
3. See Figure 91. Route stop switch wire inside blower scroll screw boss (**D**), between flywheel brake screw boss (**E**) and governor lever, and then up to stop switch.
4. Depress stop switch tab (**F**) on flywheel brake. Insert bare stop wire into stop switch, bend wire end back, and then release tab to secure.
5. Place a small quantity of Multipurpose Grease over stop switch terminal to prevent corrosion.

   NOTE: If equipped with a single or dual lead stop wire with a one-place connector, capture wire in clip and attach clip to rib of crankcase.

Speed Control Bracket

1. See Figure 92. Place fixed speed control bracket (**A**), manual speed control bracket (**B**), or variable speed control bracket (**C**) on crankcase mounting boss(es).
2. Install hex flange screw(s) (**D**) and tighten to **60-70 lb-in** (6.8-7.9 N-m).
3. If speed control bracket is equipped with stop switch wire, proceed as follows:

A. Route free end of wire below speed control bracket, and then up through opening in bracket to stop switch.

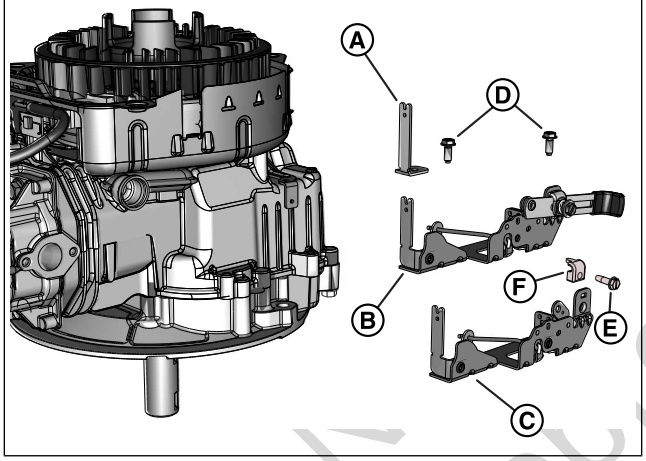
B. Depress stop switch tab on speed control bracket. Insert bare stop wire into stop switch, bend wire end back, and then release tab to secure.

C. Place a small quantity of Multipurpose Grease over stop switch terminal and pivot points as shown in Figure 93.

NOTE: If equipped with a dual lead stop wire with a one-place connector, route wire below flywheel brake as described under step 2 of *Flywheel Brake*, and then capture wire in clip and attach clip to rib of crankcase.

NOTE: If equipped with the variable speed bracket, install hex flange screw (**E**) to attach throttle cable bracket (**F**). Tighten screw to **15-20 lb-in** (1.69-2.26 N-m).

92



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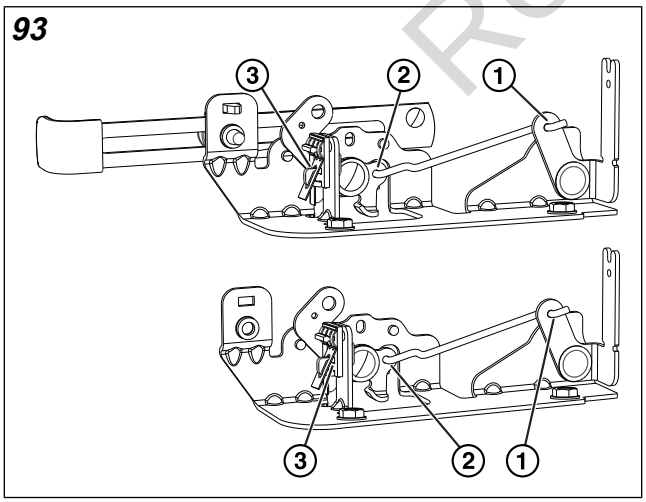
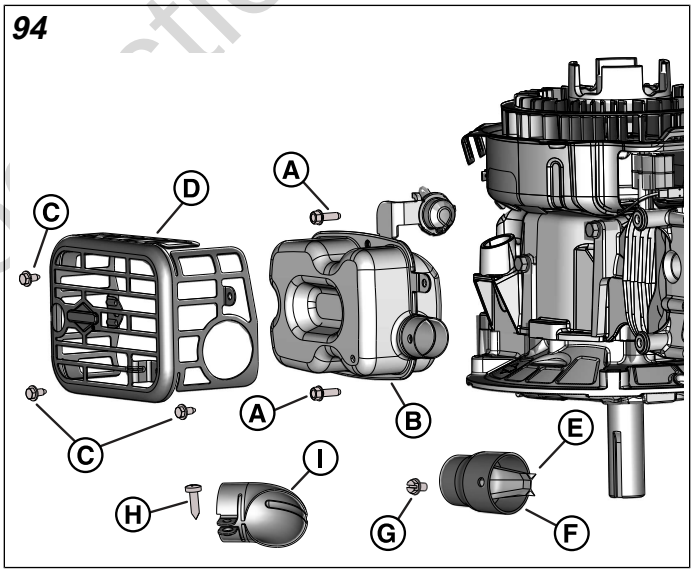


Muffler

1. Inspect muffler for holes, split seams, cracked welds, loose internal parts, corrosion, and other damage.
2. If equipped, inspect spark arrester for dirt, debris, and carbon buildup. Proceed as follows:
   A. Remove screening element from spark arrester.
   B. Gently clean screening element with a stiff bristle brush. If carbon buildup is present, soak or spray with Carburetor Cleaner (Part No. 100042).
3. See Figure 94. Install two hex flange screws (**A**) to fasten muffler (**B**) to cylinder head. Alternately tighten screws to **55-65 lb-in** (6.2-7.3 N-m).
4. Install three hex flange screws (**C**) to fasten guard (**D**) to muffler. Tighten screws to **20-30 lb-in** (2.3-3.4 N-m).
5. If equipped, install spark arrester as follows:
   A. Install screening element (**E**) into spark arrester (**F**).
   B. Install screw (**G**) to fasten spark arrester to muffler. Tighten screw to **71-124 lb-in** (8-14 N-m).
6. If equipped, install screw (**H**) to fasten muffler deflector (**I**) to muffler. Tighten screw to **8-12 lb-in** (0.9-1.4 N-m).

94



Carburetor/Governor Lever

NOTE: See *Overhaul Carburetor* for disassembly, cleaning, inspection, and assembly instructions.

1. See Figure 95. Install **new** O-ring (**A**) onto carburetor spacer (**B**).
2. Install carburetor spacer onto mounting bracket (**C**).
3. With the lip on the mounting bracket at the top, start two hex flange screws (**D**) to fasten assembly to cylinder head. Tighten screws to **55-65 lb-in** (6.2-7.3 N-m).

4. See Figure 96. If equipped, proceed as follows:

   A. Capture speed control stop switch wire in wire clip, and install anchor on clip into hole (**E**) in mounting bracket.

   B. Route rocker stop switch ground wire through wire clip (**F**) forming a loop (**G**), and then install bare end of wire into hole of mounting bracket tab (**H**). Place a small quantity of Multipurpose Grease over ground terminal to prevent corrosion.

5. See Figure 97. Install governor link (**I**) into throttle lever bracket (**J**) with the Z-bend at the bottom. Install opposite end of governor link into governor lever (**K**) with the Z-bend at the bottom. Apply a small amount of Multipurpose Grease to each pivot point.

   NOTE: If equipped, verify that speed control stop switch wire or rocker stop switch stop wire is routed below governor link.

6. Slide carburetor onto carburetor spacer while gently rotating it back and forth.

   NOTE: Exercise care to avoid bending, kinking, or stretching governor link and spring.

   NOTE: Governor link is not directional.

7. Install straight end of governor spring (**L**) into governor lever with the hooked end facing inside.

8. Install coiled end of governor spring into speed control bracket (**M**) with the hooked end facing down.

   NOTE: If *ReadyStart*® carburetor, move to step 9. If *manual choke* carburetor, proceed to step 12.

9. Connect choke return spring (**N**) between anchor spring arm (**O**) and choke lever bracket (**P**).

   NOTE: Exercise care to avoid bending, kinking, or stretching choke link (**Q**) and spring.

   NOTE: The horseshoe bend (**R**) in the choke link allows the length to be adjusted for proper starting. Exercise care to avoid either lengthening or shortening the link.

10. Install choke link into muffler thermostat lever (**S**) with the Z-bend on the inside. Install opposite end of link into thermostatic lever (**T**) with the Z-bend at the bottom.

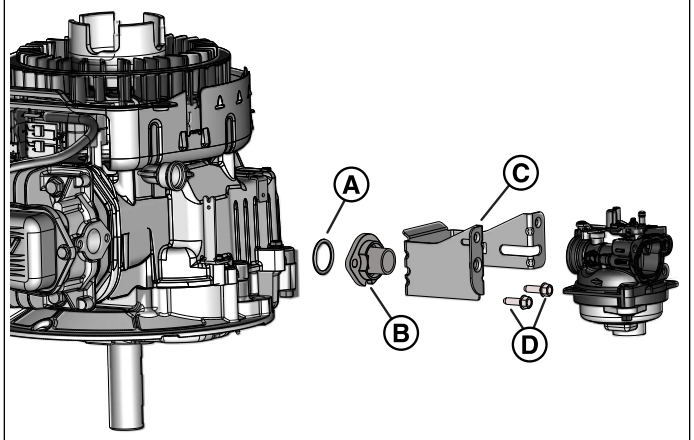
11. Install thermostatic lever onto anchor spring shaft.

12. Rotate governor lever to the Wide Open Throttle position (left towards carburetor).

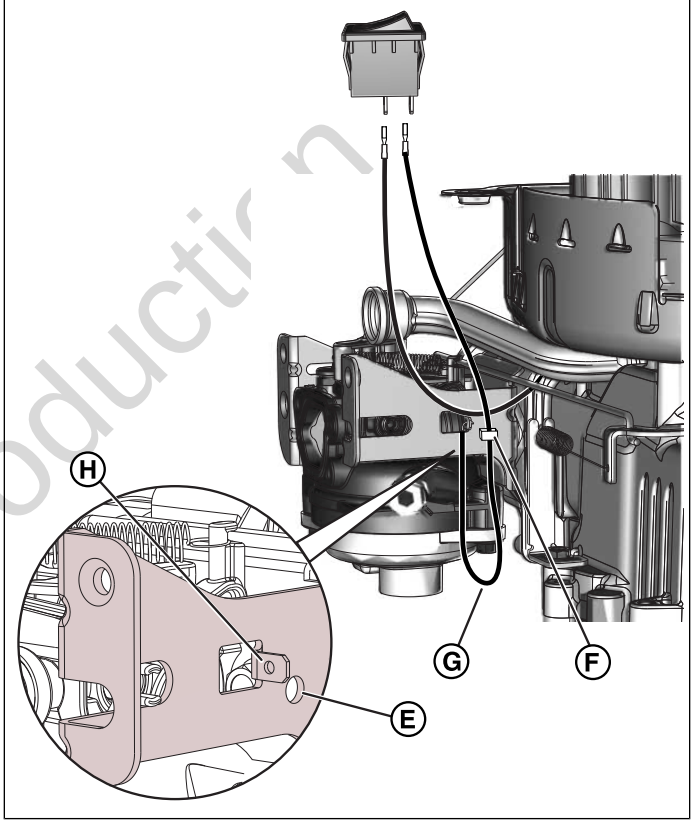
13. Holding governor lever to prevent movement, use 4 mm hex socket to rotate governor crank in a clockwise direction until it stops (about 1/8 turn).

    NOTE: Align hole in fan and flywheel with hole in blower scroll to access governor crank. See top inset of Figure 97.

95



96



14. Holding governor lever and governor crank to prevent movement, tighten hex nut (**U**) on carriage bolt (**V**) to **25-35 lb-in** (2.8-4.0 N-m).

    NOTE: Static governing can only be set once. If governor needs to be reset, the governor lever must be replaced.

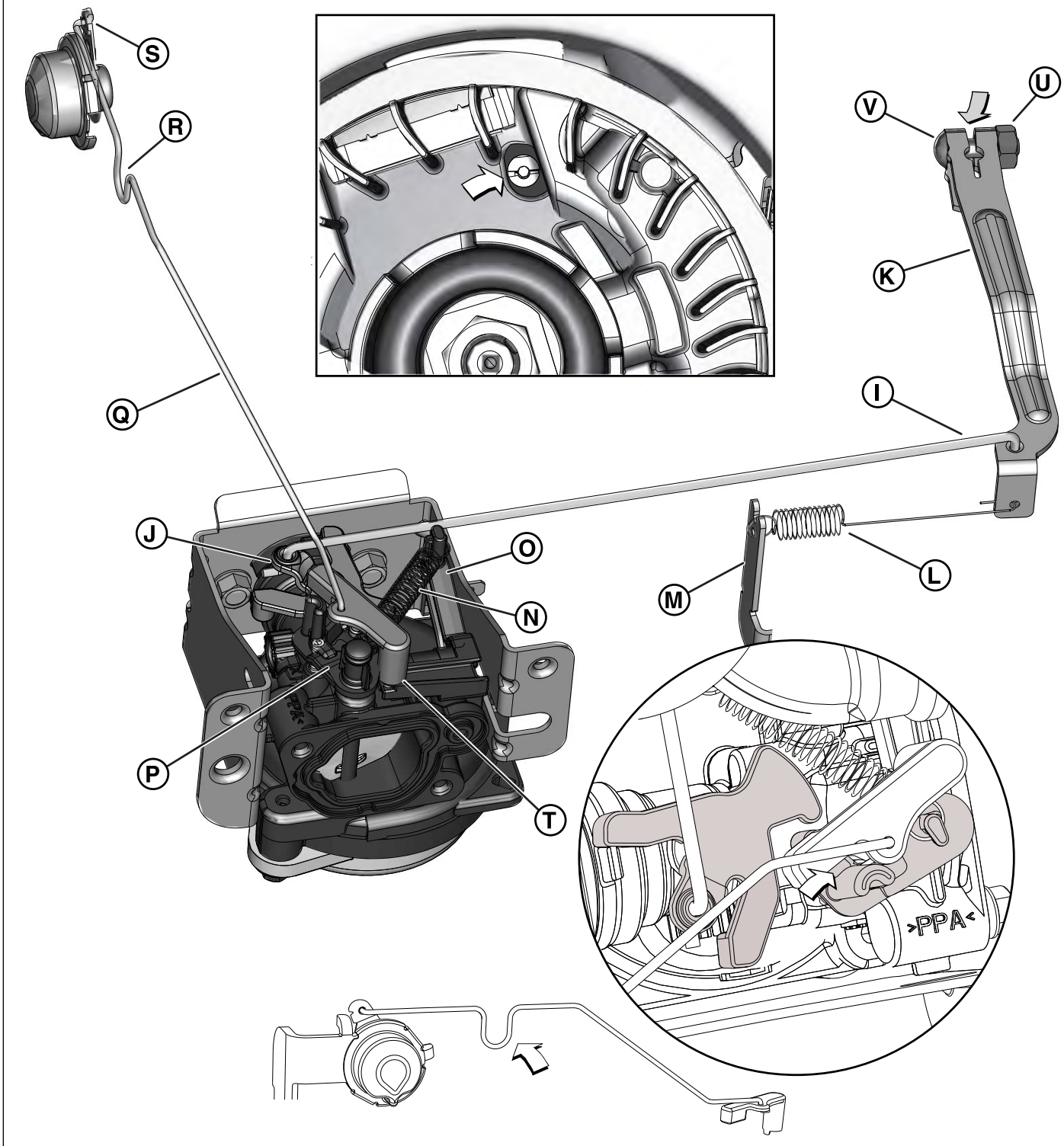
15. Verify that the governor lever has not collapsed during tightening. A gap must exist after tightening (see gray arrow in Figure 97).

16. If equipped with the *Ready Start* carburetor, choke must be fully open before setting the top no-load speed. To ensure that this occurs, proceed as follows:

    A. See bottom inset of Figure 97. Measure the gap between the flat face of the thermostatic lever and the U-shaped pedestal on the choke lever bracket (bellcrank). The gap must be **0-0.60 inches** (0-1.52 mm).

    B. If necessary, compress or expand the horseshoe bend in the choke link until gap is within specification.

97



Overhaul Carburetor

Disassembly

NOTE: Consult the *Illustrated Parts List* to obtain the correct carburetor overhaul kit.

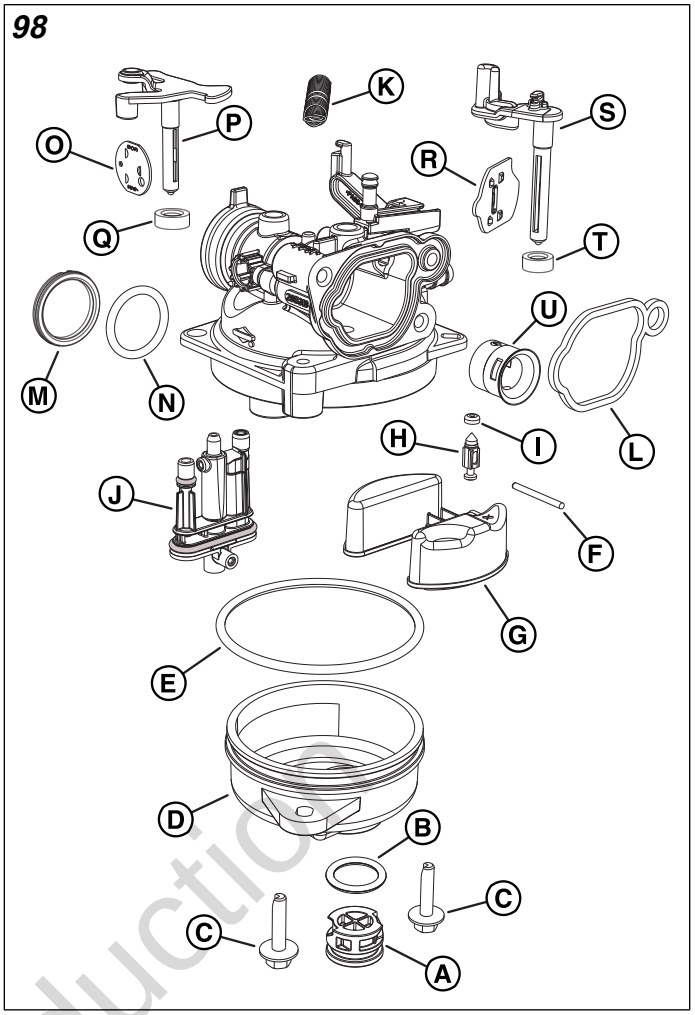
WARNING

Gasoline is extremely flammable and highly explosive. Inadequate safety precautions can result in death or serious injury. Always observe the following precautions when working with fuel system components:

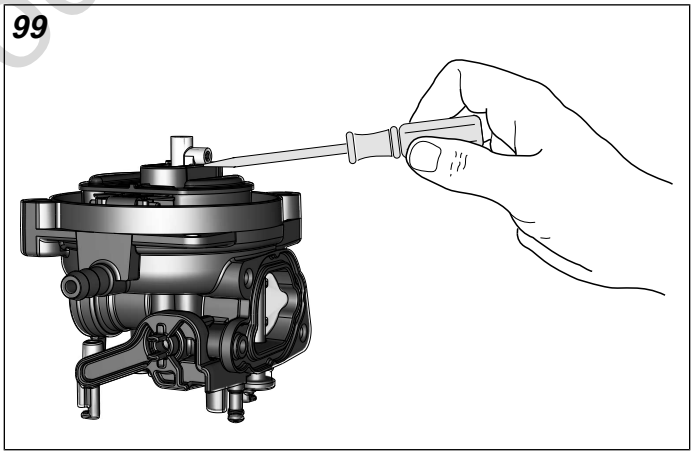
- **Wear proper eye protection.**
- **Be sure there is no open flame or potential ignition sources in the area.**
- **Keep a dry chemical fire extinguisher on hand in case of emergencies.**
- **When removing fuel hose, drain plug, float bowl, etc., cover with a shop towel to catch any residual fuel leakage.**
- **Thoroughly wipe up any spilt fuel immediately.**
- **Collect any fuel and/or shop towels in approved containers and dispose of properly.**

1. Squeeze tangs and move hose clamp away from fuel inlet fitting. Remove hose from fitting. For best results, use Fuel Hose Remover (Part No. 19620).
2. See Figure 98. Remove drain plug (**A**) with O-ring (**B**) from float bowl and drain any residual gasoline into an approved container.
3. Remove two hex flange screws (**C**) to release float bowl (**D**) from carburetor body.
4. Remove O-ring (**E**) from float bowl.
5. Using a needle nose pliers, pull pin (**F**) from groove in each pedestal.
6. Remove float (**G**) from carburetor body. Remove pin from float hinge.
7. Remove needle valve (**H**) from slot on float hinge.
8. To remove needle valve seat (**I**), see *Cleaning and Inspection,* step 9.
9. Remove fuel module (**J**) from tower in carburetor body. For best results, pry main jet housing upward using a small flat blade screwdriver as shown in Figure 99.
10. If equipped, remove choke return spring (**K**) between anchor spring arm and choke lever bracket.
11. Remove choke flange seal (**L**) from groove in choke lever side of carburetor body.
12. Remove O-ring retainer (**M**) and O-ring (**N**) from throttle lever side.

98



99



13. Using a needle nose pliers, pull throttle valve (**O**) from throttle shaft (**P**). Remove throttle shaft from carburetor body. Remove foam seal (**Q**) from throttle shaft.
14. Using a needle nose pliers, pull choke valve (**R**) from choke shaft (**S**). Remove choke shaft from carburetor body. Remove foam seal (**T**) from choke shaft.
15. From throttle lever side, push venturi (**U**) from throat of carburetor body.

Cleaning and Inspection

1. Obtain Carburetor Cleaner (Part No. 100042).

   NOTE: Set aside all rubber parts, or those that have rubber components, as these can be damaged by the carburetor cleaner.

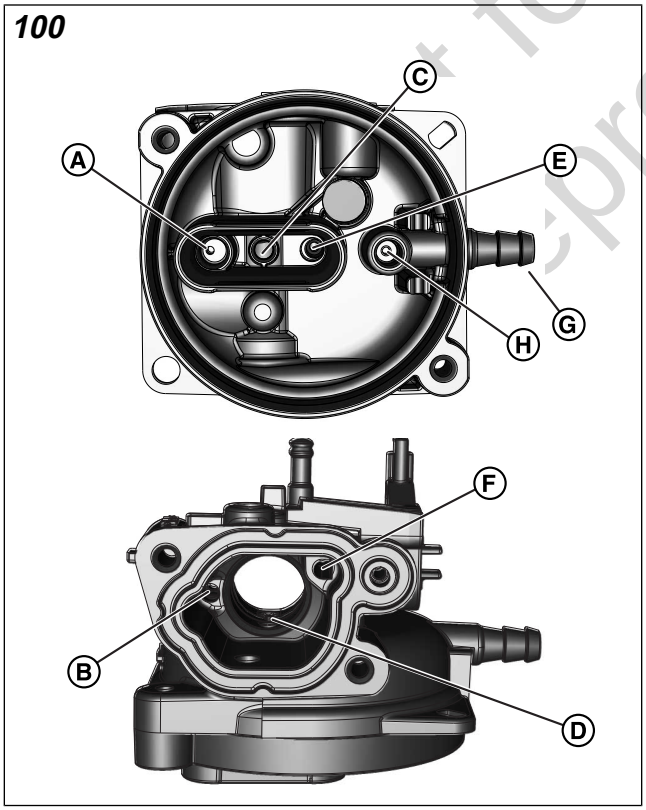
2. See Figure 98. Check float bowl O-ring (**E**) and drain plug O-ring (**B**) for cuts, tears, or general deterioration.
3. Check float bowl hex flange screws (**C**) for stripped or damaged threads.
4. Inspect carburetor body and float bowl (**D**) for sediment, gum or varnish deposits. Spray parts and then wipe away cleaning solution with a clean cloth.
5. Inspect carburetor body and float bowl for cracks or other damage.
6. See Figure 100. Clean carburetor body as follows:

   NOTE: Avoid use of wires or pointed tools as they can scratch or damage surfaces, enlarge holes, and push grit and dirt deeper into carburetor.

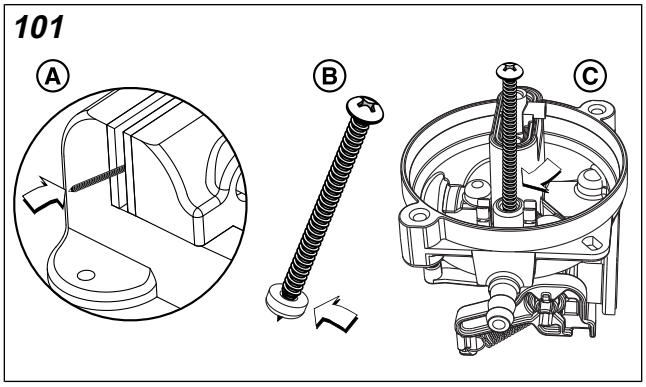
   A. Low Speed/Idle Circuit: Spray carburetor cleaner into the idle fuel jet port (**A**). Verify that the solution exits the idle fuel jet hole (**B**).

   B. High Speed/Load Circuit: Spray carburetor cleaner into the main jet port (**C**). Verify that the solution exits the main jet nozzle hole (**D**).

100



101



   C. High Speed Air Bleed: Spray carburetor cleaner into the high speed air bleed port (**E**). Verify that the solution exits the high speed air bleed hole (**F**).

   D. Fuel Inlet: Spray carburetor cleaner into the fuel inlet fitting (**G**). Verify that the solution exits the needle valve seat (**H**).

   E. Repeat steps 6(A) thru 6(D) using low pressure compressed air.

7. See Figure 98. Inspect float (**G**) for distortion, dents, cracks, or holes. Submerge float in a glass of water to verify that it is water tight.
8. Check the needle valve (**H**) for scratches, wear, or a ring grove at or near the tip.
9. Check the needle valve seat (**I**) for scratches or wear. To remove needle valve seat, proceed as follows:

   A. Secure head of drywall screw in a vise with the pointed end out. See A of Figure 101.

   B. Engage hole in needle valve seat with point of screw and rotate carburetor body until positive engagement is obtained. Continue rotation until needle valve seat is free. See B of Figure 101.

   C. Clamp carburetor body in vise. Install **new** needle valve seat with the chamfered side in.

   D. Using the drywall screw and old needle valve seat as a driver, lightly tap screw to bottom needle valve seat in bore. See C of Figure 101.

10. See Figure 98. Check fuel module (**J**) base O-ring and idle tube O-ring for cuts, tears, or general deterioration. Replace fuel module if necessary.
11. See Figure 102. Clean fuel module as follows:

    NOTE: Avoid use of wires or pointed tools as they can scratch or damage surfaces, enlarge holes, and push grit and dirt deeper into module.

    A. Low Speed/Idle Circuit: Spray carburetor cleaner into the main jet (**A**). While spraying, place two gloved fingers over the main jet nozzle (**C**) and high

speed air bleed jet (**D**). Verify that the solution exits the idle fuel jet (**B**).

B. High Speed/Load Circuit: Spray carburetor cleaner into the main jet (**A**). While spraying, place two gloved fingers over the idle fuel jet (**B**) and high speed air bleed jet (**D**). Verify that the solution exits the main jet nozzle (**C**).

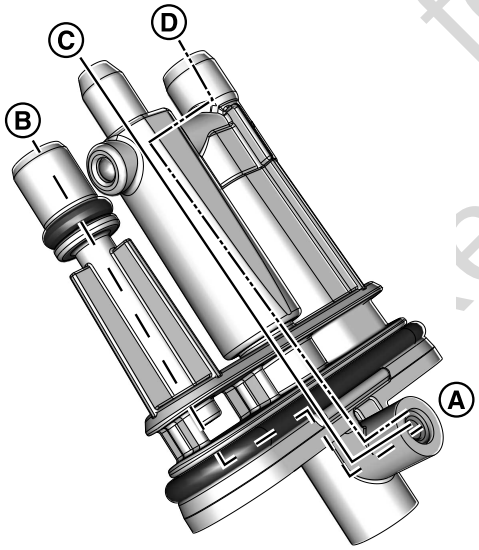
C. High Speed Air Bleed: Spray carburetor cleaner into the main jet (**A**). While spraying, place two gloved fingers over the idle fuel jet (**B**) and main jet nozzle (**C**). Verify that the solution exits the high speed air bleed jet (**D**).

D. Repeat steps 11(A) thru 11(C) using low pressure compressed air.

12. See Figure 98. If equipped, check choke return spring (**K**) for kinks, stretching, or distortion.
13. Check choke flange seal (**L**) for cuts, tears, or general deterioration.
14. Check O-ring retainer (**M**) for cracks or breakage. Check O-ring (**N**) for cuts, tears, or general deterioration.
15. Check foam throttle shaft seal (**Q**) and choke shaft seal (**T**) for damage or deterioration.
16. Check venturi (**U**) for cracks or breakage.
17. Inspect hose for cuts, nicks, cracks, hardness, or general deterioration.

8

102

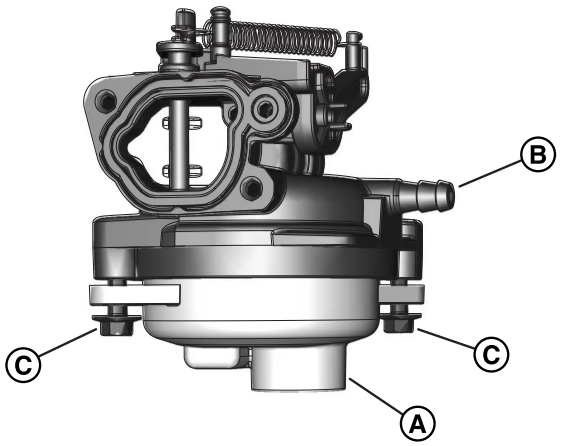


Assembly

1. See Figure 98. From choke valve side, install venturi (**U**) into throat of carburetor body until slot on venturi engages tab in throat. Look into main jet port (middle) of fuel module tower to verify that hole in venturi is aligned with hole for main jet nozzle.
2. Install foam seal (**T**) onto choke shaft (**S**). Install choke shaft into carburetor body. Install choke valve (**R**) into choke shaft, so that tab in shaft engages slot in valve.
3. Install foam seal (**Q**) onto throttle shaft (**P**). Install throttle shaft into carburetor body. Install throttle valve (**O**) into throttle shaft, so that the air bleed hole is on the bottom right side.
4. Install O-ring (**N**) and O-ring retainer (**M**) into carburetor body on throttle lever side.
5. Install choke flange seal (**L**) into groove on choke lever side.
6. If equipped, install choke return spring (**K**) between anchor spring arm and choke lever bracket.
7. Install fuel module (**J**) into tower in carburetor body.
8. Install needle valve (**H**) into slot on hinge of float (**G**).
9. Install pin (**F**) into float hinge.
10. Place float onto carburetor body and install pin into groove in each pedestal.
11. Install O-ring (**E**) into groove in float bowl (**D**).
12. See Figure 103. Start float bowl onto carburetor body with the drain plug (**A**) on the same side as the fuel inlet fitting (**B**). With the thru holes in float bowl flanges aligned with the threaded holes in the carburetor body, hand start the two hex flange screws (**C**).

    NOTE: To avoid cross threading damage, tighten each screw by hand 4-5 turns, and then alternately tighten to **22-26 lb-in** (2.5-2.9 N-m).
13. See Figure 98. Install O-ring (**B**) into groove in drain plug (**A**).
14. Install drain plug into float bowl. Tighten drain plug securely, but do not over-tighten.
15. Install hose with clamp onto fuel inlet fitting. Squeeze tangs and move clamp about **1/8 inch** (3 mm) from end of hose with tangs pointing outward for best access.

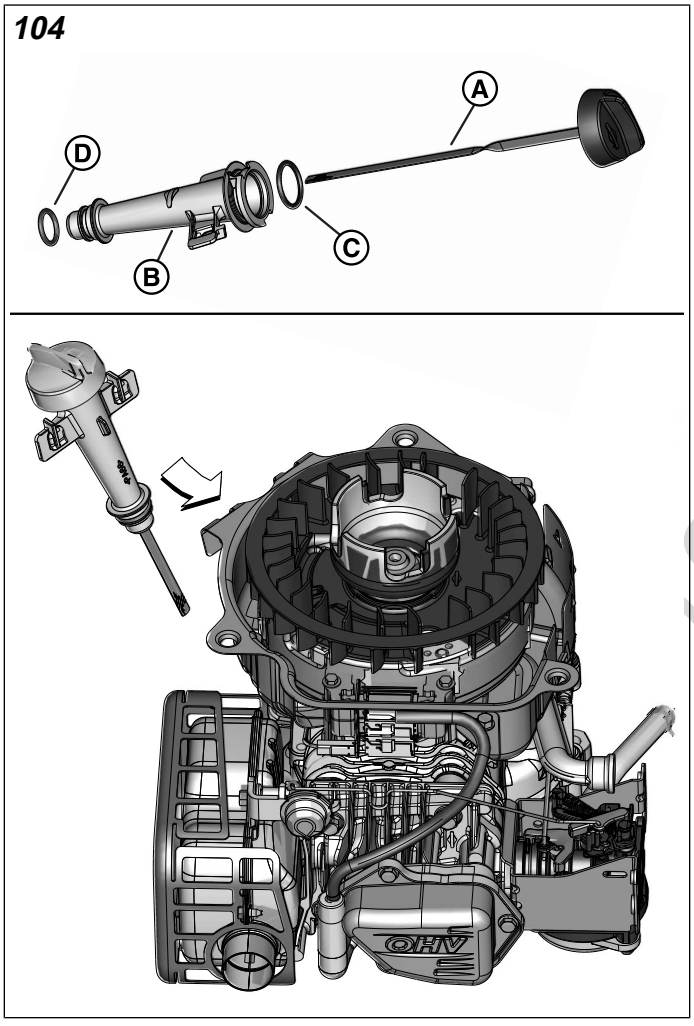
103



Oil Dipstick Tube/Dipstick

1. See Figure 104. Remove dipstick (**A**) from dipstick tube (**B**).
2. Verify that O-ring (**C**) on oil fill cap is not damaged or missing. Check for cuts, tears, or general deterioration. Replace as necessary.
3. Verify that O-ring (**D**) on dipstick tube is not damaged or missing. Check for cuts, tears, or general deterioration. Replace as necessary.
4. Lubricate oil dipstick tube O-ring with clean water.
5. Install oil dipstick tube into crankcase engaging two slots on tube with tabs on blower scroll.
6. Install dipstick into dipstick tube.

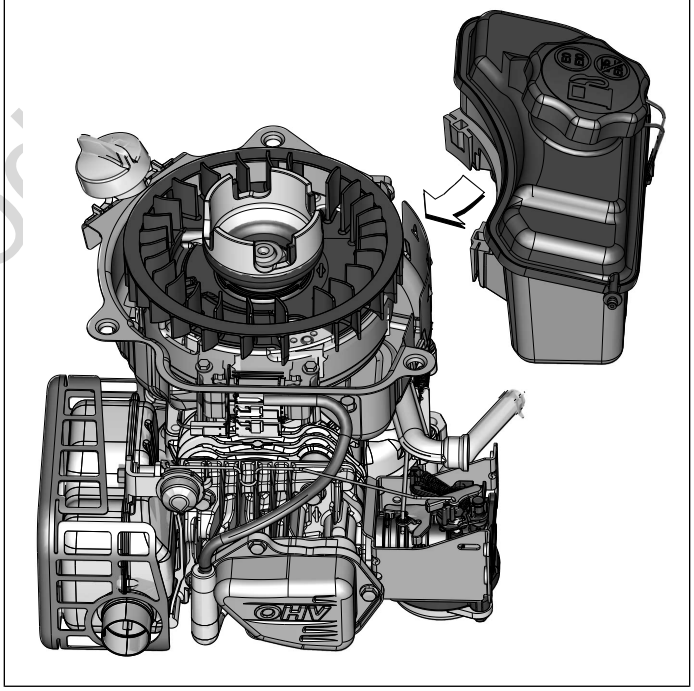
104



Fuel Tank

1. Inspect the fuel tank for damage. Replace as necessary.
2. Remove fuel cap, if installed.
3. Direct the beam of a small flashlight into the fuel tank. Look for sludge, debris, dirt, and other contaminants. Thoroughly clean dirty or gummy fuel tanks with Carburetor Cleaner (Part No. 100042).
4. With the beam of the flashlight directed into the fuel tank, inspect the external surface area for light that would indicate the presence of pin holes or small cracks.
5. Install fuel cap.
6. See Figure 105. Install fuel tank engaging two tabs on tank with slots on blower scroll. Push on tank until it bottoms in blower scroll slots.
7. Inspect hose for cuts, nicks, cracks, hardness, or general deterioration. Replace if necessary.
8. Install hose with clamp onto fuel tank fitting. Squeeze tangs and move hose clamp about **1/8 inch** (3 mm) from end of hose with tangs pointing down for best access.

105

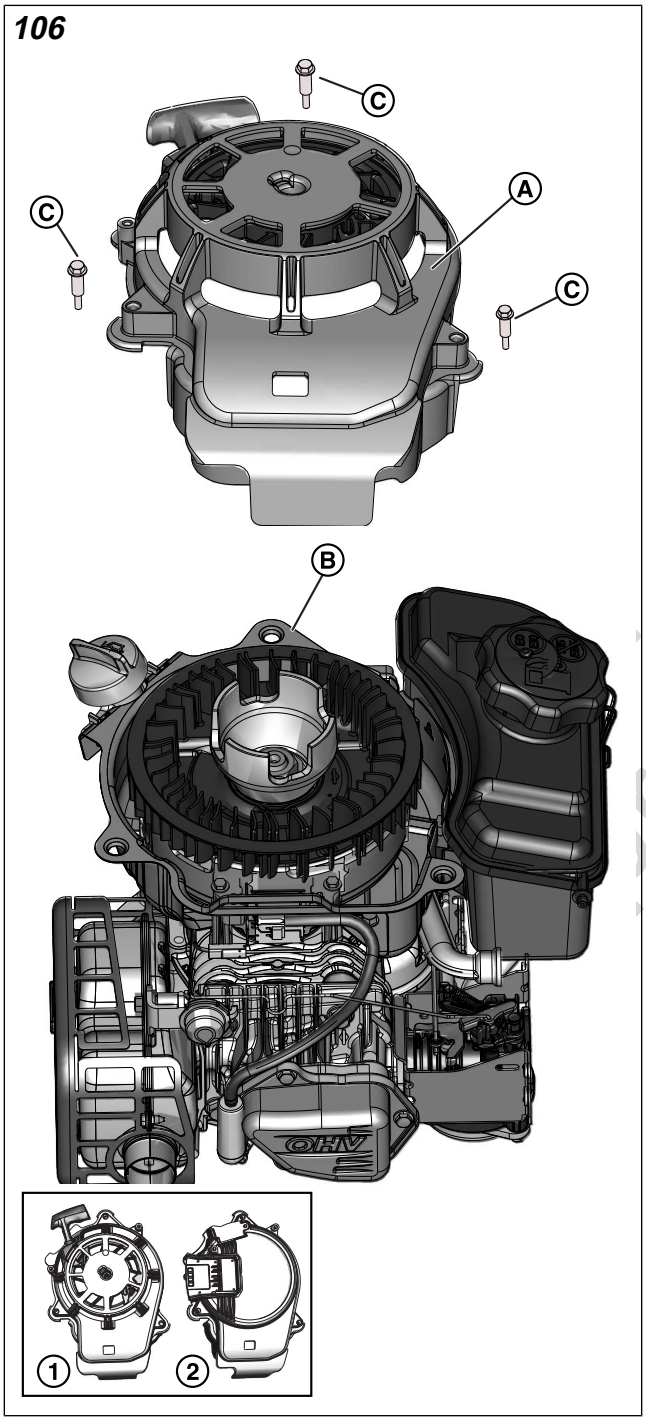


Blower Housing (If Equipped)

NOTE: See inset of Figure 106. The appearance of the blower housing differs depending upon whether the engine is equipped with a rewind starter (**1**) or battery pack (**2**).

1. If equipped with rewind starter, inspect as follows:
   A. Pull rope to verify that pulley moves freely in both directions.

106



   B. Verify that tension increases when rope is pulled and decreases when rope is released.

      NOTE: If rope is broken, verify that tension increases when pulley is rotated by hand in a counter-clockwise direction.

   C. Verify that the rope eyelet in the rewind starter housing is in good condition (without burrs or excessive wear).
   D. Inspect rope for cuts, breaks, or fraying. If rope replacement is necessary, see *Replace Rewind Starter Rope.*
2. Position blower housing (**A**) on blower scroll (**B**).
3. Loosely install three hex flange shoulder screws (**C**) to fasten blower housing to blower scroll.

   NOTE: To ensure that pawls evenly engage flywheel starter cup on engines equipped with a rewind starter, pull starter rope, tighten hex flange screws until snug, and then release starter rope.
4. Alternately tighten screws to **30-40 lb-in** (3.4-4.5 N-m).

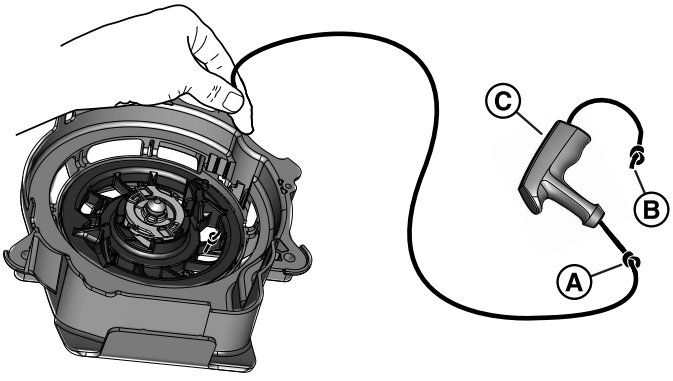
   NOTE: If equipped with starter motor, see *Starter Motor* in this section.

Replace Rewind Starter Rope (If Equipped)

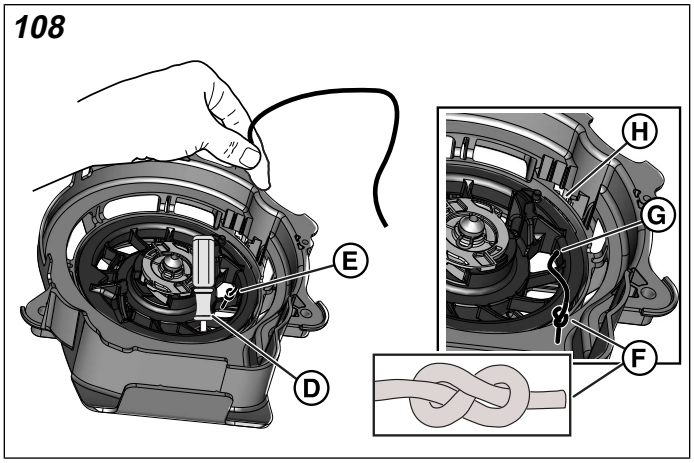
NOTE: Consult the *Illustrated Parts List* for the required length and diameter of rope.

1. See Figure 107. Pull rope part way out and tie a temporary knot (**A**).
2. Pull knot (**B**) out of recess in handle (**C**). Untie knot and remove handle from rope.

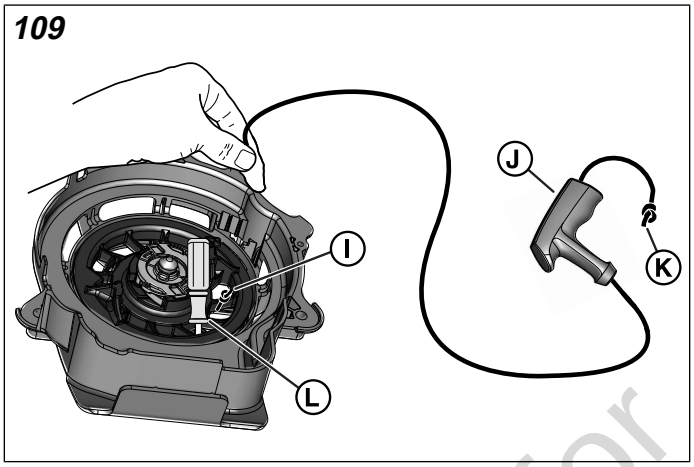
107



108



109



3. See Figure 108. Untie temporary knot and pull rope out as far as it will go. Secure pulley with a screwdriver (**D**) to prevent further rotation.
4. Grasp knot (**E**) with a needle nose pliers and pull rope out through rewind starter housing eyelet and pulley hole.
5. Using old rope as a gauge, cut **new** rope to size.

   NOTE: For ease of installation and to prevent fraying or unraveling, either melt the rope end or use a suitable rope whipping compound.
6. Tie a knot (**F**) at one end of rope.

   NOTE: Use a figure-eight type knot for the best security.

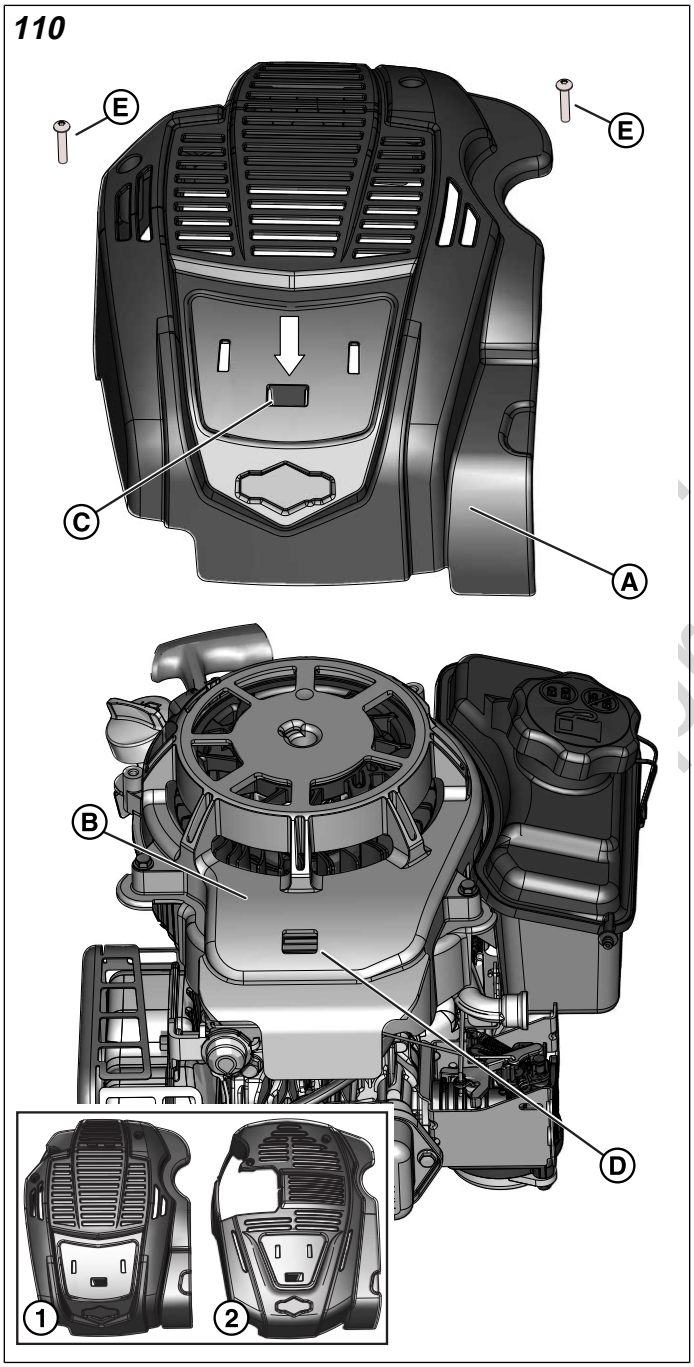
   NOTE: If rope was broken or screwdriver was not inserted to hold position of pulley, turn pulley in a counter-clockwise direction until spring is tightly wound, then rotate pulley clockwise one turn before aligning pulley hole with rewind starter housing eyelet.
7. Insert rope through pulley hole (**G**) and rewind starter housing eyelet (**H**).
8. See Figure 109. Pull rope until knot is seated in pulley recess (**I**).
9. Insert end of rope through handle (**J**).
10. Tie knot (**K**) at end of rope.
11. Pull rope until knot is seated in recess of handle.
12. Remove screwdriver (**L**) and allow pulley to slowly rewind rope.
13. Operate rewind starter to check for smooth operation.

Static Cover (If Equipped)

NOTE: See inset of Figure 110. The appearance of the static cover differs depending upon whether the engine is equipped with a rewind starter (**1**) or battery pack (**2**).

1. Position static cover (**A**) on blower housing (**B**).
2. Push static cover rearward (down) to engage latch (**C**) with catch (**D**) on blower housing.
3. Install two TORX screws (**E**) to fasten static cover to blower housing. Alternately tighten screws to **12-18 lb-in** (1.4-2.0 N-m).
4. Install knob on choke shaft, if equipped.

110



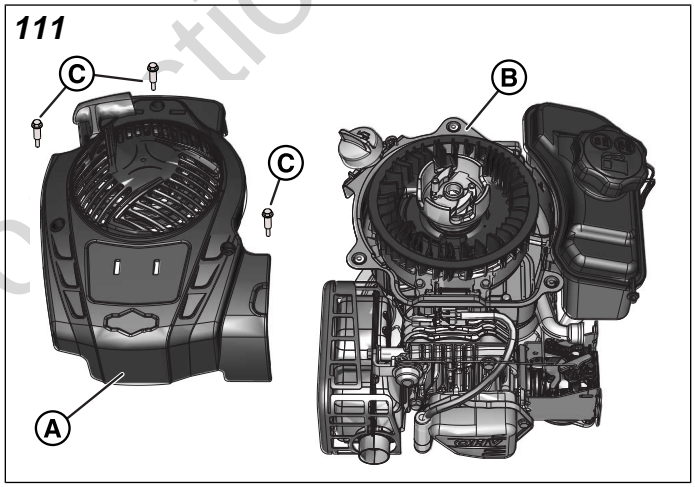
5. If equipped, push tabs on cover insert (decorative trim) into slots in static cover.

Rewind Starter Housing (If Equipped)

1. Inspect rewind starter as follows:
   A. Pull rope to verify that pulley moves freely in both directions.
   B. Verify that tension increases when rope is pulled and decreases when rope is released.

      NOTE: If rope is broken, verify that tension increases when pulley is rotated by hand in a counter-clockwise direction.
   C. Verify that the rope eyelet in the rewind starter housing is in good condition (without burrs or excessive wear).
   D. Inspect rope for cuts, breaks, or fraying. If rope replacement is necessary, see *Replace Rewind Starter Rope.*
2. See Figure 111. Position rewind starter housing (**A**) on blower scroll (**B**).

111



NOTE: If equipped, connect two socket spade terminals to rocker stop switch.

3. Loosely install three hex flange shoulder screws (**C**) to fasten rewind starter housing to blower scroll.

   NOTE: To ensure that pawls evenly engage flywheel starter cup, pull starter rope, tighten hex flange screws until snug, and then release starter rope.
4. Alternately tighten screws to **30-40 lb-in** (3.4-4.5 N-m).

Air Cleaner

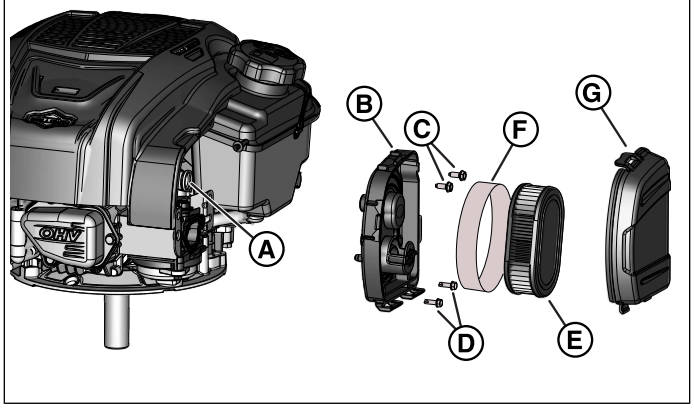
1. Wash air cleaner cover and air cleaner base in warm, soapy water, or use a soft bristle brush and a portable hand vacuum to remove all dust and dirt.
2. See Figure 112. Install breather tube (**A**) to port on air cleaner base (**B**).
3. Install two outside hex flange screws (**C**) to fasten air cleaner base to carburetor mounting bracket. Alternately tighten screws to **30-35 lb-in** (3.4-4.0 N-m).

   NOTE: Nub (or small protuberance) on each side of base engages hole on each side of bracket.
4. Install two inside hex flange screws (**D**) to fasten air cleaner base to carburetor. Alternately tighten screws to **20-30 lb-in** (2.3-3.4 N-m).
5. Gently tap air filter cartridge (**E**) on a hard surface to loosen dirt and debris. Carefully brush and/or vacuum air filter cartridge as necessary.

   NOTE: Use of pressurized air or solvents will damage foam pre-cleaner and air filter cartridge.
6. Gently wash foam pre-cleaner (**F**) in warm, soapy water. Thoroughly rinse with clean water and allow to air dry completely. Do not oil pre-cleaner.
7. Carefully inspect foam pre-cleaner and air filter cartridge. Replace parts if they cannot be adequately cleaned or if any damage is observed.
8. Install foam pre-cleaner onto air filter cartridge.
9. Place air filter cartridge with foam pre-cleaner onto air cleaner base.
10. Insert tabs on air cleaner cover (**G**) into slots in air cleaner base, and then rotate cover until latch fully engages.

    NOTE: Slot in air cleaner cover captures fuel tank vent tube on some models.

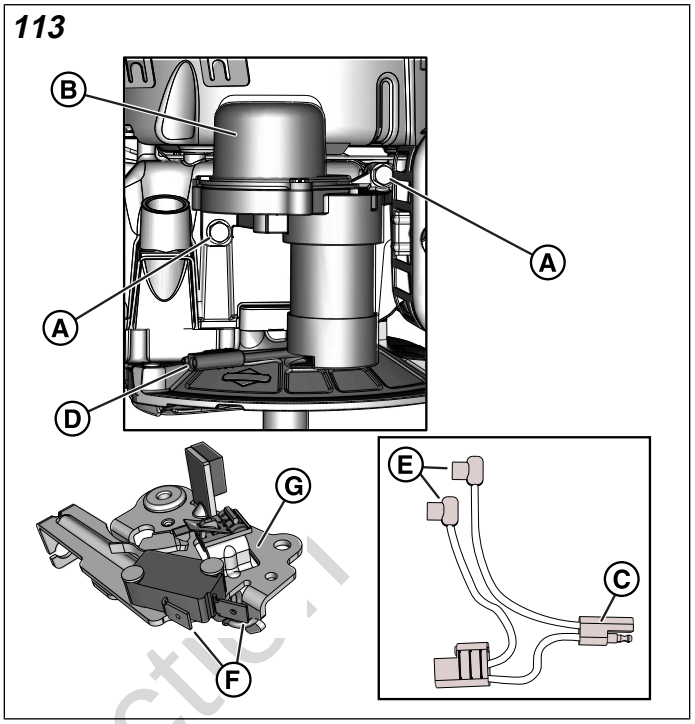
112



Starter Motor (If Equipped)

1. See Figure 113. Install two hex flange screws (**A**) to fasten starter motor (**B**) to crankcase. Alternately tighten screws to **75-95 lb-in** (8.5-10.7 N-m).

113



2. To install wire harness and other electrical components, proceed as follows:

   NOTE: If configuration differs from that described below, route wires and make electrical connections as noted during disassembly.

Brake Wire Routing

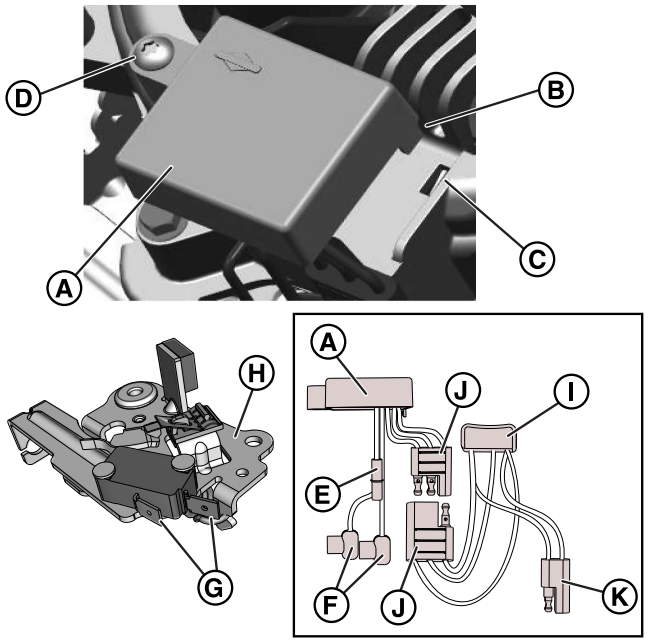
1. See Figure 113. Connect two-place wire harness connector (**C**) to starter motor connector (**D**).
2. Connect two 90° connectors (**E**) to micro switch terminals (**F**) on flywheel brake (**G**).

   NOTE: The micro switch terminal connectors are interchangeable.

Bail Start Wire Routing

1. See Figure 114. Install bail start module (**A**), so that tab (**B**) engages slot (**C**) in blower housing.
2. Install TORX screw (**D**) and tighten to **12-18 lb-in** (1.4-2.0 N-m).
3. Connect white one-place connector (**E**) to armature wire connector.

114



4. Connect two 90° connectors (**F**) to micro switch terminals (**G**) on flywheel brake (**H**).

   NOTE: The micro switch terminal connectors are interchangeable.
5. Connect wire block (**I**) to blower housing terminals.
6. Connect three-place connector (**J**) between wire block and bail start module.
7. Connect two-place connector (**K**) to starter motor connector.

Final Instructions

1. Add engine oil as follows:
   A. Place engine on a flat, level surface.
   B. Remove oil fill cap.
   C. Slowly pour **15 ounces** (444 ml) of the recommended type of oil into the dipstick tube. Do NOT OVERFILL.

      NOTE: See *Section 1 - Safety and General Information, General Information, Oil Recommendations.*
   D. See A of Figure 115. Slowly insert dipstick until oil fill cap contacts collar on dipstick tube.
   E. Slowly remove dipstick.
   F. See B of Figure 115. Verify that oil level is on the cross hatch pattern at or near the high mark.

      NOTE: Observe oil level on both sides of the dipstick. The lower level of the two readings is the correct oil level measurement.
   G. Add oil as necessary.
   H. Install dipstick into dipstick tube. Tighten oil fill cap.
2. Fill fuel tank with fresh gasoline.
3. Install spark plug wire onto spark plug terminal.
4. Start and run engine. Check for oil and fuel leaks while engine is running.

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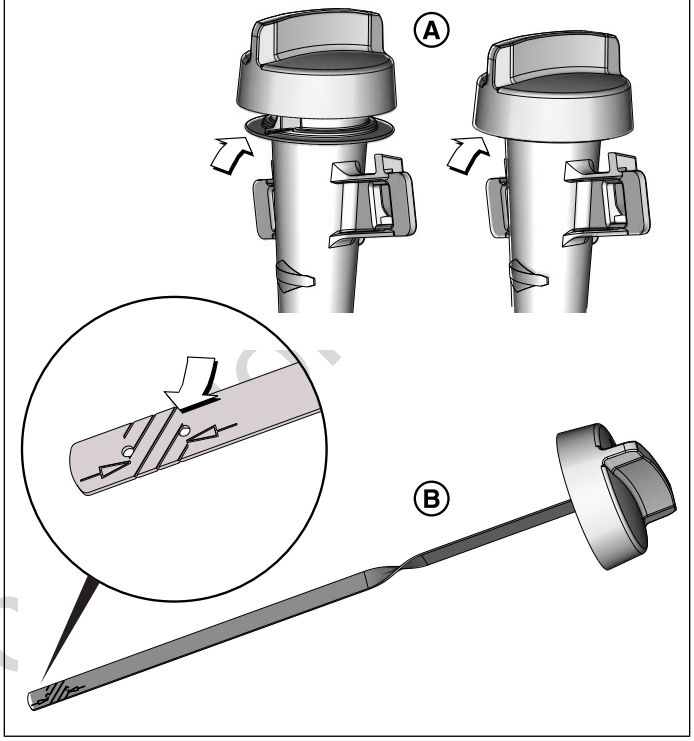

Set Top No-Load Speed

1. Obtain the Top No-Load Speed for the engine. Proceed as follows:
   A. **Dealers:** See *www.thepowerportal.com.*
   B. **Consumers:** Contact your local Briggs & Stratton authorized service dealer.

      NOTE: Have your complete model-type-trim number and code number in hand.
2. See Figure 116. Obtain Digital Tachometer and Hour Meter (Part No. 19598) (**A**). Proceed as follows:
   A. Insert solder lug of white wire under engine or frame bolt for suitable ground (**B**).
   B. Tightly coil red wire over an insulated section of the spark plug wire using three to four turns (**C**).

NOTE: Keep wires away from hot or moving engine parts.

3. Obtain Tang Adjusting Tool (Part No. 19480).
4. Start and run engine. Bend speed control bracket tang (**D**) to set high speed no-load to value obtained in step 1. Bend tang towards carburetor to increase engine speed, away from carburetor to decrease engine speed.

   NOTE: Do not twist or rotate tang. Only bend in same plane as spring acts.
5. Stop engine and remove Digital Tachometer and Hour Meter.

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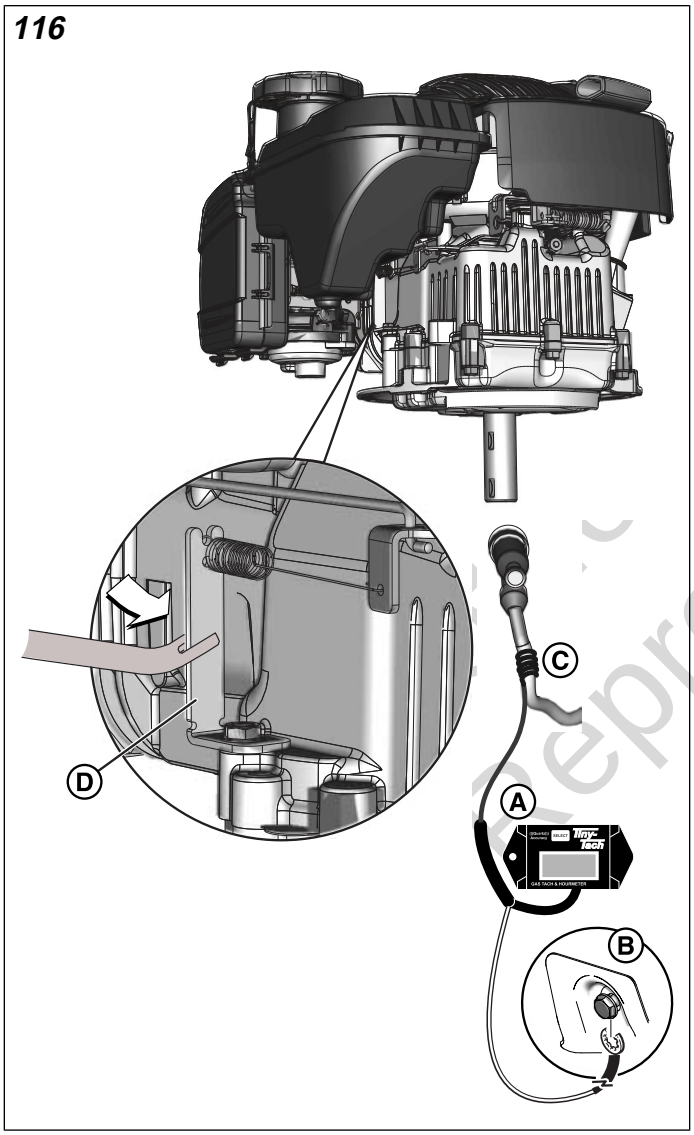

SECTION 9 – SPECIFICATIONS

9

Engine Specifications

ENGINE	
Bore	2.688 in (68.28 mm)
Stroke	1.75 in (44.45 mm)
Displacement	9.95 ci (163 cc)
Compression Ratio	8.75:1
Crankshaft End Play	0.002-0.040 in (0.05-1.02 mm)
Oil Capacity	15 oz (444 ml)
Fuel Tank Capacity	1.09 qt (1.0 L)
Ignition Timing	Variable
Armature Air Gap	0.006-0.014 in (0.15-0.36 mm)
Spark Plug Gap	0.030 in (0.76 mm)
Valve Clearance - Intake	0.004-0.008 in (0.10-0.20 mm)
Valve Clearance - Exhaust	0.004-0.008 in (0.10-0.20 mm)
Governor Shaft Seal Depth	0.020-0.030 in (0.508-0.762 mm)
Governor Crank Push Nut Clearance	0.002-0.015 in (0.05-0.38 mm)
Crankcase MAG Bearing Oil Seal Depth	Flush +/- 0.010 in (Flush +/- 0.25 mm)
Crankcase Cover (Sump) PTO Bearing Oil Seal Depth	0.175-0.225 in (4.45-5.71 mm)

Torque Specifications

FASTENER	TORQUE
Air Cleaner Base to Carburetor Screw	20-30 lb-in (2.3-3.4 N-m)
Air Cleaner Base to Carburetor Bracket Screw	30-35 lb-in (3.4-4.0 N-m)
Armature Screw	20-35 lb-in (2.3-4 N-m)
Bail Start Module Screw	12-18 lb-in (1.4-2.0 N-m)
Blower Scroll Screw	55-65 lb-in (6.2-7.3 N-m)
Blower Housing Screw	30-40 lb-in (3.4-4.5 N-m)
Breather Reed Screw	30-40 lb-in (3.4-4.5 N-m)
Carburetor Mounting Bracket Screw	55-65 lb-in (6.2-7.3 N-m)
Carburetor Float Bowl Screw	22-26 lb-in (2.5-2.9 N-m)
Casing Clamp Screw	2-4 lb-in (0.2-0.4 N-m)
Connecting Rod Cap Screw	90-105 lb-in (10.2-11.9 N-m)
Crankcase Cover (Sump) Screw *	95-115 lb-in (10.7-13.0 N-m)
Cylinder Head Screw *	120-140 lb-in (13.6-15.8 N-m)
Fixed/Manual/ Variable Speed Control Bracket Screw	60-70 lb-in (6.8-7.9 N-m)
Throttle Cable Bracket Screw (to Variable Speed Control Bracket)	15-20 lb-in (1.69-2.26 N-m)
Flywheel Nut	55-65 lb-ft (74.6-88.1 N-m)
Flywheel Brake Screw	25-40 lb-in (2.8-4.5 N-m)
Governor Lever Nut	25-35 lb-in (2.8-4.0 N-m)
Muffler Screw	55-65 lb-in (6.2-7.3 N-m)
Muffler Guard Screw	20-30 lb-in (2.3-3.4 N-m)
Muffler Spark Arrester Screw	71-124 lb-in (8-14 N-m)
Muffler Deflector Screw	8-12 lb-in (0.9-1.4 N-m)
Rocker Arm Stud	40-60 lb-in (4.5-6.8 N-m)

FASTENER	TORQUE
Rocker Ball Set Screw	19-25 lb-in (2.1-2.8 N-m)
Rewind Starter Housing Screw	30-40 lb-in (3.4-4.5 N-m)
Spark Plug	140-200 lb-in (15.8-22.6 N-m)
Starter Motor Screw	75-95 lb-in (8.5-10.7 N-m)
Static Cover Screw	12-18 lb-in (1.4-2.0 N-m)
Valve Cover Screw	45-55 lb-in (5.0-6.2 N-m)

* Use step torque procedure per instructions.

Standard/Reject Sizes

ITEM	STANDARD SIZE	REJECT SIZE
CRANKCASE/CYLINDER		
Camshaft Bearing Bore Diameter	0.502 in (12.738 mm)	0.504 in (12.788 mm) or more
Crankshaft Bearing Bore Diameter	0.877 in (22.276 mm)	0.879 in (22.326 mm) or more
Cylinder Bore Out-Of-Round	0.002 in (0.05 mm)	0.0015 in (0.04 mm) or more
Cylinder Bore Diameter	2.689 in (68.288 mm)	
CYLINDER HEAD		
Intake		
Valve Seat Angle	46°	
Valve Seat Width	0.0098 +/- 0.0019 in (0.25 +/- 0.05 mm)	
Valve Stem Diameter	0.197 in (4.99 mm)	0.191 in (4.84 mm) or less
Valve Guide Bore Diameter	0.20 in (5.08 mm)	0.203 in (5.16 mm) or more
Exhaust		
Valve Seat Angle	46°	
Valve Seat Width	0.0098 +/- 0.0019 in (0.25 +/- 0.05 mm)	
Valve Stem Diameter	0.197 in (4.99 mm)	0.191 in (4.84 mm) or less
Valve Guide Bore Diameter	0.20 in (5.08 mm)	0.203 in (5.16 mm) or more
CRANKCASE COVER (SUMP)		
Camshaft Bearing Bore Diameter	0.502 in (12.737 mm)	0.503 in (12.787 mm) or more
Crankshaft Bearing Bore Diameter	1.065 in (27.043 mm)	1.067 in (27.093 mm) or more
CRANKSHAFT		
Crank Pin Journal Diameter	0.998 in (25.349 mm)	0.996 in (25.299 mm) or less
MAG Bearing Journal Diameter	0.874 in (22.205 mm)	0.872 in (22.155 mm) or less
PTO Bearing Journal Diameter	1.062 in (26.967 mm)	1.06 in (26.917 mm) or less
CAMSHAFT		
MAG Bearing Journal Diameter	0.499 in (12.675 mm)	0.497 in (12.625 mm) or less
PTO Bearing Journal Diameter	0.499 in (12.675 mm)	0.497 in (12.625 mm) or less
CONNECTING ROD		
Crank Pin Bearing Bore Diameter	1.001 in (25.415 mm)	1.003 in (25.465 mm) or more
Piston Pin Bearing Bore Diameter	0.491 in (12.468 mm)	0.493 in (12.518 mm) or more
PISTON		
Piston Pin Diameter	0.49 in (12.438 mm)	0.489 in (12.408 mm) or less
Piston Pin Bore Diameter	0.491 in (12.471 mm)	0.493 in (12.521 mm) or more
Top Compression Ring End Gap	0.009 in (0.229 mm)	0.039 in (0.989 mm) or more
Middle Oil Wiper Ring End Gap	0.036 in (0.914 mm)	0.066 in (1.674 mm) or more
Bottom Oil Control Ring End Gap	0.030 in (0.762 mm)	0.065 in (1.652 mm) or more
Top Compression Ring Side Clearance **	0.004 in (0.102 mm)	0.011 in (0.279 mm) or more

** Only top ring side clearance needs to be checked.

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