

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 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.

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This engine repair manual includes the following engine models:

- MODEL 19V300, 25V300

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.

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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.

NOTE: A few exceptions to this rule do exist, such as the muffler and rewind starter, which may be serviced without having to remove other external assemblies.

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, CAMSHAFT, AND BALANCER*; 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.

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SECTION 2 – MAINTENANCE

SECTION 3 – TROUBLESHOOTING/SPECIAL TOOLS

SECTION 4 – REMOVE EXTERNAL ASSEMBLIES

SECTION 5 – DISASSEMBLE ENGINE

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SECTION 9 – SPECIFICATIONS

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SAFETY


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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 instructions recommend that oil be drained from the oil fill hole, 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.



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.



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.



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.



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.



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.



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.

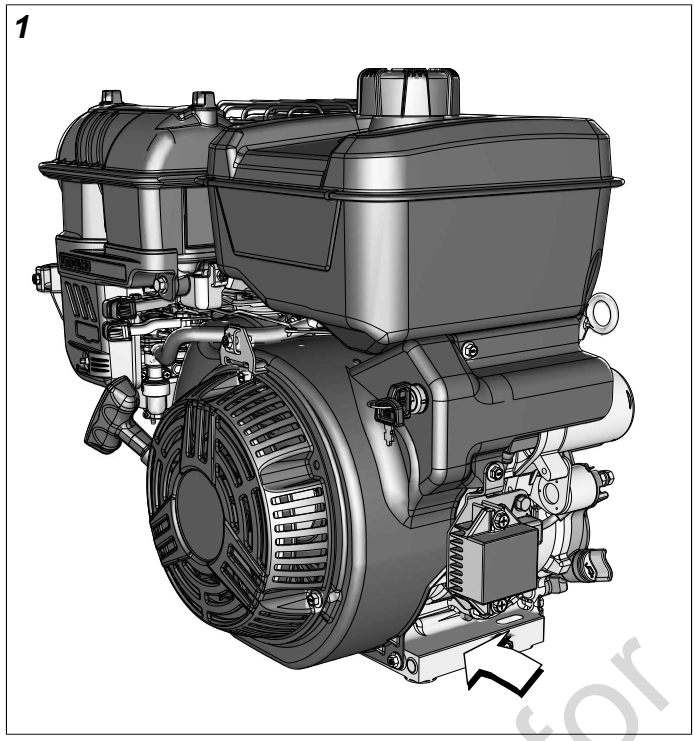
NOTICE

Failure to follow instructions could result in property damage.

GENERAL INFORMATION

Engine Identification

See Figure 1 for location of engine identification.



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

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.

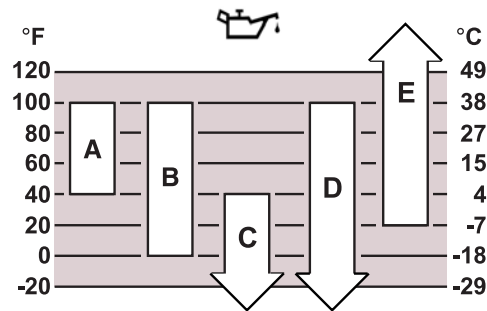
Fuel Recommendations

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 the appropriate **Operator's Manual** for recommendations. 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).



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

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.

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MAINTENANCE

Maintenance Schedule

After First 5 Hours

- Change Engine Oil

Every 8 Hours or Daily

- Check Engine Oil Level
- Clean Muffler, Rewind Starter Finger Guard, and Controls

Every 100 Hours or Annually

- Clean/Inspect Muffler and Spark Arrester

Every 200 Hours or Annually

- Change Engine Oil
- Clean Air Filter †

Every 600 Hours or 3 Years

- Replace Air Filter

Annually

- Clean/Gap/Replace Spark Plug
- Clean/Replace In-Tank Fuel Filter ‡
- Clean Carburetor Sediment Bowl and Fuel Filter Screen ‡
- 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/Check Engine Oil Level

1. Place engine on a flat, level surface.
2. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.
3. Remove all dirt and debris from around the dipstick tube.
4. See Figure 2. Remove dipstick (A) and wipe with a clean, lint free cloth.

NOTE: Proceed to step 10 if only checking engine oil level.

5. Remove oil drain plug with sealing washer (B) at base of engine and drain oil into an approved container.
6. Install oil drain plug with sealing washer and tighten to **140-200 lb-in** (15.8-22.6 N-m).
7. Remove oil fill cap (C) from valve cover.
8. Slowly pour the recommended type and amount of oil into the valve cover opening. See *Section 1 - Safety and General Information, General Information, Oil Recommendations and Section 9 - Specifications, Engine Specifications, Oil Capacity*. DO NOT overfill.
9. Allow a few seconds to elapse to allow oil to drain to the crankcase.

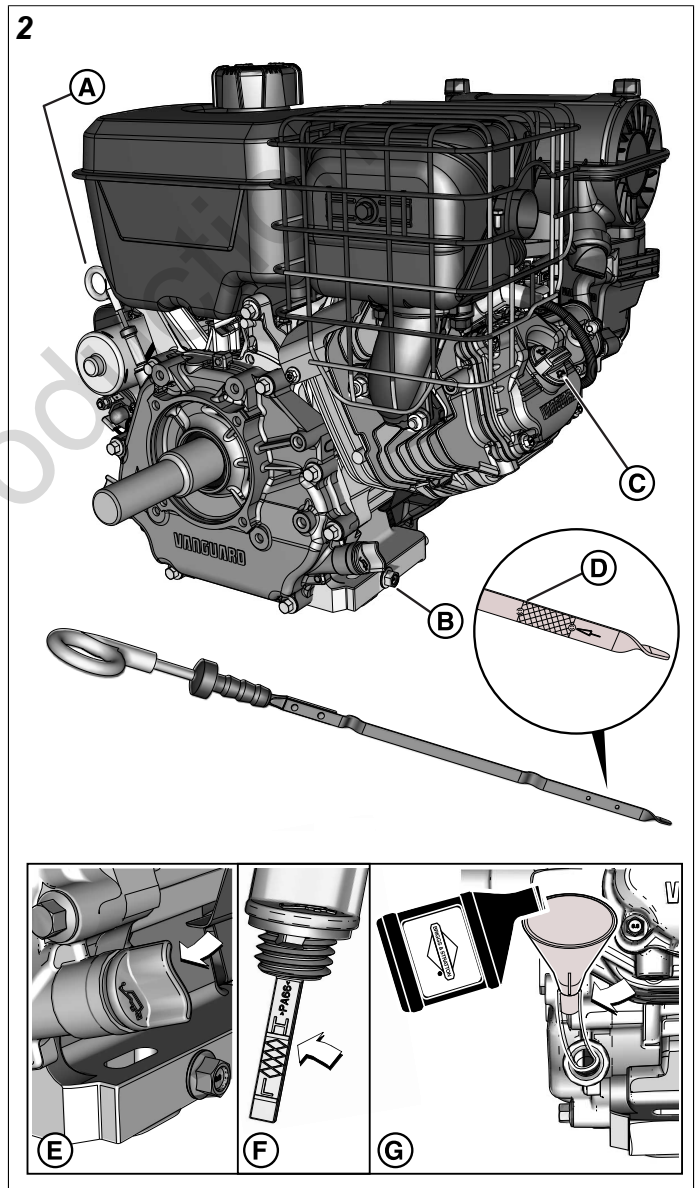
10. Slowly insert dipstick until it bottoms in the dipstick tube.

NOTE: The most accurate oil level readings are obtained when the engine is cold.

11. Slowly remove dipstick.
12. Verify that oil level (D) 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 correct.
14. Install dipstick into dipstick tube.



15. Install oil fill cap into valve cover. Tighten oil fill cap securely, but do not over-tighten.

NOTE: If using the dipstick oil plug, the foregoing instructions still apply, but with the following differences: screw plug completely into bore (E) before checking if engine oil level is at or near the high mark (F), and if adding oil, use a funnel and a short length of plastic tubing (G) for best results.

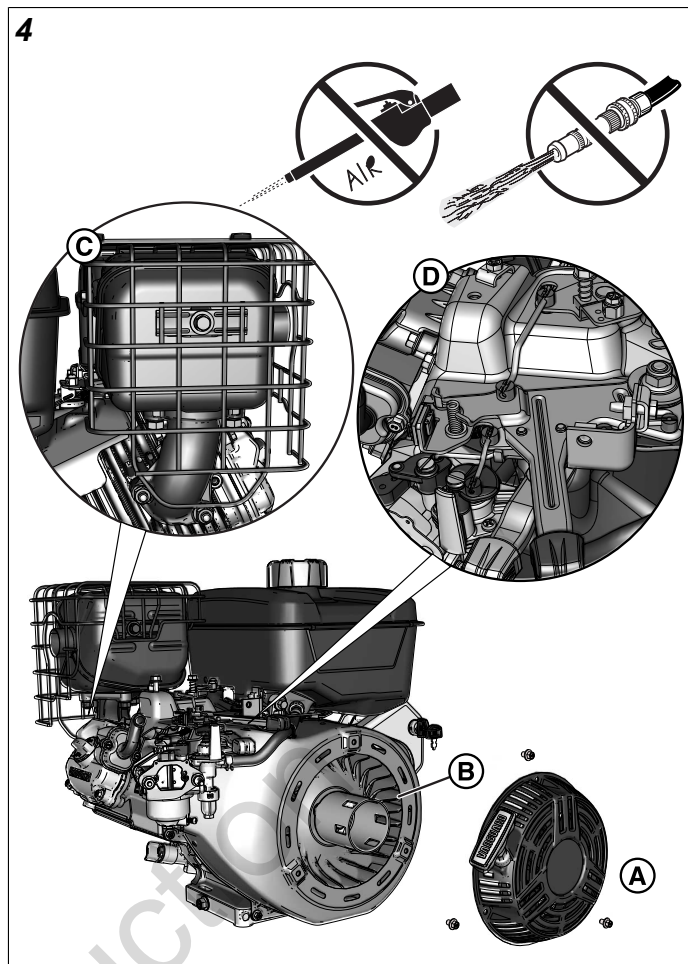
16. Install spark plug wire onto spark plug terminal.
17. Start and run engine for one minute. Check for oil leaks while engine is running.
18. Dispose of used oil at a proper waste disposal or recycling center.

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.
2. See Figure 3. Remove hex flange nut (A) to release trim panel (B) from inside carburetor mounting stud.



3. Remove hex flange screw (C) to release trim panel and air cleaner base (D) from control bracket.
4. Remove breather hose (E) from port on air cleaner base.
5. Remove two hex flange nuts (F) to release air cleaner base from carburetor mounting studs.
6. Remove hex flange screw (G) to release air cleaner base from control bracket.
7. See Figure 4. Remove three hex flange screws to release rewind starter (A) from blower housing.

NOTE: Note orientation of the rewind starter before removal.

8. Thoroughly clean rewind starter finger guard, flywheel fan (B), and muffler (C). Carefully clean governor link, springs, and controls (D). 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.

9. Verify that all combustible debris is removed from area around and behind muffler.
10. Verify that governor link, springs, and controls move freely without sticking, binding, or contacting blower housing or fuel tank.
11. Orient rewind starter as noted before removal.

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NOTE: Rewind starter may be installed in the 2 o'clock, 8 o'clock, 10 o'clock, or 12 o'clock positions.

12. Loosely install three hex flange screws to fasten rewind starter to blower housing.

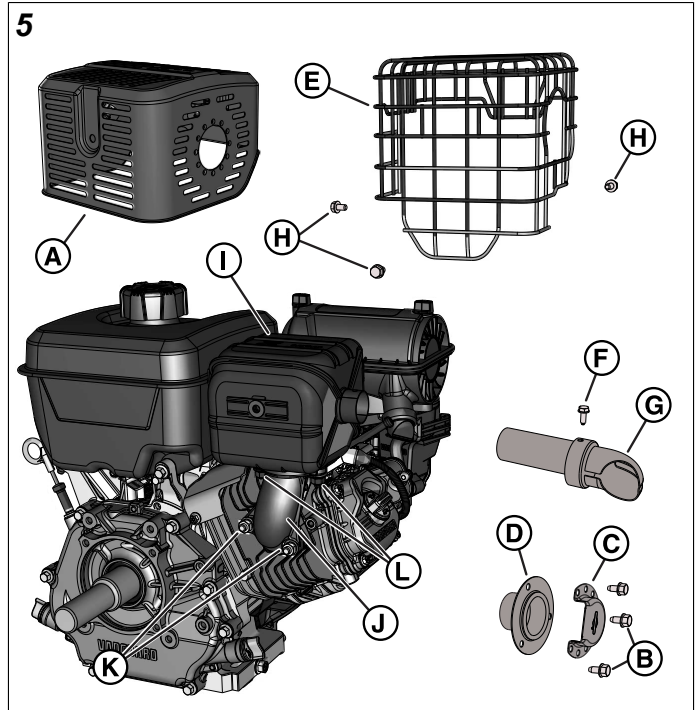
NOTE: To ensure that pawls evenly engage flywheel starter cup, pull starter rope, tighten hex flange screws until snug, and then release starter rope.

13. Alternately tighten three hex flange screws to **25-35 lb-in** (2.8-4 N-m).
14. Install air cleaner base onto carburetor mounting studs.
15. Install two hex flange nuts onto carburetor mounting studs. Tighten nuts to **30-50 lb-in** (3.4-5.7 N-m).
16. Install hex flange screw to fasten air cleaner base to control bracket. Tighten screw to **80-110 lb-in** (9-12.4 N-m).
17. Install trim panel onto inside carburetor mounting stud. Start hex flange nut onto stud.
18. Install hex flange screw to fasten trim panel and air cleaner base to control bracket. Tighten screw to **40-60 lb-in** (4.5-6.8 N-m).
19. Tighten hex flange nut on inside carburetor mounting stud to **25-35 lb-in** (2.8-4 N-m).
20. Install breather hose from valve cover to port on air cleaner base.
21. Install spark plug wire onto spark plug terminal.

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. Inspect muffler deflector/spark arrester for dirt, debris, and carbon buildup. Proceed as follows:
 - A. Note orientation of muffler deflector before removal.
 - B. See Figure 5. If stamped guard (A), remove three screws (B) to release muffler deflector (C) and spark arrester (D).



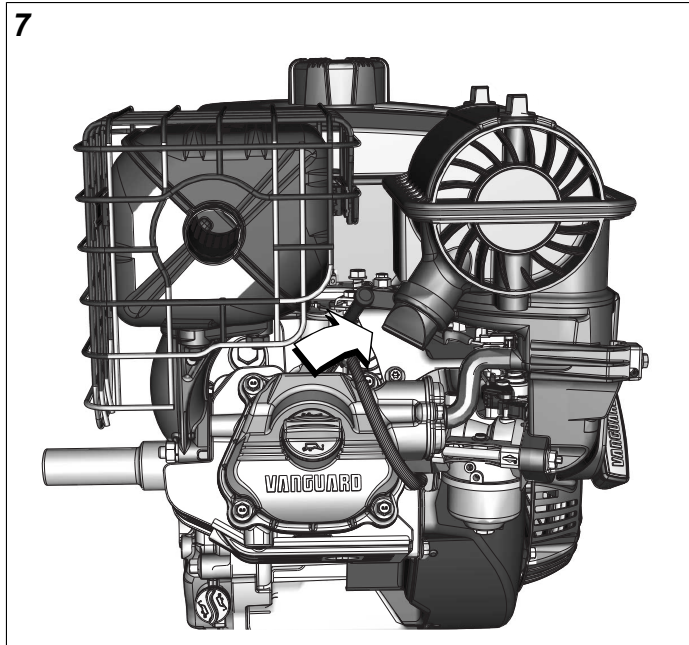
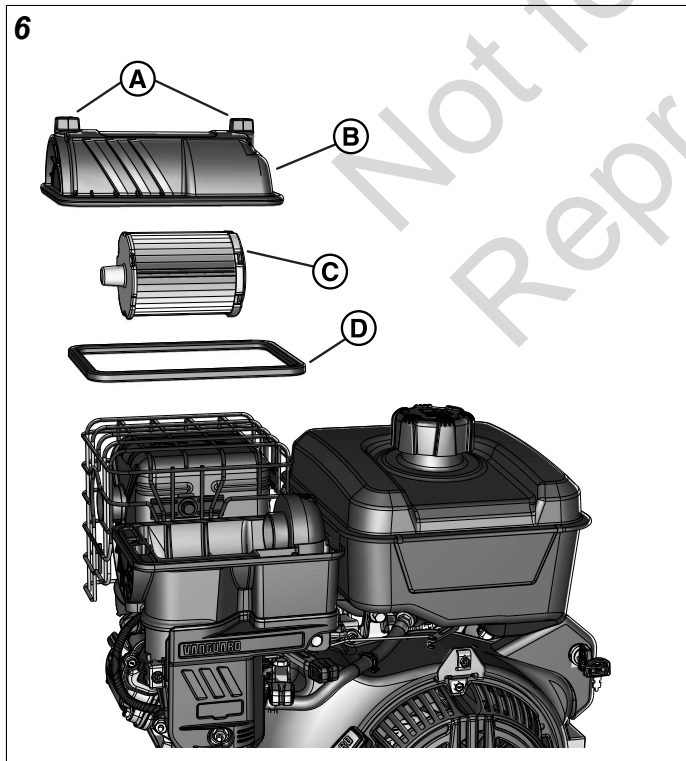
- C. If wire guard (E), remove single screw (F) to release muffler deflector/spark arrester (G).
 - D. Clean spark arrester screen with a stiff bristle brush. If carbon buildup is present, soak or spray with Carburetor Cleaner (Part No.'s 100041 or 100042). Blow dry from the inside-out with low pressure compressed air.
- NOTE:** Exercise care to avoid bending or puncturing screen. Replace assembly if screen cannot be adequately cleaned or if any damage is observed.
3. Remove three hex flange screws (H) to release wire guard or stamped guard from muffler (I).
 4. 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.
 - 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. Inspect muffler for holes, split seams, cracked welds, loose internal parts, corrosion, and other damage. Replace as necessary.
 6. Inspect muffler manifold (J) and mounting flanges for cracked welds, breakage, and other damage. Replace as necessary.

7. Verify that two hex nuts (K) securing muffler manifold to exhaust flange studs are tightened to **195-230 lb-in** (22-26 N-m).
8. Verify that two hex nuts (L) securing muffler manifold to muffler studs are tightened to **177-221 lb-in** (20-25 N-m).
9. Start three hex flange screws to fasten wire guard or stamped guard to muffler. Tighten screws to **146-177 lb-in** (16.5-20 N-m).
10. Install muffler deflector/spark arrester as follows:
 - A. Orient muffler deflector as noted before removal.

NOTE: Muffler deflector is installed in either the 9 o'clock or the optional 6 o'clock position.
 - B. If stamped guard, start three screws to install spark arrester and muffler deflector. Tighten screws to **25-35 lb-in** (2.8-4 N-m).
 - C. If wire guard, install single screw to fasten muffler deflector/spark arrester 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/Replace Air Filter

1. See Figure 6. Loosen two thumbscrews (A) to release air cleaner cover (B) from air cleaner base.
2. Remove air filter (C) from air cleaner base.



NOTE: Use of pressurized air or solvents will damage air filter cartridge.

NOTE: Exercise care to keep dust and dirt out of carburetor. Inadequate precautions can result in engine damage.

3. Gently tap air filter cartridge on a hard surface to remove dust, dirt and debris.
4. Carefully inspect air filter cartridge. Replace if any damage is observed.
5. Inspect quad seal (D) on air cleaner base for cuts, tears, holes, or general deterioration. Replace if necessary.
6. Use a soft bristle brush and a portable hand vacuum to remove all dust and dirt from air cleaner cover and air cleaner base.
7. Install air filter cartridge into air cleaner base.
8. Install air cleaner cover onto air cleaner base. Alternately tighten two thumbscrews until snug, but do not over-tighten.
9. See Figure 7. Inspect duckbill air valve on air inlet port of air cleaner base. Look for cuts, tears, holes, or general deterioration. Replace duckbill air valve if damaged or missing.

IMPORTANT NOTE: Engine operation without the duckbill air valve can reduce filter efficiency by as much as 50 percent.

17. Install fuel filter fitting into fuel tank. Tighten fitting to **62-71 lb-in** (7-8 N-m).
18. Inspect two rubber isolation mounts for cuts, tears, or general deterioration. Replace if necessary. Install isolation mounts onto crankcase flanges.
19. Place fuel tank onto engine, so that studs engage fuel pump bracket (if equipped), isolation mounts, and crankcase flanges.
20. Inspect hose for cuts, nicks, cracks, or general deterioration. Replace hose if necessary.
21. Install hose with clamp onto fuel filter fitting. Squeeze tangs and move hose clamp about **1/8 inch** (3 mm) from end of hose with tangs pointing down for best access.
22. Capture hose in clip anchored in hole of blower housing. Replace cable clip if damaged or missing. Verify that hose does not contact governor link or governor link spring.
23. Hand start two hex flange screws to fasten fuel tank to crankcase flanges. Tighten screws to **144-174 lb-in** (16.3-19.7 N-m).
24. Install two hex flange nuts onto fuel tank studs. Alternately tighten nuts to **144-174 lb-in** (16.3-19.7 N-m).
25. Connect wire harness connector to key switch. Install two hex flange screws to fasten key switch panel to crankcase. Alternately tighten screws to **80-110 lb-in** (9-12.4 N-m).
26. Install spark plug wire onto spark plug terminal.

Clean Carburetor Sediment Bowl

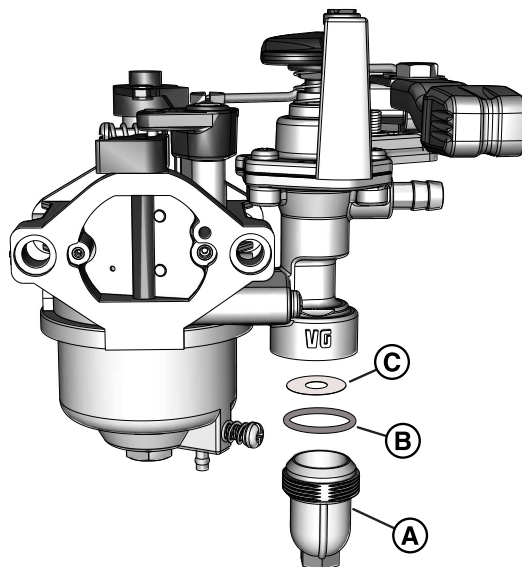


WARNING

Wrap shop towel around sediment bowl to catch any fuel leakage. 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.
 - Thoroughly wipe up any spilt fuel immediately.
 - Collect any fuel and/or shop towels in approved containers and dispose of properly.
1. Start and run engine until fuel tank is empty.
 2. Position throttle lever/fuel valve to OFF.
 3. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.

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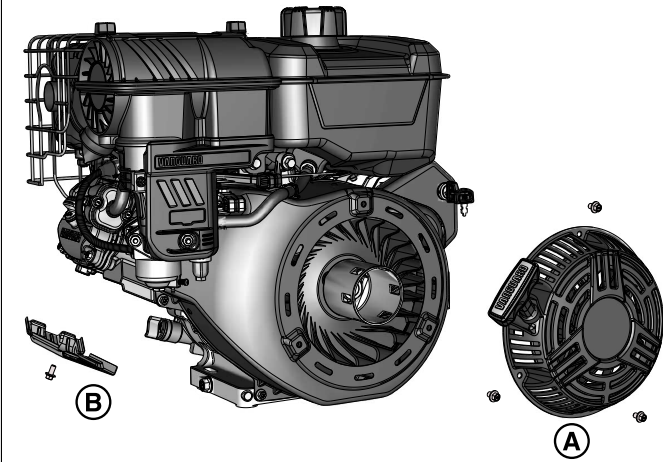


4. See Figure 10. Remove sediment bowl (A) from fuel shutoff valve. Remove O-ring (B) and fuel filter screen (C).
5. Thoroughly clean sediment bowl of sediment, gum or varnish deposits. Use Carburetor Cleaner (Part No. 100042), if necessary.
6. Check sediment bowl O-ring and fuel filter screen for cuts, tears, or general deterioration. Clean or replace as necessary.
7. Install fuel filter screen and O-ring into sediment bowl. Install sediment bowl onto fuel shutoff valve, and tighten to **20-25 lb-in** (2.3-2.8 N-m).
8. Install spark plug wire onto spark plug terminal.

Clean Air Cooling System

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.
 2. See Figure 11. Remove three hex flange screws to release rewind starter (A) from blower housing.
- NOTE:** Note orientation of the rewind starter before removal.
3. Remove hex flange screw to release heat shield (B) from cylinder head.



4. Clean cylinder cooling fins, the inside of the rewind starter, and the flywheel fan 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. Install hex flange screw to fasten heat shield to cylinder head. Tighten screw to **40-60 lb-in** (4.5-6.8 N-m).
6. Orient rewind starter as noted before removal.

NOTE: Rewind starter may be installed in the 2 o'clock, 8 o'clock, 10 o'clock, or 12 o'clock positions.

7. Loosely install three hex flange screws to fasten rewind starter to blower housing.

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

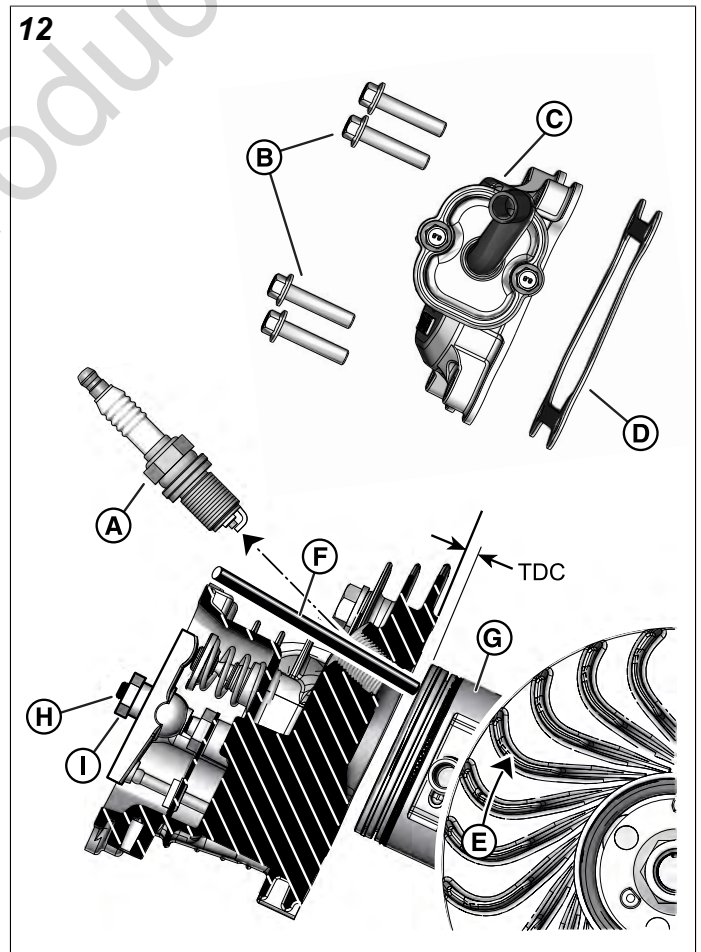
8. Alternately tighten three hex flange screws to **25-35 lb-in** (2.8-4 N-m).

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. See Figure 12. Remove spark plug (A) from cylinder head using the 5/8 inch Spark Plug Wrench (Part No. 19576S).
4. Remove four hex flange screws (B) to release valve cover (C).
5. Remove and discard valve cover gasket (D).
6. Move piston to Top Dead Center (TDC) of the compression stroke. Proceed as follows:
 - A. While rotating flywheel end of crankshaft (E) 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 (F) through the spark plug hole until seated at the top of the piston (G).

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- 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. Remove wooden dowel.
7. Insert feeler gauge between rocker arm and exhaust valve stem. Verify that exhaust valve clearance is **0.006-0.008 inches** (0.15-0.20 mm).
8. If adjustment is necessary to obtain proper clearance, proceed as follows:
 - A. Loosen set screw (**H**) and turn rocker ball nut (**I**) as necessary.
 - B. Holding rocker ball nut to prevent rotation, tighten set screw to **60-80 lb-in** (6.8-9 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 **0.004-0.006 inches** (0.10-0.15 mm). If adjustment is necessary, see step 8.
10. Remove old gasket material from valve cover and cylinder head flanges. Gasket material left on sealing surfaces will cause leaks.
11. Install **new** valve cover gasket onto valve cover.
12. Start four hex flange screws to fasten valve cover to cylinder head. Alternately tighten screws to **70-90 lb-in** (7.9-10.2 N-m) using a crosswise pattern.
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.

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SECTION 3 – TROUBLESHOOTING/SPECIAL TOOLS

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TROUBLESHOOTING

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.

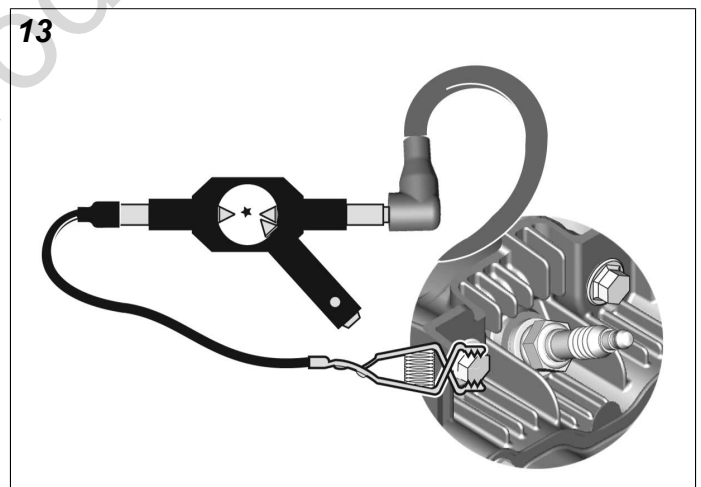
Engine Does Not Start

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 13. Install free end of spark plug wire onto inline tester prong. Install tester alligator clip onto good engine ground.



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.



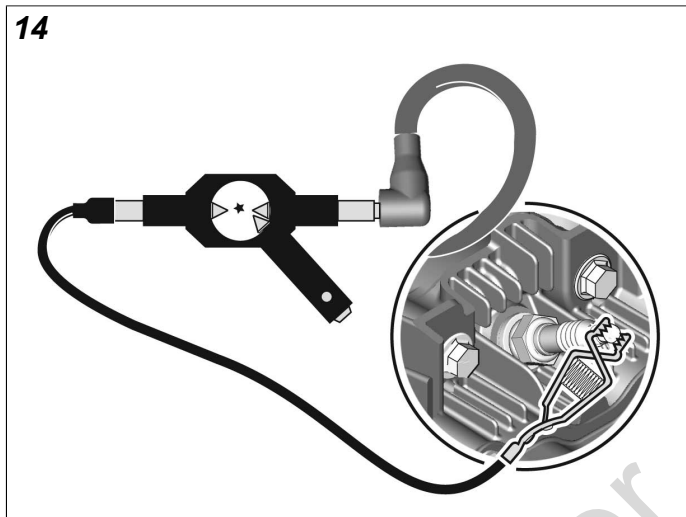
Engine Runs But Misses

9. Obtain Ignition Tester (Part No. 19368).
10. Remove spark plug wire from spark plug terminal.
11. See Figure 14. Install free end of spark plug wire onto inline tester prong. Install tester alligator clip onto spark plug terminal.



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.



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 (or fuel tank) 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.

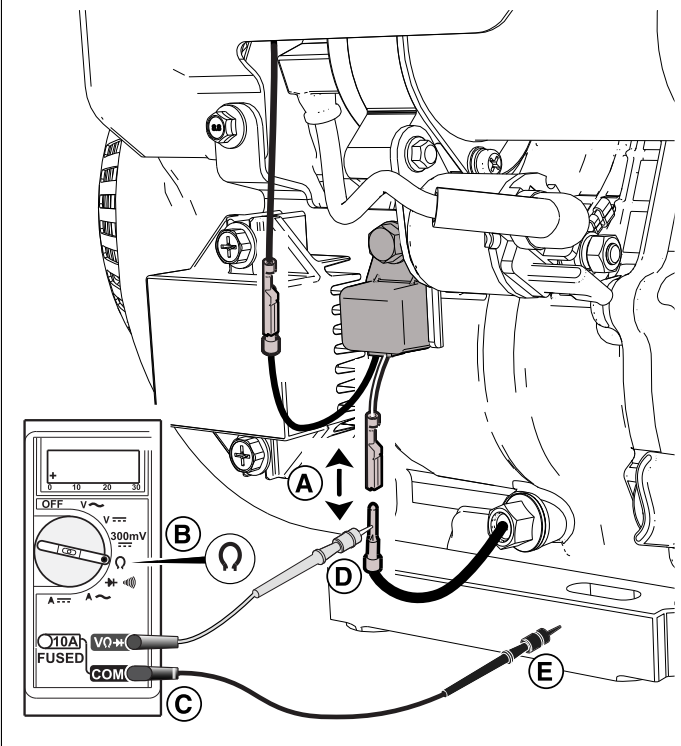
NOTE: Any air leaks at the tester connections and fittings will adversely affect test results.
3. The sound of air flow:
 - between the cylinder and cylinder head indicates the cylinder head gasket is leaking.
 - from the carburetor indicates air is leaking past the intake valve and valve seat.
 - from 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 Low Oil Sensor System

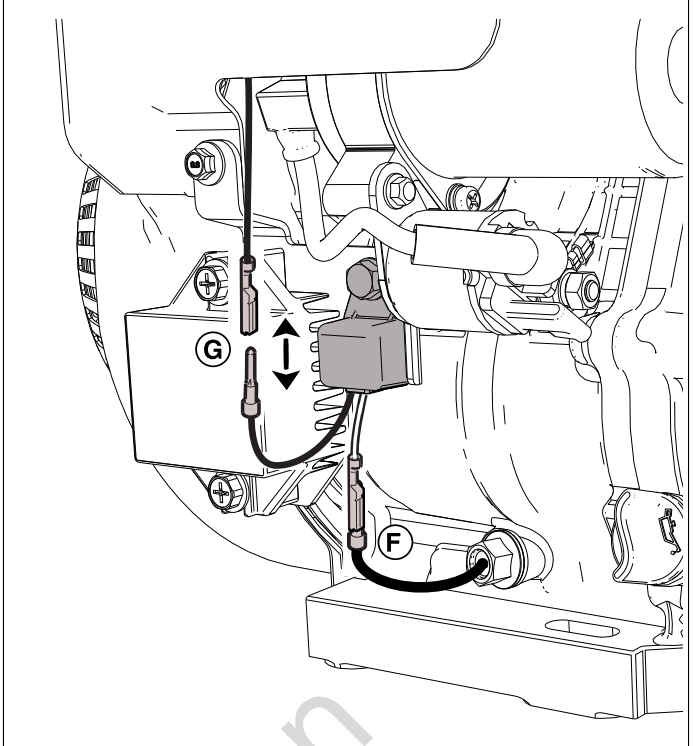
Engine Does Not Start

1. Verify that engine oil level is within the cross hatch pattern on the dipstick.
2. See Figure 15. If engine oil level is satisfactory, disconnect one-place wire connector between oil sensor module and oil sensor in crankcase (**A**).

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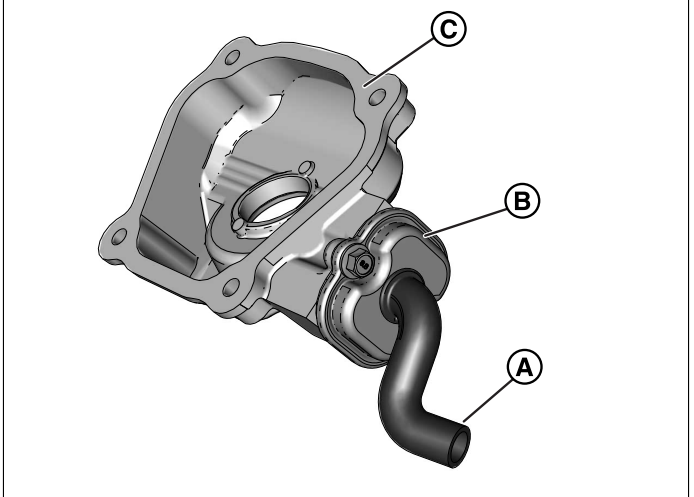
3. Obtain Digital Multimeter (Part No. 19602), and set to read ohms (B).
4. Insert RED meter test lead into V Ω receptacle, and BLACK meter test lead into COM receptacle (C).
5. Connect red meter test lead to oil sensor wire (D), and black meter test lead to engine base (E).
6. Measure resistance. Replace sensor in crankcase if continuity is obtained. Proceed to next step if meter reads infinity.
7. See Figure 16. Connect one-place wire connector between oil sensor module and oil sensor in crankcase (F).
8. Disconnect one-place wire connector between oil sensor module and armature coil (G).
9. Start engine. Verify that oil sensor module wire is not touching ground.
10. Replace oil sensor module if engine starts. If engine does not start, check oil sensor module wiring for shorts to ground.

Check Breather Valve

Engine Does Not Start

1. See Figure 17. Gently blow air into breather hose (A) to verify that there is no air flow through valve.
2. Apply vacuum or draw air out through breather hose to verify that air flows freely through valve.
3. If air flow has no resistance when blowing or is restricted under vacuum, the breather valve (B) is faulty. Replace the valve cover (C).

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SPECIAL TOOLS

Special Tools

1. Piston Ring Compressor (Part No. 19070)
2. Flywheel Puller (Part No. 19203)
3. Valve Lapping Tool (Part No. 19258)
4. Piston Ring Expander (Part No. 19340)
5. Ignition Tester (Part No. 19368)
6. Torque Wrench (Part No. 19393)
7. Tang Adjusting Tool (Part No. 19480)
8. Telescoping Gauge (Part No. 19485)
9. Dial Bore Gauge (Part No. 19487)
10. Leakdown Tester (Part No. 19545)
11. Master Seat Cutter Kit (Part No. 19547)
12. Spark Plug Wrench (Part No. 19576S)
13. Digital Tachometer/Hour Meter (Part No. 19598)
14. Digital Multimeter (Part No. 19602)
15. Dial Caliper (Part No. 19609)
16. Fuel Hose Remover (Part No. 19620)
17. Valve Lapping Compound (Part No. 94150)
18. Carburetor Cleaner (Part No. 100042)
19. Armature Air Gap Gauge (Part No. CE5121)
20. Crankshaft End Play Shim Kit (Part No. 84003590)

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SECTION 4 – REMOVE EXTERNAL ASSEMBLIES

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REMOVE EXTERNAL ASSEMBLIES

Preliminary Instructions

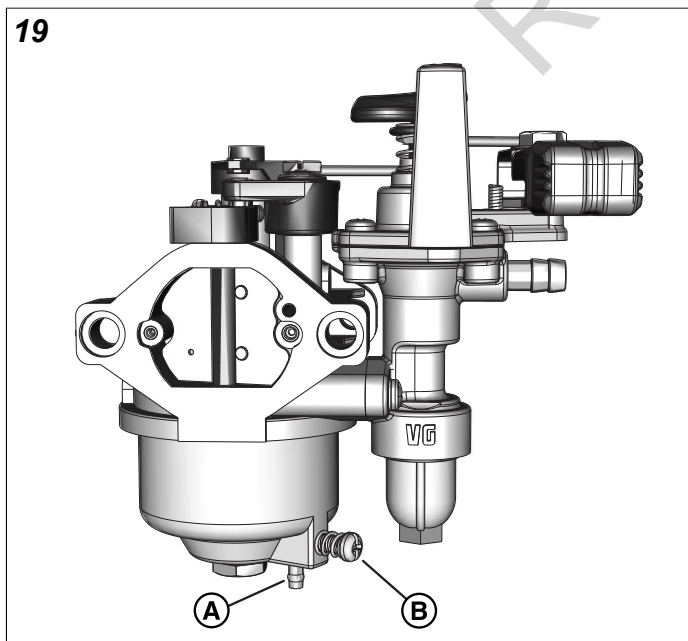
1. Start and run engine until fuel tank is empty. If the engine will not start, drain fuel tank as follows:



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.
- Thoroughly wipe up any spilt fuel immediately.
- Collect any fuel and/or shop towels in approved containers and dispose of properly.

- A. Obtain suitable length of 1/8 inch tubing.
- B. See Figure 19. Attach one end of tubing to float bowl fitting (A).
- C. Direct free end of tubing into an approved container.
- D. Position throttle lever/fuel valve to ON and loosen float bowl drain screw (B).
- E. When fuel tank has drained completely, position throttle lever/fuel valve to OFF.

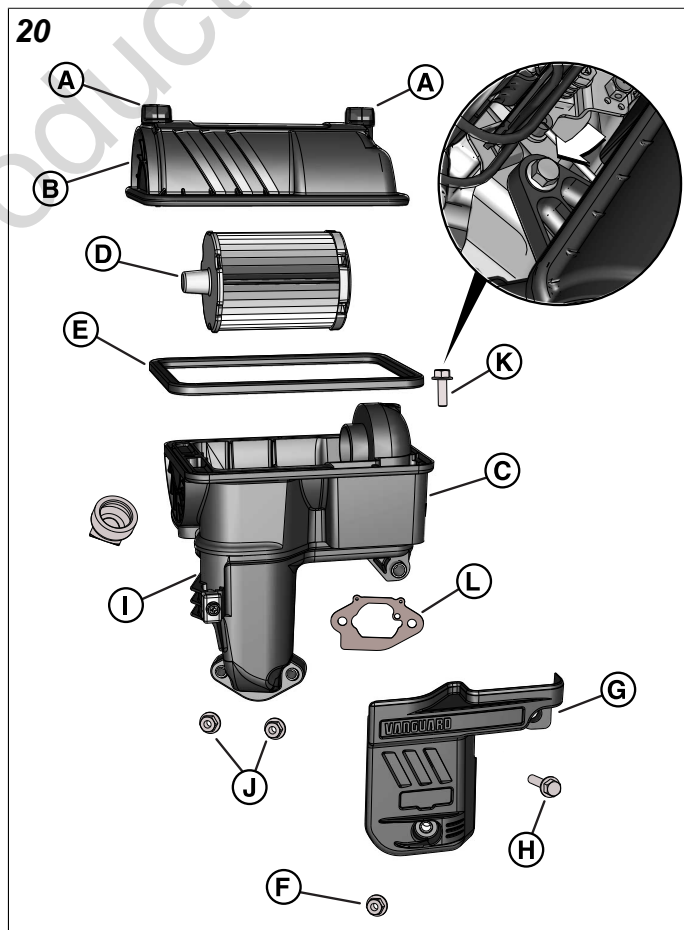


- F. Tighten float bowl drain screw to **8-12 lb-in** (0.9-1.3 N-m).

- G. Remove 1/8 inch tubing from float bowl fitting.
2. Remove spark plug wire from spark plug terminal. Secure spark plug wire to prevent unintentional contact with spark plug terminal.
3. Remove oil drain plug(s) with sealing washer(s) at base of engine and drain oil into an approved container.

Air Cleaner

1. See Figure 20. Loosen two thumbscrews (A) to release air cleaner cover (B) from air cleaner base (C).
2. Remove air filter (D) from air cleaner base.
3. Remove quad seal (E) from air cleaner base.
4. Remove hex flange nut (F) to release trim panel (G) from inside carburetor mounting stud.



5. Remove hex flange screw (H) to release trim panel and air cleaner base from control bracket.
6. Remove breather hose from port (I) on air cleaner base.
7. Remove two hex flange nuts (J) to release air cleaner base from carburetor mounting studs.
8. Remove hex flange screw (K) to release air cleaner base from control bracket.
9. Remove gasket (L) from two pins next to mounting flange of air cleaner base. Discard gasket.

Fuel Tank

1. See Figure 21. If equipped, remove two hex flange screws (A) to release key switch panel (B) from crankcase. Disconnect wire harness connector from key switch.

2. Remove two hex flange screws (C) to release fuel tank (D) from crankcase flanges.
 3. Remove two hex flange nuts (E) from fuel tank studs.
 4. Squeeze tangs and move hose clamp (F) away from in-tank fuel filter fitting (G).
 5. Release hose (H1 or H2) from clip (I) anchored in hole of blower housing.
- NOTE:** Hose (H2) is only used on models equipped with the optional fuel pump.
6. Remove hose from in-tank fuel filter fitting. For best results, use Fuel Hose Remover (Part No. 19620) (J).
 7. Raise and remove fuel tank.
 8. Remove two rubber isolation mounts (K) from crankcase flanges.

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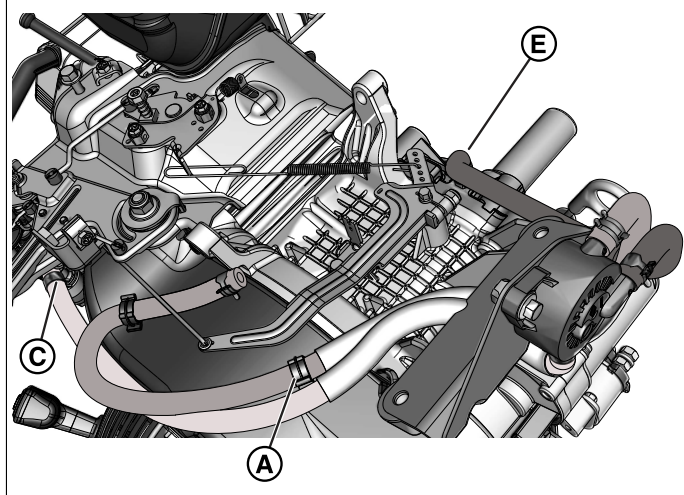
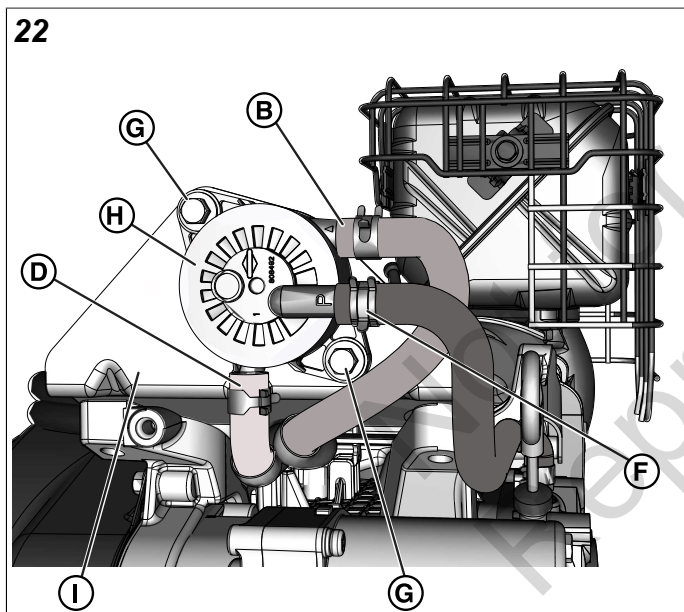


Fuel Pump/Hoses (If Equipped)

1. Squeeze tangs to move each hose clamp away from fitting, and then proceed as follows:

NOTE: For best results, use Fuel Hose Remover (Part No. 19620).

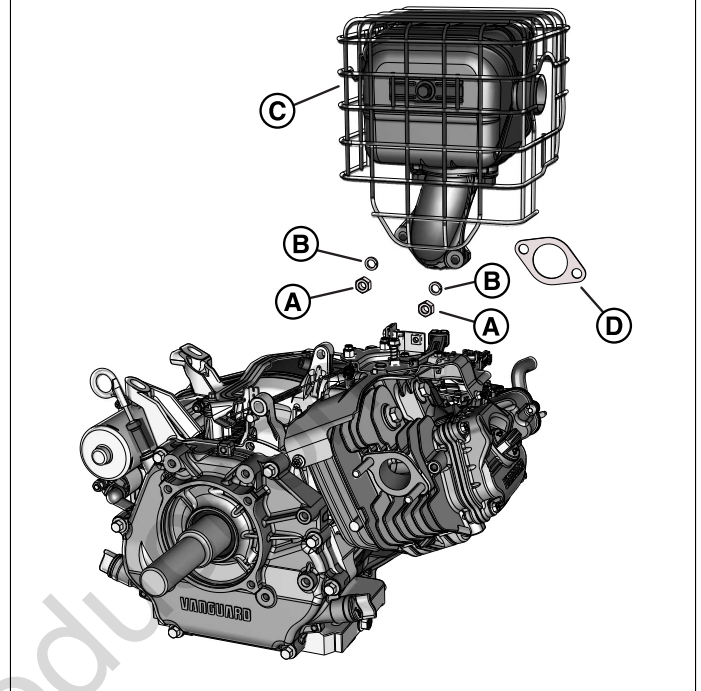
- A. See Figure 22. Release hose from clip (A) anchored in hole of blower housing. If necessary, remove hose from fuel pump fuel inlet fitting (B).
- B. Remove hose from carburetor fuel inlet fitting (C). If necessary, remove other end from fuel pump fuel outlet fitting (D).
- C. Remove hose from crankcase cover fitting (E). If necessary, remove other end from pulse pump fitting (F).
- D. Remove two hex flange screws (G) to release fuel pump (H) from bracket (I).



Muffler

1. See Figure 23. Remove two hex nuts (A) with lock washers (B) to release muffler (C) from exhaust flange studs.
2. Remove and discard muffler gasket (D).

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Control Bracket/Governor Lever

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

1. See Figure 24. Depress stop switch tab (A), and then straighten and remove stop wire.
2. Release TransportGuard link from connector groove (B) on fuel shutoff cam.
3. Remove Nyloc nut (C), flat washer (D), and square-head screw (E) from governor lever (F). Remove governor lever from governor crank (G).

NOTE: Do not remove spring clip from governor crank or it will drop into crankcase.

NOTE: For governor crank removal, see SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, CRANKCASE AND CRANKCASE COVER, DISASSEMBLY.

4. Disengage governor idle spring (H) from slot in idle speed adjustment tang (I).
5. Remove opposite end of governor idle spring from slot in governor lever.

6. Remove three hex flange screws (J) to release control bracket from crankcase.

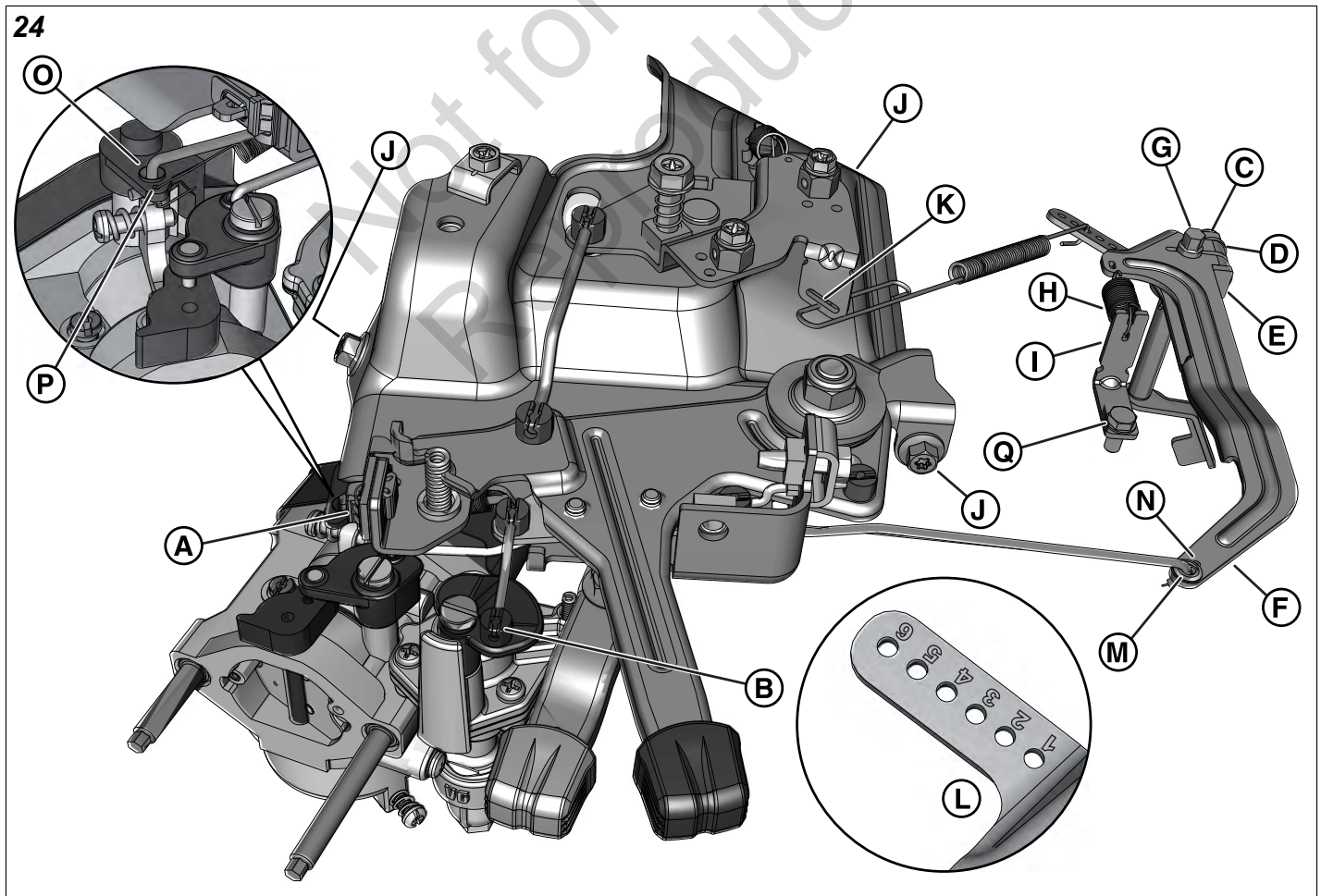
NOTE: Use the internal T25 TORX recess for best results.

7. Remove trombone end of the main governor spring (K) from slot in high speed adjustment tang.

NOTE: Remove control bracket and set aside.

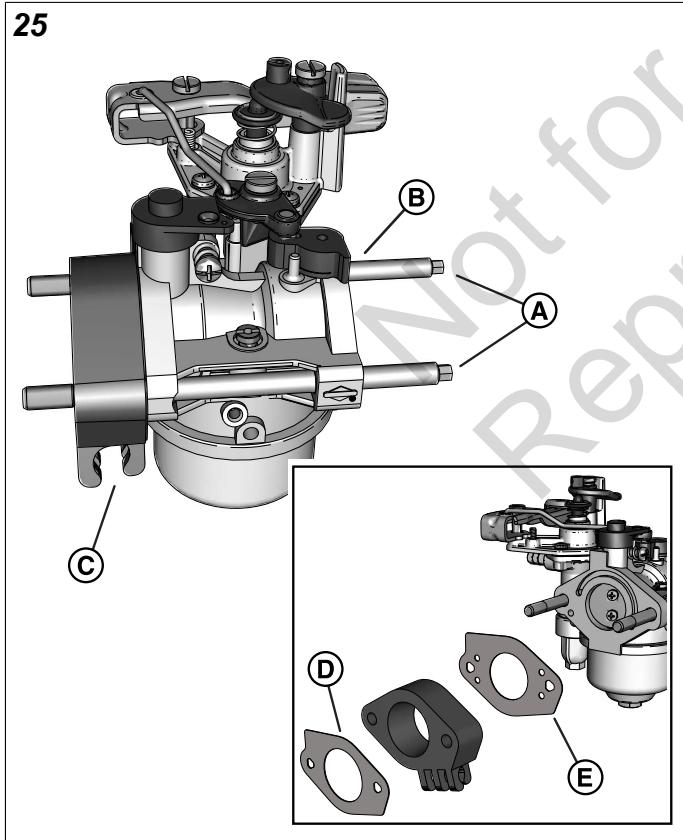
8. Remove opposite end of main governor spring from hole in governor lever (L). Note the number of the hole from which spring is removed to ensure proper assembly when governor lever is installed.
9. Remove governor link from grommet (M) in governor lever.
10. Remove governor link spring from hole (N) next to grommet.
11. Remove governor link from hole in throttle shaft (O).
12. Remove governor link spring from hole in throttle shaft (P).
13. Remove governor lever and set aside.
14. Remove hex flange screw (Q) to release governor idle spring bracket from crankcase boss.

4



Carburetor

- See Figure 25. Using a 4 mm hex socket, alternately loosen and remove two carburetor studs (A). If end of stud will not accept a 4 mm hex socket due to damage or wear, proceed as follows:
 - Retrieve the two hex flange nuts removed from the studs during air cleaner removal.
 - Thread first nut onto stud upside down.
 - Thread second nut onto stud right-side up until it makes firm contact with the first.
 - Rotate inside nut in a counter-clockwise direction until stud is loose.
 - Remove stud from cylinder head. Remove hex flange nuts from stud.
 - Repeats steps 1(B) thru 1(E) to remove second stud.
- Removing carburetor (B) as an assembly, release spark plug wire and stop switch wire from slot in carburetor adapter (C).
- Remove carburetor adapter gasket (D), carburetor adapter, and carburetor gasket (E). Discard gaskets.

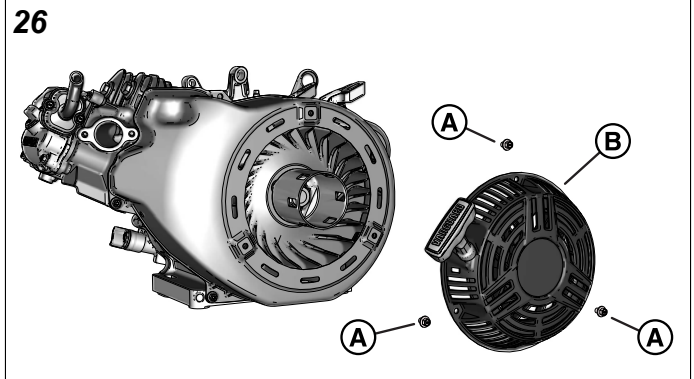


Rewind Starter

- See Figure 26. Remove three hex flange screws (A) to release rewind starter (B) from blower housing.

NOTE: Note orientation of the rewind starter before removal. Rewind starter may be installed in the 2 o'clock, 8 o'clock, 10 o'clock, or 12 o'clock positions.

NOTE: While removal of the rewind starter is not required for removal of the blower housing, it is recommended for cleaning and inspection purposes.

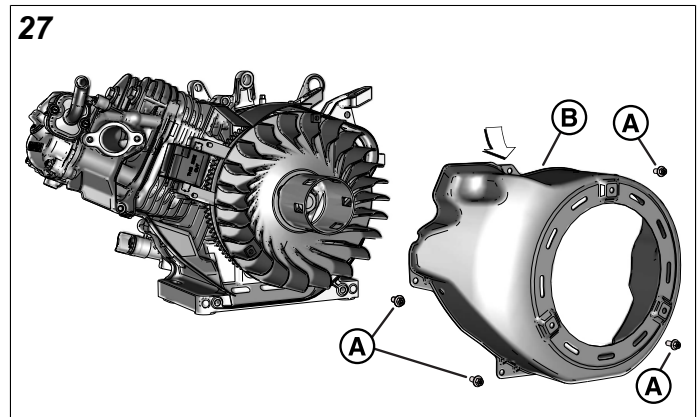


Blower Housing

- See Figure 27. Remove four hex flange screws (A) to release blower housing (B) from cylinder head, crankcase, and engine base.

NOTE: Use the internal T25 TORX recess for best results.

NOTE: The fifth screw (see arrow) was removed with the control bracket.

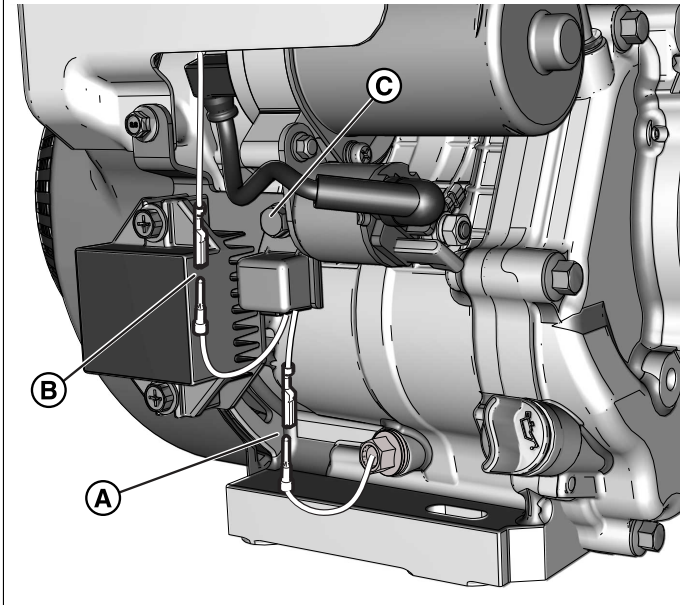


Low Oil Sensor Module (If Equipped)

- See Figure 28. Disconnect one-place wire connector (A) between oil sensor and oil sensor module.
- Disconnect one-place wire connector (B) between oil sensor module and armature.
- If necessary, remove hex flange screw (C) to release oil sensor module bracket from regulator bracket.

NOTE: For low oil sensor removal, see SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, CRANKCASE AND CRANKCASE COVER, DISASSEMBLY.

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5. See Figure 29. Remove two screws (A) to release regulator (B) from bracket (C).
6. Remove screw (D) to release bracket from crankcase. Top screw was removed with key switch panel earlier.
7. From top of starter motor, draw key switch yellow and orange wires upward out from behind starter motor.
8. Remove two screws (E) to release starter motor (F) from crankcase bore.

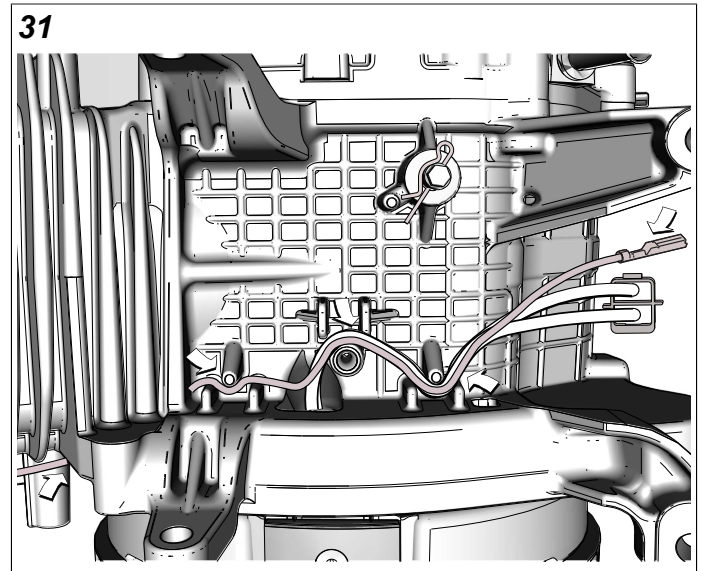
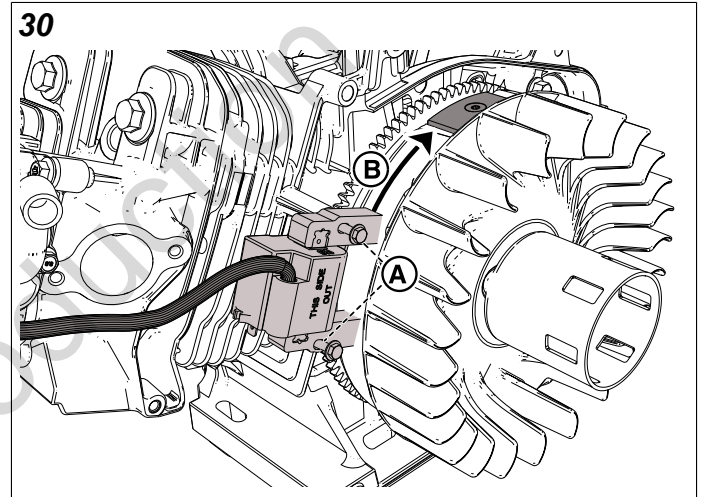
Armature

1. See Figure 30. 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.
3. See Figure 31. Pull armature wire from between ribs at top of crankcase.

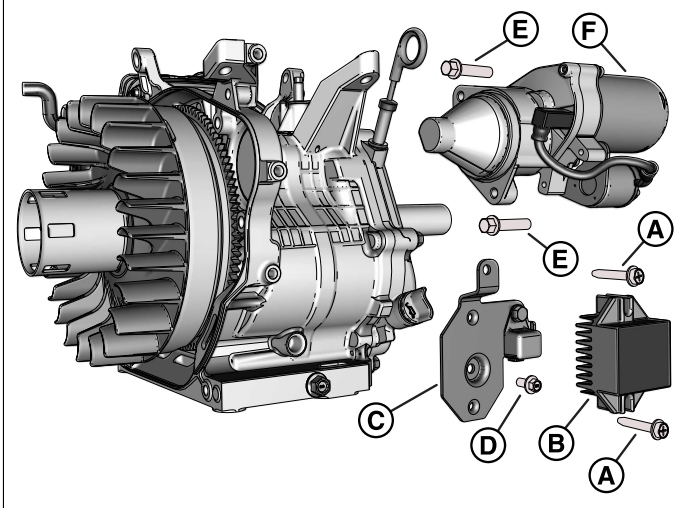
4

Starter Motor/Regulator (If Equipped)

1. Cut cable strap to release regulator and stator wires from bundle.
2. Disconnect two-place wire connector between regulator (yellow wires) and stator (black wires).
3. Remove key switch yellow wire socket terminal from starter solenoid spade terminal.
4. Remove hex nut from starter solenoid post, and remove lock washer, flat washer, regulator red wire ring terminal, key switch orange wire ring terminal, and flat washer.



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SECTION 5 – DISASSEMBLE ENGINE

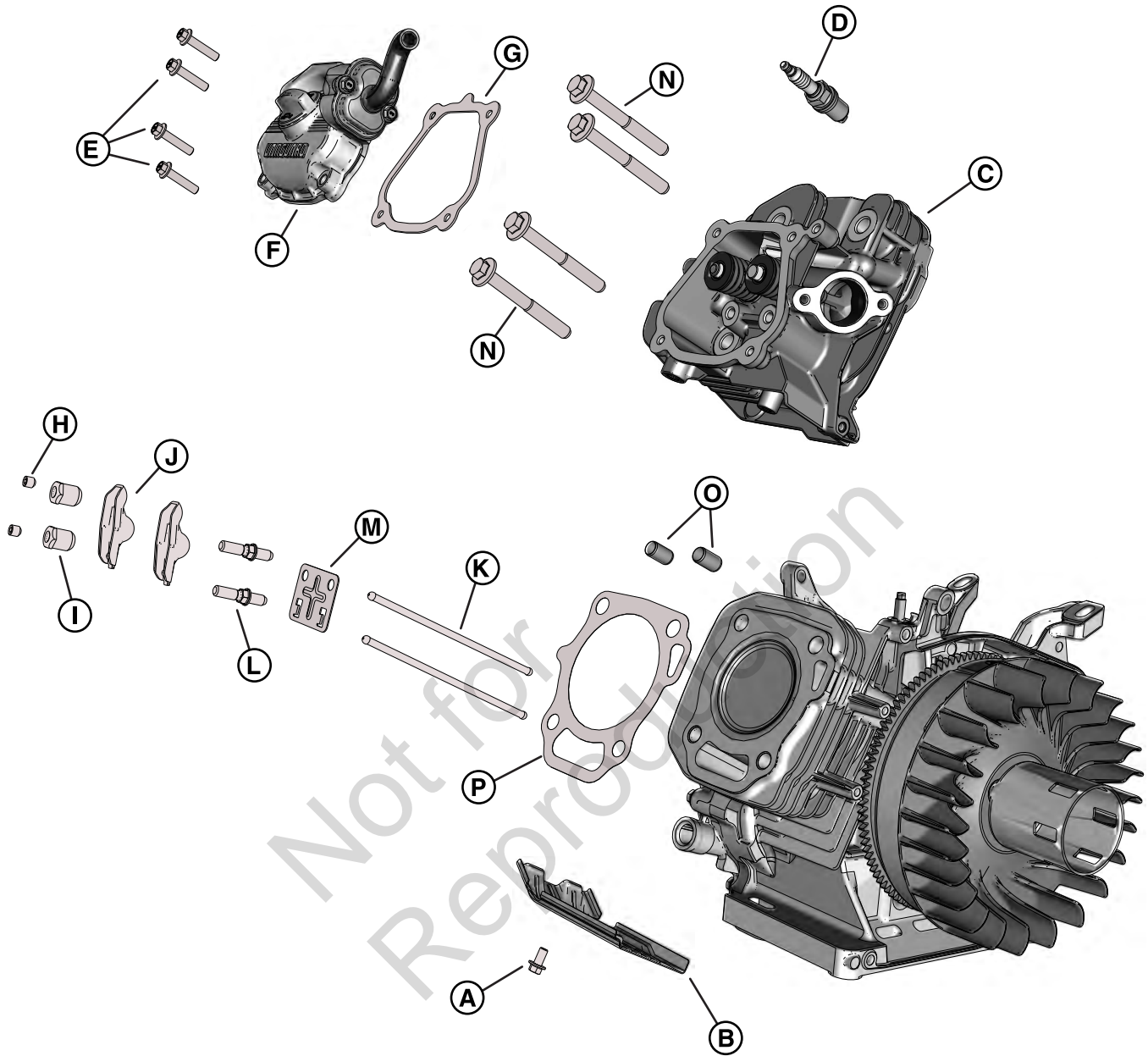
TOP END DISASSEMBLY	34
BOTTOM END DISASSEMBLY	36

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TOP END DISASSEMBLY

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5



1. See SECTION 4 - REMOVE EXTERNAL ASSEMBLIES.
2. See Figure 32. Remove hex flange screw (A) to release heat shield (B) from cylinder head (C).
3. 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.
4. Thoroughly clean area around spark plug to keep dirt and debris out of combustion chamber.

5. Remove spark plug (**D**) from cylinder head using the 5/8 inch Spark Plug Wrench (Part No. 19576S).
6. Remove four hex flange screws (**E**) to release valve cover (**F**) from cylinder head.
7. Remove and discard valve cover gasket (**G**).
8. Move piston to Top Dead Center (TDC) of the compression stroke. Proceed as follows:

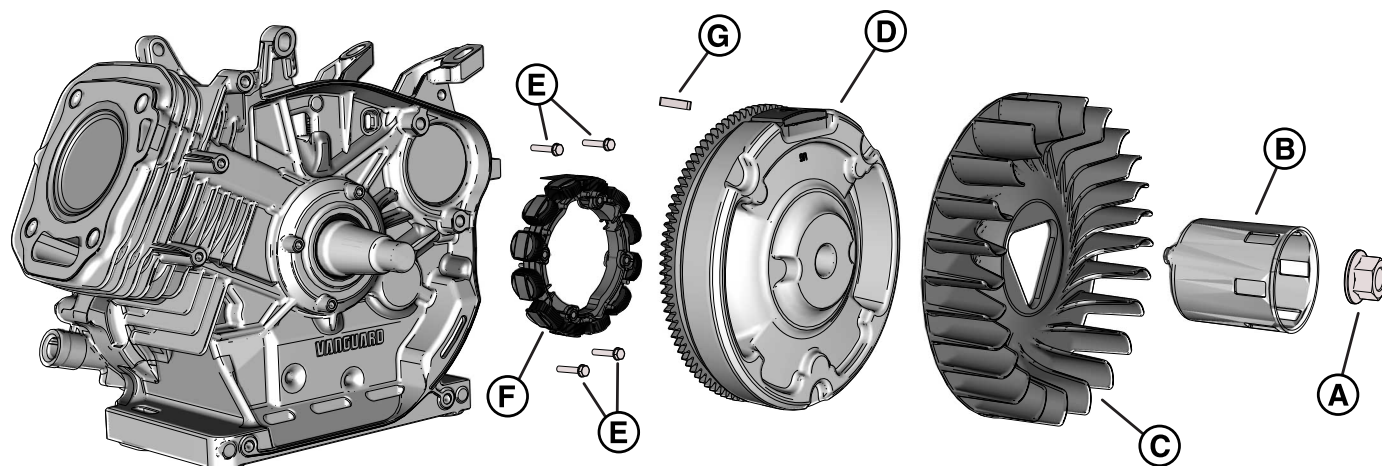
NOTE: Disassembly with the valve train loaded can result in bent push rods.

 - 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.
9. Remove set screws (**H**) from rocker balls (**I**). Remove rocker balls and rocker arms (**J**) from rocker arm studs.
10. Remove the intake and exhaust push rods (**K**).
11. Remove rocker arm studs (**L**) and push rod guide plate (**M**).
12. Remove cylinder head screws (**N**) from cylinder head.
13. Remove cylinder head from two locating pins (**O**) in downside of cylinder deck.
14. Remove and discard the cylinder head gasket (**P**).
15. Remove locating pins from cylinder deck and set aside.
16. See *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES, CYLINDER HEAD*.

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BOTTOM END DISASSEMBLY

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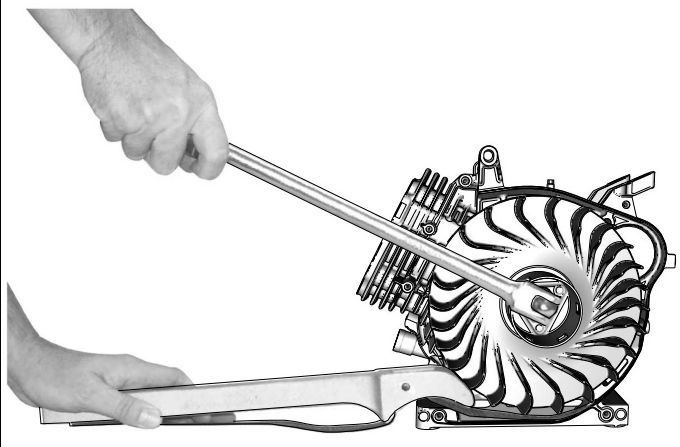
1. See *TOP END DISASSEMBLY* in this section.
2. Obtain a suitable strap wrench, 21 mm socket, and breaker bar. Proceed as follows:

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

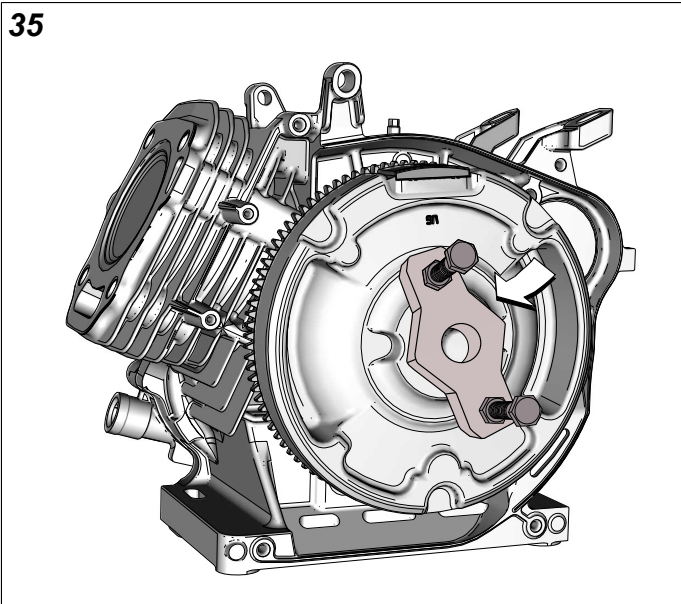
- A. See Figure 34. Fit loop of strap around flywheel and tighten until snug.
- B. Pinch strap between heel of wrench and flywheel as shown.
- C. Holding tool down by the handle, loosen flywheel nut using breaker bar and 21 mm socket.
- D. Remove strap wrench from flywheel.

3. See Figure 33. Remove flywheel nut (A) from crankshaft.
4. Remove starter cup (B) and flywheel fan (C).
5. Obtain Flywheel Puller (Part No. 19203) and remove flywheel (D) from crankshaft. Proceed as follows:
 - A. Install flywheel nut onto end of crankshaft until top is flush with the end of the thread pattern.
 - B. Run hex nut about half way down each of two puller screws.
 - C. Install puller screws into outside holes of puller.
 - D. Run remaining two hex nuts several threads down each screw.
 - E. Place center hole in puller over flywheel nut, and start puller screws into threaded holes in flywheel. Install puller screws into flywheel an equal number of turns until positive engagement is obtained.
 - F. Move top hex nuts down puller screws until firm contact is made with top of puller.
 - G. Move bottom hex nuts down puller screws until firm contact is made with flywheel.
 - H. Verify that tool is square, and not slanting or leaning. See Figure 35.
 - I. Alternately turn each hex screw in small increments until flywheel is free.
 - J. Remove puller from flywheel.
6. Remove flywheel nut and flywheel.

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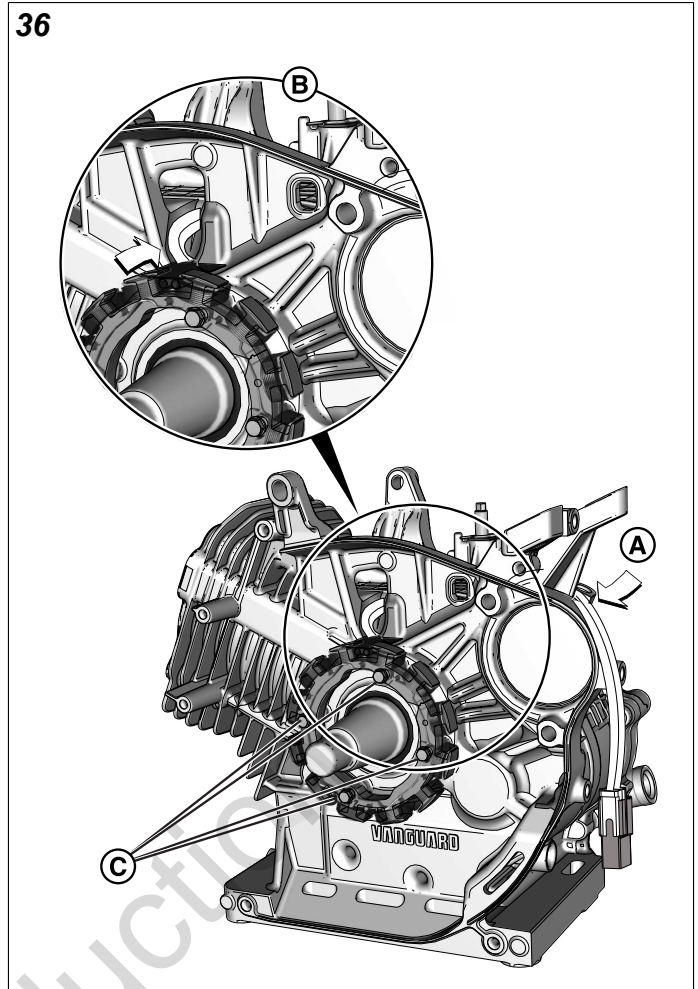
7. If **not** equipped with stator, move to step 8. If stator equipped, proceed as follows:
- See Figure 36. Pull stator wires (A) from between ribs and then out through opening (B) at top of crankcase.
 - Remove four hex flange screws (C) to release stator.

**CAUTION**

The edges of the crankshaft keyway are sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

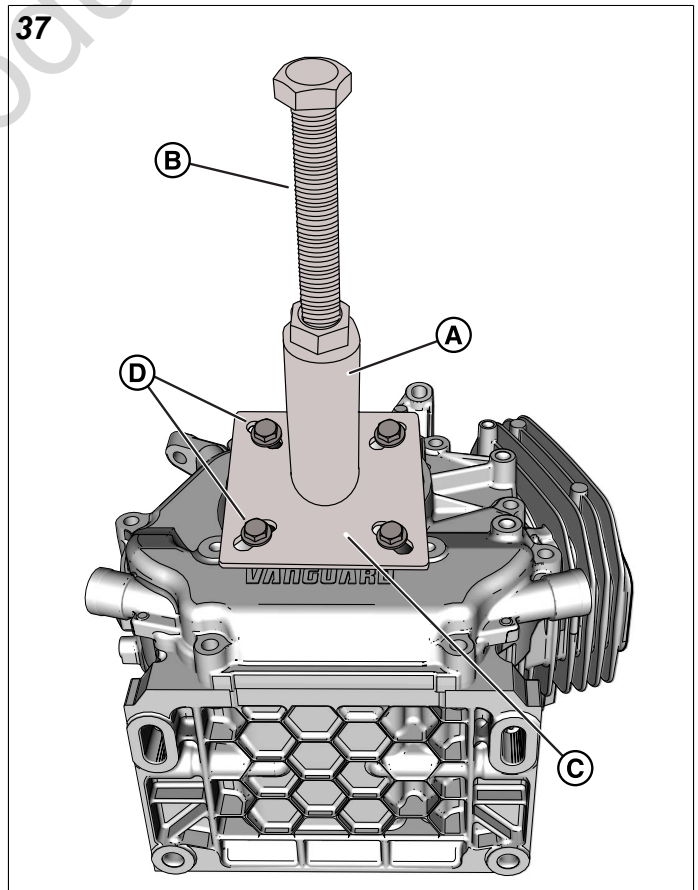
- See See Figure 33. Remove key (G) from keyway on crankshaft taper.
- Remove high mount dipstick from crankcase cover, if installed.
- Remove the crankcase cover as follows:
 - Remove seven hex flange screws from crankcase cover.
 - Obtain a suitable crankcase cover puller.
 - See Figure 37. Place tube (A) of puller over crankshaft seating end of forcing screw (B) at end of crankshaft.
 - Back up forcing screw as necessary, so that base (C) seats flat against crankcase cover.
 - Rotate base to align slots with four threaded holes in crankcase cover.
 - Install four screws with flat washers (D) to fasten base to cover, and alternately tighten in a crosswise pattern until snug.

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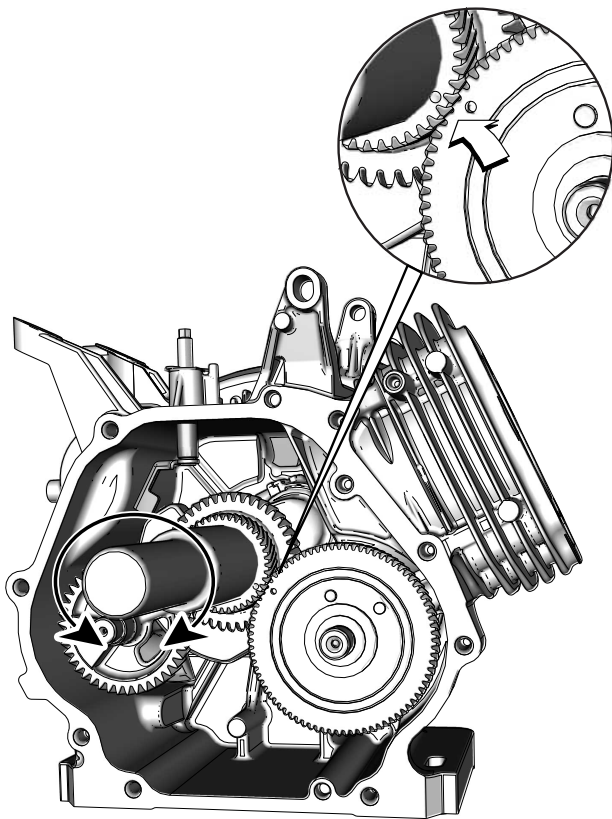


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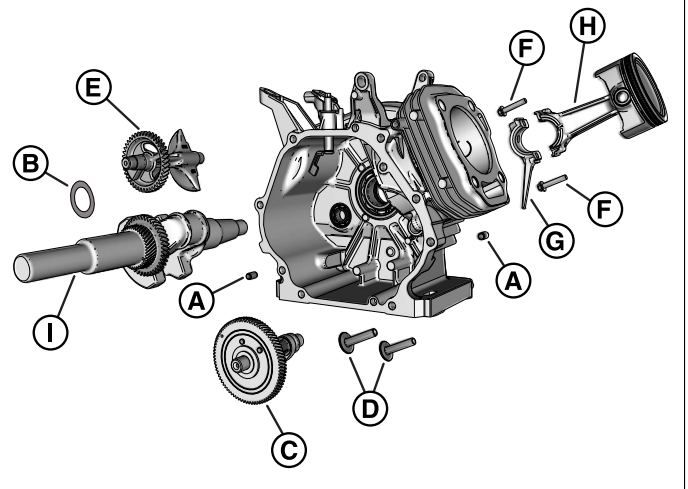
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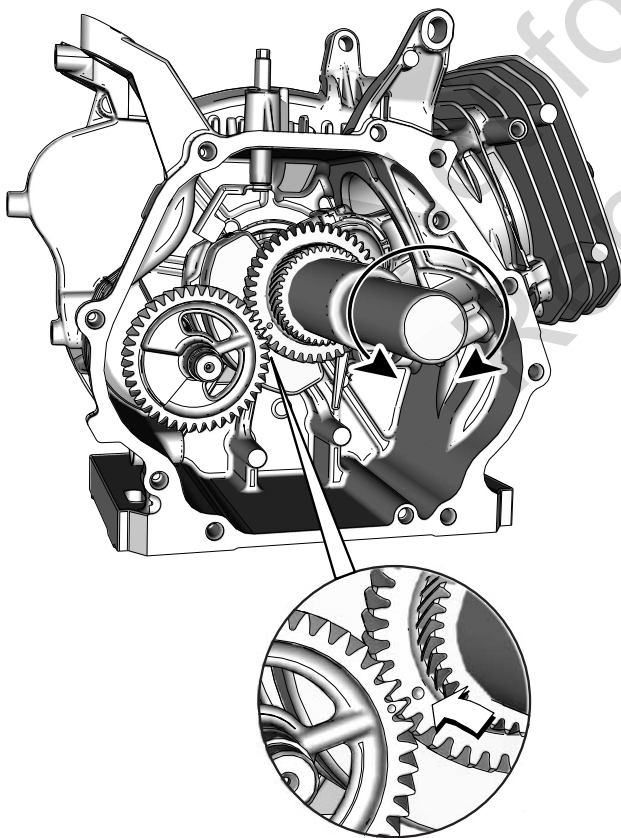
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- G. Rotate forcing screw in a clockwise direction until cover is free.
- H. Remove screws to release puller tool from cover.

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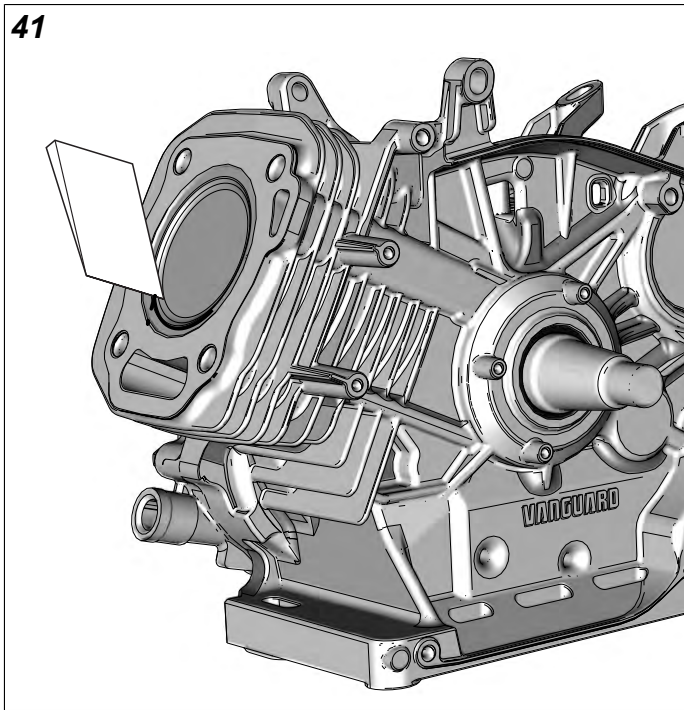


11. See Figure 40. Remove locating pins (A) from crankcase and set aside.
12. Carefully remove crankshaft end play shims (B), if installed. Count shims as they are removed to be sure of installing the correct number when the engine is assembled.
13. See Figure 38. Rotate crankshaft to align timing marks on crankshaft gear tooth and camshaft gear root.

NOTE: Valve tappets are now clear of the camshaft lobes.

14. See Figure 40. Remove camshaft (C) from bearing bore in crankcase.
15. Remove valve tappets (D) from crankcase. Tag each tappet as it is removed, so that it can be installed in its original location when the engine is assembled.
16. See Figure 39. Rotate crankshaft to align timing marks on crankshaft gear root and balancer gear tooth.
17. See Figure 40. Remove balancer (E) from bearing bore in crankcase.
18. Rotate crankshaft until piston is at the bottom of its stroke.
19. See Figure 41. 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.



20. Rotate crankshaft as necessary to obtain best access to connecting rod cap screws.
21. See Figure 40. Remove two hex flange screws (**F**) to release connecting rod cap (**G**) from connecting rod (**H**).
22. Remove connecting rod and piston assembly from cylinder bore.
23. Remove crankshaft (**I**) from crankcase.
24. See the following topics under *SECTION 6 - SERVICE ENGINE SUBASSEMBLIES*:
 - *PISTON AND CONNECTING ROD*
 - *FLYWHEEL, CRANKSHAFT, CAMSHAFT, AND BALANCER*
 - *CRANKCASE AND CRANKCASE COVER.*

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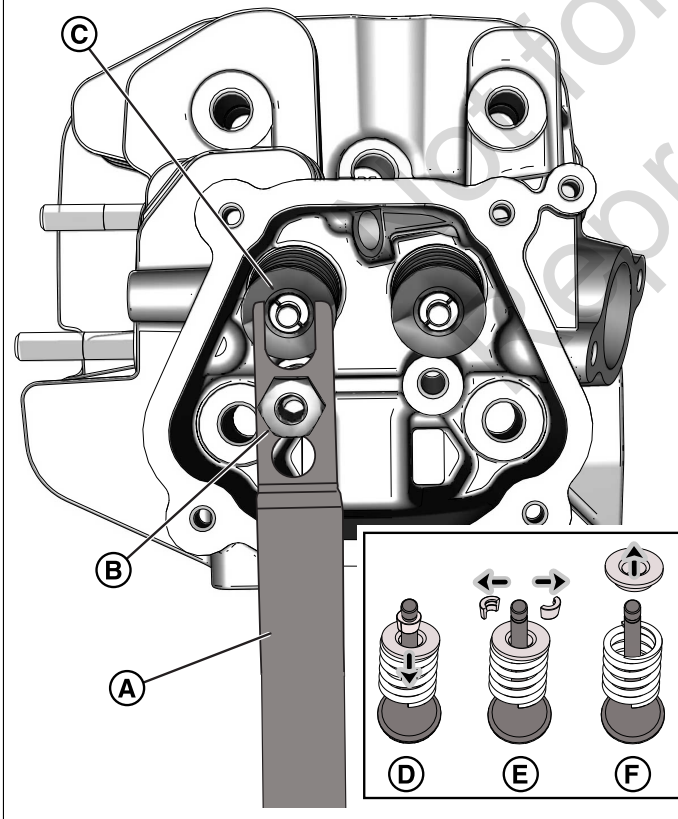
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CYLINDER HEAD

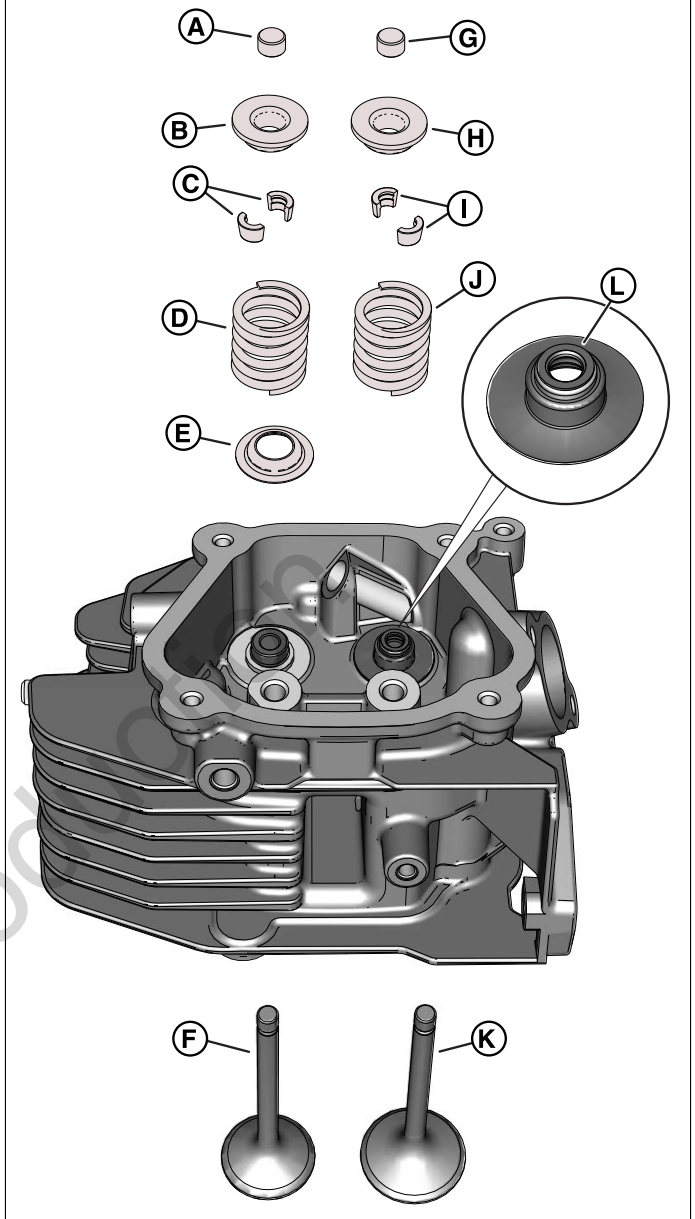
Disassembly

1. 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 43. Remove valve cap (A).
 - B. Install rocker arm stud and tighten until snug.
 - C. Obtain a suitable valve spring compressor.
 - D. See Figure 42. Place tool (A) over rocker arm stud engaging small end of slot.
 - E. Install rocker ball (B) on rocker arm stud until positive thread engagement is obtained.
 - F. With prongs of tool on valve spring retainer (C), pivot tool to compress valve spring (D).
 - G. Using a magnet for best results, remove the tapered keepers from the valve stem groove (E).
 - H. Release the valve spring compression.

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- I. Remove rocker ball, tool, and rocker arm stud. Remove the valve spring retainer and valve spring (F).
- J. See Figure 43. Remove valve spring seat (E).
- K. Remove valve (F) from valve guide.
- L. Mark the bottom of the valve to identify it as the exhaust valve. Bag the valve, valve cap, valve spring retainer, tapered keepers, valve spring, and valve spring seat, 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 (G).
- B. Using the valve spring compressor, press down on valve spring retainer (H) to compress valve spring.
- C. Using a magnet for best results, remove tapered keepers (I) from valve stem groove.
- D. Release valve spring compression.
- E. Remove rocker ball, tool, and rocker arm stud. Remove valve spring retainer and valve spring (J).
- F. Inspect valve stem 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 stem groove with clean engine oil, and then remove valve (K) from valve guide.

NOTE: Carefully inspect valve stem seal (L) for nicks, cuts or other damage. Valve stem seal damage requires cylinder head replacement.

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

Cleaning

1. 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.
2. 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.

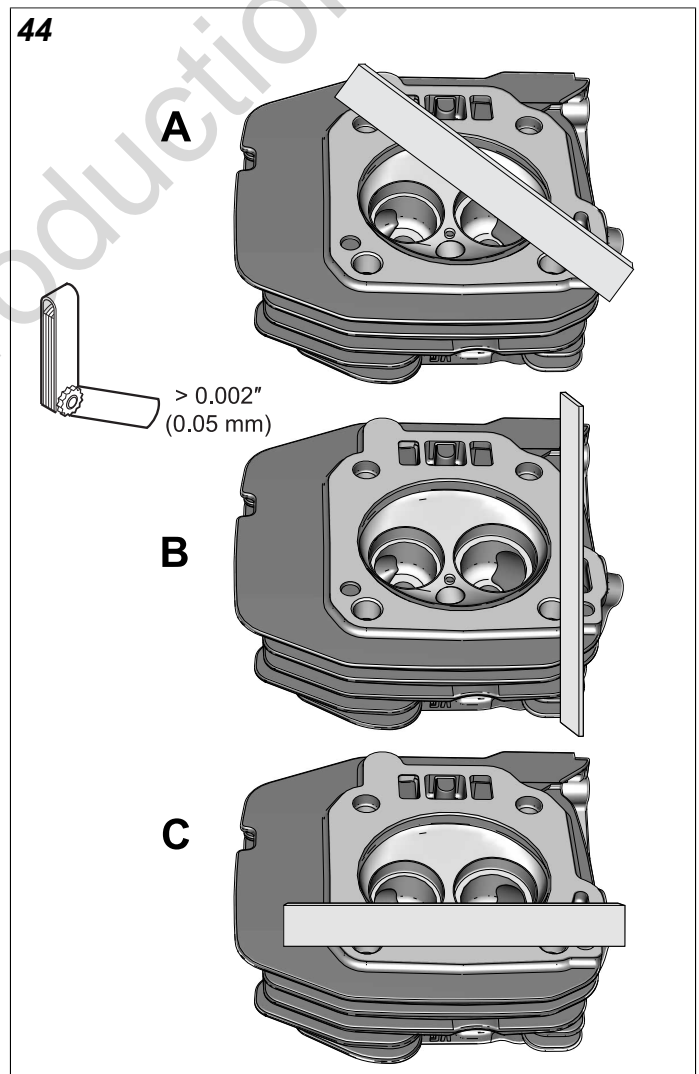
NOTE: Do not use glass or sand to bead blast surfaces exposed to the engine oil. Bead blasting materials become lodged in the pores of the casting where they cannot be removed through ordinary cleaning methods. Only after the engine is put to use will heat expansion cause this material to be released,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

3. Thoroughly clean the cylinder head, valves, valve springs, valve spring retainers, valve caps, tappets, push rods, 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.
3. Check the cylinder head to cylinder mating surface for warpage or distortion. Discard the cylinder head if any low spot is **0.002 inches** (0.05 mm) or more. Proceed as follows:
 - A. See A of Figure 44. 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 44. 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 44. 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. Repeat the 6 point check outlined under step 3 to check for warpage or distortion of the cylinder head to valve cover mating surfaces. Be sure to check both the cylinder head and valve cover. Discard the cylinder head or valve cover if any low spot is **0.002 inches** (0.05 mm) or more.
 5. Visually inspect the cylinder head for cracks or discoloration due to excessive heat. Replace cylinder head if either of these conditions are found.
 6. Verify that breather hole, and intake and exhaust ports are clean and open.

Valve Guides

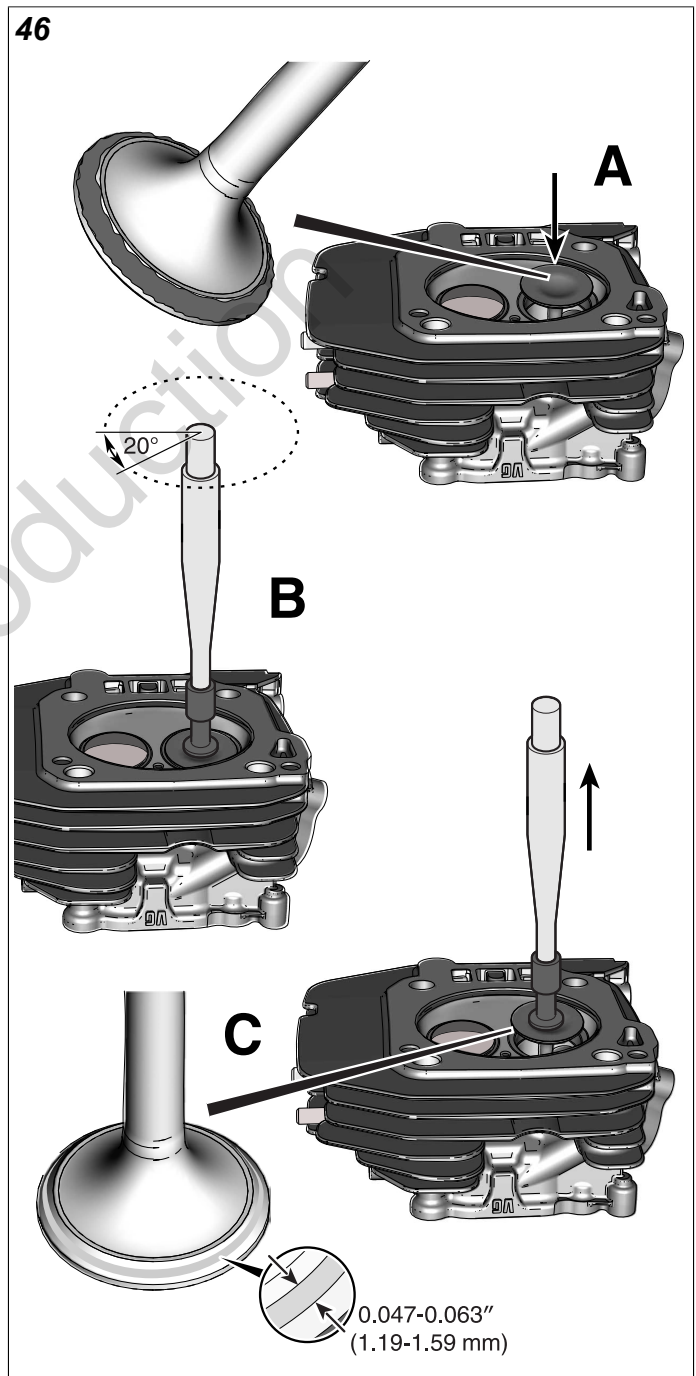
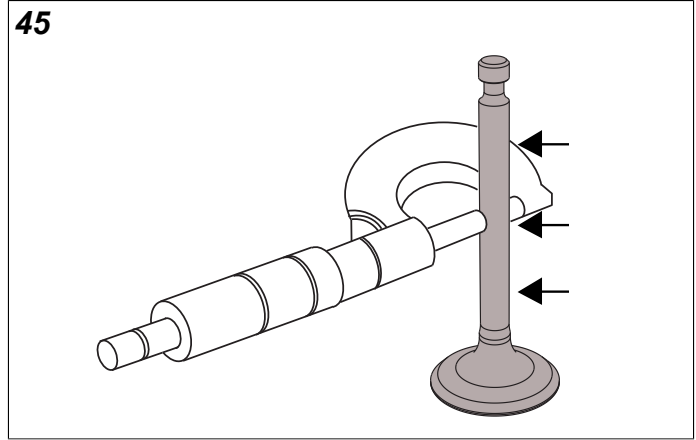
1. Inspect external surface of valve guides for cracks (particularly the combustion chamber side). Replace the cylinder head if cracks are found.
2. To verify cleanliness, lightly hone bore using a suitable valve guide hone and then scrub with a valve guide cleaning brush to remove any dirt or debris.
3. Measure the inside diameter using an inside ball micrometer or plug gauge. Replace the cylinder head if the measurement is **0.264 inches** (6.695 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.
3. Inspect the valve stem 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 45. Measure the top, center and bottom of the intake valve stem using an outside micrometer. Replace the intake valve if any measurement is **0.253 inches** (6.415 mm) or less.



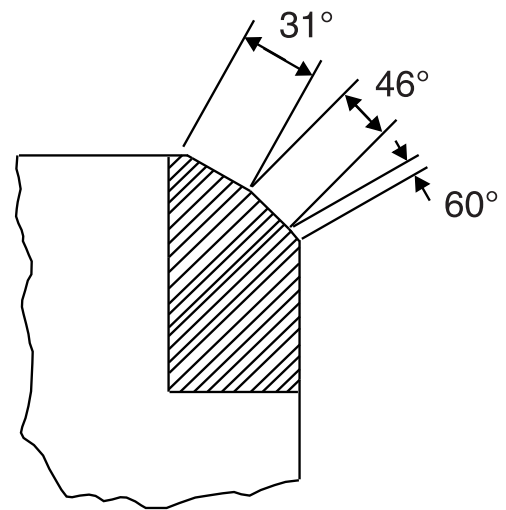
6. Measure the top, center and bottom of the exhaust valve stem. Replace the exhaust valve if any measurement is **0.252 inches** (6.395 mm) or less.
7. Hold each valve against a worn wire wheel in a bench grinder to remove all carbon deposits from the valve head and face, but exercise caution to avoid 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 46. 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 46. 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.
 - I. See C of Figure 46. 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.

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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 47. Install the 60° cutter on the pilot to make the bottom-narrowing cut. Rotate the cutter three or 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.
 - 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.

- 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/Tapered Keepers

- Inspect parts for rust pits or corrosion. Replace as necessary.
- Inspect inside diameter of valve spring retainers for damage or excessive wear. Center must be well defined without distortion.
- Inspect inside of tapered keepers for excessive wear. Upraised center must be well defined and fit snugly in valve stem grooves. Place keepers into grooves and verify that they grip tightly without sliding.

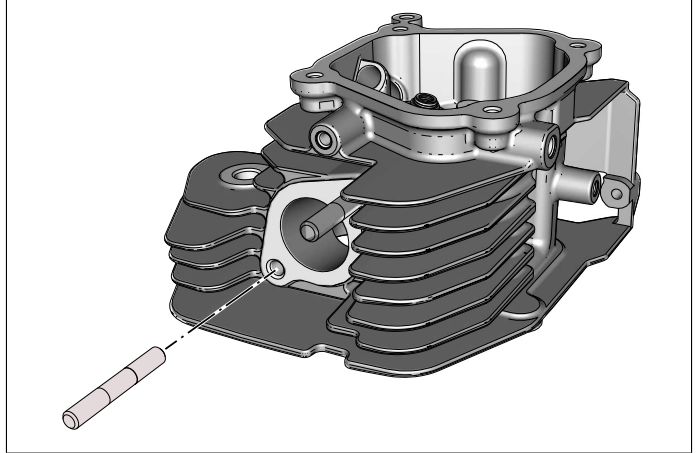
Tappets, Push Rods, and Rocker Arms

- Inspect tappet sockets for signs of scuffing, pitting or general wear.
- 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.
- 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.
- Check the push rod guide plate for cracks or other damage. Replace if necessary.
- 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.

Muffler Studs

- Inspect muffler studs. Replace studs if broken, bent, or if severe thread damage is observed.
- Replace a muffler stud as follows:
 - Retrieve the two hex nuts removed from the studs during muffler removal.
 - Thread first nut onto stud.
 - Thread second nut onto stud until it makes firm contact with the first.

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- Rotate inside nut in a counter-clockwise direction until stud is loose.

NOTE: If stud is difficult to remove, apply suitable penetrating oil to threads, and then work stud in and out until it moves freely.

- Remove stud from cylinder head. Remove hex nuts from stud.
- See Figure 48. Install **new** stud into the cylinder head.
- Repeats steps 2(B) and 2(C).
- Rotating outside nut in a clockwise direction, tighten stud to **40-60 lb-in** (4.5-6.8 N-m).

Assembly

- See Figure 49. Install exhaust valve (A) assembly as follows:
 - 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.

- From the bottom of the cylinder head, insert the valve stem into the valve guide.
- 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.
- Using a suitable degreaser, thoroughly clean valve face, valve guide, and end of valve stem of any excess assembly lube.
- Install valve spring seat (B) down valve stem until contact is made with machined surface of cylinder head.

- F. Install valve spring (C) over the valve stem until seated on valve spring seat.
- G. Set the valve spring retainer (D) on top of the valve spring.
- H. Obtain a suitable valve spring compressor.
- I. Place tool over rocker arm stud engaging small end of slot.
- J. Install rocker ball on rocker arm stud until positive thread engagement is obtained.
- K. With prongs of tool on valve spring retainer, pivot tool to compress valve spring.
- L. Fit the tapered keepers (E) into the valve stem groove with the tapered side down. For best results, apply a suitable engine assembly lube to the inside of the keepers before installation. Arrange keepers so that the gap is evenly spaced, and release the valve spring compression.
- M. Remove rocker ball, tool, and rocker arm stud.
- N. Tap the end of the valve once or twice with a soft mallet to ensure that the keepers are tightly seated in the valve stem groove.
- O. 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.
- P. Install valve cap (F) on end of valve stem.

2. See Figure 49. Install intake valve (G) assembly as follows:

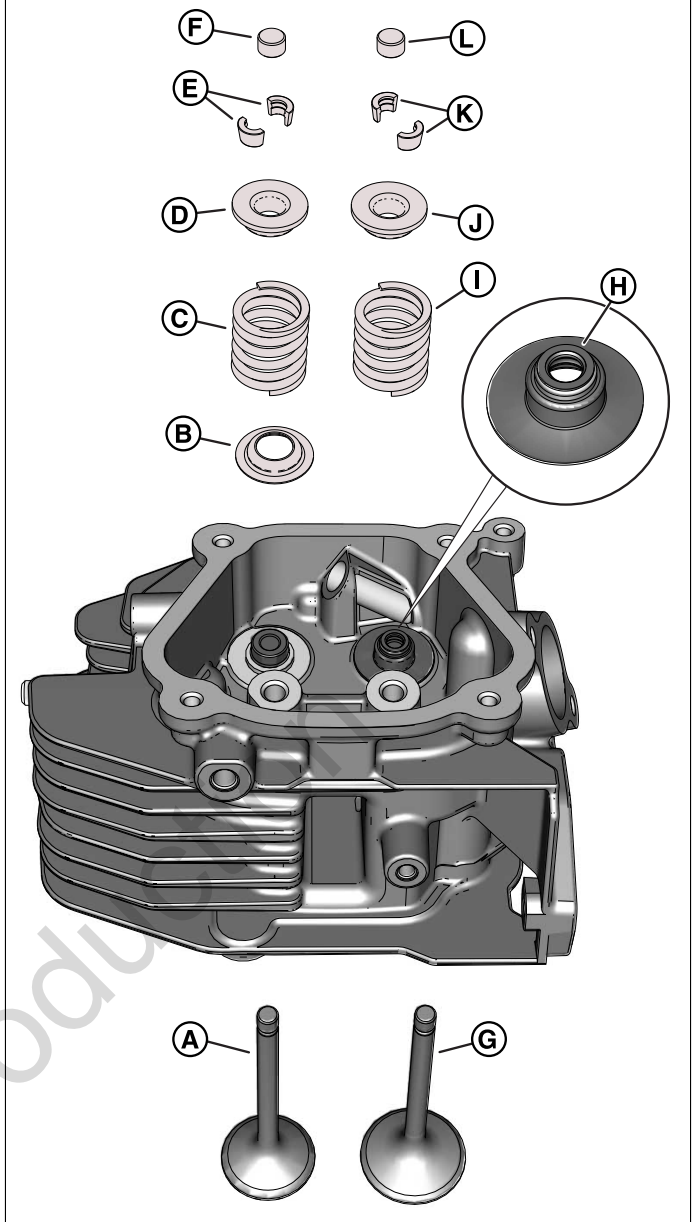
- A. Lightly lubricate inside diameter of valve stem seal (H) with clean engine oil.

NOTE: Inadequate precautions may cause the valve stem seal to catch the edge of the valve stem groove. The resulting damage may lead to leakage around the valve stem causing increased oil consumption and possible valve sticking.

NOTE: Valve stem seal is not replaceable. Damage to the valve stem seal requires cylinder head replacement.

- B. Apply a suitable engine assembly lube to the valve stem.
- C. From the bottom of the cylinder head, insert the valve stem into the valve guide.
- D. 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.
- E. Using a suitable degreaser, thoroughly clean valve face, valve guide, and end of valve stem of any excess assembly lube.

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- F. Install valve spring (I) over the valve stem and valve guide.
- G. Set the valve spring retainer (J) on top of the valve spring.
- H. Using the valve spring compressor to compress the valve spring, fit the tapered keepers (K) into the valve stem groove with the tapered side down. For best results, apply a suitable engine assembly lube to the inside of the keepers before installation. Arrange keepers so that the gap is evenly spaced, and release the valve spring compression.
- I. Remove rocker ball, tool, and rocker arm stud.
- J. Tap the end of the valve once or twice with a soft mallet to ensure that the keepers are tightly seated in the valve stem groove.

K. 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.

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

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

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PISTON AND CONNECTING ROD

Disassembly

1. See Figure 50. Insert small pick into pick lock groove and pull piston pin lock ring out of pin boss groove. Discard lock ring.

CAUTION

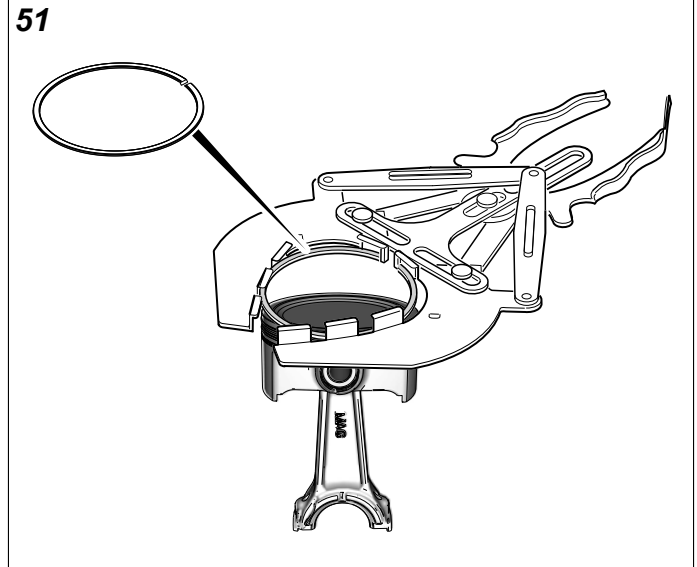
Always wear proper eye protection when removing piston pin lock ring. Slippage can propel the ring with enough force to cause eye injury.

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).

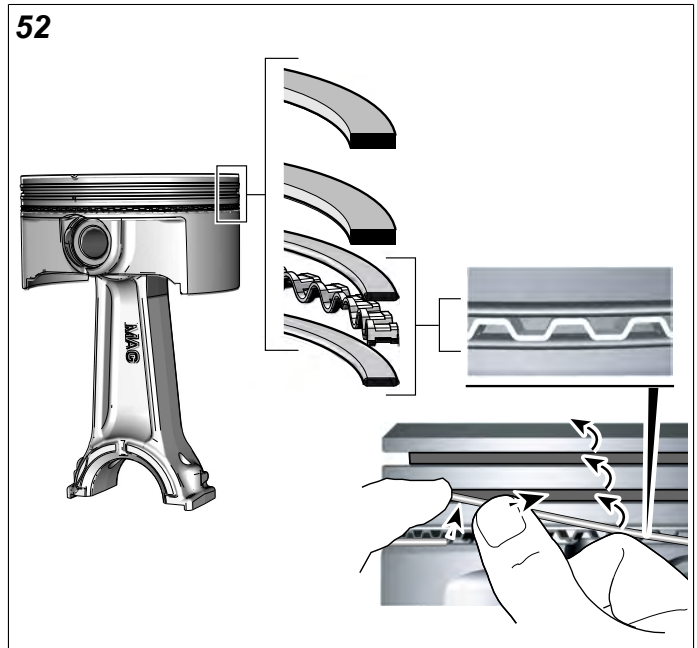
CAUTION

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 51. Remove compression ring from the top ring groove.



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 52. 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.



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

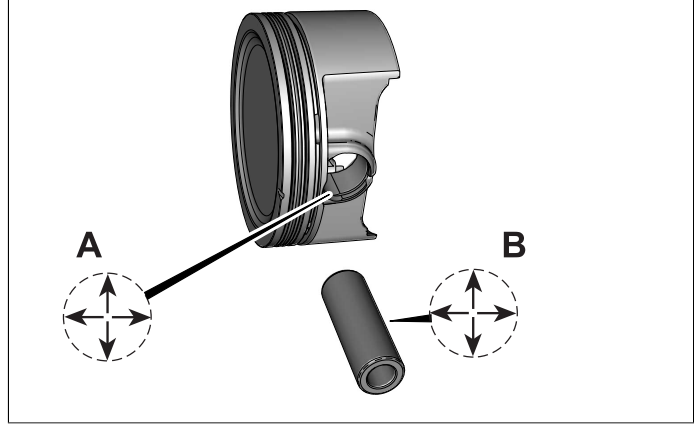
1. Thoroughly clean parts in a non-volatile cleaning solution or solvent. Follow up with a thorough wash in hot soapy water.
2. Blow dry with low pressure compressed air.
3. Verify that oil holes in connecting rod shank and at top of piston pin bore are clean and open.

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.

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- 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.

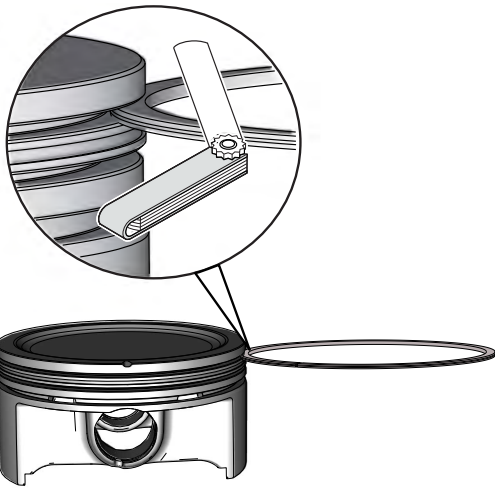
NOTE: A piston with superficial wear marks, minor scratching or mild scoring may continue to be used.

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 53. 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 **inches** (mm) or more.
4. See B of Figure 53. 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 **inches** (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 54. 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.

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- 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 **0.010 inches** (0.25 mm) or more.

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

Piston Rings

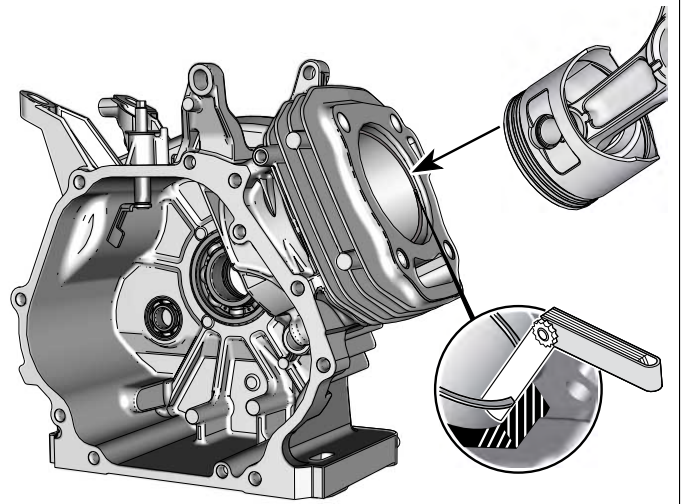
NOTE: Always use **new** piston rings. Recondition (deglaze) or resize (hone) cylinder before installing new rings.

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 55. 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** (0.99 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 **0.065 inches** (1.66 mm) or more.

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- 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 **0.074 inches** (1.89 mm) or more.

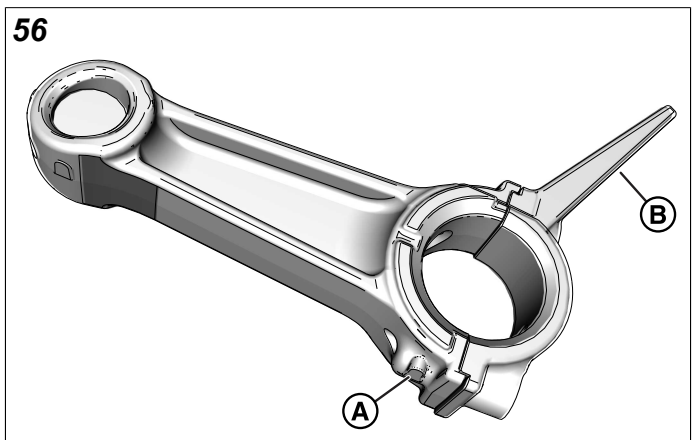
Connecting Rod

1. Inspect the connecting rod for cracks, twisting or bending.
2. Inspect bearing surfaces for scratches or scoring.
3. Inspect dipper on connecting rod cap for bending, chipping, or cracking.

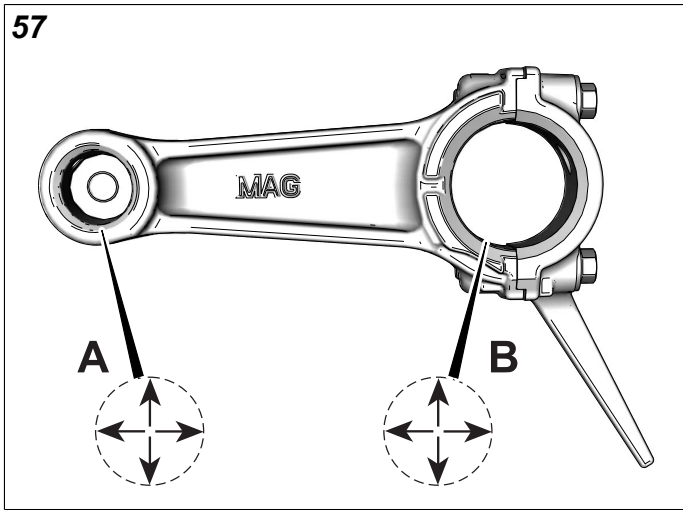
NOTE: Replace connecting rod and cap if any of the above conditions are found. Always replace connecting rod and cap as an assembly.

4. Start two hex flange screws to fasten connecting rod cap to connecting rod. Alternately tighten screws to **90-110 lb-in** (10.2-12.4 N-m).

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NOTE: See Figure 56. Install the connecting rod cap, so that boss (A) on shank is opposite oil slinger on cap (B).

5. Obtain Telescoping Gauge (Part No. 19485) and inside micrometer or plug gauge.
6. See A of Figure 57. Measure piston pin bearing bore diameter at two locations- parallel and perpendicular to the crankshaft. Replace connecting rod if either measurement is **inches** (mm) or more.
7. See B of Figure 57. Measure the crank pin bearing bore diameter at two locations- parallel and perpendicular to the crankshaft. Replace the connecting rod if either measurement is **inches** (mm) or more.
8. 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 58. 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.
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

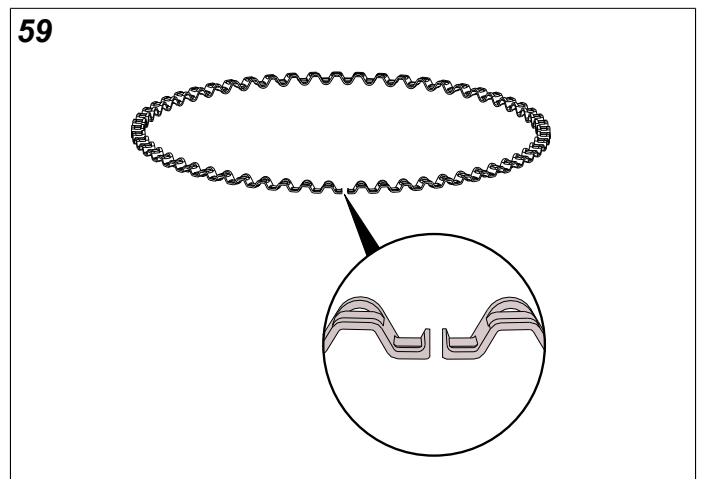
Always wear proper eye protection when installing piston pin lock ring. Slippage can propel the ring with enough force to cause eye injury.

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 59. Install expander spring, so that the gap ends point toward the piston crown.
 - See Figure 60. Spiral bottom oil rail into space below expander spring.
 - Spiral top oil rail into space above expander spring.

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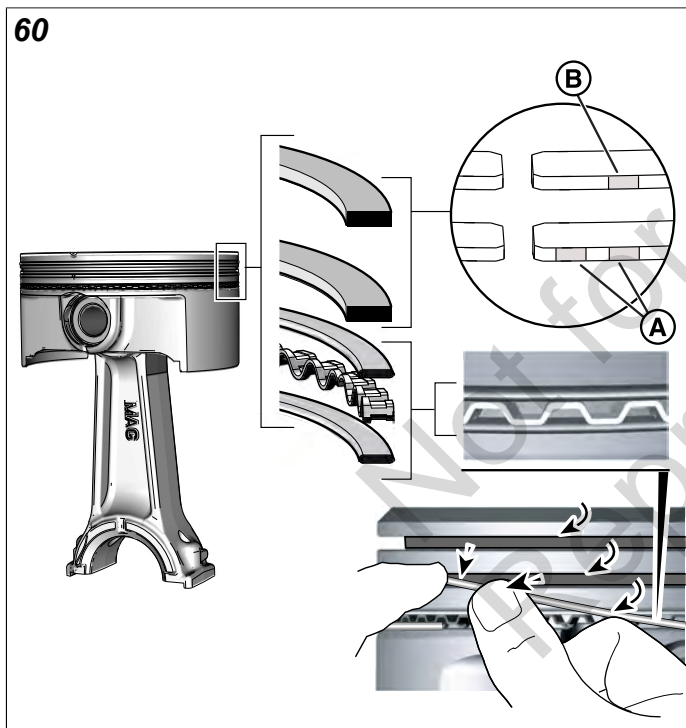


8. Obtain the Piston Ring Expander (Part No. 19340).

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.

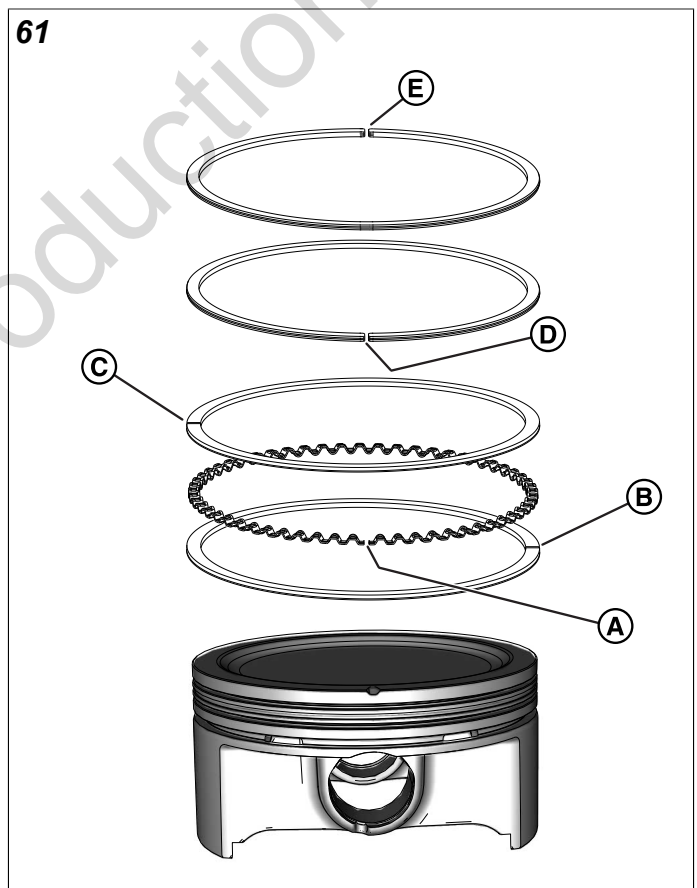


9. See inset of Figure 60. Carefully install the oil wiper ring (A) into the middle ring groove, so that the two painted marks are to the right of the ring end gap.

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 gaps around the piston. Proceed as follows:
- A. See Figure 61. 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).



FLYWHEEL, CRANKSHAFT, CAMSHAFT, AND BALANCER

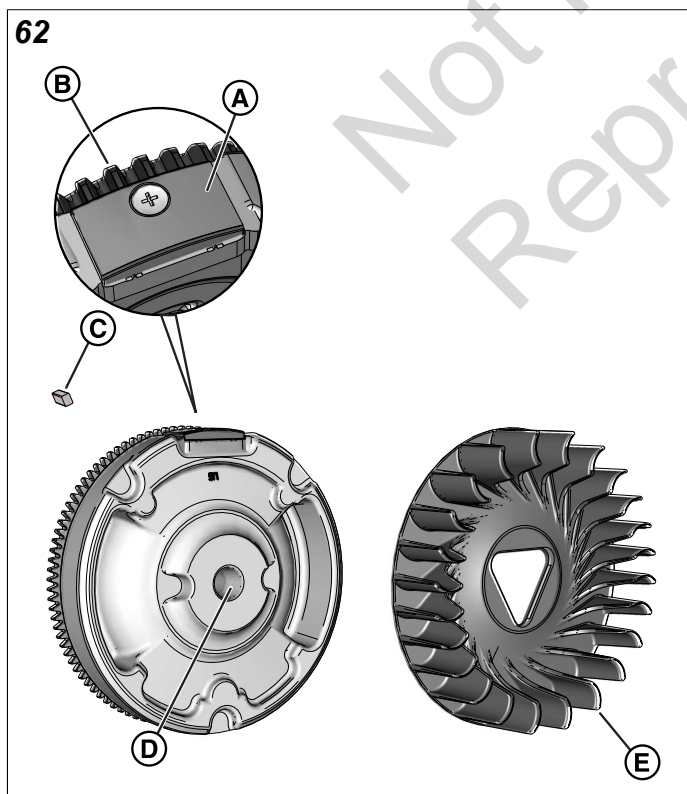
Cleaning

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

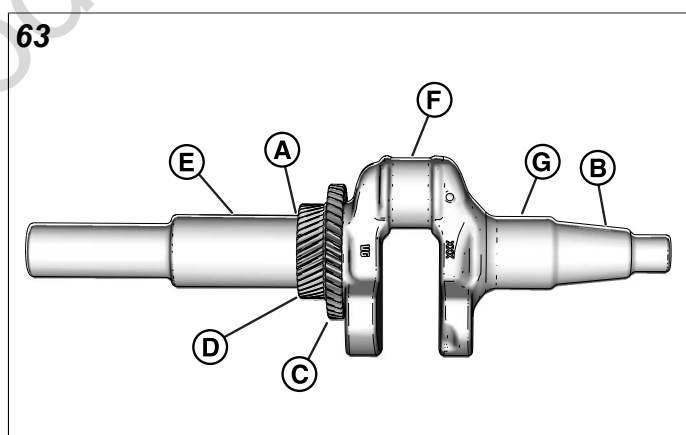
Flywheel

1. See Figure 62. Inspect flywheel magnet (A) for cracks, chips, or other damage. Check magnet for looseness.
2. 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.



Crankshaft

1. See Figure 63. Carefully remove crankshaft end play shims (A), if installed. Count shims as they are removed to be sure of installing the correct number when the engine is assembled. Inspect shims for tears, holes, or other damage. Replace shims as necessary using the Crankshaft End Play Shim Kit (Part No. 84003590).
2. Inspect keyway (B) for damage or distortion.
3. Check balancer timing gear (C) and camshaft timing gear (D) for worn, cracked, chipped, or missing teeth.
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 (E), crankpin journal (F), and MAG bearing journal (G) for scoring.
7. Using an outside micrometer, measure the crankpin journal diameter. Replace the crankshaft if measurement is **inches** (mm) or less.
8. Measure the MAG bearing and PTO bearing journal diameters. Replace the crankshaft if either measurement is **1.375 inches** (34.921 mm) or less.

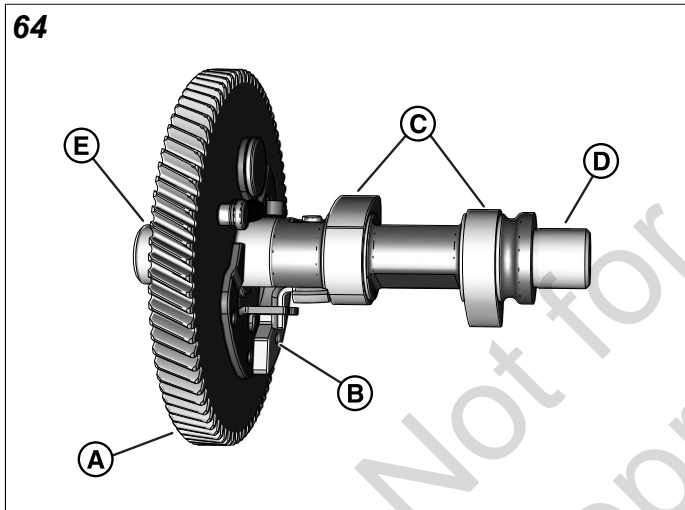


Camshaft

1. See Figure 64. Check camshaft gear (A) for worn, cracked, chipped, or missing teeth.
2. Check operation of yoke on Mechanical Compression Release (MCR) mechanism (B).

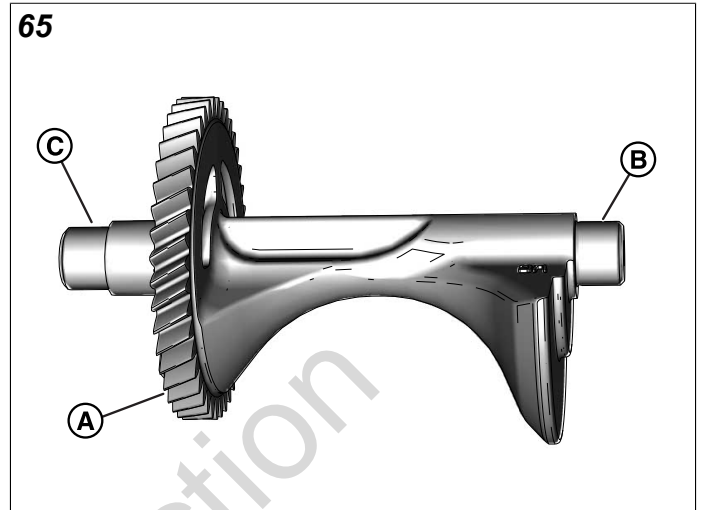
NOTE: Press yoke to the OPEN position, and then verify that it returns to the fully CLOSED position when released.

3. Check camshaft lobes (C) for scratching, scoring, or excessive wear.
4. Check MAG bearing journal (D) and PTO bearing journal (E) for scratching or scoring.
5. Using an outside micrometer, measure the MAG bearing journal and PTO bearing journal diameters. Replace the camshaft if either measurement is **0.628 inches** (15.941 mm) or less.



Balancer

1. See Figure 65. Check balancer gear (A) for worn, cracked, chipped, or missing teeth.
2. Check MAG bearing journal (B) and PTO bearing journal (C) for scratching or scoring.
3. Using an outside micrometer, measure the MAG bearing journal and PTO bearing journal diameters. Replace the balancer if either measurement is **0.587 inches** (14.923 mm) or less.



CRANKCASE AND CRANKCASE COVER

Disassembly

Crankcase

Governor Crank

1. Remove spring clip from hole in governor crank. Remove flat washer from crankcase boss.
2. Remove governor crank from inside crankcase.

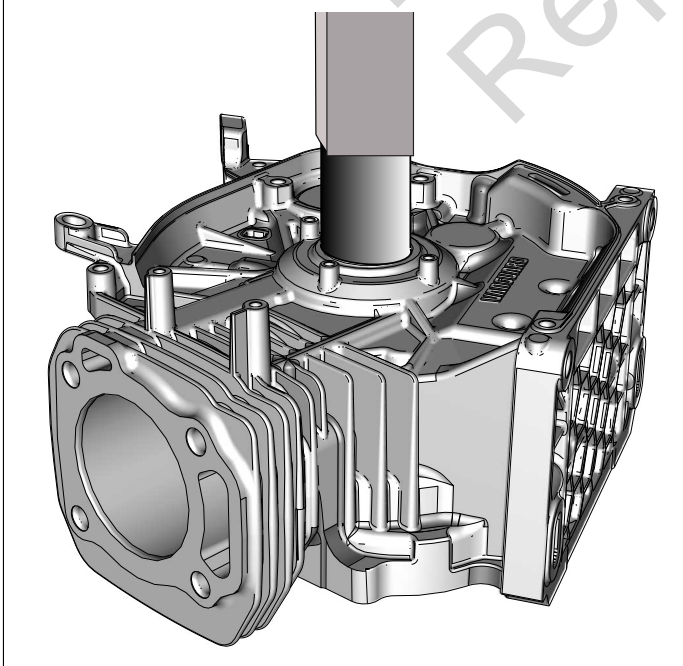
Low Oil Sensor (If Equipped)

1. Remove hex flange nut to release oil sensor fitting from hole in crankcase.
2. Remove two hex flange screws to release oil sensor from inside crankcase.

MAG Bearing/Oil Seal

1. Remove and discard oil seal from crankcase bearing bore. Exercise care to avoid scratching bearing bore during removal.
2. With the outside facing upward, support crankcase on wooden blocks on deck of arbor press.
3. Place suitable bearing driver on outer race of bearing.
4. See Figure 66. Center bearing driver under ram.

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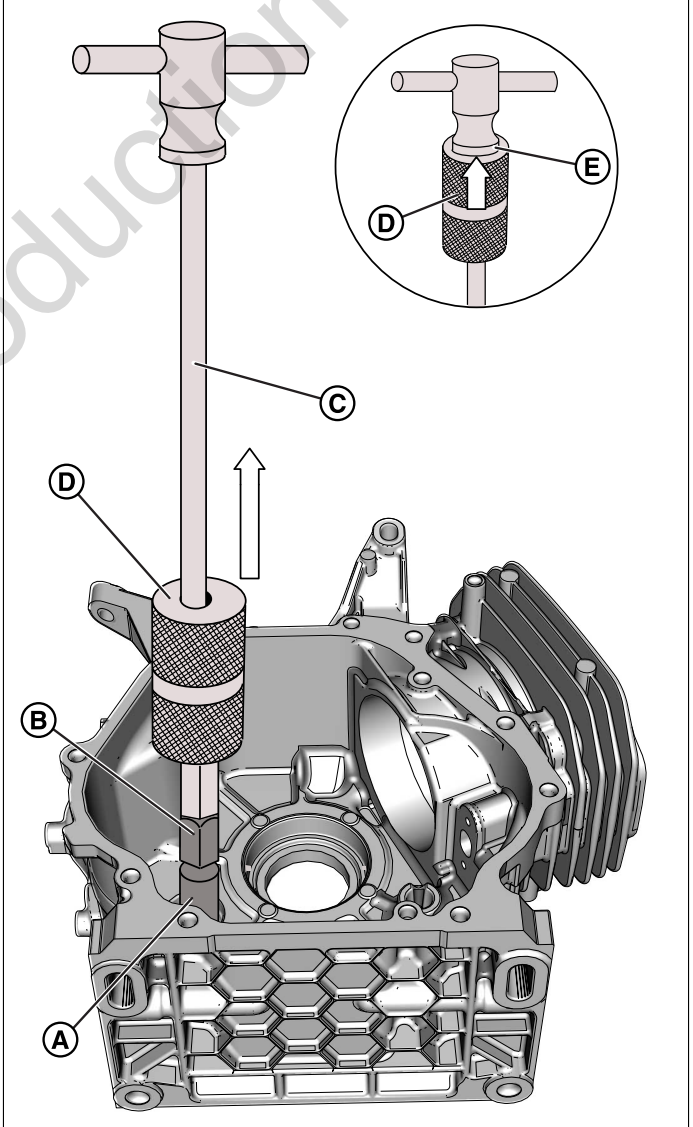


5. Apply pressure to bearing driver until bearing is free. Discard bearing.

Balancer Bearing

1. Obtain suitable bearing remover collet and slide hammer.
2. See Figure 67. Push expandable end of collet (A) through bearing bore.
3. Turn hex (B) at end of collet shaft in a clockwise direction to expand collet slightly.
4. Feel for inside edge of bearing, and then use an open end wrench to turn hex until tool is tight.
5. Install slide hammer (C) onto threaded end of collet.

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6

- To remove bearing, raise hammer (D) with sufficient force, so that it makes hard contact with collar (E) on tool.



CAUTION

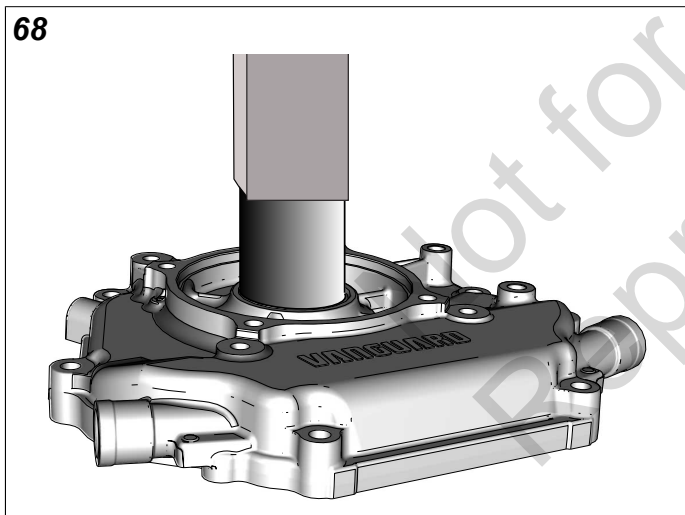
Keep hand on handle and away from collar when using slide hammer. Inadequate safety precautions can result in injury to hands or fingers.

Crankcase Cover

PTO Bearing/Oil Seal

- Remove and discard oil seal from crankcase cover bearing bore. Exercise care to avoid scratching bearing bore during removal.
- With the outside facing upward, support crankcase cover on wooden blocks on deck of arbor press.
- Place suitable bearing driver on outer race of bearing.
- Center bearing driver under ram.
- See Figure 68. Apply pressure to bearing driver until bearing is free. Discard bearing.

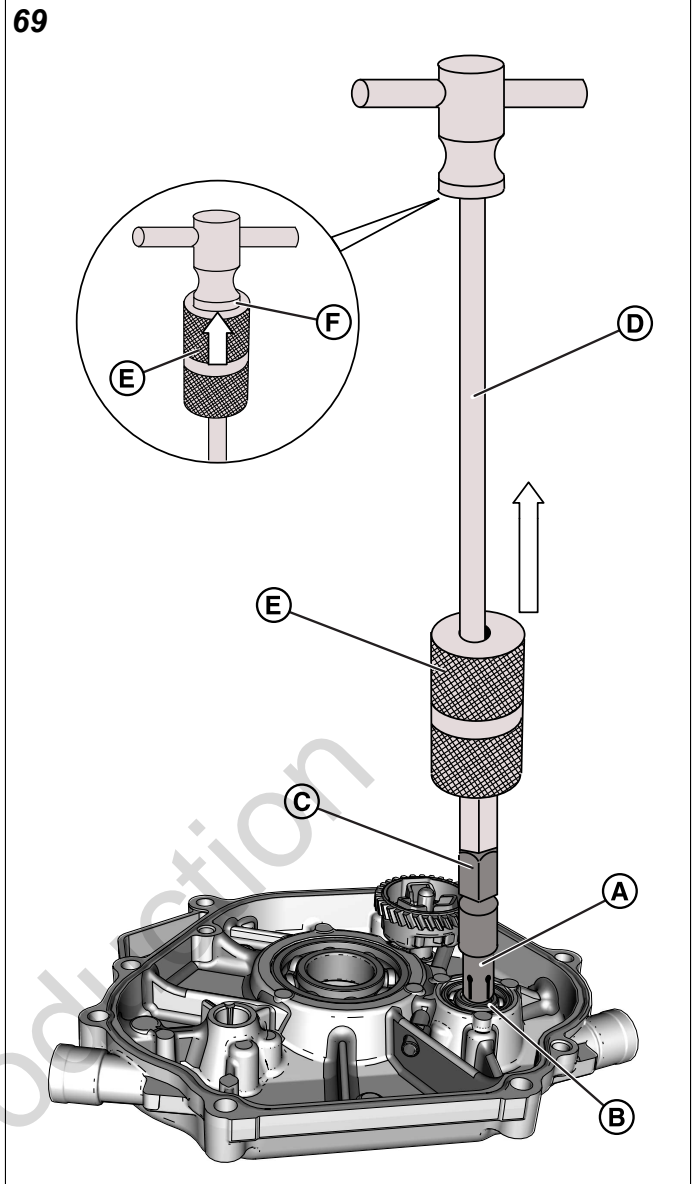
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68

Balancer Bearing

- Obtain suitable bearing remover collet and slide hammer.
- See Figure 69. Push expandable end of collet (A) through bearing bore (B).
- Turn hex (C) at end of collet shaft in a clockwise direction to expand collet slightly.
- Feel for inside edge of bearing, and then use an open end wrench to turn hex until tool is tight.
- Install slide hammer (D) onto threaded end of collet.



- To remove bearing, raise hammer (E) with sufficient force, so that it makes hard contact with collar (F) on tool.



CAUTION

Keep hand on handle and away from collar when using slide hammer. Inadequate safety precautions can result in injury to hands or fingers.

Cleaning

- Tape over governor gear to keep out dirt and debris.
- 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.
- 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.

4. To soften stubborn deposits, soak the crankcase and crankcase cover in a suitable chemical solution or other carbon and gum dissolving agent. Repeat steps 2-3 as necessary.
5. 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

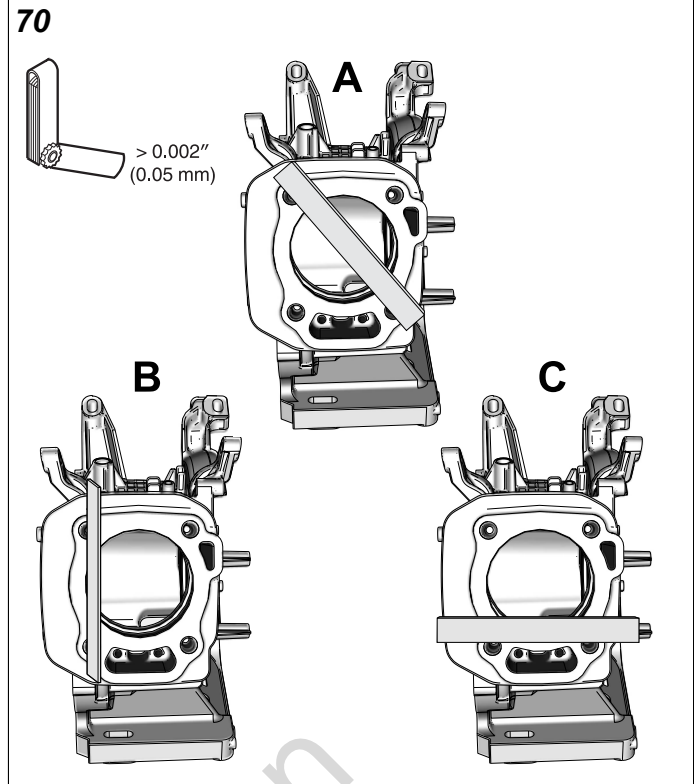
1. Inspect governor gear as follows:

NOTE: Governor gear damage requires crankcase cover replacement.

- A. Inspect governor gear for worn, cracked, chipped, or missing teeth.
 - B. Use your index finger to manually rotate the governor gear in both directions. Verify that gear rotates freely without roughness, sticking, or unusual noise.
 - C. Spin governor gear to verify that flyweights move freely.
2. Using an inside micrometer, check the crankcase and the crankcase cover camshaft bearing bores for wear. Replace either part if measurement is **0.634 inches** (16.093 mm) or more.
 3. Check the crankcase for cracks or broken cooling fins. Check the crankcase cover for cracks. Replace parts as necessary.
 4. Check for scratches and nicks on all gasket sealing surfaces. Use a fine-tooth file to carefully remove any nicks or burrs found.
 5. 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.

6. 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.
7. Using Magnaflux Dye Penetrant, inspect the cylinder bore for cracks. If no cracks are found, thoroughly wash cylinder to remove traces of dye.
8. Check the cylinder to cylinder head mating surface for warpage or distortion. Discard the crankcase if any low spot is **0.002 inches** (0.05 mm) or more. Proceed as follows:



- A. See A of Figure 70. 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 70. 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 70. Set a straightedge horizontally across the length of the cylinder gasket surface. Use feeler gauge to check for warpage. Repeat step on opposite side.
9. Repeat the 6 point check outlined under step 8 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 **0.002 inches** (0.05 mm) or more.
 10. 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 71. 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. If cylinder is not worn beyond the service limits described under step 10(D) and 10(E), see *DEGLAZE (RECONDITION) CYLINDER BORE*.
- G. If cylinder is worn beyond the service limits described under step 10(D) and 10(E), see *HONE (RESIZE) CYLINDER BORE*.

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Deglaze (Recondition) Cylinder Bore

NOTE: While also restoring the proper 45° cross hatch pattern, deglazing removes wear patterns, minor scuff marks and scratches without enlarging the bore diameter.

1. Tape over governor gear to keep out honing grit and other debris.
2. To prevent damage to finishing stones, check the top and bottom of the cylinder bore for burrs. Remove any burrs with a fine-tooth file.
3. Obtain a three blade rigid hone with 320 grit aluminum oxide finishing stones.
4. Place hone drive shaft in chuck of portable, variable speed drill and tighten.
5. Using a suitable honing oil, liberally lubricate cylinder bore and finishing stones.
6. Hone cylinder bore using a drill speed of approximately 200 RPM at 40-60 strokes per minute.
7. See Figure 72. Stop frequently to examine the cylinder bore. A precise 45° cross hatch pattern in the piston travel area is the most important.

NOTE: The angular cross hatch pattern ensures an even flow of oil onto the cylinder walls and promotes longer cylinder, piston and ring life. An improper cross hatch pattern will result in insufficient oil retention and possible piston seizure and/or high oil consumption.

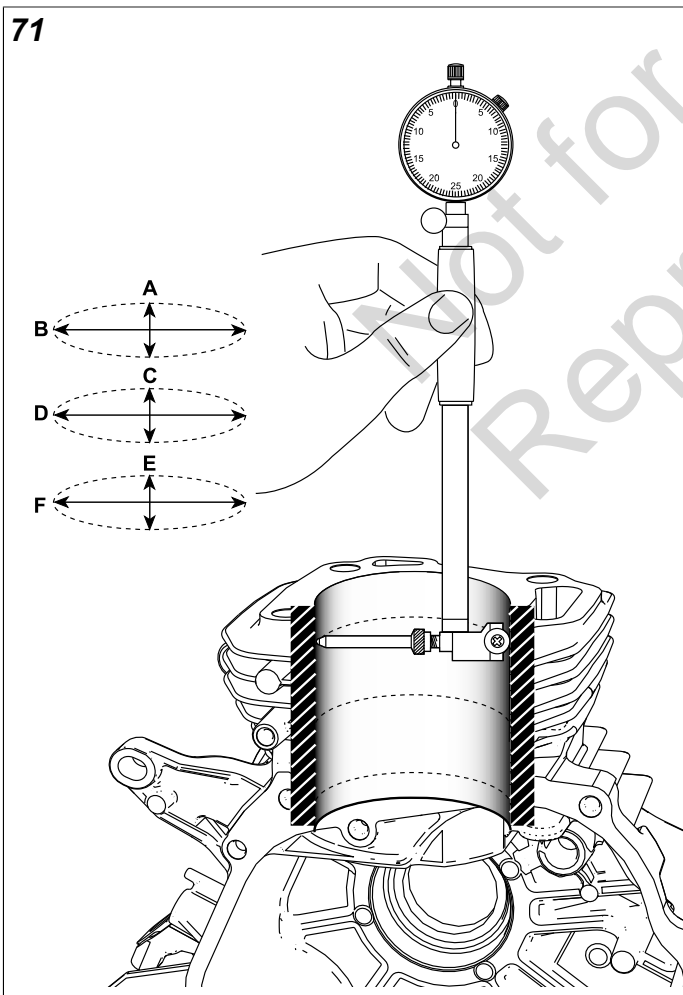
Hone (Resize) Cylinder Bore

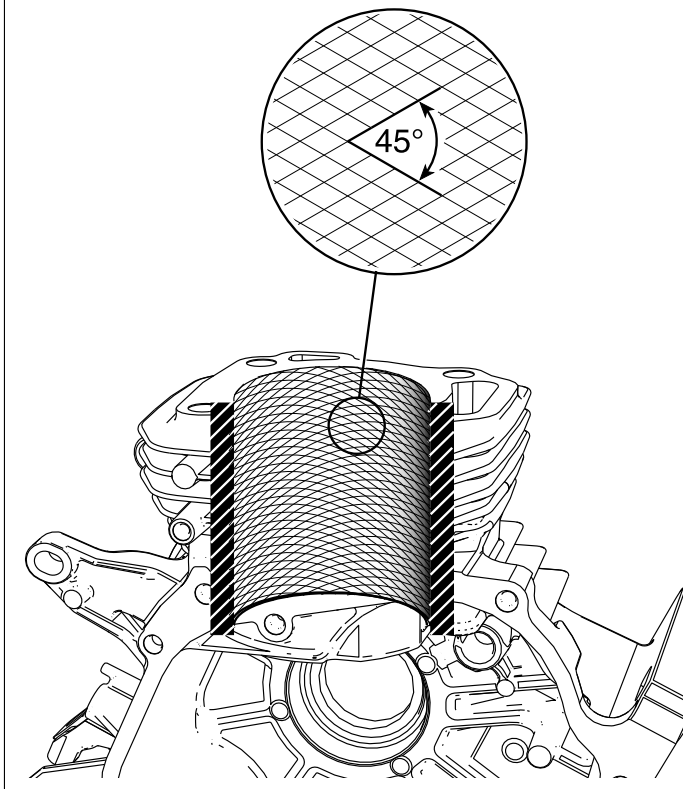
NOTE: If lacking the necessary tools, skills, or experience, take crankcase to a qualified machine shop for cylinder boring.

NOTE: Resize the cylinder bore if worn **0.003 inches** (0.08 mm), or is **0.0015 inches** (0.04 mm) out-of-round. Always resize exactly **0.020 inches** (0.51 mm) larger than the standard bore diameter to ensure service oversize piston and rings have the proper clearances.

1. Obtain a three blade rigid hone with 220 grit aluminum oxide stones.
2. To prevent damage to stones, check the top and bottom of the cylinder bore for burrs. Remove any burrs with a fine-tooth file.
3. Securely fasten cylinder to a heavy iron bracket or suitable honing fixture and place on level floor.
4. Place hone drive shaft in chuck of portable, variable speed drill and tighten.
5. Using a suitable honing oil, liberally lubricate cylinder bore and stones.
6. Place hone in middle of cylinder bore.

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7. Tighten adjusting knob until stones fit snugly against cylinder wall.
8. Activate drill and move hone up and down lower end of cylinder bore. The cylinder is not worn at the bottom, so it will help to keep hone straight in the bore. As the bottom of the bore increases in diameter, gradually increase each stroke until hone travels the full length of the bore.

NOTE: Hone cylinder bore with a drill speed of 300 to 700 RPM maximum at 40-60 strokes per minute.

NOTE: Do not extend hone more than **3/4-1 inches** (19.05-25.4 mm) from either end of the bore or stones may be damaged.

9. As cutting tension decreases, stop hone and tighten adjusting knob.
10. Frequently stop to examine the cylinder bore and take measurements.

NOTE: Hone cylinder bore about **0.0005 inches** (0.01 mm) larger than the desired size to allow for contraction as the cylinder cools.

11. Lubricate hone frequently to prevent build up on stones.
12. Stop frequently to examine the cylinder bore and take measurements.
13. When cylinder is resized to within **0.0015 inches** (0.04 mm) of the desired size, use finishing stones to achieve the final size and produce

the correct cross hatch pattern. See *Deglaze (Recondition) Cylinder Bore*, steps 3-7.

NOTE: An improper cross hatch pattern or too fine a hone will result in insufficient oil retention and possible piston seizure and/or high oil consumption.

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 honing grit are gone. Continue cleaning until a clean cloth shows no evidence of dirt or debris.

NOTE: Honing grit, which appears as a grey residue, is highly abrasive and will cause rapid cylinder, piston and ring wear resulting in premature engine failure.

5. Hot rinse the crankcase and dry with moisture free compressed air.
6. Verify that breather passage, intake and exhaust ports, and governor gear assembly are completely clean and free of dirt and grit.
7. Verify that oil hole between the tappet bores is clean and open.
8. Lightly lubricate cylinder bore with clean engine oil.

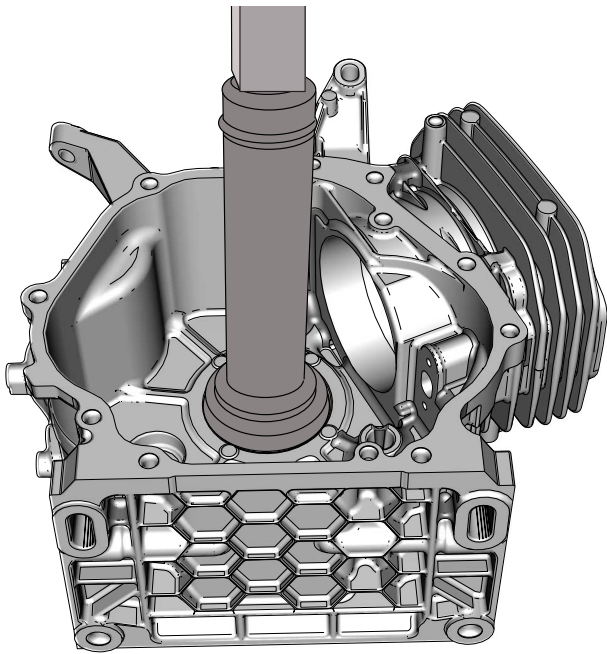
Assembly

Crankcase

MAG Bearing/Oil Seal

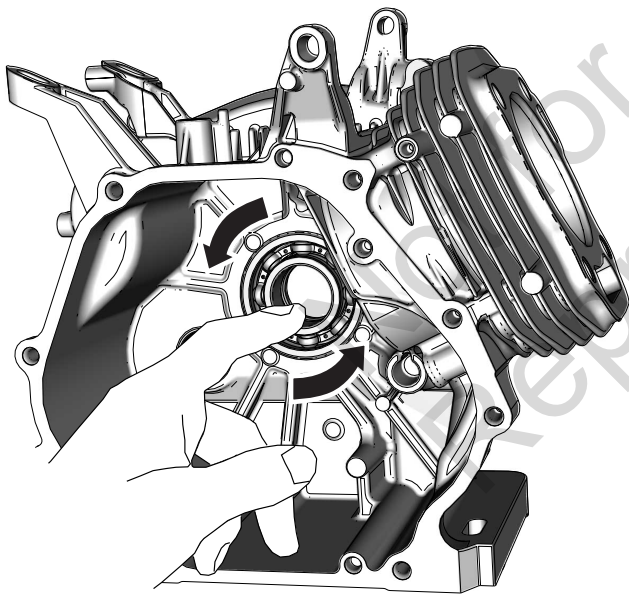
1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. Apply a thin film of clean engine oil to bearing bore and outside diameter of **new** bearing.
3. With the inside facing upward, support crankcase on wooden blocks on deck of arbor press.
4. With the bearing manufacturer's identification facing the inside of the crankcase, place bearing into bearing bore.
5. Place suitable crankshaft bearing driver on outer race of bearing.
6. Center bearing driver under ram.
7. Verify that assembly is square, so that bearing is not cocked during installation.

73



6

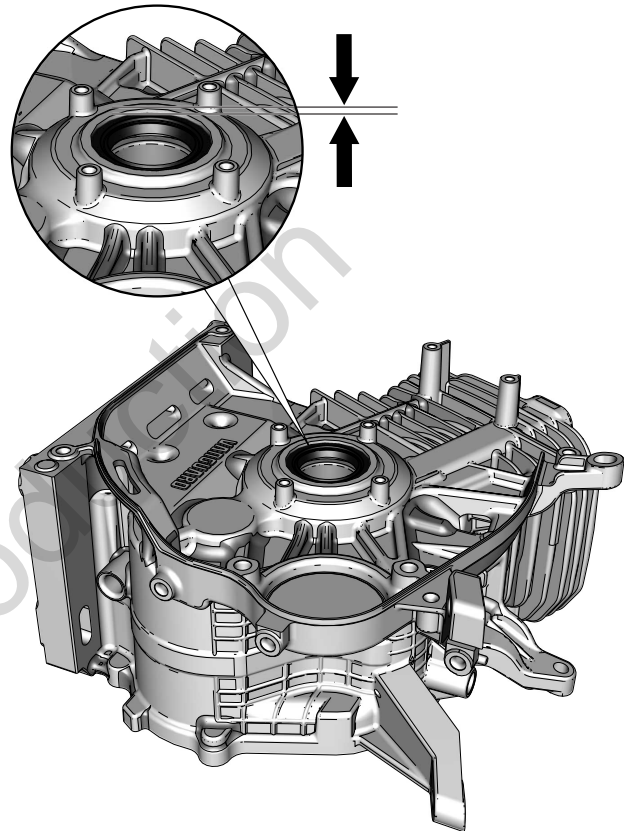
74



8. See Figure 73. Apply pressure to bearing driver until bearing is fully seated in bore.
9. Inspect the bearing for damage or distortion.
10. See Figure 74. Use your index finger to manually rotate the bearing in both directions. Verify that bearing rotates freely without roughness, sticking, or unusual noise.
11. With the outside facing upward, support crankcase on wooden blocks on deck of arbor press.

12. Apply a thin film of clean engine oil to oil seal bore and outside diameter of **new** oil seal.
13. Verify that oil seal lip garter spring is not broken or missing.
14. Place oil seal into bearing bore.
15. Place suitable oil seal driver on outside edge of oil seal.
16. Center oil seal driver under ram.
17. See Figure 75. Slowly apply pressure to oil seal driver until oil seal is at a depth of **0.049-0.069 inches** (1.25-1.75 mm).

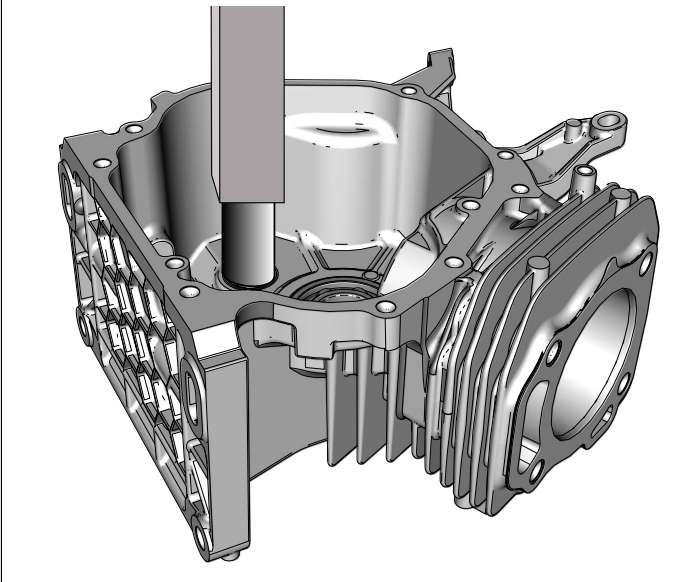
75



Balancer Bearing

1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. Apply a thin film of clean engine oil to bearing bore and outside diameter of **new** bearing.
3. With the inside facing upward, support crankcase on wooden blocks on deck of arbor press.
4. With the bearing manufacturer's identification facing the inside of the crankcase, place bearing into bearing bore.
5. Place suitable bearing driver on outer race of bearing.

76

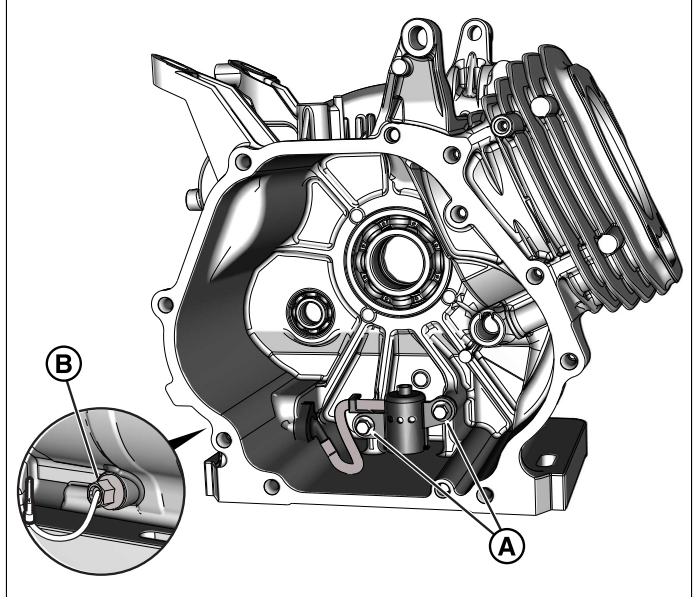


6. Center bearing driver under ram.
7. Verify that assembly is square, so that bearing is not cocked during installation.
8. See 76. Apply pressure to bearing driver until bearing is fully seated in bore.
9. Inspect the bearing for damage or distortion.
10. Use your index finger to manually rotate the bearing in both directions. Verify that bearing rotates freely without roughness, sticking, or unusual noise.

Low Oil Sensor (If Equipped)

1. Inspect low oil sensor for damage. Verify that float mechanism moves freely without sticking.
2. Inspect rubber washer on oil sensor fitting for cuts, tears, or signs of deterioration. Replace as necessary.
3. Route oil sensor wire and fitting through crankcase hole.
4. See Figure 77. Install two hex flange screws (A) to fasten oil sensor to threaded bosses inside crankcase. Tighten screws to **50-70 lb-in** (5.7-7.9 N-m).
5. From outside crankcase, install hex flange nut (B) on fitting and tighten to **30-50 lb-in** (3.4-5.7 N-m).

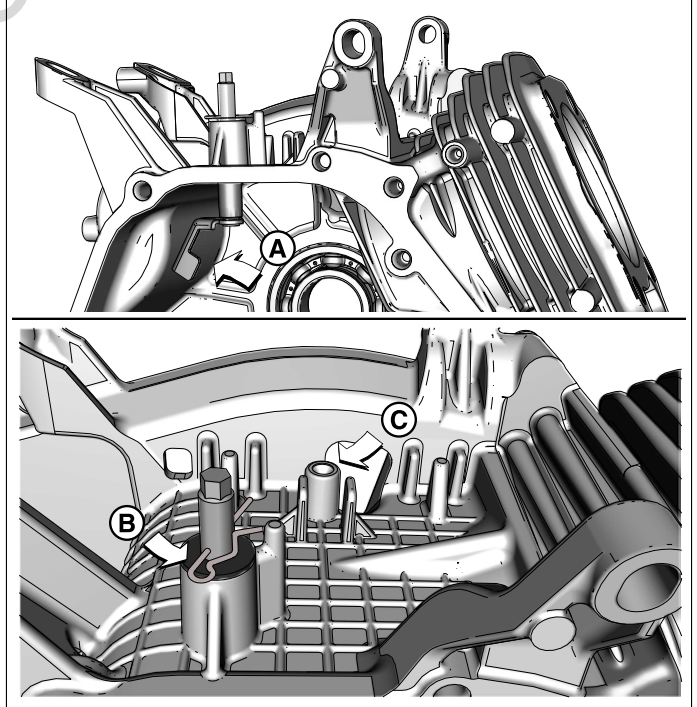
77



Governor Crank

1. From inside crankcase, insert governor crank thru hole at top of crankcase.
2. At top of crankcase, install flat washer over governor crank until seated on crankcase boss.
3. See Figure 78. Rotate governor crank (A), so that the paddle will be next to the governor gear cup once the crankcase cover is installed.

78



6

4. Install straight leg of spring clip through hole in governor crank (**B**), so that it points toward the governor idle spring bracket screw boss (**C**).
5. Verify that governor crank rotates freely without sticking.

Crankcase Cover

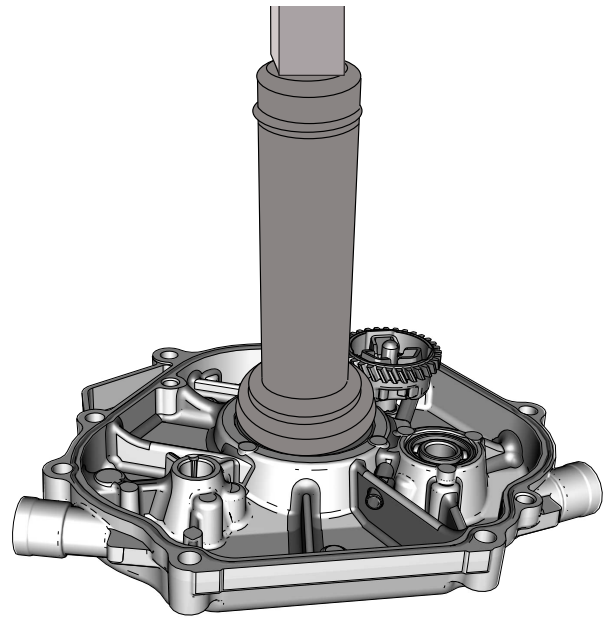
Governor Gear

1. Verify cleanliness of governor gear.
2. Inspect governor gear for worn, cracked, chipped, or missing teeth.

NOTE: Governor gear damage requires crankcase cover replacement.

3. See Figure 79. Use your index finger to manually rotate the governor gear in both directions. Verify that gear rotates freely without roughness, sticking, or unusual noise.
4. Spin governor gear to verify that flyweights move freely.

80



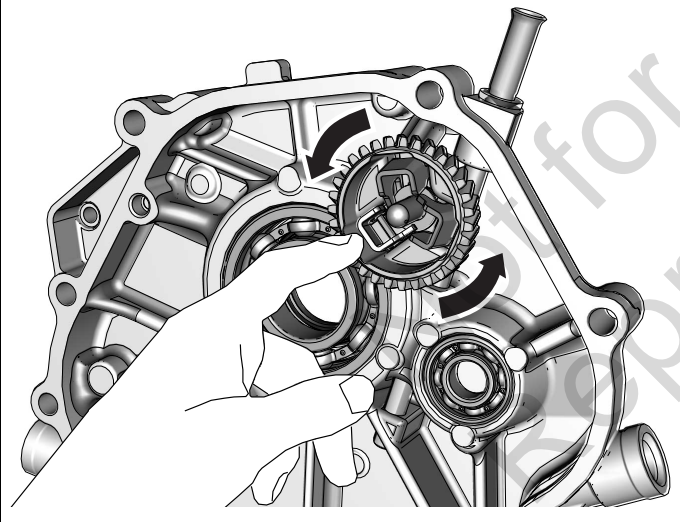
5. Place suitable crankshaft bearing driver on outer race of bearing.
6. Center bearing driver under ram.
7. Verify that assembly is square, so that bearing is not cocked during installation.
8. See Figure 80. Apply pressure to bearing driver until bearing is fully seated in bore.

NOTE: Exercise care to avoid any contact with the governor gear. Damage to the governor gear requires crankcase cover replacement.

9. Inspect the bearing for damage or distortion.
10. See Figure 81. Use your index finger to manually rotate the bearing in both directions. Verify that bearing rotates freely without roughness, sticking, or unusual noise.
11. With the outside facing upward, support crankcase cover on wooden blocks on deck of arbor press.
12. Apply a thin film of clean engine oil to oil seal bore and outside diameter of **new** oil seal.
13. Verify that oil seal lip garter spring is not broken or missing.
14. Place oil seal into bearing bore.
15. Place suitable oil seal driver on outside edge of oil seal.
16. Center oil seal driver under ram.
17. See Figure 82. Slowly apply pressure to oil seal driver until oil seal is at a depth of **0.177-0.197 inches** (4.5-5.0 mm).

6

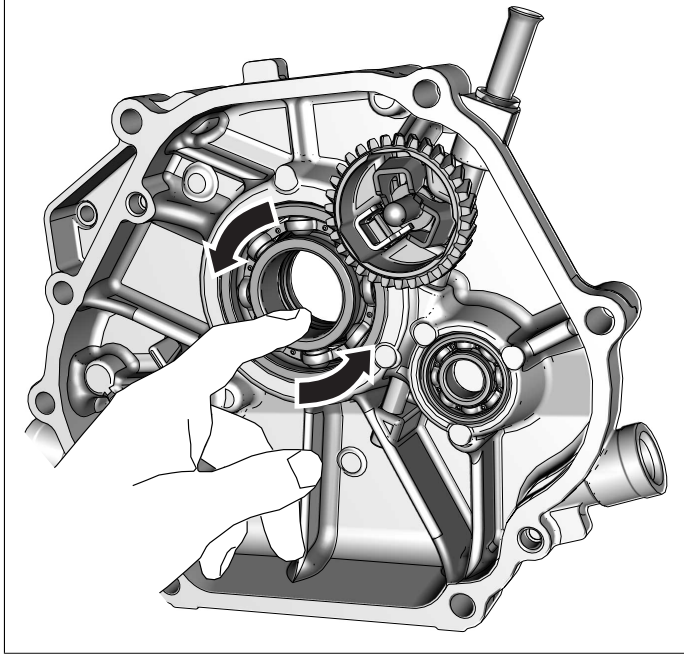
79



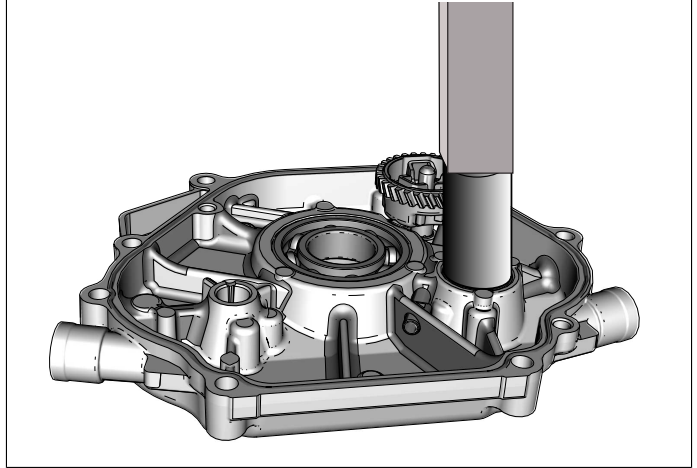
PTO Bearing/Oil Seal

1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. Apply a thin film of clean engine oil to bearing bore and outside diameter of **new** bearing.
3. With the inside facing upward, support crankcase cover on wooden blocks on deck of arbor press.
4. With the bearing manufacturer's identification facing the inside of the crankcase cover, place bearing into bearing bore.

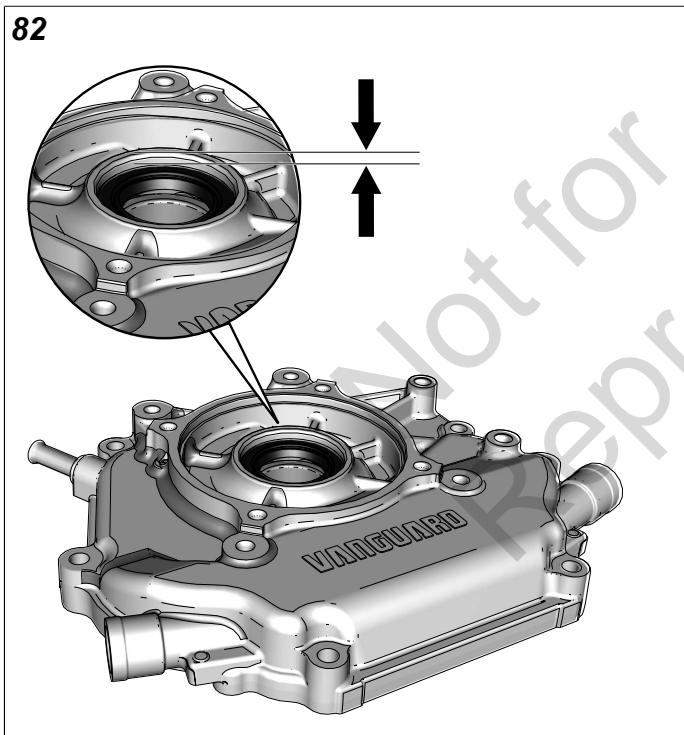
81



83



82



4. With the bearing manufacturer's identification facing the inside of the crankcase cover, place bearing into bearing bore.
5. Place suitable bearing driver on outer race of bearing.
6. Center bearing driver under ram.
7. Verify that assembly is square, so that bearing is not cocked during installation.
8. See Figure 83. Apply pressure to bearing driver until bearing is fully seated in bore.

NOTE: Exercise care to avoid any contact with the governor gear. Damage to the governor gear requires crankcase cover replacement.

9. Inspect the bearing for damage or distortion.
10. Use your index finger to manually rotate the bearing in both directions. Verify that bearing rotates freely without roughness, sticking, or unusual noise.

6

Balancer Bearing

1. Feel bearing bore for smoothness. Use fine steel wool or crocus cloth to remove any burrs or minor imperfections.
2. Apply a thin film of clean engine oil to bearing bore and outside diameter of **new** bearing.
3. With the inside facing upward, support crankcase cover on wooden blocks on deck of arbor press.

Not for
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SECTION 7 – ASSEMBLE ENGINE

BOTTOM END ASSEMBLY	68
TOP END ASSEMBLY	73

Not for
Reproduction

BOTTOM END ASSEMBLY

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: Use black electrical tape if oil seal protector sleeve is not available.

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:

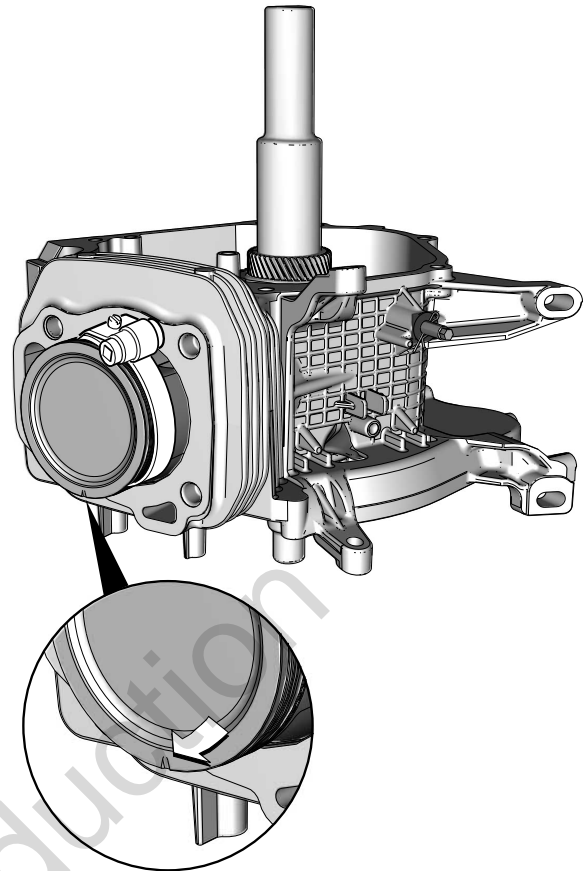
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CAUTION

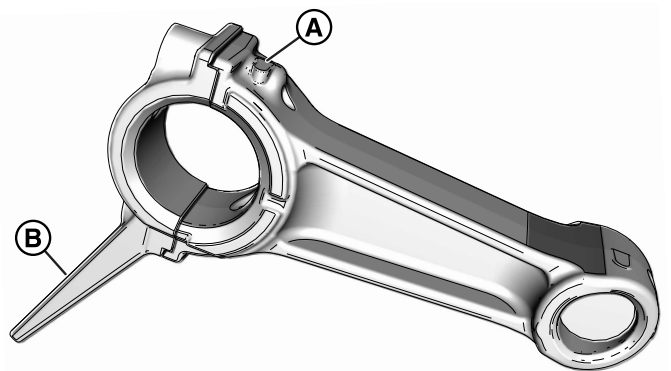
The edges of the piston ring compressor are sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

- A. Using tool wrench, unwind sleeve of piston ring compressor. Do not unwind sleeve too far or tool damage will occur.
- B. Apply clean engine oil to piston rings, piston skirt, cylinder bore, and inside wall of Piston Ring Compressor.
- C. See Figure 84. With notch on piston crown pointing toward the MAG bearing side, start piston and connecting rod assembly into cylinder bore.
- D. 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.

84



85



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 85. With connecting rod positioned on crank pin journal, install connecting rod cap, so that boss (A) on shank is opposite oil slinger on cap (B).

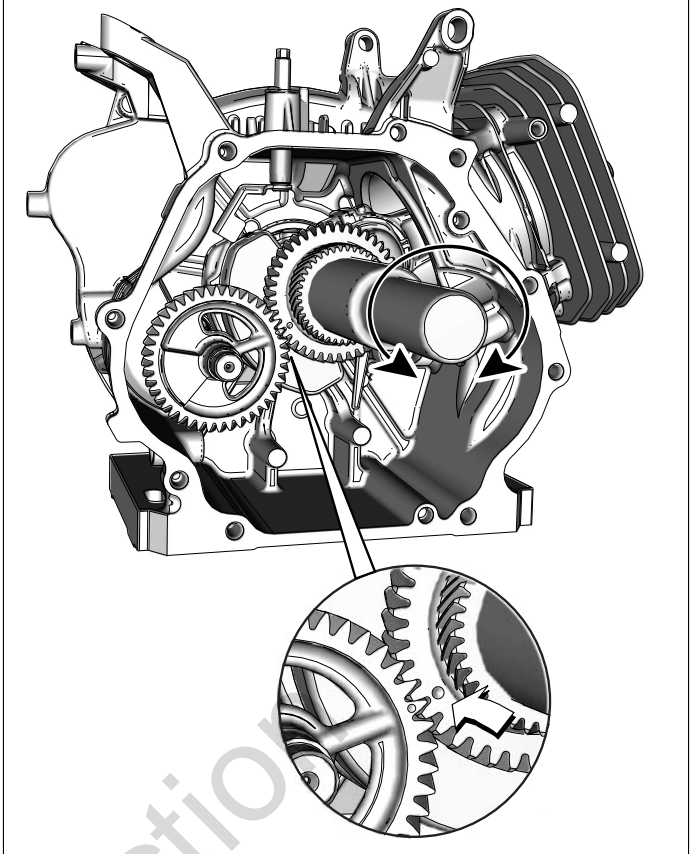
NOTE: Straight edge on connecting rod cap and shank are opposite the MAG bearing side.

11. Start two hex flange screws to fasten connecting rod cap to connecting rod. Starting with the screw closest to the piston (side opposite oil dipper), tighten screws to **90-110 lb-in** (10.2-12.4 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. Lubricate the balancer MAG bearing journal, and balancer bearing in crankcase with clean engine oil.
15. See Figure 86. Start balancer into bearing bore, and rotate crankshaft to align timing mark on balancer gear tooth with timing mark on crankshaft gear root.
16. Lubricate the balancer and crankshaft gear mesh with clean engine oil.
17. Check operation of yoke on Mechanical Compression Release (MCR) mechanism on camshaft gear.

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

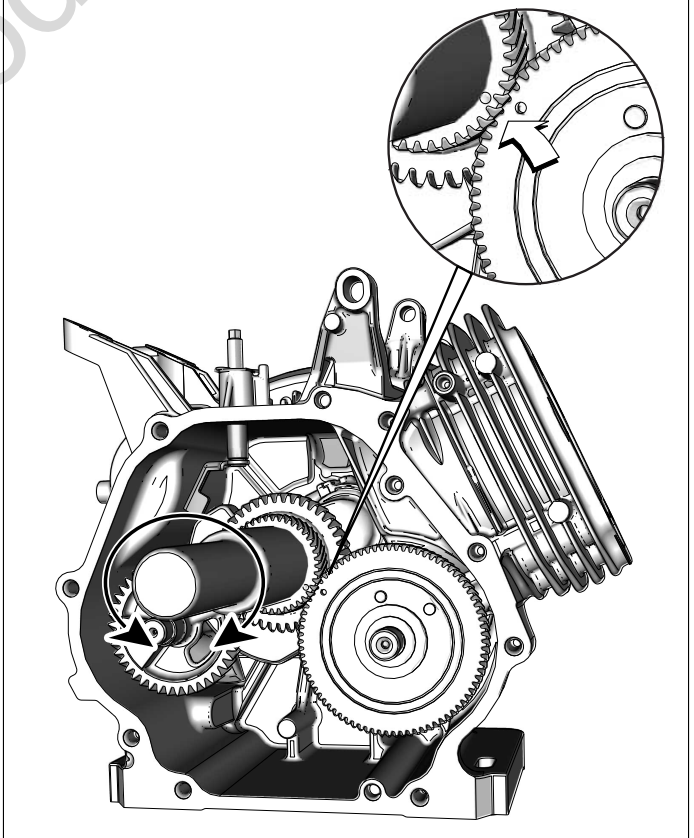
18. Thoroughly lubricate tappet bores and tappet shafts with clean engine oil.
19. Install tappets into tappet bores. Be sure to install each tappet in the same bore from which it was removed.
20. Lubricate the camshaft MAG bearing journal, camshaft lobes, and camshaft bearing bore in crankcase with clean engine oil.
21. See Figure 87. Verify that valve tappets are clear of camshaft lobes, start camshaft into bearing bore, and rotate crankshaft to align timing mark on camshaft gear root with timing mark on crankshaft gear tooth.
22. Install end play shims on crankshaft, if used.
23. Lubricate the camshaft and crankshaft gear mesh with clean engine oil.
24. Lubricate the balancer PTO bearing journal, and balancer bearing in crankcase cover with clean engine oil.
25. Lubricate the camshaft PTO bearing journal, and camshaft bearing bore in crankcase cover with clean engine oil.

86

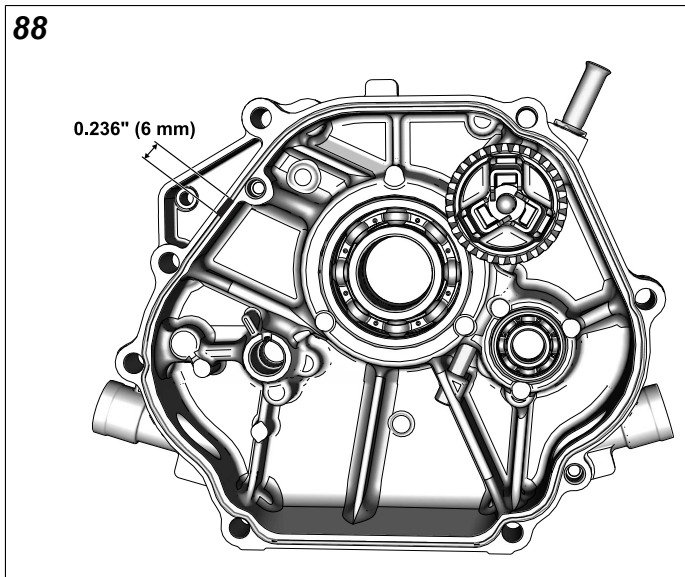


7

87



88



26. Verify two locating pins are present on crankcase flange. Install **new** locating pins if damaged or missing.
27. Verify that mating surfaces of crankcase and crankcase cover are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.
28. See Figure 88. Apply a bead of liquid gasket **0.071 inches** (1.8 mm) thick to crankcase cover. Bead must be a continuous closed loop with an overlap **0.236 inches** (6 mm).

NOTE: Crankcase cover must be installed within five minutes of liquid gasket application. If time limit is exceeded, scrape off liquid gasket and reapply.

29. Install oil seal protector sleeve on crankshaft.

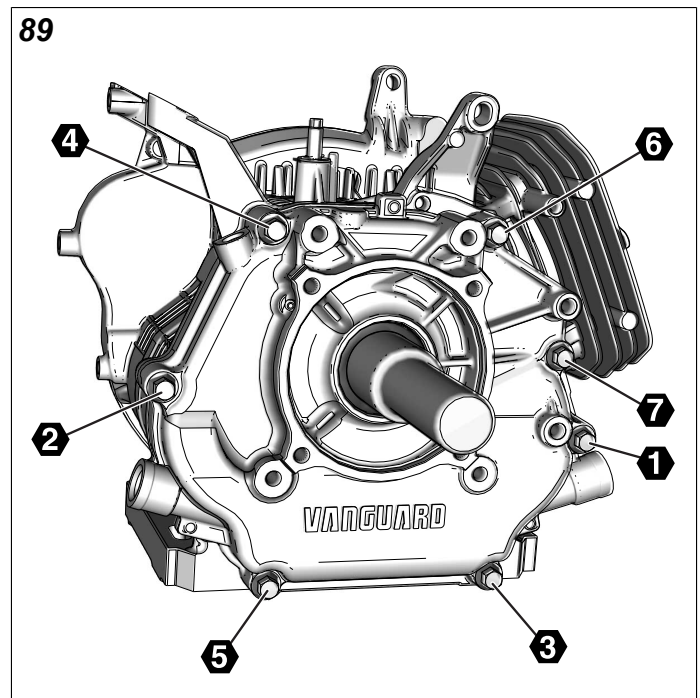
NOTE: Use black electrical tape if oil seal protector sleeve is not available.

30. Apply a thin film of clean engine oil to PTO bearing oil seal lip.
31. Install crankcase cover onto locating pins.
32. Remove oil seal protector sleeve (or black electrical tape) from crankshaft.
33. Start seven hex flange screws to fasten crankcase cover to crankcase. Proceed as follows:

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

- A. Tighten screws to **83-90 lb-in** (9-10 N-m) using the sequence shown in Figure 89.
- B. Tighten screws to **166-180 lb-in** (19-20 N-m) using the sequence shown.

89

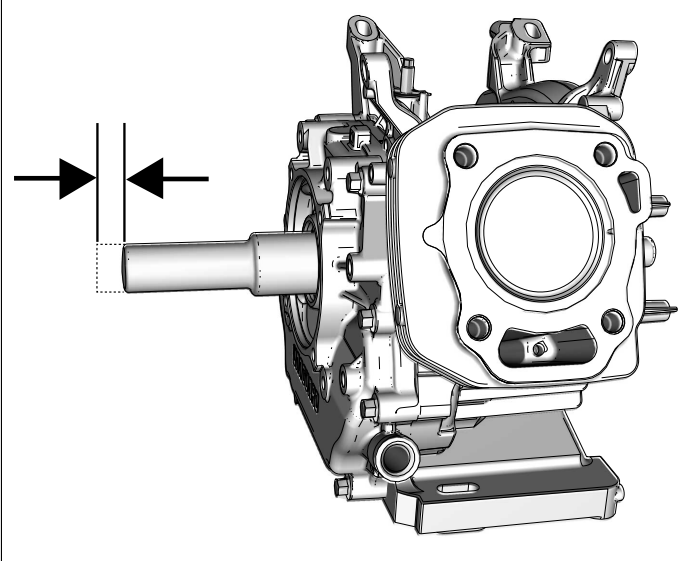


- C. Final tighten screws to **250-270 lb-in** (28.2-30.5 N-m) using the sequence shown.

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

34. Rotate crankshaft to check for binding.
35. See Figure 90. 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 **0.01-0.019 inches** (0.25-0.48 mm), or **0.005-0.012 inches** (0.12-0.30 mm) if engine is used in a pump application.
- H. Repeat the procedure to verify the reading.
- I. If end play is not within specification, replace the crankcase cover. If engine is used in a pump application, remove crankcase cover, and remove or add shims as necessary using the Crankshaft End Play Shim Kit (Part No. 84003590).

90



- A. See Figure 91. Orient stator, so that wires are at the top and facing the crankcase. Route wires through opening (A) in crankcase.
- B. Start four hex flange screws (B) to fasten stator to crankcase. Alternately tighten screws to **15-25 lb-in** (1.7-2.8 N-m) using a crosswise pattern.
- C. See Figure 92. Tightly pull stator wires through opening in crankcase, and then keeping wires tight, route between ribs at top of crankcase. Push down on wires, so that they are snugly seated against casting.

NOTE: Through contact with the governor lever, link, or springs, loose stator wires can interfere with governor operation.

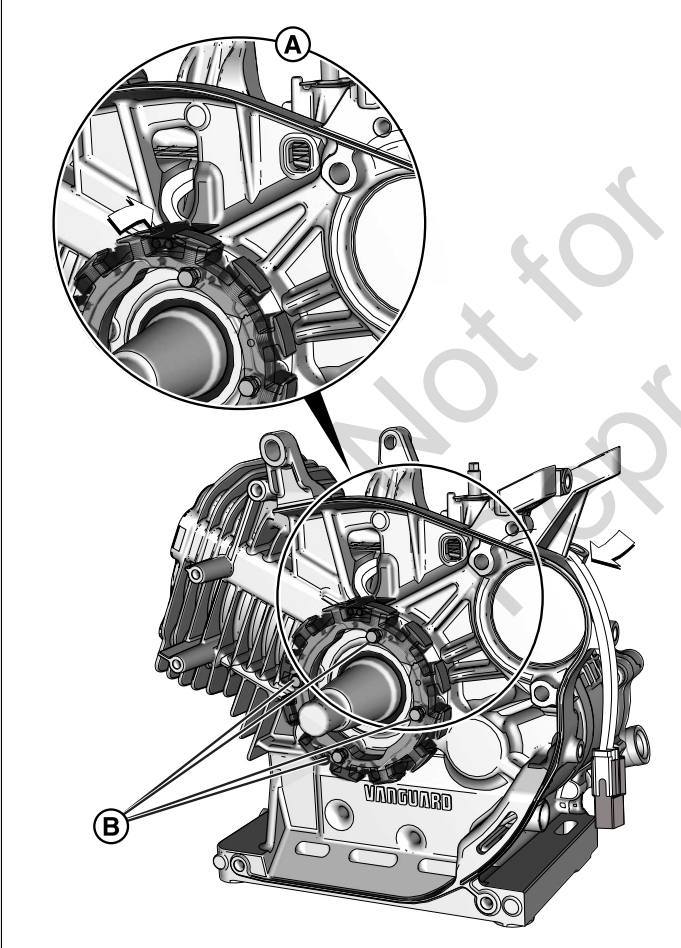
- 38. Verify that flywheel and crankshaft tapers are free of grease, oil, dust, and dirt. Verify that keyways are clean and completely free of dirt and grit.



CAUTION

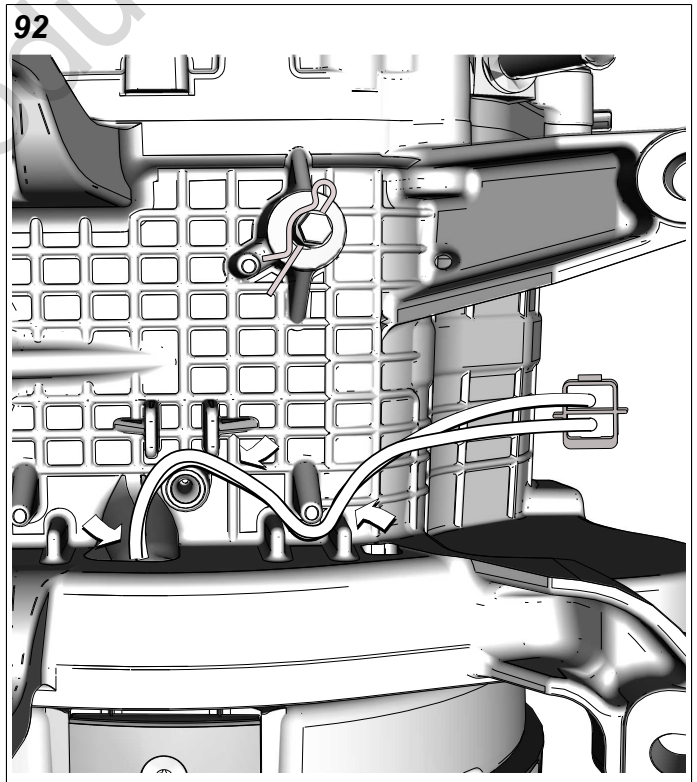
The edges of the crankshaft keyway are sharp. Wear appropriate safety gloves and exercise care to avoid hand injury.

91



- 39. See Figure 93. Install key (C) into keyway on crankshaft taper.

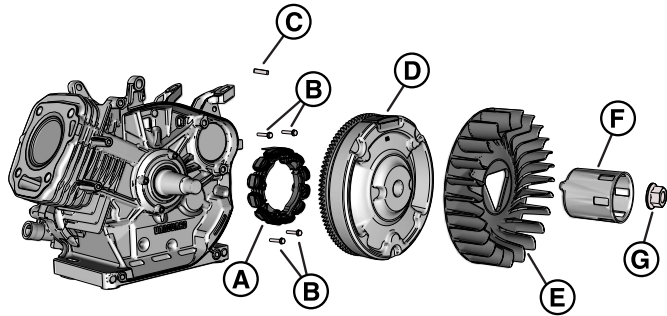
92



- 36. Install high mount dipstick and dipstick oil plugs into crankcase cover.
- 37. If **not** equipped with stator, move to step 40. If stator equipped, proceed as follows:

40. Install flywheel (D) engaging keyway with installed key on crankshaft taper. Verify that flywheel fits tightly without wobbling.

93

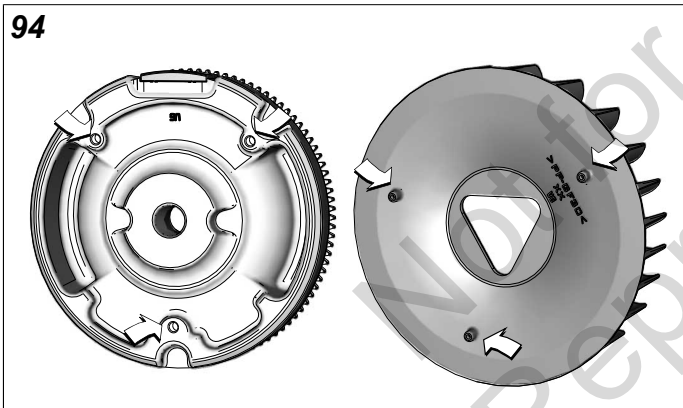


41. Install flywheel fan (E) onto flywheel, so that the deeper indentation at the back fits over the flywheel magnet.

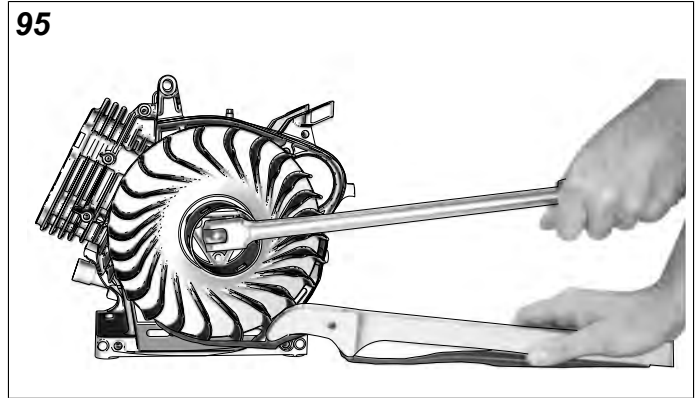
NOTE: See Figure 94. Rotate flywheel fan slightly to ensure that three pegs engage blind holes in flywheel bosses.

7

94



95



42. See Figure 93. Install starter cup (F).
43. Install flywheel nut (G). Hand tighten flywheel nut, so that flywheel, flywheel fan, and starter cup remain fully engaged.
44. Obtain a suitable strap wrench, torque wrench, and 21 mm socket. Proceed as follows:
- See Figure 95. Fit loop of strap around flywheel and tighten until snug.
 - Pinch strap between heel of wrench and flywheel.
 - Holding tool down by the handle, tighten flywheel nut to **105-115 lb-ft** (142.4-155.9 N-m).
 - Remove strap wrench from flywheel.
45. See *TOP END ASSEMBLY* in this section.

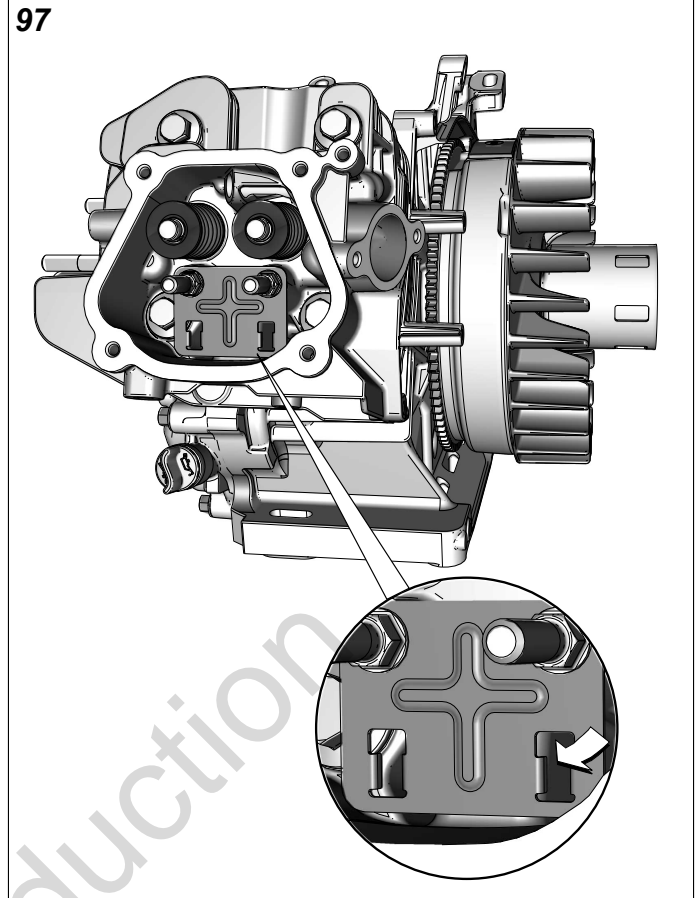
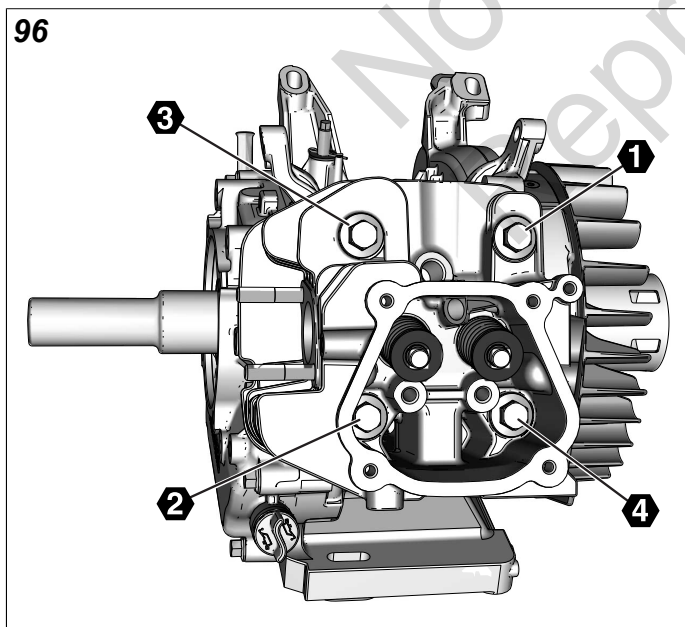
TOP END ASSEMBLY

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. Verify that two locating pins are present on downside of cylinder deck. Install **new** locating pins if damaged or missing.
3. Install **new** cylinder head gasket onto locating pins.
4. Install cylinder head onto locating pins.
5. Start four cylinder head screws and hand tighten until snug.

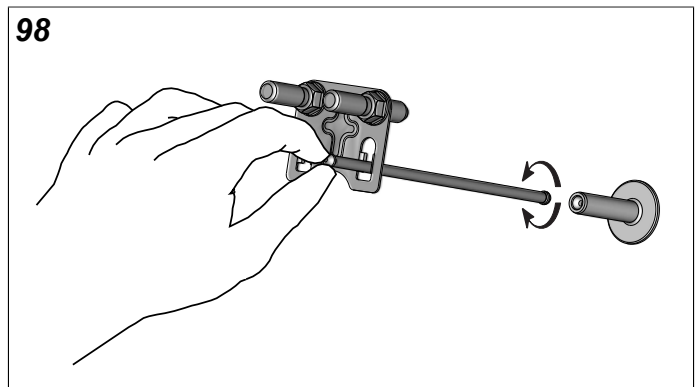
NOTE: Verify cleanliness of cylinder head screws. Friction caused by dirt will result in a false torque reading.

6. Tighten cylinder head screws as follows:
 - A. Tighten screws to **83-90 lb-in** (9-10 N-m) using the sequence shown in Figure 96.
 - B. Tighten screws to **166-180 lb-in** (19-20 N-m) using the sequence shown.
 - C. Final tighten screws to **250-270 lb-in** (28.2-30.5 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.



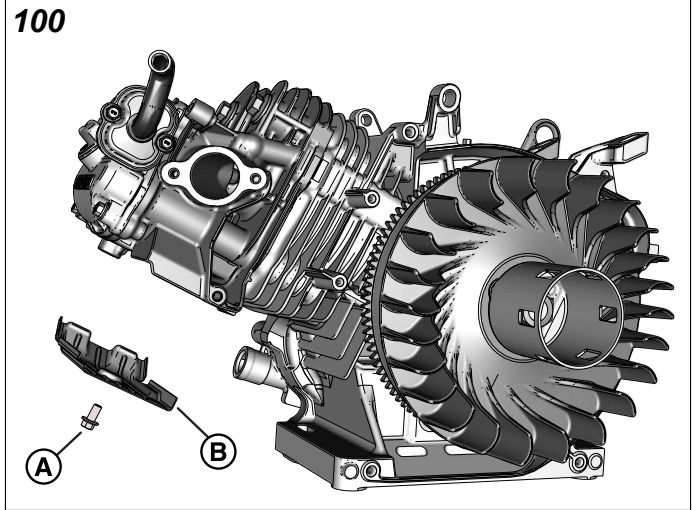
7. See Figure 97. Install push rod guide plate and rocker arm studs in cylinder head. Verify that tangs on push rod guide plate are facing down. Tighten rocker arm studs to **230-250 lb-in** (26-28.3 N-m).
8. See Figure 98. Insert push rods through guide plate to engage valve tappets. Rotate push rods to be sure that ball ends are seated in valve tappet sockets.



9. Install rocker arms and rocker balls onto rocker arm studs. Start set screws into rocker balls.
10. Tighten rocker ball nuts to obtain zero clearance between rocker arms and valve stem tips.
11. Slowly rotate crankshaft to verify proper movement of push rods and rocker arms.
12. Adjust valve clearance. See *SECTION 2 - MAINTENANCE, CHECK/ADJUST VALVE CLEARANCE*, steps 6-9.
13. Verify that mating surfaces of cylinder head and valve cover are clean and dry. Any dust or dirt left on mating surfaces can cause leaks.
14. Install **new** valve cover gasket onto valve cover.
15. Start four hex flange screws to fasten valve cover to cylinder head. Alternately tighten screws to **70-90 lb-in** (7.9-10.2 N-m) using the sequence shown in Figure 99.
16. 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) using the 5/8 inch Spark Plug Wrench (Part No. 19576S).

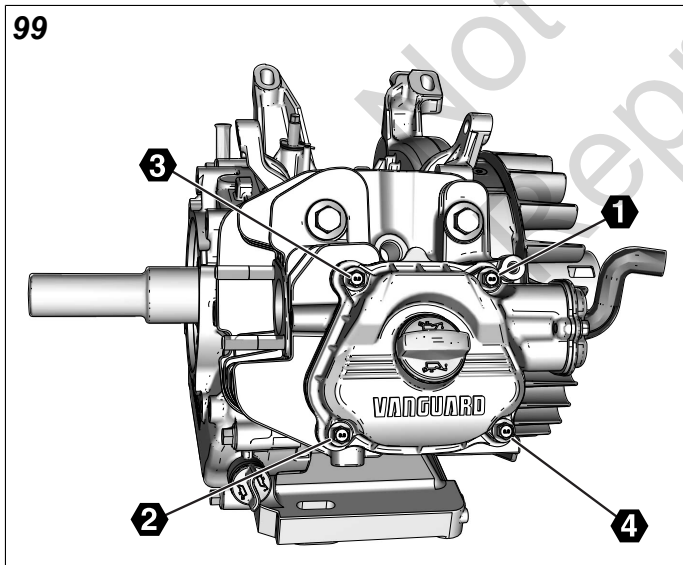
NOTE: Do not install spark plug wire onto spark plug terminal at this time.

17. See Figure 100. Install hex flange screw (A) to fasten heat shield (B) to cylinder head. Tighten screw to **40-60 lb-in** (4.5-6.8 N-m).



18. See *SECTION 8 - INSTALL EXTERNAL ASSEMBLIES*.

7



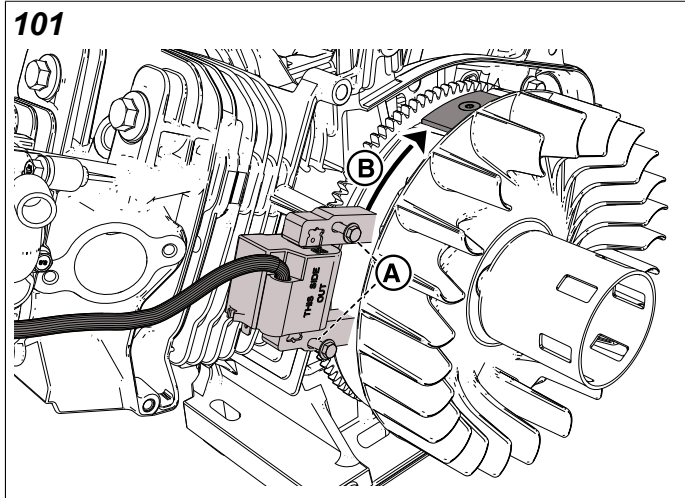
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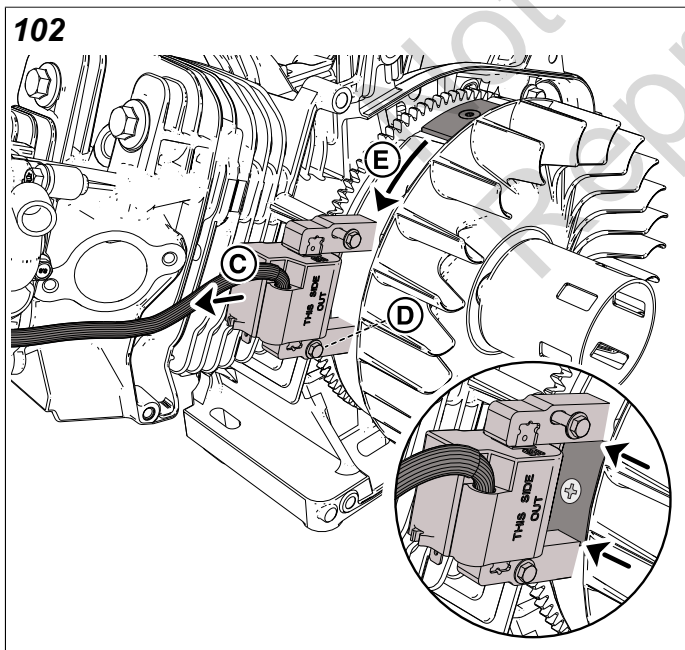
INSTALL EXTERNAL ASSEMBLIES

Armature

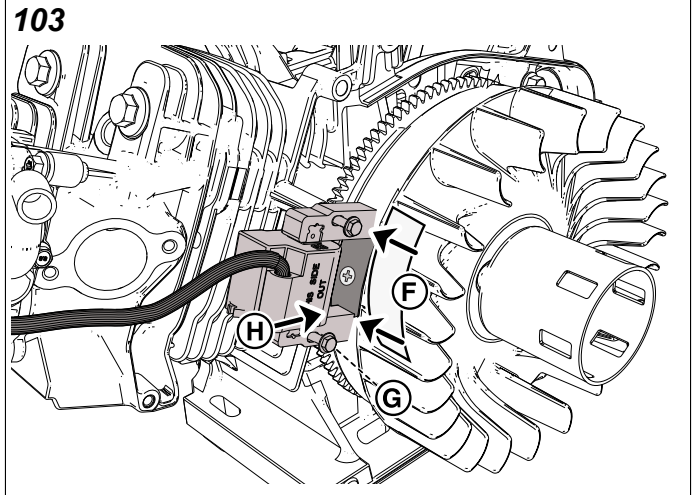
1. See Figure 101. Loosely install two hex flange screws (A) to fasten armature to crankcase.
2. Rotate flywheel to move magnet away from armature legs (B).



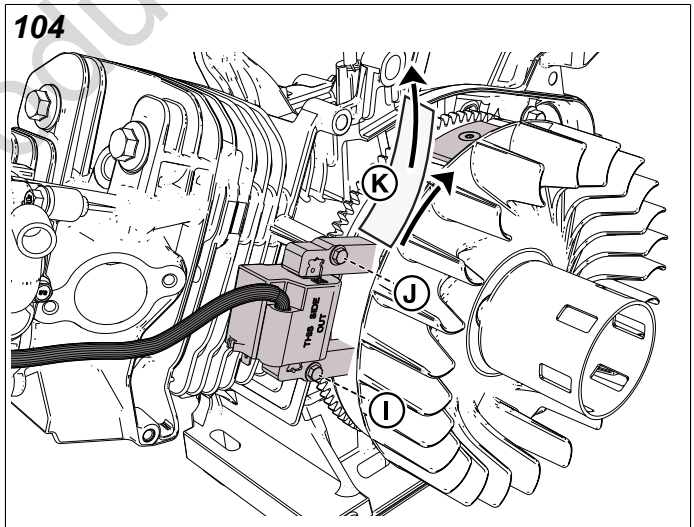
3. See Figure 102. Slide armature (C) away from flywheel.
4. Tighten bottom hex flange screw (D) until snug.
5. Rotate flywheel, so that magnet is aligned with armature legs (E).



6. See Figure 103. Insert feeler gauge (F) or Armature Air Gap Gauge (Part No. CE5121) between flywheel and armature legs. To set air gap to **0.010-0.014 inches** (0.25-0.35 mm), loosen bottom hex flange screw (G) to allow magnet to pull armature legs (H) against gauge.

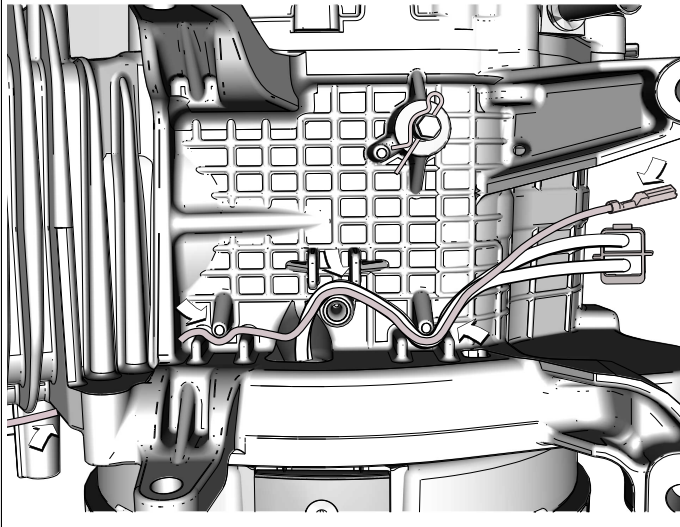


7. See Figure 104. Tighten bottom hex flange screw (I) and top hex flange screw (J) to **20-35 lb-in** (2.3-4 N-m).
8. Rotate flywheel to remove gauge (K).
9. See Figure 105. Route armature wire (to low oil sensor module) between ribs at top of crankcase. First pull wire tight and then push down firmly, so that it is snugly seated against casting (or stator wires, if equipped).



NOTE: Through contact with governor lever, link, or springs, loose wires can interfere with governor operation.

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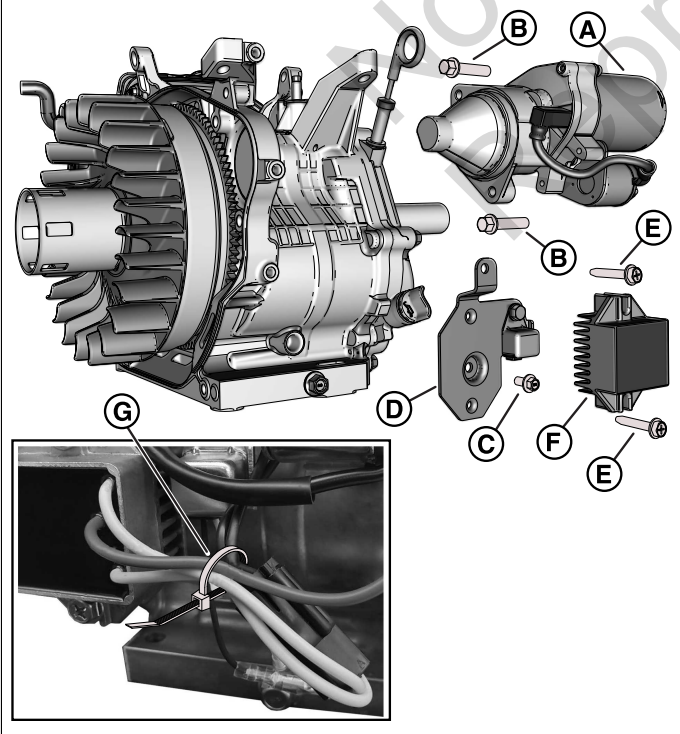


- Route unterminated stop switch wire to intake port of cylinder head.

Starter Motor/Regulator (If Equipped)

- See Figure 106. With the stator wires routed over the top of the starter motor, install starter motor (A) into crankcase bore. Start two screws (B), and then alternately tighten to **160-210 lb-in** (18-24 N-m).
- From top of starter motor, route key switch yellow and orange wires downward behind starter motor to area of starter solenoid.

106



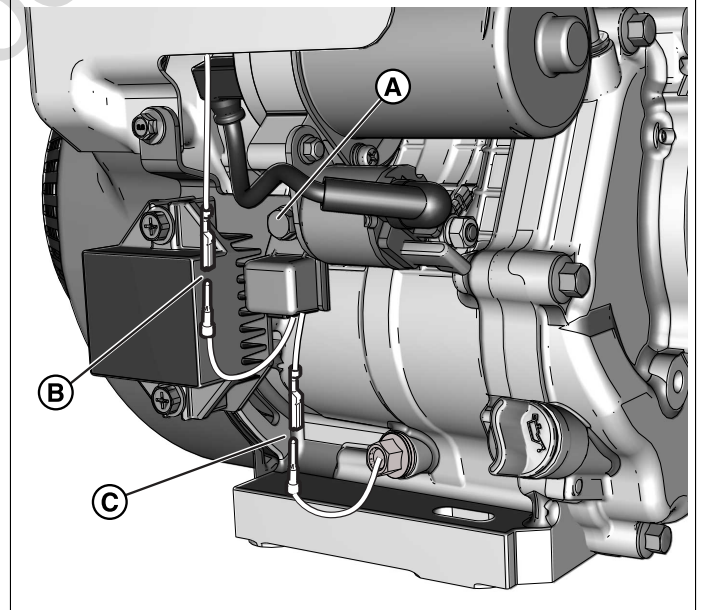
- Install key switch yellow wire socket terminal onto starter solenoid spade terminal.

- Install flat washer and key switch orange wire ring terminal onto starter solenoid post. Loosely install hex nut.
- Install center screw (C) to fasten bracket (D) to crankcase. Top screw is installed with the key switch panel later.
- Install two screws (E) to fasten regulator (F) to bracket.
- Remove hex nut from starter solenoid post. Install regulator red wire ring terminal, flat washer, lock washer, and hex nut. Tighten hex nut to **30-40 lb-in** (3.4-4.5 N-m).
- Connect two-place wire connector between regulator (yellow wires) and stator (black wires).
- Loop or coil any excess wire length and secure bundle (regulator and stator wires) with a cable strap (G). Tuck wire bundle in towards the engine.

Low Oil Sensor Module (If Equipped)

- See Figure 107. If removed, install hex flange screw (A) to fasten oil sensor module bracket to regulator bracket. Tighten screw to **30-80 lb-in** (3.4-9 N-m).
- Connect one-place wire connector (B) between armature and oil sensor module.
- Connect one-place wire connector (C) between oil sensor module and oil sensor.

107



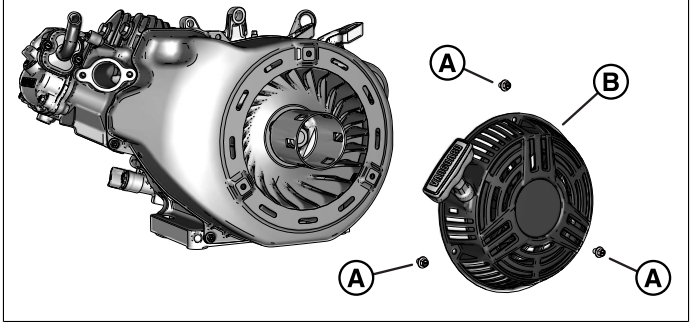
Blower Housing

1. See Figure 108. Start four hex flange screws (A) to install blower housing (B).
2. Route stop switch (C) wire and spark plug wire (D) through recess in blower housing as shown.
3. Using the sequence shown in top inset, alternately tighten screws to **80-110 lb-in** (9-12.4 N-m). Verify that bottom of blower housing is above or flush with bottom of engine base.

NOTE: Use the internal T25 TORX recess for best results.

NOTE: Do not install the fifth screw (see arrow in top inset) at this time. Screw is installed with the control bracket.

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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. Orient rewind starter as noted before removal.

NOTE: Rewind starter may be installed in the 2 o'clock, 8 o'clock, 10 o'clock, or 12 o'clock positions.

3. See Figure 109. Loosely install three hex flange screws (A) to fasten rewind starter (B) to blower housing.

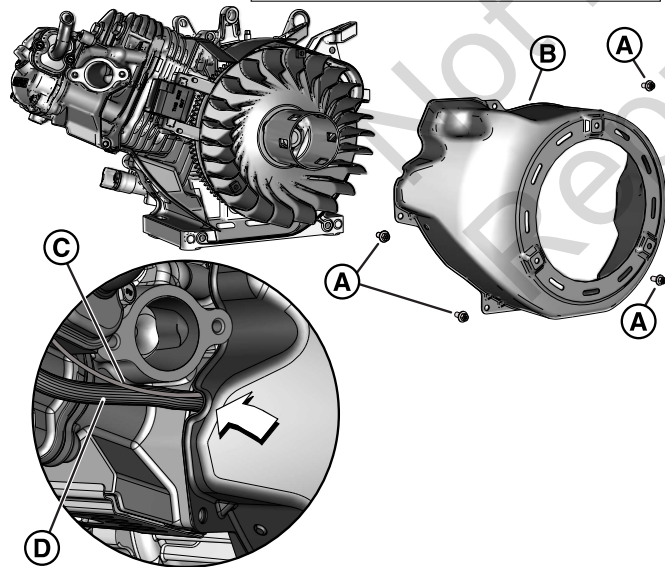
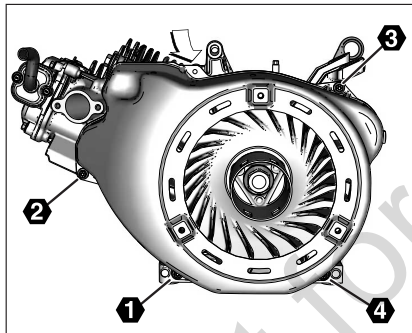
NOTE: To ensure that pawls evenly engage flywheel starter cup, pull starter rope, tighten hex flange screws until snug, and then release starter rope.

4. Alternately tighten three hex flange screws to **25-35 lb-in** (2.8-4 N-m).

Replace Rewind Starter Rope

1. See Figure 110. Pull rope part way out and tie a temporary knot (A).
2. Remove insert (B) from handle (C).
3. Pull knot (D) out of recess in insert. Untie knot and remove insert and handle from rope.
4. See Figure 111. Untie temporary knot and pull rope out as far as it will go. Secure pulley with a screwdriver (E) to prevent further rotation.
5. Grasp knot (F) with a needle nose pliers and pull rope out through rewind starter housing eyelet (G) and pulley hole (H).
6. Using old rope as a gauge, cut **new** rope to size.

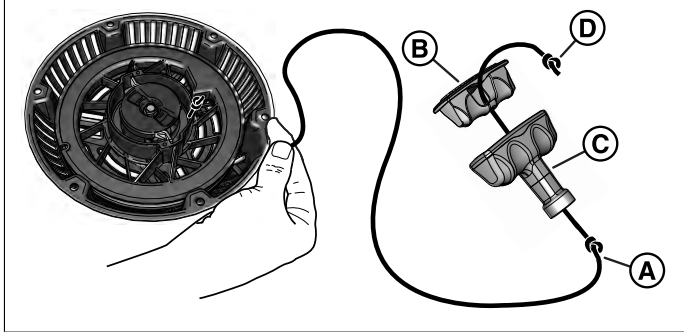
108



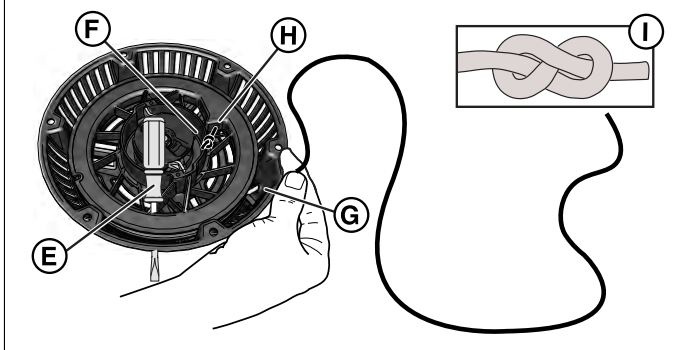
Rewind Starter

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.

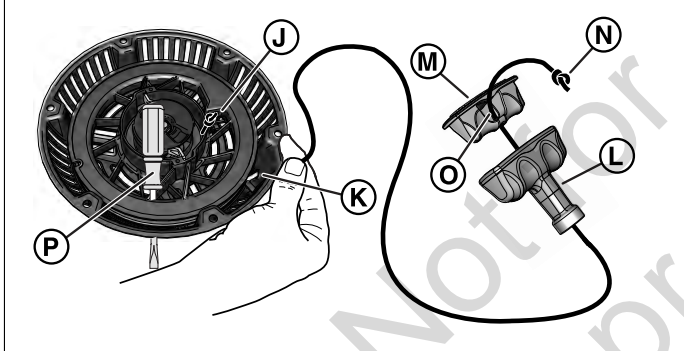
110



111



112



NOTE: For ease of installation and to prevent fraying or unraveling, either melt the rope end or use a suitable rope whipping compound.

7. Tie a knot (I) 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.

8. See Figure 112. Insert rope through pulley hole (J) and rewind starter housing eyelet (K).
9. Pull rope until knot is seated in pulley recess.
10. Insert end of rope through handle (L) and insert (M).
11. Tie knot (N) at end of new rope.

12. Pull rope until knot is seated in recess (O) of insert. Fit insert into handle.
13. Remove screwdriver (P) and allow pulley to slowly rewind rope.
14. Operate rewind starter to check for smooth operation.

Carburetor

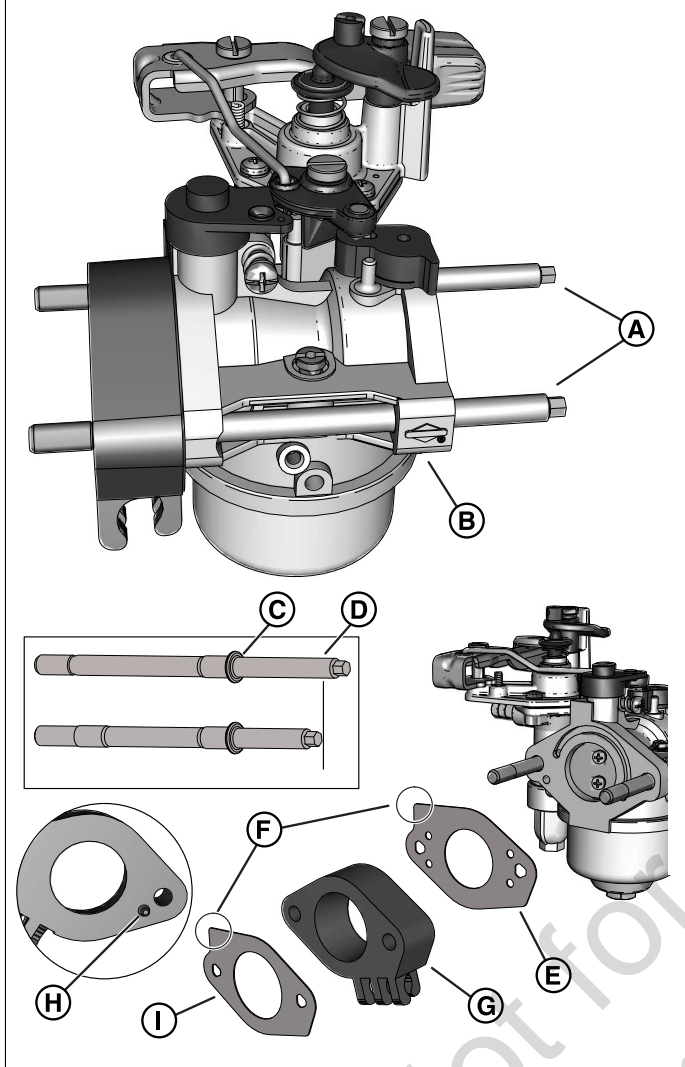
NOTE: See *Overhaul Carburetor* for disassembly, cleaning, inspection, and assembly instructions.

1. See Figure 113. Assemble carburetor as follows:
 - A. Install carburetor mounting studs (A) into carburetor (B), so that collar (C) on each stud seats against carburetor counterbore. Be sure that the long stud (D) goes on the same side as the fuel hose.
 - B. Install carburetor gasket (E) onto carburetor mounting studs, so that tab (F) on gasket is at the top with the white lettering facing outside.
 - C. Install carburetor adapter (G) onto carburetor mounting studs, so that the ribs are at the bottom. A nub (H) engages a hole in the carburetor gasket and a blind hole in the carburetor flange to ensure correct assembly.
 - D. Install carburetor adapter gasket (I) onto carburetor mounting studs, so that tab (F) on gasket is at the top with the white lettering facing outside.
2. If removed, install fuel hose with clamp onto carburetor fuel inlet fitting.
3. Squeeze tangs and move hose clamp about **1/8 inch** (3 mm) from end of hose with tangs pointing upward for best access.
4. Start carburetor mounting studs into cylinder head.

NOTE: Verify that fuel hose insulation is not pinched between carburetor adapter and gasket.

5. See Figure 114. Capture stop switch (A) wire and then spark plug wire (B) in slot of carburetor adapter (C).
6. Hand tighten carburetor mounting studs into cylinder head.
7. Using a 4 mm hex socket, alternately tighten carburetor mounting studs to **70-90 lb-in** (7.9-10.2 N-m). If end of stud will not accept a 4 mm hex socket due to damage or wear, proceed as follows:
 - A. Retrieve the two hex flange nuts removed from the studs during air cleaner removal.

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- B. Thread first nut onto stud upside down.
- C. Thread second nut onto stud right-side up until it makes firm contact with the first.
- D. Rotating outside nut in a clockwise direction, tighten stud to specification.
- E. Remove hex flange nuts from stud.
- F. Repeats steps 7(B) thru 7(E) to install second stud.

Overhaul Carburetor

Disassembly

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



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:

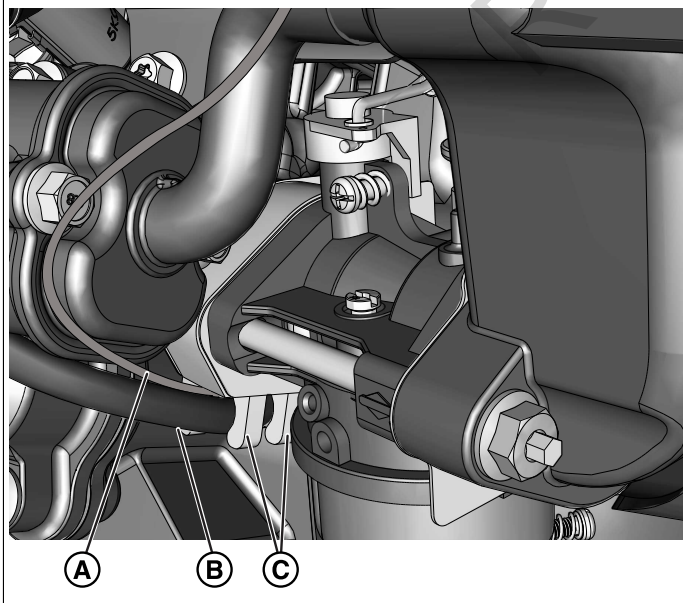
- Wear proper eye protection.
- Be sure there is no open flame or potential ignition sources in the area.
- Keep a dry chemical fire extinguisher on hand in case of emergencies.
- When removing fuel hose, drain plug, float bowl, sediment bowl, etc., cover with a shop towel to catch any residual fuel 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 115. Remove float bowl/main jet screw (A) with gasket (B) to release float bowl (C) from carburetor body.
3. Remove hinge pin (D) from pedestals to release float (E).

NOTE: The hinge pin is directional. Locate the end with the flats (F) as shown in the inset of Figure 115. Using a punch and a soft mallet, tap the opposite (round) end (G) of pin to remove.

4. Remove needle valve (H) with wireform clip (I) from tab on float hinge.
5. Remove float bowl O-ring (J) from groove in carburetor body.
6. Using a small flat blade screwdriver, remove nozzle keeper (K) from center passage in carburetor body.

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7. Slide main nozzle (L) from center passage.
8. Using a small flat blade screwdriver, remove idle jet (M) at top of carburetor body.
9. Remove sediment bowl (N) from fuel shutoff valve. Remove O-ring (O) and fuel filter screen (P).

Cleaning and Inspection

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

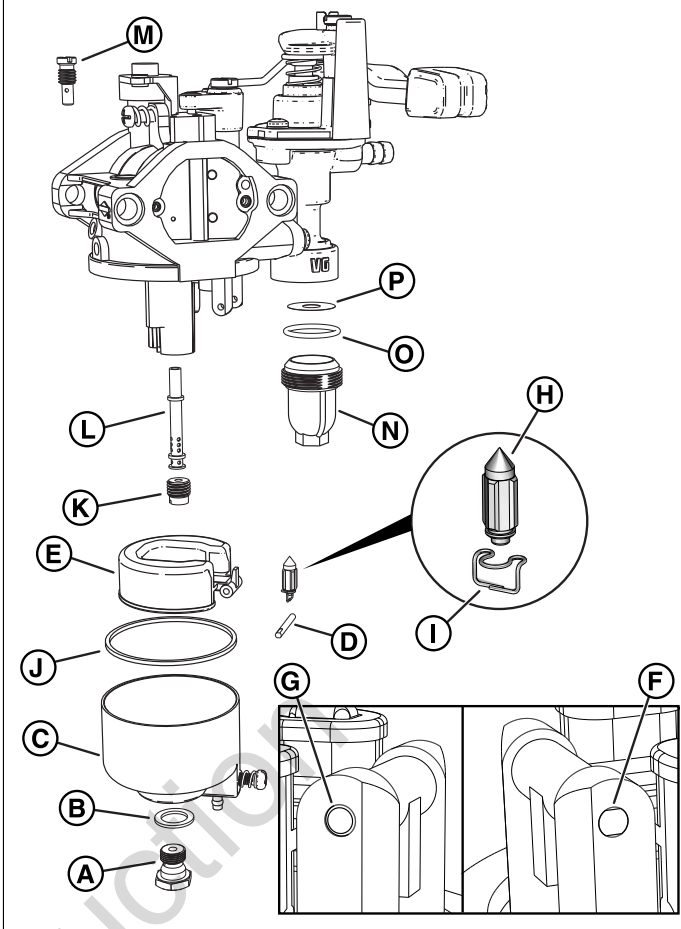
NOTE: Remove and set aside all rubber parts or those that have rubber components, such as the needle valve, O-rings, and fuel hose, as these can be damaged by the carburetor cleaner.

2. Inspect carburetor body and float bowl for sediment, gum or varnish deposits. Spray parts and then wipe away cleaning solution with a clean cloth. Repeat step until clean cloth shows no evidence of dirt or debris.
3. Inspect carburetor body and float bowl for cracks or other damage. Replace carburetor if either condition is observed.
4. Locate each fuel and air passageway in the carburetor body. Look for the brass or bronze beads in the casting, which point out where the cross drillings of the passageways are located.
5. Spray carburetor cleaner into the entrance of each passageway and look for the solution to exit from one or more passageways.
6. Use carburetor cleaner and compressed air to ensure that each passageway is clean and open.

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.

7. Look through the main nozzle while holding it up to the light. The bore should appear round and unobstructed. Verify that all orifices at sides are clean and open. Thoroughly clean with carburetor cleaner and compressed air.
8. Check main nozzle passageway for discoloration, dirt, and debris. Clean passageway with a soft bristle gun cleaning brush.
9. Use carburetor cleaner and compressed air to clean holes in main jet and idle jet.
10. Use compressed air to clean atmospheric vent holes and air/fuel jets embedded in the carburetor body.
11. Inspect the needle valve and seat. Check tip of needle valve for wear or grooves. Check wireform clip for damage or distortion. Replace parts as necessary.
12. Inspect float for distortion, dents, cracks, or holes. Submerge float in a glass of hot water to verify that it is water tight. Replace float if damaged or if it cannot be adequately cleaned.

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13. Spray choke shaft and valve and then wipe using a clean cloth. Inspect for damage or wear.
14. Spray throttle shaft and valve and then wipe using a clean cloth. Inspect for damage or wear.
15. Thoroughly dry all parts with compressed air.
16. Check sediment bowl O-ring and fuel filter screen for cuts, tears, or general deterioration. Clean or replace as necessary.
17. Check float bowl O-ring and gasket for cuts, tears, or general deterioration. Replace as necessary.

Assembly

1. Install fuel filter screen (P) and O-ring (O) into fuel shutoff valve. Install sediment bowl (N) and tighten to **20-25 lb-in** (2.3-2.8 N-m).
2. Slide main nozzle (L) into center passage in carburetor body. Install nozzle keeper (K) and tighten to **12-13 lb-in** (1.3-1.5 N-m) using a small flat blade screwdriver.
3. Install idle jet (M) at top of carburetor body. Tighten to **9-12 lb-in** (1.0-1.4 N-m) using a small flat blade screwdriver.
4. Install float bowl O-ring (J) into groove in carburetor body.

5. Install needle valve (**H**) and wireform clip (**I**) onto tab on float hinge. Verify that loops on wireform clip face hinge pin sleeve.
6. Place float (**E**) onto carburetor body and install hinge pin (**D**) into pedestals. Verify that float is level.

NOTE: The hinge pin is directional. Insert round end (**G**) of pin into pedestal first, and using a punch and a soft mallet, tap end of pin with flats (**F**) to install.
7. Install float bowl/main jet screw (**A**) with gasket (**B**) to fasten float bowl (**C**) to carburetor body. Tighten screw to **44-62 lb-in** (5-7 N-m).

Control Bracket/Governor Lever

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

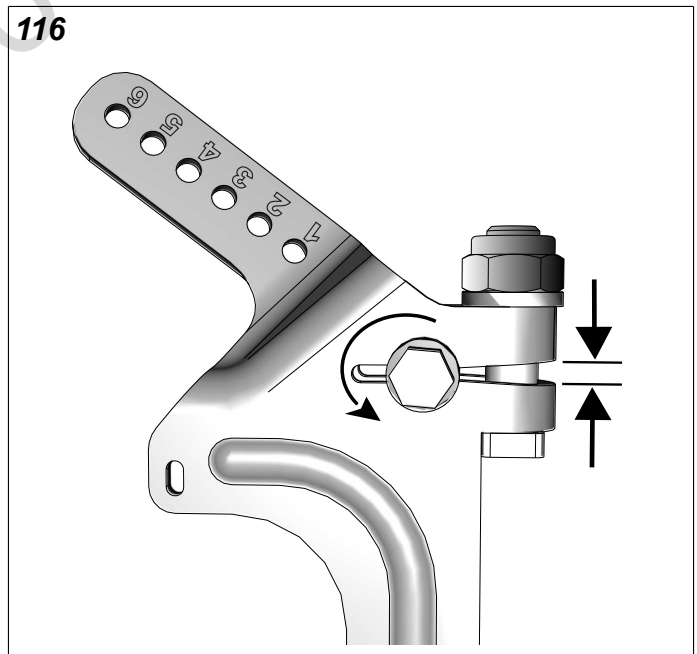
1. See Figure 117. Install hex flange screw (**A**) to fasten governor idle spring bracket (**B**) to crankcase boss. Tighten screw to **40-60 lb-in** (4.5-6.8 N-m).

NOTE: Capture armature wire (to low oil sensor module) and stator wires, if equipped, below governor idle bracket, but be sure they are not pinched as screw is tightened.
2. Install governor link into grommet (**C**) in governor lever (**D**) with the hooked end pointing down.
3. Install opposite end of governor link into hole in throttle shaft (**E**) with Z-bend end at the bottom.
4. Install governor link spring into hole (**F**) next to grommet in governor lever with the hooked end pointing down.
5. Install opposite end of governor link spring into hole in throttle shaft (**G**) with the hooked end pointing down.
6. Install governor idle spring (**H**) into slot in governor lever with the hooked end at the bottom.
7. Engage opposite end of governor idle spring in slot of idle speed adjustment tang with the hooked end at the top.
8. Install square-head screw (**I**) onto governor lever and start Nyloc nut (**J**) with flat washer (**K**).
9. Install governor lever onto governor crank (**L**), but do not tighten Nyloc nut at this time.
10. Start three hex flange screws (**M**) to fasten control bracket to crankcase. Alternately tighten screws to **80-110 lb-in** (9-12.4 N-m).

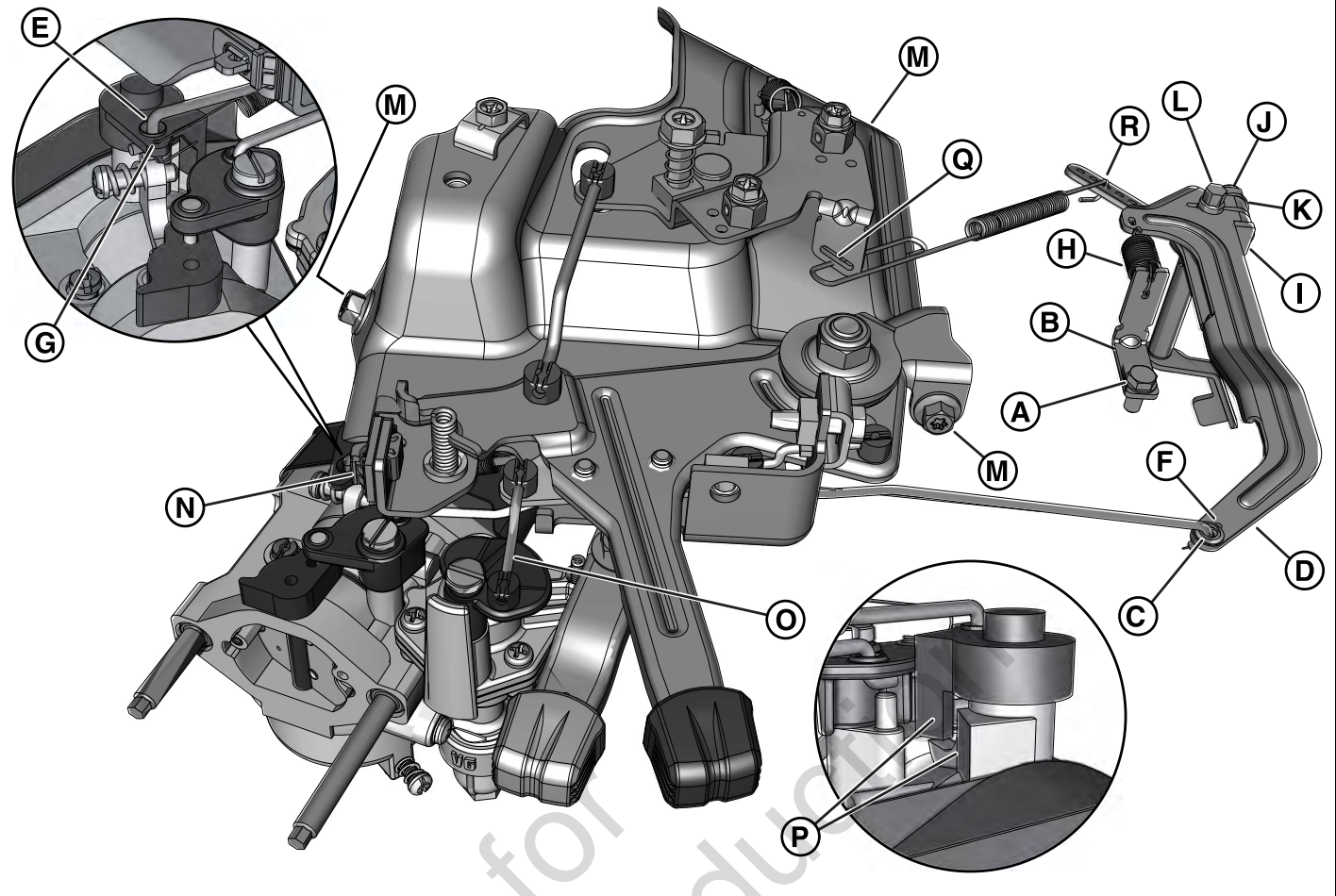
NOTE: Use the internal T25 TORX recess for best results.
11. Depress stop switch tab (**N**) on control bracket. Insert stop wire into stop switch, bend wire end back, and then release tab to secure. Place a small quantity of Multipurpose Grease over stop switch terminal to prevent corrosion.

12. Install hooked end of TransportGuard link (**O**) into connector groove on fuel shutoff cam.
13. Rotate governor lever to the Wide Open Throttle position (left towards carburetor).
14. Verify that the throttle shaft contacts the cast stop post (**P**) on the carburetor.
15. Holding governor lever to prevent movement, use a 4 mm hex socket to rotate governor crank in a counter-clockwise direction until it stops (about 1/8 turn).
16. Holding governor lever and governor crank to prevent movement, tighten Nyloc nut to **30-45 lb-in** (3.4-5.1 N-m).
17. Verify that the governor lever has not collapsed during assembly. A gap must exist after tightening as shown in Figure 116.
18. Verify that hook end of main governor spring is pointing down, and then insert trombone end under control bracket to engage slot on high speed adjustment tang (**Q**).
19. Install opposite end of main governor spring (**R**) into hole in governor lever with the hooked end pointing down.

NOTE: Use the same numbered hole from which the governor spring was removed.
20. Manually exercise governor lever. Verify that governor lever, link, and springs move freely without binding, sticking, or contacting blower housing.
21. Move the throttle lever to the High Speed position to verify that carburetor returns to Wide Open Throttle position against the cast stop post.



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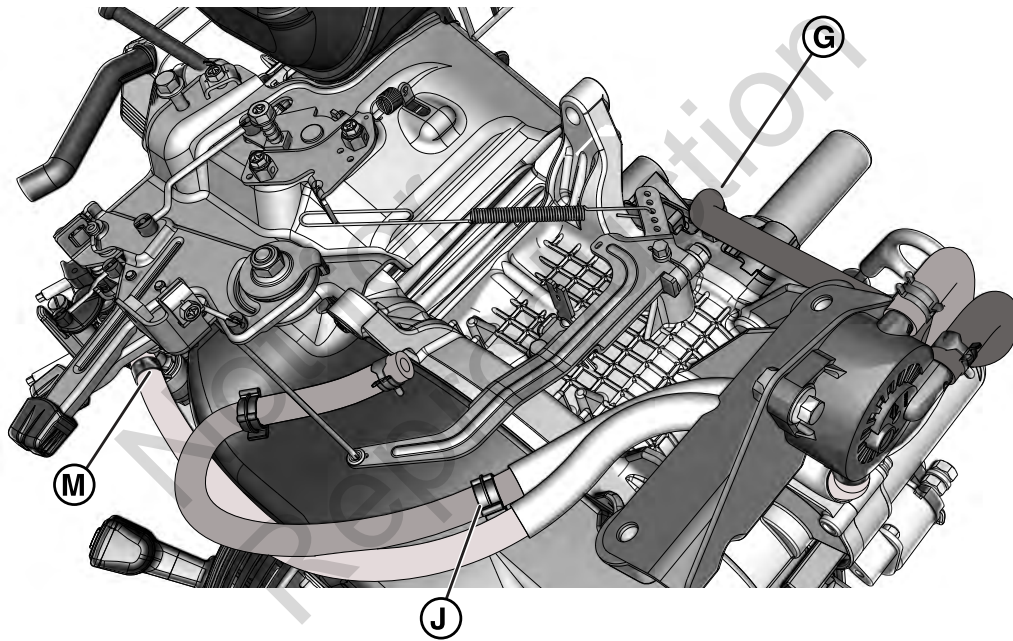
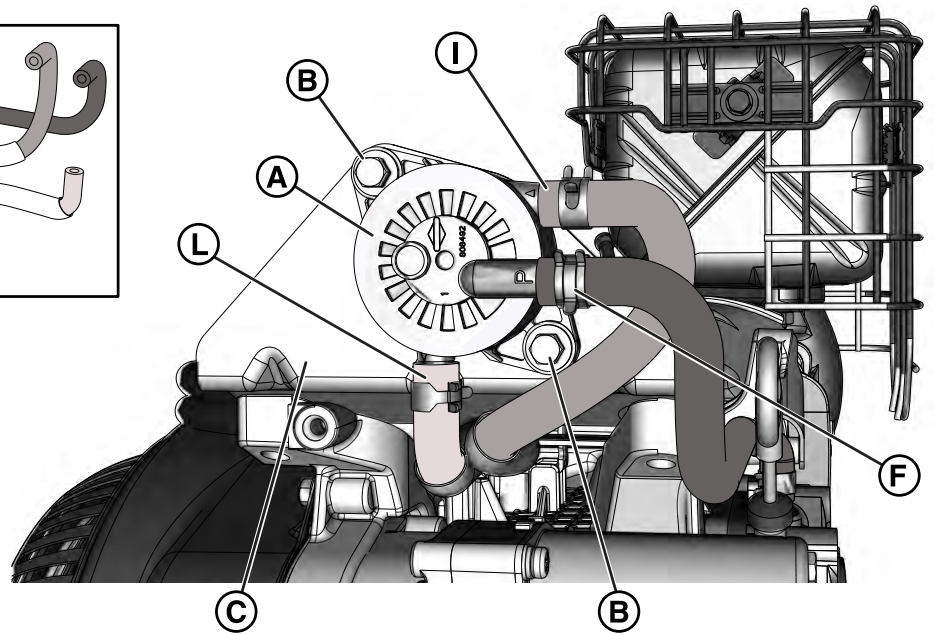
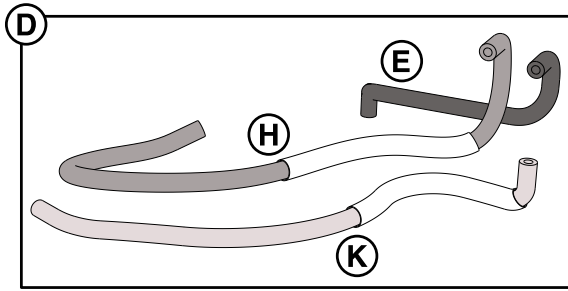
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Muffler

1. If equipped, inspect muffler deflector/spark arrester for dirt, debris, and carbon buildup. Proceed as follows:
 - A. Note orientation of muffler deflector before removal.
 - B. See Figure 118. If stamped guard (A), remove three screws (B) to release muffler deflector (C) and spark arrester (D).
 - C. If wire guard (E), remove single screw (F) to release muffler deflector/spark arrester (G).
 - D. Clean spark arrester screen with a stiff bristle brush. If carbon buildup is present, soak or spray with Carburetor Cleaner (Part No.'s 100041 or 100042). Blow dry from the inside-out with low pressure compressed air.

NOTE: Exercise care to avoid bending or puncturing screen. Replace assembly if screen cannot be adequately cleaned or if any damage is observed.
2. Remove three hex flange screws (H) to release wire guard or stamped guard from muffler (I).
3. Clean muffler 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.
4. Inspect muffler for holes, split seams, cracked welds, loose internal parts, corrosion, and other damage. Replace as necessary.
5. Inspect muffler manifold (J) and mounting flanges for cracked welds, breakage, and other damage. Replace as necessary.
6. Verify that mating surfaces of muffler manifold and cylinder head are clean and dry. Any dust or dirt left on mating surfaces can cause exhaust leaks.
7. Install **new** muffler manifold gasket (K) onto exhaust flange studs.

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8

Fuel Pump/Hoses (If Equipped)

1. See Figure 119. If removed, orient fuel pump (A) as shown and install two hex flange screws (B) to fasten fuel pump to bracket (C). Tighten screws to **35-55 lb-in** (4.0-6.2 N-m).
2. Inspect each of three preformed hoses (D) for cuts, nicks, cracks, hardness, or general deterioration. Replace hoses as necessary.
3. Install clamps onto ends of each hose, and proceed as follows:

- A. Install hose (E) to pulse pump fitting (F), if removed. Install other end to crankcase cover fitting (G).
- B. Install hose (H) to fuel pump fuel inlet fitting (I), if removed. Capture hose in clip (J) anchored in hole of blower housing. Verify that clip opening faces away from governor lever. Replace clip if damaged or missing.
- C. Install hose (K) to fuel pump fuel outlet fitting (L), if removed. Connect other end to carburetor fuel inlet fitting (M).

NOTE: After hose installation, squeeze tangs and move each clamp about 1/8 inch (3 mm) from end of hose.

Fuel Tank

1. Inspect the fuel tank for damage and corrosion. Replace as necessary.
2. Remove fuel cap, if installed.
3. Remove filler neck filter, if equipped. Replace filter if damaged or if it cannot be adequately cleaned.
4. Check fuel cap and filler neck for proper seals and vents.
5. 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).
6. 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.
7. Install filler neck filter and fuel cap.
8. See Figure 120. Inspect in-tank fuel filter as follows:
 - A. Using hex, remove fuel filter fitting (A) from fuel tank.

- B. Unthread fuel filter (B) and remove O-ring (C) from fuel filter fitting.
 - C. Inspect fuel filter for dirt and debris. Clean or replace as necessary.
 - D. Inspect O-ring for cuts, tears, or general deterioration. Replace if necessary.
 - E. Install O-ring onto fuel filter fitting. Verify O-ring is fully seated in groove.
 - F. Thread fuel filter into fuel filter fitting.
 - G. Install fuel filter fitting into fuel tank (D). Tighten fitting to **62-71 lb-in** (7-8 N-m).
9. Inspect two rubber isolation mounts (E) for cuts, tears, or general deterioration. Replace if necessary. Install isolation mounts onto crankcase flanges.
 10. Place fuel tank onto engine, so that studs engage fuel pump bracket (if equipped), isolation mounts, and crankcase flanges.
 11. Install hose (F1 or F2) with clamp (G) onto in-tank fuel filter fitting. Squeeze tangs and move clamp about **1/8 inch** (3 mm) from end of hose with tangs pointing down for best access.

NOTE: Hose (F2) is only used on models equipped with the optional fuel pump.

12. Capture hose in clip (H) anchored in hole of blower housing. Replace clip if damaged or missing. Verify that hose does not contact governor link or governor link spring.
13. Hand start two hex flange screws (I) to fasten fuel tank to crankcase flanges. Tighten screws to **144-174 lb-in** (16.3-19.7 N-m).
14. Install two hex flange nuts (J) onto fuel tank studs. Alternately tighten nuts to **144-174 lb-in** (16.3-19.7 N-m).
15. If equipped, connect wire harness connector to key switch. Install two hex flange screws (K) to fasten key switch panel (L) to crankcase. Alternately tighten screws to **80-110 lb-in** (9-12.4 N-m).
16. Manually exercise governor lever. Verify that governor lever, link, and springs move freely without binding, sticking, or contacting fuel tank.

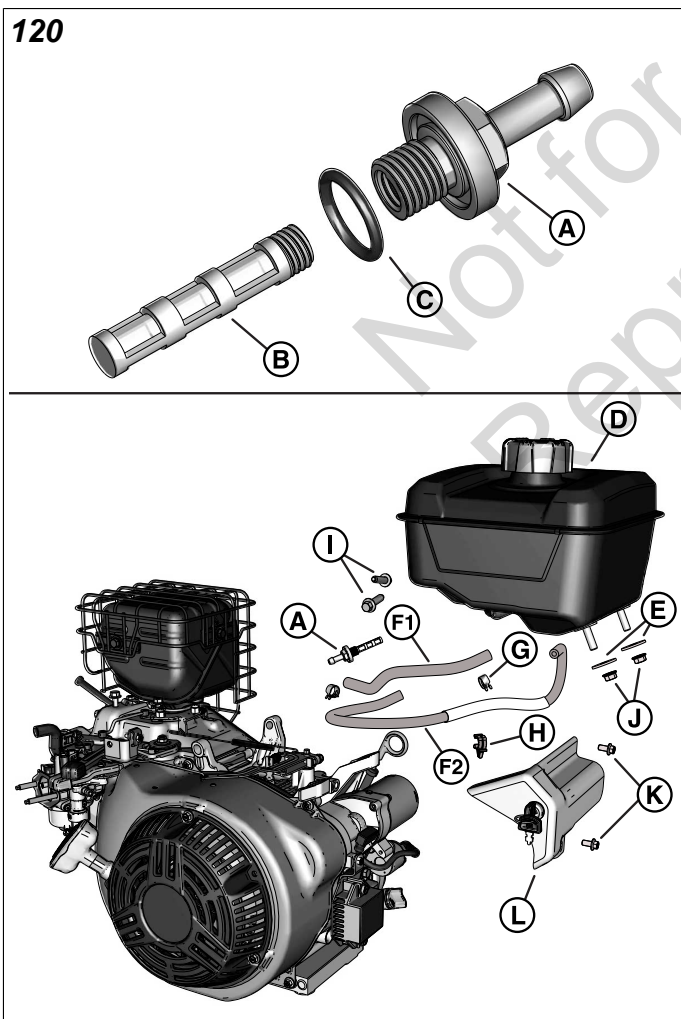
Air Cleaner

1. Wash air cleaner cover, air cleaner base, and duckbill air valve in warm, soapy water, or use a soft bristle brush and a portable hand vacuum to remove all dust and dirt.
2. See Figure 121. Hang gasket (A) on two pins next to mounting flange of air cleaner base, so that tab on gasket is at the bottom with the white lettering facing outside.

NOTE: Improper gasket installation will block the carburetor float bowl vent. The engine will not run if

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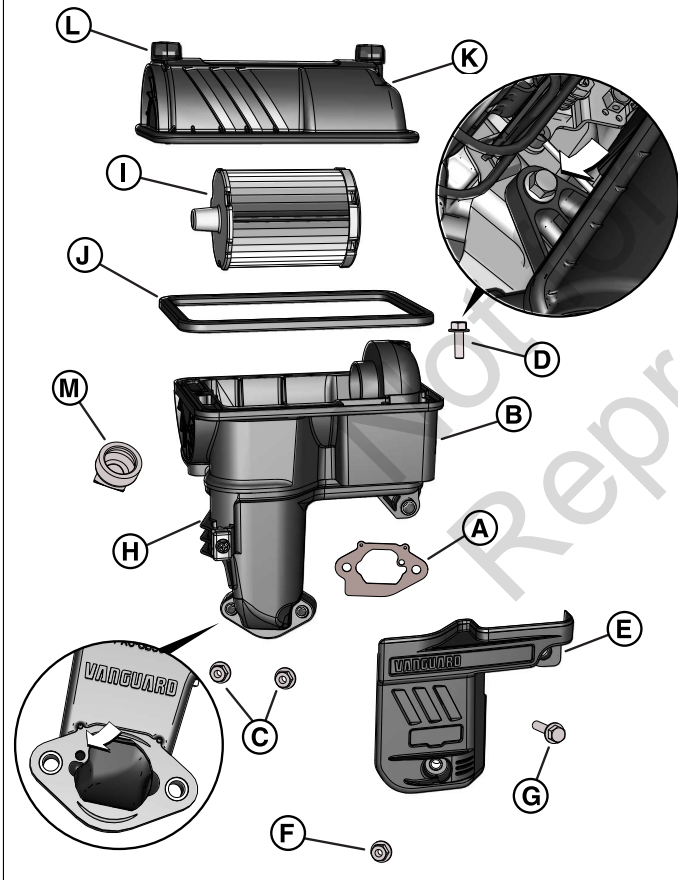
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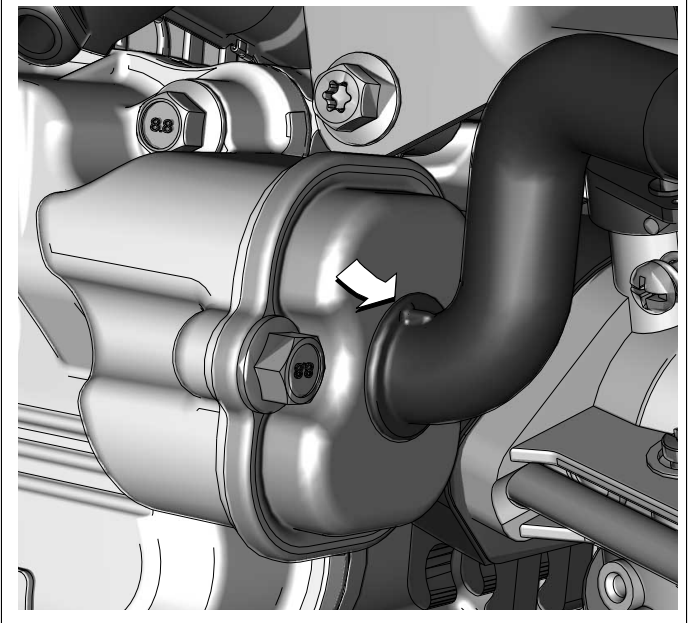
the float bowl vent is blocked. See bottom inset of Figure 121.

3. Install air cleaner base (B) onto carburetor mounting studs.
4. Install two hex flange nuts (C) onto carburetor mounting studs. Tighten nuts to **30-50 lb-in** (3.4-5.7 N-m).
5. Install hex flange screw (D) to fasten air cleaner base to control bracket. Tighten screw to **80-110 lb-in** (9-12.4 N-m).
6. Install trim panel (E) onto inside carburetor mounting stud. Start hex flange nut (F) onto stud.
7. Install hex flange screw (G) to fasten trim panel and air cleaner base to control bracket. Tighten screw to **40-60 lb-in** (4.5-6.8 N-m).
8. Tighten hex flange nut on inside carburetor mounting stud to **25-35 lb-in** (2.8-4 N-m).

121



122

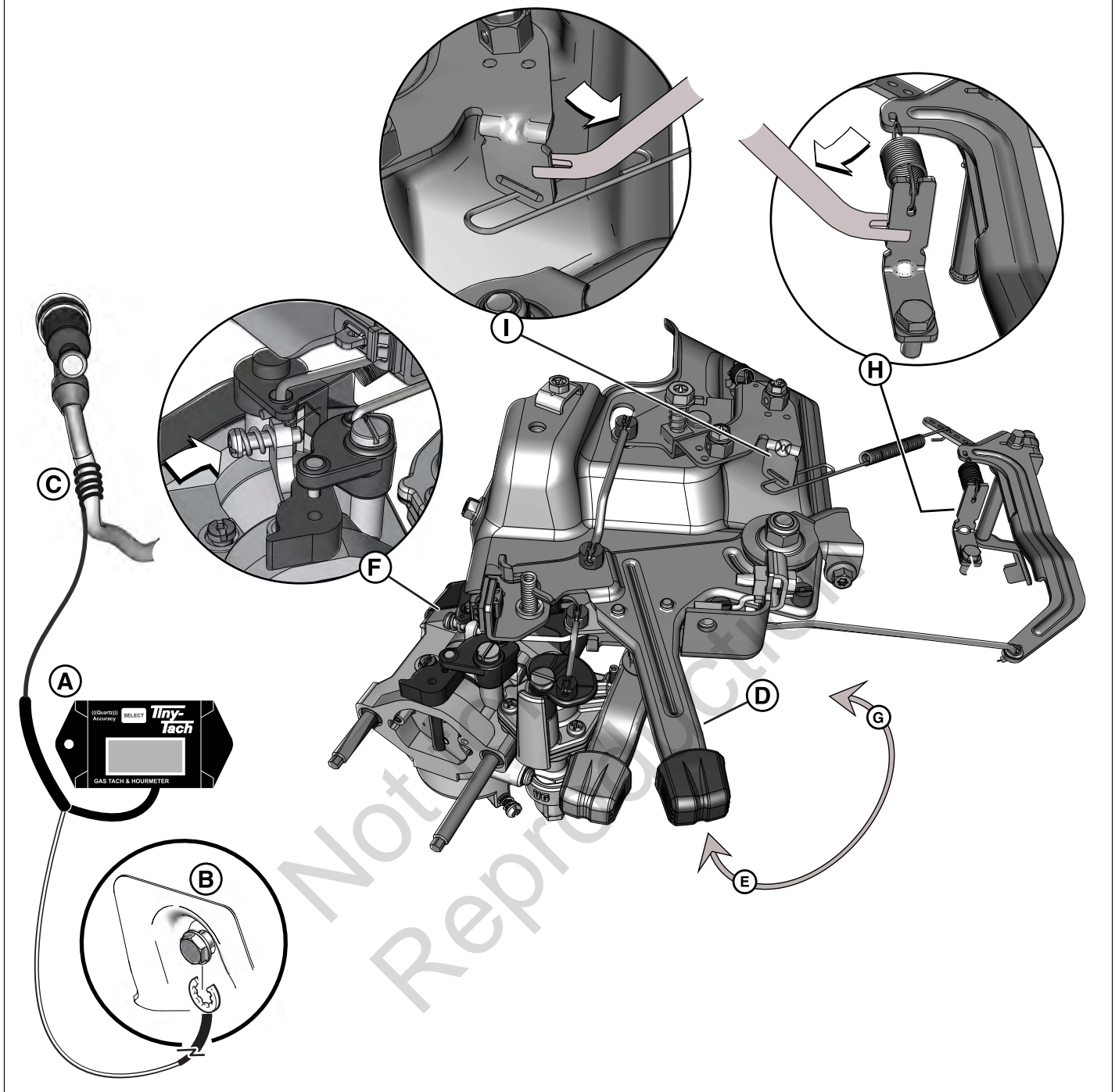


9. Install breather hose to port (H) on air cleaner base. Verify that tab on valve cover side of breather hose is at the top as shown in Figure 122.
10. Gently tap air filter cartridge (I) on a hard surface to loosen dirt and debris.

NOTE: Use of pressurized air or solvents will damage air filter cartridge.

11. Carefully inspect air filter cartridge. Replace if any damage is observed.
12. Inspect quad seal (J) for cuts, tears, holes, or general deterioration. Replace if necessary.
13. Install air filter cartridge into air cleaner base.
14. Install air cleaner cover (K) onto air cleaner base. Alternately tighten two thumbscrews (L) until snug, but do not over-tighten.
15. Inspect duckbill air valve (M) on air inlet port of air cleaner base. Look for cuts, tears, holes, or general deterioration. Replace duckbill air valve if damaged or missing.

IMPORTANT NOTE: Engine operation without the duckbill air valve can reduce filter efficiency by as much as 50 percent.



Final Instructions

1. Install oil drain plug(s) with sealing washer(s) and tighten to **140-200 lb-in** (15.8-22.6 N-m).
2. Add engine oil. See *SECTION 2 - MAINTENANCE, CHANGE ENGINE OIL/CHECK ENGINE OIL LEVEL*, steps 7-15.
3. Fill fuel tank with fresh gasoline.
4. Install spark plug wire onto spark plug terminal.
5. Start and run engine. Check for oil and fuel leaks while engine is running.

Set Idle and Top No-Load Speeds

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 123. 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. Set throttle control lever (D) to FAST (E) and start engine.
- 4. Adjust dead idle screw (F) to set dead idle speed to 1000 +/- 100 RPM.
- 5. Set throttle control lever to IDLE (G).
- 6. Obtain Tang Adjusting Tool (Part No. 19480).
- 7. Bend idle speed adjustment tang (H) to set idle speed to 1450 +/- 100 RPM.

NOTE: Do not twist or rotate tang. Only bend in same plane as spring acts.

- 8. Move throttle control lever to FAST.
- 9. Bend high speed adjustment tang (I) on control bracket to set top no-load speed value obtained in step 1.
- 10. Stop engine and remove Digital Tachometer and Hour Meter.

Remote Control

Remove the air cleaner. See SECTION 4 - REMOVE EXTERNAL ASSEMBLIES, AIR CLEANER.

Braided Wire Cable

NOTE: The braided wire cable is installed in one of two directions.

Cylinder Head

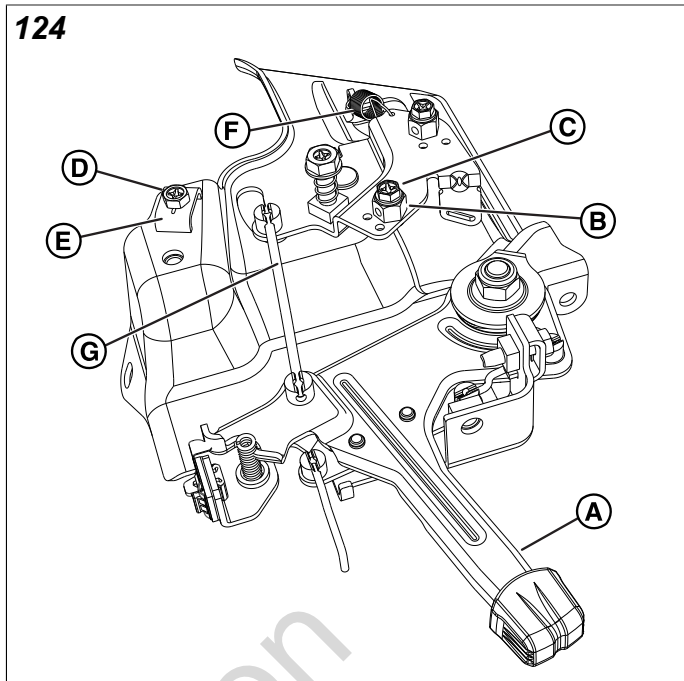
- 1. See Figure 124. Move the throttle control lever (A) to the FAST position.
- 2. Hold the cable mounting nut (B) and loosen Phillips screw (C). Rotate nut to accept cable wire.
- 3. Insert the cable wire through the hole in cable mounting nut, so that it does not extend more than **1/2 inches** (12.7 mm) past the exit hole.
- 4. Hold the cable mounting nut and tighten Phillips screw.
- 5. Loosen hex screw (D) and capture cable sheath in casing clamp (E). Tighten screw.

NOTE: Use the internal T25 TORX recess for best results.

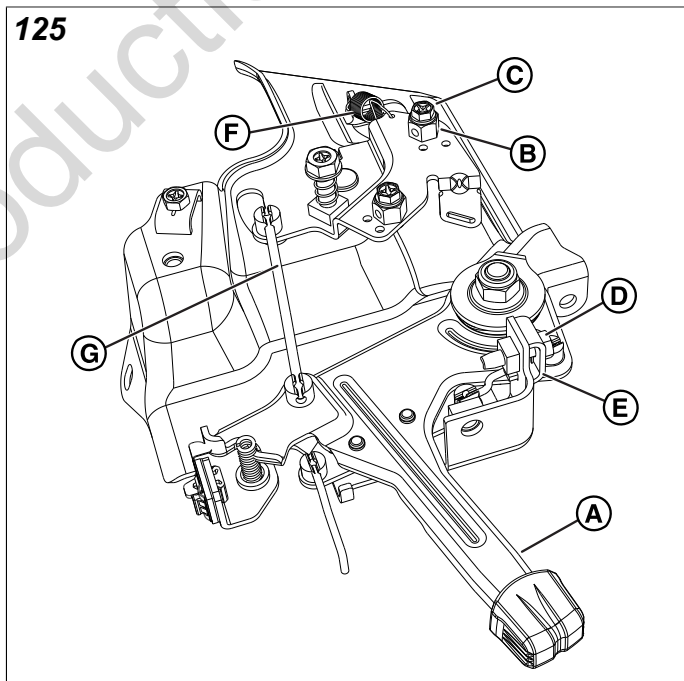
- 6. Verify that return spring (F) is installed.
- 7. Remove the control link (G), if present.

- 8. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.
- 9. Install air cleaner. See AIR CLEANER in this section.

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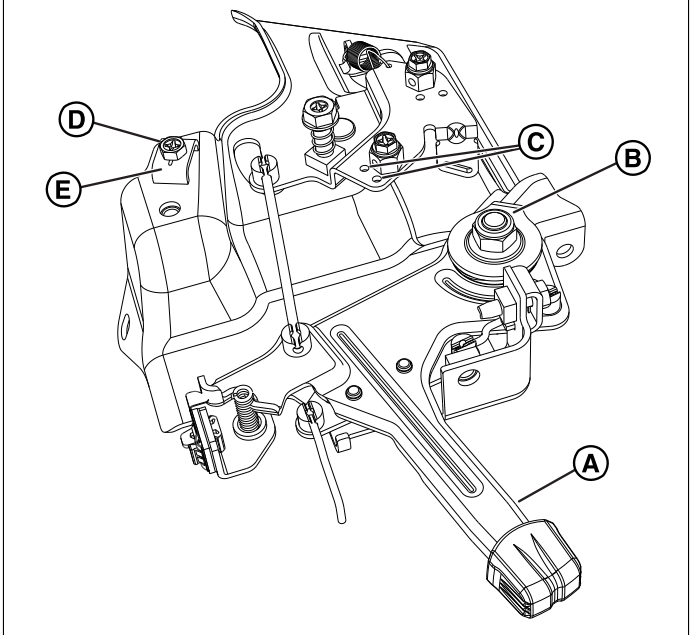
125



Front

1. See Figure 125. Move the throttle control lever (A) to the FAST position.
2. Hold the cable mounting nut (B) and loosen Phillips screw (C). Rotate nut to accept cable wire.
3. Insert the cable wire through the hole in cable mounting nut, so that it does not extend more than **1/2 inches** (12.7 mm) past the exit hole.
4. Hold the cable mounting nut and tighten Phillips screw.
5. Loosen hex screw (D) and capture cable sheath in casing clamp (E). Tighten screw.
6. Verify that return spring (F) is installed.
7. Remove the control link (G), if present.
8. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.
9. Install air cleaner. See *AIR CLEANER* in this section.

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Solid Wire Cable

NOTE: The solid wire cable is installed in one of four directions.

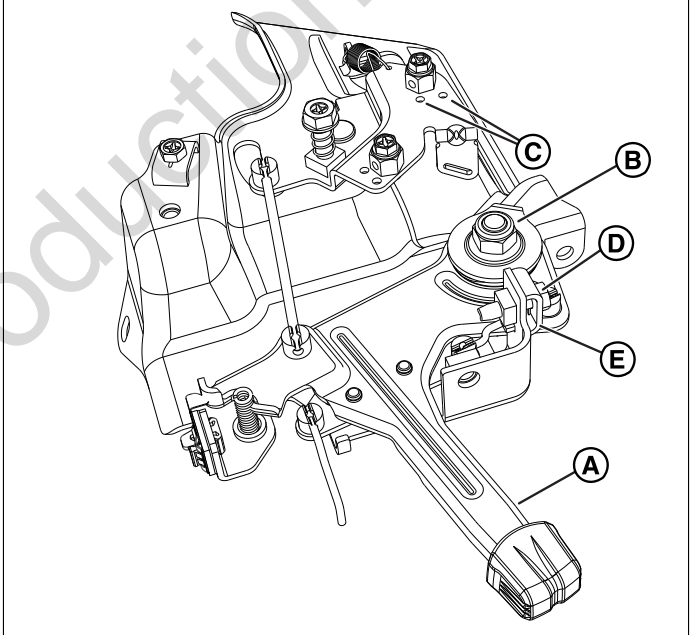
Cylinder Head

1. See Figure 126. Move the throttle control lever (A) to the FAST position.
2. Verify that nut (B) on throttle control lever is loose (1/2 turn from tightened position).
3. Install Z-fitting of cable into either hole (C) in bellcrank.
4. Loosen hex screw (D) and capture cable sheath in casing clamp (E). Tighten screw.

NOTE: Use the internal T25 TORX recess for best results.

5. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.
6. Install air cleaner. See *AIR CLEANER* in this section.

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Front

1. See Figure 127. Move the throttle control lever (A) to the FAST position.
2. Verify that nut (B) on throttle control lever is loose (1/2 turn from tightened position).
3. Install Z-fitting of cable into either hole (C) in bellcrank.
4. Loosen hex screw (D) and capture cable sheath in casing clamp (E). Tighten screw.

5. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.
6. Install air cleaner. See *AIR CLEANER* in this section.

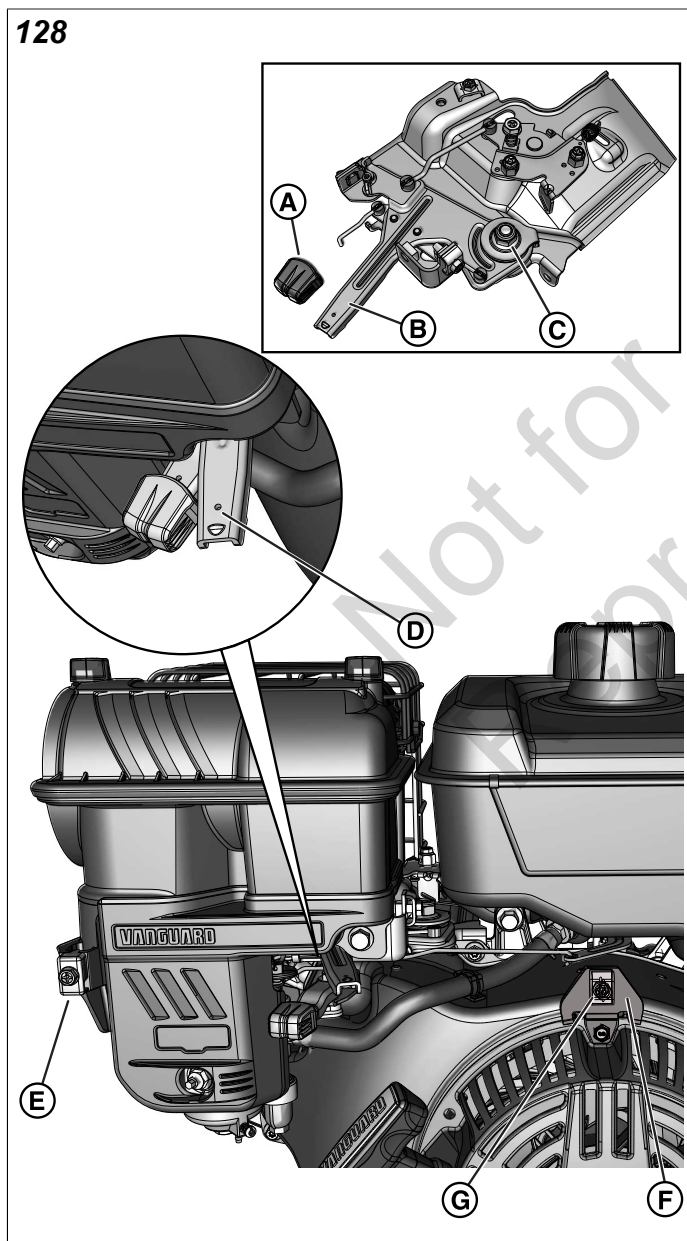
Left

1. See Figure 128. Remove black knob (A) from throttle control lever, if installed. For best results, tap knob from behind using a flat punch and soft mallet.
2. Move the throttle control lever (B) to the FAST position.
3. Verify that nut (C) is loose (1/2 turn from tightened position).

4. Install air cleaner. See *AIR CLEANER* in this section.
5. Install Z-fitting of cable into hole in throttle control lever (D).
6. Loosen hex screw (E) on air cleaner elbow. Capture cable sheath in casing clamp. Tighten screw.
7. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.

Right

1. See Figure 128. Remove black knob (A) from throttle control lever, if installed. For best results, tap knob from behind using a flat punch and soft mallet.
2. Move the throttle control lever (B) to the FAST position.

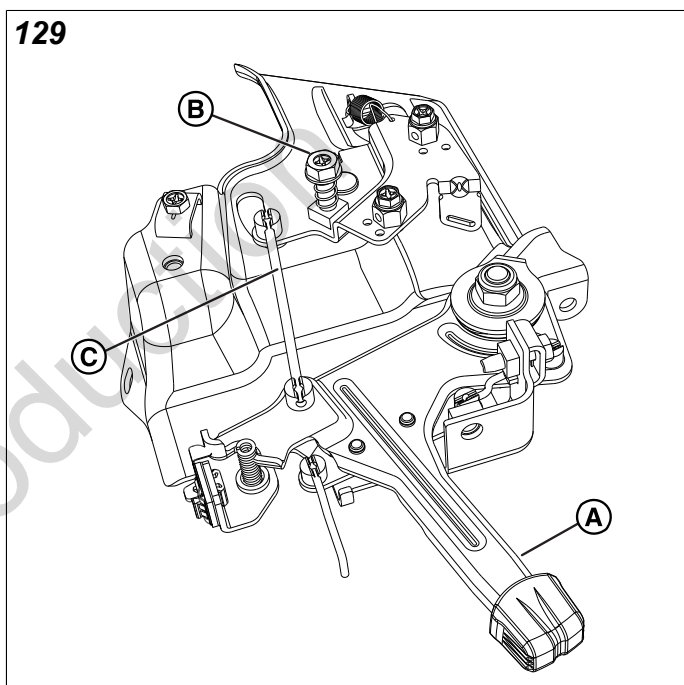


3. Verify that nut (C) is loose (1/2 turn from tightened position).
4. Install air cleaner. See *AIR CLEANER* in this section.

5. Remove top hex flange screw on rewind starter. Install screw capturing casing clamp bracket (F). Tighten screw to **25-35 lb-in** (2.8-4 N-m).
6. Install Z-fitting of cable into hole in throttle control lever (D).
7. Loosen hex screw (G). Capture cable sheath in casing clamp. Tighten screw.
8. Exercise the throttle control lever to verify that lever and cable move freely without sticking or binding.

Fixed Speed Control (No Wire Cable)

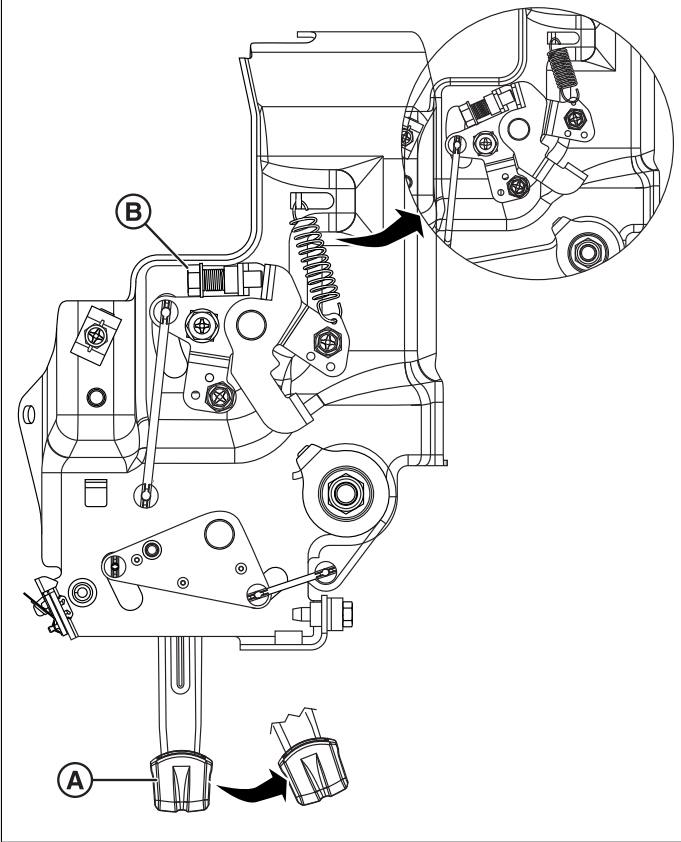
1. See Figure 129. Move the throttle control lever (A) to the FAST position.
2. Tighten screw (B) on bellcrank to **25 lb-in** (2.8 N-m).
3. Remove the control link (C), if installed.



Speed Adjustment Screw

1. Start the engine before you change the speed-adjustment screw.
2. See Figure 130. Move the throttle control lever (A) to the FAST position (Rabbit icon).
3. Use a Philips screwdriver to turn the speed-adjustment screw (B) clockwise to increase the engine-operating speed (this opens up the throttle speed) between the range of 2600 – 4200 RPM. To decrease the engine operating speed, turn the speed-adjustment screw counterclockwise.

Note: The adjustment affects the highest RPM that the engine can achieve.



4. Use a handheld Tachometer (or equipment display, if installed) to make sure you have the necessary RPM adjustment (between 2600 – 4200 RPM).

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SECTION 9 – SPECIFICATIONS

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SPECIFICATIONS

Engine Specifications

ENGINE	
Bore - 19V3	3.150 in (80 mm)
Bore - 25V3	3.465 in (88 mm)
Stroke - 19V3	2.402 in (61 mm)
Stroke - 25V3	2.638 in (67 mm)
Displacement - 19V3	18.734 ci (307 cc)
Displacement - 25V3	24.898 ci (408 cc)
Compression Ratio	8.4:1
Crankshaft End Play	0.01-0.019 in (0.25-0.48 mm)
Crankshaft End Play (Pump Applications)	0.005-0.012 in (0.12-0.30 mm)
Oil Capacity - 19V3	26-30 oz (770-890 ml)
Oil Capacity - 25V3	28-32 oz (830-950 ml)
Fuel Tank Capacity - 19V3	1.26 qt (4.78 L)
Fuel Tank Capacity - 25V3	1.61 qt (6.1 L)
Ignition Timing	Variable
Armature Air Gap	0.010-0.014 in (0.25-0.35 mm)
Spark Plug Gap	0.030 in (0.76 mm)
Valve Clearance - Intake	0.004-0.006 in (0.10-0.15 mm)
Valve Clearance - Exhaust	0.006-0.008 in (0.15-0.20 mm)
Crankcase MAG Bearing Oil Seal Depth	0.049-0.069 in (1.25-1.75 mm)
Crankcase Cover PTO Bearing Oil Seal Depth	0.177-0.197 in (4.5-5.0 mm)

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Torque Specifications

FASTENER	TORQUE
Air Cleaner Base Nut	30-50 lb-in (3.4-5.7 N-m)
Air Cleaner Trim Panel Nut	25-35 lb-in (2.8-4 N-m)
Air Cleaner Base/Trim Panel Screw	40-60 lb-in (4.5-6.8 N-m)
Air Cleaner Base Control Bracket Screw	80-110 lb-in (9-12.4 N-m)
Armature Screw	20-35 lb-in (2.3-4 N-m)
Blower Housing Screw	80-110 lb-in (9-12.4 N-m)
Breather Cover Screw	53-62 lb-in (6-7 N-m)
Breather Valve Screw	25-35 lb-in (2.8-4 N-m)
Carburetor Float Bowl Drain Screw	8-12 lb-in (0.9-1.3 N-m)
Carburetor Float Bowl/Main Jet Screw	44-62 lb-in (5-7 N-m)
Carburetor Main Nozzle Keeper	12-13 lb-in (1.3-1.5 N-m)
Carburetor Idle Jet	9-12 lb-in (1.0-1.4 N-m)
Carburetor Sediment Bowl	20-25 lb-in (2.3-2.8 N-m)
Carburetor Choke Lever Crank Screw	6-11 lb-in (0.7-1.2 N-m)
Carburetor Choke Lever Screw	lb-in (5.3-6 N-m)
Carburetor Throttle Valve Screw	6-9 lb-in (0.7-1.0 N-m)
Carburetor Stud	70-90 lb-in (7.9-10.2 N-m)
Connecting Rod Cap Screw	90-110 lb-in (10.2-12.4 N-m)
Control Bracket Screw	80-110 lb-in (9-12.4 N-m)
Crankcase Cover Screw *	250-270 lb-in (28.2-30.5 N-m)
Cylinder Head Screw *	250-270 lb-in (28.2-30.5 N-m)

FASTENER	TORQUE
Cylinder Head Heat Shield Screw	40-60 lb-in (4.5-6.8 N-m)
Flywheel Nut	105-115 lb-ft (142.4-155.9 N-m)
Fuel Pump (Optional) Screw	35-55 lb-in (4.0-6.2 N-m)
Fuel Tank Screw	144-174 lb-in (16.3-19.7 N-m)
Fuel Tank Nut	144-174 lb-in (16.3-19.7 N-m)
Fuel Tank Fuel Filter Fitting	62-71 lb-in (7-8 N-m)
Control Bracket Screw	80-110 lb-in (9-12.4 N-m)
Governor Lever Nut (Nyloc)	30-45 lb-in (3.4-5.1 N-m)
Governor Idle Bracket Screw	40-60 lb-in (4.5-6.8 N-m)
Key Switch Panel Screw	80-110 lb-in (9-12.4 N-m)
Low Oil Sensor Module Screw	30-80 lb-in (3.4-9 N-m)
Low Oil Sensor Module Screw (With Regulator Bracket)	80-110 lb-in (9-12.4 N-m)
Low Oil Sensor Screw	50-70 lb-in (5.7-7.9 N-m)
Low Oil Sensor Nut	30-50 lb-in (3.4-5.7 N-m)
Muffler Stud	40-60 lb-in (4.5-6.8 N-m)
Muffler Manifold to Exhaust Flange Stud Nut *	195-230 lb-in (22-26 N-m)
Muffler Manifold to Muffler Stud Nut	177-221 lb-in (20-25 N-m)
Muffler Stamped Guard Screw	146-177 lb-in (16.5-20 N-m)
Muffler Stamped Guard Muffler Deflector/Spark Arrester Screw	25-35 lb-in (2.8-4 N-m)
Muffler Wire Guard Screw	146-177 lb-in (16.5-20 N-m)
Muffler Wire Guard Muffler Deflector/Spark Arrester Screw	8-12 lb-in (0.9-1.4 N-m)
Oil Drain Plug	140-200 lb-in (15.8-22.6 N-m)
Dipstick Oil Plug (Crankcase Cover)	10-30 lb-in (1.1-3.4 N-m)
Oil Fill Cap (Valve Cover)	10-30 lb-in (1.1-3.4 N-m)
Regulator Bracket Screw	80-110 lb-in (9-12.4 N-m)
Regulator Screw	60-80 lb-in (6.8-9 N-m)
Rewind Starter Screw	25-35 lb-in (2.8-4 N-m)
Rocker Arm Stud	230-250 lb-in (26-28.3 N-m)
Rocker Ball Set Screw	60-80 lb-in (6.8-9 N-m)
Spark Plug	140-200 lb-in (15.8-22.6 N-m)
Stator Screw	15-25 lb-in (1.7-2.8 N-m)
Starter Motor Screw	160-210 lb-in (18-24 N-m)
Starter Solenoid Post Nut	30-40 lb-in (3.4-4.5 N-m)
Valve Cover Screw	70-90 lb-in (7.9-10.2 N-m)

* Use step torque procedure per instructions.

Standard/Reject Sizes

ITEM	STANDARD SIZE	REJECT SIZE
CRANKCASE/CYLINDER		
Camshaft Bearing Bore Diameter	0.631 in (16.034 mm)	0.634 in (16.093 mm) or more
Cylinder Bore Out-Of-Round	0.0003 in (0.008 mm)	0.0015 in (0.04 mm) or more
Cylinder Bore Diameter - 19V3	3.150 in (80 mm)	3.153 in (80.0876 mm) or more
Cylinder Bore Diameter - 25V3	3.465 in (88 mm)	3.468 in (88.0876 mm) or more
CYLINDER HEAD		
Intake		
Valve Seat Angle	44.875°	

ITEM	STANDARD SIZE	REJECT SIZE
Valve Seat Width	0.018 in (0.45 mm)	
Valve Stem Diameter	0.259 in (6.5725 mm)	0.253 in (6.415 mm) or less
Valve Guide Bore Diameter	0.260 in (6.6075 mm)	0.264 in (6.695 mm) or more
Exhaust		
Valve Seat Angle	44.875°	
Valve Seat Width	0.018 in (0.45 mm)	
Valve Stem Diameter	0.258 in (6.5525 mm)	0.252 in (6.395 mm) or less
Valve Guide Bore Diameter	0.260 in (6.6075 mm)	0.264 in (6.695 mm) or more
CRANKCASE COVER		
Camshaft Bearing Bore Diameter	0.631 in (16.034 mm)	0.634 in (16.093 mm) or more
CRANKSHAFT		
Crank Pin Journal Diameter - 19V3	1.259 in (31.983 mm)	1.257 in (31.926 mm) or less
Crank Pin Journal Diameter - 25V3	33.983 in (33.983 mm)	1.336 in (33.926 mm) or less
MAG Bearing Journal Diameter	1.377 in (34.978 mm)	1.375 in (34.921 mm) or less
PTO Bearing Journal Diameter	1.377 in (34.978 mm)	1.375 in (34.921 mm) or less
CAMSHAFT		
MAG Bearing Journal Diameter	0.630 in (16.0 mm)	0.628 in (15.941 mm) or less
PTO Bearing Journal Diameter	0.630 in (16.0 mm)	0.628 in (15.941 mm) or less
BALANCER		
MAG Bearing Journal Diameter	0.589 in (14.973 mm) or less	0.587 in (14.923 mm) or less
PTO Bearing Journal Diameter	0.589 in (14.973 mm) or less	0.587 in (14.923 mm) or less
CONNECTING ROD		
Crank Pin Bearing Bore Diameter - 19V3	1.261 in (32.024 mm)	1.263 in (32.081 mm) or more
Crank Pin Bearing Bore Diameter - 25V3	1.340 in (34.024 mm)	1.342 in (34.081 mm)
Piston Pin Bearing Bore Diameter - 19V3	0.690 in (17.516 mm)	0.692 in (17.573 mm) or more
Piston Pin Bearing Bore Diameter - 25V3	0.788 in (20.016 mm)	0.790 in (20.073 mm) or more
PISTON		
Piston Pin Diameter - 19V3	0.689 in (17.5 mm)	0.688 in (17.467 mm) or less
Piston Pin Diameter - 25V3	0.787 in (20.0 mm)	0.786 in (19.967 mm) or less
Piston Pin Bore Diameter - 19V3	0.690 in (17.52 mm)	0.692 in (17.576 mm) or more
Piston Pin Bore Diameter - 25V3	0.788 in (20.02 mm)	0.790 in (20.076 mm) or more
Top Compression Ring End Gap	0.006 in (0.15 mm)	0.039 in (0.99 mm) or more
Middle Oil Wiper Ring End Gap	0.032 in (0.80 mm)	0.065 in (1.66 mm) or more
Bottom Oil Control Ring End Gap	0.030 in (0.75 mm)	0.074 in (1.89 mm) or more
Top Compression Ring Side Clearance **	0.002 in (0.05 mm)	0.010 in (0.25 mm) or more

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

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