



**Residential Products**

# **TORO® Twin Cylinder Engine Service Manual**



**Issued: February 2017**

# ABOUT THIS MANUAL

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This service manual was written expressly for Toro® service technicians. The Toro Company has made every effort to make the information in this manual complete and correct.

Basic shop safety knowledge and mechanical/electrical skills are assumed. The Table of Contents lists the systems and the related topics covered in this manual.

We are hopeful that you will find this manual a valuable addition to your service shop. If you have any questions or comments regarding this manual, please contact us at the following address:

**The Toro Company**  
**Residential and Landscape Contractor Service Training Department**  
**8111 Lyndale Avenue South**  
**Bloomington, MN 55420**

The Toro Company reserves the right to change product specifications or make changes to this manual without notice.

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# GENERAL SERVICE INFORMATION

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# GENERAL SERVICE INFORMATION

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This symbol means **WARNING or PERSONAL SAFETY INSTRUCTION** – read the instruction because it has to do with your safety. Failure to comply with the instruction may result in personal injury or even death.

This manual is intended as a service and repair manual only. The safety instructions provided herein are for troubleshooting, service, and repair of the Toro Twin Cylinder Engine.

The Toro product operator's manual contains safety information and operating tips for safe operating practices. Operator manuals are available online or through your Toro parts source:

**The Toro Company**  
**8111 Lyndale Avenue South**  
**Bloomington, MN 55420**

## **Think Safety First**

### **Avoid unexpected starting of engine...**

Always turn off the engine and disconnect the spark plug wire(s) before cleaning, adjusting, or repair.

### **Avoid lacerations and amputations...**

Stay clear of all moving parts whenever the engine is running. Treat all normally moving parts as if they were moving whenever the engine is running or has the potential to start.

### **Avoid burns...**

Do not touch the engine, muffler, or other components, which may increase in temperature during operation, while the unit is running or shortly after it has been running.

### **Avoid fires and explosions...**

Avoid spilling fuel and never smoke while working with any type of fuel or lubricant. Wipe up any spilled fuel or oil immediately. Never remove the fuel cap or add fuel when the engine is running. Always use approved, labeled containers for storing or transporting fuel and lubricants.

### **Avoid asphyxiation...**

Never operate an engine in a confined area without proper ventilation.

### **Avoid injury from batteries...**

Battery acid is poisonous and can cause burns. Avoid contact with skin, eyes and clothing. Battery gases can explode. Keep cigarettes, sparks and flames away from the battery.

### **Avoid injury due to inferior parts...**

Use only original equipment parts to ensure that important safety criteria are met.

### **Avoid injury to bystanders...**

Always clear the area of bystanders before starting or testing powered equipment.

### **Avoid injury due to projectiles...**

Always clear the area of sticks, rocks or any other debris that could be picked up and thrown by the powered equipment.

### **Avoid modifications...**

Never alter or modify any part unless it is a factory approved procedure.

### **Avoid unsafe operation...**

Always test the safety interlock system after making adjustments or repairs on the machine.

# GENERAL SERVICE INFORMATION

## Service Reminders:

1. Only use genuine Toro parts and lubrication products.
2. Always install new gaskets, o-rings and seals when reassembling.
3. Always torque fasteners to specification and follow recommended sequences.
4. Always lubricate friction components with clean engine oil or engine assembly lube when assembling the engine.

## Engine Model/Serial Number Location

The engine model and serial numbers are engraved into the crankcase (Figure 1). At the time of production, there is a disposable paper tag located on the blower shroud, above the emission label.

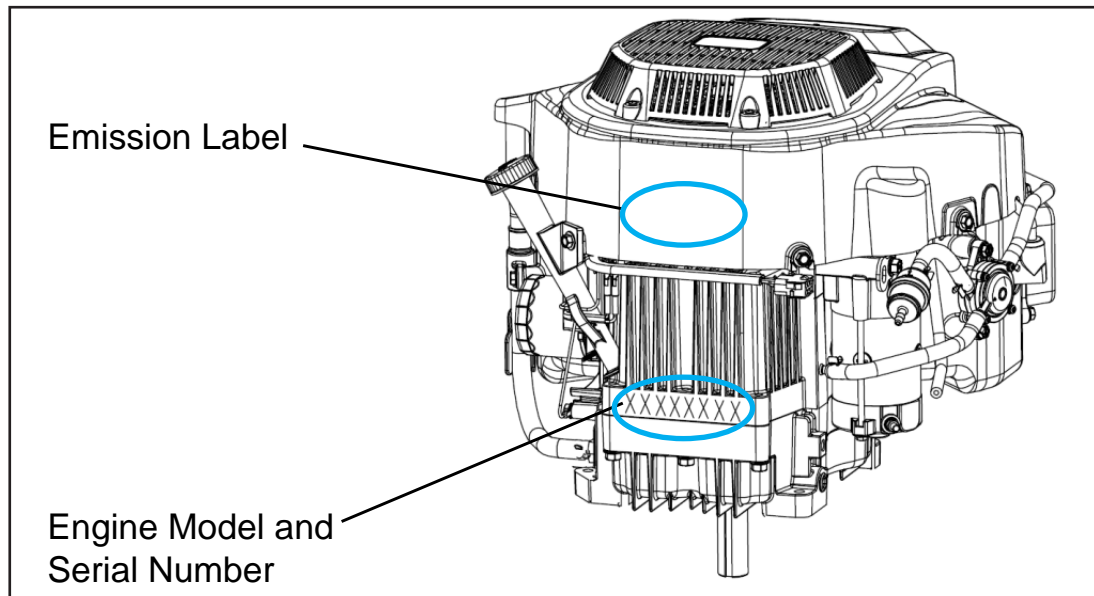


Figure 1

Example of engine model and serial number:

**127-XXXX**

Engine Model Number

**XXXXXXXXXXXXXX**

Engine Serial Number

**Top Row:** The seven digit number is the engine model number formatted three digits, a hyphen, then four digits.

**Bottom Row:** The 12 digits are the engine serial number, first four digits are the date of the engine manufacturer, two digit year, two digit month.

# GENERAL SERVICE INFORMATION

## Specifications

Engine General Specifications	
Engine Name	2P77F
Type	V-Twin Cylinder, 4-Stroke, Forced Air Cooling, OHV
Bore X Stroke	77 x 76 mm
Displacement	708 cc
Compression Ratio	8.7:1
Lubrication	Oil Pump with Oil Filter
Starting	Electric
Rotation	Counter Clockwise (from P.T.O. side)
Ignition System	Transistorized Magneto Ignition
Air Cleaner	Paper with Foam Wrap
Fuel Type	Unleaded Gasoline, 87 Octane
Oil Capacity	80 oz. (2.4 L) with Filter Change
Dimension (L x W x H)	468.4 x 472.7 x 382.7 mm
Weight	90 lbs. (40.8 kg)

Engine Fastener Torque Specifications (Engine 2P77F)	
Baffle, Cylinder Shoulder Bolts	89 in - lbs. (10 Nm)
Blower Shroud Shoulder Bolts	89 in - lbs. (10 Nm)
Breather Plate Bolts	89 in - lbs. (10 Nm)
Carburetor Mounting Nuts	71 in - lbs. (8 Nm)
Carburetor Mounting Studs	62 in - lbs. (7 Nm)
Carburetor Solenoid	89 in - lbs. (10 Nm)
Connecting Rod Bolts	106 in - lbs. (12 Nm)
Connector Pipe, Oil Drain Tube	19 ft - lbs. (26 Nm)
Connector Pipe, Oil Filter	31 ft - lbs. (42.5 Nm)
Crankcase Cover Bolts	20 ft - lbs. (28 Nm)
Cylinder Head Bolts (50 & 70 mm)	39 ft - lbs. (52.2 Nm)
Cylinder Head Exhaust Studs	124 in - lbs. (14 Nm)
Blower Shroud Cover Screws	11 in - lbs. (1.3 Nm)
Flywheel Cooling Fan Bolts	16 ft - lbs. (22.5 Nm)
Flywheel Nut	61 ft - lbs. (82.5 Nm)
Flywheel Rotating Screen Bolts	35 in - lbs. (4 Nm)
Fuel Pump Mounting Bolts	62 in - lbs. (7 Nm)
Governor Arm Clamp	89 in - lbs. (10 Nm)
Ignition Coil Bolts	89 in - lbs. (10 Nm)

# GENERAL SERVICE INFORMATION

Engine Fastener Torque Specifications (Engine 2P77F) (Cont.)	
Intake Manifold Bolts	89 in - lbs. (10 Nm)
Oil Drain Hose Cleat Bolts	62 in - lbs.(7 Nm)
Oil Drain Plug	19 ft - lbs.(26 Nm)
Oil Filter	106 in - lbs. (12 Nm)
Oil Pump Cover Bolts	89 in - lbs. (10 Nm)
Oil Screen Cover Bolts	89 in - lbs. (10 Nm)
Muffler Nuts	146 in - lbs.(17 Nm)
Rocker Arm Pivot Lock Nuts	124 in - lbs.(14 Nm)
Rocker Arm Studs	22 ft - lbs. (30 Nm)
Spark Plugs	21 ft - lbs. (28.5 Nm)
Starter Motor Bolts	19 ft - lbs. (26 Nm)
Stator Coil Bolts	89 in - lbs. (10 Nm)
Throttle/Choke Bracket Assembly Bolts	89 in - lbs. (10 Nm)
Valve Cover Bolts	89 in - lbs. (10 Nm)
Voltage Regulator/Dipstick Tube Bolts	62 in - lbs. (7 Nm)
Standard Torque Values	M5 Bolt/Nut 54 in - lbs. (6 Nm)
	M6 Bolt/Nut 89 in - lbs. (10 Nm)
	M8 Bolt/Nut 19 ft - lbs. (26 Nm)
	M10 Bolt/Nut 28 ft - lbs. (38 Nm)
	M12 Bolt/Nut 41 ft -lbs. (55 Nm)



# GENERAL SERVICE INFORMATION

Engine Component Specifications			
Part	Item	Standard	Service Limit
Engine	Operating (Top) RPM	3300 ± 100 RPM	-
	Idle RPM	1800 ± 150 RPM	-
Cylinder Head	Warpage	-	0.00197 in. (0.05 mm)
Cylinder	Sleeve Taper/Out of Round (Inside Diameter)	3.0315 - 3.0319 in. (77 - 77.01 mm)	3.0354 in. (77.10 mm)
Piston	Skirt Outside Diameter	3.620 - 3.621 in. (76.965 - 76.975 mm)	3.0219 in. (76.755 mm)
	Cylinder Clearance	0.00098 - 0.00177 in. (0.025 - 0.045 mm)	0.01 in. (0.255 mm)
	Piston Pin Bore Inside Diameter	0.6694 - 0.6696 in. (17.002 - 17.008 mm)	0.674 in. (17.12 mm)
	Piston Pin Clearance	0.00016 - 0.00063 in. (0.004 - 0.016 mm)	0.0011 in. (0.029 mm)
Piston Pin	Outside Diameter	0.669 - 0.6692 in. (16.992 - 16.998 mm)	0.6654 in. (16.90 mm)
Piston Rings	Ring To Groove (Top and Middle)	0.00079 - 0.00236 in. (0.02 - 0.06 mm)	0.00433 in. (0.11 mm)
	End Gap (Top and Middle)	0.0079 - 0.0157 in. (0.20 - 0.40 mm)	0.0177 in. (0.45 mm)
	Width (Top)	0.038 - 0.039 in. (0.97 - 0.99 mm)	0.0354 in. (0.90 mm)
	Width (Middle)	0.046 - 0.047 in. (1.17 - 1.19 mm)	0.0433 in. (1.10 mm)
	Width (Oil Ring)	0.11 - 0.126 in. (1.65 - 1.85 mm)	0.1063 in. (1.60 mm)
Connecting Rod	Small End Inside Diameter	0.6695 - 0.66996 in. (17.006 - 17.017 mm)	0.6713 in. (17.05 mm)
	Large End Inside Diameter	1.5754 - 1.5758 in. (40.015 - 40.025 mm)	1.5774 in. (40.065 mm)
	Large End Side Clearance	0.000945 - 0.00311 in. (0.024 - 0.079 mm)	0.0051 in. (0.129 mm)
Crankshaft	All Three Bearing Diameters	1.5735 - 1.5744 in. (39.966 - 39.991 mm)	1.5551 in. (39.50 mm)
Valve	Clearance (cold) (Intake)	0.004 - 0.006 in. (0.10 - 0.15 mm)	-
	Clearance (cold) (Exhaust)	0.006 - 0.008 in. (0.15 - 0.20 mm)	-
	Stem Diameter (Intake)	0.2584 - 0.2590 in. (6.565 - 6.58 mm)	0.2565 in. (6.515 mm)
	Stem Diameter (Exhaust)	0.2577 - 0.2583 in. (6.545 - 6.56 mm)	0.2557 in. (6.495 mm)

# GENERAL SERVICE INFORMATION

Engine Component Specifications (Cont.)			
Part	Item	Standard	Service Limit
Valve Guides	Inside Diameter (Intake, Exhaust)	0.2598 - 0.2604 in. (6.60 - 6.615 mm)	0.2624 in. (6.665 mm)
	Stem to Guide Clearance (Intake)	0.00079 - 0.00197 in. (0.02 - 0.05 mm)	0.0059 in. (0.15 mm)
	Stem to Guide Clearance (Exhaust)	0.00157 - 0.00275 in. (0.04 - 0.07 mm)	0.00669 in. (0.17 mm)
Valve Seat	Seat Width	0.02756 - 0.03149 in. (0.7 - 0.8 mm)	0.05118 in. (1.3 mm)
Valve Spring	Free Length	1.555 - 1.594 in. (39.5 - 40.5 mm)	1.535 in. (39.0 mm)
Camshaft	Height (Intake & Exhaust)	1.1791 - 1.1831 in. (29.95 - 30.05 mm)	1.1713 in. (29.75 mm)
	Journal (Bearing)	0.6286 - 0.6293 in. (15.966 - 15.984 mm)	0.6266 in. (15.916 mm)
Crankcase Cover	Camshaft Hole Diameter	0.6299 - 0.6306 in. (16.0 - 16.018 mm)	0.6326 in. (16.068 mm)
	Crankshaft Hole Diameter	1.5751 - 1.5758 in. (40.009 - 40.025 mm)	1.5778 in. (40.075 mm)
Spark Plug	Gap	0.030 in. (0.7 - 0.8 mm)	-
Ignition Coil	Resistance (Primary)	1.6 - 1.9 $\Omega$	-
	Resistance (Secondary)	6.2 - 7.1 K $\Omega$	-
	Gap to Flywheel	0.011 in. (0.3 mm)	-
Governor Assembly Clearance	Governor end play	0.002-0.013 in. (0.05-0.35 mm)	-



# GENERAL SERVICE INFORMATION

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## Tool Requirements:

- 1) Digital Multi-Meter
- 2) Cylinder Leak Down Tester
- 3) Two Spark Testers
- 4) Carburetor Pressure Tester
- 5) Feeler Gauge
- 6) Flywheel Puller
- 7) Valve Seat Cutter Kit
- 8) Valve Lapping Tool
- 9) Metric Tap & Die Set
- 10) Spark Plug Wrench
- 11) Foot Pound and Inch Pound Torque Wrench
- 12) Tachometer (Digital Preferred)
- 13) Metric Wrench and Socket Set
- 14) 7/32 in. or 15/64 in. Pin Punch
- 15) Piston Ring Compressor
- 16) Plastic Mallet
- 17) Valve Spring Compressor
- 18) Micrometer (Inside & Outside)

# GENERAL SERVICE INFORMATION

## Troubleshooting

Problem	Possible Causes	Next Step...
<b>Engine Cranks but will NOT Start</b>	Air filter restricted	Check: clogging debris (may need to replace air filter)
	Choke Not Closed	Check: choke fully closed
	Electrical Issues	Check: battery voltage to solenoid, low battery voltage, spark, or ignition coils/ground
	Fuel Delivery System	Check: tank level, fuel lines, filter and venting or fuel pump, carburetor
	Fuel Quality	Check fuel condition: age, octane, ethanol percentage, water or other contaminants
	Correct Spark	Check: spark plug boot installed, ignition coil gap, ground wire, spark plugs and plug gap
	Insufficient Compression	Check: leak down test, compression test, valve(s) not seating, head gasket leaking or worn cylinder
<b>Engine Hard Starting/Poor Running</b>	Fuel Quality	Check fuel condition: age, octane, ethanol percentage, water or other contaminants
	Fuel Delivery System	Check: tank level, fuel lines, filter and venting or fuel pump, carburetor
	Engine Oil	Check: oil level/viscosity
	Electrical	Check: weak battery/charging system
	Spark Plug	Check: incorrect gap, fouled, loose or faulty
	Air Filter	Check: clogging debris
	Air Intake	Check: system leak
	Ignition Coil (Spark Test)	Check: coil air gap, spark test
	Choke Function	Check: choke position matches cable position
	RPM	Check: verify engine top RPM
	Governor	Check: governor zero point, binding linkage





# GENERAL SERVICE INFORMATION

## Troubleshooting (Cont.)

Problem	Possible Causes	Next Step...
<b>Engine Hard Starting/Poor Running (Cont.)</b>	Sufficient Compression	Check: leak down test, compression test, valve(s) not seating, head gasket leaking or worn cylinder
<b>Engine Overheats</b>	Cooling Screen and Fan	Check: damage or debris build-up
	Engine Gaskets Leaking	Check: valve cover or head gasket leaking
	Oil	Check: proper oil viscosity for temperature, proper level, condition
	Excessive Engine Load	Check: not operating unit at full throttle under load
	Cylinder Cooling Fins	Check: blocked or broken
<b>Engine doesn't Crank</b>	Electrical issues	Check: battery voltage to electric starter motor or engine grounds, safety interlock system
	Electric starter	Check: bench test electric start; <a href="#">see "Bench Test," chapter 5, page 5-15</a>

# GENERAL SERVICE INFORMATION

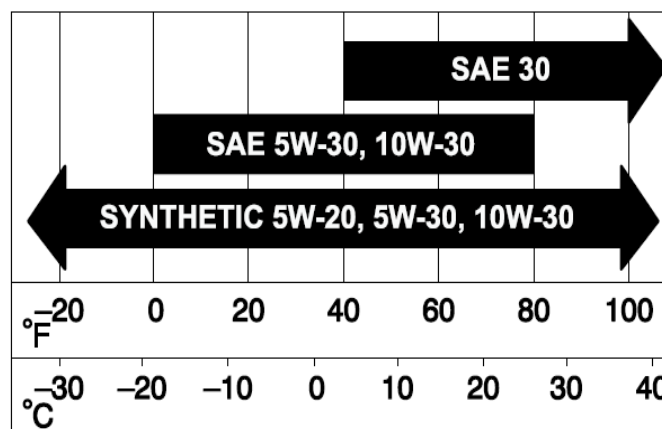
## Maintenance

Maintenance Schedule		Each Use	First month or 5 hours	Every 3 months or 25 hours	Every 6 months or 50 hours	Every year or 100 hours	Every 2 years or 200 hours
Top Shroud	Clean					●	
Engine Oil	Oil Level	●					
	Change		●		●		
Air Cleaner Foam Element	Clean			●*			
	Change					●*	
Air Cleaner Paper Element	Clean					●*	
	Change					●*	
Oil Filter	Replace		●		●		
Fuel Filter	Replace					●	
Spark Plug	Replace						●**
	Check-Adjust					●**	
Valve Clearance	Check-Adjust						●**
Combustion Chamber	Clean						●**
Remove blower shroud and clean	Compressed air					●	
Fuel Hose	Every 2 years (Replace if Necessary)						

\* Service more frequently when used in dirty/dusty conditions.

\*\* These items are to be maintained by authorized service dealers unless the user has special tools and skills for maintenance.

## Oil Chart



# AIR FILTER SYSTEM

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# AIR FILTER SYSTEM

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**Introduction:** The air intake system is a unique air filtration system containing a heavy duty air filter door, dual element air filter, self-cleaning air box and cast aluminum air filter manifold (Figure 1).

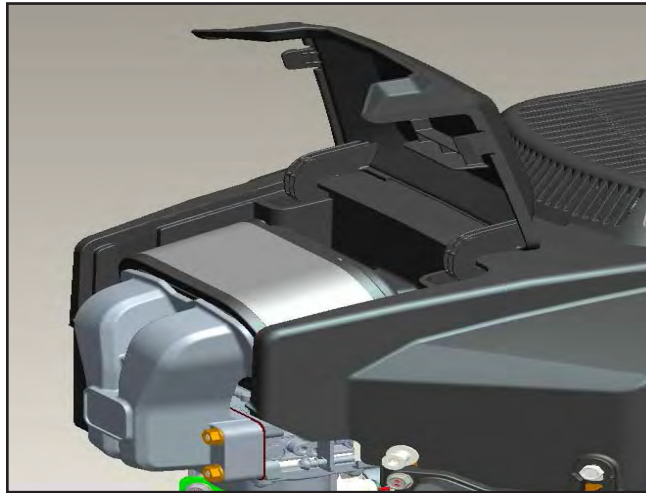


Figure 1

## Component Description

Air Filter Door: Attaches to the blower shroud, heavy duty hinge design and no tools required to maintain the air filter. Locks air filter into position by simply closing the door and the air filter will slide into place (Figure 2).



Figure 2

# AIR FILTER SYSTEM

## Component Description (Cont.)

Air Filter: Dual element, foam pre-filter fits over paper element. Two outlets fit snugly onto the air filter manifold ports (Figure 3).



Figure 3

Air Box: The chamber is designed to keep debris away from the filter, angled floor away from engine and three holes in blower shroud allows air from the flywheel fan to blow debris past the filter (Figure 4).



Figure 4

# AIR FILTER SYSTEM

---

## Component Description (Cont.)

Air Filter Manifold: Constructed of cast aluminum for durability. Filter mount ports are angled to prevent debris from entering when servicing the filter. The ports are machined to provide proper seal to air filter. The manifold has vent ports for the fuel tank vent and the crankcase breather vent (Figure 5).

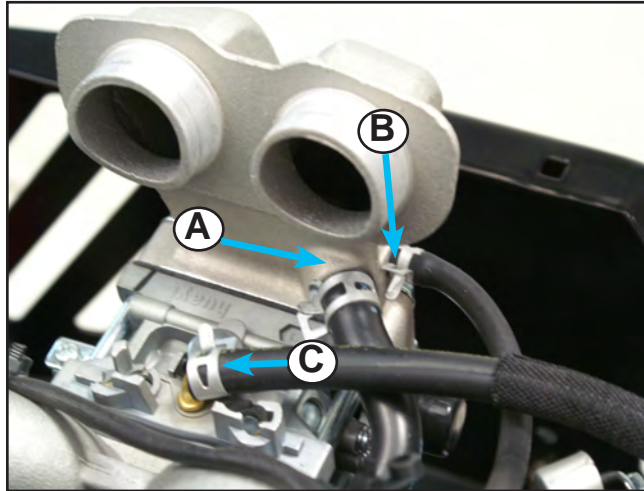


Figure 5

- A. Crankcase Breather
- B. Fuel Tank Vent
- C. Fuel line

# AIR FILTER SYSTEM

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## Removal

1. Open the air filter door.
2. Rotate the filter upward by lifting at door hinge to remove from air filter manifold.

## Service

1. Foam wrap is washable (hot soapy water, then air dry).
2. Paper element can be cleaned by lightly tapping to remove debris.

**NOTE: Do not use compressed air to clean paper element.**

3. Replace filter if damaged or contaminated by oil, gas, water, etc.

**NOTE: The replacement air filter includes both the paper and foam elements.**

## Installation

1. Install foam wrap (dry) over paper element.

**NOTE: Do not tear the foam or damage the paper pleats.**

2. Align holes of filter to the manifold ports.
3. Rotate filter down into the chamber and fully seat against air filter manifold.
4. Close the air filter door to lock into place.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

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# TWO BARREL CARBURETOR AND FUEL SYSTEM

This section covers the description, location, and operation of the fuel system including the two-barrel carburetor, cast aluminum intake manifold, fuel lines, fuel filter, and fuel pump.

**WARNING:** Unauthorized adjustment to the carburetor or fuel system may make the machine non-compliant to EPA standards. Verify components are set to factory standards.

<p><b>⚠ WARNING</b></p> <p>Explosive fuel can cause fires and severe burns.</p> <p>Do not fill fuel tank while engine is hot or running.</p> <p>Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, occupied buildings, away from sparks or flames. Spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Never use gasoline as a cleaning agent.</p>
---

## Fuel System

**Introduction:** The fuel system consists of a sealed gas tank with venting into the air filter intake manifold, a vacuum powered fuel pump, a two-barrel carburetor with a vacuum override choke system and a cast aluminum intake manifold mounted to the top of each cylinder head.

## Operation

**Fuel Flow:** The fuel flows from the fuel tank through the fuel filter, to the fuel pump and continues to the top of the carburetor. When the carburetor float drops, the needle opens and the fuel flows into the bowl until the float rises and closes the needle. Air moving through each venturi creates a low pressure. Atmospheric pressure pushing down on the fuel in the carburetor bowl pushes fuel up the nozzles and into the air stream. The air stream, mixed with fuel droplets, continues through the intake pipe into the combustion chamber (Figure 1).

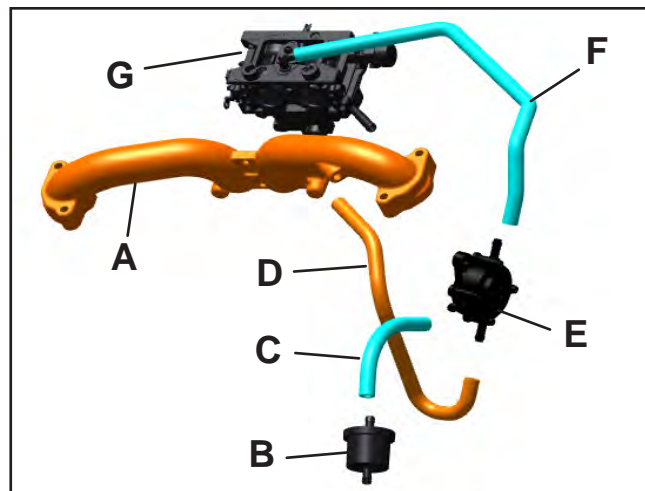


Figure 1

- |                    |               |
|--------------------|---------------|
| A. Intake Manifold | E. Fuel Pump  |
| B. Fuel Filter     | F. Fuel Line  |
| C. Fuel Line       | G. Carburetor |
| D. Vacuum Line     |               |

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Components

**Fuel Pump and Hoses:** The fuel pump is a pulse diaphragm style pump, located on the #1 cylinder shroud. The pulse line connects to the intake manifold above the #1 cylinder head. The change in vacuum at the #1 cylinder intake pulses the diaphragm of the fuel pump. The vacuum supplied is a pulse, less than two psi, not a constant vacuum that is measurable.

**Fuel Filter:** The fuel filter is in-line, located between the fuel tank and the fuel pump. The fuel filter has a clear design for visibility of any potential debris or moisture. If contaminants are observed, replace the filter.

**Fuel Supply and Vent Hoses:** A low permeation fuel hose must be installed to maintain EPA and CARB compliance. The fuel tank vent hose connects to the air filter manifold.

## Fuel Pump Test

1. Inspection (Figure 2)
  - Remove pulse line and inspect for fuel. Pulse line should not contain liquid fuel at fuel pump. Replace fuel pump if found.
  - Inspect fuel pump vent for debris blockage. Replace fuel pump if blocked.

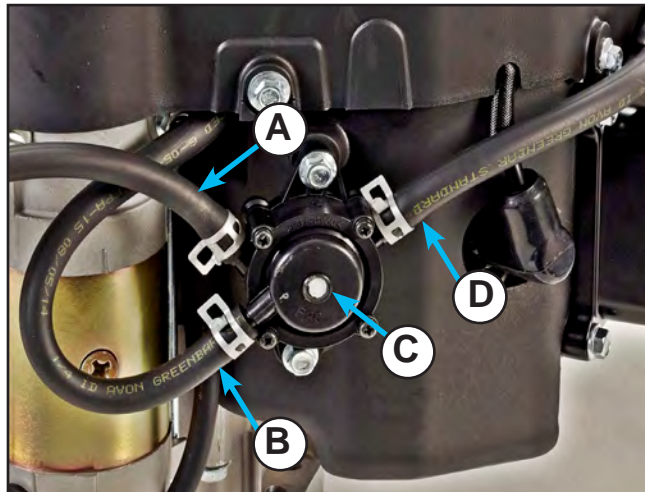


Figure 2

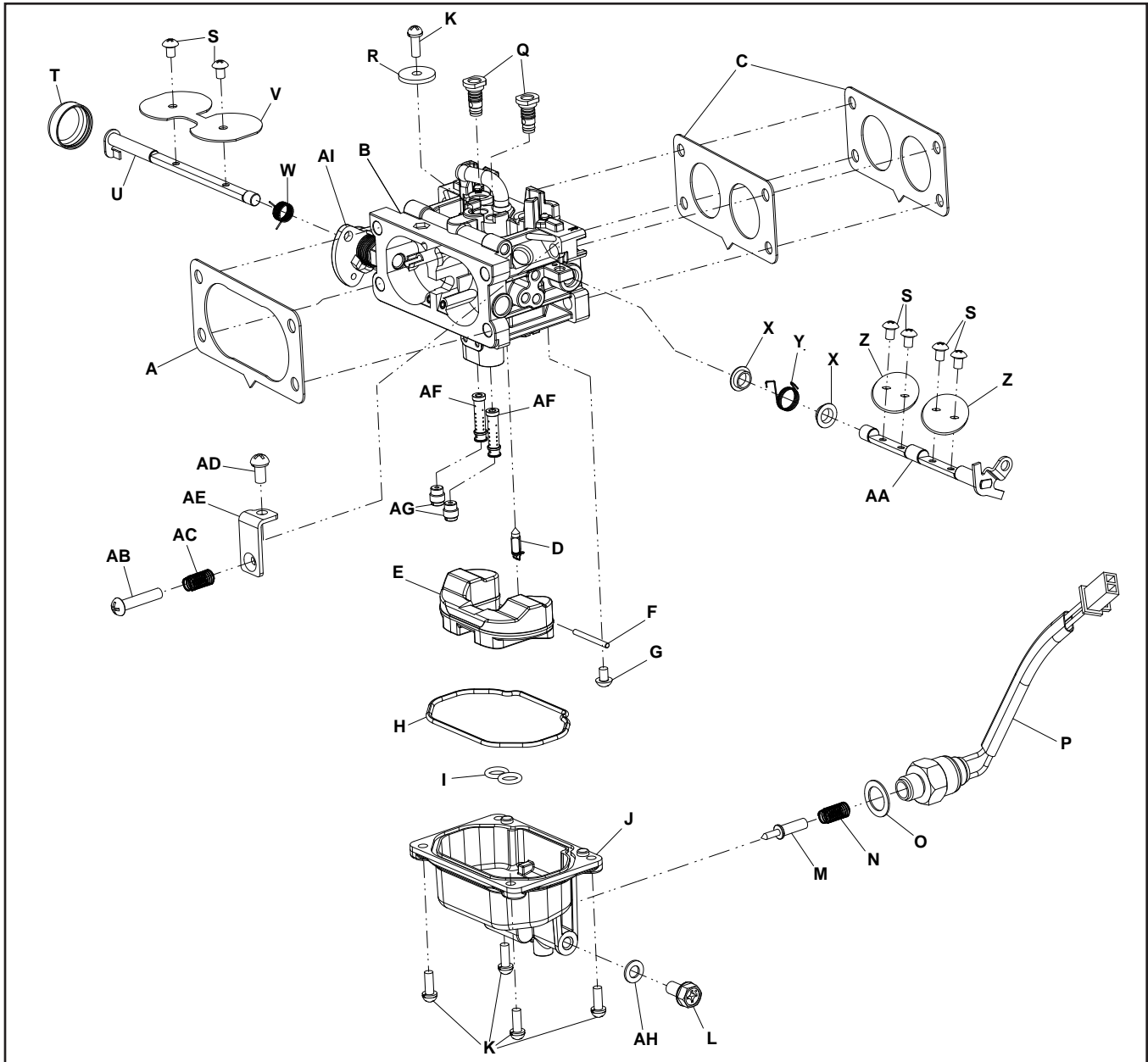
- |               |                |
|---------------|----------------|
| A. Fuel Inlet | C. Vent        |
| B. Pulse Line | D. Fuel Outlet |

2. Connect hand pressure tester to either inlet or outlet fitting of fuel pump; block other fitting.
3. Apply pressure, up to 5 psi
  - Pressure should not drop.
  - If pressure drops, spray soapy water mix on fuel pump to determine where air is leaking.
4. Replace fuel pump if testing failed, as it is not serviceable.

**NOTE: Pulse port and vent are not pressure tested.**

## TWO BARREL CARBURETOR AND FUEL SYSTEM

## Two Barrel Carburetor Exploded View



### Figure 3

- |                      |                       |                      |                         |
|----------------------|-----------------------|----------------------|-------------------------|
| A. Carburetor Gasket | J. Carburetor Bowl    | S. Screw             | AB. Idle Adjust Screw   |
| B. Carburetor Body   | K. Screw (Bowl Mount) | T. Choke Shaft Cover | AC. Idle Adjust Spring  |
| C. Carburetor Gasket | L. Drain Bolt         | U. Choke Shaft       | AD. Screw               |
| D. Needle Float      | M. Solenoid Valve     | V. Choke Butterfly   | AE. Idle Adjust Plate   |
| E. Float             | N. Spring             | W. Choke Spring      | AF. Main Nozzle         |
| F. Float Pin         | O. Washer             | X. Bushing           | AG. Main Jet            |
| G. Screw             | P. Solenoid Body      | Y. Spring (Throttle) | AH. Gasket (Bowl Drain) |
| H. Gasket (Bowl)     | Q. Pilot Jet          | Z. Throttle Valve    | AI. Choke Override      |
| I. Gasket (Nozzle)   | R. Washer             | AA. Throttle Shaft   | Lever                   |

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Two-Barrel Carburetor

**Introduction:** The two-barrel carburetor has the advantage of a unique fuel-air mix for each cylinder. Each barrel has a main jet, nozzle and pilot jet to maximize each cylinder's output. The two-barrel carburetor is located between the intake manifold and the air filter manifold. All components are made of aluminum for durability (Figure 4).



Figure 4

## Operation

**Slow Throttle:** To operate in slow throttle operation; throttle is closed (or almost closed), engine is under light load. Air is drawn through each barrel creating low pressure at the throttle disc. Air at atmospheric pressure in the float bowl pushes on the fuel, the fuel is metered through the idle circuit. Fuel flows through the main jets and nozzles into the idle circuit, air mixes with the fuel at each pilot jet. Fuel-air mix flows through a series of holes on the side of the barrel near the closed throttle disc. As throttle disc opens with increasing load, more holes are exposed to low pressure allowing more fuel-air mix into the air stream.

**NOTE:** Fuel does not flow into the main venturi until the throttle disc opens beyond the holes in the barrel.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Operation (Cont.)

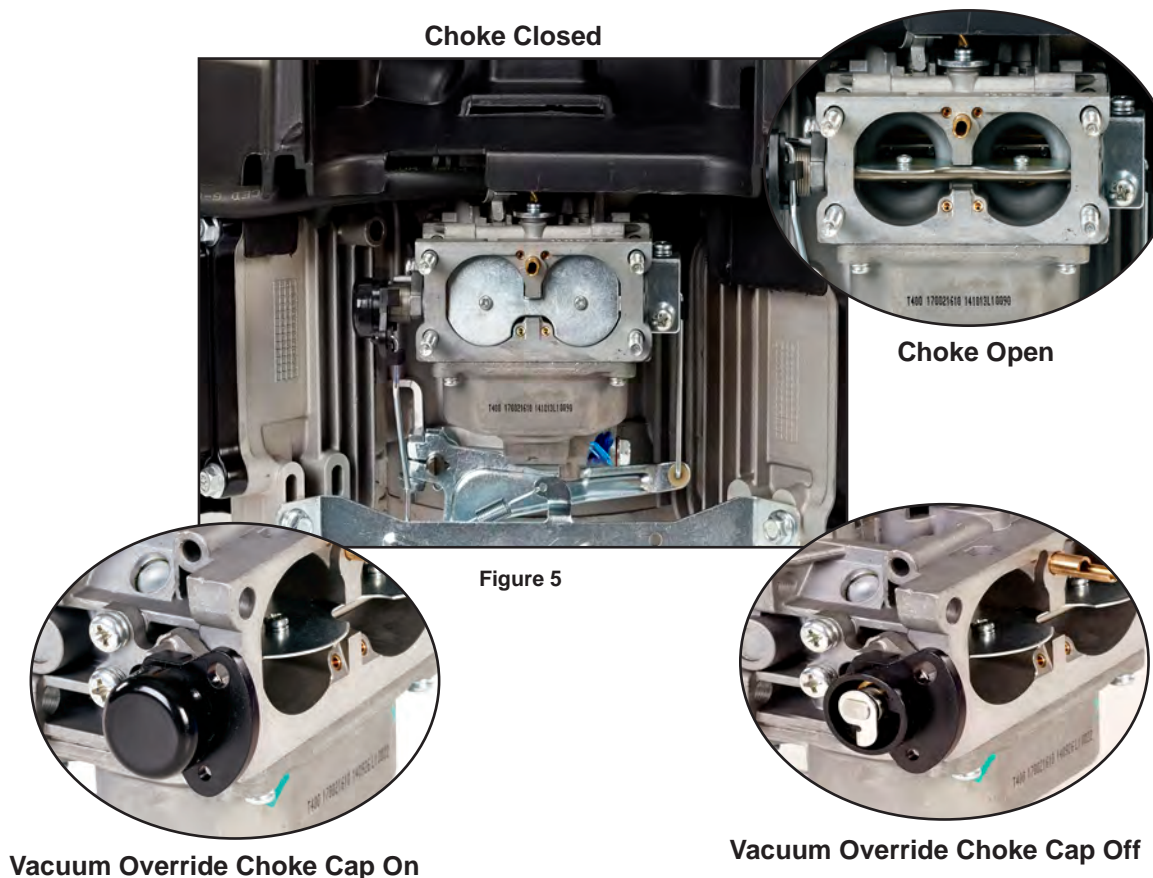
**Fast Throttle:** The fuel-air mix is metered by the main circuit. The throttle discs open, engine is under medium to full load, air is drawn through each barrel and the venturi creates a low pressure. Air at atmospheric pressure in the float bowl pushes on the fuel. Fuel is metered through the main jets and enters through the nozzles. The nozzle has a series of holes for air to mix with the fuel. Fuel-air mixture flows up the nozzle and into the venturi.

**NOTE: High altitude applications: Toro has a high altitude jet and nozzle kit available. Use Toro Parts Lookup in the fuel system drawing, reference 99.**

**Vacuum Override Choke:** A unique feature of the carburetor is the vacuum override choke. The “override” allows the choke to partially open when the engine starts and the choke cable is positioned at full choke. The intake vacuum of the operating engine “overrides” the choke spring and partially opens the choke butterfly, allowing the engine to run smoothly until the choke cable is returned to the “no choke” position.

**NOTE: Once the engine starts, always return the choke control to the “no choke” position.**

The override feature is possible due to the two springs on the choke shaft. The outer spring (closest to the carburetor body) opens the choke when the choke control is in the “no choke” position. The inner spring (under the cap) (W) (Figure 3) allows the intake vacuum from the running engine to partially open the choke, slightly overriding the choke spring.



# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Operation (Cont.)

**NOTE:** DO NOT remove the override choke components as they are press fit into the carburetor. If removed, a new carburetor is required (Figure 6).



Figure 6

Solenoid: The fuel shut-off solenoid is located in the lower part of the carburetor float bowl. Its function is to shut off the fuel flow to the main jets of the carburetor when the engine is shut off. The solenoid is spring loaded to close when battery voltage is removed and opens when the battery voltage is supplied (M-P) (Figure 3).

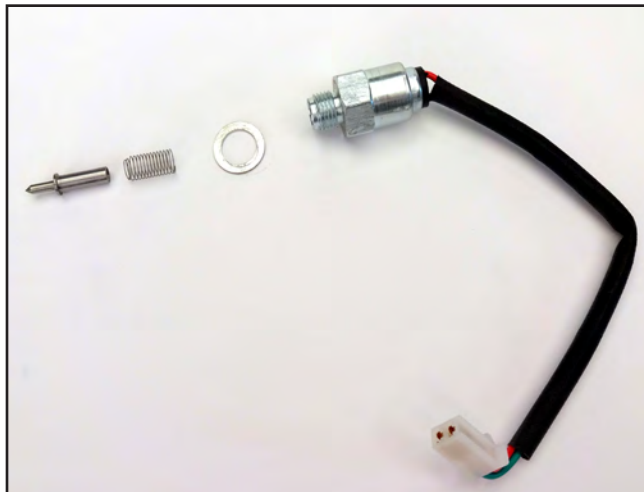


Figure 7

Fuel Bowl Drain: Completely remove the drain screw to drain the fuel bowl (L) (Figure 3).



# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Items to check prior to carburetor analysis

NOTE: Items listed below are not in any particular order, one or more may apply.

Possible Cause/Issue	What to Check	Actions/Corrections
Contaminated Fuel	Fuel tank, hoses, filter	-Inspect and flush fuel system
Low/No Fuel	Fuel level in tank	-Add fresh fuel
Fuel Tank is not Vented	Vent hose is pinched or obstructed	-Inspect and reroute/replace vent hose
Leaking Fuel Pump	Fuel Pump	-Fuel Pump Test; <a href="#">see “Fuel Pump Test,” chapter 3, page 3-3</a>
Blocked Air intake	Dirty air filter	-Clean/replace air filter
Leaking Intake	Leaky intake gaskets, air leaks Fuel pump vacuum hose	-Inspect/replace components
Fuel Solenoid not Energized	Correct voltage to solenoid, proper grounds	-Measure voltage to solenoid, if none measure voltage on start solenoid and ground. -Inspect safety system and battery (replace as needed)
Weak Spark at Spark Plug, Spark Timing	Ignition coils	-Ignition Coil test or OHM test; <a href="#">see “Ignition Coil Test,” chapter 5, page 5-8</a> or <a href="#">“Secondary Coil Test,” chapter 5, page 5-9</a>
	Chassis safety system	-Inspect proper grounds, replace components
	Flywheel key	-Inspect flywheel key if sheared, replace
	Spark plugs	-Inspect/replace as needed
Engine Controls to Carburetor	Throttle cable and choke cable, installed and adjusted correctly	-Control Plate; <a href="#">see “Choke Cable,” chapter 4, page 4-5</a> and <a href="#">“Throttle Cable,” chapter 4, page 4-6</a>
Combustion Chamber Integrity	Perform leak down test on each cylinder	-Engine Inspection and Reconditioning; <a href="#">details in chapter 8, page 8-1</a>
Incorrect Valve Lash	Measure valve clearance at all four valves	-Engine Assembly; <a href="#">specifications in section 9, page 9-22</a>

NOTE: Always have the choke fully closed for maximum fuel pump vacuum when starting and testing.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Troubleshooting

Problem	Possible Fuel system Causes	Next Step...
Engine starts hard, runs rough or stalls at idle speed	Low speed, RPM setting too slow Air leak in pilot jet circuit	-Adjust low idle speed to specification -Inspect pilot jets for blockage or damaged o-rings
Engine runs rich (indicated by black, sooty exhaust smoke, misfiring, loss of speed and power, governor hunting or excessive throttle opening)	Restricted air cleaner filter	-Clean or replace air cleaner filter
	Choke partially closed during operation	-Check choke system for proper operation: cable adjustment, shaft/butterfly not binding, choke spring length, and debris
	Air leak in pilot jet circuit	-Inspect pilot jets for blockage or damage to o-rings
	Fuel level too high in float bowl	-Pressure test float and needle -Inspect float for cracks or binding pivot, fuel in float -Inspect needle and seat for dirt/debris/wear ring on needle tip
	Bowl vent or air bleeds plugged	-Clean vent, ports, and air bleeds -Blow out all passages with compressed air.
	Faulty Fuel Pump	-Check fuel pump; <a href="#">see “Fuel Pump Test,” chapter 3, page 3-3</a> -Check for fuel in pulse line at fuel pump
Engine runs lean (indicated by misfiring, loss of speed and power, governor hunting or excessive throttle opening)	Fuel solenoid partially closed	-Inspect fuel solenoid for proper operation or debris, blocked valve
	Fuel level too low in bowl	-Inspect float for binding pivot -Inspect inlet fitting for blockage -Check adequate fuel flow from tank
	Blockage in jets, nozzles, or pilot circuit	-Disassemble and clean: use carburetor cleaner or ultrasound, then compressed air only
Fuel Leaks from Carburetor	Float not closing needle, needle not sealing	-Pressure test float and needle -Inspect float for cracks or binding pivot, fuel in float -Inspect needle and seat for dirt/debris/wear ring on needle tip
	Bowl vents blocked	-Clean vent, ports, and air bleeds. -Blow out all passages with compressed air.
	Carburetor gaskets leaking: bowl, drain screw, fuel solenoid	-Inspect if damaged or mis-assembled
	Fuel line leak	-Inspect fuel supply line



# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Troubleshooting (Cont.)

Problem	Possible Fuel System Causes	Next Step...
Engine Cranks over but won't start	Fuel solenoid closed	-Inspect fuel solenoid for proper operation or debris, blocked valve
	Choke not closed	-Check choke system for proper operation: cable adjustment, shaft/butterfly not binding, choke spring length, and debris
	Blockage in jets, nozzles, or pilot circuit	-Disassemble and clean: use carburetor cleaner or ultrasound, then compressed air only
	Fuel level too low in bowl	-Inspect float for binding pivot -Inspect inlet fitting for blockage -Check adequate fuel flow from tank

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Disassembly

### Solenoid

1. Loosen and remove solenoid from the carburetor bowl.
2. Remove spring and solenoid valve if they remain in the carburetor bowl.

**NOTE: A small magnet may be used to assist removal.**

3. Inspect spring and valve for damage (Figure 8).

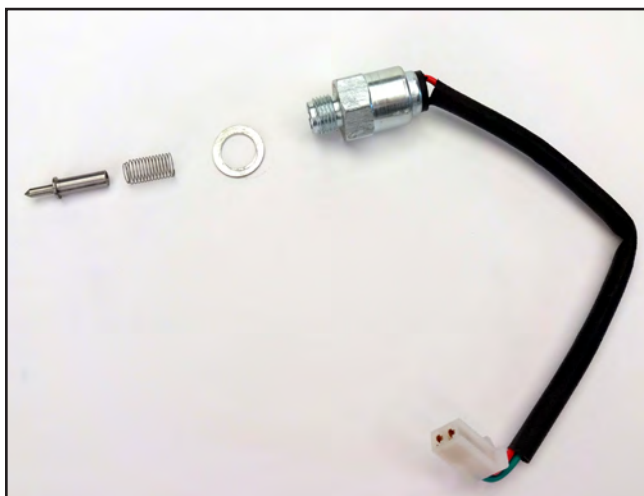


Figure 8

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Float Bowl and Gaskets

**NOTE:** The float bowl is a shared chamber for both main jet nozzles. The fuel solenoid and the bowl drain bolt mount to the float bowl.

The main nozzles are sealed with an o-ring gasket (I) (Figure 9) that fits into the float bowl. The bowl gasket (H) is an o-ring gasket that fits into a groove of the float bowl (J).

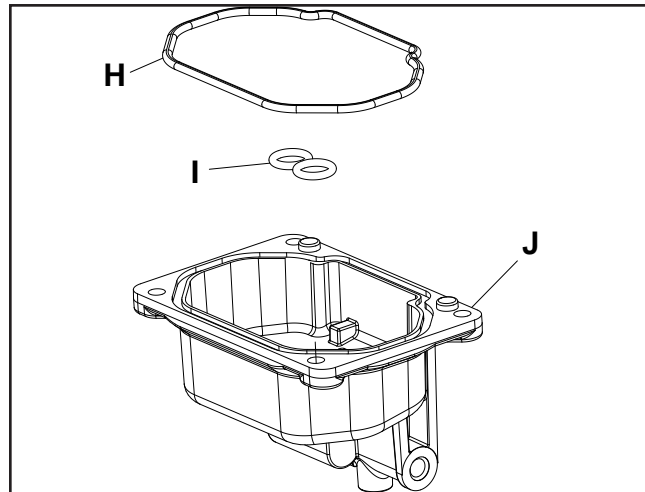


Figure 9

1. Remove the four screws and float bowl.

**NOTE:** Use a small clamping pliers to initially loosen the screws.

2. Remove and inspect the o-ring gaskets for cuts or damage, then discard. An example of damaged o-ring gaskets is shown below (Figure 10).

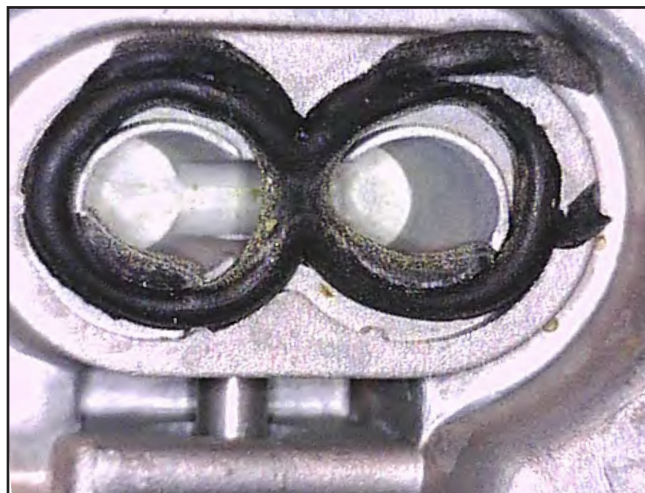


Figure 10

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Float Bowl and Gaskets (Cont.)

3. Inspect the float bowl for corrosion, contamination or old fuel residue.
4. Replace if damaged or unable to clean.

### Float and Needle

1. Loosen the screw (G) (Figure 11), remove the float pin (F). Remove the float (E) and needle (D).

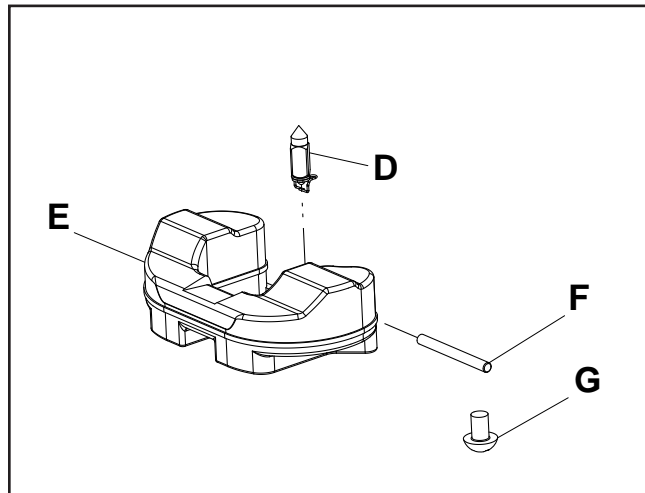


Figure 11

2. Inspect the float for cracks, or if liquid is inside. Test the float to make sure it floats.
3. Inspect the needle and retaining clip for corrosion or damage.
4. Inspect the tip of the needle for damage or ring from debris and seat contact (Figures 12).

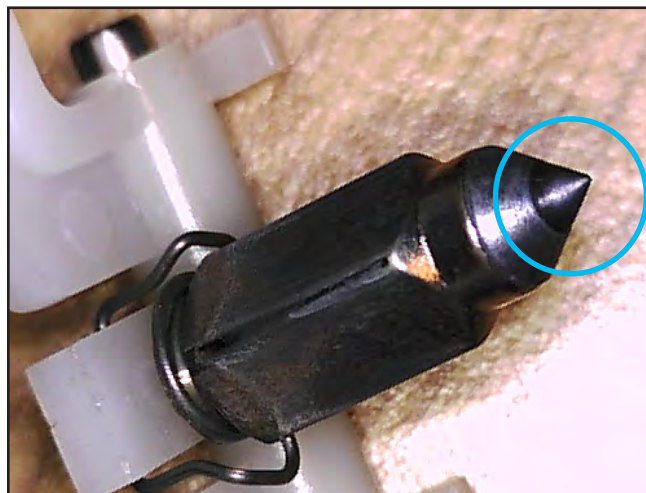


Figure 12

# TWO BARREL CARBURETOR AND FUEL SYSTEM

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## Disassembly (Cont.)

### Float and Needle (Cont.)

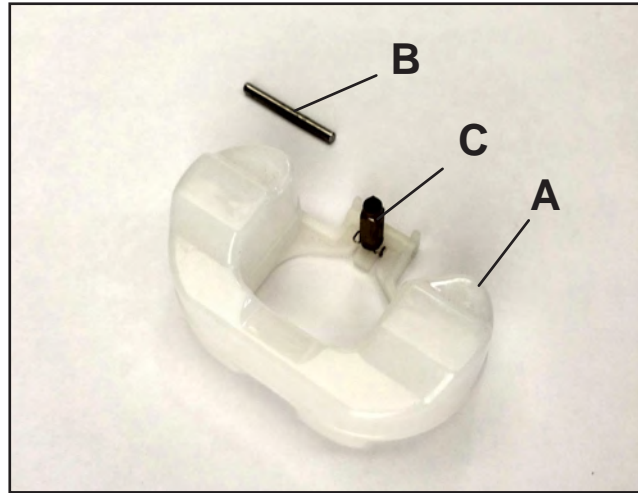


Figure 13

- A. Float
- B. Float Pin
- C. Needle

5. Inspect the seat for corrosion, old fuel residue, debris.

**NOTE:** Use of a magnifying glass is recommended.

6. Replace components if damaged or unable to clean.

**NOTE:** Pop Off testing in [section 3, page 3-36](#).

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Main Jets and Nozzles

**NOTE:** The main jets and nozzles are serviced as a kit (two nozzles, two jets).

1. Using a flat screwdriver, loosen and remove the main jets (AG) (Figure 14).

**NOTE:** Main jets and nozzles are made of brass and easily damaged.

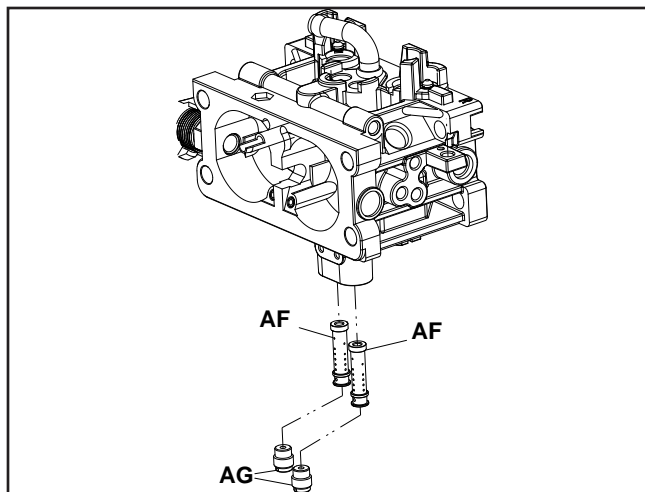


Figure 14

2. Remove the main nozzles (AF) (Figure 14).

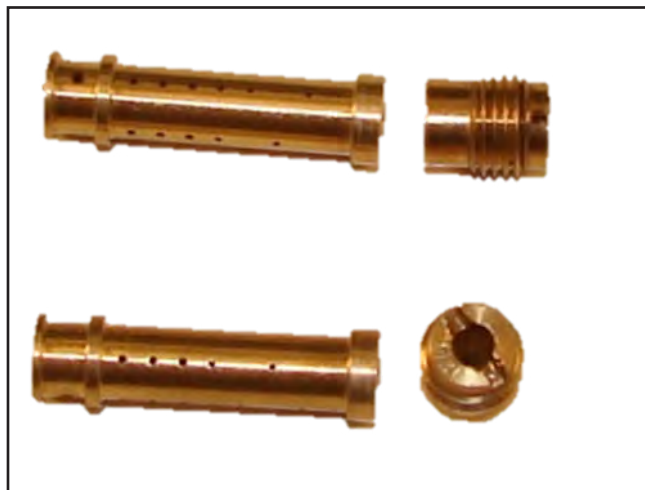


Figure 15

# TWO BARREL CARBURETOR AND FUEL SYSTEM

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## Disassembly (Cont.)

### Main Jets and Nozzles (Cont.)

**NOTE:** To assist in removing a nozzle, a straightened paper clip with just the tip folded over can be inserted into the nozzle, hooking the top and gently pulling the nozzle out.

3. Inspect the jets and nozzles for debris clogging the small orifices.
4. Replace if unable to clean or damaged.

**NOTE:** Clean with carburetor cleaner or ultrasonic cleaner. Do not use metallic tools to clean.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Pilot Jets

**NOTE:** Serviced as a kit containing both pilot jets and a retaining screw with washer.

1. Remove the screw (K) (Figure 16) and washer (R) at the top of the carburetor, near the fuel inlet.

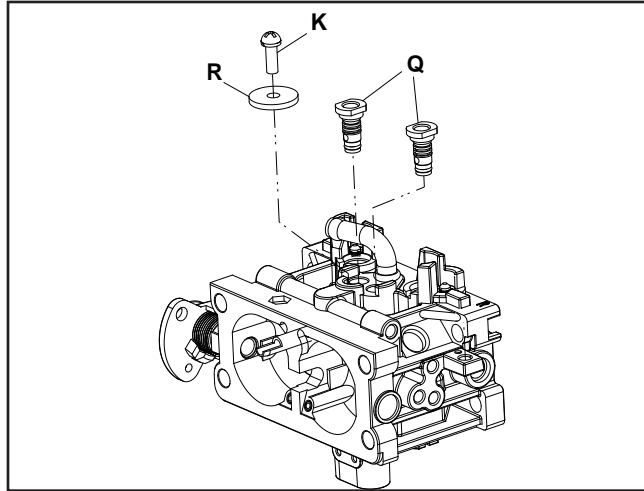


Figure 16

2. Remove each pilot jet (Q) (Figure 16) using a small flat screwdriver to **carefully** remove.

**NOTE:** Do NOT twist when removing.



Figure 17



# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Disassembly (Cont.)

### Pilot Jets (Cont.)

3. Inspect the small orifice on the tip of each jet.
4. Inspect the o-rings for cuts or damage.

**NOTE: Clean with carburetor cleaner or ultrasonic cleaner. Do not use metallic tools to clean.**

5. Replace if unable to clean or if damaged.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Throttle Shaft

1. Remove the four screws and both throttle discs (Figure 18).

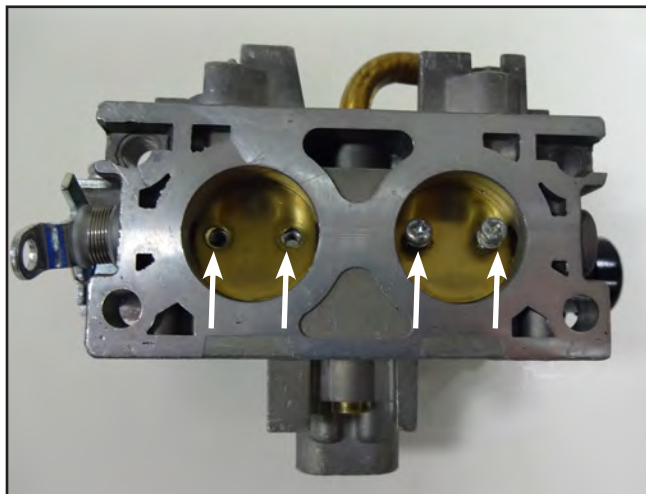


Figure 18

2. Unhook the throttle shaft spring while sliding the shaft out of the carburetor body (Figure 19).

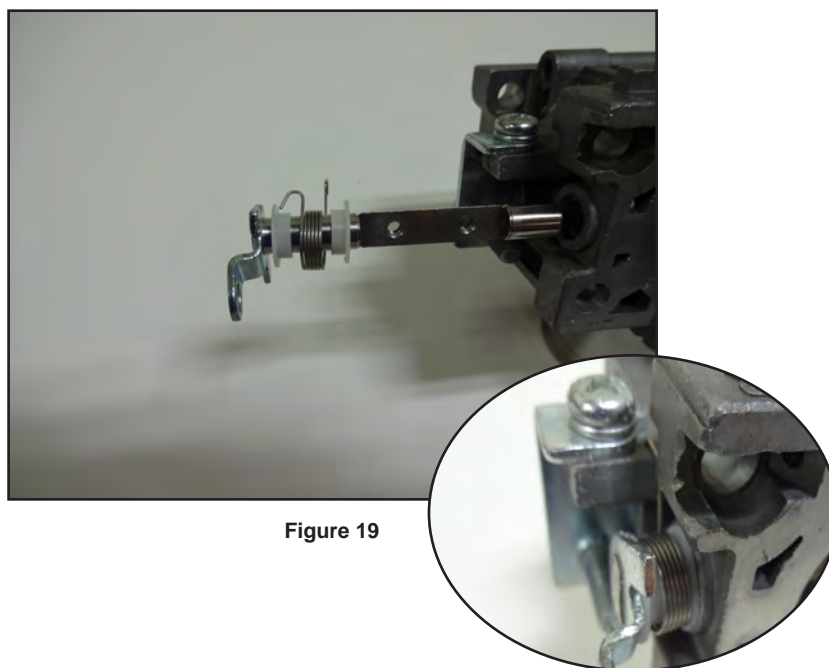


Figure 19

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Throttle Shaft (Cont.)

3. Inspect the shaft, spring, bushings and discs for wear or damage (Figure 20).

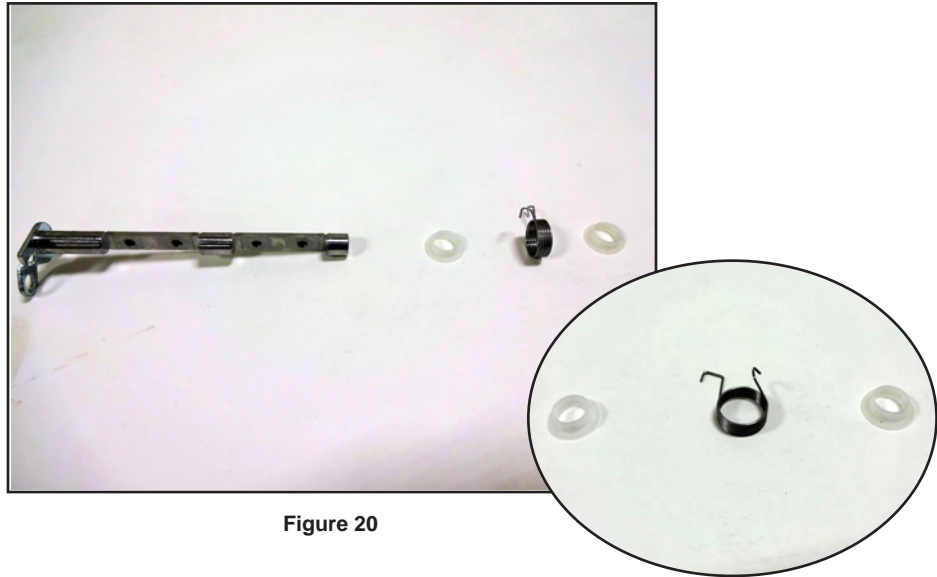


Figure 20

4. Replace if damaged or worn (Figure 21).

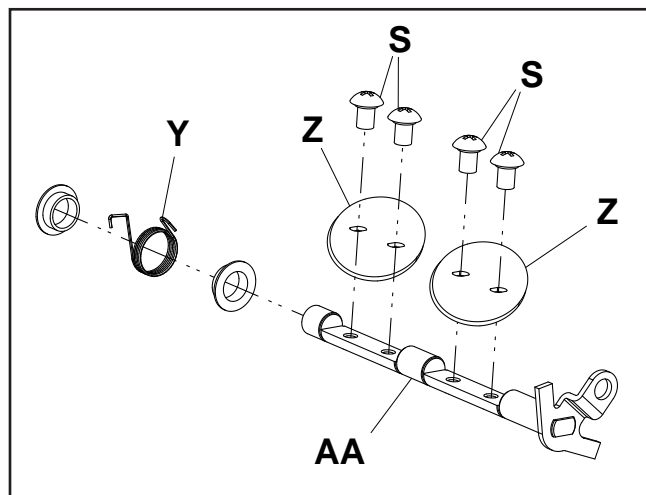


Figure 21

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Disassembly (Cont.)

### Choke Shaft

1. Remove the two screws (S) (Figure 22) and choke butterfly (V).
2. Remove the outer plastic cap (T) (Figure 22) from the override assembly.

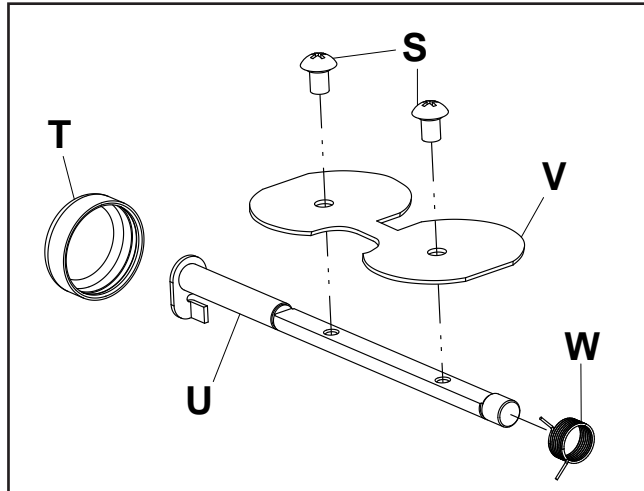


Figure 22

**NOTE:** If needed, use a screwdriver to remove the outer plastic cap.

3. Slide the shaft with the spring out of the black override assembly. Remove from the carburetor body (Figure 23).

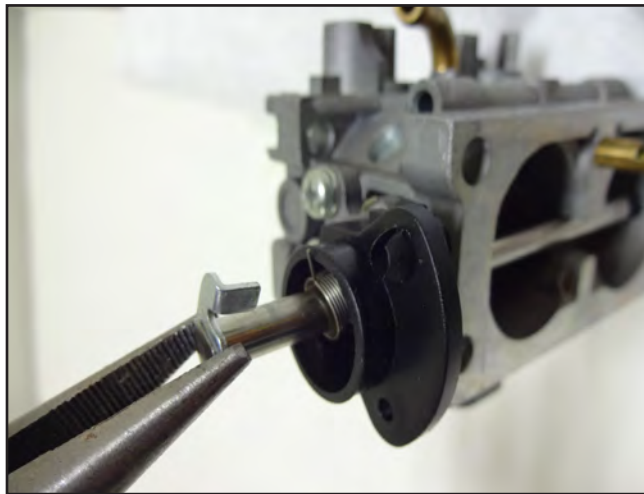


Figure 23

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Disassembly (Cont.)

### Choke Shaft (Cont.)

**NOTE:** Do not remove the vacuum override parts (retaining plate and screws, bushing, plastic arm and spring). Replace entire carburetor if removed (Figure 24).



Figure 24

4. Inspect the choke shaft, spring and choke butterfly for wear or damage.
5. Replace components if damaged or worn.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Cleaning and Inspection

**NOTE:** Always remove the following components prior to cleaning with a soak tank or ultrasonic cleaner:

- Solenoid Assembly
- Carburetor Bowl and Gaskets
- Float and Needle
- Main Jets and Nozzles
- Pilot Jets
- Throttle Shaft Assembly
- Choke Shaft Assembly



### WARNING

Use a carburetor soak container or ultrasound to thoroughly clean the carburetor body and float bowl, follow the carburetor cleaner manufacturer's guidelines.



**Important:** Do NOT use metal tools to clean passage ways.

### Final Inspection

**NOTE:** Thoroughly rinse and dry the components after cleaning (use compressed air to dry and clear passages. Specifically, all orifices and pivot points).

Inspect components for remaining debris or residue blocking the passages.

**NOTE:** Use a flashlight to check that small orifices are clear in jets and nozzles.

Repeat cleaning cycle if required, if unable to clean, replace components.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Assembly

**NOTE:** Replace bowl gaskets and float needle.

**NOTE:** If choke override was accidentally removed, replace carburetor assembly.

### Choke Shaft

1. Insert the spring with the inner end in the short slot of the override assembly, place the other end resting on the outer edge (Figure 25).

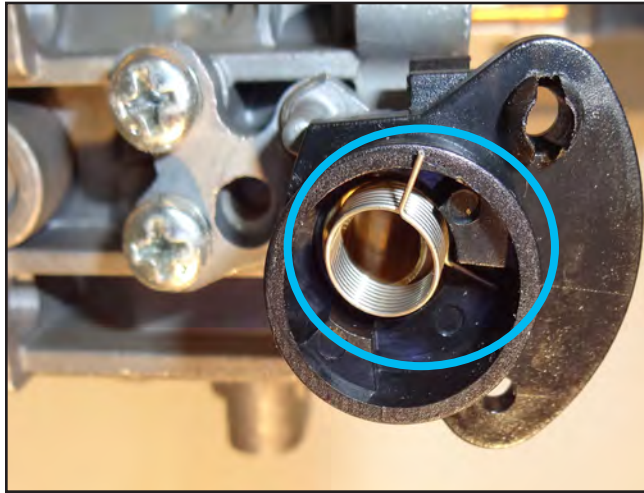


Figure 25

2. Place a drop of motor oil on each bearing surface of the choke shaft.
3. Insert the shaft through the spring and into the override and carburetor while rotating the shaft counter-clockwise to hook the spring end with the tang (Figure 26).

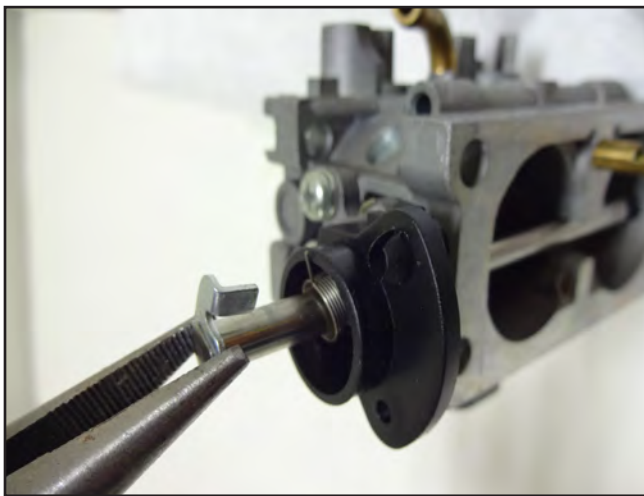


Figure 26

**NOTE:** The end of the spring sits against the curve of the tang.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Assembly (Cont.)

### Choke Shaft (Cont.)

4. Apply slight pressure to keep the spring hooked, rotate the shaft counter-clockwise until it drops into the short slot of the override assembly (Figure 27).



Figure 27

5. Snap on the outer cap to keep the shaft in position.
6. Insert the choke butterfly above the choke shaft in the fully open position (Figure 28).

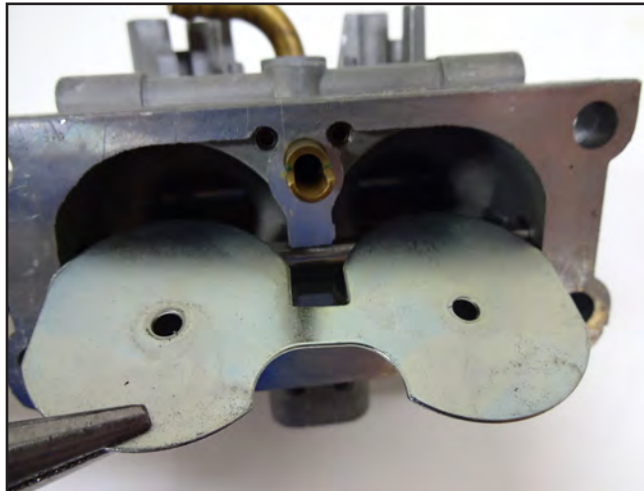


Figure 28



# TWO BARREL CARBURETOR AND FUEL SYSTEM

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## Assembly (Cont.)

### Choke Shaft (Cont.)

NOTE: Plate only fits one way, the deeper narrow slot goes toward the carburetor (Figure 29).

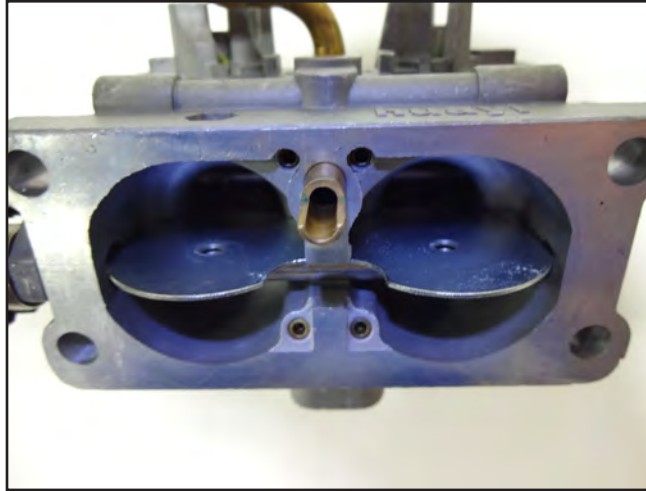


Figure 29

7. Rotate the shaft and butterfly to the fully closed position, attach the choke butterfly with the two screws.
8. Verify the choke shaft rotates freely and the override functions:
  - Check that the choke assembly is free to rotate, choke fully opens by the spring action.
  - While holding the choke override lever to close the choke, rotate the choke butterfly and shaft to the fully open position.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Assembly (Cont.)

### Throttle Shaft

1. Place a drop of motor oil on each bearing surface of the shaft (Figure 30).

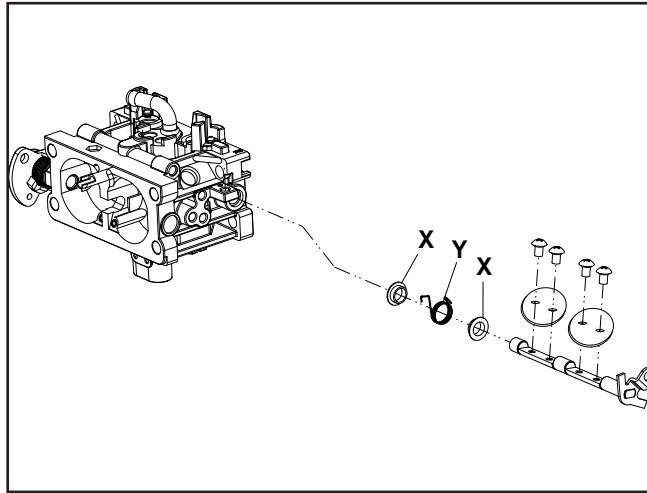


Figure 30

2. Install the spring and guides onto the throttle shaft if previously removed. Place a plastic guide (X) (Figure 30) on each side of the spring (Y). The long end of the spring is toward the carburetor, the short end hooks over the tang.
3. Slide the throttle shaft with the spring and bushings into the carburetor body, until only 1 in. of the shaft is exposed.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Assembly (Cont.)

### Throttle Shaft (Cont.)

4. Connect the spring to the carburetor and the shaft tang:
  - Hook the long end into the hole of the carburetor body (Figure 31).
  - Hook the outer end to the tang that contacts the idle speed screw (Figure 32). The tang is clockwise from the throttle link connector.

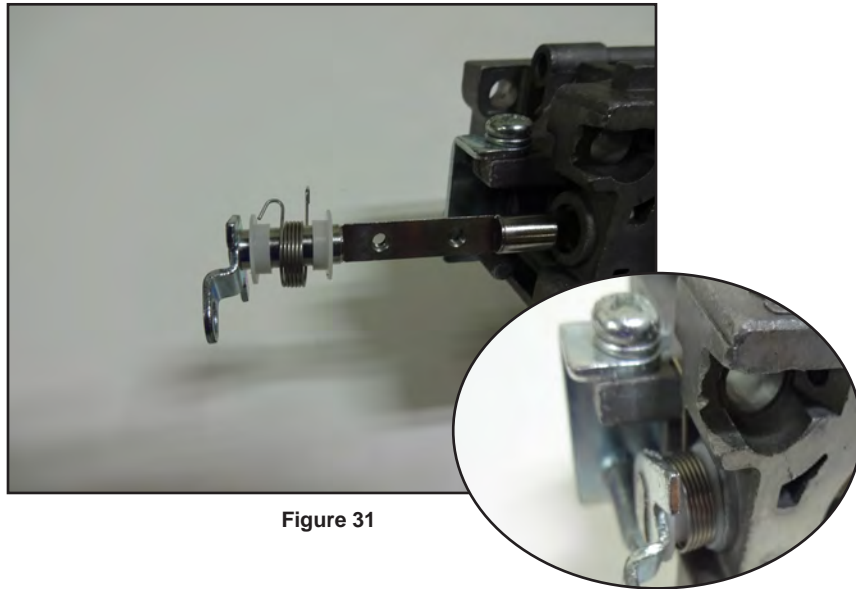


Figure 31

5. Rotate shaft counter-clockwise until the tang is past the idle screw, fully insert the shaft (Figure 32).



Figure 32

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Assembly (Cont.)

### Throttle Shaft (Cont.)

6. Install the throttle discs with the top of the disc inserted first, retain with four screw (Figure 33).

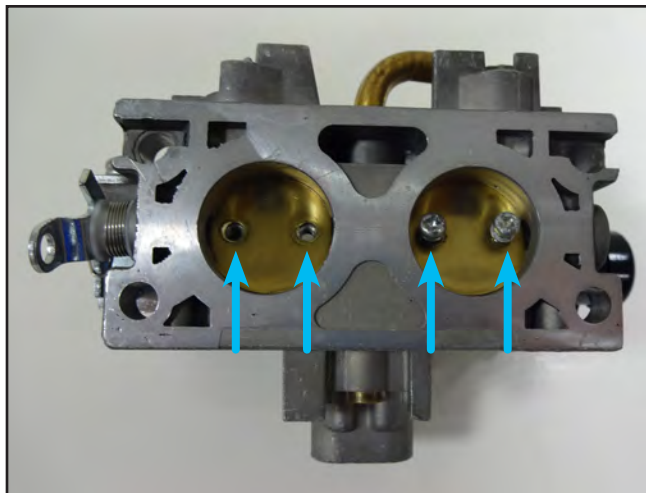


Figure 33

7. Verify the shaft is free to rotate and closes by the spring action (Figure 32).

# TWO BARREL CARBURETOR AND FUEL SYSTEM

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## Assembly (Cont.)

### Pilot Jets

1. Lightly lubricate the o-rings with engine oil.
2. Align the flat of the jet to match the carburetor casting. Slowly, insert into position, do not twist when installing (Figure 34).



Figure 34

3. Repeat for other jet.
4. Retain with a screw and washer.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Assembly (Cont.)

### Main Nozzles and Jets

1. Install the main nozzle with the wider shoulder inserted first, double shoulder is last (Figure 35).

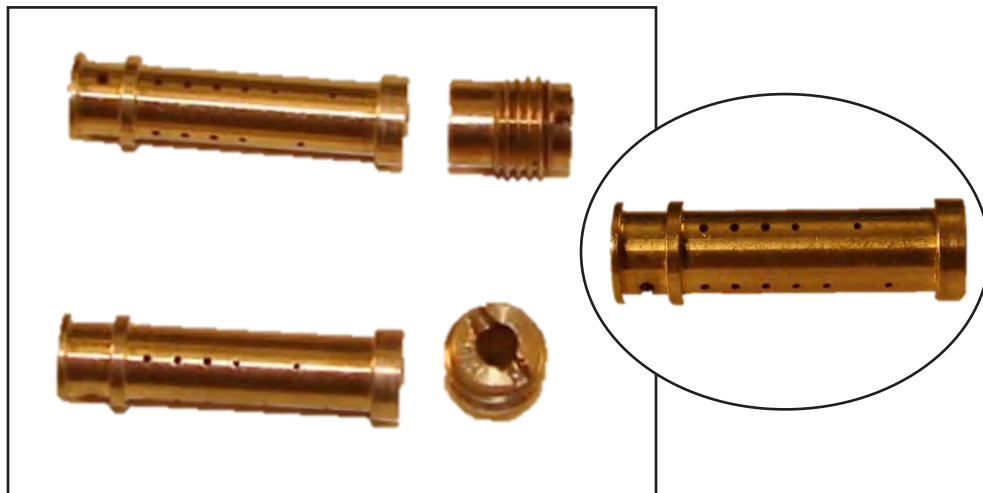


Figure 35

2. Install the threaded jet and tighten with fingers, tighten using a flat screwdriver.

**NOTE: When fully installed, jet is slightly lower than flush.**

3. Repeat for other nozzle and jet.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Assembly (Cont.)

### Needle and Float

1. Install the needle onto the tang of the float, needle tip pointed toward float (Figure 36).



Figure 36

**NOTE:** The tang has a slight hook to retain the needle.

2. Slide the needle into the seat while aligning the pivot of the float.
3. Install the float pin and clamp by tightening the screw (Figure 37).



Figure 37

**NOTE:** Verify the pin is fully inserted in the groove of the carburetor body.

4. Verify the float is free to pivot and the needle isn't sticking.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Assembly (Cont.)

### Float Bowl and Gaskets

1. Install a new o-ring gasket in the float bowl for the main nozzle (Figure 38).

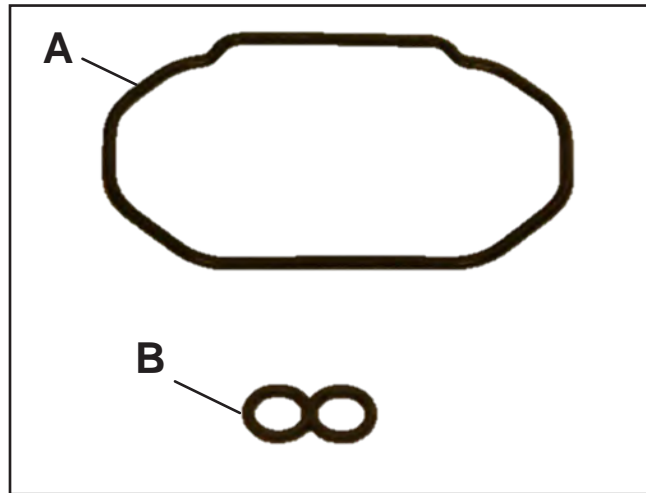


Figure 38

A. Float Bowl O-Ring Gasket      B. Main Nozzle O-Ring Gasket

2. Install a new bowl o-ring gasket onto the float bowl.
3. Align the two pins of the float bowl to the two holes in the carburetor body (Figure 39).

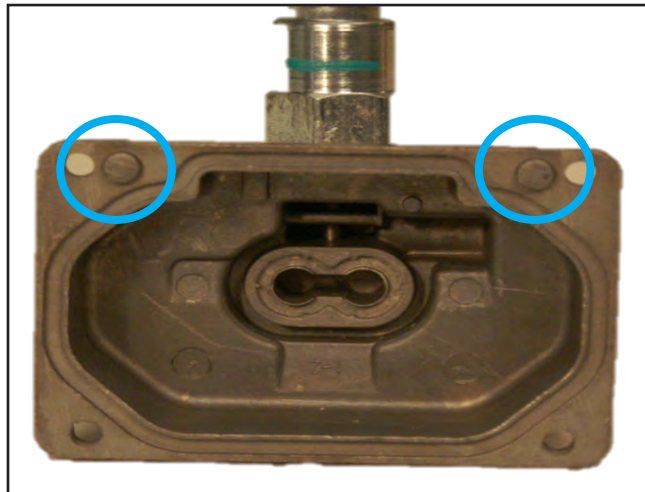


Figure 39

4. While holding the bowl to the carburetor body, use fingers to tighten the four screws.
5. Use a Phillips screwdriver in a crisscross pattern for the final tightening.
6. If previously removed, install new gasket onto drain screw, then install onto the float bowl.



# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Assembly (Cont.)

### Solenoid

1. Assemble solenoid (Figure 40):
  - Install spring into solenoid body, smaller coils of spring toward needle
  - Install needle into solenoid body, tip facing outward
  - Install new gasket

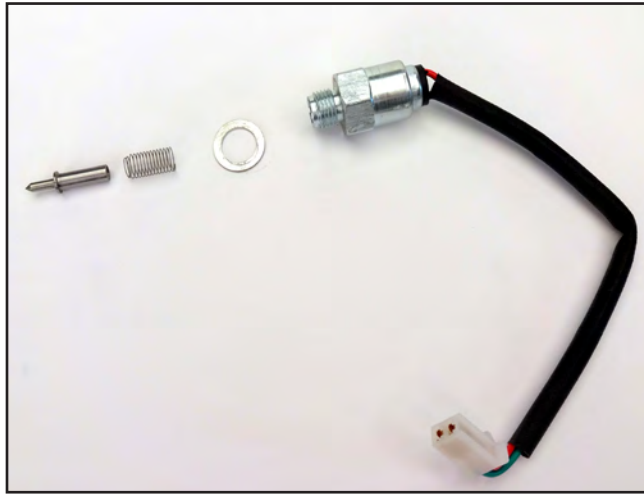


Figure 40



2. Install the solenoid assembly into the float bowl.
3. Torque the solenoid to 89 in-lbs. (10 Nm).

# TWO BARREL CARBURETOR AND FUEL SYSTEM

## Adjusting Idle Speed

**NOTE:** Perform adjustments with engine at operating temperature.

1. Verify idle speed RPM with tachometer.



2. Adjust the idle speed screw with the engine idling, to obtain the recommended engine idle speed of  $1800 \pm 150$  RPM (Figure 41).



Figure 41

**NOTE:** The carburetor does not have any additional adjustments.

# TWO BARREL CARBURETOR AND FUEL SYSTEM

---

## Carburetor Testing

### Pop Off Test

1. With carburetor removed, position with float bowl up.
2. Using a hand pressure tester, apply pressure to the fuel inlet.

**NOTE: Follow tester instructions.**

3. While pumping, observe the pressure increase.
4. Stop pumping, observe the pressure drop slightly, then stabilize as the float weight closes the needle and holds pressure. The pressure should not drop to zero.

**NOTE: An exact pressure value isn't required to measure the integrity of the float and needle to hold pressure.**

5. If pressure drops, evaluate needle tip and seat condition. Replace needle or carburetor as needed.

### Fuel Solenoid Test

1. Remove fuel shut-off solenoid from the carburetor.
2. Hold the solenoid vertically, with the solenoid valve pointing up, to keep the solenoid valve and spring from falling out.

**NOTE: Refer to [section 3, page 34](#) for proper assembly.**

3. Apply 12V DC power and ground to the solenoid leads. The solenoid valve should retract inside the solenoid body.

**NOTE: The solenoid should make an audible "click" when the key switch is turned on.**

4. Remove the voltage and the spring should push the solenoid valve back out.
5. Replace assembly if test fails as the solenoid is not serviceable.

# CONTROL PLATE (THROTTLE AND CHOKE)

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# CONTROL PLATE (THROTTLE AND CHOKE)

---

This section covers the description, location, and operation of the engine controls including throttle and choke cable mounting, governor troubleshooting, “zero” adjustment and top no-load RPM adjustment.

**WARNING:** Unauthorized adjustment to the carburetor or fuel system may make the machine non-compliant to EPA standards. Make sure components are set to factory standards.

<p><b>⚠ WARNING</b></p> <p>Explosive fuel can cause fires and severe burns.</p> <p>Do not fill fuel tank while engine is hot or running.</p> <p>Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, occupied buildings, away from sparks or flames. Spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Never use gasoline as a cleaning agent.</p>
---

## Engine Controls Operation

**Introduction:** The control plate transfers the operator’s choke and throttle settings to the carburetor (Figure 1).

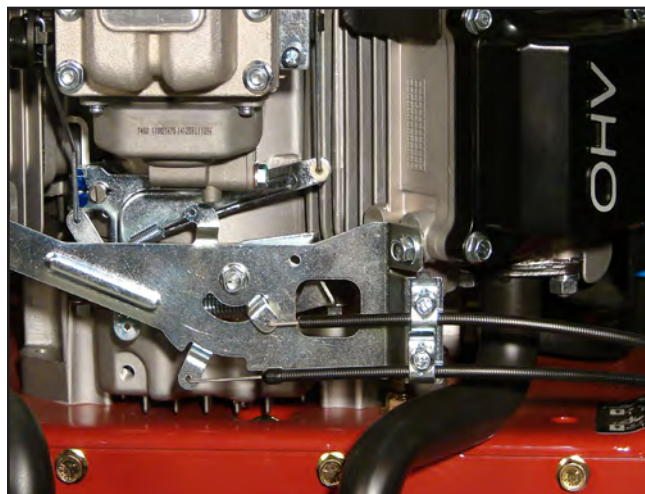


Figure 1

# CONTROL PLATE (THROTTLE AND CHOKE)

## Cable Location

Throttle and Choke Cable Mounts: The throttle cable is the upper cable, choke cable is the lower cable. The conduit is clamped below with an anchor screw (Figure 2).

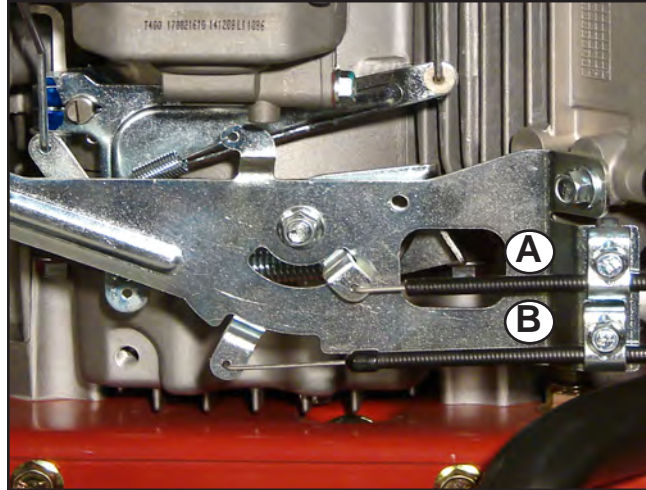


Figure 2

- A. Throttle Cable
- B. Choke Cable

# CONTROL PLATE (THROTTLE AND CHOKE)

## Control Plate Exploded View

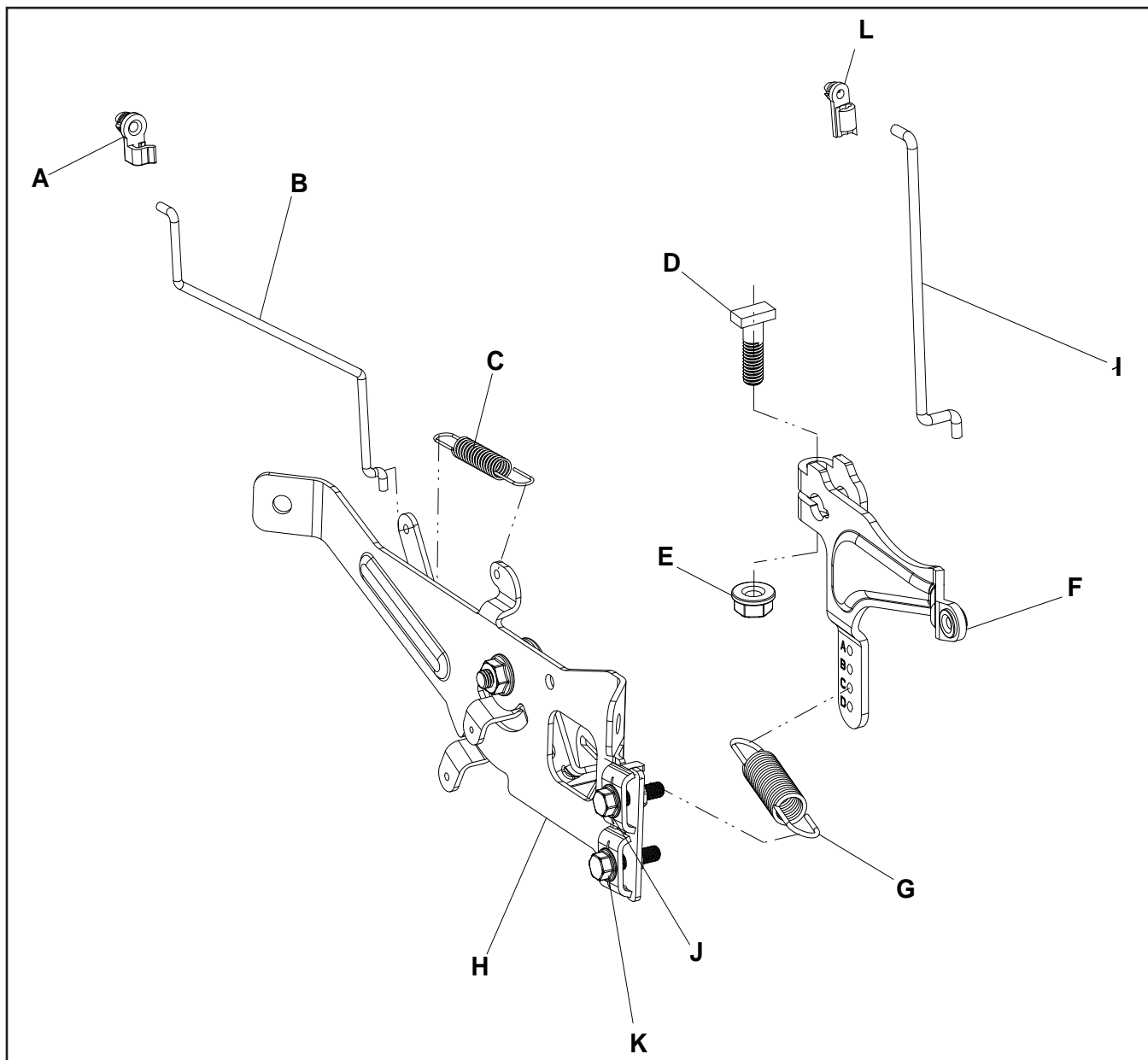


Figure 3

- |                       |                           |
|-----------------------|---------------------------|
| A. Choke Linkage Clip | G. Governor Spring        |
| B. Choke Linkage      | H. Control Plate Assembly |
| C. Choke Spring       | I. Throttle Linkage       |
| D. Governor Arm Bolt  | J. Throttle Cable Clamp   |
| E. Flange Nut         | K. Choke Cable Clamp      |
| F. Governor Arm       | L. Clamp Lock             |

# CONTROL PLATE (THROTTLE AND CHOKE)

## Adjustments



### Choke Cable (Figure 4)

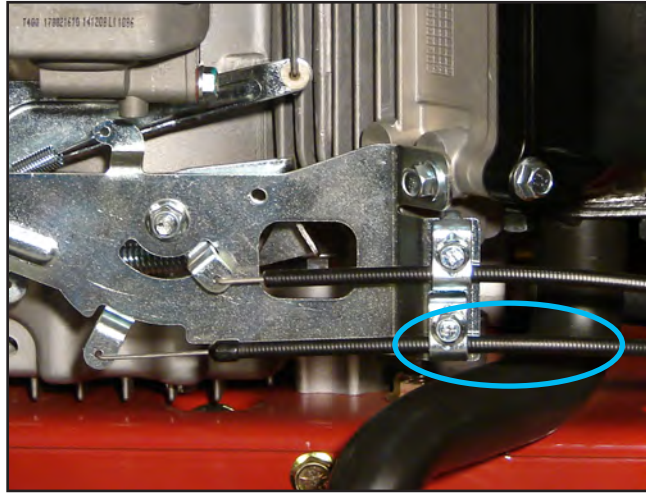


Figure 4

1. Move the control lever to full choke and hold.
2. Loosen the clamp.
3. Pull the conduit to the right to remove the slack in the cable.
4. Tighten the clamp on the control plate.
5. Verify proper operation of choke.

**NOTE:** During start-up, the cable may not stay in the full choke position unless the operator holds it.

**NOTE:** Choke must be fully closed for maximum fuel pump output.



# CONTROL PLATE (THROTTLE AND CHOKE)

---

## Adjustments

### Throttle Cable (Figure 5)

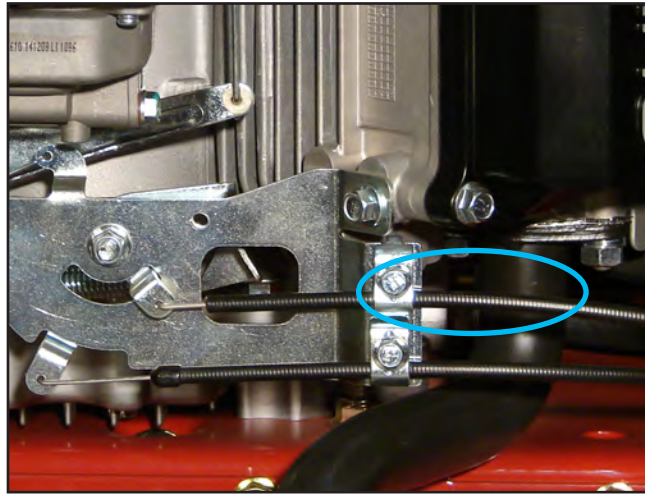


Figure 5



1. Move control lever to “fast speed” setting (full forward) and hold.

**NOTE:** There is a slight detent.

2. Loosen the clamp.
3. Pull the conduit to the right to remove slack in the cable.
4. Tighten the clamp on the control plate.
5. Verify all linkages are free to move.
6. Check top no-load RPM; [see “Top No-Load RPM,” chapter 4, page 4-9.](#)

# CONTROL PLATE (THROTTLE AND CHOKE)

## Linkages and Springs

**Introduction:** The control plate and the governor control the carburetor with linkages and springs.

### Operation

**Choke Linkage:** Connects the choke override lever to the choke pivot on the control plate. It is located on the number one cylinder side of the carburetor. The upper end of the link has a quick clip for easy carburetor removal. The choke linkage is longer than the throttle linkage, and has multiple bends (Figure 6).

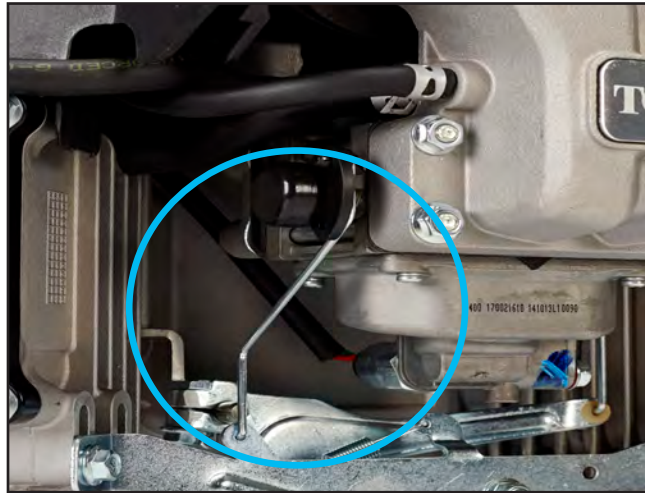


Figure 6

**Choke Spring:** Located behind the control plate, it assists in opening the choke. Connects to the pivot arm and fixed anchor on the control plate, approximate length is 2.44 in. (61.98 Nm) (Figure 7).

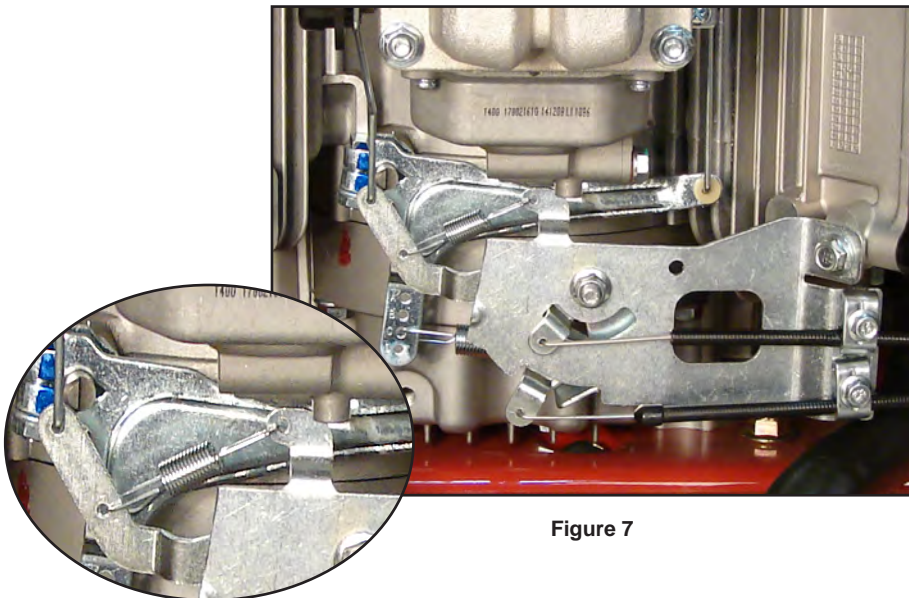


Figure 7

# CONTROL PLATE (THROTTLE AND CHOKE)

---

## Linkages and Springs (Cont.)

Throttle Linkage: Located on the number two cylinder side of the carburetor. Connects governor arm to the throttle shaft. The upper end connects to the throttle shaft with a quick clip for easy carburetor removal. The lower end connects to the governor arm. The throttle linkage is shorter than choke linkage, and has fewer bends (Figure 8).

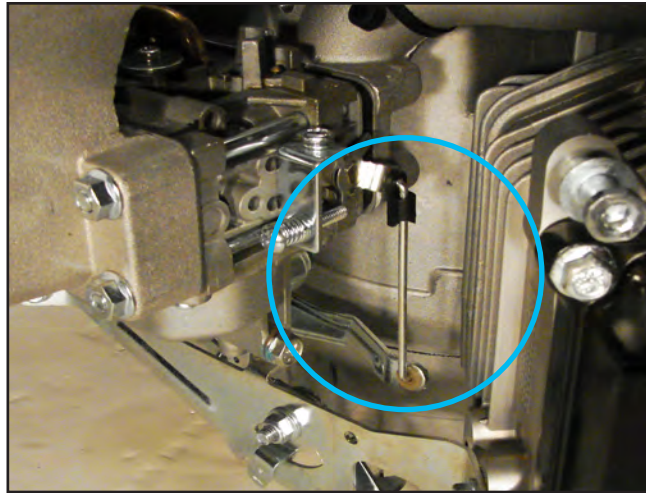


Figure 8

Governor Spring: Located behind the control plate, and assists in maintaining proper engine RPM by pulling the throttle open. One end connects to hole "C" of the governor arm, the other end connects to the throttle pivot on the control plate. Approximate length is 1.64 in. (41.66 Nm) (Figure 9).



Figure 9

# CONTROL PLATE (THROTTLE AND CHOKE)

## Linkages and Springs (Cont.)

### Disassembly

#### Link (Choke or Throttle)

1. Unclip the quick clip (A) (Figure 3) and rotate away from link.
2. Remove the upper end from the carburetor.
3. Unhook the lower end and remove the link (Figure 10).

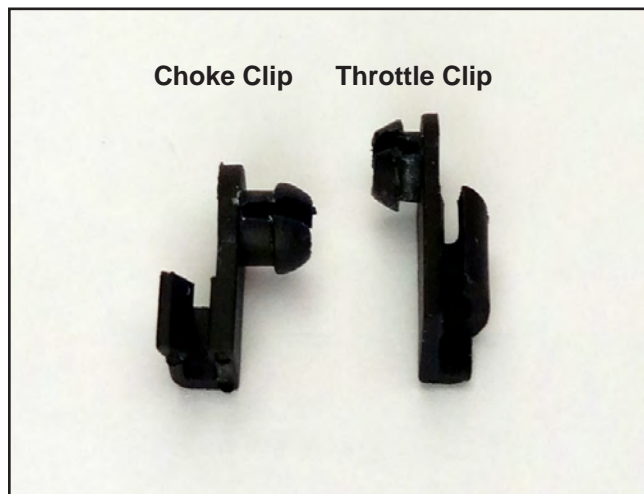


Figure 10

### Adjustment

#### Top No-Load RPM

- A) Verify
1. Start and run engine until at operating temperature.
  2. Move the throttle control to "Fast Speed" setting.
  3. Check RPM with tachometer, top no-load RPM  $3300 \pm 100$  RPM.

# CONTROL PLATE (THROTTLE AND CHOKE)

---

## Adjustment (Cont.)

### Top No-Load RPM (Cont.)

#### B) Adjust

1. Insert pin into alignment hole through the control plate and throttle pivot arm (Figure 11).

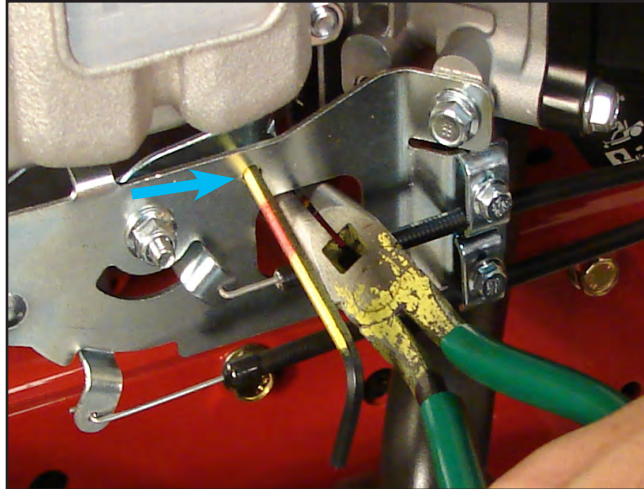


Figure 11

**NOTE:** Examples of a pin: hex key, end of drill bit, solid rod, screwdriver, etc.

2. Change speed by bending the governor spring anchor on the control plate.
  - Increase speed (elongate spring): insert pliers and rotate clockwise (CW) to bend anchor.
  - Decrease speed (shorten spring): insert pliers and rotate counter-clockwise (CCW) to bend anchor.
3. Remove the pin.
4. Verify top no-load RPM adjustment with a tachometer.

### Idle RPM

See “Adjusting Idle Speed,” chapter 3, page 3-35.



# CONTROL PLATE (THROTTLE AND CHOKE)

## Adjustment (Cont.)

### Governor “Zero”

1. Engine off.
2. Verify throttle is in (Wide Open Throttle) WOT position.

**NOTE: Governor spring pulls to WOT when throttle control is set to “fast speed.”**

3. Slightly loosen clamp nut/bolt on governor arm.
4. Rotate D of governor shaft counter-clockwise (CCW) while maintaining WOT.
5. Hold and tighten clamp nut/bolt.

**NOTE: Internal engine damage will occur if engine is operated with clamp loose.**

6. Verify throttle linkage is free to move up and down.
7. Test run to operating temperature and check top no-load RPM with tachometer (Figure 12).

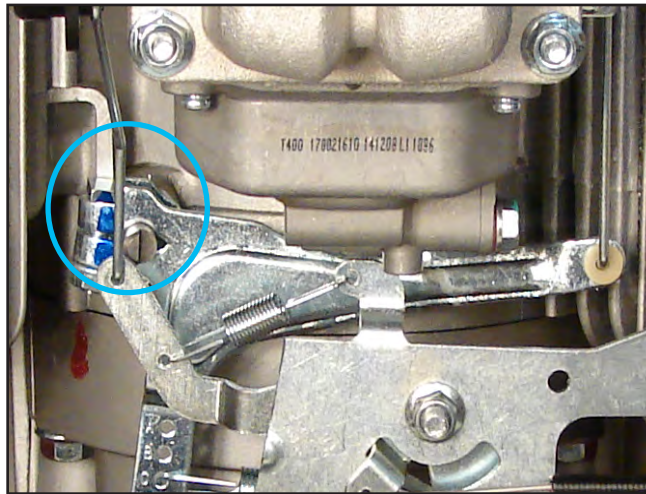


Figure 12

# CONTROL PLATE (THROTTLE AND CHOKE)

## Troubleshooting

### Engine Surging/Hunting

1. Start and run engine until at operating temperature.
2. Move throttle control to “fast speed” setting.
3. Check RPM with tachometer, top no-load RPM  $3300 \pm 100$  RPM.

**NOTE:** [See “Top No-Load RPM,” chapter 4, page 4-9.](#)

4. If RPM varies beyond limits:
  - Verify adequate clean air.
  - Verify adequate clean fresh fuel supply.
  - Verify not caused by parasitic load (transmission or clutch).
5. Troubleshoot to determine if engine related:
  - Hold throttle shaft or link to maintain top no-load RPM.
  - Refer to troubleshooting chart (in no particular order).

\*Hold throttle shaft or link to maintain top no-load RPM

Symptom	Possible Cause	Action
<b>If engine still surges</b>	Air leak into intake system between carburetor and cylinder heads.	-Check and replace gaskets -Check fuel pump and pulse hose
	Lack of fuel in carburetor bowl.	-Check fuel delivery system -Check float and needle
	Fuel supply partially blocked in carburetor Air vents partially blocked in carburetor	-Check pilot jets, main jets and nozzles, venturi ports -Check air passages using compressed air
<b>If engine is constant RPM</b>	Linkage binding	-Check linkage or governor spring are not binding
	Throttle shaft binding	-Check throttle shaft and components for debris/damage
	Governor out of adjustments	-Adjust governor “zero”; <a href="#">see “Governor Zero,” chapter 4, page 4-11</a>
	Governor Spring	-Check spring is not binding -Check spring length
<b>If engine quits running</b>	Fuel supply blocked in carburetor Air vents blocked in carburetor	-Check pilot jets, main jets and nozzles, venturi ports -Check air passages using compressed air -Check fuel solenoid function, <a href="#">see “Solenoid,” chapter 3, page 3-34</a>

6. Test run to operating temperature and verify top no-load RPM with tachometer.

# ELECTRICAL SYSTEM AND COMPONENTS

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# ELECTRICAL SYSTEM AND COMPONENTS

## Electrical System Components

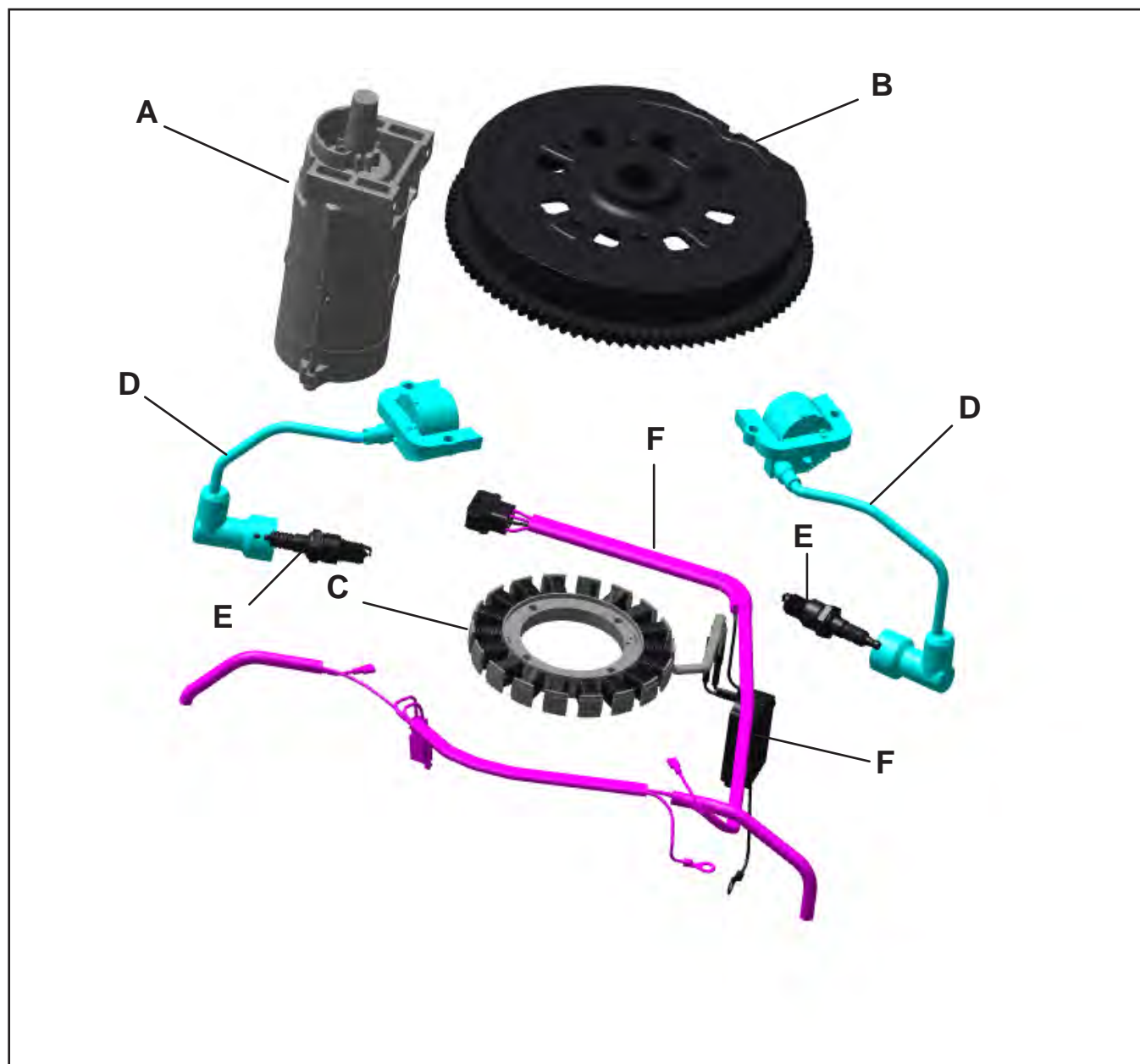


Figure 1

- |                        |  |
|------------------------|--|
| A. Electric Starter    | D. Ignition Coils                      |
| B. Flywheel            | E. Spark Plugs                         |
| C. Stator (Alternator) | F. Voltage Regulator with Wire Harness |

# ELECTRICAL SYSTEM AND COMPONENTS

This section covers the description, location, and operation of the electrical system components including the charging system, electric starter, and the ignition spark circuit.

<b>⚠ WARNING</b>
<b>Electric shock can cause injury.</b>
<b>Do not touch wires while engine is running.</b>

## Spark Circuit

The spark circuit components include the two ignition coils, flywheel magnets, and spark plugs.

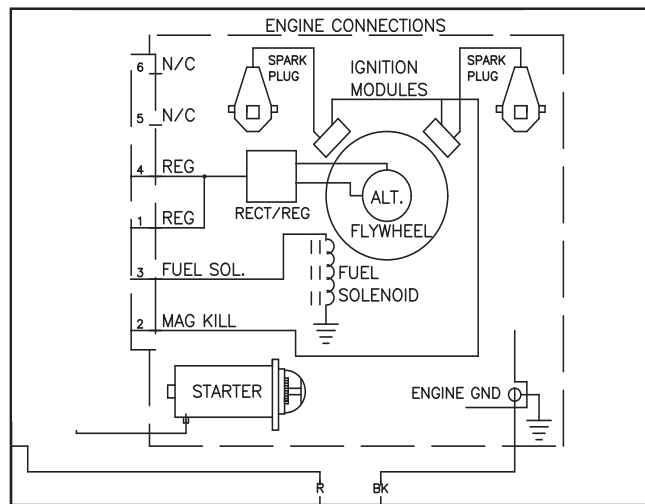


Figure 2

Voltage Regulator = Yellow  
Fuel Solenoid= Red  
Mag Kill= Black  
Engine Ground=Green

Spark Plugs: One per cylinder, emission certified for all three choices:

1. NHSP BP8RES
2. Champion RN9YC
3. NGK BPR6ES

Proper gap is 0.030 in. (0.76 mm). A normal spark plug condition (color, oily, dry) should be light gray or tan in color. The center electrode should be dry, like new. The porcelain should be white to tan, not cracked.

Ignition Coils: The ignition coils create high voltage spark for the combustion ignition. They are mounted under the blower shroud on top of each cylinder, next to the flywheel. They are interchangeable for either cylinder (Figure 1).



# ELECTRICAL SYSTEM AND COMPONENTS

## Charging System

**Introduction:** The charging system components include the stator, voltage regulator with the wiring harness, and flywheel (Figure 1).

**Flywheel:** Located under the blower shroud and mounted to the upper end of the crankshaft, made of cast iron and permanent magnets (two exterior and twenty interior). Magnets create magnetic field for ignition coils to create spark, and stator to create AC voltage.

**Stator (Alternator):** Located under the flywheel and mounted to the top of the engine block. Made of 18 copper wire windings over an iron core, it creates AC voltage as the flywheel magnets rotate around the windings.

**Voltage Regulator:** Mounted to the dipstick tube, converts AC voltage to DC voltage and limits maximum DC voltage output. It also contains the engine wire harness.

**Engine Wire Harness:** Located under the blower shroud, it is attached to the intake manifold with several plastic ties. The fuel shut-off solenoid connects to the harness above the intake manifold. There are two ground terminals;

1. At the sump cover below the oil filter and
2. At the intake manifold bolt above the #2 cylinder.

The harness connects the following engine components to the chassis harness; fuel shut-off solenoid, ignition coil grounds, and the voltage regulator (Figure 3).

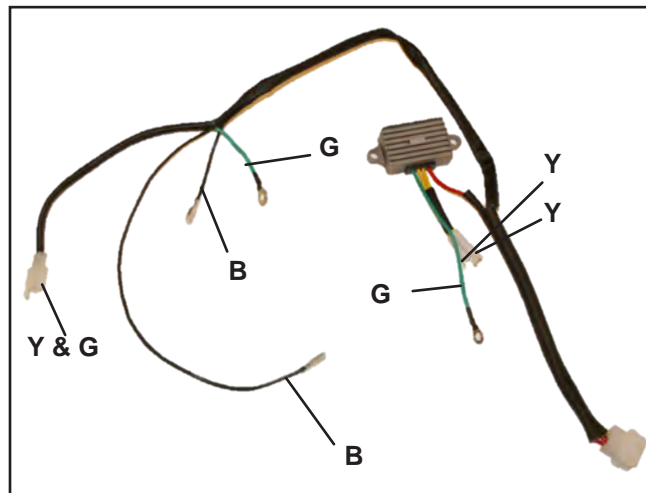


Figure 3

### Wire Colors:

B: Black  
G: Green  
Y: Yellow

# ELECTRICAL SYSTEM AND COMPONENTS

## Charging System Testing

**NOTE:** Use the three stator tests below to determine if the flywheel or stator has failed.

### OHM Resistance Test Across the Leads

1. Shut engine off.
2. Set Digital Multi-Meter to OHMs.
3. Connect Digital Multi-Meter leads to stator leads.

**NOTE:** Unplug from engine harness.



Figure 4

4. Measure the resistance. Expected measurement should be less than one OHM (component at room temperature).
5. Replace stator if measured resistance is higher than one OHM.

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Charging System Testing (Cont.)

### OHM Resistance Test to Ground

1. Shut off the engine.
2. Set Digital Multi-Meter to OHMs.
3. Connect one Digital Multi-Meter lead to either stator lead.

#### **NOTE: Unplug from engine harness.**

4. Connect other Digital Multi-Meter lead to ground (stator frame or engine block if stator mounted to the engine block).
5. Measure the resistance. Expected measurement should be (high resistance) infinity (component at room temperature).
6. Replace stator if measured resistance is less than infinity.

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Charging System Testing (Cont.)

### AC Volts Output at Leads

1. Engine running at Top No-Load RPM (3300 RPM).
2. Set Digital Multi-Meter to AC volts.
3. Connect both Digital Multi-Meter leads to each stator lead.
4. Measured AC volts. Expected reading should be minimum of 30 VAC at top no-load RPM.
5. If measure voltage is below 30 volts AC, inspect flywheel for broken or cracked magnets.
6. Replace flywheel if magnets are damaged.
7. Repeat step 4.
8. If measured voltage is still below 30 volts AC replace stator.

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Ignition Coil Testing

### Ignition Coil Test:

**NOTE:** Either bench test or test mounted to the engine.

1. Set Digital Multi-Meter to OHMs.

#### 2. Primary coil test (Figure 5)

- Connect one lead to the ground terminal of the coil (harness wire removed).
- Connect other lead to the iron core of the coil.
- Measure resistance, primary coil resistance 1.6-1.9  $\Omega$

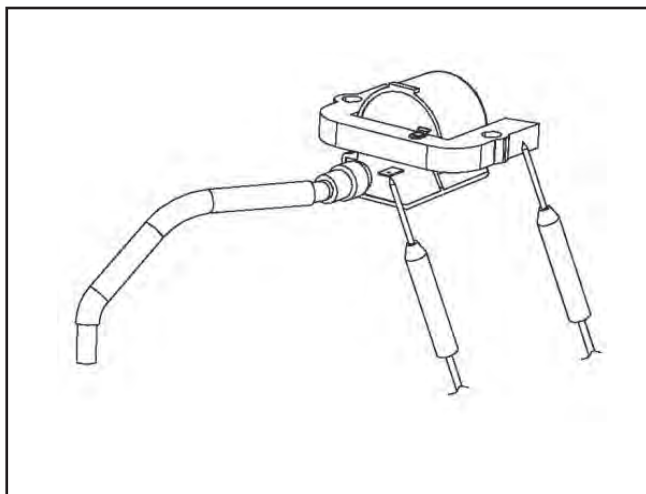


Figure 5

3. Replace ignition coil if measured resistance is out of range.

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Ignition Coil Testing (Cont.)

### Ignition Coil Test (Cont.):

#### 4. Secondary coil test (Figure 6)

- Connect one lead to the spark plug's high tension terminal.
- Connect the other lead to the iron core of the coil.
- Measure resistance, secondary coil resistance 6.2-7.1 K $\Omega$ .

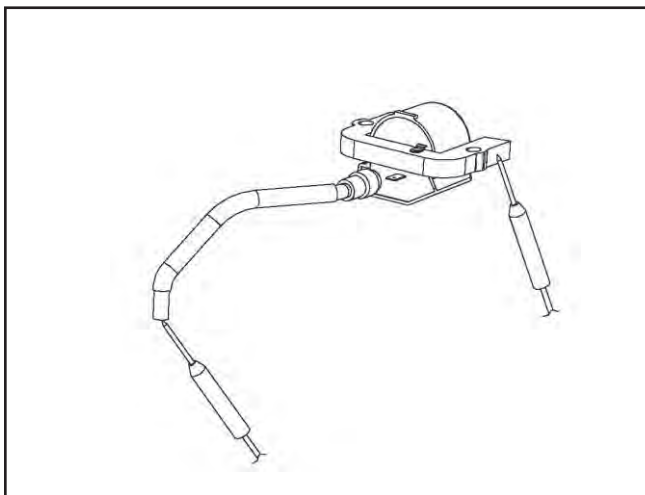


Figure 6

5. Replace ignition coil if out of specification.



# ELECTRICAL SYSTEM AND COMPONENTS

---

## Ignition Coil Testing (Cont.)

### Testing spark while engine is operating

1. Shut off the engine.
2. Connect in-line spark tester between the spark plug's high tension terminal and the spark plug (Figure 7).

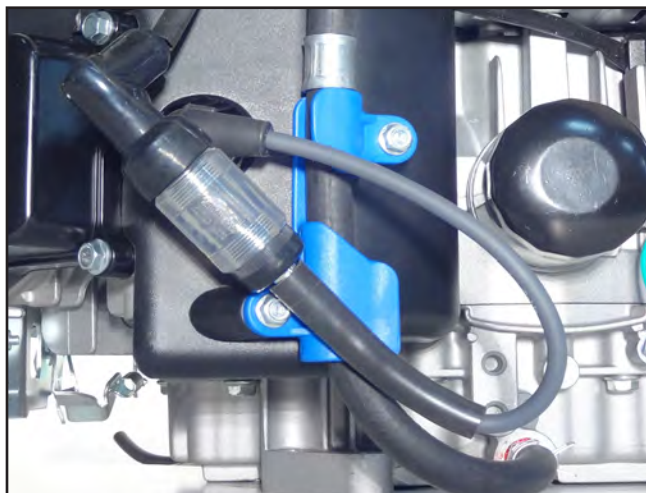


Figure 7

3. If two testers are available both coils can be checked at once.
4. Start the engine.
5. Monitor tester(s) for spark at both idle and fast throttle.

**NOTE: Spark plug condition affects testing accuracy.**

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Ignition Coil Testing (Cont.)

### Testing spark using electric starter only

 <b>WARNING</b>
Avoid fire and explosion.
This test creates open spark which could ignite spilled fuel.

1. Connect spark tester to spark plug's high tension terminal.

**NOTE: Do not remove the spark plugs.**

2. Ground tester to engine block.

**NOTE: Tester must have good ground to cylinder block, not plastic.**

3. If two testers are available, both coils can be checked at once.
4. Use electric starter to rotate engine.

**NOTE: Do not engage the starter for more than 10 seconds at a time. Failure to follow these instructions can damage the starter motor.**

5. Monitor tester(s) for spark.

### If no spark is present

1. Check chassis safety system, refer to product service manual.
2. Verify spark tester is fully inserted into spark plug's high tension terminal.
3. Repeat test.
4. Remove coil ground wire.
5. Repeat test.
6. Replace ignition coil if still no spark.



# ELECTRICAL SYSTEM AND COMPONENTS

---

## Voltage Regulator Testing

### Setup

1. Shut off the engine.
2. Verify the battery is in good condition (minimum 12.5 VDC).

**NOTE: If weak or no battery in the circuit, voltage regulator output will be zero.**

3. Measure the battery voltage at the battery for baseline voltage reading.

### Test 1 (Complete Circuit Test)


1. Set Digital Multi-Meter to DC volts.
  - Connect the red lead to the positive post of the battery.
  - Connect the black lead to the negative post of the battery.
2. Start the engine.
3. Measure the battery voltage as engine speed increases from idle to fast.
4. Compare to expected voltage (battery voltage up to 15.1 VDC with speed 2200 to 3300 RPM):
  - If measured voltage is above or below expected voltage perform Test 2 ([page 5-13](#)).
  - If measured voltage is in range, voltage regulator is working properly.

# ELECTRICAL SYSTEM AND COMPONENTS

---

## Voltage Regulator Testing (Cont.)

### Test 2 (Circuit Test without Chassis Harness)

- 
1. Set Digital Multi-Meter to DC volts.
    - Connect the red lead to the red wire of the engine harness plug (DO NOT unplug from chassis harness).
    - Connect the black lead to the **negative post of the battery**.
  2. Start the engine.
  3. Measure the battery voltage as engine speed increases from idle to fast.
  4. Compare to expected voltage (battery voltage up to 15.1 VDC with speed 2200 to 3300 RPM):
    - If measured voltage is above or below expected voltage perform Test 3.
    - If measured voltage is in range, voltage regulator is working properly and the chassis harness has an issue between the voltage regulator and battery.
      - a. Verify wire harness connections
        - At engine harness to chassis harness
        - At ignition switch
        - At starter solenoid
        - At positive battery terminal
      - b. Inspect fuses
        - Charge system
        - Main harness
      - c. Repeat Test 1 to validate charging system is working properly.



# ELECTRICAL SYSTEM AND COMPONENTS

---

## Voltage Regulator Testing (Cont.)

### Test 3 (Test Voltage Regulator Only)

1. Set Digital Multi-Meter to DC volts.
  - Connect the red lead to the red wire of the engine harness plug (**DO NOT** unplug from chassis harness).
  - Connect the black lead to the **ground on the engine block**.
2. Start the engine.
3. Measure the battery voltage as engine speed increases from idle to fast.
4. Compare to expected voltage. Expected voltage range (battery voltage up to 15.1 VDC with speed 2200 to 3300 RPM).
  - a. If measured voltage is above or below expected voltage, replace the voltage regulator.
  - b. If measured voltage is in range, voltage regulator is working properly and the ground circuit has an issue between the engine and battery:
    - Inspect the battery cables and terminals for corrosion, clean terminals and/or replace cables.
    - Verify ground connections, negative battery cable to engine and voltage regulator to sump cover.
  - c. Repeat Test 1 to validate charging system is working properly.

# ELECTRICAL SYSTEM AND COMPONENTS

## Electric Starter Testing

### Bench Test

<b>⚠ WARNING</b>
Avoid lacerations and amputations.
This test has exposed rotating parts.

1. Clamp the mounting ear of the starter in the vice.

**NOTE: Do not clamp circular motor body.**

2. Apply battery voltage to electric starter terminal.
3. Apply ground momentarily (2 seconds) to base of starter.
3. Observe starter and Bendix gear action.
4. Replace starter if failed test.

### Test on Engine

1. Turn the ignition key off.
2. Remove chassis power to starter (tape for safety).
3. Apply battery voltage momentarily (2 seconds) to the starter terminal (Figure 8).



Figure 8

4. Observe starter and Bendix gear action.
5. Replace starter if failed test.

# LUBRICATION SYSTEM

---

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# LUBRICATION SYSTEM

## Lubrication Components

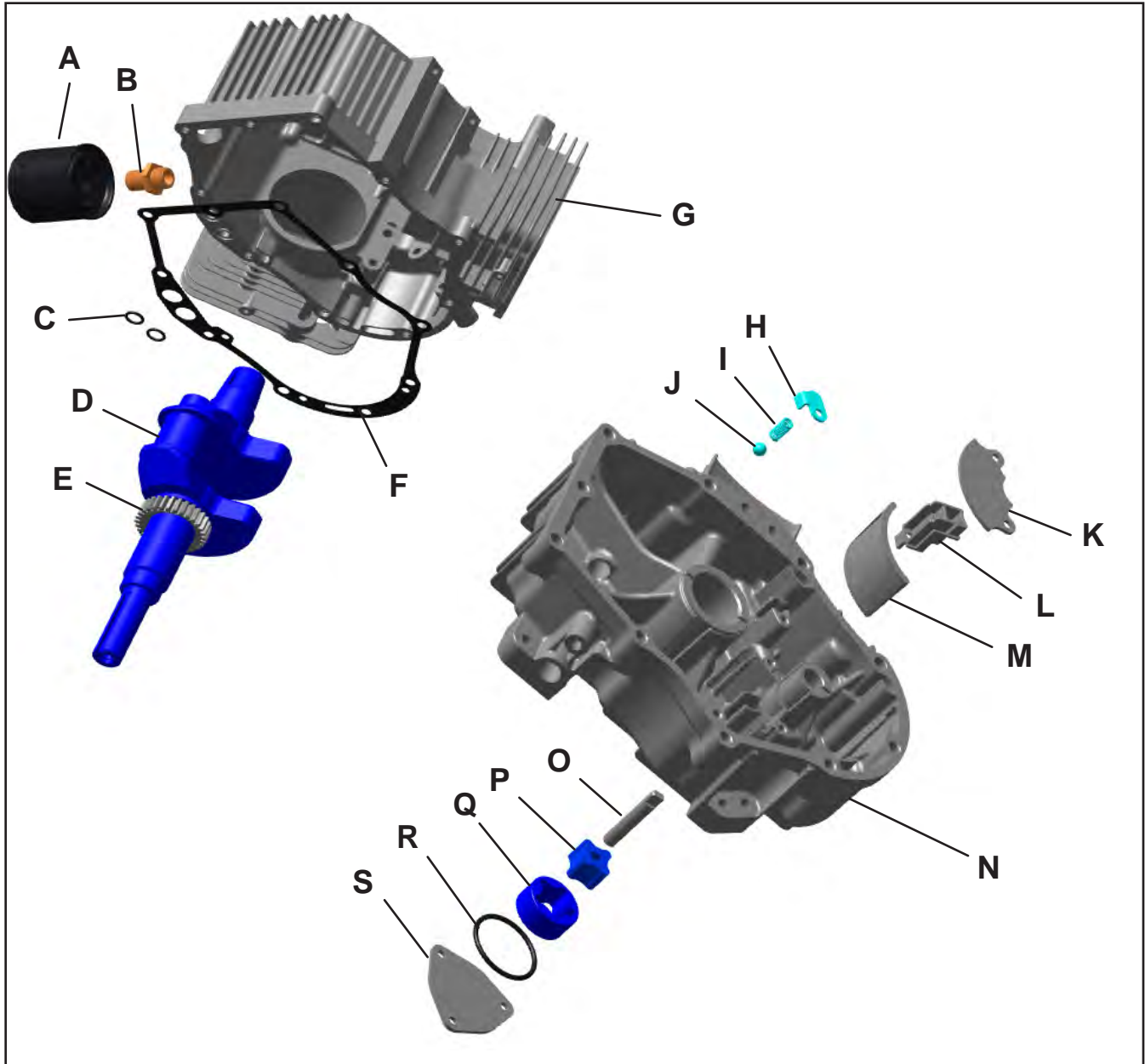


Figure 1

- |                      |                                 |                    |
|----------------------|---------------------------------|--------------------|
| A. Oil Filter        | H. Cover (Check Ball Assembly)  | O. Oil Pump Shaft  |
| B. Adapter Fitting   | I. Spring (Check Ball Assembly) | P. Gerotor (Inner) |
| C. O-Rings           | J. Check Ball                   | Q. Gerotor (Outer) |
| D. Crankshaft        | K. Cover (Screen Assembly)      | R. O-Ring          |
| E. Crankshaft Gear   | L. Retainer (Screen Assembly)   | S. Oil Pump Cover  |
| F. Sump Cover Gasket | M. Screen                       |                    |
| G. Crankcase         | N. Sump Cover                   |                    |



# LUBRICATION SYSTEM

This section covers the components for the lubrication system. The system uses a gerotor pump to provide pressurized oil to the following critical bearing surfaces; upper and lower crankshaft, connecting rod journals.

## Oil Flow

Oil Filtration: Mesh screen in crankcase sump cover, spin-on oil filter.

Oil Pressure Circuit: Gerotor Pump (gear pump) located at the lowest point of the crankcase sump. Driven by the camshaft, draws oil through the screen and creates pressurized oil. Pressure relief valve is located in the crankcase sump and protects the pressurized circuit from over pressure, exits the sump cover/enters the crankcase, flows through the oil filter. Pressurized and clean, flow splits, upper and lower crankshaft bearing. The lower crankshaft bearing is cross drilled allowing oil flow to the connecting rod journals. Each rod cap has an oil relief for maximum lubrication.

## Maintenance

No tools oil change

**NOTE: Change the oil when engine is warm.**

1. Clean external areas of the engine.
  - Dipstick and Tube
  - Oil Filter
  - Drain Hose
2. Remove the oil drain hose from the blower shroud.
  - Unwind hose from the cleat,
  - While twisting, pull downward on the hose (Figure 2).

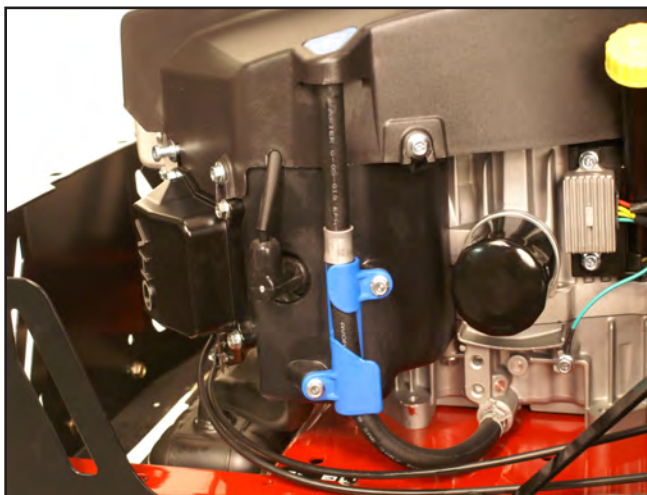


Figure 2

# LUBRICATION SYSTEM

---

## Maintenance (Cont.)

3. Lower the hose into the drain pan.
4. Drain the oil.
5. Place a drain pan under the oil filter and remove.
6. Remove and discard oil filter gasket if still on the cylinder block.
7. Once oil has drained, install hose into the cleat and slide onto shroud fitting.
8. Install the new oil filter.

**NOTE: Verify oil filter gasket from step 6 is removed.**



9. Tighten filter until the gasket contacts the engine block, continue tightening 3/4 turn or torque 106 in-lbs. (12 Nm).
10. Fill the crankcase with oil, [see “Oil Chart,” section 1, page 1-11.](#)

# ENGINE DISASSEMBLY

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# ENGINE DISASSEMBLY

## Upper Disassembly 1

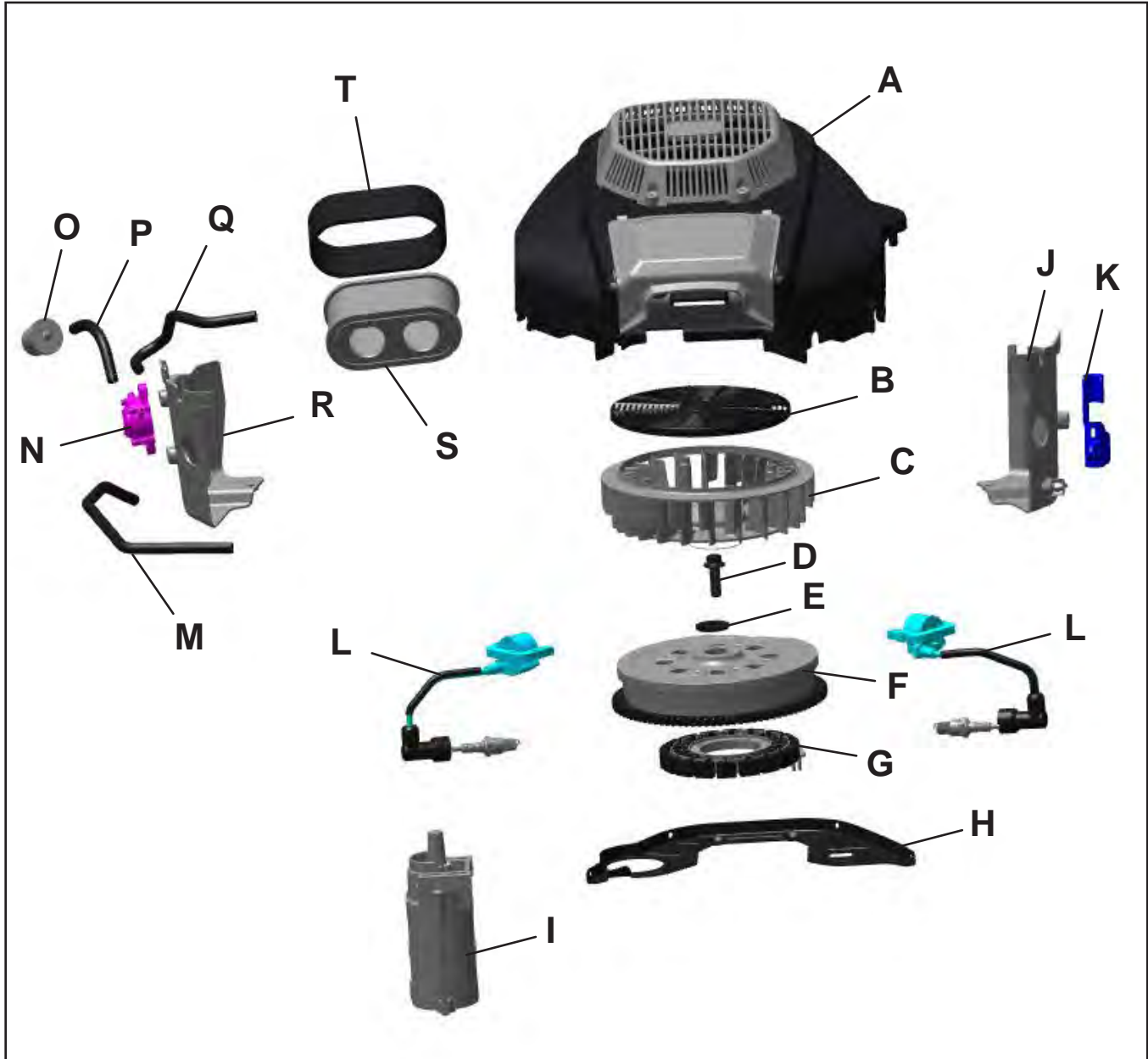


Figure 1

- |                    |                         |                  |
|--------------------|-------------------------|------------------|
| A. Blower Shroud   | H. Lower Baffle         | O. Fuel Filter   |
| B. Shredder Screen | I. Electric Starter     | P. Fuel Line     |
| C. Flywheel Fan    | J. Side Shroud          | Q. Vacuum Line   |
| D. Bolt            | K. Oil Drain Hose Cleat | R. Side Shroud   |
| E. Washer          | L. Ignition Coil        | S. Paper Element |
| F. Flywheel        | M. Fuel Line            | T. Foam Element  |
| G. Stator          | N. Fuel Pump            |                  |

**NOTE:** Mounting components not shown.

# ENGINE DISASSEMBLY

## Upper Disassembly 2

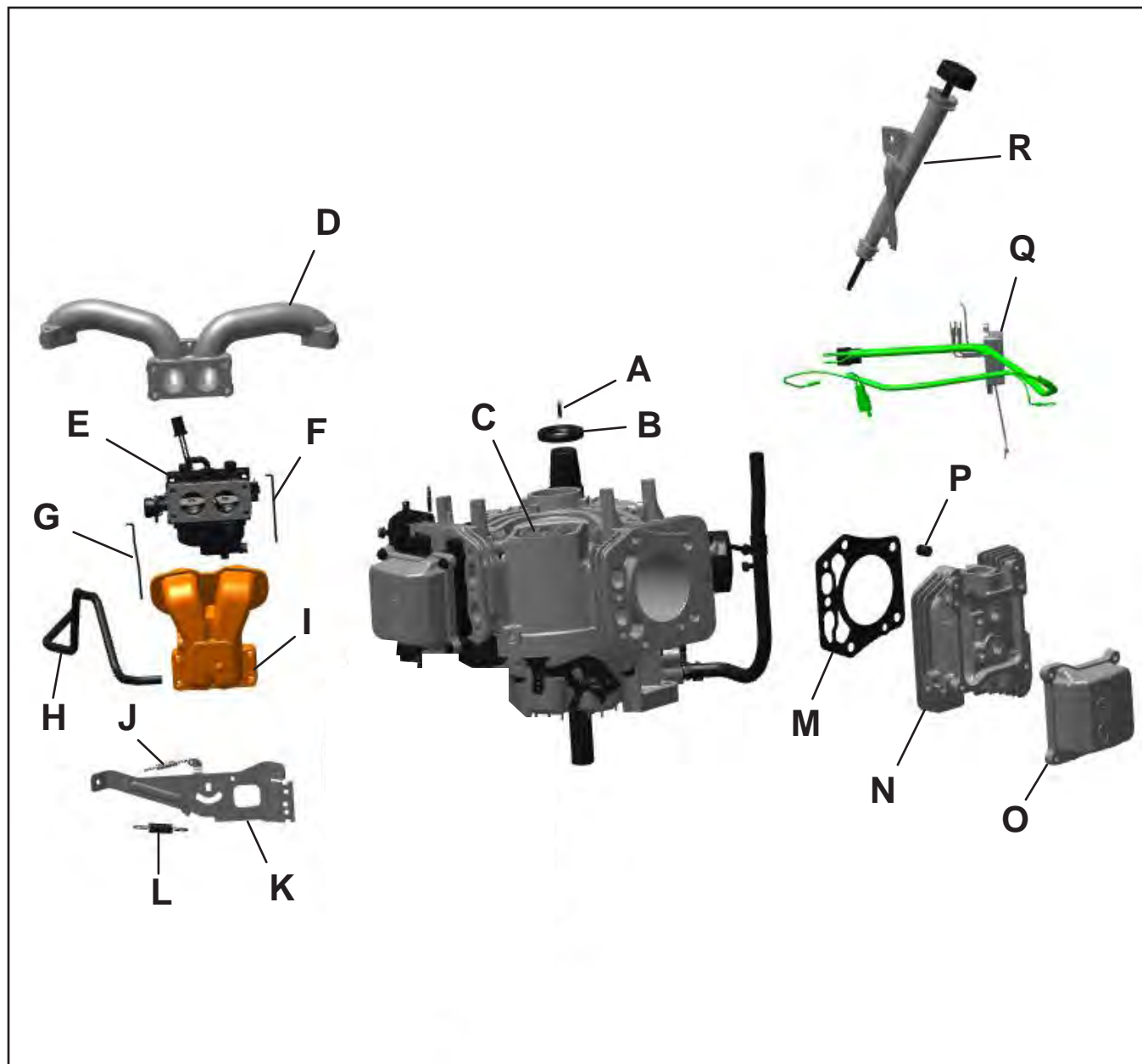


Figure 2

A. Flywheel Key  
B. Upper Seal  
C. Breather Assembly  
D. Intake Manifold  
E. Carburetor  
F. Throttle Link  
G. Choke Link

H. Fuel Tank Vent Line  
I. Air Filter Manifold  
J. Choke Spring  
K. Control Plate  
L. Throttle Spring  
M. Head Gasket

N. Cylinder Head  
O. Valve Cover  
P. Alignment Pin  
Q. Voltage Regulator and Wire  
Harness  
R. Dipstick and Tube

**NOTE:** Mounting components not shown.



# ENGINE DISASSEMBLY

## Lower Disassembly 1

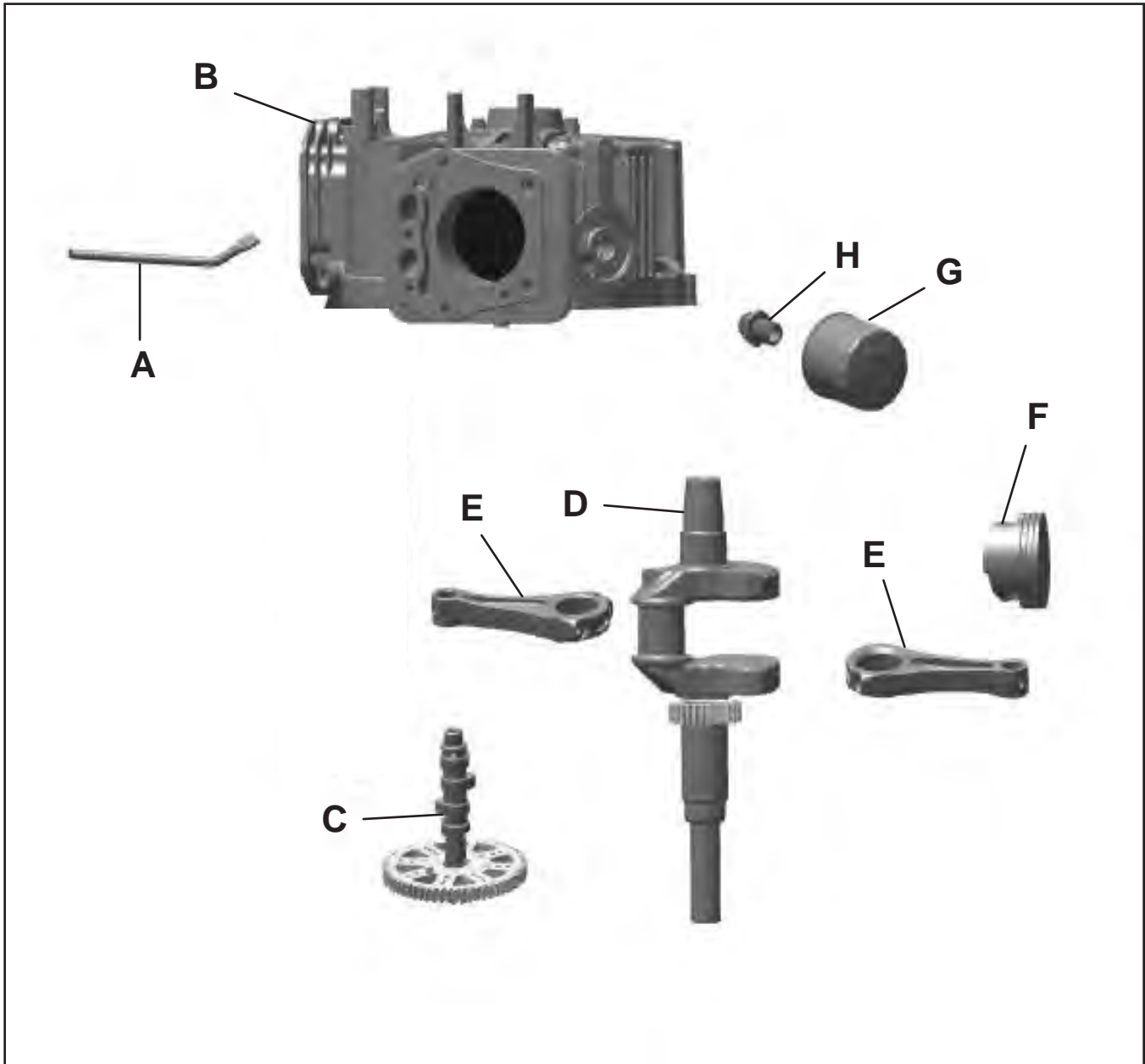


Figure 3

- |                 |                                |
|-----------------|--------------------------------|
| A. Governor Rod | E. Connecting Rod              |
| B. Crankcase    | F. Piston (1 shown)            |
| C. Camshaft     | G. Oil Filter                  |
| D. Crankshaft   | H. Oil Filter Threaded Fitting |

**NOTE:** Mounting components not shown.


## Disassembly

[illegible]

A. Oil Screen Cover	I. Shaft (Gov. Asm.)	Q. Oil Drain Hose Asm.
B. Oil Screen	J. Seal	R. Crankcase Cover
C. Screen Retainer	K. Oil Pump Shaft (Oil Pump Asm.)	S. Crankcase Gasket Cover
D. Rubber Oil Deflector	L. Inner Rotor (Oil Pump Asm.)	T. Dowel Pin (1 Shown)
E. Spool (Gov. Asm.)	M. Outer Rotor (Oil Pump Asm.)	U. Ball Valve
F. Retaining Ring (Gov. Asm.)	N. O-Ring	V. Spring
G. Gear w/Fly Weights (Gov. Asm.)	O. Oil Pump Cover	W. Retainer Plate
H. Anchored Washer (Gov. Asm.)	P. Hose Fitting	X. O-Ring

**TORO** **Twin Cylinder Engine Service Manual**  
February 2017 - Digital Edition

# ENGINE DISASSEMBLY

 This chapter covers the complete disassembly of the Toro Twin Cylinder engine, 2P77F. It includes suggested sequence steps for complete engine disassembly.

**NOTE:** Details of the unique features such as the air filter system, two-barrel carburetor, engine controls, and pressurized lubrication system are in other chapters.

Clean all parts before making measurements. If using chemicals or solvents to clean, be sure they are thoroughly removed from the parts before reassembling the engine.

## WARNING

Disable engine to prevent accidental starts.

Remove spark plug wires and disconnect battery power.

## Engine Removal

Refer to the product specific service manual for engine removal. Drain fluids prior to disassembly.

## Disassembly Upper End

### Air Cleaner Filter

1. Lift to open the air filter door.
2. Rotate filter out from the rear (Figure 5).

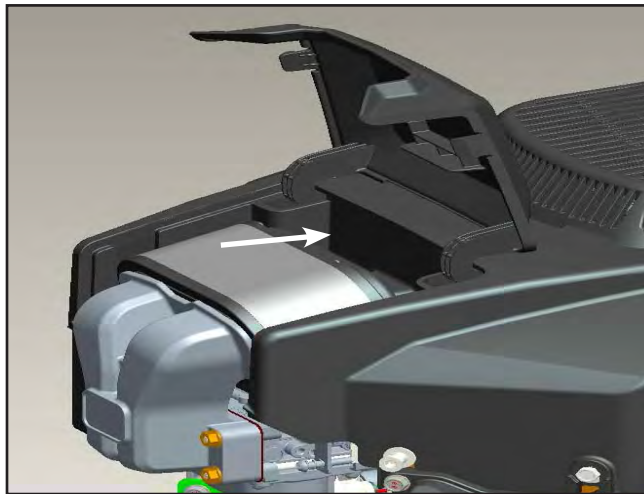


Figure 5



# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Engine Shroud

#### a. Blower Shroud Removal

**NOTE:** The blower shroud is retained with six identical shoulder bolts (Figure 6).



Figure 6

1. Loosen each bolt a few turns.
2. Remove the blower shroud with the fan cover and air filter door attached.

**NOTE:** Remove the oil drain hose from the shroud if it was reattached after draining the oil.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Engine Shroud (Cont.)

#### b. Cylinder Side Shrouds

**NOTE:** Both cylinders have a plastic shroud to provide proper cooling. Each shroud is mounted with two upper bolts and one lower bolt.

#### #1 Cylinder Shroud

**NOTE:** The #1 cylinder shroud has the fuel pump mounted to it.



Figure 7

1. Remove the fuel pump vacuum line from the intake manifold near the #1 cylinder (Figure 7).
2. Remove the fuel supply line from the top of the carburetor.
3. Remove the three shroud mounting bolts, two upper and 1 lower.
4. Remove the #1 cylinder shroud along with the fuel pump and lines.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Engine Shroud (Cont.)

#### b. Cylinder Side Shrouds (Cont.)

##### **#2 Cylinder Shroud**

**NOTE:** The #2 cylinder shroud has the oil drain hose cleat mounted to it (Figure 8).



Figure 8

1. Remove the oil drain hose from the cleat.
2. Remove the three mounting bolts two upper and one lower.
3. Remove the shroud with the cleat still attached.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Ignition Coils

1. Remove the two mounting bolts for each coil.
2. Lift each coil and remove it's ground wire terminal.

**NOTE:** Remove the spark plug boots from the spark plugs if not previously removed.

3. Remove the ignition coils (Figure 9).

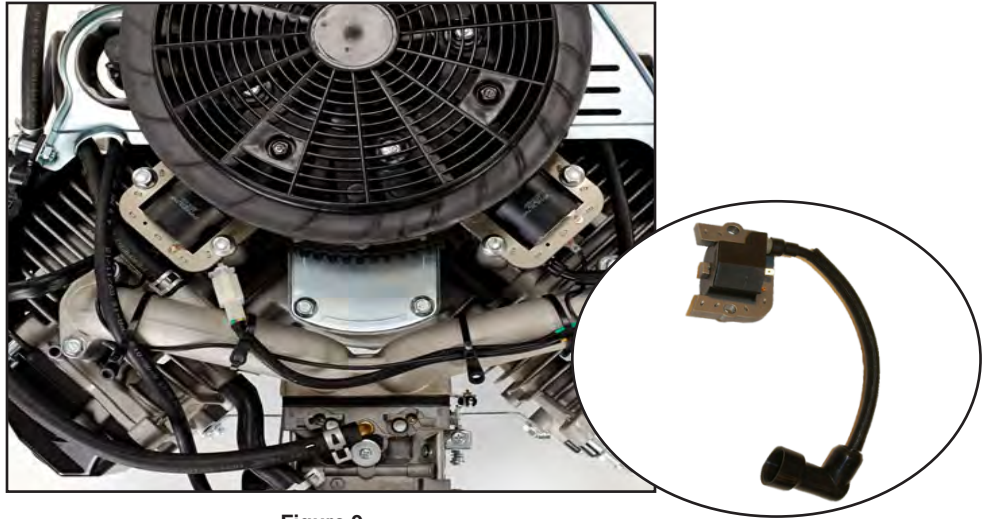


Figure 9

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Electric Starter

1. Remove the two mounting bolts and the electric starter (Figure 10).

**NOTE:** One bolt retains the engine lift bracket.

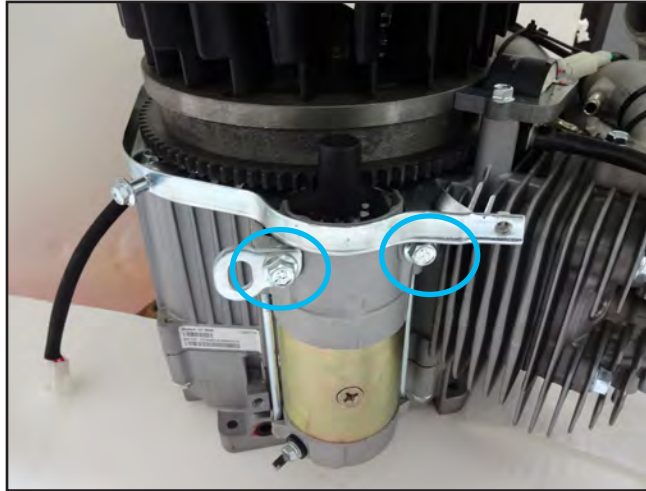


Figure 10

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Flywheel/Screen/Fan

1. Remove the blower shroud (Figure 11) (if not previously removed), [see “Engine Shroud,” chapter 7, page 7-7.](#)

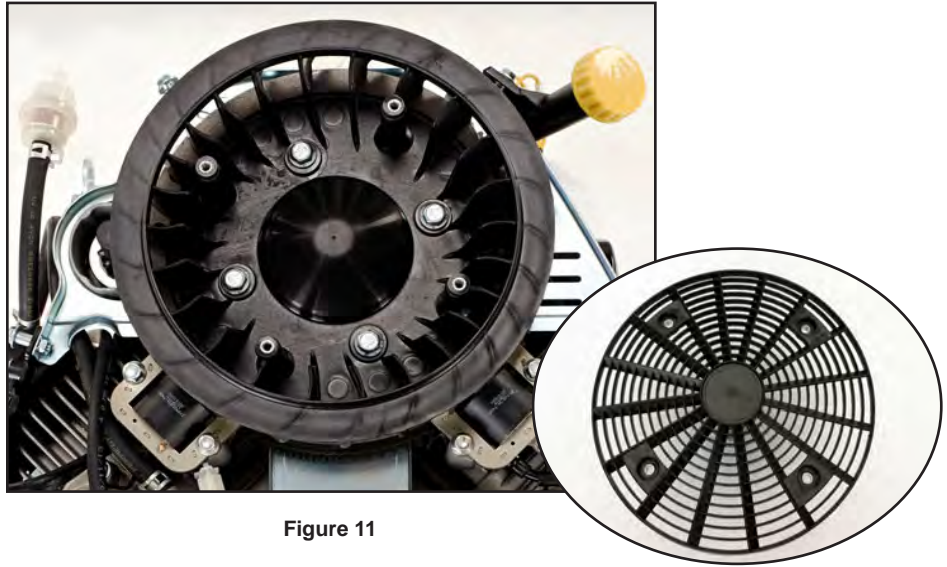


Figure 11

2. Remove the four screws retaining the shredder screen and remove the shredder screen.
3. Remove the four bolts retaining the cooling fan and remove the cooling fan.
4. Remove the flywheel bolt and washer.

**NOTE:** Remove ignition coils if not previously removed, [see “Ignition Coils,” chapter 7, page 7-10.](#)

**NOTE:** When loosening the flywheel bolt, use a strap wrench to hold the flywheel from rotating if needed.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Flywheel/Screen/Fan (Cont.)

5. Remove the flywheel, use a two or four bolt puller.

**NOTE:** Lift the flywheel straight upward so that the charging magnets on the underside. Do not contact the stator.

6. Remove the flywheel key with a side cutter or pliers (Figure 12).

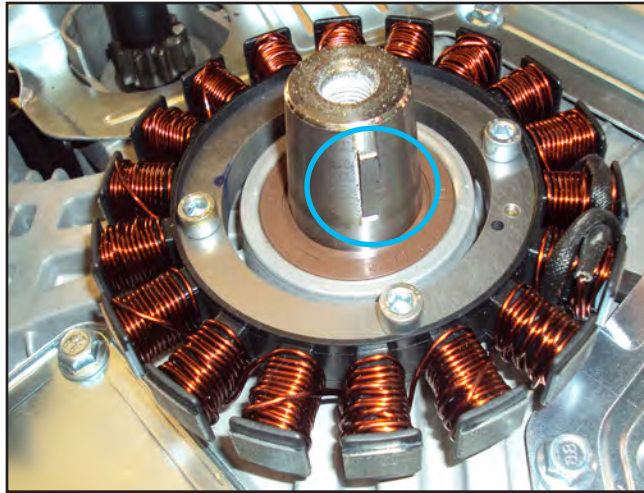


Figure 12



# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Lower Baffle

1. Remove the shoulder bolt retaining the dipstick tube to the baffle.
2. Remove the four bolts mounting the baffle to the engine block and remove the baffle (Figure 13).

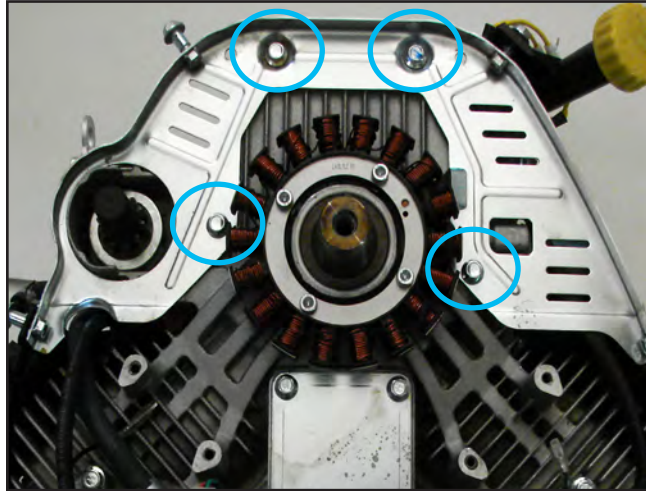


Figure 13

### Stator (Alternator)

1. Unplug the two stator wires from the wire harness near the dipstick tube.
2. Remove the four mounting bolts to the engine block.
3. Remove the stator assembly (Figure 14).

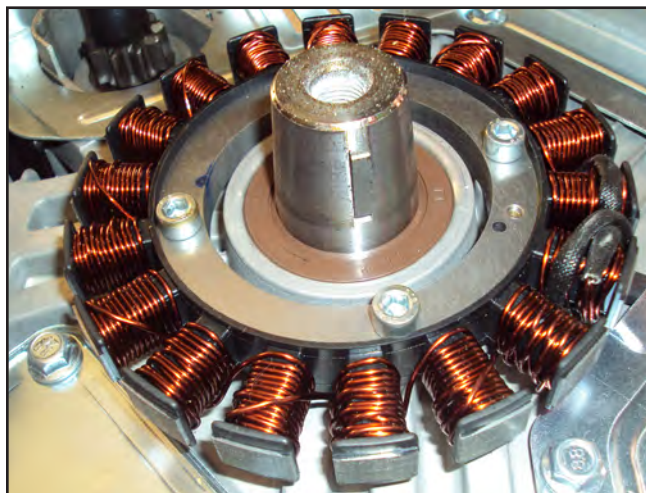


Figure 14



# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Breather Assembly

**NOTE:** The breather is located on the top of the engine block between the flywheel and the intake manifold, between the two cylinders. Remove the flywheel to access the breather (Figure 15).

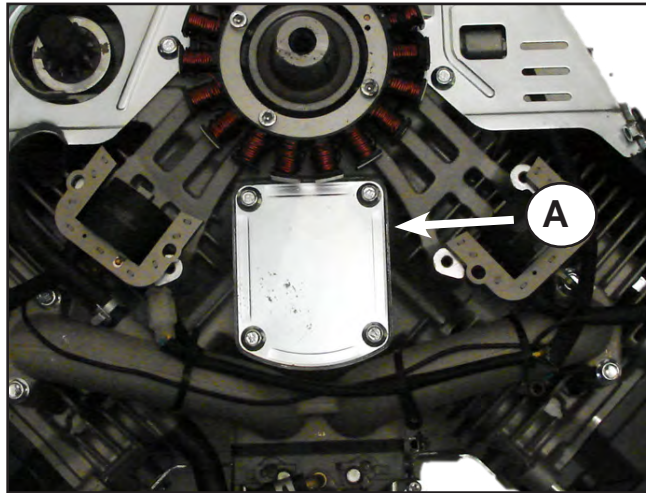


Figure 15

### A. Breather

1. Remove the four bolts and cover.
2. Remove the gasket and discard.

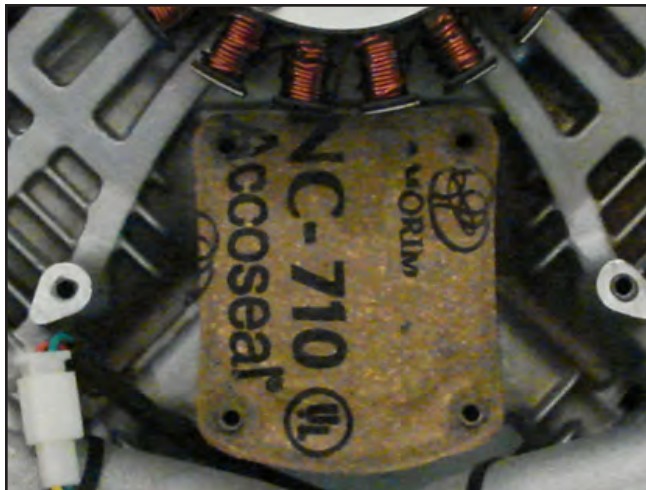


Figure 16

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Breather Assembly (Cont.)

3. Remove the breather filter (blue sponge).
4. Remove the bolt retaining the breather reed assembly (Figure 17).

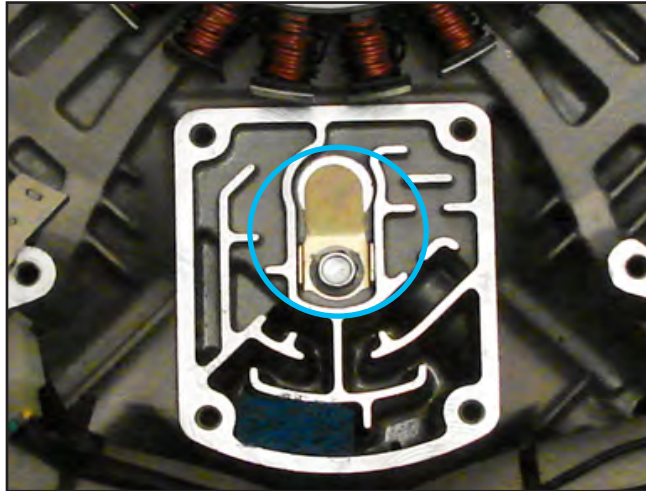


Figure 17

5. Remove the breather reed.

# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Air Filter Manifold

**NOTE:** The air filter manifold is made of cast aluminum for durability. Both the engine breather and the fuel tank vent ports attach to it, [see “Air Filter Manifold,” chapter 2, page 2-4.](#)

1. Remove the four nuts retaining the air filter manifold to the carburetor.
2. Cut the zip tie retaining the fuel tank vent hose to the intake manifold (**Figure 18**).

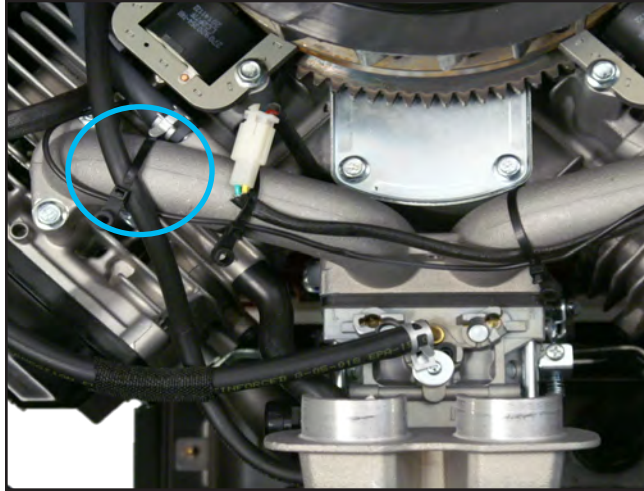


Figure 18

3. Slide the manifold off the four studs with the breather hose and tank vent hose still attached to the manifold.

**NOTE:** The breather hose is only clamped at the manifold.

4. Remove the air filter manifold gasket if still on the studs.

**NOTE:** Remove hoses if replacing the air filter manifold.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Carburetor

**NOTE:** The air filter manifold (previously removed), clamps the two-barrel carburetor to the intake manifold. Remove the blower shroud, if not previously removed, to access the carburetor, [see “Engine Shroud,” chapter 7, page 7-7.](#)

1. Remove the choke (Figure 19) and throttle (Figure 20) linkages by rotating the plastic clips at both the throttle shaft and choke override lever. Then slide the linkage end out of the throttle shaft and choke override lever.



Figure 19



Figure 20

2. Unhook both linkages from the control plate.

**NOTE:** The use of the plastic clips allows for easy carburetor removal.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Carburetor (Cont.)

3. Disconnect the fuel solenoid wire at the wire harness plug located near the #1 cylinder port of the intake manifold. Carefully remove the plug from between the intake manifold and the cylinder block (Figure 21).

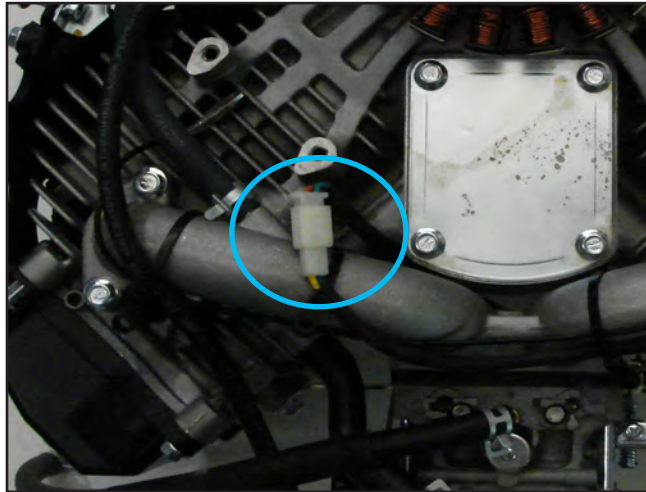


Figure 21

4. Slide the carburetor with the fuel solenoid off the mounting studs.
5. Remove any remaining gaskets and the insulator. Retain the insulator, discard the gaskets.

**NOTE:** The two-barrel carburetor function, analysis, and rebuild [details are in chapter 3, section 3-1.](#)



# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Control Plate (Throttle/Choke)

**NOTE:** The choke and throttle linkages were previously removed.

1. Remove the two mounting bolts, one from each cylinder head.
2. Unhook the governor spring from the governor arm.

**NOTE:** Note the location of the spring on the governor arm, hole “C” (Figure 22).

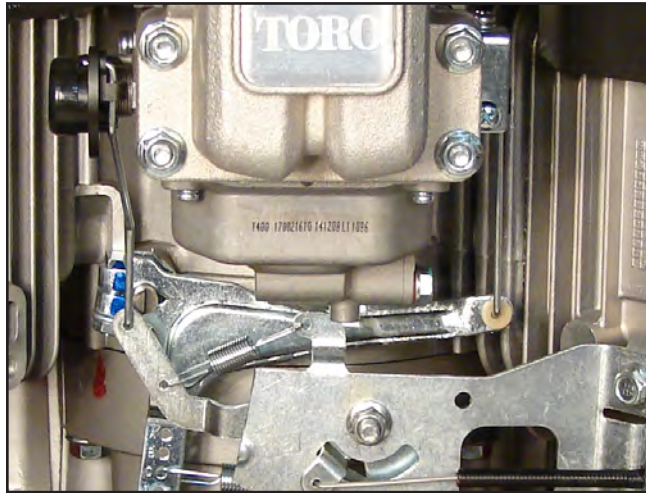


Figure 22

3. Remove the control plate.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Intake Manifold

**NOTE:** The intake manifold has the engine wire harness attached to it with zip ties. If reusing all components, remove as an assembly; intake manifold, wire harness and voltage regulator mounted to the dipstick tube (Figure 23).

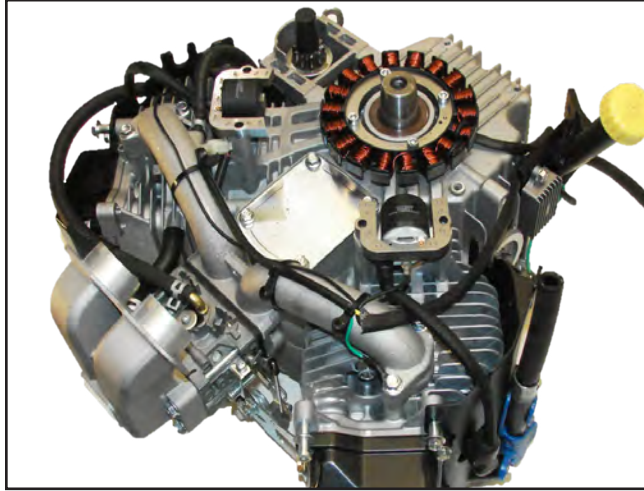


Figure 23

1. Remove two mounting bolts from the top of each head.
2. Remove the wire harness ground bolt located below the voltage regulator.
3. Remove the intake manifold along with the wire harness/voltage regulator and dipstick tube (Figure 24).



Figure 24

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Voltage Regulator with Wire Harness

Refer to intake manifold removal, [see “Intake Manifold,” chapter 7, page 7-21.](#)

**NOTE:** The voltage regulator contains the engine wire harness and is mounted to the dipstick tube (Figure 25).

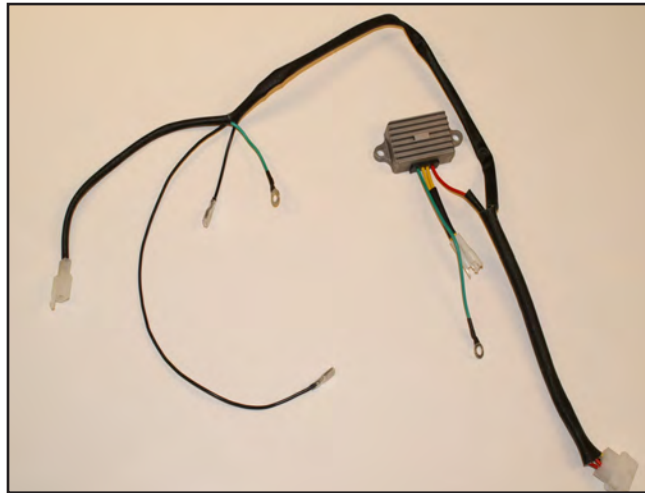


Figure 25

### Dipstick and Tube

1. Remove the blower shroud shoulder bolt, if not previously removed.
2. Remove voltage regulator, if not previously removed, refer to “Voltage Regulator with Wire harness” above.
3. Remove dipstick and tube assembly.



# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Cylinder Heads

**NOTE:** The cylinder heads are unique; #1 cylinder is to the left of the carburetor and #2 cylinder is to the right of the carburetor.

1. Remove the four bolts and valve cover for each head, discard gaskets.
2. Remove the five head bolts.

**NOTE:** There are three longer bolts and two shorter bolts for each head (Figure 26 and 27).

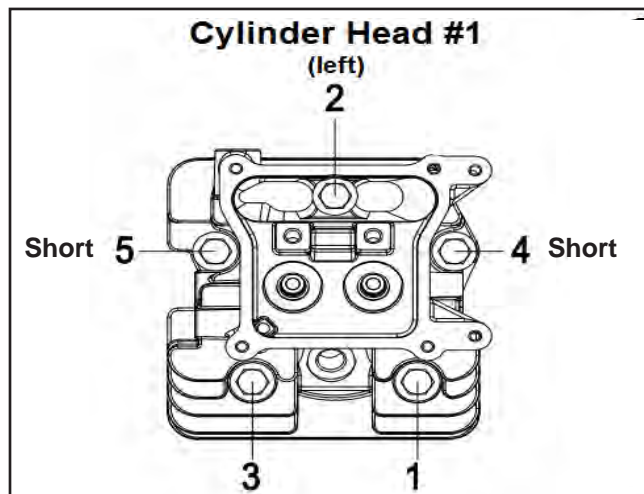


Figure 26

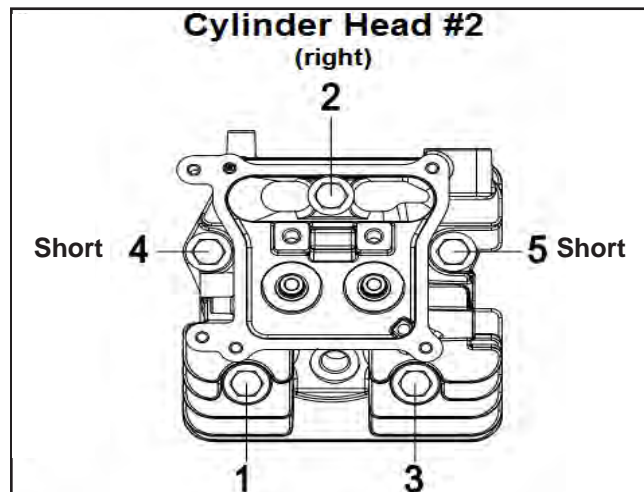


Figure 27

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Cylinder Heads (Cont.)

3. Remove the cylinder head.
4. Remove the two alignment pins (Figure 28).

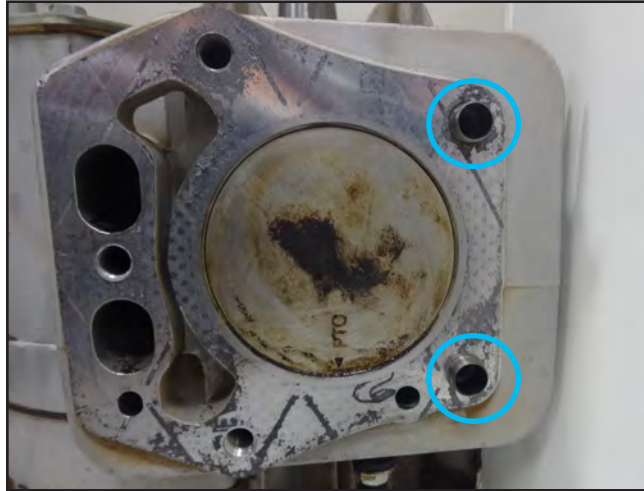


Figure 28

**NOTE:** Each head has two alignment pins, retain for assembly. Discard head gaskets.

5. Remove each push rod and mark it for *cylinder #1* or *#2* and if *exhaust* or *intake*. Repeat for other side.

# ENGINE DISASSEMBLY

---

## Disassembly Upper End (Cont.)

### Rockers and Valves (Cylinder Head Disassembly)

**NOTE:** Keep each valve's components separate and mark by *cylinder #1 and #2* and whether *exhaust or intake*.

**TECH TIP:** Use two empty egg cartons to keep the parts sorted, one for each head. Mark the cartons #1 and #2. Then mark each end of the cartons *intake* and *exhaust*. Place the corresponding parts into the correct carton (Figure 29 and 30).

#### Number 1 Cylinder Head



Figure 29

#### Number 2 Cylinder Head



Figure 30

# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Rockers and Valves (Cylinder Head Disassembly) (Cont.)

1. While holding the rocker arm pivot (B) (Figure 31), loosen and remove the rocker lock nut (A). Repeat for other rocker.

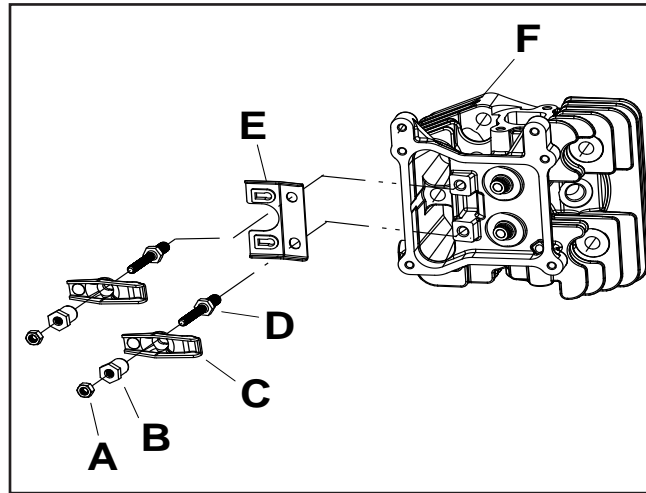


Figure 31

- |                     |                    |
|---------------------|--------------------|
| A. Rocker Lock Nut  | D. Rocker Arm Stud |
| B. Rocker Arm Pivot | E. Push Rod Plate  |
| C. Rocker Arm       | F. Cylinder Head   |

2. Remove the rocker arm pivot and rocker arm (B and C) (Figure 31). Repeat for other rocker.
3. Remove both rocker arm studs and the push-rod guide plate (D and E) (Figure 31).

# ENGINE DISASSEMBLY

## Disassembly Upper End (Cont.)

### Rockers and Valves (Cylinder Head Disassembly) (Cont.)

4. Use a valve spring compressor to compress the valve spring and remove the two valve keepers. Repeat for other valve.
5. Remove the remaining valve system components from the head (E) (Figure 32):
  - Spring retainers (A)
  - Valve springs (B)
  - Valve seals (C)
  - Valve spring seat (D)
  - Intake and exhaust valves (F)

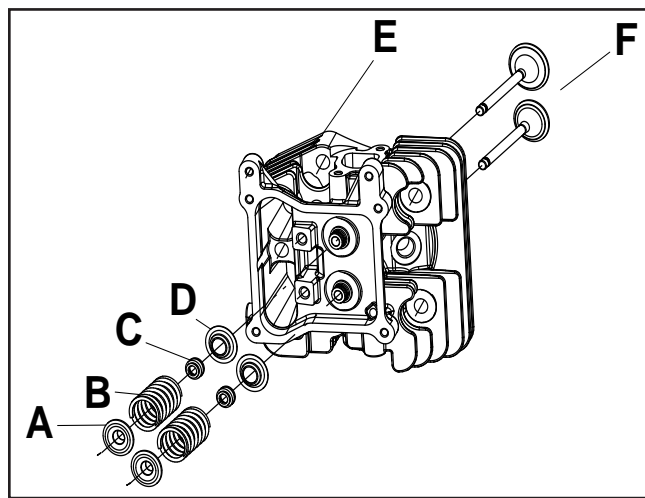


Figure 32



**NOTE:** Repeat for other cylinder head. Do NOT mix with other head components.

# ENGINE DISASSEMBLY

## Disassembly Lower End

### Oil Pump

1. Remove the three bolts and cover from the sump cover (Figure 33).

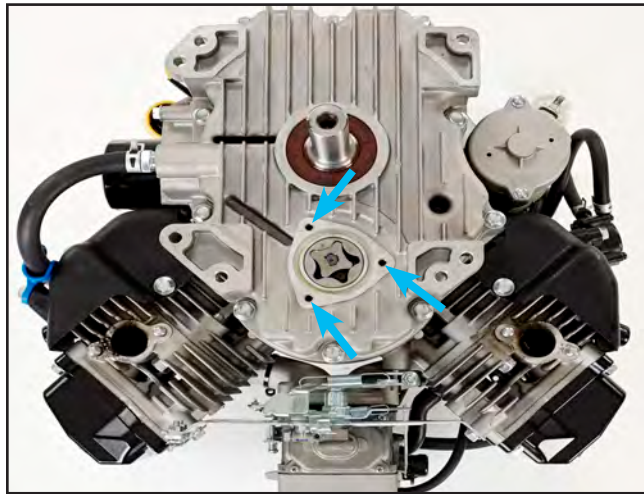


Figure 33

2. Remove o-ring and discard (Figure 34).

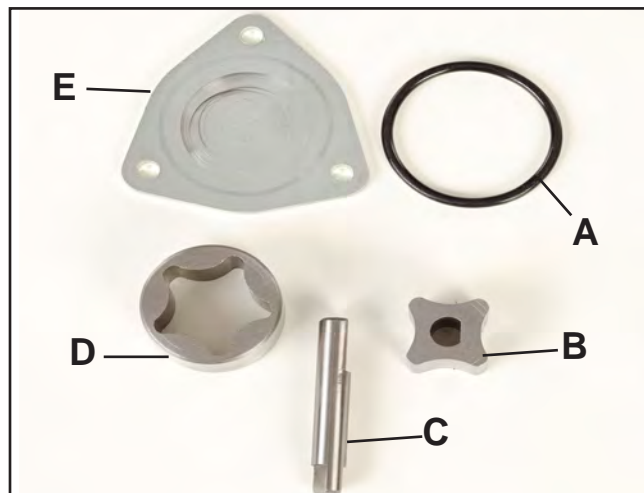


Figure 34

- |                   |                   |
|-------------------|-------------------|
| A. O-Ring         | D. Outer Rotor    |
| B. Inner Rotor    | E. Oil Pump Cover |
| C. Oil Pump Shaft |                   |

3. Remove the gerotor pump (B and D) (Figure 34).

4. Remove oil pump shaft (C) (Figure 34).

**NOTE:** A magnet will assist in removing the gerotor pump from the sump cover.

# ENGINE DISASSEMBLY

## Disassembly Lower End (Cont.)

### Sump Cover

1. Remove the oil pump assembly (A), if not previously removed, [see “Oil Pump.” chapter 7, page 7-28.](#)
2. Remove the ten (Figure 35) bolts retaining the sump cover to the engine crankcase.

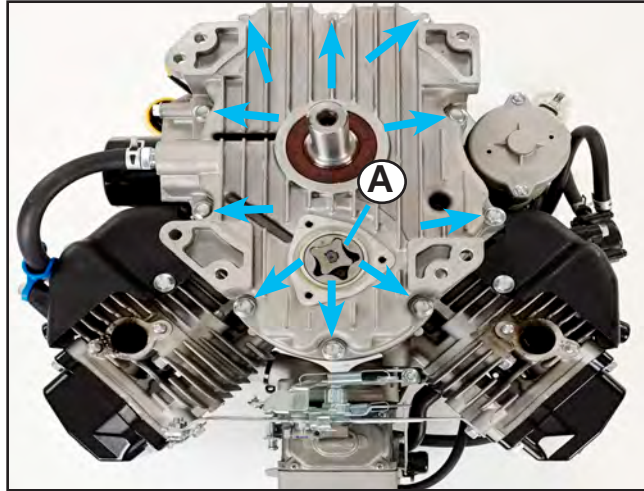


Figure 35

3. Clean the crankshaft of rust and debris.
4. Remove the sump cover with the drain hose.

**NOTE: A plastic mallet will assist in loosening the cover from the crankcase.**

5. Remove the two alignment pins.
6. Remove and discard the gasket.

**NOTE: Use liquid gasket remover to assist in cleaning gasket. Do not use metal tools to scrape gasket.**



# ENGINE DISASSEMBLY

## Disassembly Lower End (Cont.)

### Sump Cover (Cont.) (Figure 36 and 37)

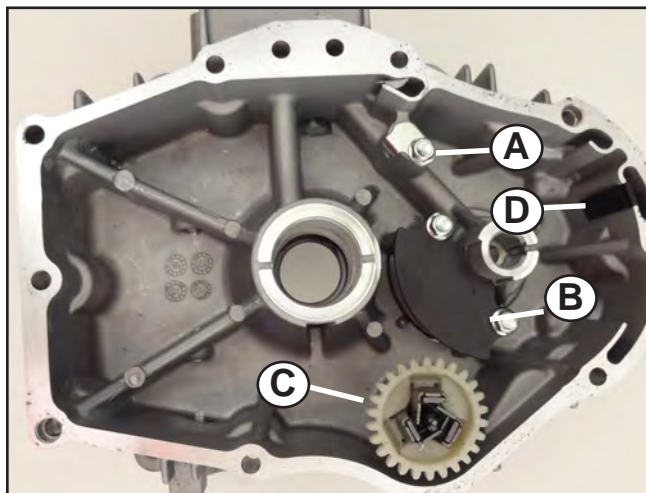


Figure 36

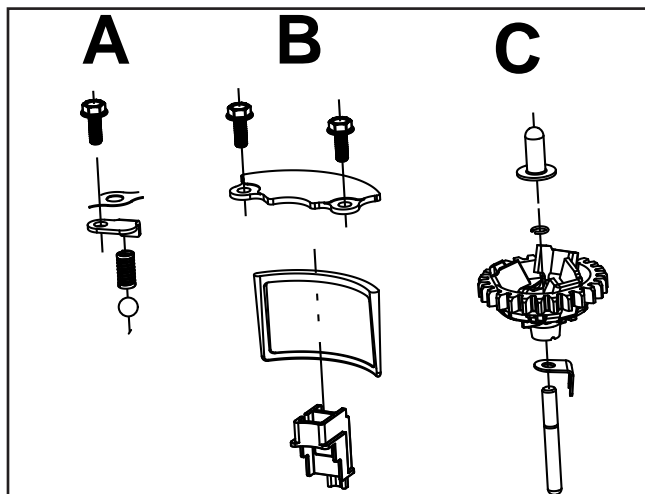


Figure 37

- a. Pressure lube check ball system (A) (Figure 37)
  1. Remove the screw and retainer.
  2. Remove the spring and check ball.
- b. Oil pre-screen assembly (B) (Figure 37)
  1. Remove the two screws and cover.
  2. Remove the screen and retainer (Figure 37).
- c. Governor assembly (optional removal) (C) (Figure 37)
  1. From the outside of the sump cover use a 7/32 in. or 15/64 in. roll pin punch to carefully drive the center dowel of the governor assembly out of the sump cover.
- d. Remove the oil deflector (rubber) (D) (Figure 37).



# ENGINE DISASSEMBLY

## Disassembly Lower End (Cont.)

### Camshaft and Followers

1. Rotate the crankshaft until timing marks align.
2. Lift out camshaft.
3. Remove the four followers, marking each for *cylinder #1* and *#2* and whether *intake* and *exhaust* (Figure 38).

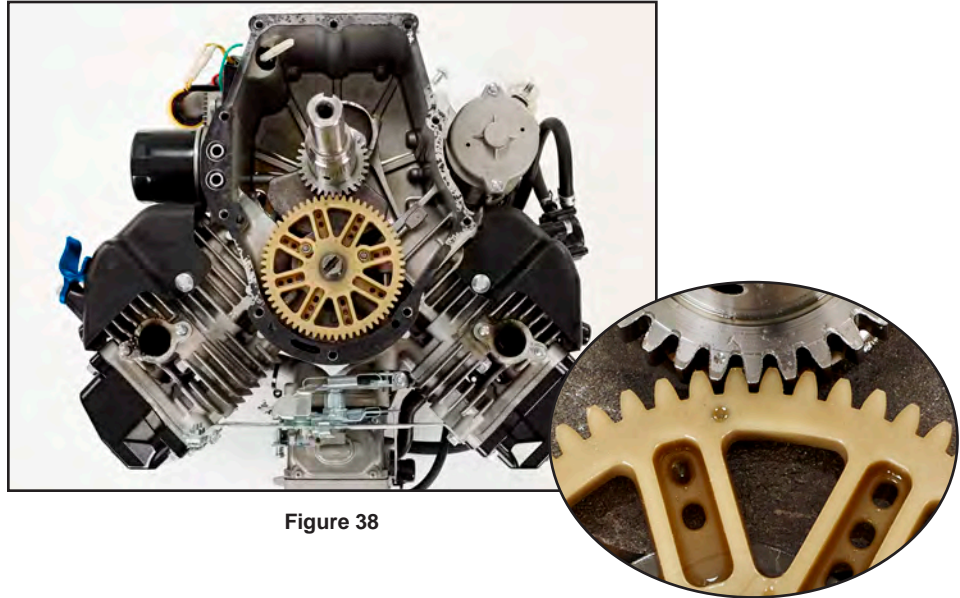


Figure 38

# ENGINE DISASSEMBLY

## Disassembly Lower End (Cont.)

### Piston and Connecting Rod Assembly

1. Remove the connecting rod cap bolts and cap for each rod (Figure 39).

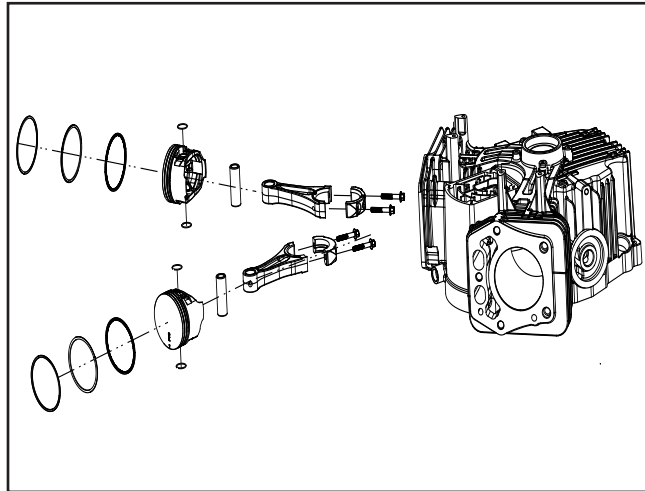


Figure 39

**NOTE:** Each cap is stamped to match the connecting rod (Figure 40).

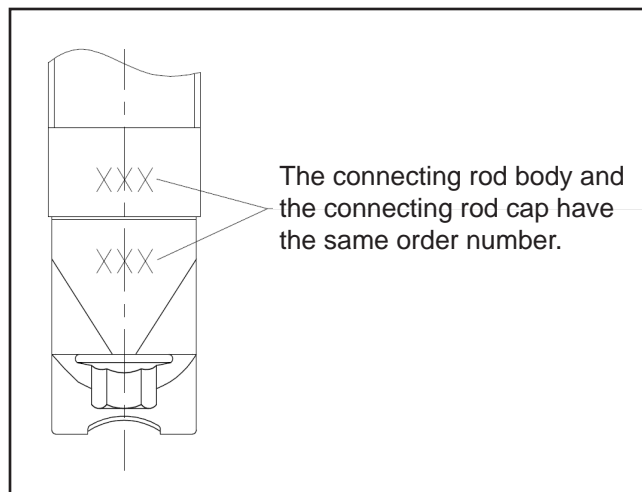


Figure 40

2. Slide the piston and rod assembly out of the cylinder, away from crankshaft.
3. Repeat for other piston assembly.
4. Re-install matching rod cap and bolts to corresponding rod.
5. Mark each piston and connecting rod assembly either cylinder #1 or #2.

# ENGINE DISASSEMBLY

## Disassembly Lower End (Cont.)

### Piston Rings and Wrist Pin

#### a. Piston rings

1. Remove each ring off the dome end of the piston; start with the top ring, middle and then the three piece oil ring (if reusing rings, be careful not to break them).

**NOTE: Use of a ring removal tool is optional.**

### WARNING

Use protective eye wear when removing the wrist pin.

#### b. Wrist pin

1. Remove both piston pin clips.
2. Remove the piston pin.

**NOTE: If difficult to remove, support the piston on a block of wood with a hole in it. Drive out the piston pin into the hole (Figure 41).**

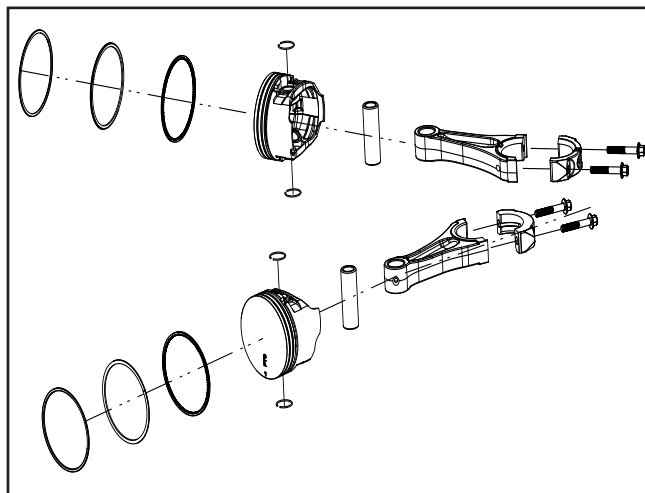


Figure 41

#### c. Keep parts sorted for cylinder #1 and #2.

# ENGINE DISASSEMBLY

---

## Disassembly Lower End (Cont.)

### Crankshaft

1. Slide the crankshaft out of the crankcase (Figure 42).



Figure 42

# ENGINE INSPECTION AND RECONDITIONING

---

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# ENGINE INSPECTION AND RECONDITIONING

---

This chapter covers the inspection and reconditioning of primary engine components as listed in the table of contents. See engine exploded views in “Engine Disassembly” section, [Figure 1](#), [Figure 2](#), [Figure 3](#) and [Figure 4](#).

**NOTE:** The following components are covered in their own section:

Air Intake System [Chapter 2](#)

Two-Barrel Carburetor and Fuel System [Chapter 3](#)

Control Plate (Choke and Throttle) [Chapter 4](#)

Electrical [Chapter 5](#)

Lubrication [Chapter 6](#)

Clean all components prior to evaluation. Remove and discard all seals and gaskets. If needed, use a gasket remover or equivalent to assist in removing gaskets. Do not scrape the surface in attempt to clean since it could gouge and damage the surface. Rinse all components of cleaner solvents prior to reassembly.



## WARNING

Explosive fuel can cause fires and severe burns.

Do not fill fuel tank while engine is hot or running.

Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, occupied buildings, away from sparks or flames. Spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Never use gasoline as a cleaning agent.

# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning

### Cylinder Head Cleaning Inspection

1. Remove the carbon deposits.
2. Clean the cylinder head of any remaining gasket material; intake, exhaust, valve cover and head gaskets.
3. Inspect the cylinder head for cracks, specifically around the following (Figure 1):
  - Spark plug threads (A)
  - Valve seats (B)
  - Exhaust Port (C)
  - Intake Ports (D)
  - Coolant Fins (E)

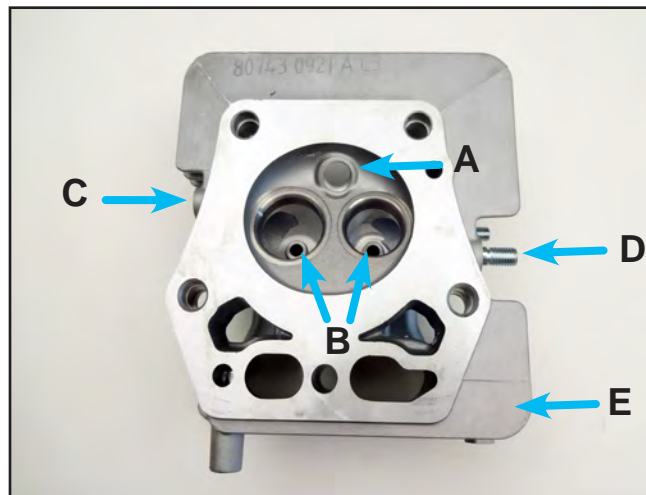


Figure 1

4. Inspect the cylinder head for warpage using a straight edge and feeler gauge. Measure and compare to specifications.

Cylinder Head	
Service Limit	0.002 in.

5. Inspect the intake and exhaust ports mounting surface for warpage.

# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning (Cont.)

### Cylinder Head Valve Seat Inspection

Thoroughly clean the cylinder head to remove carbon deposits.

1. Inspect valve seats (Figure 2):

- Loose Seat
- Proper valve face contact (see steps below)
- Proper seat width, standard 0.028-0.030 in., service limit 0.040 in.

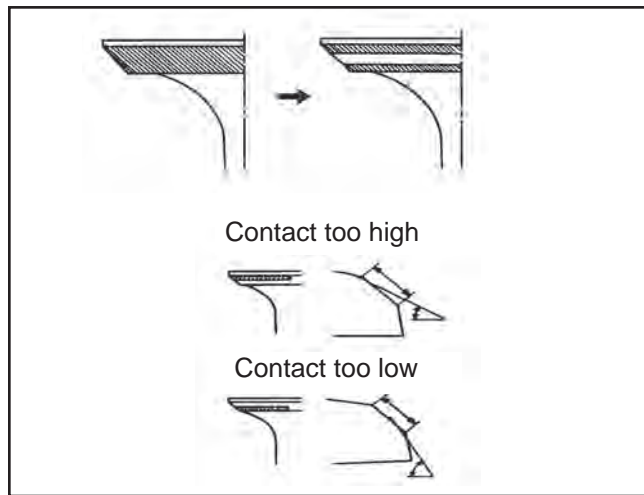


Figure 2

2. Repeat inspection for all valves and seats.



# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning (Cont.)

### Valve Face Contact Test

1. Apply a light coat of Prussian Blue or erasable felt-tipped marker ink to the valve face.
2. Insert the valve, lift valve and snap closed against the seat several times.

**NOTE: Be sure the valve does not rotate on the seat.**

3. Inspect the transferred marking compound for any area of the seat that is not concentric.
4. Replace cylinder head if any of the above items are found out of specification.

### Valve Guide Inspection

1. Measure and compare to specifications, inside diameter (intake and exhaust).

Valve Guides (Inside Diameter)	
Standard	0.2598-0.2604 in. (6.60-6.615 mm)
Service Limit	0.2624 in. (6.665 mm).

**NOTE: Replace cylinder head if any of the above items are found to be out of specification.**



# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning (Cont.)

### Valve Inspection

1. Clean carbon from the valve (Figure 3).

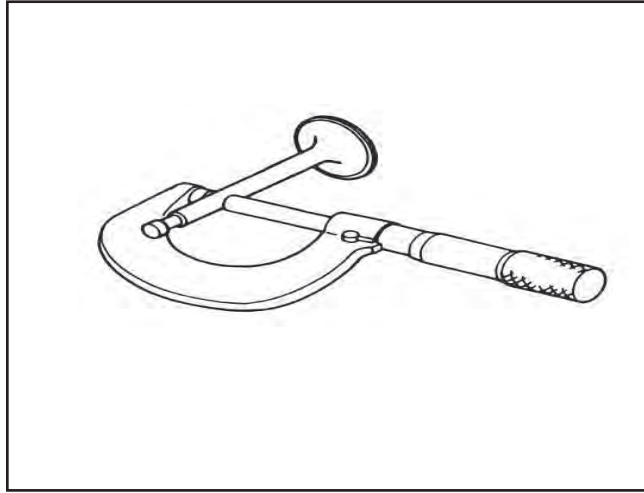


Figure 3

2. Inspect the valve stem for pitting, wear or if bent. Compare to standard.

Stem Diameter	Standard	Service Limit
Intake	0.258-0.259 in.	0.255 in.
Exhaust	0.257-0.258 in.	0.255 in.

Replace the valve if the stem outside diameter is smaller than the service limit.

3. Inspect valve face for pitting, wear or corrosion.
4. Replace valve if encounter any of the items above.
5. Repeat inspection for all valves.

# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning (Cont.)

### Valve Seat Reconditioning

1. Using a 45-46° cutter, remove enough material to produce a smooth, concentric seat. Follow the valve seat cutter manufacturer's instructions (Figure 4).

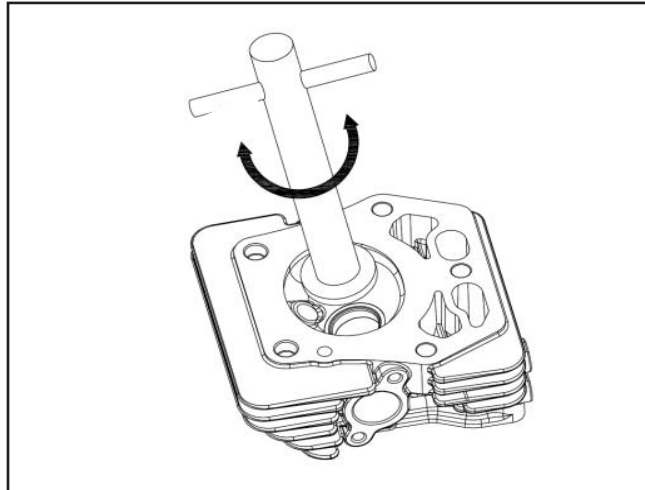


Figure 4

**NOTE:** Turn the cutter clockwise, never counterclockwise, continue to turn the cutter while lifting from the valve seat.

2. Using the 30-32° and 60° cutter to narrow and adjust the valve seat, the valve should contact the middle of the valve face. Be sure that the width of the finished valve seat is with specification.

Valve Seat	
Standard	0.0275-0.0315 in.
Service Limit	0.050 in.

**NOTE:** The 30-32° cutter removes material from the top edge. The 60° cutter removes material from the bottom edge of the valve seat.

# ENGINE INSPECTION AND RECONDITIONING

---

## Upper End Inspection and Reconditioning (Cont.)

### Valve Seat Reconditioning (Cont.)

3. Make a final light pass with a 45-46° cutter to remove any possible burrs at the edges of the seat.
4. After resurfacing the seats, inspect for even valve seating.
5. Refer to [“Valve Face Contact Test,” chapter 8, page 8-5.](#)

**NOTE: Replace the valve if not making full contact.**

6. Repeat valve seat cutting for all seats.

### Valve Reconditioning (Lapping)

1. Perform valve lapping if any of the following were performed (Figure 5):
  - New valve
  - Reground valve
  - Valve seat was reconditioned

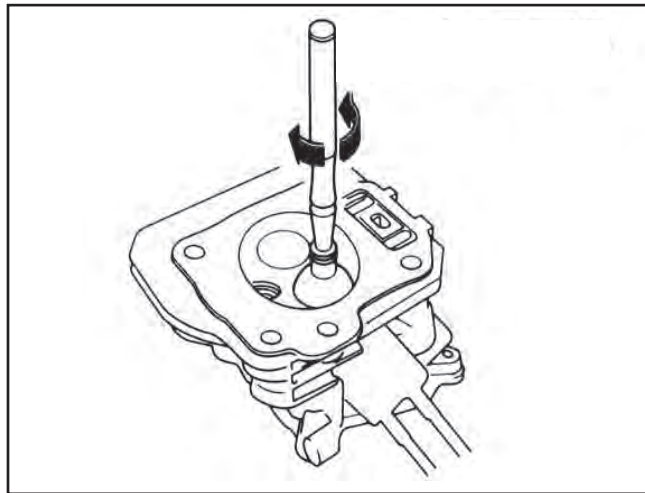


Figure 5

2. Use a hand valve-lapping tool with suction cup end. Attach suction cup to the end of valve.
3. Apply a light coat of valve grind compound to the valve face.
4. Insert the valve into the matching valve guide.
5. Rotate valve on the seat with tool until a smooth surface is on the valve face and valve seat.

**NOTE: Wipe clean any excess compound. Immediately clean any compound on the valve stem, guide, etc.**

6. Repeat lapping for all valves.

# ENGINE INSPECTION AND RECONDITIONING

## Upper End Inspection and Reconditioning (Cont.)

### Valve Reconditioning (Lapping) (Cont.)

7. Clean entire cylinder head and all valves of grinding compound with hot soapy water.

8. After drying, apply a light coat of engine oil.



**NOTE:** To avoid severe engine damage, be sure to remove all lapping compound from the head and valve components before reassembling.

### Valve Spring

1. Inspect the free length of the valve spring. (Figure 6).

Valve Spring	
Standard	1.55-1.60 in.
Service Limit	1.53 in.

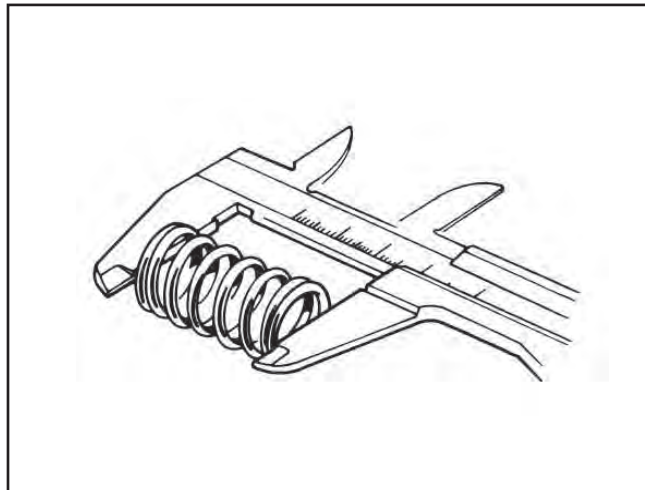


Figure 6

2. Inspect for bent coils of the spring, spring stands straight.

### Valve Mounting Components

1. Clean and inspect all other valve mounting components.
  - Spring retainers
  - Keepers
  - Spring seats

# ENGINE INSPECTION AND RECONDITIONING

---

## Upper End Inspection and Reconditioning (Cont.)

### Push Rods

1. Inspect push rods for straightness and wear on the ball ends
2. Replace if bent or worn.

### Breather Assembly

1. Clean the breather filter (blue sponge) or replace if deteriorated.
2. Clean and inspect the reed assembly for burrs or cracks. Replace if damaged (Figure 7).



Figure 7

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning

### Crankshaft

1. Inspect all three bearings for wear, pitting or other damage.
2. Measure each bearing surface (upper bearing, rod bearing, and lower bearing), compare to specifications. (Figure 8).

Crank Bearing	
Standard	1.5735-1.5744 in. (39.966-39.991 mm)
Service Limit	1.5551 in. (39.50 mm)

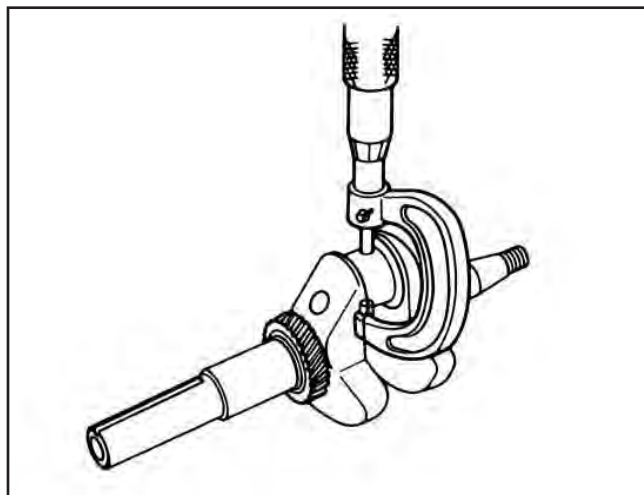


Figure 8

3. Inspect and clean lubrication channel from lower bearing to crank pin journal.
4. Inspect the timing gear teeth.
5. Inspect both keyways (flywheel and PTO) for damage.
6. Inspect the threads for damage at each end of the crankshaft.
7. Replace crankshaft if out of specification or damaged.

# ENGINE INSPECTION AND RECONDITIONING

---

## Lower End Inspection and Reconditioning (Cont.)

### Camshaft and Followers

1. Inspect timing gear teeth.
2. Inspect the Automatic Compression Relief (ACR) for free movement.

**NOTE:** Only serial number 50,000 and lower have the ACR (Figure 9 and 10).

Camshaft ACR



Figure 9

Camshaft without ACR

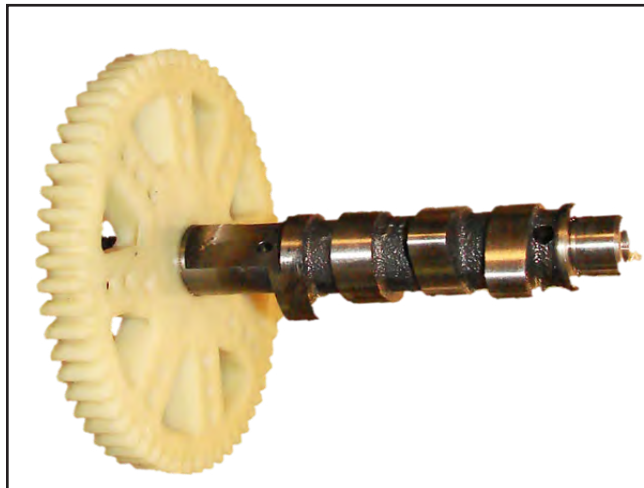


Figure 10



# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Camshaft and Followers (Cont.)

3. Measure the lobe heights, compare to specifications. Height (intake and exhaust) (Figure 11).

Lobe Heights	
Standard	1.1791-1.1831 in. (29.95-30.05 mm)
Service Limit	1.1713 in. (29.75 mm)

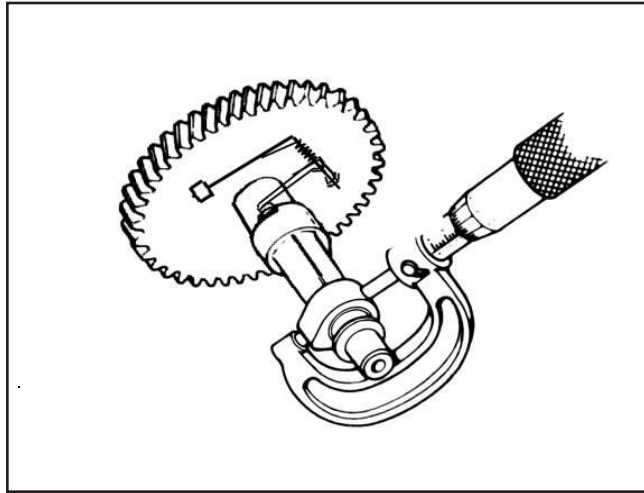


Figure 11

4. Measure journals, compare to specifications. (Figure 12).

Journal (Bearing)	
Standard (Height)	0.6286-0.6293 in. (15.966-15.984 mm)
Service Limit	0.6266 (16.916 mm)

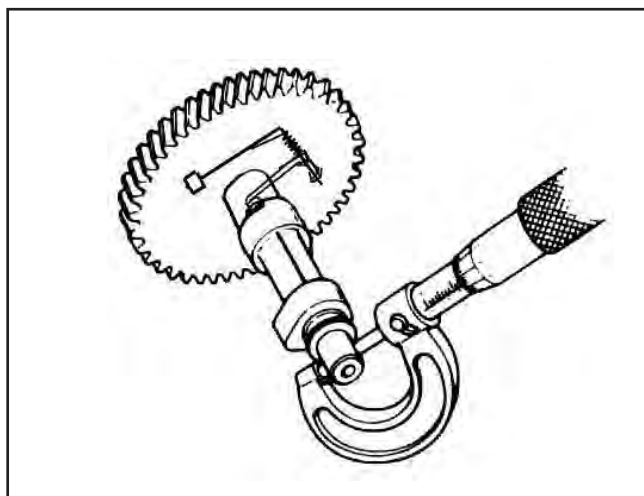


Figure 12

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Camshaft and Followers (Cont.)

**NOTE:** Replace camshaft if out of specification.

5. Inspect camshaft followers for wear or damage on shaft or face.

**NOTE:** Replace if worn or damaged.

### Crankcase

1. Inspect the cylinder bores (Figure 13).
  - Inspect for surface wear, pitting and scratches.
  - Inspect for cylinder taper and cylinder out of round.
  - Measure cylinder bore, compare to specifications.

Sleeve Taper/Out of Round (inside diameter)	
Standard (Height)	3.0315-3.0319 in. (77-77.01 mm)
Service Limit	3.0354 in. (77.10 mm)

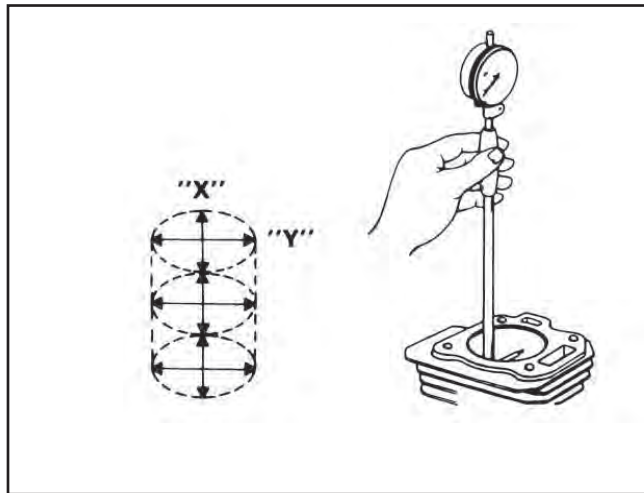


Figure 13

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Crankcase (Cont.)

2. Recondition the cylinder bore:
  - Hone cylinder bore to obtain crosshatch
  - Clean bore after honing with hot soapy water
  - Remeasure bore to specification in previous step (1c above).
3. Clean and remove all gasket material. Inspect all gasket surfaces for nicks and deep scratches.
4. Inspect the upper crankshaft bearing.
  - Remove and discard the upper crankshaft oil seal.
  - Inspect for surface wear, pitting and scratches.
  - Measure and compare to specifications.

Crankshaft Hole Diameter	
<b>Standard (Height)</b>	1.5751-1.5758 in. (40.009-40.025 mm)
<b>Service Limit</b>	1.5778 in. (40.075 mm)

5. Inspect the upper camshaft bearing.
  - Inspect for surface wear, pitting and scratches.
  - Measure and compare to specifications.
  - Inspect upper camshaft bearing.

Camshaft Hole Diameter	
<b>Standard (Height)</b>	0.6299-0.6303 in. (16.0-16.018 mm)
<b>Service Limit</b>	0.6326 in. (16.068 mm)

6. Inspect and clean oil lubrication passage to upper crankcase bearing (Figure 14).

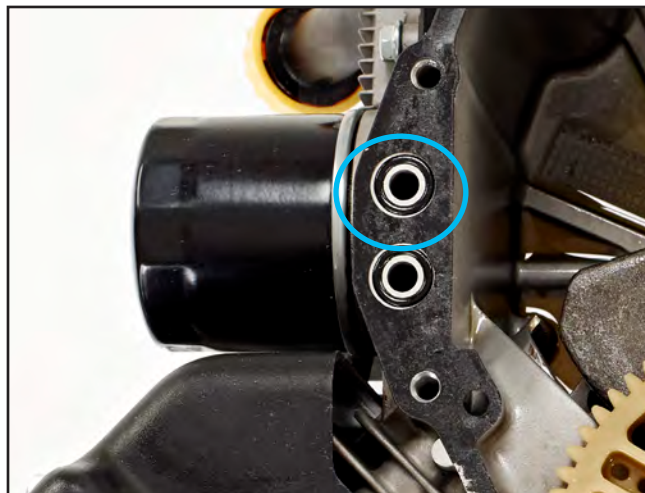


Figure 14

**NOTE:** Replace complete engine assembly if any issues are found with the crankcase assembly.

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Pistons

1. Clean the pistons; remove carbon, debris from the piston dome and ring lands.
2. Inspect pistons for damage (scuffs, scoring or overheating).
3. Skirt outside diameter measurement:  
Measure and compare to specifications (Figure 15).

Skirt Outside Diameter	
Standard (Height)	3.620-3.621 in. (76.965-76.975 mm)
Service Limit	3.0219 in. (76.755 mm)

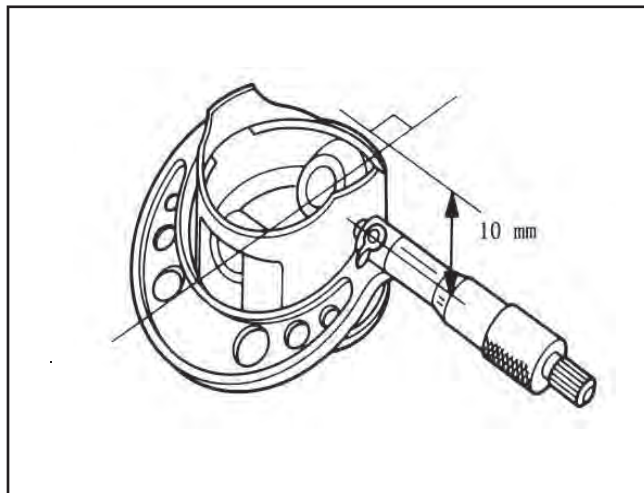


Figure 15

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Pistons (Cont.)

4. Ring land side clearance measurement:  
Measure and compare to specifications, (Figure 16).

Ring to Groove (top and middle)	
Standard (Height)	0.00079-0.00236 in. (0.02-0.06 mm)
Service Limit	0.00433 in. (0.11 mm)

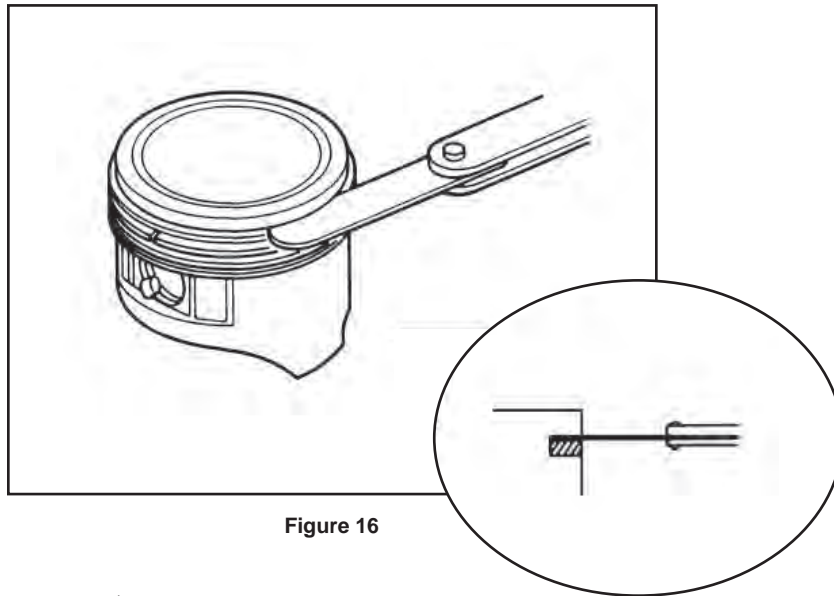


Figure 16

5. Piston to cylinder wall measurement:  
Measure and compare to specifications.

Cylinder Clearance	
Standard (Height)	0.00098-0.00177 in. (0.025-0.045 mm)
Service Limit	0.01 in. (0.255 mm)

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Pistons (Cont.)

**NOTE:** If piston is damaged or out of specification, replace piston, piston rings and piston clips.

6. Piston Pin (wrist) inspect and measure:

Inspect pin and clips, measure and compare to specifications, (Figure 17).

Piston Pin (Wrist) outside diameter	
Standard (Height)	0.669-0.6692 in. (16.992-16.998 mm)
Service Limit	0.6654 (16.90 mm)

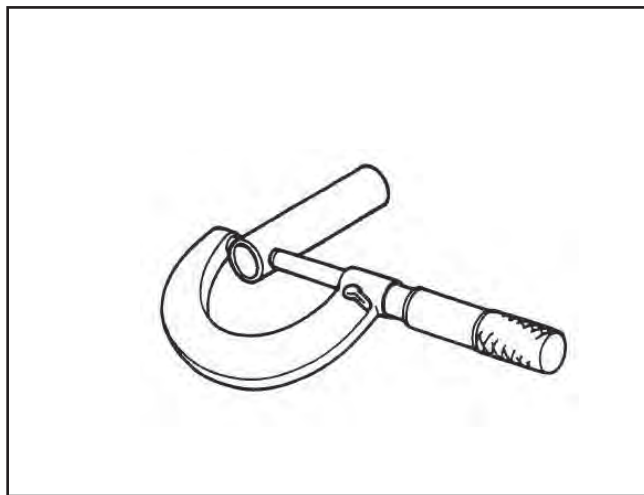


Figure 17

7. Piston Clips inspection:

Inspect each clip if damaged, or out of round. Replace if failed (Figure 18).

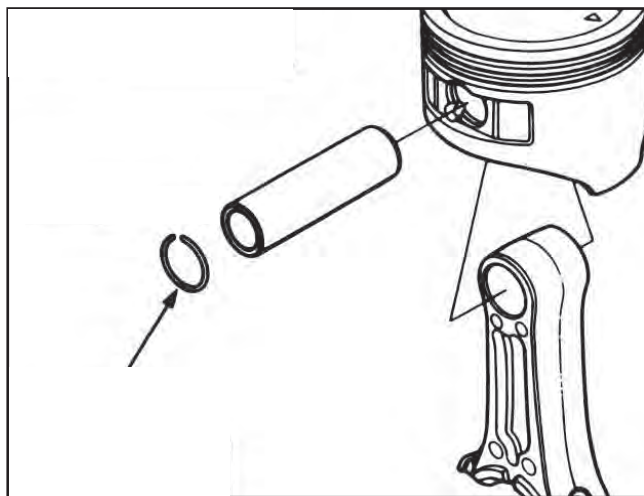


Figure 18

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Pistons (Cont.)

8. Piston Rings inspect and measure:

Inspect each for surface wear, broken, pitting or scratches. Measure and compare each ring to specifications (Figure 19).

Ring Thickness		
Ring	Standard	Service Limit
Width (Top)	0.038-0.039 in. (0.97-0.99 mm)	0.0354 in. (0.90 mm)
Width (Middle)	0.046-0.047 in. (1.17-1.19 mm)	0.0433 in. (1.10 mm)
Width (Oil Ring)	0.110-0.126 in. (1.65-1.85 mm)	0.1063 in. (1.60 mm)

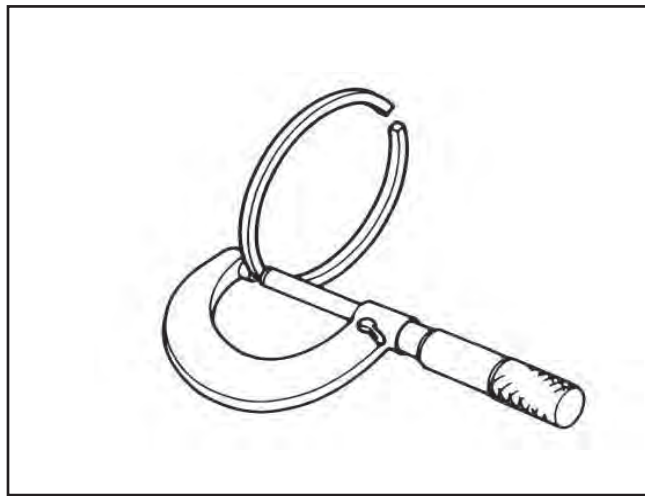


Figure 19

9. Piston ring end gap measurement:

Insert into the matching cylinder, use a piston dome to push ring evenly into the cylinder bore about one inch. Check the end gap of top and middle rings for each piston.

Piston ring end gap measurement	
Standard (Height)	0.0078-0.0157 in.
Service Limit	0.0177 in.

10. Replace ring set if any of the three rings are out of specification.

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Connecting Rods

1. Inspect the connecting rods for damage:
  - Bent: the rods are identical, compare side-by-side
  - Overheated: a good rod should be bright aluminum in color
  - Scored: inspect both rod ends for scuffs, pitting or scoring. Light faint scratches at crank journal is normal.
2. Wrist pin end inside diameter, measure and compare specifications (Figure 20).

Connecting Rod <i>Small End ID</i>	
<b>Standard</b>	0.6695-0.6699 in.
<b>Service Limit</b>	0.6712 in.

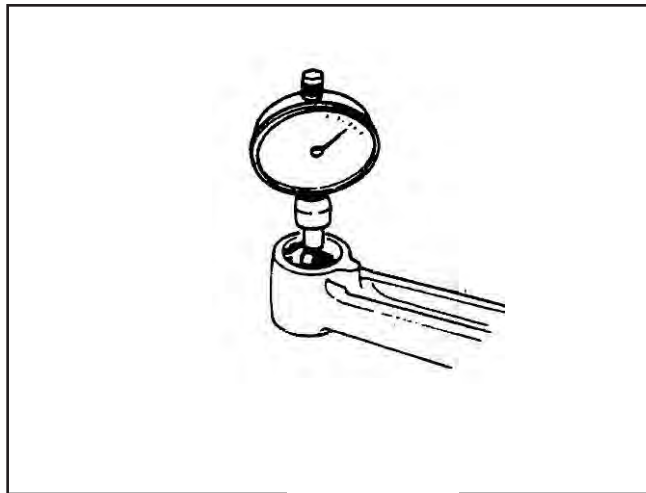


Figure 20



# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Connecting Rods (Cont.)

3. Crankshaft end inside diameter, measure and compare to specifications (Figure 21).

Connecting Rod <i>Large End ID</i>	
Standard	1.5754-1.5757 in.
Service Limit	1.5773 in.

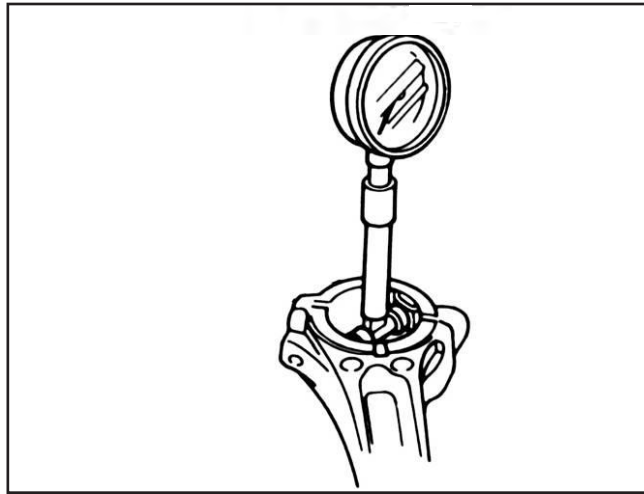


Figure 21

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Connecting Rods (Cont.)

4. Crankshaft end side/thrust clearance, measure and compare to specifications (Figure 22).

Connecting Rod Large End Axial Clearance	
Standard	0.0177-0.0374 in.
Service Limit	0.0413 in.

5. Connecting rod large end oil clearance (radial)

- Clean all oil from the crankshaft rod journal and thrust side.
- Place a piece of plastic gauge on the crankshaft rod journal, assemble connecting rod matching cap/rod stamping, and tighten the bolts to specified torque. Bolt torque 106 in-lbs. (12.5 Nm).

**NOTE: Do not rotate the crankshaft while tightening the connecting rod bolt (Figure 22).**

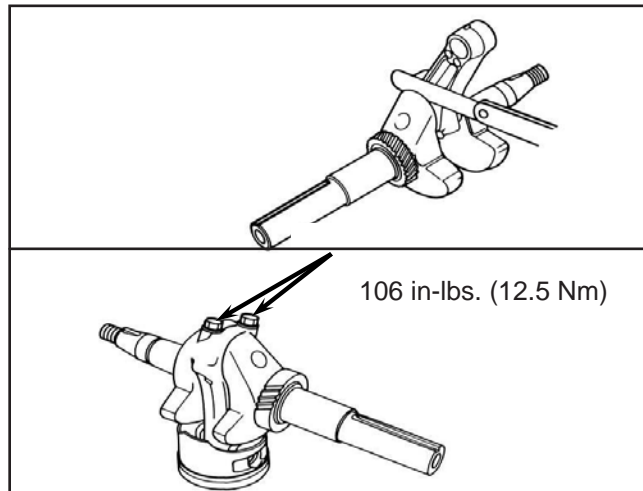


Figure 22

c. Remove the connecting rod and measure the plastic gauge.

Plastic Gauge	
Standard	0.0015-0.0024 in.
Service Limit	0.0032 in.

d. If the clearance is greater than the service limit, replace the connecting rod and recheck clearance with a new rod. If the clearance still exceeds the service limit, replace the crankshaft and repeat the previous steps.

e. Repeat for other connecting rod.

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Oil Pump

1. Inspect the gerotor inner and outer for damage; chips, scuffs or broken gear (Figure 23).

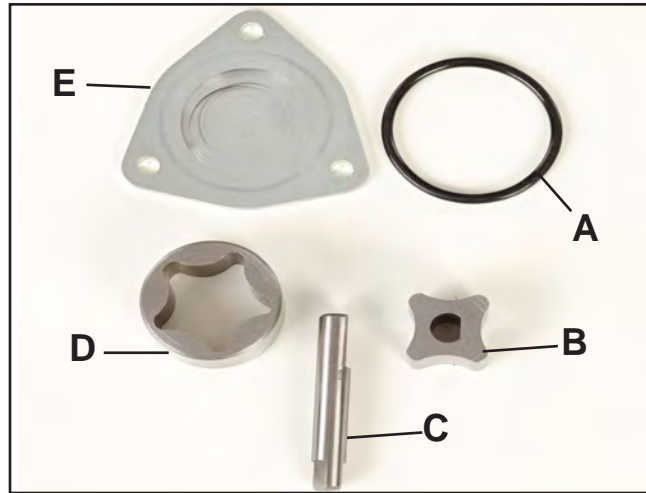


Figure 23

- |                   |                   |
|-------------------|-------------------|
| A. O-Ring         | D. Outer Rotor    |
| B. Inner Rotor    | E. Oil Pump Cover |
| C. Oil Pump Shaft |                   |

2. Inspect the oil pump shaft for wear.
3. Inspect for scuffing between the gerotor and cover.

**NOTE: Replace oil pump assembly if damaged.**

4. Inspect cover plate for warpage.

**NOTE: Replace cover if warped.**

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Sump Cover

1. Clean and inspect gasket surface for nicks and deep scratches.
2. Remove and discard the crankshaft oil seal.
3. Inspect and measure the lower crankshaft bearing.
  - Inspect surface for wear, pitting and scratches
  - Measure and compare to specifications.

Sump Cover Crankshaft Hole Diameter	
Standard	1.5751-1.5758 in. (40.009-40.025 mm)
Service Limit	1.5778 in. (40.075 mm)

4. Remove and inspect the following, if not previously removed (Figure 24):
  - oil screen
  - check ball and spring
  - rubber oil deflector

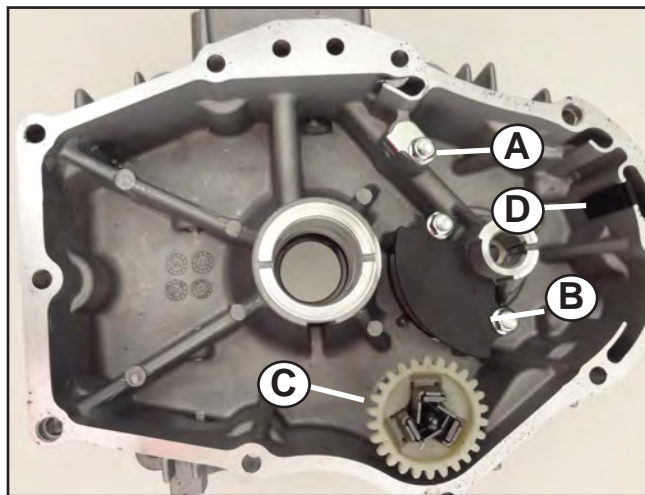


Figure 24

- A. Check Ball System
- B. Oil Pre-Screen Assembly
- C. Governor Assembly
- D. Oil Deflector (Rubber)

# ENGINE INSPECTION AND RECONDITIONING

## Lower End Inspection and Reconditioning (Cont.)

### Governor Assembly

1. Inspect the gear for wear or damage.
2. Inspect the weights and spool for free movement.
3. Measure end play clearance between the washer and housing.
4. Measure and compare to specifications, governor end play 0.05 in. (0.35 mm) (Figure 25).

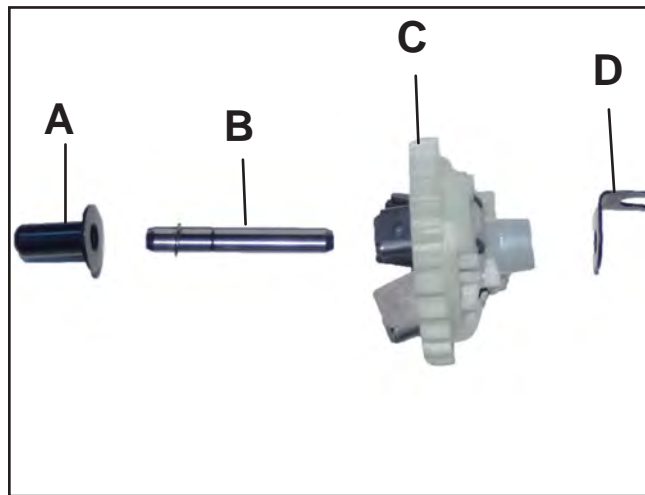


Figure 25

- A. Spool
- B. Shaft
- C. Gear w/Fly Weights
- D. Anchored Washer

### Mounting Hardware Inspection

1. Clean threads of all removed hardware.
2. Inspect all, replace if corroded, damaged or stretched.

# ENGINE ASSEMBLY

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# ENGINE ASSEMBLY

## Upper Assembly 1

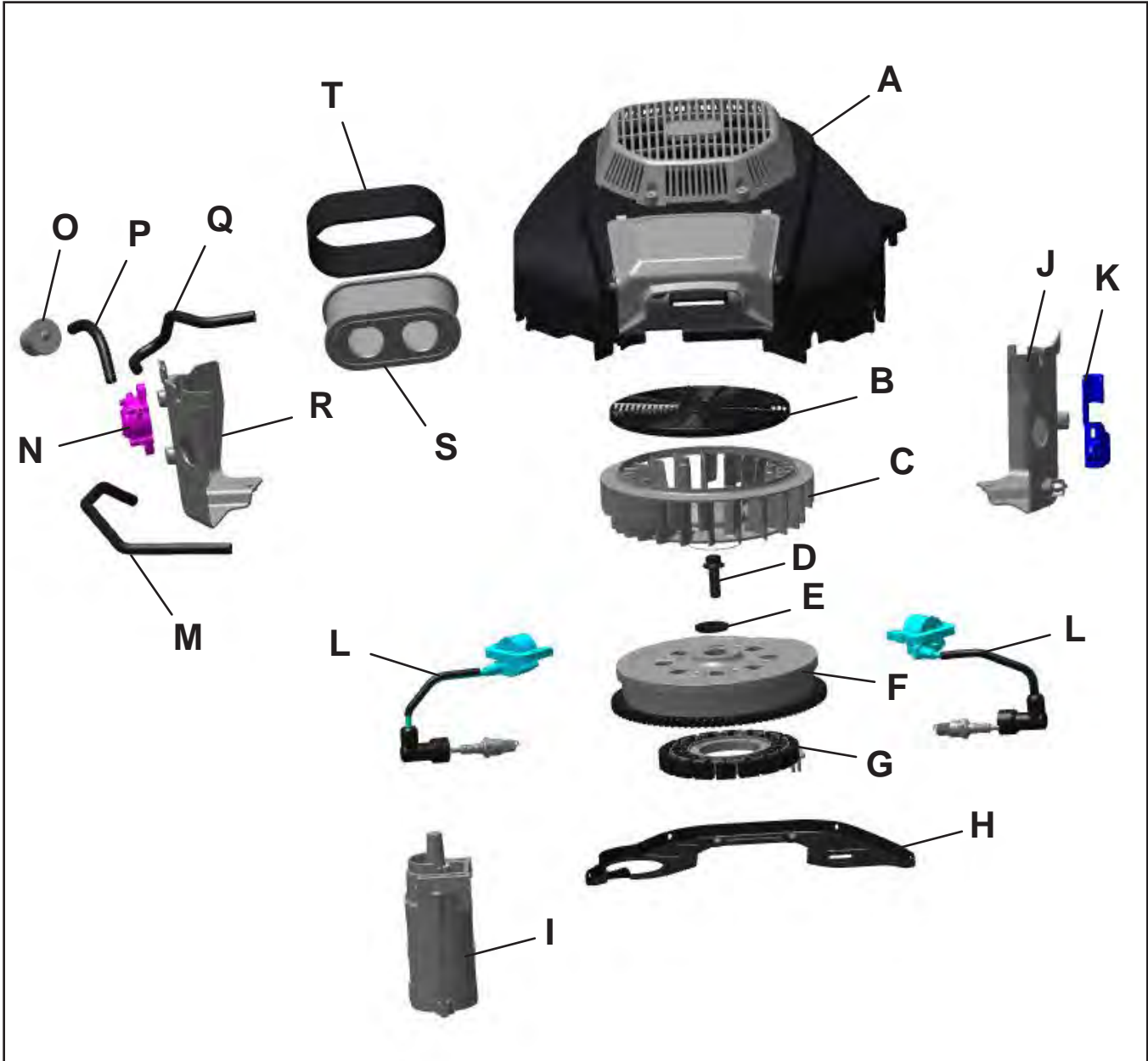


Figure 1

A. Blower Shroud  
B. Shredder Screen  
C. Flywheel Fan  
D. Bolt  
E. Washer  
F. Flywheel  
G. Stator

H. Lower Baffle  
I. Electric Starter  
J. Side Shroud  
K. Oil Drain Hose Cleat  
L. Ignition Coil  
M. Fuel Line  
N. Fuel Pump

O. Fuel Filter  
P. Fuel Line  
Q. Vacuum Line  
R. Side Shroud  
S. Paper Element  
T. Foam Element

**NOTE: Mounting components not shown.**

# ENGINE ASSEMBLY

## Upper Assembly 2

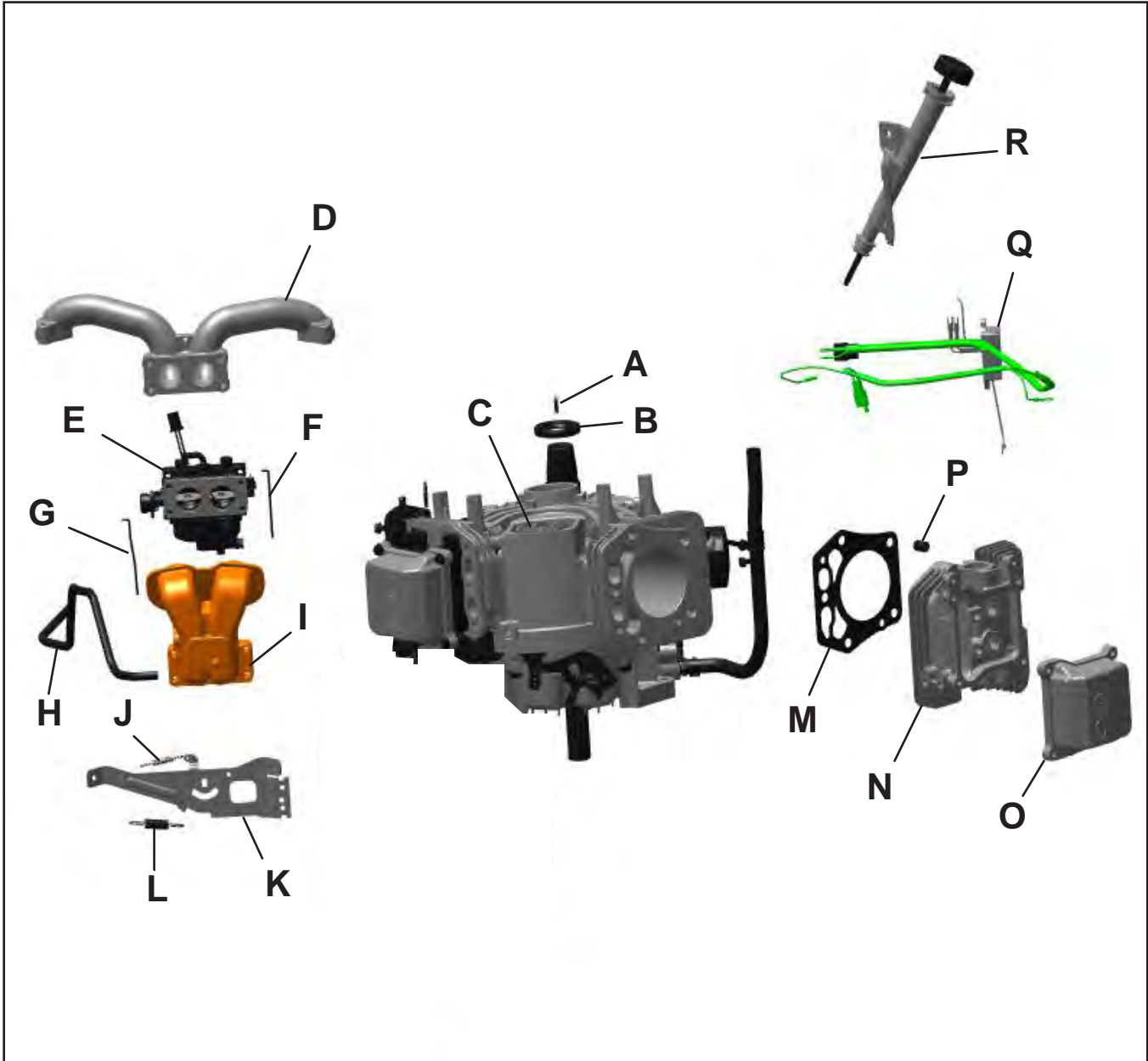


Figure 2

A. Flywheel Key  
B. Upper Seal  
C. Breather Assembly  
D. Intake Manifold  
E. Carburetor  
F. Throttle Link  
G. Choke Link

H. Fuel Tank Vent Line  
I. Air Filter Manifold  
J. Choke Spring  
K. Control Plate  
L. Throttle Spring  
M. Head Gasket

N. Cylinder Head  
O. Valve Cover  
P. Alignment Pin  
Q. Voltage Regulator and Wire  
Harness  
R. Dipstick and Tube

**NOTE: Mounting components not shown.**





# ENGINE ASSEMBLY

## Lower Assembly 1

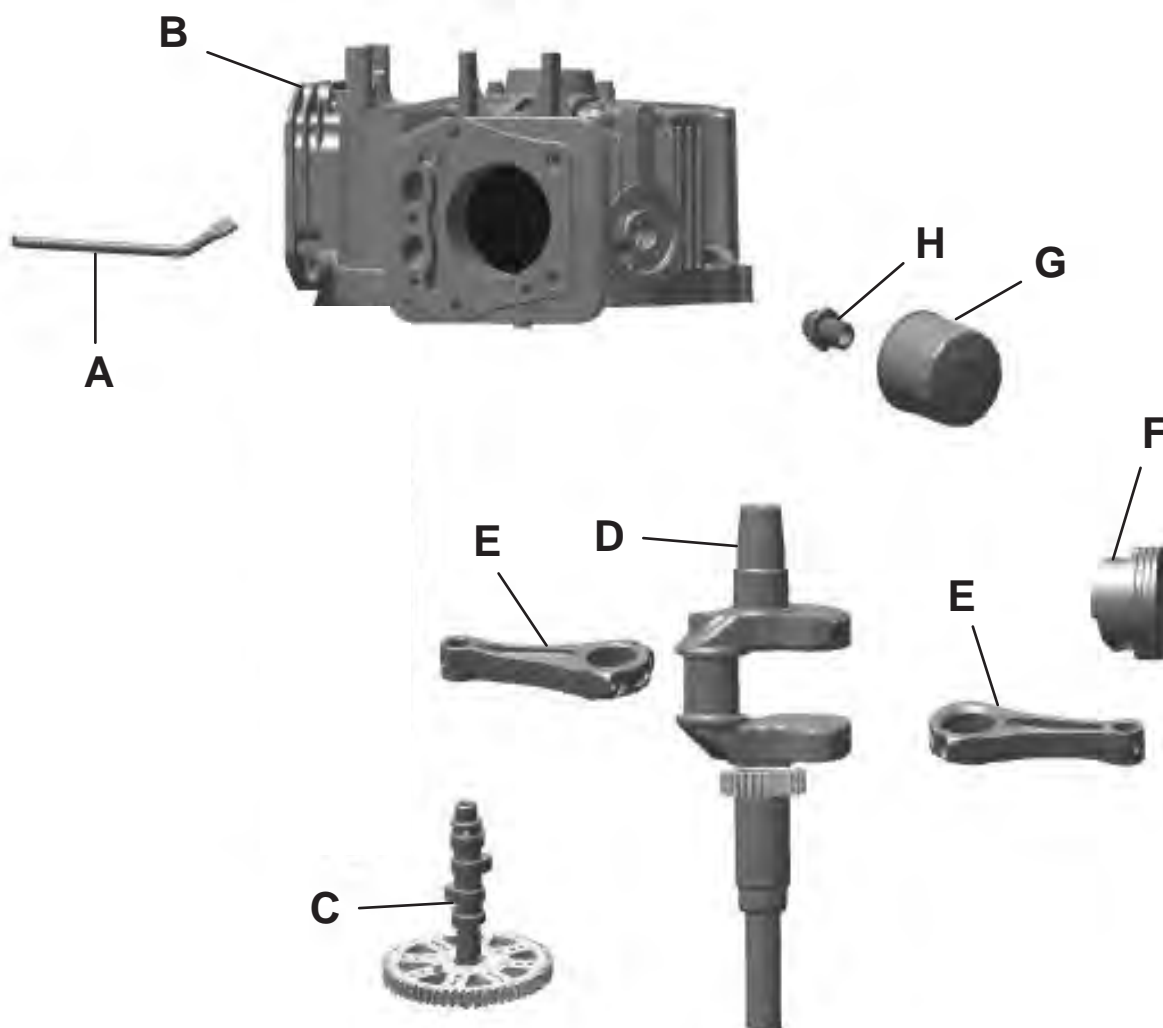


Figure 3

- |                 |                                |
|-----------------|--------------------------------|
| A. Governor Rod | E. Connecting Rod              |
| B. Crankcase    | F. Piston (1 shown)            |
| C. Camshaft     | G. Oil Filter                  |
| D. Crankshaft   | H. Oil Filter Threaded Fitting |

**NOTE:** Mounting components not shown.

# ENGINE ASSEMBLY

## Lower Assembly 2

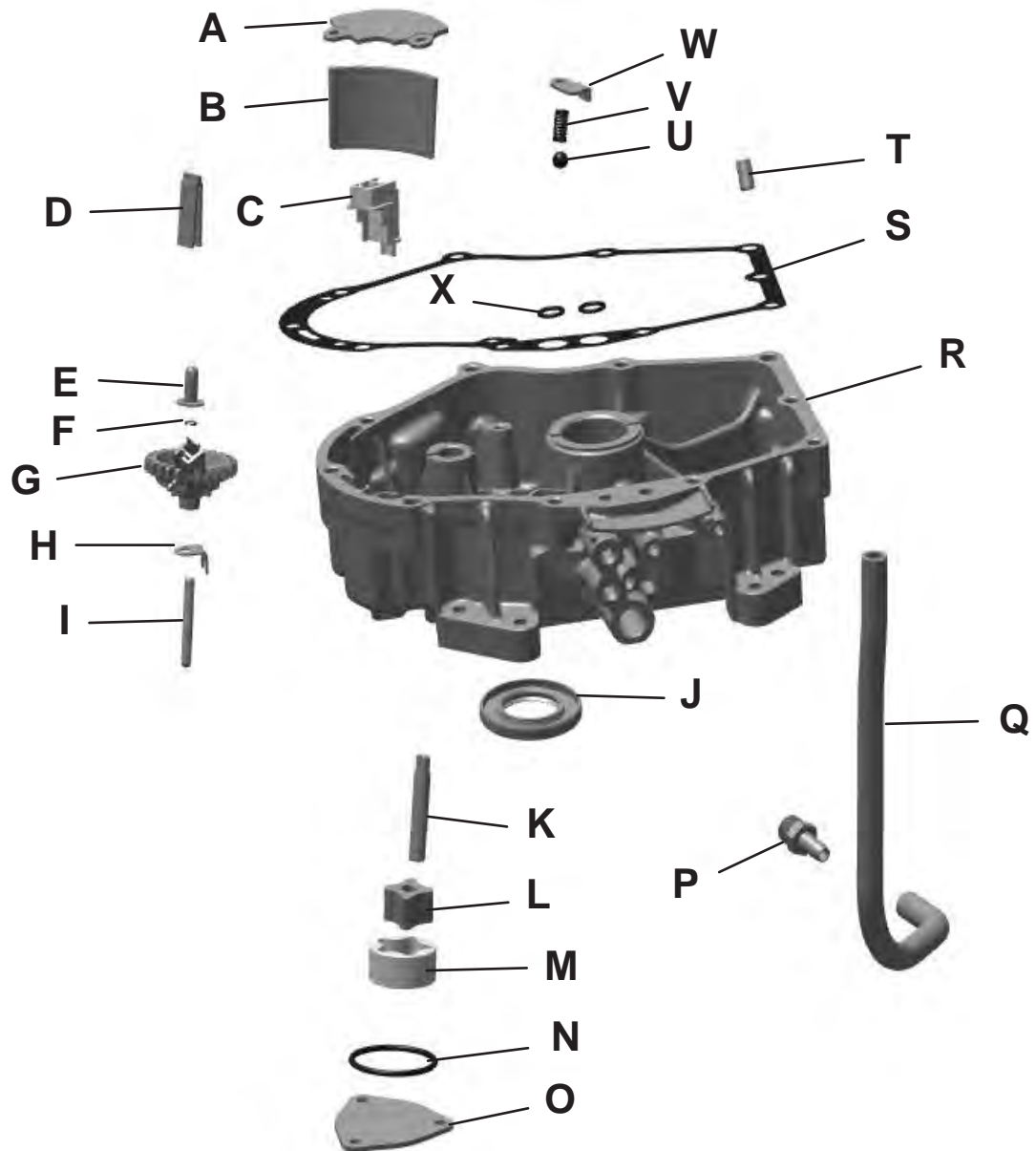


Figure 4

- |                                   |                                   |                           |
|-----------------------------------|-----------------------------------|---------------------------|
| A. Oil Screen Cover               | I. Shaft (Gov. Asm.)              | Q. Oil Drain Hose Asm.    |
| B. Oil Screen                     | J. Seal                           | R. Crankcase Cover        |
| C. Screen Retainer                | K. Oil Pump Shaft (Oil Pump Asm.) | S. Crankcase Gasket Cover |
| D. Rubber Oil Deflector           | L. Inner Rotor (Oil Pump Asm.)    | T. Dowel Pin (1 Shown)    |
| E. Spool (Gov. Asm.)              | M. Outer Rotor (Oil Pump Asm.)    | U. Ball Valve             |
| F. Retaining Ring (Gov. Asm.)     | N. O-Ring                         | V. Spring                 |
| G. Gear w/Fly Weights (Gov. Asm.) | O. Oil Pump Cover                 | W. Retainer Plate         |
| H. Anchored Washer (Gov. Asm.)    | P. Hose Fitting                   | X. O-Ring                 |

**NOTE:** Mounting components not shown.



# ENGINE ASSEMBLY

---

## Assemble Lower End

### General Steps of Internal Assembly

1. Only use components that have been previously cleaned and pass inspection [see chapter 8, page 8-1.](#)
2. Lubricate components at each assembly step, using a good clean motor oil or assembly grease.

### Crankshaft

1. Oil the crankshaft bearing surfaces.
2. Insert the tapered flywheel end of the crank into the crankcase.

### Piston Rings onto Piston

1. Assemble the rings onto each piston in the following order (Figure 5):
  - oil ring
  - middle ring
  - top ring

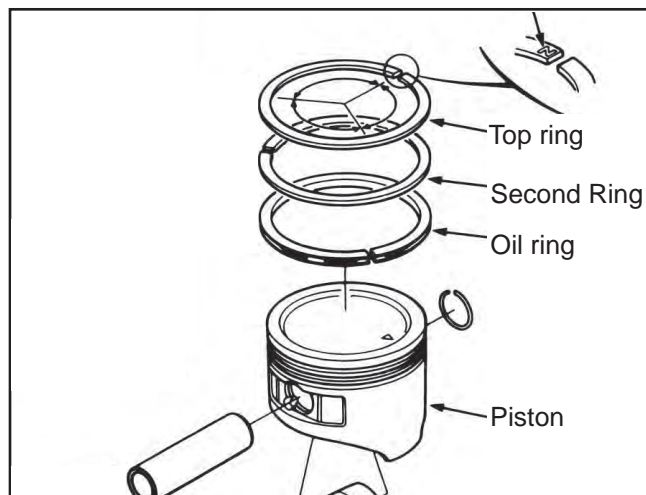


Figure 5

**NOTE:** Upper two rings are stamped near the ring gap, assemble with the stamp mark facing the piston dome.

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Piston Rings onto Piston (Cont.)

2. Stagger the ring gaps approximately 120° apart (Figure 6).

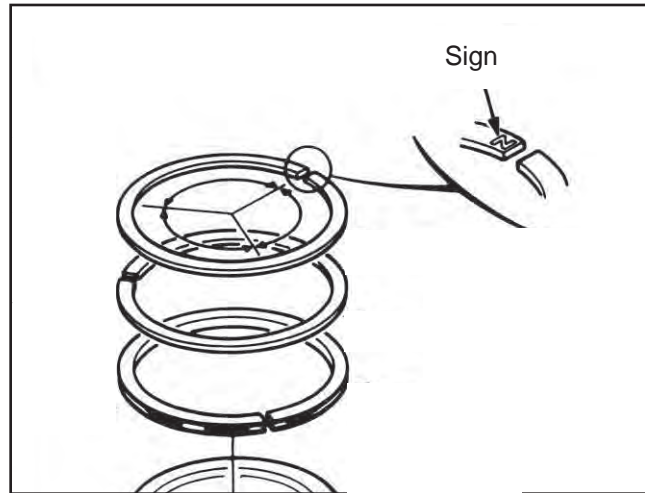


Figure 6

3. Repeat for other piston.

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Piston onto Connecting Rod (#1 Cylinder)

1. Gather matching components for the #1 cylinder (piston, wrist pin, two clips, connecting rod, cap and bolts) (Figure 7).

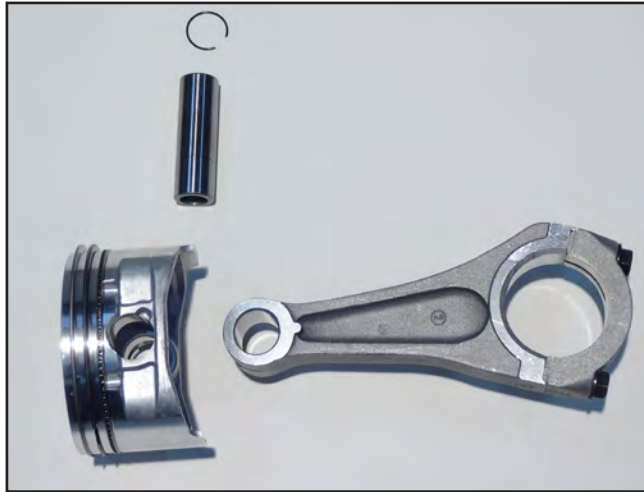


Figure 7

2. Install a piston pin clip into the piston.
3. Orient the piston with the "PTO" mark pointing down (Figure 8).
4. Assemble the piston to the connecting rod with the long length rotated 90° counter-clockwise (CCW) of the PTO (circled below) (Figure 8).

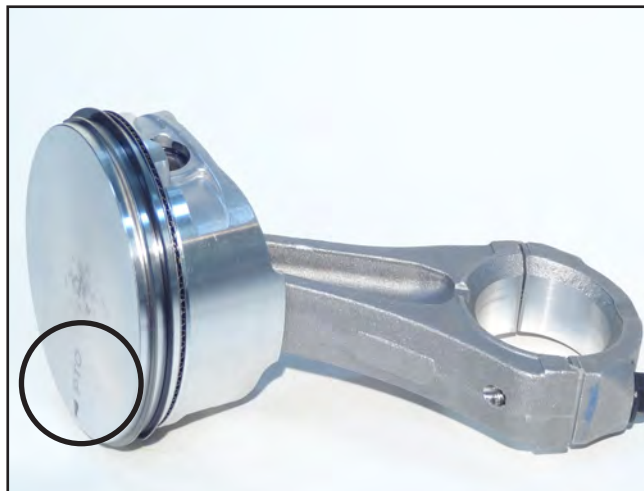


Figure 8

5. Insert wrist pin.

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)


### Piston onto Connecting Rod (#1 Cylinder) (Cont.)

6. Install the second piston pin clip.

**NOTE:** Rotate both clips so the ends are not in the cutout area of the piston (Figure 9).



Figure 9

-  7. Verify the connecting rod crank journal has the large taper facing upward when the piston “PTO” mark is downward.

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Piston onto Connecting Rod (#2 Cylinder)

1. Gather the matching components for the #2 cylinder.
2. Install the piston pin clip into the piston.
3. Orient the piston with the "PTO" mark pointing down.
4. Assemble the piston to the connecting rod with long length rotated 90° clockwise of the PTO.
5. Insert the pin.
6. Install the second piston pin clip.

**NOTE: Rotate both clips so the ends are not in the cutout area of the piston.**


-  7. Verify the connecting rod crank journal has the large taper facing down when the piston "PTO" (circled below) mark is downward (Figure 10).



Figure 10

# ENGINE ASSEMBLY

## Assemble Lower End (Cont.)

### Piston and Connecting Rod Assemblies onto Crankshaft

1. Remove rod cap if not previously removed.
2. Oil the piston and rings.
3. Using a ring compressor, insert the piston assembly into the matching cylinder with the piston dome “PTO” mark pointing toward PTO end of the crankshaft (#1 piston assembly in the #1 bore, #2 piston assembly in #2 bore).
4. Push piston into the bore until the rod is at the crank journal.
5. Match the rod cap stamping to rod and install with two bolts.
6. Torque to specification, connecting rod bolts 106 in-lbs. (12 Nm).
7. Verify crankshaft moves freely.
8. Repeat for other piston and rod assembly.

**NOTE:** When the rods are properly assembled to the crank the tapers will be to the upper and lower crank thrust sides and both piston dome stamps point to the PTO end of crankshaft (Figure 11).

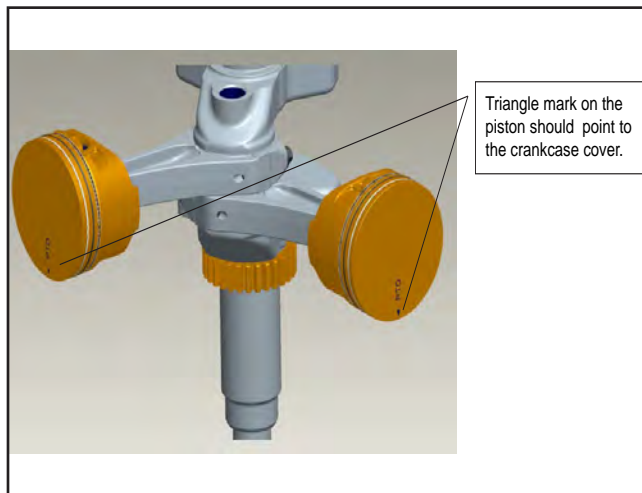


Figure 11

9. Verify crankshaft moves freely.



# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Camshaft and Followers

1. Oil and insert the exhaust and intake followers (tappets), each into their respective holes in the crankcase.

**NOTE: Intake is upper, exhaust is lower.**

2. Rotate the crankshaft so the timing mark points toward the camshaft location.

3. Oil camshaft bearing and lobes.


 4. Rotate and insert camshaft to match the timing marks on the crankshaft (Figure 12).



Figure 12

5. Verify crankshaft moves freely.

# ENGINE ASSEMBLY

## Assemble Lower End (Cont.)

### Sump Cover Sub-Assembly



1. Insert check ball, spring, and retain with spring and screw. Torque cover plate screw to 89 in-lbs. (10 Nm).



2. Insert retainer, oil screen, and plate, mount with two screws. Torque oil screen cover bolts to 89 in-lbs. (10 Nm) (Figure 13).

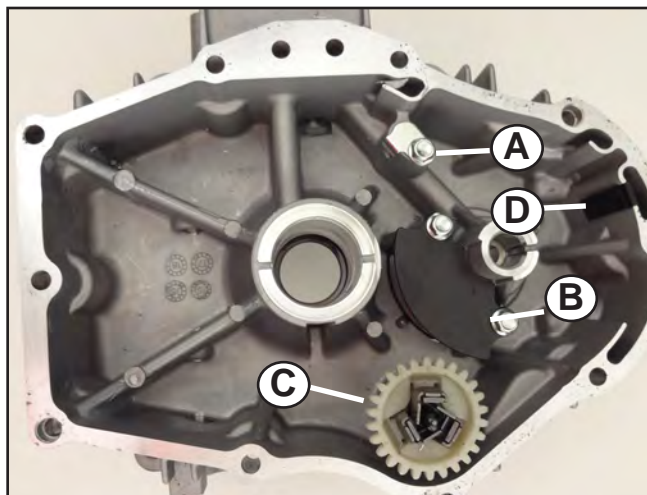


Figure 13

- A. Check Ball System
- B. Oil Pre-Screen Assembly
- C. Governor Assembly
- D. Oil Deflector (Rubber)

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Governor Assembly

*Assemble governor components (spool, shaft, and governor gear), [see “Governor Assembly,” chapter 8, page 8-25.](#)*

1. Install shaft into governor gear.

**NOTE:** Snap ring should be about a quarter inch down the shaft, not in the groove.

2. While holding the three weights, install governor spool over the shaft.
3. Verify the spool rests in the groove of each weight.
4. Rotate the assembly with the spool downward, lightly tap the shaft, moving the snap ring into the groove of the shaft.
5. Verify governor assembly is properly assembled:
  1. Spool should be retained.
  2. Spin weights with finger, should move outward lifting spool away from governor.

### ***Install Governor assembly into sump cover***

1. Install anchored washer over hole and sump cover rib.

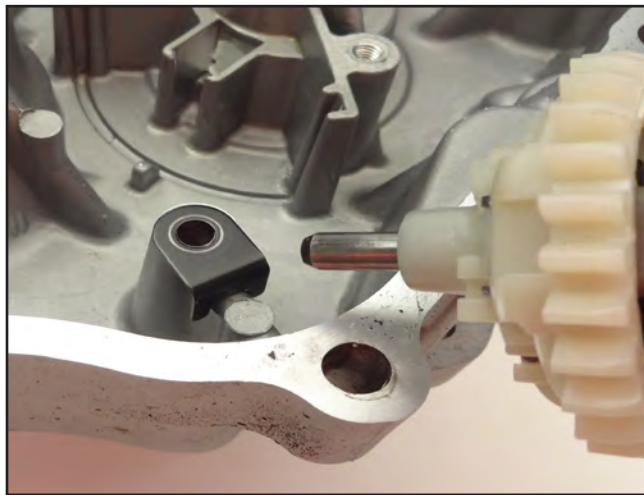


Figure 14

2. Install governor assembly through anchored washer into sump cover by lightly tapping the spool until proper clearance is obtained.
3. End play clearance specification. Governor end play to 0.002-0.013 in. (0.05-0.35 mm) (Figure 14).
4. Test governor for proper assembly by quickly spinning governor assembly with finger, weights should move outward lifting the spool away from the sump cover. Weights and spool should move together.



# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Sump Cover Sub-Assembly (Cont.)

5. Insert the remaining components onto the sump cover (if removed) (Figure 15).

- oil deflector
- oil drain plug
- oil drain hose and fittings

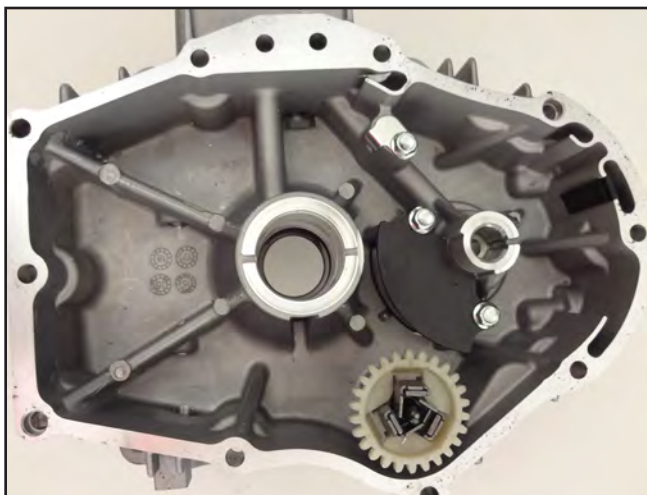


Figure 15



7. Torque the oil drain plug or hose fitting to 19 ft-lbs. (26 Nm).

# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Sump Cover

1. Install both alignment pins into the crankcase.
2. Install the gasket and two o-rings.

**NOTE: The o-rings provide additional sealing for the pressure lubrication system.**

3. Slide the sump cover over the crankshaft until against gasket and crankcase.

**NOTE: Rotate the crankshaft slightly to assist assembly. DO NOT use bolts to pull cover to crankcase.**

4. Install the bolts loosely. Torque in two passes, follow the torque sequence below (Figure 16):

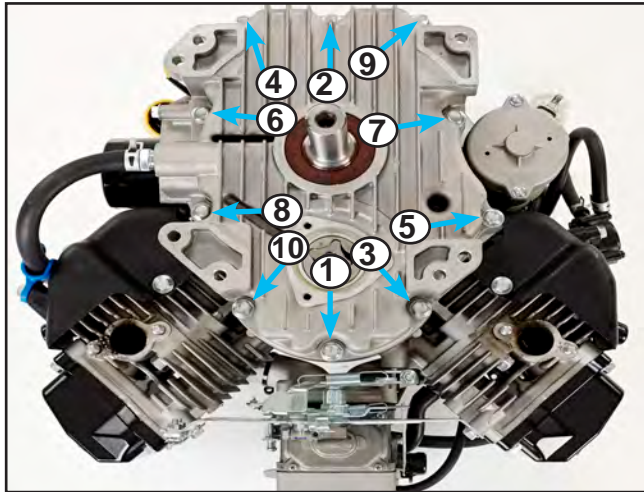


Figure 16

### Sequence for Tightening:

Sump Bolts (10)  
First Pass 10 ft. lbs.  
Final Torque 21 ft. lbs.

# ENGINE ASSEMBLY

## Assemble Lower End (Cont.)

### Oil (Gerotor) Pump

1. Install the oil pump shaft (double “D” end into the end of camshaft) (Figure 17).

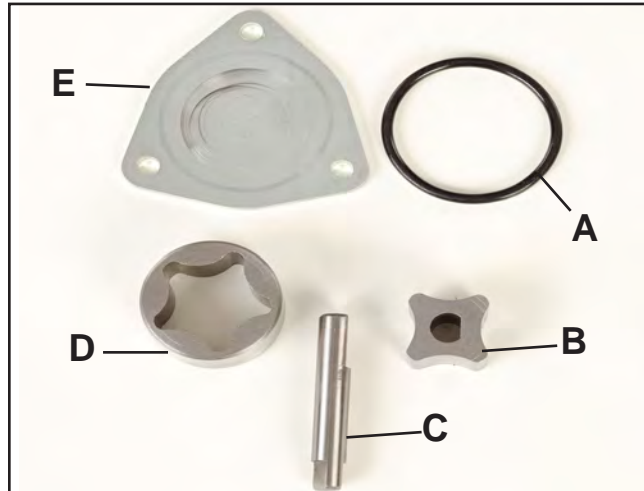


Figure 17

- |                   |                   |
|-------------------|-------------------|
| A. O-Ring         | D. Outer Rotor    |
| B. Inner Rotor    | E. Oil Pump Cover |
| C. Oil Pump Shaft |                   |

2. Install the gerotor (inner and outer) onto the shaft.
3. Install a new o-ring.
4. Install the cover plate and secure with three bolts.
5. Torque the oil pump cover bolts to 89 in-lbs. (10 Nm).



# ENGINE ASSEMBLY

---

## Assemble Lower End (Cont.)

### Crank Seals (Upper and Lower)

1. Cover the end of crankshaft with a plastic bag or use a seal protector (Figure 18).

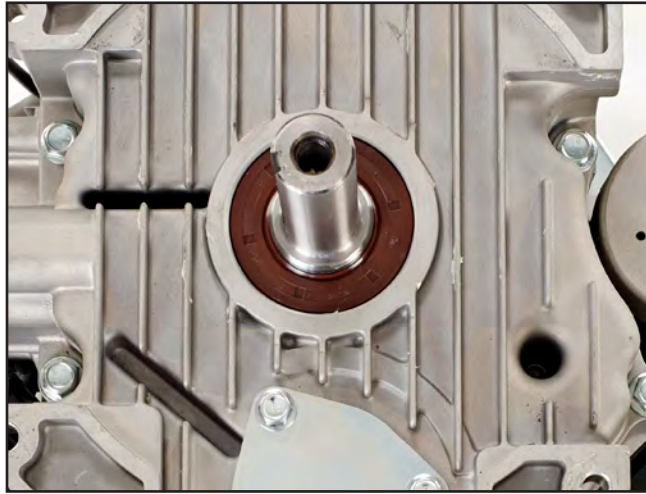


Figure 18

2. Carefully install both upper and lower crank seals.

**NOTE: Proper depth is just below flush.**

### Oil Filter

1. Install the new oil filter onto the filter adapter and turn the oil filter clockwise until the rubber gasket contacts the crankcase. Tighten the oil filter an additional 1/2 - 3/4 turn.
2. Torque oil filter to 106 in-lbs. (12 Nm).



### Verify Engine Assembly Turns Freely

1. Rotate crankshaft two complete revolutions to verify assembly rotates freely.
2. If unable to rotate, disassemble lower end to determine issue.



# ENGINE ASSEMBLY

## Assemble Upper End

### Cylinder Head Sub-Assembly

#### WARNING

Use protective eye wear when assembling the valves.

#### 1. Installation of valves (Figure 19)

- Match valves and components to each cylinder head.
- Lubricate valve stem.
- Insert valve (L) into head (F).
- Install valve spring seat (K).
- Oil and install valve seal (J).
- Install valve spring (I).
- Install valve spring retainer (H).
- Using a valve spring compressor, install the two valve keepers (G).
- Slowly remove the valve spring compressor.
- Repeat for other valves.

#### 2. Rocker arms (Figure 19)

- Install the plate (E) (push-rod guide) retain with two rocker arm studs (D).
- Torque rocker arm studs to 22 ft-lbs. (30 Nm).
- Install the rocker arm (C) onto stud and retain loosely with a pivot nut (B).
- Loosely install lock nut (A) onto the stud next to the pivot nut (B).

**NOTE: Rocker arms final torque step in *Adjust Valve Clearance* section.**

- Repeat for other head assembly.

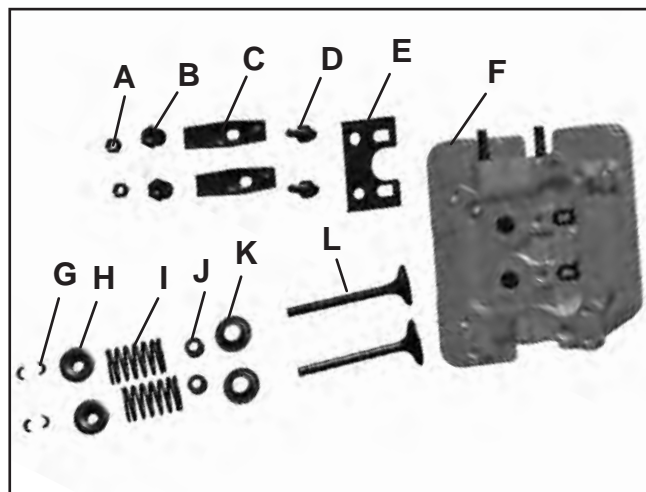


Figure 19



# ENGINE ASSEMBLY

---

## Assemble Upper End

### Cylinder Heads

1. Install the two locator pins for each head.
2. Install a new head gasket.
3. Place head onto locator pins and hold.
4. Loosely install the five head bolts (three longer, two shorter), [refer to Figure 20 and 21, page 9-21.](#)
5. Tighten bolts in three passes following torque sequence and specification.

# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Cylinder Heads (Cont.)



6. Torque cylinder head bolts (50 and 70 mm) to 39 ft-lbs. (52.5 Nm) (Figure 20 and 21).

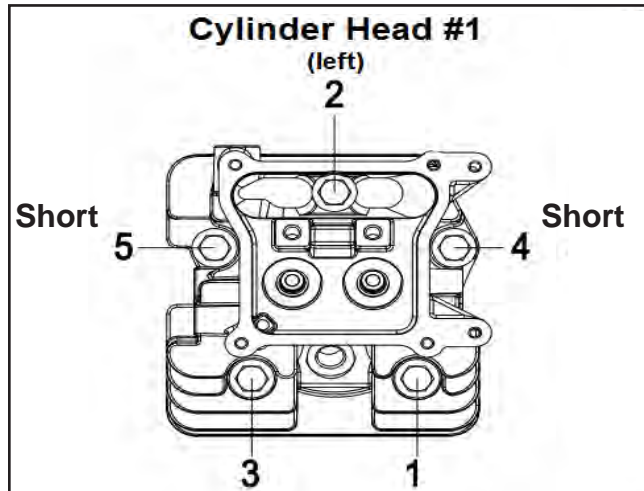


Figure 20

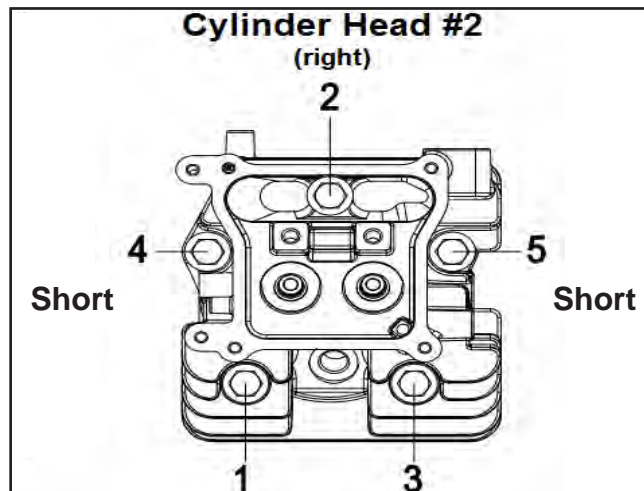


Figure 21

#### Sequence for Tightening:

First Pass 15 ft. lbs.  
Mid-Point 25 ft. lbs.  
Final Torque 39 ft. lbs.

7. Install the matching push rods for this head.

**NOTE: Be sure ball end fits into end of follower.**

8. Repeat for other head.



# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Cylinder Heads (Cont.)

7. Adjust valve clearance (Figure 22):

- Rotate engine until piston is at TDC (top dead center) on compression stroke.
- Rotate the rocker to fit the short end over push-rod.
- Using a feeler gauge between the valve stem and the rocker, tighten the pivot nut to obtain proper clearance.

**NOTE: Be careful to not open valve while adjusting pivot nut.**

Valve Clearance (cold) - Intake	0.004-0.006 in. (0.10-0.15 mm)
Valve Clearance (cold) - Exhaust	0.006-0.008 in. (0.15-0.20 mm)

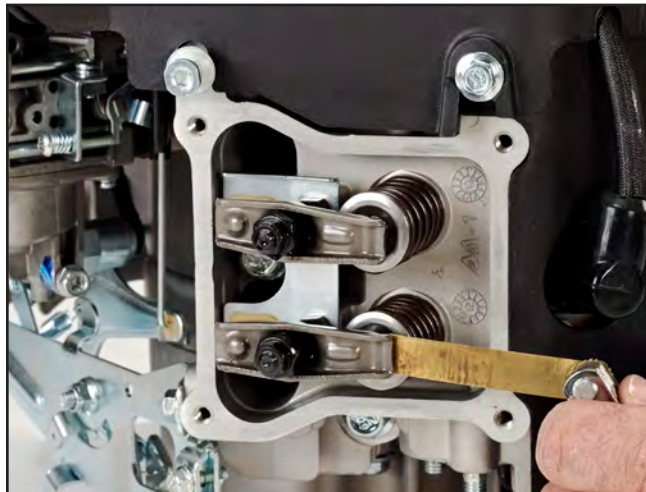


Figure 22



8. While holding pivot nut, tighten lock nut.
9. Torque the lock nut to 124 in-lbs. (14 Nm).
10. Repeat for other valve.
11. Install the new valve cover gasket.
12. Install the valve cover with four mounting bolts.

# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)



### Cylinder Heads (Cont.)

13. Torque valve cover bolts to 89 in-lbs. (10 Nm) (Figure 23).

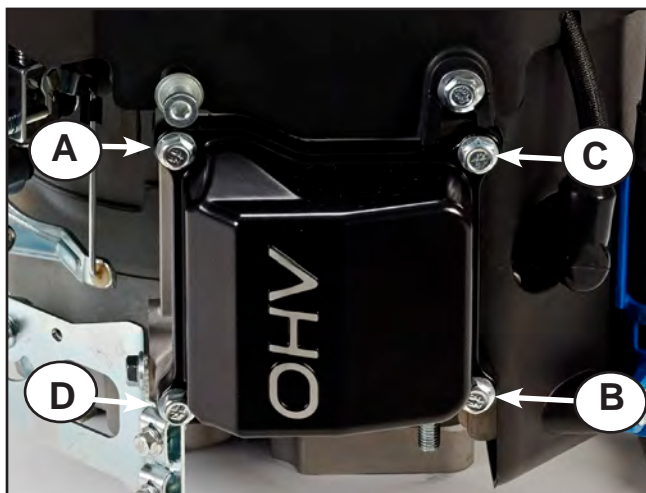


Figure 23

#### **Torque Sequence A-D:**

First Pass 45 in-lbs. (5 Nm)

Final Torque 89 in-lbs. (10 Nm)

14. Set gap to 0.030 in. (0.7-0.8 mm) and install the new spark plug.



15. Torque the spark plug to 21 ft-lbs. (28.5 Nm).

**NOTE: Repeat for the #2 cylinder head assembly.**

# ENGINE ASSEMBLY

---

## Assemble Upper End (Cont.)

### Breather

1. Install the breather reed with the reed toward the engine block (Figure 24).

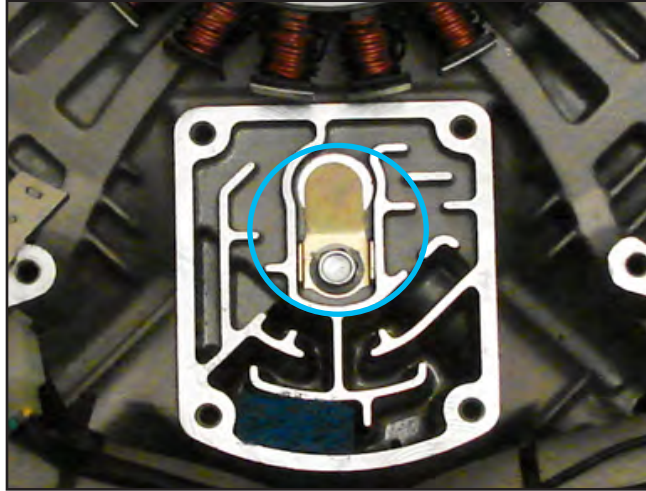


Figure 24



2. Torque bolt to 89 in-lbs. (10 Nm).

3. Install the breather sponge.

4. Install the new gasket and cover, secure with four bolts.



5. Torque the breather plate bolts to 89 in-lbs. (10 Nm).

# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Intake Manifold with Engine Wire Harness and Voltage Regulator

NOTE: If replacing the intake manifold only, [see “Dipstick Tube \(Voltage Regulator Mounted\).” chapter 9, page 26](#) step for voltage regulator and wire harness installation, wire harness placement and anchor locations on the manifold (Figure 25).

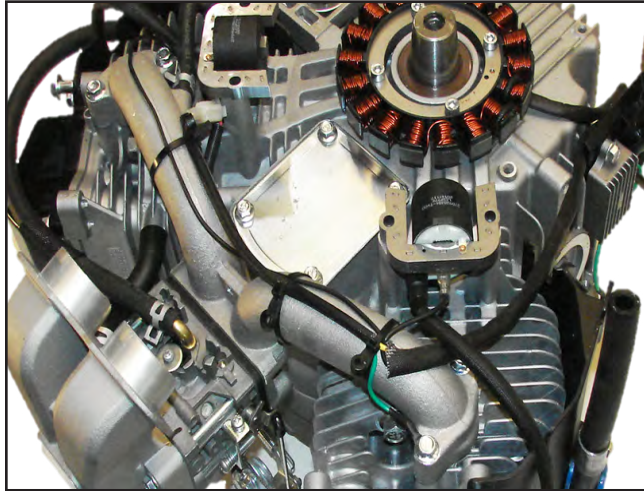


Figure 25

1. Lay out the wire harness and intake manifold onto the top of the engine block with the voltage regulator and harness plug near the dipstick mounting.
2. Using new gaskets, mount the intake manifold to each head with two bolts per head (Figure 26).



Figure 26

NOTE: #2 cylinder mounting bolt, closest to carburetor, has the wire harness ground terminal.



3. Torque bolts to 89 in-lbs. (10 Nm) in two passes:
  - 1st pass 44 in-lbs. (5 Nm)
  - 2nd pass 89 in-lbs. (10 Nm)

# ENGINE ASSEMBLY

---

## Assemble Upper End (Cont.)

### Dipstick Tube (Voltage Regulator Mounted)

1. Install the voltage regulator to the dipstick tube if previously removed (Figure 27).

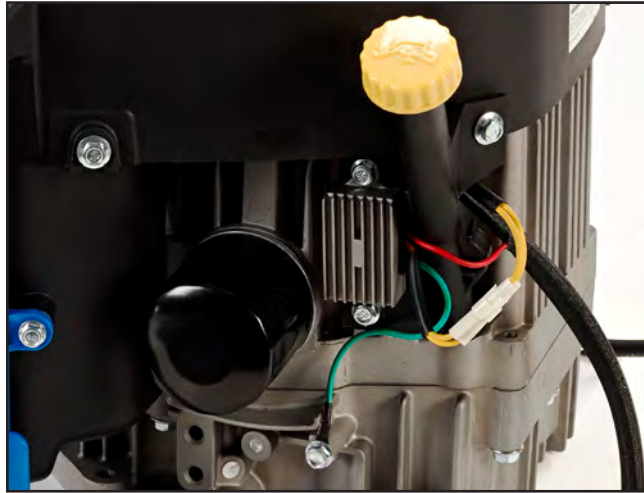


Figure 27



2. Torque the voltage regulator/dipstick tube bolts to 62 in-lbs. (7 Nm).
3. Install new o-ring on dipstick tube.
4. Loosely install the dipstick tube assembly into the engine block.
5. Orient the wire harness and engine harness plug around the dipstick tube, between it and the engine block.
6. Mount the ground wire with bolt to the sump cover.
7. Torque the harness ground bolt to 89 in-lbs. (10 Nm).



**NOTE:** If the complete voltage regulator with the wire harness was removed, anchor the harness to the intake manifold with four plastic ties, [see “Intake Manifold with Engine Wire Harness and Voltage Regulator,” chapter 9, page 9-25](#) for location of terminals and tie anchors.



# ENGINE ASSEMBLY

---

## Assemble Upper End (Cont.)

### Stator (Alternator)

1. Install the stator with the wire harness toward the dipstick tube and engine block (Figure 28).

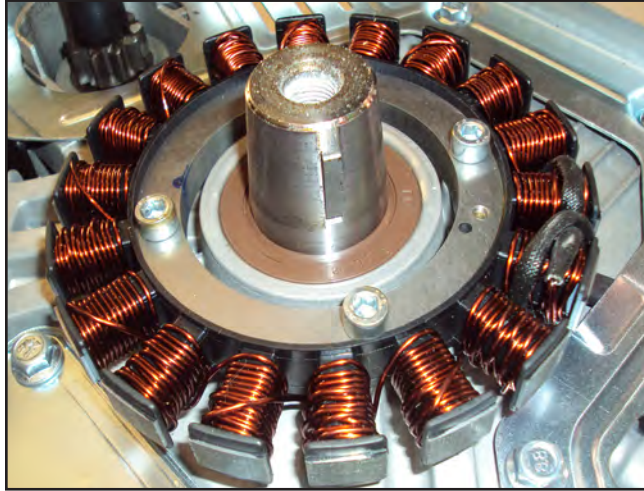


Figure 28

2. Secure stator with the four bolts.
3. Torque the stator charging coil bolts to 89 in-lbs. (10 Nm).
4. Route the stator wire between the dipstick tube and engine block, slide the harness into the retainer on the dipstick tube.
5. Connect the stator wire terminals to the voltage regulator wire harness terminals (orientation doesn't matter).





# ENGINE ASSEMBLY

---

## Assemble Upper End (Cont.)

### Lower Baffle

1. Place the lower baffle on the engine block while holding the stator wires in recess of the crankcase (Figure 29).

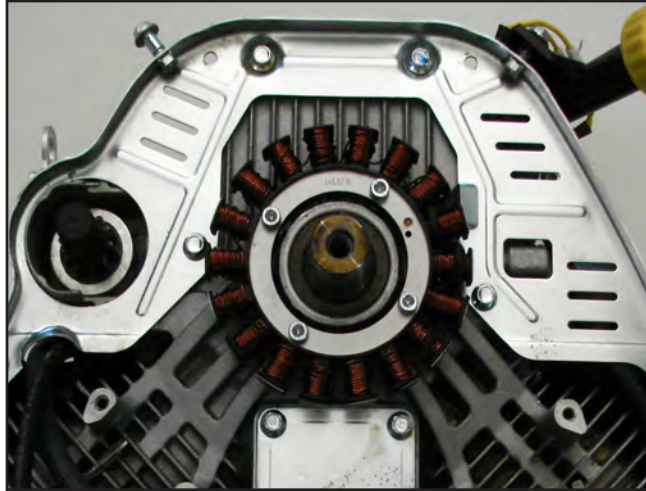


Figure 29

**NOTE: Do not pinch the stator or harness wires.**

2. Install with four bolts.



3. Torque the baffle, cylinder shoulder bolts to 89 in-lbs. (10 Nm).
4. Loosely mount the dipstick tube to the lower baffle with shoulder bolt.

# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Flywheel

1. Clean the taper of crank and flywheel ID taper.
2. Install the flywheel key into the slot on crankshaft taper (Figure 30).

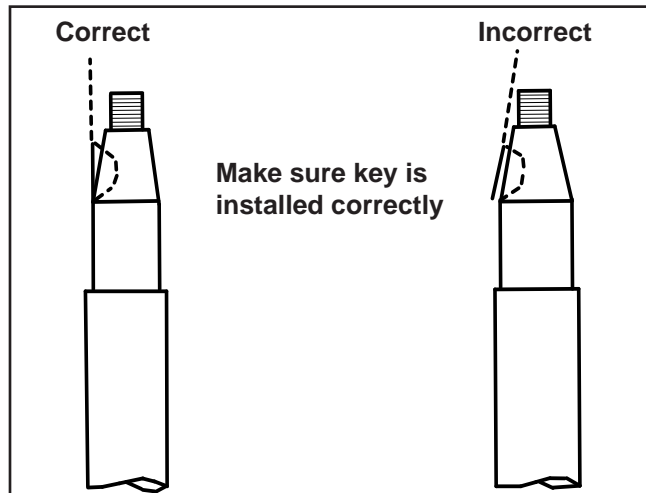


Figure 30

**NOTE:** Long flat of key should be parallel to the length of the crankshaft, not parallel to taper of crankshaft (Figure 31).

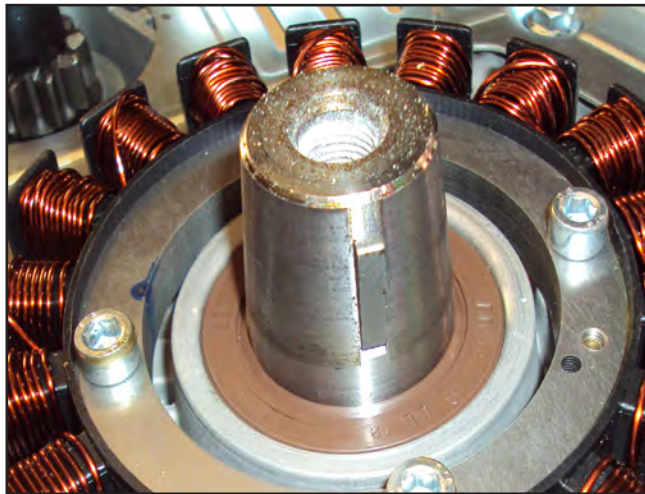


Figure 31

3. Install the flywheel onto the crankshaft aligning the keyway and not contacting the stator coils under the flywheel.

**NOTE:** Use caution as the flywheel magnets are strong.

# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Flywheel (Cont.)

4 Install the flywheel compression washer cup side toward the flywheel.



5. Install and torque the flywheel nut to 61 ft-lbs. (82.5 Nm).

**NOTE: Use a strap wrench to hold flywheel.**

6. Plastic coolant fan (Figure 32)

- Align two guide pins of the fan to match the holes in the flywheel.
- Install the coolant fan with four bolts.
- Torque flywheel cooling fan bolts to 16 ft-lbs. (22.5 Nm).



Figure 32

7. Install the fan screen with four screws.



8. Torque the fan screen screws to 11 in-lbs. (1.3 Nm).

9. Rotate the flywheel and crankshaft to verify engine rotates freely.

**NOTE: If the spark plugs are installed the engine will rotate with resistance during the compression strokes.**

**NOTE: If unable to rotate, remove flywheel components to determine cause.**

# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Ignition Coils

1. Install the ground wire to male terminal on ignition coil (Figure 33).

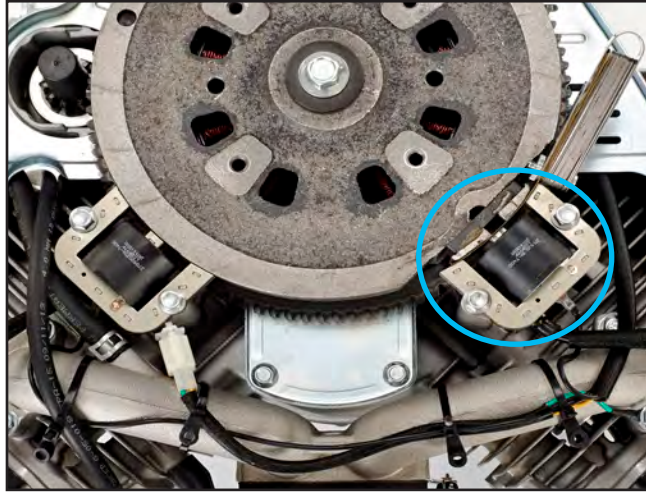


Figure 33

2. Install the ignition coil and loosely mount with two screws.
3. Rotate the flywheel to align magnets to ignition coil.
4. Using proper thickness gauge, tighten the ignition coil screws. Ignition coil air gap is 0.011 in. (0.3 mm).

**NOTE: Use caution as the magnet will strongly pull the ignition coil to the flywheel.**



5. Torque the ignition coil bolts to 89 in-lbs. (10 Nm).
6. Repeat for other coil.

**NOTE: To prevent accidental starting, do not install spark plug boots onto the spark plugs.**

# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Electric Starter

1. Install the electric starter with two mounting bolts (Figure 34).

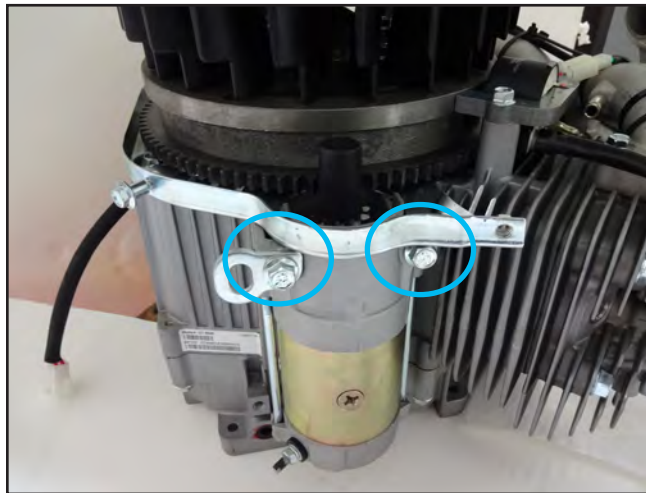


Figure 34

**NOTE:** One bolt has the engine lift hook, place this bolt on the left side of the electric starter with the loop toward left, not up.



2. Torque the starter motor bolts to 19 ft-lbs. (26 Nm).

# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Throttle/Choke Control Plate

1. Hook the choke spring to the control plate and choke arm on the control plate if previously removed (Figure 35).



Figure 35



**NOTE:** Choke spring is 2.44 on. (61.98 Nm) long with coils compressed, throttle spring is 1.64 in. (41.66 Nm) long with coils compressed.

2. Hook the governor spring to hole “C” of governor arm and to throttle pivot on the control plate (Figure 36).

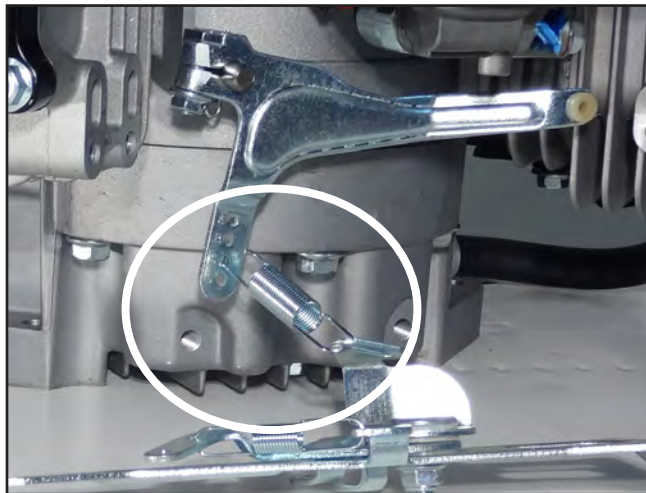


Figure 36

3. Install plate to each head with one bolt.
4. Torque the throttle/choke bracket assembly bolts to 89 in-lbs. (10 Nm).





# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Carburetor

**NOTE:** Complete disassembly, inspection, and assembly, [chapter 3, page 3-1](#).

1. Install the gasket, spacer, and gasket onto the intake manifold studs.
2. Slide the carburetor onto the intake manifold studs.
3. Route fuel solenoid wire up and under the intake manifold. Connect the fuel solenoid wire into the wire harness (Figure 37).

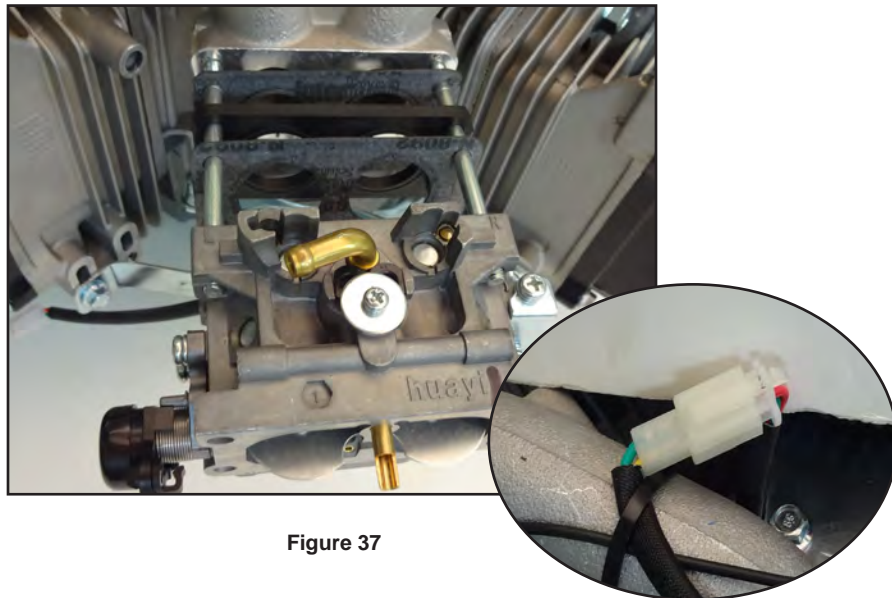


Figure 37

4. Install the choke link to the choke pivot on the control plate, then insert onto the choke override lever on the carburetor, lock by rotating the clip over the link (Figure 38).

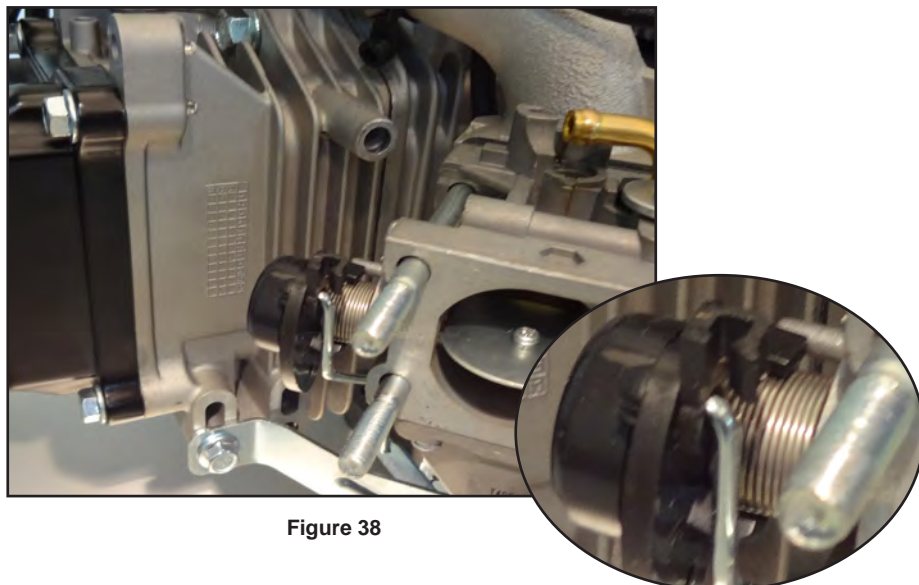


Figure 38

# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Carburetor (Cont.)

**NOTE:** Choke link is longer and has multiple bends.

5. Install throttle link to throttle pivot on the control plate, then insert into the throttle shaft on the carburetor, lock by rotating the clip over link (Figure 39).

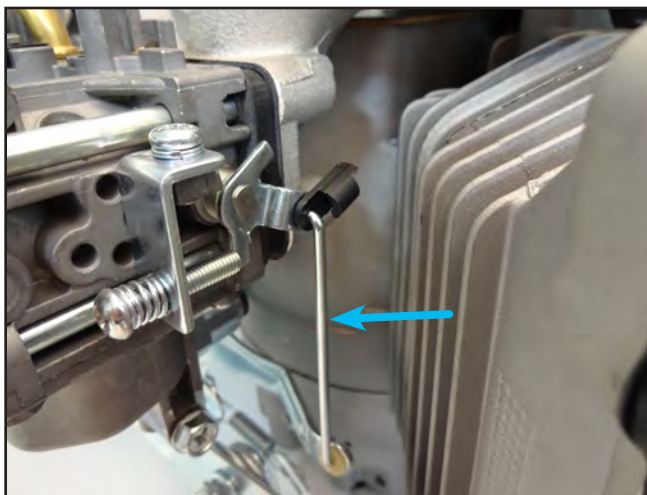


Figure 39

**NOTE:** Throttle link is shorter, with no bends.



# ENGINE ASSEMBLY

## Assemble Upper End (Cont.)

### Air Filter Manifold

1. Install the gasket onto the intake manifold studs (Figure 40).
2. Install the air filter manifold onto the intake manifold studs.

**NOTE:** Slide the breather vent hose (A) (Figure 40) over the fitting on #1 head while installing the manifold.

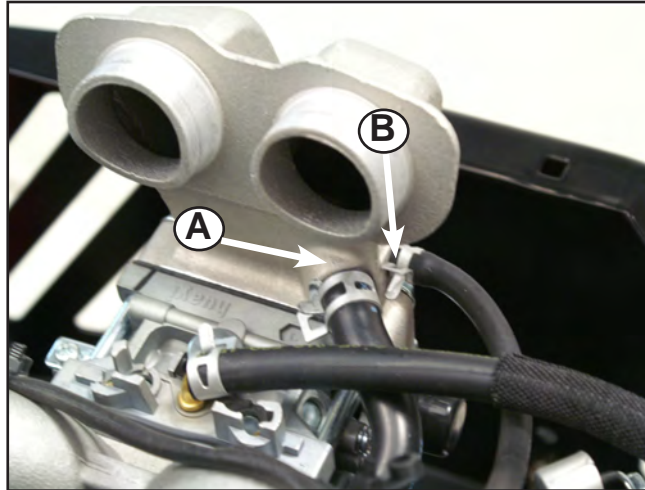


Figure 40

3. Retain manifold with four nuts.
4. Torque the intake manifold bolts to 89 in-lbs. (10 Nm).
5. Route the fuel tank vent hose (B) (Figure 41) over the intake manifold near #1 head and retain with a plastic tie.

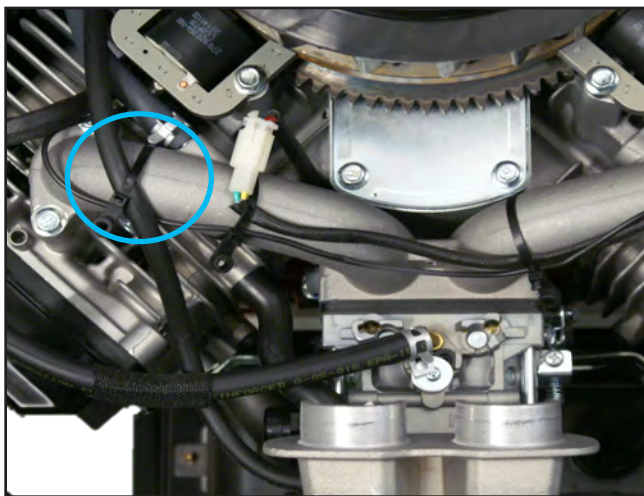


Figure 41

**NOTE:** Hose exits the engine near the electric starter (Figure 41).

# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Engine Shrouds

1. Install the cylinder #2 plastic shroud.

2. Install the oil drain hose cleat if previously removed.



3. Torque the oil drain hose cleat bolts to 62 in-lbs. (7 Nm).

4. Loosely install the two longer shoulder bolts to the upper mount.

5. Install the short shoulder bolt to the underside of the head.

6. Torque the shroud mount bolts to 89 in-lbs. (10 Nm).

7. Install the cylinder #1 plastic shroud.

8. Install the fuel pump assembly if previously removed.



9. Torque the fuel pump mounting bolts to 62 in-lbs. (7 Nm).

10. Loosely install two longer shoulder bolts to the upper mount.

11. Install the shoulder bolt to the underside of the head.



12. Torque the shroud mount bolts to 89 in-lbs. (10 Nm).

13. Connect the fuel supply hose from the fuel pump to the top of the carburetor.

14. Connect the vacuum line from the fuel pump to #1 cylinder side of the intake manifold.

15. Loosely install any remaining longer shoulder bolts to retain the blower shroud.

16. Install the blower shroud sliding over the shoulder bolts. The blower shroud mounts between the lower baffle and dipstick.

**NOTE: Do not pinch fuel, vent or vacuum lines when installing blower shroud.**

17. While holding the shroud down, tighten the six shoulder bolts starting with the bolts on each side of the air filter.



18. Torque the six blower shroud shoulder bolts to 89 in-lbs. (10 Nm).

19. Weave the oil drain hose onto the cleat.



# ENGINE ASSEMBLY

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## Assemble Upper End (Cont.)

### Engine Shrouds (Cont.)

20. Slide end of the hose onto the fitting of the blower shroud (Figure 42).



Figure 42

### Air Cleaner Filter

1. Install the new air filter (Figure 43).

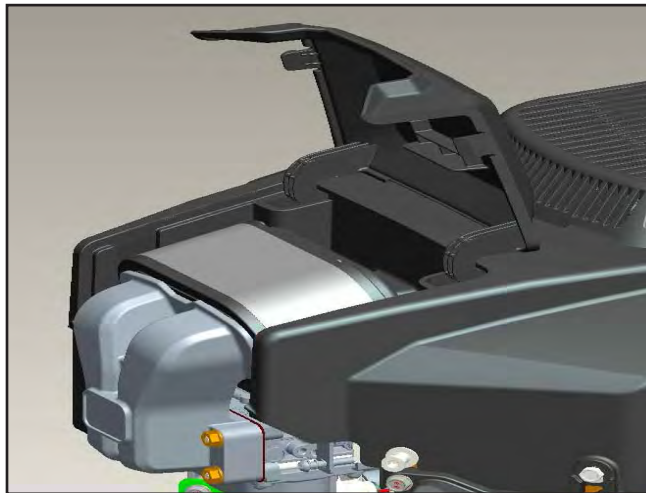


Figure 43



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