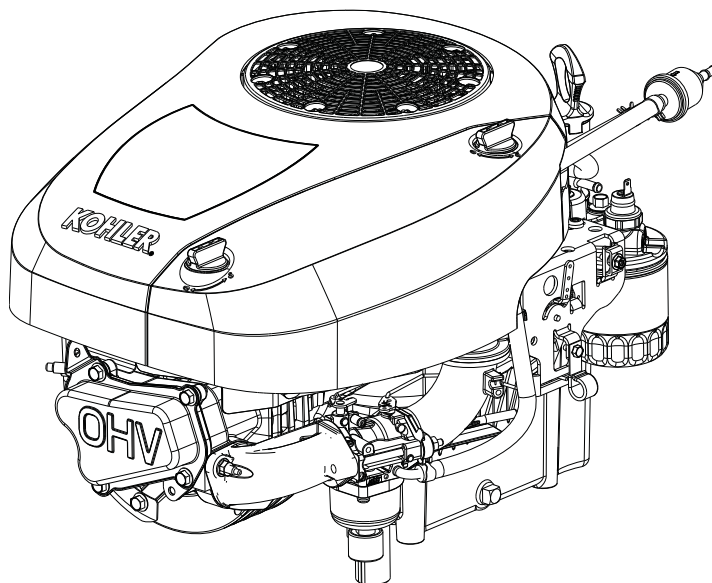


# KOHLER® 5400 Series

KS530-KS595

## Service Manual



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**IMPORTANT:** Read all safety precautions and instructions carefully before operating equipment. Refer to operating instruction of equipment that this engine powers.

Ensure engine is stopped and level before performing any maintenance or service.

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# Safety


## SAFETY PRECAUTIONS


**⚠ WARNING:** A hazard that could result in death, serious injury, or substantial property damage.


**⚠ CAUTION:** A hazard that could result in minor personal injury or property damage.


NOTE: is used to notify people of important installation, operation, or maintenance information.


	<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, unoccupied 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>	


	<p><b>⚠ WARNING</b></p> <p>Rotating Parts can cause severe injury.</p> <p>Stay away while engine is in operation.</p>
<p>Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate engine with covers, shrouds, or guards removed.</p>	


	<p><b>⚠ WARNING</b></p> <p>Carbon Monoxide can cause severe nausea, fainting or death.</p> <p>Avoid inhaling exhaust fumes. Never run engine indoors or in enclosed spaces.</p>
<p>Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled.</p>	

	<p><b>⚠ WARNING</b></p> <p>Accidental Starts can cause severe injury or death.</p> <p>Disconnect and ground spark plug lead(s) before servicing.</p>
<p>Before working on engine or equipment, disable engine as follows: 1) Disconnect spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.</p>	


	<p><b>⚠ WARNING</b></p> <p>Hot Parts can cause severe burns.</p> <p>Do not touch engine while operating or just after stopping.</p>
<p>Never operate engine with heat shields or guards removed.</p>	

	<p><b>⚠ WARNING</b></p> <p>Cleaning Solvents can cause severe injury or death.</p> <p>Use only in well ventilated areas away from ignition sources.</p>
<p>Carburetor cleaners and solvents are extremely flammable. Follow cleaner manufacturer's warnings and instructions on its proper and safe use. Never use gasoline as a cleaning agent.</p>	

	<p><b>⚠ CAUTION</b></p> <p>Electrical Shock can cause injury.</p> <p>Do not touch wires while engine is running.</p>
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	<p><b>⚠ CAUTION</b></p> <p>Damaging Crankshaft and Flywheel can cause personal injury.</p>
<p>Using improper procedures can lead to broken fragments. Broken fragments could be thrown from engine. Always observe and use precautions and procedures when installing flywheel.</p>	

## MAINTENANCE INSTRUCTIONS

	<p><b>⚠ WARNING</b></p> <p>Accidental Starts can cause severe injury or death.</p> <p>Disconnect and ground spark plug lead(s) before servicing.</p>	<p>Before working on engine or equipment, disable engine as follows: 1) Disconnect spark plug lead(s). 2) Disconnect negative (–) battery cable from battery.</p>
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Normal maintenance, replacement or repair of emission control devices and systems may be performed by any repair establishment or individual; however, warranty repairs must be performed by a Kohler authorized dealer.

## MAINTENANCE SCHEDULE

Every 25 Hours or Annually<sup>1</sup> (whichever comes first)

<ul style="list-style-type: none"> <li>• Service/replace precleaner (if equipped).</li> </ul>	Air Cleaner/Intake
<ul style="list-style-type: none"> <li>• Replace air cleaner element (if not equipped with precleaner).</li> </ul>	Air Cleaner/Intake

Every 100 Hours or Annually<sup>1</sup> (whichever comes first)

<ul style="list-style-type: none"> <li>• Replace air cleaner element (if equipped with precleaner).</li> </ul>	Air Cleaner/Intake
<ul style="list-style-type: none"> <li>• Change oil and filter.</li> </ul>	Lubrication System
<ul style="list-style-type: none"> <li>• Remove cooling shrouds and clean cooling areas.</li> </ul>	Air Cleaner/Intake

Every 100 Hours

<ul style="list-style-type: none"> <li>• Replace fuel filter.</li> </ul>	
<ul style="list-style-type: none"> <li>• Check that all fasteners are in place and components are properly secured.</li> </ul>	Reassembly

Every 200 Hours<sup>2</sup>

<ul style="list-style-type: none"> <li>• Have valve lash checked/adjusted.</li> </ul>	Reassembly
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Every 300 Hours<sup>3</sup>

<ul style="list-style-type: none"> <li>• Change oil and filter (KOHLER PRO 10W-50 oil and KOHLER PRO filter only).</li> </ul>	Lubrication System
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Every 500 Hours

<ul style="list-style-type: none"> <li>• Replace spark plug and set gap.</li> </ul>	Electrical System
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<sup>1</sup> Perform these procedures more frequently under severe, dusty, dirty conditions.

<sup>2</sup> Have a Kohler authorized dealer perform this service.

<sup>3</sup> Option only if using KOHLER<sup>®</sup> PRO oil and PRO filter.

## REPAIRS/SERVICE PARTS

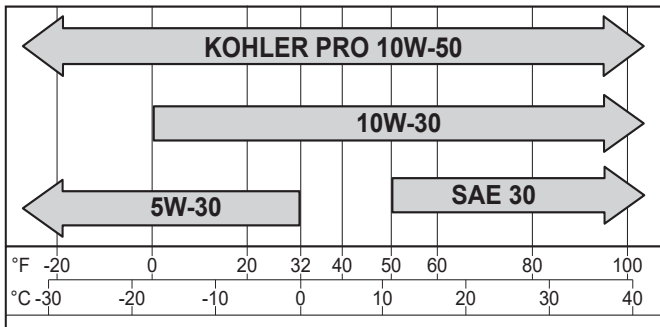
Kohler genuine service parts can be purchased from Kohler authorized dealers. To find a local Kohler authorized dealer visit [KohlerEngines.com](http://KohlerEngines.com) or call 1-800-544-2444 (U.S. and Canada).

# Maintenance

## OIL RECOMMENDATIONS

All-season KOHLER® PRO 10W-50 Synthetic Oil is the ideal oil for KOHLER® engines. It is specifically formulated to extend the oil and oil filter change interval to 300 Hours when paired with a KOHLER PRO Extended Life Oil Filter.

300-Hour oil and oil filter change intervals are exclusive to and only authorized on KOHLER engines that utilize both the KOHLER PRO 10W-50 Synthetic Oil and KOHLER PRO Extended Life Oil Filter. Alternative engine oils and oil filters may be used with KOHLER engines but require 100-Hour oil and oil filter change intervals for proper maintenance. Oil must be API (American Petroleum Institute) service class SJ or higher. Select viscosity based on air temperature at time of operation as shown below.



## FUEL RECOMMENDATIONS



### ⚠ 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, unoccupied 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.

NOTE: E15, E20 and E85 are NOT approved and should NOT be used; effects of old, stale or contaminated fuel are not warrantable.

Fuel must meet these requirements:

- Clean, fresh, unleaded gasoline.
- Octane rating of 87 (R+M)/2 or higher.
- Research Octane Number (RON) 90 octane minimum.
- Gasoline up to 10% ethyl alcohol, 90% unleaded is acceptable.
- Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blend (max 15% MTBE by volume) are approved.
- Do not add oil to gasoline.
- Do not overfill fuel tank.
- Do not use gasoline older than 30 days.

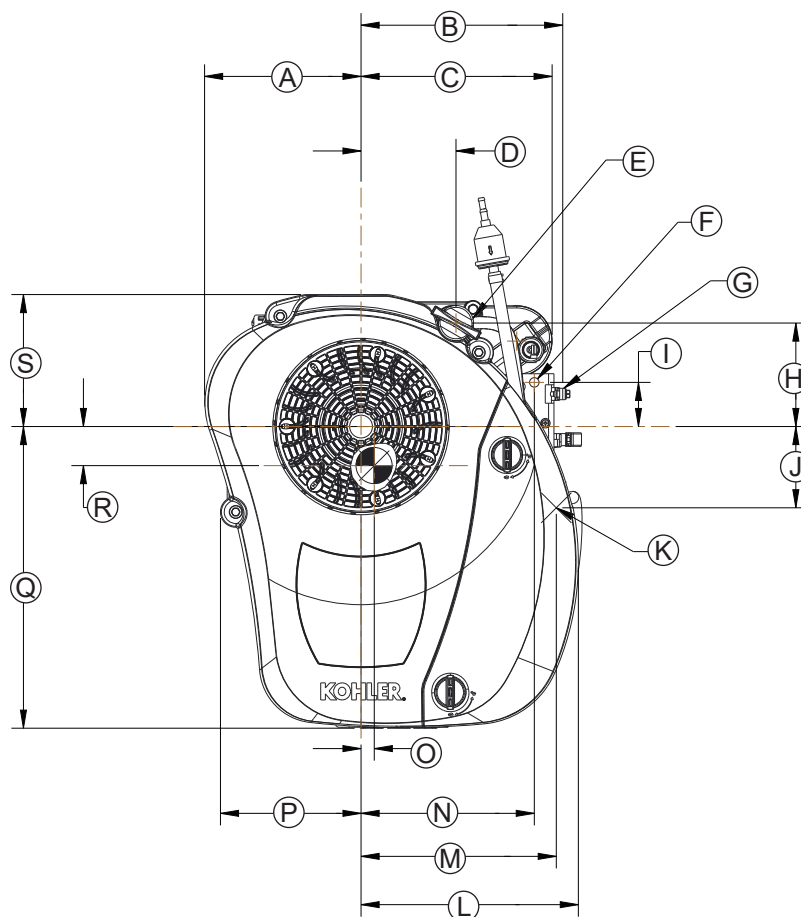
## STORAGE

If engine will be out of service for 2 months or more follow procedure below.

1. Add Kohler PRO Series fuel treatment or equivalent to fuel tank. Run engine 2-3 minutes to get stabilized fuel into carburetor (failures due to untreated fuel are not warrantable).
2. Change oil while engine is still warm from operation (NOT required if using KOHLER PRO 10W-50 full-synthetic oil). Remove spark plug(s) and pour about 1 oz. of engine oil into cylinder(s). Replace spark plug(s) and crank engine slowly to distribute oil.
3. Disconnect negative (-) battery cable.
4. Store engine in a clean, dry place.



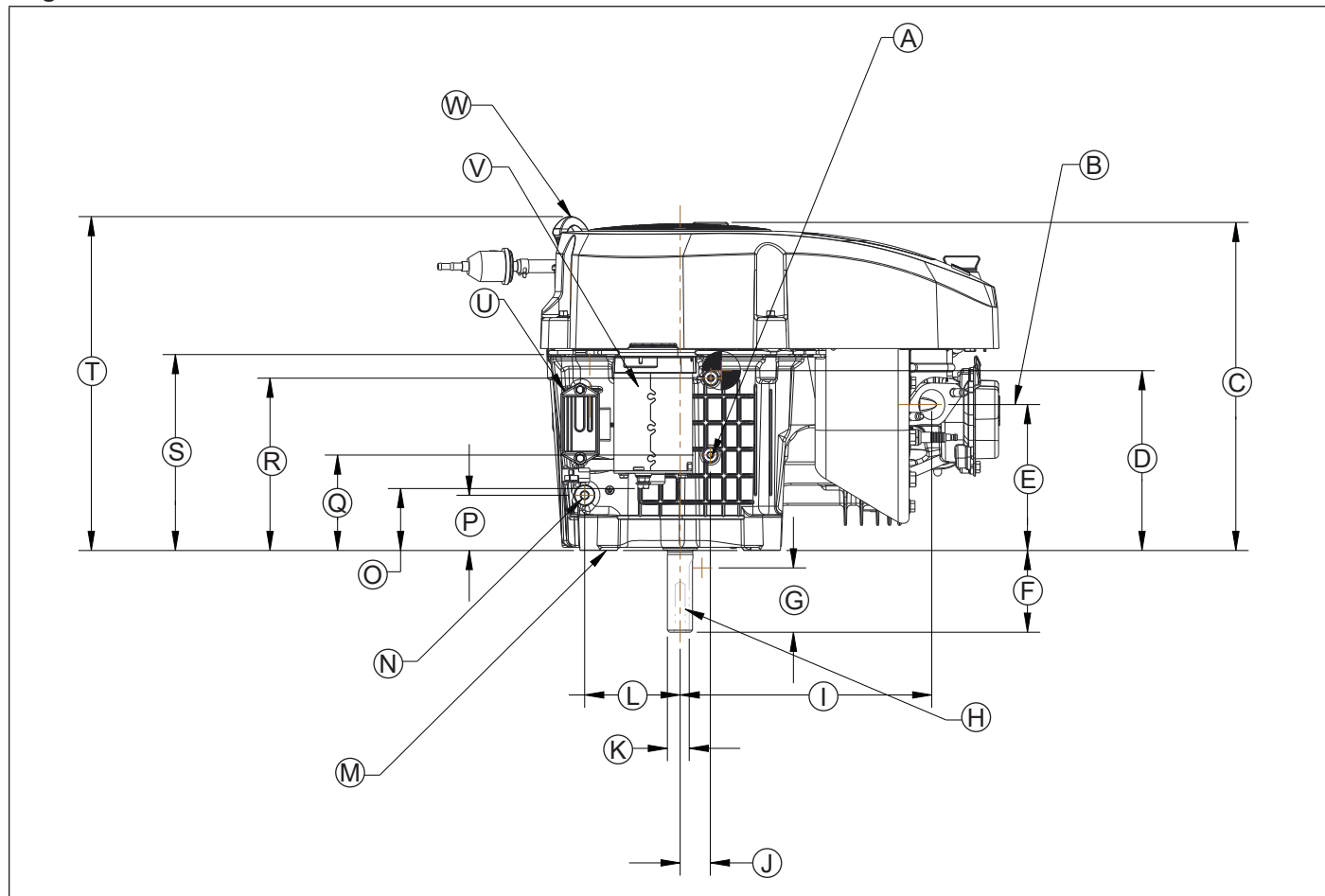
## Engine Dimensions-Flywheel Side



<b>A</b>	164.8 mm (6.49 in.) to Starter	<b>B</b>	212.4 mm (8.36 in.)	<b>C</b>	201.3 mm (7.92 in.) to Oil Filter	<b>D</b>	100.0 mm (3.94 in.)
<b>E</b>	Oil Fill and Dipstick	<b>F</b>	Ø 10.0 mm (0.39 in.) Lifting Point	<b>G</b>	Throttle Cable Clip	<b>H</b>	109.0 mm (4.29 in.)
<b>I</b>	46.5 mm (1.83 in.)	<b>J</b>	85.1 mm (3.35 in.)	<b>K</b>	Connection for Evaporative Hose (7/32" I.D.)	<b>L</b>	228.9 mm (9.01 in.)
<b>M</b>	205.8 mm (8.10 in.)	<b>N</b>	182.5 mm (7.19 in.)	<b>O</b>	13.9 mm (0.55 in.) to Center of Gravity	<b>P</b>	148.1 mm (5.83 in.)
<b>Q</b>	317.8 mm (12.51 in.)	<b>R</b>	41.2 mm (1.62 in.) to Center of Gravity	<b>S</b>	139.0 mm (5.47 in.)		

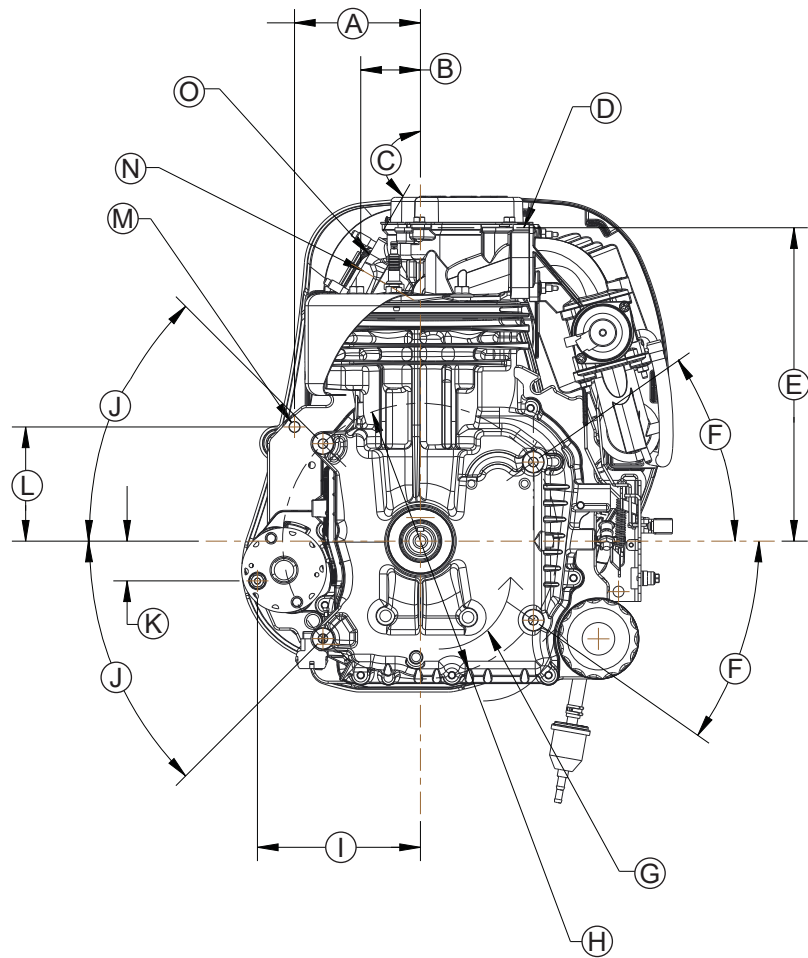
# Specifications

## Engine Dimensions-Starter Side



<b>A</b>	2 X Cored for M6 Self Tapping Screw 17.7 mm (0.70 in.) Min. Depth (Accessory Mounting Location)	<b>B</b>	Exhaust Port Axis	<b>C</b>	326.5 mm (12.85 in.)	<b>D</b>	179.0 mm (7.05 in.) to Center of Gravity
<b>E</b>	145.2 mm (5.72 in.) to Exhaust Port	<b>F</b>	81.3 mm (3.20 in.)	<b>G</b>	64.0 mm (2.52 in.) Keyway Length	<b>H</b>	7/16-20 UNF-2B IN. 38.1 mm (1.50 in.) Depth
<b>I</b>	250.3 mm (9.86 in.) to Exhaust Port	<b>J</b>	2 X 30.0 mm (1.18 in.)	<b>K</b>	21.6-21.8 mm (0.85-0.86 in.) Keyway Depth	<b>L</b>	95.0 mm (3.74 in.)
<b>M</b>	Engine Mounting Surface	<b>N</b>	Cored for M8 Self Tapping Screw 20.0 mm (0.79 in.) Min. Depth (Ground Lug Location)	<b>O</b>	61.9 mm (2.44 in.) to Starter Stud	<b>P</b>	55.0 mm (2.17 in.)
<b>Q</b>	95.0 mm (3.74 in.)	<b>R</b>	171.5 mm (6.75 in.)	<b>S</b>	195.0 mm (7.68 in.) Lifting Point	<b>T</b>	332.3 mm (13.08 in.)
<b>U</b>	Optional Rectifier-Regulator	<b>V</b>	Starter Motor	<b>W</b>	Oil Fill and Dipstick		

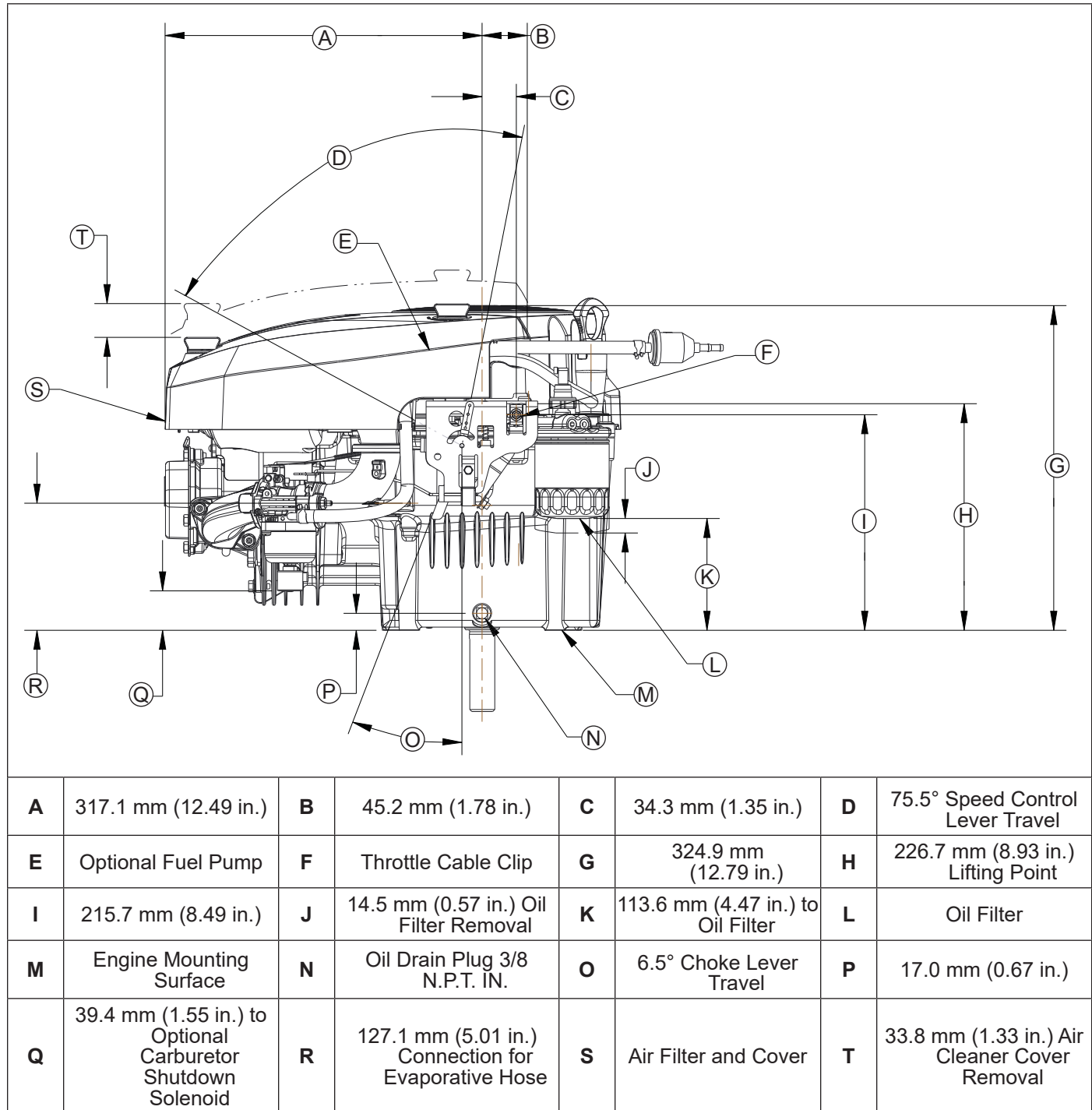
Engine Dimensions-PTO Side



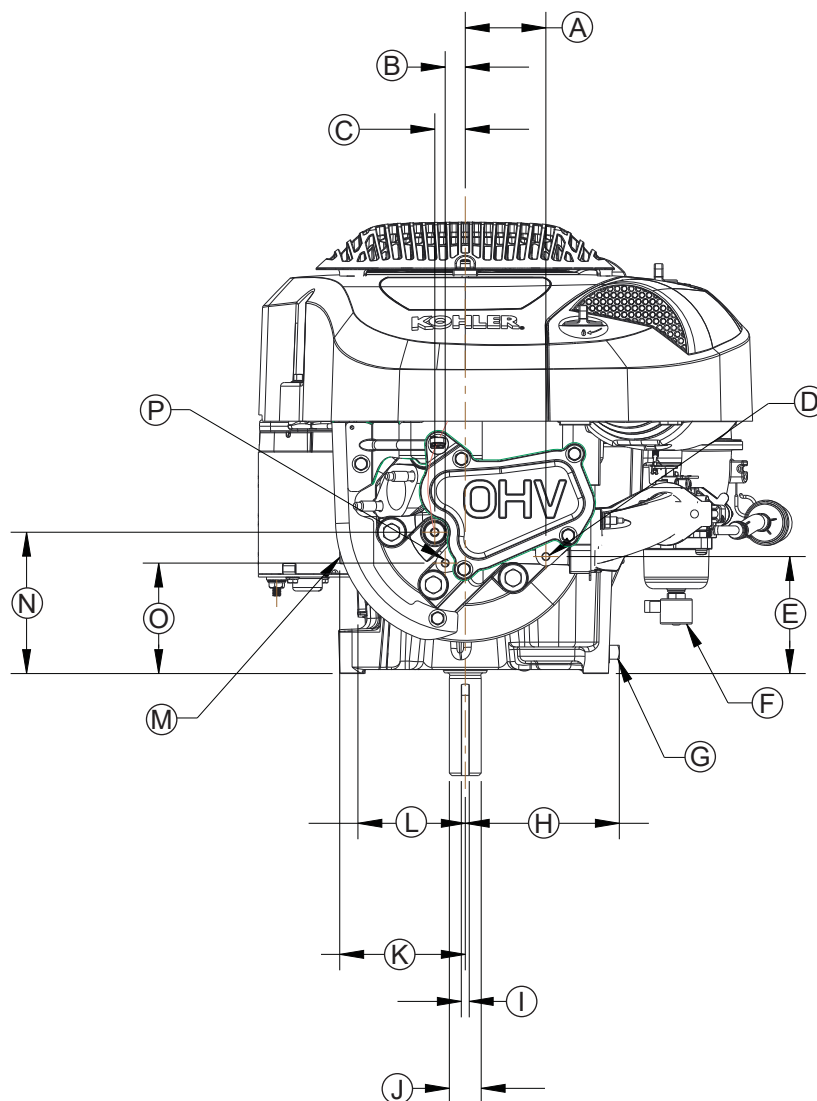
<b>A</b>	116.0 mm (4.57 in.)	<b>B</b>	55.0 mm (2.17 in.)	<b>C</b>	150°	<b>D</b>	Accessory Mounting Surface
<b>E</b>	2 X 288.8 mm (11.37 in.)	<b>F</b>	35°	<b>G</b>	Rotation Direction	<b>H</b>	Ø 254.0 mm (10.00 in.)
<b>I</b>	150.2 mm (5.91 in.)	<b>J</b>	45°	<b>K</b>	36.6 mm (1.44 in.)	<b>L</b>	105.2 mm (4.14 in.)
<b>M</b>	Ø 9.7 mm (0.38 in.) Lifting Point	<b>N</b>	Exhaust Port Axis	<b>O</b>	Exhaust Flange Mounting Surface		

# Specifications

## Engine Dimensions-Oil Filter Side



## Engine Dimensions-Valve Cover Side

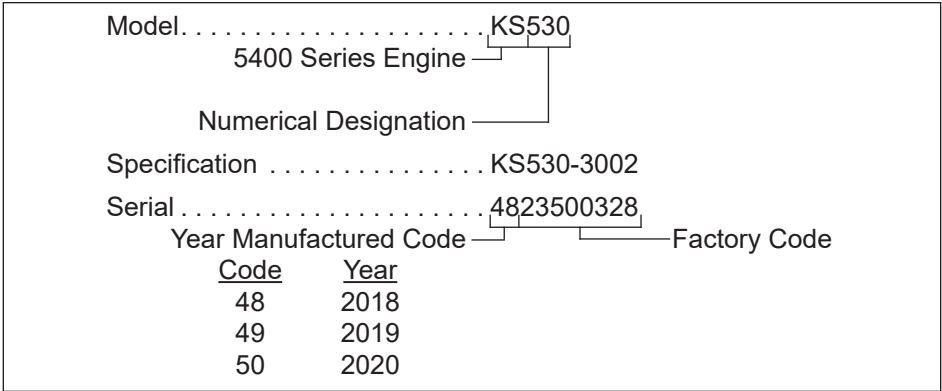


<b>A</b>	64.2 mm (2.53 in.)	<b>B</b>	16.0 mm (0.63 in.)	<b>C</b>	24.3 mm (0.96 in.) to Spark Plug	<b>D</b>	Cored for M6 Self Tapping Screw 16.5 mm (0.65 in.) Min. Depth (Accessory Mounting Location)
<b>E</b>	93.2 mm (3.67 in.)	<b>F</b>	Carburetor	<b>G</b>	Oil Drain Plug	<b>H</b>	122.7 mm (4.83 in.)
<b>I</b>	6.32-6.36 mm (0.249-0.250 in.) Keyway Width	<b>J</b>	Ø 25.37-25.40 mm (0.999-1.0 in.)	<b>K</b>	100.0 mm (3.94 in.)	<b>L</b>	85.5 mm (3.37 in.) Ground Lug Mounting Boss
<b>M</b>	2 X Accessory Mounting Surface	<b>N</b>	112.6 mm (4.43 in.) to Spark Plug	<b>O</b>	88.0 mm (3.47 in.)	<b>P</b>	Cored for M6 Self Tapping Screw Thru (Accessory Mounting Location)


Specifications

ENGINE IDENTIFICATION NUMBERS

Kohler engine identification numbers (model, specification and serial) should be referenced for efficient repair, ordering correct parts, and engine replacement.



GENERAL SPECIFICATIONS <sup>3,4</sup>	KS530	KS540	KS590	KS595
Bore	94 mm (3.70 in.)			
Stroke	78 mm (3.1 in.)			
Displacement	541 cc (33.0 cu. in.)			
Oil Capacity (refill)	1.4 L (1.5 U.S. qt.)			
Maximum Angle of Operation (@ full oil level) <sup>5</sup>	25°			

TORQUE SEQUENCES	KS530	KS540	KS590	KS595
(Refer to Torque Specifications for torque values).				
Connecting Rod Fasteners				

<sup>3</sup> Values are in Metric units. Values in parentheses are English equivalents.

<sup>4</sup> Any and all horsepower (hp) references by Kohler are Certified Power Ratings and per SAE J1940 & J1995 hp standards. Details on Certified Power Ratings can be found at KohlerEngines.com.

<sup>5</sup> Exceeding maximum angle of operation may cause engine damage from insufficient lubrication.

## TORQUE SEQUENCES

KS530

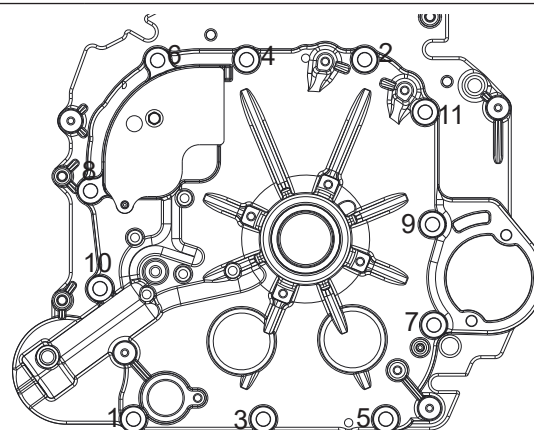
KS540

KS590

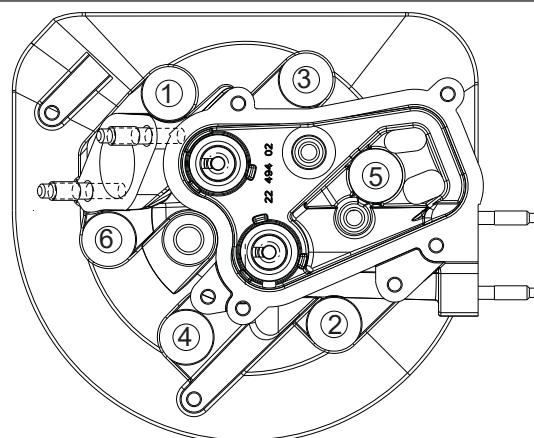
KS595

(Refer to Torque Specifications for torque values).

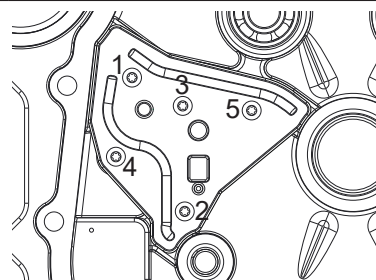
Closure Plate Fasteners



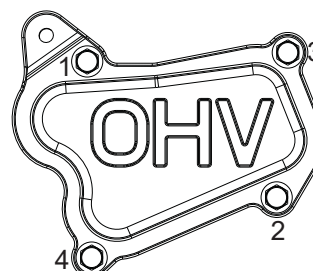
Cylinder Head Fasteners



Oil Passage Cover Fasteners



Valve Cover Fasteners





# Specifications

## TORQUE SPECIFICATIONS<sup>3,6</sup>

KS530

KS540

KS590

KS595

### Auto Choke

Smart-Choke <sup>™</sup> Diaphragm Assembly Fastener	1 N·m (9 in. lb.)
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### Barrel Baffle

Fastener	9.3 N·m (82 in. lb.) into new hole 4.0 N·m (35 in. lb.) into used hole
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### Blower Housing to Adapter

4.8 Hi-Lo Fastener	1 N·m (9 in. lb.)
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### Blower Housing to Closure Plate

Fastener	11.3 N·m (100 in. lb.) into new hole 6.8 N·m (60 in. lb.) into used hole
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### Breather

Cover Fastener	6.5 N·m (58 in. lb.)
Reed/Retainer Fastener	6.5 N·m (58 in. lb.)

### Cam Levers

Fastener	12.5 N·m (110 in. lb.)
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### Carburetor

Stud	4.3 N·m (38 in. lb.)
M6 Nut	9 N·m (80 in. lb.)
Fuel Bowl Retaining Screws	4.0 N·m (35 in. lb.)

### Choke Wire Hold Down Clamp (if equipped)

Fastener	2.7 N·m (24 in. lb.)
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### Closure Plate (torque sequence on page 11)

Fastener	24 N·m (212 in. lb.)
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### Connecting Rod (torque sequence on page 10)

Cap Fastener (torque in 2 increments)	5.5, 11.8 N·m (50, 105 in. lb.)
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### Crankcase

Oil Drain Plug	14.0 N·m (125 in. lb.)
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### Cylinder Head (torque sequence on page 11)

Fastener (torque in 2 increments)	24.4, 42.7 N·m (216, 378 in. lb.)
Rocker Arm Pivot Stud	13.5 N·m (120 in. lb.)
Rocker Arm Adjustment Nut Set Screw	5.5 N·m (50 in. lb.)

### Dipstick Tube

Fastener	6.5 N·m (58 in. lb.) into new hole 3.4 N·m (30 in. lb.) into used hole
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<sup>3</sup> Values are in Metric units. Values in parentheses are English equivalents.

<sup>6</sup> Lubricate threads with engine oil prior to assembly.

<b>TORQUE SPECIFICATIONS<sup>3,6</sup></b>	<b>KS530</b>	<b>KS540</b>	<b>KS590</b>	<b>KS595</b>
<b>Electric Starter</b>				
10/24 Mounting Nut		3.8 N·m (34 in. lb.)		
1/4-20 Nut		7.9 N·m (70 in. lb.)		
<b>Fixed Guard (if equipped)</b>				
Fastener		0.8 N·m (7 in. lb.)		
<b>Flywheel</b>				
M12 Retaining Screw		115 N·m (85 ft. lb.)		
<b>Fuel Line J-Clip</b>				
Fastener		6.5 N·m (58 in. lb.)		
<b>Fuel Pump Bracket</b>				
4.8 Hi-Lo Fastener		1 N·m (9 in. lb.)		
<b>Governor</b>				
Lever Nut		7.7 N·m (68 in. lb.)		
<b>Ignition</b>				
Spark Plug		27 N·m (20 ft. lb.)		
Module Fastener		8.8 N·m (78 in. lb.) into new hole 3.4 N·m (30 in. lb.) into used hole		
Rectifier-Regulator Fastener		8.8 N·m (78 in. lb.)		
<b>Intake Manifold to Cylinder Head</b>				
Nuts		10.2 N·m (90 in. lb.)		
<b>Muffler</b>				
Retaining Nuts		27.8 N·m (246 in. lb.)		
Bracket Fastener		11.3 N·m (100 in. lb.)		
<b>Oil Filter Pad Pipe Plug</b>				
1/8" N.P.T.F.		8.5 N·m (75 in. lb.)		
<b>Oil Baffle</b>				
Fastener		7.9 N·m (70 in. lb.)		
<b>Oil Passage Cover (torque sequence on page 11)</b>				
Fastener		6.5 N·m (58 in. lb.)		
<b>Oil Pump Housing</b>				
Fastener		4.8 N·m (42 in. lb.)		
<b>Oil Sentry<sup>™</sup></b>				
Pressure Switch		6.2 N·m (55 in. lb.)		

<sup>3</sup> Values are in Metric units. Values in parentheses are English equivalents.

<sup>6</sup> Lubricate threads with engine oil prior to assembly.

# Specifications

## TORQUE SPECIFICATIONS<sup>3,6</sup>

KS530

KS540

KS590

KS595

### Speed Control Bracket Assembly

Fastener	11.3 N·m (100 in. lb.) into new hole 7.5 N·m (65 in. lb.) into used hole
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### Stator

Mounting Screw	8.8 N·m (78 in. lb.)
Stator Wire Clip Fastener	6.5 N·m (58 in. lb.)

### Valve Cover

Fastener	12.9 N·m (114 in. lb.) into new hole 6.8 N·m (60 in. lb.) into used hole
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## CLEARANCE SPECIFICATIONS<sup>3</sup>

KS530

KS540

KS590

KS595

### Camshaft

End Play	0.317/1.187 mm (0.0125/0.0467 in.)
Running Clearance	0.025/0.126 mm (0.0009/0.0049 in.)
Bore I.D. New Max. Wear Limit	14.389/14.414 mm (0.5665/0.5675 in.) 14.427 mm (0.5680 in.)
Bearing Surface O.D. New Max. Wear Limit	14.288/14.364 mm (0.5625/0.5655 in.) 14.285 mm (0.5624 in.)

### Connecting Rod

Connecting Rod-to-Crankpin Running Clearance New Max. Wear Limit	0.040/0.081 mm (0.0016/0.0032 in.) 0.096 mm (0.0038 in.)
Connecting Rod-to-Crankpin Side Clearance	0.400/0.630 mm (0.0157/0.0248 in.)
Connecting Rod-to-Piston Pin Running Clearance	0.012/0.034 mm (0.0005/0.0013 in.)
Piston Pin End I.D. New Max. Wear Limit	20.012/20.029 mm (0.7879/0.7885 in.) 20.042 mm (0.7891 in.)

### Crankcase

Governor Cross Shaft Bore I.D. New Max. Wear Limit	6.026/6.05 mm (0.2372/0.2382 in.) 6.063 mm (0.2387 in.)
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### Crankshaft

End Play (free)	0.225/0.875 mm (0.0089/0.0344 in.)
Bore in Crankcase I.D. New Max. Wear Limit	41.003/41.027 mm (1.6143/1.6152 in.) 41.053 mm (1.6163 in.)
Bore in Closure Plate I.D. New Max. Wear Limit	40.9875/41.0125 mm (1.6137/1.6147 in.) 41.0385 mm (1.6157 in.)
Crankshaft Bore (PTO)-to-Crankshaft Running Clearance New	0.068/0.114 mm (0.0027/0.0045 in.)

<sup>3</sup> Values are in Metric units. Values in parentheses are English equivalents.

<sup>6</sup> Lubricate threads with engine oil prior to assembly.

CLEARANCE SPECIFICATIONS <sup>3</sup>	KS530	KS540	KS590	KS595
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## Crankshaft (continued)

Flywheel End Main Bearing Journal O.D. New Max. Wear Limit Max. Taper Max. Out of Round	40.913/40.935 mm (1.6107/1.6116 in.) 40.880 mm (1.6094 in.) 0.0220 mm (0.0009 in.) 0.0250 mm (0.0010 in.)
PTO End Main Bearing Journal O.D. New Max. Wear Limit Max. Taper Max. Out of Round	40.913/40.935 mm (1.6107/1.6116 in.) 40.880 mm (1.6094 in.) 0.0200 mm (0.0008 in.) 0.0250 mm (0.0010 in.)
Connecting Rod Journal O.D. New Max. Wear Limit Max. Taper Max. Out of Round	40.982/41.000 mm (1.6135/1.6142 in.) 40.964 mm (1.612 in.) 0.0120 mm (0.0005 in.) 0.0250 mm (0.0010 in.)
T.I.R. PTO End, Crankshaft in Engine Entire Crankshaft , in V-Blocks	0.150 mm (0.0059 in.) 0.100 mm (0.0039 in.)

## Cylinder Bore

Bore I.D. New	94.010/94.035 mm (3.7011/3.7021 in.)
Max. Wear Limit	94.073 mm (3.704 in.)
Max. Taper Max. Out of Round	0.050 mm (0.0020 in.) 0.120 mm (0.0047 in.)

## Cylinder Head

Max. Out-of-Flatness	0.076 mm (0.003 in.)
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## Governor

Governor Cross Shaft -to-Crankcase Running Clearance	0.014/0.075 mm (0.0006/0.0030 in.)
Cross Shaft O.D. New Max. Wear Limit	5.975/6.012 mm (0.2352/0.2367 in.) 5.962 mm (0.2347 in.)
Governor Gear Shaft -to-Governor Gear Running Clearance	0.070/0.160 mm (0.0028/0.0063 in.)
Gear Shaft O.D. New Max. Wear Limit	5.990/6.000 mm (0.2358/0.2362 in.) 5.977 mm (0.2353 in.)

## Ignition

Spark Plug Gap	0.76 mm (0.030 in.)
Module Air Gap	0.203/0.305 mm (0.008/0.012 in.)

<sup>3</sup>Values are in Metric units. Values in parentheses are English equivalents.

# Specifications






CLEARANCE SPECIFICATIONS <sup>3</sup>	KS530	KS540	KS590	KS595
Piston, Piston Rings, and Piston Pin				
Piston-to-Piston Pin Running Clearance	0.007/0.017 mm (0.0003/0.0007 in.)			
Pin Bore I.D. New Max. Wear Limit	20.007/20.012 mm (0.7877/0.7879 in.) 20.025 mm (0.7884 in.)			
Pin O.D. New Max. Wear Limit	19.995/20.000 mm (0.7872/0.7874 in.) 19.994 mm (0.7872 in.)			
Top Compression Ring-to-Groove Side Clearance	0.025/0.065 mm (0.0010/0.0026 in.)			
Middle Compression Ring-to-Groove Side Clearance	0.040/0.080 mm (0.0016/0.0032 in.)			
Oil Control Ring-to-Groove Side Clearance	0.090/0.210 mm (0.0035/0.0083 in.)			
Top Compression Ring End Gap New Bore New Bore Used Bore (max.)	0.150/0.400 mm (0.0059/0.0157 in.) 0.770 mm (0.0300 in.)			
Middle Compression Ring End Gap New Bore New Bore Used Bore (max.)	1.000/1.250 mm (0.0394/0.0492 in.) 1.504 mm (0.0592 in.)			
Thrust Face O.D. <sup>7</sup> New	93.975/93.989 mm (3.6998/3.7003 in.)			
Max. Wear Limit	93.875 mm (3.6960 in.)			
Piston Thrust Face-to-Cylinder Bore <sup>7</sup> Running Clearance	0.034/0.073 mm (0.0013/0.0029 in.)			
Valves and Valve Tappets				
Valve Lash <sup>8</sup>	0.101/0.152 mm (0.004/0.006 in.)			
Intake Valve Stem-to-Valve Guide Running Clearance	0.038/0.076 mm (0.0015/0.0030 in.)			
Exhaust Valve Stem-to-Valve Guide Running Clearance	0.050/0.088 mm (0.0020/0.0035 in.)			
Intake Valve Guide I.D. New Max. Wear Limit	6.038/6.058 mm (0.2377/0.2385 in.) 6.135 mm (0.2415 in.)			
Exhaust Valve Guide I.D. New Max. Wear Limit	6.038/6.058 mm (0.2377/0.2385 in.) 6.160 mm (0.2425 in.)			
Intake Valve Minimum Lift	9.4 mm (0.370 in.)			
Exhaust Valve Minimum Lift	9.3 mm (0.366 in.)			
Nominal Valve Seat Angle	45°			

<sup>3</sup> Values are in Metric units. Values in parentheses are English equivalents.






<sup>7</sup> Measure 7.5 mm (0.2953 in.) above bottom of piston skirt at right angles to piston pin.

<sup>8</sup> Check valve lash every 200 hours, adjust as required.

## GENERAL TORQUE VALUES

English Fastener Torque Recommendations for Standard Applications				
Bolts, Screws, Nuts and Fasteners Assembled Into Cast Iron or Steel				Grade 2 or 5 Fasteners Into Aluminum
Size	 Grade 2	 Grade 5	 Grade 8	 
<b>Tightening Torque: N·m (in. lb.) ± 20%</b>				
8-32	2.3 (20)	2.8 (25)	—	2.3 (20)
10-24	3.6 (32)	4.5 (40)	—	3.6 (32)
10-32	3.6 (32)	4.5 (40)	—	—
1/4-20	7.9 (70)	13.0 (115)	18.7 (165)	7.9 (70)
1/4-28	9.6 (85)	15.8 (140)	22.6 (200)	—
5/16-18	17.0 (150)	28.3 (250)	39.6 (350)	17.0 (150)
5/16-24	18.7 (165)	30.5 (270)	—	—
3/8-16	29.4 (260)	—	—	—
3/8-24	33.9 (300)	—	—	—

<b>Tightening Torque: N·m (ft. lb.) ± 20%</b>				
5/16-24	—	—	40.7 (30)	—
3/8-16	—	47.5 (35)	67.8 (50)	—
3/8-24	—	54.2 (40)	81.4 (60)	—
7/16-14	47.5 (35)	74.6 (55)	108.5 (80)	—
7/16-20	61.0 (45)	101.7 (75)	142.5 (105)	—
1/2-13	67.8 (50)	108.5 (80)	155.9 (115)	—
1/2-20	94.9 (70)	142.4 (105)	223.7 (165)	—
9/16-12	101.7 (75)	169.5 (125)	237.3 (175)	—
9/16-18	135.6 (100)	223.7 (165)	311.9 (230)	—
5/8-11	149.5 (110)	244.1 (180)	352.6 (260)	—
5/8-18	189.8 (140)	311.9 (230)	447.5 (330)	—
3/4-10	199.3 (147)	332.2 (245)	474.6 (350)	—
3/4-16	271.2 (200)	440.7 (325)	637.3 (470)	—

Metric Fastener Torque Recommendations for Standard Applications						
Size	Property Class					Noncritical Fasteners Into Aluminum
						
Tightening Torque: N·m (in. lb.) ± 10%						
M4	1.2 (11)	1.7 (15)	2.9 (26)	4.1 (36)	5.0 (44)	2.0 (18)
M5	2.5 (22)	3.2 (28)	5.8 (51)	8.1 (72)	9.7 (86)	4.0 (35)
M6	4.3 (38)	5.7 (50)	9.9 (88)	14.0 (124)	16.5 (146)	6.8 (60)
M8	10.5 (93)	13.6 (120)	24.4 (216)	33.9 (300)	40.7 (360)	17.0 (150)
Tightening Torque: N·m (ft. lb.) ± 10%						
M10	21.7 (16)	27.1 (20)	47.5 (35)	66.4 (49)	81.4 (60)	33.9 (25)
M12	36.6 (27)	47.5 (35)	82.7 (61)	116.6 (86)	139.7 (103)	61.0 (45)
M14	58.3 (43)	76.4 (56)	131.5 (97)	184.4 (136)	219.7 (162)	94.9 (70)

Torque Conversions	
N·m = in. lb. x 0.113	in. lb. = N·m x 8.85
N·m = ft. lb. x 1.356	ft. lb. = N·m x 0.737

## Tools and Aids

Certain quality tools are designed to help you perform specific disassembly, repair, and reassembly procedures. By using these tools, you can properly service engines easier, faster, and safer! In addition, you'll increase your service capabilities and customer satisfaction by decreasing engine downtime.

Here is a list of tools and their source.

NOTE: Not all tools listed are required to service this engine.

### SEPARATE TOOL SUPPLIERS

Kohler Tools  
Contact your local Kohler source of supply.

SE Tools  
415 Howard St.  
Lapeer, MI 48446  
Phone 810-664-2981  
Toll Free 800-664-2981  
Fax 810-664-8181

Design Technology Inc.  
768 Burr Oak Drive  
Westmont, IL 60559  
Phone 630-920-1300  
Fax 630-920-0011

### TOOLS

Description	Source/Part No.
<b>Alcohol Content Tester</b> For testing alcohol content (%) in reformulated/oxygenated fuels.	Kohler 25 455 11-S
<b>Camshaft Endplay Plate</b> For checking camshaft endplay.	SE Tools KLR-82405
<b>Camshaft Seal Protector (Aegis)</b> For protecting seal during camshaft installation.	SE Tools KLR-82417
<b>Cylinder Leakdown Tester</b> For checking combustion retention and if cylinder, piston, rings, or valves are worn. Individual component available: Adapter 12 mm x 14 mm (Required for leakdown test on XT-6 engines)	Kohler 25 761 05-S Design Technology Inc. DTI-731-03
<b>Dealer Tool Kit (Domestic)</b> Complete kit of Kohler required tools. Components of 25 761 39-S Ignition System Tester Cylinder Leakdown Tester Oil Pressure Test Kit Rectifier-Regulator Tester (120 V AC/60Hz)	Kohler 25 761 39-S  Kohler 25 455 01-S Kohler 25 761 05-S Kohler 25 761 06-S Kohler 25 761 20-S
<b>Dealer Tool Kit (International)</b> Complete kit of Kohler required tools. Components of 25 761 42-S Ignition System Tester Cylinder Leakdown Tester Oil Pressure Test Kit Rectifier-Regulator Tester (240 V AC/50Hz)	Kohler 25 761 42-S  Kohler 25 455 01-S Kohler 25 761 05-S Kohler 25 761 06-S Kohler 25 761 41-S
<b>Digital Vacuum/Pressure Tester</b> For checking crankcase vacuum. Individual component available: Rubber Adapter Plug	Design Technology Inc. DTI-721-01 Design Technology Inc. DTI-721-10
<b>Electronic Fuel Injection (EFI) Diagnostic Software</b> For Laptop or Desktop PC.	Kohler 25 761 23-S
<b>EFI Service Kit</b> For troubleshooting and setting up an EFI engine. Components of 24 761 01-S Fuel Pressure Tester Noid Light 90° Adapter Code Plug, Red Wire Code Plug, Blue Wire Shrader Valve Adapter Hose Wire Probe Set (2 pieces regular wire with clip; 1 piece fused wire) Hose Removal Tool, Dual Size/End (also sold as individual Kohler tool) K-Line Adapter Jumper Lead Wiring Harness	Kohler 24 761 01-S Design Technology Inc. DTI-019 DTI-021 DTI-023 DTI-027 DTI-029 DTI-037 DTI-031 DTI-033 Kohler 25 176 23-S
<b>Kohler Wireless Diagnostic System Module (Bluetooth®)</b> For wireless Android EFI diagnostics. Individual component available: Wireless Diagnostic System Interface Cable	Kohler 25 761 45-S  Kohler 25 761 44-S



## TOOLS

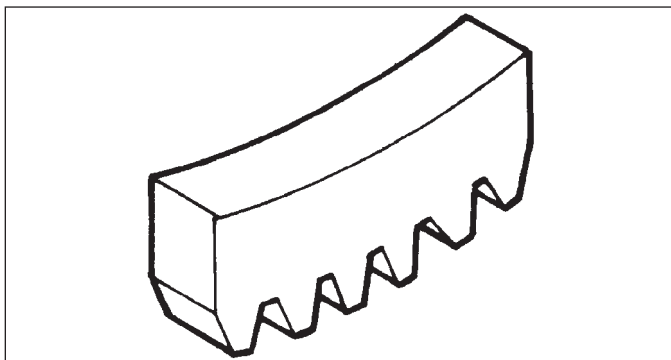
Description	Source/Part No.
<b>Flywheel Puller</b> For properly removing flywheel from engine.	SE Tools KLR-82408
<b>Flywheel Anchor Bolts, Washers, Nuts Tool</b> Used with Flywheel Puller for properly removing flywheel from 5400 Series engine.	Kohler 25 086 753-S
<b>Hose Removal Tool, Dual Size/End (also available in EFI Service Kit)</b> Used to properly remove fuel hose from engine components.	Kohler 25 455 20-S
<b>Hydraulic Valve Lifter Tool</b> For removing and installing hydraulic lifters.	Kohler 25 761 38-S
<b>Ignition System Tester</b> For testing output on all systems, including CD.	Kohler 25 455 01-S
<b>Inductive Tachometer (Digital)</b> For checking operating speed (RPM) of an engine.	Design Technology Inc. DTI-110
<b>Offset Wrench (K and M Series)</b> For removing and reinstalling cylinder barrel retaining nuts.	Kohler 52 455 04-S
<b>Oil Pressure Test Kit</b> For testing/verifying oil pressure on pressure lubricated engines.	Kohler 25 761 06-S
<b>Rectifier-Regulator Tester (120 volt current)</b> <b>Rectifier-Regulator Tester (240 volt current)</b> For testing rectifier-regulators. Components of 25 761 20-S and 25 761 41-S CS-PRO Regulator Test Harness Special Regulator Test Harness with Diode	Kohler 25 761 20-S Kohler 25 761 41-S  Design Technology Inc. DTI-031R DTI-033R
<b>Spark Advance Module (SAM) Tester</b> For testing SAM (ASAM and DSAM) on engines with SMART-SPARK™.	Kohler 25 761 40-S
<b>Starter Servicing Kit (All Starters)</b> For removing and reinstalling drive retaining rings and brushes. Individual component available: Starter Brush Holding Tool (Solenoid Shift)	SE Tools KLR-82411  SE Tools KLR-82416
<b>Stepper Motor Controller Tool</b> For testing operation of stepper motor/Digital Linear Actuator (DLA).	Kohler 25 455 21-S
<b>Jumper Lead Tool</b> For use with Stepper Motor Controller Tool to test rotary stepper motor.	Kohler 25 518 43-S
<b>Triad/OHC Timing Tool Set</b> For holding cam gears and crankshaft in timed position while installing timing belt.	Kohler 28 761 01-S
<b>Valve Guide Reamer (K and M Series)</b> For properly sizing valve guides after installation.	Design Technology Inc. DTI-K828
<b>Valve Guide Reamer O.S. (Command Series)</b> For reaming worn valve guides to accept replacement oversize valves. Can be used in low-speed drill press or with handle below for hand reaming.	Kohler 25 455 12-S
<b>Reamer Handle</b> For hand reaming using Kohler 25 455 12-S reamer.	Design Technology Inc. DTI-K830

## Tools and Aids

### AIDS

Description	Source/Part No.
<b>Camshaft Lubricant (Valspar ZZ613)</b>	Kohler 25 357 14-S
<b>Dielectric Grease (GE/Novaguard G661)</b>	Kohler 25 357 11-S
<b>Dielectric Grease</b>	Loctite® 51360
<b>Kohler Electric Starter Drive Lubricant (Inertia Drive)</b>	Kohler 52 357 01-S
<b>Kohler Electric Starter Drive Lubricant (Solenoid Shift)</b>	Kohler 52 357 02-S
<b>RTV Silicone Sealant</b> Loctite® 5900® Heavy Body in 4 oz. aerosol dispenser. Only oxime-based, oil resistant RTV sealants, such as those listed, are approved for use. Permatex® the Right Stuff® 1 Minute Gasket™ or Loctite® Nos. 5900® or 5910® are recommended for best sealing characteristics.	Kohler 25 597 07-S Loctite® 5910® Loctite® Ultra Black 598™ Loctite® Ultra Blue 587™ Loctite® Ultra Copper 5920™ Permatex® the Right Stuff® 1 Minute Gasket™
<b>Spline Drive Lubricant</b>	Kohler 25 357 12-S

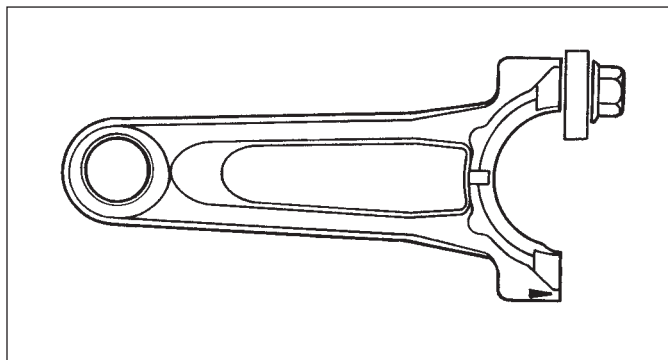
### FLYWHEEL HOLDING TOOL



A flywheel holding tool can be made out of an old junk flywheel ring gear and used in place of a strap wrench.

1. Using an abrasive cut-off wheel, cut out a six tooth segment of ring gear as shown.
2. Grind off any burrs or sharp edges.
3. Invert segment and place it between ignition bosses on crankcase so tool teeth engage flywheel ring gear teeth. Bosses will lock tool and flywheel in position for loosening, tightening, or removing with a puller.

### ROCKER ARM/CRANKSHAFT TOOL



A spanner wrench to lift rocker arms or turn crankshaft may be made out of an old junk connecting rod.

1. Find a used connecting rod from a 10 HP or larger engine. Remove and discard rod cap.
2. Remove studs of a Posi-Lock rod or grind off aligning steps of a Command rod, so joint surface is flat.
3. Find a 1 in. long capscrew with correct thread size to match threads in connecting rod.
4. Use a flat washer with correct I.D. to slip on capscrew and approximately 1 in. O.D. Assemble capscrew and washer to joint surface of rod.

## TROUBLESHOOTING GUIDE

When troubles occur, be sure to check simple causes which, at first, may seem too obvious to be considered. For example, a starting problem could be caused by an empty fuel tank.

Some general common causes of engine troubles are listed below and vary by engine specification. Use these to locate causing factors.

### Engine Cranks But Will Not Start

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- Battery connected backwards.
- Blown fuse.
- Carburetor solenoid malfunction.
- Choke not closing.
- Clogged fuel line or fuel filter.
- Diode in wiring harness failed in open circuit mode.
- Empty fuel tank.
- Faulty spark plug.
- Fuel pump malfunction-vacuum hose clogged or leaking.
- Fuel shut-off valve closed.
- Ignition module faulty or improperly gapped.
- Interlock switch is engaged or faulty.
- Key switch or kill switch in OFF position.
- Low oil level.
- Quality of fuel (dirt, water, stale, mixture).
- Spark plug lead disconnected.

### Engine Starts But Does Not Keep Running

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- Faulty carburetor.
- Faulty cylinder head gasket.
- Faulty or misadjusted choke or throttle controls.
- Fuel pump malfunction-vacuum hose clogged or leaking.
- Intake system leak.
- Loose wires or connections that intermittently ground ignition kill circuit.
- Quality of fuel (dirt, water, stale, mixture).
- Restricted fuel tank cap vent.

### Engine Starts Hard

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- Clogged fuel line or fuel filter.
- Engine overheated.
- Faulty ACR mechanism.
- Faulty or misadjusted choke or throttle controls.
- Faulty spark plug.
- Flywheel key sheared.
- Fuel pump malfunction-vacuum hose clogged or leaking.
- Interlock switch is engaged or faulty.
- Loose wires or connections that intermittently ground ignition kill circuit.
- Low compression.
- Quality of fuel (dirt, water, stale, mixture).
- Weak spark.

### Engine Will Not Crank

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- Battery is discharged.
- Faulty electric starter or solenoid.
- Faulty key switch or ignition switch.
- Interlock switch is engaged or faulty.
- Loose wires or connections that intermittently ground ignition kill circuit.
- Seized internal engine components.

### Engine Runs But Misses

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- Carburetor malfunction.
- Engine overheated.
- Faulty spark plug.
- Ignition module faulty or improperly gapped.
- Interlock switch is engaged or faulty.
- Loose wires or connections that intermittently ground ignition kill circuit.
- Quality of fuel (dirt, water, stale, mixture).
- Spark plug lead boot loose on plug.
- Spark plug lead loose.

### Engine Will Not Idle

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- Engine overheated.
- Faulty spark plug.
- Idle fuel circuit in carburetor plugged/restricted.
- Idle speed adjusting screw improperly set.
- Inadequate fuel supply.
- Low compression.
- Quality of fuel (dirt, water, stale, mixture).
- Restricted fuel tank cap vent.

### Engine Overheats

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- Cooling fan broken.
- Excessive engine load.
- High crankcase oil level.
- Lean fuel mixture.
- Low crankcase oil level.
- Cooling system components clogged or restricted.

### Engine Knocks

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- Excessive engine load.
- Incorrect oil viscosity/type.
- Internal wear or damage.
- Low crankcase oil level.
- Quality of fuel (dirt, water, stale, mixture).

# Troubleshooting

## Engine Loses Power

- Dirty air cleaner element.
- Engine overheated.
- Excessive engine load.
- Restricted exhaust.
- Faulty spark plug.
- High crankcase oil level.
- Incorrect governor setting.
- Low battery.
- Low compression.
- Low crankcase oil level.
- Quality of fuel (dirt, water, stale, mixture).

## Engine Uses Excessive Amount of Oil

- Loose or improperly torqued fasteners.
- Blown head gasket/overheated.
- Breather reed broken.
- Clogged, broken, or inoperative crankcase breather.
- Crankcase overfilled.
- Incorrect oil viscosity/type.
- Worn cylinder bore.
- Worn or broken piston rings.
- Worn valve stems/valve guides.

## Oil Leaks from Oil Seals, Gaskets

- Breather reed broken.
- Clogged, broken, or inoperative crankcase breather.
- Loose or improperly torqued fasteners.
- Piston blow by, or leaky valves.
- Restricted exhaust.

## EXTERNAL ENGINE INSPECTION



NOTE: It is good practice to drain oil at a location away from workbench. Be sure to allow ample time for complete drainage.

Before cleaning or disassembling engine, make a thorough inspection of its external appearance and condition. This inspection can give clues to what might be found inside engines (and cause) when it is disassembled.

- Check for buildup of dirt and debris on crankcase, cooling fins, grass screen, and other external surfaces. Dirt or debris on these areas can cause overheating.
- Check for obvious fuel and oil leaks, and damaged components. Excessive oil leakage can indicate a clogged or inoperative breather, worn or damaged seals or gaskets, or loose fasteners.
- Check air cleaner components for damage or indications of improper fit and seal.
- Check air cleaner element. Look for holes, tears, cracked or damaged sealing surfaces, or other damage that could allow unfiltered air into engine. A dirty or clogged element could indicate insufficient or improper maintenance.
- Check carburetor throat for dirt. Dirt in throat is further indication that air cleaner was not functioning properly.
- Check if oil level is within operating range on dipstick. If it is above, sniff for gasoline odor.
- Check condition of oil. Drain oil into a container; it should flow freely. Check for metal chips and other foreign particles.

Sludge is a natural by-product of combustion; a small accumulation is normal. Excessive sludge formation could indicate over rich fuel settings, weak ignition, overextended oil change interval or wrong weight or type of oil was used.


## CLEANING ENGINE


	 <b>WARNING</b>
	Cleaning Solvents can cause severe injury or death. Use only in well ventilated areas away from ignition sources.
Carburetor cleaners and solvents are extremely flammable. Follow cleaner manufacturer's warnings and instructions on its proper and safe use. Never use gasoline as a cleaning agent.	

After inspecting external condition of engine, clean engine thoroughly before disassembly. Clean individual components as engine is disassembled. Only clean parts can be accurately inspected and gauged for wear or damage. There are many commercially available cleaners that will quickly remove grease, oil, and grime from engine parts. When such a cleaner is used, follow manufacturer's instructions and safety precautions carefully.

Make sure all traces of cleaner are removed before engine is reassembled and placed into operation. Even small amounts of these cleaners can quickly break down lubricating properties of engine oil.

## CRANKCASE VACUUM TEST

	<b>⚠ WARNING</b>
	Carbon Monoxide can cause severe nausea, fainting or death. Avoid inhaling exhaust fumes. Never run engine indoors or in enclosed spaces.
Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled.	

	<b>⚠ WARNING</b>
	Rotating Parts can cause severe injury. Stay away while engine is in operation.
Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate engine with covers, shrouds, or guards removed.	

A partial vacuum should be present in crankcase when engine is operating. Pressure in crankcase (normally caused by a clogged or improperly assembled breather) can cause oil to be forced out at oil seals, gaskets, or other available spots.

Crankcase vacuum is best measured with either a water manometer or a vacuum gauge (inches of water gauge only). Complete instructions are provided in kits.

To test crankcase vacuum with manometer:

1. Insert rubber stopper into oil fill hole. Be sure pinch clamp is installed on hose and use tapered adapters to connect hose between stopper and one manometer tube. Leave other tube open to atmosphere. Check that water level in manometer is at 0 line. Make sure pinch clamp is closed.
2. Start engine and run no-load high speed.
3. Open clamp and note water level in tube.  
Level in engine side should be a minimum of 10.2 cm (4 in.) above level in open side.  
If level in engine side is less than specified (low/no vacuum), or level in engine side is lower than level in open side (pressure), check for conditions in table below.
4. Close pinch clamp before stopping engine.

To test crankcase vacuum with vacuum/pressure gauge (inches of water gauge only):

1. Remove dipstick or oil fill plug/cap.
2. Install adapter into oil fill/dipstick tube opening, upside down over end of a small diameter dipstick tube, or directly into engine if a tube is not used. Insert barbed gauge fitting into hole in stopper.
3. Run engine and observe gauge reading.  
Analog tester—needle movement to left of 0 is a vacuum, and movement to right indicates a pressure.  
Digital tester—depress test button on top of tester.  
Crankcase vacuum should be a minimum of 10.2 cm (4 in.) of water. If reading is below specification, or if pressure is present, check table below for possible causes and conclusions.

Condition	Conclusion
Crankcase breather clogged or inoperative.	Disassemble breather, clean parts thoroughly, check sealing surfaces for flatness, reassemble, and recheck pressure.
Seals and/or gaskets leaking. Loose or improperly torque fasteners.	Replace all worn or damaged seals and gaskets. Make sure all fasteners are tightened securely. Use appropriate torque values and sequences when necessary.
Piston blow by or leaky valves (confirm by inspecting components).	Recondition piston, rings, cylinder bore, valves and valves guides.
Restricted exhaust.	Check exhaust screen/spark arrestor (if equipped). Clean or replace as needed. Repair or replace any other damaged/restricted muffler or exhaust system parts.

# Troubleshooting

## COMPRESSION TEST

These engines are equipped with an automatic compression release (ACR) mechanism. It is difficult to obtain an accurate compression reading because of ACR mechanism. As an alternative, use cylinder leakdown test described below.

## CYLINDER LEAKDOWN TEST

A cylinder leakdown test can be a valuable alternative to a compression test. By pressurizing combustion chamber from an external air source you can determine if valves or rings are leaking, and how badly.

Cylinder leakdown tester is a relatively simple, inexpensive leakdown tester for small engines. This tester includes a quick-connect for attaching adapter hose and a holding tool.

1. Run engine for 3-5 minutes to warm it up.
2. Remove spark plug(s) and air filter from engine.
3. Rotate crankshaft until piston (of cylinder being tested) is at top dead center (TDC) of compression stroke. Hold engine in this position while testing. Holding tool supplied with tester can be used if PTO end of crankshaft is accessible. Lock holding tool onto crankshaft. Install a 3/8 in. breaker bar into hole/slot of holding tool, so it is perpendicular to both holding tool and crankshaft PTO.

If flywheel end is more accessible, use a breaker bar and socket on flywheel nut/screw to hold it in position. An assistant may be needed to hold breaker bar during testing. If engine is mounted in a piece of equipment, it may be possible to hold it by clamping or wedging a driven component. Just be certain that engine cannot rotate off of TDC in either direction.

4. Install adapter into spark plug hole, but do not attach it to tester at this time.
5. Turn regulator knob completely counterclockwise.
6. Connect an air source of at least 50 psi to tester.
7. Turn regulator knob clockwise (increase direction) until gauge needle is in yellow set area at low end of scale.
8. Connect tester quick-connect to adapter hose. While firmly holding engine at TDC, gradually open tester valve. Note gauge reading and listen for escaping air at combustion air intake, exhaust outlet, and crankcase breather.

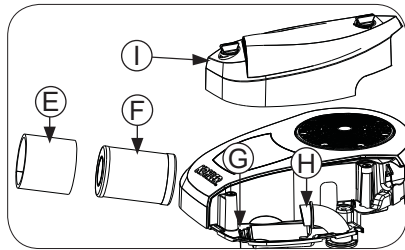
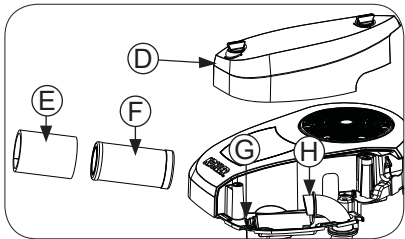
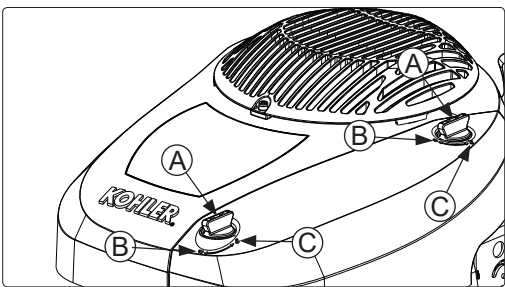
Condition	Conclusion
Air escaping from crankcase breather.	Ring or cylinder worn.
Air escaping from exhaust system.	Defective exhaust valve/improper seating.
Air escaping from intake.	Defective intake valve/improper seating.
Gauge reading in low (green) zone.	Piston rings and cylinder in good condition.
Gauge reading in moderate (yellow) zone.	Engine is still usable, but there is some wear present. Customer should start planning for overhaul or replacement.
Gauge reading in high (red) zone.	Rings and/or cylinder have considerable wear. Engine should be reconditioned or replaced.



AIR CLEANER

These systems are CARB/EPA certified and components should not be altered or modified in any way.

Air Cleaner Components



<b>A</b>	Cover Knob	<b>B</b>	Lock Symbol
<b>C</b>	Unlock Symbol	<b>D</b>	Standard Air Cleaner Cover
<b>E</b>	Precleaner	<b>F</b>	Paper Element
<b>G</b>	Retainer	<b>H</b>	Air Cleaner Adapter
<b>I</b>	PRO Air Cleaner Cover		

NOTE: Operating engine with loose or damaged air cleaner components could cause premature wear and failure. Replace all bent or damaged components.

NOTE: Paper element cannot be blown out with compressed air.

Turn knobs toward unlock symbol and remove air cleaner cover.

Precleaner (if equipped)

1. Remove precleaner from paper element.
2. Replace or wash precleaner in warm water with detergent. Rinse and allow to air dry.
3. Lightly oil precleaner with new engine oil; squeeze out excess oil.
4. Reinstall precleaner over paper element.

Paper Element

1. Remove element from air cleaner adapter; service precleaner. Discard element.
2. Install precleaner over new paper element and install on air cleaner adapter. Secure element behind retainer in housing.

Position air cleaner cover on housing and line up knobs with unlock symbol. Turn knobs toward lock symbol to secure.

BREATHER TUBE

Ensure both ends of breather tube are properly connected.

AIR COOLING

	<b>WARNING</b> Hot Parts can cause severe burns. Do not touch engine while operating or just after stopping.
Never operate engine with heat shields or guards removed.	

Proper cooling is essential. To prevent over heating, clean screens, cooling fins, and other external surfaces of engine. Avoid spraying water at wiring harness or any electrical components. Refer to Maintenance Schedule



# Fuel System

Typical carbureted fuel system and related components include:

- Fuel tank.
- Fuel lines.
- In-line fuel filter.
- Fuel pump.
- Carburetor.

Fuel from tank is moved through in-line filter and fuel lines by fuel pump. On engines not equipped with a fuel pump, fuel tank outlet is located above carburetor inlet and gravity moves fuel. Fuel then enters carburetor float bowl and is drawn into carburetor body and mixed with air. This fuel-air mixture is then burned in engine combustion chamber.

## FUEL RECOMMENDATIONS

Refer to Maintenance.

## FUEL LINE

Low permeation fuel line must be installed on carbureted Kohler Co. engines to maintain EPA and CARB regulatory compliance.

## FUEL PUMP

Some engines are equipped with an optional pulse fuel pump secured on a bracket installed on blower housing.

Fuel pump has two internal chambers separated by a diaphragm. Air chamber is connected to engine crankcase by a rubber hose. Fuel chamber has an inlet from fuel tank, and an outlet to carburetor. Inlet and outlet each have an internal, one-way check valve.

Alternating negative and positive pressures in crankcase activate pump. When piston moves upward in cylinder, negative pressure (vacuum) is created in crankcase and in air chamber of pump. Diaphragm flexes toward negative pressure, and suction draws fuel past inlet check valve, into fuel chamber. Downward movement of piston causes a positive pressure in crankcase and air chamber, pushing diaphragm in opposite direction, putting pressure on fuel. Inlet check valve has now closed, so fuel is forced past outlet check valve, to carburetor.

## Repair

---

Pulse fuel pumps are not serviceable and must be replaced when faulty.

## Removal

---

1. Turn knobs toward unlock symbol and remove air cleaner cover.
2. Disconnect inlet, outlet, and pulse lines from fuel pump. Mark lines for proper reassembly.
3. Remove fuel pump from bracket.

## Installation

---

1. Install new fuel pump, pressing fuel pump onto bracket past locking tabs.

NOTE: If necessary, carefully rebend locking tabs to ensure fuel pump is secured.

2. Connect inlet, outlet, and pulse lines to their respective fittings on pump. Secure with clamps.
3. Position air cleaner cover on housing and line up knobs with unlock symbol. Turn knobs toward lock symbol to secure.

## AUTO CHOKE (IF EQUIPPED)

If engine is equipped with Smart-Choke<sup>TM</sup>, follow troubleshooting procedures starting on page 32 of this manual.

## FUEL SYSTEM TESTS


When engine starts hard or turns over but will not start, fuel system might be causing problems. Test fuel system by performing following test.

1. Check for fuel in combustion chamber.
  - a. Disconnect and ground spark plug lead.
  - b. Close choke on carburetor.
  - c. Crank engine several times.
  - d. Remove spark plug and check for fuel at tip.
2. Check for fuel flow from tank to fuel pump.
  - a. Remove fuel line from inlet fitting of fuel pump.
  - b. Hold line below bottom of tank. Open shut-off valve (if equipped) and observe flow.
3. Check operation of fuel pump.
  - a. Remove fuel line from inlet fitting of carburetor.
  - b. Crank engine several times and observe flow.

Condition	Conclusion
Fuel at tip of spark plug.	Fuel is reaching combustion chamber.
No fuel at tip of spark plug.	Check fuel flow from fuel tank (step 2).
Fuel flows from fuel line.	Check for faulty fuel pump (step 3). If fuel pump is working, check for faulty carburetor. Refer to Carburetor.
No fuel flow from fuel line.	Check fuel tank cap vent, fuel pickup screen, in-line filter, shut-off valve, and fuel line. Correct any observed problem and reconnect line.
Fuel line condition.	Check for a clogged fuel line. If fuel line is unobstructed, check for overfilled crankcase and/or oil in pulse line. If checks don't reveal cause of problem, replace pump.

# Fuel System

## CARBURETOR



**⚠ 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, unoccupied 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.

<b>K</b>	Gasket	<b>L</b>	Shut-off Solenoid Assembly
<b>M</b>	Fuel Bowl Screw	<b>N</b>	Float Pin
<b>O</b>	Float	<b>P</b>	Idle Speed Screw and Spring
<b>Q</b>	Throttle Plate Screw	<b>R</b>	Throttle Plate
<b>S</b>	Filter	<b>T</b>	Throttle Lever and Shaft Assembly

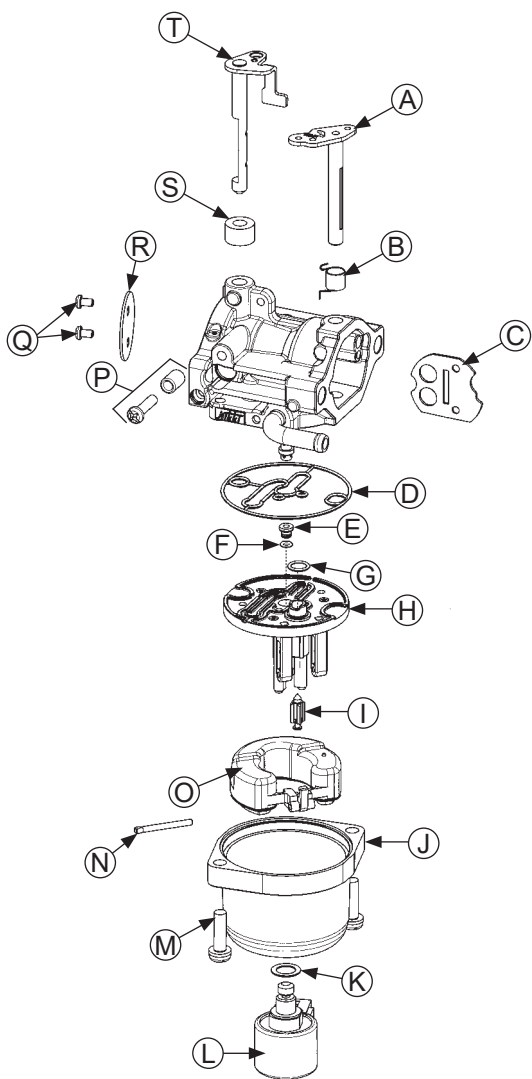
These engines are equipped with a fixed main jet carburetor. Carburetors will have a low idle speed adjustment screw.

### Troubleshooting Checklist

When engine starts hard, runs rough, or stalls at low idle speed, check these areas before adjusting or disassembling carburetor.

1. Make sure fuel tank is filled with clean, fresh gasoline.
2. Make sure fuel tank cap vent is not blocked and is operating properly.
3. Make sure fuel is reaching carburetor. This includes checking fuel shut-off valve, fuel tank filter screen, in-line fuel filter, fuel lines and fuel pump for restrictions or faulty components as necessary.
4. Make sure blower housing and carburetor are securely fastened to engine using gaskets in good condition.
5. Make sure air cleaner element (including precleaner if equipped) is clean and all air cleaner components are fastened securely.
6. Make sure ignition system, governor system, exhaust system, and throttle and choke controls are operating properly.

### Typical One-Barrel Carburetor Components



<b>A</b>	Choke Lever and Shaft Assembly	<b>B</b>	Choke Return Spring
<b>C</b>	Choke Plate	<b>D</b>	O-Ring
<b>E</b>	Main Jet	<b>F</b>	O-Ring
<b>G</b>	O-Ring	<b>H</b>	Carb Spacer
<b>I</b>	Fuel Inlet Needle	<b>J</b>	Fuel Bowl

Troubleshooting-Carburetor Related Causes		
Condition	Possible Cause	Conclusion
Engine starts hard, runs rough, or stalls at idle speed.	Low idle fuel mixture/speed improperly adjusted.	Adjust low idle speed screw, then adjust low idle fuel needle.
	Improper choke adjustment.	Correct choke adjustment.
Engine runs rich (indicated by black, sooty exhaust smoke, misfiring, loss of speed and power, governor hunting, or excessive throttle opening).	Choke partially closed during operation.	Check choke lever/linkage to ensure choke is operating properly.
	Dirt under fuel inlet needle.	Remove needle; clean needle and seat and blow with compressed air.
	Bowl vent or air bleeds plugged.	Remove fuel bowl. Clean vent, ports, and air bleeds. Blow out all passages with compressed air.
	Fuel bowl O-ring leaks.	Remove fuel bowl and replace O-ring.
Engine runs lean (indicated by misfiring, loss of speed and power, governor hunting, or excessive throttle opening).	Leaky, cracked, or damaged float.	Submerge float to check for leaks.
	Idle holes plugged; dirt in fuel delivery channels.	Remove fuel bowl. Clean main fuel jet and all passages; blow out with compressed air.
Fuel leaks from carburetor.	Dirt under fuel inlet needle.	Remove fuel bowl. Clean vent, ports, and air bleeds. Blow out all passages with compressed air.
	Float is cracked or damaged.	Replace float.
	Carburetor solenoid gasket damaged.	Replace gasket.
	Bowl retaining screws loose.	Torque screws to 4.0 N·m (35 in. lb.).

## FUEL SYSTEM

### Fuel Shut-off Solenoid

Most carburetors are equipped with a fuel shut-off solenoid. Solenoid is attached to fuel bowl. Solenoid has a spring-loaded pin that retracts when 12 volts is applied to lead, allowing fuel flow to main jet. When current is removed, pin extends blocking fuel flow.

Below is a simple test, performed with engine off, that can determine if solenoid is functioning properly:

1. Shut off fuel and remove solenoid from carburetor. When solenoid is loosened and removed, gas will leak out of carburetor. Have a container ready to catch fuel.
2. Wipe tip of solenoid with a shop towel or blow with compressed air to remove any remaining fuel. Take solenoid to a location with good ventilation and no fuel vapors present. You will also need a 12 volt power source that can be switched on and off.
3. Be sure power source is switched OFF. Connect positive power source lead to either terminal of solenoid and negative lead to other terminal of solenoid.
4. Turn power source ON and observe pin in center of solenoid. Pin should retract with power ON and return to its original position with power OFF. Test several times to verify operation.

# Fuel System

## Carburetor Circuits

### Float

Fuel level in bowl is maintained by float and fuel inlet needle. Buoyant force of float stops fuel flow when engine is at rest. When fuel is being consumed, float will drop and fuel pressure will push inlet needle away from seat, allowing more fuel to enter bowl. When demand ceases, buoyant force of float will again overcome fuel pressure, rising to predetermined setting and stop flow.

### Slow and Mid-Range

At low speeds engine operates only on slow circuit. As a metered amount of air is drawn through slow air bleed jets, fuel is drawn through main jet and further metered through slow jet. Air and fuel are mixed in body of slow jet and exit to idle progression (transfer port) chamber. From idle progression chamber, air fuel mixture is metered through idle port passage. At low idle air/fuel mixture is preset and not adjustable. This mixture is then mixed with main body of air and delivered to engine. As throttle plate opening increases, greater amounts of air/fuel mixture are drawn in through fixed and metered idle progression holes. As throttle plate opens further, vacuum signal becomes great enough at venturi so main circuit begins to work.

### Main (high-speed)

At high speeds/loads engine operates on main circuit. As a metered amount of air is drawn through air jet, fuel is drawn through main jet. Air and fuel are mixed in main nozzle then enters main body of airflow where further mixing of fuel and air occurs. This mixture is then delivered to combustion chamber. Carburetor has a fixed main circuit; no adjustment is possible.

## Carburetor Adjustments

NOTE: Carburetor adjustments should be made only after engine has warmed up.

Carburetor is designed to deliver correct fuel-to-air mixture to engine under all operating conditions. Main fuel jet is calibrated at factory and is not adjustable. Idle fuel is also set at factory and is not adjustable.

### Low Idle Speed (RPM) Adjustment

NOTE: Actual low idle speed depends on application. Refer to equipment manufacturer's recommendations.

1. Low idle speed (without governor) for basic engines is 1200 RPM ( $\pm 75$  RPM). This can be adjusted by holding throttle lever against stop and turning low idle speed screw in or out.
2. These engines have governed idle. To set to manufacturer's recommendation, turn adjustment screw on speed control bracket in (clockwise) to increase or out (counterclockwise) to decrease RPM speed.

### High Speed (RPM) Adjustment

1. With engine running, move throttle control to fast and pin.
2. Loosen speed control bracket mounting screws, slide bracket to adjust high speed setting, then tighten screws.

## Carburetor Servicing

NOTE: Main and slow jets are fixed and size specific. Fixed jets for high altitudes are available.

- Inspect carburetor body for cracks, holes, and other wear or damage.
- Inspect float for cracks, holes, and missing or damaged float tabs. Check float hinge and shaft for wear or damage.
- Inspect fuel inlet needle and seat for wear or damage.
- Inspect spring loaded choke plate to make sure it moves freely on shaft.

1. Perform removal procedures for appropriate air cleaner and carburetor outlined in Disassembly.
2. Clean exterior surfaces of dirt or foreign material before disassembling carburetor. Remove bowl retaining screws and carefully separate fuel bowl from carburetor body. Do not damage fuel bowl O-rings. Transfer any remaining fuel into an approved container. Save all parts.
3. Remove float pin, float, and inlet needle. Seat for inlet needle is serviceable by replacing carb spacer (inlet seat assembly). Remove carb spacer by carefully lifting up and off carburetor body.

NOTE: Lift straight up and not sideways to ensure main tube isn't damaged.

4. Main jet can be removed from carb spacer by using a blunt tool and gently pushing jet out of center stem. Main jet is retained in carb spacer by O-ring. Inspect O-ring during disassembly and replace if damaged. Repair kits are available for both gravity and fuel pump equipped engines.
5. Clean carburetor bowl and assembly as required.
6. See illustration for carburetor components on page 28. Note O-ring on carb spacer to carburetor body and fuel bowl, inlet seat/spacer well and main jet. Cleaning of passages and orifices can be done using compressed air. Do not use wire or carburetor cleaner.
7. After cleaning, inspect choke shaft and choke valve assembly for wear. Replace as required with choke shaft kit. To install kit go to step 8, otherwise go to step 10. Inspect throttle shaft and throttle valve assembly. If wear is found on throttle shaft, install throttle shaft kit. To install kit go to step 10, otherwise go to step 12. If wear is noted within choke and/or throttle shaft bores of carburetor body, a complete carburetor replacement is recommended.

8. Inspect and note choke valve position, placement, and mating of valve plate to choke bore for proper reassembly. While holding choke shaft in full open position, pull choke valve straight out of bore and choke shaft using a pliers. Lift choke shaft and spring out of carburetor body. Inspect choke shaft bores for wear or dirt. If wear is noted within choke shaft bore of carburetor body, a complete carburetor replacement is recommended.
9. Install new choke shaft and spring into carburetor choke shaft bore in same position as noted in previous step. Position spring tab in proper position. While holding choke in full open position, carefully slide new choke valve through center slot of choke shaft, paying attention to proper orientation of valve. Push valve plate into shaft until plate parks in detent. Rotate choke shaft assembly from full open to full closed position. No interference should be noted.
10. Inspect and note throttle valve and lever position. Turn idle speed screw out (counterclockwise) two full turns to allow throttle valve to seat in a fully closed position with throttle bore. While holding throttle in closed position, remove two screws from throttle shaft/valve plate. Remove throttle plate from throttle shaft. Lift throttle shaft and shaft filter out of carburetor body. Inspect throttle shaft bores for wear or dirt. If wear is noted within throttle shaft bore of carburetor body, a complete carburetor replacement is recommended.
11. Install new shaft filter over throttle shaft and position at top of shaft against lever. Install new throttle shaft into carburetor throttle shaft bore in same position as noted in previous step. Ensure that throttle lever will contact idle speed screw when moved to closed position. Inspect edge of new throttle plate. Note that edge is chamfered to seal against throttle bore of carburetor when closed. Installing throttle plate incorrectly may allow throttle to pinch tight. Place a drop of Loctite® on threads of each new screw. While holding slight pressure on throttle lever to closed position, align and start two plate screws. Rotate throttle shaft assembly from completely closed to full open position. Ensure there is no binding or restriction, then tighten screws securely. Do not overtighten.
12. Install new O-ring on main jet. Put a light film of oil on O-ring. Place jet with O-ring into center stem of carb spacer. Use a blunt tool to gently push and seat jet/O-ring.
13. Install new small O-ring over inlet seat boss of carb spacer. Position new O-ring into molded grooves of carb spacer.
14. Holding both carburetor pieces in upright position, gently push to seat carb spacer into carburetor body.
15. Place inlet needle on float and lower into position on carb spacer; install float pin to secure.
16. Reinstall carburetor bowl and secure to body with two screws. Torque screws to 4.0 N·m (35 in. lb.).
17. Install new gasket on solenoid assembly. Install solenoid assembly in fuel bowl and tighten securely.
18. Reinstall carburetor using appropriate new carburetor gaskets.

## High Altitude Operation

If this engine is operated at an altitude of 4000 ft. (1219 meters) or above, a high altitude carburetor kit is required. To obtain high altitude carburetor kit information or to find a Kohler authorized dealer, visit [KohlerEngines.com](http://KohlerEngines.com) or call 1-800-544-2444 (U.S. and Canada).

This engine should be operated in its original configuration below 4000 ft. (1219 meters).

Operating this engine with the wrong engine configuration at a given altitude may increase its emissions, decrease fuel efficiency and performance, and result in damage to the engine.

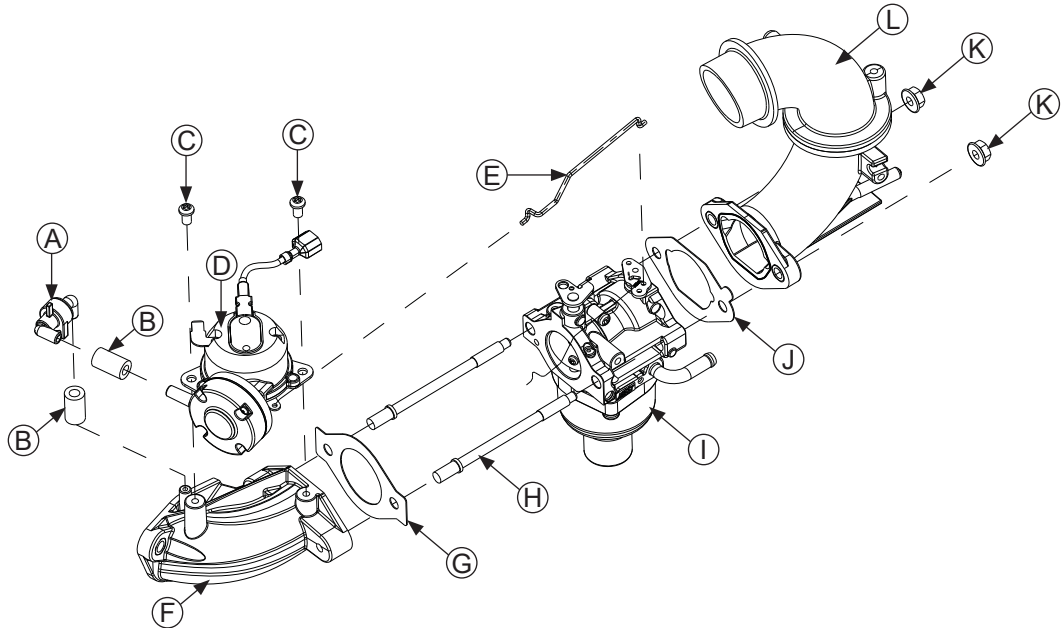


# Fuel System

## Smart-Choke™

Diaphragm assembly consists of a spring controlled diaphragm for initial choke pull-off and a thermostat to completely open choke while engine warms up. A vacuum signal from intake manifold is routed through a check valve to diaphragm and partially opens choke once engine starts. To complete choke opening, a bimetallic spring in diaphragm assembly heats up over a preset time once this thermostat sees 12V as activated by oil pressure switch. When engine is cold, a spring on diaphragm, in conjunction with a bimetallic spring, will hold choke closed for starting. When engine is warm, bimetallic spring holds choke completely open while engine is running. Choke will be 2/3 closed when warm and not running, allowing for partial choke on a hot restart. These two elements work together to operate a smooth choke system that facilitates easy reliable starting in all conditions.

## Smart-Choke™ Components



<b>A</b>	Check Valve Assembly	<b>B</b>	Vacuum Hose	<b>C</b>	K40 x 1.79 Screw	<b>D</b>	Diaphragm Assembly
<b>E</b>	Choke Linkage	<b>F</b>	Intake Manifold	<b>G</b>	Intake Manifold Gasket	<b>H</b>	Carburetor Gasket (Throttle)
<b>I</b>	Carburetor Assembly	<b>J</b>	Carburetor Gasket	<b>K</b>	Carburetor Nut	<b>L</b>	Intake Adapter



Troubleshooting Smart-Choke™ Related Causes		
Condition	Possible Cause	Conclusion
Engine starts hard, runs rough, or stalls at idle speed.	Choke not closing.	Check choke lever/linkage to ensure choke is operating properly.
		Check that bimetallic spring actuates freely.
Engine runs rich (indicated by black, sooty exhaust smoke, misfiring, loss of speed and power, governor hunting, or excessive throttle opening).	Choke partially closed during operation.	Check choke lever/linkage to ensure choke is operating properly.
		Check that bimetallic spring actuates freely.
		Check choke diaphragm assembly mounting.
		Confirm 12V to thermostat on top of diaphragm assembly.
		Confirm check valve routing from intake manifold to diaphragm assembly is clear. Confirm initial pull-off of choke during cranking.

## Smart-Choke™ System Troubleshooting

These procedures are to be performed on a cold engine.

**NOTE:** Bimetallic spring assembly is pre-set at factory and riveted shut. DO NOT attempt to adjust/change its settings.

**NOTE:** Do not remove or loosen diaphragm screws on diaphragm assembly. Position and torque is pre-set at factory.

**NOTE:** Thermostat temperature must be at room temperature before testing.

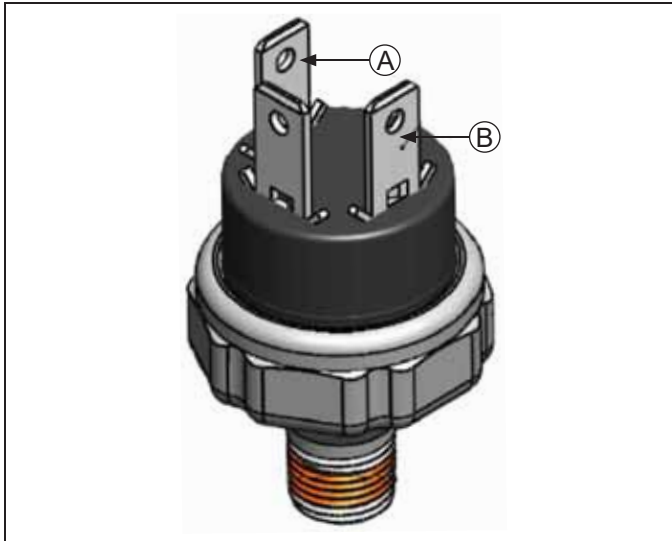
- Turn knobs toward unlock symbol and remove air cleaner cover. Lift and remove precleaner (if equipped) and air cleaner element from air cleaner adapter.
- Remove blower housing.
- Choke plate should be fully closed when engine is cold.
- There should be light spring tension holding choke closed.
- There should not be any binding when choke shaft assembly is rotated, which could cause choke to remain partially open.
- Check choke linkage for binding or debris build up. Gently actuate linkage and observe that choke plate has full range of movement (open and close).
- Unplug red wire with black tracer power lead of bimetallic spring assembly. Measure heat circuit resistance of choke thermostat assembly, with a volt ohm meter at room temperature (68°F/20°C).
- Attach one wire of meter to red wire w/yellow tracer terminal of assembly, and other wire to ground of bracket or to ground strip of assembly body.  
Thermostat resistance should read 15 ohms (+/- 10 ohms). If assembly is warm, allow unit to cool to room temperature (68°F/20°C) for accurate testing. If an infinite (open) reading is found, replace diaphragm assembly. Diaphragm vacuum signal will not open choke plate fully when cold and will not close choke plate fully when engine is warm.
- Unplug check valve assembly from diaphragm and draw a vacuum of -5 psig and confirm that it holds for at least 30 seconds. If it does not, replace diaphragm assembly.
- Confirm check valve assembly is oriented correctly and that it flows easily in one direction – toward manifold.
- Reinstall blower housing.
- Start engine. Upon start up, choke plate should be 1/3 closed. Choke plate should gradually change to full open position after 2 to 2-1/2 minutes of running. This action is performed by bimetallic spring assembly being heated. If choke plate fails to open, recheck linkage for binding.
- With engine running, check voltage at bimetallic spring choke bracket assembly. Using a DVOM, attach black lead of meter to ground screw on assembly bracket, and red lead of meter to red wire w/black tracer.

## Fuel System

14. Select DC VOLTS on your meter. You should see a minimum of 12 volts DC.

If no voltage is present, test for voltage at oil pressure switch.

### Oil Pressure Switch



<b>A</b>	Power In Terminal
<b>B</b>	Power Out Terminal

If voltage is present at power in terminal but not at power out terminal when engine is running, pressure switch is potentially faulty. Remove switch and install a pressure test gauge and start engine. Consult troubleshooting section of this manual for oil pressure testing instructions. If adequate pressure is found, replace pressure switch and confirm operation/voltage readings.

15. If linkage is free and choke plate fails to open fully after 2 minutes, check spring tension of bimetallic assembly. If necessary, replace diaphragm assembly.
16. Reinstall air cleaner element (with precleaner if equipped) on air cleaner adapter. Secure element behind retainer in housing. Position air cleaner cover on housing and line up knobs with unlock symbol. Turn knobs toward lock symbol to secure.

### Starting an Engine Equipped with Smart-Choke™

1. Smart-Choke™ system will automatically control choke plate position for starting.
2. Make sure equipment is in neutral.
3. Activate starter switch. Release switch as soon as engine starts.  
If starter does not turn engine over, shut starter off immediately. Do not make further attempts to start engine until condition is corrected. Do not jump start using another battery. See your Kohler authorized dealer for trouble analysis.
4. For operation, after engine starts, move throttle and set desired engine operating speed.

## CONTROLS

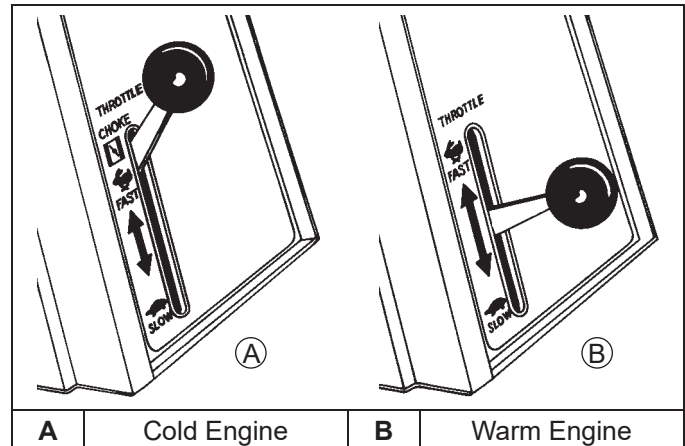
Some engines are equipped with single wire controls. Refer to Unitized Throttle and Choke Control for details. Some engines are equipped with separate throttle and choke controls. Refer to Separate Throttle and Choke Control for details. Some engines are equipped with a Smart-Choke™ assembly and a separate throttle control.

### Unitized Throttle and Choke Control

Some engines are equipped with a unitized throttle and choke control. This assembly controls choke and engine speed with a single lever.

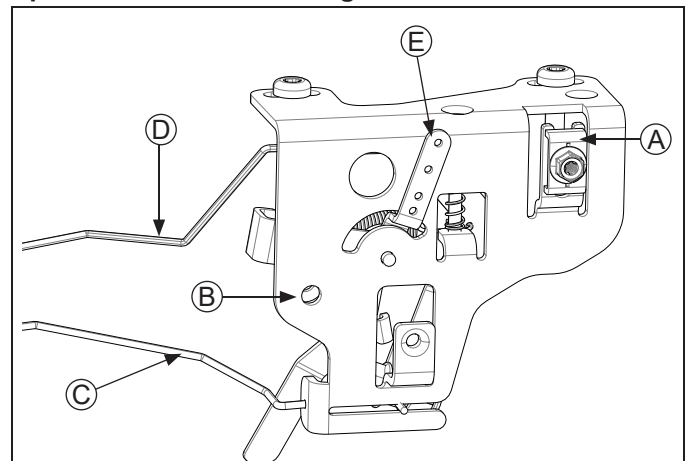
### Throttle Cable Adjustment

#### Throttle/Choke Controls Details



<b>A</b>	Cold Engine	<b>B</b>	Warm Engine
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### Speed Control Bracket Alignment Hole



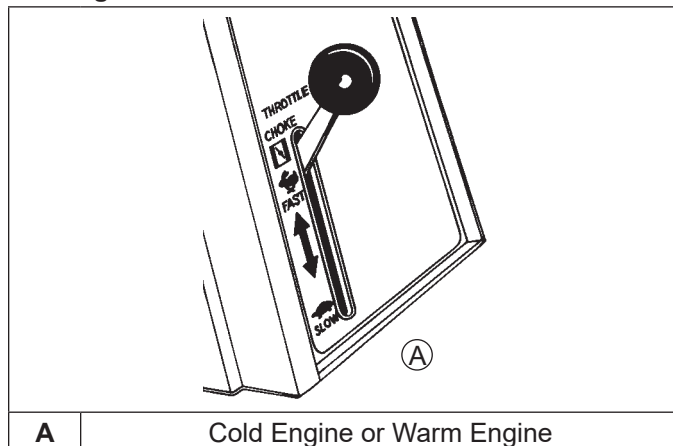
<b>A</b>	Throttle Cable Clamp	<b>B</b>	Alignment Hole
<b>C</b>	Choke Linkage	<b>D</b>	Throttle Linkage
<b>E</b>	Throttle Control Lever		

**NOTE:** Choke is placed ON by moving throttle control slightly past fast position. If throttle control does not have a designated choke ON position, be sure to leave sufficient throttle control travel past fast position. This will enable choke to be placed ON.

1. Loosen control cable clamp.
2. Place throttle control lever of equipment into fast or high speed position.
3. Align hole in throttle lever with hole in speed control bracket by inserting a pencil or 6.35 mm (1/4 in.) drill bit.
4. Pull on outer shield of throttle control cable to remove any slack. Tighten cable clamp securely.

## Starting an Engine Equipped with Unitized Throttle and Choke Control

### Starting Throttle Control Details



**NOTE:** Do not crank engine continuously for more than 10 seconds at a time. If engine does not start, allow a 60 second cool down period between starting attempts. Failure to follow these guidelines can burn out starter motor.

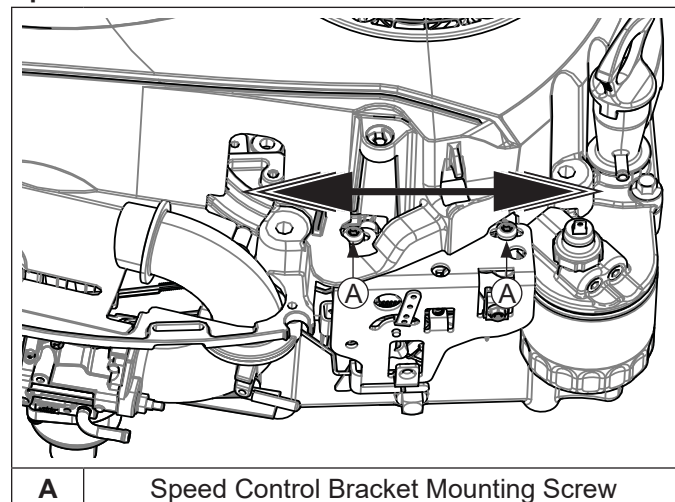
**NOTE:** If engine develops sufficient speed to disengage starter but does not keep running (a false start), engine rotation must be allowed to come to a complete stop before attempting to restart engine. If starter is engaged while flywheel is rotating, starter pinion and flywheel ring gear may clash, resulting in damage to starter.

If starter does not turn engine over, shut starter off immediately. Do not make further attempts to start engine until condition is corrected. Do not jump start using another battery. See your Kohler authorized dealer for trouble analysis.

1. For a Cold or Warm Engine – Place throttle/choke control into fast/choke ON position. This will also place choke into ON position.
2. Make sure equipment is in neutral.
3. Activate starter switch. Release switch as soon as engine starts.
4. For Operation – After engine starts, move throttle/choke control from fast/choke ON position and set desired engine operating speed (between slow and fast position).

## High Speed (RPM) Adjustment

### Speed Control Bracket Details



Recommended maximum no-load high speed (RPM) for most engines is 3300 RPM. Actual high speed (RPM) depends on application. Refer to equipment manufacturer's instructions for specific information.

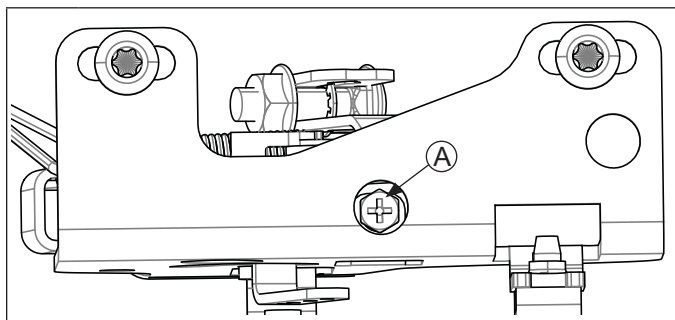
**NOTE:** If engine is equipped with a fuel pump, carefully remove fuel lines from housing and remove pump from bracket.

1. Make sure throttle cable is adjusted properly (see Throttle Cable Adjustment).
2. Start engine and allow it to warm up. Place throttle control lever into fast or high speed position. Turn governed idle adjusting screw out/counterclockwise, so there is clearance from control lever, and that contact cannot occur during Step 4.
3. Align hole in throttle lever with hole in speed control bracket by inserting a pencil or 6.35 mm (1/4 in.) drill bit.
4. Loosen speed control bracket mounting screws. Slide bracket forward or backward, until desired high speed (RPM) is reached. Check speed with a tachometer.  
To increase high speed (RPM), move bracket toward carburetor.  
To decrease high speed (RPM), move bracket away from carburetor.
5. Tighten speed control bracket mounting screws. Recheck speed with a tachometer and readjust if necessary.  
Torque mounting screws as follows:  
Into new hole – 11.3 N·m (100 in. lb.).  
Into used hole – 7.5 N·m (65 in. lb.).
6. Adjust governed idle (see Governed Idle Adjustment which follows).

# Fuel System

## Governed Idle Adjustment

This procedure must follow High Speed Adjustment just described. If not already completed, perform that operation first.



**A** Governed Idle Screw

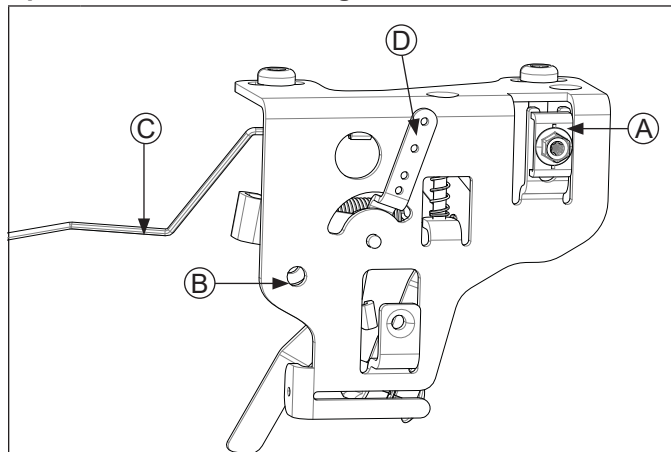
1. Turn governed idle adjusting screw out (counterclockwise), until it no longer contacts control lever.
2. Then turn it back in (clockwise), until it just makes contact.
3. While observing choke link, move throttle control lever to low idle (slow) position, then back to full throttle (fast). Choke link should not move as throttle moves through normal range. If it does, back adjusting screw out until it no longer moves.
4. Move throttle control lever to choke position. Check if choke has fully closed by placing your finger on right side of lower end of choke lever/choke link and applying gentle pressure towards carburetor. If controls have been properly set, link should not move.

## SEPARATE THROTTLE AND CHOKE CONTROL

Some engines are equipped with separate throttle and choke controls. This allows you to adjust choke and throttle controls individually.

## Install Separate Control Cables

### Speed Control Bracket Alignment Hole Details



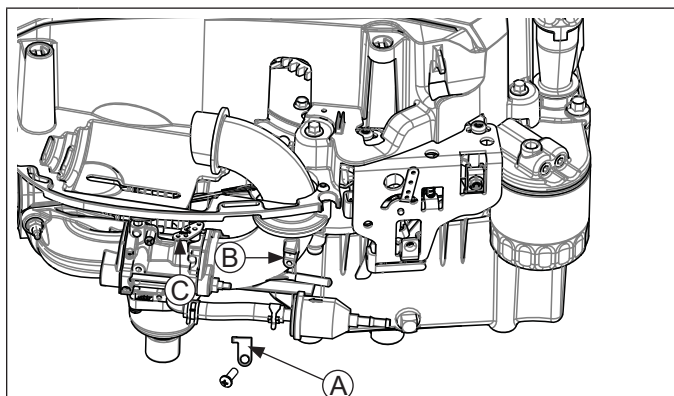
<b>A</b>	Throttle Cable Clamp	<b>B</b>	Alignment Hole
<b>C</b>	Throttle Linkage	<b>D</b>	Throttle Control Lever

### Throttle Control Installation

1. Loosen cable clamp screw on speed control bracket assembly.
2. Move application throttle control lever to maximum full (fast) throttle position, and then move it back 3/16" or 4.75 mm. Insert cable body wire into throttle control lever on control plate.
3. Position throttle cable under cable clamp.
4. Align hole in throttle lever with hole in speed control bracket by inserting a pencil or 6.35 mm (1/4 in.) drill bit.
5. Pull on outer shield of throttle control cable to remove any slack. Tighten cable clamp securely.
6. Move application throttle lever to slow position, then to full throttle. Check engine control to ensure it stops against stop screw, which means it is properly set.

## Choke Control Installation

In this engine series, choke cable connects to carburetor choke lever and is secured to air cleaner adapter with a cable clamp.



<b>A</b>	Cable Clamp	<b>B</b>	Air Intake Adapter
<b>C</b>	Choke Lever		

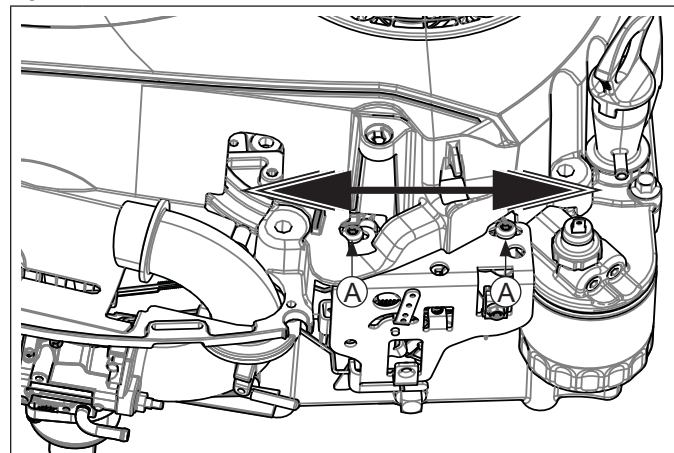
1. Connect choke cable boden wire to carburetor choke lever.
2. Position choke cable under cable clamp and secure to air intake adapter.
3. Push/move choke control to off position in application panel until it bottoms, then pull it back approximately 1/16 in.
4. Push on choke cable, ahead of clamp on air cleaner adapter, until choke lever stops. Do not force. Then tighten cable clamp screw.

## Starting an Engine Equipped with Separate Control Cables

1. Place throttle control midway between slow and fast positions. Place choke control into on position.
2. Start engine.
3. For a Cold Engine – Gradually return choke control to off position after engine starts and warms up.  
Engine/equipment may be operated during warm up period, but it may be necessary to leave choke partially on until engine warms up.
4. For a Warm Engine – Return choke to off position as soon as engine starts.

## Changing High Speed (RPM) on Engines with Separate Controls (Increase or Decrease RPM)

### Speed Control Bracket Details



<b>A</b>	Speed Control Bracket Mounting Screw
----------	--------------------------------------

**NOTE:** If engine is equipped with a fuel pump, carefully remove fuel lines from housing and remove pump from bracket.

1. Check that governor spring and installation matches intended high speed RPM operating range.
2. Start engine, move application throttle lever to full throttle/fast, and loosen mounting screws of main speed control bracket to allow repositioning.
3. To increase RPM: Move speed control bracket, towards carburetor. To decrease RPM: Move speed control bracket, away from carburetor. Check RPM with a tachometer and tighten screws when correct setting has been obtained.
4. To ensure that RPM has been obtained, move throttle lever to low idle/slow then back to full throttle/fast position and check RPM with a tachometer.

### Setting Low Idle RPM

1. Move application control to slow position.
2. Using a tachometer, check RPM. Then, using a screwdriver, turn low idle speed screw inward (clockwise) to increase RPM, and outward (counterclockwise) to lower RPM.



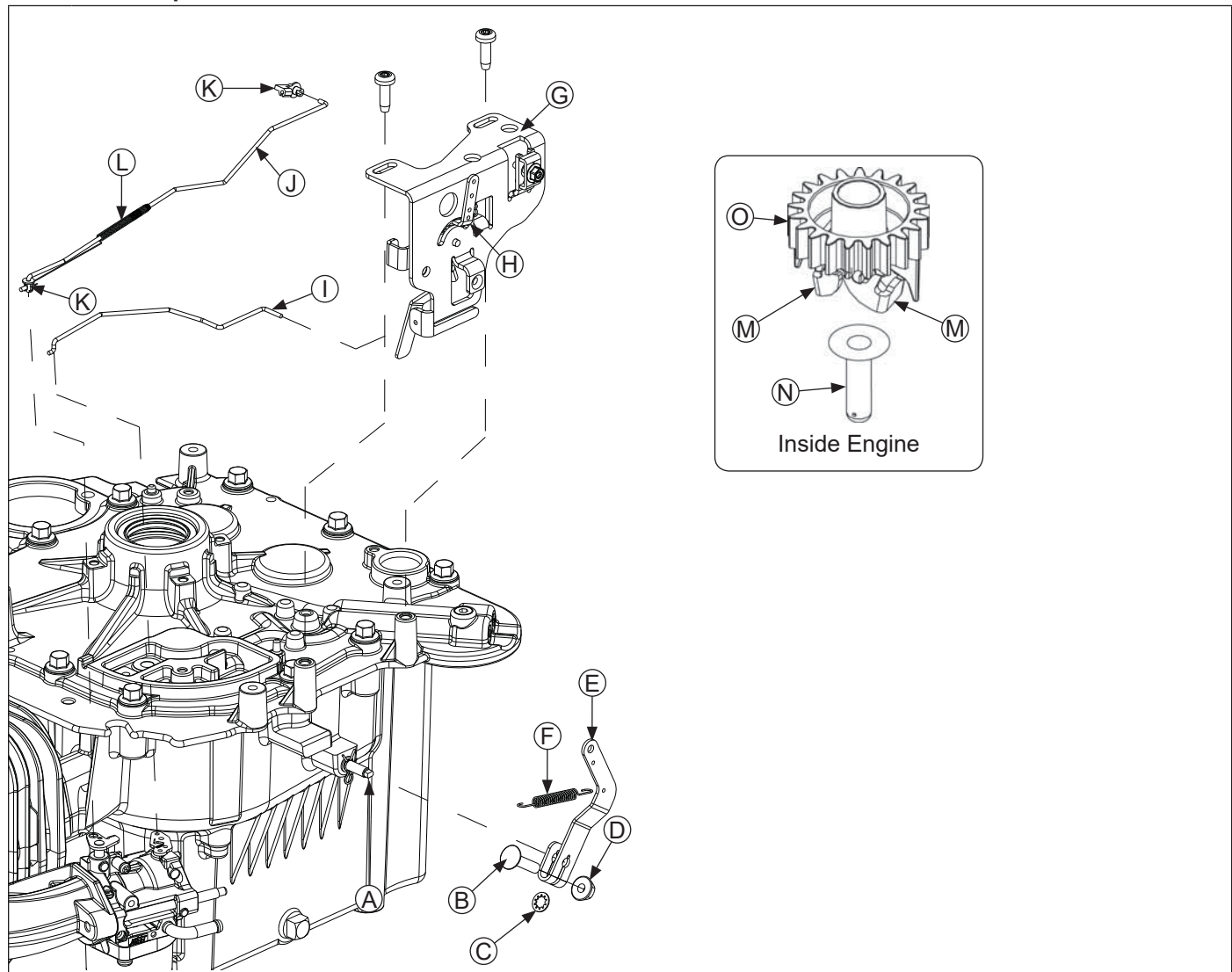
# Governor System

## GOVERNOR

Governed speed setting is determined by position of throttle control. It can be variable or constant, depending on engine application.

Governor is designed to hold engine speed constant under changing load conditions. Most engines are equipped with a centrifugal flyweight mechanical governor. Governor gear/flyweight mechanism of mechanical governor is mounted inside closure plate and is driven off gear on crankshaft.

## Governor Components



<b>A</b>	Governor Cross Shaft	<b>B</b>	Round Head Square Neck Bolt	<b>C</b>	Lock Washer	<b>D</b>	Nut
<b>E</b>	Governor Lever	<b>F</b>	Governor Spring	<b>G</b>	Speed Control Bracket	<b>H</b>	Control Lever
<b>I</b>	Choke Linkage	<b>J</b>	Throttle Linkage and Spring	<b>K</b>	Linkage Retainer Bushing	<b>L</b>	Linkage Spring
<b>M</b>	Flyweight	<b>N</b>	Regulating Pin	<b>O</b>	Governor Gear		

This governor design works as follows:

- Centrifugal force acting on rotating governor gear assembly causes flyweights to move outward as speed increases. Governor spring tension moves them inward as speed decreases.
- As flyweights move outward, they cause regulating pin to move outward.
- Regulating pin contacts tab on cross shaft causing shaft to rotate.
- One end of cross shaft protrudes through crankcase. Rotating action of cross shaft is transmitted to throttle lever of carburetor through external throttle linkage.
- When engine is at rest, and throttle is in fast position, tension of governor spring holds throttle plate open. When engine is operating, governor gear assembly is rotating. Force applied by regulating pin against cross shaft tends to close throttle plate. Governor spring tension and force applied by regulating pin balance each other during operation, to maintain engine speed.
- When load is applied and engine speed and governor gear speed decreases, governor spring tension moves governor arm to open throttle plate wider. This allows more fuel into engine, increasing engine speed. As speed reaches governed setting, governor spring tension and force applied by regulating pin will again offset each other to hold a steady engine speed.

## Governor Adjustments

NOTE: Do not tamper with governor setting. Overspeed is hazardous and could cause personal injury.

### Initial Adjustment Procedure

Make this adjustment whenever governor arm is loosened or removed from cross shaft. Adjust as follows:

1. Make sure throttle linkage is connected to governor arm and throttle lever on carburetor.
2. Loosen nut holding governor lever to cross shaft.
3. Move governor lever toward carburetor as far as it will go (wide open throttle) and hold in this position.
4. Grasp cross shaft with a pliers, and turn shaft counterclockwise as far as it will go. Torque nut to 7.7 N·m (68 in. lb.).

### Governor Sensitivity Adjustment

Governor sensitivity is adjusted by repositioning governor spring in holes in governor lever. If speed surging occurs with a change in load, governor is set too sensitive. If a big drop in speed occurs when a normal load is applied, governor should be set for greater sensitivity.

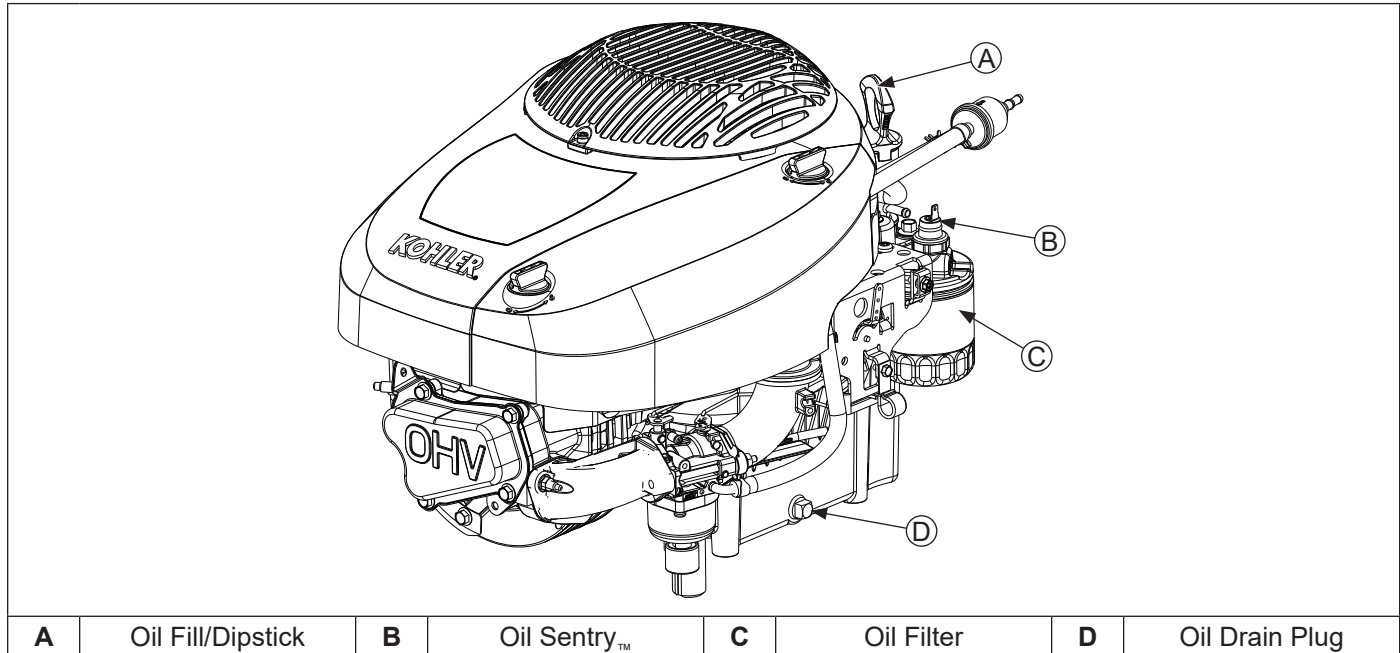
Desired high speed setting (RPM) will determine governor spring used.

# Lubrication System

This engine uses a full pressure lubrication system which delivers oil under pressure to crankshaft, camshaft, and connecting rod bearing surfaces. Other component areas are splash lubricated.

A high-efficiency gerotor oil pump maintains high oil flow and oil pressure, even at low speeds and high operating temperatures. A pressure relief valve limits maximum pressure of system. Closure plate must be removed to service oil pickup, pressure relief valve, and oil pump.

## Lubrication Components



## OIL RECOMMENDATIONS

Refer to Maintenance.

### CHECK OIL LEVEL

**NOTE:** To prevent extensive engine wear or damage, never run engine with oil level below or above operating range indicator on dipstick.

Ensure engine is cool and level. Clean oil fill/dipstick areas of any debris.

1. Remove dipstick; wipe oil off.
2. Reinsert dipstick into tube; press completely down.
3. Remove dipstick; check oil level. Level should be at top of indicator on dipstick.
4. If oil is low on indicator, add oil up to top of indicator mark.
5. Reinstall and secure dipstick.

### CHANGE OIL AND FILTER

Change oil while engine is warm.

1. Clean area around oil fill cap/dipstick. Remove drain plug and oil fill cap/dipstick. Allow oil to drain completely.
2. Clean area around oil filter. Place a container under filter to catch any oil and remove filter. Wipe off mounting surface. Reinstall drain plug. Torque to 14.0 N·m (125 in. lb.).
3. Place new filter in shallow pan with open end up. Fill with new oil until oil reaches bottom of threads. Allow 2 minutes for oil to be absorbed by filter material.

4. Apply a thin film of clean oil to rubber gasket on new filter.
5. Refer to instructions on oil filter for proper installation.
6. Fill crankcase with new oil. Level should be at top of indicator on dipstick.
7. Reinstall oil fill cap/dipstick and tighten securely.
8. Start engine; check for oil leaks. Stop engine; correct leaks. Recheck oil level.
9. Dispose of used oil and filter in accordance with local ordinances.

### OIL SENTRY™ (if equipped)

This switch is designed to prevent engine from starting in a low oil or no oil condition. Oil Sentry™ may not shut down a running engine before damage occurs. In some applications this switch may activate a warning signal. Read your equipment manuals for more information.

Oil Sentry™ pressure switch is installed in closure plate pressure port. On engines not equipped with Oil Sentry™, installation hole is sealed with a 1/8" pipe plug.

### Installation

1. Apply pipe sealant with Teflon® (Loctite® PST® 592™ Thread Sealant or equivalent) to threads of switch.
2. Install switch into closure plate.
3. Torque switch to 6.2 N·m (55 in. lb.). Connect lead to terminal or connector plug to terminals on Oil Sentry™ switch.

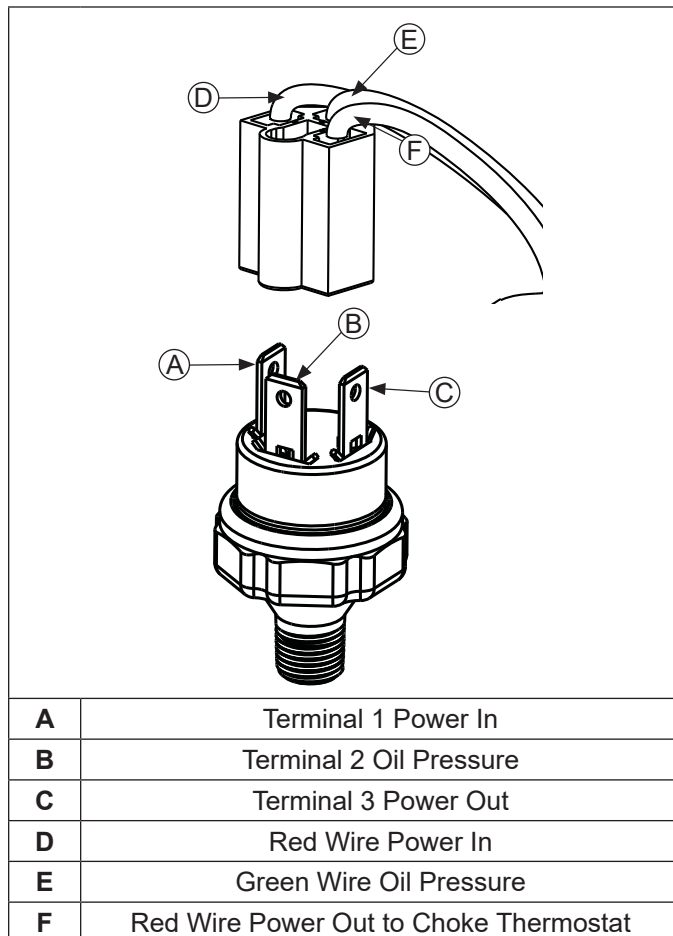


## Testing

Compressed air, a pressure regulator, pressure gauge, and a continuity tester are required to test switch.

Identify switch used and follow appropriate testing procedure.

### 3-Terminal Switch



#### Test 1

1. Connect continuity tester across blade terminal #2 and metal case of switch. With 0 PSI applied to switch, tester should indicate continuity (contacts closed).
2. Gradually increase pressure to switch. As pressure increases through range of 2-5 PSI, tester should indicate a change to no continuity (contacts open). Switch contacts should remain open as pressure is further increased to 90 PSI.
3. Gradually decrease pressure through range of 2-5 PSI. Tester should indicate a change in continuity at terminal (Switch closed) down to 0 PSI.

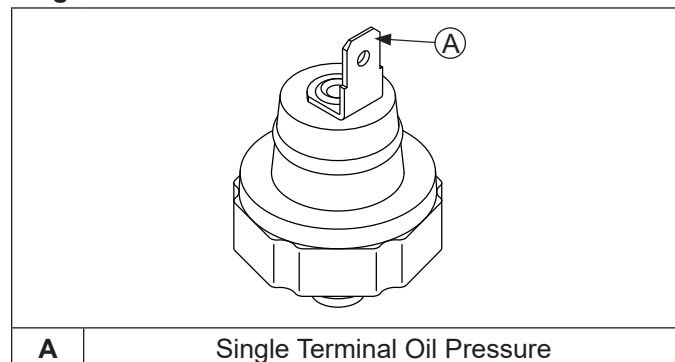
#### Test 2

1. Connect continuity tester leads at terminal #1 and terminal #3 of switch. With 0 PSI applied to switch, tester should indicate no continuity (contacts open) between terminals #1 and #3.

2. Gradually increase pressure to switch. As pressure increases through range of 2-5 PSI, tester should indicate a change to continuity (contacts closed) between terminal #1 and terminal #3 on switch. Continuity condition between #1 and #3 terminals should remain closed while pressure is further increased to 90 PSI.
3. Gradually decrease pressure through range of 2-5 PSI. Tester should indicate a change in continuity between terminals #1 and #3 (contacts open) down to 0 PSI.

Replace switch if it does not operate as expected for either test 1 or 2 as detailed above.

### Single-Terminal Switch



1. Connect continuity tester across blade terminal and metal case of switch. With 0 psi pressure applied to switch, tester should indicate continuity (switch closed).
2. Gradually increase pressure to switch. As pressure increases through range of 2-5 psi tester should indicate a change to no continuity (switch open). Switch should remain open as pressure is increased to 90 psi maximum.
3. Gradually decrease pressure through range of 2-5 psi. Tester should indicate a change to continuity (switch closed) down to 0 psi.
4. Replace switch if it does not operate as specified.

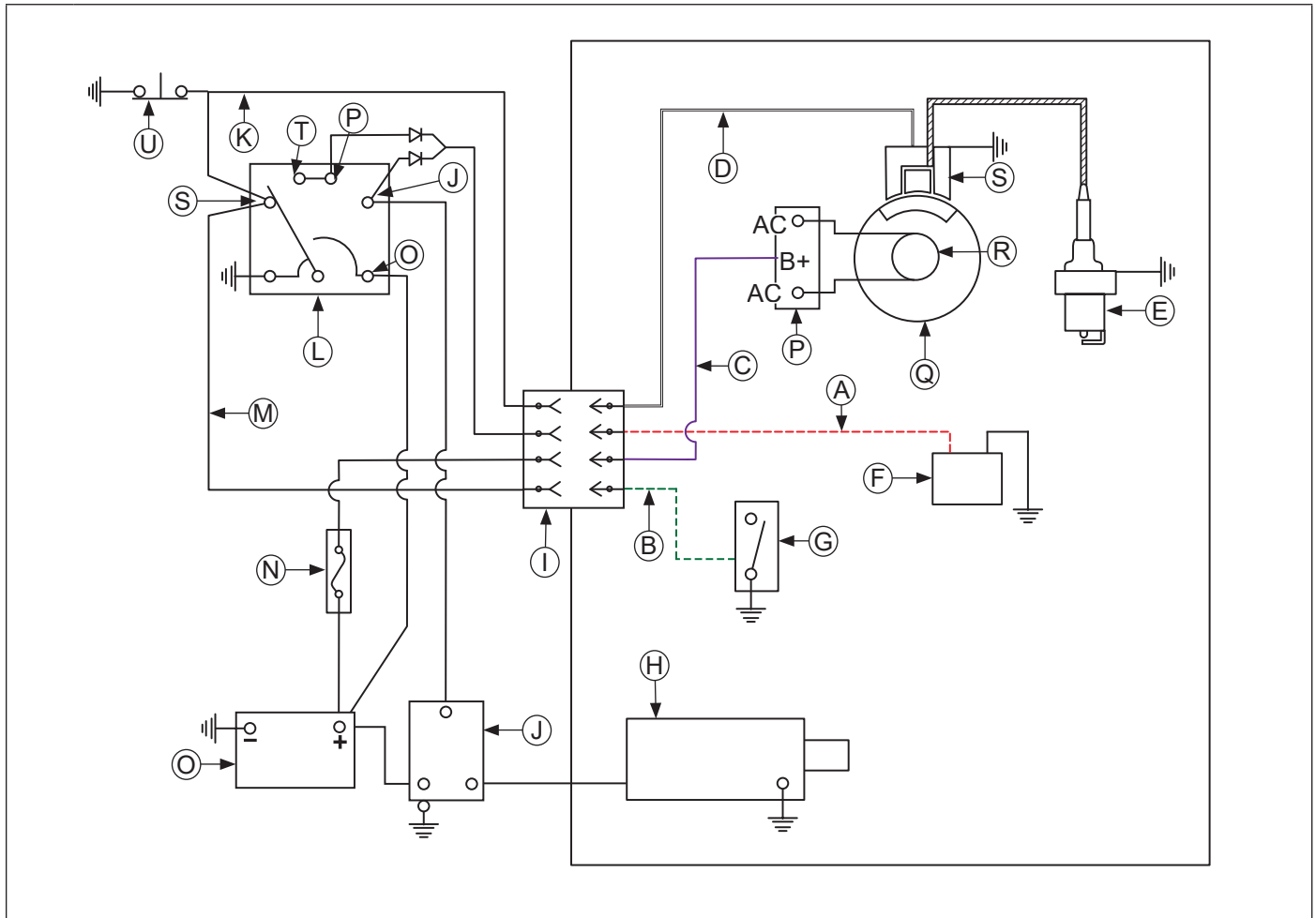
## OIL PRESSURE

### Testing

Engine oil pressure can be tested using an oil pressure tester. Follow instructions included with tester. Pressure can be tested by removing oil filter and installing tester adapter on mounting pad, or by removing Oil Sentry™ pressure switch (or pipe plug) and threading tester hose directly into mounting hole.



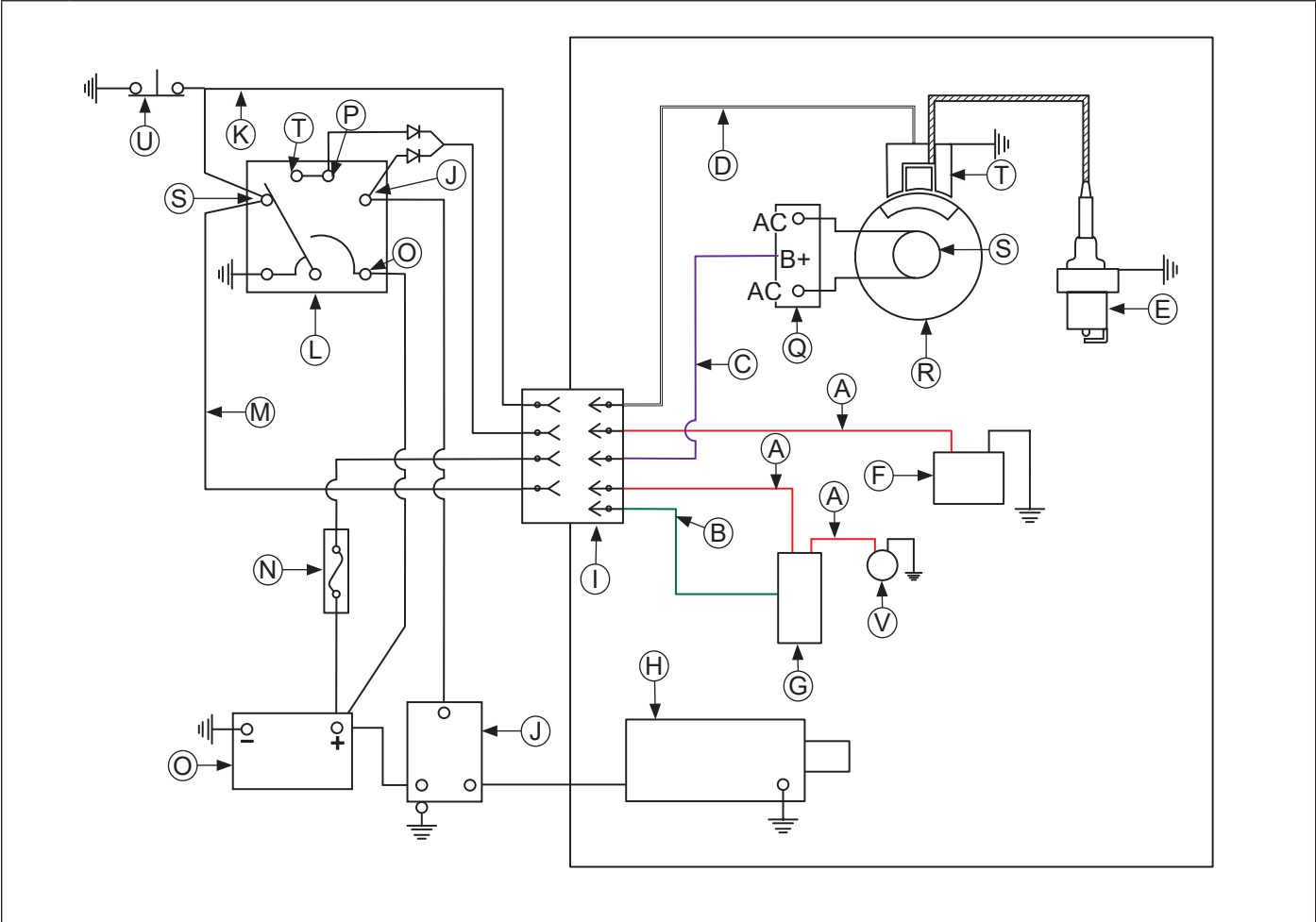
**Wiring Diagram-12/15 Amp Regulated Battery Charging System**



<b>A</b>	Red	<b>B</b>	Green	<b>C</b>	Violet	<b>D</b>	White
<b>E</b>	Spark Plug	<b>F</b>	Optional Fuel Shut-off Solenoid	<b>G</b>	Optional Oil Sentry™ Switch (Indicator)	<b>H</b>	Bendix Starter
<b>I</b>	Engine Connector	<b>J</b>	Starter Solenoid	<b>K</b>	Ground-To-Kill Lead	<b>L</b>	Key Switch
<b>M</b>	Optional Oil Sentry™	<b>N</b>	Optional Fuse	<b>O</b>	Battery	<b>P</b>	Rectifier-Regulator
<b>Q</b>	Flywheel	<b>R</b>	Stator	<b>S</b>	Ignition Module	<b>T</b>	Accessory
<b>U</b>	Equipment Safety Circuit						

Electrical System

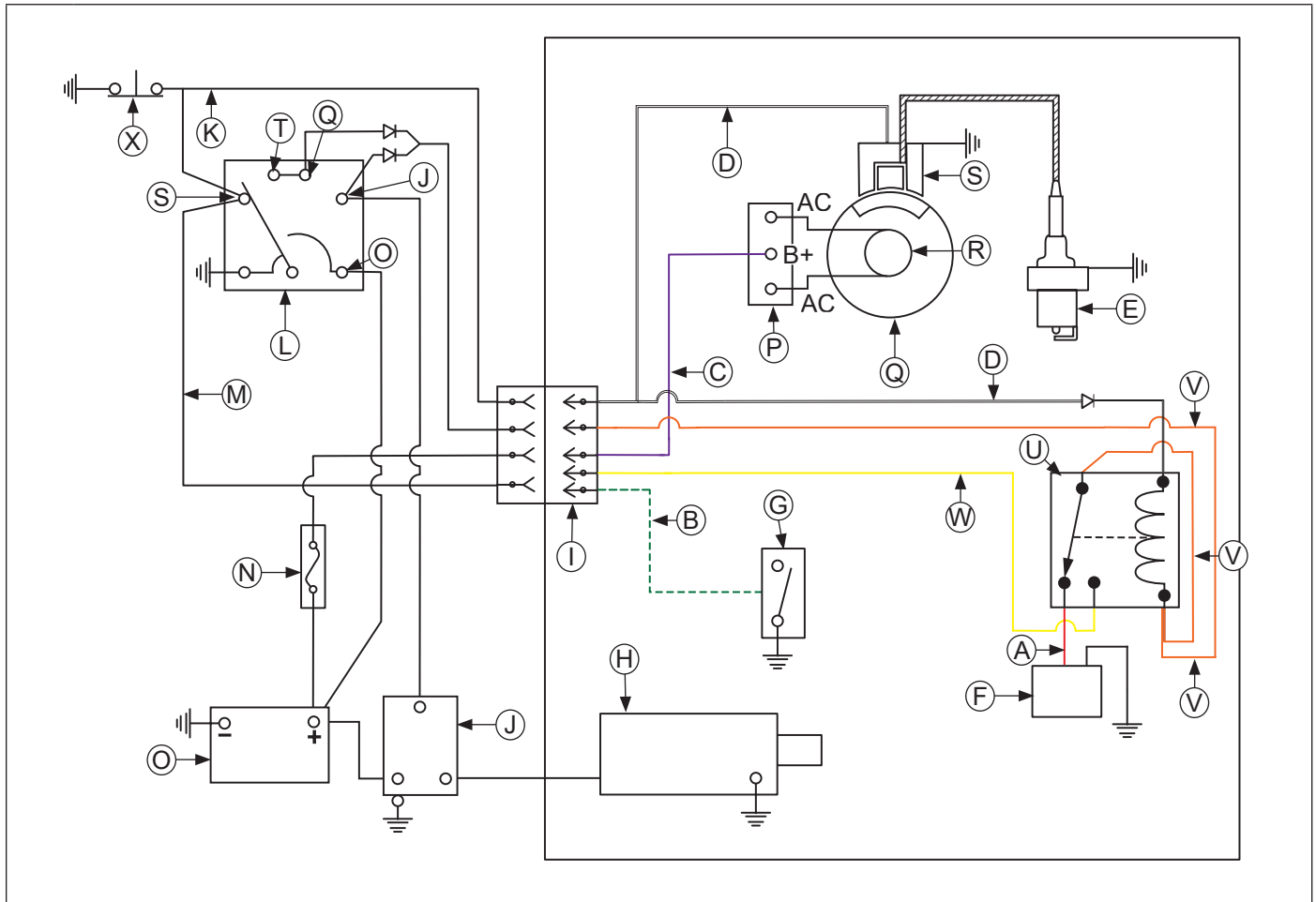
Wiring Diagram-12/15 Amp Regulated Battery Charging System with Smart-Choke™



<b>A</b>	Red	<b>B</b>	Green	<b>C</b>	Violet	<b>D</b>	White
<b>E</b>	Spark Plug	<b>F</b>	Fuel Shut-off Solenoid	<b>G</b>	3-Terminal Oil Sentry™ Switch (Indicator)	<b>H</b>	Bendix Starter
<b>I</b>	Engine Connector	<b>J</b>	Starter Solenoid	<b>K</b>	Ground-To-Kill Lead	<b>L</b>	Key Switch
<b>M</b>	Optional Oil Sentry™	<b>N</b>	Optional Fuse	<b>O</b>	Battery	<b>P</b>	Rectifier-Regulator
<b>Q</b>	Flywheel	<b>R</b>	Stator	<b>S</b>	Ignition Module	<b>T</b>	Accessory
<b>U</b>	Equipment Safety Circuit	<b>V</b>	Smart-Choke™ Diaphragm Assembly				

NOTE: Refer to Smart-Choke™ in Fuel System section for troubleshooting.

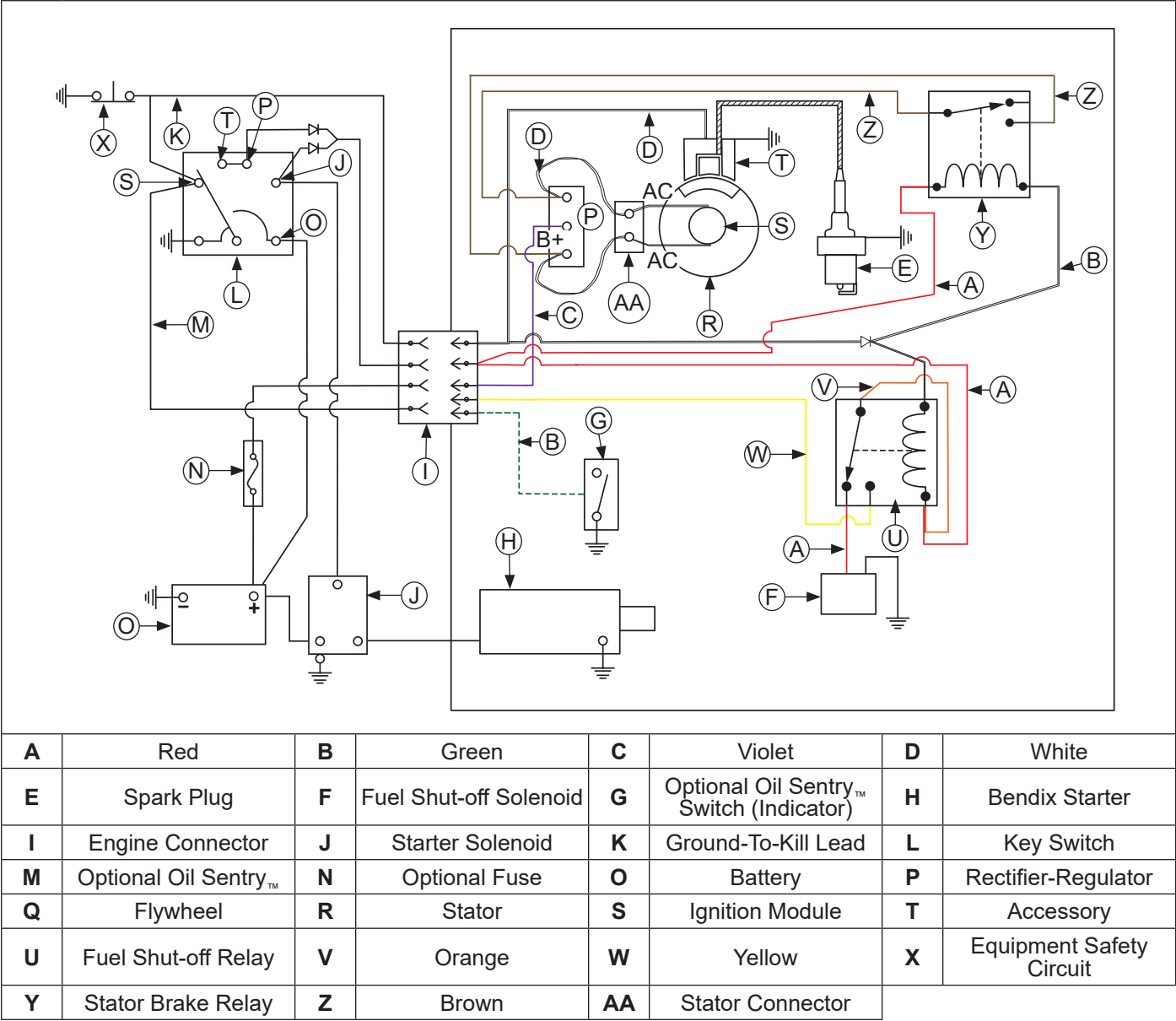
### Wiring Diagram-12/15 Amp Regulated Battery Charging System with Fuel Relay



<b>A</b>	Red	<b>B</b>	Green	<b>C</b>	Violet	<b>D</b>	White
<b>E</b>	Spark Plug	<b>F</b>	Fuel Shut-off Solenoid	<b>G</b>	Optional Oil Sentry™ Switch (Indicator)	<b>H</b>	Bendix Starter
<b>I</b>	Engine Connector	<b>J</b>	Starter Solenoid	<b>K</b>	Ground-To-Kill Lead	<b>L</b>	Key Switch
<b>M</b>	Optional Oil Sentry™	<b>N</b>	Optional Fuse	<b>O</b>	Battery	<b>P</b>	Rectifier-Regulator
<b>Q</b>	Flywheel	<b>R</b>	Stator	<b>S</b>	Ignition Module	<b>T</b>	Accessory
<b>U</b>	Fuel Shut-off Relay	<b>V</b>	Orange	<b>W</b>	Yellow	<b>X</b>	Equipment Safety Circuit

Electrical System

Wiring Diagram-12/15 Amp Regulated Battery Charging System with Fuel Relay and Stator Brake Relay



## 12/15 Amp Battery Charging Systems

**NOTE:** Always zero digital volt-ohm meter (DVOM) on each scale before testing to ensure accurate readings. Voltage test should be made with engine running at specific test condition noted. Battery should be checked for state of charge (non-operating voltage 12.5 VDC or lower, battery should be charged or replaced).

When problems occur in keeping a battery fully charged or a battery charges at a high rate, battery or charging system may be cause of fault. Before performing any testing, battery must be fully charged.

To test charging system:

1. Visually inspect system components and wiring. Look for damaged or loose wire connections, including battery cables.
2. Set DVOM to DC volts, place one lead of tester on rectifier-regulator body and other lead to battery negative (-) terminal. Run engine and observe volt reading on meter. If voltage is 0.5 VDC or less continue with testing. If voltage is higher than 0.5 VDC, inspect and repair wiring/connections as needed (insufficient ground).
3. Perform these output tests for charging system using DVOM set to DC volts.
  - a. With engine off and key switch in OFF position, measure voltage at battery. If less than 12.4 VDC, recharge battery and retest. If 12.5 VDC continue with tests.
  - b. Run engine at high speed no load (greater than 3000 RPM). After running 1 minute, measure voltage at battery.
    - i. If voltage increases to between 13-15 VDC, system is working correctly.
    - ii. If voltage increases to 15.5 VDC or higher, system is overcharging. Replace rectifier-regulator.
    - iii. If voltage stays at 12.5 VDC or decreases, charging system is NOT operating, proceed to step 4.
4. With engine off, unplug rectifier-regulator connector and inspect connector terminals within connector body and rectifier-regulator terminals for corrosion/ arcing/damage. Repair/replace as needed. If OK, proceed to next test.

**NOTE:** If engine is equipped with stator brake, inspect white 2 wire stator connector in addition to 3 terminal rectifier-regulator connector.

5. Set DVOM to AC volts, place test leads to each white stator wire. Run engine at 1200 RPM or greater and monitor voltage.

Condition	Conclusion
Voltage is 13 volts AC or more.	Stator is OK.
Voltage is less than 13 volts AC.	Stator is faulty. Continue with steps 6 and 7).

6. With engine off and stator unplugged from rectifier-regulator, check for resistance/continuity between across stator leads (white wires).

Condition	Conclusion
Resistance is 0.1/0.2 ohms.	Stator coil is OK.
Resistance is 0 ohms.	Stator is shorted; replace.
Resistance is infinity ohms/no continuity.	Stator is open; replace.

**NOTE:** If engine is equipped with stator brake, retest at white 2 wire stator connector if results are found to be unacceptable for confirmation.

7. With engine off and stator unplugged from rectifier-regulator, check for resistance/continuity from stator leads (white wires) to ground.

Condition	Conclusion
Resistance is infinity ohms (no continuity).	Stator is OK (not shorted to ground).
Resistance (or continuity) measured.	Stator leads are shorted to ground; replace.

8. If stator tests good (steps 4-7), but system was identified in step 3 as not working, failure is likely with rectifier-regulator. Replace rectifier-regulator, retest system to confirm repairs (step 3).

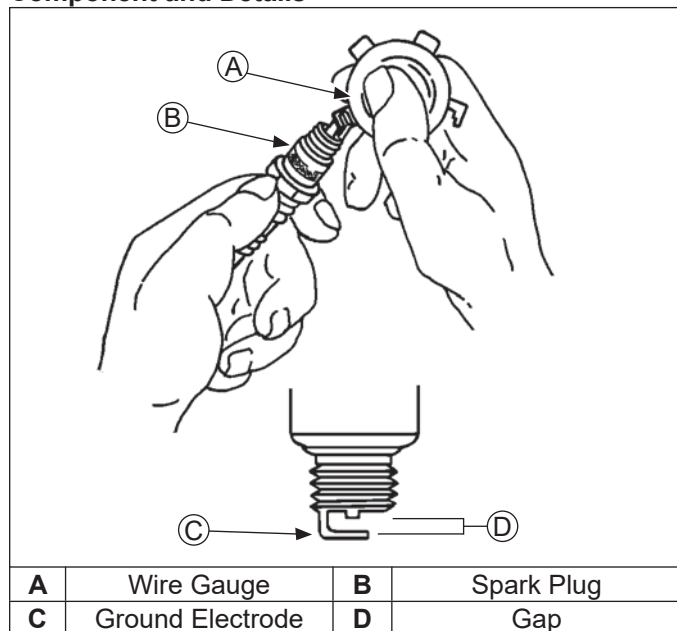


# Electrical System

## IGNITION SYSTEM

### Spark Plug

#### Component and Details



**NOTE:** Do not clean spark plug in a machine using abrasive grit. Some grit could remain in spark plug and enter engine causing extensive wear and damage.

Engine misfire or starting problems are often caused by a spark plug that has improper gap or is in poor condition.

Engine is equipped with following spark plugs:

	Standard Plug	RFI Plug
Gap	0.76 mm (0.030 in.)	0.76 mm (0.030 in.)
Thread Size	12 mm	12 mm
Reach	19.1 mm (3/4 in.)	19.1 mm (3/4 in.)
Hex Size	15.9 mm (5/8 in.)	17.5 mm (11/16 in.)

Refer to Maintenance for Repairs/Service Parts.

#### Service

Clean out spark plug recess. Remove plug and replace.

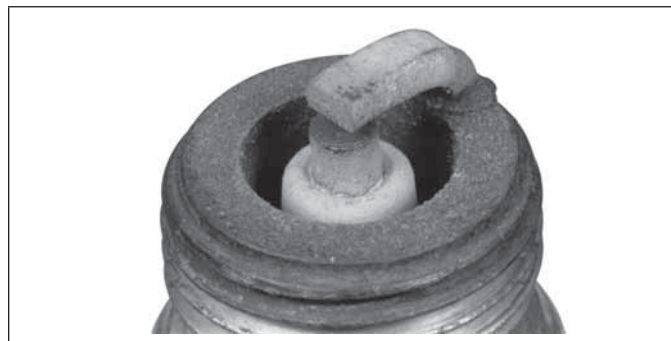
1. Check gap using wire feeler gauge. Adjust gap to 0.76 mm (0.030 in.).
2. Install plug into cylinder head.
3. Torque plug to 27 N·m (20 ft. lb.).

#### Inspection

Inspect each spark plug as it is removed from cylinder head. Deposits on tip are an indication of general condition of piston rings, valves, and carburetor.

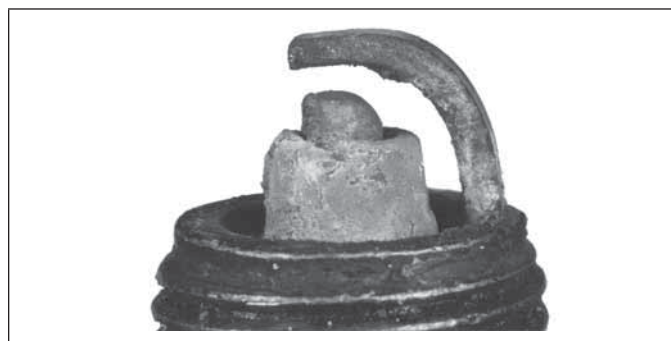
Normal and fouled plugs are shown in following photos:

#### Normal



Plug taken from an engine operating under normal conditions will have light tan or gray colored deposits. If center electrode is not worn, plug can be set to proper gap and reused.

#### Worn



On a worn plug, center electrode will be rounded and gap will be greater than specified gap. Replace a worn spark plug immediately.

#### Wet Fouled



A wet plug is caused by excess fuel or oil in combustion chamber. Excess fuel could be caused by a restricted air cleaner, a carburetor problem, or operating engine with too much choke. Oil in combustion chamber is usually caused by a restricted air cleaner, a breather problem, worn piston rings, or valve guides.



## Carbon Fouled



Soft, sooty, black deposits indicate incomplete combustion caused by a restricted air cleaner, over rich carburetion, weak ignition, or poor compression.

## Overheated



Chalky, white deposits indicate very high combustion temperatures. This condition is usually accompanied by excessive gap erosion. Lean carburetor settings, an intake air leak, or incorrect spark timing are normal causes for high combustion temperatures.

## Electronic Ignition System Tests

**NOTE:** Ignition tester must be used to test ignition on these engines. Use of any other tester can result in inaccurate findings. Battery on unit must be fully charged and properly connected before performing tests (a battery that is hooked up or charged backward will crank engine but it won't have spark). Be certain drive is in neutral and all external loads are disconnected.

### Test Ignition Systems

**NOTE:** If engine starts or runs during testing, you may need to ground kill lead to shut it down. Because you have interrupted kill circuit, it may not stop using switch.

Isolate and verify trouble is within engine.

1. Locate connectors where wiring harnesses from engine and equipment are joined. Separate connectors and remove white kill lead from engine connector. Rejoin connectors and position or insulate kill lead terminal so it cannot touch ground. Try to start engine to verify whether reported problem is still present.

Condition	Possible Cause	Conclusion
Problem goes away.	Electrical System	Check key switch, wires, connections, safety interlocks, etc.
Problem persists.	Ignition or Electrical System	Leave kill lead isolated until all testing is completed.

# Electrical System

## Test for Spark

NOTE: To maintain engine speeds normally obtained during cranking, do not remove engine spark plug.

1. Make sure spark plug lead is connected to spark plug.
2. Check condition of spark plug. Make sure gap is set to 0.76 mm (0.030 in.). If plug is in good condition, check/adjust gap and reinstall.
3. a. Test for spark with ignition tester. Disconnect spark plug lead and connect it to post terminal of tester. Connect clip to a good ground, not spark plug.  
b. Make sure engine ignition switch, kill switch, or key switch is in RUN position.
4. Crank engine (minimum speed 500 RPM), and observe tester. Visible and audible sparks should be produced.

Condition	Possible Cause	Conclusion
Audible and visible sparks are produced.	Ignition Module	Ignition module is OK.
Audible and visible sparks are not produced.	Ignition Module or Electrical System	Make sure engine ignition switch, kill switch, or key switch is in RUN position. Check wires and terminals of ignition module and other components for accidental grounding and damaged insulation. If wires and terminals are OK, ignition module is probably faulty and should be replaced. Test module further using an ohmmeter.

## Test Ignition Module with Ohmmeter

NOTE: This test cannot be performed unless module has been fired at least once.

Measure resistance of module secondary using an ohmmeter.

1. Zero ohmmeter.
2. Connect one ohmmeter lead to laminations. Connect other lead to spark plug terminal of high-tension lead.
3. With ohmmeter leads connected in this manner, resistance of secondary should be 8,200 to 23,000 ohms. Refer to Disassembly and Reassembly for complete ignition module removal and installation procedures.

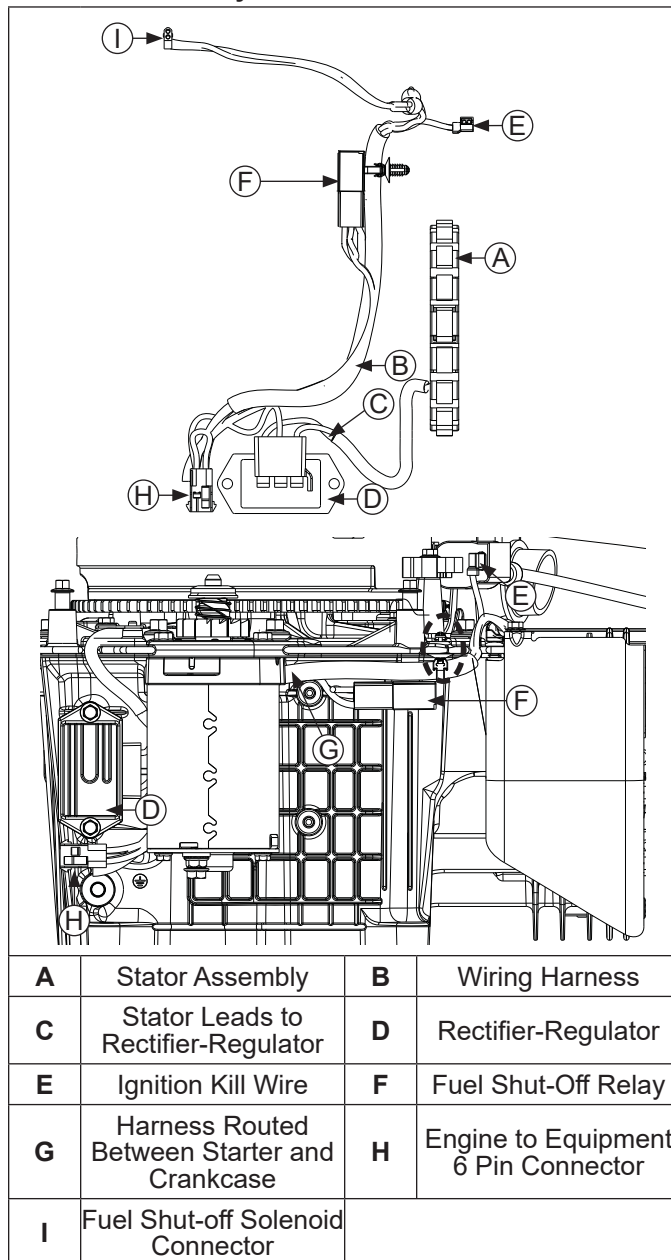
Condition	Possible Cause	Conclusion
Resistance is within specified range.	Module Secondary	Module secondary is OK.
Resistance is low or 0 ohms.		Module secondary is shorted. Replace module.
Resistance is high or infinity ohms.		Module secondary is open. Replace module.

## FUEL SHUT-OFF RELAY CIRCUIT

Some engines are equipped with a fuel shut-off relay. This relay is part of wiring harness and is activated with voltage supplied by equipment. Power is supplied to fuel shut-off solenoid through a relay. By design, power to solenoid can be interrupted by application safety interlock circuit (seat switch/brake switch/operator present).

If relay needs replacement, wiring harness must be replaced.

### Fuel Shut-off Relay Harness Connections



## Troubleshooting-Fuel Shut-Off Relay System

**NOTE:** Refer to Fuel Shut-Off Solenoid in Fuel System section for individual testing of solenoid valve. Review Fuel System section for more information.

If engine cranks but does not start, restricted fuel delivery could be a possible cause. Confirm fuel delivery to carburetor.

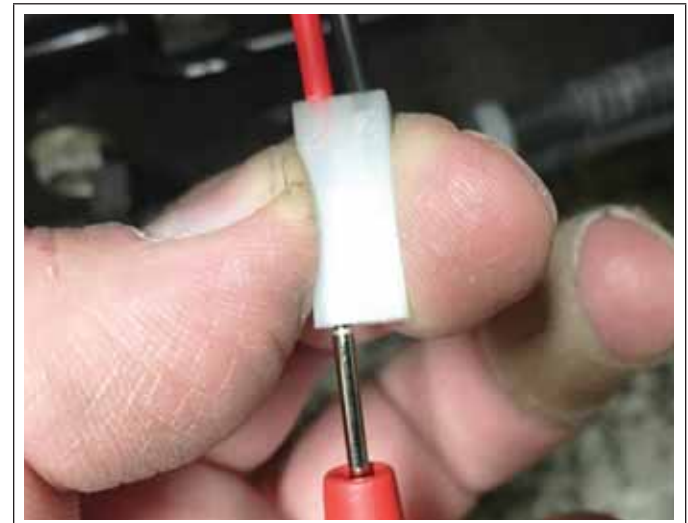
To test fuel shut-off circuit/relay, confirm all equipment safety switches are in starting mode (refer to equipment manual for detailed safety operation procedures).

1. Locate engine to equipment 6 pin connector. With equipment switch in ON/RUN position, use appropriate size meter probe and measure voltage at yellow wire of 6 pin connector using a volt/ohm meter.



Zero (0) voltage should be seen at yellow wire.

2. Remove 2 pin connector from fuel shut-off solenoid and probe red wire terminal. Battery voltage should be present.



If voltage is present at yellow wire of 6 pin connector, this is an indication that engine kill wire is grounded/ equipment safety circuit has been activated through a seat switch/PTO switch/operator present switch (if equipped). Refer to equipment manual to identify and determine fault. If relay of circuit is found to be at fault, replace wiring harness (relay is not serviced separately).

## Electrical System

<b>Condition</b>	Engine operates as designed.			
	Key Switch	Safety Circuit	Yellow Wire (Volts)	Solenoid (Volts)
	OFF	Operate	0	0
	ON	Operate	0	12
	START	Operate	0	12
<b>Possible Cause</b>	None, system OK.			
<b>Conclusion</b>	None, system OK.			

<b>Condition</b>	Engine cranks but will not start (voltage at yellow wire).			
	Key Switch	Safety Circuit	Yellow Wire (Volts)	Solenoid (Volts)
	OFF	Activated	0	0
	ON	Activated	12	0
	START	Activated	12	0
<b>Possible Cause</b>	Equipment safety system activated or white kill wire shorted to ground.			
<b>Conclusion</b>	Refer to equipment manual for inspection/repair procedures or repair white kill wire short.			

<b>Condition</b>	Engine cranks but will not start.			
	Key Switch	Safety Circuit	Yellow Wire (Volts)	Solenoid (Volts)
	OFF	Operate	0	0
	ON	Operate	0	0
	START	Operate	0	0
<b>Possible Cause</b>	No voltage at yellow wire, no voltage at fuel shut-off solenoid.			
<b>Conclusion</b>	Bad connection, broken wire, bad fuel shut-off relay.			

<b>Condition</b>	Engine cranks but will not start.			
	Key Switch	Safety Circuit	Yellow Wire (Volts)	Solenoid (Volts)
	OFF	Operate	0	0
	ON	Operate	0	12
	START	Operate	0	12
<b>Possible Cause</b>	Defective fuel shut-off solenoid or bad/open ground wire at solenoid connector.			
<b>Conclusion</b>	Replace fuel shut-off solenoid or repair/replace wiring harness.			

## BLADE STOP STATOR BRAKE AND FUEL SHUT-OFF CIRCUIT

Some engines are equipped with a fuel shut-off relay and a stator brake relay. These relays are part of wiring harness. Refer to FUEL SHUT-OFF RELAY CIRCUIT (on previous pages) for troubleshooting fuel relay part of circuit.

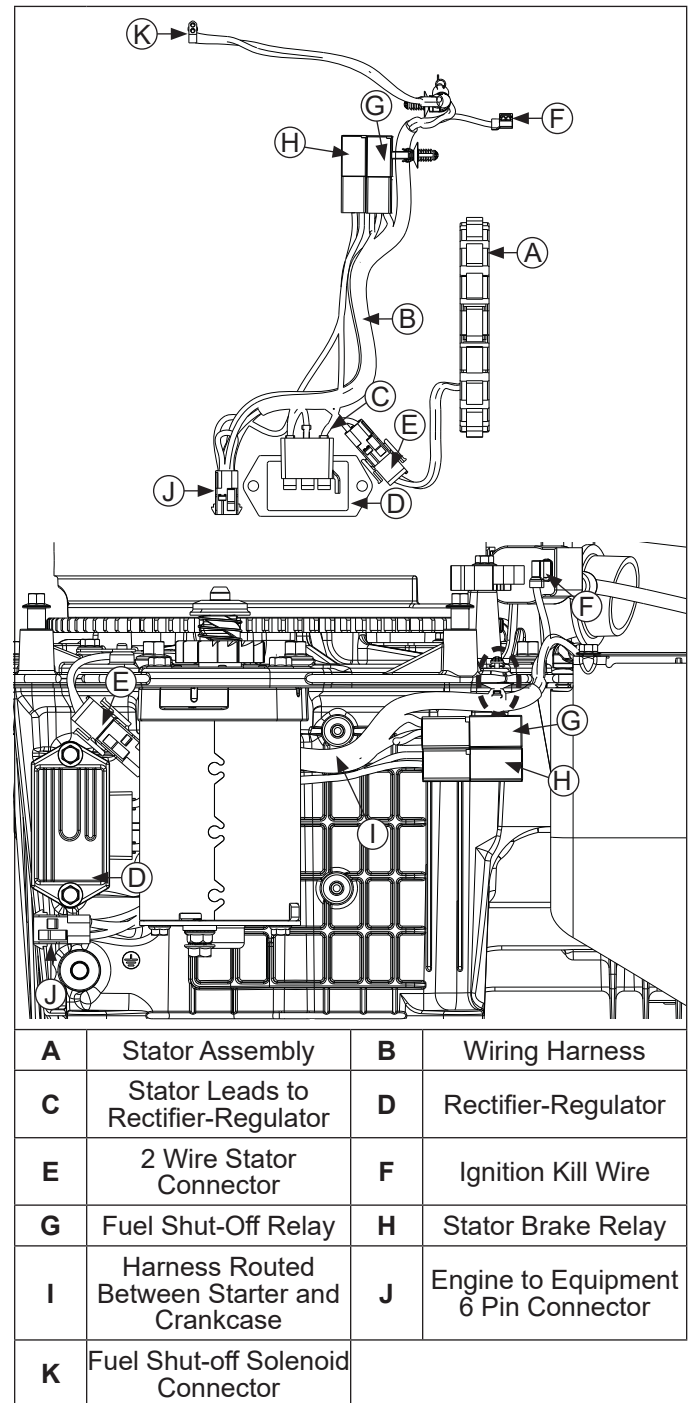
Blade stop stator brake circuit is provided as a safety feature to ensure application can meet ANSI (American National Standards Institute) application blade stop requirements.

Circuit is activated if operator gets off of seat of application while mower blade system is activated or in certain reverse mow conditions.

Circuit is activated by taking ignition shutdown (kill) lead to ground. This action turns on stator-brake relay which shorts charging AC stator leads to produce a magnetic field that will counter or resist rotation of flywheel, along with removing power from fuel solenoid. This added resistance to rotation decreases amount of time it takes for application deck blades to come to a full stop.

If relay needs replacement, wiring harness must be replaced.

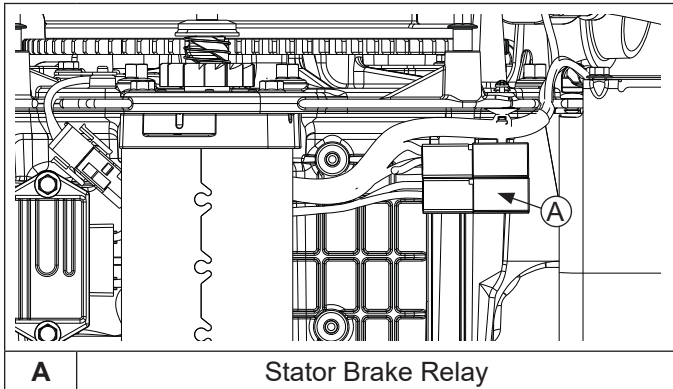
## Stator Brake and Fuel Shut-off Relay Harness Connections



# Electrical System

## Troubleshooting-Stator Brake System

**NOTE:** If removing stator brake relay for testing, carefully remove sealing tape from around that relay only. Ensure this area is then resealed with electrical tape if relay is reinstalled after testing, to protect relay from debris, etc.



Problems that could occur with Kohler portion of circuit generally could be caused by component failures, which will create following conditions.

1. Dead battery
2. Engine cranks but will not start

### To test for dead battery:

Stator brake relay may have failed and is keeping stator shorted, so no charge current can be passed from rectifier-regulator to battery, eventually allowing battery to discharge.

1. Check battery voltage using a test meter with application off.
2. Check battery voltage using a test meter with application operating at maximum speed.

Battery voltage should increase from engine off condition to engine full speed condition.

Condition	Conclusion
Voltage does not increase.	Shut down engine, remove stator brake relay from its socket and retest at full engine speed.  If battery voltage does not increase with engine operating, problem is likely not with stator brake relay. Continue testing stator and rectifier-regulator. Refer to page Battery Charging System earlier in this section.

### To test engine that will crank but will not start:

Stator brake relay is interacting with application safeties or reverse mow electronics, preventing normal engine start up.

1. Remove brake relay from its socket and attempt to restart engine.

Condition	Conclusion
Engine starts.	Relay has failed. Replace wiring harness.
Engine does not start.	Problem may exist with application reverse mow circuit, application safeties, or with key switch keeping ignition shutdown line tied to engine ground. Refer to equipment manual.

2. Remove engine shutdown (kill) white lead from application wire harness and attempt to start engine again.

Condition	Conclusion
Engine does not start.	Fuel or ignition problem.
Engine starts.	White kill wire circuit/application safety circuit issue. Refer to equipment manual.



NOTE: Do not crank engine continuously for more than 10 seconds. Allow a 60 second cool-down period between starting attempts. Failure to follow these guidelines can burn out starter motor.

NOTE: If engine develops sufficient speed to disengage starter but does not keep running (a false start), engine rotation must be allowed to come to a complete stop before attempting to restart engine. If starter is engaged while flywheel is rotating, starter pinion and flywheel ring gear may clash and damage starter.

NOTE: If starter does not crank engine, shut off starter immediately. Do not make further attempts to start engine until condition is corrected.

NOTE: Do not drop starter or strike starter frame. Doing so can damage starter.

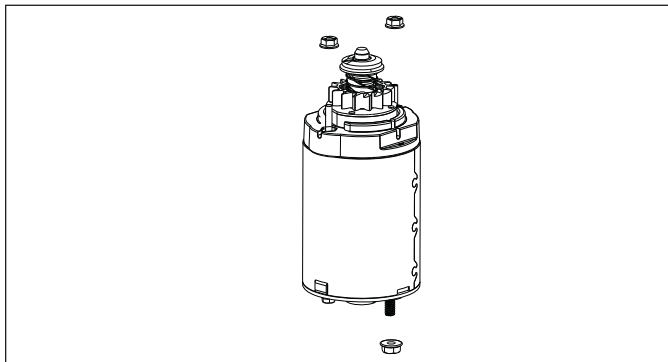
NOTE: Battery must be tested and confirmed acceptable prior to troubleshooting starter system. Follow battery or OEM battery testing procedures.

Engines in this series use inertia drive starters. Inertia drive starters are not serviceable.

## Troubleshooting-Starting Difficulties

Condition	Possible Cause	Conclusion
Starter does not energize.	Battery	Check specific gravity of battery and battery state of charge. If low, recharge or replace battery as necessary.
	Wiring	Clean corroded connections and tighten loose connections. Replace wires in poor condition and with frayed or broken insulation.
	Starter Switch or Solenoid	By-pass switch or solenoid with a jumper wire. If starter cranks normally, replace faulty components. Consult with OEM electrical system service procedures for OEM related component diagnostics. Perform solenoid test procedure.
Starter energizes but turns slowly.	Battery	Check specific gravity of battery and battery state of charge. If low, recharge or replace battery as necessary.
	Transmission or Engine	Make sure clutch or transmission is disengaged or placed in neutral. This is especially important on equipment with hydrostatic drive. Transmission must be exactly in neutral to prevent resistance which could keep engine from starting. Check for seized engine components such as bearings, connecting rod, and piston.

## INERTIA DRIVE ELECTRIC STARTERS



When power is applied to starter, armature rotates. As armature rotates, drive pinion moves out on drive shaft splines and into mesh with flywheel ring gear. When pinion reaches end of drive shaft, it rotates flywheel and cranks engine.

When engine starts, flywheel rotates faster than starter armature and drive pinion. This moves drive pinion out of mesh with ring gear and into retracted position. When power is removed from starter, armature stops rotating and drive pinion is held in retracted position by anti-drift spring.



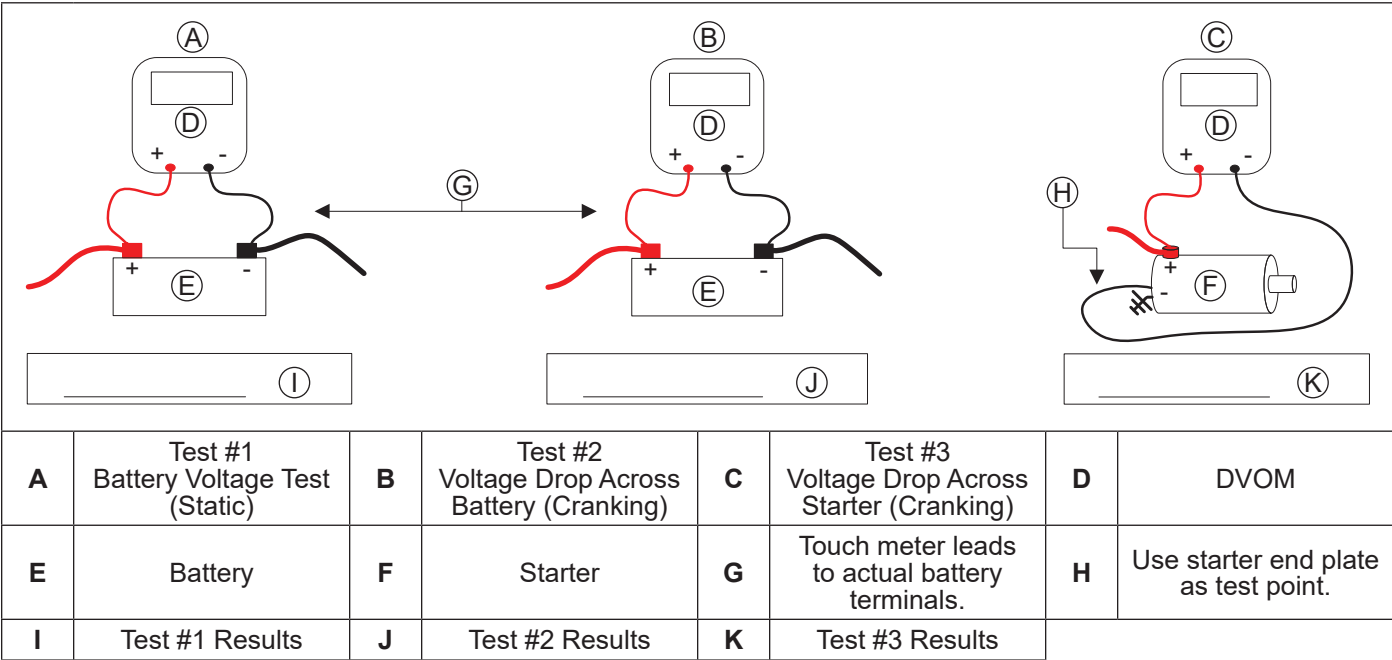
Starter System

Inertia Drive Starter Tests

NOTE: Please perform following testing as near to conditions during failure.

Before Starting

- Disable ignition system: disconnect spark plug lead from spark plug, then ground spark plug lead to engine block using mechanical means.
- Battery voltage should be tested and must be at 12.4 VDC or higher. Do not proceed if battery voltage is less than 12.4 VDC as battery should be charged.
- Test meter leads before use. (Set meter to Ohms and check for resistance reading of less than 0.5 Ohm.)
- If available, use clamping meter leads to assist with testing.
- Set meter to next highest voltage scale that includes 12 VDC.
- When taking readings, allow meter to stabilize before recording. Reading should stabilize after 3 to 5 seconds. If reading continues to drop while cranking, stop test and perform a battery load test.



Test 1 Conclusions

- If battery voltage is above 12.4 VDC continue to Test 2.
- If voltage is below 12.4 VDC, charge battery and retest.
- If battery will not hold a charge it should be replaced before continuing test or replacing starter.

Test 2 Conclusions

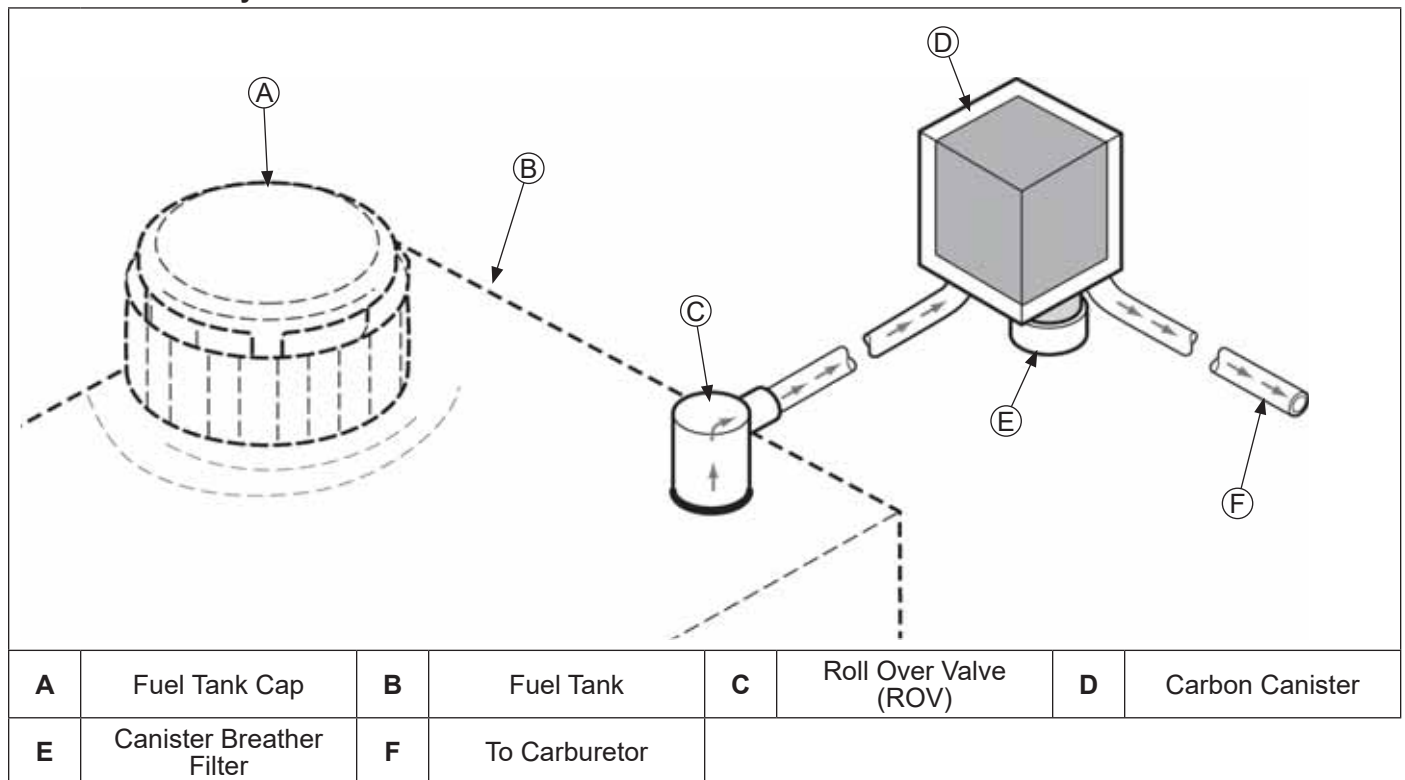
- If battery cranking voltage is above 9.0 VDC continue to Test 3.
- If battery cranking voltage is below 9.0 VDC you should check battery by using a load tester. Also check for external engine load.

Test 3 Conclusions

- If difference between test 2 and test 3 is greater than 1 VDC check all positive and negative electrical connections for corrosion and/or loose fasteners in starter circuit.

## EVAPORATIVE EMISSION COMPLIANT SYSTEM

### Carbon Canister System



For engine to be Tier III compliant, it may be fitted with a Kohler supplied canister vapor recovery system, or a system developed and installed by Original Equipment Manufacturer (OEM). Details on Kohler system are included below.

#### Operation

Fuel vapors travel from fuel tank through tubing to carbon canister. On intake stroke of engine fuel vapors are drawn in through a port in carburetor and burned with fuel charge.

#### Maintenance

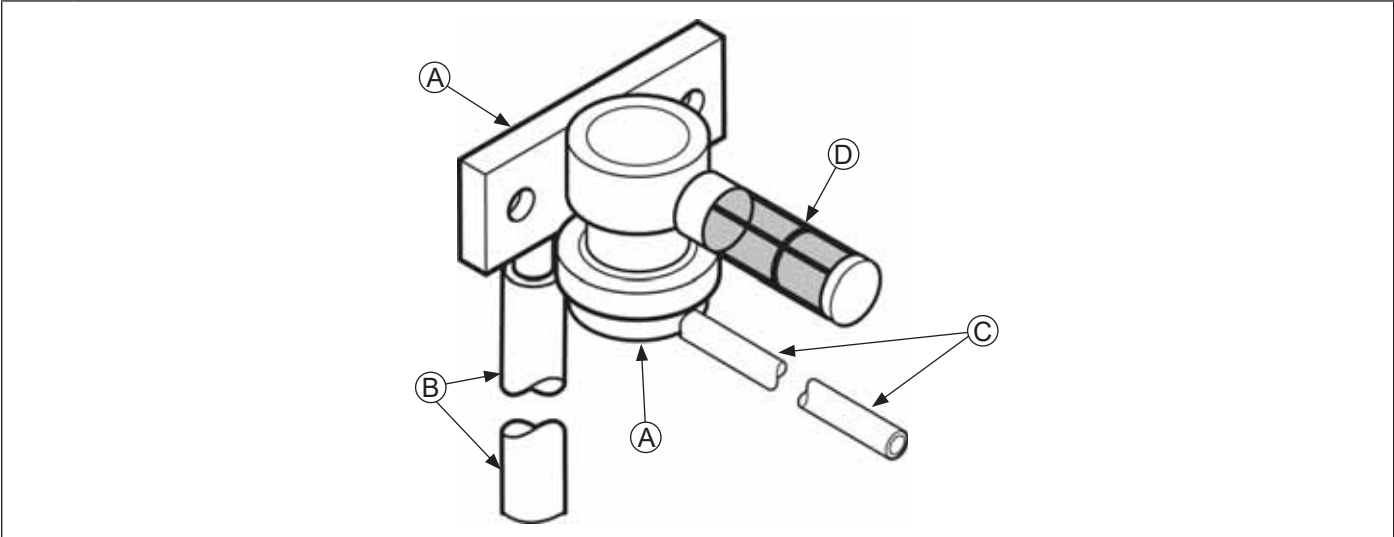
On Kohler-supplied canisters, breather filter can be removed and cleaned with hot soapy water, dried and reinstalled. Do not oil breather screen. This is done periodically or if system operation is suspect. Carbon canister is sealed and requires no maintenance.

In some applications or installations, OEM will have installed a different canister or fuel vapor recovery system. See OEM equipment documentation for service or maintenance information.

# Emission Compliant Systems

## SECONDARY EMISSION COMPLIANT SYSTEM

### Secondary Air Induction System



<b>A</b>	Secondary Air Valve Assembly	<b>B</b>	Hose To Exhaust Manifold	<b>C</b>	Hose To Carburetor	<b>D</b>	Inlet Screen
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For engine to be Tier III compliant, it may be fitted with a secondary air induction system (SAI).

#### Operation

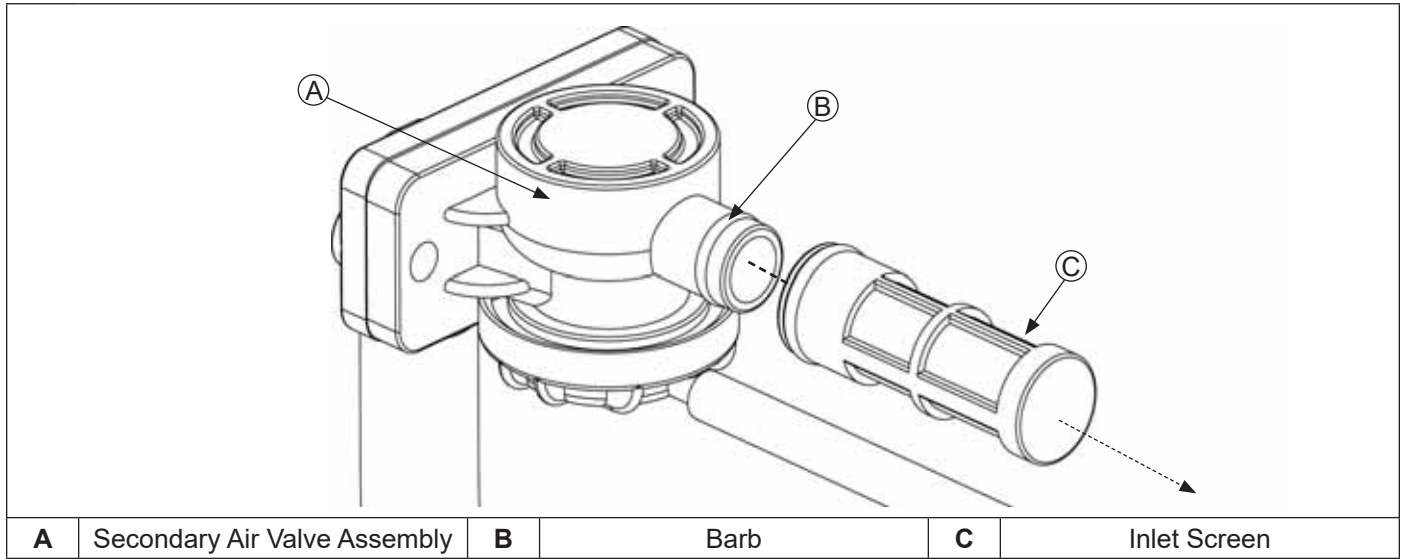
Intake pulse of engine activates secondary air valve. Air is drawn through an inlet screen of secondary air valve. Air is then drawn into exhaust manifold and muffler where it mixes with any unburned hydrocarbons, which then burn in heat of muffler. A hose is connected between a carburetor port and a diaphragm chamber in secondary air valve. Carburetor vacuum moves diaphragm to close valve when air induction is not required, primary idle.

#### Maintenance

Air inlet screen in secondary air valve can be removed, cleaned, and reinstalled. If inspection of system reveals any damage or decomposition of hoses, secondary air valve, or exhaust system, parts should be replaced.

## Remove Inlet Screen

### Inlet Components

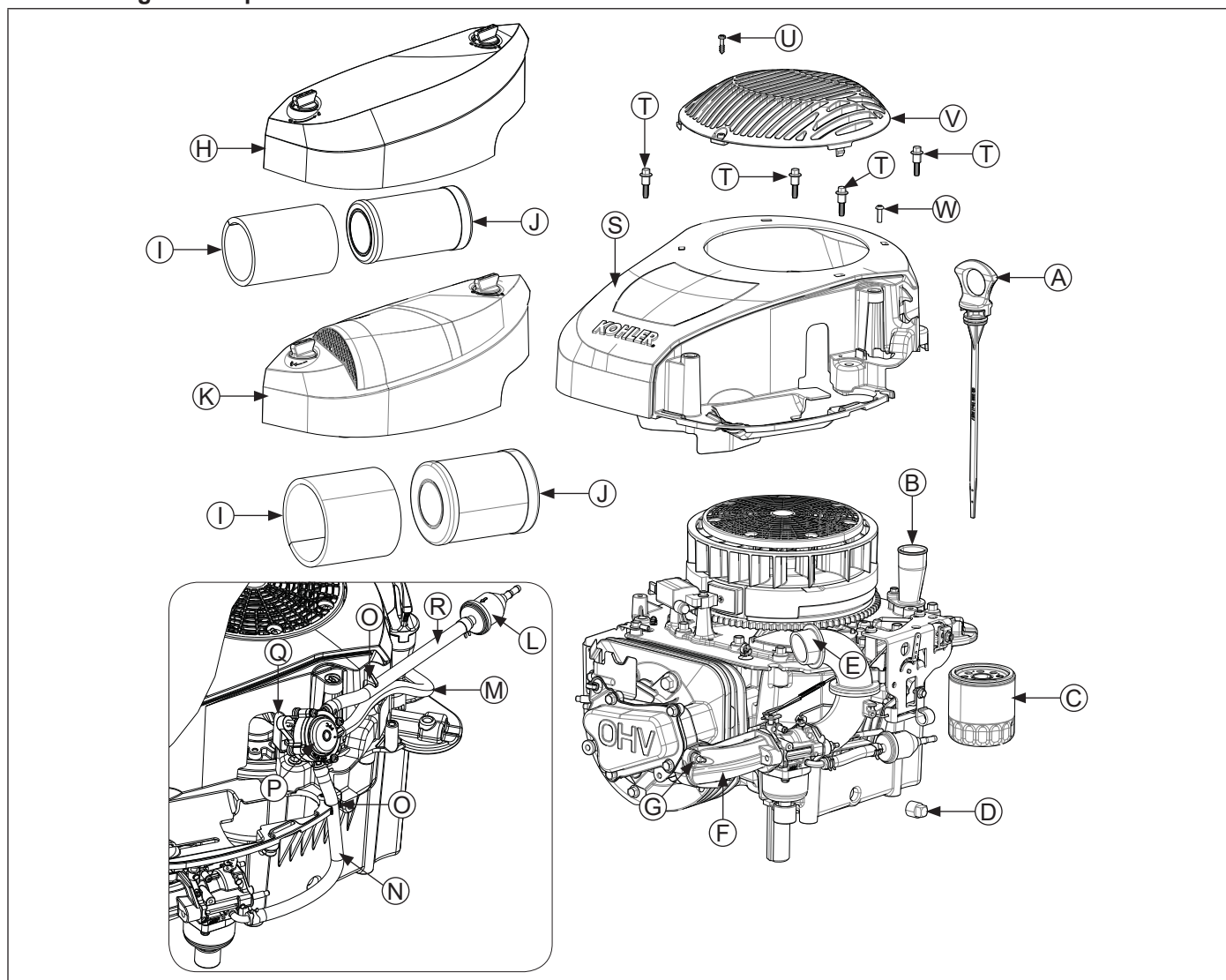


1. Remove inlet screen from secondary air valve assembly by grasping inlet screen at base and gently pulling away from valve assembly.
2. Use a soft brush to remove debris from screen.
3. Run water through inlet screen in reverse direction.
4. To reinstall, push inlet screen onto barb of secondary air valve assembly. An audible click will be heard when inlet screen is properly reinstalled.

# Disassembly/Inspection and Service

	<b>⚠ WARNING</b>	Before working on engine or equipment, disable engine as follows: 1) Disconnect spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.
	Accidental Starts can cause severe injury or death. Disconnect and ground spark plug lead(s) before servicing.	

## External Engine Components



<b>A</b>	Oil Fill/Dipstick	<b>B</b>	Oil Fill/Dipstick Tube	<b>C</b>	Oil Filter	<b>D</b>	Oil Drain Plug
<b>E</b>	Air Cleaner Adapter	<b>F</b>	Intake Manifold	<b>G</b>	Intake Manifold Nut	<b>H</b>	Standard Air Cleaner Cover
<b>I</b>	Precleaner	<b>J</b>	Paper Element	<b>K</b>	PRO Air Cleaner Cover	<b>L</b>	Fuel Filter
<b>M</b>	Pulse Line	<b>N</b>	Outlet Fuel Line	<b>O</b>	Line Retained in Housing	<b>P</b>	Fuel Pump
<b>Q</b>	Fuel Pump Bracket	<b>R</b>	Inlet Fuel Line	<b>S</b>	Blower Housing	<b>T</b>	Blower Housing to Closure Plate Screw
<b>U</b>	Fixed Guard Screw	<b>V</b>	Fixed Guard	<b>W</b>	Blower Housing to Adapter Screw		

Clean all parts thoroughly as engine is disassembled. Only clean parts can be accurately inspected and gauged for wear or damage. There are many commercially available cleaners that will quickly remove grease, oil, and grime from engine parts. When such a cleaner is used, follow manufacturer's instructions and safety precautions carefully.

Make sure all traces of cleaner are removed before engine is reassembled and placed into operation. Even small amounts of these cleaners can quickly break down lubricating properties of engine oil.

## Disconnect Spark Plug Lead

Carefully pull on boot section and disconnect spark plug lead. Carefully remove spark plug lead wire tie from valve cover.

## Turn Off Fuel Supply

Shut off fuel supply.

## Drain Oil from Crankcase and Remove Oil Filter

1. Remove oil drain plug and oil fill cap/dipstick.
2. Allow ample time for oil to drain from crankcase.
3. Remove and discard oil filter.

## Remove Air Cleaner

1. Turn knobs toward unlock symbol and remove air cleaner cover.
2. Lift and remove precleaner (if equipped) and air cleaner element from air cleaner adapter.

## Remove Fuel Pump (if equipped)

NOTE: Inlet, outlet, and pulse lines can remain on fuel pump unless replacement is required.

NOTE: Unless fuel pump is being replaced, disassembly from fuel pump bracket is unnecessary.

1. Disconnect fuel pump outlet line from carburetor inlet fitting. Line is retained in blower housing, pull to remove.
2. Using hose removal tool (see Tools and Aids), carefully remove pulse line from oil fill/dipstick tube.
3. Remove fuel pump from bracket.

## Remove Fixed Guard (if equipped)

NOTE: Unless fixed guard is damaged, disassembly from blower housing is unnecessary.

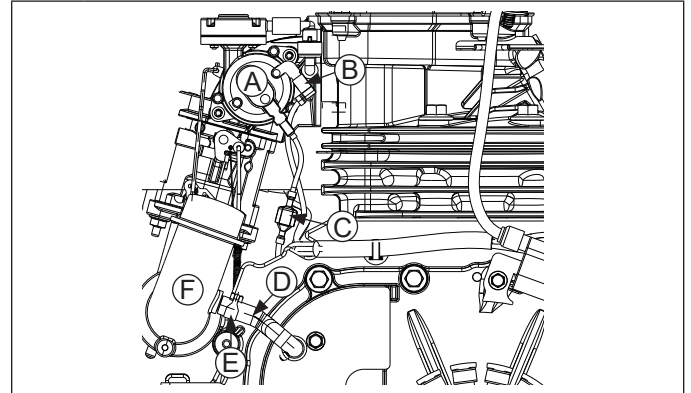
Remove screw securing fixed guard to blower housing. Unsnap guard from housing.

## Remove Blower Housing

NOTE: Unless fuel pump bracket is damaged disassembly from blower housing is unnecessary.

1. Remove screws securing blower housing to closure plate.
2. Remove screw securing blower housing to air cleaner adapter and lift off blower housing.

## Remove Intake Manifold, Carburetor, Air Cleaner Adapter

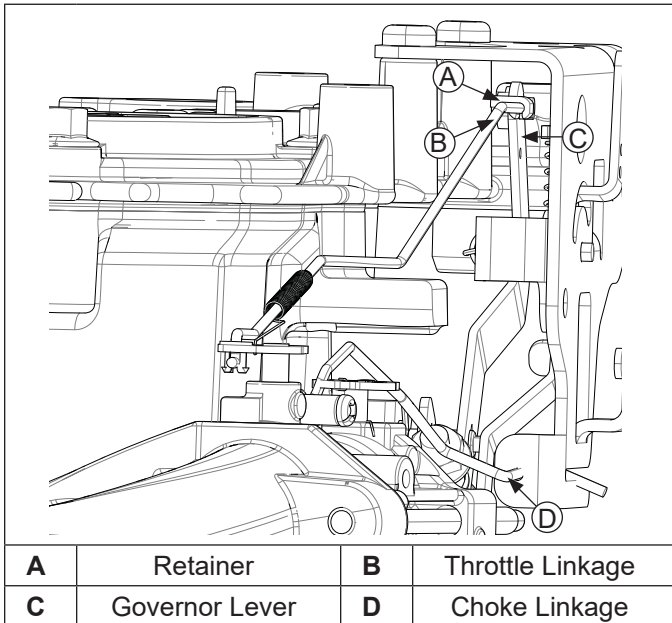


<b>A</b>	Diaphragm Assembly	<b>B</b>	Black Ground Wire
<b>C</b>	Red Wire	<b>D</b>	Breather Hose
<b>E</b>	Hose Clamp	<b>F</b>	Air Cleaner Adapter

1. If carburetor uses a fuel solenoid, disconnect fuel solenoid lead from carburetor solenoid.
2. If engine is equipped with Smart-Choke<sup>™</sup>, unplug diaphragm assembly red wire from wiring harness. Unplug black ground wire from Smart-Choke<sup>™</sup> diaphragm assembly.

## Disassembly/Inspection and Service

- Move hose clamp on breather hose away from air intake elbow. Using Hose Removal Tool (see Tools and Aids), carefully remove breather hose from air cleaner adapter.



- Unhook retainer from throttle linkage and remove linkage from governor lever. Snap retainer on end of linkage for reassembly.
- Remove nuts securing intake manifold to cylinder head.

### Standard Choke Single Wire Controls

Slide assembly forward and off intake studs. Turn assembly 90° to remove choke linkage from speed control bracket. Remove and discard intake manifold gasket.

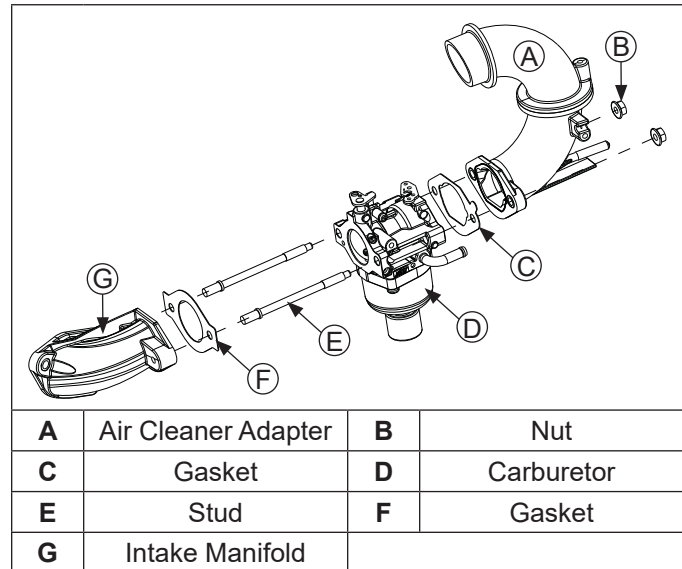
### Smart-Choke™

Slide assembly forward and off intake studs. Remove and discard intake manifold gasket.

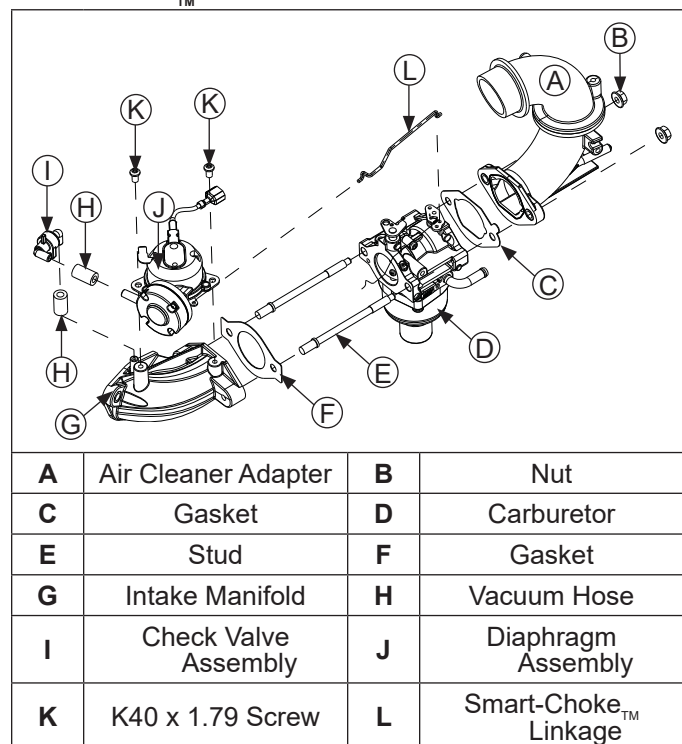
Assembly includes plastic intake manifold, carburetor with solenoid and linkage(s), air intake adapter, and if equipped Smart-Choke components.

Separate parts only if additional service is required.

### Standard Choke

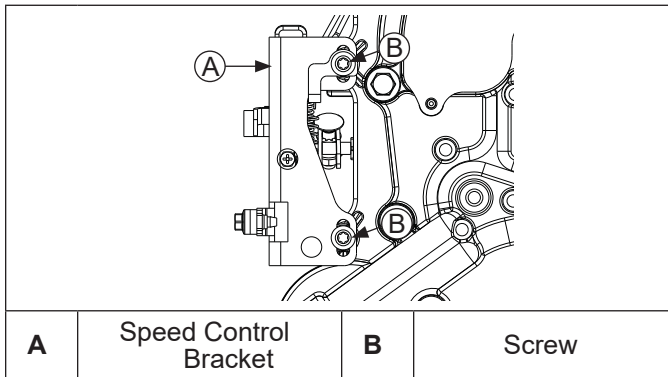


### Smart-Choke™





## Remove External Governor Components



1. Mark mounted position of speed control bracket in slotted holes and remove screws securing speed control bracket to closure plate. Note or mark governor spring hole for correct installation later and unhook governor spring. Remove screws securing speed control bracket to closure plate. Remove control bracket.
2. Loosen nut and remove governor lever, bolt, lock washer, and nut from governor cross shaft.

## Remove Oil Fill/Dipstick Tube

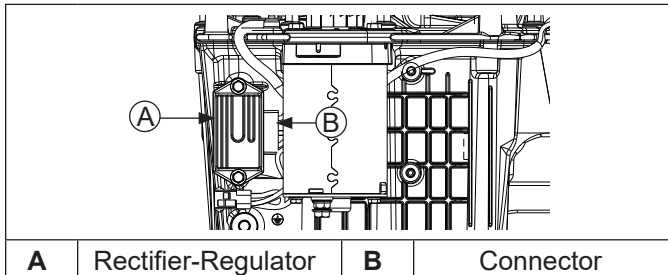
Remove screw securing tube to closure plate. Lift tube from closure plate.

## Remove Oil Sentry™ Pressure Switch (if equipped)

NOTE: Pressure switch is installed into closure plate.

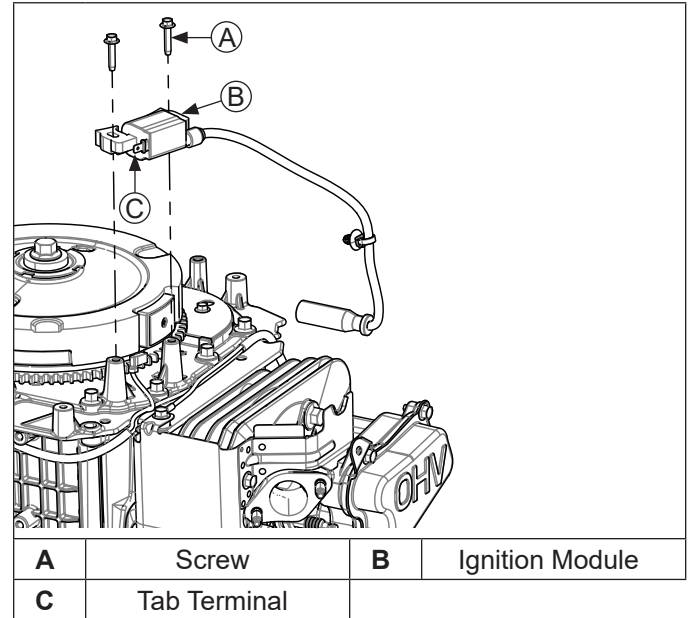
1. Cut wire tie securing lead to switch.
2. Disconnect lead or remove connector from Oil Sentry™ pressure switch.
3. Remove pressure switch from closure plate.

## Remove Rectifier-Regulator



1. Remove screws securing rectifier-regulator to crankcase. Remove rectifier-regulator.
2. Unplug connector from rectifier-regulator.

## Remove Ignition Module



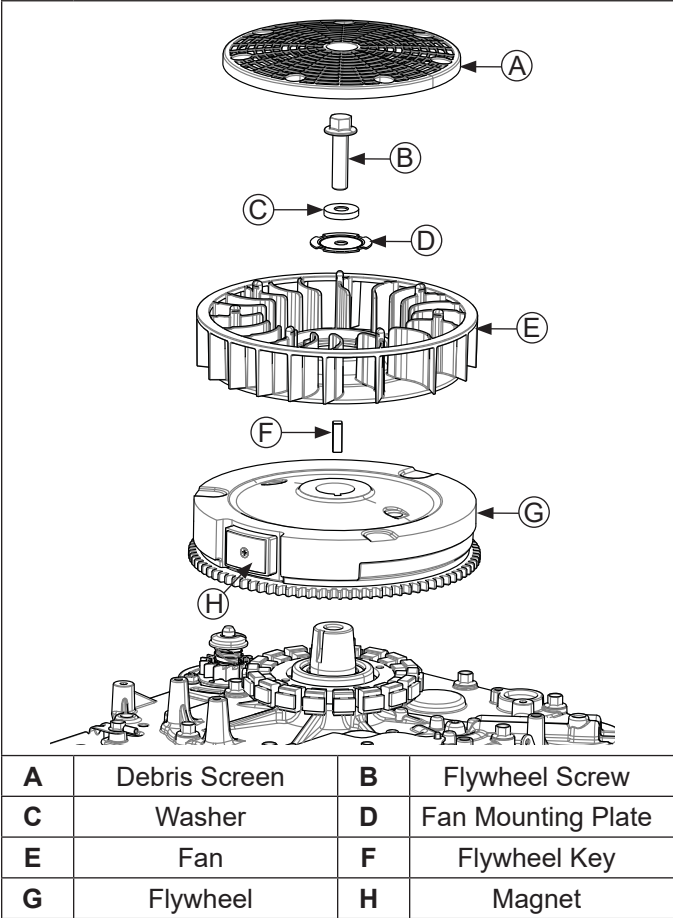
1. Disconnect white lead wire from ignition module tab terminal.
2. Rotate flywheel magnet away from module.
3. Remove screws and ignition module.

## Remove Wiring Harness

1. Remove purple B+ wire from center of rectifier-regulator connector.
2. Remove cylinder head baffle screw securing ground wire of wiring harness.
3. Carefully remove both wire ties securing harness to closure plate. Starter side from below closure plate; above closure plate by cylinder head.

Disassembly/Inspection and Service

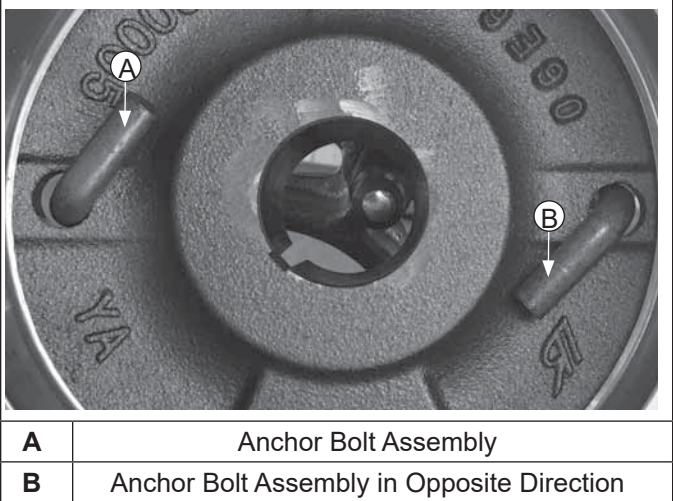
Remove Debris Screen, Fan, and Flywheel



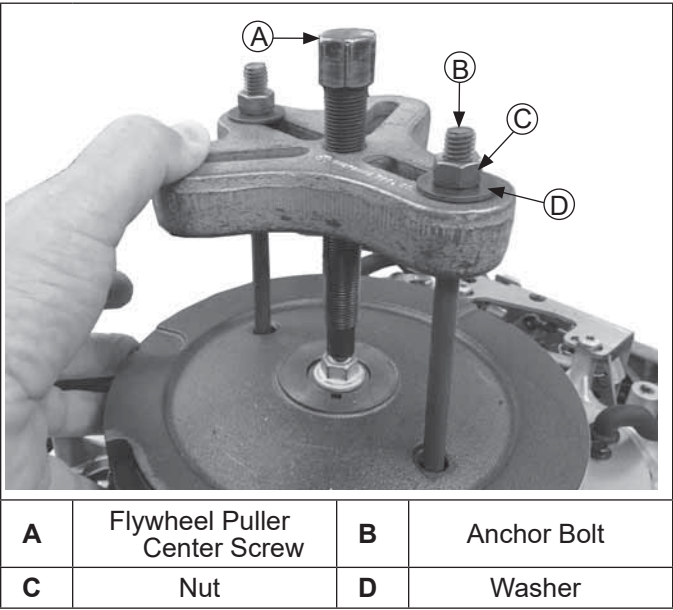
NOTE: Always use a flywheel strap wrench or flywheel holding tool (see Tools and Aids) to hold flywheel when loosening or tightening flywheel and fan retaining fasteners. Do not use any type of bar or wedge between fins of cooling fan, as fins could become cracked or damaged.

NOTE: Always use a puller to remove flywheel from crankshaft. Do not strike crankshaft or flywheel, as they could be cracked or damaged.

1. Unsnap debris screen from cooling fan.
2. Remove retaining screw, washer, and fan mounting plate, securing fan and flywheel to crankshaft.
3. Carefully lift cooling fan to disengage two drive pins and remove it from flywheel.
4. Reinstall flywheel retaining screw.
5. Install an anchor bolt assembly (see Tools and Aids) in each hole of flywheel. Be sure to install them in opposite directions as shown.



6. Position flywheel puller with center screw on flywheel screw. Secure each anchor bolt evenly to puller as shown.



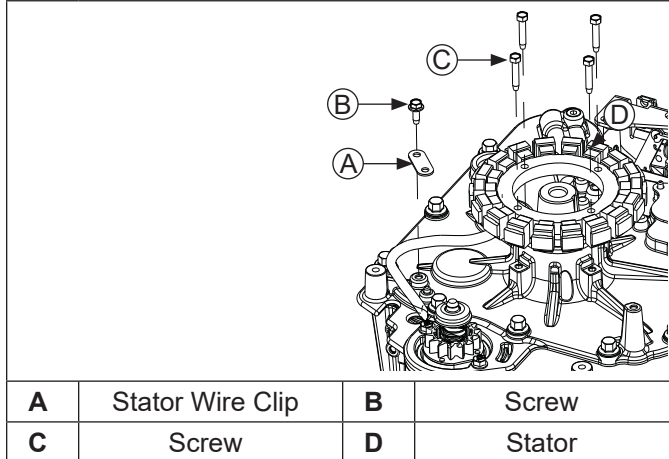
7. Turn center screw of puller to loosen and remove flywheel. Use puller to lift flywheel from engine.
8. Remove flywheel key from crankshaft.

Flywheel Inspection

Inspect flywheel for cracks and check keyway for wear or damage. Replace flywheel if cracked. If flywheel key is sheared or keyway is damaged, replace crankshaft, flywheel, and key.

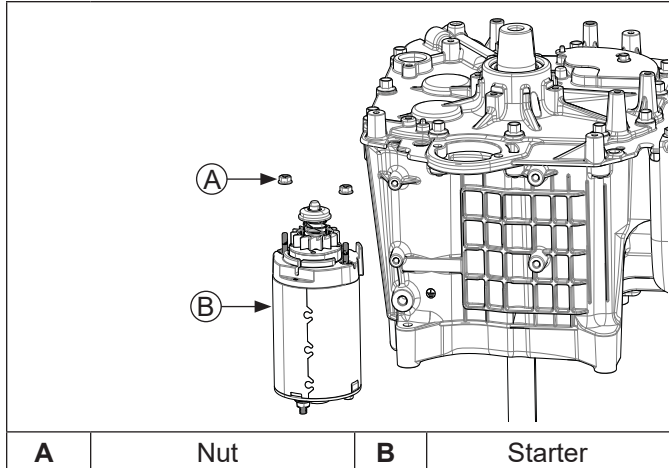
Inspect ring gear for cracks or damage. Ring gears are not available separately. Replace flywheel if ring gear is damaged.

## Remove Stator



1. Remove screw securing stator wire clip; remove clip.
2. Remove screws securing stator to closure plate bosses.

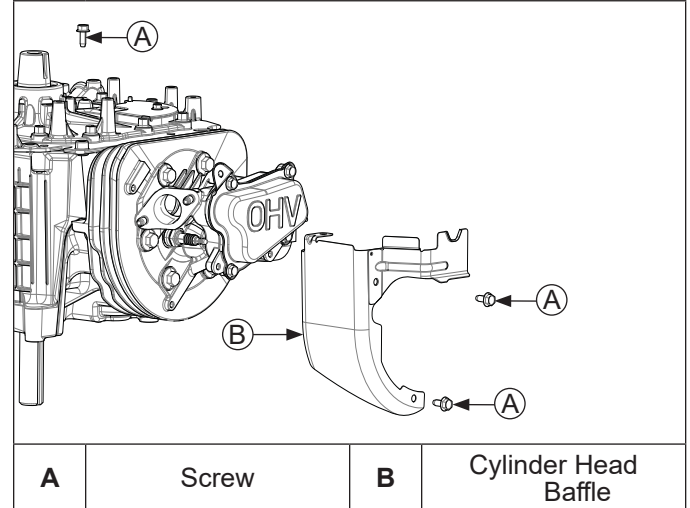
## Remove Electric Starter



NOTE: Before removing, observe placement of starter in closure plate for reassembly.

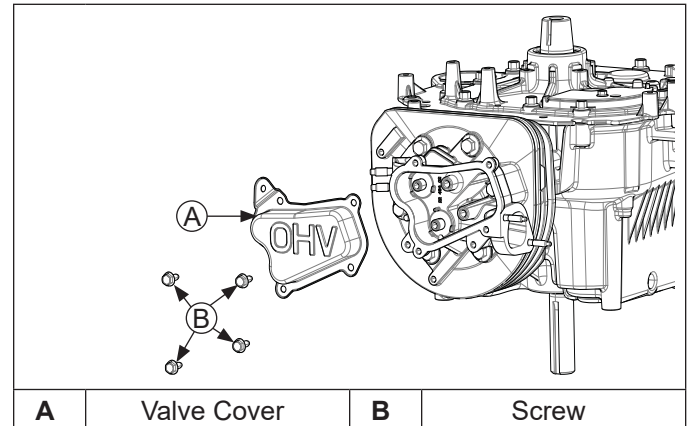
Remove nuts securing starter to closure plate. Remove starter.

## Remove Cylinder Head Baffle



Remove screws attaching cylinder head baffle to cylinder head and remove cylinder head baffle.

## Remove Valve Cover

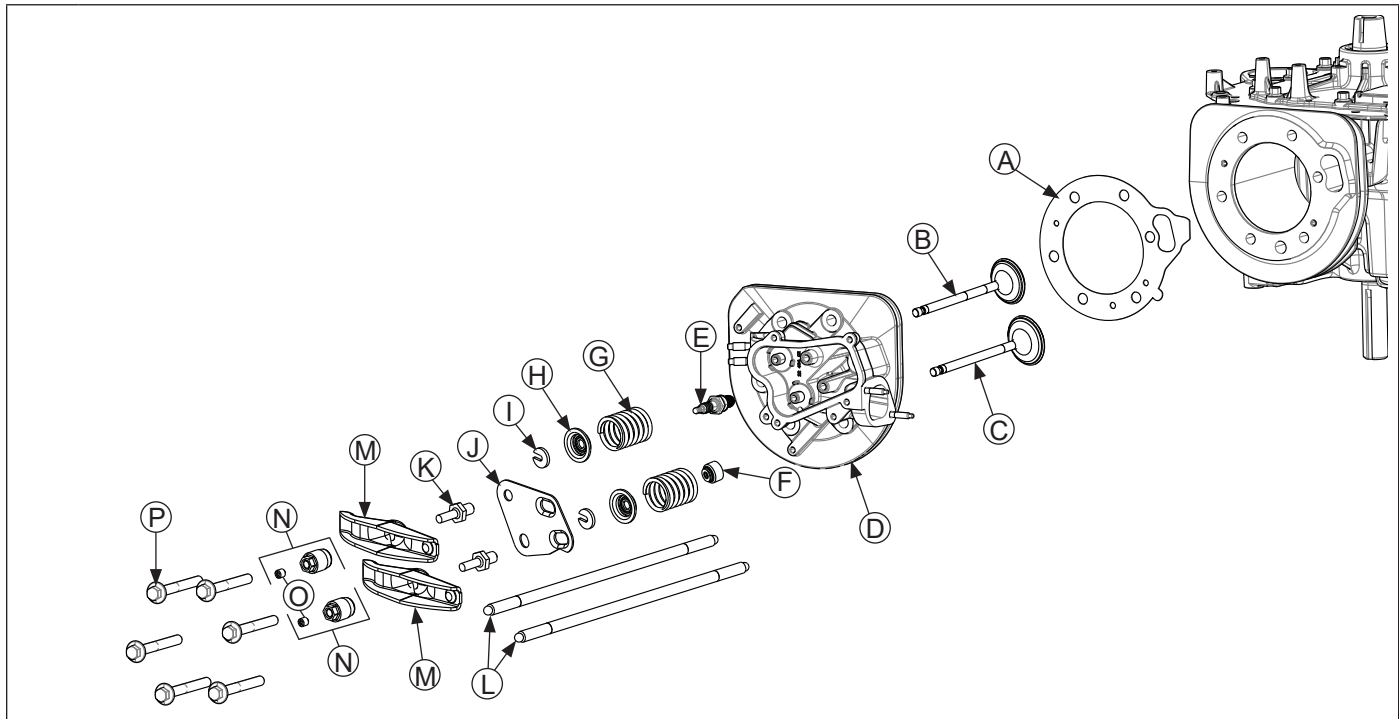


NOTE: Valve cover is sealed to cylinder head using RTV silicone sealant. When removing valve cover, use care not to damage sealing surfaces of cover and cylinder head. To break RTV seal, hold a block of wood against 1 flat face of valve cover. Strike wood firmly with a mallet. If seal doesn't break loose after 1 or 2 attempts, repeat procedure on other side.

1. Remove screws securing valve cover.
2. Remove valve cover from cylinder head.
3. Using a brass wire brush and gasket remover or similar solvent, clean old RTV from surface of cylinder head and valve cover.

# Disassembly/Inspection and Service

## Remove Cylinder Head

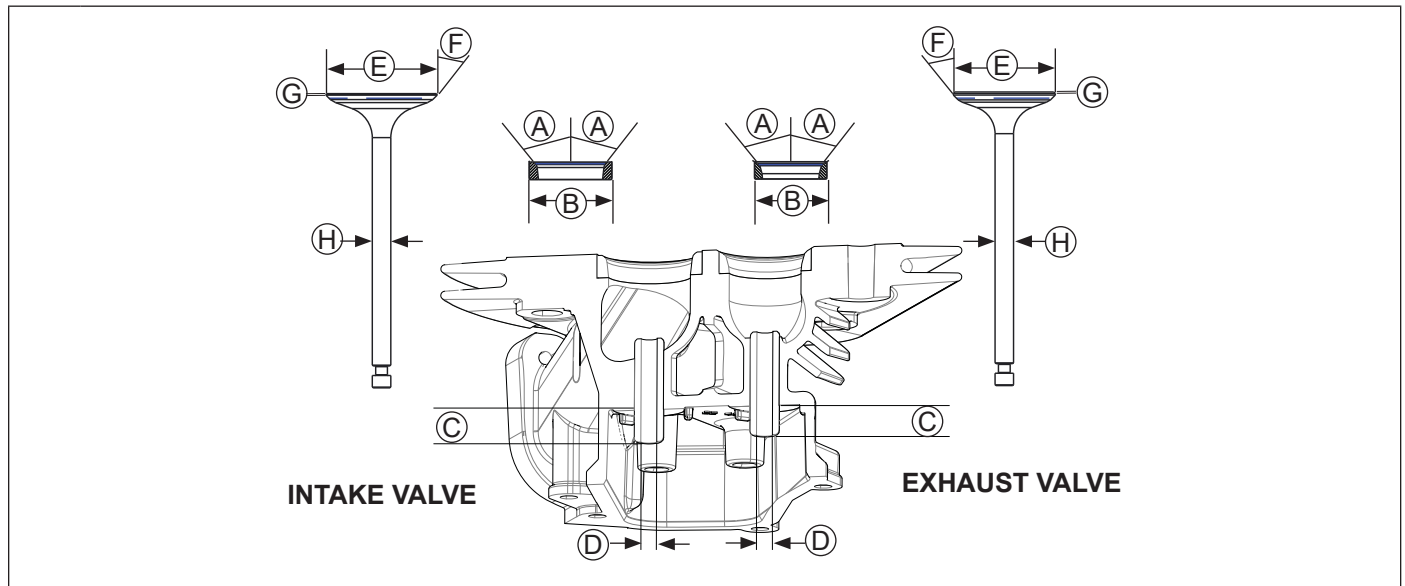


<b>A</b>	Cylinder Head Gasket	<b>B</b>	Exhaust Valve	<b>C</b>	Intake Valve	<b>D</b>	Cylinder Head
<b>E</b>	Spark Plug	<b>F</b>	Valve Stem Seal	<b>G</b>	Valve Spring	<b>H</b>	Valve Spring Cap
<b>I</b>	Retainer Lock	<b>J</b>	Push Rod Guide Plate	<b>K</b>	Rocker Stud	<b>L</b>	Push Rod
<b>M</b>	Rocker Arm	<b>N</b>	Rocker Pivot Assembly	<b>O</b>	Set Screw	<b>P</b>	Cylinder Head Screw

**NOTE:** Before disassembly, mark all valve train components that will be reused, to ensure they are reassembled on same side.

1. Loosen inner set screws (T15 Torx Drive) and back off rocker arm adjusting nuts. Remove push rods and mark them, so they can be reinstalled in same location.
2. Remove adjustment nuts, pivots and rocker arms from pivot studs.
3. Remove rocker arm pivot studs and push rod guide plate.
4. Remove spark plug.
5. Remove screws securing cylinder head.
6. Remove cylinder head and head gasket.
7. Remove valves.
  - a. Compress valve springs using a valve spring compressor and remove retainers.
  - b. Remove compressor; then remove valve spring caps, valve springs, and valves.

## Inspection and Service Valve Details



Dimension		Intake	Exhaust
<b>A</b>	Seat Angle	44.5°	44.5°
<b>B</b>	Insert O.D.	40.094/40.11 mm (1.578/1.579 in.)	35.094/35.11 mm (1.381/1.382 in.)
<b>C</b>	Guide Depth	11.85/12.25 mm (0.466/0.482 in.)	10.80/11.20 mm (0.425/0.440 in.)
<b>D</b>	Guide I.D.	6.038/6.058 mm (0.2377/0.2385 in.)	6.038/6.058 mm (0.2377/0.2385 in.)
<b>E</b>	Valve Head Diameter	35.875/36.125 mm (1.412/1.422 in.)	32.875/33.125 mm (1.294/1.304 in.)
<b>F</b>	Valve Face Angle	45°	45°
<b>G</b>	Valve Margin (Min.)	0.5 mm (0.0196 in.)	1.0 mm (0.0393 in.)
<b>H</b>	Valve Stem Diameter	5.982/6.000 mm (0.2355/0.2362 in.)	5.970/5.988 mm (0.2350/0.2357 in.)

After cleaning, check flatness of cylinder head and corresponding top surface of crankcase, using a surface plate or precision straight edge and feeler gauge. Maximum allowable out of flatness is 0.076 mm (0.003 in.).

Carefully inspect valve mechanism parts. Inspect valve springs and related hardware for excessive wear or distortion. Check valves and valve seats for evidence of deep pitting, cracks, or distortion.

Check running clearance between valve stems and guides.

Hard starting, or loss of power accompanied by high fuel consumption, may be symptoms of faulty valves. Although these symptoms could also be attributed to worn rings, remove and check valves first. After removal, clean valve heads, faces, and stems with a power wire brush. Then, carefully inspect each valve for defects such as warped head, excessive corrosion, or worn stem end. Replace valves found to be in bad condition.

### Valve Guides

If a valve guide is worn beyond specifications, it will not guide valve in a straight line. This may result in burned valve faces or seats, loss of compression, and excessive oil consumption.

To check valve guide-to-valve stem clearance, thoroughly clean valve guide and, using a split-ball gauge, measure inside diameter. Then, using an outside micrometer, measure diameter of valve stem at several points on stem where it moves in valve guide. Use largest stem diameter to calculate clearance. If intake clearance exceeds 0.038/0.076 mm (0.0015/0.0030 in.) or exhaust clearance exceeds 0.050/0.088 mm (0.0020/0.0035 in.), determine whether valve stem or guide is responsible for excessive clearance.

Maximum (I.D.) wear on intake valve guide is 6.135 mm (0.2415 in.) while 6.160 mm (0.2425 in.) is maximum allowed on exhaust guide. Guides are not removable. If guides are within limits but valve stems are worn beyond limits, replace valves.



# Disassembly/Inspection and Service

## Valve Seat Inserts

Hardened steel alloy intake and exhaust valve seat inserts are press fitted into cylinder head. Inserts are not replaceable, but they can be reconditioned if not too badly pitted or distorted. If seats are cracked or badly warped, cylinder head should be replaced.

Recondition valve seat inserts following instructions provided with valve seat cutter being used. Final cut should be made with a 44.5° cutter as specified for valve seat angle. Cutting proper 45° valve face angle, as specified, and proper valve seat angle (44.5°, half of full 89° angle) will achieve desired 0.5° (1.0° full cut) interference angle where maximum pressure occurs on valve face and seat.

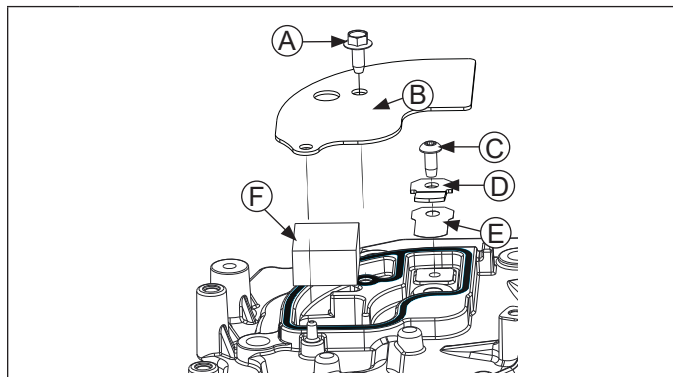
## Lapping Valves

Reground or new valves must be lapped in, to provide a good seal. Use a hand valve grinder with suction cup for final lapping. Lightly coat valve face with fine grade of grinding compound, then rotate valve on seat with grinder. Continue grinding until smooth surface is obtained on seat and on valve face. Thoroughly clean cylinder head in soap and hot water to remove all traces of grinding compound. After drying cylinder head, apply a light coating of engine oil to prevent rusting.

## Intake Valve Stem Seal

Always use a new seal when valves are removed from cylinder head. Seals should also be replaced if deteriorated or damaged in any way. Never reuse an old seal.

## Remove Breather

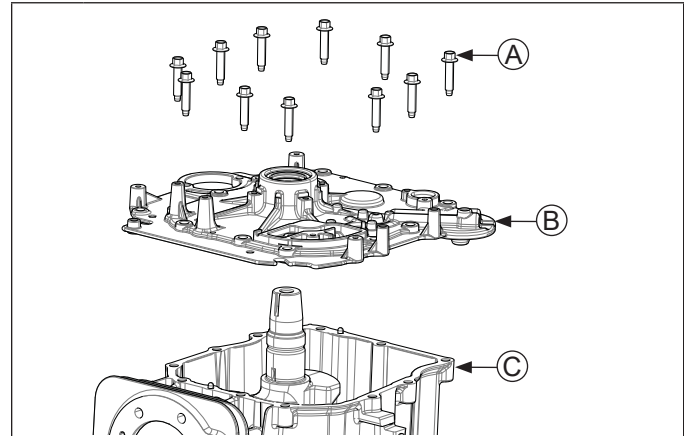


<b>A</b>	Breather Cover Screw	<b>B</b>	Breather Cover
<b>C</b>	Torx Screw	<b>D</b>	Reed Retainer
<b>E</b>	Breather Reed	<b>F</b>	Breather Filter

NOTE: Breather cover is sealed to closure plate using RTV silicone sealant. Once removed, cover must be replaced. When removing breather cover, use care not to damage sealing surface of closure plate.

1. Remove screw securing breather cover to closure plate; remove cover.
2. Remove Torx screw, reed retainer, and breather reed.
3. Remove breather filter from closure plate.

## Remove Closure Plate

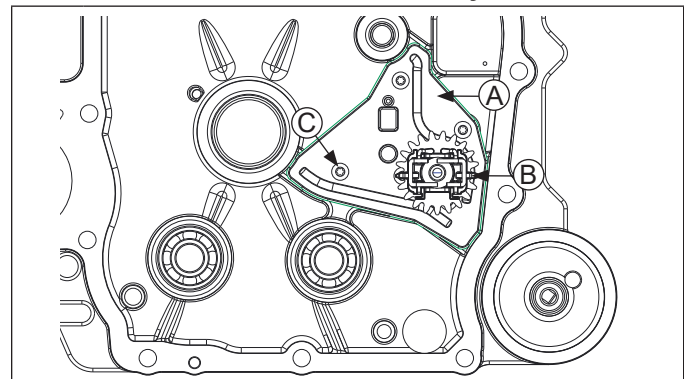


<b>A</b>	Closure Plate Screw	<b>B</b>	Closure Plate Assembly
<b>C</b>	Crankcase		

NOTE: Closure plate is sealed to crankcase using RTV silicone sealant. When removing closure plate, use care not to damage sealing surface of crankcase.

1. Remove screws securing closure plate to crankcase.
2. To break RTV seal, use a prying device and apply pressure at corner of closure plate where breather is located until RTV separates; then pull from corners to remove closure plate assembly. Do not pry on sealing surfaces of crankcase or closure plate, as this can cause damage resulting in leaks.

## Disassemble Closure Plate Assembly



<b>A</b>	Oil Passage Cover	<b>B</b>	Governor Gear
<b>C</b>	Oil Passage Cover Screws		

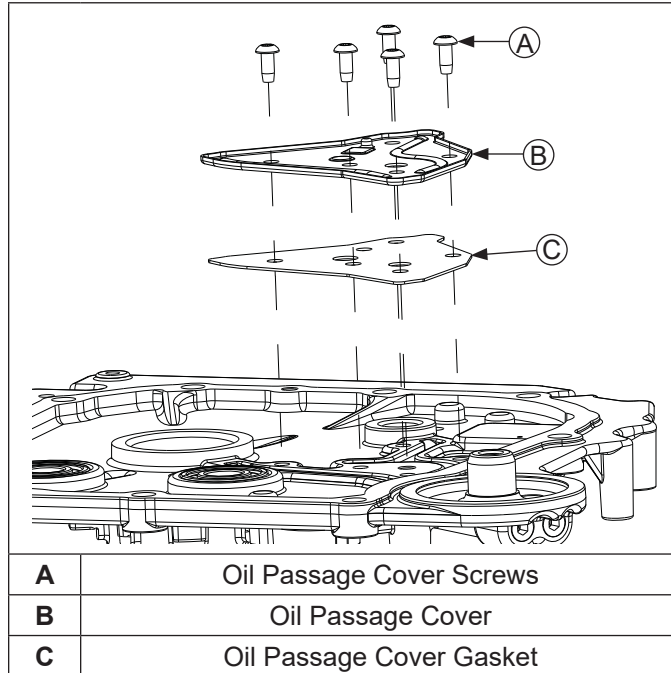
NOTE: Governor gear is held onto shaft by small molded tabs in gear. When gear is removed these tabs are destroyed and gear must be replaced. Governor gear removal is required for closure plate disassembly and cleaning of oil passages. Unless bearings are being replaced, they can stay in closure plate.

## Governor Gear Inspection

Inspect governor gear teeth. Look for any evidence of worn, chipped, or cracked teeth. If one or more of these problems is noted, replace governor gear.

Gear is held onto governor shaft by molded tabs, which are damaged when gear is removed. Never reuse gear once it has been pulled from shaft.

## Remove Governor Gear and Oil Passage Cover



1. Remove governor gear and regulating pin assembly. Gently pry upward using blades of two small screwdrivers.
2. Remove screws securing oil passage cover to closure plate. Remove cover and gasket.

## Oil Seal Inspection

Inspect oil seal in closure plate and remove it if it is worn or damaged.

## Governor Shaft Inspection

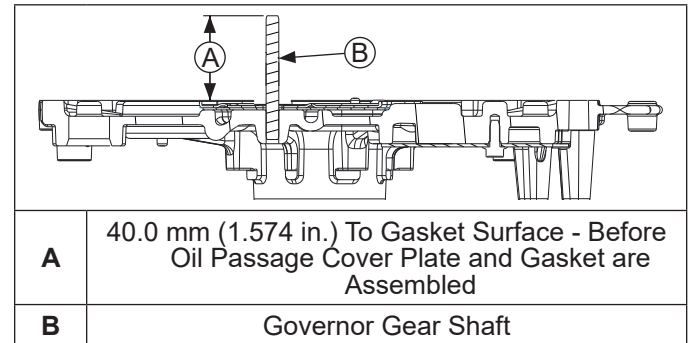
Replace governor shaft only if it is damaged or worn.

## Remove Governor Shaft

1. Locate governor shaft from flywheel side. With a small punch, drive shaft out of closure plate. This could also be done with a press. Do not remove governor shaft with a vise grip or pliers, you may damage closure plate.
2. Using a brass wire brush and gasket remover or similar solvent, clean old RTV from surface of closure plate and crankcase. Do not scrape surfaces, as any scratches, nicks, or burrs can result in leaks.

## Install Governor Shaft

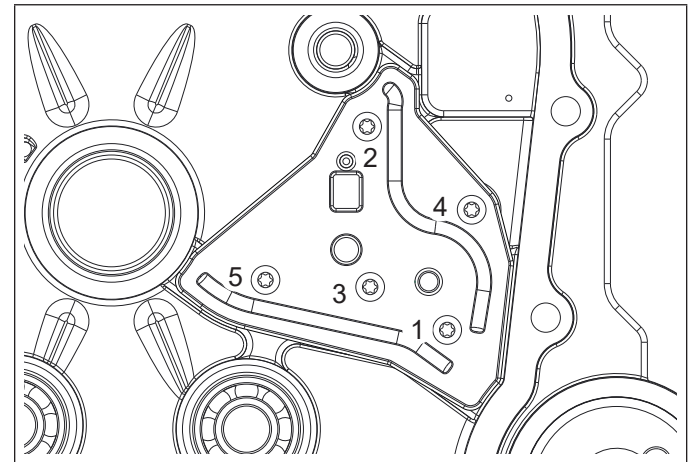
### Governor Shaft Components and Details



Install new governor gear shaft by pressing or lightly tapping it into closure plate. It must be installed so that it protrudes 40.0 mm (1.574 in.), plus or minus 0.2 mm (0.0078 in.) above closure plate boss.

## Closure Plate and Passage Cover Inspection and Service

### Passage Cover Torque Sequence



If disassembly was performed, inspect and ensure oil passages in closure plate and passage cover are completely clean and not obstructed in any way. Check straightness of passage cover if required, against a flat surface.

Use a new passage cover gasket and install passage cover onto closure plate. Reinstall mounting screws and torque to 6.5 N·m (58 in. lb.), following sequence.

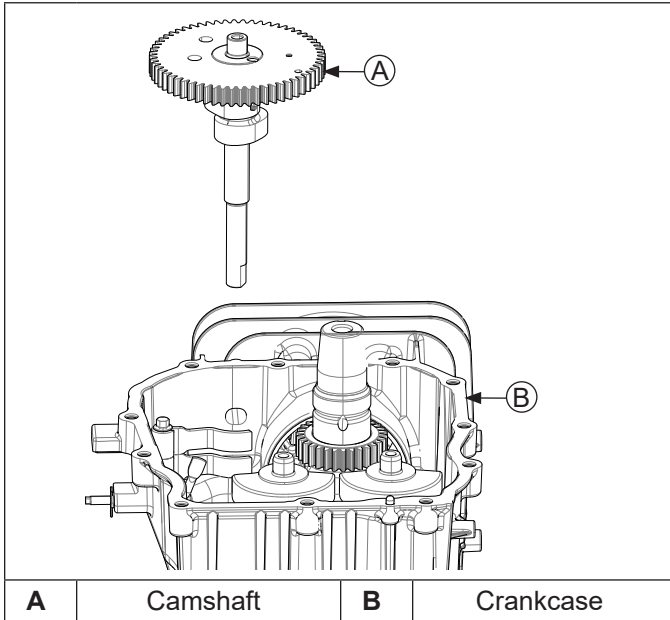
## Install New Governor Gear Assembly

1. Install new governor regulating pin and governor gear assembly.
2. Make sure governor gear assembly rotates freely.



# Disassembly/Inspection and Service

## Remove Camshaft



Carefully pull upward on camshaft to remove assembly from crankcase cavity.

### Automatic Compression Release (ACR)

These engines are equipped with an ACR mechanism. ACR lowers compression at cranking speeds to make starting easier.

#### Operation

ACR mechanism consists of an actuating spring and a pivoting flyweight/control pin assembly. At cranking speeds (700 RPM or lower), spring holds flyweight in and rounded surface of control pin protrudes above exhaust cam lobe. This pushes exhaust valve off its seat during first part of compression stroke. Compression is reduced to an effective ratio of about 2:1 during cranking.

After starting, when engine speed exceeds 700 RPM, centrifugal force overcomes force of flyweight spring. Flyweight moves outward, rotating control pin to expose flat surface, which is lower than cam lobe. Control pin no longer has any effect on exhaust valve, and engine operates at full power.

When engine is stopped, spring returns flyweight/control pin assembly to compression release position, ready for next start.

#### Benefits

As a result of reduced compression at cranking speeds, several important benefits are obtained:

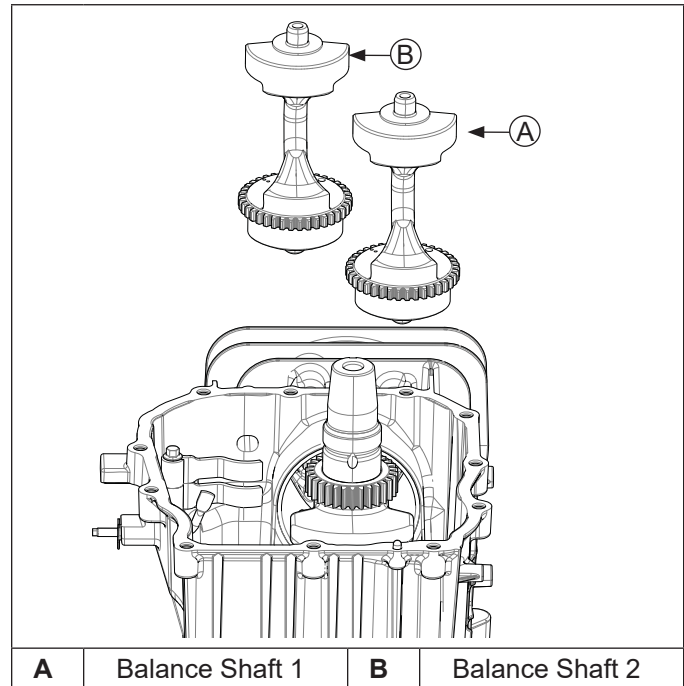
1. Electric start models can use a smaller starter and battery which are more practical for application.
2. ACR eliminates need for a spark retard/advance mechanism. A spark retard/advance mechanism would be required on engines without ACR to prevent kickback which would occur during starting. ACR eliminates this kickback, making manual starting safer.
3. Choke control setting is less critical with ACR. If flooding occurs, excess fuel is blown out opened exhaust valve and does not hamper starting.

4. Engines with ACR start much faster in cold weather than engines without ACR.
5. Engines with ACR can be started with spark plugs which are worn or fouled. Engines without ACR are more difficult to start with those same spark plugs.

### Cam Gear Inspection and Service

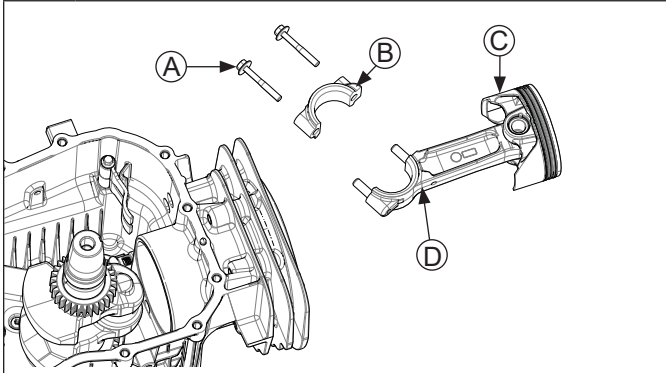
Inspect gear teeth and cam lobes of camshaft. If lobes exhibit excessive wear, or teeth are worn, chipped or broken, replacement of camshaft will be necessary.

## Remove Balance Shafts



1. Rotate crankshaft clockwise to line up lower timing marks on crankshaft gear and balance shaft 1 gear.
2. Lift balance shaft 1 from crankcase and mark BS1 for reassembly.
3. Rotate crankshaft clockwise to move crankshaft weights, then lift balance shaft 2 from crankcase and mark BS2 for reassembly.

## Remove Connecting Rod and Piston



<b>A</b>	Connecting Rod Screw	<b>B</b>	Rod Cap
<b>C</b>	Piston Assembly	<b>D</b>	Connecting Rod

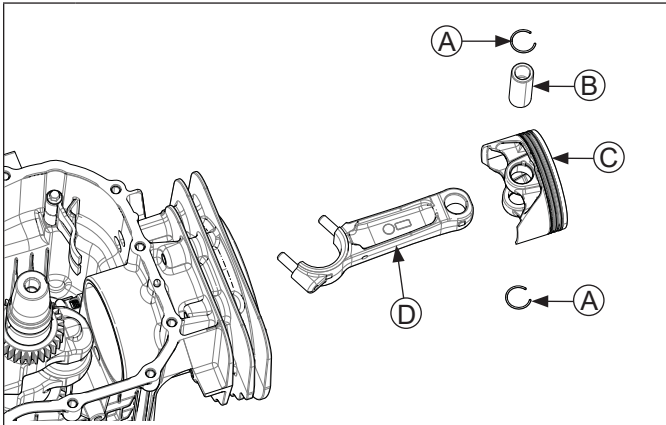
**NOTE:** If a carbon ridge is present at top of bore, use a ridge reamer to remove it before attempting to remove piston.

1. Rotate crankshaft so rod journal is in 8 o'clock position.
2. Remove screws and connecting rod cap.
3. Carefully push connecting rod and piston away from crankshaft and out of cylinder bore.

## Inspection and Service

Check bearing area (big end) for score marks and excessive wear. Service replacement connecting rods are available in STD crankpin size.

## Remove Piston from Connecting Rod



<b>A</b>	Piston Pin Retainer	<b>B</b>	Piston Pin
<b>C</b>	Piston Assembly	<b>D</b>	Connecting Rod

Remove piston pin retainers and piston pin. Separate piston from connecting rod.

## Piston and Rings Inspection

Scuffing and scoring of pistons and cylinder walls occurs when internal temperatures approach welding point of piston. Temperatures high enough to do this are created by friction, which is usually attributed to improper lubrication, and/or overheating of engine.

Normally, very little wear takes place in piston boss-piston pin area. If original piston and connecting rod can be reused after new rings are installed, original pin can also be reused, but new piston pin retainers are required. Piston pin is part of piston assembly; if pin boss or pin are worn or damaged, a new piston assembly is required.

Ring failure is usually indicated by excessive oil consumption and blue exhaust smoke. When rings fail, oil is allowed to enter combustion chamber where it is burned along with fuel. High oil consumption can also occur when piston ring end gap is incorrect because ring cannot properly conform to cylinder wall under this condition. Oil control is also lost when ring gaps are not staggered during installation.

When cylinder temperatures get too high, lacquer and varnish collect on pistons causing rings to stick which results in rapid wear. A worn ring usually takes on a shiny or bright appearance.

Scratches on rings and pistons are caused by abrasive material such as carbon, dirt, or pieces of hard metal.

Detonation damage occurs when a portion of fuel charge ignites spontaneously from heat and pressure shortly after ignition. This creates two flame fronts that meet and explode to create extreme hammering pressures on a specific area of piston. Detonation generally occurs from using low octane fuels.

Preignition or ignition of fuel charge before timed spark can cause damage similar to detonation. Preignition damage is often more severe than detonation damage. Preignition is caused by a hot spot in combustion chamber from sources such as glowing carbon deposits, blocked fins, improperly seated valve, or wrong spark plug.

Replacement pistons are available in STD bore size. Replacement pistons include new piston ring sets and new piston pins.

Replacement ring sets are also available separately for STD pistons. Always use new piston rings when installing pistons. Never reuse old rings.

## Remove Piston Rings

1. Remove top and center compression rings using a ring expander.
2. Remove oil control ring rails, then remove spacer.

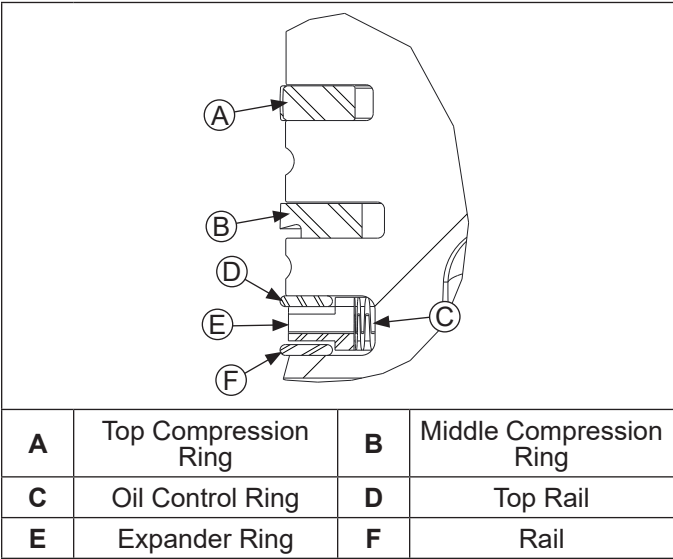
Disassembly/Inspection and Service

Some important points to remember when servicing piston rings:

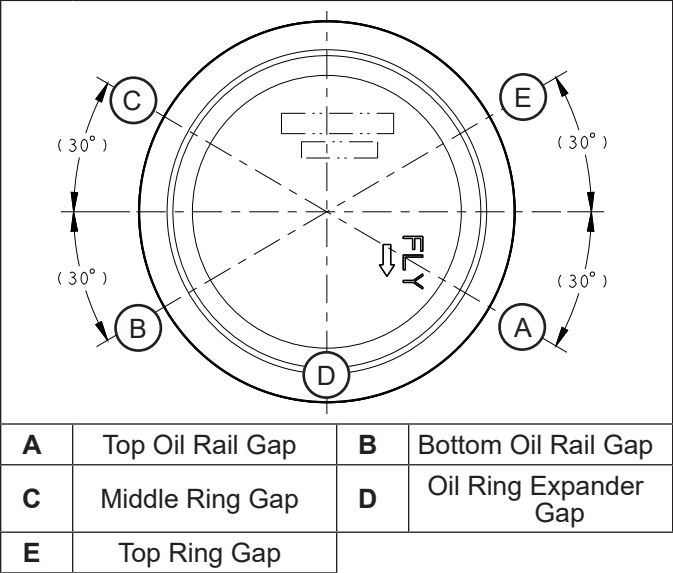
- 1. Cylinder bore must be deglazed before service ring sets are used.
- 2. If cylinder bore is within wear limits (refer to Specifications) and old piston is within wear limits, free of score or scuff marks, old piston may be reused.
- 3. Remove old rings and clean up grooves. Never reuse old rings.
- 4. Before installing new rings on piston, place top 2 rings, each in turn, in its running area in cylinder bore and check end gap. Top compression ring end gap clearance is 0.150/0.400 mm (0.0059/0.0157 in.) for a new bore, or 0.770 mm (0.0300 in.) for a used bore. Middle compression ring end cap is 1.000/1.250 mm (0.0394/0.0492 in.) for a new bore, or 1.504 mm (0.0592 in.) for a used bore.
- 5. After installing new compression (top and middle) rings on piston, make sure top compression ring-to-groove side clearance and is 0.025/0.065 mm (0.0010/0.0026 in.) and middle compression ring-to-groove side clearance 0.040/0.080 mm (0.0016/0.032 in.). If side clearance is greater than specified, a new piston must be used.

Piston and Rings

Piston and Rings Components and Details



Install New Piston Rings  
Piston Ring Orientation

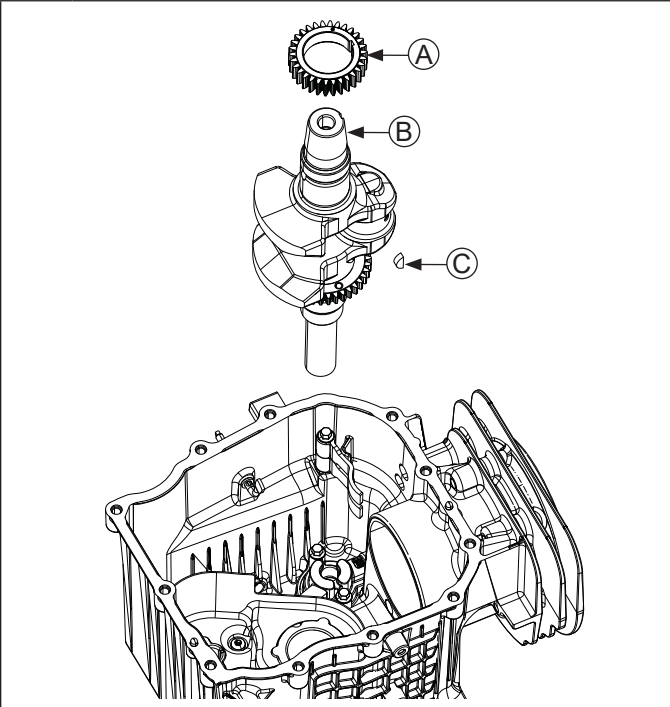


NOTE: Rings must be installed correctly. Use a piston ring expander to install rings. Install bottom (oil control) ring first and top compression ring last.

To install piston rings, proceed as follows:

- 1. Oil control ring (bottom groove): Install expander and then rails. Make sure ends of expander are not overlapped.
- 2. Middle Compression ring (center groove): Install center ring using a piston ring installation tool. Make sure identification mark is up when ring is installed.
- 3. Top Compression ring (top groove): Install top ring using a piston ring installation tool. Make sure identification mark is up when ring is installed.

Remove Crankshaft



A	Crankshaft Gear	B	Crankshaft
C	Key		

1. Carefully remove crankshaft from crankcase.
2. Remove crankshaft gear from crankshaft and carefully remove key from keyway.

**Crankshaft and Crankshaft Gear Inspection and Service**

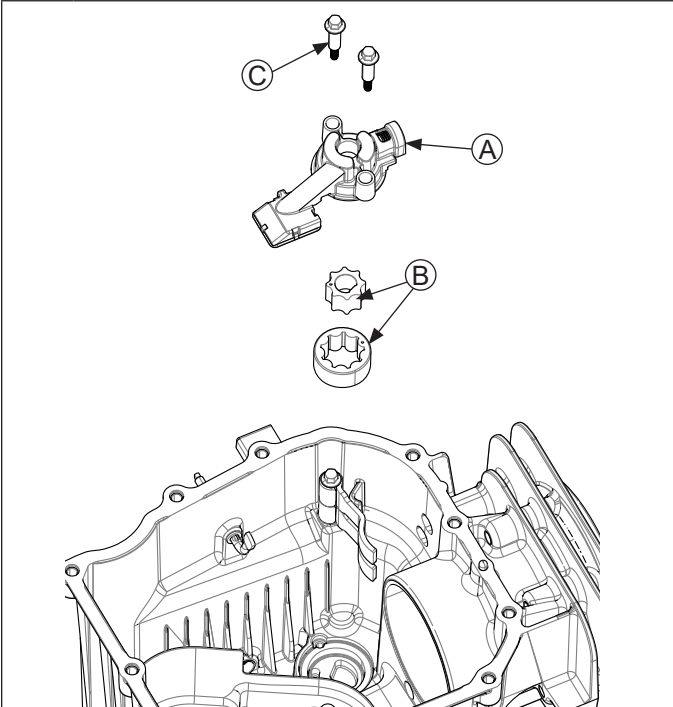
Inspect teeth of crankshaft gear. If teeth are badly worn, chipped, or some are missing, replacement of crankshaft gear will be necessary. Remove gear by pulling it off key and crankshaft.

Inspect crankshaft bearing journal surfaces for wear, scoring, grooving, etc. If they show signs of damage or are out of running clearance specifications, crankshaft must be replaced.

Inspect crankshaft keyways. If worn or chipped, replacement of crankshaft will be necessary.

Inspect crankpin for wear, score marks or aluminum transfer. Slight score marks can be cleaned with crocus cloth soaked in oil. If wear limits are exceeded, it will be necessary to replace crankshaft.

Remove Oil Pump Assembly



A	Oil Pump Housing Assembly
B	Oil Pump Assembly
C	Oil Pump Housing Screws

1. Remove screws and lift oil pump housing assembly from crankcase.
2. Remove oil pump assembly gerotor gears from crankcase.

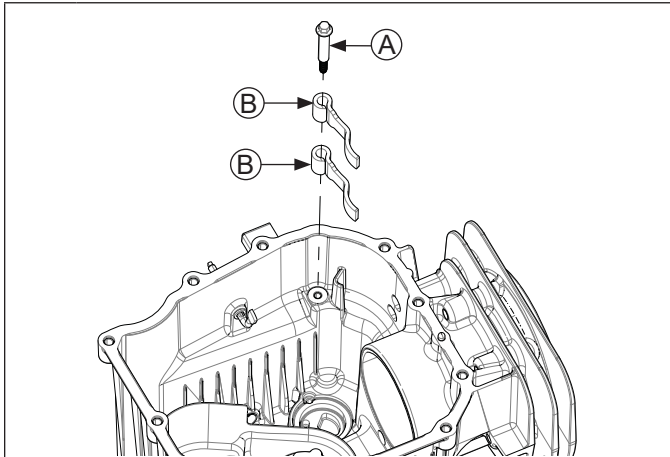
**Oil Pump Inspection**

Check oil pump and gears for cracks, damage, wear, and smooth rotation. Replace pump if any binding is noted or reuse is questionable in any way.

A pressure relief valve is built into oil pump to limit maximum pressure. It is not serviceable. If a problem exists with pressure relief valve, oil pump assembly should be replaced.

# Disassembly/Inspection and Service

## Remove Cam Levers

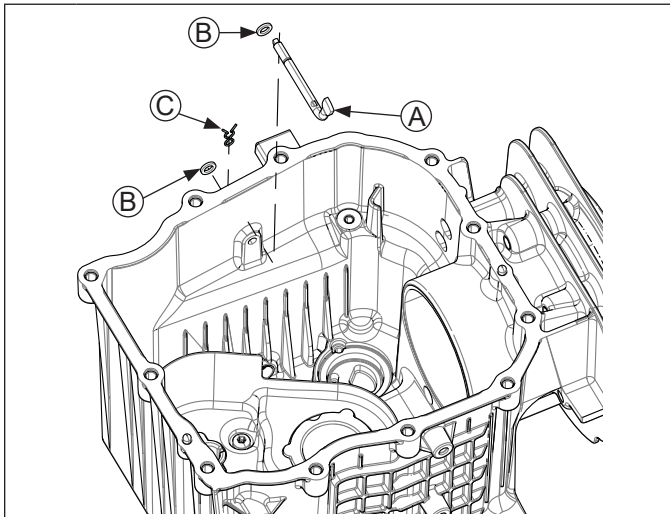


<b>A</b>	Cam Lever Screw
<b>B</b>	Cam Levers

**NOTE:** It is not necessary to remove cam levers unless replacement is intended. If cam lever screw is removed for any reason, discard screw, do not reuse/reinstall. A new screw must be used.

Remove screw and cam levers from crankcase. Mark cam levers (T top, B bottom) for proper reassembly.

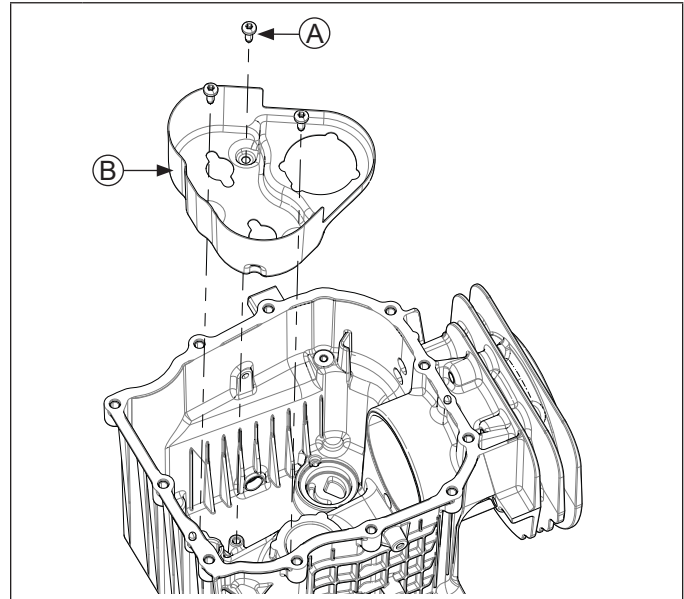
## Remove Governor Cross Shaft



<b>A</b>	Governor Cross Shaft
<b>B</b>	Washer
<b>C</b>	Hitch Pin

1. Remove hitch pin and washer located on outside of governor cross shaft.
2. Slide shaft inward and remove it through inside of crankcase. Be careful not to lose washer on inside portion of shaft.

## Remove Oil Baffle



<b>A</b>	Oil Baffle Screws
<b>B</b>	Oil Baffle

Remove screws securing oil baffle to bottom of crankcase; remove oil baffle.

## Remove PTO Side Oil Seal

Use a seal puller to remove PTO side oil seal.

## Crankcase

### Inspection and Service

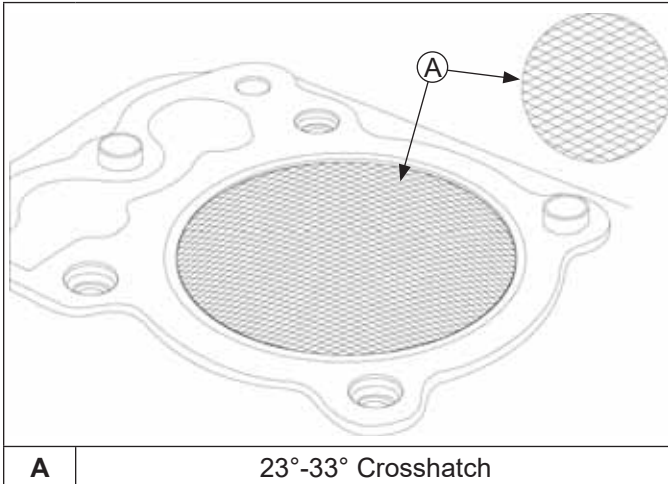
Check all gasket surfaces to make sure they are free of gasket fragments and deep scratches or nicks.

Check cylinder wall for scoring. In severe cases, unburned fuel can wash necessary lubricating oil off piston and cylinder wall. Piston rings make metal to metal contact with wall, causing scuffing and scoring. Scoring of cylinder wall can also be caused by localized hot spots from blocked cooling fins or from inadequate or contaminated lubrication.

If cylinder bore is scored, worn, tapered, or out-of-round, use an inside micrometer or telescoping gauge to determine amount of wear (refer to Specifications). If wear exceeds published limits, a short block or replacement engine will need to be considered.



## Honing Detail



While most commercially available cylinder hones can be used with either portable drills or drill presses, use of a low speed drill press is preferred as it facilitates more accurate alignment of bore in relation to crankshaft counter bore. Honing is best accomplished at a drill speed of about 250 RPM and 60 strokes per minute. After installing coarse stones in hone, proceed as follows:

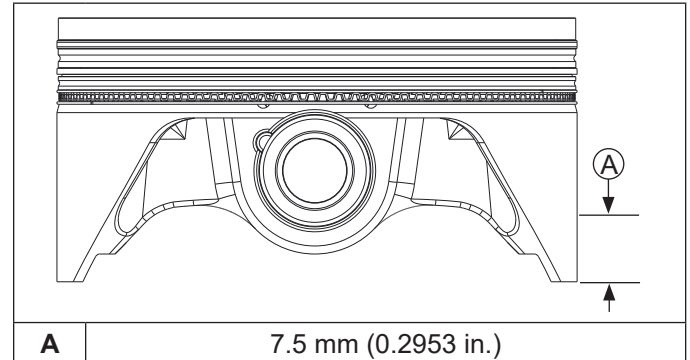
1. Lower hone into bore and, after centering, adjust it so stones are in contact with cylinder wall. Use of a commercial cutting-cooling agent is recommended.
2. With lower edge of each stone positioned even with lowest edge of bore, start drill and honing process. Move hone up and down while resizing to prevent formation of cutting ridges. Check size frequently. Make sure bore is cool when measuring.
3. When bore is within 0.064 mm (0.0025 in.) of desired size, remove coarse stones and replace with burnishing stones. Continue with burnishing stones until within 0.013 mm (0.0005 in.) of desired size and then use finish stones (220-280 grit) and polish to final size. A crosshatch should be observed if honing is done correctly. Crosshatch should intersect at approximately 23°-33° off horizontal. Too flat an angle could cause rings to skip and wear excessively, too steep an angle will result in high oil consumption.
4. After honing, check bore for roundness, taper, and size. Use an inside micrometer, telescoping gauge, or bore gauge to take measurements. These measurements should be taken at three locations in cylinder – at top, middle, and bottom. Two measurements should be taken (perpendicular to each other) at 3 different locations.

## Clean Cylinder Bore after Honing

Proper cleaning of cylinder walls following honing is critical. Grit left in cylinder bore can destroy an engine in less than one hour of operation after a rebuild.

Final cleaning operation should always be a thorough scrubbing with a brush and hot, soapy water. Use a strong detergent capable of breaking down machining oil while maintaining a good level of suds. If suds break down during cleaning, discard dirty water and start again with more hot water and detergent. Following scrubbing, rinse cylinder with very hot, clear water, dry it completely, and apply a light coating of engine oil to prevent rusting.

## Measuring Piston-to-Bore Clearance Piston Detail



**NOTE:** Do not use a feeler gauge to measure piston-to-bore clearance; it will yield inaccurate measurements. Always use a micrometer.

Before installing piston into cylinder bore, it is necessary that clearance be accurately checked. This step is often overlooked, and if clearances are not within specifications, engine failure will usually result.

Use following procedure to accurately measure piston-to-bore clearance:

1. Use a micrometer and measure diameter of piston 7.5 mm (0.2953 in.) above bottom of piston skirt and perpendicular to piston pin.
2. Use an inside micrometer, telescoping gauge, or bore gauge and measure cylinder bore. Measurement approximately 63.5 mm (2.5 in.) below top of bore and perpendicular to piston pin.
3. Piston-to-bore clearance is difference between bore diameter and piston diameter (step 2 minus step 1).

# Reassembly

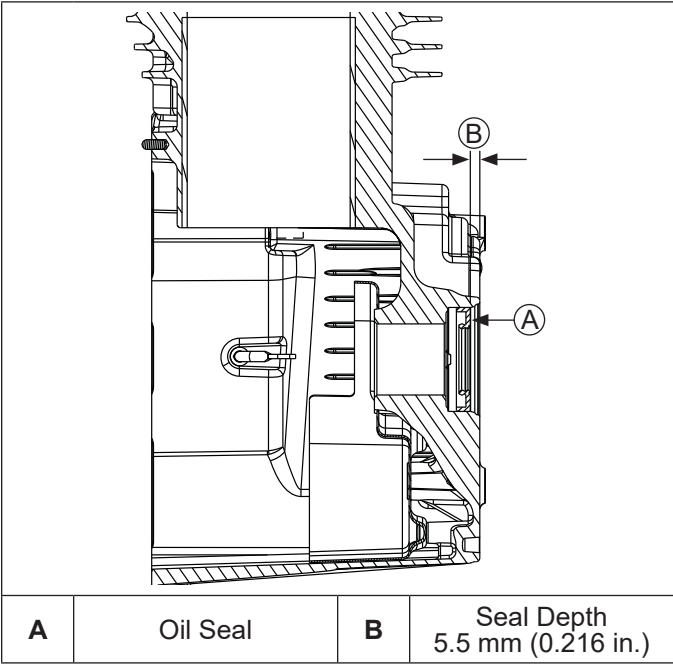
NOTE: Make sure engine is assembled using all specified torque values, torque sequences, and clearances. Failure to observe specifications could cause severe engine wear or damage. Always use new gaskets. Apply a small amount of oil to threads of critical fasteners before assembly, unless a sealant or Loctite® is specified or preapplied.

Make sure all traces of any cleaner are removed before engine is assembled and placed into operation. Even small amounts of these cleaners can quickly break down lubricating properties of engine oil.

Check closure plate, crankcase, cylinder head, and valve cover to be certain all old sealing material has been removed. Use gasket remover, lacquer thinner, or paint remover to remove any remaining traces. Clean surfaces with isopropyl alcohol, acetone, lacquer thinner, or electrical contact cleaner.

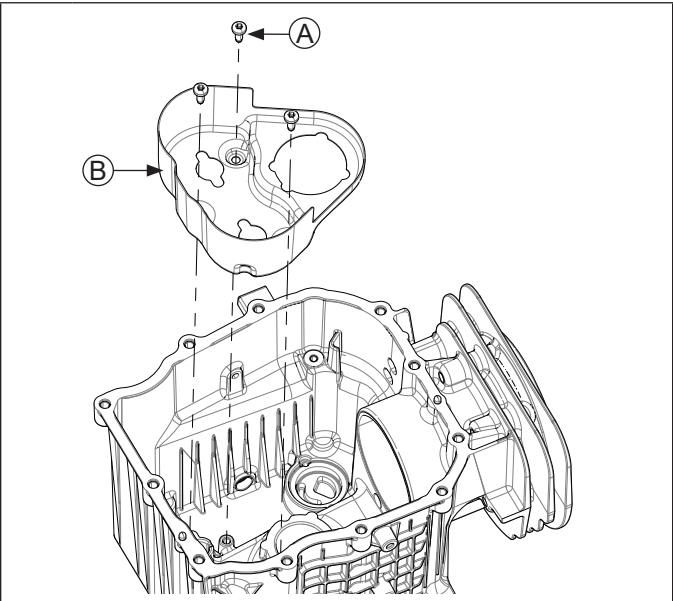
## Install PTO Side Oil Seal

### PTO Seal Depth Details



Use a seal driver and install to a depth of 5.5 mm (0.216 in.) into crankcase.

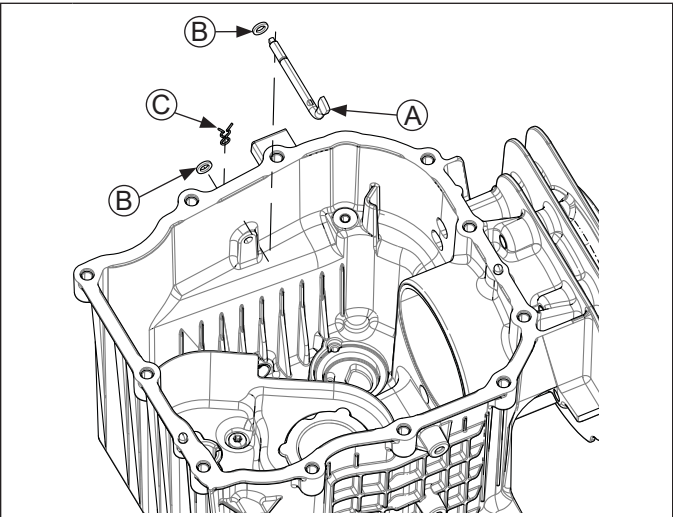
## Install Oil Baffle



<b>A</b>	Oil Baffle Screws
<b>B</b>	Oil Baffle

Install oil baffle in crankcase and secure with screws. Torque screws to 7.9 N·m (70 in. lb.).

## Install Governor Cross Shaft

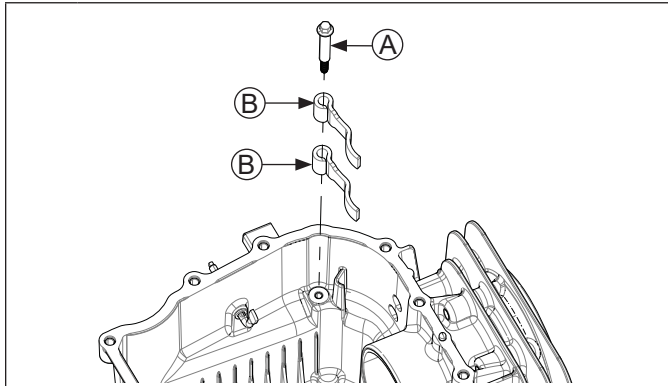


<b>A</b>	Governor Cross Shaft
<b>B</b>	Washer
<b>C</b>	Hitch Pin

1. Place first washer onto governor cross shaft as far as it will go.
2. Lightly lubricate shaft with oil, and install it from inside crankcase.
3. Slide second washer onto shaft from outside as far as it will go. Secure by inserting hitch pin in machined groove.



## Install Cam Levers

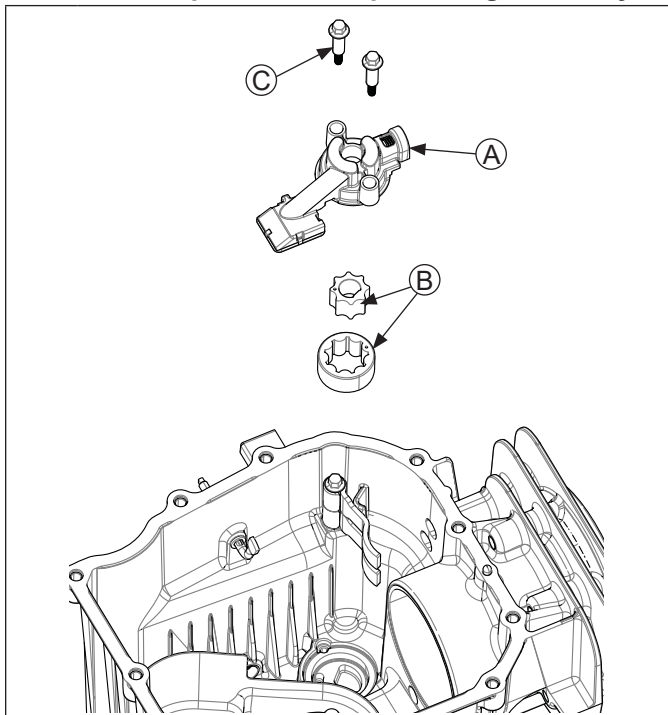


<b>A</b>	Cam Lever Screw
<b>B</b>	Cam Levers

**NOTE:** Do not reinstall a cam lever screw that has been removed. Discard removed screw and install new screw with Loctite® Dri-Loc® patch.

Install cam levers on screw and secure to crankcase. Torque screw to 12.5 N·m (110 in. lb.).

## Install Oil Pump and Oil Pump Housing Assembly

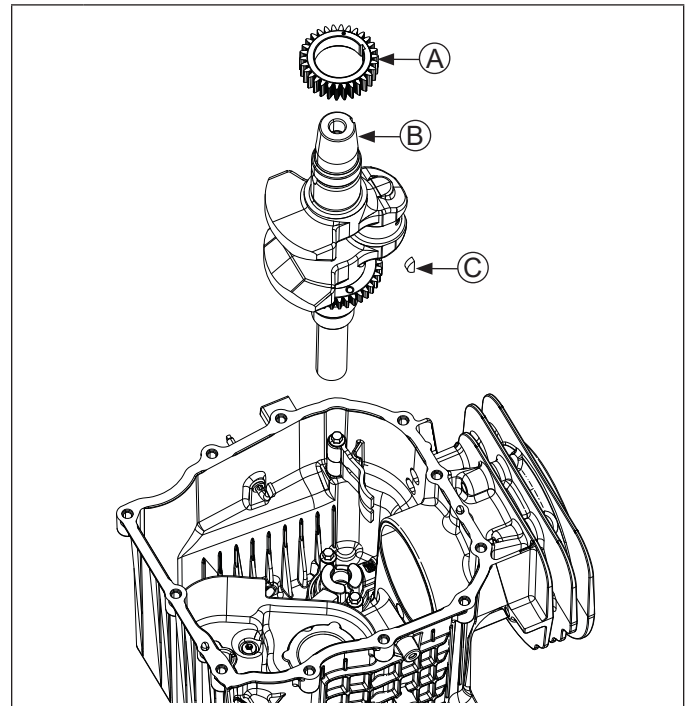


<b>A</b>	Oil Pump Housing Assembly
<b>B</b>	Oil Pump Assembly
<b>C</b>	Oil Pump Housing Screws

1. Lightly grease gerotor gears and set them into crankcase.
2. Install oil pump housing and secure to crankcase with screws; torque screws to 4.8 N·m (42 in. lb.).

3. Install camshaft into oil pump housing; turn to drop into place. Turn camshaft to align timing mark to center of crankshaft PTO bore.
4. Lift camshaft out.

## Install Crankshaft and Crankshaft Gear

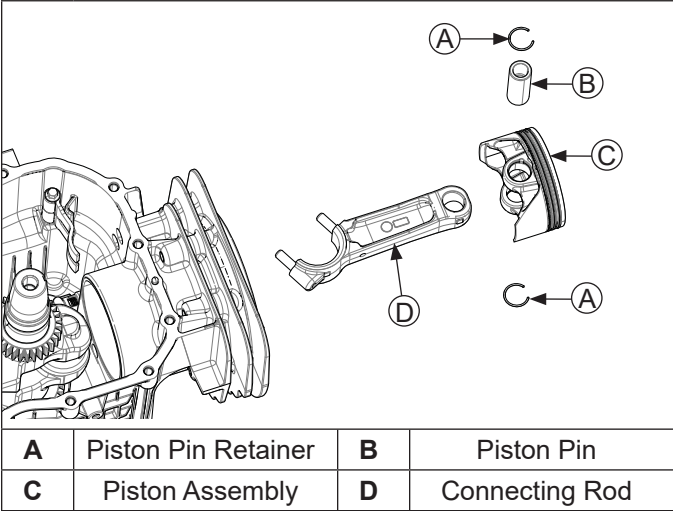


<b>A</b>	Crankshaft Gear
<b>B</b>	Crankshaft
<b>C</b>	Key

1. Carefully install crank gear key in keyway and slide crankshaft gear on crankshaft.
2. Carefully install crankshaft into crankcase, through PTO seal, and seat fully into place.

# Reassembly

## Install Piston to Connecting Rod



Assemble piston, connecting rod, piston pin, and piston pin retainers.

## Install Piston to Connecting Rod

### Connecting Rod Fastener Torque Sequence



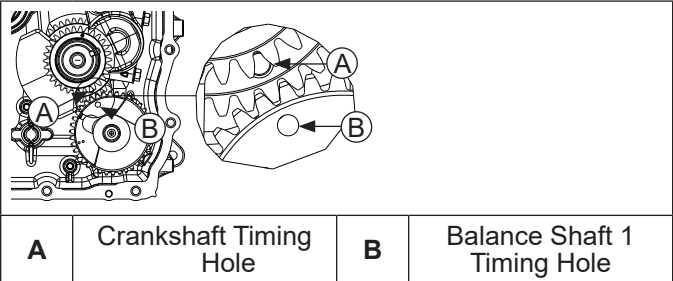
NOTE: Proper orientation of piston/connecting rod inside engine is extremely important. Improper orientation can cause extensive wear or damage.

1. If piston rings were removed, see Disassembly/ Inspection and Service procedure to install rings.
2. Lubricate cylinder bore, crankshaft journal, connecting rod journal, piston, and rings with engine oil.
3. Compress piston rings using a piston ring compressor. Orient FLY mark on piston toward flywheel side of crankcase. Place ring compressor on top surface of crankcase and make certain it is seated down around entire circumference. Use a soft, rubber grip hammer handle and tap piston/ connecting rod into bore. First tap should be rather firm, so oil ring moves from compressor into bore in one smooth, quick motion. Otherwise oil ring rails may spring out and jam between ring compressor and top of bore.

4. Guide connecting rod down and rotate crankshaft to mate journals. Install rod cap.
5. Install screws and torque in 2 increments, in sequence shown, first to 5.5 N·m (50 in. lb.), finally to 11.8 N·m (105 in. lb.).

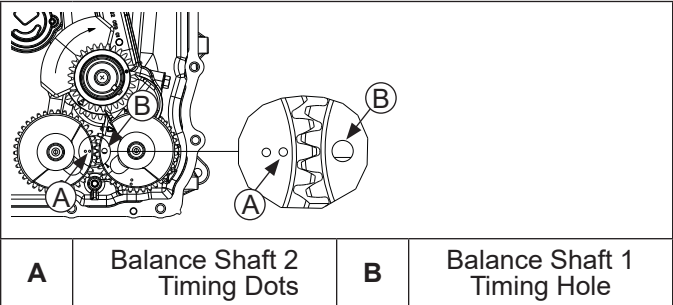
## Install Balance Shafts

### Balance Shaft 1 Timing Mark Detail



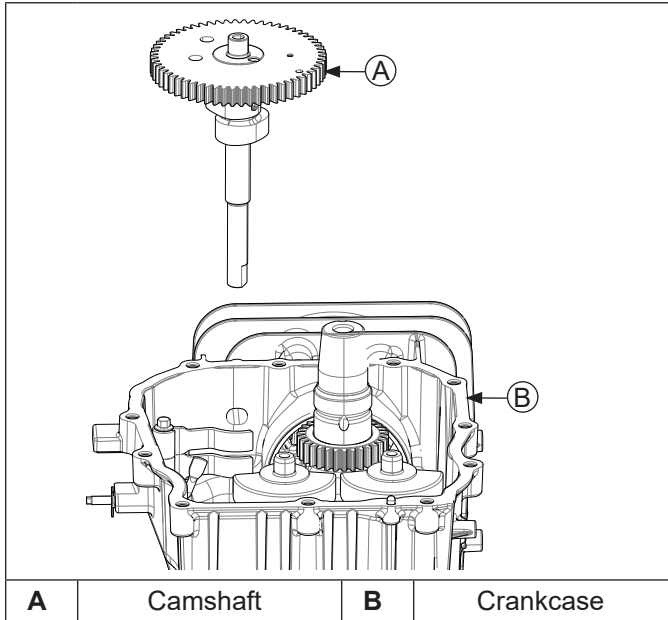
1. Rotate crankshaft clockwise (to move weights) and install balance shaft 1 into crankcase aligning timing hole in balance shaft 1 with timing hole on crank gear.

### Balance Shaft 2 Timing Mark Detail



2. Rotate crankshaft clockwise again (to move weights toward oil pump) and install balance shaft 2 aligning 2 dots on balance shaft 2 with 1 hole in balance shaft 1.
3. Rotate crankshaft to TDC.

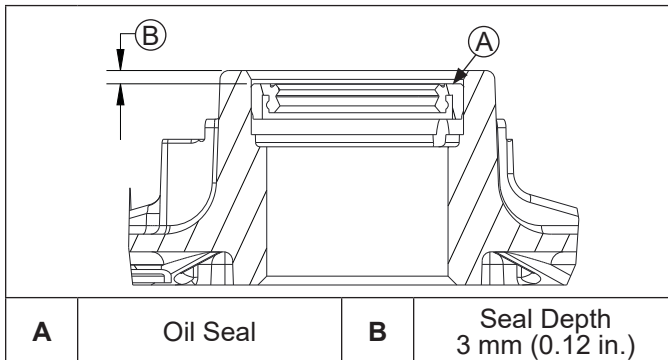
## Install Camshaft



1. Ensure cam levers are in proper position toward cylinder.
2. Install camshaft aligning timing mark with crankshaft gear mark. Proper installation places cam gear below crankcase surface.

## Install Flywheel Side Oil Seal

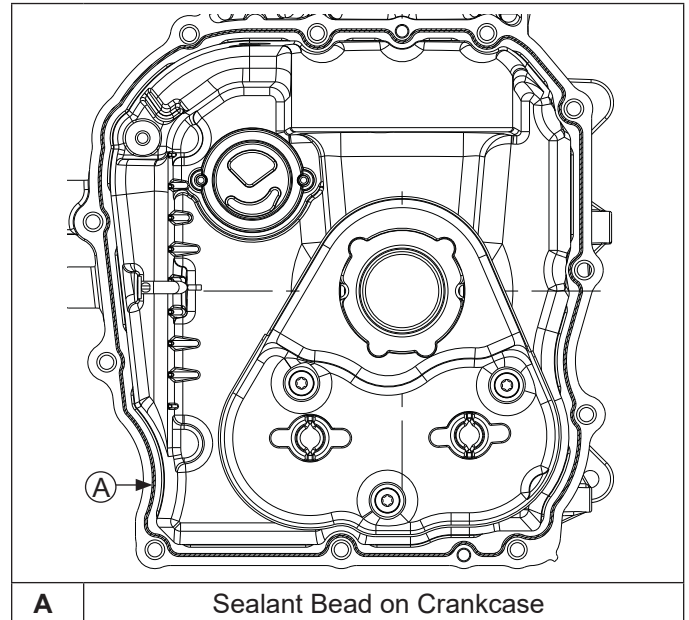
### Oil Seal Depth Details



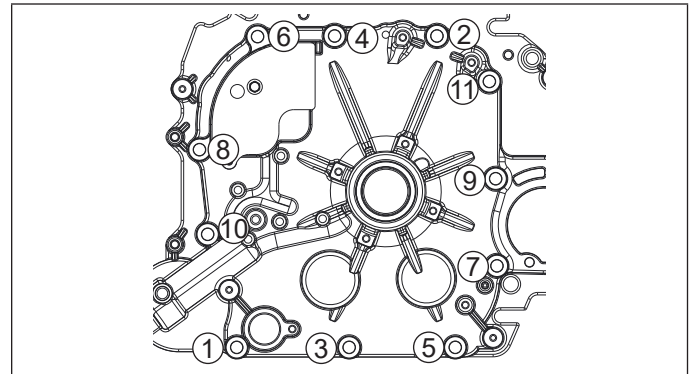
Lubricate outside diameter and lip of flywheel end oil seal. Support closure plate and install oil seal. Using a seal driver, drive seal to a depth of 3 mm (0.12 in.) in seal bore.

## Install Closure Plate

### Closure Plate Sealant Pattern on Crankcase



### Closure Plate Fastener Torque Sequence



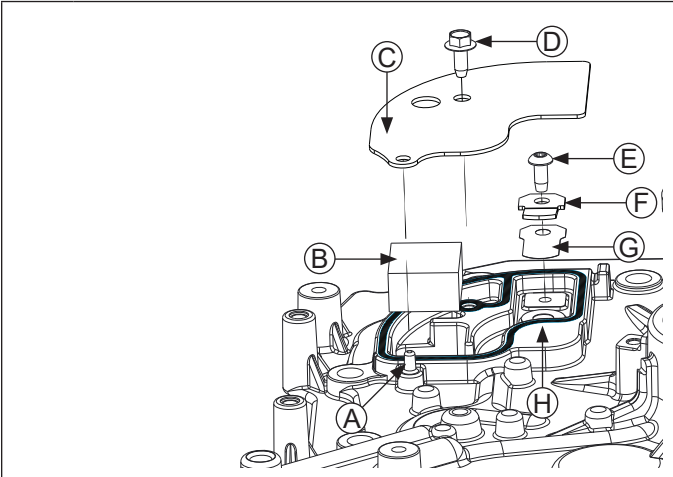
**NOTE:** Always use fresh sealant. Using outdated sealant can result in leakage. Refer to Tools and Aids for a listing of approved sealants.

1. Make sure sealing surfaces of crankcase and closure plate are clean, dry, and free of any nicks or burrs.
2. Ensure oil passage cover gasket, oil passage cover, and governor gear assembly, have been properly assembled to closure plate. As closure plate is lowered into position, rotate crankshaft slightly to help engage governor gear.
3. Install screws securing closure plate to crankcase.
4. Torque closure plate fasteners to 24.0 N·m (212 in. lb.) using sequence shown.

# Reassembly

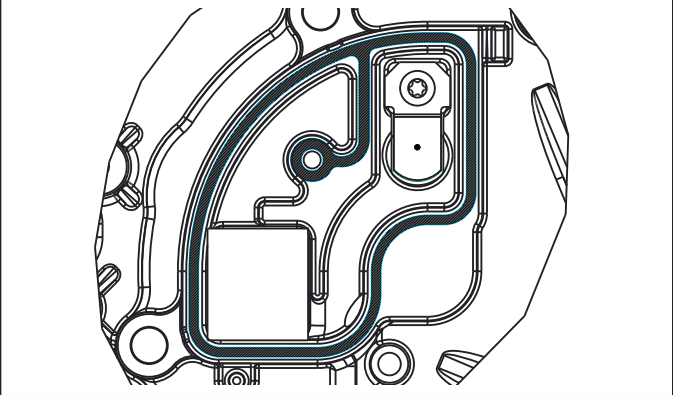
## Install Breather

### Components



A	Breather Cover Alignment Pin	B	Breather Filter
C	Breather Cover	D	Cover Screw
E	Breather Reed Screw	F	Reed Retainer
G	Breather Reed	H	Sealant Bead

## Breather Cover Sealant Pattern

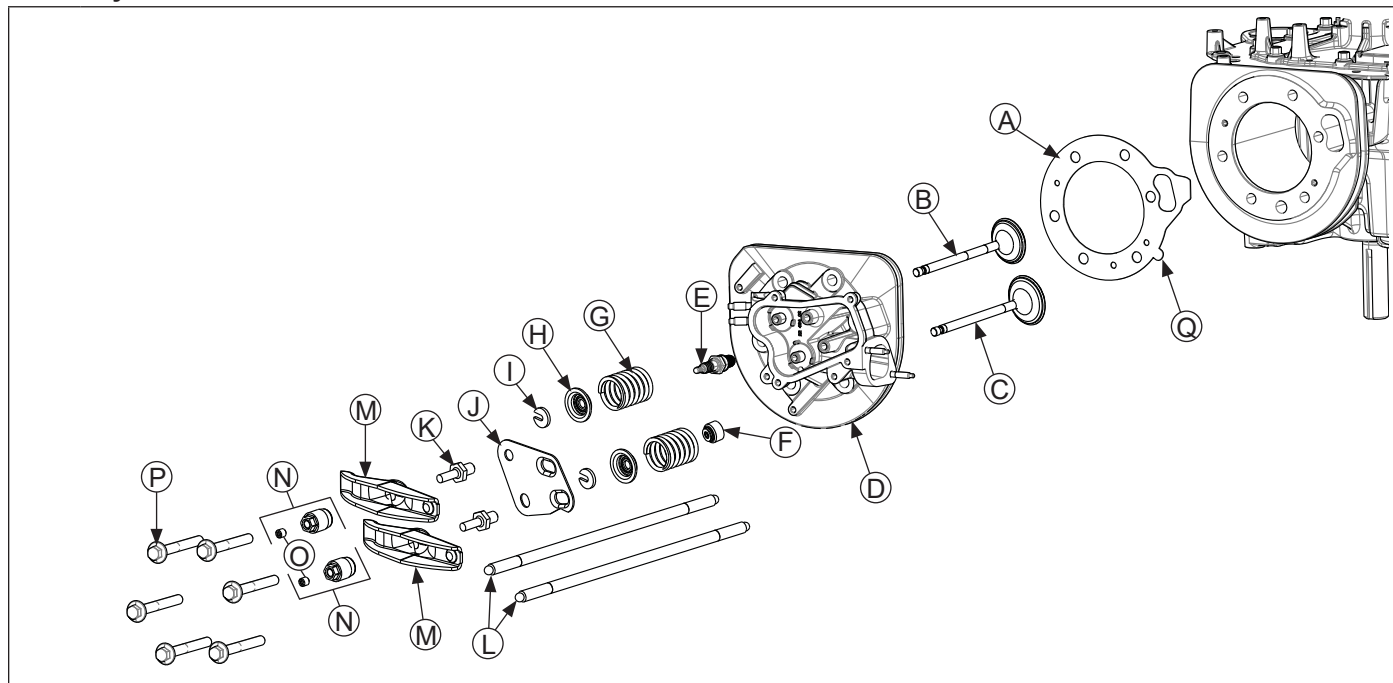


**A** Sealant Bead on Closure Plate

**NOTE:** Always use fresh sealant. Using outdated sealant can result in leakage. Refer to Tools and Aids for a listing of approved sealants.

1. Install breather filter into closure plate.
2. Install breather reed and reed retainer; hold them in alignment and secure with screw. Torque screw to 6.5 N·m (58 in. lb.).
3. Make sure sealing surfaces are clean and free of nicks or damage.
4. Apply a 1.5 mm (1/16 in.) bead of RTV sealant to breather cover sealing surface of closure plate as shown. Bead must surround entire screw hole.
5. Position a new breather cover on alignment pin and secure with screw. Torque screw to 6.5 N·m (58 in. lb.).
6. Install breather hose into breather cover.

## Install Cylinder Head



<b>A</b>	Cylinder Head Gasket	<b>B</b>	Exhaust Valve	<b>C</b>	Intake Valve	<b>D</b>	Cylinder Head
<b>E</b>	Spark Plug	<b>F</b>	Valve Stem Seal	<b>G</b>	Valve Spring	<b>H</b>	Valve Spring Cap
<b>I</b>	Retainer Lock	<b>J</b>	Push Rod Guide Plate	<b>K</b>	Rocker Stud	<b>L</b>	Push Rod
<b>M</b>	Rocker Arm	<b>N</b>	Rocker Pivot Assembly	<b>O</b>	Set Screw	<b>P</b>	Cylinder Head Screw
<b>Q</b>	Tab						

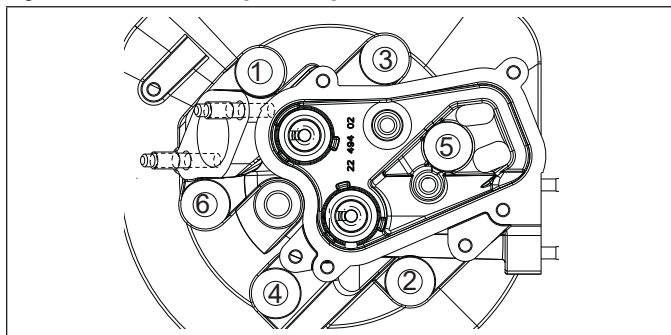
### Assemble Cylinder Head

Prior to assembly, lubricate all components with engine oil, including tips of valve stems and valve guides. Using a valve spring compressor, install following items in order listed.

- Valve spring seal (intake valve only).
- Intake and exhaust valves.
- Valve springs.
- Valve spring caps.
- Valve spring retainer locks.

### Install Cylinder Head

#### Cylinder Head Torque Sequence



**NOTE:** Do not reuse cylinder head screws or gasket, always replace with new parts.

**NOTE:** If crankshaft has not been turned since installation of crank gear, turn it one (1) complete revolution. This will set piston at top dead center (TDC) of compression stroke, for proper valve lash adjustment later.

1. Check to make sure there are no nicks or burrs on sealing surfaces of cylinder head or crankcase.
2. Install a new cylinder head gasket with tab on gasket in 4 o'clock position.
3. Install cylinder head and start six screws.
4. Using torque sequence shown, torque cylinder head screws in two stages; initially to 24.4 N·m (216 in. lb.), and finally to 42.7 N·m (378 in. lb.).

### Install Rocker Arms and Push Rods

**NOTE:** Installation and seating of push rods into cam lever recesses during this sequence is critical. Position engine with cylinder head up if possible, to aid with proper installation of push rods and rocker arms, and adjusting valve lash.

**NOTE:** If being reused, push rods should always be installed in their original position.

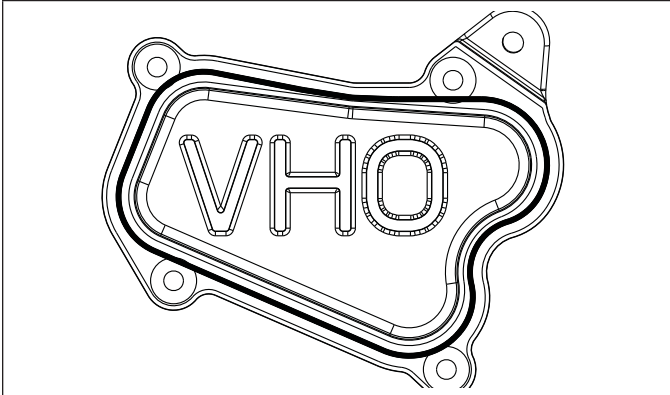


## Reassembly

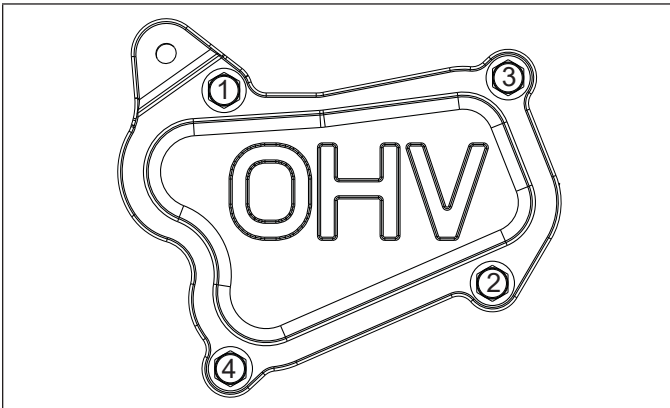
1. Position push rod guide plate on cylinder head with extruded edges down over push rod bores. Secure by installing rocker arm pivot studs. Torque studs to 13.5 N·m (120 in. lb.).
2. Note mark or tag identifying push rod as either intake or exhaust. Apply grease to ends of push rods. Insert push rods into push rod bores and seat lower end into dimpled recess of cam levers. It may be necessary to lift or shift lower end of push rod slightly, and feel rod seats into recess.
3. Apply grease to contact surfaces of rocker arms and adjusting nuts and install them onto pivot studs.
4. With engine at TDC of compression stroke, insert a 0.127 mm (0.005 in.) flat feeler gauge between end of 1 valve and rocker arm. Turn adjustment nut with a wrench until a slight drag is felt on feeler gauge. Hold nut in position and torque set screw (T15 Torx drive) to 5.5 N·m (50 in. lb.). To prevent damage to nut, torque Torx screw only. Perform adjustment procedure on other valve. After tightening, recheck adjustment. Proper valve clearance is 0.101/0.152 mm (0.004/0.006 in.).

### Install Valve Cover

#### Valve Cover Sealant Pattern



#### Valve Cover Torque Sequence



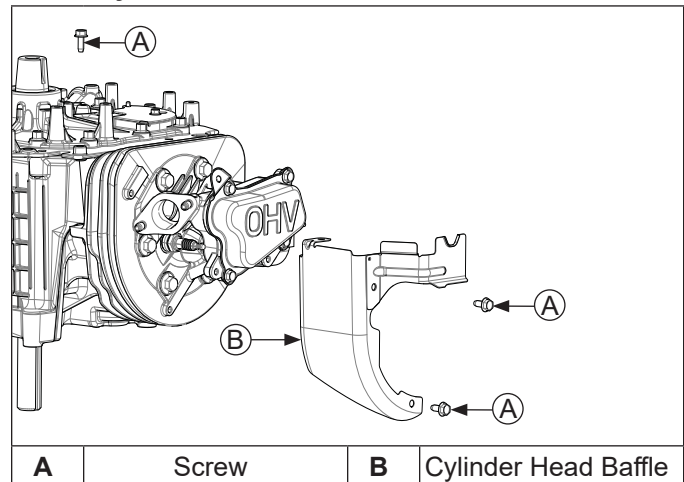
NOTE: Always use fresh sealant. Using outdated sealant can result in leakage. Refer to Tools and Aids for a listing of approved sealants.

1. Make sure sealing surfaces of valve cover and cylinder head are clean, and free of any nicks or burrs.
2. Apply a 1.5 mm (1/16 in.) bead of sealant to valve cover as shown. Position valve cover and start mounting screws.
3. Torque valve cover screws to 12.9 N·m (114 in. lb.) into new holes, or 6.8 N·m (60 in. lb.) into used holes, using sequence shown.

### Install Spark Plug

1. Check gap using wire feeler gauge. Adjust gap to 0.76 mm (0.030 in.).
2. Install plug into cylinder head.
3. Torque plug to 27 N·m (20 ft. lb.).

### Install Cylinder Head Baffle

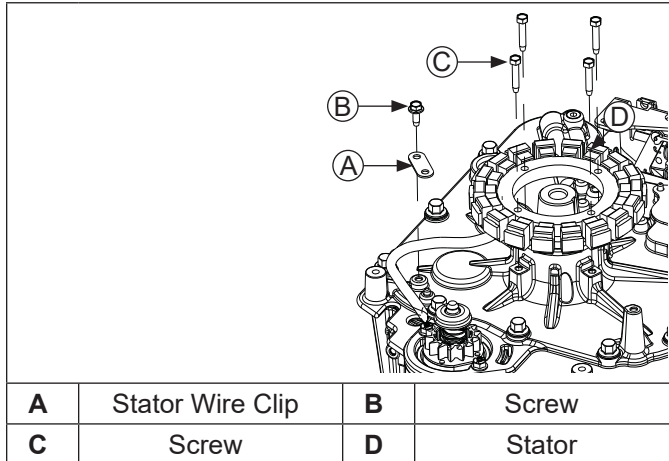


Install screws securing baffle to cylinder head. Leave screw securing baffle to crankcase loose. Torque screws to 9.3 N·m (82 in. lb.) into new holes, or 4.0 N·m (35 in. lb.) into used holes.

### Install Electric Starter

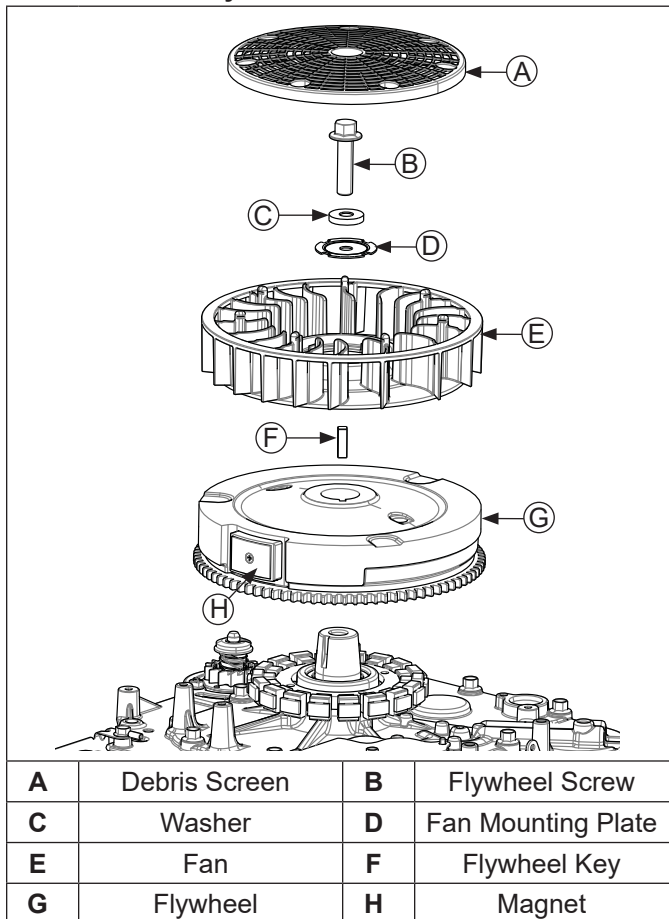
Install electric starter to closure plate and secure with nuts. Torque nuts to 3.8 N·m (34 in. lb.).


## Install Stator



1. Position stator onto mounting bosses so leads lay in channel and recess of closure plate.
2. Install screws to secure stator. Torque to 8.8 N·m (78 in. lb.).
3. Install stator wire clip and secure to closure plate. Torque screw to 6.5 N·m (58 in. lb.).

## Install Fan and Flywheel





**CAUTION**

Damaging Crankshaft and Flywheel can cause personal injury.

Using improper procedures can lead to broken fragments. Broken fragments could be thrown from engine. Always observe and use precautions and procedures when installing flywheel.

**NOTE:** Before installing flywheel make sure crankshaft taper and flywheel hub are clean, dry and completely free of lubricants. Presence of lubricants can cause flywheel to be overstressed and damaged when mounting screw is torqued to specification.

**NOTE:** Make sure flywheel key is installed properly in keyway. Flywheel can become cracked or damaged if key is not properly installed.

**NOTE:** Always use a flywheel strap wrench or flywheel holding tool to hold flywheel when tightening flywheel fastener. Do not use any type of bar or wedge between cooling fins or flywheel ring gear, as these parts could become cracked or damaged.

1. Install flywheel onto crankshaft aligning keyway with key. Be careful not to shift or unseat key.
2. Install key into crankshaft keyway. Make sure key is fully seated.
3. Position fan onto flywheel, so locating pins drop into corresponding recesses.
4. Install fan mounting plate onto fan, aligning four cutouts, followed by heavy flat washer and screw.
5. Use a flywheel strap wrench or holding tool to hold flywheel and torque screw. Torque to 115 N·m (85 ft. lb.).
6. Snap debris screen onto cooling fan.

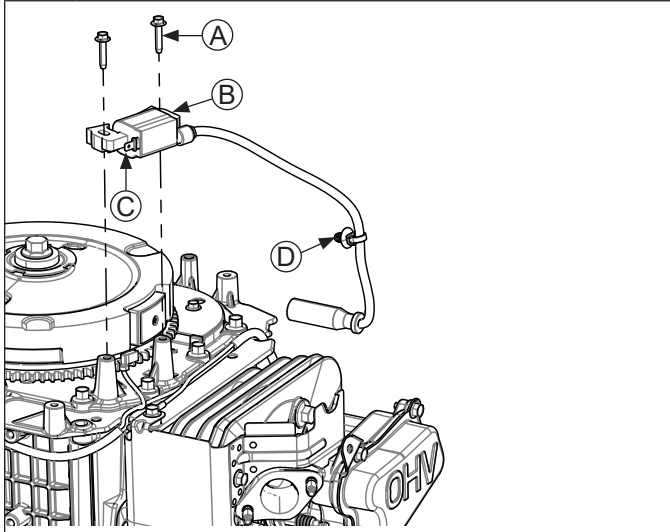
## Install Wiring Harness

1. On starter side of engine, secure wiring harness clip from below closure plate. On cylinder head side of engine, secure wiring harness clip from above closure plate.
2. Remove cylinder head baffle screw and secure ground lead. Torque screw to 9.3 N·m (82 in. lb.) into new hole, or 4.0 N·m (35 in. lb.) into used hole.
3. Check that locking tang on terminal of violet B+ wiring harness lead is angled upward. Insert terminal into center location of rectifier-regulator plug connector until it locks into place. If not already inserted, two AC leads from stator go in outer locations.



# Reassembly

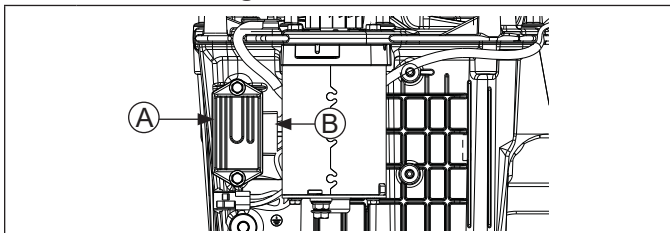
## Install Ignition Module



<b>A</b>	Screw	<b>B</b>	Ignition Module
<b>C</b>	Tab Terminal	<b>D</b>	Wire Tie

1. Rotate flywheel so magnet is away from ignition module bosses. Using screws, install ignition module to crankcase bosses. Move module as far away from flywheel as possible. Tighten screws sufficiently to keep module in position.
2. Rotate flywheel to align magnet with ignition module.
3. Insert a 0.25 mm (0.010 in.) flat feeler gauge between magnet and ignition module. Loosen screws so magnet pulls module against feeler gauge.
4. Torque screws to 8.8 N·m (78 in. lb.) into new holes, or 3.4 N·m (30 in. lb.) into used holes.
5. Rotate flywheel back and forth checking for clearance between magnet and ignition module. Make sure magnet does not strike module. Recheck air gap with a feeler gauge and readjust if necessary. Final air gap: 0.203/0.305 mm (0.008/0.012 in.).
6. Connect kill lead to tab terminal on ignition module.
7. Secure spark plug lead wire tie into valve cover.

## Install Rectifier-Regulator



<b>A</b>	Rectifier-Regulator	<b>B</b>	Connector
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1. Attach connector to rectifier-regulator terminals.
2. Using M6 screws, mount rectifier-regulator onto crankcase bosses, with cooling fins out. Torque screws to 8.8 N·m (78 in. lb.).

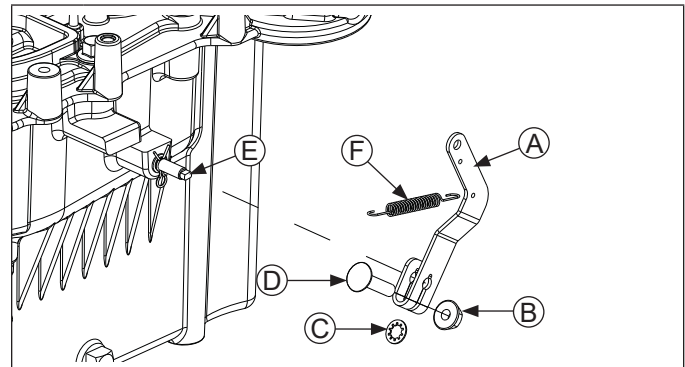
## Install Oil Sentry™ or Pipe Plug

Apply pipe sealant with Teflon® (Loctite® PST® 592™ Thread Sealant or equivalent), to threads of 1/8" pipe plug. Install and tighten into port on closure plate. Torque pipe plug to 4.5-5.0 N·m (40-45 in. lb.). If a switch was installed, apply sealant to threads of Oil Sentry™ switch and install into port on closure plate. Torque switch to 6.2 N·m (55 in. lb.). Connect wiring harness lead or connector to switch. Wire tie leads to switch.

## Install Oil Fill Tube

Install tube into closure plate and secure with screw. Torque screw to 6.5 N·m (58 in. lb.) into new holes, or 3.4 N·m (30 in. lb.) into used holes.

## Install Governor Lever

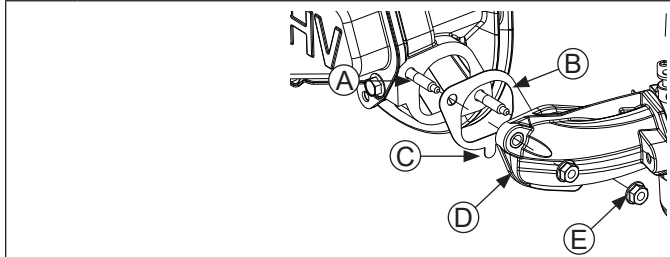


<b>A</b>	Governor Lever	<b>B</b>	Nut
<b>C</b>	Lock Washer	<b>D</b>	Round Head Bolt
<b>E</b>	Governor Cross Shaft	<b>F</b>	Governor Spring

NOTE: It is recommended a new governor lever be installed whenever removal is performed.

1. Install governor lever onto governor shaft with lever section up.
2. Insert lock washer into governor lever; secure lever with bolt and nut.
3. Install governor spring (long end loop) in governor lever.

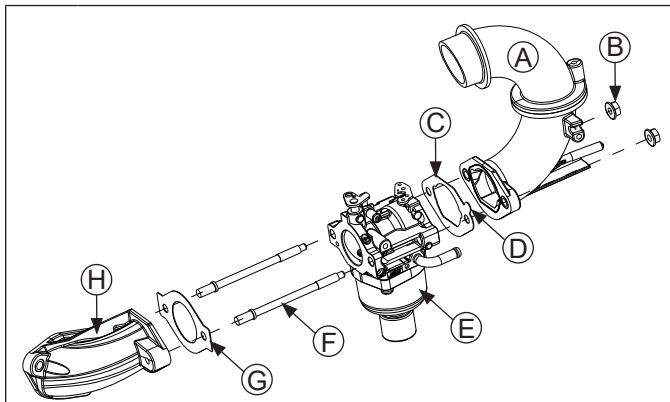
## Install Intake Manifold



<b>A</b>	Intake Port Stud	<b>B</b>	Intake Manifold Gasket
<b>C</b>	Indicator Tab Down	<b>D</b>	Intake Manifold
<b>E</b>	Nut		

1. Install a new gasket on intake port studs with Indicator tab on gasket pointing down.
2. Slide intake manifold onto intake port studs and start nuts on studs. Torque nuts to 10.2 N·m (90 in. lb.).

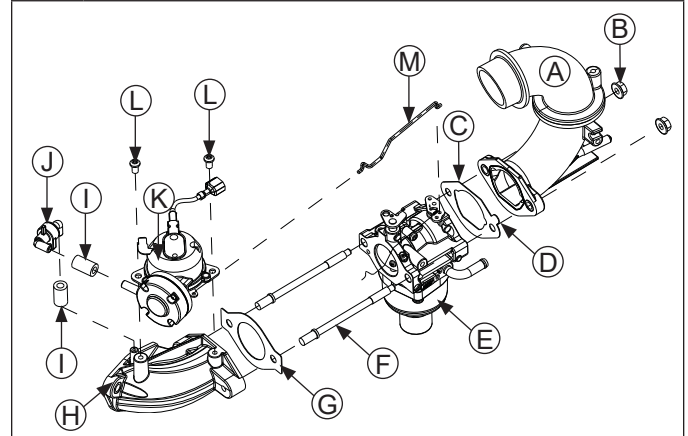
## Install Carburetor Standard Choke



<b>A</b>	Air Cleaner Adapter	<b>B</b>	Nut
<b>C</b>	Carburetor Gasket (Choke)	<b>D</b>	Indicator Tab Up (on Fuel Inlet Side)
<b>E</b>	Carburetor	<b>F</b>	Stud
<b>G</b>	Carburetor Gasket (Throttle)	<b>H</b>	Intake Manifold

1. Install studs into intake manifold. Torque to 4.3 N·m (38 in. lb.).
2. Install carburetor gasket (throttle) on studs, followed by carburetor.
3. Install carburetor gasket (choke) with indicator tab up (on fuel inlet side) on studs, follow by air cleaner adapter. Secure with nuts. Torque to 9 N·m (80 in. lb.).
4. Install choke linkage into choke lever on carburetor.
5. Install bushing into throttle lever on carburetor. Install throttle linkage and linkage spring into throttle lever.

## Smart-Choke™

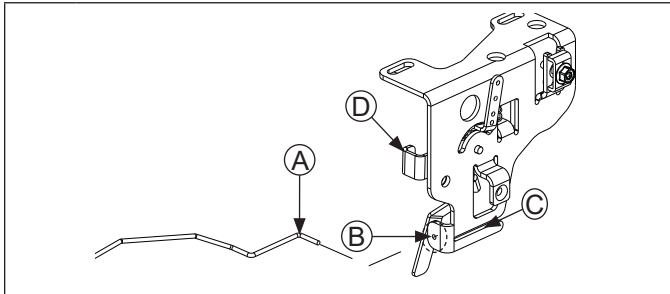


<b>A</b>	Air Cleaner Adapter	<b>B</b>	Nut
<b>C</b>	Carburetor Gasket (Choke)	<b>D</b>	Indicator Tab Up (on Fuel Inlet Side)
<b>E</b>	Carburetor	<b>F</b>	Stud
<b>G</b>	Carburetor Gasket (Throttle)	<b>H</b>	Intake Manifold
<b>I</b>	Vacuum Hose	<b>J</b>	Check Valve Assembly
<b>K</b>	Diaphragm Assembly	<b>L</b>	K40 x 1.79 Screw
<b>M</b>	Smart-Choke™ Linkage		

1. Install studs into intake manifold. Torque to 4.3 N·m (38 in. lb.).
2. Install carburetor gasket (throttle) on studs, followed by carburetor.
3. Install carburetor gasket (choke) with indicator tab up (on fuel inlet side) on studs, follow by air cleaner adapter. Secure with nuts. Torque to 9 N·m (80 in. lb.).
4. Install Smart-Choke™ linkage to choke lever on carburetor.
5. Assemble vacuum hoses to check valve, then assemble to Smart-Choke™ assembly.
6. Install other end of Smart-Choke™ linkage into lever of Smart-Choke™ assembly.
7. Attach vacuum hose to intake manifold and secure Smart-Choke™ assembly to manifold. Torque screws to 1 N·m (9 in. lb.).
8. Install bushing into throttle lever on carburetor. Install throttle linkage and linkage spring into throttle lever.

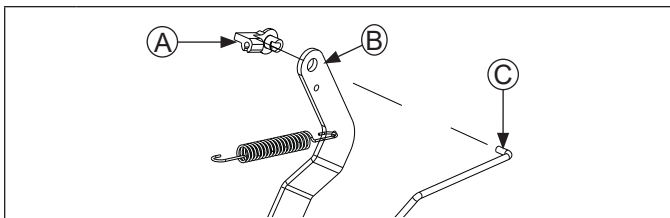
# Reassembly

## Connect Wire Controls



<b>A</b>	Choke Linkage	<b>B</b>	Control Bracket Lower Hole
<b>C</b>	Control Bracket Slot	<b>D</b>	Governor Spring Location in Control Bracket

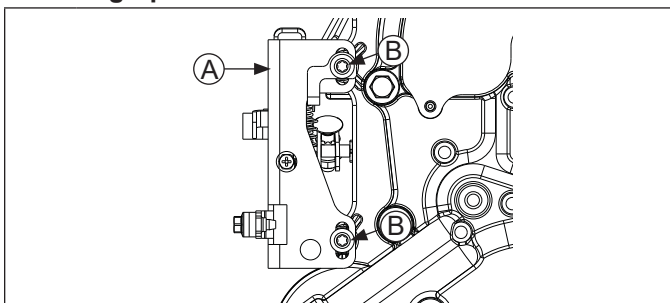
1. If engine has Standard Choke Single Wire Controls, position choke linkage from carburetor into lower hole in speed control bracket and out lower slot.



<b>A</b>	Throttle Linkage Bushing	<b>B</b>	Governor Lever
<b>C</b>	Throttle Linkage		

2. Insert throttle linkage bushing into governor lever; insert throttle linkage into governor lever and secure with bushing.
3. Move governor lever toward carburetor, to limit of its travel (wide-open throttle) and hold in this position. Do not apply excessive pressure, flexing or distorting linkage. Grasp cross shaft with a pliers, and turn shaft counterclockwise as far as it will go. Torque nut to 7.7 N·m (68 in. lb.).

## Mounting Speed Control Bracket



<b>A</b>	Speed Control Bracket	<b>B</b>	Screw
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1. Attach governor spring to throttle lever of speed control bracket.

2. Attach speed control bracket to mounting locations on engine with M6 screws. Position bracket as marked during disassembly. Torque screws to 11.3 N·m (100 in. lb.) into new holes, or 7.5 N·m (65 in. lb.) into used holes.

## Governor Spring Detail

### KS530

RPM	Throttle Stop	Governor Spring Color
3600	Yes	Brown
3450	Yes	Brown
3400	Yes	Yellow
3300	Yes	Yellow
3200	Yes	Yellow
2800	Yes	Yellow

### KS540

RPM	Throttle Stop	Governor Spring Color
3600	Yes	Yellow
3450	Yes	Yellow
3400	Yes	Yellow
3300	Yes	Brown
3200	Yes	Yellow
2800	Yes	Blue

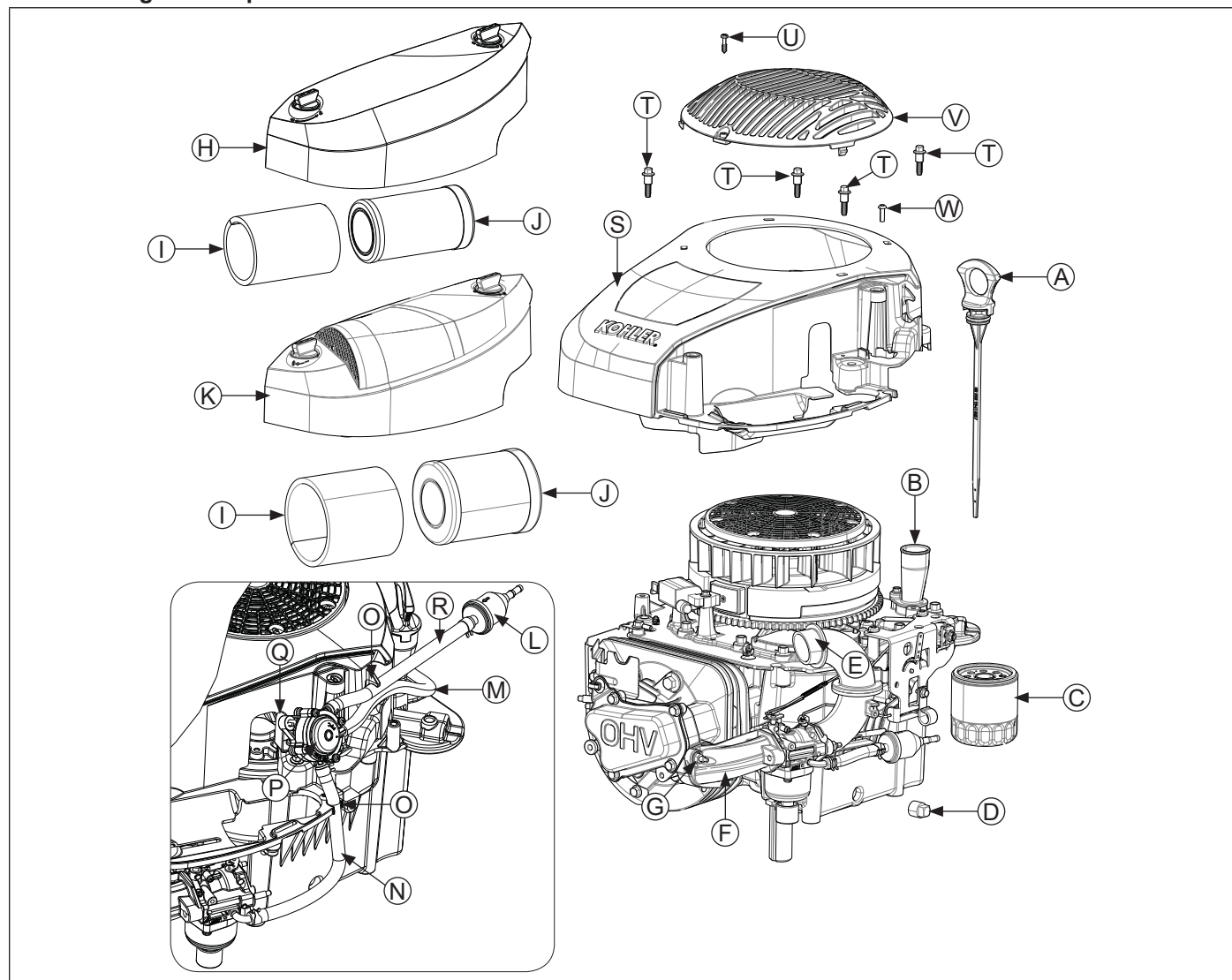
### KS590

RPM	Throttle Stop	Governor Spring Color
3600	Yes	Red
3450	Yes	Red
3400	Yes	Yellow
3300	Yes	Yellow
3200	Yes	Yellow
2800	Yes	Blue

### KS595

RPM	Throttle Stop	Governor Spring Color
3600	No	Red
3450	No	Red
3400	No	Brown
3300	No	Brown
3200	No	Brown
2800	No	Blue

## External Engine Components



<b>A</b>	Oil Fill/Dipstick	<b>B</b>	Oil Fill/Dipstick Tube	<b>C</b>	Oil Filter	<b>D</b>	Oil Drain Plug
<b>E</b>	Air Cleaner Adapter	<b>F</b>	Intake Manifold	<b>G</b>	Intake Manifold Nut	<b>H</b>	Standard Air Cleaner Cover
<b>I</b>	Precleaner	<b>J</b>	Paper Element	<b>K</b>	PRO Air Cleaner Cover	<b>L</b>	Fuel Filter
<b>M</b>	Pulse Line	<b>N</b>	Outlet Fuel Line	<b>O</b>	Line Retained in Housing	<b>P</b>	Fuel Pump
<b>Q</b>	Fuel Pump Bracket	<b>R</b>	Inlet Fuel Line	<b>S</b>	Blower Housing	<b>T</b>	Blower Housing to Closure Plate Screw
<b>U</b>	Fixed Guard Screw	<b>V</b>	Fixed Guard	<b>W</b>	Blower Housing to Adapter Screw		

# Reassembly

## Install Blower Housing

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1. Position blower housing on engine.
2. Align mounting locations, then install M6 shouldered mounting screws.  
Torque screws to 11.3 N·m (100 in. lb.) into new holes, or 6.8 N·m (60 in. lb.) into used holes.
3. Install T15 screw securing blower housing to air cleaner adapter. Torque screw to 1 N·m (9 in. lb.).

## Install Fixed Guard (if equipped)

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Install fixed guard. Torque screw to 0.8 N·m (7 in. lb.).

## Install Fuel Pump (if equipped)

---

1. Attach fuel pump mounting bracket to blower housing with screw. Torque screw to 1 N·m (9 in. lb.).
2. Install fuel pump so pulse fitting is oriented in three o'clock position, pressing fuel pump onto bracket past locking tabs.

NOTE: If necessary, carefully rebend locking tabs to ensure fuel pump is secured.

3. Connect pulse line to dipstick tube and fuel line to carburetor inlet fitting and secure with clamps.
4. Route fuel lines into retaining cutouts in blower housing.

## Install Air Cleaner Element, Precleaner, and Air Cleaner Cover

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1. Install precleaner (if equipped) over new paper element and install on air cleaner adapter. Secure element behind retainer in housing.
2. Position air cleaner cover on housing and line up knobs with unlock symbol. Turn knobs toward lock symbol to secure.

## Install Drain Plug, Oil Filter, and Oil

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1. Install oil drain plug. Torque plug to 14 N·m (125 in. lb.).
2. Place new filter in shallow pan with open end up. Fill with new oil until oil reaches bottom of threads. Allow 2 minutes for oil to be absorbed by filter material.
3. Apply a thin film of clean oil to rubber gasket on new filter.
4. Refer to instructions on oil filter for proper installation.
5. Fill crankcase with new oil. Level should be at top of indicator on dipstick.
6. Reinstall and secure oil fill cap/dipstick.

## Prepare Engine for Operation

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Engine is now completely reassembled. Before starting or operating engine, be sure following have been done.

1. All hardware is tightened securely.
2. Oil drain plug, Oil Sentry™ pressure switch (if equipped), and a new oil filter are installed.
3. Crankcase is filled with correct amount, weight, and type of oil.

## Connect Spark Plug Lead

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Connect lead to spark plug.

## Testing Engine

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It is recommended engine be operated on a test stand or bench prior to installation in piece of equipment.

1. Set engine up on a test stand. Install an oil pressure gauge. Start engine and check to be certain oil pressure (5 psi or more) is present.
2. Run engine for 5-10 minutes between idle and mid-range. Adjust throttle and choke controls and high-speed setting as necessary. Make sure maximum engine speed does not exceed equipment manufacturer's recommended RPM. Adjust carburetor idle speed screw as necessary. Refer to Fuel System and Governor System.











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