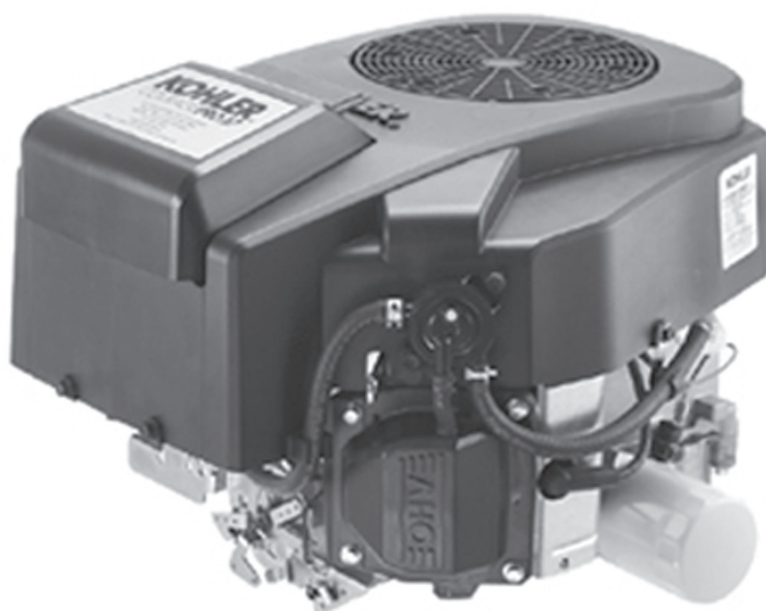


# *SERVICE MANUAL*

**KOHLER<sup>®</sup> COURAGE SV710-740**

**KOHLER<sup>®</sup> COURAGE PRO SV810-840**

**VERTICAL CRANKSHAFT**



**KOHLER<sup>®</sup>**  
ENGINES



# Contents

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Section 1. Safety and General Information .....	1
Section 2. Tools & Aids .....	2
Section 3. Troubleshooting .....	3
Section 4. Air Cleaner and Air Intake System .....	4
Section 5. Fuel System and Governor .....	5
Section 6. Lubrication System .....	6
Section 7. Electrical System and Components .....	7
Section 8. Disassembly .....	8
Section 9. Inspection and Reconditioning .....	9
Section 10. Reassembly .....	10
Section 11. Emission Compliance Systems .....	11

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# Section 1

## Safety and General Information

### Safety Precautions

To ensure safe operation please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information. This manual contains safety precautions which are explained below. Please read carefully.



#### WARNING

Warning is used to indicate the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.



#### CAUTION

Caution is used to indicate the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the caution is ignored.

#### NOTE

Note is used to notify people of installation, operation, or maintenance information that is important but not hazard-related.

#### For Your Safety!

*These precautions should be followed at all times. Failure to follow these precautions could result in injury to yourself and others.*

<b>WARNING</b>
<b>Accidental Starts can cause severe injury or death.</b>  Disconnect and ground spark plug leads before servicing.

#### Accidental Starts!

**Disabling engine. Accidental starting can cause severe injury or death.** Before working on the engine or equipment, disable the engine as follows: 1) Disconnect the spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.

<b>WARNING</b>
<b>Rotating Parts can cause severe injury.</b>  Stay away while engine is in operation.

#### Rotating Parts!

Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the engine with covers, shrouds, or guards removed.

<b>WARNING</b>
<b>Hot Parts can cause severe burns.</b>  Do not touch engine while operating or just after stopping.

#### Hot Parts!

Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running - or immediately after it is turned off. Never operate the engine with heat shields or guards removed.

## Section 1

### Safety and General Information

#### **WARNING**



**Explosive Fuel can cause fires and severe burns.**

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

#### **Explosive Fuel!**

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. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use gasoline as a cleaning agent.

#### **WARNING**



**Cleaning Solvents can cause severe injury or death.**

Use only in well ventilated areas away from ignition sources.

#### **Flammable Solvents!**

Carburetor cleaners and solvents are extremely flammable. Keep sparks, flames, and other sources of ignition away from the area. Follow the cleaner manufacturer's warnings and instructions on its proper and safe use. Never use gasoline as a cleaning agent.

#### **WARNING**



**Carbon Monoxide can cause severe nausea, fainting or death.**

Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

#### **Lethal Exhaust Gases!**

Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

#### **CAUTION**



**Electrical Shock can cause injury.**

Do not touch wires while engine is running.

#### **Electrical Shock!**

Never touch electrical wires or components while the engine is running. They can be sources of electrical shock.

#### **WARNING**



**Explosive Gas can cause fires and severe acid burns.**

Charge battery only in a well ventilated area. Keep sources of ignition away.

#### **Explosive Gas!**

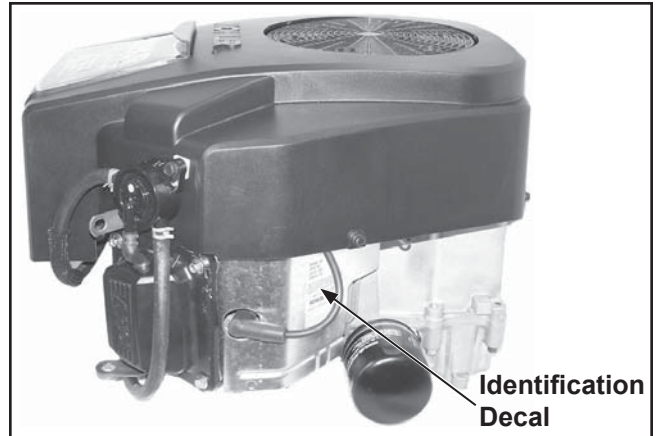
Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries.

Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or gasoline vapors are present.

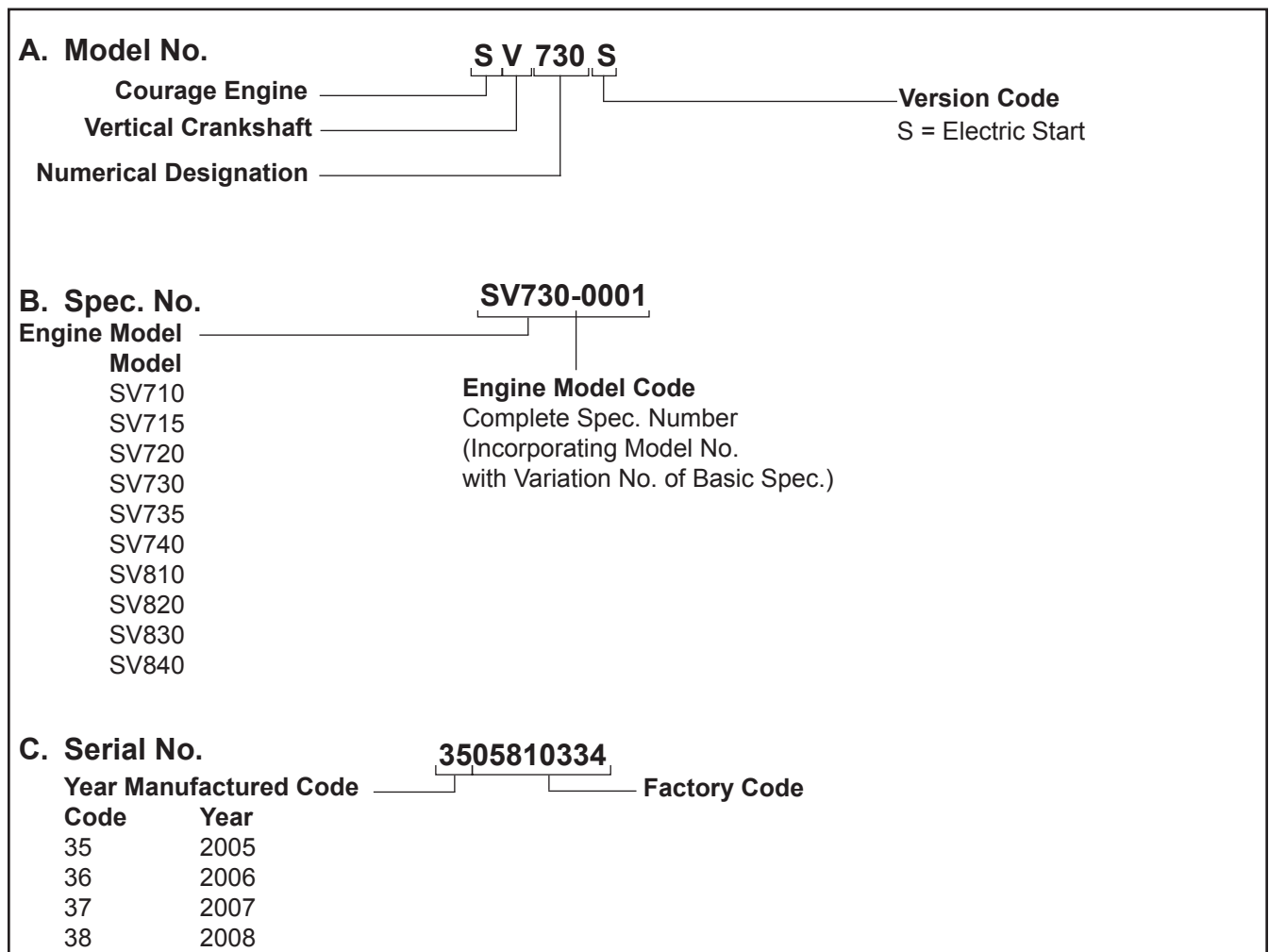
### Engine Identification Numbers

When ordering parts, or in any communication involving an engine, always give the **Model, Specification and Serial Numbers**, including letter suffixes if there are any.

The engine identification numbers appear on a decal, or decals, affixed to the engine shrouding. See Figure 1-1. An explanation of these numbers is shown in Figure 1-2.



**Figure 1-1. Engine Identification Decal Location.**



**Figure 1-2. Explanation of Engine Identification Numbers.**

# Section 1

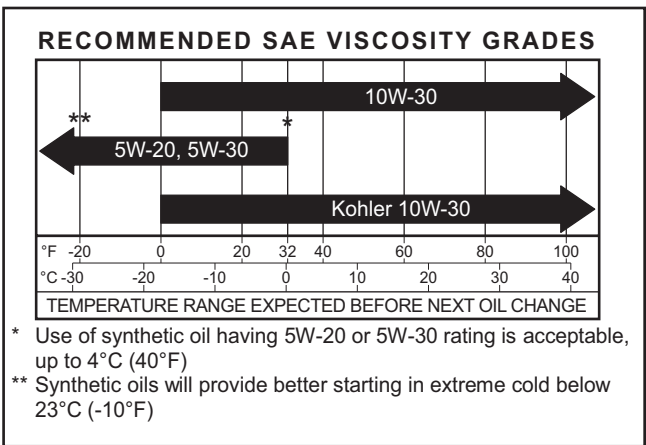
## Safety and General Information

### Oil Recommendations

Using the proper type and weight of oil in the crankcase is extremely important. So is checking oil daily and changing oil regularly. Failure to use the correct oil, or using dirty oil, causes premature engine wear and failure.

#### Oil Type

Use high-quality detergent oil of **API (American Petroleum Institute) Service Class SJ or higher**. Select the viscosity based on the air temperature at the time of operation as shown in the following table.



**NOTE:** Using other than service class SJ or higher oil or extending oil change intervals longer than recommended can cause engine damage.

**NOTE:** Synthetic oils meeting the listed classifications may be used with oil changes performed at the recommended intervals. However, to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade. See Figure 1-3.



**Figure 1-3. Oil Container Logo.**

Refer to Section 6, Lubrication System for detailed procedures on checking the oil, changing the oil and changing the oil filter.

### Fuel Recommendations



#### **WARNING: Explosive Fuel!**

*Gasoline is extremely flammable and its vapors can explode if ignited. Before servicing the fuel system, make sure there are no sparks, open flames or other sources of ignition nearby as these can ignite gasoline vapors. Disconnect and ground the spark plug leads to prevent the possibility of sparks from the ignition system.*

### General Recommendations

Purchase gasoline in small quantities and store in clean, approved containers. A container with a capacity of 2 gallons or less with a pouring spout is recommended. Such a container is easier to handle and helps eliminate spillage during refueling.

Do not use gasoline left over from the previous season, to minimize gum deposits in your fuel system and to ensure easy starting.

Do not add oil to the gasoline.

Do not overfill the fuel tank. Leave room for the fuel to expand.

#### Fuel Type

For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 (R+M)/2 or higher. In countries using the Research Octane Number (RON), it should be 90 octane minimum. Leaded gasoline is not recommended and must not be used on EFI engines or on other models where exhaust emissions are regulated.

#### Gasoline/Alcohol blends

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends including E20 and E85 are not to be used and not approved. Any failures resulting from use of these fuels will not be warranted.

#### Gasoline/Ether blends

Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved.



### Periodic Maintenance Instructions



#### **WARNING: Accidental Starts!**

*Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine as follows: 1) Disconnect the spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.*

### Maintenance Schedule

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 service center.**

Frequency	Maintenance Required	Refer to
<b>Daily Or Before Starting Engine</b>	<ul style="list-style-type: none"> <li>• Fill fuel tank.</li> <li>• Check oil level.</li> <li>• Check air cleaner for dirty<sup>1</sup>, loose, or damaged parts.</li> <li>• Check air intake and cooling areas, clean as necessary<sup>1</sup>.</li> </ul>	Section 5 Section 6 Section 4 Section 4
<b>Annually or Every 25 Hours</b>	<ul style="list-style-type: none"> <li>• Service precleaner element<sup>1</sup> (if equipped).</li> <li>• Service air cleaner element (if not equipped with precleaner).</li> </ul>	Section 4 Section 4
<b>Annually or Every 100 Hours</b>	<ul style="list-style-type: none"> <li>• Replace air cleaner element<sup>1</sup> (if equipped with precleaner).</li> <li>• Change oil and filter. (More frequently under severe conditions).</li> <li>• Remove cooling shrouds and clean cooling areas<sup>1</sup>.</li> <li>• Check that all fasteners are in place and components are properly secured.</li> <li>• Replace fuel filter.</li> <li>• Check spark plug condition and gap.</li> </ul>	Section 4 Section 6 Section 4  Section 5 Section 7
<b>Every 200 Hours</b>	<ul style="list-style-type: none"> <li>• Have valve lash checked/adjusted<sup>2</sup>.</li> </ul>	Section 10
<b>Every 500 Hours</b>	<ul style="list-style-type: none"> <li>• Have bendix starter drive serviced<sup>2</sup>.</li> <li>• Have solenoid shift starter disassembled and cleaned<sup>2</sup>.</li> <li>• Replace spark plug.</li> </ul>	Section 7 Section 7 Section 7

<sup>1</sup>Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.

<sup>2</sup>Have a Kohler Engine Service Dealer perform these services.

### Storage

If the engine will be out of service for two months or more, use the following storage procedure:

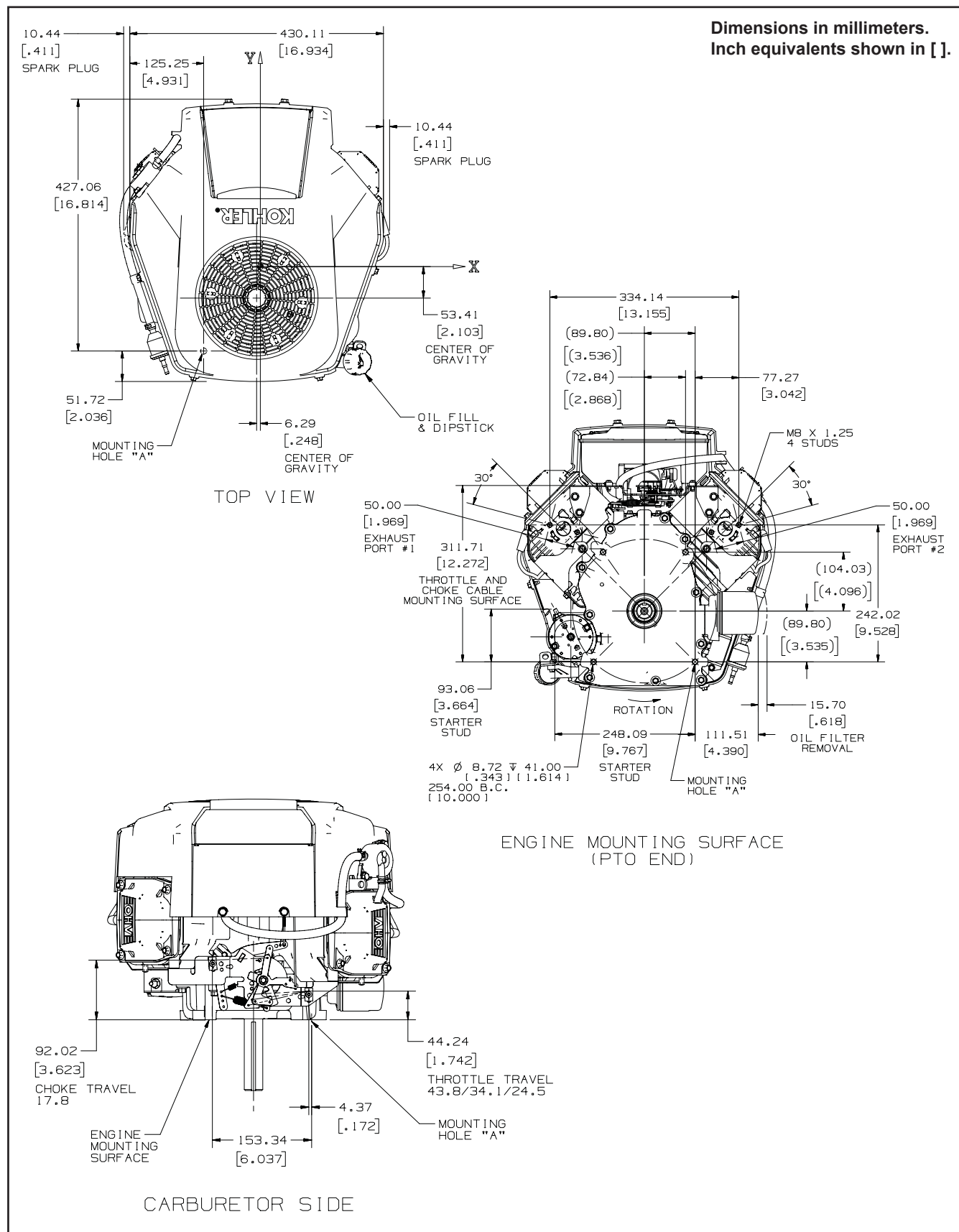
1. Clean the exterior surfaces of the engine. Avoid spraying water at the wiring harness or any of the electrical components.
2. Change the oil and oil filter while the engine is still warm from operation. See Section 6, Change Oil and Oil Filter.
3. The fuel system must be completely emptied, or the gasoline must be treated with a stabilizer to prevent deterioration. If you choose to use a stabilizer, follow the manufacturer's recommendations, and add the correct amount for the capacity of the fuel system.
4. Remove the spark plugs and add one tablespoon of engine oil into each spark plug hole. Install the spark plugs, but do not connect the plug leads. Crank the engine two or three revolutions.
5. Disconnect the battery or use a battery minder to keep the battery charged during storage.
6. Store the engine in a clean, dry place.

Fill the fuel tank with clean, fresh gasoline. Run the engine for 2 to 3 minutes to get stabilized fuel into the rest of the system. Close the fuel shut-off valve when the unit is being stored or transported.

To empty the system, run the engine until the tank and the system is empty.

## Section 1

### Safety and General Information



**Figure 1-4. Typical Engine Dimensions.**

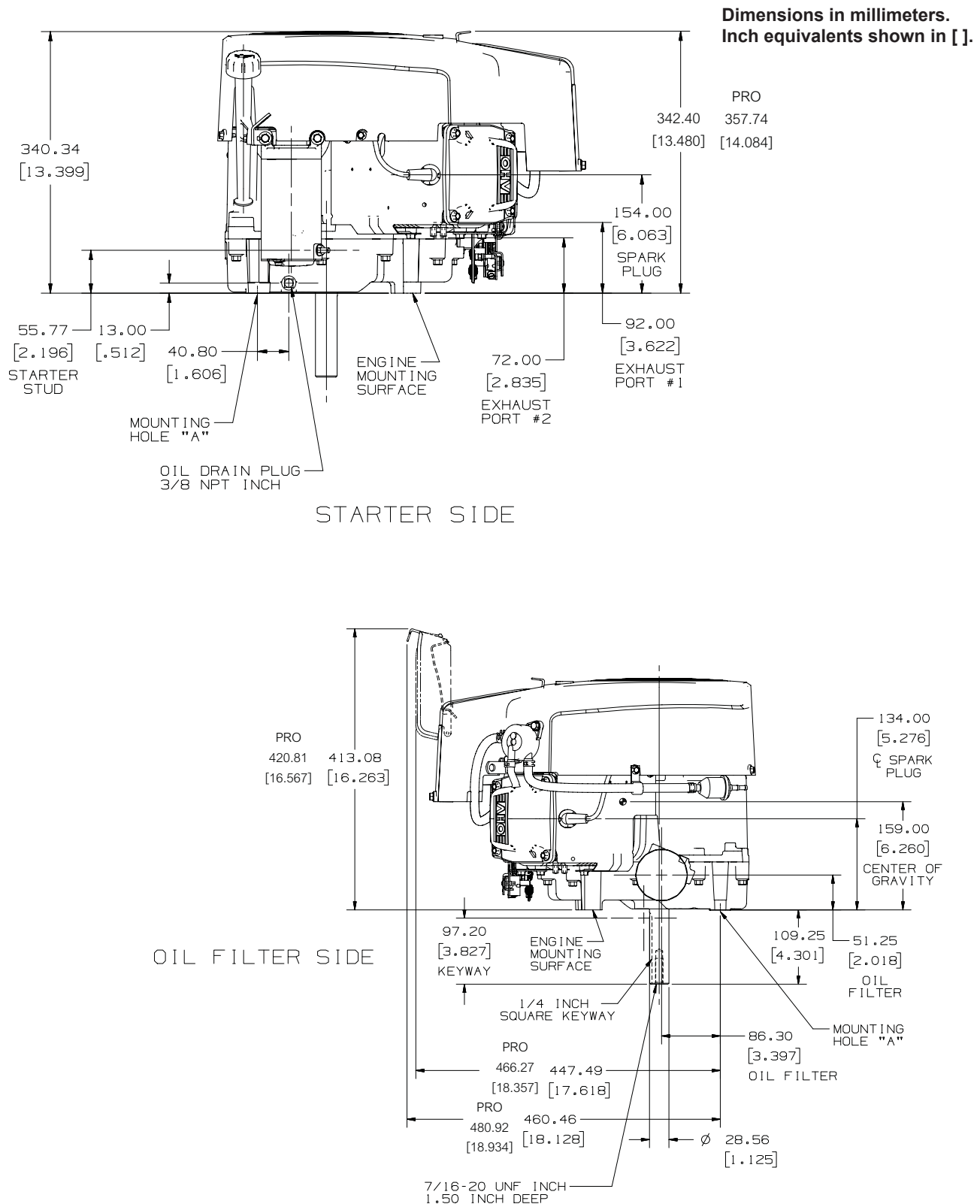


Figure 1-5. Typical Engine Dimensions.

## Section 1

### Safety and General Information

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#### General Specifications<sup>1</sup>

Power (@ 3600 RPM, Horsepower ratings exceed Society of Automotive Engineers Small Engine Test Code J1940.)

SV710, SV810 .....	14.9 kW (20 HP)
SV715 .....	16.4 kW (22 HP)
SV720, SV820 .....	17.2 kW (23 HP)
SV725 .....	17.9 kW (24 HP)
SV730, SV830 .....	18.6 kW (25 HP)
SV735 .....	19.4 kW (26 HP)
SV740, SV840 .....	20.1 kW (27 HP)

Bore .....83 mm (3.27 in.)

Stroke .....67 mm (2.64 in.)

Displacement .....725 cc (44 cu. in.)

Compression Ratio .....9.0:1

Dry Weight .....41.2 kg (91 lb.)

Oil Capacity (w/filter) - approximate,  
determined by oil filter and if oil cooler equipped .....1.6-1.8 L (1.7-1.9 qt)

Angle of Operation - Maximum (At Full Oil Level) All Directions.....25°

#### Blower Housing and Sheet Metal

M4 HI-LO Screws Torque .....2.8 N·m (25 in. lb.)

M5 Fasteners Torque.....4.0 N·m (35 in. lb.)

M6 Fasteners Torque.....6.8 N·m (60 in. lb.)

Rectifier-Regulator Fastener Torque.....4.0 N·m (35 in. lb.)

#### Camshaft

End Play (With Shim).....0.076/0.127 mm (0.0030/0.0050 in.)

Running Clearance.....0.025/0.063 mm (0.0010/0.0025 in.)

Bore I.D.

New.....20.000/20.025 mm (0.7874/0.7884 in.)

Max. Wear Limit .....20.038 mm (0.7889 in.)

Camshaft Bearing Surface O.D.

New.....19.962/19.975 mm (0.7859/0.7864 in.)

Max. Wear Limit .....19.959 mm (0.7858 in.)

#### Carburetor and Intake Manifold

Intake Manifold Mounting Fastener Torque

Torque in Two Stages .....first to 7.4 N·m (66 in. lb.)  
.....finally to 9.9 N·m (88 in. lb.)

Carburetor Mounting Nut Torque.....6.2-7.3 N·m (55-65 in. lb.)

<sup>1</sup>Values are in Metric units. Values in parentheses are English equivalents. Lubricate threads with engine oil prior to assembly.

---

### Connecting Rod

Cap Fastener Torque (torque in increments).....	11.3 N·m (100 in. lb.)
Connecting Rod-to-Crankpin Running Clearance	
New.....	0.030/0.055 mm (0.0012/0.0022 in.)
Max. Wear Limit .....	0.070 mm (0.0028 in.)
Connecting Rod-to-Crankpin Side Clearance.....	0.26/0.63 mm (0.0102/0.0248 in.)
Connecting Rod-to-Piston Pin Running Clearance.....	0.015/0.028 mm (0.0006/0.0011 in.)
Piston Pin End I.D.	
New.....	17.015/17.023 mm (0.6699/0.6702 in.)
Max. Wear Limit .....	17.036 mm (0.6707 in.)

### Crankcase

Governor Cross Shaft Bore I.D.	
New.....	8.025/8.075 mm (0.3159/0.3179 in.)
Max. Wear Limit .....	8.088 mm (0.3184 in.)

### Breather Assembly

Inner Cover	
Fastener Torque.....	10.7 N·m (95 in. lb.) into new hole 7.3 N·m (65 in. lb.) into used hole
Outer Cover	
Stud Torque .....	6.2 N·m (55 in. lb.) into new hole 4.0 N·m (35 in. lb.) into used hole
Hex Nut Torque .....	1.3 N·m (11.5 in. lb.)

Oil Drain Plug Torque .....	13.6 N·m (120 in. lb.)
-----------------------------	------------------------

### Oil Pan

Oil Pan Fastener Torque.....	24.4 N·m (216 in. lb.)
------------------------------	------------------------

### Crankshaft

End Play (Free) .....	0.070/0.590 mm (0.0028/0.0230 in.)
Crankshaft Bore (In Crankcase)	
New.....	40.965/41.003 mm (1.6128/1.6143 in.)
Max. Wear Limit .....	41.016 mm (1.6148 in.)
Crankshaft Bore (In Oil Pan) - New .....	40.987/40.974 mm (1.6136/1.6131 in.)
Crankshaft Bore (In Oil Pan) -to-Crankshaft	
Running Clearance - New .....	0.039/0.074 mm (0.0015/0.0029 in.)

### Flywheel End Main Bearing Journal

O.D. - New .....	40.913/40.935 mm (1.6107/1.6116 in.)
O.D. - Max. Wear Limit.....	40.84 mm (1.608 in.)
Max. Taper .....	0.022 mm (0.0009 in.)
Max. Out-of-Round .....	0.025 mm (0.0010 in.)

## Section 1

### Safety and General Information

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#### Crankshaft (Continued)

##### Oil Pan End Main Bearing Journal

O.D. - New .....	40.913/40.935 mm (1.6107/1.6116 in.)
O.D. - Max. Wear Limit .....	40.84 mm (1.608 in.)
Max. Taper .....	0.022 mm (0.0009 in.)
Max. Out-of-Round .....	0.025 mm (0.0010 in.)

##### Connecting Rod Journal

O.D. - New .....	35.955/35.973 mm (1.4156/1.4163 in.)
O.D. - Max. Wear Limit .....	35.94 mm (1.415 in.)
Max. Taper .....	0.018 mm (0.0007 in.)
Max. Out-of-Round .....	0.025 mm (0.0010 in.)

##### Crankshaft T.I.R.

PTO End, Crank in Engine .....	0.279 mm (0.0110 in.)
Entire Crank, in V-Blocks .....	0.10 mm (0.0039 in.)

#### Cylinder Bore

##### Cylinder Bore I.D.

New .....	83.031/83.006 mm (3.2689/3.2679 in.)
Max. Wear Limit .....	83.069 mm (3.2704 in.)
Max. Out-of-Round .....	0.12 mm (0.0047 in.)
Max. Taper .....	0.05 mm (0.0020 in.)

#### Cylinder Head

##### Cylinder Head Fastener Torque

Head Bolt - Torque in Two Stages .....	first to 22.6 N·m (200 in. lb.) finally to 41.8 N·m (370 in. lb.)
--	--

Max. Out-of-Flatness .....	0.076 mm (0.003 in.)
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Rocker Arm Screw Torque .....	11.3 N·m (100 in. lb.)
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Rocker Arm Stud Torque (AVT) .....	11.3 N·m (100 in. lb.)
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Rocker Arm/Valve Adjustment Jam Nut Torque .....	7.3 N·m (65 in. lb.)
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Rocker Arm/Valve Adjustment Setscrew Torque (AVT) .....	7.9 N·m (70 in. lb.)
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#### Fan/Flywheel

Flywheel Retaining Screw Torque .....	74.5 N·m (55 ft. lb.)
---------------------------------------	-----------------------

#### Governor

Governor Cross Shaft-to-Crankcase Running Clearance .....	0.025/0.126 mm (0.0009/0.0049 in.)
---	------------------------------------

##### Governor Cross Shaft O.D.

New .....	7.949/8.000 mm (0.3129/0.3149 in.)
Max. Wear Limit .....	7.936 mm (0.3124 in.)

##### Governor Gear Shaft-to-Governor

Gear Running Clearance .....	0.015/0.140 mm (0.0006/0.0055 in.)
------------------------------	------------------------------------

##### Governor Gear Shaft O.D.

New .....	5.990/6.000 mm (0.2358/0.2362 in.)
Max. Wear Limit .....	5.977 mm (0.2353 in.)

### Governor (Continued)

Governor Lever Nut Torque .....6.8 N·m (60 in. lb.)

### Ignition

Spark Plug Type (Champion® or Equivalent) .....RC12YC, XC12YC, or Platinum 3071

Spark Plug Gap.....0.76 mm (0.030 in.)

Spark Plug Torque.....24.4-29.8 N·m (18-22 ft. lb.)

Ignition Module Air Gap .....0.28/0.33 mm (0.011/0.013 in.)

Ignition Module Fastener Torque .....4.0-6.2 N·m (35-55 in. lb.)

### Muffler

Muffler Fasteners Torque

M8 Hex Nuts .....24.4 N·m (216 in. lb.)

5/16-18 Capscrews .....16.9 N·m (150 in. lb.)

### Oil Filter

Oil Filter Installation.....refer to the oil filter for instructions.

Nipple Torque (Oil Filter/Oil Cooler Adapter).....33.9 N·m (300 in. lb.)

### Piston, Piston Rings, and Piston Pin

Piston-to-Piston Pin Running Clearance .....0.006/0.017 mm (0.0002/0.0007 in.)

Piston Pin Bore I.D.

New.....17.006/17.012 mm (0.6695/0.6698 in.)

Max. Wear Limit .....17.025 mm (0.6703 in.)

Piston Pin O.D.

New.....16.995/17.000 mm (0.6691/0.6693 in.)

Max. Wear Limit .....16.994 mm (0.6691 in.)

Top Compression Ring-to-Groove Side Clearance .....0.025/0.048 mm (0.0010/0.0019 in.)

Middle Compression Ring-to-Groove Side Clearance .....0.015/0.037 mm (0.0006/0.0015 in.)

Oil Control Ring-to-Groove Side Clearance.....0.026/0.176 mm (0.0010/0.0070 in.)

Top and Center Compression Ring End Gap

New Bore .....0.25/0.56 mm (0.0100/0.0224 in.)

Used Bore (Max.) .....0.94 mm (0.037 in.)

Piston Thrust Face O.D.<sup>2</sup>

New .....82.947 mm (3.2656 in.)

Max. Wear Limit .....82.802 mm (3.2599 in.)

Piston Thrust Face-to-Cylinder Bore<sup>2</sup> Running Clearance

New .....0.06/0.100 mm (0.0023/0.0039 in.)

<sup>2</sup>Measure 6 mm (0.236 in.) above the bottom of the piston skirt at right angles to the piston pin.

## Section 1

### Safety and General Information

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#### Speed Control Bracket

Fastener Torque .....10.7 N·m (95 in. lb.) into new holes  
7.3 N·m (65 in. lb.) into used holes

#### Starter Assembly

Thru Bolt Torque  
FASCO (Inertia Drive).....4.5-5.7 N·m (40-50 in. lb.)  
Delco-Remy (Solenoid Shift).....5.6-9.0 N·m (49-79 in. lb.)  
Mounting Screw Torque (All).....15.3 N·m (135 in. lb.)

#### Brush Holder Mounting Screw Torque

Delco-Remy Starter.....2.5-3.3 N·m (22-29 in. lb.)

#### Solenoid (Starter)

Mounting Hardware Torque  
Delco-Remy Starter.....4.0-6.0 N·m (35-53 in. lb.)  
Nut, Positive (+) Brush Lead Torque  
Delco-Remy Starter.....8.0-11.0 N·m (71-97 in. lb.)

#### Stator

Mounting Screw Torque.....6.2 N·m (55 in. lb.)

#### Valve Cover

Valve Cover Fastener Torque.....6.2 N·m (55 in. lb.)






#### Valves and Valve Tappets

Valve Clearance .....0.101/0.152 mm (0.004/0.006 in.)  
  
Valve Tappet to Crankcase Running Clearance.....0.013/0.073 mm (0.0005/0.0029 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.....7.038/7.058 mm (0.2771/0.2779 in.)  
Max. Wear Limit .....7.134 mm (0.2809 in.)  
  
Exhaust Valve Guide I.D.  
New.....7.038/7.058 mm (0.2771/0.2779 in.)  
Max. Wear Limit .....7.159 mm (0.2819 in.)  
  
Valve Guide Reamer Size  
Standard.....7.048 mm (0.2775 in.)  
0.25 mm O.S.....7.298 mm (0.2873 in.)  
Intake Valve Minimum Lift .....8.07 mm (0.3177 in.)  
  
Exhaust Valve Minimum Lift .....8.07 mm (0.3177 in.)  
  
Nominal Valve Seat Angle .....45°








## General Torque Values

### Metric Fastener Torque Recommendations for Standard Applications

Tightening Torque: N·m (in. lb.) + or - 10%						
	Property Class					Noncritical Fasteners Into Aluminum
Size						
<b>M4</b>	1.2 (11)	1.7 (15)	2.9 (26)	4.1 (36)	5.0 (44)	2.0 (18)
<b>M5</b>	2.5 (22)	3.2 (28)	5.8 (51)	8.1 (72)	9.7 (86)	4.0 (35)
<b>M6</b>	4.3 (38)	5.7 (50)	9.9 (88)	14.0 (124)	16.5 (146)	6.8 (60)
<b>M8</b>	10.5 (93)	13.6 (120)	24.4 (216)	33.9 (300)	40.7 (360)	17.0 (150)






  

Tightening Torque: N·m (ft. lb.) + or - 10%						
	Property Class					Noncritical Fasteners Into Aluminum
Size						
<b>M10</b>	21.7 (16)	27.1 (20)	47.5 (35)	66.4 (49)	81.4 (60)	33.9 (25)
<b>M12</b>	36.6 (27)	47.5 (35)	82.7 (61)	116.6 (86)	139.7 (103)	61.0 (45)
<b>M14</b>	58.3 (43)	76.4 (55)	131.5 (97)	184.4 (136)	219.7 (162)	94.9 (70)

## Section 1

### Safety and General Information

#### English Fastener Torque Recommendations for Standard Applications

Tightening Torque: N·m (in. lb.) + or - 20%				
Bolts, Screws, Nuts and Fasteners Assembled Into Cast Iron or Steel				Grade 2 or 5 Fasteners Into Aluminum
	 Grade 2	 Grade 5	 Grade 8	 
Size				
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)	-----	-----	-----
Tightening Torque: N·m (ft. lb.) + or - 20%				
Size				
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)	142.4 (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	149.2 (110)	244.1 (180)	352.6 (260)	-----
5/8-18	189.8 (140)	311.9 (230)	447.5 (330)	-----
3/4-10	199.3 (150)	332.2 (245)	474.6 (350)	-----
3/4-16	271.2 (200)	440.7 (325)	637.3 (470)	-----

#### Torque Conversions

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

## Section 2

# Tools & Aids

2

Certain quality tools are designed to help you perform specific disassembly, repair, and reassembly procedures. By using tools designed for the job, 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 the list of tools and their source.

### Separate Tool Suppliers:

Kohler Tools  
Contact your 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

Tools	
Description	Source/Part No.
<b>Camshaft Endplay Plate</b> For checking camshaft endplay.	SE Tools KLR-82405
<b>Camshaft Seal Protector (Aegis)</b> To protect 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.	Kohler 25 761 05-S
<b>Electronic Fuel Injection (EFI) Diagnostic Software</b> Use with Laptop or Desktop PC.	Kohler 25 761 23-S
<b>EFI Service Kit</b> For troubleshooting and setting up an EFI engine.	Kohler 24 761 01-S
Individual Components Available Pressure Tester Noid Light 90° Adapter Oetiker Clamp Pliers Code Plug, Red Wire Code Plug, Blue Wire	Design Technology Inc. DTI-019 DTI-021 DTI-023 DTI-025 DTI-027 DTI-029
<b>Flywheel Holding Tool (CS Series)</b>	SE Tools KLR-82407
<b>Flywheel Puller</b> To remove flywheel from engine.	SE Tools KLR-82408
<b>Flywheel Strap Wrench</b> To hold flywheel during removal.	SE Tools KLR-82409

## Section 2

### Tools & Aids

<b>Tools (Continued)</b>	
<b>Description</b>	<b>Source/Part No.</b>
<b>Hydraulic Valve Lifter Tool</b> To remove and install hydraulic lifters.	Kohler 25 761 38-S
<b>Ignition System Tester</b> For testing output on all systems, except CD. For testing output on capacitive discharge (CD) ignition system.	Kohler 25 455 01-S Kohler 24 455 02-S
<b>Offset Wrench (K &amp; M Series)</b> To remove and reinstall cylinder barrel retaining nuts.	SE Tools KLR-82410
<b>Oil Pressure Test Kit</b> To test and verify oil pressure.	Kohler 25 761 06-S
<b>Rectifier-Regulator Tester (120 volt current)</b> <b>Rectifier-Regulator Tester (240 volt current)</b> Used to test rectifier-regulators.	Kohler 25 761 20-S Kohler 25 761 41-S
Individual Components Available CS-PRO Regulator Test Harness Special Regulator Test Harness with Diode	Design Technology Inc. DTI-031 DTI-033
<b>Spark Advance Module (SAM) Tester</b> To test the SAM (ASAM and DSAM) on engines with SMART-SPARK™.	Kohler 25 761 40-S
<b>Starter Retaining Ring Tool (Inertia Drive)</b> To remove and reinstall drive retaining rings (excluding FASCO starters).	Kohler 25 761 18-S
<b>Starter Servicing Kit (All Starters)</b> To remove and reinstall drive retaining rings and brushes.	SE Tools KLR-82411
Individual Component Available Starter Brush Holding Tool (Solenoid Shift)	SE Tools KLR-82416
<b>Tachometer (Digital Inductive)</b> For checking operating speed (RPM) of an engine.	Design Technology Inc. DTI-110
<b>Vacuum/Pressure Tester</b> Alternative to a water manometer.	Kohler 25 761 22-S

<b>Aids</b>	
<b>Description</b>	<b>Source/Part No.</b>
<b>Camshaft Lubricant</b> (Valspar ZZ613)	Kohler 25 357 14-S
<b>Dielectric Grease</b> (GE/Novaguard G661)	Kohler 25 357 11-S
<b>Dielectric Grease</b> (Fel-Pro)	Lubri-Sel
<b>Electric Starter Drive Lubricant</b> (Inertia Drive)	Kohler 52 357 01-S
<b>Electric Starter Drive Lubricant</b> (Solenoid Shift)	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. Loctite® Nos. 5900 or 5910 are recommended for best sealing characteristics. Loctite® 5910 Loctite® Ultra Black 598 Loctite® Ultra Blue 587 Loctite® Ultra Copper	Kohler 25 597 07-S
<b>Spline Drive Lubricant</b>	Kohler 25 357 12-S

## Section 2

### Tools & Aids

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#### Special Tools You Can Make

##### Flywheel Holding Tool

A flywheel holding tool can be made out of an old junk flywheel ring gear as shown in Figure 2-1, and used in place of a strap wrench.

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

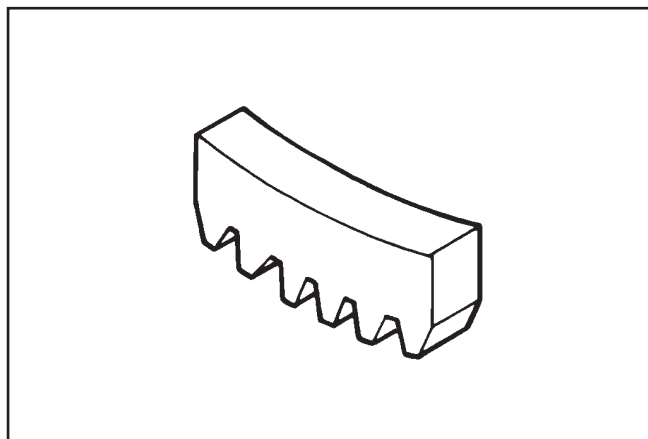


Figure 2-1. Flywheel Holding Tool.

##### Rocker Arm/Crankshaft Tool

A spanner wrench to lift the rocker arms or turn the 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 the rod cap.

2. Remove the studs of a Posi-Lock rod or grind off the aligning steps of a Command rod, so the joint surface is flat.
3. Find a 1 in. long capscrew with the correct thread size to match the threads in the connecting rod.
4. Use a flat washer with the correct I.D. to slip on the capscrew and approximately 1" O.D. (Kohler Part No. **12 468 05-S**). Assemble the capscrew and washer to the joint surface of the rod, as shown in Figure 2-2.

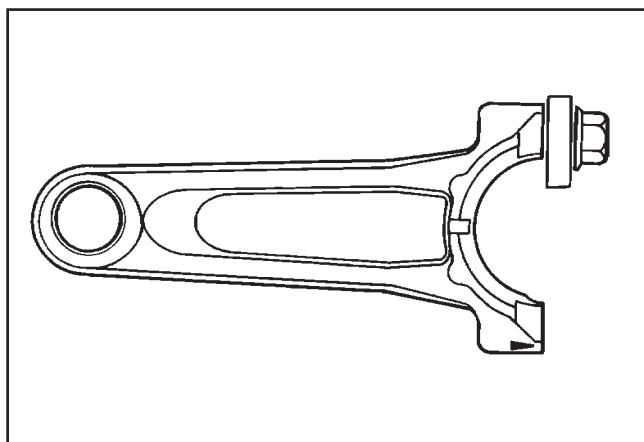


Figure 2-2. Rocker Arm/Crankshaft Tool.

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# Section 3

## Troubleshooting

### Troubleshooting Guide

When troubles occur, be sure to check the 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. Use these to locate the causing factors. Refer to the specific section(s) within this service manual for more detailed information.

#### Engine Cranks But Will Not Start

1. Empty fuel tank.
2. Fuel shut-off valve closed.
3. Poor fuel, dirt or water in the fuel system.
4. Clogged fuel line.
5. Spark plug lead(s) disconnected.
6. Key switch or kill switch in "off" position.
7. Faulty spark plugs.
8. Faulty ignition module(s).
9. DSAI or DSAM malfunction (applicable models).
10. Carburetor solenoid malfunction.
11. Diode in wiring harness failed in open circuit mode.
12. Vacuum fuel pump malfunction, or oil in vacuum hose.
13. Vacuum hose to fuel pump leaking/cracked.
14. Battery connected backwards.

#### Engine Starts But Does Not Keep Running

1. Restricted fuel tank cap vent.
2. Poor fuel, dirt or water in the fuel system.
3. Faulty or misadjusted choke or throttle controls.
4. Loose wires or connections that short the kill terminal of ignition module to ground.
5. Faulty cylinder head gasket.
6. Faulty carburetor.
7. Vacuum fuel pump malfunction, or oil in vacuum hose.
8. Leaking/cracked vacuum hose to fuel pump.
9. Intake system leak.
10. Diode in wiring harness failed in open circuit mode.

#### Engine Starts Hard

1. PTO drive is engaged.
2. Dirt or water in the fuel system.
3. Clogged fuel line.
4. Loose or faulty wires or connections.
5. Faulty or misadjusted choke or throttle controls.
6. Faulty spark plugs.
7. Low compression.
8. Faulty ACR mechanism (equipped models).
9. Weak spark.
10. Fuel pump malfunction causing lack of fuel.
11. Engine overheated-cooling/air circulation restricted.
12. Quality of fuel.
13. Flywheel key sheared.
14. Intake system leak.

#### Engine Will Not Crank

1. PTO drive is engaged.
2. Battery is discharged.
3. Safety interlock switch is engaged.
4. Loose or faulty wires or connections.
5. Faulty key switch or ignition switch.
6. Faulty electric starter or solenoid.
7. Seized internal engine components.

#### Engine Runs But Misses

1. Dirt or water in the fuel system.
2. Spark plug lead disconnected.
3. Poor quality of fuel.
4. Faulty spark plug(s).
5. Loose wires or connections that intermittently ground the ignition kill circuit.
6. Engine overheated.
7. Faulty ignition module or incorrect air gap.
8. Carburetor adjusted incorrectly.
9. DSAI or DSAM malfunction (applicable models).

## Section 3

### Troubleshooting

---

#### Engine Will Not Idle

1. Dirt or water in the fuel system.
2. Stale fuel and/or gum in carburetor.
3. Faulty spark plugs.
4. Fuel supply inadequate.
5. Idle fuel adjusting needle improperly set (some models).
6. Idle speed adjusting screw improperly set.
7. Low compression.
8. Restricted fuel tank cap vent.
9. Engine overheated-cooling system/air circulation problem.

#### Engine Overheats

1. Air intake/grass screen, cooling fins, or cooling shrouds clogged.
2. Excessive engine load.
3. Low crankcase oil level.
4. High crankcase oil level.
5. Faulty carburetor.
6. Lean fuel mixture.
7. DSAI or DSAM malfunction (applicable models).

#### Engine Knocks

1. Excessive engine load.
2. Low crankcase oil level.
3. Old or improper fuel.
4. Internal wear or damage.
5. Hydraulic lifter malfunction.
6. Quality of fuel.
7. Incorrect grade of oil.

#### Engine Loses Power

1. Low crankcase oil level.
2. High crankcase oil level.
3. Dirty air cleaner element.
4. Dirt or water in the fuel system.
5. Excessive engine load.
6. Engine overheated.
7. Faulty spark plugs.
8. Low compression.
9. Exhaust restriction.
10. DSAI or DSAM malfunction (applicable models).
11. Low battery.
12. Incorrect governor setting.

#### Engine Uses Excessive Amount of Oil

1. Incorrect oil viscosity/type.
2. Clogged or improperly assembled breather.
3. Breather reed broken.
4. Worn or broken piston rings.
5. Worn cylinder bore.
6. Worn valve stems/valve guides.
7. Crankcase overfilled.
8. Blown head gasket/overheated.

#### Oil Leaks from Oil Seals, Gaskets

1. Crankcase breather is clogged or inoperative.
2. Breather reed broken.
3. Loose or improperly torqued fasteners.
4. Piston blowby, or leaky valves.
5. Restricted exhaust.

#### External Engine Inspection

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

- Check for buildup of dirt and debris on the crankcase, cooling fins, grass screen, and other external surfaces. Dirt or debris on these areas are causes of higher operating temperatures and overheating.
- Check for obvious fuel and oil leaks, and damaged components. Excessive oil leakage can indicate a clogged or improperly-assembled breather, worn/damaged seals and gaskets, or loose or improperly-torqued fasteners.
- Check the air cleaner cover and base for damage or indications of improper fit and seal.
- Check the air cleaner element. Look for holes, tears, cracked or damaged sealing surfaces, or other damage that could allow unfiltered air into the engine. Also note if the element is dirty or clogged. These could indicate that the engine has been under serviced.
- Check the carburetor throat for dirt. Dirt in the throat is further indication that the air cleaner is not functioning properly.
- Check the oil level. Note if the oil level is within the operating range on the dipstick, or if it is low or overfilled.



- Check the condition of the oil. Drain the oil into a container - the oil 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 overrich carburetion, weak ignition, overextended oil change intervals or wrong weight or type of oil was used, to name a few.

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

### Cleaning the Engine

After inspecting the external condition of the engine, clean the engine thoroughly before disassembling it. Also clean individual components as the 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 the manufacturer's instructions and safety precautions carefully.*

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

### Basic Engine Tests

#### Crankcase Vacuum Test

A partial vacuum should be present in the crankcase when the engine is operating. Pressure in the 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 (Kohler Part No. 25 761 22-S). Complete instructions are provided in the kits.

To test the crankcase vacuum with the manometer:

1. Insert the stopper/hose into the oil fill hole. Leave the other tube of manometer open to atmosphere. Make sure the shut off clamp is closed.
2. Start the engine and run at no-load high speed (3200 to 3750 RPM).
3. Open the clamp and note the water level in the tube.

The level in the engine side should be a minimum of **10.2 cm (4 in.)** above the level in the open side.

If the level in the engine side is less than specified (low/no vacuum), or the level in the engine side is lower than the level in the open side (pressure), check for the conditions in the table on page 3.4.

4. Close the shut-off clamp **before** stopping the engine.

To test the crankcase vacuum with the Vacuum/Pressure Gauge Kit (Kohler Part No. 25 761 22-S):

1. Remove the dipstick or oil fill plug/cap.
2. Install the adapter into the oil fill/dipstick tube opening.
3. Push the barbed fitting on the gauge solidly into the hole in the adapter.
4. Start the engine and bring it up to operating speed (3200-3600 RPM).
5. Check the reading on the gauge. If the reading is to the **left** of "0" on the gauge, vacuum or negative pressure is indicated. If the reading is to the **right** of "0" on the gauge, positive pressure is present.

Crankcase vacuum should be 4-10 (inches of water). If the reading is below specification, or if pressure is present, check the table on page 3.4 for possible causes and remedies.

# Section 3

## Troubleshooting

### No Crankcase Vacuum/Pressure in Crankcase

Possible Cause	Solution
1. Crankcase breather clogged or inoperative.	1. Disassemble breather, clean parts thoroughly, reassemble, and recheck pressure.
2. Seals and/or gaskets leaking. Loose or improperly torqued fasteners.	2. Replace all worn or damaged seals and gaskets. Make sure all fasteners are tightened securely. Use appropriate torque values and sequences when necessary.
3. Piston blow by or leaky valves (confirm by inspecting components).	3. Recondition piston, rings, cylinder bore, valves, and valve guides.
4. Restricted exhaust.	4. Repair/replace restricted muffler/exhaust system.

### Compression Test

Some of these engines are equipped with an automatic compression release (ACR) mechanism. Because of the ACR mechanism, it is difficult to obtain an accurate compression reading. As an alternative, perform a cylinder leakdown test.

### Cylinder Leakdown Test

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

Kohler Part No. 25 761 05-S is a relatively simple, inexpensive leakdown tester for small engines. The tester includes a quick disconnect for attaching the adapter hose, and a holding tool.

### Leakdown Test Instructions

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

If the flywheel end is more accessible, use a breaker bar and socket on the flywheel nut/screw to hold it in position. An assistant may be needed to hold the breaker bar during testing. If the 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 the engine cannot rotate off of TDC in either direction.

4. Install the adapter into the spark plug hole, but do not attach it to the tester at this time.
5. Connect an air source of at least 50 psi to the tester.
6. Turn the regulator knob in the increase direction (clockwise) until the gauge needle is in the yellow "set" area at the low end of the scale.
7. Connect the tester quick-disconnect to the adapter hose while firmly holding the engine at TDC. Note the gauge reading and listen for escaping air at the carburetor intake, exhaust outlet, and crankcase breather.
8. Check the test results against the following table:

Leakdown Test Results

Air escaping from crankcase breather .....	Rings or cylinder worn.
Air escaping from exhaust system .....	Defective exhaust valve/improper seating.
Air escaping from carburetor.....	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.



## Section 4

# Air Cleaner and Air Intake System

4

### Air Cleaners

#### General

Air cleaner systems used on these engines will be either the standard size or PRO Series increased capacity (slightly taller) design. Each system uses a replaceable, high-density paper air cleaner element. Some are also equipped with an oiled-foam precleaner, which surrounds the paper element. See Figures 4-1 and 4-2.

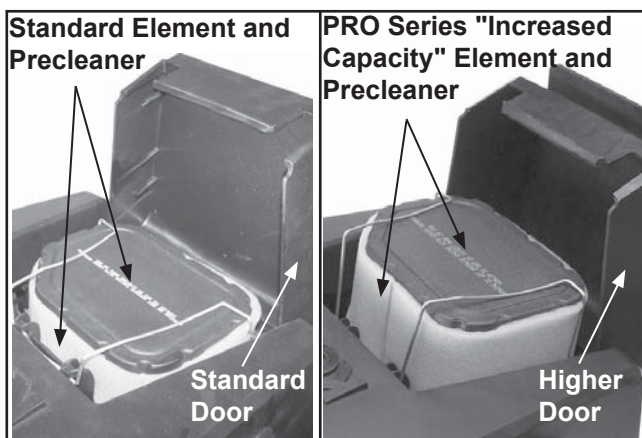


Figure 4-1. Air Cleaner Element Location.

#### Service

Check the air cleaner **daily or before starting the engine**. Check for and correct any buildup of dirt and debris, along with loose or damaged components.

NOTE: Operating the engine with loose or damaged air cleaner components could allow unfiltered air into the engine causing premature wear and failure.

#### Precleaner Service

If so equipped, wash and reoil the precleaner **annually or every 25 hours** of operation (more often under extremely dusty or dirty conditions). Replace the precleaner **annually or every 100 hours**.

To service the precleaner, see Figures 4-1 and 4-2, and perform the following steps:

1. Open the door on the blower housing to access the air cleaner element and precleaner. (On Pro models the door can be removed).
2. Unhook the latch and remove the precleaner from the air cleaner element, or remove as an assembly for servicing. Make sure the base and the sealing area is clean before reassembly is performed.
3. Wash the precleaner in warm water with detergent. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow the precleaner to air dry.
4. Saturate the precleaner with new engine oil. Squeeze out all excess oil.
5. Reinstall the precleaner over the paper air cleaner element. Secure the element with the latch.
6. Close and latch the door.

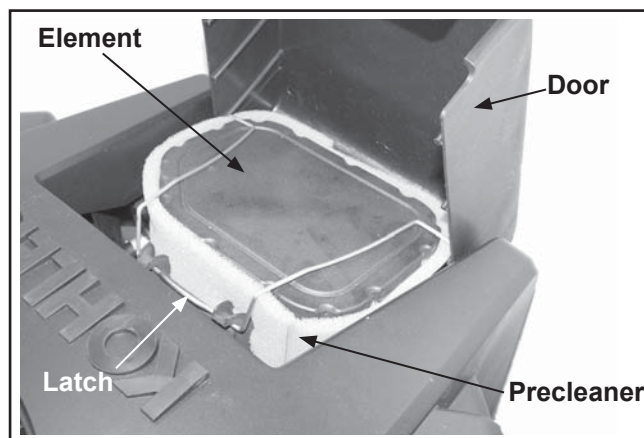


Figure 4-2. Precleaner on Air Cleaner.

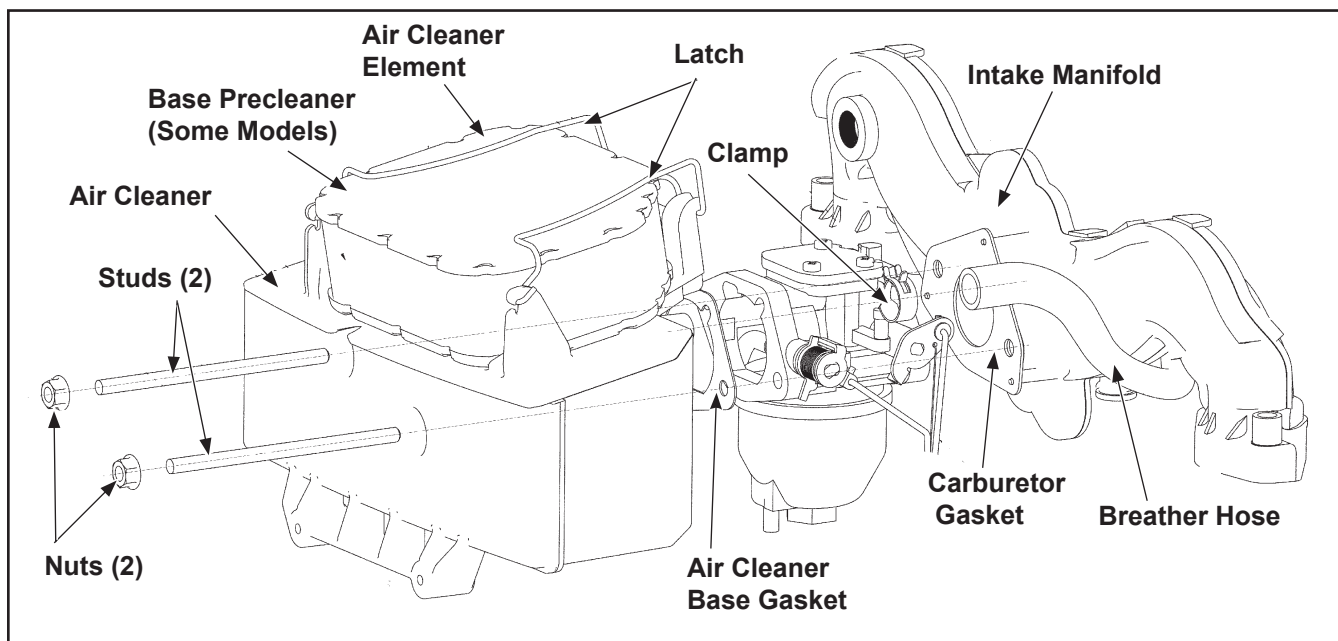
## Section 4

### Air Cleaner and Air Intake System

## Paper Element Service

Clean the paper element **annually or every 25 hours**, or replace if necessary. Replace the paper element **annually or every 100 hours** of operation (more often under extremely dusty or dirty conditions). See Figure 4-1, and follow these steps:

1. Open the door on the blower housing to access the air cleaner element. See Figures 4-1 and 4-2.
2. Unhook the latch and remove the air cleaner element and precleaner (if equipped). See Figure 4-2.
3. Remove the precleaner (if so equipped) from the paper element. Service the precleaner as described in Precleaner Service.
4. If damaged, replace the precleaner.
5. Clean the air cleaner base as required and check condition.
6. Reinstall the precleaner (if equipped), over the paper air cleaner element and install on the base. Secure with the latch.
7. Close and latch the door.



**Figure 4-3. Air Cleaner System Components.**

## Air Cleaner Components

Whenever the air cleaner cover door is opened, and/or the paper element or precleaner is serviced, check the following:

**Air Cleaner Element** - Make sure the element is not bent or damaged. Check that the element is properly secured and the latch is not damaged or missing.

**Air Cleaner Base** - Make sure the base is secured tightly to the carburetor and not cracked or damaged.

**Breather Hose** - Make sure the hose is attached to the air cleaner base and the breather reed cover.

NOTE: Damaged, worn or loose air cleaner components can allow unfiltered air into the engine causing premature wear and failure. Tighten or replace all loose or damaged components.

### Air Cleaner Base

#### Disassembly/Reassembly

If the air cleaner base requires removal, proceed as follows:

1. Remove the mounting screws for the fuel pump (if equipped), and the blower housing.
2. Raise or remove the blower housing for access to the air cleaner base.
3. Remove the air cleaner components from the base. See Figure 4-3.
4. Remove the two hex flange nuts securing the air cleaner base onto the mounting studs.
5. Disconnect the breather hose from the air cleaner base, then remove the base and gasket.
6. Reverse procedure to reassemble components. Torque the two hex flange nuts to **6.2-7.3 N·m (55-65 in. lb.)**. Torque the blower housing screws to **4.0 N·m (35 in. lb.)**, and the two front HI-LO screws to **2.8 N·m (25 in. lb.)**.

### Air Intake/Cooling System

To ensure proper cooling, make sure the grass screen, cooling fan fins, and other external surfaces of the engine are kept clean **at all times**.

**Annually or every 100 hours** of operation (more often under extremely dusty or dirty conditions), remove the blower housing and other cooling shrouds. Clean the cooling fins and external surfaces as necessary. Make sure the cooling shrouds are reinstalled.

NOTE: Operating the engine with a blocked grass screen, dirty or plugged cooling fins, and/or cooling shrouds removed, will cause engine damage due to overheating.

## **Section 4**

### **Air Cleaner and Air Intake System**

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# Section 5

## Fuel System and Governor

5

This section covers the carbureted fuel systems used on these engines. The governor system is covered at the end of this section.



### **WARNING: Explosive Fuel!**

*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. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use gasoline as a cleaning agent.*

### **Fuel System Components**

The typical carbureted fuel system and related components include the following:

- Fuel Tank
- Fuel Lines
- In-line Fuel Filter
- Fuel Pump
- Carburetor

### **Operation**

The fuel from the tank is moved through the in-line filter and fuel lines by the fuel pump. On engines not equipped with a fuel pump, the fuel tank outlet is located above the carburetor inlet allowing gravity to feed fuel to the carburetor.

Fuel then enters the carburetor float bowl and is drawn into the carburetor body. There, the fuel is mixed with air. This fuel-air mixture is then burned in the engine combustion chamber.

## **Fuel Recommendations**

### **General Recommendations**

Purchase gasoline in small quantities and store in clean, approved containers. A container with a capacity of 2 gallons or less with a pouring spout is recommended. Such a container is easier to handle and helps eliminate spillage during refueling.

- Do not use gasoline left over from the previous season, to minimize gum deposits in your fuel system and to ensure easy starting.
- Do not add oil to the gasoline.
- Do not overfill the fuel tank. Leave room for the fuel to expand.

### **Fuel Type**

For best results use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 (R+M)/2 or higher. In countries using the Research Octane Number (RON), it should be 90 octane minimum. Leaded gasoline is not recommended and must not be used on EFI engines or on other models where exhaust emissions are regulated.

### **Gasoline/Alcohol blends**

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends including E20 and E85 are not to be used and not approved. Any failures resulting from use of these fuels will not be warranted.

### **Gasoline/Ether blends**

Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to a maximum of 15% MTBE by volume) are approved as a fuel for Kohler engines. Other gasoline/ether blends are not approved.

## Section 5

### Fuel System and Governor

#### Fuel Filter

Most engines are equipped with an in-line filter. Periodically inspect the filter and replace **annually** or every **100 hours** with a genuine Kohler filter.

#### Fuel Line

These engines use low permeation rated fuel lines, certified to comply with California and U.S. EPA evaporative emission requirements. Fuel lines that do not meet these requirements may not be used.

Order replacement hose through a Kohler Service Center.

#### Fuel System Tests

When the engine starts hard, or turns over but will not start, it is possible that the problem is in the fuel system. To find out if the fuel system is causing the problem, perform the following tests.

#### Troubleshooting – Fuel System Related Causes

Test	Conclusion
1. Check the following: <ul style="list-style-type: none"><li>a. Make sure the fuel tank contains clean, fresh, proper fuel.</li><li>b. Make sure the vent in fuel tank is open.</li><li>c. Make sure the fuel valve is open.</li><li>d. Make sure vacuum and fuel lines to fuel pump are secured and in good condition.</li></ul>	
2. Check for fuel in the combustion chamber. <ul style="list-style-type: none"><li>a. Disconnect and ground spark plug leads.</li><li>b. Close the choke on the carburetor.</li><li>c. Crank the engine several times.</li><li>d. Remove the spark plug and check for fuel at the tip.</li></ul>	2. If there <b>is</b> fuel at the tip of the spark plug, fuel is reaching the combustion chamber.  If there is <b>no</b> fuel at the tip of the spark plug, check for fuel flow from the fuel tank (Test 3).
3. Check for fuel flow from the tank to the fuel pump. <ul style="list-style-type: none"><li>a. Remove the fuel line from the inlet fitting of fuel pump.</li><li>b. Hold the line below the bottom of the tank. Open the shut-off valve (if so equipped) and observe flow.</li></ul>	3. If fuel <b>does</b> flow from the line, check for faulty fuel pump (Test 4).  If fuel <b>does not</b> flow from the line, check the fuel tank vent, fuel pickup screen, in-line filter, shut-off valve, and fuel line. Correct any observed problem and reconnect the line.
4. Check the operation of fuel pump. <ul style="list-style-type: none"><li>a. Remove the fuel line from the inlet fitting of carburetor.</li><li>b. Crank the engine several times and observe flow.</li></ul>	4. If fuel <b>does</b> flow from the line, check for faulty carburetor. (Refer to the Carburetor portions of this section.)  If fuel <b>does not</b> flow from the line, check for a clogged fuel line. If the fuel line is unobstructed, check for overfilled crankcase and/or oil in pulse line. If none of the checks reveal the cause of the problem, replace the pump.

## Fuel Pump

### General

On engines equipped with a pulse type fuel pump, the pumping action is created by the oscillation of positive and negative pressures within the crankcase. This pressure is transmitted to the pulse pump through a rubber hose connected between the pump and crankcase. The pumping action causes the diaphragm on the inside of the pump to pull fuel in on its downward stroke and to push it into the carburetor on its upward stroke. Two check valves prevent fuel from going backward through the pump.

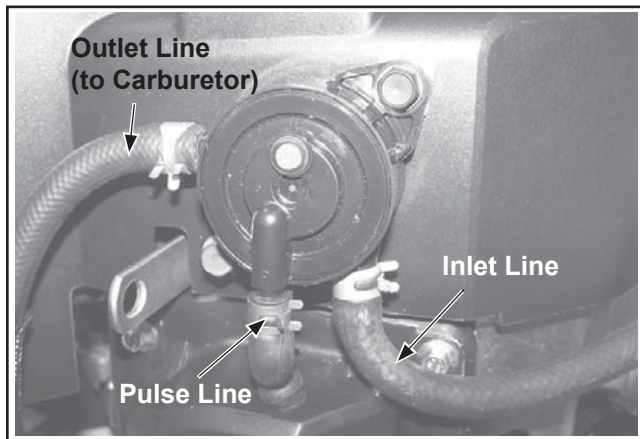


Figure 5-1. Pulse Pump Connections.

### Performance

Minimum fuel delivery rate must be 7.5 L/hr. (2 gal./hr.) with a pressure at 0.3 psi and a fuel lift of 24 in. A 1.3 L/hr. (0.34 gal./hr.) fuel rate must be maintained at 5 Hz.

### Replacing the Fuel Pump

Replacement pumps are available through your source of supply. To replace the pulse pump follow these steps. Note the orientation of the pump before removing.

1. Disconnect the fuel lines from the inlet, outlet and pulse fittings on fuel pump.
2. Remove the two mounting screws and take off the pump.
3. Connect the pulse line to the new fuel pump and make sure opposite end is properly connected into valve cover.

NOTE: Make sure the orientation of the new pump is consistent with the removed pump. Internal damage may occur if installed incorrectly.

4. Attach the new fuel pump using the hex flange screws. Torque the screws to 2.3 N·m (20 in. lb.).
5. Connect the fuel lines to the inlet and outlet fittings and secure with the clamps.

## Carburetor

### General

Engines in this series are equipped with either a Keihin or Nikki fixed main jet carburetor. Most carburetors utilize a fuel shut-off solenoid and feature a self-relieving choke. These carburetors include three main circuits, which function as follows.

**Float Circuit:** The fuel level in the bowl is maintained by the float and fuel inlet needle. The buoyant force of the float stops fuel flow when the engine is at rest. When fuel is being consumed, the float will drop and fuel pressure will push the inlet needle away from the seat, allowing more fuel to enter the bowl. When demand ceases, the buoyant force of the float will again overcome the fuel pressure and stop the flow.

## Section 5

### Fuel System and Governor

**Slow Circuit:** (See Figure 5-2) At low speeds the engine operates only on the slow circuit. As a metered amount of air is drawn through the slow air bleed jet, fuel is drawn through the main jet and further metered through the slow jet. Air and fuel are mixed in the body of the slow jet and exit to the transfer port. From the transfer port this air fuel mixture is delivered to the idle progression chamber. From the idle progression chamber the air fuel mixture is metered through the idle port passage. At low idle when the vacuum signal is weak, the air fuel mixture is controlled by the preset idle mixture setting. This mixture is then mixed with the main body of air and delivered to the engine. As the throttle plate opening increases, greater amounts of air fuel mixture are drawn in through the fixed and metered idle progression holes. As the throttle plate opens further the vacuum signal becomes great enough so the main circuit begins to work.

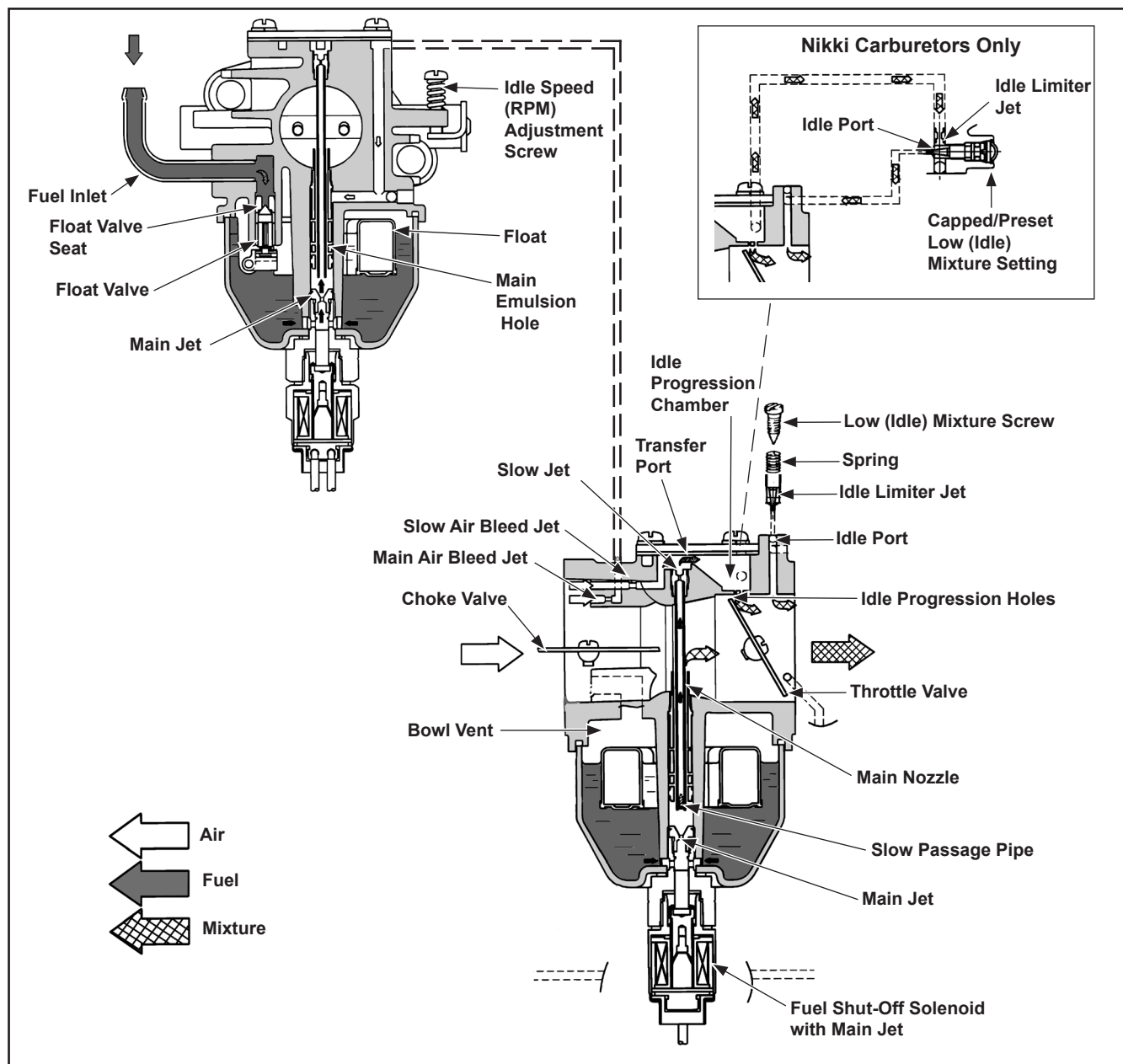


Figure 5-2. Slow Circuit (Typical).

**Main Circuit:** (See Figure 5-3) At high speeds/loads the engine operates on the main circuit. As a metered amount of air is drawn through the main air bleed jet, fuel is drawn through the main jet. The air and fuel are mixed in the main nozzle and then enter the main body of airflow, where further mixing of the fuel and air takes place. This mixture is then delivered to the combustion chamber. The carburetor has a fixed main circuit; no adjustment is possible.

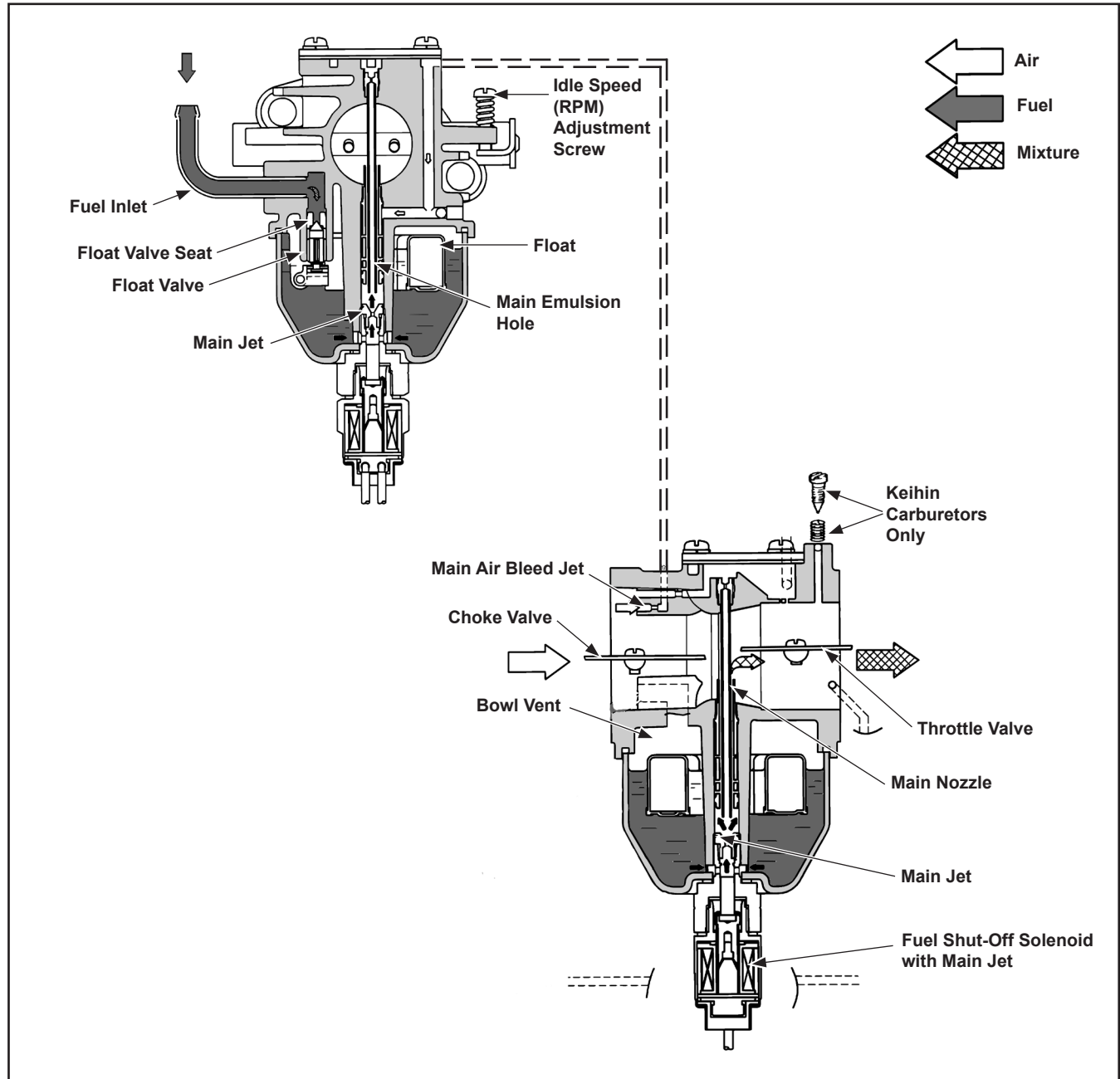


Figure 5-3. Main Circuit (Typical).

## Section 5

### Fuel System and Governor

#### Troubleshooting - Carburetor Related Causes

Condition	Possible Cause/Probable Remedy
1. Engine starts hard, runs roughly or stalls at idle speed.	1. Low idle fuel mixture (some models)/speed improperly adjusted. Adjust the low idle speed tab, then adjust the low idle fuel needle.
2. Engine runs rich (indicated by black, sooty exhaust smoke, misfiring, loss of speed and power, governor hunting, or excessive throttle opening).	2a. Clogged air cleaner. Clean or replace. b. Choke partially closed during operation. Check the choke lever/linkage to ensure choke is operating properly. c. Low idle fuel mixture is improperly adjusted. Adjust low idle fuel needle (some models). d. Float level is set too high. Separate carburetor air horn from carburetor body, adjust float according to steps outlined in Float Replacement procedure. e. Dirt under the fuel inlet needle. Remove needle; clean needle and seat and blow with compressed air. f. Bowl vent or air bleeds plugged. Remove low idle fuel adjusting needle. Clean vent, ports, and air bleeds. Blow out all passages with compressed air. g. Leaky, cracked or damaged float. Submerge float to check for leaks.
3. Engine runs lean (indicated by misfiring, loss of speed and power, governor hunting or excessive throttle opening).	3a. Low idle fuel mixture is improperly adjusted. Adjust low idle fuel needle (some models). b. Float level is set too low. Separate carburetor air horn from carburetor body, adjust float according to steps outlined in Float Replacement procedure. c. Idle holes plugged; dirt in fuel delivery channels. Remove low idle fuel adjusting needle. Clean main fuel jet and all passages; blow out with compressed air.
4. Fuel leaks from carburetor.	4a. Float level set too high. See Remedy 2d. b. Dirt under fuel inlet needle. See Remedy 2e. c. Bowl vents plugged. Blow out with compressed air. d. Carburetor bowl gasket leaks. Replace gasket.

#### Troubleshooting Checklist

When the engine starts hard, runs roughly or stalls at low idle speed, check the following areas before adjusting or disassembling the carburetor.

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

If the engine is hard-starting, runs roughly or stalls at low idle speed, it may be necessary to service the carburetor.



### High Altitude Operation

Operating the engine with the wrong engine configuration at a given altitude may increase its emissions and decrease fuel efficiency and performance. To ensure correct engine operation at altitudes above 1219 meters (4000 ft), it may be necessary to have an authorized Kohler dealer install a special high altitude jet kit in the carburetor. If a high altitude kit has been installed, the engine must be reconverted to the original jet size, before it is operated at lower altitudes, or overheating and engine damage can result.

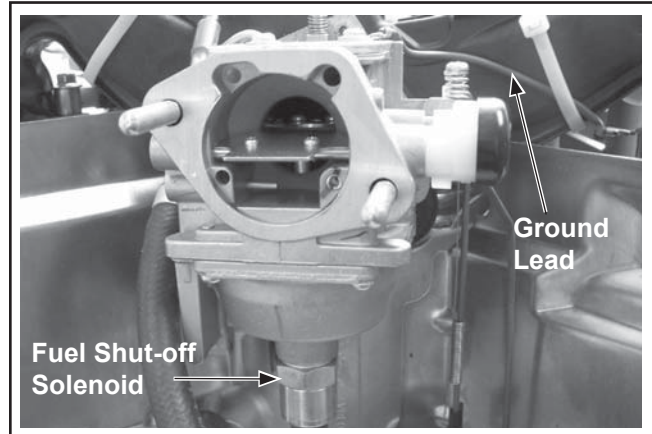
To obtain high altitude kit information or locate a dealer near you, call 1-800-544-2444 to find the names of the nearest Kohler Co. Service Centers or, access our web site at: [www.kohlerengines.com](http://www.kohlerengines.com) and click on the "Service & Dealer Locator" located in the upper right hand corner. The service center will need your engine specification number which is found on your Engine ID Label.

### Fuel Shut-off Solenoid

Most carburetors are equipped with a fuel shut-off solenoid. See Figure 5-4. The solenoid is installed in place of the bowl retaining screw. The solenoid has a spring-loaded pin that retracts when 12 volt current is applied to the lead. When it is extended, the main fuel jet is blocked, preventing normal carburetor operation.

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

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



**Figure 5-4. Fuel Shut-off Solenoid Location.**

### Carburetor Adjustments

#### General

The carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. The high speed mixture is preset at the factory and cannot be adjusted. The low idle fuel adjusting screw (some models) is also set at the factory and normally does not need adjustment. See Figure 5-5. Engines in this series depending on the model and application, may also be equipped with a Governed Idle System.

If the engine is equipped with a Governed Idle System, refer to **Models with Governed Idle System** when performing any carburetor adjustment, as an additional step to the listed procedure(s) is required.

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

**NOTE:** Some carburetors may have a fixed idle or limiter cap on the idle fuel adjusting needle. Do not attempt steps 1 and 2 below. Proceed directly to step 3. Step 5 can only be performed within the limits allowed by the cap.

#### Adjusting Low Idle Fuel and Speed

To adjust the carburetor idle fuel and speed, see Figure 5-5, and follow these steps.

1. With the engine stopped, turn the low idle fuel adjusting screw in (clockwise) until it bottoms lightly. Access this screw through the air cleaner base. See Figures 5-5 and 5-6.

## Section 5

### Fuel System and Governor

NOTE: The tip of the idle fuel adjusting screw is tapered to critical dimensions. Damage to the needle end and the seat in the carburetor body will result if it is forced.

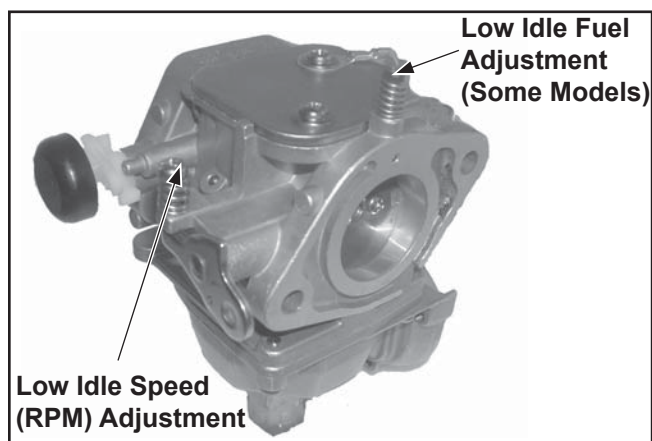


Figure 5-5. Carburetor Adjustments.

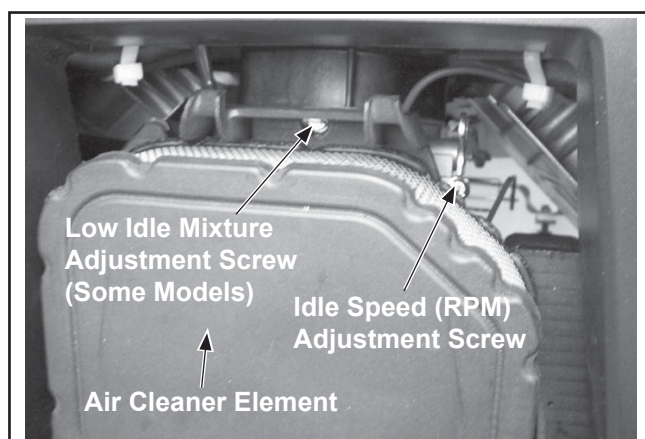


Figure 5-6. Carburetor Adjustment Screw Locations.

2. **Preliminary Settings:** Turn the adjusting screw out (counterclockwise) from lightly bottomed 2-1/4 turns.
3. Start the engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings. Check that the throttle and choke plates can fully open.

NOTE: If the carburetor has a self-relieving choke, the choke plate and shaft assembly is spring loaded. Check to make sure the plate moves freely and is not binding, affecting idle fuel delivery.

4. **Low Idle Speed Setting:** Place the throttle control into the **idle** or **slow** position. Set the low idle speed to 1200 RPM\* ( $\pm 75$  RPM) by turning the low idle speed adjusting screw in or out. Check the speed using a tachometer.

\*NOTE: The actual low idle speed depends on the application. Refer to the equipment manufacturer's recommendations. The low idle speed for basic engines is 1200 RPM. To ensure best results when setting the low idle fuel needle, the low idle speed should be 1200 RPM ( $\pm 75$  RPM).

5. **Low Idle Fuel Needle Setting:** Place the throttle into the **idle** or **slow** position. Turn the low idle fuel adjusting screw in (slowly) until engine speed decreases and then back out approximately 3/4 to 1 turn to obtain the best low speed performance.
6. Recheck the idle speed using a tachometer and readjust the speed as necessary.

#### Models with Governed Idle System

An optional governed idle control system is supplied on some engines. The purpose of this system is to maintain a desired idle speed regardless of ambient conditions (temperature, parasitic load, etc.) that may change. Engines with this feature contain a small secondary spring connected between the governor lever and the lower adjustment tab of the main bracket. See Figure 5-7.

The system requires an additional procedure for setting the idle speed. If speed adjustments are required proceed as follows.

1. Make any necessary speed or control adjustments following the appropriate instructions covered in this section.
2. Move the throttle control to the idle position. Hold the governor lever away from the carburetor, or hold the throttle lever so it is tight against the idle speed adjusting screw, to negate the governor activation. See Figure 5-8. Check the speed with a tachometer and adjust it to 1500 RPM.



3. Release the governor lever and allow the engine to return to the governed idle speed. Check it with a tachometer against the equipment manufacturers recommended idle speed. Governed Idle Speed (RPM) is typically 300 RPM (approximate) higher than the low idle speed. If adjustment is necessary, bend the adjusting tab on the speed control assembly to set. See Figure 5-7.

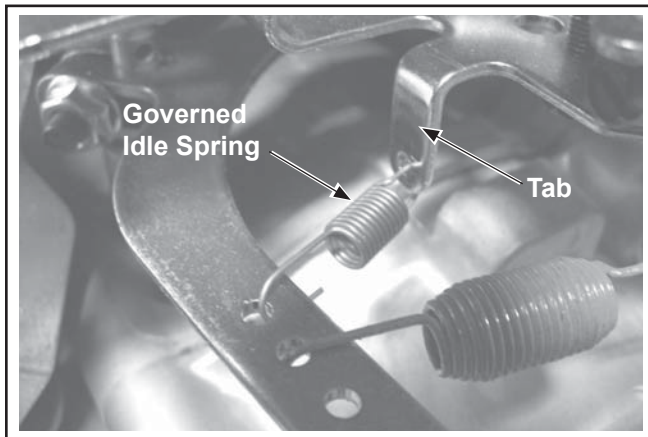


Figure 5-7. Governed Idle Spring Location.

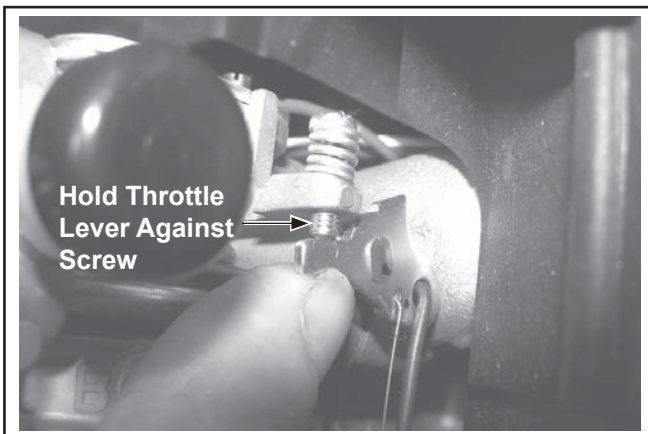


Figure 5-8. Holding Throttle Lever Against Idle Stop Screw.

## Carburetor Servicing

### Keihin Carburetors

#### Float Replacement

1. Clean the exterior surfaces of dirt or foreign material before disassembling the carburetor. Remove the four fuel bowl screws and carefully separate the fuel bowl from the carburetor. Do not damage the O-Ring(s). Transfer any remaining fuel into an approved container. Save all parts. See Figure 5-9.

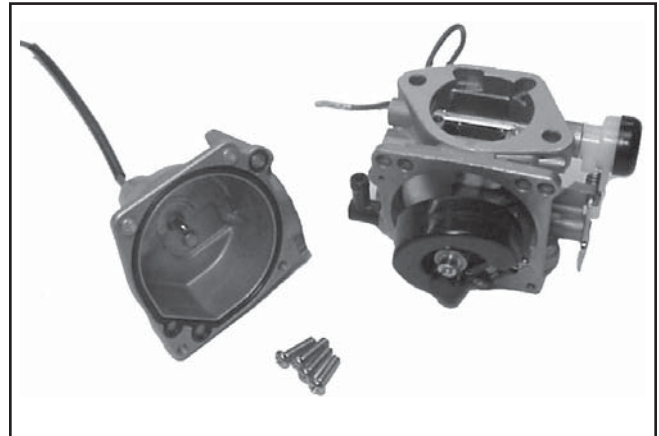


Figure 5-9. Fuel Bowl Removed from Carburetor.

2. Remove the float pin screw and lift out the old float, pin, and inlet needle. See Figure 5-10. Discard all of the parts. The seat for the inlet needle is not serviceable, and should not be removed.

5

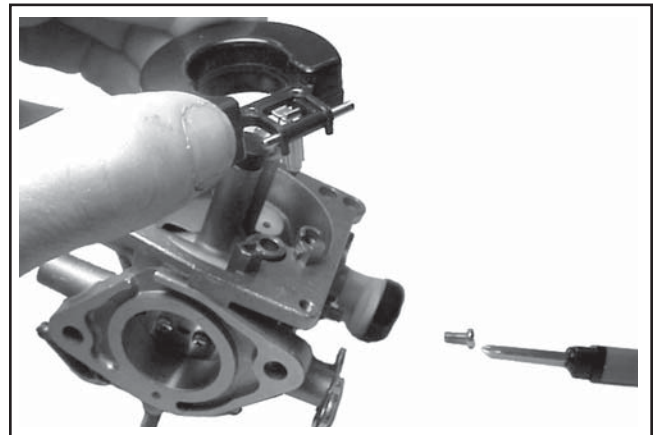


Figure 5-10. Removing Float and Inlet Needle.

3. Clean the carburetor bowl and inlet seat areas as required, before installation of new parts.
4. Attach the inlet needle to the metal tang of the float with the wire clip. The formed 90° lip of the metal tang should point up, with the needle valve hanging down. See Figure 5-11.

## Section 5

### Fuel System and Governor



Figure 5-11. Float and Inlet Needle.

5. Install the float and inlet needle down into the seat and carburetor body. Insert the new pivot pin through the float hinge and secure with the new retaining screw. See Figure 5-12.

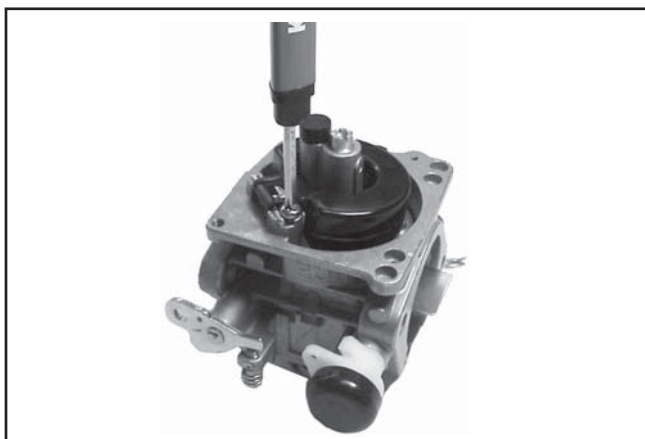


Figure 5-12. Installing Float Assembly.

6. Hold the carburetor body so the float assembly hangs vertically and rests lightly against the fuel inlet needle. The inlet needle should be fully seated but the center pin of the needle (on retainer clip end) should not be depressed. Check the float height adjustment.

NOTE: The inlet needle center pin is spring loaded. Make sure the float assembly rests against the fuel inlet needle without depressing the center pin.

7. The correct float height adjustment is **12.0 mm (0.472 in.)** measured from the float bottom to the body of the carburetor. See Figure 5-13. Adjust the float height by carefully bending the metal tang of the float.

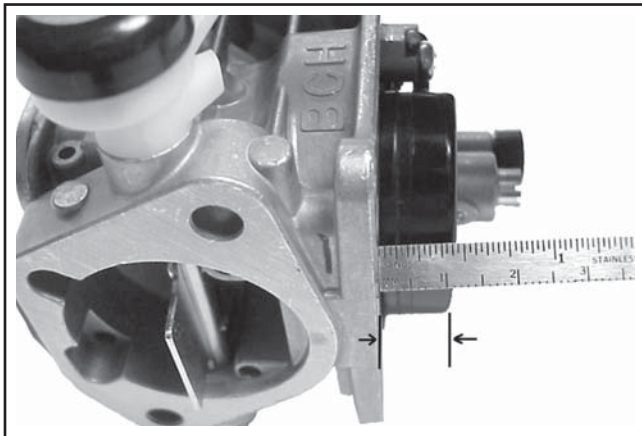


Figure 5-13. Checking Float Height.

NOTE: Be sure to measure from the casting surface, not the rubber gasket, if still attached.

8. When the proper float height is obtained, carefully reinstall the fuel bowl, with the O-Ring(s) in place, onto the carburetor. Secure with the four original screws. Torque the screws to **2.5 ± 0.3 N·m (23 ± 2.6 in. lb.)**. Reattach the accelerator pump hose (if so equipped), and secure with the clip. See Figure 5-14.

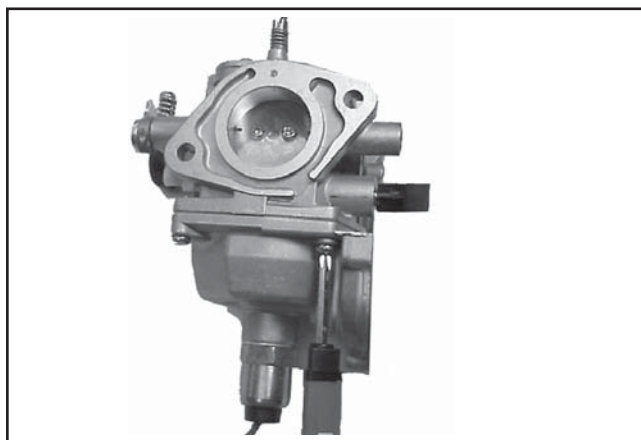


Figure 5-14. Installing Fuel Bowl.

#### Disassembly/Overhaul

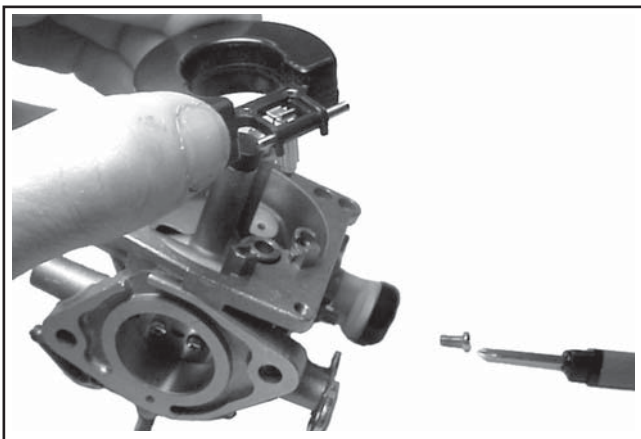
1. Clean the exterior surfaces of dirt or foreign material before disassembling the carburetor. Remove the four fuel bowl screws and separate the fuel bowl from the carburetor. Transfer any remaining fuel into an approved container. Remove and discard the old O-Ring(s). See Figure 5-15.



**Figure 5-15. Fuel Bowl Removed from Carburetor.**

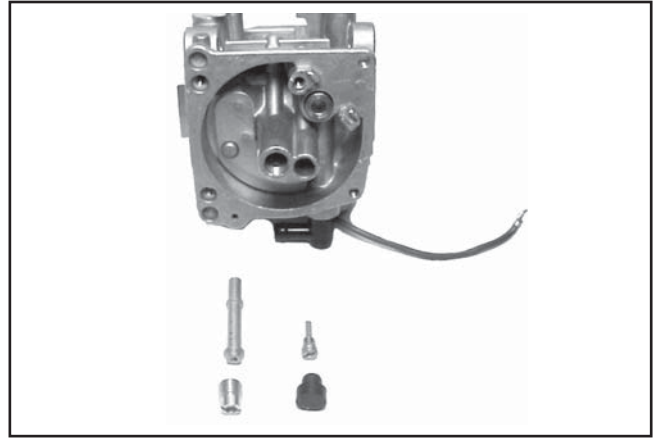
NOTE: Further disassembly of fuel bowl is not necessary unless a Fuel Solenoid Kit (obtained separately), is also being installed.

2. Remove the float pin screw and lift out the old float, pin, and inlet needle. See Figure 5-16. Discard all of the parts. The seat for the inlet needle is not serviceable, and should not be removed.



**Figure 5-16. Removing Float and Inlet Needle.**

3. Remove and discard the round plug from the bottom of the slow jet tower of the carburetor body. Use an appropriate size flat screwdriver, and carefully remove the slow and main jets from the carburetor. After the main jet has been removed, the main nozzle can be taken out through the bottom of the main tower. Save the parts for cleaning and reuse. See Figure 5-17.



**Figure 5-17. Main Jet and Slow Jet Removed.**

4. Remove the two screws securing the top cover, gasket, and ground lead (fuel solenoid-equipped models). Discard the gasket and screws only.
5. Remove the idle speed and idle fuel adjusting screws and springs from the carburetor. Discard the parts.

NOTE: The carburetor is now disassembled for appropriate cleaning and installation of the parts in the overhaul kit. Further disassembly is not necessary. The throttle shaft assembly, fuel inlet seat, and bowl chamber baffle, are non-serviceable items and should not be removed. The choke shaft assembly is serviceable, however it should not be removed unless a Choke Repair Kit will be installed.

6. Clean the carburetor body, jets, vent ports, seats, etc., using a good commercially available carburetor solvent. Use clean, dry compressed air to blow out the internal channels and ports. Inspect and thoroughly check the carburetor for cracks, wear, or damage. Inspect the fuel inlet seat for wear or damage. Check the spring loaded choke plate to make sure it moves freely on the shaft.
7. Clean the carburetor float bowl as required. If it has an accelerator pump that is not being serviced at this time, prevent the cleaning solvent from contacting the check valve and accelerator pump components.
8. Install the main nozzle and the main jet into the tower of the carburetor body. See Figure 5-18.



## Section 5

### Fuel System and Governor

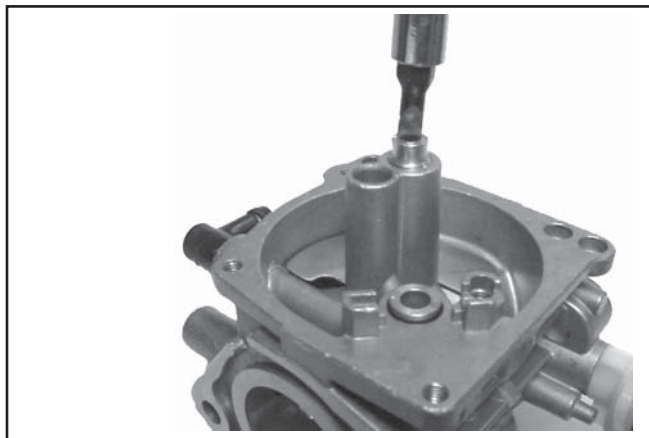


Figure 5-18. Installing Main Nozzle and Main Jet.

9. Install the slow jet and new plug into end of slow jet tube. See Figures 5-19 and 5-20.

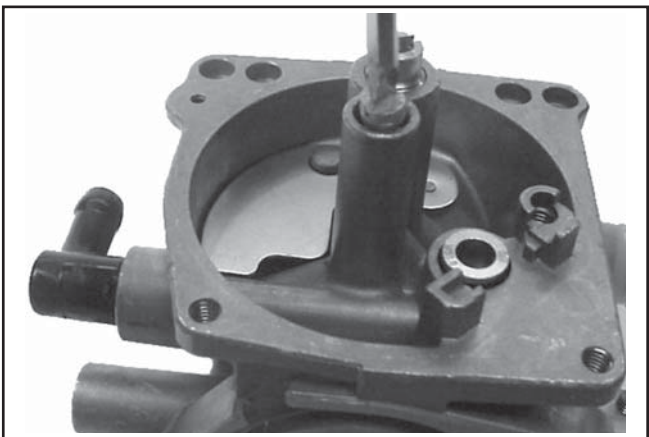


Figure 5-19. Installing Slow Jet.

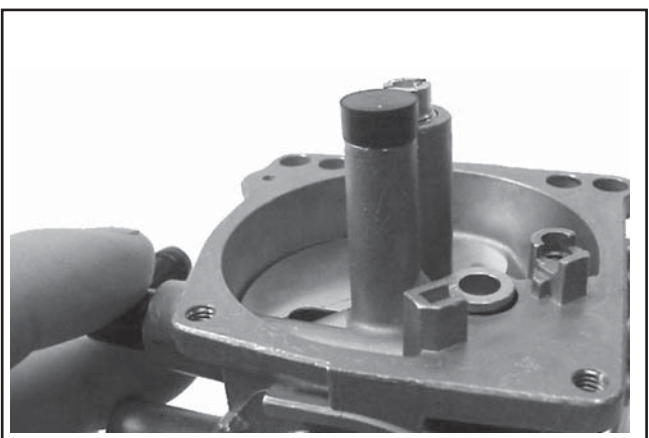


Figure 5-20. Installing Plug into Slow Jet Tube.

10. Attach the inlet needle to the metal tang of the float with the wire clip. The formed 90° lip of the metal tang should point **up**, with the needle valve hanging **down**. See Figure 5-21.



Figure 5-21. Float and Inlet Needle.

11. Install the float and inlet needle down into the seat and carburetor body. Insert the new pivot pin through the float hinge and secure with the new retaining screw. See Figure 5-22.

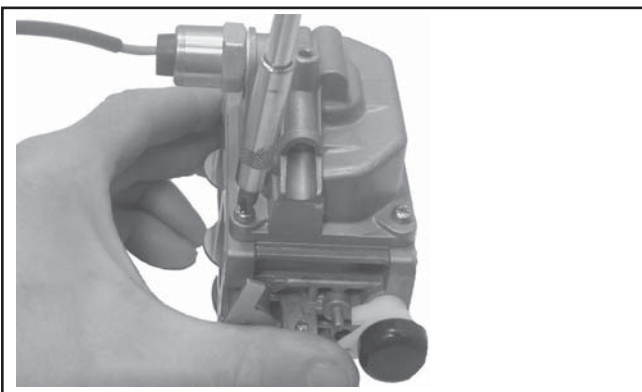
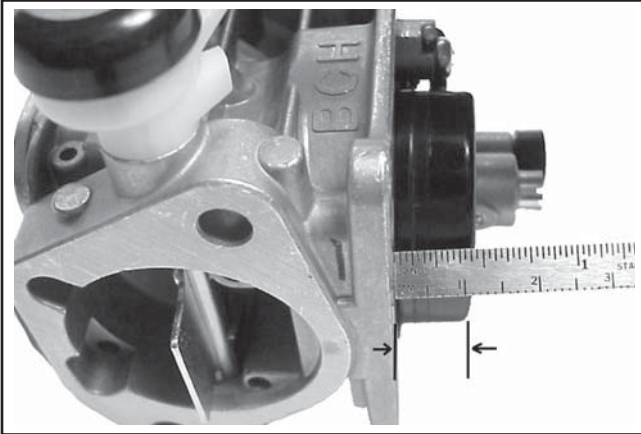


Figure 5-22. Installing Float Assembly.

12. Hold the carburetor body so the float assembly hangs vertically and rests lightly against the fuel inlet needle. The inlet needle should be fully seated but the center pin of the needle (on retainer clip end) should not be depressed. Check the float height adjustment.

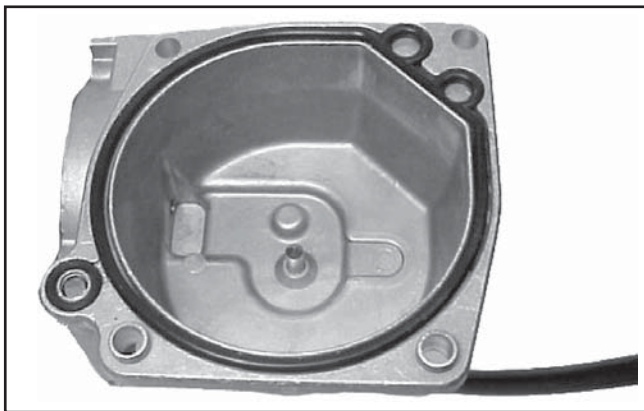
NOTE: The inlet needle center pin is spring loaded. Make sure the float assembly rests against the fuel inlet needle, without depressing the center pin.

13. The correct float height adjustment is **12.0 mm (0.472 in.)** measured from the float bottom to the body of the carburetor. See Figure 5-23. Adjust the float height by carefully bending the metal tang of the float.



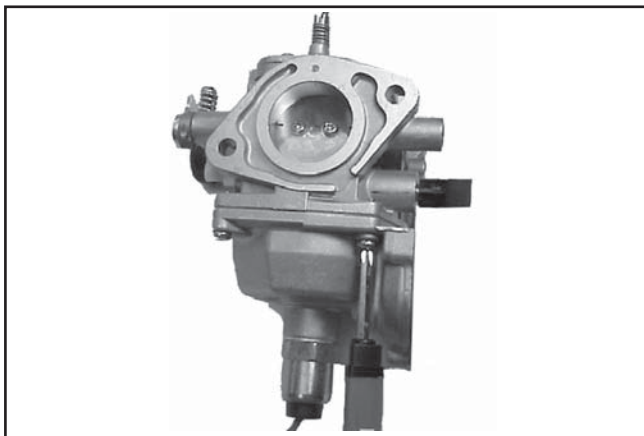
**Figure 5-23. Checking Float Height.**

14. When the proper float height is obtained, carefully install the new O-Rings for the fuel bowl and transfer passage (if so equipped). See Figure 5-24.



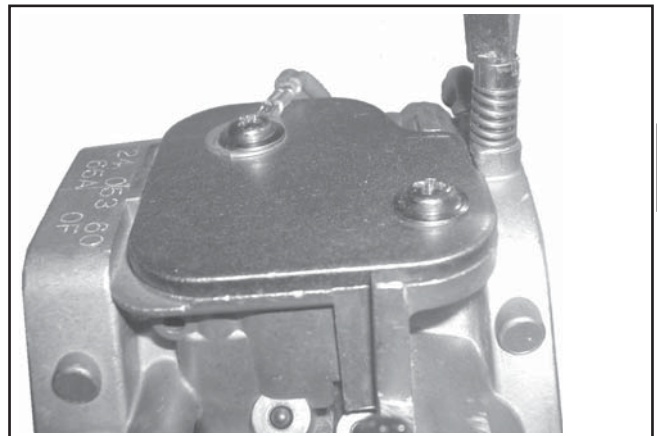
**Figure 5-24. Installing Fuel Bowl O-Rings.**

15. Install the fuel bowl onto the carburetor. Secure with the four original screws. Torque the screws to  $2.5 \pm 0.3 \text{ N}\cdot\text{m}$  ( $23 \pm 2.6 \text{ in. lb.}$ ). See Figure 5-25.



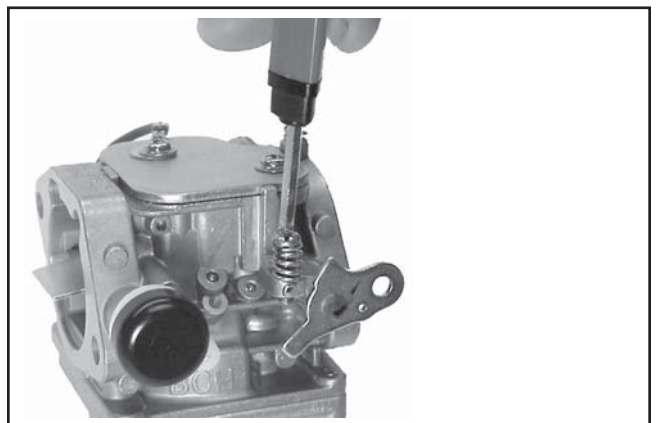
**Figure 5-25. Installing Fuel Bowl.**

16. Install the new cover gasket and top cover on the carburetor. Secure with the two large-head screws and attach the ground lead (if equipped with a fuel solenoid), to the original screw location. Torque the top cover screws to  $2.5 \pm 0.3 \text{ N}\cdot\text{m}$  ( $23 \pm 2.6 \text{ in. lb.}$ ).
17. Place the longer new spring onto the idle fuel adjusting screw and install it into the carburetor. As an initial adjustment, set to 1 turn out from lightly seated. See Figure 5-26.



**Figure 5-26. Installing Idle Fuel Adjusting Screw and Spring.**

18. Place the shorter new spring onto the idle speed adjusting screw and install it into the carburetor. Thread in until 3 or 4 threads are exposed, as an initial adjustment. See Figure 5-27.



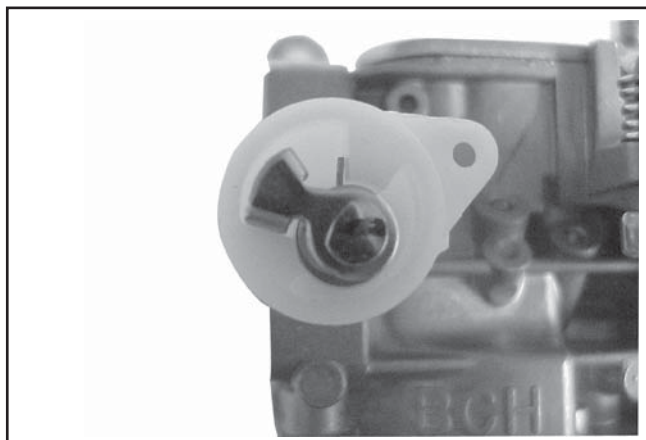
**Figure 5-27. Installing Idle Speed Adjusting Screw and Spring.**

## Section 5

### Fuel System and Governor

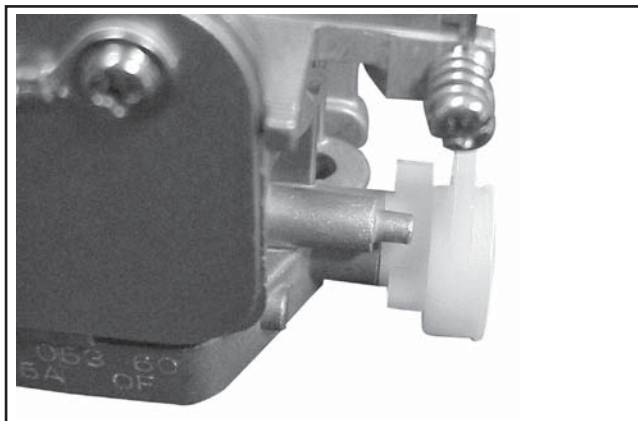
#### Choke Repair

1. Remove the carburetor from the engine. Discard the old mounting gaskets for the air cleaner and carburetor.
2. Clean the areas around the choke shaft and the self-relieving choke mechanism thoroughly.
3. Remove and discard the plastic cap from the top of the choke lever/shaft assembly.
4. Note the position of the spring legs and the choke plate for correct reassembly later. See Figure 5-28. Remove the two screws attaching the choke plate to the choke shaft. Pull the shaft out of the carburetor body and discard the removed parts.



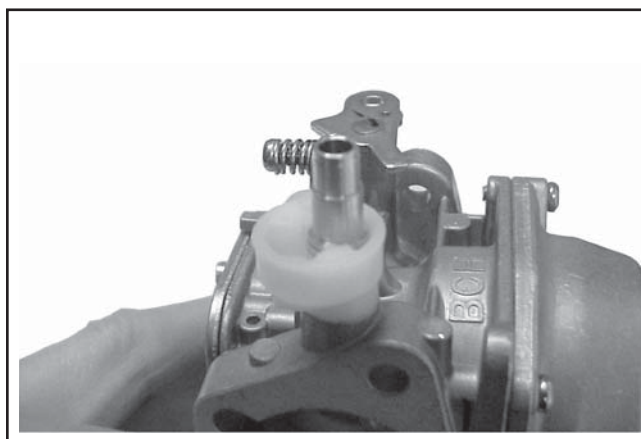
**Figure 5-28. Choke Details.**

5. Use a screw extractor (easy out) and remove the original choke shaft bushing with the old choke lever from the carburetor housing. Save the bushing to use as a driver for installing the new bushing. Discard the old lever.
6. Clean the I.D. of both choke shaft bores as required.
7. Insert the new bushing through the new choke lever from the outside, and start the bushing in the outer shaft bore. Position the choke lever so that the protruding boss on the carburetor housing is between the two stops formed in the choke lever. See Figure 5-29.



**Figure 5-29. Assembling Choke Lever.**

8. Turn the old bushing upside down and use it as a driver to carefully press or tap the new bushing into the carburetor body until it bottoms. Check that the choke lever pivots freely without restriction or binding. See Figure 5-30.



**Figure 5-30. Installing Bushing.**

9. Install the new return spring onto the new choke shaft, so the upper leg of the spring is between the two formed stops on the end of the choke shaft. See Figure 5-31. Note: Make sure it stays in this location during the following step.



Figure 5-31. Choke Shaft and Spring Details.

10. Slide the choke shaft and spring, into the carburetor. Pivot (preload) the shaft and set the inner leg of the spring, against the formed stop within the choke lever as originally assembled. See Figures 5-31 and 5-28. The opposing leg of the spring must still be between the formed stops of the choke shaft.
11. Place a drop of the Loctite® on the threads of each new screw. Install the new choke plate to the flat side of the choke shaft and start the two screws. The larger cutout must be on the right. Close the choke and check the plate alignment within the carburetor throat, then tighten the screws securely. **Do not overtighten.**
12. Check for proper operation and free movement of the parts. Install the new cap.

Always use new gaskets when servicing or reinstalling carburetors. Repair kits are available which include new gaskets and other components. Service/repair kits available for Keihin carburetors and affiliated components are:

Carburetor Repair Kit  
Float Kit  
Solenoid Assembly Kit  
Choke Repair Kit  
High Altitude Kit (1219-2434 m/4,000-8,000 ft.)

## Nikki Carburetors

### Float Replacement

If symptoms described in the carburetor troubleshooting guide indicate float level problems, remove the carburetor from the engine to check and/or replace the float. Use a float kit to replace float, pin and inlet needle or valve.

1. Remove the air cleaner and air intake components from the carburetor as described in Section 4.
2. Disconnect the fuel inlet line from the carburetor.
3. Disconnect governor/throttle linkage from the carburetor.
4. Disconnect lead wires from fuel solenoid-equipped carburetor.
5. Slide the carburetor off the retaining studs. Remove the fuel bowl retaining screw or fuel shut-off solenoid and drain the fuel into a safe container. Remove the bowl from the carburetor body.

5

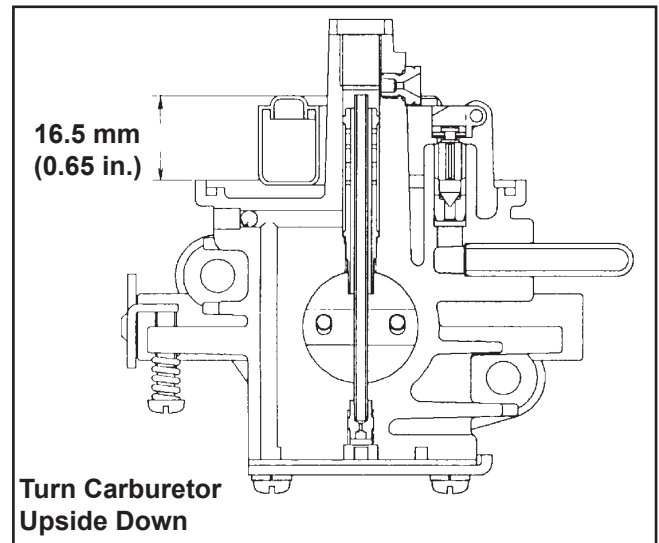


Figure 5-32. Proper Float Level.

6. Turn the carburetor body upside down and check the float level as shown in Figure 5-32. With the float needle valve fully seated, 16.5 mm (0.65 in.) should be measured from the body to the float as indicated. Don't attempt to adjust by bending the tab; replace the float with a kit if the level is wrong.



## Section 5

### Fuel System and Governor

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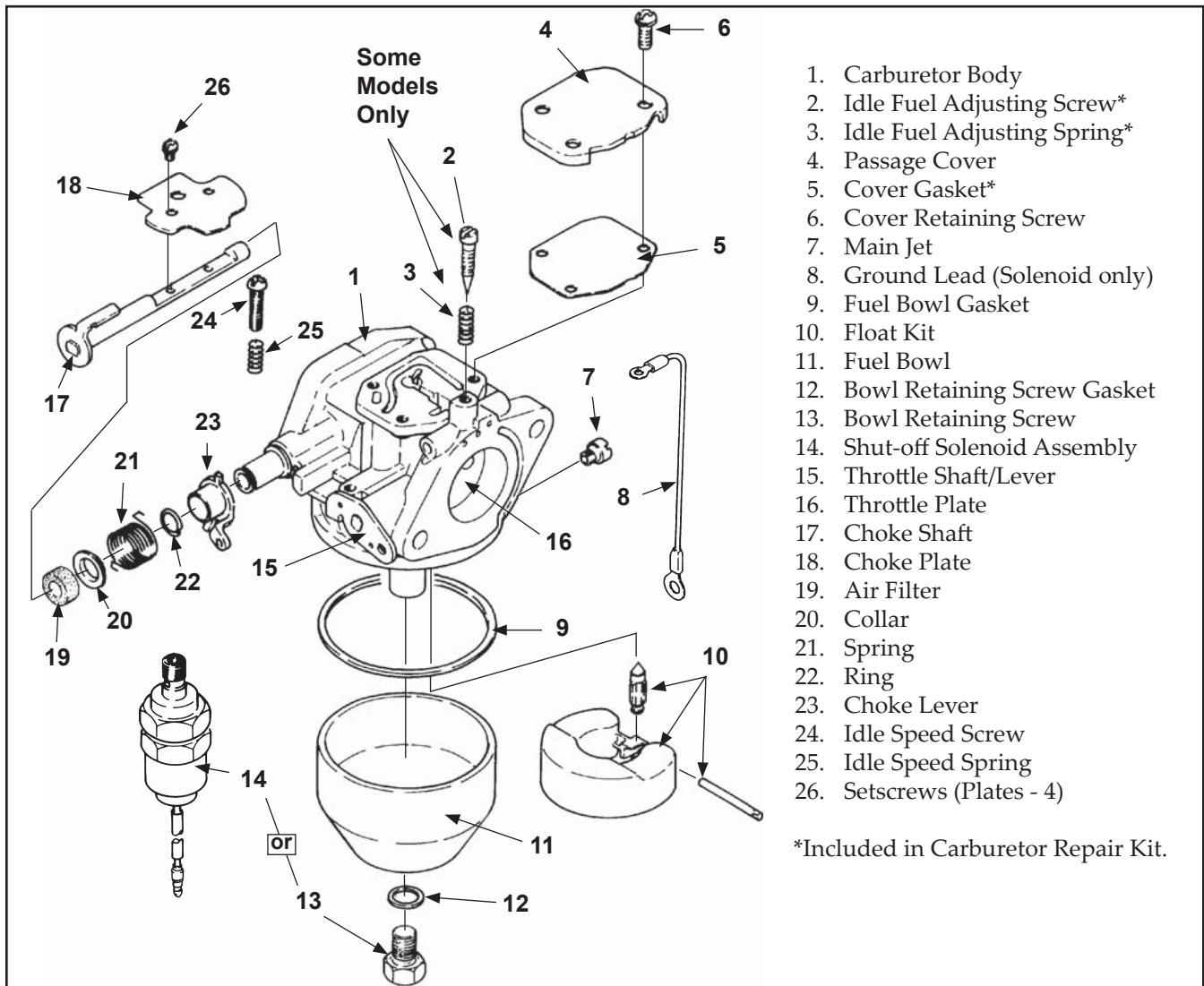
7. Pull the float hinge pin and remove the float with the inlet needle attached to inspect the needle and seat. If dirty, blow out with compressed air. Replace the float components as needed with the kit.
8. Using new gaskets, reinstall the bowl and tighten the bowl retaining screw or solenoid to **5.1-6.2 N·m (45-55 in. lb.)**.
9. Reinstall the carburetor on the engine, reconnect the fuel line, control linkages and air intake components. Retest operation.
2. Pull the float hinge pin, and remove the float with the inlet needle attached.
3. Remove the vent plug from the column on fuel solenoid-equipped carburetors.
4. Remove the screws holding the throttle plate to the throttle shaft, pull the throttle shaft from the carburetor body.
5. Remove the screws securing the choke plate to the choke shaft assembly and pull the choke shaft assembly out of the carburetor body. Disassemble the self-relieving parts from shaft as needed.

#### Disassembly

Use the carburetor repair kit (and the float repair kit if float components are to be replaced). Refer to Figure 5-33 for parts identification. The Kohler part number and the Nikki lot number are stamped on the choke side flange on top of the carburetor body. Refer to the parts manual for the carburetor involved to ensure the correct repair kits and replacement parts are used. Disassemble carburetor as follows after removal from the engine. See Figure 5-33.

1. Remove the fuel bowl retaining screw or solenoid assembly, then remove the bowl and bowl gasket. On solenoid-equipped carburetors, the main jet is mounted in the tip of the solenoid pin. Be careful that it does not get damaged while the solenoid is separated from the carburetor.
6. Remove the three screws holding the passage cover to the body, remove the cover gasket.
7. Remove the idle fuel adjusting needle and spring if it does not have a limiter. Remove the idle speed screw and spring. Except for the slow jet nozzle, main jet, and emulsion tubes, which are considered non-serviceable, the carburetor is now completely disassembled and ready for thorough inspection and cleaning.





**Figure 5-33. Typical Carburetor - Exploded View.**

### Inspection/Repair

To clean vent ports, seats etc., use a good commercially available carburetor solvent, such as Gumout™, and clean, dry compressed air to blow out internal channels and ports. Use a suitable shop rag to prevent debris from hitting someone.

Carefully inspect all components and replace those that are worn or damaged.

- Inspect the carburetor body for cracks, holes and other wear or damage.
- Inspect the float for cracks, holes, and missing or damaged float tabs. Check the float hinge and shaft for wear or damage.
- Inspect the fuel inlet needle and seat for wear or damage.
- Inspect the tip of the low idle fuel adjusting needle (if equipped), for wear or grooves.
- The choke plate is spring loaded. Check to make sure it moves freely.

## Section 5

### Fuel System and Governor

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Always use new gaskets when servicing or reinstalling carburetors. Repair kits are available which include new gaskets and other components. Service/repair kits available for Nikki carburetors and affiliated components are:

Carburetor Repair Kit

Float Kit

High Altitude Kit (1219-2434 m/4,000-8,000 ft.)

Solenoid Assembly Kit

#### Reassembly Procedure

Reassembly is essentially the reverse of the disassembly procedure. Use new gaskets, springs and adjusting screws as provided in the carburetor repair kit. Also use new carburetor and intake manifold gaskets. Set the idle speed (RPM) adjusting screw (if equipped) 2-1/4 turns open for initial adjustment and make final adjustments as described earlier.

### Governor

#### General

The engine is equipped with a centrifugal flyweight mechanical governor. It is designed to hold the engine speed constant under changing load conditions. The governor gear/flyweight mechanism is mounted inside the crankcase on the oil pan, and is driven off the gear on the camshaft. The governor works as follows:

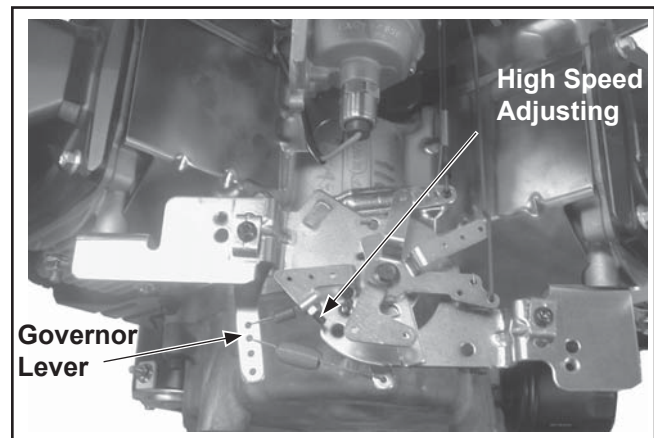
- Centrifugal force acting on the rotating governor gear assembly causes the flyweights to move outward as speed increases. Governor spring tension moves them inward as speed decreases.
- As the flyweights move outward, they cause the regulating pin to move outward.
- The regulating pin contacts the tab on the cross shaft causing the shaft to rotate. One end of the cross shaft protrudes through the crankcase. The rotating action of the cross shaft is transmitted to the throttle lever of the carburetor through the external linkage. See Figure 5-34.

- When the engine is at rest, and the throttle is in the fast position, the tension of the governor spring holds the throttle plate open. When the engine is operating, the governor gear assembly is rotating. The force applied by the regulating pin against the cross shaft tends to close the throttle plate. The governor spring tension and the force applied by the regulating pin balance each other during operation, to maintain engine speed.
- When load is applied and the engine speed and governor gear speed decreases, the governor spring tension moves the governor lever to open the throttle plate wider. This allows more fuel into the engine, increasing engine speed. As speed reaches the governed setting, the governor spring tension and the force applied by the regulating pin will again offset each other to hold a steady engine speed.

### Adjustments

#### General

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



**Figure 5-34. Governor Controls and Linkage (External).**

### Initial Adjustment

Make this adjustment whenever the governor arm is loosened or removed from the cross shaft. See Figure 5-34 and adjust as follows:

1. Make sure the throttle linkage is connected to the governor lever and the throttle lever on the carburetor.
2. Loosen the hex nut holding the governor lever to the cross shaft.
3. Move the governor lever toward the carburetor as far as it will move (wide-open throttle) and hold in position.
4. Insert a nail into the hole in the end of the cross shaft and rotate the shaft **counterclockwise** as far as it will turn, then tighten the hex nut securely.

### Sensitivity Adjustment

Governor sensitivity is adjusted by repositioning the governor spring in the holes of the governor lever. If speed surging occurs with a change in engine load, the governor is set too sensitive. If a big drop in speed occurs when normal load is applied, the governor should be set for greater sensitivity. See Figure 5-34 and adjust as follows:

1. To increase the sensitivity, move the spring closer to the governor lever pivot point.
2. To decrease the sensitivity, move the spring away from the governor lever pivot point.

### High Speed (RPM) Adjustment (Refer to Figures 5-34 and 5-35.)

1. With the engine running, move the throttle control to **fast**. Use a tachometer to check the RPM speed.
2. Loosen the lock nut on the high speed adjusting screw. Turn the screw counterclockwise to decrease, or clockwise to increase RPM speed. Check RPM with a tachometer.
3. When the desired RPM speed is obtained, retighten the lock nut.

**NOTE:** When the throttle and choke control cables are routed side-by-side, especially under a single clamp, there must be a small gap between the cables to prevent internal binding. After the high-speed setting has been completed, check that there is a gap of at least **0.5 mm (0.020 in.)** between the control cables.

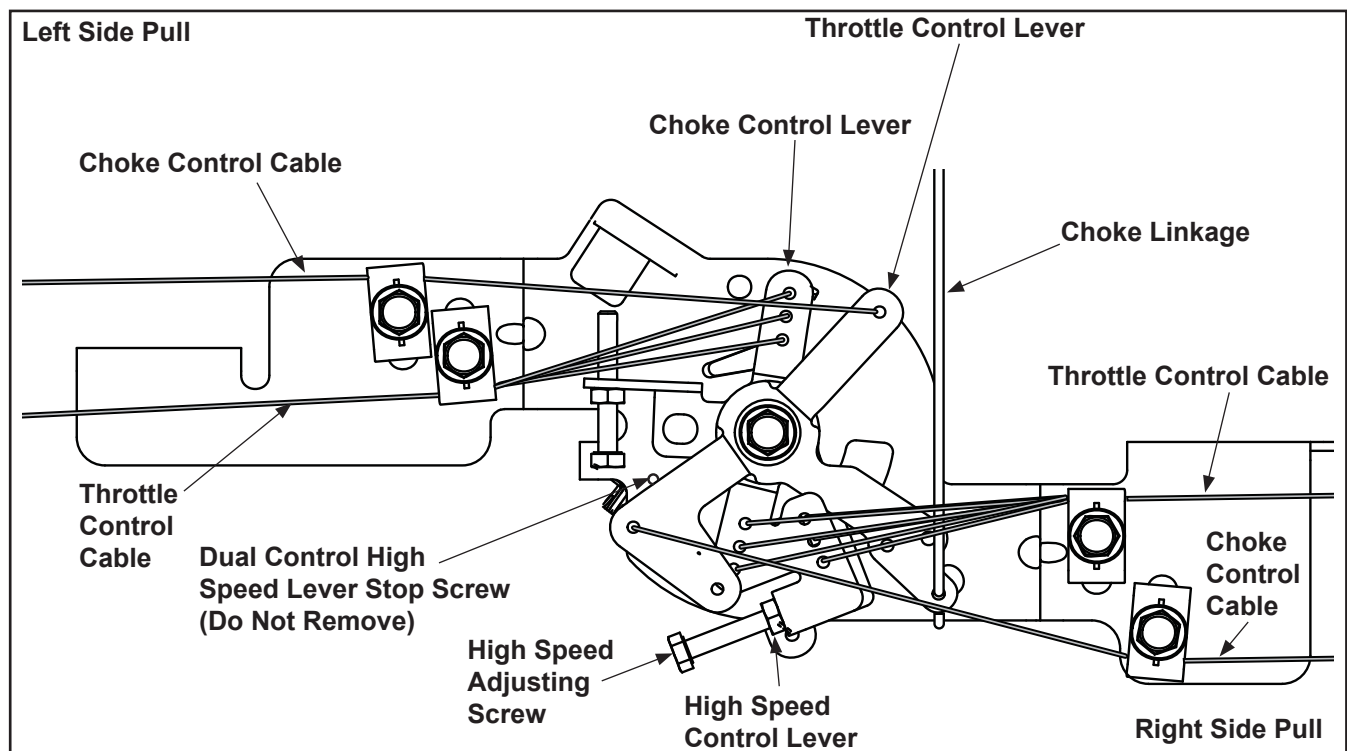


Figure 5-35. Governor Control Connections.

## **Section 5**

### **Fuel System and Governor**

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# Section 6

## Lubrication System

6

### General

This engine uses a combination pressure/splash lubrication system, delivering oil under pressure to the crankshaft, connecting rod and main bearing surfaces. Other component areas are splash lubricated.

A high-efficiency gerotor pump is located in the oil pan. The oil pump maintains oil flow and oil pressure, even at low speeds and high operating temperatures. A pressure relief valve in the oil pump limits the maximum pressure of the system.

### Service

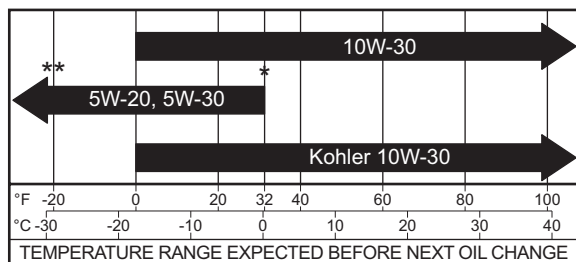
The oil pan must be removed to service the oil pump or oil pickup. Refer to the appropriate procedures in Section 9, Inspection and Reconditioning.

### Oil Recommendations

Using the proper type and weight of oil in the crankcase is extremely important; so is checking oil daily and changing the oil and filter regularly.

Use high-quality detergent oil of **API (American Petroleum Institute) Service Class SJ, or higher**. Select the viscosity based on the air temperature at the time of operation as shown in the following table.

**RECOMMENDED SAE VISCOSITY GRADES**



\* Use of synthetic oil having 5W-20 or 5W-30 rating is acceptable, up to 4°C (40°F)

\*\* Synthetic oils will provide better starting in extreme cold below 23°C (-10°F)

NOTE: Using other than service class SJ or higher oil, or extending oil change intervals longer than recommended can cause engine damage.

NOTE: Synthetic oils meeting the listed classifications may be used with oil changes performed at the recommended intervals. However, to allow piston rings to properly seat, a new or rebuilt engine should be operated for at least 50 hours using standard petroleum based oil before switching to synthetic oil.

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade. See Figure 6-1.



**Figure 6-1. Oil Container Logo.**

The top position of the symbol shows service class such as **API SERVICE CLASS SJ**. The symbol may show additional categories such as **SH, SG/CC, or CD**. The center portion shows the viscosity grade such as **SAE 10W-30**. If the bottom portion shows "Energy Conserving," it means that oil is intended to improve fuel economy in passenger car engines.

## Section 6

### Lubrication System

#### Checking Oil Level

The importance of checking and maintaining the proper oil level in the crankcase cannot be overemphasized. Check oil **BEFORE EACH USE** as follows:

1. Make sure the engine is stopped, level, and cool so the oil has had time to drain into the sump.
2. Clean the area around and the under side of the oil fill cap/dipstick before removing it. This will help to keep dirt, grass clippings, and other foreign matter out of the engine. See Figure 6-2.

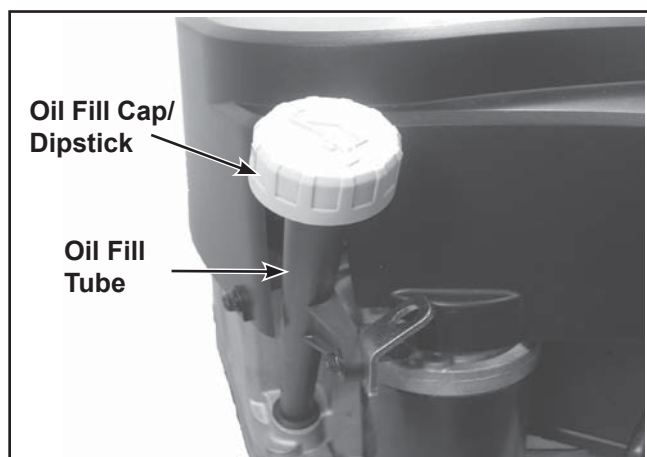


Figure 6-2. Oil Fill Cap/Dipstick and Oil Fill Tube.

3. Unthread and remove the oil fill cap/dipstick; wipe off oil. Reinsert the dipstick into the oil fill tube and rest the oil fill cap/dipstick on the oil fill tube. Turn it counterclockwise until the oil fill cap drops down to the lowest point of the thread leads. **Do not** thread the oil fill cap onto the tube. See Figure 6-3.

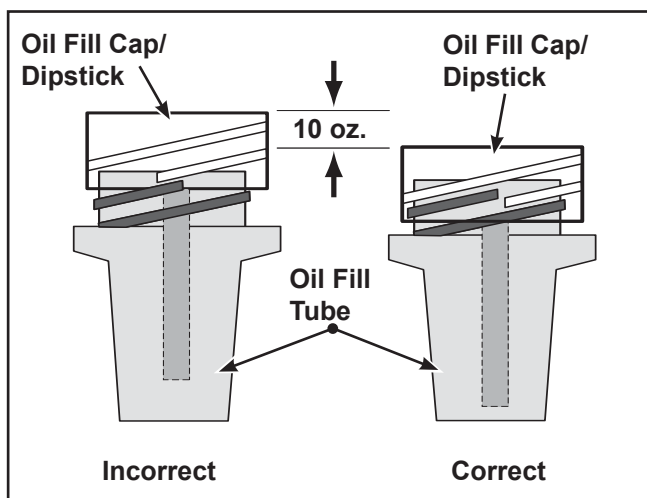


Figure 6-3. Oil Fill Cap and Oil Fill Tube Threads.

4. Remove the oil fill cap/dipstick and check oil level. The oil level needs to be within the operating range. See Figure 6-4. If low, add oil of the proper type up to the full mark. If oil is above "F" or FULL mark, drain oil to reach proper level. Reinstall the oil fill cap/dipstick and thread until tight.

NOTE: To prevent extensive engine wear or damage, always maintain the proper oil level in the crankcase. Never operate the engine with the oil level above the "F" or FULL mark, or below the "L" or LOW mark on the dipstick.

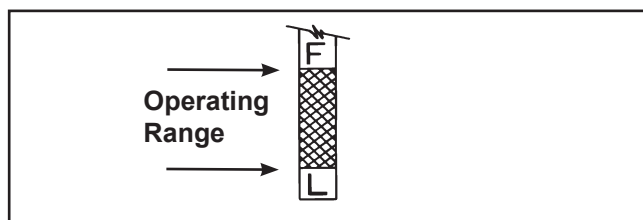


Figure 6-4. Oil Level Marks on Dipstick (Typical).

#### Changing Oil and Oil Filter

Change the oil and oil filter **annually or every 100 hours** of operation (more frequently under severe conditions). Refill with service class SJ oil as specified in the "Viscosity Grades" table. Always use a genuine Kohler oil filter.

Change the oil while the engine is still warm. The oil will flow more freely and carry away more impurities. Make sure the engine is level when filling or checking oil. Change the oil and oil filter as follows.

1. The drain plug is located on the starter side of the oil pan. See Figure 6-5. Clean the area around the oil drain plug and the oil fill cap/dipstick.

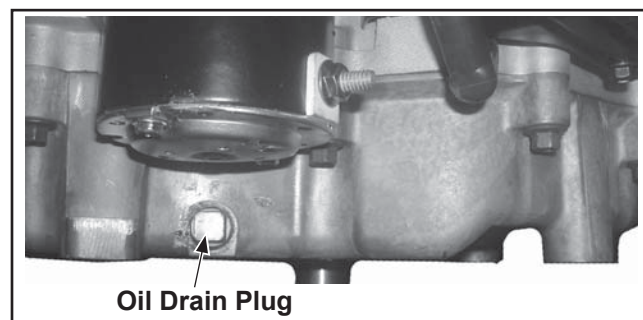
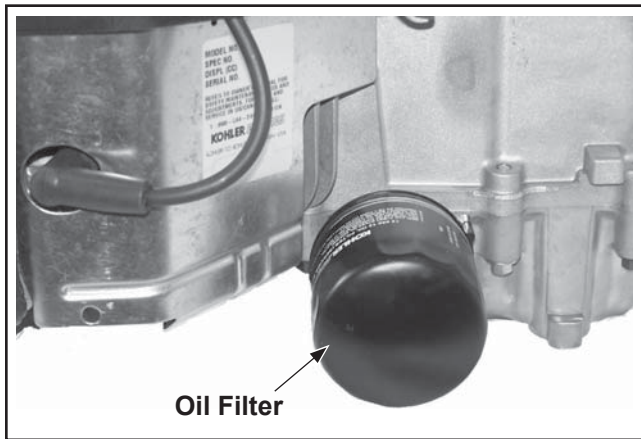


Figure 6-5. Oil Drain Plug Location.

2. Remove the drain plug and the oil fill cap/dipstick.
3. Allow the oil to drain and then reinstall the drain plug. Tighten 13.6 N·m (10 ft. lb.).



4. Remove the old filter and wipe off the filter adapter with a clean cloth. See Figure 6-6.

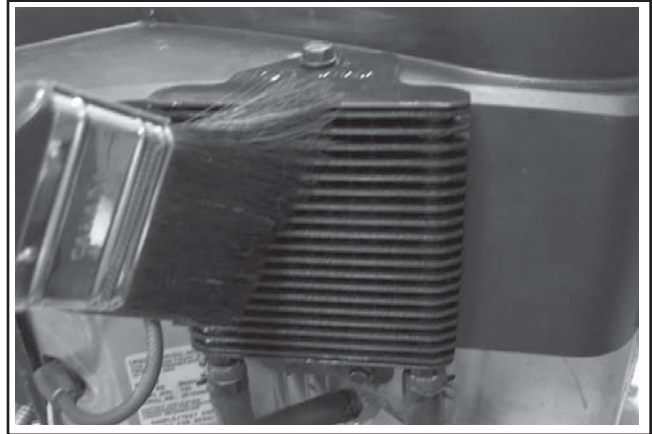


**Figure 6-6. Oil Filter Location.**

5. Place a new replacement filter in a shallow pan with the open end up. Pour new oil, of the proper type, in through the threaded center hole. Stop pouring when the oil reaches the bottom of the threads. Allow a minute or two for the oil to be absorbed by the filter material.
6. Apply a thin film of clean oil to the rubber gasket on the new oil filter.
7. Install the new oil filter to the filter adapter or oil cooler. Refer to instructions on the oil filter for proper installation.
8. Fill the engine with the proper oil to the "FULL" or "F" mark on the dipstick. Always check the oil level with the dipstick before adding more oil.
9. Reinstall the oil fill cap/dipstick.
10. Start the engine and check for oil leaks. Recheck oil level before placing the engine into service. Stop the engine, correct any leaks, and allow a minute for the oil to drain down, then recheck the level on the dipstick.

### Service Oil Cooler

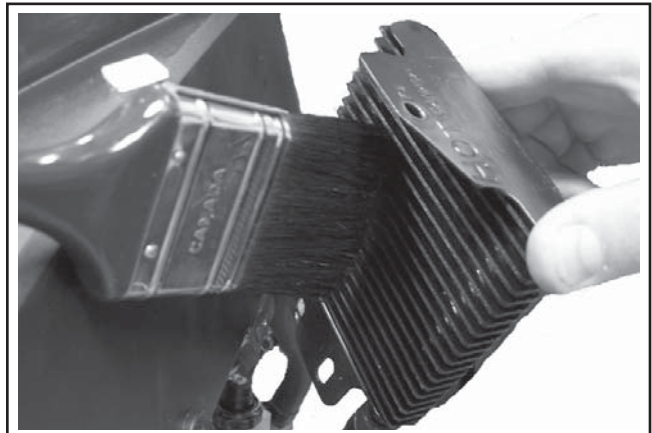
Some engines are equipped with an optional oil cooler. Inspect and clean the oil cooler annually or every **100 hours** of operation (more frequently under severe conditions). Oil cooler must be kept free of debris.



**Figure 6-7. Cleaning Outside of Oil Cooler.**

To service the oil cooler, clean the outside of fins with a soft brush. See Figure 6-7. Remove the mounting screws holding the cooler unit to the blower housing. Tilt the cooler outward as shown in Figure 6-8. Clean the inside of the cooler with a brush or with compressed air. After cleaning, reinstall the oil cooler to the blower housing with the mounting screws.

6



**Figure 6-8. Cleaning Inside of Oil Cooler.**

### Oil Sentry™

#### General

Some engines are equipped with an optional Oil Sentry™ switch. This switch is designed to prevent the engine from starting in a low oil or no oil condition. The 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.

The pressure switch is designed to break contact as the oil pressure increases above 3-5 psi, and make contact as the oil pressure decreases below 3-5 psi.

## Section 6

### Lubrication System

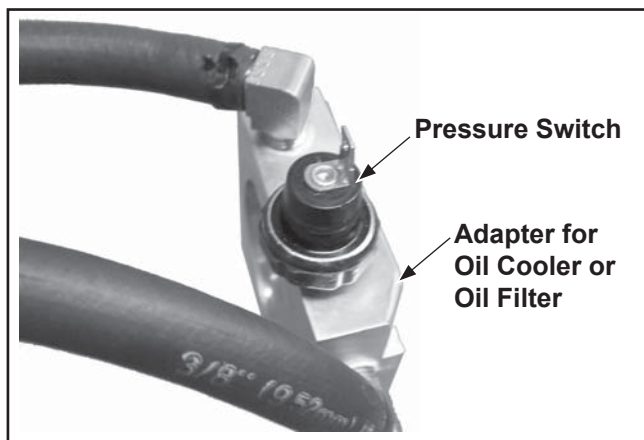
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On stationary or unattended applications (pumps, generators, etc.), the pressure switch can be used to ground the ignition module to stop the engine. On vehicular applications (lawn tractors, mowers, etc.) the pressure switch can only be used to activate a low oil warning light or signal.

**NOTE:** Make sure the oil level is checked before each use, and is maintained up to the “FULL” or “F” mark on the dipstick. This includes engines equipped with Oil Sentry™.

#### Installation

The pressure switch on Oil Sentry™ equipped models is mounted to the oil filter or oil cooler adapter. See Figure 6-9.



**Figure 6-9. Oil Sentry™ Location.**

To install the switch, follow these steps:

1. Apply **pipe sealant with Teflon®** (Loctite® No. 59241 or equivalent) to the threads of the switch.
2. Install the switch into the tapped hole in the adapter. See Figure 6-9.
3. Torque the switch to **4.5 N·m (40 in. lb.)**.

#### Testing the Switch

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

1. Connect the continuity tester across the blade terminal and the metal case of the switch. With **0 psi** pressure applied to the switch, the tester should indicate **continuity (switch closed)**.
2. Gradually increase the pressure to the switch. As pressure increases through the range of **3.0/5.0 psi**, the tester should indicate a change to **no continuity (switch open)**. The switch should remain open as the pressure is increased to **90 psi maximum**.
3. Gradually decrease the pressure through the range of **3.0/5.0 psi**. The tester should indicate a change to **continuity (switch closed) down to 0 psi**.
4. Replace the switch if it does not operate as specified.



# Section 7

## Electrical System and Components

This section covers the operation, service, and repair of the electrical system components. Systems and components covered in this section are:

- Spark Plugs
- Battery and Charging System
- Electronic CD Ignition System
- Electric Starter

### Spark Plugs

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

The engine is equipped with the following spark plugs:

**Type:** The standard spark plug is a Champion® RC12YC (Kohler Part No. 12 132 02-S). RFI compliant engines use a Champion® XC12YC (Kohler 25 132 14-S) spark plug. A high-performance spark plug, Champion® Platinum 3071 (Kohler Part No. 25 132 12-S) is also available. Equivalent alternate brand spark plugs can also be used.

**Gap:** 0.76 mm (0.030 in.)  
**Thread Size:** 14 mm  
**Reach:** 19.1 mm (3/4 in.)  
**Hex Size:** 15.9 mm (5/8 in.)

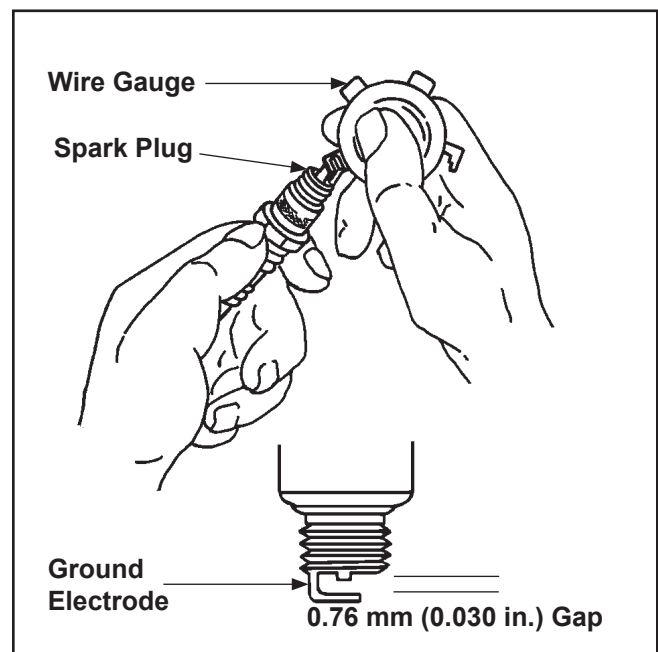
### Spark Plug Service

Remove the spark plugs **annually or every 100 hours** of operation. Check their condition and either reset the gap or replace with new plugs as necessary. To service the plugs, perform the following steps:

1. Before removing a spark plug, clean the area around the base of the plug to keep dirt and debris out of the engine.
2. Remove the spark plug and check its condition. See "Inspection" following this procedure. Replace the spark plug if necessary.

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

3. Check the gap using a wire feeler gauge. Adjust the gap to **0.76 mm (0.030 in.)** by carefully bending the ground electrode. See Figure 7-1.



**Figure 7-1. Servicing Spark Plug.**

4. Reinstall the spark plug into the cylinder head and torque to **24.4-29.8 N·m (18-22 ft. lb.)**.

### Inspection

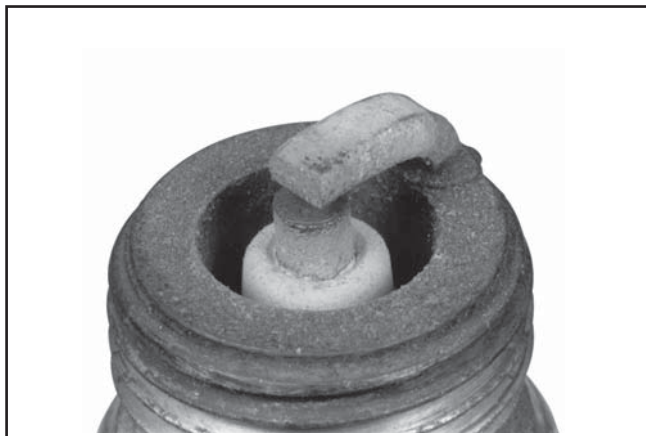
Inspect each spark plug as it is removed from the cylinder head. The deposits on the tip are an indication of the general condition of the piston rings, valves, and carburetor.

Normal and fouled plugs are shown in the following photos:

## Section 7

### Electrical System and Components

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**Normal:** A plug taken from an engine operating under normal conditions will have light tan or gray colored deposits. If the center electrode is not worn, a plug in this condition could be set to the proper gap and reused.



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



**Carbon Fouled:** Soft, sooty, black deposits indicate incomplete combustion caused by a restricted air cleaner, over-rich fuel mixture, 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.



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

Battery

General

A 12-volt battery with minimum of 400 cold cranking amps is generally recommended for starting in all conditions. A smaller capacity battery is often sufficient if an application is started only in warmer temperatures. Refer to the following table for minimum cold cranking amp (cca) capacities, based on anticipated ambient temperatures. The actual cold cranking requirement depends on engine size, application and starting temperatures. The cranking requirements increase as temperatures decrease and battery capacity shrinks. Refer also to the operating instructions for the piece of equipment for specific battery requirements.

Temperature	Battery Required
Above 32°F (0°C)	200 cca minimum
0°F to 32°F (-18°C to 0°C)	250 cca minimum
-5°F to 0°F (-21°C to -18°C)	300 cca minimum
-10°F (-23°C) or below	400 cca minimum

If the battery charge is not sufficient to turn over the engine, recharge the battery.

Battery Maintenance

Regular maintenance is necessary to prolong battery life.



WARNING: Explosive Gas!

Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries.

Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal, which could cause an explosion if hydrogen gas or gasoline vapors are present.

1. Regularly check the level of electrolyte. Add distilled water as necessary to maintain the recommended level.

NOTE: Do not overfill the battery. Poor performance or early failure due to loss of electrolyte will result.

2. Keep the cables, terminals, and external surfaces of the battery clean. A build-up of corrosive acid or grime on the external surfaces can cause the battery to self-discharge. Self-discharge occurs rapidly when moisture is present.
3. Wash the cables, terminals, and external surfaces with a mild baking soda and water solution. Rinse thoroughly with clear water.

NOTE: Do not allow the baking soda solution to enter the cells, as this will destroy the electrolyte.

Battery Test

To test the battery, you will need a DC voltmeter. Perform the following steps (see Figure 7-2):

1. Connect the voltmeter across the battery terminals.
2. Crank the engine. If the battery drops below 9 volts while cranking, the battery is too small, discharged, or faulty.

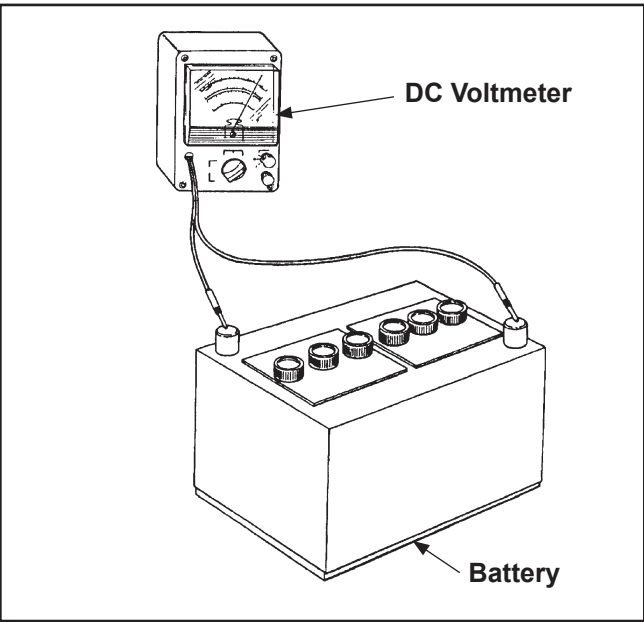


Figure 7-2. Battery Voltage Test.

## Section 7

### Electrical System and Components

#### Electronic Ignition Systems

There are three different types of ignition systems used on the Courage twin cylinder engines. All systems use an ignition module which energizes the spark plug. The difference in the system is in the way the ignition timing is triggered.

The **Fixed Ignition System** utilizes a Capacitive Discharge (CD) coil (See Figure 7-3). This is a basic ignition system that uses a fixed ignition module where the ignition timing and spark remains constant regardless of the engine speed.

The **Digital Spark Advance Ignition (DSAI) System** (See Figure 7-6). This system uses a digital microprocessor which is located in the ignition modules. The ignition timing varies depending upon the engine speed with this system.

The **Digital Spark Advance Module (DSAM)** which was previously known as Smart Spark™ (See Figure 7-9). This system uses a digital microprocessor that triggers the ignition modules and spark. The ignition timing varies depending upon the engine speed with this system.

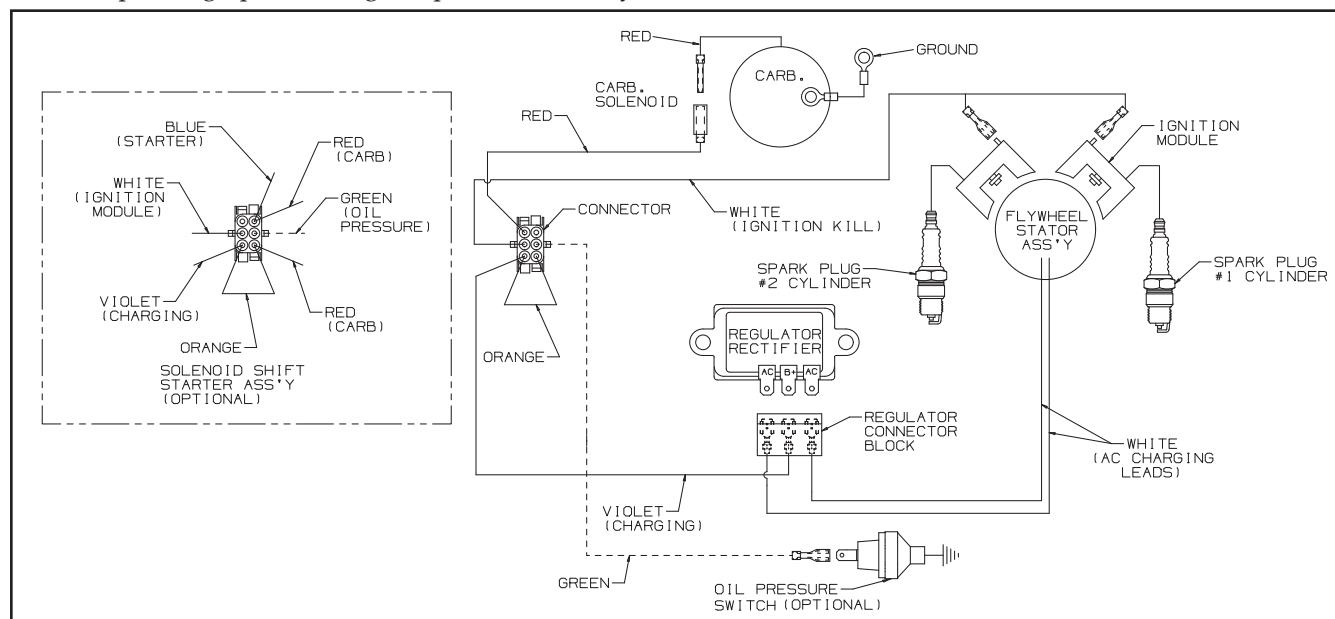


Figure 7-3. Electronic CD Fixed Ignition Timing System.

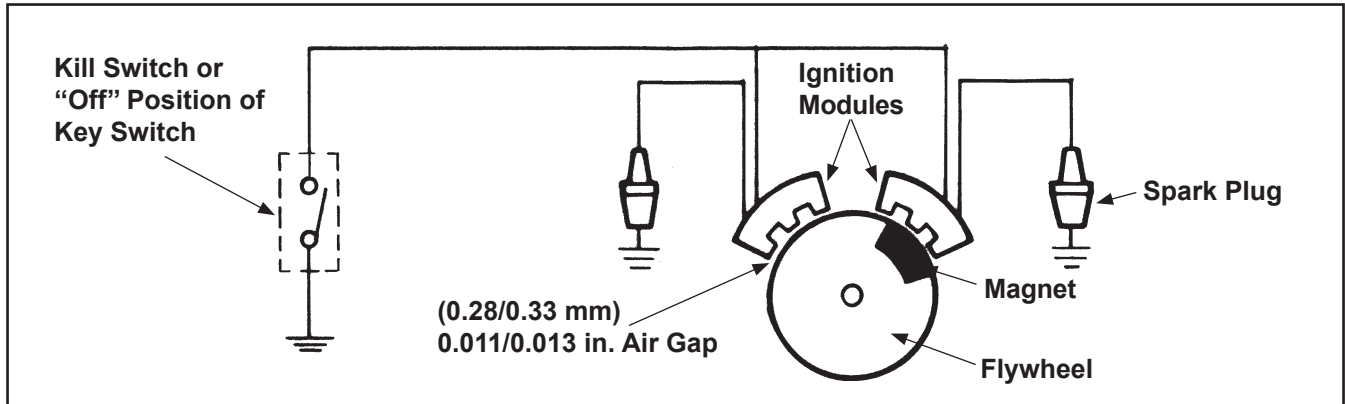
#### Operation of CD Ignition Systems

##### A. Fixed Timing System

This system (Figure 7-3) consists of the following components:

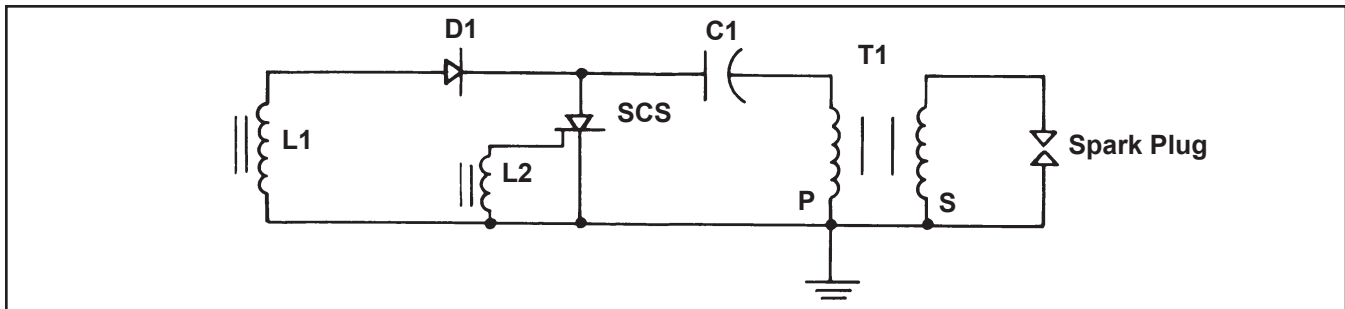
- A magnet assembly which is permanently affixed to the flywheel.
- Two electronic capacitive-discharge ignition modules which mount on the engine crankcase (Figure 7-4).
- A kill switch (or key switch) which grounds the modules to stop the engine.
- Two spark plugs.

**Operation:** As the flywheel rotates, the magnet grouping passes the input coil (L1). The corresponding magnetic field induces energy into the input coil (L1). The resultant pulse is rectified by D1 and charges capacitor C1. As the magnet assembly completes its pass, it activates the triggering device (L2), which causes the semiconductor switch (SCS) to turn on. With the device switch "ON," the charging capacitor (C1) is directly connected across the primary (P) of the output transformer (T1). As the capacitor discharges, the current initiates a fast rising flux field in the transformer core. A high voltage pulse is generated from this action into the secondary winding of the transformer. This pulse is delivered to the spark plug gap. Ionization of the gap occurs, resulting in an arc at the plug electrodes. This spark ignites the fuel-air mixture in the combustion chamber.



**Figure 7-4. Capacitive Discharge Fixed Timing Ignition System.**

The timing of the spark is controlled by the location of the flywheel magnet group as referenced to engine top dead center.



**Figure 7-5. Capacitive Discharge (CD) Ignition Module Schematic.**

### Troubleshooting CD Ignition Systems

The CD ignition systems are designed to be trouble free for the life of the engine. Other than periodically checking/replacing the spark plugs, no maintenance or timing adjustments are necessary or possible. Mechanical systems do occasionally fail or break down however, so the following troubleshooting information is provided to help you get to the root of a reported problem.



#### **CAUTION: High-Energy Electric Spark!**

*The CD ignition systems produce a high-energy electric spark, but the spark must be discharged, or damage to the system can result. Do not crank or run an engine with a spark plug lead disconnected. Always provide a path for the spark to discharge to ground.*

Reported ignition problems are most often due to poor connections. Before beginning the test procedure, check all external wiring. Be certain all ignition-related wires are connected, including the spark plug leads. Be certain all terminal connections fit snugly. Make sure the ignition switch is in the run position.

**NOTE:** The CD ignition systems are sensitive to excessive load on the kill lead. If a customer complains of hard starting, low power, or misfire under load, it may be due to excessive draw on the kill circuit. Perform the appropriate test procedure.

### **Test Procedure for Standard (Fixed Timing) CD Ignition System**

Isolate and verify the trouble is within the engine ignition system.

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

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



## Section 7

### Electrical System and Components

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- a. If the problem is gone, the electrical system on the unit is suspect. Check the key switch, wires, connections, safety interlocks, etc.
  - b. If the problem persists the condition is associated with the ignition or electrical system of the engine. Leave the kill lead isolated until all testing is completed.
2. Test for spark on both cylinders with Kohler ignition tester, (Kohler Part No. 24 455 02-S). Disconnect one spark plug lead and connect it to the post terminal of the tester. Connect the clip to a good ground, not to the spark plug. Crank the engine and observe the tester spark gap. Repeat the procedure on the other cylinder. Remember to reconnect the first spark plug lead.
    - a. If one side is not firing, check all wiring, connections, and terminations on that side. If wiring is okay, replace ignition module and retest for spark.
    - b. If the tester shows spark, but the engine misses or won't run on that cylinder, try a new spark plug.
    - c. If neither side is firing, recheck position of ignition switch and check for shorted kill lead.

#### B. DSAI Ignition System Explanation

A digital spark advance ignition system (DSAI) is used on some models. The DSAI ignition system is an advanced 12 volt version of the fixed timing ignition system used on other models. Two inductive style ignition modules control the ignition timing based on engine RPM. A typical DSAI application (Figure 7-6) consists of the following components:

- A magnet assembly, which is permanently affixed to the flywheel.
- Two inductive 12 volt ignition modules, which mount on the engine crankcase (Figure 7-6).
- A 12 volt battery, which supplies current to the ignition modules.
- A kill switch (or key switch) which grounds the spark advance module to stop the engine.
- Two spark plugs.

#### Operation

The system provides more consistent energy to the spark plugs at all engine speeds by using the 12 volt battery as its source of power. Engine speed and top

dead center (TDC) location reference information is provided by the flywheel magnet group as it passes the ignition module. System triggering and engine timing is performed by a digitally controlled microprocessor. This digital control provides repeatable and consistent engine cylinder spark timing. Each DSAI module performs its function independently for each engine cylinder.

#### Troubleshooting DSAI Ignition Systems

The DSAI ignition system is designed to be trouble free for the life of the engine. Other than periodically checking/replacing the spark plugs, no maintenance, timing, or module adjustments are necessary or possible. Mechanical systems do occasionally fail or break down however, so the following troubleshooting information is provided to help you get to the root of a problem.

Reported ignition problems are most often due to poor connections. Before beginning the test procedure, check all external wiring. Be certain all ignition-related wires are connected, including the spark plug leads. Be certain all terminal connections fit snugly. Make sure the ignition switch is in the **RUN** position.

**NOTE:** Ignition systems are sensitive to excessive load on the kill lead. If a customer complains of hard starting, low power, or misfire under load, it may be due to excessive draw on the kill circuit. Perform the appropriate test procedure.

#### Test Procedure for DSAI Ignition Systems

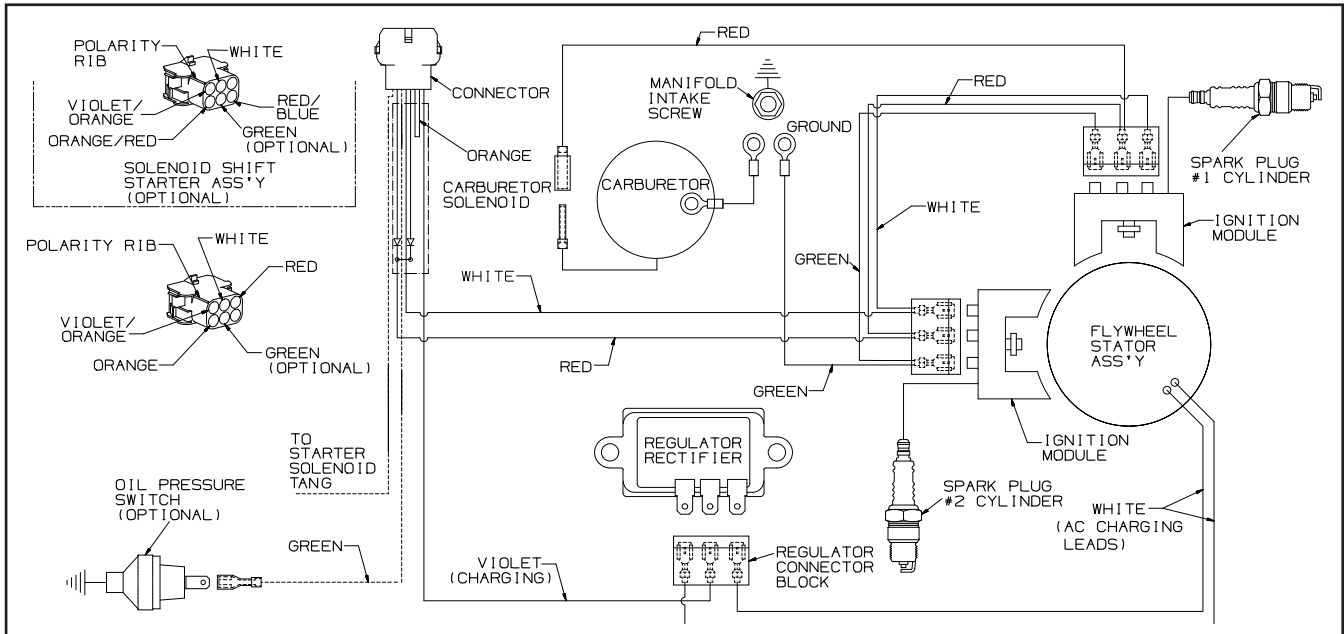
The following procedures are provided for troubleshooting ignition problems on DSAI equipped engines. They will allow you to isolate and pinpoint the failed component(s).

##### Special Tools Required:

- Hand Tachometer
- Ignition Tester\* (Kohler Part No. 25 455 01-S)
- Automotive Timing Light
- Multi-meter (Digital)

##### Specifications Required:

- Spark plug gap 0.76 mm (0.030 in.)



**Figure 7-6. Digital Spark Advance Ignition (DSAI) System.**

\*NOTE: Ignition tester (Kohler Part No. 25 455 01-S), must be used to test ignition on these engines. Use of any other tester can result in inaccurate findings. The battery on the unit must be fully charged and properly connected before making any of these tests (a battery that is hooked up or charged backward will crank the engine, but it won't have spark). Be certain the drive is in neutral and all external loads are disconnected.

### Test 1. Isolate and Verify the Trouble is Within the Engine Ignition System

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

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

- a. If the problem goes away, the electrical system on the equipment is suspect. Check the key switch, wires, connections, safety interlocks, etc.
- b. If the problem persists, the condition is associated with the ignition or electrical system of the engine. Leave the kill lead isolated until all testing is completed.
- c. Identify the white kill lead of the engine wiring harness connector. Establish a connection to a known good ground location. The engine should kill completely. If not, or only one cylinder is affected, go to Test 4, but also check the white kill lead connection for the affected DSAI module.

### Test 2. Test for Spark

1. With the engine stopped, disconnect one spark plug lead. Connect the spark plug lead to post terminal of spark tester (Kohler Part No. 25 455 01-S), and attach tester clip to a good engine ground.

NOTE: If two testers are available, testing can be performed simultaneously for both cylinders. However, if only one tester is available, two individual tests must be performed. The side not being tested must have the spark plug lead connected or grounded. Do not crank the engine or perform tests with one spark plug lead disconnected and not grounded, or permanent system damage may occur.

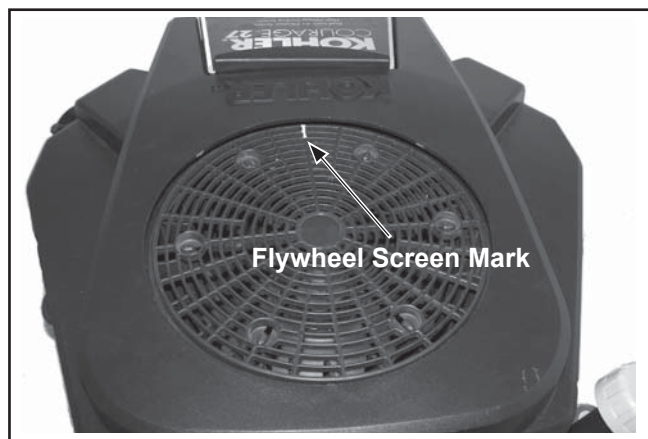
## Section 7

### Electrical System and Components

2. Crank the engine over, establishing a minimum of 550-600 RPM, and observe tester(s) for spark.
3. Repeat the spark test on the opposite cylinder if cylinders are being tested individually.
  - a. If both cylinders have good spark but the engine runs poorly, or existing plug(s) condition or appearance is questionable, install new spark plugs gapped at 0.76 mm (0.030 in.), and retest engine performance. If problem persists, go to Test 3.
  - b. If one cylinder had good spark but the other cylinder had no spark, or intermittent spark, go to Test 4.
  - c. If there was spark on both cylinders but power is suspect, go to Test 3.

#### Test 3. Check for Timing Advance

1. Make a line near the edge of the flywheel screen with a marking pen or narrow tape. See Figure 7-7.
2. Connect an automotive timing light to cylinder that had good spark.



**Figure 7-7. Check For Timing Advance.**

3. Run the engine at idle and use the timing light beam to locate the line on the screen. Draw a line on the blower housing next to the line on the screen. Accelerate to full throttle and watch for movement of the line on the screen relative to the line on the blower housing. If both cylinders had good spark, repeat the test on the other cylinder. See Figure 7-8.



**Figure 7-8. Check for timing advance.**

- a. If the line on the screen moved away from the line on the blower housing during acceleration, the DSAI ignition module for the cylinder being tested is working properly. If it didn't move away, go to Test 4.
- b. If you were able to check timing on both cylinders, the lines you made on the blower housing should be 90° apart. If not, go to Test 4.

#### Test 4. Test the Ignition Modules and Connections

1. Remove the blower housing from the engine. Inspect the wiring for any damage, cuts, bad crimps, loose terminals, or broken wires. Check that connections are oriented properly on terminals of modules.
2. Disconnect the leads from the ignition module(s) and clean all of the terminals (male and female) with aerosol electrical contact cleaner to remove any old dielectric compound, dark residue, dirt, or contamination. Disconnect the spark plug leads from the spark plugs.
3. Using a multi-meter, check that a proper ground is established between the ground (black) lead of the DSAI module (closest to spark plug lead), and a known good ground location on the engine.



4. Turn the key switch to the ON position and check for 12 volts at the center/power (red) lead terminal of the DSAI module. Use the same ground location for the multi-meter as in Step 3.
  - a. If all tests are OK and module has no spark or fails to advance, replace the affected module.
  - b. If any of the tests are bad; determine cause and fix as required, then retest.

### **C. Digital Spark Advance Module (DSAM)**

DSAM, previously known as Smart-Spark™, equipped engines utilize an electronic capacitive discharge ignition system with electronic spark advance. A typical application (Figure 7-9) consists of the following components:

- A magnet assembly which is permanently affixed to the flywheel.
- Two electronic capacitive discharge ignition modules which mount on the engine crankcase (Figure 7-9).
- A spark advance module which mounts to the engine shrouding (Figure 7-9).
- A 12 volt battery which supplies current to the spark advance module.
- A kill switch (or key switch) which grounds the spark advance module to stop the engine.
- Two spark plugs.

**Operation:** The ignition module for this system operates in the same fashion as the fixed timing module, except the trigger circuit for the semi-conductor (L2, Figure 7-5) is replaced by the spark advance module (Figure 7-9).

The pulse generated by the input coil of the ignition module (L1, Figure 7-5) is fed to the input of the conditioning circuit. The conditioning circuit shapes this pulse, putting it in a useable form for the additional circuits. This pulse starts the charge pump, which charges a capacitor in a linear fashion that is directly related to the engine speed. At the same time the pulse resets the delay circuit for the length of the pulse width. The capacitor is off during this period and no output is generated. As soon as the original pulse drops back to zero, the capacitor in the delay circuit begins to charge.

When the charge on the delay capacitor exceeds the charge on the charge pump capacitor, the capacitor changes state, activating the pulse generator.

This pulse turns “ON” the CD ignition module semi-conductor. Energy is then transferred to the secondary output transformer (T1, Figure 7-5). The high voltage pulse generated here is delivered to the spark plug, causing arcing of the spark gap and igniting the fuel-air mixture in the combustion chamber. As the trigger pulse is generated, all associated circuits are reset, their capacitors discharged. The longer it takes the delay circuit to surpass the charge pump capacitor voltage, the later the trigger pulse will occur, retarding the timing accordingly.

Section 7

Electrical System and Components

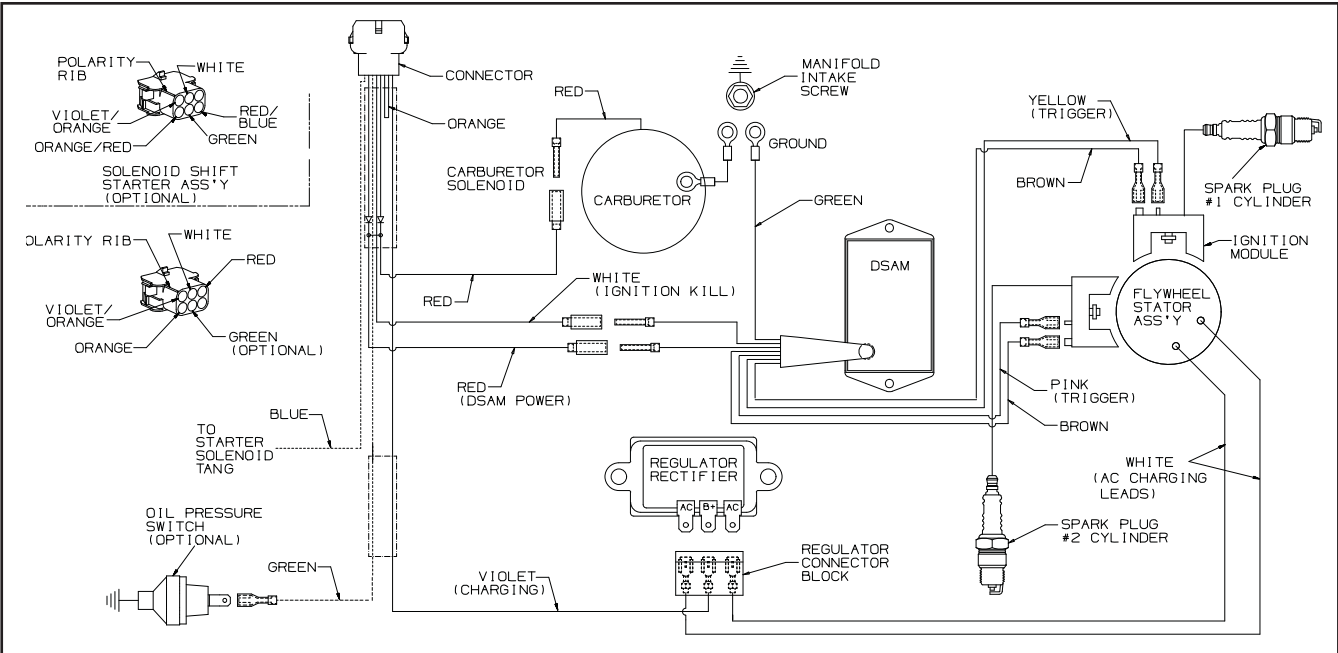


Figure 7-9. Digital Spark Advance Module (DSAM) Ignition System.

The timing of the spark is controlled by the location of the flywheel magnet group as referenced to engine top dead center and the delay created by the spark advance module.

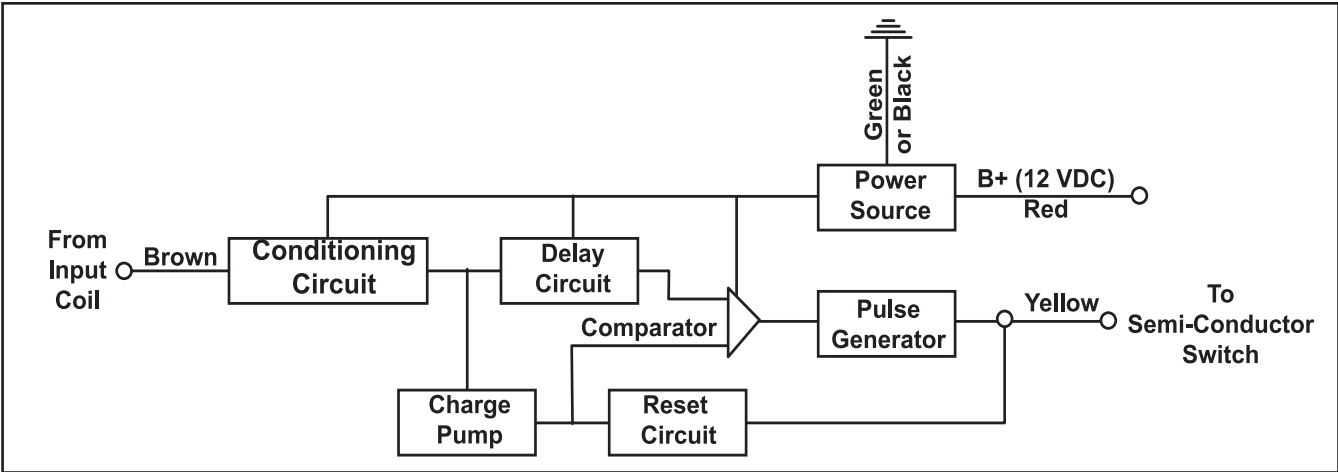


Figure 7-10. Block Diagram - Spark Advance Module (DSAM).

### Troubleshooting CD Ignition Systems

The CD ignition systems are designed to be trouble free for the life of the engine. Other than periodically checking/replacing the spark plugs, no maintenance or timing adjustments are necessary or possible. Mechanical systems do occasionally fail or break down however, so the following troubleshooting information is provided to help you get to the root of a reported problem.



#### **CAUTION: High-Energy Electric Spark!**

*The CD ignition systems produce a high-energy electric spark, but the spark must be discharged, or damage to the system can result. Do not crank or run an engine with a spark plug lead disconnected. Always provide a path for the spark to discharge to ground.*

Reported ignition problems are most often due to poor connections. Before beginning the test procedure, check all external wiring. Be certain all ignition-related wires are connected, including the spark plug leads. Be certain all terminal connections fit snugly. Make sure the ignition switch is in the **RUN** position.

**NOTE:** The CD ignition systems are sensitive to excessive load on the kill lead. If a customer complains of hard starting, low power, or misfire under load, it may be due to excessive draw on the kill circuit. Perform the appropriate test procedure.

### Test Procedure for DSAM Ignition Systems

The following procedures are provided for troubleshooting ignition problems on DSAM or Smart-Spark™ equipped engines, to allow you to isolate and pinpoint the failed component(s).

#### **Special Tools Required:**

- Hand Tachometer
- Tester\* (Kohler Part No. 24 455 02-S)
- Automotive Timing Light
- Multi-Meter (Digital)

#### **Specifications Required:**

- Spark Plug Gap 0.76 mm (0.030 in.)
- Ignition Module Air Gap 0.28/0.33 mm (0.011-0.013 in.), 0.30 mm (0.012 in.) nominal

\*NOTE: Ignition tester (Kohler Part No. 24 455 02-S), 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 making any of these tests (a battery that is hooked up or charged backward will crank the engine, but it won't have spark). Be sure drive is in neutral and all external loads are disconnected.

### **Test 1. Isolate and Verify the Trouble is Within the Engine Ignition System.**

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

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

- a. If the problem is gone, the electrical system on the unit is suspect. Check the key switch, wires, connections, safety interlocks, etc.
- b. If the problem persists the condition is associated with the ignition or electrical system of the engine. Leave the kill lead isolated until all testing is completed.

### **Test 2. Test for Spark.**

1. With the engine stopped, disconnect one spark plug lead. Connect the spark plug lead to post terminal of spark tester (Kohler Part No. 24 455 02-S), and attach tester clip to a good engine ground.

**NOTE:** If two testers are available, testing can be performed simultaneously for both cylinders. However, if only one tester is available, two individual tests must be performed. The side not being tested must have the spark plug lead connected or grounded. Do not crank the engine or perform tests with one spark plug lead disconnected and not grounded or permanent system damage may occur.

2. Crank the engine over, establishing a minimum of 550-600 RPM, and observe tester(s) for spark.

## Section 7

### Electrical System and Components

3. Repeat the spark test on the opposite cylinder if cylinders are being tested individually.
  - a. If both cylinders have good spark but the engine runs poorly, install new spark plugs gapped at 0.76 mm (0.030 in.), and retest engine performance. If problem persists, go to Test 3.
  - b. If one cylinder had good spark but the other cylinder had no spark, or intermittent spark, go to Test 3.
  - c. If there was no spark or intermittent spark on both cylinders, go to Test 4.

#### Test 3. Check For Timing Advance.

1. Make a line near the edge of the flywheel screen with a marking pen or narrow tape. See Figure 7-11.

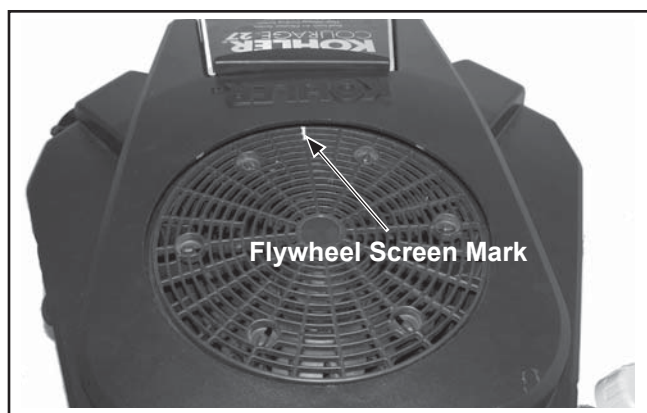


Figure 7-11. Check For Timing Advance.

2. Connect an automotive timing light to cylinder that had good spark.
3. Run the engine at idle and use the timing light beam to locate the line on the screen. Draw a line on the blower housing adjacent to the line on the screen. See Figure 7-12. Accelerate to full throttle and watch for movement of the line on the screen relative to the line on the blower housing. If both cylinders had good spark, repeat the test on the other cylinder.



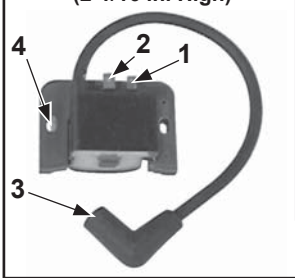
Figure 7-12. Check For Timing Advance.

- a. If the line on the screen moved away from the line on the blower housing during acceleration, the DSAM is working properly. If it didn't move away, go to Test 5.
- b. If you were able to check timing on both cylinders, the lines you made on the blower housing should be 90° apart. If they're not, go to Test 4.

#### Test 4. Test the Ignition Modules and Connections.

1. Remove the blower housing from the engine. Inspect the wiring for any damage, cuts, bad crimps, loose terminals, or broken wires.
2. Disconnect the leads from the ignition module(s) and clean all of the terminals (male and female) with aerosol electrical contact cleaner to remove any old dielectric compound, dark residue, dirt, or contamination. Disconnect the spark plug leads from the spark plugs.
3. Remove one of the mounting screws from each of the ignition modules. Look in the mounting hole with a flashlight and use a small round wire brush to remove any loose rust from the laminations inside the mounting hole.
4. Refer to the following table and use a digital ohmmeter to check the resistance values of the ignition modules and compare them to the table. When testing resistance to the laminations, touch the probe to the laminations inside the screw hole, as some laminations have a rust preventative coating on the surface which could alter the resistance reading.
  - a. If all of the resistance values are within the ranges specified in the table, go to Step 5.
  - b. If any of the resistance values are not within the ranges specified in the table,<sup>#</sup> that module is faulty and must be replaced.

#NOTE: The resistance values apply only to modules that have been on a running engine. New service modules may have higher resistance until they have been run.

	<b>24 584 36-S</b> (2-1/16 in. High)	<b>Test</b> (Use Digital Ohmmeter)	<b>24 584 36-S</b> (2-1/16 in. High)
		From No. 1 to 4	590 to 616 ohms

Ignition Module Resistance Table

5. Check and/or adjust the ignition module air gap(s). An air gap of 0.28/0.33 mm (0.011/0.013 in.) must be maintained under all three legs of the ignition module(s). Checking/adjusting should be performed with the parts at room temperature.
- a. If the module was not loosened or replaced, check that the specified air gap is present under all three legs. If the gap is correct, reinstall the second mounting screw removed earlier and recheck gap after tightening.
- b. If the gap is incorrect, or the module was loosened or replaced, adjust the gap as follows.
- 1) Turn the flywheel magnet away from the module position.
- 2) Attach the module to the mounting legs, pull it away from the flywheel, and tighten the screws to hold it temporarily.
- 3) Rotate the flywheel so the magnet is centered under the module.
- 4) Position a 0.30 mm (0.012 in.) feeler gauge between the magnet and all three legs of the module. The ignition module air gap is critical to proper system performance. **Do not** attempt to set it with a business card or folded microfiche card. Use the feeler gauge specified.

- 5) Loosen the mounting screws, allow the magnet to pull the module down against the feeler gauge, and retighten the mounting screws.
- 6) Rotate the flywheel to remove the feeler gauge, position the magnet back under the module, and recheck that the specified gap, **minimum of 0.28 mm (0.011 in.)**, exists under each leg of the module. When you are certain the gap is correct, torque the module mounting screws to **4.0 N·m (35 in. lb.)**. Repeat these 6 steps to set the other ignition module.

6. Reattach the lead wires to the ignition module(s), noting if resistance is felt, indicating a snug fit between the male and female terminals. If any connections do not feel snug, disconnect the lead, lightly pinch the female terminal with a pliers, and recheck the fit.
7. When the integrity of all connections has been verified, repeat the spark test (Test 2).
- a. If a strong, steady spark is now present (both sides). Go to Test 5, step 4.
- b. If there is still a spark problem, perform Test 5.



## Section 7

### Electrical System and Components

#### Test 5. Test the DSAM.

1. Trace the red power source lead from the DSAM to the harness connection. Separate the connector and connect the red lead of a DC voltmeter to the harness terminal. Trace the ground lead (green) from the SAM to the grounding screw. Connect the black voltmeter lead to the eyelet terminal of the ground lead or the ground screw/bolt. Check the voltage with the key switch in both the "START" and "RUN" positions. A minimum of **7.25 volts** must be present.
  - a. If correct voltage is not measured, connect black voltmeter lead directly to the negative (-) post of the battery and test voltage again in both key positions. If correct voltage is now indicated, check the ground circuit connections. If the ground screw/bolt or any other fasteners in the ground circuit are black (oxide-coated), replace them with zinc plated (silver colored) fasteners.
  - b. If correct voltage is still not indicated, check the harness connector terminal for a good connection and crimp to the lead. Then trace the power source circuit back through the harness, key switch, etc., looking for any poor connections, or faulty circuits.
2. Disconnect **all** of the DSAM leads, isolating it from the engine. Test the DSAM with tester 25 761 40-S, using the instructions following, or use TT-5152 provided with the tester. If the DSAM tests bad, replace it.
3. Reattach the DSAM leads, verifying a snug fit at the ignition module terminals. If any connections do not feel snug, disconnect the lead, lightly pinch the female terminal with a pliers, and recheck the fit.
4. Seal the base of the ignition module connections with GE/Novaguard G661 (Kohler Part No. 25 357 11-S) or Fel-Pro Lubri-Sel dielectric compound. The beads should overlap between the two connections to form a solid bridge of compound. **Do not** put any compound inside the connectors.
5. Test for spark (Test 2) to be sure the system is working, before you reinstall the blower housing. If there is still a spark problem on one side, replace that ignition module and recheck spark.

Use the following procedure to test the digital DSAM module (previously known as Smart Spark™).

#### To Test - Using 25 761 40-S Tester

NOTE: The DSAM **must** be at room temperature when tested. Disconnect **all** of the DSAM leads, isolating it from the main wiring harness and the ignition module(s). Testing may be performed with the module mounted or loose. The figures show the part removed from the engine for clarity.

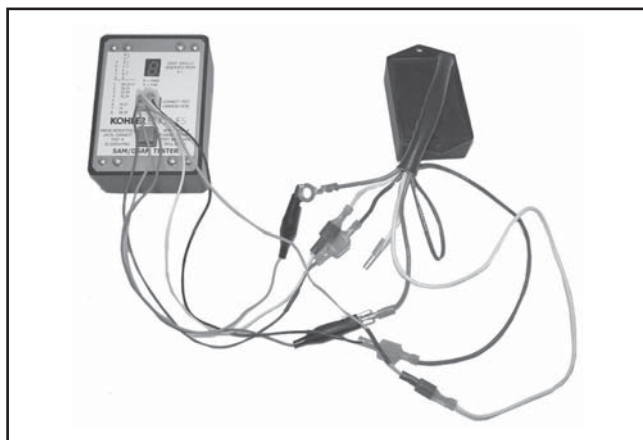


Figure 7-13.

1. Connect the tester to the DSAM as follows:

#### Attach:

- **Yellow** tester lead to the **long yellow** module lead.
- **Brown** tester lead to the **long brown** module lead.
- **Red** tester lead to the **red** module lead.
- **Black** tester lead to the **green or black** module ground lead with the eyelet\* terminal.
- **Pink** tester lead to the **short yellow or pink** module lead.
- **Brown tester lead with black band or terminal** to the **short brown** module lead.

**Caution:** Do not allow the alligator clip leads to touch each other.

#### \*IMPORTANT!

2. Check the DSAM part number, stamped on the end of the tester housing, noting the last two digits. Using those numbers, refer to the table below or tester faceplate to determine the test number to be used.

DSAM Part No.	_____	24 584 31	_____	_____
------------------	-------	-----------	-------	-------

DSAM Part No.	_____	_____	_____	_____
------------------	-------	-------	-------	-------

3. Depress the tester button repeatedly until the correct test number appears on the display. After a few seconds, the test number will flash three times and the test will begin. A reverse numerical sequence will be displayed, starting with a 6 and progressing down to 1, followed by a “P” (pass) or “F” (fail), indicating the condition of the part. See Figures 7-14 and 7-15.
4. If you get a “-” sign instead of the numerical sequence, and/or an “F” at the end of the test cycle, recheck all of the connections, check the condition of the tester battery\* and repeat the test. If you get the “-” or “F” sign again in the retest replace the DSAM.

**\*IMPORTANT!**  
Allow 15-20 seconds for the tester to clear and reset itself between tests or if the test is interrupted before completion of the test cycle. Otherwise, a false reading may be displayed in the form of a “-” or a faint “8”.



Figure 7-14. Select Test Number.



Figure 7-15. “Pass” Indicator.

**\*\*** The tester is powered by a 9-volt battery. Most SAM’s are designed to operate down to a minimum of 7.25 volts. If the tester battery drops below that level, incorrect test readings will result. The tester battery should be checked periodically by connecting a DC voltmeter between the red and green lead wires, with the tester connected to a DSAM. Start the appropriate test sequence. While the test is running monitor the voltage reading on the voltmeter. If the voltage drops below 7.5 at any time during the cycle, the 9-volt tester battery must be replaced. Use an extended life (alkaline) battery.

To replace the battery, remove the outer set of screws on the faceplate and carefully lift the panel from the body. Unplug the connector and pull battery (with mounting tape) off the back of the tester. Attach the connector to the new battery and mount the battery to the case with double-backed tape. Reinstall the faceplate and secure with the four screws.

Battery Charging System

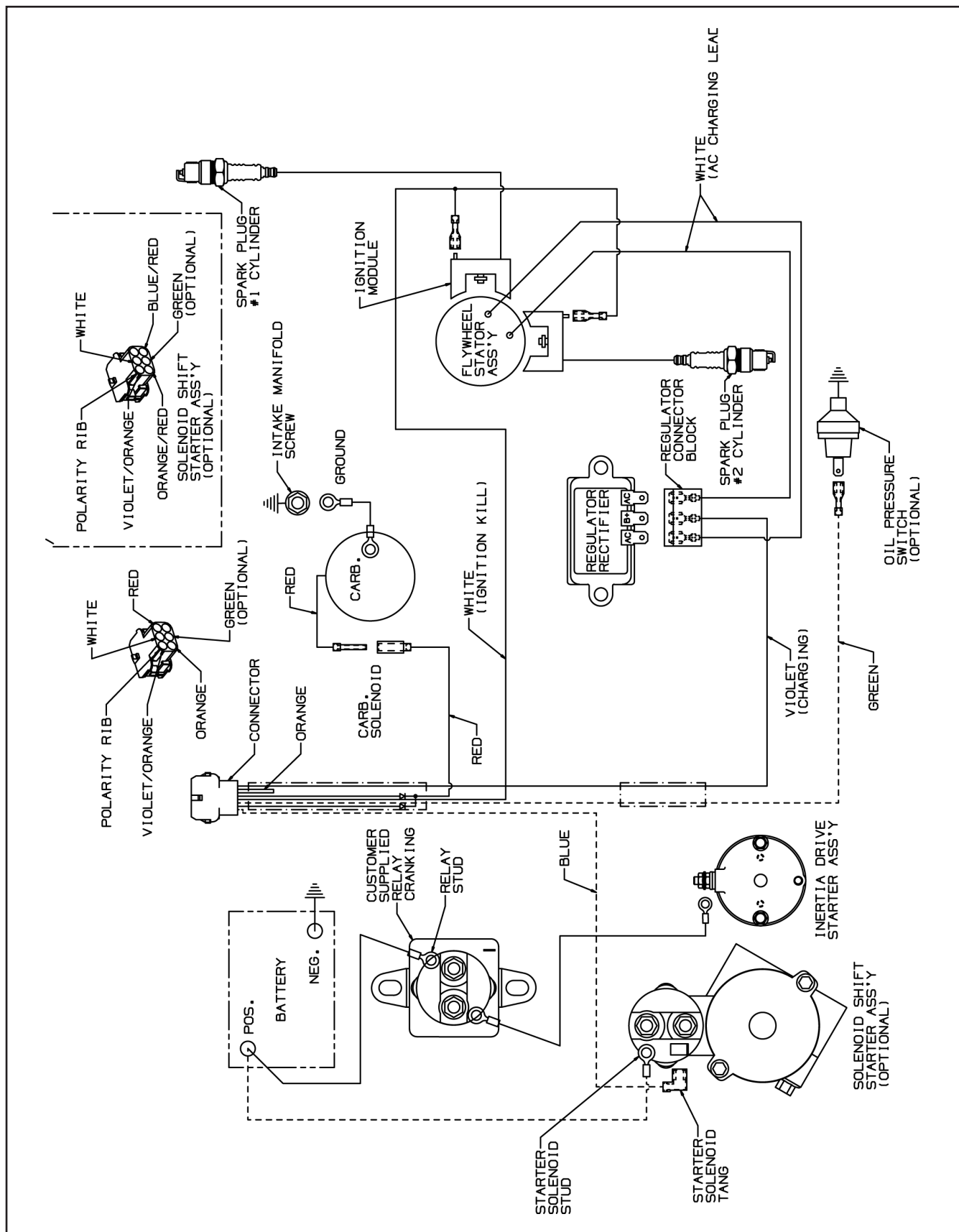
**General**  
Most engines are equipped with a 15 amp regulated charging system. Some have a 25 amp regulated charging system. See Figure 7-16, 7-17, and 7-18 for the wiring/charging system diagrams of ignition systems.

**NOTE:** Observe the following guidelines to avoid damage to the electrical system and components:

- Make sure the battery polarity is correct. A negative (-) ground system is used.
- Disconnect the rectifier-regulator plug and/or the wiring harness plug before doing any electric welding on the equipment powered by the engine. Also, disconnect all other electrical accessories in common ground with the engine.
- Prevent the stator (AC) leads from touching or shorting while the engine is running. This could damage the stator.

## Section 7

### Electrical System and Components



**Figure 7-16. Wiring Diagram – Fixed Timing Ignition System.**



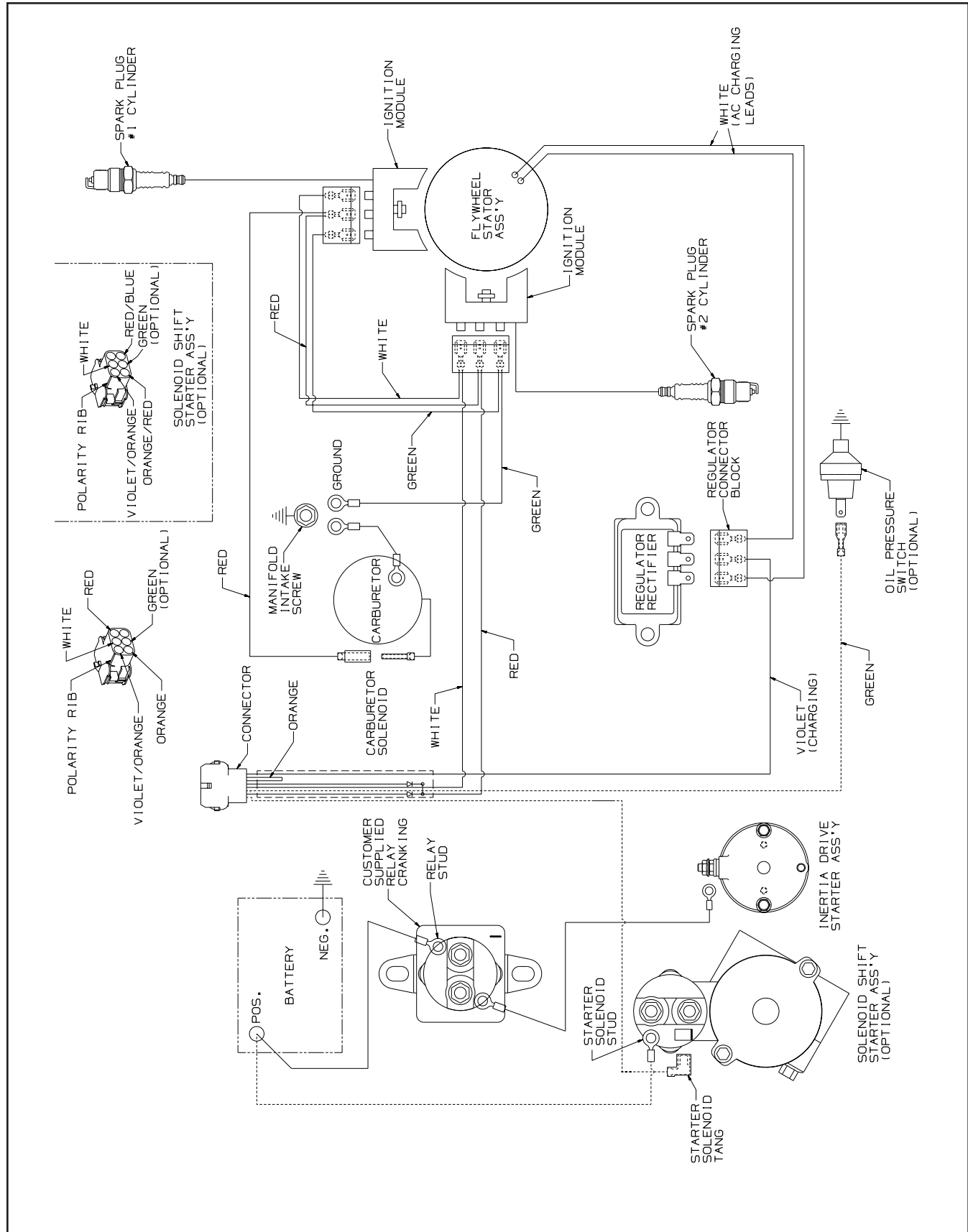
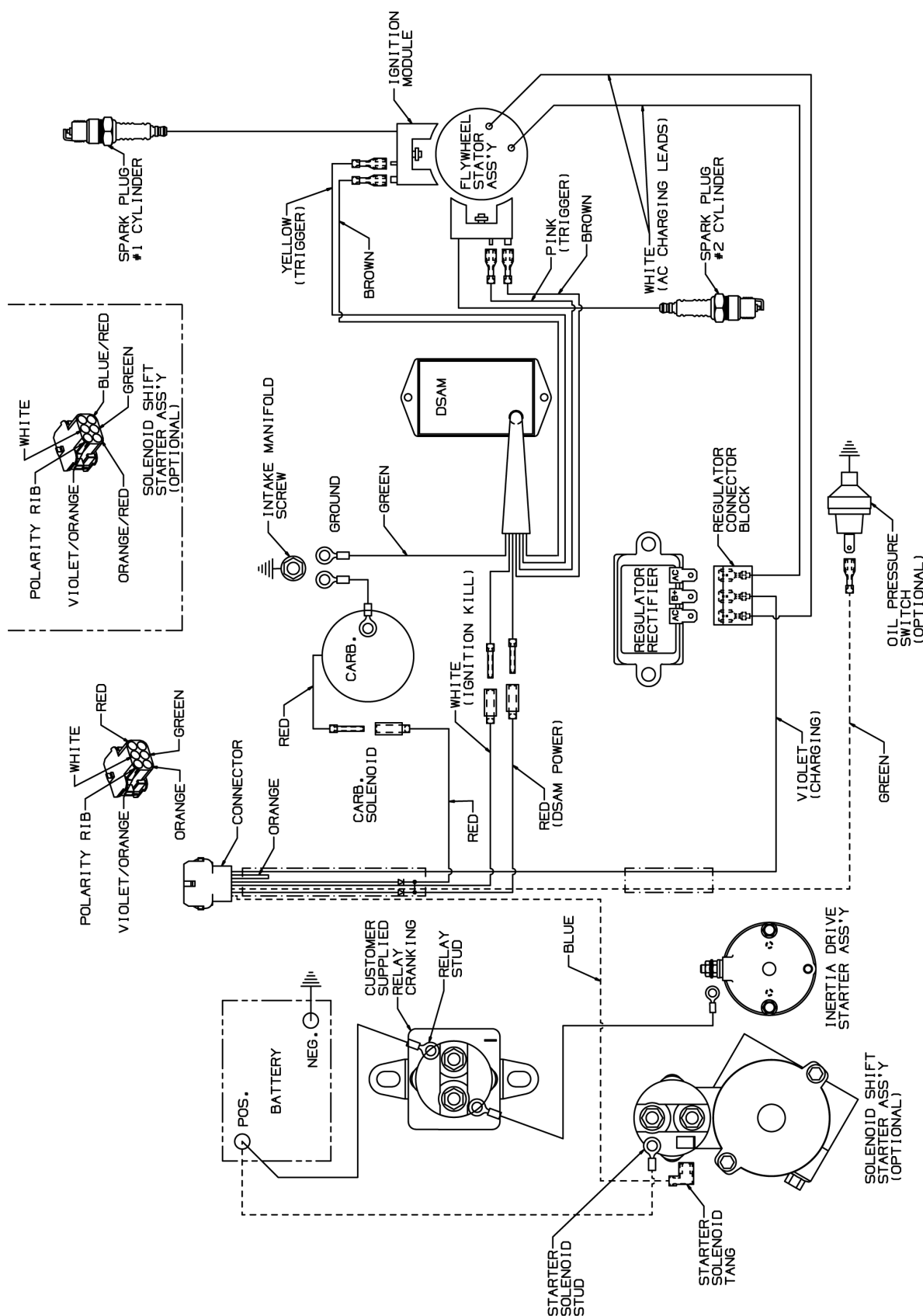


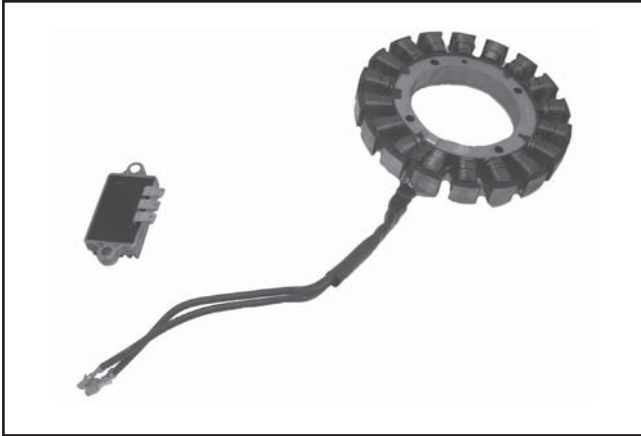
Figure 7-17. Wiring Diagram – DSAI Ignition System.

## Section 7

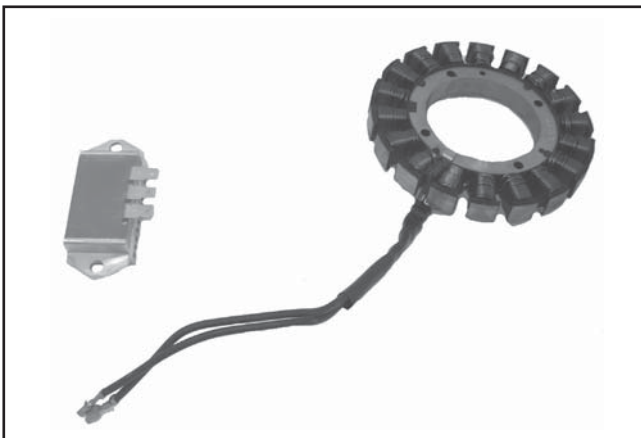
### Electrical System and Components



**Figure 7-18. Wiring Diagram – DSAM Ignition System.**



**Figure 7-19. 15 Amp Stator and Rectifier-Regulator.**



**Figure 7-20. 25 Amp Stator and Rectifier-Regulator.**

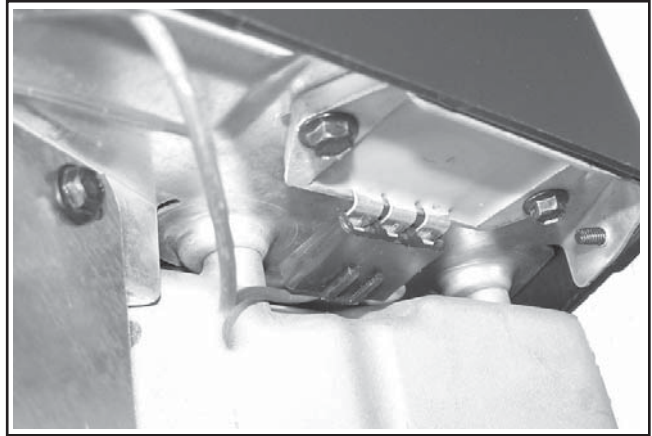
### **Stator**

The stator is mounted on the crankcase behind the flywheel. Follow the procedures in Section 8, Disassembly and Section 10, Reassembly if stator replacement is necessary.

### **Rectifier-Regulator**

The rectifier-regulator is mounted to the underside of the backing plate on the oil filter side. See Figure 7-21. To replace it, remove the two mounting screws and disconnect the plug.

**NOTE:** When installing the rectifier-regulator, take note of the terminal markings and install the plug accordingly.



**Figure 7-21. Rectifier-Regulator Location.**

Testing of the rectifier-regulator may be performed as follows, using the appropriate Rectifier-Regulator Tester.

### **To Test –**

**NOTE:** Disconnect all electrical connections attached to the rectifier-regulator. Testing may be performed with the rectifier-regulator mounted or loose. The figures show the part removed from the engine for clarity. Repeat the applicable test procedure two or three times to determine the condition of the part.

**7**

### **15 Amp Rectifier-Regulators**

1. Connect the tester ground lead (with spring clamp) to the body of the rectifier-regulator being tested.
2. Connect the tester red lead to the B+ terminal of the rectifier-regulator and the two black tester leads to the two AC terminals. See Figure 7-22.



**Figure 7-22.**

## Section 7

### Electrical System and Components

3. Plug the tester into a 110 volt AC outlet and turn on the power switch. See Figure 7-23. The POWER light should be illuminated and one of the four status lights may be on as well. This does not represent the condition of the part.



Figure 7-23.

4. Press the TEST button until a click is heard and then release. See Figure 7-24. Momentarily one of the four status lights will illuminate, indicating the condition of the part.



Figure 7-24.

- a. If the OK (green) light comes on and stays steady, the part is good and may be used.
- b. If any other light is displayed,\* the rectifier-regulator is faulty and should not be used.

\*NOTE: A flashing LOW light can also occur as a result of an inadequate ground lead connection. Make certain connection location is clean and clamp is secure.

#### 25 Amp Rectifier-Regulators

1. Connect the single lead adapter in between the B+ (center) terminal of the rectifier-regulator being tested and the squared single end of the tandem adapter lead. See Figure 7-25.

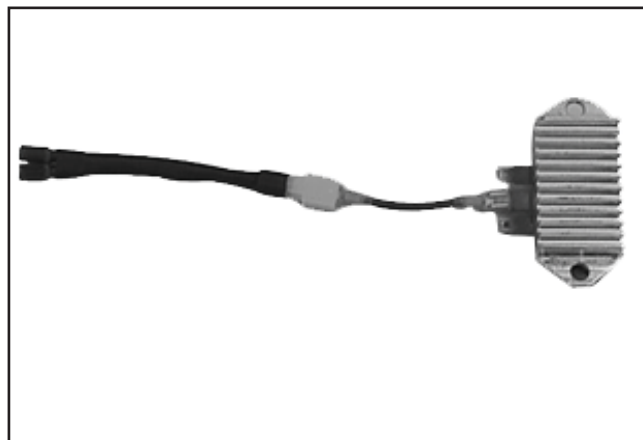


Figure 7-25.

2. Connect the tester ground lead (with spring clamp) to the body of the rectifier-regulator.
3. Connect the red lead and one of the black leads to the pair of terminals on the open end of the tandem adapter lead (connections are not location specific).
4. Connect the remaining black lead from the tester to one of the outer AC terminals on the rectifier-regulator. See Figure 7-26.



Figure 7-26.

5. Plug the tester into a 110 volt AC outlet and turn on the power switch. The POWER light should be illuminated and one of the four status lights may be on as well. See Figure 7-23. This does not represent the condition of the part.

## Section 7

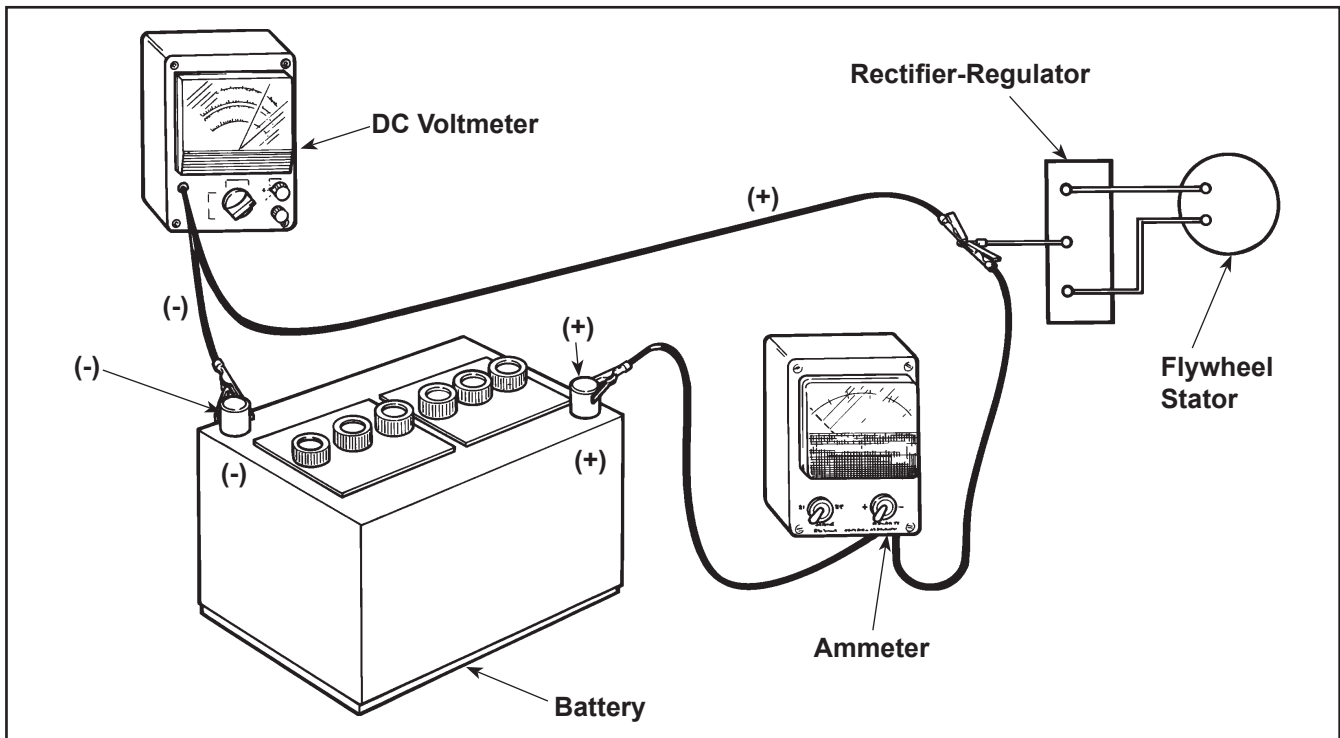
### Electrical System and Components

6. Press the TEST button until a click is heard and then release. See Figure 7-24. Momentarily one of the four status lights will illuminate indicating the partial condition of the part.

- a. If the OK (green) light comes on, disconnect the tester black lead attached to one AC terminal and reconnect it to the other AC terminal. Repeat the test. If the OK (green) light comes on again, the part is good and may be used.

- b. If any other light is displayed\* in either of the tests, the rectifier-regulator is faulty and should not be used.

NOTE: A flashing LOW light can also occur as a result of an inadequate ground lead connection. Make certain the connection location is clean and the clamp is secure.



7

**Figure 7-27. Connections for Testing Charging System.  
15 & 25 amp Battery Charging Systems**

When problems occur in keeping the battery charged or the battery charges at too high a rate, the problem can usually be found somewhere in the charging system or with the battery.

NOTE: Always zero ohmmeter on each scale before testing to ensure accurate readings. Voltage tests should be made with the engine running at 3600 RPM - no load. The battery must be good and fully charged.

## Section 7

### Electrical System and Components

Problem	Test	Conclusion
<b>No Charge to Battery</b>	1. Trace B+ lead from rectifier-regulator to key switch, or other accessible connection. Disconnect it from switch or connection. Connect an ammeter from loose end of B+ lead to positive terminal of battery. Connect DC voltmeter from loose end of B+ lead to negative terminal of battery. With engine running at 3600 RPM, read voltage on voltmeter.  If voltage is 13.8 volts or more, place a minimum load of 5 amps* on battery to reduce voltage. Observe ammeter.  *NOTE: Turn on lights, if 60 watts or more. Or place a 2.5 ohm, 100 watt resistor across battery terminals.	1. If voltage is 13.8-14.7 and charge rate increases when load is applied, the charging system is OK and battery was fully charged.  If voltage is less than 13.8 or charge rate does not increase when load is applied, test stator (Tests 2 and 3).
	2. Remove connector from rectifier-regulator. With engine running at 3600 RPM, measure AC voltage across stator leads using an AC voltmeter.	2. If voltage is <b>28 volts or more</b> , stator is OK. Rectifier-regulator is faulty. Replace the rectifier-regulator.  If voltage is <b>less than 28 volts</b> , stator is probably faulty and should be replaced. Test stator further using an ohmmeter (Test 3).
	3a. With engine stopped, measure the resistance across stator leads using an ohmmeter.	3a. If resistance is <b>0.064/0.2 ohms</b> , the stator is OK.  If the resistance is <b>infinity ohms</b> , stator is open. Replace stator.
	3b. With the engine stopped, measure the resistance from each stator lead to ground using an ohmmeter.	3b. If the resistance is <b>infinity ohms</b> (no continuity) the stator is OK (not shorted to ground).  If resistance (or continuity) is <b>measured</b> , the stator leads are shorted to ground. Replace stator.
<b>Battery Continuously Charges at High Rate</b>	1. Perform same test as step 1 above.	1. If the voltage is <b>14.7 volts or less</b> the charging system is OK. The battery is unable to hold a charge. Service battery or replace as necessary.  If voltage is <b>more than 14.7 volts</b> , the rectifier-regulator is faulty. Replace rectifier-regulator.

### Electric Starting Motors

These engines may use either an inertia drive or solenoid shift style electric starter. The inertia drive starter is covered first and the solenoid shift following.

### Starting Motor Precautions

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

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



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

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

### Starter Removal and Installation

Refer to the Disassembly and Reassembly Sections for starter removal and installation procedures.

### Inertia Drive Electric Starters

This subsection covers the operation, troubleshooting, and repair of the inertia drive, permanent magnet electric starters.

## Troubleshooting Guide – Starting Difficulties

Problem	Possible Fault	Correction
<b>Starter Does Not Energize</b>	<b>Battery</b>	1. Check the specific gravity of battery. If low, recharge or replace battery as necessary.
	<b>Wiring</b>	1. Clean corroded connections and tighten loose connections. 2. Replace wires in poor condition and with frayed or broken insulation.
	<b>Starter Switch or Solenoid</b>	1. By-pass the switch or solenoid with a jumper wire. If starter cranks normally, replace the faulty components. <b>Solenoid Shift Starters:</b> Perform individual solenoid test procedure. See page 7.31
<b>Starter Energizes but Turns Slowly</b>	<b>Battery</b>	1. Check the specific gravity of battery. If low, recharge or replace battery as necessary.
	<b>Brushes</b>	1. Check for excessively dirty or worn brushes and commutator. Clean using a coarse cloth (not emery cloth). 2. Replace brushes if excessively or unevenly worn.
	<b>Transmission or Engine</b>	1. Make sure the clutch or transmission is disengaged or placed in neutral. This is especially important on equipment with hydrostatic drive. The transmission must be exactly in neutral to prevent resistance which could keep the engine from starting. 2. Check for seized engine components such as the bearings, connecting rod, and piston.

### Operation - Inertia Drive Starters

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

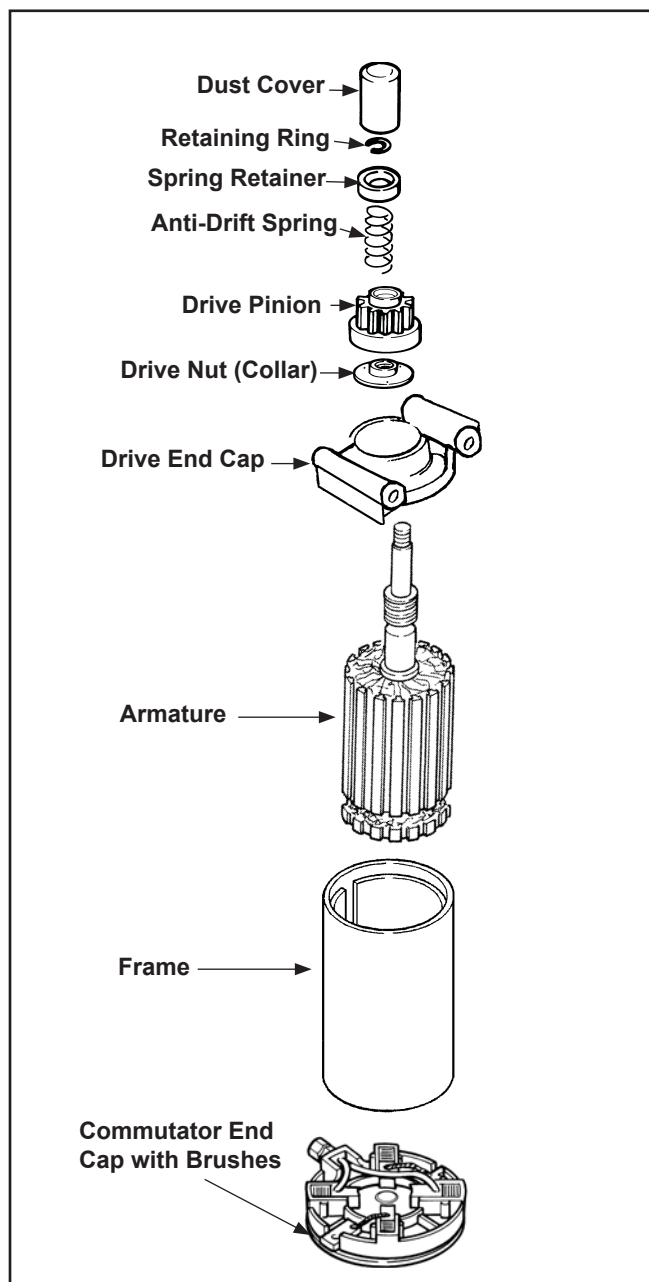
When the engine starts, the flywheel rotates faster than the starter armature and drive pinion. This moves the drive pinion out of mesh with the ring gear and into the retracted position. When power is removed from the starter, the armature stops rotating and the drive pinion is held in the retracted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

### Starter Drive Service

**Every 500 hours** of operation clean and lubricate the splines on the starter drive shaft. If the drive pinion is worn, or has chipped or broken teeth, it must be replaced. See Figure 7-28.

## Section 7

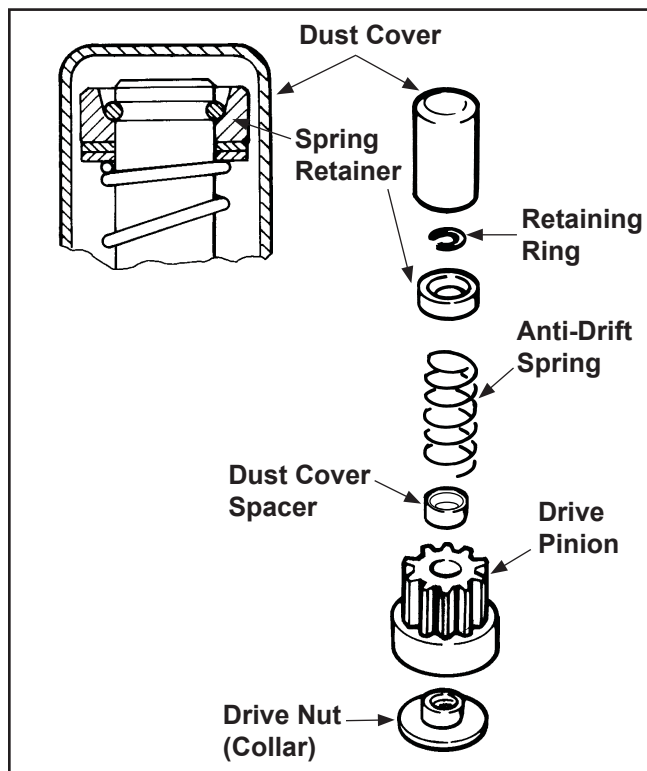
### Electrical System and Components



**Figure 7-28. Inertia Drive Electric Starter.**

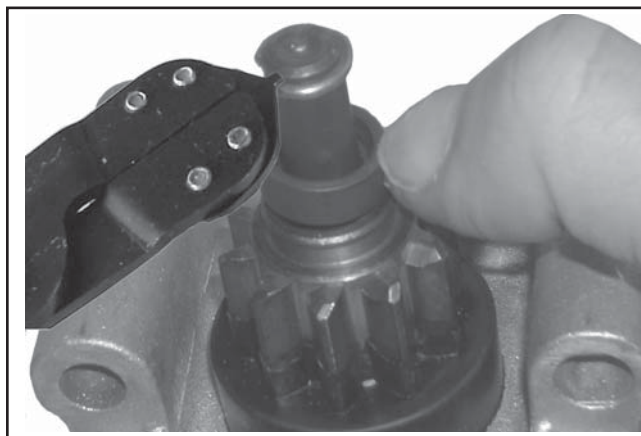
#### Drive Service

1. The rubber dust cover has a molded lip on the inside that snaps over a lip on the front of the drive pinion. See Figure 7-29. Turn the drive pinion clockwise until it reaches the fully extended position. While holding it in the extended position, grasp the tip of the dust cover with a pliers or vise grip and pull it free from the pinion.



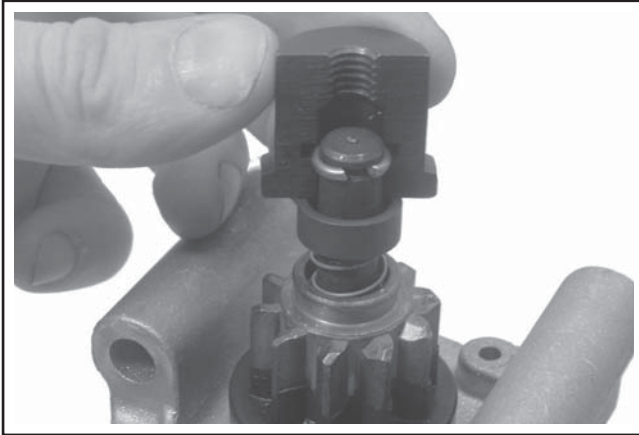
**Figure 7-29. Drive Components, Inertia Drive Starter.**

2. Grasp the spring retainer with a pliers and push it toward the starter, compressing the anti-drift spring to expose the retaining ring. See Figure 7-29.
3. Remove the retaining ring from the armature shaft using either a retaining ring pliers or snap ring removal tool (Kohler Part No. 25 761 18-S), as described in Steps 4, and 5. See Figures 7-30, 7-31, and 7-32. Do not reuse the old retainer.



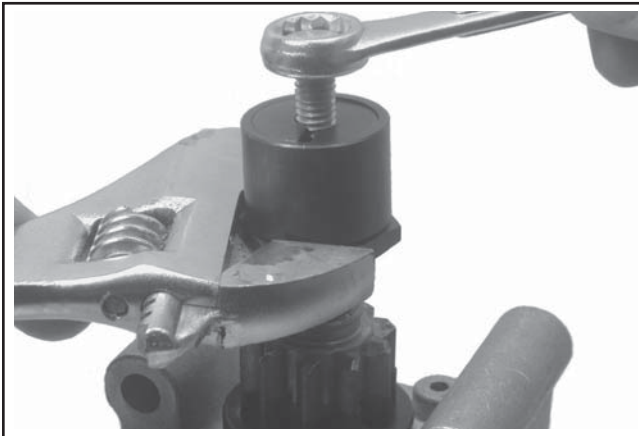
**Figure 7-30. Removing Retaining Ring with Pliers.**

4. Holding the spring retainer in the retracted position, assemble the inner halves of the removal tool around the armature shaft with the retaining ring in the inner groove (see Figure 7-31). Slide the collar over the inner halves to hold them in position.



**Figure 7-31. Assembling Inner Half of Removal Tool Around Armature Shaft and Retaining Ring.**

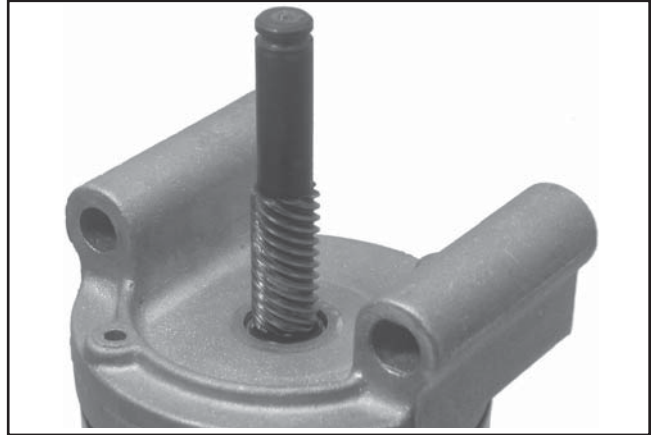
5. Thread the center screw into the removal tool until you feel resistance. Use a wrench (1-1/8" or adjustable) to hold the base of the removal tool. Use another wrench or socket (1/2" or 13 mm) to turn the center screw clockwise (see Figure 7-32). The resistance against the center screw will tell you when the retaining ring has popped out of the groove in the armature shaft.



**Figure 7-32. Holding Tool and Turning Center Screw (Clockwise) to Remove Retaining Ring.**

6. Remove the drive components from the armature shaft, paying attention to the sequence. If the splines are dirty, clean them with solvent.

7. The splines should have a light film of lubricant. See Figure 7-33. Lubricate as necessary with Kohler starter drive lubricant (Kohler Part No. 52 357 01-S). Reinstall or replace the drive components, assembling them in the reverse order they were removed.



**Figure 7-33. Splines on Armature Shaft.**

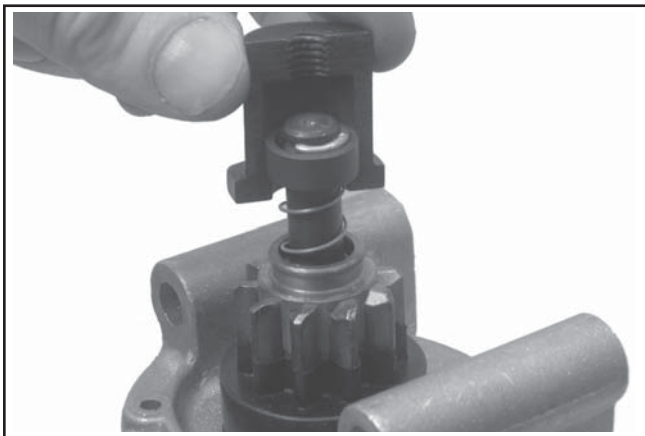
#### Retaining Ring Installation

1. Position the retaining ring in the groove in one of the inner halves. Assemble the other half over the top and slide on the outer collar.
2. Be certain the drive components are installed in correct sequence onto the armature shaft.
3. Slip the tool over the end of the armature shaft, so the retaining ring inside is resting on the end of the shaft. Hold the tool with one hand, exerting slight pressure toward the starter. Tap the top of the tool with a hammer until you feel the retaining ring snap into the groove. Disassemble and remove the tool.
4. Squeeze the retaining ring with a pliers to compress it into the groove.
5. Assemble the inner halves with the larger cavity around the spring retainer (see Figure 7-34). Slide the collar over them and thread the center screw in until resistance is felt.

7

## Section 7

### Electrical System and Components



**Figure 7-34. Assembling Larger Inner Half Around Spring Retainer.**

6. Hold the base of the tool with a 1-1/8" wrench and turn the center screw clockwise with a 1/2" or 13 mm wrench to draw the spring retainer up around the retaining ring. Stop turning when resistance increases. Disassemble and remove the tool.
7. Reinstall the dust cover.

#### Starter Disassembly

1. Remove the drive components following the instructions for servicing the drive.
2. Remove the thru bolts.
3. Remove the commutator end cap containing the brush holder, brushes, brush springs and thrust washer (cup).
4. Remove the drive end cap.
5. Remove the armature from inside the starter frame.

#### End Cap/Brush Replacement

The brushes are contained in a plastic carrier housing, attached to the end cap. Replacement brushes in the brush holder come preassembled, attached to the end cap with the commutator end thrust washer (cup) holding the brushes in the retracted position. When installation is performed, the end of the armature shaft will push the thrust washer (cup) back into final position allowing the brushes to contact the commutator. **Do not** remove the protective tape and shipping strip holding the washer (cup) until the part is ready to be installed.

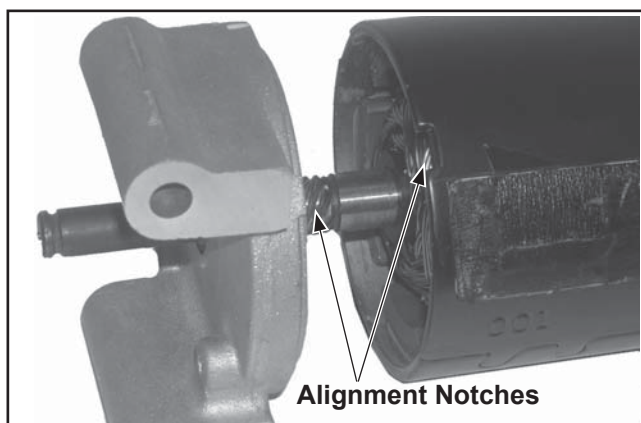
#### Commutator Service

Clean the commutator with a coarse, lint free cloth. Do not use emery cloth.

If the commutator is badly worn or grooved, turn it down on a lathe or replace the starter.

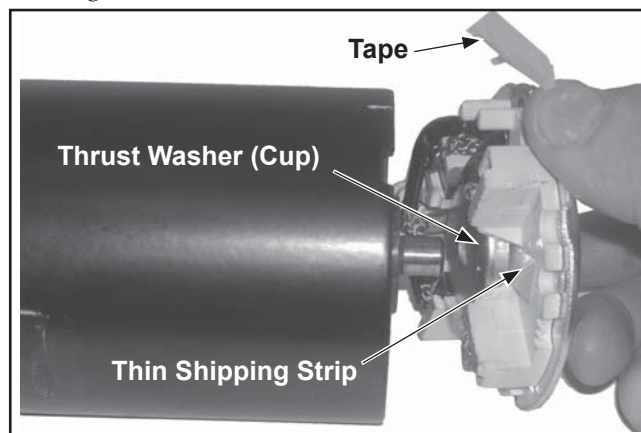
#### Starter Reassembly

1. Insert the armature into the starter frame. Make sure the magnets are closer to the drive shaft end of the armature. The magnets will hold the armature inside the frame.
2. Install the drive end cap over the drive shaft and align with cutout the starter frame. See Figure 7-35.



**Figure 7-35. Aligning End Cap and Frame.**

3. **Installing new brushes:** carefully remove the tape holding the thrust washer (cup) in place against the brushes. **Do not** allow the thrust washer (cup) to move out of this position. Align the terminal stud block with the notch in the starter frame and start the brush holder/end cap assembly onto the end of the armature. See Figure 7-36.



**Figure 7-36. Assembling Commutator End Cap onto Armature.**



4. Pull out the thin shipping strip from behind the thrust washer (cup), and slide the brush holder/end cap into position. See Figure 7-36.
5. Install the thru bolts and torque to **4.5-5.7 N·m (40-50 in. lb.)**. See Figure 7-37.



**Figure 7-37. Installing and Torquing Thru Bolts.**

6. Lubricate the drive shaft with Kohler starter drive lubricant (Kohler Part No. 52 357 01-S). Install the drive components following the instructions for servicing the starter drive.

### Solenoid Shift Electric Starters

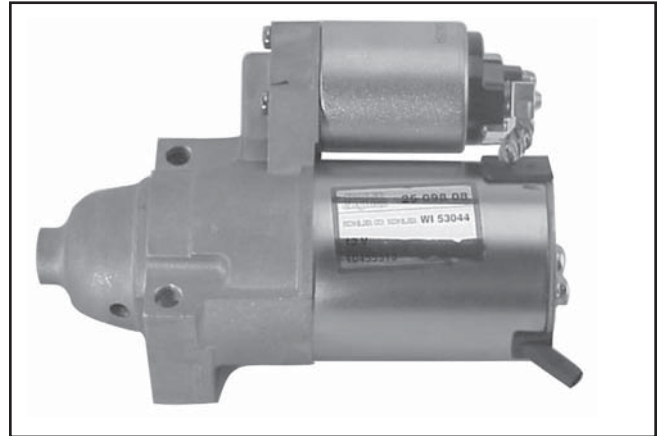
The following subsection covers the Delco-Remy solenoid shift electric starter. Much of the information in the proceeding subsection relates to this type starter also, so it is not repeated here.

#### Operation – Solenoid Shift Starter

When power is applied to the starter the electric solenoid moves the drive pinion out onto the drive shaft and into mesh with the flywheel ring gear. When the pinion reaches the end of the drive shaft it rotates the flywheel and cranks the engine.

When the engine starts and the start switch is released the starter solenoid is deactivated, the drive lever moves back, and the drive pinion moves out of mesh with the ring gear into the retracted position.

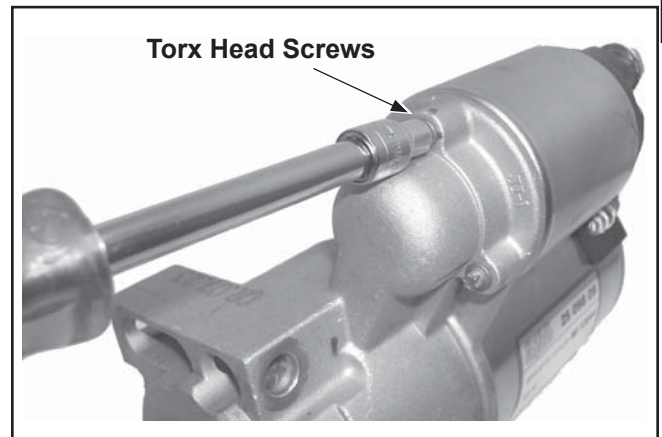
### Delco-Remy Starters



**Figure 7-38. Delco-Remy Starter.**

#### Starter Disassembly

1. Remove the hex nut and disconnect the positive (+) brush lead/bracket from the solenoid terminal.
2. Remove the three Torx head screws securing the solenoid to the starter. See Figure 7-39.



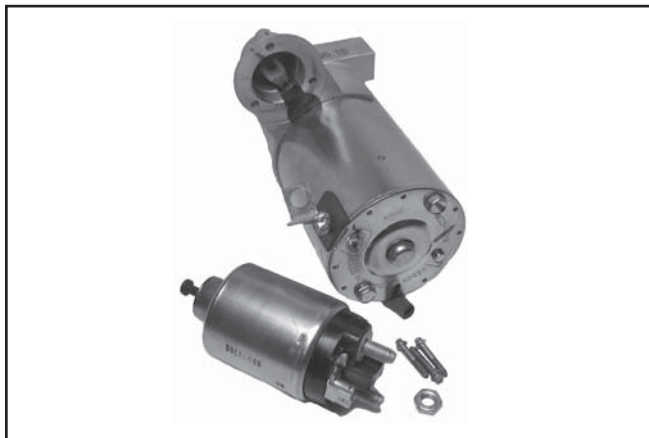
**Figure 7-39. Removing Solenoid Screws.**

3. Unhook the plunger pin from the drive lever. Remove the gasket from the recess in the housing. See Figures 7-40 and 7-41.

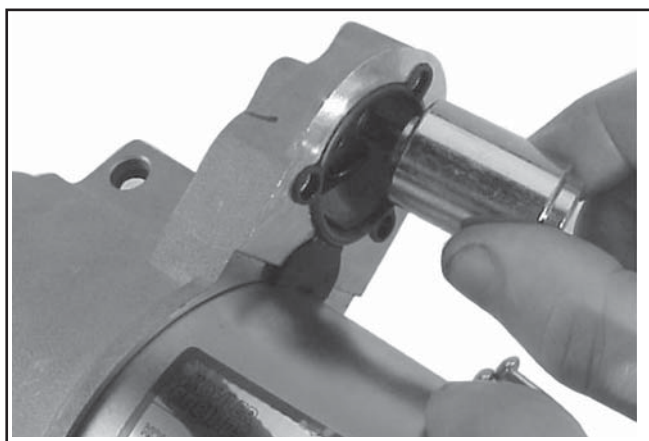
**NOTE:** Test procedure for checking starter solenoid on page 7-35.

## Section 7

### Electrical System and Components



**Figure 7-40. Solenoid Removed from Starter.**



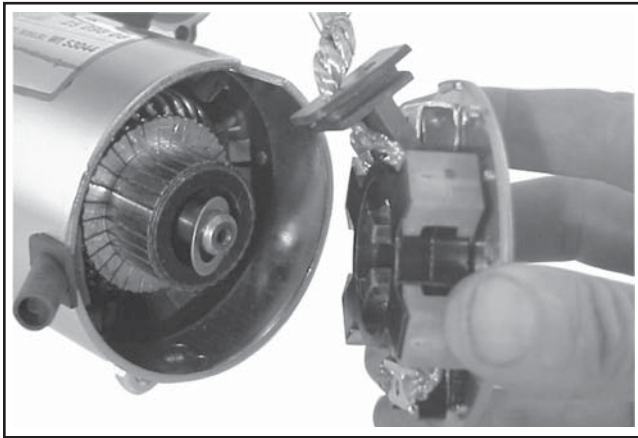
**Figure 7-41. Removing Plunger.**

4. Remove the two thru (larger) bolts. See Figure 7-42.



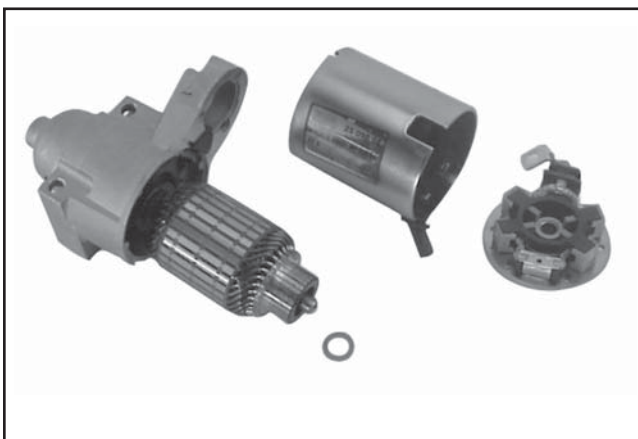
**Figure 7-42. Removing Thru Bolts.**

5. Remove the commutator end plate assembly, containing the brush holder, brushes, springs, and locking caps. Remove the thrust washer from inside the commutator end. See Figure 7-43.



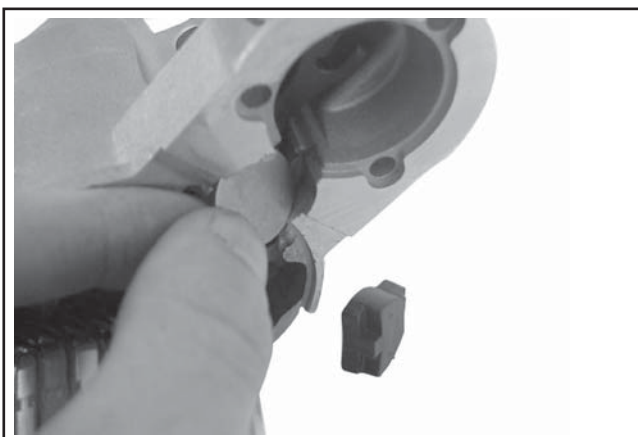
**Figure 7-43. Removing Commutator End Plate Assembly.**

6. Remove the frame from the armature and drive end cap. See Figure 7-44.



**Figure 7-44. Starter Frame Removed.**

7. Remove the drive lever pivot bushing and backing plate from the end cap. See Figure 7-45.



**Figure 7-45. Removing Pivot Bushing and Backing Plate.**



## Section 7

### Electrical System and Components

8. Take out the drive lever and pull the armature out of the drive end cap. See Figure 7-46.
9. Remove the thrust washer from the armature shaft. See Figure 7-46.

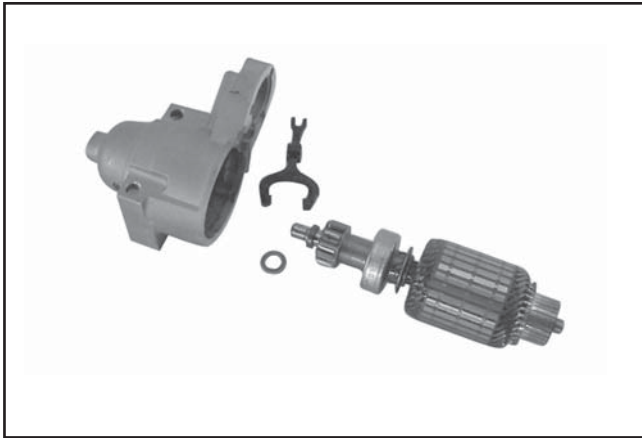


Figure 7-46. Armature and Lever Removed.

10. Push the stop collar down to expose the retaining ring. See Figure 7-47.



Figure 7-47. Retaining Ring Detail.

11. Remove the retainer from the armature shaft. Save the stop collar.

NOTE: Do not reuse the old retainer.

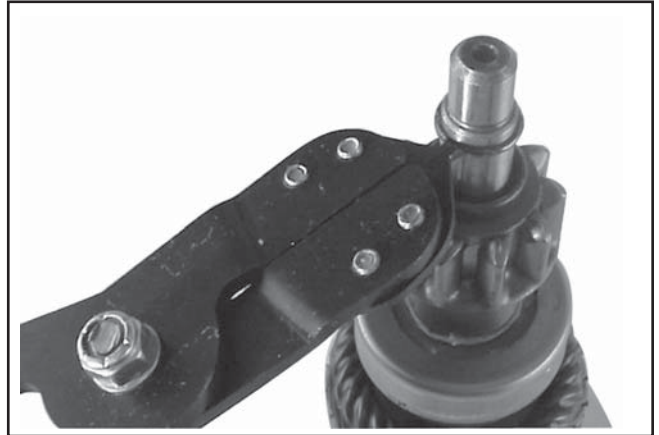


Figure 7-48. Removing Retaining Ring.

12. Remove the drive pinion assembly from the armature.

13. Clean the parts as required.

NOTE: **Do not** soak the armature or use solvent when cleaning. Wipe clean using a soft cloth, or use compressed air.

## Section 7

### Electrical System and Components

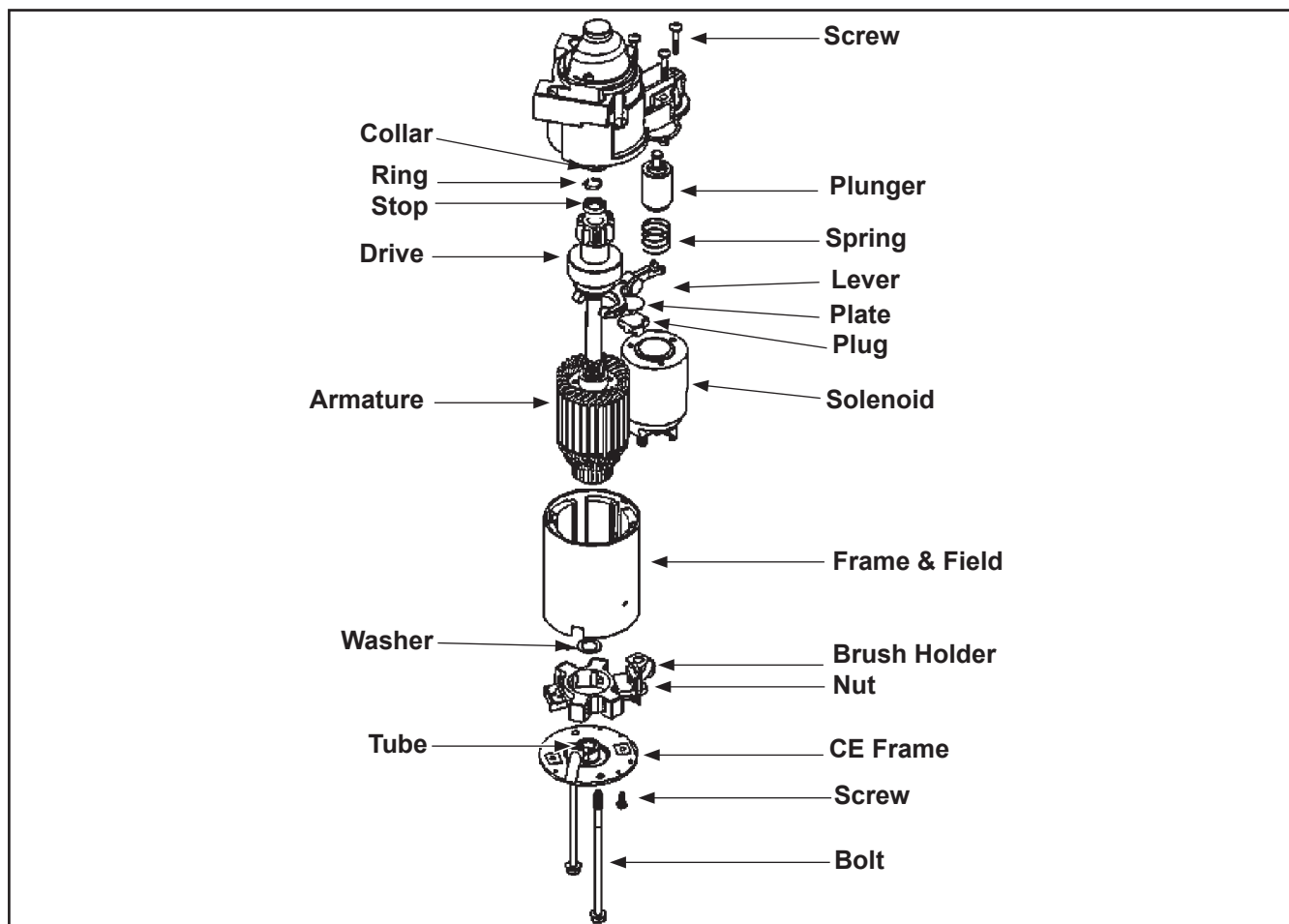


Figure 7-49. Delco-Remy Starter.

### Inspection

#### Drive Pinion

Check and inspect the following areas:

- The pinion teeth for abnormal wear or damage.
- The surface between the pinion and the clutch mechanism for nicks, or irregularities which could cause seal damage.
- Check the drive clutch by holding the clutch housing and rotating the pinion. The pinion should rotate in one direction only.

#### Brushes and Springs

Inspect both the springs and brushes for wear, fatigue, or damage. Measure the length of each brush. The minimum length for each brush is **7.6 mm (0.300 in.)**. See Figure 7-50. Replace the brushes if they are worn undersize, or their condition is questionable.

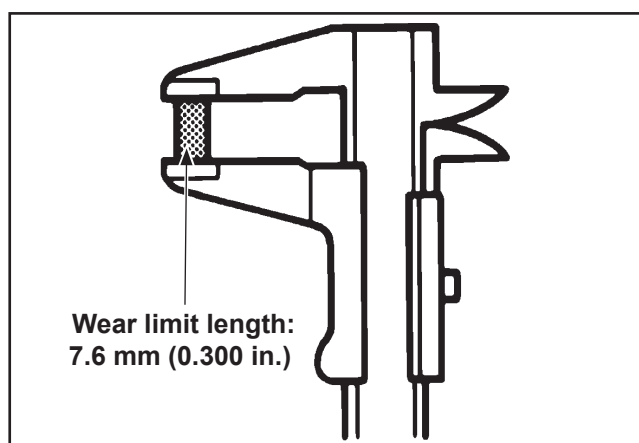
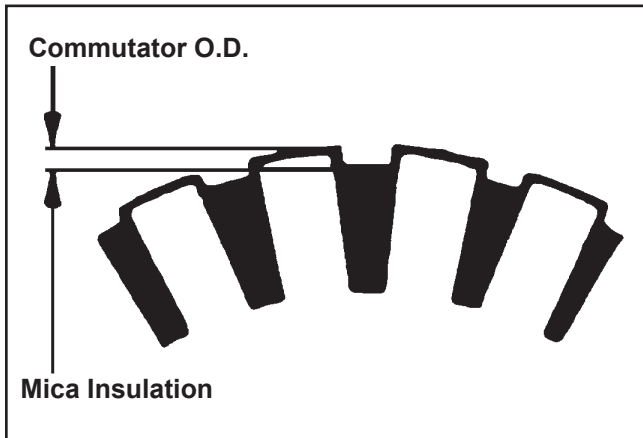


Figure 7-50. Checking Brushes.

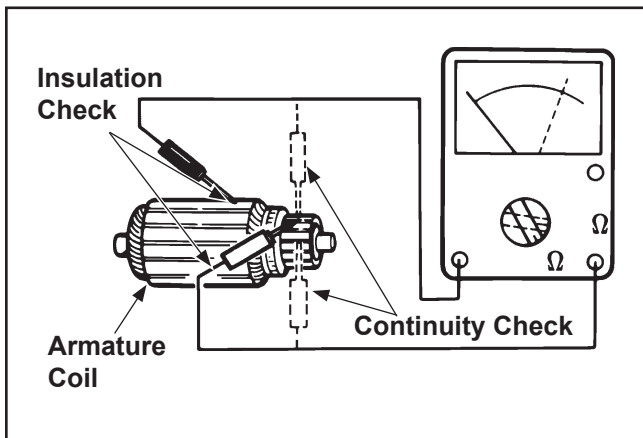
#### Armature

- Clean and inspect the commutator (outer surface). The mica insulation must be lower than the commutator bars (undercut) to ensure proper operation of the commutator. See Figure 7-51.



**Figure 7-51. Commutator Mica Inspection.**

2. Use an ohmmeter set to the Rx1 scale. Touch the probes between two different segments of the commutator, and check for continuity. See Figure 7-52. Test all the segments. Continuity must exist between all or the armature is bad.



**Figure 7-52. Checking Armature.**

3. Check for continuity between the armature coil segments and the commutator segments. See Figure 7-52. There should be no continuity. If continuity exists between any two, the armature is bad.
4. Check the armature windings/insulation for shorting.

#### Shift Fork

Check that the shift fork is complete, and the pivot and contact areas are not excessively worn, cracked or broken.

#### Brush Replacement

The brushes and springs are serviced as a set (4). Use Brush and Spring Kit, Kohler Part No. 25 221 01-S, if replacement is necessary.

1. Perform steps 1-5 in Starter Disassembly.
2. Remove the two screws securing the brush holder assembly to the end cap (plate). Note the orientation for reassembly later. See Figure 7-53. Discard the old brush holder assembly.



**Figure 7-53. Removing Brush Holder.**

3. Clean the component parts as required.
4. The new brushes and springs come preassembled in a brush holder with a protective sleeve that will also serve as an installation tool. See Figure 7-54.



**Figure 7-54. Service Brush Kit.**

5. Perform Steps 10-13 in the Starter Reassembly sequence. Installation must be done after the armature, drive lever, and frame are installed, if the starter has been disassembled.

## Section 7

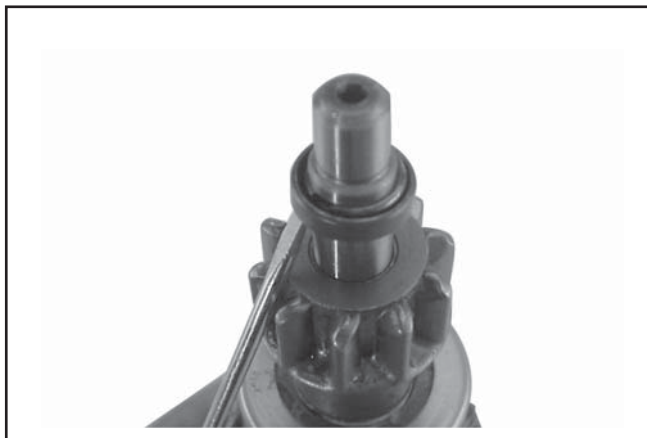
### Electrical System and Components

#### Starter Service

Clean the drive lever and armature shaft. Apply Kohler electric starter drive lubricant Part No. 52 357 02-S (Versilube G322L or Mobil Temp SHC 32) to the lever and shaft. Clean and check the other starter parts for wear or damage as required.

#### Starter Reassembly

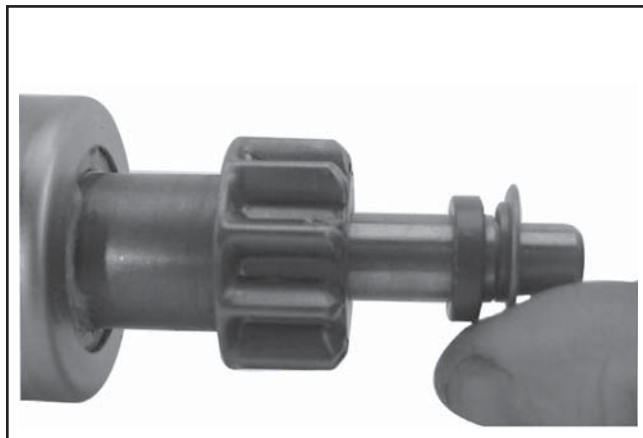
1. Apply drive lubricant (Kohler Part No. 52 357 02-S) to the armature shaft splines. Install the drive pinion onto the armature shaft.
2. Install and assemble the stop collar/retainer assembly.
  - a. Install the stop collar down onto the armature shaft with the counter bore (recess) up.
  - b. Install a new retainer in the larger (rear) groove of the armature shaft. Squeeze with a pliers to compress it in the groove.
  - c. Slide the stop collar up and lock it into place, so the recess surrounds the retainer in the groove. If necessary, rotate the pinion outward on the armature splines against the retainer to help seat the collar around the retainer.



**Figure 7-55. Installing Stop Collar and Retainer.**

**NOTE:** Always use a new retainer. Do not reuse old retainers, which have been removed.

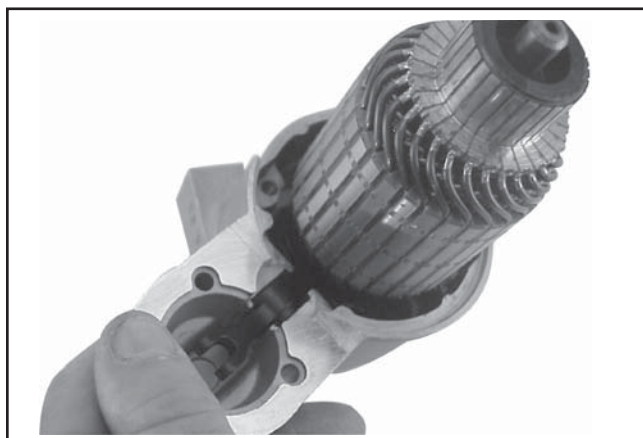
3. Install the offset thrust (stop) washer so the smaller "offset" of the washer faces the retainer/collar. See Figure 7-56.



**Figure 7-56. Installing Thrust Washer.**

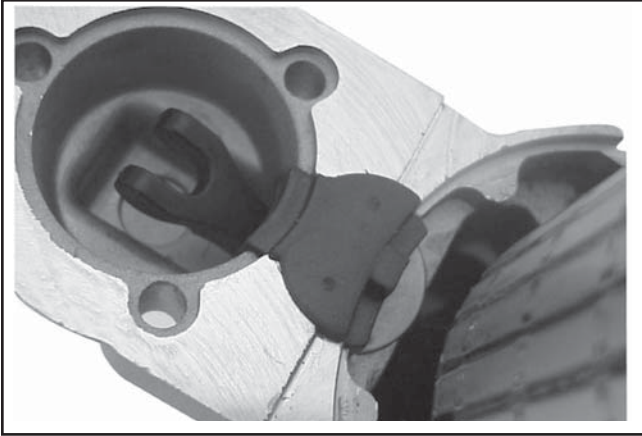
4. Apply a small amount of oil to the bearing in the drive end cap, and install the armature with the drive pinion.
5. Lubricate the fork end and center pivot of the drive lever with drive lubricant (Kohler Part No. 52 357 02-S). Position the fork end into the space between the captured washer and the rear of the pinion.
6. Slide the armature into the drive end cap, and at the same time seat the drive lever into the housing.

**NOTE:** Correctly installed, the center pivot section of the drive lever will be flush or below the machined surface of the housing which receives the backup washer. See Figure 7-57.



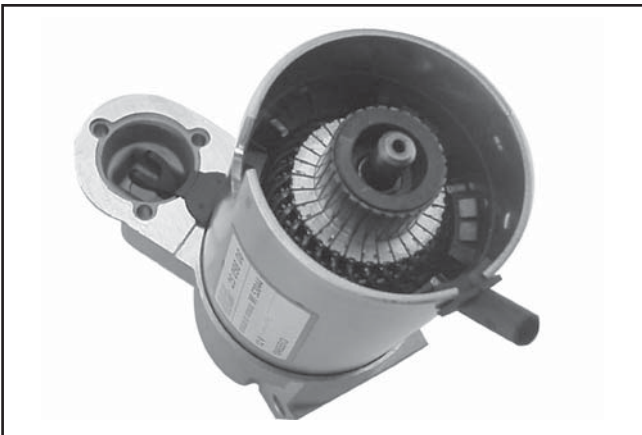
**Figure 7-57. Installing Armature and Pivot Lever.**

7. Install the backup washer, followed by the rubber grommet, into the matching recess of the drive end cap. The molded recesses in the grommet should be out, matching and aligned with those in the end cap. See Figure 7-58.



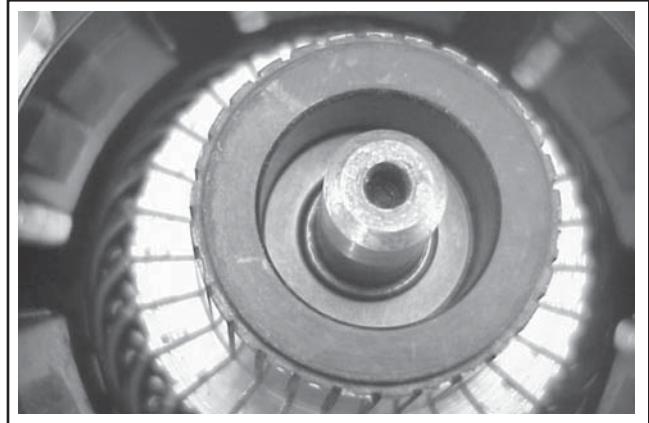
**Figure 7-58. Installing Backup Washer and Grommet.**

8. Install the frame, with the small notch forward, onto the armature and drive end cap. Align the notch with the corresponding section in the rubber grommet. Install the drain tube in the rear cutout, if it was removed previously. See Figure 7-59.



**Figure 7-59. Installing Frame and Drain Tube.**

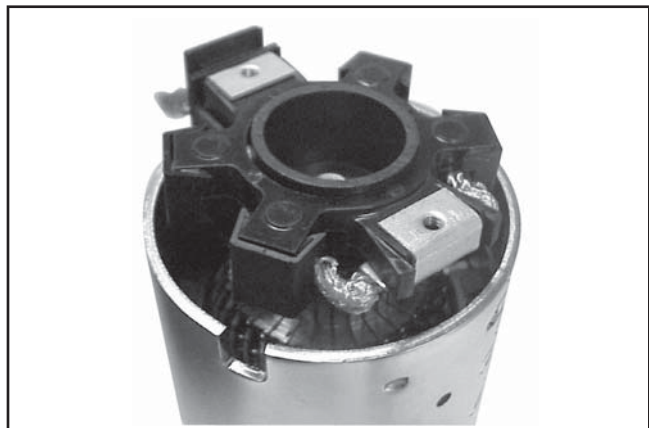
9. Install the flat thrust washer onto the commutator end of the armature shaft. See Figure 7-60.



**Figure 7-60. Installing Thrust Washer.**

10. Starter reassembly when **replacing** the Brushes/Brush Holder Assembly:
  - a. Hold the starter assembly vertically on the end housing, and carefully position the assembled brush holder assembly, with the supplied protective tube, against the end of the commutator/armature. The mounting screw holes in the metal clips must be up/out. Slide the brush holder assembly down into place around the commutator, and install the positive (+) brush lead grommet in the cutout of the frame. See Figure 7-61. The protective tube may be saved and used for future servicing.

**7**



**Figure 7-61. Installing Brush Holder Assembly with Supplied Tube.**

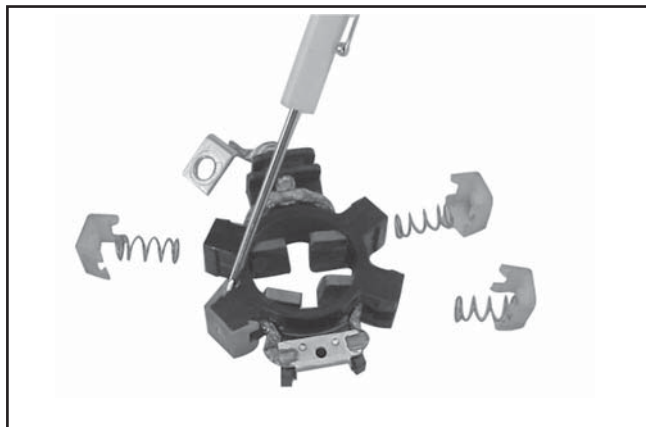
Starter reassembly when **not** replacing the Brushes/Brush Holder Assembly:

- a. Carefully unhook the retaining caps from over each of the brush assemblies. Do not lose the springs.



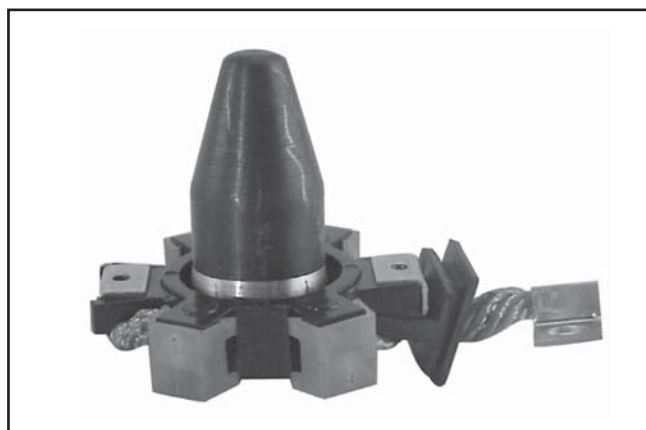
## Section 7

### Electrical System and Components



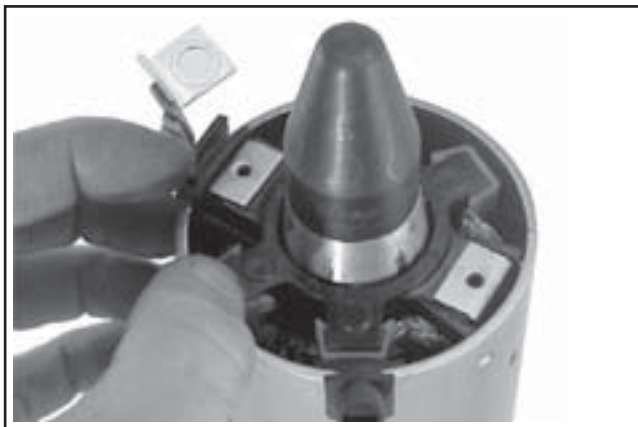
**Figure 7-62. Removing Retaining Clips.**

- b. Position each of the brushes back in their slots so they are flush with the I.D. of the brush holder assembly. Insert the Brush Installation Tool with extension, or use the tube described above from a prior brush installation, through the brush holder assembly, so the holes in the metal mounting clips are "up/out."
- c. Install the brush springs and snap on the four retainer caps. See Figure 7-63.



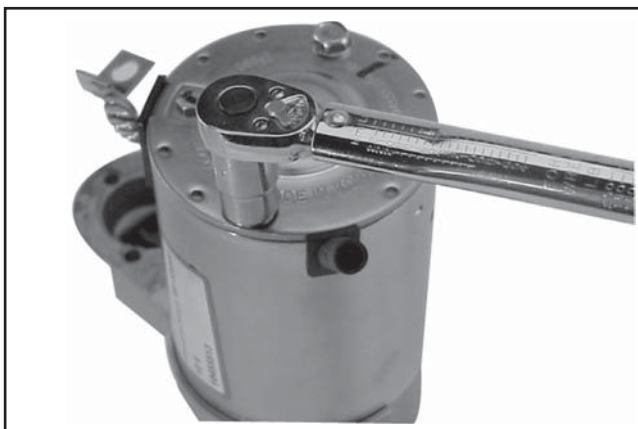
**Figure 7-63. Brush Installation Tool with Extension.**

- d. Hold the starter assembly vertically on the end housing, and carefully place the tool with extension) and assembled original brush holder assembly onto the end of the armature shaft. Slide the brush holder assembly down into place around the commutator, install the positive (+) brush lead grommet in the cutout of the frame. See Figure 7-64.



**Figure 7-64. Installing Brush Holder Assembly using Tool with Extension.**

- 11. Install the end cap onto the armature and frame, aligning the thin raised rib in the end cap with the corresponding slot in the grommet of the positive (+) brush lead.
- 12. Install the two thru bolts, and the two brush holder mounting screws. Torque the thru bolts to **5.6-9.0 N·m (49-79 in. lb.)**. Torque the brush holder mounting screws to **2.5-3.3 N·m (22-29 in. lb.)**. See Figures 7-65 and 7-66.



**Figure 7-65. Torquing Thru Bolts.**





**Figure 7-66. Torquing Brush Holder Screws.**

13. Hook the plunger behind the upper end of the drive lever, and install the spring into the solenoid. Insert the three mounting screws through the holes in the drive end cap. Use these to hold the solenoid gasket in position, then mount the solenoid. Torque the screws to **4.0-6.0 N·m (35-53 in. lb.)**.
14. Connect the positive (+) brush lead/bracket to the solenoid and secure with the hex nut. Torque the nut to **8-11 N·m (71-97 in. lb.)**. Do not overtighten. See Figure 7-67.



**Figure 7-67. Positive (+) Brush Lead Connection.**

## **Solenoid Test Procedure**

### **Solenoid Shift Style Starters**

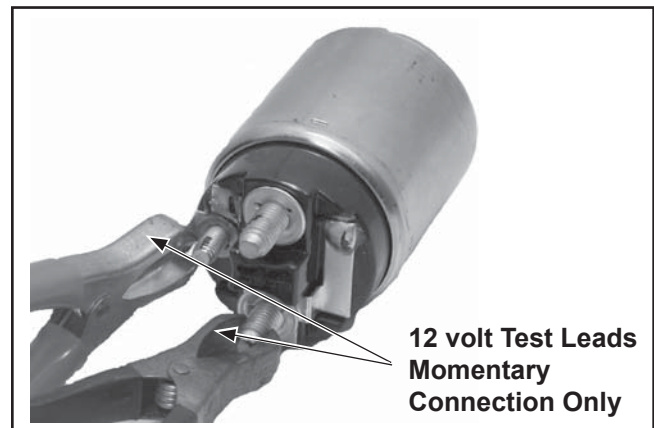
Disconnect all leads from the solenoid including the positive brush lead attached to the lower stud terminal. Remove the mounting hardware and separate the solenoid from the starter for testing.

#### **Test 1. Solenoid Pull-In Coil/Plunger Actuation Test.**

Use a 12 volt power supply and two test leads. Connect one lead to the flat spade S/start terminal on the solenoid. Momentarily\* connect the other lead to the lower large post terminal. See Figure 7-68.

**NOTE:** DO NOT leave the 12 volt test leads connected to the solenoid for any time over what is necessary for performing each of the individual tests. Internal damage to the solenoid may otherwise occur.

When the connection is made the solenoid should energize (audible click), and the plunger retract. Repeat the test several times. If the solenoid fails to activate, it should be replaced.



**Figure 7-68. Testing Pull-In Coil/Plunger Actuation.**

## Section 7

### Electrical System and Components

#### Test 2. Solenoid Pull-In Coil/Contact Continuity Test.

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (1) and check for continuity. See Figure 7-69. The ohmmeter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

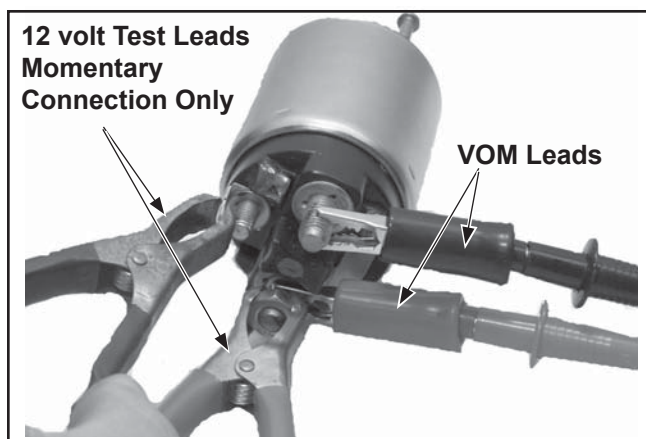


Figure 7-69. Testing Pull-In Coil/Solenoid Contact Continuity.

#### Test 3. Solenoid Hold-In Coil Function Test.

Connect one 12 volt test lead to the flat spade S/start terminal on the solenoid, and the other lead to the body or mounting surface of the solenoid. Then, manually push the plunger in and check if the Hold-In coil holds the plunger retracted. See Figure 7-70. Do not allow the test leads to remain connected to the solenoid for a prolonged period of time. If the plunger fails to stay retracted, the solenoid should be replaced.

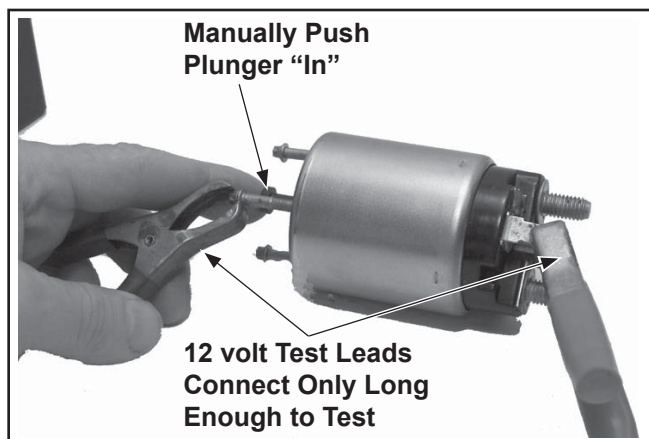


Figure 7-70. Testing Hold-In Coil/Function Test.

#### Test 4. Solenoid Hold-In Coil/Contact Continuity Test.

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (3) and check for continuity. See Figure 7-71. The meter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

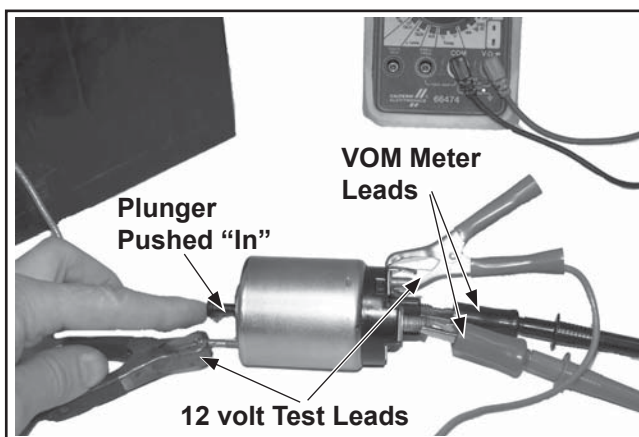


Figure 7-71. Testing Hold-In Coil/Solenoid Contact Continuity.

# Section 8

## Disassembly



### **WARNING: Accidental Starts!**

*Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine as follows: 1) Disconnect the spark plug lead(s). 2) Disconnect negative (-) battery cable from battery.*

Clean all parts thoroughly as the 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 the manufacturer's instructions and safety precautions carefully.

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

### **Typical Disassembly Sequence**

The following sequence is suggested for complete engine disassembly. The sequence can be varied to accommodate options or special equipment.

1. Disconnect spark plug leads.
2. Shut off fuel supply.
3. Drain oil from crankcase and remove oil filter.
4. Remove adapter and oil cooler (if equipped).
5. Remove muffler.
6. Remove fuel pump.
7. Remove blower housing and outer baffles.
8. Remove throttle controls.
9. Remove external governor controls.
10. Remove air cleaner and carburetor.
11. Remove electric starter.
12. Remove inner baffles.
13. Remove ignition modules.
14. Remove intake manifold and rectifier-regulator.
15. Remove spark plugs.
16. Remove valve covers and cylinder heads.
17. Remove grass screen, fan, and flywheel.
18. Remove backing plate and stator.
19. Remove outer breather assembly.
20. Remove oil pan assembly.

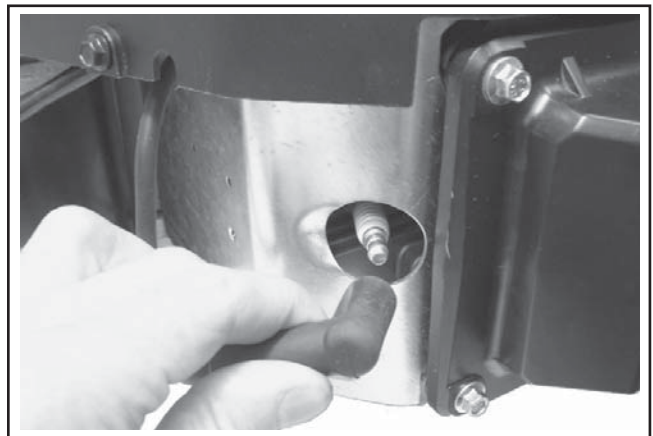
21. Remove camshaft and valve tappets.
22. Remove governor cross shaft
23. Remove connecting rods with pistons and rings.
24. Remove crankshaft.
25. Remove inner breather assembly.
26. Remove flywheel and PTO end oil seals.

### **Disconnect Spark Plug Leads**

1. Disconnect the leads from the spark plugs. See Figure 8-1.

**NOTE:** Pull on boot only, to prevent damage to spark plug lead.

8



**Figure 8-1. Disconnect Spark Plug Leads.**

### **Shut Off Fuel Supply**

### **Drain Oil From Crankcase and Remove Oil Filter**

1. Remove oil fill cap/dipstick and the oil drain plug.

## Section 8 Disassembly

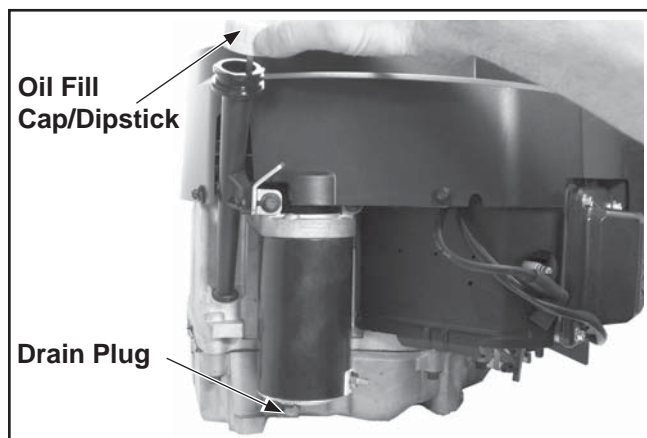


Figure 8-2. Removing Oil Fill Cap/Dipstick.

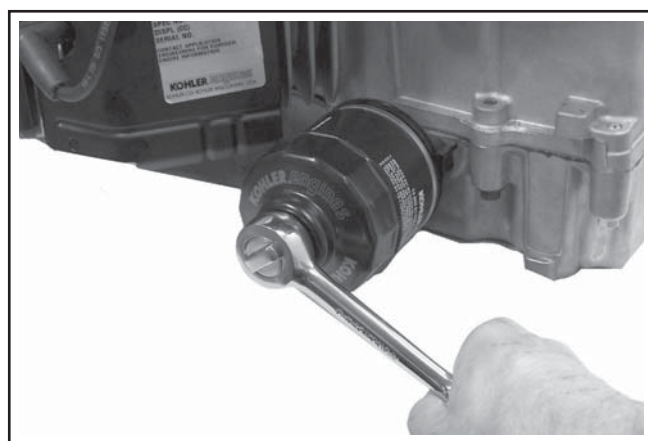


Figure 8-3. Removing Oil Filter.

2. Allow ample time for the oil to drain from the crankcase and oil filter.
3. Remove and appropriately discard the oil filter. See Figure 8-3.
4. Use an allen wrench to loosen the adapter nipple. Note the locating pin of the adapter and corresponding notch in the pad of the oil pan. Remove the nipple, washer (plastic adapters only), and oil filter adapter. See Figure 8-4.

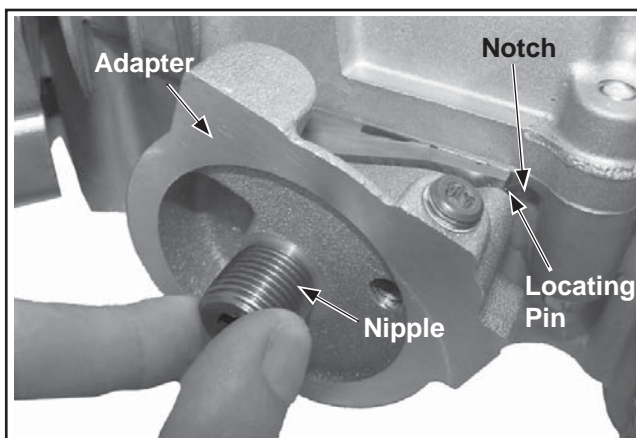


Figure 8-4. Removing Oil Filter Adapter.

5. If an oil cooler is used remove the mounting screws securing the cooler unit to the blower housing. See Figure 8-5.

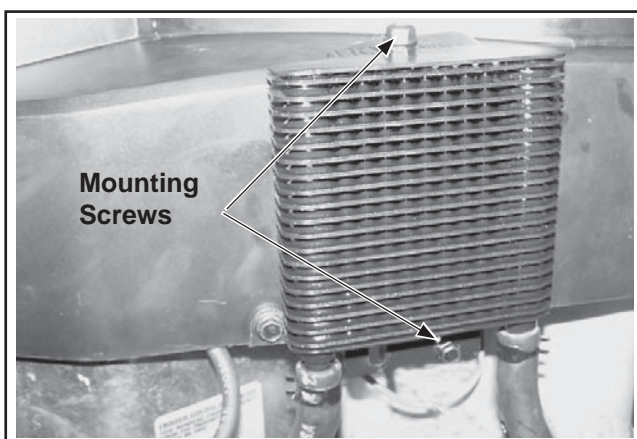


Figure 8-5. Removing Oil Cooler From Blower Housing.

6. Remove the oil pump outlet tube assembly and the oil feed tube (if not removed with nipple).

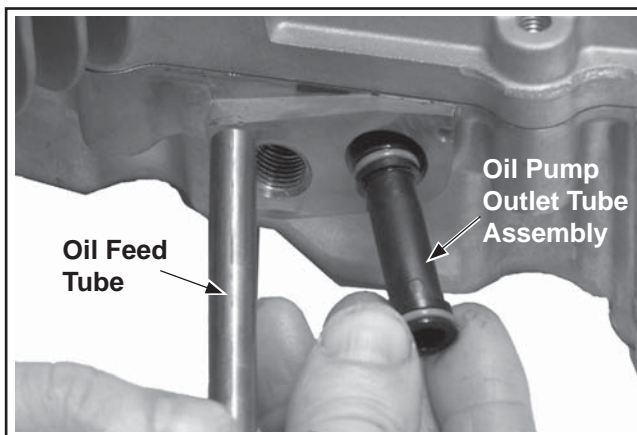


Figure 8-6. Removing Oil Pump Outlet Tube Assembly and Oil Feed Tube.



## Remove Muffler

1. Remove the exhaust system and attaching hardware from the engine.

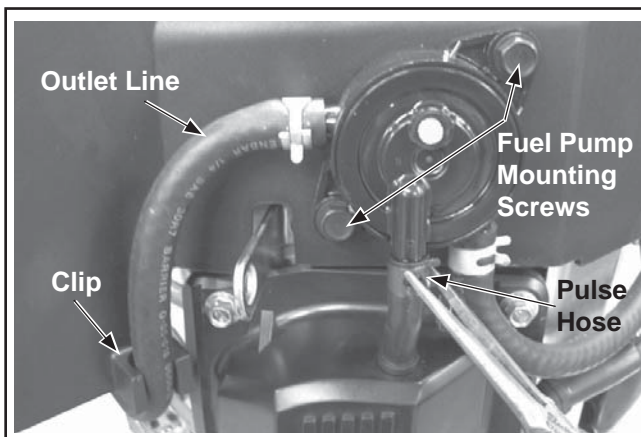
## Remove Fuel Pump (Equipped Models)



### **WARNING: Explosive Fuel!**

*Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks, open flames and other sources of ignition away from the engine.*

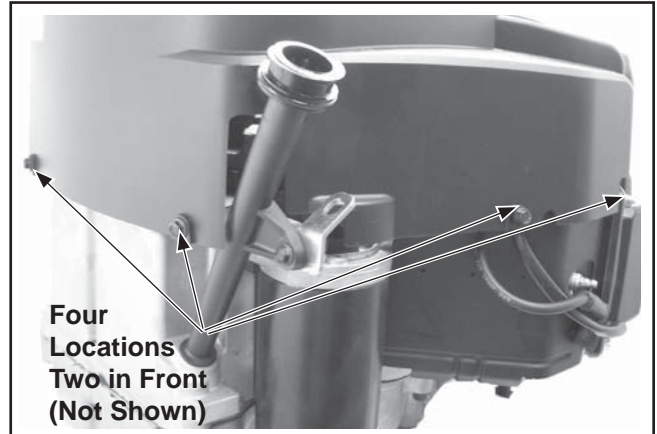
1. Disconnect the pulse (vacuum) hose and outlet fuel line from the fuel pump. See Figure 8-7.
2. Remove the two hex flange mounting screws, unhook outlet hose from blower housing clip, and remove the fuel pump from the blower housing.



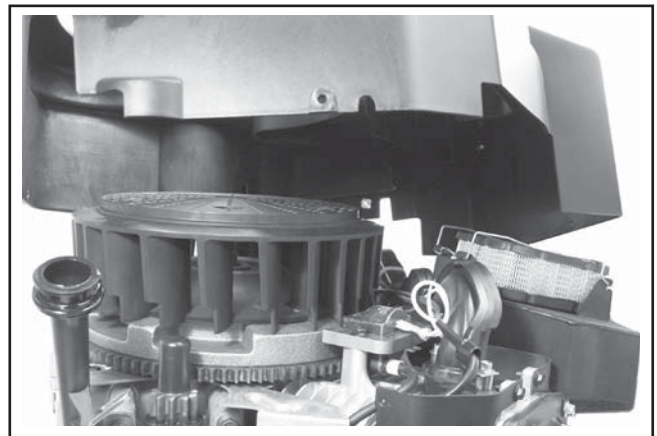
**Figure 8-7. Removing Pulse Pump.**

## Remove Blower Housing and Outer Baffles

1. Remove the six hex flange screws securing the blower housing. See Figure 8-8.
2. Remove the blower housing from the engine. See Figure 8-9.
3. Remove the M6 mounting screw on the bottom of each outer baffle into the cylinder, and the M5 screws going into the backing plate and the cylinder head flange. One screw may also secure the lift strap on one side.

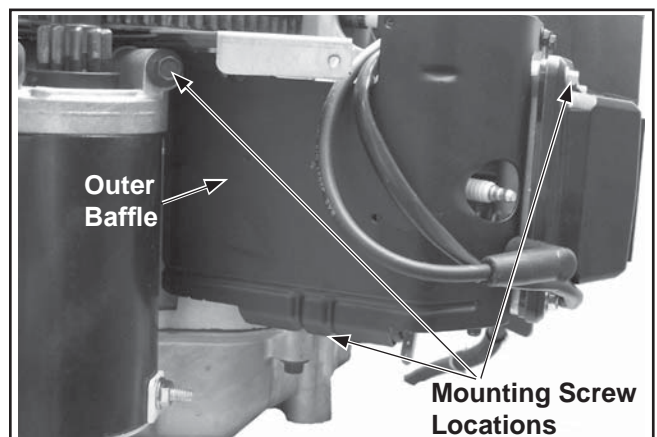


**Figure 8-8. Blower Housing Mounting Screws.**



**Figure 8-9. Removing Blower Housing.**

**8**



**Figure 8-10. Outer Baffles Mounting Screws.**

## Remove Throttle Controls

1. Remove the four hex flange screws securing the throttle control bracket to the cylinder heads. See Figure 8-11.

## Section 8

### Disassembly

2. Disconnect the choke linkage from the choke actuator lever. Unhook the governor spring, and dampener spring from the governor lever. Note the hole locations for reassembly. See Figure 8-12.

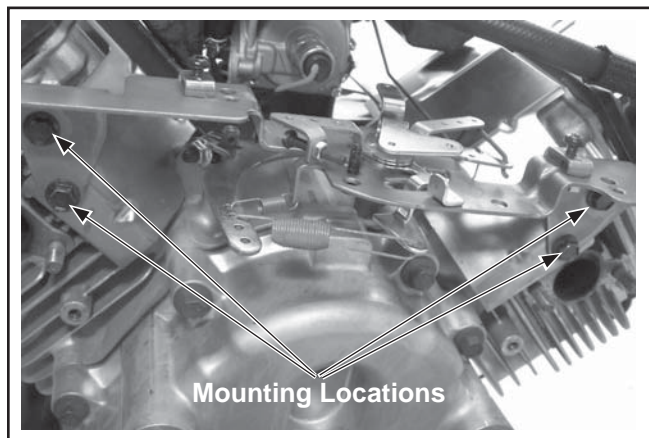


Figure 8-11. Control Bracket Mounting Locations.

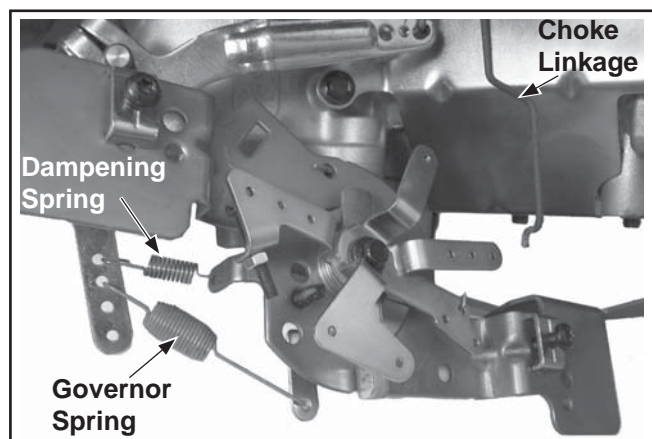


Figure 8-12. Disconnecting Linkage and Governor Springs.

#### Remove External Governor Controls

1. Loosen the hex flange nut and remove the governor lever from the cross shaft. See Figure 8-13. Leave the lever attached to the throttle linkage.

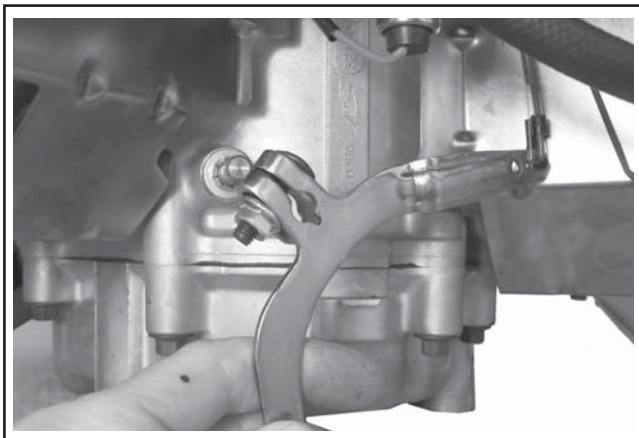


Figure 8-13. Removing Governor Lever.

#### Remove Air Cleaner and Carburetor



#### **WARNING: Explosive Fuel!**

*Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable, and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine.*

1. Remove the two carburetor/air cleaner base mounting nuts and disconnect the breather hose. Remove the air cleaner base and gasket. See Figures 8-14 and 8-15.

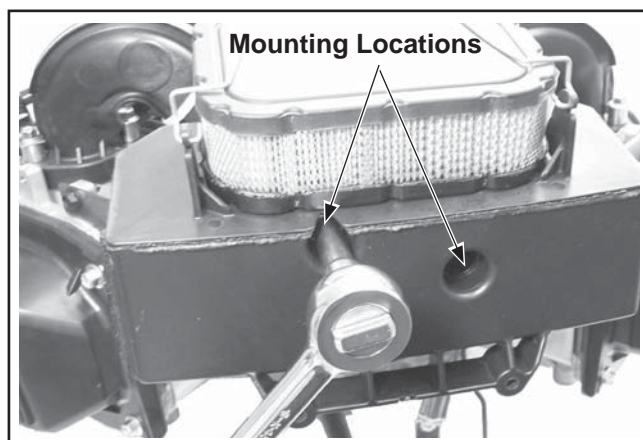
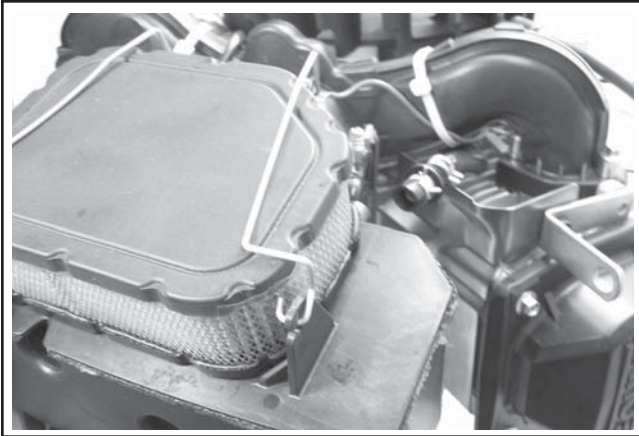


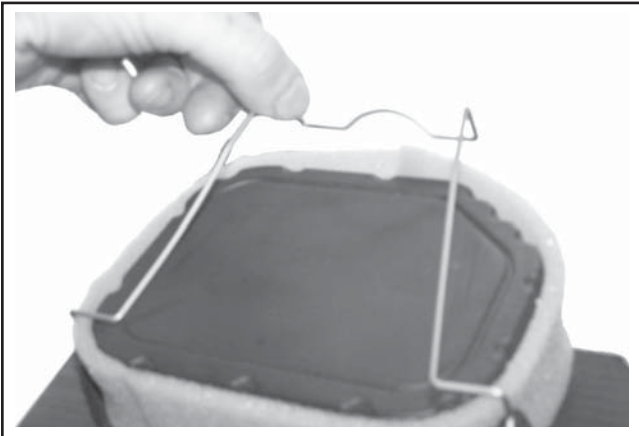
Figure 8-14. Removing Mounting Nuts.





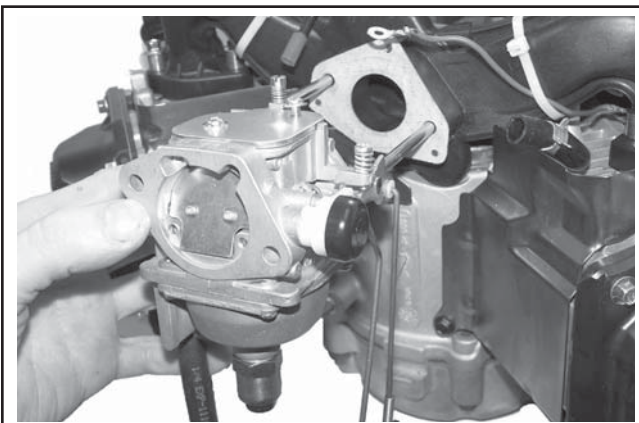
**Figure 8-15. Removing Air Cleaner Assembly.**

2. Unhook the retainer and remove the air cleaner element and precleaner (if equipped) from the air cleaner base for servicing. See Figure 8-16.



**Figure 8-16. Removing Air Cleaner Element.**

3. Disconnect the ground lead and the fuel shut-off solenoid lead (if equipped).
4. Remove the carburetor, throttle linkage and governor lever as an assembly. See Figure 8-17.

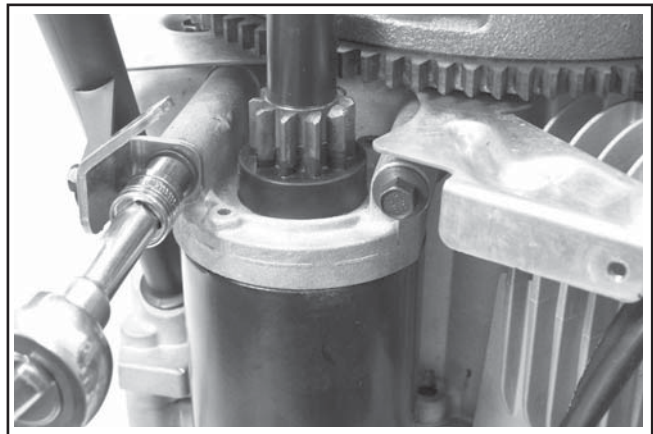


**Figure 8-17. Removing Carburetor.**

5. Remove the carburetor gasket.
6. If necessary, the carburetor, throttle linkage and governor lever can be separated. Reattach the bushings to the linkage following separation to avoid losing them.

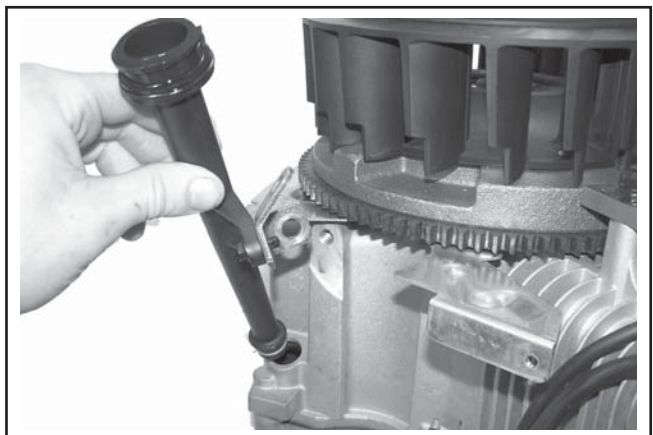
### **Remove Electric Starter Motor**

1. Disconnect the leads from the starter.
2. Remove the two hex flange screws. See Figure 8-18.
3. Remove the starter assembly.



**Figure 8-18. Removing Electric Starter Motor.**

4. Pull out the oil fill tube with the lifting strap from the crankcase. See Figure 8-19.



**Figure 8-19. Removing Oil Fill Tube.**

## Section 8

### Disassembly

#### Remove Inner Baffles

1. Remove the mounting screws securing the two inner baffles to the crankcase. Note the position of any lifting bracket(s). Remove the inner baffles. See Figure 8-20.

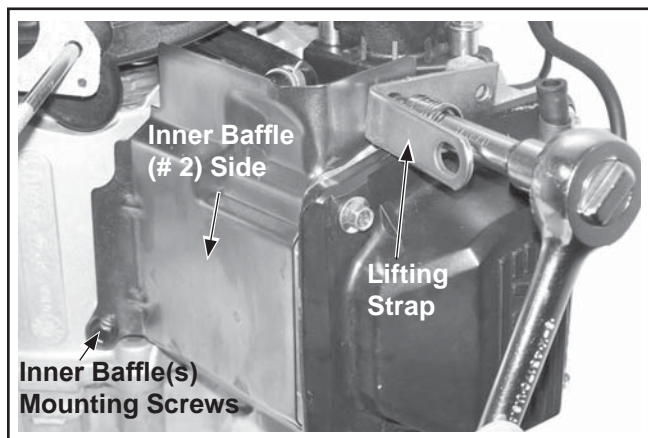


Figure 8-20. Removing Inner Baffles.

#### Remove Ignition Modules

1. Rotate the flywheel so the magnet is away from the modules.
2. Disconnect the lead(s) from each ignition module. Fixed Timing Models and DSAI Models have one lead per module and DSAM or SMART-SPARK™ (variable timing) ignition modules have two leads per module. See Figure 8-21.
3. Remove the mounting screws and ignition modules. Note the position of the ignition modules.

Standard (Fixed) Timing Ignition Module (Single Lead) shown



DSAM or SMART-SPARK™ Ignition Module (Two-Leads)



Figure 8-21. Removing Ignition Modules.

#### Remove Intake Manifold and Rectifier-Regulator

1. Remove the four hex flange screws securing the intake manifold to the cylinder heads. Note which screws hold the wiring clamp(s).
2. Remove the intake manifold and O-Rings. Leave the wiring harness attached to the manifold. See Figure 8-22.

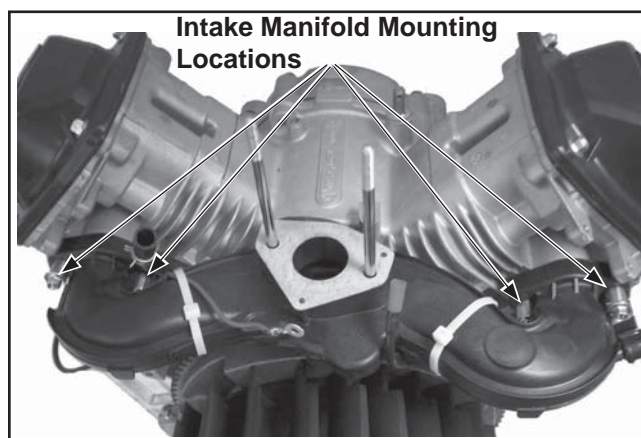


Figure 8-22. Intake Manifold Mounting Locations.



3. Remove the two screws securing the rectifier-regulator to the backing plate and disconnect the plug. See Figure 8-23.
4. Use the tip of a small screwdriver or similar small flat tool to bend the locking tang, then remove the B+ (center lead) from the terminal plug as shown in Figure 8-24. This will allow the intake manifold to be removed with the wiring harness intact.

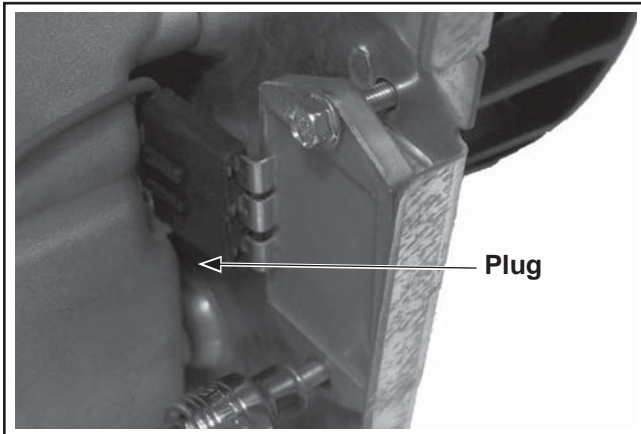


Figure 8-23. Removing Rectifier-Regulator.

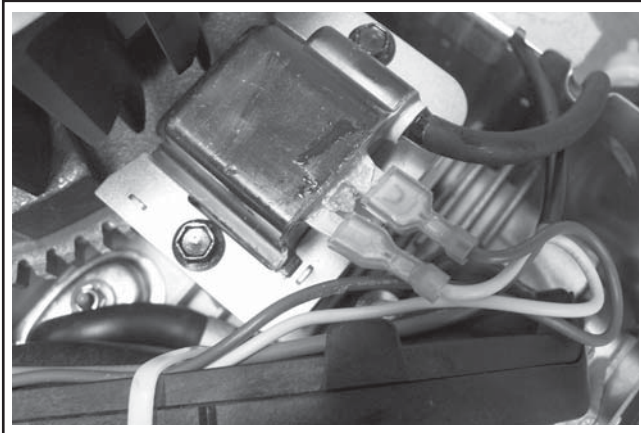


Figure 8-24. Removing B+ Lead from Terminal Plug.

### Remove Spark Plugs

1. Remove the spark plug from each cylinder head. See Figure 8-25.

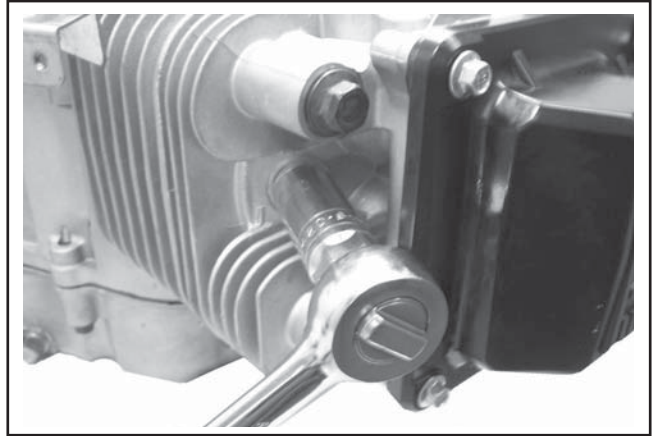


Figure 8-25. Removing Spark Plug.

### Remove Valve Covers and Cylinder Heads

#### Plastic Valve Covers with O-rings

1. Remove the four hex flange screws securing each valve cover. Most valve covers have the screw hole spacers molded in place. Remove the valve covers and O-Rings. See Figure 8-26.

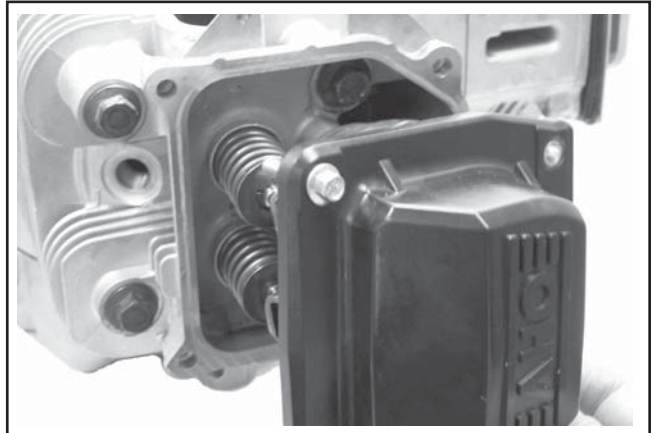


Figure 8-26. Removing Valve Covers.

## Section 8

### Disassembly

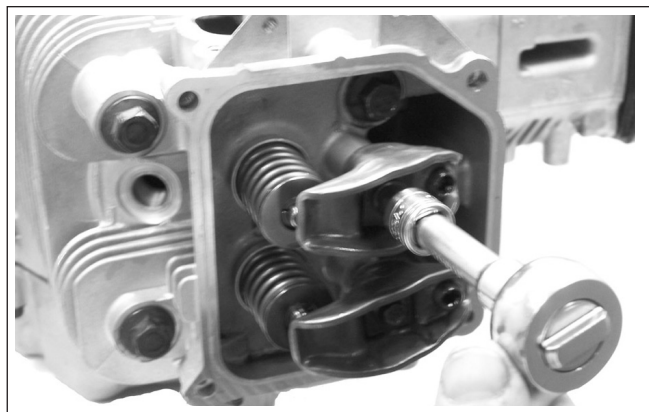
#### Stamped Steel Valve Covers with RTV Sealant

1. Remove the four hex flange screws, or Torx screws securing each valve cover.

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

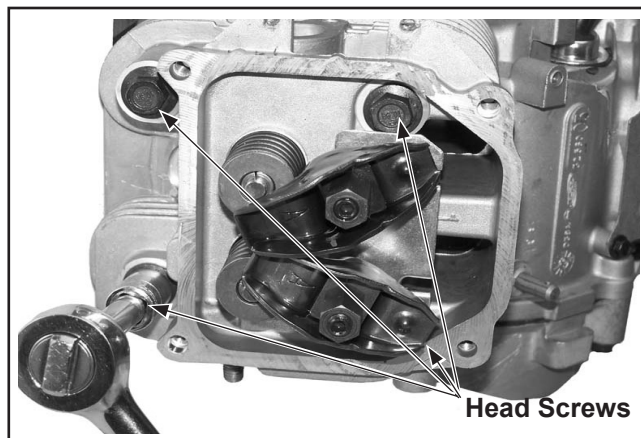
#### Remove Cylinder Heads

2. Loosen the rocker arm pivot screws, or inner setscrews (T25 TORX) based on design, and back off the rocker arm adjusting nuts. See Figure 8-27.
3. Mark the location of the push rods as either intake or exhaust and cylinder 1 or 2. Push rods should always be installed in the same positions.



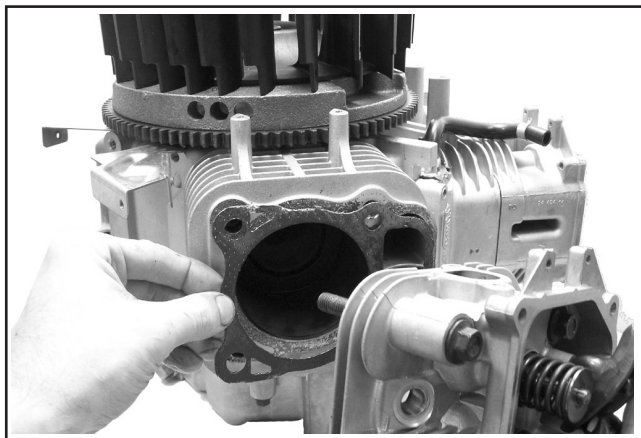
**Figure 8-27. Loosening Pivot Screws (End Adjustment Style Shown).**

4. Remove the four hex flange screws securing each cylinder head. Discard the screws once removed. Do not reuse. See Figure 8-28.



**Figure 8-28. Removing Cylinder Head Screws (Center Pivot Adjustment Style Shown).**

5. Remove the cylinder head and head gasket. See Figure 8-29.



**Figure 8-29. Removing Cylinder Head and Gasket.**

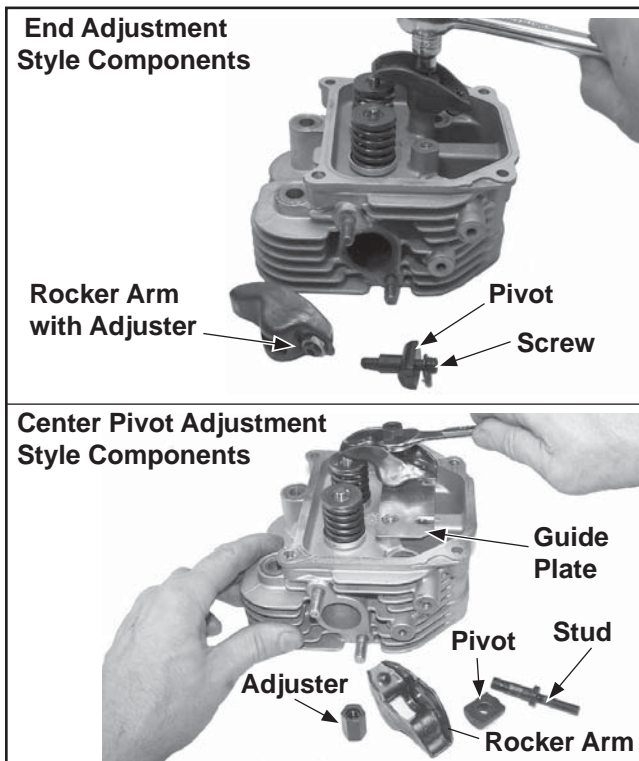
**NOTE:** The exhaust side is located on the output shaft side of the engine, while the intake side is located on the fan side of the engine. The cylinder head number is embossed on the outside of each cylinder head. See Figure 8-30.



**Figure 8-30. Match Marks on Cylinder Barrel and Heads.**

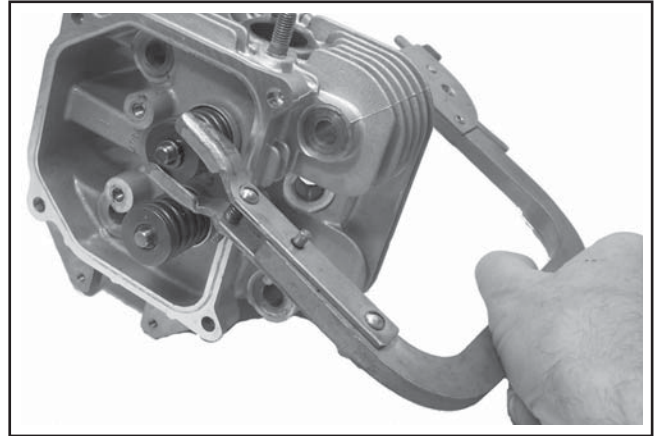
### Disassemble Cylinder Heads

1. Remove the two hex flange screws, rocker arm pivots and rocker arms with adjusters from the cylinder head. See Figure 8-31.



**Figure 8-31. Removing Rocker Arm Assemblies.**

2. Compress the valve springs using a valve spring compressor. See Figure 8-32.

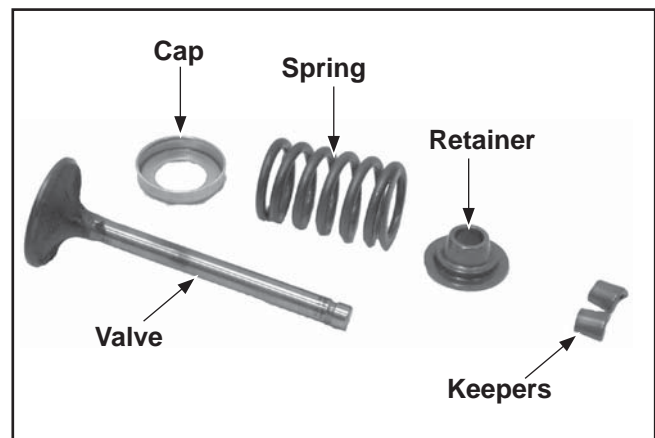


**Figure 8-32. Removing Valves with Valve Spring Compressor.**

3. Once the valve spring is compressed, remove the following items. See Figures 8-33 and 8-34:

- Valve spring keepers
- Valve spring retainers
- Valve springs
- Valve spring caps
- Intake and exhaust valves (mark position)
- Valve stem seal\* (intake valve – some models)

8

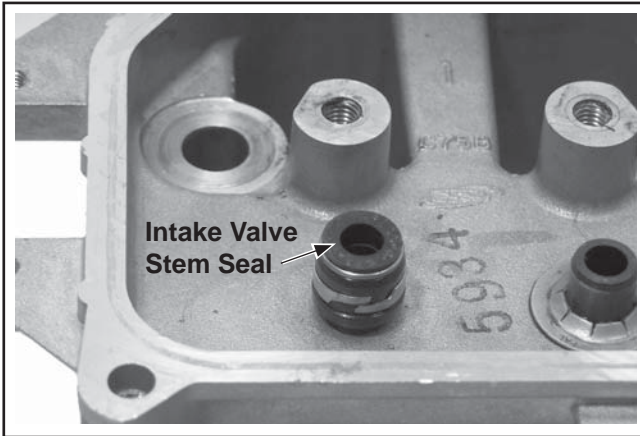


**Figure 8-33. Valve Components.**



## Section 8

### Disassembly



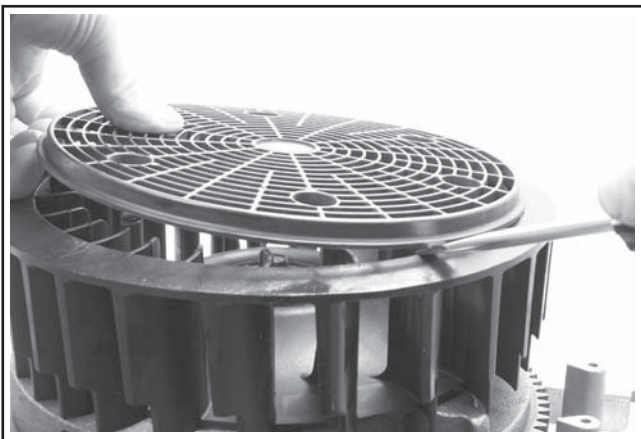
**Figure 8-34. Intake Valve Stem Seal\* (Some Models).**

\*NOTE: On engines with valve stem seals on the intake valves; use a new seal whenever the valve is removed or if the seal is deteriorated or damaged. Never reuse an old seal.

4. Repeat the above procedure for the other cylinder head. Do not interchange parts from one cylinder head to the other.

#### Remove Grass Screen, Fan, and Flywheel

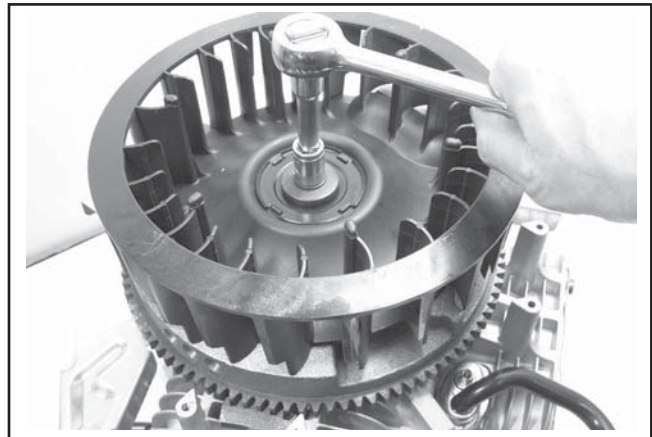
1. Unsnap the grass screen from the cooling fan. See Figure 8-35.



**Figure 8-35. Removing Grass Screen.**

NOTE: Always use a flywheel strap wrench or flywheel holding tool (see Section 2, Special Tools) to hold the flywheel when loosening or tightening the flywheel and fan retaining fasteners. Do not use any type of bar or wedge between the fins of the cooling fan, as the fins could become cracked or damaged.

2. Remove the retaining screw, washer, and the fan mounting plate, securing the fan and flywheel to the crankshaft. See Figure 8-36.

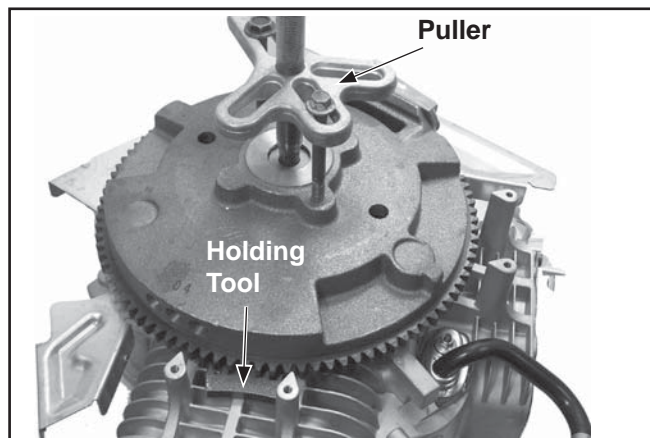


**Figure 8-36. Removing Fan and Flywheel Mounting Hardware.**

3. Carefully lift the cooling fan to disengage the two drive pins and remove it from the flywheel.
4. Remove the flywheel from the crankshaft using a puller. See Figure 8-37.

NOTE: Always use a puller to remove the flywheel from the crankshaft. Do not strike the crankshaft or flywheel, as these parts could become cracked or damaged. Striking the puller or crankshaft can cause the crank gear to move, affecting crankshaft endplay.

5. Remove the woodruff key. See Figure 8-38.



**Figure 8-37. Removing Flywheel.**



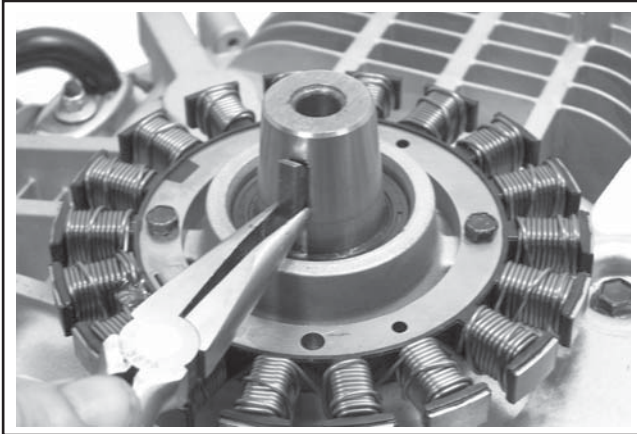


Figure 8-38. Removing Key.

### Remove Backing Plate and Stator

1. Remove the four mounting screws and the backing plate from crankcase. See Figure 8-39.

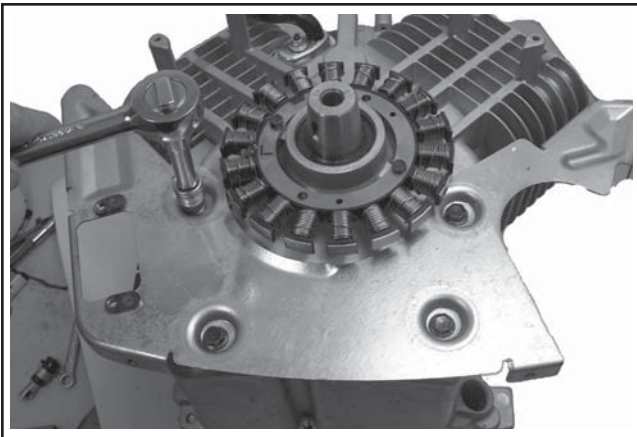


Figure 8-39. Removing Backing Plate.

2. Remove the two hex flange screws and the stator. See Figure 8-40. Note the routing of the stator leads.

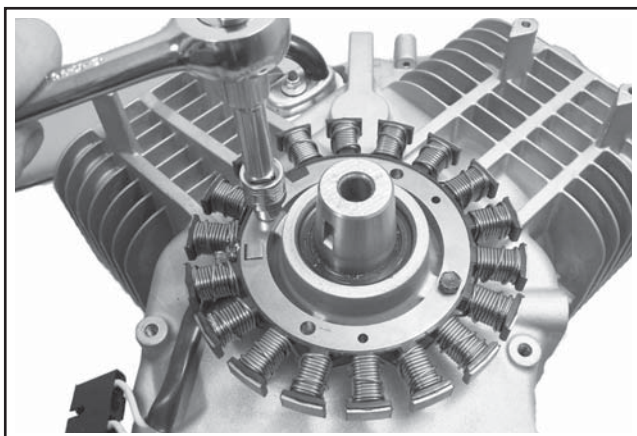


Figure 8-40. Removing Stator.

### Remove Outer Breather Assembly

1. RTV sealant is used between the outer breather cover and the crankcase. Remove the hex nut and sealing (flat) washer securing the breather cover to the crankcase. Carefully pry under the small tab of the cover flange to separate and remove. Do not bend or distort the cover. See Figure 8-41.



Figure 8-41. Removing Outer Breather Cover.

2. Unscrew and remove the mounting stud, retainer and breather reed. See Figure 8-42.

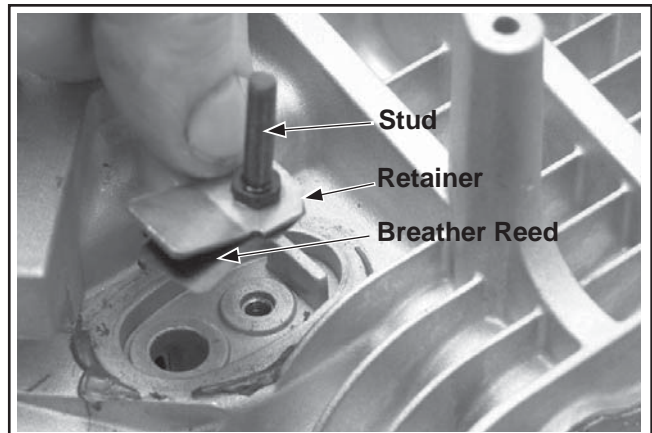


Figure 8-42. Removing Stud, Retainer, and Breather Reed.

### Remove Oil Pan Assembly

1. Remove the ten hex flange screws securing the oil pan to the crankcase. See Figure 8-43.

## Section 8

### Disassembly

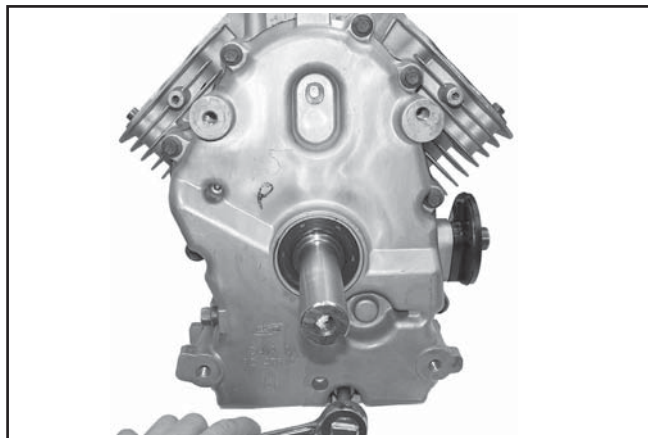


Figure 8-43. Removing Oil Pan Screws.

2. Locate the splitting tab cast into the perimeter of the oil pan. Insert the drive end of a 1/2" breaker bar between the splitting tab and the crankcase and turn it to break the RTV seal. See Figure 8-44. Do not pry on the sealing surfaces as this can cause leaks.

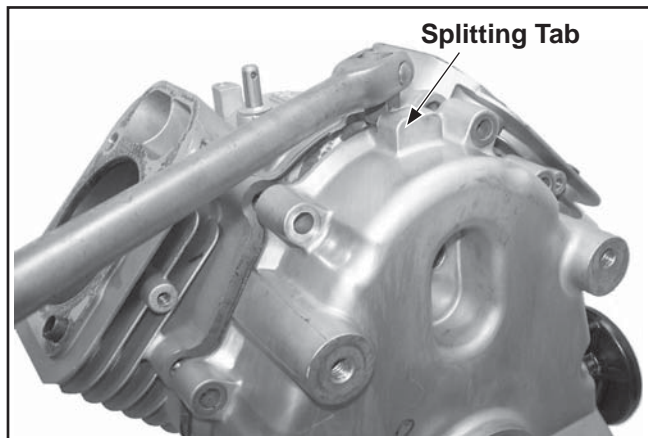


Figure 8-44. Removing Oil Pan.

#### Governor Assembly

The governor gear assembly is located inside the oil pan. If service is required, refer to the service procedures in Section 9, Governor Assembly.

#### Oil Pump Assembly

The oil pump is mounted inside the oil pan. If service is required, refer to the service procedures under Section 9, Oil Pump Assembly.

#### Remove Camshaft and Valve Tappets

1. Position the crankcase so the flywheel side is down. Remove the camshaft and shim. See Figure 8-45.

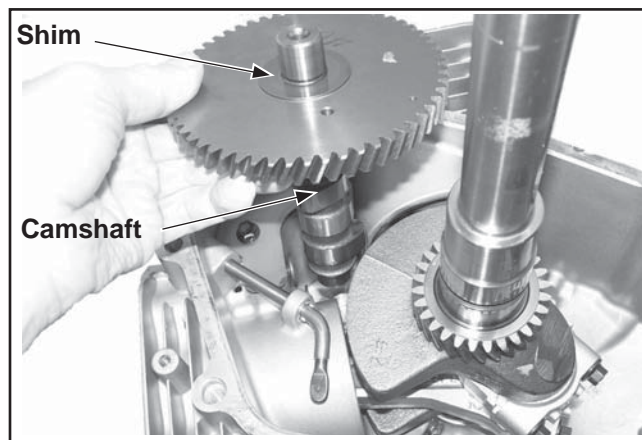


Figure 8-45. Removing Camshaft.

2. Remove the valve tappets from the crankcase and mark them by their location, as either intake or exhaust and cylinder 1 or 2. Tappets should always be reinstalled in the same position. See Figure 8-46.

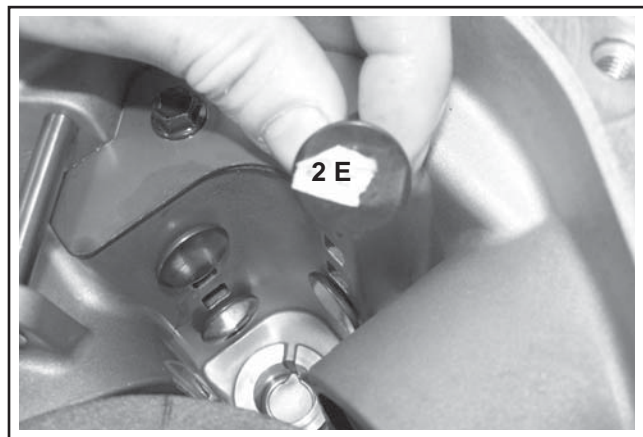
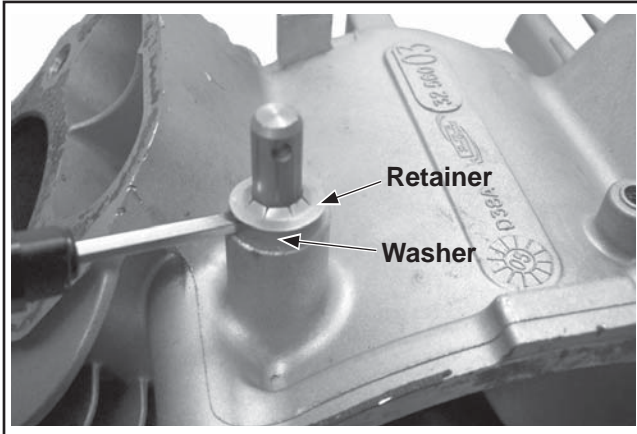


Figure 8-46. Removing Valve Tappets.

#### Remove Governor Cross Shaft

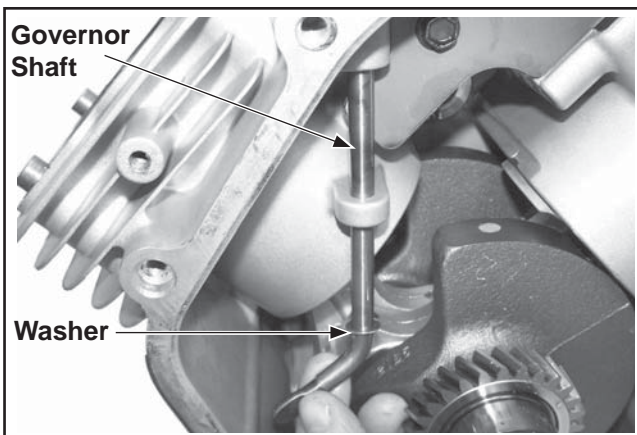
1. Remove the retainer and washer from the governor cross shaft. See Figure 8-47.





**Figure 8-47. Removing Governor Cross Shaft Retainer.**

2. Remove the cross shaft with the small inner washer through the inside of the crankcase. See Figure 8-48.

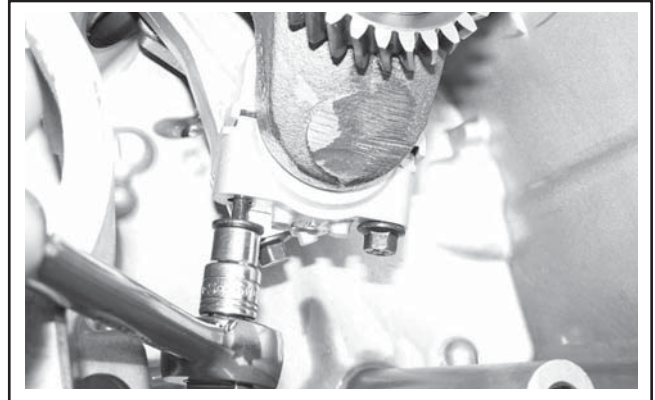


**Figure 8-48. Removing Governor Cross Shaft.**

3. Remove the governor shaft seal from the crankcase.

### Remove Connecting Rods with Pistons and Rings

1. Remove the two hex flange screws securing the closest connecting rod end cap. Remove the end cap. See Figure 8-49.



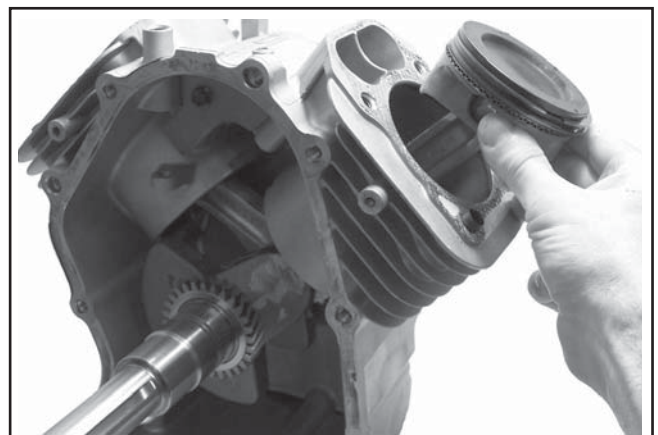
**Figure 8-49. Removing Connecting Rod End Cap.**

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

2. Carefully remove the connecting rod and piston assembly from the cylinder bore. See Figure 8-50.

**NOTE:** The cylinders are numbered on the crankcase. Use the numbers to mark each end cap, connecting rod and piston for reassembly. Do not mix end caps and connecting rods.

**8**



**Figure 8-50. Removing Connecting Rod and Piston Assembly.**

3. Repeat the above procedure for the other connecting rod and piston assembly.

## Section 8

### Disassembly

#### Remove Crankshaft

1. Carefully pull the crankshaft from the crankcase. See Figure 8-51.

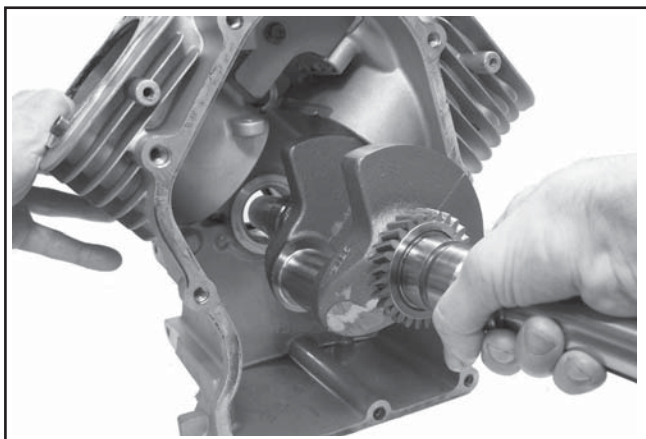


Figure 8-51. Removing Crankshaft.

#### Remove Inner Breather Assembly

1. Remove the screw securing the inner breather cover and gasket to the crankcase.
2. Carefully remove the cover, gasket, and the breather filter. See Figure 8-52. Make sure the drain back hole is not plugged or restricted.

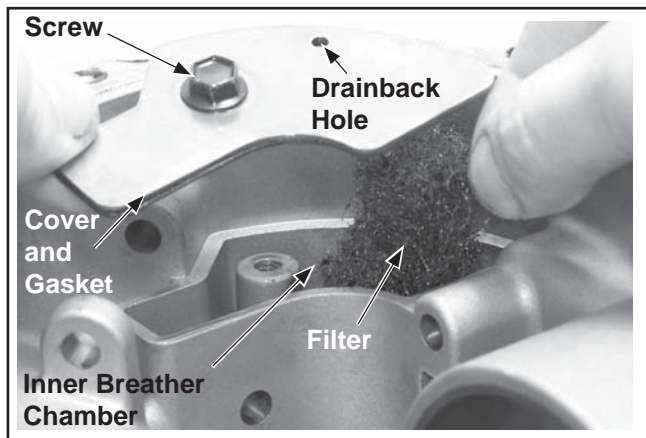


Figure 8-52. Removing Breather Cover and Filter.

#### Remove Flywheel and PTO End Oil Seals

1. Remove the oil seals from the crankcase and oil pan. See Figure 8-53.



Figure 8-53. Removing Oil Seals.

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# Section 9

## Inspection and Reconditioning

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This section covers the operation, inspection, and repair/reconditioning of major internal engine components. The following components are not covered in this section. They are covered in sections of their own:

Section 4: Air Cleaner and Intake System  
Section 5: Carburetor & External Governor  
Section 7: Ignition, Charging & Electric Starter

Clean all parts thoroughly. 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 the manufacturer's instructions and safety precautions carefully. Make sure all traces of the cleaner are removed before the engine is reassembled and placed into operation. Even small amounts of these cleaners can quickly break down the lubricating properties of engine oil.

Use an aerosol gasket remover, paint stripper, or lacquer thinner to remove any old sealant. Apply the solvent, allow time for it to work, and then brush the surface with a brass wire brush. After the old sealant is removed, clean the surface with isopropyl alcohol, lacquer thinner, or aerosol electrical contact cleaner. **Do not** scrape the surfaces, as any scratches, nicks, or burrs can result in leaks.

Refer to A Guide to Engine Rebuilding (TP-2150-A) for additional information. Measurement Guide (TP-2159-B) and Engine Inspection Data Record (TP-2435) are also available; use these to record inspection results.

### Automatic Compression Release (ACR)

Some engines may be equipped with the optional Automatic Compression Release (ACR) mechanism. The ACR lowers compression at cranking speeds to make starting easier.

### Camshaft

#### Inspection and Service

Check the lobes of the camshaft for wear or damage. See Section 1, Specifications and Tolerances for minimum lift specifications. Inspect the cam gear for badly worn, chipped or missing teeth. Replacement of the camshaft will be necessary if any of these conditions exist.

### Crankshaft

#### Inspection and Service

Inspect the gear teeth of the crankshaft. If the teeth are badly worn, chipped, or some are missing, replacement of the crankshaft will be necessary.

Inspect the crankshaft bearing surfaces for scoring, grooving, etc. Measure the running clearance between the crankshaft journals and their respective bearing bores. Use an inside micrometer or telescoping gauge to measure the inside diameter of both bearing bores in the vertical and horizontal planes. Use an outside micrometer to measure the outside diameter of the crankshaft main bearing journals. Subtract the journal diameters from their respective bore diameters to get the running clearances. Check the results against the values in Section 1, Specifications and Tolerances. If the running clearances are within specification, and there is no evidence of scoring, grooving, etc., no further reconditioning is necessary. If the bearing surfaces are worn or damaged, the crankcase and/or oil pan will need to be replaced.

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



## Section 9

# Inspection and Reconditioning

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Inspect the crankpin for score marks or metallic pickup. Slight score marks can be cleaned with crocus cloth soaked in oil. If wear limits, as stated in Section 1, Specifications and Tolerances are exceeded, it will be necessary to replace the crankshaft.

### Crankcase

#### Inspection and Service

Check all gasket surfaces to make sure they are free of gasket fragments. Gasket surfaces must also be free of deep scratches or nicks.

Check the cylinder bore for scoring. In severe cases, unburned fuel can cause scuffing and scoring of the cylinder wall. It washes the necessary lubricating oils off the piston and cylinder wall. As raw fuel seeps down the cylinder wall, the piston rings make metal to metal contact with the wall. Scoring of the cylinder wall can also be caused by localized hot spots resulting from blocked cooling fins or from inadequate or contaminated lubrication.

If the cylinder bore is badly scored, excessively worn, tapered, or out-of-round, resizing is necessary. Use an inside micrometer to determine the amount of wear (refer to Section 1, Specifications and Tolerances). A **0.25 mm (0.010 in.)** oversize piston is available if resizing is selected. Initially, resize using a boring bar, then use the following procedures for honing the cylinder.

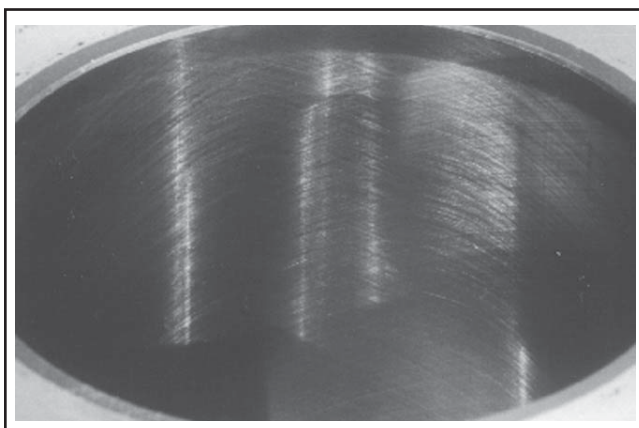
#### Honing

While most commercially available cylinder hones can be used with either portable drills or drill presses, the use of a low speed drill press is preferred as it facilitates more accurate alignment of the bore in relation to the crankshaft crossbore. 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 so that the stones are in contact with the cylinder wall. Use of a commercial cutting-cooling agent is recommended.
2. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and honing process. Move the hone up and down while resizing to prevent the formation of cutting ridges. Check the size frequently.

**NOTE:** Kohler pistons are custom-machined to exacting tolerances. When over-sizing a cylinder, it should be machined exactly **0.25 mm (0.010 in.)** over the new diameter (Section 1, Specifications and Tolerances). The oversize Kohler replacement piston will then fit correctly.

3. When the bore is within **0.064 mm (0.0025 in.)** of the desired size, remove the coarse stones and replace them with burnishing stones. Continue with the burnishing stones until the bore is within **0.013 mm (0.0005 in.)** of the desired size and then use finish stones (**220-280 grit**) and polish the bore to its final size. A crosshatch should be observed if honing is done correctly. The crosshatch should intersect at approximately 23°-33° off the horizontal. Too flat an angle could cause the rings to skip and wear excessively, and too steep an angle will result in high oil consumption. See Figure 9-1.



**Figure 9-1. Cylinder Bore Crosshatch After Honing.**

4. After resizing, check the bore for roundness, taper, and size. Use an inside micrometer, telescoping gauge, or bore gauge to take measurements. The measurements should be taken at three locations in the cylinder – at the top, middle, and bottom. Two measurements should be taken (perpendicular to each other) at each of the three locations.

#### Clean Cylinder Bore After Honing

Proper cleaning of the cylinder walls following boring and/or honing is very critical to a successful overhaul. Machining grit left in the cylinder bore can destroy an engine in less than one hour of operation after a rebuild.



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

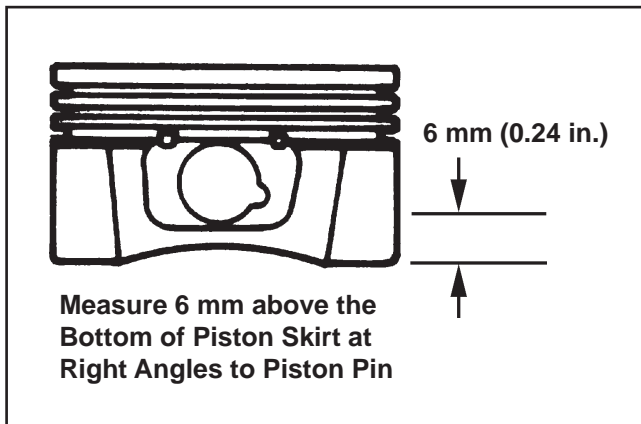
### Measuring Piston-to-Bore Clearance

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

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

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

1. Use a micrometer and measure the diameter of the piston **6 mm (0.24 in.)** above the bottom of the piston skirt and perpendicular to the piston pin (See Figure 9-2).



**Figure 9-2. Measuring Piston Diameter.**

2. Use an inside micrometer, telescoping gauge, or bore gauge and measure the cylinder bore. Take the measurement approximately **63.5 mm (2.5 in.)** below the top of the bore and perpendicular to the piston pin.
3. Piston-to-bore clearance is the difference between the bore diameter and the piston diameter (step 2 minus step 1).

## Flywheel

### Inspection

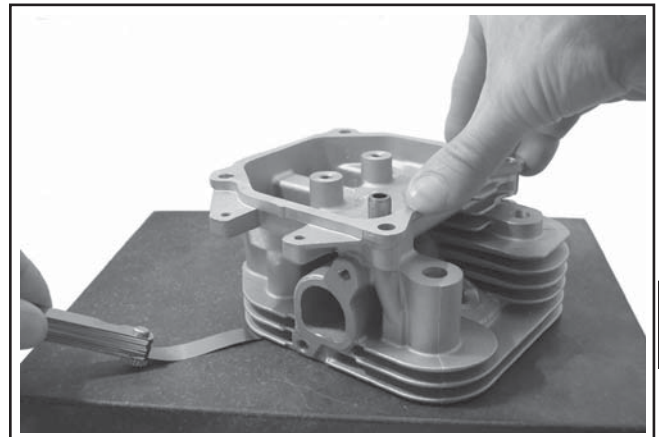
Inspect the flywheel for cracks, and the flywheel keyway for damage. Replace flywheel if it is cracked. Replace the flywheel, the crankshaft, and the key if the flywheel key is sheared or the keyway is damaged.

Inspect the ring gear for cracks or damage. Kohler does not provide ring gears as a serviceable part. Replace the flywheel if the ring gear is damaged.

## Cylinder Head and Valves

### Inspection and Service

After cleaning, check the flatness of the cylinder head and the corresponding top surface of the crankcase, using a surface plate or piece of glass and feeler gauge as shown in Figure 9-3. The maximum allowable out of flatness is **0.076 mm (0.003 in.)**.



**Figure 9-3. Checking Cylinder Head Flatness.**

Carefully inspect the valve mechanism parts. Inspect the valve springs and related hardware for excessive wear or distortion. Check the valves and valve seat area or inserts for evidence of deep pitting, cracks, or distortion. Check clearance of the valve stems in the guides. See Figure 9-5 for valve details and specifications.

## Section 9

### Inspection and Reconditioning

#### Stamped Steel Valve Cover

Using a brass wire brush and gasket remover or similar solvent, clean the old RTV from the surface of the cylinder head and valve cover.

The sealing surface of stamped steel valve covers must be checked for flatness prior to reinstallation. Hold the valve cover down firmly against a flat, level surface or piece of glass, and check around the entire perimeter that a **0.012 in. (0.30 mm)** feeler gauge cannot be inserted anywhere. See Figure 9-4. If the gauge goes in anywhere, the cover needs to be replaced. Refer to Section 10 for valve cover reassembly procedures.

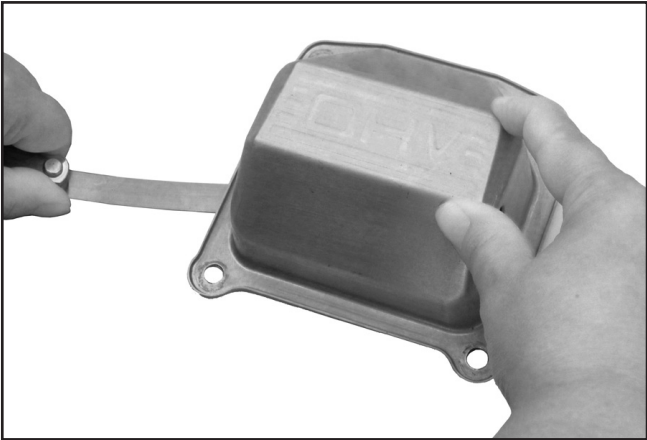


Figure 9-4. Checking with Feeler Gauge.

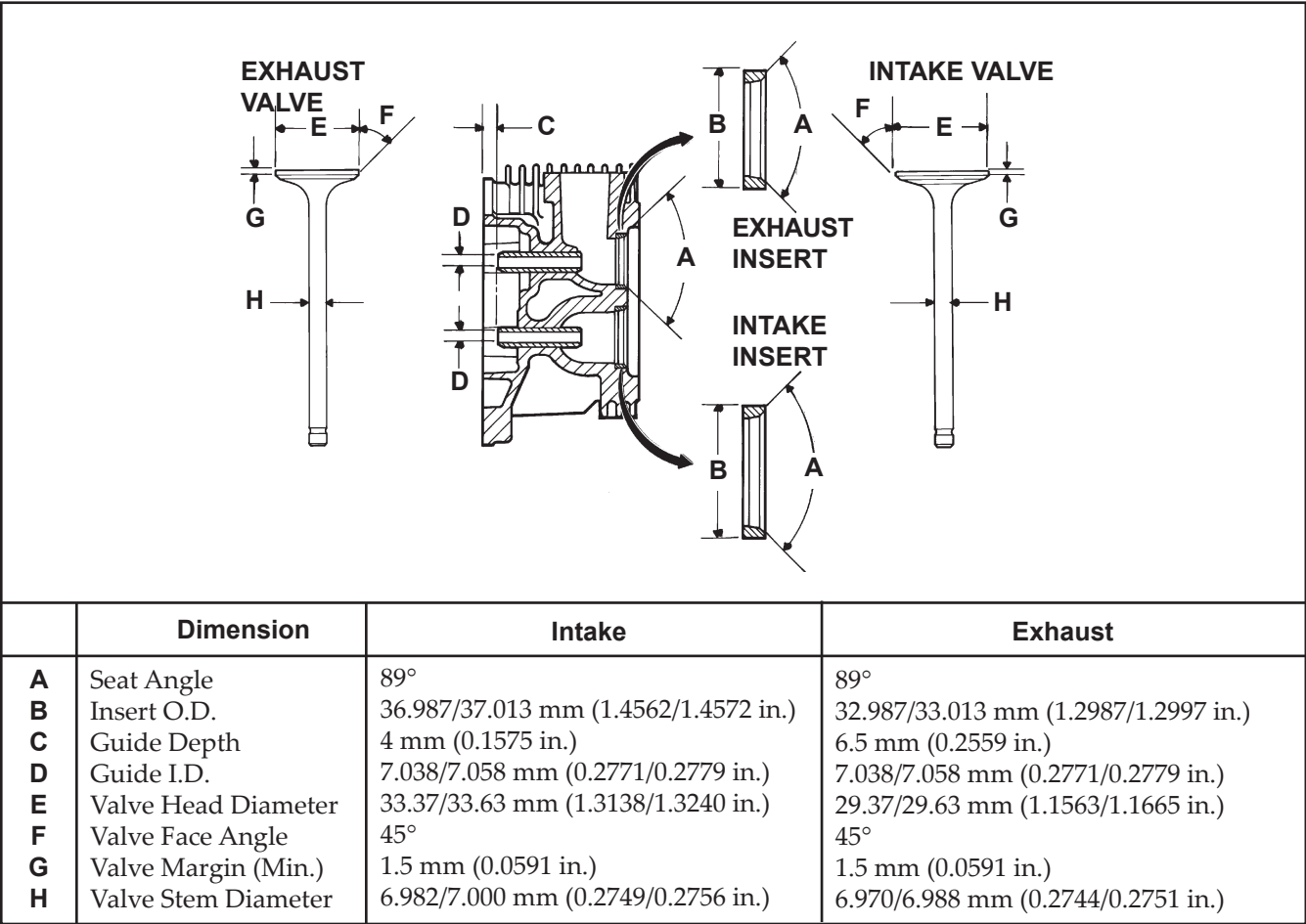


Figure 9-5. Valve Details.

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 the valves first. After removal, clean the 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. A normal valve and valves in bad condition are shown in the accompanying illustrations.



**Normal:** Even after long hours of operation a valve can be reconditioned and reused if the face and margin are in good shape. If a valve is worn to where the margin is less than 1/32" do not reuse it. The valve shown was in operation for almost 1000 hours under controlled test conditions.



**Leakage:** A poor grind on face or seat of valve will allow leakage resulting in a burned valve on one side only.



**Bad Condition:** The valve depicted here should be replaced. Note the warped head; margin damaged and too narrow. These conditions could be attributed to excessive hours or a combination of poor operating conditions.

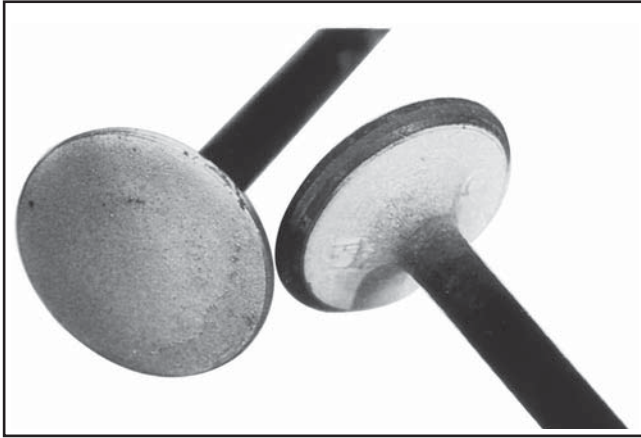


**Coking:** Coking is normal on intake valves and is not harmful. If the seat is good, the valve could be reused after cleaning.

## Section 9

### Inspection and Reconditioning

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**Excessive Combustion Temperatures:** The white deposits seen here indicate very high combustion temperatures, usually due to a lean fuel mixture.



**Stem Corrosion:** Moisture in fuel or from condensation is the most common causes of valve stem corrosion. Condensation occurs from improper preservation during storage and when engine is repeatedly stopped before it has a chance to reach normal operating temperatures. Replace corroded valves.



**Gum:** Gum deposits usually result from using stale gasoline. Gum is a prevalent cause of valve sticking. The cure is to ream the valve guides and clean or replace the valves, depending on their condition.



**Overheating:** An exhaust valve subject to overheating will have a dark discoloration in the area above the valve guide. Worn guides and faulty valve springs may cause this condition. Also check for clogged air intake, and blocked fins when this condition is noted.

### Valve Guides

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

To check valve guide-to-valve stem clearance, thoroughly clean the valve guide and, using a split-ball gauge, measure the inside diameter of the guide. Then, using an outside micrometer, measure the diameter of the valve stem at several points on the stem where it moves in the valve guide. Use the largest stem diameter to calculate the clearance by subtracting the stem diameter from the guide diameter. If the **intake** clearance exceeds **0.038/0.076 mm (0.0015/0.003 in.)** or the exhaust clearance exceeds **0.050/0.088 mm (0.0020/0.0035 in.)**, determine whether the valve stem or guide is responsible for the excessive clearance.

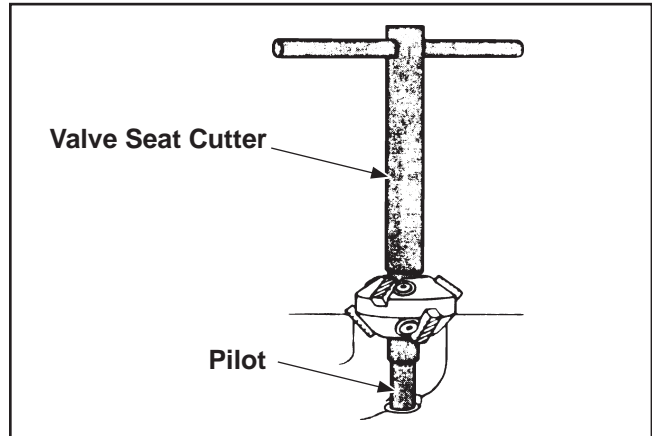
The maximum (I.D.) wear on the **intake** valve guide is **7.134 mm (0.2809 in.)** while **7.159 mm (0.2819 in.)** is the maximum allowed on the exhaust guide. The guides are not removable but can be reamed **0.25 mm (0.010 in.)** oversize. Valves with **0.25 mm** oversize stems must then be used.

If the guides are within limits but the valve stems are worn beyond limits, install new valves.

### Valve Seat Inserts

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

Recondition the valve seat inserts following the instructions provided with the valve seat cutter being used. A typical cutter is shown in Figure 9-6. The final cut should be made with an 89° cutter as specified for the valve seat angle in Figure 9-5. Cutting the proper 45° valve face angle, as specified in Figure 9-5, and the proper valve seat angle (44.5°, half of the full 89° angle), will achieve the desired 0.5° (1.0° full cut) interference angle where the maximum pressure occurs on the outside diameters of the valve face and seat.



**Figure 9-6. Typical Valve Seat Cutter.**

### Lapping Valves

Reground or new valves must be lapped in, to provide fit. 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 **SAE 10** oil to prevent rusting.

### Intake Valve Stem Seal

Some engines use valve stem seals on the intake valves. Always use a new seal when the valves are removed from the cylinder head. The seals should also be replaced if deteriorated or damaged in any way. **Never reuse an old seal.**

## Pistons and Rings

### Inspection

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

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



## Section 9

### Inspection and Reconditioning

Ring failure is usually indicated by excessive oil consumption and blue exhaust smoke. When rings fail, oil is allowed to enter the combustion chamber where it is burned along with the fuel. High oil consumption can also occur when the piston ring end gap is incorrect because the ring cannot properly conform to the 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 the fuel

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

Pre-ignition or ignition of the fuel charge before the timed spark can cause damage similar to detonation. Pre-ignition damage is often more severe than detonation damage. Pre-ignition is caused by a hot spot in the combustion chamber such as glowing carbon deposits, blocked cooling fins, an improperly seated valve, or wrong spark plug(s).

See Figure 9-7 for some common types of piston and ring damage.



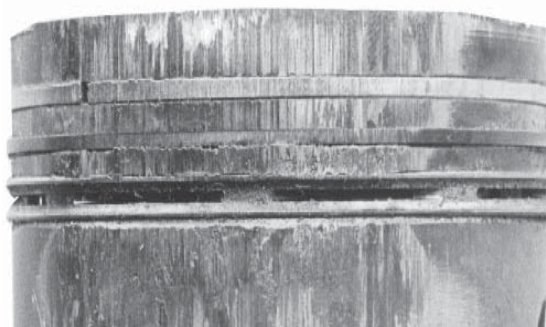
**Stuck, Broken Rings**



**Abrasive Scratched Rings**



**Overheated or Deteriorated Oil**



**Scored Piston and Rings**

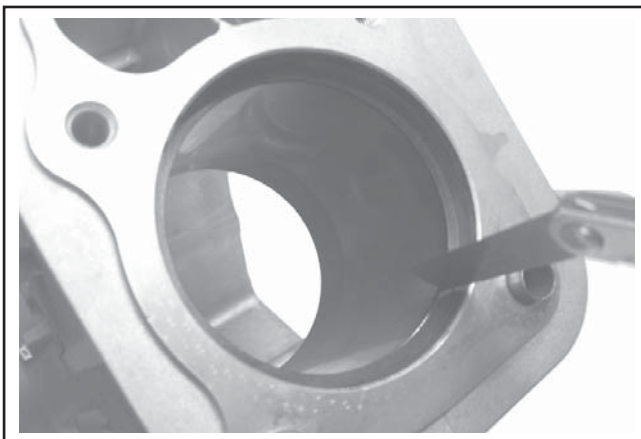
**Figure 9-7. Common Types of Piston Damage.**

Replacement pistons are available in STD bore size, and 0.25 mm (0.010 in.) oversize. Replacement pistons include new piston ring sets and new piston pins.

Replacement ring sets are also available separately for STD, and 0.25 mm (0.010 in.) oversize pistons. Always use new piston rings when installing pistons. Never use old rings.

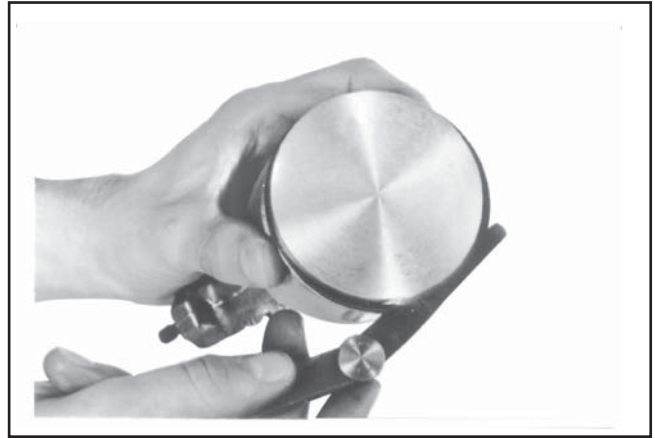
Some important points to remember when servicing piston rings:

1. The cylinder bore must be de-glazed before service ring sets are used.
2. If the cylinder bore does not need re-boring and if the old piston is within wear limits and free of score or scuff marks, the old piston may be reused.
3. Remove the old rings and clean up the grooves. **Never reuse old rings.**
4. Before installing the new rings on the piston, place the top two rings, each in turn, in its running area in the cylinder bore and check the end gap. (See Figure 9-8.) Compare the ring gap to the measurements in Section 1, Specifications and Tolerances.



**Figure 9-8. Measuring Piston Ring End Gap.**

5. After installing the new compression (top and middle) rings on the piston, check the piston-to-ring side clearance. Compare the clearance to specifications listed in Section 1, Specifications and Tolerances. If the side clearance is greater than specified, a new piston **must** be used. Refer to Figure 9-9.

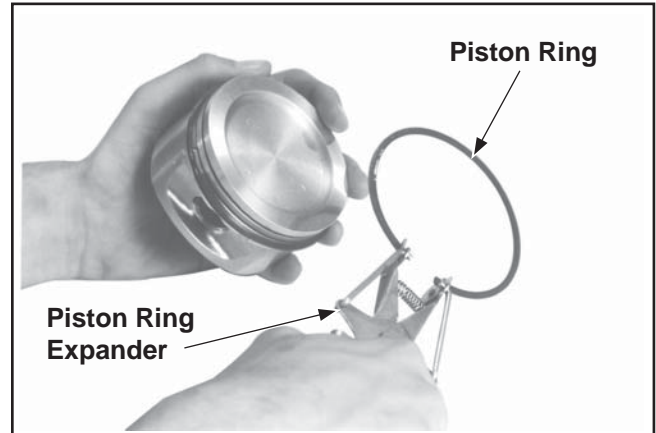


**Figure 9-9. Measuring Piston Ring Side Clearance.**

### Install New Piston Rings

To install new piston rings, proceed as follows:

**NOTE:** Rings must be installed correctly. Ring installation instructions are usually included with new ring sets. Follow instructions carefully. Use a piston ring expander to install rings (see Figure 9-10). Install the bottom (oil control) ring first and the top compression ring last. Refer to Figure 9-11.



**Figure 9-10. Installing Piston Rings.**

## Section 9

### Inspection and Reconditioning

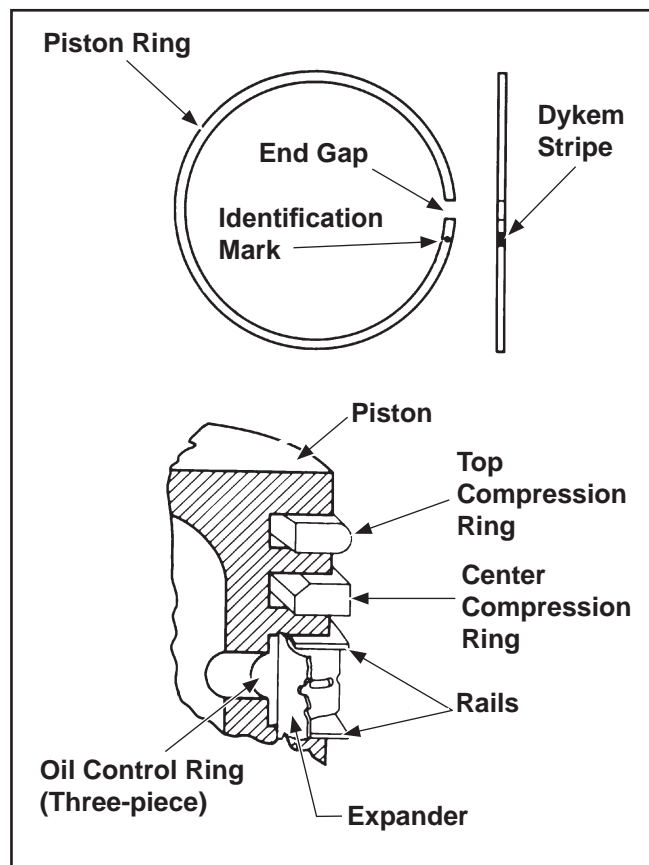


Figure 9-11. Piston Ring Installation.

1. Oil Control Ring (Bottom Groove): Install the expander and then the rails. Make sure the ends of the expander are not overlapped.
2. Middle Compression Ring (Center Groove): Install the center ring using a piston ring expander tool. Make sure the identification mark is up or the dykem stripe (if contained) is to the left of the end gap.
3. Top Compression Ring (Top Groove): Install the top ring using a piston ring expander tool. Make sure the identification mark is up or the dykem stripe (if contained) is to the left of the end gap.

#### Connecting Rods

Offset, stepped-cap connecting rods are used in all these engines.

#### Inspection and Service

Check the bearing area (big end) for excessive wear, score marks, running and side clearances (see Section 1, Specifications and Tolerances). Replace the rod and cap if scored or excessively worn.

Service replacement connecting rods are available in STD size and 0.25 mm (0.010 in.) undersize. The 0.25 mm (0.010 in.) undersized rods have an identification marking on the lower end of the rod shank. Always refer to the appropriate parts information to ensure that correct replacements are used.

#### Valve Tappets

##### Inspection

Check the base surface of the valve tappet(s) for wear or damage. Replace tappet(s) if condition is questionable in any way. The corresponding camshaft lobe(s) should also be checked for wear or damage. Whenever tappets are replaced, apply a liberal coating of Kohler lubricant 25 357 14-S to the base of each new tappet before it is installed.

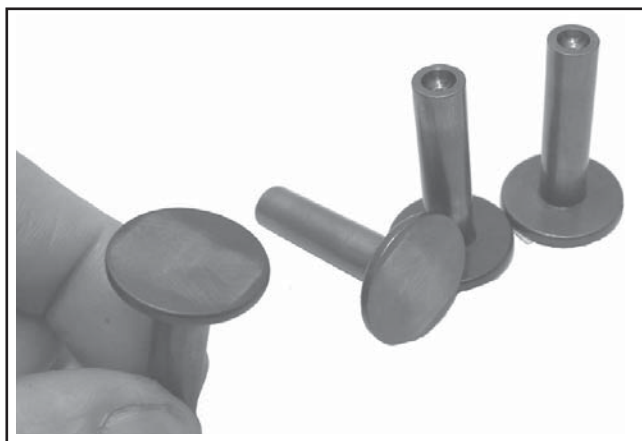


Figure 9-12. Valve Tappet.

#### Oil Pan Assembly

##### Inspection

Inspect the oil seal in the oil pan and remove it if it is worn or damaged. The new oil seal is installed after the oil pan is assembled to the crankcase. See Section 10, Reassembly, Oil Seal in Oil Pan.

Inspect the main bearing surface for wear or damage (refer to Section 1 Specifications and Tolerances). Replace the oil pan assembly if required.

## Governor Assembly (Internal)

### Inspection

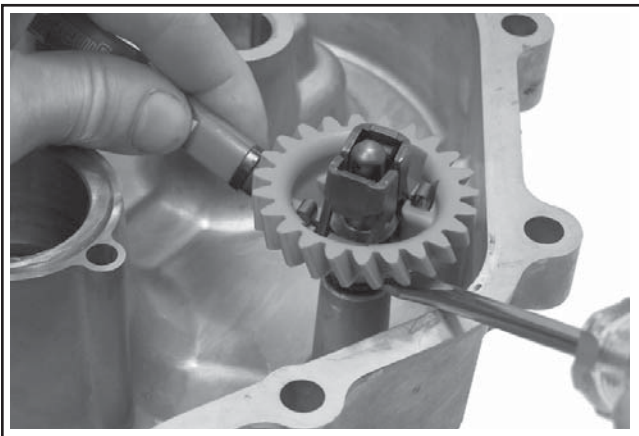
Inspect the governor gear teeth. Replace the gear if it is worn, chipped, or if any teeth are missing. Inspect the governor weights. They should move freely in the governor gear.

### Disassembly

The governor gear **must** be replaced once it is removed from the oil pan.

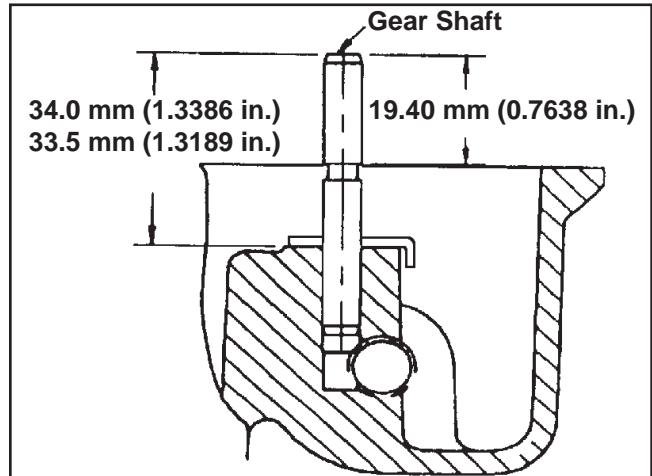
**NOTE:** The governor gear is held onto the shaft by small molded tabs in the gear. When the gear is removed from the shaft, these tabs are destroyed and the gear must be replaced. Therefore, remove the gear only if absolutely necessary.

1. Use two small screwdrivers and carefully pry upward to remove the regulating pin and governor gear assembly. See Figure 9-13.



**Figure 9-13. Removing Governor Gear.**

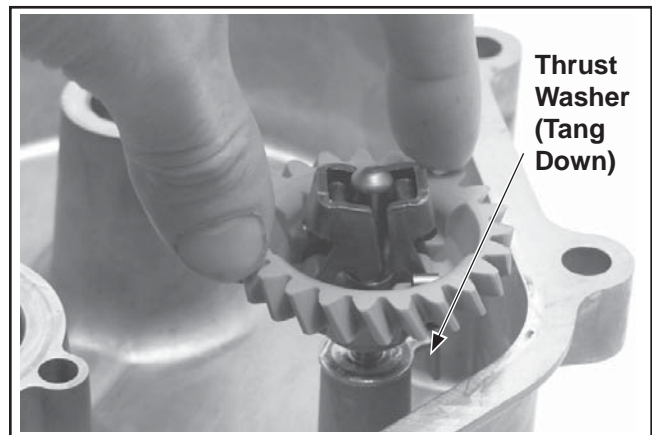
2. Remove the locking tab thrust washer located under the governor assembly.
3. Carefully inspect the governor gear shaft and replace it only if it is damaged. After removing the damaged shaft, press or lightly tap the replacement shaft into the closure plate to the depth shown in Figure 9-14.



**Figure 9-14. Governor Shaft Press Depth.**

### Reassembly

1. Install the locking tab thrust washer on the governor gear shaft with the tab down.
2. Position the regulating pin within the governor gear/flyweights assembly and slide both onto governor shaft until assembly locks into place. See Figure 9-15.



**Figure 9-15. Installing Thrust Washer, Regulating Pin and Governor Gear Assembly.**

## Oil Pump Assembly

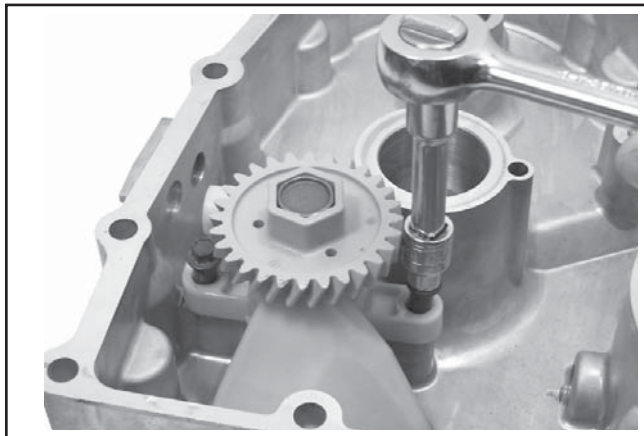
### Disassembly

1. Remove the two hex flange screws. See Figure 9-16.
2. Lift the oil pump assembly from the oil pan. See Figure 9-17.



## Section 9

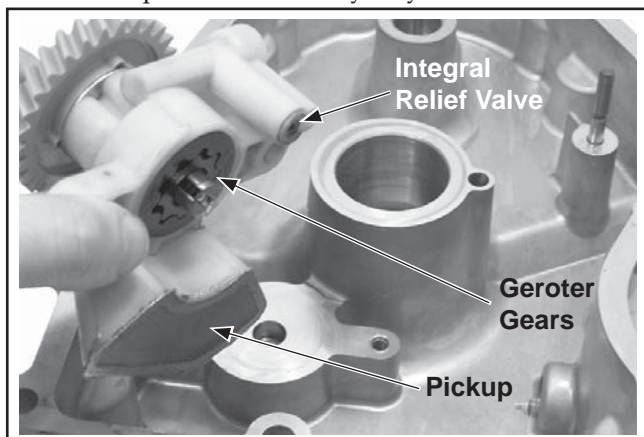
### Inspection and Reconditioning



**Figure 9-16. Removing Oil Pump Mounting Screws.**

3. The outer Gerotor gear is typically held captive in the oil pump housing. If the gear becomes separated, see Step 1 under Reassembly for proper reinstallation.

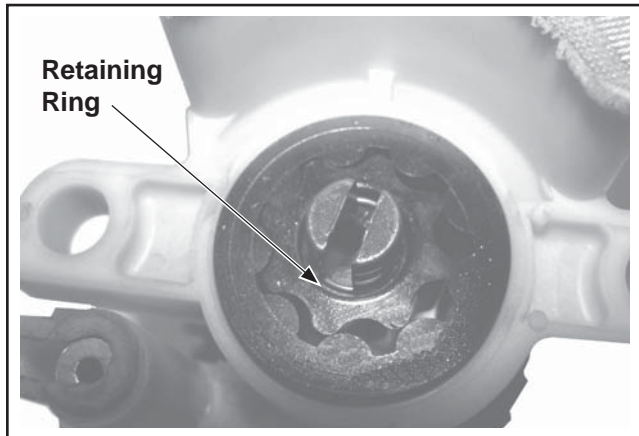
**NOTE:** The relief valve is sealed as part the oil pump housing and not serviceable. Replace the oil pump if the relief valve condition or function is questionable in any way.



**Figure 9-17. Oil Pump Components, Oil Pickup, and Integral Relief Valve.**

#### Inspection

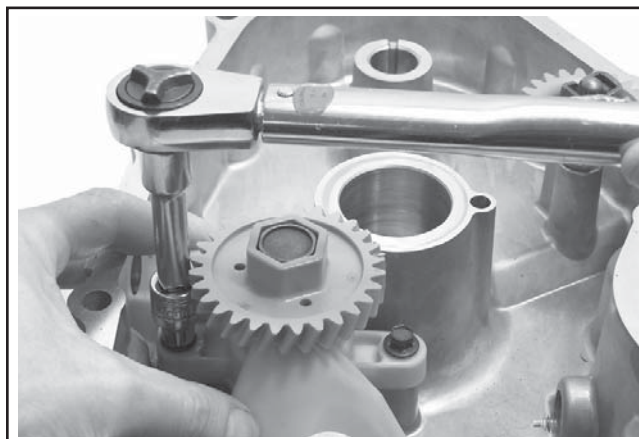
Inspect the oil pump housing, gear, and rotors for nicks, burrs, wear, or any visible damage. Check the oil pickup screen for damage or restriction. If any parts are worn or damaged, replace the oil pump assembly. Disassembly of oil pump is not recommended. If the retaining ring of main shaft is removed for any reason, a new retaining ring should be used. Do not install a used ring. See Figure 9-18.



**Figure 9-18. Oil Pump Details.**

#### Reassembly

1. Lubricate the outer Gerotor gear with oil. If the outer gear was separated from the oil pump housing examine the outer edges. On the Gerotor Gears: one edge contains small molding marks or dots, which must be matched to those on the inner gear. If the dots are not visible on the inner gear, install the outer gear with the dots down or in. If the dots are visible, the outer gear should be installed with the dots up or out. Not matching the molding dots will result in reduced pump output efficiency.
2. Install the oil pump inserting the center shaft into the corresponding recess in oil pan. Secure the oil pump by torquing the hex flange screws in the indicated sequence to **11.2 N·m (100 in. lb.)** in new, as-cast holes, or **7.3 N·m (65 in. lb.)** into used holes. See Figures 9-19 and 9-20.



**Figure 9-19. Installing Oil Pump.**



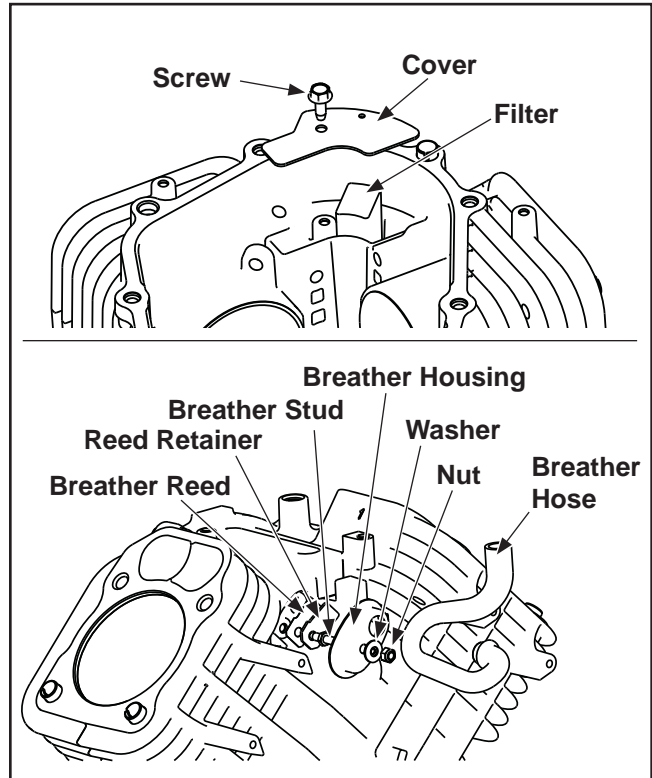


**Figure 9-20. Oil Pump Torque Sequence.**

- a. Start fastener 1 into hole, apply only minimal torque to position the pump.
- b. Torque fastener 2 to full value.
- c. Torque fastener 1 to full value.
- d. After torquing, rotate the gear and check for freedom of movement. Make sure there is no binding. If binding occurs, loosen the screws, reposition the pump, retorque the hex flange screws and recheck the movement.

### Breather Design

The breather system is designed to control the amount of oil in the head area and still maintain the necessary vacuum in the crankcase. The system consists of an inner chamber with a mesh filter inside the crankcase, plus a spring steel reed, retainer, breather cover and breather hose mounted on the outside of the crankcase. See Figure 9-21. When the pistons move downward, crankcase gasses pass through a passage into the inner chamber, in turn air is pushed past the reed into intake system. The upward travel of the pistons closes the reed and creates a low vacuum in the lower crankcase, in the process separating the oil from the airflow in the mesh filter. Any oil separated out through the filter drains back into the crankcase through a small hole in the cover of the inner (filter) chamber.

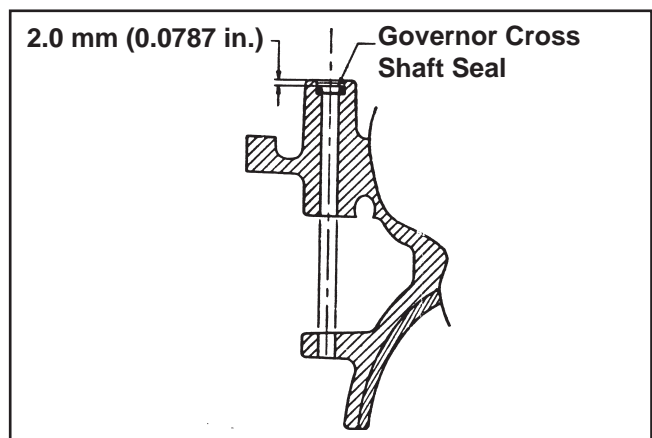


**Figure 9-21. Breather Assembly Details.**

### Governor Cross Shaft Oil Seal

If the governor cross shaft seal is damaged and/or leaks, replace it using the following procedure.

Remove the oil seal from the crankcase and replace it with a new one. Install the new seal to the depth shown in Figure 9-22.



**Figure 9-22. Governor Cross Shaft Oil Seal Details.**



# Section 10

## Reassembly

### General

**NOTE:** Make sure the engine is assembled using all specified torque values, tightening sequences, and clearances. Failure to observe specifications could cause severe engine wear or damage. Always use new gaskets.

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

Check the oil pan, crankcase, cylinder heads, and valve covers to be certain that all old sealing material has been removed. Use gasket remover, lacquer thinner, or paint remover to remove any remaining traces. Clean the surfaces with isopropyl alcohol, acetone, lacquer thinner, or electrical contact cleaner.

### Typical Reassembly Sequence

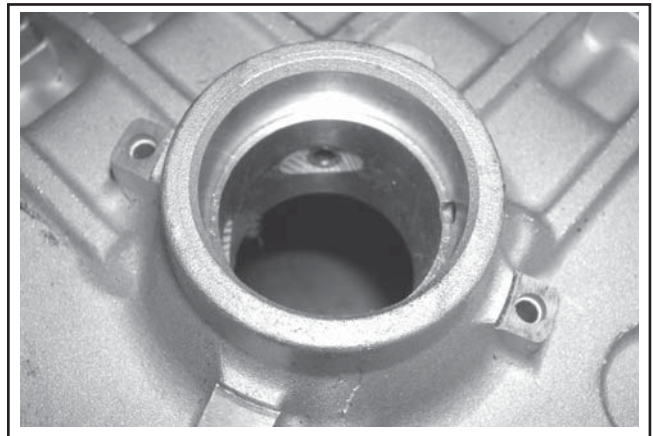
The following sequence is suggested for complete engine reassembly. This procedure assumes that all components are new or have been reconditioned, and all component subassembly work has been completed. The sequence may vary to accommodate options or special equipment. Detailed procedures follow.

1. Install flywheel end oil seal.
2. Install breather filter and inner cover.
3. Install governor cross shaft.
4. Install crankshaft.
5. Install connecting rods with pistons and rings.
6. Install valve tappets and camshaft.
7. Install oil seal in oil pan.
8. Install oil transfer tubes and filter adapter.
9. Install oil pan assembly.
10. Install breather reed and outer cover.
11. Install stator and backing plate.
12. Install flywheel and cooling fan.
13. Install grass screen.
14. Assemble and install cylinder heads.
15. Adjust valve clearance.
16. Install valve covers.
17. Install spark plugs.

18. Install ignition modules.
19. Install intake manifold.
20. Install rectifier-regulator.
21. Install inner and outer cylinder baffles.
22. Install carburetor and air cleaner.
23. Install external governor controls.
24. Install air cleaner element.
25. Install throttle and choke controls.
26. Install electric starter motor and oil fill tube.
27. Install blower housing.
28. Install fuel pump.
29. Install muffler.
30. Install oil filter and oil.
31. Connect spark plug leads.

### Install Flywheel End Oil Seal

1. Make sure that the seal bore of the crankcase is clean and free of any nicks or burrs. See Figure 10-1.



**Figure 10-1. Seal Bore of Crankcase.**

2. Apply a light coat of engine oil to the outside diameter of the oil seal.

## Section 10

### Reassembly

3. Install the oil seal into the crankcase using a seal driver. Make sure the oil seal is installed straight and true in the bore and the tool bottoms against the crankcase. See Figure 10-2.

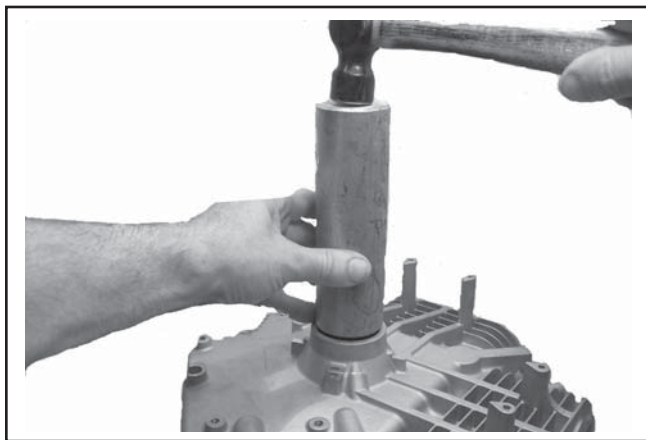


Figure 10-2. Installing Oil Seal in Crankcase.

#### Install Breather Filter and Inner Cover

1. Install the breather filter between the two ribs inside the inner breather chamber. See Figure 10-3.
2. Make sure the sealing surfaces are clean and free of nicks or damage. Install a new breather cover gasket and the breather cover onto the chamber. See Figure 10-3.

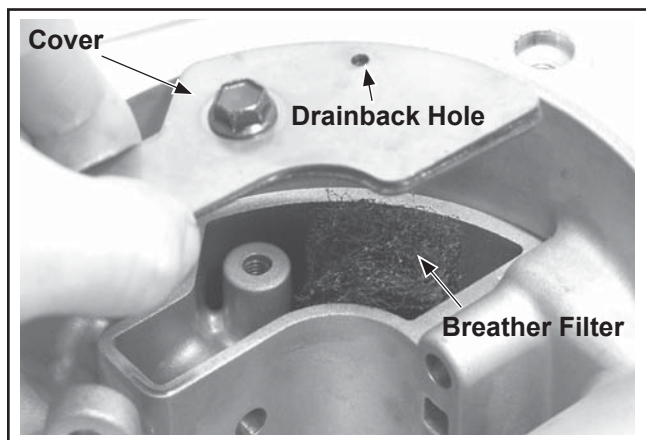


Figure 10-3. Installing Breather Filter and Cover.

3. Secure the breather cover with the M6 hex flange screw. Torque the screw to **10.7 N·m (95 in. lb.)** into a new, cored hole, or **7.3 N·m (65 in. lb.)** into a used hole. See Figures 10-3 and 10-4.

**NOTE:** Make sure the drainback hole in the gasket and cover is aligned and open after the cover is secured. Check using a piece of wire or similar tool.

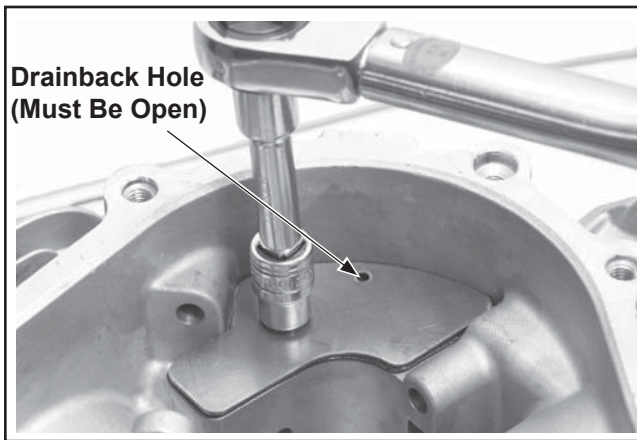


Figure 10-4. Torquing Breather Cover Screw.

#### Install Governor Cross Shaft

1. Lubricate the governor cross shaft bearing surfaces in the crankcase with engine oil.
2. Slide the lower washer onto the governor cross shaft and install the cross shaft from the inside of the crankcase. See Figure 10-5.

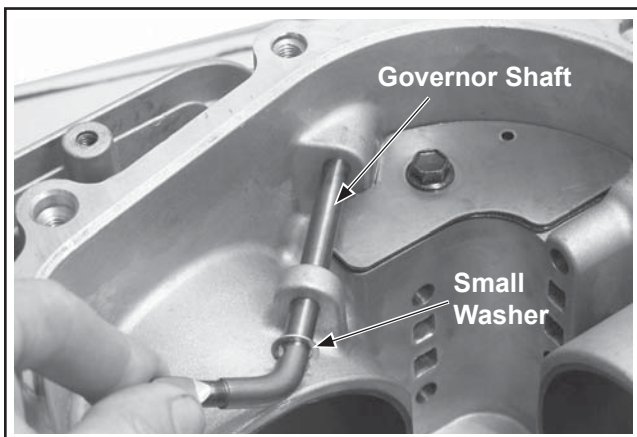
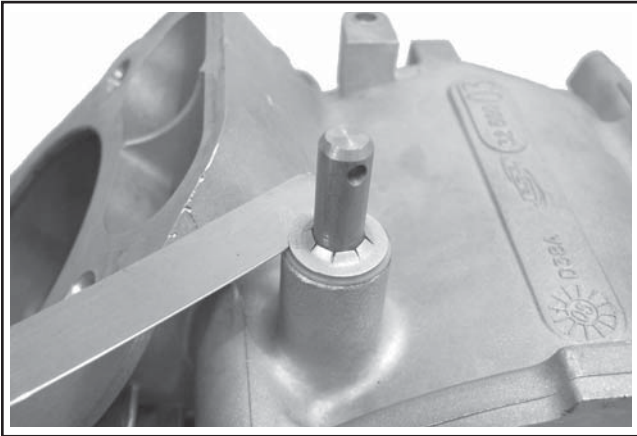


Figure 10-5. Installing Governor Shaft.

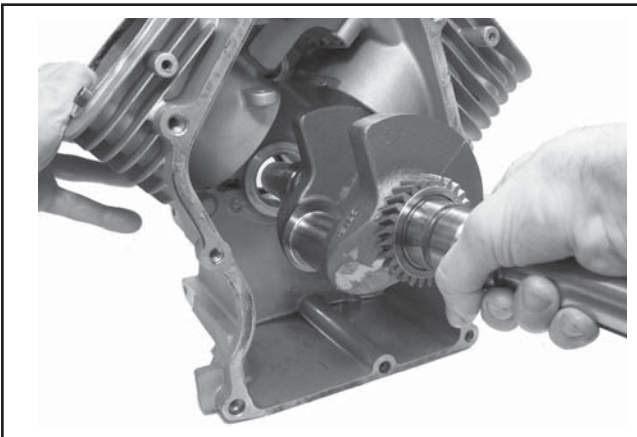
3. Install the nylon washer onto the governor cross shaft, then start the push-on retaining ring. Hold the cross shaft up in position, place a 0.50 mm (0.020 in.) feeler gauge on top of the nylon washer, and push the retaining ring down the shaft to secure. Remove the feeler gauge, which will have established the proper endplay. See Figure 10-6.



**Figure 10-6. Setting Governor Shaft Endplay.**

#### Install Crankshaft

1. Lubricate the flywheel side main bearing surface and the lips of the oil seal in the crankcase with clean engine oil.
2. Carefully slide the flywheel end of the crankshaft through the main bearing in the crankcase. See Figure 10-7.

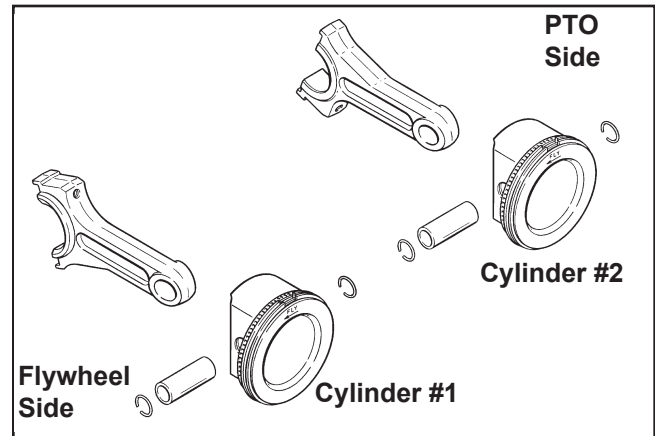


**Figure 10-7. Installing Crankshaft in Crankcase.**

#### Install Connecting Rods with Pistons and Rings

**NOTE:** The cylinders are numbered on the crankcase. Make sure to install the piston, connecting rod, and end cap into its appropriate cylinder bore as previously marked during disassembly. Do not mix the end caps and connecting rods.

**NOTE:** Proper orientation of the piston/connecting rod assemblies inside the engine is extremely important. Improper orientation can cause extensive wear or damage. Be certain the pistons and connecting rods are assembled exactly as shown in Figure 10-8.



**Figure 10-8. Proper Piston Connecting Rod Orientation.**

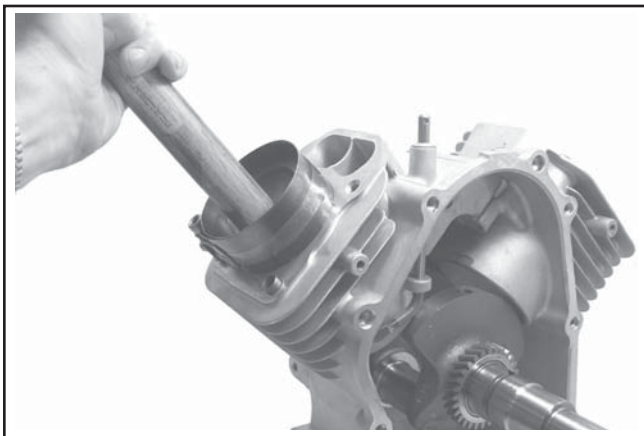
1. Stagger the piston rings in the grooves until the end gaps are 120° apart. The oil ring rails should also be staggered.
2. Lubricate the cylinder bore, piston, and piston rings with engine oil. Compress the rings using a piston ring compressor.
3. Lubricate the crankshaft journals and connecting rod bearing surfaces with engine oil.



## Section 10

### Reassembly

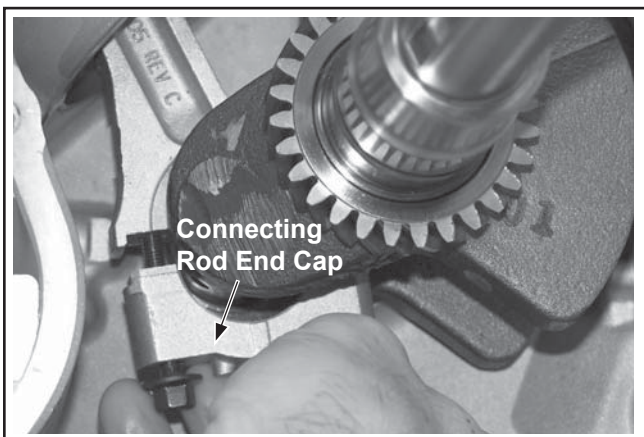
4. Make sure the **Fly** stamping on the piston is facing toward the flywheel side of the engine. Use a hammer with a rubber or wood grip and gently tap the piston into the cylinder as shown in Figure 10-9. Be careful that the oil ring rails do not spring free between the bottom of the ring compressor and the top of the cylinder.



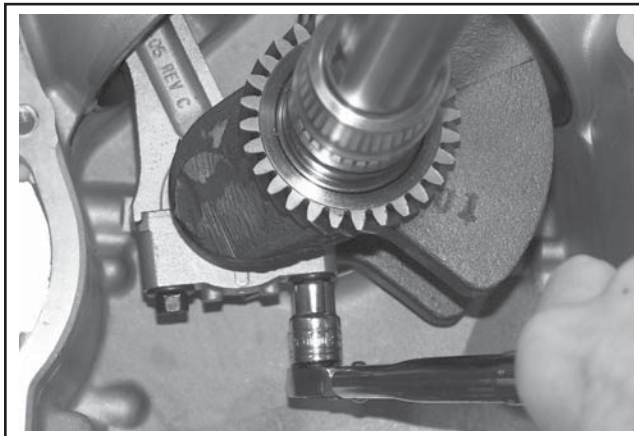
**Figure 10-9. Installing Piston Assembly Using Ring Compressor Tool.**

5. Install the inner rod cap to the connecting rod using the two hex flange screws. Torque the screws in increments to **11.3 N·m (100 in. lb.)**. Illustrated instructions are provided in the service rod package. See Figures 10-10 and 10-11.

**NOTE:** Align the chamfer of the connecting rod with the chamfer of its mating end cap. When installed, the flat faces of the connecting rods should face each other. The faces with the raised rib should be toward the outside.



**Figure 10-10. Installing Connecting Rod End Cap.**

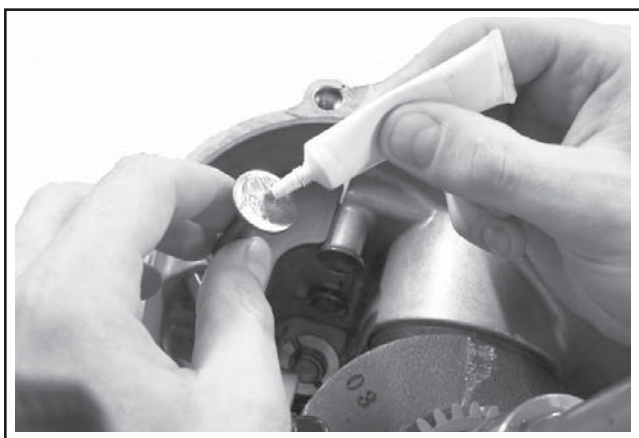


**Figure 10-11. Torquing Connecting Rod End Cap.**

6. Repeat the above procedure for the other connecting rod and piston assembly.

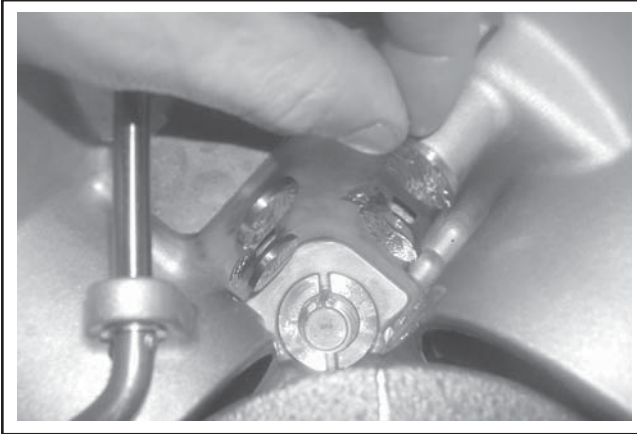
### Install Valve Tappets and Camshaft

1. Apply camshaft lubricant (Kohler Part No. 25 357 14-S) to the contact surface of the valve tappets. See Figure 10-12. Note the mark or tag identifying the tappets and install them in their appropriate crankcase locations. See Figure 10-13. A small amount of grease applied to the stems will hold the valve tappets up until the camshaft is installed.



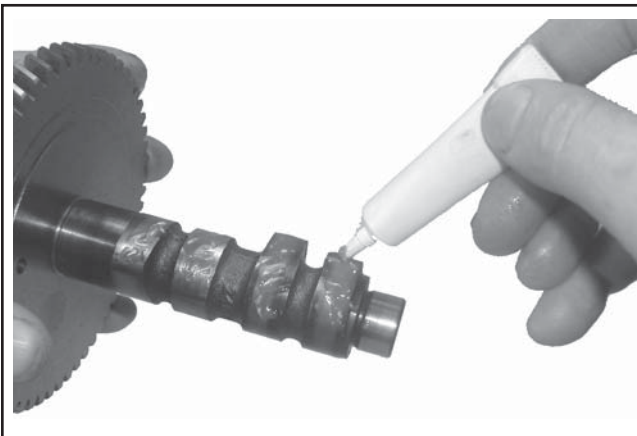
**Figure 10-12. Applying Camshaft Lubricant to Valve Tappets.**

**NOTE:** The exhaust valve tappets are located on the output shaft side of the engine, while the intake valve tappets are located on the fan side of the engine. The cylinder number is embossed on the outside of each cylinder on the crankcase. Valve tappets should always be installed in the same position as before disassembly.



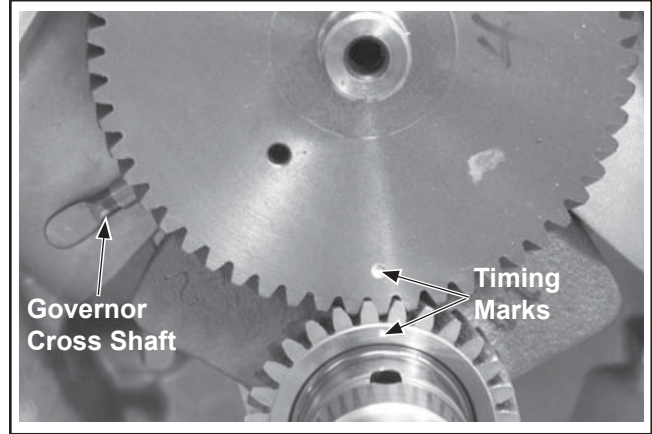
**Figure 10-13. Installing Valve Tappets.**

2. Liberally apply camshaft lubricant to the lobes of the camshaft. Lubricate the camshaft bearing surfaces of the crankcase and camshaft with engine oil. See Figure 10-14.



**Figure 10-14. Apply Camshaft Lubricant to Cam Lobes.**

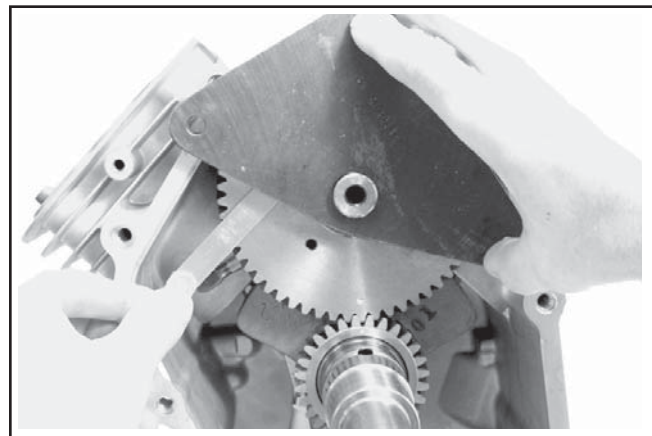
3. Position the timing mark of the crankshaft gear at the 12 o'clock position.
4. Turn the governor cross shaft clockwise until the lower end (blade) is laying against the bottom of the cylinder. Make sure the cross shaft remains in this position while installing the camshaft. See Figure 10-15.
5. Slide the camshaft into the bearing surface of the crankcase, positioning the timing mark of camshaft gear at the 6 o'clock position. Make sure the camshaft gear and crankshaft gear mesh with both timing marks aligned. See Figure 10-15.



**Figure 10-15. Aligning Crankshaft and Camshaft Timing Marks.**

### Determining Camshaft End Play

1. If a camshaft shim was used, install the shim removed during disassembly onto the camshaft.
2. Position the camshaft endplay checking tool on the camshaft. See Figure 10-16.



**Figure 10-16. Checking Camshaft End Play.**

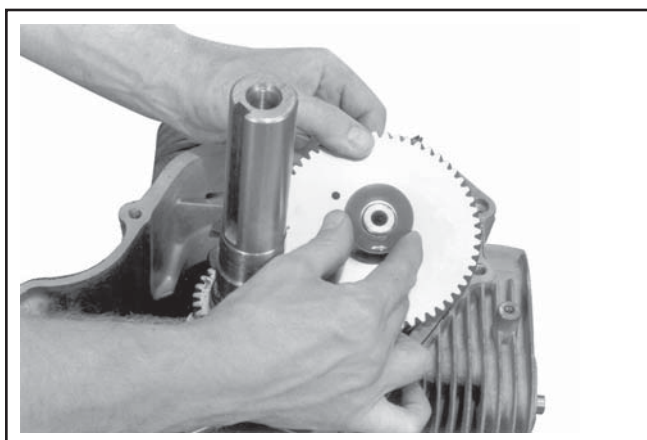
3. Apply pressure on the endplay tool (pushing camshaft toward crankshaft). Use a feeler gauge to measure the camshaft endplay between the shim (if used) and the endplay tool. Camshaft endplay should be 0.076/0.127 mm (0.003/0.005 in.).

## Section 10

### Reassembly

4. If the camshaft endplay is not within the specified range, remove the endplay tool and shim accordingly. See Figure 10-17. Shims are color-coded by thickness and listed below.

<b>White:</b>	0.69215/0.73025 mm (0.02725/0.02875 in.)
<b>Blue:</b>	0.74295/0.78105 mm (0.02925/0.03075 in.)
<b>Red:</b>	0.79375/0.83185 mm (0.03125/0.03275 in.)
<b>Yellow:</b>	0.84455/0.88265 mm (0.03325/0.03475 in.)
<b>Green:</b>	0.89535/0.99345 mm (0.03525/0.03675 in.)
<b>Gray:</b>	0.94615/0.98425 mm (0.03725/0.03875 in.)
<b>Black:</b>	0.99695/1.03505 mm (0.03925/0.04075 in.)



**Figure 10-17. Change Shim to Obtain Correct End Play.**

5. Reinstall the endplay tool and recheck the end play.

### Oil Pump Assembly

The oil pump is mounted inside the oil pan. If service was required, and the oil pump was removed, refer to the assembly procedures in **Section 9, Inspection and Reconditioning**.

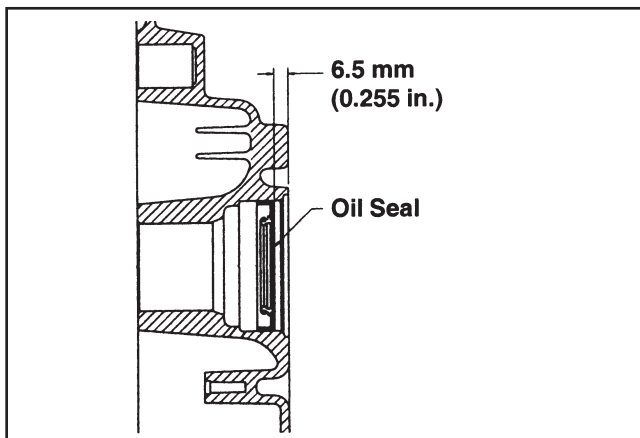
### Governor Assembly

The governor assembly is located inside the oil pan. If service was required, and the governor was removed, refer to the assembly procedures in **Section 9, Inspection and Reconditioning**.

### Install Oil Seal in Oil Pan

1. Check to make sure that there are no nicks or burrs in the crankshaft bore of the oil pan.
2. Apply a light coat of engine oil to the outside diameter of the oil seal.

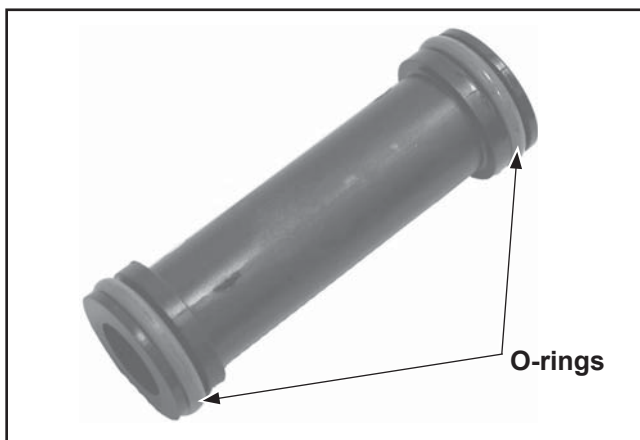
3. Drive the oil seal into the oil pan using a seal driver. Make sure the oil seal is installed straight and true in the bore, to the depth shown in Figures 10-18.



**Figure 10-18. Oil Seal Depth in Oil Pan.**

### Install Oil Transfer Tubes and Filter Adapter

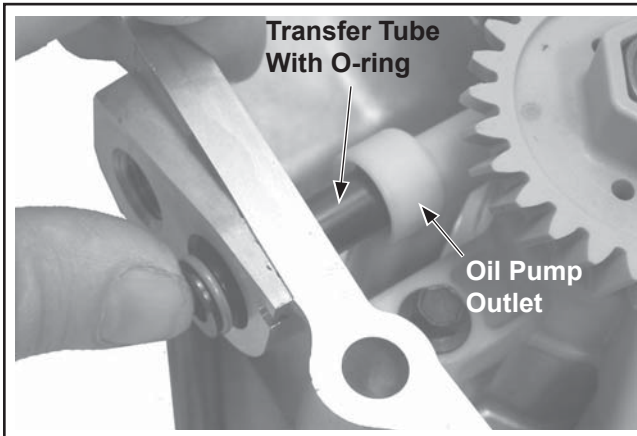
1. Lubricate new O-rings with clean oil and install into the groove on the ends of the oil pump transfer tube. See Figure 10-19.



**Figure 10-19. Oil Pump Transfer Tube Details.**

2. Install the transfer tube with the O-rings. Push in until seated into the outlet of oil pump. Make sure the inner O-ring is not unseated or damaged when installing. See Figure 10-20.





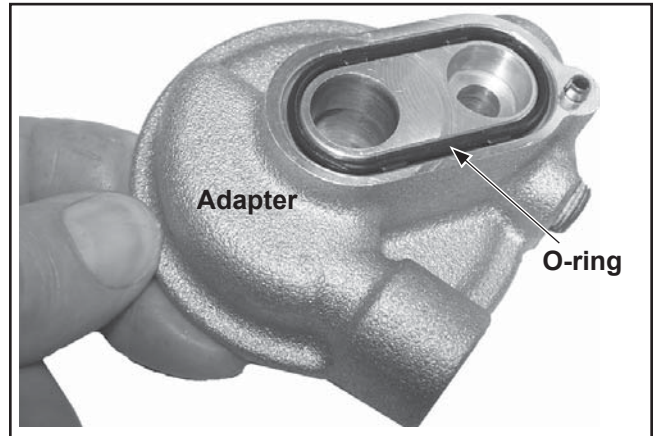
**Figure 10-20. Installing Oil Pump Outlet Tube.**

- Slide the oil feed tube through the oil pan and into the hole for the main bearing. See Figure 10-21. A small amount of grease applied to the outside, forward end of the tube will hold the tube in position until the adapter is installed.



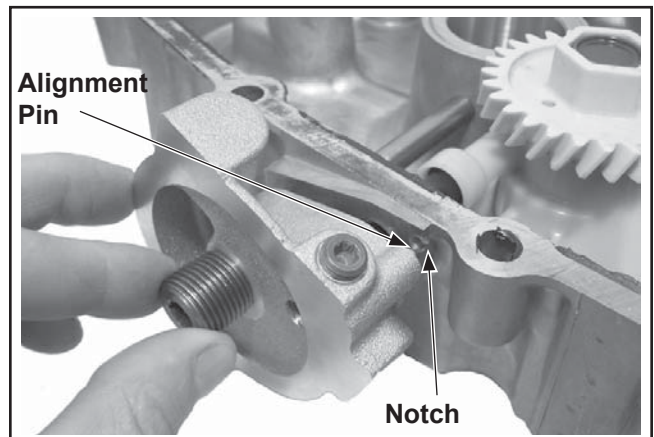
**Figure 10-21. Installing Oil Feed Tube.**

- Apply a small amount of grease and install a new O-ring into the groove of the adapter for oil filter or oil cooler. See Figure 10-22.

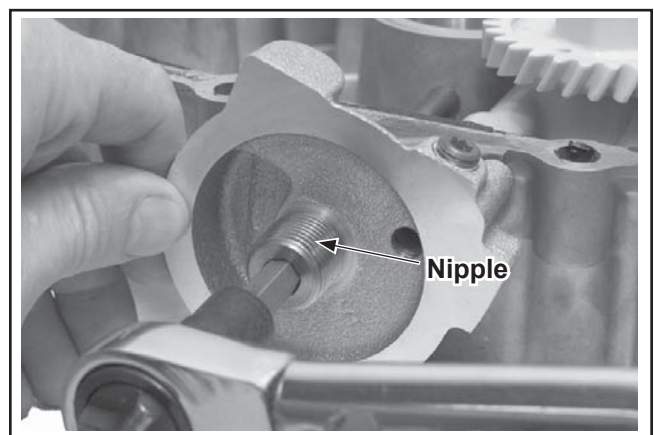


**Figure 10-22. Oil Filter Adapter and O-ring.**

- Position the adapter, aligning the locating pin with the corresponding recess in oil pan. Install the flat washer (plastic adapters only) onto the adapter nipple, then insert through the adapter, surrounding the oil feed tube and finger tighten. See Figures 10-23 and 10-24. Tighten the nipple and torque to 33.9 N·m (300 in. lb.). Do not overtighten.



**Figure 10-23. Installing Nipple and Adapter.**



**Figure 10-24. Torquing Nipple.**

## Section 10

### Reassembly

#### Install Oil Pan Assembly

RTV sealant is used as a gasket between the oil pan and the crankcase. Refer to **Section 2, Special Tools** for a listing of approved sealants. Always use fresh sealant. Using outdated sealant can result in leakage.

1. Be sure the sealing surfaces have been cleaned and prepared as described at the beginning of **Section 10**.
2. Check to make sure that there are no nicks or burrs on the sealing surfaces of the oil pan or crankcase.
3. Apply a 1.5 mm (1/16 in.) bead of Black RTV sealant to the sealing surface of the oil pan. See Figure 10-25 for the sealant pattern. Oil pan must be installed within five minutes of the sealant being applied for proper sealing to occur.

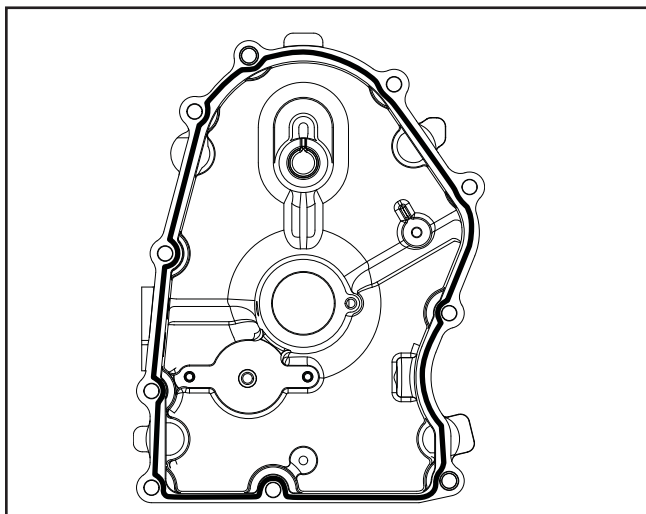


Figure 10-25. Oil Pan Sealant Pattern.

4. Make sure the end of the governor cross shaft is lying against the bottom of cylinder inside the crankcase. See Figure 10-15.
5. Install the oil pan to the crankcase. Carefully seat the camshaft with shim and crankshaft into their mating bearings. Rotate the crankshaft to help engage the oil pump and governor gear meshes.
6. Install the ten hex flange screws securing the oil pan to the crankcase. Torque the fasteners in the sequence shown in Figure 10-26 to **24.4 N·m (216 in. lb.)**. On some engines one of the ten mounting screws is plated. The plated screw is typically installed in the #6 hole shown in Figure 10-26.

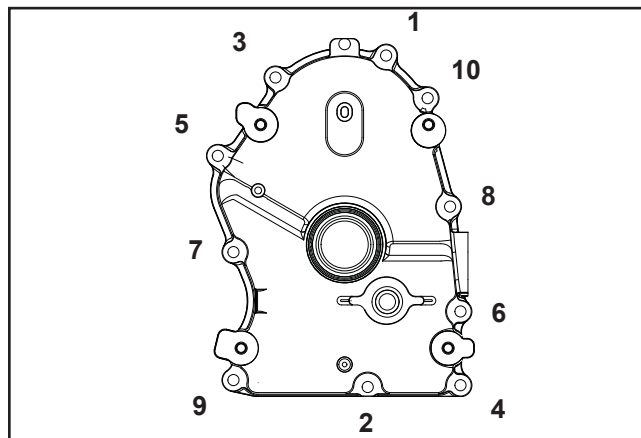


Figure 10-26. Oil Pan Fastener Torque Sequence.

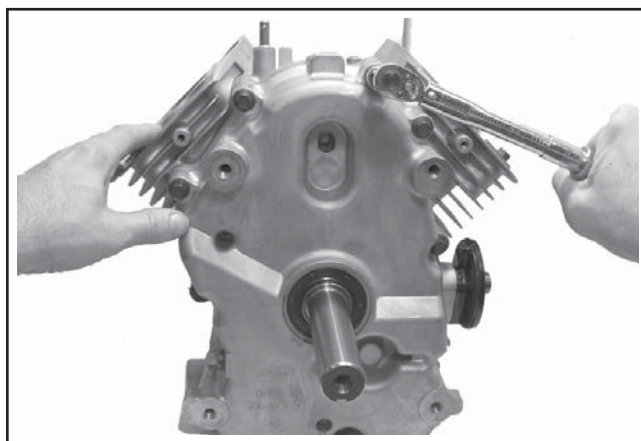


Figure 10-27. Torquing Oil Pan Fasteners.

#### Install Breather Reed and Outer Cover

1. Install the breather reed, followed by the retainer over the passage hole and mounting hole in the crankcase. Hold in position and secure with the mounting stud. Torque the stud to **6.2 N·m (55 in. lb.)** into a new, cored hole, or **4.0 N·m (35 in. lb.)** into a used hole. See Figure 10-28.

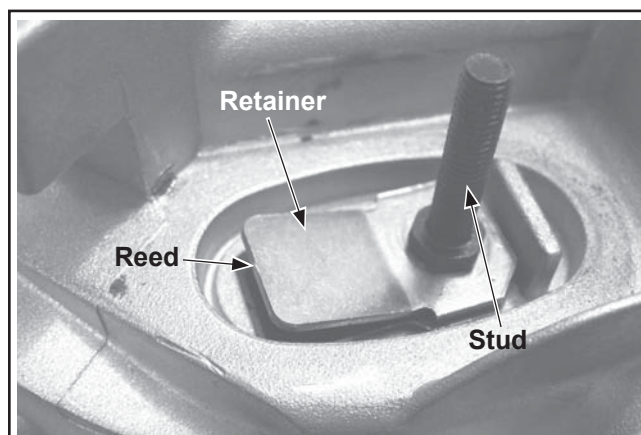


Figure 10-28. Installing Breather Reed and Retainer.



2. Invert the breather housing (cover) and apply a 1.5 mm (1/16 in.) bead of RTV sealant to the perimeter flange of the outer housing (cover) as shown in Figure 10-29. Use Loctite® 5900 or 5910, Kohler Part No. 25 597 07-S.

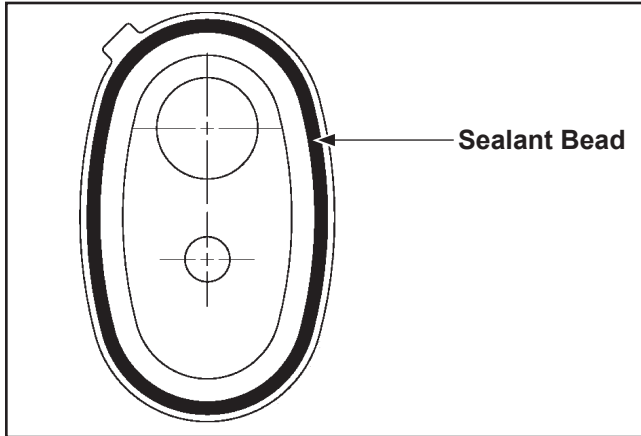


Figure 10-29. Sealant Applied to Breather Cover.

3. Immediately install the housing over the mounting stud and onto crankcase. Do not allow the RTV sealant to come in contact with the breather reed, or the reed sealing surface.
4. Secure with a new sealing washer and the M5 hex nut. Torque the hex nut to **1.3 N·m (12 in. lb.)**. Check that a complete seal has occurred by the RTV sealant being squeezed out around the entire flange perimeter. See Figure 10-30.

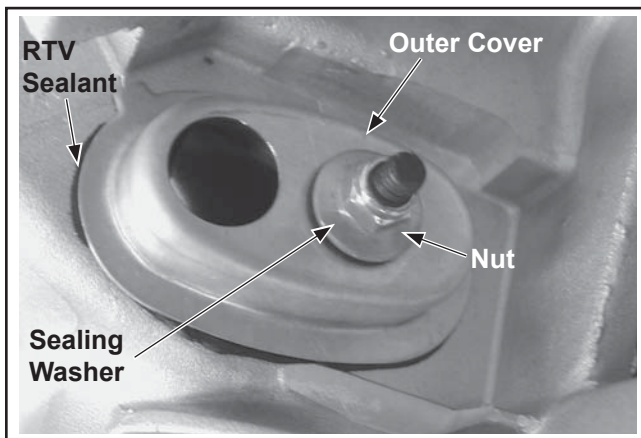


Figure 10-30. Installed Breather Cover and RTV Details.

5. Attach the breather hose to the housing if disconnected earlier. Make sure the cover is between the formed lips of the breather hose. Position the hose so the opposite end is away from the crankshaft. See Figure 10-31.

NOTE: The RTV sealant should be allowed to cure a minimum of one hour before the engine is started.

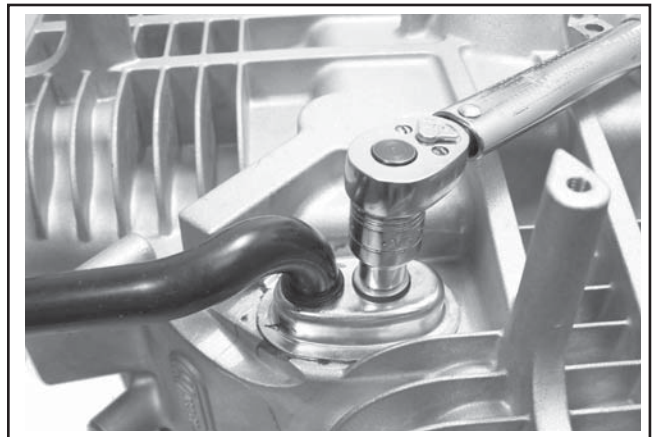


Figure 10-31. Breather Cover and Breather Hose Installation.

### Install Stator and Backing Plate

1. Apply pipe sealant with Teflon® (Loctite® No. 59241 or equivalent) to the stator mounting holes.
2. Position the stator aligning the mounting holes so that the leads are at the bottom, toward the crankcase.
3. Install and torque the two hex flange screws to **6.2 N·m (55 in. lb.)**. See Figure 10-32.

10

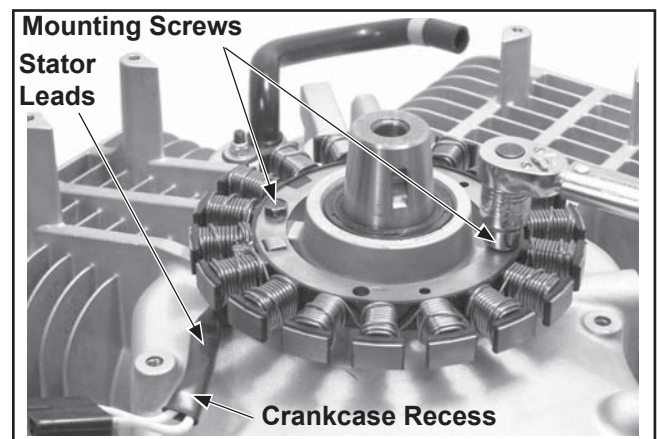


Figure 10-32. Installing Stator.

## Section 10

### Reassembly

4. Route the stator leads in the crankcase recess, then install the backing plate. Secure with the four hex flange screws. See Figures 10-32 and 10-33. Torque the screws in the indicated sequence to 7.3 N·m (65 in. lb.).

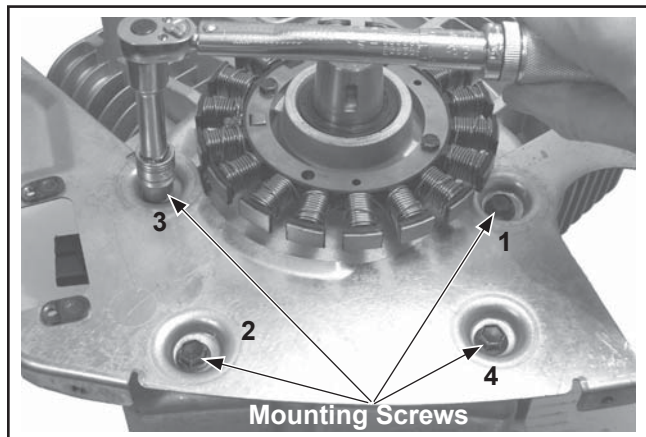


Figure 10-33. Installing Backing Plate.

### Install Flywheel and Fan

**⚠ WARNING: Damaging Crankshaft and Flywheel Can Cause Personal Injury!**

*Using improper procedures to install the flywheel can crack or damage the crankshaft and/or flywheel. This not only causes extensive engine damage, but can also cause personal injury, since broken fragments could be thrown from the engine. Always observe and use the following precautions and procedures when installing the flywheel.*

**NOTE:** Before installing the flywheel, make sure the crankshaft taper and flywheel hub are clean, dry, and completely free of lubricants. The presence of lubricants can cause the flywheel to be overstressed and damaged when the flange screw is torqued to specifications.

1. Install the woodruff key into the keyway of the crankshaft. Make sure that the key is properly seated and parallel with the shaft taper. See Figure 10-34.

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

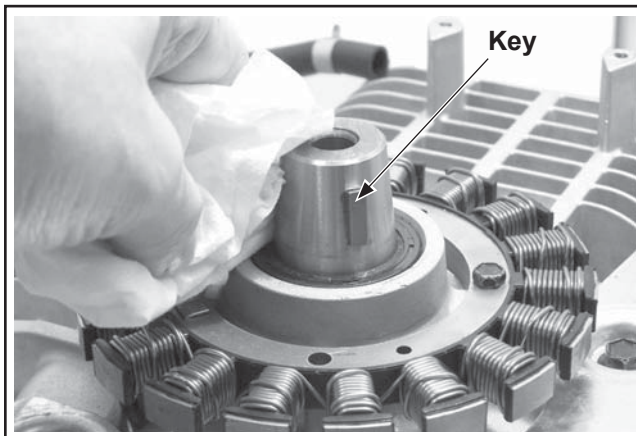


Figure 10-34. Clean and Dry Taper of Crankshaft, Install Key.

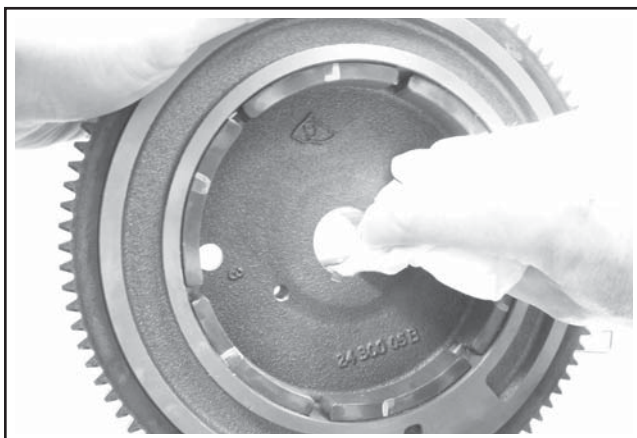


Figure 10-35. Clean and Dry Flywheel Hub.

2. Install the flywheel onto the crankshaft being careful not to shift the woodruff key. See Figure 10-36.

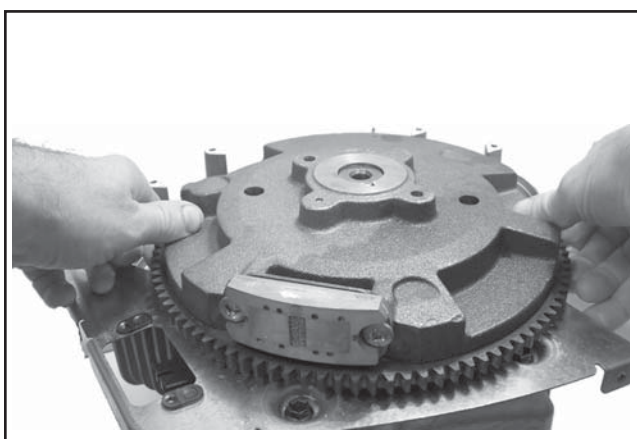
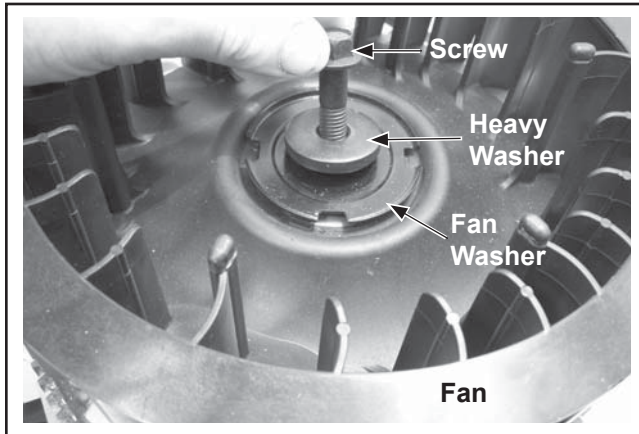


Figure 10-36. Installing Flywheel.

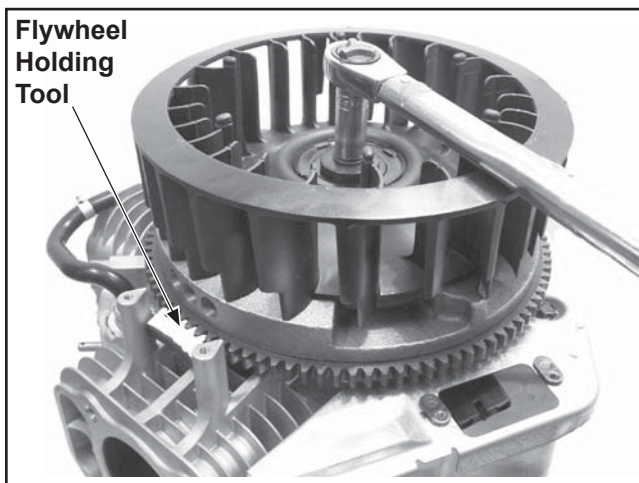


3. Install the fan onto the flywheel, so the locating pins fit into the corresponding recesses.
4. Install the fan mounting plate onto the fan, aligning the four cutouts, followed by the heavy flat washer and hex flange screw. See Figure 10-37.



**Figure 10-37. Installing Fan and Mounting Hardware to Flywheel.**

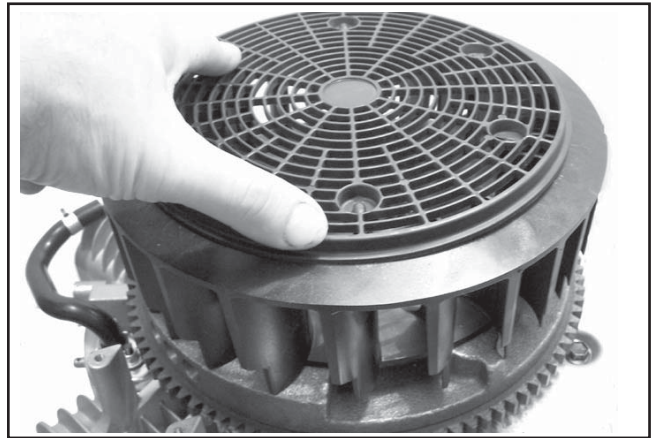
5. Use a flywheel strap wrench or holding tool to hold the flywheel. Torque the hex flange screw securing the flywheel to the crankshaft to 74.5 N·m (55.0 ft. lb.). See Figure 10-38.



**Figure 10-38. Torquing Flywheel Fastener.**

### Install Grass Screen

1. Snap the screen onto the fan. See Figure 10-39.

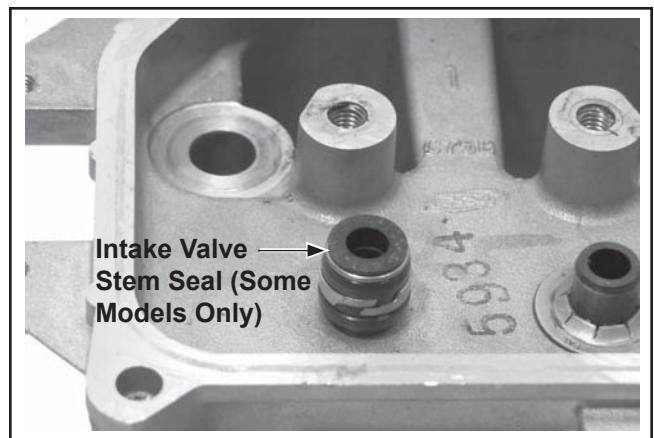


**Figure 10-39. Installing Grass Screen.**

### Assemble and Install Cylinder Heads

#### Valve Stem Seals

Some engines use a valve stem seal on the intake valves. If the engine being serviced used a valve stem seal, use a new seal whenever the valve is removed, or if the seal is deteriorated or damaged. Never reuse an old seal.



**Figure 10-40. Intake Valve Seal Location.**

## Section 10

### Reassembly

Prior to installation, lubricate all components with engine oil, paying particular attention to the lip of the valve stem seal, valve stems, and valve guides. Install the following items in the order listed below using a valve spring compressor. See Figures 10-41 and 10-42.

- Intake and exhaust valves
- Valve spring caps
- Valve springs
- Valve spring retainers
- Valve spring keepers

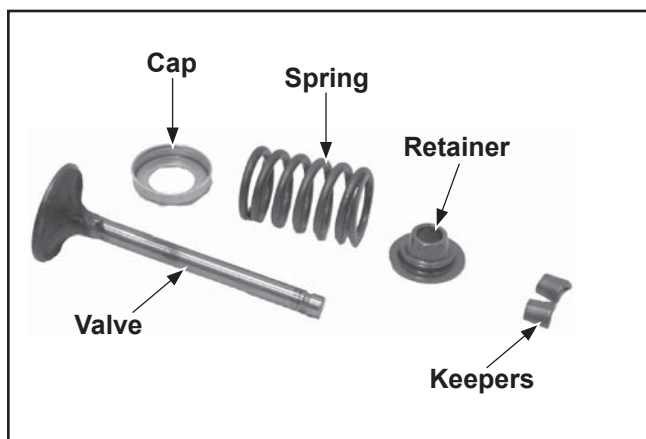


Figure 10-41. Valve Components.

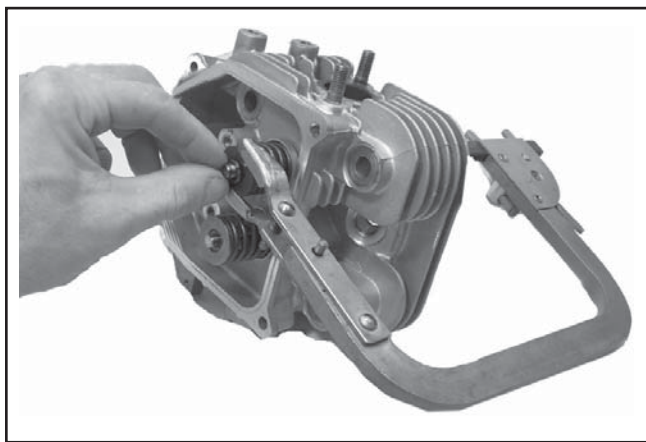


Figure 10-42. Installing Valves with Valve Spring Compressor.

1. Check to make sure there are no nicks or burrs on the sealing surfaces of the cylinder head or crankcase. Make sure that dowel locating pins are in the lower two cylinder bolt holes on each side.
2. Install a new cylinder head gasket (with printing up) on each side. See Figure 10-43.

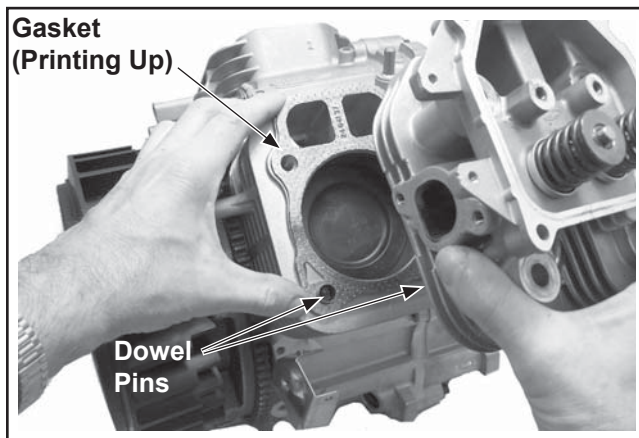


Figure 10-43. Installing Cylinder Head Gasket and Cylinder Head.

NOTE: Match the numbers embossed on the cylinder heads and crankcase. See Figure 10-44.

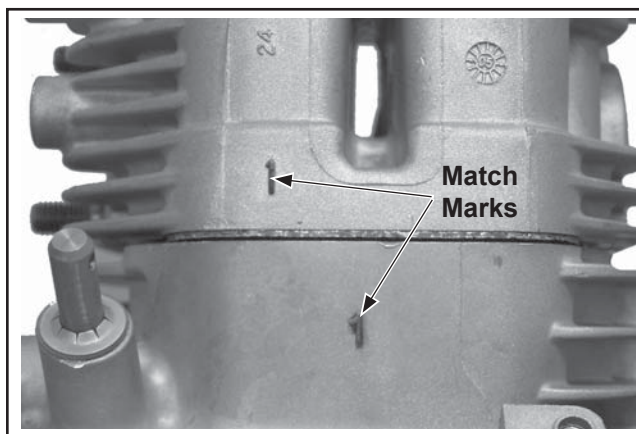
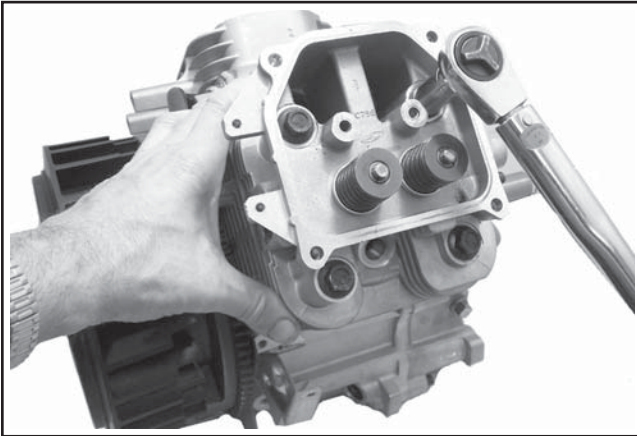


Figure 10-44. Match Marks Location.

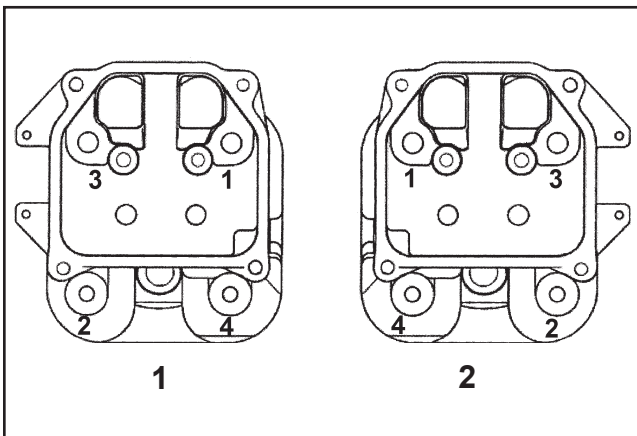
3. Install each cylinder head and start the four **new** hex flange screws.

NOTE: When installing cylinder heads, **new** hex flange screws should always be used. New screws are supplied in the gasket sets.



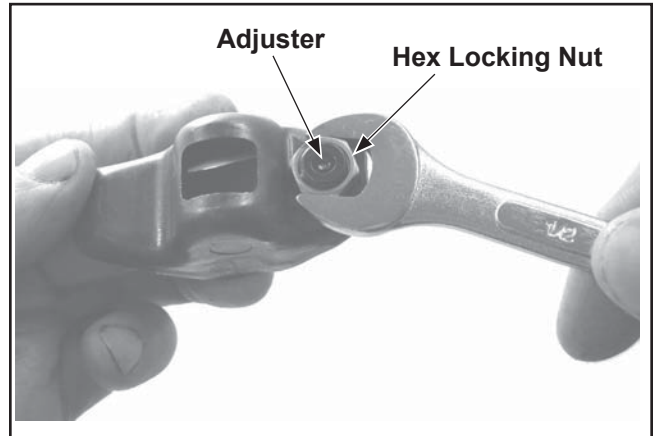
**Figure 10-45. Torquing Cylinder Head Fasteners.**

4. Torque the hex flange screws in two stages; first to **22.6 N·m (200 in. lb.)**, then finally to **41.8 N·m (370 in. lb.)**, following the sequence in Figure 10-46.



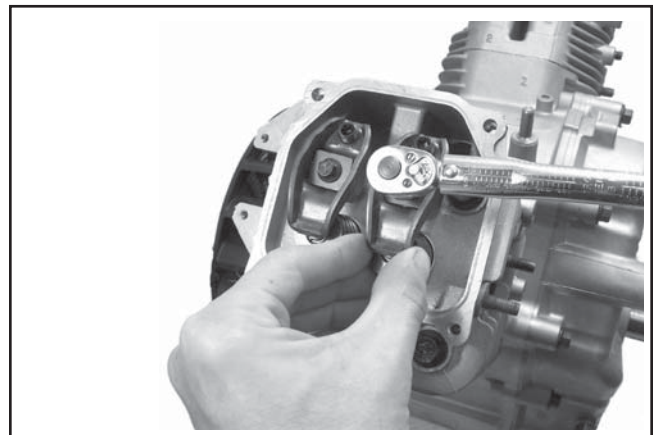
**Figure 10-46. Cylinder Head Fastener Torque Sequence.**

1. Loosen the hex locking nut and back off the adjusters for the rocker arms. If the adjusters for the rocker arms were removed, reinstall them into the threaded end of arm approximately three threads and screw the hex locking nut onto the adjuster from the underside. Screw adjuster flush with the bottom of the nut as an initial setting. Do not tighten the locking nut at this time, final adjustment will be made later. See Figure 10-47.



**Figure 10-47. Loosing Nut and Backing Off Adjuster.**

2. Apply grease to the contact surfaces of the adjusters, rocker arms and rocker arm pivots. Install the rocker arms and rocker arm pivots onto the appropriate cylinder head, and start the two hex flange screws.
3. Hold the rocker arms in aligned position and torque the hex flange screws to **11.3 N·m (100 in. lb.)**. See Figure 10-48.



**Figure 10-48. Torquing Rocker Arm Screws.**



## Section 10

### Reassembly

- Note the mark or tag identifying the push rod as either intake or exhaust and cylinder #1 or #2. Check that each push rod is straight and not bent. Dip the ends of the push rods in engine oil and install in their original positions, making sure that each push rod ball seats in its tappet socket. See Figure 10-49.

NOTE: Push rods should always be installed in the same position as before disassembly.

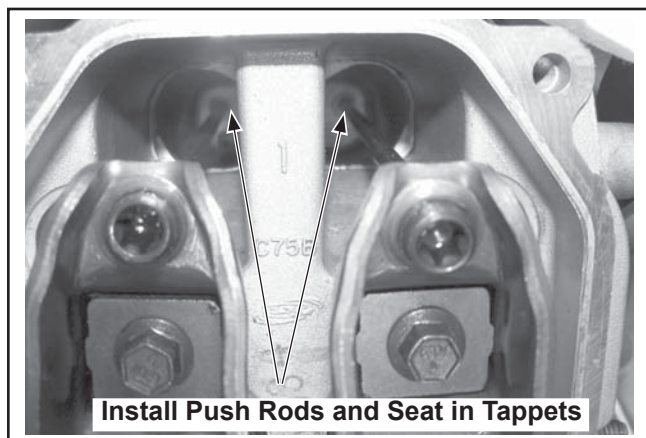


Figure 10-49. Installed Push Rods.

### Adjust Valve Clearance

- Turn the adjusters in the rocker arms or pivots down (clockwise) only enough to capture the push rods in the recesses. See Figures 10-50.

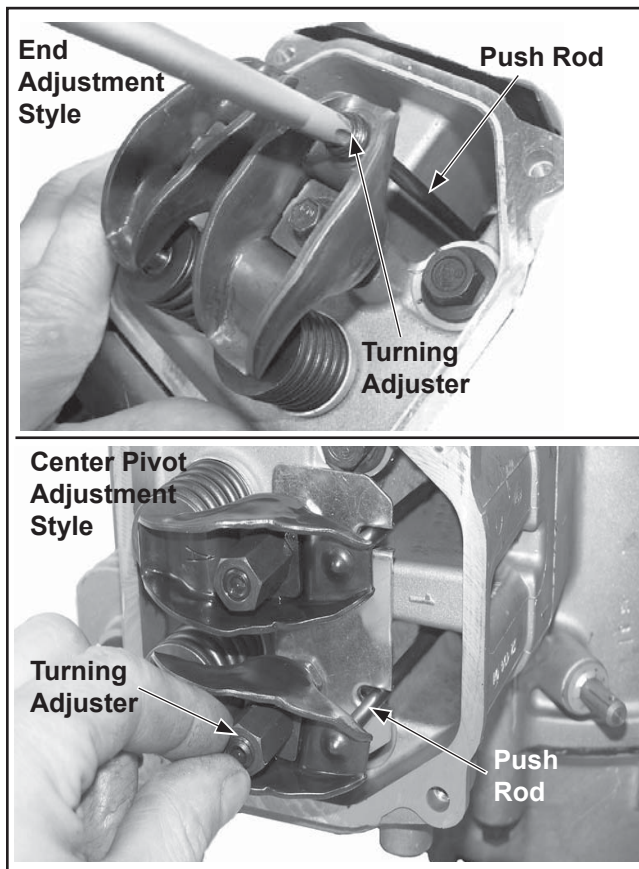


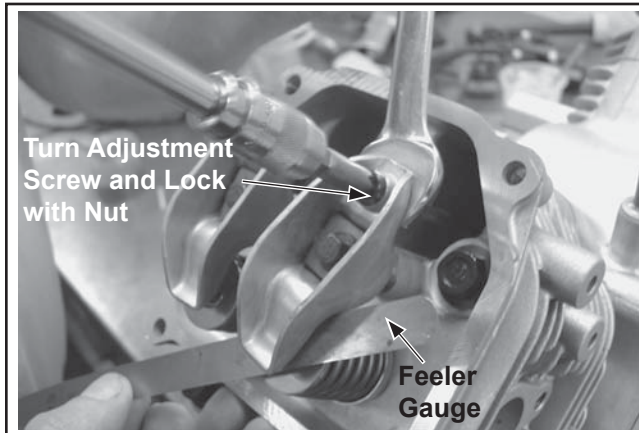
Figure 10-50. Turning Adjusters In to Retain Push Rods.

- Rotate the crankshaft to establish Top Dead Center (TDC) on the **Compression Stroke** for the #1 cylinder.

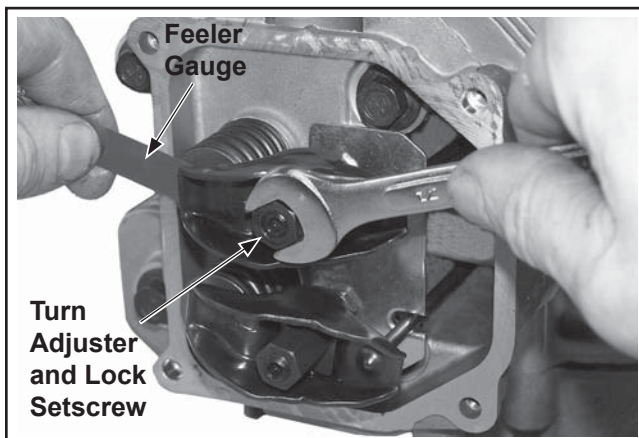
Check for:

- Compression will be felt through the spark plug hole.
  - Keyway of crankshaft will be aligned with #1 cylinder.
  - No rocker arm/push rod movement if crankshaft is rotated slightly back and forth. If they are moving, rotate the crankshaft one full revolution.
- Insert a **0.127 mm (0.005 in.)** feeler gauge between the end of one valve and the rocker arm. Turn the adjuster or adjustment nut (based on design), until a slight drag is felt. Hold in this position and tighten the locking nut or setscrew securely. Torque setscrew to **7.9 N·m (70 in. lb.)**. After tightening recheck adjustment. Proper valve clearance is **0.101/0.152 mm (0.004/0.006 in.)**.

See Figures 10-51 and 10-52.



**Figure 10-51. Adjusting Valve Clearance and Tightening Locking Nut (End Adjustment Style).**



**Figure 10-52. Adjusting Valve Clearance (Center Pivot Adjustment Style).**

4. Repeat the procedure for the other valve on the #1 side.
5. Viewed from the PTO end, rotate the crankshaft 270° (3/4 turn) **counterclockwise** and align the crankshaft keyway with the #2 cylinder, which now puts that cylinder at TDC on the compression stroke.
6. Repeat Steps 3-4 for setting the valve clearance on the #2 side.
7. Rotate the crankshaft to check for free operation of the valve train. Check for clearance between the valve spring coils at full lift, or bending of push rod(s) can occur. Minimum allowable clearance is **0.25 mm (0.010 in.)**.

### Check Assembly

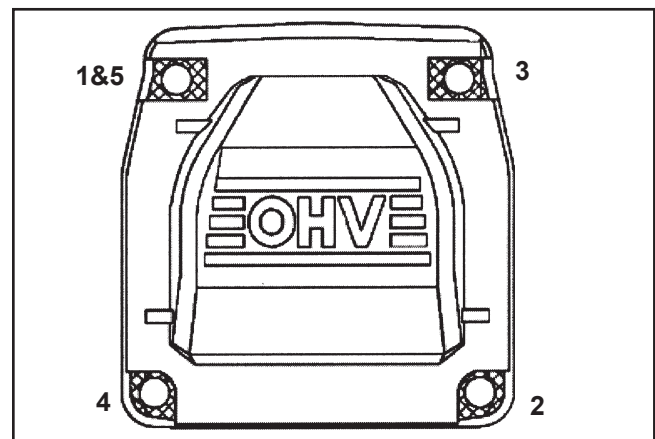
**Important:** Rotate the crankshaft a minimum of two revolutions to check longblock assembly and overall proper operation.

### Install Valve Covers

The plastic valve covers contain integral bolt hole spacers molded in place. Sealing of plastic valve covers is accomplished using a yellow colored O-ring. In stamped steel valve covers sealing is accomplished using RTV sealant.

#### Plastic Valve Covers with O-rings

1. Make sure the sealing surfaces of valve covers and cylinder heads are clean and free of any nicks or burrs.
2. Install a new O-ring in the groove of each cover. **Do Not** use gaskets or RTV sealant.
3. Position the covers on the cylinder heads. If a pulse style fuel pump is used the valve cover with the pulse fitting hole must be installed on the #2 side. Install the four hex flange screws in each cover and finger tighten.
4. Torque the valve cover fasteners to **6.2 N·m (55 in. lb.)**, using the sequence shown in Figure 10-53.



**Figure 10-53. Plastic Valve Cover Fastener Torque Sequence.**

## Section 10

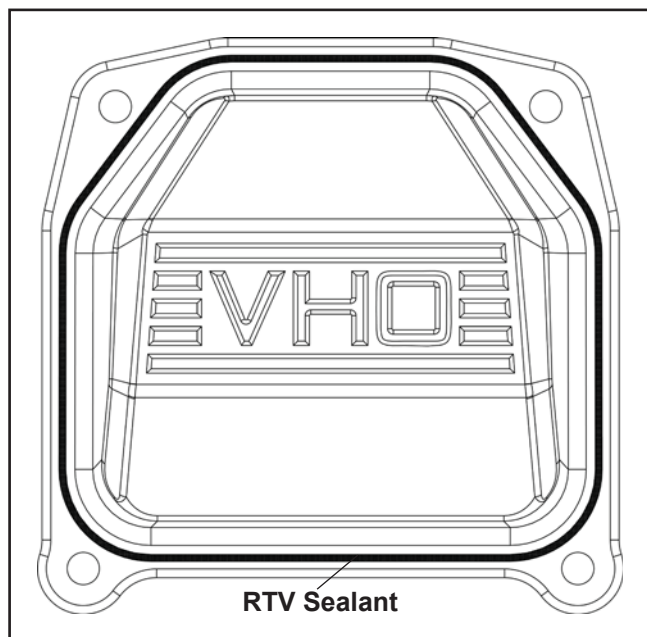
### Reassembly

#### Stamped Steel Valve Covers with RTV Sealant

RTV silicone sealant is used as a gasket between the valve cover and cylinder head. Refer to page 2.3 for a listing of approved sealants.

**NOTE:** Always use fresh sealant. Using outdated sealant can result in leakage. Refer to **Section 2 Tools & Aids** for information on the sealant dispenser.

1. Prepare the sealing surfaces of the cylinder heads and valve covers following Service Bulletin 252 (or refer to page 9.1). The flatness of the sealing surface must be checked prior to reinstallation. See **Section 9**.
2. Apply a 1.5 mm (1/16 in.) bead of sealant to the valve cover as shown in Figure 10-54.

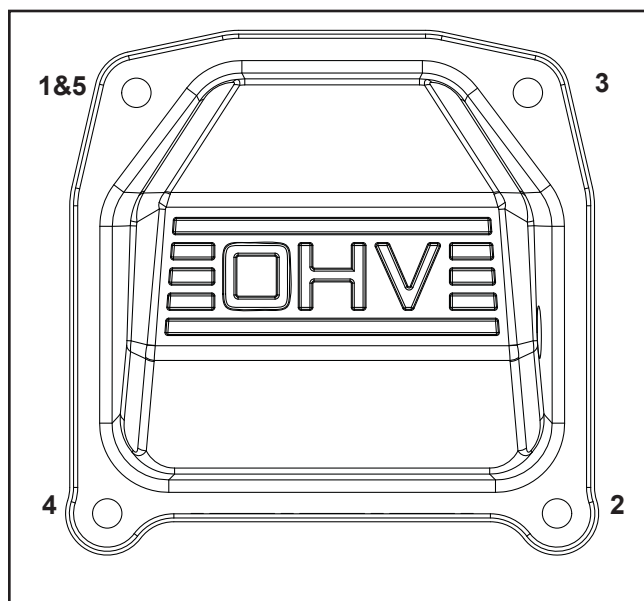


**Figure 10-54. Apply RTV to Valve Covers.**

**NOTE:** To ensure proper adhesion of the sealant to both sealing surfaces, perform Step 3 immediately (5 minutes maximum) after application of RTV.

3. Position the covers on the cylinder heads. If a pulse style fuel pump is used the valve cover with the pulse fitting hole must be installed on the #2 side. Install the four hex flange screws in each cover and finger tighten.

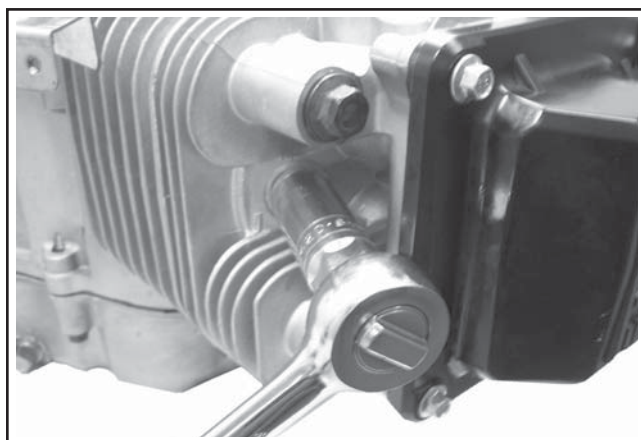
4. Torque the valve cover fasteners to **6.2 N·m (55 in. lb.)**, using the sequence shown in Figure 10-55.



**Figure 10-55. Stamped Steel Valve Cover Fastener Torque Sequence.**

#### Install Spark Plugs

1. Use new Champion® (or equivalent) spark plugs.
2. Set the gap at 0.76 mm (0.030 in.).
3. Install new plugs and torque to **24.4/29.8 N·m (18/22 ft. lb.)**. See Figure 10-56.



**Figure 10-56. Installing Spark Plugs.**

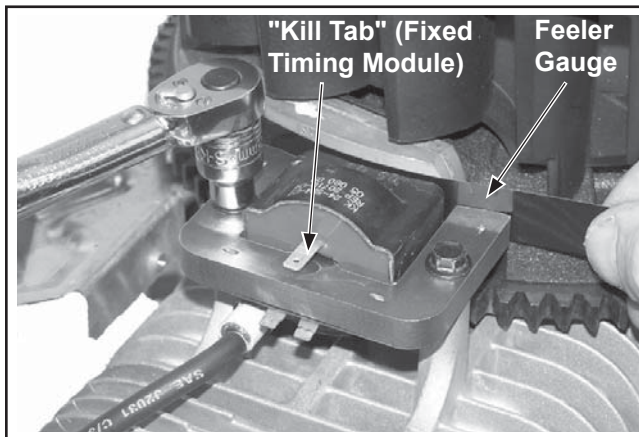


### Install Ignition Modules

1. Rotate the flywheel to position the magnet away from the ignition module bosses.
2. On engines equipped with a DSAI or DSAM Ignition system, both modules are installed the same way – with the tabs out. See Figure 10-62.

On engines equipped with a Fixed Ignition System, the modules are installed with the spark plug lead from the module always away from the cylinder. On #1 cylinder, the single kill tab should be up/towards you. See Figure 10-57. On the #2 cylinder, the single kill tab should be down/away from you.

3. Install each ignition module to the crankcase bosses with the two screws. Slide the modules up as far away from the flywheel as possible and snug the screws to hold them in that position.
4. Rotate the flywheel to position the magnet directly under one ignition module.
5. Insert a 0.30 mm (0.012 in.) flat feeler gauge between the magnet and the ignition module (see Figure 10-57). Loosen the screws enough to allow the magnet to pull the module against the feeler gauge.



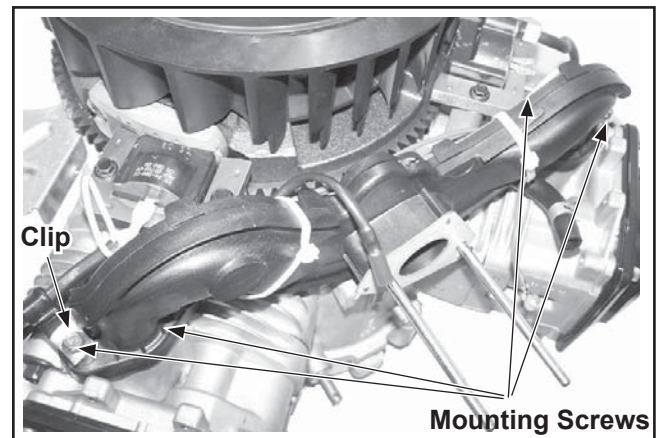
**Figure 10-57. Setting Ignition Module Gap.**

6. Torque the screws to 4.0-6.2 N·m (35-55 in. lb.).
7. Repeat Steps 4 through 6 for the other ignition module.

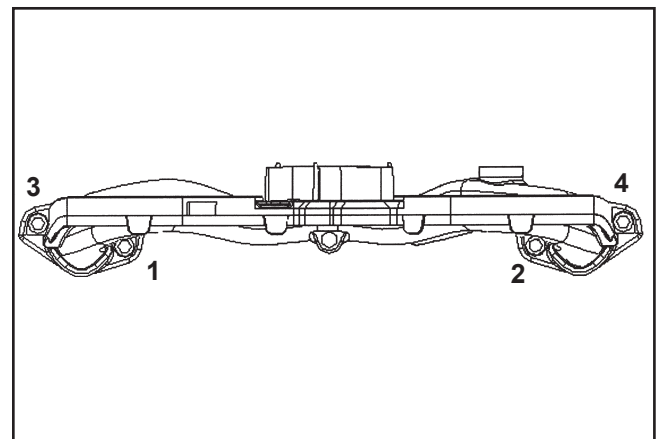
8. Rotate the flywheel back and forth checking for clearance between the magnet and ignition modules. Make sure the magnet does not strike the modules. Check the gap with a feeler gauge and readjust if necessary. Final air gap: 0.280/0.330 mm (0.011/0.013 in.).

### Install Intake Manifold

1. Install the intake manifold using new O-rings, with the wiring harness attached, onto the cylinder heads. Slide any wiring harness clips onto the appropriate bolts before installing. See Figure 10-58. The ground lead for the fuel solenoid (equipped models) should be attached to the inner screw on the #2 side. Using the sequence shown in Figure 10-59, torque the four screws in two stages, first to 7.4 N·m (66 in. lb.), then to 9.9 N·m (88 in. lb.).



**Figure 10-58. Installing Intake Manifold with Wiring Harness.**



**Figure 10-59. Intake Manifold Torque Sequence.**

## Section 10

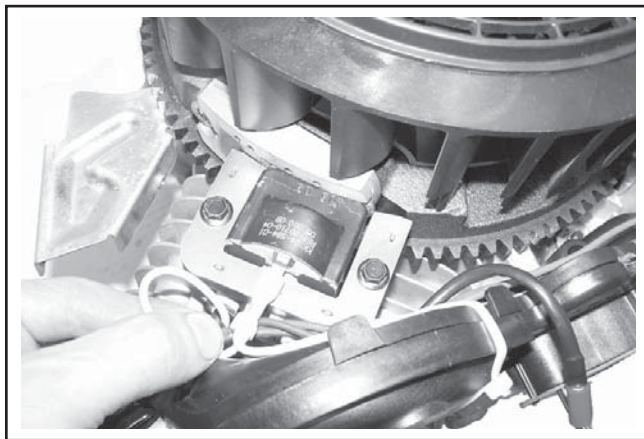
### Reassembly

**NOTE:** If the wires were disconnected from the ignition modules on engines with DSAM, reattach the leads and seal the base of the terminal connectors with GE/Novaguard G661 (Kohler Part No. 25 357 11-S) or Fel-Pro Lubri-Sel dielectric compound. The beads should overlap between the terminals to form a solid bridge of compound. See Figures 10-60 and 10-62. Do not put any compound inside the terminals.

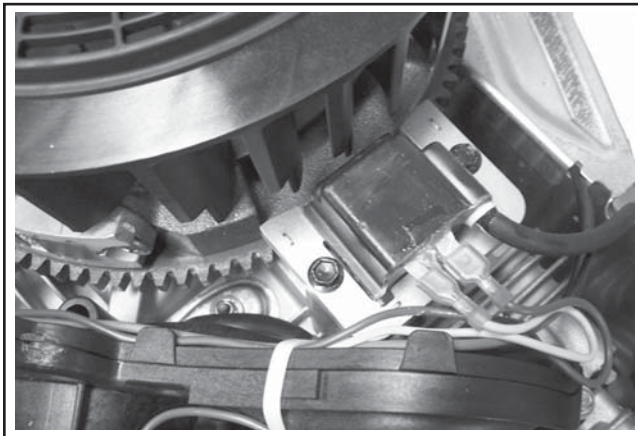


**Figure 10-60. Sealant Applied to Terminals.**

2. Connect the kill lead to the tab terminal on standard ignition modules. See Figure 10-61.



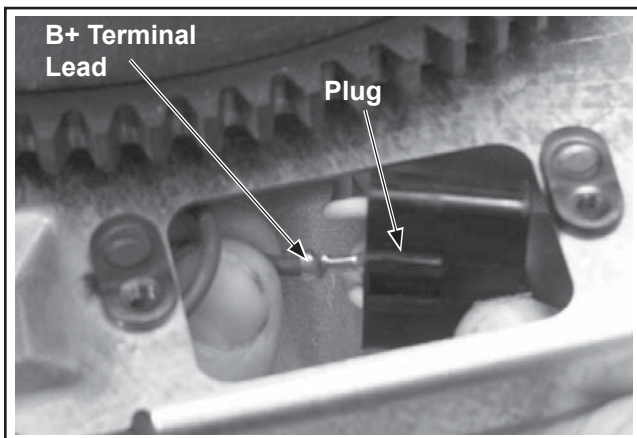
**Figure 10-61. Connecting Kill Leads on Fixed Ignition Modules.**



**Figure 10-62. Connect Leads on DSAM Ignition Modules.**

#### Install Rectifier-Regulator (Equipped Models)

1. Install the B+ terminal/lead into the center position of the rectifier-regulator plug so it locks in place, and connect the plug to the rectifier-regulator. See Figure 10-63.



**Figure 10-63. Connecting B+ Lead to Plug.**

2. Attach the rectifier-regulator to the opening in backing plate from the underside, and secure with the two mounting screws. See Figure 10-64.



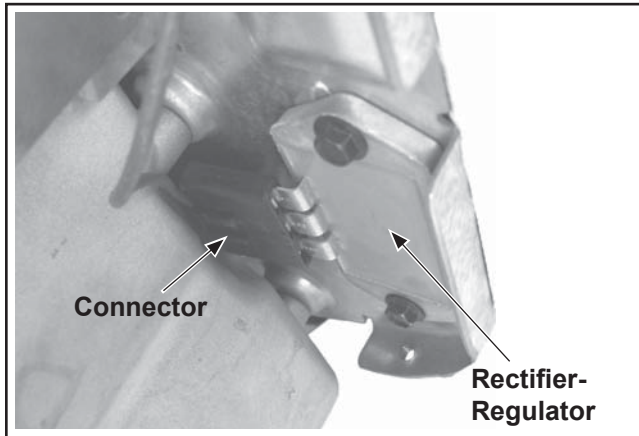


Figure 10-64. Installed Rectifier-Regulator.

### Install the Inner and Outer Cylinder Baffles

1. Attach the outer cylinder baffles and secure with the M6 screw (lower cylinder location), and M5 screw into the backing plate. See Figure 10-65. Tighten the screws as listed following Step 2.

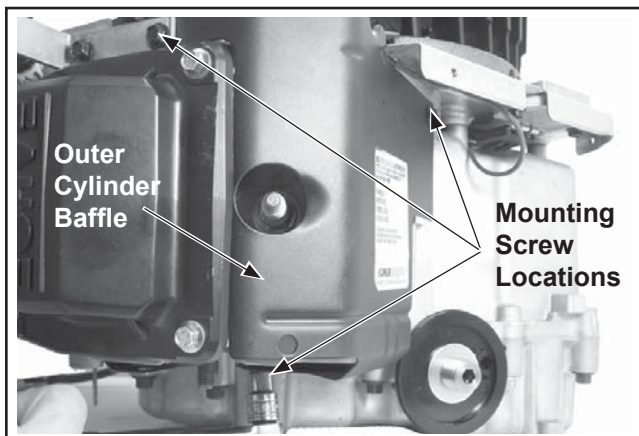


Figure 10-65. Installing Outer Cylinder Baffles.

2. Attach the inner baffles including any lifting straps to the cylinder head flanges and to the two crankcase mounting bosses. The lift strap should be outside the outer baffle. Secure with the M5 screws. See Figure 10-66. The remaining lower inner baffle mounting screws will be installed later.

Torque the baffle mounting screws:

M5 screws: **6.2 N·m (55 in. lb.)** into a new cored hole, or **4.0 N·m (35 in. lb.)** into a used hole.

M6 screws: **10.7 N·m (95 in. lb.)** into a new cored hole, or **7.3 N·m (65 in. lb.)** into a used hole.

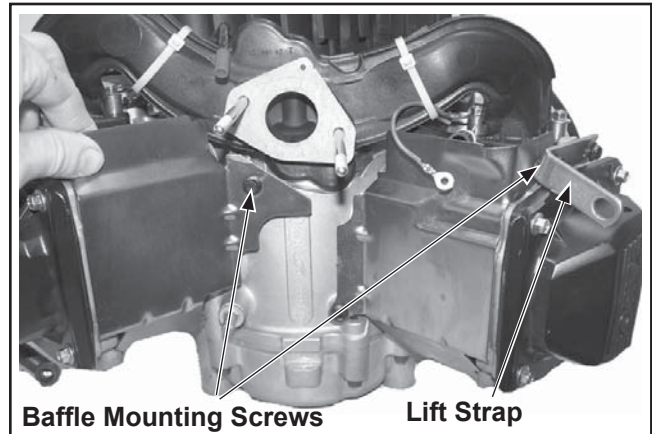


Figure 10-66. Installing Inner Baffles and Lift Strap.

3. Install the spark advance module (DSAM) if equipped, onto the outer cylinder baffle. See Figure 10-67.

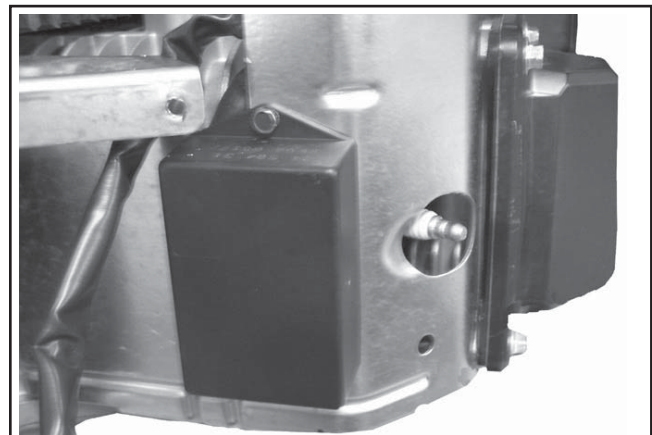


Figure 10-67. SAM Mounting.

## Section 10

### Reassembly

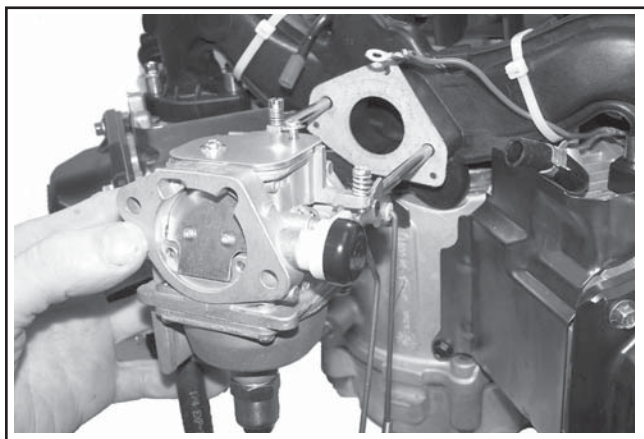
#### Install Carburetor



##### **WARNING: Explosive Fuel!**

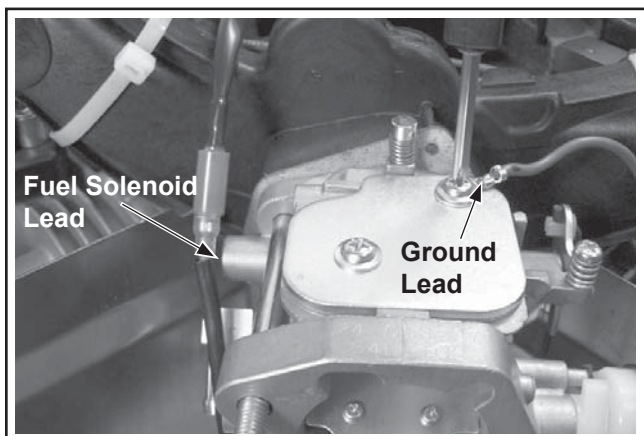
*Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine.*

1. Install a new carburetor gasket. Make sure all holes align and are open.
2. Install the carburetor, throttle linkage and governor lever as an assembly. See Figure 10-68.



**Figure 10-68. Installing Carburetor, Throttle Linkage and Governor Lever.**

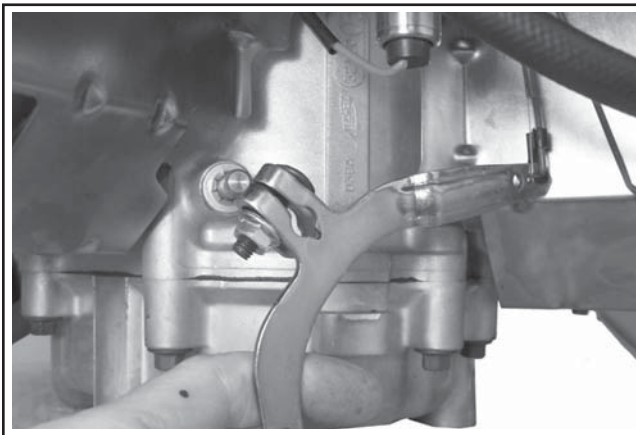
3. If the carburetor is equipped with a fuel solenoid, connect the red (power) lead. Attach the eyelet terminal of ground lead to the inner top carburetor cover mounting screw. See Figure 10-69.



**Figure 10-69. Connecting Fuel Solenoid and Ground Lead.**

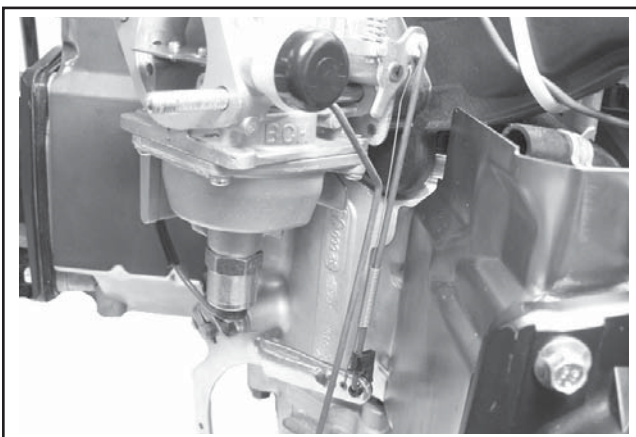
#### Install External Governor Controls

1. Install the governor lever onto the governor cross shaft if disconnected previously. See Figure 10-70.



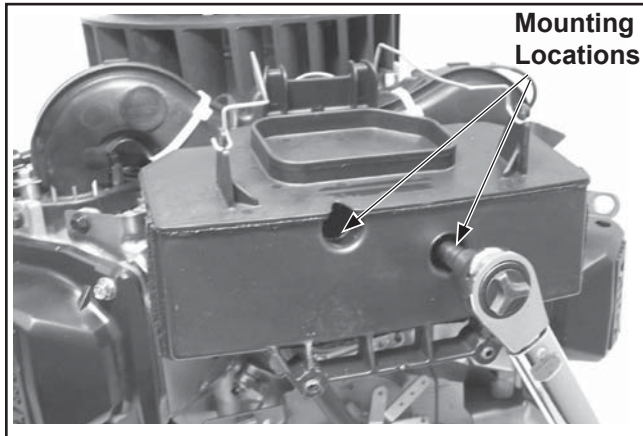
**Figure 10-70. Installing Governor Lever to Cross Shaft.**

2. Make sure the throttle linkage is connected to the governor lever and the throttle lever on the carburetor. Connect the choke linkage to carburetor choke lever. See Figure 10-71.



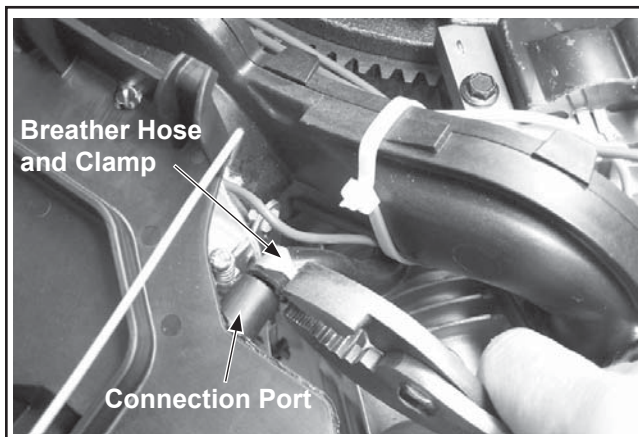
**Figure 10-71. Linkage Details.**

3. Attach the fuel line to the carburetor and secure with a clamp.
4. Install a new air cleaner base gasket and the air cleaner base onto the mounting studs. Torque the two hex flange nuts to 6.2-7.3 N·m (55-65 in. lb.). See Figure 10-72.



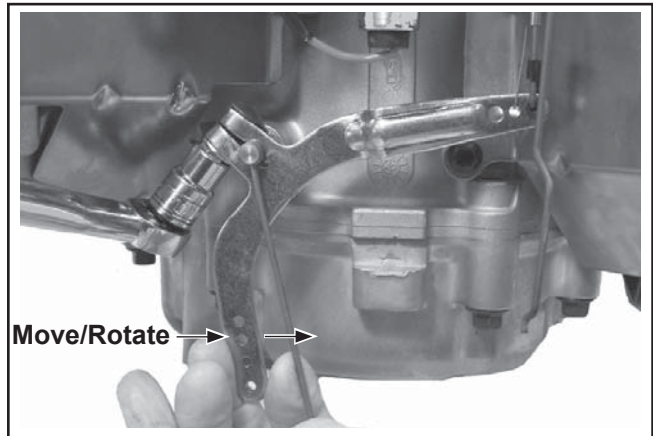
**Figure 10-72. Installing Air Cleaner Base and Gasket.**

5. Connect the breather hose to the air cleaner base and secure with the clamp. See Figure 10-73.



**Figure 10-73. Connecting Breather Hose.**

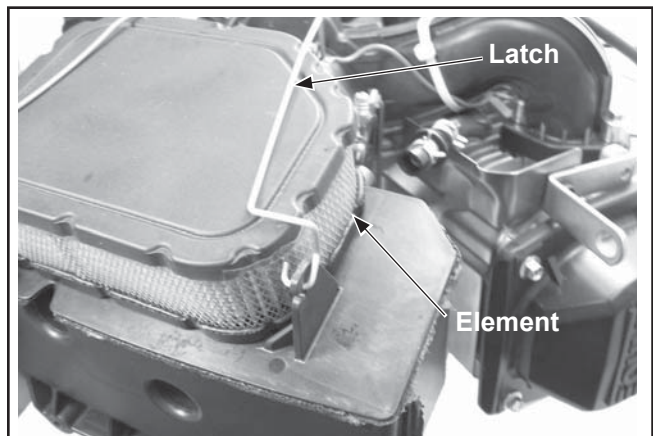
6. Move the governor lever toward the carburetor as far as it will go (wide-open throttle), and hold in position.
7. Insert a nail or similar tool into the hole on the cross shaft and rotate the shaft counterclockwise as far as will turn, then torque the hex nut to **6.8 N·m (60 in. lb.)**. See Figure 10-74.



**Figure 10-74. Adjusting Governor Lever (Air Cleaner Base Removed for Clarity).**

### Install Air Cleaner Element

1. Install the air cleaner element (with precleaner if equipped), onto the air cleaner base. Secure with the latch. See Figure 10-75.



**Figure 10-75. Installing Air Cleaner Element.**



Section 10  
Reassembly

Install Throttle and Choke Controls

- 1. Connect the choke linkage to the choke actuator lever on the main control bracket assembly. See Figure 10-76.

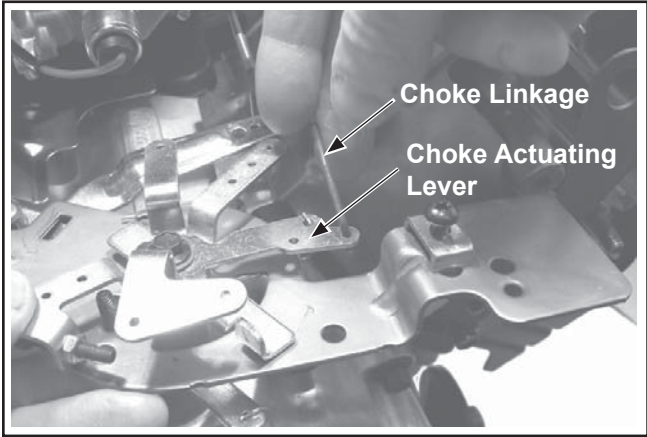


Figure 10-76. Connecting Choke Linkage.

- 2. Install the main control bracket to the cylinder heads using the four hex flange screws. The two lower screws should also secure the inner baffles. Torque the screws to 10.7 N·m (95 in. lb.) into new holes, or 7.3 N·m (65 in. lb.) into used holes. See Figure 10-77.

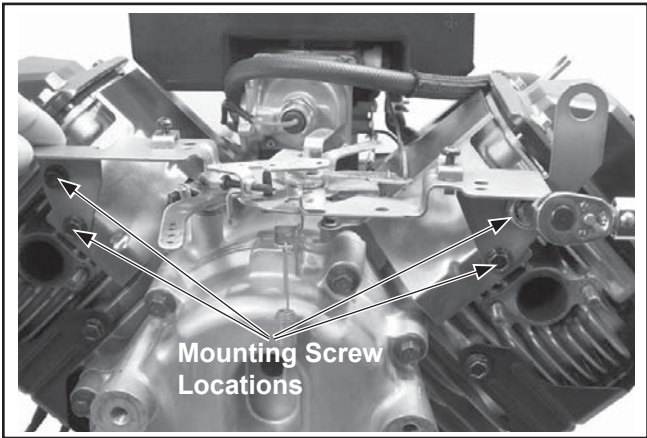


Figure 10-77. Throttle/Choke Control Bracket Mounting Detail.

- 3. Connect the governed idle spring to governor lever and main control bracket. Connect the governor spring from the throttle control bracket to the appropriate hole in the governor lever, as indicated in the applicable chart. Note that hole positions are counted from the pivot point of the governor lever. See Figure 10-78.

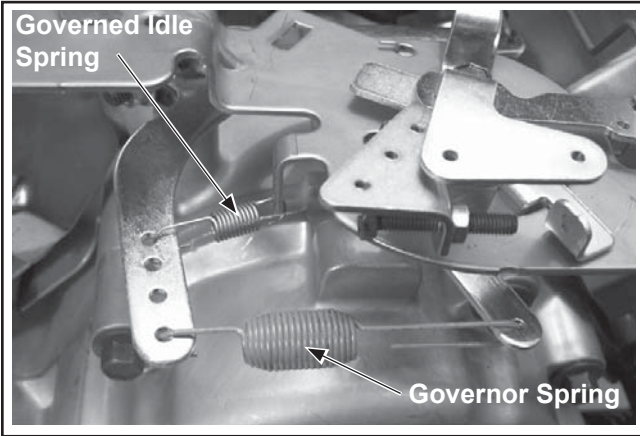


Figure 10-78. Governor and Dampening Spring Installation (Typical).

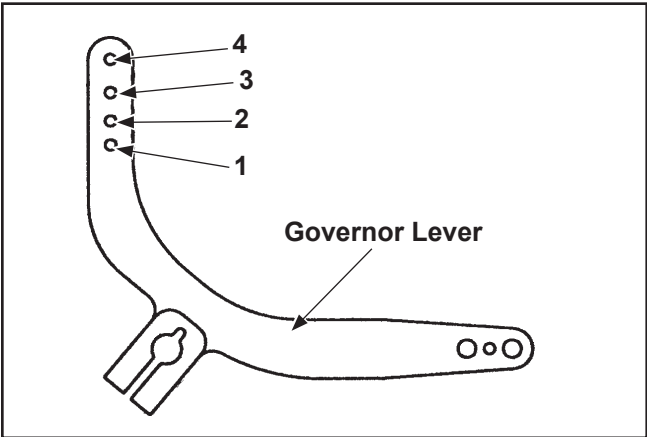
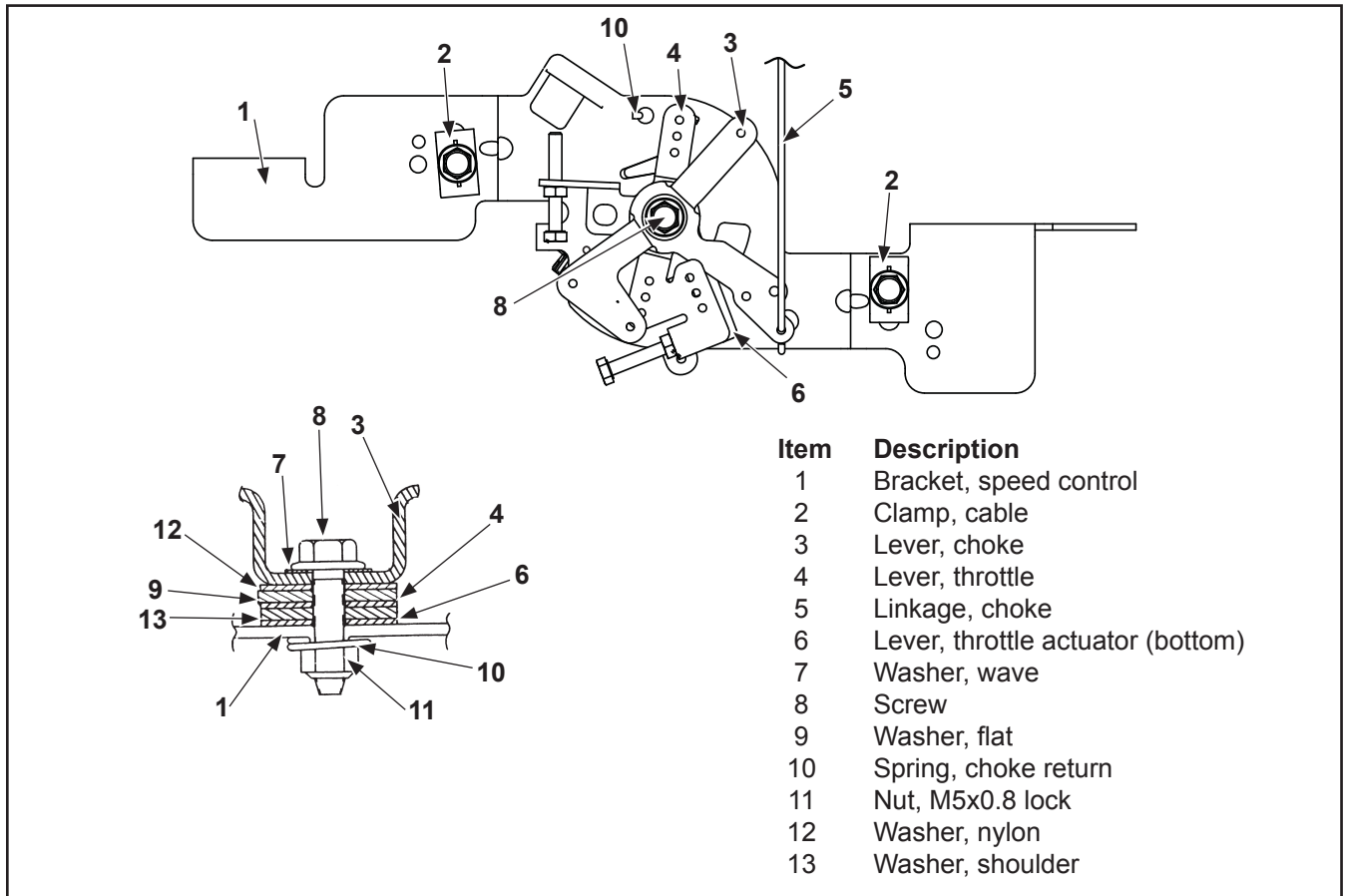


Figure 10-79. Governor Lever and Hole Position/RPM Chart.

Governor Lever and Hole Position/RPM Chart

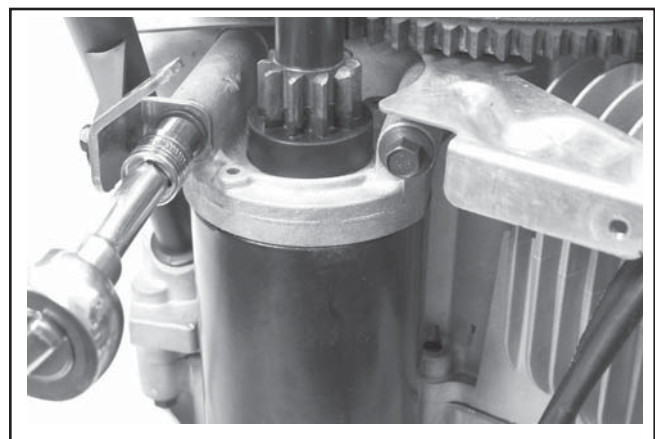
High Idle RPM	Governor Lever Hole No.	Governor Spring Color Code
2900	1	Black
3300	1	Orange



**Figure 10-80. Throttle/Choke Control Bracket and Governor Lever Detail.**

### Install Electric Starter Motor and Oil Fill/Dipstick Tube

1. Install the starter motor, lift bracket, and oil fill/dipstick tube (if not separated from bracket), using the two hex flange screws. Position the lift bracket as shown to also secure the dipstick tube. See Figure 10-81.
2. Torque the two hex flange screws to **15.3 N·m (135 in. lb.)**. See Figure 10-81.



**Figure 10-81. Installing Starter, Lift Bracket, and Oil Fill/Dipstick Tube.**

3. On models with a solenoid shift starter, connect the leads to the solenoid.



## Section 10

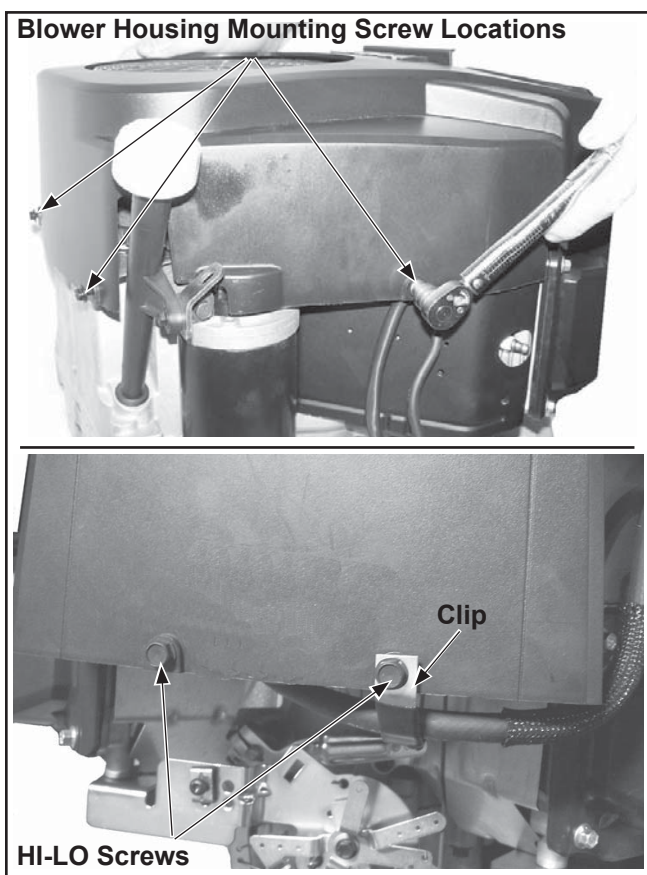
### Reassembly

4. If separated earlier, install the dipstick tube and align the mounting hole with the threaded hole in the lift bracket. Secure with the M5 hex flange screw. Torque the screw to **4.0 N·m (35 in. lb.)**.
5. Install the oil fill cap/dipstick.

#### Install Blower Housing

**NOTE:** Do not completely tighten screws until all are installed to allow shifting for hole alignment.

1. Install the blower housing with the access door onto the engine. Start all the mounting screws. The two HI-LO thread screws are installed in the front securing the blower housing to the air cleaner base. Make sure the wire harness and spark plug leads exit out through the appropriate openings in the shrouding. Attach any fuel line clamps used. See Figure 10-82.



**Figure 10-82. Blower Housing Mounting Details.**

2. Torque the screws as follows:

M5 Blower Housing Screws: **6.2 N·m (55 in. lb.)** in a new hole, or **4.0 N·m (35 in. lb.)** in a used hole.

M4 HI-LO Screws: **2.8 N·m (25 in. lb.)**.

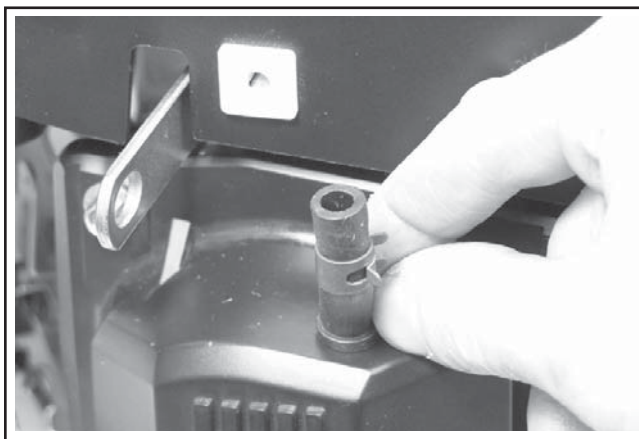
#### Install Fuel Pump



##### **WARNING: Explosive Fuel!**

*Gasoline may be present in the carburetor and fuel system. Gasoline is extremely flammable and its vapors can explode if ignited. Keep sparks and other sources of ignition away from the engine.*

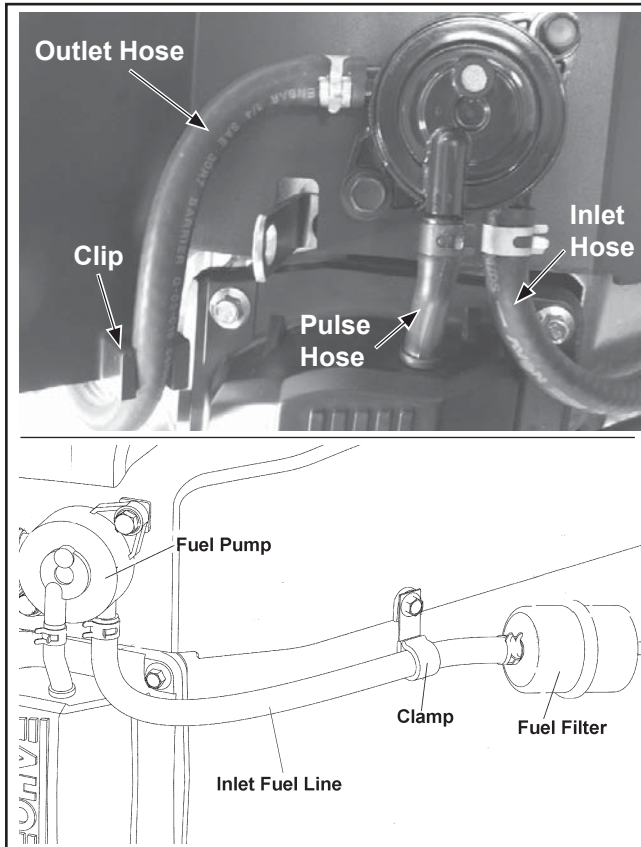
1. Connect the pulse hose to the valve cover. The valve cover should be situated between the two formed lips on the pulse hose. See Figure 10-83.
2. Attach the pulse hose to the fuel pump and secure with a clamp. Mount the fuel pump to the blower housing with the two screws. Torque the screws to **2.3 N·m (20 in. lb.)**.



**Figure 10-83. Installing Pulse Hose.**

3. Connect the inlet and outlet fuel lines to the pump. Route inlet hose through the fuel line clamp (if used) as shown, and seat outlet hose in the blower housing clip. See Figure 10-84.

**NOTE:** If a new fuel pump is being installed, make sure the orientation of the new pump is consistent with the removed pump. Internal damage may occur if installed incorrectly.



**Figure 10-84. Fuel Pump Details.**

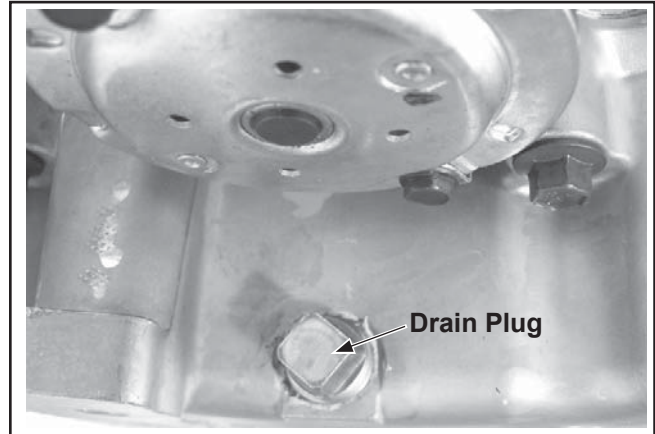
### Install Muffler

1. Install the muffler and attaching hardware to the muffler bracket. Torque screws to **9.9 N·m (88 in. lb.)**.
2. Install the M8 hex flange nuts or 5/16-18 hex head capscrews (based on head design), to secure the muffler. Torque the hex flange nuts to **24.4 N·m (216 in. lb.)**, or the capscrews to **16.9 N·m (150 in. lb.)**.

### Install Oil Filter and Fill Crankcase with Oil

1. Install the oil drain plug. See Figure 10-85. Torque the plug to **13.6 N·m (120 in. lb.)**.

**NOTE:** Make sure that the oil drain plug is installed and torqued to the above specification to prevent oil leakage.



**Figure 10-85. Installed Drain Plug.**

2. Prefill a new oil filter following the instructions in **Section 6, Lubrication System**.
3. Apply a thin film of clean oil to the rubber gasket on the oil filter and thread it onto the adapter nipple. See Figure 10-86.
4. Install the new oil filter to the filter adapter or oil cooler. Refer to instructions on the oil filter for proper installation.



**Figure 10-86. Installing New Oil Filter.**

## Section 10

### Reassembly

5. Add oil to bring the level up to the F/Full mark. Turn the oil fill cap/dipstick counterclockwise until the oil fill cap drops down to the lowest point of the thread leads. **Do not** thread the oil fill cap onto the tube. See Figure 10-87 and 10-88. The oil level needs to be within the operating range. See Figure 10-89. If low, add oil of the proper type up to the full mark. If oil is above F or FULL mark, drain oil to reach proper level. Reinstall the oil fill cap/dipstick and thread until tight.

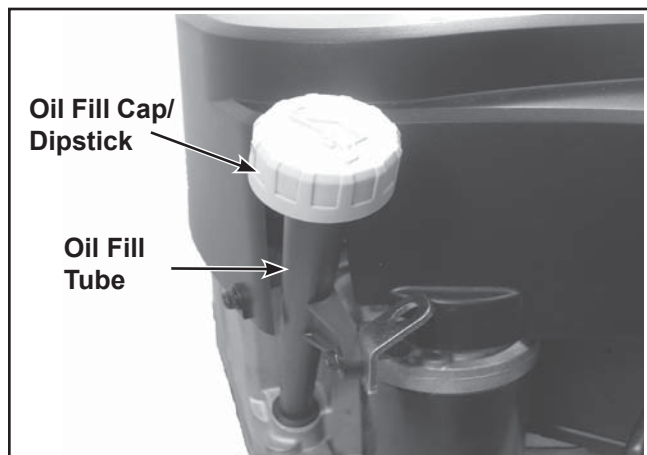


Figure 10-87. Oil Fill Cap/Dipstick and Oil Fill Tube.

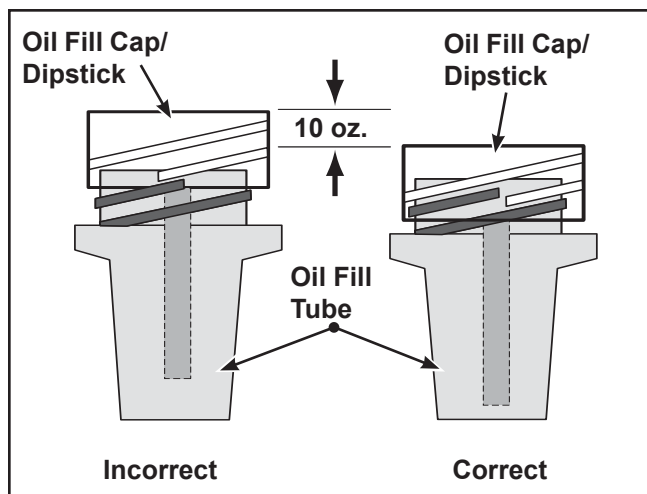


Figure 10-88. Oil Fill Cap and Oil Fill Tube Threads.

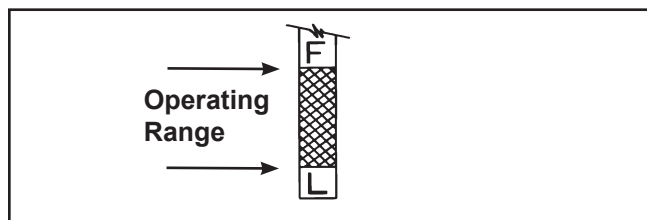


Figure 10-89. Oil Level Marks on Dipstick (Typical).

### Connect Spark Plug Leads

1. Connect the leads to the spark plugs. See Figure 10-90.

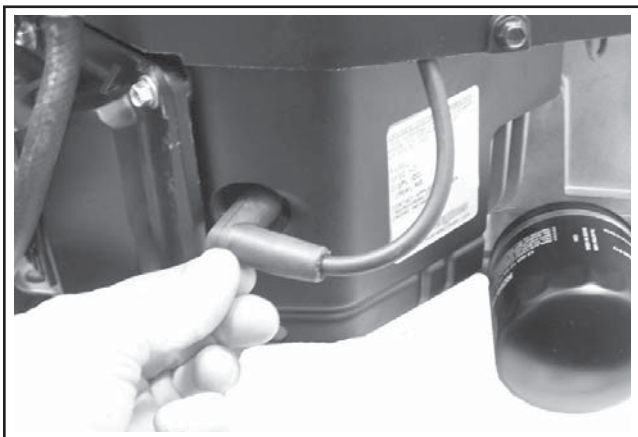


Figure 10-90. Connect Spark Plug Leads.

### Prepare the Engine for Operation

The engine is now completely reassembled. Before starting or operating the engine, be sure to do the following.

1. Make sure all hardware is tightened securely.
2. Make sure the oil drain plug, oil sentry pressure switch, and a new oil filter are installed.
3. Fill the crankcase with the correct amount, weight, and type of oil. Refer to oil recommendations and procedures in **Section 1, Safety and General Information** and **Section 6 Lubrication System**.
4. Adjust the carburetor idle fuel needle, or idle speed adjusting screw as necessary. Refer to **Section, 5 Fuel System and Governor**.

### Testing the Engine

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

1. Run the engine at idle for 2-3 minutes, then 5-6 minutes more between idle and midrange. Adjust the carburetor mixture setting as necessary.
2. Adjust the idle speed screw and high-speed stop as necessary. Make sure the maximum engine speed does not exceed 3750 RPM (no load).

# Section 11

## Emission Compliance Systems

### Evaporative Emission Compliance System

For the 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 the Original Equipment Manufacturer (OEM). Details on the Kohler system are included below.

**Operation:** Fuel vapors travel from the fuel tank through tubing to the carbon canister. On the intake stroke of the engine fuel vapors are drawn in through a port in the carburetor and burned with the fuel charge. See Figure 11-1.

**Maintenance:** On Kohler-supplied canisters, the breather filter can be removed and cleaned with hot soapy water, dried and reinstalled. Do not oil the breather screen. This is done periodically or if system operation is suspect. The carbon canister is sealed and requires no maintenance. See Figure 11-1.

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

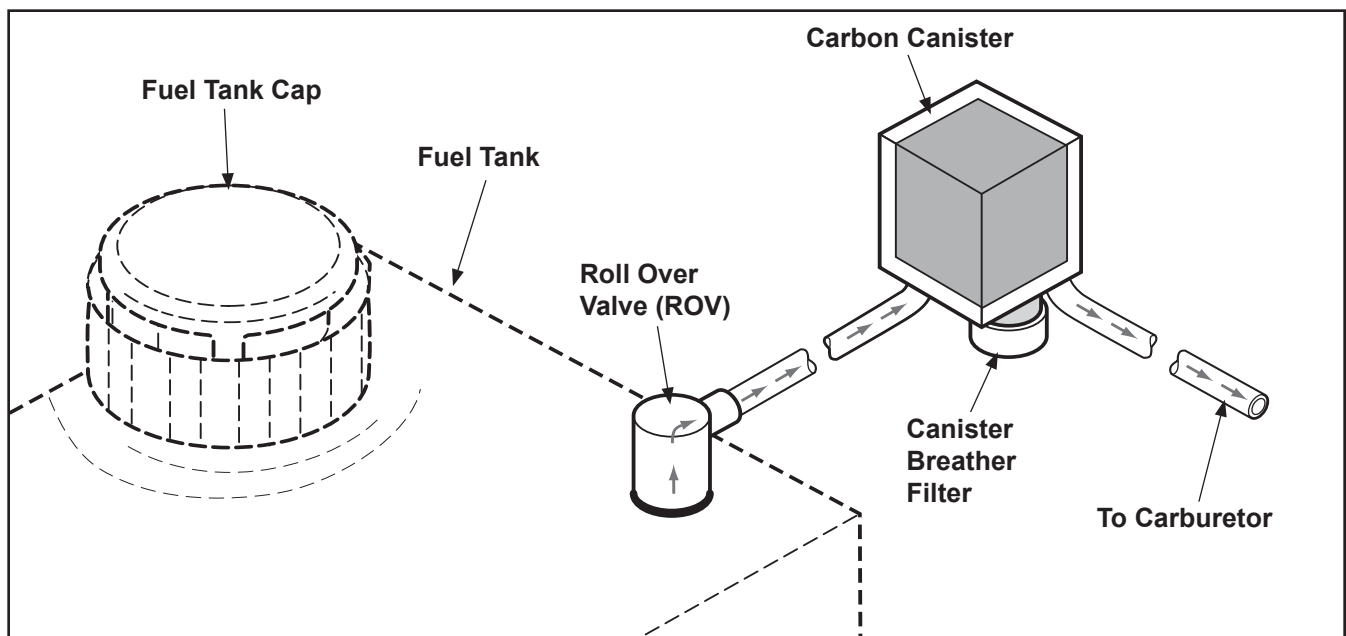


Figure 11-1. Carbon Canister System Diagram.

## Section 11

### Emission Compliance Systems

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#### Secondary Emission Compliance System

For the engine to be Tier III compliant, it may be fitted with a secondary air induction system (SAI).

**Operation:** The intake pulse of the engine activates the secondary air valve. Air is drawn through an inlet screen of the secondary air valve. The air is then drawn into the exhaust manifold and muffler where it mixes with any unburned hydrocarbons, which then burn in the heat of the muffler. A hose is connected between a carburetor port and a diaphragm chamber in the secondary air valve. The carburetor vacuum moves the diaphragm to close the valve when air induction is not required, primary idle. See Figure 11-2.

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

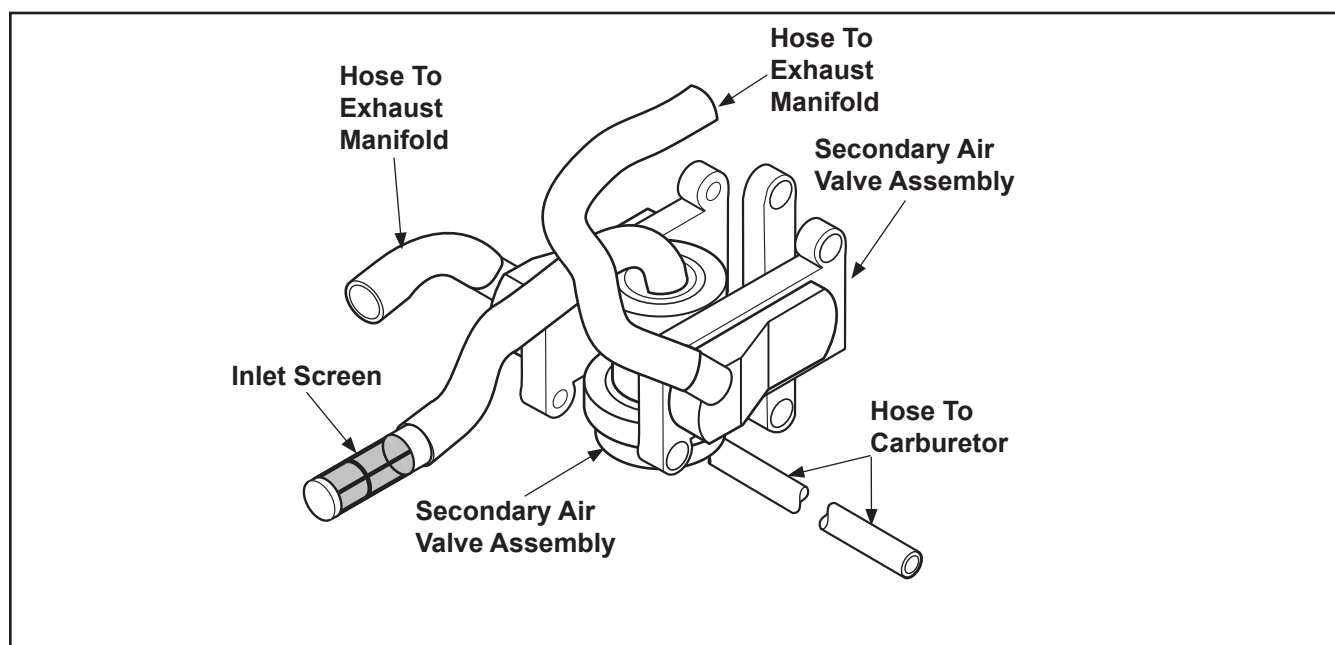


Figure 11-2. Secondary Air Induction System Diagram.





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