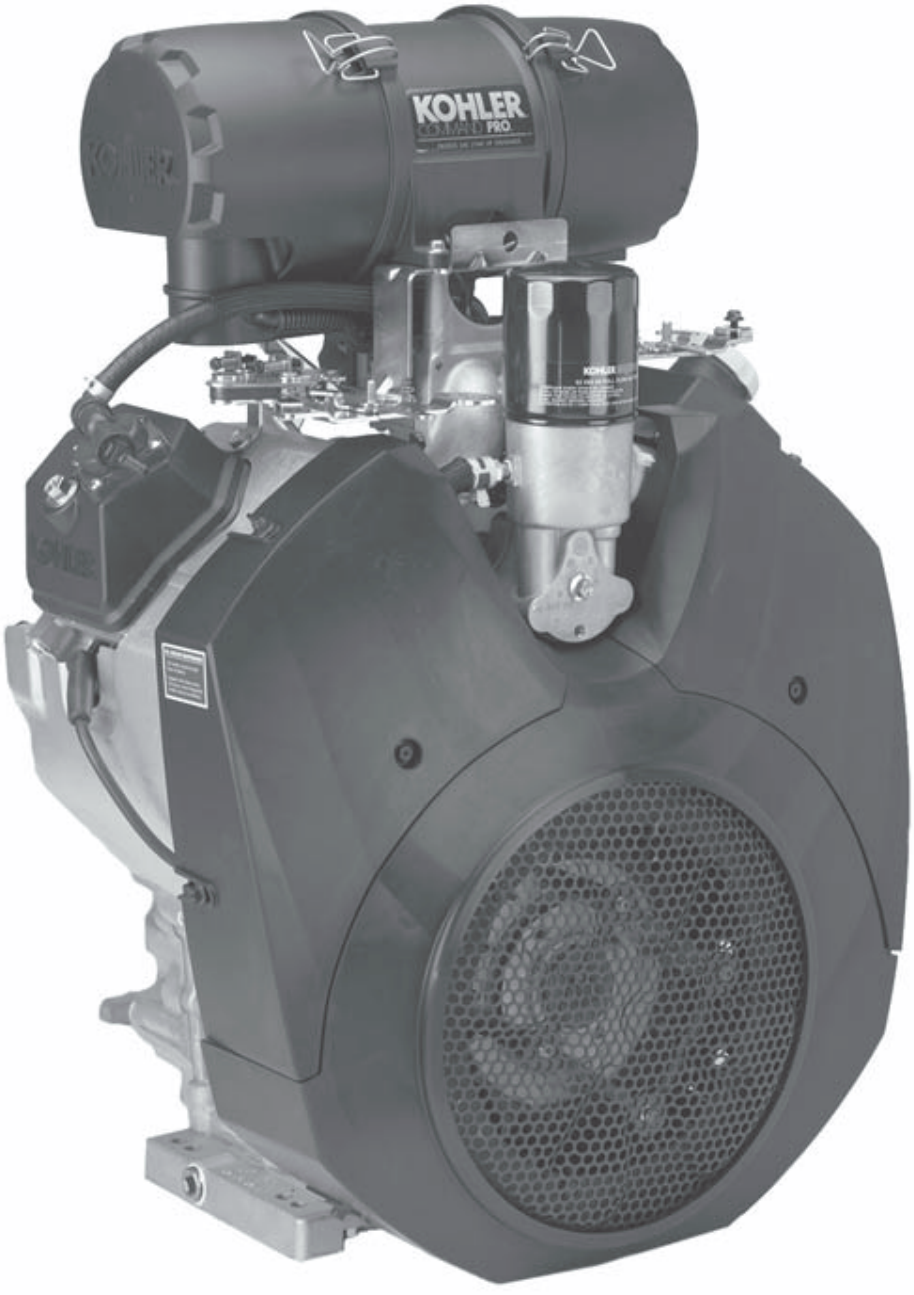
KOHLER® COMMAND PRO

CH940-CH980

HORIZONTAL CRANKSHAFT



KOHLER® ENGINES

Contents

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.

WARNING

Accidental Starts can cause severe injury or death.

Disconnect and ground spark plug leads before servicing.

WARNING

Rotating Parts can cause severe injury.

Stay away while engine is in operation.

WARNING

Hot Parts can cause severe burns.

Do not touch engine while operating or just after stopping.

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.

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.

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.

⚠ 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.

⚠ 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.

⚠ 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.

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.

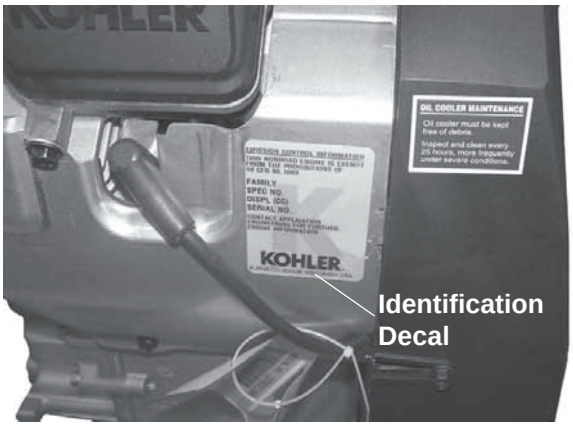


Figure 1-1. Engine Identification Decal Location.

A. Model No. **C H 980 S**

- **Command Engine**
- **Horizontal Crankshaft**
- **Numerical Designation**
- **Version Code**
  S = Electric Start

B. Spec. No.

CH940-0001
CH960-0001
CH980-0001
Complete Spec. Number (Incorporating Model No. with Variation No. of Basic Spec.)

C. Serial No. **3705810334**

- **Year Manufactured Code**
- **Factory Code**

Code	Year
37	2007
38	2008

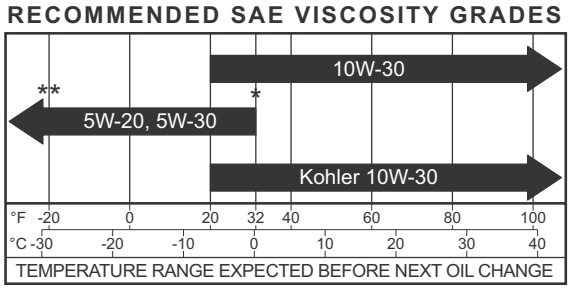
Figure 1-2. Explanation of Engine Identification Numbers.

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. It is also recommended that a consistent brand of oil be used. 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 SG, SH, SJ or higher.** Select the viscosity based on the air temperature at the time of operation as shown in the following table.



* 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 SG, SH, 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 that can be used within 30 days, and store only in clean, approved containers. Do not use gasoline left over from the previous season, unless treated with a fuel stabilizer (see **Storage**), to minimize gum deposits and ensure easy starting. Do not use gasoline containing Methanol, or 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 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. 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

These required maintenance procedures should be performed at the frequency stated in the table. They should also be included as part of any seasonal tune-up.

Frequency	Maintenance	Refer to:
Daily or Before Starting Engine	• Fill fuel tank. • Check oil level. • Check air cleaner for dirty[1], loose, or damaged parts. • Check air intake and cooling areas, clean as necessary.	Section 5 Section 6 Section 4 Section 4
Weekly	• Check filter minder or air cleaner element.	Section 4
Seasonally or Every 150 Hours	• Check air cleaner element. • Replace fuel filter. • Change oil. Oil filter is recommended. (More frequently under severe conditions.) • Remove cooling shrouds and clean cooling areas[1]. • Check oil cooler fins, clean as necessary.	Section 4 Section 5 Section 6 Section 4 Section 6
Every 200 Hours	• Check spark plug condition and gap.	Section 7
Seasonally or Every 300 Hours	• Change oil filter. • Replace air cleaner element.	Section 6 Section 4
Yearly or Every 500 Hours	• Have solenoid shift starter disassembled and cleaned[2]. • Have crankshaft splines lubricated[2].	Section 7
Every 600 Hours	• Replace inner air cleaner element. • Replace spark plugs.	Section 4 Section 7

[1]*Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.*
[2]*Have a Kohler Engine Service Dealer perform this service.*

Storage

If the engine will be out of service for 30 days 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 Changing Oil and Oil Filter in Section 6.

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.

   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 are empty.

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.

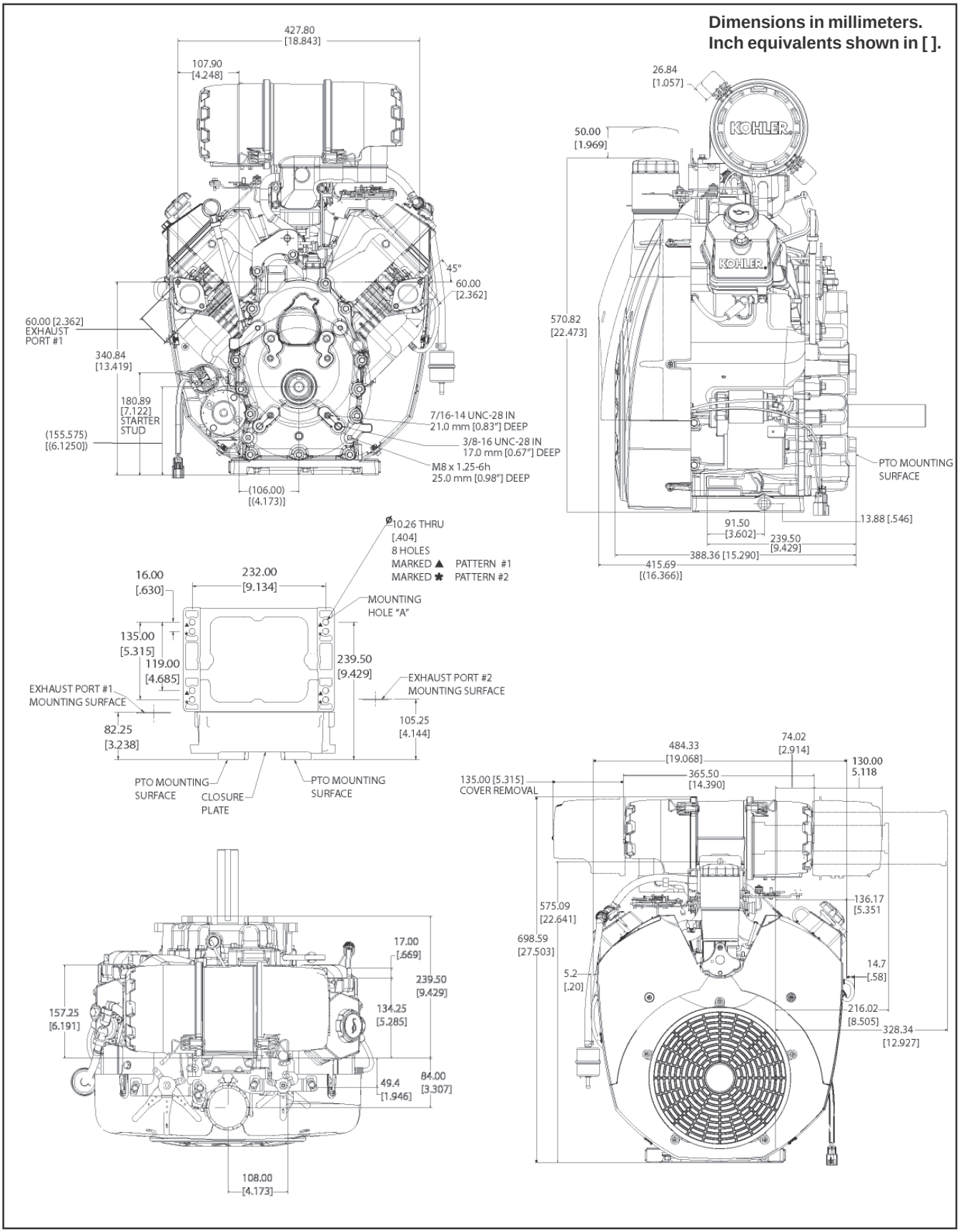


Figure 1-4. Typical CH PRO Series Engine Dimensions with Heavy-Duty Air Cleaner.

General Specifications[1]

Power (@ 3600 RPM, exceeds Society of Automotive Engineers-Small Engine Test Code J1940.)
- CH940 ..... 25.4 kW (34 HP)
- CH960 ..... 26.9 kW (36 HP)
- CH980 ..... 28.3 kW (38 HP)

Bore ..... 90 mm (3.54 in.)

Stroke ..... 78.5 mm (3.1 in.)

Displacement ..... 999 cc (61 cu. in.)

Compression Ratio 8.8:1

Dry Weight ..... 59.8 kg (132 lb.)

Oil Capacity (w/filter) - approximate,
determined by oil filter used ..... 2.7 L (2.9 U.S. qt.)

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

Blower Housing and Sheet Metal

M6 Shoulder Screw Torque
- New, Untapped Hole (casting) ..... 10.7 N·m (95 in. lb.)
- Used, Tapped Hole (casting) ..... 7.3 N·m (65 in. lb.)
- New, Extruded Hole (sheet metal) ..... 4.0 N·m (35 in. lb.)
- Used, Extruded Hole (sheet metal) ..... 2.0 N·m (17.7 in. lb.)
- Mounting Clip (valley baffle) ..... 2.5 N·m (22.1 in. lb.)

M6 Screw Torque
- New, Untapped Hole (casting) ..... 10.7 N·m (95 in. lb)
- Used, Tapped Hole (casting) ..... 7.3 N·m (65 in. lb)

Rectifier-Regulator Fastener Torque ..... 2.0 N·m (18 in. lb.)

Oil Cooler Fastener Torque ..... 2.2 N·m (20 in. lb.)

Camshaft

End Play ..... 0.3/1.3 mm (0.011/0.051 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.)

Cam Lobe Profile (Minimum Dimension, Measured From Base Circle To Top Of Lobe)
Exhaust ..... 35 mm (1.3779 in.)
Intake ..... 35 mm (1.3779 in.)

[1] Values are in Metric units. Values in parentheses are English equivalents. Lubricate threads with engine oil prior to assembly.

Carburetor, Intake Manifold, and Air Cleaner

Intake Manifold Mounting Fastener Torque
- Torque (Using Sequence) in Two Stages ..... first to 16.9 N·m (150 in. lb.) finally to 22.6 N·m (200 in. lb.)

Carburetor/Air Cleaner Mounting Nut Torque ..... 7.9 N·m (70 in. lb.)

Air Cleaner Mounting Screw Torque (Into Intake Manifold) ..... 9.9 N·m (88 in. lb.)

Control Bracket

Mounting Screw (Into Intake Manifold from Air Cleaner) Torque ..... 9.9 N·m (88 in. lb.)

Connecting Rod

Cap Fastener Torque (Torque In Increments) ..... 11.3 N·m (100 in. lb.)

Crankpin End I.D. @ 70°F
- New ..... 44.030/44.037 mm (1.7334/1.7337 in.)
- Max. Wear Limit ..... 0.070 mm (0.0028 in.)

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 ..... 0.30/0.59 mm (0.0118/0.0232 in.)

Connecting Rod-to-Piston Pin Running Clearance ..... 0.015/0.028 mm (0.0006/0.0011 in.)

Piston Pin End I.D. @ 70°F
- New ..... 19.023/19.015 mm (0.7489/0.7486 in.)
- Max. Wear Limit ..... 19.036 mm (0.7494 in.)

Crankcase

Governor Cross Shaft Bore I.D.
- New ..... 8.025/8.050 mm (0.3159/0.3169 in.)
- Max. Wear Limit ..... 8.088 mm (0.3184 in.)

Breather Cover Fastener Torque ..... 5.7 N·m (51 in. lb.)

Oil Drain Plug Torque ..... 21.4 N·m (15.7 ft. lb.)

Closure Plate

Closure Plate Fastener Torque ..... 24.4 N·m (216 in. lb.)

Reservoir (Oil)

Mounting Screw Torque ..... 24.4 N·m (216 in. lb.)

Crankshaft

End Play (Free) ..... 0.30/1.50 mm (0.011/0.059 in.)

Crankshaft Bore (In Crankcase)
- New, Without Main Bearing ..... 50.00/50.025 mm (1.9685/1.969 in.)
- With Main Bearing Installed ..... 45.040/45.145 mm (1.7732/1.7773 in.)
- Max. Wear Limit ..... 45.158 mm (1.7778 in.)

Crankshaft to Sleeve Bearing (In Crankcase)
- Running Clearance - New ..... 0.040/0.167 mm (0.0015/0.0065 in.)

Crankshaft Bore (In Closure Plate) - New, Without Bearing ..... 50.025/50.00 mm (1.9694/1.9685 in.)

Crankshaft to Sleeve Bearing (In Closure Plate)
Running Clearance - New ..... 0.040/0.167 mm (0.0015/0.0065 in.)

Flywheel End Main Bearing Journal
O.D. - New ..... 44.978/45.00 mm (1.770/1.771 in.)
O.D. - Max. Wear Limit ..... 44.90 mm (1.767 in.)
Max. Taper ..... 0.022 mm (0.0009 in.)
Max. Out-of-Round ..... 0.025 mm (0.0010 in.)

Closure Plate End Main Bearing Journal
O.D. - New ..... 44.978/45.00 mm (1.770/1.771 in.)
O.D. - Max. Wear Limit ..... 44.90 mm (1.767 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 ..... 43.982/44.000 mm (1.731/1.732 in.)
O.D. - Max. Wear Limit ..... 43.97 mm (1.731 in.)
Max. Taper ..... 0.018 mm (0.0007 in.)
Max. Out-of-Round ..... 0.025 mm (0.0010 in.)
Width ..... 53.00/53.09 mm (2.0866/2.0901 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 ..... 90.000/90.025 mm (3.543/3.544 in.)
Max. Wear Limit ..... 90.075 mm (3.546 in.)
Max. Out-of-Round ..... 0.013 mm (0.00051 in.)
Max. Taper ..... 0.013 mm (0.00051 in.)

Main Bearing I.D. (Crankcase/Closure Plate)
New (Installed) ..... 45.040/45.145 mm (1.773/1.777 in.)
Max. Wear Limit ..... 45.158 mm

Cylinder Head
Cylinder Head Fastener Torque
Head Bolt - Torque in Two Stages ..... first to 22.6 N·m (200 in. lb.)
finally to 45.2 N·m (400 in. lb.)

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

Pipe Plug (3/4") Torque ..... 28.25 N·m (250 in. lb.)

Rocker Arm Screw Torque ..... 14.6 N·m (130 in. lb.)

Fan/Flywheel
Fan Fastener Torque ..... 9.9 N·m (88 in. lb.)

Flywheel Retaining Screw Torque ..... 67.8 N·m (50 ft. lb.)

Grass Screen
Hex Stud Torque ..... 9.9 N·m (88 in. lb.)
Mounting Screw Torque ..... 9.9 N·m (88 in. lb.)

Front Drive Shaft Screw Torque (Into Flywheel) ..... 24.4 N·m (216 in. lb.)

Governor
Governor Cross Shaft-to-Crankcase Running Clearance ..... 0.025/0.087 mm (0.0009/0.0034 in.)

Governor Cross Shaft O.D.
New ..... 7.963/8.000 mm (0.3135/0.3149 in.)
Max. Wear Limit ..... 7.936 mm (0.3124 in.)

Governor Gear Shaft-to-Governor Gear Running Clearance ..... 0.070/0.160 mm (0.0027/0.0063 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 Lever Nut Torque ..... 7.3 N·m (65 in. lb.)

Ignition
Spark Plug Type (Champion® or Equivalent) XC10YC

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 ..... 6.2 N·m (55 in. lb.) into new holes, or
4.0 N·m (35 in. lb.) into used holes

Lifter Feed Chamber
Cover/Baffle Screw Torque ..... 6.2 N·m (55 in. lb.)

Muffler
Muffler Retaining Nut Torque ..... 24.4 N·m (216 in. lb.)

Oil Cooler
Mounting Screws Torque ..... 3.9 N·m (35 in. lb.)

Oil Filter
Oil Filter Torque ..... 3/4-1 turn after gasket contact

Oil Filter Adapter/Housing
Mounting Screw Torque ..... 24.4 N·m (216 in. lb.)

Piston, Piston Rings, and Piston Pin
Piston-to-Piston Pin Running Clearance ..... 0.006/0.018 mm (0.0002/0.0007 in.)

Piston Pin Bore I.D.
New ..... 19.006/17.013 mm (0.7482/0.7485 in.)
Max. Wear Limit ..... 19.025 mm (0.7490 in.)

Piston Pin O.D.
New ..... 18.995/19.000 mm (0.7478/0.7480 in.)
Max. Wear Limit ..... 18.994 mm (0.7478 in.)

Top Compression Ring-to-Groove Side Clearance ..... 0.04/0.08 mm (0.0015/0.0031 in.)

Middle Compression Ring-to-Groove Side Clearance ..... 0.04/0.08 mm (0.0015/0.0031 in.)

Oil Control Ring-to-Groove Side Clearance ..... 0.03/0.19 mm (0.0011/0.0074 in.)

Top and Center Compression Ring End Gap
- New Bore ..... 0.30/0.55 mm (0.011/0.021 in.)
- Used Bore (Max.) ..... 0.94 mm (0.037 in.)

Piston Thrust Face O.D.[2]
- New ..... 89.953/89.967 mm (3.5414/3.5420 in.)
- Max. Wear Limit ..... 89.925 mm (3.540 in.)

Piston Thrust Face-to-Cylinder Bore[2] Running Clearance
- New ..... 0.033/0.72 mm (0.0013/0.0028 in.)

Starter Assembly

Thru Bolt Torque
- Delco-Remy (Solenoid Shift) ..... 5.6-9.0 N·m (49-79 in. lb.)

Mounting Screw Torque ..... 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.)

Throttle/Choke Control Bracket

Fastener Torque ..... 9.9 N·m (88 in. lb.)

Valve Cover

Valve Cover Fastener Torque ..... 7.9 N·m (70 in. lb.)

Valves and Valve Lifters

Hydraulic Valve Lifter to Crankcase Running Clearance ..... 0.012/0.050 mm (0.0004/0.0019 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 ..... 7.135 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.)

[2]Measure 11 mm (0.433 in.) above the bottom of the piston skirt at right angles to the piston pin.

Valve Guide Reamer Size
Standard ..... 7.048 mm (0.2775 in.)
0.25 mm O.S. ..... 7.298 mm (0.2873 in.)

Nominal Valve Face 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
	4.8	5.8	8.8	10.9	12.9	
Size						
M4	1.2 (11)	1.7 (15)	2.9 (26)	4.1 (36)	5.0 (44)	2.0 (18)
M5	2.5 (22)	3.2 (28)	5.8 (51)	8.1 (72)	9.7 (86)	4.0 (35)
M6	4.3 (38)	5.7 (50)	9.9 (88)	14.0 (124)	16.5 (146)	6.8 (60)
M8	10.5 (93)	13.6 (120)	24.4 (216)	33.9 (300)	40.7 (360)	17.0 (150)

Tightening Torque: N·m (ft. lb.) + or - 10%

	Property Class					Noncritical Fasteners Into Aluminum
	4.8	5.8	8.8	10.9	12.9	
M10	21.7 (16)	27.1 (20)	47.5 (35)	66.4 (49)	81.4 (60)	33.9 (25)
M12	36.6 (27)	47.5 (35)	82.7 (61)	116.6 (86)	139.7 (103)	61.0 (45)
M14	58.3 (43)	76.4 (55)	131.5 (97)	184.4 (136)	219.7 (162)	94.9 (70)

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

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.**
Balance Gear Timing Tool (K & M Series) To hold balance gears in timed position when assembling engine.	Kohler 25 455 06-S (Formerly Y-357)
Camshaft Endplay Plate For checking camshaft endplay.	SE Tools KLR-82405
Camshaft Seal Protector (Aegis) To protect seal during camshaft installation.	SE Tools KLR-82417
Cylinder Leakdown Tester For checking combustion retention and if cylinder, piston, rings, or valves are worn.	Kohler 25 761 05-S
Electronic Fuel Injection (EFI) Diagnostic Software Use with Laptop or Desktop PC.	Kohler 25 761 23-S
EFI Service Kit 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
Flywheel Holding Tool (CS Series)	SE Tools KLR-82407
Flywheel Puller To remove flywheel from engine.	SE Tools KLR-82408
Flywheel Strap Wrench To hold flywheel during removal.	SE Tools KLR-82409

Tools (cont.)	
Description	**Source/Part No.**
Hydraulic Valve Lifter Tool To remove and install hydraulic lifters.	Kohler 25 761 38-S
Ignition System Tester 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
Offset Wrench (K & M Series) To remove and reinstall cylinder barrel retaining nuts.	SE Tools KLR-82410
Oil Pressure Test Kit To test and verify oil pressure.	Kohler 25 761 06-S
Rectifier-Regulator Tester (120 volt current) **Rectifier-Regulator Tester (240 volt current)** 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
Spark Advance Module (SAM) Tester To test the SAM (ASAM and DSAM) on engines with SMART-SPARK™.	Kohler 25 761 40-S
Starter Brush Holding Tool (Solenoid Shift) To hold brushes during servicing.	SE Tools KLR-82416
Starter Retaining Ring Tool (Inertia Drive) To remove and reinstall drive retaining rings (excluding FASCO starters).	Kohler 25 761 18-S
Starter Servicing Kit (All Starters) 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
Tachometer (Digital Inductive) For checking operating speed (RPM) of an engine.	Design Technology Inc. DTI-110
Vacuum/Pressure Tester Alternative to a water manometer.	Kohler 25 761 22-S
Valve Guide Reamer (K & M Series) For sizing valve guides after installation.	SE Tools KLR-82413

Aids	
Description	**Source/Part No.**
Camshaft Lubricant (Valspar ZZ613)	Kohler 25 357 14-S
Dielectric Grease (GE/Novaguard G661)	Kohler 25 357 11-S
Dielectric Grease (Fel-Pro)	Lubri-Sel
Electric Starter Drive Lubricant (Inertia Drive)	Kohler 52 357 01-S
Electric Starter Drive Lubricant (Solenoid Shift)	Kohler 52 357 02-S
RTV Silicone Sealant 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
Spline Drive Lubricant	Kohler 25 357 12-S

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 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.

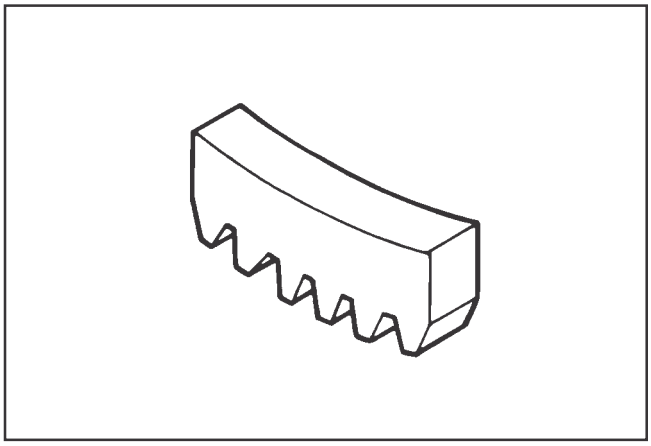


Figure 2-1. Flywheel Holding Tool.

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.

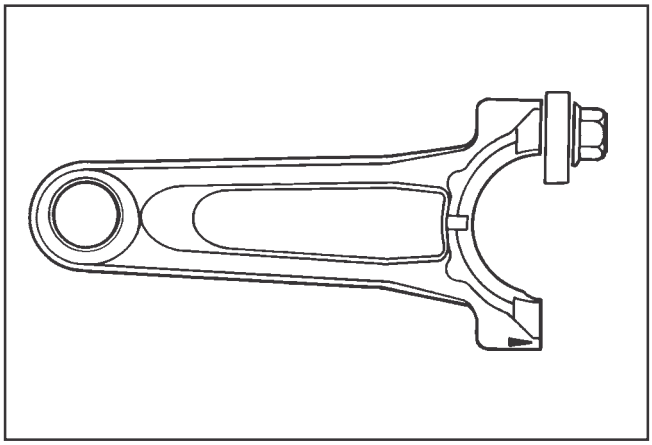


Figure 2-2. Rocker Arm/Crankshaft Tool.

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. Kill switch in **off** position.
7. Faulty spark plugs.
8. Faulty ignition module(s).
9. Carburetor solenoid malfunction.
10. Battery connected backwards.
11. Safety interlock system engaged.

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. Intake system leak.

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. Weak spark.
9. Fuel pump malfunction causing lack of fuel.
10. Engine overheated-cooling/air circulation restricted.
11. Quality of fuel.
12. Flywheel key sheared.
13. 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.

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 needles improperly set.
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.

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. Low battery.
11. Incorrect governor setting.

Engine Uses Excessive Amount of Oil

1. Incorrect oil viscosity/type.
2. Clogged, broken, or inoperative crankcase breather.
3. Worn or broken piston rings.
4. Worn cylinder bore.
5. Worn valve stems/valve guides.
6. Crankcase overfilled.
7. Blown head gasket/overheated.

Oil Leaks from Oil Seals, Gaskets

1. Clogged, broken or inoperative crankcase breather.
2. Loose or improperly torqued fasteners.
3. Piston blowby, or leaky valves.
4. 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 (see Section 2). 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 below.

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

To test the crankcase vacuum with the Vacuum/ Pressure Gauge Kit (see Section 2):

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 a minimum of 4 inches of water. If the reading is below the specification, or if pressure is present, check the table below for possible causes and remedies.

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

A compression test is best performed on a warm engine. Clean any dirt or debris away from the base of the spark plugs before removing them. Be sure the choke is off, and the throttle is wide open during the test. Compression should be at least 160 psi and should not vary more than 15% between cylinders.

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.

The Cylinder Leakdown Tester (see Section 2) 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 (TDC) 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

Air Cleaners

General

These engines use a heavy-duty style air cleaner as shown in Figure 4-1, consisting of a cylindrical housing attached to the carburetor and intake manifold. The air cleaner housing contains a paper element and inner element, designed for longer service intervals. The system is CARB/EPA certified and the components should not be altered or modified in any way.

Heavy-Duty Style Air Cleaner

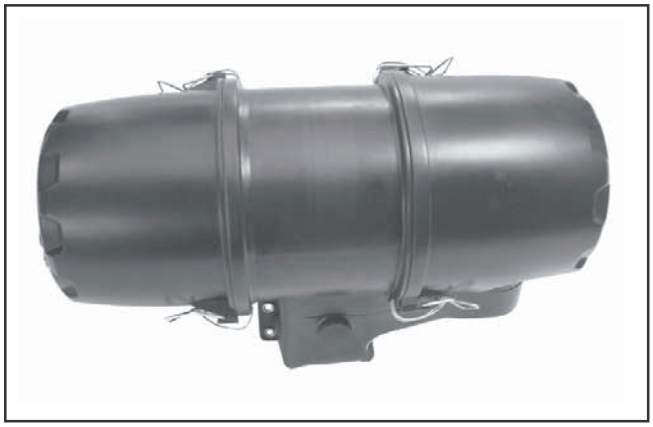


Figure 4-1. Heavy-Duty Style Air Cleaner.

Service

Weekly and every 150 hours: Check filter minder (if equipped), unhook the two retaining clips on each end and remove the end caps. Perform inspection of the paper element and inlet screen area.

Seasonally or every 300 hours of operation (more often under extremely dusty or dirty conditions), replace the paper element and check the inner element. Follow these steps.

1. Unhook the two retaining clips on each end and remove the end caps from the air cleaner housing.
2. Check and clean the screen area on the inlet side. Pull the air cleaner paper element out of the housing on opposite side. See Figures 4-2 and 4-3.

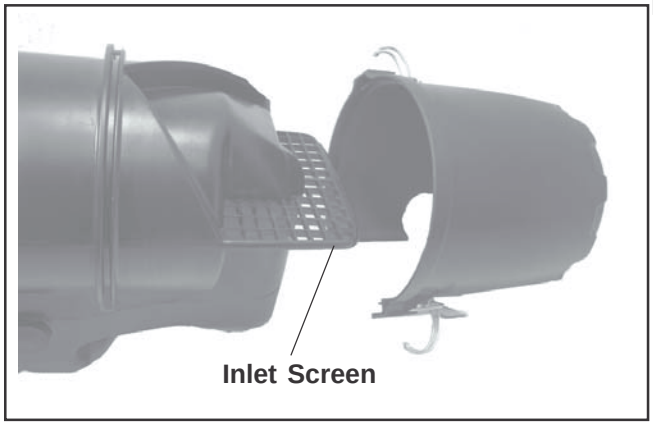


Figure 4-2. Accessing Inlet Screen.

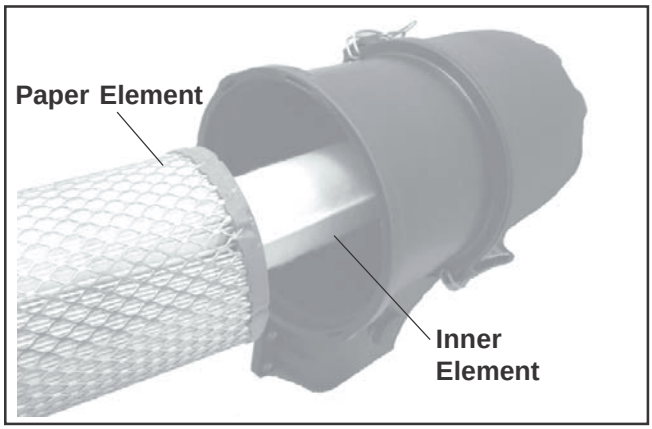


Figure 4-3. Removing Elements.

3. After the paper element is removed, check the condition of the inner element. It should be replaced whenever it appears dirty, typically every other time the paper element is replaced or every **600 hours**. Clean the area around the base of the inner element before removing it, so dirt does not get into the engine.

4. **Do not** wash the paper element and inner element or use compressed air, this will damage the elements. Replace dirty, bent, or damaged elements with new genuine Kohler elements as required. Handle the new elements carefully; do not use if the sealing surfaces are bent or damaged.

5. Check all parts for wear, cracks, or damage, and that ejector area is clean. See Figure 4-4. Replace any damaged components.

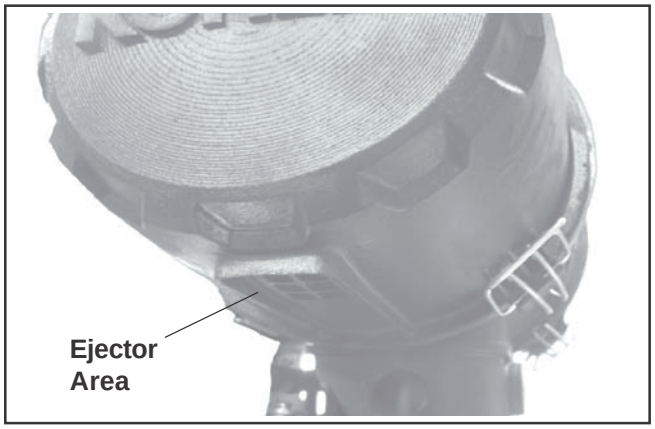


Figure 4-4. Ejector Area.

6. Install the new inner element, followed by the paper element. Slide each fully into place in the air cleaner housing.

7. Reinstall the end caps and secure with the retaining clips. See Figure 4-1.

Air Cleaner Components

Whenever the air cleaner cover is removed, or the paper element or inner element are serviced, check the following:

Air Cleaner Housing - Make sure the housing is not damaged or broken and properly secured**.**

Air Cleaner Inlet - Make sure the air cleaner inlet is secured tightly to the carburetor and not cracked or damaged.

Breather Tube - Make sure the tube is attached to the air cleaner base and the breather 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 Intake/Cooling System

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

Seasonally or every 150 hours of operation (more often under extremely dusty or dirty conditions), remove the cylinder shrouds and blower housing. Clean the cooling fins and external surfaces as necessary. Make sure all shrouds are reinstalled.

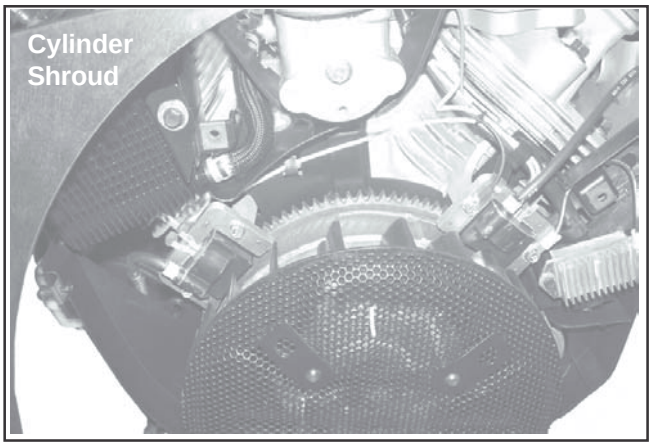


Figure 4-5. Removing Shrouds for Cleaning.

Section 5
Fuel System and Governor

Description

This section covers the standard carbureted fuel system used on these engines. The governor system used 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 and Valve
- 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 that can be used within 30 days and store only in clean, approved containers. Do not use gasoline left over from the previous season, unless treated with a fuel stabilizer (see **Storage** in Section 1), to minimize gum deposits and ensure easy starting. Do not use gasoline containing Methanol, or 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 or higher. In countries using the Research fuel rating method, it should be 90 octane minimum.

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. Leaded gasoline is not recommended .

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.

Fuel Filter

Most engines are equipped with an in-line fuel filter. Periodically inspect the filter and replace with a genuine Kohler filter **seasonally** or **every 150 operating hours**.

Fuel Line

These engines use Low Permeation SAE 30 R7 rated fuel line; certified to meet emission requirements. Standard fuel line may not be used. Order replacement hose by part number through a Kohler Engine Service Dealer.

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: a. Make sure the fuel tank contains clean, fresh, proper fuel. b. Make sure the vent in fuel tank cap is open. c. Make sure the fuel valve is open. d. Make sure the fuel lines to fuel pump are secured and in good condition.	
2. Check for fuel in the combustion chamber. a. Disconnect and ground spark plug leads. b. Close the choke on the carburetor. c. Crank the engine several times. d. Remove the spark plug and check for fuel at the tip.	2. If there **is** fuel at the tip of the spark plug, fuel is reaching the combustion chamber. If there is **no** 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. a. Remove the fuel line from the inlet fitting of the fuel pump. b. Hold the line below the bottom of the tank. Open the shut-off valve (if so equipped) and observe flow.	3. If fuel **does** flow from the line, check for faulty fuel pump (Test 4). If fuel **does not** flow from the line, check the fuel tank cap 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 the fuel pump. a. Remove the fuel line from the inlet fitting of the carburetor. b. Crank the engine several times and observe flow.	4. If fuel **does** flow from the line, check for faulty carburetor. (Refer to the Carburetor portions of this section.) If fuel **does not** 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

These engines use either a mechanical fuel pump, or optional remote-mounted electric fuel pump assembly. See Figures 5-1 and 5-2. Operation of the mechanical fuel pump occurs by direct lever/pump actuation off rocker arm movement. 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, internal check valves prevent fuel from going backward through the pump.

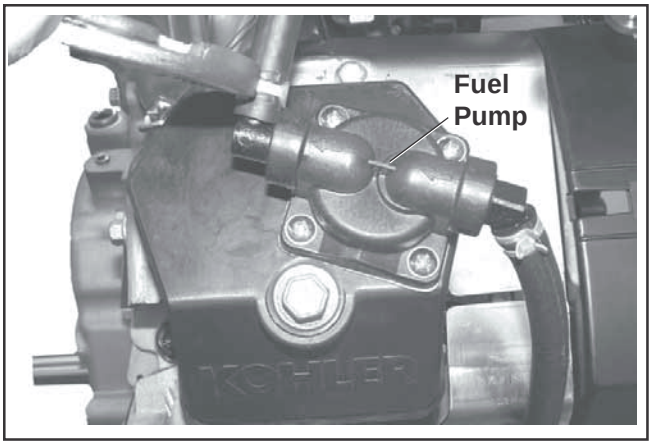


Figure 5-1. Mechanical Fuel Pump.

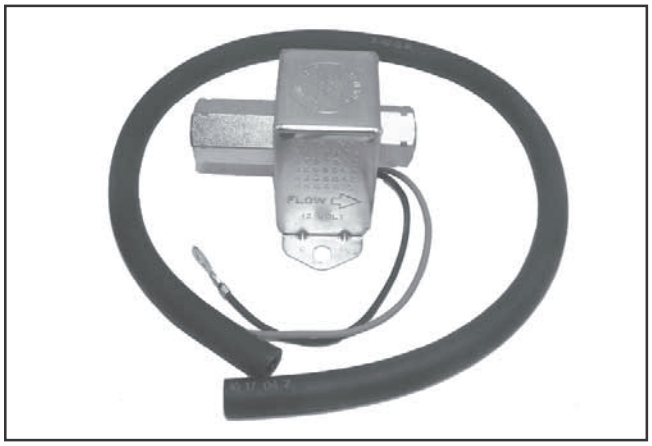


Figure 5-2. Optional Electric Fuel Pump.

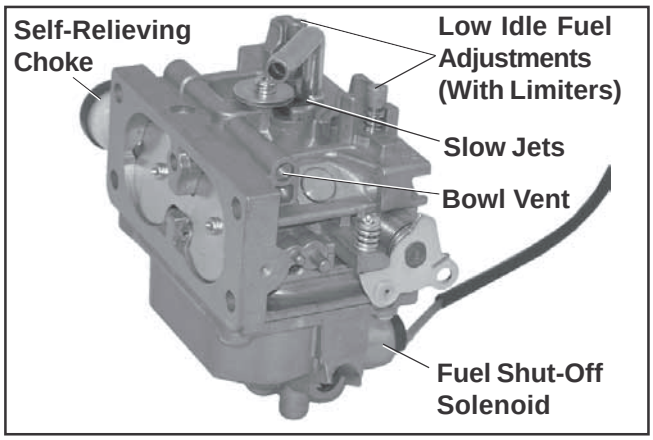


Figure 5-3. Keihin Two-Barrel Carburetor.

Fuel Pump - Replacement

Replacing the Mechanical Fuel Pump

The mechanical fuel pump is an integral part of the valve cover assembly and not serviced separately. See Figure 5-1.

1. Disconnect the fuel lines from the inlet and outlet fittings. Note orientation.
2. Follow the procedure for replacing the valve cover (see Sections 8 and 10).
3. Reconnect the fuel lines to the inlet and outlet fittings and secure with the clamps.

Carburetor

General

Engines in this series are equipped with a Keihin BK two-barrel, side-draft carburetor with fixed main jets on a matching intake manifold. The carburetor features a self-relieving choke, serviceable slow jets, main jets, bowl drain and a fuel shutdown solenoid. See Figure 5-3.

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.

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 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 adjust or service the carburetor.

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. Adjust float according to 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. Adjust float according to 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.

High Altitude Operation

When operating the engine at altitudes of 1500 m (5000 ft.) and above, the fuel mixture tends to get over-rich. This can cause conditions such as black, sooty exhaust smoke, misfiring, loss of speed and power, poor fuel economy, and poor or slow governor response.

To compensate for the effects of high altitude, special high altitude jet kits are available. The kits include new main jets, slow jets (where applicable), necessary gaskets, and O-Rings. Refer to the parts manual for the correct kit number.

Fuel Shut-off Solenoid

Most carburetors are equipped with a fuel shut-off solenoid. The solenoid is attached to the fuel bowl. See Figure 5-4. The solenoid has a spring-loaded pin that retracts when 12 volts is applied to the lead, allowing fuel flow to the main jets. When current is removed the pin extends blocking the fuel flow.

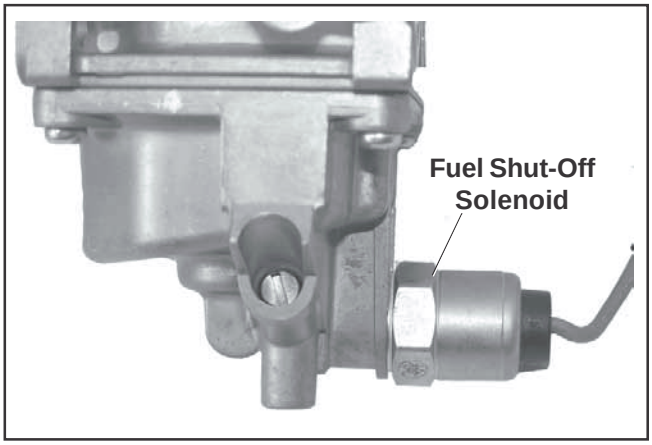


Figure 5-4. Fuel Shut-off Solenoid.

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

1. Shut off 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. You will also need a 12 volt power source that can be switched on and off.

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.

Carburetor Details

The Keihin BK two-barrel carburetor is a side-draft design. The circuits within the carburetor function as described following:

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, rising to the predetermined setting and stop the flow.

Slow & Mid-Range Circuit:

At low speeds the engine operates only on the slow circuit. As a metered amount of air is drawn through the slow air bleed jets, fuel is drawn through the two main jets and further metered through the slow jets. Air and fuel are mixed in the body of the slow jet and exit to the transfer port. From the transfer port the 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 passages. At low idle when the vacuum signal is weak, the air/fuel mixture is controlled by the setting of the idle fuel adjusting screws. 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.

Main (High-Speed) Circuit:

At high speeds/loads the engine operates on the main circuit. As a metered amount of air is drawn through the four air jets, fuel is drawn through the main jets. The air and fuel are mixed in the main nozzles and then enter the main body of airflow, where further mixing of the fuel and air occurs. This mixture is then delivered to the combustion chamber. The carburetor has a fixed main circuit; no adjustment is possible.

Carburetor Adjustments

Adjustment

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

The carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. The main fuel jet is calibrated at the factory and is not adjustable*. The idle fuel adjusting needles are also set at the factory and normally do not need adjustment.

*__NOTE:__ Engines operating at altitudes above approximately 1500 m (5000 ft.) may require a special high altitude main jet. Refer to High Altitude Operation later in this section.

If, however, the engine is hard-starting or does not operate properly, it may be necessary to adjust or service the carburetor.

Low Idle Speed (RPM) Adjustment

1. **Low Idle Speed (RPM) Setting**: Place the throttle control in the **idle** or **slow** position. Set the low idle speed approximately **300 RPM* less** than the intended or specified Governed Idle Speed, by turning the low idle speed adjusting screw in or out. Check the speed using a tachometer. **IMPORTANT: The Governed Idle Speed Adjustment must follow any resetting of the Low Idle Speed.**

   *__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 (± 75 RPM**).

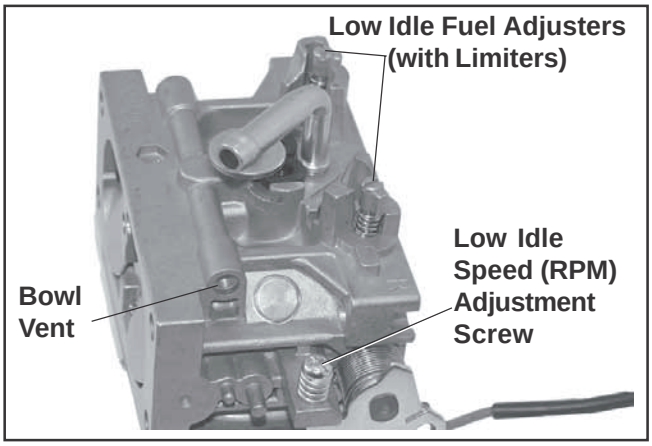


Figure 5-5. Carburetor Adjustment Locations.

Low Idle Fuel Adjustment

NOTE: Engines will have fixed low idle or limiter caps on the two idle fuel adjusting needles. Step 3 can only be performed within the limits allowed by the cap. Do not attempt to remove the limiter caps.

1. Start the engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before doing steps 2, 3, and 4.

2. Place the throttle control into the **idle** or **slow** position. Adjust the low idle speed to 1200 RPM. Follow the Adjusting the Low Idle Speed (RPM) procedure.

3. **Low Idle Fuel Needle(s) Setting:** Place the throttle into the **idle** or **slow** position.

   a. Turn one of the low idle fuel adjusting needles out (counterclockwise) from the preliminary setting until the engine speed decreases (rich). Note the position of the needle. Now turn the adjusting needle in (clockwise). The engine speed may increase, then it will decrease as the needle is turned in (lean). Note the position of the needle. Set the adjusting needle midway between the rich and lean settings. See Figure 5-6.

   b. Repeat the procedure on the other low idle adjustment needle.

4. Recheck/adjust the Low Idle Speed (RPM) to the specified setting.

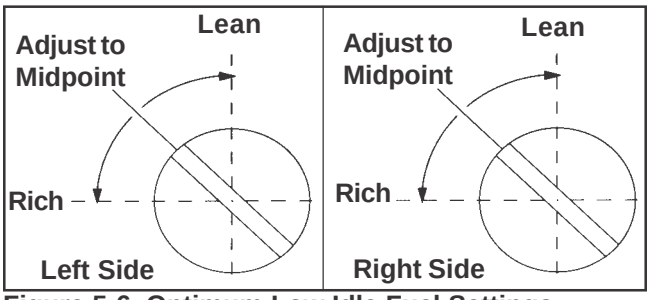


Figure 5-6. Optimum Low Idle Fuel Settings.

Governed Idle System

A governed idle control system is used to maintain a desired idle speed regardless of ambient conditions (temperature, parasitic load, etc.) that may change. An outer secondary spring connected between the governor lever and the governed idle adjuster on the main bracket establishes the governed idle speed. See Figure 5-7.

Governed Idle Speed Adjustment

1. Make sure the governed idle spring is in the outer hole in the governor lever and the hole in the governed idle (outer) adjuster. See Figure 5-7.

2. Make sure the governor spring is in the inner slot of the governor lever and the hole in the high speed (inner) adjuster. See Figure 5-7. Pull the governor lever **away** from carburetor to the limit of its travel and check that the governor spring is loose and not under any tension. See Figure 5-8. Turn the high-speed (RPM) adjustment screw counter-clockwise (if required) until spring is loose.

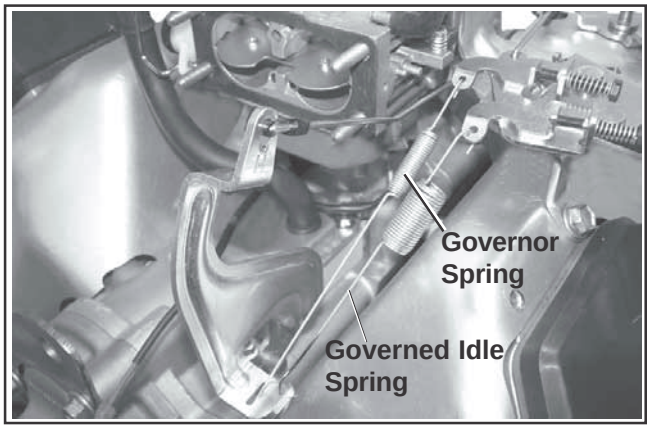


Figure 5-7. Governor Springs Installed.

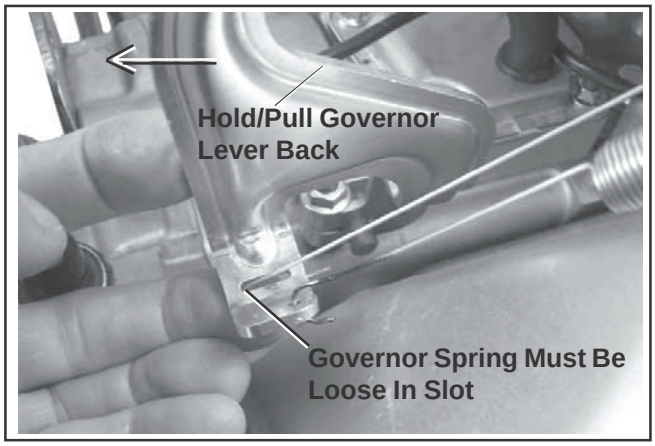


Figure 5-8. Checking Spring Looseness.

3. Hold the governor lever away from the carburetor so the throttle lever is against the idle speed (RPM) adjustment screw of the carburetor. Start the engine and allow to warm up, then adjust the screw to set approximately **1200 RPM**. Check using a tachometer. Turn the adjustment screw (inner) clockwise (in) to increase or counterclockwise (out) to decrease speed.

4. Release the governor lever and check that the throttle lever is in the idle (centered) position. See Figure 5-9. Turn the governed idle (outer) adjustment screw to obtain the equipment manufacturer's recommended idle speed **(1500-1800 RPM)**. The governed idle speed (RPM) is typically 300 RPM (approximate) higher than the low idle speed. See Figure 5-10.

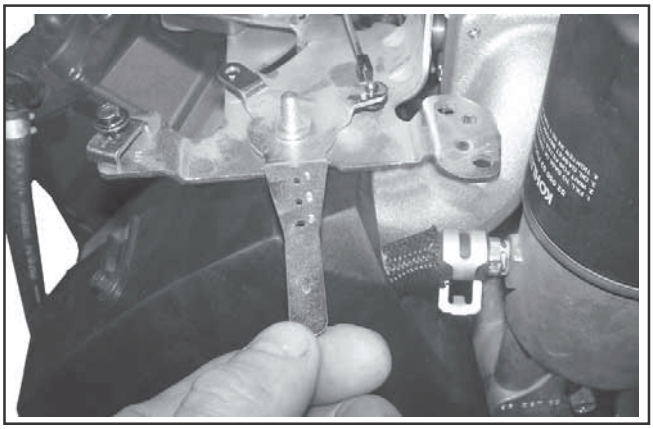


Figure 5-9. Throttle Lever in Idle Position.

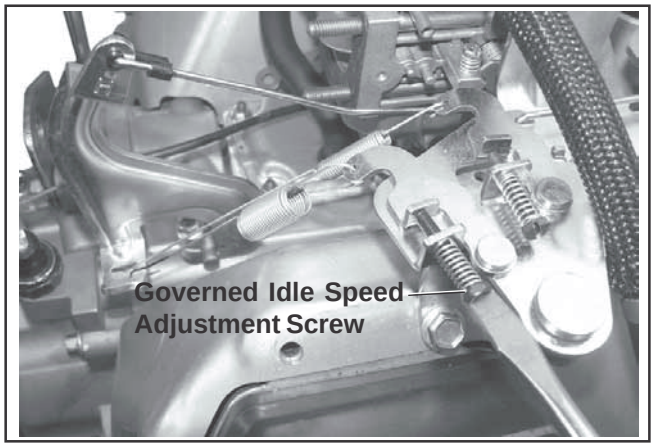


Figure 5-10. Setting Governed Idle Speed RPM (Air Cleaner Removed For Clarity).

5. Move the throttle lever to the wide-open/full throttle position and hold in this position. Check the RPM using a tachometer. Turn the high speed screw to obtain the intended high speed no-load RPM. **The governed idle speed must be set before making this adjustment.** See Figure 5-11.

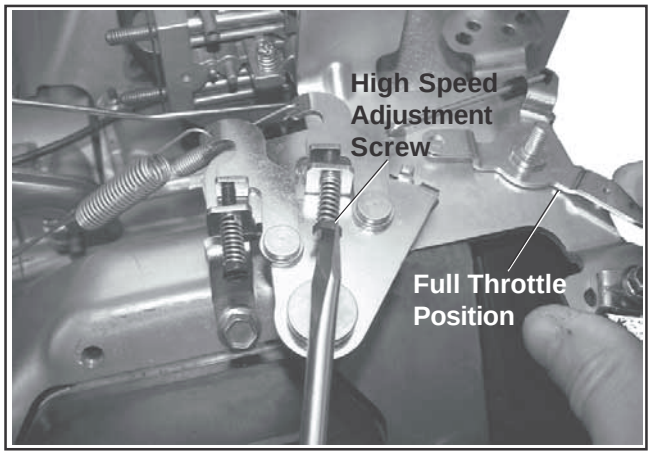


Figure 5-11. Setting High Speed RPM (Air Cleaner Removed for Clarity).

Carburetor Servicing

The following section covers the disassembly, various servicing procedures, and reassembly of the carburetor. For each procedure carefully inspect all components and replace those that are worn or damaged. The following should also be noted as service is performed.

- 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.

- The choke plate is spring loaded. Check to make sure it moves freely on the shaft.

NOTE: The main and slow jets are fixed and side specific and can be removed if required. Fixed jets for high altitudes are available.

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 the float, pin, float valve, clip, and screw.

1. Perform the removal procedures for the appropriate air cleaner and the carburetor outlined in Section 8 Disassembly.

2. Clean the exterior surfaces of dirt or foreign material before disassembling the carburetor. Remove the four mounting screws and carefully separate the fuel bowl from the carburetor. Do not damage the fuel bowl O-Rings. Transfer any remaining fuel into an approved container. Save all parts. Fuel can also be drained prior to bowl removal by loosening/removal of the bowl drain screw. See Figure 5-12.

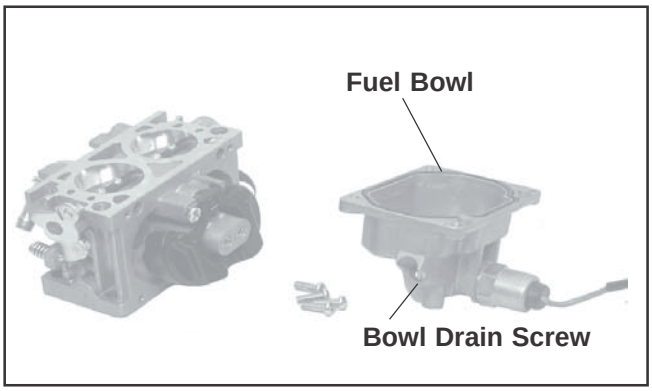


Figure 5-12. Fuel Bowl Removed From Carburetor.

3. Remove the float pin screw and lift out the old float, pin and inlet needle. See Figure 5-13. Discard all of the parts. The seat for the inlet needle is not serviceable, and should not be removed.

4. Clean the carburetor bowl and inlet seat areas as required, before installing the new parts.

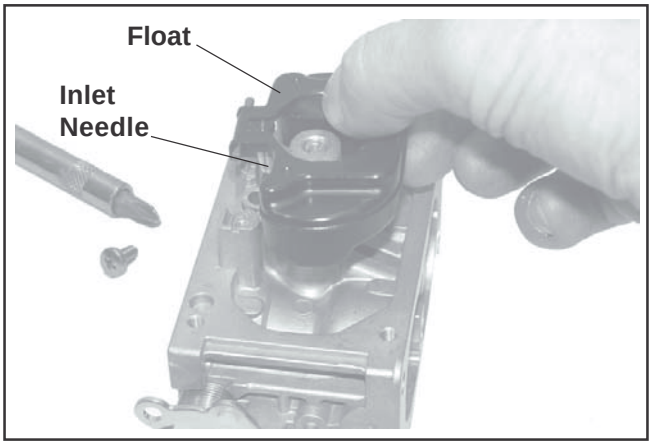


Figure 5-13. Removing Float and Inlet Needle.

5. Attach the inlet needle to the plastic tang of the float with the wire clip. The formed 90° lip should point up, with the needle valve hanging down. See Figure 5-14.

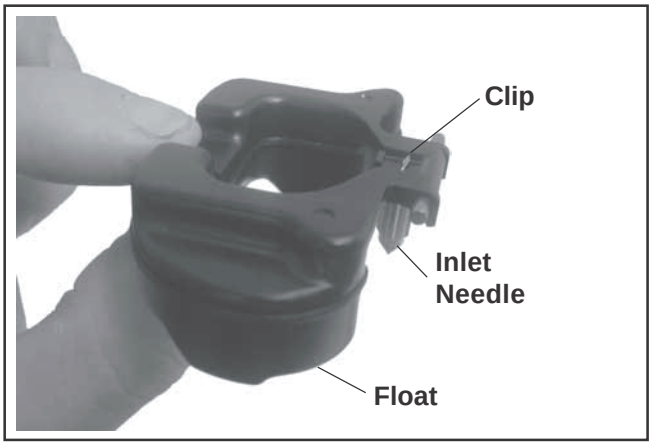


Figure 5-14. Float and Inlet Needle Details.

6. Install the float and inlet needle down into the seat and carburetor body. Install the new pivot pin through the float hinge and secure with the new retaining screw. See Figure 5-15.

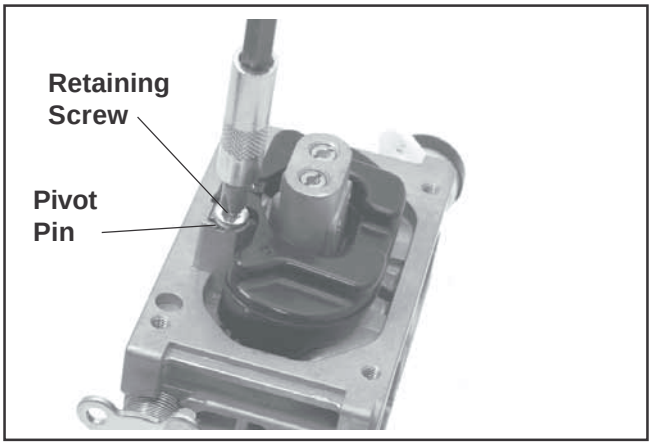


Figure 5-15. Installing Float Assembly.

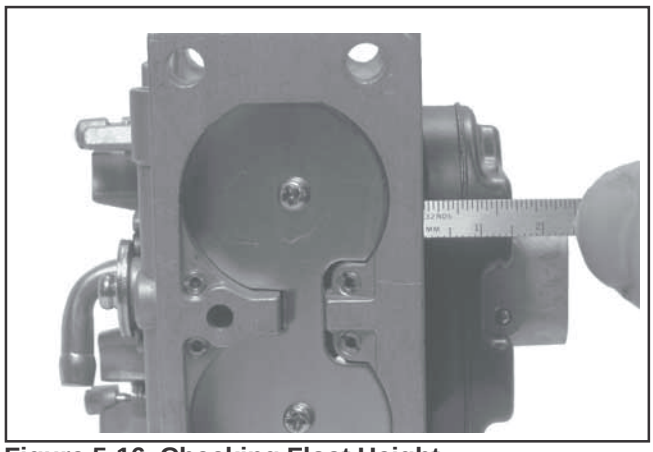


Figure 5-16. Checking Float Height.

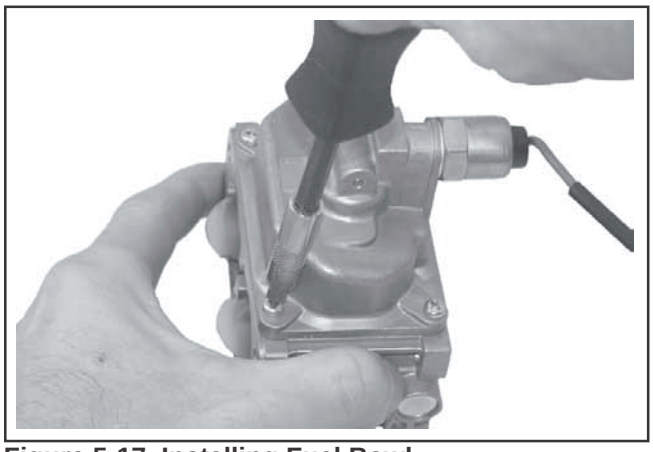


Figure 5-17. Installing Fuel Bowl.

7. 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 rests against the fuel inlet needle without depressing the center pin.

8. The correct float height setting is **17 mm (0.669 in.) ± 1.5 mm (0.059 in.)**, measured from the float bottom to the body of the carburetor. See Figure 5-16. Replace the float if the height is different than specified. **DO NOT** attempt to adjust by bending float tab.

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

9. When the proper float height is obtained, carefully reinstall the fuel bowl onto the carburetor, using new O-Rings. Secure with the four original screws. Torque the screws to **2.5 ± 0.3 N·m (23 ± 2.6 in. lb.)**. See Figure 5-17.

10. Install the carburetor and reassemble the engine as outlined in Section 10 Reassembly.

5

Disassembly/Overhaul

1. Clean the exterior surfaces of dirt or foreign material before disassembling the carburetor. Remove the four mounting screws and separate the fuel bowl from the carburetor. Transfer any remaining fuel into an approved container. Remove and discard the old O-Rings. Fuel can also be drained prior to bowl removal by loosening/removal of the bowl drain screw. See Figure 5-18.

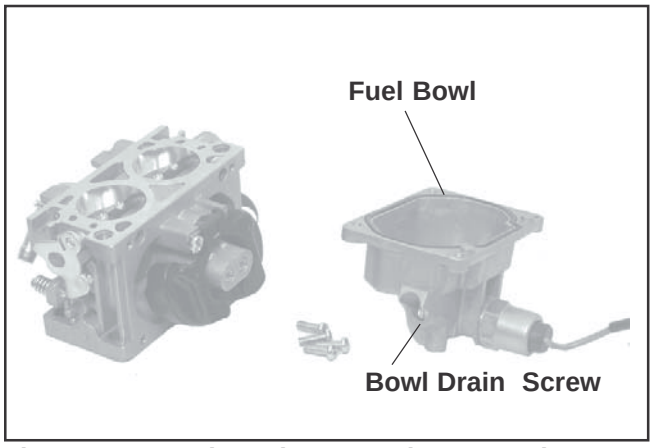


Figure 5-18. Fuel Bowl Removed From Carburetor.

NOTE: Further disassembly of the fuel bowl is not necessary unless the Fuel Solenoid Kit, or Fuel Bowl Kit (obtained separately), will also be installed.

2. Remove the float pin screw and lift out the old float, pin, and inlet needle. See Figure 5-19. Discard all the old parts. The seat for the inlet needle is not serviceable, and should not be removed.

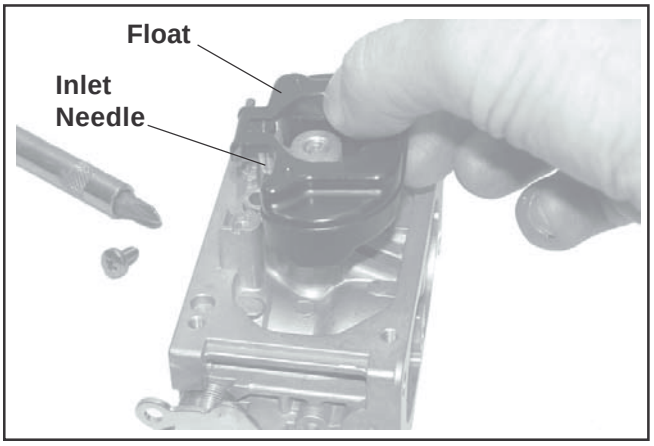


Figure 5-19. Removing Float and Inlet Needle.

3. Use an appropriate size flat screwdriver, and carefully remove the two main jets from the carburetor. Note and mark the jets by location for proper installation. The main jets may be size/side specific. After the main jets are removed, the main nozzles can be removed out through the bottom of the main towers. Note the orientation/direction of the nozzles. The end with the two raised shoulders should be out/down adjacent to the main jets. Save the parts for cleaning and reuse. See Figure 5-20.

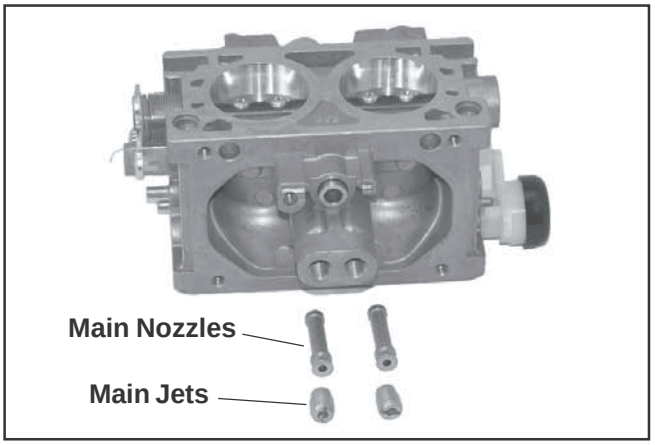


Figure 5-20. Main Jets and Nozzles Removed.

4. Remove the screw securing the flat washer and ground lead (if equipped), from the top of the carburetor; then carefully pull (lift) out the two slow jets. The slow jets may be sized/side specific. Mark or tag the jets for proper reassembly. Note the small O-Ring on the bottom of each jet. See Figure 5-21 and 5-22. Save parts for cleaning and reuse unless a Jet Kit is also being installed. Clean the slow jets using compressed air. Do not use wire or carburetor cleaner.

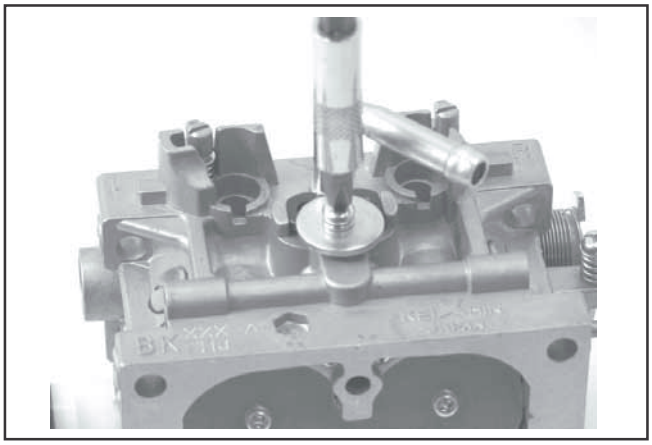


Figure 5-21. Removing Screw and Washer.

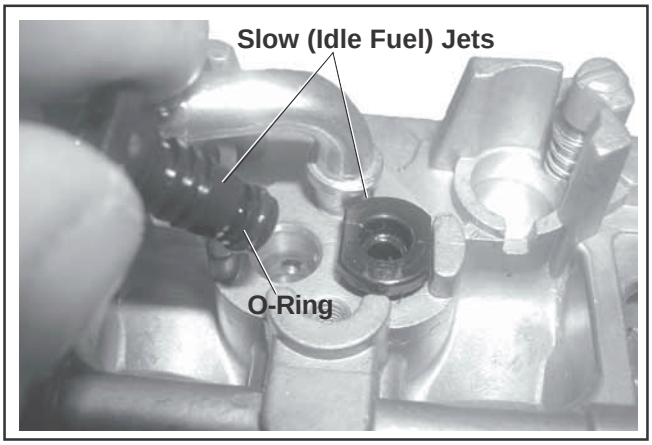


Figure 5-22. Slow Jets and O-Ring Detail.

5. Remove the idle speed (RPM) adjustment screw and spring 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, idle fuel adjustment screws with limiter, and carburetor body, 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, main jets, vent ports, seats, etc., using a good commercially available carburetor solvent. Keep away from plastic or rubber parts if non-compatible. Use clean, dry compressed air to blow out the internal channels and ports. Do not use metal tools or wire to clean orifices and jets. 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 fuel bowl as required.

8. Install the two main nozzles into the towers of the carburetor body. The end of the main nozzles with the two raised shoulders should be out/down (adjacent to the main jets). Make sure the nozzles are completely bottomed. Carefully install the main jets into the towers of the carburetor body on the appropriate side, as identified when removal was performed. See Figure 5-23.

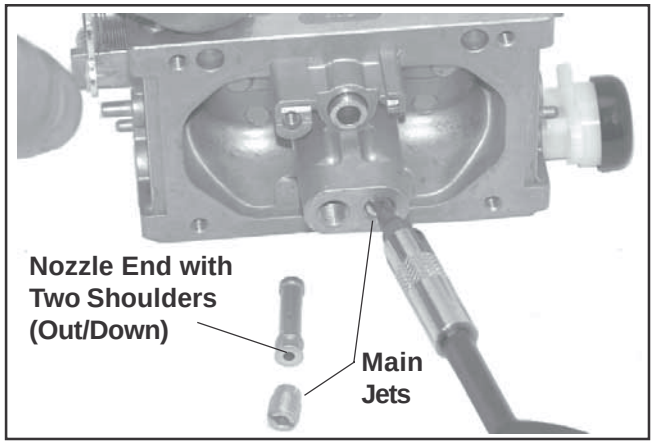


Figure 5-23. Installing Main Nozzles and Main Jets.

9. Make sure the O-Ring near the bottom of each slow jet is new, or in good condition. Align and insert the two slow jets into the top of the carburetor. See Figure 5-22.

10. Install the large flat retaining washer and secure with the mounting screw, attaching the ground lead if originally secured by the screw.

11. Install the new idle speed (RPM) adjustment screw and spring onto the carburetor. Thread in until 3 or 4 threads are exposed, as an initial adjustment. See Figure 5-24.

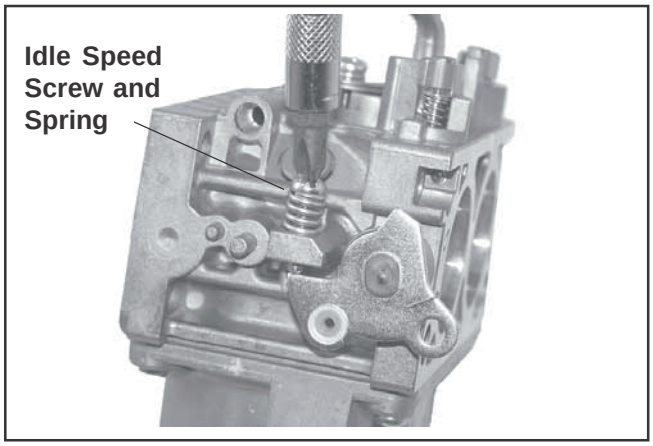


Figure 5-24. Installing Idle Speed Adjusting Screw and Spring.

12. Attach the inlet needle to the plastic tang of the float with the wire clip. The formed 90° lip should point up, with the needle valve hanging down. See Figure 5-25.

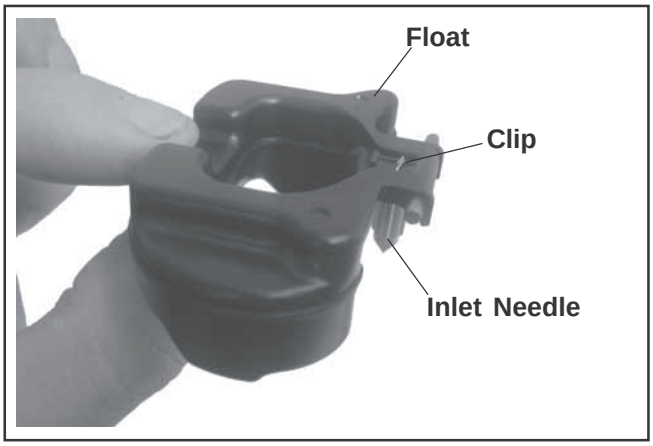


Figure 5-25. Float and Inlet Needle Details.

13. Install the float and inlet needle down into the seat and carburetor body. Install the new pivot pin through the float hinge and secure with the new retaining screw. See Figure 5-26.

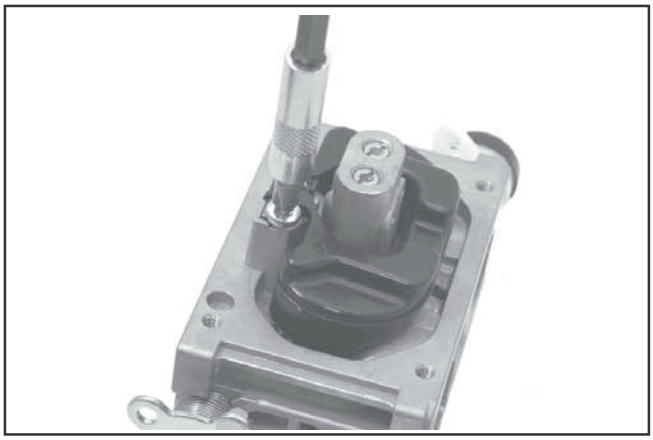


Figure 5-26. Installing Float Assembly.

14. 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 rests against the fuel inlet needle without depressing the center pin.

15. The correct float height setting is **17 mm (0.669 in.) ± 1.5 mm (0.059 in.)**, measured from the float bottom to the body of the carburetor. See Figure 5-27. Replace the float if the height is different than specified. Do not attempt to adjust by bending the float tab.

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

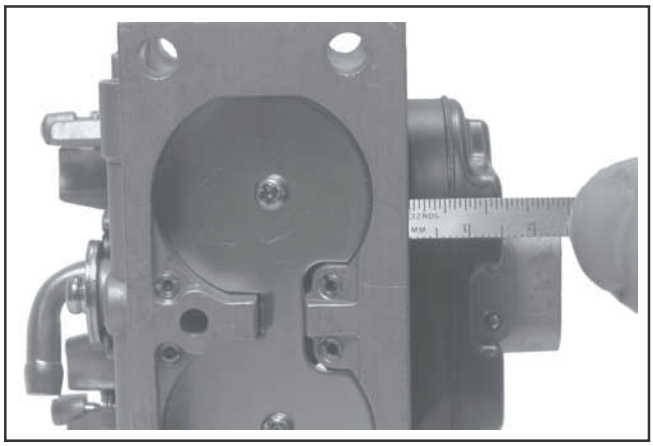


Figure 5-27. Checking Float Height.

16. When the proper float height is obtained, carefully reinstall the fuel bowl, using new O-Rings onto the carburetor. Secure with the four original screws. Torque the screws to **2.5 ± 0.3 N·m (23 ± 2.6 in. lb.)**. See Figure 5-28.

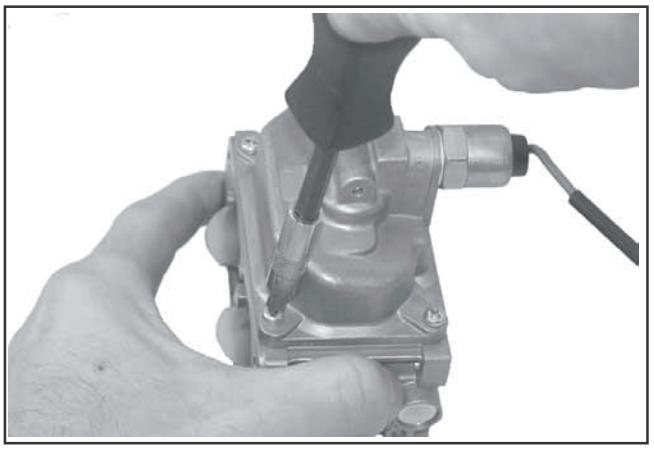


Figure 5-28. Installing Fuel Bowl.

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 end of the choke lever/shaft assembly.

4. Note the position of the spring legs and the choke plate for correct reassembly later. See Figure 5-29. Remove the two screws attaching the choke plate to the choke shaft. Pull the shaft out of the carburetor body, note the preload of spring and discard the removed parts.

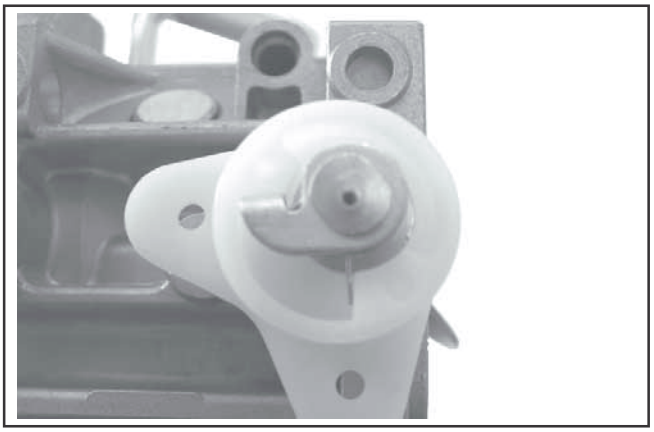


Figure 5-29. Choke Details.

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 the protruding boss on the carburetor housing is between the two stops formed in the choke lever. See Figure 5-30.

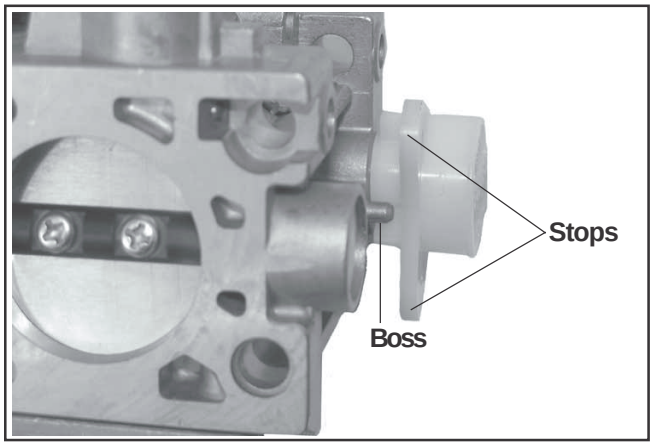


Figure 5-30. Assembling Choke Lever.

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 5-31.

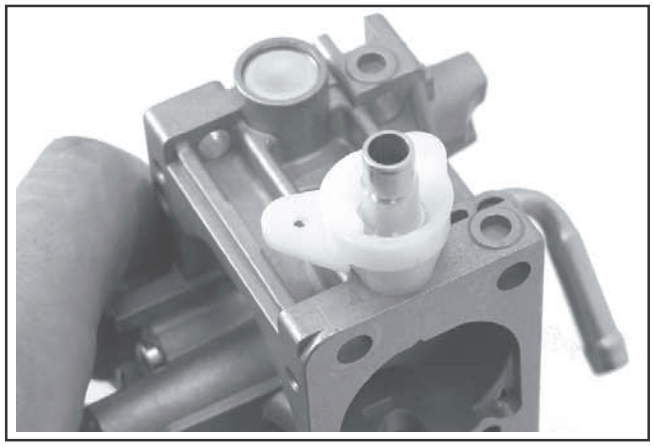


Figure 5-31. Installing Bushing.

9. Install the new return spring onto the new choke shaft, so the outboard leg of the spring is behind the formed stop on the end of the choke shaft. See Figure 5-32.

   NOTE: Make sure it stays in this location during the following step.

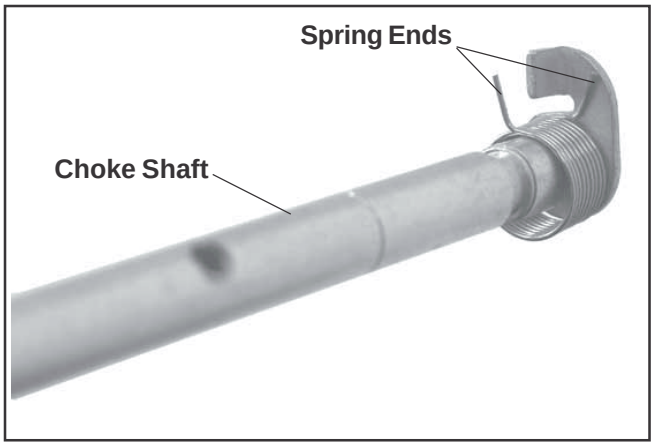


Figure 5-32. Choke Shaft and Spring Details.

10. Slide the choke shaft and spring into the carburetor. Pivot (preload) the shaft 3/4 turn counterclockwise with the inner leg of the spring against the formed stop within the choke lever as originally assembled. See Figures 5-29 and 5-33. The outer leg of the spring must still be behind the formed stop of the choke shaft.

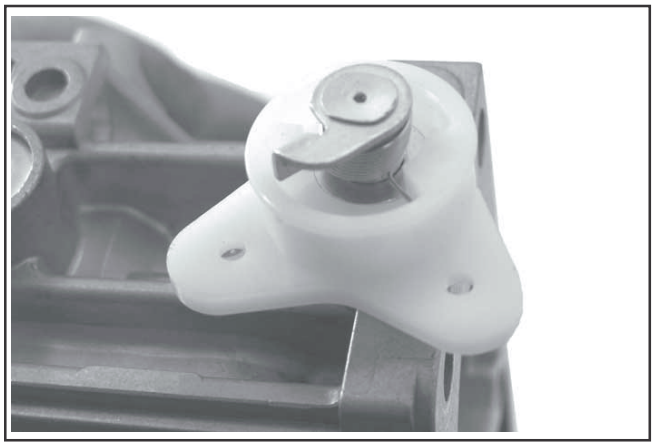


Figure 5-33. Installing Choke Assembly Components.

11. Place a drop of Loctite® on the threads of each new screw. Position and install the new choke plate to the flat side of the choke shaft. Start the two screws. Close the choke and check the plate alignment within the carburetor throat, then tighten the screws securely. **Do not** overtighten. See Figure 5-34.

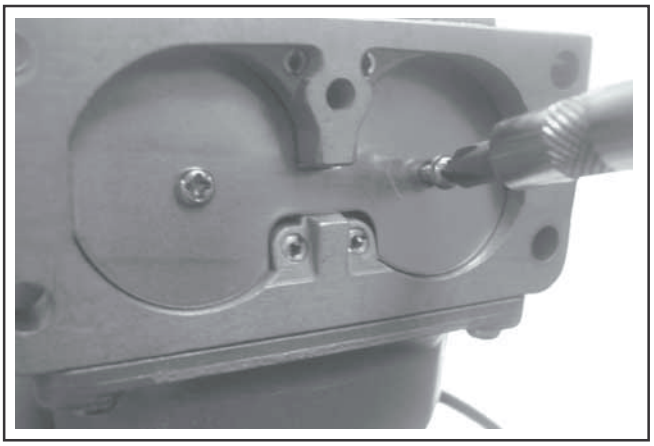
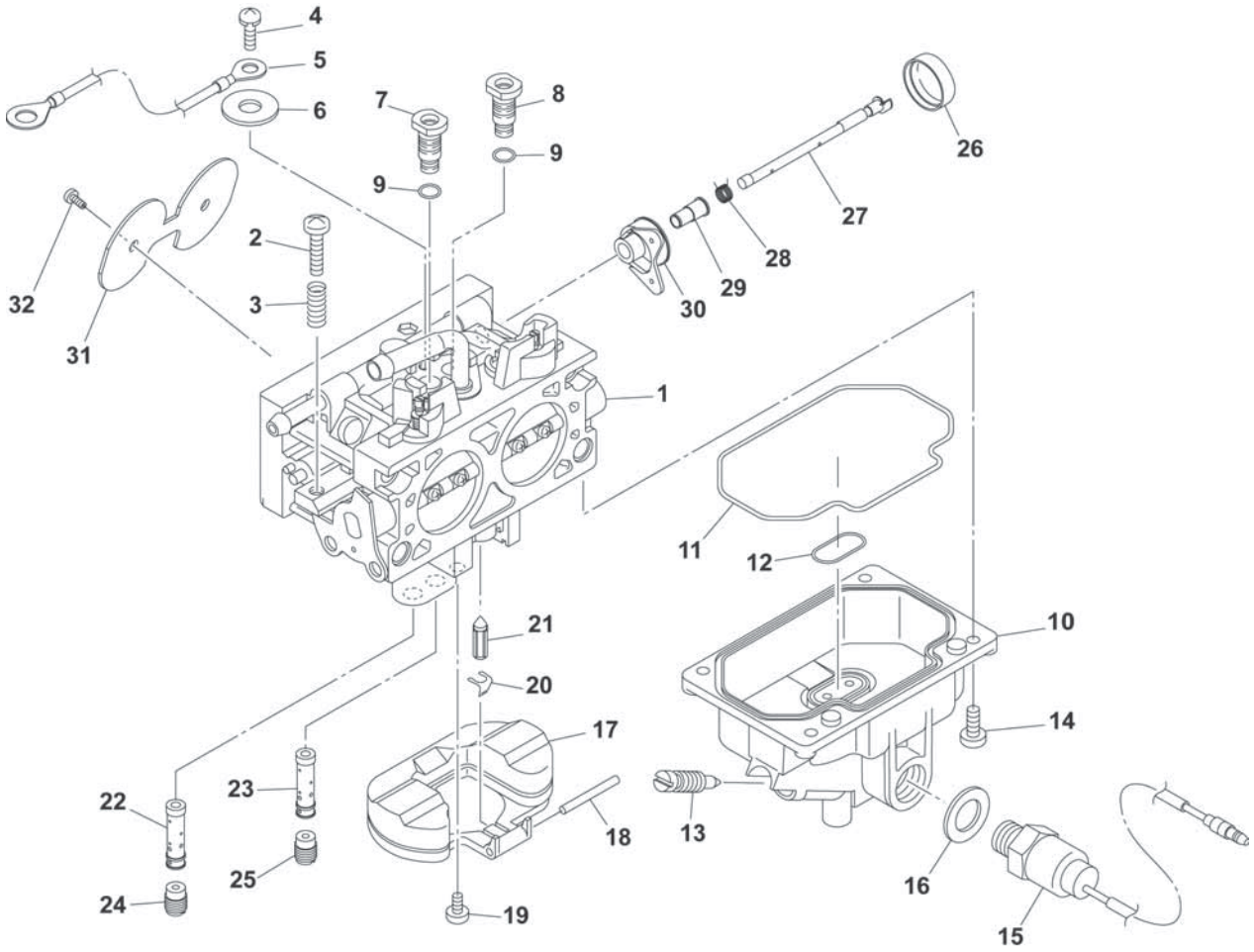


Figure 5-34. Installing Choke Plate.

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 BK two-barrel carburetors and affiliated components are:

Carburetor Overhaul Kit
Float Kit
Fuel Solenoid Kit
Bowl Kit
High Altitude Kit (1525-3048 m/5,000-10,000 ft.)
High Altitude Kit (Over 3048 m/10,000 ft.)



1. Carburetor Body Subassembly
2. Idle Speed Screw
3. Idle Speed Spring
4. Screw
5. Ground Lead
6. Retaining Washer
7. Slow Jet - RH Side
8. Slow Jet - LH Side
9. O-Ring (Slow Jet) (2)
10. Fuel Bowl
11. O-Ring (Fuel Bowl - Upper)
12. O-Ring (Fuel Bowl - Lower)
13. Drain Screw
14. Bowl Screw (4)
15. Fuel Solenoid
16. Sealing Washer
17. Float
18. Pin
19. Screw
20. Float Clip
21. Float Valve/Inlet Needle
22. Main Nozzle - Right Side
23. Main Nozzle - Left Side
24. Main Jet - Right Side
25. Main Jet - Left Side
26. Choke Dust Cap
27. Choke Shaft
28. Spring
29. Bushing
30. Choke Lever
31. Choke Plate
32. Choke Plate Screw (2)

Figure 5-35. Keihin BK Two-Barrel Carburetor - Exploded View.

Governor

General

The governor is designed to hold the engine speed constant under changing load conditions. Most engines are equipped with a centrifugal flyweight mechanical governor. The governor gear/flyweight mechanism of the mechanical governor is mounted inside the crankcase and is driven off the gear on the camshaft. This governor design 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 throttle linkage. See Figure 5-36.

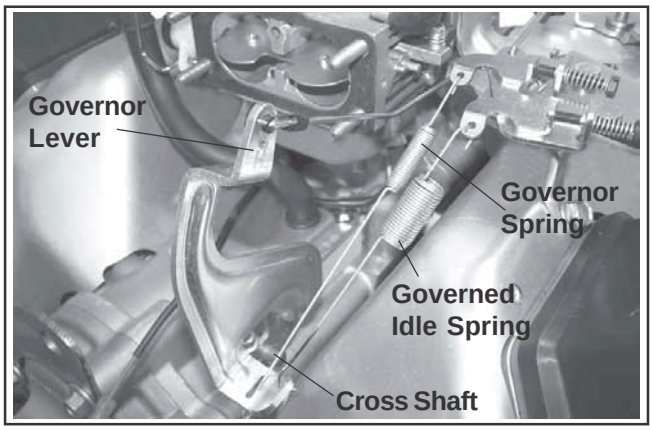


Figure 5-36. Governor Linkage (Air Cleaner Removed for Clarity).

- 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 arm to open the throttle plate wider. This allows more fuel into the engine, increasing the engine speed. As the 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

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

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.

Initial Adjustment Procedure

Make this adjustment whenever the governor arm is loosened or removed from the cross shaft. See Figure 5-36 and adjust as follows:

1. Make sure the throttle linkage is connected to the governor arm 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 go (wide open throttle) and hold in this position.

4. Insert a long thin rod or tool into the hole on the cross shaft and rotate the shaft clockwise (viewed from the end) as far as it will turn, then torque the hex nut to **7.3 N·m (65 in. lb.)**.

High Speed (RPM) Adjustment

1. With the engine running, move the throttle control to **fast**. Use a tachometer to check the RPM speed.

2. Turn the inner adjustment screw outward to decrease, or inward to increase the RPM speed. Check RPM with a tachometer.

3. Stop when the desired RPM speed is obtained.

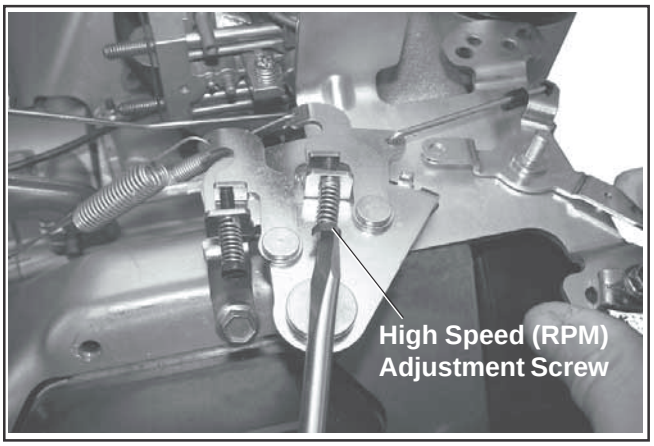


Figure 5-37. High Speed RPM Adjustment (Air Cleaner Removed For Clarity.

Section 6
Lubrication System

General

This engine uses a full pressure lubrication system. This system delivers oil under pressure to the crankshaft, camshaft, and connecting rod bearing surfaces. In addition to lubricating the bearing surfaces, the lubrication system supplies oil to the hydraulic valve lifters.

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

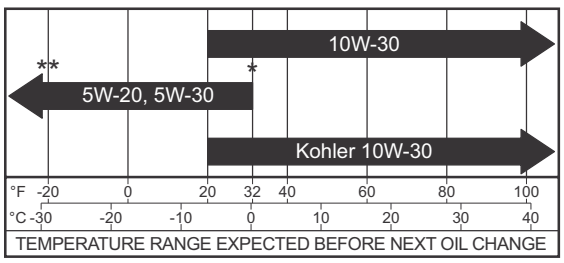
Service

The closure plate must be removed to service the oil pickup, the pressure relief valve, and the oil pump. Refer to the appropriate procedures in Sections 8, 9, and 10.

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. It is also recommended that a consistent brand of oil be used. Failure to use the correct oil, or using dirty oil, causes premature engine wear and failure.

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



* 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 SG, SH, 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 portion 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.

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 is cool so the oil has had time to drain into the sump.

2. Clean the area around the dipstick before removing it. This will help to keep dirt, grass clippings, etc., out of the engine.

3. Remove the dipstick; wipe oil off. Reinsert the dipstick into the tube until fully seated. See Figure 6-2.

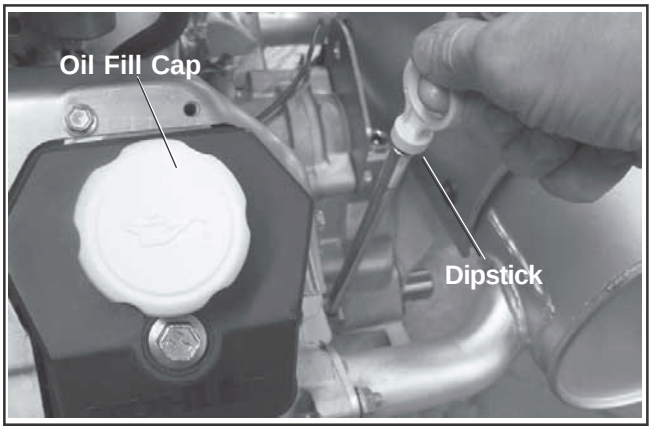


Figure 6-2. Dipstick and Oil Fill Cap Locations

4. Remove dipstick and check oil level. The level should be between the ''F'' and ''L'' marks. If low, remove the oil fill cap and add oil of the proper type up to the "F" mark. Reinstall oil fill cap and dipstick.

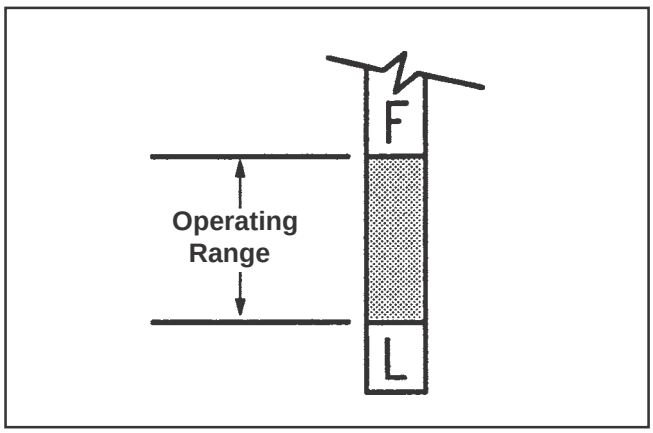


Figure 6-3. Oil Level Marks on Dipstick.

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 below the ''L" mark or above the ''F" mark on the dipstick.

Changing Oil and Oil Filter

Changing Oil

Change oil **seasonally or every 150 hours** of operation, (more frequently under severe conditions). Refill with service class SG, SH, SJ, or higher oil as specified in the Viscosity Grades table on page 6.1.

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 as follows:

1. Clean the areas around one of the drain plugs, oil fill cap, and dipstick.

2. Remove one of the oil drain plugs, oil fill cap, and dipstick. Be sure to allow ample time for complete drainage.

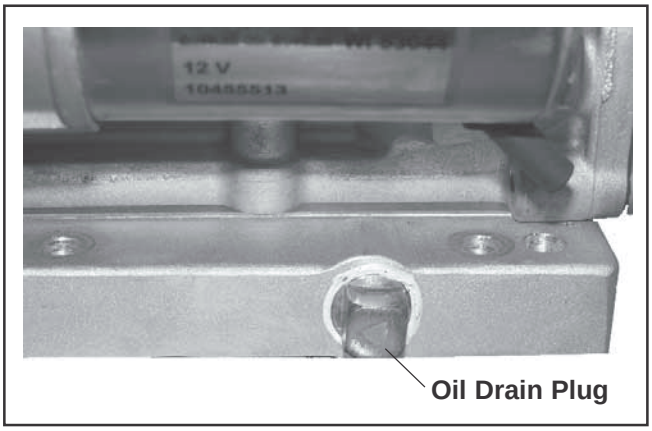


Figure 6-4. Oil Drain Plug (Starter Side).

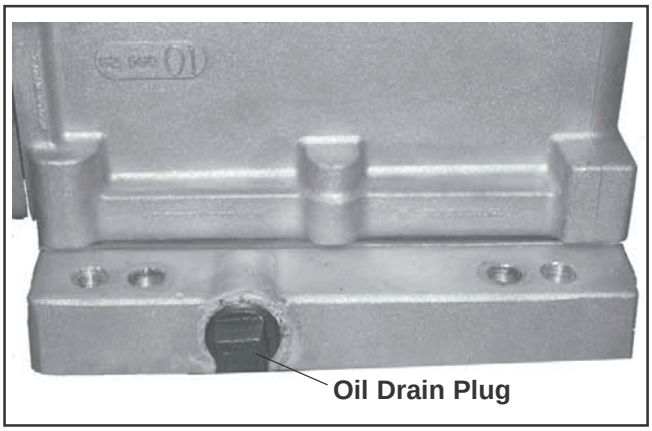


Figure 6-5. Oil Drain Plug (No. 2 Side).

3. Reinstall the drain plug and torque to **21.4 N·m (15.7 ft. lb.)**.

4. Fill the crankcase, with new oil of the proper type, to the "F" mark on the dipstick. Refer to Oil Type on page 6.1. Always check the level with the dipstick before adding more oil.

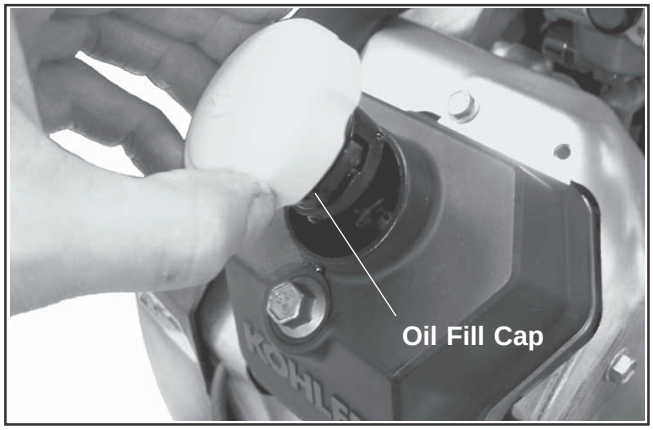


Figure 6-6. Removing Oil Fill Cap.

5. Reinstall the oil fill cap and tighten securely. Reinstall dipstick.

Changing Oil Filter

Replace the oil filter **seasonally (150 hours)**, or at least every other oil change (**every 300 hours** of operation). Always use a genuine Kohler oil filter. The oil filter on most engines is located on top of the crankcase between the cylinders. Some models use a remote mounted oil filter. See Figures 6-7 and 6-8.

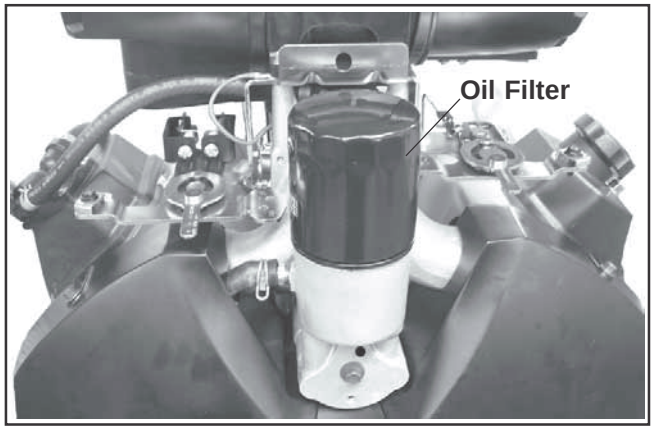


Figure 6-7. Engine Mounted Oil Filter.

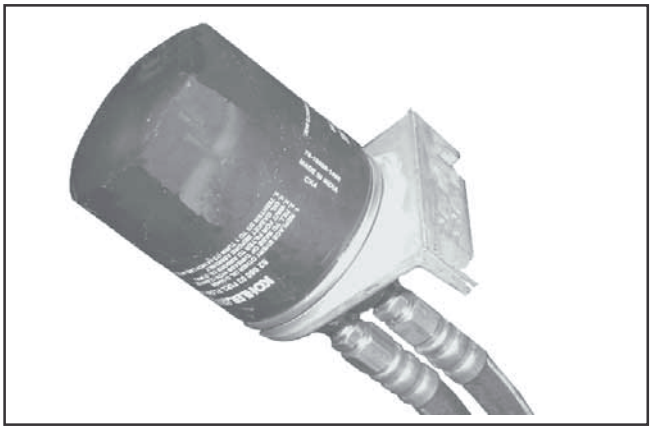


Figure 6-8. Optional Remote Mounted Oil Filter.

Replace the oil filter as follows:

1. Before removing the oil filter, clean the area around the oil filter and housing to keep dirt and debris out of the engine. Remove the old filter. On crankcase mounted oil filter housings, a spring loaded inner cup allows automatic oil drainback into the crankcase as the oil filter is removed. Wipe off the surface where the oil filter mounts.

2. Drain the oil from the engine crankcase.

3. Allow ample time for the oil to drain from the crankcase.

4. Reinstall the drain plug and torque to **21.4 N·m (15.7 ft. lb.)**.

5. Apply a thin film of clean oil to the rubber gasket on the new filter. Partial prefilling of the oil filter is recommended.

6. Install the replacement oil filter to the filter adapter or oil cooler. Turn the oil filter clockwise until the rubber gasket contacts the oil filter housing (not inner cup), then tighten the filter an additional **3/4-1 turn**.

7. Fill the crankcase with new oil of the proper type to the "F" mark on the dipstick.

8. Start the engine and check for oil leaks. Correct any leaks before placing the engine into service. Check oil level to be sure it is up to but not over the "F" mark.

Service Oil Cooler

These engines are equipped with an oil cooler mounted under the No. 2 side cylinder shroud, separate from the oil filter. See Figure 6-9.

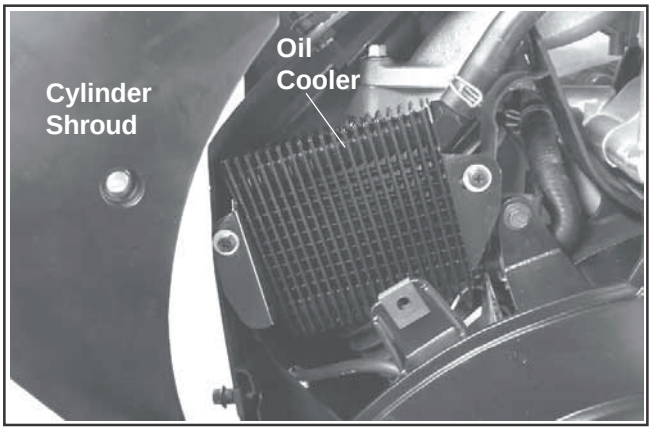


Figure 6-9. Oil Cooler.

Inspect and clean the oil cooler every **150 hours of operation** (more frequently under severe conditions). In order to be effective, the oil cooler must be kept free of debris.

To service the oil cooler, clean the outside of fins with a brush, vacuum, or compressed air. If required, remove the two screws holding the cooler unit to the backing shroud asseembly. Carefully pull the cooler outward and clean the underside. After cleaning, reinstall the oil cooler to the backing shroud with the two mounting screws.

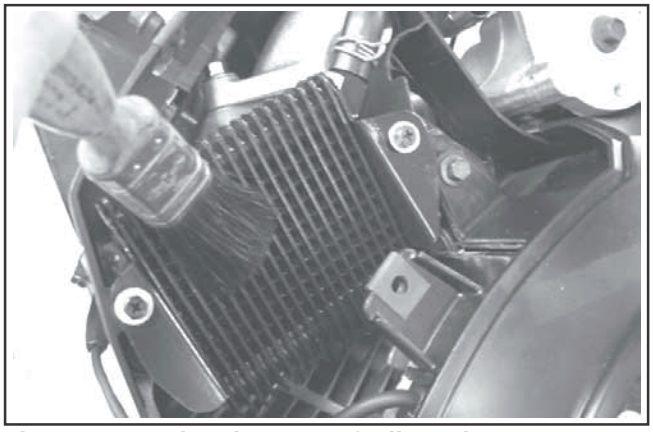


Figure 6-10. Cleaning Top of Oil Cooler.

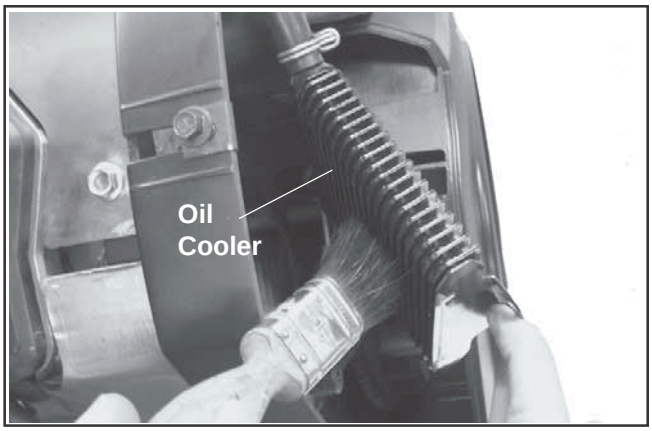


Figure 6-11. Cleaning Underside of Oil Cooler.

Oil Sentry™

General

Some engines are equipped with an optional Oil Sentry™ oil pressure monitor switch. See Figure 6-12. If the oil pressure drops below an acceptable level, the Oil Sentry™ will either shut off the engine or activate a warning signal, depending on the application.

The pressure switch is designed to break contact as the oil pressure increases above 7-11 psi, and make contact as the oil pressure decreases below 7-11 psi.

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 "F" mark on the dipstick. This includes engines equipped with Oil Sentry™ .

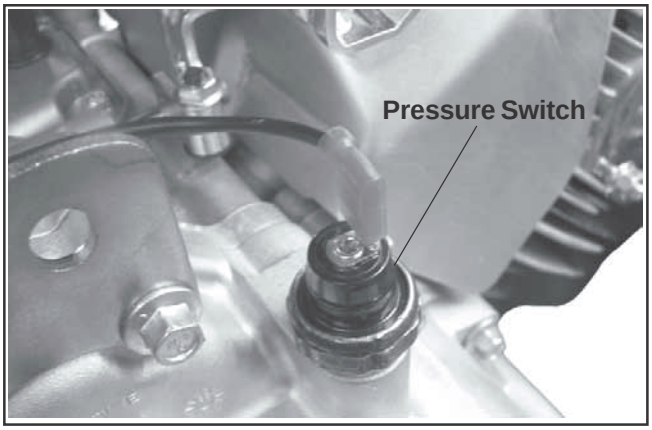


Figure 6-12. Oil Sentry™ Pressure Switch.

Installation

The Oil Sentry™ pressure switch is installed in the closure plate pressure port. See Figure 6-12. On engines not equipped with Oil Sentry™ the installation hole is sealed with a 1/8-27 N.P.T.F. pipe plug.

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 closure plate. See Figure 6-12.

3. Torque the switch to **10.1 N·m (90 in. lb.)**.

Testing

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 the pressure increases through the range of **7-11 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 **7-11 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
- 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® XC10YC (Kohler Part No. 62 132 04-S). Equivalent alternate brand 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

Every **200 hours** of operation, remove each spark plug. Check its condition and either reset the gap or replace with a new plug as necessary. Replace spark plugs every **600 hours.** To service the plugs, perform the following steps:

1. Before removing each spark plug, clean the area around the base of the plug to keep dirt and debris out of the engine.

2. Remove the plug and check its condition. See Inspection following this procedure. Replace the plug if necessary.

   NOTE: Do not clean spark plug 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.

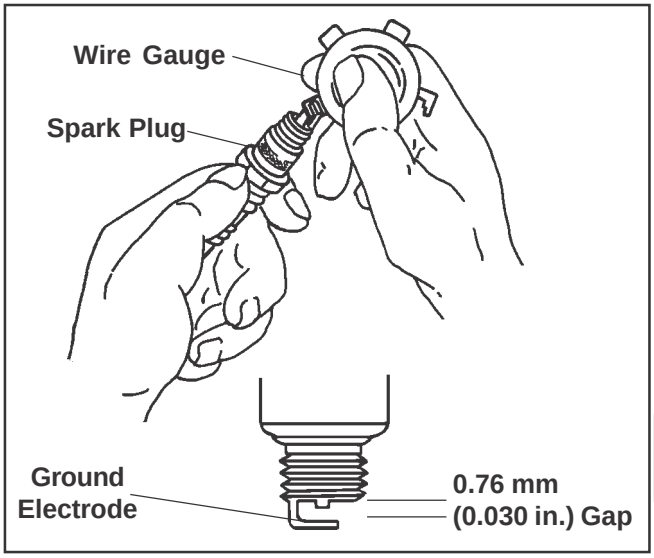


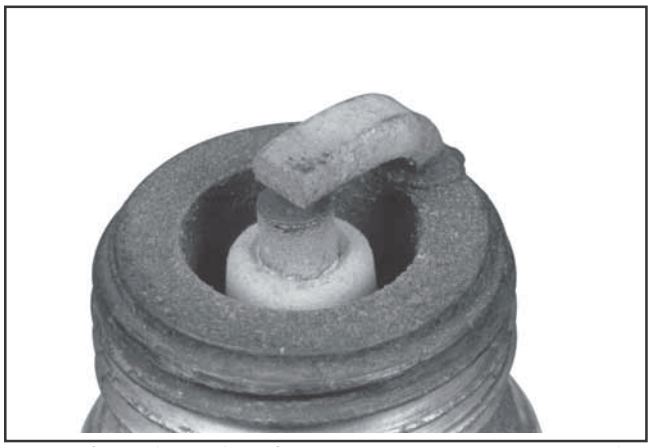
Figure 7-1. Servicing Spark Plug.

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:

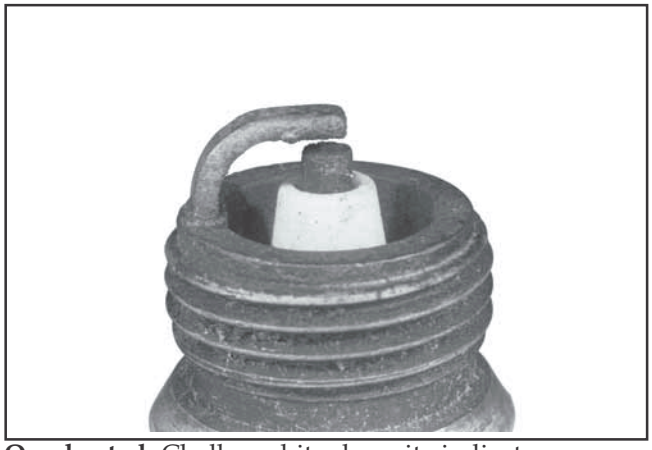


Normal: A plug taken from an engine operating under normal conditions will have light tan or gray colored deposits. If the center electrode is not worn, a plug in this condition could be set to the proper gap and reused.

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

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.

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, worn piston rings, or valve guides.



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.

Battery

General

A 12-volt battery with 400 cold cranking amps (cca) 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 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 of the equipment this engine powers for specific battery requirements.

Battery Size Recommendations

Temperature	Battery Required
Above 32°F (0°C)	300 cca minimum
0°F to 32°F (-18°C to 0°C)	300 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 insufficient 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.

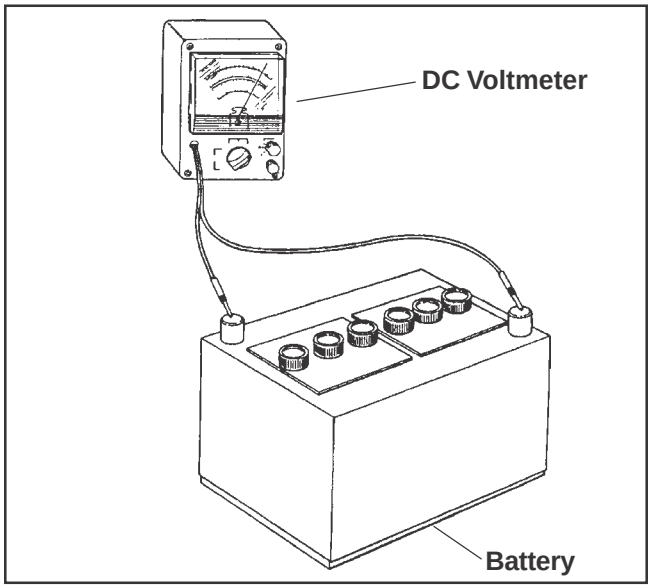


Figure 7-2. Battery Voltage Test.

Electronic CD Ignition System

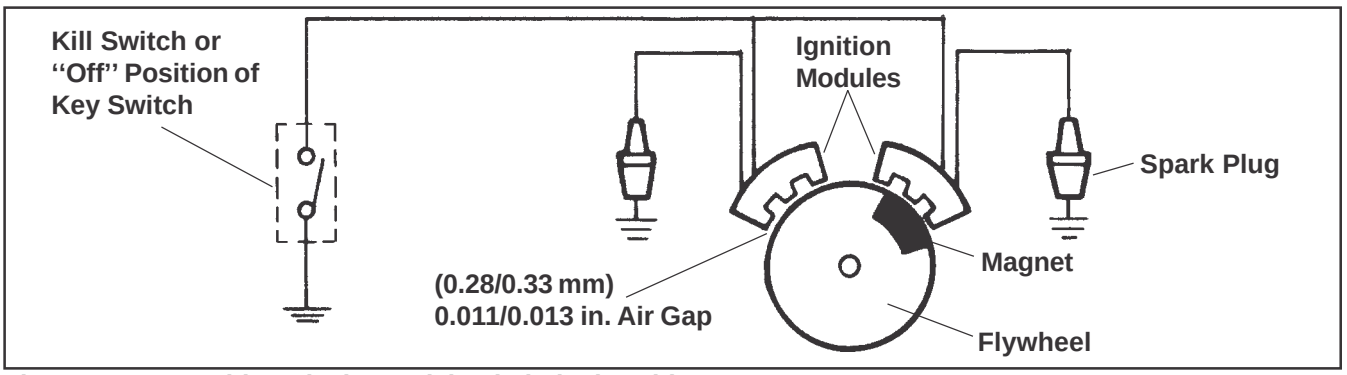


Figure 7-3. Capacitive Discharge (Fixed Timing) Ignition System.

Operation of CD Ignition System

Capacitive Discharge with Fixed Timing

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 (Figure 7-3) which mount on the engine crankcase .
- A kill switch (or key switch) which grounds the modules to stop the engine.
- Two spark plugs.

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

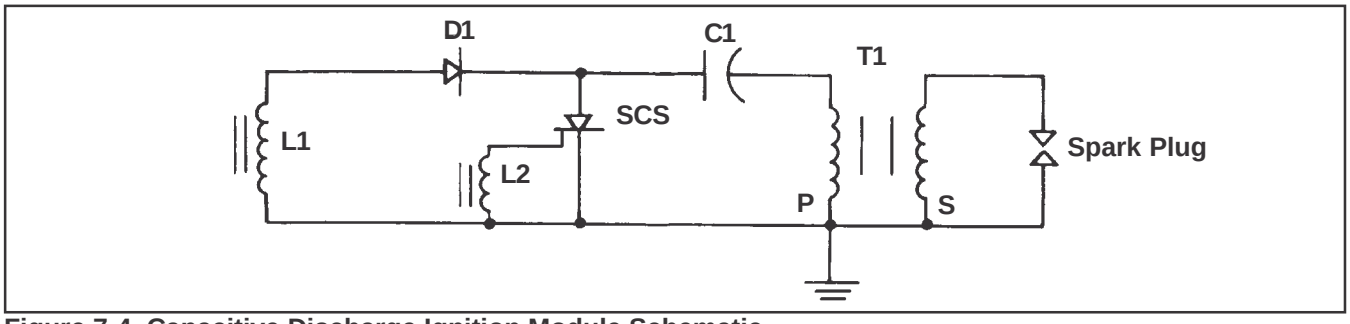


Figure 7-4. Capacitive Discharge Ignition Module Schematic.

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.

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.

    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.

**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.

2. Test for spark on both cylinders with Kohler ignition tester (see Section 2). 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.

Battery Charging System

General

Most engines are equipped with a 15, 20, or 25 amp regulated charging system. See Figures 7-5, 7-6, 7-7, and 7-8.

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.

15/20/25 Amp Regulated Charging System

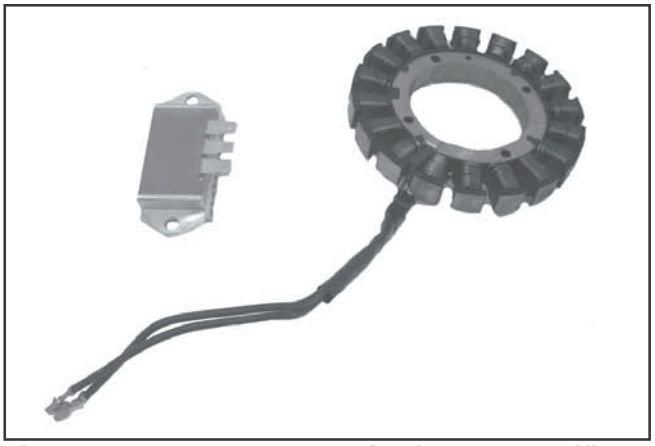


Figure 7-5. 25 Amp Stator and 20/25 AmpRectifier-Regulator.

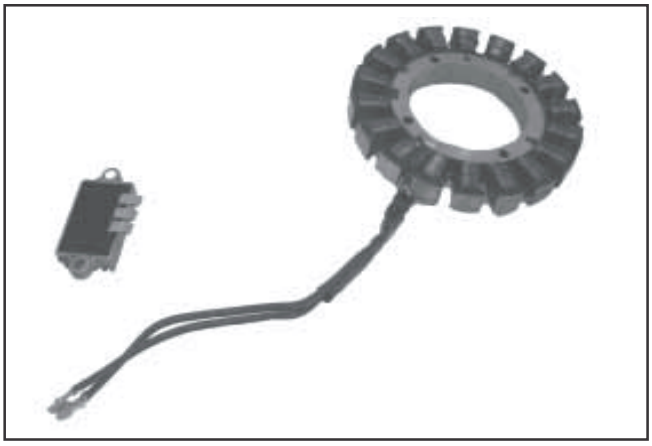


Figure 7-6. 15 Amp Stator and Rectifier-Regulator.

NOTE: 20 amp charging systems use a 15 amp stator with a 25 amp rectifier-regulator.

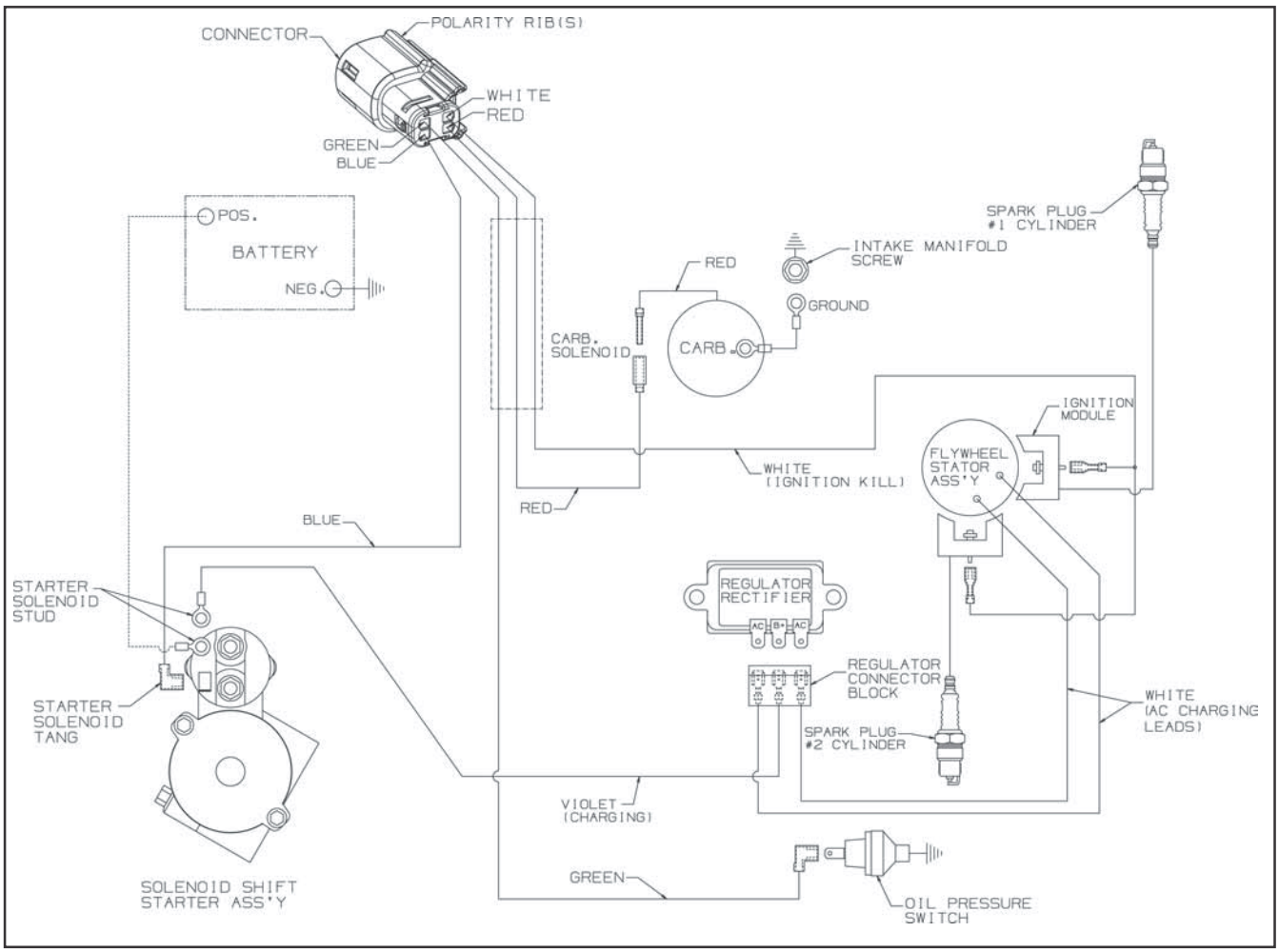


Figure 7-7. Wiring Diagram-15/20/25 Amp Regulated Battery Charging System with Fixed Timing, Four Pin Connector.

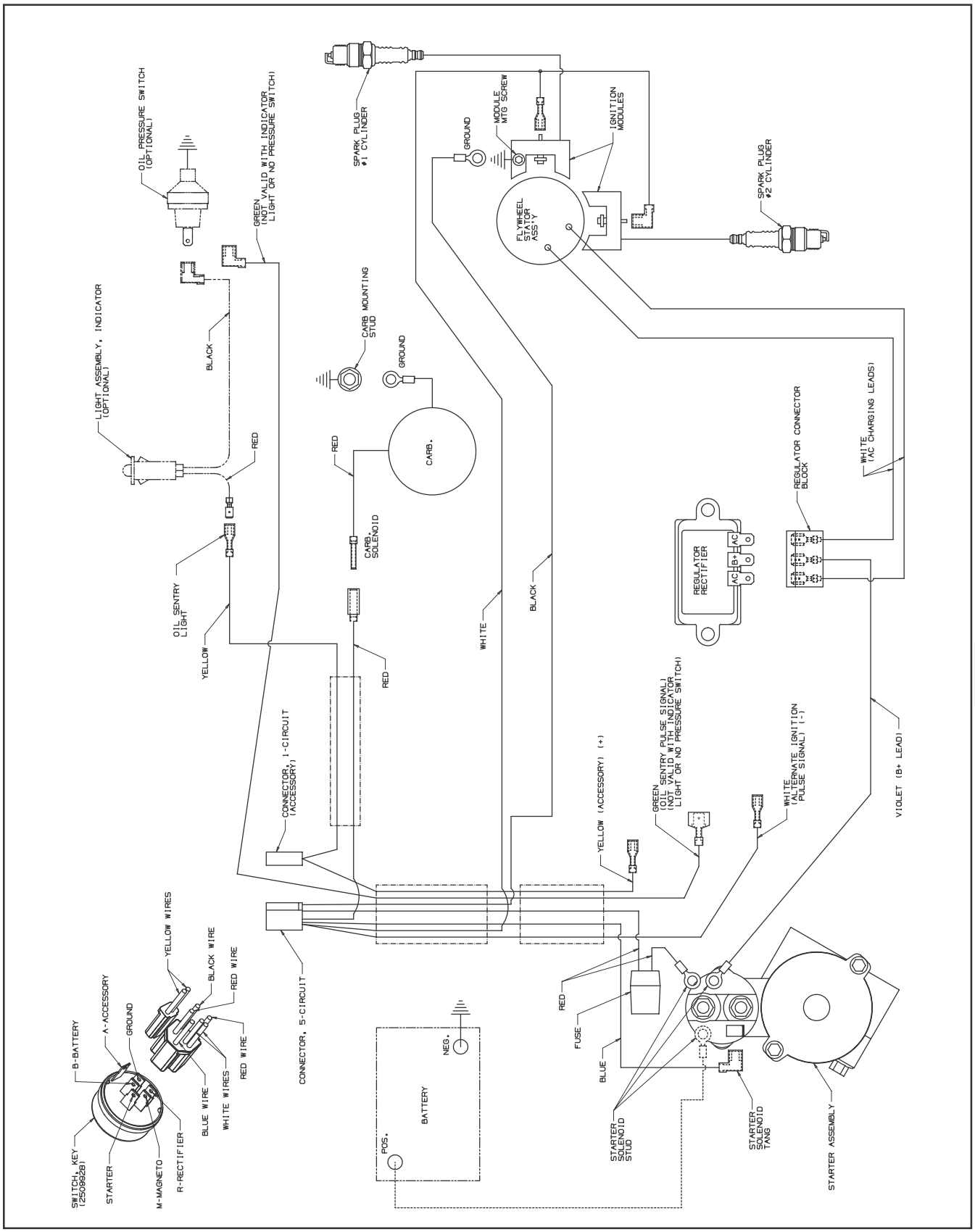


Figure 7-8. Wiring Diagram15/20/25 Amp Regulated Battery Charging System with Fixed Timing, Five Pin Connector, Key Switch, and Fuse.

Stator

The stator is mounted on the crankcase behind the flywheel. Follow the procedures in Section 9 - Disassembly and Section 11 - Reassembly if stator replacement is necessary.

Rectifier-Regulator

The rectifier-regulator is mounted on the backing shroud assembly. See Figure 7-9. To replace it, disconnect the plug, remove the two mounting screws, and ground lead.

NOTE: When installing the rectifier-regulator, take note of the terminal positions and install the plug correctly.

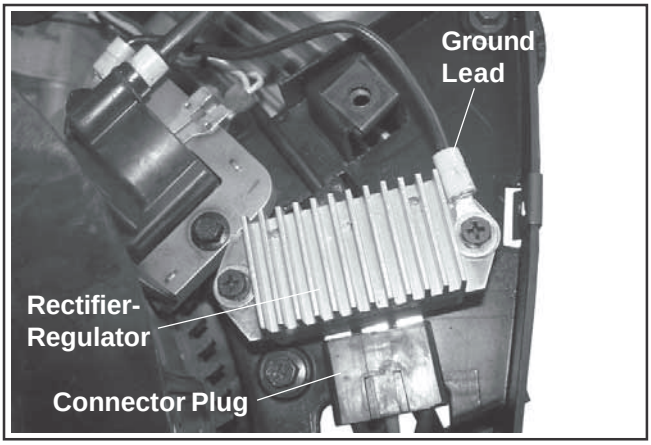


Figure 7-9. Rectifier-Regulator.

Testing of the rectifier-regulator may be performed as follows, using the appropriate Rectifier-Regulator Tester (see Section 2).

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.

20/25 Amp Rectifier-Regulators

1. Connect the single lead adapter in between the B+ (center) terminal of rectifier-regulator being tested and the squared single end of the tandem adapter lead. See Figure 7-10.

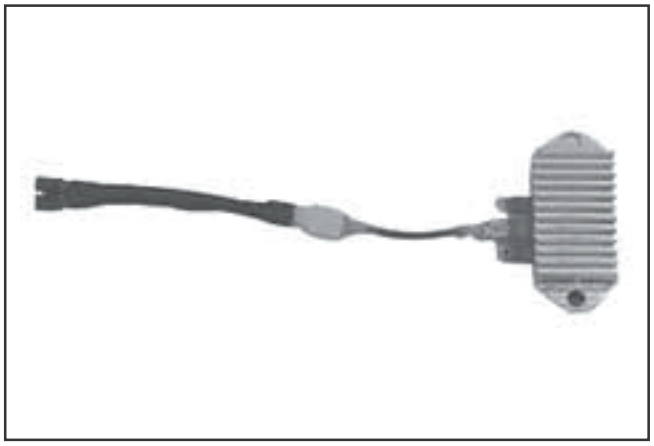


Figure 7-10. Connected Adapter.

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 7-11.

Figure 7-11. Connected Tester.

5. Plug the tester into the proper AC outlet/power for tester being used. 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 7-12. This **does not** represent the condition of the part.

Figure 7-12. Powered Tester.

6. Press the TEST button until a click is heard and then release. See Figure 7-13. Momentarily one of the four lights will illuminate indicating the **partial condition** of the part.

Figure 7-13. Pressing Test Button.

   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.

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 7-14.

Figure 7-14. Tester Connected to 15 Amp Rectifier-Regulator.

3. Plug the tester into the proper AC outlet/power for tester being used. Turn on the power switch. See Figure 7-12. 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.

4. Press the TEST button until a click is heard and then release. See Figure 7-13. Momentarily one of the four status lights will illuminate, indicating the condition of the part.

   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.

Troubleshooting Guide

15/20/25 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.**

Problem	Test	Conclusion
No Charge to Battery	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 **28 volts or more,** stator is OK. Rectifier-regulator is faulty. Replace the rectifier-regulator. If voltage is **less than 28 volts,** 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 **0.064/0.2 ohms,** the stator is OK. If the resistance is **infinity ohms,** 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 **infinity ohms** (no continuity), the stator is OK (not shorted to ground). If resistance (or continuity) **is measured,** the stator leads are shorted to ground. Replace stator.
Battery Continuously Charges at High Rate	1. Perform same test as step 1 above.	1. If the voltage is **14.7 volts or less** the charging system is OK. The battery is unable to hold a charge. Service battery or replace as necessary. If voltage is **more than 14.7 volts,** the rectifier-regulator is faulty. Replace rectifier-regulator.

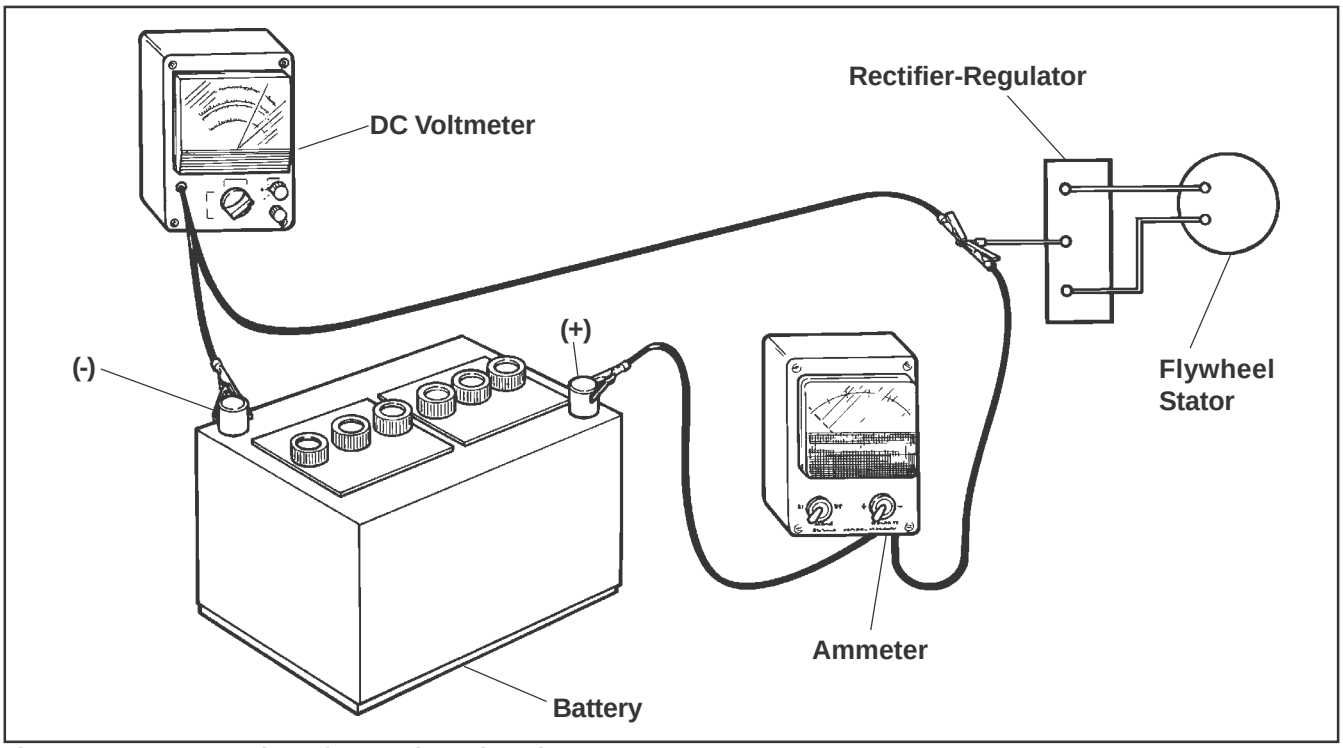


Figure 7-15. Connections for Testing Charging System.

Electric Starting Motors

The engines in this series use solenoid shift starters. A Delco-Remy solenoid shift starter is typically used.

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.

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.

Troubleshooting Guide – Starting Difficulties

Problem	Possible Fault	Correction
Starter Does Not Energize	Battery	1. Check the specific gravity of the battery. If low, recharge or replace battery as necessary.
	Wiring	1. Clean corroded connections and tighten loose connections. 2. Replace wires in poor condition and with frayed or broken insulation.
	Starter Switch or Solenoid	1. By-pass the switch or solenoid with a jumper wire. If starter cranks normally, replace the faulty components. Remove and perform individual solenoid test procedure. See pages 7.20 and 7.21.
Starter Energizes but Turns Slowly	Battery	1. Check the specific gravity of the battery. If low, recharge or replace battery as necessary.
	Brushes	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.
	Transmission or Engine	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.

Delco-Remy Starters

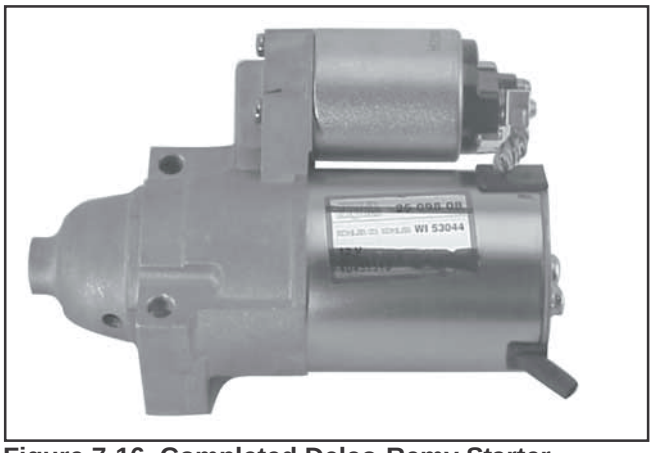


Figure 7-16. Completed Delco-Remy Starter.

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 7-17.

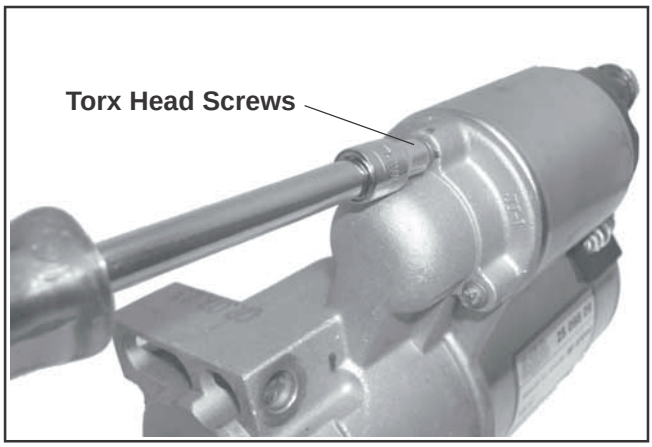


Figure 7-17. Removing Solenoid Screws.

3. Unhook the plunger pin from the drive lever. Remove the gasket from the recess in the housing. See Figures 7-18 and 7-19.

NOTE: Test procedure for checking starter solenoid is on pages 7.20 and 7.21.

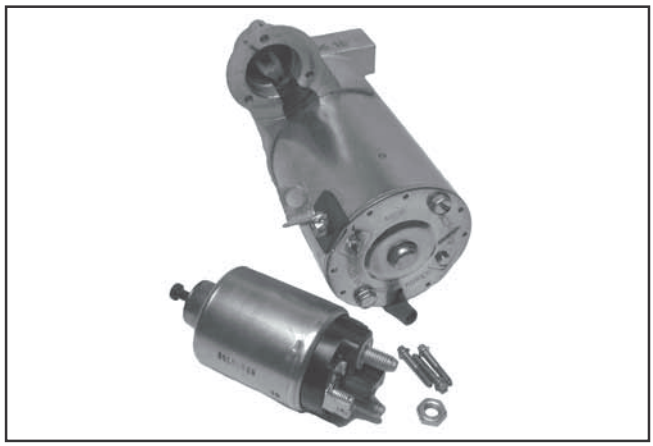


Figure 7-18. Solenoid Removed from Starter.

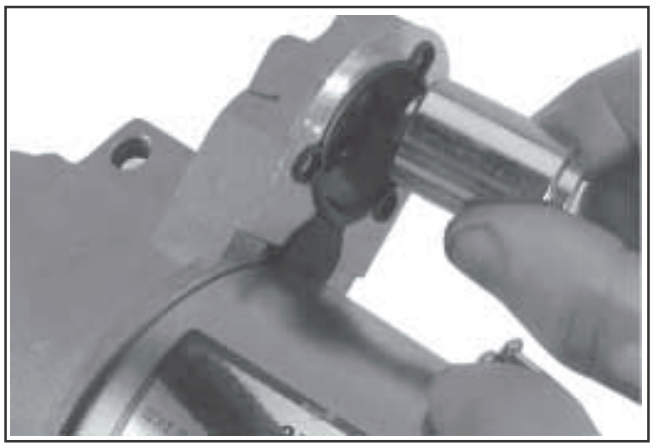


Figure 7-19. Removing Plunger.

4. Remove the two thru (larger) bolts. See Figure 7-20.

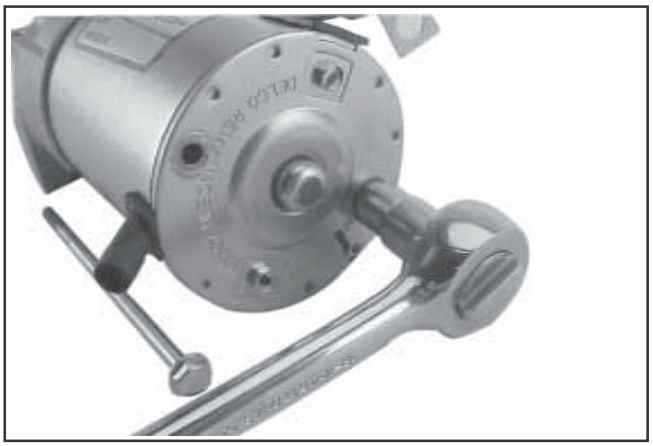


Figure 7-20. Removing Thru Bolts.

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 7-21.

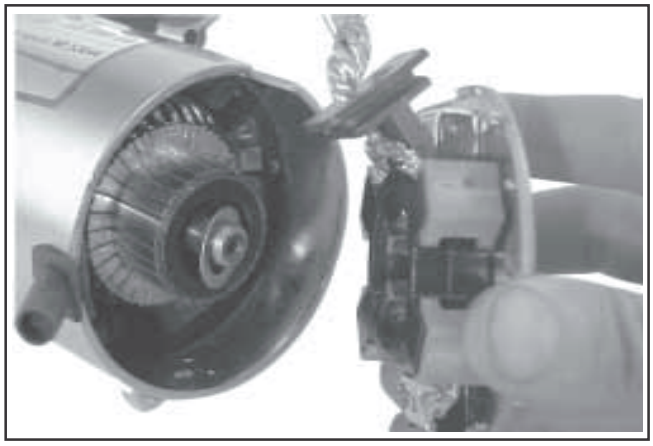


Figure 7-21. Removing Commutator End Plate Assembly.

6. Remove the frame from the armature and drive end cap. See Figure 7-22.

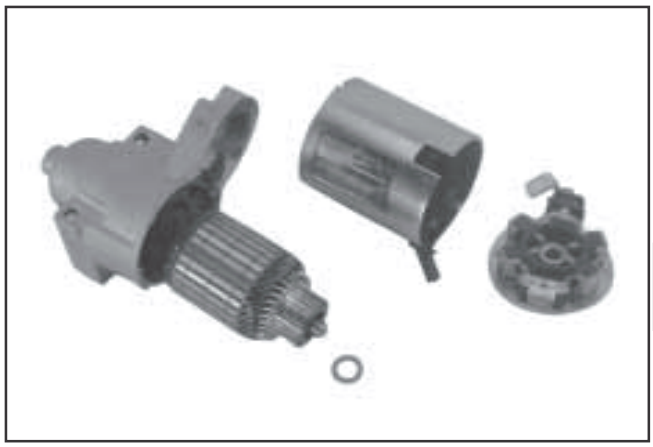


Figure 7-22. Starter Frame Removed.

7. Remove the drive lever pivot bushing and backing plate from the end cap. See Figure 7-23.

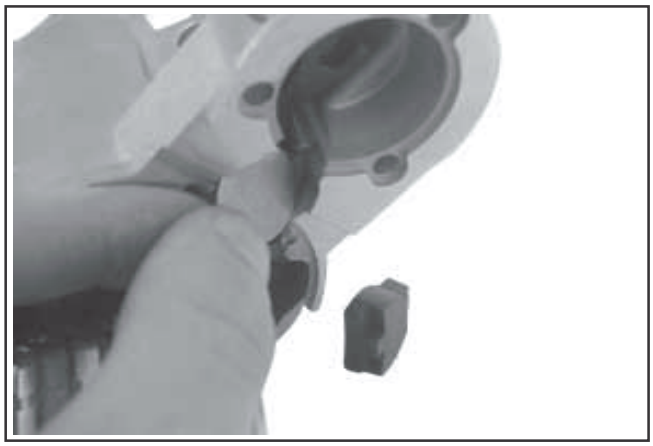


Figure 7-23. Removing Backing Plate and Pivot Bushing.

8. Take out the drive lever and pull the armature out of the drive end cap. See Figure 7-24.

9. Remove the thrust washer from the armature shaft. See Figure 7-24.

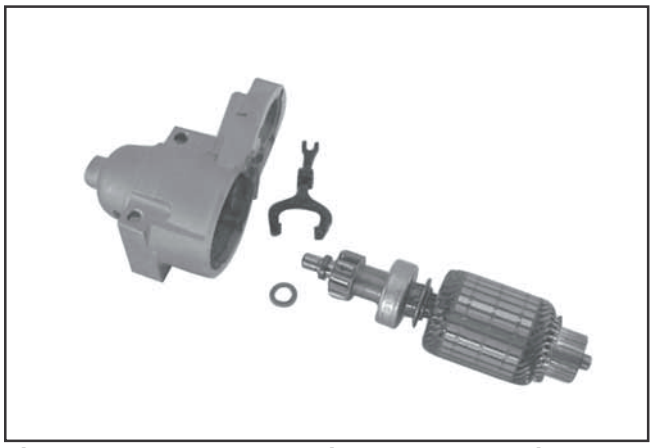


Figure 7-24. Armature and Lever Removed.

10. Push the stop collar down to expose the retaining ring. See Figure 7-25.

Figure 7-25. Retaining Ring Detail.

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

    NOTE: Do not reuse the old retainer.

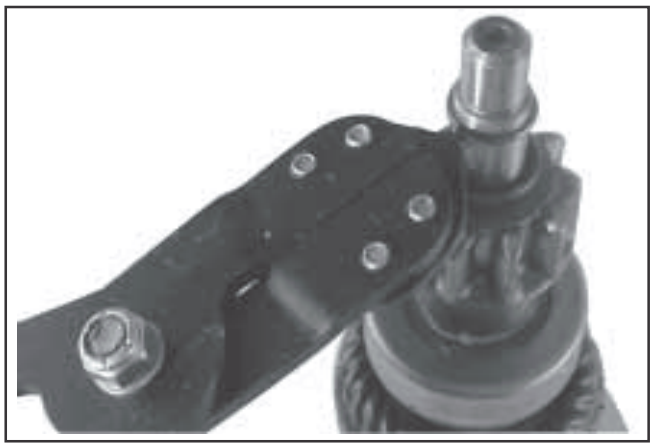


Figure 7-26. Removing Retaining Ring.

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.

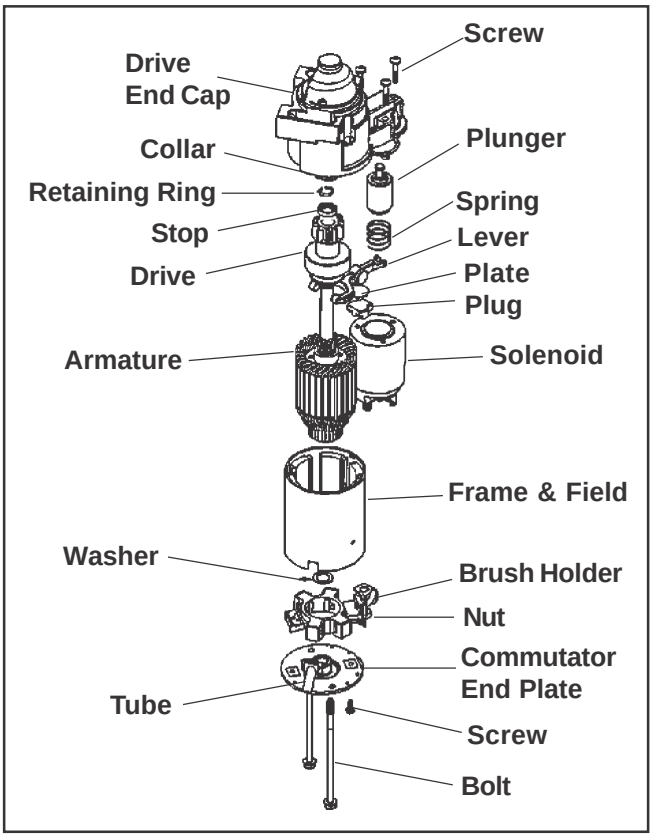


Figure 7-27. Delco-Remy Starter.

Inspection

Drive Pinion

Check and inspect the following areas:

a. The pinion teeth for abnormal wear or damage.

b. The surface between the pinion and the clutch mechanism for nicks, or irregularities which could cause seal damage.

c. 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 7-28. Replace the brushes if they are worn undersize, or their condition is questionable.

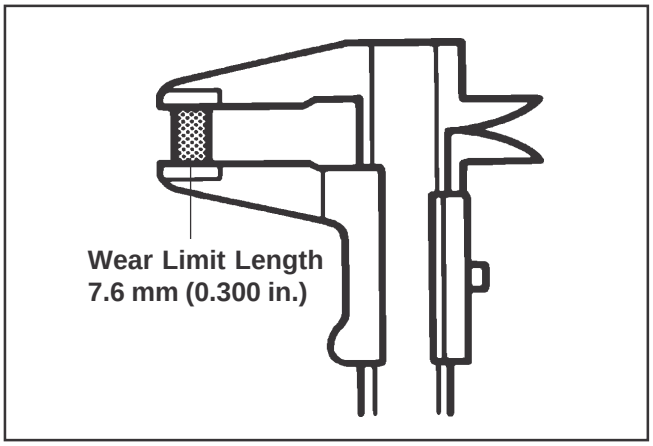


Figure 7-28. Checking Brushes.

Armature

1. 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 7-29.

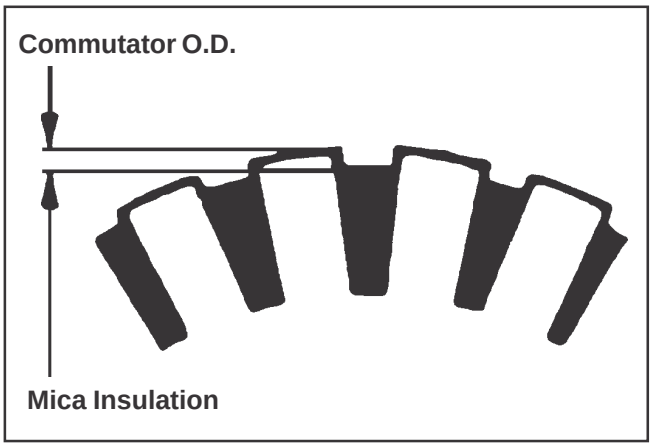


Figure 7-29. Commutator Mica Inspection.

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 7-30. Test all the segments. Continuity must exist between all or the armature is bad.

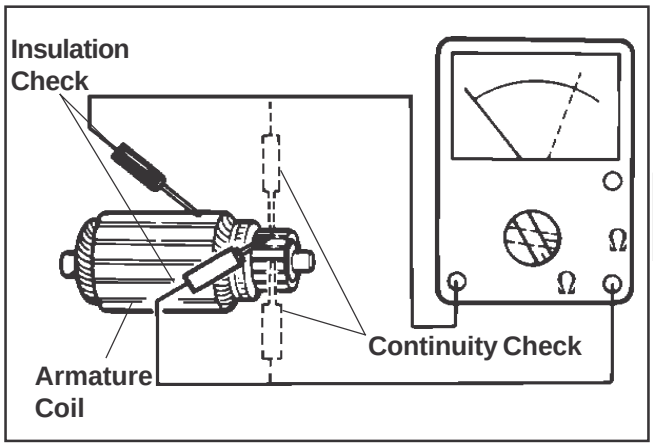


Figure 7-30. Checking Armature.

3. Check for continuity between the armature coil segments and the commutator segments. See Figure 7-30. 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 a new Kohler Brush and Spring Kit, 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 7-31. Discard the old brush holder assembly.

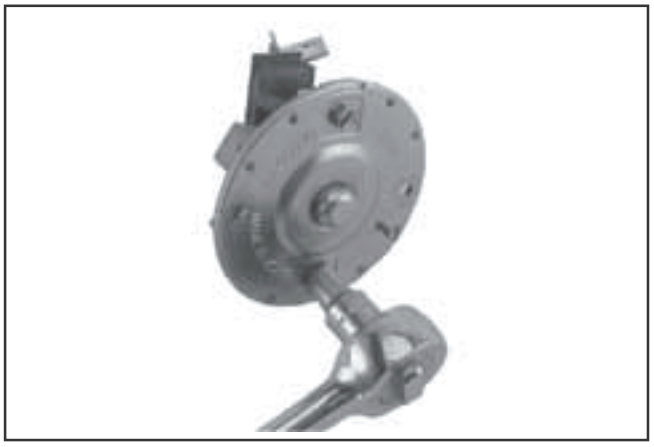


Figure 7-31. Removing Brush Holder.

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 7-32.

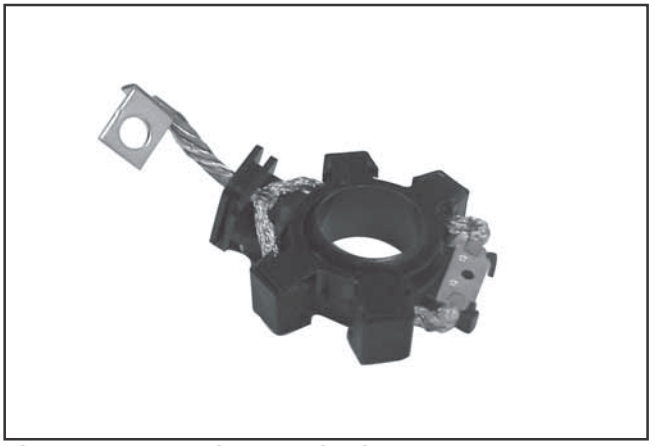


Figure 7-32. Service Brush Kit.

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.

Starter Service

Clean the drive lever and armature shaft. Apply Kohler electric starter drive lubricant (see Section 2) (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 (see Section 2) 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.

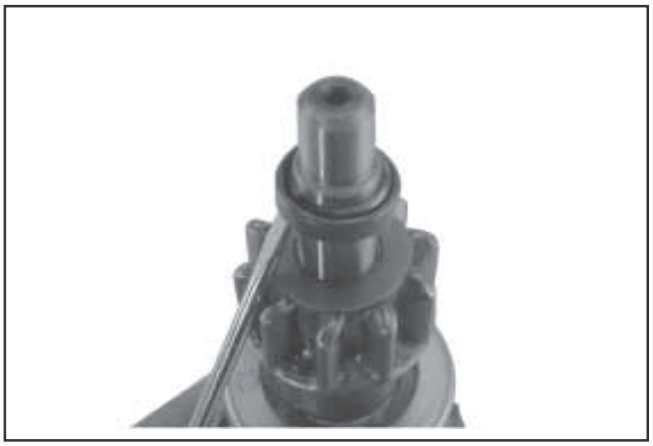


Figure 7-33. Installing Stop Collar and Retainer.

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 7-34.

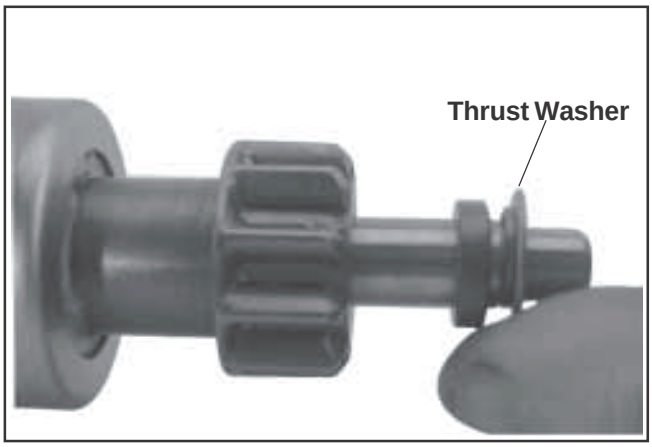


Figure 7-34. Installing Thrust Washer.

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 (see Section 2). 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 7-35.

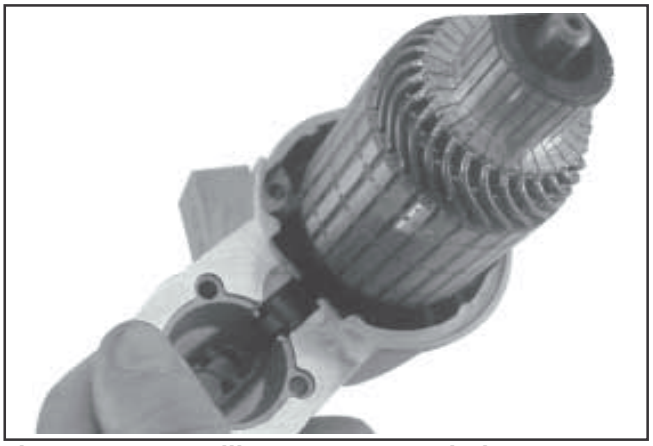


Figure 7-35. Installing Armature and Pivot Lever.

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 7-36.

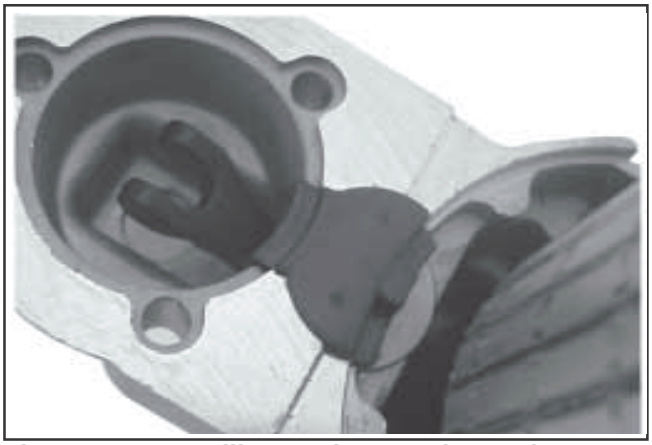


Figure 7-36. Installing Backup Washer and Grommet.

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 7-37.

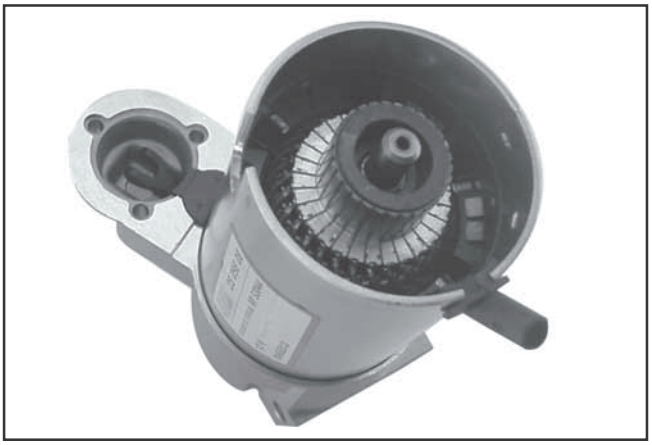


Figure 7-37. Installing Frame and Drain Tube.

9. Install the flat thrust washer onto the commutator end of the armature shaft. See Figure 7-38.

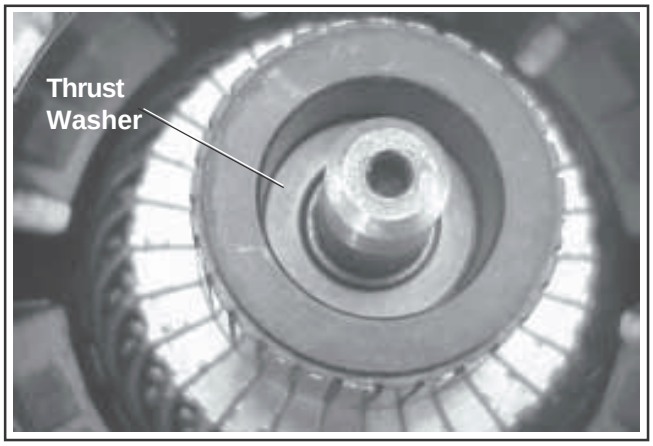


Figure 7-38. Installing Thrust Washer.

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 7-39. The protective tube may be saved and used for future servicing.

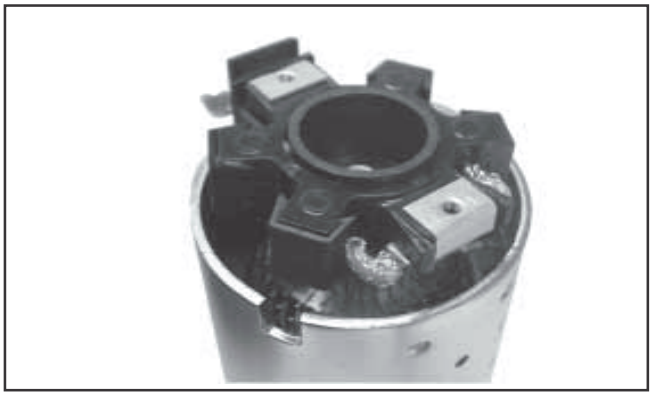


Figure 7-39. Installing Brush Holder Assembly with Supplied Tube.

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. See Figure 7-40.

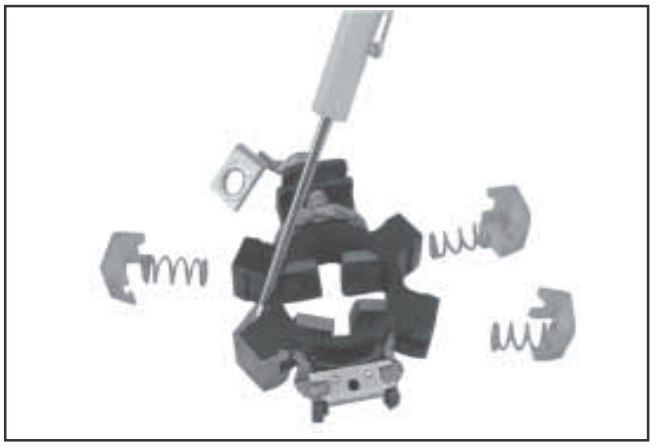


Figure 7-40. Removing Retaining Clips.

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 7-41.

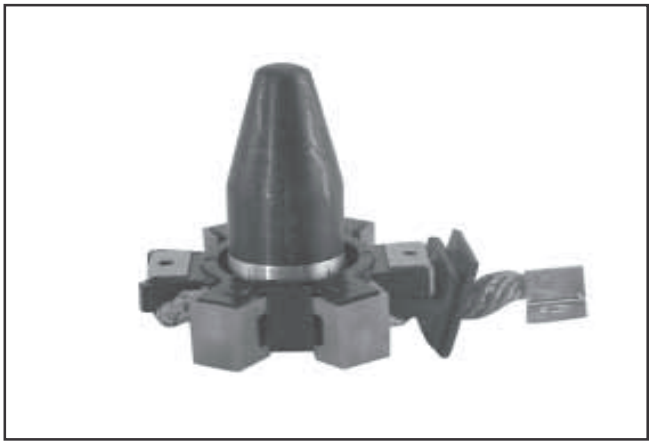


Figure 7-41. Brush Installation Tool with Extension.

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 7-42.

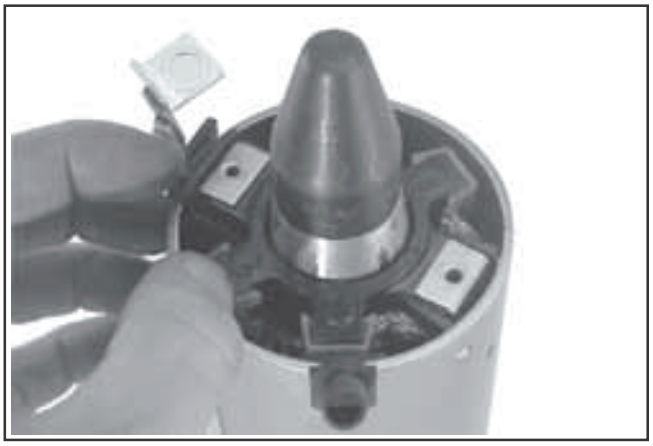


Figure 7-42. Installing Brush Holder Assembly using Tool with Extension.

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 7-43 and 7-44.

Figure 7-43. Torquing Thru Bolts.

Figure 7-44. 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 7-45.

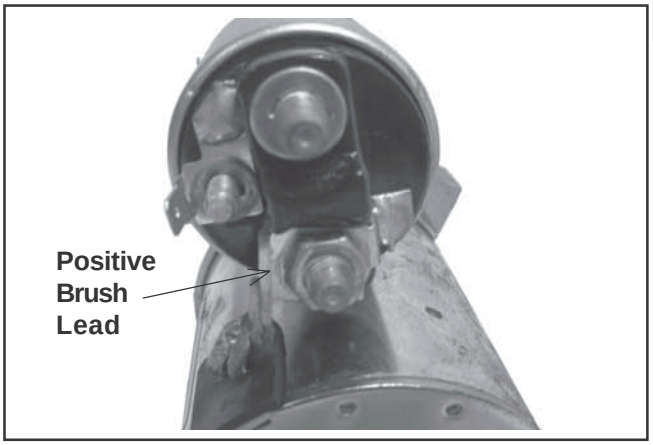


Figure 7-45. Positive (+) Brush Lead Connection.

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 7-46. 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.

*__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.

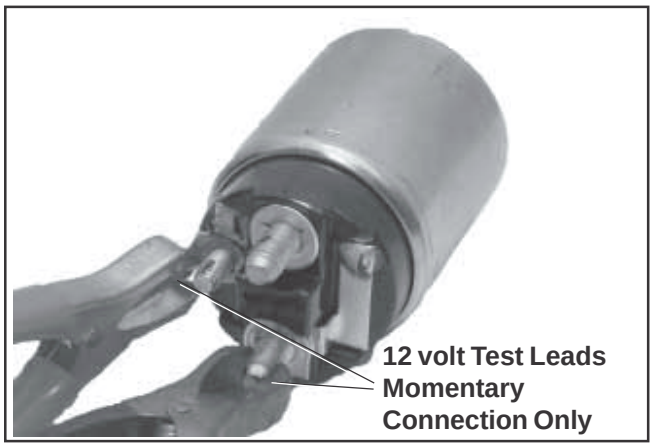


Figure 7-46. Testing Pull-In Coil/Plunger Actuation.

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 7-47. The ohmmeter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

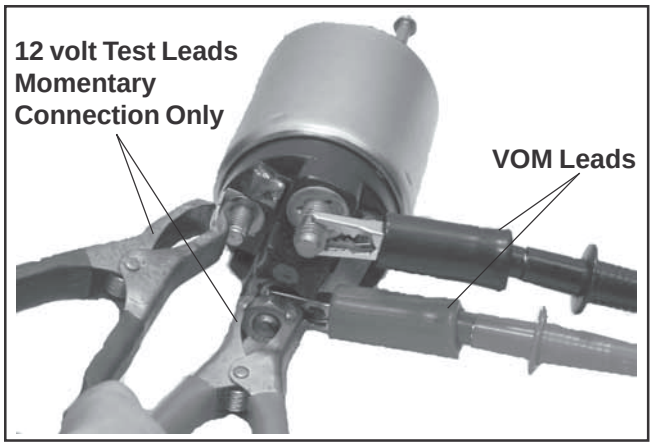


Figure 7-47. Testing Pull-In Coil/Solenoid Contact Continuity.

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 7-48. 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.

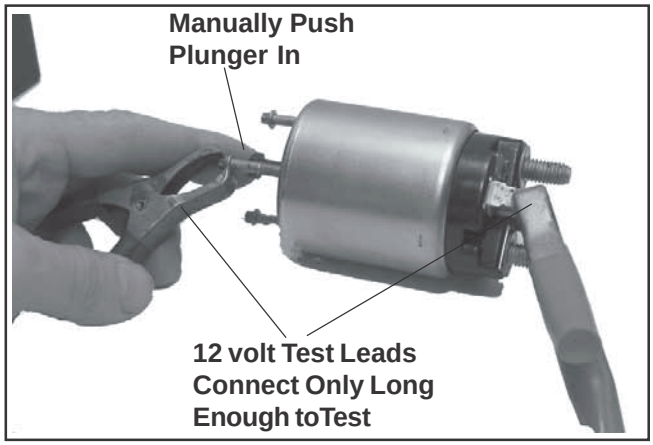


Figure 7-48. Testing Hold-In Coil/Function Test.

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 7-49. The meter should indicate continuity. If no continuity is indicated, the solenoid should be replaced. Repeat test several times to confirm condition.

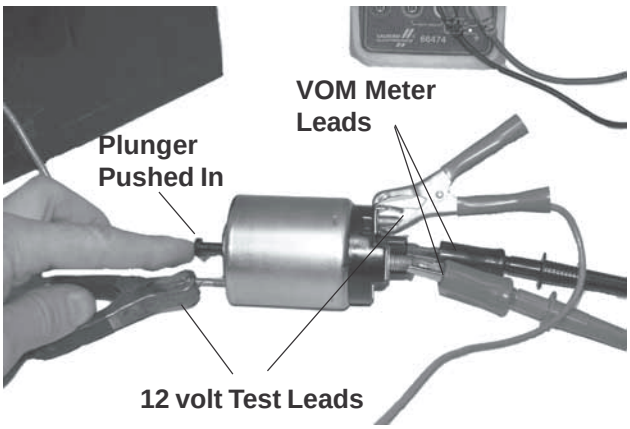


Figure 7-49. Testing Hold-In Coil/Solenoid Contact Continuity.

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.*

General

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 muffler.
5. Remove cylinder shrouds and blower housing.
6. Remove electric starter motor.
7. Remove air cleaner assembly.
8. Remove control bracket, governor springs, and lever.
9. Remove carburetor.
10. Remove Oil Sentry™ (if equipped).
11. Remove baffles and intake manifold.
12. Remove oil cooler.
13. Remove oil filter housing and oil filter adapter.
14. Remove ignition modules.
15. Remove grass screen and cooling fan
16. Remove flywheel.
17. Remove stator, rectifier-regulator, and wiring harness.
18. Remove backing shroud assembly.
19. Remove spark plugs.
20. Remove valve covers and fuel pump.
21. Remove cylinder heads and hydraulic lifters.
22. Disassemble cylinder heads.
23. Remove breather assembly.
24. Remove oil reservoir and pickup screen.
25. Remove closure plate assembly.
26. Remove camshaft.
27. Remove connecting rods with pistons and rings.
28. Remove crankshaft.
29. Removal of governor gear assembly.
30. Remove governor yoke, cross shaft, and seal.
31. Remove lifter feed cover and gaskets.
32. Remove flywheel and PTO end oil seals.
33. Removal of main bearings.

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.

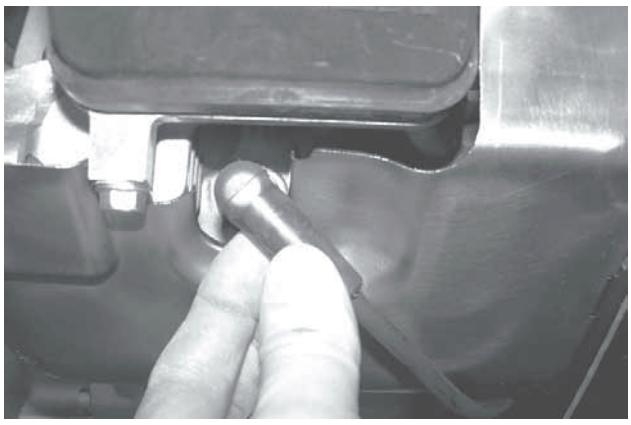


Figure 8-1. Disconnect Both Spark Plug Leads.

Shut Off Fuel Supply

Drain Oil from Crankcase and Remove Oil Filter

1. Clean the oil filter and housing area. Remove and discard the oil filter. See Figure 8-2.

Figure 8-2. Removing Oil Filter.

2. Remove the dipstick and one of the oil drain plugs.

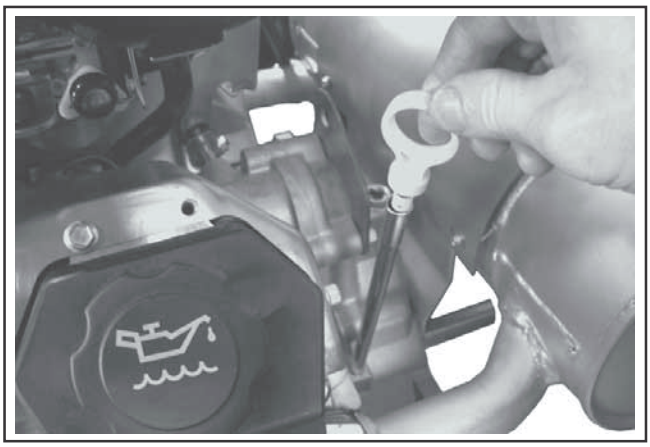


Figure 8-3. Removing Dipstick from Tube.

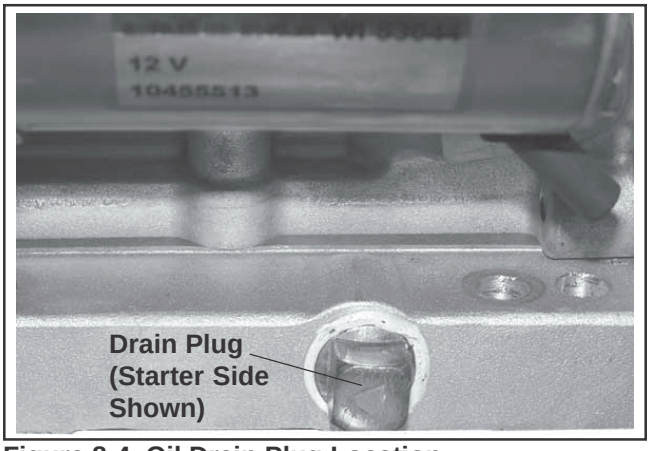


Figure 8-4. Oil Drain Plug Location.

3. Allow ample time for the oil to drain from the crankcase.

Remove Muffler

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

Remove Cylinder Shrouds and Blower Housing

1. Remove the top mounting screw and loosen the two shoulder screws on each side. Lift off the two cylinder shrouds. See Figure 8-5.

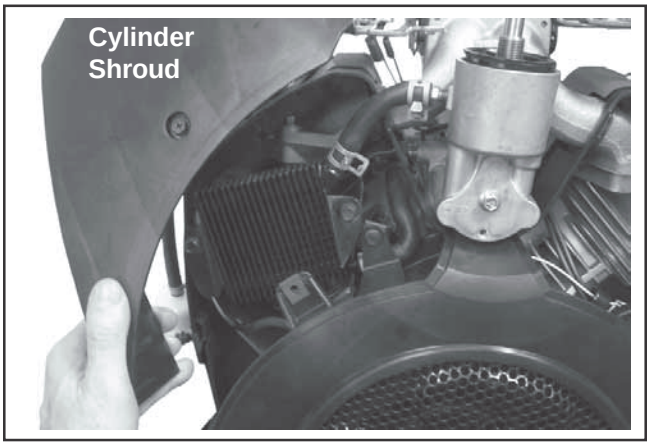


Figure 8-5. Removing Cylinder Shrouds.

2. Remove the four mounting screws and separate the blower housing from the lower half. See Figure 8-6.

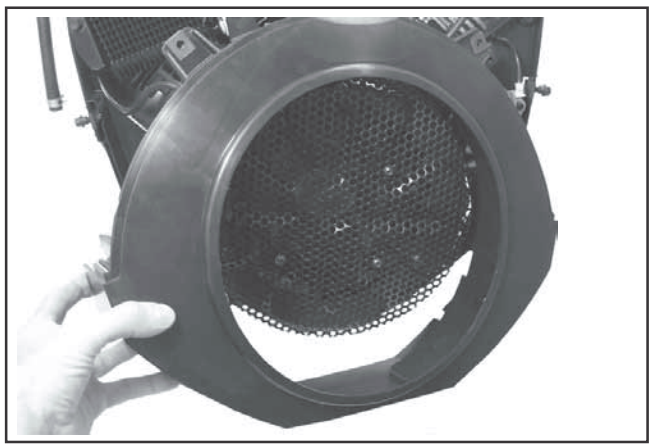


Figure 8-6. Removing Blower Housing.

Remove Electric Starter Motor

1. Disconnect the leads from the starter.

2. Remove the two hex flange screws and starter. See Figure 8-7.

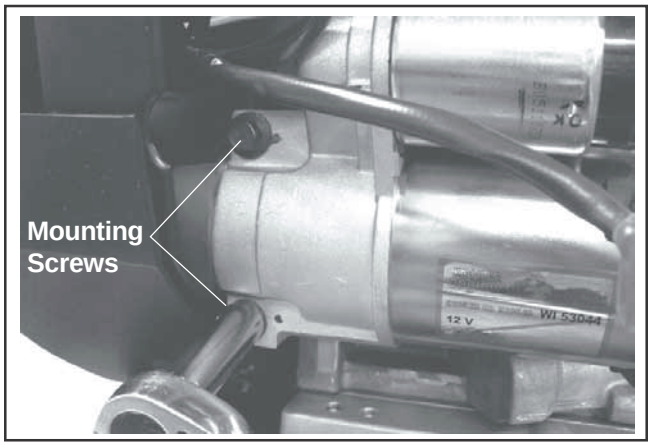


Figure 8-7. Removing Electric Starter.

Remove Air Cleaner Assembly

1. Disconnect the breather hose from the air cleaner, and the formed vent hose from the vent port on the carburetor.

2. Remove the four hex flange nuts, ground lead, and choke return spring bracket from the mounting studs. See Figure 8-8.

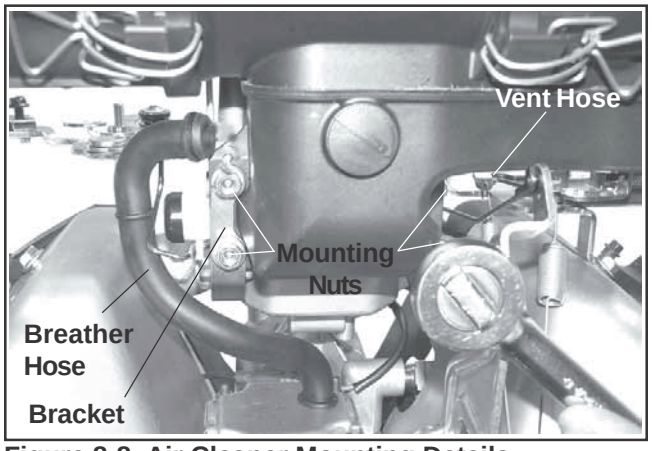


Figure 8-8. Air Cleaner Mounting Details.

3. Remove the two screws securing the air cleaner and main control bracket to the intake manifold bosses. See Figure 8-9.

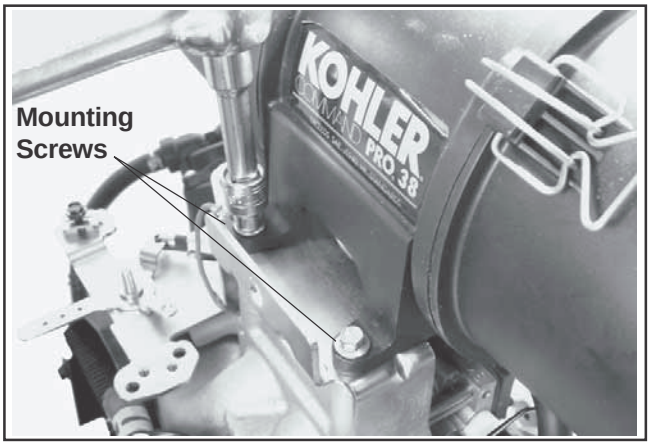


Figure 8-9. Mounting Screws.

4. Remove the air cleaner as an assembly from the engine. See Figure 8-10.

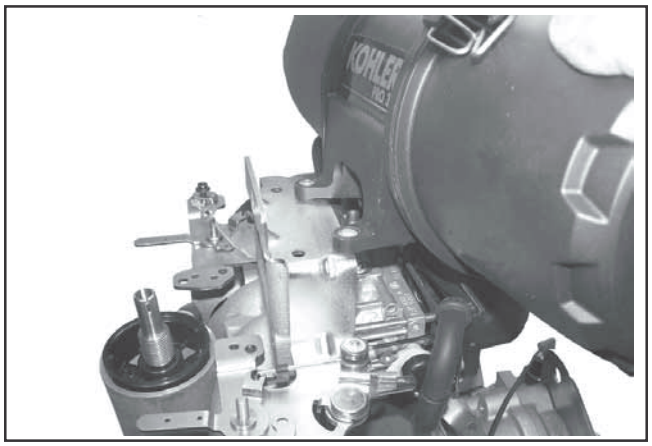


Figure 8-10. Removing Air Cleaner Assembly.

Removing Control Bracket, Governor Springs, and Lever

1. Unhook the governed idle and governor springs from the controls on the main bracket and governor lever. Note the color, location and position of each. See Figure 8-11.

2. Disconnect the throttle linkage and dampening spring from the governor lever at the small bushing. See Figure 8-11.

3. Carefully pry off the pal nut, remove the two washers (note assembly order), and disconnect the choke linkage from the pivot lever. Do not lose any parts. Secure remaining pivot parts with tape to avoid losing them. Always use a new pal nut during reassembly. See Figure 8-11.

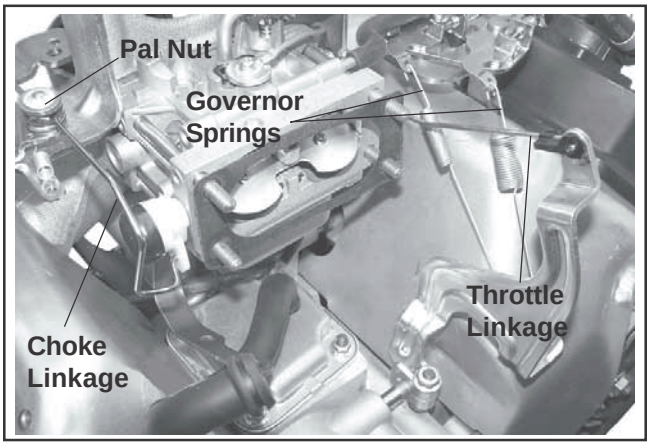


Figure 8-11. Disconnect Control Linkages and Governor Springs.

4. Remove the rear mounting screw on each side and lift off the control bracket. See Figure 8-12.

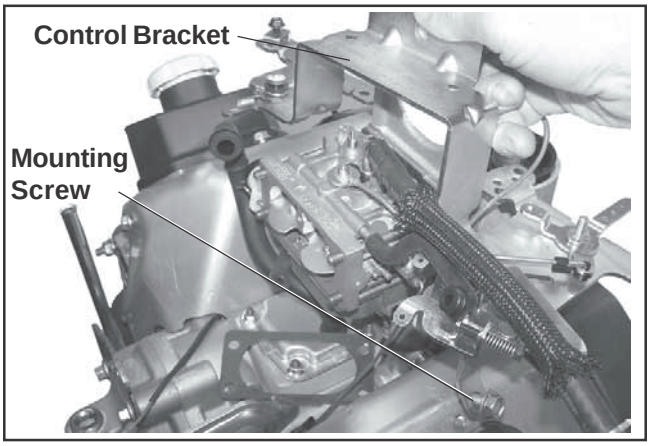


Figure 8-12. Removing Control Bracket.

5. Loosen the hex flange nut and remove the governor lever from cross shaft. See Figure 8-13.

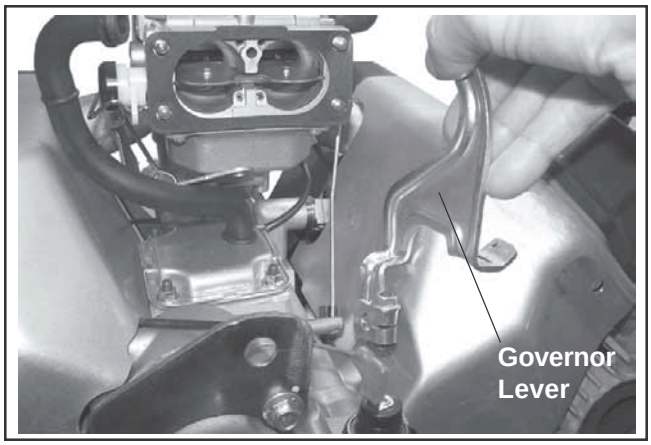


Figure 8-13. Removing Governor Lever.

Remove Carburetor

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.

1. Disconnect the fuel shut-off solenoid lead.

2. Remove the fuel inlet hose from the carburetor or fuel pump. Properly contain any remaining fuel.

3. Remove the carburetor and linkages with choke return components as an assembly. See Figure 8-14.

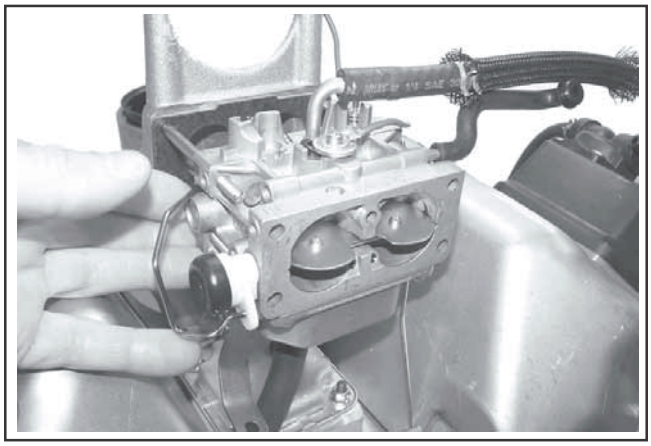


Figure 8-14. Removing Carburetor.

4. Remove the carburetor gasket.

5. The carburetor and linkages can be separated as necessary.

Remove Oil Sentry™ (If Equipped)

1. Disconnect the lead from the Oil Sentry™ switch.

2. Remove the Oil Sentry™ switch from the closure plate. See Figure 8-15.

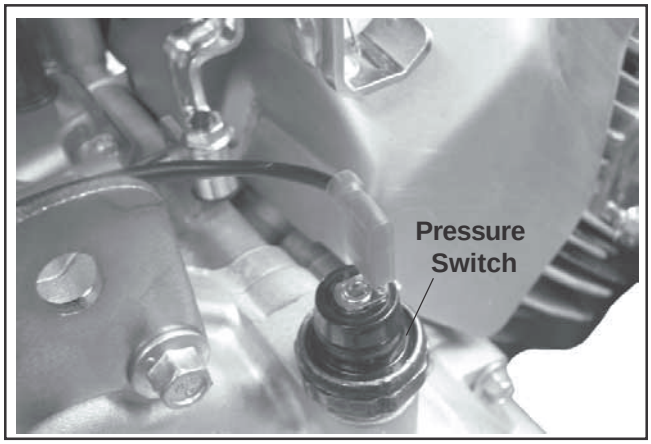


Figure 8-15. Oil Sentry™ Switch Location in Closure Plate.

Remove Baffles and Intake Manifold

1. Remove the screws securing the valley baffles to the cylinder heads and backing shroud assembly.

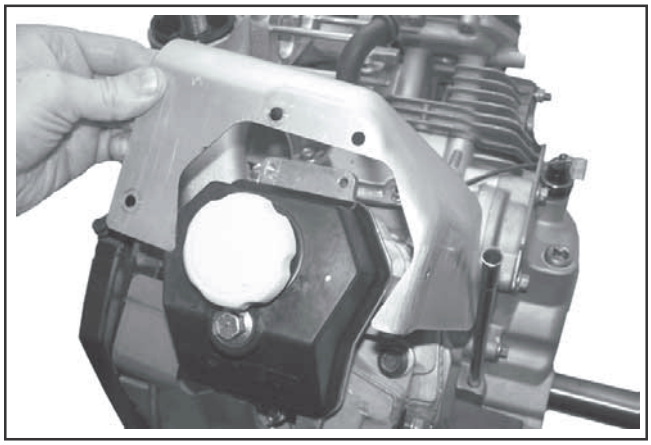


Figure 8-16. Removing Valley Baffles.

2. Remove the four screws securing each of the outer cylinder baffles in place. Two of the screws are accessed from the backing shroud side. See Figure 8-17.

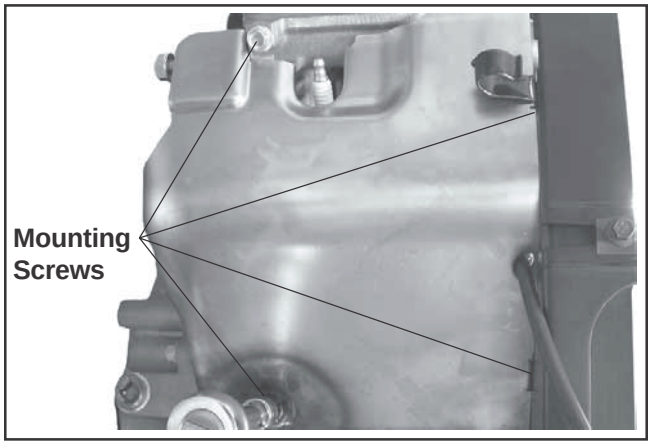


Figure 8-17. Removing Outer Cylinder Baffles.

3. Remove the four hex flange screws securing the intake manifold to the cylinder heads. Cut any wire ties that secure the wiring harness or leads to the intake manifold.

4. Remove the intake manifold and gaskets. See Figure 8-18.

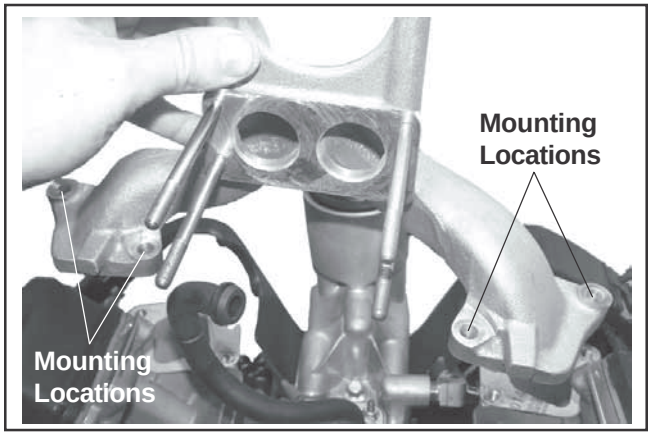


Figure 8-18. Removing Intake Manifold.

Remove Oil Cooler

1. Remove the two oil cooler mounting screws. Do not lose any washers (if used). See Figure 8-19.

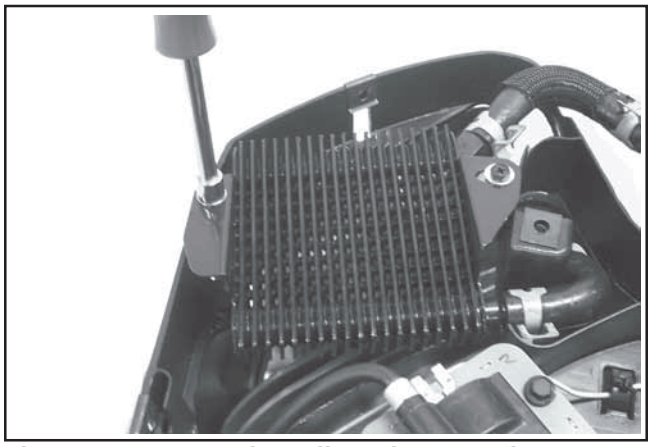


Figure 8-19. Removing Oil Cooler Mounting Screws.

2. Loosen the clamps and disconnect each of the hoses from the oil cooler. See Figure 8-20.

   NOTE: New clamps are recommended any time disassembly is performed, or if clamps have been loosened (expanded) several times.

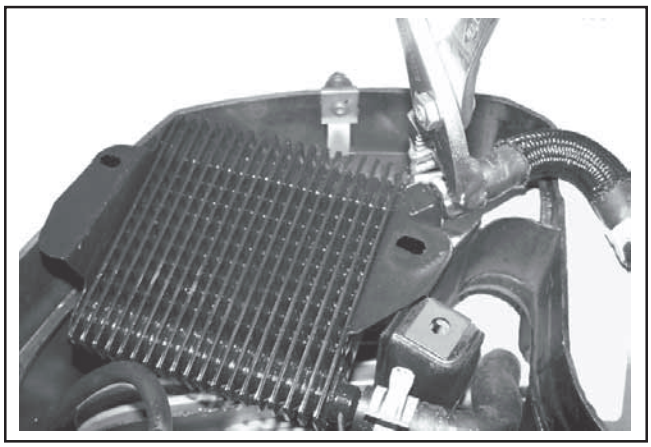


Figure 8-20. Disconnecting Hoses From Oil Cooler.

Remove Oil Filter Housing and Oil Filter Adapter

1. Remove the screw securing the oil filter housing and individual O-Rings to the adapter. Carefully separate the parts. See Figure 8-21.

   NOTE: Further disassembly of the oil filter housing assembly is not required unless individual servicing must be performed. Follow substeps a, b, and c.

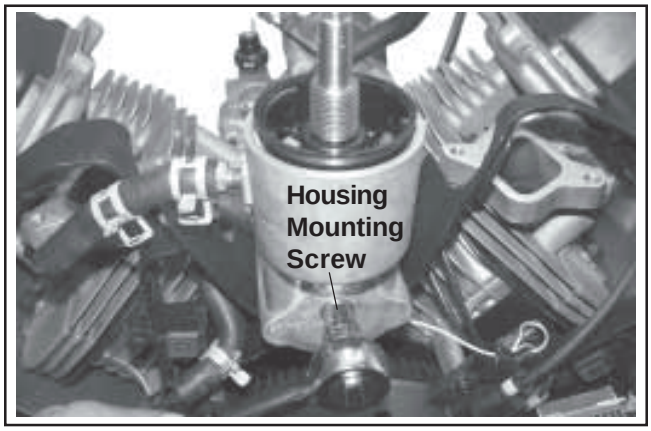


Figure 8-21. Removing Oil Filter Housing From Adapter.

Perform the following only if the oil filter housing assembly requires individual servicing.

a. Remove the nipple from the cup and oil filter housing. See Figure 8-22.

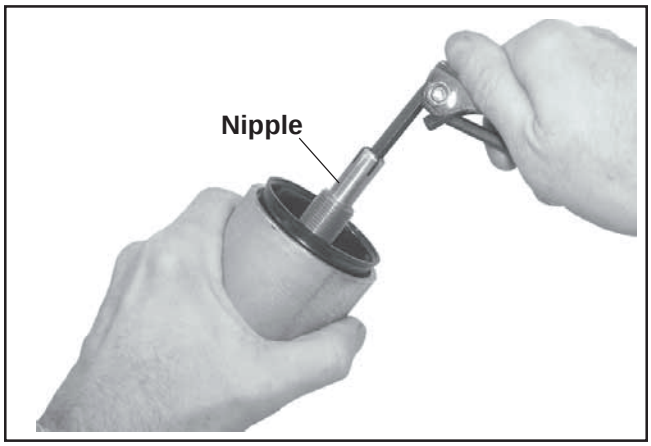


Figure 8-22. Removing Nipple.

b. Remove the oil filter cup and spring from housing. See Figure 8-23.

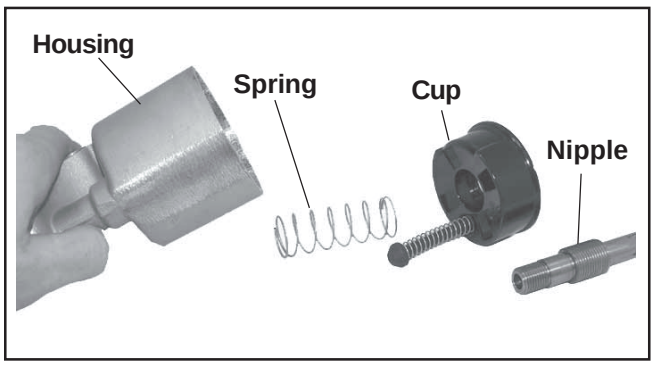


Figure 8-23. Disassembled Cup and Spring.

c. Remove the rubber valve and spring from the cup. See Figure 8-24.

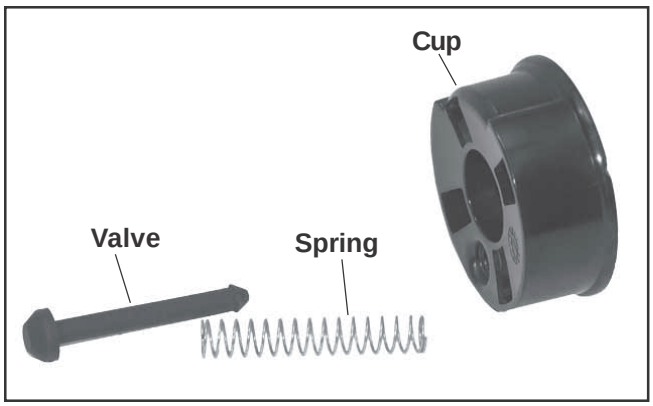


Figure 8-24. Rubber Valve and Spring Removed from Cup.

2. Remove the screw securing the oil filter adapter and individual O-Rings to the crankcase, then carefully separate the parts. See Figure 8-25.

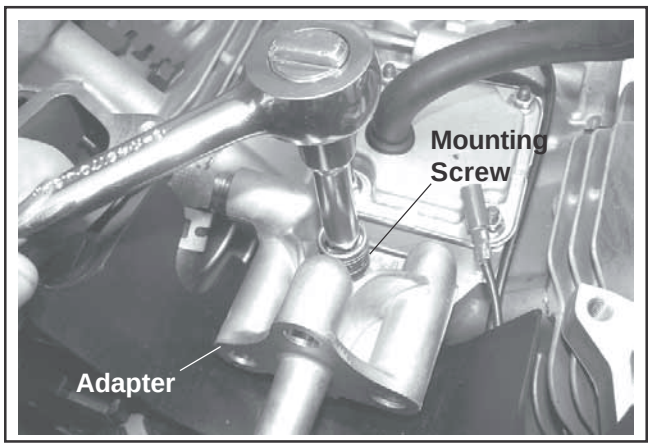


Figure 8-25. Removing Oil Filter Housing Adapter.

Remove Ignition Modules

1. Rotate the flywheel so the magnet is away from the modules.

2. Remove the mounting screws and disconnect the kill lead from the ignition modules. Note the position of ignition modules. See Figure 8-26.

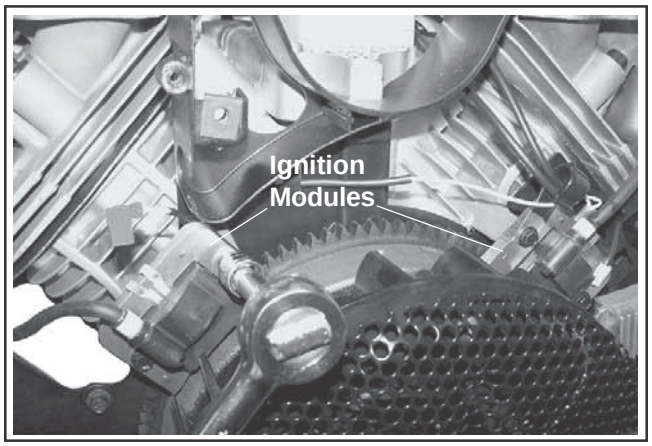


Figure 8-26. Removing Ignition Modules.

Remove Grass Screen and Cooling Fan

1. Remove the screws, attaching hardware and hex studs securing the grass screen, stiffeners and cooling fan to the flywheel. See Figures 8-27, 8-28 and 8-29.

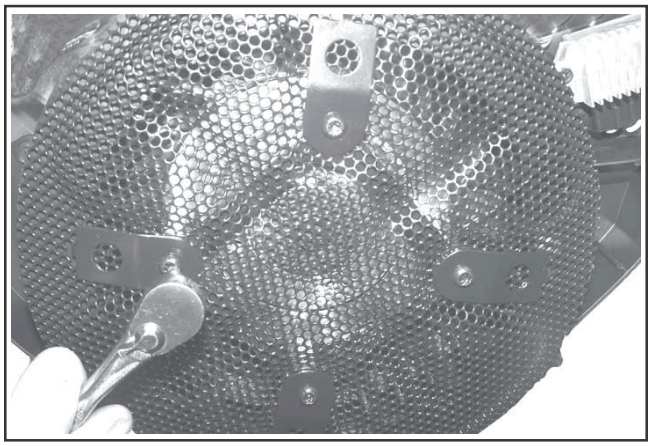


Figure 8-27. Removing Grass Screen Fasteners.

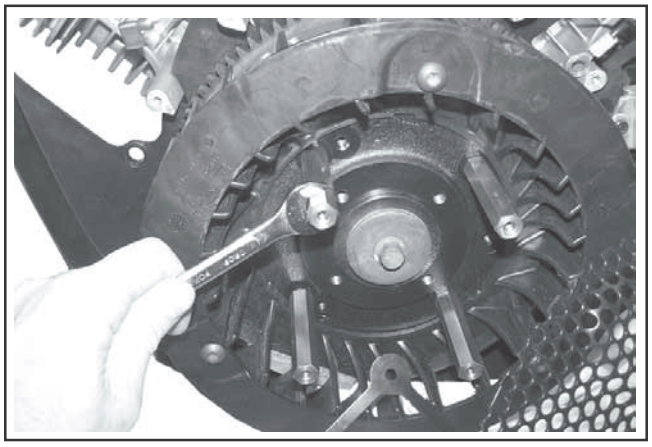


Figure 8-28. Removing Mounting Studs.

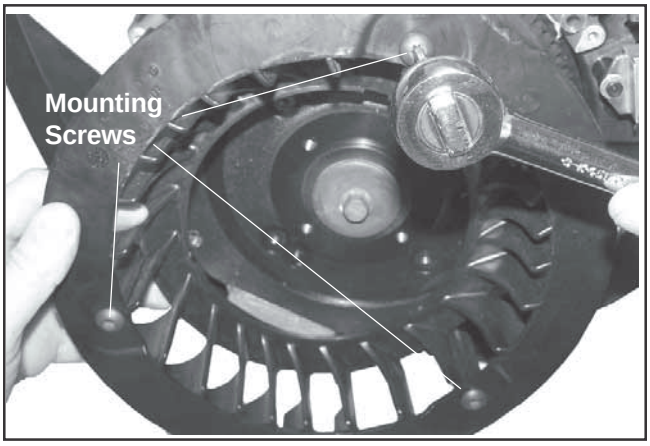


Figure 8-29. Removing Fan.

Remove Flywheel

1. Use a flywheel strap wrench or holding tool (see Section 2) to hold the flywheel and loosen the hex flange screw securing the flywheel to the crankshaft. See Figure 8-30.

   NOTE: Always use a flywheel strap wrench or holding tool to hold the flywheel when loosening or tightening the flywheel screw. **Do not** use any type of bar or wedge to hold the flywheel. Use of such tools could cause the flywheel to become cracked or damaged.

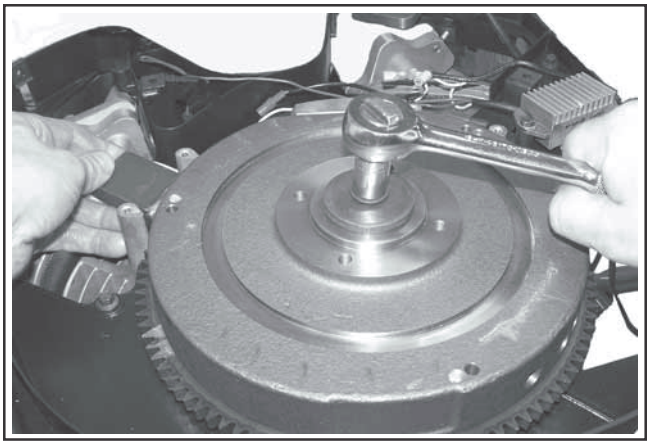


Figure 8-30. Removing Flywheel Fastener Using Holding Tool.

2. Remove the hex flange screw and washer.

3. Use a puller to remove the flywheel from the crankshaft. See Figure 8-31.

   NOTE: Always use a flywheel puller to remove the flywheel from the crankshaft. **Do not** strike the crankshaft or flywheel, as these parts could become cracked or damaged.

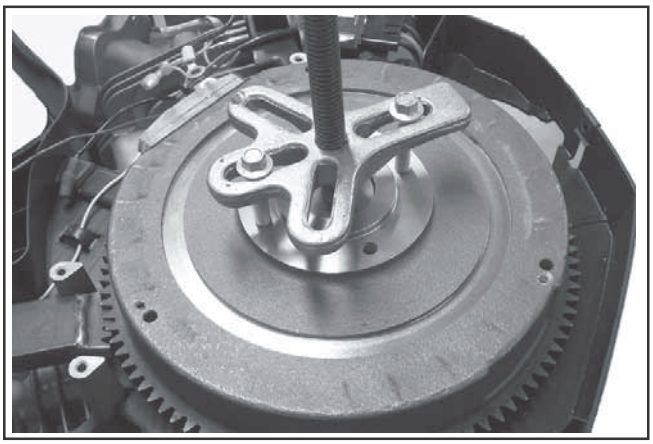


Figure 8-31. Removing Flywheel with a Puller.

4. Remove the woodruff key from the crankshaft.

Remove Stator, Rectifier-Regulator, and Wiring Harness

1. Disconnect the plug from the rectifier-regulator. If the B+ (center) lead must be removed from the plug, use a small flat tool to bend the locking tang. Then remove the lead.

2. Remove the mounting screws securing the rectifier-regulator to the backing shroud assembly. Note the location of the ground lead. If the rectifier-regulator is not being replaced, it may remain mounted to the lower blower housing. See Figure 8-32.

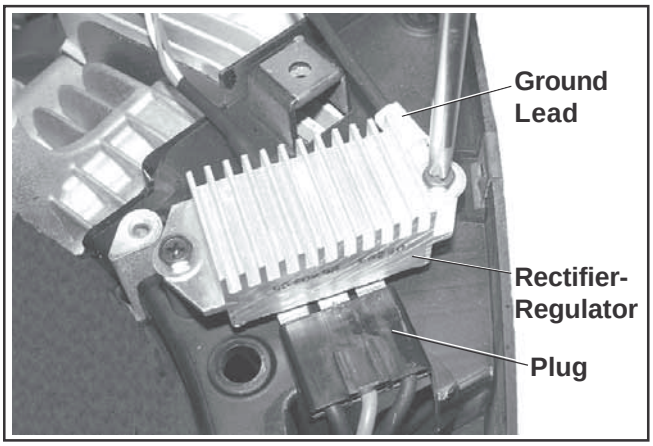


Figure 8-32. Rectifier-Regulator Details.

3. Remove the two screws securing the stator to the crankcase and carefully separate the stator wires from the blower housing clips.

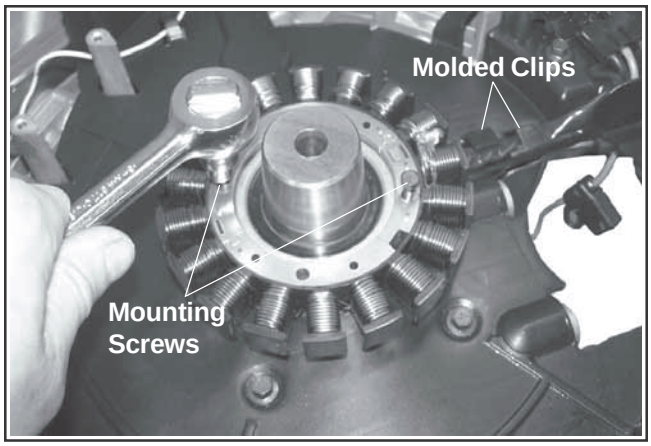


Figure 8-33. Removing Stator.

4. Unhook the wiring harness from the molded clips if it is being serviced separately. See Figure 8-34.

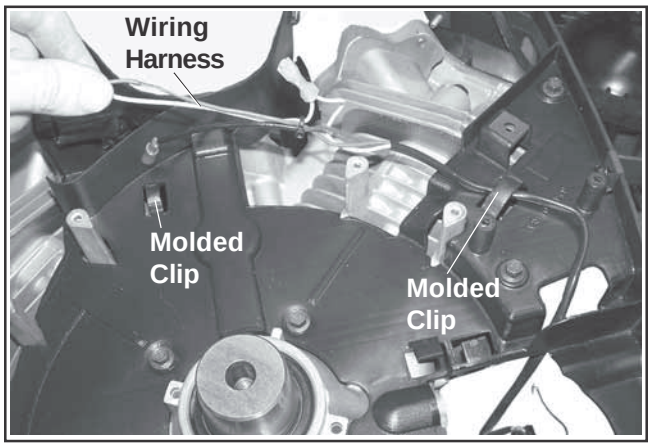


Figure 8-34. Removing Wiring Harness.

Remove Backing Shroud Assembly

1. Remove the four mounting screws securing the backing shroud assembly to the crankcase. See Figure 8-35.

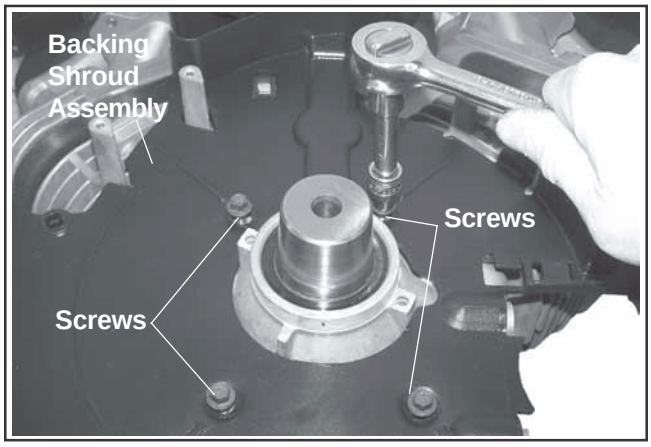


Figure 8-35. Removing Backing Shroud Mounting Screws.

Remove Spark Plugs

1. Remove the spark plug from each cylinder head.

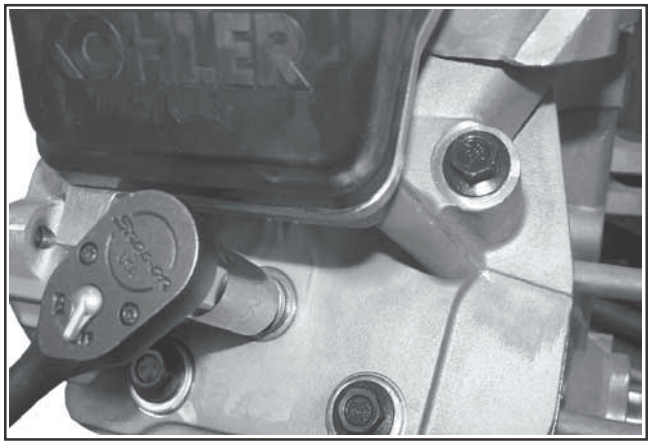


Figure 8-36. Removing Spark Plugs.

Remove Valve Covers and Fuel Pump

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.

NOTE: Based on the style of fuel pump used refer to the following when removing valve covers.

Mechanical Fuel Pump

1. The mechanical fuel pump is part of the valve cover and not serviced separately. Remove with the valve cover. Disconnect the fuel lines at the fuel pump fittings. See Figure 8-37. Properly contain any remaining fuel.

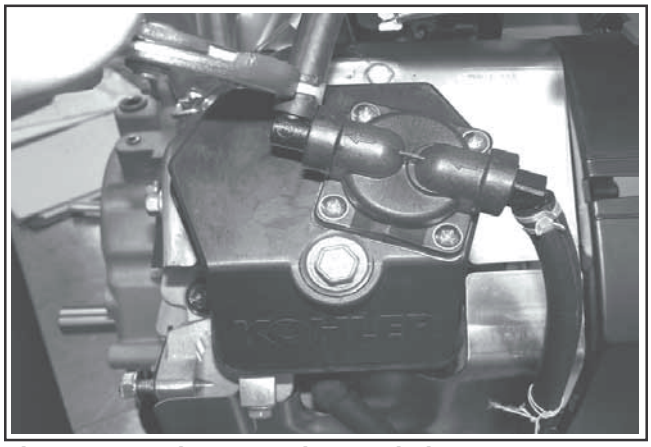


Figure 8-37. Disconnecting Fuel Lines.

8

Electric Fuel Pump

1. Removal will be determined based on mounted location and application. Disconnect the lead connections, fuel line connections, and mounting hardware as required. Properly contain any remaining fuel.

Valve Covers

1. Remove the screw and grommet securing each valve cover.

2. Remove the valve cover and gasket from each cylinder head. Note the locations of individual valve covers if they are different. See Figure 8-38.

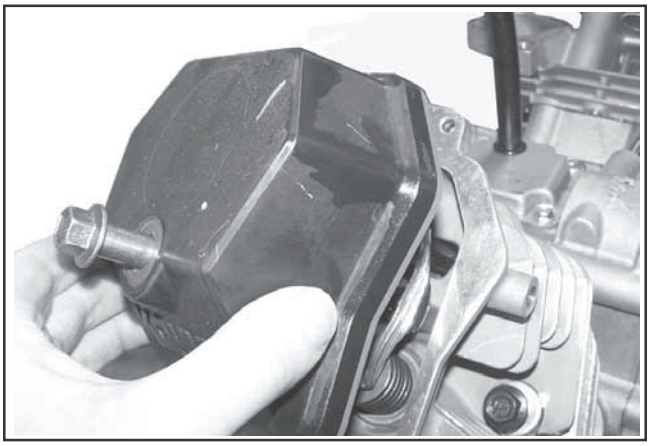


Figure 8-38. Removing Valve Covers.

Remove Cylinder Heads and Hydraulic Lifters

1. Remove the pipe plug from the cylinder head to access the screw in the upper center location. See Figure 8-39.

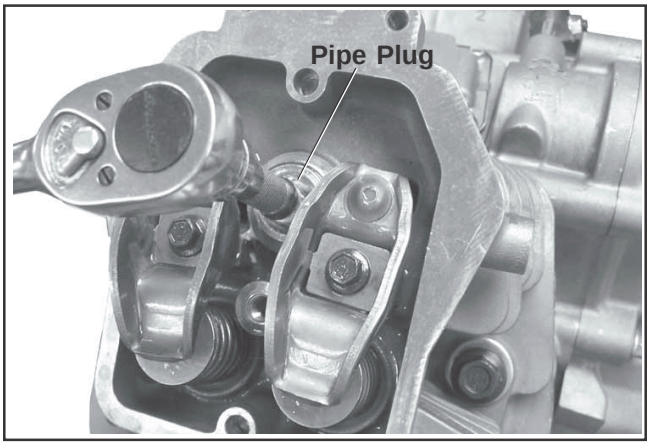


Figure 8-39. Removing Pipe Plug.

2. Remove the five hex flange screws securing each cylinder head. Note the locations of washers and spacer. See Figure 8-40.

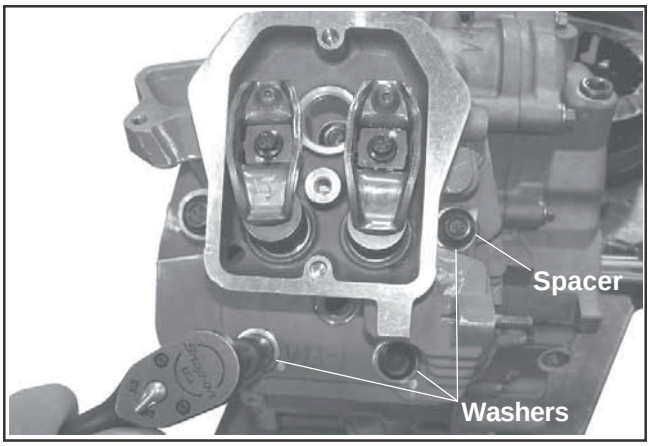


Figure 8-40. Removing Cylinder Head Fasteners.

3. Mark the position of the push rods as either intake or exhaust and cylinder 1 or 2. Push rods should always be reinstalled in the same positions.

4. Carefully remove the push rods, cylinder head and head gasket. See Figure 8-41.

5. Repeat the procedure for the other cylinder head.

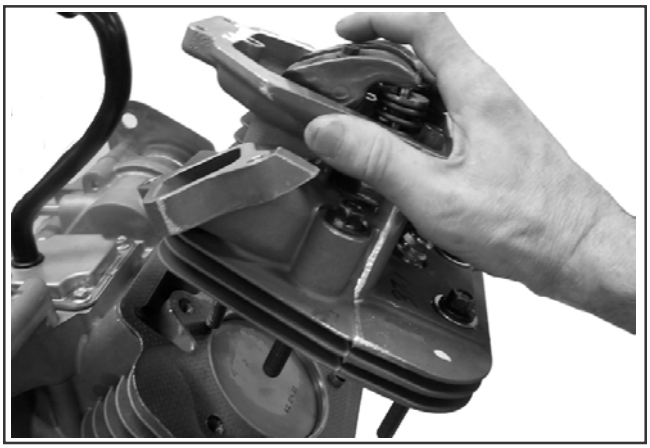


Figure 8-41. Removing Cylinder Head Assembly.

6. Remove the lifters from the lifter bores. Use a Hydraulic Lifter Tool. Do not use a magnet to remove lifters. Mark the lifters by location, as either intake or exhaust and cylinder 1 or 2. Hydraulic lifters should always be reinstalled in the same position. See Figures 8-42 and 8-43.

   NOTE: The exhaust lifters are located on the output shaft side of the engine while the intake lifters are located on the fan side of the engine. The cylinder head number is embossed on the outside of each cylinder head. See Figure 8-43.

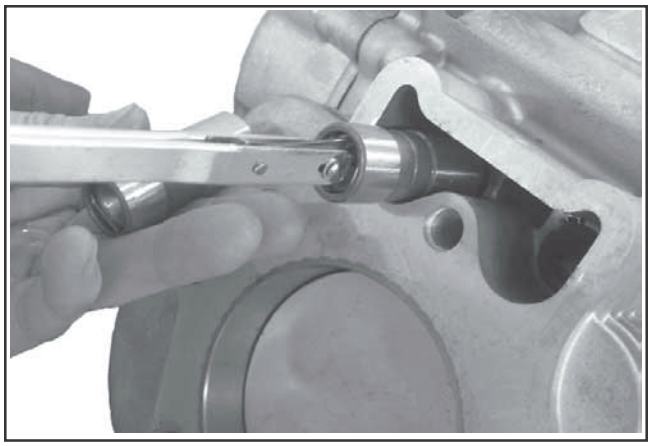


Figure 8-42. Removing Hydraulic Lifters.

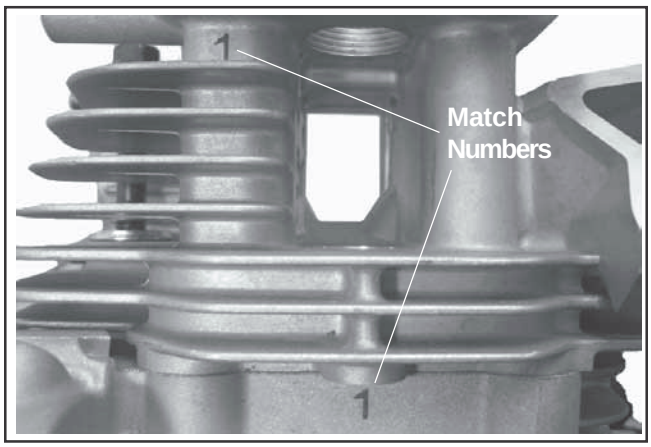


Figure 8-43. Match Numbers on Cylinder Barrel and Heads.

Disassemble Cylinder Heads

1. Remove the two hex flange screws, rocker arm pivots, and rocker arms from the cylinder head. See Figure 8-44.

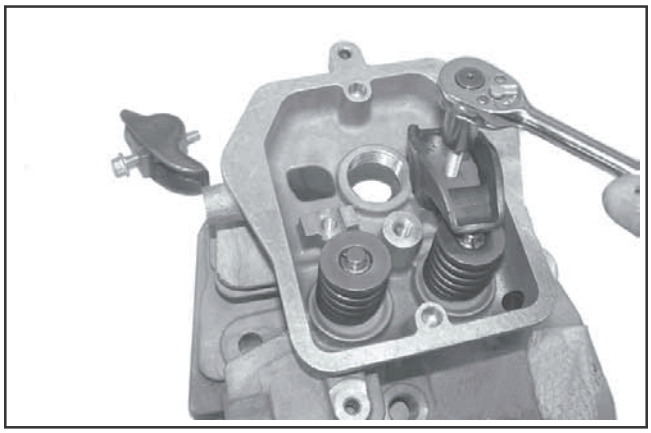


Figure 8-44. Removing Rocker Arms.

2. Compress the valve springs using a valve spring compressor. See Figure 8-45.

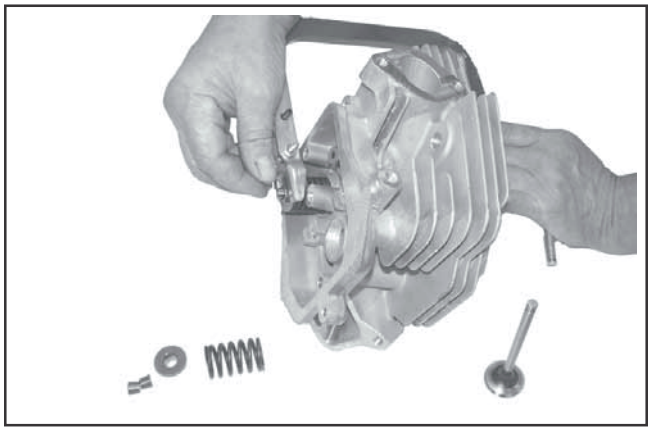


Figure 8-45. Removing Valves with Valve Spring Compressor.

3. Once the valve spring is compressed, remove the following items. See Figures 8-46 and 8-47.

   - Valve spring keepers
   - Valve spring retainers
   - Valve springs
   - Valve spring caps
   - Intake and exhaust valves (mark position)
   - Valve stem seals

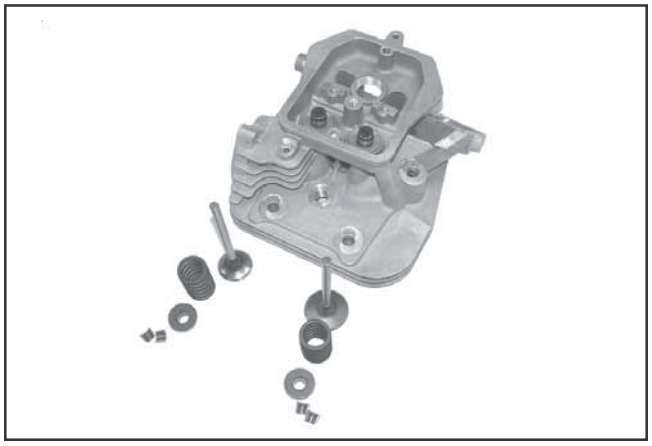


Figure 8-46. Valve Train Components.

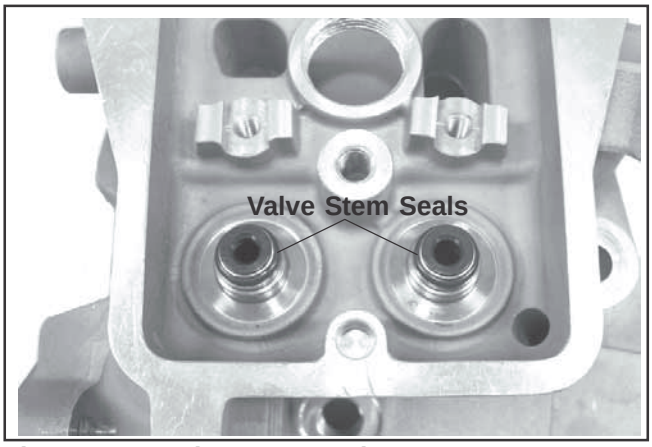


Figure 8-47. Valve Stem Seals.

NOTE: These engines use valve stem seals on the intake and exhaust valves. Use a new seal whenever valves are removed, or if the seal is deteriorated in any way. 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 Breather Assembly

1. Remove the four fasteners securing the breather assembly, breather adapter (style based on spec), and gaskets to the crankcase.

2. Carefully break the gasket seals and remove all parts. Do not pry on the sealing surfaces as it could cause damage resulting in leaks. Note the assembly and orientation of parts. See Figures 8-48 and 8-49.

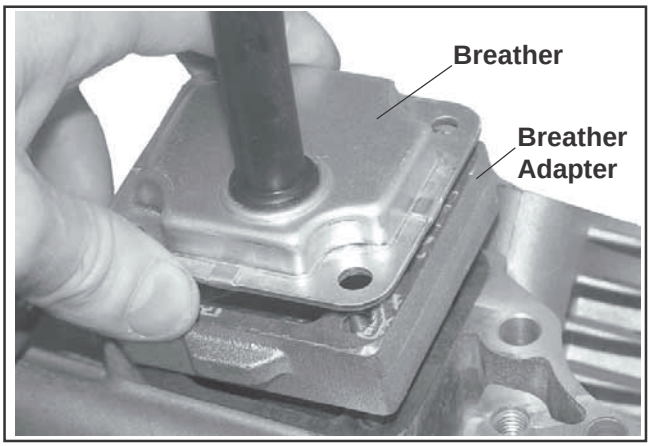


Figure 8-48. Removing Breather Assembly.

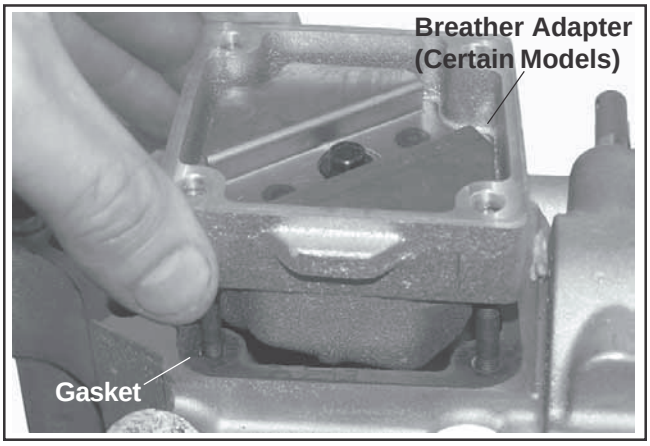


Figure 8-49. Removing Breather Adapter.

Remove Oil Reservoir and Pickup Screen

1. Remove the eight screws securing the oil reservoir and gasket to engine.

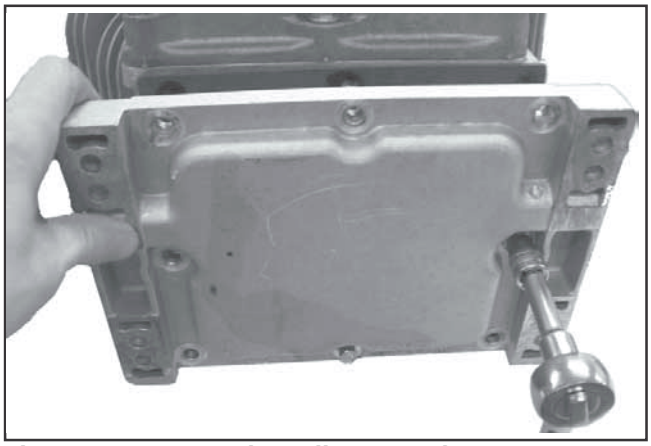


Figure 8-50. Removing Oil Reservoir.

2. Remove the mounting screw and carefully work the pickup screen off the end of the pickup tube. See Figure 8-51.

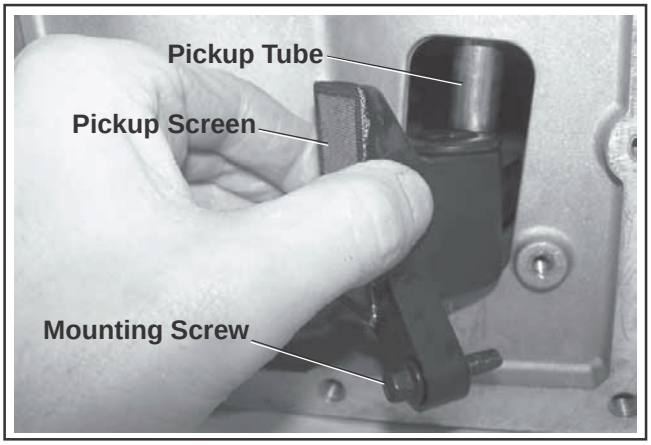


Figure 8-51. Removing Pickup Screen.

Remove Closure Plate Assembly

1. Remove the fourteen hex flange screws securing the closure plate to the crankcase. See Figure 8-52.

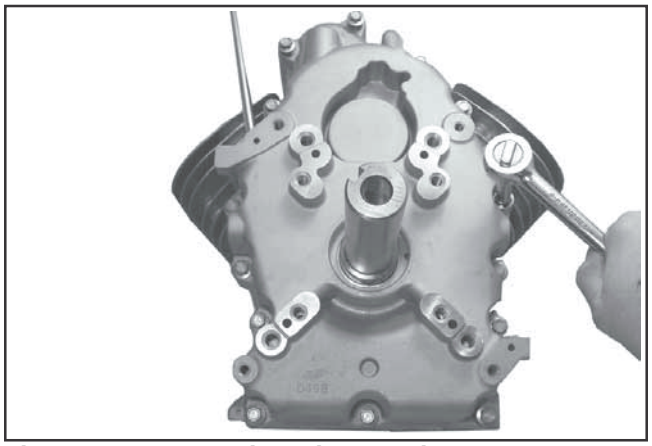


Figure 8-52. Removing Closure Plate Screws.

2. Locate the two protruding tabs on the closure plate. Carefully tap to break the gasket seal. Do not pry on the sealing surfaces as this could cause leaks. Separate the closure plate from the crankcase. See Figure 8-53 and 8-54. Remove the old gasket.

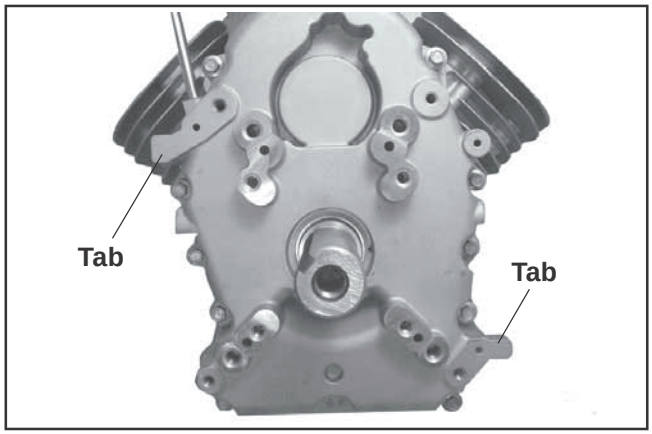


Figure 8-53. Location of Tabs.

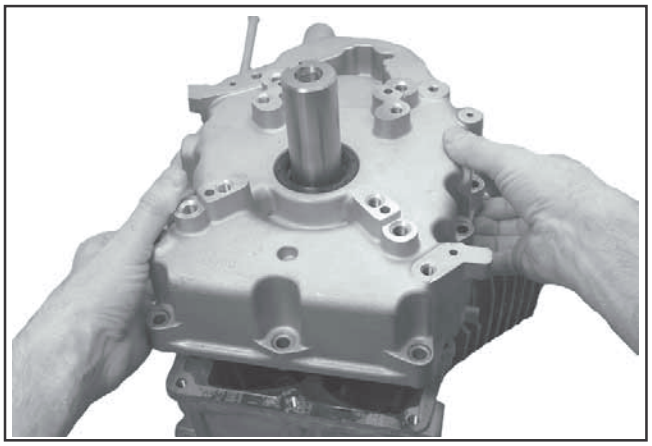


Figure 8-54. Removing Closure Plate.

Oil Pump Assembly

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

Remove Camshaft

1. Remove the camshaft and shim (if used). See Figure 8-55.

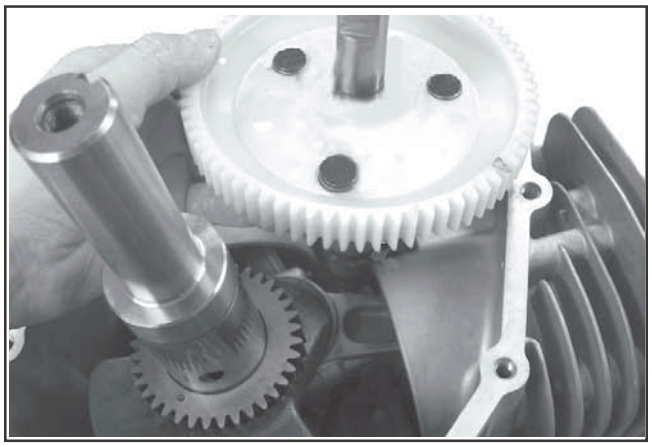


Figure 8-55. Removing Camshaft.

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 8-56.

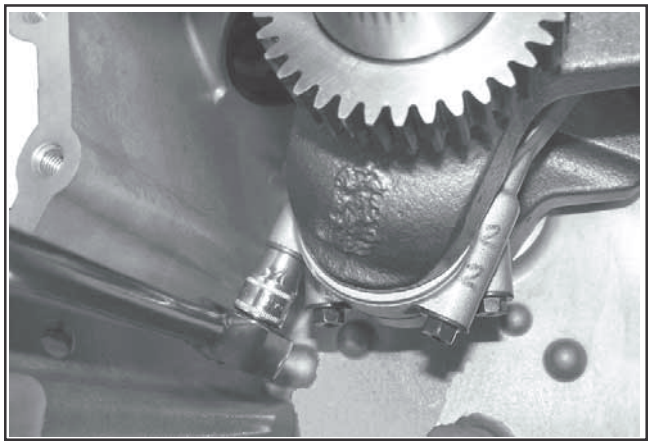


Figure 8-56. Removing Connecting Rod Screws.

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

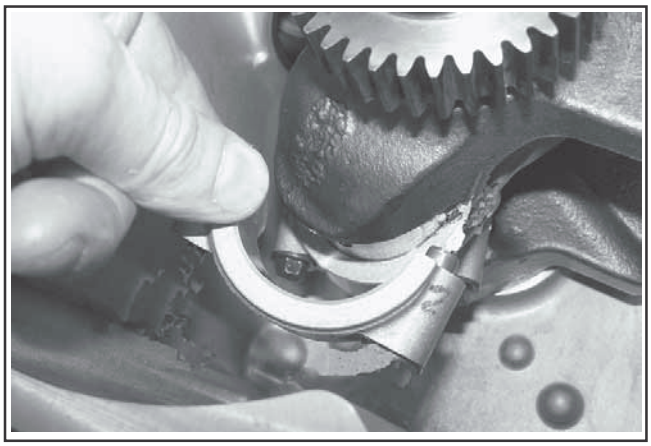


Figure 8-57. Remove Connecting Rod Caps.

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.

2. Carefully remove the connecting rod and piston assembly from the cylinder bore. See Figure 8-58.

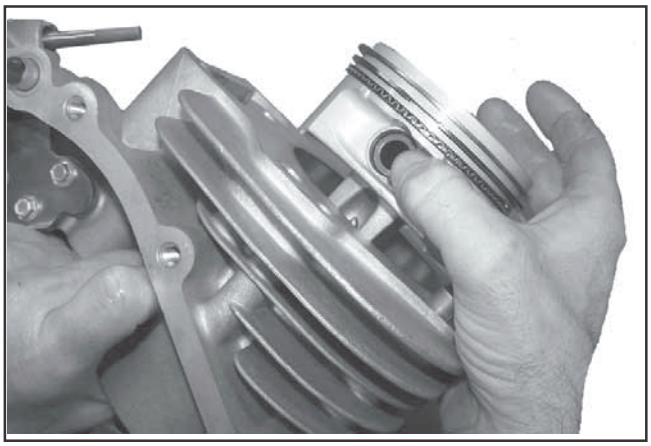


Figure 8-58. Removing Piston/Connecting Rod Assemblies.

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

Remove Crankshaft

1. Carefully pull the crankshaft from the crankcase. See Figure 8-59. Note thrust washers and shims if used.

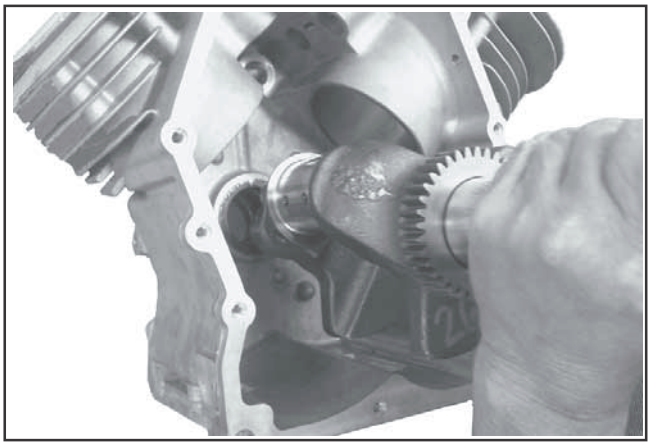


Figure 8-59. Removing Crankshaft.

Removal of Governor Gear Assembly

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. If the governor cross shaft, yoke, or gear condition does not require removal, the governor gear may be left in place. If removal is necessary, perform as follows:

1. Remove the locking tab thrust washer and note orientation.

2. Using a screwdriver, carefully pry upward to unseat the governor gear assembly from the governor gear shaft. Remove the regulating pin and governor gear assembly. See Figure 8-60.

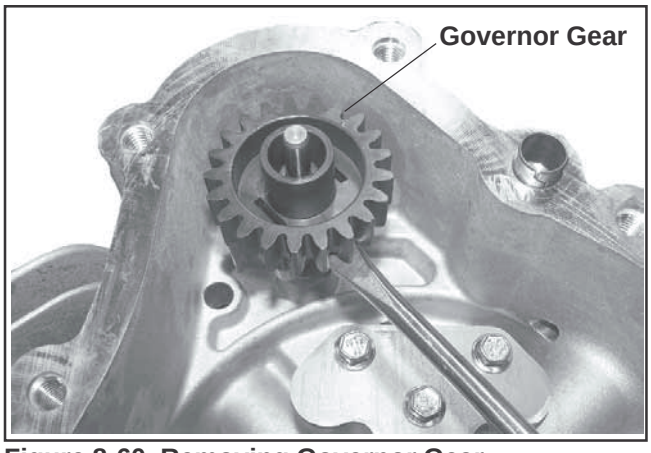


Figure 8-60. Removing Governor Gear.

3. Inspect the governor gear shaft for wear or damage. Remove the shaft only if replacement is needed.

Remove Governor Yoke, Cross Shaft, and Seal

1. Remove the two mounting screws securing the yoke to the governor cross shaft. See Figure 8-61.

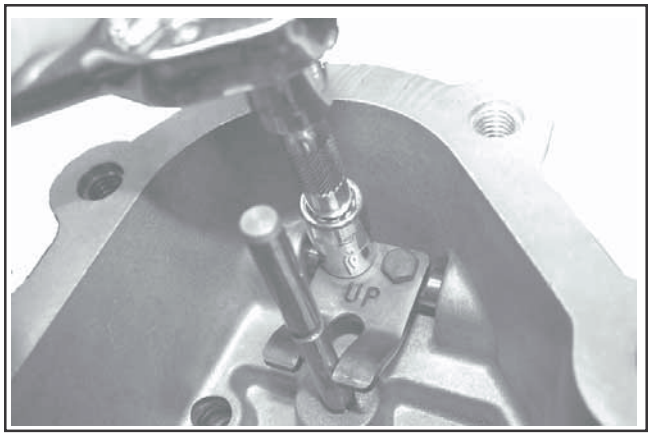


Figure 8-61. Removing Cross Shaft/Yoke Screws.

2. Pull the governor cross shaft out of the crankcase and remove the seal.

Remove Lifter Feed Chamber Cover and Gaskets

1. Remove the three screws securing the lifter feed chamber baffle (some models only), cover, and gaskets. Carefully separate the parts from the crankcase. See Figure 8-62.

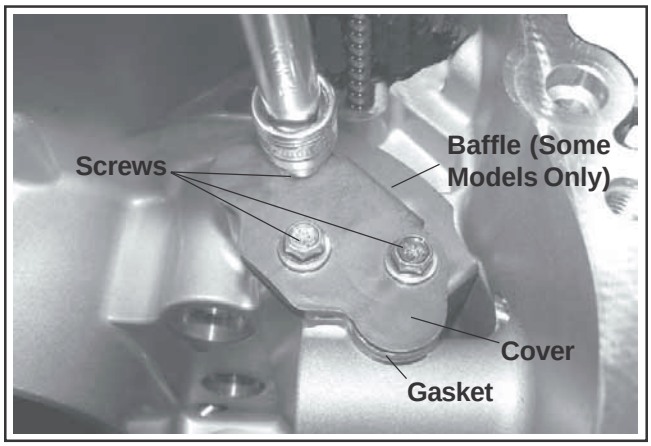


Figure 8-62. Removing Lifter Feed Chamber Cover Components.

Remove Flywheel and PTO End Oil Seals

1. Remove the oil seals from the crankcase and closure plate using a seal puller. See Figure 8-63.

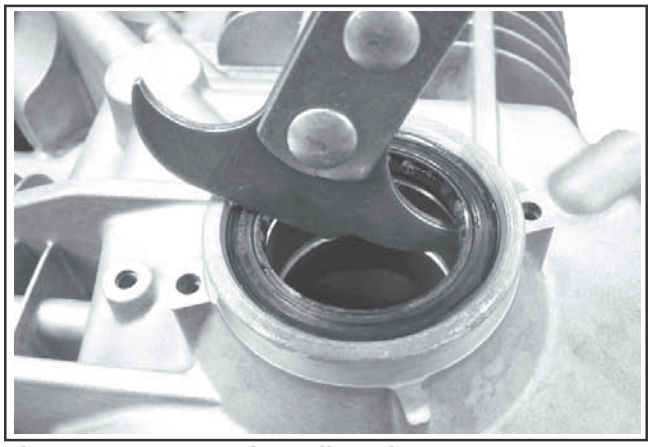


Figure 8-63. Removing Oil Seals.

Removal of Main Bearings

NOTE: Flywheel and PTO side main bearings should only be removed if replacement is required due to wear. If removal is performed, use a press and support the casting surface around the bearing flange. **Do not** press against or support by the gasket/outer perimeter surface. See Figure 8-64.

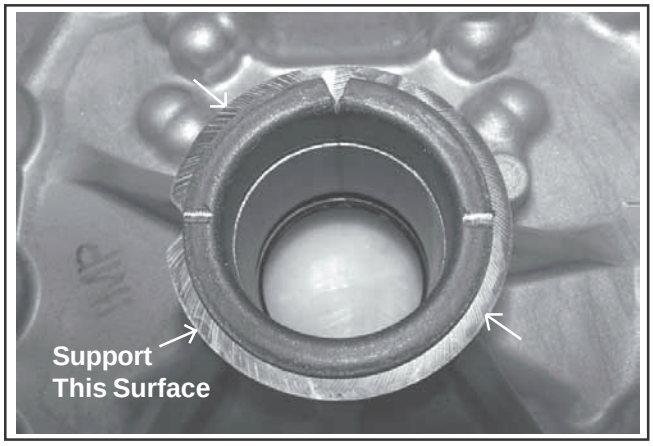


Figure 8-64. Support Surface Details.

Section 9
Inspection and Reconditioning

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:

Air Cleaner, Section 4
Carburetor & External Governor, Section 5
Ignition, Charging, & Electric Starter, Section 7

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 gasket material. Apply the solvent, allow time for it to work, and then brush the surface with a **brass** wire brush. After all old material 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. See Service Bulletin 252 for further information.

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.

Camshaft

Inspection and Service

Check the lobes of the camshaft for wear or damage. See Section 1 for minimum lift and/or dimensional 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. Replaceable bearings are used in the crankshaft bore of the closure plate and/or crankcase. Do not replace bearings unless they show signs of damage or are out of running clearance specifications. If the crankshaft turns easily, without noise, and there is no evidence of scoring, grooving, etc., on the races or bearing surfaces, the bearings can be reused.

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

Inspect the crankpin for score marks or metallic pickup. Slight score marks can be cleaned with crocus cloth soaked in oil. If the wear limits, as stated in Specifications and Tolerances are exceeded, it will be necessary to either replace the crankshaft or regrind the crankpin to **0.25 mm (0.010 in.)** undersize. If reground, a **0.25 mm (0.010 in.)** undersize connecting rod (big end) must then be used to achieve proper running clearance. Measure the crankpin for size, taper, and out-of-round.

NOTE: If the crankpin is reground, visually check to ensure that the fillet blends smoothly with the crankpin surface. See Figure 9-1.

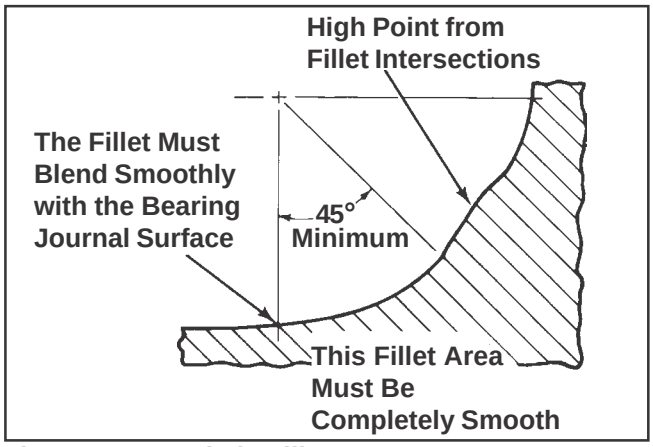


Figure 9-1. Crankpin Fillets.

The connecting rod journal can be ground one size under. When grinding a crankshaft, grinding stone deposits can get caught in the oil passages, which could cause severe engine damage. Removing the crankpin plug when the crankshaft is ground provides easy access for removing any grinding deposits that may collect in the oil passages.

Use the following procedure to remove and replace the plug.

Procedure to Remove Crankshaft Plug:

1. Drill a 3/16" hole through the plug in the crankshaft.

2. Thread a 3/4" or 1" long self-tapping screw with a flat washer into the drilled hole. The flat washer must be large enough to seat against the shoulder of the plug bore. See Figure 9-2.

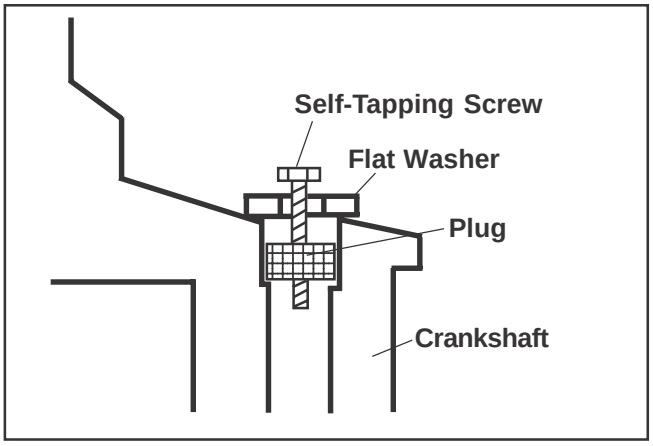


Figure 9-2. Removing Crankpin Plug.

3. Tighten the self-tapping screw until it draws the plug out of the crankshaft.

Procedure to Install New Plug:

1. Use a single cylinder camshaft pin, Kohler Part No. **47 380 09-S** as a driver and tap the plug into the plug bore until it seats at the bottom of the bore. Make sure the plug is tapped in evenly to prevent leakage.

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.

Inspect the main bearing (if so equipped) for wear or damage (refer to Section 1, Specifications, Tolerances, and Special Torque Values). Replace the bearing or crankcase using a miniblock or short block as required.

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 the Specifications, Tolerances, and Special Torque Values, in Section 1), then select the nearest suitable oversize of either **0.25 mm (0.010 in.)** or **0.50 mm (0.020 in.)**. Resizing to one of these oversizes will allow usage of the available oversize piston and ring assemblies. 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 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 oversizing a cylinder, it should be machined exactly **0.25 mm (0.010 in.)** or **0.50 mm (0.020 in.)** over the new diameter (Section 1). The corresponding 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 9-3.

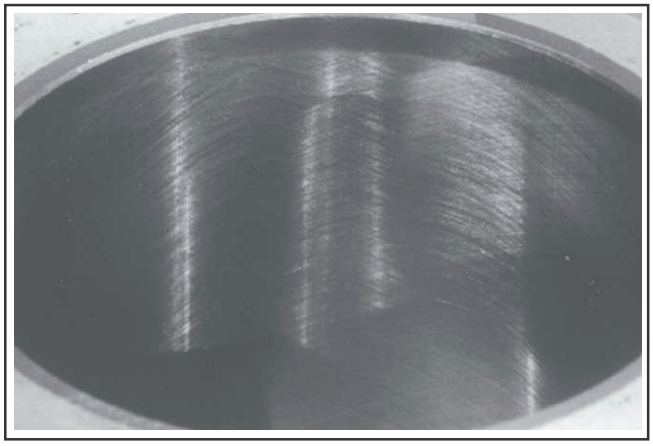


Figure 9-3. Cylinder Bore Crosshatch after Honing.

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 **11 mm (0.433 in.)** above the bottom of the piston skirt and perpendicular to the piston pin. See Figure 9-4.

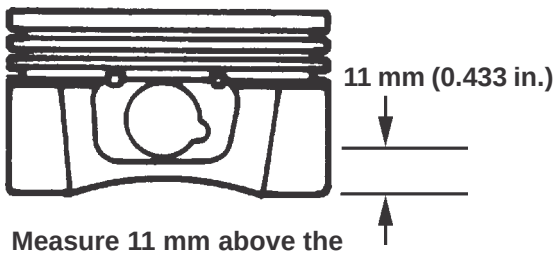


Figure 9-4. Measuring Piston Diameter.

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

Inspect the ring gear for cracks or damage. Kohler does not provide the ring gear 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 9-5. The maximum allowable out of flatness is **0.076 mm (0.003 in.)**.

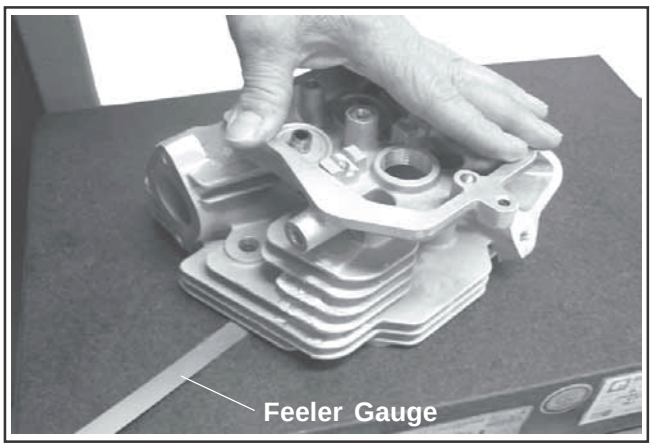
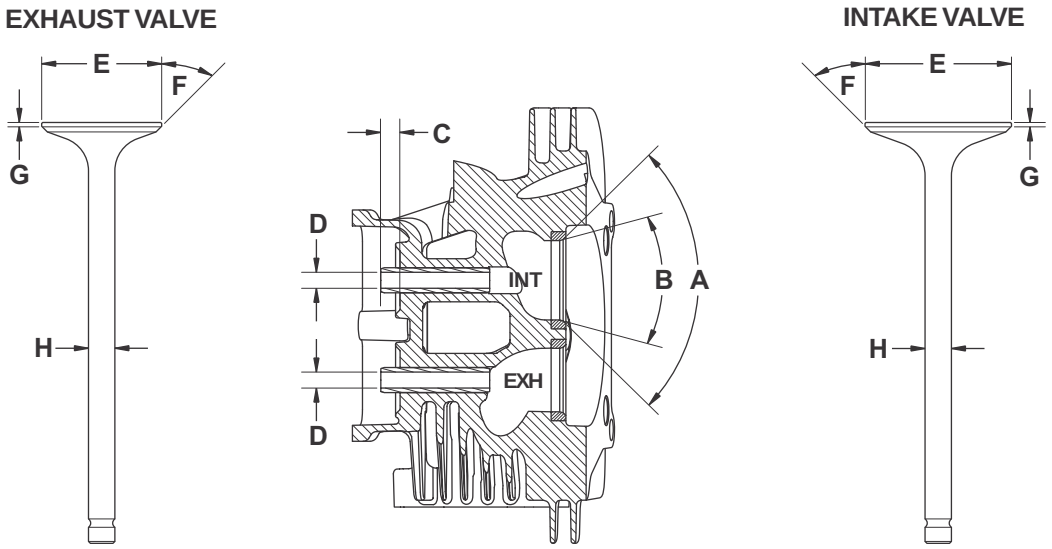


Figure 9-5. Checking Cylinder Head Flatness.

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 9-6 for valve details and specifications.



	Dimension	Intake	Exhaust
A	Seat Angle	89°	89°
B	Seat Taper	30°	30°
C	Guide Depth	8.5 mm (0.334 in.)	8.5 mm (0.334 in.)
D	Guide I.D.	7.038/7.058 mm (0.2771/0.2779 in.)	7.038/7.058 mm (0.2771/0.2779 in.)
E	Valve Head Diameter	38.625/38.685 mm (1.5206/1.5230 in.)	31.625/31.825 mm (1.2450/1.2549 in.)
F	Valve Face Angle	45°	45°
G	Valve Margin (Min.)	1.0 mm (0.0393 in.)	1.0 mm (0.0393 in.)
H	Valve Stem Diameter	6.982/7.000 mm (0.2749/0.2756 in.)	6.970/6.988 mm (0.2744/0.2751 in.)

Figure 9-6. Valve Details.

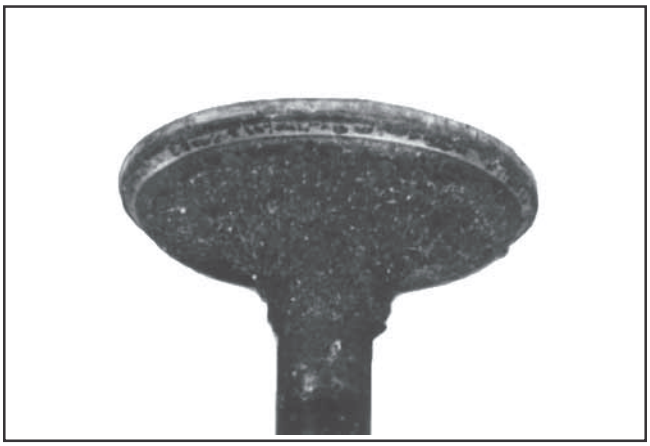
Hard starting or loss of power accompanied by high fuel consumption may be symptoms of faulty valves. Although these symptoms could also be attributed to worn rings, remove and check the valves first. After removal, clean the valve heads, faces, and stems with a power wire brush.

Then, carefully inspect each valve for defects such as a warped head, excessive corrosion, or a 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.

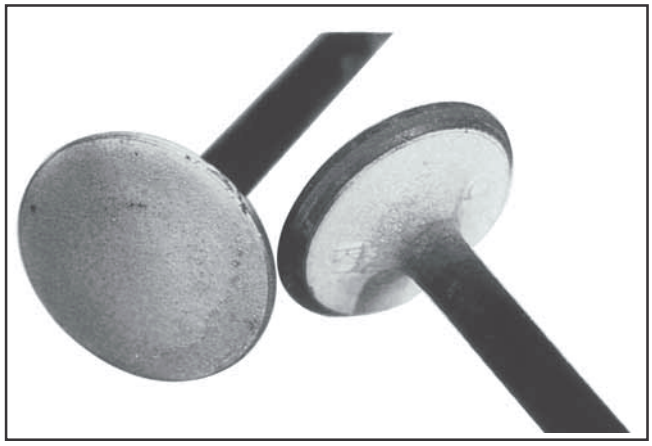
Normal: Even after long hours of operation a valve can be reconditioned and reused if the face and margin are in good shape. If a valve is worn to where the margin is less than 1/32" do not reuse it. The valve shown was in operation for almost 1000 hours under controlled test conditions.

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.



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

S**tem Corrosion:** Moisture in fuel or from condensation are 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 (0.0015/0.0030 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 **7.135 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 9-7. The final cut should be made with an 89° cutter as specified for the valve seat angle in Figure 9-6. Cutting the proper 45° valve face angle as specified in Figure 9-6, 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.

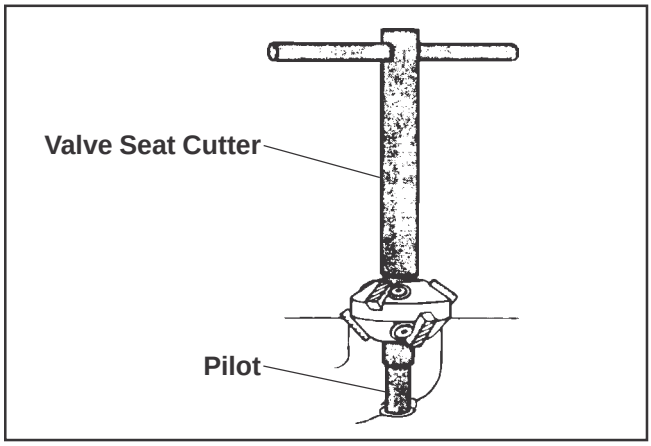


Figure 9-7. Typical Valve Seat Cutter.

Lapping Valves

Reground or new valves must be lapped in, to provide proper fit. Use a hand valve grinder with a suction cup for final lapping. Lightly coat the valve face with a fine grade of grinding compound, then rotate the valve on its seat with the grinder. Continue grinding until a smooth surface is obtained on the seat and on the valve face. Thoroughly clean the cylinder head in soap and hot water to remove all traces of grinding compound. After drying the cylinder head, apply a light coating of **SAE 10** oil to prevent rusting.

Valve Stem Seals

These engines use valve stem seals on the intake and exhaust valves. Always use new seals 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.

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.

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

See Figure 9-8 for some common types of piston and ring damage.

Stuck, Broken Rings

Abrasive Scratched Rings

Overheated or Deteriorated Oil

Scored Piston and Rings

Figure 9-8. Common Types of Piston and Ring Damage.

Replacement pistons are available in STD bore size, and in 0.25 mm (0.010 in.), and 0.50 mm (0.020 in.) oversize. Replacement pistons include new piston ring sets and new piston pins.

Replacement ring sets are also available separately for STD, 0.25 mm (0.010 in.), and 0.50 mm (0.020 in.) oversize pistons. Always use new piston rings when installing pistons. Never reuse old rings.

Some important points to remember when servicing piston rings:

1. The cylinder bore must be deglazed before service ring sets are used.

2. If the cylinder bore does not need reboring 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 9-9. Compare the ring gap to the specifications listed in Section 1.

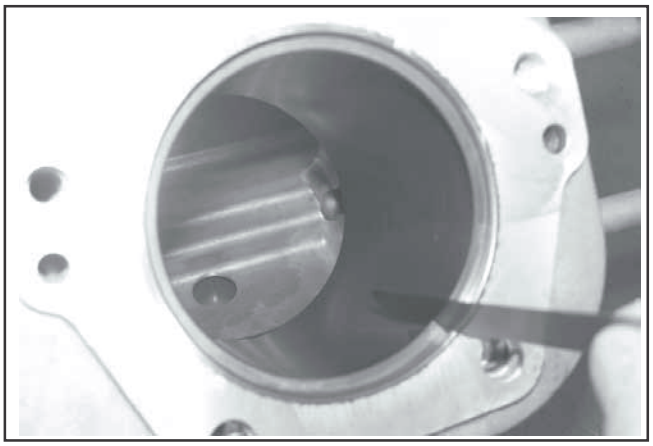


Figure 9-9. Measuring Piston Ring End Gap.

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. If the side clearance is greater than specified, a new piston **must** be used. Refer to Figure 9-10.

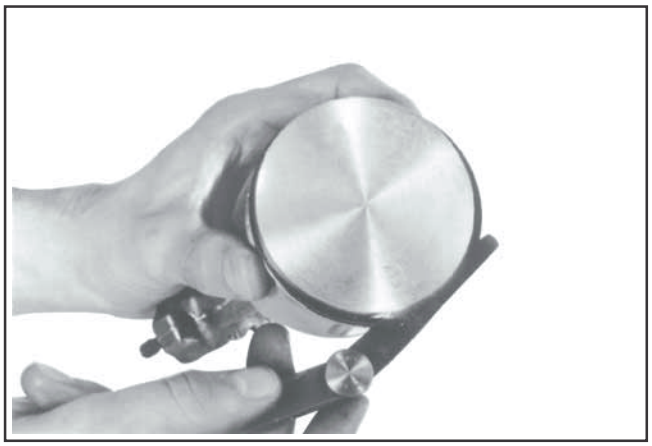


Figure 9-10. Measuring Piston Ring Side Clearance.

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 9-11. Install the bottom (oil control) ring first and the top compression ring last. Refer to Figure 9-12.

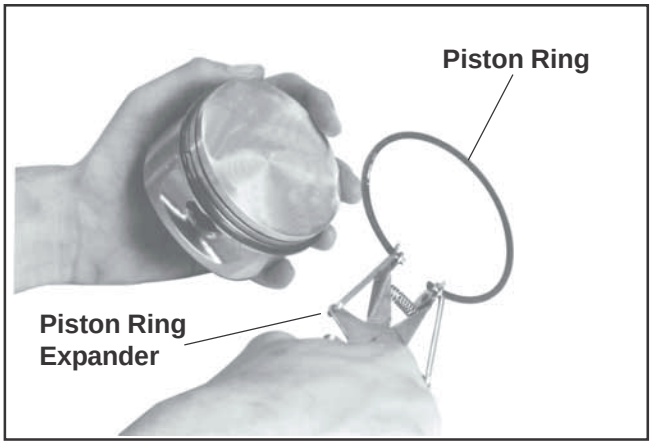


Figure 9-11. Installing Piston Rings.

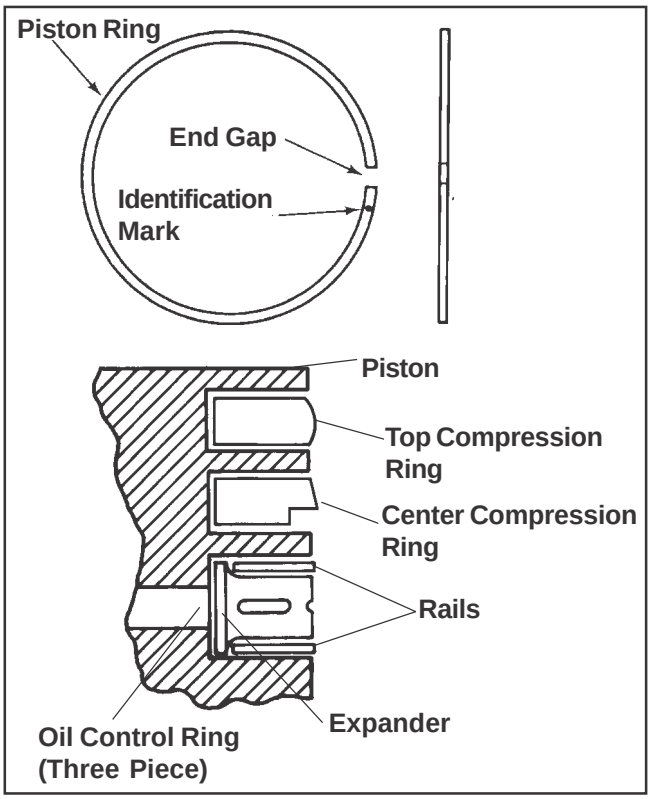


Figure 9-12. Piston Ring Installation.

1. Oil Control Ring (Bottom Groove): Install the expander and then the rails. Make sure the ends of expander are not overlapped.

2. Middle Compression Ring (Center Groove): Install the center ring using a piston ring installation 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. 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 these engines.

Inspection and Service

Check the bearing area (big end) for excessive wear, score marks, running and side clearances (refer to Section 1, Specifications, Tolerances, and Special Torque Values). Replace the rod and cap if scored or excessively worn.

Service replacement connecting rods are available in STD crankpin size and **0.25 mm (0.010 in.)** undersize. Always refer to the appropriate parts information to ensure that correct replacements are used.

Hydraulic Lifters

Inspection

Check the base surface of the hydraulic lifters for wear or damage. If the lifters need to be replaced, apply a liberal coating of Kohler lubricant (see Section 2) to the base of each new lifter before it is installed.

"Bleeding" the Lifters

To prevent a possible bent push rod or broken rocker arm, it is important to "bleed" any excess oil out of the lifters before they are installed.

1. Cut a 50-75 mm (2-3 in.) piece from the end of an old push rod and chuck it in a drill press.

2. Lay a rag or shop towel on the table of the drill press and place the lifter, open end up, on the towel.

3. Lower the chucked push rod until it contacts the plunger in the lifter. Slowly "pump" the plunger two or three times to force the oil out of the feed hole in the side of the lifter.

Governor Gear Assembly

Inspection

The governor gear is located within the crankcase. 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 crankcase.

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.

Closure Plate Assembly

Inspection

Inspect the oil seal in the closure plate and remove it if it is worn or damaged. Refer to Install Closure Plate Oil Seal in Section 10 for new oil seal installation.

Inspect the main bearing surface for wear or damage (refer to Section 1, Specifications, Tolerances, and Special Torque Values). Replace the bearing or closure plate assembly if required.

Oil Pump Assembly

Disassembly

1. Remove the three hex flange screws securing the oil pump housing including the relief valve baffle, and the single screw with clamp for the pickup tube. See Figure 9-13.

2. Remove the oil pump housing and pickup tube from the closure plate.

3. Remove the oil pump gerotor gears from the closure plate recess.

4. Remove the oil pickup by pulling it free from the oil pump body.

5. The relief valve is a one-piece style, staked to the oil pump housing; removal should not be attempted, nor is internal servicing possible. If a problem with the relief valve is encountered, the oil pump should be replaced. See Figure 9-15.

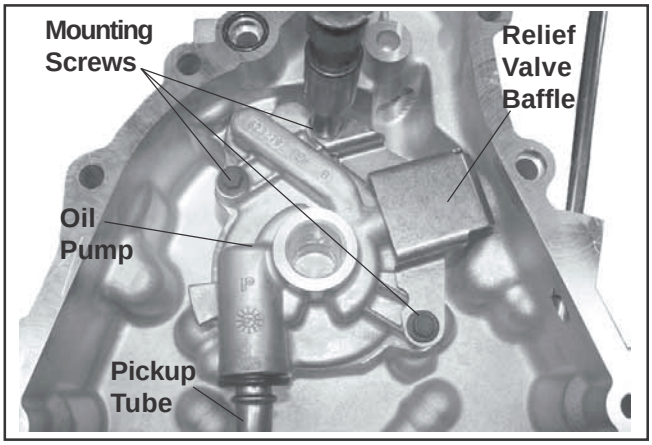


Figure 9-13. Removing Oil Pump.

Inspection

Inspect the oil pump housing, gerotor gears, and closure plate recess for nicks, burrs, wear, or any visible damage. Inspect the inlet seal for the pickup tube in the housing. If any parts are worn or damaged, replace the seal, oil pump or closure plate as required.

Reassembly

1. Make sure the recess in the closure plate for the oil pump gerotor gears is clean.

2. Lubricate the oil pump gerotor gears with grease (Lubriplate® 100 or equivalent), and install into the recess. See Figure 9-14.

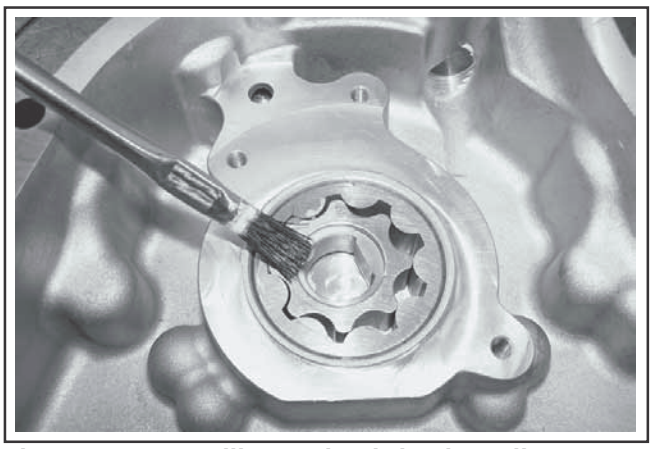


Figure 9-14. Installing and Lubricating Oil Pump Gerotor Gears.

3. Lightly lubricate with oil and install the inlet seal into the oil pump housing until it is fully seated. See Figure 9-15.

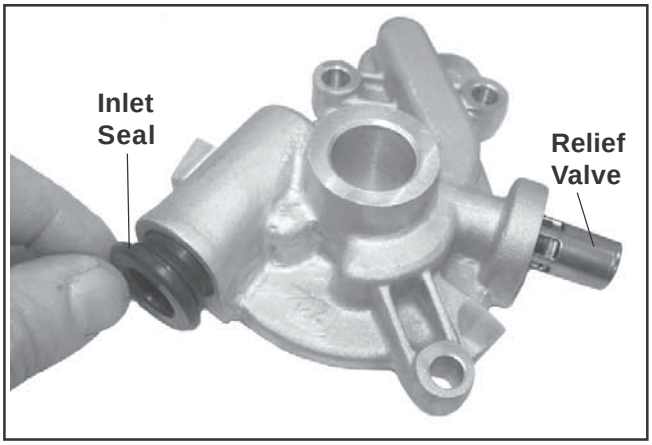


Figure 9-15. Installing Inlet Seal in Oil Pump Housing.

4. Install the O-Ring in the groove of the oil pump housing. Use a small quantity of grease to hold it in place. See Figure 9-16.

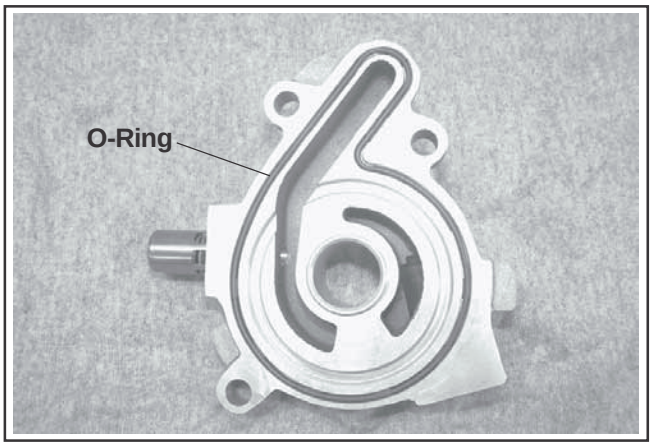


Figure 9-16. O-Ring Installed in Oil Pump Housing.

5. Lightly lubricate the I.D. of the inlet seal with oil and carefully insert the ferruled end of the pickup tube through the grommet, into the oil pump housing. Position the pickup tube so the outboard end faces up. See Figure 9-17.

6. Install the oil pump housing with the pickup tube, over the oil pump boss and gears. Position the relief valve baffle on screws 2 and 3. See Figure 9-18. Align the three screw hole locations.

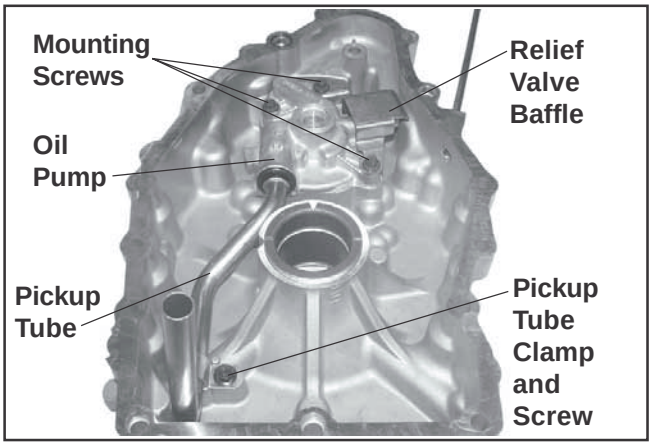


Figure 9-17. Installed Oil Pump and Pickup Tube.

7. Install the clamp for the pickup tube and finger tighten the screw. Check the alignment of the parts and torque the oil pump housing screws as specified using the sequence shown in Figure 9-18.

   Torque the hex flange screws as follows:
   a. Install fastener into location No. 1 and lightly tighten to position the pump.

   b. Install fastener into location No. 2 and fully torque to the recommended value.

   c. Install fastener into location No. 3 and fully torque to the recommended value.

   d. Finish torquing fastener in location No. 1 to the recommended value.

   First Time Installation: **10.7 N·m (95 in. lb.)**
   All Reinstallations: **6.7 N·m (60 in. lb.)**

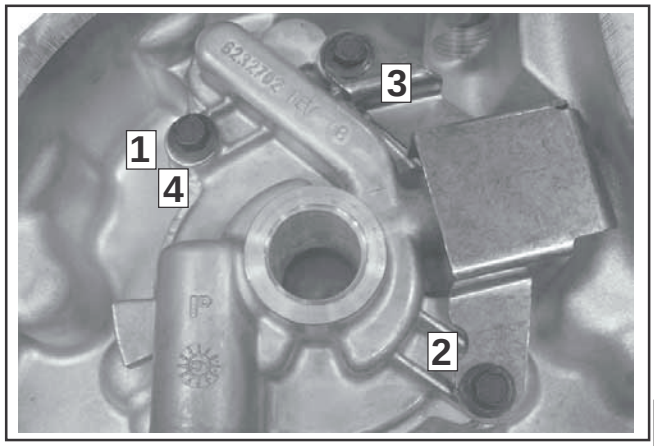


Figure 9-18. Oil Pump Screws Torque Sequence.

8. Torque the clamp (pickup tube) mounting screw to **10.7 N·m (95 in. lb.)** into a new hole, or **7.3 N·m (65 in. lb.**) into a used hole. See Figure 9-17.

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. Apply a small amount of oil to the threads of critical fasteners before assembly, unless a Sealant or Loctite® is specified or preapplied.

Make sure all traces of any cleaner are removed before 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 closure plate, crankcase, cylinder heads, and valve covers to be certain that all of the old gasket 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 lifter feed chamber gaskets and cover.
3. Install flywheel end main bearing.
4. Install governor shafts, seal, and governor gear.
5. Install crankshaft.
6. Install connecting rods with pistons and rings.
7. Install camshaft.
8. Install closure plate main bearing and oil seal.
9. Install closure plate assembly.
10. Install oil pickup screen.
11. Install oil reservoir.
12. Check crankshaft end play.
13. Install breather assembly.
14. Install hydraulic lifters.
15. Assemble and install cylinder heads.
16. Install push rods and rocker arms.
17. Install valve covers.
18. Install spark plugs.
19. Install oil filter adapter.
20. Install intake manifold.
21. Install oil filter housing assembly.
22. Install backing shroud assembly.
23. Install stator, wiring harness, and rectifier-regulator.
24. Install flywheel.
25. Install ignition modules.
26. Install outer cylinder baffles.
27. Install oil cooler.
28. Install cooling fan and grass screen.
29. Install electric starter.
30. Install valley baffles.
31. Install carburetor
32. Install governor lever.
33. Install control bracket and air cleaner assembly.
34. Install throttle and choke linkages.
35. Install Oil Sentry™ switch (if equipped).
36. Install blower housing and cylinder shrouds.
37. Install control panel (if equipped).
38. Install muffler.
39. Install oil filter and add oil to crankcase.
40. 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.

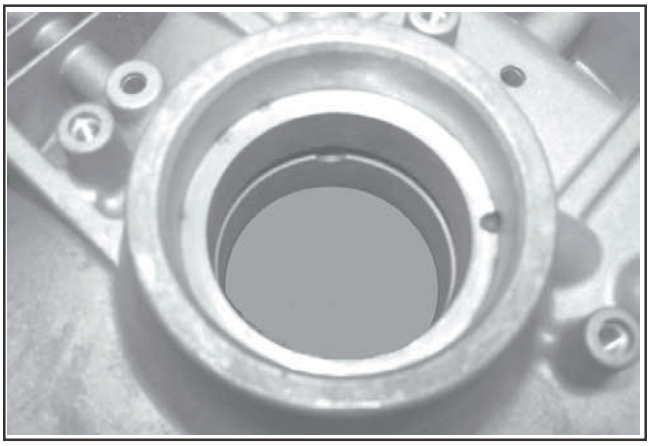


Figure 10-1. Seal Bore of Crankcase.

2. Apply a light coat of clean engine oil to the outside diameter of the oil seal.

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 that the tool bottoms against the crankcase. See Figures 10-2 and 10-3.

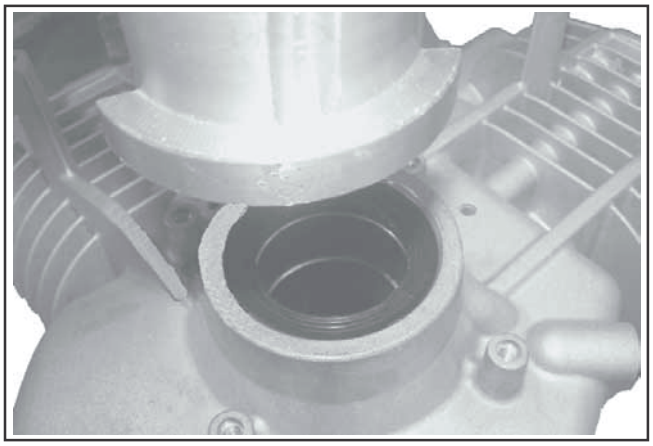


Figure 10-2. Installing Oil Seal with Driver.

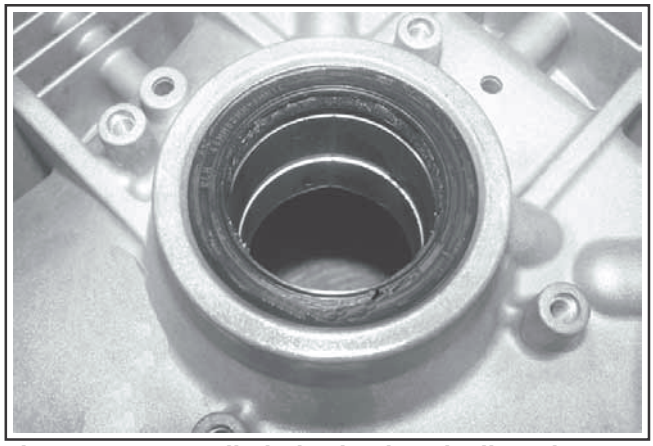


Figure 10-3. Installed Flywheel End Oil Seal.

Install Lifter Feed Chamber Gaskets and Cover

1. Install the lifter feed chamber gasket, followed by the lifter feed cover over the lifter feed chamber. If used, position the breather baffle on top of the parts with the winged offset down.

2. Install the three screws. Make sure all the parts are properly aligned. Torque the screws to **6.2 N·m (55 in. lb.)** into new holes, or **4.0 N·m (35 in. lb.)**, into used holes. See Figure 10-4.

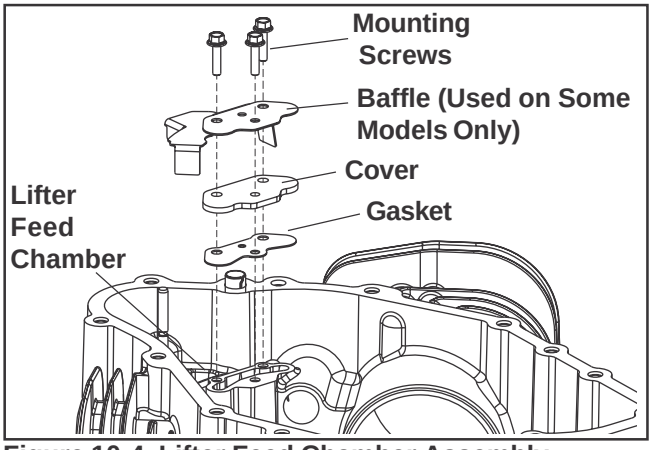


Figure 10-4. Lifter Feed Chamber Assembly Details.

Install Flywheel End Main Bearing

If the flywheel end main bearing was removed in servicing, install a new bearing using an arbor press and driver.

1. Make sure the crankcase bore for the main bearing is clean, dry and free of nicks or burrs.

2. Press the flywheel side main bearing in place with the notch oriented in the 12 o'clock position using an arbor press and driver. See Figure 10-5. Make sure the bearing is fully seated against the flange and the oil feed hole is open in the crankcase. See Figure 10-6.

3. Apply a light coat of clean engine oil to the inner surface of the main bearing.

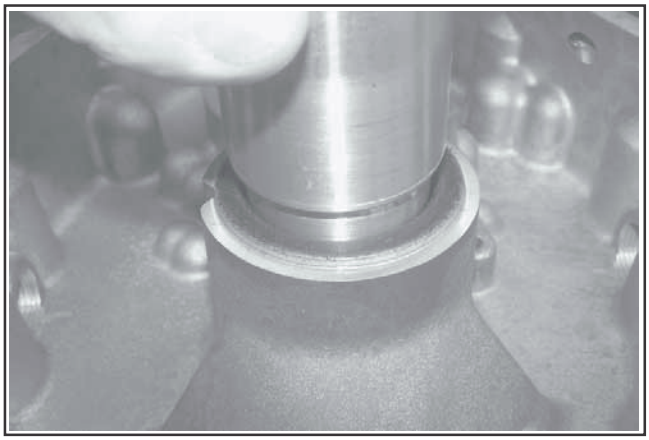


Figure 10-5. Installing Main Bearing.

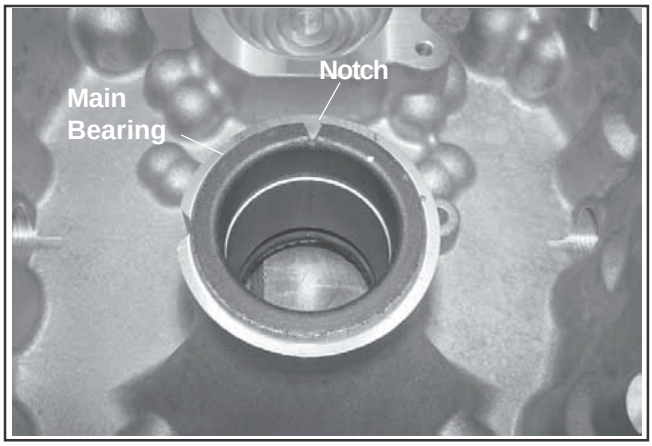


Figure 10-6. Installed Main Bearing.

Install Governor Shafts, Seal, and Governor Gear

If the governor shafts, seal, and/or governor gear were removed, reassemble as follows.

1. Lightly oil the lip and outside diameter of the new governor cross shaft seal. Install the seal into the crankcase to the depth shown in Figure 10-8.

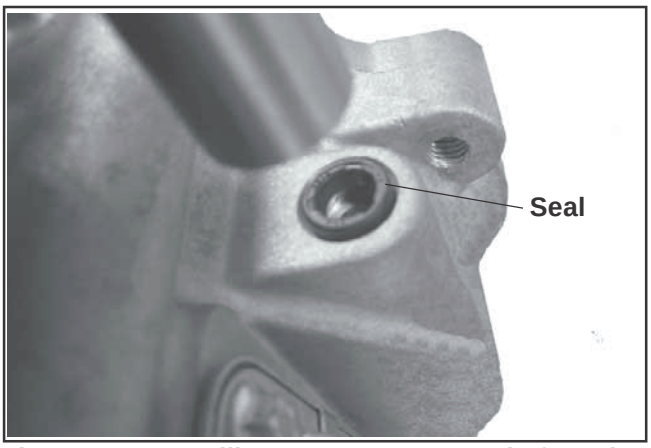


Figure 10-7. Installing Governor Cross Shaft Seal.

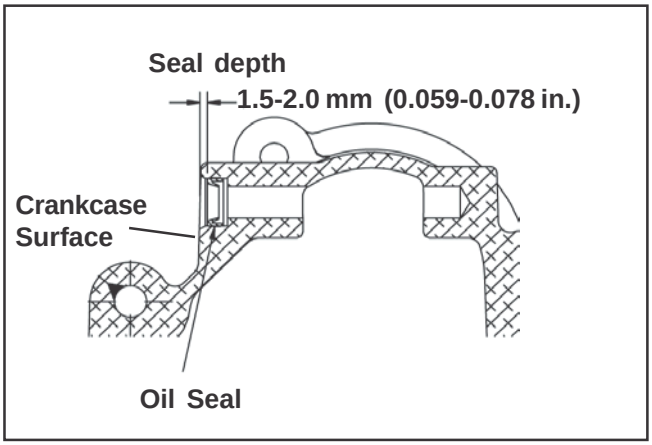


Figure 10-8. Governor Shaft Seal Depth.

2. If the governor gear shaft was removed, press or lightly tap the replacement shaft into the closure plate to depth shown in Figure 10-10.

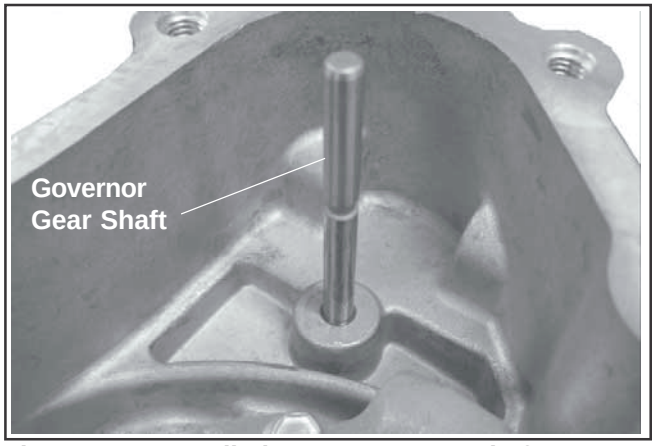


Figure 10-9. Installed Governor Gear Shaft.

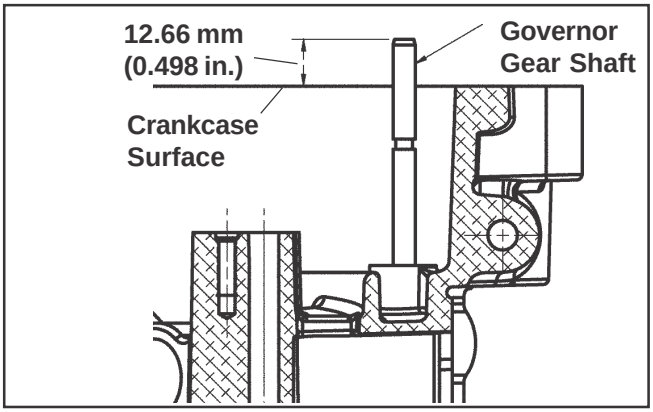


Figure 10-10. Governor Gear Shaft Press Depth.

3. Lubricate the governor cross shaft bearing surfaces in the crankcase with engine oil. Insert the end with the flat for the governor gear yoke into the crankcase first and position so the flat is **up**. See Figure 10-11.

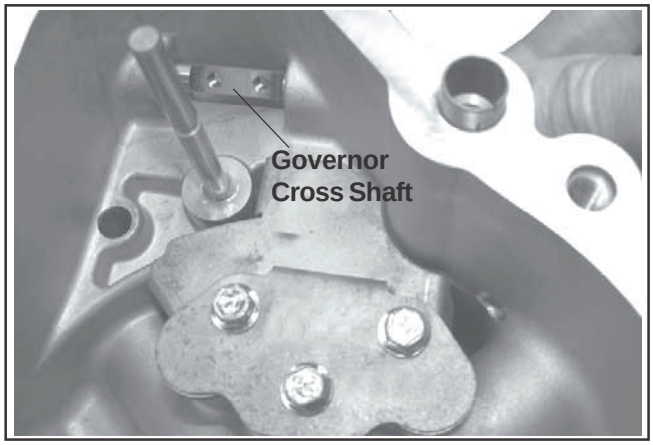


Figure 10-11. Installing Governor Cross Shaft.

4. Attach the governor yoke to the cross shaft so the curved section is **up** as marked. Secure with the two screws. If a thread locking compound is not preapplied, apply a small amount of Loctite® No. 266 or equivalent, to the screw threads before installing. Torque the screws to **2.2 N·m (20 in. lb.)**. See Figure 10-12.

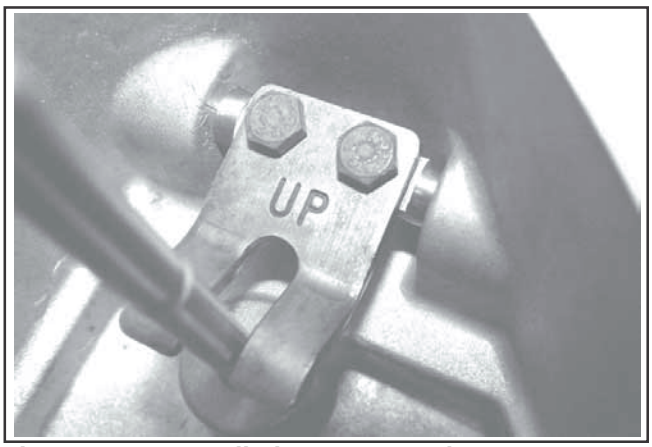


Figure 10-12. Installed Governor Yoke.

5. Install the first regulating pin with the head down so it will contact the yoke. Install the governor gear with the second regulating pin and the flyweight assembly in/down onto the governor shaft until it locks into position. Apply a small amount of grease to the locking tab thrust washer and install on top of the governor gear so the tang is facing **up** in the 6 o'clock position. See Figures 10-13, 10-14, and 10-15.

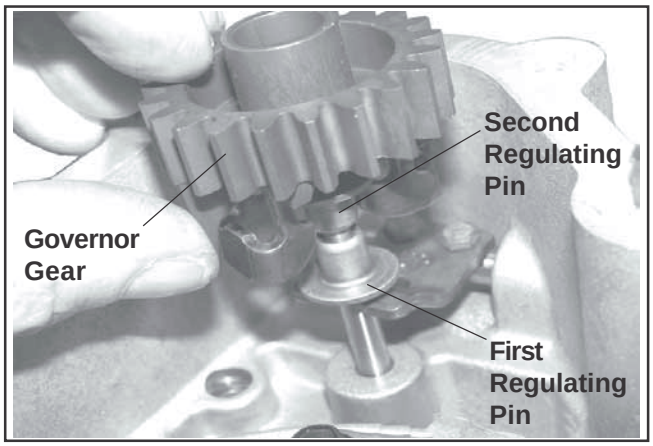


Figure 10-13. Regulating Pins and Governor Gear.

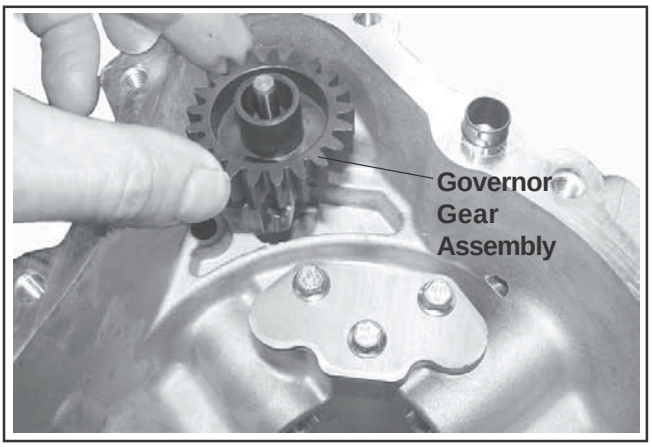


Figure 10-14. Installing Governor Gear Assembly.

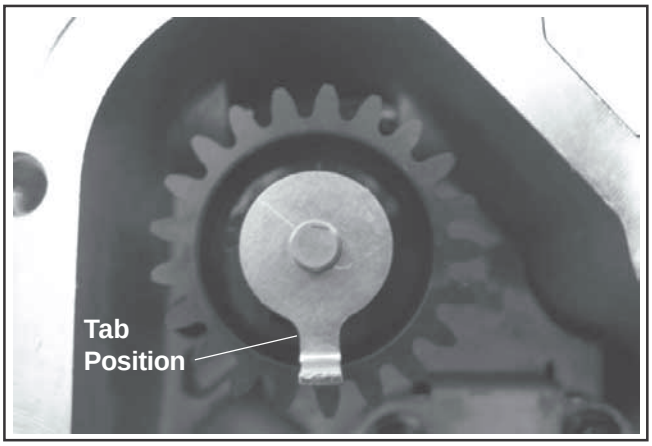


Figure 10-15. Installed Locking Tab Washer.

Install Crankshaft

1. Carefully slide the flywheel end of the crankshaft through the main bearing in the crankcase. See Figure 10-16.

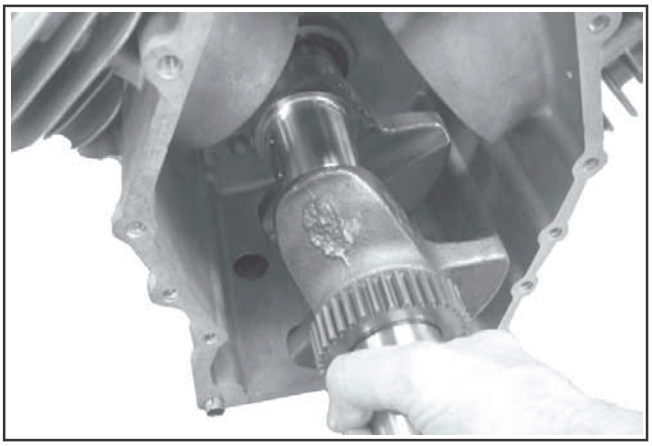


Figure 10-16. Installing Crankshaft.

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 the appropriate cylinder bore as previously marked at 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 10-17.

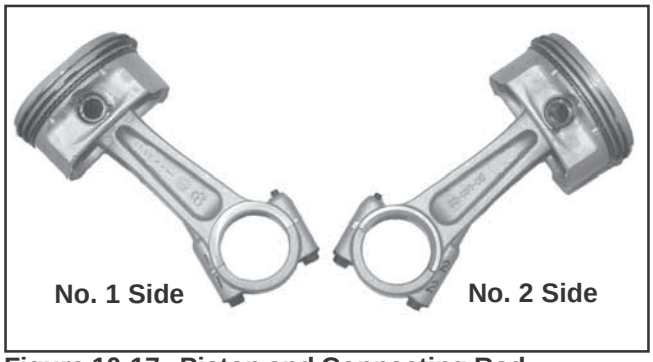


Figure 10-17. Piston and Connecting Rod Orientation.

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 of the #1 piston using a piston ring compressor.

3. Lubricate the crankshaft journals and connecting rod bearing surfaces with engine oil.

4. Make sure the **FLY** stamping on the piston is facing toward the flywheel side of the engine. See Figure 10-18. Use a hammer with a rubber grip and gently tap the piston into the cylinder as shown in Figure 10-19. Be careful that the oil ring rails do not spring free between the bottom of the ring compressor and top of the cylinder.

Figure 10-18. FLY Mark on Piston.

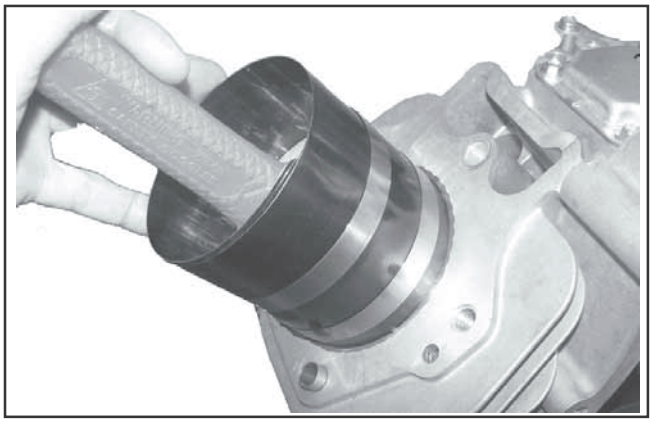


Figure 10-19. Installing Piston Assembly Using Ring Compressor Tool.

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 Figure 10-20.

   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.

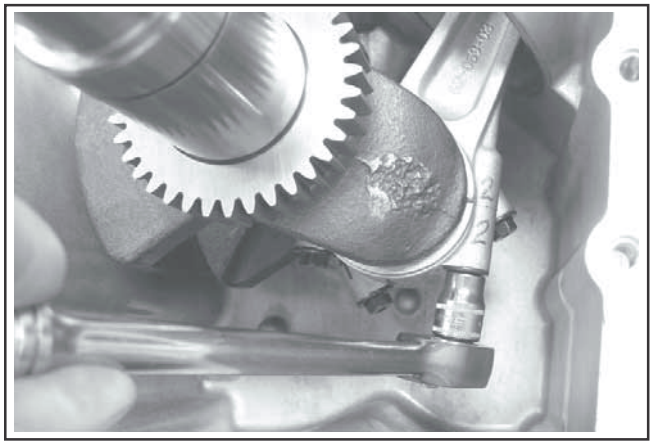


Figure 10-20. Torquing Connecting Rod End Cap Screws.

6. Repeat this procedure for the other connecting rod and piston assembly.

Install Camshaft

1. Liberally apply camshaft lubricant (see Section 2) to each of the cam lobes. Lubricate the camshaft bearing surfaces of the crankcase and the camshaft with engine oil. See Figure 10-21.

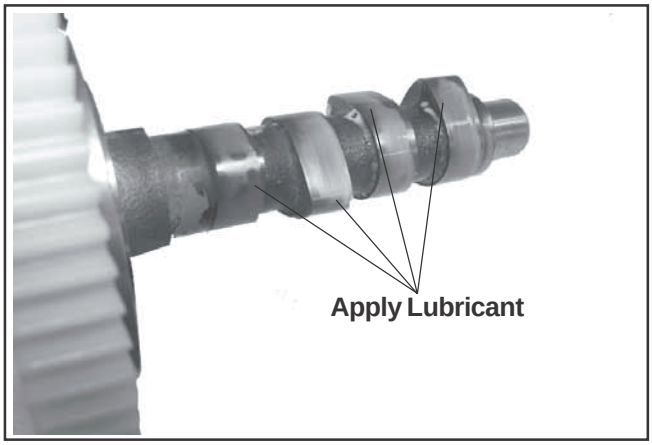


Figure 10-21. Apply Camshaft Lubricant to Cam Lobes.

2. Position the timing mark of the crankshaft gear at the 12 o'clock position.

3. Slide the camshaft into the bearing surface of the crankcase, positioning the timing mark of the camshaft gear at the 6 o'clock position. Make sure that the camshaft gear and crankshaft gear mesh, with both timing marks aligned. See Figure 10-22.

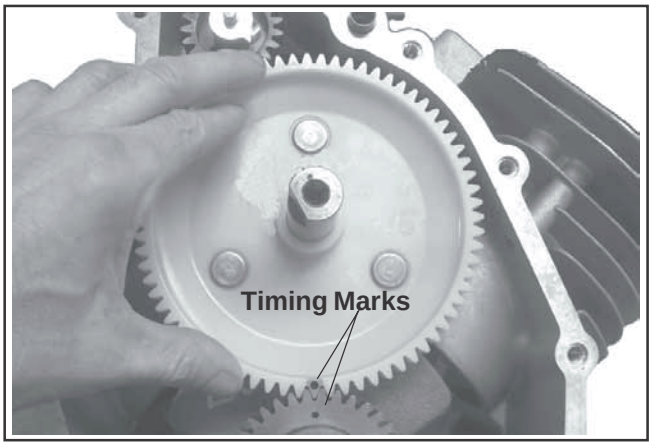


Figure 10-22. Installing Camshaft and Aligning Timing Marks.

Determining Camshaft End Play

1. Place a new closure plate gasket into position on the crankcase.

2. Position the camshaft end play checking tool over the camshaft. Use a feeler gauge to check the end play between the camshaft and end play checking tool. Camshaft endplay should be between **0.3/1.3 mm (0.011/0.051 in.)**. See Figure 10-23.

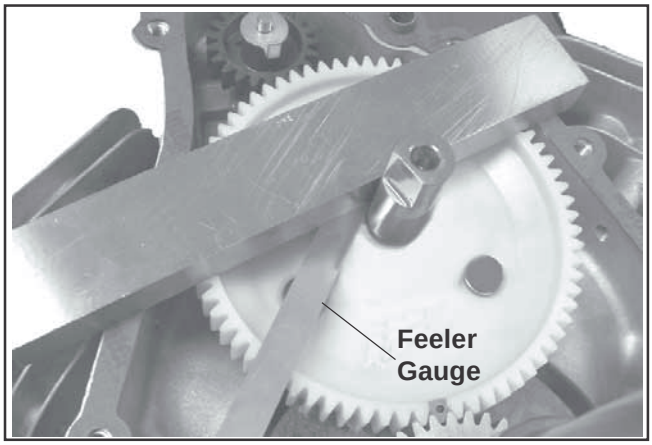


Figure 10-23. Checking Camshaft End Play.

3. No shim is typically used from the factory. However, if the camshaft end play is not within the specified range, remove the checking tool and shim as necessary.

Several color coded shims are available:

White: 0.69215/0.73025 mm (0.02725/0.02875 in.)
Blue: 0.74295/0.78105 mm (0.02925/0.03075 in.)
Red: 0.79375/0.83185 mm (0.03125/0.03275 in.)
Yellow: 0.84455/0.88265 mm (0.03325/0.03475 in.)
Green: 0.89535/0.99345 mm (0.03525/0.03675 in.)
Gray: 0.94615/0.98425 mm (0.03725/0.03875 in.)
Black: 0.99695/1.03505 mm (0.03925/0.04075 in.)

4. Reinstall the end play checking tool and recheck the end play.

Install Closure Plate Main Bearing and Oil Seal

Main Bearing

If the closure plate main bearing was removed during servicing, install a new bearing.

1. Make sure the closure plate bore for the main bearing is clean, dry, and free of nicks or burrs.

2. Install a new bearing with the notch in the 12 o'clock position, using a press and driver. Make sure the bearing is fully seated against the flange. See Figure 10-24.

3. Lightly oil the inside diameter of the bearing.

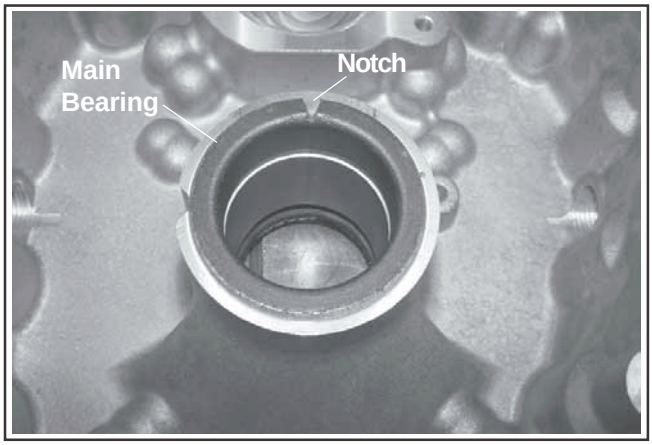


Figure 10-24. Installed Main Bearing In Closure Plate.

Oil Seal

1. Check to make sure there are no nicks or burrs in the crankshaft seal bore of the closure plate.

2. Lightly oil the outside diameter of the oil seal.

3. Install the oil seal into the closure plate using a seal driver. See Figure 10-25. Make sure the oil seal is installed straight and true in the bore to the depth shown in Figure 10-26.

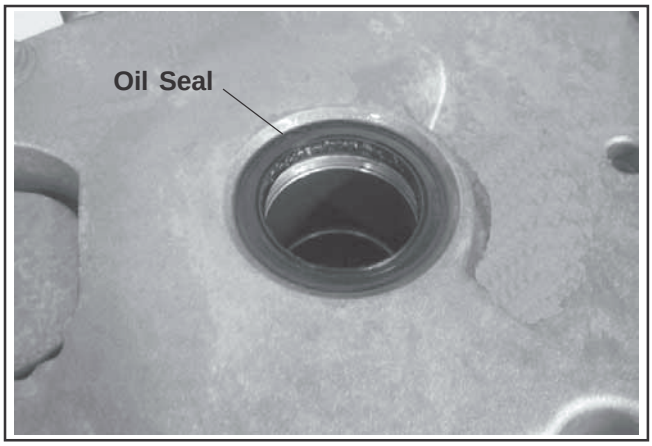


Figure 10-25. Installed Oil Seal in Closure Plate.

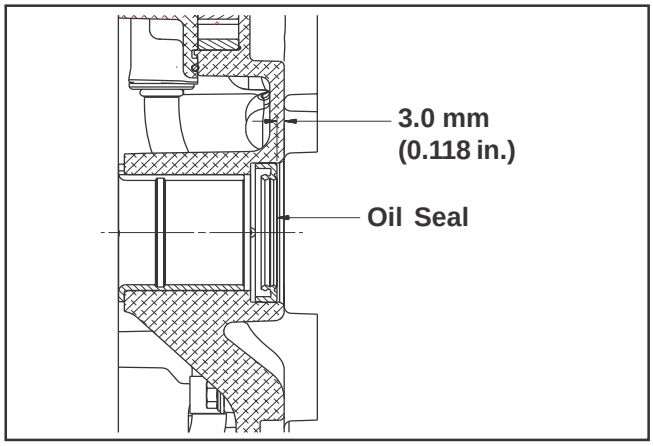


Figure 10-26. Oil Seal Depth in Closure Plate.

4. Apply a light coat of clean engine oil to the inner surface of the main bearing.

Oil Pump Assembly

The oil pump is mounted inside the closure plate. If service was required and the oil pump was removed, refer to the assembly procedures under Oil Pump Assembly in Section 9.

Install Closure Plate Assembly

1. Make sure the sealing surfaces of the closure plate and crankcase are clean, dry, and free of any nicks or burrs. Install a new O-Ring in the closure plate. See Figure 10-27.

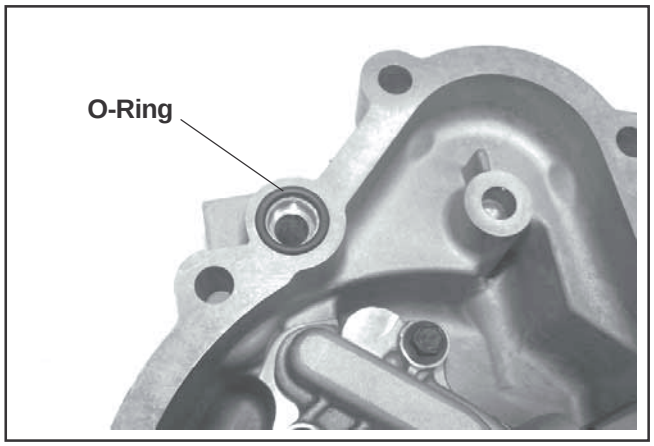


Figure 10-27. O-Ring Installed.

2. Install a new closure plate gasket onto the crankcase.

3. Make sure the oil pump is installed and the oil pickup tube faces outward at lower end.

4. Ensure the end of the tabbed washer on the governor gear is positioned **outward** in the 6 o'clock position inside the crankcase. See Figure 10-28.

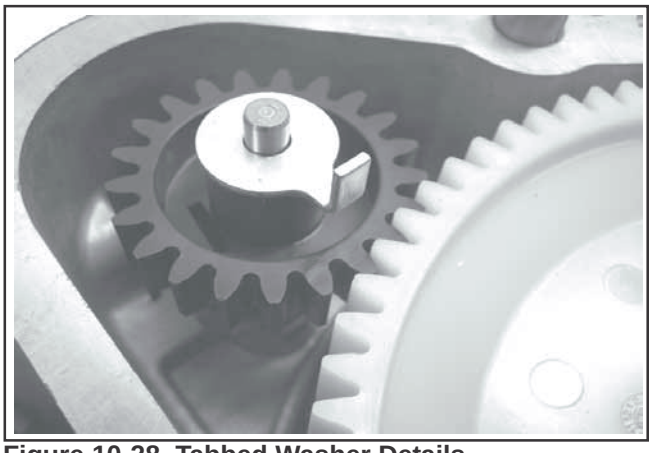


Figure 10-28. Tabbed Washer Details.

5. Orient the flat of the oil pump gear to match the position of the flat on the camshaft. Then install the closure plate to the crankcase. Carefully seat the camshaft and the crankshaft into their mating bearings. Rotate the crankshaft slightly to help the oil pump and governor gears mesh. See Figure 10-29.

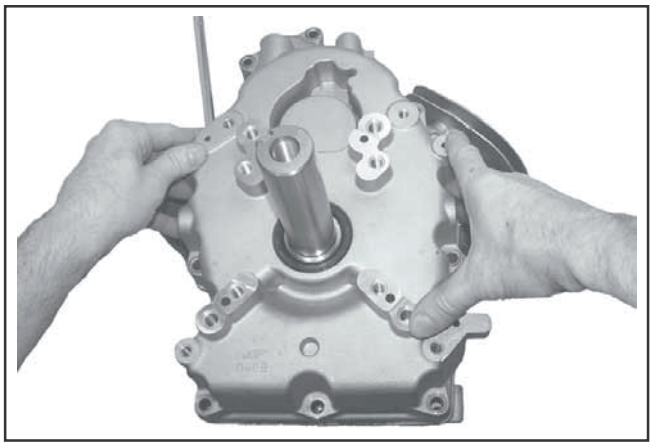


Figure 10-29. Installing Closure Plate.

6. Install the fourteen hex flange screws securing the closure plate to the crankcase. Torque the fasteners in the sequence shown in Figure 10-31 to **24.4 N·m (216 in. lb)**.

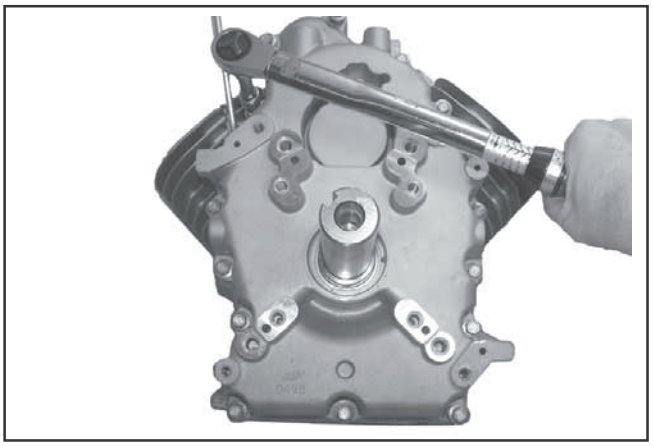


Figure 10-30. Torquing Closure Plate Screws.

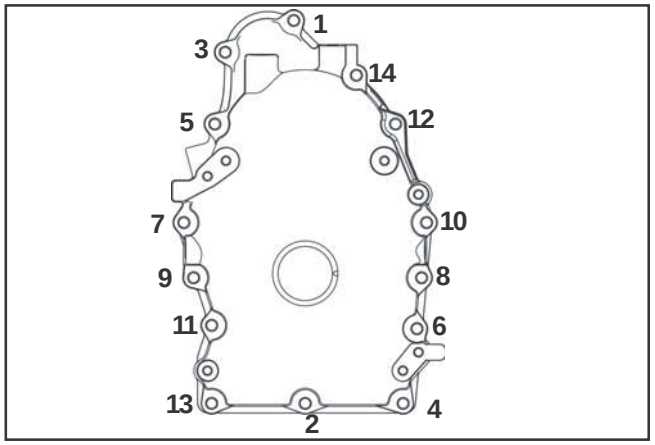


Figure 10-31. Closure Plate Fastener Torque Sequence.

Install Oil Pickup Screen

1. Apply a small amount of oil to the grommet of the pickup screen and insert it onto the lower end of pickup tube within the crankcase. Secure the pickup to the boss on the bottom of crankcase. Torque the mounting screw to **10.7 N·m (95 in. lb.)** into a new hole, or **7.3 N·m (65 in. lb.)** into a used hole. See Figures 10-32 and 10-33.

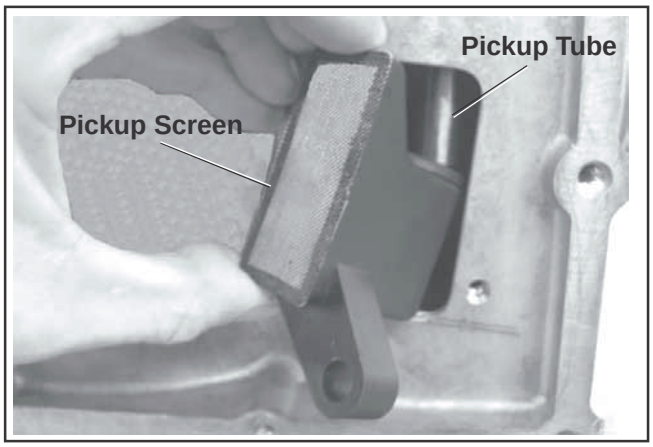


Figure 10-32. Installing Pickup Screen.

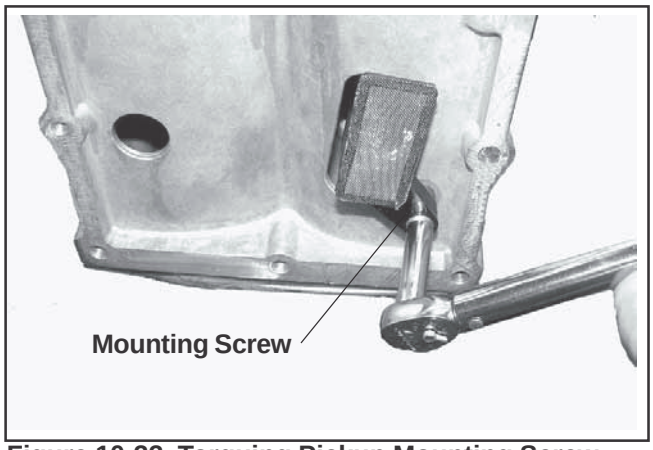


Figure 10-33. Torquing Pickup Mounting Screw.

Install Oil Reservoir

1. Use two bolts with the heads removed, or a similar item as temporary alignment pins and install into the two center holes on the ends as shown in Figure 10-34.

2. Install a new oil reservoir gasket onto the bottom of the crankcase using the alignment pins. The notched side of the gasket must be towards the flywheel.

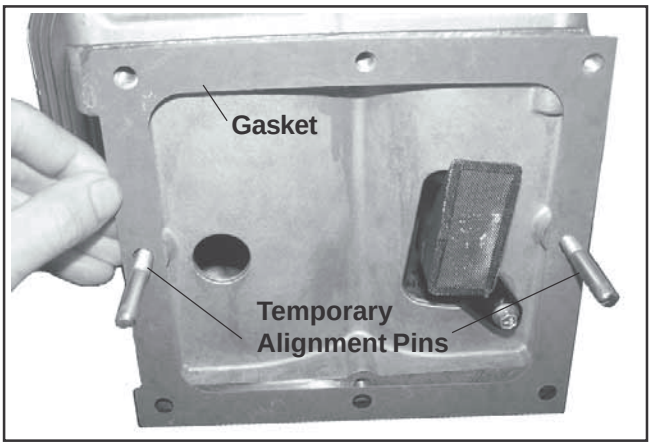


Figure 10-34. Installing Oil Reservoir Gasket.

3. Install the oil reservoir onto the crankcase and temporary alignment pins. The flywheel side is indicated on the cover. Install and finger tighten the screws. Remove the two alignment pins and install the two remaining screws. Torque the screws in the sequence shown in Figure 10-36 to **24.4 N·m (216 in. lb.)**.

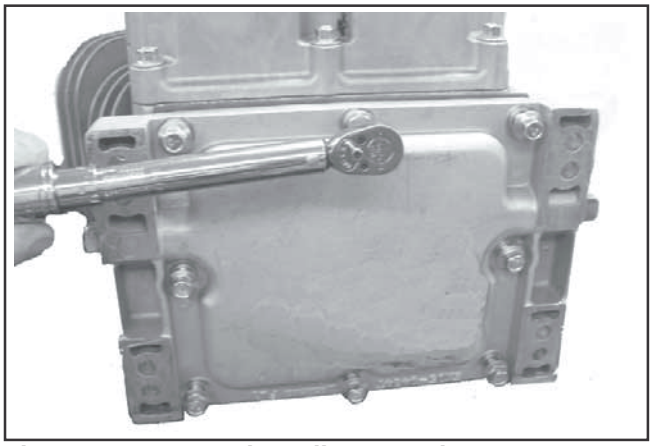


Figure 10-35. Torquing Oil Reservoir Fasteners.

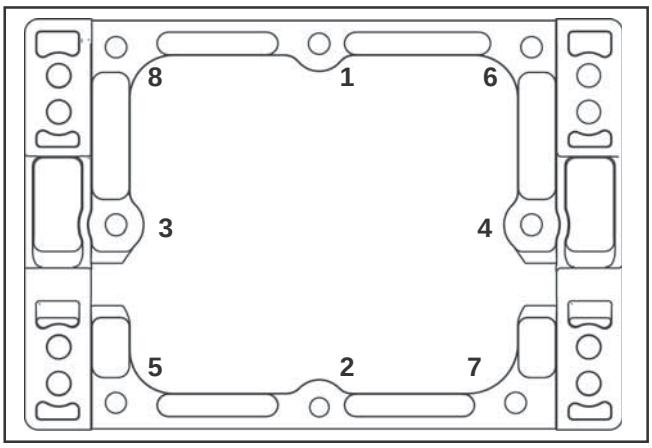


Figure 10-36. Oil Reservoir Torque Sequence.

Check Crankshaft End Play

1. Set the engine on the base, and use a dial indicator to check the crankshaft end play against the specification listed in Section 1.

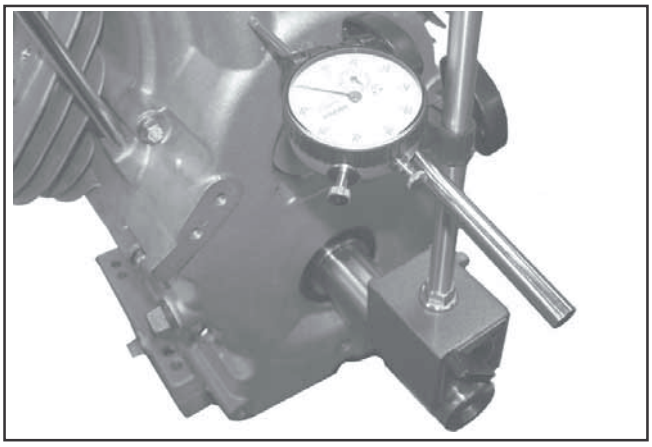


Figure 10-37. Checking Crankshaft Endplay.

Install Breather Assembly

1. Make sure the sealing surfaces of the crankcase and breather cover are clean and free of any nicks or burrs. **Do not** scrape the surfaces, as this could result in leakage. Install the four breather mounting studs into the crankcase if removed during disassembly.

2. Install the breather chamber gasket as shown. See Figure 10-38. Assemble and install breather assembly components as illustrated in Figure 10-39. Make sure the filter does not extend above top surface and all parts are properly aligned.

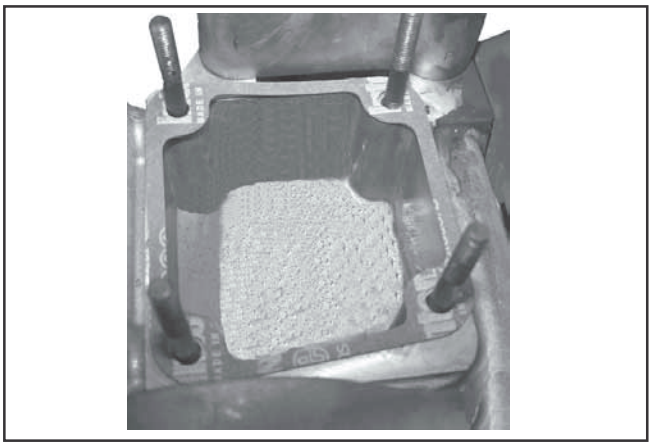


Figure 10-38. Breather Chamber and Gasket.

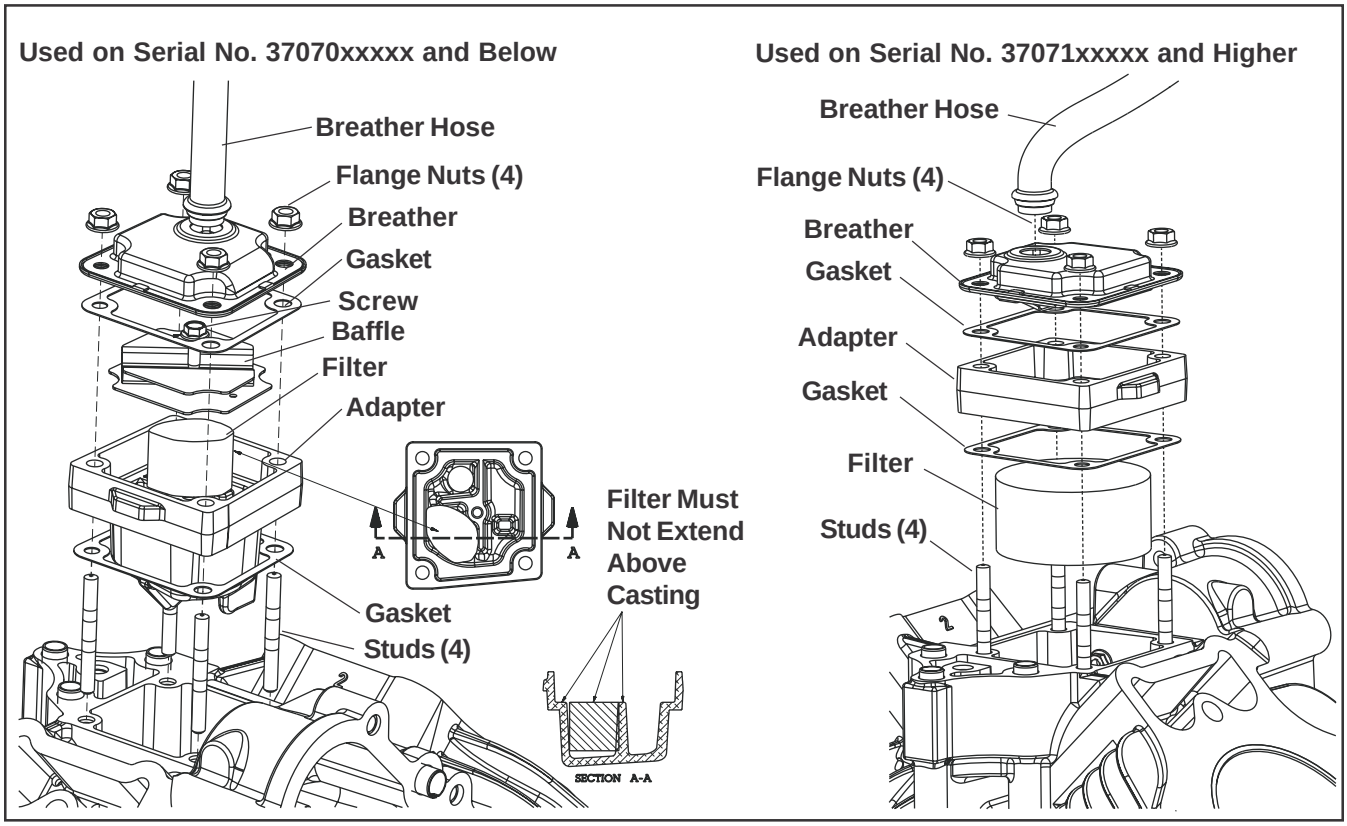


Figure 10-39. Breather Assembly Details.

3. Install the M5 hex flange nuts onto the studs, then torque using the sequence shown in Figure 10-40 to **5.7 N·m (51 in. lb.)**.

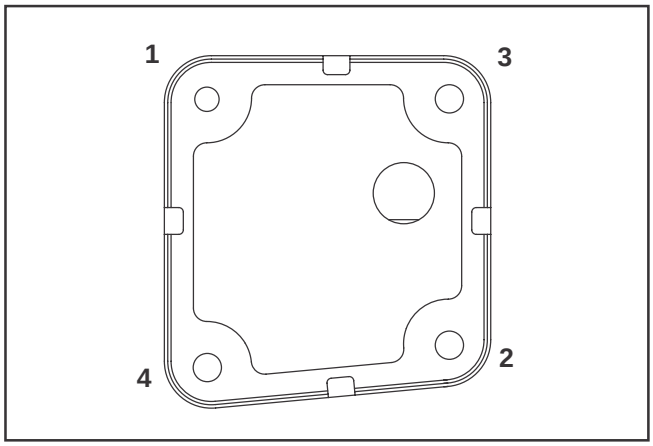


Figure 10-40. Breather Assembly Fastener Torque Sequence.

4. Lightly oil the lower end of the breather hose and install into the hole in the breather assembly. The cover should be situated between the two raised rings of the hose.

Install Hydraulic Lifters

1. See Servicing Hydraulic Lifters in Section 9 for lifter preparation (bleed down) procedures.

2. Apply camshaft lubricant (see Section 2) to the bottom surface of each lifter. See Figure 10-41. Lubricate the hydraulic lifters and the lifter bores in the crankcase with engine oil.

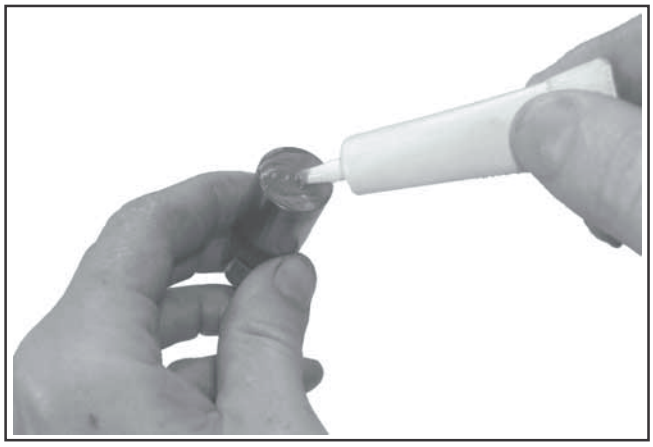


Figure 10-41. Applying Camshaft Lubricant to Bottom of Lifters.

3. Note the mark or tag identifying the hydraulic lifters as either intake or exhaust and cylinder 1 or cylinder 2. Install the hydraulic lifters into their appropriate location in the crankcase. Do not use a magnet. See Figure 10-42.

   NOTE: Hydraulic lifters should always be installed in the same position as they were disassembled. The exhaust lifters are located on the output shaft side of the engine while the intake lifters are located on the fan side of the engine. The cylinder numbers are embossed on the top of the crankcase and each cylinder head. See Figure 10-43.

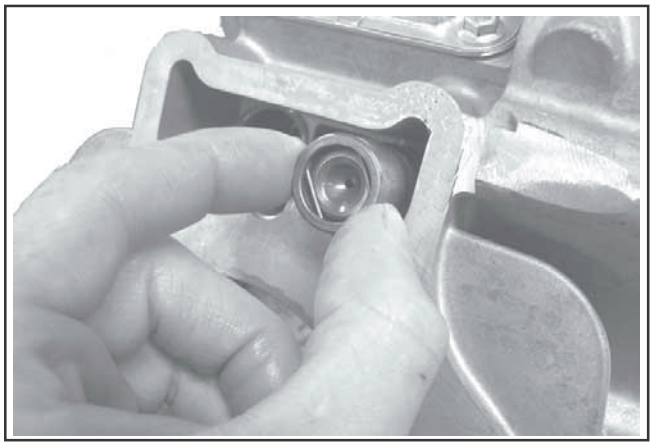


Figure 10-42. Installing Hydraulic Lifters.

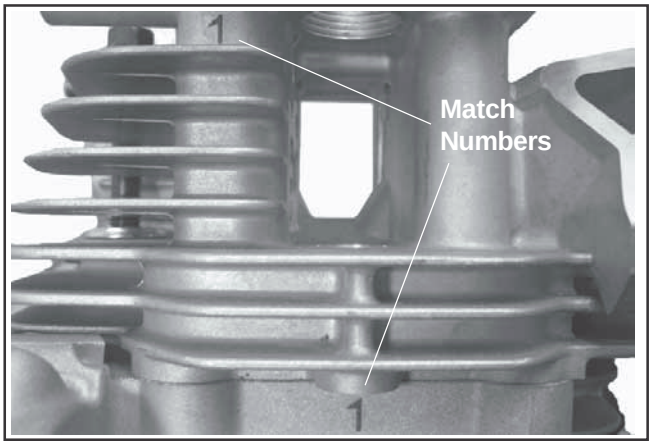


Figure 10-43. Match Numbers on Cylinder Barrel and Head.

Valve Stem Seals

These engines use valve stem seals on the intake and exhaust valves. Always use new seals whenever valves are removed from the cylinder head. The seals should also be replaced if worn or damaged. Never reuse an old seal. See Figure 10-44.

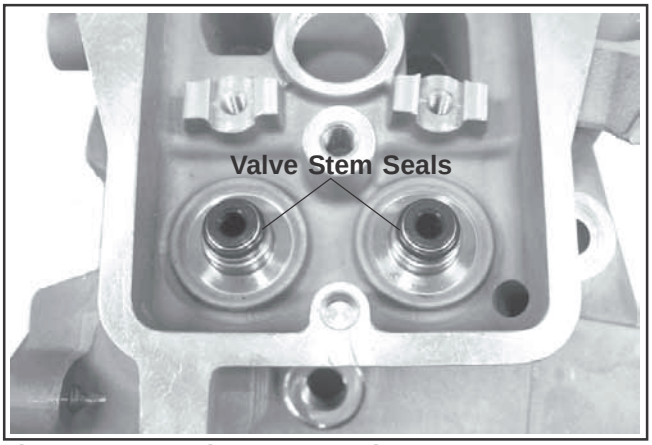


Figure 10-44. Valve Stem Seals.

Assemble Cylinder Heads

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 10-45 and 10-46.

- Intake and exhaust valves
- Valve spring retainers
- Valve springs
- Valve spring keepers
- Valve stem seals

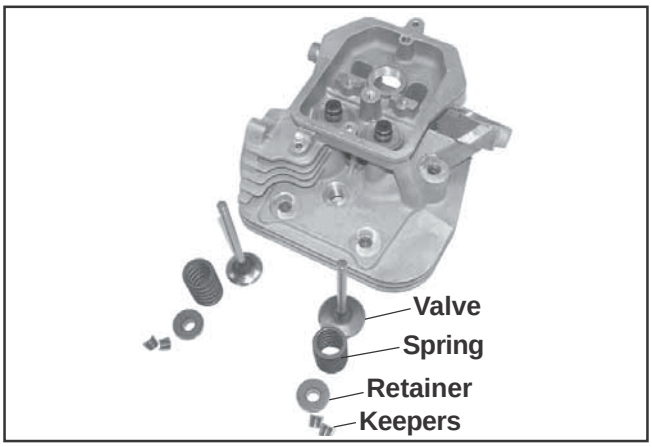


Figure 10-45. Valve Components.

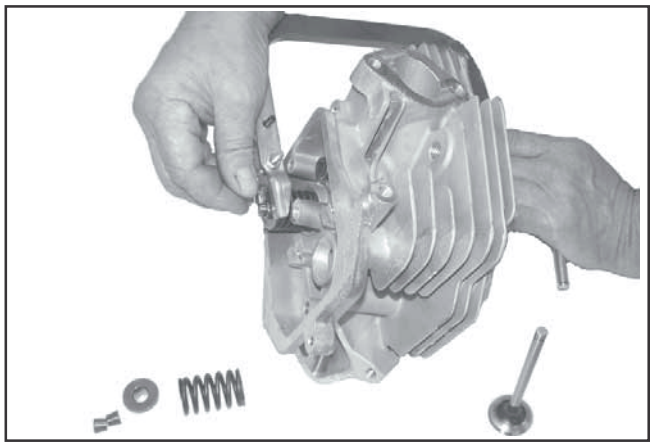


Figure 10-46. Installing Valves with Valve Spring Compressor.

Install Cylinder Heads

1. Check to make sure there are no nicks or burrs on the sealing surfaces of the cylinder head or the crankcase.

2. Check that the dowel pins are in place in the two lower locations, and install a new cylinder head gasket, (printed side up). See Figure 10-47.

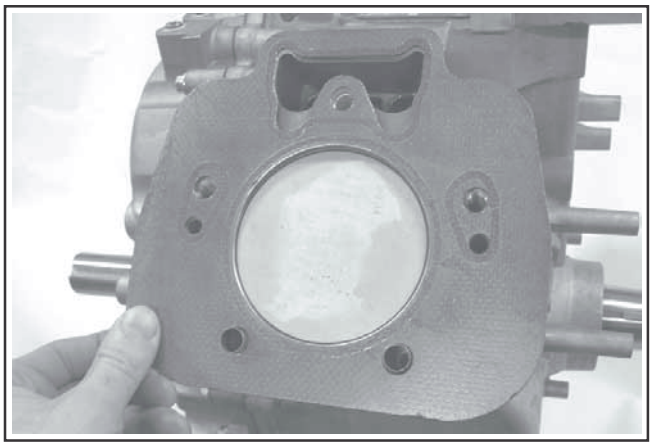


Figure 10-47. Installing New Head Gaskets.

NOTE: Match the numbers embossed on the cylinder heads and crankcase. See Figure 10-43.

3. Install the cylinder head. Make sure the head is flat on the gasket and dowel pins. Install a flat washer on the screws in **locations 1 and 3**. Install the spacer followed by a flat washer on the screw **in location 5**. See Figures 10-48 and 10-50. Start the five hex flange screws.

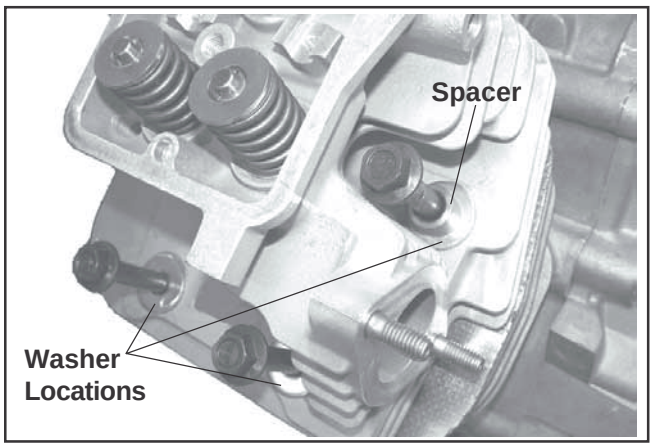


Figure 10-48. Washers and Spacer Locations.

4. Torque the hex flange screws in two stages; first to **22.6 N·m (200 in. lb.)**, finally to **45.2 N·m (400 in. lb.)**, following the sequence in Figure 10-50.

5. Repeat the procedure for the opposite cylinder.

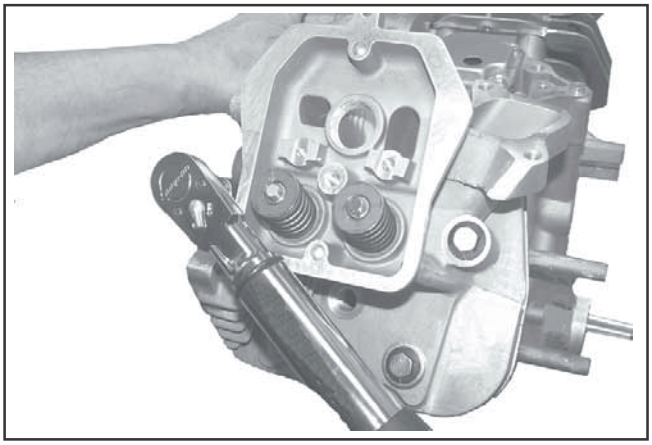


Figure 10-49. Torquing Cylinder Head Fasteners.

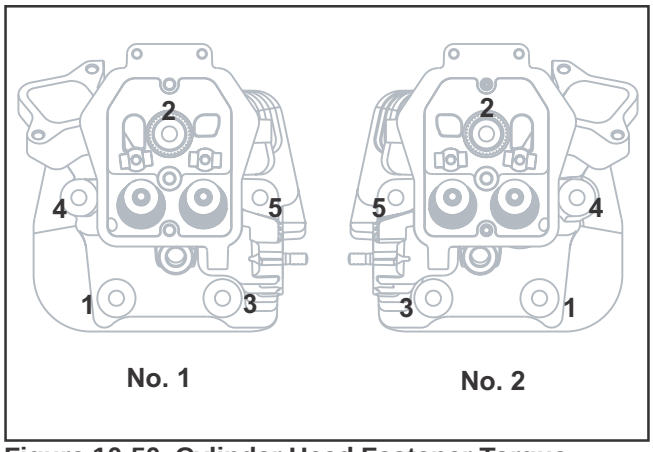


Figure 10-50. Cylinder Head Fastener Torque Sequence.

6. Make sure the threads of the pipe plugs for the cylinder heads are clean and dry. Install a plug into each cylinder head above the No. 2 screw location and torque to **29.3 N·m (260 in. lb.)**. See Figure 10-51.

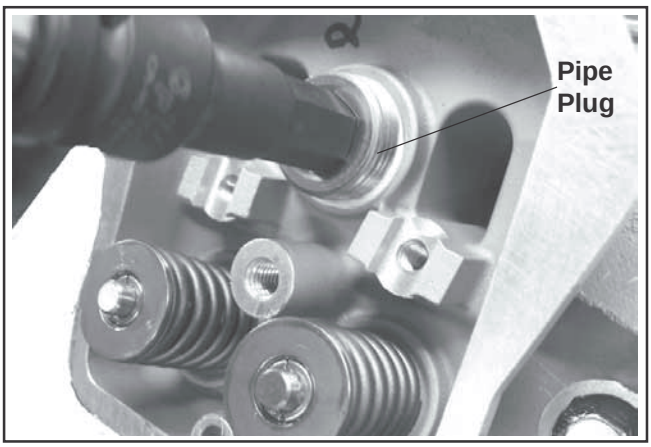


Figure 10-51. Installing Pipe Plug in Cylinder Heads.

Install Push Rods and Rocker Arms

NOTE: Push rods should always be installed in the same position as before disassembly.

1. Note the mark or tag identifying the push rod as either intake or exhaust and cylinder 1 or 2. Dip the ends of the push rods in engine oil and install, making sure that each push rod ball seats in its hydraulic lifter socket. See Figure 10-52.

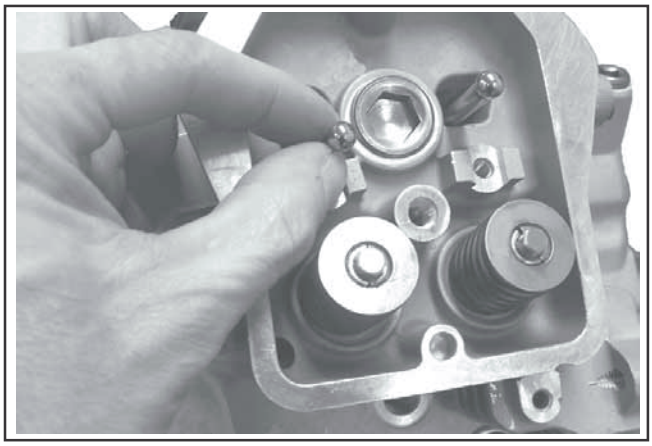


Figure 10-52. Install Push Rods in Their Original Position.

2. Apply grease to the contact surfaces of the rocker arms and rocker arm pivots. Install the rocker arms and rocker arm pivots on the No. 1 cylinder head, and start the two hex flange screws.

3. Rotate the crankshaft to establish Top Dead Center (TDC) on the compression stroke. The keyway should be aligned with the No. 1 cylinder.

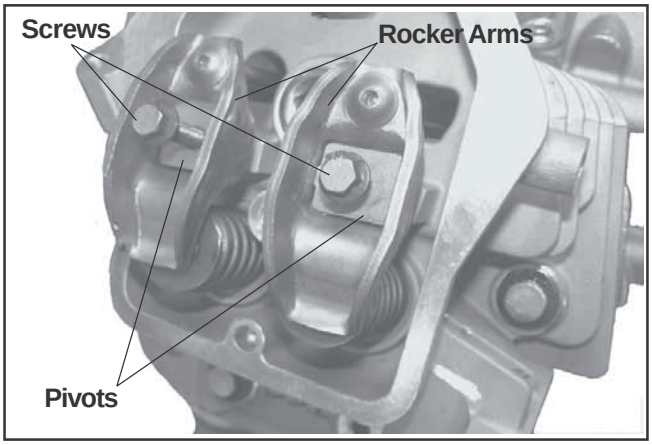


Figure 10-53. Assembling Rocker Arms and Pivots.

4. Torque the hex flange screws to **14.6 N·m (130 in. lb.)**. See Figure 10-54.

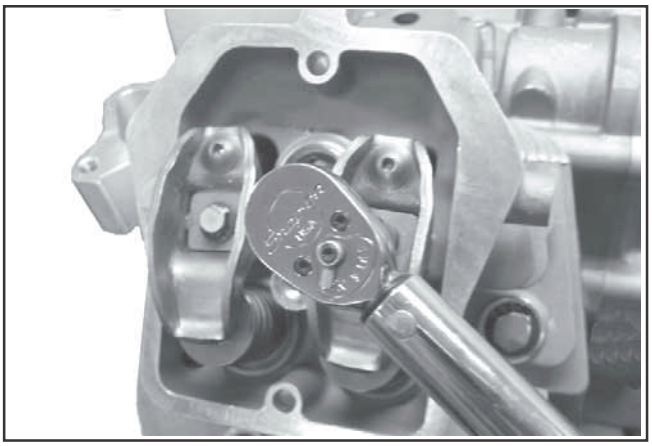


Figure 10-54. Torquing Rocker Arm Screws.

5. If push rods were not already seated, use a spanner wrench or rocker arm lifting tool (see Section 2), to lift the rocker arms and position the push rods underneath. See Figure 10-55.

6. From the PTO end, rotate the crankshaft 270° (3/4 turn) **counterclockwise** and align the crankshaft keyway with the No. 2 cylinder. This now puts the No. 2 cylinder at TDC on the compression stroke.

7. Repeat steps 1-5 for the remaining cylinder. Do not interchange parts from the cylinder heads.

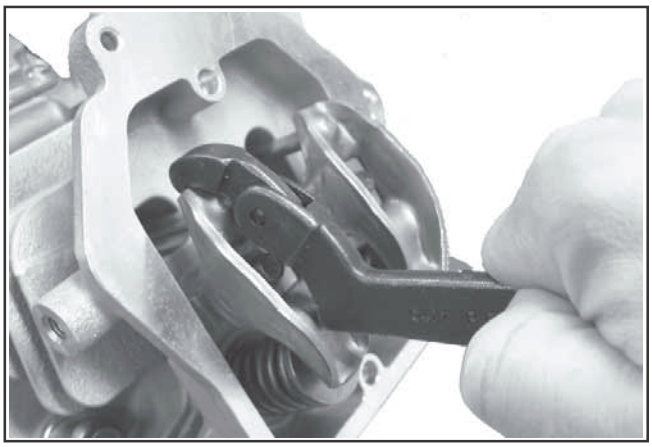


Figure 10-55. Using Spanner Wrench to Lift Rocker Arm Over Push Rod.

8. Rotate the crankshaft to check for free operation of the valve train. Check the clearance between the valve spring coils at full lift. Minimum allowable clearance is **0.25 mm (0.010 in.)**.

Install Valve Covers

1. Make sure the sealing surfaces are clean and free of any nicks or burrs.

2. Install and properly seat the seal onto each of the valve covers. See Figure 10-56.

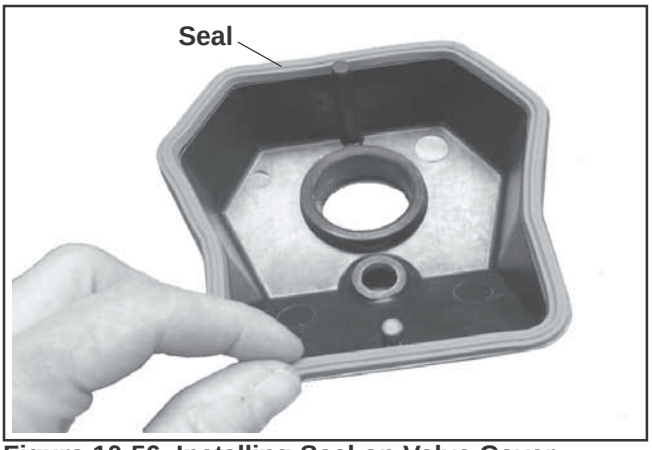


Figure 10-56. Installing Seal on Valve Cover.

3. Install the valve covers on the same side as they were originally installed.

4. Install a new grommet on each valve cover mounting screw. Start each screw into the hole.

5. Check the position of each cover and seal, then torque each screw to **7.9 N·m (70 in. lb.)**. See Figure 10-57.

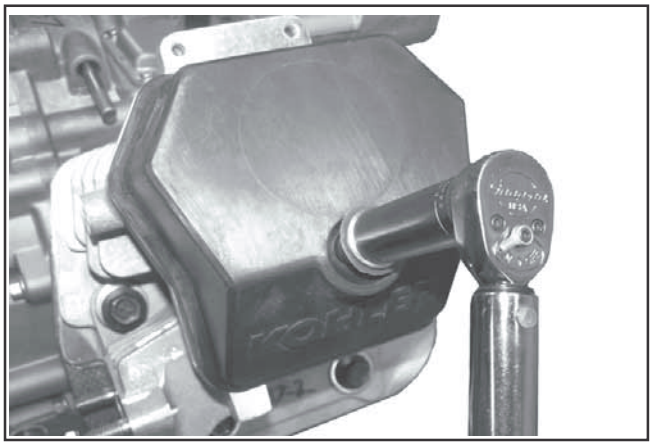


Figure 10-57. Torquing Valve Cover Screw.

6. Install the oil fill cap onto valve cover (if equipped).

Install Spark Plugs

1. Use new Champion® XC10YC (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 10-58.

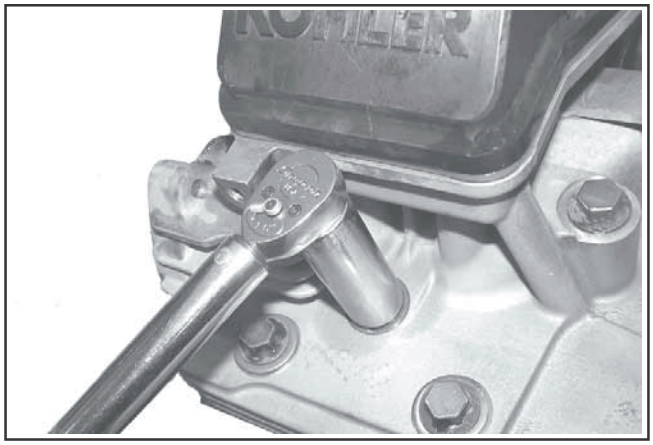


Figure 10-58. Installing Spark Plugs.

Install Oil Filter Adapter

1. Make sure all sealing surfaces are clean and the three dowel pins are in place on the crankcase adapter surface. Carefully install a new O-Ring around each of the dowel pins. Then install three new O-Rings onto the dowel pins of the oil filter adapter. See Figure 10-59.

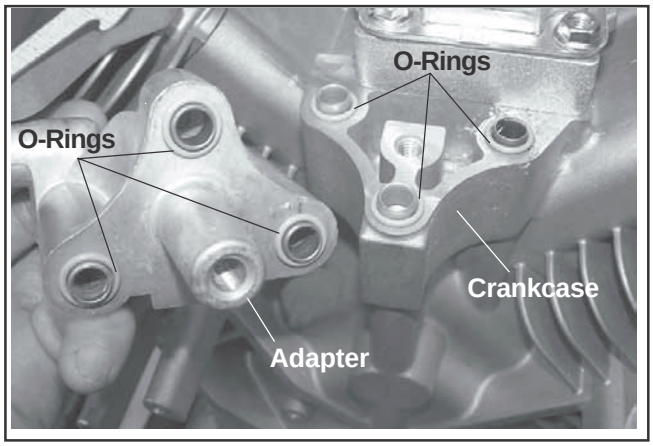


Figure 10-59. Installed O-Rings on Crankcase and Oil Filter Adapter.

2. Install the oil filter adapter onto the crankcase. Install and torque the M8 capscrew to **24.4 N·m (216 in. lb.)**. See Figure 10-60.

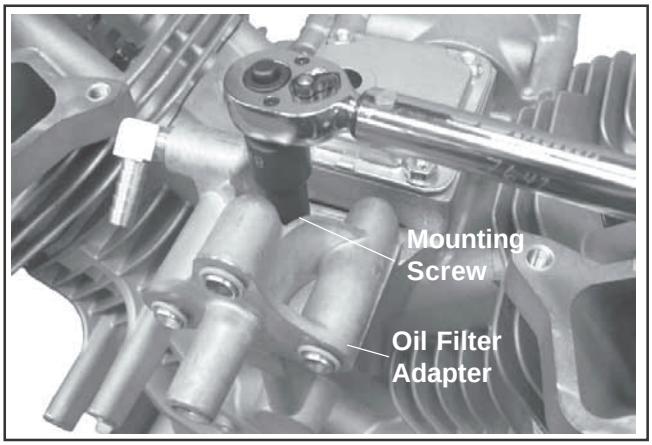


Figure 10-60. Torquing Oil Filter Adapter.

Install Intake Manifold

1. Install new intake manifold gaskets so the notched section is inward and points toward the flywheel side. See Figure 10-61.

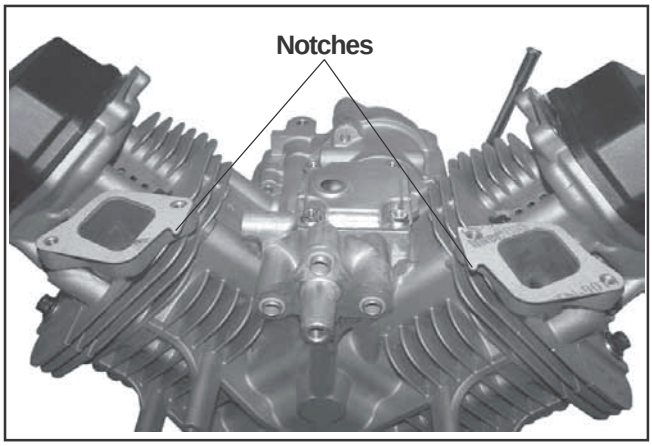


Figure 10-61. Installed Intake Manifold Gaskets.

2. Mount the intake manifold to the cylinder heads. Make sure the gaskets remain in the proper position. Torque the four screws in two stages, first to **16.9 N·m (150 in. lb.)**, finally to **22.6 N·m (200 in. lb.)**, using the sequence shown in Figure 10-62.

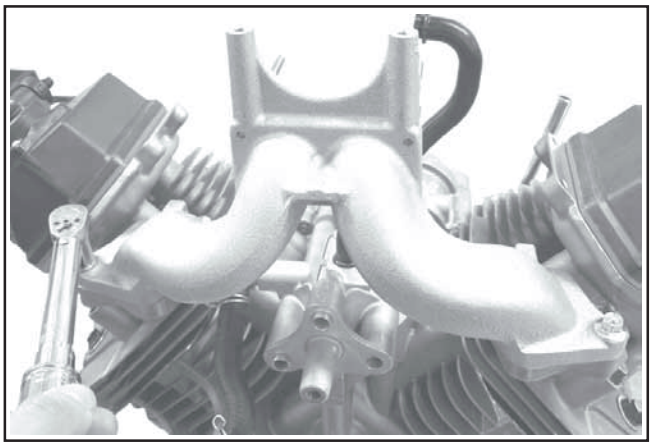


Figure 10-62. Installing Intake Manifold

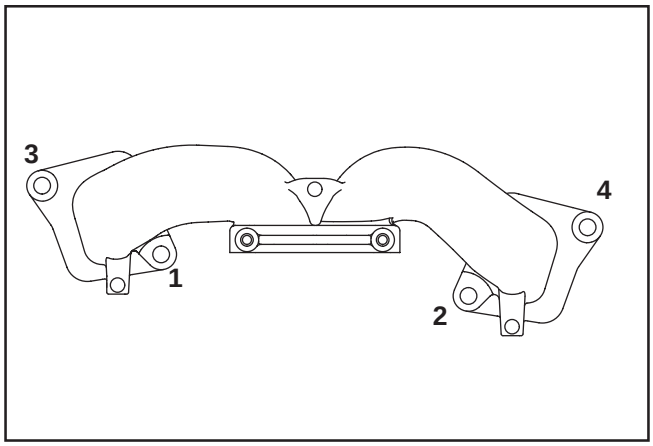


Figure 10-63. Intake Manifold Torque Sequence.

3. Install the carburetor mounting studs into the intake manifold if previously removed. Use two hex nuts, locked flange to flange, and tighten each of the studs until bottomed/tight.

Install Oil Filter Housing Assembly

Reassemble the oil filter housing if disassembled previously.

Reassembly

1. Install the small spring onto the rubber valve, and insert the small end through the corresponding hole in cup until properly seated. See Figure 10-64.

2. Install the larger spring into the filter housing. See Figure 10-65.

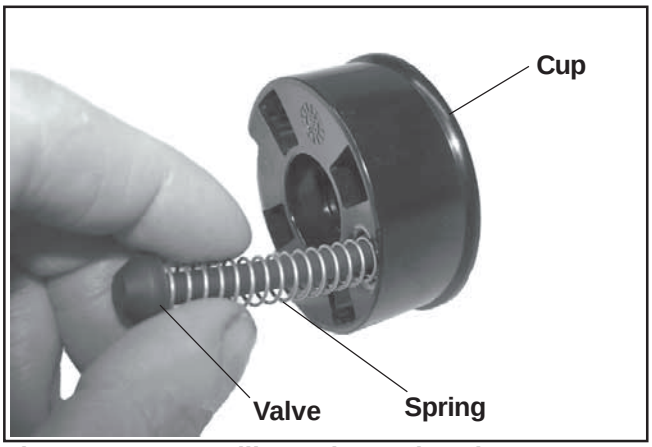


Figure 10-64. Installing Valve and Spring to Cup.

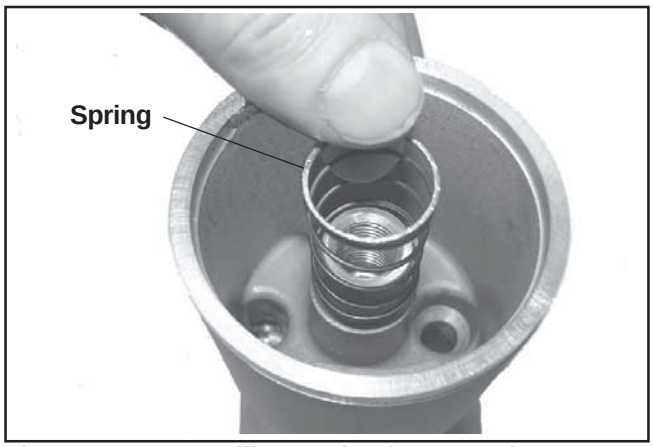


Figure 10-65. Installing Spring into Housing.

3. Insert the oil filter cup, aligning the cutout with the corresponding section in the housing. See Figure 10-66.

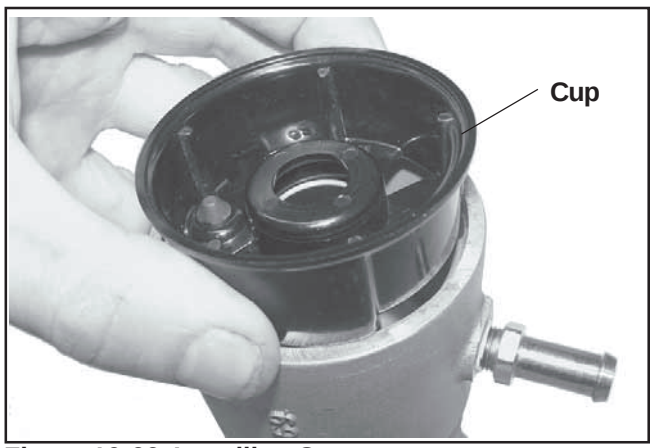


Figure 10-66. Installing Cup.

4. Install the nipple in housing and torque to **18.0 N·m (160 in. lb.)**. See Figures 10-67 and 10-68.

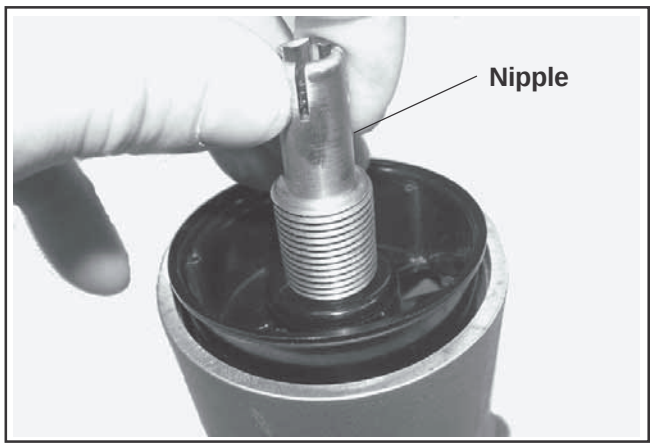


Figure 10-67. Installing Nipple.


Figure 10-68. Torquing Nipple.

Installation

1. Make sure all sealing surfaces are clean and all three dowel pins are in position. Install or check that new O-Rings are around all three dowel pins of the oil filter adapter. See Figure 10-69.

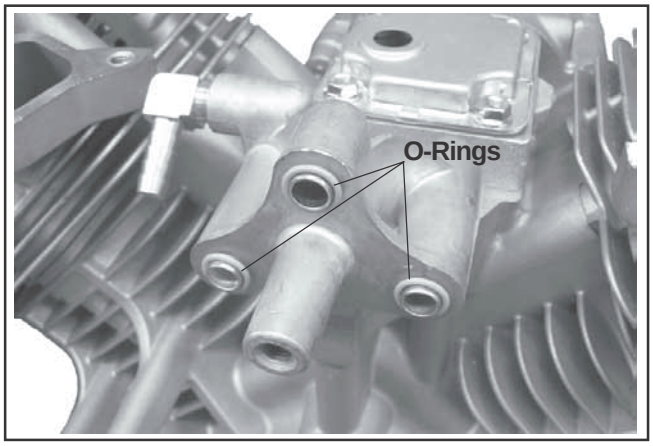


Figure 10-69. O-Rings Installed on Adapter for Oil Filter Housing.

2. Install the oil filter housing assembly to the adapter and secure with the M8 hex head screw. Make sure the housing is flat on the crankcase and all O-Rings remain in position. Torque the screw to **24.4 N·m (216 in. lb.)**.

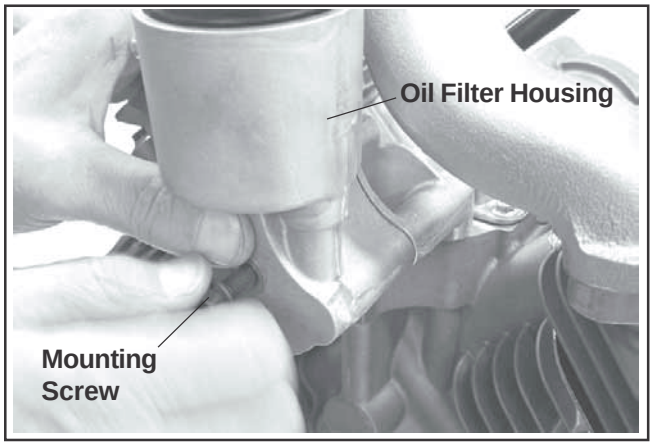


Figure 10-70. Installing Oil Filter Housing.

3. The oil filter may be installed now or upon completion of engine assembly, as described in Section 6.

Install Backing Shroud Assembly

1. To aid assembly, install the lower oil cooler hose onto the oil filter housing prior to installation of the backing shroud assembly, and secure with a clamp. See Figure 10-71.

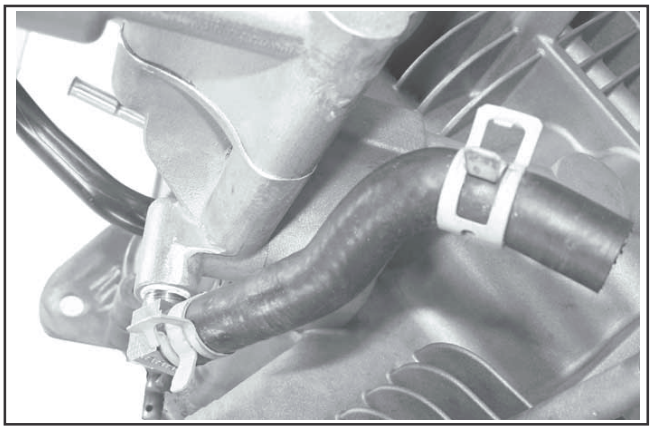


Figure 10-71. Lower Oil Cooler Hose Details.

NOTE: New hose clamps are recommended for reassembly, or if clamps have been loosened (expanded) several times to avoid leakage.

2. Install the backing shroud assembly and secure to the crankcase with the four M6 screws. Torque the screws to **10.7 N·m (99 in. lb.)** into new holes, or **7.3 N·m (65 in. lb.)** into used holes. See Figure 10-72.

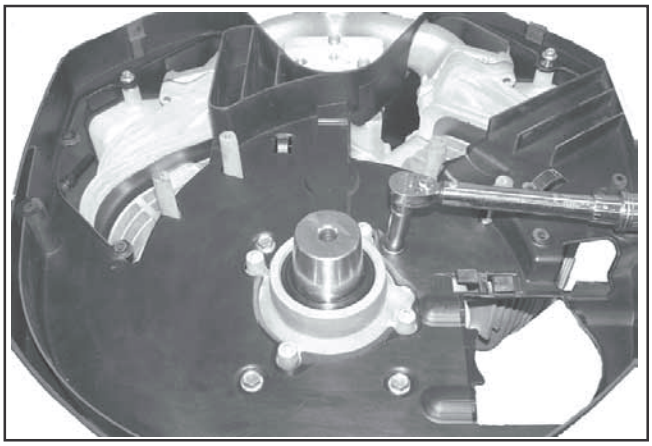


Figure 10-72. Installing Backing Shroud Assembly.

Install Stator, Wiring Harness, and Rectifier-Regulator

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 the leads are at the bottom and toward the rectifier-regulator mount on the No. 1 side.

3. Install and torque the two hex flange screws to **6.2 N·m (55 in. lb.)**. See Figure 10-73.

4. Route the stator wires under the two molded clips in the backing shroud assembly. See Figure 10-73.

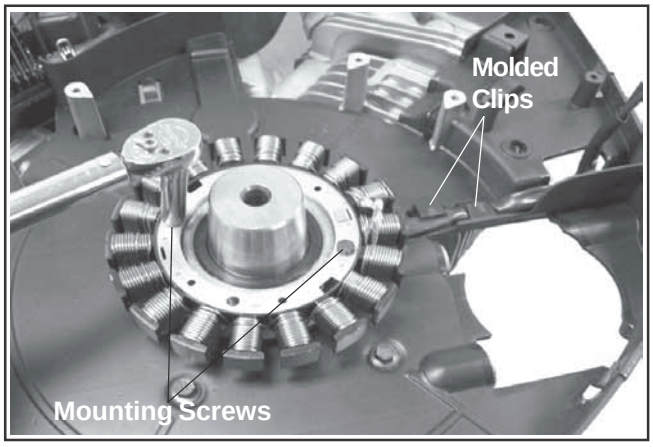


Figure 10-73. Installing Stator.

5. Check the terminal on the end of the B+ charging lead to be sure the locking tang is angled upward. Insert the terminal into the center location of the connector until it locks into place.

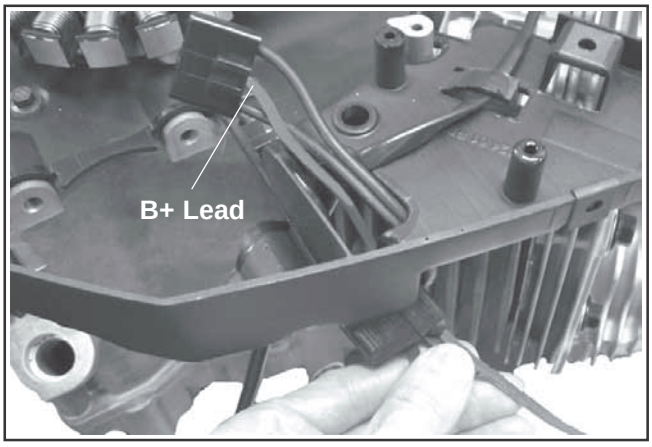


Figure 10-74. B+ Charging Lead Details.

6. Install the wiring harness under the molded clips in the backing shroud assembly. See Figure 10-75.

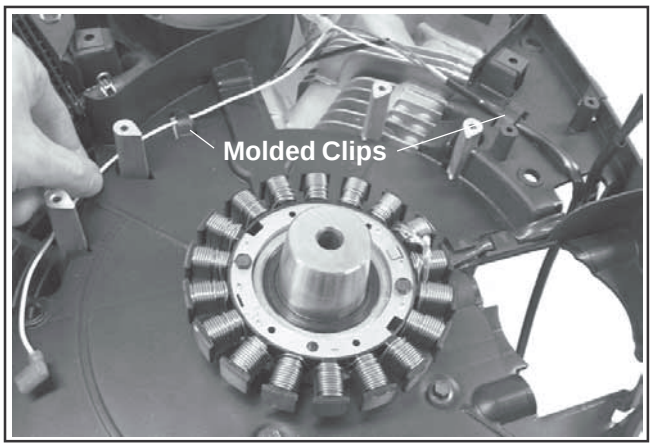


Figure 10-75. Installing Wiring Harness.

7. Position the rectifier-regulator onto the mounting posts with the cooling fins up. Attach the ground lead to the outer screw and washer, then torque the mounting screws to **2.0 N·m (18 in. lb.)**. Connect the plug to the rectifier-regulator. See Figure 10-76.

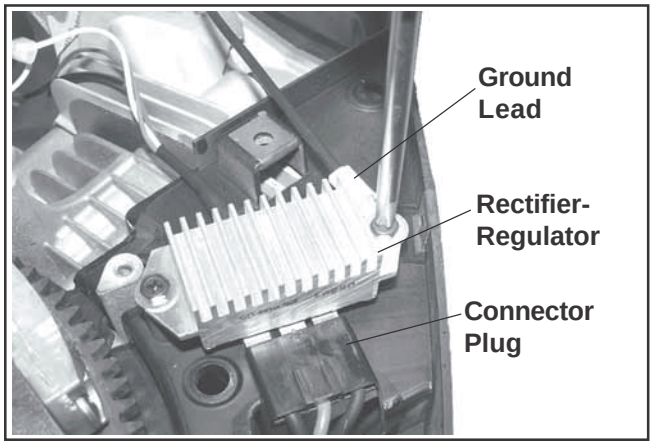


Figure 10-76. Installing Rectifier-Regulator and Ground Lead.

Install Flywheel

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 the flywheel hub are clean, dry, and completely free of any lubricants. The presence of lubricants can cause the flywheel to be over stressed and damaged when the hex flange screw is torqued to specifications. See Figures 10-77 and 10-78.

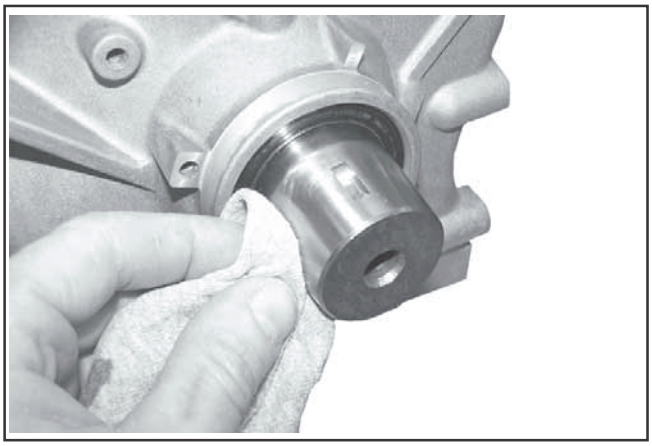


Figure 10-77. Clean and Dry Taper of Crankshaft.

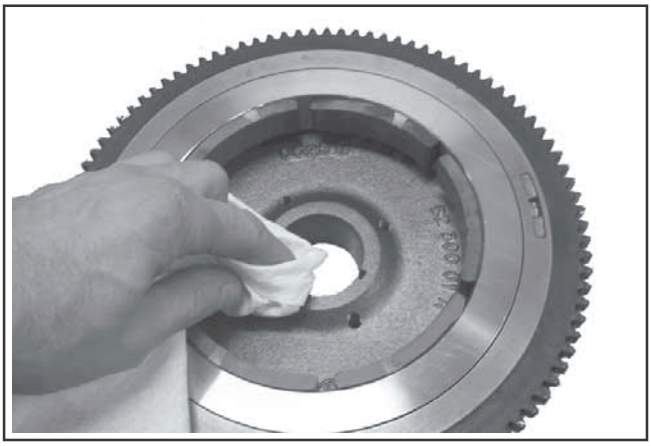


Figure 10-78. Clean and Dry Flywheel Hub.

NOTE: Make sure the flywheel key is installed properly in the keyway. The flywheel can become cracked or damaged if the key is not properly installed. See Figure 10-79.

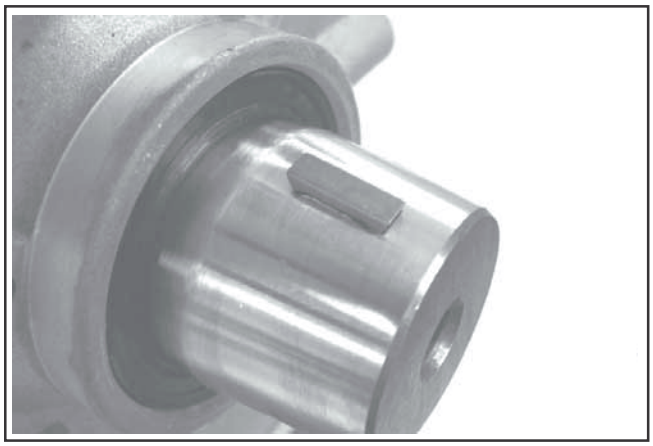


Figure 10-79. Installed Flywheel Key.

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.

2. Install the flywheel onto the crankshaft, being careful not to shift the woodruff key.

3. Install the hex flange screw and washer.

4. Use a flywheel strap wrench or holding tool to hold the flywheel. Torque the hex flange screw securing the flywheel to the crankshaft to **67.8 N·m (50 ft. lb.)**. See Figure 10-80 shown on the next page.

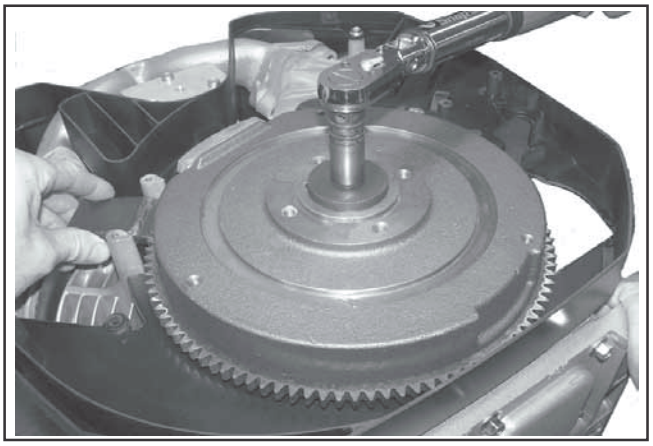


Figure 10-80. Torquing Flywheel Fastener.

Install Ignition Modules

1. Rotate the flywheel to position the magnet away from the ignition module bosses.

2. Connect the ground lead to the single kill tab and install the modules onto the crankcase bosses so the tab is away from you (in). The spark plug lead should be towards you (out). Mount the wiring harness clamp with the loop **up**, on the starter (No. 1) side inner module screw and route harness through it. Attach the rectifier-regulator ground lead to the outer screw. See Figure 10-81.

3. Slide the modules up as far away from the flywheel as possible and snug the screws to hold them in that position.

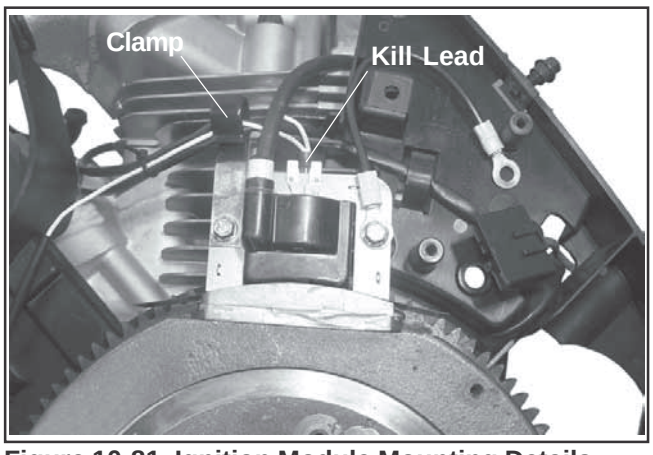


Figure 10-81. Ignition Module Mounting Details.

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 10-82. Loosen the screws enough to allow the magnet to pull the module down against the feeler gauge.

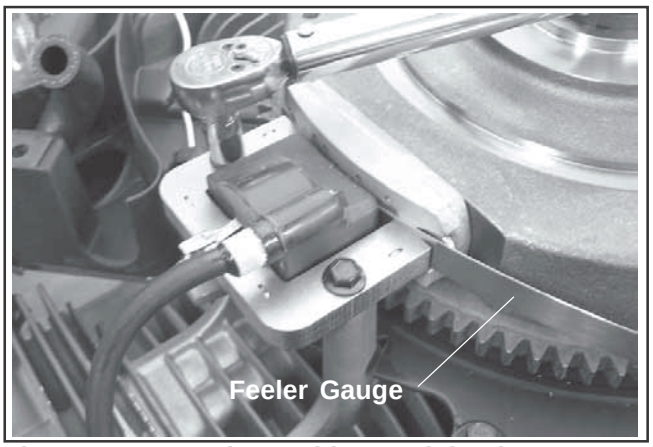


Figure 10-82. Setting Ignition Module Air Gap.

6. Torque the screws to **6.2 N·m (55 in. lb.)** into new holes, or **4.0 N·m (35 in. lb.)** into used holes.

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.)**.

9. Make sure the leads are under the molded clip on the starter side. See Figure 10-83.

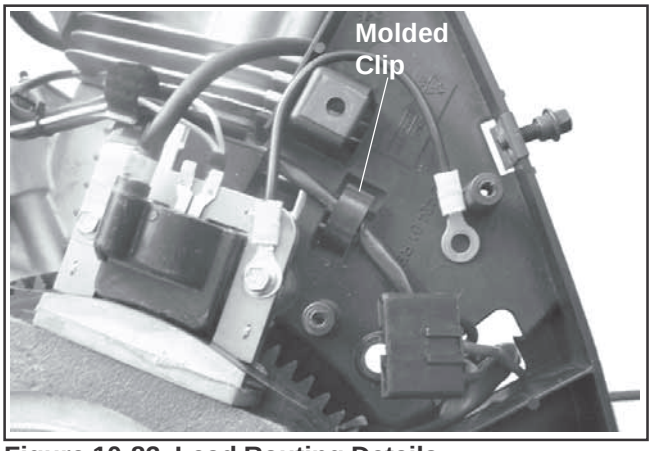


Figure 10-83. Lead Routing Details.

Install Outer Cylinder Baffles

1. Install the outer cylinder baffles. Make sure the spark plug lead is routed through the corresponding opening in each baffle. Start each of the screws. Torque the M6 shoulder screws going through the backing shroud assembly into the extruded holes in the baffles to **4.0 N·m (35 in. lb.)** for first time installations, or **2.0 N·m (17.7 in. lb.)** for all reinstallations.

Torque the M6 screws going into the cylinder head and crankcase to **10.7 N·m 95 in. lb.)** for new holes, or **7.3 N·m 65 in. lb.** for used holes. See Figure 10-84.

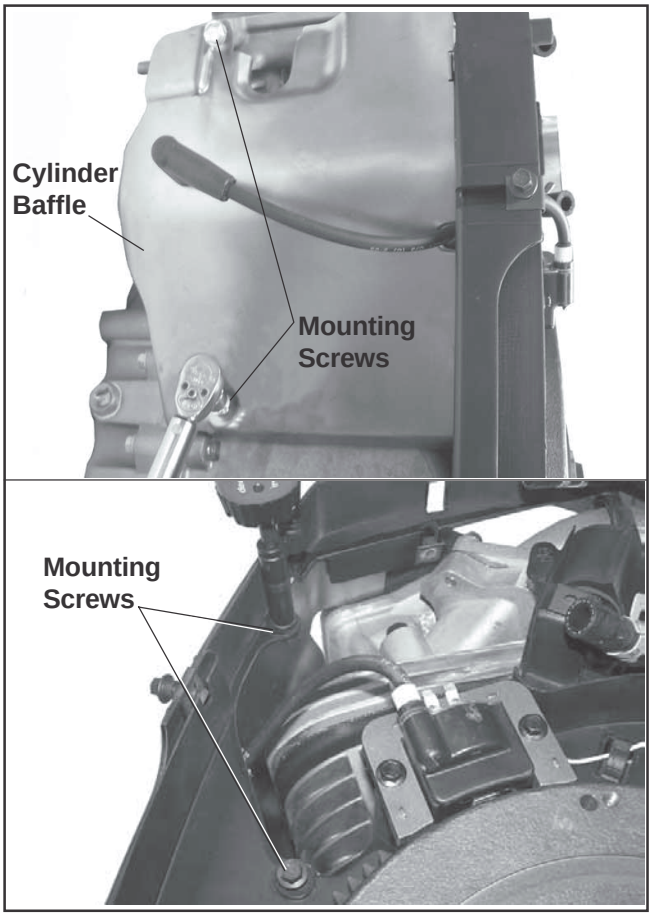


Figure 10-84. Installing Cylinder Baffles.

Install Oil Cooler

1. Connect the two hoses between the oil filter adapter and oil cooler. Secure with new clamps. See Figure 10-85.

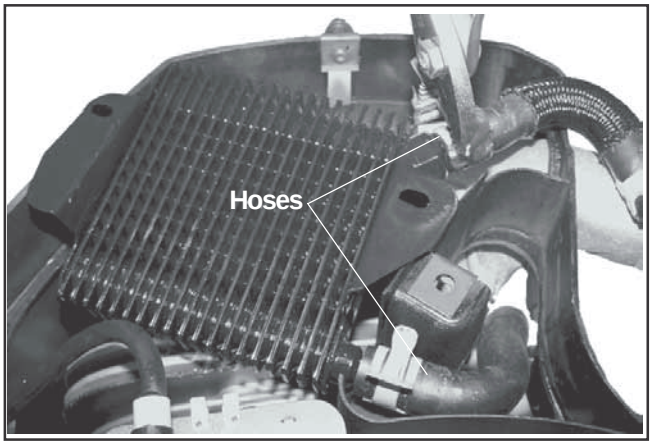


Figure 10-85. Connecting Oil Cooler Hoses.

2. Align the oil cooler with the bosses in the backing shroud assembly. Secure with the two screws and washers. See Figure 10-86.

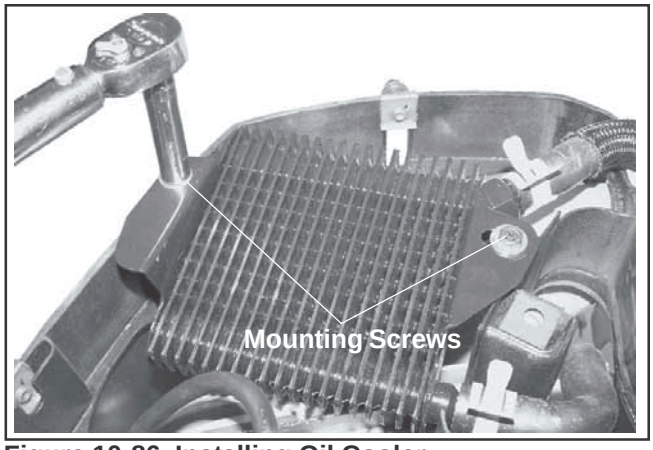


Figure 10-86. Installing Oil Cooler.

Install Cooling Fan and Grass Screen

CAUTION:
Failure to utilize or reassemble the grass screen as designed could result in grass screen failure and serious personal injury.

1. Position the cooling fan onto the flywheel aligning the mounting locations. Apply a small amount of Loctite® No. 243 to the threads and install the three long mounting screws. Torque the screws to **9.9 N·m (88 in. lb.)**. See Figure 10-87.

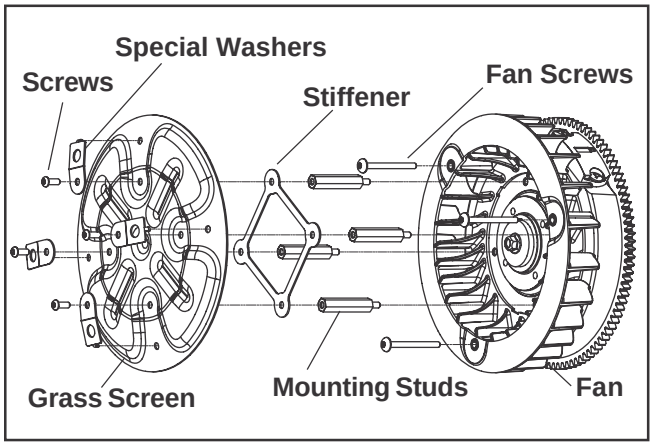


Figure 10-87. Cooling Fan and Grass Screen Assembly Details.

2. Apply a small amount of Loctite® No. 243 to the external threaded section, (unless new parts with preapplied locking compound are being used). Thread the four grass screen hex studs into the mounting holes in the flywheel. Torque each stud to **9.9 N·m (88 in. lb.)**. See Figure 10-87.

3. Install the stiffener followed by the metal grass screen onto the four hex studs. Secure with the four special washers and mounting screws using Loctite® No. 243 on the threads. Torque the screws to **9.9 N·m (88 in. lb.).** See Figure 10-87.

Install Electric Starter

1. Install the electric starter motor using the two hex flange screws. See Figure 10-88.

2. Torque the two hex flange screws to **15.3 N·m (135 in. lb.)**.

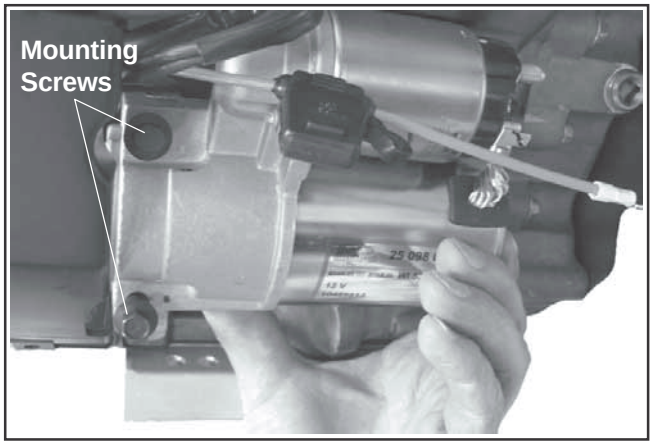


Figure 10-88 Installing Electric Starter.

3. Connect the leads to the solenoid. See Figure 10-89.

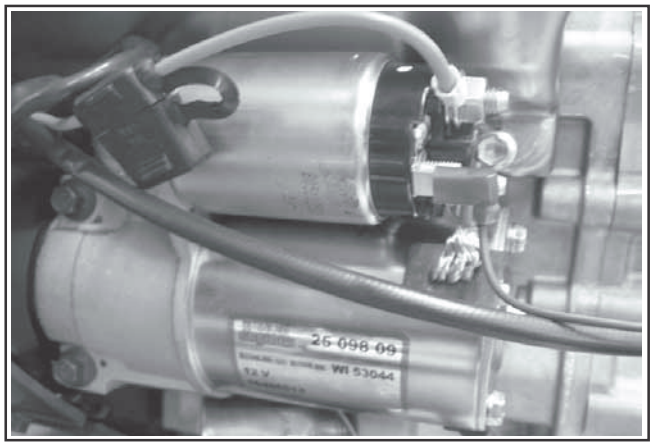


Figure 10-89. Leads Connected to Starter.

Install Valley Baffles

1. Install the two valley baffles and secure with the mounting screws. The lower section should fit under the outer baffle. Torque the M6 screws going into the cylinder head to **10.7 N·m (95 in. lb.)** for new holes, or **7.3 N·m (65 in. lb.)** for used holes. Start the upper M6 screws only if the main control bracket rear supports attach to the these screws.

   Torque the M6 screw going into the lower blower housing mounting clip to **3.9 N·m (35 in. lb.)**. See Figure 10-90.

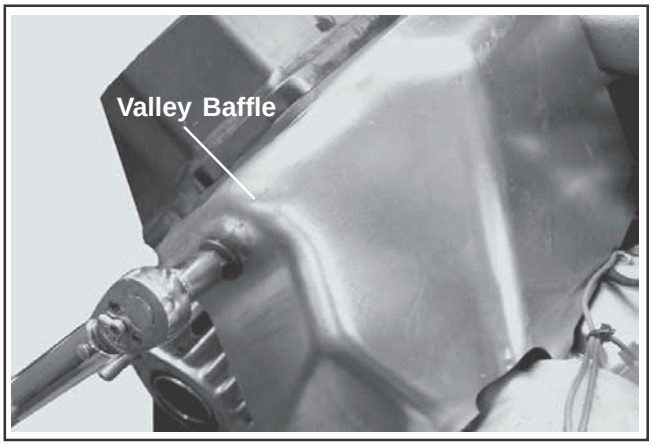


Figure 10-90. Installing Valley Baffles.

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 onto the intake manifold with the tab **up**. Make sure all holes align and are open.

2. Attach the choke return spring and bracket to the front hole in the choke lever on carburetor. See Figure 10-91.

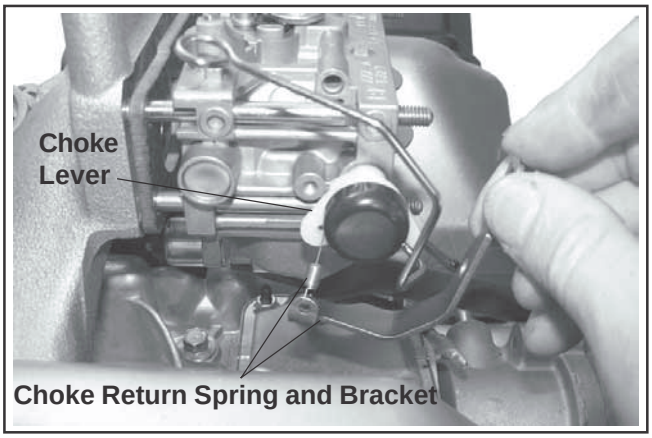


Figure 10-91. Choke Return Spring and Bracket Details.

3. Connect the throttle and choke linkages to the carburetor if they were previously disconnected. Install the carburetor with the linkages attached as an assembly. See Figure 10-92.

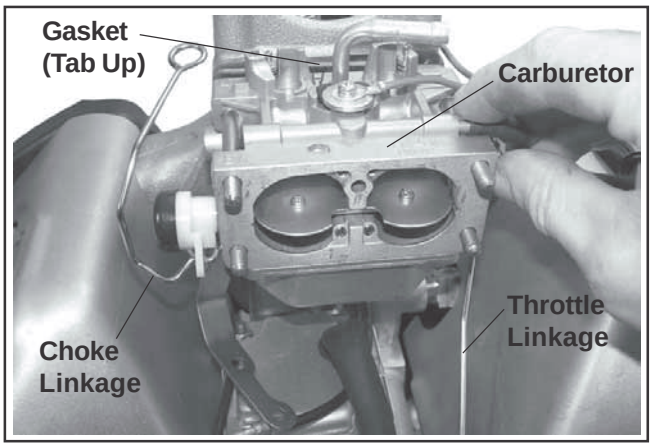


Figure 10-92. Installing Carburetor with Linkages.

4. Connect the fuel line to the carburetor inlet and secure with a clamp.

Install Governor Lever

1. Install the governor lever onto the governor shaft and connect the throttle linkage with the black clip. Do not tighten the governor lever at this time. See Figure 10-93.

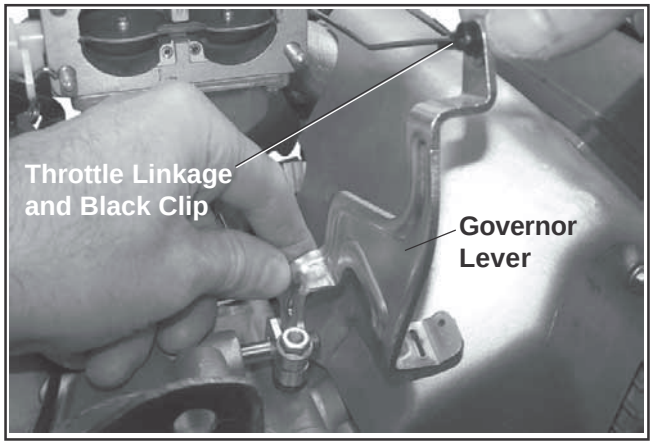


Figure 10-93. Installing Governor Lever.

Install Control Bracket and Air Cleaner Assembly

1. Position the control bracket assembly onto the two intake manifold bosses. Align the rear supports with the top valley baffle/cylinder head mounting screw locations and install the two screws, but do not fully tighten. See Figure 10-94.

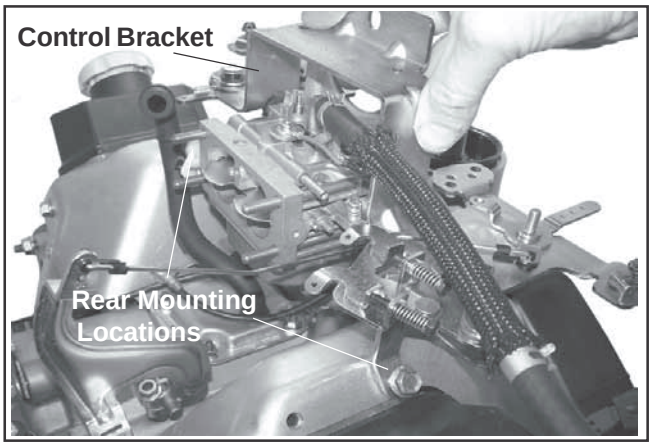


Figure 10-94. Installing Control Bracket.

2. Connect the choke link to the control pivot pin. Reinstall the washer and secure with a **new** push-on pal nut. See Figure 10-95.

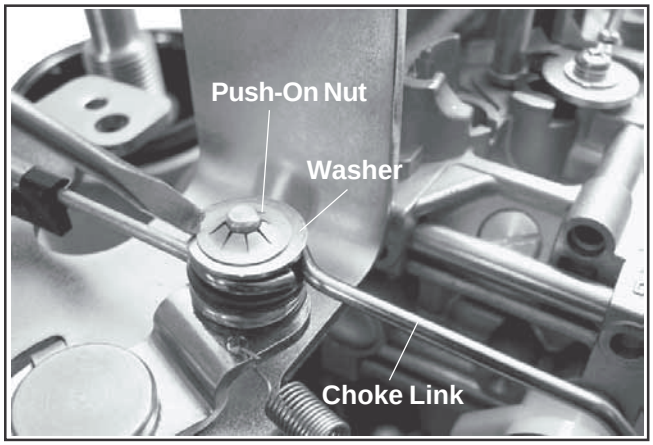


Figure 10-95. Installing Choke Link and Push-On Nut.

3. Install a new air cleaner elbow gasket onto the carburetor mounting studs.

4. Slide the air cleaner assembly onto the four carburetor mounting studs. Align the two forward mounting holes in the base with the mounting holes/bosses of the intake manifold and control bracket. Attach the ground lead under the hex nut as originally installed. Install the remaining three hex nuts and start the two hex flange screws. Install the rear mounting screws into the valley baffle/cylinder head. Check the positions of all parts then torque the four hex flange nuts to **7.9 N·m (70 in. lb.)** in the sequence shown (Figure 10-98), and the four hex flange screws to **9.9 N·m (88 in. lb.)**. See Figures 10-96, 10-97, and 10-98.

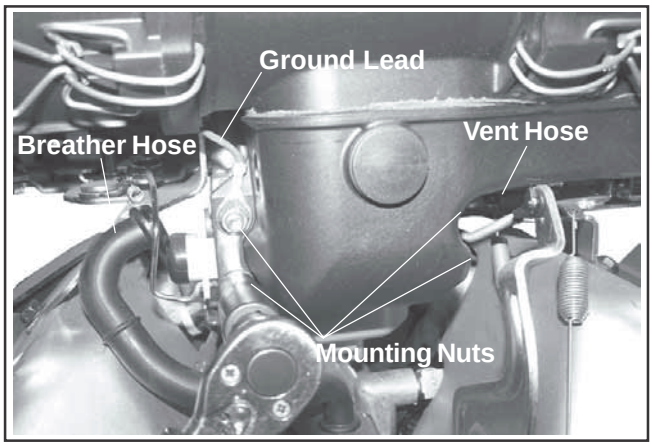


Figure 10-96. Mounting Air Cleaner and Hoses.

Figure 10-97. Installing Air Cleaner and Control Bracket Screws.

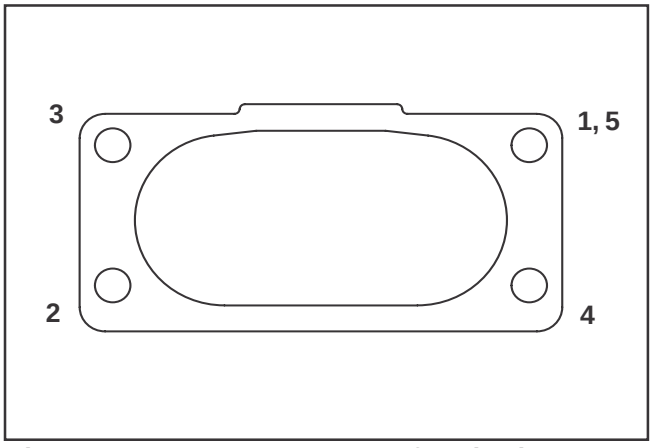


Figure 10-98. Torque Sequence for Air Cleaner Mounting Nuts.

5. Connect the breather hose to the fitting on the outlet of the air cleaner and connect the fuel solenoid lead.

6. Connect the formed vent hose to the air cleaner housing and the vent port on the carburetor.

Install Throttle and Choke Linkages

If the individual throttle/choke lever control linkages were disconnected during disassembly, reconnect them based on the operating direction of the control cables to be used.

On Control Levers:
Hole **A** is used for **Outer Pull** control cable actuation.
Hole **B** is used for **Inner Pull** control cable actuation.
See Figures 10-99 and 10-100.

1. Connect the choke linkage to the appropriate hole in the choke lever and secure with the small clip.

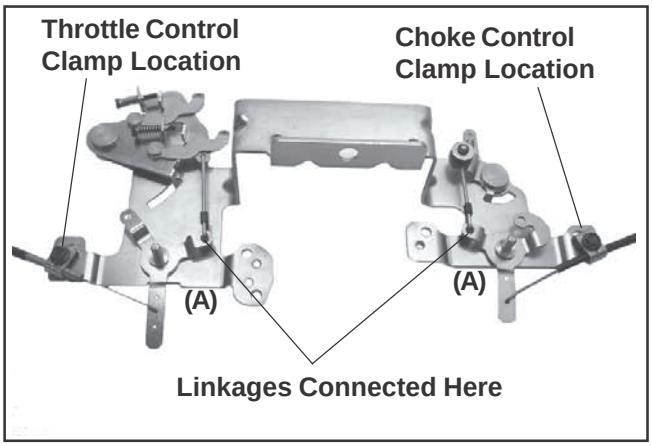


Figure 10-99. Throttle/Choke Linkage Details for Outer Pull Actuation.

2. Connect the throttle linkage to the appropriate hole in the throttle lever and secure with the small clip.

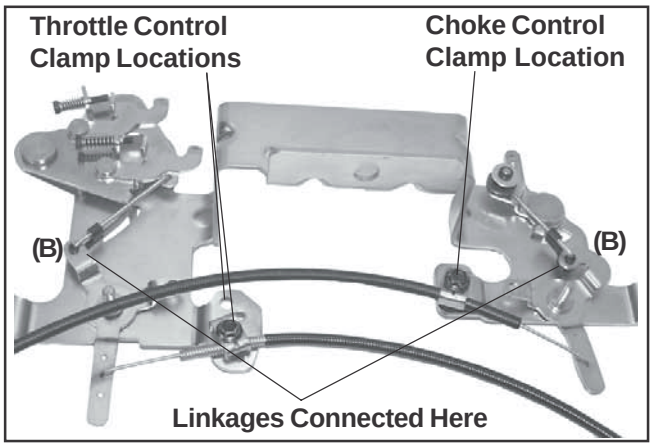


Figure 10-100. Throttle/Choke Linkage Details for Inner Pull Actuation.

Adjusting Governor

1. Position the governor lever so the clamping area is inboard but completely on the knurled area of governor cross shaft. See Figure 10-101.

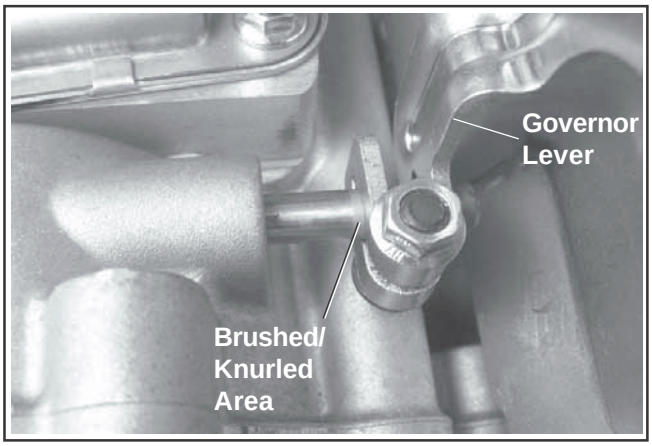


Figure 10-101. Brushed/Knurled Area.

2. Move the governor lever toward the carburetor as far as it will go (wide-open throttle) and hold in position. See Figure 10-102.

3. Insert a long thin rod or tool into the hole on the cross shaft and rotate the shaft clockwise (viewed from the end) as far as it will turn, then torque the hex nut to **7.3 N·m (65 in. lb.)**. See Figure 10-102.

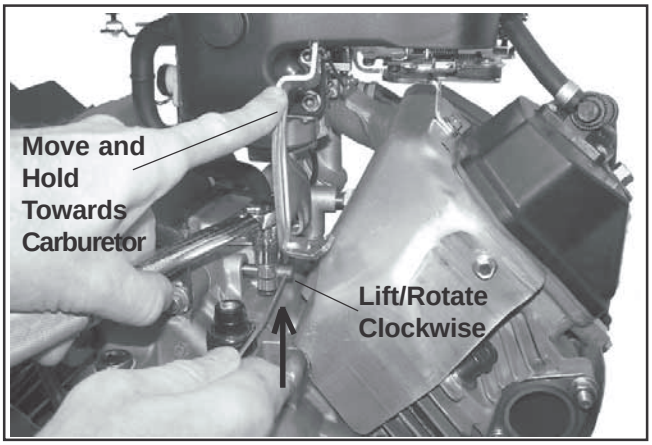


Figure 10-102. Adjusting Governor.

4. Ensure that the correct color springs are used. Connect the governor spring (with long looped end), to the inner hole on the governor lever and control bracket.

   Connect the governed idle spring to the outer governor lever hole and control bracket. The long end of each spring must be toward the governor lever. Make sure the springs do not contact the valley baffle. See Figure 10-103.

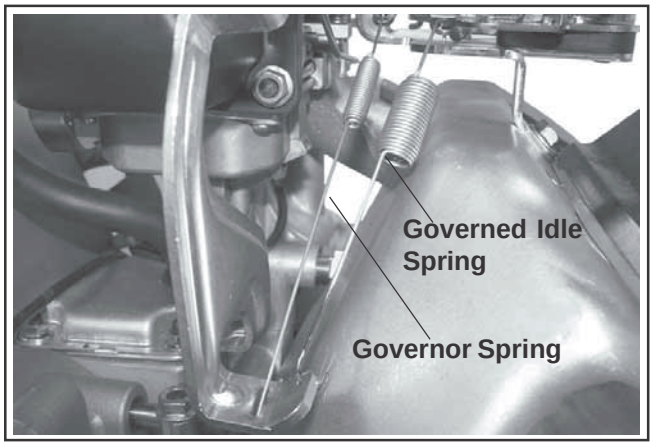


Figure 10-103. Governor Springs Installed.

Governor Spring/RPM Chart

Governed Idle Spring (Color)	Idle Speed (RPM)
Clear	1200-1550 RPM
Black	1551-1800 RPM

Governor Spring (Color)	High Speed (RPM)
Orange	3000-3150 RPM
Yellow	3151-3300 RPM
Brown	3301-3450 RPM
Red	3451-3675 RPM
Green	3676-3900 RPM

Figure 10-104. Governor Spring/RPM Chart.

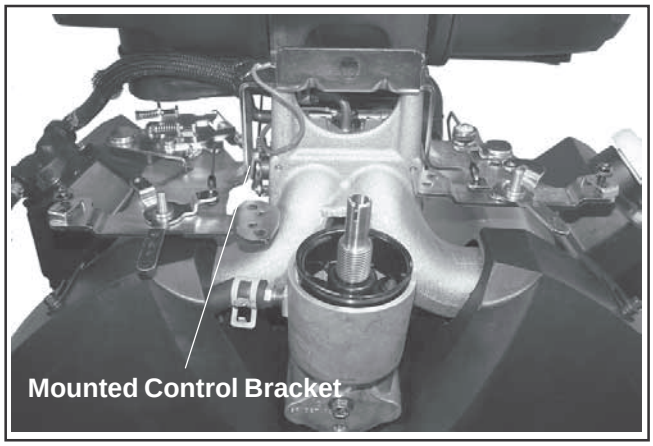


Figure 10-105. Control Bracket Assembly on Engine.

Install Oil Sentry™ (If Equipped)

1. Apply pipe sealant with Teflon® (Loctite® No. 59241 or equivalent) to the threads of the Oil Sentry™ switch and install it into the 1/8″ port in the closure plate. See Figure 10-106. Torque the switch to **10.1 N·m (90 in. lb.)**.

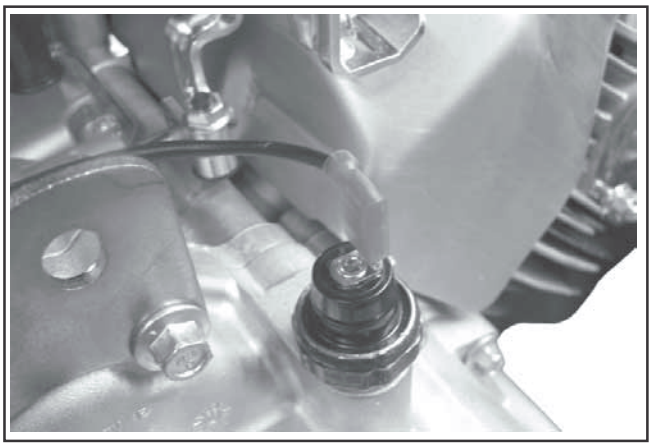


Figure 10-106. Oil Sentry™ Pressure Switch Location.

2. Connect the green wire lead to the Oil Sentry™ terminal.

Install Blower Housing and Cylinder Shrouds

1. Align and install the blower housing. See Figure 10-107.

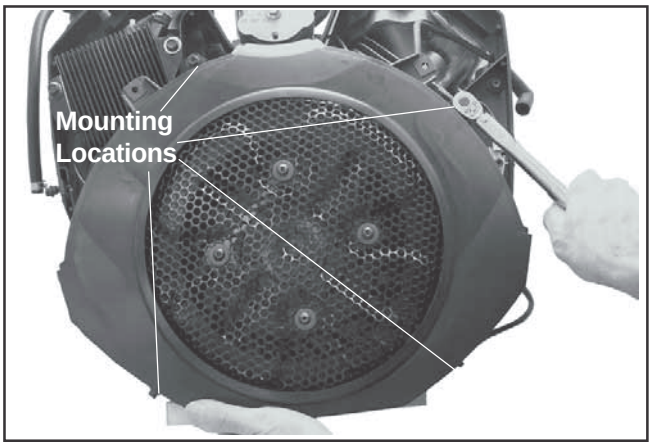


Figure 10-107. Installing Blower Housing.

2. Secure the blower housing with the four shoulder screws. Torque the screws to **4.0 N·m (35 in. lb.)** for initial installations, or **2.0 N·m (17.7 in. lb.)** for reinstallations.
3. Install the two cylinder shrouds and secure with the shoulder screws. Torque the screws to **4.0 N·m (35 in. lb.)** for initial installations, or **2.0 N·m (17.7 in. lb.)** for reinstallations. See Figure 10-108.

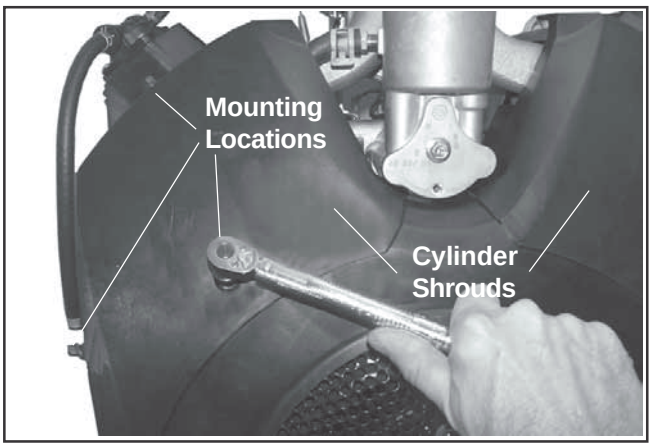


Figure 10-108. Installing Cylinder Shrouds.

Install Control Panel (If Equipped)

1. Install the control panel to the main control bracket and oil filter housing. Torque the M6 screw going into the oil filter housing to **10.7 N·m (95 in. lb.)** into a new hole, or **7.3 N·m (65 in. lb.)** into a used hole. Torque the two upper M5 screws to **6.2 N·m (55 in. lb.)** into new holes, or **4.0 N·m (35 in. lb.)** into used holes. See Figure 10-109.
2. Connect the Oil Sentry™ indicator light wires.
3. Install the knobs onto the control levers.

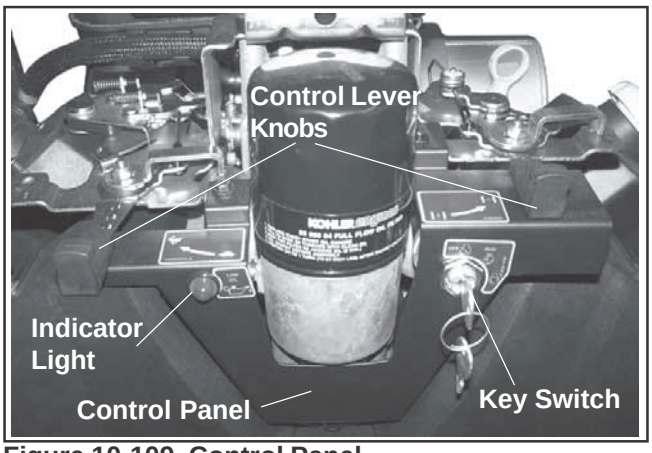


Figure 10-109. Control Panel.

Install Muffler

1. Install the port liners (if equipped). Attach the muffler and secure with the four hex flange nuts onto the exhaust studs. See Figure 10-110. Torque the hex flange nuts to **24.4 N·m (216 in. lb.)**.

2. Install any attaching hardware and brackets. Torque M6 screws to **9.9 N·m (88 in. lb.),** and M8 screws to **24.4 N·m (216 in. lb.)**.

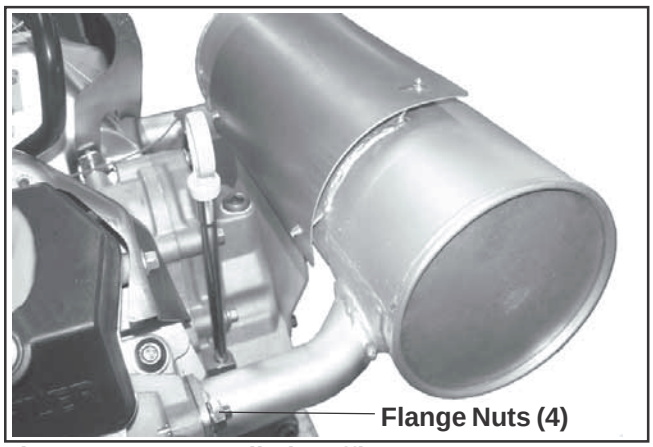


Figure 10-110. Installed Muffler.

3. Install spark arrestor (if used).

Install Oil Filter and Add Oil to Crankcase

1. Install the oil drain plugs. See Figure 10-111. Torque the plugs to **21.4 N·m (15.7 ft. lb.)**.

   NOTE: Make sure that both oil drain plugs are installed and torqued to the above specifications to prevent oil leakage.

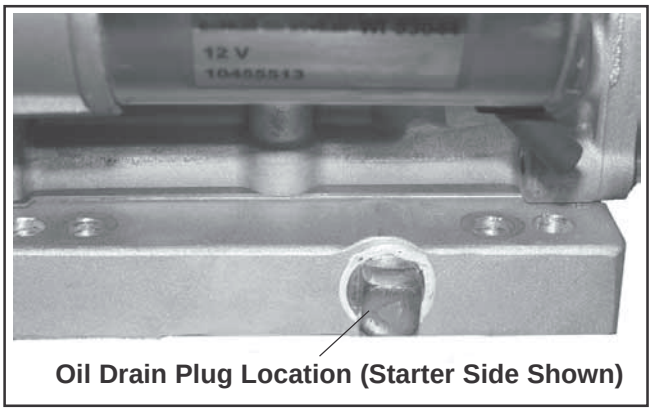


Figure 10-111. Reinstall Oil Drain Plugs.

2. Install a new oil filter following the instructions in Section 6.

3. Apply a thin film of clean engine oil to the rubber gasket on the oil filter and thread the filter onto the adapter nipple. See Figure 10-112.

4. Hand tighten the filter until the rubber gasket contacts the oil filter housing (not inner cup), then tighten the filter an additional 3/4-1 turn. See Figure 10-112.

Figure 10-112. Installing Oil Filter.

5. Add oil to bring the level up to the "F" mark. Reinstall the dipstick and oil fill cap. See Figure 10-113.

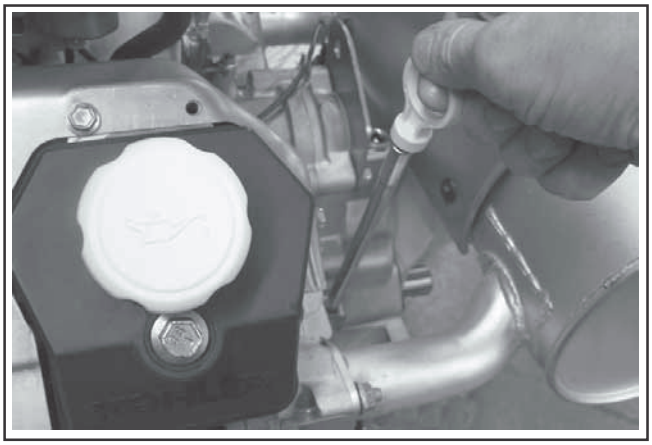


Figure 10-113. Reinstall the Dipstick.

Connect Spark Plug Leads

1. Connect the leads to the spark plugs. See Figure 10-114.

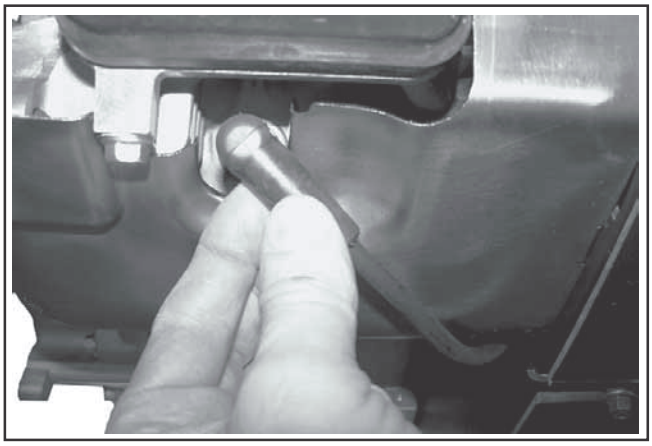


Figure 10-114. Connect Spark Plug Leads.

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 plugs, 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 in Section 6 Lubrication System.

4. Adjust the carburetor, idle fuel needles, 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 test stand or bench prior to installation in the piece of equipment.

1. Set the engine up on a test stand. Install an oil pressure gauge. Start the engine and check to be certain that oil pressure (20 psi or more) is present. Run the engine at idle for 2-3 minutes, then 5-6 minutes more between idle and midrange. Adjust the carburetor mixture settings as necessary (as available).

2. Adjust the governed idle and high speed (RPM) to required settings. Make sure the maximum engine speed does not exceed 3900 RPM (no load).

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