SERVICE MANUAL

KOHLER COMMAND CH11-16

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 lead 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.

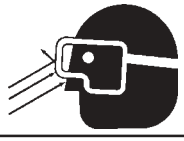
⚠ WARNING

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



Uncoiling Spring can cause severe injury.

Wear safety goggles or face protection when servicing retractable starter.

Spring Under Tension!

Retractable starters contain a powerful, recoil spring that is under tension. Always wear safety goggles when servicing retractable starters and carefully follow instructions in the Retractable Starter Section 7 for relieving spring tension.

⚠ 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 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 12.5 ST**

Command Engine

Horizontal Crankshaft

Horsepower

11 = 11 HP
12.5 = 12.5 HP
13 = 13 HP
14 = 14 HP
15 = 15 HP
16 = 16 HP

Version Code

S = Electric Start
T = Retractable Start
ST = Electric/Retractable Start
GT = Generator Application/Retractable Start
GS = Generator Application/Electric Start
PT = Pump/Retractable Start
RT = Gear Reduction/Retractable Start

B. Spec. No. **1903**

Engine Model Code

Code	Model
16	CH11
19	CH12.5
22	CH13
18	CH14
44	CH15
45	CH16

Variation of Basic Engine

C. Serial No. **2005810334**

Year Manufactured Code

Factory Code

Code	Year	Code	Year
20	1990	29	1999
21	1991	30	2000
22	1992	31	2001
23	1993	32	2002
24	1994	33	2003
25	1995	34	2004
26	1996	35	2005
27	1997	36	2006
28	1998	37	2007

MODEL NO. CH12.5ST — A
SPEC. NO. 1903 — B
SERIAL NO. 2005810334 — C

REFER TO OWNER'S MANUAL FOR SAFETY, MAINTENANCE SPECS AND ADJUSTMENTS. FOR SALES AND SERVICE IN US/CANADA CALL: 1-800-544-2444.

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KOHLER engines

KOHLER CO. KOHLER, WI USA

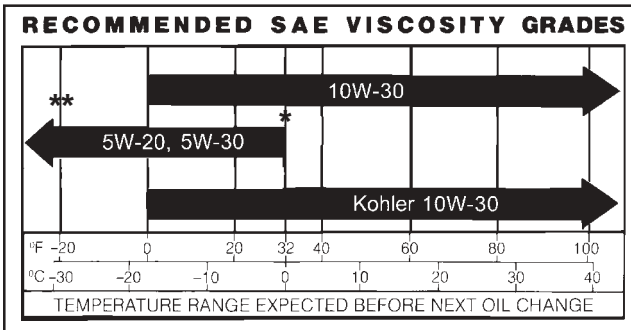
Figure 1-2. Explanation of Engine Identification Numbers.

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. 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 oil check, oil change, and oil filter procedures.

Fuel Recommendations

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.

General Recommendations

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

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

Do not add oil to the gasoline.

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

Fuel Type

For best results, use only clean, fresh, unleaded gasoline with a pump sticker octane rating of 87 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. Leaded gasoline may be used in areas where unleaded is not available and exhaust emissions are not regulated. Be aware however, that the cylinder head will require more frequent service.

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 are not approved.

Gasoline/Ether blends

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

Periodic Maintenance

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

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

Frequency	Maintenance Required	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[1].	Section 5 Section 6 Section 4 Section 4
Every 25 Hours	• Service precleaner element[1].	Section 4
Every 50 Hours	• Check oil level in gear reduction unit.	Section 6
Every 100 Hours	• Replace air cleaner element[1]. • Change oil[1]. • Remove cooling shrouds and clean cooling areas[1].	Section 4 Section 6 Section 4
Every 200 Hours	• Change oil filter. • Check spark plug condition and gap. • Replace fuel filter.	Section 6 Section 8 Section 5
Annually or Every 500 Hours	• Have bendix starter drive serviced[2]. • Have solenoid shift starter disassembled and cleaned[2].	Section 8 Section 8

[1]Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.
[2]Only required for Denso starters. Not necessary on Delco starters. Have a Kohler Engine Service Dealer perform this service.

Storage

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

1. Clean the exterior surfaces of the engine.

2. Change the oil and oil filter while the engine is still warm from operation. See Change 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 manufacturers 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 2-3 minutes to get stabilized fuel into the carburetor.

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

4. Remove the spark plug. Add one tablespoon of engine oil into the spark plug hole. Install the plug, but do not connect the plug lead. Crank the engine two or three revolutions.

5. Remove the spark plug. Cover the spark plug hole with your thumb, and turn the engine over until the piston is at the top of its stroke. (Pressure against thumb is greatest.) Reinstall the plug, but do not connect the plug lead.

6. Store the engine in a clean, dry place.

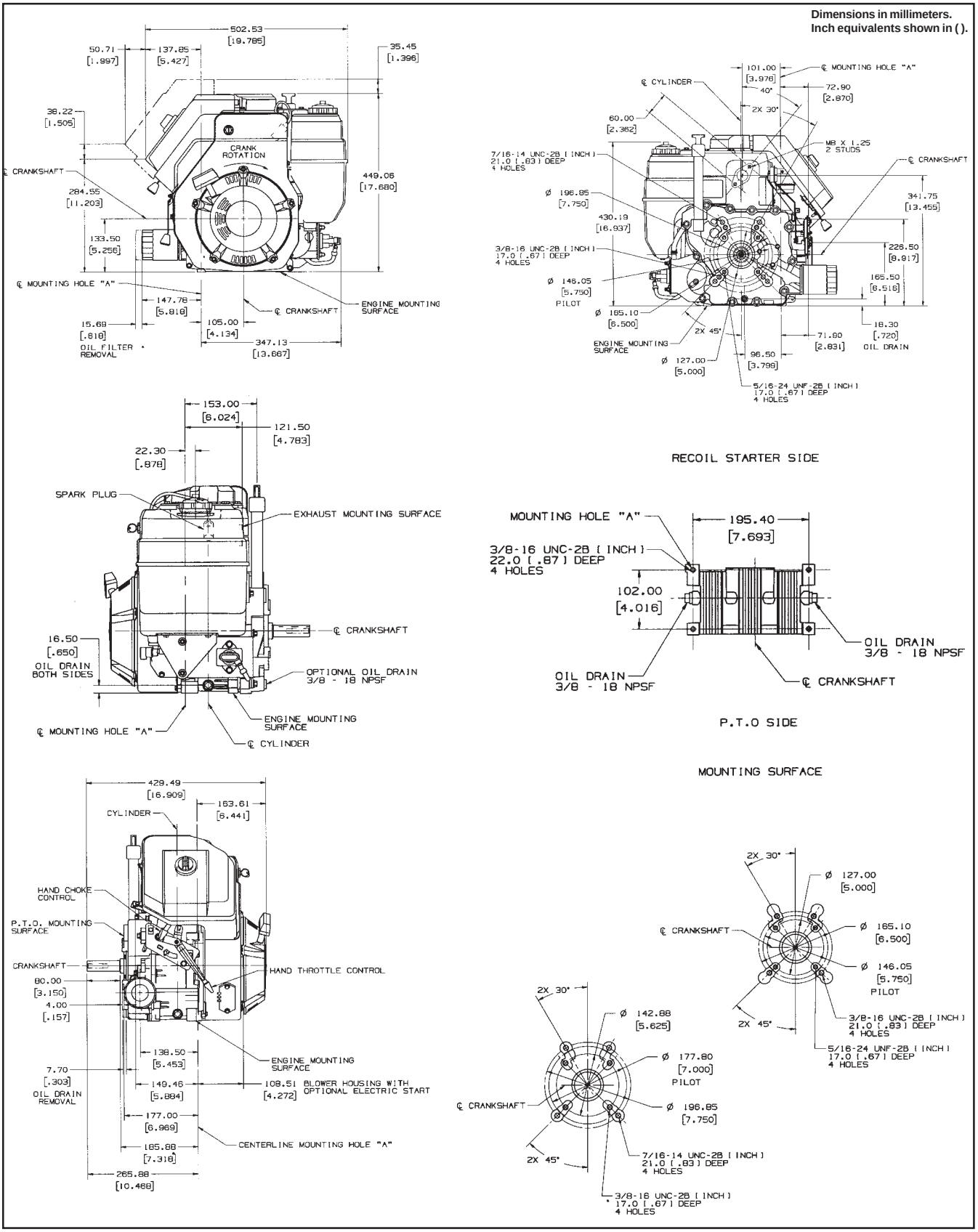


Figure 1-4. Typical Engine Dimensions.

General Specifications[1]

Power (@ 3600 RPM, exceeds SAE J1940 HP standards)
- CH11 ..... 8.20 kW (11 HP)
- CH12.5 ..... 9.33 kW (12.5 HP)
- CH13 ..... 9.75 kW (13 HP)
- CH14 ..... 10.50 kW (14 HP)
- CH15 ..... 11.20 kW (15 HP)
- CH16 ..... 11.90 kW (16 HP)

Peak Torque (@ RPM indicated)
- CH11 (@ 2400 RPM) ..... 26.7 N·m (19.7 ft. lb)
- CH12.5 (@ 2500 RPM) ..... 27.8 N·m (20.5 ft. lb)
- CH13 (@ 2400 RPM) ..... 28.8 N·m (21.2 ft. lb)
- CH14 (@ 2500 RPM) ..... 27.8 N·m (21.3 ft. lb)
- CH15 (@ 2400 RPM) ..... 34.3 N·m (25.3 ft. lb)
- CH16 (@ 2400 RPM) ..... 33.9 N·m (25.0 ft. lb)

Bore
- CH11, CH12.5, CH13, CH14 ..... 87 mm (3.43 in.)
- CH15, CH16 ..... 90 mm (3.54 in.)

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

Displacement
- CH11, CH12.5, CH13, CH14 ..... 398 cc (24.3 cu. in.^{3})
- CH15, CH16 ..... 426 cc (26.0 cu. in.^{3})

Compression Ratio 8.5:1

Weight ..... 40 kg (88.3 lb.)

Max. Oil Capacity (w/filter) ..... 1.9 L (2.0 qt.)

Lubrication ..... full pressure w/full flow filter

Air Cleaner

Base Nut Torque ..... 9.9 N·m (88 in. lb.)

Angle of Operation - Maximum (at full oil level)

Intermittent - All Directions ..... 35°
Continuous - All Directions ..... 25°

Balance Shaft

End Play (Free) ..... 0.0575/0.3625 mm (0.0023/0.0137 in.)
Running Clearance ..... 0.025/0.1520 mm (0.0009/0.0059 in.)

Bore I.D.
- New ..... 20.000/20.025 mm (0.7874/0.7884 in.)
- Max. Wear Limit ..... 20.038 mm (0.7889 in.)

Balance Shaft Bearing Surface O.D.
- New ..... 19.962/19.975 mm (0.7859/0.7864 in.)
- Max. Wear Limit ..... 19.959 mm (0.7858 in.)

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

Camshaft

End Play (Free) ..... 0.0875/0.3925 mm (0.0034/0.0154 in.)
End Play (with Shims) ..... 0.0762/0.1270 mm (0.0030/0.0050 in.)
Running Clearance ..... 0.025/0.1050 mm (0.00098/0.0041 in.)

Bore I.D.
- New ..... 20.000/20.025 mm (0.7874/0.7884 in.)
- Max. Wear Limit ..... 20.038 mm (0.7889 in.)

Camshaft Bearing Surface O.D.
- New ..... 19.962/19.975 mm (0.7859/0.7864 in.)
- Max. Wear Limit ..... 19.959 mm (0.7858 in.)

Carburetor

Fuel Bowl Nut Torque ..... 5.1-6.2 N·m (45-55 in. lb.)

Charging

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

Closure Plate

Oil Filter Tightening ..... 3/4-1 turn after gasket contacts.

Oil Filter Adapter Fastener Torque ..... 11.3 N·m (100 in. lb.)

Oil Filter Drain Plug (1/8" NPT) Torque ..... 7.3-9.0 N·m (65-80 in. lb.)

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

Oil Sentry Pressure Switch Torque ..... 6.8 N·m (60 in. lb.)

Oil Pump Cover Fastener Torque[2] ..... 4.0,6.2 N·m (35,55 in. lb.)

Connecting Rod

Cap Fastener Torque
- 6 mm straight shank bolt ..... 11.3 N·m (100 in. lb.)
- 8 mm straight shank bolt ..... 22.6 N·m (200 in. lb.)
- 8 mm step-down type bolt ..... 14.7 N·m (130 in. lb.)

Connecting Rod-to-Crankpin Running Clearance at 21°C (70°F)
- New ..... 0.030/0.055 mm (0.0012/0.0022 in.)
- Max. Wear Limit ..... 0.07 mm (0.0025 in.)

Connecting Rod-to-Crankpin Side Clearance ..... 0.18/0.41 mm (0.007/0.016 in.)

Connecting Rod-to-Piston Pin Running Clearance 21°C (70°F) ..... 0.015/0.028 mm (0.0006/0.0011 in.)

Piston Pin End I.D.
- New ..... 19.015/19.023 mm (0.7486/0.7489 in.)
- Max. Wear Limit ..... 19.036 mm (0.7495 in.)

Crankcase

Governor Cross Shaft Bore I.D.
- New ..... 6.025/6.050 mm (0.2372/0.2382 in.)
- Max. Wear Limit ..... 6.063 mm (0.2387 in.)

[2]For self-tapping (thread-forming) fasteners, the higher torque value is for installation into a new cored (non-threaded) hole. The lower torque value is for installation into a used or threaded hole.

Crankshaft

End Play (Free) ..... 0.0575/0.4925 mm (0.0022/0.0193 in.)
End Play (Thrust Bearing with Shims) ..... 0.0500/0.5300 mm (0.0019/0.0208 in.)

Crankshaft Bearing I.D. (In Crankcase)
- Sleeve Bearing (Installed) - New ..... 44.965/45.003 mm (1.7703/1.7718 in.)
- Sleeve Bearing - Max. Wear Limit ..... 45.016 mm (1.7723 in.)
- Parent Material (No Sleeve Bearing) - New ..... 44.965/44.990 mm (1.7703/1.7713 in.)
- Parent Material (No Sleeve Bearing) - Max. Wear Limit ..... 45.003 mm (1.7718 in.)

Crankshaft to Bearing Running Clearance - New
- Sleeve Bearing ..... 0.030/0.090 mm (0.0011/0.0035 in.)
- Parent Material (No Sleeve Bearing) ..... 0.030/0.077 mm (0.0011/0.0030 in.)

Crankshaft Bearing I.D. (In Closure Plate)
- Sleeve Bearing (Installed) - New ..... 41.960/42.035 mm (1.6519/1.6549 in.)
- Sleeve Bearing - Max. Wear Limit ..... 42.048 mm (1.6554 in.)
- Parent Material (No Sleeve Bearing) - New ..... 41.965/42.003 mm (1.6521/1.6536 in.)
- Parent Material (No Sleeve Bearing) - Max. Wear Limit ..... 42.015 mm (1.6541 in.)

Crankshaft Bore (In Closure Plate) to Crankshaft Running Clearance - New
- Sleeve Bearing ..... 0.025/0.1200 mm (0.00098/0.00472 in.)
- Parent Material (No Sleeve Bearing) ..... 0.030/0.0880 mm (0.0011/0.0034 in.)

Flywheel End Main Bearing Journal
- O.D. - New ..... 44.913/44.935 mm (1.7682/1.7691 in.)
- O.D. - Max. Wear Limit ..... 44.84 mm (1.765 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 ..... 41.915/41.935 mm (1.6502/1.6510 in.)
- O.D. - Max. Wear Limit ..... 41.86 mm (1.648 in.)
- Max. Taper ..... 0.020 mm (0.0008 in.)
- Max. Out-of-Round ..... 0.025 mm (0.0010 in.)

Connecting Rod Journal
- O.D. - New ..... 38.958/38.970 mm (1.5338/1.5343 in.)
- O.D. - Max. Wear Limit ..... 38.94 mm (1.5328 in.)
- Max. Taper ..... 0.012 mm (0.0005 in.)
- Max. Out-of-Round ..... 0.025 mm (0.0010 in.)

Crankshaft T.I.R.
- PTO End, Crank in Engine ..... 0.304 mm (0.012 in.)
- Entire Crank, in V-Blocks ..... 0.10 mm (0.0039 in.)

Cylinder Bore

Cylinder Bore I.D.
- New
  - CH11-14 ..... 87.000/87.025 mm (3.4252/3.4262 in.)
  - CH15, CH16 ..... 90.000/90.025 mm (3.5433/3.5442 in.)
- Max. Wear Limit
  - CH11-14 ..... 87.063 mm (3.4277 in.)
  - CH15, CH16 ..... 90.063 mm (3.5457 in.)

Cylinder Bore I.D. cont'd.
- Max. Out-of-Round
  - CH11-14 ..... 0.12 mm (0.0047 in.)
  - CH15, CH16 ..... 0.12 mm (0.0047 in.)
- Max. Taper
  - CH11-14 ..... 0.05 mm (0.0020 in.)
  - CH15, CH16 ..... 0.05 mm (0.0020 in.)

Cylinder Head

Cylinder Head Fastener Torque (torque in 2 increments) ..... 24,48.9 N·m (18,36 ft. lb.)

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

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

Electric Starter

Thru Bolt Torque
- UTE/Johnson Electric, Eaton (Inertia Drive) ..... 4.5-5.7 N·m (40-50 in. lb.)
- Nippondenso (Solenoid Shift) ..... 4.5-7.5 N·m (40-84 in. lb.)
- Delco-Remy (Solenoid Shift) ..... 5.6-9.0 N·m (49-79 in. lb)

Drive Pinion Fastener Torque (some Inertia Drive Starters) ..... 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
- Nippondenso Starter ..... 6.0-9.0 N·m (53-79 in. lb.)
- Delco-Remy Starter ..... 4.0-6.0 N·m (35-53 in. lb.)

Nut, Positive (+) Brush Lead Torque
- Nippondenso Starter ..... 8.0-12.0 N·m (71-106 in. lb)
- Delco-Remy Starter ..... 6.0-9.0 N·m (53-79 in. lb.)

Fan/Flywheel

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

Flywheel Retaining Screw Torque ..... 66.4 N·m (49 ft. lb.)

Fuel Pump

Fuel Pump/Cover Fastener Screw Torque ..... 9.0 N·m (80 in. lb.) into new holes
4.2-5.1 N·m (37-45 in. lb.) into used holes

Fuel Tank

Fuel Tank Fastener Torque ..... 7.3 N·m (65 in. lb.)

Governor

Governor Cross Shaft to Crankcase Running Clearance ..... 0.025/0.075 mm (0.0010/0.0030 in.)

Governor Cross Shaft O.D.
- New ..... 5.975/6.000 mm (0.2352/0.2362 in.)
- Max. Wear Limit ..... 5.962 mm (0.2347 in.)

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

Governor Gear Shaft O.D.
- New ..... 5.990/6.000 mm (0.2358/0.2362 in.)
- Max. Wear Limit ..... 5.977 mm (0.2353 in.)

Ignition

Spark Plug Type (Champion® or equivalent) ..... RC12YC or Platinum 3071

Spark Plug Gap
- CH11-15 ..... 1.02 mm (0.040 in.)
- CH16 ..... 0.76 mm (0.030 in.)

Spark Plug Torque ..... 38.0-43.4 N·m (28-32 ft. lb.)

Ignition Module Air Gap ..... 0.203/0.305 mm (0.008/0.012 in.)

Ignition Module Fastener Torque ..... 4.0 N·m (35 in. lb.) into new holes
6.2 N·m (55 in. lb.) into used holes

Muffler

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

Piston, Piston Rings, and Piston Pin

Piston-to-Piston Pin (selective fit) ..... 0.006/0.017 mm (0.0002/0.0007 in.)

Piston Pin Bore I.D.
- New ..... 19.006/19.012 mm (0.7483/0.7485 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 (0.74779 in.)

Top Compression Ring-to-Groove Side Clearance
- CH11-14 ..... 0.040/0.105 mm (0.0016/0.0041 in.)
- CH15, CH16 ..... 0.060/0.105 mm (0.0023/0.0041 in.)

Middle Compression Ring-to-Groove Side Clearance
- CH11-14 ..... 0.040/0.072 mm (0.0016/0.0028 in.)
- CH15, CH16 ..... 0.040/0.085 mm (0.0015/0.0002 in.)

Oil Control Ring-to-Groove Side Clearance
- CH11-14 ..... 0.551/0.675 mm (0.0217/0.0266 in.)
- CH15, CH16 ..... 0.176/0.026 (0.0069/0.0010 in.)

Top and Center Compression Ring End Gap
- New Bore
  - CH11-14 ..... 0.3/0.5 mm (0.012/0.020 in.)
  - CH15, CH16 ..... 0.27/0.51 mm (0.010/0.020 in.)
- Used Bore (Max.) ..... 0.77 mm (0.030 in.)

Piston Thrust Face O.D.
- New
  - CH11-14[3] ..... 86.941/86.959 mm (3.4229/3.4236 in.)
  - CH15, CH16[4] ..... 89.951/89.969 mm (3.5413/3.5420 in.)
- Max. Wear Limit
  - CH11-14 ..... 86.814 mm (3.4179 in.)
  - CH15, CH16 ..... 89.824 mm (3.5363 in.)

[3]Measure 6 mm (0.236 in.) above the bottom of the piston skirt at right angles to the piston pin.
[4]Measure 8 mm (0.314 in.) above the bottom of the piston skirt at right angles to the piston pin.

Piston Thrust Face-to-Cylinder Bore Running Clearance - New
- CH11-14 ..... 0.041/0.044 mm (0.0016/0.0017 in.)
- CH15, CH16 ..... 0.031/0.043 mm (0.0012/0.0016 in.)

Retractable Starter

Center Screw Torque ..... 7.4-8.5 N·m (65-75 in. lb.)

Throttle/Choke Controls

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

Speed Control Bracket Assembly Fastener Torque[2] ..... 7.3-10.7 N·m (65-95 in. lb.)

Valve Cover/Rocker Arms

Valve Cover Fastener Torque[2] ..... 7.3-10.7 N·m (65-95 in. lb.)

Rocker Arm I.D.
- New ..... 15.837/16.127 mm (0.63/0.64 in.)
- Max. Wear Limit ..... 16.13 mm (0.640 in.)

Rocker Shaft O.D.
- New ..... 15.90/15.85 mm (0.63 in.)
- Max. Wear Limit ..... 15.727 mm (0.619 in.)

Valves and Valve Lifters

Hydraulic Valve Lifter to Crankcase Running Clearance ..... 0.0124/0.0501 mm (0.0005/0.0020 in.)

Intake Valve Stem-to-Valve Guide Running Clearance ..... 0.038/0.076 mm (0.0015/0.0030 in.)

Exhaust Valve Stem-to-Valve Guide Running Clearance ..... 0.050/0.088 mm (0.0020/0.0035 in.)

Intake Valve Guide I.D.
- New ..... 7.038/7.058 mm (0.2771/0.2779 in.)
- Max. Wear Limit ..... 7.134 mm (0.2809 in.)

Exhaust Valve Guide I.D.
- New ..... 7.038/7.058 mm (0.2771/0.2779 in.)
- Max. Wear Limit ..... 7.159 mm (0.2819 in.)

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

Intake Valve Minimum Lift ..... 8.96 mm (0.353 in.)

Exhaust Valve Minimum Lift ..... 9.14 mm (0.360 in.)

Nominal Valve Seat Angle ..... 45°

[2]For self-tapping (thread-forming) fasteners, the higher torque value is for installation into a new cored (non-threaded) hole. The lower torque value is for installation into a used or threaded hole.

General Torque Values

Metric Fastener Torque Recommendations for Standard Applications

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

Size	Property Class 4.8	5.8	8.8	10.9	12.9	Noncritical Fasteners Into Aluminum
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 4.8	5.8	8.8	10.9	12.9	Noncritical Fasteners Into Aluminum
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)

Oil Drain Plugs Tightening Torque: N·m (English Equiv.)

Size	Into Cast Iron	Into Aluminum
1/8" NPT	–	4.5 (40 in. lb.)
1/4"	17.0 (150 in. lb.)	11.3 (100 in. lb.)
3/8"	20.3 (180 in. lb.)	13.6 (120 in. lb.)
1/2"	27.1 (20 ft. lb.)	17.6 (13 ft. lb.)
3/4"	33.9 (25 ft. lb.)	21.7 (16 ft. lb.)
X-708-1	27.1/33.9 (20/25 ft. lb.)	27.1/33.9 (20/25 ft. lb.)

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
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
Valve Guide Service Kit (Courage, Aegis, Command, OHC) For servicing worn value guides.	SE Tools KLR-82415

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 that the tool teeth engage the flywheel ring gear teeth. The bosses will lock the tool and flywheel in position for loosening, tightening or removing with a puller.

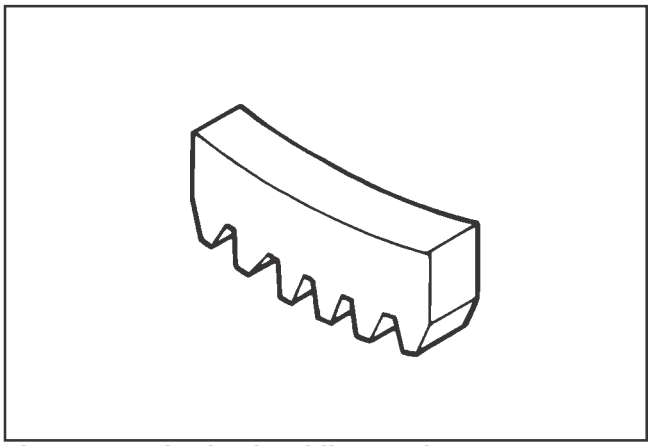


Figure 2-1. Flywheel Holding Tool.

Rocker Arm/Crankshaft Tool

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

1. Find a used connecting rod from a 10 HP or larger engine. Remove and discard the rod cap.
2. Remove the studs of a Posi-Lock rod or grind off the aligning steps of a Command rod, so the joint surface is flat.
3. Find a 1 in. long capscrew with the correct thread size to match the threads in the connecting rod.
4. Use a flat washer with the correct I.D. to slip on the capscrew and approximately 1″ O.D. (Kohler Part No. 12 468 05-S). Assemble the capscrew and washer to the joint surface of the rod, as shown in Figure 2-2.

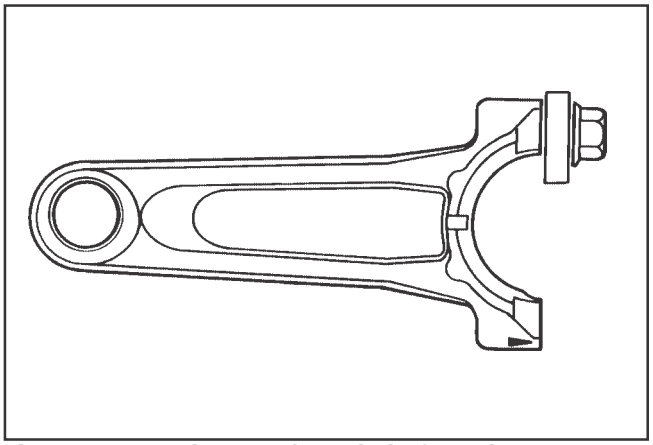


Figure 2-2. Rocker Arm/Crankshaft Tool.

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 common causes of engine trouble are listed below. Use these to locate the causing factors.

Engine Cranks But Will Not Start

1. Empty fuel tank.
2. Fuel shut-off valve closed.
3. Dirt or water in the fuel system.
4. Clogged fuel line.
5. Spark plug lead disconnected.
6. Key switch or kill switch in **off** position.
7. Faulty spark plug.
8. Faulty ignition module.
9. Choke not closing.
10. Faulty oil sending unit.

Engine Starts But Does Not Keep Running

1. Restricted fuel tank vent.
2. Dirt or water in the fuel system.
3. Faulty choke or throttle controls/cable.
4. Loose wires or connections that short the kill terminal of ignition module to ground.
5. Faulty cylinder head gasket.
6. Faulty fuel pump.
7. Faulty carburetor.
8. Faulty fuel pump.

Engines Starts Hard

1. Hydrostatic transmission not in neutral/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 choke or throttle controls/cables.
6. Faulty spark plug.
7. Low compression.
8. Faulty Automatic Compression Release (ACR) mechanism.

Engine Will Not Crank

1. Hydrostatic transmission not in neutral/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/starter solenoid.
7. Retractable starter not engaging in drive cup.
8. Seized internal engine components.

Engine Runs But Misses

1. Dirt or water in the fuel system.
2. Spark plug lead disconnected.
3. Loose wires or connections that intermittently short the kill terminal of ignition module to ground.
4. Engine overheated.
5. Faulty ignition module.

Engine Will Not Idle

1. Restricted fuel tank cap vent.
2. Dirt or water in the fuel system.
3. Faulty spark plug.
4. Idle fuel adjusting needle improperly set.
5. Idle speed adjusting screw improperly set.
6. Low compression.
7. Stale fuel and/or gum in carburetor.

Engine Overheats

1. Air intake or 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 condition.
7. Restricted exhaust.

Engine Knocks

1. Excessive engine load.
2. Low crankcase oil level.
3. Old or improper fuel.
4. Internal wear or damage.

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 plug.
8. Low compression.
9. Exhaust restriction.

Engine Uses Excessive Amount Of Oil

1. Incorrect oil viscosity/type.
2. Crankcase overfilled.
3. Clogged or improperly assembled breather.
4. Worn or broken piston rings.
5. Worn cylinder bore.
6. Worn valve stems or valve guides.

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 overheating.

- Check for obvious fuel and oil leaks, and damaged components. Excessive oil leakage can indicate a clogged or improperly assembled breather, worn or 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 underserviced.

- Check the carburetor throat for dirt. Dirt in the throat is further indication that the air cleaner is not functioning properly.

- Check that 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 the oil has not been changed at the recommended intervals, the incorrect type or weight of oil was used, overrich carburetion, and weak ignition, to name a few.

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 at normal temperatures. 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 a water manometer or vacuum/pressure test gauge. See Section 2. Complete instructions are provided with the testers.

Test the crankcase vacuum with the manometer as follows:

1. Insert the rubber stopper into the oil fill hole. Be sure the pinch clamp is installed on the hose and use the tapered adapters to connect the hose between the stopper and one of the manometer tubes. Leave the other tube open to the atmosphere. Check that the water level in the manometer is at the "0" line. Make sure the pinch clamp is closed.
2. Start the engine and run at no-load, high idle 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 the same as the open side (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 perform the test with the vacuum/pressure gauge, insert the stopper as in step 1. Insert the barbed gauge fitting into the hole in the stopper. Be sure the gauge needle is at "0". Run the engine, as in step 2, and observe the gauge reading. Needle movement to the left of "0" is a vacuum, and movement to the right indicates a pressure.

Incorrect Vacuum 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 blowby or leaky valves. Confirm with cylinder leakdown test.	3. Recondition piston, rings, cylinder bore, valves, and valve guides.
4. Restricted exhaust.	4. Repair/replace restricted muffler/exhaust system.

Compression Test

These engines are equipped with an automatic compression release (ACR) mechanism. Because of the ACR mechanism, it is difficult to obtain an accurate compression reading. As an alternate, use the leakdown test described below.

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 tester 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 engine for 3-5 minutes to warm it up.

2. Remove spark plug and air filter from engine.

3. Rotate crankshaft until piston is at top dead center of compression stroke. You will need to 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. Slide the holding tool onto the crankshaft. See TT-364-A. Install a 3/8" breaker bar into the square hole of the holding tool, so it is perpendicular to both the holding tool and crankshaft PTO.

   If the flywheel end is more accessible, you can use a breaker bar and socket on the flywheel nut/screw to hold it in position. You may need an assistant to hold the breaker bar during testing. If the engine is mounted in a piece of equipment, you may be able 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 adequate air source of at least 50 psi to the tester.

6. Turn the regulator knob in the increase (clockwise) direction until the gauge needle is in the yellow “set” area at the low end of the scale.

7. Connect 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 your test results against the table below:

Leakdown Test Results

Air escaping from crankcase breather	Defective rings or worn cylinder walls.
Air escaping from exhaust system	Defective exhaust valve.
Air escaping from carburetor	Defective intake valve.
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 Cleaner

General

These engines are equipped with a replaceable, high-density paper air cleaner element. Most are also equipped with an oiled-foam precleaner which surrounds the paper element. See Figures 4-1 and 4-2.

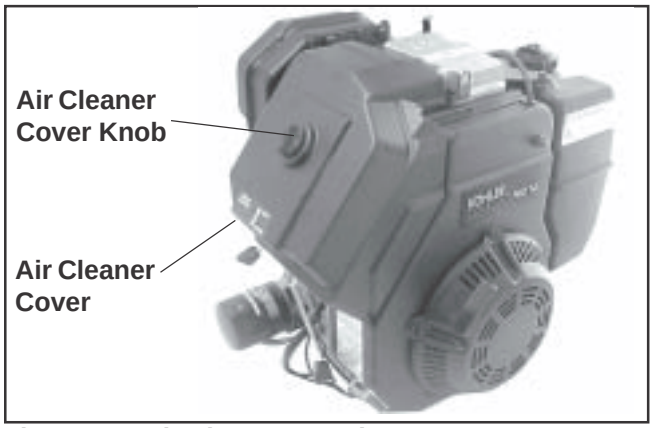


Figure 4-1. Air Cleaner Housing Components.

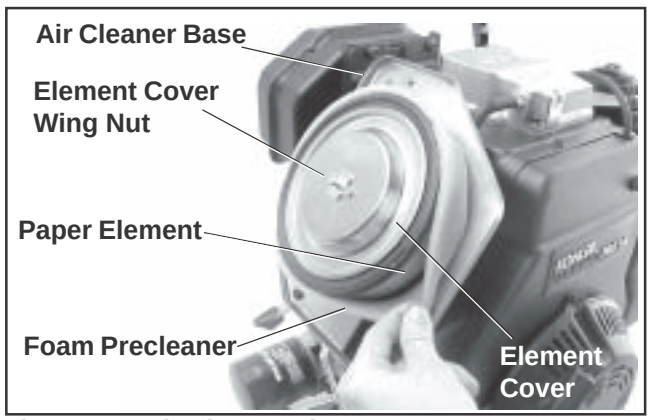


Figure 4-2. Air Cleaner Elements.

Service

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

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

Precleaner Service

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

To service the precleaner, perform the following steps:

1. Loosen the cover retaining knob and remove the cover.
2. Remove the foam precleaner from the paper air cleaner element.
3. Wash the precleaner in warm water with detergent. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow the precleaner to air dry.
4. Saturate the precleaner with new engine oil. Squeeze out all excess oil.
5. Reinstall the precleaner over the paper air cleaner element.
6. Reinstall the air cleaner cover. Secure the cover with the retaining knob.

Paper Element Service

Every **100 hours** of operation (more often under extremely dusty or dirty conditions), replace the paper element. Follow these steps:

1. Loosen the cover retaining knob and remove the cover.
2. Remove the wing nut, element cover, and air cleaner element.
3. Remove the precleaner (if so equipped) from the paper element. Service the precleaner as described in "Precleaner Service".
4. **Do not wash the paper element or use pressurized air,** as this will damage the element. Replace a dirty, bent, or damaged element with a genuine Kohler element. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.
5. Check the rubber sleeve seal for any damage or deterioration. Replace as necessary. A new seal comes packed with each replacement element.
6. Reinstall the paper element, precleaner, element cover, and wing nut.
7. Reinstall the air cleaner cover and secure with the two latches or the retaining knob.

Inspect Air Cleaner Components

Whenever the air cleaner cover is removed, or the paper element or precleaner are serviced, check the following areas/components:

Air Cleaner Base - Make sure the base is secured and not cracked or damaged. Since the air cleaner base and carburetor are secured to the intake port with common hardware, it is extremely important that the nuts securing these components are tight at all times.

Breather Tube - Make sure the breather tube is installed to both the air cleaner base and valve cover.

Disassembly

The following procedure is for complete disassembly of all air cleaner components.

1. Loosen the air cleaner cover retaining knob and remove the air cleaner cover.
2. Remove the wing nut, element cover, and air cleaner element.
3. If so equipped, remove the precleaner from the paper element.
4. Disconnect the breather hose from the valve cover.
5. Remove the air cleaner base mounting nuts, air cleaner base, and gasket.
6. If necessary, remove the self-tapping screws and elbow from air cleaner base.

Reassembly

The following procedure is for complete assembly of all air cleaner components.

1. Install the elbow and self-tapping screws to air cleaner base.
2. Install the gasket, air cleaner base, and base mounting nuts. Torque the nuts to **9.9 N·m (88 in. lb.)**.
3. Connect the breather hose to the valve cover (and air cleaner base). Secure with hose clamps.
4. If so equipped, install the precleaner (washed and oiled) over the paper element.
5. Install the air cleaner element, element cover, and wing nut.
6. Install the air cleaner cover and air cleaner cover retaining knob. Tighten the knob securely.

Air Intake/Cooling System

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

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

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

Section 5
Fuel System and Governor

Description

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 fuel system and related components include the following:

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

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; gravity moves the fuel.

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

Fuel Filter

Most engines are equipped with an in-line fuel filter. Periodically inspect the filter and replace with a genuine Kohler filter every **200 operating hours**.

Fuel Line

In compliance with CARB Tier III Emission Regulations, these engines with a **Family** identification number beginning with **6** or greater (see Figure 5-1), must use Low Permeation SAE 30 R7 rated fuel line; certified to meet CARB requirements. Standard fuel line may not be used. Order replacement hose by part number through a Kohler Engine Service Dealer.

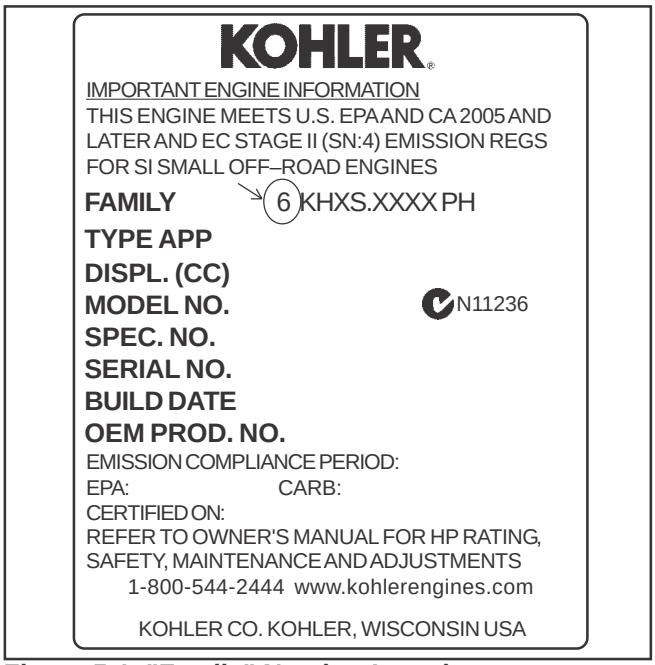


Figure 5-1. "Family" Number Location.

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 for 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.	
2. Check for fuel in the combustion chamber. a. Disconnect and ground spark plug lead. 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 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 for clogged fuel tank vent, fuel pick-up screen, in-line filter, shut-off valve, and fuel lines.
4. Check the operation of fuel pump. a. Remove the fuel line from the inlet fitting of 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 clogged fuel line. If the fuel line is unobstructed, the fuel pump is faulty and must be replaced.

Fuel Pump

General

Most engines are equipped with an optional mechanically operated fuel pump. On applications using a gravity feed fuel system, the fuel pump mounting pad is covered with a metal plate.

The fuel pump body is constructed of nylon. The nylon body insulates the fuel from the engine crankcase. This prevents the fuel from vaporizing inside the pump.

Operation

The mechanical pump is operated by a lever which rides on the engine camshaft. The lever transmits a pumping action to the diaphragm inside the pump body. On the downward stroke of the diaphragm, fuel is drawn in through the inlet check valve. On the upward stroke of the diaphragm, fuel is forced out through the outlet check valve. See Figure 5-2.

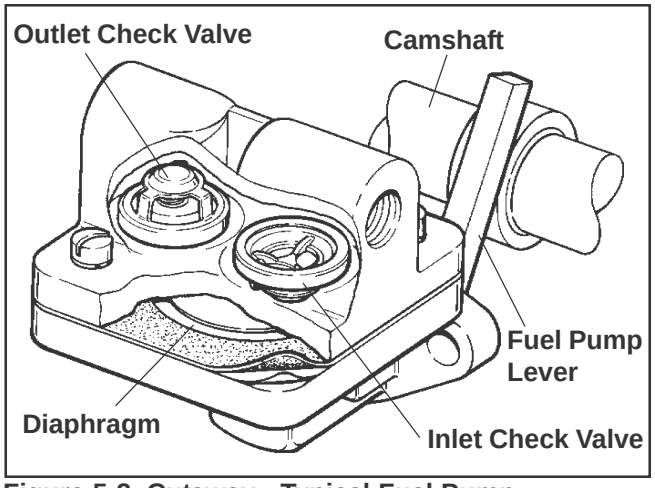


Figure 5-2. Cutaway - Typical Fuel Pump.

Replacing the Fuel Pump

Nonmetallic fuel pumps are not serviceable and must be replaced when faulty. Replacement pumps are available in kits that include the pump, fittings, and mounting gasket.

1. Disconnect the fuel lines from the inlet and outlet fittings.

2. Remove the hex flange screws, fuel pump, and gasket.

3. If necessary, remove the fittings from the pump body.

4. Install Fittings

   Threaded Fittings

   a. Apply a small amount of Permatex® Aviation Perm-a-Gasket (or equivalent) gasoline-resistant thread sealant to the threads of fittings. Turn the fittings into the pump **5 full turns**; continue turning the fittings in the same direction until the desired position is reached.

   Lock-in Fittings

   The inlet and outlet hose fittings must be installed into the fuel pump prior to mounting. The pump housing incorporates a special locking feature to retain the fittings. The release tabs **must** be depressed when the fittings are installed or removed, to avoid damage to the fitting O-Rings and a potential fuel leak. **Do not** attempt to install or force the fittings into place without first depressing the tabs. There is a snap ring included with the new fuel pump kit that will serve as a tool for this purpose.

   a. Note the direction arrows molded into the pump housing and position the snap ring so the ends depress the two square release tabs at the inlet end. See Figure 5-3.

Figure 5-3.

   b. Lubricate the O-Ring on each fitting with oil.

   c. Insert the 90° fitting until the toothed flange is just outside of the pump body. Rotate the fitting to the desired orientation and then apply pressure to seat/snap it into the housing. The flange face will be flush with the end of the housing.

   d. Transfer the snap ring to the opposite end and repeat the sequence to install the straight fitting. Remove the snap ring.

5. Clean off any remaining gasket material from the fuel pump mounting surface. Refer to the pump installation instructions to determine if the extra spacer and gasket are required to mount the new pump. Install new gasket, fuel pump, and hex flange screws.

   NOTE: Make sure the fuel pump lever is positioned to the RIGHT of the camshaft (when looking at fuel pump mounting pad). Damage to the fuel pump, and subsequent severe engine damage could result if the lever is positioned to the left of the camshaft.

   Torque the hex flange screws as follows:

   Into new holes–**9.0 N·m (80 in. lb.)**.

   Into used holes–**4.2-5.1 N·m (37-45 in. lb.)**.

6. Connect the fuel lines to the inlet and outlet fittings.

Carburetors

These engines, based upon when produced, are equipped with either an adjustable main jet carburetor, or an emission compliant fixed jet carburetor manufactured be Walbro or Nikki. See Figure 5-4.

Walbro carburetors have a low idle speed screw and a low idle fuel adjusting needle. Nikki carburetors only have a low idle speed screw. Certified carburetors will have fixed idle fuel or a limiter cap on the idle fuel adjusting needle.

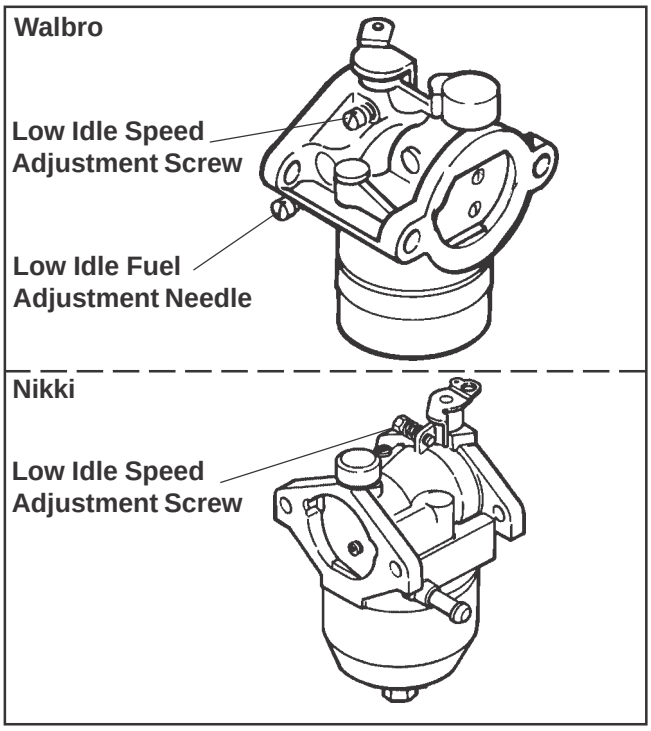


Figure 5-4. Carburetor Adjustment.

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

If engine troubles are experienced that appear to be fuel system related, 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 is securely fastened to the engine using gaskets in good condition.
- Make sure the air cleaner element 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 still hard-to-start, runs roughly, or stalls at low idle speed, it may be necessary to adjust or service the carburetor.

Condition	Possible Cause/Probable Remedy
1. Engine starts hard, or runs roughly or stalls at idle speed.	1. Low idle fuel mixture or speed are improperly adjusted. Adjust the low idle speed screw, then adjust the low idle fuel needle (adjustable carburetors), or clean the carburetor as required (fixed jet carburetors).
2. Engine runs rich (indicated by black, sooty exhaust smoke, misfiring, loss of speed and power, governor hunting, or excessive throttle opening).	2a. Choke partially closed during operation. Check the choke lever/linkage/self-relieving mechanism to ensure choke is operating properly. b. Low idle fuel mixture is incorrect. Adjust low idle speed screw, then adjust low idle fuel needle (adjustable carburetors), or clean the carburetor passages as required (fixed jet carburetors). c. Float level is set too high. With fuel bowl removed and carburetor inverted, the exposed surface of float must be parallel with the bowl gasket surface of the carburetor body. d. Dirt under the fuel inlet needle. Remove needle; clean needle and seat and blow with compressed air. e. Air filter dirty or restricted. f. Bowl vent or air bleeds plugged. Remove fuel bowl, low idle fuel adjusting needle, (not on all models), and welch plugs. Clean vent, ports, passages and air bleeds. Blow out all passages with clean, 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 incorrect. Adjust the low idle speed screw, then adjust low idle fuel needle (adjustable carburetors), or clean the carburetor passages as required (fixed jet carburetors). b. Float level is set too low. With fuel bowl removed and carburetor inverted, the exposed surface of float must be parallel with the bowl gasket surface of the carburetor body. c. Idle holes plugged; dirt in fuel delivery channels. Remove fuel bowl, low idle fuel adjusting needle (not on all models) and welch plugs. Clean main fuel jet and all passages; blow out cleaned compressed air.
4. Fuel leaks from carburetor.	4a. Float level set too high. See Remedy 2c. b. Dirt under fuel inlet needle. See Remedy 2d. c. Bowl vent plugged. Remove fuel bowl and clean bowl vent. Blow out with compressed air. d. Float is cracked or damaged. Replace float. e. Bowl gasket damaged. Replace gasket. f. Bowl screw or shut-off solenoid loose or gasket damaged. Tighten/torque screw to specifications.

Adjustment

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

Emission Compliant Non-Adjustable Carburetors

In compliance with current government emission standards, carburetors on later production engines are calibrated to deliver the correct fuel-to-air mixture to the engine under all operating conditions, without external adjustments, except for low idle speed (RPM). See Figure 5-5.

Figure 5-5. Emission Compliant Non-Adjustable.

If running performance and troubleshooting indicates a problem which cannot be rectified by external means, or adjustment of the low idle speed (RPM) setting, carburetor disassembly and cleaning may be required. The basic disassembly and service procedures for these carburetors remain the same. Refer to pages 5.6 thru 5.10 as required.

Adjust Carburetor

Low idle speed (RPM) setting:

1. Place the throttle control into the "**idle**" or "**slow**" position. Set the low idle speed to **1500 RPM** (±75RPM) by turning the low idle speed adjusting screw **in or out**. Check the speed using a tachometer.

   NOTE: The actual low idle speed depends on the application - refer to equipment manufacture's recommendations. The recommended low idle speed for basic engines is 1500 RPM.

Low Idle Fuel Needle with Limiter Cap Adjustment: Some emission compliant carburetors have a limiter cap on the low idle fuel adjustment screw. Adjustment is limited to the range established by the cap. Do not attempt to remove or adjust beyond the limits. See Figure 5-6.

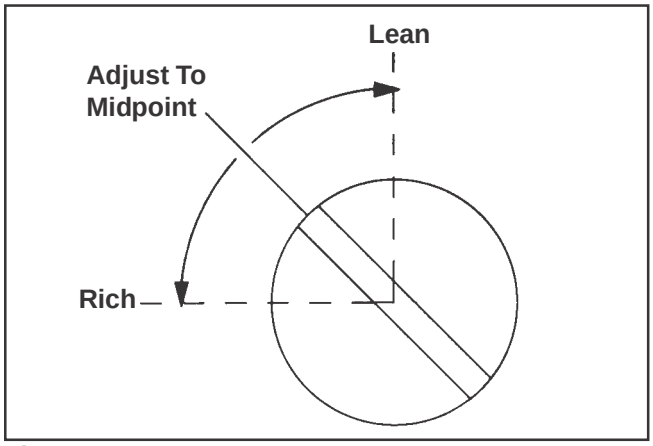


Figure 5-6.

Adjustable Carburetors

The carburetor on these engines is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. Adjustable model carburetors contain adjustment screws for the high and idle mixtures. If the engine is hard starting, runs roughly or stalls at low idle speed, it may be necessary to adjust, clean or service the carburetor.

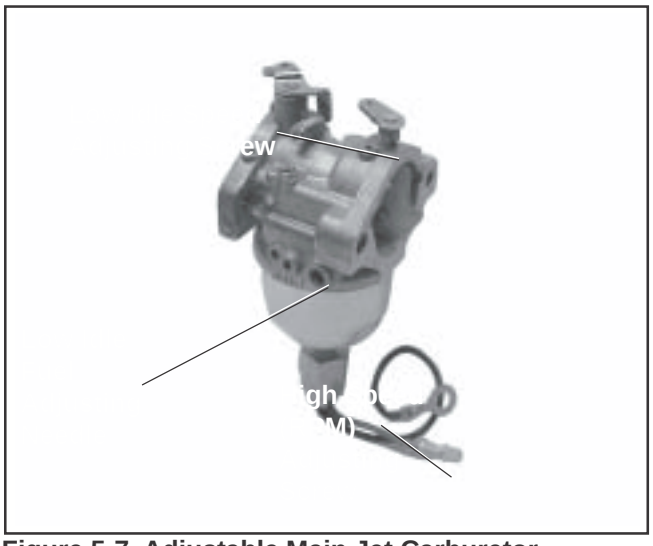


Figure 5-7. Adjustable Main Jet Carburetor.

Adjust Carburetor (Adjustable Main Jet)

1. With the engine stopped turn the low and high idle fuel adjusting needles in **(clockwise)** until they bottom **lightly**.

   NOTE: The tip of the idle fuel and high idle fuel adjusting needles are tapered to critical dimensions. Damage to the needles and the seats in carburetor body will result if the needles are forced.

2. **Preliminary Settings:** Turn the adjusting needles **out (counterclockwise)** from lightly bottomed to the positions shown in the chart.

Adjust Carburetors Only			
Turns			
	CH11	CH12.5	CH14
Idle	1-1/4	1-1/4	1-3/4
High Speed	1-1/2	1-1/2	1-1/4

3. Start the engine and run at half-throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings. Check that the throttle and choke plates can fully open.

4. **High Speed Fuel Needle Setting:** Place the throttle into the "fast" position. If possible place the engine under load. Turn the high idle fuel adjusting needle in (slowly) until engine speed decreases and then back out approximately 1/4 turn for best high-speed performance.

5. **Low Idle Speed Setting:** Place the throttle control into the "idle" or "slow" position. Set the low idle speed to **1500 RPM** *(± 75 RPM) by turning the low idle speed adjusting screw in or out. Check the speed using a tachometer.

   ***NOTE:** The actual low idle speed depends on the application - refer to equipment manufacturer's recommendations. The recommended low idle speed for basic engines is 1500 RPM. To ensure best results when setting the low idle fuel needle the low idle speed should not exceed 1500 RPM (± 75 RPM).

6. **Low Idle Fuel Needle Setting:** Place the throttle into the "idle" or "slow" position. Turn the low idle fuel adjusting needle in (slowly) until engine speed decreases, and then back out approximately 1/8 to 1/4 turn to obtain the best low speed performance.

7. Recheck the idle speed using a tachometer. Readjust the speed as necessary.

Disassembly

1. Remove the power screw, needle and spring, main jet, power screw gasket and fuel bowl.

2. Remove the bowl gasket, float shaft, float, and fuel inlet needle.

3. Remove the low idle fuel adjusting needle and spring, from the carburetor body, if not capped or containing an adjustment limiter. Remove the idle speed adjusting screw and spring.

   Further disassembly to remove the welch plug, fuel inlet seat, throttle plate and shaft, and choke plate and shaft is recommended only if these parts are to be cleaned or replaced.

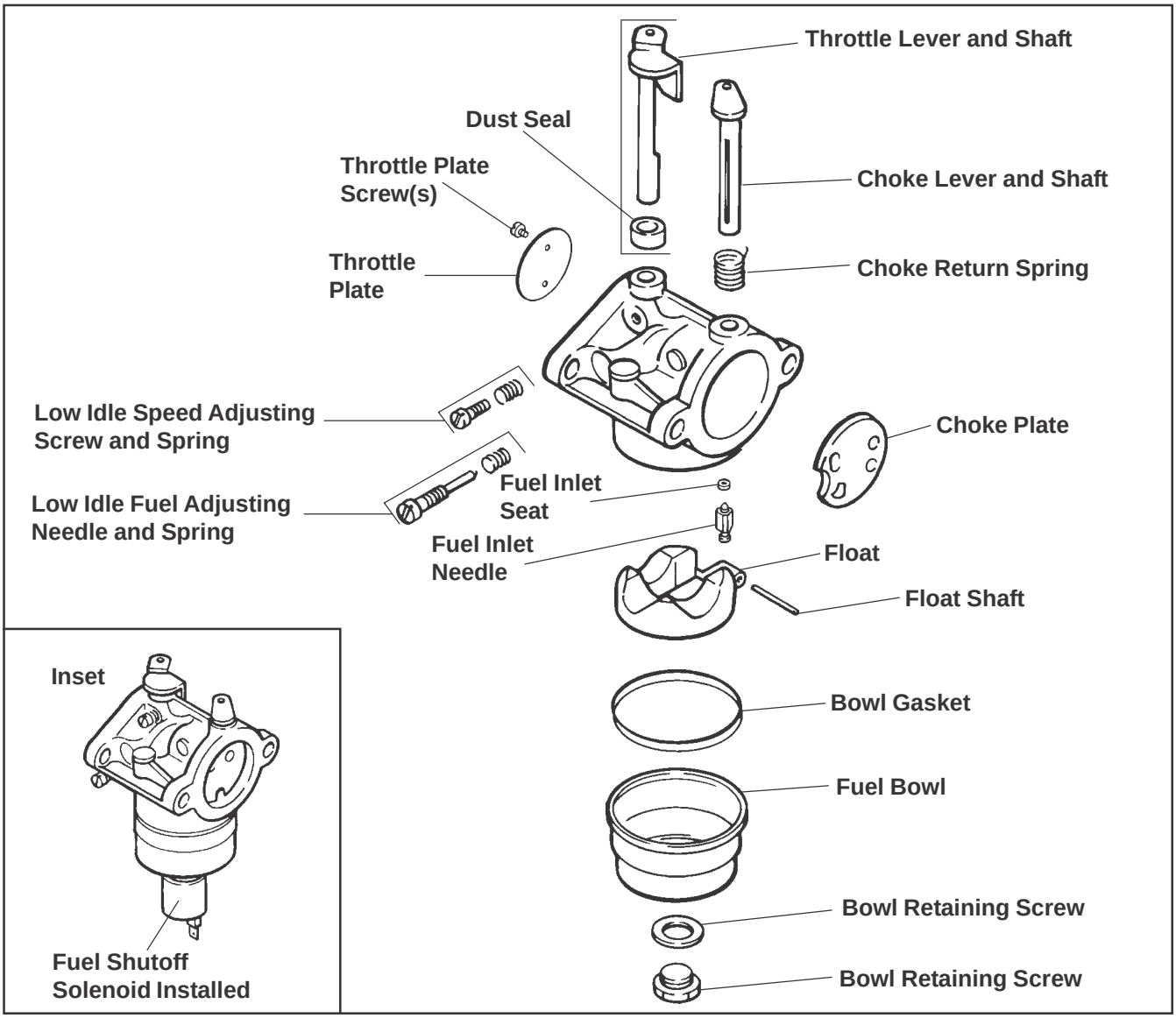


Figure 5-8. Adjustable Main Jet Carburetor - Exploded View.

Welch Plug Removal

In order to clean the "off-idle" ports and bowl vent thoroughly, remove the welch plug covering these areas.

Use Tool No. **KLR1018** and the following procedure to remove the welch plug. See Figure 5-9.

1. Pierce the welch plug with the tip of the tool.

   NOTE: To prevent damage to the carburetor, do not allow the tool to strike the carburetor body.

2. Pry out the welch plug with the tip of the tool.

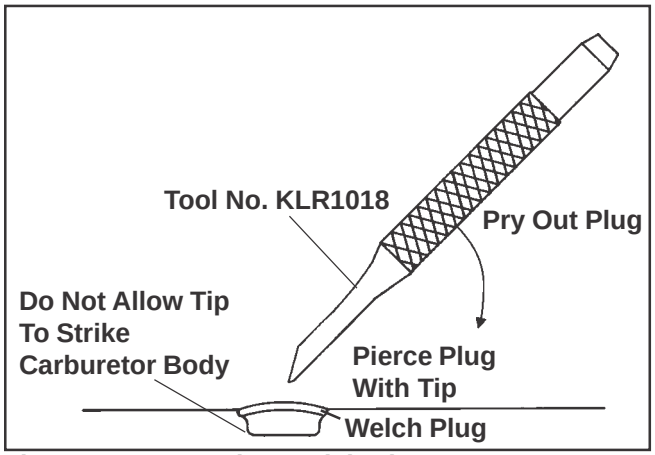


Figure 5-9. Removing Welch Plug.

Fuel Inlet Seat Removal

To remove the fuel inlet seat, pull it out of the carburetor body using a screw, drill bit, or similar tool.

NOTE: Always install a new fuel inlet seat. Do not reinstall a seat that has been removed.

Choke Shaft Removal

1. Because the edges of the choke plate are beveled, mark the choke plate and carburetor body to ensure correct reassembly. See Figure 5-10.

   Also take note of the choke plate position in bore, and the position of the choke lever and choke return spring.

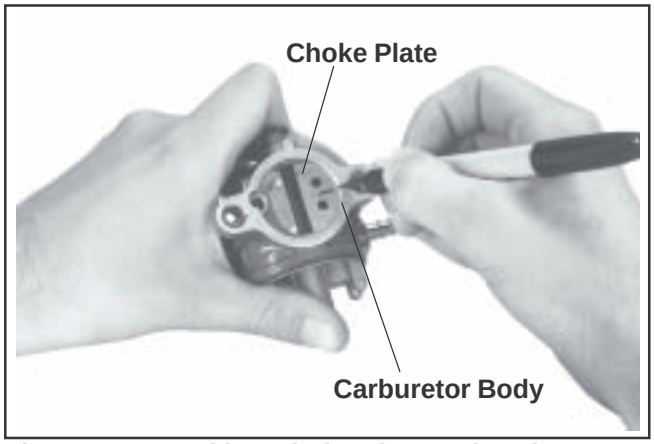


Figure 5-10. Marking Choke Plate and Carburetor Body.

2. Grasp the choke plate with a pliers. Pull it out of the slot in the choke shaft. See Figure 5-11.

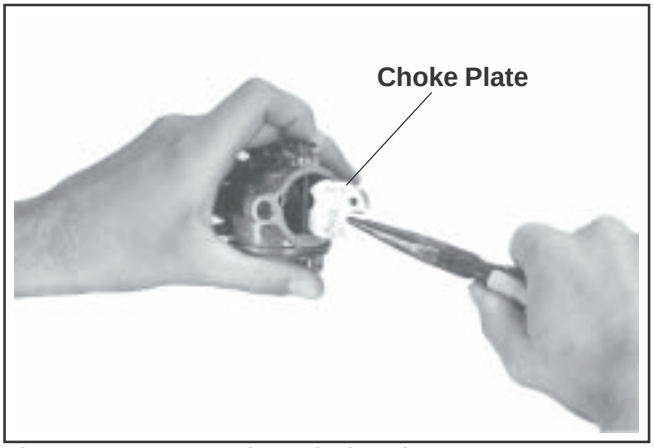


Figure 5-11. Removing Choke Plate.

3. Remove the choke shaft and choke return spring.

Throttle Shaft Removal

1. Because the edges of the throttle plate are beveled, mark the throttle plate and carburetor body to ensure correct reassembly.

   Also take note of the throttle plate position in bore, and the position of the throttle lever.

2. Carefully and slowly remove the screws securing the throttle plate to the throttle shaft. Remove the throttle plate.

3. File off any burrs which may have been left on the throttle shaft when the screws were removed. Do this **before** removing the throttle shaft from the carburetor body.

4. Remove the throttle lever/shaft assembly with foam dust seal.

Cleaning

WARNING: 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.

All parts should be cleaned thoroughly using a carburetor cleaner (such as acetone). Make sure all gum deposits are removed from the following areas:

- **Carburetor body and bore**; especially the areas where the throttle plate, choke plate and shafts are seated.
- Idle fuel and "off-idle" ports in carburetor bore, power screw, bowl vent, and fuel inlet needle and seat.

  NOTE: These areas can be cleaned with a piece of fine wire in addition to cleaners. Be careful not to enlarge the ports, or break the wire inside the ports. Blow out all passages with compressed air.
- Float and float hinge.
- Fuel bowl.
- Throttle plate, choke plate, throttle shaft, and choke shaft.

NOTE: Do not submerge the carburetor in cleaner or solvent when fiber, rubber, or foam seals or gaskets are installed. The cleaner may damage these components.

Inspection

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

- Inspect the carburetor body for cracks, holes, and other wear or damage.
- Inspect the float for cracks, holes, and missing or damaged float tabs. Check the float hinge and shaft for wear or damage.
- Inspect the fuel inlet needle and seat for wear or damage.
- Inspect the tip of the low idle fuel adjusting needle and power screw needle for wear or grooves.
- Inspect the throttle and choke shaft and plate assemblies for wear or excessive play.

Repair

Always use new gaskets when servicing or reinstalling carburetors. Repair kits are available which include new gaskets and other components.

Always refer to the Parts Manual for the engine being serviced to ensure the correct repair kits and replacement parts are ordered.

Reassembly

Throttle Shaft Installation

1. Install the foam dust seal on the throttle shaft.
2. Insert the throttle lever/shaft assembly into the carburetor body. Position the cutout portion of the shaft so it faces the carburetor mounting flange.
3. Install the throttle plate to the throttle shaft. Make sure the plate is positioned properly in the bore as noted and marked during disassembly. Apply **Loctite® No. 609** to the threads of the throttle plate retaining screws. Install the screws so they are slightly loose.

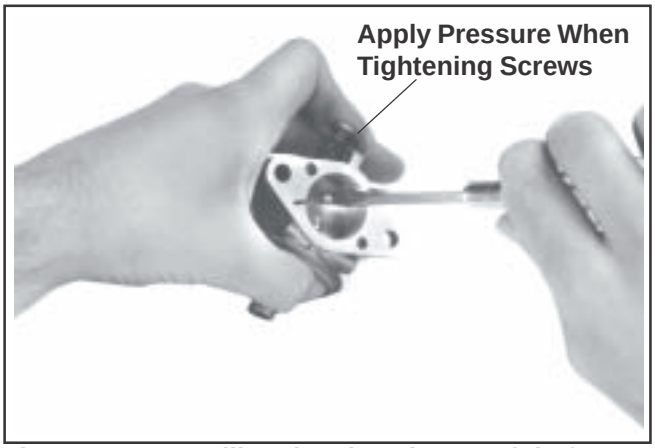


Figure 5-12. Installing the Throttle Lever/Shaft.

4. Apply finger pressure to the throttle lever/shaft to keep it firmly seated against the pivot in the carburetor body. Rotate the throttle shaft until the throttle plate closes the bore around its entire perimeter; then tighten the screws. See Figure 5-12.

5. Operate the throttle lever. Check for binding between the throttle plate and carburetor bore. Loosen the screws and adjust the throttle plate as necessary.

   Torque the screws to **0.9-1.4 N·m (8-12 in. lb.)**.

Choke Shaft Installation

1. Install the choke return spring to the choke shaft.

2. Insert the choke lever with return spring into the carburetor body.

3. Rotate the choke lever approximately 1/2 turn **counterclockwise**. Make sure the choke return spring hooks on the carburetor body.

4. Position the choke plate as noted and marked during disassembly. Insert the choke plate into the slot in the choke shaft. Make sure the choke shaft is locked between the tabs on the choke plate.

Fuel Inlet Seat Installation

Press the fuel inlet seat into the bore in carburetor body until it bottoms.

Welch Plug Installation

Use Tool KLR1019 and install new plugs as follows:

1. Position the carburetor body with the welch plug cavity to the top.

2. Place a new welch plug into the cavity with the raised surface **up**.

3. Use the end of the tool that is about the same size as the plug and **flatten** the plug. Do not force the plug below the surface of the cavity. See Figure 5-13.

4. After the plug is installed, seal it with glyptal (or an equivalent sealant). Allow the sealant to dry.

   NOTE: If a commercial sealant is not available, fingernail polish can be used.

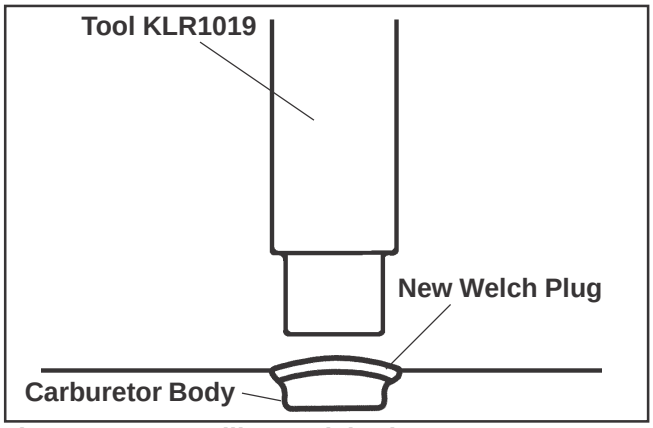


Figure 5-13. Installing Welch Plug.

Carburetor Reassembly

1. Install the low idle speed adjusting screw and spring.

2. **Non-Emission Compliant Carburetors Only -**

   a. Install the low idle fuel adjusting needle and spring. Turn the adjusting needle in (**clock wise**) until it bottoms lightly.

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

   b. Turn the low idle fuel adjusting needle **out** (counterclockwise) as specified in the "Adjustment" portion of this section.

3. Attach the fuel inlet needle to the float. Lower the float/needle into the carburetor body. See Figure 5-14.

4. Install the float shaft.

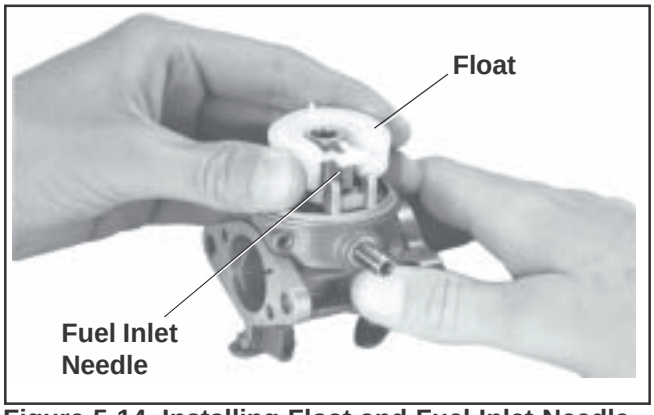


Figure 5-14. Installing Float and Fuel Inlet Needle.

5. Install the bowl gasket, fuel bowl, bowl retainer gasket, and bowl screw/shut-off solenoid/power screw, as equipped. Torque to: **5.1-6.2 N·m (45-55 in. lb.)**.

High Altitude Operation

When operating the engine at altitudes of 1830 m (6000 ft.) and above, the main fuel mixture tends to get overrich. An overrich mixture 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, a special high altitude main fuel jet can be installed. High altitude jets are sold in kits which include the jet and necessary gaskets. Refer to the parts manual for the engine being serviced for the correct kit number.

Fuel Shut-Off Solenoid

Some gasoline fueled engines are equipped with the optional fuel shutoff solenoid which is installed in place of the bowl retaining screw or main jet (power) screw, to eliminate backfiring when the engine is shut down. If backfiring occurs on engines equipped with this solenoid, check the battery first to insure that it is not discharged or faulty. A minimum of 7.3 volts D.C. is required to activate the solenoid. Also check to see that the ground lead from the carburetor body is properly connected to the carburetor mounting stud or the plated (silver) baffle screw. If these check out, the solenoid should be removed for bench testing. Remember to shut off fuel and catch any fuel spilling from the carburetor as the solenoid is removed.

Below is a simple test made with the engine off that can determine if the solenoid is functioning properly. Use a separate switched 12 volt power supply to test.

1. Shut off the fuel and remove the solenoid from the carburetor. When the solenoid is loosened and removed, gas will leak out of the carburetor. Have a container ready to catch the fuel.

2. Blow/clean off solenoid using clean, compressed air.

CAUTION

Do this test away from any fuel/vapors to prevent an accident.

3. Attach a jumper wire with alligator clips between the solenoid black ground lead and the ground lead/location of the switched 12 volt power supply.

4. With the switched 12 volt power supply "off", insert a 1/4 male spade terminal into the terminal end of the red power lead. Connect the exposed terminal to the positive (+) power supply lead/connection.

5. Turn "on" the power supply. If the pin of the solenoid retracts the solenoid is good. Perform test (switch off-on), a minimum of 6 times to verify operating performance.

Self-Relieving Choke Service

On carburetors featuring the self-relieving choke, as shown in cutaway of Figure 5-15, the choke plate is secured to the choke shaft with two screws. On carburetors without this feature, the choke plate fits into a slot in the shaft. Use the following procedure to replace the self-relieving choke components using Choke Repair Kit No. **12 757 11** for gasoline carburetors.

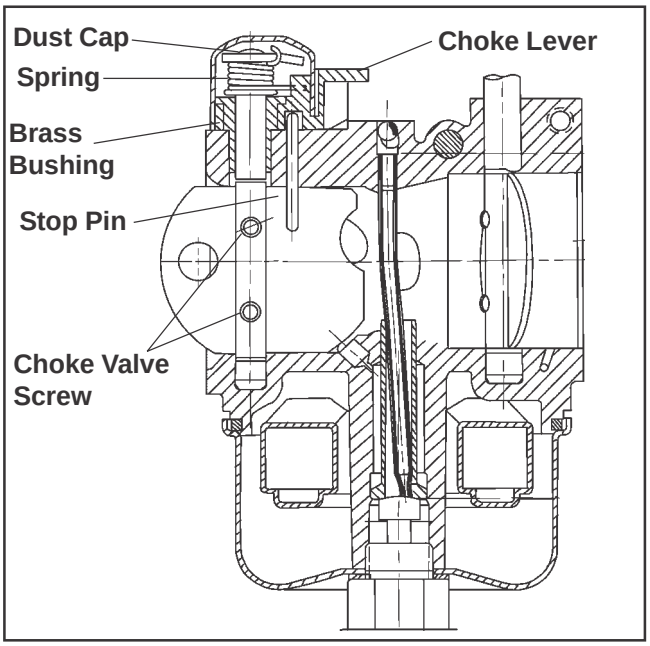


Figure 5-15. Cutaway View Showing Self-Relieving Choke Carburetor.

Removing Old Parts

1. Remove the black dust cover. This cover snaps on and off.

2. Remove and discard the two screws fastening the choke plate to the choke shaft.

3. Remove and discard the choke plate and choke shaft from the carburetor.

4. Remove the upper brass bushing using one of the following procedures:

   a. Use a slide hammer type bearing puller.

   b. Use a #3 (for 5-32 dia. hole) screw extractor. Secure extractor in a vise. Turn carburetor on to the extractor. While pulling on the carburetor, lightly tap the carburetor casting with a hammer or use a size 12-28 tap if a #3 screw extractor is not available.

Installing Kit Parts

WARNING: Prevent Eye Injury!

Suitable eye protection (safety glasses, goggles, or face shield) should be worn for any procedure involving the use of compressed air, punches, hammers, chisels, drills, or grinding tools.

1. Before installing kit parts, thoroughly clean the carburetor body with compressed air.

2. Install the new bushing through the new lever and align the slot in the bottom of the lever over the lever stop pin. To insure the proper alignment of the upper bushing and the lower shaft hole use a 3/16 diameter drill blank to align the bushing as it is pressed into the casting.

3. Install choke shaft and spring assembly with the lower spring tang installed in the second notch from the right. See Figure 5-16.

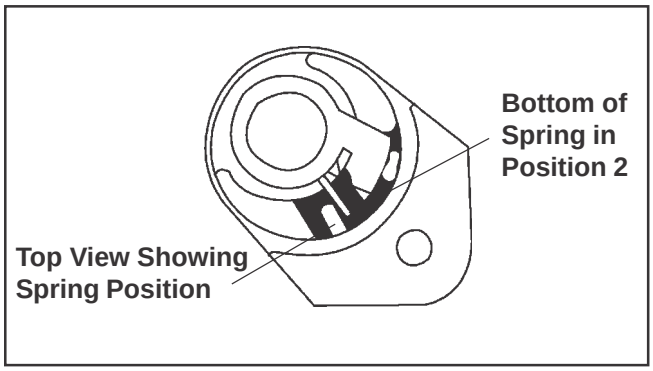


Figure 5-16. Choke Lever with Cap Removed.

4. Loosely attach the choke plate to the choke shaft using the two screws provided in the choke repair kit. Apply Loctite® No. 609 to the threads of the choke plate retaining screws. Secure these screws ONLY after the choke plate is properly aligned in the choke plate bore. To align choke plate, insert a 0.010 in. shim between the top right edge of the choke plate and bore. See Figure 5-17. Then while pushing down on the top of the choke shaft, tighten screws securely.

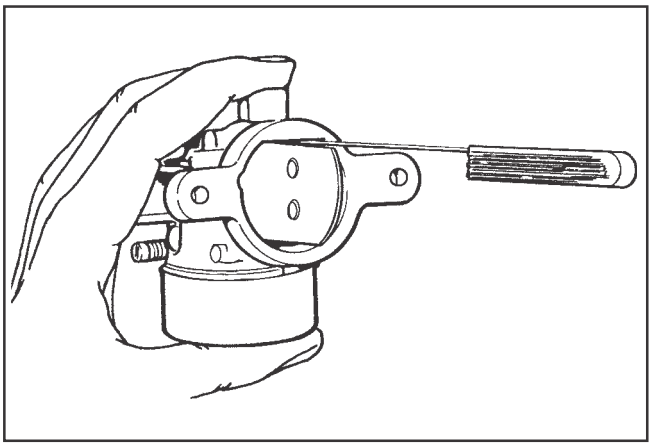


Figure 5-17. Measuring Clearance (Air Cleaner Removed For Clarity).

5. Check choke shaft and choke plate for freedom of movement by performing the following:

   a. Using the choke lever, close the choke plate. The choke lever and choke plate should move in unison.

   b. While holding the choke lever in the closed position, push on the long side of the choke plate. The choke plate should open and spring closed freely.

   c. While holding the choke lever in the wide open position, the choke plate should be against the wide open choke plate stop pin.

6. Install new dust cover by pushing it down until it snaps into place.

7. After the carburetor is reinstalled on the engine, recheck choke system for freedom of movement by moving the wire link in the direction to close the choke the wire link in the direction to close the choke and releasing it. The link should move freely in both directions.

Governor

These engines are equipped with a centrifugal flyweight mechanical governor. It is designed to hold the engine speed constant under changing load conditions. The governor gear/flyweight mechanism is mounted inside the crankcase and is driven off the gear on the camshaft.

Operation

Centrifugal force acting on the rotating governor gear assembly causes the flyweights to move outward as speed increases and 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 when the engine speed changes. One end of the cross shaft protrudes through the side of the crankcase. Through external linkage attached to the cross shaft, the rotating action is transmitted to the throttle lever of the carburetor.

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 are in ''equilibrium'' during operation, holding the engine speed constant.

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 engine speed. This action takes place very rapidly, so a reduction in speed is hardly noticed. As the speed reaches the governed setting, the governor spring tension and the force applied by the regulating pin will again be in equilibrium. This maintains the engine speed at a relatively constant level.

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

Initial Adjustment

Make this initial adjustment whenever the governor arm is loosened or removed from the cross shaft. To ensure proper setting, make sure the throttle linkage is connected to the governor arm and the throttle lever on the carburetor. The carburetor and air cleaner should be positively secured on the mounting studs, eliminating any possible movement when adjustment is being made. See Figure 5-18.

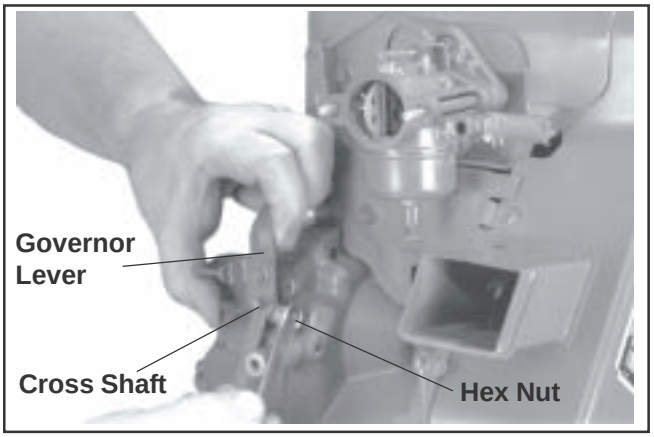


Figure 5-18. Governor Adjustment (Air Cleaner Removed for Clarity).

1. Pull the governor lever away from the carburetor (wide open throttle).

2. Insert a nail in the cross shaft hole or grasp the cross shaft flats with a pliers and turn the shaft **counterclockwise** as far as it will go.

3. Tighten the hex nut securely.

Sensitivity Adjustment

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

Remote Throttle and Choke Adjustment

1. Adjust the throttle lever. See this section.

2. Install remote throttle cable in hole in the throttle lever. See Figure 5-19.

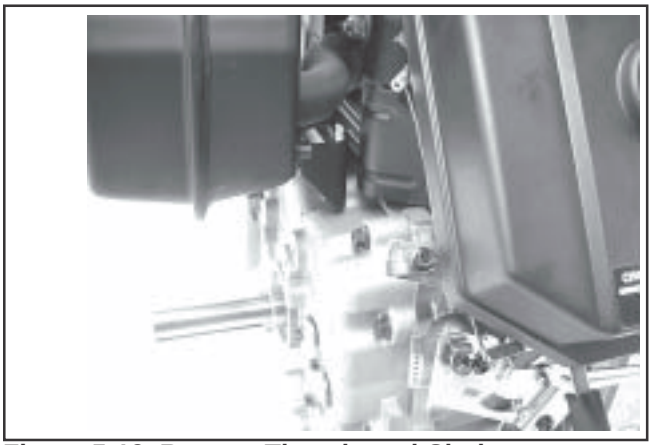


Figure 5-19. Remote Throttle and Choke Adjustment.

3. Install remote choke cable in hole in the choke lever.

4. Secure remote cables loosely with the cable clamps.

5. Position the throttle cable so that the throttle lever is against stop.

6. Tighten the throttle cable clamp.

7. Position the choke cable so that the carburetor choke plate is fully closed.

8. Tighten the choke cable clamp.

9. Check carburetor idle speed. See Adjusting Carburetor in this section.

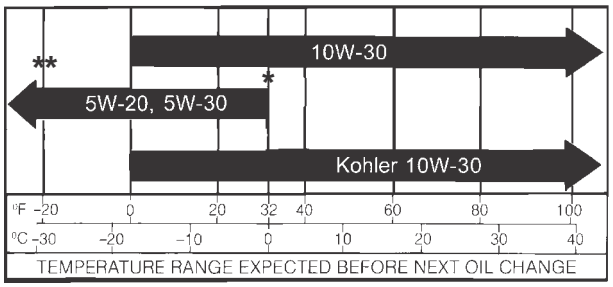
Section 6
Lubrication System

Oil Recommendations

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

Oil Type

Use high-quality detergent oil of **API (American Petroleum Institute) service class 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.

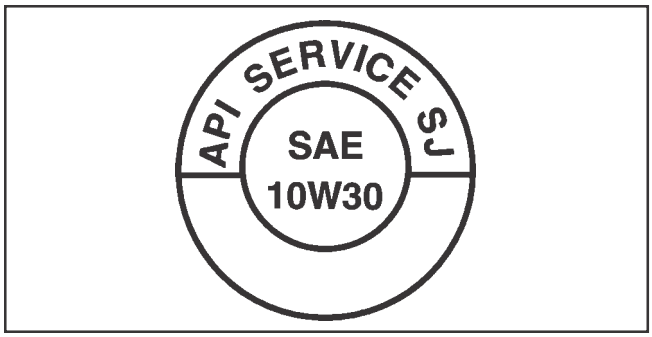


Figure 6-1. Oil Container Logo.

6

Check Oil Level

1. Make sure the engine is stopped, level, and is cool so the oil has had time to drain into the sump.

2. To keep dirt, grass clippings, etc., out of the engine, clean the area around the oil fill cap/ dipstick before removing it.

3. Remove the oil fill cap/dipstick; wipe oil off.

   For engines with a press-on style dipstick: Reinsert the dipstick into the tube and press onto the tube See Figure 6-2 (A).

   For engines with a thread-on style dipstick: Reinsert the dipstick into the tube and rest the oil fill cap on the tube. Do not thread the cap onto the tube. See Figure 6-2 (B).

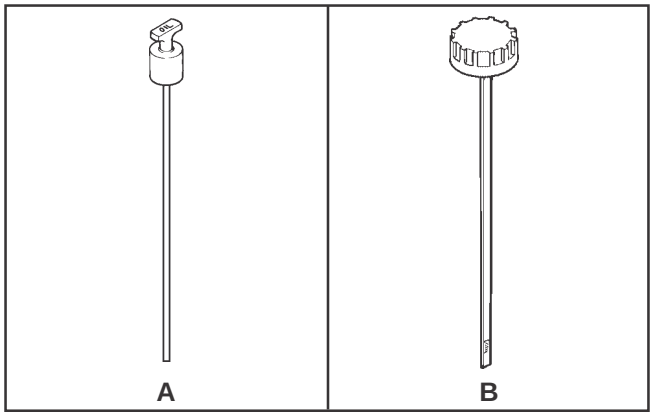


Figure 6-2. Checking Oil Level.

4. Remove the dipstick and check the oil level.

   The oil level should be up to, but not over, the "F" mark on the dipstick. See Figure 6-3.

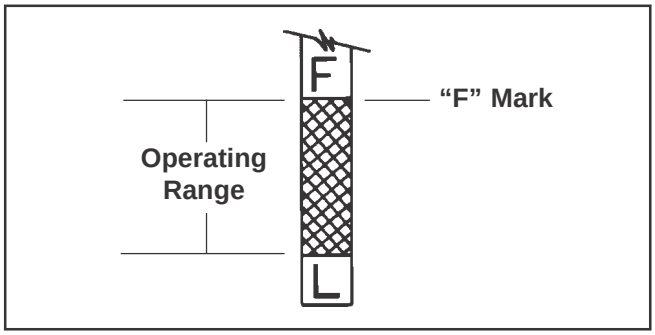


Figure 6-3. Oil Level Dipstick.

5. If the level is low, add oil of the proper type, up to the "F" mark on the dipstick. Always check the level with the dipstick before adding more oil.

   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 over the "F" mark on the dipstick.

Oil Sentry™

Some engines are equipped with an optional Oil Sentry™ oil pressure monitor. If the oil pressure gets low, Oil Sentry™ will either shut off the engine or activate a warning signal, depending on the application.

Change Oil and Oil Filter

Change Oil

Change oil after every **100 hours** of operation. Refill with service class SG, SH, SJ, or higher oil as specified in the "Viscosity Grades" table.

Change the oil as follows:

1. Run engine until warm.

2. Remove the oil drain plug and oil fill cap/dipstick. Be sure to allow ample time for complete drainage.

3. Make sure the engine is level when filling, checking, and changing the oil.

4. Reinstall the drain plug. Make sure it is tightened to**7.3-9.0 N·m (65-80 in. lb.)** torque.

5. Fill the crankcase, with new oil of the proper type, to the "F" mark on the dipstick. Always check the level with the dipstick before adding more oil.

6. Reinstall the oil fill cap/dipstick.

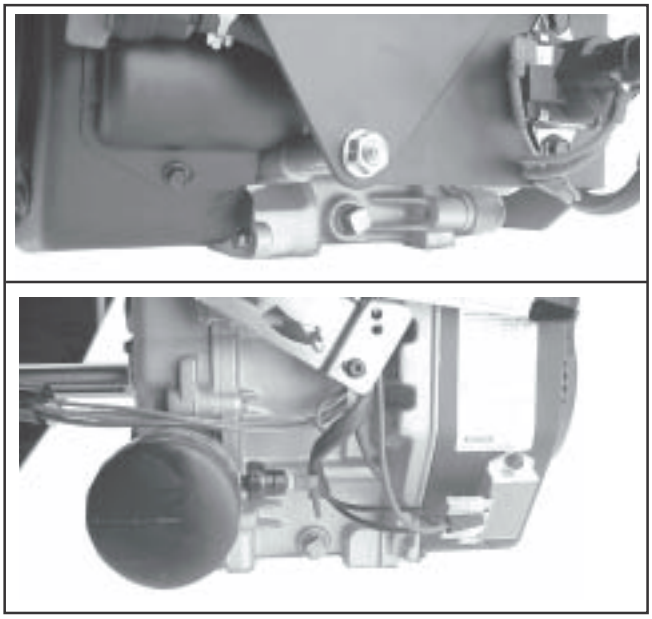


Figure 6-4. Oil Drain Plug Locations, Oil Filter, and Optional Oil Sentry™ Switch.

Oil Filter

These engines are equipped with a full-flow oil filter. See Figure 6-5.

The oil filter helps remove sludge and other combustion by-products from the oil. It also extends the oil change interval and cools the oil.

Figure 6-4. Oil Filter and Oil Sentry™.

Change Oil Filter

Replace the oil filter **at least every other oil change (every 200 hours of operation)**. Always use a genuine Kohler oil filter. Replace the oil filter as follows.

1. Drain the oil from the engine crankcase.
2. Allow the oil filter to drain.
3. Before removing the oil filter, clean the area around the oil filter to keep dirt and debris out of the engine. Remove the old oil filter. Wipe off the surface where the oil filter mounts.
4. Place a new replacement filter in a shallow pan with the open end up. Pour new oil of the proper type in through the threaded center hole. Stop pouring when the oil reaches the bottom of the threads. Allow a minute or two for the oil to be absorbed by the filter material.
5. Apply a thin film of clean oil to the rubber gasket on the new filter.
6. Install the replacement oil filter. Tighten the oil filter until the rubber gasket contacts the filter adapter, then turn the filter an additional **3/4 to 1 turn**.
7. Reinstall the drain plug and torque it to **7.3-9.0 N·m (65-80 in. lb.)**.
8. Fill the crankcase with new oil of the proper type to the "F" mark on the dipstick.
9. Start the engine and check for oil leaks. Correct any leaks before returning the engine to service. Check oil level to be sure it is up to but not over the "F" mark.

Full Pressure Lubrication System

Operation

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

A high efficiency Gerotor™ oil pump is located in the closure plate and is driven directly by the balance shaft. The oil pump maintains high oil flow and oil pressure, even at low speeds and high operating temperatures. A pressure relief valve in the closure plate limits the maximum pressure of the system.

For a cold engine at start up, the oil pressure can reach up to 60 psi. For a warm engine (normal operating temperature), at idle speed, the oil pressure can go down to 12 psi.

Service

Remove the oil pump cover on the PTO side of the closure plate to service the rotors.

The closure plate must be removed to service the oil pickup and oil pressure relief valve.

See Figures 6-6, 6-7, 6-8, and 6-9. Also refer to the Disassembly and Reassembly sections for lubrication system components removal and installation procedures.

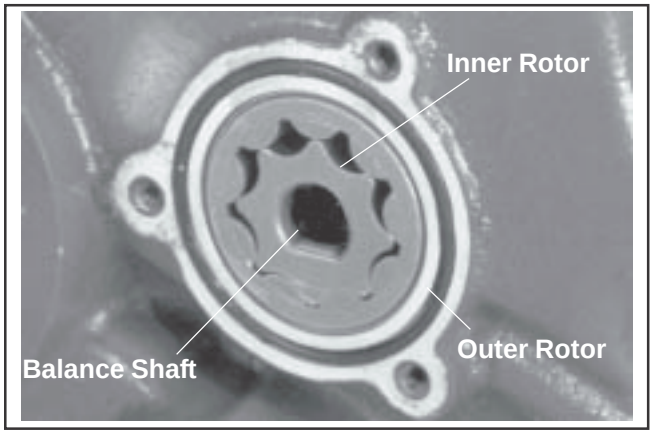


Figure 6-6. Gerotor™ Oil Pump.

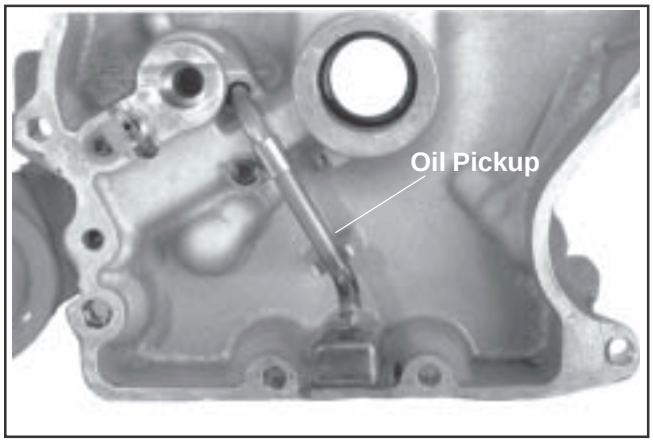


Figure 6-7. Oil Pickup.

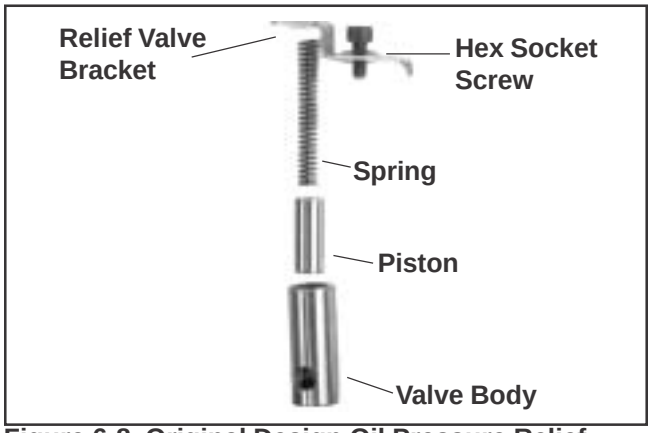


Figure 6-8. Original Design Oil Pressure Relief.

Figure 6-9. New Relief Valve.

Oil Sentry™ Oil Pressure Monitor

Some engines are equipped with an optional Oil Sentry™ oil pressure monitor. See Figure 6-5. Oil Sentry™ will either stop the engine or activate a "low oil" warning light, if the oil pressure gets low. Actual Oil Sentry™ use will depend on the engine application.

Operation

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 be used to activate a low oil warning light.

NOTE: Oil Sentry™ is not a substitute for checking the oil level BEFORE EACH USE. Make sure the oil level is maintained up to the "F" mark on the dipstick.

Installation

The pressure switch is installed in the oil filter adapter, in one of the main oil galleries of the closure plate see Figure 6-5. On engines not equipped with Oil Sentry™, the installation hole is sealed with a 1/8-27 N.P.T.F. pipe plug.

1. Apply **Loctite® No. 592 pipe sealant with Teflon®** (or equivalent) to the threads of the switch.

2. Install the switch into the tapped hole in oil filter adapter.

3. Torque the switch to **6.8 N·m (60 in. lb.)**.

Testing

The Oil Sentry™ pressure monitor is a normally closed type switch. It is calibrated to open (break contact) with increasing pressure and close (make contact) with decreasing pressure within the range of **3.0/5.0 psi**.

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 switch. With 0 psi pressure applied to the switch, the tester should indicate continuity (switch closed).

2. Gradually increase the pressure to the switch. The tester should indicate a change to no continuity (switch open) as the pressure increases through the range of 3.0/5.0 psi.

   The switch should remain open as the pressure is increased to 90 psi maximum.

3. Gradually **decrease** the pressure to the switch. The tester should indicate a change to continuity (switch closed) as the pressure decreases through the range of 3.0/5.0 psi; approaching 0 psi.

   If the switch does not operate as specified, replace the switch.

Reduction Gear Units

On engines with a reduction gear unit, remove the oil plug on the lower part of cover every **50 hours** of operation to check oil level. With the engine level, the oil level of the unit should be up to the bottom of the oil plug hole. To add oil, remove the vented plug at the top of the unit. Use AGMA No. 7 EP oil in the reduction gear unit. Following are a few products that meet this spec:

Mobilgear 634
Pennzoil Super Maxol "S"
Pennzoil Maxol EP Gear Oil
Pennzoil Super Maxol EP Gear Oil
Pennzoil Super Pennztac EP Gear Oil

Section 7
Retractable Starter

WARNING: Spring Under Tension!

Retractable starters contain a powerful, recoil spring that is under tension. Always wear safety goggles when servicing retractable starters and carefully follow instructions in this section for relieving spring tension.

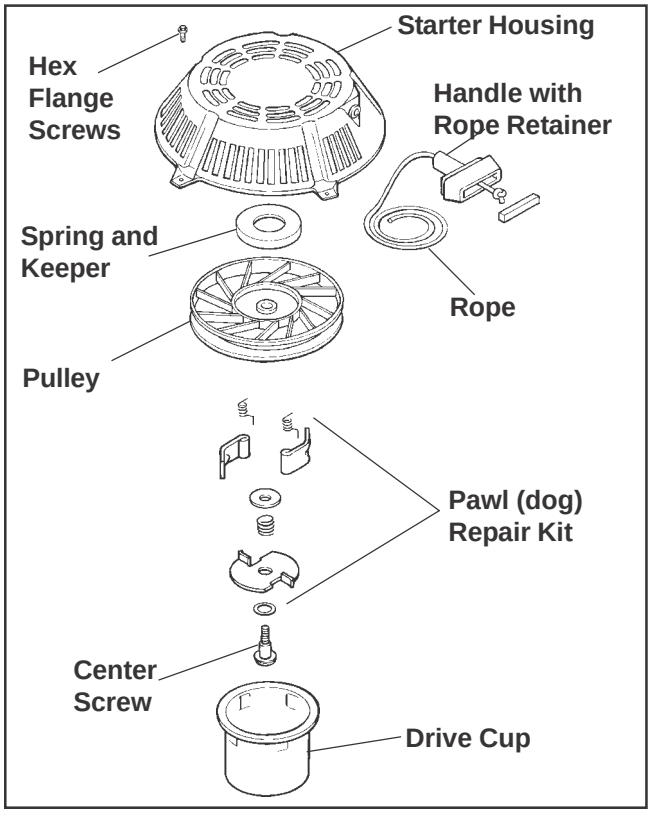


Figure 7-1. Retractable Starter - Exploded View.

Starter Removal

1. Remove the five hex flange screws securing the starter to the blower housing.

2. Remove the starter.

Starter Installation

1. Install the retractable starter and five hex flange screws to the blower housing. Leave the screws slightly loose.

2. Pull the starter handle out until the pawls engage in the drive cup. Hold the handle in this position and tighten the screws securely. See Figure 7-2.

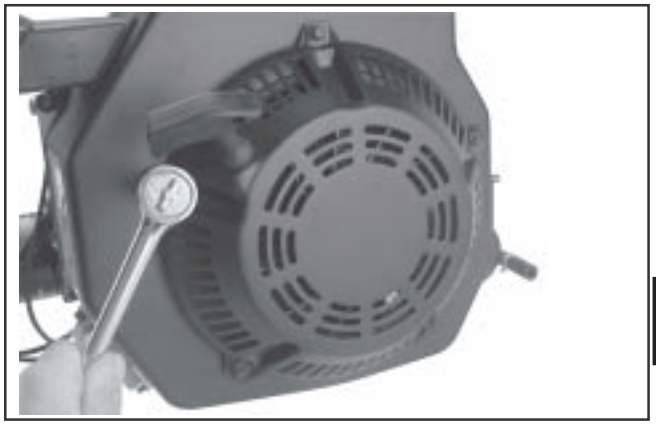


Figure 7-2. Removing Retractable Starter.

Rope Replacement

The rope can be replaced *without* complete starter disassembly.

1. Remove the starter from the engine blower housing.

2. Pull the rope out approximately 12" and tie a temporary (slip) knot in it to keep it from retracting into the starter. See Figure 7-3.

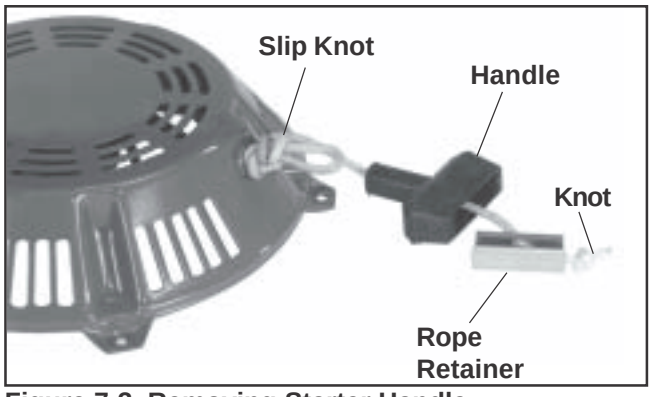


Figure 7-3. Removing Starter Handle.

3. Remove the rope retainer from inside the starter handle. Untie the single knot and remove the rope retainer and handle.

4. Hold the pulley firmly and untie the slip knot. Allow the pulley to rotate slowly as the spring tension is released.

5. When all spring tension on the starter pulley is released, remove the rope from the pulley.

6. Tie a single knot in one end of the new rope.

7. Rotate the pulley counterclockwise (when viewed from pawl side of pulley) until the spring is tight. (Approximately 6 full turns of pulley.)

8. Rotate the pulley clockwise until the rope hole in pulley is aligned with rope guide bushing of starter housing.

   NOTE: Do not allow the pulley/spring to unwind. Use a C-clamp to hold the pulley in position.

9. Insert the new rope through the rope hole in starter pulley and rope guide bushing of housing. See Figure 7-4.

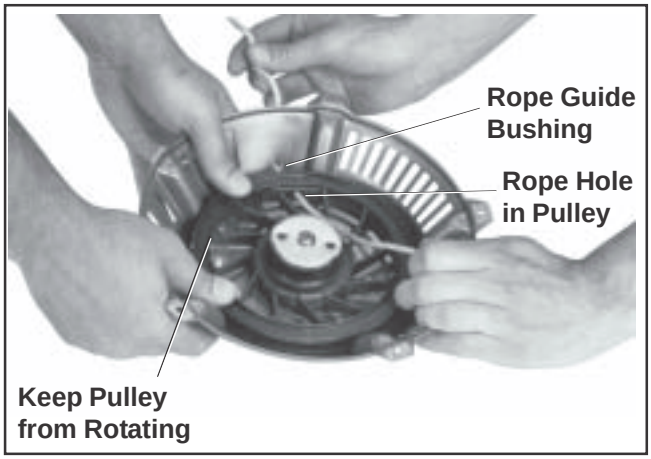


Figure 7-4. Installing Rope.

10. Tie a slip knot approximately 12" from the free end of rope. Hold the pulley firmly and allow it to rotate slowly until the slip knot reaches the guide bushing of housing.

11. Slip the handle and rope retainer onto the rope. Tie a single knot at the end of the rope. Install the rope retainer into the starter handle.

12. Untie the slip knot and pull on the handle until the rope is fully extended. Slowly retract the rope into the starter.

13. When the spring is under proper tension, the rope will retract fully and the handle will stop against the starter housing.

Pawls (Dogs) Replacement

The starter must be completely disassembled to replace the starter pawls. A pawl repair kit is available which includes the following components:

Pawl Repair Kit Contains:

Qty	Description
1	Pawl Retainer
1	Center Screw
1	Pawl (Dog) Spring
1	Brake Spring
1	Starter Pawl (Dog)
1	Brake Washer
1	Washer

Disassembly

WARNING: Spring Under Tension!

Do remove the center screw from starter until the spring tension is released. Removing the center screw before releasing spring tension, or improper starter disassembly, can cause the sudden and potentially dangerous release of the spring. Follow these instructions carefully to ensure personal safety and proper starter disassembly. Make sure adequate face protection is worn by all persons in the area.

1. Release spring tension and remove starter rope (refer to "Rope Replacement", steps 2 through 5).

2. Remove the center screw, washer, and pawl retainer. See Figure 7-5.

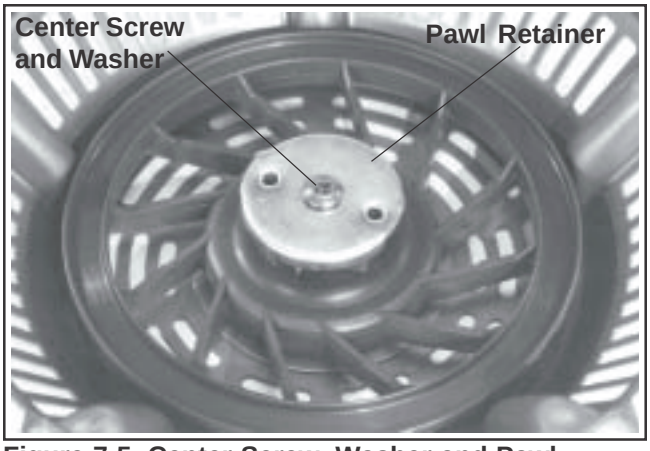


Figure 7-5. Center Screw, Washer and Pawl Retainer.

3. Remove the brake spring and brake washer. See Figure 7-6.

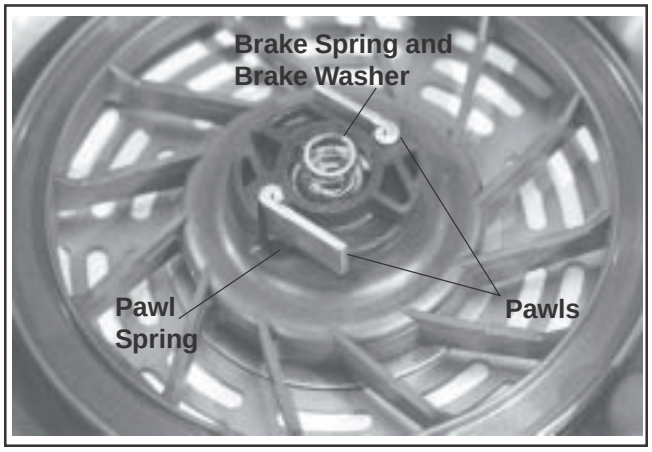


Figure 7-6. Brake Spring and Washer, Pawls, and Pawl Springs.

4. Carefully note the positions of the pawls and pawl springs before removing them.

5. Remove the pawls and pawl springs from the starter pulley.

6. Rotate the pulley **clockwise 2 full turns**. This will ensure the spring is disengaged from the starter housing.

7. Hold the pulley into the starter housing. Invert the pulley/housing so the pulley is away from your face, and away from others in the area.

8. Rotate the pulley slightly from side to side and carefully separate the pulley from the housing. See Figure 7-7.

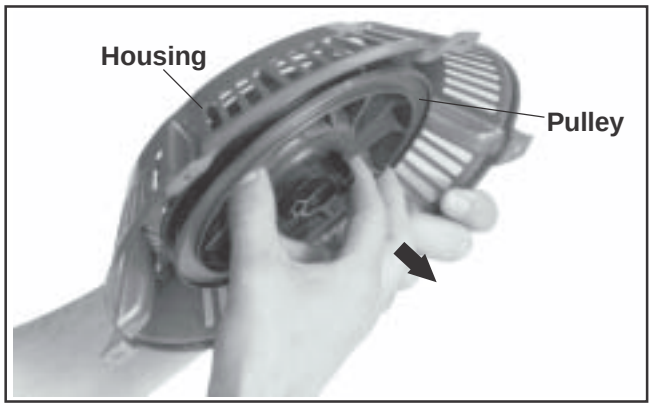


Figure 7-7. Removing Pulley from Housing.

If the pulley and the housing do not separate easily, the spring could be engaged in the starter housing, or there is still tension on the spring. Return the pulley to the housing and repeat step 5 before separating the pulley and housing.

9. Note the position of the spring and keeper assembly in the pulley. See Figure 7-8.

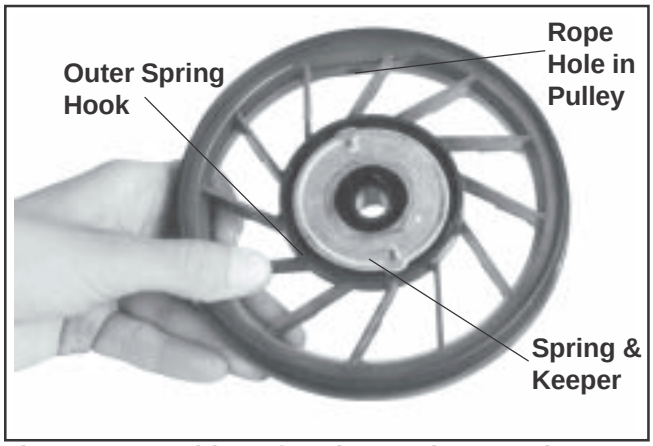


Figure 7-8. Position of Spring, and Keeper in Pulley.

10. Remove the spring and keeper assembly from the pulley as a package.

⚠ CAUTION: Spring Under Tension!

Do not remove the spring from the keeper. Severe personal injury could result from the sudden uncoiling of the spring.

7

Inspection and Service

1. Carefully inspect the rope, pawls, housing, center screw, and other components for wear or damage.

2. Replace all worn or damaged components. Use only genuine Kohler replacement parts as specified in the Parts Manual. All components shown in Figure 7-1, are available as service parts. Do not use nonstandard parts.

3. Do not attempt to rewind a spring that has come out of the keeper. Order and install a new spring and keeper assembly.

4. Clean all old grease and dirt from the starter components.

Reassembly

1. Make sure the spring and center shaft are lubricated with grease. Place the spring and keeper assembly inside the pulley (with spring toward pulley). See Figure 7-8.

2. Install the pulley with spring and keeper assembly into the starter housing. See Figure 7-9.

3. Make sure the pulley is fully seated against the starter housing. Do not wind the pulley and recoil spring at this time.

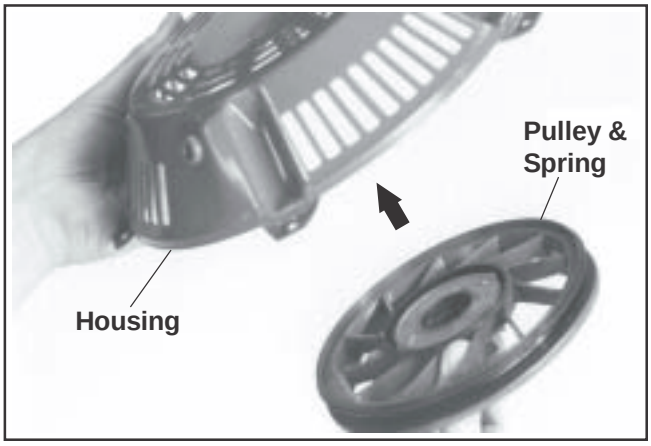


Figure 7-9. Installing Pulley and Spring into Housing.

4. Install the pawl springs and pawls into the starter pulley. See Figure 7-10.

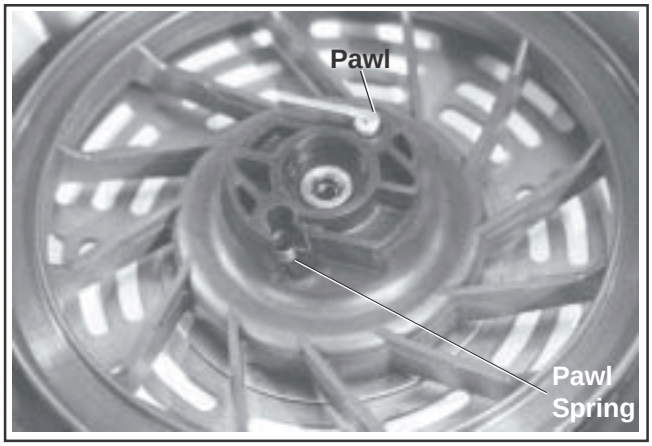


Figure 7-10. Installing Pawls and Pawl Springs.

5. Place the brake washer in the recess in starter pulley; over the center shaft.

6. Lubricate the brake spring sparingly with grease. Place the spring on the plain washer. (Make sure the threads in center shaft remain clean, dry, and free of grease and oil.) See Figure 7-6.

7. Apply a small amount of **Loctite® No. 271** to the threads of the center screw. Install the center screw, with washer and retainer, to the center shaft. Torque the screw to **7.4-8.5 N·m (65-75 in. lb.)**.

8. Tension the spring and install the rope and handle as instructed in steps 6 through 12 under "Rope Replacement."

9. Install the starter to the engine blower housing. See Figure 7-11.

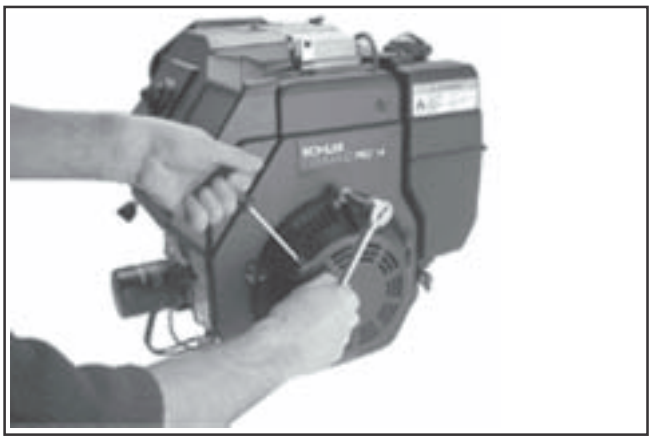


Figure 7-11.

Section 8
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 Plug
- Battery and Charging System
- Electronic CD Ignition System
- Electric Starter

Spark Plug

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

This engine is equipped with the following spark plug:

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

Gap: CH11-15 1.02 mm (0.040 in.)
CH16 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

Service the spark plug every **200 hours** of operation.

1. Before removing the 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. Replace the plug if worn or reuse is questionable.

   NOTE: Do not clean the 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 by carefully bending the ground electrode. See Figure 8-1. Gap CH11-15 plugs to **1.02 mm (0.040 in.)**. Gap CH16 plugs to **0.76 mm (0.030 in.)**.

   NOTE: LP equipped engines should have a spark plug gap of 0.4572 (0.018 in.).

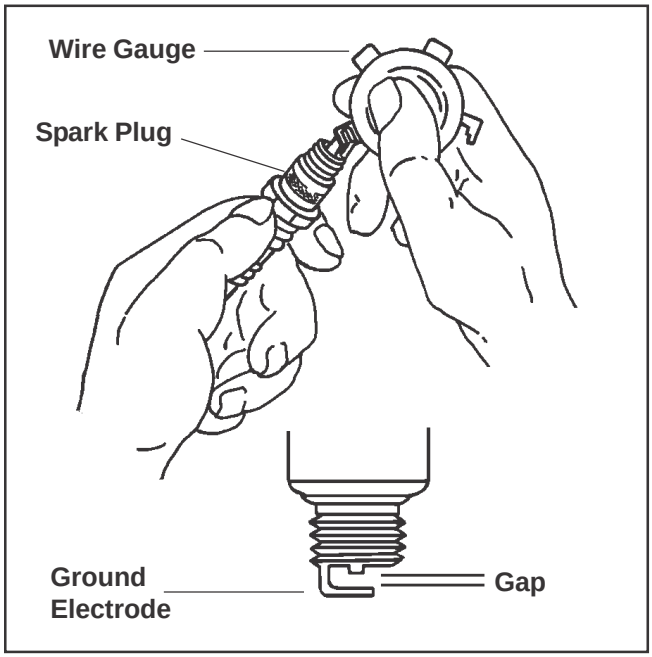


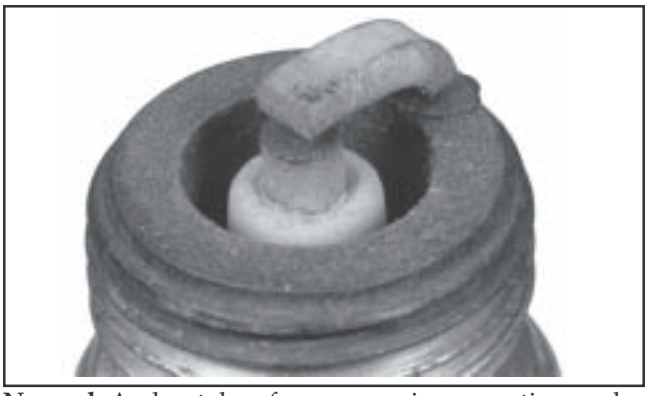
Figure 8-1. Servicing Spark Plug.

4. Reinstall the spark plug into the cylinder head. Torque the spark plug to **38.0-43.4 N·m (28-32 ft. lb.)**.

Inspection

Inspect the spark plug when 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 regapped and reused.

Carbon Fouled: Soft, sooty, black deposits indicate incomplete combustion. Incomplete combustion is usually caused by overrich carburetion, weak ignition, or poor compression.

Worn: On a worn plug, the center electrode will be rounded and the gap will be eroded .010" or more than the correct gap.

Wet Fouled: A wet plug is caused by excess fuel, or oil in the combustion chamber. Excess fuel could be caused by operating the engine with too much choke. Oil in the combustion chamber is usually caused by worn piston rings or valve guides.

Chalky White Deposits: Chalky white colored deposits indicate overheating. This condition is usually accompanied by excessive gap erosion. A clogged grass screen, clogged cooling fins, and lean carburetion are some causes of overheating.

Battery

General

A 12 volt battery with a rating of approximately 32 amp hours/250 cold cranking amps is normally used. Refer to the operating instructions of the equipment this engine powers for specific information.

Recharge the battery if the charge is not sufficient to crank the engine.

NOTE: Do not attempt to jump start the engine with another battery. Starting the engine with batteries larger than those recommended can burn out the starter motor.

Battery Maintenance

Regular maintenance will ensure the battery will accept and hold a charge.

WARNING: Dangerous Acid, Explosive Gases!

Batteries contain sulfuric acid. To prevent acid burns, avoid contact with skin, eyes, and clothing. 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.

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 battery clean. A build-up of corrosive acid or grime on the external surfaces can self-discharge the battery. Self-discharging happens rapidly when moisture is present.

3. Wash the cables, terminals, and external surfaces with a 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

Test the battery voltage by connecting a DC voltmeter across the battery terminals - crank the engine. If the battery drops below 9 volts while cranking, the battery is discharged or faulty. Refer to Figure 8-2.

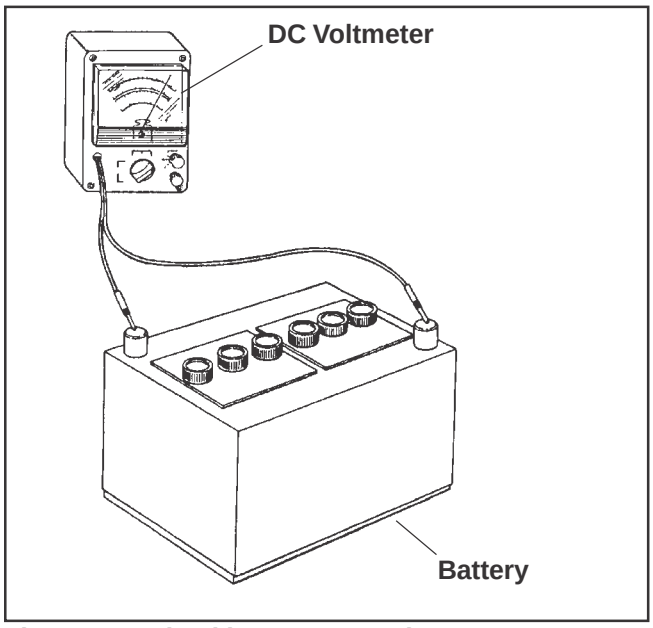


Figure 8-2. Checking Battery Voltage.

Electronic Magneto Ignition System, CH11-15 Engines

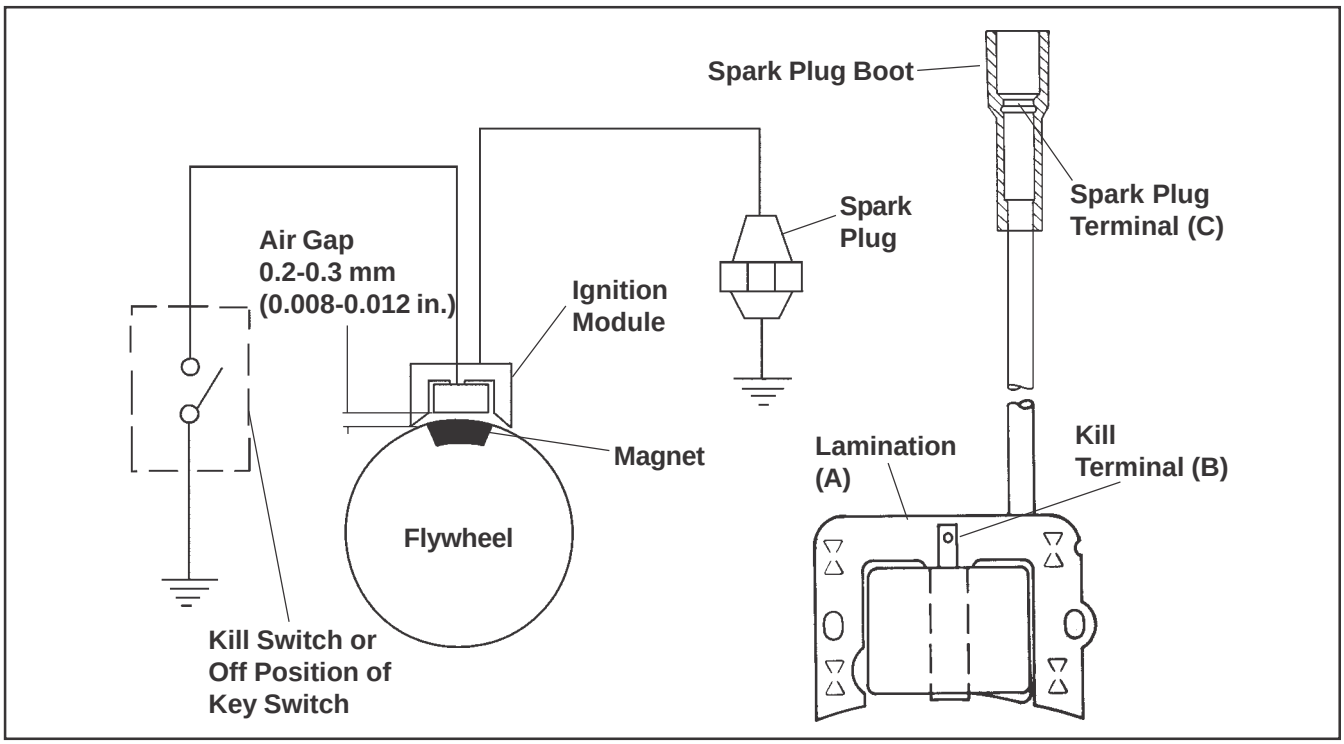


Figure 8-3. Electronic Magneto Ignition System, CH11-15 Engines.

These engines are equipped with a dependable electronic magneto ignition system. The system consists of the following components:

- A magnet assembly which is permanently affixed to the flywheel.
- An electronic magneto ignition module which mounts on the engine crankcase.
- A kill switch (or key switch) which grounds the module to stop the engine.
- A spark plug.

Operation

As the flywheel rotates and the magnet assembly moves past the ignition module, a low voltage is induced in the primary windings of the module. When the primary voltage is precisely at its peak, the module induces a high voltage in its secondary windings. This high voltage creates a spark at the tip of the spark plug. This spark ignites the fuel-air mixture in the combustion chamber.

The timing of the spark is automatically controlled by the module. Therefore, other than periodically checking/replacing the spark plug, no maintenance, timing, or adjustments are necessary or possible with this system.

In the event starting problems should occur which are not corrected by replacing the spark plug, refer to the following Troubleshooting Guide for trouble analysis procedures.

Magneto Ignition System Troubleshooting Guide

The following guide will help locate and correct ignition system-related starting problems. Refer to Section 2, "Tools & Aids" for ignition system tester.

NOTE: Use a low-voltage (2 volts or less) ohmmeter when ohmmeter is required. Always zero ohmmeter on each scale before testing to ensure accurate readings.

Problem	Test	Conclusion
Engine Will Not Start	1. Make sure the spark plug lead is connected to the spark plug.	
	2. Check the condition of spark plug. Make sure gap is set correctly. See Page 8.1.	2. If plug is in good condition, check/adjust gap and reinstall.
	3. Check ignition module using test plug. (Refer to Section 2 - "Tools & Aids)." a. Remove the high-tension lead from the engine spark plug and connect it to the test plug. **NOTE:** To maintain engine speeds normally obtained during cranking, do not remove the engine spark plug. b. Make sure the engine ignition switch, kill switch, or key switch is in the **run** position. c. Crank the engine and observe the test plug. Visible and audible sparks should be produced.	3. If visible and audible sparks **are** produced, the ignition module is OK. If visible and audible sparks **are not** produced: a. Make sure the engine ignition switch, kill switch, or key switch is in the **run** position. b. Check wires and terminals of ignition module and other components for accidental grounding and damaged insulation. c. If wires and terminals are OK, the ignition module is probably faulty and should be replaced. Test module further using an ohmmeter (Test 4).
	4. Measure the resistance of module secondary using an ohmmeter (see Figures 8-3 and 8-4): Connect one ohmmeter lead to laminations (A). Connect the other lead to the spark plug terminal of high-tension lead (C). With ohmmeter leads connected in this manner, the resistance of secondary should be **7,900 to 18,400 ohms**. **NOTE:** This test cannot be performed unless module has been fired at least once.	4. If the resistance is **low or 0 ohms,** the module secondary is shorted. Replace the module. If the resistance is **high or infinity ohms,** the module secondary is open. Replace the module. If the resistance is within the specified range, the module secondary is OK.

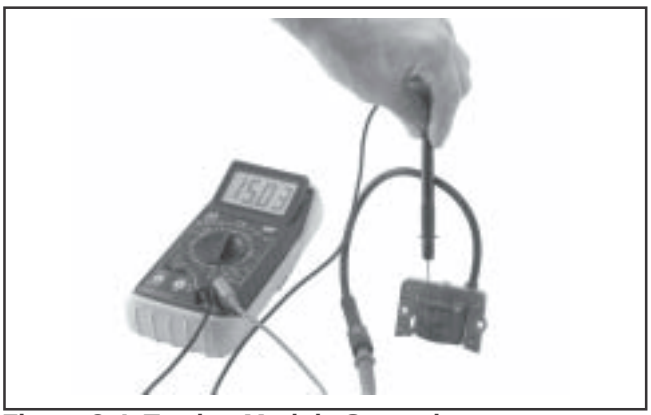


Figure 8-4. Testing Module Secondary.

Ignition Module Removal and Installation

Refer to the Disassembly and Reassembly sections for complete ignition module removal and installation procedures.

Electronic Ignition System with Spark Advance (Smart Spark™), CH16 Engines

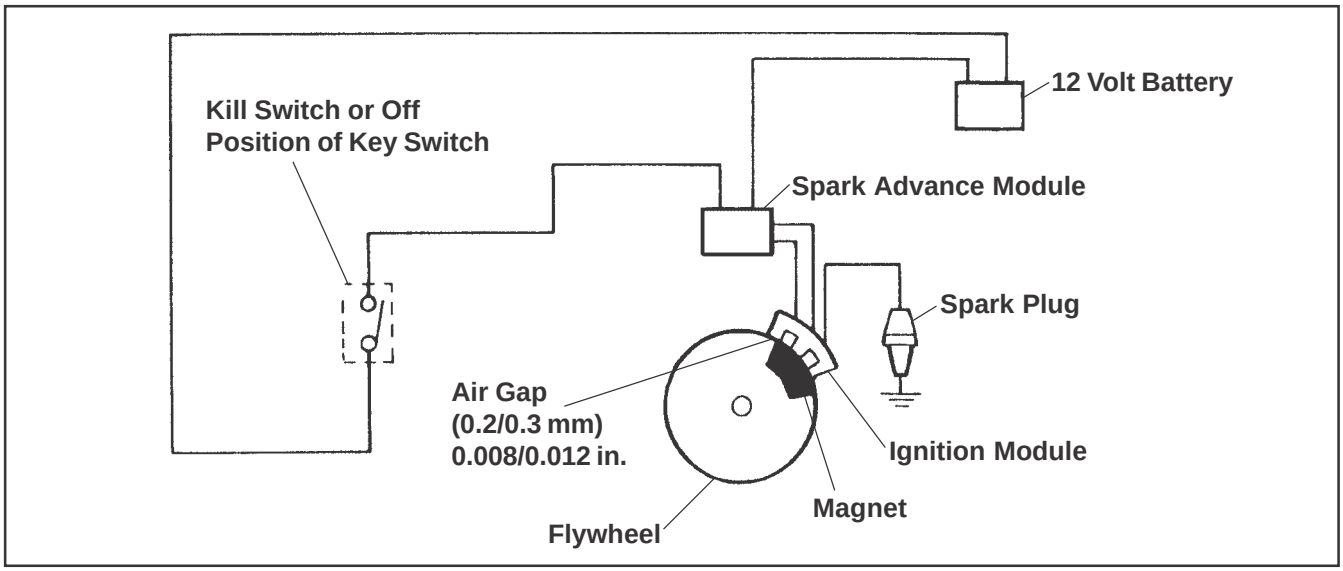


Figure 8-5. Capacitive Discharge Ignition System with Spark Advance.

CH16 engines are equipped with an electronic capacitive discharge ignition system with electronic spark advance. A typical application (Figures 8-5 and 8-6) consists of the following components.

- A magnet assembly which is permanently affixed to the flywheel.
- An electronic, capacitive discharge ignition module which mounts on the engine crankcase.
- A spark advance module which mounts to the engine shrouding.
- A 12 volt battery which supplies current to the spark advance module.
- A kill switch (or key switch) which grounds the spark advance module to stop the engine.
- A spark plug.

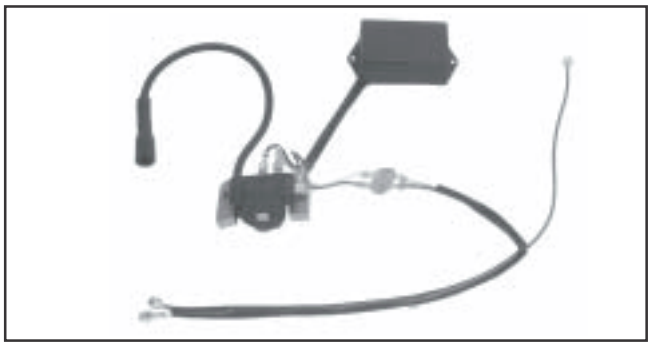


Figure 8-6. Smart Spark™ Components.

Operation

As the flywheel rotates, the magnet grouping passes the input coil (L1) of the ignition module, inducing energy in the coil. The resultant pulse is rectified by diode (D1) and charges capacitor (C1). Current from the same pulse also travels through the brown lead to the spark advance module (SAM), and enters the input of the conditioning circuit. The conditioning circuit shapes this pulse, putting it in a useable form for the other circuits. The **conditioned** pulse starts the charge pump, which charges a capacitor in linear fashion, directly related to engine speed. The pulse also resets the delay circuit. The comparator is off during this period.

When the flywheel magnet group has passed the input coil, and the original pulse drops back to zero, the capacitor in the delay circuit begins to charge off of the power source. When the charge on the delay capacitor exceeds the charge pump capacitor, the comparator changes state and activates the pulse generator, The **generated** pulse returns to the ignition module through the yellow lead and turns **on** the semiconductor switch (SCS), completing the circuits between the charging capacitor (C1) and the transformer (T1). The charging capacitor discharges into the transformer primary (P), inducing a high-voltage pulse in the transformer secondary (S). The high-voltage pulse arcs across the spark plug gap, igniting the fuel-air mixture in the combustion chamber. The longer it takes the delay circuit to surpass the reference voltage in the charge pump capacitor, the later the trigger pulse will occur, retarding the timing accordingly.

The trigger pulse exiting the SAM activates the reset circuit, discharging the capacitor and resetting the circuits for the next cycle.

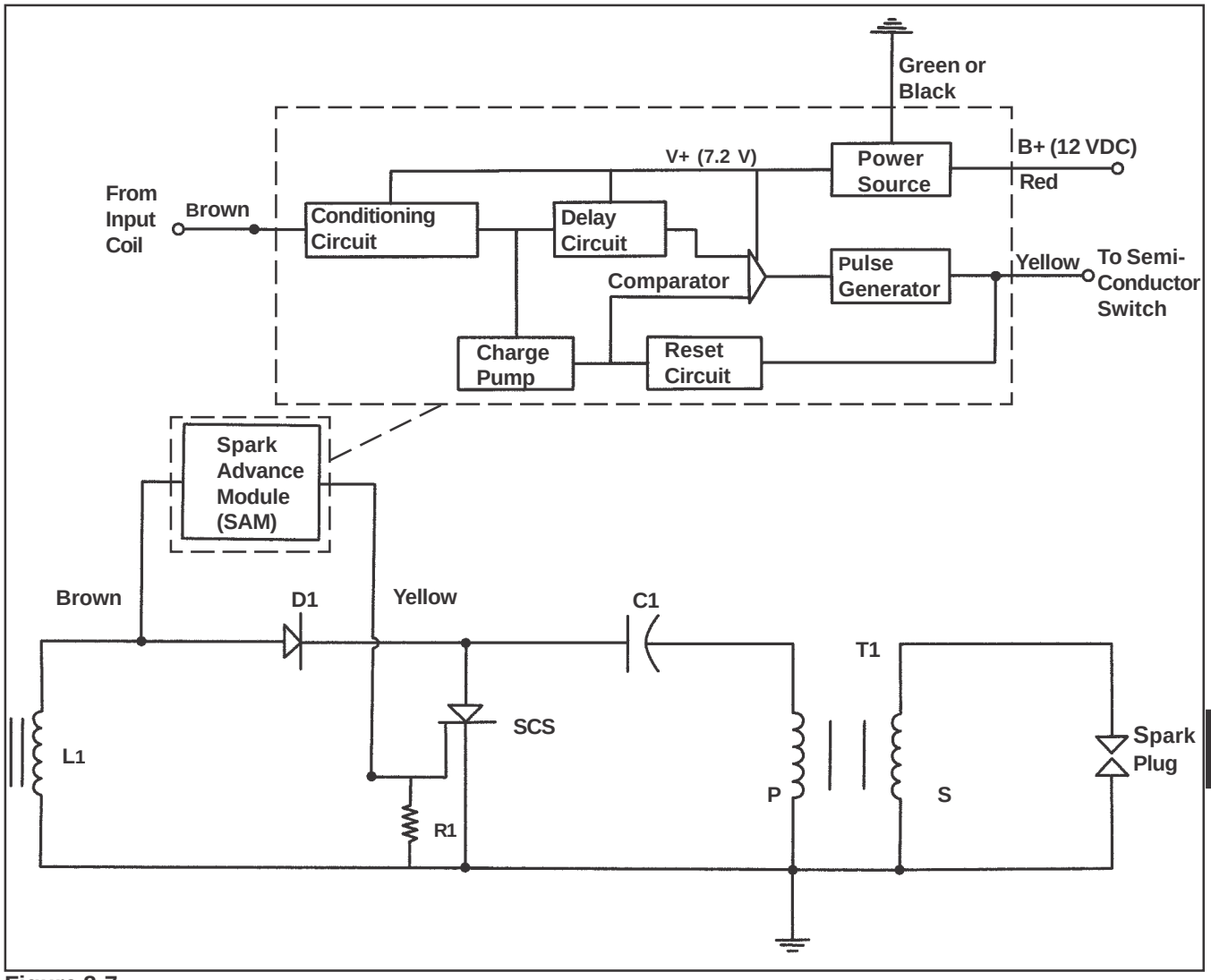


Figure 8-7.

Troubleshooting CD Ignition Systems

The CD ignition system is designed to be trouble-free for the life of the engine. Other than periodically checking/replacing the spark plug, no maintenance or timing adjustment is 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.

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 lead. 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. Disconnect any auxiliary kill wires or safety switches connected to the kill circuit and operate the engine to determine if the reported problem is gone.

NOTE: The spark advance module (SAM), used with Smart Spark™, requires an external power source of at least 7.2 volts DC. If you are installing a replacement battery on a unit that has an engine with Smart Spark™, be certain the battery is fully charged prior to installation.

Testing of Smart Spark™ Ignition Systems

The following procedure is provided for troubleshooting ignition problems on CH16 engines. It will allow you to pinpoint the failed components.

Special Tools Required:

- Ignition System Tester* (see Section 2)
- Multi-meter (digital)
- Spark Advance Module Tester* (see Section 2)

Specifications Required:

- Spark plug gap 0.76 mm (0.030 in.)
- Ignition module air gap 0.008-0.012" (0.010")

*NOTE: Ignition system tester must be used to test Smart Spark™ ignition. Use of any other tester can result in inaccurate findings. Battery on unit must be fully charged and properly connected before making any of these tests. Be sure drive is in neutral and all external loads are disconnected.

Preliminary Test

To be certain the reported problem is in the engine ignition system, it should be isolated from the unit, as follows.

1. Locate the plug connectors where the wiring harnesses from the engine and unit 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, continue with the following troubleshooting procedure. Leave the kill lead isolated until all testing is completed.

Troubleshooting Procedure

1. Disconnect spark plug lead and attach it to ignition system tester. Attach tester clip to a good ground, **not** to the spark plug.

2. Crank the engine and observe tester for spark. Do not touch tester while cranking.

3. If no spark is observed, verify that spark advance module (SAM) is getting proper voltage.

    a. Return to the connector where the engine and unit wiring harnesses are joined and find the double red lead in the back of the engine connector. Using a DC voltmeter with a probe lead, test the voltage at the terminal on the double red lead with the key switch in both the **start** and **run** positions. At least 7.2 volts must be present. If voltage is low, proceed to step 4. If voltage is above 7.2, proceed to step 5.

4. Remove the blower housing from the engine.

    a. Trace the black ground lead from the SAM and check that the ground tab and terminal connections are all tight. Recheck voltage at engine connector. If voltage is still low, check battery, key switch, and wiring on unit.

    b. When you are certain there is proper voltage at the connector, retest for spark. If there is still no spark, proceed to step 5.

5. If you skipped step 4, remove the blower housing at this time. Check all leads and connections from the SAM to the wiring harness and from the SAM to the ignition module. Pay special attention to the connection in the red lead, as the connectors can be misaligned in a way that the terminals don't make contact. Correct any problems found with the wiring or connections and retest for spark. If no wiring problems were found, or there is still no spark, proceed to step 6.

6. Zero ohmmeter and perform the following resistance checks on the ignition module. Module should be at room temperature (70° F).

    a. Remove the brown lead and test resistance from the wide tab to the laminations. Resistance should be 145-160 ohms.

    b. Remove the yellow lead and test resistance from the narrow tab to the laminations. Resistance should be 900-1000 ohms.

    c. Test resistance from the spark plug lead terminal to the laminations. Resistance should be 3800-4400 ohms.

If any of the resistance readings are outside of the specified ranges, replace the ignition module. If the resistance readings are all good, test the SAM using the instructions that came with the SAM tester.

Electrical Systems Wiring Diagrams and Battery Charging Systems

This engine is equipped with a regulated battery charging system.

Refer to the following wiring diagram and troubleshooting guide to test and service this system.

NOTE: Observe the following guidelines to prevent damage to the electrical system and components.

1. Make sure the battery polarity is correct. A negative (-) ground system is used.

2. Disconnect the rectifier-regulator leads and/or wiring harness plug before doing electric welding on the equipment powered by the engine. Also disconnect other electrical accessories in common ground with the engine.

3. Prevent the stator (AC) leads from touching or shorting while the engine is running. This could damage the stator.

Electric Start Engines, 15/20 amp Battery Charging System

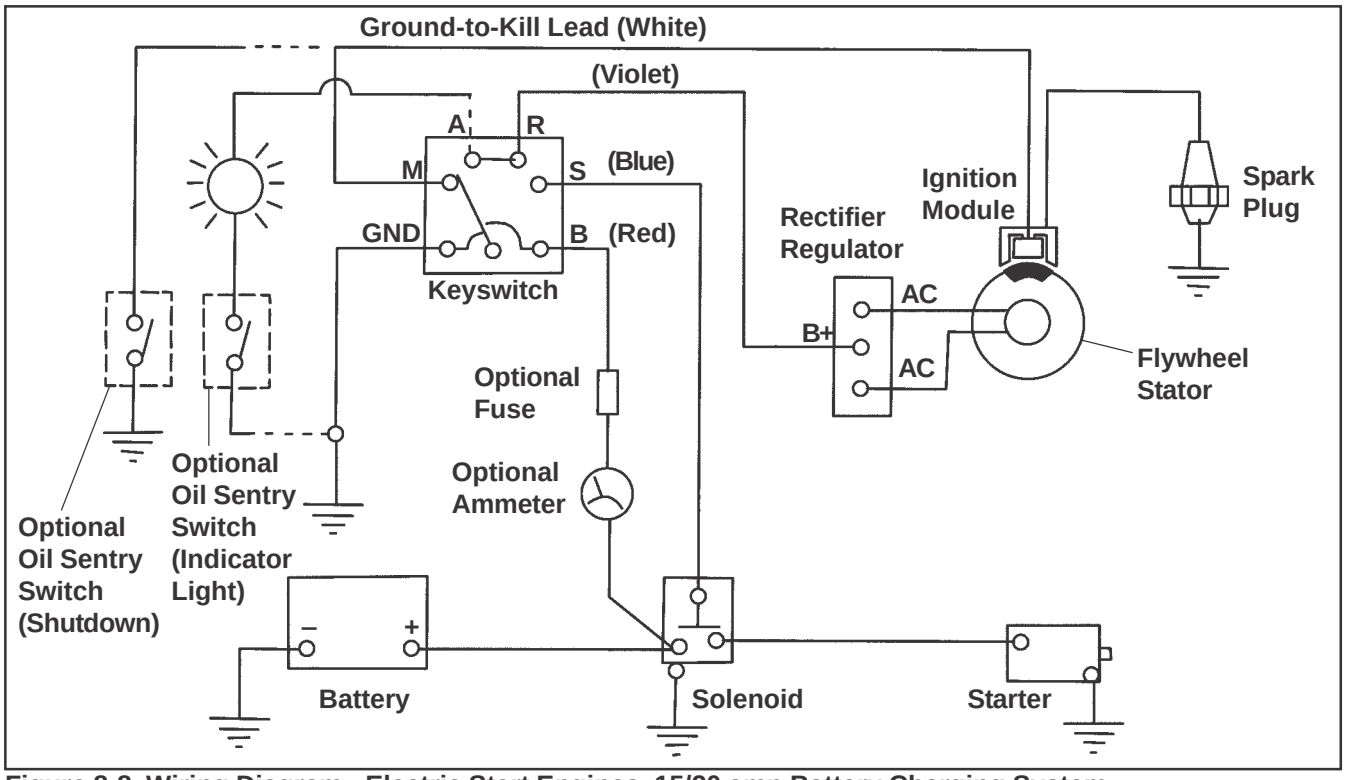


Figure 8-8. Wiring Diagram - Electric Start Engines, 15/20 amp Battery Charging System.

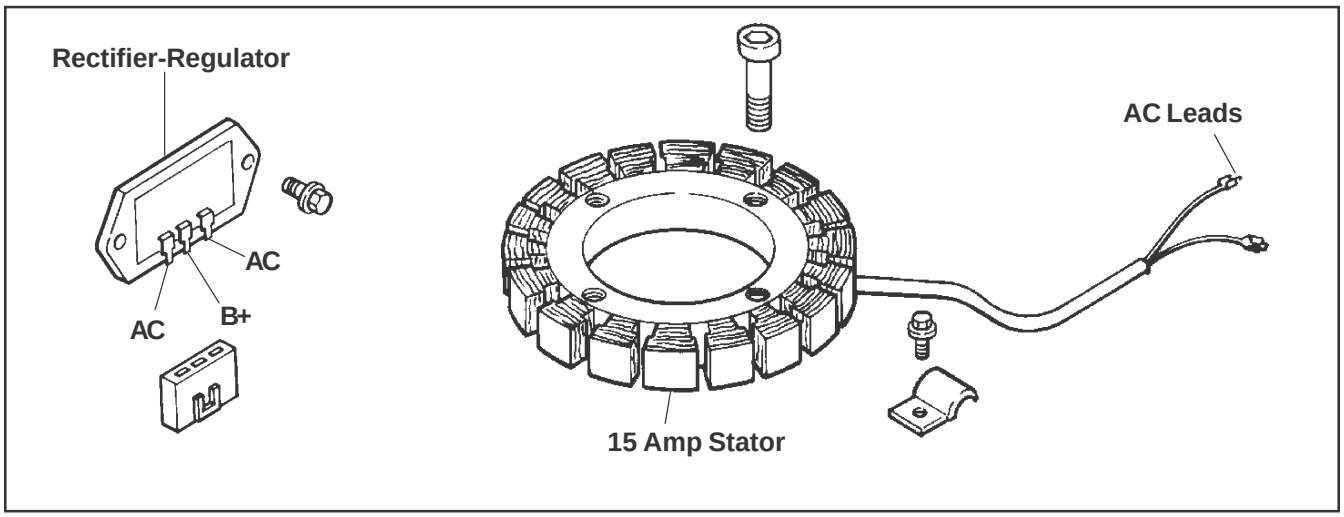


Figure 8-9. 15/20 amp Stator and Rectifier-Regulator.

Troubleshooting Guide - 15/20 amp Battery Charging System

NOTE: Zero ohmmeters and voltmeters on each scale to ensure accurate readings. Voltage tests should be made with the engine running at 3600 RPM - no load. The battery must be fully charged.

Problem	Test	Conclusion
No Charge to Battery	1. Insert an ammeter in the B+ lead from rectifier-regulator. With engine running at 3600 RPM and B+ connected, measure the voltage from B+ (at terminal on rectifier-regulator) to ground using a DC voltmeter. If the voltmeter is 13.8 volts or more, place a minimum load of 5 amps* on the battery to reduce the voltage. Observe the ammeter. ***NOTE:** Turn on lights (if 60 watts or more) or place a 2.5 ohm, 100 watt resistor across the battery terminals.	1. If the charge rate **increases** when load is applied, the charging system is OK and the battery was fully charged. If the charge rate **does not** increase when load is applied, test the stator and rectifier-regulator (tests 2 and 3).
	2. Remove the connector from the rectifier-regulator. With the engine running at 3600 RPM, measure the AC voltage across stator leads using an AC voltmeter.	2. If the voltage is **28 volts or more,** the stator is OK. The rectifier-regulator is faulty. Replace the rectifier-regulator. If the voltage is **less than 28 volts,** the stator is probably faulty. Test stator further using an ohmmeter (test 3).
	3a. With the engine stopped, measure the resistance across stator leads using an ohmmeter. 3b. With the engine stopped, measure the resistance from each stator lead to ground using an ohmmeter.	3a. If the resistance is **0.1/0.2 ohms,** the stator is OK. IF the resistance is **infinity ohms,** the stator is open. Replace the stator. 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 the stator.
Battery Continuously Charges at High Rate	1. With the engine running at 3600 RPM, measure the voltage from B+ lead to ground using a DC voltmeter.	1. If the voltage is **14.7 volts or less,** the charging system is OK; the battery is unable to hold a charge, or there is a bad connection between the rectifier-regulator and battery. Check the wiring harness; service or replace the battery as necessary. If the voltage is **more than 14.7 volts,** the rectifier-regulator is faulty. Replace the rectifier-regulator.

Electric Starters

Some engines in this series use inertia drive starting motors while others use solenoid shift type. Inertia drive types are covered first and the solenoid shift type is covered starting on page 8.16.

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. Do not attempt to jump start the engine with another battery. Starting with batteries larger than those recommended can burn out the starter motor.

NOTE: Do not drop the starter or strike the starter frame. Doing so can damage the ceramic permanent magnets inside the starter frame.

Starter Removal and Installation

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

Inertia Drive Electric Starter

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

Troubleshooting Guide

Problem	Possible Fault	Correction
Starter Does Not Energize	Battery	1. Check the specific gravity of 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. Bypass the switch or solenoid with a jumper cable. If starter cranks normally, replace the faulty components.
Starter Energizes But Turns Slowly	Battery	1. Check the specific gravity of 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.

Operation - Inertia Drive Starters

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

Starter Drive Service

Every **500 hours** of operation (or annually, whichever occurs first), clean and lubricate the splines on the starter drive shaft. If the drive pinion is worn, or has chipped or broken teeth, if must be replaced. See Figure 8-10.

If is not necessary to completely disassemble the starter to service the drive components.

Style "A" Drive Service

1. Remove the starter from the engine and remove the dust cover.

2. Hold the drive pinion in a vice with soft jaws when removing and installing the stop nut. The armature will rotate with the nut until the drive pinion stops against internal spacers.

   NOTE: Do not overtighten the vise as this can distort the drive pinion.

3. Remove the stop nut, stop gear spacer, anti-drift spring, dust cover spacer, and drive pinion.

4. Clean the splines on the drive shaft thoroughly with solvent. Dry the splines thoroughly.

5. Apply a small amount of Kohler electric starter drive lubricant, (see Section 2) to the splines. The use of other lubricants may cause the drive pinion to stick or bind.

6. Apply a small amount of **Loctite® No. 271** to the stop nut threads.

7. Install the drive pinion, dust cover spacer, anti-drift spring, stop gear spacer, and stop nut. Torque the stop nut to **17.0-19.2 N·m (150-170 in. lb.)**. Reinstall the dust cover.

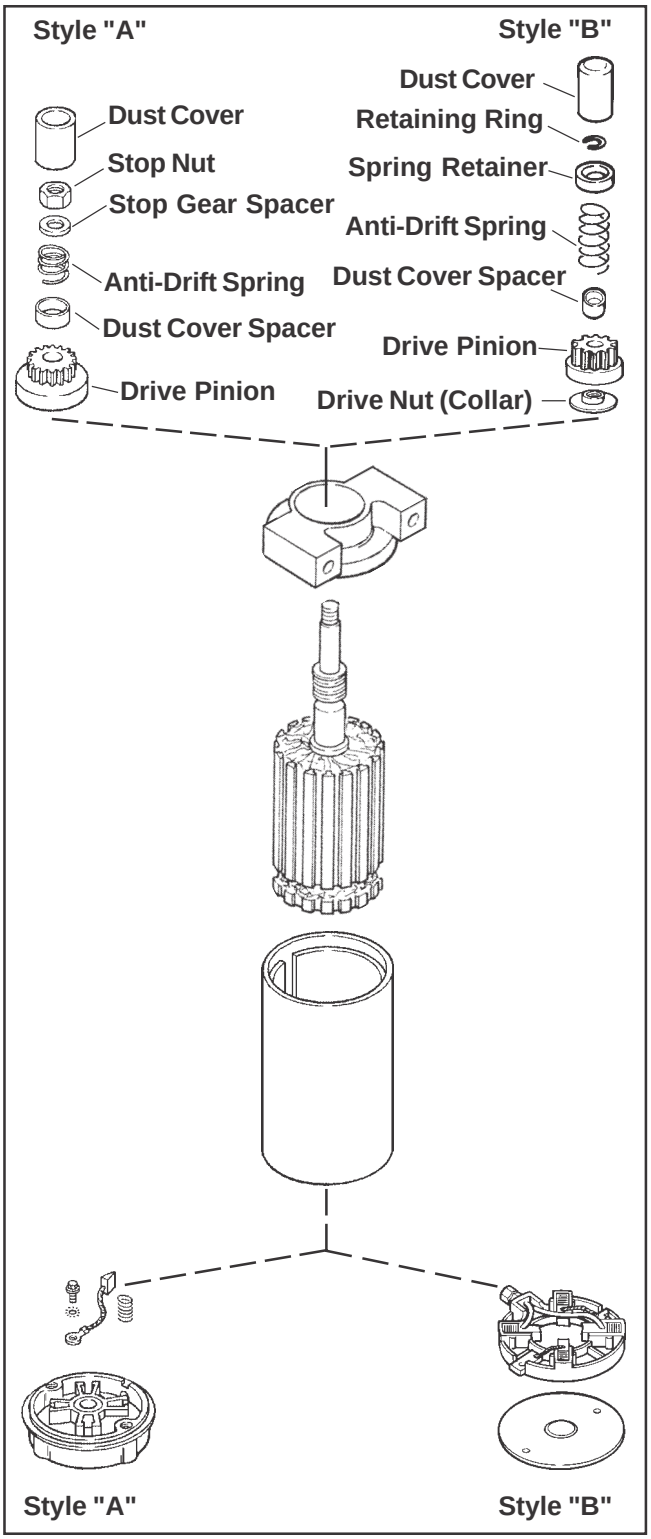


Figure 8-10. Inertia Drive Electric Starter.

Style "B" Drive Service

1. The rubber dust cover has a molded lip on the inside that snaps into a groove in the dust cover spacer (see Figure 8-11). Turn the drive pinion clockwise until it reaches the fully extended position. While holding it in the extended position, grasp the tip of the dust cover with a pliers or vise grip and pull it free from the spacer.

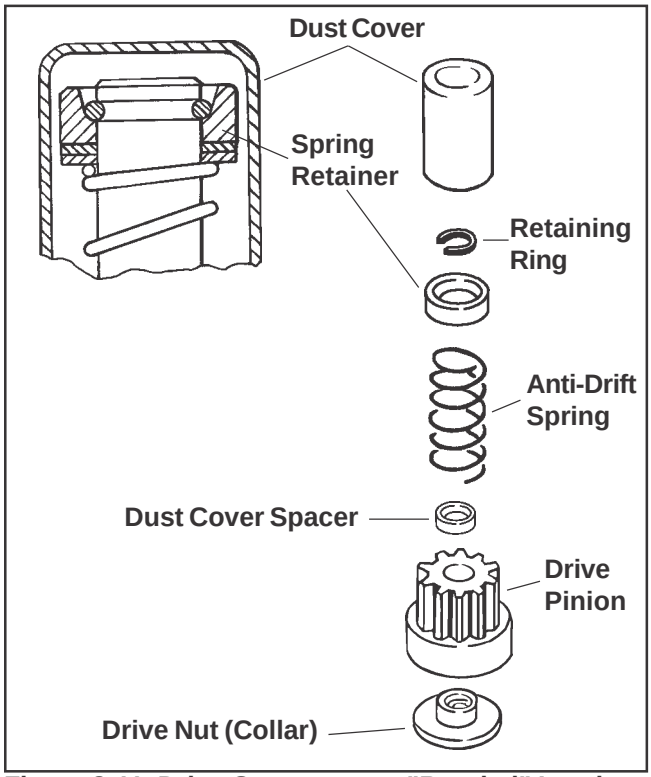


Figure 8-11. Drive Components, "Bonded" Inertia Drive Starter.

2. Disassemble the snap ring removal tool (see Section 2).

3. Again referring to Figure 8-11, grasp the spring retainer and push it toward the starter, compressing the anti-drift spring and exposing the retaining ring.

4. Holding the spring retainer in the retracted position, assemble the inner halves of the removal tool around the armature shaft with the retaining ring in the inner groove (see Figure 8-12). Slide the collar over the inner halves to hold them in position.

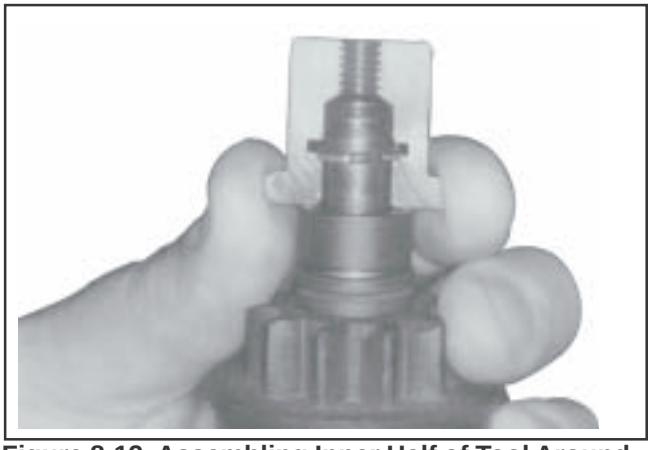


Figure 8-12. Assembling Inner Half of Tool Around Armature Shaft and Retaining Ring.

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

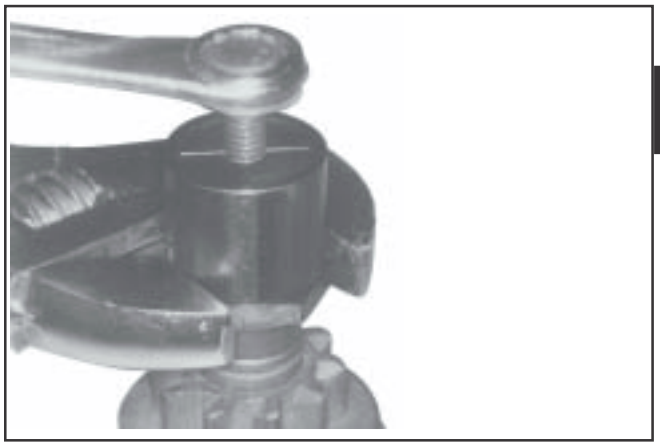


Figure 8-13. Holding Tool and Turning Center Screw (Clockwise) to Remove Retaining Ring.

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

7. The splines should have a light film of lubricant. Relubricate as necessary with Kohler bendix starter lubricant (see Section 2). Reinstall or replace the drive components, assembling them in the same sequence as they were removed.

Retaining Ring Installation

1. Position the retaining ring in the groove in one of the inner halves. Assemble the other half over the top and slide on the outer collar.

2. Be certain the drive components are installed in correct sequence onto the armature shaft.

3. Slip the tool over the end of the armature shaft, so the retaining ring inside is resting on the end of the shaft. Hold the tool with one hand, exerting slight pressure toward the starter. Tap the top of the tool with a hammer until you feel the retaining ring snap into the groove. Disassemble and remove the tool.

4. Squeeze the retaining ring with a pliers to compress it into the groove.

5. Assemble the inner halves, with the larger cavity, around the spring retainer (see Figure 8-14). Slide the collar over them and thread the center screw in until resistance is felt.

Figure 8-14. Assembling Larger Inner Half Around Spring Retainer.

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

7. Reinstall the dust cover.

Starter Disassembly

1. Remove the drive components following the instructions for servicing the drive.

2. Locate the small raised line on the edge of the drive end cap. On starters with Style "A" commutator end caps, it will be aligned with a premarked line on the starter frame. The frame is not premarked on starters with Style "B" end caps. Place a piece of masking tape on the frame and mark a line on the tape in line with the raised line on the end cap. See Figure 8-17.

3. Remove the thru bolts.

4. Remove the commutator end cap with brushes and brush springs (Style "A"). Style "B" end caps remove as a separate piece with the brushes and carrier remaining in the frame.

5. Remove the drive end cap.

6. Remove the armature and thrust washer (if so equipped) from inside the starter frame.

7. Remove the brush/carrier assembly from the frame (Style "B" end cap starters).

Style "A" End Cap Brush Replacement

1. Remove the brush springs from the pockets in brush holder. See Figure 8-15.

2. Remove the self-tapping screws, negative (-) brushes, and plastic brush holder.

3. Remove the hex flange nut and fiber washer from the stud terminal.

   Remove the stud terminal with positive (+) brushes and plastic insulating bushing from the end cap.

4. Reinstall the insulating bushing to the new stud terminal with the positive brushes. Install the stud terminal with bushing into the commutator end cap. Secure the stud with the fiber washer and hex flange screw.

5. Install the brush holder, new negative brushes, and self-tapping screws.

6. Install the brush springs and brushes into the pockets in brush holder. Make sure the chamfered sides of brushes are away from the brush springs.

   NOTE: Use a brush holder tool to keep the brushes in the pockets. A brush holder tool can easily be made from thin sheet metal. See Figure 8-16.

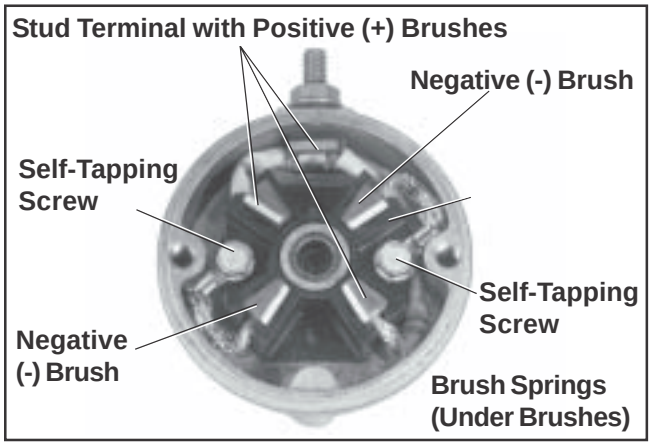


Figure 8-15. Style "A" Commutator End Cap with Brushes.

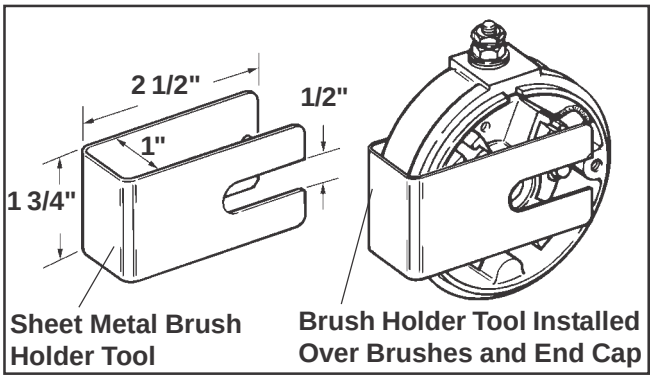


Figure 8-16. Brush Holder Tool (Style "A" End Cap).

Style "B" End Cap Brush Replacement

Starters with Style "B" end caps have the brushes in a plastic carrier housing, separate from the end cap. Replacement brushes come preassembled in the carrier housing, retained with two carton staples.

Commutator Service

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

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

Starter Reassembly

1. Place the thrust washer (if so equipped) over the drive shaft of the armature.

2. Insert the armature into the starter frame. Make sure the magnets are closer to the drive shaft end of armature. The magnets will hold the armature inside the frame.

3. Install the drive end cap over the drive shaft. Make sure the match marks on the end cap and starter frame are aligned. See Figure 8-17.

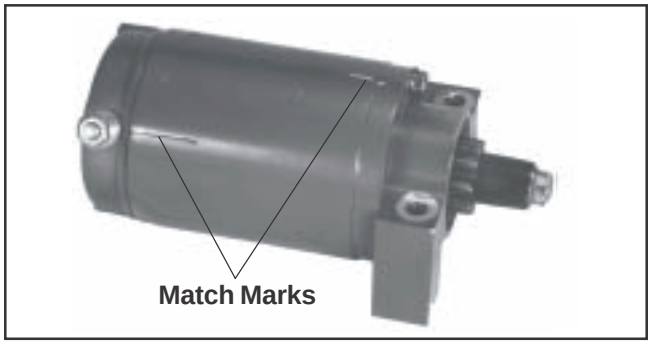


Figure 8-17. Starter Assembly Match Marks.

For Style "A" Commutator End Caps:

4. Install the brush holder tool to keep the brushes in the pockets of the commutator end cap.

5. Align the match marks on the commutator end cap and starter frame. Hold the drive end and commutator end caps firmly to the starter frame. Remove the brush holder tool.

For Style "B" Commutator End Caps:

4. If the brush assembly is not being replaced, position the brushes in their pockets in the carrier, move them to the retracted position, and install carton staples to retain them. See Figure 8-18.

5. Align the terminal stud block with the notch in the starter frame and slide the brush/carrier assembly into the frame. The commutator will push the carton staples out as the brush assembly is inserted. Position the end cap over the brush assembly, so the holes for the thru bolts are aligned with those in the brush carrier.

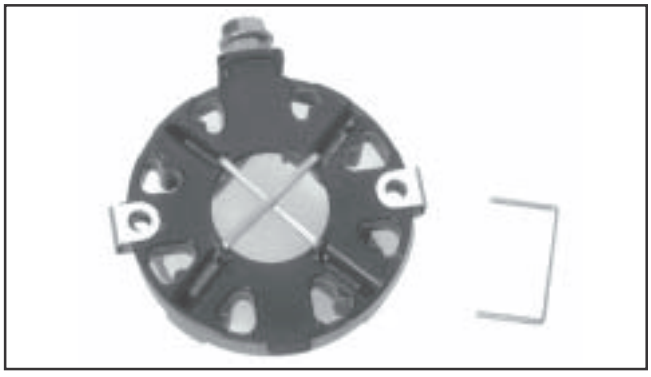


Figure 8-18. Style "B" Commutator End Cap with Brushes.

6. Install the thru bolts and tighten securely.

7. Lubricate the drive shaft with Kohler bendix starter drive lubricant (see Section 2). Install the drive components following the instructions for servicing the drive.

Solenoid Shift Electric Starters

The following subsection covers the solenoid shift electric starters. Some of the information in the preceding subsection relates also to this style of starter, so it is not repeated here. A Nippondenso or Delco-Remy solenoid shift starter may be used. The Nippondenso starter is covered first, and the Delco-Remy starter servicing follows.

Operation

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.

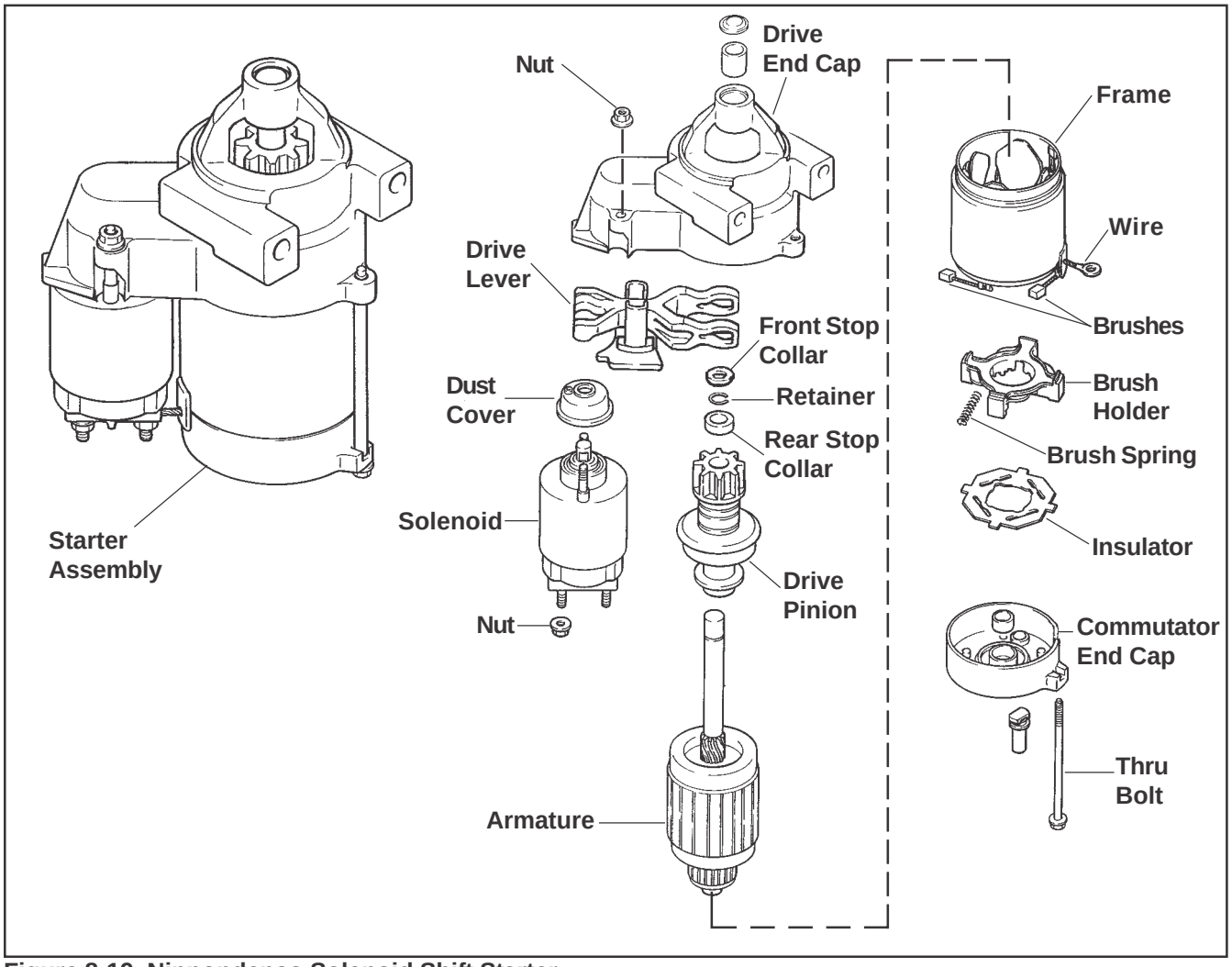


Figure 8-19. Nippondenso Solenoid Shift Starter.

Starter Disassembly

1. Disconnect the wire from the solenoid.
2. Remove the hex nuts securing the solenoid, and remove the solenoid from the starter assembly.
3. Remove the two thru bolts.
4. Remove the commutator end cap.
5. Remove the insulator and brush springs from the brush spring holder.
6. Remove the armature from the frame.
7. Remove the drive lever and armature from the drive end cap.

NOTE: When removing the lever and armature be careful not to lose the thrust washer.

8. The stop collar consists of two similar pieces held in place by being snapped over a retainer. The retainer is held in place by a groove in the armature shaft. To remove the stop collar the two pieces must be pried off the retainer.

9. When the stop collars are removed, the retainer can be removed from the armature shaft. Electric Starter Service Kit (see Section 2) includes a special pliers for removing the retainer. Do not reuse the retainer.

Brush Replacement

The brushes in the starter are part of the starter frame. Brush kit Part No. 52 221 01-S contains four replacement brushes and springs. If replacement is necessary, all four brushes should be replaced.

1. Remove brushes from brush holder, and remove brush holder from frame.

2. Cut the brush lead wire at the edge of the post with a pair of nippers.

3. File off burrs on the post.

4. The replacement brushes have a solid portion on them which should be crimped on the post.

5. Solder the crimped portion to the post.

6. Replace the brush holder in the frame and place the brushes in the brush holder. Reinstall the springs. Snap the insulator into the brush holder to keep the springs from popping out.

Starter Service

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

Starter Reassembly

1. Install the drive pinion onto the armature shaft.

2. Slide the stop collar onto the armature shaft below the retaining ring groove. Make sure the recessed side of the stop collar is **up**.

3. Position a new retainer in the groove of the armature shaft, and carefully tighten with a pliers to secure.

NOTE: Always use a new retainer. Do not nick or damage armature shaft.

4. Use an open end wrench and slide the stop collar up, until the recessed section encases the retaining ring and locks the collar into position. See Figure 8-20.

Figure 8-20. Lock Collar around Retaining Ring.

5. Install the thrust washer onto the armature shaft and lightly lubricate the end of the shaft with drive lubricant.

6. Position the lubricated drive lever around the drive pinion assembly and insert the assembly into the drive end cap. Seat the **pivot** section of drive lever into the corresponding section within the housing. See Figure 8-21.

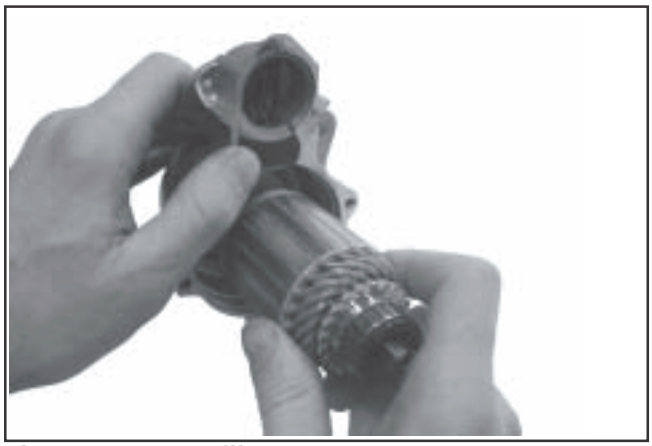


Figure 8-21. Installing Armature.

7. Mount the brush holder to rear of starter frame. Install the four brushes into the corresponding slots. Then carefully work (set) each of the four brush springs into position behind the brushes. Slide the rubber insulating grommet onto the small corresponding plastic tab on frame. See Figure 8-22.

Figure 8-22. Mounting Brush Holder to Frame.

8. Position the insulator over the brushes and springs. Hold it firmly in place so the springs do not come out. See Figure 8-23.

Figure 8-23. Holding Insulator in Place.

9. Stand the armature/drive end cap assembly on end so the commutator end is **up**. Place brush/armature installation tool over the end of the armature shaft until it rests against the commutator. See Figure 8-24.

Figure 8-24. Tool on end of Armature.

10. Carefully slide the frame, with the brush plate assembly, down over the tool and onto armature and drive end cap, aligning the cutout with lever section (on top). The rubber insulating grommet should also be **up**. See Figure 8-25.

    NOTE: Maintain pressure on the insulator while installing so the springs do not come out.

Figure 8-25. Installing Frame with Brush Plate Assembly.

11. Remove the tool and install the commutator end cap, aligning the cutout with the insulating grommet. See Figure 8-26.

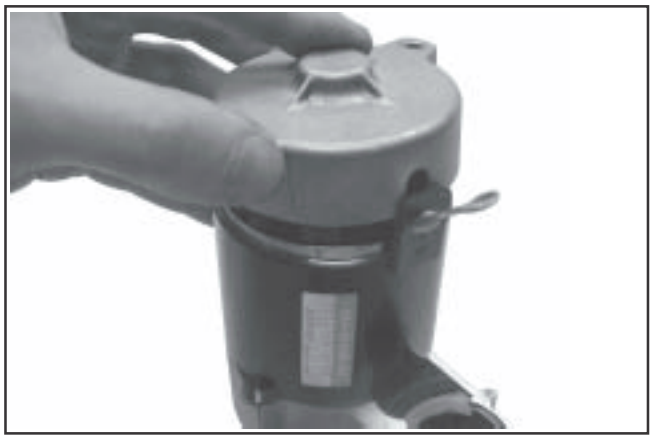


Figure 8-26. Installing End Cap.

12. Install and tighten the two thru bolts.

13. Make sure the dust cover is in place on the solenoid. Install solenoid, engaging the plunger end with the yoke of the drive lever. Check by pulling solenoid towards the rear. Mount the solenoid to the starter using the two hex flange nuts. Tighten securely. See Figure 8-27.

Figure 8-27. Installing Solenoid.

14. Connect the braided (brush) lead to lower main solenoid terminal and secure with the hex flange nut. See Figure 8-28.

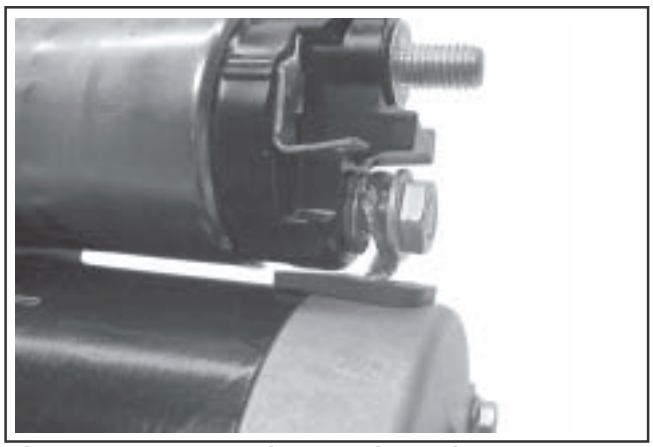


Figure 8-28. Connecting Brush Lead.

Delco-Remy Starters

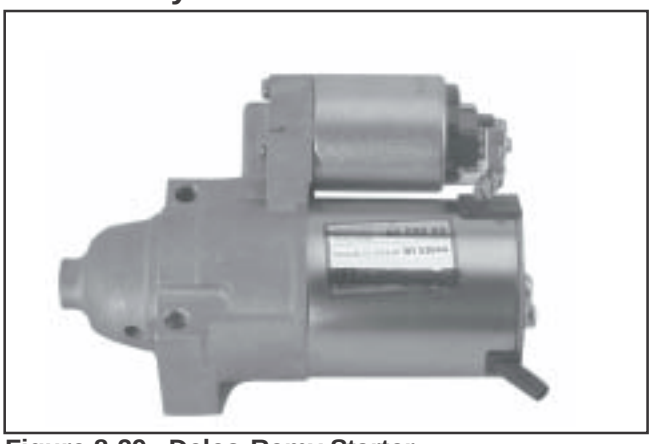


Figure 8-29. Delco-Remy Starter.

Starter Disassembly

1. Remove the hex nut and disconnect the positive (+) brush lead/bracket from the solenoid terminal.
2. Remove the three screws securing the solenoid to the starter. See Figure 8-30.

Figure 8-30. Removing Solenoid Screws.

3. If the solenoid was mounted with Phillips head screws, separate the solenoid and plunger spring from the drive end cap. If the solenoid was mounted with external Torx head screws, the plunger is part of the solenoid, unhook the plunger pin from the drive lever. Remove the gasket from the recess in the housing. See Figures 8-31 and 8-32.

NOTE: Test procedure for checking starter solenoid on pages 8.26 and 8.27.

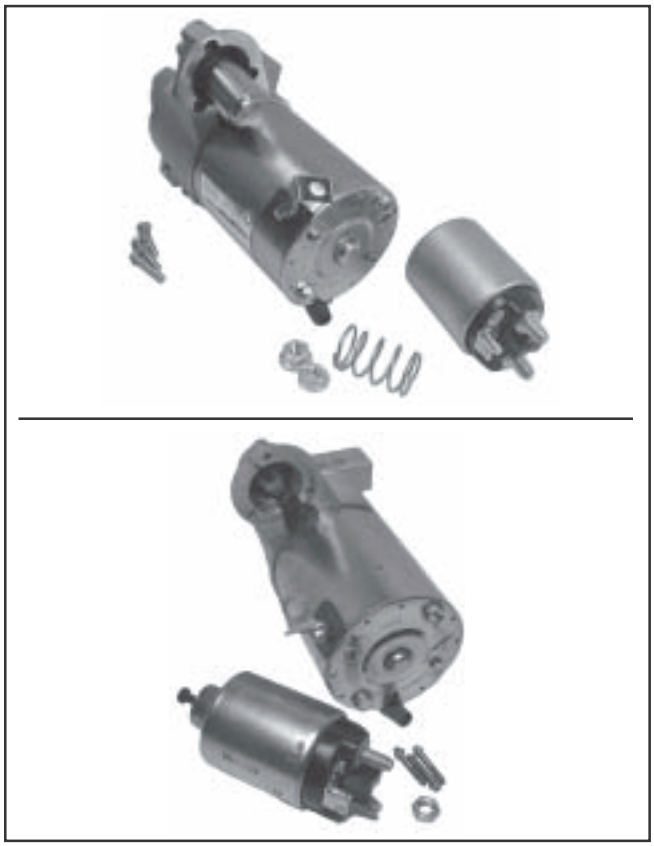


Figure 8-31. Solenoid Removed From Starter.

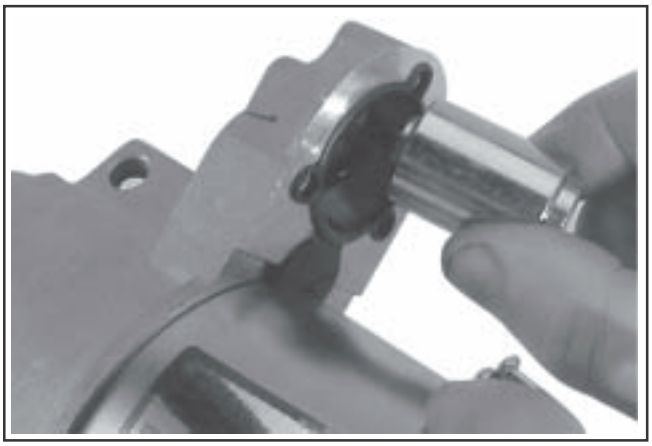


Figure 8-32. Removing Plunger.

4. Remove the two thru (larger) bolts. See Figure 8-33.

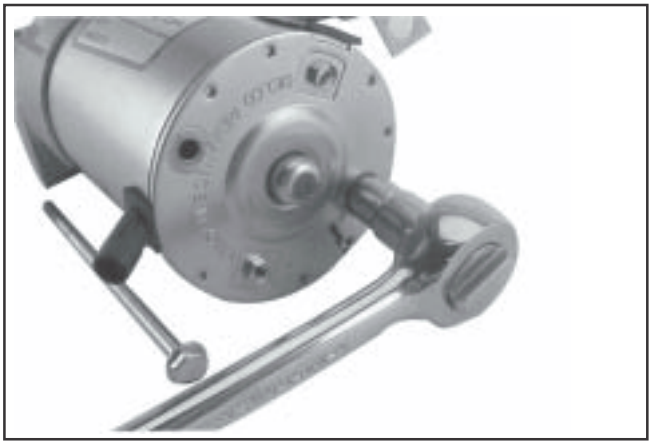


Figure 8-33. Removing Thru Bolts.

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 8-34.

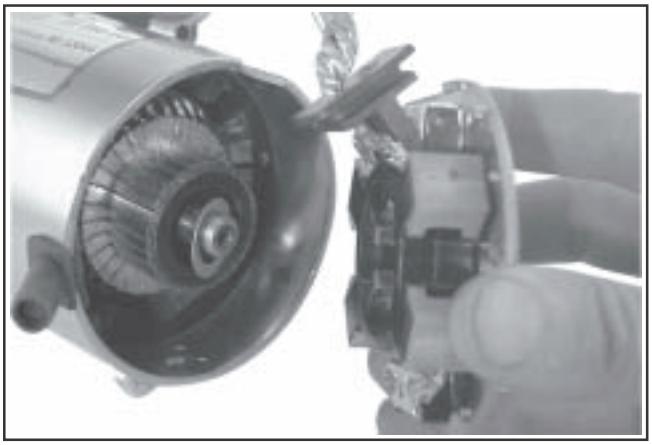


Figure 8-34. Removing Commutator End Plate Assembly.

6. Remove the frame from the armature and drive end cap. See Figure 8-35.

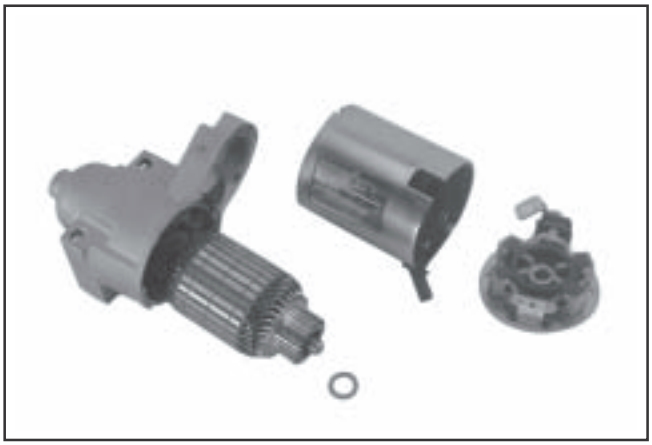


Figure 8-35. Starter Frame Removed.

7. Remove the drive lever pivot bushing and backing plate from the end cap. See Figure 8-36.

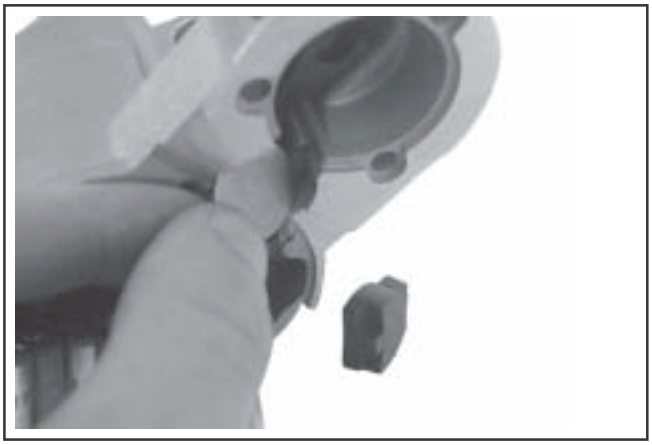


Figure 8-36. Removing Pivot Bushing and Backing Plate.

8. Take out the drive lever and pull the armature out from the drive end cap. See Figure 8-37.

9. Remove the thrust washer from the armature shaft. See Figure 8-37.

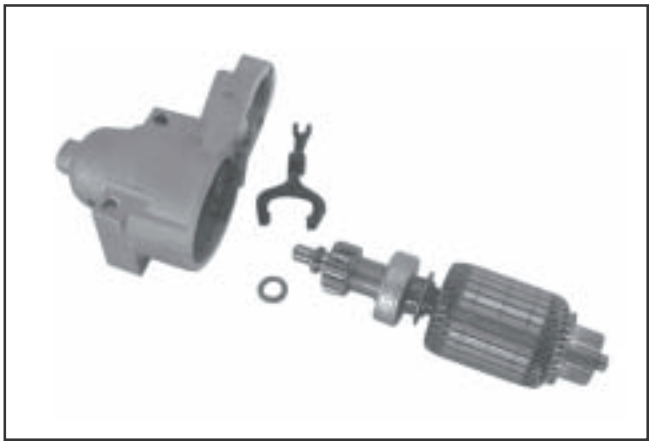


Figure 8-37. Armature and Lever Removed.

10. Push the stop collar down to expose the retaining ring. See Figure 8-38.

Figure 8-38. Retaining Ring Details.

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

    NOTE: Do not reuse the old retainer.

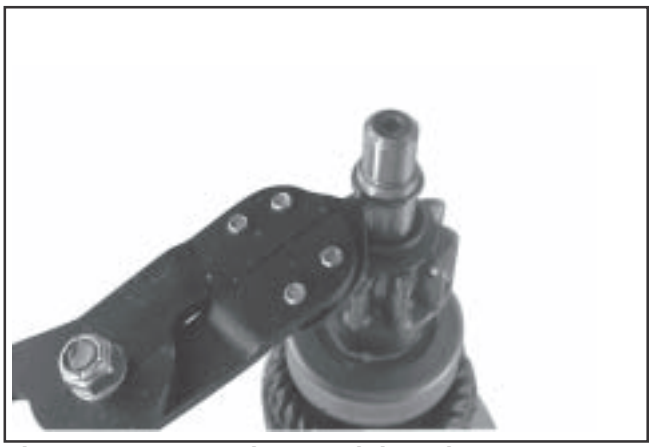


Figure 8-39. Removing Retaining Ring.

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.

Inspection

Drive Pinion

Check and inspect the following areas:

a. The pinion teeth for abnormal wear or damage.

b. The O.D. 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. 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 8-40. **Replace the brushes if they are worn undersize, or their condition is questionable.**

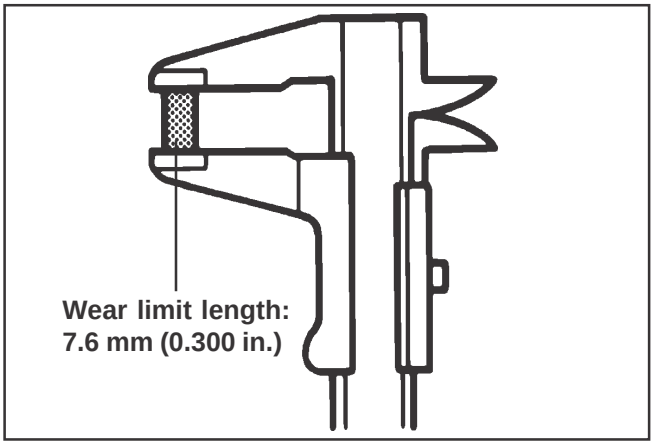


Figure 8-40. Brush Checking.

Armature

1. Clean and inspect the commutator (outer surface). The mica insulation of the commutator must be lower than the O.D. surface (undercut) to ensure proper operation of the commutator. See Figure 8-41.

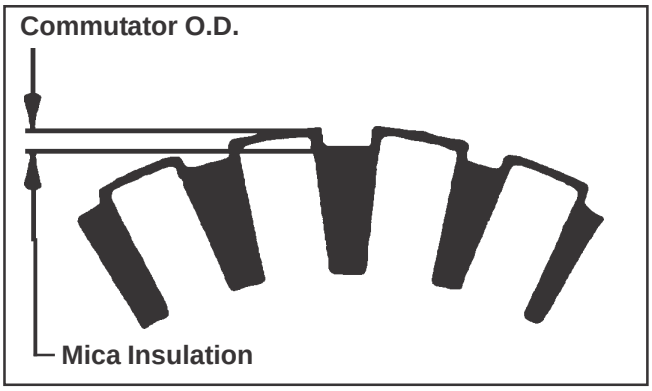


Figure 8-41. Commutator Mica Inspection.

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 8-42. Test all the segments. Continuity **must** exist between all or the armature is bad.

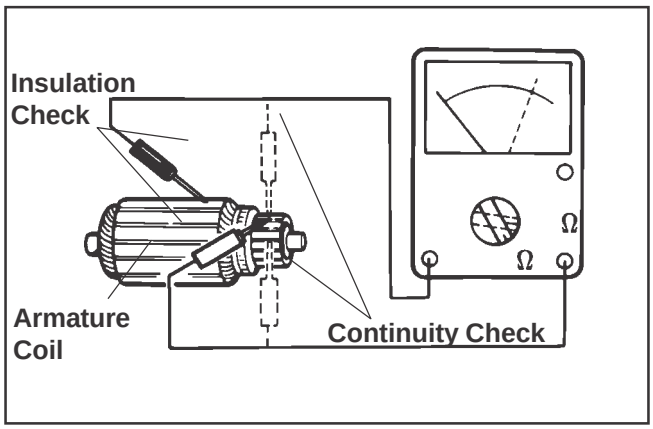


Figure 8-42. Armature Checks.

3. Check for continuity between the armature coil segments and the commutator segments. See Figure 8-42. There should be no continuity. If continuity exists between any two, the armature is bad.

4. Check the armature windings/insulation for shorting.

Shift Fork

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

Brush Replacement

The brushes and springs are serviced as a set (4). Use Brush and Spring Kit, Kohler Part No. 52 221 01-S, if replacement is necessary.

1. Perform steps 1-5 in Starter Disassembly.

2. Remove the two screws securing the brush holder assembly to the end cap (plate). Note the orientation for reassembly later. See Figure 8-43. Discard the old brush holder assembly.

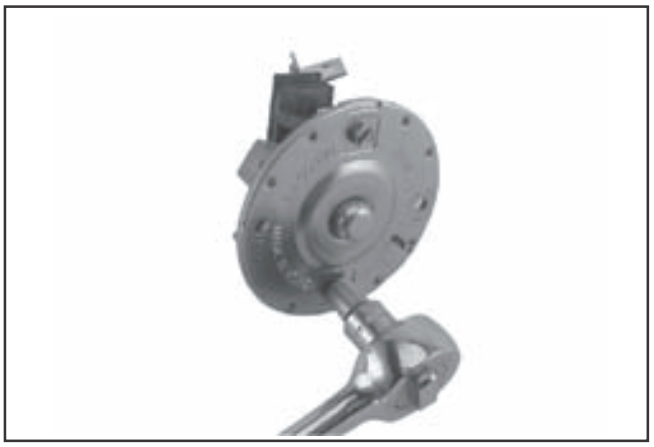


Figure 8-43. Removing Brush Holder.

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 8-44.

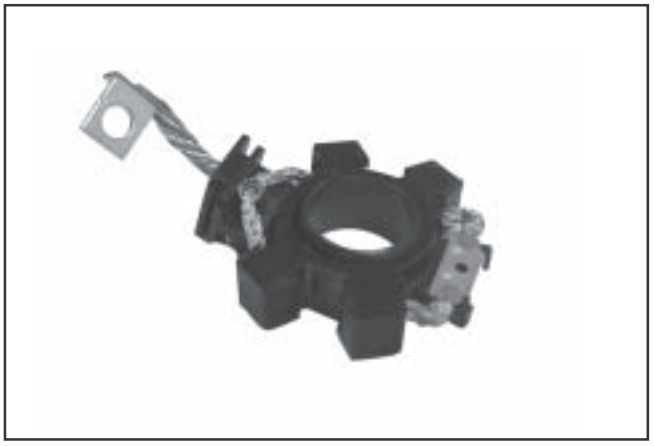


Figure 8-44. Service Brush Kit.

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) to the lever and shaft (Versilube G322L or Mobil Temp SHC 32). Clean and check the other starter parts for wear or damage as required.

Starter Reassembly

1. Apply new 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 8-45. Installing Stop Collar/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 washer faces the retainer/collar. See Figure 8-46.

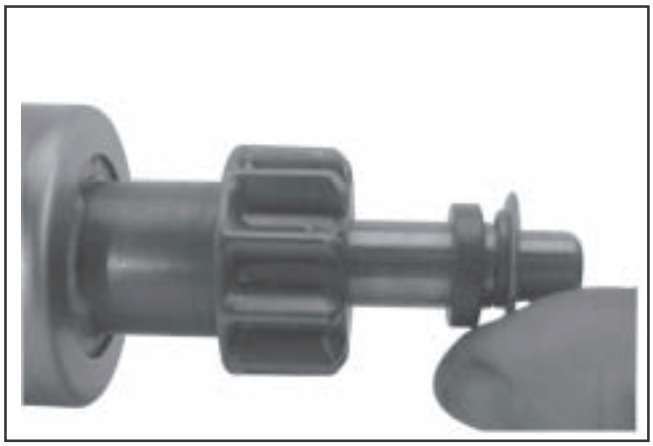


Figure 8-46. Thrust Washer Installation.

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 8-47.

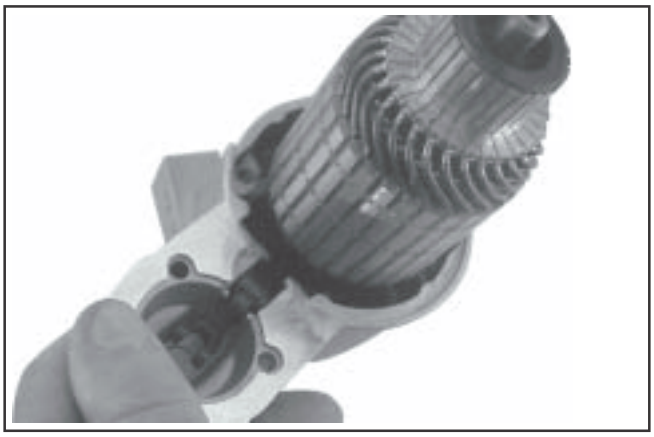


Figure 8-47. Installing Armature and Pivot Lever.

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 8-48.

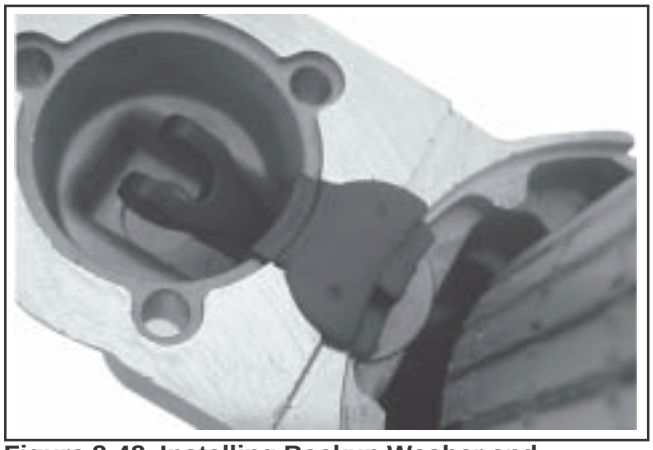


Figure 8-48. Installing Backup Washer and Grommet.

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 rear cutout, if it was removed previously. See Figure 8-49.

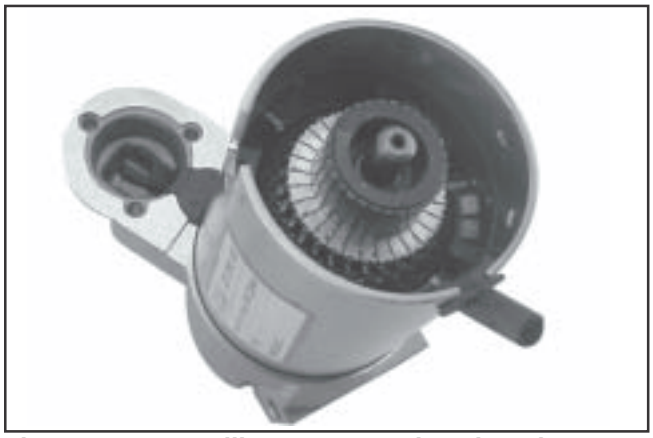


Figure 8-49. Installing Frame and Drain Tube.

9. Install the flat thrust washer onto the commutator end of the armature shaft. See Figure 8-50.

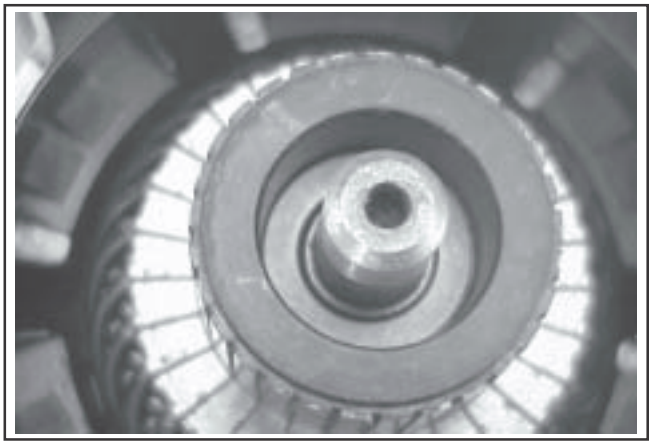


Figure 8-50. Installing Thrust Washer.

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 8-51. Save the protective tube, it may be used for future servicing.

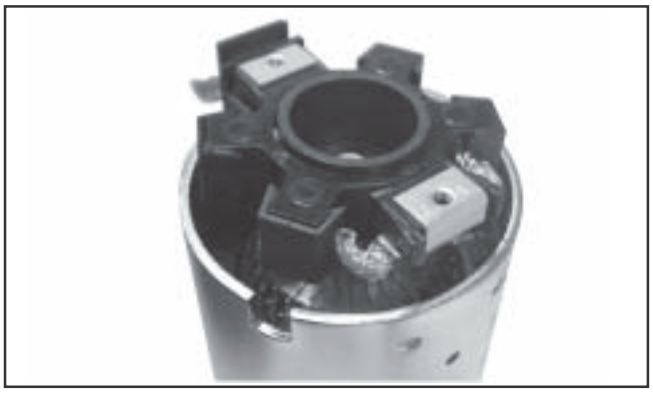


Figure 8-51. Installing Brush Holder Assembly with Supplied Tube.

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.

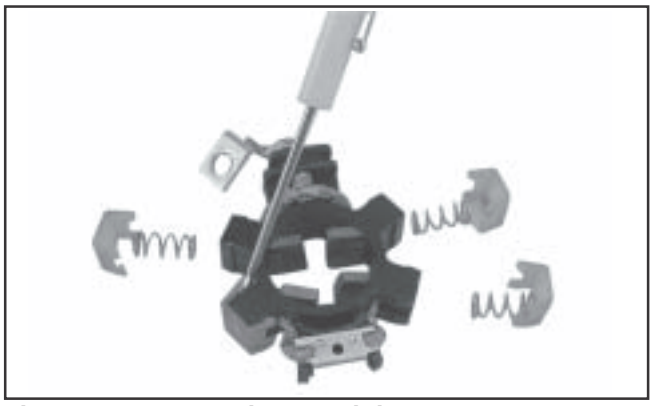


Figure 8-52. Removing Retaining Caps.

b. Position each of the brushes back in their slots so they are flush with the I.D. of the brush holder assembly. Insert 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 8-53.

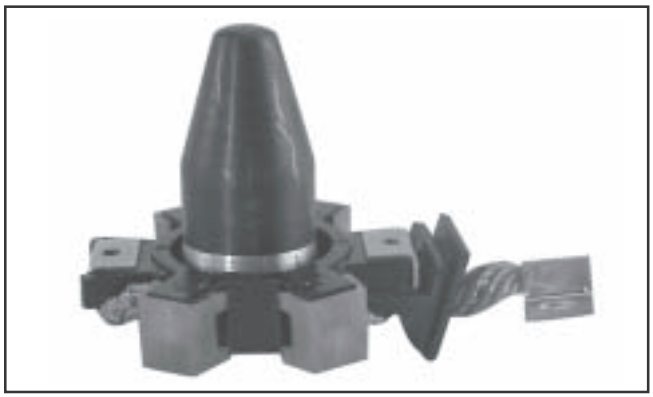


Figure 8-53. Brush Installation Tool with Extension.

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 8-54.

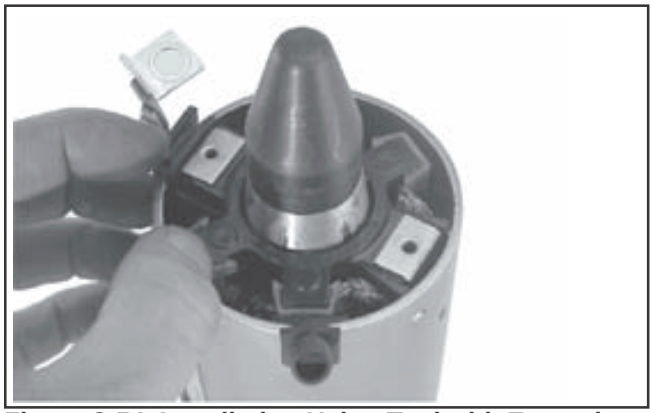


Figure 8-54. Installation Using Tool with Extension.

11. Install the end cap onto 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 8-55 and 8-56.

Figure 8-55. Torquing Thru Bolts.

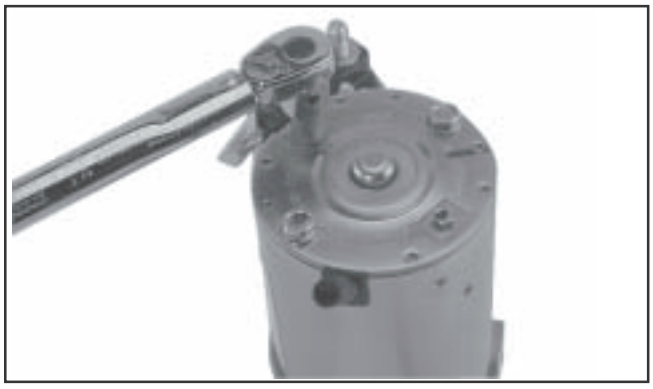


Figure 8-56. Torquing Brush Holder Screws.

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. Tighten/torque the nut to **6-9 N·m (53-79 in. lb.)**, **do not** overtighten. See Figure 8-57.

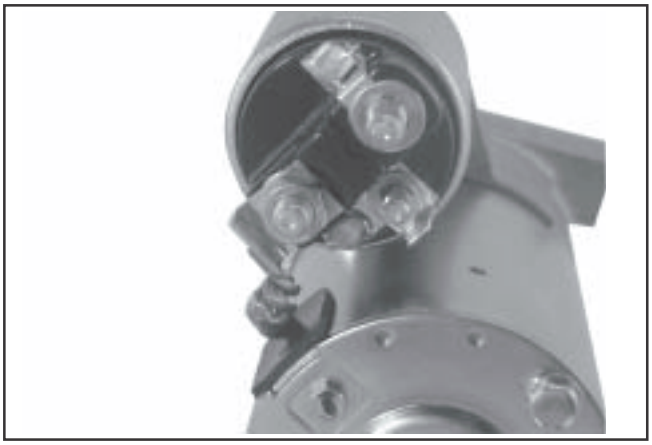


Figure 8-57. Positive (+) Brush Lead Connection.

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

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 8-58. 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.

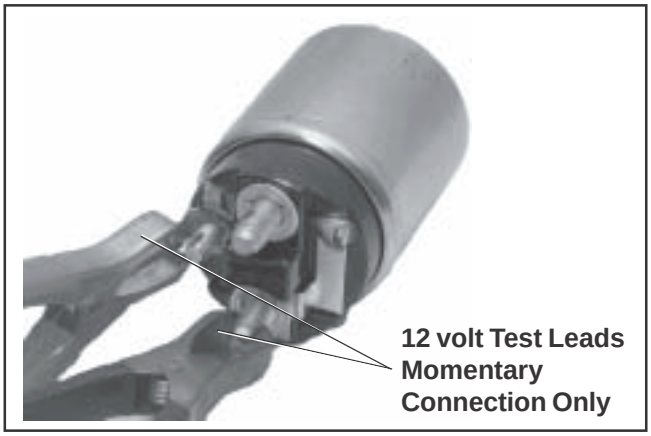


Figure 8-58. Testing Pull-In Coil/Plunger Actuation.

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 8-59. The ohmmeter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

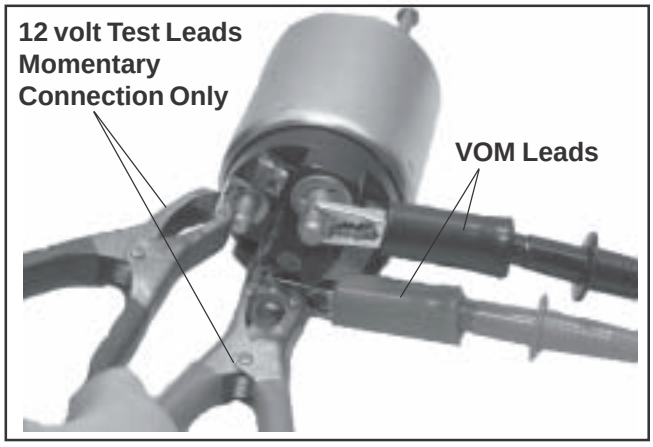


Figure 8-59. Testing Pull-In Coil/Solenoid Contact Continuity.

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 8-60. 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.

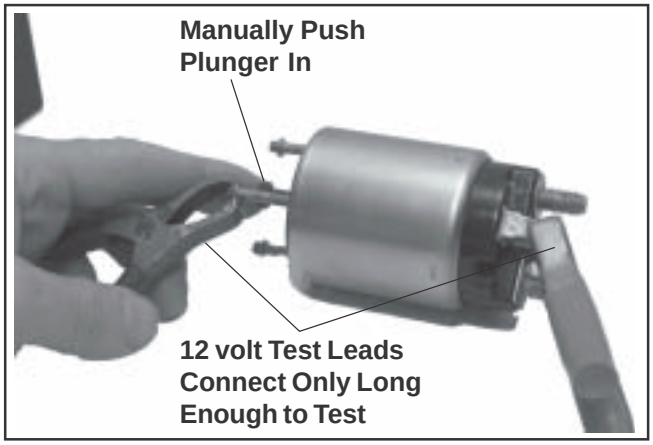


Figure 8-60. Testing Hold-In Coil/Function Test.

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 8-61. The meter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

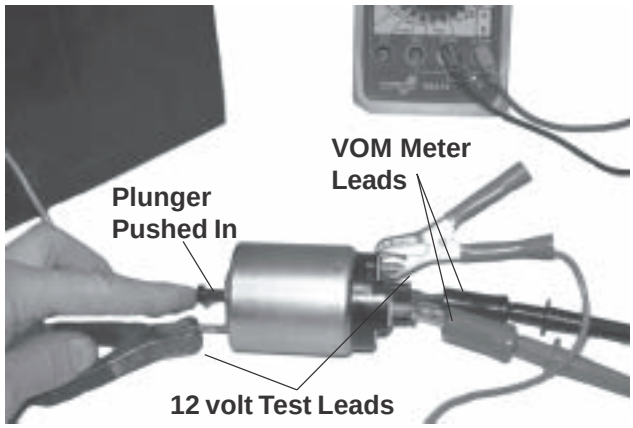


Figure 8-61. Testing Hold-In Coil/Solenoid Contact Continuity.

Section 9
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

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

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

1. Remove spark plug.
2. Drain oil and remove oil filter.
3. Remove muffler.
4. Remove air cleaner.
5. Remove throttle control bracket.
6. Remove carburetor and governor lever.
7. Remove fuel tank.
8. Remove retractable starter.
9. Remove fuel pump.
10. Remove electrical starter.
11. Remove rectifier-regulator.
12. Remove Oil Sentry.
13. Remove valve cover.
14. Remove cylinder head baffle.
15. Remove blower housing and baffles.
16. Remove carburetor adapter and heat deflector.
17. Remove ignition module.
18. Remove fuel line.
19. Remove cylinder head, push rods, and gasket.
20. Remove drive cup, grass screen, flywheel, and fan.
21. Remove stator and wiring harness.
22. Remove closure plate.
23. Remove camshaft and hydraulic lifters.
24. Remove balance shaft.
25. Remove connecting rod and piston.
26. Remove crankshaft.
27. Remove flywheel end oil seal.
28. Remove governor cross shaft and governor gear.

Disconnect Spark Plug Lead

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

Drain Oil From Crankcase and Remove Oil Filter

1. Remove the oil drain plug and oil fill cap/dipstick. See Figure 9-1.

2. Allow ample time for the oil to drain from the crankcase and oil filter.

3. Remove and discard the oil filter.

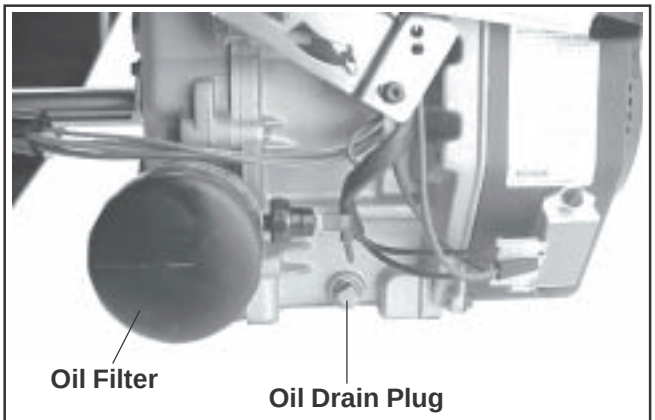


Figure 9-1. Location of Oil Drain Plug and Filter.

Remove Muffler

1. Remove the four hex flange screws securing the muffler to the upper and lower mounting brackets. See Figures 9-2 and 9-3.

2. Remove the muffler from the mounting brackets and exhaust inlet pipe.

3. Remove the two hex flange nuts from the exhaust port studs and take off the exhaust inlet pipe and gasket.

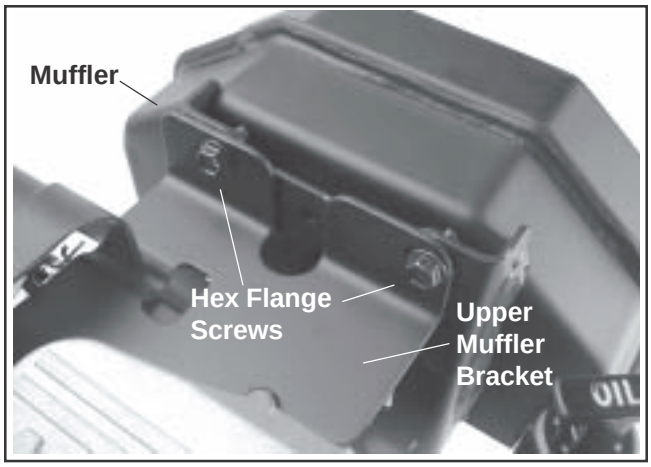


Figure 9-2. Removing Muffler.

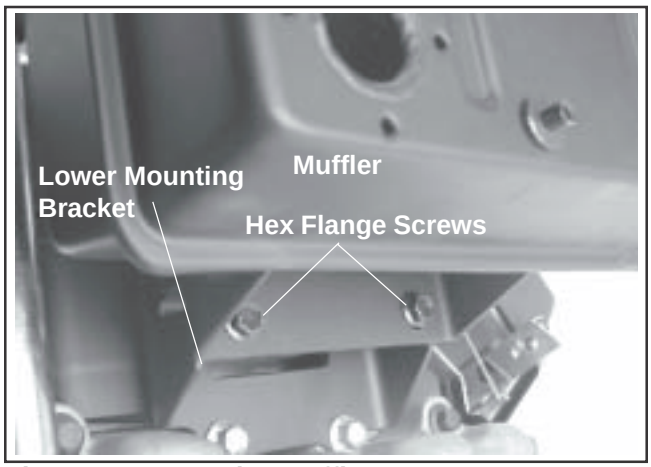


Figure 9-3. Removing Muffler.

Remove Air Cleaner

1. Remove the knob and air cleaner cover. See Figure 9-4.

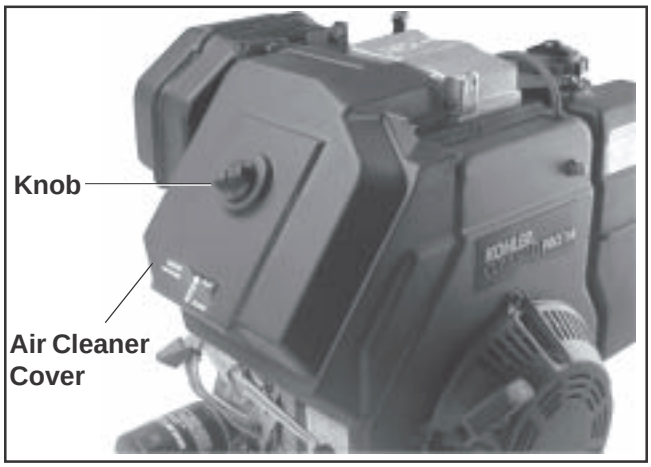


Figure 9-4. Removing Air Cleaner Cover.

2. Remove the wing nut, washer, element cover, element and precleaner. See Figure 9-5.

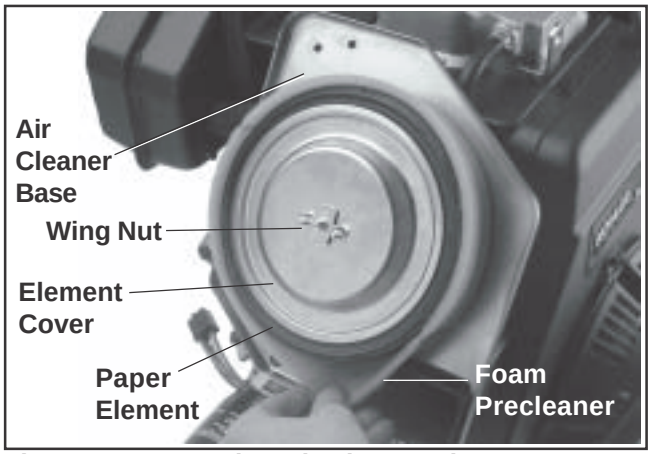


Figure 9-5. Removing Air Cleaner Elements.

3. Remove the hex flange nuts from the mounting studs, and take off the air cleaner mounting bracket, spitback cup or collector plate, and gasket as equipped. See Figure 9-6.

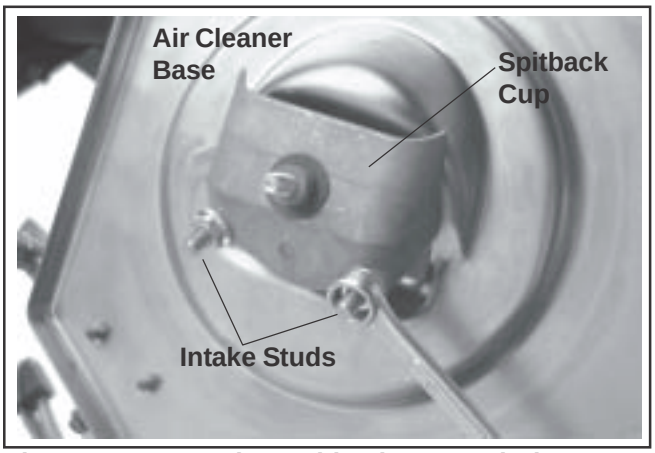


Figure 9-6. Removing Spitback Cup and Air Cleaner Base.

4. Loosen the hose clamp and disconnect the breather hose from the rocker arm cover. Remove the air cleaner base from the studs and disconnect the choke linkage from the carburetor choke lever. See Figure 9-7.

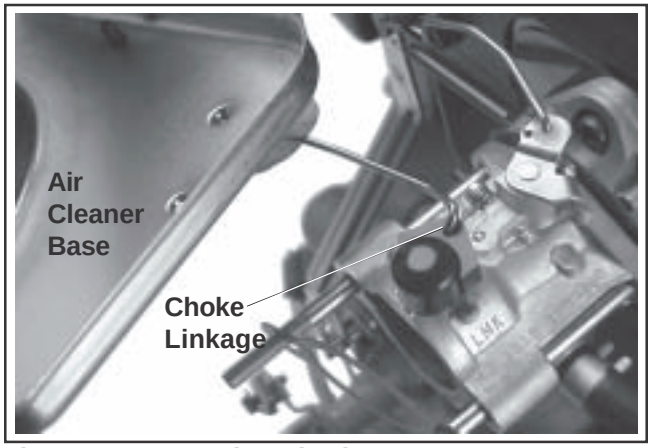


Figure 9-7. Removing Air Cleaner Base.

Remove Throttle Control Bracket

1. Remove the two mounting screws securing the throttle control bracket and ground lead (some models) to the crankcase. See Figure 9-8.

2. Mark the governor spring hole location and unhook the spring from the lever of the throttle control bracket. See Figure 9-8 and 9-9.

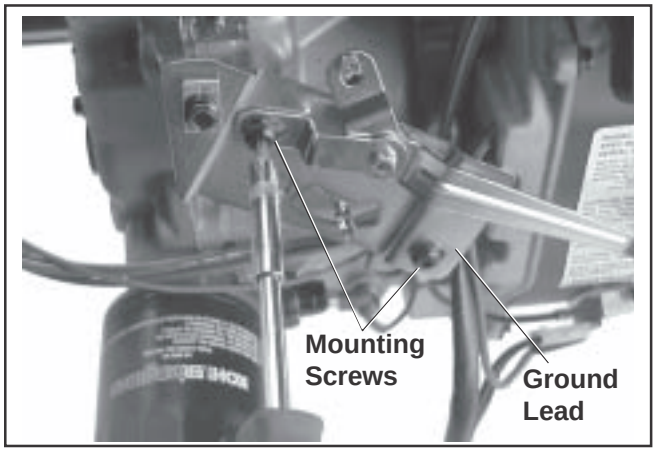


Figure 9-8. Removing Throttle Control Bracket.

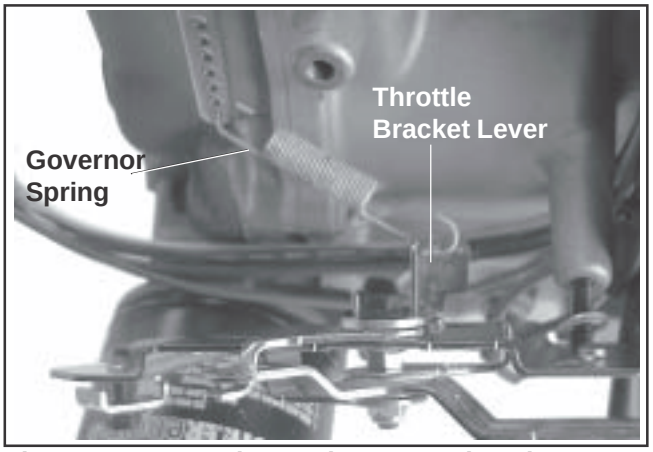


Figure 9-9. Removing Spring From Throttle Lever.

Remove Carburetor and Governor Lever

WARNING: Explosive Fuel!

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

1. Remove the fuel line from the carburetor inlet fitting. See Figure 9-10.

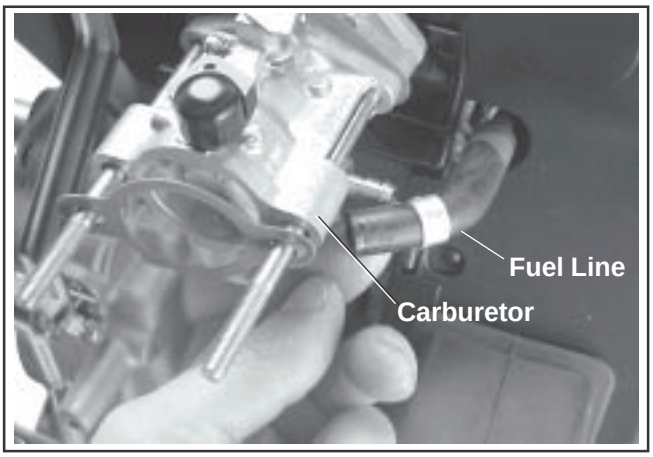


Figure 9-10. Removing Fuel Line From Carburetor.

2. Loosen the fastener securing the governor lever to the cross shaft.

3. Remove the carburetor and governor lever, with the linkage attached, from the engine. See Figure 9-11.

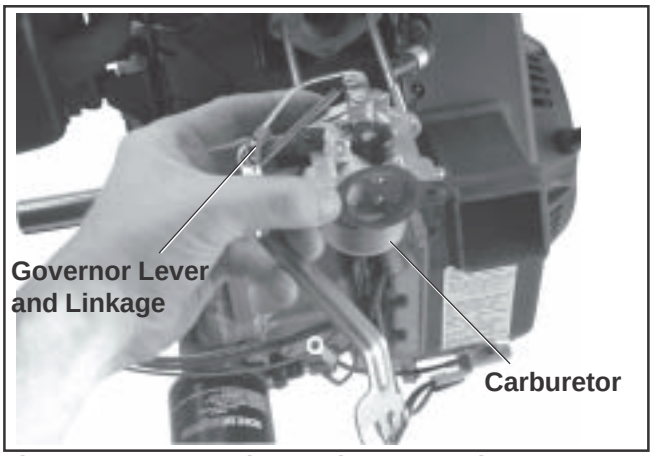


Figure 9-11. Removing Carburetor and Governor Lever.

Remove Fuel Tank

WARNING: Explosive Fuel!

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

1. Turn fuel shut-off valve to OFF (horizontal) position. Disconnect fuel line from valve.

2. Remove hex flange nuts from lower bracket and hex flange screws from upper bracket of fuel tank. See Figure 9-12.

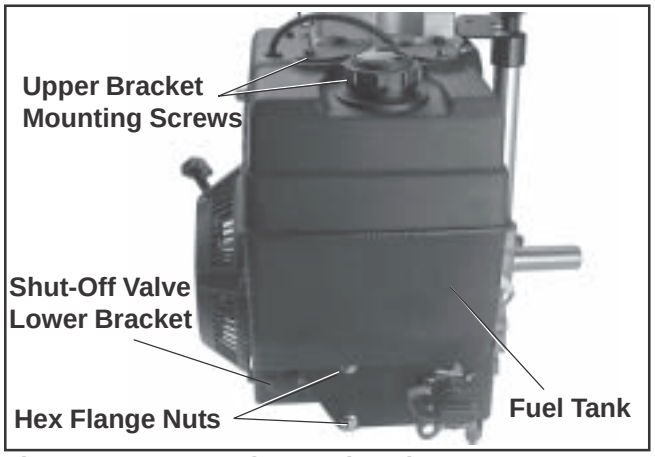


Figure 9-12. Removing Fuel Tank.

3. Remove the fuel tank.

Remove Retractable Starter

1. Remove the five hex flange screws and retractable starter. See Figure 9-13.

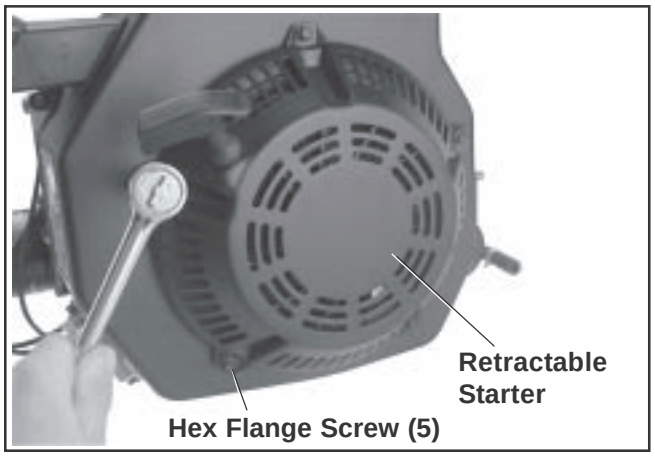


Figure 9-13. Removing Retractable Starter.

Remove Fuel Pump

WARNING: Explosive Fuel!

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

1. Disconnect the fuel line from the outlet and inlet fittings of the fuel pump. See Figure 9-14.

2. Remove the two hex flange screws, fuel pump, and gasket.

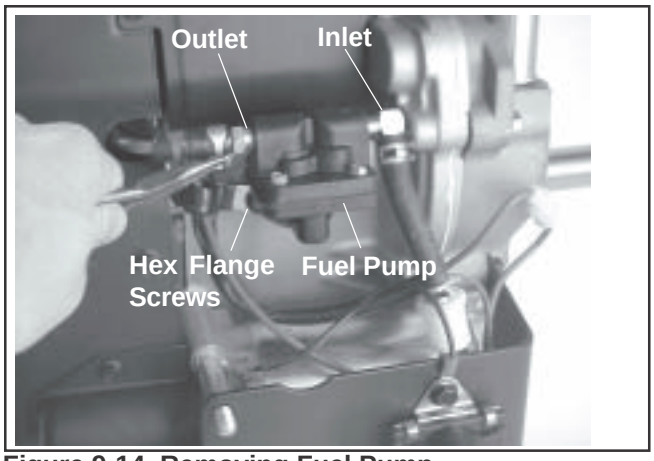


Figure 9-14. Removing Fuel Pump.

Remove Electric Starter

Electric Starter (Bendix Drive or Solenoid Shift)

1. Disconnect the lead connected to the stud terminal on the starter, or both leads from the solenoid on solenoid shift starters.

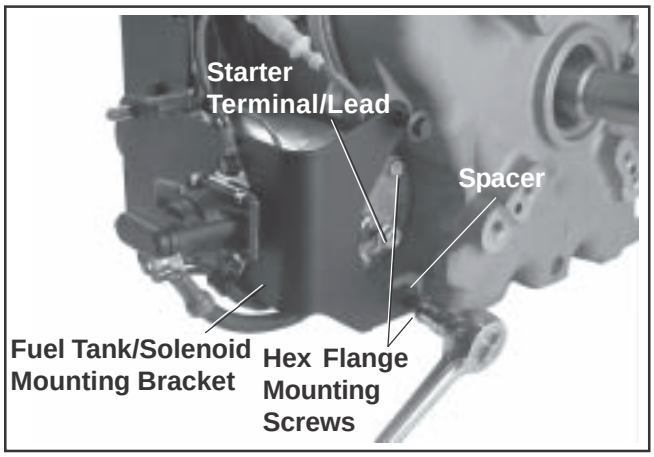


Figure 9-15. Removing Bendix Drive Starter.

2. If starter is mounted on studs with a fuel tank/ solenoid bracket. See Figure 9-15.

   a. Remove the two hex flange screws through the closure plate. Note installation of spacer washer behind bracket on lower screw. See Figure 9-15.

   b. Remove the screws securing the starter (pinion) cover to the blower housing. See Figure 9-16.

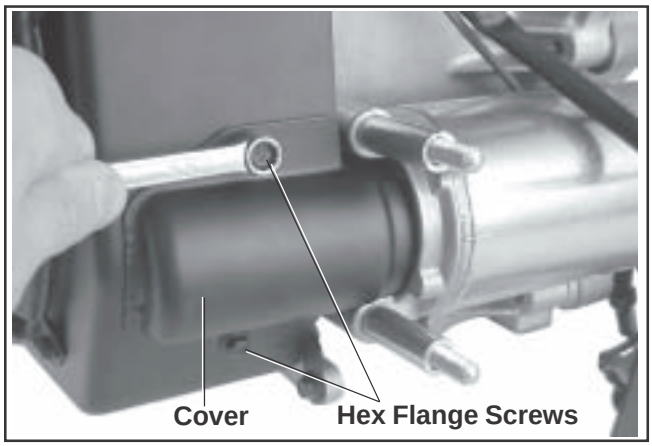


Figure 9-16. Removing Starter (pinion) Cover.

   c. Slide the starter and spacers off the studs. Note position of ground lead (if used). See Figure 9-17.

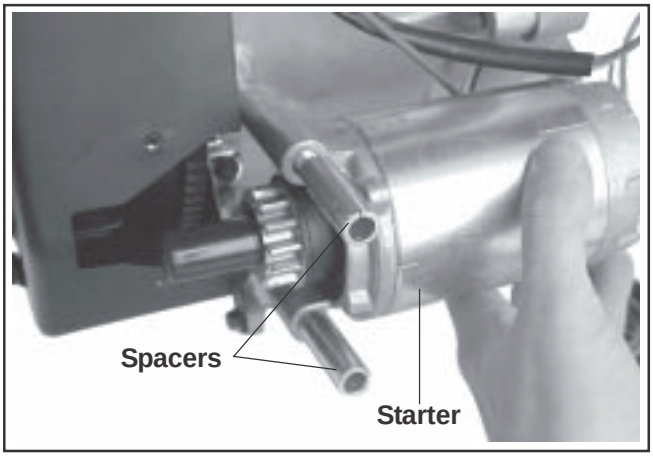


Figure 9-17. Removing Starter and Spacers.

d. If removal of the mounting studs is required, use the two hex flange nuts from the mounting studs, tightened flange to flange, to remove. See Figure 9-18.

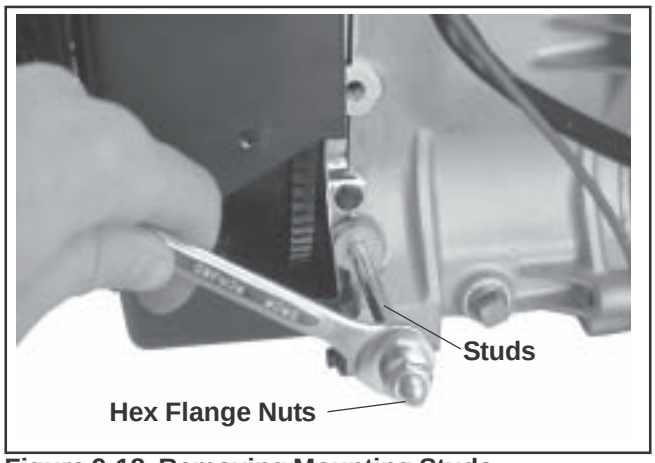


Figure 9-18. Removing Mounting Studs.

If the starter is mounted with two hex flange screws, remove the screws and pull the starter out from behind the pinion cover.

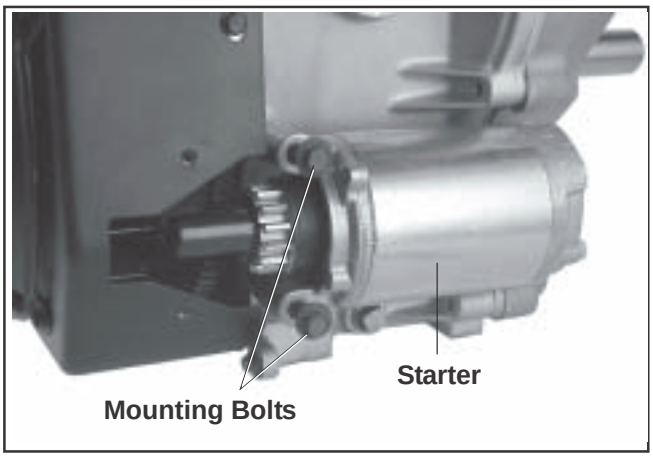


Figure 9-19. Starter Mounted With Bolts.

Remove Rectifier-Regulator

1. Remove the connector(s) from the rectifier-regulator. See Figure 9-20.

2. Remove the two hex flange screws securing the rectifier-regulator and the attached ground lead (non-metal blower housing only).

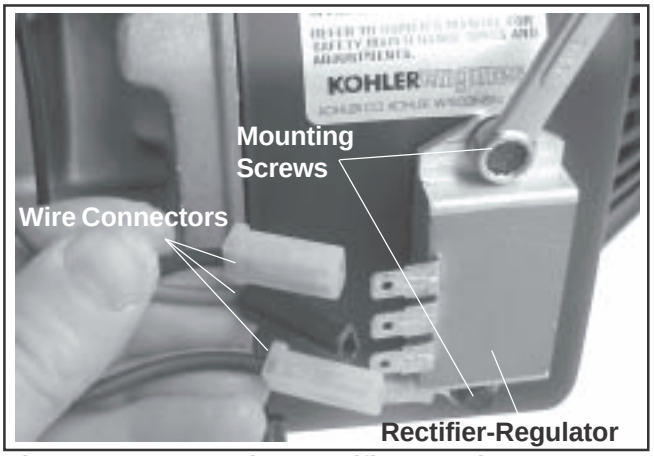


Figure 9-20. Removing Rectifier-Regulator.

Remove Oil Sentry™

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

2. Remove Oil Sentry™ switch from the oil filter adapter or adapter section of closure plate. See Figure 9-21.

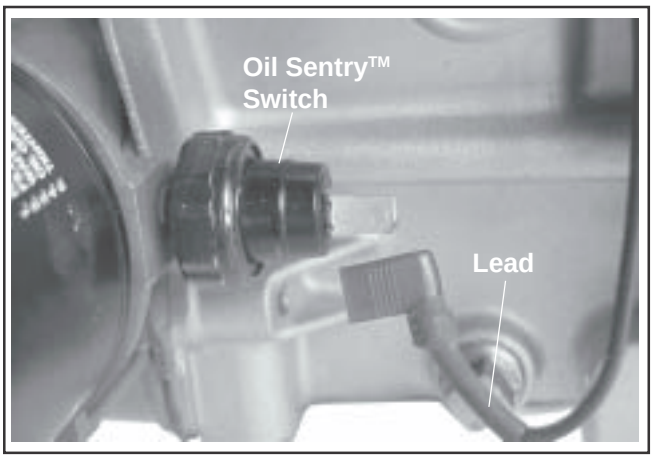


Figure 9-21. Removing Oil Sentry™ Switch.

Remove Valve Cover

1. Remove the five hex flange valve cover screws. Note the assembly orientation of any attached brackets (lift, fuel tank, muffler) and loose spacers if used. See Figure 9-22.

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

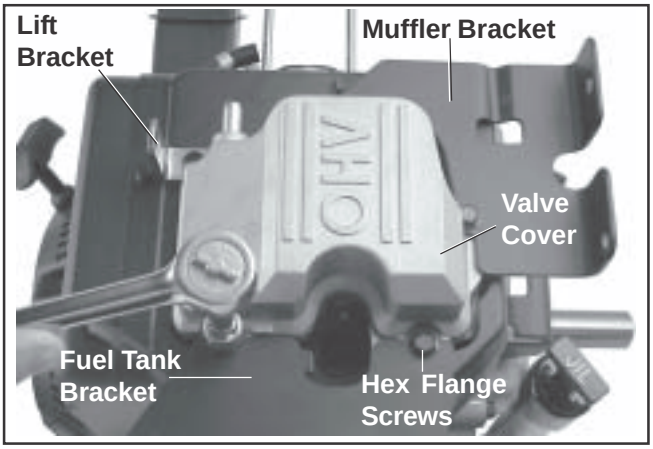


Figure 9-22. Removing Valve Cover.

Remove Cylinder Head Baffle

1. Remove the hex flange screws securing the cylinder head baffle to the cylinder head. See Figure 9-23. Remove the baffle.

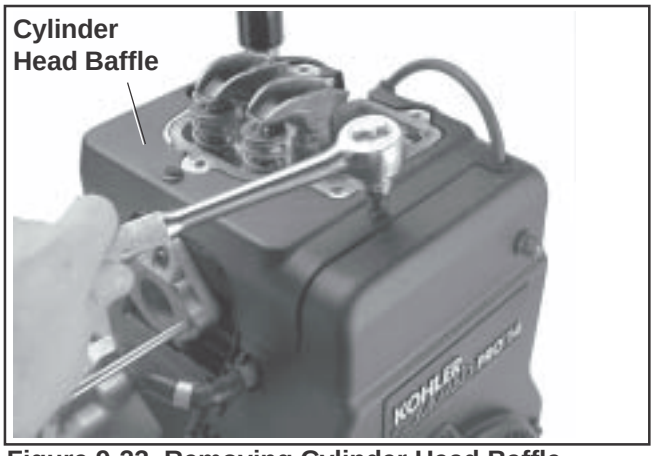


Figure 9-23. Removing Cylinder Head Baffle.

Remove Blower Housing and Baffles

1. Remove the hex flange screws from the blower housing and baffles. Disconnect the wire harness from the key switch, if equipped. Remove the blower housing, intake tube and baffles. See Figures 9-24, 9-25, and 9-26.

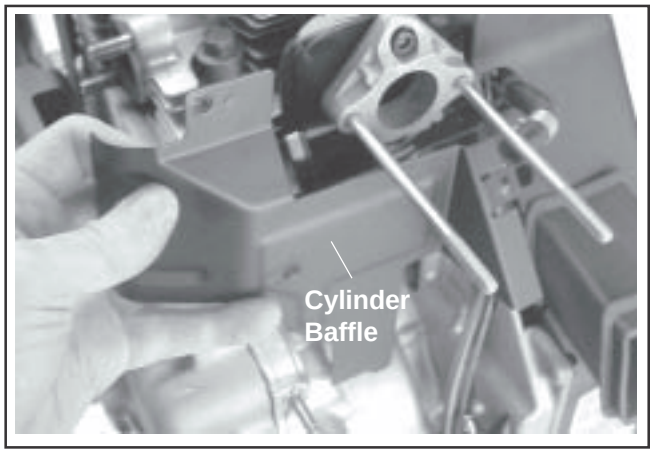


Figure 9-24. Removing Intake Side Cylinder Baffle.

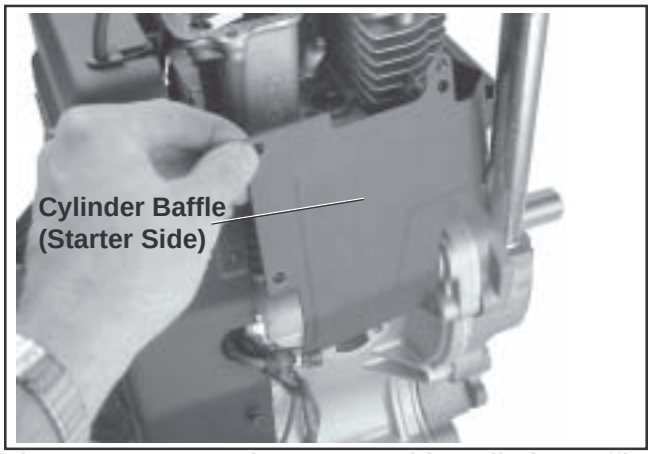


Figure 9-25. Removing Starter Side Cylinder Baffle.

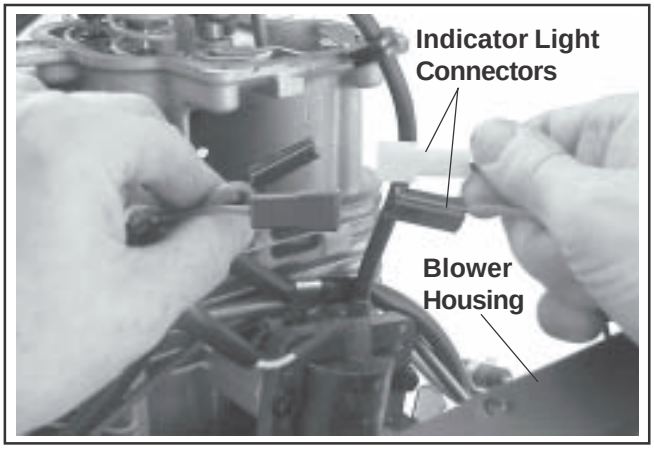


Figure 9-26. Disconnecting Indicator Light Leads and Removing Blower Housing.

Remove Carburetor Adapter and Heat Deflector

1. Remove the two socket head cap screw securing carburetor adapter, gaskets and heat deflector to the cylinder head. See Figure 9-27.

2. Remove the carburetor adapter, heat shield, and gaskets from the engine. See Figure 9-27.

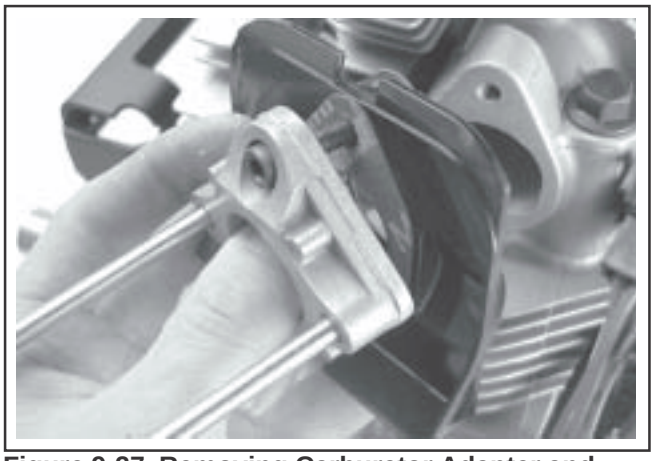


Figure 9-27. Removing Carburetor Adapter and Heat Deflector.

Remove Ignition Module

1. Disconnect the kill lead from the ignition module terminal. See Figure 9-28.

2. Rotate flywheel magnet away from ignition module.

3. Remove the two hex flange screws and ignition module.

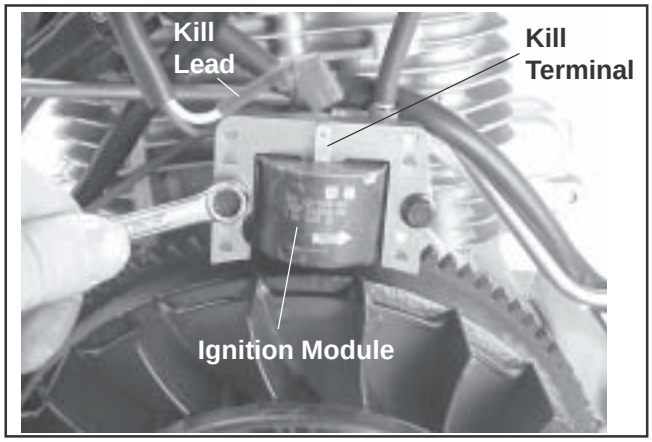


Figure 9-28. Removing Ignition Module.

Remove Fuel Line

1. Remove the hex flange screw, clip, and fuel line. See Figure 9-29.

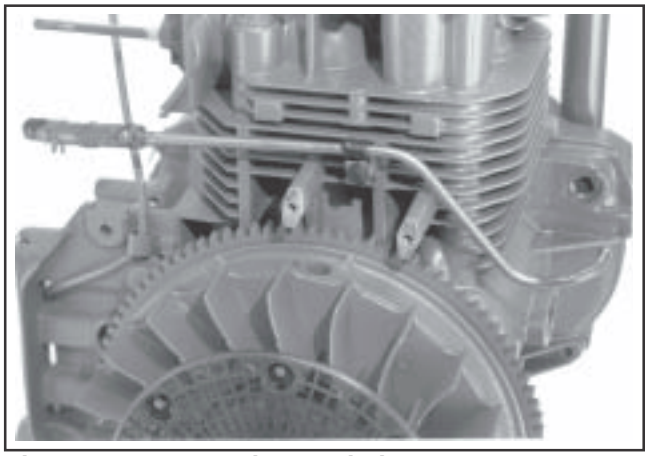


Figure 9-29. Removing Fuel Line.

Remove Cylinder Head

1. Remove the hex flange screws, spacer (from the screw by the exhaust port), cylinder head, push rods, and cylinder head gasket. See Figures 9-30 and 9-31. Mark the push rods for reassembly. Discard the screws. Do not reuse.

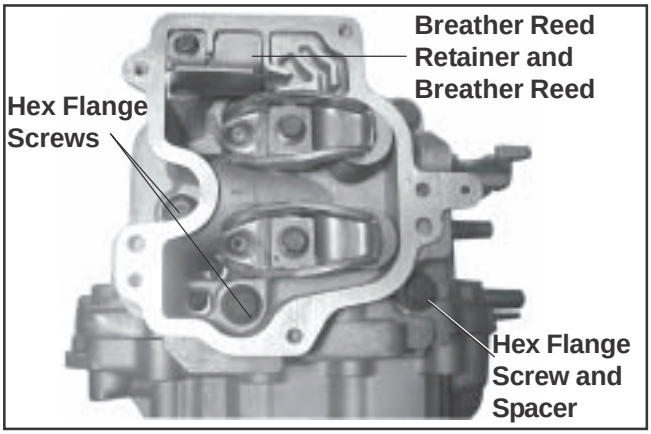


Figure 9-30. Removing Cylinder Head.

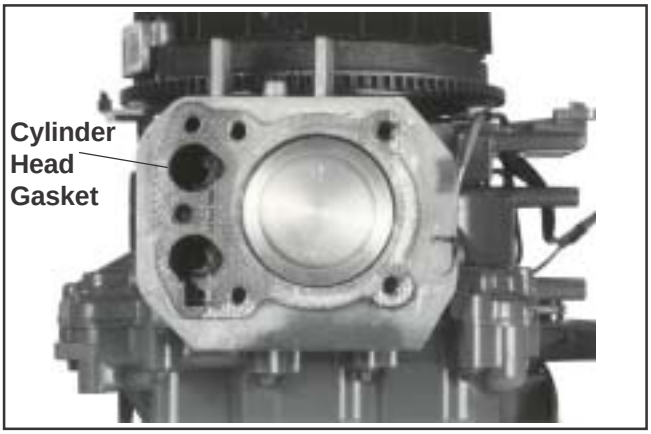


Figure 9-31. Removing Cylinder Head Gasket.

Disassemble Cylinder Head

Two basic types of heads are used. One type utilizes a rocker bridge arrangement as shown in Figure 9-33. The second type uses individually mounted rocker arm assemblies, with or without a guide plate, rather than a bridge. This type is shown in Figure 9-32. Components are unique to each style of head. Follow the appropriate procedure based upon the type of head configuration involved.

NOTE: Before disassembly, mark all valve train components to assure they are reassembled in the same side if reused.

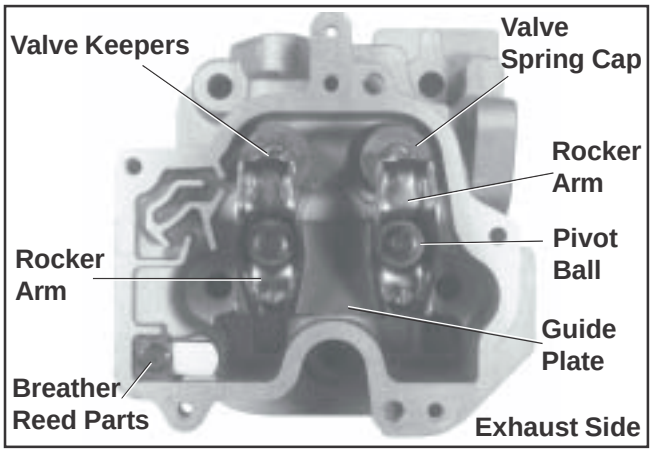


Figure 9-32. Head with Individually Mounted Pivots/Rocker Arm.

1. Remove the spark plug. See Figure 9-33.

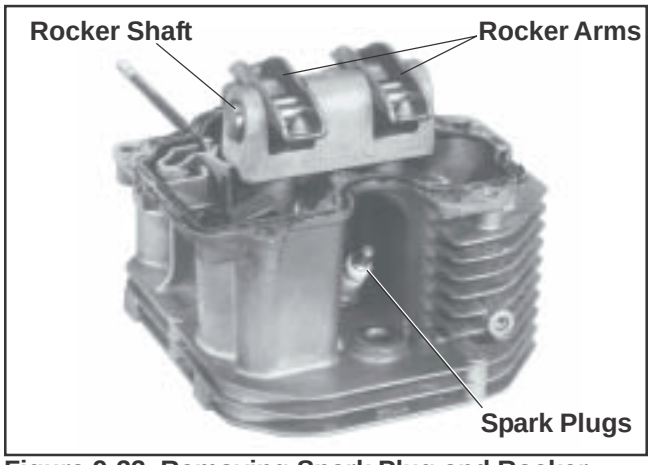


Figure 9-33. Removing Spark Plug and Rocker Arms.

2. Remove the hex flange screw, breather reed retainer, and breather reed.

3. **Rocker Bridge Equipped Heads** - Figure 9-33.

   a. Remove the rocker shaft (from the breather side of head), and rocker arms.

   b. Remove the two hex cap screws and the rocker bridge. See Figure 9-35.

   Heads with Individually Mounted Pivots/ Rocker Arms - Figure 9-32.

   c. Remove the hex flange screws securing the rocker arm/pivot assemblies, and guide plate (if so equipped), to the head.

4. Remove the valves.

   a. Compress the valve springs using a valve spring compressor. See Figure 9-32.

   b. Remove the keepers, valve spring caps, valve springs, the retainers* or exhaust valve rotator, (early models only), and the intake valve stem seal*.

   *Not used on some models.

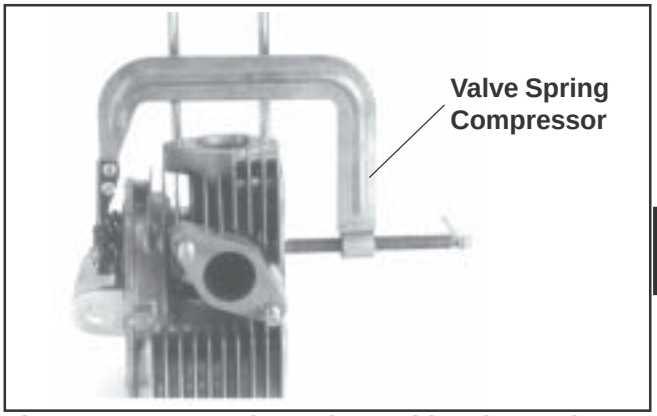


Figure 9-34. Removing Valves With Valve Spring Compressor.

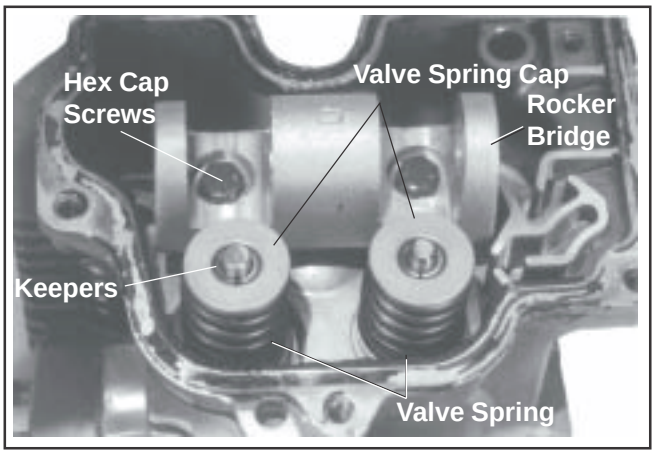


Figure 9-35. Removing Valves.

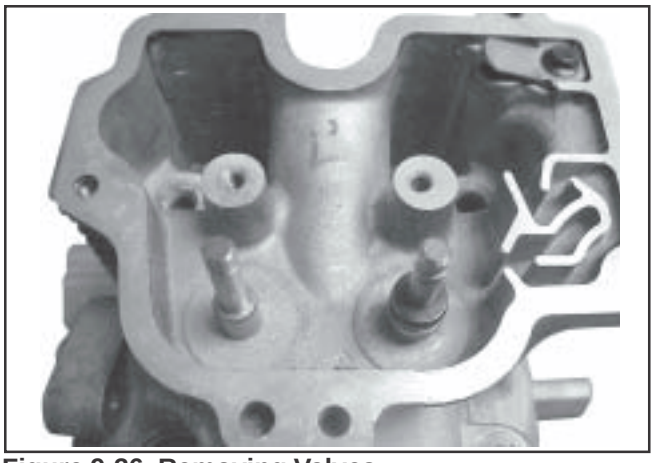


Figure 9-36. Removing Valves.

Remove Drive Cup, Grass Screen, Flywheel, and Fan

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

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

1. Remove the hex flange screw, plain washer, and recoil starter drive cup*. See Figure 9-37.

   *Not used on models with electric start only. On these models the grass screen must be removed first, to access the hex flange screw and washer.

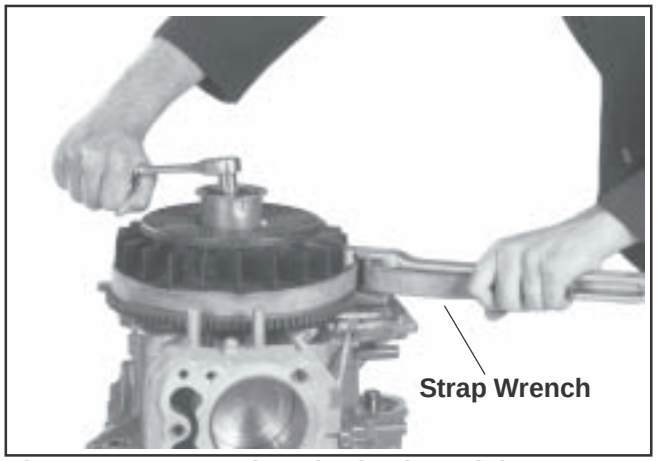


Figure 9-37. Removing Flywheel Retaining Screw and Drive Cup.

2. Unsnap and remove the grass screen from the fan.

3. Remove the flywheel from the crankshaft using a puller. See Figure 9-38.

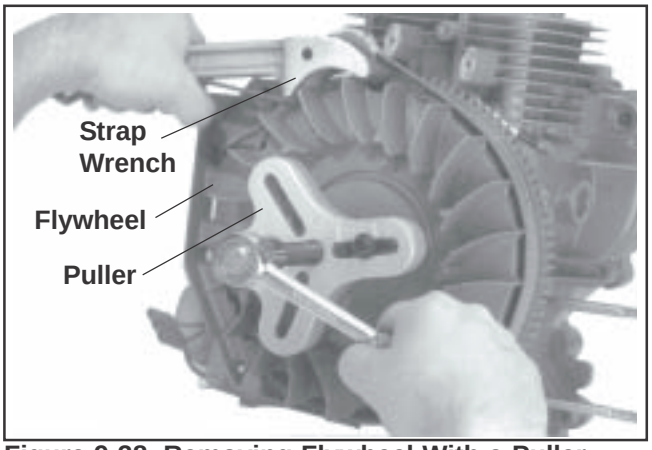


Figure 9-38. Removing Flywheel With a Puller.

4. Remove the four hex flange screws and fan from flywheel. See Figure 9-39.

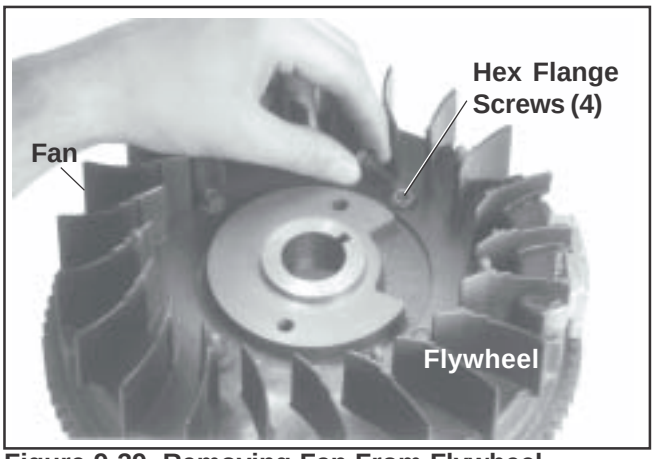


Figure 9-39. Removing Fan From Flywheel.

Remove the Stator and Wiring Harness

1. Remove the stator leads from the connector body.

2. Remove the hex flange screw and clip securing the stator leads to the crankcase. See Figure 9-40.

3. Remove the hex flange screw and clip securing the kill lead to the crankcase. Remove the four hex socket head screws and stator.

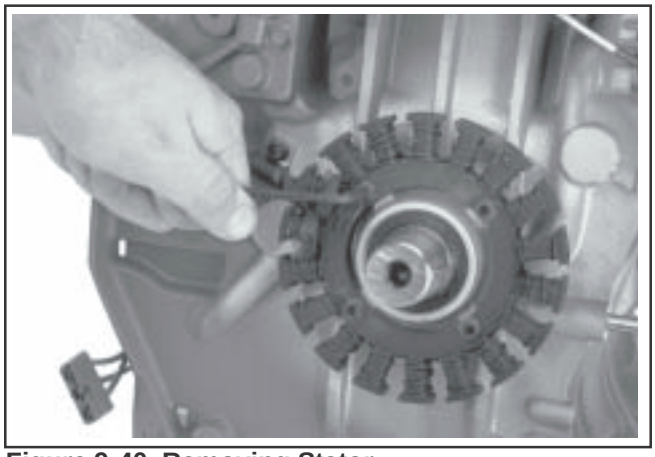


Figure 9-40. Removing Stator.

Remove Closure Plate

1. Remove the twelve hex flange screws securing the closure plate to the crankcase. See Figure 9-41.

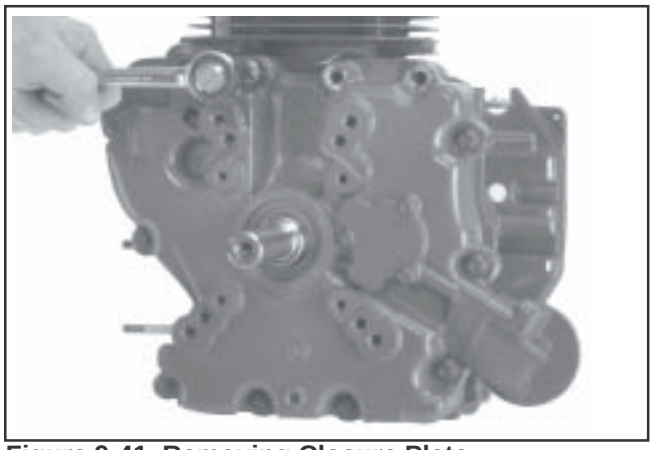


Figure 9-41. Removing Closure Plate.

2. Locate the splitting notches in the seam of the closure plate and crankcase. See Figure 9-42. Pry the closure plate from the crankcase using a large flat-blade screwdriver.

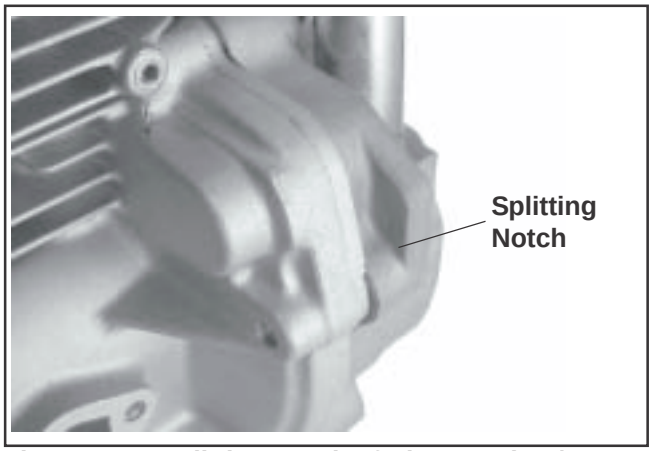


Figure 9-42. Splitting Notch of Closure Plate/ Crankcase.

NOTE: Insert the screwdriver only in the splitting notches. Do not pry on the gasket surfaces of the closure plate or crankcase as this can cause leaks.

Remove Oil Pickup, Oil Pressure Relief Valve, Oil Pump, and Oil Seal

1. Remove the oil seal from the closure plate. See Figure 9-43.

2. Remove the hex flange screw, clip, oil pickup, and O-Ring seal.

3. Identify the type of oil pressure relief valve used. If the relief valve assembly is like that shown in Figure 9-44, remove the hex socket screw, retaining bracket, valve body, piston, and spring. If the relief valve is like that shown in Figure 9-45 removal is not necessary. See the note on the next page.

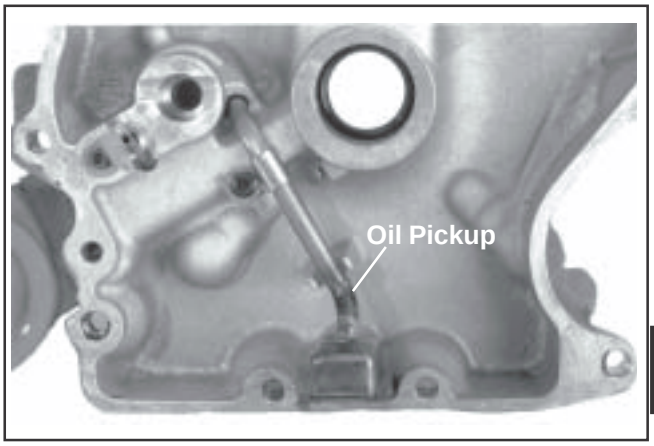


Figure 9-43. Removing Oil Seal and Pickup.

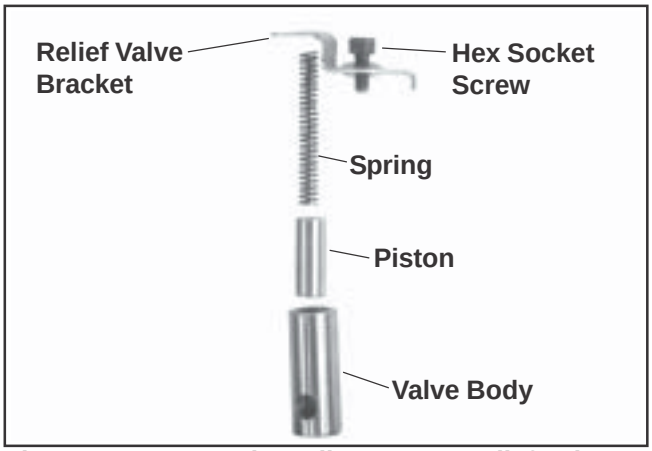


Figure 9-44. Removing Oil Pressure Relief Valve Body, Piston, and Spring (Early Style).

Figure 9-45. Later Style Oil Pressure Relief Valve.

*__NOTE:__ Later style one-piece relief valves (Figure 9-45) are staked in place and do not require removal unless replacement is intended.

4. Remove the three hex flange screws, oil pump cover, O-Ring, and oil pump rotors. See Figure 9-46.

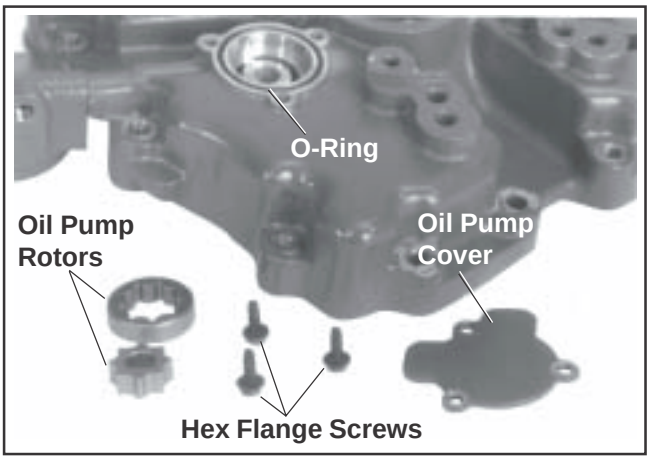


Figure 9-46. Removing Oil Pump.

Remove Camshaft and Hydraulic Lifters

1. Remove the camshaft and shim. See Figure 9-47.

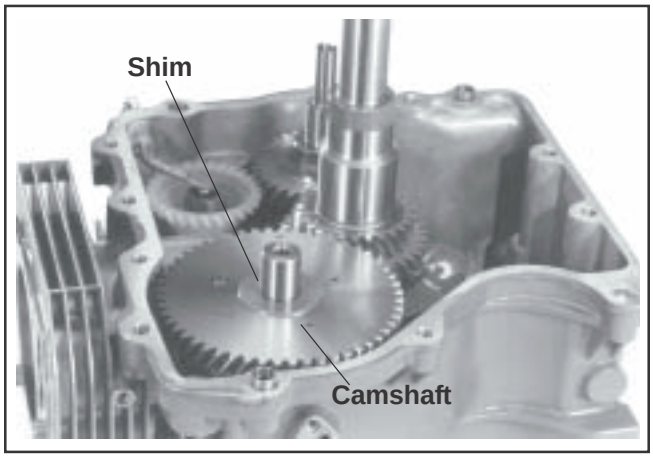


Figure 9-47. Removing Camshaft.

2. Mark or identify the hydraulic lifters as either intake or exhaust. See Figure 9-48. Remove the lifters from the crankcase.

NOTE: The intake hydraulic lifter is farthest from the crankcase gasket surface. The exhaust hydraulic lifter is nearest to the crankcase gasket surface.

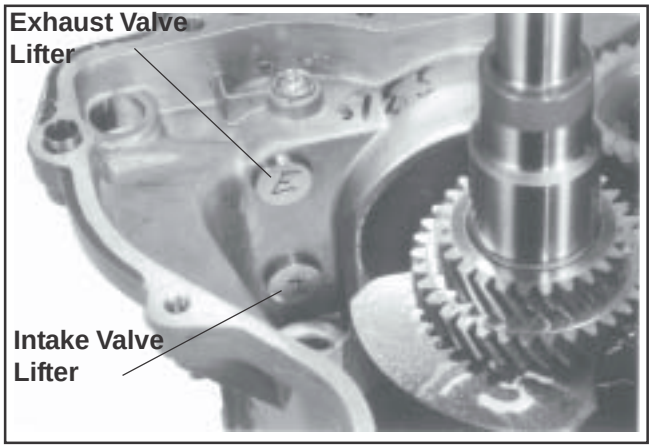


Figure 9-48. Identifying Hydraulic Lifters.

NOTE: Do not use a magnet to remove hydraulic lifters.

NOTE: Some applications do not require cylinder head removal for lifter replacement.

Remove Balance Shaft

1. Remove the balance shaft from the crankcase. See Figure 9-49.

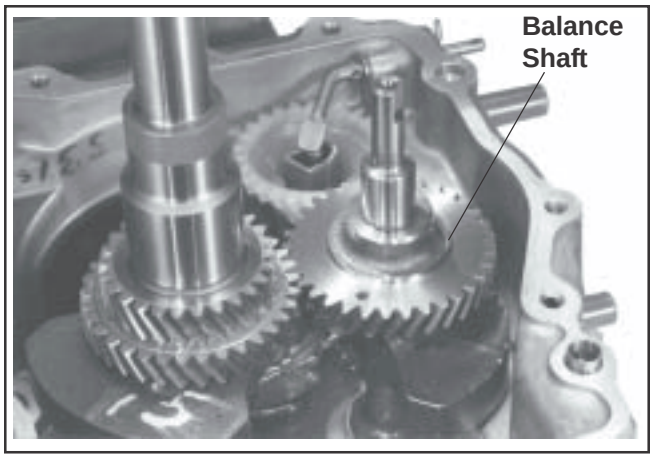


Figure 9-49. Removing Balance Shaft.

Remove Connecting Rod and Piston

1. Remove the two hex flange screws and connecting rod cap. See Figure 9-50.

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

2. Carefully push the connecting rod and the piston away from the crankshaft and out of the cylinder bore.

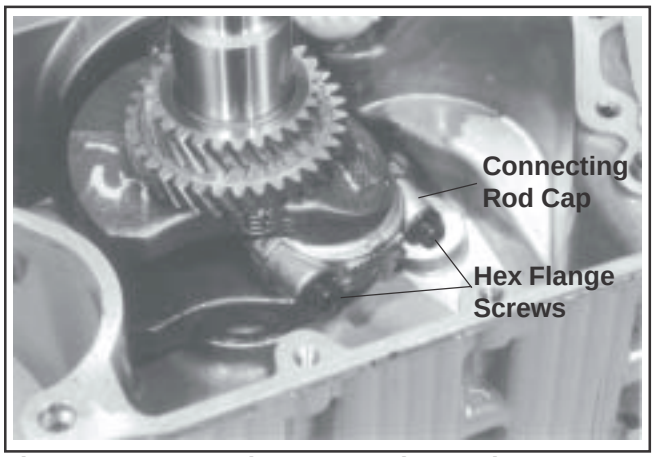


Figure 9-50. Removing Connecting Rod.

Remove Piston From Connecting Rod

1. Remove the wrist pin retainer and wrist pin. Separate the piston from the connecting rod. See Figure 9-51.

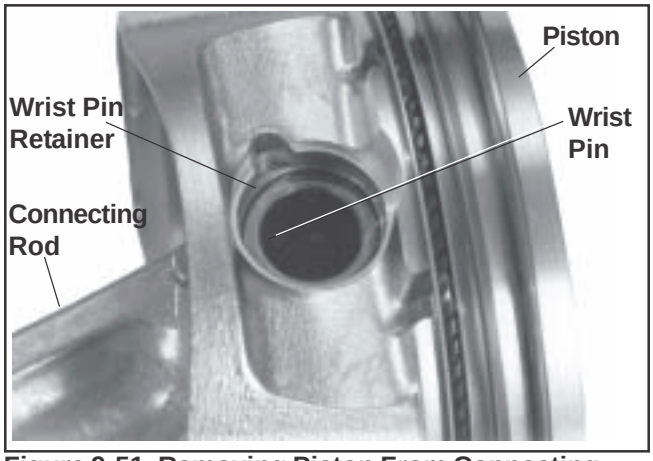


Figure 9-51. Removing Piston From Connecting Rod.

Remove Piston Rings

1. Remove the top and center compression rings using a ring expander tool. See Figure 9-52.

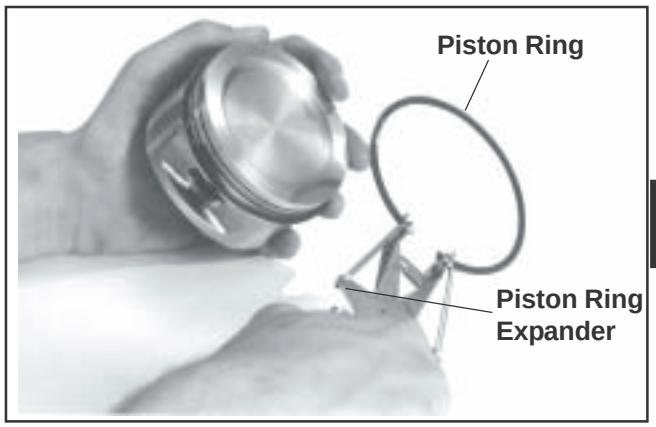


Figure 9-52. Removing Piston Rings.

2. Remove the oil control ring rails, then remove the rails spacer.

Remove Crankshaft

1. Remove the woodruff key from the flywheel end of crankshaft.

2. Remove the crankshaft from the crankcase. See Figure 9-53.

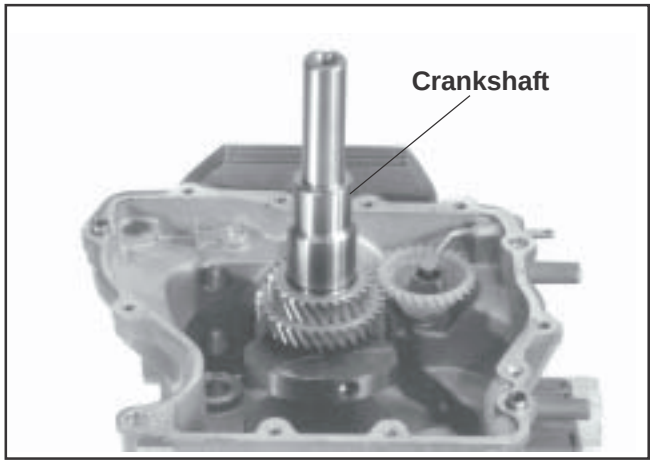


Figure 9-53. Removing Crankshaft.

Remove Flywheel End Oil Seal

1. Remove the oil seal from crankcase.

Remove Governor Cross Shaft and Governor Gear

1. Remove the hitch pin and plain washer from the governor cross shaft. See Figure 9-54.

2. Remove the cross shaft and plain washer from the crankcase.

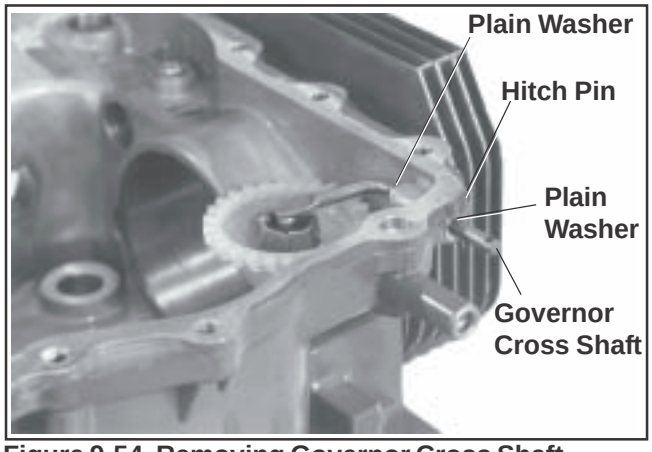


Figure 9-54. Removing Governor Cross Shaft.

3. Remove the governor cross shaft oil seal from the crankcase. See Figure 9-55.

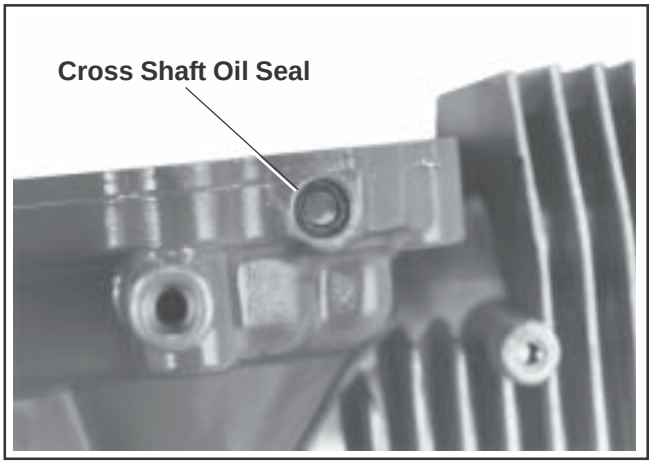


Figure 9-55. Removing Cross Shaft Oil Seal.

4. If necessary, remove the governor gear and regulating pin. See Figure 9-56.

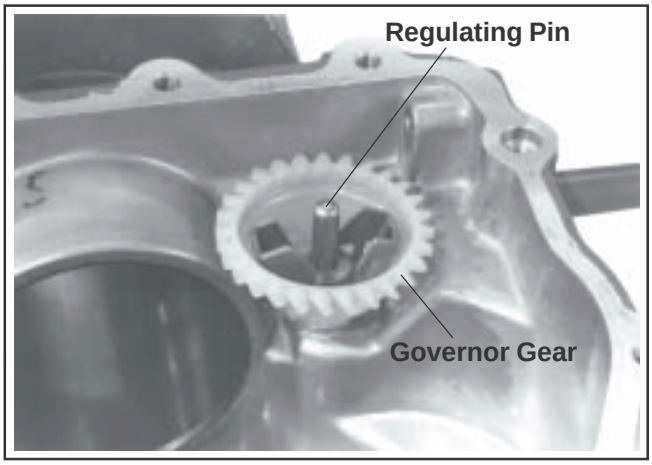


Figure 9-56. Removing Governor Gear.

NOTE: The governor gear is held onto the governor gear shaft by small molded tabs in the gear. When the gear is removed from the shaft these tabs are destroyed. This will require replacement of the gear, therefore, remove the gear only if absolutely necessary (such as when reboring, doing major engine rebuilding, etc.).

Section 10
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 8

Clean all parts thoroughly. Only clean parts can be accurately inspected and gauged for wear or damage. There are many commercially available cleaners that will quickly remove grease, oil, and grime from engine parts. When such a cleaner is used, follow the manufacturer's instructions and safety precautions carefully. Make sure all traces of the cleaner are removed before the engine is reassembled and placed into operation. Even small amounts of these cleaners can quickly break down the lubricating properties of engine oil.

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

Automatic Compression Release (ACR)

This engine is equipped with an **Automatic Compression Release (ACR)** mechanism. ACR lowers compression at cranking speeds to make starting easier.

Operation

The ACR mechanism consists of a lever and control pin assembly attached to the gear on the camshaft. At cranking speeds (700 RPM or lower), the control pin protrudes above the exhaust cam lobe. This pushes the exhaust valve off its seat during the first part of the compression stroke. The reduced compression results in an effective compression ratio during cranking of about 2:1.

After starting, engine speed increases to over 700 RPM. Centrifugal force moves the lever and the control pin drops into the recess in the exhaust cam lobe. When in the recess, the control pin has no effect on the exhaust valve and the engine operates at full power.

When the engine is stopped, the spring returns the lever and control pin assembly to the compression release position ready for the next start.

Camshaft

Inspection and Service

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

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 bearings for scoring, grooving, etc. Do not replace bearings unless they shown signs of damage or are out of running clearance specifications. If the crankshaft turns easily and noiselessly, 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 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 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.

Crankcase

Inspection and Service

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

Check the cylinder bore wall for scoring. In severe cases, unburned fuel can cause scuffing and scoring of the cylinder wall, washing 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 blocking 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 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 that the stones are in contact with the cylinder wall. Use of a commercial cutting-cooling agent is recommended.
2. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and honing process. Move the hone up and down while resizing to prevent the formation of cutting ridges. Check the size frequently.

   NOTE: Measure the piston diameter and resize the bore to the piston to obtain the specified running clearances. Keep in mind the temperatures caused by honing may cause inaccurate measurements. Make sure the bore is cool when measuring.

3. When the bore is within **0.064 mm (0.0025 in.)** of desired size, remove the coarse stones and replace with burnishing stones. Continue with the burnishing stones until within **0.013 mm (0.0005 in.)** of desired size and then use finish stones (220-280 grit) and polish to final size. A crosshatch should be observed if honing is done correctly. The crosshatch should intersect at approximately 23-33° off the horizontal. Too flat of an angle could cause the rings to skip and wear excessively, too steep of an angle will result in high oil consumption (refer to Figure 10-1).

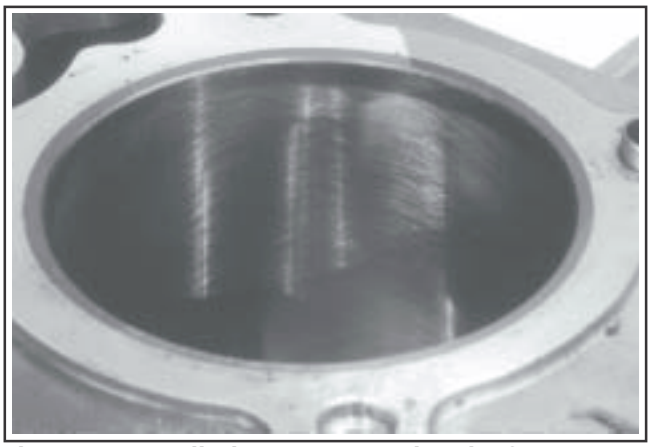


Figure 10-1. Cylinder Bore Crosshatch after Honing.

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

Clean Cylinder Bore after Honing

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

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

Measuring Piston-to-Bore Clearance

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

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

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

1. With a micrometer, measure the diameter of the piston perpendicular to the piston pin, and up from the bottom of the piston skirt as indicated in Figure 10-2, based on the model involved.

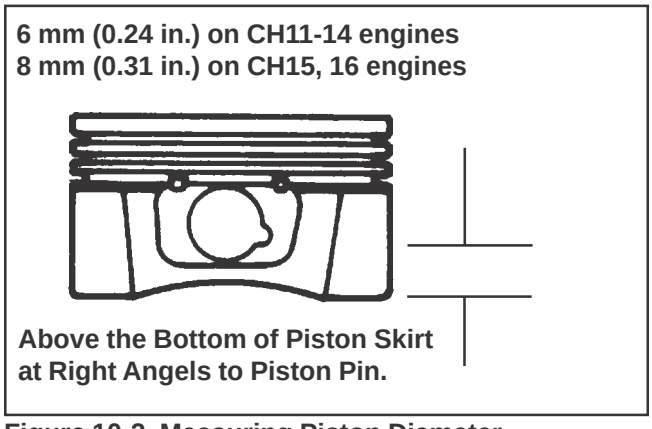


Figure 10-2. Measuring Piston Diameter.

2. Use an inside micrometer, telescoping gauge, or bore gauge and measure the cylinder bore. Take the measurement approximately **63.5 mm (2.5 in.)** below the top of the bore and perpendicular to the piston pin.

3. Piston-to-bore clearance is the difference between the bore diameter and the piston diameter (step 2 minus step 1).

Flywheel

Inspection

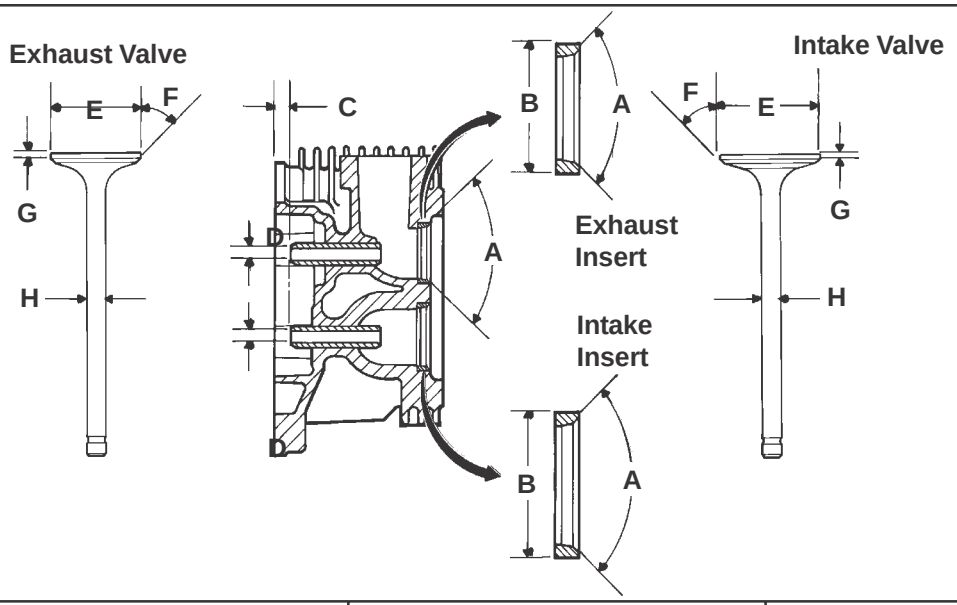
Inspect the flywheel for cracks, and the flywheel keyway for damage. Replace flywheel if cracked. Replace the flywheel, the crankshaft, and the key if flywheel key is sheared or the keyway damaged.

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

Cylinder Head and Valves

Inspection and Service

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 guides. See Figure 10-3 for valve details and specifications.



	Dimension	Intake	Exhaust
A	Seat Angle	89°	89°
B	Insert O.D.	37.987/38.013 mm	34.013/33.987 mm
C	Guide Depth	6.5 mm	6.5 mm
D	Guide I.D.	7.033/7.058 mm	7.033/7.058 mm
E	Valve Head Diameter	35.63/35.37 mm	31.63/31.37 mm
F	Valve Face Angle	45°	45°
G	Valve Margin (Min.)	1.5 mm	1.5 mm
H	Valve Stem Diameter	6.982/7.000 mm	6.970/6.988 mm

Figure 10-3. Valve Details.

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

Then, carefully inspect each valve for defects such as warped head, excessive corrosion, or worn stem end. Replace valves found to be in bad condition.

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. 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. If the clearance exceeds **7.134 mm (0.2809 in.)** on intake or **7.159 mm (0.2819 in.)** on exhaust valve, determine whether the valve stem or the guide is responsible for the excessive clearance.

If the valve stem diameter is within specifications, then recondition the valve guide.

Reconditioning Valve Guide

The valve guides in the cylinder head are not removable. Use a **0.25 mm (0.010 in.)** O/S reamer (See Section 2).

Valve Seat Inserts

Intake valve seats are usually machined into the cylinder head, however, certain applications may specify hard alloy inserts. The valve seats are not replaceable. If cracked or badly warped, the cylinder head should be replaced.

Use a standard valve seat cutter (see Figure 10-4) and cut seat to dimensions shown in Figure 10-3 (valve details illustration).

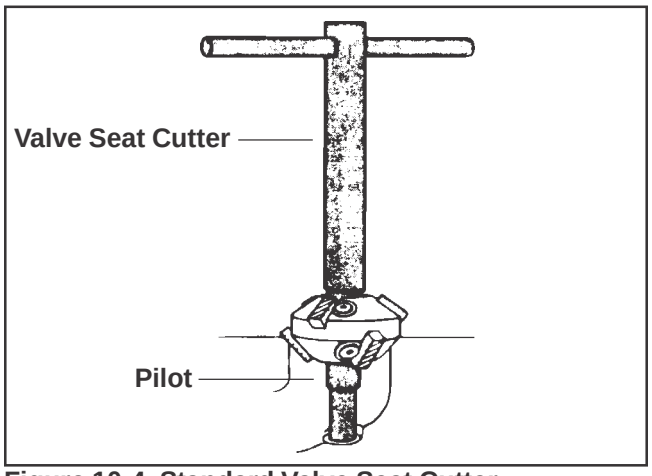


Figure 10-4. Standard Valve Seat Cutter.

Lapping Valves

Reground or new valves must be lapped in, to provide fit. Lightly coat valve face with **fine** grade of grinding compound. Use a hand valve grinder with suction cup for final lapping. Clean and dry cylinder head and apply a light coating of **SAE 10** oil to prevent rusting.

Intake Valve Stem Seal

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

Pistons and Rings

Inspection

Scuffing and scoring of pistons and cylinder walls occurs when internal temperatures approach the welding point of the piston, 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 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. 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 fuels with low octane.

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 - often a hole is quickly burned right through the piston dome. Preignition is caused by a hot spot in the combustion chamber from sources such as: glowing carbon deposits, blocked fins, improperly seated valve, or wrong spark plug.

See Figure 10-5 for some common types of piston and ring damage.

Stuck, Broken Rings

Abrasive Scratched Rings

Overheated or Deteriorated Oil

Scored Piston and Rings

Figure 10-5. 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 (0.20 in.)** oversizes. Replacement pistons include new piston ring sets and new piston pins.

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

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

Some important points to remember when servicing piston rings:

1. 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.
2. Remove old rings and clean up grooves. **Never reuse old rings.**
3. Before installing the rings on the piston, place the top two rings, each in turn, in its running area in the cylinder bore and check end gap using a feeler gauge (see Figure 10-6). Compare findings against specs below:

Top and Center Compression Ring End Gap

CH11, 12.5, 13, and 14

New Bore ..... 0.3/.05 mm (0.012/0.020 in)
Used Bore (Max.) . 0.77 mm (0.030 in)

CH15, 16

Top Compression Ring End Gap
New Bore ..... 0.2800/0.5100 mm (0.011/0.020 in)
Used Bore (Max.) . 0.79 mm (0.031 in)

Center Compression Ring End Gap
New Bore ..... 0.2200/0.4800 mm (0.0086/0.018 in)
Used Bore (Max.) . 0.76 mm (0.029 in)

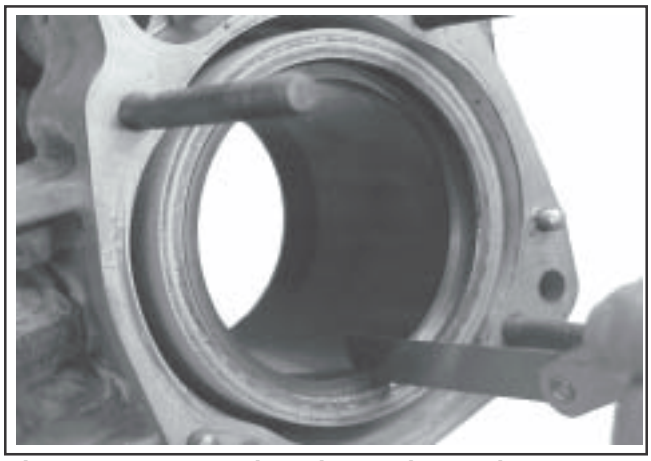


Figure 10-6. Measuring Piston Ring End Gap.

4. After installing the new compression (top and middle) rings on the piston, check the "piston-to-ring" side clearance. See Figure 10-7 Compare findings against the maximum recommended side clearances listed below. If side clearance are greater than specified, a new piston **must** be used.

Compression Ring-To-Grove Side Clearance
CH11, 12.5, 13, and 14
Top ..... 0.040/0.150 mm (0.0016/0.0041 in.)
Middle ..... 0.040/0.072 mm (0.0016/0.0028 in.)
CH15, 16
Top ..... 0.0600/0.1050 mm (0.00236/0.00413 in)
Middle ..... 0.0400/0.0850 mm (0.00157/0.00335 in.)

Figure 10-7. Measuring Piston Ring Side Clearance.

Install Piston Rings

To install piston rings, proceed as follows:

NOTE: Rings must be installed correctly. Ring installation instructions are usually included with new rings sets. Follow instructions carefully. Use a piston ring expander to install rings. Install the bottom (oil control) ring first and the top compression ring last. Refer to Figure 10-8.

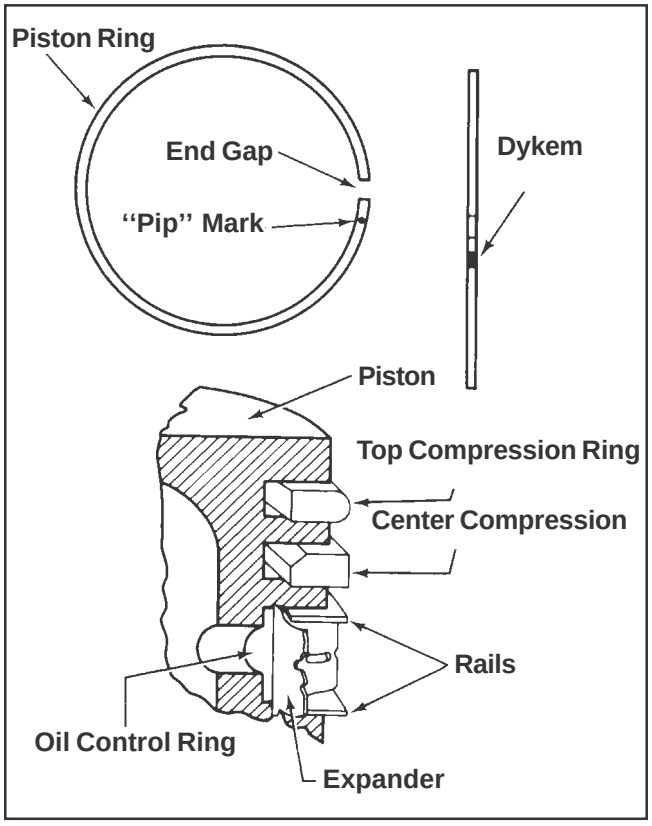


Figure 10-8. Piston Ring Installation.

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

2. Compression Ring (Center Groove): Install the center ring using a piston ring installation tool. Make sure the "pip" mark is up and the PINK dykem stripe is to the left of end gap.

3. Compression Ring (Top Groove): Install the top ring using a piston ring installation tool. Make sure the "pip" mark is up and the BLUE dykem stripe is to the left of end gap.

Connecting Rods

Offset Stepped-Cap Connecting Rods are used in all these engines.

Inspection and Service

Check bearing area (big end) for excessive wear, score marks, running and side clearances (refer to Section 1, Specifications, Tolerances, and Special Torque Values). Replace 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.

Oil Pump

Inspection and Service
Pump can be checked/replaced without removing closure plate.

Oil Pressure Relief Valve
If an original style (five-piece) oil pressure relief valve is used (see Figure 10-9), check that piston and body are free of nicks or burrs. Check the spring for any wear or distortion. The free length of the spring should be approximately **0.992 in**. Replace the spring if worn, out of specification, or damaged/distorted.

If the later style (one-piece) oil pressure relief valve (see Figure 10-10) is used (staked to the closure plate), check to see that the internal spring-loaded piston is free. Remove the valve only if it needs to be replaced.

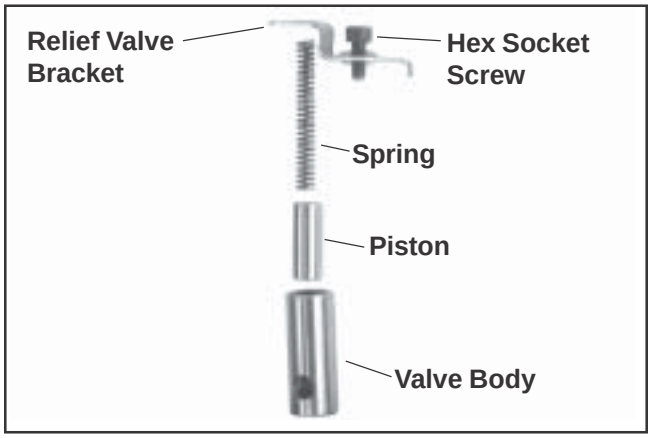


Figure 10-9. Five-Piece Oil Pressure Relief Valve.


Figure 10-10. One-Piece Oil Pressure Relief Valve.

Governor Gear

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

The governor gear **must** be replaced once it is removed from the engine.

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.

Stamped Steel Valve Cover
If the engine has stamped steel valve cover, the sealing surface must be checked for flatness prior to reinstallation. Hold the valve cover down firmly against a flat, level surface or piece of glass, and check around the entire perimeter that a **0.012 in. (0.30 mm)** feeler gauge cannot be inserted anywhere. See Figure 10-11. If the gauge goes in anywhere, the cover needs to be replaced.

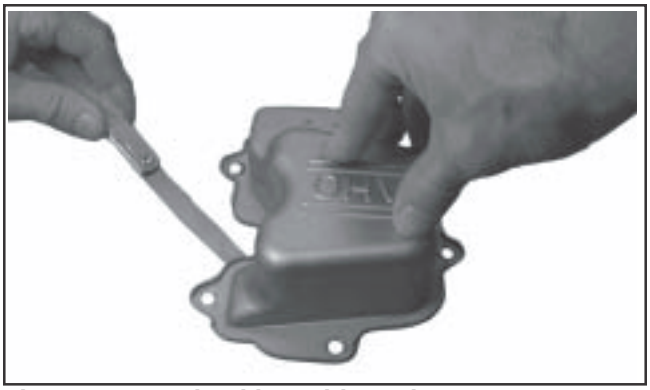


Figure 10-11. Checking with Feeler Gauge.

Section 11
Reassembly

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. This procedure may be varied to accommodate options or special equipment.

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.

NOTE: Always use new gaskets.

Typical Reassembly Sequence

1. Install governor gear and cross shaft.
2. Install crankshaft.
3. Install piston rings.
4. Assemble piston to connecting rod.
5. Install piston and connecting rod.
6. Install balance shaft.
7. Install hydraulic lifters and camshaft.
8. Check camshaft end play.
9. Install closure plate.
10. Install oil pump.
11. Install oil seal (PTO and Flywheel End).
12. Install stator and wiring harness.
13. Install flywheel, fan, grass screen and drive cup.
14. Install fuel line.
15. Install ignition module.
16. Assemble and install cylinder head.
17. Install carburetor adapter and heat deflector.
18. Install baffles and blower housing.
19. Install valve cover and muffler bracket.
20. Install fuel pump.
21. Install electric starter.
22. Install fuel tank.
23. Install rectifier-regulator.
24. Install carburetor and external governor components.
25. Install throttle bracket.
26. Install air cleaner base, air intake system, adjust governor lever.
27. Install retractable starter.
28. Install muffler.
29. Prepare engine for operation.
30. Test engine.

Install Governor Gear and Cross Shaft

NOTE: Reuse of an old (removed) governor gear is not recommended.

1. Install the thrust washer to governor gear shaft.

2. Position the regulating pin to governor gear/ flyweights as shown in Figure 11-1. Slide the governor gear/regulating pin over the governor gear shaft.

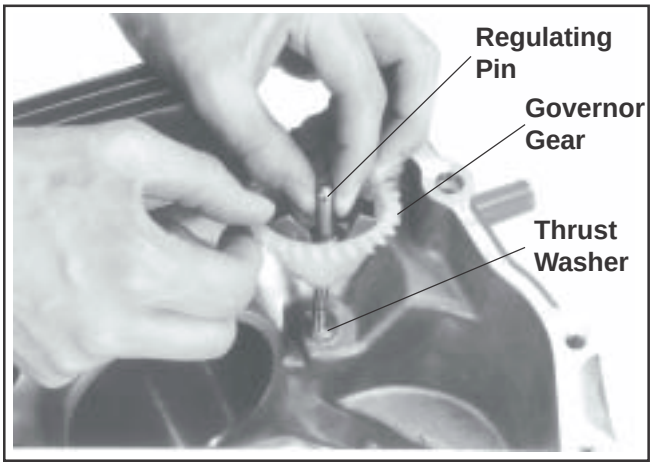


Figure 11-1. Installing Governor Gear.

3. Using the **an oil seal installer**, install a new governor cross shaft oil seal into the crankcase. See Figure 11-2.

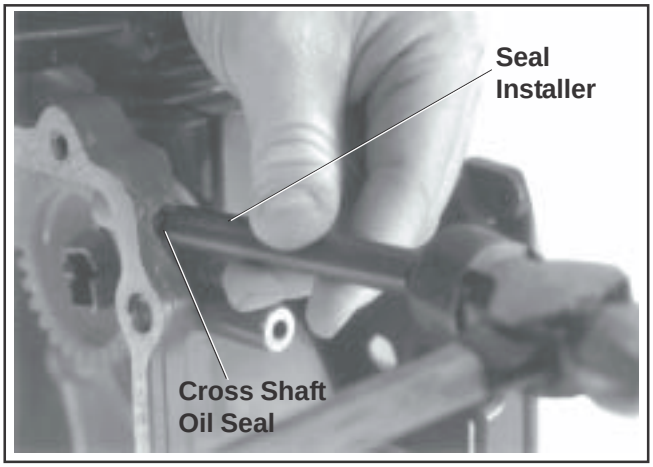


Figure 11-2. Cross Shaft Oil Seal.

4. Install one plain washer to the cross shaft and insert the cross shaft (from inside crankcase) through the crankcase and oil seal. See Figure 11-3.

5. Install one plain washer and hitch pin.

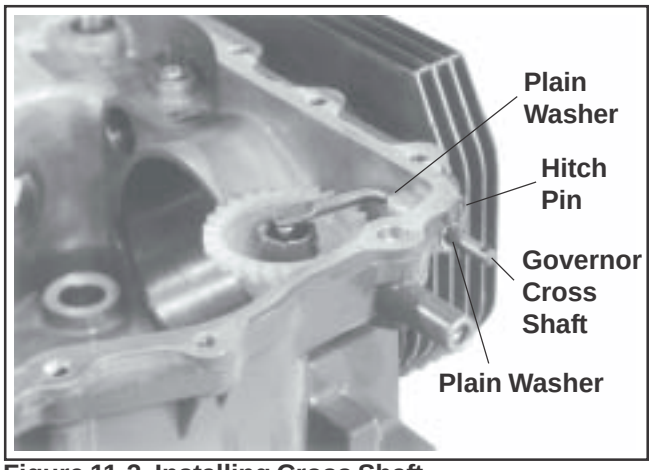


Figure 11-3. Installing Cross Shaft.

Install Crankshaft

1. Lubricate the flywheel end bearing surfaces of the crankshaft and crankcase with engine oil.

2. Insert the crankshaft through the flywheel end bearing. See Figure 11-4.

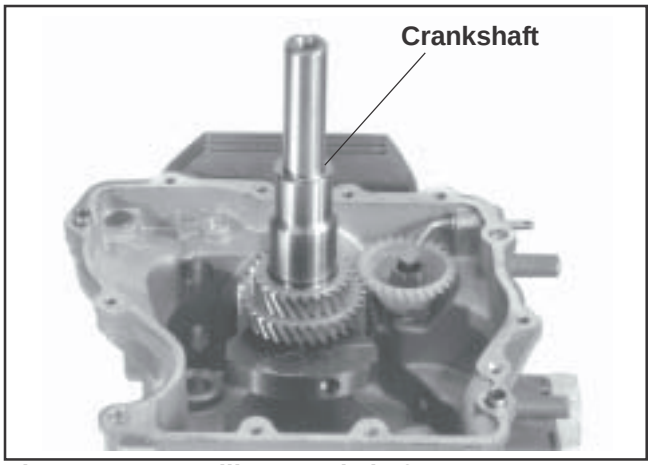


Figure 11-4. Installing Crankshaft.

Install Piston Rings

NOTE: For detailed piston inspection procedures and piston ring installation procedure, refer to Section 10.

Assemble Piston to Connecting Rod

1. Assemble the piston, connecting rod, piston pin, and piston pin retainers. See Figure 11-5.

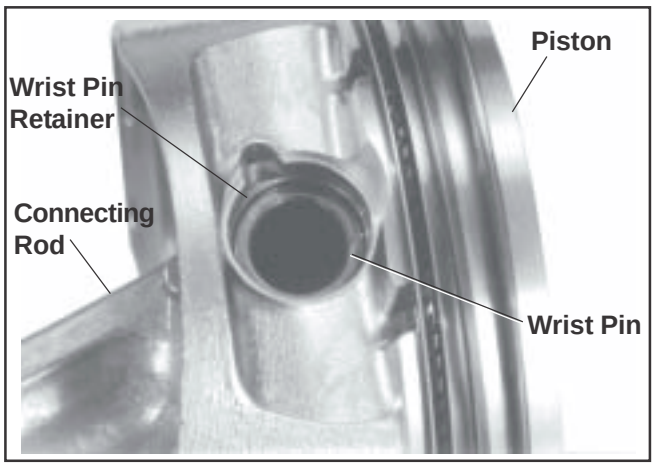


Figure 11-5. Installing Piston To Connecting Rod.

Install Piston and Connecting Rod

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

1. Stagger the piston rings in the grooves until the end gaps are 120° apart.

2. Lubricate the cylinder bore, piston, and rings with engine oil. Compress the piston rings using a piston ring compressor. See Figure 11-6. Push the piston through the compressor so the oil control (bottom) ring is just above the lower edge of the compressor.

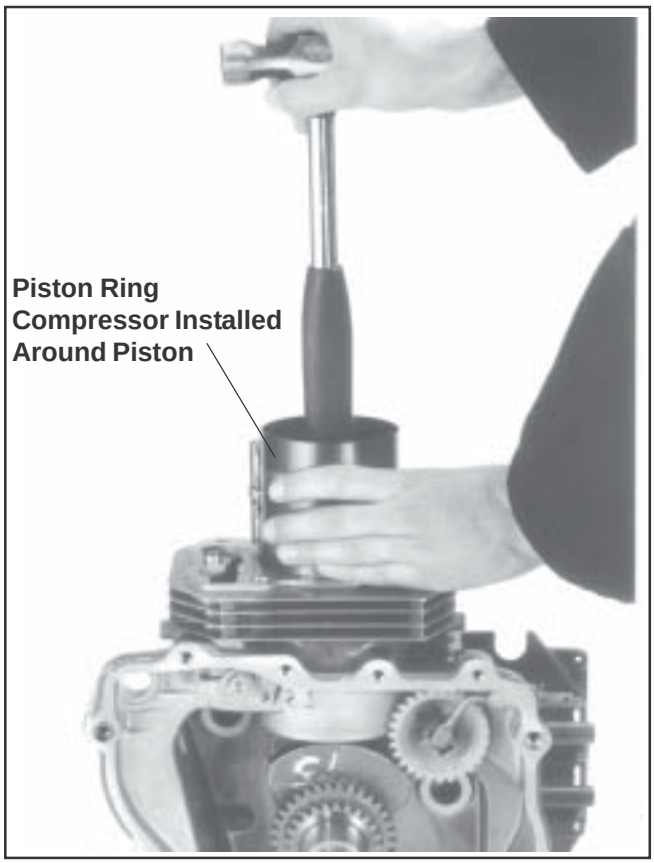


Figure 11-6. Installing Piston and Connecting Rod.

3. Place the ring compressor on the top surface of the crankcase and make certain it is seated down around the entire circumference. The **FLY** arrow on the piston should point toward the flywheel side of the crankcase. See Figure 11-7. Use a soft, rubber grip hammer handle and tap the piston/connecting rod into the bore. The first tap should be rather firm, so the oil ring moves from the compressor into the bore in one smooth, quick motion. Otherwise the oil ring rails may spring out and jam between the ring compressor and the top of the bore.

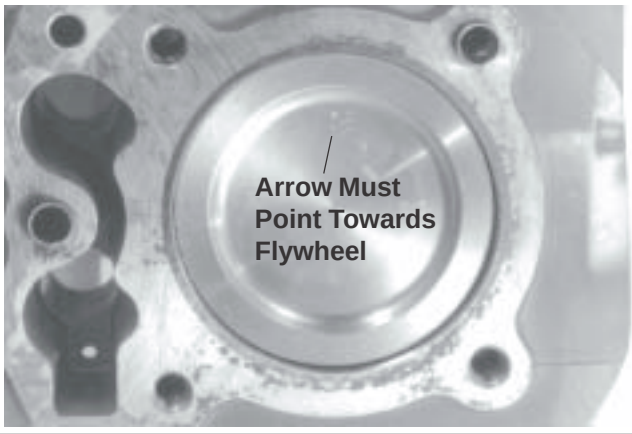


Figure 11-7. Piston Installation Identifier.

4. Lubricate the crankshaft journal and connecting rod bearing surfaces with engine oil. Install the rod cap to the connecting rod.

5. Three different types of connecting rod bolts have been used in production, and each has a different specific torque value. See Figures 11-8 and 11-9.

   The 8 mm straight shank style rod bolts must be torqued in increments to **22.7 N·m (200 in. lb.)**. The 8 mm step-down shank style rod bolts must be torqued in increments to **14.7 N·m (130 in. lb.)**. The 6 mm straight shank style rod bolts must be torqued in increments to **11.3 N·m (100. in. lb.)**. Illustrated instructions are also provide in the service rod package.

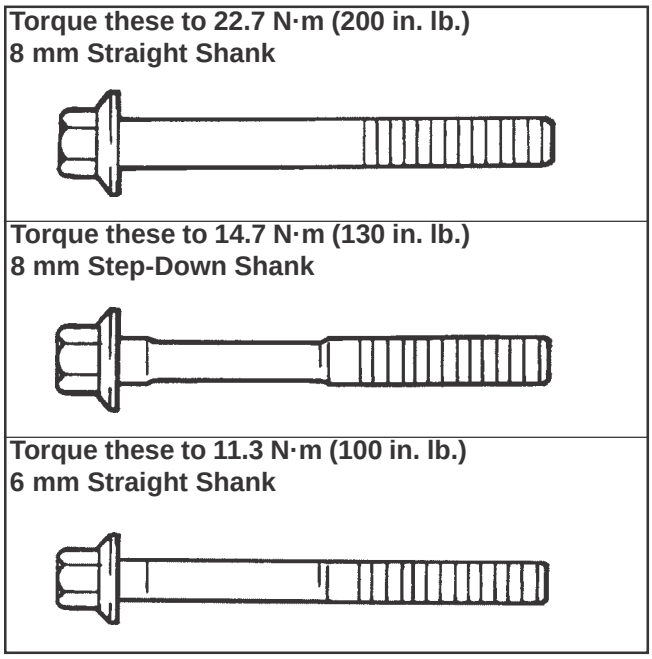


Figure 11-8. Connecting Rod Bolts.

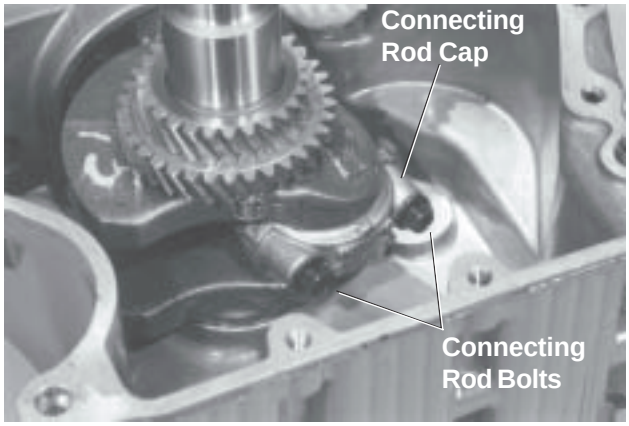


Figure 11-9. Installing Connecting Rod Fasteners.

6. Rotate the crankshaft until the piston is at top dead center (TDC) in the cylinder bore.

Install Balance Shaft

1. Lubricate the balance shaft bearing surfaces of the crankcase and balance shaft with engine oil.

2. Align the timing mark on the balance shaft gear and the larger gear on the crankshaft. Lower the balance shaft into the bearing surface in the crankcase.

3. Make sure the balance shaft gear, large crankshaft gear and the governor gear teeth mesh and the timing marks are aligned. See Figure 11-10.

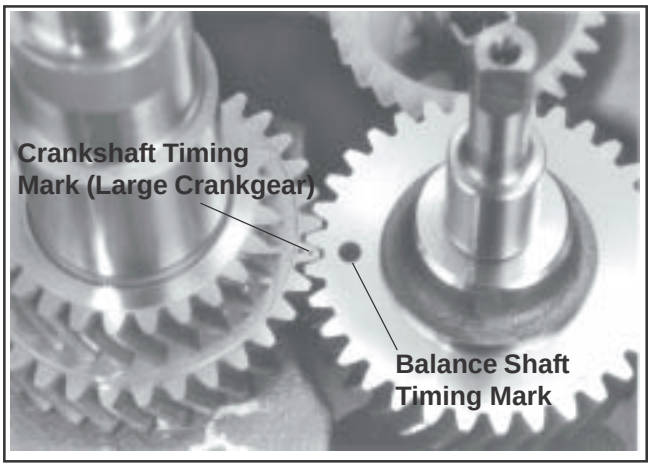


Figure 11-10. Aligning Timing Marks on Crank Gear and Balance Shaft Gear.

Install Hydraulic Lifters and Camshaft

1. See **Hydraulic Lifters** in Section 10 for lifter preparation (bleed down) procedures.

2. Apply camshaft lubricant (Kohler Part No. **25 357 14-S**) to the bottom surface of each lifter. See Figure 11-11a. Lubricate the hydraulic lifters and the lifter bores in the crankcase with engine oil.

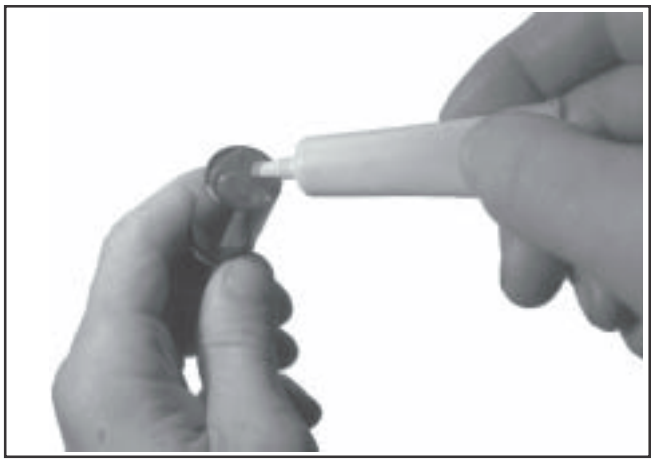


Figure 11-11a. Applying Camshaft Lubricant to Bottom of Lifters.

3. Note the mark or tag identifying the hydraulic lifters as either intake or exhaust. Install the hydraulic lifters into the crankcase. See Figure 11-11b.

   NOTE: Install lifters in the same position as before disassembly. The exhaust lifters are located on the output shaft (oil pan) side of the engine while the intake lifters are located on the fan side of the engine.

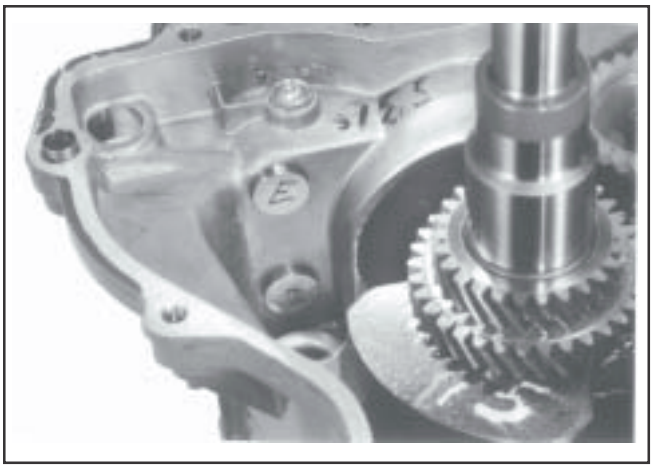


Figure 11-11b. Installing Hydraulic Lifters.

4. Align the timing marks the camshaft gear and the smaller gear on the crankshaft. Lower the camshaft into the bearing surface in crankcase.

5. Make sure the camshaft gear and the smaller gear on the crankshaft mesh and the timing marks are aligned. See Figure 11-12.

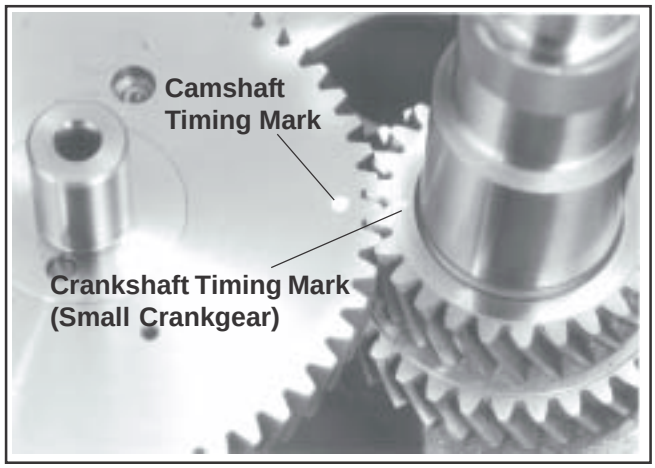


Figure 11-12. Aligning Timing Marks on Crank Gear and Cam Gear.

Determine Camshaft End Play

1. Install the shim spacer, removed during disassembly, to the camshaft.

2. Install the camshaft end play checking tool (see Section 2) to the crankcase and camshaft. Secure the tool to the crankcase with the hex flange screws provided. See Figure 11-13.

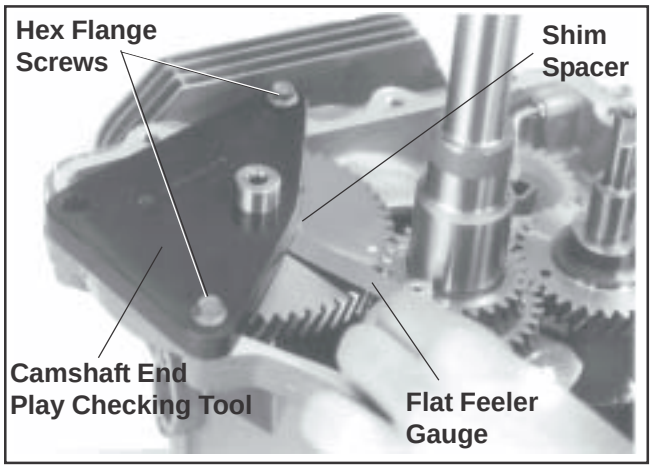


Figure 11-13. Checking Camshaft End Play.

3. Using a flat feeler gauge, measure the camshaft end play between the shim spacer and the end play checking tool. Camshaft end play should be **0.076/0.127 mm (0.003/0.005 in)**.

4. If the camshaft end play is not within the specified range, remove the end play checking tool and add, remove or replace shims 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 (0.03215/0.03275 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)

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

6. Repeat steps 4 and 5 until the end play is within the specified range.

Install Oil Pressure Relief Valve

Five-Piece Oil Pressure Relief Valve

1. Place the relief valve body in the cavity of the closure plate.

2. Insert the piston and spring into the body. See Figure 11-14.

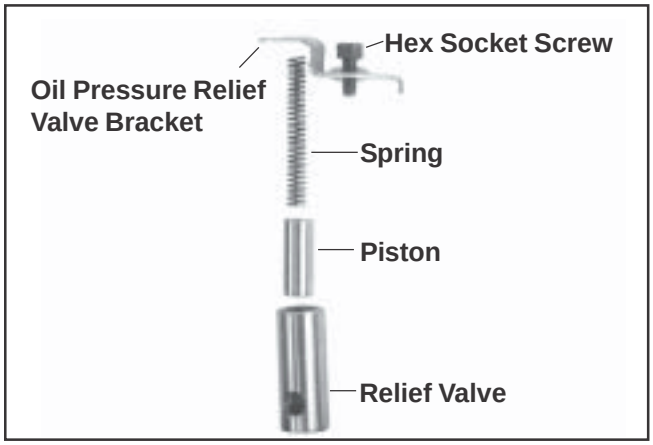


Figure 11-14. Installing Oil Pressure Relief Valve Body, Plunger, and Spring.

3. Install the bracket and hex flange screw. See Figures 11-14 and 11-18.

One-Piece Valve (if removed previously)

Figure 11-15. One-Piece Oil Pressure Relief Valve.

1. Use a piece of thin wall metal tubing or deep socket with a slightly smaller O.D. than the base. Press or tap the new relief valve into the bore of the closure plate until it bottoms. See Figure 11-16.

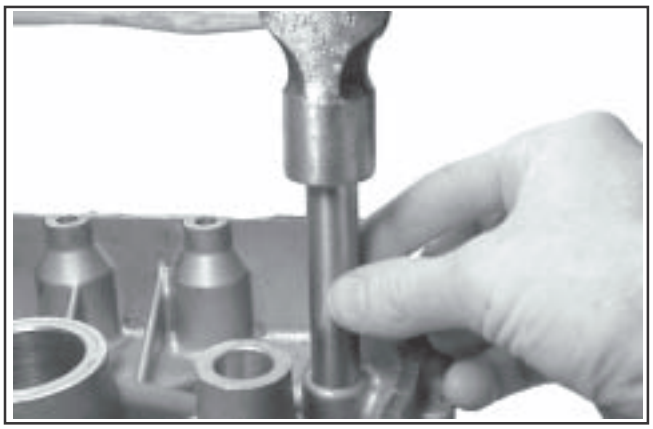


Figure 11-16. Inserting New Relief Valve into Bore of Closure Plate.

2. Stake the casting boss with a center punch in 3 or 4 locations near the inner edge to lock the relief valve into place. See Figure 11-17. **Do Not** use Loctite®.

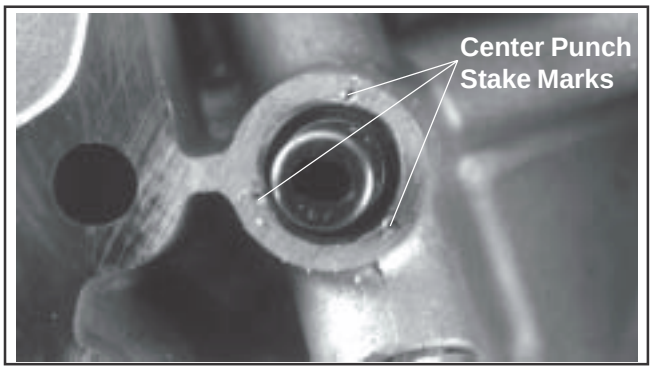


Figure 11-17. Center Punch Stake Marks.

Install Oil Pickup

1. Install the oil pickup, O-Ring, clip, and hex flange screw. See Figure 11-18.

   NOTE: Lightly grease O-Ring and install before pickup.

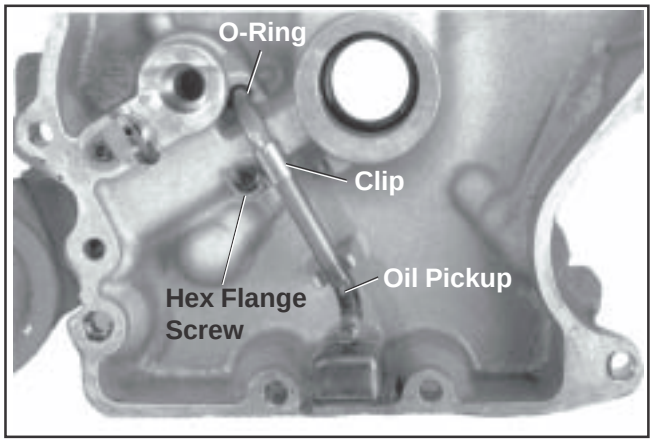


Figure 11-18. Installing Oil Pickup Components.

Install Closure Plate to Crankcase

RTV silicone sealant is used as a gasket between the closure plate and crankcase. Refer to page 2.3 for a listing of approved sealants that may be used.

NOTE: Always use fresh sealant. Using outdated sealant can result in leakage. Refer to Section 2 - Tools & Aids for information on the sealant dispenser.

1. Prepare the sealing surfaces of the crankcase and closure plate following Service Bulletin 252.

   NOTE: Do not scrape the surfaces when cleaning as this will damage the surfaces. This could result in leaks. The use of a gasket removing solvent is recommended.

2. Apply a 1/16" bead of sealant to the closure plate as shown in Figure 11-19. Do not spread with finger.

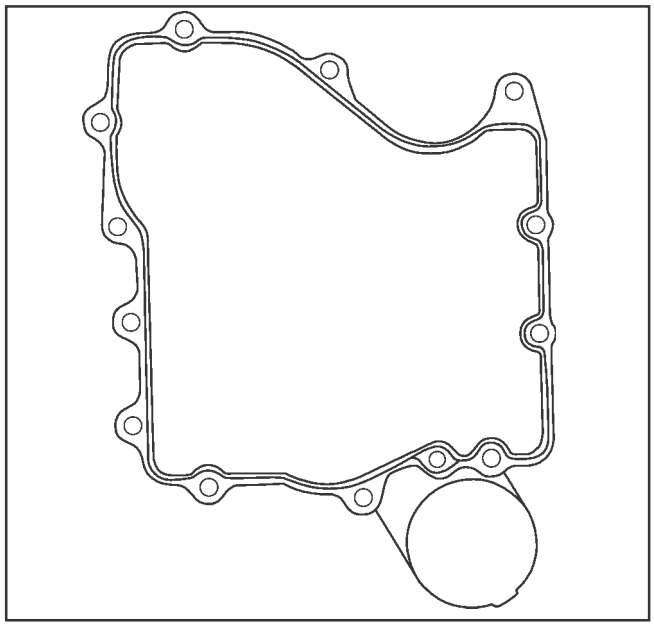


Figure 11-19. Closure Plate Sealant Pattern.

3. Install the closure plate to the crankcase and install the twelve hex flange screws. Tighten the screws hand tight.

4. Torque the fasteners, in the sequence shown in Figure 11-20 to **24.4 N·m (216 in. lb.)**.

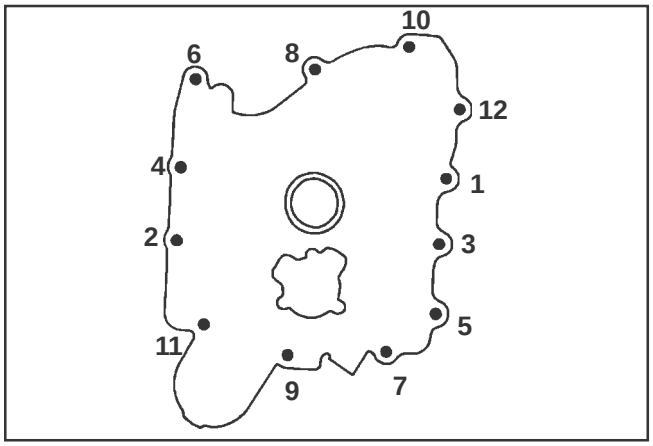


Figure 11-20. Closure Plate Fastener Torque Sequence.

Install Oil Pump

1. Lubricate the oil pump cavity and oil pump rotors with engine oil. Install the outer and inner oil pump rotors. See Figure 11-21.

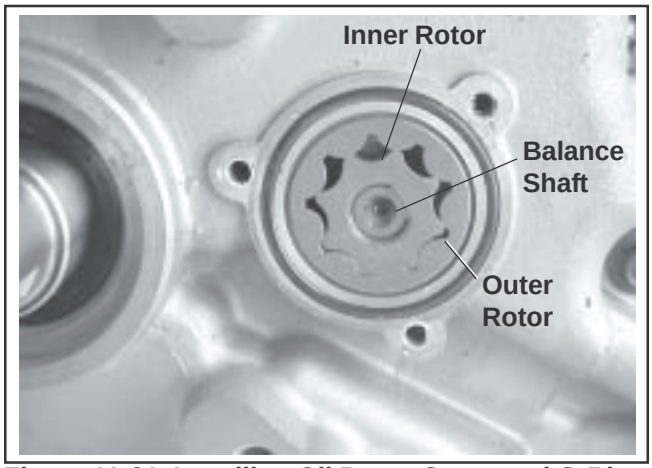


Figure 11-21. Installing Oil Pump Gears and O-Ring.

2. Install the O-Ring in the groove in the closure plate.

3. Install the oil pump cover (machined side toward O-Ring). Secure with three hex flange screws. See Figure 11-22.

   NOTE: Apply sealant to the oil pump cover hex flange screws to prevent leakage.

   Torque the screws as follows:

   First time installation on a new closure plate: **6.2 N·m (55 in. lb.)**.

   Reinstallation on a used closure plate: **4.0 N·m (35 in. lb.)**.

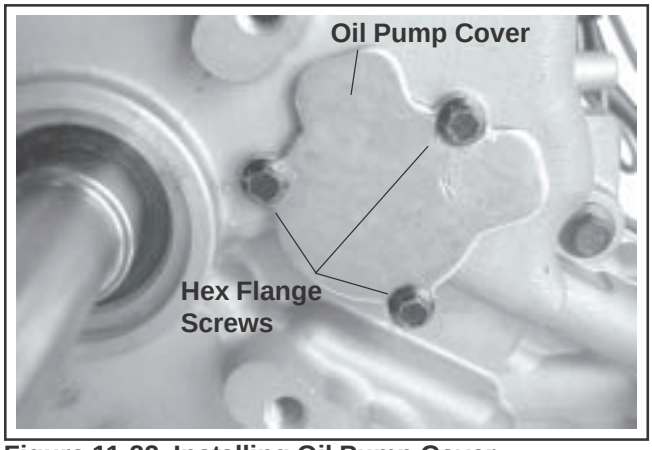


Figure 11-22. Installing Oil Pump Cover.

Install Oil Seals (PTO End and Flywheel End)

1. Slide a seal protector sleeve, over the crankshaft. Generously lubricate the lips of the oil seal with light grease. Slide the oil seal over the sleeve.

2. Use a seal driver, install the PTO end and flywheel end oil seals. See Figure 11-23.

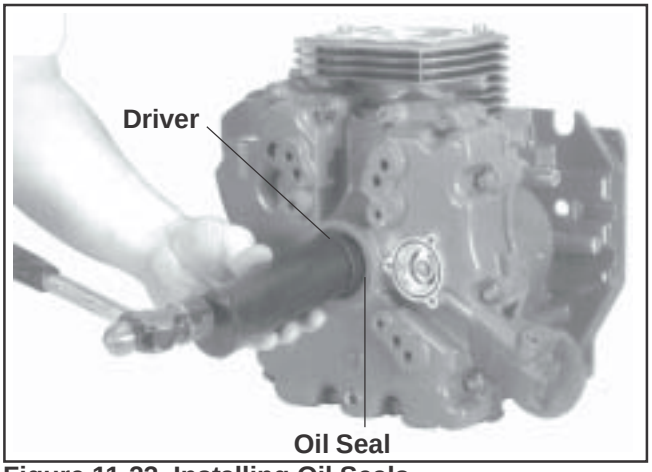


Figure 11-23. Installing Oil Seals.

Install Stator and Wiring Harness

1. Position the stator leads toward the hole in the crankcase. Insert the stator leads through the hole to the outside of the crankcase. See Figure 11-24.

2. Install the stator using four hex socket head screws.

3. Torque the screws to **4.0 N·m (35 ft. lb.)**.

4. Secure the stator leads to the crankcase with the clip and hex flange screw.

5. Install the connector body to the stator leads.

6. Secure the kill lead to the crankcase with the clip and hex flange screw.

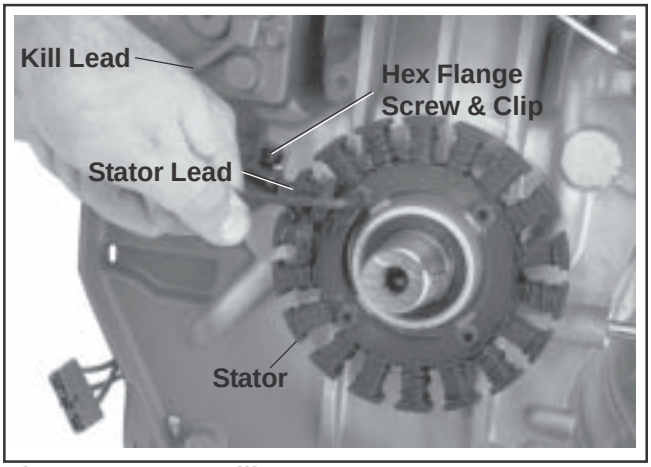


Figure 11-24. Installing Stator.

Install Fan and 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 flywheel hub are clean, dry and completely free of lubricants. The presence of lubricants can cause the flywheel to be overstressed and damaged when the flange screw is torqued to specification.

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

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

1. Install the fan, spacers and hex flange screws to the flywheel. See Figure 11-25.

2. Torque the hex flange screws to **9.9 N·m (88 in. lb.)**.

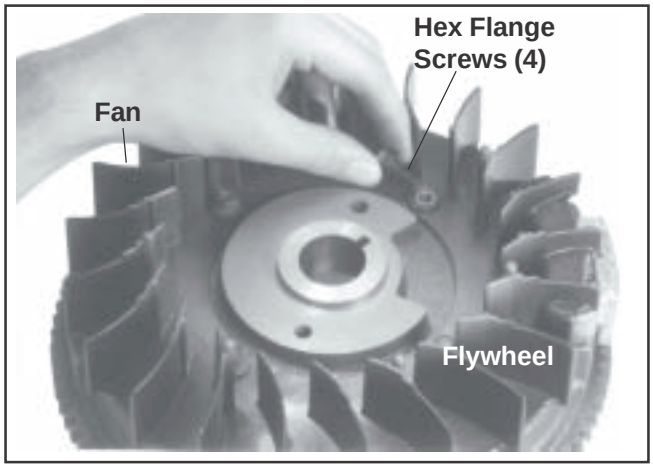


Figure 11-25. Installing Fan To Flywheel.

3. Install the woodruff key into the keyway in the crankshaft.

4. Place the flywheel over the keyway/crankshaft. Install grass screen, drive cup, plain washer (flat side of plain washer towards the drive cup), and the hex flange screw. See Figure 11-26.

5. Hold the flywheel with the strap wrench or holding tool and torque the hex flange screw to **66.4 N·m (49 ft. lb.)**. See Figure 11-26.

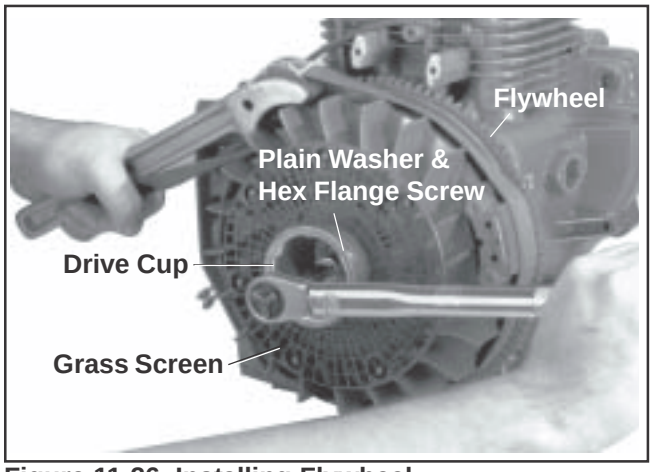


Figure 11-26. Installing Flywheel.

Install Fuel Line

1. Install the fuel line, clamp and hex flange screw. See Figure 11-27.

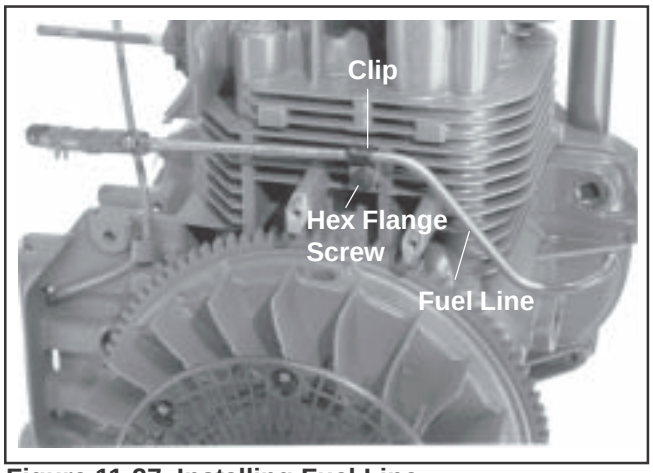


Figure 11-27. Installing Fuel Line.

Install Ignition Module

1. Rotate the flywheel so the magnet is away from the ignition module bosses. Install the ignition module to the bosses on the crankcase. The directional arrow denoting proper flywheel rotation must be up. Move the module as far from the flywheel/magnet as possible. Tighten the hex flange screws slightly.

2. Insert a **25 mm (0.010 in)** flat feeler gauge or shim stock between the magnet and ignition module. See Figure 11-28.

   Loosen the hex flange screws so the magnet pulls the module against the feeler gauge.

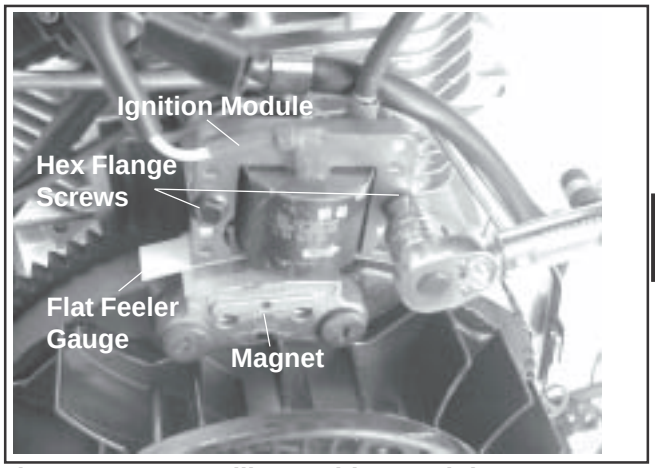


Figure 11-28. Installing Ignition Module.

3. Tighten the hex flange screws as follows:

   First Time Installation On A New Short Block: **6.2 N·m (55 in. lb.)**.

   All Reinstallations: **4.0 N·m (35 in. lb.)**.

4. Rotate the flywheel back and forth; check to make sure the magnet does not strike the module.

5. Check the gap with a feeler gauge and readjust if necessary.

   Final Air Gap: **0.203/0.305 mm (0.008/0.012 in)**.

6. Connect the kill lead to the tab terminal on the ignition module.

Reassemble Cylinder Head Components

(See Figure 11-29 thru 11-31)

1. **Rocker Bridge Heads Only -** Install the rocker bridge to the cylinder head. Make sure the small (counterbored) hole is toward the exhaust port side of the cylinder head. Secure the rocker bridge with two M6 hex cap screws. Torque the screws to **9.9 N·m (88 in. lb.)**.

2. Install the intake valve stem seal, intake valve, spring seat, intake valve spring, and valve spring cap. Compress the valve spring using a valve spring compressor and install the keepers.

3. Install the exhaust valve, valve spring, and valve spring cap. Compress the valve spring using a valve spring compressor and install the keepers.

   NOTE: Exhaust valve rotators are no longer used. **Do not** attempt to install rotators if a new head is being installed, or if head did not use one originally.

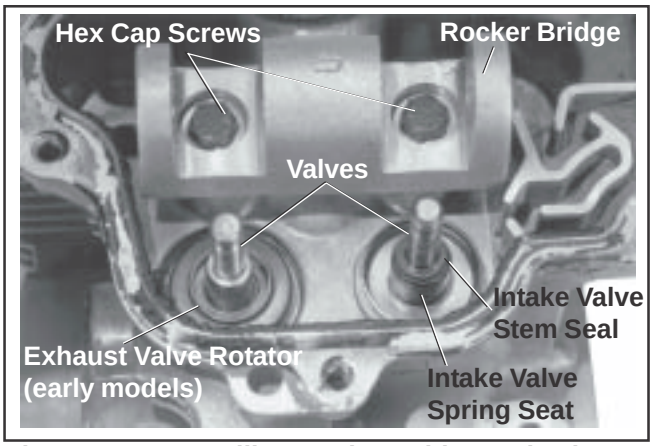


Figure 11-29. Installing Rocker Bridge and Valves.

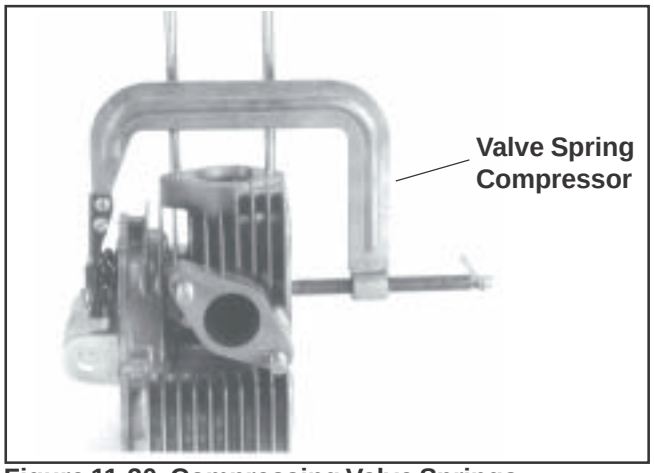


Figure 11-30. Compressing Valve Springs.

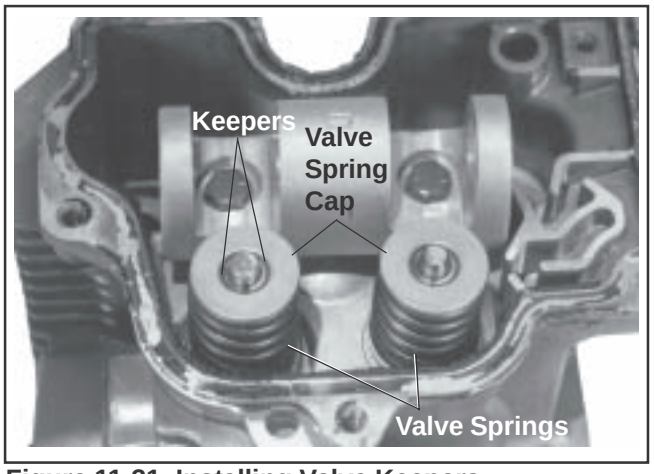


Figure 11-31. Installing Valve Keepers.

4. **Rocker Bridge Heads**
   Position the rocker arms over the valve stems and rocker arm bridge. Insert the rocker shaft through the rocker bridge and rocker arms, from the breather reed side. See Figure 11-32.

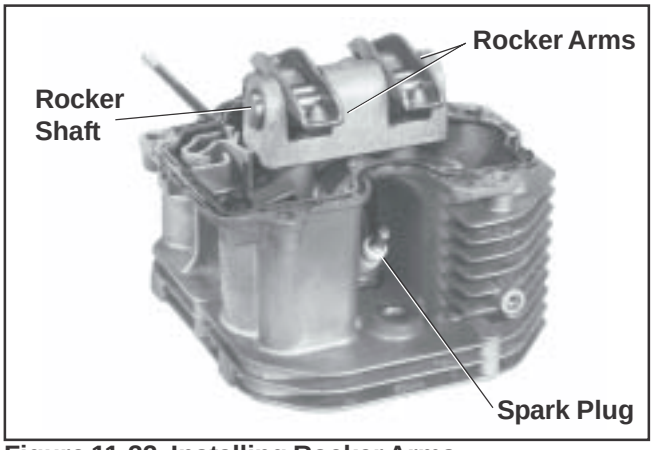


Figure 11-32. Installing Rocker Arms.

Heads with Separate Pivots/Rocker Arms
Position the pivots in the sockets of the rocker arms. Insert the screws through the pivots, rocker arms, and guide plate (some models only). Start the screws into the head and **finger tighten only at this time**. See Figure 11-33.

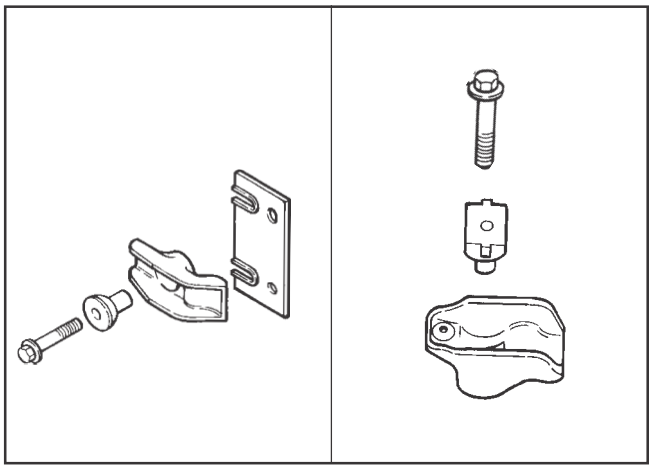


Figure 11-33. Separate Pivot/Rocker Arm Styles.

5. Install the breather reed, reed retainer and secure with the M5 hex flange screw. Torque the screw to **6.2 N·m (55 in. lb)** in new hole, or **3.9 N·m (35 in. lb.)** in used hole. See Figure 11-34.

6. Install exhaust studs (if removed previously, or new head is being installed). The threaded end with the oval point or identification symbol must be out.

Install Cylinder Head

1. Rotate the crankshaft to TDC of the compression stoke and make sure the lifters are installed in the lifter bores with the socket up.

2. Reinstall the push rods in their original position.

3. Install a new cylinder head gasket and the cylinder head assembly on the crankcase. Slide the spacer and washer onto one of the new head bolts, and install it in the #5 position (between the intake and exhaust ports). See Figure 11-34. If the engine has a high temperature cutout switch, insert the new long (90 mm) head bolt through the special washer (flat on one edge) and cutout switch, and install it in the #1 position. See Figure 11-35. Install the remaining new head bolts. Following the sequence in Figure 11-35, torque the bolts to **24 N·m (18 ft. lb.)**. Then repeat the sequence to a final torque of **48.9 N·m (36 ft. lb.)**.

NOTE: When installing cylinder heads, new head bolts should always be used.

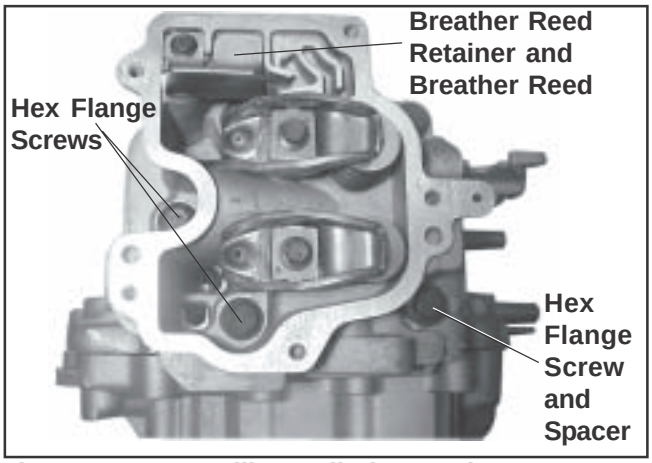


Figure 11-34. Installing Cylinder Head.

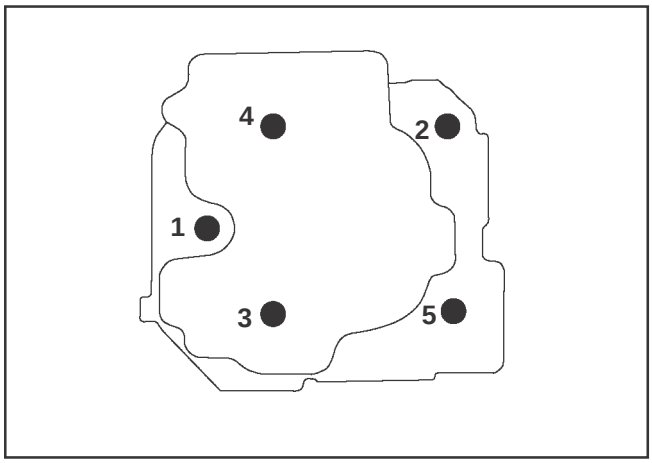


Figure 11-35. Cylinder Head Fastener Torque Sequence.

4. **Rocker Bridge Heads - Figure 11-36**
Compress the valve spring and seat the push rods into sockets under the end of the rocker arms.

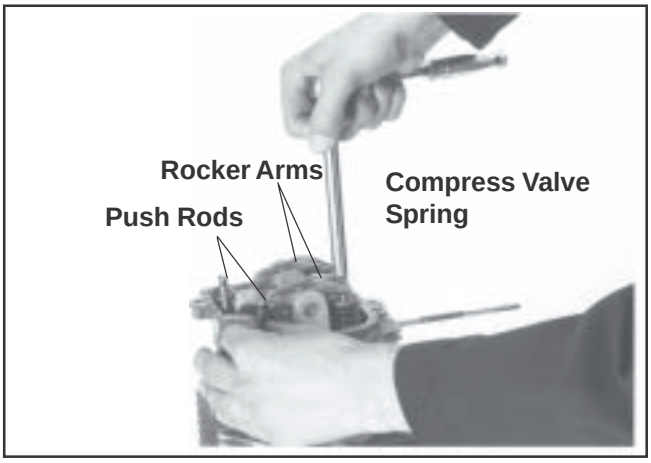


Figure 11-36. Installing Push Rods Under Rocker Arms (Rocker Bridge Style Heads).

Head with Separate Pivots/Rocker Arms - Figure 11-37
Seat the push rods into sockets under the end of the rocker arm and align the rocker arms over the valve stems. Hold the rocker arms in this position and torque the screws to **11.3 N·m (100 in. lb.)**. See Figure 11-37.

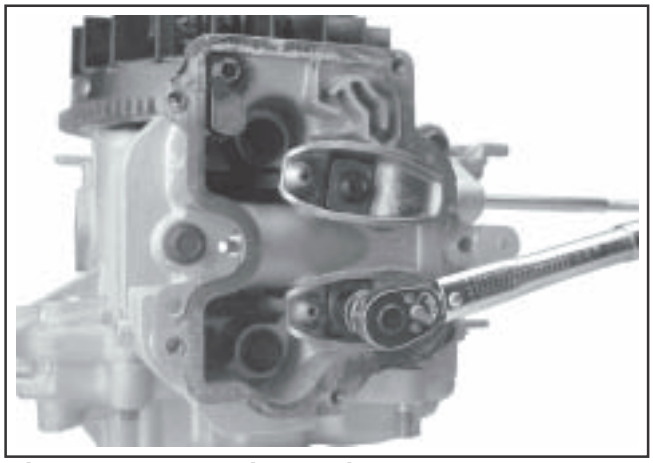


Figure 11-37. Torquing Rocker Screws.

5. If the head has a threaded hole in the intake port, install the pipe plug or vacuum line (according to application). The pipe plug should be installed for all applications which do not have a metal vacuum line at this position. Use pipe sealant with Teflon® on the threads.

6. Install the spark plug into the cylinder head. Torque the spark plug to **38.0-43.4 N·m (28-32 ft. lb.)**.

Install Carburetor Adapter and Heat Deflector

1. Install the heat deflector, carburetor adapter, and gaskets to the cylinder head intake port with the two allen head capscrews. Torque the screws to **9.9 N·m (88 in. lb.)**. See Figure 11-38.

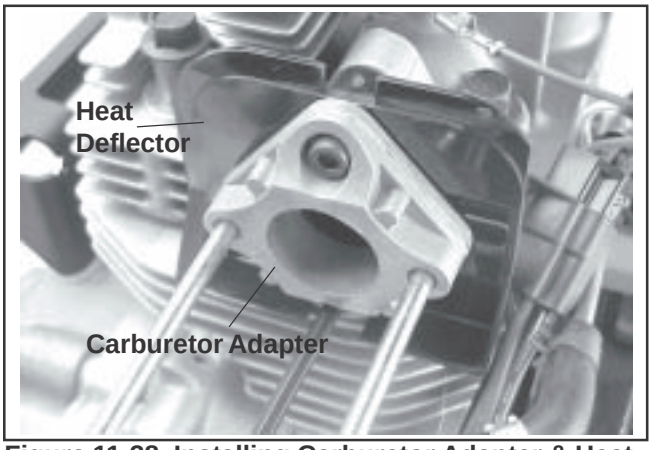


Figure 11-38. Installing Carburetor Adapter & Heat.

Install Baffles and Blower Housing

1. Connect the Oil Sentry™ Indictor Light leads (if used). See Figure 11-39.

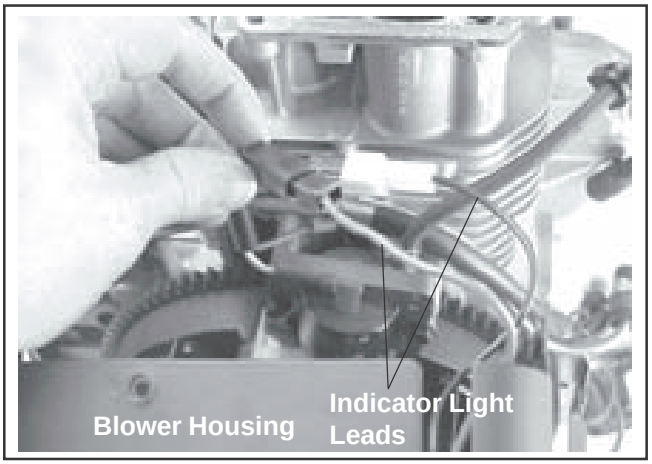


Figure 11-39. Connecting Oil Sentry™ Indicator Light Leads.

2. Install the grommet around the high tension lead. Insert the grommet into the slot in the blower housing. Install the blower housing and baffles using hex flange screws. See Figure 11-40 and 11-41.

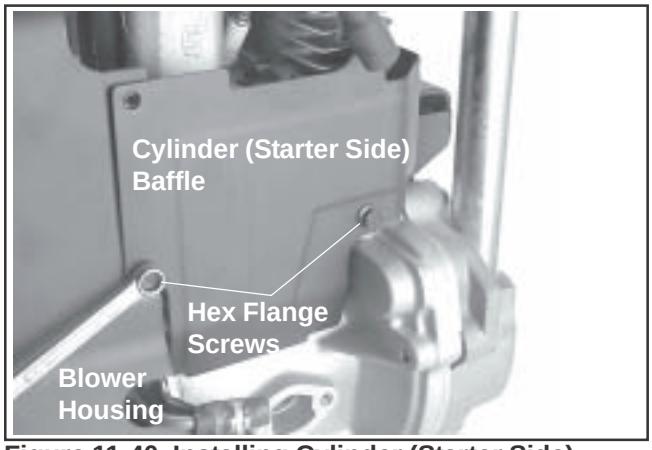


Figure 11-40. Installing Cylinder (Starter Side) Baffle.

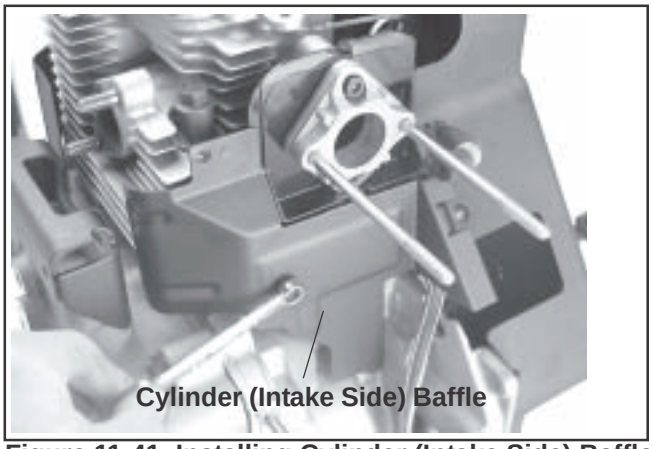


Figure 11-41. Installing Cylinder (Intake Side) Baffle.

NOTE: Leave all hardware slightly loose until all sheet metal pieces are in position.

3. Install the cylinder head baffle to the cylinder head using the hex flange screws. Torque the screws to **3.9 N·m (35 in. lb.)**. See Figure 11-42.

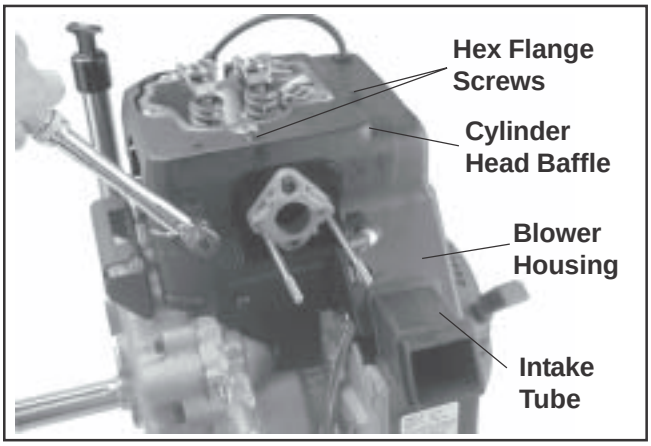


Figure 11-42. Installing Cylinder Head Baffle and Intake Tube.

4. Tighten all other mounting hardware securely.

5. Reinstall the intake tube to the opening in the blower housing.

Install Valve Cover and Muffler Bracket

RTV silicone sealant is used as a gasket between the valve cover and crankcase. Refer to page 2.3 for a listing of approved sealants.

NOTE: Always use fresh sealant. Using outdated sealant can result in leakage. Refer to Section 2 Tools & Aids for information on the sealant dispenser.

1. Prepare the sealing surfaces of the cylinder head and valve cover following Service Bulletin 252. If it is a stamped steel valve cover, the flatness of the sealing surface must be checked prior to reinstallation. See Section 10.

2. Apply a 1/16" bead of sealant to the cylinder head as shown in Figure 11-43.

   NOTE: To ensure proper adhesion of the sealant to both sealing surfaces, perform Step 3 immediately (5 minutes maximum) after application of RTV.

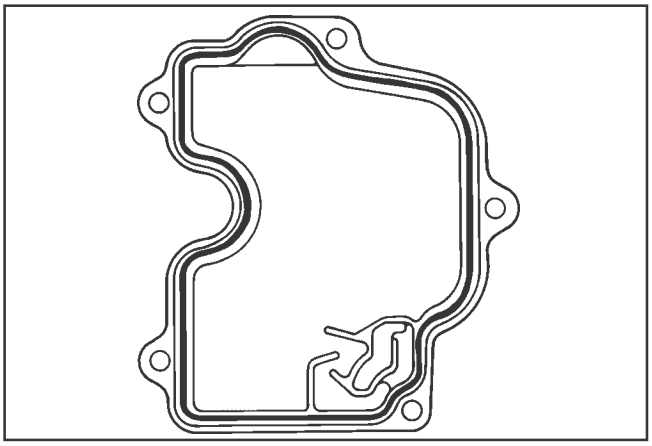


Figure 11-43. Valve Cover Sealant Pattern.

3. Install the valve cover, any attached mounting brackets (muffler, fuel tank, and/or lift*) along with any loose spacers (stamped steel cover) as originally attached onto the cylinder head. Secure with the five hex flange screws. See Figure 11-44.

   *Lifting bracket must be toward the flywheel.

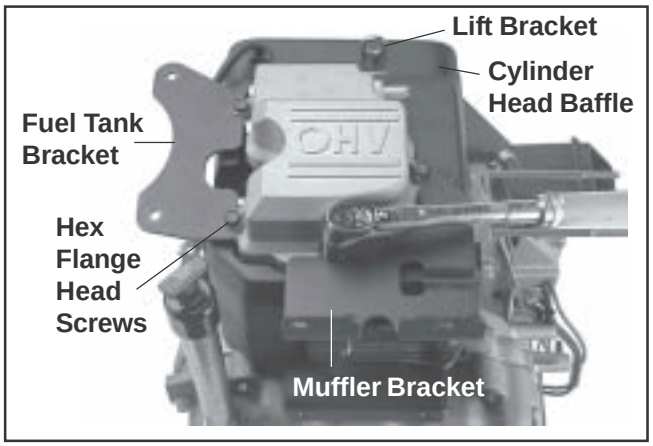


Figure 11-44. Installing Valve Cover. (Die Cast/ Aluminum Cover Shown).

4. Torque the screws in the sequence shown in Figure 11-45, as follows:

   Into new hole **10.7 N·m (95 in. lb.)**.

   Into used hole **7.3 N·m (65 in. lb.)**.

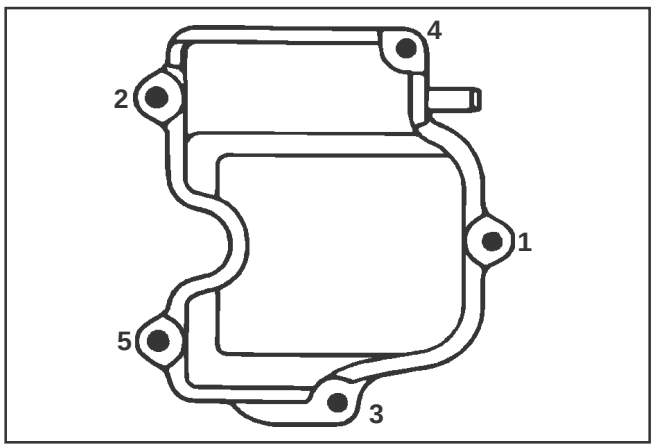


Figure 11-45. Valve Cover Torque Sequence.

Install Fuel Pump

1. Install the rubber line and two hose clamps to the fuel pump end of the metal fuel line. Secure the rubber fuel line to the metal fuel line with one of the clamps. See Figure 11-46.

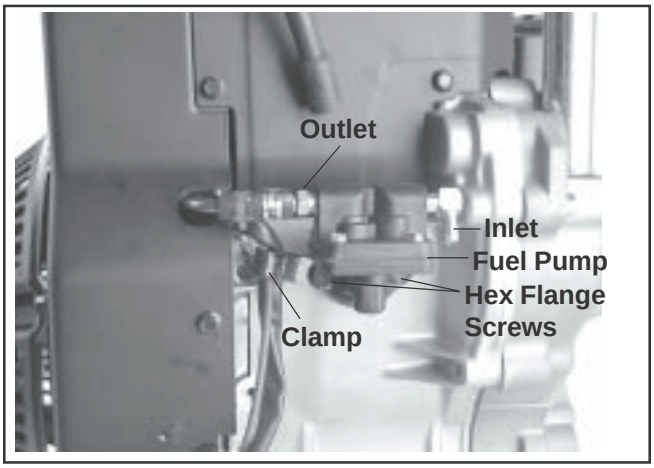


Figure 11-46. Installing Fuel Pump.

2. Install the gasket, fuel pump, and two hex flange screws. Attach the wire harness clamp (if used) onto the closest screw. Torque the screws as follows:

   Into new hole **9.0 N·m (80 in. lb.)**.

   Into used hole **4.2-5.1 N·m (37-45 in. lb.)**.

3. Install the opposite end of the rubber line to the outlet fitting of the fuel pump. Secure the fuel line to the outlet fitting with the other hose clamp.

Install Electric Starter

Electric Starter (Inertia Drive or Solenoid Shift)

1. Install the studs for starter into the crankcase (if applicable and removed previously). The longer set of threads must be out.

2. Install starter with spacer and ground lead (if used) on the studs, or install starter using the mounting bolts as originally equipped. See Figure 11-47.

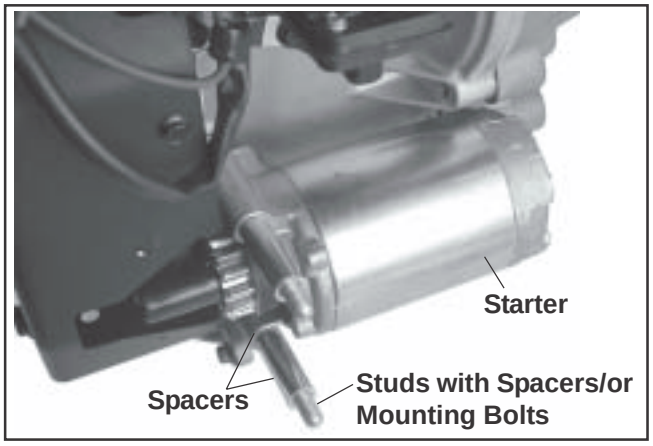


Figure 11-47. Installing Electric Starter.

3. Install fuel tank/solenoid bracket (if equipped) onto the mounting studs. Secure with the two hex flange screws through the closure plate, with the single spacer behind the bracket on the lower screw. Torque the screws to **24.4 N·m (216 in. lb.)**. See Figure 11-48. If the bracket is being installed with the closure plate, refer to Figure 11-20 for proper torque sequence.

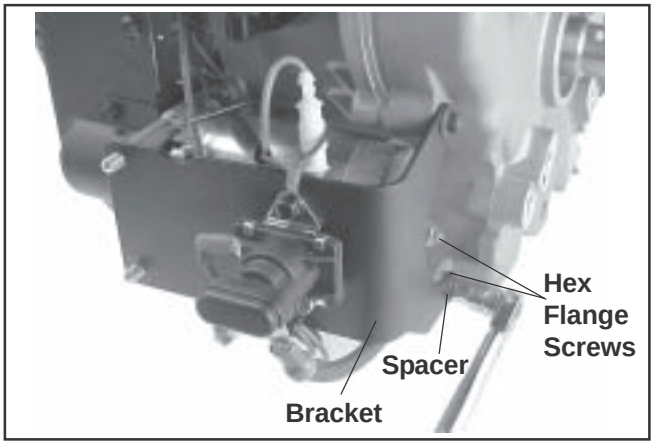


Figure 11-48. Installing Fuel Tank/Solenoid Bracket (some models).

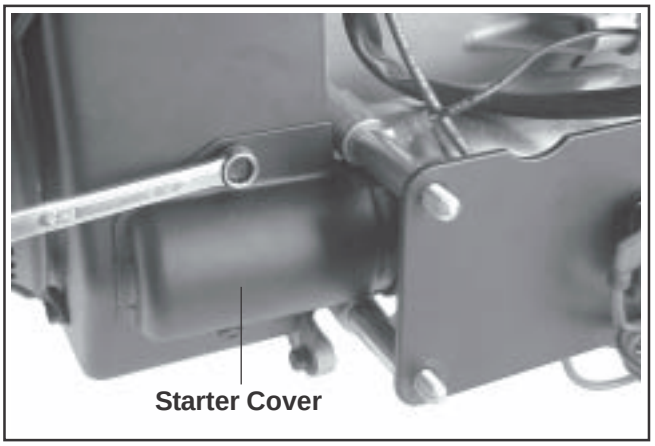


Figure 11-49. Installing Starter Cover.

4. Install the starter cover and secure with the two hex flange screws. See Figure 11-49.

5. Connect the lead(s) to the starter or solenoid terminals. To avoid damage or breakage, do not overtighten the hex flange nut. Torque the nut to **6-9 N·m (53-79 in. lb.)**.

Install Fuel Tank

1. Connect the fuel hose to the shut-off valve.

2. Install hex flange screws through upper bracket into fuel tank. Install hex flange nuts onto studs to secure the lower fuel tank mounting bracket. Torque the screws to **7.3 N·m (65 in. lb.)**. See Figure 11-50.

3. Torque the hex flange nuts to **24.4 N·m (216 in. lb.)**. See Figure 51.

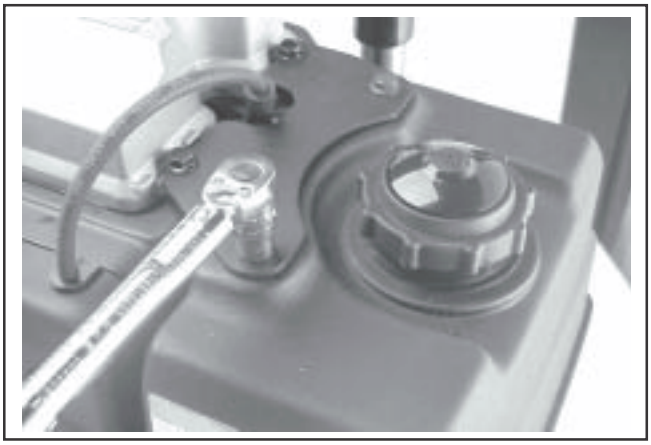


Figure 11-50. Installing Fuel Tank Upper Mounting Screws.

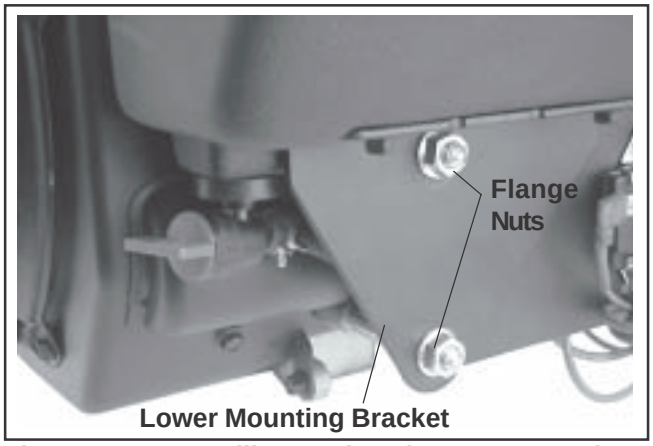


Figure 11-51. Installing Fuel Tank Lower Mounting Flange Nuts.

Install Rectifier-Regulator

1. Install the rectifier-regulator and secure with the hex flange screws. Attach the separate ground lead if used (plastic blower housing models) to one of the screws. See Figure 11-52.

2. Attach the connector assembly, or individual connectors (B+ lead to center terminal/stator leads to outer terminals) to the rectifier-regulator. See Figure 11-52.

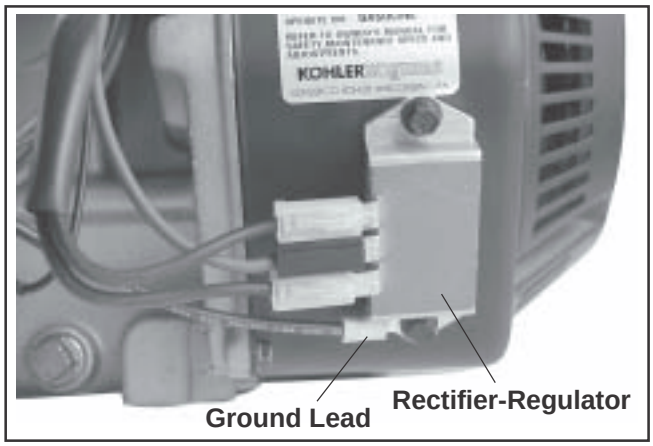


Figure 11-52. Installing Rectifier-Regulator.

Install Carburetor and External Governor Components

1. Install the rubber fuel line and two hose clamps to the metal fuel line. Secure the rubber fuel line to the metal fuel line with one of the hose clamps.

2. Install the new carburetor gasket onto the carburetor studs.

3. Assemble and connect the pivot bushing, throttle linkage, linkage with spring, and governor lever to the carburetor, if disassembled/disconnected. Install the carburetor with the governor lever and linkage connected onto the intake studs and governor cross shaft. Connect the free end of the rubber fuel line to the inlet fitting of the carburetor as it is being installed. Secure the connection with the remaining hose clamp. See Figure 11-53.

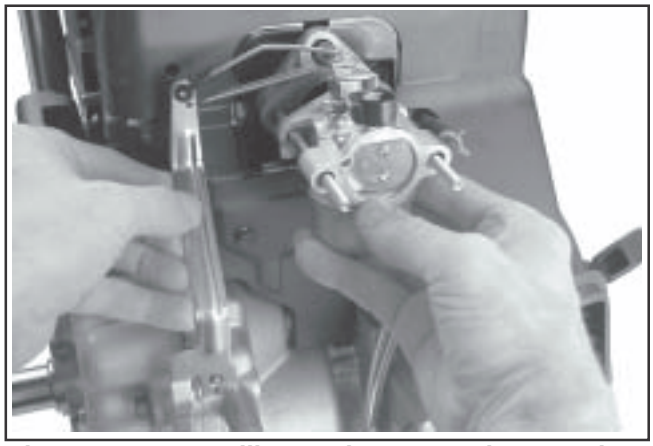


Figure 11-53. Installing Carburetor and External Governor Components.

NOTE: Do not tighten the hex nut on the governor lever mounting screw until the lever is adjusted (after air cleaner base installation).

Install Throttle Bracket

1. Install the throttle bracket assembly to the crankcase with the two mounting screws. If a rectifier-regulator ground lead (plastic blower housing models) was also secured, position it behind the throttle bracket on the lower screw. See Figure 11-54.

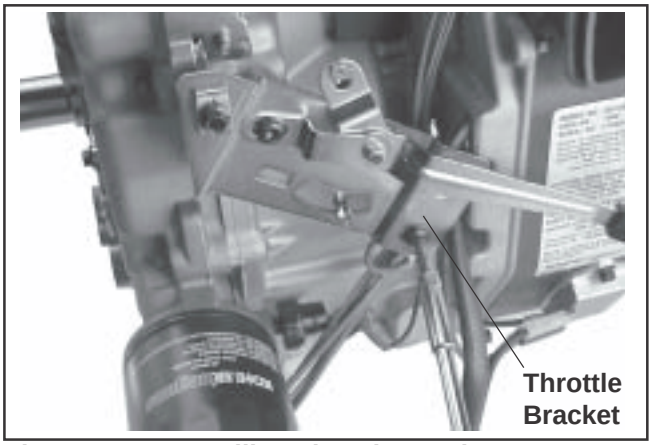


Figure 11-54. Installing Throttle Bracket.

2. Install the governor spring in the appropriate hole in the governor arm and throttle control lever, as indicated in the chart. Note that hole positions are counted from the top of the lever. See Figure 11-55.

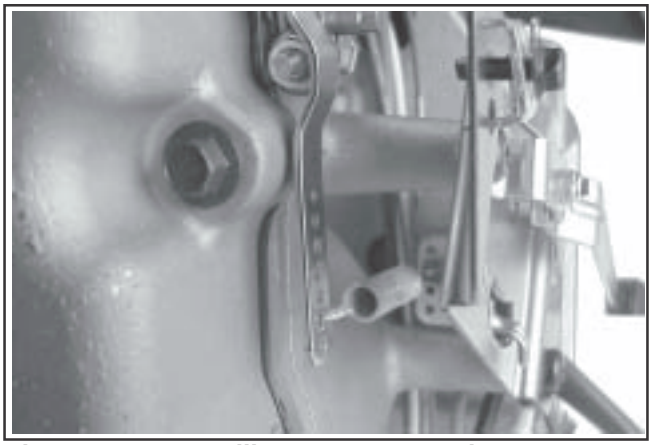


Figure 11-55. Installing Governor Spring.

RPM should be checked with a tachometer.

High Idle RPM	Governor Lever Hole No.	Throttle Lever Hole No.
3800	6	3
3600	5	1
3400	4	1
3200	3	1
3000	2	1

Install Air Cleaner Base and Air Intake System, Adjust Governor Lever

1. Connect choke linkage to the carburetor choke lever. See Figure 11-56.

2. Install a new air cleaner base gasket onto the mounting studs.

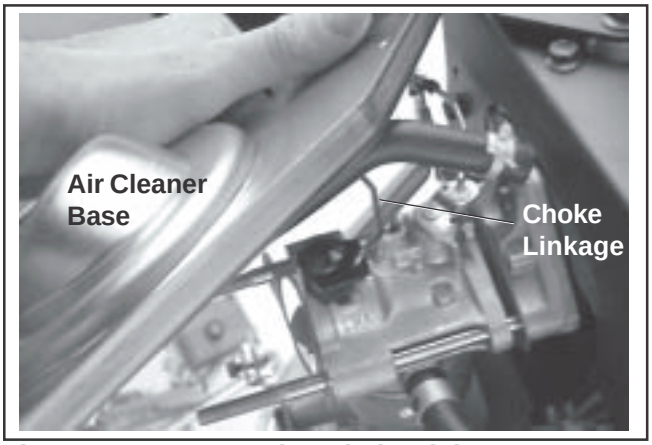


Figure 11-56. Connecting Choke Linkage.

3. Install the air cleaner base onto the mounting studs. Connect the breather hose to the fitting of the rocker cover. Secure with the clamp.

4. Install a new gasket, the spitback cup/collector plate/or air cleaner bracket as equipped, and secure with the hex nuts. Torque the hex flange nuts to **9.9 N·m (88 in. lb.)**. See Figure 11-57.

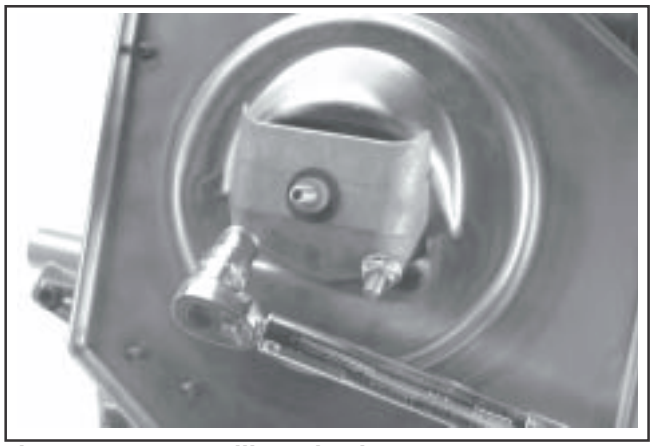


Figure 11-57. Installing Air Cleaner Base.

5. **Adjust Governor Lever**
   a. Pull the governor lever **away from the carburetor** to the wide open throttle position.

   b. Grasp the governor cross shaft with a pliers and turn the shaft **counterclockwise** as far as it will go.

   c. Tighten the hex nut on governor lever securely. See Figure 11-58.

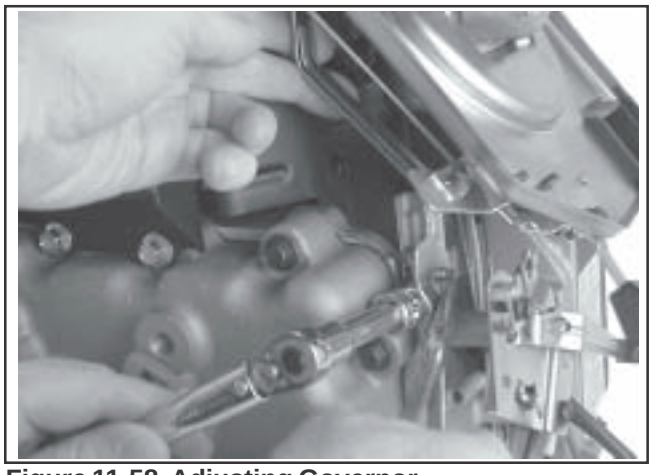


Figure 11-58. Adjusting Governor.

6. Ensure the seal* is installed on the air cleaner stud and in good condition. Install the element and precleaner, element cover and wing nut. See Figure 11-59.

*Early models used a washer under the wing nut instead of the seal. Replace with new seal on air cleaner stud when reassembling.

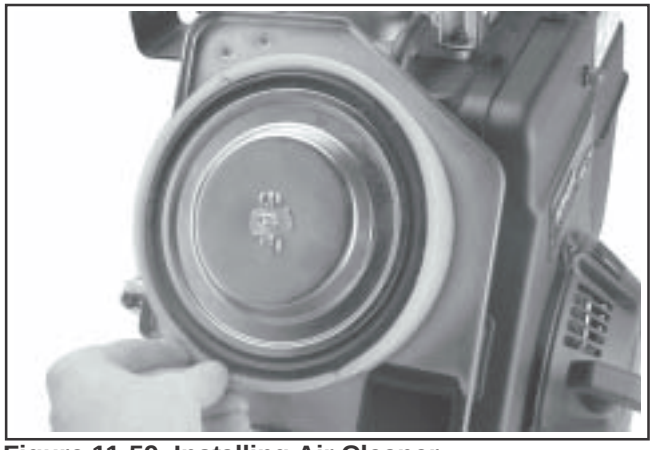


Figure 11-59. Installing Air Cleaner.

7. Install the air cleaner cover and knob. See Figure 11-60.

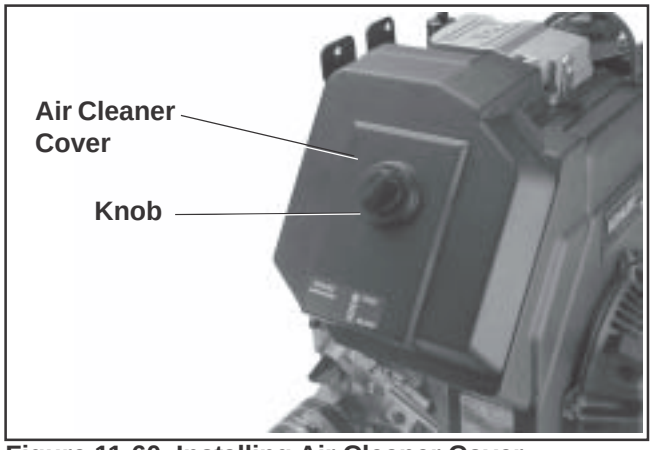


Figure 11-60. Installing Air Cleaner Cover.

Install Retractable Starter

1. Install the retractable starter and five hex flange screws to blower housing. Leave the screws slightly loose.

2. Pull the starter handle out until the pawls engage in the drive cup. Hold the handle in this position and tighten the screws securely. See Figure 11-61.

Figure 11-61. Installing Retractable Starter.

Install Muffler

1. Install new exhaust gasket, exhaust manifold or muffler inlet pipe to exhaust port studs. Install the hex flange nuts on studs and torque to **24.4 N·m (216 in. lb.)**. See Figure 11-62.

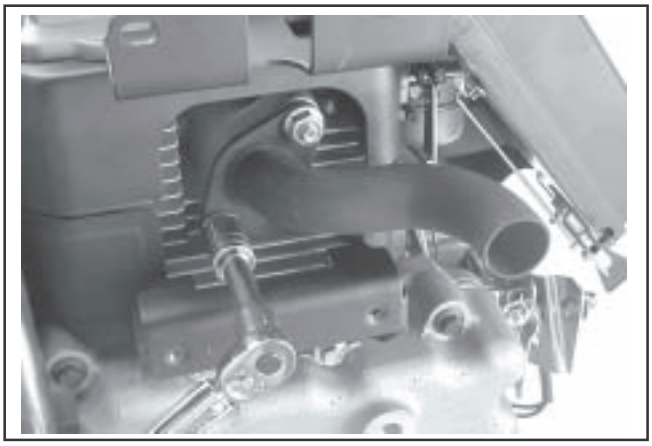


Figure 11-62. Installing Muffler Inlet Pipe.

2. Secure the muffler to the upper and lower mounting brackets with the hex flange screws. Torque the screws to **9.9 N·m (88 in. lb.)** See Figures 11-63 and 11-64.

Figure 11-63. Installing Upper Muffler Bracket and Mounting Screws.

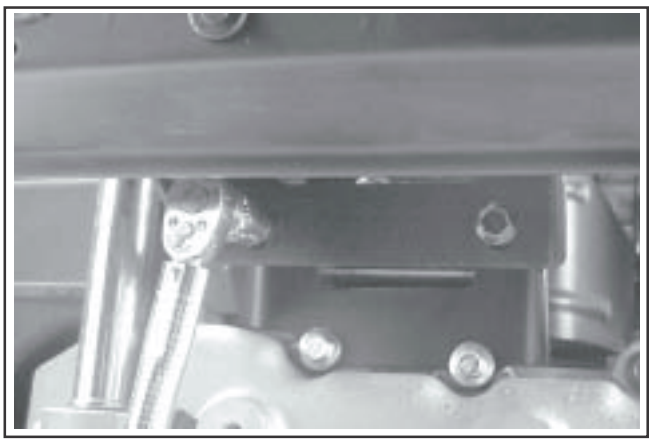


Figure 11-64. Installing Lower Muffler Bracket and Mounting Screws.

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, and 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 the Safety and General Information and Lubrication System sections.

4. Adjust the carburetor, idle fuel needle, or idle speed adjusting screw as necessary. Refer to the Fuel System and Governor section.

5. Before starting the engine, turn the engine over slowly by hand. If it can be turned over completely and compression is noted, the lifters have bled down sufficiently and the engine can be test run. If, however, it can not be turned over completely (locks up at some point), return the piston to TDC between the intake and exhaust strokes and wait ten minutes to allow the lifters time to bleed down then check for compression again. If started with extended lifters, bent push rods or other engine damage could occur.

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 in the location normally used for Oil Sentry™. Refer to Lubrication System section. Start the engine and check to be certain that oil pressure (40 psi or more) is present. Run the engine for 5-10 minutes below 1500 RPM. Adjust the carburetor mixture settings as necessary.

2. Make sure the maximum engine speed does not exceed 3750 RPM. Adjust the throttle and choke controls and the high speed stop as necessary. Refer to Section 5.

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