SERVICE MANUAL

KOHLER® COURAGE XT-6, XT-7

VERTICAL CRANKSHAFT

KOHLER® ENGINES

Contents

Section 1
Safety and General Information

Safety Precautions

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

WARNING

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

CAUTION

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

NOTE

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

For Your Safety!

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

WARNING

Accidental Starts can cause severe injury or death.

Disconnect and ground spark plug leads before servicing.

Accidental Starts!

Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine by disconnecting the spark plug lead.

WARNING

Rotating Parts can cause severe injury.

Stay away while engine is in operation.

Rotating Parts!

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

WARNING

Hot Parts can cause severe burns.

Do not touch engine while operating or just after stopping.

Hot Parts!

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

⚠ WARNING

Explosive Fuel can cause fires and severe burns.

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

Explosive Fuel!

Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, unoccupied buildings, away from sparks or flames. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use gasoline as a cleaning agent.

⚠ WARNING

Cleaning Solvents can cause severe injury or death.

Use only in well ventilated areas away from ignition sources.

Flammable Solvents!

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

⚠ WARNING

Carbon Monoxide can cause severe nausea, fainting or death.

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

Lethal Exhaust Gases!

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

⚠ CAUTION

Electrical Shock can cause injury.

Do not touch wires while engine is running.

Electrical Shock!

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

Engine Identification Numbers

When ordering parts, or in any communication involving an engine, always give the **Model, Specification, and Serial Number** of the engine.

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

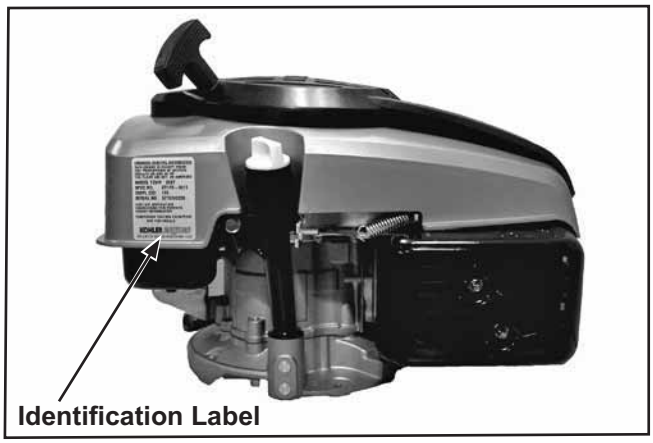


Figure 1-1. Identification Label.

A. Model No. XT 7

Courage Vertical Shaft Engine

Numerical Designation

B. Spec. No. XT173-0001

Engine Model

Model
XT-6
XT-7

First specification written in this model series

C. Serial No. 3723500328

Year Manufactured Code

Code	Year
37	2007
38	2008

Factory Code

Figure 1-2. Explanation of Identification Numbers.

Oil Recommendations

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

Oil Type

Use high quality detergent oil of **API (American Petroleum Institute) service class SJ or higher**. Select the viscosity based on the air temperature at the time of operation as shown in Figure 1-3.

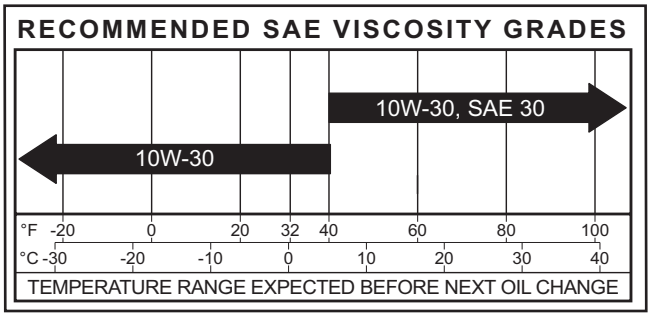


Figure 1-3. Viscosity Grades Table.

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

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade. See Figure 1-4.

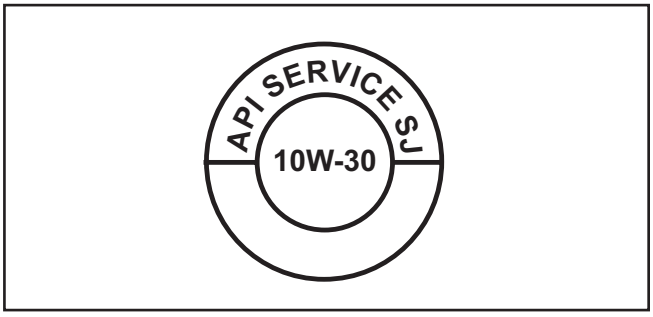


Figure 1-4. Oil Container Logo.

Refer to Section 6, Lubrication System, for detailed oil check and oil change 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 spillage during refueling.

To ensure easy starting and minimize gum deposits in the fuel system, do not use gasoline left over from the previous season. Do not add oil to the gasoline. Do not overfill the fuel tank; leave room for expansion.

Fuel Type

For best results, use only clean, fresh, unleaded gasoline with a pump sticker octane rating of 86 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, using unleaded gasoline will require more frequent cylinder head servicing.

Gasoline/Alcohol Blends

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

Gasoline/Ether Blends

Methyl Tertiary Butyl Ether (MTBE) and unleaded gasoline blends (up to 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 by disconnecting the spark plug lead.

Maintenance Schedule

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

Frequency	Maintenance Required
Daily or Before Starting Engine	Fill fuel tank.
	Check oil level.
	Check air intake and cooling areas; clean as necessary.[1]
Yearly or Every 25 Hours	Service or replace precleaner element (if equipped).[1]
	Check air cleaner element for dirty, loose or damaged parts.[1]
Yearly or Every 50 Hours	Replace fuel filter, if equipped.
	Change oil.
Yearly or Every 100 hours	Replace spark plug and set gap.
	Replace air cleaner element.[1]
[1]Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.	

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 while the engine is still warm from operation. For further information, see Section 6, Lubrication System.

3. The engine must be run until the fuel tank is completely emptied, or the gasoline must be treated with a stabilizer to prevent deterioration. If you choose to use a stabilizer, follow the manufacturer's recommendations. Fill the fuel tank with clean, fresh gasoline, and run the engine for 2-3 minutes to get stabilized fuel into the carburetor.

4. Remove the spark plug. Add one tablespoon of engine oil into the spark plug hole. Reinstall 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 the thumb is greatest). Reinstall the spark plug, but do not connect the plug lead.

6. Store the engine in a clean, dry place. Never store the machine or fuel container where there is an open flame, spark, or pilot light such as on a water heater or on other appliances.

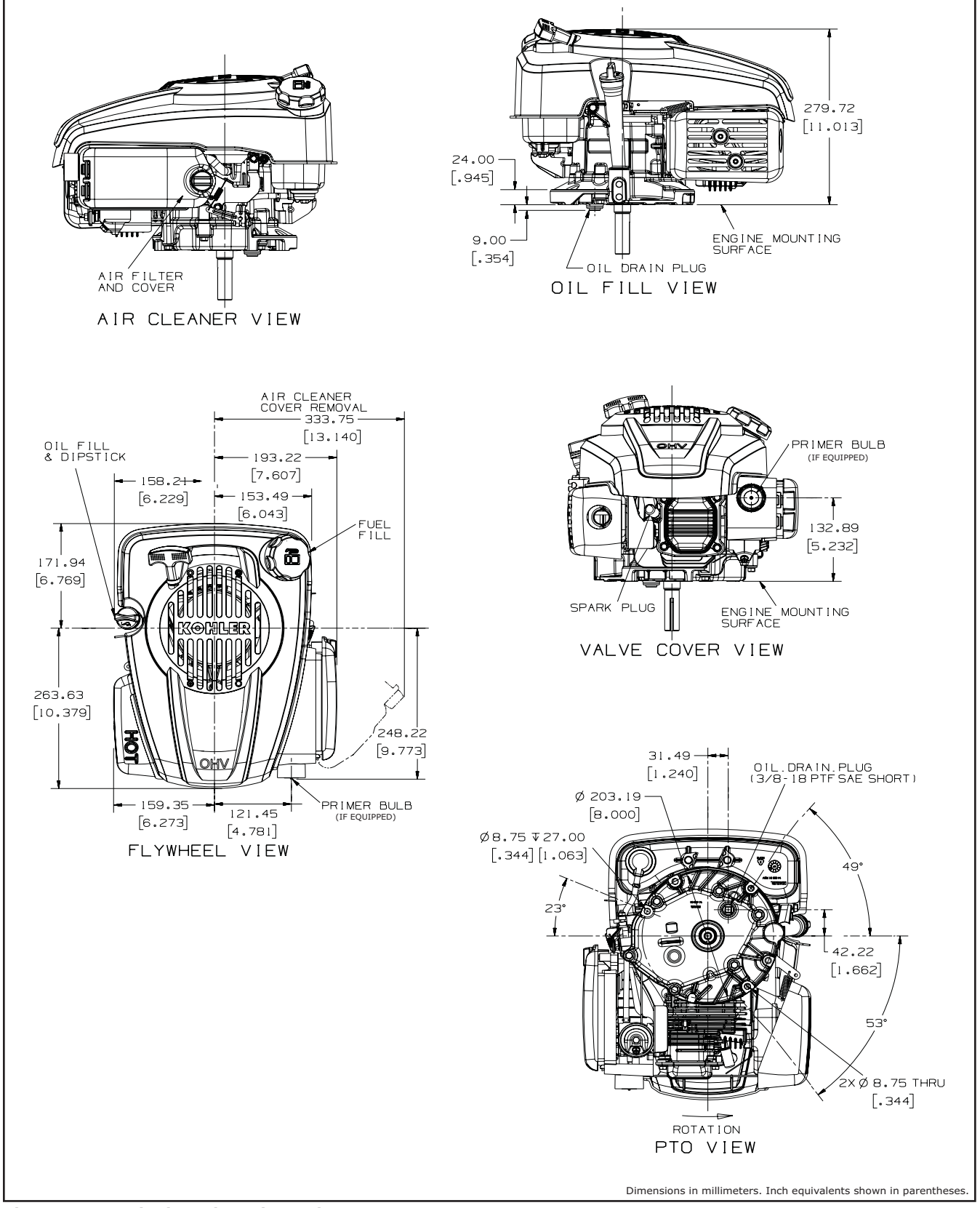


Figure 1-5. Typical Engine Dimensions.

General Specifications[1]

Net Power (@ 3600 RPM)
- XT-6 ..... 2.6 kW (3.5 HP)
- XT-7 ..... 3.4 kW (4.5 HP)

Net Peak Torque (@ 2600 RPM)
- XT-6 ..... 8 N·m (5.9 ft. lb.)
- XT-7 ..... 9.5 N·m (7 ft. lb.)

Bore
- XT-6 ..... 65 mm (2.56 in.)
- XT-7 ..... 70 mm (2.75 in.)

Stroke
- XT-6 ..... 45 mm (1.8 in.)
- XT-7 ..... 45 mm (1.8 in.)

Displacement
- XT-6 ..... 149 cc (9.1 cu. in.)
- XT-7 ..... 173 cc (10.6 cu. in.)

Compression Ratio
- XT-6 ..... 8.3:1
- XT-7 ..... 8.5:1

Dry Weight
- XT-6 ..... 10.8 kg (24 lb.)
- XT-7 ..... 13.1 kg (29 lb.)

Oil Capacity (refill)
- XT-6 ..... 0.60 L (20 oz.)
- XT-7 ..... 0.60-0.65 L (20-22 oz.)

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

Air Cleaner Base
Air Cleaner Base Fastener Torque ..... 8 N·m (71 in. lb.)
Air Cleaner Base to Crankcase Fastener Torque ..... 8 N·m (71 in. lb.)

Blower Housing
Blower Housing Stud Torque ..... 10 N·m (88 in. lb.)

Brake
Brake Mounting Fastener Torque ..... 9.5 N·m (84 in. lb.)

Breather Cover
Breather Cover Fastener Torque ..... 10 N·m (88 in. lb.)

Camshaft
End Play ..... 0.2-0.8 mm (0.0078-0.0314 in.)
Running Side Clearance ..... 0.15-0.51 mm (0.0059-0.02 in.)

Carburetor
Carburetor Stud Fastener Torque ..... 9.0 N·m (80 in. lb.)

Connecting Rod

Connecting Rod Fastener Torque[2] ..... 12.5 N·m (110 in. lb.)

Connecting Rod-to-Crankpin Running Clearance
- New ..... 0.025-0.045 mm (0.0009-0.0017 in.)

Connecting Rod-to-Crankpin Side Clearance ..... 0.13-0.37 mm (0.0051-0.0145 in.)

Connecting Rod-to-Piston Pin Running Clearance ..... 0.008-0.025 mm (0.0003-0.0009 in.)

Piston Pin End I.D.
- New ..... 18.006-18.017 mm (0.7088-0.7093 in.)

Governor Cross Shaft Bore I.D.
- New ..... 6.000-6.018 mm (0.2362-0.2369 in.)

Control Bracket to Crankcase Fastener Torque ..... 8 N·m (70 in. lb.)

Crankshaft

End Play (free) ..... 0.225-1.145 mm (0.0088-0.04507 in.)

Crankshaft Bore in Crankcase I.D.
- New ..... 24.994-25.000 mm (0.9840-0.9842 in.)

Crankshaft Bore in Closure Plate I.D.
- New ..... 25.400-25.421 mm (0.9999-1.0008 in.)

Flywheel End Main Bearing Journal O.D.
- O.D. – Max. Wear Limit ..... 24.975-24.989 mm (0.9832-0.9838 in.)
- Max. Taper ..... 0.025 mm (0.0009 in.)
- Max. Out of Round ..... 0.025 mm (0.0009 in.)

PTO End Main Bearing Journal O.D.
- New ..... 25.370-25.385 mm (0.9988-0.9994 in.)
- Max. Taper ..... 0.025 mm (0.0009 in.)
- Max. Out of Round ..... 0.025 mm (0.0009 in.)

Crankshaft Bore in Closure Plate Running Clearance
- New ..... 0.015-0.051 mm (0.0005-0.002 in.)

Crankcase

Governor Cross Shaft Bore I.D.
- New ..... 6.000-6.018 mm (0.2362-0.2369 in.)

Crankshaft Journal in Crankcase Running Clearance
- New ..... 0.005-0.025 mm (0.0002-0.0009 in.)

Connecting Rod Journal O.D.
- New ..... 29.985-29.995 mm (1.1805-1.1809 in.)
- Max. Taper ..... 0.010 mm (0.0004 in.)
- Max. Out of Round ..... 0.010 mm (0.0004 in.)

Cylinder Bore

Cylinder Bore I.D.
- New ..... 70.000-70.015 mm (2.7558-2.7564 in.)
- Max. Taper ..... 12.7 microns (0.0005 in.)
- Max. Out of Round ..... 12.7 microns (0.0005 in.)

Cylinder Head

Cylinder Head Fastener Torque[2] ..... 27.8 N·m (246 in. lb.)

Max. Out-of-Flatness ..... 0.08 mm (0.0031 in.)

Rocker Pivot Jam Nut Torque[2] ..... 9.5 N·m (84 in. lb.)
Rocker Arm Stud Torque[2] ..... 13.6 N·m (120 in. lb.)

Dipstick Tube Fastener

Dipstick Tube Fastener Torque ..... 8 N·m (71 in. lb.)

Engine Cover

Engine Cover to Valve Cover Fastener Torque ..... 2.8 N·m (25 in. lb.)
Engine Cover Insert to Engine Cover Fastener Torque ..... 2.3 N·m (20 in. lb.)

Fan/Flywheel

Flywheel Nut Torque ..... 51.5 N·m (456 in. lb.)

Fuel Tank

Tank Bracket to Crankcase Stud Torque ..... 8 N·m (71 in. lb.)
Tank Bracket to Tank Fastener Torque ..... 4.5 N·m (40 in. lb.)

Governor

Governor Cross Shaft-to-Crankcase Running Clearance ..... 0.020-0.058 mm (0.0007-0.0022 in.)
Governor Lever Fastener Torque ..... 9.5 N·m (84 in. lb.)
Governor Gear Fastener Torque ..... 9.5 N·m (84 in. lb.)

Governor Cross Shaft O.D.
- New ..... 5.96-5.98 mm (0.2346-0.2354 in.)

Governor Gear Shaft-to-Governor Gear Running Clearance ..... 0.09-0.19 mm (0.0035-0.0074 in.)

Governor Gear Shaft O.D.
- New ..... 6.01-6.03 mm (0.2366-0.2374 in.)

Ignition

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

Spark Plug Gap ..... 0.762 mm (0.030 in.)

Spark Plug Torque ..... 24.5 N·m (217 in. lb.)

Ignition Module Air Gap ..... 0.254 mm (0.010 in.)

Ignition Module Fastener Torque ..... 10 N·m (88 in. lb.)

Muffler

Exhaust Stud Torque ..... 9.0 N·m (80 in. lb.)
Exhaust Stud Fastener Torque ..... 9.5 N·m (84 in. lb.)

Oil

Oil Pan Screw Torque[2] ..... 12.3 N·m (109 in. lb.)

Oil Drain Plug Torque[3] ..... 13.5 N·m (120 in. lb.)

Piston, Piston Rings, and Piston Pin

Piston Pin Bore I.D.
New ..... 18.000-18.008 mm (0.7086-0.7089 in.)

Piston Pin O.D.
New ..... 17.990-17.996 mm (0.7082-0.7085 in.)

Top Compression Ring-to-Groove Side Clearance ..... 0.02-0.06 mm (0.0007-0.0023 in.)

Middle Compression Ring-to-Groove Side Clearance ..... 0.02-0.06 mm (0.0007-0.0023 in.)

Top and Middle Compression Ring End Gap
New Bore ..... 0.025-0.040 mm (0.0009-0.0015 in.)

Piston Thrust Face O.D.
New ..... 69.96-69.98 mm (2.7543-2.7551 in.)

Piston Thrust Face-to-Cylinder Bore Running Clearance
New ..... 0.020-0.055 mm (0.0007-0.0021 in.)

Recoil

Recoil Mounting Fastener Torque ..... 8 N·m (71 in. lb.)

Speed Control

Speed Control Bracket Assembly Fastener Torque .....8 N·m (71 in. lb.)

Valve Cover

Valve Cover Fastener Torque..... 8 N·m (71 in. lb.)

Valves and Valve Lifters

Intake Valve Lash[4] ..... 0.0762-0.127 mm (0.003-.005 in.)

Exhaust Valve Lash[4] ..... 0.0762-0.127 mm (0.003-.005 in.)

Intake Valve Minimum Lift (over base circle)..... 5.200 mm (0.2047 in.)

Exhaust Valve Minimum Lift (over base circle)..... 5.247 mm (0.2065 in.)

Nominal Valve Seat Angle ..... 25°, 45°, 60° (3 angles)

Valves and Valve Lifters (continued)

Intake Valve Stem-to-Valve Guide Running Clearance	0.020-0.047 mm (0.0007-0.0018 in.)
Exhaust Valve Stem-to-Valve Guide Running Clearance	0.055-0.082 mm (0.0021-0.0032 in.)
Intake Valve Guide I.D.	
New	5.500-5.512 mm (0.2165-0.2170 in.)
Intake Valve Stem Diameter	
New	5.465-5.480 mm (0.2151-0.2157 in.)
Exhaust Valve Guide I.D.	
New	5.500-5.512 mm (0.2165-0.2170 in.)
Exhaust Valve Stem Diameter	
New	5.430-5.445 mm (0.2137-0.2143 in.)

[1]Values are in metric units. English equivalents are shown in parentheses. Do not lubricate threads unless otherwise indicated.

[2]Apply lubricant to fastener threads before assembly. Acceptable lubricants include: 10W-30 engine oil, Mobil Assembly Oil (# 450304), Dubois MPO-10 (# 03013104), and WD-40®.

[3]Apply thread sealant around three full threads before assembly. No excess sealant allowed on inside or outside of joint. Threads with pre-applied sealant do not require the use of additional sealant. Approved sealants include Perma-Loc LH 150, Perma-Loc MM 115, Perma-Loc HH 120, Perma-Loc HL 126.

[4]Check valve lash every 200 hours; adjust as required.

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%

Size	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 Plug 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 perform specific disassembly, repair, and reassembly procedures. By using tools designed for the job, proper servicing of engines is easier, faster, and safer. In addition, customer satisfaction and service capabilities will be increased by shortening engine downtime.

Here is the list of tools and their sources:

Separate Tool Suppliers:

Kohler Tools
Contact your local Kohler source of supply.

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

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

Tools	
Description	**Source/Part No.**
Cylinder Leakdown Tester For checking combustion retention and if cylinder, piston, rings, or valves are worn.	Kohler 25 761 05-S
Flywheel Strap Wrench To hold flywheel during removal.	SE Tools KLR-82409
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
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

Aids	
Description	**Source/Part No.**
Camshaft Lubricant (Valspar ZZ613)	Kohler 25 357 14-S
Dielectric Grease (GE/Novaguard G661)	Kohler 25 357 11-S
RTV Silicone Sealant Perma-Lok LH 150 Perma-Lok MM 115 Perma-Lok HH 120 Perma-Lok HL 126.	

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 types of engine troubles are listed below. Use these to help locate the possible cause(s).

Engine Cranks But Will Not Start

1. Empty fuel tank.
2. Poor fuel, dirt or water in fuel system.
3. Clogged fuel line.
4. Spark plug lead disconnected.
5. Kill switch in off position.
6. Faulty spark plug.
7. Faulty ignition module.
8. Choke not closing (if equipped).
9. Engine not primed (if equipped).

Engine Starts But Does Not Keep Running

1. Restricted fuel tank cap vent.
2. Poor fuel, dirt or water in fuel system.
3. Faulty or incorrectly adjusted choke or throttle controls, (if equipped).
4. Loose wires or connections short ignition module's kill terminal to ground.
5. Faulty cylinder head gasket.
6. Faulty carburetor.
7. Intake system leak.

Engine Starts Hard

1. Poor fuel, dirt or water in fuel system.
2. Clogged fuel line.
3. Loose or faulty wires or connections.
4. Faulty or incorrectly adjusted choke or throttle controls (if equipped).
5. Faulty spark plug.
6. Low compression.
7. Weak spark.
8. Engine overheated; air circulation restricted.
9. Flywheel key sheared.
10. Intake system leak.

Engine Will Not Crank

1. Loose or faulty wires or connections.
2. Faulty key switch or ignition switch.
3. Seized internal engine components.

Engine Runs But Misses

1. Dirt or water in fuel system.
2. Spark plug faulty or fouled.
3. Poor quality of fuel.
4. Spark plug lead boot loose on plug.
5. Loose wires or connections intermittently short the ignition module's kill terminal to ground.
6. Engine overheated.
7. Faulty ignition module or improperly gapped.
8. Carburetor adjusted incorrectly.

Engine Will Not Idle

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

Engine Overheats

1. Air intake, grass screen, cooling fins, or cooling shroud clogged.
2. Excessive engine load.
3. Low crankcase oil level.
4. High crankcase oil level.
5. Faulty carburetor.
6. Lean fuel mixture.

Engine Knocks

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

Engine Loses Power

1. Low crankcase oil level.
2. High crankcase oil level.
3. Dirty air cleaner element.
4. Dirt or water in fuel system.
5. Excessive engine load.
6. Engine overheated.
7. Faulty spark plug.
8. Low compression.
9. Exhaust restriction.
10. Incorrect governor setting.

Engine Uses Excessive Amount of Oil

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

Oil Leaks from Oil Seals, Gaskets

1. Clogged, broken or inoperative breather.
2. Worn or broken piston rings.
3. Piston blowby, or leaky valves.
4. Restricted exhaust.

External Engine Inspection

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

- Check for buildup of dirt and debris on the crankcase, cooling fins, grass screen, and other external surfaces. Dirt or debris on these areas can cause overheating.

- Check for obvious oil leaks and damaged components. Excessive oil leakage can indicate a clogged or inoperative breather, worn or damaged seals or gaskets, or loose fasteners.

- Check 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 improper maintenance.

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

- Check if the oil level is within the operating range on the dipstick. If it is above, sniff for gasoline odor.

- Check the condition of the oil. Drain the oil into a container; it should flow freely. Check for metal chips and other foreign particles.

Sludge is a natural by-product of combustion, and small amounts of accumulation are normal. Excessive sludge formation could indicate several problems: The wrong type or weight of oil was used, the oil was not changed at the recommended intervals, an over-rich fuel mixture, or a weak ignition, to name a few possible causes.

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

Cleaning Engine

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

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

Basic Engine Tests

Crankcase Vacuum Test

A partial vacuum should be present in the crankcase when the engine is operating. Pressure in the crankcase (normally caused by a clogged or improperly-operating 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, Tools and Aids. Complete instructions are provided with the testers.

Test the crankcase vacuum with a 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 (2800 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 pinch clamp **before** stopping the engine.

To perform the test with the vacuum/pressure gauge:

1. Insert the stopper as in Step 1.

2. Insert the barbed gauge fitting into the hole in the stopper. Be sure the gauge needle is at "0."

3. 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. A minimum of 10.2 cm (4 in.) of vacuum should be present.

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 on Page 3.4.

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 or replace restricted muffler/exhaust system.

Cylinder Leakdown Test

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

The cylinder leakdown tester is a relatively simple, inexpensive leakdown tester for small engines. The tester includes a quick disconnect coupling for attaching the adapter hose and a holding tool.

Leakdown Test Instructions

1. Run the engine for 3-5 minutes to warm it up.

2. Remove the spark plug.

3. Rotate the crankshaft until the piston is at top dead center (TDC) of the 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, align the slot with one of the mounting holes on the PTO face, and tighten it onto the crankshaft. Install a 3/8" breaker bar into the slot of the holding tool, so it is perpendicular to both the holding tool and crankshaft, or insert a shoulder bolt through the slot and thread it into the mounting hole.

   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 (80-100 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 (right) end of the scale.

7. Connect the tester quick-disconnect to the adapter. Note the gauge reading and listen for escaping air at the carburetor inlet, exhaust outlet, and/or 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

This engine is equipped with a replaceable, high density paper air cleaner. An optional foam precleaner may also be included. See Figure 4-1. Intake air is drawn in through the blower housing, and passes through the precleaner (if equipped), the paper element and then into the carburetor. The outer air cleaner cover is secured by one knob, and removed by turning the knob counterclockwise.

Check the air cleaner assembly **daily or before starting the engine**. Check for any buildup of dirt and debris, as well as loose or damaged components. See Figure 4-1.

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

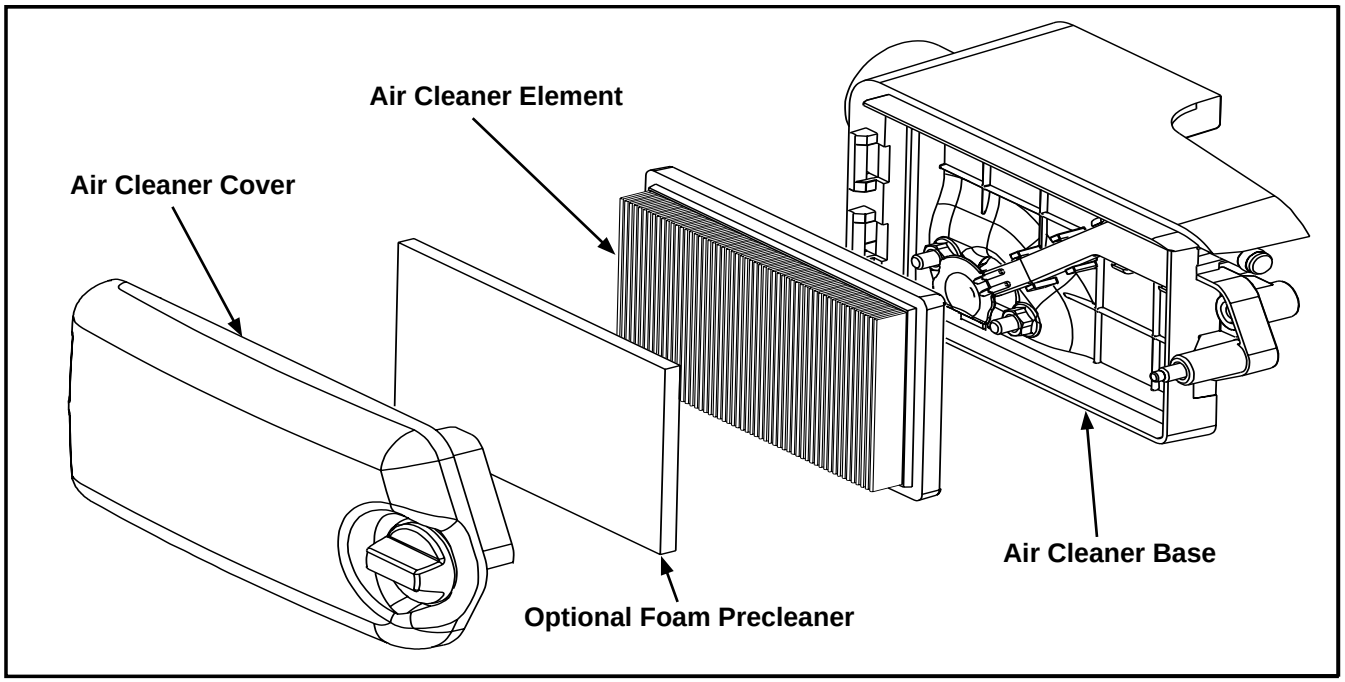


Figure 4-1. Air Cleaner Assembly (Exploded View).

Service Precleaner

Wash or replace the optional precleaner **yearly or every 25 hours** of operation; more often under extremely dusty or dirty conditions. Follow these instructions to service:

1. Loosen the air cleaner cover knob and remove the cover. See Figure 4-1.
2. Remove the precleaner and wash with detergent in warm water.
3. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring), and allow the precleaner to air dry.
4. Reinstall the precleaner.
5. Reinstall the air cleaner cover and tighten the knob securely.

Service Paper Element

Check the paper element for dirty, loose or damaged parts **every 25 hours** of operation; more often under extremely dusty or dirty conditions. **Yearly or every 100 hours** of operation replace the paper element. Follow these instructions to service:

1. Loosen the air cleaner knob and remove the cover. Remove the paper air cleaner element and the precleaner (if equipped). See Figure 4-1.

2. 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.

3. When servicing the air cleaner, check the air cleaner base. Make sure it is secured and not damaged. Also, check the air cleaner cover for damage or improper fit. Replace all damaged air cleaner components.

4. If any loose dirt or debris fell into the air cleaner when the element was removed, carefully remove it and wipe the base clean.

5. Check the condition of the rubber seal on the paper element. If the condition is questionable in any way, replace the element.

6. Reinstall the paper element and the optional precleaner, if equipped. Reattach the cover.

Disassembly

The following procedure outlines complete disassembly of the air cleaner assembly. Since removal of the air cleaner base also affects carburetor mounting and governor adjustment, Step 4 should only be performed if required. For further information see the Dissassembly and Reassembly sections of this manual.

1. Loosen the air cleaner cover retaining knob and remove the air cleaner cover.

2. Remove the foam precleaner (if equipped), and the paper air cleaner with the formed rubber seal.

3. Disconnect the breather hose from the crankcase. See Figure 4-2.

Figure 4-2. Breather Hose.

4. Remove the two hex flange nuts from the mounting studs which secure the air cleaner base, carburetor, and gaskets. Remove the third hex screw attaching the base to the crankcase.

5. Remove the air cleaner base by swinging it out to the left and disconnecting the primer hose (if equipped) from the carburetor. See Figure 4-3.

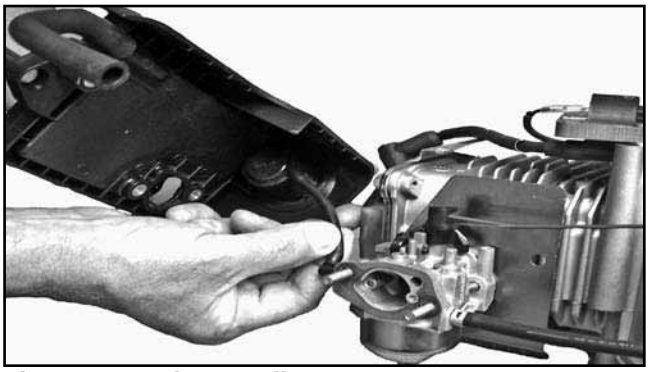


Figure 4-3. Primer Bulb Hose.

Inspect Air Cleaner Components

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

Outer Air Cleaner Cover - Make sure the air cleaner cover is in good condition, not cracked, damaged, or missing the retaining knob, which can affect the sealing ability of the air cleaner element.

Air Cleaner Base - Make sure the base is properly secured and not cracked or damaged. It is extremely important that the fasteners securing this component are tight at all times.

Primer Bulb Hose - Make sure the hose is not cracked kinked or damaged, and attached to both the air cleaner base and the carburetor. See Figure 4-3.

NOTE: Before reinstalling an air cleaner base that has been removed, make sure the metal bushings in the base mounting holes are present. The bushings prevent damage to the base and help maintain the proper mounting torque.

Reassembly

The following procedure outlines complete reassembly of all air cleaner components.

1. Reconnect the primer bulb hose (if equipped). See Figure 4-3.
2. Install the air cleaner base onto the mounting studs.
3. Install the air cleaner base with the two hex flange nuts and the hex screw. Torque all three to **8.1 N·m (72 in. lb.)**.
4. Reconnect the breather hose. See Figure 4-2.
5. Install the air cleaner element with the pleated side out.
6. Install the precleaner (if equipped) into the air cleaner cover.
7. Reinstall the air cleaner cover and secure with the cover knob.

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

Air Intake/Cooling System

Clean Air Intake/Cooling Areas

To ensure proper cooling, make sure the grass screen, cooling fins, blower housing, and other external surfaces of the engine are kept clean at all times. Under extremely dusty or dirty conditions, pay extra attention to these areas.

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

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 spillage during refueling. To minimize gum deposits in your fuel system and to ensure easy starting, **do not** use gasoline left over from the previous season. Do not add oil to the gasoline or overfill the fuel tank. Be sure to 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, using unleaded gasoline will require more frequent cylinder head servicing.

Gasoline/Alcohol blends

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

Gasoline/Ether Blends

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

Fuel System

The typical fuel system and related components include the fuel tank, in-line fuel filter (if equipped), carburetor, and fuel lines.

Operation

The fuel from the tank is moved through the in-line filter and fuel lines by gravity. 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 (Optional)

Replace the fuel filter **yearly or every 50 hours** of operation. Removing the air cleaner first will allow easy access to the fuel filter. See Figure 5-1.

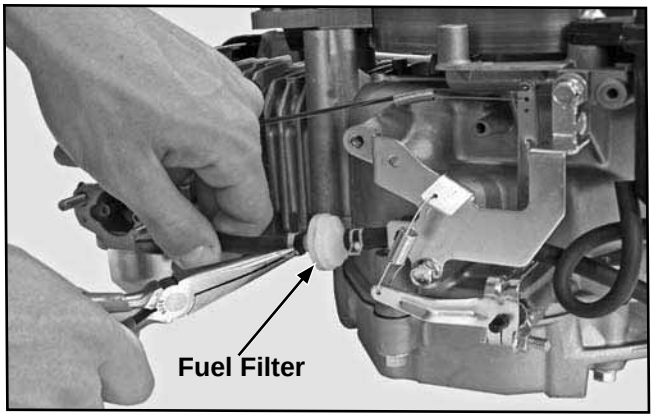


Figure 5-1. Replacing Fuel Filter (Air Cleaner Off).

Troubleshooting

Use the guide on the following page to determine if fuel is reaching the combustion chamber.

Fuel System Test Guide

Test	Conclusion
1. Check for the following: a. The fuel tank has fresh, clean gas in it. b. Make sure fuel cap vent is open.	1. Gasoline components oxidize over time resulting in lost volitility, making starting more difficult. Replace old gas with fresh gas.
2. Check for fuel in combustion chamber. a. Disconnect and ground spark plug lead. b. Close carburetor choke (if equipped). c. Turn engine over several times. d. Remove spark plug and check for fuel at tip.	2. If there is fuel at tip of spark plug, fuel is reaching the combustion chamber. If there is no fuel at tip of spark, check for fuel flow from fuel tank (Test 3).
3. Check fuel flow from tank to optional fuel filter. a. Disconnect fuel hose from filter (if equipped). b. Hold fuel line below tank and observe fuel flow.	3. If fuel does flow from fuel line, reconnect line and check for faulty fuel filter (Test 3). If fuel does not flow from fuel line, check for clogged fuel tank vent or fuel line.
4. Check for fuel flow to carburetor. a. Remove fuel line from carburetor. b. Remove air filter and test if primer bulb is spraying fuel into carburetor. c. Check for kinks or leaks in primer hose.	4. If fuel does flow from the line, check for faulty carburetor or clogged fuel line. If the fuel line is unobstructed, the fuel tank is faulty and must be replaced. If no fuel spray is entering carburetor, replace primer bulb or primer hose.

Carburetor

Courage XT engines are equipped with either a primer or choke carburetor. See Figures 5-2 and 5-3.

WARNING: Explosive Fuel!

Gasoline is extremely flammable and its vapors can explode if ignited. Store gasoline only in approved containers, in well ventilated, unoccupied buildings, away from sparks or flames. Never use gasoline as a cleaning agent.

Figure 5-2. Carburetor With Primer.

Figure 5-3. Carburetor With Choke.

Troubleshooting — Fuel System

If fuel-system related problems occur, check the following areas before attempting to adjust or disassemble the carburetor.

- Fuel tank is filled with clean, fresh gasoline.
- Fuel cap vent is not blocked and operating properly.
- Fuel is reaching carburetor via in-line fuel filter (if equipped) and fuel lines.
- Air cleaner base, carburetor, and gaskets are securely fastened and/or torqued to engine.
- Air cleaner element is clean, and all air cleaner components are fastened securely.
- Governor system, exhaust system, and throttle/choke controls are operating properly.

Fuel System Troubleshooting Guide

1. Engine starts hard, runs rough or stalls at idle.	1. Engine is out of fuel. Air filter is clogged; clean or replace. Spark plug is faulty; replace or test for spark.
2. Engine runs rich (indicated by black sooty smoke, misfiring, loss of speed and power, and governor hunting).	2. Air filter is clogged; clean or replace. Carburetor is dirty; disassemble and clean.
3. Engine runs lean (indicated by misfiring, loss of speed and power, governor hunting).	3. Obstructed fuel supply; check for clogs. Air intake leak; check for leaks.
4. Fuel leaks from carburetor.	4. Dirt or debris in carb. Disassemble and clean. Loose fuel bowl or drain screw. Disassemble and check for leaks.

Carburetor Adjustments

While this carburetor is designed to deliver the correct fuel-to-air mixture, some adjustments may be necessary.

NOTE: Adjust carburetor after engine is warmed up.

Idle Adjustment Screw

Do not tampered with this screw on engines with a primer bulb, since these models operate only at full speed, and do not idle. On engines with a choke the idle adjustment screw is used to fine tune engine idle. Should an adjustment be required, turn the screw clockwise to increase idle speed, and counterclockwise to lower idle speed. See Figure 5-4.

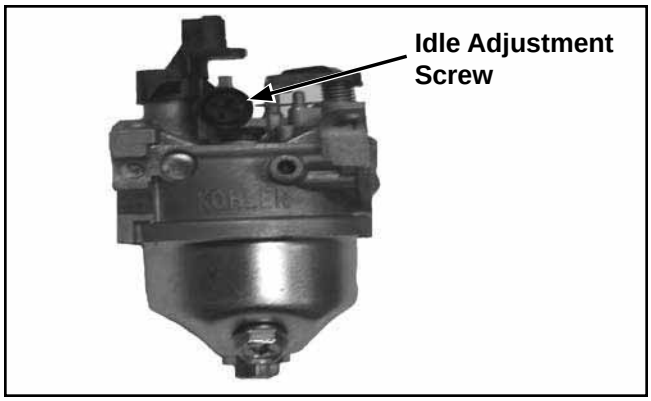


Figure 5-4. Idle Adjustment Screw.

High-Speed (RPM) Adjustment

The recommended maximum no-load high speed (RPM) for most engines is **3300 RPM**. The actual speed depends on the application.

WARNING: Overspeed is Hazardous!

Over speed is hazardous and could cause personal injury.

Engines with Primer Bulb

1. Bend the adjustment tab on the speed control bracket up to increase engine speed, and down to reduce speed. See Figure 5-5.

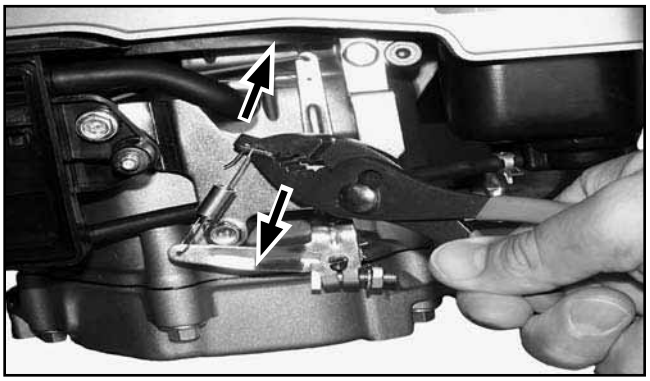


Figure 5-5. Engine Speed Adjustment Tab.

Engines With Choke

1. Turn the high-speed adjustment screw clockwise to decrease engine speed and counterclockwise to increase RPMs. See Figure 5-6.

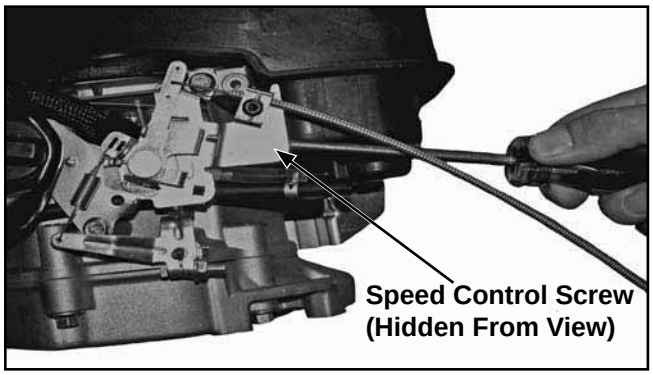


Figure 5-6. Speed Control Screw.

Carburetor Removal

NOTE: Ensure fuel tank is empty prior to carburetor removal.

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. Never use gasoline as a cleaning agent.

1. Loosen air cleaner knob and remove cover.
2. Remove foam precleaner (if equipped) and paper element.
3. Remove two hex flange nuts and hex flange screw securing air cleaner base.
4. Disconnect breather hose, primer hose, and carburetor linkage.
5. Remove carburetor, noting gasket sequence. See Figure 5-7.

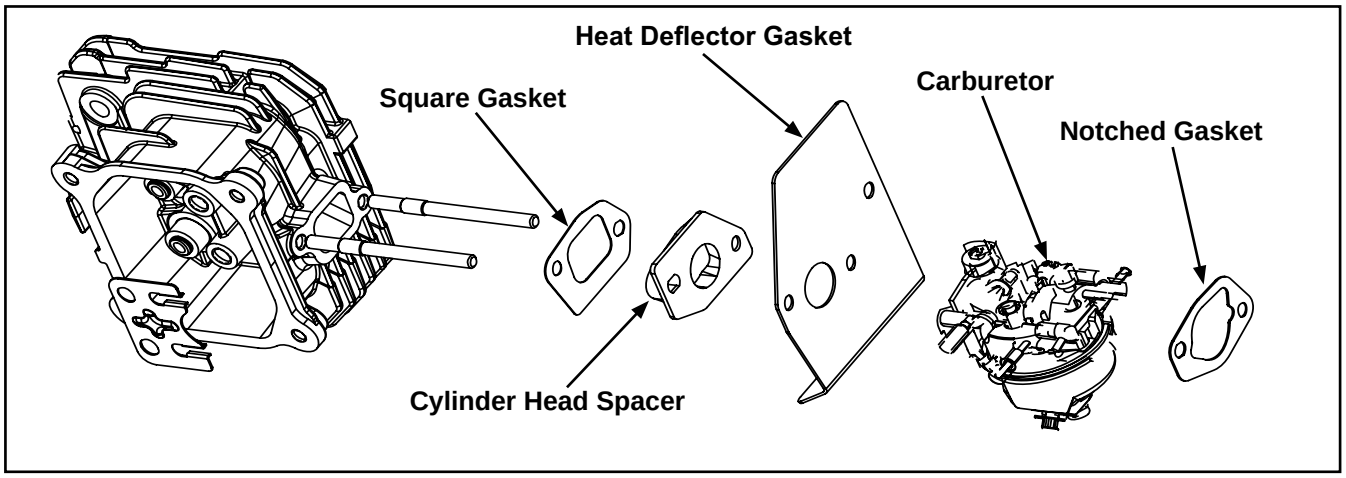


Figure 5-7. Carburetor Gasket Sequence (Exploded View).

Carburetor Disassembly

1. Remove the fuel bowl screw, fuel bowl, O-ring and float pin. See Figure 5-12.
2. Slide the spring-loaded fuel inlet needle out of the float. See Figure 5-8.

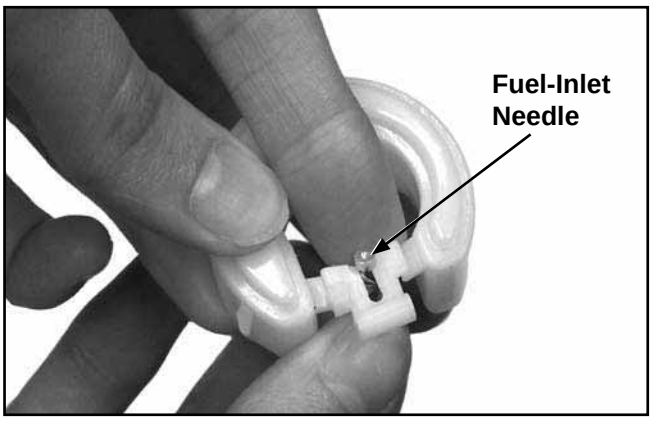


Figure 5-8. Fuel Inlet Needle Removal.

3. Unscrew the main jet from inside the tower. A light tap on the tower will dislodge the emmulsion tube. See Figure 5-9.

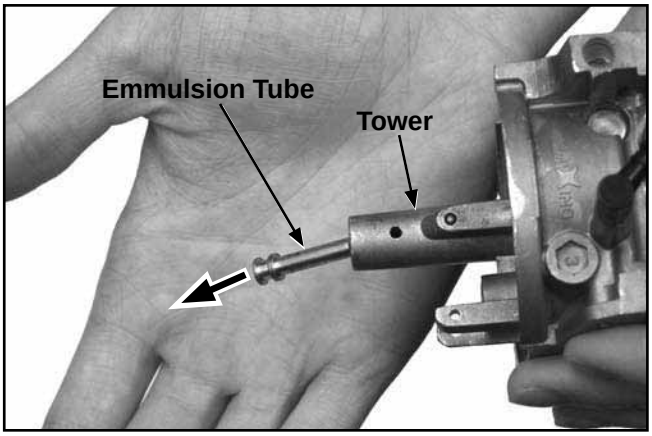


Figure 5-9. Emmulsion Tube Removal.

4. Remove the throttle-plate screw, the throttle plate, and slide out the throttle shaft, noting throttle lever position. See Figures 5-10 and 5-12.

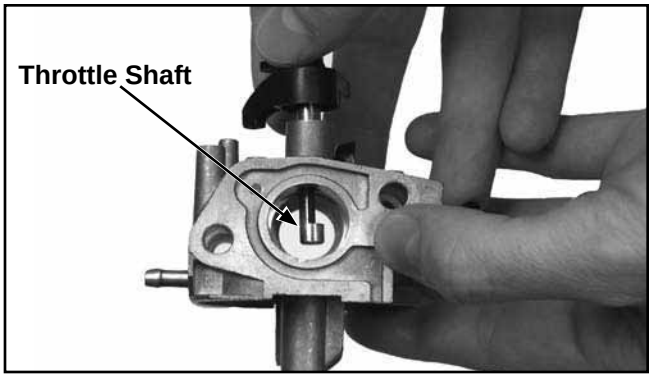


Figure 5-10. Throttle Shaft Removal.

NOTE: Throttle shaft wear is normally accompanied by corresponding wear to the carburetor body, making repair impractical. Replace the entire carburetor if the throttle shaft is worn.

5. To ensure accurate reassembly, mark the choke plate and the carburetor body with a waterproof pen. See Figure 5-11.

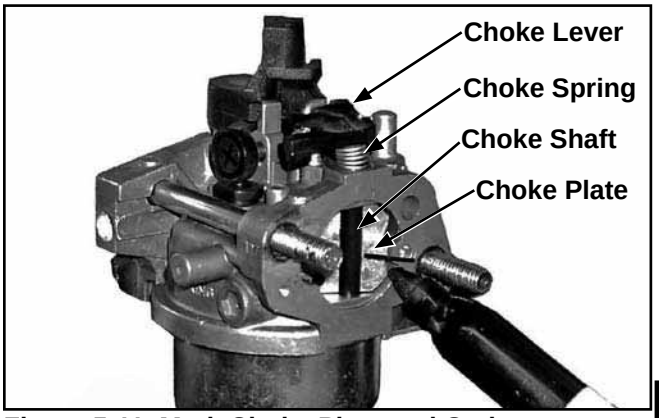


Figure 5-11. Mark Choke Plate and Carburetor.

5

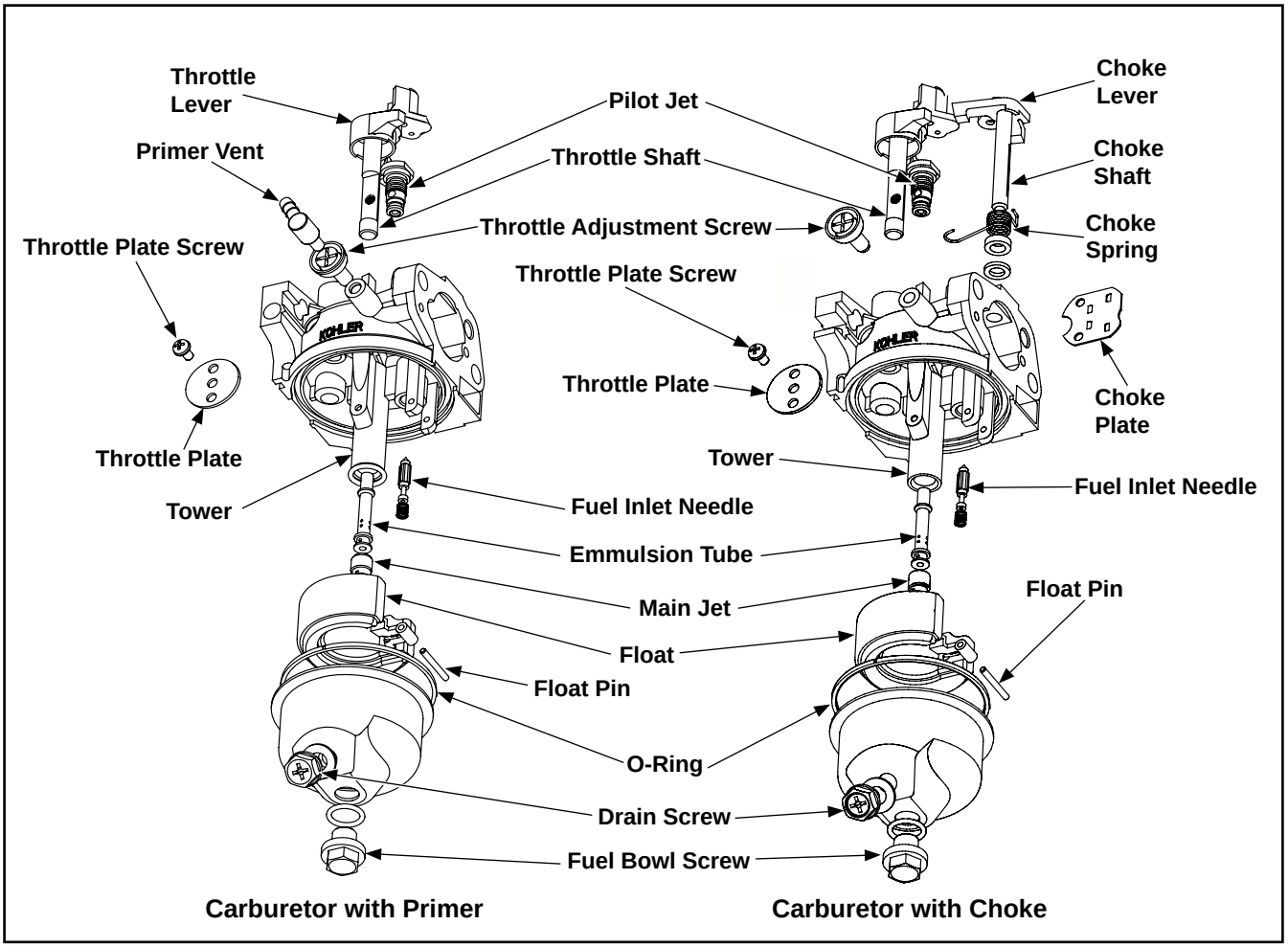


Figure 5-12. Carburetor (Exploded View).

6. Grasp the choke plate with a pliers and remove it from the choke-plate shaft. See Figure 5-13.

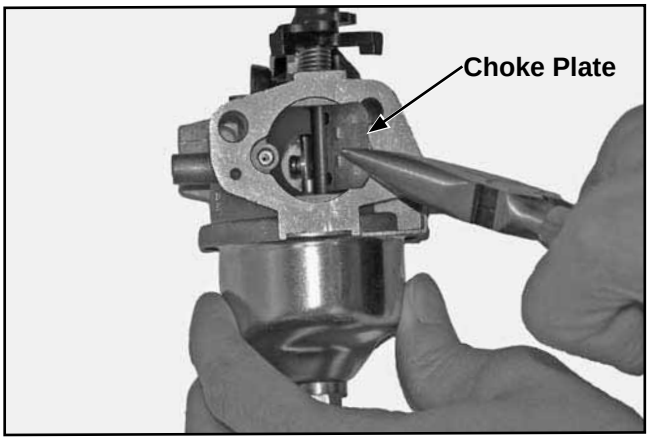


Figure 5-13. Choke Plate Removal.

7. Remove the choke shaft and disconnect the choke return spring, noting their positions for accurate reassembly. See Figure 5-14.

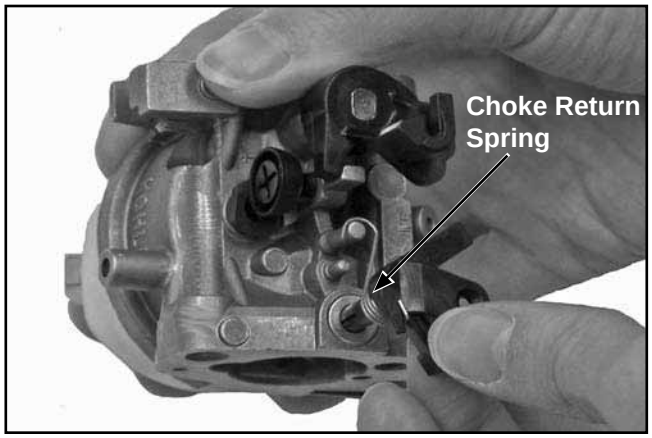


Figure 5-14. Choke Return Spring Removal.

Carburetor 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 carburetor parts should be cleaned thoroughly using a commercial carburetor cleaner. Make sure all gum deposits are removed from the following areas:

- Carburetor body and bore, especially areas where throttle plate and shaft are seated.
- Main fuel jet, emulsion tube in main jet body, fuel inlet needle and seat.
- Float, float hinge and fuel bowl.

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

Carburetor Inspection

Complete carburetor inspection should include the following:

- Inspect carburetor body for cracks, holes, and other wear or damage.
- Inspect float for cracks and holes. Check float hinge and pin for wear or damage.
- Inspect fuel inlet needle and seat for wear or damage.
- Inspect tip of low idle, fuel-adjustment needle for wear or grooves.
- Inspect throttle and choke shaft and plate assemblies for wear or excess play.

Gasket Replacement

Always use new gaskets when servicing or reinstalling carburetors. Repair kits are available which include new gaskets and other components. Always refer to the Kohler Parts Manual for the engine being serviced to ensure the correct repair kit is ordered.

Carburetor Reassembly

1. Install the throttle shaft into the carburetor body.
2. Apply thread sealant around three full threads of the throttle plate screw before attaching the plate to the throttle shaft. Wipe away any excess sealant.
3. Attach the choke return spring to the choke shaft (if equipped).
4. Insert the choke shaft into the carburetor body.
5. Noting the marks made earlier on the choke plate and the carburetor, insert the choke plate into the slot in the choke shaft. See Figure 5-11. The plate is held in the shaft by dimples on the plate's surface.

6. Attach the choke return spring to the carburetor body, and insert the choke shaft.

7. Install the emmulsion tube and then screw in the main jet. See Figure 5-9.

8. Install the fuel inlet needle, float, float pin, O-ring and fuel bowl. See Figure 5-12.

High Altitude Operation

When operating the engine at altitudes above 1525 meters (5000 ft.), the main fuel mixture tends to become too rich. When the mixture is too rich it 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 high altitude main jet can be installed. High altitude jets are sold in kits which include the jet and the necessary gaskets.

NOTE: If a high-altitude kit has been installed, the engine must be reconverted to the original jet size before it is operated at lower altitudes, or overheating and engine damage may result.

Engine Starting

Starting Engine With Primer Bulb

1. **For a Cold Engine**, firmly push the primer bulb 3 times. See Figure 5-15. Pressing the primer bulb too many times can flood the engine. For a warm engine no priming is required. Also refer to the operating instructions of the equipment this engine powers.

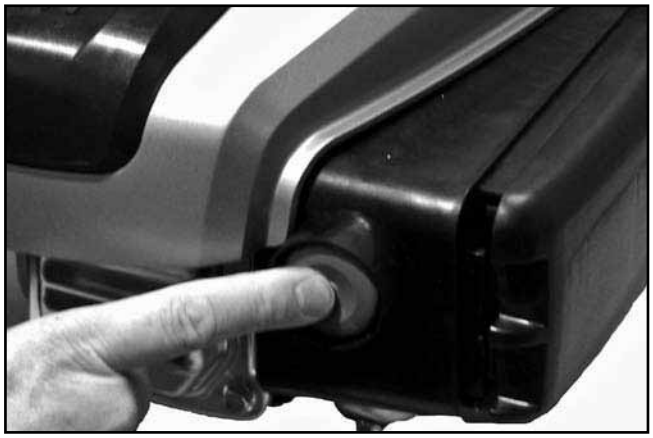


Figure 5-15. Primer Bulb.

2. Move the equipment's blade control bar into the proper start position.

3. Pull the starter handle straight out with a smooth, steady motion until the engine has started.

Starting Engine With Manual Choke Control

1. **For a Cold Engine, p**lace the application choke control into the ON position. For a warm engine no choke is required. Also refer to the operating instructions of the equipment this engine powers.

2. Move the equipment's blade control bar into the proper start position.

3. Pull the starter handle straight out with a smooth, steady motion until the engine has started.

4. After the engine starts, move the choke control from the ON position to the OFF position.

Choke Cable Installation

1. Connect the Bowden cable to the engine choke control arm on the speed control bracket. See Figure 5-16.

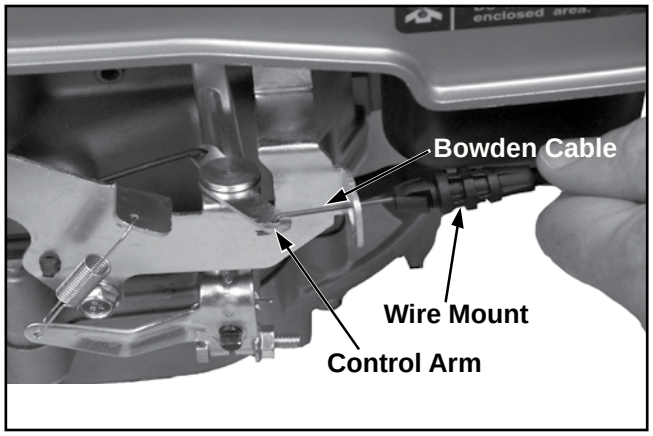


Figure 5-16. Connect Bowden Cable.

2. Set the choke control on the equipment this engine powers to the OPEN or OFF position.

3. Snap the plastic wire mount into the speed control bracket. See Figure 5-16.

Install Throttle/Choke Control Cable

Some engines are equipped with a dual throttle/choke control arm. This allows simultaneous adjustment of the throttle and choke together.

Dual Throttle/Choke Control Installation

1. Loosen the cable clamp and insert the cable sheath through the clamp. See Figure 5-17.

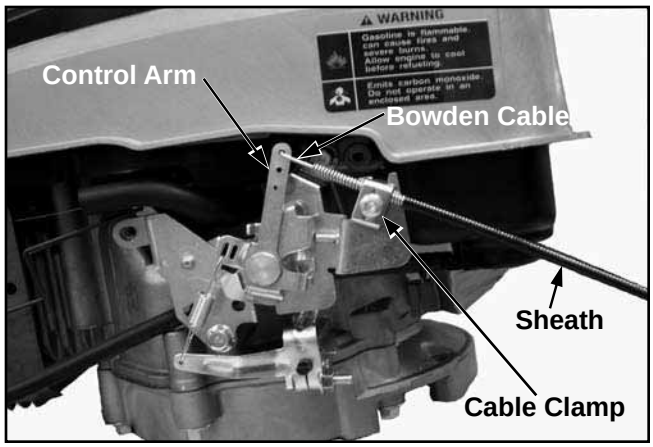


Figure 5-17. Bowden Cable Connection.

2. Connect the Bowden cable to the control arm on the speed-control bracket. For correct hole selection, refer to the operating instructions of the equipment this engine powers. See Figure 5-15.

3. Place the throttle control lever of the equipment into the FAST or high-speed position.

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

4. Manually move the control arm clockwise until it touches the speed-control screw.

5. Pull on the outer sheath of the throttle control cable to remove any slack.

6. Tighten the cable clamp securely.

Governor

These engines are equipped with a centrifugal flyweight, mechanical governor, designed to hold the engine speed constant under changing load conditions. The governor gear/flyweight mechanism is mounted on the closure plate in the crankcase, and driven off a gear on the crankshaft. See Figure 5-18.

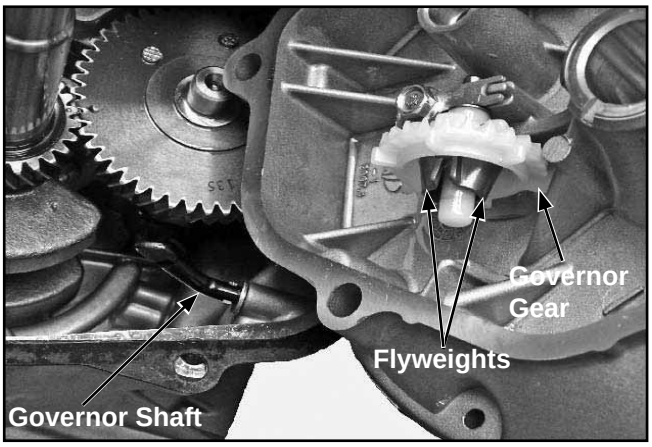


Figure 5-18. Governor Assembly.

Operation

As the governor gear rotates, centrifugal force causes the flyweights to move outward as speed increases. As the flyweights open, they cause the regulating pin to protrude out. The regulating pin contacts the tab on the cross shaft, causing the shaft to rotate. One end of the cross shaft protrudes through the side of the crankcase. The governor lever is clamped on the protruding end of the shaft and connected with linkage to the throttle lever on the carburetor, so any rotation of the shaft causes corresponding movement of the throttle plate.

When the engine is at rest and the throttle is open — as with a fixed-speed engine (primer bulb) — or in the FAST position — as with a variable-speed engine — the tension of the governor spring holds the throttle plate open. When the engine is operating, and 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/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 governed speed setting is determined by the position of the throttle control. It can be variable or constant, depending on the application.

Initial Governor Adjustment

Make this initial adjustment whenever the governor arm is loosened or removed from the cross shaft. To ensure proper adjustment, make sure the throttle linkage is connected to both the governor arm and the throttle lever on the carburetor.

1. Loosen the governor lever adjustment screw. See Figure 5-19.

Figure 5-19. Loosen Governor Lever.

2. Move the governor lever away from the carburetor (wide open throttle). See Figure 5-19. **Do not** apply excess force that may flex or distort the throttle link.

3. Grasp the cross shaft with a pliers and turn the shaft **clockwise** as far as it will go. Then torque the hex nut to **9.5 N·m (84 in. lb.)**. See Figure 5-20.

Figure 5-20. Adjust Governor Lever.

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 SJ or higher**. Select the viscosity based on the air temperature at the time of operation. See Figure 6-1.

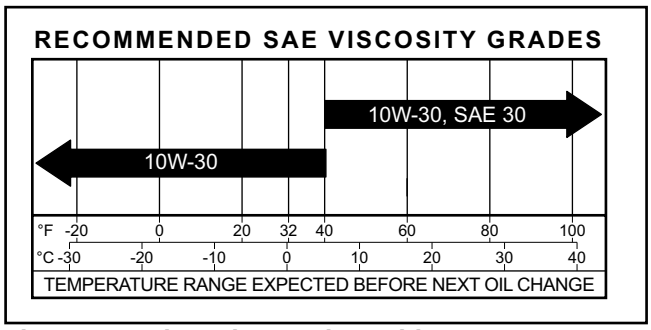


Figure 6-1. Viscosity Grades Table.

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

A logo or symbol on oil containers identifies the API service class and SAE viscosity grade. See Figure 6-2.

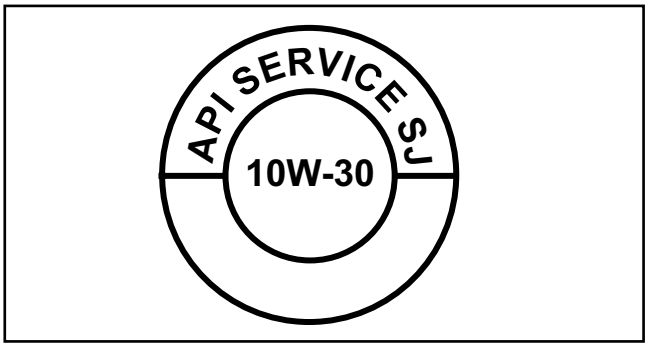


Figure 6-2. Oil Container Logo.

Check Oil Level

The importance of checking and maintaining proper oil level in the crankcase cannot be overemphasized.

Check oil **BEFORE EACH USE** as follows:

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

2. Clean the area around the oil fill cap/dipstick to keep dirt and grass clippings out of the engine.

3. Unscrew and remove the oil fill cap/dipstick; wipe off oil. Reinsert the dipstick into the tube and rest the oil fill cap on the tube. DO NOT screw the cap into the tube. See Figure 6-3.

Figure 6-3. Oil Fill Cap/Dipstick.

4. Remove the dipstick again and check the oil level. Oil should be up to, but not over the "F" or FULL mark on the dipstick. See Figure 6-4.

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

6. Reinstall the oil fill cap/dipstick and tighten securely.

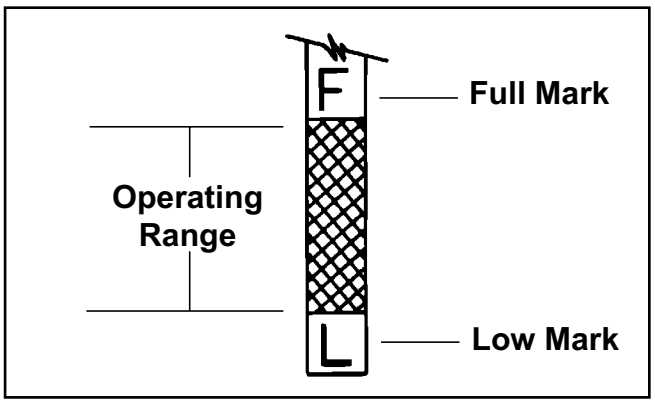


Figure 6-4. Dipstick.

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

Oil Change

Oil can be changed on this engine by either draining it from the dipstick tube, or from the drain plug. Change the oil after the **first three to five hours of operation**. After that, change the oil **yearly or every 50 hours** of operation. Refill with oil as specified in the Viscosity Grades Table, Figure 6-1.

Change the oil while the engine is still warm. The oil will flow more freely and carry away more impurities.

Drain Oil from Dipstick Tube

Change the oil as follows:

1. To keep dirt, grass clippings, and other debris out of the engine, clean the area around the oil fill cap/dipstick, and then remove it.

2. Tilt the engine on its side with the air cleaner facing up. See Figure 6-5. Drain oil into an approved container.

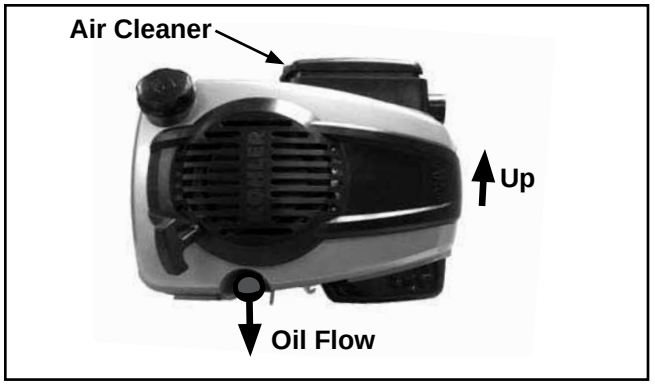


Figure 6-5. Tilted Engine With Air Cleaner Up.

3. After the crankcase is completely drained, tilt the engine back to level.

4. Fill the crankcase with new oil of the proper type to the FULL mark on the dipstick. See Figure 6-4. Always check the oil level with the dipstick before adding more oil. Do not screw the dipstick in when checking oil level.

5. Test run the engine to check for leaks. Stop the engine, allow a minute for the oil to drain down and recheck the level on the dipstick. Add more oil, if necessary, so the oil level is up to but not over the FULL mark.

6. Reinstall the oil fill cap/dipstick and tighten securely.

Drain Oil Via Crankcase Plug (If Accessible)

1. Disable the engine by disconnecting the spark plug.

2. Remove the oil fill cap/dipstick.

3. Remove the crankcase plug on the bottom of the engine and drain oil into an approved container. See Figure 6-6.

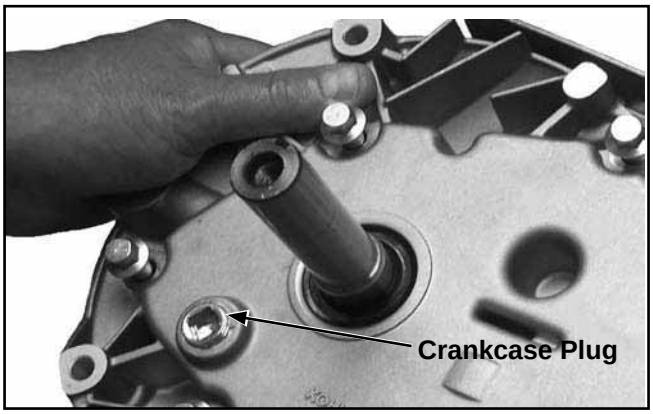


Figure 6-6. Crankcase Plug.

4. Apply thread sealant around three full threads of the drain plug. Clean up any excess sealant on the inside or outside of the joint. Threads with pre-applied sealant do not require the use of additional sealant. Approved sealants include Perma-Loc LH 150, Perma-Loc MM 115, Perma-Loc HH 120, Perma-Loc HL 126.

5. Reinstall the drain plug and torque to **13.6 N·m (120 in. lb.).**

6. Fill the crankcase with the recommended oil to the FULL mark on the dipstick. See Figure 6-4. Always check the oil level with the dipstick before adding more oil. Do not screw dipstick in when checking oil level.

7. Reinstall the oil fill cap/dipstick and tighten securely.

8. Test run the engine to check for leaks. Stop the engine, allow a minute for the oil to drain down, and recheck the level on the dipstick. Add more oil, as necessary, so the oil level is up to, but not over the FULL mark.

Splash Lubrication System

Operation

This engine uses splash lubrication to deliver oil for internal lubrication. The governor gear, located near the bottom of the oil pan, has a series of paddles on it that dip into crankcase oil and splash it onto internal engine parts.

Section 7
Electrical System and Components

This section covers the operation, service, and repair of the electrical system and electrical system components.

WARNING: Electrical Shock

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

Spark Plug

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

The engine is equipped with the following spark plug:

Type:	Champion® RC12YC
Gap:	0.762 mm (0.030 in.)
Thread Size:	14 mm (0.551 in.)
Reach:	19.1 mm (3/4 in.)
Hex Size:	15.9 mm (5/8 in.)

Spark Plug Service

Yearly or every 100 hours of operation, remove the spark plug, check its condition, and reset the gap or replace with a new plug as necessary.

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 on the spark plug and enter the engine causing extensive wear and damage.

3. Check spark plug gap using a feeler gauge. See Figure 7-1. Adjust the gap by carefully bending the ground electrode. Gap the spark plug to **0.762 mm (0.030 in.).**

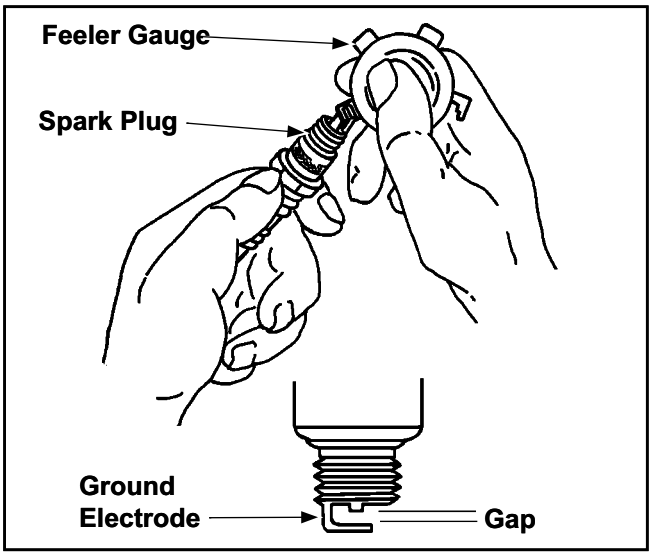


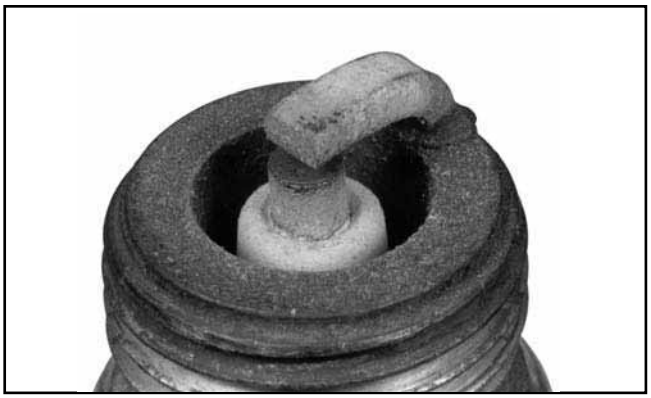
Figure 7-1. Spark Plug Gap.

4. Reinstall the spark plug into the cylinder head. Torque the plug to **24.5 N·m (217 in. lb.)**.

Inspection

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

Several examples of normal and fouled plugs are shown in the photos on the following page.



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 gapped again and reused.

Carbon Fouled: Soft, sooty, black deposits indicate incomplete combustion. This is usually caused by over-rich carburetion, weak ignition, or poor compression. Consider replacing the plug.

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

Wet Fouled: A wet plug is caused by excess fuel or oil in the combustion chamber. Excess fuel could be caused by operating the engine with too much choke or a dirty air filter. Oil in the combustion chamber is usually caused by worn piston rings or valve guides. A plug in this condition could be cleaned, dried and then reused.

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

Electronic Ignition System

These engines are equipped with a dependable magneto ignition. In a magneto ignition system, electric energy is generated by the rotational motion between the magnets embedded in the flywheel and the ignition module. This energy is stored in the ignition module coils. The stored energy is then transferred via initiation of a semiconductor switch. The resulting voltage build up in the primary coil causes a similar voltage build up in the high voltage secondary coil, called transformer action. This voltage initiates a spark that jumps across the spark plug's gap which ignites the fuel-air mixture in the combustion chamber. Two types of ignition modules are used on these engines, capacitive discharge ignition (CDI), and inductive discharge ignition (IDI). See Figures 7-2 and 7-3.

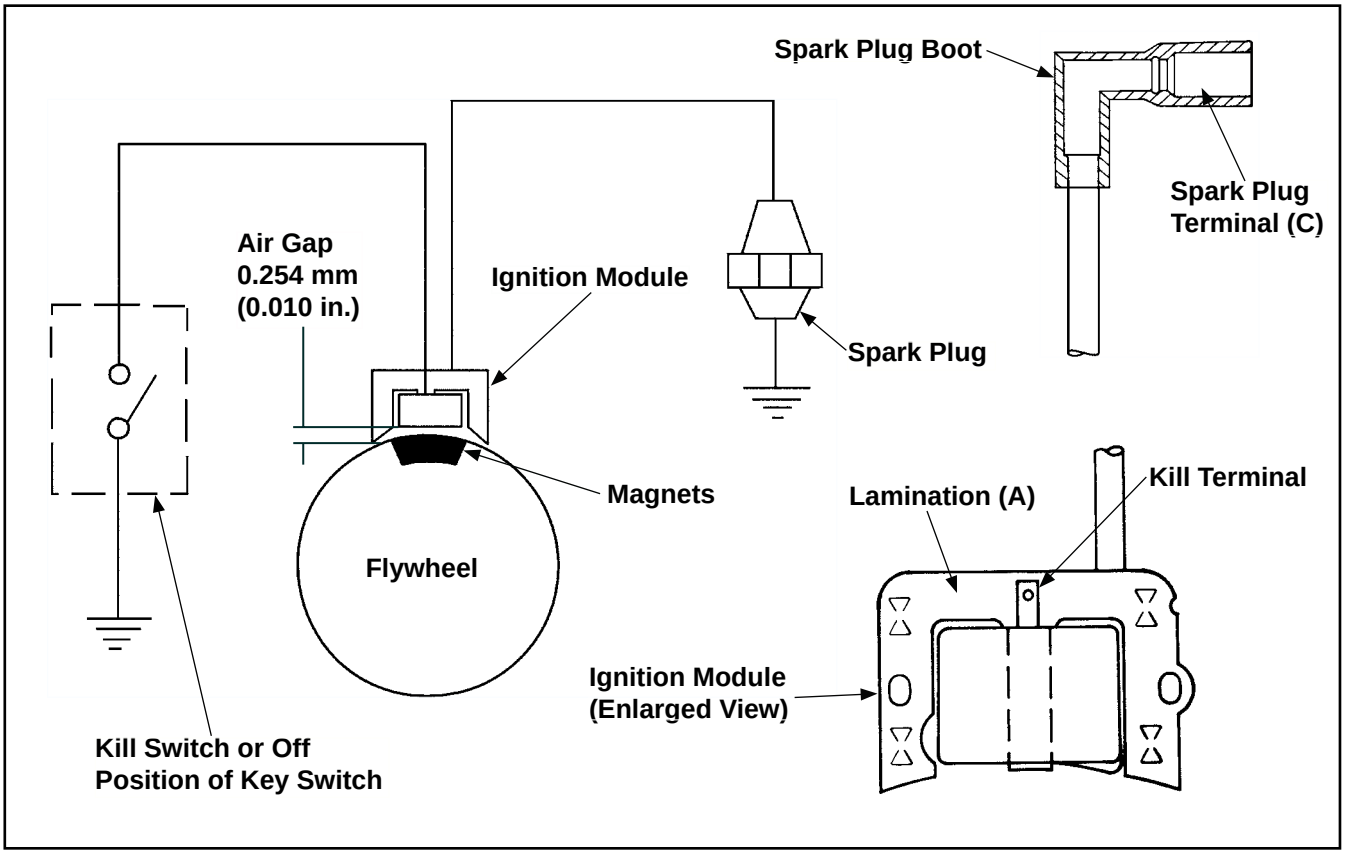


Figure 7-2. Capacitive Discharge Ignition System (CDI).

CDI Module Operation

As the flywheel rotates and the magnet passes the CDI ignition module, the magnetic field induces current in the charging coil. The current pulse is rectified by a diode and this signal charges a high-voltage capacitor. As the magnet completes its pass, a change in polarity of the signal produced by the flywheel magnet turns on the semiconductor switch, and directly connects the charged capacitor to the primary coil of the transformer. As the capacitor discharges energy, the low voltage at the primary winding is transformed to high voltage in the secondary winding of the module. A high voltage pulse is then delivered to the spark plug, where it arcs across the electrode gap and ignites the fuel in the combustion chamber.

The system consists of the following components:

- Magnets, permanently affixed to flywheel.
- Spark plug with rubber boot.
- Electronic, capacitive discharge ignition module mounted on engine crankcase.
- Kill switch (or key switch); grounds module to stop engine.
- Kill terminal, mounted on back of module.

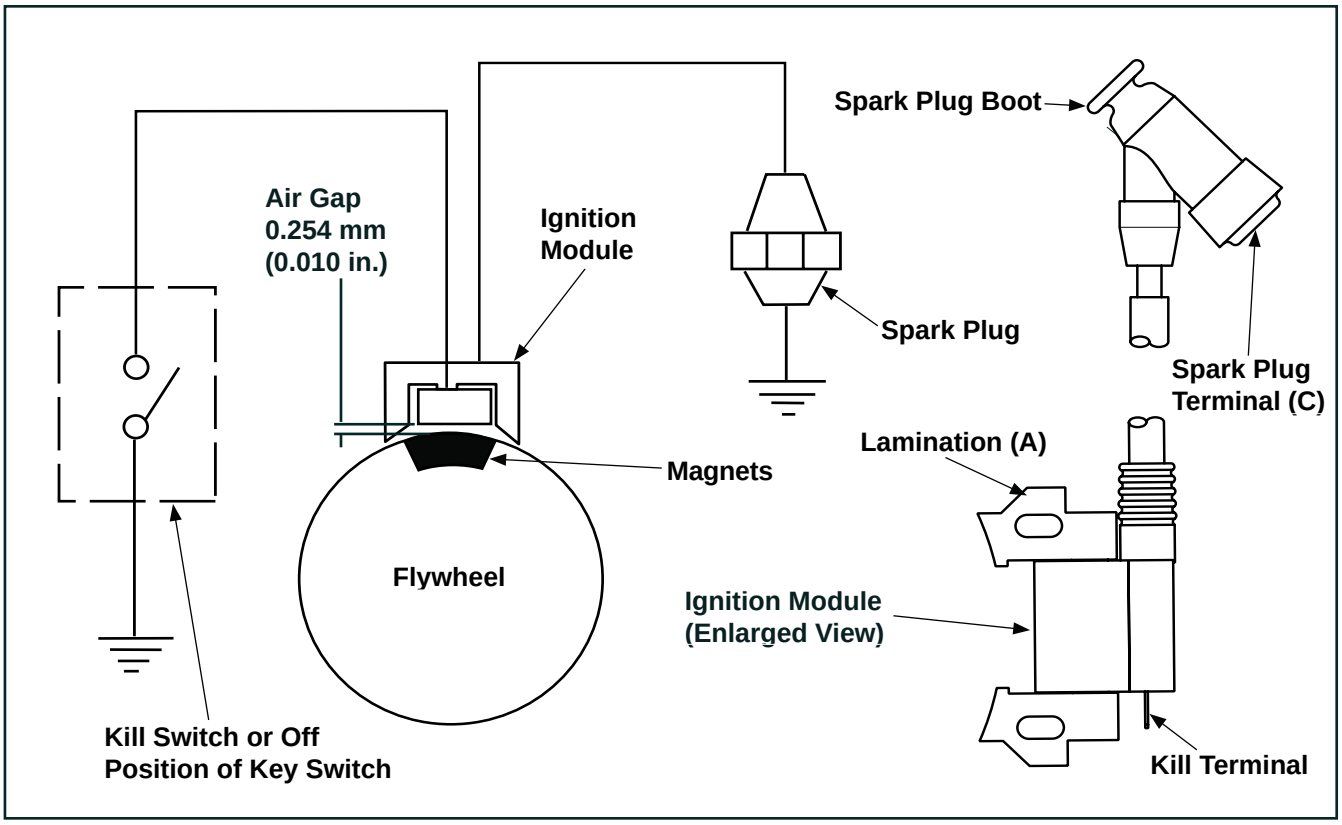


Figure 7-3. Inductive Discharge Ignition System.

IDI Module Operation

As the flywheel rotates and the magnet passes the IDI ignition module, the magnetic field induces current in the primary coil. This stores energy in the coil's magnetic circuit. As the ignition magnet completes its pass, it induces current in a small triggering coil, which then turns on a semiconductor switch. This causes the previously induced magnetic field in the primary coil to collapse. As the magnetic field begins to collapse, the coil tries to resist the drop in electricity. Transformer action in turn causes the voltage in the secondary coil to rise quickly. This sharp rise in voltage breaks down the air-to-fuel mixture in the spark plug's gap, and creates a spark that ignites fuel in the combustion chamber.

The system consists of the following components:

- Magnets, permanently affixed to flywheel.
- Spark plug with metal boot.
- Electronic, inductive discharge ignition module mounted on engine crankcase.
- Kill switch (or key switch); grounds module to stop engine.
- Kill terminal, mounted on the side of the module.

Troubleshooting and Testing Ignition

Ignition problems are most often due to poor or loose connections. Before beginning any test procedure check all external wiring. Be certain all ignition-related wires are connected, and all terminal connections fit snugly. Make sure the ignition switch is in the run position.

Both the CDI and IDI ignition systems are designed to be trouble free for the life of the engine. Other than periodically checking or replacing the spark plug, no maintenance or timing adjustment is necessary or possible. The ignition module automatically controls the timing of the spark.

Mechanical systems do occasionally fail or break down, however, so the following troubleshooting information is provided to help systematically determine the cause of a reported problem.

Ignition System Troubleshooting Guide

Problem	Test	Conclusion
Engine Will Not Start	1. Make sure spark plug lead is connected to the spark plug.	1. Spark plug is not receiving ignition pulse.
	2. Check condition of spark plug. Make sure gap is set to **0.762 mm (0.030 in.)**.	2. If plug is in good condition, check gap and adjust if necessary; reinstall plug.
	3. Test for spark with ignition tester. a. Disconnect spark plug lead and connect to post terminal of tester. See Figure 7-4. Connect clip to ground, not to spark plug. NOTE: To maintain engine speeds obtained during cranking, do not remove spark plug. b. Turn engine ignition switch to START position to initiate test. c. Crank engine to minimum of 500 RPM, and observe tester. Visible and audible sparks should be produced. d. Release switch to RUN position. Visible and audible sparks should be produced.	3. If visible and audible sparks **are** produced, ignition module is OK. If visible and audible sparks **are not** produced: a. Make sure 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, ignition module is probably faulty and should be replaced. Test module further using an ohmmeter (Test 4). d. Check safety switches (for example: seat-mounted kill switch) and other components for accidental grounding. NOTE: For further information, refer to the operating instructions for the equipment this engine powers.
	4. Measure the resistance of module secondary using an ohmmeter. See Figure 7-5). Zero ohmmeter before testing. Connect one ohmmeter lead to laminations (A). Connect the other lead to the spark plug terminal (C) of high-terminal lead. With ohmmeter leads connected in this manner, resistance of the CDI module secondary should be **4000 to 12,000 ohms**. Resistance of the IDI module secondary should be **2700 to 8600 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.[1] If the resistance is **high or infinity ohms**, the module secondary is open. Replace the module.[1] If the resistance is within the specified range, the module secondary is OK. [1]Refer to the Disassembly and Reassembly Sections for complete ignition module removal and installation procedures.

7

Figure 7-4. CDI and IDI Ignition Module Tester.

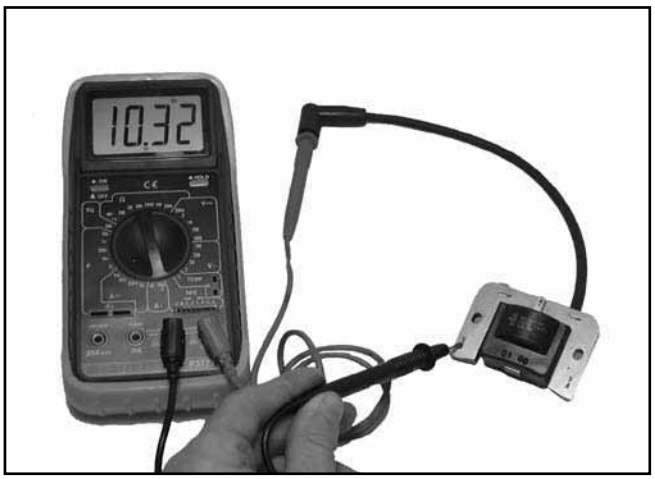


Figure 7-5. Testing CDI or IDI Ignition Modules.

Section 8
Disassembly

WARNING: Accidental Starts!

Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine by disconnecting the spark plug lead.

The following sequence is a step-by-step guide for complete engine disassembly. This procedure may vary depending on the options included.

Thoroughly clean all engine parts during the disassembly process. This allows for more accurate inspection and gauging of the engine for wear or damage. Use a commercial cleaner to remove grease, oil, and grime from engine parts. When such a cleaner is used, follow the manufacturer's instructions and safety precautions carefully.

Remove all traces of cleaners 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 Disassembly Sequence

1. Disconnect spark plug lead.
2. Ensure fuel tank is empty.
3. Remove fuel cap.
4. Drain oil from crankcase.
5. Remove engine cover insert.
6. Remove engine cover.
7. Remove recoil.
8. Remove blower housing.
9. Remove muffler guard.
10. Remove muffler and heat deflector gasket.
11. Remove air cleaner cover and filter(s).
12. Disconnect breather hose.
13. Remove air cleaner base.
14. Disconnect primer hose.
15. Disconnect fuel line.
16. Remove carburetor.
17. Disconnect carburetor linkage.
18. Remove carburetor gaskets.
19. Remove governor spring.
20. Remove speed control bracket.
22. Remove governor lever.
23. Remove fuel tank.
24. Disconnect kill lead from ignition module.
25. Remove ignition module.
26. Disconnect flywheel brake spring.
27. Remove flywheel nut and drive cup.
28. Remove fan.
29. Remove flywheel.
30. Remove breather cover.
31. Remove breather spring, disc and screen.
32. Remove spark plug.
33. Remove flywheel brake assembly.
34. Remove valve cover and gasket.
35. Remove jam nuts and rocker arm pivots.
36. Remove rocker arms
37. Remove push rods.
38. Remove guide plate.
39. Remove rocker studs.
40. Remove cylinder head.
41. Remove valves.
42. Remove dipstick tube.
43. Remove oil pan and gasket.
44. Remove camshaft.
45. Remove governor gear and retainer.
46. Remove governor hitchpin and shaft.
47. Remove tappets.
48. Remove connecting rod cap.
49. Remove piston with connecting rod.
50. Remove crankshaft.

Detailed Disassembly Sequence

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. Never use gasoline as a cleaning agent.

Disconnect Spark Plug

1. Disconnect the spark plug lead.

Empty Fuel Tank

1. Ensure the fuel tank is empty by running the engine until it stops, and is completely out of fuel.

2. Remove the gas cap.

Drain Oil

NOTE: There are two ways to drain oil from this engine: by inverting the dipstick tube, and by removing the crankcase drain plug.

Drain Oil from Dipstick Tube

1. To keep dirt, grass clippings, and other debris out of the engine, clean the area around the oil fill cap/dipstick.

2. Remove the oil fill cap/dipstick.

3. Tilt the engine on its side with the air cleaner facing up. See Figure 8-1. Drain the oil into an approved container.

Figure 8-1. Draining Oil from Dipstick Tube.

4. After the crankcase is completely drained, tilt the engine back to level.

Drain Oil Via Crankcase Plug (If Accessible)

1. To keep dirt, grass clippings, and other debris out of the engine, clean the area around the oil fill cap/dipstick, and then remove it.

2. Remove the crankcase plug on the bottom of the engine. See Figure 8-2.

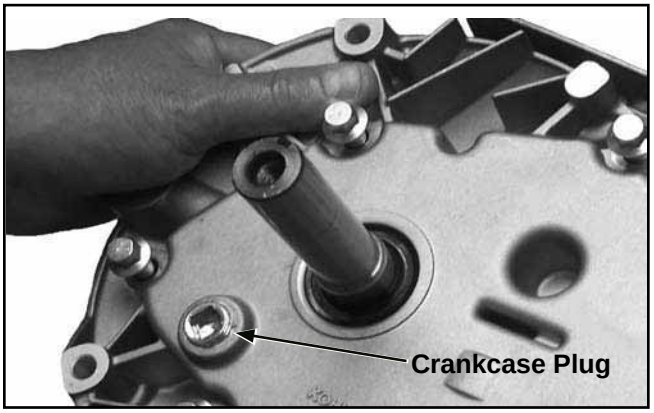


Figure 8-2. Crankcase Plug.

3. Drain the oil into an approved container.

Remove Engine Cover Insert and Cover

1. Remove the four Torx screws securing the engine cover insert. See Figure 8-3.

Figure 8-3. Removing Engine Cover Insert

2. Remove the three hex flange nuts and two hex flange screws securing the engine cover. See Figure 8-4.

3. Remove the engine cover.

Figure 8-4. Removing Engine Cover.

Remove Recoil Starter

1. Lift off the recoil starter. See Figure 8-5.

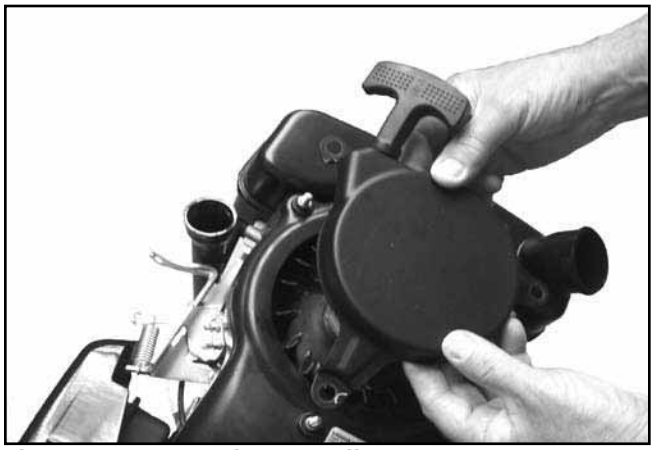


Figure 8-5. Removing Recoil.

Remove Blower Housing

1. Lift off the blower housing and retain the three stud spacers. See Figure 8-6.

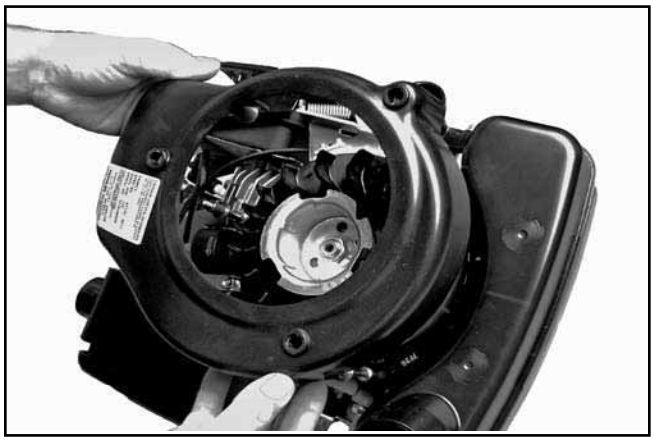


Figure 8-6. Removing Blower Housing.

Remove Muffler Assembly

1. Remove two hex flange nuts securing the heat guard to the cylinder head. See Figure 8-7.

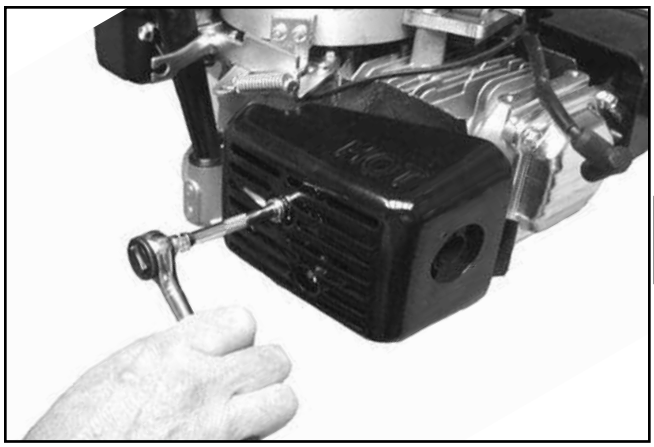


Figure 8-7. Removing Muffler Heat Guard.

2. Slide the muffler off the studs. See Figure 8-8.

Figure 8-8. Removing Muffler.

3. Remove the heat deflector gasket from the exhaust studs, noting orientation.

Remove Air Cleaner Assembly

1. Unscrew the knob on the air cleaner assembly and remove the cover. See Figure 8-9.

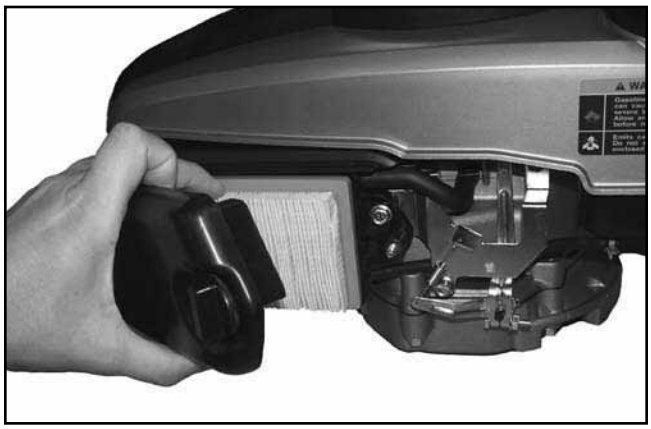


Figure 8-9. Removing Air Cleaner Cover.

2. Remove the paper element and the foam precleaner (if equipped).

3. Remove the two hex nuts and the hex flange screw securing the air cleaner base to the cylinder head and the crankcase. See Figure 8-10.

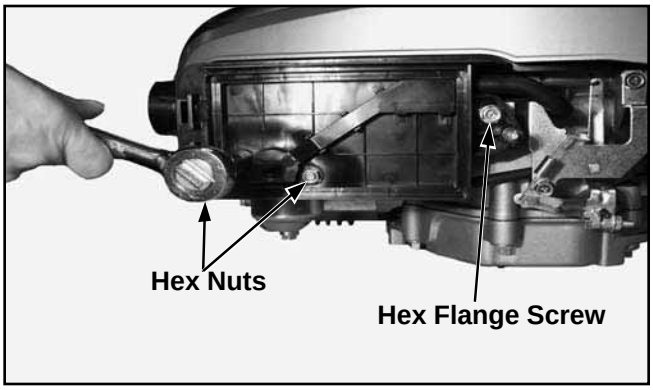


Figure 8-10. Removing Air Cleaner Base.

4. Detach the breather hose from the crankcase. See Figure 8-11.

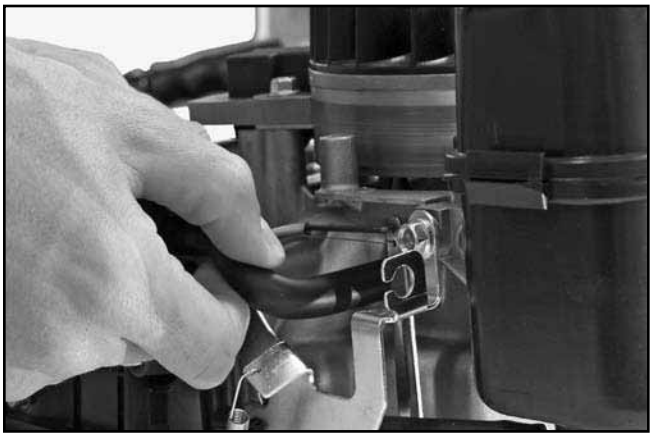


Figure 8-11. Detaching Breather Hose.

5. Remove the air cleaner base and detach the primer hose from the carburetor (primer bulb equipped models only). See Figure 8-12.

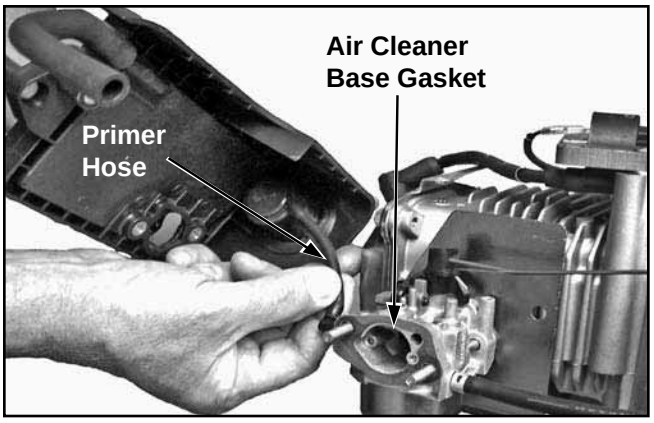


Figure 8-12. Disconnecting Primer Hose.

6. Remove the air cleaner base gasket from the carburetor, noting orientation. See Figure 8-12.

Remove Carburetor Assembly

NOTE: Ensure the fuel tank is empty by running the engine until it stops, and is completely out of fuel.

Remove Choke-less Carburetor

1. Squeeze the hose clamp and slide it and the fuel hose off the carburetor. See Figure 8-13.

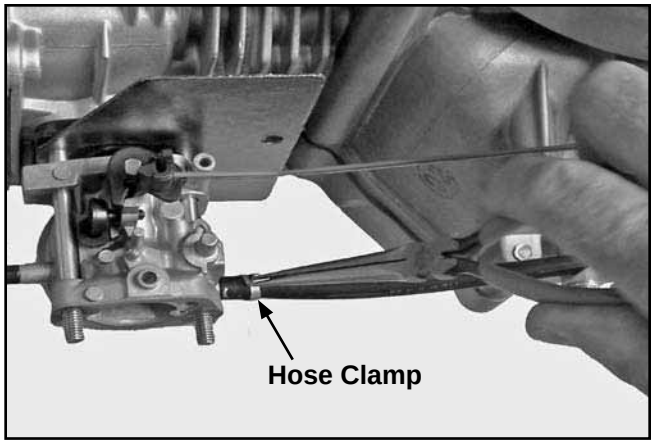


Figure 8-13. Disconnecting Fuel Line.

2. Slide carburetor to the end of the intake studs. See Figure 8-14.

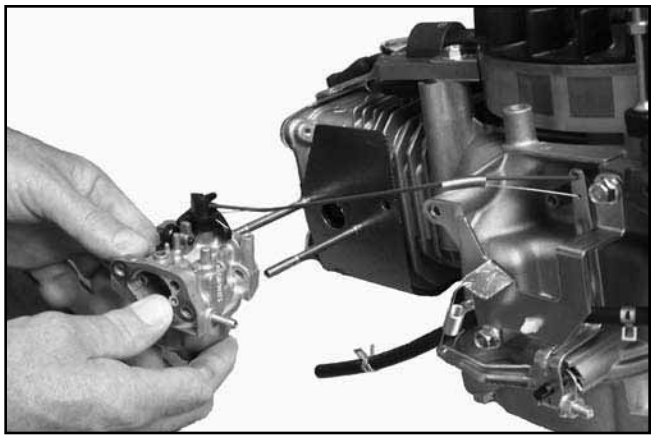


Figure 8-14. Removing Carburetor.

3. Turn the throttle lever clockwise until it stops. Gently push the rod and spring linkages up to disconnect them from the throttle lever. See Figure 8-15.

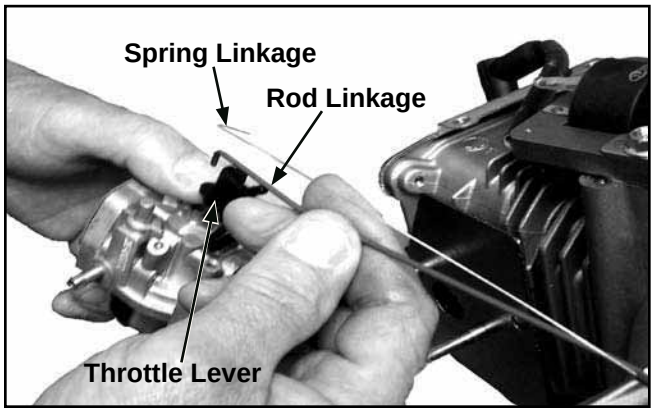


Figure 8-15. Disconnecting Carburetor Linkage.

4. Slide off the carburetor's heat shield, head spacer, and spacer gasket, noting the sequence. See Figure 8-16.

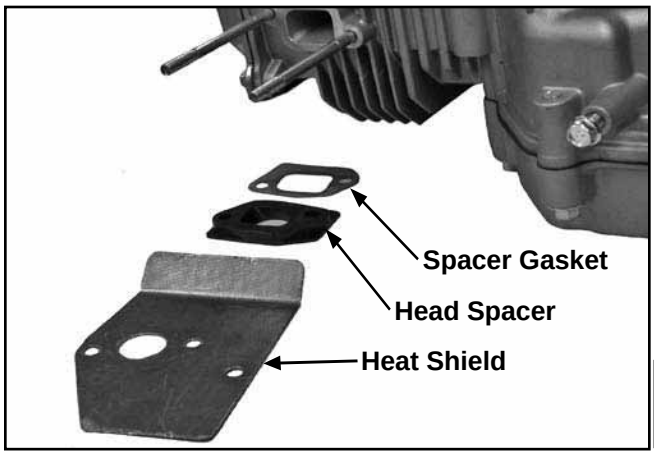


Figure 8-16. Carburetor Gasket Sequence.

Remove Carburetor with Choke

1. Squeeze the hose clamp and slide it and the fuel hose off the carburetor. See Figure 8-17.

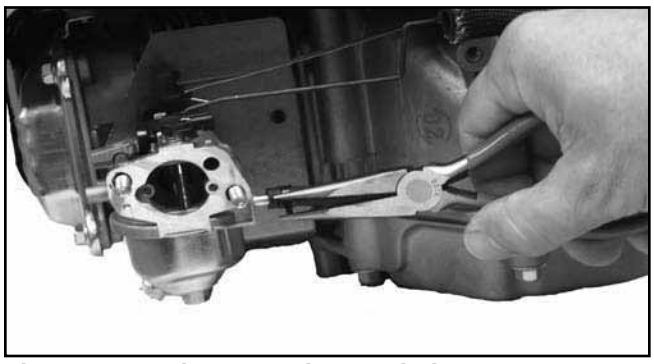


Figure 8-17. Disconnecting Fuel Line.

2. Slide carburetor to the end of the intake studs. See Figure 8-14.

3. Turn the throttle lever clockwise until it stops. Gently push the rod and spring linkages up to disconnect them from the throttle lever. See Figure 8-15.

4. Rotate the carburetor until the choke linkage can be disconnected from the carburetor. See Figure 8-18.

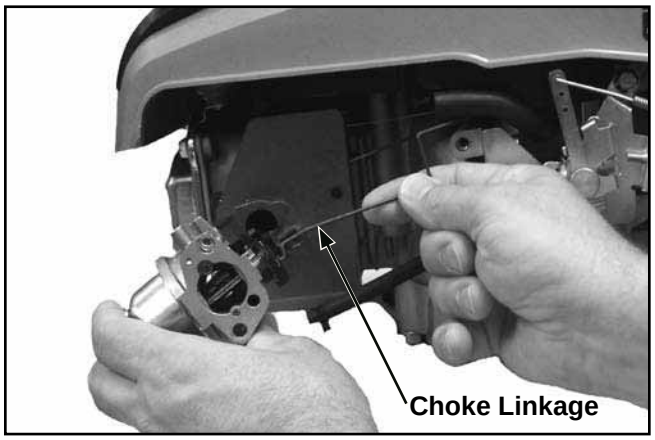


Figure 8-18. Disconnecting Choke Linkage.

5. Slide off the carburetor's heat shield, head spacer, and spacer gasket, noting the sequence. See Figure 8-19.

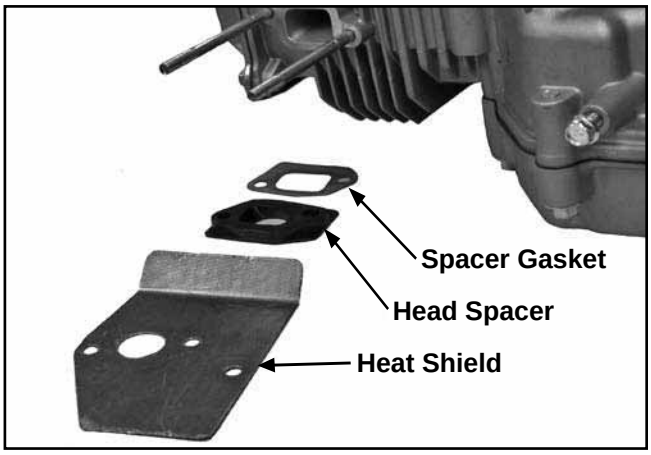


Figure 8-19. Carburetor Gasket Sequence.

Remove Governor Spring

1. Disconnect the governor spring from the speed control bracket. See Figure 8-20.

Figure 8-20. Removing Governor Spring.

Remove Speed Control Bracket

1. Remove the two hex flange screws securing the speed control bracket. See Figure 8-21.

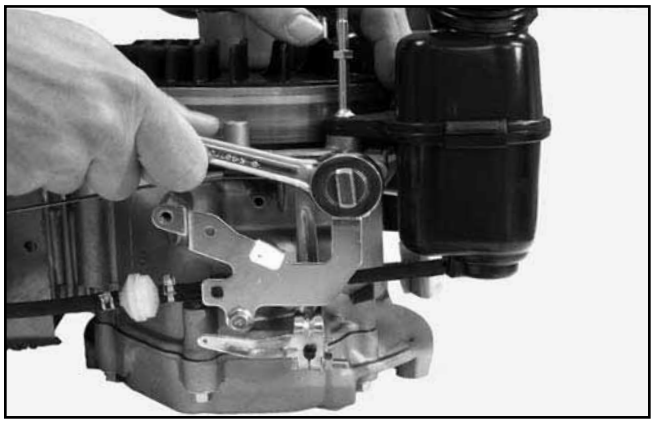


Figure 8-21. Removing Speed Control Bracket.

NOTE: The fuel hose connecting the carburetor and the fuel tank is held in place by a plastic ring, mounted on the back of the speed control bracket. If the bracket is removed from the crankcase, it will remain attached to the fuel hose by the fuel filter (not including California engines). Should replacement of the speed bracket be required, disconnect the fuel filter and slide the bracket off the hose. Do not disconnect the fuel hose from the fuel tank.

Remove Governor Lever

1. Loosen the governor lever hex nut and slide the lever off the governor shaft. See Figure 8-22.

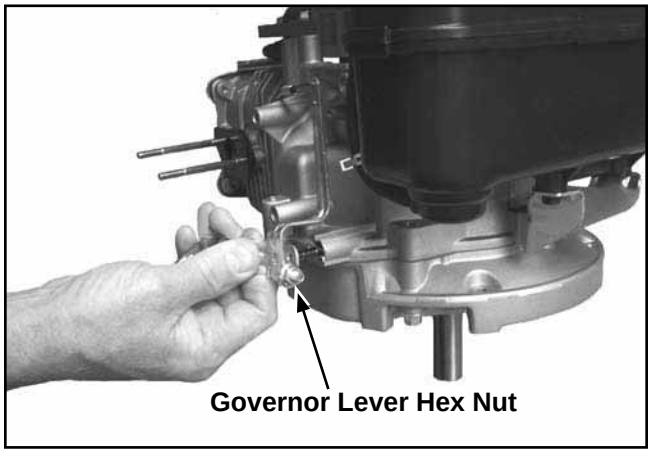


Figure 8-22. Removing Governor Lever.

Remove Fuel Tank

1. Ensure the fuel tank is empty by running the engine until it stops, and is completely out of fuel.

2. Detach the fuel tank from the crankcase bracket by removing the two hex flange screws. See Figure 8-23

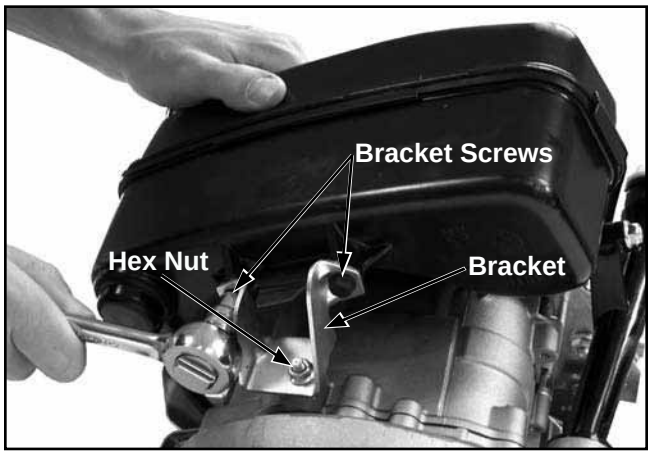


Figure 8-23. Detaching Fuel Tank Bracket.

3. Remove the two studs securing the top of the fuel tank and lift off the tank. See Figure 8-24.

NOTE: Disassembly does not require the fuel tank bracket be removed from the bottom of the tank. If removal is to be performed, unscrew the two hex bracket screws. See Figure 8-23.

Figure 8-24. Removing Fuel Tank.

Remove Ignition Module

1. Disconnect the kill lead from the ignition module. See Figure 8-25.

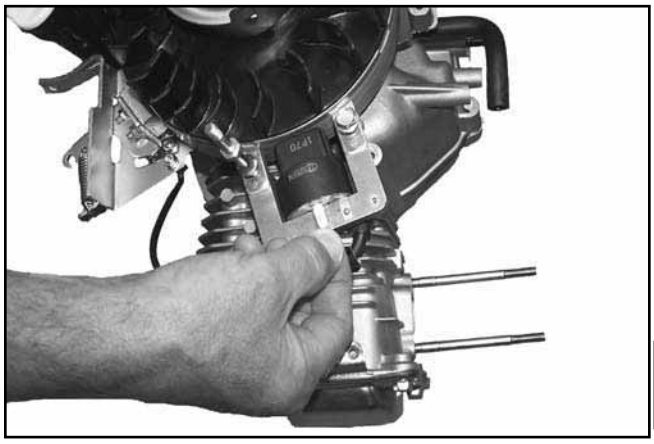


Figure 8-25. Disconnecting Kill Lead.

2. Remove the hex flange screw and the stud securing the ignition module. Mark the stud for identification during reassembly. See Figure 8-26.

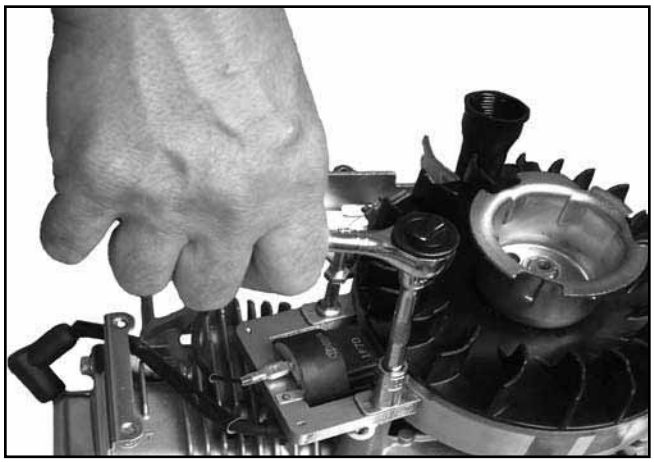


Figure 8-26. Removing Ignition Module.

Disconnect Flywheel Brake Spring

1. Grasp one end of the flywheel break spring with a pliers and stretch it to disconnect it. See Figure 8-27.

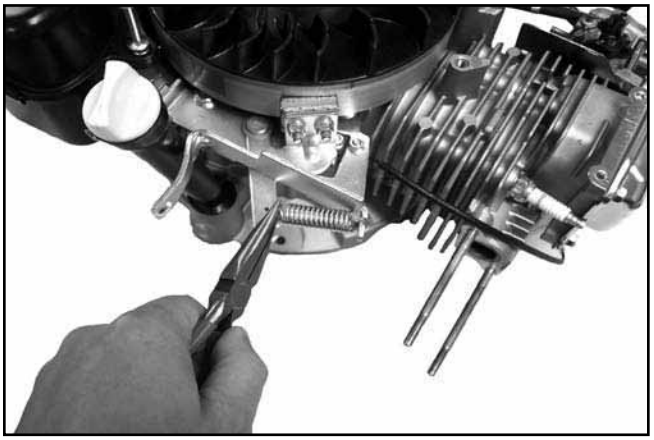


Figure 8-27. Disconnecting Flywheel Brake Spring.

Remove Flywheel

1. Using a flywheel strap wrench to hold the flywheel in place, remove the hex nut inside the drive cup. See Figure 8-28.

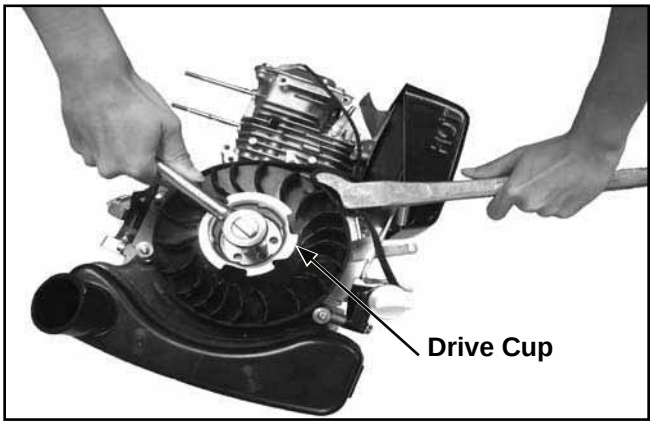


Figure 8-28. Removing Flywheel Nut (Top View).

2. Remove the drive cup and lift off the fan, noting orientation on the flywheel for reassembly.

3. The flywheel is mounted on a tapered shaft. To remove it, use a rubber mallet to land a firm blow, slightly off center on the flywheel. See Figure 8-29.

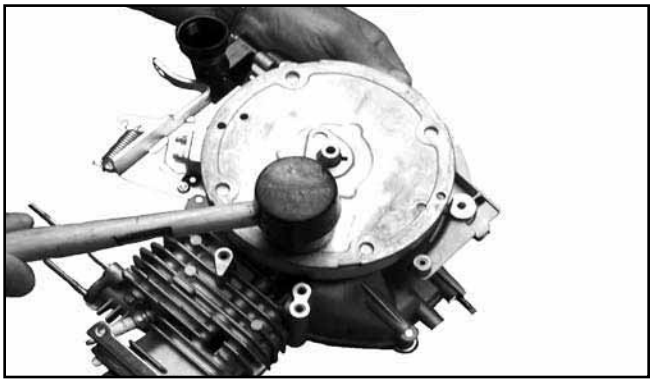


Figure 8-29. Removing Flywheel (Top View).

4. Remove the flywheel key from the crankshaft. See Figure 8-30.

Remove Breather Assembly

1. Remove the two hex flange screws securing the breather cover. See Figure 8-30. Remove cover.

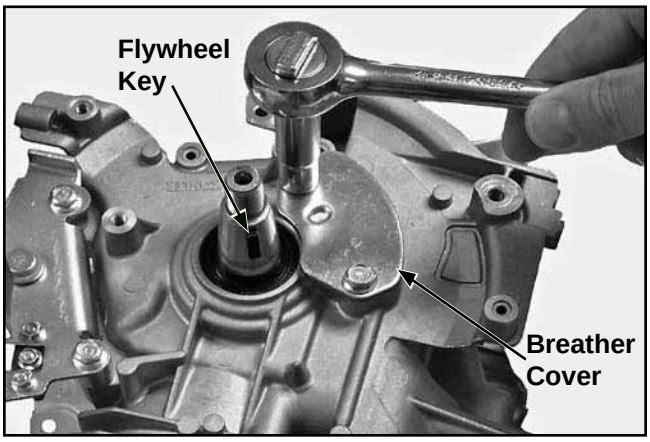


Figure 8-30. Removing Breather Cover.

2. Remove the breather spring, disc and screen. See Figure 8-31.

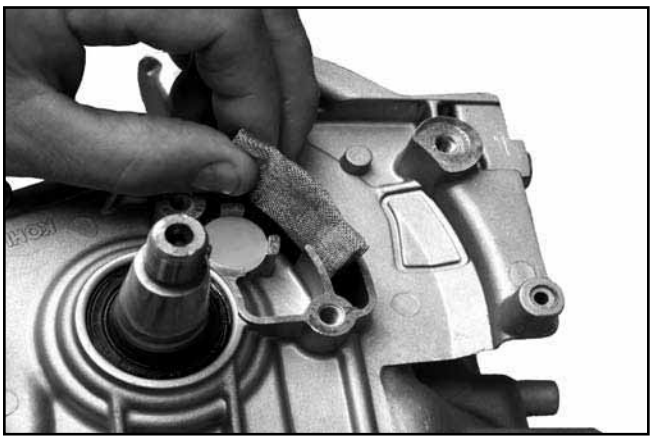


Figure 8-31. Removing Spring, Disc, and Screen

Remove Spark Plug

1. Remove the spark plug from the cylinder head. See Figure 8-32.

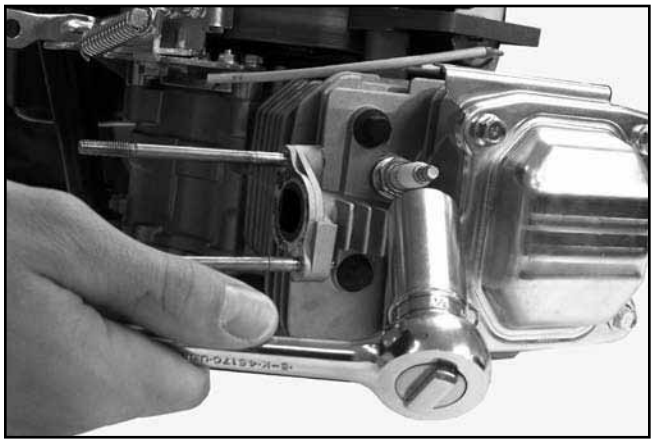


Figure 8-32. Removing Spark Plug.

Remove Flywheel Brake Assembly

1. Remove the two hex flange screws securing the flywheel brake assembly; retain the spacers. See Figure 8-33.

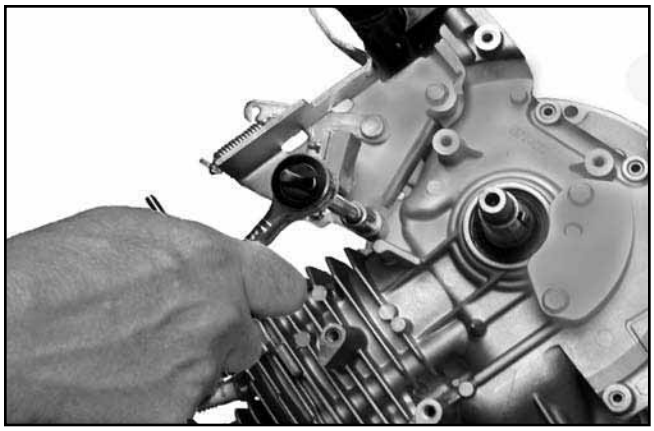


Figure 8-33. Removing Flywheel Brake Assembly.

Remove Valve Cover

1. Remove the four hex flange screws from the valve cover.
2. Remove the cover and the gasket. See Figure 8-34.

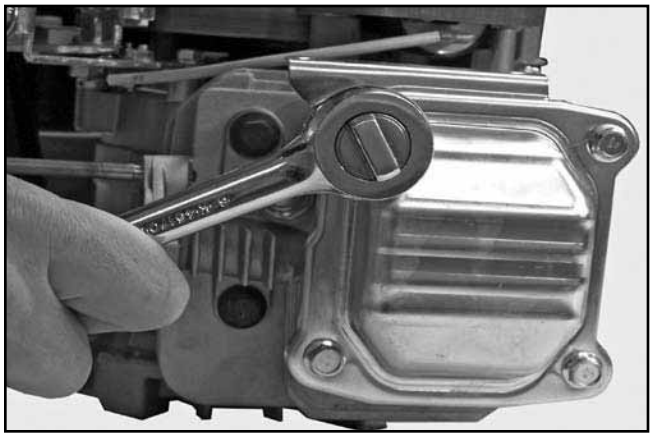


Figure 8-34. Removing Valve Cover.

Remove Jam Nuts and Pivots

1. Use a socket and wrench to remove the jam nuts and the rocker-arm pivots from the rocker studs. See Figure 8-35.

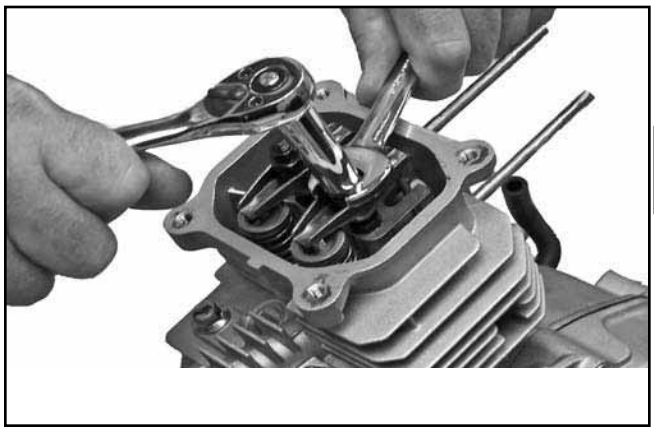


Figure 8-35. Removing Jam Nuts and Pivots.

Remove Rocker Arms

1. Noting orientation, lift the rocker arms off of the rocker studs. See Figure 8-36.

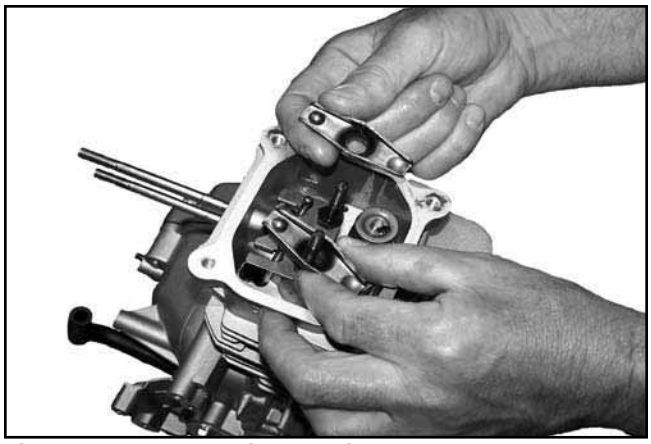


Figure 8-36. Removing Rocker Arms.

Remove Push Rods

1. Remove the push rods and mark them for reinstallation. See Figure 8-37.

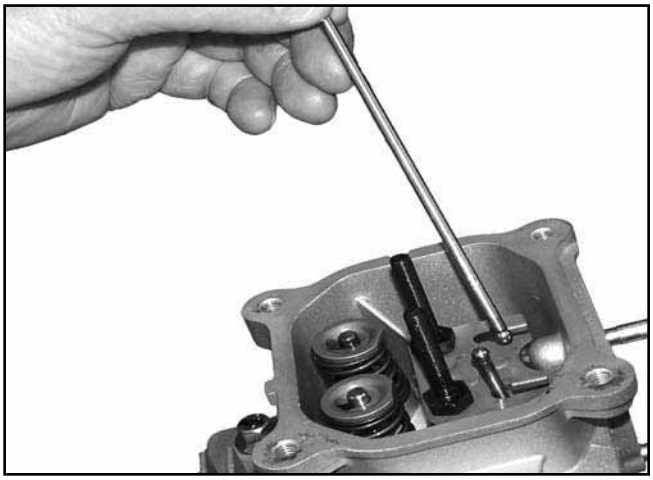


Figure 8-37. Removing Push Rods.

Remove Rocker Studs

1. Unscrew and remove the rocker studs from the cylinder head. See Figure 8-38.

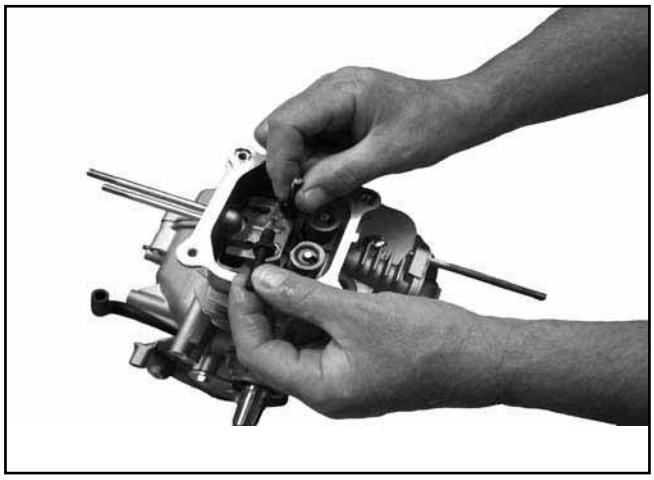


Figure 8-38. Removing Rocker Studs.

Remove Guide Plate

1. Remove the guide plate from the rocker studs. See Figure 8-39.

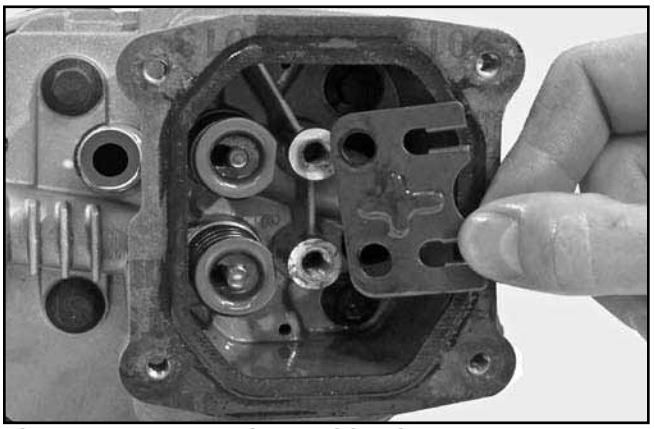


Figure 8-39. Removing Guide Plate.

Remove Cylinder Head

1. Remove the four hex flange screws securing the cylinder head. See Figure 8-40.

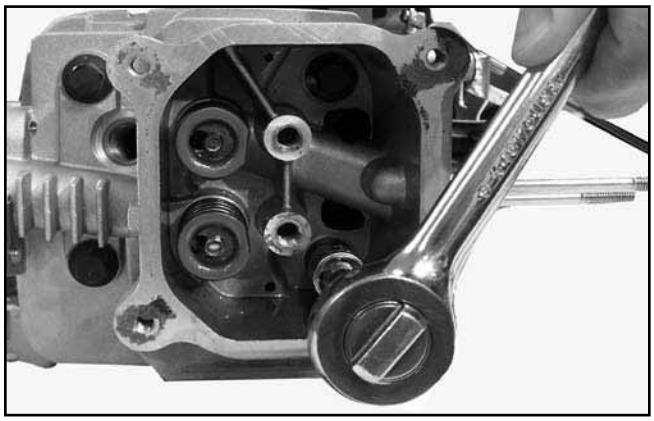


Figure 8-40. Removing Cylinder Head.

2. Remove the cylinder head, noting the positioning of the dowels. See Figure 8-41.

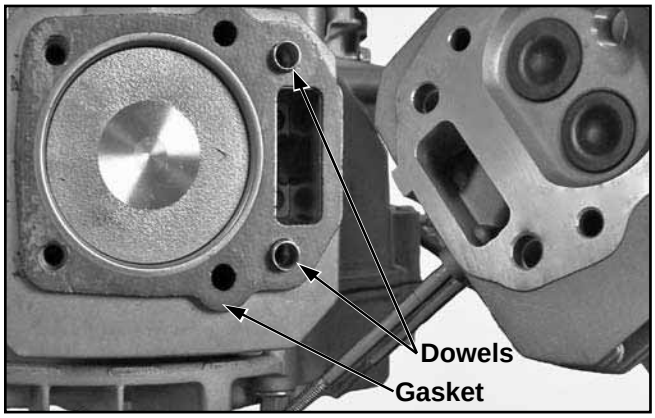


Figure 8-41. Cylinder Head Dowels.

3. Remove the head gasket and discard. See Figure 8-40.

Remove Valve Assembly

1. Push down on the valve spring keepers to release the valve springs from the valve stems. See Figure 8-42.

2. Remove the valve spring keepers and springs.

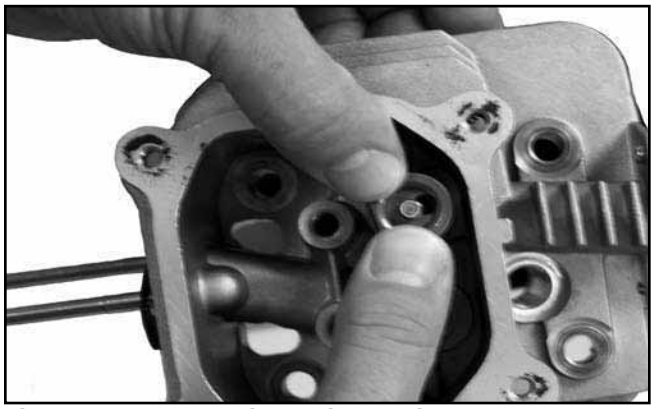


Figure 8-42. Removing Valve Spring Keepers.

3. Push the end of the intake valve (Figure 8-42) to release the valve seal (Figure 8-43), and remove both valves from the opposite end of the head (Figure 8-44). Mark the valves INTAKE and EXHAUST for reinstallation.

   NOTE: Only the cylinder's intake valve has a seal. There is no valve seal on the exhaust side.

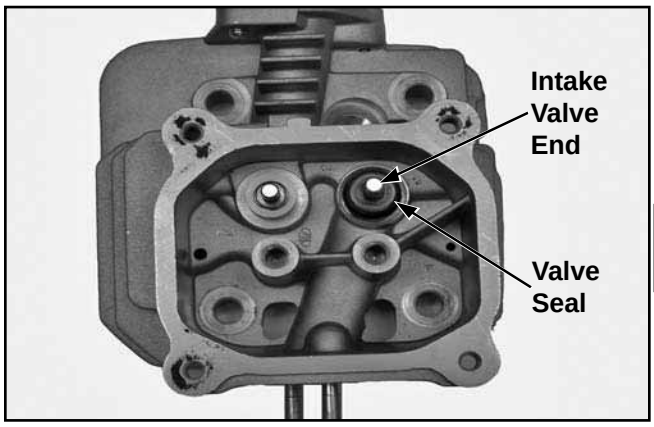


Figure 8-43. Removing Valve Seal, Intake Valve

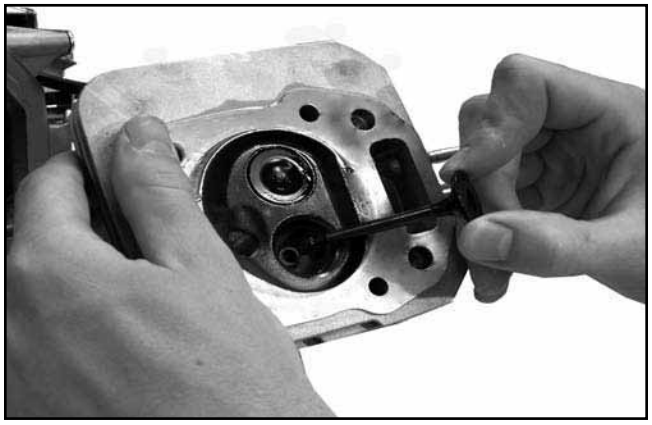


Figure 8-44. Removing Valves.

Remove Dipstick Tube

1. Remove the hex flange screw securing the dipstick tube. See Figure 8-45. Remove the tube.

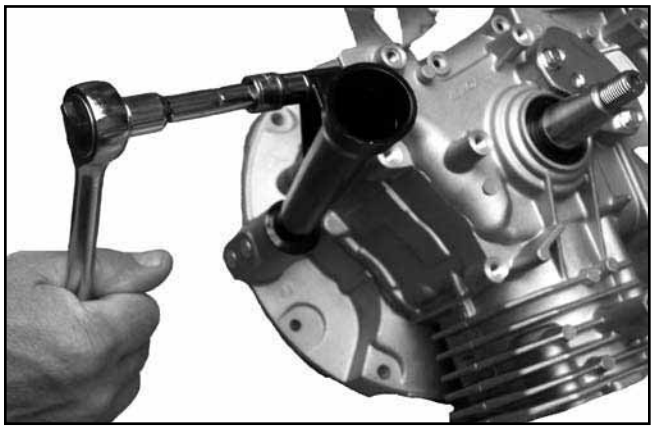


Figure 8-45. Removing Dipstick Tube.

Remove Oil Pan and Gasket

1. Remove the six hex flange screws securing the oil pan. See Figure 8-46.

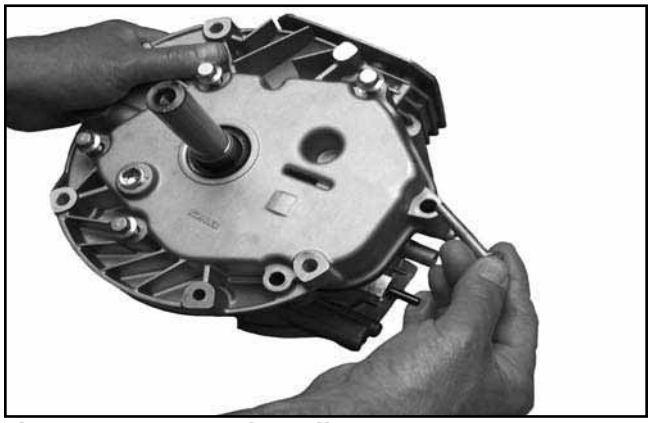


Figure 8-46. Removing Oil Pan Screws.

2. Using a flathead screwdriver as a wedge, carefully separate the oil pan from the crankcase. See Figure 8-47.

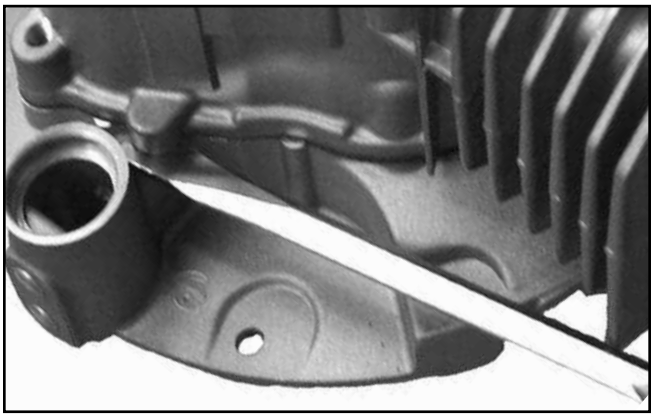


Figure 8-47. Separating Oil Pan from Crankcase.

3. Remove the old gasket and discard.

Remove Camshaft

1. Remove the camshaft from the crankcase. See Figure 8-48.

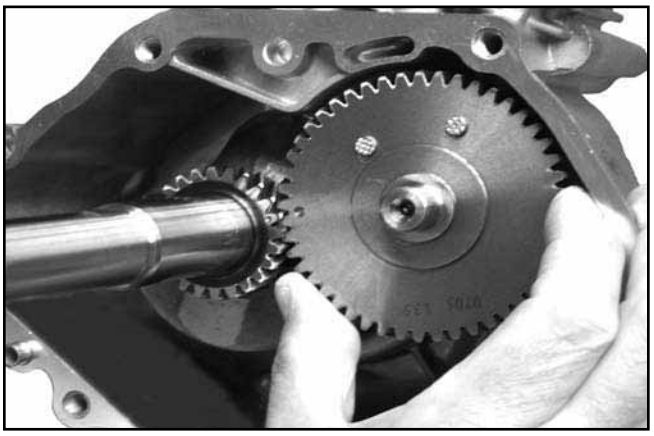


Figure 8-48. Removing Camshaft.

Remove Governor Gear and Shaft

1. Remove the hex flange screw and the retainer securing the governor gear. See Figure 8-49.

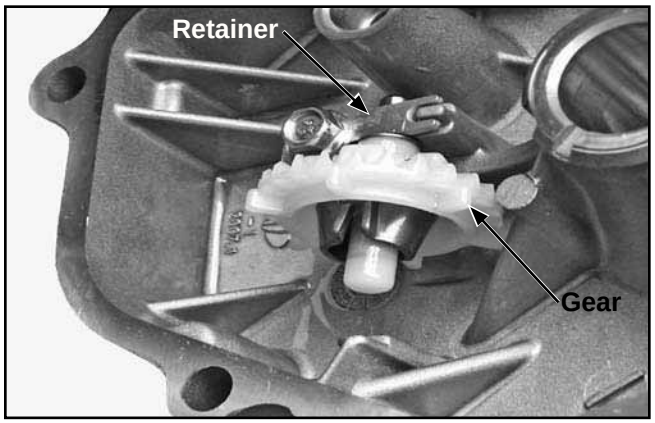


Figure 8-49. Removing Governor Gear, Retainer.

2. Remove the hitchpin securing the governor shaft. See Figure 8-50.

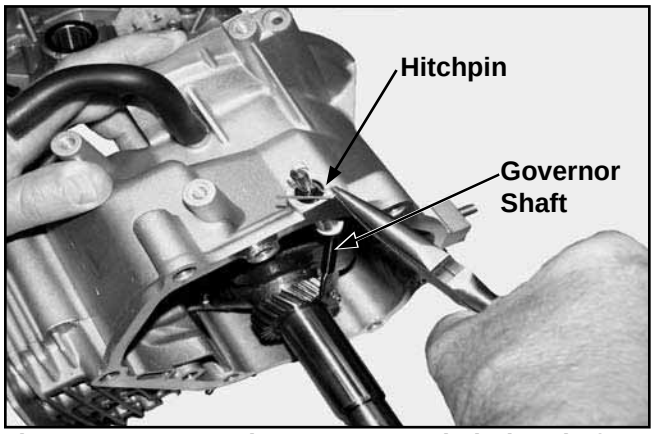


Figure 8-50. Removing Governor Hitchpin, Shaft.

Remove Tappets

1. Remove the tappets. Mark them INTAKE and EXHAUST for reinstallation. See Figure 8-51.

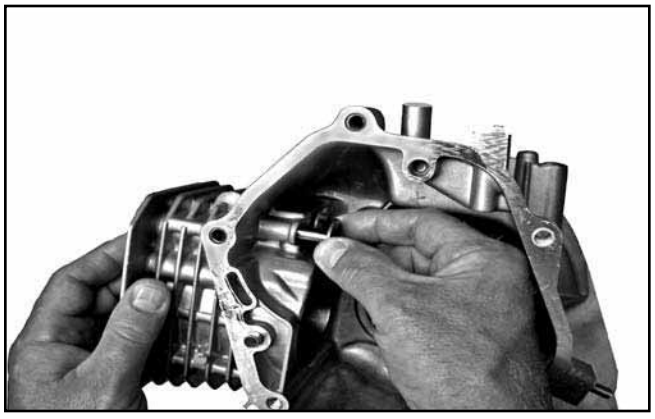


Figure 8-51. Removing Tappets.

Remove Connecting Rod Cap

1. Rotate the crankshaft to allow access to the two hex flange screws on the connecting rod cap. See Figure 8-52. Remove the screws and cap.

Figure 8-52. Removing Connecting Rod Cap.

Remove Piston

1. Carefully guide the piston and the attached connecting rod out of the cylinder bore. See Figure 8-53.

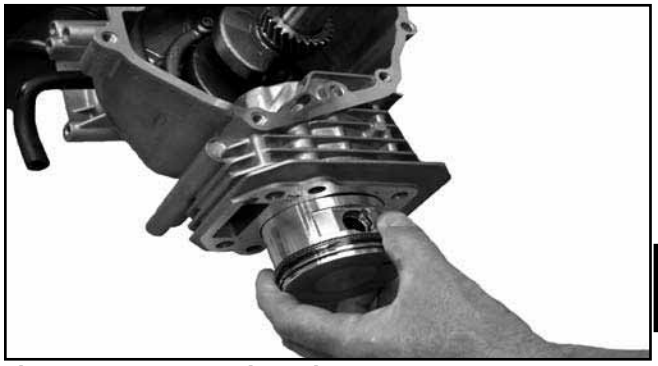


Figure 8-53. Removing Piston.

Remove Crankshaft

1. Remove the crankshaft. See Figure 8-54.

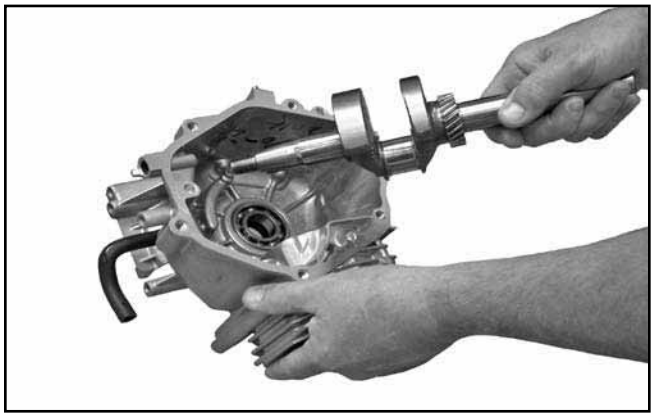


Figure 8-54. Removing Crankshaft.

Section 9
Inspection and Reconditioning

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

Air Cleaner, Section 4
Carburetor and Governor, Section 5
Ignition, Section 7

Clean all parts thoroughly. Only clean parts can be accurately inspected and gauged for wear or damage. There are many commercially available cleaners that will quickly remove grease, oil, and grime from engine parts. When such a cleaner is used, follow the manufacturer's instructions and safety precautions carefully. Use gasket remover to remove old material from the valve cover, cylinder head, crankcase, and oil pan. Do not scrape the gasket surfaces, as this could cause damage resulting in leaks.

Make sure all traces of cleaning solvents 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.

Crankcase

Inspection and Service

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

Check the cylinder wall for scoring. In severe cases, unburned fuel can dissolve lubricating oil off the piston and cylinder wall. Without lubrication, the piston rings would make metal to metal contact with the wall, causing scuffing and scoring. Scoring of the cylinder wall can also be caused by localized hot spots from blocked cooling fins or from inadequate or contaminated lubrication.

Flywheel

Inspection

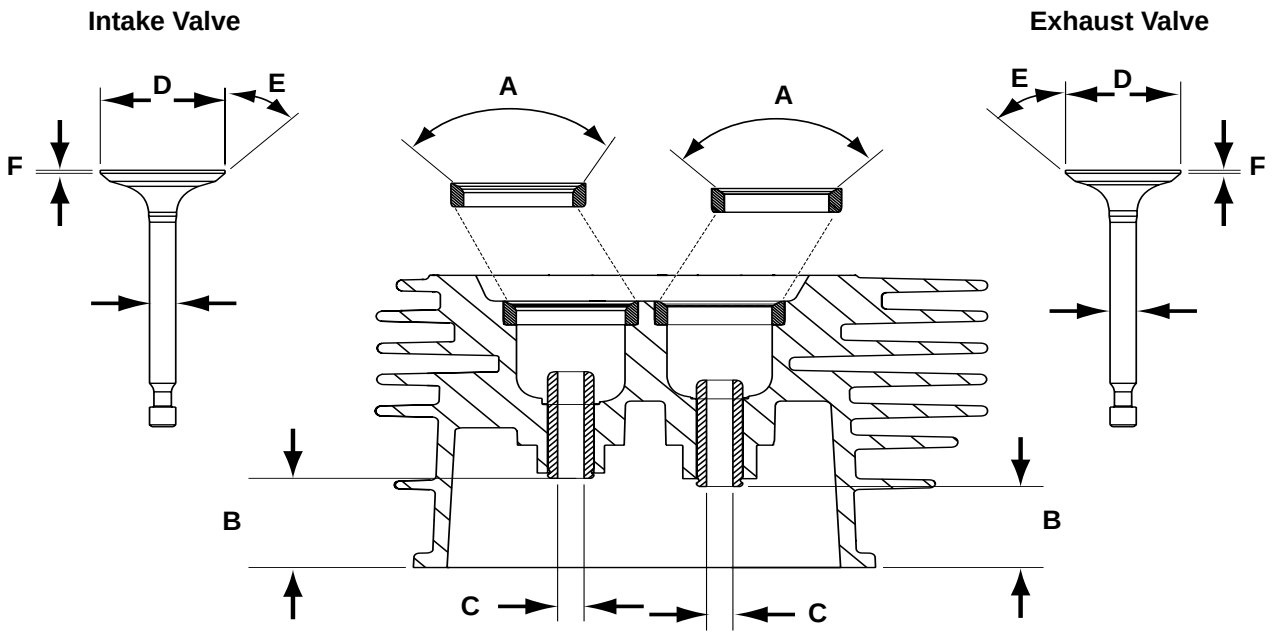
Inspect the flywheel for cracks and check the keyway for wear or damage. Replace the flywheel if cracked. If the flywheel key is sheared or the keyway is damaged, replace the crankshaft, flywheel, and key.

Inspect the ring gear for cracks or damage. Ring gears are not available separately. 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 seats for evidence of deep pitting, cracks, or distortion. The following diagram outlines valve running clearances between the valve stems and guides.



	Dimension	Intake	Exhaust
A	Seat Angle	90°	90°
B	Guide Depth	22.6 mm	20.5 mm
C	Guide I.D.	5.500/5.5.12 mm	5.500/5.5.12 mm
D	Valve Head Diameter	25.875/26.125 mm	23.875/24.125 mm
E	Valve Face Angle	45°	45°
F	Valve Margin (Min.)	0.80 mm	0.80 mm
G	Valve Stem Diameter	5.465/5.480 mm	5.465/5.480 mm

Figure 9-1. Valve Details.

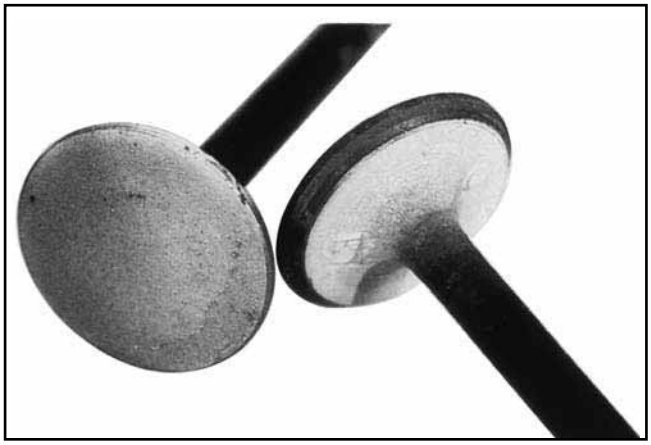
Hard starting, or loss of power accompanied by high fuel consumption, may be symptoms of faulty valves. Although these symptoms could also be attributed to worn rings, remove and check the valves first. After removal, clean the valve heads, faces, and stems with a power wire brush. Then, carefully inspect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

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

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

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

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



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

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

Gum: Gum deposits usually result from using stale gasoline. This condition is often noted in applications where fuel is not drained out of tank during the off season. Gum is a prevalent cause of valve sticking. The cure is to ream the valve guides and clean or replace the valves, depending on their condition.

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

Valve Guides

If a valve guide is worn beyond specifications, it will not guide the valve in a straight line. This may result in burned 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 intake clearance exceeds **0.047 mm (.0018 in.)** or the exhaust clearance exceeds **0.082 mm (.0032 in.)**, determine whether the valve stem or guide is responsible for the excessive clearance.

Maximum (I.D.) wear on the intake valve guide is **5.512 mm (0.2170 in.), while 5.512 mm (0.2170 in.)** is the maximum allowed on the exhaust guide. The guides are not removable. If the guides are within limits but the valve stems are worn beyond limits, replace the valves.

Valve Seat Inserts

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

Recondition the valve seat inserts following the instructions provided with the valve seat cutter being used. A typical cutter is shown in Figure 9-2. The final cut should be made with an 90° cutter as specified for the valve seat angle in Figure 9-1. With the proper 45° valve face angle, and the valve seat cut properly (44.5° as measured from center line when cut 90°) this would result in the desired 0.5° (1.0° full cut) interference angle where the maximum pressure occurs on the valve face and seat.

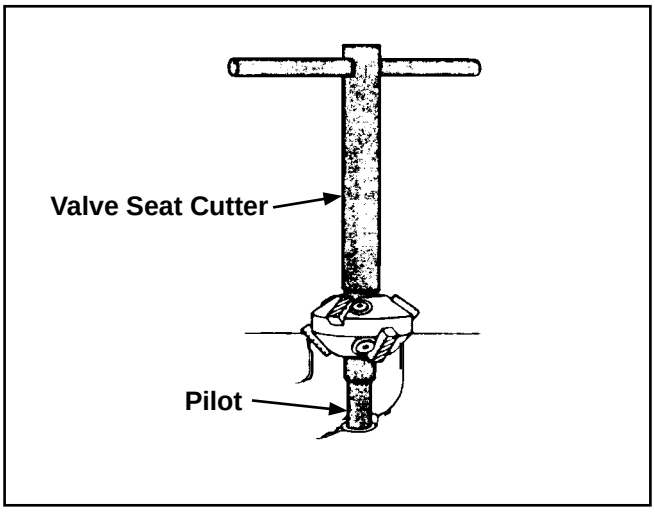


Figure 9-2. Typical Valve Seat Cutter.

Lapping Valves

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

Section 10
Reassembly

The following sequence is a step-by-step guide 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 vary to accommodate engine options or special equipment.

NOTE: Properly clean all components BEFORE reassembly.

NOTE: Remove all traces of cleaners 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.

NOTE: Assemble the engine 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 crankshaft.
2. Install piston and connecting rod.
3. Attach connecting rod cap.
4. Install tappets.
5. Install camshaft.
6. Install governor gear.
7. Install crankcase dowels and gasket.
8. Install oil pan cover.
9. Install valves (if removed).
10. Install cylinder head.
11. Install guide plate.
12. Install rocker studs.
13. Install push rods.
14. Install rocker arms.
15. Install rocker pivots.
16. Install jam nuts.
17. Install valve cover gasket and cover.
18. Install spark plug.
19. Install flywheel brake assembly.
20. Install breather cover.
21. Install flywheel key.
22. Install flywheel.
23. Install fan.
24. Install ignition module.
25. Install fuel tank bracket (if removed).
26. Install fuel tank.
27. Install flywheel brake spring.
28. Install governor.
29. Install speed control bracket.
30. Install governor. spring
31. Install carburetor gaskets.
32. Install carburetor.
33. Reconnect carburetor linkage.
34. Reconnect fuel line.
35. Install primer hose (if equipped).
36. Install air cleaner base.
37. Reconnect breather hose.
38. Install air filter(s) and cover.
39. Install dipstick tube.
40. Install muffler assembly.
41. Install blower housing.
42. Install recoil.

Install Crankshaft

1. Carefully install the crankshaft into the crankcase through the front seal, and fully seat into place. See Figure 10-1. Rotate the crankshaft until the journal for the connecting rod is away from the cylinder.

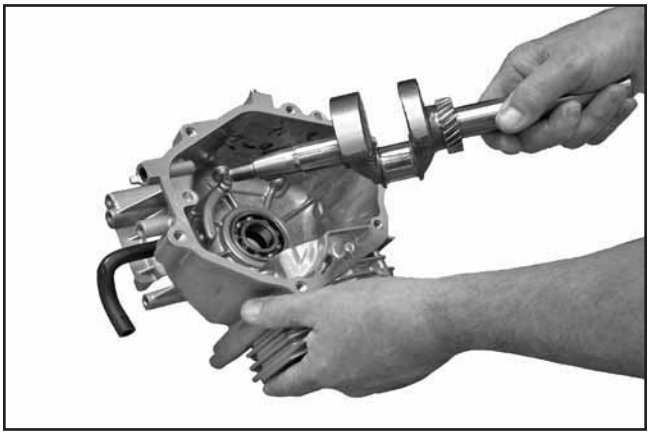


Figure 10-1. Installing Crankshaft.

Install Piston and Connecting Rod

NOTE: Proper orientation of the piston and 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. Lubricate the cylinder bore, crankshaft journal, connecting rod journal, piston, and rings with engine oil.

2. Compress the piston rings using a piston ring compressor. See Figure 10-2.

Figure 10-2. Compressing Piston Rings.

3. Aim the triangle on top of the piston towards the push rod chamber. See Figure 10-3.

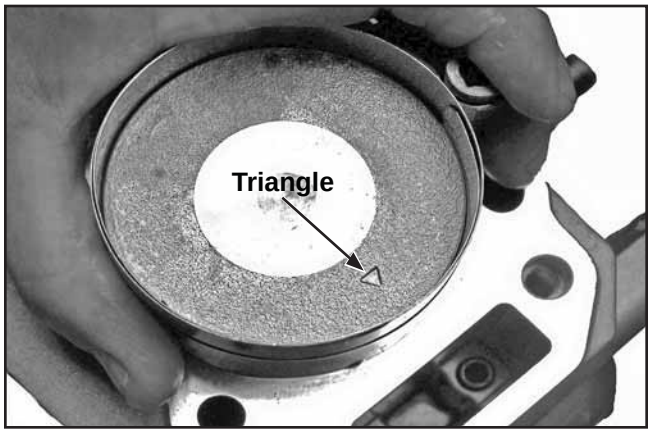


Figure 10-3. Piston Orientation (After Installation).

4. Carefully guide the connecting rod, with piston attached, into the bore. See Figure 10-4.

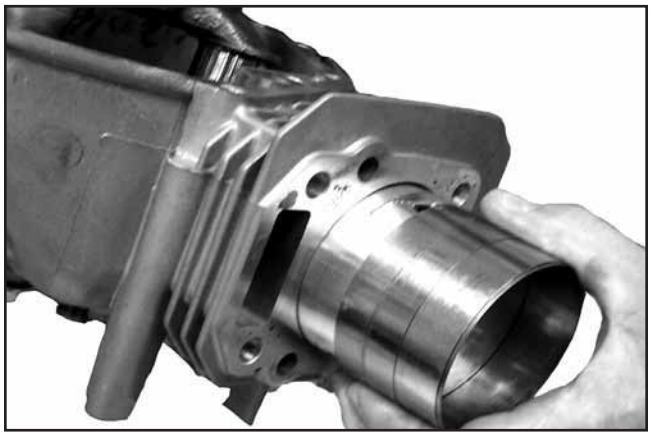


Figure 10-4. Installing Piston.

5. Use the handle of a soft, rubber-grip hammer to tap the piston into the bore. See Figure 10-5.

Figure 10-5. Tapping Piston.

6. Rotate the crankshaft to mate with the connecting rod. Align the rod cap and connecting rod to match the marks. Torque the screws to **12.5 N·m (110 in. lb.)**. See Figure 10-6.

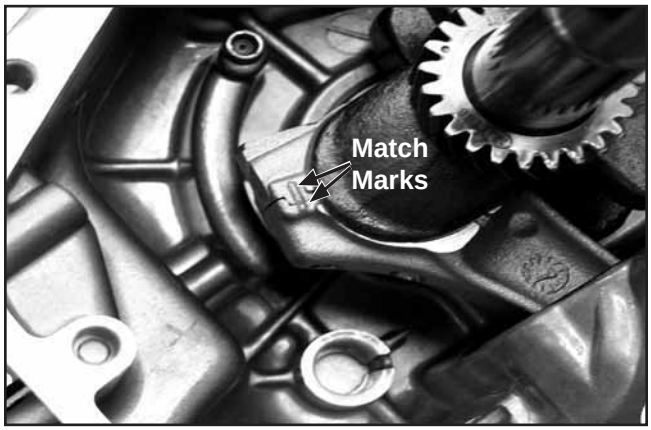


Figure 10-6. Aligning Match Marks.

Install Tappets

1. Install the INTAKE and the EXHAUST tappets into their respective positions, as previously marked. See Figure 10-7.

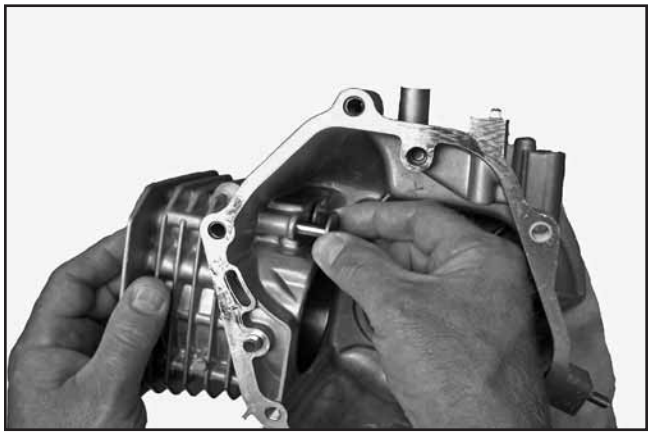


Figure 10-7. Installing Tappets.

Install Camshaft

1. Lubricate the camshaft and cam gear surfaces with light grease or oil.

2. Install the camshaft and align the timing marks. See Figure 10-8.

Figure 10-8. Aligning Timing Marks.

Install Governor Gear Assembly

1. Install the governor gear and retainer, and torque the hex flange screw to **9.5 N·m (84 in. lb.)**. See Figure 10-9.

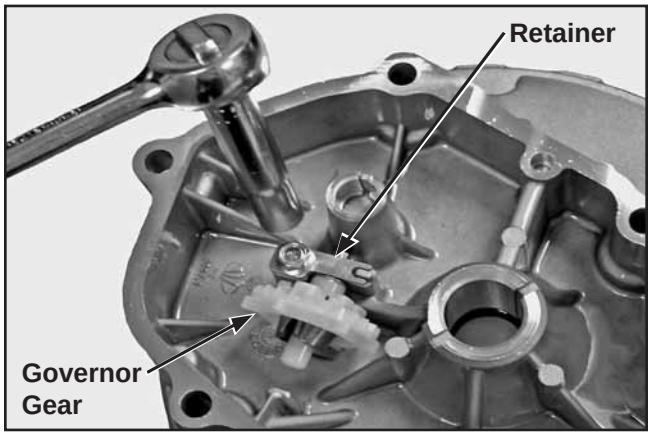


Figure 10-9. Installing Governor Gear.

2. Install the governor cross shaft and secure it with the hitch pin. See Figure 10-10.

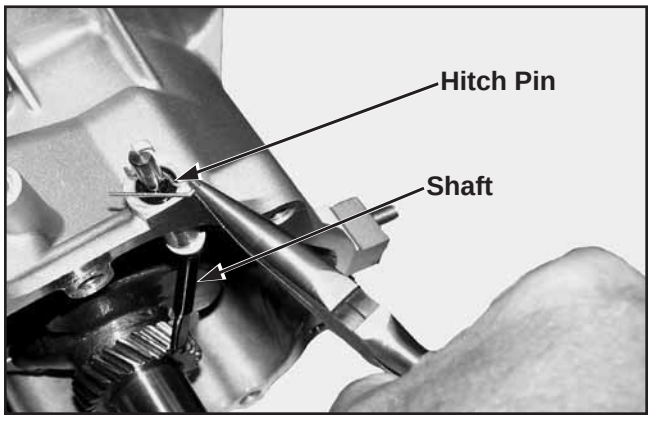


Figure 10-10. Installing Governor Shaft, Hitch Pin.

Install Oil Pan

1. The sealing surfaces of the crankcase and oil pan should be clean, dry and free of any nicks or burrs.

2. Install the two crankcase dowels into the crankcase. See Figure 10-11.

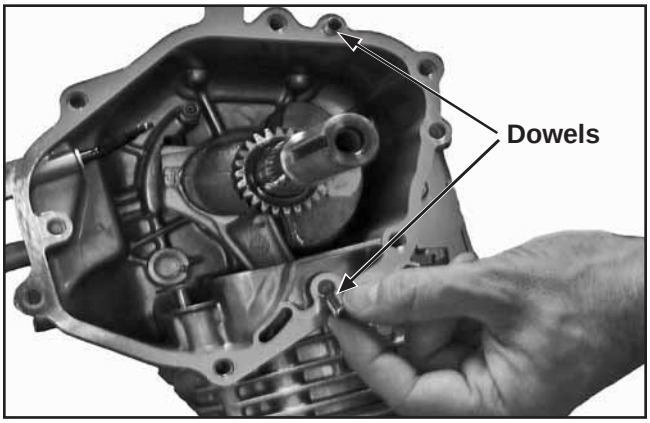


Figure 10-11. Installing Crankcase Dowels.

3. Using the crankcase dowels as a guide, install a new oil pan gasket onto the crankcase.

4. Ensure the gasket, oil pan, and governor gear assembly have been accurately matched with the crankcase. Guide the oil pan onto the crankcase, ensuring the camshaft and governor gear align with their mating surfaces. Rotate the crankshaft slightly to help engage the governor gear.

5. Install and finger tighten the six hex flange screws, securing the oil pan to the crankcase. See Figure 10-12.

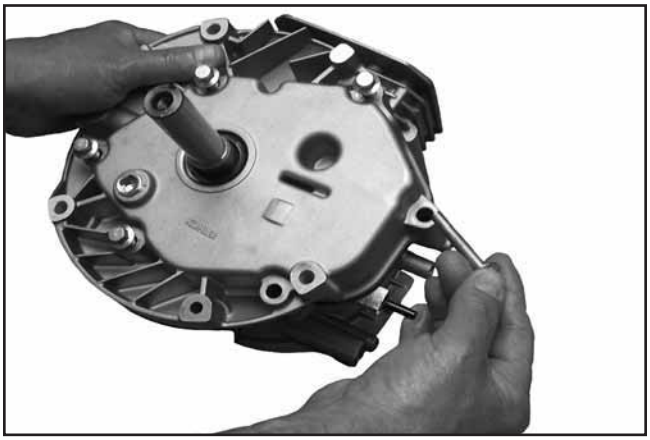


Figure 10-12. Installing Oil Pan Screws.

6. Using the torque sequence shown in Figure 10-13.

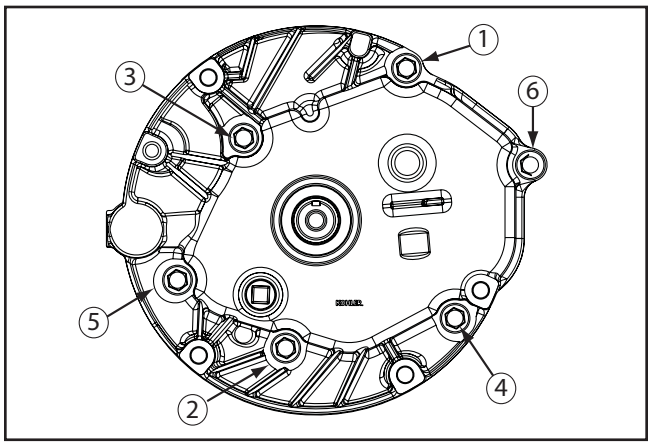


Figure 10-13. Torque Sequence.

7. Torque the oil pan screws to **12.3 N·m (109 in. lb.).** See Figure 10-14.

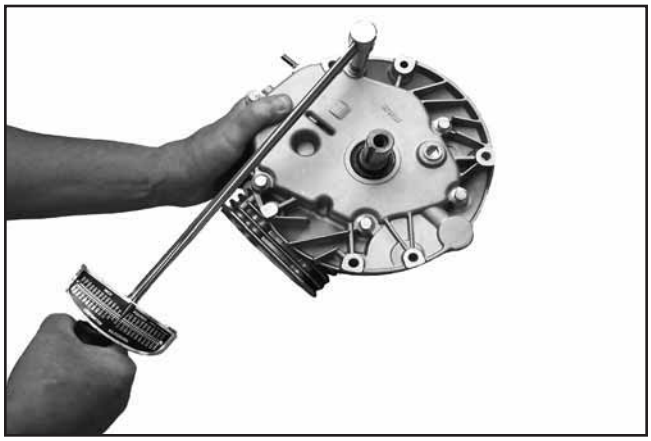


Figure 10-14. Torquing Oil Pan Screws.

Install Cylinder Head Assembly

Prior to assembly, lubricate all the components with engine oil, including the tips of the valve stems and valve guides.

Install Valve Assembly

1. Install the INTAKE and the EXHAUST valves into their respective positions in the cylinder head. See Figure 10-15.

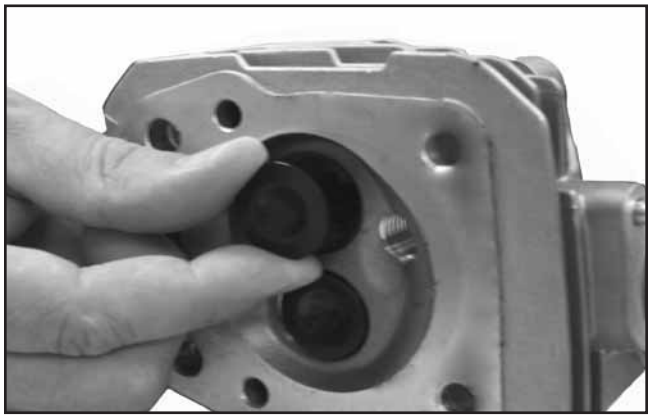


Figure 10-15. Installing Valves.

2. Install the intake valve seal onto the intake valve. Next, slide the valve springs onto both valves and lock them in place with the valve spring keepers. See Figure 10-16.

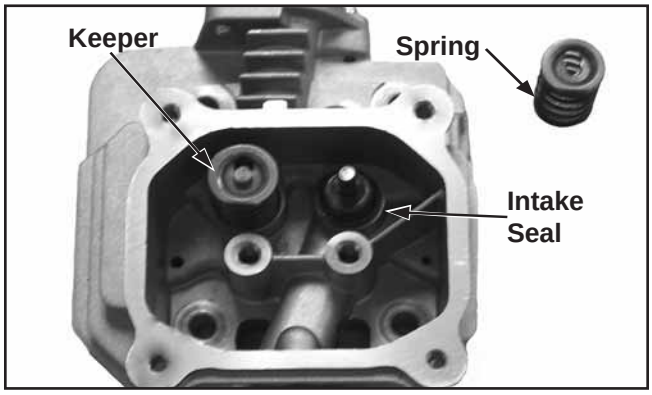


Figure 10-16. Installing Valve Assembly.

Install Cylinder Head

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

1. Examine the sealing surfaces of the cylinder head and crankcase for nicks or burrs.

2. Using the two cylinder head dowels as a guide, install a new head gasket. See Figure 10-17.

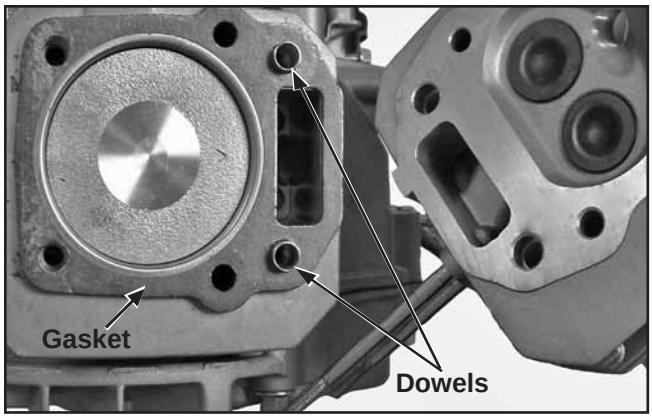


Figure 10-17. Installing Cylinder Dowels.

3. Match the two sides of the head together and finger tighten the four hex screws. See Figure 10-18.

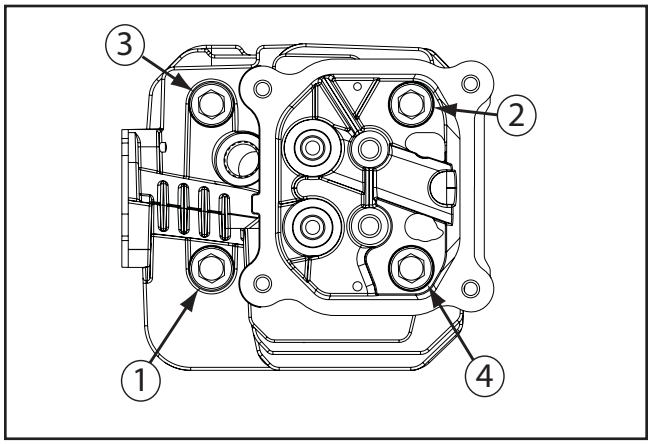


Figure 10-18. Torquing the Screws.

4. Follow the torque sequence in Figure 10-18 and torque the head screws to **27.8 N·m (246 in. lb.).**

Install Push Rod Assembly

1. Install the rocker studs through the guide plate. See Figure 10-19.

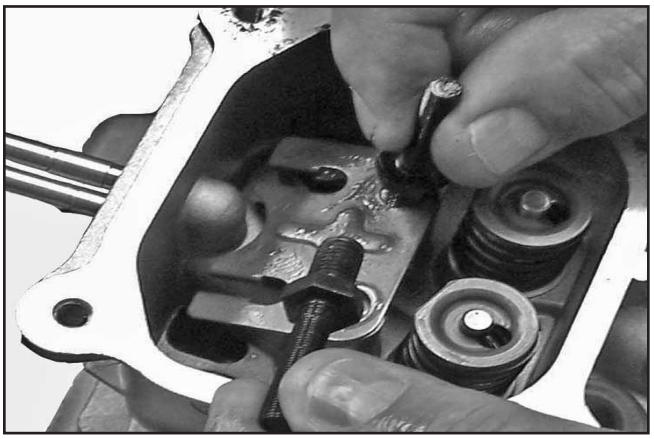


Figure 10-19. Installing Guide Plate and Studs.

2. Torque the rocker studs to **13.6 N·m (120 in. lb.).**

3. Install the push rods into the intake and exhaust positions, as previously marked. See Figure 10-20.

NOTE: Installation and seating of the push rods into the tappet recesses during this sequence is critical. To aid with proper installation of the push rods and rocker arms, and for adjusting the valve lash, position the engine with the cylinder head up. When properly installed the push rods extend approximately **1 in. (25.4 mm)** above the guide plate.

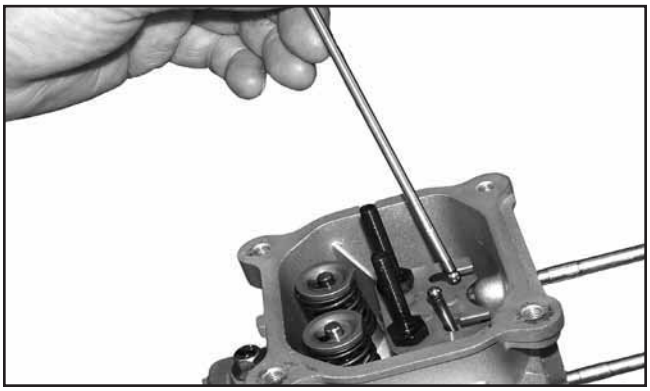


Figure 10-20. Installing Push Rods.

4. Apply grease to the contact surfaces of the rocker arms and the pivots.

5. Install the rocker arms onto the rocker studs. Match the rocker arm dimples with the round push rod ends. See Figure 10-21.

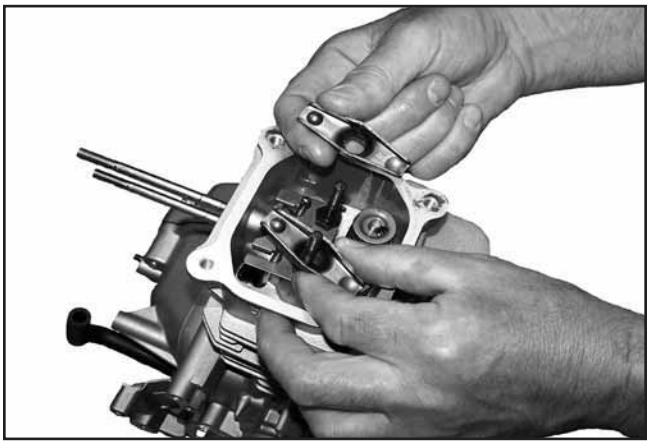


Figure 10-21. Installing Rocker Arms.

6. Loosely install the pivots and the jam nuts onto the rocker studs. See Figure 10-22.

Figure 10-22. Installing Pivots.

7. With the piston at top dead center of the compression stroke, insert a **0.1 mm (.004 in.)** flat feeler gauge between one valve stem and rocker arm. See Figure 10-23.

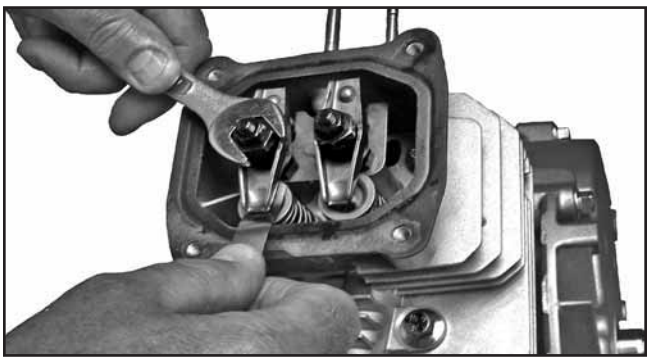


Figure 10-23. Setting Valve Lash.

Valve Clearance Specifications:
Intake Valve **0.0762-0.127 mm (0.003-0.005 in.)**
Exhaust Valve **0.0762-0.127 mm (0.003-0.005 in.)**

8. Tighten the rocker pivot with a wrench until a slight drag is felt on the feeler gauge. See Figure 10-23. Hold the nut in that position and torque the jam nut to **9.5 N·m (84 in. lb.)**. Perform the same adjustment procedure on the opposite valve.

9. Position a new valve cover gasket on the cylinder head.

10. Install the valve cover and finger tighten the four screws.

11. Using the sequence shown in Figure 10-24, torque the cover screws to **8 N·m (71 in. lb.)**.

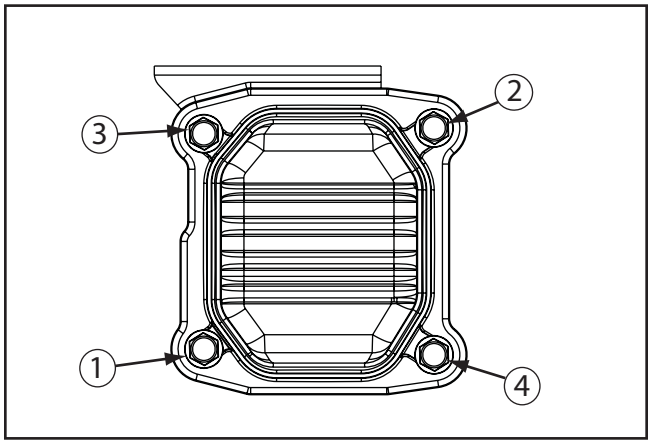


Figure 10-24. Valve Cover Torque Sequence.

Install New Spark Plug

1. Set the gap on a new Champion® RC12YC (or equivalent) to **0.762 mm (0.030 in.)**.

2. Install the spark plug and torque it to **24.5 N·m (217 in. lb.)**.

Install Flywheel Brake Assembly

1. Install the two spacers onto the two brake assembly screws.

2. Torque them to **9.5 N·m (84 in. lb.)**. See Figure 10-25.

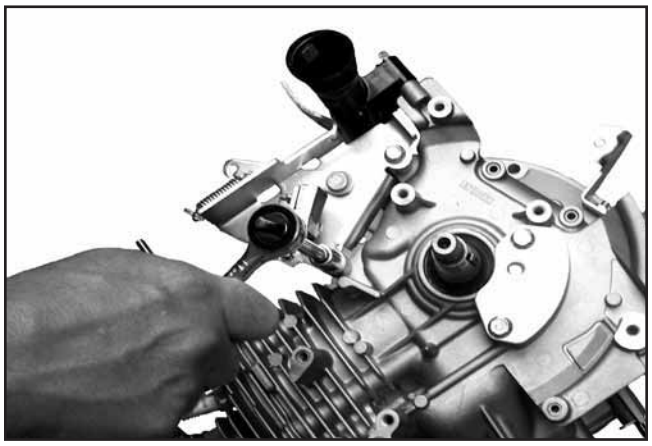


Figure 10-25. Installing Flywheel Brake Assembly.

Install Breather Assembly

1. Install the breather screen, spring, and disc**.** See Figure 10-26.

Figure 10-26. Installing Screen, Spring, and Disc.

2. Install the breather cover and torque it to **10 N·m (88 in. lb.)**. See Figure 10-27.

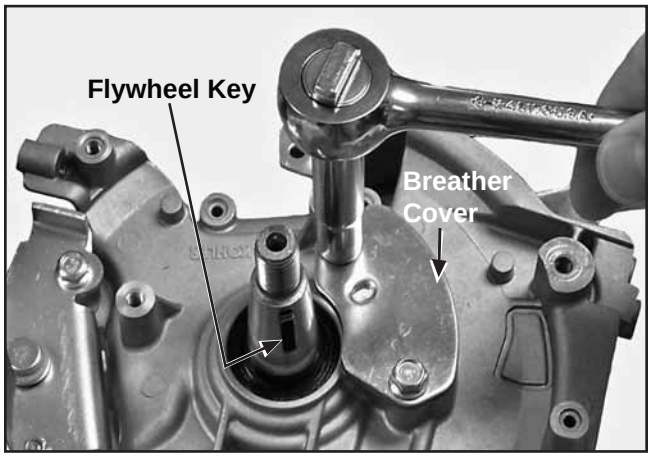


Figure 10-27. Installing Breather Cover.

Install Flywheel Assembly

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 over stressed and damaged when the mounting nut 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 properly installed.

NOTE: Always use a flywheel strap wrench to hold the flywheel when tightening the flywheel fastener. Do not use any type of bar or wedge to prevent the flywheel from rotating, as these parts could become cracked or damaged.

1. Install the key into the crankshaft keyway. Make sure key is fully seated. See Figures 10-27 and 10-28.

2. Install the flywheel onto the crankshaft aligning the keyway with the key. See Figure 10-28.

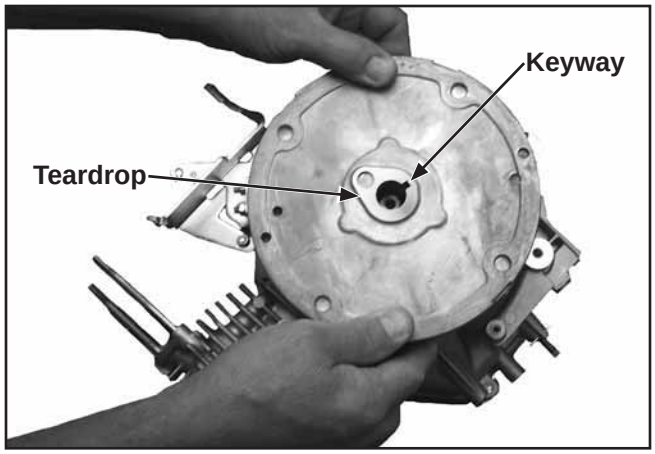


Figure 10-28. Installing Flywheel.

3. Align the teardrop slot on the fan with the raised teardrop on the flywheel. Align the drive cup on the flywheel, and install and hand tighten the nut.

4. Using a flywheel strap wrench, hold the flywheel still while simultaneously torquing the nut to **51.5 N·m (456 in. lb.).** See Figure 10-29.

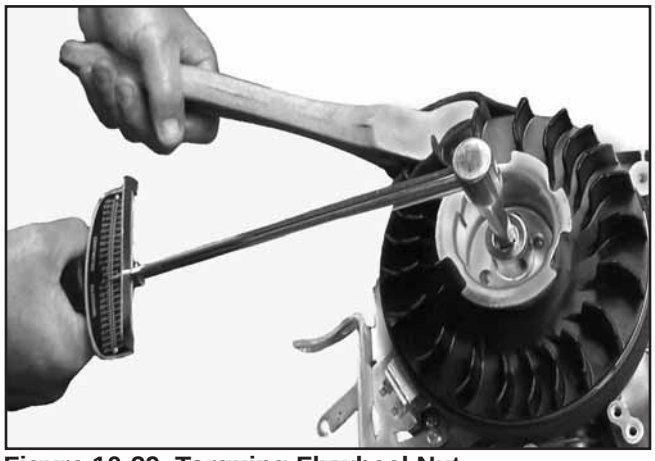


Figure 10-29. Torquing Flywheel Nut.

Install Ignition Module

1. Rotate the flywheel so the ignition magnets are away from the ignition module legs. Position the ignition module on the legs with the kill tab down. See Figures 10-30 and 10-32.

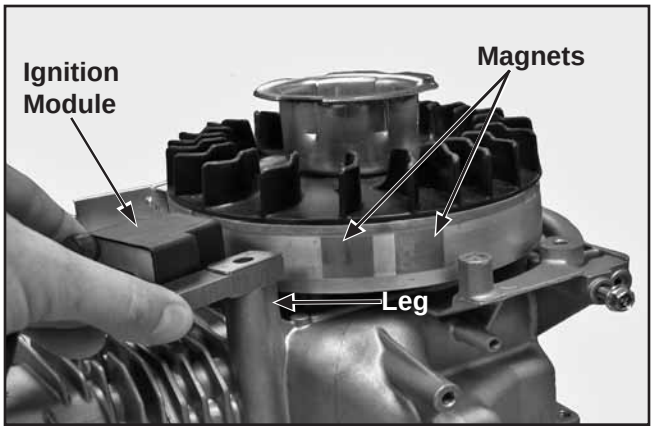


Figure 10-30. Positioning Ignition Module/Magnets

2. Loosely thread the stud in a mounting leg and the hex flange screw in another leg. See Figure 10-31. Pull the module away from the flywheel and tighten the stud to hold it in place. Rotate the flywheel so the ignition magnet is aligned with the module.

NOTE: If the stud for mounting the ignition module was not kept segregated from the two studs for mounting the fuel tank, compare their lengths and choose the short one.

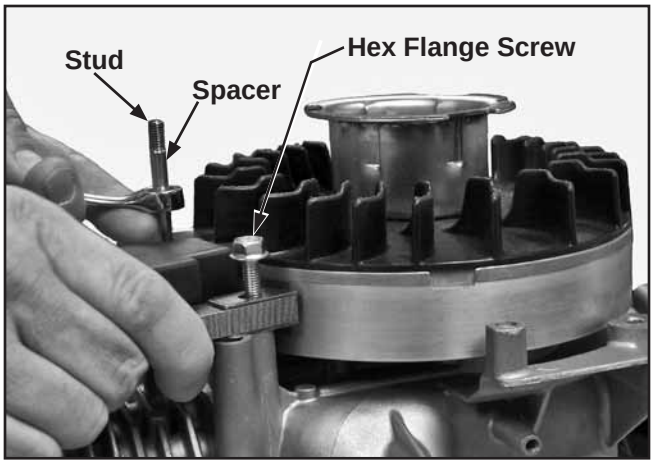


Figure 10-31. Tightening Ignition Module Stud.

3. Install the spacer onto the ignition module stud. See Figure 10-31.

4. Set the air gap by placing a **0.254 mm (0.010 in.)** plastic feeler gauge between the magnet and the module. Loosen the stud and let the magnet draw the module against the feeler gauge. See Figure 10-32. Torque the fasteners to **10 N·m (88 in. lb.).**

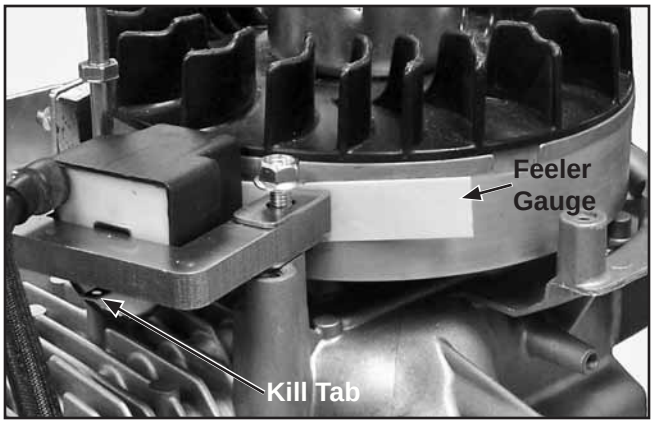


Figure 10-32. Feeler Gauge.

5. Rotate the flywheel to release the feeler gauge, and check that the module does not come in contact with the magnet. Recheck the air gap.

6. Connect the kill lead to the ignition module. See Figure 10-32.

Install Fuel Tank

1. Attach the fuel tank bracket to the tank (if removed) with the two bracket screws. See Figure 10-33. Torque the screws to **4.5 N·m (40 in. lb.).**

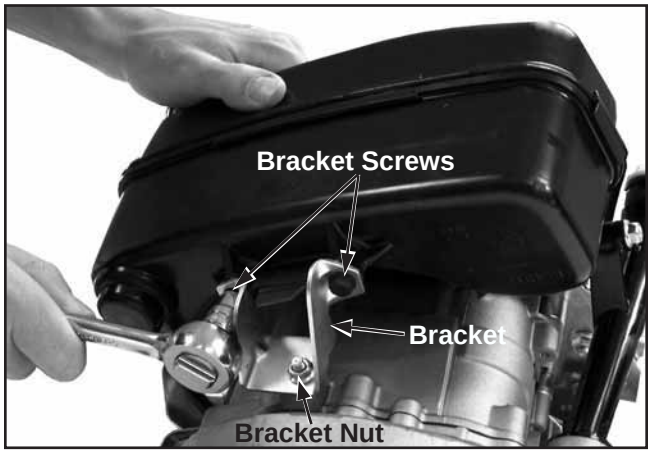


Figure 10-33. Attaching Fuel Tank Bracket.

2. Loosely attach the fuel tank bracket to the crankcase with the hex flange nut. See Figure 10-33.

3. Secure the top of the fuel tank to the crankcase by installing the two threaded studs. Torque the studs to **10 N·m (88.5 in. lb.).** See Figure 10-34.

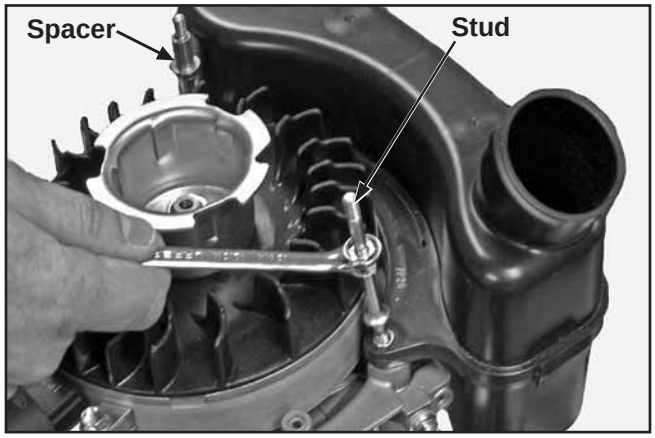


Figure 10-34. Installing Fuel Tank Studs.

4. Install **s**pacers on both studs. See Figure 10-34.

5. Secure the fuel tank bracket to the crankcase by torquing the hex flange nut to **8 N·m (71 in. lb.)**. See Figure 10-33.

Install Flywheel Brake Spring

1. Using a pliers, attach the flywheel brake spring onto the bracket hook. See Figure 10-35.

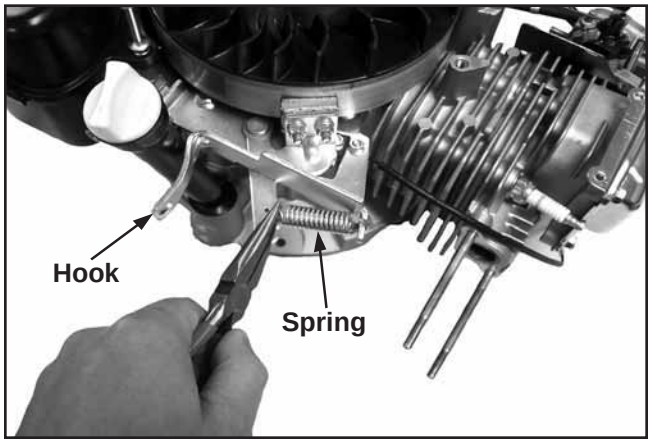


Figure 10-35. Attaching Flywheel Brake Spring.

Install Governor Assembly

1. Install the governor lever onto the governor shaft with the lever section up. See Figure 10-36.

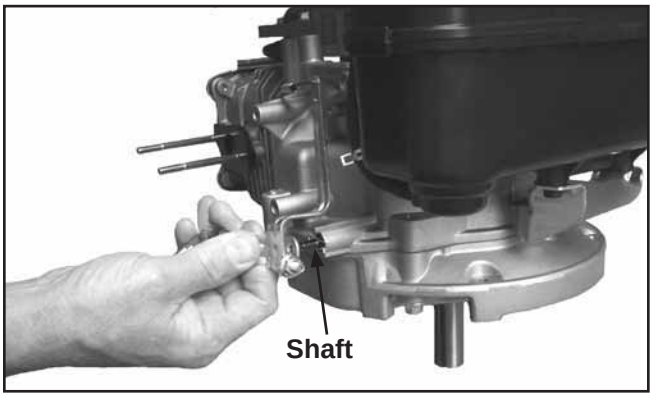


Figure 10-36. Installing Governor Lever.

2. Attach the throttle linkage and linkage spring to the top of the governor lever. See Figure 10-37.

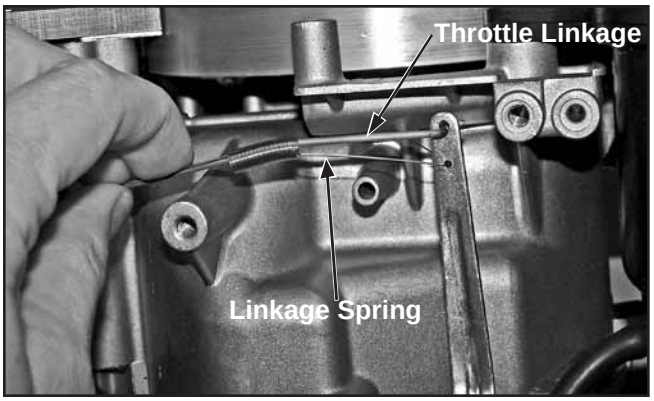


Figure 10-37. Attaching Governor Linkage.

Install Speed-Control Bracket

1. Loosely attach the speed-control bracket to the crankcase using the two shorter hex screws. The long hex screw will be used later for attachment of the air cleaner body. See Figure 10-38.

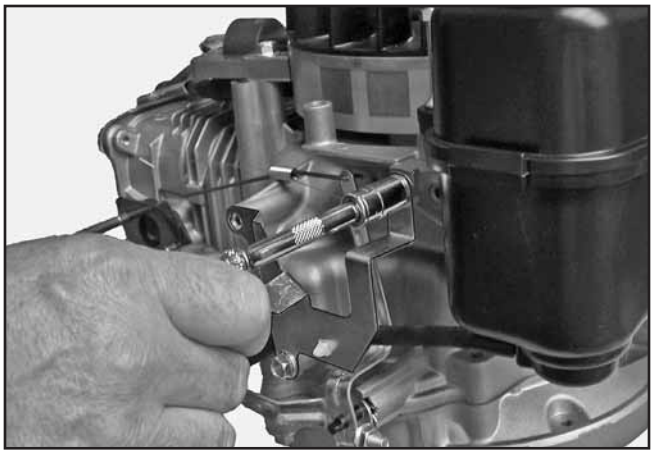


Figure 10-38. Installing Speed Bracket.

NOTE: There are three different speed bracket variations for this engine. Figures 10-39, 10-40, and 10-41 identify how different brackets connect to carburetors with and without choke.

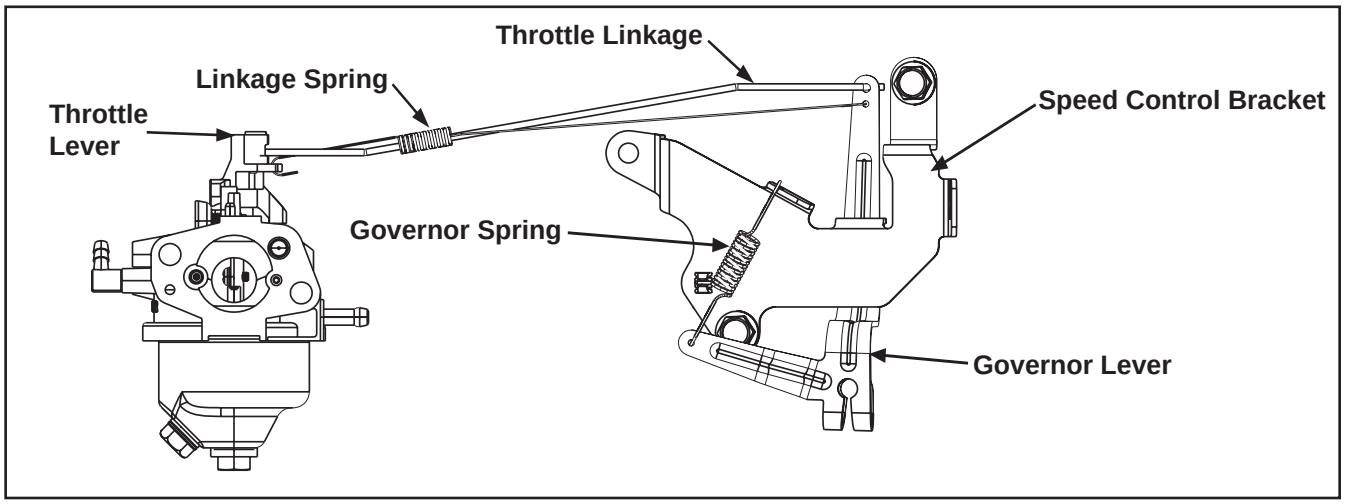


Figure 10-39. Fixed Speed with Primer (No Choke).

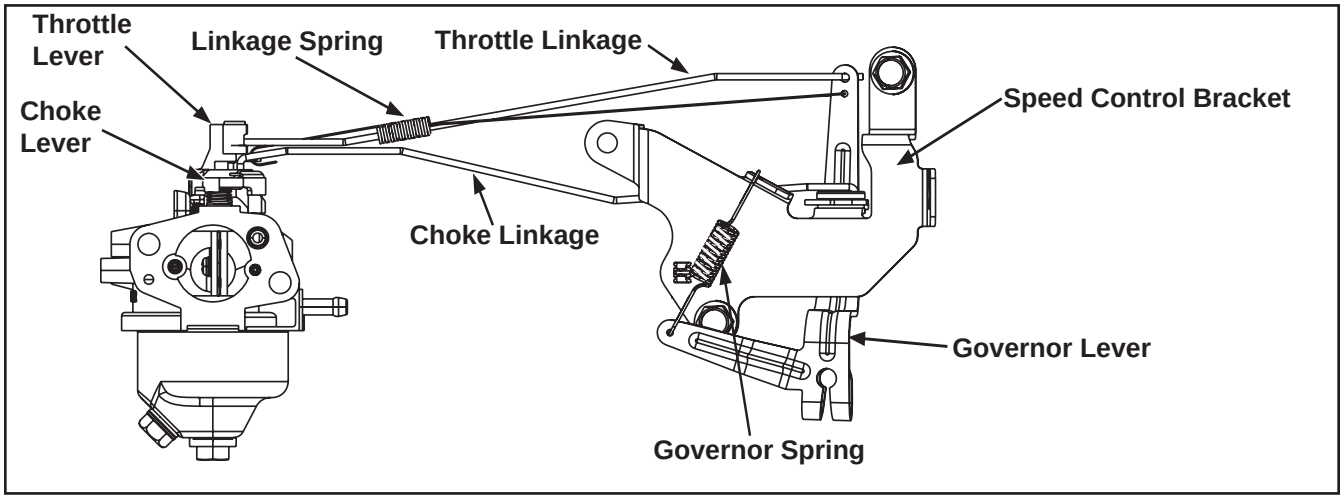


Figure 10-40. Fixed Speed with Choke.

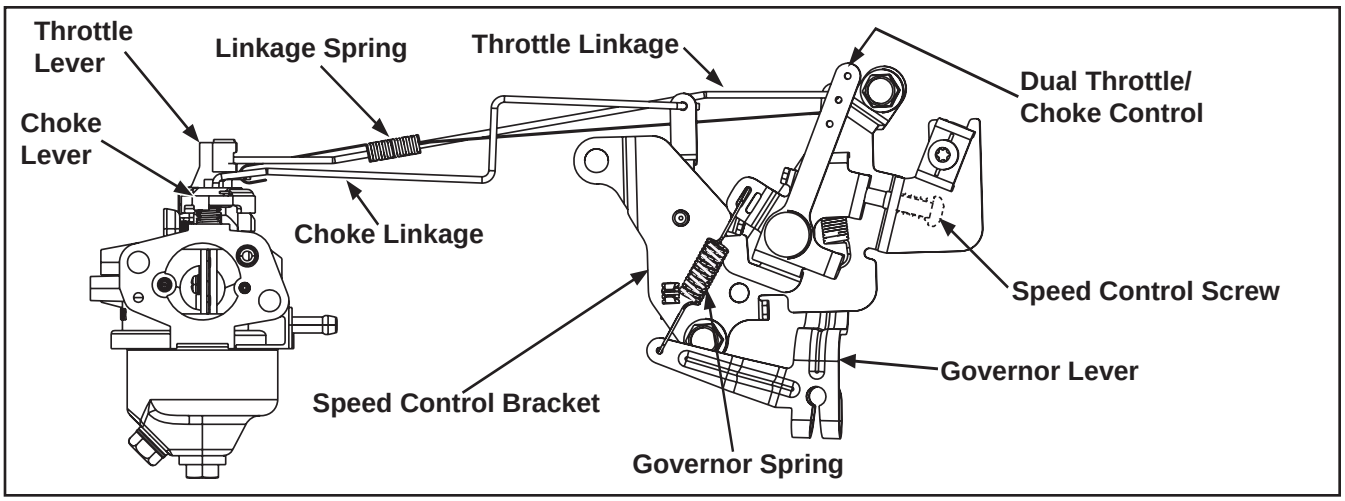


Figure 10-41. Variable Speed with Choke.

Install Governor Spring

1. Install the governor spring between the governor lever and the speed control bracket. See Figure 10-42 and 10-39.

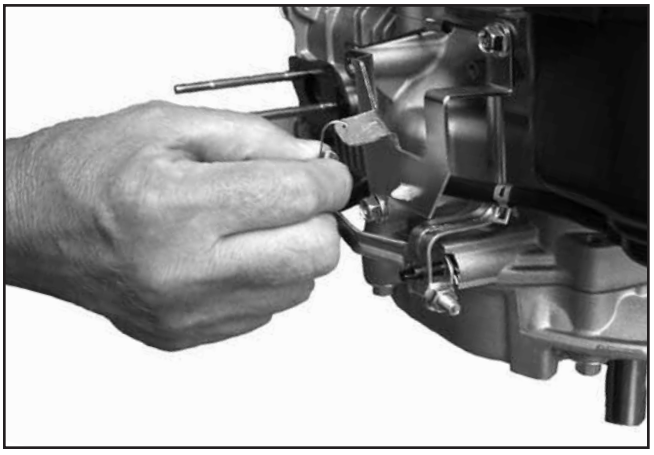


Figure 10-42. Installing Governor Spring.

Install Carburetor Gaskets

1. Place the spacer gasket, cylinder head spacer and the heat deflector gasket on the carburetor studs in the order shown in Figure 10-43.

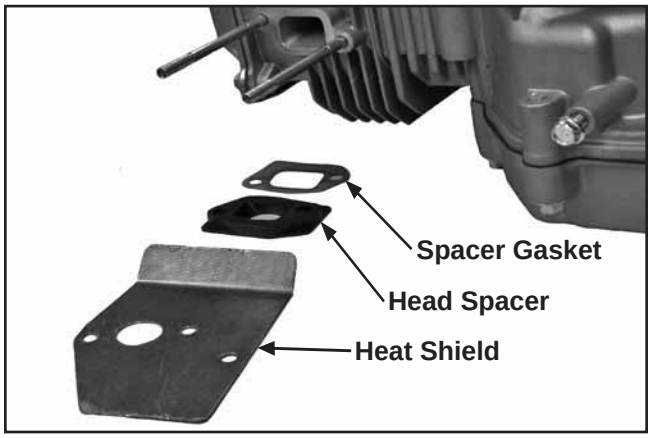


Figure 10-43. Installing Carburetor Gaskets

Install Carburetor Linkage

NOTE: There are several different ways to attach the carburetor linkage depending on the carburetor and speed bracket used. For more detailed illustrations, refer to Figures 10-39, 10-40, and 10-41.

Install Carburetor with Primer

1. With the carburetor not yet mounted on the studs, rotate it slightly to allow connection of the throttle linkage and linkage spring to the throttle lever. See Figure 10-44.

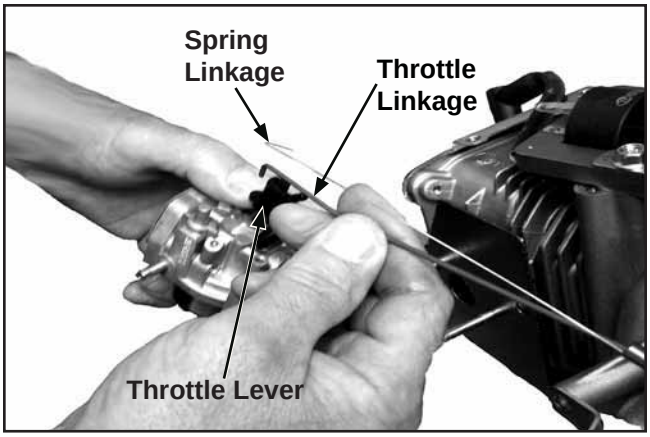


Figure 10-44. Installing Throttle Linkage.

2. Slide the carburetor onto the mounting studs. See Figure 10-45. Install the air cleaner gasket onto the studs.

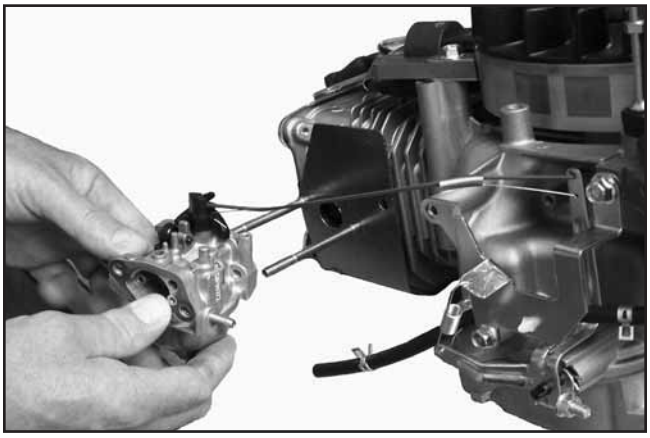


Figure 10-45. Installing Carburetor (Primer Model).

Install Carburetor with Choke

1. With the carburetor not yet mounted on the studs, rotate it slightly and slot the elbow, at the end of the linkage, into the choke lever. See Figure 10-46.

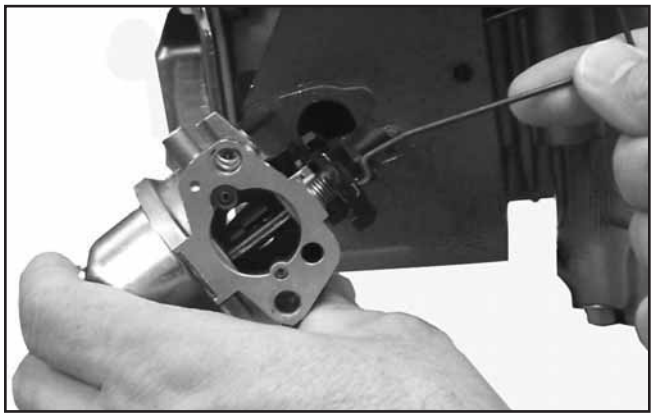


Figure 10-46. Attaching Choke Linkage.

2. Connect the throttle linkage and linkage spring to the throttle lever on the carburetor. See Figure 10-44.

3. Slide the carburetor onto the mounting studs. See Figure 10-45.

Adjust Governor

1. Move the governor lever away from the carburetor to the limit of its travel (wide-open throttle), and hold in this position. Do not stress, flex or distort the linkage. Grasp the cross shaft with a pliers and turn the shaft clockwise as far as it will go, while simultaneously tightening the hex nut. See Figure 10-47. Torque the hex nut to **9.5 N·m (84 in. lb.**).

Figure 10-47. Adjusting Governor.

Connect Fuel Line

1. Slide the fuel line tight up against the carburetor, and secure the connection with a hose clamp. See Figure 10-48.

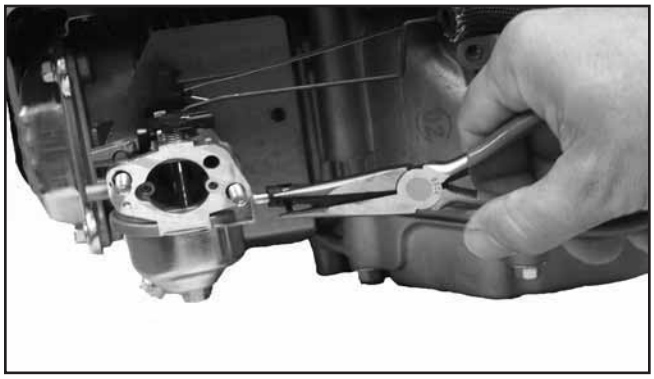


Figure 10-48. Connecting Fuel Hose.

Install Air Cleaner Assembly

1. Attach the primer hose to the carburetor (if equipped). See Figure 10-49.

2. Slide the air cleaner gasket onto the carburetor studs. See Figure 10-49.

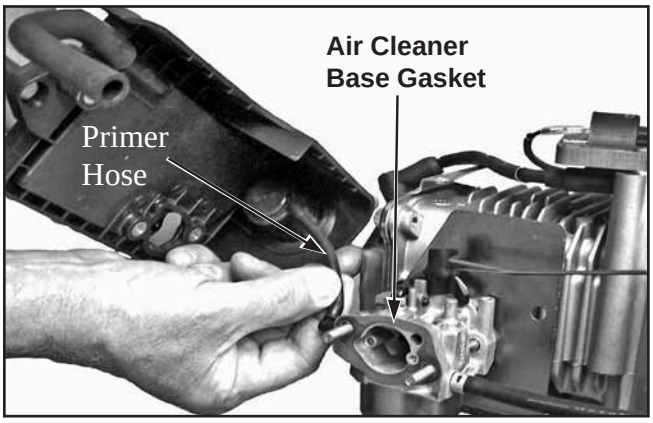


Figure 10-49. Installing Primer Hose (If Equipped).

3. Slide the air cleaner base onto the carburetor studs. Attach the base by loosley screwing the two hex nuts onto the studs, and the hex flange screw into the crankcase. See Figure 10-50.

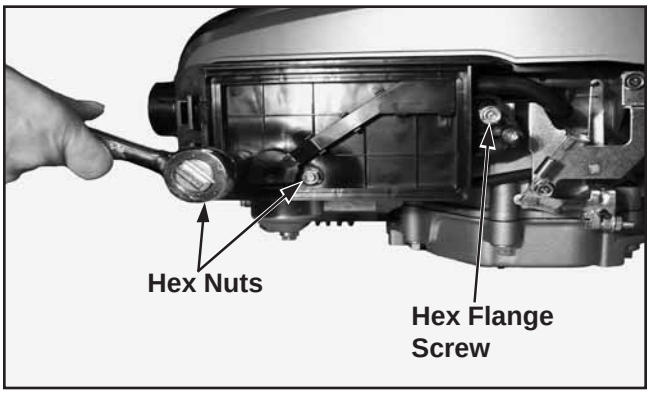


Figure 10-50. Installing Air Cleaner Base.

4. Attach the breather hose to the crankcase. See Figure 10-51.

Figure 10-51. Attaching Breather Hose.

5. Secure the air cleaner base by torquing the two hex nuts and the hex flange screw to **8 N·m (71 in. lb.).**

6. Install the paper element and the foam precleaner (if equipped) into the air cleaner body**.** See Figure 10-52. Attach and hand tighten the knob.

Figure 10-52. Installing Air Cleaner.

Install Dipstick Tube

1. Install the dipstick tube to the crankcase. See Figure 10-53.

2. Torque the hex flange screw to **8 N·m (71 in. lb.).**

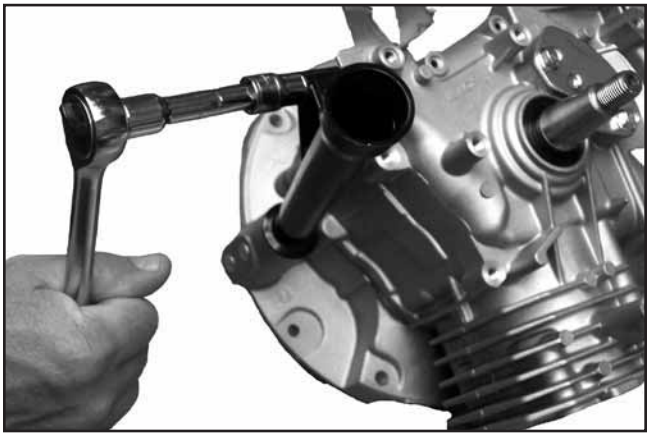


Figure 10-53. Installing Dipstick Tube.

Install Muffler Assembly

1. Install the heat deflector gasket onto the exhaust mounting studs, with the gasket folds facing the cylinder head. See Figure 10-54.

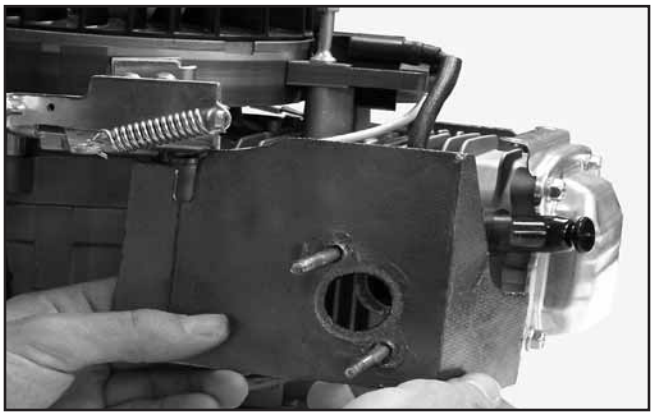


Figure 10-54. Installing Muffler Heat Deflector.

2. Slide the muffler onto the exhaust studs. See Figure 10-55.

Figure 10-55. Installing Muffler.

3. Install the muffler guard onto the exhaust studs. See Figure 10-56. Torque to **9.5 N·m (84 in. lb.).**

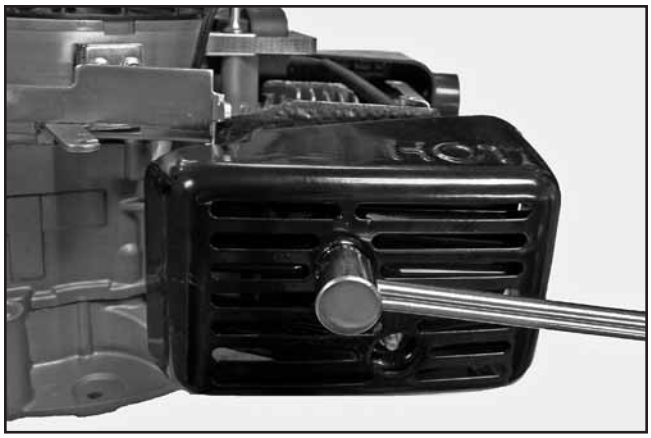


Figure 10-56. Installing Muffler Guard.

Install Blower Housing

1. Install the blower housing onto the studs. See Figure 10-57.

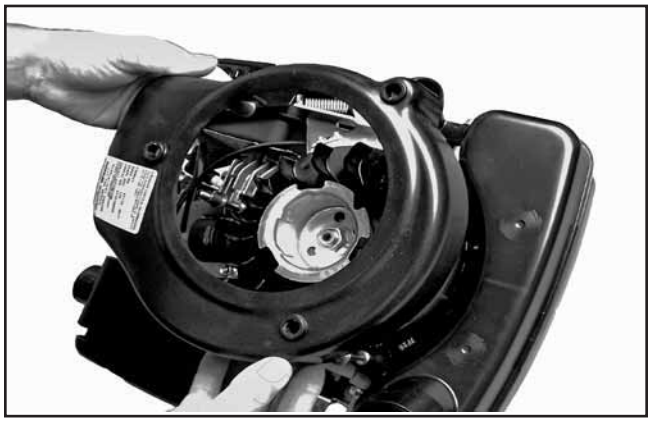


Figure 10-57. Installing Blower Housing.

Install Recoil

1. Place the recoil onto the studs protruding from the blower housing. See Figure 10-58.

Figure 10-58. Installing Recoil.

Install Engine Cover

1. Install the engine cover and secure it with the three hex nuts and two hex flange screws.

2. Torque the nuts to **2.8 N·m (25 in. lb.).** See Figure 10-59.

Figure 10-59. Installing Engine Cover.

2. Install the engine cover insert onto the engine cover, and secure with the four Torx screws. See Figure 10-60. Torque to **2.3 N·m (20 in. lb.).**

Figure 10-60. Installing Engine Cover Insert.

Install Fuel Cap

1. Screw the fuel cap tightly onto the fuel tank. See Figure 10-61.

Figure 10-61. Installing Fuel Cap.

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