SERVICE MANUAL

KOHLER® COMMAND PRO CS

4-12.75 HP

HORIZONTAL CRANKSHAFT

KOHLER® ENGINES

Contents

Section 1. Safety and General Information 1

Section 2. Tools & Aids 2

Section 3. Troubleshooting 3

Section 4. Air Cleaner and Air Intake System 4

Section 5. Fuel System and Governor 5

Section 6. Lubrication System 6

Section 7. Retractable Starter 7

Section 8. Electrical System and Components 8

Section 9. Disassembly 9

Section 10. Internal Components 10

Section 11. Reassembly 11

Section 1
Safety and General Information

Safety Precautions

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

WARNING

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

CAUTION

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

NOTE

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

For Your Safety!

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

WARNING

Accidental Starts can cause severe injury or death.

Disconnect and ground spark plug lead before servicing.

Accidental Starts!

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

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

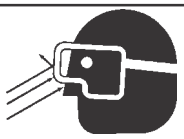
Carbon Monoxide can cause severe nausea, fainting or death.

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.

⚠ WARNING



Uncoiling Spring can cause severe injury.

Wear safety goggles or face protection when servicing retractable starter.

Spring Under Tension!

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

⚠ WARNING

Explosive Gas can cause fires and severe acid burns.

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

Explosive Gas!

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

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

⚠ CAUTION

Electrical Shock can cause injury.

Do not touch wires while engine is running.

Electrical Shock!

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

Engine Identification Numbers

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

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

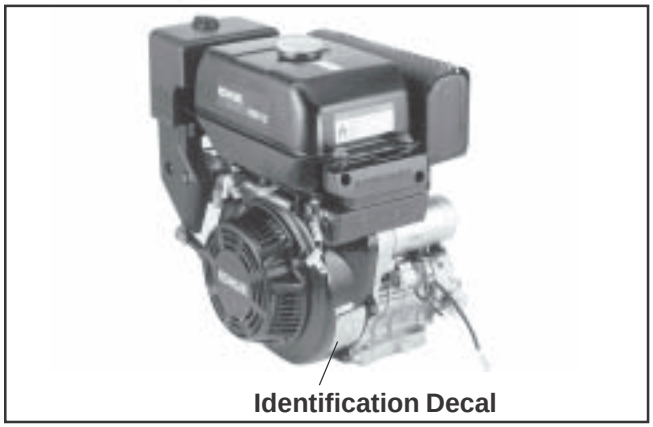


Figure 1-1. Engine Identification Decal Location.

Model Designation

Model CS6ST for example: C designates Command engine, S designates slanted cylinder configuration, and 6 designates horsepower. A suffix letter designates a specific version as follows:

A. Model No. C S 6 ST

Command Engine
Slanted Cylinder
Horsepower
4 = 4 HP
6 = 6 HP
8.5 = 8.5 HP
10 = 10 HP
12 = 12 HP

Suffix	Designates
T	Retractable Start
S	Electric Start
G	Tapered Crankshaft
P	Threaded Crankshaft
R	Gear Reduction (2:1 or 6:1)

B. Spec. No. 911509

Engine Model Code — **Variation of Basic Engine**

Code	Model
90	CS4
91	CS6
92	CS8.5# 300 cc
93	CS10
94	CS12
95	CS8.5# 250 cc

C. Serial No. 28 23701265

Year Manufactured Code — **Factory Code**

Code	Year	Code	Year
28	1998	33	2003
29	1999	34	2004
30	2000	35	2005
31	2001	36	2006
32	2002	37	2007

KOHLER®
IMPORTANT ENGINE INFORMATION
THIS ENGINE MEETS U.S. EPA PHASE II, 2002-2005 CALIFORNIA AND EC STAGE II (SN:4) EMISSION CONTROL REGS FOR SI SMALL OFF–ROAD ENGINES
FAMILY
TYPE APP
MODEL NO. CS6ST — A
SPEC. NO. 911509 — B
DISPL. (CC)
SERIAL NO. 2823701265 — C
OEM PROD. NO.
EMISSION COMPLIANCE PERIOD:
EPA: CATEGORY A
CERTIFIED ON: UNLEADED GASOLINE
REFER TO OWNER'S MANUAL FOR SAFETY, MAINTENANCE SPECS, AND ADJUSTMENTS
1-800-544-2444 www.kohlerengines.com
KOHLER CO. KOHLER, WISCONSIN USA
(REF:_____)
N432

Figure 1-2. Explanation of Engine Identification Numbers.

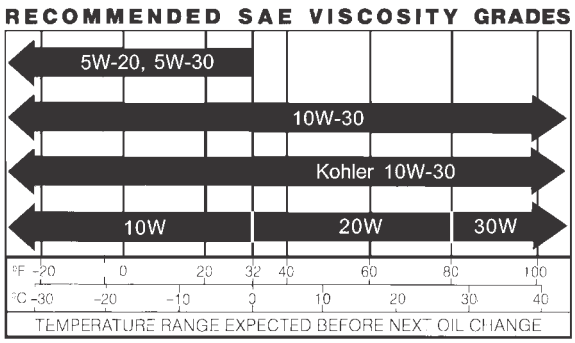
#**NOTE:** CS8.5 engines have been produced in two different specification series, **92xxxx and 95xxxx**. The design features of **92xxxx** spec. no. engines are identical to CS10 and CS12 engines, and share the same service procedures. The **95xxxx** spec. no. engines incorporate certain design differences from the 92xxxx spec. no. series. All service and repair information unique to the 95xxxx spec. no. series will be listed and covered separately.

Oil Recommendations

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

Oil Type

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



Synthetic oils should not be used.

Figure 1-3. Viscosity Grades Table.

NOTE: Using other than service class SG, SH, 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.

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

Do not add oil to the gasoline.

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

Fuel Type

For best results, use only clean, fresh, **unleaded** gasoline with a pump sticker octane rating of 87 or higher. In countries using the Research method, it should be 90 octane minimum.

Unleaded gasoline is recommended, as it leaves less combustion chamber deposits. Leaded gasoline may be used in areas where unleaded is not available and exhaust emissions are not regulated. Be aware however, that the cylinder head will require more frequent service.

Gasoline/Alcohol blends

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends are not approved.

Gasoline/Ether blends

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

Maintenance Instructions

WARNING: Accidental Starts!

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

Maintenance Schedule

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

Frequency	Maintenance Required	Refer to:
Daily or Before Starting Engine	• Fill fuel tank. • Check oil level. • Check air cleaner for dirty, loose, or damaged parts.[1] • Check air intake and cooling areas, clean as necessary.[1]	Section 5 Section 6 Section 4 Section 4
Every 25 Hours	• Service precleaner element. Replace if necessary.[1]	Section 4
Every 50 Hours	• Service solid foam element. Replace if necessary.[1]	Section 4
Every 100 Hours	• Change oil. • Replace air cleaner element.[1] • Remove cooling shrouds and clean cooling areas.[1] • Check all fittings and fasteners. • Clean fuel shut-off valve filter. Replace if necessary. • Check muffler screen/spark arrestor. Clean/replace if necessary. • Check spark plug condition and gap. Replace if necessary.	Section 6 Section 4 Section 4 Section 1 Section 5 Section 8
Annually or Every 300 Hours	• Check and adjust valve clearance when engine is cold.[2] • Check and adjust idle speed.[2] • Service starter motor drive, if so equipped.[2] • Have combustion chamber decarbonized.[2]	Section 11 Section 5 Section 7

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

Storage

If the engine will be out of service for 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. See ''Change Oil'' on page 6.2.

3. The fuel system must be completely emptied, or the gasoline must be treated with a stabilizer to prevent deterioration. If you choose to use a stabilizer, follow the manufacturers recommendations, and add the correct amount for the capacity of the fuel system. Fill the fuel tank with clean, fresh gasoline. Run the engine for 2-3 minutes to get stabilized fuel into the carburetor.

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

4. Remove the spark plug. Add one tablespoon of engine oil into the spark plug hole. Install the plug, but do not connect the plug lead. Crank the engine two or three revolutions and then turn it up against compression (when highest pull force or cranking force is required).

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

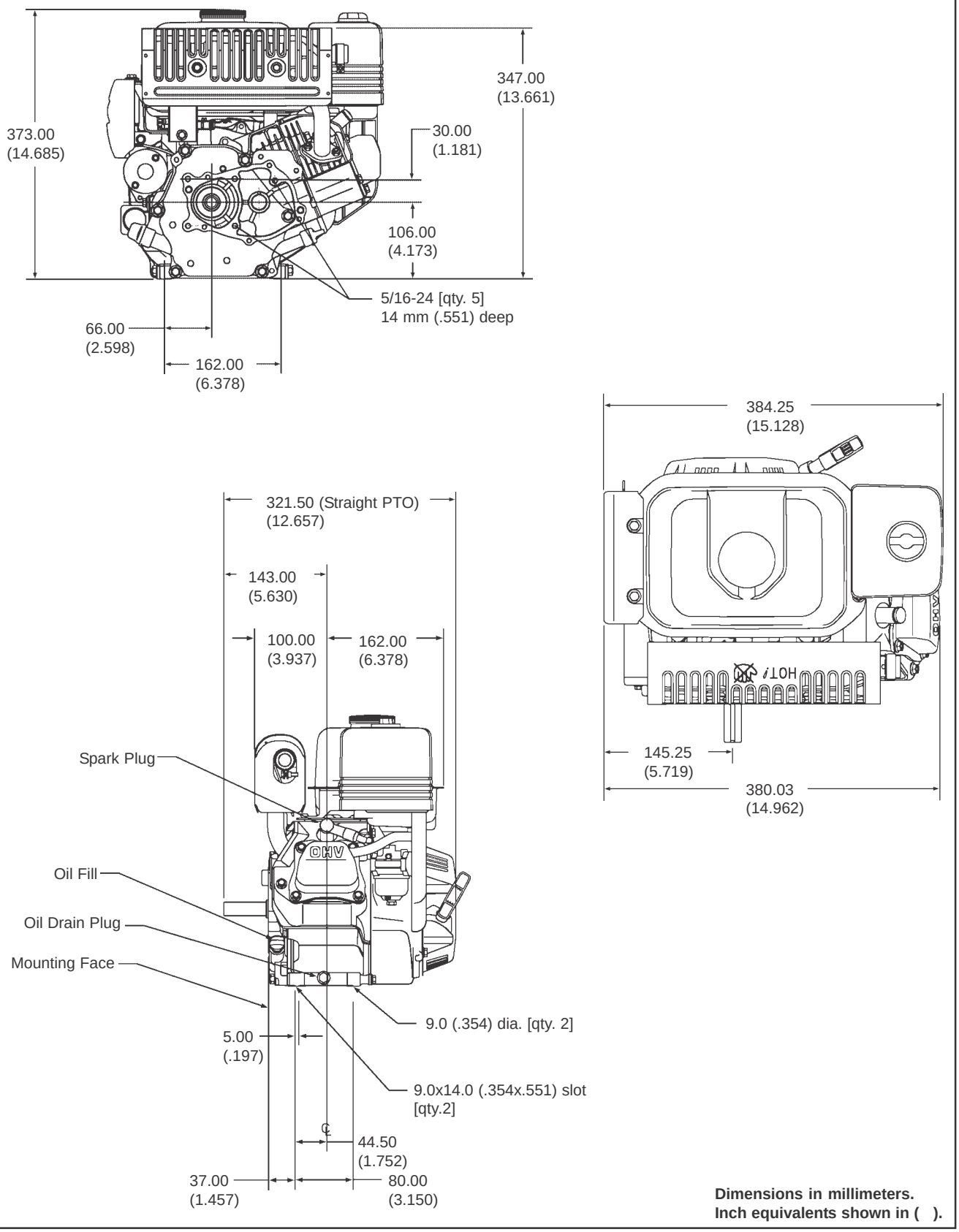


Figure 1-5. Typical Engine Dimensions CS4 and CS6.

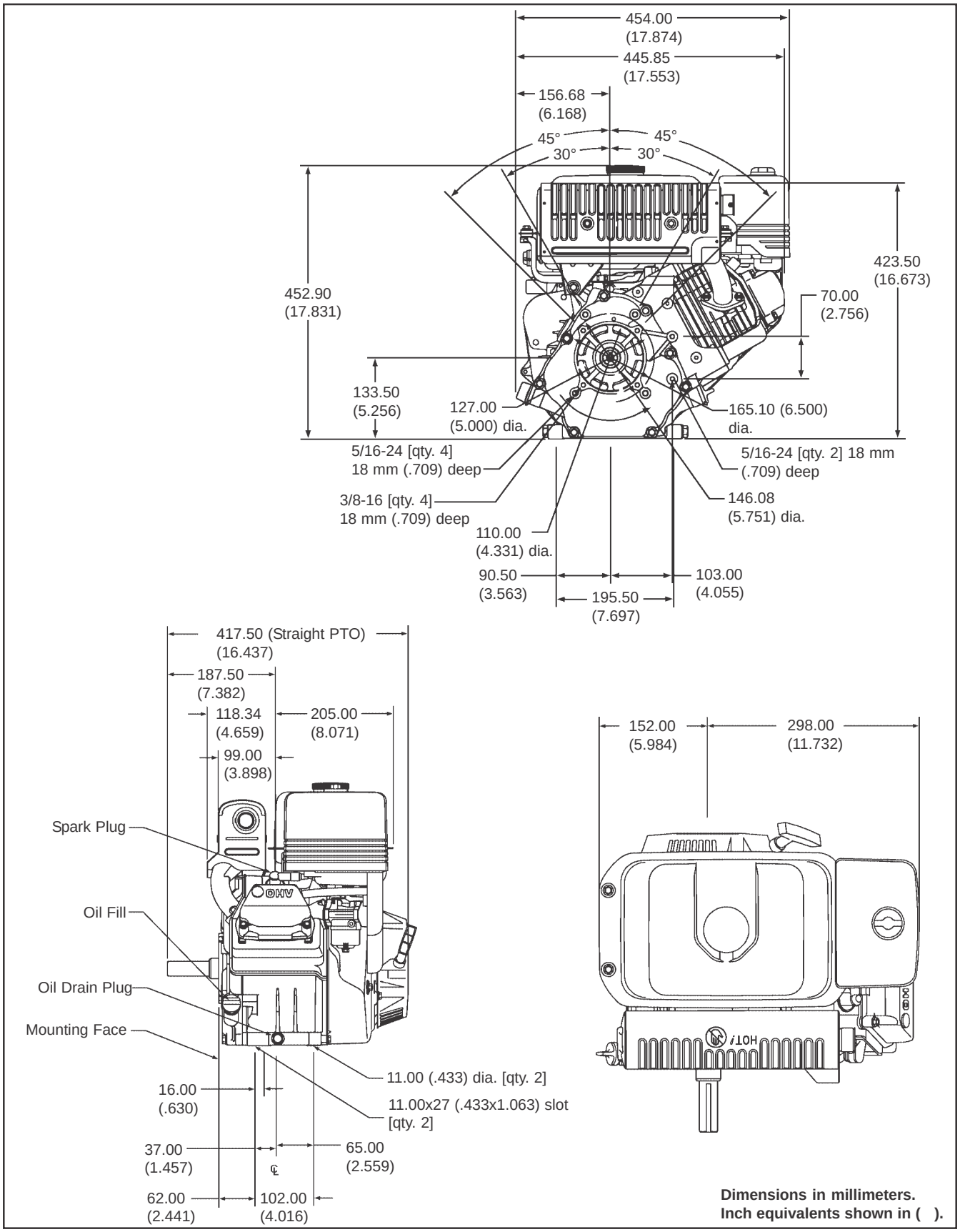
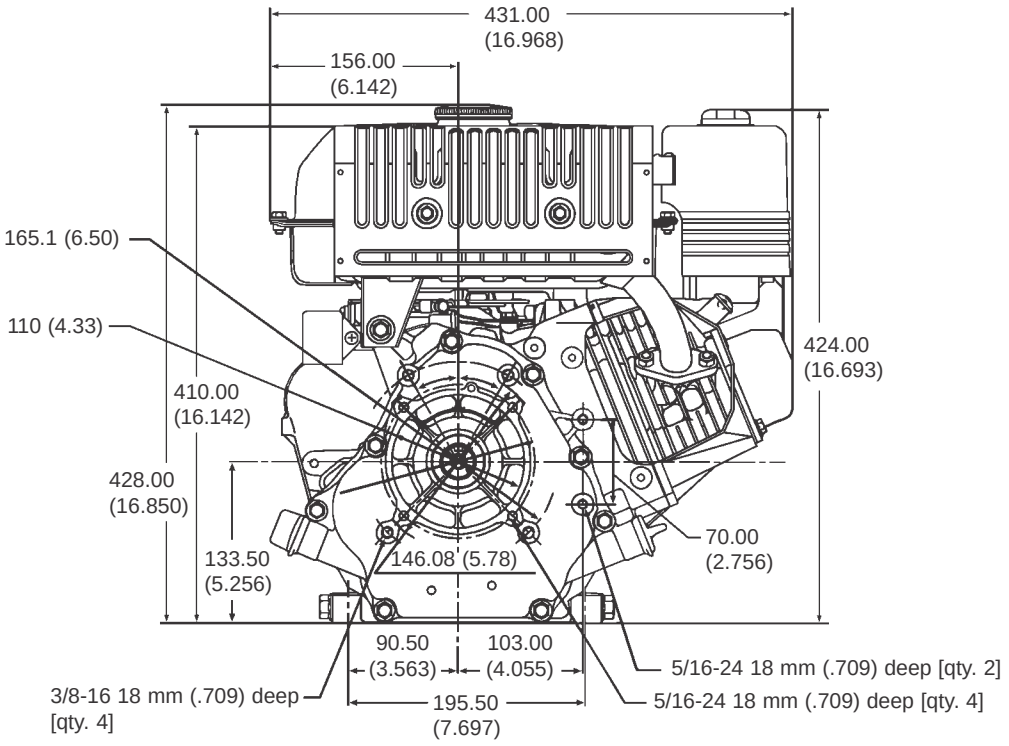
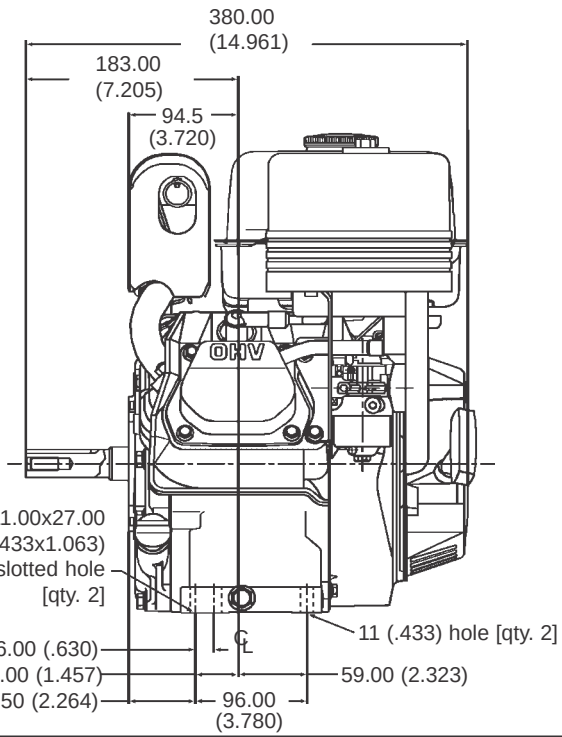
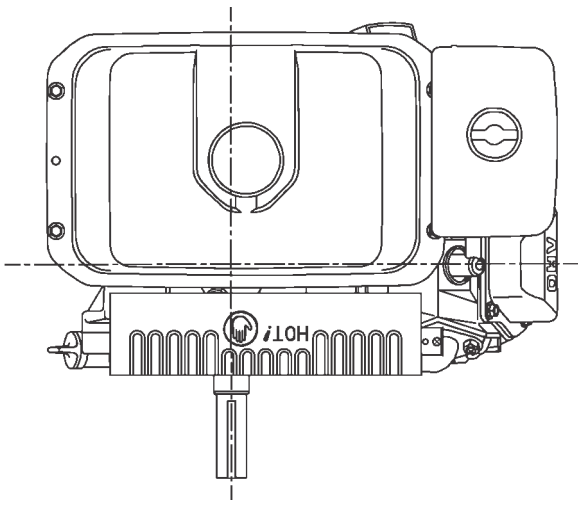


Figure 1-6. Typical Engine Dimensions CS8.5 (spec. 92xxxx), CS10, and CS12 - 12.75.







Dimensions in millimeters.
Inch equivalents shown in ( ).

Figure 1-7. Typical Engine Dimensions CS8.5 (spec. 95xxxx).

General Specifications

Power (@ 3600 RPM, exceeds SAE J1940 HP Standards)

- CS4 ..... 2.9 kW (4 HP)
- CS6 ..... 4.47 kW (6 HP)
- CS8.5 (spec. 95xxxx) ..... 5.40 kW (8.5 HP)
- CS8.5 (spec. 92xxxx) ..... 6.33 kW (8.5 HP)
- CS10 ..... 7.45 kW (10 HP)
- CS12 ..... 8.95 kW (12 HP)
- Hydro 12.75 ..... 9.5 kW (12.75 HP)

Peak Torque

- CS4 (@ 2000 RPM) ..... 7.6 N·m (5.6 ft. lb.)
- CS6 (@ 2000 RPM) ..... 10.8 N·m (8 ft. lb.)
- CS8.5 (spec. 95xxxx @ 2400 RPM) ..... 16.5 N·m (12.1 ft. lb.)
- CS8.5 (spec. 92xxxx @ 2000 RPM) ..... 19.66 N·m (14.5 ft. lb.)
- CS10 (@ 2000 RPM) ..... 19.66 N·m (14.5 ft. lb.)
- CS12 (spec. 9415xx @ 2000 RPM) ..... 22.6 N·m (16.7 ft. lb.)
- CS12 (spec. 9416xx @ 2400 RPM) ..... 24.9 N·m (18.4 ft. lb.)
- Hydro 12.75 (@ 2400 RPM) ..... 30.6 N·m (22.6 ft. lb.)

Bore

- CS4 ..... 56.0 mm (2.20 in.)
- CS6 ..... 66.0 mm (2.60 in.)
- CS8.5 (spec. 95xxxx) ..... 75.0 mm (2.95 in.)
- CS8.5 (spec. 92xxxx) ..... 78.0 mm (3.07 in.)
- CS10 ..... 78.0 mm (3.07 in.)
- CS12 ..... 85.0 mm (3.35 in.)

Stroke

- CS4,CS6 ..... 50.0 mm (1.97 in.)
- CS8.5 (spec. 95xxxx) ..... 57.0 mm (2.44 in.)
- CS8.5 (spec. 92xxxx) ..... 63.0 mm (2.48 in.)
- CS10-12 ..... 63.0 mm (2.48 in.)

Displacement

- CS4 ..... 123 cc (7.50 cu. in.)
- CS6 ..... 171 cc (10.43 cu. in.)
- CS8.5 (spec. 95xxxx) ..... 251 cc (15.30 cu. in.)
- CS8.5 (spec. 92xxxx) ..... 301 cc (18.37 cu. in.)
- CS10 ..... 301 cc (18.37 cu. in.)
- CS12 ..... 357 cc (21.79 cu. in.)

Compression Ratio

- CS4 ..... 8.3:1
- CS6 ..... 8.5:1
- CS8.5 (spec. 95xxxx) 8.3:1
- CS8.5 (spec. 92xxxx) 8.1:1
- CS10-12 ..... 8.1:1

Weight (Approx.)

- CS4,CS6 ..... 15.4 kg (35 lb.)
- CS8.5 (spec. 95xxxx) ..... 26 kg (57.2 lb.)
- CS8.5 (spec. 92xxxx) ..... 31.9 kg (70.5 lb.)
- CS10-12 ..... 31.9 kg (70.5 lb.)

General Specifications cont.

Oil Capacity (Approx.)
- CS4,CS6 ..... 0.6 L (0.64 U.S. qt.)
- CS8.5 (spec. 95xxxx) ..... 1.0 L (1.1 U.S. qt.)
- CS8.5 (spec. 92xxxx) ..... 1.1 L (1.2 U.S. qt.)
- CS10-12 ..... 1.1 L (1.2 U.S. qt.)

Fuel Tank Capacity
- CS4,CS6 ..... 3.9 L (4.1 U.S. qt.)
- CS8.5 (spec. 95xxxx) ..... 6.0 L (6.3 U.S. qt.)
- CS8.5 (spec. 92xxxx) ..... 6.9 L (7.3 U.S. qt.)
- CS10-12 ..... 6.9 L (7.3 U.S. qt.)

Angle of Operation – Maximum (At Full Oil Level) All Directions ..... 20°

Air Cleaner

Base Bolt Torque ..... 5-8 N·m (44-71 in. lb.)

Base Nut Torque
- CS4,CS6 ..... 5-8 N·m (44-71 in. lb.)
- CS8.5 (spec. 95xxxx) ..... 5-8 N·m (44-71 in. lb.)
- CS8.5 (spec. 92xxxx) ..... 10-12 N·m (88-106 in. lb.)
- CS10-12 ..... 10-12 N·m (88-106 in. lb.)

Camshaft

End Play ..... 0.05 mm (0.0020 in.)

Bore I.D. – Max. Wear Limit
- CS4,CS6 ..... 14.95 mm (0.583 in.)
- CS8.5-12 ..... 15.95 mm (0.627 in.)

Camshaft Bearing Surface O.D. – Max. Wear Limit
- CS4,CS6 ..... 15.05 mm (0.592 in.)
- CS8.5-12 ..... 16.05 mm (0.649 in.)

Carburetor

Fuel Bowl Retaining Screw Torque
- CS4,CS6 ..... 7 N·m (62 in. lb.)
- CS8.5-12 ..... 9 N·m (79 in. lb.)

Throttle/Choke Plate Screws Torque ..... 1.5-2.5 N·m (13-22 in. lb.)

Connecting Rod

Connecting Rod Fastener Torque
- CS4,CS6 ..... 12 N·m (106 in. lb.)
- CS8.5 (spec. 95xxxx) ..... 12 N·m (106 in. lb.)
- CS8.5 (spec. 92xxxx) ..... 20 N·m (177 in. lb.)
- CS10-12 ..... 20 N·m (177 in. lb.)

Connecting Rod-to-Crankpin Running Clearance
- New ..... 0.016/0.046 mm (0.0006/0.0018 in.)
- Max. Wear Limit ..... 0.1 mm (0.004 in.)

Connecting Rod-to-Crankpin Side Clearance
- CS4,CS6 ..... 0.2/0.6 mm (0.008/0.024 in.)
- CS8.5 (spec. 95xxxx) ..... 0.2/0.6 mm (0.008/0.024 in.)
- CS8.5 (spec. 92xxxx) ..... 0.2/0.65 mm (0.0079/0.0256 in.)
- CS10-12 ..... 0.2/0.65 mm (0.0079/0.0256 in.)

Connecting Rod cont.

Connecting Rod-to-Piston Pin Running Clearance ..... 0.006/0.025 mm (0.0002/0.0001 in.)

Piston Pin End I.D.
- New
  - CS4,CS6 ..... 16.006/16.020 mm (0.6301/0.6307 in.)
  - CS8.5 (spec. 95xxxx) ..... 18.006/18.020 mm (0.7089/0.7094 in.)
  - CS8.5 (spec. 92xxxx) ..... 20.006/20.020 mm (0.7876/0.7882 in.)
  - CS10-12 ..... 20.006/20.020 mm (0.7876/0.7882 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 16.10 mm (0.634 in.)
  - CS8.5 (95xxxx) ..... 18.10 mm (0.713 in.)
  - CS8.5 (92xxxx) ..... 20.10 mm (0.791 in.)
  - CS10-12 ..... 20.10 mm (0.791 in.)

Connecting Rod Journal End I.D.
- New
  - CS4,CS6 ..... 28.000/28.015 mm (1.1023/1.1029 in.)
  - CS8.5 (spec. 95xxxx) ..... 32.000/32.015 mm (1.2598/1.2604 in.)
  - CS8.5 (spec. 92xxxx) ..... 36.000/36.015 mm (1.4173/1.4179 in.)
  - CS10-12 ..... 36.000/36.015 mm (1.4173/1.4179 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 28.115 mm (1.1069 in.)
  - CS8.5 (95xxxx) ..... 32.115 mm (1.2644 in.)
  - CS8.5 (92xxxx) ..... 36.115 mm (1.4219 in.)
  - CS10-12 ..... 36.115 mm (1.4219 in.)

Crankcase

Closure Plate Fastener Torque
- CS4,CS6 ..... 22 N·m (195 in. lb.)
- CS8.5-12 ..... 30 N·m (265 in. lb.)

Oil Drain Plugs Torque
- CS4,CS6 ..... 17 N·m (150 in. lb.)
- CS8.5-12 ..... 20 N·m (177 in. lb.)

Crankshaft

End Play (Free) ..... 0.04 mm (0.0015 in.)

End Play (Threaded Pump Shaft Models Only) ..... 0.0/0.2 mm (0.0/0.007 in.)

Flywheel End Main Bearing Journal O.D.
- New
  - CS4,CS6 ..... 52 mm (2.047 in.)
  - CS8.5 (spec. 95xxxx) ..... 52 mm (2.047 in.)
  - CS8.5 (spec. 92xxxx) ..... 80 mm (3.149 in.)
  - CS10-12 ..... 80 mm (3.149 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 52.05 mm (2.0492 in.)
  - CS8.5 (spec. 95xxxx) ..... 52.05 mm (2.0492 in.)
  - CS8.5 (spec. 92xxxx) ..... 80.05 mm (3.1515 in.)
  - CS10-12 ..... 80.05 mm (3.1515 in.)

Crankshaft cont.

PTO End Main Bearing Journal O.D.
- New
  - CS4,CS6 ..... 52 mm (2.047 in.)
  - CS8.5 (spec. 95xxxx) ..... 52 mm (2.047 in.)
  - CS8.5 (spec. 92xxxx) ..... 72 mm (2.834 in.)
  - CS10-12 ..... 72 mm (2.834 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 52.05 mm (2.0492 in.)
  - CS8.5 (spec. 95xxxx) ..... 52.05 mm (2.0492 in.)
  - CS8.5 (spec. 92xxxx) ..... 72.05 mm (2.836 in.)
  - CS10-12 ..... 72.05 mm (2.836 in.)

Connecting Rod Journal O.D.
- New
  - CS4,CS6 ..... 27.969/27.984 mm (1.011/1.017 in.)
  - CS8.5 (spec. 95xxxx) ..... 31.969/31.984 mm (1.2586/1.2592 in.)
  - CS8.5 (spec. 92xxxx) ..... 35.969/35.984 mm (1.4161/1.4167 in.)
  - CS10-12 ..... 35.969/35.984 mm (1.4161/1.4167 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 27.9 mm (1.098 in.)
  - CS8.5 (spec. 95xxxx) ..... 31.9 mm (1.2559 in.)
  - CS8.5 (spec. 92xxxx) ..... 35.9 mm (1.4134 in.)
  - CS10-12 ..... 35.9 mm (1.4134 in.)

Crankshaft
- Runout (Either End) ..... 0.02 mm (0.0008 in.)
- Limit (Either End) ..... 0.04 mm (0.0016 in.)

Cylinder Bore

Cylinder Bore I.D.
- New
  - CS4 ..... 56.005/56.015 mm (2.2049/2.2053 in.)
  - CS6 ..... 66.005/66.015 mm (2.5986/2.5990 in.)
  - CS8.5 (spec. 95xxxx) ..... 75.005/75.015 mm (2.9530/2.9533 in.)
  - CS8.5 (spec. 92xxxx) ..... 78.00/78.02 mm (3.0709/3.0717 in.)
  - CS10 ..... 78.00/78.02 mm (3.0709/3.0717 in.)
  - CS12 ..... 85.00/85.02 mm (3.3465/3.3472 in.)
- Max. Wear Limit
  - CS4 ..... 56.15 mm (2.211 in.)
  - CS6 ..... 66.15 mm (2.604 in.)
  - CS8.5 (spec. 95xxxx) ..... 75.15 mm (2.959 in.)
  - CS8.5 (spec. 92xxxx) ..... 78.65 mm (3.096 in.)
  - CS10 ..... 78.65 mm (3.096 in.)
  - CS12 ..... 85.65 mm (3.372 in.)
- Max. Out-of-Round ..... 0.05 mm (0.002 in.)

Cylinder Head

Cylinder Head Bolt Torque
- CS4,CS6 ..... 20 N·m (177 in. lb.)
- CS8.5-12 ..... 50 N·m (36 ft. lb.)

Max. Out-of-Flatness ..... 0.1 mm (0.004 in.)

Electric Starter

Thru Bolt (Case) Torque
- CS8.5-12 ..... 5.3 N·m (47.7 in. lb.)

Electric Starter cont.

Mounting Bolts (To Block) Torque
- CS8.5-12 ..... 16 N·m (141 in. lb.)

Flywheel

Flywheel Retaining Screw Torque
- CS4,CS6 ..... 65 N·m (48 ft. lb.)
- CS8.5 (spec. 95xxxx) ..... 65 N·m (48 ft. lb.)
- CS8.5 (spec. 92xxxx) ..... 120 N·m (85 ft. lb.)
- CS10-12 ..... 120 N·m (85 ft. lb.)

Fuel Tank

Fuel Tank Fastener Screws Torque ..... 8-12 N·m (71-106 in. lb.)

Ignition

Spark Plug Type
- NGK ..... BPR4ES (13/16 hex)
- Champion® ..... RN14YC (13/16 hex)
- Champion® ..... RC14YC (5/8) hex)

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

Spark Plug Torque ..... 20 N·m (14.7 ft. lb./177 in. lb.)

Ignition Module Air Gap ..... 0.4/0.6 mm (0.015/0.023 in.)

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

Stator Mounting Screw Torque ..... 5-8 N·m (44-70 in. lb.)

Muffler

Muffler Torque (Flange Nuts & Bracket Bolts)
- CS4,CS6 ..... 8-12 N·m (71-106 in. lb.)
- CS8.5-12 ..... 18-22 N·m (159-195 in. lb.)

Oil Sentry™

Oil Sentry™ Float Switch Torque ..... 10 N·m (88 in. lb.)

Oil Sentry™ Indicator Light Retaining Nut Torque ..... 0.6-0.8 N·m (5-7 in. lb.)

Piston, Piston Rings, and Piston Pin

Piston-to-Piston Pin Clearance
- CS4,CS6 ..... 0.002/0.018 mm (0.0001/0.0007 in.)
- CS8.5-12 ..... 0.004/0.020 mm (0.0002/0.0008 in.)

Piston Pin Bore I.D.
- New
  - CS4,CS6 ..... 16.002/16.013 mm (0.6300/0.6304 in.)
  - CS8.5 (spec. 95xxxx) ..... 18.004/18.015 mm (0.7088/0.7093 in.)
  - CS8.5 (spec. 92xxxx) ..... 20.004/20.015 mm (0.7876/0.7880 in.)
  - CS10-12 ..... 20.004/20.015 mm (0.7876/0.7880 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 16.03 mm (0.6311 in.)
  - CS8.5 (spec. 95xxxx) ..... 18.03 mm (0.7098 in.)
  - CS8.5 (spec. 92xxxx) ..... 20.03 mm (0.7886 in.)
  - CS10-12 ..... 20.03 mm (0.7886 in.)

Piston, Piston Rings, and Piston Pin cont.

Piston Pin O.D.
- New
  - CS4,CS6 ..... 15.995/16.000 mm (0.6297/0.6299 in.)
  - CS8.5 (spec. 95xxxx) ..... 17.995/18.000 mm (0.7084/0.7086 in.)
  - CS8.5 (spec. 92xxxx) ..... 19.995/20.000 mm (0.7872/0.7874 in.)
  - CS10-12 ..... 19.995/20.000 mm (0.7872/0.7874 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 15.98 mm (0.6291 in.)
  - CS8.5 (spec. 95xxxx) ..... 17.98 mm (0.7079 in.)
  - CS8.5 (spec. 92xxxx) ..... 19.98 mm (0.7866 in.)
  - CS10-12 ..... 19.98 mm (0.7866 in.)

Top Compression Ring-to-Groove Side Clearance ..... 0.04/0.08 mm (0.0016/0.003 in.)

Middle Compression Ring-to-Groove Side Clearance
- CS4,CS6 ..... 0.02/0.06 mm (0.0008/0.0024 in.)
- CS8.5-12 ..... 0.03/0.07 mm (0.0012/0.0028 in.)

Top Compression Ring End Gap
- CS4,CS6 ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS8.5 (spec. 95xxxx) ..... 0.25/0.4 mm (0.010/0.016 in.)
- CS8.5 (spec. 92xxxx) ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS10 ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS12 ..... 0.25/0.4 mm (0.010/0.016 in.)

Middle Compression Ring End Gap
- CS4,CS6 ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS8.5 (spec. 95xxxx) ..... 0.25/0.4 mm (0.010/0.016 in.)
- CS8.5 (spec. 92xxxx) ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS10 ..... 0.2/0.4 mm (0.008/0.016 in.)
- CS12 ..... 0.25/0.4 mm (0.010/0.016 in.)

Oil Control Ring End Gap
- CS4,CS6 ..... 0.2/0.4 mm (0.0079/0.0157 in.)
- CS8.5-12 ..... 0.2/0.7 mm (0.0079/0.028 in.)

Piston Thrust Face O.D.[2]
- New
  - CS4[2] ..... 55.975/55.990 mm (2.2037/2.2043 in.)
  - CS6[2] ..... 65.975/65.990 mm (2.597/2.598 in.)
  - CS8.5[3] (spec. 95xxxx) ..... 74.954/74.998 mm (2.9509/2.9527 in.)
  - CS8.5[3] (spec. 92xxxx) ..... 77.954/77.998 mm (3.0691/3.0708 in.)
  - CS10[3] ..... 77.954/77.998 mm (3.0691/3.0708 in.)
  - CS12[3] ..... 84.954/84.998 mm (3.3446/3.3464 in.)
- Max. Wear Limit
  - CS4 ..... 55.900 mm (2.20 in.)
  - CS6 ..... 65.900 mm (2.60 in.)
  - CS8.5 (spec. 95xxxx) ..... 74.898 mm (2.9487 in.)
  - CS8.5 (spec. 92xxxx) ..... 77.898 mm (3.0669 in.)
  - CS10 ..... 77.898 mm (3.0669 in.)
  - CS12 ..... 84.898 mm (3.3424 in.)

Piston Thrust Face-to-Cylinder Bore Running Clearance
- CS4,CS6[2] ..... 0.015/0.040 mm (0.0006/0.0016 in.)
- CS8.5-12[3] ..... 0.002/0.066 mm (0.0001/0.0026 in.)

Reduction System

Case Mounting Bolt(s) Torque
- CS4,CS6 ..... 10 N·m (88 in. lb.)
- CS8.5-12 ..... 30 N·m (22 ft. lb.)

Crankshaft Gear Bolt Torque
- CS4,CS6 ..... 22 N·m (195 in. lb.)
- CS8.5 (spec. 95xxxx) ..... 22 N·m (195 in. lb.)
- CS8.5 (spec. 92xxxx) ..... 65 N·m (48 ft. lb.)
- CS10-12 ..... 65 N·m (48 ft. lb.)

Retractable Starter

Mounting Screws to Blower Housing Torque
- CS4,CS6 ..... 6.5 N·m (57 in. lb.)
- CS8.5-12 ..... 7 N·m (62 in. lb.)

Rocker Arm

Stud Into Cylinder Head Torque
- CS4,CS6 ..... 10 N·m (88 in. lb.)

Adjusting Jam Nut Torque ..... 7 N·m (62 in. lb.)

Throttle Control

Throttle Control Lever Fastener Torque
- CS4,CS6 ..... 7-9 N·m (62-80 in. lb.)
- CS8.5-12 ..... 9-11 N·m (80-97 in. lb.)

Valve Cover

Valve Cover Fastener Torque
- CS4,CS6 ..... 10 N·m (88 in. lb.)
- CS8.5-12 ..... 11 N·m (97 in. lb.)

Valves and Valve Lifters

Intake Valve Stem-to-Valve Guide Running Clearance
- CS4,CS6 ..... 0.04/0.06 mm (0.0016/0.0024 in.)
- CS8.5-12 ..... 0.037/0.064 mm (0.0015/0.0025 in.)

Exhaust Valve Stem-to-Valve Guide Running Clearance
- CS4,CS6 ..... 0.06/0.08 mm (0.002/0.003 in.)
- CS8.5-12 ..... 0.045/0.072 mm (0.0018/0.0028 in.)

Intake Valve Guide I.D.
- New
  - CS4,CS6 ..... 5.5 mm (0.22 in.)
  - CS8.5-12 ..... 6.0/6.012 mm (0.2362/0.2367 in.)
- Max. Wear Limit
  - CS4,CS6 ..... 5.60 mm (0.220 in.)
  - CS8.5-12 ..... 6.10 mm (0.240 in.)

Exhaust Valve Guide I.D.
- New
  - CS4,CS6 ..... 5.5 mm (0.22 in.)
  - CS8.5-12 ..... 6.0/6.012 mm (0.2362/0.2367 in.)

- Max. Wear Limit
  - CS4,CS6 ..... 5.6 mm (0.220 in.)
  - CS8.5-12 ..... 6.0 mm (0.236 in.)

Valves and Valve Lifters

Valve Guide Reamer Size
- STD
  - CS4,CS6 ..... 5.5 mm (0.216 in.)
  - CS8.5-12 ..... 6.0 mm (0.236 in.)

Intake Valve Minimum Lift
- CS4,CS6 ..... 2.4 mm (0.094 in.)
- CS8.5-12 ..... 2.7 mm (0.106 in.)

Exhaust Valve Minimum Lift
- CS4,CS6 ..... 2.7 mm (0.106 in.)
- CS8.5-12 ..... 2.9 mm (0.114 in.)

Nominal Valve Seat Angle ..... 45°

Valve-to-Tappet Clearance (Cold) ..... 0.1 mm (0.004 in.)

Notes:

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

2. Measure 5 mm (0.197 in.) above the bottom of the piston skirt at right angles to the piston pin.

3. Measure 10 mm (0.394 in.) above the bottom of the piston skirt at right angles to the piston pin.

Oil Drain Plugs Tightening Torque: N·m (in. lb.)

Size	Into Aluminum	Model
M10x1.25	17 (150)	CS4, CS6
M12x1.50	20 (177)	CS8.5, CS10, CS12

Torque Conversions

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

Section 2
Tools & Aids

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

Here is the list of tools and their source.

Separate Tool Suppliers:

Kohler Tools
Contact your source
of supply.

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

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

Tools	
Description	**Source/Part No.**
Balance Gear Timing Tool (K & M Series) To hold balance gears in timed position when assembling engine.	Kohler 25 455 06-S (Formerly Y-357)
Camshaft Endplay Plate For checking camshaft endplay.	SE Tools KLR-82405
Cylinder Leakdown Tester For checking combustion retention and if cylinder, piston, rings, or valves are worn.	Kohler 25 761 05-S
Electronic Fuel Injection (EFI) Diagnostic Software Use with Laptop or Desktop PC.	Kohler 25 761 23-S
EFI Service Kit For troubleshooting and setting up an EFI engine.	Kohler 24 761 01-S
Individual Components Available Pressure Tester Noid Light 90° Adapter Oetiker Clamp Pliers Code Plug, Red Wire Code Plug, Blue Wire	Design Technology Inc. DTI-019 DTI-021 DTI-023 DTI-025 DTI-027 DTI-029
Flywheel Holding Tool (CS Series)	SE Tools KLR-82407
Flywheel Puller To remove flywheel from engine.	SE Tools KLR-82408
Flywheel Strap Wrench To hold flywheel during removal.	SE Tools KLR-82409

Tools (cont.)	
Description	**Source/Part No.**
Hydraulic Valve Lifter Tool To remove and install hydraulic lifters.	Kohler 25 761 38-S
Ignition System Tester For testing output on all systems, except CD. For testing output on capacitive discharge (CD) ignition system.	Kohler 25 455 01-S Kohler 24 455 02-S
Offset Wrench (K & M Series) To remove and reinstall cylinder barrel retaining nuts.	SE Tools KLR-82410
Oil Pressure Test Kit To test and verify oil pressure.	Kohler 25 761 06-S
Rectifier-Regulator Tester (120 volt current) **Rectifier-Regulator Tester (240 volt current)** Used to test rectifier-regulators.	Kohler 25 761 20-S Kohler 25 761 41-S
Individual Components Available CS-PRO Regulator Test Harness Special Regulator Test Harness with Diode	Design Technology Inc. DTI-031 DTI-033
Spark Advance Module (SAM) Tester To test the SAM (ASAM and DSAM) on engines with SMART-SPARK™.	Kohler 25 761 40-S
Starter Brush Holding Tool (Solenoid Shift) To hold brushes during servicing.	SE Tools KLR-82416
Starter Retaining Ring Tool (Inertia Drive) To remove and reinstall drive retaining rings (excluding FASCO starters).	Kohler 25 761 18-S
Starter Servicing Kit (All Starters) To remove and reinstall drive retaining rings and brushes.	SE Tools KLR-82411
Individual Component Available Starter Brush Holding Tool (Solenoid Shift)	SE Tools KLR-82416
Tachometer (Digital Inductive) For checking operating speed (RPM) of an engine.	Design Technology Inc. DTI-110
Vacuum/Pressure Tester Alternative to a water manometer.	Kohler 25 761 22-S
Valve Guide Reamer (K & M Series) For sizing valve guides after installation.	SE Tools KLR-82413
Valve Guide Service Kit (Courage, Aegis, Command, OHC) For servicing worn value guides.	SE Tools KLR-82415

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

Special Tools You Can Make

Flywheel Holding Tool (Electric Start Models Only)

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

1. Using an abrasive cut-off wheel, cut out a six tooth segment of the ring gear as shown.

2. Grind off any burrs or sharp edges.

3. Invert the segment and place it between the ignition bosses on the crankcase so that the tool teeth engage the flywheel ring gear teeth. The bosses will lock the tool and flywheel in position for loosening, tightening or removing with a puller.

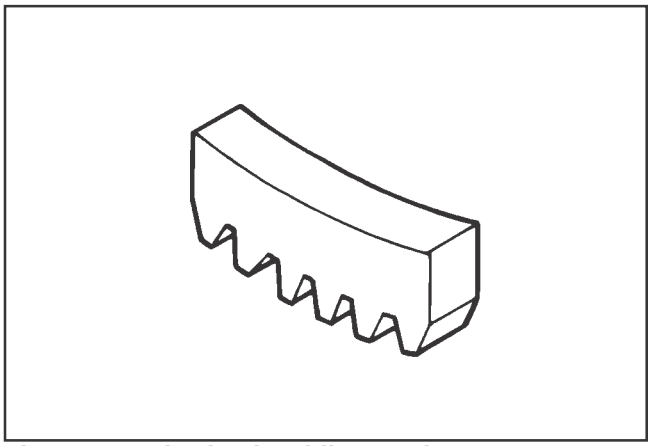


Figure 2-1. Flywheel Holding Tool.

Rocker Arm/Crankshaft Tool

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

1. Find a used connecting rod from a 10 HP or larger engine. Remove and discard the rod cap.

2. Remove the studs of a Posi-Lock rod or grind off the aligning steps of a Command rod, so the joint surface is flat.

3. Find a 1 in. long capscrew with the correct thread size to match the threads in the connecting rod.

4. Use a flat washer with the correct I.D. to slip on the capscrew and approximately 1″ O.D. (Kohler Part No. 12 468 05-S). Assemble the capscrew and washer to the joint surface of the rod, as shown in Figure 2-2.

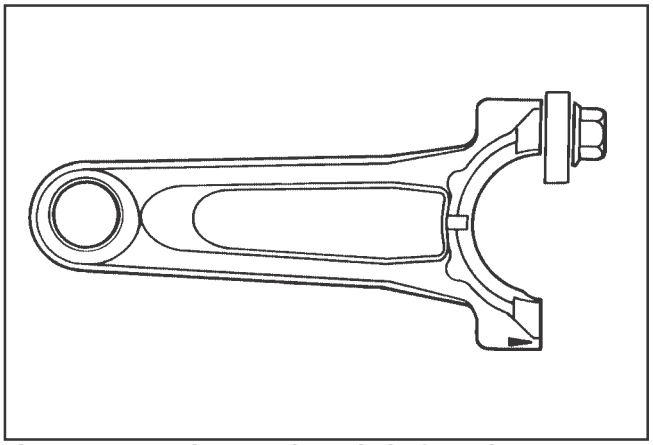


Figure 2-2. Rocker Arm/Crankshaft Tool.

Section 3
Troubleshooting

Troubleshooting Guide

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

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

Engine Cranks But Will Not Start

1. Empty fuel tank.
2. Fuel shut-off valve closed.
3. Key switch or kill switch in “off” position.
4. Low oil level.
5. Dirt or water in the fuel system.
6. Clogged fuel line.
7. Spark plug lead disconnected.
8. Faulty spark plug.
9. Faulty ignition module.

Engine Starts But Does Not Keep Running

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

Engine Starts Hard

1. PTO drive is engaged.
2. Dirt or water in the fuel system.
3. Clogged fuel line.
4. Loose or faulty wires or connections.
5. Faulty choke or throttle controls.
6. Faulty spark plug.
7. Low compression.
8. Faulty ACR mechanism.
9. Weak spark/ignition.

Engine Will Not Crank

1. PTO drive is engaged.
2. Battery (if equipped) is discharged.
3. Safety interlock switch is engaged.
4. Loose or faulty wires or connections.
5. Faulty key switch or ignition switch.
6. Faulty electric starter or solenoid (electric start).
7. Pawls not engaging in drive cup (retractable start).
8. Seized internal engine components.

Engine Runs But Misses

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

Engine Will Not Idle

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

Engine Overheats

1. Air intake/grass screen, cooling fins, or cooling shrouds clogged.
2. Excessive engine load.
3. Low crankcase oil level.
4. High crankcase oil level.
5. Faulty carburetor.

Engine Knocks

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

Engine Loses Power

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

Engine Uses Excessive Amount Of Oil

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

Oil Leaks From Oil Seals, Gaskets

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

External Engine Inspection

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

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

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

- Check the air cleaner cover and base for damage or indications of improper fit or sealing.

- Check the air cleaner element. Look for holes, tears, cracked or damaged sealing surfaces, or other damage that could allow unfiltered air into the engine. Also note if the element is dirty or clogged. These could indicate that the engine has had inadequate or infrequent maintenance.

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

- Check the oil level. Note if the oil level is within the operating range on the dipstick, or if it is low or overfilled.

- Check the condition of the oil. Drain the oil into a container - the oil should flow freely. Dark, dirty, and/or thick oil could indicate infrequent maintenance or overheating. Check for metal chips and other foreign particles.

  Sludge is a natural by-product of combustion; a small accumulation is normal. Excessive sludge formation could indicate the oil has not been changed at the recommended intervals, the incorrect type or weight of oil was used, overrich carburetion, or weak ignition, to name a few.

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

Cleaning the Engine

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

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

Basic Engine Tests

Crankcase Vacuum Test

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

Crankcase vacuum is best measured with water manometer or vacuum/pressure tester, see Section 2. Complete instructions are provided in the kits.

Test the crankcase vacuum, following the instructions, with the engine running at high idle speed (above 3500 RPM).

1. The engine should have a minimum of 4 in. of vacuum. A vacuum less than 4 in. is usually due to internal wear or a bad gasket or seal allowing air to leak into the crankcase. A pressure is usually due to a problem with the breather.
2. Refer to the following chart for possible causes and solutions.

Low/No Crankcase Vacuum or Pressure in Crankcase

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

Compression Test

A compression test or a cylinder leakdown test may be performed to check the condition of an engine. Insufficient compression pressure will result in a performance loss and may indicate leaking valves or damaged/worn piston rings.

Test the compression as follows:

1. Check/perform valve clearance adjustment.
2. Start engine if possible, and run for 3-5 minutes to warm it up, then stop.
3. Disconnect and ground spark plug lead. Remove the spark plug.
4. Install adapter and compression tester into spark plug hole.
5. Move the throttle control to the full/wide open position. Be sure the choke is off.
6. Crank engine over using recoil or electric starter and check results.

    - **Standard Compression Pressure:** 400-600 kPa (57-85 psi) with ACR mechanism in operation.

Cylinder Leakdown Test

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

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

Test the cylinder leakdown as follows:

1. Run engine for 3-5 minutes to warm it up.
2. Remove spark plug and air filter from engine.
3. Rotate crankshaft until piston (of cylinder being tested) is at top dead center (TDC) of the compression stroke. You will need to hold engine in this position while testing.

    a. If the PTO end of the crankshaft is accessible, the holding tool supplied with the tester can be used. Loosen the holding tool screws and expand the opening. Slide the tool onto the crankshaft as close as possible to the PTO face of the crankcase. If the slot in the tool can be aligned with one of the holes on the PTO face, find a bolt of appropriate length and thread size. Insert the bolt through the slot, and thread it into the selected hole, to prevent the tool from moving. Tighten the screws to lock the holding tool onto the crankshaft. If a PTO face hole is not accessible, tighten the screws to lock the holding tool onto the crankshaft. Insert the end of a 3/8" breaker bar into the slot, so the handle of the breaker bar is perpendicular to the crankshaft.

b. If the flywheel end of the engine is more accessible, you can use a breaker bar and socket on the flywheel nut/screw or a flywheel holding tool to hold it in position. When using these methods, you will need an assistant to hold it during the test.

c. 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 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 (70-100 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 end of the scale.

7. Connect tester quick-disconnect to the adapter. Note the gauge reading and listen for escaping air at the carburetor intake, exhaust outlet, and crankcase breather.

8. Check your test results against the table below:

Leakdown Test Results

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

Section 4
Air Cleaner and Air Intake System

Air Cleaners

General

These engines are equipped with one of three air cleaner configurations; the standard dual-element air cleaner assembly, an optional heavy-duty cyclonic air cleaner assembly, or a third design which uses an oiled, solid foam element. The first two styles have a replaceable, high-density paper element surrounded by an oiled-foam precleaner. See Figures 4-1 and 4-2. Servicing information for these two styles is on pages 4.1 through 4.4. The third design does not use a paper element, just the foam. See Figure 4-14. Servicing information for the third design is on page 4.5. The heavy-duty air cleaner assemblies also contain a lower swirl chamber which separates the dirt particles from the incoming air for extended service intervals.

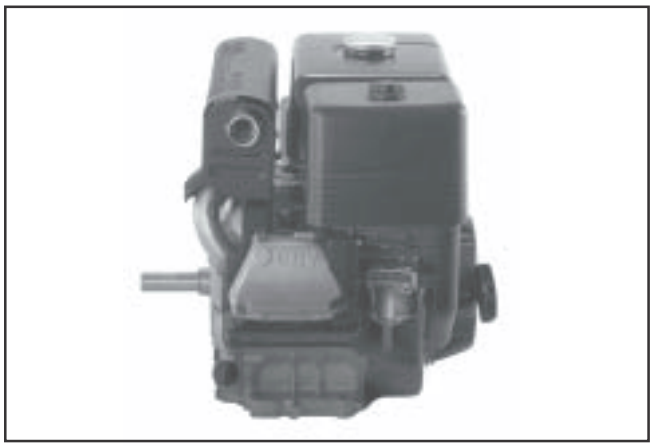


Figure 4-1. Standard Dual-Element Air Cleaner.

Figure 4-2. Heavy-Duty, Cyclonic Air Cleaner.

Service

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

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

Figure 4-3. Removing Cover Knob Standard.

Figure 4-4. Unsnapping Heavy-Duty Latches.

Figure 4-5. Standard Element/Precleaner Assembly.

Figure 4-6. Heavy-Duty Element/Precleaner Assembly.

Precleaner Service

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

To service the precleaner perform the following steps:

1. Remove the air cleaner cover knob (standard air cleaner) or unsnap the latches (heavy-duty air cleaner), and remove the cover/housing. See Figures 4-3 and 4-4.

2. Remove the precleaner from the filter element. If element is not secured to the air cleaner base with a wing nut, remove the filter element and precleaner from the cover/housing, as an assembly before separating. See Figures 4-5 and 4-6.

3. Wash the precleaner in warm water with detergent. Rinse the precleaner thoroughly until all traces of detergent are eliminated. Squeeze out excess water (do not wring). Allow the precleaner to air dry.

4. Saturate the precleaner with new engine oil. Squeeze out all excess oil.

5. Install the precleaner over the paper element. If the element was not secured with a wing nut (some heavy-duty air cleaners) install the element/precleaner assembly, small end first, into the cover/housing.

6. Reinstall the air cleaner cover/housing assembly. Secure with the knob or latches.

Figure 4-7. Removing Standard Precleaner.

Figure 4-8. Removing Heavy-Duty Precleaner.

Figure 4-9. Removing Heavy-Duty Lower Chamber.

Figure 4-10.

Figure 4-11. Installing Heavy-Duty Cover/Housing.

Paper Element Service

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

1. **Standard Air Cleaner:**
   Loosen the air cleaner cover knob and remove the cover. Remove the wing nut and lift off the air cleaner element with precleaner. Remove the precleaner from the paper element. Service the precleaner.

   Heavy-Duty, Cyclonic Air Cleaner:
   Unhook the latches and remove the housing assembly from the mounting base. Remove the wing nut (some models) securing air cleaner/ precleaner assembly, or pull the complete filter assembly out of the housing. Remove the precleaner from the paper element. Service the precleaner.

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. Handle new elements carefully; do not use if the sealing surfaces are bent or damaged.

3. When servicing the air cleaner, check the air cleaner base, and cover/housing assembly. Make sure it is secure and not bent or damaged. On a heavy-duty air cleaner, unsnap the latches and clean out the lower swirl/dirt chamber. See Figure 4-9. Make sure the air slots in the upper section of the housing and in the lower chamber are open. See Figure 4-10. Clean and inspect all components for damage or improper fit. Replace any components which are bent or damaged. Reassemble the lower chamber (heavy duty air cleaners).

NOTE: Before the air cleaner is reassembled make sure the rubber seal is in position on the stud (standard only). Also inspect the foam seal on the base of the filter element, do not use if the condition of either is questionable in any way. Replace it with a new part before reassembling.

4. **Standard Air Cleaner:**
Install the serviced precleaner over the element. Position the element/precleaner assembly on the base and secure with the wing nut. Reinstall the air cleaner cover and tighten securely. See Figure 4-5.

Heavy-Duty Cyclonic Cleaner:
Place the precleaner over the element and install it as an assembly into the cover/housing. Insert the small end first, into the housing, so the larger end with the foam seal is out (visible). Secure with the wing nut (if used). Secure the cover/housing with the latches. See Figure 4-11.

Air Cleaner Components

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

Standard Air Cleaner

Make sure the element cover is not bent, distorted or damaged. Make sure the wing nut and rubber sleeve seal on the base stud are in place and in good condition, ensuring the element is sealed against leakage. (Some models the seal is fixed).

If the air cleaner element has a foam seal on the bottom, make sure it is in good condition and not damaged. See Figure 4-12.

Heavy-Duty Cyclonic Air Cleaner

Make sure the main housing, lower swirl/dirt chamber, mounting hardware and latches are not damaged, bent or broken; affecting the sealing ability and operation of air cleaner housing. Clean and check all components as well as the airflow passages.

Air Cleaner Base

Make sure the air cleaner base is secured tightly to carburetor and not cracked, bent or damaged, preventing a proper seal.

Breather Tube

Make sure the breather tube is in good condition and connected to the air cleaner base or adapter and the breather cover. Replace the tube if it is cracked or damaged.

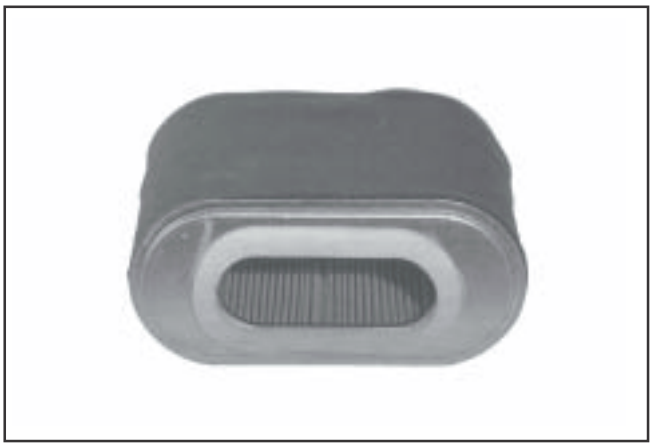


Figure 4-12. Foam Seal.

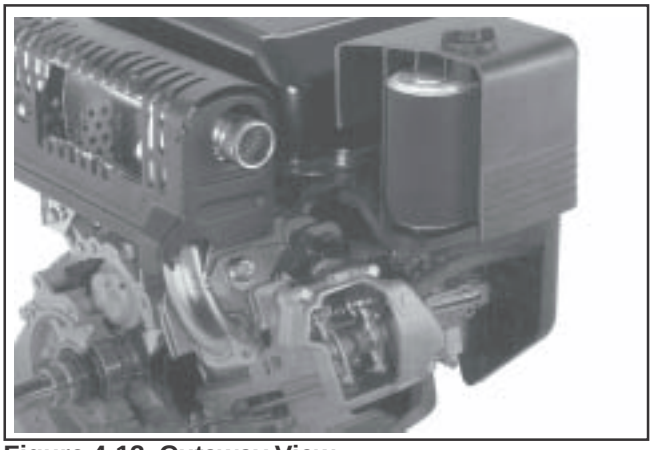


Figure 4-13. Cutaway View.

CS8.5 (spec. 95xxxx) engines use an air cleaner base with a serviceable rubber base pad to seal the air filter element on the bottom. See Figure 4-14. Make sure the pad is installed, clean, and in good condition.

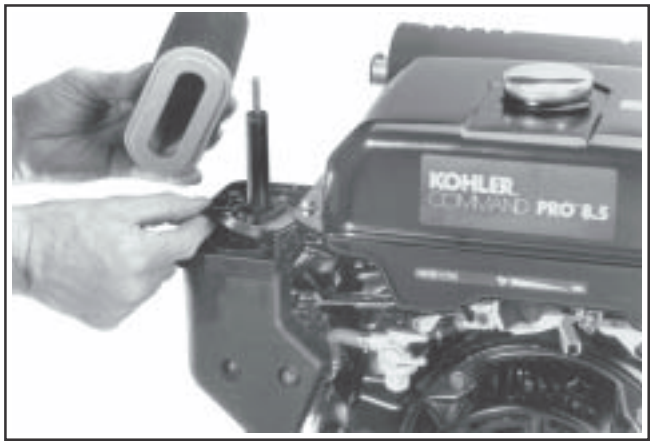


Figure 4-14. Serviceable Rubber Base Pad.

Foam Air Cleaner Element

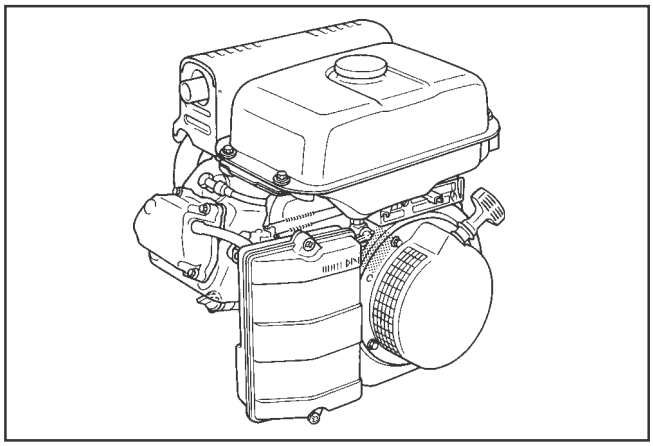


Figure 4-15. Foam Air Cleaner Configuration.

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

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

Every 50 hours of operation, wash and reoil the foam air cleaner element (more often under extremely dusty, or dirty conditions). Replace the foam element with a new genuine Kohler element if deteriorated or damaged in any way.

To service the foam element perform the following steps:

1. Remove the two screws and the outer air cleaner cover/housing. See Figure 4-16.

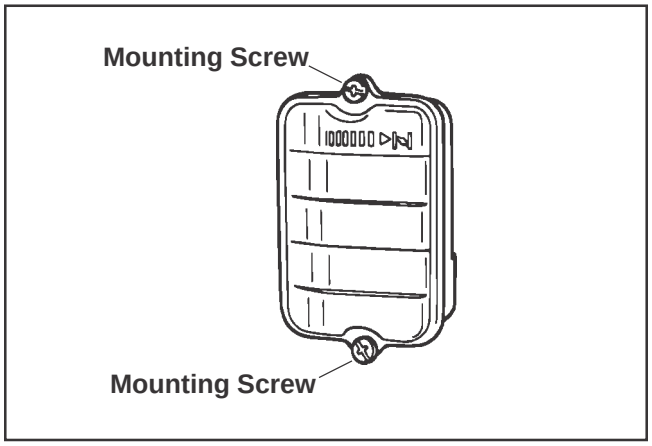


Figure 4-16. Mounting Details.

2. Remove the foam element from the air cleaner housing. See Figure 4-17.

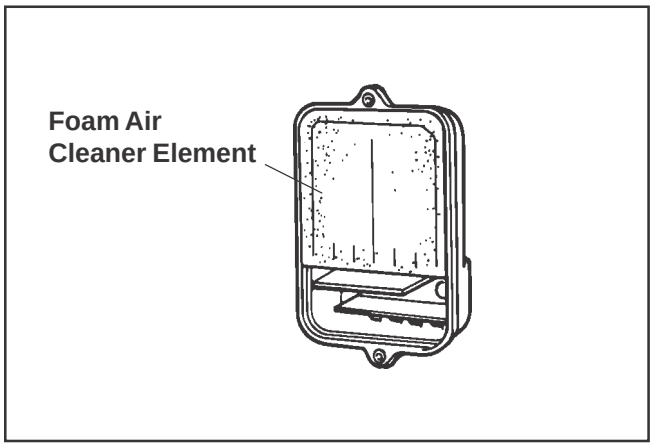


Figure 4-17. Foam Air Cleaner Element Details.

3. Wash the foam element in warm water with detergent. Rinse the element thoroughly until all traces of detergent are eliminated. Squeeze out all excess water (do not wring). Allow the element to air dry.

4. Lightly oil the element with new engine oil. Squeeze element to evenly distribute the oil and remove any excess.

5. When servicing the foam air cleaner element, clean and check the air cleaner case and outer cover for damage, distortion, or an improper seal. Replace any components which are bent or damaged.

6. Make sure the square metal fitting plate is properly positioned within the case. See Figure 4-17.

7. Reinstall the outer cover and secure with the two screws. See Figure 4-16.

NOTE: Do not operate engine without the air cleaner element; excessive piston and/or cylinder wear may result.

Air Intake/Cooling System

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

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

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

Section 5
Fuel System and Governor

Description

WARNING: Explosive Fuel!

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

Fuel System Components

The typical fuel system includes the following components:

- Fuel Tank
- Shut-off Valve with Screen Filter
- Fuel Tank Inlet Filter
- Carburetor
- Fuel Line

Operation

The fuel from the tank is moved through the shut-off valve/screen filter and fuel lines by gravity.

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

Fuel Recommendations

General Recommendations

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

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

Fuel Type

For best results, use only clean, fresh, unleaded gasoline with a pump sticker octane rating of 87 or higher. In countries using the Research fuel rating 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.

Gasoline/Alcohol blends

Gasohol (up to 10% ethyl alcohol, 90% unleaded gasoline by volume) is approved as a fuel for Kohler engines. Other gasoline/alcohol blends are not approved.

Gasoline/Ether blends

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

Fuel Filters

Serviceable screen filters are located within the inlet of the fuel tank and the shut-off valve. Periodically inspect and clean or replace as required.

Fuel Line

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

Fuel System Tests

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

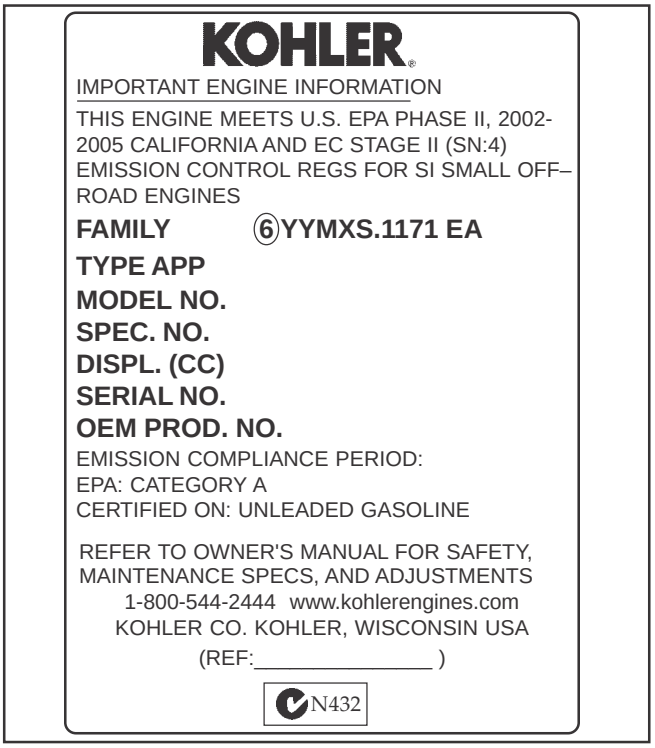


Figure 5-1. "Family" Number Location.

Troubleshooting – Fuel System Related Causes

Test	Conclusion
1. **Check the following:** a. Make sure the fuel tank contains clean, fresh, proper fuel. b. Make sure the vent in the fuel cap is open. c. Make sure the fuel valve is open.	
2. **Check for fuel in the combustion chamber.** a. Disconnect and ground the spark plug lead. b. Close the choke on the carburetor. c. Crank the engine several times. d. Remove the spark plug and check for fuel at the tip.	2. If there **is** fuel at the tip of the spark plug, fuel is reaching the combustion chamber. If there is **no** fuel at the tip of the spark plug, check for fuel flow from the fuel tank. (Test 3)
3. **Check for fuel flow from the tank to the carburetor.** a. Remove the fuel line from the inlet fitting of the carburetor. b. Hold the line below the bottom of the tank. Open the shut-off valve and observe flow.	3. If fuel **does** flow from the line, check for a problem in the carburetor (dirt, gum, varnish, etc.). If fuel **does not** flow from the line, check for a clogged fuel cap vent, inlet filter, shut-off valve screen filter, and/or fuel line(s).

Carburetor

General

The CS engines use fixed jet MIKUNI carburetors. The fixed main jet carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. The high idle mixture is set at the factory and cannot be adjusted. The low fuel adjusting needle is also set at the factory and normally does not need adjustment.

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

Troubleshooting – Carburetor Related Causes

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

Troubleshooting Checklist

If engine troubles are experienced that appear to be fuel system related, check the following areas before adjusting or disassembling the carburetor.

- Make sure the fuel tank is filled with clean, fresh gasoline.
- Make sure the fuel cap vent and inlet filter are not blocked and operating properly.
- Make sure fuel is reaching the carburetor. This includes checking the fuel shut-off valve, screen filters, and fuel lines for restrictions.
- Make sure the air cleaner base and carburetor are securely fastened to the engine using gaskets in good condition.
- Make sure the air cleaner element is clean and all air cleaner components are fastened securely.
- Make sure the ignition system, governor system, exhaust system, and throttle and choke controls are operating properly.

If, after checking all items listed above, the engine is hard to start, runs roughly, or stalls at low idle speed, it may be necessary to adjust or service the carburetor.

Adjustments

General

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

The carburetor is designed to deliver the correct fuel-to-air mixture to the engine under all operating conditions. The high idle mixture is set at the factory and cannot be adjusted. The low idle fuel adjusting needle is also set at the factory and has a limiting cap. It normally does not need adjustment.

Adjusting Low Idle Fuel and Speed

NOTE: Certified engines have a limiter cap on the idle fuel adjusting needle. Adjustment can only be performed within the limits allowed by the cap.

1. Start engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before making final settings.

2. **Low Idle Fuel Needle Setting:** Place the throttle into the **"idle"** or **"slow"** position. Turn the low idle fuel adjusting needle in or out within the adjustment range, to obtain the best low speed performance.

3. **Low Idle Speed Setting:** Place the throttle control into the **"idle"** or **"slow"** position. Set the low idle speed to **2000 RPM*** (± 150 RPM) by turning the low idle speed adjusting screw **in or out**. Check the speed using a tachometer.

   ***NOTE:** The actual low idle speed depends on the application – refer to equipment manufacturer's recommendations. The recommended low idle speed for basic engines is 2000 RPM. To ensure best results when setting the low idle fuel needle, the low idle speed must not exceed **2000 RPM** (± 150 RPM).

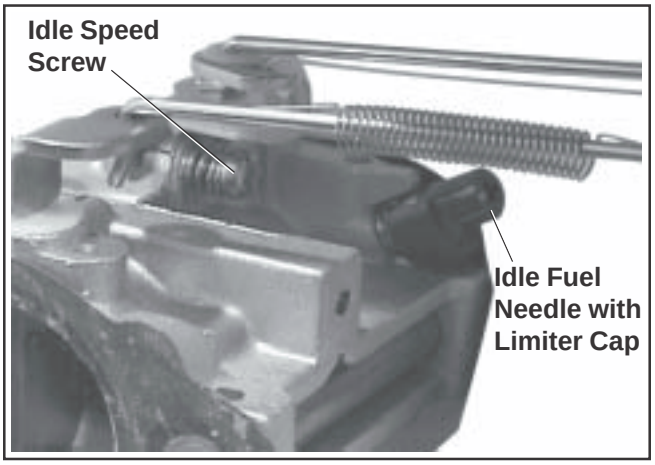
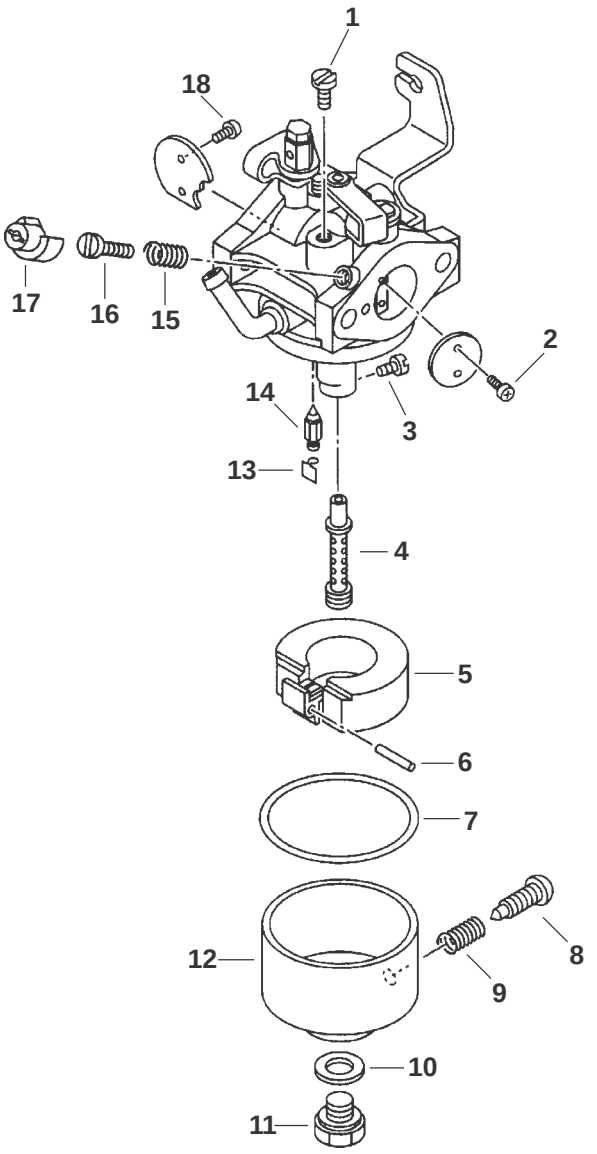
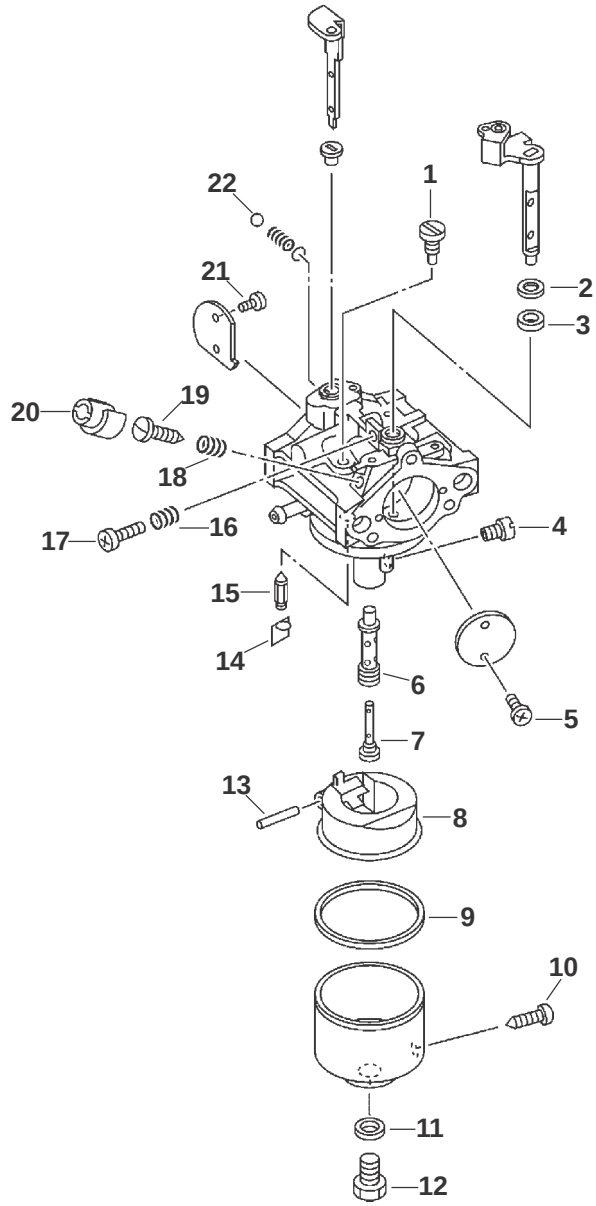


Figure 5-2. Carburetor Adjustments.



1. Pilot Jet
2. Screw
3. Main Jet
4. Main Nozzle
5. Float
6. Float Pin
7. Float Gasket
8. Drain Plug
9. Spring
10. Washer
11. Bowl Retaining Screw
12. Float Bowl
13. Clip
14. Needle Assembly
15. Spring
16. Idle Fuel Adjusting Screw
17. Limiter Cap
18. Screw

Figure 5-3. CS4 and CS6 Carburetor - Exploded View.



1. Pilot Jet
2. Plug Screw Washer
3. Seal
4. Main Jet
5. Screw
6. Main Nozzle
7. Main Pipe
8. Float
9. Float Gasket
10. Drain Plug
11. Gasket
12. Bowl Retaining Screw
13. Float Pin
14. Clip
15. Needle Assembly
16. Spring
17. Throttle Adjusting Screw
18. Spring
19. Idle Fuel Adjusting Screw
20. Limiter Cap
21. Screw
22. Ball

Figure 5-4. CS8.5-12 Carburetor - Exploded View.

Carburetor Service

If symptoms described in the carburetor troubleshooting guide indicate a problem within the carburetor, the following steps can be used to remove the carburetor from the engine and provide the necessary service.

1. Remove the air cleaner cover, wing nut, filter element with precleaner, the air cleaner base mounting screws and hex flange nuts from the mounting bracket(s) and main mounting studs.

2. Disconnect the breather hose from the valve cover or air cleaner base, and remove the base from the engine.

3. Disconnect the fuel line from the carburetor inlet.

4. Disconnect the choke link and spring at the carburetor end (CS8.5-12 only).

5. Slide the carburetor off of the mounting studs while disconnecting the throttle link and dampening spring.

6. Clean all dirt and debris from exterior of carburetor.

7. Remove the screw from the bottom center of carburetor bowl. Carefully separate the bowl from the main body and remove the bowl gasket from the body.

8. Place the carburetor in an inverted position. Lift up the float so that the tip of the float valve lightly contacts the float arm. See Figure 5-5. Measure the float height from the casting surface as illustrated in Figure 5-6. Float height for the CS4 and CS6 is 16 mm (0.63 in.). Float height for the CS8.5, CS10, and CS12 is 14.9 mm (0.59 in.). Install a float kit if the float height is incorrect.

Float Kit Contains:

Qty	Description
1	Float
1	Gasket, bowl
1	Gasket, bowl screw
1	Pin, float
2	Gasket, intake
1	Gasket, air cleaner base

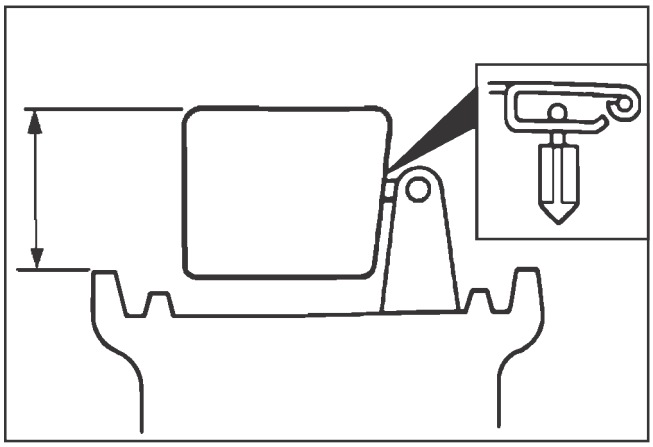


Figure 5-5. Float Height Position.

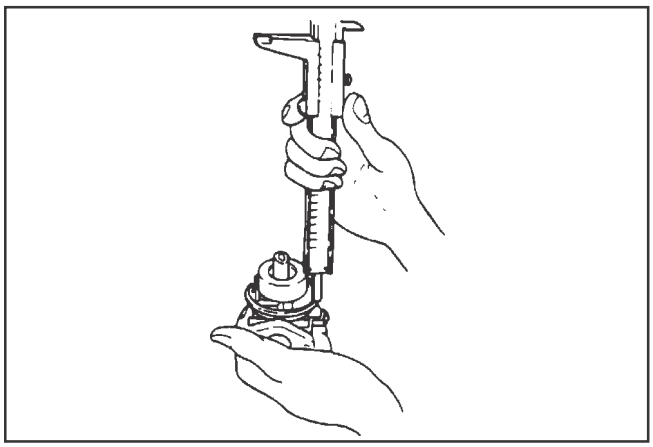


Figure 5-6. Measuring Float Height.

CAUTION

Do not bend the float in an attempt to reset the height. The correct float height is determined by the design of the inlet needle and float. There is no provision for physical adjustment.

9. Check to see if the fuel inlet needle or seat is dirty, obstructed or worn.

   a. Remove the main jet from the side of the tower.

   b. Grab the exposed end of the float pin with a needle nose pliers and pull it out.

   c. Lift out the float and inlet needle. Slide the inlet needle and clip off of the float tab.

   d. Check components for contamination, wear, or damage. See Figure 5-7. Use carburetor cleaner to clean out any dirt or contamination. Use a float kit if the inlet needle or float is damaged or worn. If the inlet seat is damaged or worn, the carburetor must be replaced.

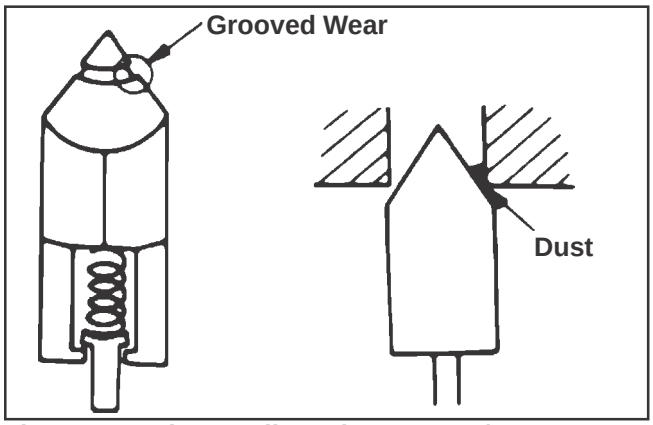


Figure 5-7. Inlet Needle and Seat Wear/Damage Details.

10. After the parts have been cleaned or exchanged, slide the inlet needle onto the float tab, reinstall the float assembly into the carburetor, and verify that the correct float height has been restored.

11. If there were gum or varnish deposits in the area of the inlet needle and seat, there is a good possibility that the main nozzle may also need cleaning before the bowl is reinstalled. The main nozzle is threaded into the tower and can be removed for cleaning, but be careful not to damage it, as it is not available as a service part.

    a. Use a thin, flat blade screwdriver to remove the nozzle from the tower. If it does not turn easily, use some carburetor cleaner to clean the exposed threads in the tower.

    b. Soak the nozzle in carburetor cleaner to remove any deposits and blow it dry with compressed air.

    c. Reinstall it in the tower and thread it in until it bottoms.

12. Reinstall the main jet and install the bowl gasket in the groove. Reassemble the bowl to the carburetor with the screw removed in step 7. Position the bowl so the drain screw will be accessible after the carburetor is mounted to the engine.

13. Use the reverse of steps 1-5 to reinstall the carburetor on the engine.

Governor

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

Operation

Centrifugal force acting on the rotating governor gear assembly causes the flyweights to move outward as speed increases. See Figure 5-8. As the flyweights move outward, they cause the regulating pin to extend from the governor gear assembly.

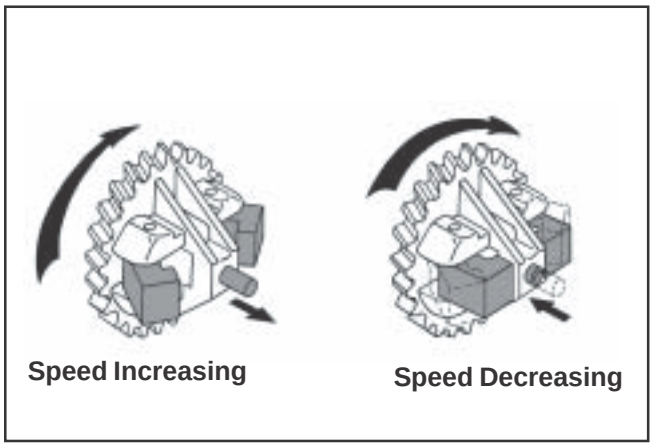


Figure 5-8. Action of Governor Gear.

The regulating pin contacts the tab on the cross shaft, causing the shaft to rotate when the engine speed changes. See Figure 5-9. One end of the cross shaft protrudes through the side of the closure plate. Through external linkage attached to the cross shaft, the rotating action is transmitted to the throttle lever of the carburetor.

When the engine is at rest, and the throttle control is in the ''fast'' position, the tension of the governor spring holds the throttle plate open. When the engine is operating (the governor gear assembly is rotating), the force applied by the regulating pin against the cross shaft tends to close the throttle plate. The governor spring tension and the force applied by the regulating pin are in ''equilibrium'' during operation, holding the engine speed constant.

When a load is applied and the engine speed (and governor gear speed) decreases, the governor spring tension moves the governor lever to open the throttle plate wider. This allows more fuel into the engine, increasing engine speed. (This action occurs 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.

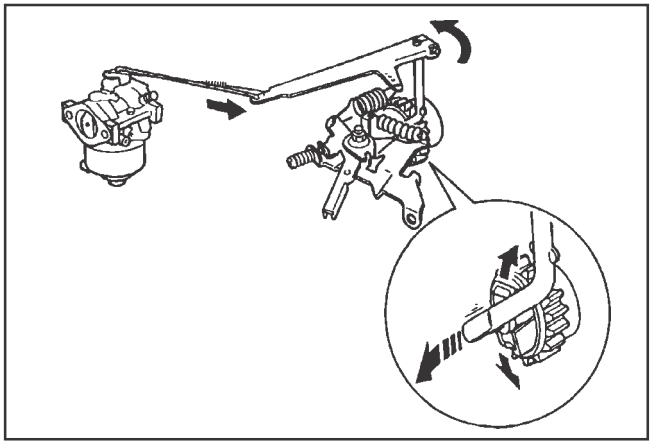


Figure 5-9. Governor System.

Initial Adjustment

Make this initial adjustment whenever the governor lever is loosened or removed from the cross shaft. To ensure proper setting, make sure the throttle linkage is connected to the governor lever and to the carburetor throttle lever (certain engine components removed for clarity of illustration).

Governor Adjustment

1. Close the fuel shut-off valve.

2. Remove the air cleaner outer cover. Then either reposition the fuel tank to access governor shaft and lever joint, or disconnect the fuel line and remove the tank from the engine.

   NOTE: Make sure the carburetor is mounted and secured in place when adjustment is being made/checked.

3. Loosen the governor lever mounting bolt.

4. Move the governor lever clockwise until it stops.

5. Rotate the governor shaft clockwise until it stops.

6. Hold both in this position and tighten the governor lever bolt.

   Torque the bolt to:
   8 N·m (70.8 in. lb.) on **CS4, CS6**
   10 N·m (88.5 in. lb.) on **CS8.5, CS10, CS12**

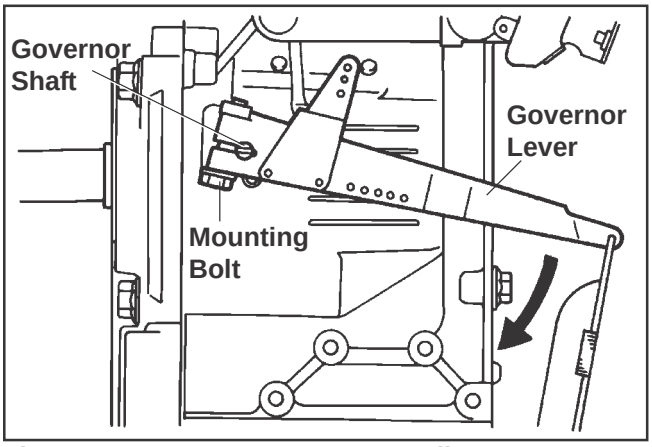


Figure 5-10. CS4, CS6 Governor Adjustment.

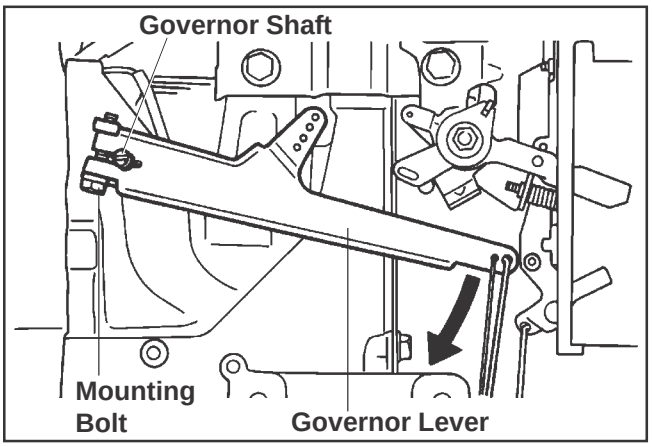


Figure 5-11. CS8.5 (spec. 92xxxx), CS10, and CS12 Governor Adjustment.

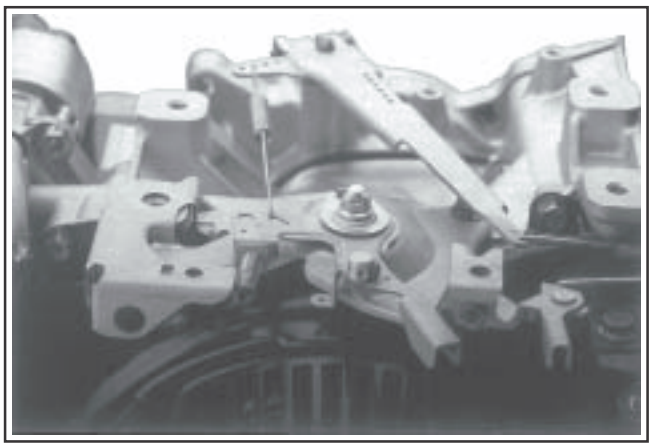


Figure 5-12. CS8.5 (spec. 95xxxx) Governor Adjustment.

High Idle Speed Adjustment

The recommended maximum no-load high idle speed for the CS engines is **3750 RPM** (± 100 RPM) for tapered shaft models, and **3800 RPM** (± 100 RPM) for all others. The actual high idle speed depends on the application. Refer to the equipment manufacturer's instructions for specific information.

The high idle speed is set by turning the throttle stop screw on the throttle lever bracket assembly **in or out**. See Figures 5-13 to 5-15 and follow the procedures below.

1. Start the engine and allow it to warm up. Place the throttle control lever into the ''fast'' or high idle position.

2. Check the engine speed with a tachometer.

3. **To increase the high idle speed**–turn the high idle speed adjusting screw **out** (counterclockwise), while applying light pressure to the throttle control lever in the counterclockwise direction (away from the carburetor).

   To decrease the high idle speed–turn the high idle speed adjusting screw **in** (clockwise), until the desired engine speed is attained.

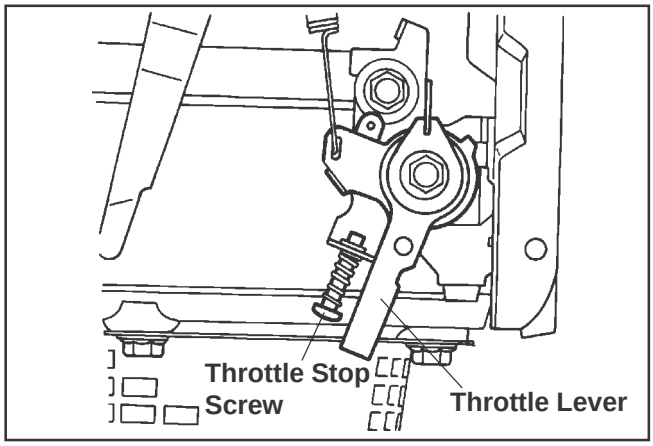


Figure 5-13. CS4, CS6 Throttle Lever/Throttle Stop Screw Details.

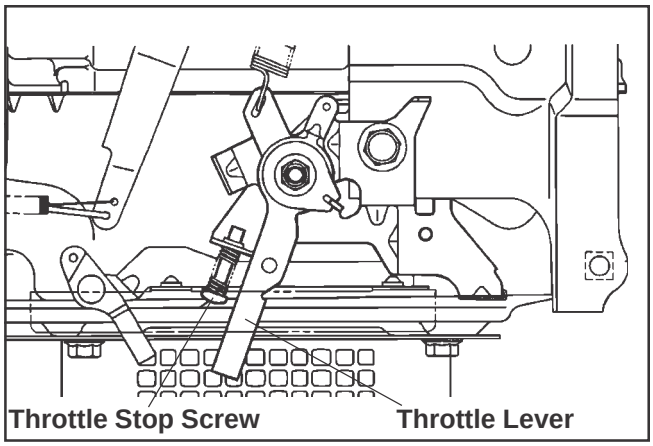


Figure 5-14. CS8.5 (spec. 92xxxx), CS10, and CS12 Throttle Lever/Throttle Stop Screw Details.

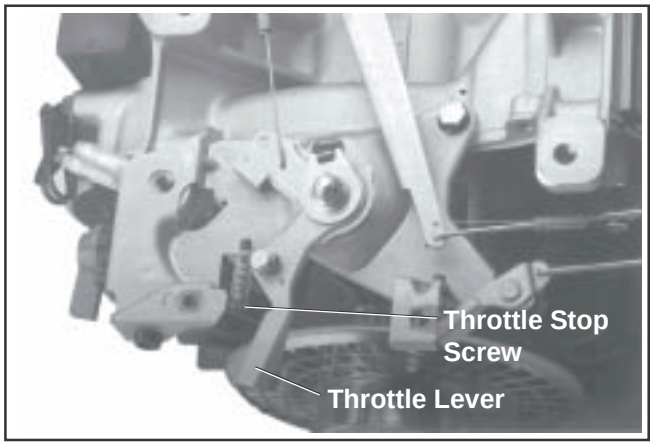


Figure 5-15. CS8.5 (spec. 95xxxx) Throttle Lever/ Throttle Stop Screw Details.

5

Low Idle Speed Adjustment

The recommended low idle speed is **2000 RPM** (± 100 RPM). The low idle speed is set by turning the low idle speed screw **in or out**, see Figures 5-16 and 5-17.

1. With the engine warm, move the throttle lever clockwise until it stops.

2. Check the idle speed with a tachometer.

3. Turn the adjustment screw **in** (clockwise) to increase the idle speed, or **out** (counterclockwise) to decrease the idle speed, until the correct speed is attained.

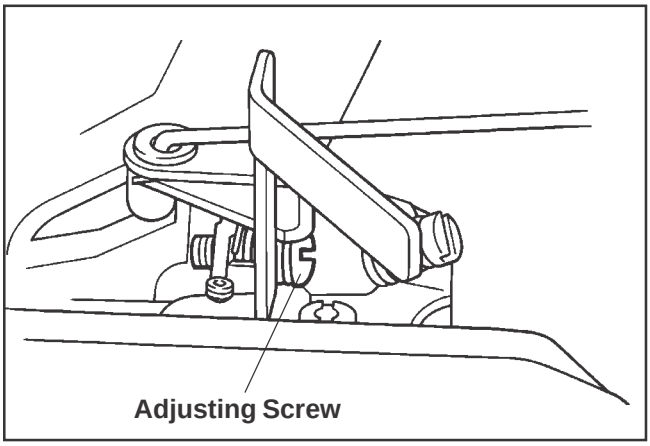


Figure 5-16. CS4, CS6 Low Idle Speed Adjusting Screw.

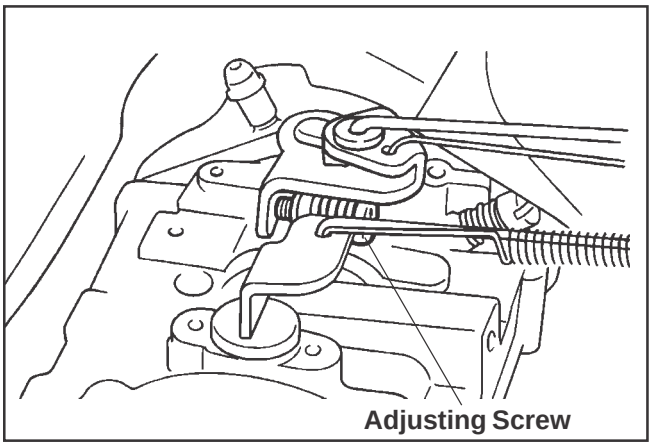


Figure 5-17. CS8.5-12 Low Idle Speed Adjusting Screw.

Section 6
Lubrication System

General

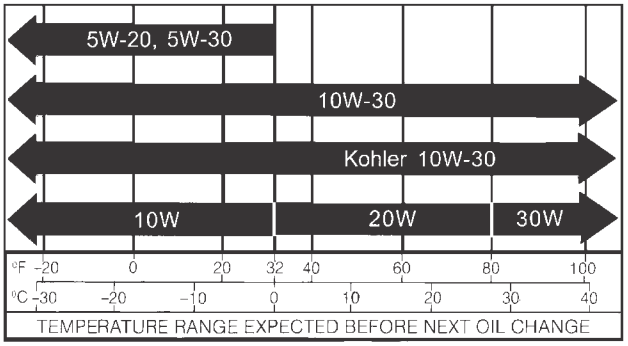
These engine use a splash lubrication system, supplying necessary lubrication to the crankshaft, camshaft, connecting rod and valve train components.

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 can cause premature engine wear and failure.

Oil Type

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



Synthetic oils should not be used.

NOTE: Using other than service class SG, SH, 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 6-1.

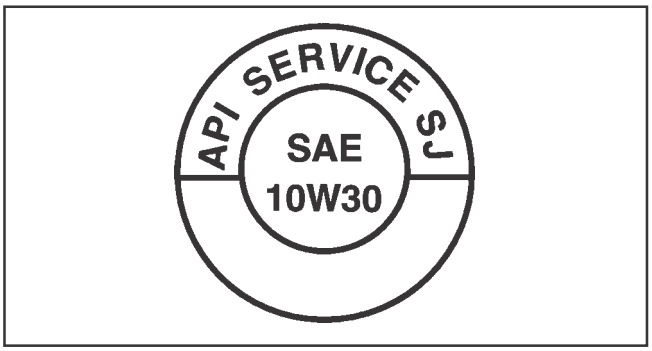


Figure 6-1. Oil Container Logo.

Check Oil Level

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

1. Make sure the engine is stopped, level, and is cool so the oil has had time to drain into the sump.
2. Clean the area around the oil fill cap to keep dirt, debris, etc., out of the engine.
3. Unthread and remove the oil fill cap.
4. The oil level should be at the point of overflowing out of the filler neck. See Figure 6-2.

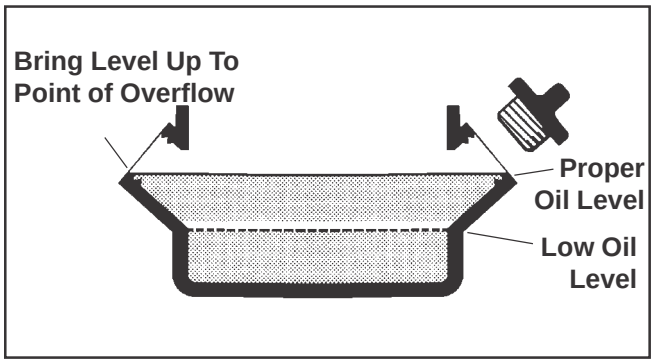


Figure 6-2. Cutaway Showing Proper Oil Level.

5. If the level is low add oil of the proper type to bring the level up to the point of overflowing.

NOTE: To prevent extensive engine wear or damage, always maintain the proper oil level in the crankcase. Never operate the engine with the oil below the low oil level.

NOTE: Just because you can see oil in the crankcase doesn't mean the level is in the safe range. Bring the level up to the point of overflowing the filler neck.

Oil Sentry™

Some engines are equipped with an Oil Sentry™ oil monitor. When the oil level falls below the safe level, the engine stops automatically. Unless you refill with oil, the engine will not start again. See Figure 6-3.

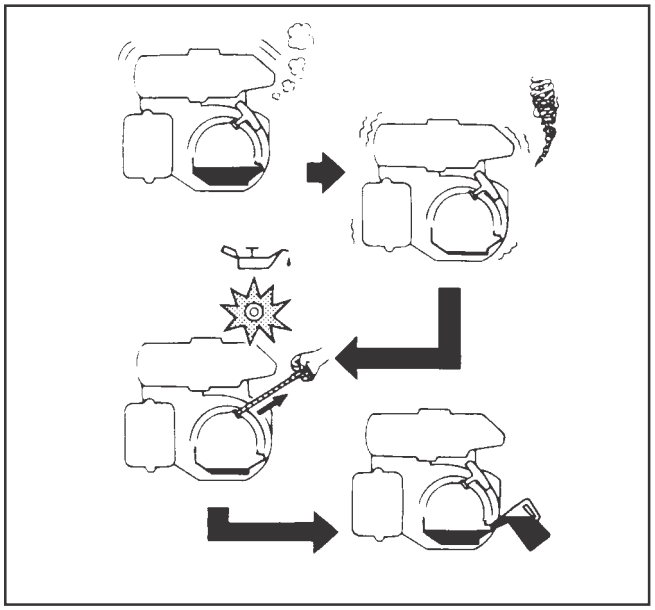


Figure 6-3. Oil Sentry™ Operation.

NOTE: If the engine stalls or does not start, turn the engine switch to the **"on"** position and attempt to start the engine. If the oil warning light flickers for a few seconds, the engine oil is insufficient. Add oil and restart.

NOTE: Make sure the oil level is checked BEFORE EACH USE and is maintained up to the point of overflowing the filter neck.

Change Oil

For a new engine, change oil after the first **20 hours** of operation. Thereafter, change oil after every **100 hours** of operation.

For an overhauled engine, use *10W-30 weight* service class SG, SH, SJ or higher oil for the first **5 hours** of operation. Change the oil after this initial run-in period. Refill with service class SG, SH, SJ or higher oil as specified in the "Viscosity Grades" table on page 6.1.

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

Change the oil as follows:

1. To keep dirt and debris out of the engine, clean the area around the oil fill/check plug before removing it.

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

3. Reinstall the drain plug. Make sure it is tightened to **17.6 N·m (13 ft. lb.)** torque.

4. Fill the crankcase, with new oil of the proper type, up to the point of overflowing the filler neck. Refer to ''Oil Type'' on page 6.1. Always check the level before adding more oil.

5. Reinstall the oil fill/check plug and tighten securely.

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 low oil level.

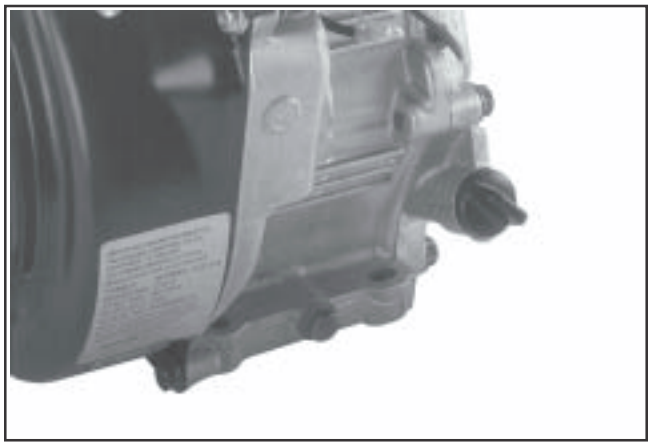


Figure 6-4. CS4, CS6 Right Oil Fill/Level Plug Location.

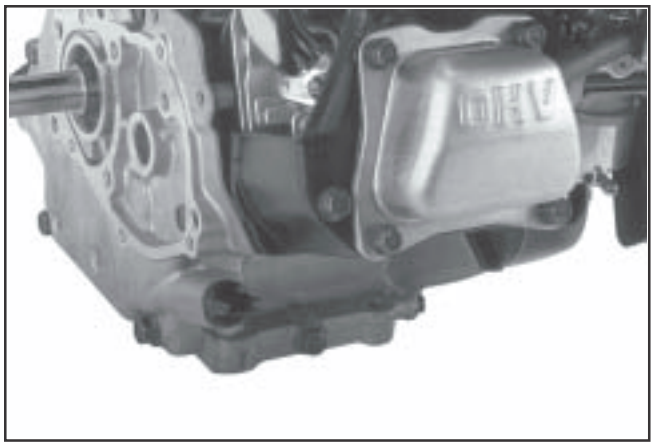


Figure 6-5. CS4, CS6 Left Oil Fill/Level Plug Location.

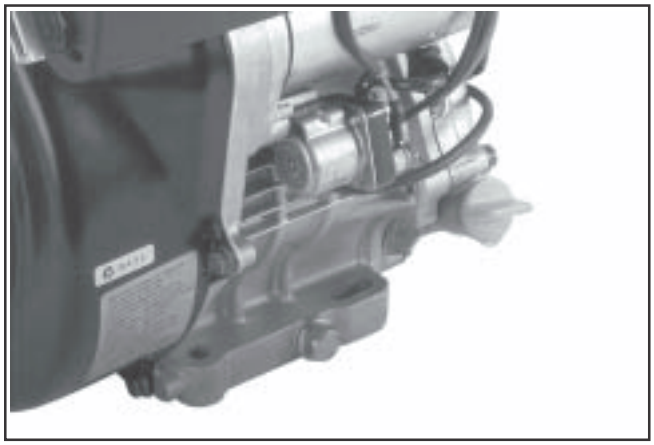


Figure 6-6. CS8.5-12 Right Oil Fill/Level Plug Location.

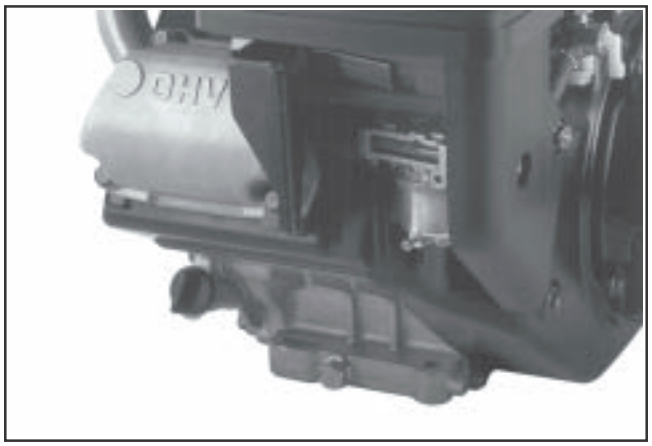


Figure 6-7. CS8.5-12 Left Oil Fill/Level Plug Location.

Section 7
Retractable Starter

WARNING: Spring Under Tension!

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

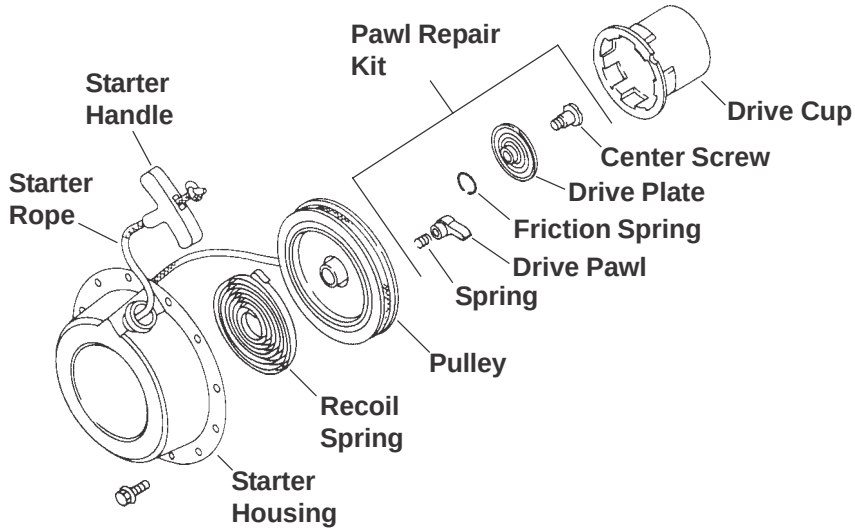


Figure 7-1. Retractable Starter - Exploded View.

To Remove Starter

1. Remove the hex flange screws (three on CS4 and CS6, four on CS8.5-12) securing the starter assembly to the blower housing.

2. Remove the starter assembly.

To Install Starter

1. Align the retractable starter with the mounting locations on the blower housing, and install the hex flange screws. Leave the screws slightly loose.

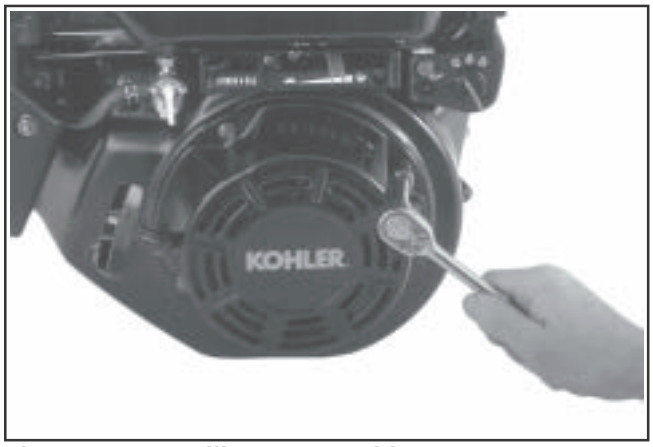


Figure 7-2. Installing Retractable Starter.

2. Pull the starter handle out until the pawls engage the drive cup. Hold the handle in this position and torque the screws to **5.5 N·m (48 in. lb.)**. See Figure 7-3.

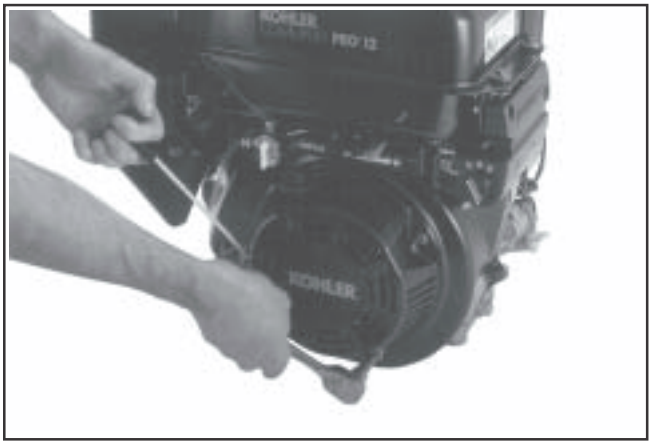


Figure 7-3. Engage Pawls and Tighten Mounting Screws.

Rope Replacement

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

1. Remove the starter from the engine blower housing.

2. Pull the rope out approximately 12" and tie a temporary (slip) knot in it to keep it from retracting into the starter. See Figure 7-4.

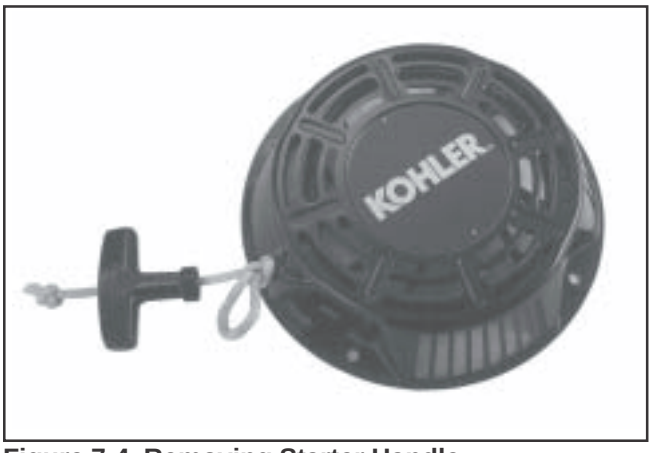


Figure 7-4. Removing Starter Handle.

3. Pull the knot end out of the handle, untie the knot, and slide the handle off.

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

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

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

7. Rotate the pulley counterclockwise to pre-tension the spring (approximately 4 full turns of pulley on CS4 and CS6; approximately 5 full turns of pulley on CS8.5-12).

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

   NOTE: Do not allow the pulley/spring to unwind. Enlist the aid of a helper if necessary.

9. Feed the unknotted end of the rope through the rope hole in the starter pulley and rope guide bushing of the housing. See Figure 7-5.

Figure 7-5. Installing Rope.

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

11. Slip the handle onto the rope. Tie a single knot at the end of the rope.

12. Untie the slip knot and pull on the handle until the rope is fully extended. Slowly retract the rope into the starter. If the spring is properly tensioned, the rope will retract fully and the handle will stop against the starter housing.

Pawl (Dogs) Replacement

Only partial disassembly of the starter is necessary to replace the pawls. Pawl repair kits are available which include the following components:

CS4 and CS6 Pawl Repair Kit Contains

Qty	Description
1	Drive Plate
1	Center Screw
1	Clip
2	Starter Pawl (Dog)

CS8.5-12 Pawl Repair Kit Contains

Qty	Description
1	Drive Plate
1	Center Screw
2	Pawl (Dog) Spring
1	Clip
2	Starter Pawl (Dog)

Disassembly

WARNING: Spring Under Tension!

Do not remove the center screw from starter until the spring tension is released. Removing the center screw before releasing spring tension, or improper starter disassembly, can cause the sudden and potentially dangerous release of the spring. Follow these instructions carefully to ensure personal safety and proper starter disassembly. Make sure adequate face protection is worn by all persons in the area.

1. Release recoil spring tension by:
   CS4, CS6: Loosen the center screw approximately **1 turn**. Rotate the pulley against spring tension until the pulley rope hole with knot is adjacent to outlet in housing. Lift up the slack in rope between pulley and housing, slowly allow the pulley to unwind, releasing the spring tension. Count the number of rotations for reassembly later.

   CS8.5-12: Rotate the pulley against spring tension, until the cutout in pulley is adjacent to outlet in housing. Lift up the slack in rope through the cutout and slowly allow pulley to unwind, releasing spring tension. Count the number of rotations for reassembly later.

2. Unscrew the center screw and lift off the drive plate. The center screw will be captured by the clip around the shoulder on backside of plate.

3. Note the positions of the pawls and pawl springs (CS8.5-12 only) before removing. Remove parts from pulley.

4. Carefully inspect the components for wear, cracks, and/or damage. Replace all worn or damaged components. Use only genuine Kohler replacement parts as specified in the parts manuals. All components shown in Figure 7-1 are available as service parts. Do not use nonstandard parts.

5. Install pawl springs (CS8.5-12 only) and pawls onto pawl studs of pulley. All parts must be dry.

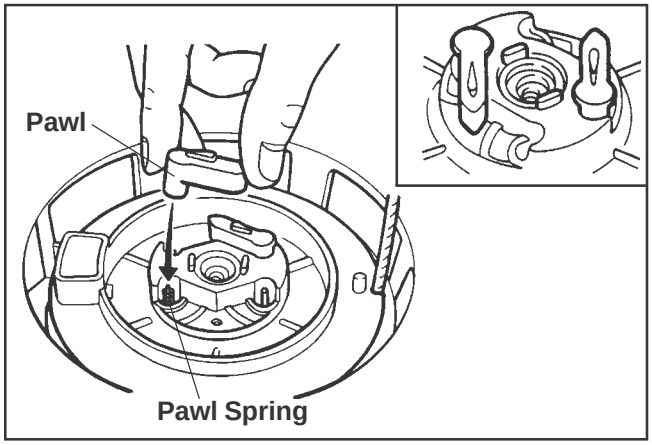


Figure 7-6.

6. Position the drive plate over the pawls, aligning the actuating slots in the plate with the raised sections on each drive pawl. Torque the center screw to **5-6 N·m (44-53 in. lb.)**. Rotate the pulley by hand and check operation. See Figure 7-7.

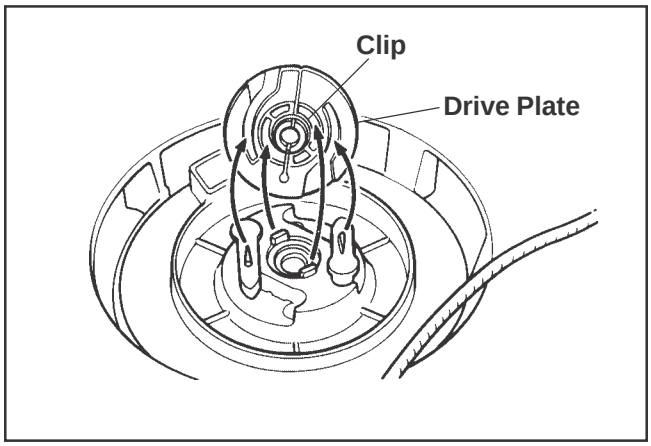


Figure 7-7. Drive Plate and Pawl Details.

7. Rehook the slack in rope into notch of pulley and rotate the pulley counterclockwise (viewed from pawl side) to re-tension the spring (approximately 4 full turns on CS4 and CS6; approximately 5 full turns on CS8.5-12).

Recoil Spring, Pulley, and/or Housing Replacement

Disassembly

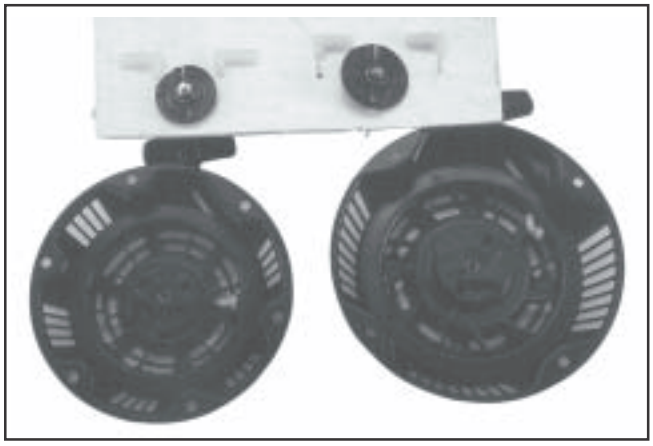


Figure 7-8. Retractable Starter Pawl Assembly Details.

WARNING: Spring Under Tension!

Do not remove the center screw from starter until the spring tension is released. Removing the center screw before releasing spring tension, or improper starter disassembly, can cause the sudden and potentially dangerous release of the spring. Follow these instructions carefully to ensure personal safety and proper starter disassembly. Make sure adequate face protection is worn by all persons in the area.

1. Release spring tension and remove the handle and starter rope. (Refer to ''Rope Replacement''.)

2. Unscrew the center screw and lift off the drive plate. The screw will be captured within plate by the clip on backside.

3. Carefully note the positions of the pawls and pawl springs (CS8.5-12 only) before removing them. Remove the parts from the starter pulley.

4. Rotate the pulley clockwise (1/2 to 1 full turn) this will ensure the spring is disengaged from the starter housing.

5. Carefully lift the pulley out of the recoil housing, while reaching through the spokes of the pulley to keep the spring from coming out of the pulley.

6. Wearing adequate eye/face protection, carefully remove the spring from the pulley cavity.

7. Clean all parts including the starter spring cavity in pulley and recoil housing of all old grease and dirt. Inspect all parts for wear or damage and replace as required.

Figure 7-9. Disassembled Retractable Starter.

Reassembly

1. Generously lubricate the recoil spring with a commercially available bearing grease.

2. Engage the outer spring hook into the pulley ''slit'' opening, then carefully wind the spring counterclockwise into the drum of the pulley from larger to smaller diameter.

3. Carefully install pulley into recoil housing, engaging the spring hook with starter housing tab. See Figure 7-10.

   NOTE: Rotating pulley counterclockwise slightly will assist engagement.

4. Install the pawl springs (CS8.5-12 only) and pawls onto pawl studs of pulley.

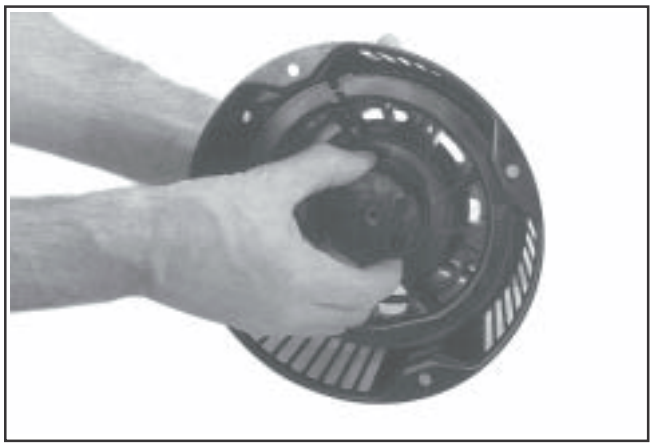


Figure 7-10. Assembling Starter Pulley to Housing.

5. Mount drive plate over pawls onto pulley, aligning the actuating slots in plate with the raised sections on each drive pawl. Torque the screw to **5-6 N·m (44-53 in. lb.)**. Rotate the pulley by hand and check operation. See Figure 7-11.

Figure 7-11. Torque Center Mounting Screw.

6. Tension the spring and install the rope and handle as outlined in Steps 6 through 12 under ''Rope Replacement.''

7. Install the recoil starter to engine blower housing but do not fully tighten the mounting screws.

8. Pull out on recoil handle/rope to engage the pawls to the drive cup, hold engaged and torque the mounting screws to **5.5 N·m (47.7 in. lb.)**. See Figure 7-3.

Section 8
Electrical System and Components

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

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.

This engine uses the following spark plugs:

Type:	The original spark plug is an NGK BPR4ES[1]. The Champion® equivalent of that NGK spark plug is RN14YC[2]. The service replacement is Champion® RC14YC[3] (Kohler Part No. 66 132 01-S). Equivalent alternate brand spark plugs can also be used.
Gap:	0.76 mm (0.030 in.)
Thread Size:	14 mm
Reach:	19.1 mm (3/4 in.)
Hex Size:	[1,2] 20.6 mm (13/16 in.) [3] 15.9 mm (5/8 in.)

Spark Plug Service

Every **100 hours** of operation, remove the spark plug, check its condition and reset the gap, or replace it 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 which uses abrasive grit. Some grit could remain on/in the spark plug and enter the engine, causing extensive wear and damage.

3. Check the gap using a wire feeler gauge. Adjust the gap to **0.76 mm (0.030 in.)** by carefully bending the ground electrode. See Figure 8-1.

4. Reinstall the spark plug into the cylinder head. Torque the spark plug to **20 N·m (177 in. lb.)**.

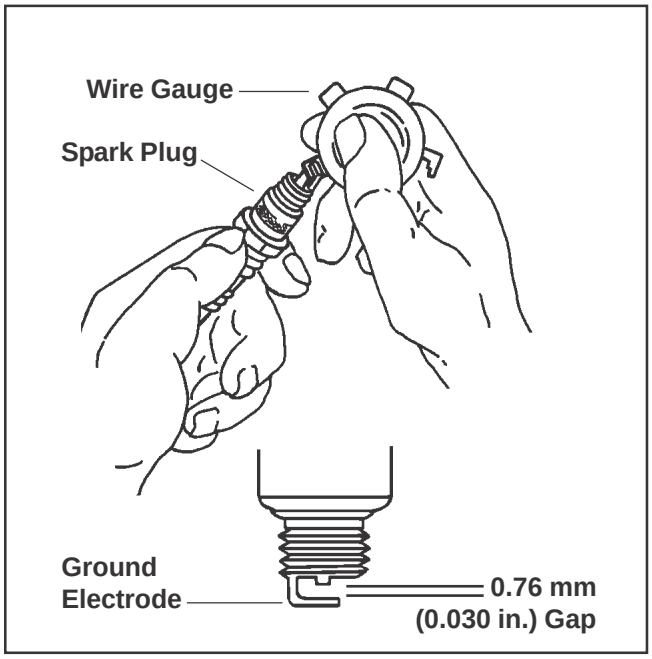
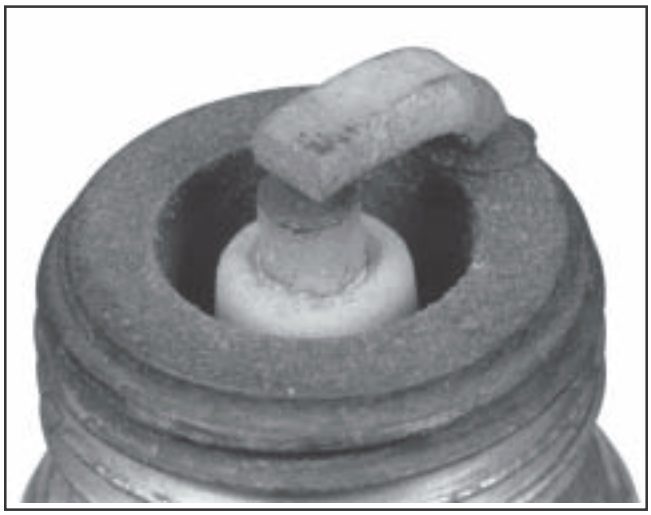


Figure 8-1. Servicing Spark Plug.

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.

Normal and fouled plugs are shown in the following photos.



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

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

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

Wet Fouled: A wet plug is caused by excess fuel or oil in the combustion chamber. Excess fuel could be caused by a restricted air cleaner, a carburetor problem, or operating the engine with too much choke. Oil in the combustion chamber is usually caused by a restricted air cleaner, a breather problem, or internal engine wear.

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

Electronic TCI (Transistor Controlled Ignition) System

These engines are equipped with a dependable electronic TCI system providing:

- Maintenance free operation.
- Strong spark output.
- Stable, controlled ignition timing.

The system consists of the following components:

- A magnet assembly which is permanently affixed to the flywheel.
- A TCI module which mounts on the engine crankcase.
- An engine stop switch which grounds the module to stop the engine.
- A spark plug.

Electric Start Engines also contain:

- An electric starter motor.
- A 3-position starter switch.
- A starter solenoid.
- Wiring harness with fuse.
- Rectifier-Regulator.

Operation

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

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

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

Oil Sentry™ Control System

Most engines are equipped with an Oil Sentry™ oil monitor control system. When the oil level within the crankcase falls below the safe level, the engine stops automatically. Unless the oil level is brought up to the proper level the oil warning light will flicker for a few seconds when attempting to start, and the engine will not start. See Figure 8-2.

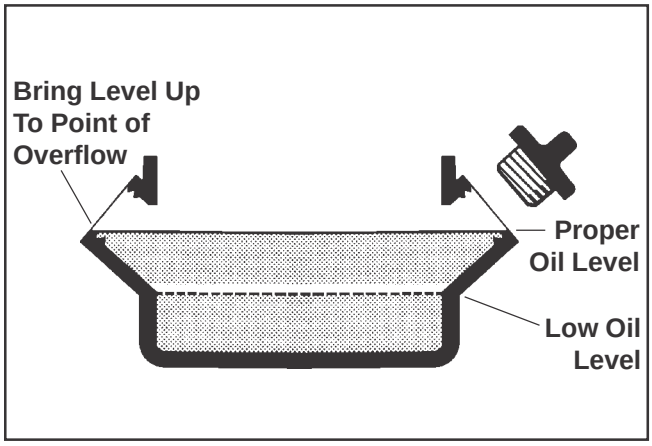


Figure 8-2. Cutaway Showing Proper Oil Level.

Oil Sentry™ systems typically consist of the following components:

- An oil warning control unit (black box).
- An oil level float switch.
- An indicator light.

Troubleshooting Guide

Ignition and Oil Sentry™ Systems

Before testing, be certain all electrical leads are connected and crankcase oil is at the point of overflowing the filler neck.

Problem	Test	Conclusion
Engine Will Not Start	1. Disconnect the cap from the spark plug and attach it to the terminal end of spark tester Kohler Part No. 25 455 01-S. Attach tester spring clip to a good ground, not to the spark plug. Turn ignition/key switch ''on'' and crank the engine while observing the firing tip of the tester.	1. If tester is firing, ignition system is good. Install a new spark plug and try to start engine. If it still will not start, check other possible causes (fuel, compression, etc.). If tester does not fire, go to step 2.
	2. On electric start engines, remove the starter cover panel. Locate the black/white kill lead coming from the ignition module inside the blower housing. Disconnect the bullet connector where the kill lead plugs into the harness. Repeat the spark test (step 1).	2. If spark is now present, check for a shorted lead in the kill circuit or a faulty switch (step 7). If there is still no spark, go to step 3.
	3. Trace the blue lead from the Oil Sentry™ control module. Disconnect the bullet connector where it joins the lead from the Oil Sentry™ float switch (black with gray sleeve). Repeat spark test again.	3. If spark is now present, the control module or float switch is faulty. Test the control module (step 4) and the float switch (step 5). If there is still no spark, test the ignition module (step 6).
	4. Connect a jumper lead from the blue lead terminal to a bare spot on the crankcase (ground). Turn the ignition switch ''on'', crank the engine, and observe the red LED indicator lamp. a. If the indicator lamp was not flashing, trace the black (manual start models) or black/white (electric start models) lead from the ignition switch. Separate the bullet connector where the switch lead joins the double red harness lead. Crank the engine, again observing the red LED indicator lamp.	4. If the indicator lamp flashes during cranking, the control module is functioning, proceed to step 5. If the lamp was not flashing initially but did flash in step 4a, the control module is good, but the ignition switch is probably faulty. Test the float switch (step 5) and the ignition switch (step 7).
	5. Set an ohmmeter to the Rx1 scale and zero the meter. Connect one ohmmeter lead to the Oil Sentry™ float switch lead (black with gray sleeve) and touch the other lead to a bare spot on the crankcase (ground). Drain the oil from the crankcase and repeat the test. a. If continuity was indicated with and without oil above, check if the insulation has been scraped off the float switch lead. b. With the float switch removed, connect one ohmmeter lead to the float switch lead terminal and connect the other lead to mounting bracket. Test resistance with the switch in the normal position and inverted.Repeat test 2 or 3 times in each direction.	5. With the oil at the proper level, no continuity should have been indicated. After the oil was drained, continuity should have been indicated. If test results are other than specified, remove the closure plate from the engine and remove the float switch for further testing (5a and 5b). a. If the lead wire is bare, allowing it to short, repair with electrical tape or replace float switch. b. Switch continuity should be as indicated in Figure 8-3. If not, replace it.

Problem	Test	Conclusion
Engine Will Not Start	6. Set an ohmmeter to the Rx1K or Rx10K scale and zero. Connect one ohmmeter lead to the kill lead (black/white) terminal and connect the other lead into the spark plug cap. a. Remove the cap from the spark plug lead and test the resistance of the cap alone. b. If resistances are other than specified, remove the blower housing and remove the ignition module. With the kill lead and spark plug cap removed, test resistance from the small spade terminal to the core of the spark plug lead wire.	6. Resistance of the ignition module should be 13.5-18.0 K ohms. a. Resistance of the cap should be 4-6 K ohms. b. Resistance should be 9.5-12.9 K ohms . If resistance is not in this range, replace the module.
	7. Set an ohmmeter to the Rx1 scale and zero the meter. Test the ignition/key switch as follows. a. On manual start engines, trace the two black leads from the on/off switch and separate them from any connections. Connect the ohmmeter leads to the switch leads, and check for continuity in both switch positions. b. On electric start engines, trace the four leads (red, red/white, black, black/white) from the key switch and separate them from any connections. Connect the ohmmeter leads to the black and black/white leads and check for continuity in all three switch positions. Then connect the ohmmeter leads to the red and red/white leads and test again in all three switch positions.	a. Continuity should be indicated when and only when switch is in the ''off'' position. Replace switch for any other results. b. Continuity should be indicated between the black and black/white leads only when the key switch is in the **off** position. There should be continuity between the red and red/white leads only in the **start** position. Replace switch for any other results.

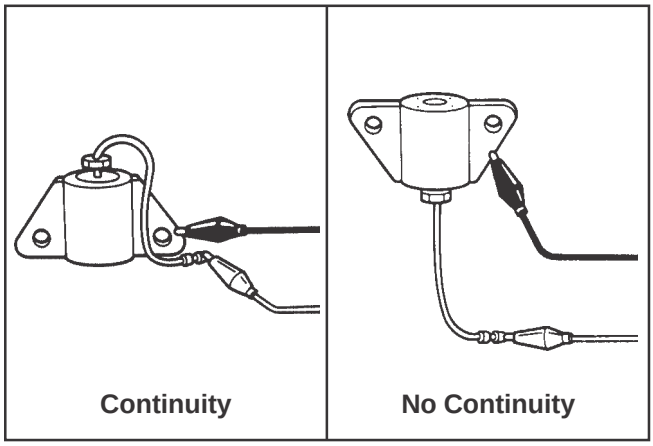


Figure 8-3.

Battery Charging Systems

General

CS engines may be equipped with a 7 amp, 10 amp, or 18 amp regulated battery charging system. Refer to the selection tables below and the appropriate wiring diagram, based upon the specific Model and Spec. No.

Wiring Diagram Selection Tables

The following selection tables and individual wiring diagrams (Figures 8-4 through 8-22) provide a reference for troubleshooting and servicing. Locate the appropriate diagram based on the Model and Spec. No. involved.

Model No.	Spec. No.	Figure No.	Page No.
CS4T	901501	8-4	8.8
CS4T	901502	8-5	8.8
CS4T	901503	8-5	8.8
CS4TR	901504	8-5	8.8
CS4TP	901505	8-5	8.8
CS4T	901506	8-6	8.9
CS4TG	901511	8-5	8.8
CS4TR	901512	8-5	8.8

Model No.	Spec. No.	Figure No.	Page No.
CS6T	911501	8-4	8.8
CS6T	911502	8-5	8.8
CS6T	911503	8-5	8.8
CS6TR	911504	8-5	8.8
CS6TP	911505	8-5	8.8
CS6TG	911506	8-5	8.8
S6T	911507	8-6	8.9
CS6TR	911508	8-5	8.8
CS6ST	911509	8-7	8.9
CS6TG	911510	8-5	8.8
CS6TG	911511	8-5	8.8
CS6T	911512	8-6	8.9
CS6ST	911513	8-7	8.9
CS6T	911514	8-4	8.8
CS6T	911515	8-4	8.8
CS6T	911516	8-7	8.9
CS6TG	911517	8-5	8.8
CS6TG	911518	8-4	8.8
CS6TR	911519	8-4	8.8

Model No.	Spec. No.	Figure No.	Page No.
CS8.5T	921501	8-5	8.8
CS8.5T	921502	8-5	8.8
CS8.5TP	921503	8-5	8.8
CS8.5TR	921504	8-5	8.8
CS8.5TR	921505	8-5	8.8
CS8.5TG	921506	8-5	8.8
CS8.5TG	921509	8-5	8.8
CS8.5ST	921507	8-8	8.10
CS8.5ST	921508	8-9	8.10
CS8.5TG	921510	8-5	8.8

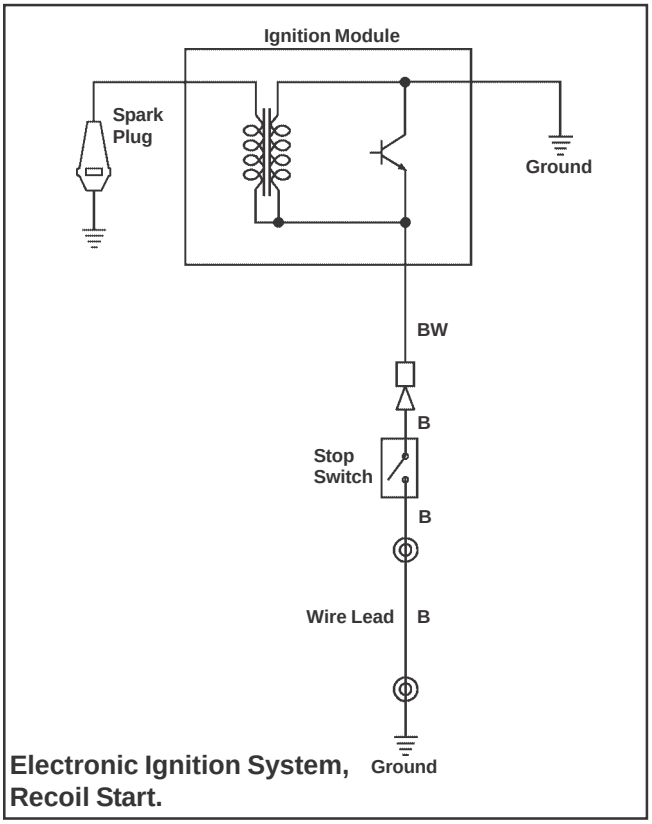
Model No.	Spec. No.	Figure No.	Page No.
CS8.5T	951500	8-12	8.12
CS8.5T	951501	8-12	8.12
CS8.5T	951502	8-12	8.12
CS8.5TP	951503	8-12	8.12
CS8.5TR	951504	8-12	8.12
CS8.5TR	951505	8-12	8.12
CS8.5TG	951506	8-12	8.12
CS8.5TG	951507	8-12	8.12
CS8.5ST	951508	8-13	8.12
CS8.5T	951509	8-12	8.12
CS8.5T	951510	8-14	8.13
CS8.5TG	951511	8-12	8.12
CS8.5ST	951512	8-19	8.15
CS8.5TG	951513	8-12	8.12
CS8.5ST	951514	8-12	8.12
CS8.5T	951515	8-12	8.12
CS8.5T	951516	8-12	8.12
CS8.5TR	951517	8-21	8.16
CS8.5T	951518	8-21	8.16

Model No.	Spec. No.	Figure No.	Page No.
CS10T	931501	8-5	8.8
CS10T	931502	8-5	8.8
CS10TG	931503	8-5	8.8
CS10TP	931504	8-5	8.8
CS10TR	931505	8-5	8.8
CS10TR	931506	8-5	8.8
CS10STG	931507	8-8	8.10
CS10ST	931508	8-8	8.10
CS10S	931509	8-8	8.10
CS10ST	931510	8-9	8.10
CS10TG	931511	8-5	8.8
CS10	931512	8-5	8.8
CS10T	931601	8-5	8.8
CS10T	931602	8-5	8.8
CS10TG	931603	8-5	8.8
CS10TP	931604	8-5	8.8
CS10TR	931605	8-5	8.8
CS10TR	931606	8-5	8.8
CS10STG	931607	8-16	8.14
CS10ST	931608	8-16	8.14
CS10S	931609	8-16	8.14
CS10ST	931610	8-17	8.14
CS10TG	931611	8-6	8.9
CS10TG	931612	8-6	8.9
CS10STG	931614	8-18	8.15
CS10TG	931615	8-6	8.9
CS10TR	931616	8-22	8.17
CS10T	931617	8-5	8.8
CS10STG	931618	8-18	8.15
CS10STG	931619	8-18	8.15
CS10TG	931620	8-5	8.8
CS10T	931621	8-19	8.15
CS10TR	931622	8-19	8.15

Model No.	Spec. No.	Figure No.	Page No.
CS12T	941501	8-5	8.8
CS12T	941502	8-5	8.8
CS12TG	941503	8-5	8.8
CS12TG	941511	8-5	8.8
CS12TP	941504	8-5	8.8
CS12TR	941505	8-5	8.8
CS12TR	941506	8-5	8.8
CS12STG	941507	8-8	8.10
CS12STG	941512	8-8	8.10
CS12ST	941508	8-8	8.10
CS12S	941509	8-8	8.10
CS12ST	941510	8-9	8.10
CS12GT	941513	8-5	8.8

Model No.	Spec. No.	Figure No.	Page No.
CS12STG	941515	8-10	8.11
CS12STG	941516	8-10	8.11
CS12STG	941517	8-11	8.11
CS12STG	941518	8-15	8.13
CS12STG	941519	8-10	8.11
CS12T	941520	8-5	8.8
CS12S	941521	8-5	8.8

Model No.	Spec. No.	Figure No.	Page No.
CS12T	941601	8-5	8.8
CS12T	941602	8-5	8.8
CS12TG	941603	8-5	8.8
CS12TP	941604	8-5	8.8
CS12TR	941605	8-5	8.8
CS12TR	941606	8-5	8.8
CS12STG	941607	8-16	8.14
CS12ST	941608	8-16	8.14
CS12S	941609	8-16	8.14
CS12ST	941610	8-17	8.14
CS12TG	941611	8-5	8.8
CS12STG	941612	8-16	8.14
CS12TG	941613	8-5	8.8
CS12STG	941615	8-18	8.15
CS12STG	941616	8-18	8.15
CS12STG	941617	8-18	8.15
CS12STG	941618	8-16	8.14
CS12STG	941619	8-18	8.15
CS12T Hydro 12.75	941620	8-6	8.9
CS12S	941621	8-6	8.9
CS12STG	941622	8-18	8.15
CS12TG	941623	8-5	8.8
CS12STG	941624	8-18	8.15
CS12TR	941625	8-5	8.8
CS12T	941626	8-5	8.8
CS12ST	941627	8-16	8.14
CS12STR	941628	8-16	8.14
CS12STG	941629	8-18	8.15
CS12ST	941630	8-16	8.14
CS12STG	941631	8-18	8.15
CS12STG	941632	8-16	8.14
CS12T	941633	8-5	8.8
CS12ST	941634	8-20	8.16
CS12T	941635	8-19	8.15
CS12TR	941636	8-19	8.15
CS12ST	941637	8-16	8.14
CS12TG	941638	8-5	8.8

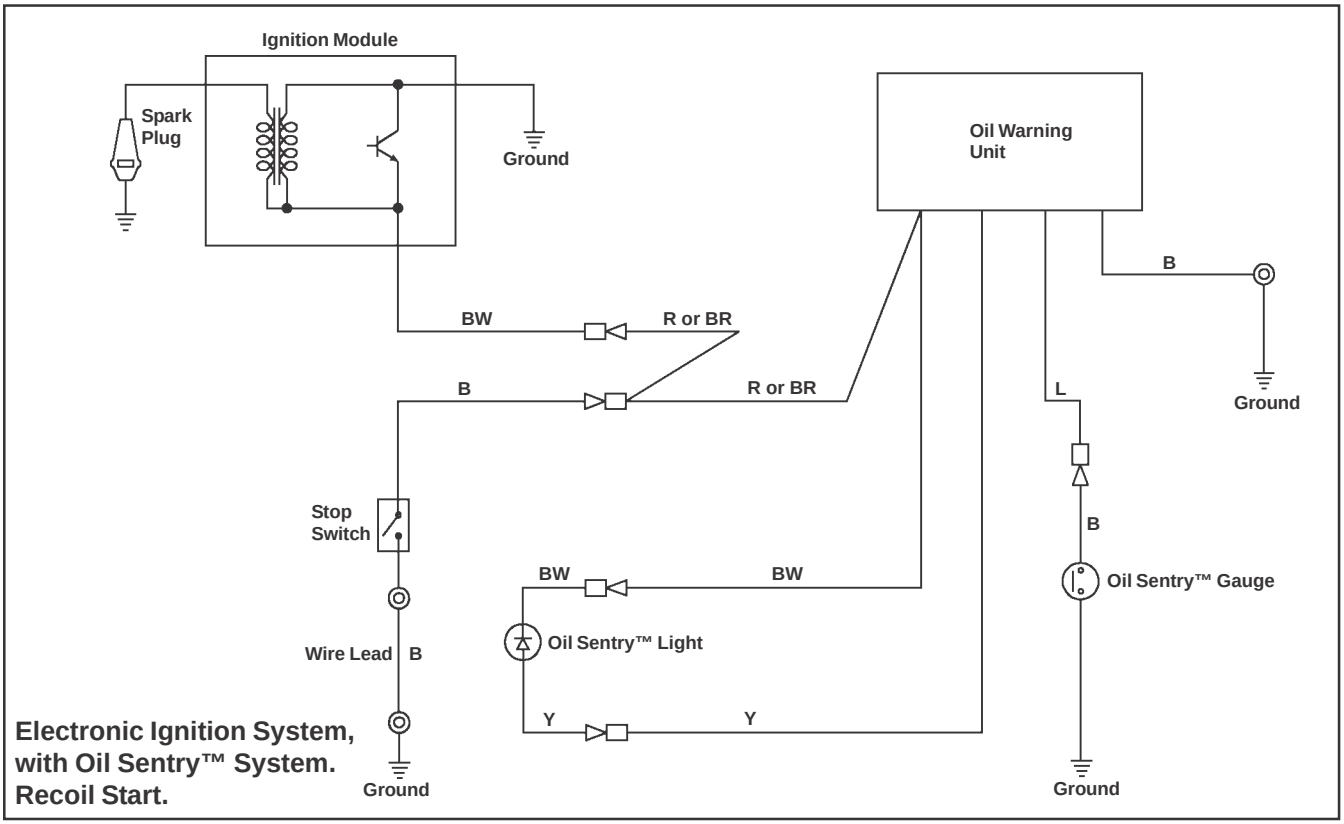


Electronic Ignition System, Recoil Start.

Figure 8-4.

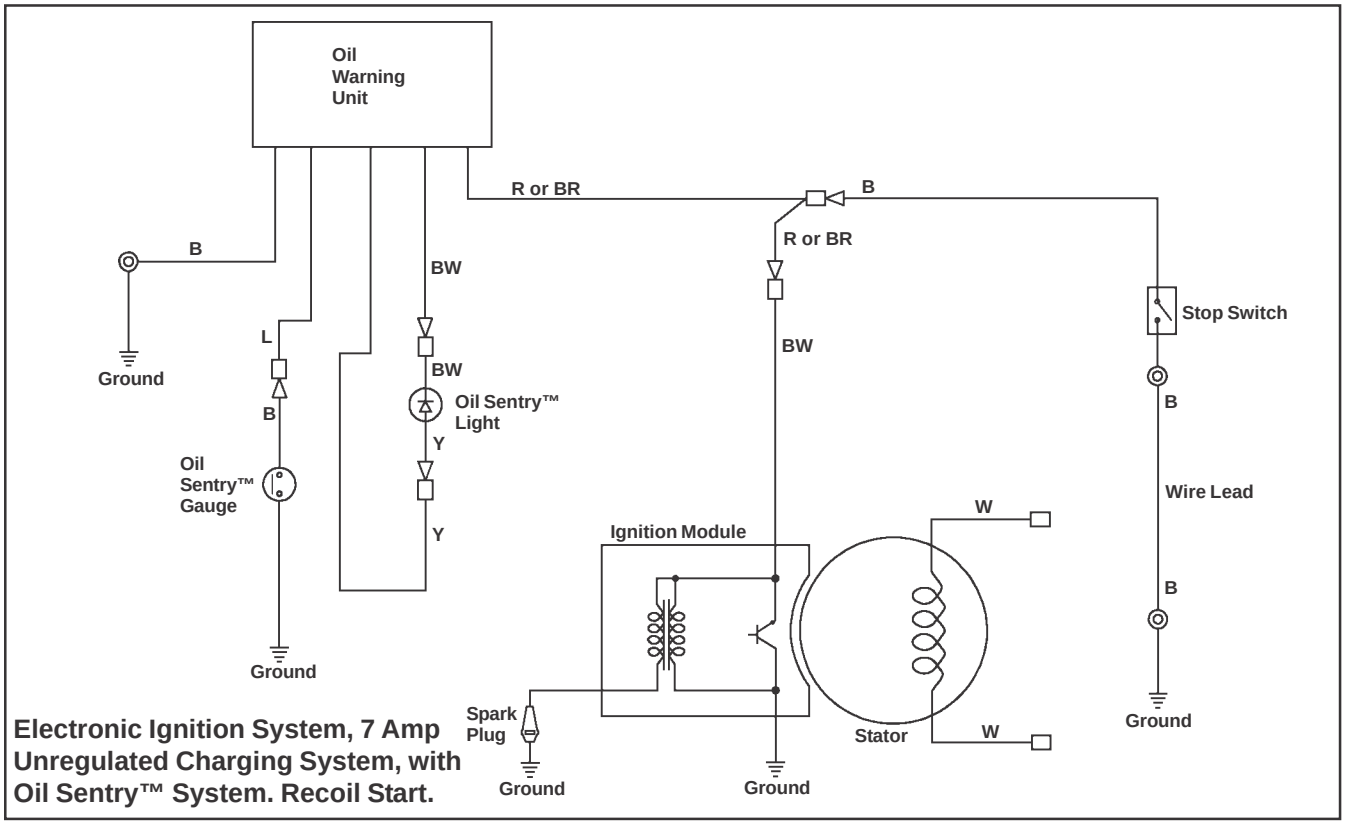
Wiring Color Codes

B	Black
L	Blue
R	Red
Y	Yellow
W	White
Br	Brown
G	Green
Gy	Gray
B/W	Black w/White Stripe
R/W	Red w/White Stripe
W/L	White w/Blue Stripe
G/R	Green w/Red Stripe
G/Y	Green w/Yellow Stripe
L/W	Blue w/White Stripe
L/R	Blue w/Red Stripe
G/B	Green w/Black Stripe
Oil Sentry™ Gauge Lead	Black w/Gray Shielding



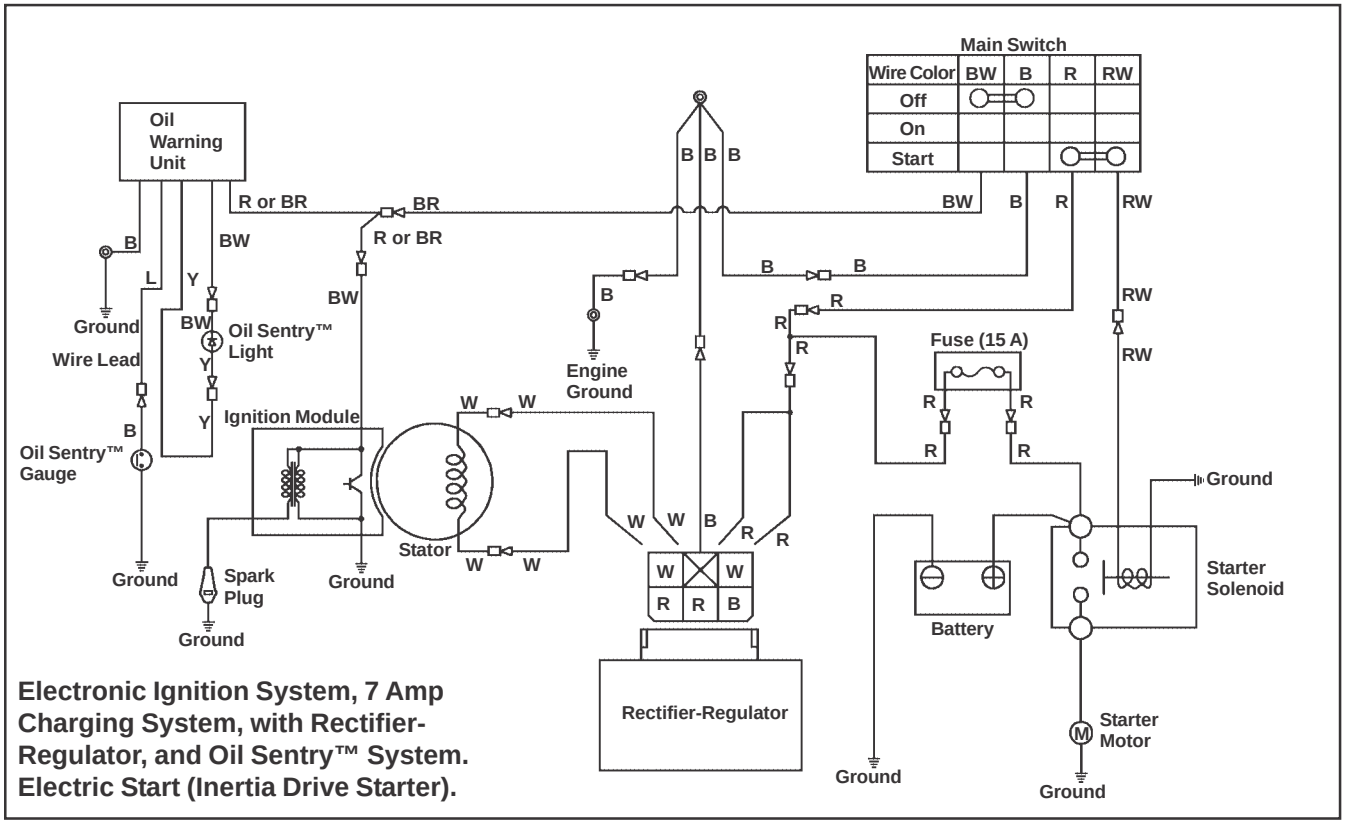
Electronic Ignition System, with Oil Sentry™ System. Recoil Start.

Figure 8-5.



Electronic Ignition System, 7 Amp Unregulated Charging System, with Oil Sentry™ System. Recoil Start.

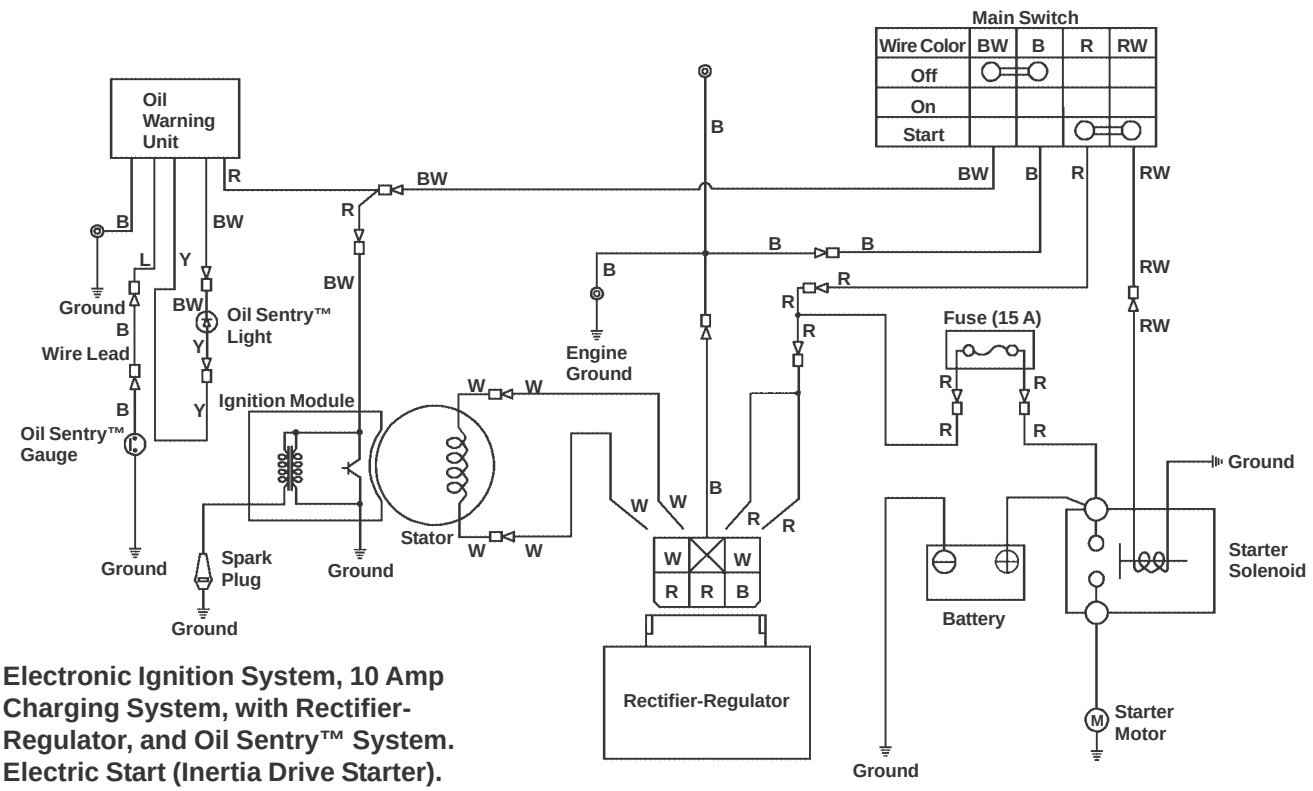
Figure 8-6.



Electronic Ignition System, 7 Amp Charging System, with Rectifier-Regulator, and Oil Sentry™ System. Electric Start (Inertia Drive Starter).

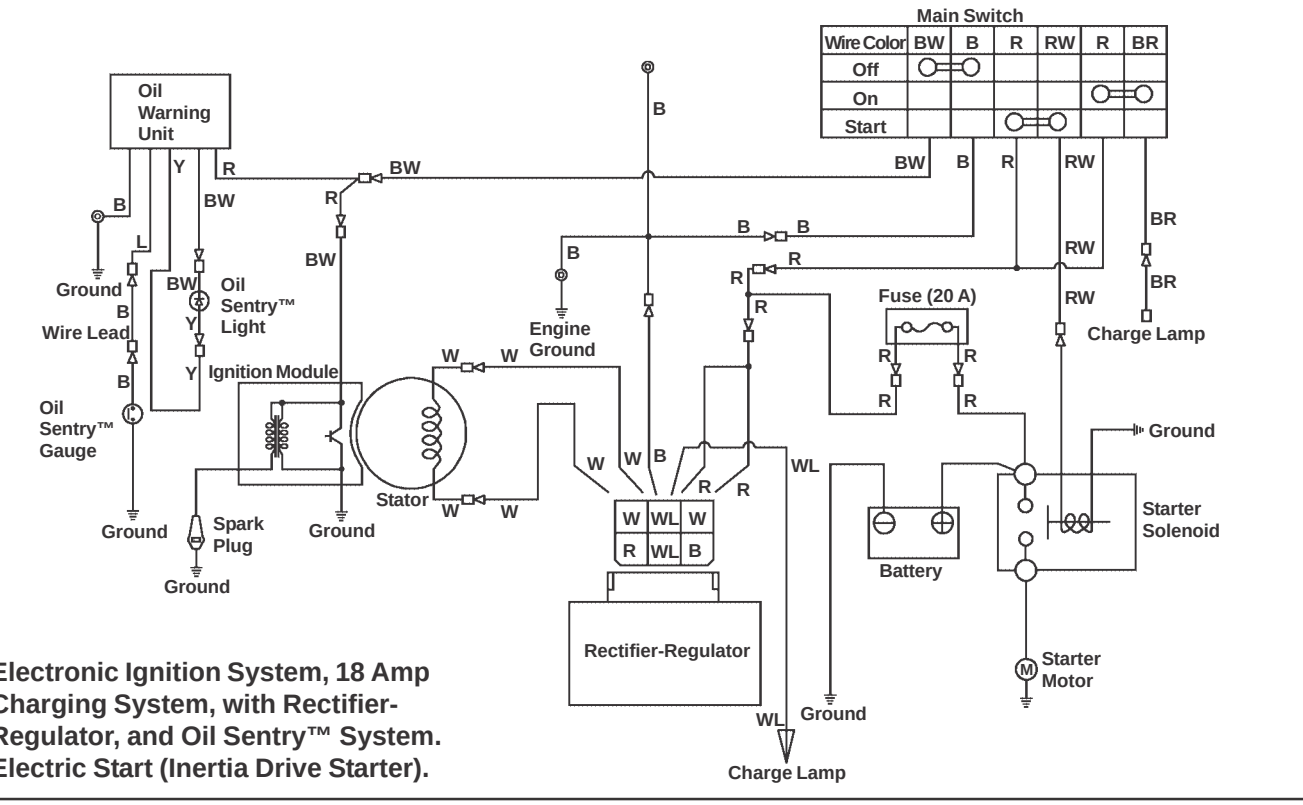
Figure 8-7.

8



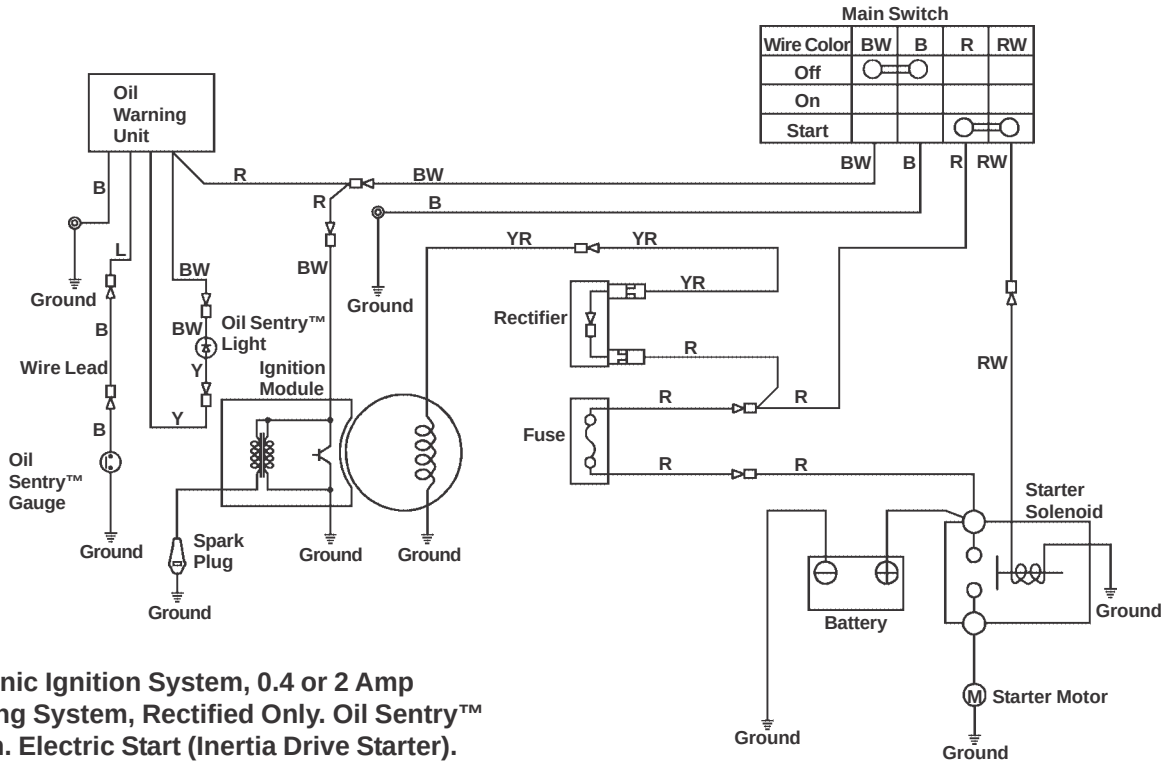
Electronic Ignition System, 10 Amp Charging System, with Rectifier-Regulator, and Oil Sentry™ System. Electric Start (Inertia Drive Starter).

Figure 8-8.



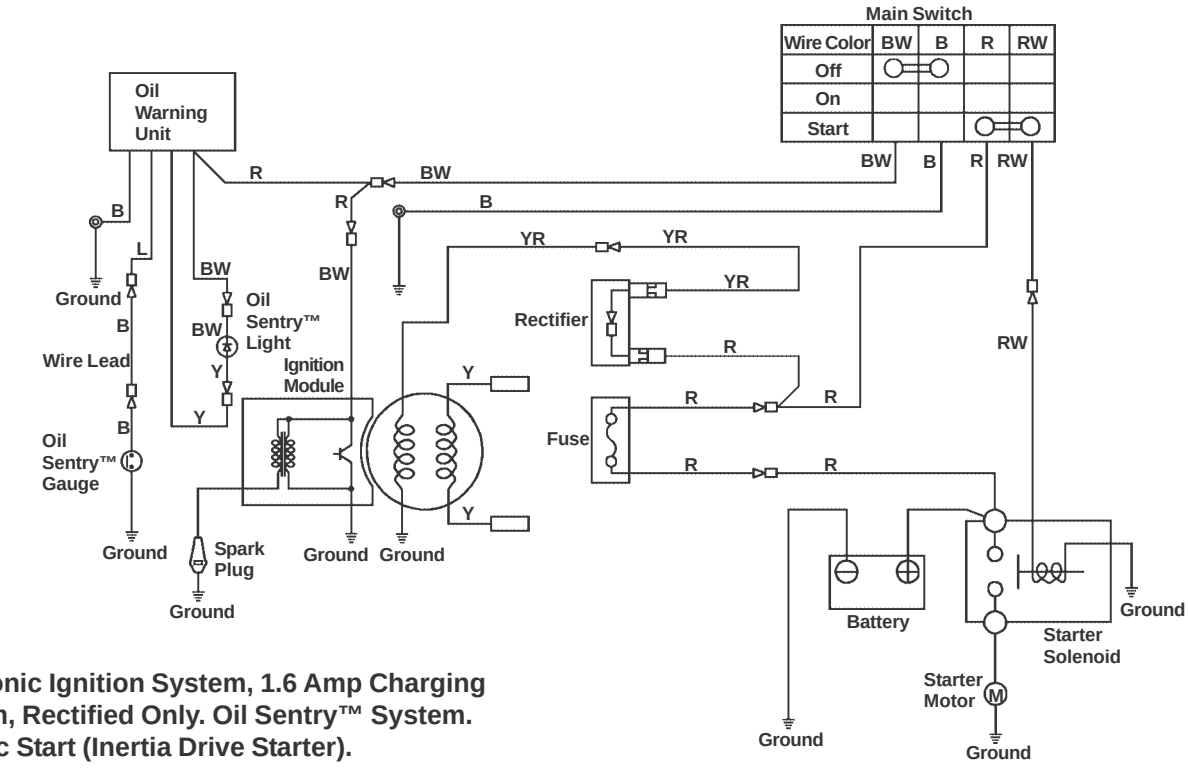
Electronic Ignition System, 18 Amp Charging System, with Rectifier-Regulator, and Oil Sentry™ System. Electric Start (Inertia Drive Starter).

Figure 8-9.



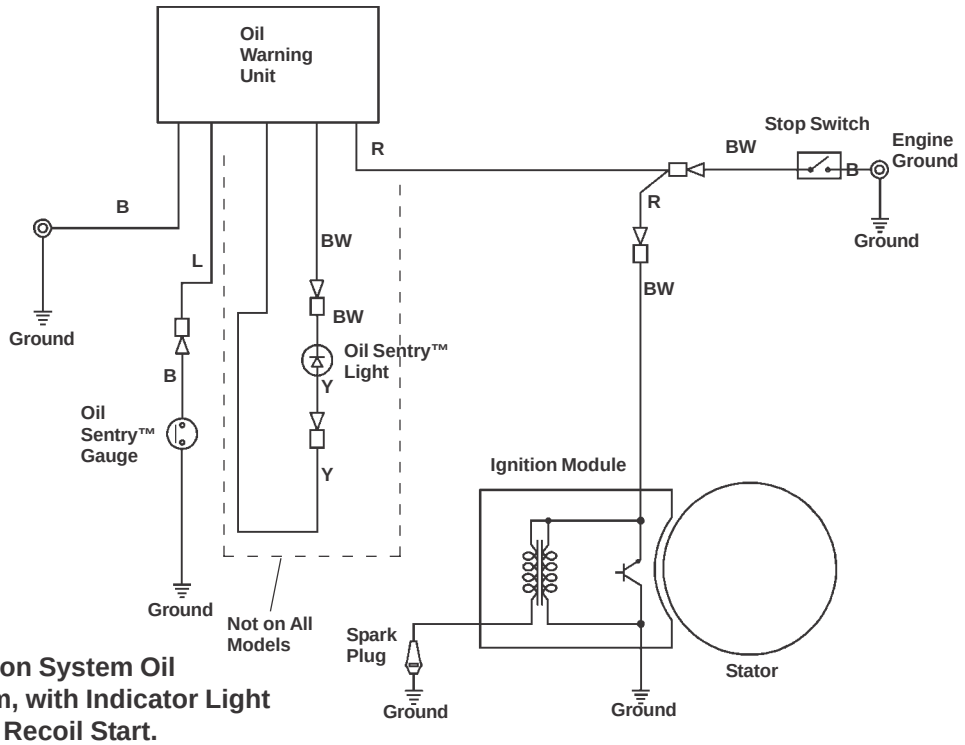
Electronic Ignition System, 0.4 or 2 Amp Charging System, Rectified Only. Oil Sentry™ System. Electric Start (Inertia Drive Starter).

Figure 8-10.



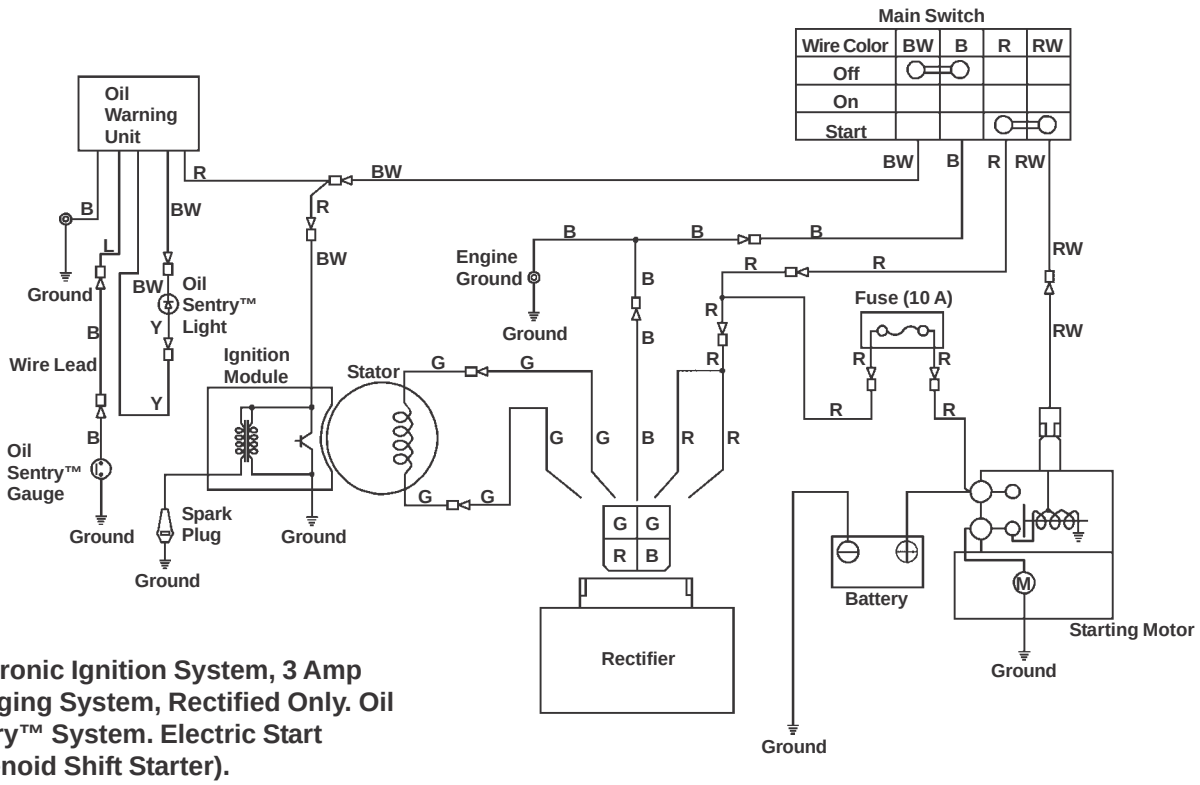
Electronic Ignition System, 1.6 Amp Charging System, Rectified Only. Oil Sentry™ System. Electric Start (Inertia Drive Starter).

Figure 8-11.



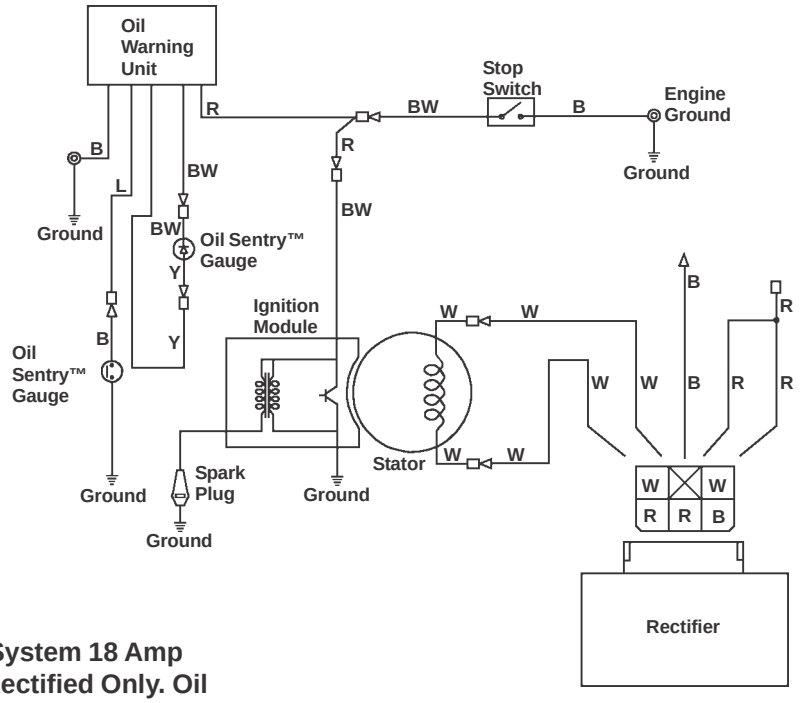
Electronic Ignition System Oil Sentry™ System, with Indicator Light (Some Models), Recoil Start.

Figure 8-12.



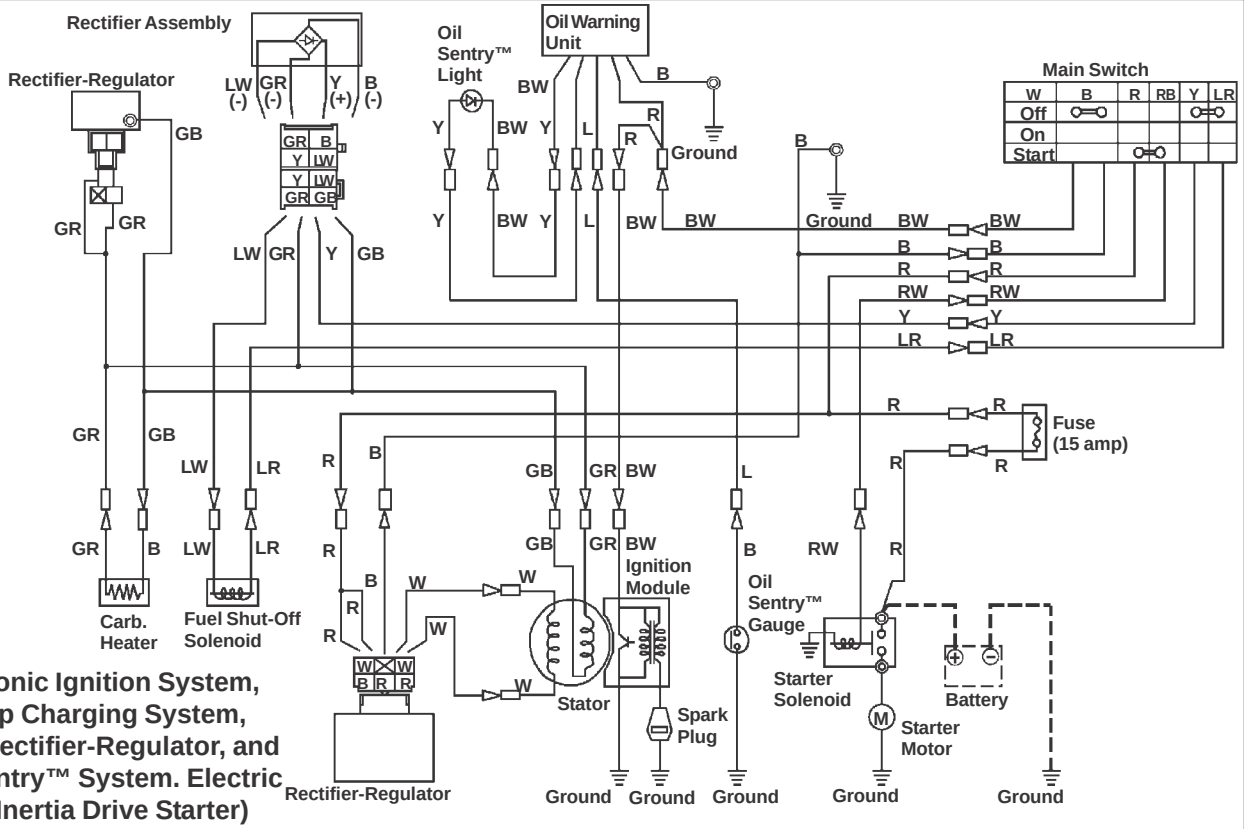
Electronic Ignition System, 3 Amp Charging System, Rectified Only. Oil Sentry™ System. Electric Start (Solenoid Shift Starter).

Figure 8-13.



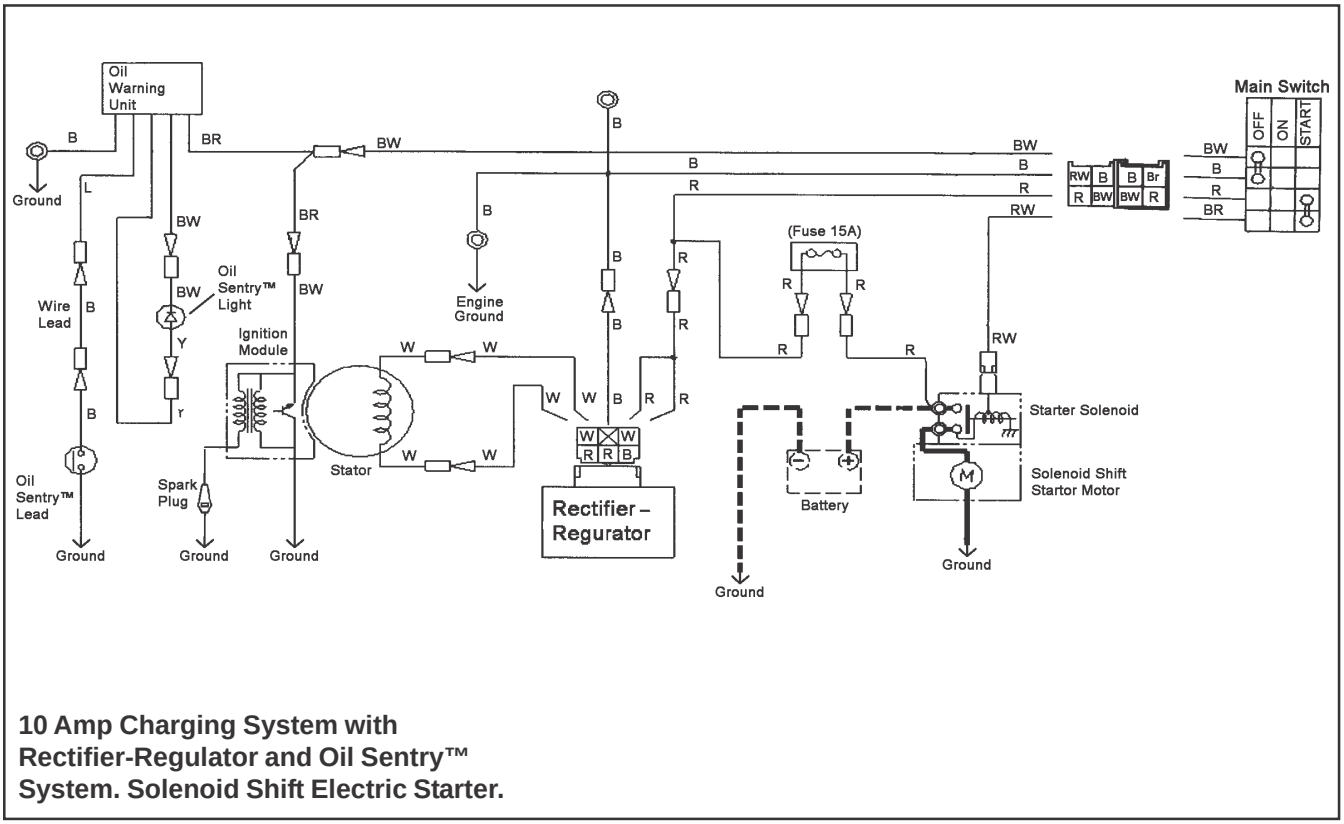
Electronic Ignition System 18 Amp Charging System, Rectified Only. Oil Sentry™ System. Recoil Start.

Figure 8-14.



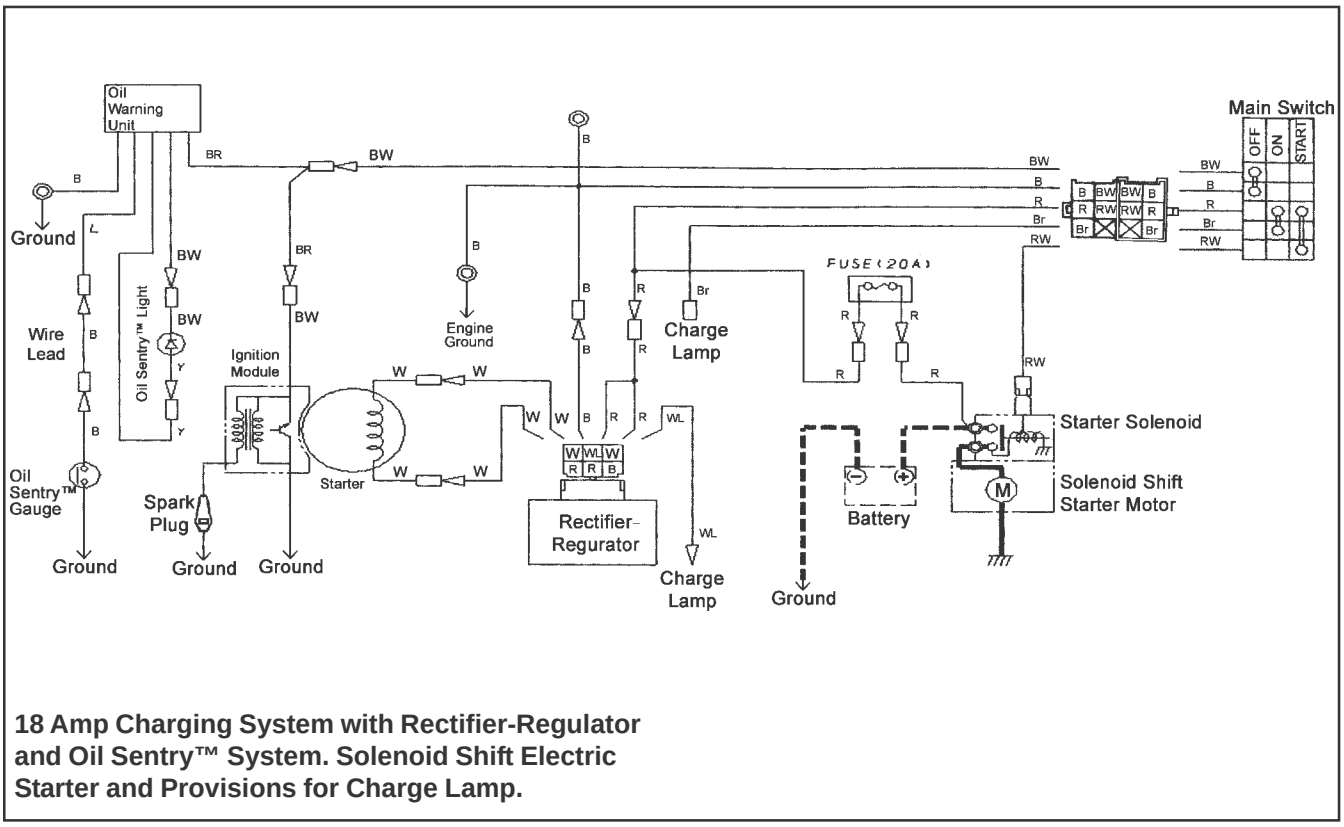
Electronic Ignition System, 10 Amp Charging System, with Rectifier-Regulator, and Oil Sentry™ System. Electric Start (Inertia Drive Starter) Special Generator Application Options.

Figure 8-15.



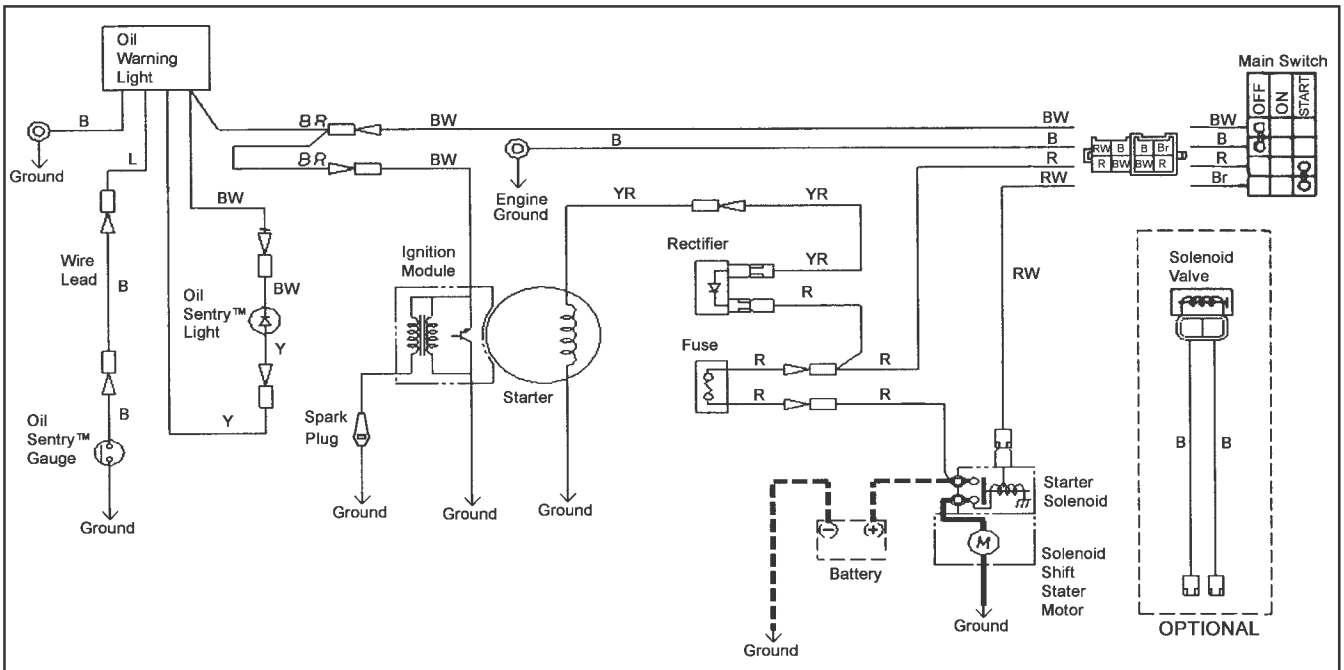
10 Amp Charging System with Rectifier-Regulator and Oil Sentry™ System. Solenoid Shift Electric Starter.

Figure 8-16.



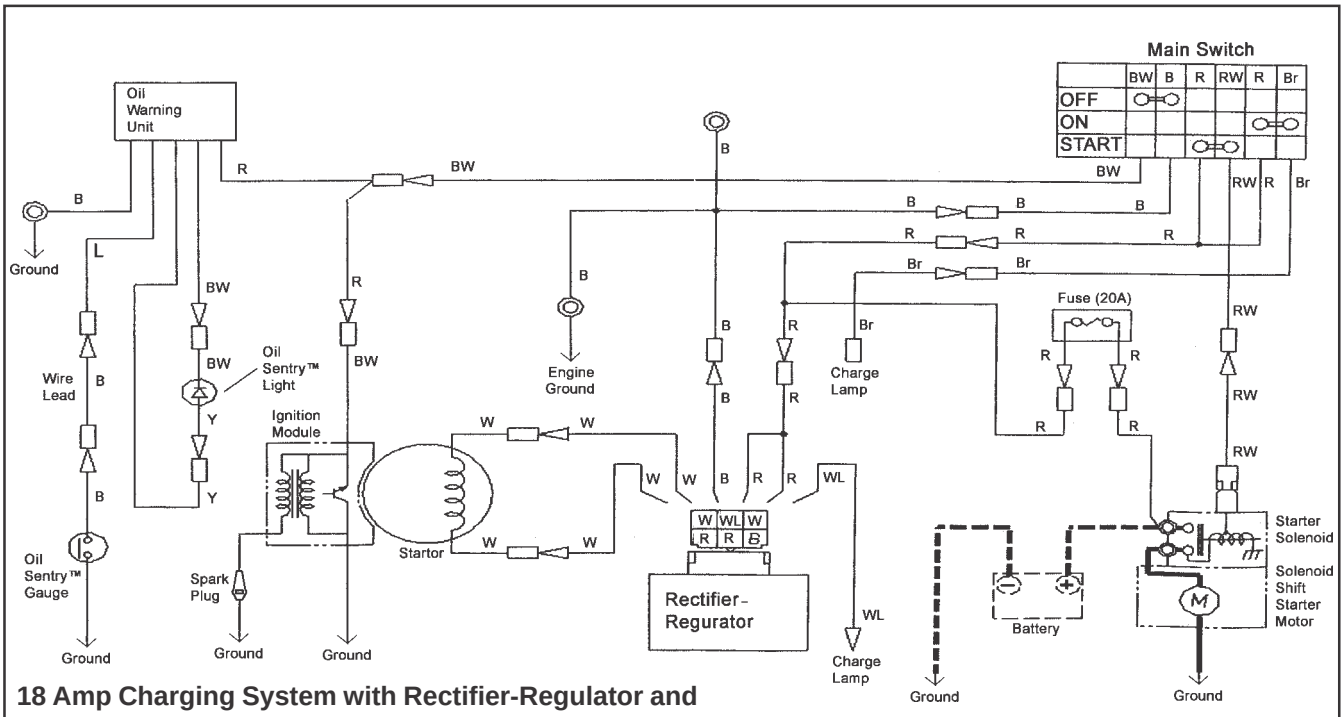
18 Amp Charging System with Rectifier-Regulator and Oil Sentry™ System. Solenoid Shift Electric Starter and Provisions for Charge Lamp.

Figure 8-17.



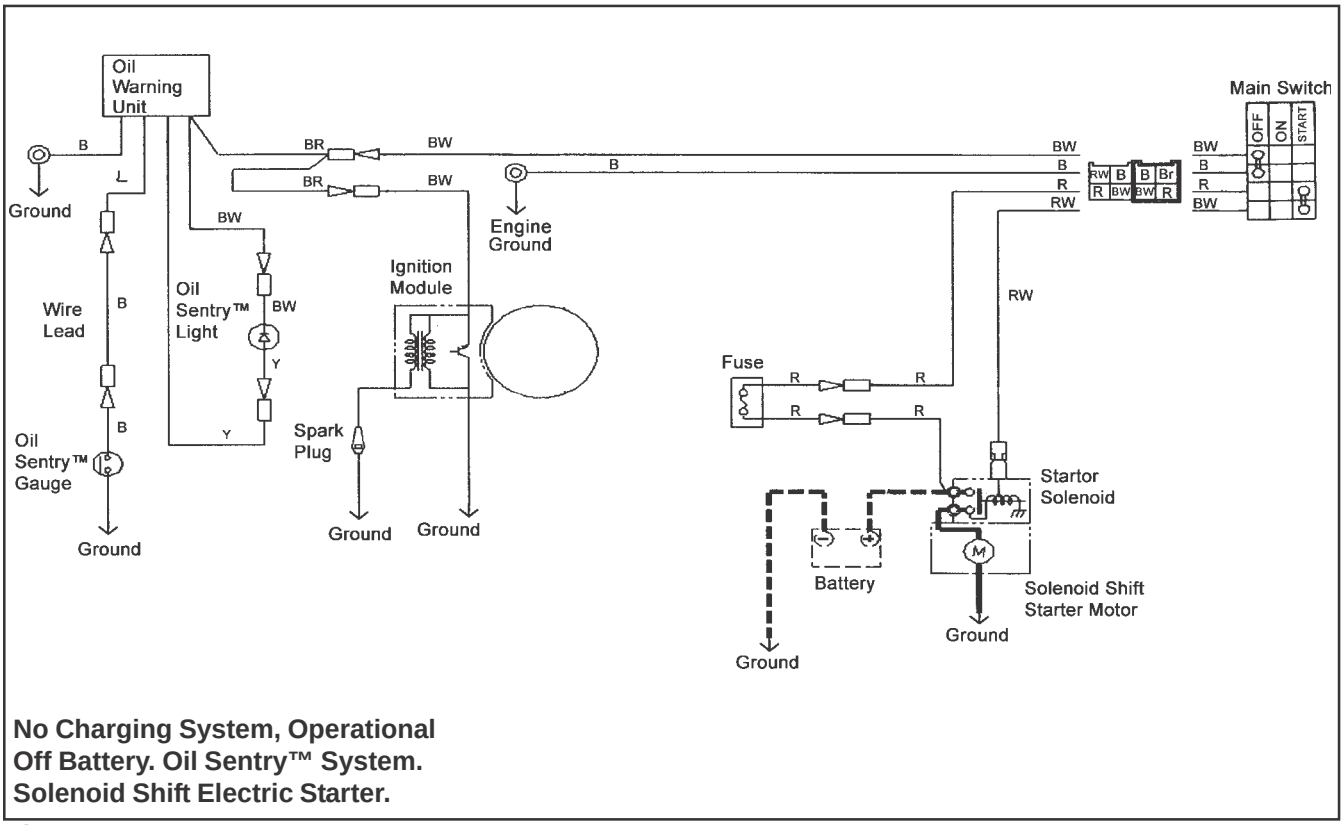
0.4 or 2 Amp Charging System-Rectified Only and Oil Sentry™ System. Solenoid Shift Electric Starter. Optional Solenoid Valve (Some Models).

Figure 8-18.



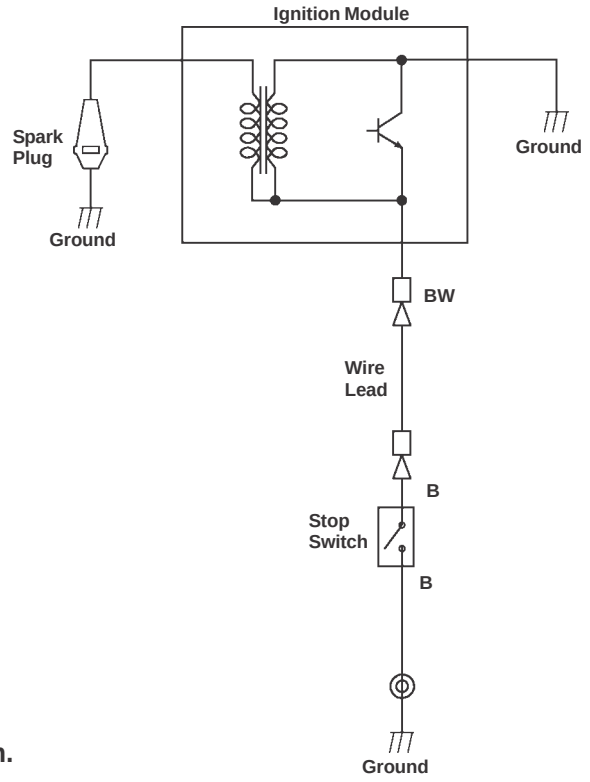
18 Amp Charging System with Rectifier-Regulator and Oil Sentry™ System. Solenoid Shift Electric Starter and Provisions for Charge Lamp. Spec. Specific Ignition Switch and Wiring Harness Connectors.

Figure 8-19.



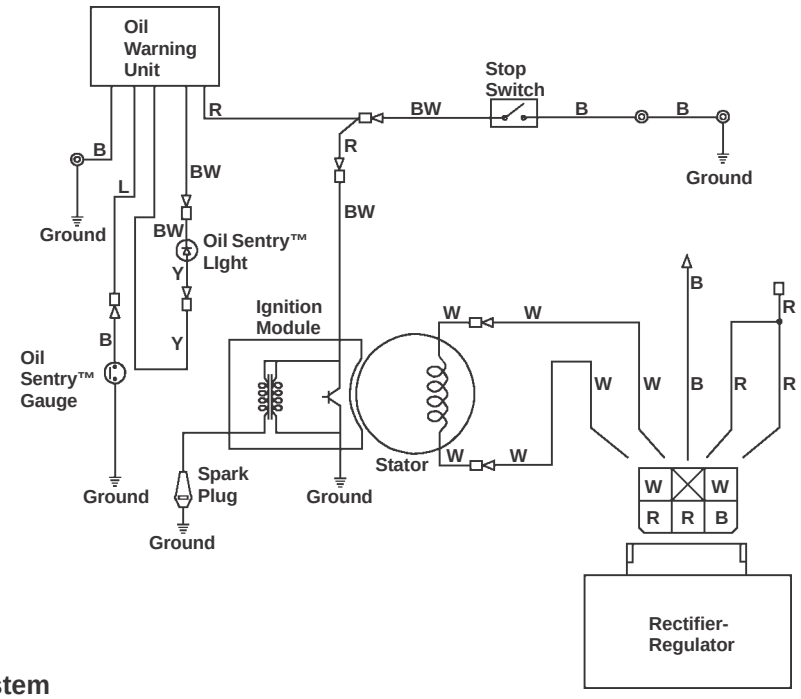
No Charging System, Operational Off Battery. Oil Sentry™ System. Solenoid Shift Electric Starter.

Figure 8-20.



Recoil Start
No Oil Sentry™ System.
Stop Switch Only.

Figure 8-21.



**10 Amp Charging System
Recoil Start Only
Oil Sentry™ System.**

Figure 8-22.

8

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

- Make sure the battery polarity is correct. A negative (-) ground system is used.
- Make sure all ground connections are secure and in good condition.
- Disconnect both battery cables before doing electrical welding on the equipment powered by the engine. Also, disconnect other electrical accessories in common ground with the engine.
- Prevent the stator (AC) leads from touching or shorting while the engine is running. This can damage the stator.

Stator

The stator is mounted on the crankcase behind the flywheel. Should the stator have to be replaced, follow the procedures in Section 9 Disassembly.

Rectifier-Regulator

The rectifier-regulator is connected to the engine with a matching wiring harness containing a plug-in connector. Grounded through the wiring harness, the rectifier-regulator is secured to the equipment in a suitable location with two mounting screws. To replace it, disconnect the plug, and remove the two mounting screws.

NOTE: When installing the rectifier-regulator, push the wiring harness plug into the regulator receptacle until it locks into place.

The rectifier-regulator converts the AC voltage coming from the stator to DC voltage, while also monitoring and controlling the battery voltage. There are two different rectifier-regulators which are used; an 18 amp and a 7/10 amp assembly. Although externally similar, the internal circuits differ and the two should not be interchanged.

18 Amp Rectifier-Regulator

The 18 amp rectifier-regulators contain a 6-terminal plug-in configuration, illustrated in Figure 8-23. The upper center terminal is the control or **monitor** terminal, through which the regulator monitors battery voltage. This terminal is connected internally to SCRs, which are turned on and off as required, controlling the battery voltage between 14 and 15 volts. The connection between the B+ (charge) lead and the monitor terminal lead is made within the wiring harness. The lower center terminal serves as a connection for a pilot lamp circuit, to indicate when the charging system is functioning.

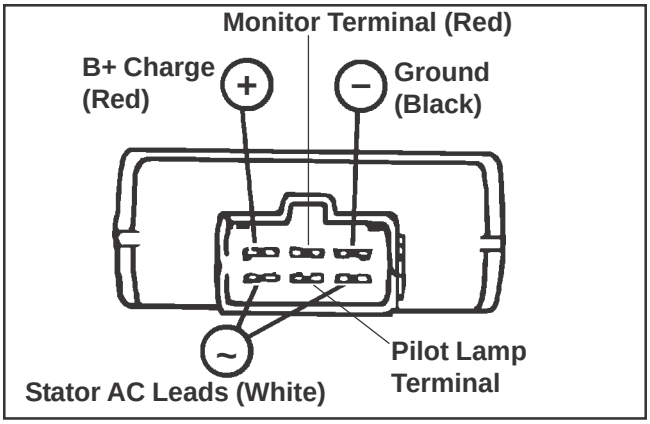


Figure 8-23. 18 Amp Rectifier-Regulator.

7/10 Amp Rectifier-Regulator

The 7/10 amp rectifier-regulators contain a 5-terminal plug-in configuration (See Figure 8-24), with two differences from the 6-terminal/18 amp system. Battery voltage is monitored by the internal circuitry of the rectifier-regulator instead of through the lead connection at the upper center location. The terminal in the upper center location serves no function. No lower center (pilot lamp) terminal exists on the 7/10 amp rectifier-regulator.

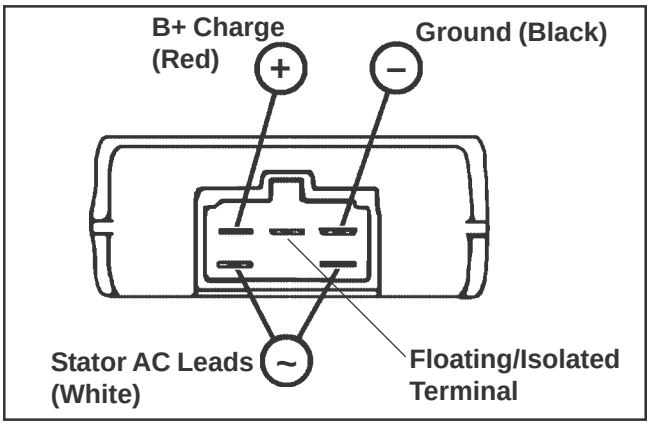


Figure 8-24. 7/10 Amp Rectifier-Regulator.

Rectified Only (Non-Regulated) Systems

Some engines are equipped with a rectified only, non-regulated charging system, with output ranging from 0.2 amp to 18 amps. The rectifier is normally connected to the engine with a matching wiring harness and secured to the equipment with a single mounting screw. Grounding is achieved through the wiring harness. In certain other applications the rectifier may be integrated within the basic engine wiring harness. The rectifier converts AC voltage coming from the stator to DC voltage only. The 3 amp rectifier is shown in Figure 8-25.

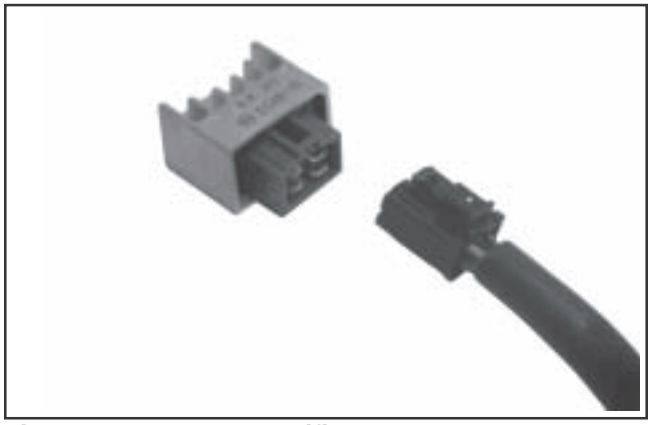


Figure 8-25. 3 Amp Rectifier.

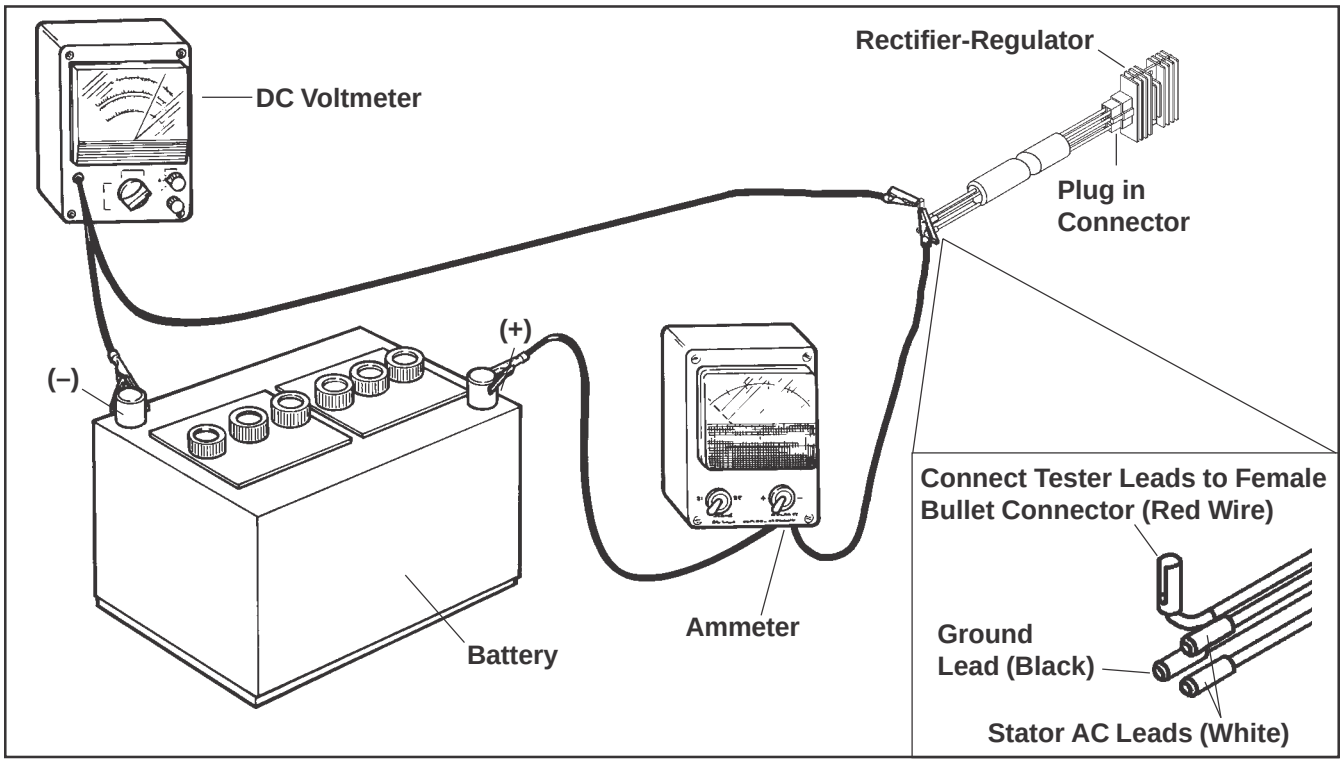


Figure 8-26. Connections for Testing Charging Systems.

Troubleshooting Guide

Battery Charging System

NOTE: Zero ohmmeters on each scale to ensure accurate readings. Voltage tests should be made with engine running at 3600 RPM - no load. Battery must be fully charged. Check the specific gravity of battery. If low, recharge or replace battery as necessary.

<table>
<tr><th>Problem</th><th>Test</th><th>Conclusion</th></tr>
<tr><td rowspan="4">No Charge to Battery</td><td>1. Refer to Figure 8-26. Separate the bullet connector in the red lead from the rectifier-regulator. Connect an ammeter from the female terminal to the positive (+) terminal of the battery. Connect a DC voltmeter from the female terminal to the negative (-) terminal of the battery. Leave the other rectifier-regulator leads connected in the normal manner. Run the engine at 3600 RPM and read the voltage on the voltmeter.

If voltage is 14.0 volts or more, place a minimum load of 5 amps* on battery to reduce voltage. Observe ammeter.

*NOTE: Turn on lights (if 60 watts or more) or place a 2.5 ohm, 100 watt resistor across battery terminals.</td><td>1. If voltage is 14.0-15.0 volts and charge rate increases when load is applied, the charging system is OK and the battery was fully charged.

If voltage is less than 14.0 volts or charge rate does not increase when load is applied, test stator (Tests 2 and 3).</td></tr>
<tr><td>2. Separate the bullet connectors in the AC (white) leads. Connect an AC voltmeter across the stator leads (female terminals). With engine running at 3600 RPM, measure the AC output from the stator.</td><td>2. If voltage is 20.0 volts or more, stator is OK. Rectifier-regulator is faulty. Replace the rectifier-regulator.

If voltage is less than 20.0 volts, stator is probably faulty and should be replaced. Test stator further using an ohmmeter (Test 3).</td></tr>
<tr><td>3a. With engine stopped, measure the resistance across stator/charging leads using an ohmmeter. Compare the meter reading obtained against the specified range, based on the charging system involved.</td><td>3a. If resistance value obtained is within the range specified the stator is OK.
<table><tr><th>Charging System</th><th>Normal Resistance (ohms)</th></tr><tr><td>1.2 and 1.6 amp</td><td>0.90 - 1.6 ohms</td></tr><tr><td>0.85 and 3.0 amp</td><td>0.28 - 0.50 ohms</td></tr><tr><td>7, 10, and 18 amp</td><td>0.10 - 0.30 ohms</td></tr></table></td></tr>
<tr><td>3b. With the engine stopped, measure the resistance from each stator lead to ground using an ohmmeter.</td><td>3b. If the resistance is infinity ohms (no continuity), the stator is OK (not shorted to ground).

If resistance (or continuity) is measured, the stator leads are shorted to ground. Replace stator.</td></tr>
<tr><td>Battery Continuously Charges at High Rate</td><td>1. Perform same test as step 1 above.</td><td>1. If the voltage is 15.0 volts or less the charging system is OK. The battery is unable to hold a charge. Service or replace battery as necessary.

If voltage is more than 15.0 volts, the rectifier-regulator is faulty. Replace the rectifier-regulator.</td></tr>
</table>

Battery

General

A 12 volt battery (not furnished) with a minimum current rating of 160 (CS4, CS6) or 200 (CS8.5-12) cold cranking amps should be sufficient for cranking most electric start engine models. The actual cold cranking requirement depends on engine size, application and starting temperatures. Cranking requirements increase as temperatures decrease and battery capacity shrinks. Refer to the operating instructions of the equipment this engine powers for specific battery requirements.

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

Battery Maintenance

Regular maintenance is necessary to prolong battery life.

WARNING: Explosive Gas!

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

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

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

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

2. Keep the cables, terminals, and external surfaces of the battery clean. A build-up of corrosive acid or grime on the external surfaces can cause the battery to self-discharge. Self-discharge occurs rapidly when moisture is present.

3. Wash the cables, terminals, and external surfaces with a mild baking soda and water solution. Rinse thoroughly with clear water.

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

Battery Test

To test the battery, you will need a DC voltmeter. Perform the following steps (See Figure 8-27).

1. Connect the voltmeter across the battery terminals.

2. Crank the engine. If the battery drops below 9 volts while cranking, the battery is discharged or faulty.

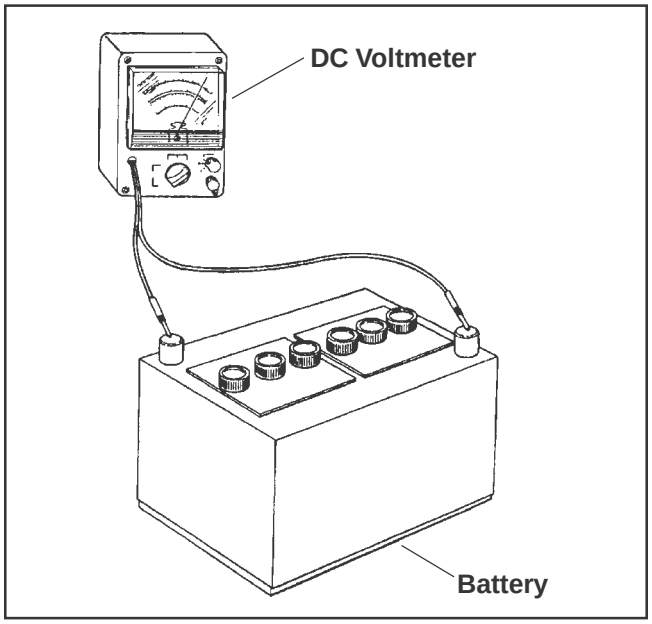


Figure 8-27. Battery Voltage Test.

Electric Starting Motors

Electric start engines in this series will use either an inertia drive, or a solenoid shift starter. Each style has its own respective starter solenoid incorporated into the mounting configuration. The inertia drive starters are covered first, beginning on page 8.25, and the solenoid shift style covered starting on page 8.31.

Starting Motor Precautions

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

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

NOTE: If the starter does not crank the engine, shut off the starter immediately. Check the condition of the inline fuse and do not make further attempts to start the engine until the condition is corrected.

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

Starter Removal and Installation

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

Troubleshooting Guide – Starting Difficulties

Problem	Possible Fault	Correction
Starter Does Not Energize	Battery	1. Check the specific gravity of battery. If low, recharge or replace battery as necessary.
	Wiring	1. Check fuse condition. 2. Clean corroded connections and tighten loose connections. 3. Replace wires in poor condition and with frayed or broken insulation.
	Starter Switch or Solenoid	1. Check the switch or solenoid operation. If starter cranks normally, replace the faulty components.
Starter Energizes But Turns Slowly	Battery	1. Check the specific gravity of battery. If low, recharge or replace battery as necessary.
	Wiring	1. Check for corroded connections, poor ground connection.
	Brushes	1. Check for excessively dirty or worn brushes and commutator. Clean using a coarse cloth (not emery cloth). 2. Replace brushes if excessively or unevenly worn.
	Transmission or Engine	1. Make sure the clutch or transmission is disengaged or placed in neutral. This is especially important on equipment with hydrostatic drive. The transmission must be exactly in neutral to prevent resistance which could keep the engine from starting. 2. Check for seized engine components such as the bearings, connecting rod, and piston.

Troubleshooting Guide – Electric Starting System

Problem	Test	Conclusion
Starter Motor Does Not Operate With Key Switch	1. Test battery on unit. a. Connect a DC voltmeter across the battery terminals and read battery voltage (key switch **off**). b. Turn key switch to **start** position and read battery voltage again. Turn switch **off**.	1. a. Battery voltage should be at least **12 volts** If low charge battery. b. Battery voltage should not fall below **9 volts** during cranking. If it does, battery may be faulty or there may be a short in the starting circuit. Have battery load tested. If battery passes load test, check circuitry.
	2. Remove the electric starter cover panel and check the fuse inside the plastic holder. The fuse outside the holder is a spare.	2. If fuse is blown, check for a wiring problem (bare wire, short circuit). Correct problem and replace fuse. Try to start engine. If it still won't start, go to step 3.
	3. Disconnect the red/white solenoid lead from red/white switch lead at the bullet connection. Be sure transmission is in neutral and PTO is **off**. Connect one end of a jumper lead to the positive terminal of the battery. Connect the other end to the terminal of the red/white solenoid lead.	3. If solenoid engages and starter begins to crank, the key switch is faulty, or there is a wiring problem to/from the key switch. Check wiring and test key switch circuits with an ohmmeter.
	4. Use a known, good, fully-charged battery and jumper cables to test starter motor. Be sure the transmission is in neutral and PTO is **off**. **Inertia Drive Starters:** Remove the heavy lead from the post terminal on the starter. Connect one end of the positive jumper cable to the post terminal and connect the other end to the positive terminal of the battery. **Solenoid Shift Starters:** Connect one end of the positive jumper cable to the positive brush lead attached to the lower stud terminal of solenoid. Connect the other end to the positive terminal of the battery. Connect one end of the negative jumper cable to the negative terminal of the battery. Touch the other end of the negative jumper cable to a bare surface on the crankcase or to the starter housing.	4. When negative jumper cable is touched to crankcase or starter housing, starter motor should operate. If it does, continue with step 5. If starter does not operate, refer to the servicing procedures for the starter motor and check out the brushes and armature. Repair or replace as required.
	5. **Inertia Drive Starters:** Disconnect the leads from the starter solenoid and remove it from the starter for testing. See Figure 8-33 on page 8.25. a. Set an ohmmeter on the Rx1 scale and zero the meter. Connect one ohmmeter lead to the terminal of the red/white lead from the solenoid. Connect the other ohmmeter lead to the solenoid mounting bracket. b. With the ohmmeter still on the Rx1 scale, connect the leads to the two large post terminals. c. Leave the ohmmeter leads connected to the large terminals. Connect a jumper lead from the positive terminal of the battery to the terminal of the red/white solenoid lead. Connect another jumper lead from the negative terminal of the battery to the solenoid mounting bracket. **Solenoid Shift Starters:** Perform the solenoid tests on page 8.24.	5. a. The resistance of the energizing coil should be at least 3.4 ohms. If the meter reading is less than 3.4 ohms, or an open circuit is indicated (infinity ohms), the solenoid is faulty and must be replaced. b. The meter should indicate an open circuit (infinity ohms, no continuity). c. When the circuit is completed, applying **12 volts** to the energizing coil, an audible click should be heard as the solenoid engages, and the ohmmeter should then indicate continuity between the large terminals. If the results are other than indicated, replace the solenoid.

Solenoid Test Procedure

Solenoid Shift Style Starters

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

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

Use a 12 volt power supply and two test leads. Connect one lead to the flat spade "S/start" terminal on the solenoid. Momentarily* connect the other lead to the lower large post terminal. See Figure 8-28. When the connection is made the solenoid should energize (audible click), and the plunger retract. Repeat the test several times. If the solenoid fails to activate, it should be replaced.

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

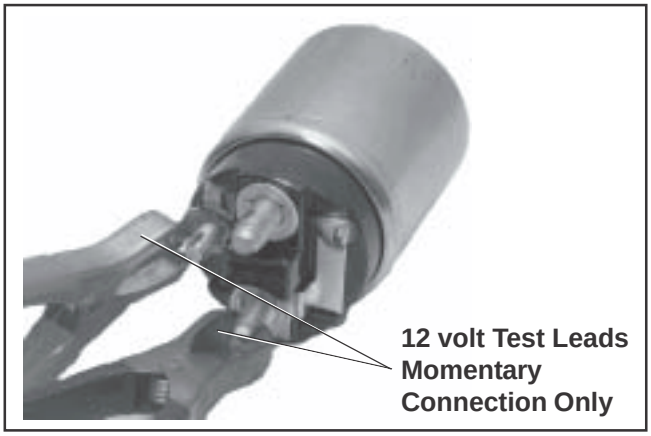


Figure 8-28. Testing Pull-In Coil/Plunger Actuation.

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

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (1) and check for continuity. See Figure 8-29. The ohmmeter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

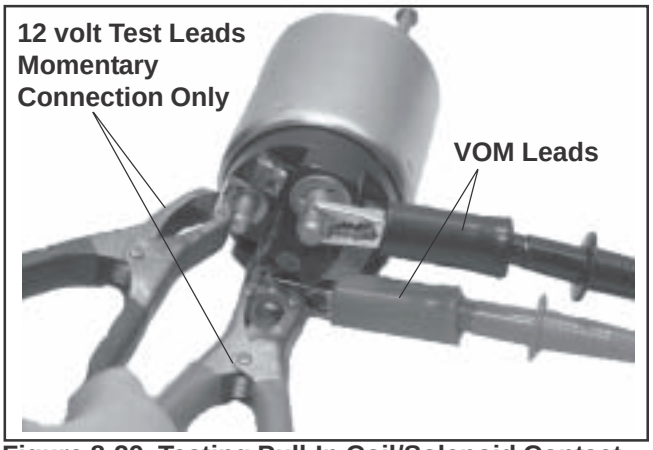


Figure 8-29. Testing Pull-In Coil/Solenoid Contact Continuity.

Test 3. Solenoid Hold-In Coil Function Test.

Connect one 12 volt test lead to the flat spade "S/start" terminal on the solenoid, and the other lead to the body or mounting surface of the solenoid. Then, manually push the plunger "In" and check if the "Hold-In" coil holds the plunger retracted. See Figure 8-30. Do not allow the test leads to remain connected to the solenoid for a prolonged period of time. If the plunger fails to stay retracted, the solenoid should be replaced.

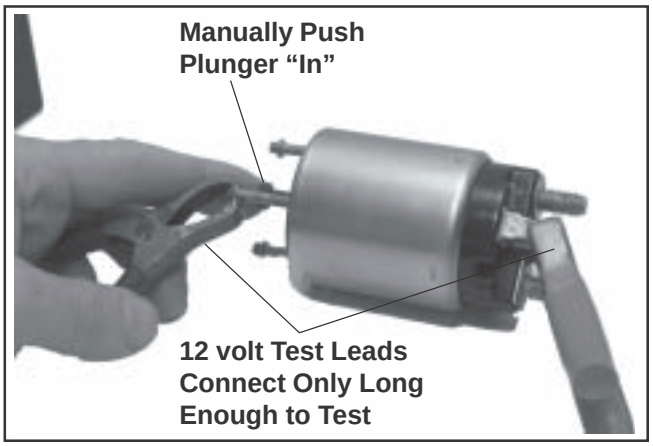


Figure 8-30. Testing Hold-In Coil/Function Test.

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

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (3) and check for continuity. See Figure 8-31. The meter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

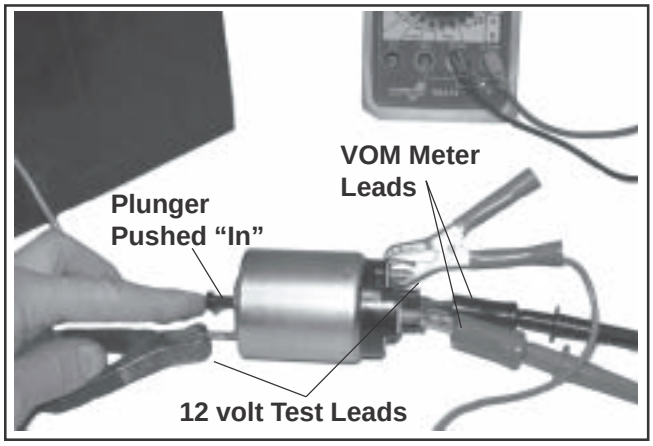


Figure 8-31. Testing Hold-In Coil/Solenoid Contact Continuity.

Inertia Drive Electric Starters

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

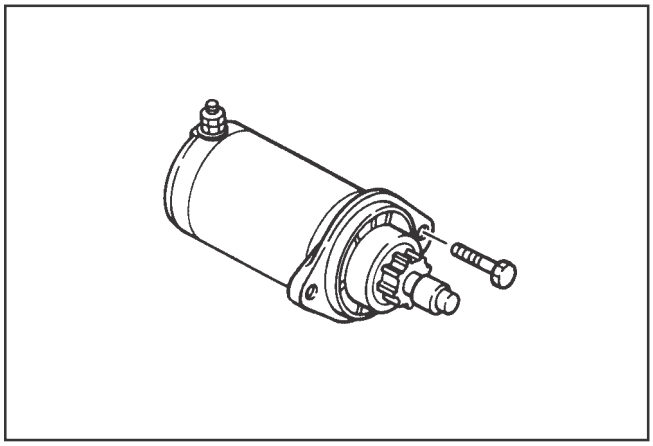


Figure 8-32. Inertia Drive Starter.

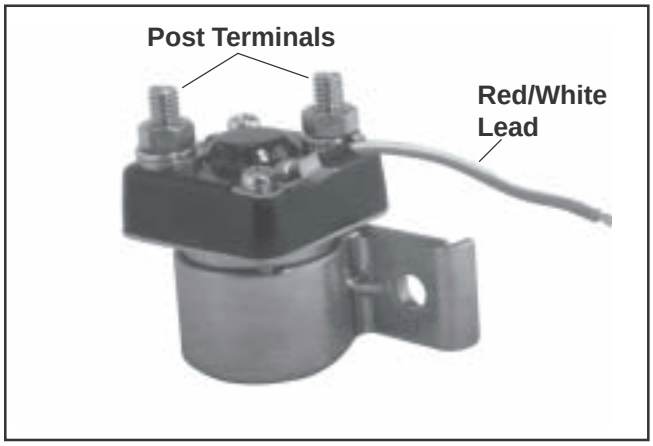


Figure 8-33. Solenoid Details.

Operation

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

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

Starter Drive Service

Every 300 hours of operation (or annually, whichever occurs first), clean and lubricate the splines on the starter drive shaft. If the drive pinion is worn, or has chipped or broken teeth, it must be replaced.

It is not necessary to completely disassemble the starter to service the drive components. Service the drive as follows:

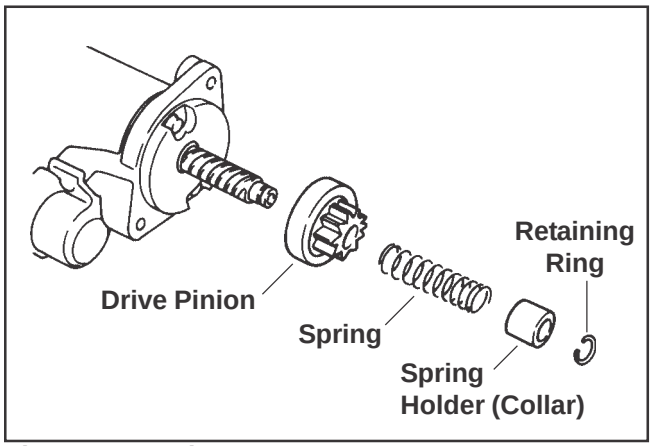


Figure 8-34. Drive Components.

1. Remove the starter from the engine.

2. Push back the spring holder (collar) to expose the retaining ring on the armature shaft, which secures the drive components. Remove the retaining ring using either of the Kohler retaining ring removal tools.

Figure 8-35. Removing Retaining Ring.

3. Remove the spring holder (collar), spring and drive pinion assembly from the armature shaft.

Figure 8-36. Disassembled Drive Components.

4. Use a solvent to thoroughly clean any dirt or old lubricant from the splines.

5. Inspect the splines and drive components for wear or damage. If the splines are damaged, it will be necessary to replace the starter. The drive components are available as individual service parts if any of them are worn or damaged.

6. Apply a small amount of molybdenum disulfide lubricant to the splines.

7. Install the drive pinion, spring, and spring holder (collar) onto the armature shaft.

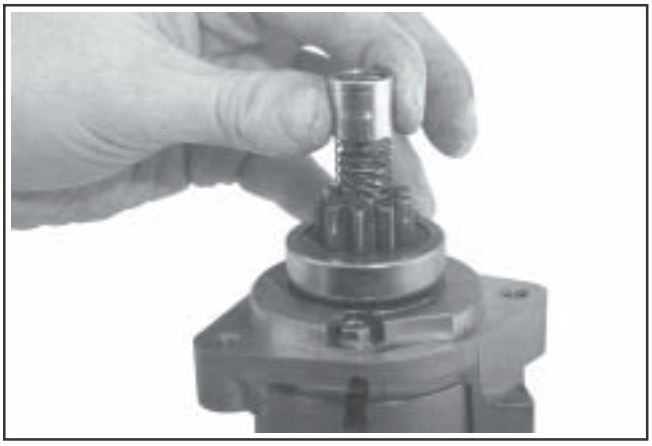


Figure 8-37. Installing Drive Components.

8. Install a new retaining ring into the groove of the armature shaft. Squeeze it with a pliers to compress it into the groove. It must fit into the recess in the end of the spring holder.

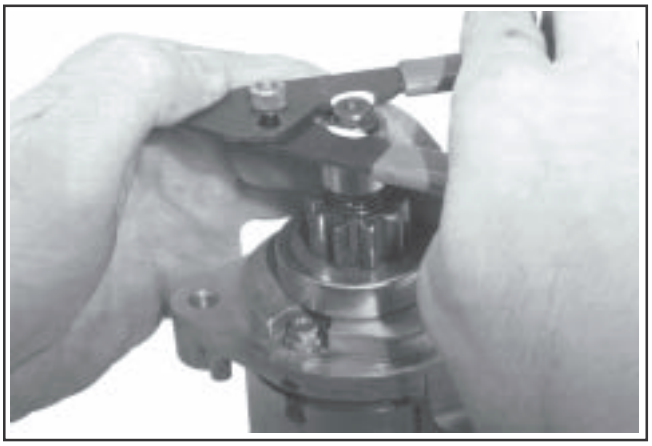


Figure 8-38. Installing Retaining Ring.

Starter Disassembly

1. Remove the retaining ring, spring holder (collar), spring, and drive pinion assembly from the armature shaft. Refer to Starter Drive Service.

2. Disconnect the solenoid lead from the starter terminal. Hold the lower jam nut from turning with a wrench while loosening the top nut, to prevent damaging internal components. See Figure 8-39. The solenoid may be removed or left in place.

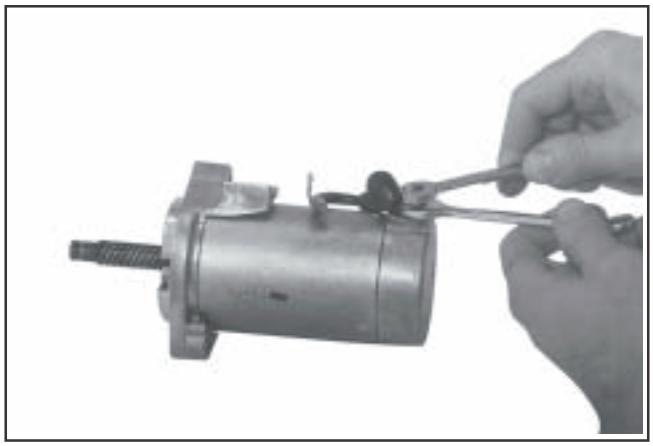


Figure 8-39. Removing Solenoid Lead.

3. Scribe or mark a small line from the starter frame to each end cap to serve as match marks for reassembly later. See Figure 8-40.

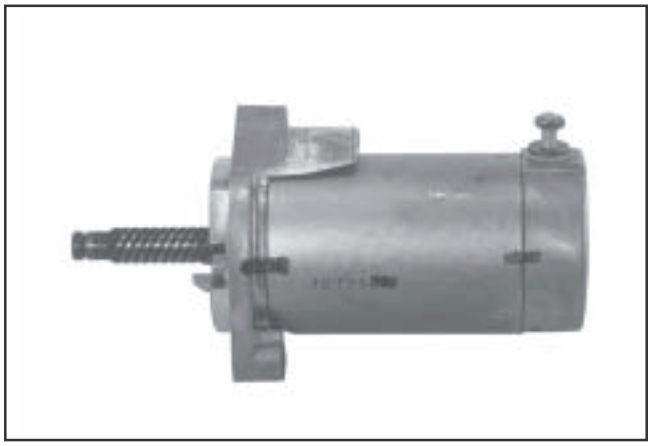


Figure 8-40. Match Marks for Reassembly.

4. Remove the two thru bolts, with sealing O-Rings, from the starter. See Figure 8-41.

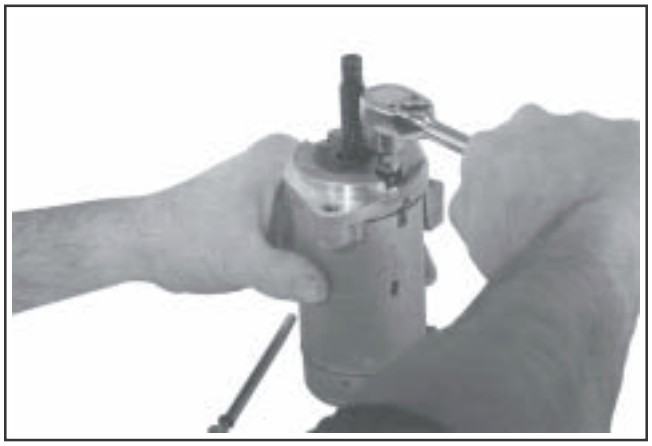


Figure 8-41. Removing Starter Thru Bolt.

5. Remove the commutator end cap and brush plate assembly. See Figure 8-42.

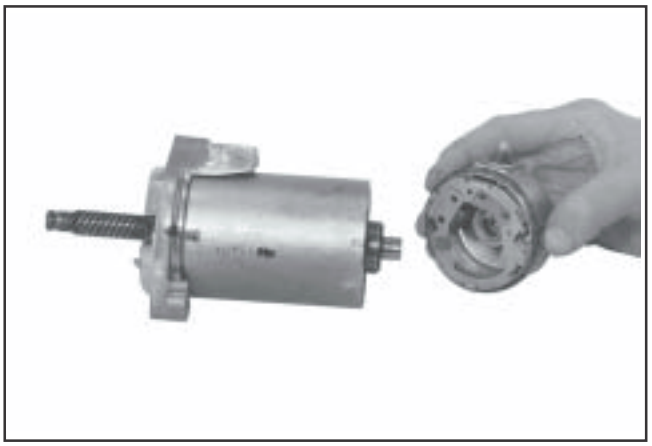


Figure 8-42. Removing End Cap with Brush Plate.

6. Pull the armature out of the starter frame.

Brush Inspection/Replacement

1. Remove the lower jam nut, metal washer, insulating washer, and O-Ring from the positive (+) stud. Carefully push the stud inward to separate the brush plate assembly from the end cap. See Figure 8-43.

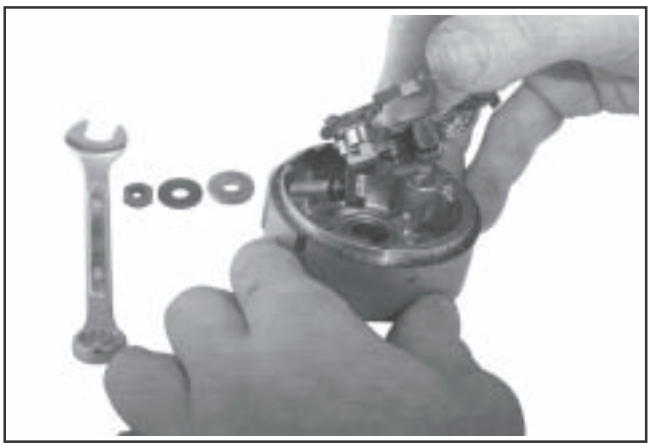


Figure 8-43. Removing Brush Plate.

2. Inspect both the springs and brushes for wear, fatigue, or damage. Measure the length of each brush. The minimum length for each brush must be **9 mm (0.350 in.)**. See Figure 8-44. Replace the brush plate assembly if the condition of parts is out of specification or questionable.

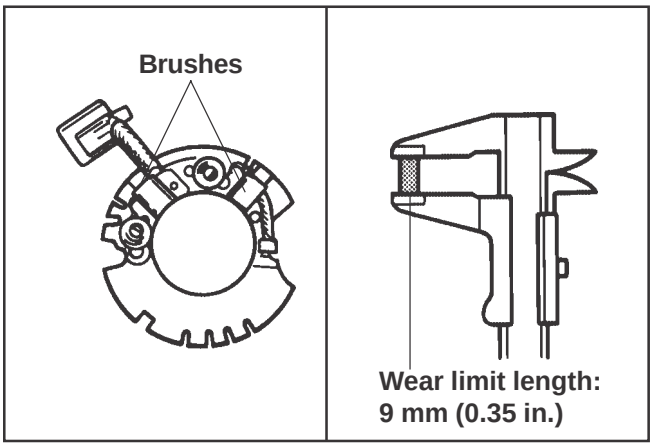


Figure 8-44. Brush Checking.

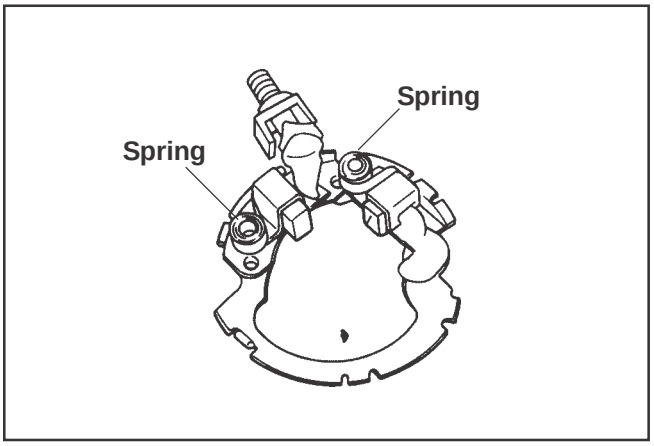


Figure 8-45. Brush Plate Details.

Armature Commutator

1. Clean and inspect commutator (outer surface). Use 600 grit sandpaper to clean if necessary.

2. Measure the mica (insulation depth between the commutator segments). The depth should be **2 mm (0.079 in.)**. If less, cut/scrape the mica to the proper measurement using a hacksaw blade or similar tool ground to fit between the segments. See Figure 8-46.

   NOTE: The mica insulation of the commutator must be undercut to ensure proper operation of the commutator.

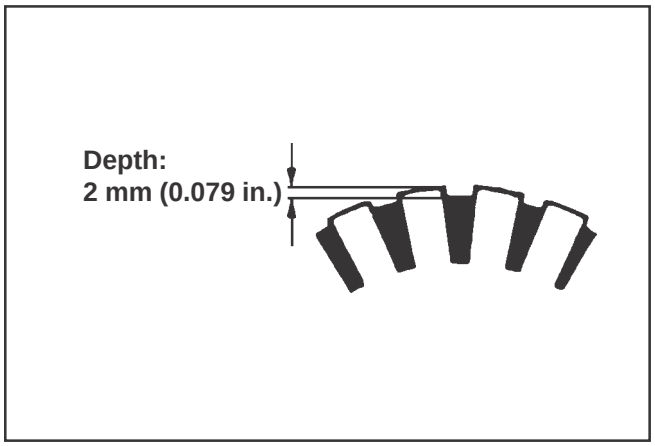


Figure 8-46. Commutator Mica Depth.

Armature Coil

1. Use an ohmmeter set to the Rx1 scale. Touch the probes between two different segments of the commutator, and check for continuity. See Figure 8-47. Test all the segments. Continuity **must** exist between all or the armature is defective.

2. Check for continuity between the armature coil segments and the commutator segments. See Figure 8-47. There should be no continuity. If continuity exists between any two, the armature is defective.

3. Check armature windings/insulation for shorting. See Figure 8-47.

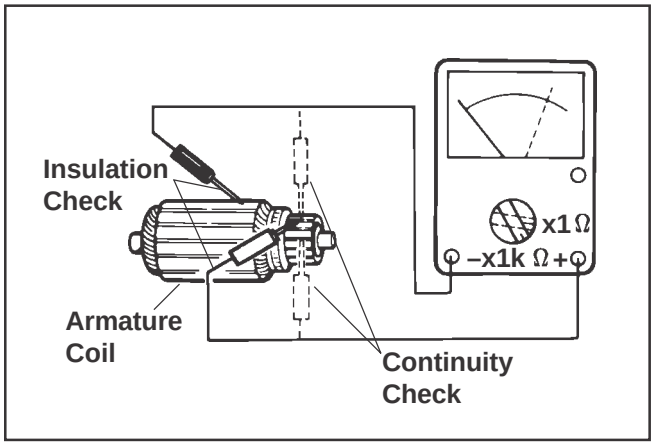


Figure 8-47. Armature Checking.

Starter Reassembly

1. Position the thrust washer in the recess inside the drive end cap. Install cover gasket on housing flange if removed previously.

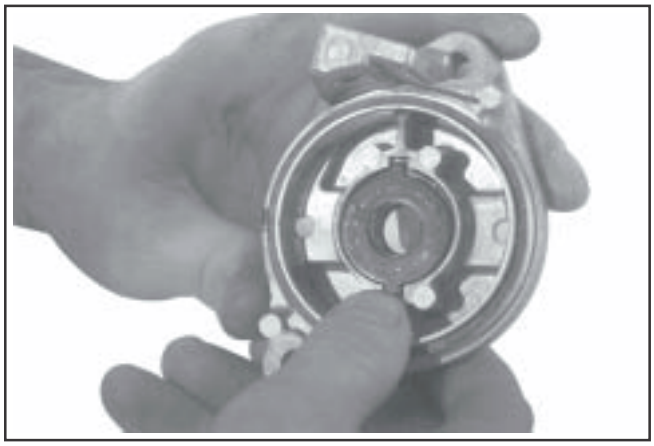


Figure 8-48. Installing Thrust Washer and Gasket.

2. Carefully apply one or two drops of oil to the bronze bushing in the drive end cap and wipe away any excess. Insert the armature shaft through the end cap.

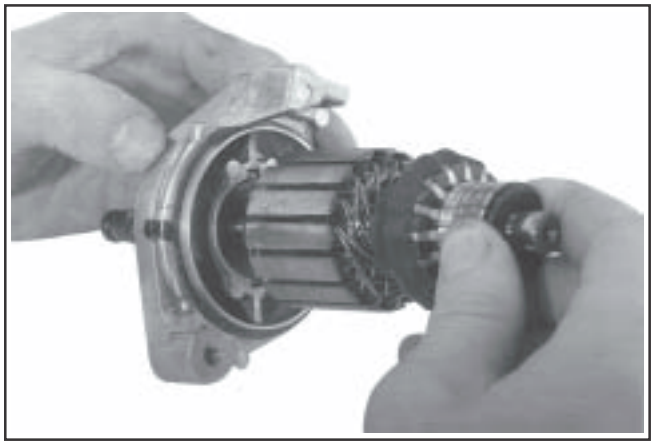


Figure 8-49. Installing Armature.

3. Install the starter frame (magnet end first) over the armature, aligning the scribed marks made earlier. See Figure 8-50.

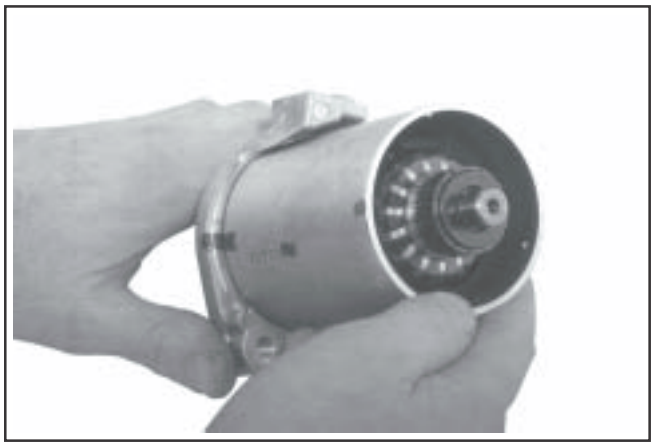


Figure 8-50. Installing Frame.

4. With the brushes and brush springs in place on brush plate, align the tabs and install the brush plate in commutator end cap. Insert the positive brush stud, with plastic support, through hole in the end cap from the inside out. Install the O-Ring, fiber washer, metal washer, and inner hex jam nut. Tighten nut to secure but **do not overtighten**, or damage to the inside plastic support can occur.

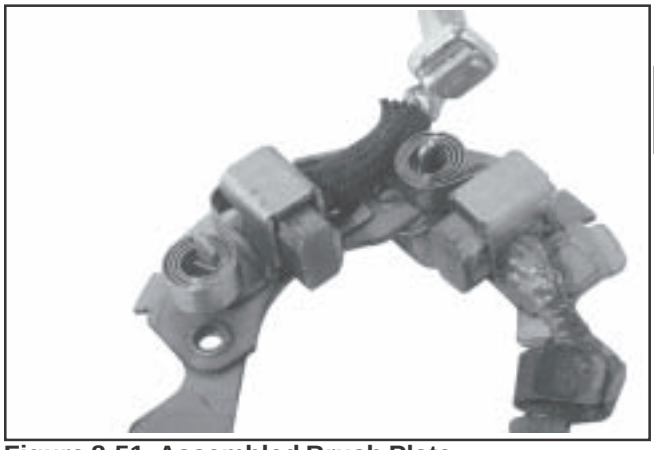


Figure 8-51. Assembled Brush Plate.

Figure 8-52. Brush Plate and Terminal Components.

5. Assemble the end cap assembly to the starter, inserting the commutator below the brushes and gently guiding the end of the armature shaft into the bushing within the end cap, against the brush spring tension. See Figure 8-53.

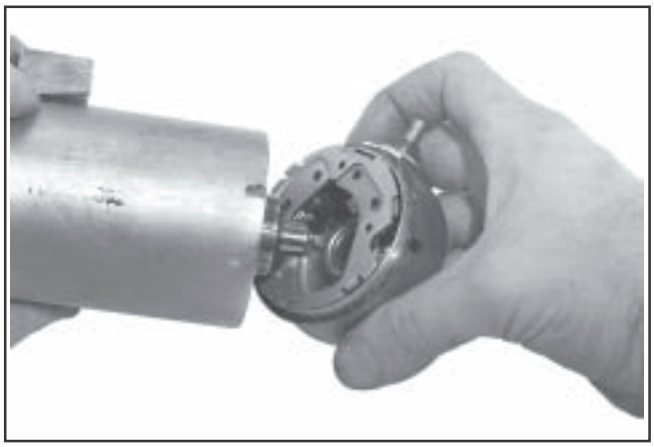


Figure 8-53. Installing End Cap Assembly.

6. Align all scribe marks and install the thru bolts with O-Rings. Torque the bolts to **5.3 N·m (48 in. lb.)**. See Figure 8-54.

Figure 8-54. Torquing Thru Bolts.

7. Attach the starter lead from the solenoid to the stud and add the lock washer and outer hex jam nut to secure. Hold the lower jam nut from turning with a wrench while tightening the top nut, to prevent damaging the internal components. See Figure 8-55.

   Reinstall the protective boot over the connection. If the solenoid was removed from the starter, reinstall it at this time, and connect the starter lead to the lower large terminal. See Figure 8-56.

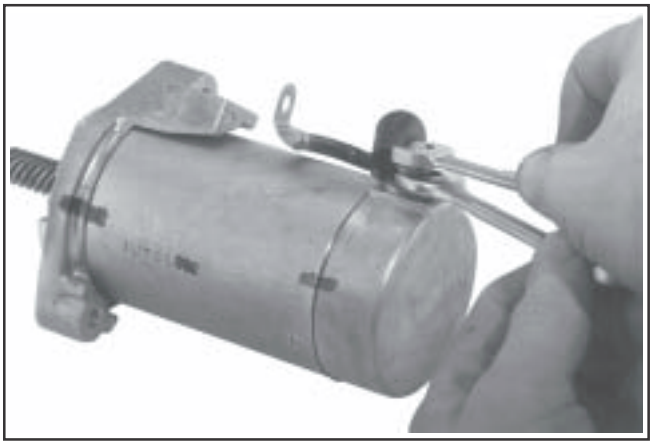


Figure 8-55. Assembling Starter Lead.

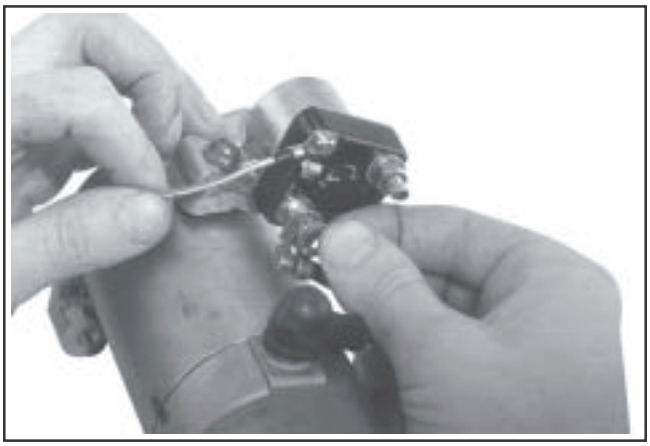


Figure 8-56. Installing Solenoid Connections.

8. Apply a light film of molybdenum disulfide to the splines of armature shaft and install the drive pinion, spring, and spring holder.

9. Push the spring holder down and install a new retaining ring into the groove of the armature shaft. Squeeze it with a pliers to compress it into the groove. It must fit into the recess in the end of the spring holder.

10. Install the starter back onto the engine. Refer to Section 11 Reassembly.

Solenoid Shift Electric Starter

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

Operation (Solenoid Shift Starter)

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

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

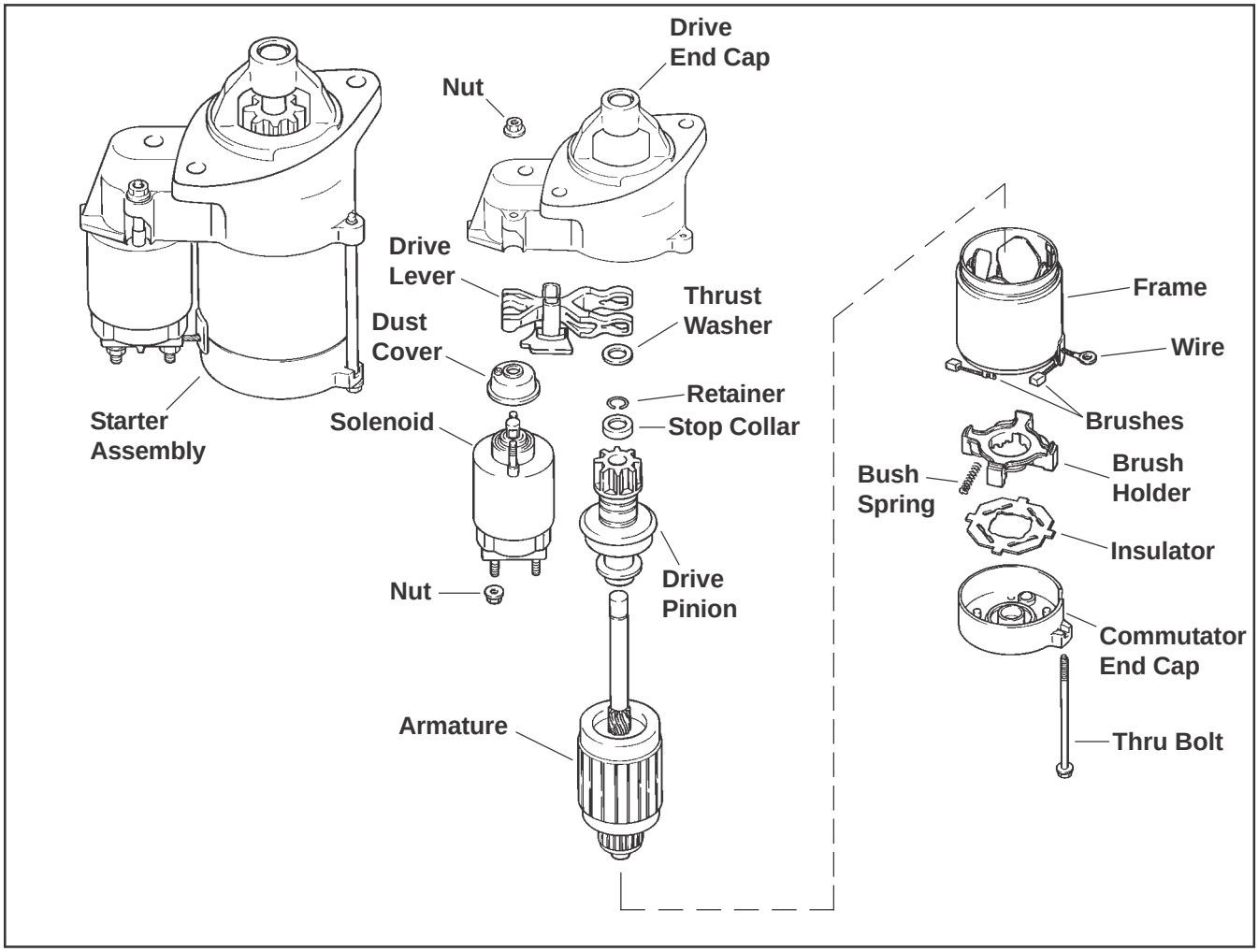


Figure 8-57. Nippendenso Solenoid Shift Starter.

Starter Disassembly

1. Remove flange nut and disconnect the braided wire from lower main solenoid terminal.

2. Remove the two hex flange nuts securing the solenoid, and carefully separate the solenoid from the starter assembly (the front end of solenoid must be lifted slightly to permit disengagement from drive lever in starter). See Figure 8-58.

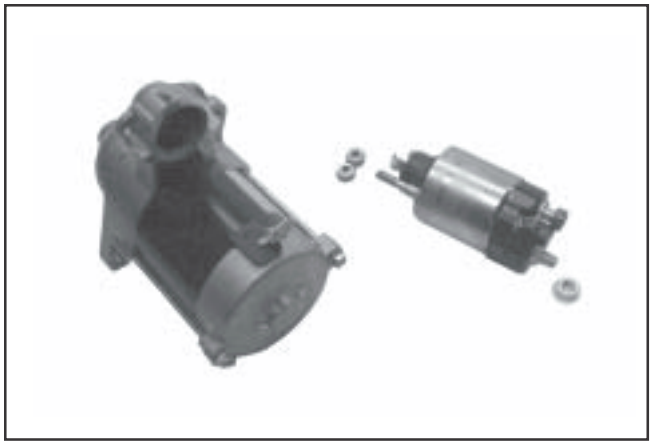


Figure 8-58. Starter with Solenoid Removed.

3. Remove the two thru bolts.

4. Remove the commutator end cap from the starter frame and the rubber insulating grommet.

5. Carefully remove the insulator and brush springs from the brush holder.

6. Lift the four brushes out of their corresponding slots and remove the brush holder.

7. Remove the frame from around the armature and drive end cap. See Figure 8-59.

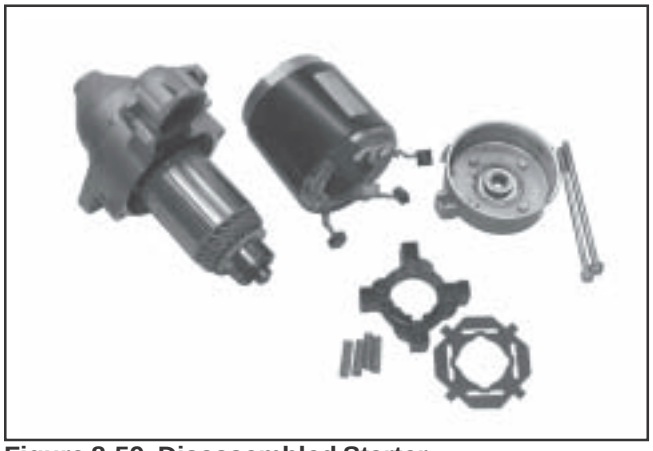


Figure 8-59. Disassembled Starter.

8. Pull outward on the pivot portion of the drive lever, and remove the drive lever and armature from the drive end cap. See Figure 8-60.

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

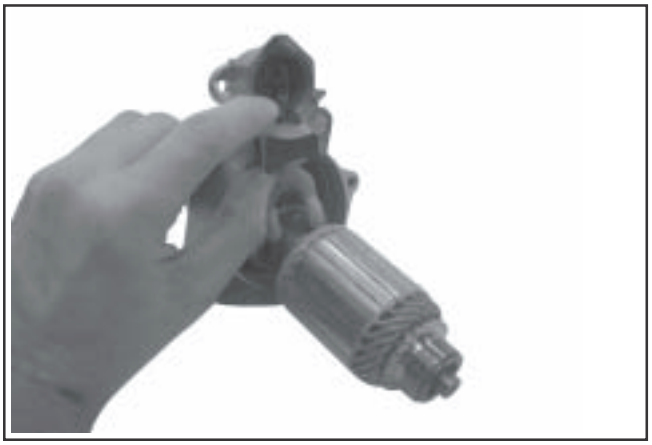


Figure 8-60. Removing Drive Lever and Armature.

9. The stop collar is held in place by being snapped over the retainer from the bottom-up. The retainer is positioned in a groove in the armature shaft. To access the retainer, the stop collar must be pushed **back** or **down** towards the drive pinion. See Figure 8-61.

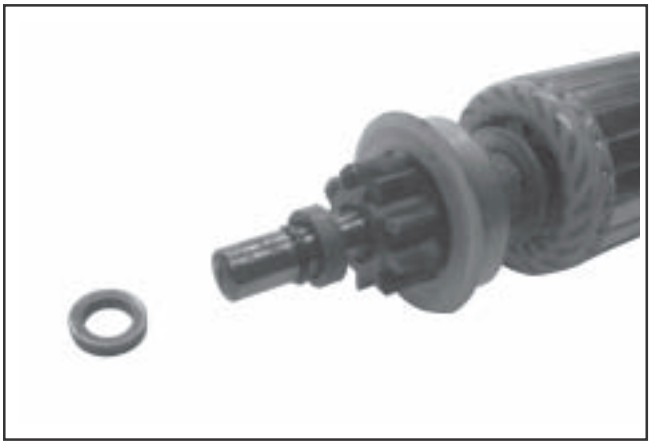


Figure 8-61. Starter Drive and Stop Components.

10. With the stop collar dislodged, the retainer can be removed from the armature shaft. Do not reuse the retainer.

11. Remove the drive pinion assembly from the armature for servicing/replacement.

12. Clean all parts and the splines on the armature as necessary.

Brush Replacement

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

1. Remove brushes from brush holder, and remove brush holder from frame.
2. Cut the brush lead wire at the edge of the post with a pair of nippers.
3. File off burrs on the post.
4. The replacement brushes have a solid portion on them which should be crimped on the post.
5. Solder the crimped portion to the post.
6. Replace the brush holder in the frame and place the brushes in the brush holder. Reinstall the springs.

Starter Service

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

Starter Reassembly

1. Install the drive pinion onto the armature shaft.
2. Slide the stop collar onto the armature shaft below the retaining ring groove. Make sure the recessed side of the stop collar is **up**.
3. Position a new retainer in the groove of armature shaft, and carefully tighten with a pliers to secure.

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

4. Use an open end wrench and slide the stop collar up until the recessed section encases the retaining ring and locks the collar into position. See Figure 8-62.

Figure 8-62. Lock Collar around Retaining Ring.

5. Install the thrust washer onto the armature shaft and lightly lubricate the end of the shaft with drive lubricant.
6. Position the lubricated drive lever around the drive pinion assembly and insert the assembly into the drive end cap. Seat the **pivot** section of drive lever into the corresponding section within the housing. See Figure 8-63.

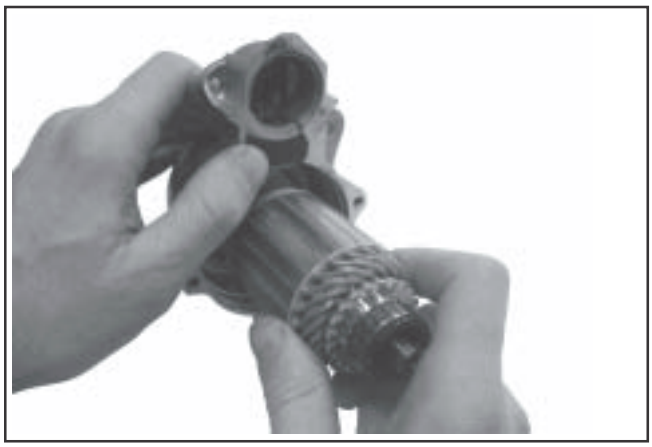


Figure 8-63. Installing Armature.

7. Mount the brush holder to rear of starter frame. Install the four brushes into the corresponding slots. Then carefully work (set) each of the four brush springs into position behind the brushes. Slide the rubber insulating grommet onto the small corresponding plastic tab on frame. See Figure 8-64.

Figure 8-64. Mounting Brush Holder to Frame.

8. Position the insulator over the brushes and springs. Hold it firmly in place so the springs do not come out. See Figure 8-65.

Figure 8-65. Holding Insulator in Place.

9. Stand the armature/drive end cap assembly on end so the commutator end is **up**. Place brush/armature installation tool over the end of armature shaft until it rests against the commutator. See Figure 8-66.

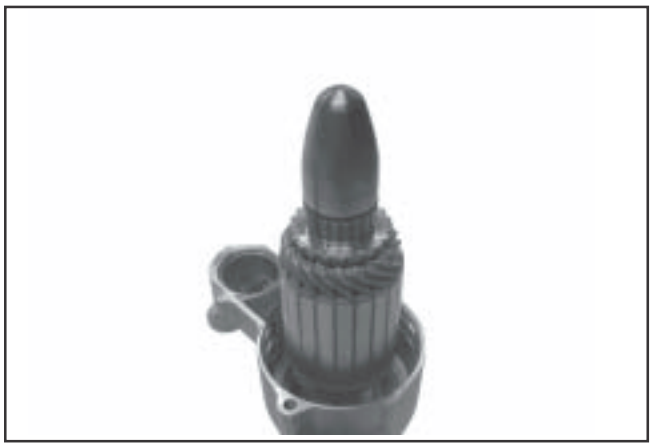


Figure 8-66. Tool on end of Armature.

10. Carefully slide the frame with the brush plate assembly down over the tool and onto armature and drive end cap, aligning the cutout with lever section (on top). The rubber insulating grommet should also be **up**. See Figure 8-67.

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

Figure 8-67. Installing Frame with Brush Plate Assembly.

11. Remove the tool and install the commutator end cap, aligning the cutout with the insulating grommet. See Figure 8-68.

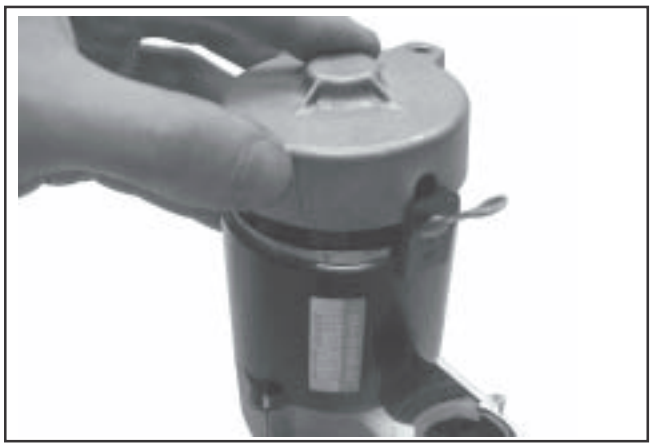


Figure 8-68. Installing End Cap.

12. Install and tighten the two thru bolts.

13. Make sure the dust cover is in place on solenoid. Install solenoid engaging the plunger end with the yoke of the drive lever. Check by pulling solenoid towards the rear. Mount the solenoid to the starter using the two hex flange nuts. Tighten securely. See Figure 8-69.

Figure 8-69. Installing Thru Bolts.

14. Connect the braided (brush) lead to lower main solenoid terminal and secure with the loose hex flange nut. See Figure 8-70.

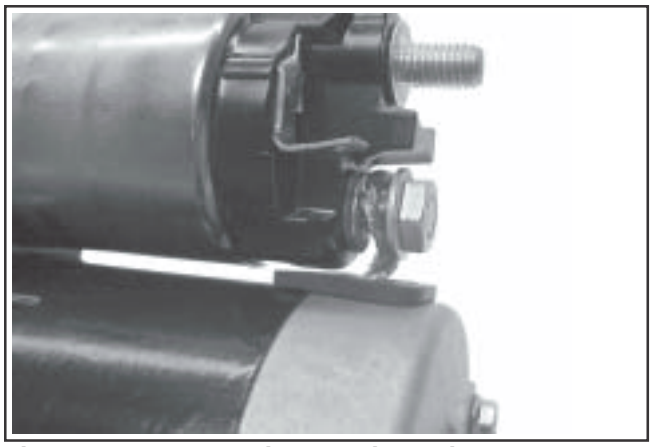


Figure 8-70. Connecting Brush Lead.

Section 9
Disassembly

WARNING: Accidental Starts!

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

General

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

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

Typical Disassembly Sequence

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

1. Disconnect spark plug lead.
2. Turn fuel shut-off valve to **off** position.
3. Drain oil from crankcase.
4. Remove muffler and heat shield assembly.
5. Remove air cleaner assembly.
6. Remove fuel tank and fuel tank support.
7. Remove external governor, throttle, and choke linkage.
8. Remove carburetor.
9. Remove retractable starter.
10. Remove blower housing.*
11. Remove right fuel tank bracket, switch bracket, electric starter, and housing/cover panel assembly.
12. Remove left fuel tank bracket.
13. Remove governor lever and throttle linkage.
14. Remove valve cover/breather, air shroud, cylinder head assembly, and push rods.
15. Remove flywheel.
16. Remove ignition module.
17. Remove stator and protective shield.
18. Remove reduction assembly.
19. Remove closure plate.
20. Remove balance shaft assembly.
21. Remove camshaft and valve tappets.
22. Remove connecting rod with piston and rings.
23. Remove crankshaft.
24. Remove governor cross shaft.
25. Remove oil seals and bearings.

* Loosening/removing the electric starter cover panel will provide access to upper housing mounting screw.

Disconnect Spark Plug Lead

1. Disconnect the lead from the spark plug. See Figure 9-1.

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

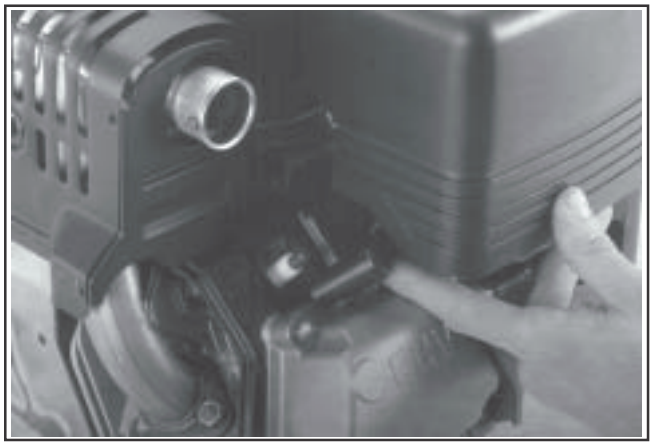


Figure 9-1. Disconnecting Spark Plug Lead.

Turn Fuel Shut-Off Valve to Off Position

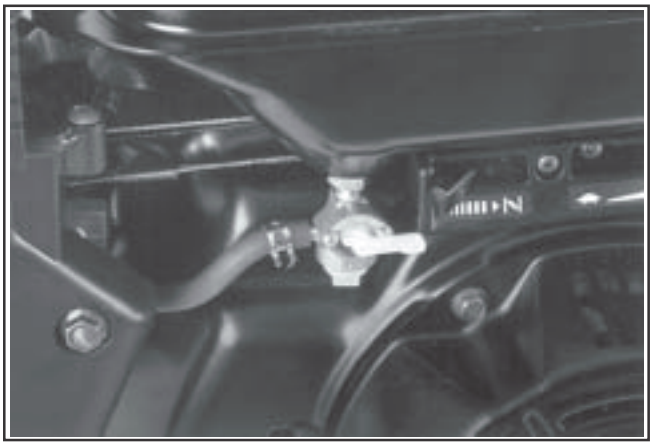


Figure 9-2. Fuel Shut-Off Valve.

Drain Oil From Crankcase

1. Remove one of the oil drain plugs and one of the oil fill caps.

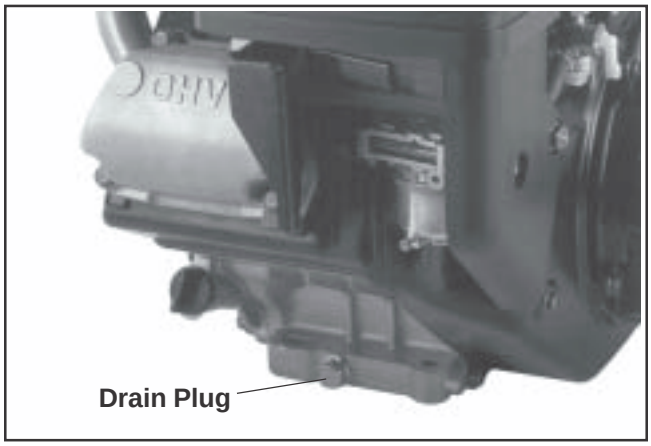


Figure 9-3. Oil Drain Plug.

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

3. On engines with a 2:1 reduction system, tip the engine toward the flywheel to drain most of the oil out of the reduction housing; then drain out of the crankcase.

Remove Muffler and Heat Shield Assembly

1. Remove the hex nuts from the exhaust studs and the hex flange screw from the muffler bracket.

2. Remove the muffler assembly from the exhaust outlet.

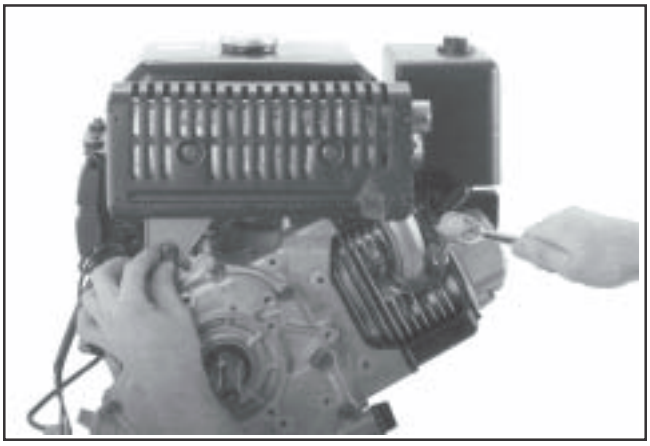


Figure 9-4. Removing Muffler.

3. Remove the exhaust gasket from the outlet.

Remove Air Cleaner Assembly

Remove the air cleaner components from the air cleaner base as outlined in Section 4.

Remove the air cleaner base from engine as follows:

1. Remove the hex flange screw(s) securing the air cleaner base to the mounting bracket(s), based on the specific model involved. See Figures 9-5, 9-6, and 9-7.

Figure 9-5. CS4, CS6 Air Cleaner Base.

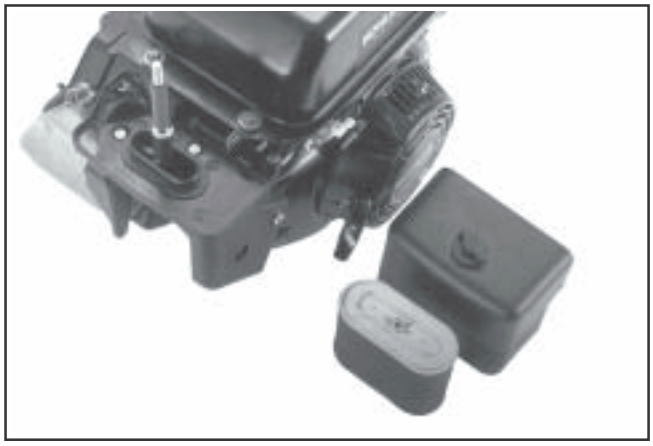


Figure 9-6. CS8.5 (spec. 92xxxx), CS10, and CS12 Air Cleaner Base.

Figure 9-7. CS8.5 (spec. 95xxxx) Air Cleaner Base.

2. Remove the two hex flange nuts securing the base to the carburetor mounting studs.

3. Disconnect one end of the breather hose from the valve cover or air cleaner base.

4. Pull the air cleaner base off the studs.

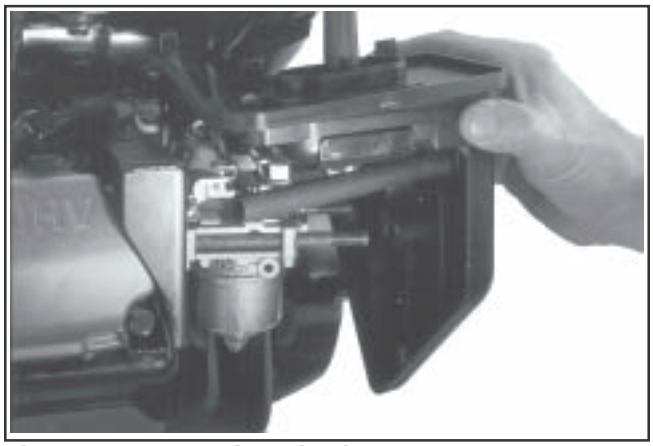


Figure 9-8. Removing Air Cleaner Base.

Remove Fuel Tank

1. Make sure the fuel tank is empty. If the fuel shut-off valve is mounted directly to tank, close the valve. See Figure 9-2.

2. Loosen the clamp and disconnect the fuel line from the outlet of shut-off valve (fuel tank mounted valves) on CS4, CS6, CS8.5 (spec. 92xxxx), CS10, and CS12 engines. See Figure 9-9. On the CS8.5 (spec. 95xxxx) loosen the clamp and disconnect the fuel line from the inlet of the shut-off valve (blower housing mounted valves). See Figure 9-10.

Figure 9-9. Disconnecting Fuel Line on CS4, CS6, CS8.5 (spec. 92xxxx), CS10, and CS12.

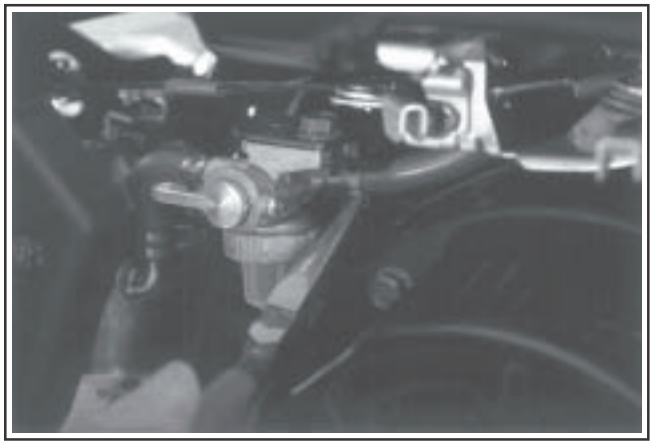


Figure 9-10. Disconnecting Fuel Line on CS8.5 (spec. 95xxxx).

3. Remove the four fuel tank mounting screws and lift off the fuel tank assembly.

4. On CS8.5 (spec. 95xxxx) remove the five screws and washers securing the fuel tank support to the crankcase, and the single screw into the throttle control bracket. Lift off the fuel tank support. See Figure 9-11.

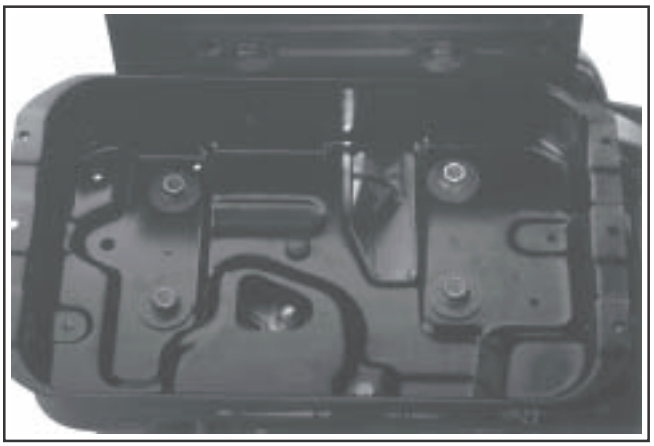


Figure 9-11. CS8.5 (spec. 95xxxx) Fuel Tank Support.

Remove External Governor, Throttle, and Choke Linkage

1. Carefully lift up and unhook the choke link and spring from the choke lever on the carburetor **(CS8.5, CS10, and CS12 only)**. The choke link may stay connected on **CS4 and CS6 engines**.

Figure 9-12. Disconnecting Choke Link and Dampening Spring from CS8.5-CS12 Carburetor.

2. Loosen the hex flange screw securing the governor lever to the governor shaft.* Mark which hole location the governor spring is in. Lift off the governor lever with throttle linkage and spring attached, unhooking the governor spring from the throttle lever. Unhook the throttle linkage and dampening spring from the carburetor throttle shaft.

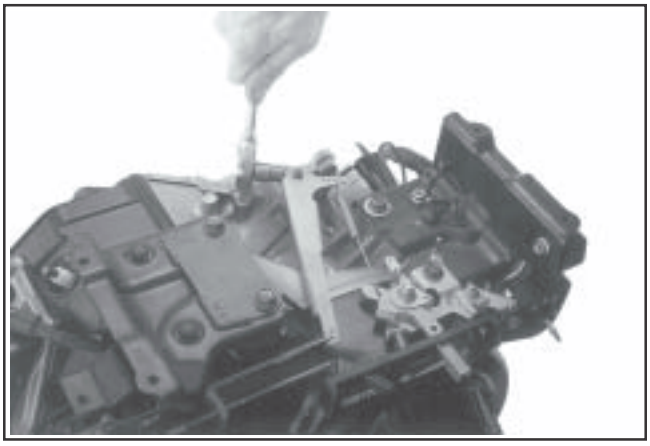


Figure 9-13. Loosening Governor Lever.

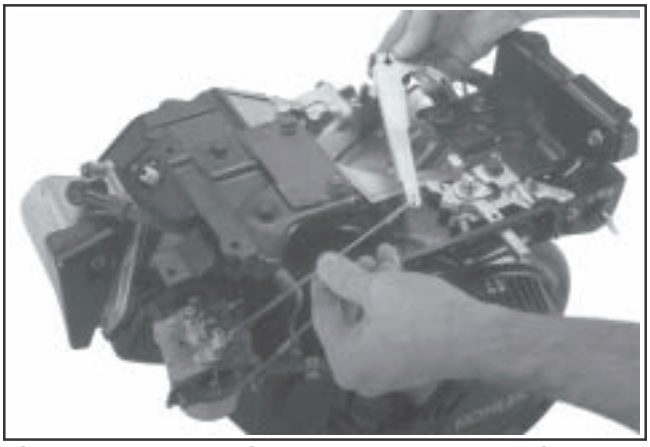


Figure 9-14. Removing Governor Lever and Linkage.

3. On CS8.5 (spec. 95xxxx) remove the single hex flange screw securing the throttle control bracket to the crankcase. See Figure 9-15.

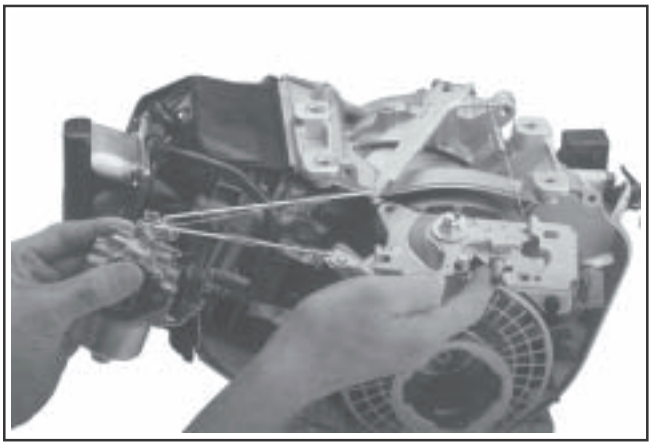


Figure 9-15. Removing Control Bracket on CS8.5 (spec. 95xxxx).

Remove Carburetor

WARNING:

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

1. Remove the air cleaner base gasket from the two mounting studs.
2. Pull the carburetor outward and off the mounting studs.
3. Remove the outer gasket, spacer block, and inner gasket from the studs.

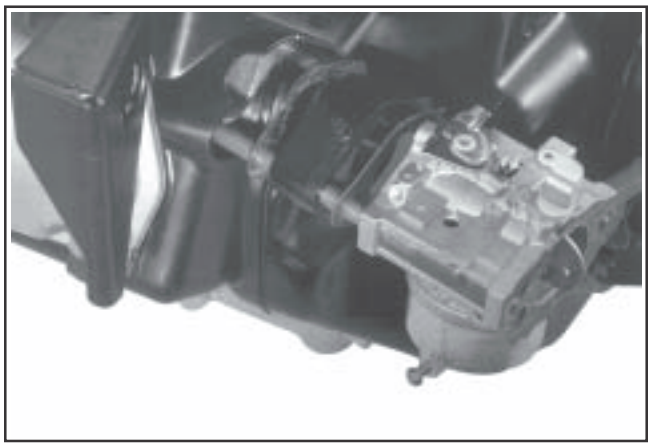


Figure 9-16. Removing Carburetor, Gaskets, and Spacer.

*If you want to remove the carburetor without disturbing the governor lever mounting, proceed as follows.

1. Gently hold the governor lever in the **full throttle** (left/clockwise) position.
2. Pull the carburetor outward and off the mounting studs. Tilt the carburetor and disconnect the throttle link and dampening spring from the throttle lever. See Figure 9-17.

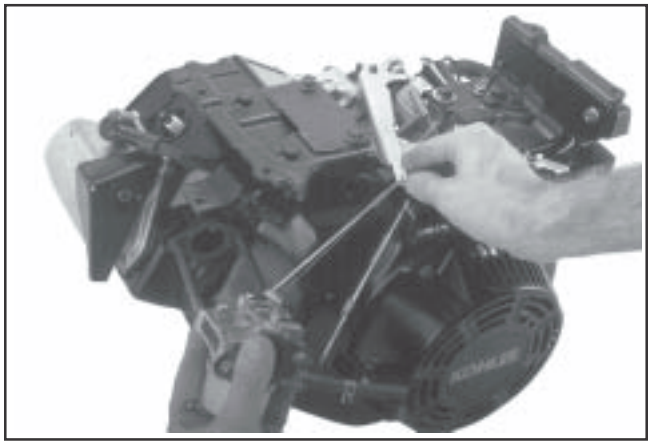


Figure 9-17. Removing Carburetor Without Governor Lever Removal.

Remove Retractable Starter

1. Remove the hex flange screws securing the retractable starter to the blower housing. See Figure 9-18.

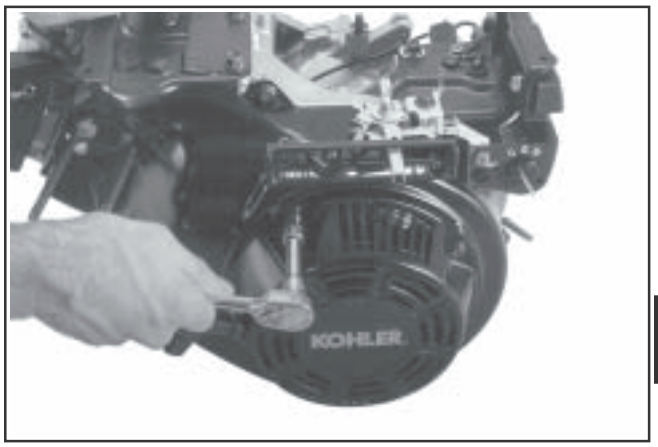


Figure 9-18. Removing Starter Mounting Screws.

Remove Blower Housing

1. Remove the hex flange screws securing the blower housing. The screw in the upper right-hand position may also secure a ground lead on some models. See Figures 9-20 and 9-21.

   NOTE: On models with electric starters, loosening or removing the starter cover panel mounting screws will allow easier access to the screw in the upper right-hand position.

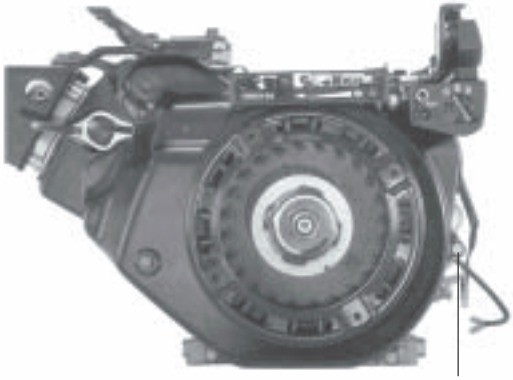


Figure 9-19. CS8.5, CS10, and CS12 Blower Housing Screws.

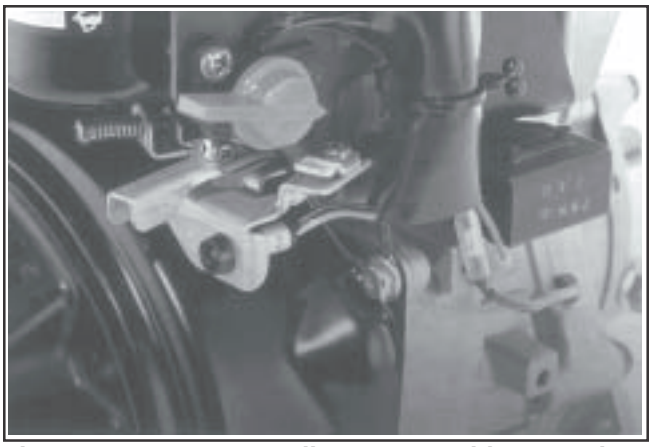


Figure 9-20. CS4, CS6 Silver Screw with Ground Lead.

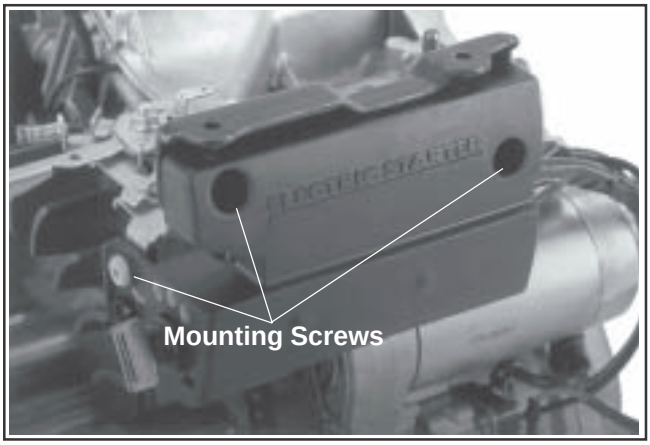


Figure 9-21. Cover Panel Mounting Screws.

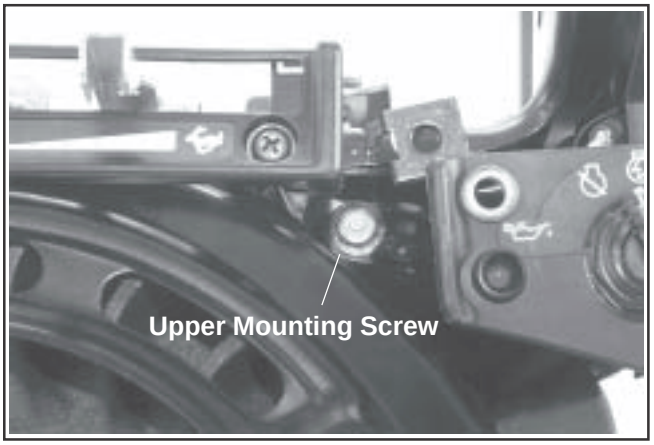


Figure 9-22. CS8.5 (spec. 92xxxx), CS10, and CS12 Upper Right-Hand Mounting Screw.

2. Pull the blower housing off.

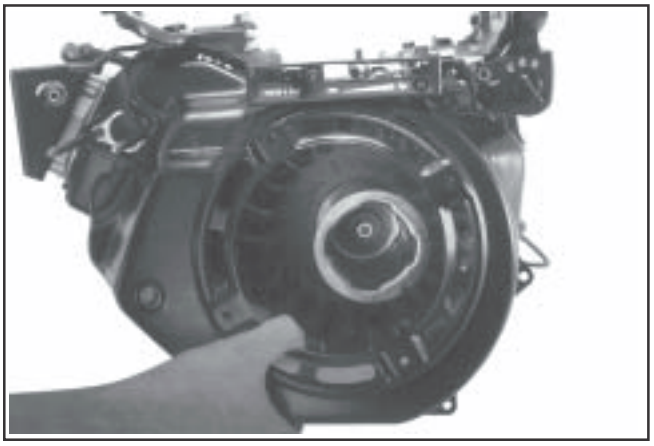


Figure 9-23. Removing the Blower Housing.

Remove Right Fuel Tank Bracket (if so equipped), Switch Bracket, Electric Starter, and Housing/Cover Panel Assembly

1. Disconnect the wiring harness bullet connectors for the oil sentry and ignition module. Remove the mounting screw securing the ground lead. See Figures 9-24 and 9-25. Disconnect the rectifier-regulator lead connections if used.

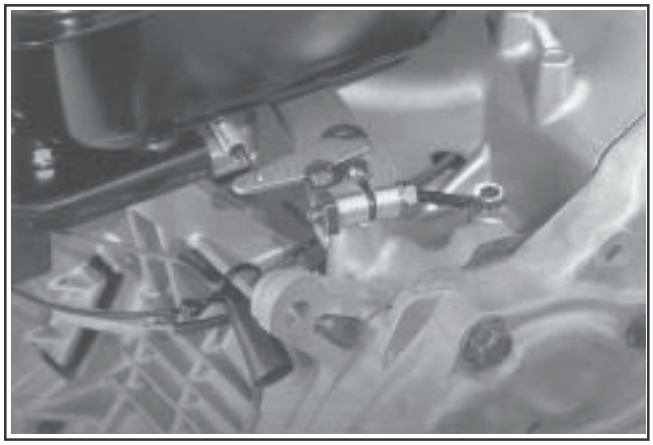


Figure 9-24. CS8.5 (spec. 92xxxx), CS10, and CS12 Ground Lead Location.

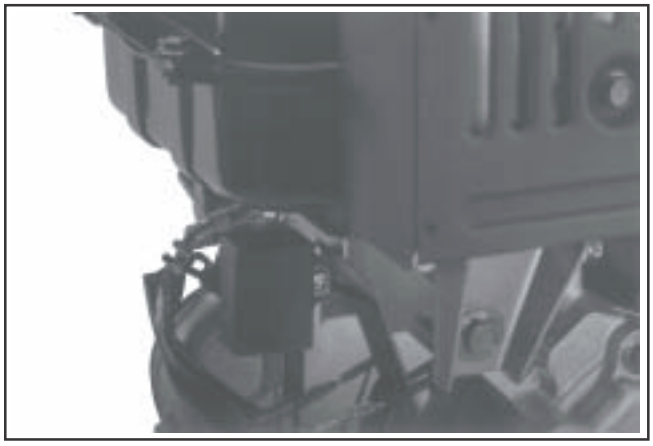


Figure 9-25. CS8.5 (spec. 95xxxx) Ground Lead Location.

2. Remove the two front fuel tank bracket (not used on CS8.5 [spec. 95xxxx]) mounting screws, attaching the throttle lever mechanism, switch and oil sentry light bracket. On electric start engines the electrical control panel housing will also be included. Note the washer used on PTO side screw only. See Figure 9-31.

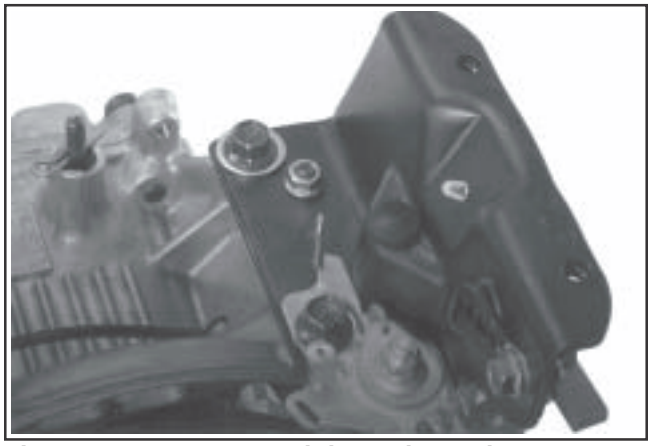


Figure 9-26. CS4, CS6 Right Tank Bracket Mounting Details.

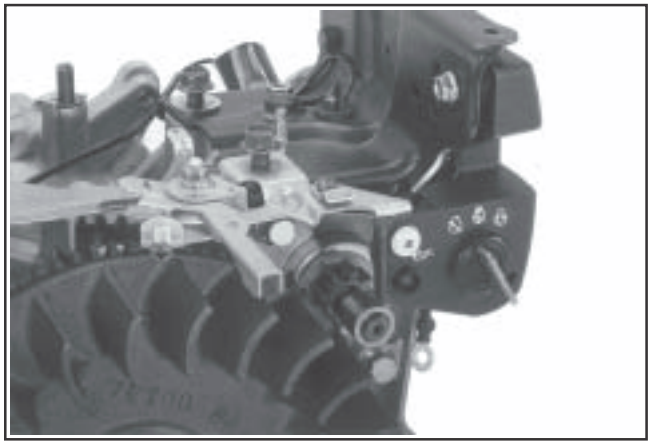


Figure 9-27. CS8.5 (spec. 92xxxx), CS10, and CS12 Right Tank Mounting Bracket Details.

Electric Start Engines Only

3. Remove the two screws securing the control panel and mounting bracket for the electrical components. See Figure 9-28.

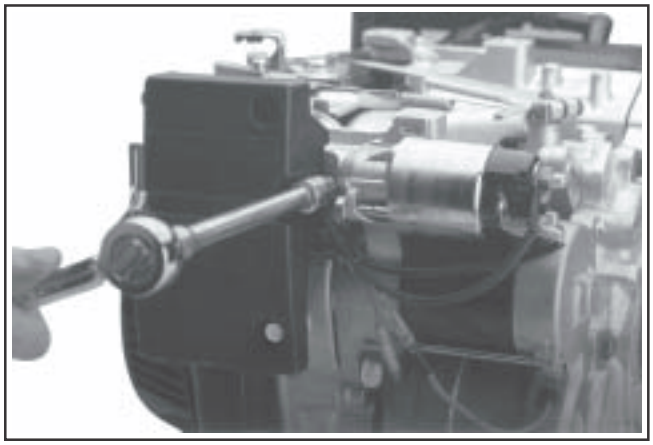


Figure 9-28. Removing Control Panel Screws.

4. Remove the two electric starter mounting bolts. See Figures 9-29 and 9-30.

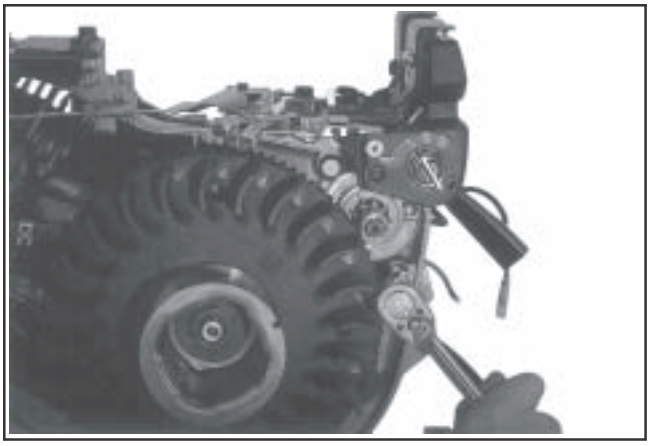


Figure 9-29. Removing Inertia Drive Starter Mounting Bolts.

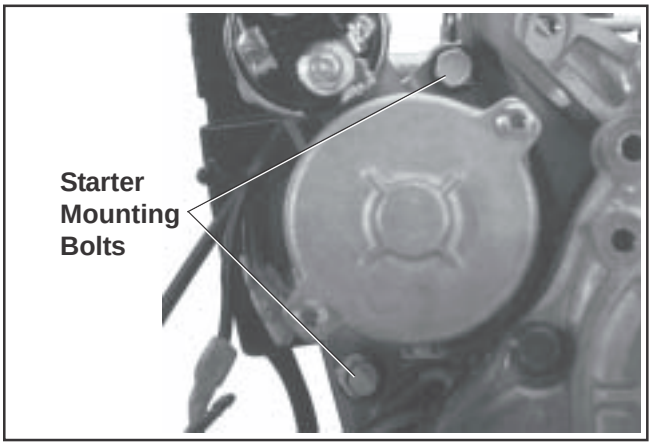


Figure 9-30. Starter Bolts on Models with Solenoid Shift Starters.

5. Remove the starter motor, wiring harness and control panel housing from the engine. Components may be further disassembled if required. See Figures 9-31, 9-32, and 9-33.

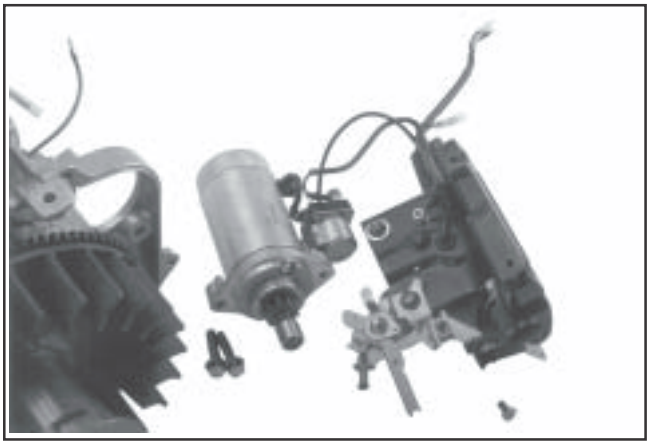


Figure 9-31. Inertia Drive Starter and Control Panel Removed.

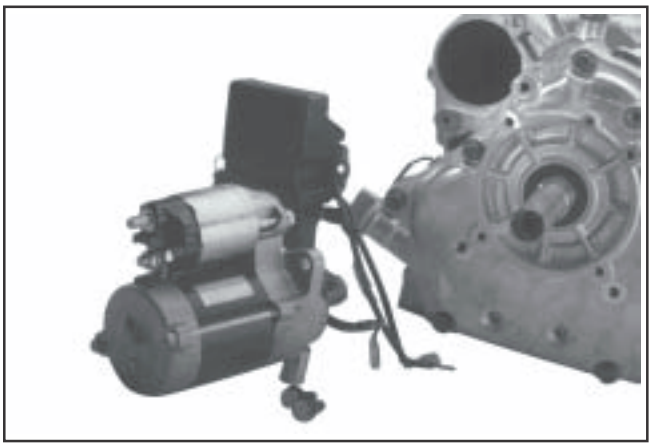


Figure 9-32. Solenoid Shift Starter and Control Panel Removed.

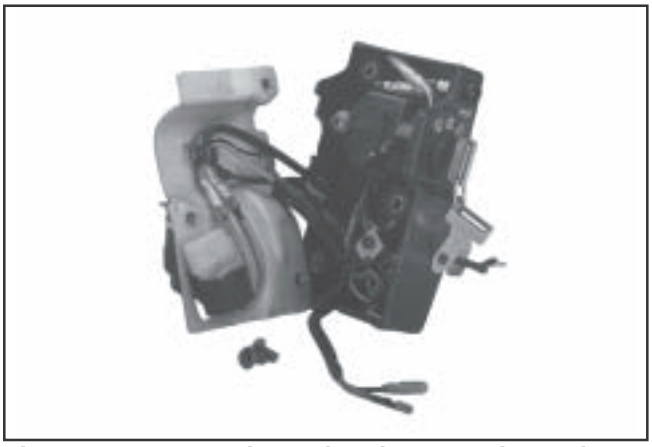


Figure 9-33. Control Panel and R.H. Tank Bracket.

Remove Left Fuel Tank Bracket

1. Remove the left fuel tank mounting bracket by removing the two screws. Figure 9-34 and 9-35. Washers are used on the CS4 and CS6 only.

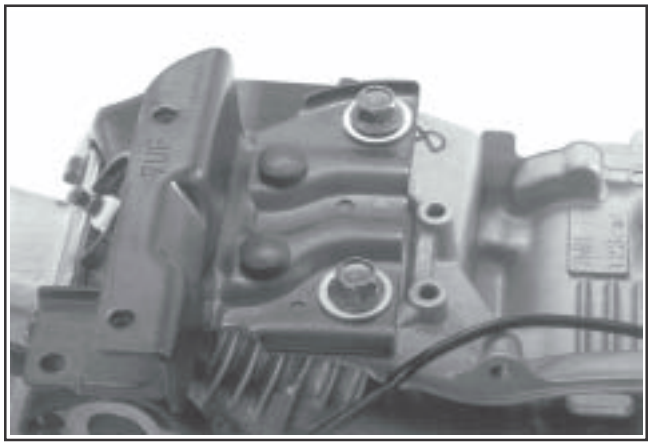


Figure 9-34. CS4, CS6 Left Side Tank Mounting Bracket Details.

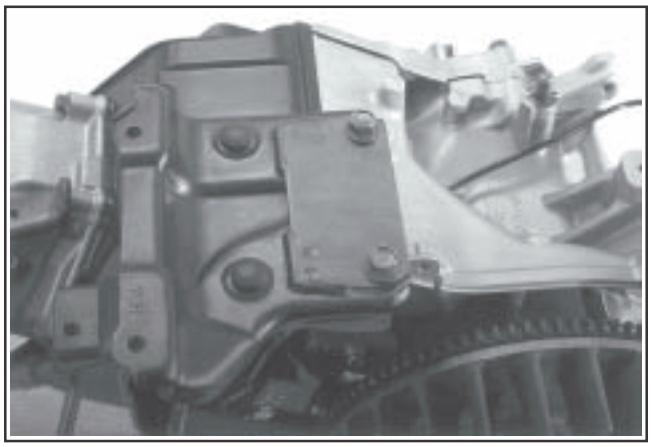


Figure 9-35. CS8.5 (spec. 92xxxx), CS10, and CS12 Left Side Tank Mounting Bracket Details.

Remove Valve Cover/Breather, Air Shroud, Cylinder Head Assembly, and Push Rods

1. Remove the four hex flange screws securing the valve cover. The air cleaner support bracket (CS8.5-12) may be mounted off two of the screws or directly to cylinder head. Remove the support bracket and note the locations of all the screws. See Figures 9-36 and 9-37.

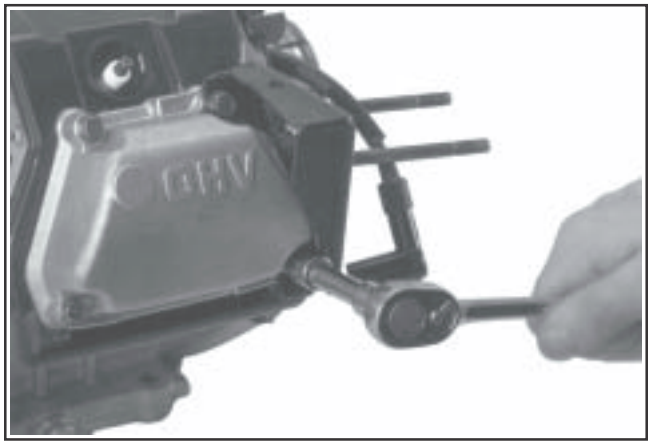


Figure 9-36. Removing Valve Cover Screws on Models with Attached Support Bracket.

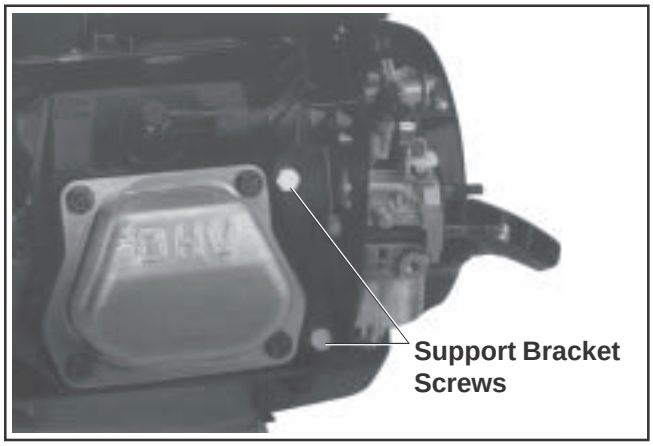


Figure 9-37. Support Bracket Screws on CS8.5 (spec. 95xxxx).

2. Remove the valve cover and gasket from the cylinder head. See Figure 9-38. The breather assembly is inside the valve cover.

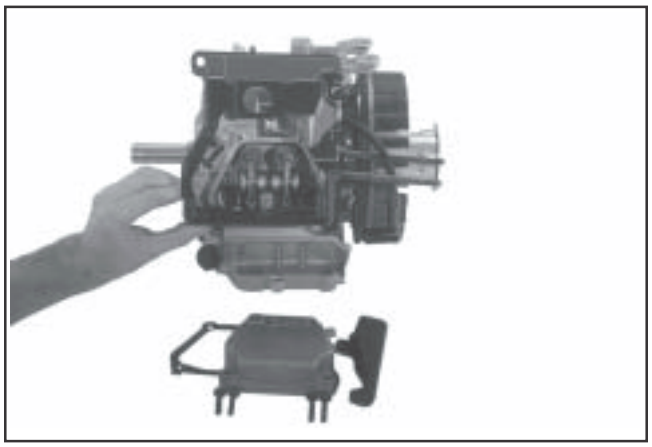


Figure 9-38. Valve Cover, Gasket, and Air Shroud Removed.

3. Lift off the air shroud from the cylinder head. CS4 and CS6 air shrouds have one mounting screw which must be removed. See Figure 9-39.

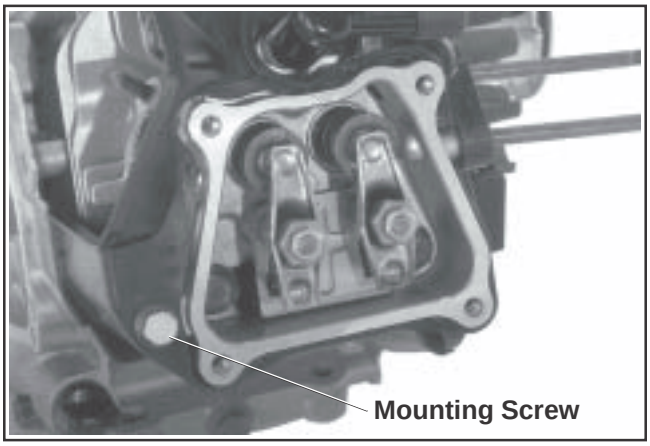


Figure 9-39. CS4, CS6 Mounting Screw Location.

4. Remove the four hex flange screws securing cylinder head. Remove the cylinder head, dowel pins (2), push rods, and cylinder head gasket.

   NOTE: Mark the push rods so they will be reinstalled in the same location.

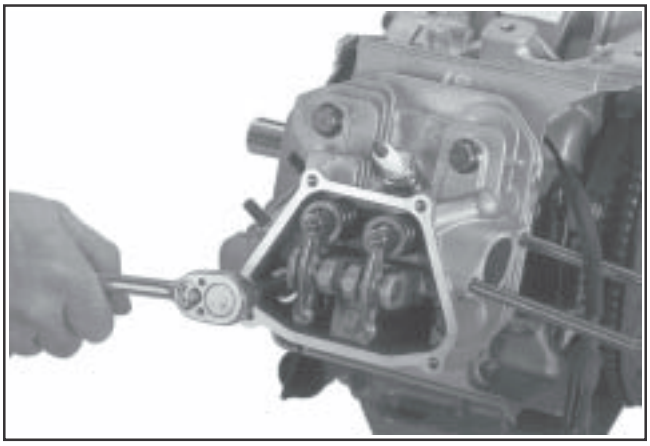


Figure 9-40. Remove Cylinder Head Mounting Screws.

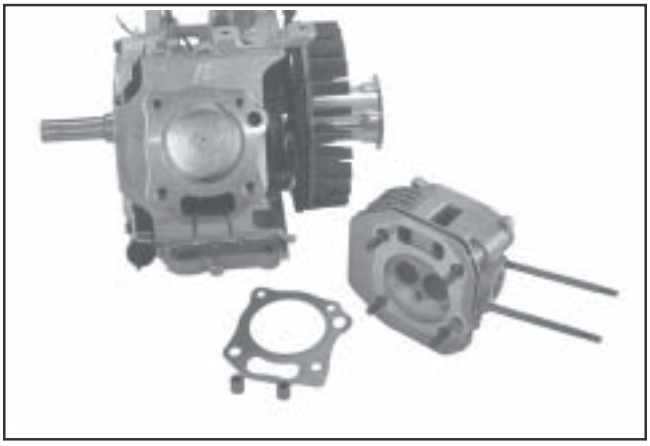


Figure 9-41. Cylinder Head and Gasket Removed.

Disassemble Cylinder Head

1. Remove the spark plug.

2. Slide the rocker shaft out and remove the rocker arm assemblies on CS8.5-12 engines. Mark or note position of each part, if it is to be reused.

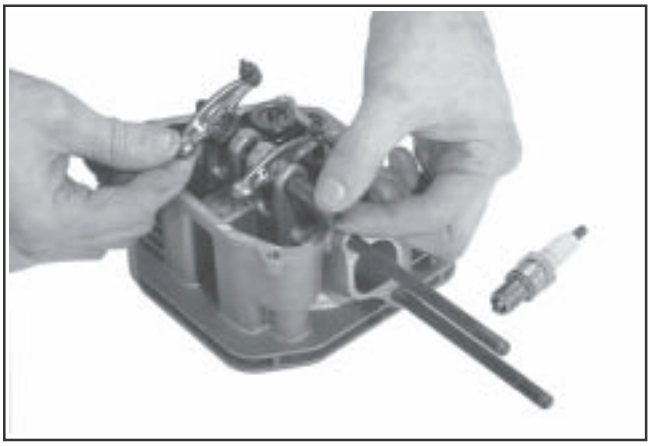


Figure 9-42. CS8.5 (spec. 92xxxx), CS10, and CS12 Removing Rocker Arms and Spark Plug.

3. Using a valve spring compressor, remove the valves by compressing the valve springs and removing the keepers. See Figure 9-43.

Figure 9-43. Disassembling Valve Assemblies.

4. Remove and replace the intake valve stem seal whenever the cylinder head is serviced or diassembled. See Figure 9-44.

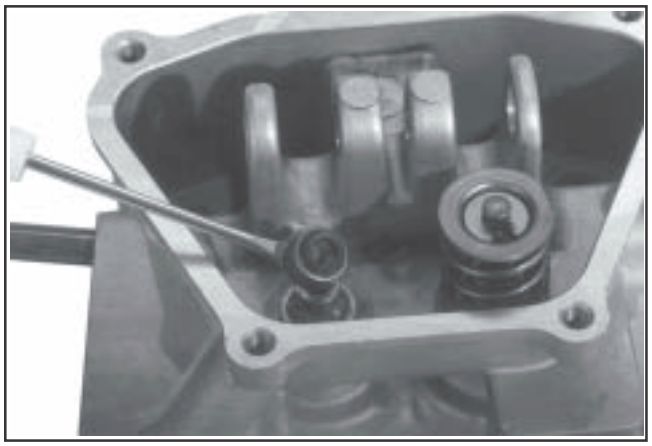


Figure 9-44. Removing Intake Valve Stem Seal.

5. If the cylinder head is being replaced, the carburetor mounting studs can be removed by using the air cleaner base nuts locked together. See Figure 9-45.

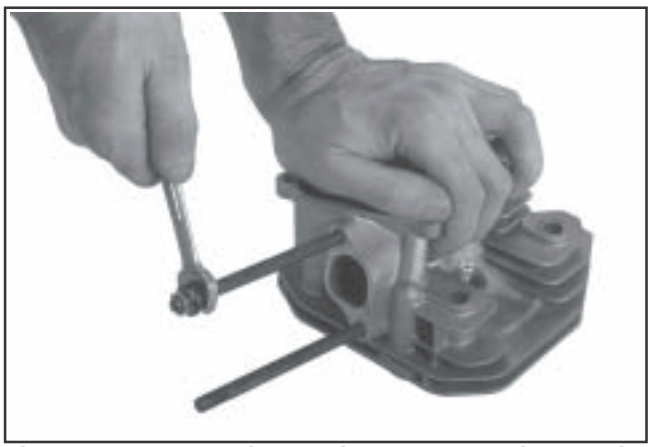


Figure 9-45. Removing Carburetor Mounting Studs.

Remove Flywheel

NOTE: Whenever possible, an impact wrench should be used to loosen the flywheel retaining nut. A flywheel strap wrench, or an approved holding tool (see Section 2) may also be used to hold the flywheel when loosening or tightening the flywheel retaining nut.

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

NOTE: Some electric start flywheels require the ignition module be taken off first, or loosened, to remove the flywheel from crankshaft. See Figure 9-46. Perform "**Remove Ignition Module**" prior to Step 1 if applicable.

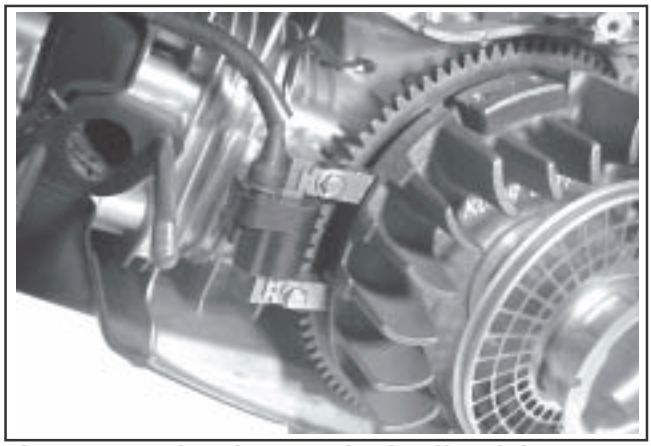


Figure 9-46. Electric Start Flywheel/Module Configuration (some models).

1. Remove the flywheel retaining nut, washer, and drive cup. See Figures 9-47 and 9-48.

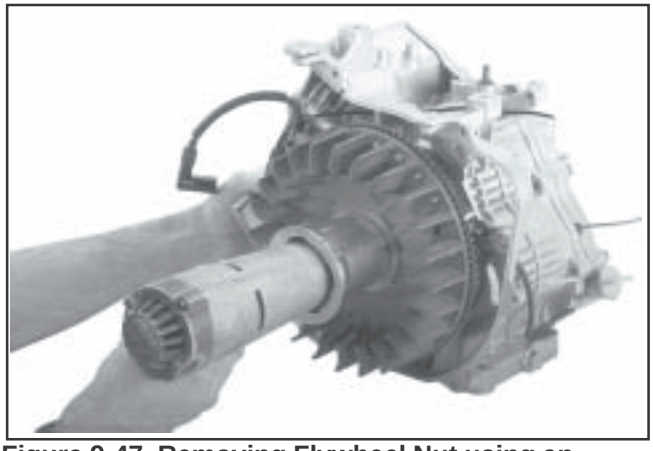


Figure 9-47. Removing Flywheel Nut using an Impact Wrench.

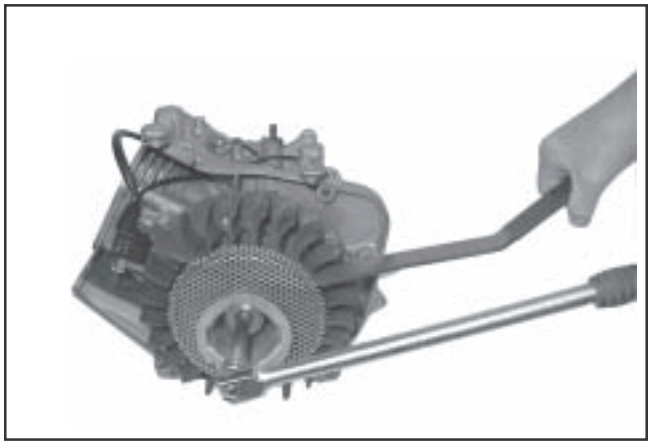


Figure 9-48. Removing Flywheel Nut Using Holding Tool.

2. Remove the flywheel from the crankshaft using a puller. See Figure 9-49 and 9-50.

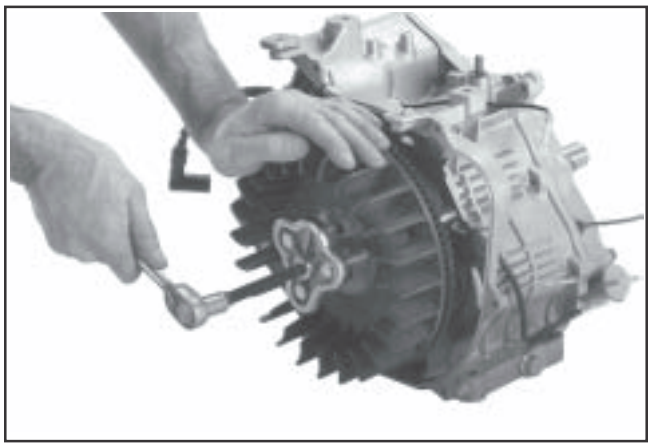


Figure 9-49. Using Puller to Remove Flywheel on CS8.5-CS12.

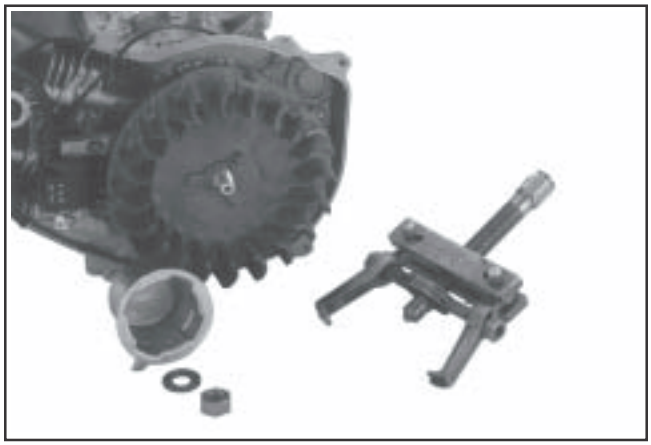


Figure 9-50. Use External Type Puller to Remove Flywheel on CS4, CS6.

3. Remove the flywheel key from keyway.

Remove Ignition Module

1. Remove the two hex flange screws securing the ignition module to the crankcase. See Figure 9-51.

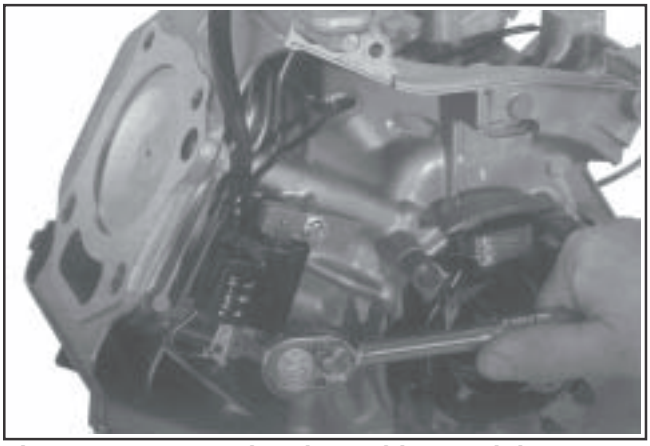
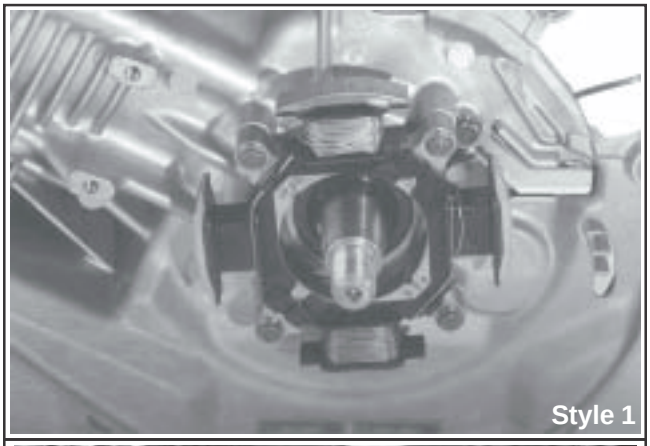


Figure 9-51. Removing the Ignition Module Screws.

Remove Stator and Protective Shield (If So Equipped)

1. Remove the mounting screw and protective shield over the stator leads. See Figure 9-52.



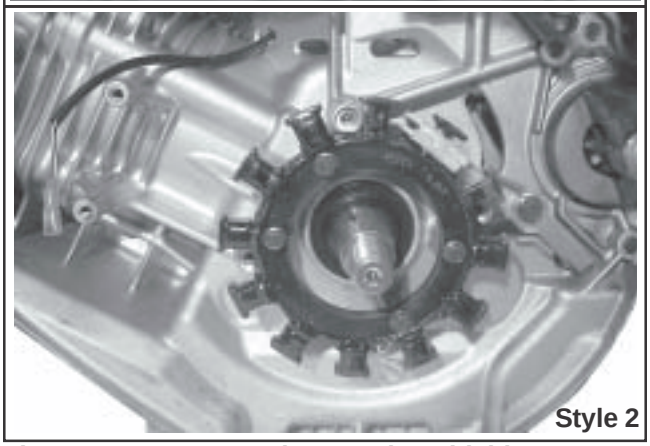


Figure 9-52. Stator and Protective Shield.

2. Remove the four hex flange shoulder screws securing the stator to the crankcase. Remove the stator and pull the wires through the opening in the casting. See Figure 9-53.

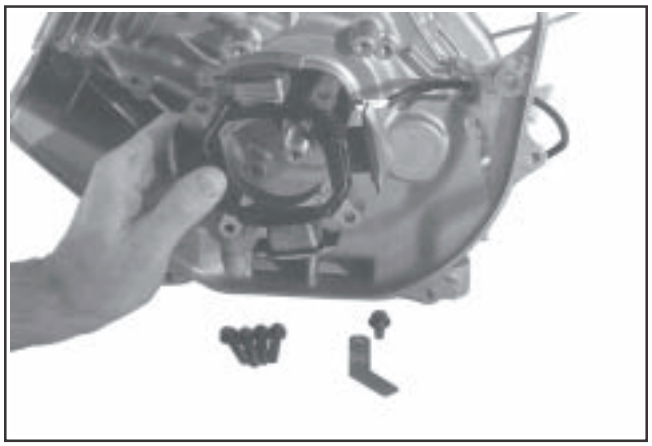


Figure 9-53. Removing Mounting Screws and Stator.

Remove Reduction Assembly (If So Equipped)

2:1 Reduction Assembly

1. Remove any drive coupling and the key from the reduction assembly output shaft. Clean the shaft and keyway of any burrs/damage.

2. Remove the mounting bolts securing the reduction system housing onto the crankcase. Place a flat pan or towel under the housing to catch any remaining oil. See Figures 9-54 and 9-55.

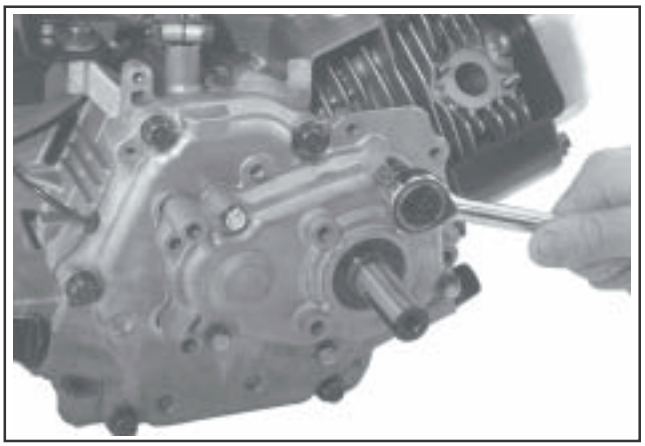


Figure 9-54. Removing Reduction Housing Screws on CS4, CS6.

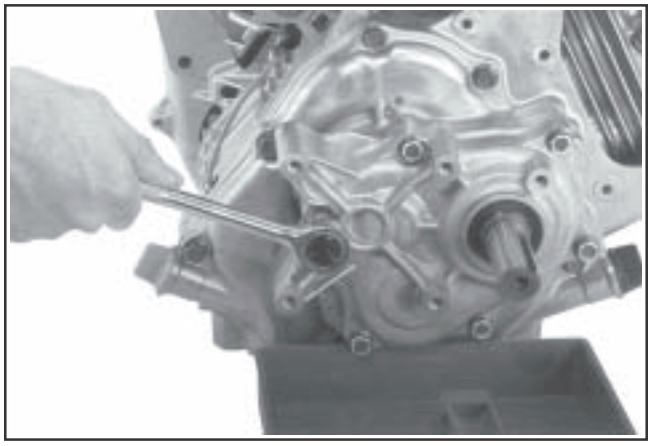


Figure 9-55. Removing Reduction Housing Screws on CS8.5-CS12.

3. Pull the reduction housing off the closure plate.

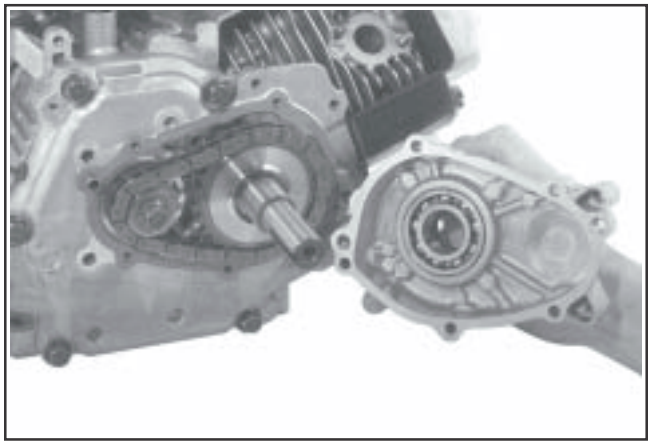


Figure 9-56. Removing Reduction Housing on CS4, CS6.

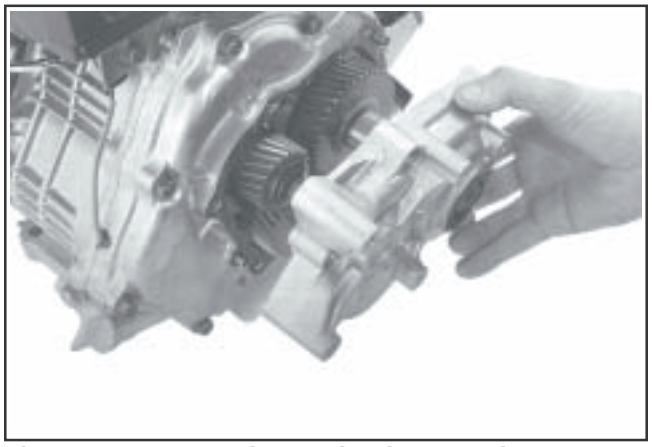


Figure 9-57. Removing Reduction Housing on CS8.5-CS12.

4. Remove the screw and washer securing the crankshaft sprocket/gear.

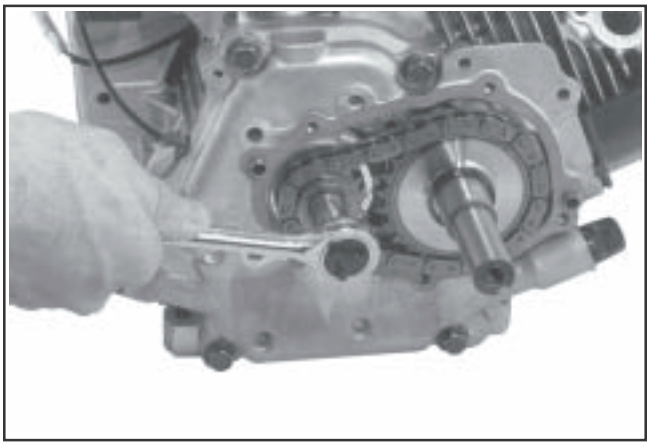


Figure 9-58. Removing Screw from Crankshaft on CS4, CS6.

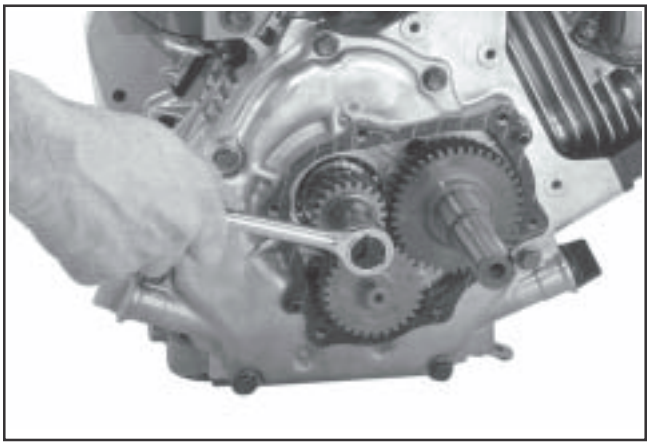


Figure 9-59. Removing Screw from Crankshaft on CS8.5-CS12.

5. Remove the reduction components.

   a. On CS4 and CS6, leave the chain intact, and pull out the two sprockets as an assembly. See Figure 9-60. Note the position of the wave washer and remove it from the output shaft. Also remove the thrust washer from the end of the crankshaft. See Figure 9-61.

Figure 9-60. Removing Sprockets and Chain on CS4, CS6.

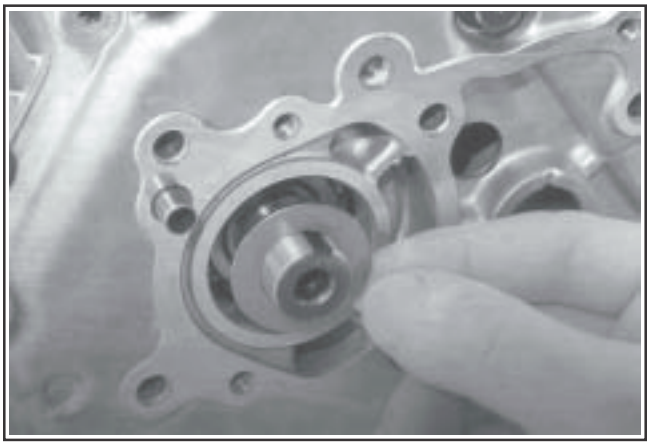


Figure 9-61. Thrust Washer Behind Crank Sprocket on CS4, CS6.

   b. On CS8.5-12, remove the crankshaft gear, counter gear, and output shaft/gear assembly. See Figure 9-62.

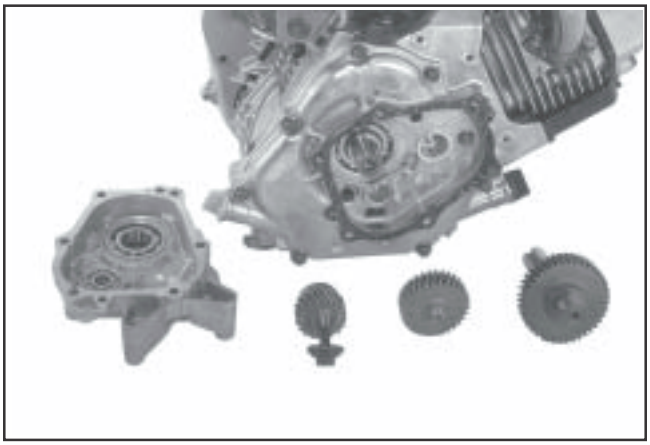


Figure 9-62. CS8.5-CS12 Disassembled Reduction Assembly.

6. Check the reduction system bearings for wear or excessive play. See Figure 9-63. If bearing removal is required, use an internal bearing puller to remove the housing bearings. An arbor press should be used for removal of the others.

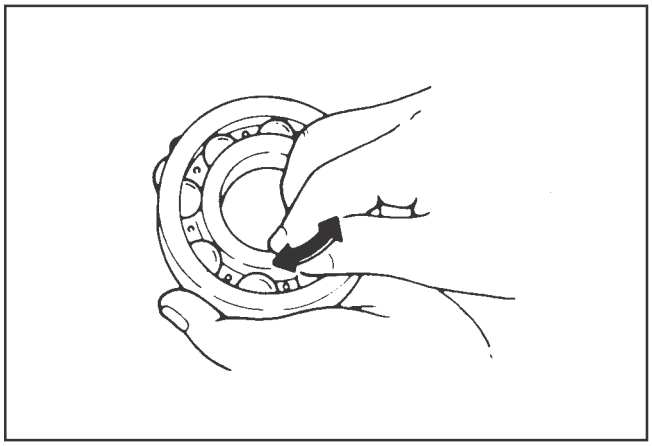


Figure 9-63. Checking Bearing Play.

6:1 Reduction Assemblies, CS4 and CS6

1. Remove any drive coupling and the key from the reduction output shaft. Clean the shaft and keyway of any burrs/damage.

2. Remove the four reduction cover mounting screws. Use a flat pan to catch oil when the screws are removed and the cover is separated. See Figure 9-64.

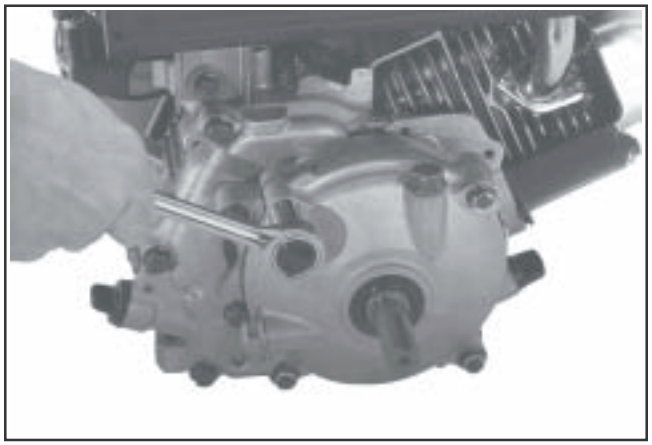


Figure 9-64. Loosening Reduction Housing Cover Screws.

3. Remove the cover from the reduction housing assembly.

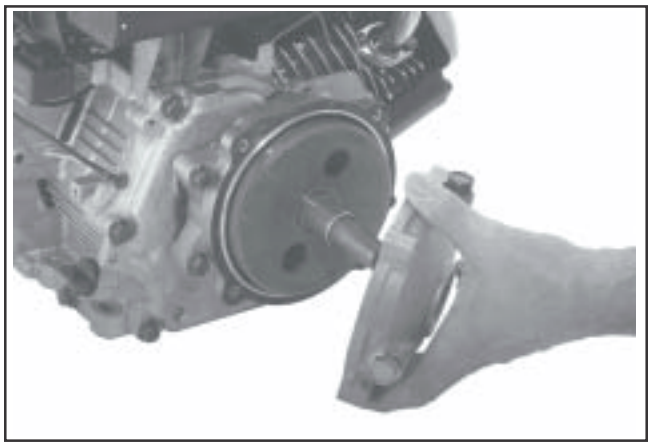


Figure 9-65. Removing Cover from Reduction Housing.

4. Remove the ring gear/output shaft assembly. See Figure 9-66.

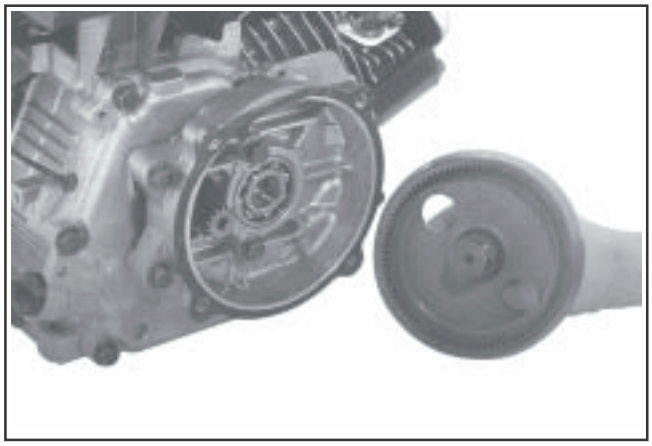


Figure 9-66. Removing Ring Gear/Shaft.

5. If the reduction housing requires removal from the closure plate, remove the four mounting screws and separate the two castings.

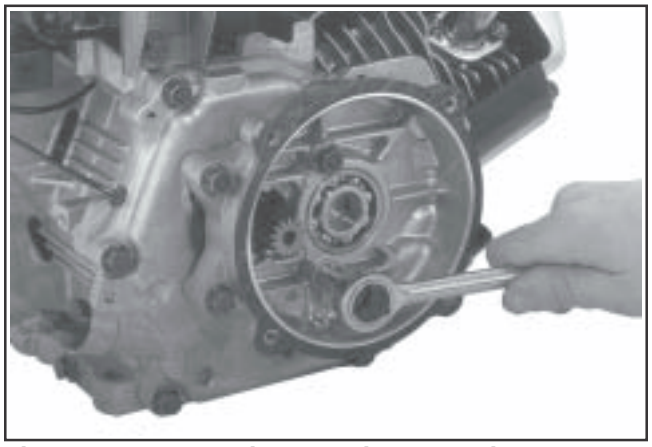


Figure 9-67. Removing Housing Mounting Screws.

6. Remove the gasket(s) and clean the respective sealing surfaces with a cleaning solvent or aerosol type gasket remover. **Do not nick or scrape the sealing surfaces.**

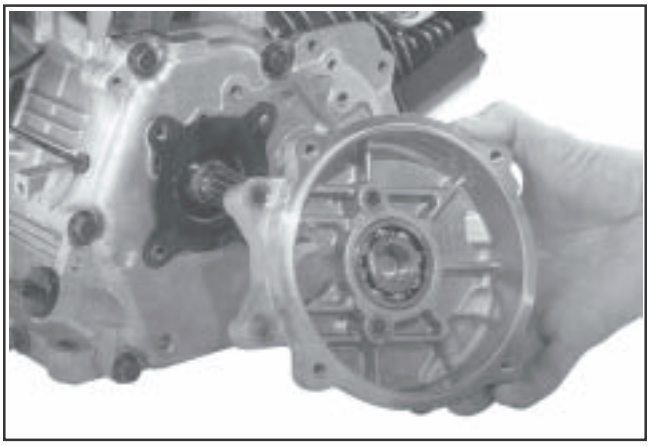


Figure 9-68. Separate Reduction Housing from Closure Plate.

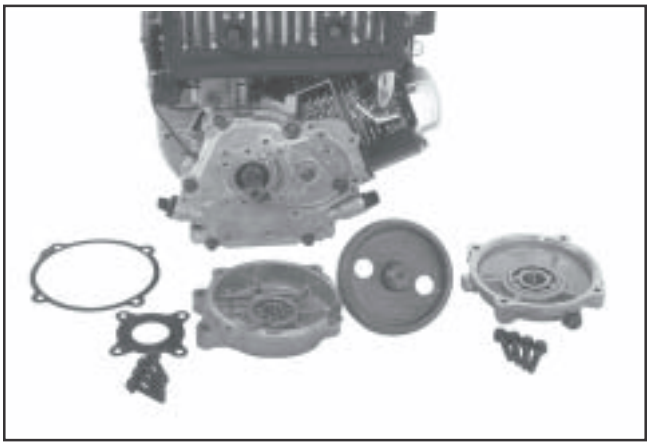


Figure 9-69. CS4, CS6 6:1 Reduction Assembly Components.

7. Check the reduction system bearings for wear or excessive play. See Figure 9-63. If bearing removal is required, use an internal bearing puller to remove the housing bearings. An arbor press should be used for removal of the others.

6:1 Reduction Assemblies, CS8.5, CS10, and CS12

1. Remove any drive coupling and the key from the reduction assembly output shaft. Clean the shaft and keyway of any burrs/damage.

2. Remove the six reduction cover mounting screws. See Figure 9-70.

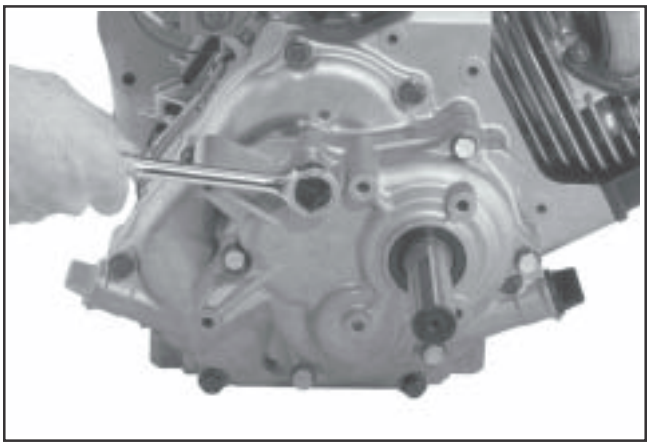


Figure 9-70. Removing Housing Cover Screws.

3. Remove the cover from the reduction assembly. Place a flat drain pan or shop towel under the housing to catch any remaining oil.

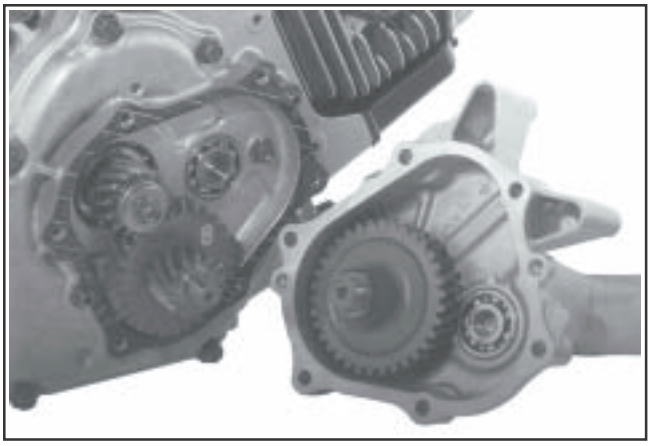


Figure 9-71. Removing Housing Cover.

4. Pull the output shaft/gear assembly out of the housing cover or closure plate. See Figure 9-72.

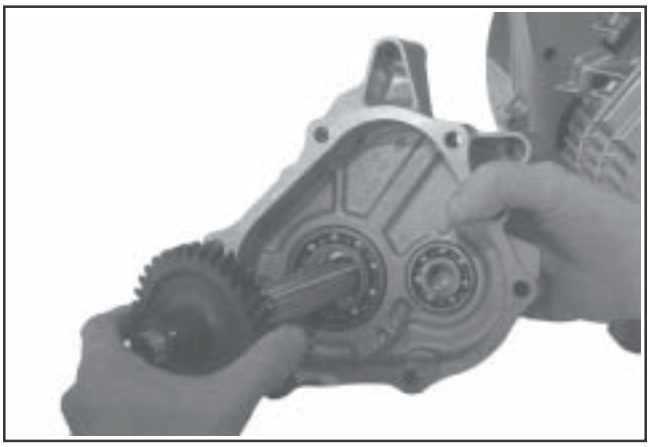


Figure 9-72. Removing Output Shaft/Gear from Cover.

5. Remove the counter gear from the closure plate. Remove the screw and washer securing the crank gear and slide the gear off of the crankshaft splines. See Figure 9-73.

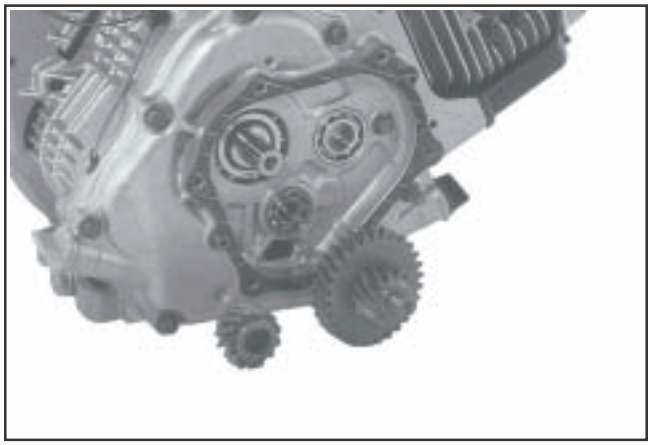


Figure 9-73. Removing Counter Gear and Crank Gear.

6. Remove the dowel pins and gasket. Clean the gasket surfaces with a cleaning solvent or aerosol type gasket remover. **Do not nick or scrape the sealing surfaces.** See Figure 9-74.

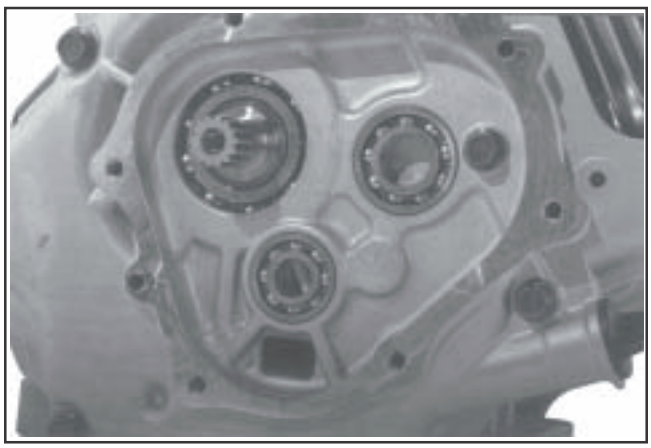


Figure 9-74. Removing Dowel Pins and Gasket.

7. Check the reduction system bearings for wear or excessive play. See Figure 9-63. If bearing removal is required, use an internal bearing puller to remove the housing bearings. An arbor press should be used for removal of the others.

Remove Closure Plate

1. Remove the hex flange screws securing the closure plate to the crankcase (six on CS4 and CS6; eight on CS8.5-CS12). See Figures 9-75 and 9-76.

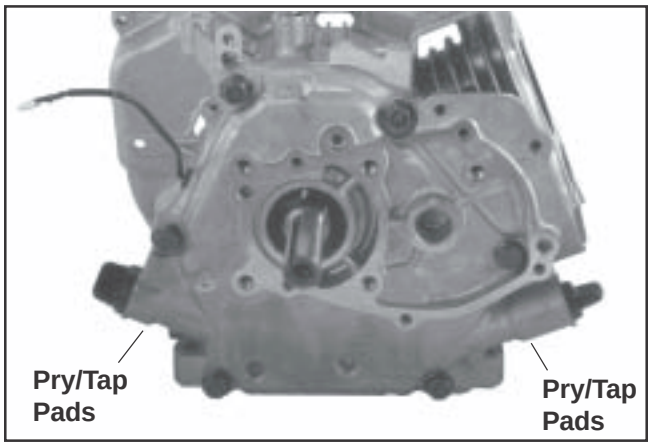


Figure 9-75. CS4, CS6 Closure Plate Mounting Screws.

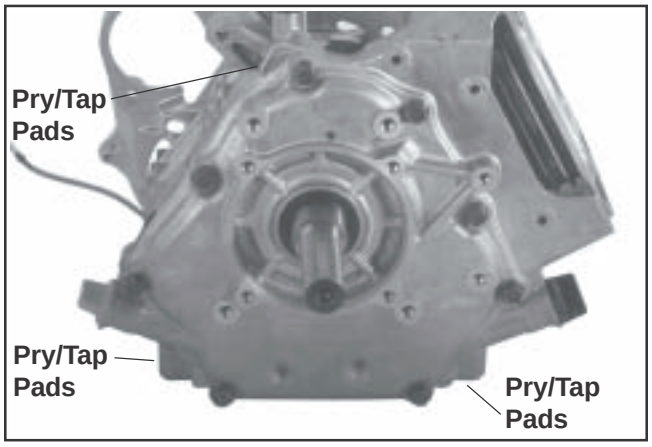


Figure 9-76. CS8.5-CS12 Closure Plate Mounting Screws.

2. Locate the pry/tap pads on the closure plate. See Figures 9-75 and 9-76. These areas permit separation of the closure plate from the crankcase with a flat screwdriver or by tapping lightly with a plastic hammer.

   NOTE: Do not pry on the gasket surface of the crankcase or closure plate, as this can cause damage and leakage.

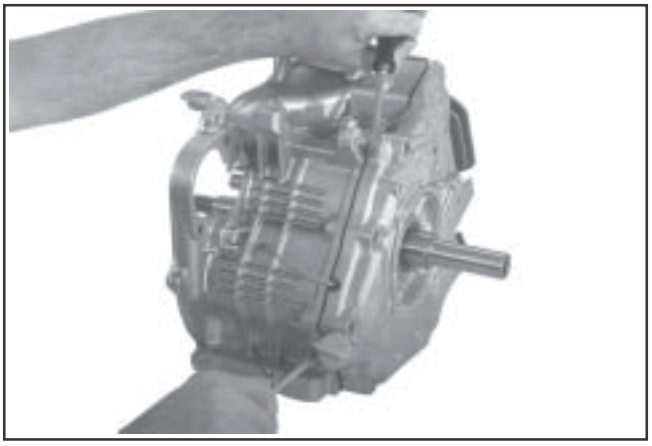


Figure 9-77. Separating Closure Plate From Crankcase.

Steps 3-7 should be performed only if further disassembly or servicing in the respective areas is necessary.

3. Remove the two hex flange screws mounting the oil sentry gauge and the single screw holding the wire shield in place. See Figure 9-78.

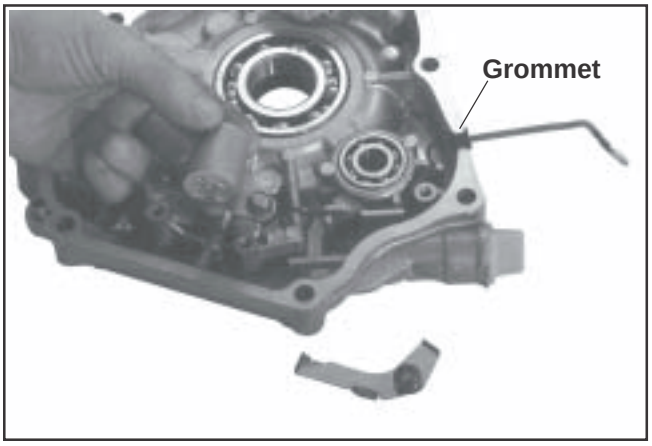


Figure 9-78. Removing Shield and Oil Sentry™.

4. Pull the grommet out of the cutout in the casting and remove the oil sentry gauge. Note the routing of the wire.

5. Remove the governor gear/flyweight assembly by carefully applying upward pressure with two small screwdrivers between the gear and the closure plate bosses. This will unseat the retaining ring from the groove, allowing removal of the gear and mounting components by pulling upward. Do not pry against the gasket surface. Note the placement and order of all parts. See Figure 9-79.

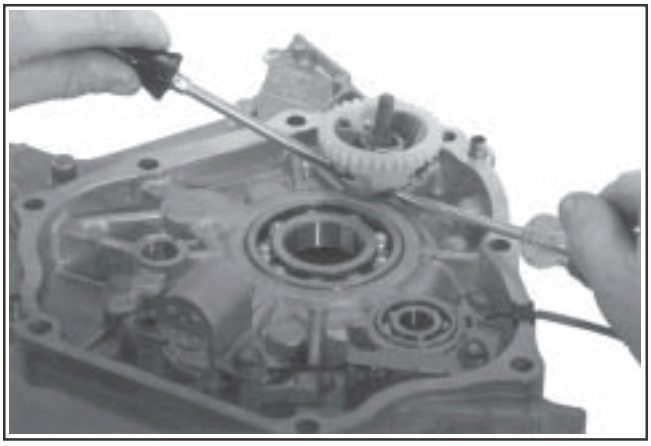


Figure 9-79. Removing Governor Gear.

6. Remove the crankshaft seal. See Figure 9-80.

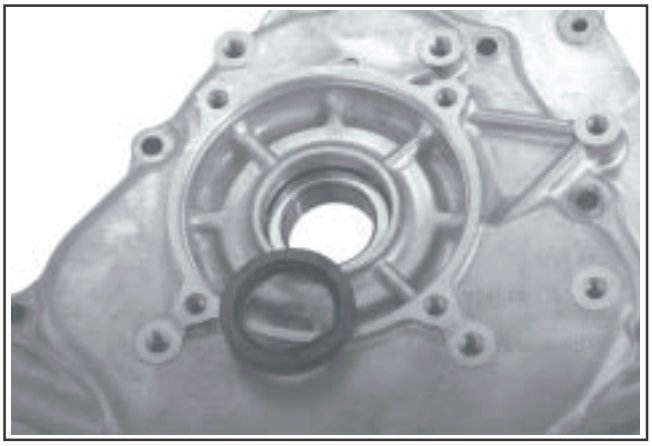


Figure 9-80. Removed Crankshaft Seal.

7. Press out the crankshaft bearing using an arbor press. Use an internal bearing puller to remove the balance shaft bearing.

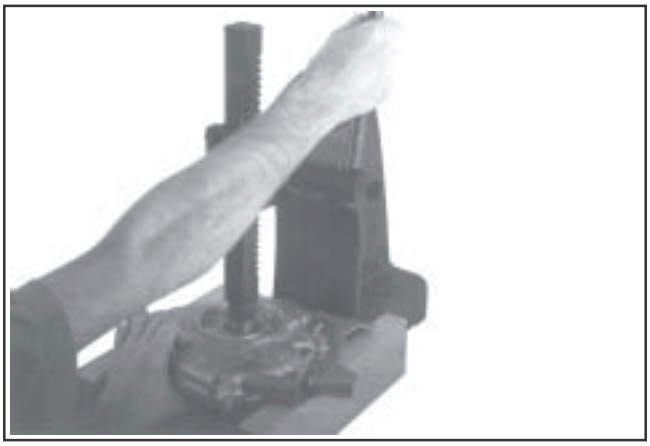


Figure 9-81. Bearing Removal Using a Press.

Remove Balance Shaft (If So Equipped)

1. Pull the balance shaft out of the crankcase.

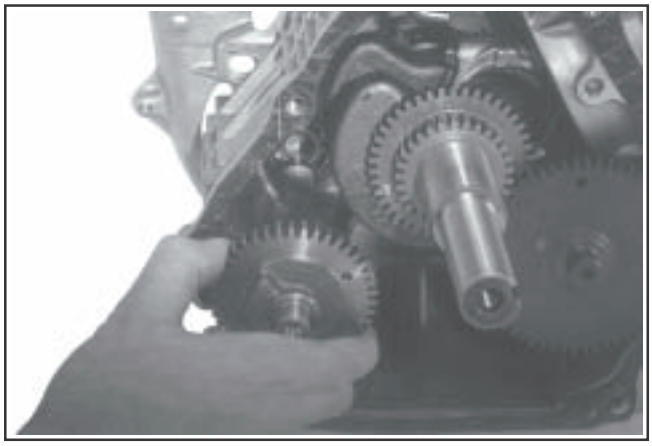


Figure 9-82. Removing Balance Shaft.

Remove Camshaft and Tappets

1. Remove the camshaft from the crankcase.

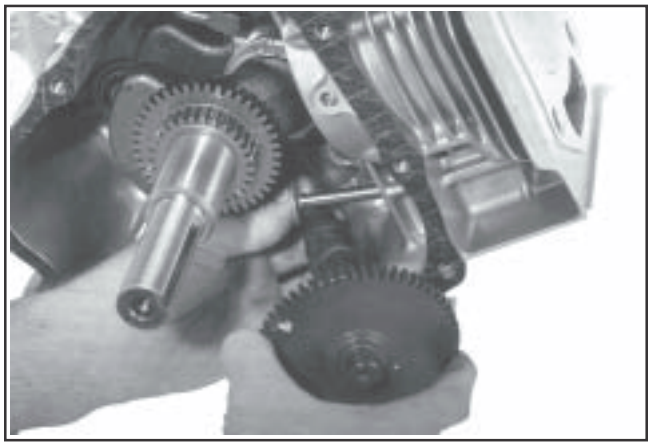


Figure 9-83. Removing Camshaft and Tappets.

2. Remove and mark the tappets.

Remove Connecting Rod with Piston and Rings

1. Remove the two hex flange screws securing the connecting rod cap. Remove the rod cap.

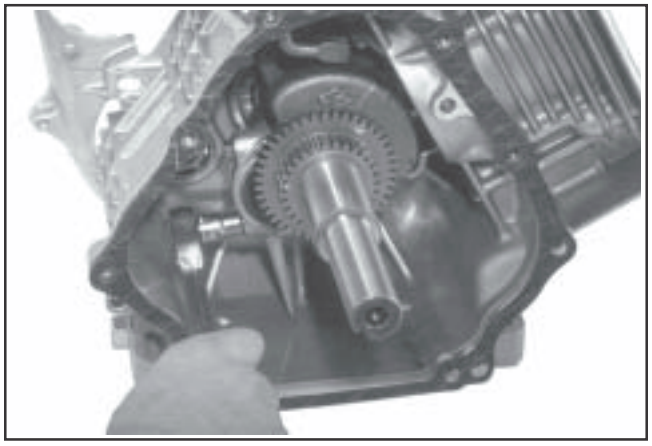


Figure 9-84. Removing Connecting Rod Bolts.

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

2. Carefully remove the connecting rod and piston assembly from the cylinder bore. See Figure 9-85.

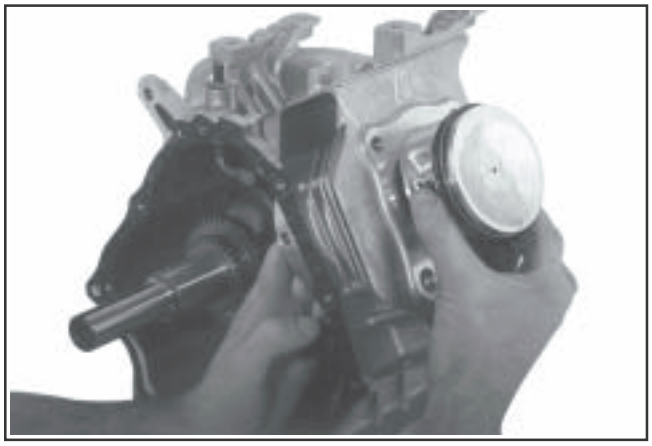


Figure 9-85. Removing Piston.

Remove Crankshaft

1. Carefully remove the crankshaft from the crankcase.

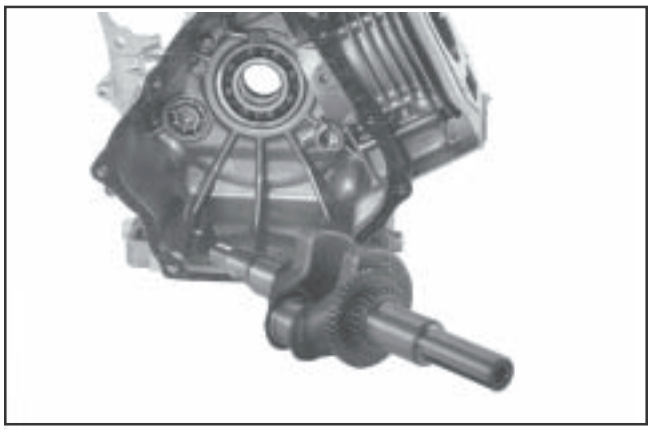


Figure 9-86. Removing Crankshaft.

Remove Governor Cross Shaft

1. Remove the hitch pin and plain washer from the governor cross shaft. See Figure 9-87.

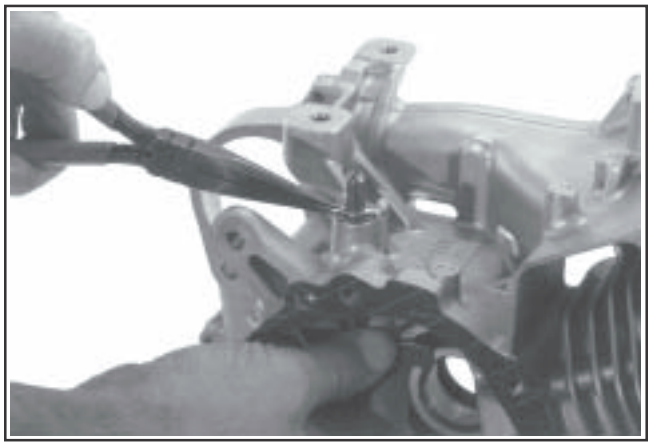


Figure 9-87. Removing Governor Cross Shaft Hitch Pin.

2. Remove the cross shaft out through the inside of the crankcase.

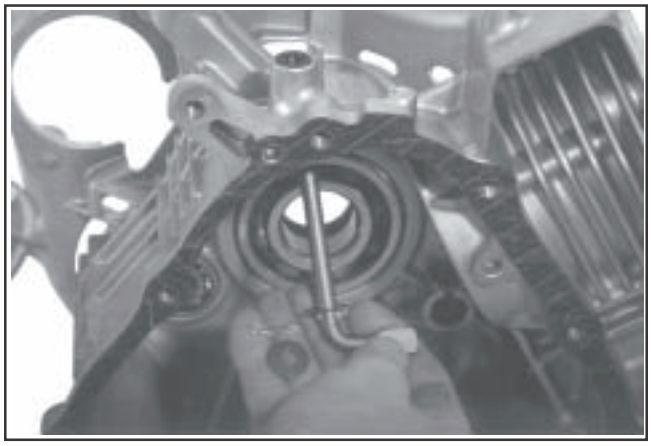


Figure 9-88. Removing Governor Cross Shaft with Inner Washer.

Remove Flywheel End Main Bearing and Oil Seal

1. Remove the front oil seal from the crankcase. See Figure 9-89.

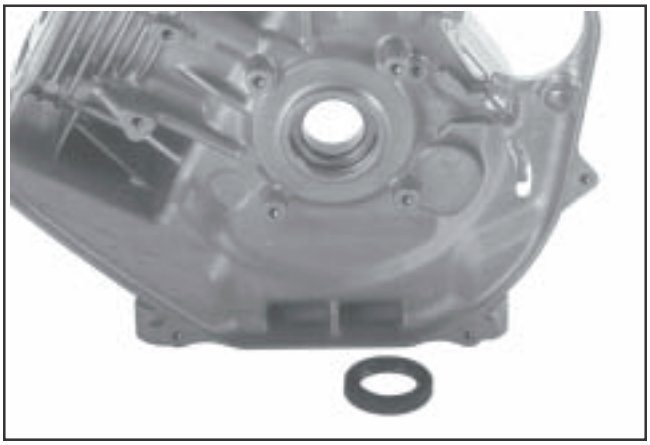


Figure 9-89. Oil Seal Removed.

2. Remove the front main bearing from the crankcase using an arbor press. See Figure 9-90.

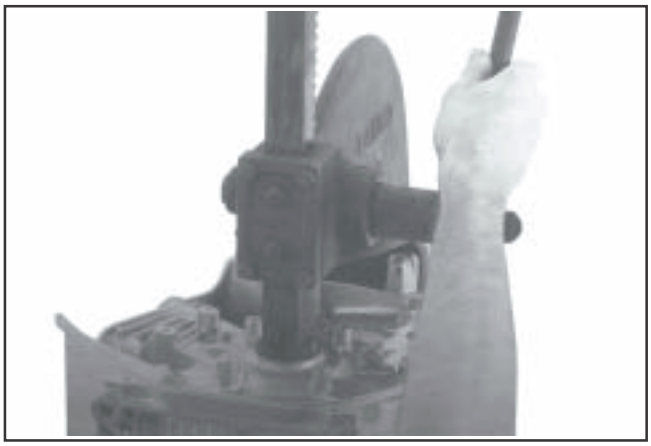


Figure 9-90. Removing Main Bearing with Press.

Remove Balance Shaft Bearing

1. Remove the balance shaft bearing using an internal bearing puller.

Section 10
Internal Components

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 their own sections:

Air Cleaner, Section 4
Carburetor & External Governor, Section 5
Retractable Starter, Section 7
Ignition, Charging, & Electric Starter, Section 8

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

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

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

Automatic Compression Release (ACR)

These engines are equipped with an **Automatic Compression Release (ACR)** mechanism. ACR lowers compression at cranking speeds to make starting easier.

Operation

The ACR mechanism consists of a spring-loaded arm and sliding pin mounted to the camshaft. When the engine is rotating at low cranking speeds (600 RPM or less) the arm holds the pin so it protrudes above the heel of the exhaust cam. This holds the exhaust valve off of its seat during the first part of the compression stroke.

After the engine speed increases above approximately 600 RPM, centrifugal force causes the spring-loaded arm to move outward causing the pin to retract. When in this position the pin has no effect on the exhaust valve and the engine operates at full compression and power.

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

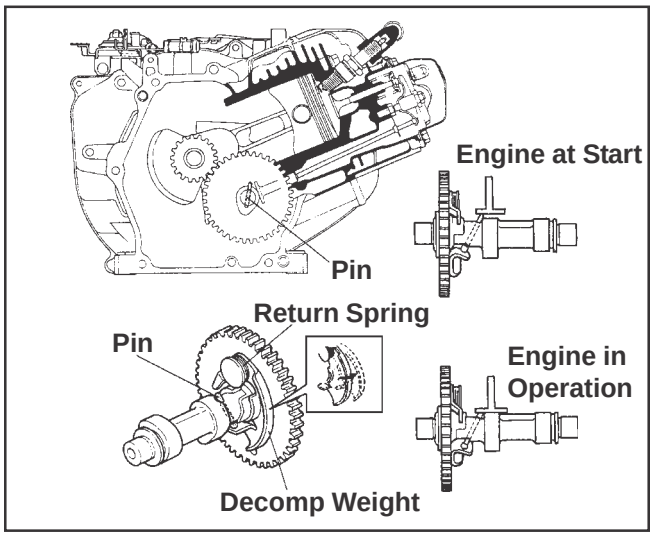


Figure 10-1. ACR Operation Details.

Benefits

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

1. Manual (retractable) starting is much easier. Without ACR, manual starting would be virtually impossible.

2. Electric start models can use a smaller starter and battery that are more practical for the application.

3. ACR eliminates the need for a spark retard/ advance mechanism. A spark retard/advance mechanism would be required on engines without ACR to prevent the kickback that would occur during starting. ACR eliminates this kickback making manual starting safer.

4. The choke control setting is less critical with ACR. In the event of flooding, excess fuel is blown out the opened exhaust valve and does not hamper starting.

5. Engines with ACR start much faster in cold weather than engines without ACR.

6. Engines with ACR can be started with spark plugs that are worn or fouled. Engines without ACR are more difficult to start with those same spark plugs.

Camshaft & Tappets

Inspection and Service

Inspect the gear teeth of the camshaft. If the teeth are badly worn, chipped, or some are missing, replacement of the camshaft will be necessary. If unusual wear or damage is evident on either lobe or the mating tappet, the camshaft and both tappets must be replaced. Check the condition and operation of the ACR mechanism. See Figure 10-2.

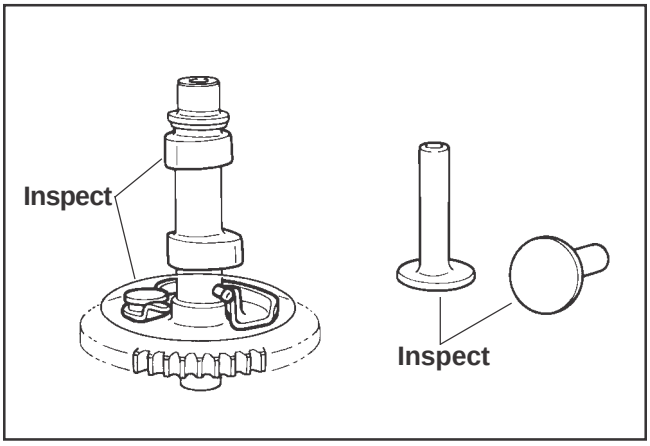


Figure 10-2. Camshaft and Tappet Inspection Points.

Measure the cam lobe profile, **A** and **B**, as shown using an outside micrometer and compare with specifications listed.

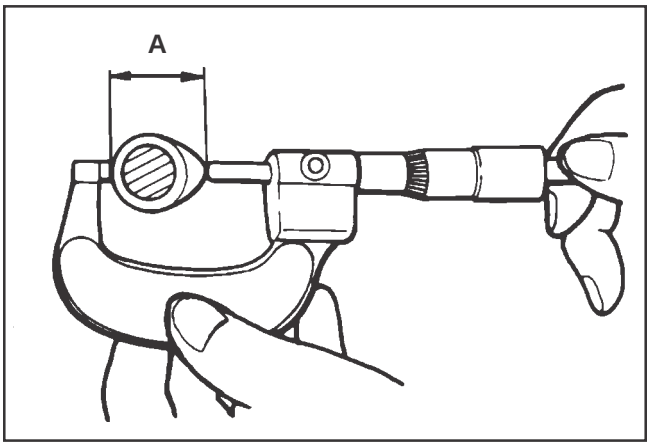


Figure 10-3. Cam Lobe Checking "A".

Cam Lobe Dimension–A

	Intake	Exhaust
CS4, CS6	26.9 ± 0.05 mm (1.06 ± 0.002 in.)	26.68 ± 0.05 mm (1.05 ± 0.002 in.)
CS8.5, CS10, CS12	32.55 ± 0.05 mm (1.28 ± 0.002 in.)	32.55 ± 0.05 mm (1.28 ± 0.002 in.)

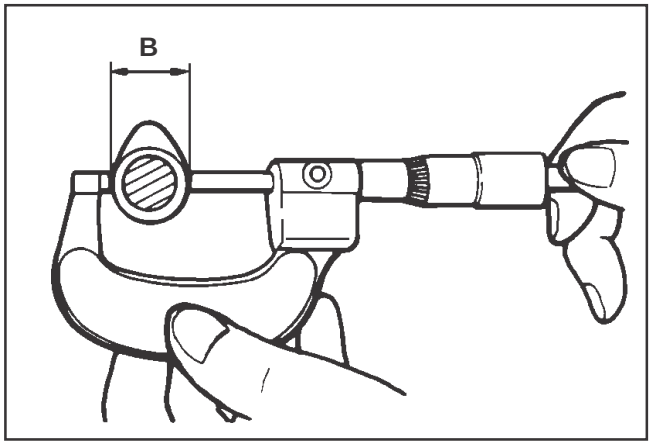


Figure 10-4. Cam Lobe Checking ''B''.

Cam Lobe Dimension–B

	Intake	Exhaust
CS4, CS6	22.0 ± 0.05 mm (0.87 ± 0.002 in.)	22.0 ± 0.05 mm (0.87 ± 0.002 in.)
CS8.5, CS10, CS12	26.08 ± 0.05 mm (1.03 ± 0.002 in.)	26.08 ± 0.05 mm (1.03 ± 0.002 in.)

Measure the camshaft journals, which fit in the ball bearings, for wear using a micrometer. Compare with specifications listed.

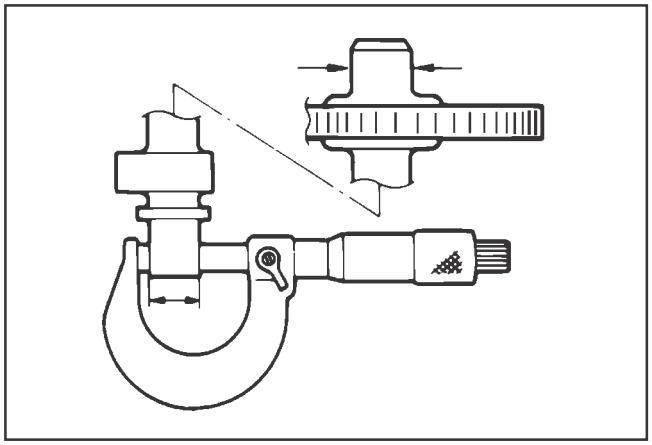


Figure 10-5. Camshaft Journal Checking.

Camshaft Journal Specifications

CS4, CS6	14.95 mm (0.589 in.)
CS8.5, CS10, CS12	15.965-15.990 mm (0.6285-0.6295 in.)
Limit	15.95 mm (0.6280 in.)

Crankshaft

Inspection and Service

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

Inspect the crankshaft bearing surfaces for scoring, grooving, etc. Do not replace the main bearings unless they shown signs of damage or are out of running clearance specifications. If the crankshaft turns easily and noiselessly, and there is no evidence of scoring, grooving, etc., on the races or bearing surfaces, the bearings can be reused.

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

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

Crankcase

Inspection and Service

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

Check the cylinder bore for wear, scoring, or vertical scratches. In severe cases, unburned fuel can cause scuffing and scoring of the cylinder wall, it washes the necessary lubricating oils off the piston and cylinder wall. As raw fuel seeps down the cylinder wall, the piston rings make metal to metal contact with the wall. Scoring of the cylinder wall can also be caused by localized hot spots resulting from blocked cooling fins or from inadequate or contaminated lubrication. Measure the cylinder bore using an inside micrometer or bore gauge. See Figure 10-6. Compare readings with specifications in Section 1.

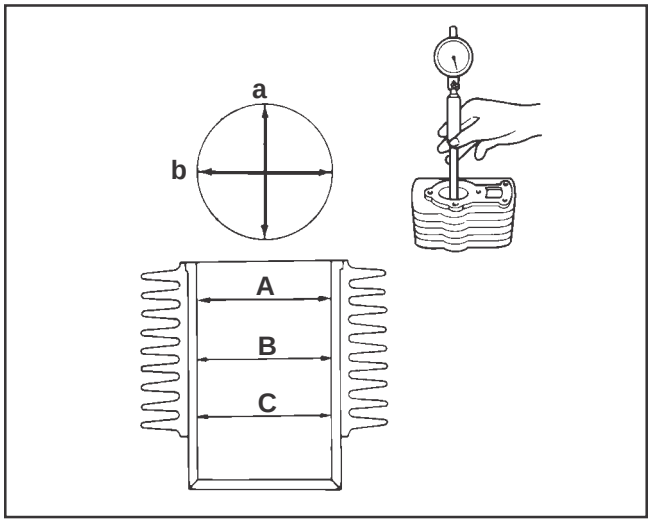


Figure 10-6. Measuring Cylinder Bore.

If the cylinder bore is badly scored, excessively worn, tapered, or out of round, resizing is necessary. Use a measuring device (inside micrometer, etc.) to determine the amount of wear (refer to the Specifications, Tolerances, and Special Torque Values, in Section 1), then select the nearest suitable oversize of either **0.25 mm (0.010 in.)** or **0.50 mm (0.020 in.)**. Resizing to one of these oversizes will allow usage of the available oversize piston and ring assemblies. Initially, resize using a boring bar, then use the following procedures for honing the cylinder.

Honing

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

1. Lower hone into bore and after centering, adjust so that the stones are in contact with the cylinder wall. Use of a commercial cutting-cooling agent is recommended.

2. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and honing process. Move the hone up and down while resizing to prevent the formation of cutting ridges. Check the size frequently.

NOTE: Keep in mind the temperatures caused by honing may cause inaccurate measurements. Make sure the bore is cool when measuring.

3. When the bore is within **0.064 mm (0.0025 in.)** of desired size, remove the coarse stones and replace with burnishing stones. Continue with the burnishing stones until within **0.013 mm (0.0005 in.)** of desired size and then use finish stones (220-280 grit) and polish to final size. A crosshatch should be observed if honing is done correctly. The crosshatch should intersect at approximately 20° off the horizontal. Too flat an angle could cause the rings to skip and wear excessively; too steep an angle will result in high oil consumption. See Figure 10-7.

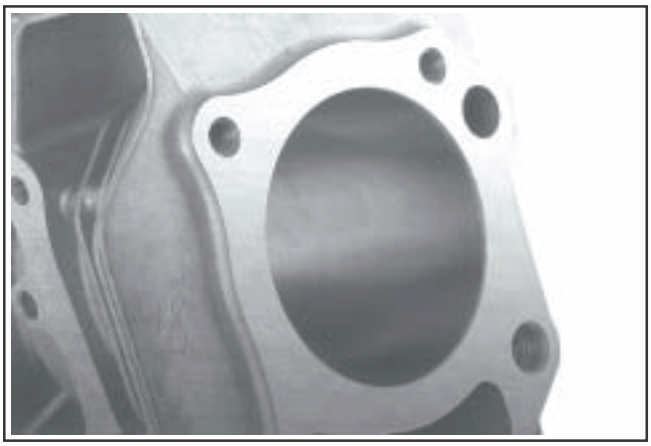


Figure 10-7. Cylinder Bore Crosshatch after Honing.

4. After resizing, check the bore for roundness, taper, and size. Use an inside micrometer, telescoping gauge, or bore gauge to take measurements. The measurements should be taken at three locations in the cylinder – at the top, middle, and bottom. Two measurements should be taken (perpendicular to each other) at each of the three locations. See Figure 10-6.

Clean Cylinder Bore After Honing

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

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

Closure Plate and Crankcase

1. Clean the sealing surfaces of the closure plate and crankcase of all gasket material.

NOTE: **Do not scrape** the surfaces when cleaning as this will damage the surfaces and could cause leaks. The use of a gasket-removing solvent or aerosol spray is recommended.

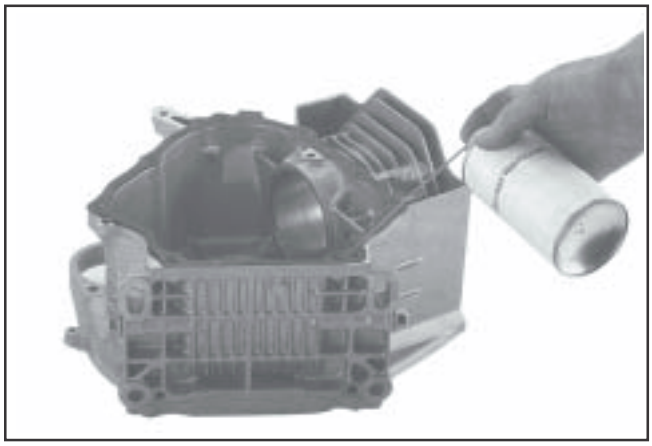
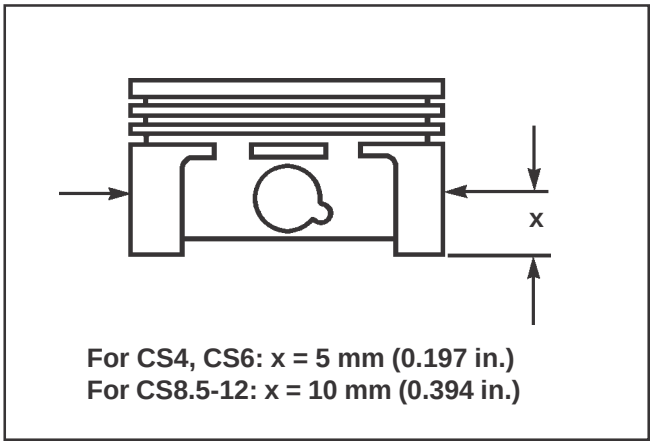


Figure 10-8. Removing Gasket with Aerosol Spray.

Measuring Piston-to-Bore Clearance

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

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



For CS4, CS6: x = 5 mm (0.197 in.)
For CS8.5-12: x = 10 mm (0.394 in.)

Figure 10-9. Measuring Piston Diameter.

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

1. Use a micrometer and measure the diameter of the piston at location indicated above the bottom of the piston skirt and perpendicular to the piston pin. See Figure 10-9.

2. Use an inside micrometer, telescoping gauge, or bore gauge and measure the cylinder bore. Take the measurement approximately **40 mm (1.6 in.)** below the top of the bore and perpendicular to the piston pin.

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

Flywheel

Inspection

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

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

Cylinder Head and Valves

Inspection and Service

Carefully inspect the valve mechanism parts. Inspect the valve springs and related hardware for excessive wear or distortion. Check the valves and valve seat area for evidence of deep pitting, cracks, or distortion. Check clearance of the valve stems in guides. See Figure 10-10 for valve details and specifications.

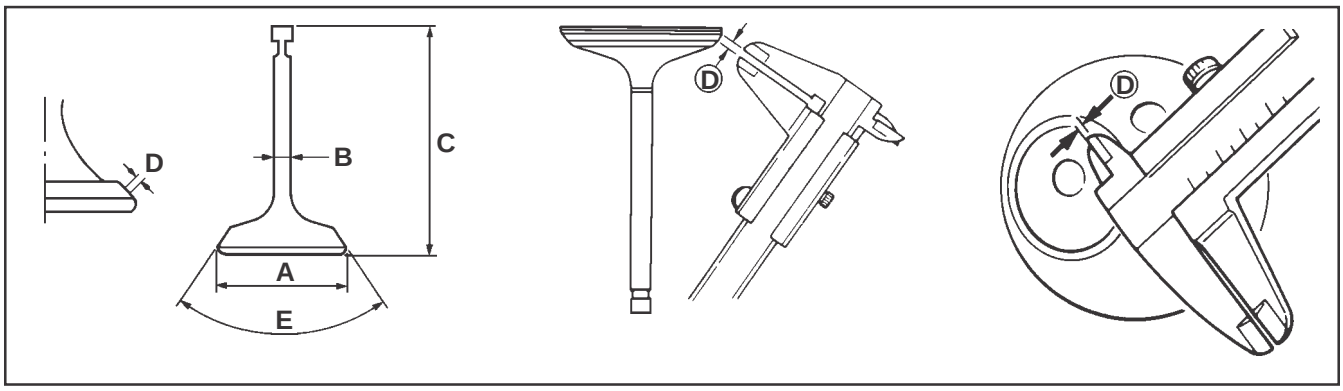


Figure 10-10. Valve and Valve Seat Measuring Locations.

CS4, CS6 Valve Specifications

	Dimension	Intake	Exhaust
A	Head Diameter (CS4)	21.0 mm (0.83 in.)	19.0 mm (0.75 in.)
	Head Diameter (CS6)	24.0 mm (0.94 in.)	22.0 mm (0.87 in.)
B	Stem Diameter	5.5 mm (0.22 in.)	5.5 mm (0.22 in.)
C	Length (CS4)	64.5 mm (2.54 in.)	64.5 mm (2.54 in.)
	Length (CS6)	65.9 mm (2.59 in.)	64.5 mm (2.54 in.)
D	Face/Seat Width	0.7 mm (0.0276 in.)	0.7 mm (0.0276 in.)
	Face/Seat Limit	1.7 mm (0.067 in.)	1.7 mm (0.067 in.)
E	Face/Seat Angle (Insert Area)	90°	90°
	Valve Stem Bend Limit	0.01 mm (0.0004 in.)	0.01 mm (0.0004 in.)
	Valve Guide		
	Guide Inside Diameter	5.5 mm (0.22 in.)	5.5 mm (0.22 in.)
	Stem to Guide Clearance	0.04/0.06 mm (0.0016/0.002 in.)	0.06/0.08 mm (0.002/0.003 in.)
	Valve Clearance	0.1 mm (0.004 in.)	0.1 mm (0.004 in.)
	Valve Seat Contact Width		
	Std.	0.7 mm (0.03 in.)	0.7 mm (0.03 in.)
	Limit	1.7 mm (0.067 in.)	1.7 mm (0.067 in.)

CS8.5, CS10, CS12 Valve Specifications

	Dimension	Intake	Exhaust
A	Head Diameter	32.0 mm (1.26 in.)	27.0 mm (1.06 in.)
B	Stem Diameter	5.948/5.963 mm (0.2342/0.2348 in.)	5.940/5.955 mm (0.2339/0.2344 in.)
C	Length	88.1 mm (3.47 in.)	87.9 mm (3.46 in.)
D	Face/Seat Width	0.7/0.9 mm (0.0276/0.0354 in.)	0.7/0.9 mm (0.0276/0.0354 in.)
	Face/Seat Limit	1.4 mm (0.055 in.)	1.4 mm (0.055 in.)
E	Face/Seat Angle (Insert Area)	90°	90°
	Valve Stem Bend Limit	0.01 mm (0.0004 in.)	0.01 mm (0.0004 in.)
	Valve Guide		
	Guide Inside Diameter	6.0/6.012 mm (0.2362/0.2367 in.)	6.0/6.012 mm (0.2362/0.2367 in.)
	Stem to Guide Clearance	0.037/0.064 mm (0.00146/0.00252 in.)	0.045/0.072 mm (0.00177/0.00283 in.)
	Valve Clearance	0.1 mm (0.004 in.)	0.1 mm (0.004 in.)
	Valve Seat Contact Width		
	Std.	0.7 mm (0.03 in.)	0.7 mm (0.03 in.)
	Limit	1.7 mm (0.067 in.)	1.7 mm (0.067 in.)

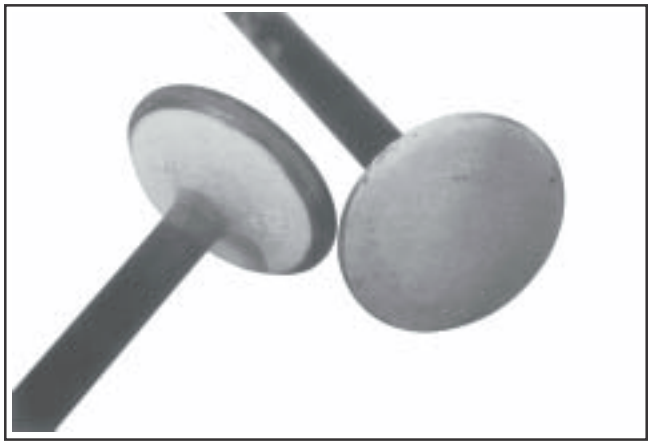
Hard starting, or loss of power accompanied by high fuel consumption may be symptoms of faulty valves. Although these symptoms could also be attributed to worn rings, remove and check the valves first. After removal, clean the valve heads, faces, and stems with a power wire brush. Then, carefully inspect 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 in. do not reuse it. The valve shown was in operation for almost 1000 hours under controlled test conditions.

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.

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

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.

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

Stem Corrosion: Moisture in the fuel, or 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.

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

Valve Guides

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

To check valve guide-to-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. Compare measurements and clearance to the specifications listed (See Figure 10-10) for the individual model involved. Determine whether the valve stem or the guide is responsible for the excessive clearance. The valve guides are not replaceable.

Valve Seat Inserts

The valve seats are not replaceable. If the seats become badly pitted, worn, or distorted, the inserts can be reconditioned.

Use a standard valve seat cutter (see Figure 10-11) and cut seat to dimensions shown in Figure 10-10. (Valve details illustration.)

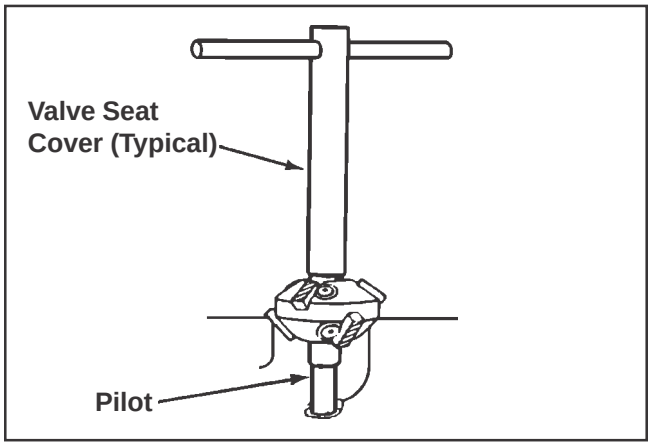


Figure 10-11. Standard Valve Seat Cutter.

Lapping Valves

Reground or new valves must be lapped in, to provide proper fit. Use a hand valve grinder 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 valve and cylinder head in soap and hot water to remove all traces of grinding compound. After drying, apply a light coating of **SAE 10** oil to prevent rusting.

Intake Valve Stem Seal

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

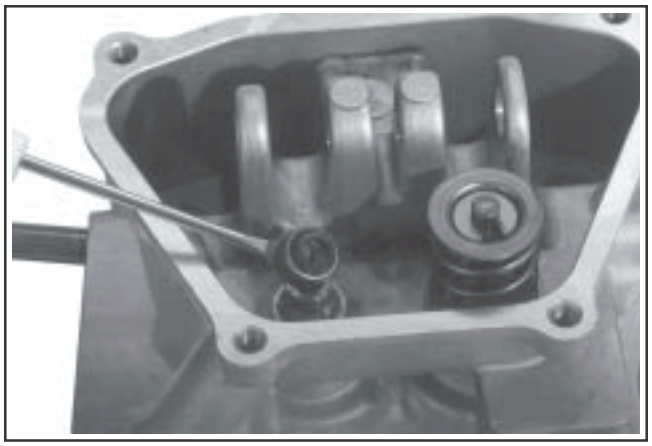


Figure 10-12. Valve Stem Seal.

Pistons and Rings

Inspection

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

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

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

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

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

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

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

See Figure 10-13 for common types of piston and ring damage.

Stuck, Broken Rings

Abrasive Scratched Rings

Abrasive Worn Rings

Scored Piston and Rings

Figure 10-13. Common Types of Piston and Ring Damage.

Replacement pistons are available in STD bore size, and in **0.25 mm (0.010 in.)** and **0.50 mm (0.20 in.)** oversizes. Replacement pistons include new piston ring sets and new piston pins.

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

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

Some important points to remember when servicing piston rings:

1. If the cylinder bore does not need reboring and the old piston is within wear limits, and free of score or scuff marks, the old piston may be reused.

2. Remove old rings and clean up grooves. **Never reuse old rings.**

3. Before installing the rings on the piston, place the top two rings, each in turn, in its running area in the cylinder bore, and check end gap. See Figure 10-14. This gap should be a maximum of **0.9 mm (0.035 in.)** in a used cylinder bore and **0.2 mm/ 0.4 mm (0.008/0.016 in.)** in a new cylinder bore.

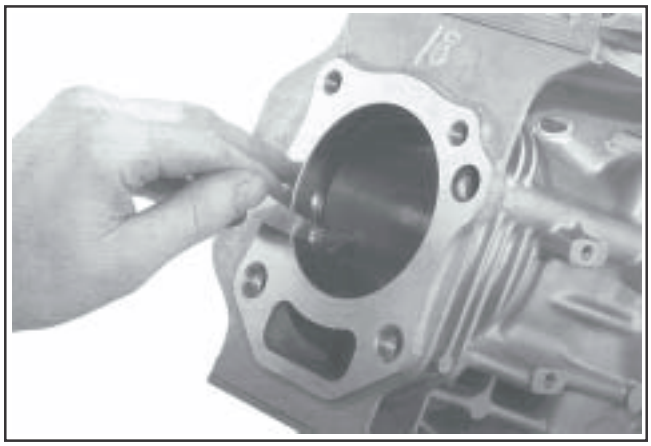


Figure 10-14. Measuring Piston Ring End Gap.

4. After installing the new rings on the piston, check piston-to-ring side clearance. Maximum recommended side clearance is:

   Top ring -
   0.04/0.08 mm (0.0016/0.0033 in.)
   2nd ring -
   CS4, CS6: 0.02/0.06 mm (0.0008/0.0024 in.)
   CS8.5-12: 0.03/0.07 mm (0.0012/0.0028 in.)
   Piston Ring Side Clearance Limit -
   0.1 mm (0.004 in.)

If side clearance is greater than specified, a new piston **must** be used. Refer to Figure 10-15.

Figure 10-15. Measuring Piston Ring Side Clearance.

Install Piston Rings

To install piston rings, proceed as follows:

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

Top Ring	
2nd Ring (Has R Marking)	
Oil Ring	

1. Oil Control Ring (Bottom Groove): Place the expander in the lowest groove. The ends of the expander must butt. **Do not** allow the ends to overlap; incorrect tension and a loss of oil control will result.

   Place one end of a rail between the upper side of the expander and groove, and ''wind'' into position. Be careful that the end of rail does not scratch the piston. Repeat this procedure with the second rail on the lower side of the expander. Position rail gaps 90° from the expander gap and 180° from each other. Check the assembly to ensure freedom of movement in the groove. See Figure 10-16.

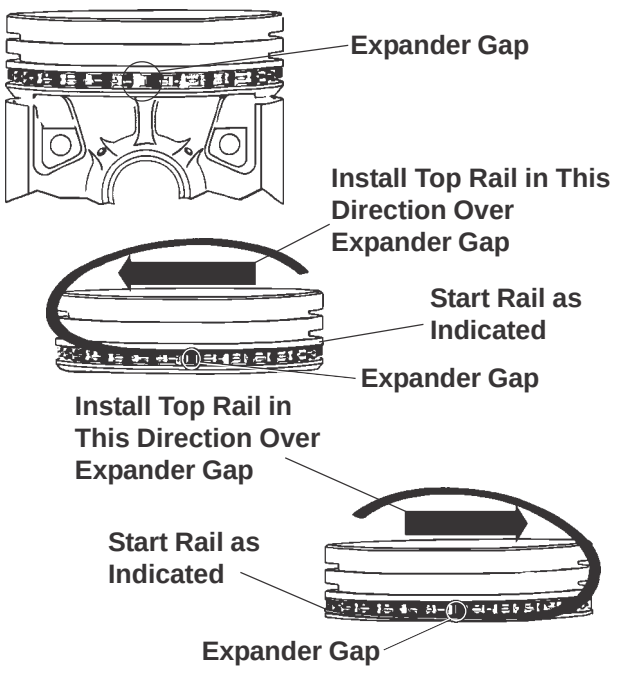


Figure 10-16. Oil Control Ring Details.

2. Middle Compression Ring: Locate and identify the compression ring with the **R** marking. Using a piston ring expander, install this ring in the middle groove with the **R** up towards the top of the piston. See Figure 10-17.

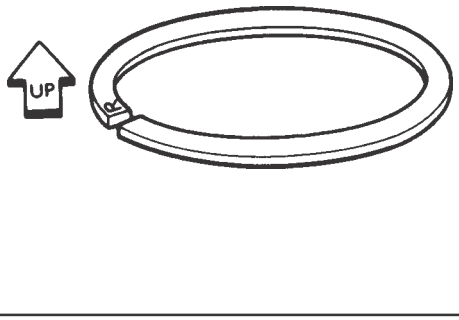


Figure 10-17. Middle Compression Ring.

3. Top Compression Ring: Using a piston ring expander, install the compression ring, with no markings, into the top groove. It is symmetrical in design, so it may be installed with either side up.

4. Stagger/position the two compression rings, so the end gaps are spaced 120° apart, as well as from the expander gap. See Figure 10-18.

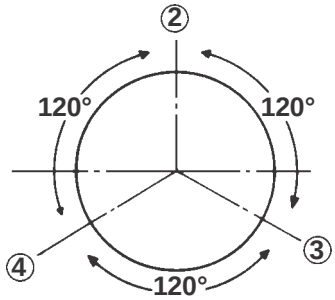


Figure 10-18. Ring Gap Positioning.

Connecting Rods

Inspection and Service

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

Governor Gear

Inspection and Service

Inspect the governor gear teeth, look for any evidence of worn, chipped, or cracked teeth. Check the condition of flyweights and pivot pins for wear or damage. Movement must be free but not sloppy. If any of these conditions or problems are noted, the governor gear must be replaced.

Removal

The governor gear is held onto the governor gear shaft by a small retaining clip located near the center section of the gear, within the flyweight assemblies. The mounting of the governor gear also retains the governor regulating pin and thrust washer in place.

The gear can be removed by using two small screwdrivers and carefully applying upward pressure from beneath the gear and against the bosses in the closure plate. **Do not pry against or nick/damage the gasket surface of the closure plate.** See Figure 10-19.

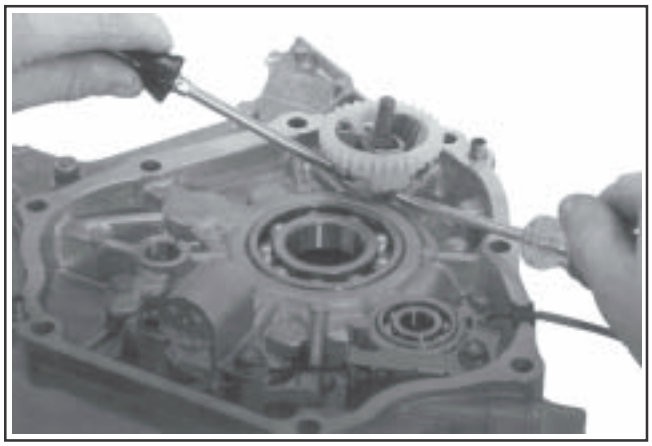


Figure 10-19. Governor Gear Removal.

Governor Shaft Position (In Closure Plate)

The governor shaft is pressed into the closure plate to a specified height and normally should not require removal or servicing. The position is critical to proper operation of the governor gear and the entire governor assembly. If, for any reason the mounted position of the governor shaft is changed, or affected, it must be reset to the specified height as shown in Figure 10-20.

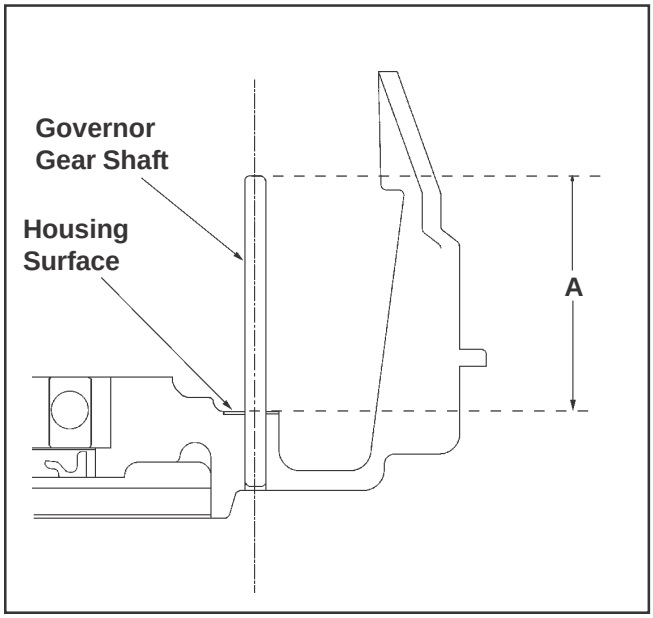


Figure 10-20. Governor Shaft Position Details.

Exposed Shaft Length–A

CS4, CS6	29.2 ± 0.2 mm (1.149 ± 0.007 in.)
CS8.5, CS10, CS12	36.0 ± 0.6 mm (1.417 ± 0.023 in.)

Governor Reassembly

1. Install one thrust washer onto the governor shaft, followed by the governor gear/flyweight assembly.

2. Start the retaining clip over the end of the shaft.

3. Raise the gear up on the shaft sufficiently to install the other thrust washer and governor regulating pin under the outer fingers of the flyweights. See Figure 10-21.

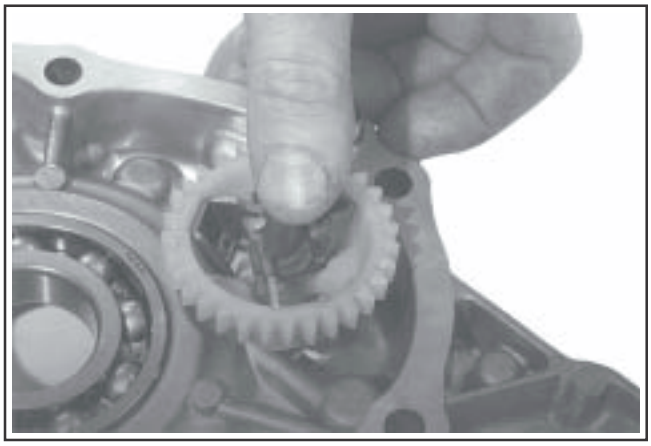


Figure 10-21. Installing Governor Gear Assembly.

4. Push the governor regulating pin down until the retaining ring locks into place in the shaft groove. Governor gear should now be retained on shaft and operate freely. Check gear and flyweight operation.

Gear Reduction Assemblies

Clean and inspect all components for wear and damage. Remove the housing gasket and dowel pins, then clean the gasket surfaces with a cleaning solvent or aerosol type gasket remover. **Do not nick or scrape the sealing surfaces.**

a. Inspect all sprocket/gear teeth for excessive wear. If teeth are worn to a point, the gear(s)/sprocket(s) and chain (CS4 and CS6) should be replaced. See Figure 10-22.

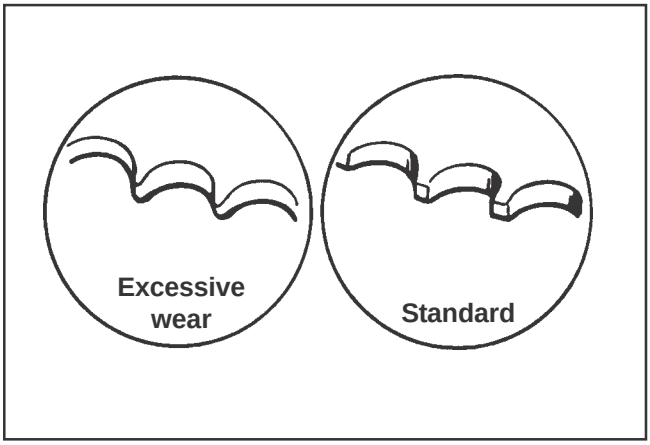


Figure 10-22. Sprocket Wear/Inspection on CS4, CS6.

b. Clean the chain (CS4 and CS6) in solvent to remove as much dirt as possible. Dry and then check the condition of the chain. If any links are tight and do not pivot freely (see Figure 10-25), or the chain has stretched beyond the specified limit measured across 10 pitches (see Figure 10-24), it must be replaced.

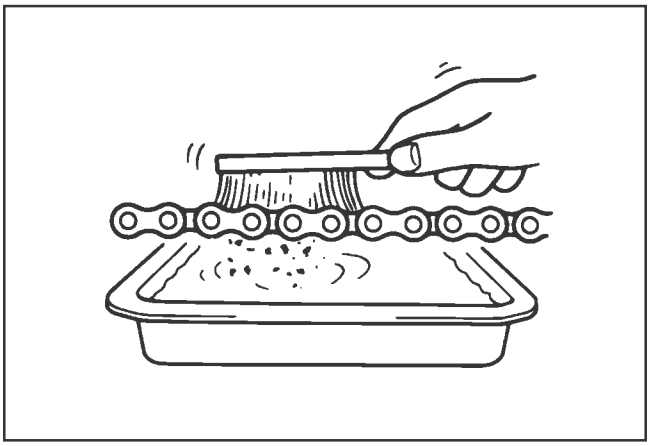


Figure 10-23. Clean Chain Using Solvent.

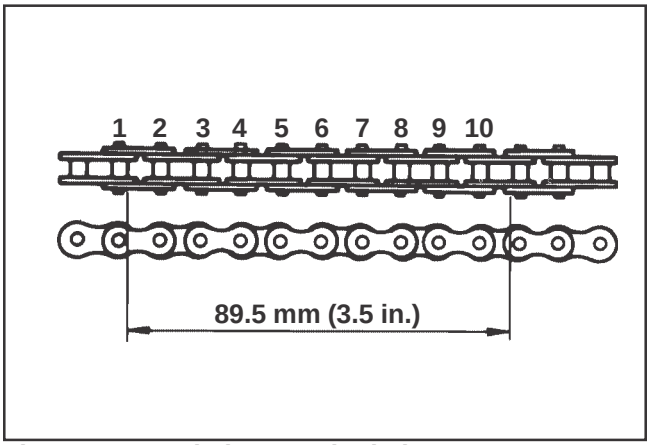


Figure 10-24. Chain Stretch Limit.

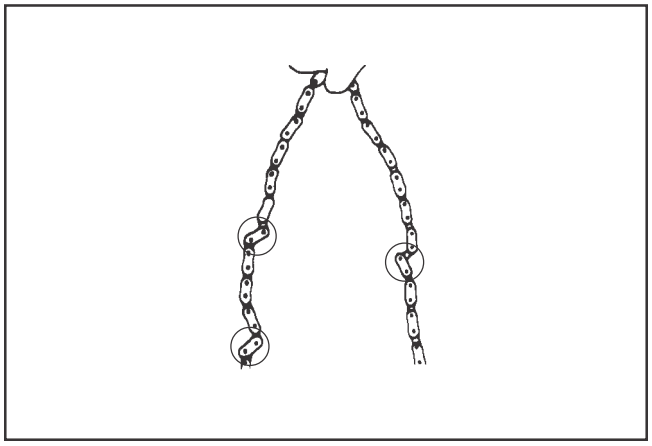


Figure 10-25. Inspect for Binding.

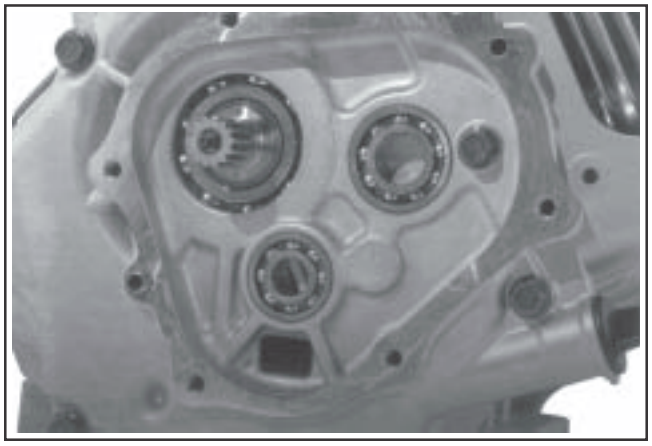


Figure 10-27. CS8.5-12 Oil Passage.

5. Check to see that the closure plate/oil passages to the reduction assembly are open and not restricted. See Figures 10-26 and 10-27.

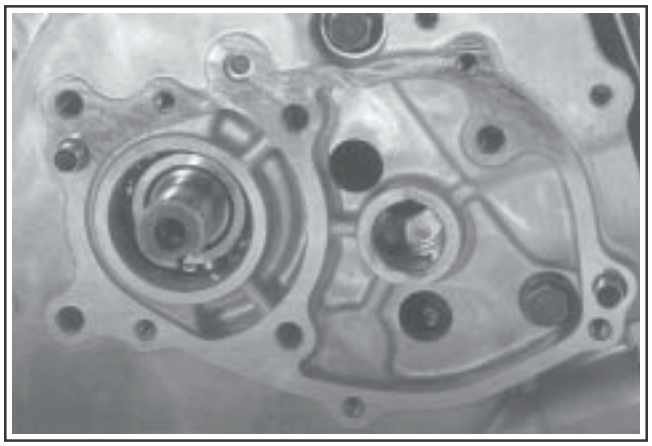


Figure 10-26. CS4, CS6 Oil Passage.

Section 11
Reassembly

General

NOTE: Make sure the engine is assembled using all specified torque values, tightening sequences, and clearances. Failure to observe specifications could cause severe engine wear or damage. Always use new gaskets.

Typical Reassembly Sequence

The following sequence is suggested for complete engine reassembly. This procedure assumes that all components are new or have been reconditioned, and all component subassembly work has been completed. The sequence may vary to accommodate options or special equipment. Detailed procedures can be found in subsequent subsections.

1. Install oil seals and bearings.
2. Install governor cross shaft.
3. Install crankshaft.
4. Install connecting rod with piston and rings.
5. Install camshaft and valve tappets.
6. Install balance shaft assembly (CS8.5-12 only).
7. Install oil sentry gauge and governor gear to closure plate.
8. Install closure plate assembly.
9. Install reduction assembly (some models).
10. Install stator and wire shield.
11. Install flywheel.
12. Install ignition module.
13. Assemble and install cylinder head.
14. Install push rods, rocker arms, studs, and rocker shaft.
15. Install valve cover.
16. Install fuel tank supports, throttle lever, wiring and electrical components.
17. Install governor lever, throttle and governor springs.
18. Connect electrical leads and install electric starter (electric starter only).
19. Install blower housing (and electric starter cover panel).
20. Install carburetor.
21. Install air cleaner base and element.
22. Adjust/Set governor.
23. Install fuel tank and fuel tank support.
24. Install outer air cleaner cover.
25. Install retractable starter.
26. Install muffler.

Install Oil Seals and Bearings

1. Make sure there are no nicks, burrs, or damage in the bores for the bearings. The closure plate and crankcase must be clean.

2. Use an arbor press to make sure the bearings are installed straight, into their respective bores, until fully seated.

   NOTE: Install the bearings and oil seals (step 3) with their manufacturer's marks or numbers visible, facing you.

   Oil the bearings liberally with engine oil when installing.

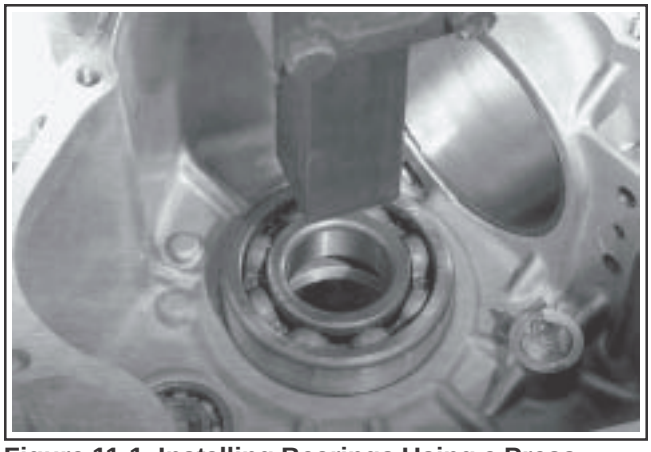


Figure 11-1. Installing Bearings Using a Press.

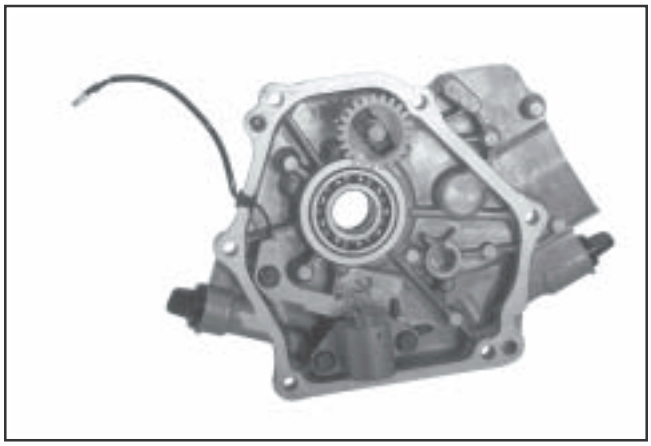


Figure 11-2. Installing Bearing in Closure Plate.

3. Use a seal driver and install the crankshaft oil seals (manufacturer's numbers visible) into crankcase and closure plate. Seals should be installed to a depth of 2 mm (0.080 in.) below outer surface. See Figure 11-3. Apply a light coating of lithium grease to seal lips when installing.

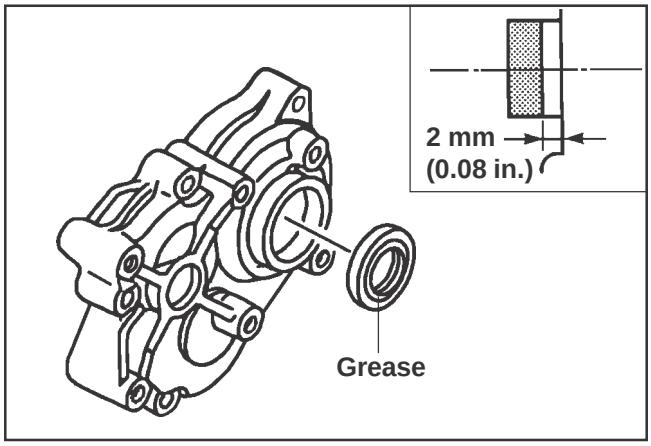


Figure 11-3. Installing Oil Seal.

Install Governor Cross Shaft

1. Install the governor shaft seal, with the manufacturer's marks out, into the governor shaft bore in crankcase until flush with the top. A 1/2 in. O.D. seal driver or round stock may be used to install.

2. Install one thrust washer onto the governor cross shaft and slide the shaft up through the inside of the crankcase.

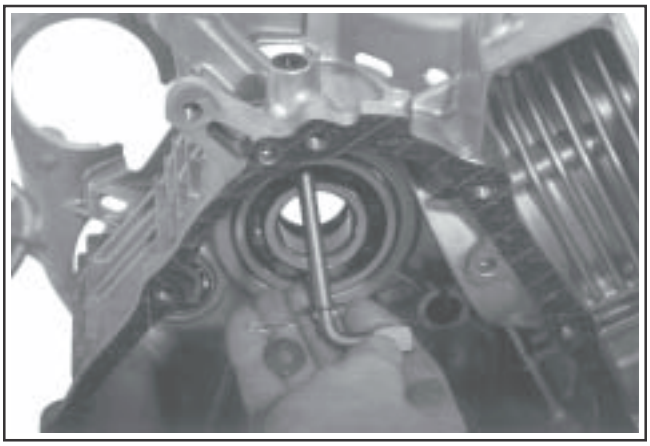


Figure 11-4. Installing Governor Shaft.

Figure 11-5. Installing Outer Washer.

3. Install the second flat washer onto the shaft. Position the shaft so the lower flat section faces to the right (3 o'clock position) and insert the hitch pin so the end of the clip comes in contact with the raised section of the housing boss, limiting the inward movement of the arm. See Figures 11-6 and 11-7.

NOTE: Verify that correct installation has been made at this time.

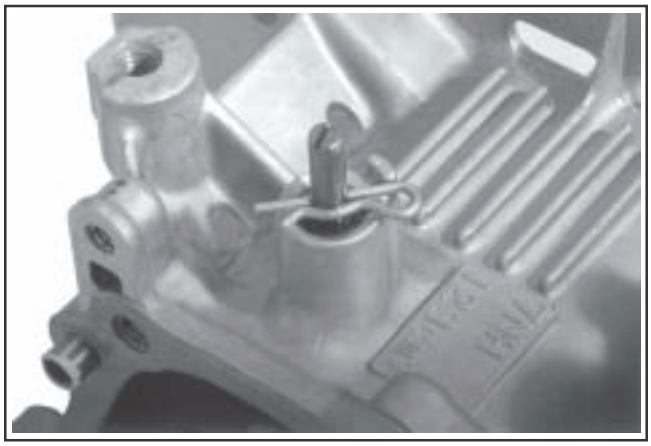


Figure 11-6. CS4, CS6. Installing Hitch Pin.

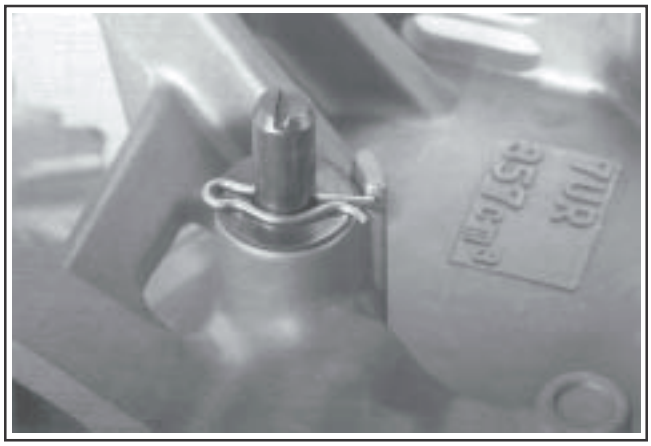


Figure 11-7. CS8.5-12. Installing Hitch Pin.

Install Crankshaft

1. Carefully slide the flywheel end of the crankshaft through the main ball bearing and seal.

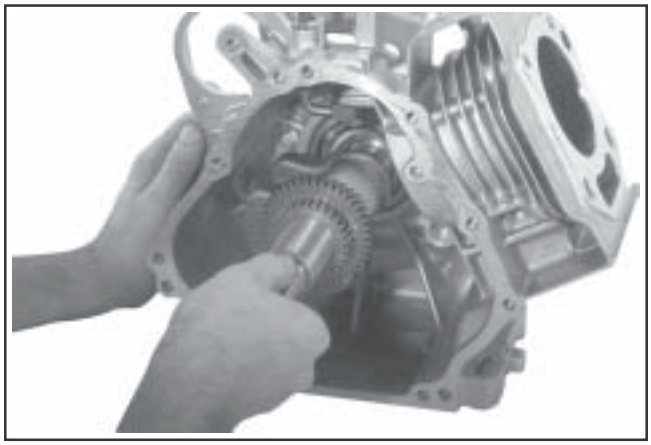


Figure 11-8. Installing Crankshaft.

Install Connecting Rod with Piston and Rings

1. If the piston and/or connecting rod has been changed or removed, make sure the following is correct before installing.

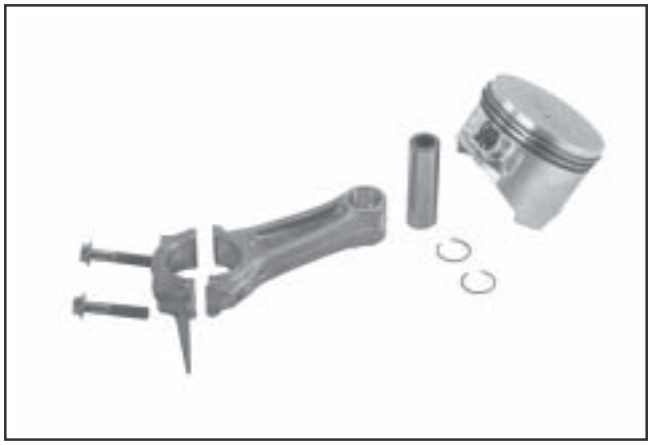


Figure 11-9.

   a. The locating mark on piston is down. See Figure 11-10.

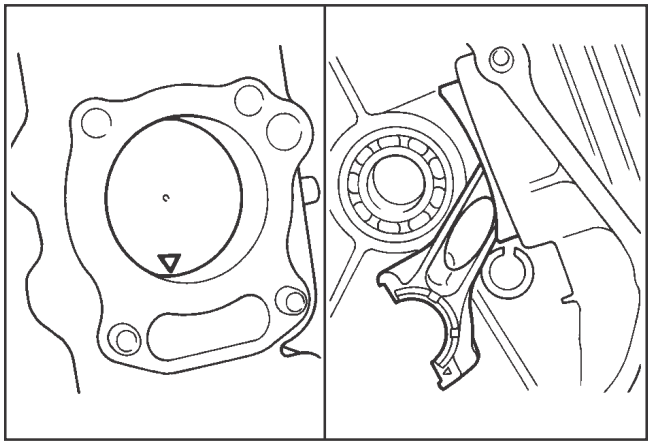


Figure 11-10. Piston Installation Details.

b. The connecting rod offset is down and oil hole is in the 3 o'clock position. Match marks should align as shown with dipper down. See Figure 11-11.

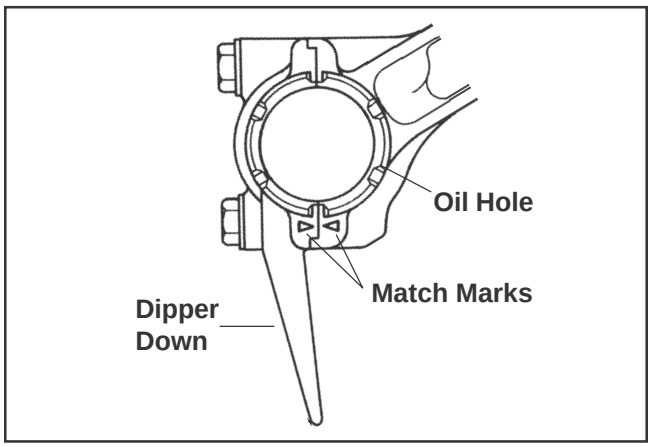


Figure 11-11. Connecting Rod Details.

2. Stagger the piston rings in the grooves until the end gaps are 120º apart. See Figure 11-12. The oil ring rails should also be staggered.

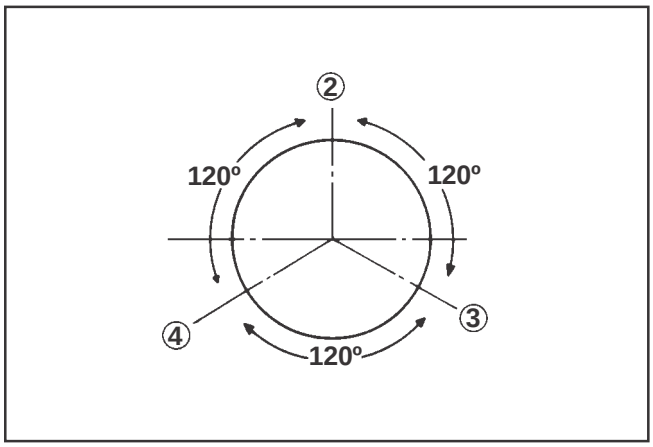


Figure 11-12. Piston Ring Gap Positioning.

3. Lubricate cylinder bore, piston, piston pin, and piston rings with engine oil. Compress the rings using a piston ring compressor.

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

5. Make sure ''∇'' stamping on piston is facing down toward the base of the engine. Use a hammer handle with a rubber grip and gently tap the piston into the cylinder as shown in Figure 11-13. Be careful that the oil ring rails do not spring free between the bottom of the ring compressor and the top of the cylinder.

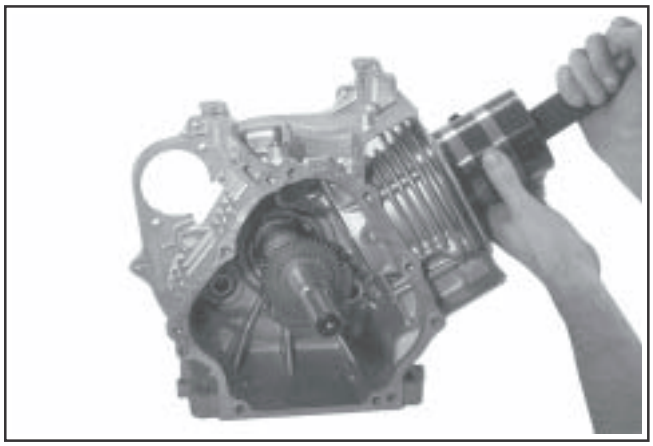


Figure 11-13. Installing Piston Using a Ring Compressor.

6. Install the connecting rod cap to the connecting rod so the dipper is down, and the match marks are aligned. See Figure 11-14.
Torque in increments to:
CS4, CS6: 12 N·m (106 in. lb.)
CS8.5-12: 20 N·m (177 in. lb.)

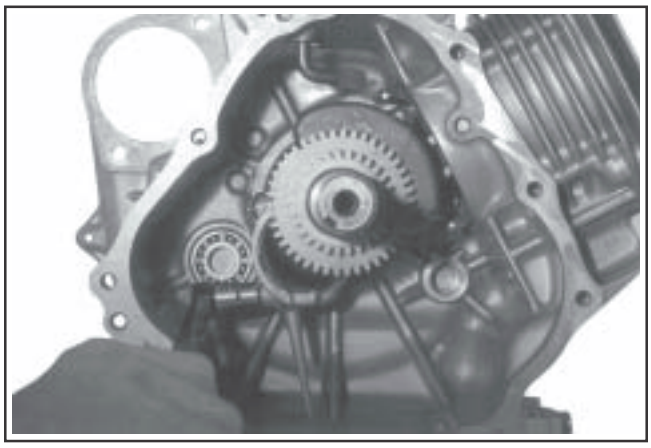


Figure 11-14. Rod Cap/Dipper Position.

Install Valve Tappets and Camshaft

1. Identify the valve tappets as to their proper locations. Lubricate the face and stem of each tappet with engine oil. Install each into their respective bores.

2. Lubricate the camshaft bearing surfaces and cam lobes as well as the camshaft bore in the crankcase with engine oil.

3. Rotate the crankshaft to TDC so the timing mark (dimple) on crankgear (smaller gear) is in the 4 o'clock position. Install the camshaft into the crankcase, aligning the timing marks on the two gears. See Figures 11-15 and 11-16.

   NOTE: Timing mark is the hole on CS4, CS6 and the small dimple on CS8.5-12.

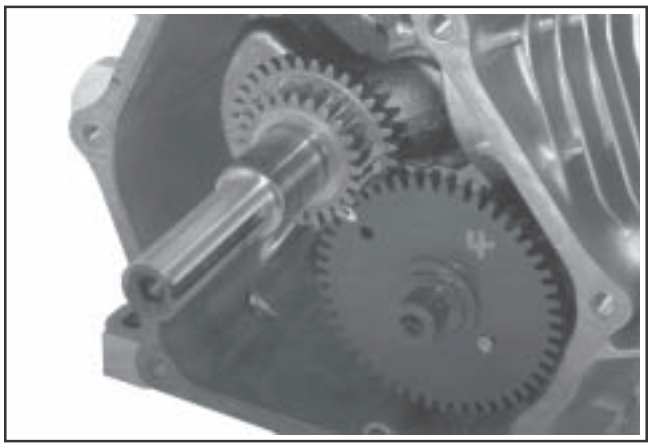


Figure 11-15. CS4, CS6. Aligning Crankshaft and Camshaft Timing Marks.

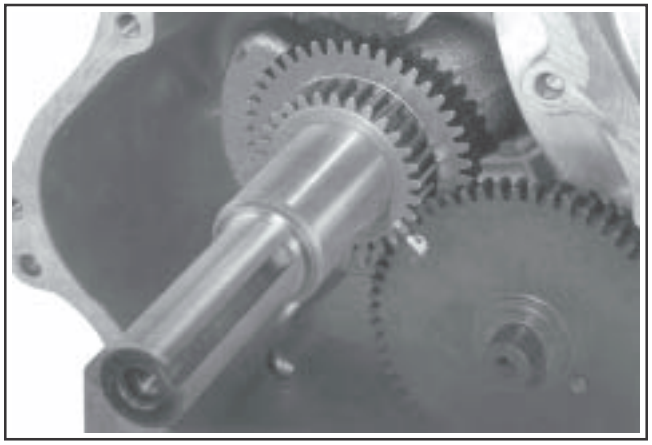


Figure 11-16. CS8.5-12. Aligning Crankshaft and Camshaft Timing Marks.

Install Balance Shaft (CS8.5-12, If So Equipped)

1. Position the crankshaft so the timing mark (dimple) on the larger crankgear is in the 8 o'clock position.
2. Install the balance shaft, aligning the timing mark (hole) with the timing mark (dimple) on the larger crankgear. See Figure 11-17.

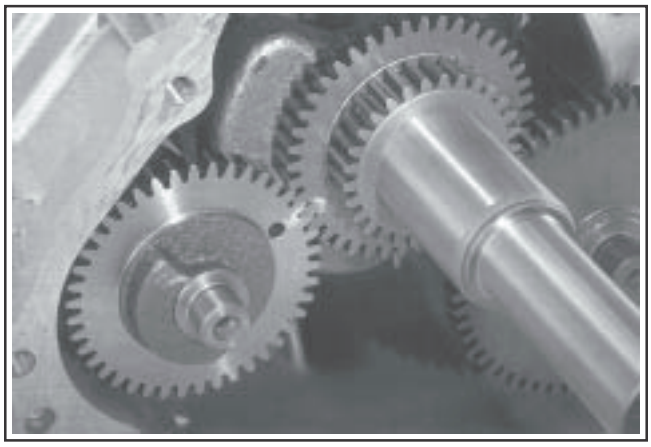


Figure 11-17. CS8.5-12. Aligning Balance Shaft and Crankgear Timing Marks.

Install Governor Assembly

The governor gear assembly is located inside the closure plate. If servicing was performed or the governor was removed, reassemble as per procedures under Governor Reassembly in Section 10.

Install Oil Sentry™ Gauge

1. Mount the Oil Sentry™ gauge into the closure plate using two M6x1.0 hex flange screws. Route the wire lead and seat the grommet in the cutout as shown in Figure 11-18.

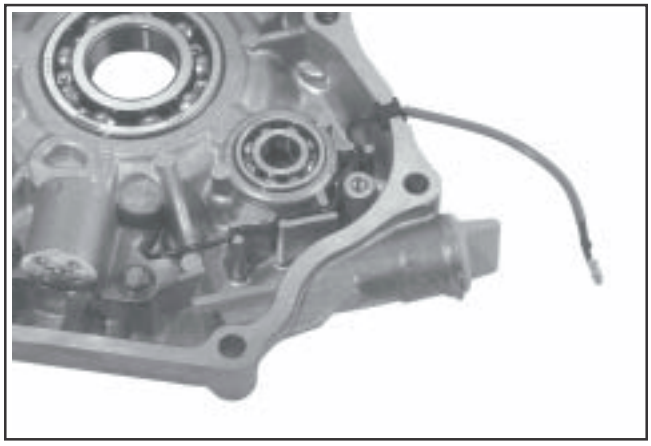


Figure 11-18. Oil Sentry™ Gauge Mounting and Lead Routing Details.

2. Install shield for lead and secure with the M6x1.0 hex flange screw. **Torque all three screws to 10 N·m (88.5 in. lb.).** See Figure 11-19.

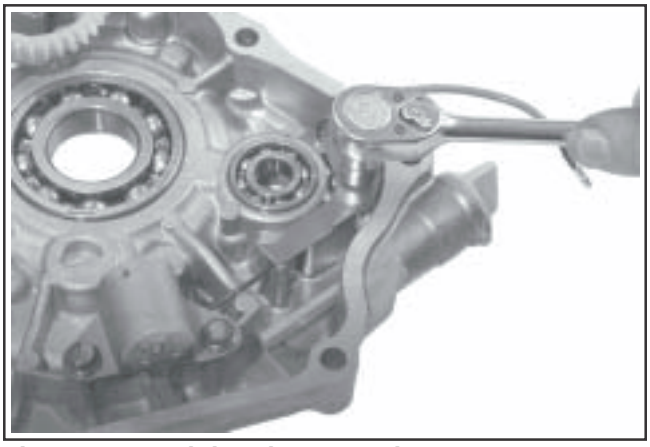


Figure 11-19. Tightening Mounting Screws.

Install Closure Plate Assembly

1. Check to make sure the sealing surfaces of the crankcase and closure plate are clean and free of nicks/burrs.

2. Install the two dowel pins into the locations shown in the crankcase. Install the new closure plate gasket (dry) onto the dowel pins. Make sure the governor lever is facing towards the right (cylinder side).

   Completed assembly, before closure plate is installed, should look like Figures 11-20 and 11-21.

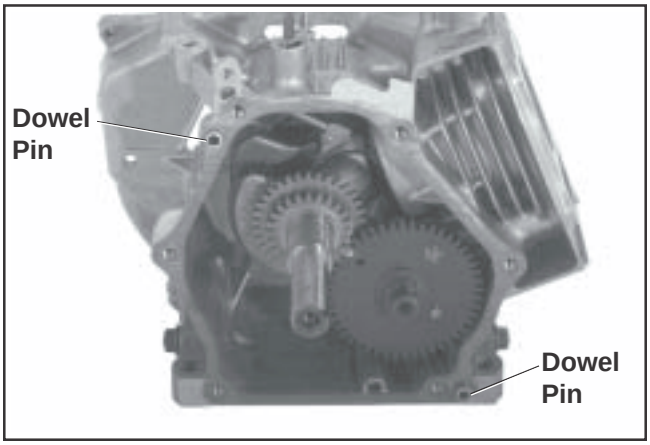


Figure 11-20. CS4, CS6. Internal Details.

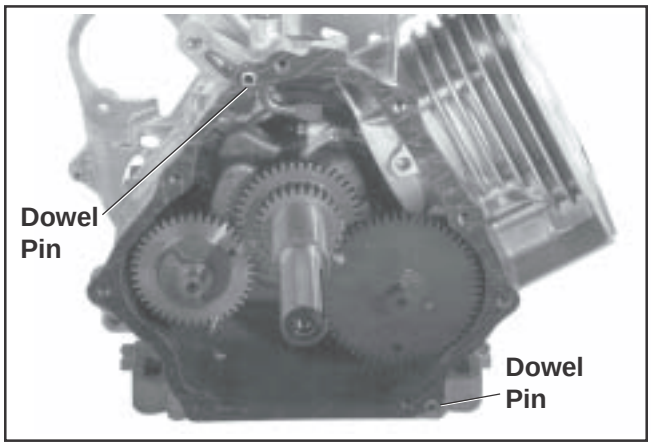


Figure 11-21. CS8.5-12. Internal Details.

3. Install the closure plate to the crankcase. Carefully seat the ends of the camshaft and balance shaft into their mating bearings. Rotate the crankshaft slightly to help engage the governor gear teeth.

4. On pump (threaded crankshaft) models only, install two or three of the fasteners securing the closure plate to the crankcase. Check crankshaft end play using a dial indicator. End play must be 0.0/0.2 mm (0.0/0.007 in.). If end play is not within the specified range, shims are available in the following thicknesses: 0.1 mm (0.0039 in.), 0.2 mm (0.007 in.), and 0.3 mm (0.011 in.) for CS4 and CS6; 0.1 mm (0.0039 in.), 0.2 mm (0.007 in.), 0.3 mm (0.011 in.), and 0.4 mm (0.015 in.) for CS8.5-12. When proper end play has been established, install all screws and torque in the sequence shown in Figure 11-22 or 11-23.

   On all other models, install the hex flange screws securing the closure plate to the crankcase. See Figure 11-22 or 11-23.

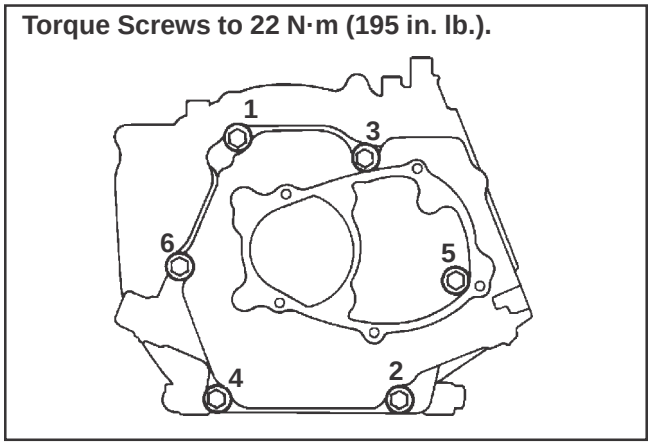


Figure 11-22. CS4, CS6. Closure Plate Torque Sequence.

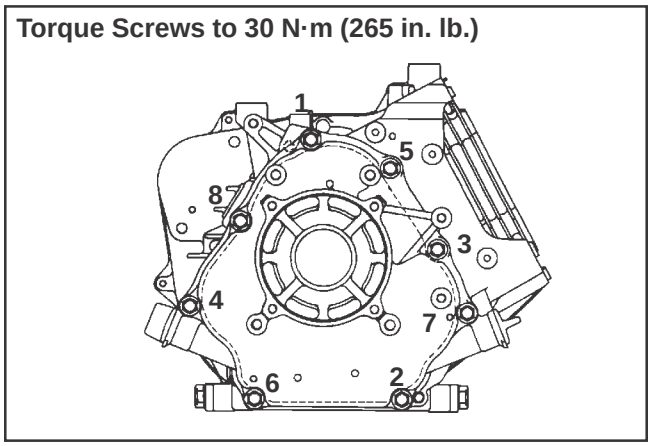


Figure 11-23. CS8.5-12. Closure Plate Torque Sequence.

Install Reduction System (If So Equipped)

2:1 Reduction Assemblies

1. If any bearings were removed, press the new bearing(s) into the housing so the manufacturer's marks are visible. Pre-lube the bearings with engine oil on installation. See Figures 11-24 and 11-25.

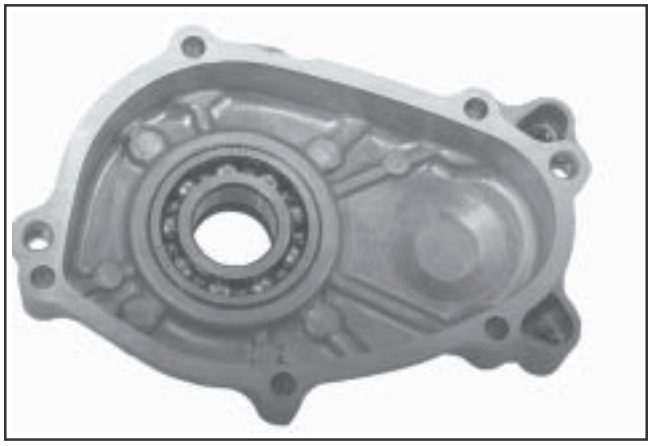


Figure 11-24. CS4, CS6. Installing Bearing.

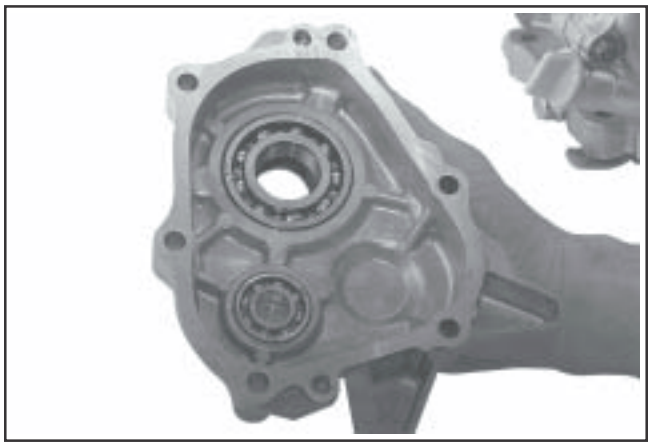


Figure 11-25. CS8.5-12. Installing Bearing.

2. Install a new oil seal into the cover to a depth of 2 mm (0.08 in.). See Figure 11-26. Apply a light coating of lightweight lithium grease to lip of seal.

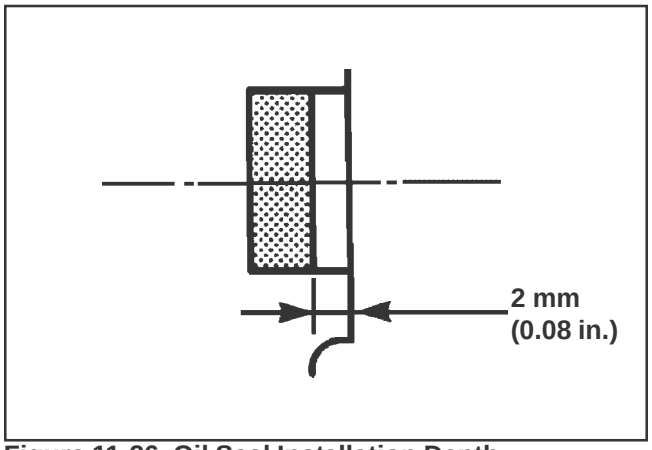


Figure 11-26. Oil Seal Installation Depth.

3. Pre-lube all bearing surfaces with engine oil.

4. **CS4, CS6:** Reinstall the washer (behind crankshaft key) and crankshaft key. Install the chain around both the crankshaft sprocket and the output shaft/sprocket assembly, then slide the complete assembly into place. Reinstall the wave washer onto the output shaft. See Figures 11-27, 11-28, and 11-29.

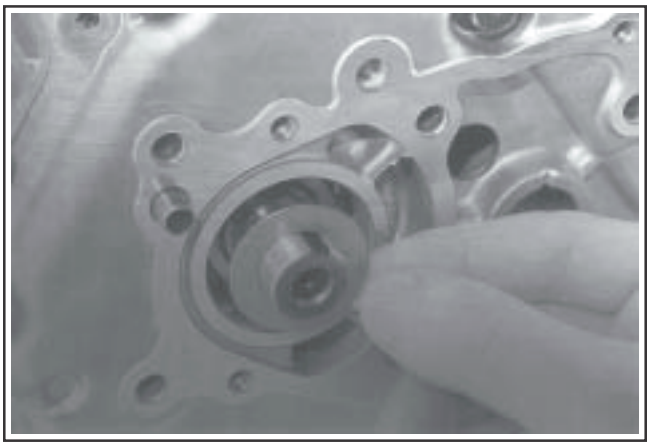


Figure 11-27. CS4, CS6. Installing Thrust Washer.

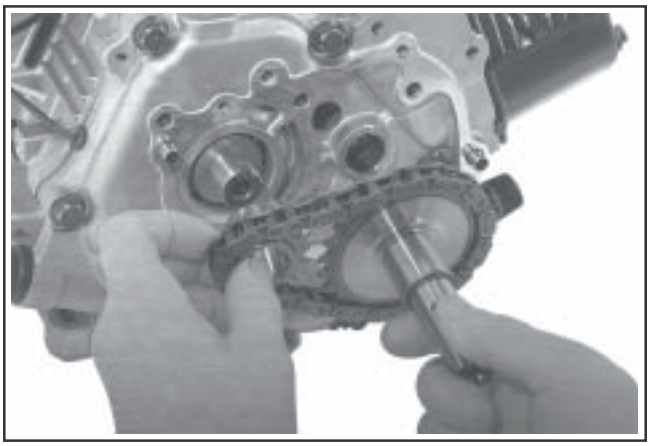


Figure 11-28. CS4, CS6. Installing Sprockets and Chain.

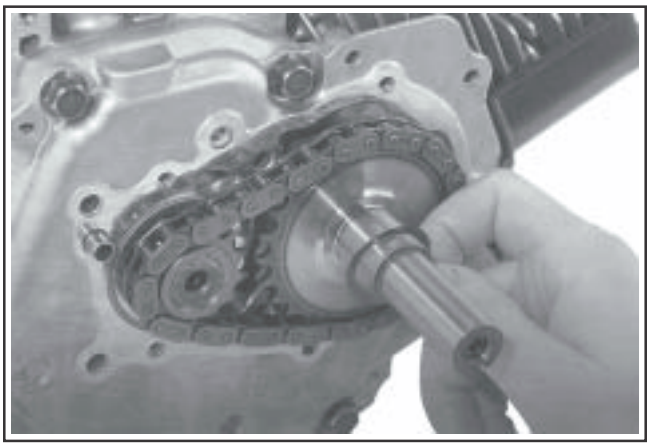


Figure 11-29. CS4, CS6. Installing Wave Washer.

Install hex flange screw and flat washer into crankshaft. **Torque the screw to 20-24 N·m (177-212 in. lb.).** See Figures 11-30 and 11-31.

Figure 11-30. Installing Mounting Bolt and Washer.

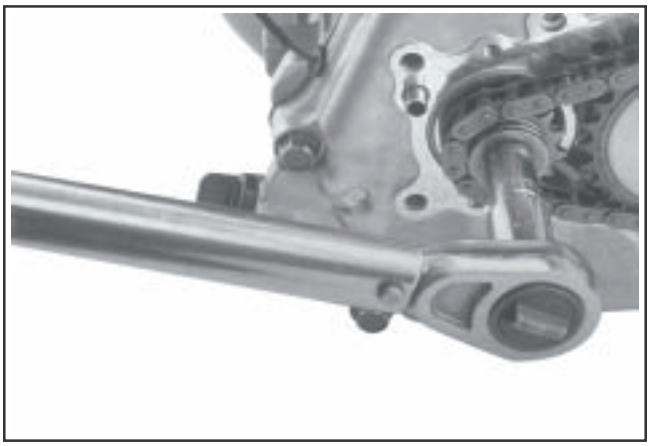


Figure 11-31. Torquing Mounting Bolt.

CS8.5-12: Install the key into the keyway of the crankshaft. Install the crankshaft gear onto the engine crankshaft. Secure with the flat washer and hex flange screw. See Figure 11-32.
Torque the screw to:
CS8.5 (spec. 92xxxx), CS10, CS12:
60-70 N·m (44-51 ft. lb.)
CS8.5 (spec. 95xxxx): 22 N·m (195 in. lb.)

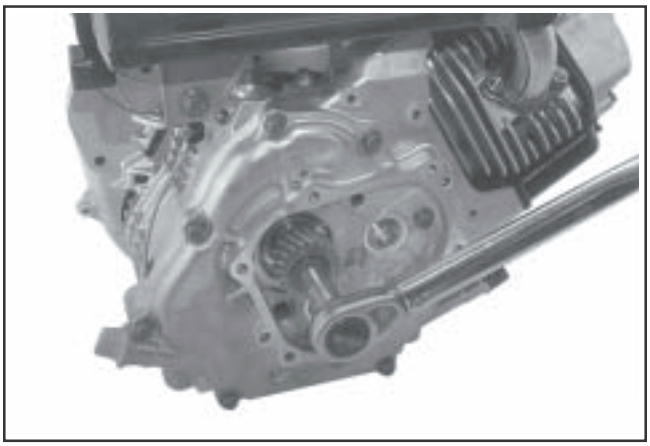


Figure 11-32.

Install the counter gear into the pre-oiled bearing boss in the closure plate, engaging teeth with gear on crankshaft.

Install the output shaft/gear assembly into the corresponding pre-oiled bearing boss in the closure plate. See Figure 11-33.

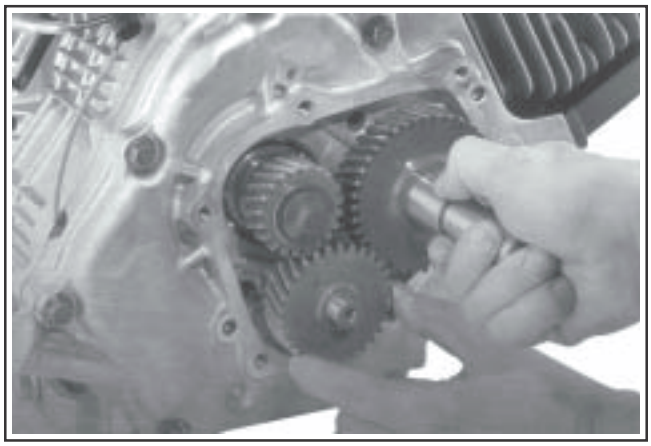


Figure 11-33. CS8.5-12. Installing Counter Gear and Output Shaft/Gear Assembly.

5. Install the dowel pins into their respective locations in the closure plate, and install a new gasket (dry) onto the dowel pins. See Figures 11-34 and 11-35.

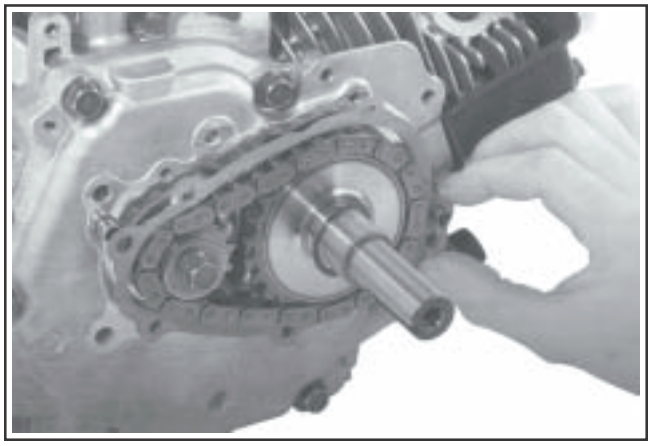


Figure 11-34. CS4, CS6. Installing Dowel Pins and Gasket.

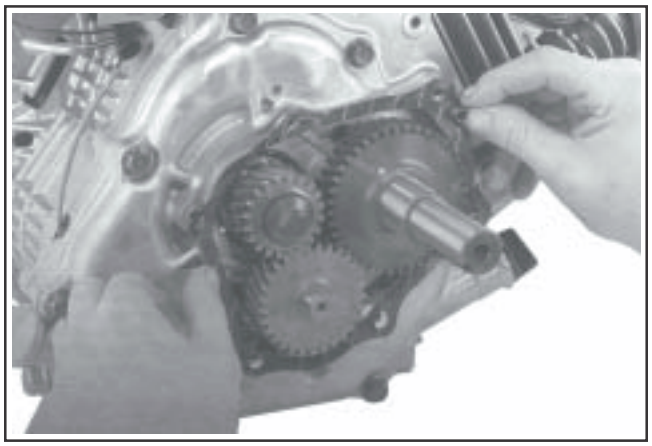


Figure 11-35. CS8.5-12. Installing Dowel Pins and Gasket.

6. Assemble the cover onto the closure plate, aligning the dowel pin and hole locations.

7. Install the cover mounting screws and torque to:
   CS4,CS6: 10 N·m (88.5 in. lb.)
   CS8.5-12: 30 N·m (265 in. lb.)

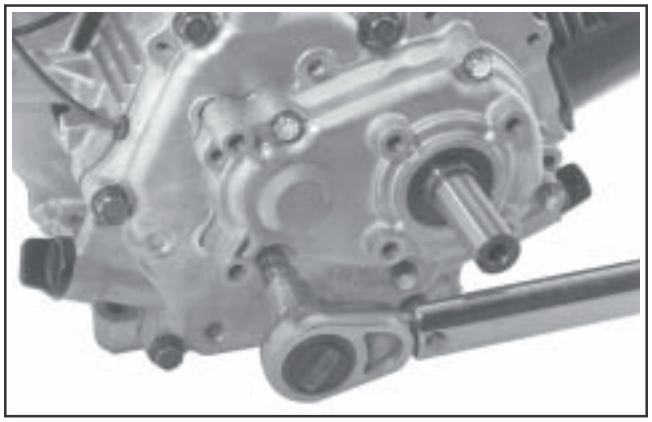


Figure 11-36. CS4, CS6. Torquing Cover Mounting Screws.

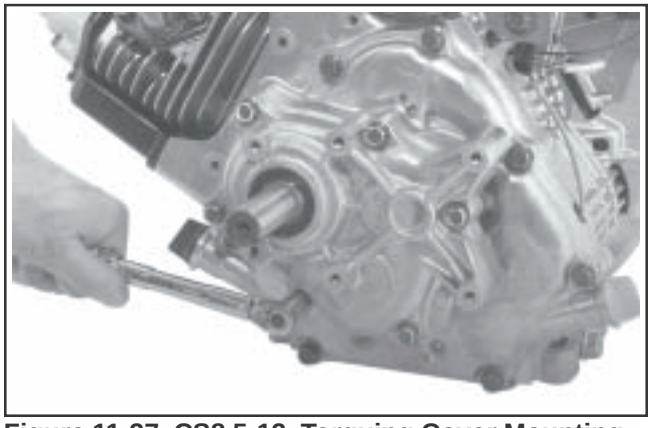
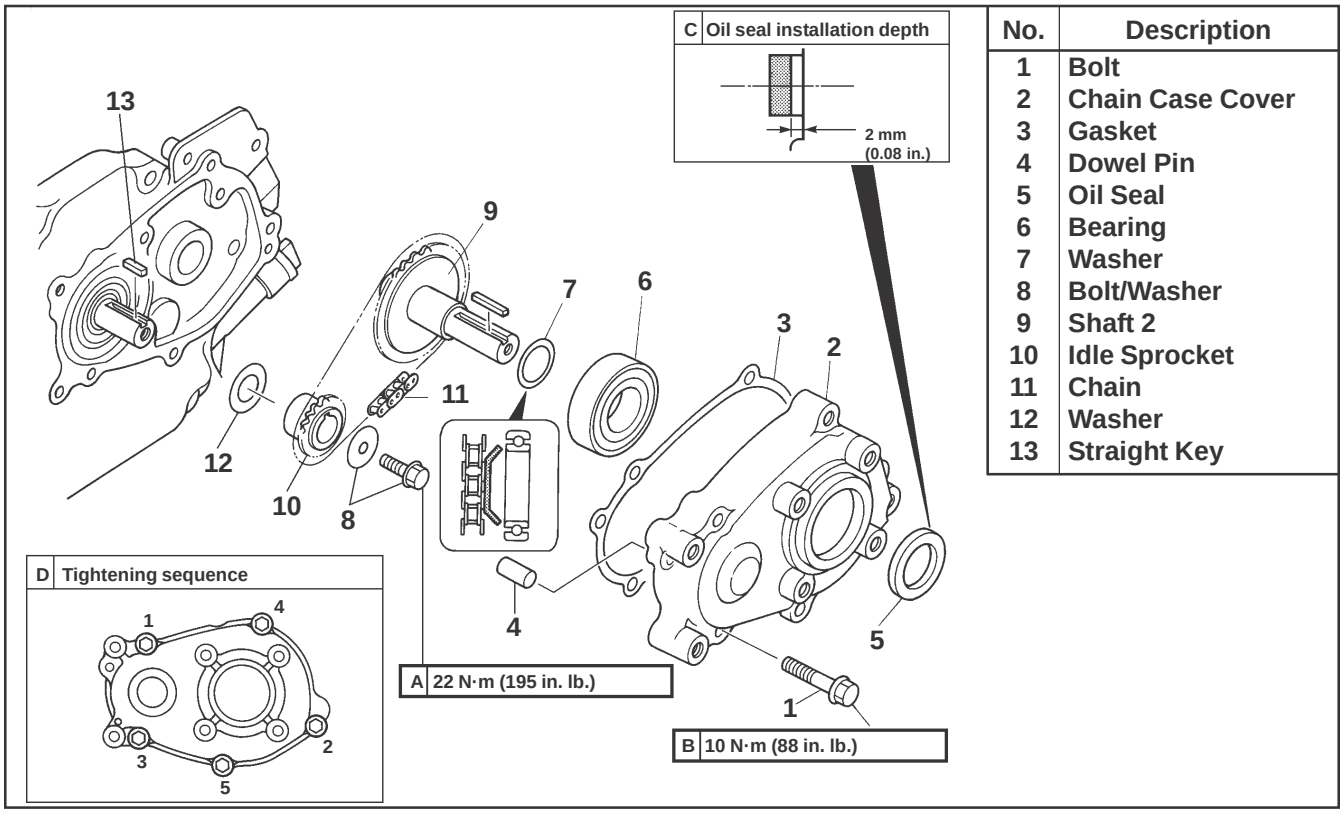
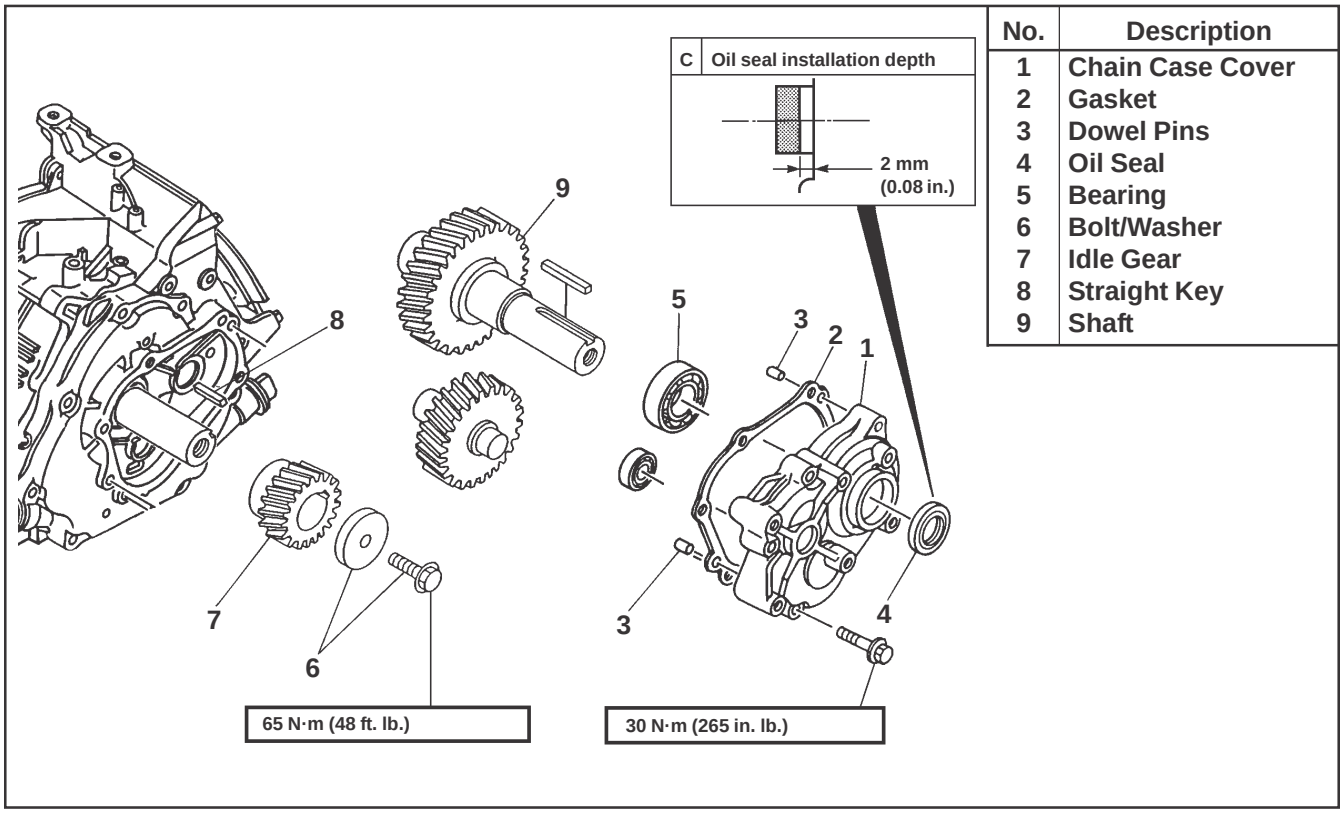


Figure 11-37. CS8.5-12. Torquing Cover Mounting Screws.



No.	Description
1	Bolt
2	Chain Case Cover
3	Gasket
4	Dowel Pin
5	Oil Seal
6	Bearing
7	Washer
8	Bolt/Washer
9	Shaft 2
10	Idle Sprocket
11	Chain
12	Washer
13	Straight Key

Figure 11-38. CS4, CS6. 2:1 Reduction Assembly Components.



No.	Description
1	Chain Case Cover
2	Gasket
3	Dowel Pins
4	Oil Seal
5	Bearing
6	Bolt/Washer
7	Idle Gear
8	Straight Key
9	Shaft

Figure 11-39. CS8.5-12. 2:1 Reduction Assembly Components.

6:1 Reduction Assemblies
CS4 and CS6

1. If any bearings were removed, press the new bearing(s) into the housing or cover, so the manufacturer's marks are visible. Pre-lube the bearings with engine oil on installation.

2. Install a new oil seal into the cover to a depth of 2 mm (0.08 in.). See Figure 11-40. Apply a light coating of lightweight lithium grease to the lip of the seal.

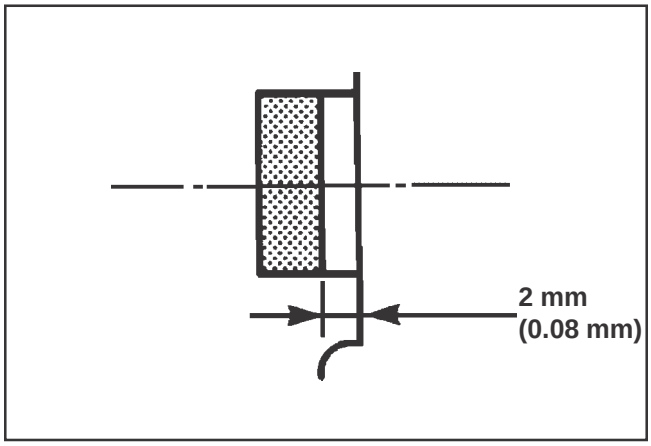


Figure 11-40. Oil Seal Installation Depth.

3. Pre-lube all bearing surfaces with engine oil.

4. Install a new gasket between the reduction housing and closure plate.

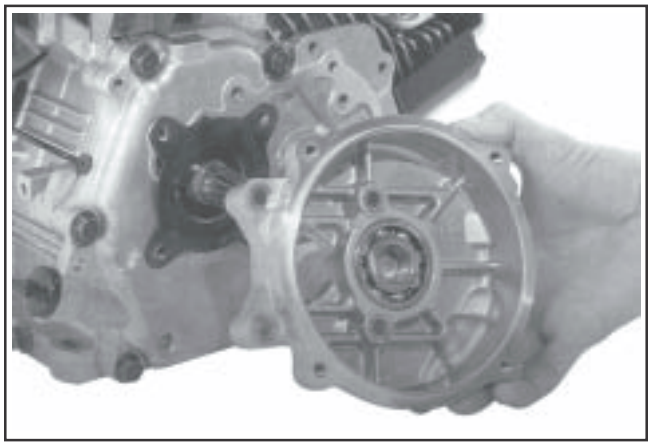


Figure 11-41. Installing Gasket and 6:1 Reduction Housing.

5. Install the reduction housing to the closure plate as shown and secure with the four hex flange screws. Torque the screws to **20-24 N·m (177-212 in. lb.)**.

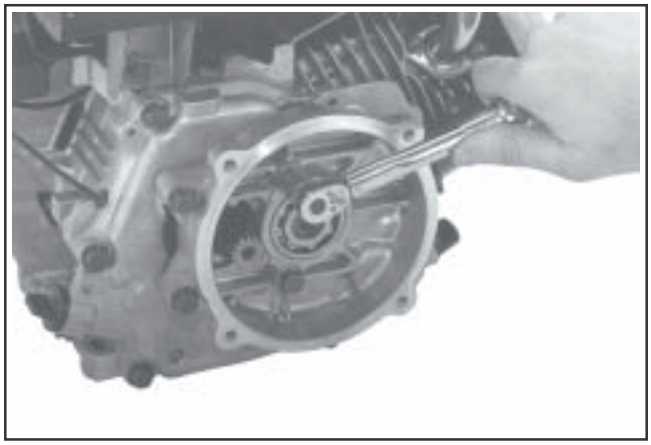


Figure 11-42. Torquing Housing Mounting Screws.

6. Lubricate the teeth of the ring gear/output shaft assembly with oil and install. Engage teeth with splines on crankshaft and slide assembly into the bearing bore in the housing.

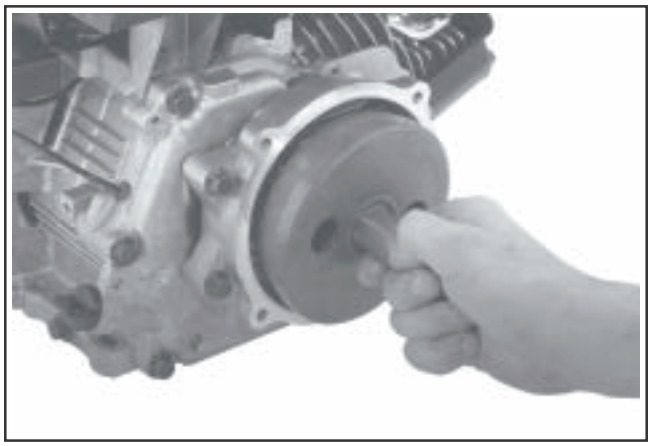


Figure 11-43. Installing Ring/Gear Output Shaft Assembly.

7. Install a new gasket (dry) onto the housing and attach the cover with the four mounting screws, so the Oil Fill and Oil Level port locations are positioned exactly as shown. Torque the screws to **20-24 N·m (177-212 in. lb.)**.

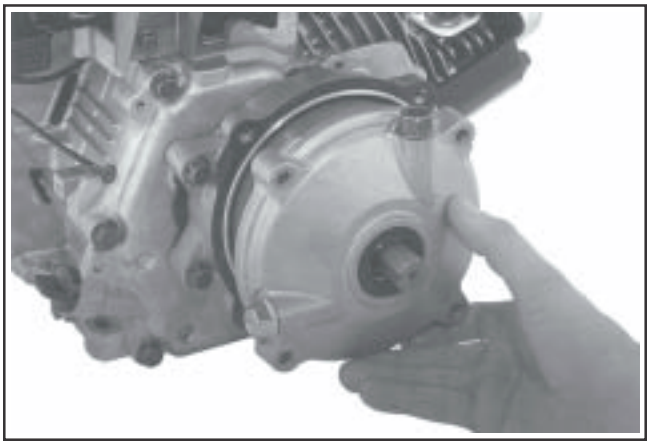


Figure 11-44. Installing Cover Assembly.

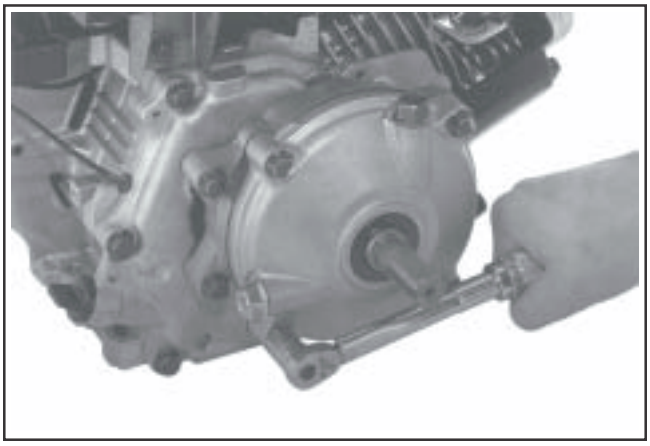


Figure 11-45. Torquing Cover Mounting Screws.

8. Add oil. Use the same weight oil as in the engine. Fill through the fill plug hole (on top) until oil is even with bottom of level plug hole (on side). Capacity=0.15 liter (5.02 fl. oz.).

9. Install the level plug and fill plug into their respective locations. The fill plug contains a vent hole and must be installed on top. See Figure 11-46. **Torque the plugs to 15-19 N·m (133-168 in. lb.).**

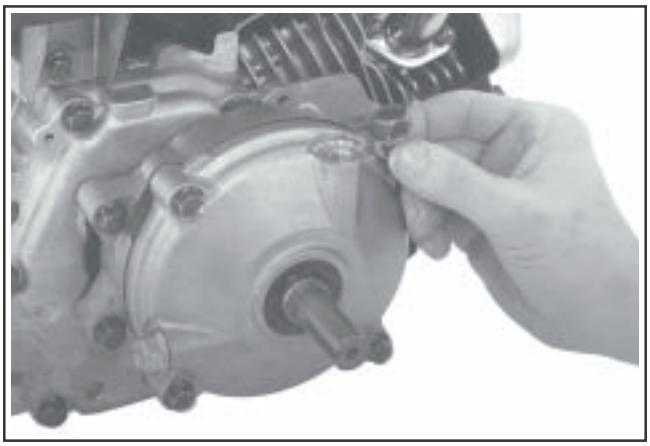


Figure 11-46. Fill/Vent Plug Installation.

CS8.5-12

1. If any bearings were removed, press the new bearing(s) into the housing so the manufacturer's marks are visible. Pre-lube the bearings with engine oil on installation.

2. Install a new oil seal in cover, to a depth of 2 mm (0.08 in.) See figure 11-47. Apply a light coating of lightweight lithium grease to the lip of the seal.

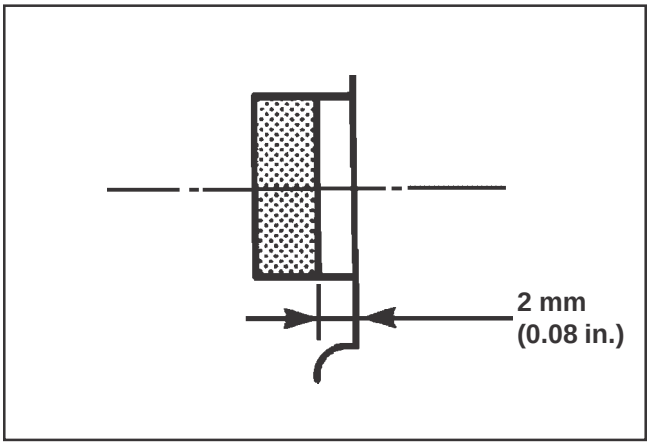


Figure 11-47. Oil Seal Installation Depth.

3. Slide the crankshaft gear onto the splines of the crankshaft. Secure with the flat washer and hex flange screw. **Torque the screw to 20-24 N·m (177-212 in. lb.).**

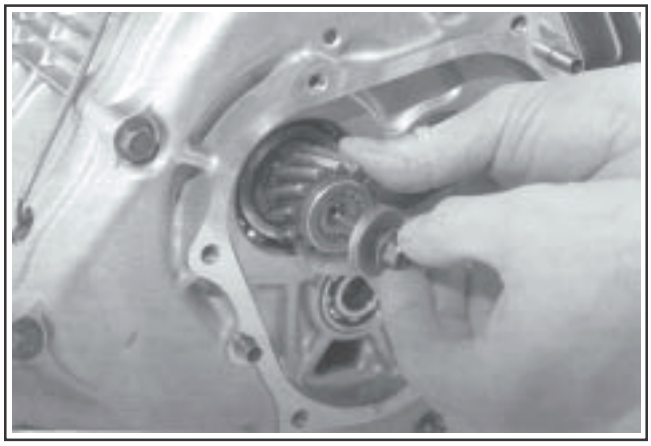


Figure 11-48. Installing Crankshaft Gear, Mounting Screw, and Washer.

4. Lubricate the bearing surfaces with oil, and install the counter gear into the closure plate bore, engaging teeth with gear on crankshaft.

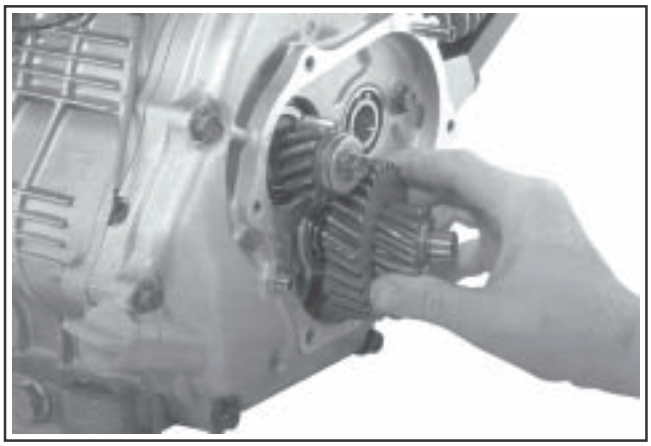


Figure 11-49. Installing Counter Gear Assembly.

5. Lubricate the bearing surfaces with oil, and install the output shaft/gear assembly into the cover. See Figure 11-50.

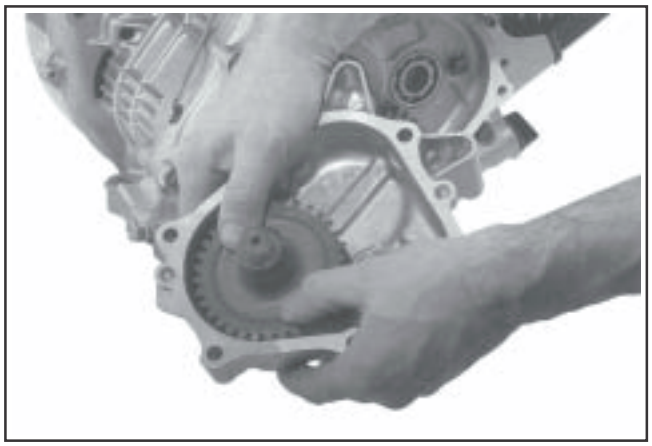


Figure 11-50. Installing Output Shaft Assembly.

6. Reinstall the two dowel pins into their respective locations in the closure plate. Install a new housing/cover gasket (dry) onto the dowel pins.

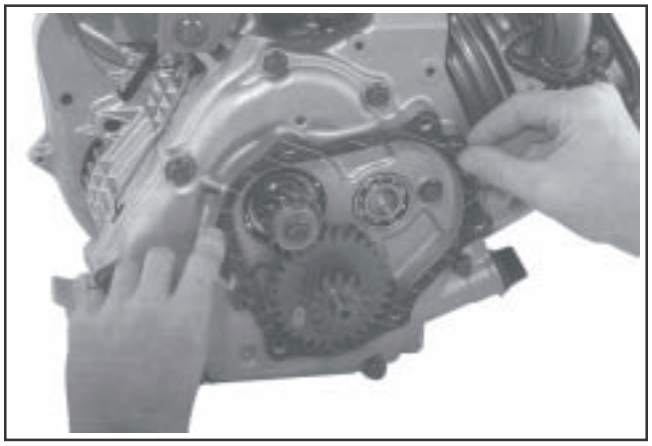


Figure 11-51. Installing Dowel Pins and Gasket.

7. Install the reduction housing cover, and secure with the six mounting screws. **Torque the screws to 28-32 N·m (247-283 in. lb.).**

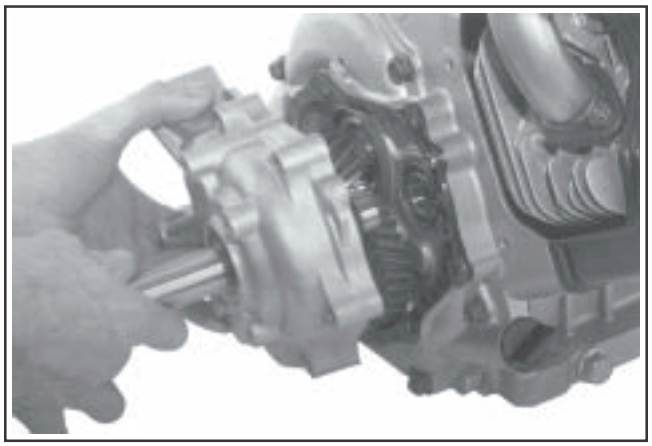


Figure 11-52. Installing Cover.

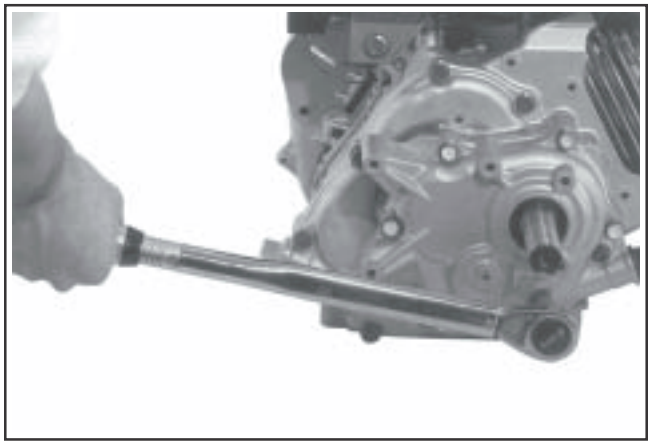


Figure 11-53. Torquing Mounting Screws.

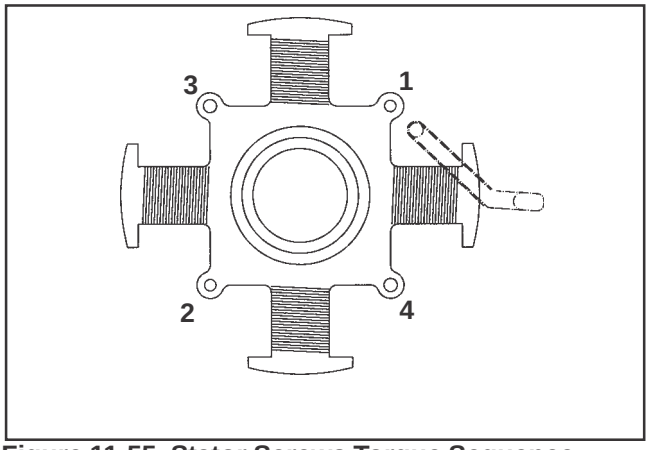


Figure 11-55. Stator Screws Torque Sequence.

Install Stator and Wire Shield (If So Equipped)

1. Align stator holes with mounting bosses of crankcase so the leads are at the 1 o'clock position and toward the crankcase. Install the four M6 shoulder screws and torque the screws in sequence shown (as applicable) to 5-8 N·m (44-70 in. lb.).

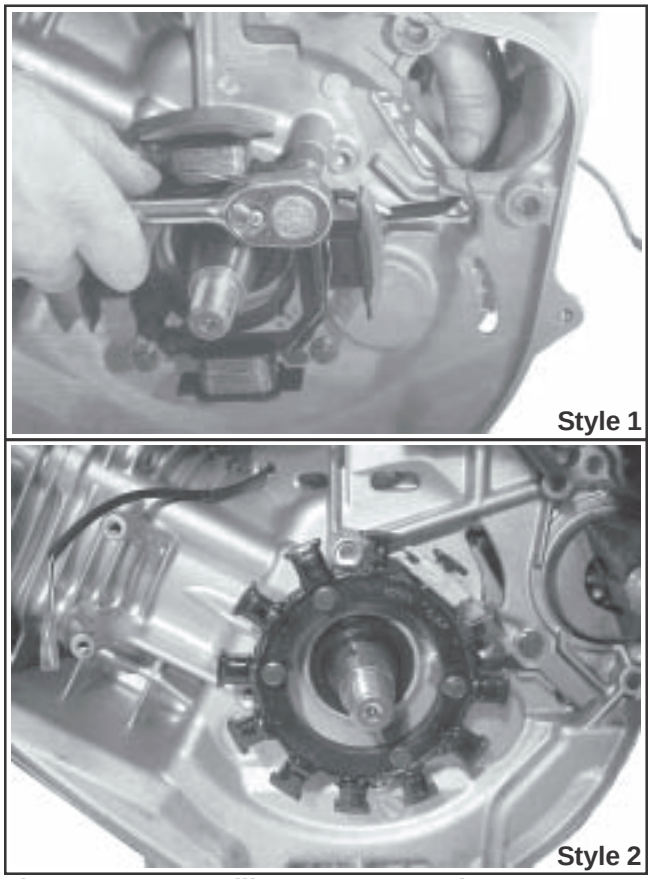


Figure 11-54. Installing Stator Mounting Screws.

2. Route the stator leads along the formed channel and out through the hole in the crankcase casting.

3. Install the protective wire shield over the channel and secure in place with the M6x1.0 screw. **Torque screw to 10 N·m (88.5 in. lb.).** See Figure 11-56.

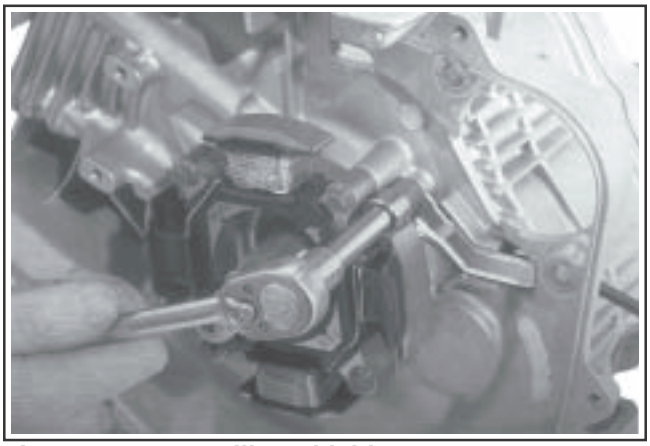


Figure 11-56. Installing Shield.

Install Flywheel

WARNING: Damaging Crankshaft and Flywheel Can Cause Personal Injury!

Using improper procedures to install the flywheel can crack or damage the crankshaft and/or flywheel. This not only causes extensive engine damage, but can also cause personal injury, since broken fragments could be thrown from the engine. Always observe and use the following precautions and procedures when installing the flywheel.

NOTE: Before installing the flywheel make sure the crankshaft taper and 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 flange screw is torqued to specifications.

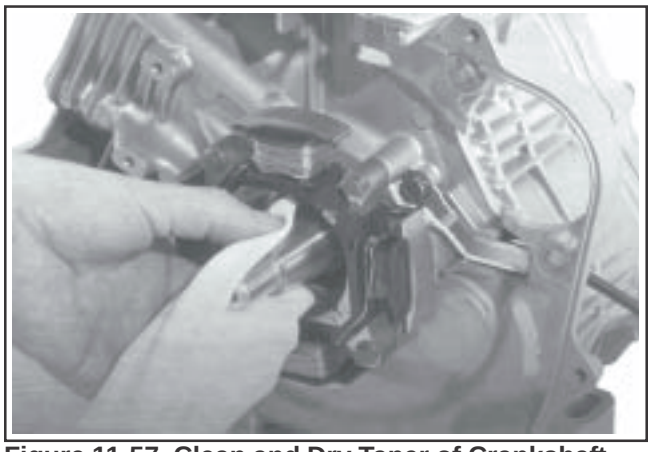


Figure 11-57. Clean and Dry Taper of Crankshaft.

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

1. Install the woodruff key into the keyway of the crankshaft. Make sure that the key is properly seated and parallel with taper of shaft.

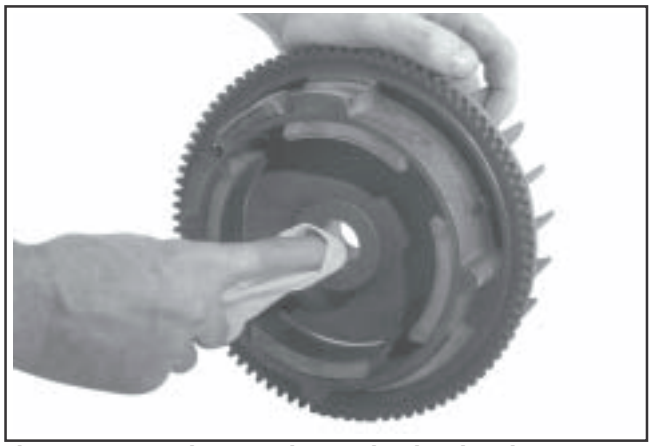


Figure 11-58. Clean and Dry Flywheel Hub.

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

3. Install the drive cup (with grass screen if so equipped) engaging it with the flywheel. Hold in position and install the large flat washer and hex nut. Finger tighten to keep cup engaged.

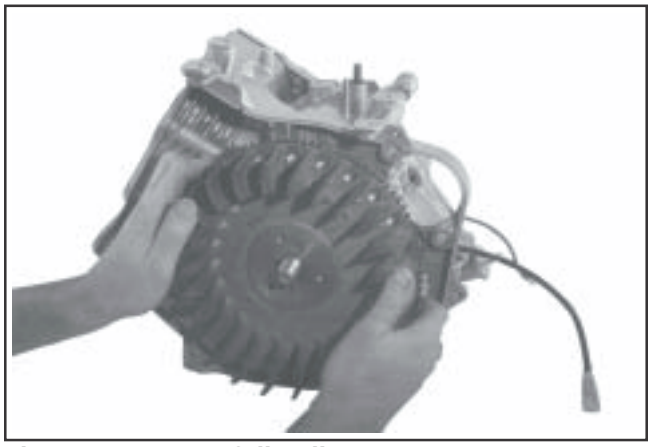


Figure 11-59. Carefully Align Keyway to Key.

4. Use a flywheel holding tool and torque wrench to tighten flywheel nut. Torque the hex nut to:
   CS4, CS6, CS8.5 (spec. 95xxxx):
   65 N·m (48 ft. lb.)
   CS8.5 (spec. 92xxxx), CS10, CS12:
   120 N·m (88 ft. lb.)

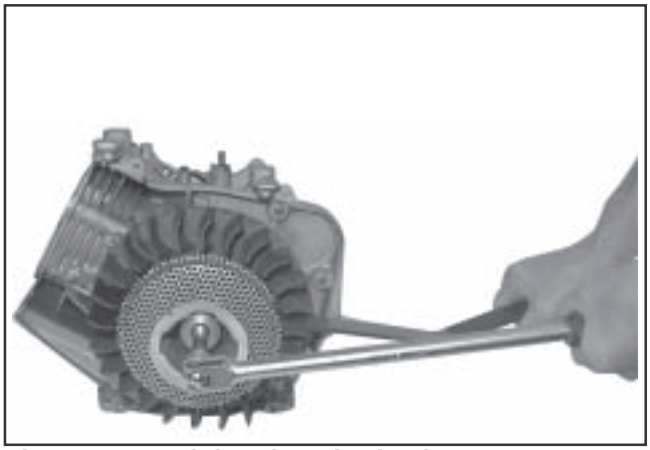


Figure 11-60. Tightening Flywheel Nut.

Install Ignition Module

1. Turn the flywheel so the magnet is away from the location where the ignition module will be installed.

2. Install the ignition module loosely to the bosses with the two hex flange screws. Move the module as far away from the flywheel as possible, then tighten the screws just enough to hold it in position.

3. Route the ignition module lead as shown in Figure 11-61 or 11-62.

4. Rotate the flywheel in a clockwise direction until the magnet is under the legs of the ignition module.

5. Insert a 0.5 mm (0.020 in.) flat feeler gauge between each leg of module and magnet. Loosen the screws allowing the magnet to draw the module against the gauge(s). Push against module to hold legs tight against the feeler gauge(s) while tightening screws. Tighten the lower screw first. **Torque screws to 10 N·m (88.5 in. lb.).** See Figures 11-61 and 11-62.

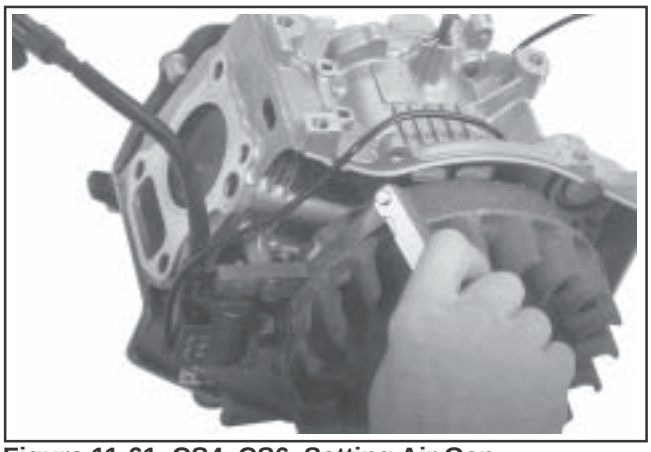


Figure 11-61. CS4, CS6. Setting Air Gap.

Figure 11-62. CS8.5-12. Setting Air Gap.

6. Rotate the flywheel back and forth, checking to make sure the magnet does not strike the module. Connect the kill lead to the terminal.

Assemble Cylinder Head

1. Lubricate all the valve train components with engine oil. Pay particular attention to the lip of the valve stem seal, valve stems and valve guides.

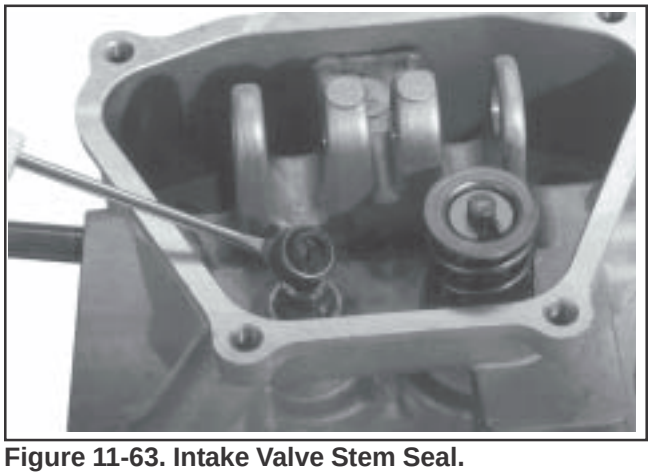


Figure 11-63. Intake Valve Stem Seal.

NOTE: The engine utilizes a valve stem seal on the intake valve. Always use a new seal when valves are installed in the cylinder head. Replace the seal if it is deteriorated or damaged in any way. Never reuse an old seal.

2. Install the valves, valve springs, and retainers into their respective locations in the cylinder head.

3. Compress each valve spring/retainer assembly with a valve spring compressor and lock in place with lock clip. Install the lock clip with its rounded edges down.

Figure 11-64. Installing Valves Using Valve Spring Compressor.

4. If intake or exhaust port studs were removed previously reinstall them at this time. **Torque the studs to:**
CS4, CS6, CS8.5 (spec. 95xxxx):
4-5 N·m (35-44 in. lb.)
CS8.5 (spec. 92xxxx), CS10, CS12:
12-19 N·m (106-168 in. lb.)

Install Cylinder Head

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

2. Rotate the crankshaft to position the piston at TDC on compression stroke.

3. Install the dowel pins into the recesses around the lower cylinder head bolt holes.

4. Install a new cylinder head gasket.

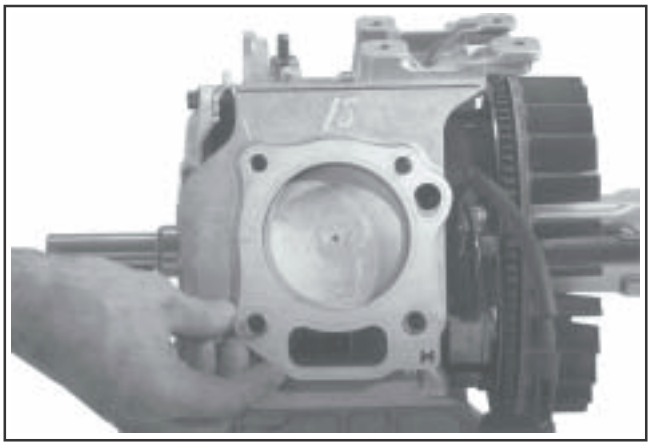


Figure 11-65. Installing Dowel Pins and New Head Gasket.

5. Install the cylinder head and start the four hex flange screws. Torque the screws in several increments, using the sequence shown (See Figures 11-66 and 11-67) to:
CS4, CS6: 20 N·m (177 in. lb.)
CS8.5-12: 50 N·m (36 ft. lb.)

Figure 11-66. Tightening Cylinder Head Screws.

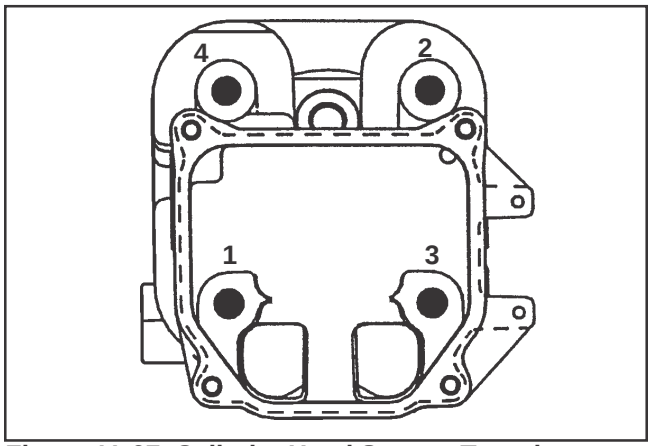


Figure 11-67. Cylinder Head Screws Torquing Sequence.

Install Push Rods, Rocker Arms, Studs, and Rocker Shaft

NOTE: Push rods should always be installed in the original location.

1. Identify the proper position of each push rod. Dip the ends of the push rods in engine oil and install them in their respective locations, seating each into the tappet socket.

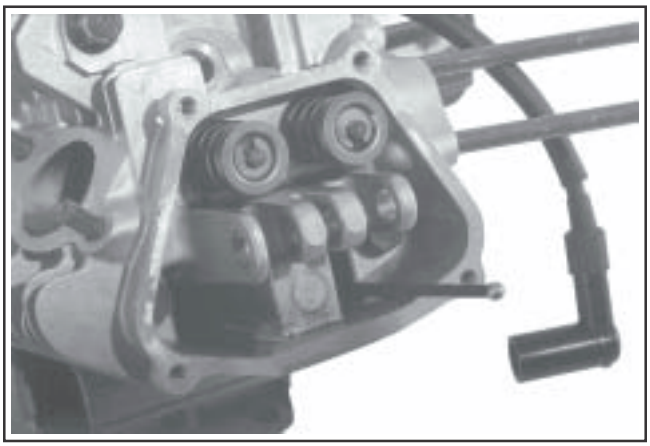


Figure 11-68. Installing Push Rods.

2. **CS4, CS6, CS8.5 (spec. 95xxxx):** Install the push rod guide plate, aligning the holes for the rocker arm studs. Screw in the rocker arm studs and torque to **10 N·m (88.5 in. lb.).** See Figure 11-69.

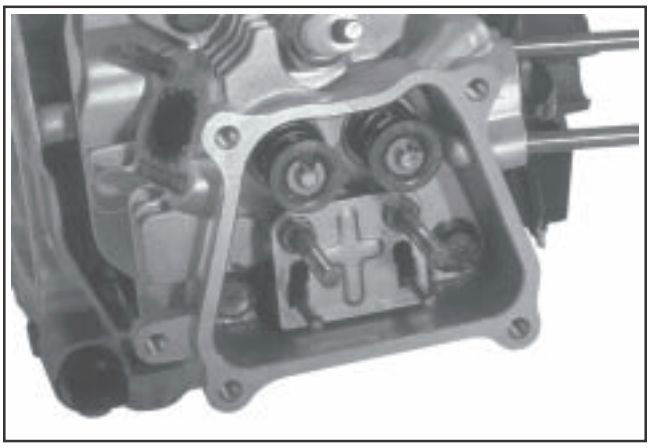


Figure 11-69. CS4, CS6, CS8.5 (spec. 95xxxx).

3. **CS4, CS6, CS8.5 (spec. 95xxxx):** Assemble the rocker arms, adjusters, and locknuts onto the studs and push rods.

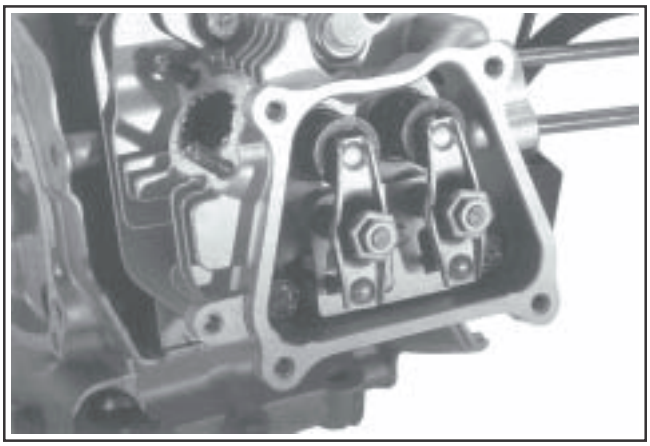


Figure 11-70. CS4, CS6, CS8.5 (spec. 95xxxx). Assembled Rocker Arms in Position.

CS8.5 (spec. 92xxxx), CS10, CS12: Install the rocker arms and adjuster assemblies into their original locations. Seat the push rods into the cupped end of the rocker arms. Oil the rocker arm shaft and install it through the cylinder head supports and rocker arms. Center the rocker arm shaft so it does not protrude out either side. See Figures 11-71 and 11-72.

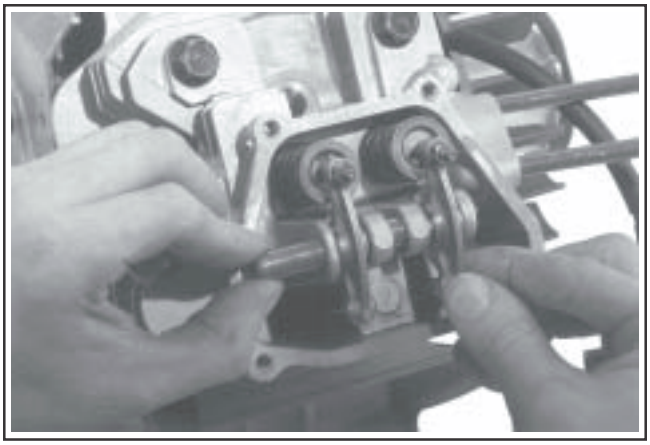


Figure 11-71. CS8.5 (spec. 92xxxx), CS10, CS12. Assembling Rocker Arms and Pivot Shaft.

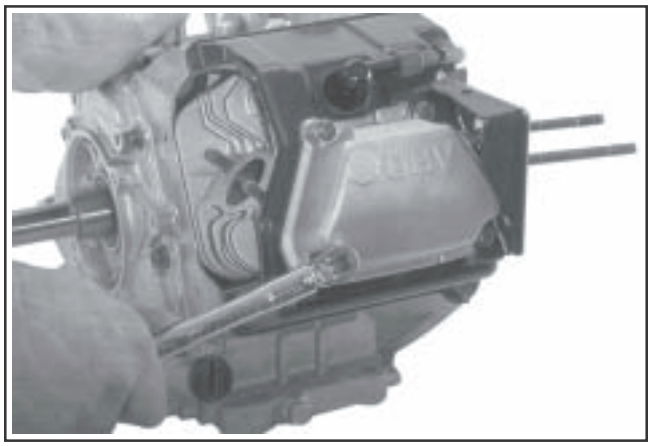


Figure 11-72. CS8.5 (spec. 92xxxx), CS10, CS12.

4. Adjust the valve tappet clearance as follows:

   a. Make sure the piston is still at the top of the compression stroke.

   b. Insert a flat feeler gauge between the rocker arm and the valve stem. The recommended valve to rocker arm clearance for both intake and exhaust is 0.1 mm (0.004 in.).

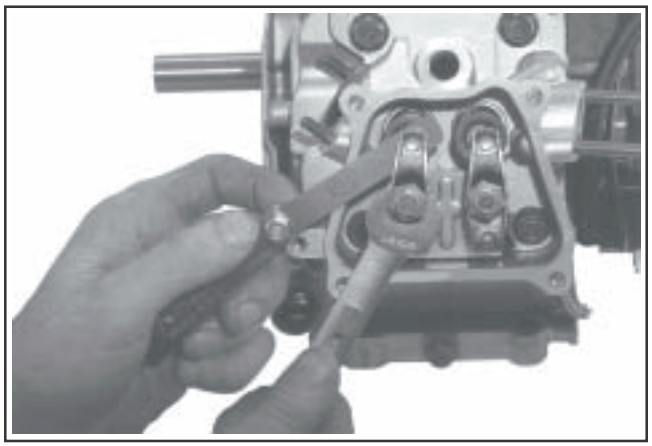


Figure 11-73. CS4, CS6, CS8.5 (spec. 95xxxx). Adjusting Valve to Rocker Arm Clearance.

   c. Adjust clearance as required by loosening the locknut and turning* the adjuster.

      Turn **clockwise** to decrease clearance. Turn **counterclockwise** to increase clearance.

      ***On CS8.5 (spec. 92xxxx), CS10, CS12:** Hold the adjuster up when making adjustment.

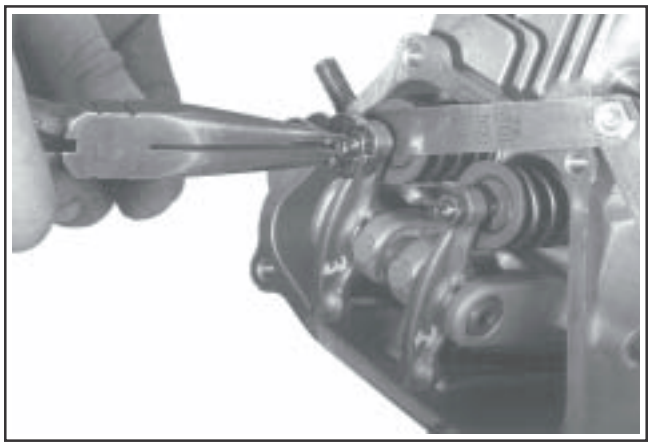


Figure 11-74. CS8.5 (spec. 92xxxx), CS10, CS12. Adjusting Valve to Rocker Arm Clearance.

   d. Hold the adjuster from turning and tighten the locknut. **Torque locknut to:**
      CS4, CS6, CS8.5 (spec. 95xxxx):
      10 N·m (88.5 in. lb.)
      CS8.5 (spec. 92xxxx), CS10, CS12:
      7 N·m (62 in. lb.)

5. Use a new Champion® RN14YC, Champion® RC14YC (Kohler Part No. 66 132 01-S), or equivalent spark plug.

6. Set gap to 0.76 mm (0.030 in.). Install the spark plug in the cylinder head and torque to **20 N·m (177 in. lb.).**

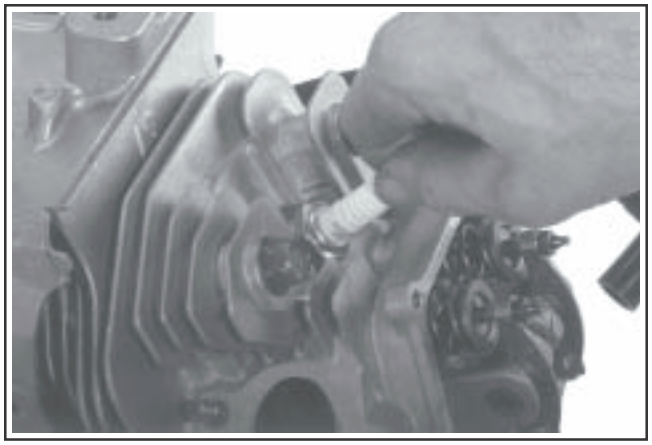


Figure 11-75. Installing and Torquing New Spark Plug.

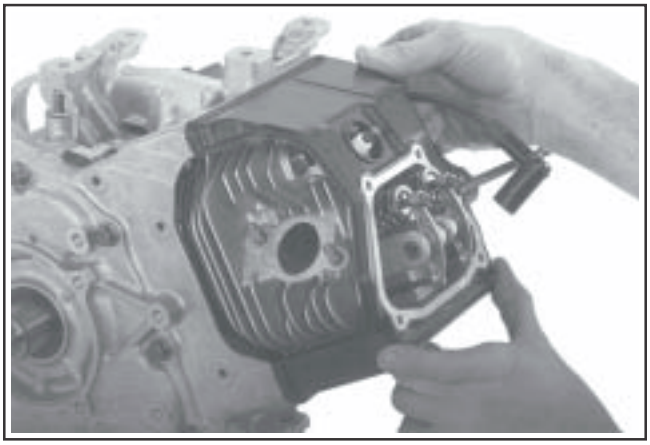


Figure 11-76. Installing Cylinder Air Shroud.

7. Install the cylinder air shroud. Matching the alignment slot on the ends with the corresponding raised groove in the crankcase.

   CS4, CS6: Install and torque the single M6x1.0 mounting screw to **10 N·m (88.5 in. lb.)** See Figure 11-77.

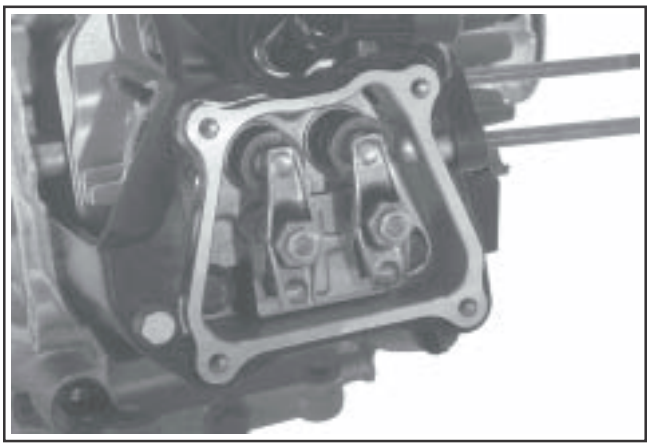


Figure 11-77. CS4, CS6. Cylinder Air Shroud Mounting Bolt Location.

8. Position the spark plug lead within the corresponding cutout in the air shroud.

Install Valve Cover

1. Install a new valve cover gasket onto the cylinder head.

2. Install the valve cover assembly.

   CS4, CS6, CS8.5 (spec. 95xxxx): Install the four hex flange screws and torque to **10-12 N·m (88-106 in. lb.).**

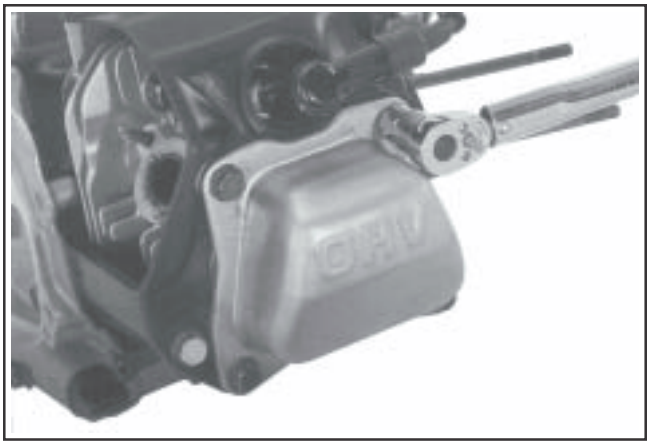


Figure 11-78. CS4, CS6, CS8.5 (spec. 95xxxx). Torquing Valve Cover Screws.

   CS8.5-12: Install the four valve cover screws. Mount the air cleaner base support bracket off the two right side valve cover locations, or to the cylinder head boss locations (based upon the model involved) using the two longer screws. Torque all the screws to **10-12 N·m (88-106 in. lb.)**. See Figure 11-79 and 11-80.

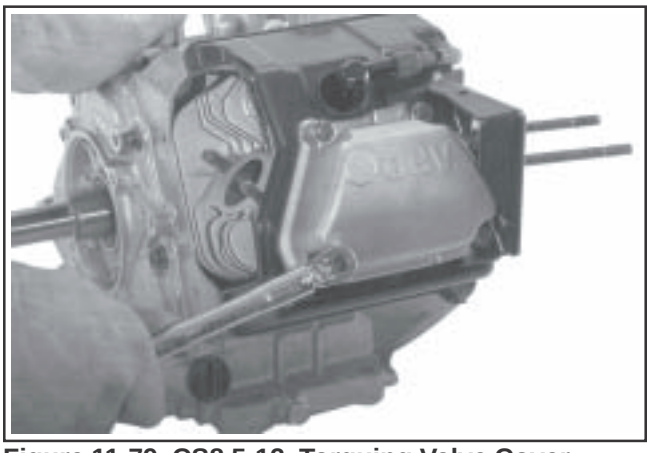


Figure 11-79. CS8.5-12. Torquing Valve Cover Screws.

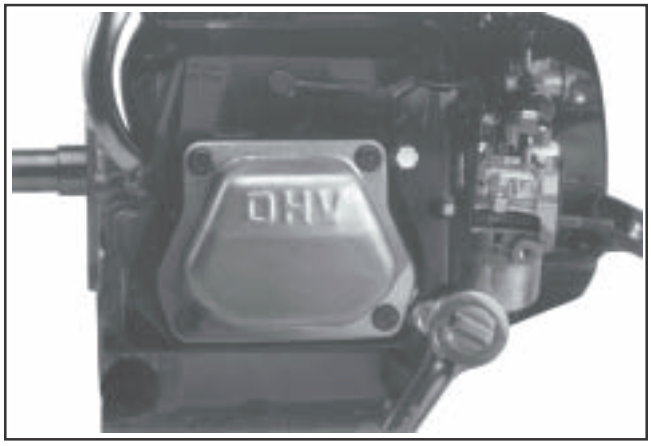


Figure 11-80. CS8.5-12. Torquing Screws.

Install Fuel Tank Supports (If So Equipped), Throttle Lever, Wiring Harness, Ignition Switch, and Oil Sentry™ Control Module

CS4, CS6, CS8.5 (spec. 92xxxx), CS10, CS12:

1. Attach the left fuel tank support to the crankcase bosses with the two hex flange screws and flat washers under the heads (CS4 and CS6 only). Torque screws to:
   CS4, CS6: 22-26 N·m (195-230 in. lb.)
   CS8.5 (spec. 92xxxx), CS10, CS12: 27-31 N·m (237-274 in. lb.)

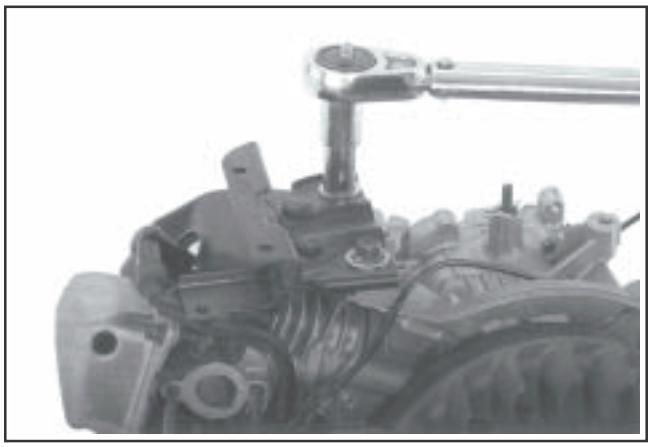


Figure 11-81. CS4, CS6. Mounting Left Fuel Tank Support.

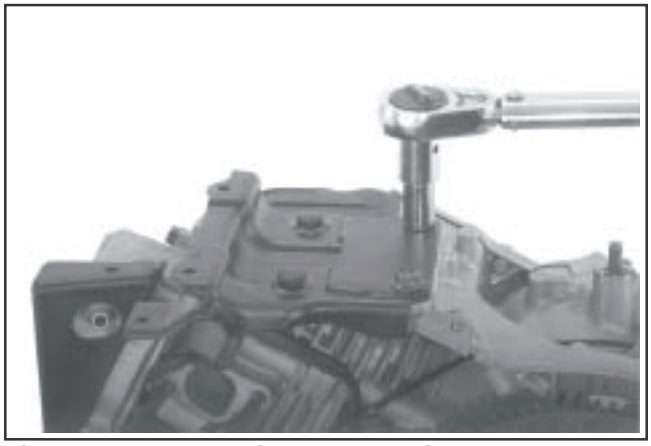


Figure 11-82. CS8.5 (spec. 92xxxx), CS10, CS12. Mounting Left Fuel Tank Support.

2. Assemble the right fuel tank support and attached electrical components* to the crankcase bosses. Mount the throttle control bracket off the flywheel side screw as shown in Figures 11-83 and 11-84. Install a flat washer under the head of screw on PTO side only. Torque screws to:
   CS4, CS6: 22-26 N·m (195-230 in. lb.)
   CS8.5 (spec. 92xxxx), CS10, CS12: 27-31 N·m (238-274 in. lb.)

   *The fuel tank support may have the ignition switch, wiring harness, oil sentry control module, starter and warning light attached (based on model/spec. involved).

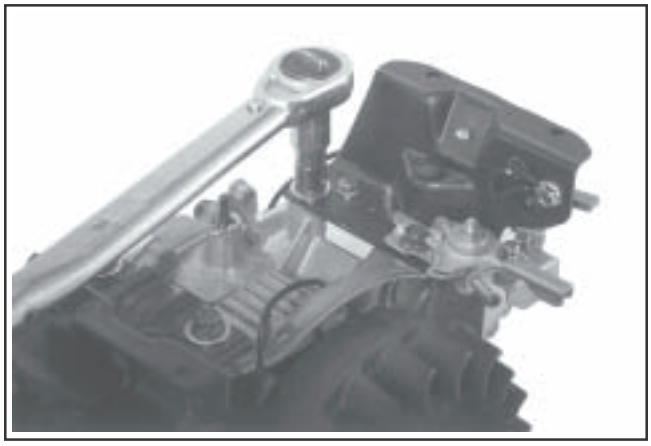


Figure 11-83. CS4, CS6. Mounting Right Fuel Tank Support.

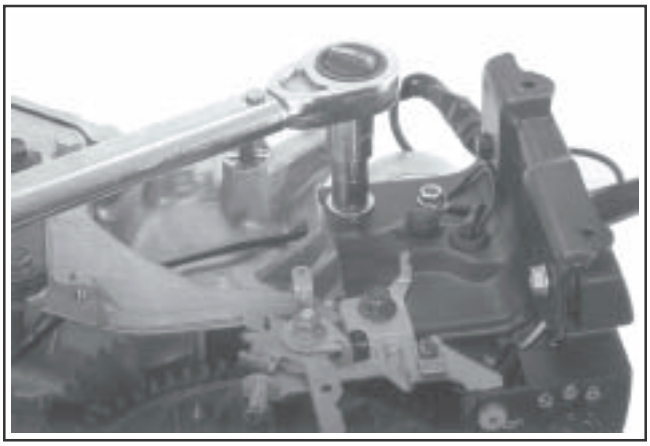


Figure 11-84. CS8.5 (Spec 92xxxx) 10, CS-12 Mounting Right Fuel Tank Support.

CS8.5 (spec. 95xxxx): Align and mount the throttle control bracket to the top of the crankcase with the hex flange screw. Make sure the hole in the bracket for mounting the base pan is aligned with the threaded hole in the crankcase. Torque the screw to **10-13 N·m (88-106 in. lb.)**. On **retractable start** engines, mount the Oil Sentry™ control module to the crankcase and attach the ground lead to the same mounting screw. Torque the screw to **10-12 N·m (88-106 in. lb.)**. On **electric start** engines mount the bracket with control panel attached to the crankcase using the two hex flange head screws. Torque the screws to **10-12 N·m (88-106 in. lb.)**.

3. Check that the ground leads are secured at the bracket locations, as shown in Figures 11-83 through 11-85.

   CS8.5-12: Reattach the ignition system ground lead to the crankcase boss adjacent to the governor shaft (See Figure 11-85), or to the control module mounting bolt location based on model involved.

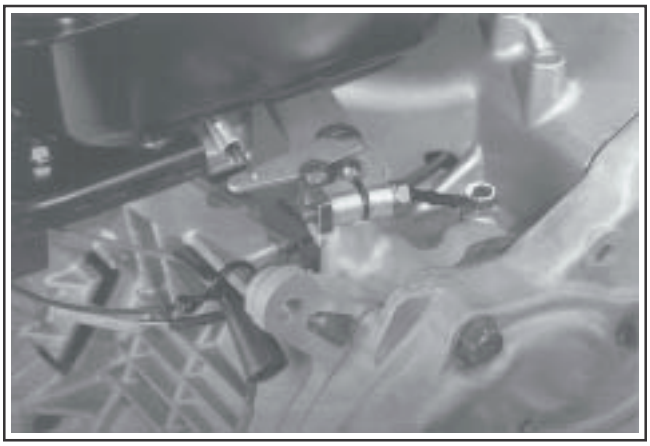


Figure 11-85. CS8.5-12. Ground Lead Location.

Install Governor Lever, Throttle Link, Throttle and Governor Springs

1. Install the governor lever onto the shaft. Do not tighten at this time. Adjustment will be made later.

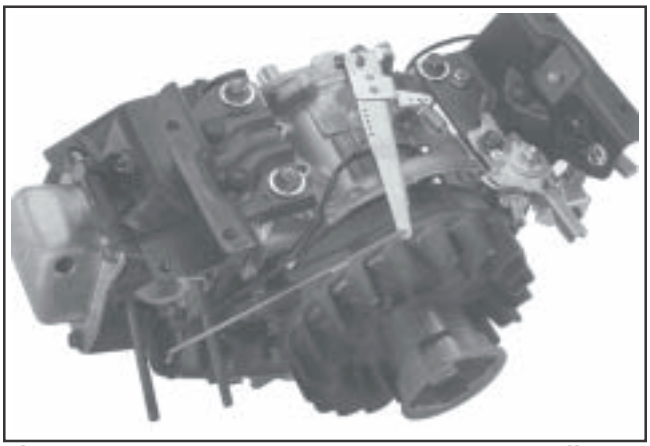


Figure 11-86. CS4, CS6. Governor Lever Details.

2. Connect the governor spring to the arm of the governor lever and into the slot in the throttle lever. See Figures 11-89, 11-90, and 11-91 according to model number for proper assembly if necessary.

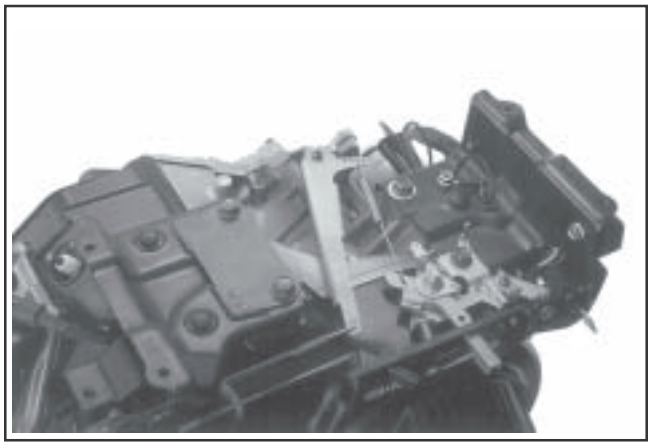


Figure 11-87. CS8.5 (spec. 92xxxx), CS10, CS12. Governor Lever Installation.

3. Connect the throttle link and the shorter end of dampening spring, from the top down, into the hole(s) in long end of governor lever as shown in Figures 11-86, 11-87, and 11-88.

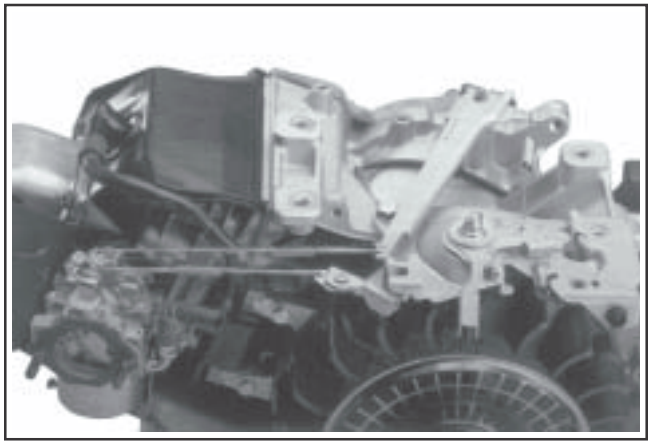


Figure 11-88. CS8.5 (spec. 95xxxx), CS10, CS12. Governor Linkage Connected to Governor Arm.

Model	Figure Number	Hole Position
CS4 All models	11-89	2
CS6 All models except listed specs.	11-89	1
CS6 Specs: 911510	11-89	2
CS8.5 All models except listed specs.	11-90	3
CS8.5 Spec: 921509	11-90	1
CS8.5 Spec: 951511	11-90	2
CS10 All models except listed specs.	11-90	3
CS10 Specs: 931512, 931612 931614, 931615	11-91	4
CS10 Spec: 931618	11-91	2

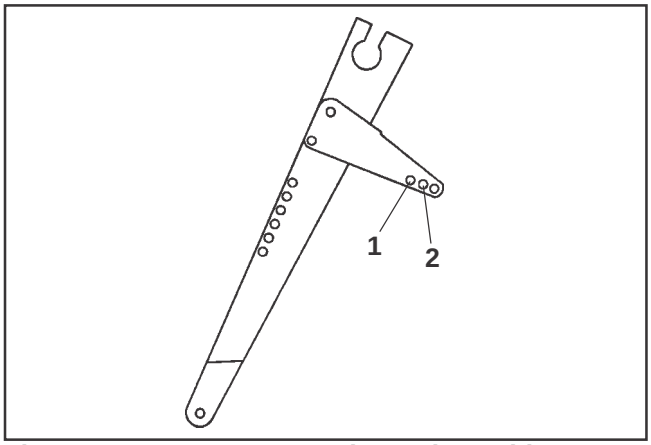


Figure 11-89. CS4, CS6. Spring Hole Position.

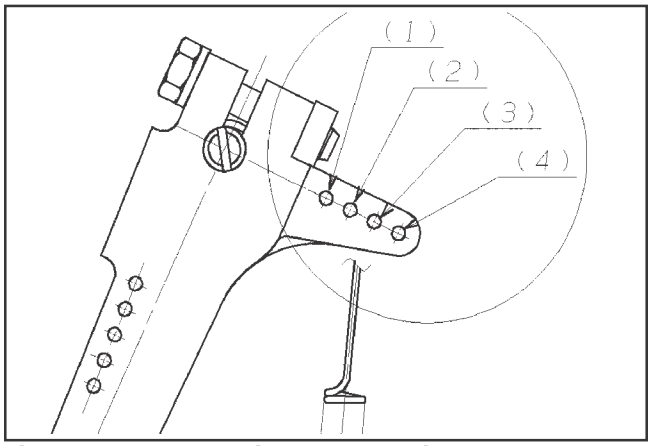


Figure 11-90. CS8.5 (spec. 92xxxx), CS10, CS12. Spring Hole Position.

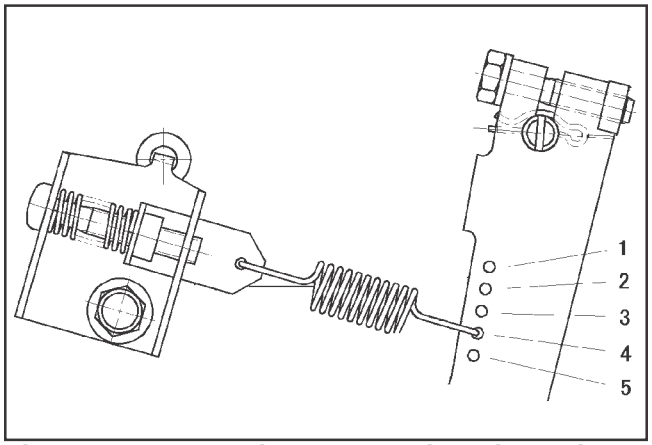


Figure 11-91. CS8.5 (spec. 95xxxx). Spring Hole Position.

11

Model	Spec. No.	Figure Number	Hole Position
(CS12)			
CS12T	941501	11-90	3
CS12T	941502	11-90	3
CS12TG	941503	11-90	1
CS12TP	941504	11-90	3
CS12TR	941505	11-90	3
CS12TR	941506	11-90	3
CS12STG	941507	11-90	1
CS12ST	941508	11-90	3
CS12S	941509	11-90	3
CS12ST	941510	11-90	3
CS12TG	941511	11-90	2
CS12STG	941512	11-90	2
CS12GT	941513	11-91	4
CS12STG	941515	11-91	4
CS12STG	941516	11-90	1
CS12STG	941517	11-90	3
CS12STG	941518	11-91	4
CS12STG	941519	11-91	4
CS12T	941520	11-90	3
CS12S	941521	N/A	(Application Governed)
CS12T	941601	11-90	3
CS12T	941602	11-90	3
CS12TG	941603	11-90	1
CS12TP	941604	11-90	3
CS12TR	941605	11-90	3
CS12TR	941606	11-90	3
CS12STG	941607	11-90	1
CS12ST	941608	11-90	3
CS12S	941609	11-90	3
CS12ST	941610	11-90	3
CS12TG	941611	11-90	2
CS12STG	941612	11-90	2
CS12TG	941613	11-91	4
CS12STG	941615	11-91	4
CS12STG	941616	11-90	1
CS12STG	941617	11-90	3
CS12SG	941618	11-91	4
CS12STG	941619	11-91	4
CS12T	941620	11-90	3
CS12S	941621	N/A	(Application Governed)
CS12STG	941622	11-91	3
CS12TG	941623	11-90	3
CS12STG	941624	11-91	4
CS12TR	941625	11-90	3
CS12T	941626	11-90	3
CS12ST	941627	11-90	3
CS12STR	941628	11-90	3
CS12STG	941629	11-91	4
CS12ST	941630	11-90	3
CS12STG	941631	11-90	4
CS12STG	941632	11-90	4

Model	Spec. No.	Figure Number	Hole Position
CS12T	941633	11-90	3
CS12ST	941634	11-90	3
CS12T	941635	11-90	3
CS12TR	941636	11-90	3
CS12ST	941637	11-90	3
CS12TG	941638	11-90	3

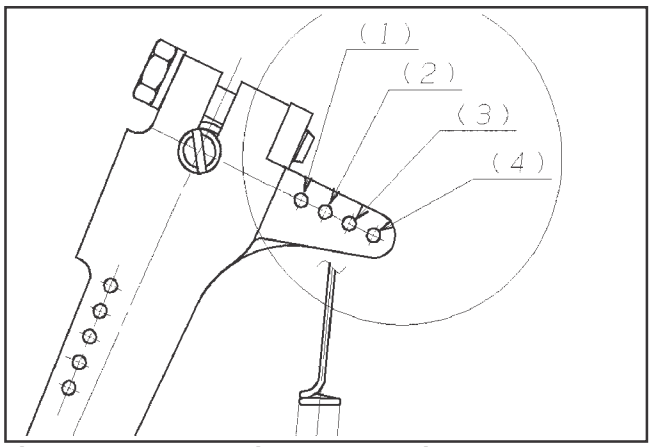


Figure 11-90. CS8.5 (spec. 92xxxx), CS10, CS12. Spring Hole Position.

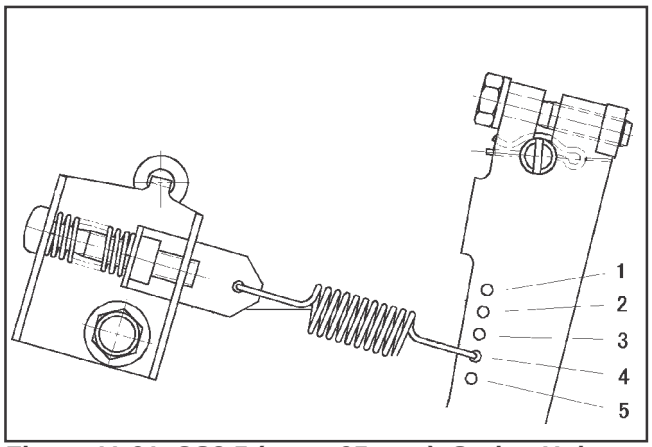


Figure 11-91. CS8.5 (spec. 95xxxx). Spring Hole Position.

Connect Electrical Leads and Install Electric Starter (If So Equipped)

CS8.5 (spec. 92xxxx), CS10, CS12 with Inertia Drive Starters

1. Mount the electric starter, with the control panel and solenoid attached, onto the crankcase. Install and torque the two hex flange screws to **30 N·m (265 in. lb.)**. Leave the three cover panel screws out at this time.

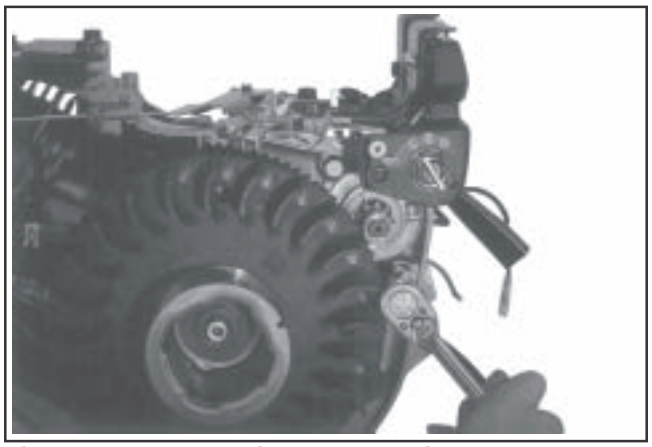


Figure 11-92. CS8.5 (spec. 92xxxx), CS10, CS12. Installing Electric Starter.

2. Connect the electrical leads for the Oil Sentry™, ignition module, keyswitch, solenoid, and starter. Attach the red/white wire harness lead to the solenoid terminal opposite the terminal containing the starter lead.

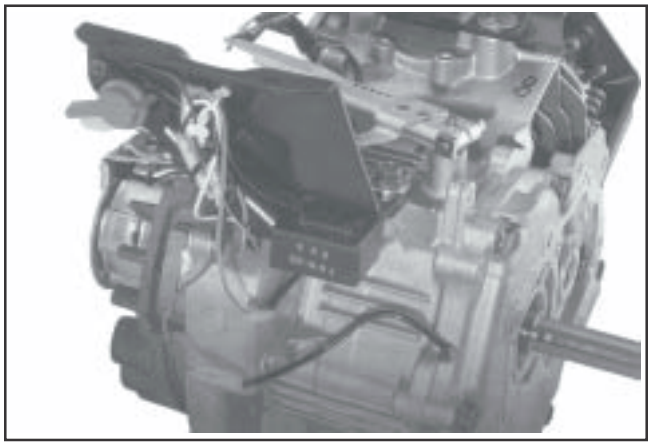


Figure 11-93. CS8.5 (spec. 92xxxx), CS10, CS12. Reconnect Electrical Leads.

Figure 11-94. CS8.5 (spec. 92xxxx), CS10, CS12. Reconnect Solenoid/Wiring Harness Lead.

CS8.5 (spec. 95xxxx), CS10, CS12 with Solenoid Shift Starters

1. Align and mount the electric starter motor to the crankcase. Install and torque the two hex flange screws to **30 N·m (265 in. lb.)**. See Figure 11-95.

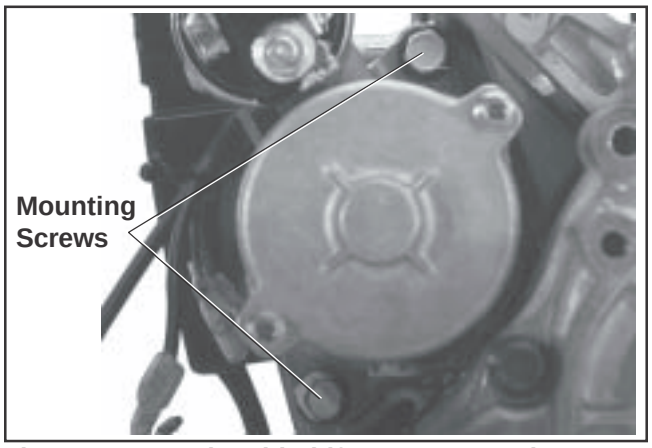


Figure 11-95. Solenoid Shift Starter Mounting.

2. Connect the electrical leads for the Oil Sentry™, ignition module, keyswitch, solenoid, and starter. Attach the red/white wire harness lead to the spade terminal of solenoid. Attach the red harness lead with the ring terminal, to the main (upper) terminal on the solenoid that is attached to the battery cable. Secure the wires together and out of the way using the beaded tie.

Install Blower Housing and Electric Starter Cover Panel (If So Equipped)

1. Install the blower housing behind the throttle link and dampening spring. Start all the hex flange screws. On CS4 and CS6 engines, secure the ground lead with the silver screw in the upper right hand location. See Figures 11-96, 11-97, and 11-98. Torque the screws to **7 N·m (62 in. lb.)**.

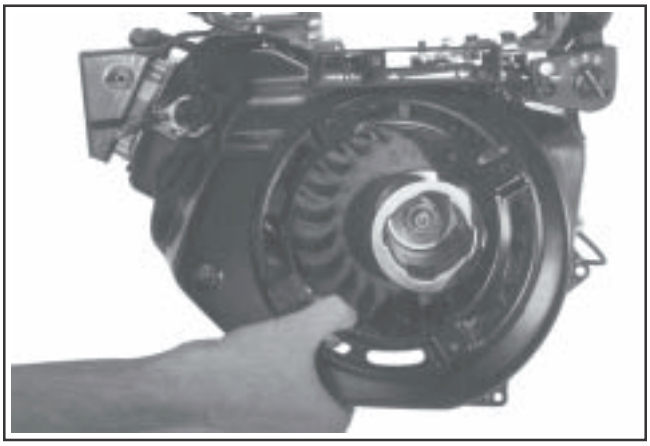


Figure 11-96. Installing Blower Housing.

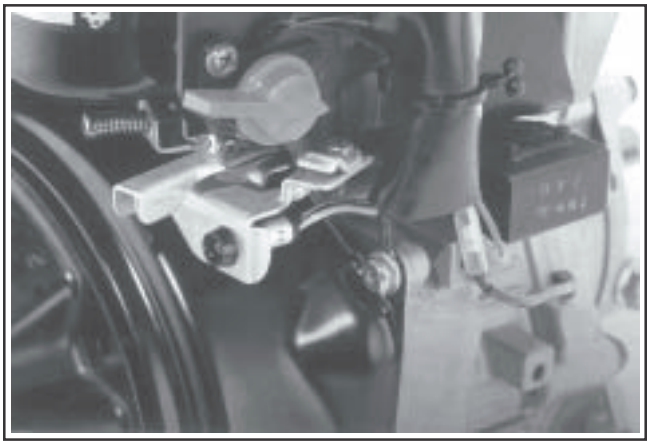


Figure 11-97. CS4, CS6. Silver Screw and Ground Lead Location.

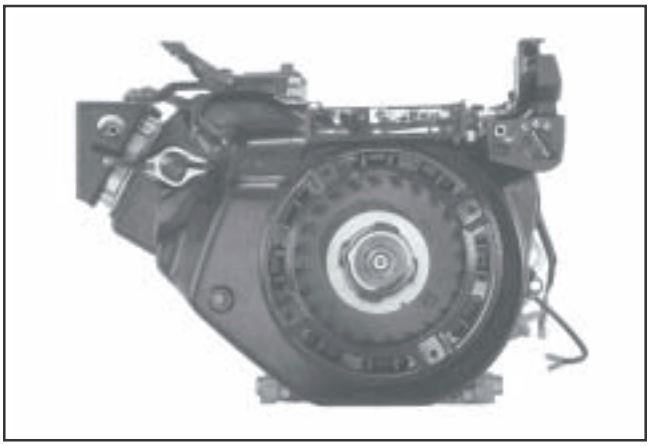


Figure 11-98. CS8.5 (spec. 92xxxx), CS10, CS12. Blower Housing Installed.

2. Attach the electric starter cover panel (if so equipped) to the right tank support with the three phillips head screws and one flange nut. See Figure 11-99.

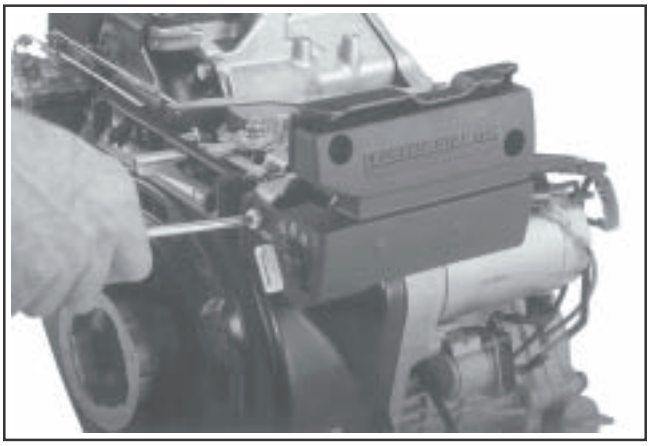


Figure 11-99. CS8.5 (spec. 92xxxx), CS10, CS12. Attaching Electrical Starter Cover Panel.

Install Carburetor

1. Install a new carburetor spacer gasket onto the carburetor studs, followed by the carburetor spacer and another spacer gasket. See Figure 11-100.

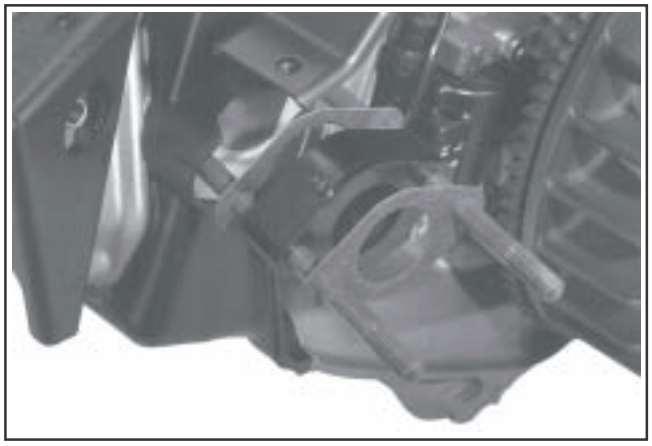


Figure 11-100. Carburetor Spacer and Gaskets.

2. Tilt the carburetor to hook the throttle link and dampening spring into the hole(s) of the throttle lever. See Figures 11-101 and 11-102.

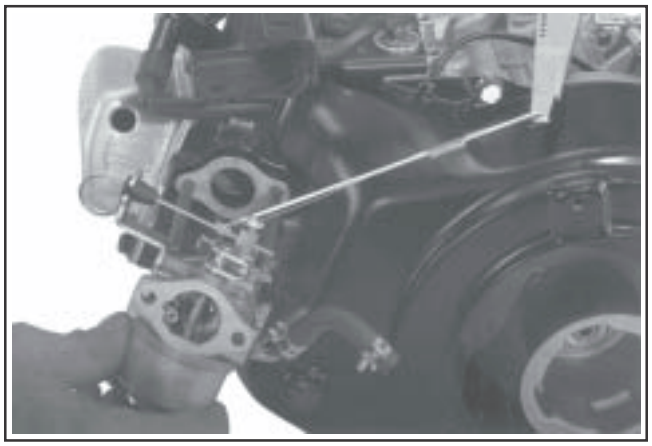


Figure 11-101. CS4, CS6. Assembling Linkage.

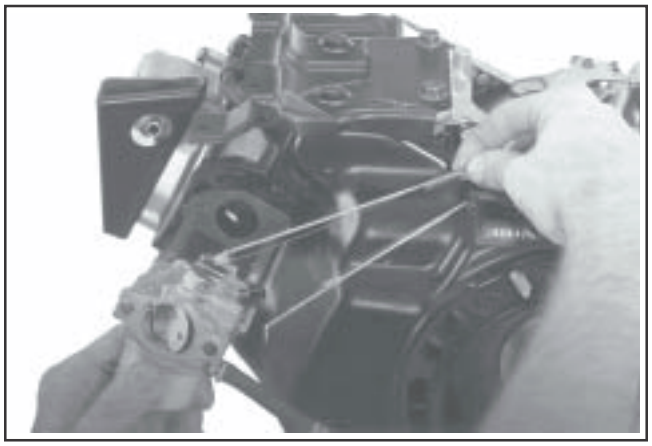


Figure 11-102. CS8.5-12. Assembling Linkage.

3. **CS8.5-12:** Connect Z end of choke link and dampening spring to choke lever on blower housing or control bracket. Then connect the angled end of the link and spring into the holes of the choke lever on the carburetor as shown in Figure 11-103.

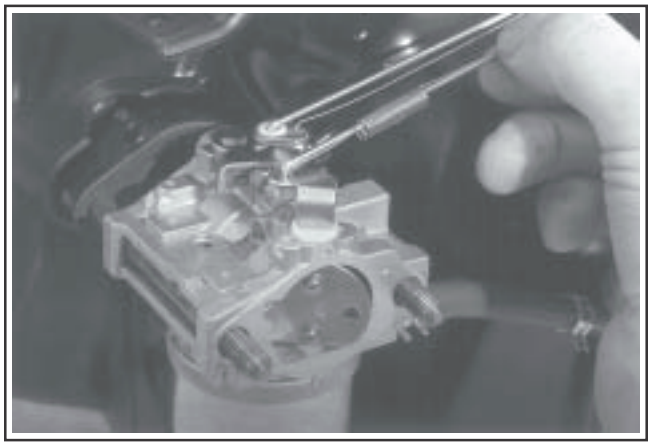


Figure 11-103. CS8.5-12. Attaching Choke Link and Dampening Spring.

4. Push the carburetor and linkage all the way onto the studs.

Install Air Cleaner Base and Element

1. Install the air cleaner base gasket onto the mounting studs. Attach the breather hose onto the air cleaner base connection port. Then install the air cleaner base onto the studs. Connect the opposite end of the breather hose to the valve cover. Secure the base with the two hex flange nuts on the mounting studs and the one or two hex flange screw(s) into the support bracket(s), depending on the model involved. See Figures 11-104, 11-105, and 11-106. On models using a separate rubber seal between the air filter element and base, install or make sure the rubber seal for the air cleaner is clean, installed, and in good condition. See Figure 11-106.

   Torque hex flange nuts to:
   CS4, CS6: 5-8 N·m (44-71 in. lb.)
   CS8.5-12: 10-12 N·m (88-106 in. lb.)

   Torque hex flange screw(s) to:
   5-8 N·m (44-71 in. lb.)

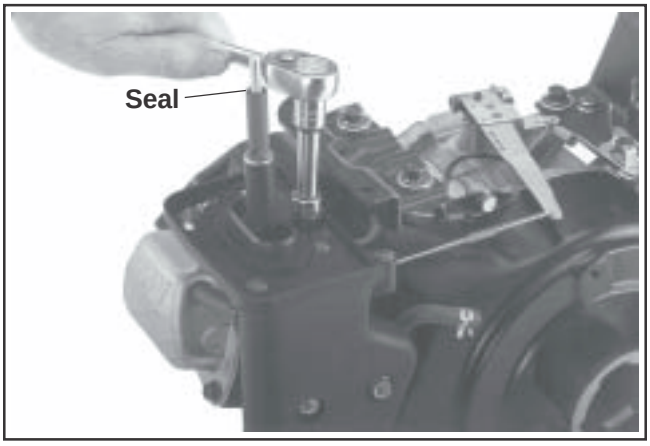


Figure 11-104. CS4, CS6. Installing Air Cleaner Base.

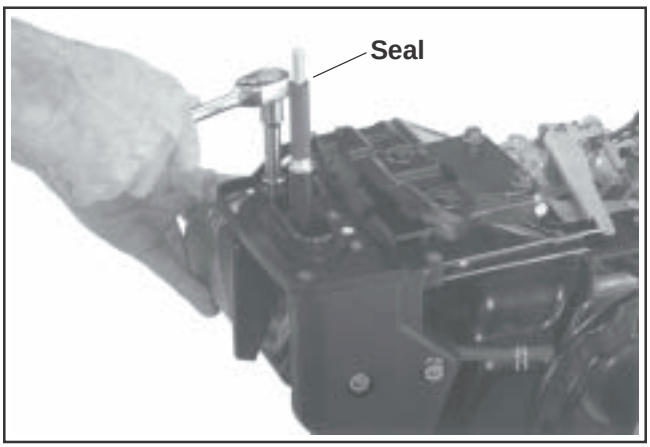


Figure 11-105. CS8.5-12. Installing Air Cleaner Base.

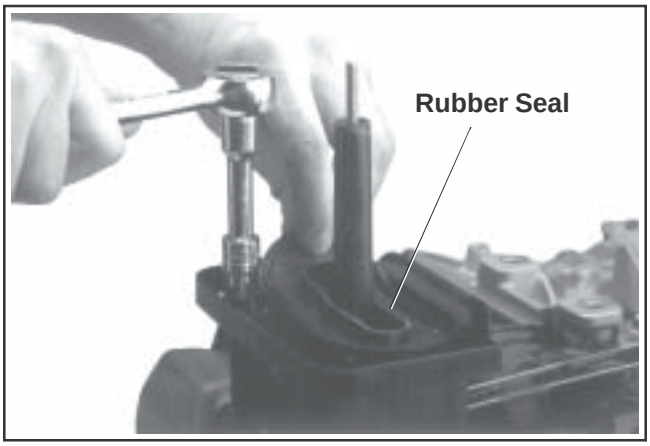


Figure 11-106. CS8.5 Air Cleaner Base and Rubber Seal. (Some Models).

2. Make sure the seal is on the air cleaner base stud (fixed on some models). See Figures 11-104, 11-105, and 11-106. Install the filter element with precleaner and secure with the wing nut. **Do not** install the outer air cleaner cover and knob at this time.

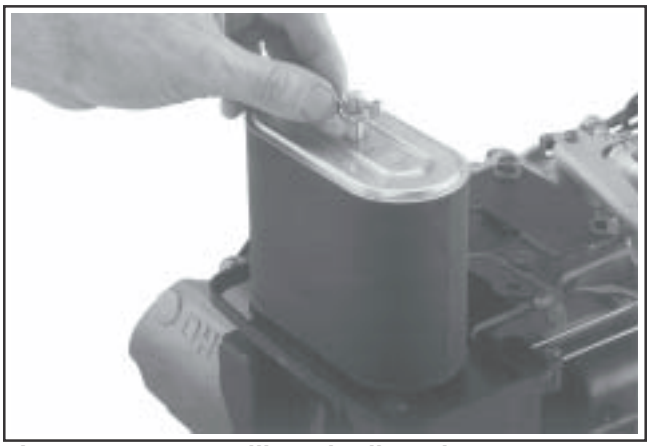


Figure 11-107. Installing Air Filter Element, Precleaner, and Wing Nut.

Adjust/Set Governor

1. Adjust and set the governor as follows (See Figures 108 and 109):

   a. Rotate the governor lever clockwise until it stops.

   b. Turn the governor shaft clockwise until it stops.

   c. Torque the clamp bolt to:
   CS4, CS6: 8 N·m (71 in. lb.)
   CS8.5-12: 10 N·m (88.5 in. lb.)

Figure 11-108. CS4, CS6. Adjusting Governor.

Figure 11-109. CS8.5-12. Adjusting Governor.

Install Fuel Tank

CS4, CS6, CS8.5 (spec. 92xxxx), CS10, CS12

1. If the fuel shut-off valve was removed or serviced separately, install and secure with the flange nut so the outlet faces directly to the left. The O-Ring on the fitting must be in good condition. Replace if deteriorated in any way.

Figure 11-110. CS4, CS6, CS8.5 (spec. 92xxxx), CS10, CS12. Shut-Off Valve Orientation.

2. Install the fuel tank assembly onto the mounting brackets. Secure with the four M6 hex flange screws and a flat washer [CS8.5 (spec. 92xxxx), CS10, CS12 only] under each screw head. Torque the screws to **8-12 N·m (71-106 in. lb.)**.

3. Connect the fuel line to the shut-off valve and secure with the clamp.

Figure 11-111. Tightening Fuel Tank Mounting Screws.

CS8.5 (spec. 95xxxx)

1. Install the fuel tank support to top of crankcase. Align the four mounting holes with the crankcase locations. Install and finger tighten the four M8 hex flange screws, with flat washers under each head. Install the single M6 hex flange screw in the hole, as shown, and thread it into the throttle control bracket. Torque the four M8 screws to **27-31 N·m (238-274 in. lb.)** and the single M6 screw to **8-12 N·m (71-106 in. lb.).** See Figure 11-112.

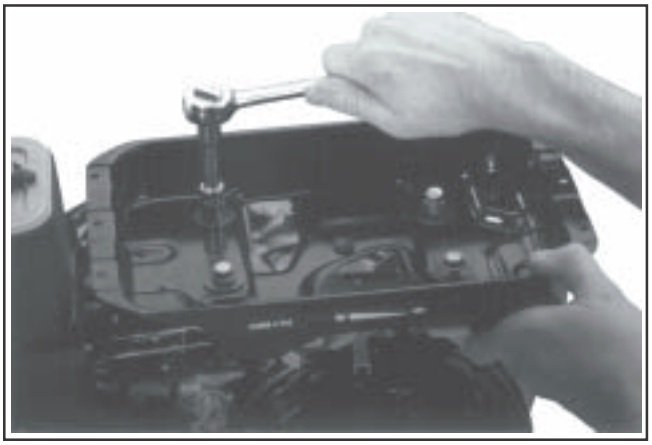


Figure 11-112. CS8.5 (spec. 95xxxx) Installing Fuel Tank Support.

2. Install the fuel tank assembly, with the fuel line connected to the outlet fitting, into the fuel tank support. Route the fuel hose beneath the linkages and align the mounting holes. Secure with the four M6 hex flange screws. Torque the screws to **8-12 N·m (71-106 in. lb.)**.

3. If the fuel shut-off valve was removed or serviced separately, reassemble it and secure it to the mounting bracket. Torque the top mounting screw to **8-12 N·m (71-106 in. lb.)**. See Figure 11-113.

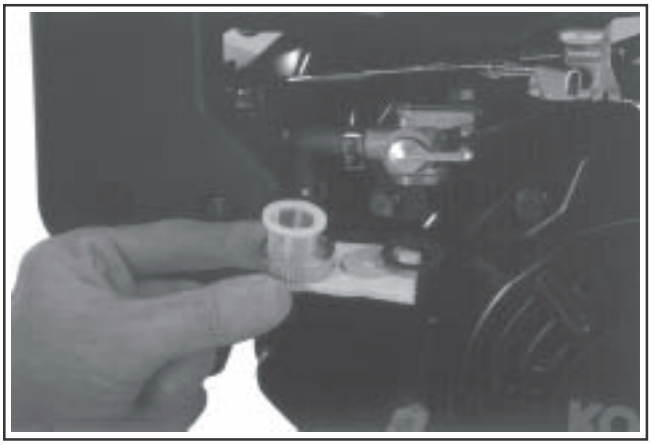


Figure 11-113. CS8.5 (spec. 95xxxx). Shut-Off Valve Details.

4. Connect the fuel line from the fuel tank to the inlet fitting of the shut-off valve and secure with the clamp. Mount the bracket/shut-off valve assembly to the blower housing aligning the indexing mark and screw hole. Install the hex flange head screw and torque to **8-12 N·m (71-106 in. lb.)**. See Figure 11-114.

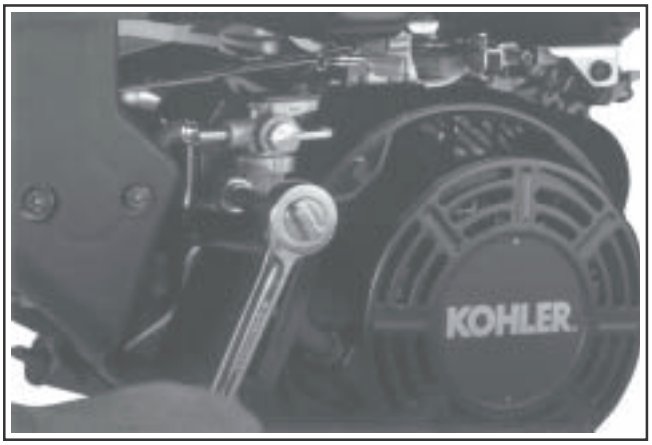


Figure 11-114. CS8.5 (spec. 95xxxx). Mounting Shut-Off Valve.

5. Connect the fuel line to the outlet of the shut-off valve and the carburetor inlet. Secure with the clamps.

Install Outer Air Cleaner Cover

1. Install the outer air cleaner cover onto the stud, over the element. Secure with the knob.

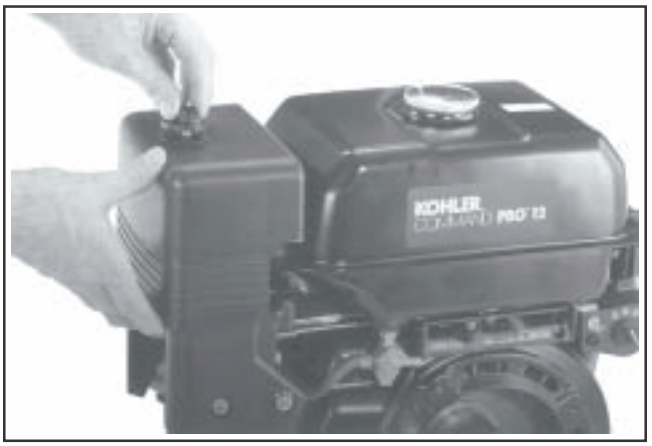


Figure 11-115. Installing Outer Air Cleaner Cover and Knob.

Install the Retractable Starter

1. Install the retractable starter using the hex flange screws. Finger tighten the mounting screws only.

2. Pull the rope handle to engage the pawls, centering the starter to the drive cup. Hold in this position and torque the mounting screws to **6.5-7 N·m (57-62 in. lb.)**.

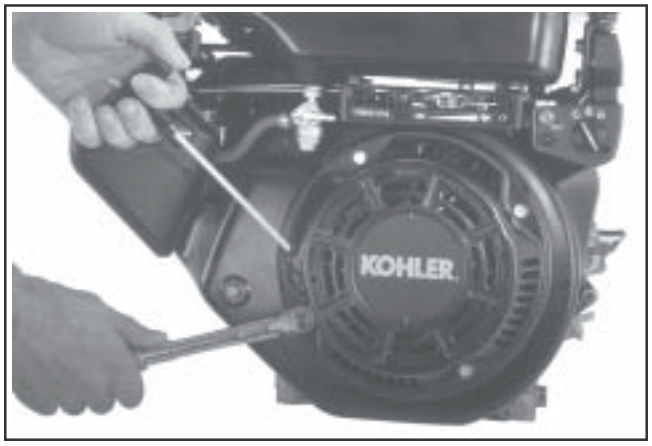


Figure 11-116. Engage Pawls and Torque Mounting Screws.

Install Muffler

1. Install a new exhaust gasket onto the exhaust studs.

2. Install the muffler and heat shield assembly. Install the hex flange screw, with a flat washer, through the front support bracket, into the crankcase boss.

   Torque hex flange nuts to:
   CS4, CS6: 6-8 N·m (53-71 in. lb.)
   CS8.5-12: 18-22 N·m (159-195 in. lb.)

   Torque hex flange screw to:
   CS4, CS6: 7 N·m (62 in. lb.)
   CS8.5-12: 15 N·m (133 in. lb.)

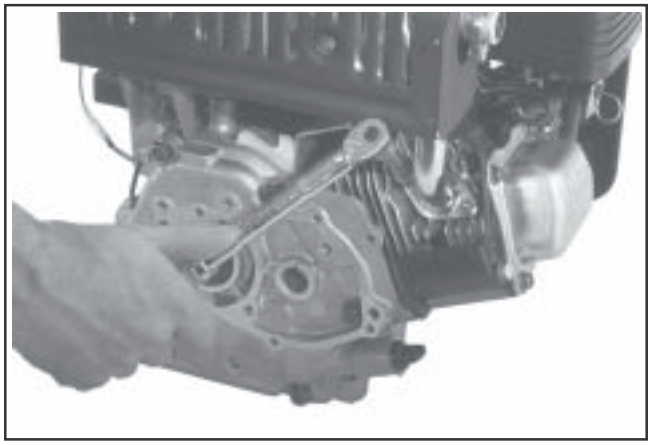


Figure 11-117. Torquing Muffler Mounting Screws.

Prepare the Engine for Operation

The engine is now reassembled. Before starting or operating the engine be sure to do the following:

1. Make sure all hardware is properly torqued.

2. Make sure the oil drain plugs and oil sentry control unit are tightened securely.

3. Fill the crankcase with the correct oil. Refer to the oil recommendations and procedures in the General Information and Lubrication System sections.

4. Reconnect the rectifier-regulator, if so equipped.

Testing the Engine

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

1. Set the engine up on a test stand. Check gas and oil levels. Start the engine and run for 5-10 minutes between idle and midrange. Adjust the carburetor settings as required. Low idle speed should be set to 2000 RPM (+ 150) or application specifications.

2. Make sure the maximum engine speed does not exceed:

Type/Engine Speed	Maximum
Tapered Shaft Models	3750 ± 100 RPM
Others	3800 ± 100 RPM

Adjust the throttle, choke, and/or high speed stop screw as necessary. See Figures 11-118, 11-119, and 11-120 on page 11.32. Refer also to Fuel System and Governor section.

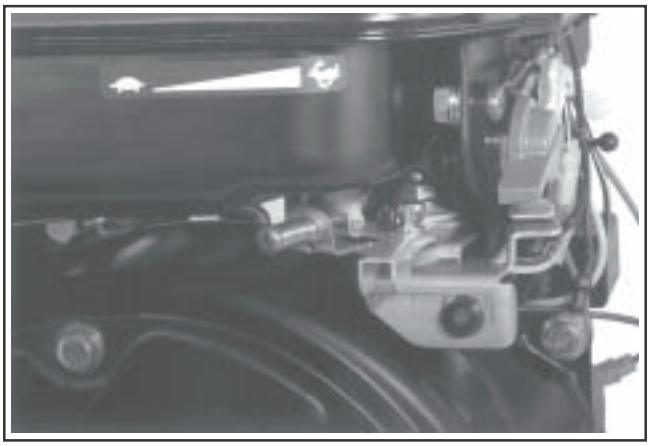


Figure 11-118. CS4, CS6. High Speed Stop Screw.

Figure 11-119. CS8.5 (spec. 92xxxx), CS10, CS12. High Speed Stop Screw.

Figure 11-120. CS8.5 (spec. 95xxxx). High Speed Stop Screw.

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