SERVICE MANUAL

KOHLER COMMAND PRO

CV940-CV1000 Vertical Crankshaft





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Section 1 Safety and General Information

Safety Precautions

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



WARNING

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



CAUTION

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

NOTE

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

For Your Safety!

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



Accidental Starts can cause severe injury or death.

Disconnect and ground spark plug leads before servicing.

Accidental Starts!

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



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.



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.







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.







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.

A CAUTION



Electrical Shock can cause injury.

Do not touch wires while engine is running.

Electrical Shock!

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

WARNING



Explosive Gas can cause fires and severe acid burns.

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

Explosive Gas!

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

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

Engine Identification Numbers

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

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



Figure 1-1. Engine Identification Decal Location.

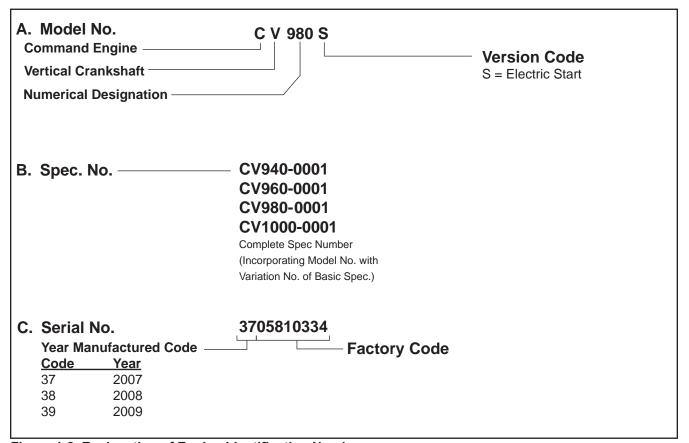


Figure 1-2. Explanation of Engine Identification Numbers.

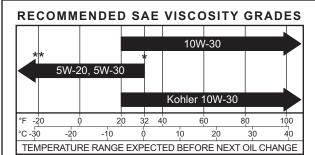
Safety and General Information

Oil Recommendations

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

Oil Type

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



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

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

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

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

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

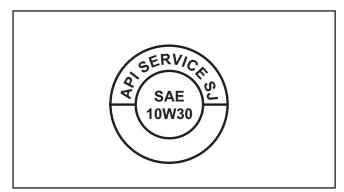


Figure 1-3. Oil Container Logo.

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

Fuel Recommendations



WARNING: Explosive Fuel!

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

General Recommendations

Purchase gasoline in small quantities that can be used within 30 days, and store in only clean, approved containers. Do not use gasoline left over from the previous season, unless treated with a fuel stabilizer (see **Storage**), to minimize gum deposits and ensure easy starting. Do not use gasoline containing Methanol, or add oil to the gasoline.

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

Fuel Type

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

Unleaded gasoline is recommended as it leaves less combustion chamber deposits and reduces harmful exhaust emissions. Leaded gasoline is not recommended and **must not** be used on EFI engines, or on other models where exhaust emissions are regulated.

Gasoline/Alcohol blends

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

Gasoline/Ether blends

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

Periodic Maintenance Instructions

A

WARNING: Accidental Starts!

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

Maintenance Schedule

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

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

¹Perform these maintenance procedures more frequently under extremely dusty, dirty conditions.

Storage

If the engine will be out of service for 30 days or more, use the following storage procedure.

- Clean the exterior surfaces of the engine. Avoid spraying water at the wiring harness or any of the electrical components.
- 2. Change the oil and oil filter while the engine is still warm from operation. See "Change Oil and Oil Filter" in Section 6.
- The fuel system must be completely emptied, or the gasoline must be treated with a stabilizer to prevent deterioration. If you choose to use a stabilizer, follow the manufacturer's recommendations, and add the correct amount for the capacity of the fuel system.

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

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

- 4. Remove the spark plugs and add one tablespoon of engine oil into each spark plug hole. Install the spark plugs, but do not connect the plug leads. Crank the engine two or three revolutions.
- 5. Disconnect the battery or use a battery minder to keep the battery charged during storage.
- 6. Store the engine in a clean, dry place.

²Have a Kohler Engine Service Dealer perform this service.

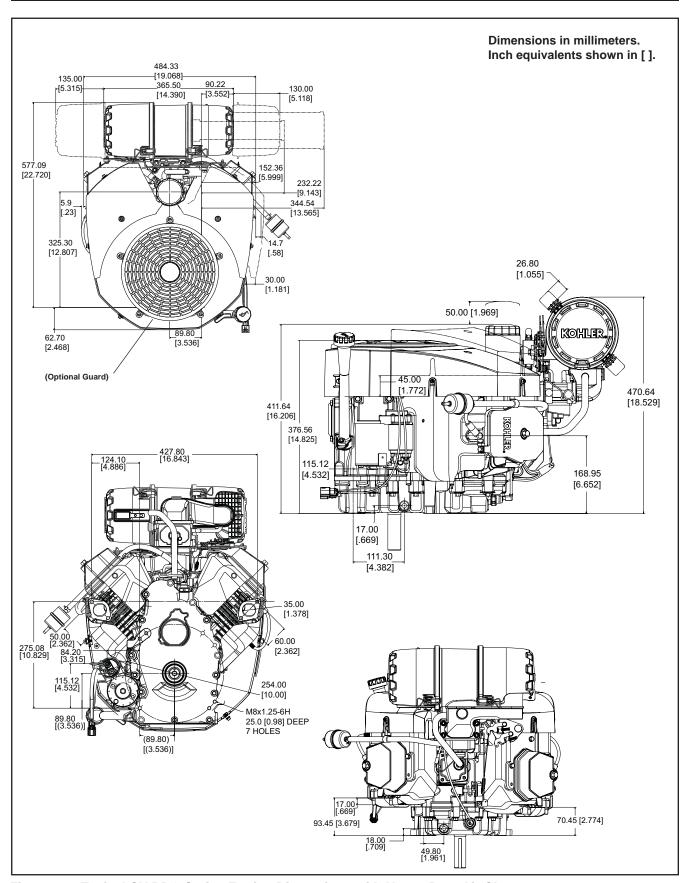


Figure 1-4. Typical CV PRO Series Engine Dimensions with Heavy Duty Air Cleaner.

General Specifications¹ Power (@3600 RPM, exceeds Society of Automotive Engineers-Small Engine Test Code J1940.) Oil Capacity (w/filter) - approximate, Angle of Operation - Maximum (At Full Oil Level) All Directions....... 25° **Blower Housing and Sheet Metal** M6 Shoulder Screw Torque Into: New, Untapped Hole (casting) 10.7 N·m (95 in. lb.) M6 Screw Torque Camshaft Bore I.D. Camshaft Bearing Surface O.D. Cam Lobe Profile (Minimum Dimension, Measured From Base Circle To Top Of Lobe.) ¹Values are in Metric units. Values in parentheses are English equivalents. Lubricate threads with engine oil prior to assembly.

Carburetor, Intake Manifold, and Air Cleaner Intake Manifold Mounting Fastener Torque	
Torque Using Sequence in Two Stages	first to 16.9 N·m (150 in. lb.) finally to 22.6 N·m (200 in. lb.)
Carburetor/Air Cleaner Mounting Nut Torque	7.9 N·m (70 in. lb.)
Air Cleaner Mounting Screw Torque (Into Intake Manifold)	9.9 N·m (88 in. lb.)
Control Bracket Mounting Screw (Into Intake Manifold from Air Cleaner) Torque	9.9 N·m (88 in. lb.)
Connecting Rod Cap Fastener Torque (torque in increments)	11.3 N·m (100 in. lb.)
Crankpin End I.D. @ 70°F New Max. Wear Limit	,
Connecting Rod-to-Crankpin Running Clearance New	
Connecting Rod-to-Crankpin Side Clearance	0.30/0.59 mm (0.0118/0.0232 in.)
Connecting Rod-to-Piston Pin Running Clearance	0.015/0.028 mm (0.0006/0.0011 in.)
Piston Pin End I.D. @ 70°F New Max. Wear Limit	· · · · · · · · · · · · · · · · · · ·
Crankcase Governor Cross Shaft Bore I.D.	
NewMax. Wear Limit	· · · · · · · · · · · · · · · · · · ·
Breather Cover Fastener Torque	5.7 N·m (51 in. lb.)
Oil Drain Plug Torque	21.4 N·m (15.7 ft. lb.)
Oil Pan Fastener Torque	24.4 N·m (216 in. lb.)
Crankshaft End Play (Free)	0.30/1.50 mm (0.011/0.059 in.)
Crankshaft Bore (In Crankcase) New, Without Main Bearing With Main Bearing Installed Max. Wear Limit	45.040/45.145 mm (1.7732/1.7773 in.)
Crankshaft to Sleeve Bearing (Crankcase) Running Clearance - New	0.040/0.167 mm (0.0015/0.0065 in.)
Crankshaft Bore (In Oil Pan) - New, without Bearing	50.025/50.00 mm (1.9694/1.9685 in.)

Crankshaft to Sleeve Bearing (In Oil Pan) Running Clearance - New	0.040/0.167 mm (0.0015/0.0065 in.)
Flywheel End Main Bearing Journal O.D New O.D Max. Wear Limit Max. Taper Max. Out-of-Round	44.90 mm (1.767 in.) 0.022 mm (0.0009 in.)
Closure Plate End Main Bearing Journal O.D New O.D Max. Wear Limit Max. Taper Max. Out-of-Round	44.90 mm (1.767 in.) 0.022 mm (0.0009 in.)
Connecting Rod Journal O.D New O.D Max. Wear Limit Max. Taper Max. Out-of-Round Width	43.97 mm (1.731 in.) 0.018 mm (0.0007 in.) 0.025 mm (0.0010 in.)
Crankshaft T.I.R. PTO End, Crank in Engine Entire Crank, in V-Blocks	, ,
Cylinder Bore Cylinder Bore I.D. New	90.075 mm (3.546 in.) 0.013 mm (0.00051 in.)
Main Bearing I.D. (Crankcase/Oil Pan) New (Installed)	· · · · · · · · · · · · · · · · · · ·
Cylinder Head Cylinder Head Fastener Torque Head Bolt - Torque in Two Stages	first to 22.6 N·m (200 in. lb.) finally to 45.2 N·m (400 in. lb.)
Max. Out-of-Flatness	0.076 mm (0.003 in.)
Pipe Plug, 3/4" Torque	28.25 N·m (250 in. lb.)
Rocker Arm Stud (AVT) Torque	11.3 N·m (100 in. lb.)
Setscrew, AVT pivot locking	7.3 N·m (65 in. lb.)
Fan/Flywheel Fan Fastener Torque	9.9 N·m (88 in. lb.)
Flywheel Retaining Screw Torque	67.8 N·m (50 ft. lb.)

Section 1 Safety and General Information

Grass Screen Hex Stud Torque Mounting Screw Torque	
Governor Cross Shaft-to-Crankcase Running Clearance	0.025/0.087 mm (0.0009/0.0034 in.)
Governor Cross Shaft O.D. New	7.042/9.000 mm (0.2125/.2140 in.)
Max. Wear Limit	
Governor Gear Shaft-to-Governor Gear Running Clearance	0.070/0.160 mm (0.0027/0.0063 in.)
Governor Gear Shaft O.D. New	5 000/4 000 mm /0 2259/0 2242 in)
Max. Wear Limit	
Governor Lever Nut Torque	7.3 N·m (65 in. lb.)
Ignition Spark Plug Type (Champion® or Equivalent)	XC10YC
Spark Plug Gap	0.76 mm (0.030 in.)
Spark Plug Torque	24.4-29.8 N·m (18-22 ft. lb.)
Ignition Module Air Gap	0.28/0.33 mm (0.011/0.013 in.)
Ignition Module Fastener Torque	6.2 N·m (55 in. lb.) into new holes, or 4.0 N·m (35 in. lb.) into used holes
Lifter Feed Chamber Cover/Baffle Screw Torque	6.2 N·m (55 in. lb.)
Muffler Muffler Retaining Nut Torque	24.4 N·m (216 in. lb.)
Screw, intermittent bracket (into weld nut)	13.5 N·m (120 in. lb.)
Oil Cooler Mounting Screws Torque	3.9 N·m (35 in. lb.)
Oil Filter Oil Filter Torque	3/4-1 turn after gasket contact
Oil Filter Adapter/Housing Mounting Screw Torque	24.4 N·m (216 in. lb.)
Piston, Piston Rings, and Piston Pin Piston-to-Piston Pin Running Clearance	0.006/0.018 mm (0.0002/0.0007 in.)
Piston Pin Bore I.D. New Max. Wear Limit	
Piston Pin O.D. New Max. Wear Limit	,

Top Compression Ring-to-Groove Side Clearance	0.04/0.08 mm (0.0015/0.0031 in.)
Middle Compression Ring-to-Groove Side Clearance	0.04/0.08 mm (0.0015/0.0031 in.)
Oil Control Ring-to-Groove Side Clearance	0.03/0.19 mm (0.0011/0.0074 in.)
Top and Center Compression Ring End Gap New Bore Used Bore (Max.)	` ,
Piston Thrust Face O.D. ² New Max. Wear Limit	
Piston Thrust Face-to-Cylinder Bore ² Running Clearance New	0.033/0.72 mm (0.0013/0.0028 in.)
Starter Assembly	
Thru Bolt Torque Delco-Remy (Solenoid Shift)	5.6-9.0 N·m (49-79 in. lb.)
Mounting Screw Torque	15.3 N·m (135 in. lb.)
Brush Holder Mounting Screw Torque Delco-Remy Starter	2.5-3.3 N·m (22-29 in. lb.)
Solenoid (Starter) Mounting Hardware Torque Delco-Remy Starter	4.0-6.0 N·m (35-53 in. lb.)
Nut, Positive (+) Brush Lead Torque Delco-Remy Starter	8.0-11.0 N·m (71-97 in. lb.)
Stator Mounting Screw Torque	6.2 N·m (55 in. lb.)
Throttle/Choke Control Bracket Fastener Torque	9.9 N·m (88 in. lb.)
Valve Cover Fastener Torque	7.9 N·m (70 in. lb.)
Valves and Valve Lifters Hydraulic Valve Lifter to Crankcase Running Clearance	0.012/0.050 mm (0.0004/0.0019 in.)
Intake Valve Stem-to-Valve Guide Running Clearance	0.038/0.076 mm (0.0015/0.0030 in.)
Exhaust Valve Stem-to-Valve Guide Running Clearance	0.050/0.088 mm (0.0020/0.0035 in.)
Intake Valve Guide I.D. New Max. Wear Limit	
Exhaust Valve Guide I.D. New Max. Wear Limit	7.159 mm (0.2819 in.)

Section 1 **Safety and General Information**

Valve Guide Reamer Size	
Standard	7.048 mm (0.2775 in.)
0.25 mm O.S	7.298 mm (0.2873 in.)
Nominal Valve Face Angle	45°

General Torque Values

Tigh	tening Torq	ıue: N⋅m (in. l	b.) + or - 10%			
Property Class					Noncritical Fasteners	
	4.8	(5.8)	8.8	10.9	12.9	Into Aluminum
Size						
M4	1.2 (11)	1.7 (15)	2.9 (26)	4.1 (36)	5.0 (44)	2.0 (18)
M5	2.5 (22)	3.2 (28)	5.8 (51)	8.1 (72)	9.7 (86)	4.0 (35)
M6	4.3 (38)	5.7 (50)	9.9 (88)	14.0 (124)	16.5 (146)	6.8 (60)
M8	10.5 (93)	13.6 (120)	24.4 (216)	33.9 (300)	40.7 (360)	17.0 (150)
Tight	ening Torqu	ue: N·m (ft. lb	.) + or - 10%			
0						
			Property Clas	SS		Noncritical
			Property Clas	ss		Noncritical Fasteners
	4.8	(5.8)	Property Clas	5S (10.9)	(12.9)	
-			8.8	10.9		Fasteners Into Aluminum
M10 M12	21.7 (16) 36.6 (27)	27.1 (20) 47.5 (35)			81.4 (60) 139.7 (103)	Fasteners

English Fastener Torque Recommendations for Standard Applications

Tightening Torque: N·m (in. lb.) + or - 20%				
•	s, Nuts and Fasteners nto Cast Iron or Steel Grade 2	Grade 5	Grade 8	Grade 2 or 5 Fasteners Into Aluminum
Size 8-32 10-24 10-32 1/4-20 1/4-28 5/16-18 5/16-24 3/8-16 3/8-24	2.3 (20) 3.6 (32) 3.6 (32) 7.9 (70) 9.6 (85) 17.0 (150) 18.7 (165) 29.4 (260) 33.9 (300)	2.8 (25) 4.5 (40) 4.5 (40) 13.0 (115) 15.8 (140) 28.3 (250) 30.5 (270)	 18.7 (165) 22.6 (200) 39.6 (350) 	2.3 (20) 3.6 (32) 7.9 (70) 17.0 (150)
Size 5/16-24	Torque: N·m (ft. lb.)		40.7 (30)	
3/8-16 3/8-24 7/16-14 7/16-20	47.5 (35) 61.0 (45)	47.5 (35) 54.2 (40) 74.6 (55) 101.7 (75)	67.8 (50) 81.4 (60) 108.5 (80) 142.4 (105)	
1/2-13 1/2-20 9/16-12 9/16-18	67.8 (50) 94.9 (70) 101.7 (75) 135.6 (100)	108.5 (80) 142.4 (105) 169.5 (125) 223.7 (165)	155.9 (115) 223.7 (165) 237.3 (175) 311.9 (230)	
5/8-11 5/8-18 3/4-10 3/4-16	149.2 (110) 189.8 (140) 199.3 (150) 271.2 (200)	244.1 (180) 311.9 (230) 332.2 (245) 440.7 (325)	352.6 (260) 447.5 (330) 474.6 (350) 637.3 (470)	

Torque Conversions

 $N \cdot m = in. lb. x 0.113$ $N \cdot m = ft. lb. x 1.356$ $in. lb. = N \cdot m x 8.85$ $ft. lb. = N \cdot m x 0.737$

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.
Camshaft Endplay Plate For checking camshaft endplay.	SE Tools KLR-82405
Camshaft Seal Protector (Aegis) To protect seal during camshaft installation.	SE Tools KLR-82417
Cylinder Leakdown Tester For checking combustion retention and if cylinder, piston, rings, or valves are worn.	Kohler 25 761 05-S
Electronic Fuel Injection (EFI) Diagnostic Software Use with Laptop or Desktop PC.	Kohler 25 761 23-S
EFI Service Kit For troubleshooting and setting up an EFI engine.	Kohler 24 761 01-S
Individual Components Available Pressure Tester Noid Light 90° Adapter Oetiker Clamp Pliers Code Plug, Red Wire Code Plug, Blue Wire	Design Technology Inc. DTI-019 DTI-021 DTI-023 DTI-025 DTI-027 DTI-029
Flywheel Holding Tool (CS Series)	SE Tools KLR-82407
Flywheel Puller To remove flywheel from engine.	SE Tools KLR-82408
Flywheel Strap Wrench To hold flywheel during removal.	SE Tools KLR-82409

Section 2 Tools & Aids

Tools (Continued)	
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 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

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

Special Tools You Can Make

Flywheel Holding Tool

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

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

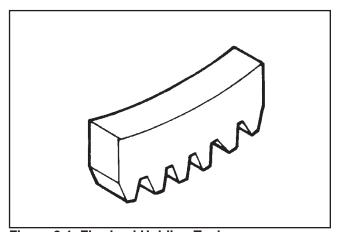


Figure 2-1. Flywheel Holding Tool.

Rocker Arm/Crankshaft Tool

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

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

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

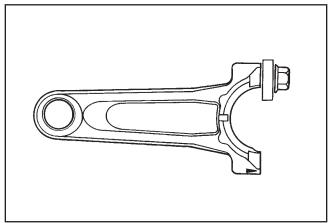


Figure 2-2. Rocker Arm/Crankshaft Tool.

Section 3 Troubleshooting

Troubleshooting Guide

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

Some general common causes of engine troubles are listed below. Use these to locate the causing factors. Refer to the specific section(s) within this service manual for more detailed information.

Engine Cranks But Will Not Start

- 1. Empty fuel tank.
- 2. Fuel shut-off valve closed.
- 3. Poor fuel, dirt or water in the fuel system.
- 4. Clogged fuel line.
- 5. Spark plug lead(s) disconnected.
- 6. Kill switch in "off" position.
- 7. Faulty spark plugs.
- 8. Faulty ignition module(s).
- 9. Carburetor solenoid malfunction.
- 10. Vacuum fuel pump malfunction, or oil in vacuum hose.
- 11. Vacuum hose to fuel pump leaking/cracked.
- 12. Battery connected backwards.
- 13. Safety interlock system engaged.

Engine Starts But Does Not Keep Running

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

Engine Starts Hard

- 1. PTO drive is engaged.
- 2. Dirt or water in the fuel system.
- 3. Clogged fuel line.
- 4. Loose or faulty wires or connections.
- 5. Faulty or misadjusted choke or throttle controls.
- 6. Faulty spark plugs.

- 7. Low compression.
- 8. Weak spark.
- 9. Fuel pump malfunction causing lack of fuel.
- 10. Engine overheated-cooling/air circulation restricted.
- 11. Quality of fuel.
- 12. Flywheel key sheared.
- 13. Intake system leak.

Engine Will Not Crank

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

Engine Runs But Misses

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

Engine Will Not Idle

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

Section 3 Troubleshooting

Engine Overheats

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

Engine Knocks

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

Engine Loses Power

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

Engine Uses Excessive Amount of Oil

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

Oil Leaks from Oil Seals, Gaskets

- Clogged, broken or inoperative crankcase breather.
- 2. Loose or improperly torqued fasteners.
- 3. Piston blowby, or leaky valves.
- 4. Restricted exhaust.

External Engine Inspection

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

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

Sludge is a natural by-product of combustion; a small accumulation is normal. Excessive sludge formation could indicate overrich carburetion, weak ignition, overextended oil change intervals or wrong weight or type of oil was used, to name a few.

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

Cleaning the Engine

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

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

Basic Engine Tests

Crankcase Vacuum Test

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

Crankcase vacuum is best measured with either a water manometer or a vacuum gauge (see Section 2). Complete instructions are provided in the kits.

To test the crankcase vacuum with the manometer:

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

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

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

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

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

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

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

No Crankcase Vacuum/Pressure in Crankcase			
Possible Cause	Solution		
Crankcase breather clogged or inoperative.	Disassemble breather, clean parts thoroughly, reassemble, and recheck pressure		
Seals and/or gaskets leaking. Loose or improperly torqued fasteners.	Replace all worn or damaged seals and gaskets. Make sure all fasteners are tightened securely. Use appropriate torque values and sequences when necessary		
Piston blow by or leaky valves (confirm by inspecting components)	Recondition piston, rings, cylinder bore, valves, and valve guides.		
Restricted exhaust.	Repair/replace restricted muffler/exhaust system		

Section 3 Troubleshooting

Compression Test

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

Cylinder Leakdown Test

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

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

Leakdown Test Instructions

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

If the flywheel end is more accessible, use a breaker bar and socket on the flywheel nut/screw to hold it in position. An assistant may be needed to hold the breaker bar during testing. If the engine is mounted in a piece of equipment, it may be possible to hold it by clamping or wedging a driven component. Just be certain that the engine cannot rotate off of TDC in either direction.

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

Leakdown Test Results

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

Section 4 Air Cleaner and Air Intake System

Air Cleaners

General

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

Heavy-Duty Style Air Cleaner



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

Service

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

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

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

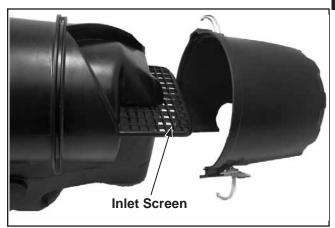


Figure 4-2. Accessing Inlet Screen.

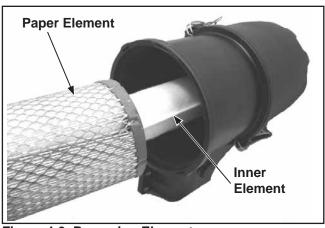


Figure 4-3. Removing Elements.

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

Section 4

Air Cleaner and Air Intake System

- 4. Do not wash the paper element and inner element or use compressed air, this will damage the elements. Replace dirty, bent or damaged elements with new genuine Kohler elements as required. Handle the new elements carefully; do not use if the sealing surfaces are bent or damaged.
- 5. Check all parts for wear, cracks, or damage, and that ejector area is clean. See Figure 4-4. Replace any damaged components.

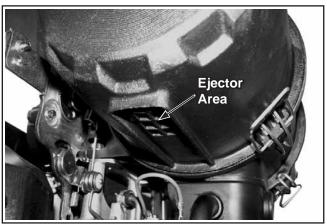


Figure 4-4. Ejector Area.

- Install the new inner element, followed by the paper element. Slide each fully into place in the air cleaner housing.
- 7. Reinstall the end caps and secure with the retaining clips. See Figure 4-1.

Air Cleaner Components

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

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

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

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

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

Air Intake/Cooling System

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

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



Figure 4-5. Removing Shrouds for Cleaning.

Description

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



WARNING: Explosive Fuel!

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

Fuel System Components

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

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

Operation

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

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

Fuel Recommendations

General Recommendations

Purchase gasoline in small quantities that can be used within 30 days and store only in clean, approved containers. Do not use gasoline left over from the previous season, unless treated with a fuel stabilizer (see Storage in Section 1), to minimize gum deposits

and ensure easy starting. Do not use gasoline containing Methanol, or add oil to the gasoline. Do not overfill the fuel tank. Leave room for the fuel to expand.

Fuel Type

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

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

Gasoline/Alcohol blends

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

Gasoline/Ether blends

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

Fuel Filter

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

Fuel Line

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

Fuel System Tests

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

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

Fuel Pump

General

These engines use either a pulse style fuel pump, or optional remote-mounted electric fuel pump assembly. See Figures 5-1 and 5-2. The pumping action of pulse style pumps is created by the oscillation of positive and negative pressures within the crankcase. This pressure is transmitted to the pulse pump through the rubber hose connected between the pump and crankcase. The pumping action causes the diaphragm on the inside of the pump to pull fuel in on its downward stroke and to push it into the carburetor on its upward stroke. Two check valves prevent fuel from going backward through the pump.

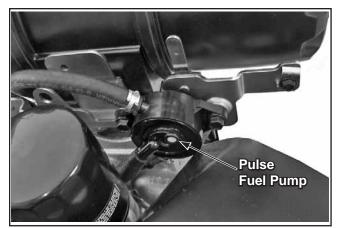


Figure 5-1. Pulse Style Fuel Pump.

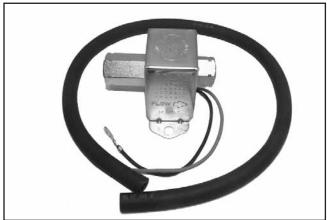


Figure 5-2. Optional Electric Fuel Pump.

Fuel Pump - Replacement

Replacing the Pulse Style Fuel Pump

Replacement pumps are available through your source of supply. To replace the pulse pump follow these steps. Note orientation of pump before removing. See Figure 5-1.

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

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

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

Carburetor

General

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

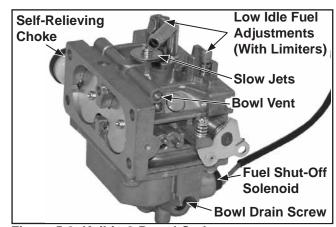


Figure 5-3. Keihin 2-Barrel Carburetor.

WARNING: Explosive Fuel

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

Troubleshooting Checklist

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

- Make sure the fuel tank is filled with clean, fresh gasoline.
- Make sure the fuel tank cap vent is not blocked and that it is operating properly.
- Make sure fuel is reaching the carburetor. This
 includes checking the fuel shut-off valve, fuel
 tank filter screen, in-line fuel filter, fuel lines and
 fuel pump for restrictions or faulty components
 as necessary.

- Make sure the air cleaner base and carburetor are securely fastened to the engine using gaskets in good condition.
- Make sure the air cleaner element (including precleaner if equipped) is clean and all air cleaner components are fastened securely.
- Make sure the ignition system, governor system, exhaust system, and throttle and choke controls are operating properly. If the engine is hardstarting, runs roughly, or stalls at low idle speed, it may be necessary to adjust or service the carburetor.

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

High Altitude Operation

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

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

Fuel Shut-off Solenoid

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

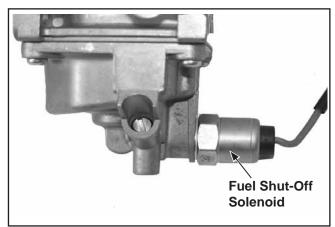


Figure 5-4. Fuel Shut-off Solenoid.

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

- Shut off fuel and remove the solenoid from the carburetor. When the solenoid is loosened and removed, gas will leak out of the carburetor. Have a container ready to catch the fuel.
- Wipe the tip of the solenoid with a shop towel or blow it off with compressed air, to remove any remaining fuel. Take the solenoid to a location with good ventilation and no fuel vapors present. You will also need a 12 volt power source that can be switched on and off.
- Be sure the power source is switched "off".
 Connect the positive power source lead to the red lead of the solenoid. Connect the negative power source lead to the solenoid body.

4. Turn the power source "on" and observe the pin in the center of the solenoid. The pin should retract with the power "on" and return to its original position with the power off. Test several times to verify operation.

Carburetor Details

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

Float Circuit:

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

Slow & Mid-Range Circuit:

At low speeds the engine operates only on the slow circuit. As a metered amount of air is drawn through the slow air bleed jets, fuel is drawn through the two main jets and further metered through the slow jets. Air and fuel are mixed in the body of the slow jet and exit to the transfer port. From the transfer port the air fuel mixture is delivered to the idle progression chamber. From the idle progression chamber the air fuel mixture is metered through the idle port passages. At low idle when the vacuum signal is weak, the air/fuel mixture is controlled by the setting of the idle fuel adjusting screws. This mixture is then mixed with the main body of air and delivered to the engine. As the throttle plate opening increases, greater amounts of air/fuel mixture are drawn in through the fixed and metered idle progression holes. As the throttle plate opens further the vacuum signal becomes great enough so the main circuit begins to work.

Main (High-Speed) Circuit:

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

Carburetor Adjustments

Adjustment

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

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

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

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

Low Idle Speed (RPM) Adjustment

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

*NOTE: The actual low idle speed depends on the application. Refer to the equipment manufacturer's recommendations.

The low idle speed for basic engines is 1200 RPM. To ensure best results when setting the low idle fuel needle, the low idle speed should be 1200 RPM (± 75 RPM).

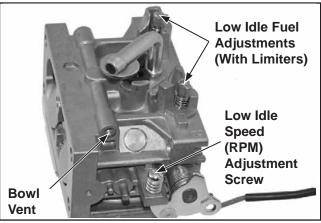


Figure 5-5. Carburetor Adjustment Locations.

Low Idle Fuel Adjustment

NOTE: Engines will have fixed low idle or limiter caps on the two idle fuel adjusting needles.

Step 3 can only be performed within the limits allowed by the cap. Do not attempt to remove the limiter caps.

- 1. Start the engine and run at half throttle for 5 to 10 minutes to warm up. The engine must be warm before doing steps 2, 3, and 4.
- 2. Place the throttle control into the "idle" or "slow" position. Adjust the low idle speed to 1200 RPM. Follow the "Adjusting the Low Idle Speed (RPM)" procedure.
- 3. **Low Idle Fuel Needle(s) Setting:** Place the throttle into the "idle" or "slow" position.
 - a. Turn one of the low idle fuel adjusting needles out (counterclockwise) from the preliminary setting until the engine speed decreases (rich). Note the position of the needle. Now turn the adjusting needle in (clockwise). The engine speed may increase, then it will decrease as the needle is turned in (lean). Note the position of the needle. Set the adjusting needle midway between the rich and lean settings. See Figure 5-6.
 - b. Repeat the procedure on the other low idle adjustment needle.
- 4. Recheck/adjust the Low Idle Speed (RPM), to the specified setting.

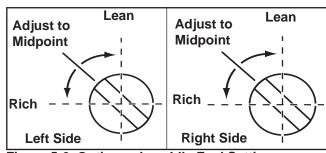


Figure 5-6. Optimum Low Idle Fuel Settings.

Governed Idle System

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

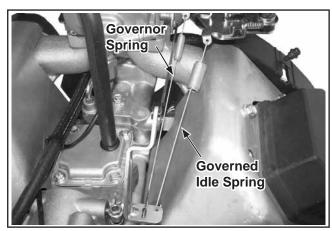


Figure 5-7. Governor Springs Installed.

Governed Idle Speed Adjustment

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

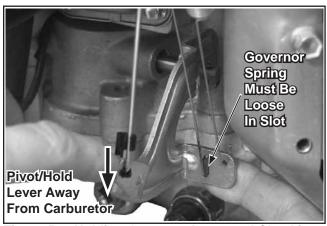


Figure 5-8. Holding Governor Lever and Checking Spring Looseness.

- 3. Hold the governor lever away from the carburetor so the throttle lever is against the idle speed (RPM) adjustment screw of the carburetor. Start the engine and allow it to warm up, then adjust the screw to set approximately 1200 RPM. Check using a tachometer. Turn the adjustment screw (inner) clockwise (in) to increase or counterclockwise (out) to decrease speed.
- 4. Release the governor lever and check that the throttle lever is in the idle (centered) position. See Figure 5-9. Turn the governed idle (outer) adjuster screw to obtain the equipment manufacturer's recommended idle speed (1500-1800 RPM). The governed idle speed (RPM) is typically 300 RPM (approximate) higher than the low idle speed. See Figure 5-10.



Figure 5-9. Throttle Lever in Idle Position (Air Cleaner Removed for Clarity).

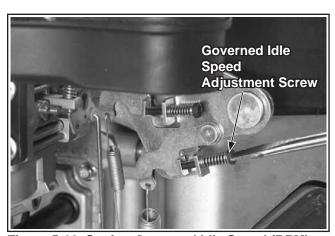


Figure 5-10. Setting Governed Idle Speed (RPM).

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

Fuel System and Governor

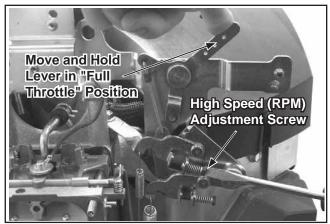


Figure 5-11. Setting High Speed RPM (Air Cleaner Removed for Clarity).

Carburetor Servicing

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

- Inspect the carburetor body for cracks, holes, and other wear or damage.
- Inspect the float for cracks, holes, and missing or damaged float tabs. Check the float hinge and shaft for wear or damage.
- Inspect the fuel inlet needle and seat for wear or damage.
- The choke plate is spring loaded. Check to make sure it moves freely on the shaft.

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

Float Replacement

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

- 1. Perform the removal procedures for the appropriate air cleaner and the carburetor outlined in Section 8 "Disassembly."
- Clean the exterior surfaces of dirt or foreign material before disassembling the carburetor.
 Remove the four mounting screws and carefully

separate the fuel bowl from the carburetor. Do not damage the inner or bowl O-Ring. Transfer any remaining fuel into an approved container. Save all parts. Fuel can also be drained prior to bowl removal by loosening/removal of the bowl drain screw. See Figure 5-12.

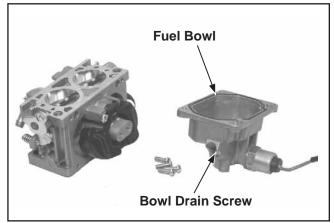


Figure 5-12. Fuel Bowl Removed From Carburetor.

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

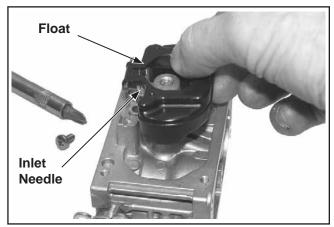


Figure 5-13. Removing Float and Inlet Needle.

- 4. Clean the carburetor bowl and inlet seat areas as required, before installing the new parts.
- 5. Attach the inlet needle to the plastic tang of the float with the wire clip. The formed 90° lip should point up, with the needle valve hanging down. See Figure 5-14.

Section 5 Fuel System and Governor

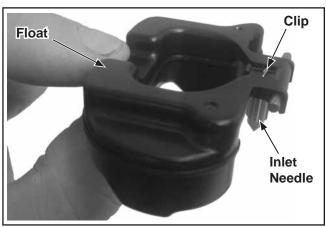


Figure 5-14. Float and Inlet Needle Details.

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

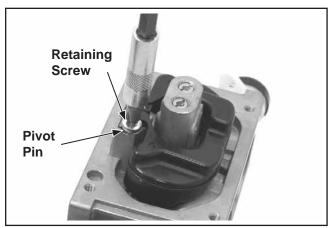


Figure 5-15. Installing Float Assembly.

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

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

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

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

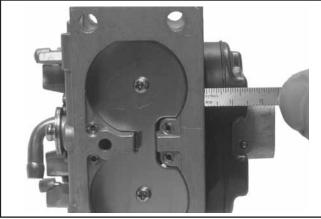


Figure 5-16. Checking Float Height.

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

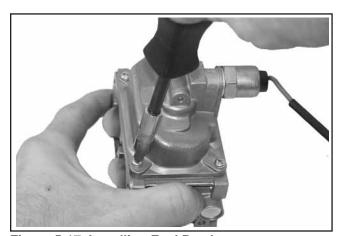


Figure 5-17. Installing Fuel Bowl.

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

Disassembly/Overhaul

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

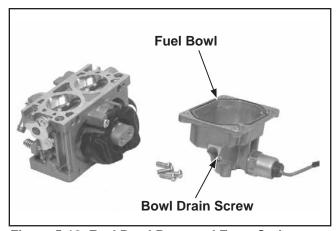


Figure 5-18. Fuel Bowl Removed From Carburetor.

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

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

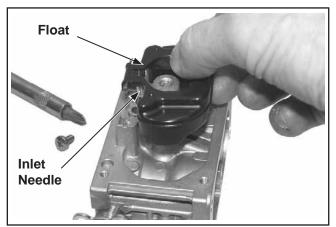


Figure 5-19. Removing Float and Inlet Needle.

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

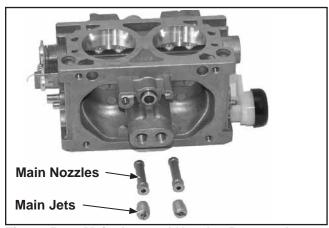


Figure 5-20. Main Jets and Nozzles Removed.

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

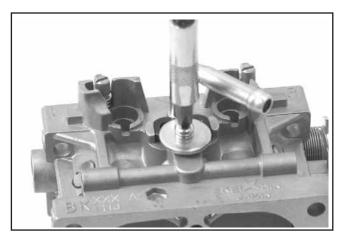


Figure 5-21. Removing Screw and Washer.

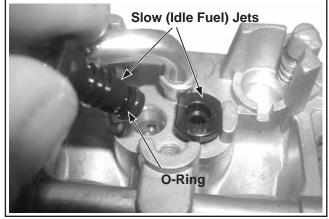


Figure 5-22. Slow Jets and O-Ring Detail.

- 5. Remove the idle speed (RPM) adjustment screw and spring from the carburetor. Discard the parts.
 - NOTE: The carburetor is now disassembled for appropriate cleaning and installation of the parts in the overhaul kit. Further disassembly is not necessary. The throttle shaft assembly, fuel inlet seat, idle fuel adjustment screws with limiter, and carburetor body, are non-serviceable items and should not be removed. The choke shaft assembly is serviceable, however it should not be removed unless a Choke Repair Kit will be installed.
- 6. Clean the carburetor body, main jets, vent ports, seats, etc. using a good commercially available carburetor solvent. Keep away from plastic or rubber parts if non-compatible. Use clean, dry compressed air to blow out the internal channels and ports. Do not use metal tools or wire to clean orifices and jets. Inspect and thoroughly check the carburetor for cracks, wear, or damage. Inspect the fuel inlet seat for wear or damage. Check the spring loaded choke plate to make sure it moves freely on the shaft.
- 7. Clean the carburetor fuel bowl as required.
- 8. Install the two main nozzles into the towers of the carburetor body. The end of the main nozzles with the two raised shoulders should be out/down (adjacent to the main jets). Make sure the nozzles are completely bottomed. Carefully install the main jets into the towers of the carburetor body on the appropriate side, as identified when removal was performed. See Figure 5-23.

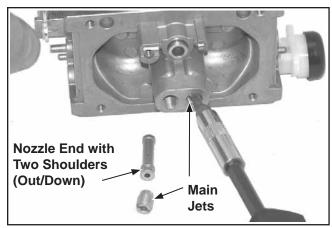


Figure 5-23. Installing Main Nozzles and Main Jets.

- 9. Make sure the O-Ring near the bottom of each slow jet is new, or in good condition. Align and insert the two slow jets into the top of the carburetor. See Figure 5-22.
- 10. Install the large, flat retaining washer and secure with the mounting screw, attaching the ground lead if originally secured by the screw.
- 11. Install the new idle speed (RPM) adjustment screw and spring onto the carburetor. Thread in until 3 or 4 threads are exposed, as an initial adjustment. See Figure 5-24.

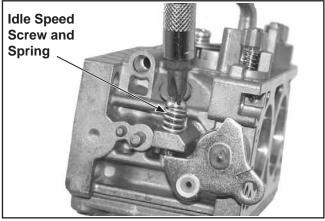


Figure 5-24. Installing Idle Speed Adjusting Screw and Spring.

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



Figure 5-25. Float and Inlet Needle Details.

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

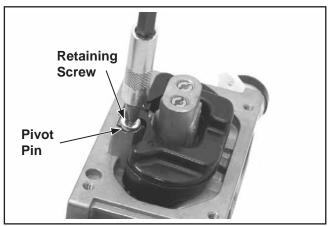


Figure 5-26. Installing Float Assembly.

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

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

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

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

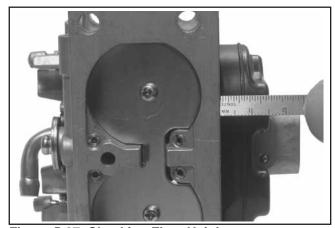


Figure 5-27. Checking Float Height.

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

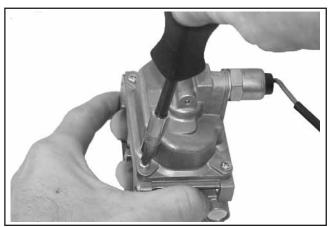


Figure 5-28. Installing Fuel Bowl.

Choke Repair

- Remove the carburetor from the engine. Discard the old mounting gaskets for the air cleaner and carburetor.
- 2. Clean the areas around the choke shaft and the self-relieving choke mechanism thoroughly.
- 3. Remove and discard the plastic cap from the end of the choke lever/shaft assembly.
- 4. Note the position of the spring legs and the choke plate for correct reassembly later. See Figure 5-29. Remove the two screws attaching the choke plate to the choke shaft. Pull the shaft out of the carburetor body, note the preload of spring and discard the removed parts.

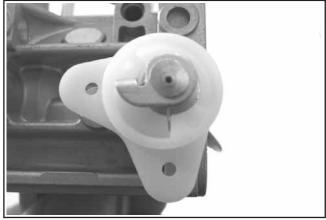


Figure 5-29. Choke Details.

Section 5 Fuel System and Governor

- 5. Use a screw extractor (easy-out) and remove the original choke shaft bushing with the old choke lever from the carburetor housing. Save the bushing to use as a driver for installing the new bushing. Discard the old lever.
- 6. Clean the I.D. of both choke shaft bores as required.
- 7. Insert the new bushing through the new choke lever from the outside, and start the bushing in the outer shaft bore. Position the choke lever so the protruding boss on the carburetor housing is between the two stops formed in the choke lever. See Figure 5-30.

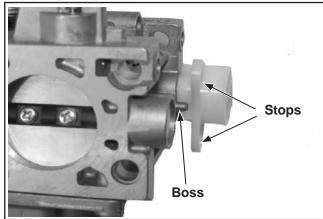


Figure 5-30. Assembling Choke Lever.

8. Turn the old bushing upside down and use it as a driver to carefully press or tap the new bushing into the carburetor body until it bottoms. Check that the choke lever pivots freely without restriction or binding. See Figure 5-31.



Figure 5-31. Installing Bushing.

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

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

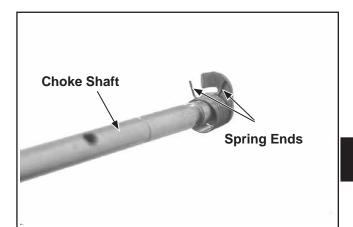


Figure 5-32. Choke Shaft and Spring Details.

10. Slide the choke shaft and spring into the carburetor. Pivot (preload) the shaft ¾ turn counterclockwise with the inner leg of the spring, against the formed stop within the choke lever as originally assembled. See Figures 5-29 and 5-33. The outer leg of the spring must still be behind the formed "stop" of the choke shaft.

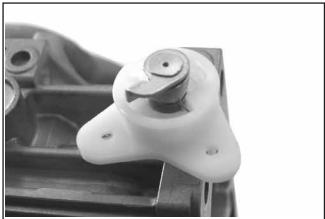


Figure 5-33. Installing Choke Assembly Components.

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

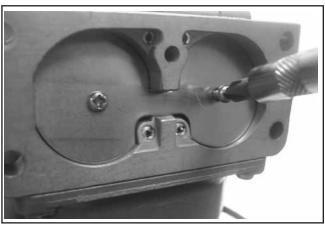
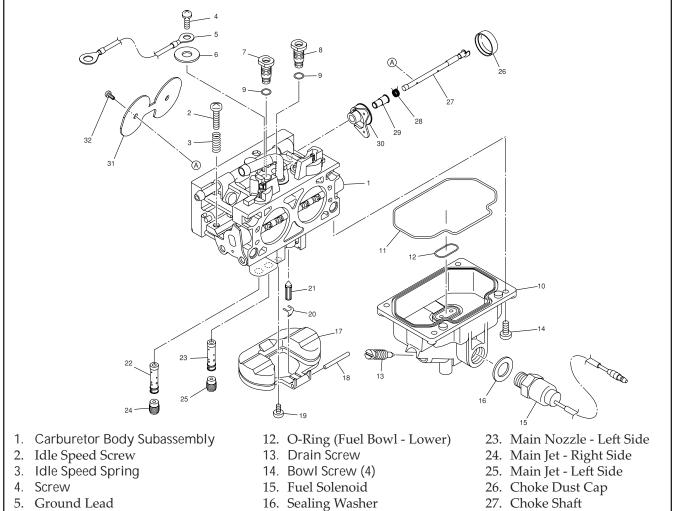


Figure 5-34. Installing Choke Plate.

12. Check for proper operation and free movement of the parts. Install the new cap.

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

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



- 6. Retaining Washer
- 7. Slow Jet RH Side
- 8. Slow Jet LH Side
- 9. O-Ring (Slow Jet) (2)
- 10. Fuel Bowl
- 11. O-Ring (Fuel Bowl Upper)
- 17. Float
- 18. Pin
- 19. Screw
- 20. Float Clip
- 21. Float Valve/Inlet Needle
- 22. Main Nozzle Right Side
- 28. Spring
- 29. Bushing
- 30. Choke Lever
- 31. Choke Plate
- 32. Choke Plate Screw (2)

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

Section 5 Fuel System and Governor

Governor

General

The governor is designed to hold the engine speed constant under changing load conditions. Most engines are equipped with a centrifugal flyweight mechanical governor. The governor gear/flyweight mechanism of the mechanical governor is mounted inside the crankcase and is driven off the gear on the camshaft. This governor design works as follows:

 Centrifugal force acting on the rotating governor gear assembly causes the flyweights to move outward as speed increases. Governor spring tension moves them inward as speed decreases.

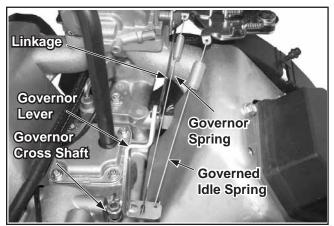


Figure 5-36. Governor Linkage (Air Cleaner Removed for Clarity).

- As the flyweights move outward, they cause the regulating pin to move outward.
- The regulating pin contacts the tab on the cross shaft causing the shaft to rotate.
- One end of the cross shaft protrudes through the crankcase. The rotating action of the cross shaft is transmitted to the throttle lever of the carburetor through the external throttle linkage. See Figure 5-36.
- When the engine is at rest, and the throttle is in the "fast" position, the tension of the governor spring holds the throttle plate open. When the engine is operating, the governor gear assembly is rotating. The force applied by the regulating pin against the cross shaft tends to close the throttle plate. The governor spring tension and the force applied by the regulating pin balance each other during operation, to maintain engine speed.

 When load is applied and the engine speed and governor gear speed decreases, the governor spring tension moves the governor arm to open the throttle plate wider. This allows more fuel into the engine, increasing the engine speed. As the speed reaches the governed setting, the governor spring tension and the force applied by the regulating pin will again offset each other to hold a steady engine speed.

Adjustments

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

General

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

Initial Adjustment Procedure

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

- 1. Make sure the throttle linkage is connected to the governor arm and the throttle lever on the carburetor.
- Loosen the hex nut holding the governor lever to the cross shaft.
- 3. Move the governor lever **toward** the carburetor as far as it will go (wide open throttle) and hold in this position.
- 4. Insert a long thin rod or tool into the hole on the cross shaft and rotate the shaft clockwise (viewed from the end) as far as it will turn, then torque the hex nut to 7.3 N·m (65 in. lb.).

High Speed (RPM) Adjustment (Refer to Figure 5-37.)

- 1. With the engine running, move the throttle control to **fast**. Use a tachometer to check the RPM speed.
- 2. Turn the inner/upper screw outward to decrease, or inward to increase the RPM speed. Check RPM with a tachometer.

3. Stop when the desired RPM speed is obtained.

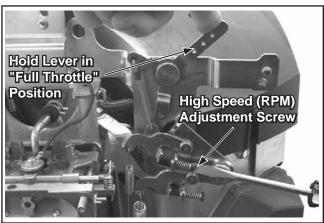


Figure 5-37. Adjusting High Speed RPM (Air Cleaner Removed for Clarity).

Section 6 Lubrication System

General

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

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

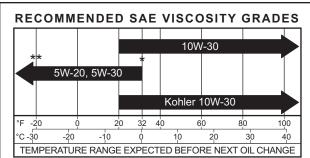
Service

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

Oil Recommendations

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

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



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

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

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

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

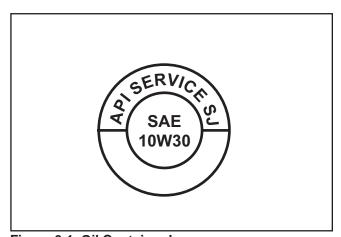


Figure 6-1. Oil Container Logo.

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

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

Checking Oil Level

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

- 1. Make sure the engine is stopped, level and is cool so the oil has had time to drain into the sump.
- 2. Clean the area around the oil fill cap/dipstick before removing it. This will help to keep dirt, grass clippings, etc., out of the engine.
- 3. Remove the oil fill cap/dipstick; wipe oil off. Reinsert the dipstick into the tube and rest the oil fill cap on the tube. Do not thread the cap onto the tube. See Figure 6-2.

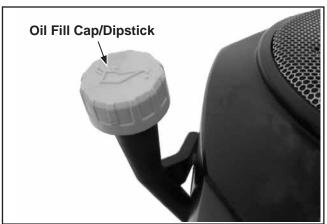


Figure 6-2. Oil Fill Cap/Dipstick.

4. Remove dipstick and check oil level. The level should be between the "F" and "L" marks. If low, remove the cap from the oil fill tube and add oil of the proper type up to the "F" mark. Reinstall oil fill cap and dipstick. (Refer to "Oil Type" on page 6.1.) Always check the level with the dipstick before adding more oil.

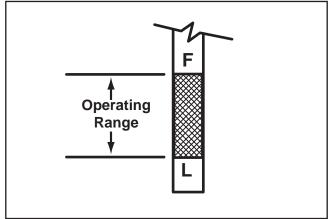


Figure 6-3. Oil Level Marks on Dipstick.

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

Changing Oil and Oil Filter

Changing Oil

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

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

Change the oil as follows:

- 1. Clean the areas around one of the drain plugs, oil fill cap/dipstick.
- Remove one of the oil drain plugs, oil fill cap/dipstick. Be sure to allow ample time for complete drainage.

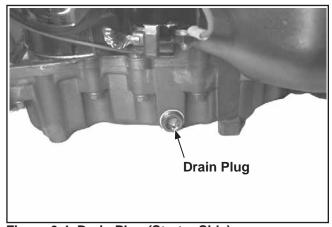


Figure 6-4. Drain Plug (Starter Side).

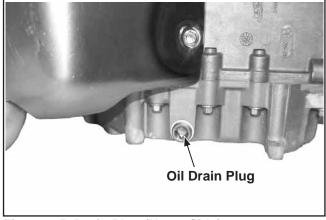


Figure 6-5. Drain Plug (No. 2. Side).

- 3. Reinstall the drain plug and torque to 21.4 N·m (15.7 ft. lb.).
- 4. Fill the crankcase, with new oil of the proper type, to the "F" mark on the dipstick. Refer to "Oil Type" on page 6.1. Always check the level with the dipstick before adding more oil.
- 5. Reinstall the oil fill cap/dipstick and tighten securely.



Figure 6-6. Reinstalling Oil Fill Cap/Dipstick.

Changing Oil Filter

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



Figure 6-7. Engine Mounted Oil Filter.



Figure 6-8. Optional Remote Mounted Oil Filter.

Replace the oil filter as follows:

- 1. Before removing the oil filter, clean the area around the oil filter and housing to keep dirt and debris out of the engine. Remove the old filter. On crankcase mounted oil filter housings, a spring loaded inner cup allows automatic oil drainback into the crankcase as the oil filter is removed. Wipe off the surface where the oil filter mounts.
- 2. Drain the oil from the engine crankcase.
- 3. Allow ample time for the oil to drain from the crankcase.
- 4. Reinstall the drain plug and torque to 21.4 N·m (15.7 ft. lb.).
- 5. Apply a thin film of clean oil to the rubber gasket on the new filter. Partial prefilling of the oil filter is recommended.
- 6. Install the replacement oil filter to the filter adapter or oil cooler. Turn the oil filter clockwise until the rubber gasket contacts the oil filter housing (not inner cup), then tighten the filter an additional 3/4-1 turn.
- 7. Fill the crankcase with new oil of the proper type to the "F" mark on the dipstick.
- 8. Start the engine and check for oil leaks. Correct any leaks before placing the engine into service. Check oil level to be sure it is up to but not over the "F" mark.

Section 6 Lubrication System

Service Oil Cooler

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

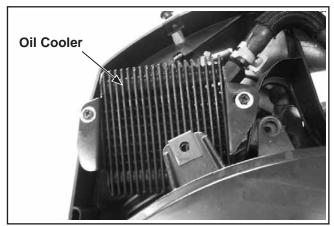


Figure 6-9. Oil Cooler.

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

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

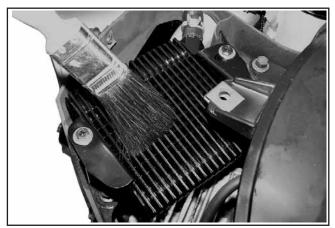


Figure 6-10. Cleaning Top of Oil Cooler.

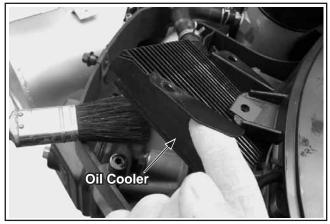


Figure 6-11. Cleaning Underside of Oil Cooler.

Oil Sentry™

General

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

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

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

NOTE: Make sure the oil level is checked **before** each use and is maintained up to the "F" mark on the dipstick. This includes engines equipped with Oil SentryTM.

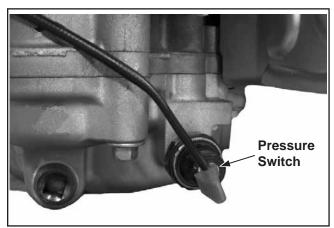


Figure 6-12. Oil Sentry™ Pressure Switch.

Section 6 Lubrication System

Installation

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

To install the switch, follow these steps:

- 1. Apply **pipe sealant with Teflon**® (Loctite® No. 59241 or equivalent) to the threads of the switch.
- 2. Install the switch into the tapped hole in oil pan. See Figure 6-12.
- 3. Torque the switch to 10.1 N·m (90 in. lb.).

Testing

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

- Connect the continuity tester across the blade terminal and the metal case of the switch. With 0 psi pressure applied to the switch, the tester should indicate continuity (switch closed).
- Gradually increase the pressure to the switch. As
 the pressure increases through the range of
 7-11 psi the tester should indicate a change to
 no continuity (switch open). The switch should
 remain open as the pressure is increased to 90 psi
 maximum.
- 3. Gradually decrease the pressure through the range of **7-11 psi**. The tester should indicate a change to **continuity** (switch closed) down to **0 psi**.
- 4. Replace the switch if it does not operate as specified.

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

- Spark Plugs
- Battery and Charging System
- Electric Starter
- Electronic Ignition Systems (CD and DSAI)

Spark Plugs

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

The engine is equipped with the following spark plugs:

Type: The standard spark plug is a Champion•

XC10YC (Kohler Part No. 62 132 04-S). Equivalent alternate brand plugs can also be

used.

Gap: 0.76 mm (0.030 in.)

Thread Size: 14 mm

Reach: 19.1 mm (3/4 in.) Hex Size: 15.9 mm (5/8 in.)

Spark Plug Service

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

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

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

damage.

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

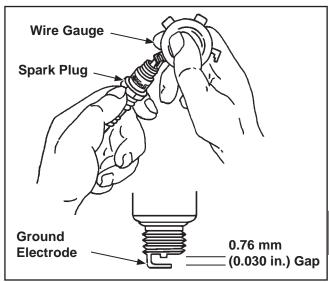


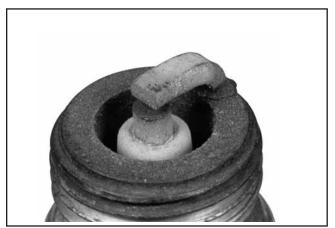
Figure 7-1. Servicing Spark Plug.

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

Inspection

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

Normal and fouled plugs are shown in the following photos:



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



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



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



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



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

Battery

General

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

Battery Size Recommendations

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

If the battery charge is insufficient to turn over the engine, recharge the battery.

Battery Maintenance

Regular maintenance is necessary to prolong battery life.



WARNING: Explosive Gas!

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

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

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

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

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

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

Battery Test

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

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

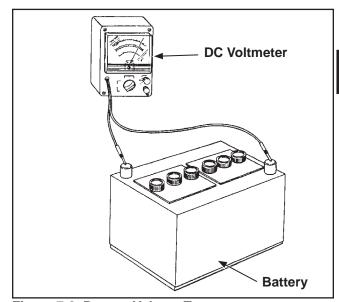


Figure 7-2. Battery Voltage Test.

Electronic Ignition Systems

There are two different types of ignition systems used on theseengines. All systems use an ignition module which energizes the spark plug. The difference in the system is in the way the ignition timing is triggered.

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

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

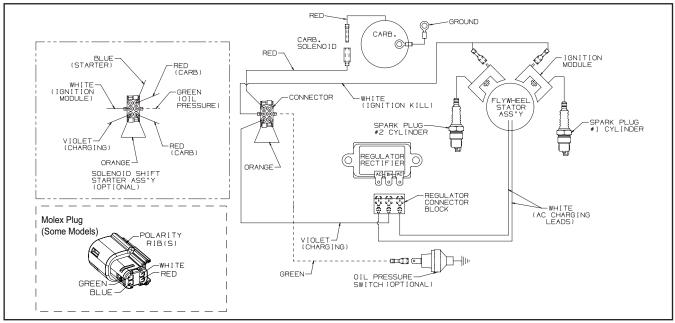


Figure 7-3. Electronic CD Fixed Ignition Timing System.

Operation of CD Ignition Systems

Fixed Timing System

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

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

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

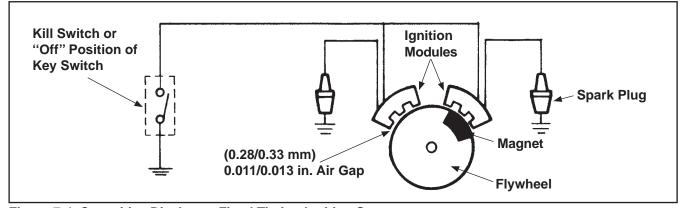


Figure 7-4. Capacitive Discharge Fixed Timing Ignition System.

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

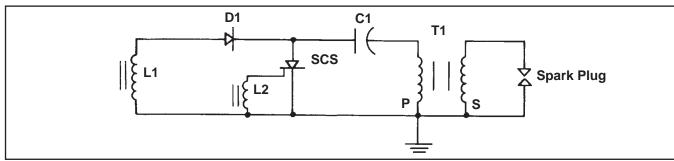


Figure 7-5. Capacitive Discharge (CD) Ignition Module Schematic.

Troubleshooting CD Ignition Systems

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



CAUTION: High-Energy Electric Spark!

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

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

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

Test Procedure for Standard (Fixed Timing) CD Ignition System

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

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

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

- a. If the problem is gone, the electrical system on the unit is suspect. Check the key switch, wires, connections, safety interlocks, etc.
- b. If the problem persists the condition is associated with the ignition or electrical system of the engine. Leave the kill lead isolated until all testing is completed.
- Test for spark on both cylinders with Kohler ignition tester, (Kohler Part No. 24 455 02-S).
 Disconnect one spark plug lead and connect it to the post terminal of the tester. Connect the clip to a good ground, not to the spark plug.

Crank the engine and observe the tester spark gap. Repeat the procedure on the other cylinder. Remember to reconnect the first spark plug lead.

- a. If one side is not firing, check all wiring, connections, and terminals on that side. If wiring is okay, replace ignition module and retest for spark.
- If the tester shows spark, but the engine misses or won't run on that cylinder, try a new spark plug.
- c. If neither side is firing, recheck position of ignition switch and check for shorted kill lead.

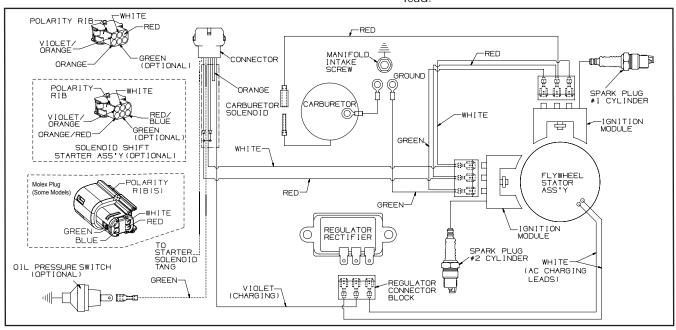


Figure 7-6. Digital Spark Advance Ignition (DSAI) System.

Operation of DSAI Ignition Systems

DSAI Ignition System Explanation

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

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

Operation

The system provides more consistent energy to the spark plugs at all engine speeds by using the 12-volt battery as its source of power. Engine speed and top dead center (TDC) location reference information is provided by the flywheel magnet group as it passes the ignition module. System triggering and engine timing is performed by a digitally-controlled microprocessor. This digital control provides repeatable and consistent engine cylinder spark timing. Each DSAI module performs its function independently for each engine cylinder.

Troubleshooting DSAI Ignition Systems

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

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

Test Procedure for DSAI Ignition Systems

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

Special Tools Required:

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

Specifications Required:

• Spark plug gap 0.76 mm (0.030 in.)

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

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

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

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

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

Test 2. Test for Spark

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

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

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

Test 3. Check for Timing Advance

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

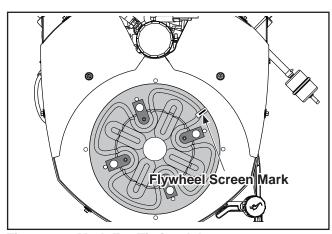


Figure 7-7. Mark For Timing Advance.

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

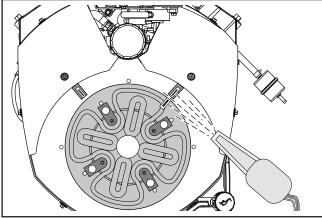


Figure 7-8. Check For Timing Advance.

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

Test 4. Test the Ignition Modules and Connections

- Remove the blower housing from the engine.
 Inspect the wiring for any damage, cuts, bad crimps, loose terminals, or broken wires. Check that connections are oriented properly on terminals of modules.
- Disconnect the leads from the ignition module(s) and clean all of the terminals (male and female) with aerosol electrical contact cleaner to remove any old dielectric compound, dark residue, dirt, or contamination. Disconnect the spark plug leads from the spark plugs.
- Using a multi-meter, check that a proper ground is established between the ground (black) lead of the DSAI module (closest to spark plug lead), and a known good ground location on the engine.
- 4. Turn the key switch to the ON position and check for 12 volts at the center/power (red) lead terminal of the DSAI module. Use the same ground location for the multi-meter as in Step 3.
 - a. If all tests are OK and module has no spark or fails to advance, replace the affected module.
 - b. If any of the tests are bad; determine cause and fix as required, then retest.

Battery Charging System

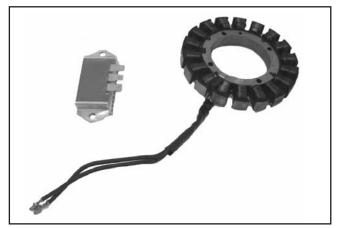
General

Most engines are equipped with a 15, 20, or 25 amp regulated charging system. See Figures 7-9 through 7-13.

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

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

15/20/25 Amp Stator and Rectifier-Regulator





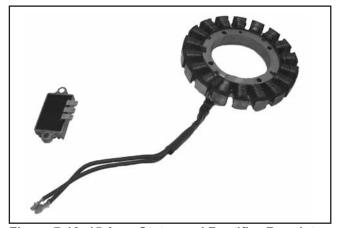


Figure 7-10. 15 Amp Stator and Rectifier-Regulator.

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

15/20/25 Amp Regulated Charging System

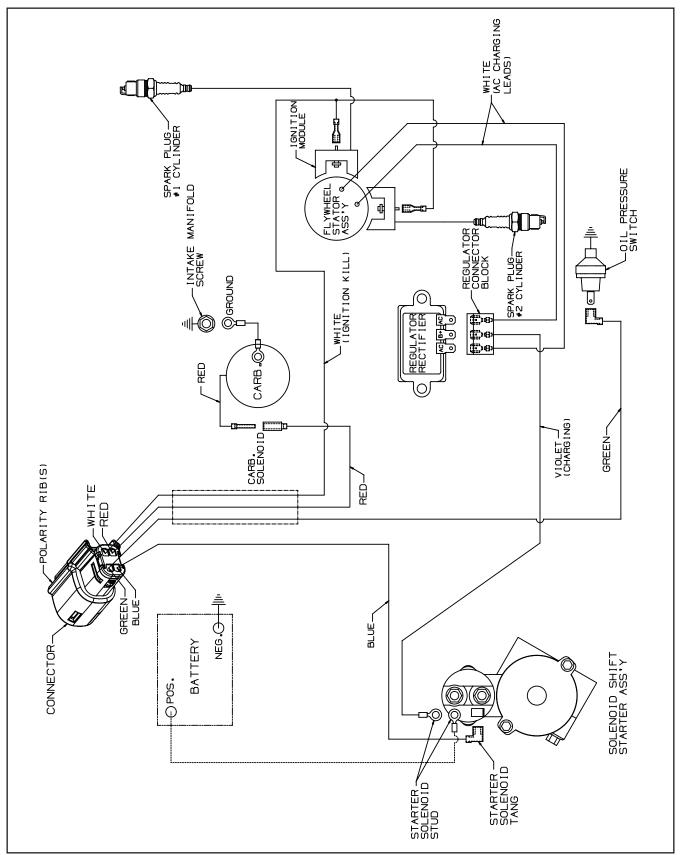


Figure 7-11. Wiring Diagram - 15/20/25 Amp Regulated Battery Charging System with CD Ignition and Four Pin Connector.

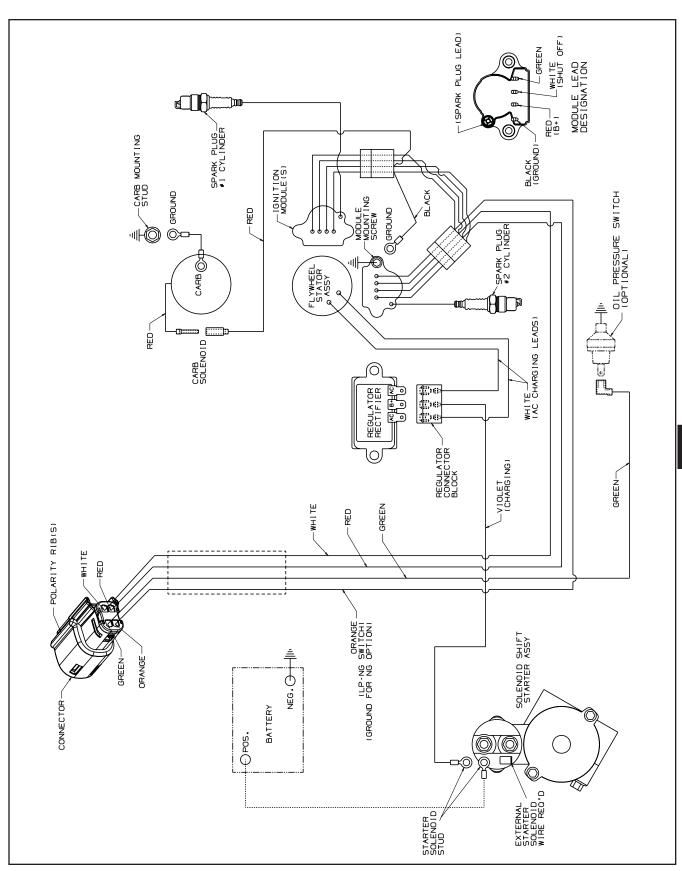


Figure 7-12. Wiring Diagram - 15/20/25 Amp Regulated Battery Charging System with DSAI Ignition and Four Pin Connector.

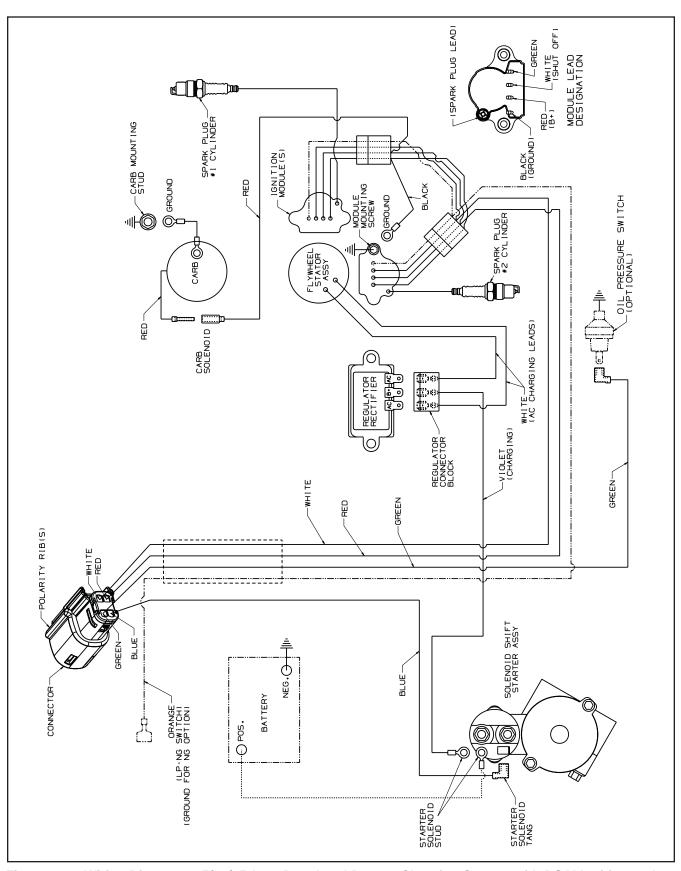


Figure 7-13. Wiring Diagram - 15/20/25 Amp Regulated Battery Charging System with DSAI Ignition and Five Pin Connector.

Stator

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

Rectifier-Regulator

The rectifier-regulator is mounted on the backing shroud assembly. See Figure 7-14. To replace it, remove the two mounting screws, then disconnect the plug and ground lead.

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

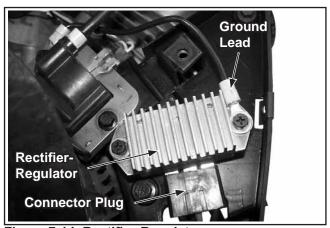


Figure 7-14. Rectifier-Regulator.

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

To Test -

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

20/25 Amp Rectifier-Regulators

1. Connect the single lead adapter in between the B+ (center) terminal of rectifier-regulator being tested and the squared single end of the tandem adapter lead. See Figure 7-15.

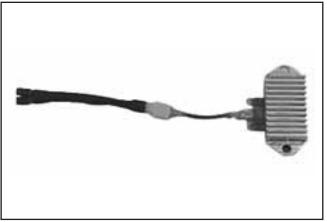


Figure 7-15. Connected Adapter.

- 2. Connect the tester ground lead (with spring clamp) to the body of the rectifier-regulator.
- 3. Connect the red lead and one of the black leads to the pair of terminals on the open end of the tandem adapter lead (connections are not location specific).
- 4. Connect the remaining black lead from the tester to one of the outer AC terminals on the rectifier-regulator. See Figure 7-16.



Figure 7-16. Connected Tester.

Section 7

Electrical System and Components

5. Plug the tester into the proper AC outlet/power for tester being used. Turn on the power switch. The "POWER" light should be illuminated and one of the four status lights may be on as well. See Figure 7-17. This does not represent the condition of the part.



Figure 7-17. Powered Tester.

6. Press the "TEST" button until a "click" is heard and then release. See Figure 7-18. Momentarily one of the four lights will illuminate indicating the partial condition of the part.



Figure 7-18. Pressing Test Button.

- a. If the "OK" (green) light comes on, disconnect the tester black lead attached to one AC terminal and reconnect it to the other AC terminal. Repeat the test. If the "OK" (green) light comes on again, the part is good and may be used.
- b. If any other light is displayed* in either of the tests, the rectifier-regulator is faulty and should not be used.

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

15 Amp Rectifier-Regulators

- 1. Connect the tester ground lead (with spring clamp) to the body of the rectifier-regulator being tested.
- 2. Connect the tester red lead to the B+ terminal of the rectifier-regulator and the two black tester leads to the two AC terminals. See Figure 7-19.



Figure 7-19. Tester Connected to 15 Amp Rectifier-Regulator.

- 3. Plug the tester onto a 110 volt outlet and turn on the power switch. See Figure 7-17. The "POWER" light should be illuminated and one of the four status lights may be on as well. This does not represent the condition of the part.
- 4. Press the "TEST" button until a "click" is heard and then release. See Figure 7-18. Momentarily on of the four status lights will illuminate, indicating the condition of the part.
 - a. If the "OK" (green) light comes on and stays steady, the part is good and may be used.
 - b. If any other light is displayed,* the rectifier-regulator is faulty and should not be used.

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

Troubleshooting Guide

15/20/25 Amp Battery Charging Systems

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

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

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

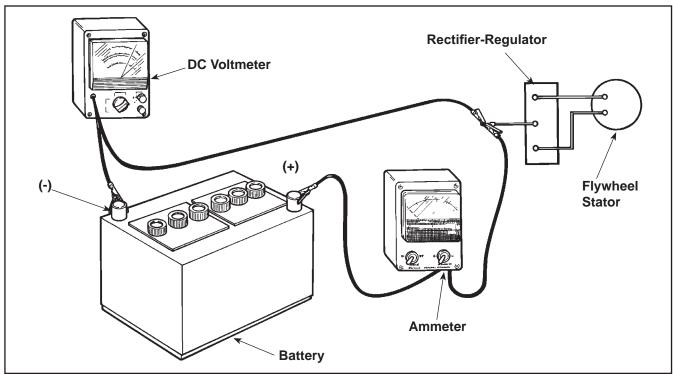


Figure 7-20. Connections for Testing Charging System.

Electric Starting Motors

These engines use solenoid shift starters for electric starting. A Delco-Remy solenoid shift starter is typically used.

Starting Motor Precautions

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

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

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

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

Operation – Solenoid Shift Starter

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

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

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	Check the specific gravity of the battery. If low, recharge or replace battery as necessary.
	Wiring	 Clean corroded connections and tighten loose connections. Replace wires in poor condition and with frayed or broken insulation.
	Starter Switch or Solenoid	1. By-pass the switch or solenoid with a jumper wire. If starter cranks normally, replace the faulty components. Remove and perform individual solenoid test procedure. See pages 7.25 and 7.26.
Starter Energizes	Battery	Check the specific gravity of the battery. If low, recharge or replace battery as necessary.
	Brushes	 Check for excessively dirty or worn brushes and commutator. Clean using a coarse cloth (not emery cloth). Replace brushes if excessively or unevenly worn.
but Turns Slowly	Transmission or Engine	 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. Check for seized engine components such as the bearings, connecting rod, and piston.

Delco-Remy Starters



Figure 7-21. Delco-Remy Starter.

Starter Disassembly

- Remove the hex nut and disconnect the positive
 brush lead/bracket from the solenoid terminal.
- 2. Remove the three Torx head screws securing the solenoid to the starter. See Figure 7-22.

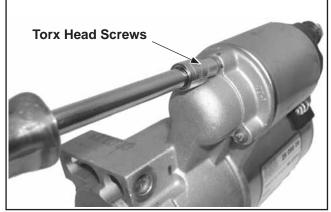


Figure 7-22. Removing Solenoid Screws.

3. Unhook the plunger pin from the drive lever. Remove the gasket from the recess in the housing. See Figures 7-23 and 7-24.

NOTE: Test procedure for checking starter solenoid is on pages 7.25 and 7.26.



Figure 7-23. Solenoid Removed from Starter.

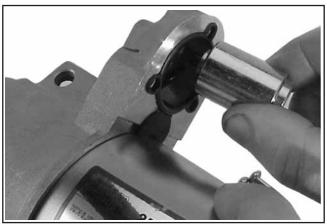


Figure 7-24. Removing Plunger.

4. Remove the two thru (larger) bolts. See Figure 7-25.



Figure 7-25. Removing Thru Bolts.

5. Remove the commutator end plate assembly, containing the brush holder, brushes, springs, and locking caps. Remove the thrust washer from inside the commutator end. See Figure 7-26.



Figure 7-26. Removing Commutator End Plate Assembly.

6. Remove the frame from the armature and drive end cap. See Figure 7-27.

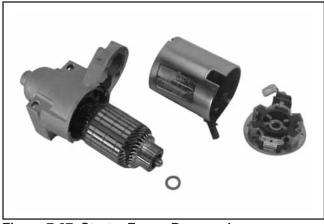


Figure 7-27. Starter Frame Removed.

7. Remove the drive lever pivot bushing and backing plate from the end cap. See Figure 7-28.

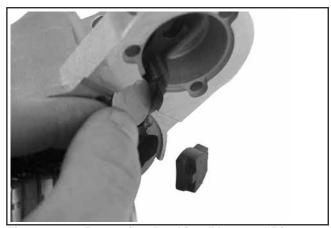


Figure 7-28. Removing Backing Plate and Pivot Bushing.

- 8. Take out the drive lever and pull the armature out of the drive end cap. See Figure 7-29.
- 9. Remove the thrust washer from the armature shaft. See Figure 7-29.

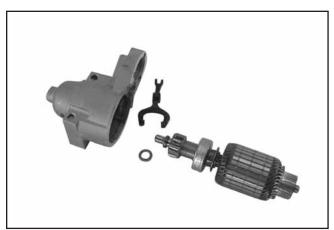


Figure 7-29. Armature and Lever Removed.

10. Push the stop collar down to expose the retaining ring. See Figure 7-30.



Figure 7-30. Retaining Ring Detail.

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

NOTE: Do not reuse the old retainer.



Figure 7-31. Removing Retaining Ring.

- 12. Remove the drive pinion assembly from the armature.
- 13. Clean the parts as required.

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

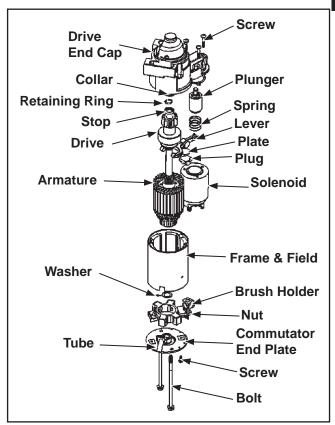


Figure 7-32. Delco-Remy Starter.

Inspection

Drive Pinion

Check and inspect the following areas:

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

Brushes and Springs

Inspect both the springs and brushes for wear, fatigue, or damage. Measure the length of each brush. The minimum length for each brush is **7.6 mm** (0.300 in.). See Figure 7-33. Replace the brushes if they are worn undersize, or their condition is questionable.

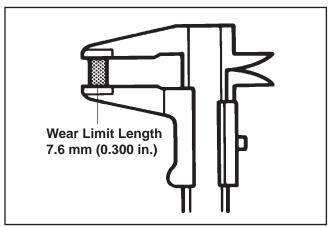


Figure 7-33. Checking Brushes.

Armature

1. Clean and inspect the commutator (outer surface). The mica insulation must be lower than the commutator bars (undercut) to ensure proper operation of the commutator. See Figure 7-34.

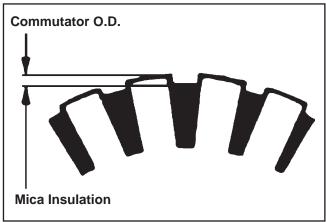


Figure 7-34. Commutator Mica Inspection.

2. Use an ohmmeter set to the Rx1 scale. Touch the probes between two different segments of the commutator, and check for continuity. See Figure 7-35. Test all the segments. Continuity must exist between all or the armature is bad.

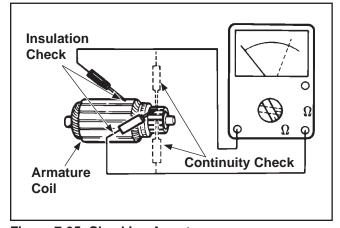


Figure 7-35. Checking Armature.

- 3. Check for continuity between the armature coil segments and the commutator segments. See Figure 7-35. There should be no continuity. If continuity exists between any two, the armature is bad.
- 4. Check the armature windings/insulation for shorting.

Shift Fork

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

Brush Replacement

The brushes and springs are serviced as a set (4). Use a new Kohler Brush and Spring Kit, if replacement is necessary.

- 1. Perform steps 1-5 in "Starter Disassembly."
- 2. Remove the two screws securing the brush holder assembly to the end cap (plate). Note the orientation for reassembly later. See Figure 7-36. Discard the old brush holder assembly.

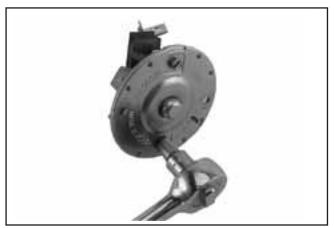


Figure 7-36. Removing Brush Holder.

- 3. Clean the component parts as required.
- 4. The new brushes and springs come preassembled in a brush holder with a protective sleeve that will also serve as an installation tool. See Figure 7-37.



Figure 7-37. Service Brush Kit.

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

Starter Service

Clean the drive lever and armature shaft. Apply Kohler electric starter drive lubricant (see Section 2) (Versilube G322L or Mobil Temp SHC 32) to the lever and shaft. Clean and check the other starter parts for wear or damage as required.

Starter Reassembly

- 1. Apply drive lubricant (see Section 2) to the armature shaft splines. Install the drive pinion onto the armature shaft.
- 2. Install and assemble the stop collar/retainer assembly.
 - a. Install the stop collar down onto the armature shaft with the counter bore (recess) up.
 - b. Install a new retainer in the larger (rear) groove of the armature shaft. Squeeze with a pliers to compress it in the groove.
 - c. Slide the stop collar up and lock it into place, so the recess surrounds the retainer in the groove. If necessary, rotate the pinion outward on the armature splines against the retainer to help seat the collar around the retainer.

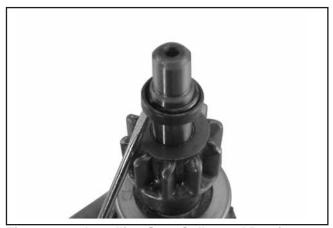


Figure 7-38. Installing Stop Collar and Retainer.

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

3. Install the offset thrust (stop) washer so the smaller "offset" of the washer faces the retainer/collar. See Figure 7-39.

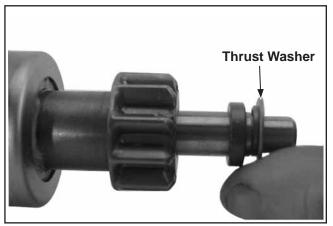


Figure 7-39. Installing Thrust Washer.

- 4. Apply a small amount of oil to the bearing in the drive end cap, and install the armature with the drive pinion.
- 5. Lubricate the fork end and center pivot of the drive lever with drive lubricant (see Section 2). Position the fork end into the space between the captured washer and the rear of the pinion.
- 6. Slide the armature into the drive end cap, and at the same time seat the drive lever into the housing.

NOTE: Correctly installed, the center pivot section of the drive lever will be flush or below the machined surface of the housing which receives the backup washer. See Figure 7-40.



Figure 7-40. Installing Armature and Pivot Lever.

7. Install the backup washer, followed by the rubber grommet, into the matching recess of the drive end cap. The molded recesses in the grommet should be "out", matching and aligned with those in the end cap. See Figure 7-41.

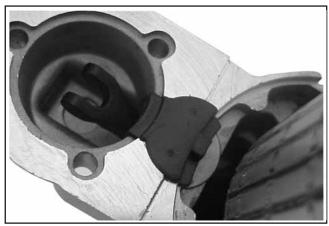


Figure 7-41. Installing Backup Washer and Grommet.

8. Install the frame, with the small notch forward, onto the armature and drive end cap. Align the notch with the corresponding section in the rubber grommet. Install the drain tube in the rear cutout, if it was removed previously. See Figure 7-42.



Figure 7-42. Installing Frame and Drain Tube.

9. Install the flat thrust washer onto the commutator end of the armature shaft. See Figure 7-43.

Section 7 Electrical System and Components

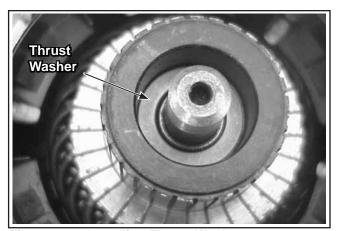


Figure 7-43. Installing Thrust Washer.

- 10. Starter reassembly when **replacing** the Brushes/ Brush Holder Assembly:
 - a. Hold the starter assembly vertically on the end housing, and carefully position the assembled brush holder assembly, with the supplied protective tube, against the end of the commutator/armature. The mounting screw holes in the metal clips must be "up/out." Slide the brush holder assembly down into place around the commutator, and install the positive (+) brush lead grommet in the cutout of the frame. See Figure 7-44. The protective tube may be saved and used for future servicing.



Figure 7-44. Installing Brush Holder Assembly with Supplied Tube.

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

a. Carefully unhook the retaining caps from over each of the brush assemblies. Do not lose the springs. See Figure 7-45.

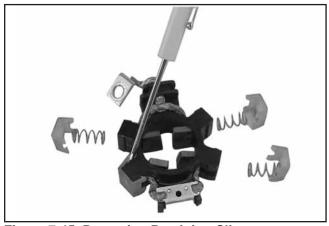


Figure 7-45. Removing Retaining Clips.

- b. Position each of the brushes back in their slots so they are flush with the I.D. of the brush holder assembly. Insert the Brush Installation Tool (with extension), or use the tube described above from a prior brush installation, through the brush holder assembly, so the holes in the metal mounting clips are "up/out."
- c. Install the brush springs and snap on the four retainer caps. See Figure 7-46.



Figure 7-46. Brush Installation Tool with Extension.

Electrical System and Components

Extension.

d. Hold the starter assembly vertically on the end housing, and carefully place the tool (with extension) and assembled original brush holder assembly onto the end of the armature shaft. Slide the brush holder assembly down into place around the commutator, install the positive (+) brush lead grommet in the cutout of the frame. See Figure 7-47.



Figure 7-47. Installing Brush Holder Assembly using Tool with Extension.

- 11. Install the end cap onto the armature and frame, aligning the thin raised rib in the end cap with the corresponding slot in the grommet of the positive (+) brush lead.
- 12. Install the two thru bolts, and the two brush holder mounting screws. Torque the thru bolts to 5.6-9.0 N·m (49-79 in. lb.). Torque the brush holder mounting screws to 2.5-3.3 N·m (22-29 in. lb.). See Figures 7-48 and 7-49.



Figure 7-48. Torquing Thru Bolts.

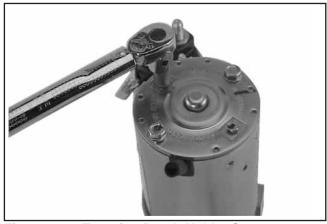


Figure 7-49. Torquing Brush Holder Screws.

- 13. Hook the plunger behind the upper end of the drive lever, and install the spring into the solenoid. Insert the three mounting screws through the holes in the drive end cap. Use these to hold the solenoid gasket in position, then mount the solenoid. Torque the screws to 4.0-6.0 N·m (35-53 in. lb.).
- 14. Connect the positive (+) brush lead/bracket to the solenoid and secure with the hex nut. Torque the nut to **8-11 N·m (71-97 in. lb.)**. Do not overtighten. See Figure 7-50.

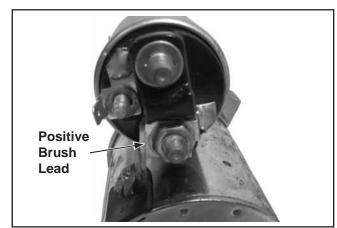


Figure 7-50. Positive (+) Brush Lead Connection.

Section 7 Electrical System and Components

Solenoid Test Procedure

Solenoid Shift Style Starters

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

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

Use a 12 volt power supply and two test leads. Connect one lead to the flat spade "S/start" terminal on the solenoid. Momentarily* connect the other lead to the lower large post terminal. See Figure 7-51. When the connection is made the solenoid should energize (audible click), and the plunger retract. Repeat the test several times. If the solenoid fails to activate, it should be replaced.

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

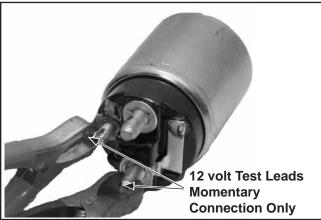


Figure 7-51. Testing Pull-In Coil/Plunger Actuation.

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

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (1) and check for continuity. See Figure 7-52. The ohmmeter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

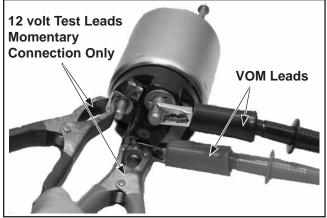


Figure 7-52. Testing Pull-In Coil/Solenoid Contact Continuity.

Test 3. Solenoid Hold-In Coil Function Test.

Connect one 12 volt test lead to the flat spade "S/ start" terminal on the solenoid, and the other lead to the body or mounting surface of the solenoid. Then, manually push the plunger "In" and check if the "Hold-In" coil holds the plunger retracted. See Figure 7-53. Do not allow the test leads to remain connected to the solenoid for a prolonged period of time. If the plunger fails to stay retracted, the solenoid should be replaced.

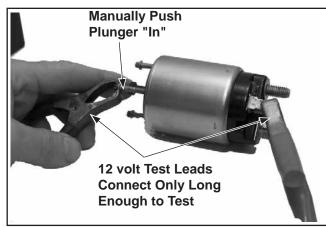


Figure 7-53. Testing Hold-In Coil/Function Test.

Section 7

Electrical System and Components

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

Use an ohmmeter set to the audible or Rx2K scale, and connect the two ohmmeter leads to the two large post terminals. Perform the preceding test (3) and check for continuity. See Figure 7-54. The meter should indicate continuity, if no continuity is indicated the solenoid should be replaced. Repeat test several times to confirm condition.

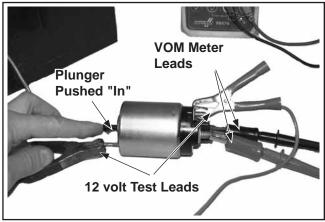


Figure 7-54. Testing Hold-In Coil/Solenoid Contact Continuity.

Section 8 Disassembly



WARNING: Accidental Starts!

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

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

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

Typical Disassembly Sequence

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

- 1. Disconnect spark plug leads.
- 2. Shut off fuel supply.
- 3. Drain oil from crankcase and remove oil filter.
- 4. Remove muffler.
- 5. Remove cylinder shrouds and blower housing.
- 6. Remove electric starter motor.
- 7. Remove air cleaner assembly.
- 8. Remove fuel pump.
- 9. Remove control bracket, governor springs and lever.
- 10. Remove carburetor.
- 11. Remove intake manifold.
- 12. Remove Oil Sentry™ (if equipped).
- 13. Remove baffles and intake manifold.
- 14. Remove oil cooler.
- 15. Remove oil filter housing.
- 16. Remove ignition modules.
- 17. Remove grass screen and cooling fan.
- 18. Remove flywheel.
- 19. Remove stator, rectifier-regulator and wiring harness.
- 20. Remove backing shroud assembly.

- 21. Remove spark plugs.
- 22. Remove valve covers.
- 23. Remove cylinder heads and hydraulic lifters.
- 24. Remove breather assembly.
- 25. Remove oil pan assembly.
- 26. Remove camshaft.
- 27. Remove connecting rods with pistons and rings.
- 28. Remove crankshaft.
- 29. Removal of governor gear.
- 30. Remove governor gear yoke, cross shaft and seal.
- 31. Remove lifter feed chamber cover and gaskets.
- 32. Remove flywheel and PTO end oil seals.
- 33. Removal of main bearings.

Disconnect Spark Plug Leads

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

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



Figure 8-1. Disconnect Spark Plug Leads.

Shut Off Fuel Supply

Drain Oil from Crankcase and Remove Oil Filter

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



Figure 8-2. Removing Oil Filter.

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



Figure 8-3. Removing Dipstick from Tube.

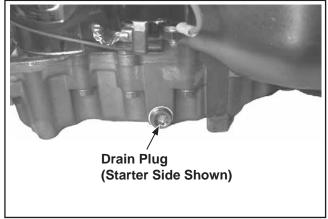


Figure 8-4. Oil Drain Plug Location.

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

Remove Muffler

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

Remove Cylinder Shrouds and Blower Housing

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



Figure 8-5. Removing Cylinder Shrouds.

 Remove the four mounting screws and separate the blower housing from the backing shroud assembly. One screw also secures the oil fill/ dipstick tube. See Figure 8-6. The fixed guard (equipped models) may be removed with the blower housing.

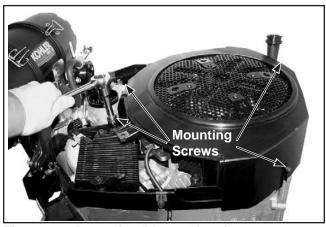


Figure 8-6. Removing Blower Housing.

3. Remove the lower mounting screw and pull the oil fill tube out of the crankcase.

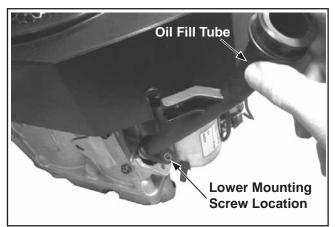


Figure 8-7. Removing Oil Fill Tube.

Remove Electric Starter Motor

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

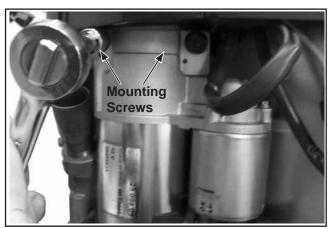


Figure 8-8. Removing Electric Starter.

Remove Air Cleaner Assembly

- 1. Disconnect the breather hose from the air cleaner, and the formed vent hose from the vent port on the carburetor.
- 2. Remove the four hex flange nuts and ground lead from the mounting studs. See Figure 8-9.

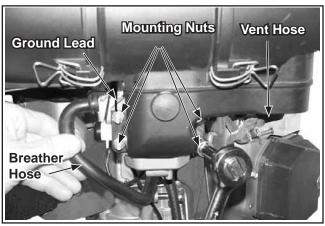


Figure 8-9. Air Cleaner Mounting Details.

3. Remove the two screws securing the air cleaner and main control bracket to the intake manifold bosses. See Figure 8-10.



Figure 8-10. Mounting Screws.

4. Remove the air cleaner from the engine as an assembly. See Figure 8-11.

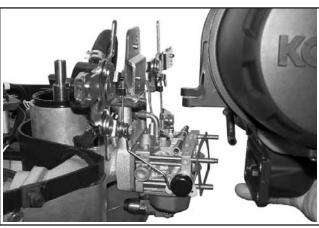


Figure 8-11. Removing Air Cleaner Assembly.

Remove Fuel Pump



WARNING: Explosive Fuel!

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

NOTE: Based on the style of fuel pump used, refer to the following.

Pulse Style Fuel Pump

The pulse style fuel pump is mounted to the side of the control bracket. It may be removed separately or with the bracket.

To remove separately:

- 1. Remove the two hex flange mounting screws securing the fuel pump to the control bracket.
- 2. Disconnect the inlet, outlet, and pulse (vacuum) hoses and remove the fuel pump. See Figure 8-12. Properly contain any remaining fuel.

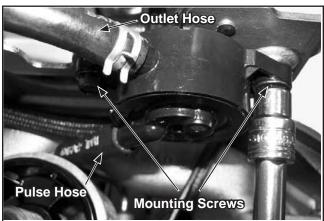


Figure 8-12. Removing Pulse Pump.

Electric Fuel Pump

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

Remove Control Bracket, Governor Springs and Lever

1. Unhook the governed idle and governor springs from the controls on the main bracket and the governor lever. Note the color, location, and position of each. See Figure 8-13.

2. Disconnect the throttle linkage and dampening spring from the governor lever at the small bushing. See Figure 8-13.

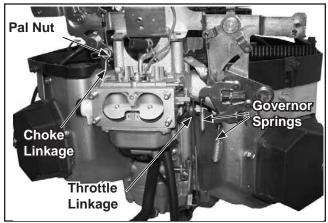


Figure 8-13. Disconnect Linkages and Governor Springs.

- Carefully pry off the pal nut, remove the two washers (note assembly order), and disconnect the choke linkage from the pivot lever. Do not lose any parts. Secure the remaining pivot parts with tape, to avoid losing them. Always use a new pal nut during reassembly.
- 4. If the fuel pump is being removed with the bracket disconnect the pulse (vacuum) hose and outlet fuel hose from the pulse pump. Properly contain any remaining fuel. See Figure 8-14.

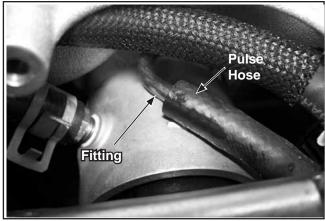


Figure 8-14. Disconnecting Pulse Hose.

5. Remove the lower mounting screw going into the intake manifold and remove the main control bracket. See Figure 8-15

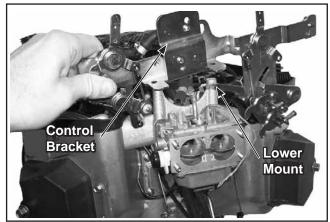


Figure 8-15. Removing Control Bracket.

6. Loosen the hex flange nut and remove the governor lever from cross shaft. See Figure 8-16.

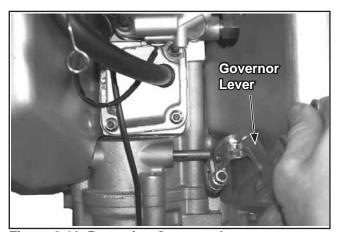


Figure 8-16. Removing Governor Lever.

Remove Carburetor



WARNING: Explosive Fuel!

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

- 1. Disconnect the fuel shut-off solenoid lead.
- 2. Remove the fuel inlet hose from the carburetor. Properly contain any remaining fuel.
- 3. Remove the carburetor, and linkages as an assembly. See Figure 8-17.

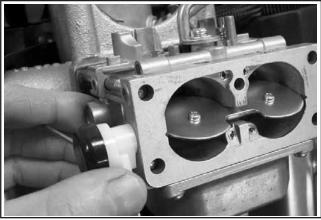


Figure 8-17. Removing Carburetor.

- 4. Remove the carburetor gasket.
- 5. The carburetor and linkages can be separated as necessary.

Remove Oil Sentry™ (If Equipped)

- 1. Disconnect the lead from the Oil Sentry[™] switch.
- 2. Remove the Oil Sentry[™] switch from the oil pan. See Figure 8-18.

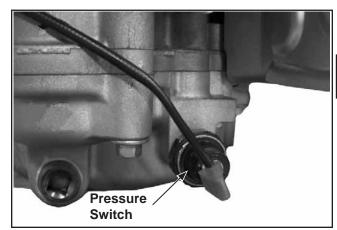


Figure 8-18. Oil Sentry™ Switch Location in Oil Pan.

Remove Baffles and Intake Manifold

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

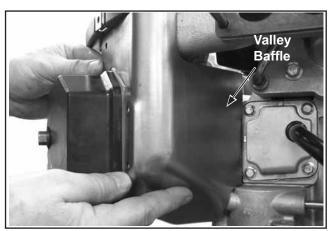


Figure 8-19. Removing Valley Baffles.

2. Remove the four screws securing each of the outer cylinder baffles in place. See Figure 8-20.

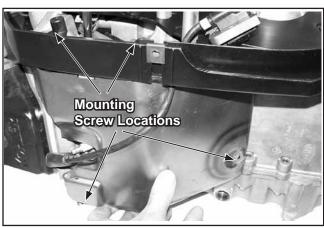


Figure 8-20. Removing Outer Cylinder Baffles.

- 3. Remove the four hex flange screws securing the intake manifold to the cylinder heads. Cut any wire ties securing wiring.
- 4. Remove the intake manifold and gaskets. See Figure 8-21.

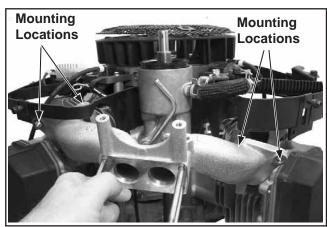


Figure 8-21. Removing Intake Manifold.

Remove Oil Cooler

1. Remove the two oil cooler mounting screws. Do not lose any washers (if used). See Figure 8-22.

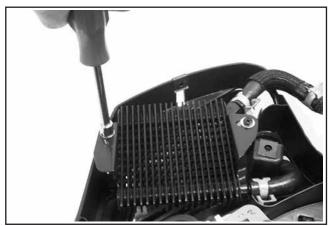


Figure 8-22. Removing Oil Cooler Mounting Screws.

2. Loosen the clamps and disconnect each of the hoses from the oil cooler. See Figure 8-23.

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

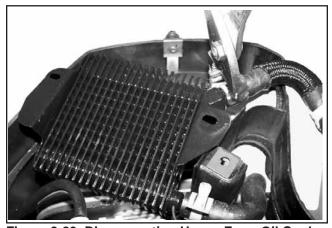


Figure 8-23. Disconnecting Hoses From Oil Cooler.

Remove Oil Filter Housing

1. Remove the screw securing the oil filter housing and individual O-Rings to the crankcase, then carefully separate the parts. See Figure 8-24.

NOTE: Further disassembly of the oil filter housing assembly is not necessary unless being serviced individually. Follow Substeps a, b, and c.

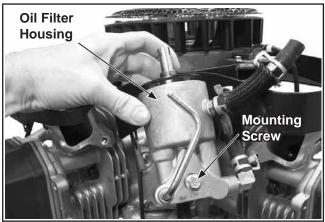


Figure 8-24. Removing Oil Filter Housing.

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

a. Remove the nipple from the cup and oil filter housing using a 5/16" Allen wrench/bit. See Figure 8-25.

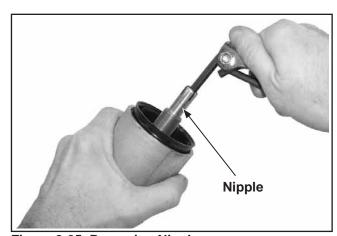


Figure 8-25. Removing Nipple.

b. Remove the oil filter cup and spring from housing. See Figure 8-26.

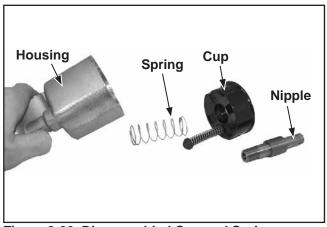


Figure 8-26. Disassembled Cup and Spring.

c. Remove the rubber valve and spring from the cup. See Figure 8-27.

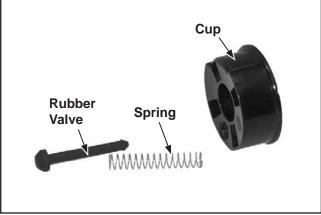


Figure 8-27. Rubber Valve and Spring Removed from Cup.

Remove Ignition Modules

- 1. Rotate the flywheel so the magnet is away from the modules.
- 2. Remove the mounting screws and disconnect the kill lead from the ignition modules. Note the position of the ignition modules and wiring harness clip. See Figure 8-28.

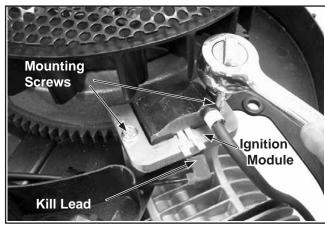


Figure 8-28. Removing and Disconnecting Ignition Modules.

Remove Grass Screen and Cooling Fan

1. Remove the screws, attaching hardware, and hex studs securing the grass screen, stiffeners, and cooling fan to the flywheel. See Figures 8-29 and 8-30.

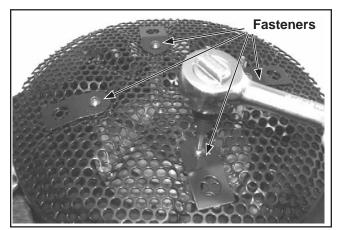


Figure 8-29. Removing Grass Screen Fasteners.

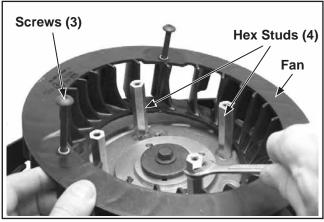


Figure 8-30. Removing Cooling Fan and Hex Studs.

Remove Flywheel

1. Use a flywheel strap wrench or holding tool (see Section 2), to hold the flywheel and loosen the hex flange screw securing the flywheel to the crankshaft. See Figure 8-31.

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

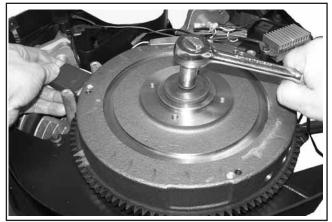


Figure 8-31. Removing Flywheel Fastener Using Holding Tool.

- 2. Remove the hex flange screw and washer.
- 3. Use a puller to remove the flywheel from the crankshaft. See Figure 8-32.

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



Figure 8-32. Removing Flywheel with a Puller.

4. Remove the woodruff key from the crankshaft.

Remove Stator, Rectifier-Regulator and Wiring Harness

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

2. Remove the mounting screws securing the rectifier-regulator to the backing shroud assembly. Note the location of the ground lead. If the rectifier-regulator is not being replaced, it may remain mounted to the backing shroud assembly. See Figure 8-33.

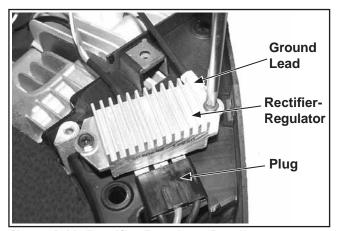


Figure 8-33. Rectifier-Regulator Details.

3. Remove the two screws securing the stator to the crankcase and carefully separate the stator wires from the molded clips. See Figure 8-34.

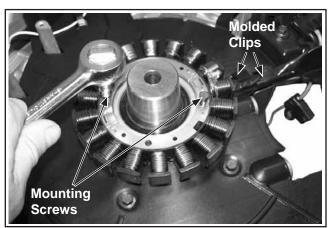


Figure 8-34. Removing Stator.

4. Unhook the wiring harness from the molded clips if being serviced separately. See Figure 8-35.

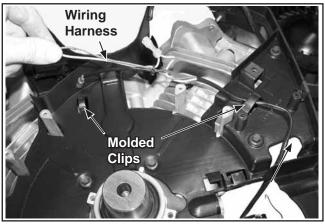


Figure 8-35. Removng Wiring Harness.

Remove Backing Shroud Assembly

1. Remove the four screws securing the backing shroud assembly to the crankcase. See Figure 8-36.



Figure 8-36. Removing Backing Shroud Mounting Screws.

Remove Spark Plugs

1. Remove the spark plug from each cylinder head.



Figure 8-37. Removing Spark Plugs.

Remove Valve Covers

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



Figure 8-38. Removing Valve Covers.

Remove Cylinder Heads and Hydraulic Lifters

- 1. Loosen the inner set screws and back off the rocker arm adjusting nuts.
- 2. Remove the pipe plug from the cylinder head to access the screw in the center location. See Figure 8-39.

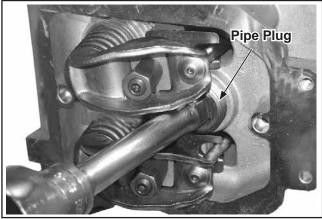


Figure 8-39. Removing Pipe Plug.

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

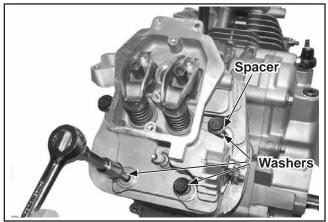


Figure 8-40. Removing Cylinder Head Fasteners.

- 3. Mark the position of the push rods as either intake or exhaust and cylinder 1 or 2. Push rods should always be reinstalled in the same positions.
- 4. Carefully remove the push rods, cylinder head, and head gaskets. See Figure 8-41.
- 5. Repeat the procedure for the other cylinder head.

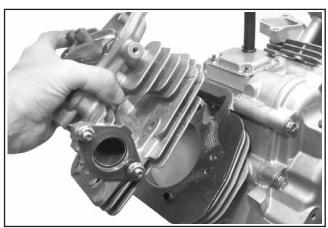


Figure 8-41. Removing Cylinder Head Assembly.

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

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

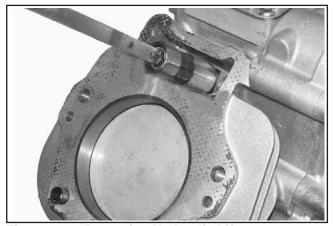


Figure 8-42. Removing Hydraulic Lifters.

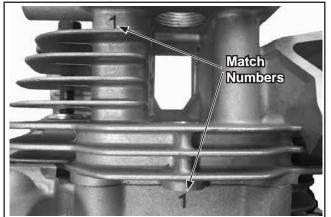


Figure 8-43. Match Numbers on Cylinder Barrel and Heads.

Disassemble Cylinder Heads

1. Remove the two adjusters, rocker arm pivots, and rocker arms from the cylinder head. Remove the pivot studs and guide plate as required. See Figure 8-44.

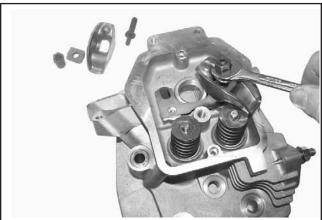


Figure 8-44. Removing Rocker Arms.

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

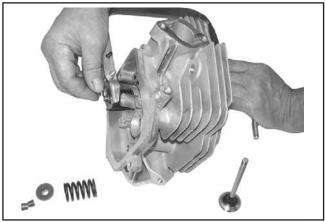


Figure 8-45. Removing Valves with Valve Spring Compressor.

- 3. Once the valve spring is compressed, remove the following items. See Figures 8-46 and 8-47.
 - Valve spring keepers
 - Valve spring retainers
 - Valve springs
 - Valve spring caps
 - Intake and exhaust valves (mark position)
 - Valve stem seals



Figure 8-46. Valve Train Components.

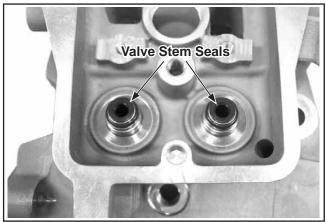


Figure 8-47. Valve Stem Seals.

NOTE: These engines use valve stem seals on the intake and exhaust valves. Use a new seal whenever valves are removed, or if the seal is deteriorated in any way. Never reuse an old seal.

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

Remove Breather Assembly

- 1. Remove the four hex flange screws securing the breather assembly, and gasket to the crankcase.
- 2. Carefully break the gasket seal and remove the breather and filter. Do not pry on the sealing surfaces as it could cause damage resulting in leaks. Note the assembly and orientation of parts. See Figures 8-48 and 8-49.

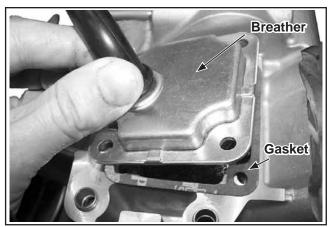


Figure 8-48. Removing Breather Assembly.



Figure 8-49. Removing Breather Filter.

Remove Oil Pan Assembly

1. Remove the fourteen hex. flange screws securing the oil pan to the crankcase. See Figure 8-50.



Figure 8-50. Removing Oil Pan Screws.

 Locate the two protruding tabs on the oil pan. Carefully tap to break the gasket seal. Do not pry on the sealing surfaces as this could cause leaks. Separate the oil pan from the crankcase. See Figures 8-51 and 8-52. Remove the old gasket.

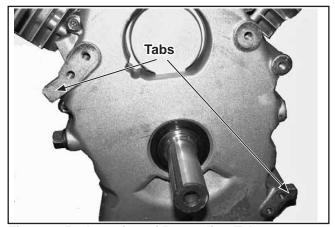


Figure 8-51. Location of Protruding Tabs.

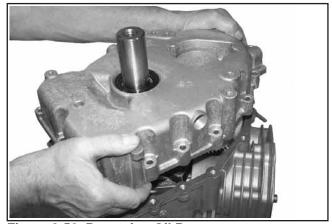


Figure 8-52. Removing Oil Pan.

Oil Pump Assembly

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

Remove Camshaft

1. Remove the camshaft and shim (if used). See Figure 8-53.

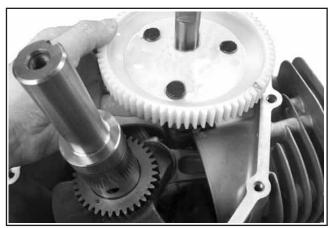


Figure 8-53. Removing Camshaft.

Remove Connecting Rods with Pistons and Rings

1. Remove the two hex flange screws securing the closest connecting rod end cap. Remove the end cap. See Figures 8-54 and 8-55.



Figure 8-54. Removing Connecting Rod Screws.

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



Figure 8-55 Remove Connecting Rod Caps.

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

2. Carefully remove the connecting rod and piston assembly from the cylinder bore. See Figure 8-56.

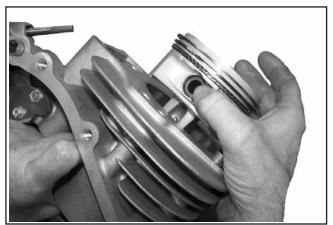


Figure 8-56. Removing Piston/Connecting Rod Assemblies.

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

Remove Crankshaft

 Carefully pull the crankshaft from the crankcase. See Figure 8-57. Note thrust washers and shims if used.

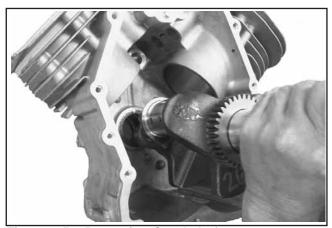


Figure 8-57. Removing Crankshaft.

Removal of Governor Gear Assembly

The governor gear is held onto the shaft by small molded tabs in the gear. When the gear is removed from the shaft, these tabs are destroyed and the gear must be replaced. Therefore, remove the gear only if absolutely necessary. If the governor cross shaft, yoke, or gear condition does not require removal, the governor gear may be left in place. If removal is necessary, perform as follows:

- 1. Remove the locking tab thrust washer and note orientation.
- 2. Using a screwdriver, carefully pry up to unseat governor gear assembly from the governor gear shaft. Remove the regulating pin and governor gear assembly. See Figure 8-58.

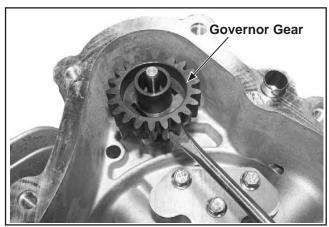


Figure 8-58. Removing Governor Gear.

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

Remove Governor Yoke, Cross Shaft, and Oil Seal

1. Remove the two mounting screws securing the yoke to the governor cross shaft. See Figure 8-59.

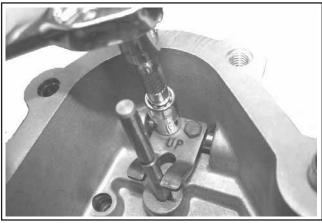


Figure 8-59. Removing Cross Shaft/Yoke Screws.

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

Ö

Remove Lifter Feed Chamber Cover and Gaskets

1. Remove the three screws securing the lifter feed chamber cover, and gaskets. Carefully separate the parts from the crankcase. See Figure 8-60.

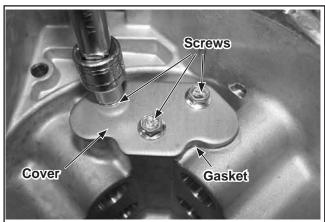


Figure 8-60. Removing Lifter Feed Chamber Cover Components.

Remove Flywheel and PTO End Oil Seals

1. Remove the oil seals from the crankcase and oil pan using a seal puller. See Figure 8-61.



Figure 8-61. Removing Oil Seals.

Removal of Main Bearings

NOTE: Flywheel and PTO side main bearings should only be removed if replacement is required due to wear. If removal is performed, use a press and support the adjacent cast surface around the bearing flange when performing. **Do not** press against or support by the gasket/outer perimeter surface. See Figure 8-62.

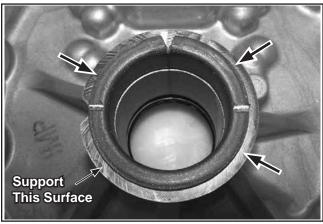


Figure 8-62. Support Surface Details.

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

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

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

Use an aerosol gasket remover, paint stripper, or lacquer thinner to remove any old gasket material. Apply the solvent, allow time for it to work, and then brush the surface with a **brass** wire brush. After all old material is removed, clean the surface with isopropyl alcohol, lacquer thinner, or aerosol electrical contact cleaner. **Do not** scrape the surfaces, as any scratches, nicks, or burrs can result in leaks. See Service Bulletin 252 for further information.

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

Camshaft

Inspection and Service

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

Crankshaft

Inspection and Service

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

Inspect the crankshaft bearing surfaces for scoring, grooving, etc. Replaceable bearings are used in the crankshaft bore of the oil pan and/or crankcase. Do not replace the bearings unless they show signs of damage or are out of running clearance specifications. If the crankshaft turns easily, without noise, and there is no evidence of scoring, grooving, etc., on the races or bearing surfaces, the bearings can be reused.

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

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

Inspection and Reconditioning

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

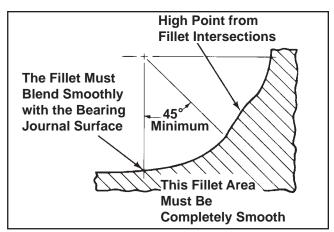


Figure 9-1. Crankpin Fillets.

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

Use the following procedure to remove and replace the plug.

Procedure to Remove Crankshaft Plug:

- 1. Drill a 3/16" hole through the plug in the crankshaft.
- 2. Thread a 3/4" or 1" long self-tapping screw with a flat washer into the drilled hole. The flat washer must be large enough to seat against the shoulder of the plug bore. See Figure 9-2.
- 3. Tighten the self-tapping screw until it draws the plug out of the crankshaft.

Procedure to Install New Plug:

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

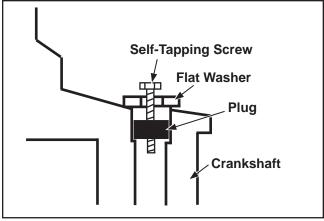


Figure 9-2. Removing Crankpin Plug.

Crankcase

Inspection and Service

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

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

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

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

Honing

While most commercially available cylinder hones can be used with either portable drills or drill presses, the use of a low speed drill press is preferred as it facilitates more accurate alignment of the bore in relation to the crankshaft crossbore. Honing is best

accomplished at a drill speed of about 250 RPM and 60 strokes per minute. After installing coarse stones in hone, proceed as follows:

- 1. Lower hone into bore and after centering, adjust so the stones are in contact with the cylinder wall. Use of a commercial cutting-cooling agent is recommended.
- 2. With the lower edge of each stone positioned even with the lowest edge of the bore, start drill and honing process. Move the hone up and down while resizing to prevent the formation of cutting ridges. Check the size frequently.

NOTE: Kohler pistons are custom-machined to exacting tolerances. When oversizing a cylinder, it should be machined exactly 0.25 mm (0.010 in.) or 0.50 mm (0.020 in.) over the new diameter (Section 1). The corresponding oversize Kohler replacement piston will then fit correctly.

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

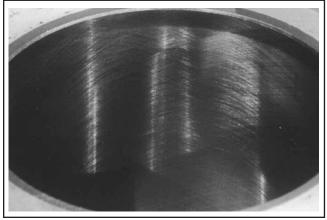


Figure 9-3. Cylinder Bore Crosshatch after Honing.

4. After resizing, check the bore for roundness, taper, and size. Use an inside micrometer, telescoping gauge, or bore gauge to take measurements. The measurements should be

taken at three locations in the cylinder – at the top, middle, and bottom. Two measurements should be taken (perpendicular to each other) at each of the three locations.

Clean Cylinder Bore After Honing

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

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

Measuring Piston-to-Bore Clearance

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

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

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

1. Use a micrometer and measure the diameter of the piston 11 mm (0.433 in.) above the bottom of the piston skirt and perpendicular to the piston pin. See Figure 9-4.

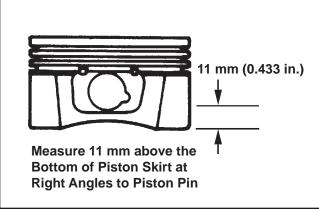


Figure 9-4. Measuring Piston Diameter.

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

Flywheel

Inspection

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

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

Cylinder Head and Valves

Inspection and Service

After cleaning, check the flatness of the cylinder head and the corresponding top surface of the crankcase, using a surface plate or piece of glass and feeler gauge as shown in Figure 9-5. The maximum allowable out of flatness is 0.076 mm (0.003 in.).

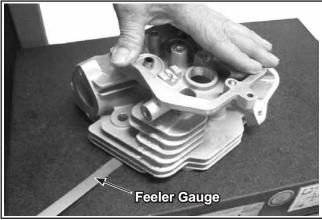
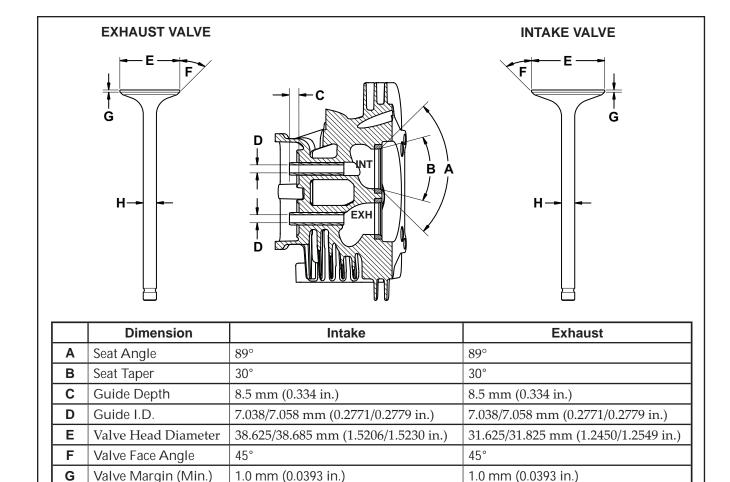


Figure 9-5. Checking Cylinder Head Flatness.

Carefully inspect the valve mechanism parts. Inspect the valve springs and related hardware for excessive wear or distortion. Check the valves and valve seat area or inserts for evidence of deep pitting, cracks, or distortion. Check clearance of the valve stems in the guides. See Figure 9-6 for valve details and specifications.



6.982/7.000 mm (0.2749/0.2756 in.)

Figure 9-6. Valve Details.

Valve Stem Diameter

Н

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

Then, carefully inspect each valve for defects such as a warped head, excessive corrosion, or a worn stem end. Replace valves found to be in bad condition. A normal valve and valves in bad condition are shown in the accompanying illustrations.

6.970/6.988 mm (0.2744/0.2751 in.)



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



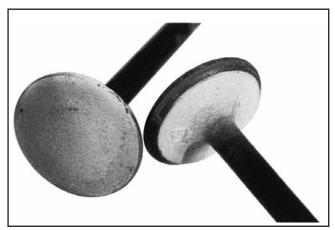
Leakage: A poor grind on face or seat of valve will allow leakage resulting in a burned valve on one side only.



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



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



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



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



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



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

Section 9

Inspection and Reconditioning

Valve Guides

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

To check valve guide-to-valve stem clearance, thoroughly clean the valve guide and, using a splitball gauge, measure the inside diameter of the guide. Then, using an outside micrometer, measure the diameter of the valve stem at several points on the stem where it moves in the valve guide. Use the largest stem diameter to calculate the clearance by subtracting the stem diameter from the guide diameter. If the intake clearance exceeds 0.038/0.076 mm (0.0015/0.0030 in.), or the exhaust clearance exceeds 0.050/0.088 mm (0.0020/0.0035 in.), determine whether the valve stem or guide is responsible for the excessive clearance.

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

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

Valve Seat Inserts

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

Recondition the valve seat inserts following the instructions provided with the valve seat cutter being used. A typical cutter is shown in Figure 9-7. The final cut should be made with an 89° cutter as specified for the valve seat angle in Figure 9-6. Cutting the proper 45° valve face angle as specified in Figure 9-6, and the proper valve seat angle (44.5°, half of the full 89° angle), will achieve the desired 0.5° (1.0° full cut) interference angle where the maximum pressure occurs on the outside diameters of the valve face and seat.

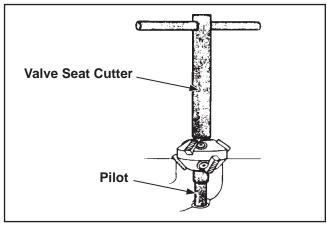


Figure 9-7. Typical Valve Seat Cutter.

Lapping Valves

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

Valve Stem Seals

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

Pistons and Rings

Inspection

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

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

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

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

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

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

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

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



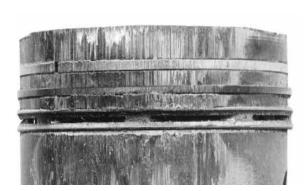
Stuck, Broken Rings



Abrasive Scratched Rings



Overheated or Deteriorated Oil



Scored Piston and Rings

Figure 9-8. Common Types of Piston Damage.

Inspection and Reconditioning

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

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

Some important points to remember when servicing piston rings:

- 1. The cylinder bore must be deglazed before service ring sets are used.
- 2. If the cylinder bore does not need reboring and if the old piston is within wear limits and free of score or scuff marks, the old piston may be reused.
- 3. Remove the old rings and clean up the grooves. **Never reuse old rings.**
- 4. Before installing the new rings on the piston, place the top two rings, each in turn, in its running area in the cylinder bore and check the end gap. (See Figure 9-9.) Compare the ring gap to the specifications listed in Section 1.

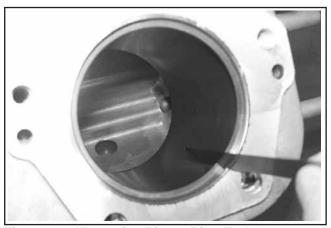


Figure 9-9. Measuring Piston Ring End Gap.

5. After installing the new compression (top and middle) rings on the piston, check the piston-to-ring side clearance. Compare the clearance to specifications listed in Section 1. If the side clearance is greater than specified, a new piston must be used. Refer to Figure 9-10.



Figure 9-10. Measuring Piston Ring Side Clearance.

Install New Piston Rings

To install new piston rings, proceed as follows:

NOTE: Rings must be installed correctly. Ring installation instructions are usually included with new ring sets. Follow instructions carefully. Use a piston ring expander to install rings (see Figure 9-11). Install the bottom (oil control) ring first and the top compression ring last. Refer to Figure 9-12.

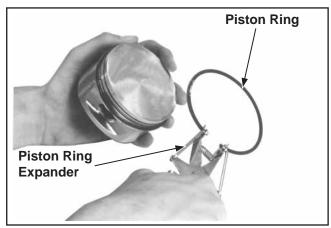


Figure 9-11. Installing Piston Rings.

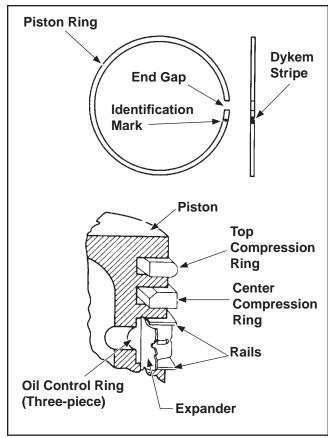


Figure 9-12. Piston Ring Installation.

- 1. Oil Control Ring (Bottom Groove): Install the expander and then the rails. Make sure the ends of the expander are not overlapped.
- 2. Middle Compression Ring (Center Groove): Install the center ring using a piston ring installation tool. Make sure the "identification" mark is up or the dykem stripe (if contained) is to the left of the end gap.
- 3. Top Compression Ring (Top Groove): Install the top ring using a piston ring expander. Make sure the "identification" mark is up or the dykem stripe (if contained), is to the left of the end gap.

Connecting Rods

Offset, stepped-cap connecting rods are used in these engines.

Inspection and Service

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

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

Hydraulic Lifters

Inspection

Check the base surface of the hydraulic lifters for wear or damage. If the lifters need to be replaced, apply a liberal coating of Kohler lubricant 25 357 14-S to the base of each new lifter before it is installed.

"Bleeding" the Lifters

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

- 1. Cut a 50-75 mm (2-3 in.) piece from the end of an old push rod and chuck it in a drill press.
- 2. Lay a rag or shop towel on the table of the drill press and place the lifter, open end up, on the towel.
- 3. Lower the chucked push rod until it contacts the plunger in the lifter. Slowly "pump" the plunger two or three times to force the oil out of the feed hole in the side of the lifter.

Governor Gear Assembly

Inspection

The governor gear is located within the crankcase. Inspect the governor gear teeth. Replace the gear if it is worn, chipped, or if any teeth are missing. Inspect the governor weights. They should move freely in the governor gear.

Disassembly

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

NOTE: The governor gear is held onto the shaft by small molded tabs in the gear. When the gear is removed from the shaft these tabs are destroyed and the gear must be replaced. Therefore, remove the gear **only** if absolutely necessary.

Inspection and Reconditioning

Oil Pan Assembly

Inspection

Inspect the oil seal in the oil pan and remove it if it is worn or damaged. Refer to "Install Oil Pan Oil Seal" in Section 10 for new oil seal installation.

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

Oil Pump Assembly

Disassembly

- 1. Remove the three hex flange screws securing the oil pump housing including the relief valve baffle, and the single screw for the pickup. See Figure 9-13.
- 2. Remove the oil pump housing and pickup from the oil pan.
- 3. Remove the oil pump gerotor gears from the oil pan recess.
- 4. Remove the oil pickup by pulling it free from the oil pump body.
- 5. The relief valve is a one-piece style, staked to the oil pump housing; removal should not be attempted, nor is internal servicing possible. If a problem with the relief valve is encountered, the oil pump should be replaced. See Figure 9-15.

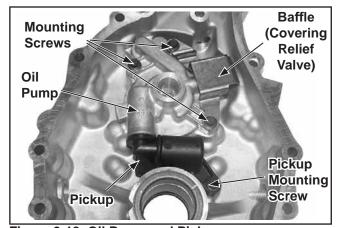


Figure 9-13. Oil Pump and Pickup.

Inspection

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

Reassembly

- 1. Make sure the recess in the closure plate for the oil pump gerotor gears is clean.
- 2. Lubricate the oil pump Gerotor gears with grease (Lubriplate® 100, Pre-Kote 45 or equivalent), and install into the recess. See Figure 9-14.

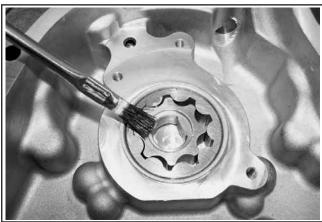


Figure 9-14. Installing and Lubricating Oil Pump Gerotor Gears.

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

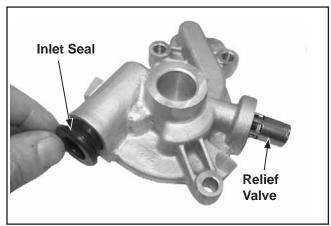


Figure 9-15. Installing Inlet Seal in Oil Pump Housing.

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

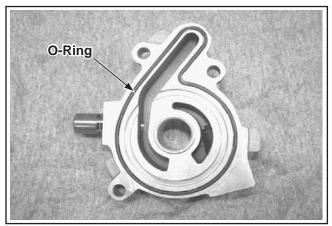


Figure 9-16. O-Ring Installed in Oil Pump Housing.

- 5. Lightly lubricate the I.D. of the inlet seal with oil and carefully insert the end of the pickup through the seal, into the oil pump housing.
- 6. Install the oil pump housing with the pickup tube, over the oil pump boss and gears. Position the relief valve baffle on screws 2 and 3. Align the three screw hole locations.

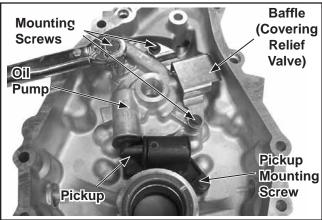


Figure 9-17. Installing Oil Pump and Pickup.

7. Check the alignment of parts and torque the oil pump housing screws as specified using the sequence shown in Figure 9-18.

Torque the hex. flange screws as follows:

- a. Install fastener into location No. 1 and lightly tighten to position the pump.
- b. Install fastener into location No. 2 and fully torque to the recommended value.
- c. Install fastener into location No. 3 and fully torque to the recommended value.
- d. Finish torquing fastener in location No. 1 to the recommended value.

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

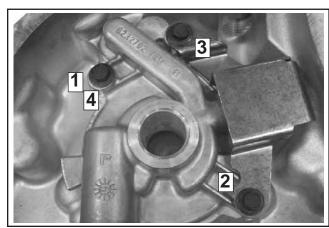


Figure 9-18. Oil Pump Screws Torque Sequence.

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

10

Section 10 Reassembly

General

NOTE: Make sure the engine is assembled using all specified torque values, tightening sequences, and clearances. Failure to observe specifications could cause severe engine wear or damage. Always use new gaskets. Apply a small amount of oil to the threads of critical fasteners before assembly, unless a Sealant or Loctite® is specified or preapplied.

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

Check the oil pan, crankcase, cylinder heads, and valve covers to be certain that all of the old gasket material has been removed. Use gasket remover, lacquer thinner, or paint remover to remove any remaining traces. Clean the surfaces with isopropyl alcohol, acetone, lacquer thinner, or electrical contact cleaner.

Typical Reassembly Sequence

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

- 1. Install flywheel end oil seal.
- 2. Install lifter feed chamber gaskets and cover.
- 3. Install flywheel end main bearing.
- 4. Install governor shafts, seal and governor gear.
- 5. Install crankshaft.
- 6. Install connecting rods with pistons and rings.
- 7. Install camshaft.
- 8. Install oil pan seal and main bearing.
- 9. Install oil pan assembly.
- 10. Check crankshaft endplay.
- 11. Install breather assembly.
- 12. Install hydraulic lifters.
- 13. Assemble and install cylinder heads.
- 14. Install push rods and rocker arms.
- 15. Install valve covers.

- 16. Install spark plugs.
- 17. Install oil filter housing.
- 18. Install intake manifold.
- 19. Install backing shroud assembly.
- 20. Install stator, wiring harness, and rectifier-regulator.
- 21. Install flywheel.
- 22. Install ignition module.
- 23. Install outer cylinder baffles
- 24. Install oil cooler.
- 25. Install cooling fan and grass screen.
- 26. Install electric starter.
- 27. Install valley baffles.
- 28. Install carburetor.
- 29. Install governor lever.
- 30. Install control bracket and air cleaner assembly.
- 31. Install throttle and choke linkages.
- 32. Install fuel pump.
- 33. Install Oil Sentry switch (if equipped).
- 34. Install blower housing and cylinder shroud.
- 35. Install muffler.
- 36. Install oil filter and add oil to crankcase.
- 37. Connect spark plug leads.

Install Flywheel End Oil Seal

1. Make sure that the seal bore of the crankcase is clean and free of any nicks or burrs. See Figure 10-1.

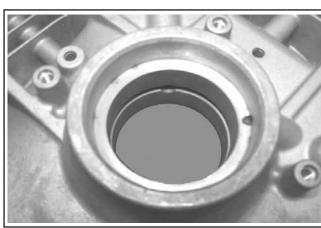


Figure 10-1. Seal Bore of Crankcase.

Section 10 Reassembly

- 2. Apply a light coat of clean engine oil to the outside diameter of the oil seal.
- 3. Install the oil seal into the crankcase using a seal driver. Make sure the oil seal is installed straight and true in the bore and that the tool bottoms against the crankcase. See Figures 10-2 and 10-3.

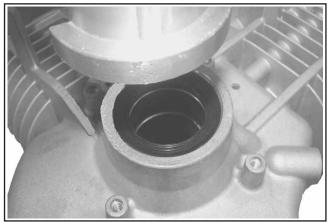


Figure 10-2. Installing Oil Seal.

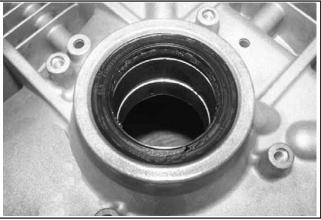


Figure 10-3. Installed Flywheel Side Oil Seal.

Install Lifter Feed Chamber Gaskets and Cover

- 1. Install the lifter feed chamber gasket, followed by the lifter feed cover, over the lifter feed chamber.
- Install the three screws. Make sure all the parts are properly aligned. Torque the screws to
 N·m (55 in. lb.) into new holes, or 4.0 N·m (35 in. lb.), into used holes. See Figure 10-4.

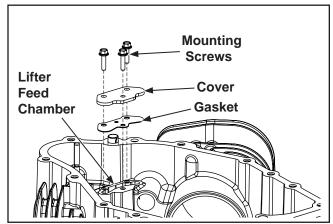


Figure 10-4. Lifter Feed Chamber Assembly Details.

Install Flywheel End Main Bearing

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

- 1. Make sure the crankcase bore for the main bearing is clean, dry and free of nicks or burrs.
- 2. Press the flywheel end main bearing in place with the notch oriented in the 12 o'clock position using an arbor press and driver. See Figure 10-5. Make sure the bearing is fully seated against the flange and the oil feed hole is open in the crankcase. See Figure 10-6.
- 3. Apply a light coat of clean engine oil to the inner surface of the main bearing.



Figure 10-5. Installing Main Bearing.



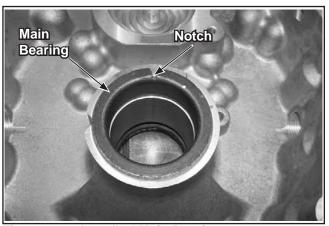


Figure 10-6. Installed Main Bearing.

Install Governor Shafts, Seal, and Governor Gear

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

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

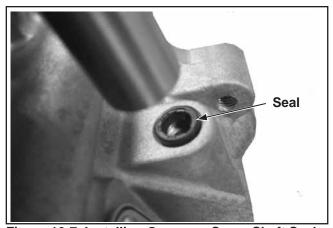


Figure 10-7. Installing Governor Cross Shaft Seal.

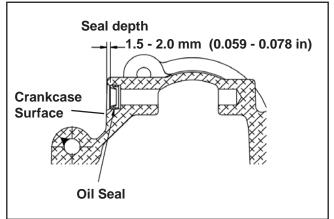


Figure 10-8. Governor Shaft Seal Depth.

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

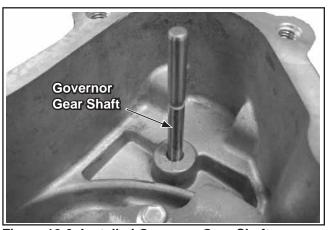


Figure 10-9. Installed Governor Gear Shaft.

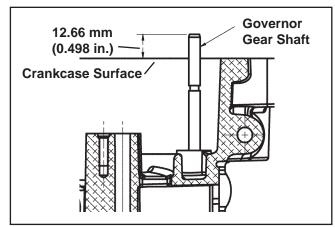


Figure 10-10. Governor Gear Shaft Press Depth.

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



Figure 10-11. Installing Governor Cross Shaft.

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

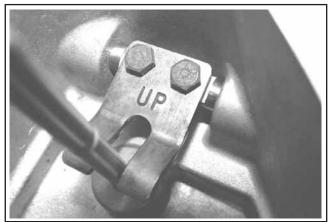


Figure 10-12. Installed Governor Shaft Yoke.

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

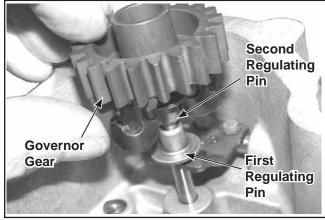


Figure 10-13. Regulating Pin Details.



Figure 10-14. Installing Governor Gear Assembly.

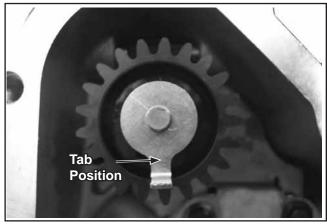


Figure 10-15. Installed Locking Tab Washer.

Install Crankshaft

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

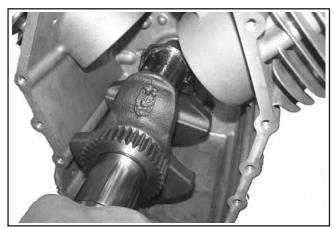


Figure 10-16. Installing Crankshaft.

10

Install Connecting Rods with Pistons and Rings

NOTE: The cylinders are numbered on the crankcase. Make sure to install the piston, connecting rod and end cap into its appropriate cylinder bore as previously marked at disassembly.

Do not mix the end caps and connecting rods.

NOTE: Proper orientation of the piston/connecting rod assemblies inside the engine is extremely important. Improper orientation can cause extensive wear or damage. Be certain the pistons and connecting rods are assembled exactly as shown in Figure 10-17.

1. Stagger the piston rings in the grooves until the end gaps are 120° apart. The oil ring rails should also be staggered.

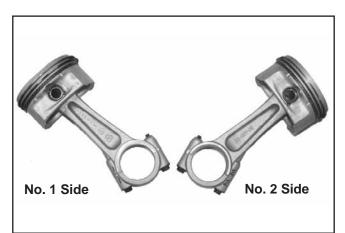


Figure 10-17. Proper Piston and Connecting Rod Orientation.

- 2. Lubricate the cylinder bore, piston, and piston rings with engine oil. Compress the rings of the #1 piston using a piston ring compressor.
- 3. Lubricate the crankshaft journals and connecting rod bearing surfaces with engine oil.
- 4. Make sure the "Fly" stamping on the piston is facing toward the flywheel side of the engine. See Figure 10-18. Use a hammer with a rubber grip and gently tap the piston into the cylinder as shown in Figure 10-19. Be careful that the oil ring rails do not spring free between the bottom of the ring compressor and top of the cylinder.



Figure 10-18. "Fly" Mark on Piston.

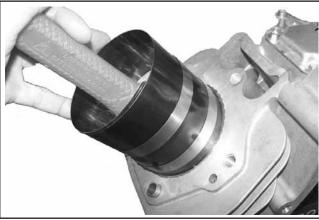


Figure 10-19. Installing Piston Assembly Using Ring Compressor Tool.

5. Install the inner rod cap to the connecting rod using the two hex flange screws. Torque the screws in increments to 11.3 N·m (100 in. lb.). Illustrated instructions are provided in the service rod package. See Figure 10-20.

NOTE: Align the chamfer of the connecting rod with the chamfer of its mating end cap. When installed, the flat faces of the connecting rods should face each other. The faces with the raised rib should be toward the outside.

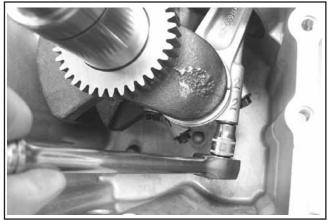


Figure 10-20. Torquing Connecting Rod End Cap Screws.

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

Install Camshaft

1. Liberally apply camshaft lubricant (Kohler Part No. 25 357 14-S) to each of the cam lobes. Lubricate the camshaft bearing surfaces of the crankcase and the camshaft with engine oil. See Figure 10-21.

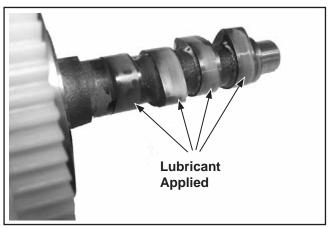


Figure 10-21. Camshaft Lubricant Applied to Cam Lobes.

- 2. Position the timing mark of the crankshaft gear at the 12 o'clock position.
- 3 Slide the camshaft into the bearing surface of the crankcase, positioning the timing mark of the camshaft gear at the 6 O'clock position. Make sure that the camshaft gear and crankshaft gear mesh, with both timing marks aligned. See Figure 10-22.

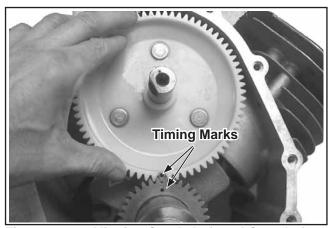


Figure 10-22. Aligning Crankshaft and Camshaft Timing Marks.

Determining Camshaft End Play

- 1. Place a new oil pan gasket into position on the crankcase.
- Position the camshaft endplay checking tool over camshaft. Use a feeler gauge to check the endplay between the camshaft and endplay checking tool. Camshaft endplay should be between 0.3/1.3 mm (0.011/0.051 in.). See Figure 10-23.

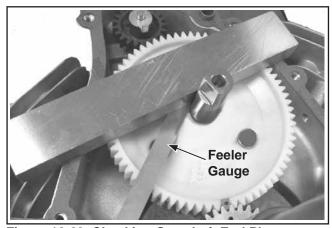


Figure 10-23. Checking Camshaft End Play.

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

Several color coded shims are available:

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

Install Oil Pan Seal and Main Bearing Main Bearing

If the oil pan main bearing was removed for servicing, a new bearing should be installed at this time.

- 1. Make sure the oil pan bore for the main bearing is clean, dry, and free of nicks or burrs.
- 2. Install a new bearing with the notch in the 12 o'clock position, using a press and driver. Make sure the bearing is fully seated against the flange. See Figure 10-24.
- 3. Lightly lubricate the inside diameter of the bearing with oil.

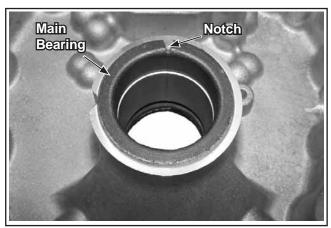


Figure 10-24. Installed Main Bearing In Oil Pan.

Oil Seal

- 1. Check to make sure that there are no nicks or burrs in the crankshaft seal bore of the oil pan.
- 2. Apply a light coat of engine oil to the outside diameter of the oil seal.
- 3. Install the oil seal into the oil pan using a seal driver. Make sure the oil seal is installed straight and true in the bore to the depth shown in Figure 10-26.

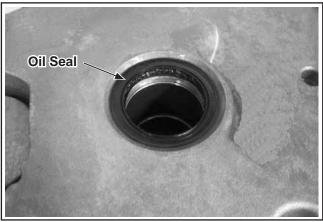


Figure 10-25. Installed Oil Seal in Oil Pan.

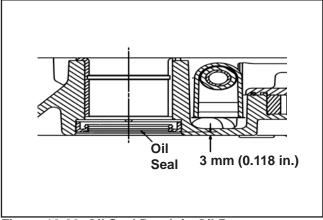


Figure 10-26. Oil Seal Depth in Oil Pan.

4. Apply a light coat of clean engine oil to the inside diameter of the main bearing.

Oil Pump Assembly

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

10

Install Oil Pan Assembly

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

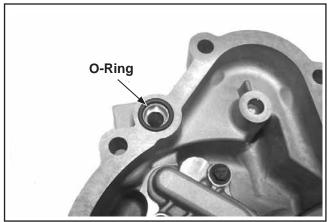


Figure 10-27. O-Ring Installed.

- 2. Install a new oil pan gasket onto the crankcase.
- 3. Make sure the oil pump and oil pick up are installed in the oil pan.
- 4. Ensure the end of the locking tab washer on the governor gear is positioned "outward" in the 6 o'clock position inside the crankcase. See Figure 10-28.



Figure 10-28. Locking Tab Washer Details.

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

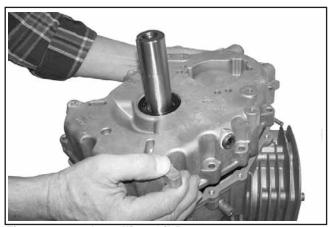


Figure 10-29. Installing Oil Pan.

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

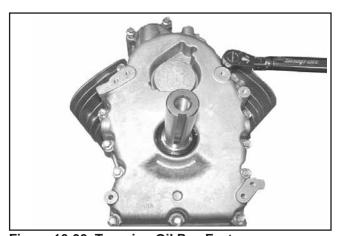


Figure 10-30. Torquing Oil Pan Fasteners.

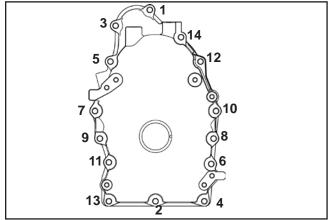


Figure 10-31. Oil Pan Fastener Torque Sequence.

IU

Check Crankshaft End play

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



Figure 10-32. Checking Crankshaft End play.

Install Breather

- 1. Make sure the sealing surfaces of the crankcase and breather cover are clean, and free of any nicks or burrs. **Do not** scrape the surfaces as this could result in leakage.
- 2. Install the breather chamber gasket as shown. See Figure 10-33. Assemble and install breather assembly components as illustrated in Figure 10-34. Make sure the filter does not extend above the top surface and all parts are properly aligned.

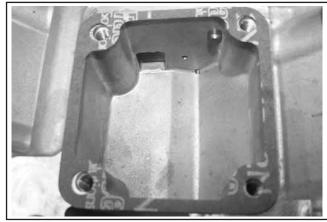


Figure 10-33. Breather Chamber and Gasket.

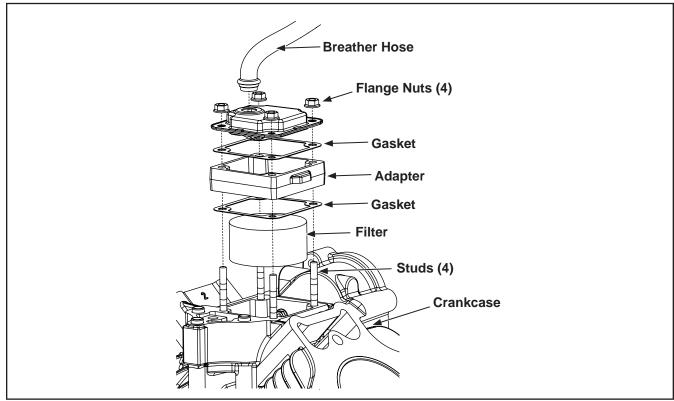


Figure 10-34. Breather Assembly Details.

3. Install the four hex flange screws, and torque using the sequence shown in Figure 10-35 to 5.7 N·m (51 in. lb.).

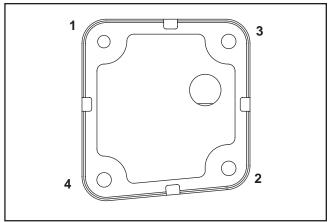


Figure 10-35. Breather Assembly Fastener Torque Sequence.

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

Install Hydraulic Lifters

1. Bleed the hydraulic lifters of internal oil so the plunger in the lifter can be depressed by hand. Use an old cutoff push rod mounted in a drill press, arbor press, or vice, and slowly apply pressure two or three times to bleed the lifters. See Figure 10-36. If a vice is used in bleeding the lifters, be sure to install protective coverings over the jaws to avoid damage to the base of the lifter.

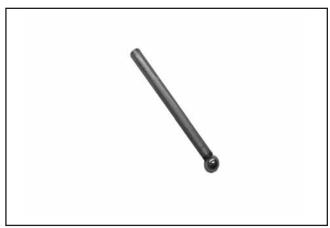


Figure 10-36. Push Rod Tool.

NOTE: Another tool for bleeding may be made from an old tappet and ball bearing welded together. See Figure 10-37.



Figure 10-37. Tappet and Ball Bearing Welded Together.

2. Apply camshaft lubricant (see Section 2) to the bottom surface of each lifter. See Figure 10-38. Lubricate the hydraulic lifters and the lifter bores in the crankcase with engine oil. Do not prime the lifters.

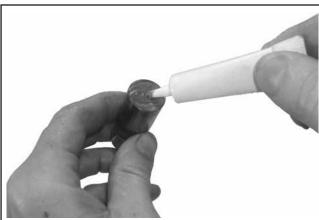


Figure 10-38. Applying Camshaft Lubricant to Bottom of Lifters.

3. Note the mark or tag identifying the hydraulic lifters as either intake or exhaust and cylinder 1 or cylinder 2. Install the hydraulic lifters into their appropriate location in the crankcase. Do not use a magnet. See Figure 10-39.

NOTE: Hydraulic lifters should always be installed in the same position as before disassembly. The exhaust lifters are located on the output shaft side of the engine while the intake lifters are located on the fan side of the engine. The cylinder numbers are embossed on the top of the crankcase and each cylinder head. See Figure 10-40.



Figure 10-39. Installing Hydraulic Lifters.

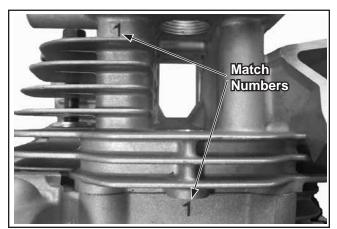


Figure 10-40. Match Numbers on Cylinder Barrel and Head.

Valve Stem Seals

These engines use valve stem seals on the intake and exhaust valves. Always use new seals whenever valves are removed or if the seal is deteriorated or damaged in any way. Never reuse an old seal. Figure 10-41.

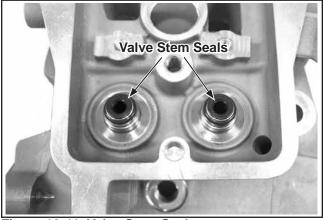


Figure 10-41. Valve Stem Seals.

Assemble Cylinder Heads

Prior to installation, lubricate all components with engine oil, paying particular attention to the lip of the valve stem seal, valve stems and valve guides. Install the following items in the order listed below using a valve spring compressor. See Figures 10-42 and 10-43.

- Intake and exhaust valves
- Valve spring retainers
- Valve springs
- Valve spring keepers
- Valve Stem Seals
- Guide Plate
- Pivot Studs

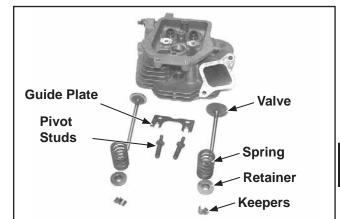


Figure 10-42. Valve Components.

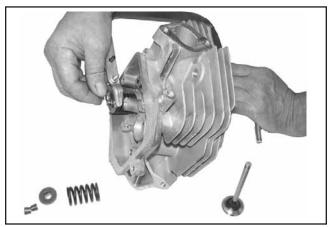


Figure 10-43. Installing Valves with Valve Spring Compressor.

Install Cylinder Heads

- 1. Check to make sure there are no nicks or burrs on the sealing surfaces of the cylinder head or the crankcase.
- 2. Check that the dowel pins are in place in the two lower locations, and install a new cylinder head gasket (with printing up). See Figure 10-44.

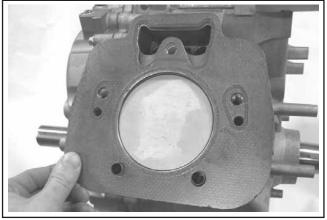


Figure 10-44. Installing New Head Gaskets.

NOTE: Match the numbers embossed on the cylinder heads and crankcase. See Figure 10-40.

3. Install the cylinder head. Make sure the head is flat on the gasket and dowel pins. Install a flat washer on the screws in the lower two locations (1 and 3) and the location closest to the exhaust port (location 5). See Figures 10-45 and 10-47. Start the five hex flange screws.

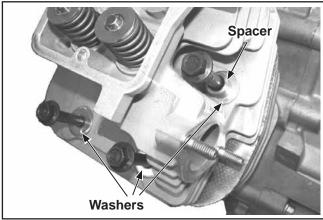


Figure 10-45. Washers and Spacer Locations on Cylinder Head Screws.

- Torque the hex flange screws in two stages; first to 22.6 N·m (200 in. lb.), finally to 45.2 N·m (400 in. lb.), following the sequence in Figure 10-47.
- 5. Repeat the procedure for the opposite cylinder.

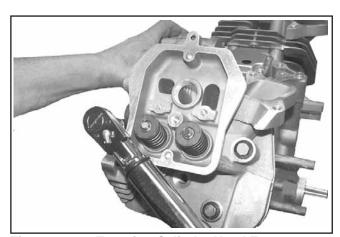


Figure 10-46. Torquing Cylinder Head Fasteners.

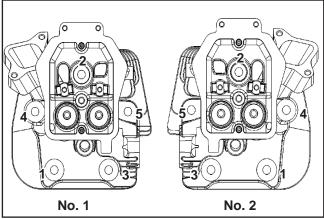


Figure 10-47. Cylinder Head Fastener Torque Sequence.

6. Make sure the threads of the pipe plugs for the cylinder heads are clean and dry. Install a plug into each cylinder head above the No. 2 (screw) location and torque to 29.3 N·m (260 in. lb.). See Figure 10-48.

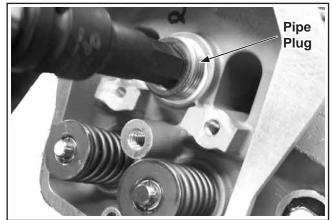


Figure 10-48. Installing Pipe Plug in Cylinder Heads.

Install Guide Plate, Pivot Studs, Push Rods and Rocker Arms

1. Install the push rod guide plate and rocker arm pivot studs onto the cylinder heads if removed previously. Torque the pivot studs to 12.4 N·m (110 in. lb.). See Figure 10-49.

NOTE: Install the push rod guide plate so the flange is **down** (towards cylinder) on the **No. 1 side**, and **up** (away from cylinder) on the **No. 2 side**.

2. Note the mark or tag identifying the push rod as either intake or exhaust and cylinder #1 or #2. Dip the ends of the push rods in engine oil and install, making sure that each push rod ball seats in its hydraulic lifter socket. See Figure 10-50.

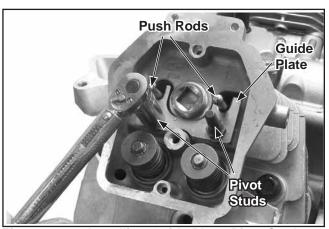


Figure 10-49. Installing Guide Plate, Pivot Studs and Push Rods.

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

3. Apply grease to the contact surfaces of the rocker arms and rocker arm pivots. Install the rocker arms, rocker arm pivots, and adjusters on the #1 cylinder head.

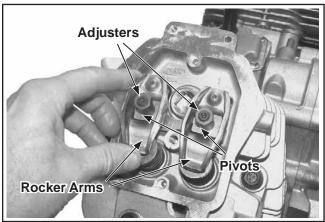


Figure 10-50. Installing Rocker Arms, Pivots and Adjusters.

Adjust Valve Clearance

With Pre-Bled Lifters Before Installation

1. Turn the adjusters in the rocker arms by hand **clockwise** (down), only enough to capture push rods in the recesses. See Figure 10-51.

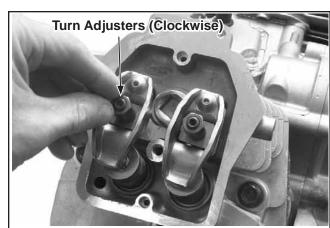


Figure 10-51. Turning Adjusters In To Retain Push Rods.

2. Rotate the crankshaft to establish Top Dead Center (TDC) on the "Compression Stroke" for the #1 cylinder.

Check for:

- a. Compression will be felt through the spark plug hole.
- b. Keyway of crankshaft will be aligned with #1 cylinder.
- No rocker arm/push rod movement if crankshaft is rotated slightly back and forth. If they are moving, rotate the crankshaft one full revolution.
- 3. **Pre-bled Lifters:** Apply downward pressure to the push rod side of rocker arm, to compress the lifter and "bottom" the internal plunger. Several "manual" compressions may be necessary. **Hold in this position for Step 4**.

Non-bled Lifters: Follow the valve clearance adjustment procedure: *Non-Bled Lifters, When Cylinder Heads and Lifters are Not Removed.*

NOTE: It takes two hands to make the lash adjustment. A clamping device or an assistant to hold the lifter compressed while making the adjustment will make this noticeably easier.

4. Insert a 0.127 mm (0.005 in.) feeler gauge between the end of one valve and the rocker arm. Turn the adjuster until a slight drag is felt. Hold the adjuster in this position and tighten the locking setscrew. Torque the setscrew to 7.3 N·m (65 in. lb.). After tightening recheck the adjustment. Proper valve clearance is 0.101/0.152 mm (0.004/0.006 in.). See Figure 10-52.



Figure 10-52. Adjusting Valve Clearance.

5. Repeat the procedure for the other valve on this side.

- 6. Viewed from the PTO end, rotate the crankshaft 270° (3/4 turn) **counterclockwise** and align the crankshaft keyway with the #2 cylinder, which now puts that cylinder at TDC on the compression stroke.
- 7. Repeat steps 3-5 for setting the valve clearance on the #2 side.
- 8. Rotate the crankshaft to check for free operation of the valve train. Check for clearance between the valve spring coils at full lift, or bending of push rod(s) can occur. Minimum allowable clearance is 0.25 mm (0.010 in.).

Check Assembly

Important: Rotate the crankshaft a minimum of two revolutions to check assembly and overall proper operation.

Adjust Valve Clearance

Non-Bled Lifters, When Cylinder Heads and Lifters are Not Removed .

- 1. Turn the adjusters in the rocker arms down (clockwise) only enough to capture the push rods in the recesses. See Figure 10-50.
- 2. Rotate the crankshaft to establish Top Dead Center (TDC) on the "Compression Stroke" for the #1 cylinder.

Check for:

- a. Compression will be felt through the spark plug hole.
- b. Keyway of crankshaft will be aligned with #1 cylinder.
- c. No rocker arm/push rod movement if crankshaft is rotated slightly back and forth. If they are moving, rotate the crankshaft one full revolution.
- 3. Turn one of the #1 side rocker arm adjusting nuts down until push rod is snug but can be rotated with drag. This is "0" lash. See Figure 10-53.

Figure 10-53. Establishing the "0" Lash Point.

4. Mark or note the setting of the adjustment nut, then turn (tighten) the adjuster nut four (4) complete revolutions clockwise, plus one flat of nut (1/6 turn), or a total of 4-1/6 turns.

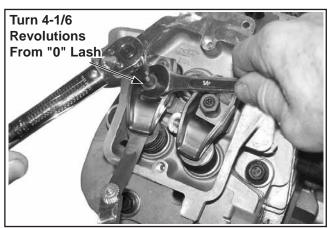


Figure 10-54. Setting Valve Lash (Non-Bled Lifters).

- 5. Hold the adjuster nut in this position and tighten the locking setscrew. Torque the setscrew to 7.3 N⋅m (65 in. lb.).
- 6. Repeat the procedure for the other valve on the this side.
- 7. Viewed from the PTO end, rotate the crankshaft 270° (3/4 turn) **counterclockwise** and align the crankshaft keyway with the #2 cylinder, which now puts that cylinder at TDC on the compression stroke.
- 8. Repeat steps 3-6 for setting the valve clearance on the #2 side.
- Rotate the crankshaft to check for free operation of the valve train. Check the clearance between the valve spring coils at full lift. Minimum allowable clearance is 0.25 mm (0.010 in.).

Check Assembly

Important: Check if engine can be turned over completely and compression is noted. If it cannot (locks up at some point), return the piston to TDC between the intake and exhaust strokes first for one cylinder and then the other waiting ten minutes to allow lifters to bleed down, then check for compression again.

Install Valve Covers

- 1. Make sure the sealing surfaces are clean and free of any nicks or burrs.
- 2. Install and properly seat the seal onto each of the valve covers. See Figure 10-55.

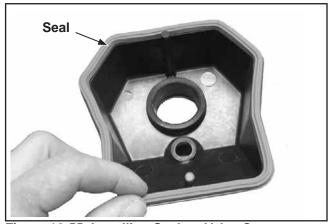


Figure 10-55. Installing Seal on Valve Cover.

- 2. Install the valve covers on the same sides as originally installed.
- 3. Install a new grommet on each valve cover mounting screw. Start each screw.
- 4. Check the position of each cover and gasket, then torque each screw to 7.9 N⋅m (70 in. lb.). See Figure 10-56.

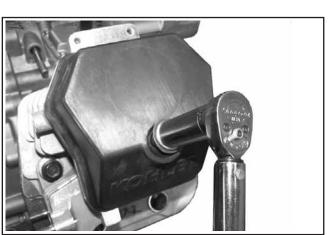


Figure 10-56. Torquing Valve Cover Screw.

10

Install Spark Plugs

- 1. Use new Champion® XC10YC (or equivalent) spark plugs.
- 2. Set the gap at 0.76 mm (0.030 in.).
- 3. Install new plugs and torque to 24.4-29.8 N⋅m (18-22 ft. lb.). See Figure 10-57.



Figure 10-57. Installing Spark Plugs.

Install Oil Filter Housing Assembly

Reassemble the oil filter housing if disassembled previously. See Figures 10-58 through 10-63.

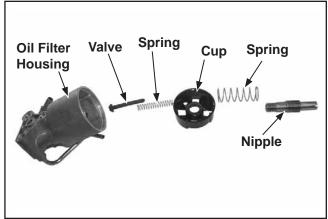


Figure 10-58. Oil Filter Housing Components.

- a. Install the small spring onto the rubber valve, and insert the small end through the corresponding hole in the cup until properly seated. See Figure 10-59.
- b. Install the larger spring into the filter housing. See Figure 10-60.

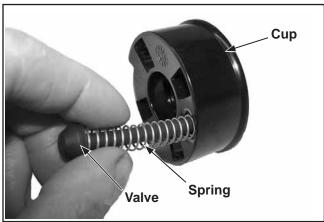


Figure 10-59. Installing Valve and Spring to Cup.



Figure 10-60. Installing Spring into Housing.

- c. Insert the oil filter cup, aligning the cutout with the corresponding section in the housing. See Figure 10-61.
- d. Install and tighten the nipple in the housing. Use a 5/16" Allen wrench/bit and torque to 18.0 N·m (160 in. lb.). See Figures 10-62 and 10-63.

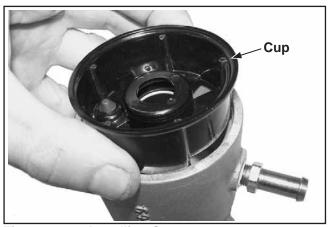


Figure 10-61. Installing Cup.

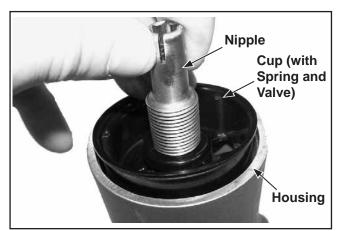


Figure 10-62. Installing Nipple into Cup and Oil Filter Housing.



Figure 10-63. Torquing Nipple into Housing.

Installation

1. Make sure all sealing surfaces are clean and all three dowel pins are in position. Install or check that new O-Rings are around all three dowel pins of the oil filter adapter. See Figure 10-64.

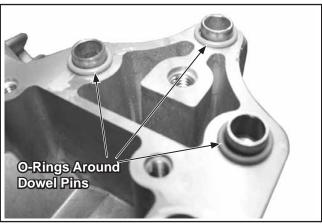


Figure 10-64. O-Rings Installed on Crankcase for Oil Filter Housing.

2. Install the filter housing assembly and secure with the M8 hex head screw. Make sure the housing is flat on crankcase and O-Ring remains in position. Torque the screw to 24.4 N⋅m (216 in. lb.). See Figure 10-65.

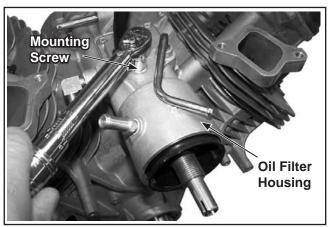


Figure 10-65. Torquing Oil Filter Housing.

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

Install Intake Manifold

1. Install new intake manifold gaskets so the notched section is inward and points toward the flywheel side. See Figure 10-66.

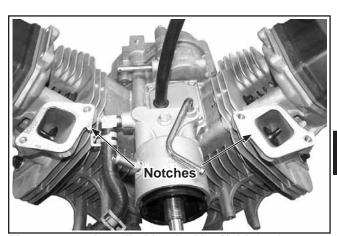


Figure 10-66. Installed Intake Manifold Gaskets.

 Mount the intake manifold to the cylinder heads. Make sure the gaskets remain in the proper position. Torque the four screws in two stages, first to 16.9 N·m (150 in. lb.), finally to 22.6 N·m (200 in. lb.), using the sequence shown in Figure 10-68.

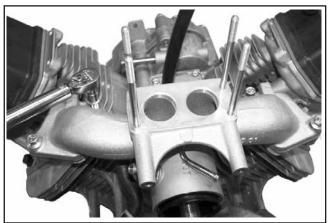


Figure 10-67. Installing Intake Manifold.

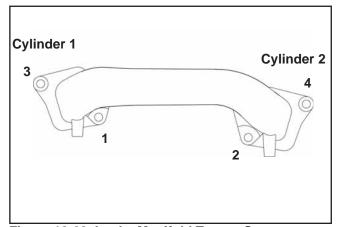


Figure 10-68. Intake Manifold Torque Sequence.

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

Install Backing Shroud Assembly

1. To aid assembly, install the lower oil cooler hose onto the oil filter housing prior to installing the backing shroud assembly. Secure with a clamp positioned as shown. See Figure 10-69.

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

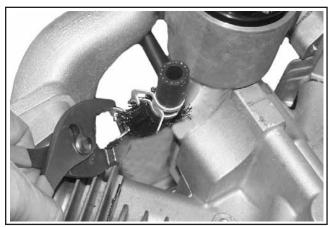


Figure 10-69. Lower Oil Cooler Hose Details.

Install the backing shroud assembly and secure to the crankcase with the four M6 screws. Torque the four screws going into the crankcase to 10.7 N·m (99 in. lb.) into new holes, or 7.3 N·m (65 in. lb.) into used holes. See Figure 10-70.



Figure 10-70. Installing Backing Shroud Assembly.

Install Stator, Wiring Harness, and Rectifier-Regulator

- 1. Apply pipe sealant with Teflon® (Loctite® No 59241 or equivalent) to the stator mounting holes.
- 2. Position the stator aligning the mounting holes so the leads are at the bottom, and toward the rectifier-regulator mount on the No. 1 side.
- 3. Install and torque the two hex flange screws to 6.2 N⋅m (55 in. lb.). See Figure 10-71.
- 4. Route the stator wires under the two molded clips in backing shroud assembly. See Figure 10-71.



Figure 10-71. Installing Stator.

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

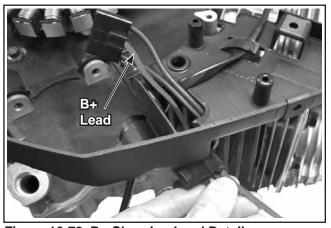


Figure 10-72. B+ Charging Lead Details.

6. Install the wiring harness under the two molded clips in the backing shroud assembly. See Figure 10-73.

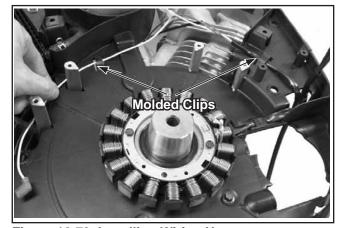


Figure 10-73. Installing Wiring Harness.

7. Position the rectifier-regulator onto the mounting posts with the cooling fins "up." Attach the ground lead to the outer screw and washer, then torque the mounting screws to 2.0 N·m (18 in lb.). Connect the plug to the rectifier-regulator. See Figure 10-74.

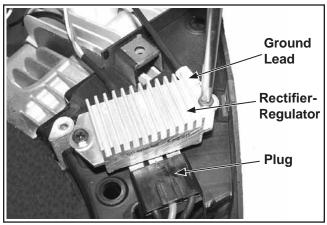


Figure 10-74. Installing Rectifier-Regulator.

Install Flywheel

WARNING: Damaging Crankshaft and Flywheel Can Cause Personal Injury!

Using improper procedures to install the flywheel can crack or damage the crankshaft and/or flywheel. This not only causes extensive engine damage, but can also cause personal injury, since broken fragments could be thrown from the engine. Always observe and use the following precautions and procedures when installing the flywheel.

NOTE: Before installing the flywheel make sure the crankshaft taper and the flywheel hub are clean, dry, and completely free of any lubricants. The presence of lubricants can cause the flywheel to be over stressed and damaged when the hex flange screw is torqued to specifications.

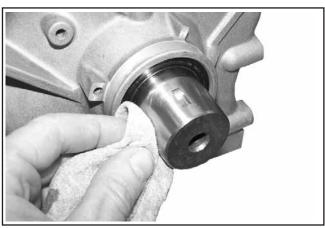


Figure 10-75. Clean and Dry Taper of Crankshaft.

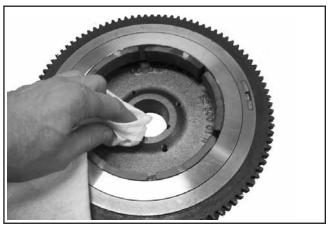


Figure 10-76. Clean and Dry Flywheel Hub.

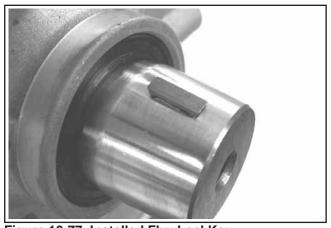


Figure 10-77. Installed Flywheel Key.

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

- 1. Install the woodruff key into the keyway of the crankshaft. Make sure that the key is properly seated and parallel with the shaft taper.
- 2. Install the flywheel onto the crankshaft being careful not to shift the woodruff key.
- 3. Install the hex flange screw and washer.
- 4. Use a flywheel strap wrench or holding tool to hold the flywheel. Torque the hex flange screw securing the flywheel to the crankshaft to 67.8 N·m (50 ft. lb.). See Figure 10-78.

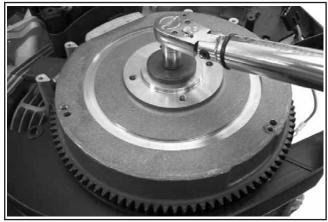


Figure 10-78. Installing and Torquing Flywheel Fastener.

Install Ignition Modules

- 1. Rotate the flywheel to position the magnet away from the ignition module bosses.
- 2. Connect the ground lead to the single kill tab and install the modules onto the crankcase bosses so the tab is away from you (in). The spark plug lead should be towards you (out). Mount the wiring harness clamp with the loop **up**, on the starter (No.1) side inner module screw and route the harness through it. Attach the rectifier-regulator ground lead to the outer screw. See Figure 10-79.

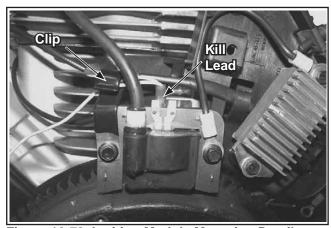


Figure 10-79. Ignition Module Mounting Details.

- 3. Slide the modules up as far away from the flywheel as possible and snug the screws to hold them in that position.
- 4. Rotate the flywheel to position the magnet directly under one ignition module.

5. Insert a 0.30 mm (0.012 in.) flat feeler gauge between the magnet and the ignition module. See Figure 10-80. DSAI engines do not require or have an air gap setting. Loosen the screws enough to allow the magnet to pull the module down against the feeler gauge.

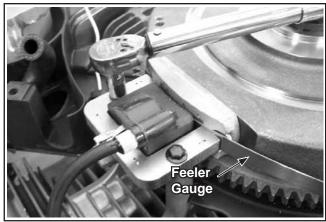


Figure 10-80. Setting Ignition Module Air Gap.

- 6. Torque the screws to 6.2 N·m (55 in. lb.) into new holes, or 4.0 N·m (35 in. lb.) into used holes.
- 7. Repeat steps 4 through 6 for the other ignition module.
- 8. Rotate the flywheel back and forth, checking for clearance between the magnet and ignition modules. Make sure the magnet does not strike the modules. Check the gap with a feeler gauge and readjust if necessary. Final Air Gap: 0.280/0.330 mm (0.011/0.013 in.).
- 9. Make sure the leads are under the molded clip on the starter side. See Figure 10-81.

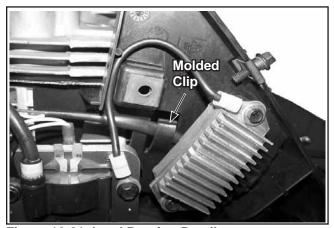


Figure 10-81. Lead Routing Details.

Install Outer Cylinder Baffles

1. Install the outer cylinder baffles. Make sure the spark plug lead is routed through the corresponding opening in each baffle. Start each of the screws. Torque the M6 shoulder screws going through the backing shroud assembly into the extruded holes in the baffles to 4.0 N·m (35 in. lb.) for initial installations, or 2.0 N·m (17.7 in. lb.) anytime thereafter. Torque the M6 screws going into the cylinder head and crankcase to 10.7 N·m (95 in. lb.) for new holes, or 7.3 N·m (65 in. lb.) for used holes.

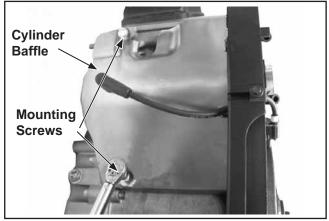


Figure 10-82. Installing Outer Cylinder Baffles.

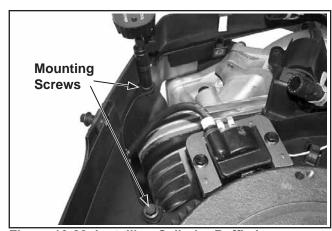


Figure 10-83. Installing Cylinder Baffle Inner Screws.

Install Oil Cooler

1. Connect the two oil cooler hoses between the oil filter adapter and the oil cooler. Secure with new clamps. See Figure 10-84.

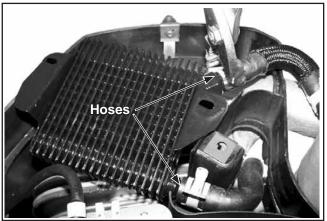


Figure 10-84. Connecting Oil Cooler Hoses.

2. Align the oil cooler with the bosses in the backing shroud assembly. Secure with the two screws and washers. See Figure 10-85.

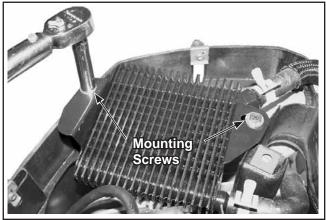


Figure 10-85. Installing Oil Cooler.

Install Cooling Fan and Grass Screen



CAUTION:

Failure to utilize or re-assemble the grass screen as designed could result in grass screen failure and serious personal injury.

- Position the cooling fan onto the flywheel, aligning the mounting locations. Apply a small amount of Loctite® No. 243 to the threads and install the three long mounting screws. Torque the screws to 9.9 N·m (88 in. lb.). See Figure 10-86.
- 2. Apply a small amount of Loctite® No 243 to the external threaded section, (unless new parts with

- pre-applied locking compound are being used). Thread the four hex grass screen studs into the mounting holes in the flywheel. Torque each stud to 9.9 N·m (88 in. lb.). See Figure 10-86.
- 3. Install the stiffener followed by the metal grass screen onto the four hex studs. Secure with the four special washers and mounting screws using Loctite® No. 243 on the threads. Torque the screws to 9.9 N·m (88 in. lb.). See Figure 10-86.

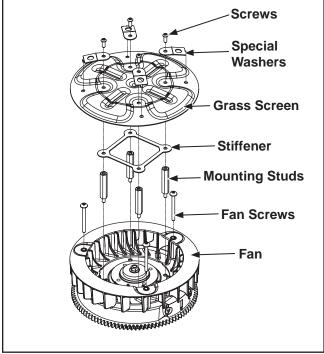


Figure 10-86. Cooling Fan and Grass Screen Assembly Details.

Install Electric Starter

- 1. Install the electric starter motor using the two hex flange screws. See Figure 10-87.
- 2. Torque the two hex flange screws to 15.3 N·m (135 in. lb.).



Figure 10-87. Installing Electric Starter Motor.

3. Connect the leads to the solenoid. See Figure 10-88.



Figure 10-88. Connecting Leads to Starting Motor.

Install Valley Baffles

 Install the two valley baffles and secure with the mounting screws. The lower section should fit under the outer baffle. Torque the M6 screws going into the cylinder head to 10.7 N·m (95 in. Ib.) for new holes, or 7.3 N·m (65 in. Ib.), for used holes. Torque the M6 screw going into the lower blower housing mounting clip to 3.9 N·m (35 in. Ib.). See Figure 10-89.

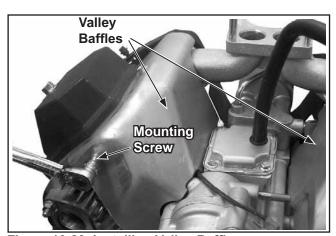


Figure 10-89. Installing Valley Baffles.

Install Carburetor



WARNING: Explosive Fuel!

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

1. Install a new carburetor gasket onto the intake manifold with the tab **up**. Make sure all holes align and are open.

2. Attach the throttle and choke linkages to the carburetor if disconnected previously. Install the carburetor with the linkages attached as an assembly. See Figure 10-90.

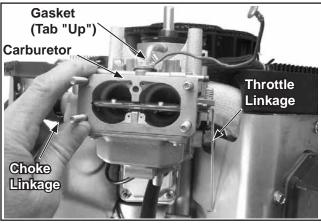


Figure 10-90. Installing Carburetor onto Manifold.

Install Governor Lever

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

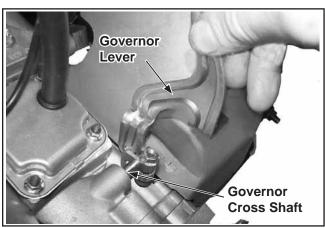


Figure 10-91. Installing Governor Lever.

10

Install Control Bracket and Air Cleaner Assembly

1. Position the control bracket assembly onto the three intake manifold bosses, aligning the mounting holes. See Figure 10-92.

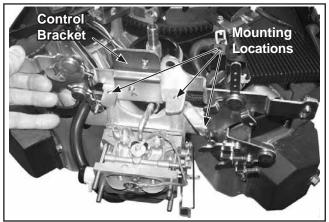


Figure 10-92. Installing Control Bracket.

- 2. Install a new air cleaner elbow gasket onto the mounting studs.
- 3. Slide the air cleaner assembly onto the four carburetor mounting studs, attach the ground lead (with star washer if used), and finger tighten the hex flange nuts. Align the two forward mounting holes in the base with the mounting holes/bosses of the intake manifold and control bracket, then start the two hex flange screws. Check positions of all parts, then torque the four hex flange nuts to 7.9 N·m (70 in. lb.) in the sequence illustrated, and the two hex flange screws to 9.9 N·m (88 in. lb.). See Figures 10-93, 10-94, and 10-95.

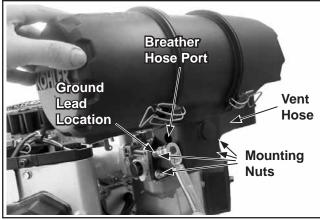


Figure 10-93. Installing Air Cleaner.

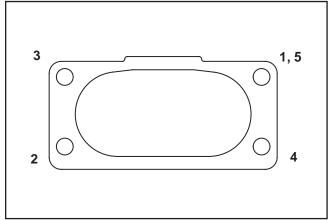
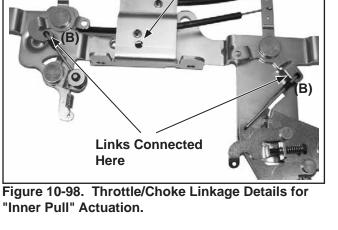


Figure 10-94. Torque Sequence for Air Cleaner Mounting Nuts.



Figure 10-95. Installing Alr Cleaner Mounting Screws.

- 4. Connect the breather hose to the fitting on the outlet of the air cleaner and connect the fuel solenoid lead.
- 5. Connect the formed vent hose to the air cleaner housing and the vent port on the carburetor.
- 6. Connect the choke link to the control pivot pin. Reinstall the washer and secure with a **new** pushon pal nut. See Figure 10-96.



Control Cable Clamp Locations

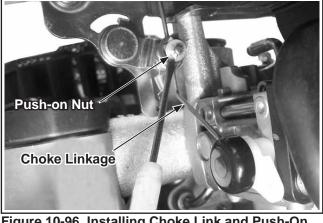


Figure 10-96. Installing Choke Link and Push-On

Install Throttle and Choke Linkages

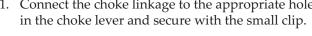
If the individual throttle/choke control linkages were disconnected during disassembly, reconnect them based on the operating direction of the control cables to be used.

On Control Levers:

Hole A is used for Outer Pull control cable actuation.

Hole *B* is used for *Inner Pull* control cable actuation. See Figures 10-97 and 10-98.

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



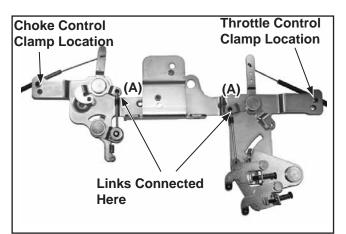


Figure 10-97. Throttle/Choke Linkage Details for "Outer Pull" Actuation.

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

Install Fuel Pump

- 1. Install the fuel pump with hoses to the control bracket, if removed earlier. Torque the mounting screws to 4.0 N·m (35 in. lb.).
- 2. Connect the outlet fuel line to the carburetor inlet and secure with a clamp.
- 3. Install the pulse hose, and inlet hoses in their proper locations. See Figure 10-99.

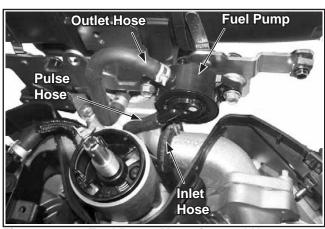


Figure 10-99. Fuel Pump Mounting and Hose Details.

Adjusting Governor

1. Position the governor lever so the clamping area is inboard but completely on the knurled area of governor cross shaft. See Figure 10-100.

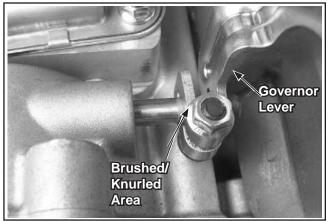


Figure 10-100. Brushed/Knurled Area.

- 2. Move the governor lever **toward** the carburetor as far as it will go (wide-open throttle) and hold in position. See Figure 10-101.
- 3. Insert a long thin rod or tool into the hole on the cross shaft and rotate the shaft clockwise (viewed from the end) as far as it will turn, then torque the hex nut to 7.3 N·m (65 in. lb.). See Figure 10-101.

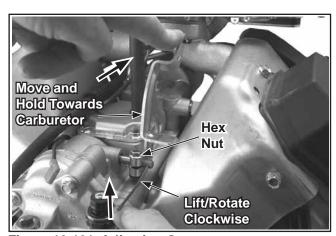


Figure 10-101. Adjusting Governor.

4. Ensure that the correct colored springs are used. Connect the governor spring (with long looped end), to the inner hole on the governor lever and control bracket. Connect the governed idle spring to the outer governor lever hole and control bracket. The long end of each spring must be toward the governor lever. Check that the springs do not contact the valley baffle. See Figure 10-102.

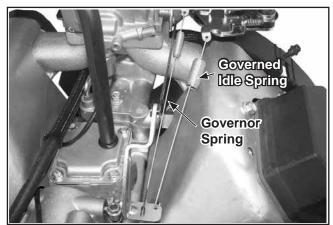


Figure 10-102. Governor Springs Installed.

Governor Spring/RPM Chart

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

Governor Spring (Color)	High Speed (RPM)
Orange	3000 - 3100 RPM
Red	3101 - 3300 RPM
Green	3301 - 3750 RPM
Purple	3751 - 3900 RPM

Figure 10-103. Governor Spring/RPM Chart.

Install Oil Sentry™ (If Equipped)

Apply pipe sealant with Teflon® (Loctite® No. 59241 or equivalent) to the threads of the Oil Sentry™ switch and install it into the 1/8" port in the oil pan. See Figure 10-104. Torque to 10.1 N·m (90 in. lb.).

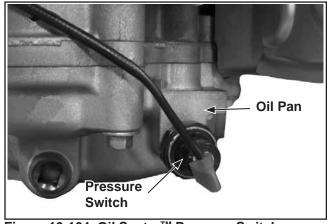


Figure 10-104. Oil Sentry™ Pressure Switch Location.

Install Blower Housing and Cylinder Shrouds

- Install the dipstick tube, with a new lower O-Ring, into the crankcase. Secure with the lower mounting screw. Torque the screw to 4.0 N·m (35 in. lb.). See Figure 10-105.
- 2. Attach the lift bracket (if used) onto crankcase with the two mounting screws. Torque the screws to 9.9 N·m (88 in. lb.). See Figure 10-105.

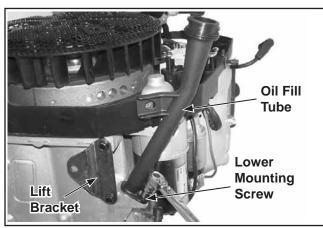


Figure 10-105. Oil Fill Tube and and Lift Bracket.

3. Align and install the blower housing. Secure with the four shoulder screws. Torque the screws to 4.0 N·m (35 in. lb.) for inital installations, or 2.0 N·m (17.7 in. lb.) anytime thereafter. See Figure 10-106.

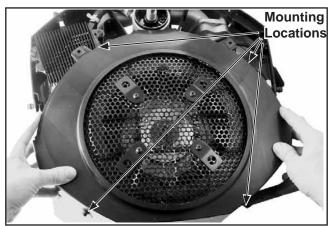


Figure 10-106. Installing Blower Housing.

4. Install the two cylinder shrouds and secure with the shoulder screws. Torque the screws to 4.0 N·m (35 in. lb.) for initial installations, or 2.0 N·m (17.7 in. lb.) anytime thereafter. See Figure 10-107.

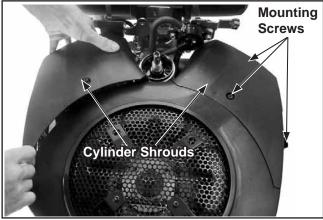


Figure 10-107. Installing Cylinder Shrouds.

Install Muffler

- 1. Install the port liners (if equipped). Attach the muffler and secure with the four hex flange nuts onto the exhaust studs. Torque the hex flange nuts to 24.4 N·m (216 in. lb.).
- 2. Install any attaching hardware and brackets. Torque M6 screws to 9.9 N·m (88 in. lb.), and M8 screws to 24.4 N·m (216 in. lb.).

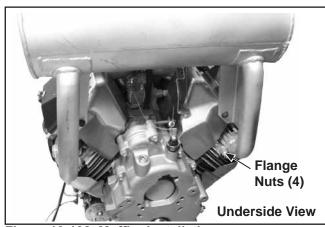


Figure 10-108. Muffler Installation.

3. Install the spark arrestor (if used).

10

Install Oil Filter and Add Oil to Crankcase

1. Install the oil drain plugs. See Figure 10-109. Torque the plugs to **21.4 N·m (15.7 ft. lb.)**.

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

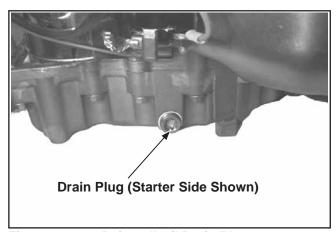


Figure 10-109. Reinstall Oil Drain Plugs.

- 2. Install a new oil filter following the instructions in Section 6.
- 3. Apply a thin film of clean engine oil to the rubber gasket on the oil filter and thread the filter onto the adapter nipple. See Figure 10-110.
- 4. Hand tighten the filter until the rubber gasket contacts the adapter, then tighten the filter an additional 3/4-1 turn. See Figure 10-110.



Figure 10-110. Installing and Tightening Oil Filter.

5. Add oil to bring the level up to the "F" mark and reinstall the dipstick. See Figure 10-111.



Figure 10-111. Reinstall the Dipstick in Tube.

Connect Spark Plug Leads

1. Connect the leads to the spark plugs. See Figure 10-112.



Figure 10-112. Connect Spark Plug Leads.

Prepare the Engine for Operation

The engine is now completely reassembled. Before starting or operating the engine, be sure to do the following.

- 1. Make sure all hardware is tightened securely.
- 2. Make sure the oil drain plugs, Oil Sentry[™] pressure switch, and a new oil filter are installed.
- 3. Fill the crankcase with the correct amount, weight, and type of oil. Refer to oil recommendations and procedures in the "Safety and General Information" and "Lubrication System" sections.
- 4. Adjust the carburetor, idle fuel needles, or idle speed adjusting screw as necessary. Refer to Section 5, the "Fuel System and Governor".

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Testing the Engine

It is recommended that the engine be operated on a test stand or bench prior to installation in the piece of equipment.

- 1. Set the engine up on a test stand. Install an oil pressure gauge. Start the engine and check to be certain that oil pressure (20 psi or more) is present. Run the engine at idle for 2-3 minutes, then 5-6 minutes more between idle and midrange. Adjust the carburetor mixture settings as necessary (as available).
- 2. Adjust the governed idle and high speed(RPM) to required settings. Make sure the maximum engine speed does not exceed 3900 RPM (no load).



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