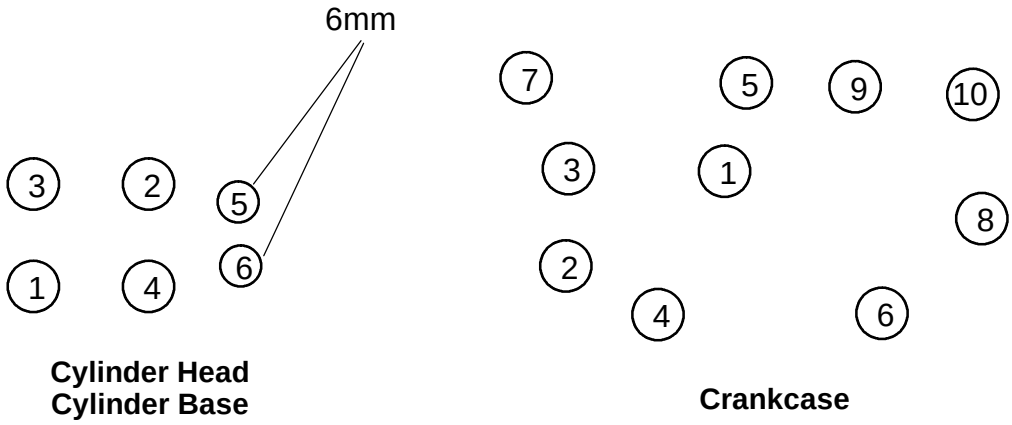
CHAPTER 3
ENGINE

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS		
Fastener	**Size**	**EH50PLE Ft. Lbs. (Nm)**
Blind Plug (Oil Pressure)	1/8 PT (28tpi)	6.5-11 (9-15 Nm)
Camshaft Sprocket	6mm	5-6.5 (7-9 Nm)
Camshaft Chain Tensioner Lever	6mm	5-6.5 (7-9 Nm)
Camshaft Chain Tensioner	6mm	5-6.5 (7-9 Nm)
Camshaft Chain Tensioner Cap	11mm	14-19 (20-25 Nm)
Carburetor Adaptor	8mm	12-14 (16-20 Nm)
Crankcase	8mm	14-15 (19-21 Nm)
Crankshaft Slotted Nut (Cam Chain Drive Sprocket)	28mm	35-51 (47-69 Nm)
Cylinder Base Bolts	10mm 6mm	45-49 (61-67 Nm) 6-8 (9-11 Nm)
Cylinder Head Bolts	11mm 6mm	Refer to Engine Assembly for torque procedure
Drive Clutch Bolt	7/16 - 20	40 (55 Nm)
Flywheel	16mm	58-72 (78-98 Nm)
Oil Delivery Pipe	12mm	11-15 (15-21 Nm)
Oil Drain Bolt (Crankcase)	14mm	14-17 (19-23 Nm)
Oil Filter Pipe Fitting	20mm	36-43 (49-59 Nm)
Oil Hose Fitting	1/8 Pipe Thread	6.5-11 (9-15 Nm)
Oil Pump	6mm	5-6.5 (7-9 Nm)
Oil Pump Case Screw	5mm	1.5-2 (2-3 Nm)
One Way Valve	11mm	14-19 (20-25 Nm)
Recoil Housing	6mm	5-6.5 (7-9 Nm)
Rocker Cover	6mm	7-8 (9-11 Nm)
Rocker Support	8mm	8-10 (11-13 Nm)
Rocker Adjuster Screw	6mm	6-7 (8-10 Nm)
Water Pump Impeller Nut	6mm	5-6.5 (7-9 Nm)
Water Pump Housing Cover	6mm	5-6.5 (7-9 Nm)
Stator Plate	6mm	5-6.5 (7-9 Nm)
Starter Motor	6mm	5-6.5 (7-9 Nm)
Spark Plug	14mm	9-11 (12-15 Nm)

ENGINE FASTENER TORQUE PATTERNS

Tighten cylinder head, cylinder base, and crankcase fasteners in 3 steps following the sequence outlined below.



Cylinder Head
Cylinder Base

Crankcase

PISTON IDENTIFICATION

Note the directional and identification marks when viewing the pistons from the top. The letter "F", " → ", " ▶" or **:** must always be toward the flywheel side of the engine. The other numbers are used for identification as to diameter, length and design. Four stroke engine rings are rectangular profile. See text for oil control ring upper rail installation. Use the information below to identify pistons and rings.

Engine Model No.	Oversize Available* (mm)	Piston Length	Standard Piston Identification
EH50PLE06	.25 .50	72mm	C

*****Pistons and rings marked 25 equal .25mm (.010″) oversized
Pistons and rings marked 50 equal .50mm (.020″) oversized

EH50PLE06 ENGINE SERVICE DATA

Cylinder Head / Valve				EH50PLE-06
Rocker Arm	Rocker arm ID			.8669-.8678″ (22.020-22.041 mm)
	Rocker shaft OD			.8656-.8661″ (21.987-22.0 mm)
	Rocker shaft Oil Clearance		Std	.0008-.0021″ (.020-.054 mm)
			Limit	.0039″ (.10 mm)
Camshaft	Cam lobe height	In	Std	1.2884-1.2924″ (32.726-32.826 mm)
			Limit	1.2766″ (32.426 mm)
		Ex	Std	1.2884-1.2924″ (32.726-32.826 mm)
			Limit	1.2766″ (32.426 mm)
	Camshaft journal OD		Mag	1.4935-1.4941″ (37.935-37.950 mm)
			PTO	1.4935-1.4941″ (37.935-37.950 mm)
	Camshaft journal bore ID		Mag	1.4963-1.4970″ (38.005-38.025 mm)
			PTO	1.4963-1.4970″ (38.005-38.025 mm)
	Camshaft Oil clearance		Std	.0022-.0035″ (.055-.090 mm)
			Limit	.0039″ (.10 mm)
Cylinder Head	Surface warpage limit			.0020″ (.05 mm)
	Standard height			3.870″ (98.3 mm)
Valve Seat	Contacting width	In	Std	.028″ (.7 mm)
			Limit	.055″ (1.4 mm)
		Ex	Std	.039″ (1.0 mm)
			Limit	.071″ (1.8 mm)
Valve Guide	Inner diameter			.2362-.2367″ (6.0-6.012 mm)
	Protrusion above head			.689-.709″ (17.5-18.0 mm)
Valve	Margin thickness	In	Std	.039″ (1.0 mm)
			Limit	.031″ (.8 mm)
		Ex	Std	.047″ (1.2 mm)
			Limit	.031″ (.8 mm)
Valve	Stem diameter		In	.2343-.2348″ (5.950-5.965 mm)
			Ex	.2341-.2346″ (5.945-5.960 mm)
	Stem oil clearance	Std	In	.0014-.0024″ (.035-.062 mm)
			Ex	.0016-.0026″ (.040-.067 mm)
		Limit		.0059″ (.15 mm)
	Overall length		In	3.976″ (101.0 mm)
			Ex	3.984″ (101.2 mm)
Valve Spring	Overall length		Std	1.654″ (42.0 mm)
			Limit	1.575″ (40.0 mm)
	Squareness			.075″ (1.9 mm)

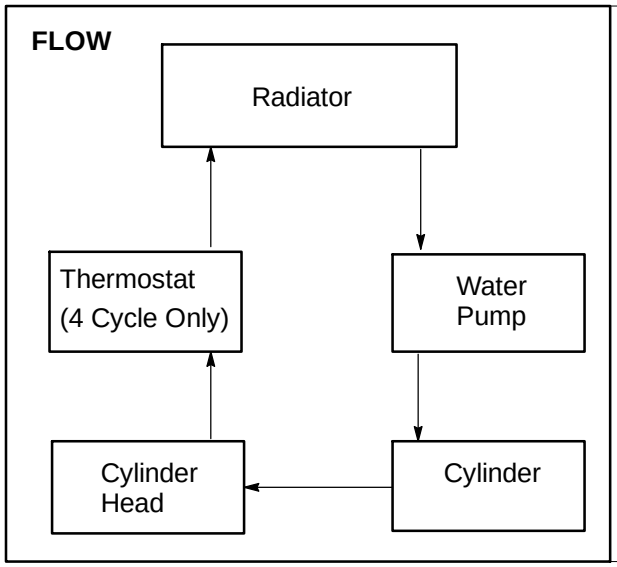
EH50PLE06 ENGINE SERVICE DATA

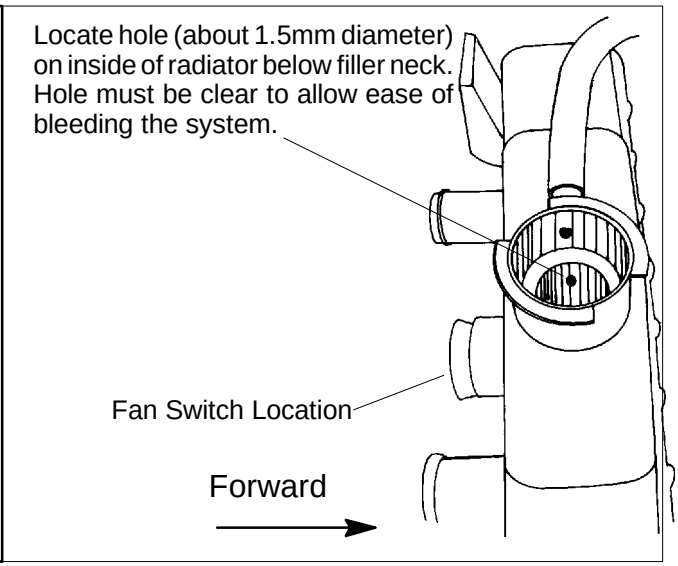
Cylinder / Piston / Connecting Rod				EH50PL06
Cylinder	Surface warpage limit (mating with cylinder head)			.0020″ (.05 mm)
	Cylinder bore		Std	3.6216-3.6224″ (91.99-92.01 mm)
	Taper limit			.0020″ (.050 mm)
	Out of round limit			.0020″ (.050 mm)
	Piston clearance		Std	.0006-.0018″ (.015-.045 mm)
			Limit	.0024″ (.060 mm)
	Boring limit			.020″ (.5 mm)
Piston	Outer diameter	Std		3.6206-3.6210″ (91.96-91.97 mm)
		.0098″ (.25 mm) OS		3.6304-3.6310 (92.21-92.23 mm)
		.0197″ (.50 mm) OS		3.6403-3.6407 (92.46-92.47 mm)
	Standard inner diameter of piston pin bore			.9055-.9057″ (23.0-23.006 mm)
Piston Pin	Outer diameter			.9053-.9055″ (22.994-23.0 mm)
	Standard clearance-piston pin to pin bore			.0002-.0003″ (.004-.008 mm)
	Degree of fit			Piston pin must be a push (by hand) fit at 68° F (20° C)
Piston Ring	Piston ring installed gap	Top ring	Std	.0079-.0138″ (.20-.36 mm)
			Limit	.039″ (1.0 mm)
		Second ring	Std	.0079-.0138″ (.20-.36 mm)
			Limit	.039″ (1.0 mm)
		Oil ring	Std	.0079-.0276″ (.20-.70 mm)
			Limit	.059″ (1.5 mm)
Piston Ring	Standard clearance - piston ring to ring groove	Top ring	Std	.0016-.0031″ (.040-.080 mm)
			Limit	.0059″ (.15 mm)
		Second ring	Std	.0012-.0028″ (.030-.070 mm)
			Limit	.0059″ (.15 mm)
Connecting Rod	Connecting rod small end ID			.9058-.9063″ (23.007-23.020 mm)
	Connecting rod small end radial clearance		Std	.0003-.0010″ (.007-.026 mm)
			Limit	.0020″ (.05 mm)
	Connecting rod big end side clearance		Std	.0039-.0256″ (.1-.65 mm)
			Limit	.0315″ (.80 mm)
	Connecting rod big end radial clearance		Std	.0004-.0015″ (.011-.038 mm)
			Limit	.0020″ (.05 mm)
Crankshaft	Crankshaft runout limit			.0024″ (.06 mm)

KEY - Std: Standard; OS: Oversize; ID: Inner Diameter; OD: Outer Diameter; Mag: Magneto Side; PTO: Power Take Off Side

COOLING SYSTEM

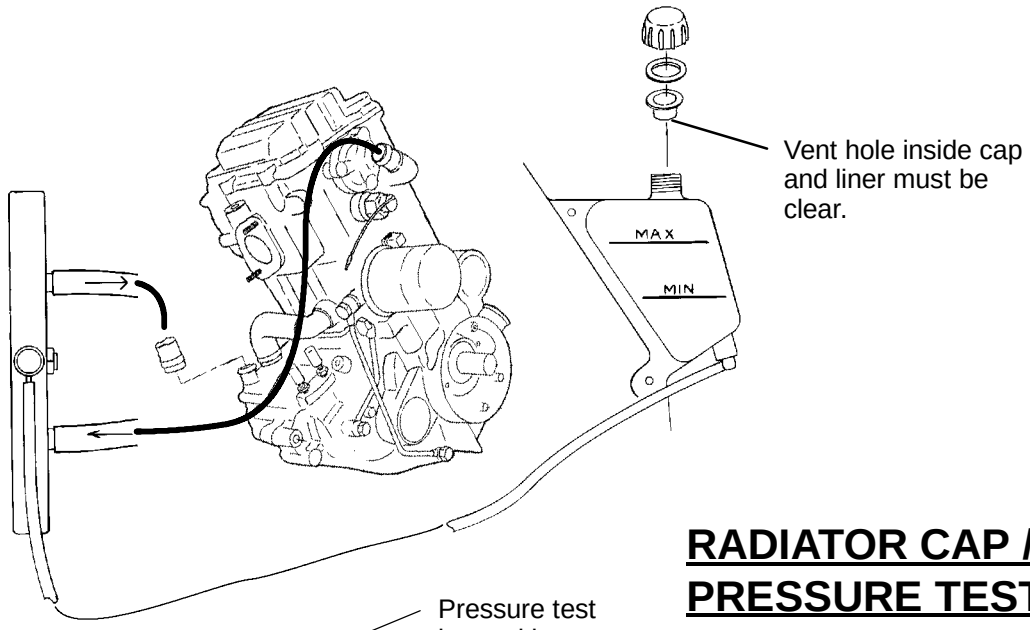
WARNING: Never remove radiator cap when engine is warm or hot. The cooling system is under pressure and serious burns may result. Allow the engine and cooling system to cool before servicing.

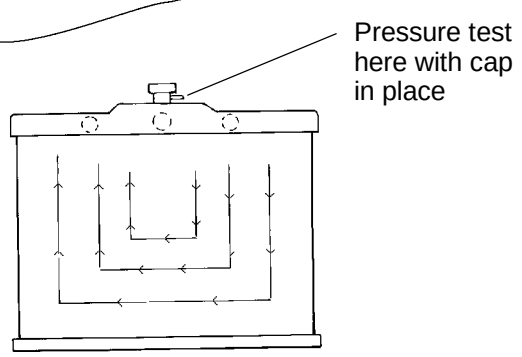




Bleed Hole Inspection

When coolant is added, air is purged through a bleed hole at the top between the two halves (see illustration above). If there is difficulty bleeding the cooling system or if overheating problems are encountered, remove the radiator cap and inspect to see if the bleed hole is clear.

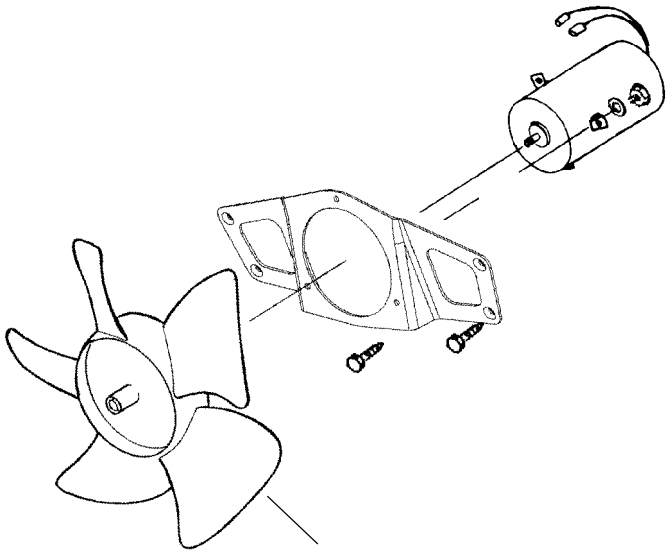




RADIATOR CAP / SYSTEM PRESSURE TEST

1. Remove radiator cap and test using a cap tester (commercially available).
2. The radiator cap relief pressure is 13 lbs. for all models.

COOLING SYSTEM, CONT.



Plastic Fan Blade

RECOMMENDED COOLANT

Use only high quality antifreeze/coolant mixed with *distilled* water in a 50/50 or 60/40 ratio, depending on freeze protection required in your area. **CAUTION:** Using tap water in the cooling system will lead to a buildup of deposits which may restrict coolant flow and reduce heat dissipation, resulting in possible engine damage. Polaris Premium 60/40 Antifreeze/Coolant is recommended for use in all cooling systems, and comes pre-mixed and ready to use.

COOLING SYSTEM SPECIFICATIONS

Fan Switch (Off) Fan Switch (On)	165° F (74° C) ± 8° 185° F (85° C) ± 7°
Hot Light On	221° F (105° C)
System Capacity	2.25 Quarts
Radiator Cap Relief Pressure	13 PSI
Thermostat	Starts opening 176° F (80° C) Open 8mm @ 205° F (96° C)

ACCESSIBLE COMPONENTS

The following components can be serviced or removed with the engine installed in the frame:

- Flywheel
- Alternator/Stator
- Starter Motor/Starter Drive
- Cylinder Head
- Cylinder
- Piston/RIngs
- Camshaft
- Rocker Arms
- Cam Chain and Sprockets
- Water Pump / Water Pump Mechanical Seal*

The following components require engine removal for service:

- Oil pump / Oil Pump Drive Gear
- Counterbalance Shaft or Bearing(s)
- Connecting Rod
- Crankshaft
- Crankshaft Main Bearings
- Crankcase

*****It may be necessary to loosen engine mounts and move engine slightly to access water pump. Special tool PN 2872105 is required to replace mechanical seal with engine in frame.

ENGINE REMOVAL (TYPICAL)

1. Clean work area.
2. Thoroughly clean the ATV engine and chassis.
3. Disconnect battery negative (-) cable.
4. Remove the following parts as required.
   - Seat
   - Left and Right Side Covers (Refer to Chapter 5)
   - Fuel Tank Cover / Front Cab (Refer to Chapter 5)
   - Fuel Tank (Refer to Chapter 4)
5. Disconnect spark plug high tension lead.
6. Remove springs from exhaust pipe and remove pipe.
7. Drain coolant and engine oil.
8. Remove air pre-cleaner and duct.
9. Remove airbox.
10. Remove carburetor. Insert a shop towel into the carburetor flange to prevent dirt from entering the intake port.
11. Remove center chain guard on chain drive AWD models.
12. Remove center drive and driven sprocket bolts and remove chain and sprockets as an assembly.
13. Refer to PVT System to remove outer clutch cover, drive belt, drive clutch, driven clutch, and inner cover.
14. Starter motor. Note ground cable location. Mark positive (+) cable mounting angle and remove cable.
15. Remove transmission linkage rod(s) from gear selector and secure out of the way.
16. Disconnect coolant temperature sensor wire.
17. Remove engine to chassis ground cable.
18. Remove all engine mount nuts and / or engine mount plates.
19. Remove engine through right side of frame.

ENGINE INSTALLATION NOTES

After the engine is installed in the frame, review this checklist and perform all steps that apply.

General Items

1. Install previously removed components using new gaskets, seals, and fasteners where applicable.
2. Perform regular checks on fluid levels, controls, and all important areas on the vehicle as outlined in the daily pre-ride inspection checklist (refer to Chapter 2 or the Owner's Safety and Maintenance Manual).

PVT System

1. Adjust center distance of drive and driven clutch. (Chapter 6)
2. Adjust clutch offset, alignment, and belt deflection. (Chapter 6)
3. Clean clutch sheaves thoroughly and inspect inlet and outlet ducts for proper routing and sealing. (Chapter 6)

Transmission

1. Inspect transmission operation and adjust linkage if necessary. Refer to Chapter 2 and Chapter 8.

Exhaust

1. Replace exhaust gaskets. Seal connections with high temp silicone sealant.
2. Check to be sure all springs are in good condition.

Bleed Cooling System

1. Remove radiator cap and slowly add coolant to top of filler neck.
2. Fill coolant reservoir tank to full mark.
3. Install radiator cap and squeeze coolant lines to force air out of system.
4. Again remove radiator cap and slowly add coolant to top of fill neck.
5. Start engine and observe coolant level in the radiator. Allow air to purge and top off as necessary. Reinstall radiator cap and bring engine to operating temp. Check level in reservoir tank after engine is cool and add coolant if necessary.

Engine Break In Period

4 Cycle Engine Break-In Period is defined as the first 10 hours of engine operation, or 2 full tanks of fuel.

1. Use only Polaris Premium 4 All Season synthetic oil, or API certified "SH" oil. Never substitute or mix oil brands. Serious engine damage can result.
2. Use fuel with a minimum octane of 87 (R+M)/2 method.
3. Change break-in oil and filter at 20 hours or 500 miles, whichever comes first.

CYLINDER HONE SELECTION/HONING PROCEDURE

Selecting a hone which will straighten as well as remove material from the cylinder is very important. Using a common spring loaded finger type glaze breaker for honing is never advised. Polaris recommends using a rigid hone or arbor honing machine which also has the capability of oversizing.

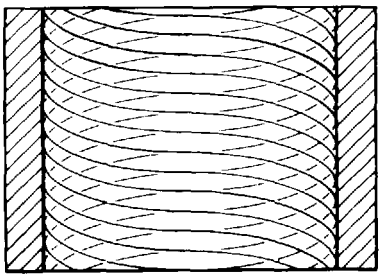
Cylinders may be wet or dry honed depending upon the hone manufacturer's recommendations. Wet honing removes more material faster and leaves a more distinct pattern in the bore.

CAUTION:

HONING TO OVERSIZE

If cylinder wear or damage is excessive, it will be necessary to oversize the cylinder using a new oversize piston and rings. This may be accomplished by either boring the cylinder and then finish honing to the final bore size, or by rough honing followed by finish honing.

For oversize honing always wet hone using honing oil and a coarse roughing stone. Measure the piston (see piston measurement) and rough hone to the size of the piston. Always leave .002 - .003″ (.05 - .07 mm) for finish honing. Refer to piston-to-cylinder clearance specifications on page 3.4 before honing. Complete the sizing with fine grit stones to provide the proper cross-hatch finish and required piston clearance.



EXAMPLE OF CROSS HATCH PATTERN

A finished cylinder should have a cross-hatch pattern to ensure piston ring seating and to aid in the retention of the fuel/oil mixture during initial break in. Hone cylinder according to hone manufacturer's instructions, or these guidelines:

- Use a motor speed of approximately 300-500 RPM, run the hone in and out of the cylinder rapidly until cutting tension decreases. Remember to keep the hone drive shaft centered (or cylinder centered on arbor) and to bring the stone approximately 1/2″ (1.3 cm) beyond the bore at the end of each stroke.
- Release the hone at regular intervals and inspect the bore to determine if it has been cleared, and to check piston fit. **NOTE:** Do not allow cylinder to heat up during honing. The thinner areas of the liner around the ports will expand causing uneven bore.
- After honing has been completed inspect all port opening areas for rough or sharp edges. Apply a slight chamfer to all ports to remove sharp edges or burrs, paying particular attention to the corners of the intake and exhaust ports.

IMPORTANT:

CLEANING THE CYLINDER AFTER HONING

It is very important that the cylinder be thoroughly cleaned after honing to remove all grit material. Wash the cylinder in a solvent, then in hot, soapy water. Pay close attention to areas where the cylinder sleeve meets the aluminum casting (transfer port area). Use electrical contact cleaner if necessary to clean these areas. Rinse thoroughly, dry with compressed air, and oil the bore immediately with Polaris 2 Cycle Lubricant.

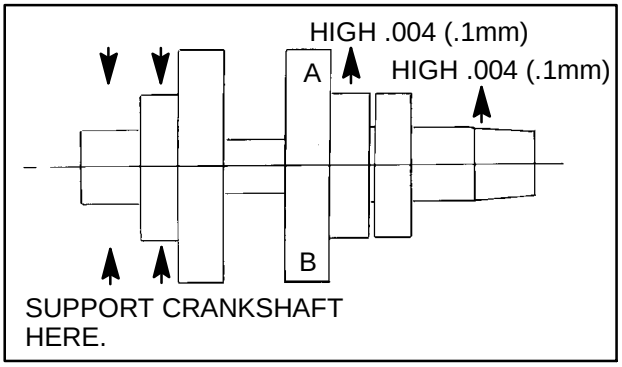
CRANKSHAFT STRAIGHTENING

Lubricate the bearings and clamp the crankshaft securely in the holding fixture. Refer to the illustrations below.

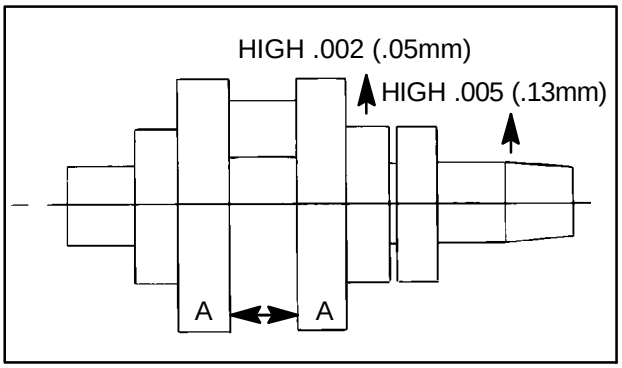
Crankshaft Alignment Fixture
PN 2870569

NOTE: The rod pin position in relation to the dial indicator position tells you what action is required to straighten the shaft.

4. To correct a situation like the one shown in the illustration at right, strike the shaft at point A with a brass hammer.

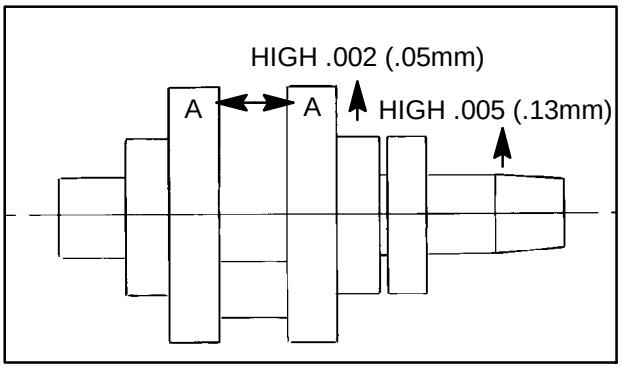


5. To correct a situation like the one shown in the illustration at right, squeeze the crankshaft at point A. (Use tool from alignment kit).



6. If the crank rod pin location is 180° from the dial indicator (opposite that shown above), it will be necessary to spread the crankshaft at position A as shown in the illustration at right. When rebuilding and straightening a crankshaft, runout must be as close to zero as possible.

NOTE: Maximum allowable runout is .0024″.



ENGINE LUBRICATION - EH50PL

Oil Type . . . . . Polaris Premium 4 Synthetic (PN 2871281); or API certified “SH” 5W30 oil

Capacity . . . . . Approximately 2 U.S. Quarts (1.9 l)

Filter . . . . . PN 3084963

Filter Wrench . . . . . Snap On PN YA997 or equivalent

Drain Plug / Screen Fitting . . . 14 ft. lbs. (19 Nm) (If fitting is removed, follow oil pump priming procedure).

Oil Pressure Specification . . . . 20 PSI @ 5500 RPM, Polaris 0W/40 Synthetic (Engine Hot)

OIL PRESSURE TEST - EH50PL

1. Remove blind plug on front left cylinder head.
2. Insert a 1/8 NPT oil pressure gauge adaptor into the cylinder head and attach the gauge.
3. Start engine and allow it to reach operating temperature, monitoring gauge indicator.

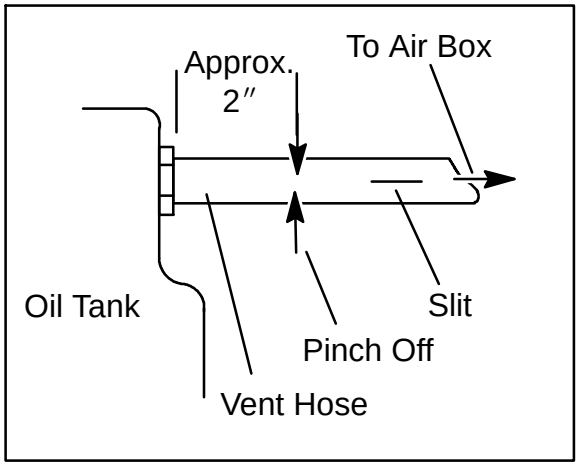
NOTE: Use Polaris Premium 4 Synthetic Engine Lubricant

Oil Pressure at 5500 RPM (Engine Hot):
Standard: 20 PSI
Minimum: 12 PSI

OIL PUMP PRIMING PROCEDURE

NOTE:This priming procedure must be performed whenever the oil hose connection between the oil tank and pump inlet has been disconnected.

1. Clamp or pinch off vent line approximately 2″ from oil tank to avoid the end of oil tank vent fitting, and the vent line’s pressure relief slit
2. Run engine for 45-60 seconds.
3. Remove the vent line clamp. The oil pump will now be properly primed and ready for field operation.



OIL FLOW - EH50PL

The chart on page 3.15 describes the flow of oil through the EH50PL engine. Beginning at the oil tank, the oil flows through a screen fitting in the bottom of the tank and into the oil supply hose. The feed side of the oil pump draws oil through the hose and into the crankcase oil gallery, and then pumps the oil through another passage to the one way valve. (When the engine is off, the one way valve closes to prevent oil in the tank from draining into the crankcase.) The oil is pumped through a delivery pipe to the oil filter. If the oil filter is obstructed, a bypass valve contained in the filter allows oil to bypass the filter element.

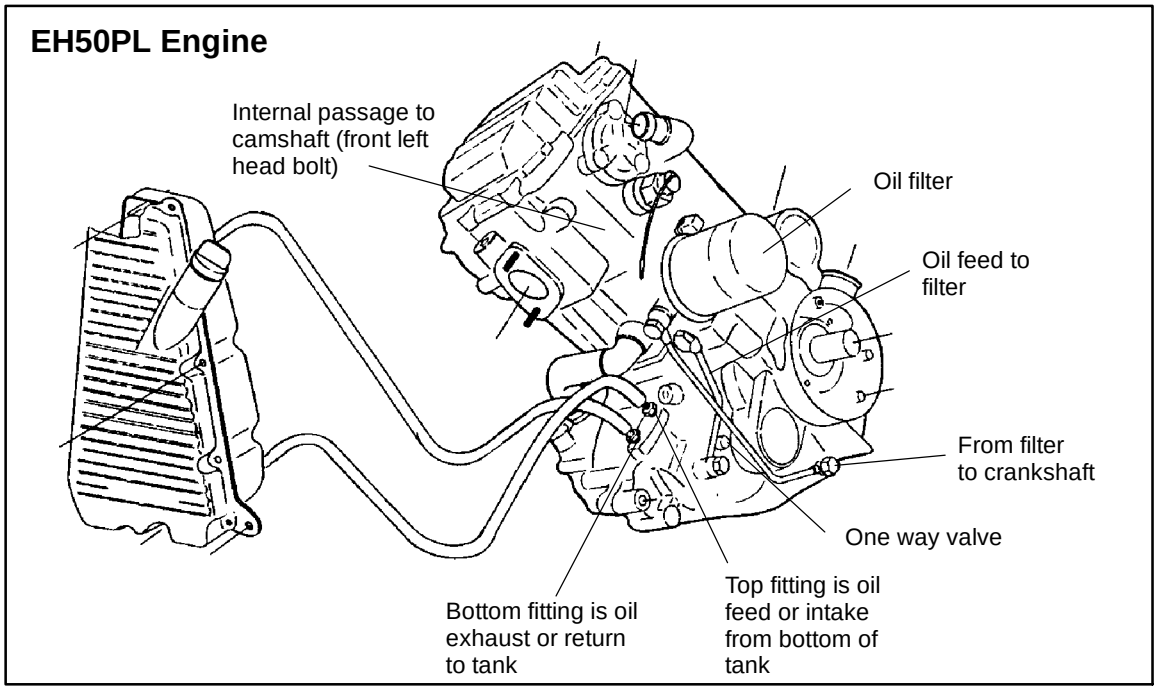
At this point, the oil is diverted in two directions. Oil is supplied to the camshaft through the left front cylinder stud, and an oil passage in the head. Oil enters the camshaft through the PTO (L) journal. The camshaft journals, cam lobes, and rocker arms are lubricated through holes in the camshaft. The oil lubricates the cam chain and sprocket and drains to the sump.

The other oil path from the filter leads through a delivery pipe to the crankcase main oil gallery, which leads to the stator plate oil passage. Here it passes through the slotted friction bearing (located in the stator plate) into the crankshaft. An oil seal on the stator plate prevents oil from entering the stator/flywheel area. Oil travels through the crankshaft to the crank pin, lubricating the connecting rod large end bearing directly. Oil also passes through an oil jet (drilled orifice) in the end of the crank pin to the PTO end main bearings and counterbalancer gears.

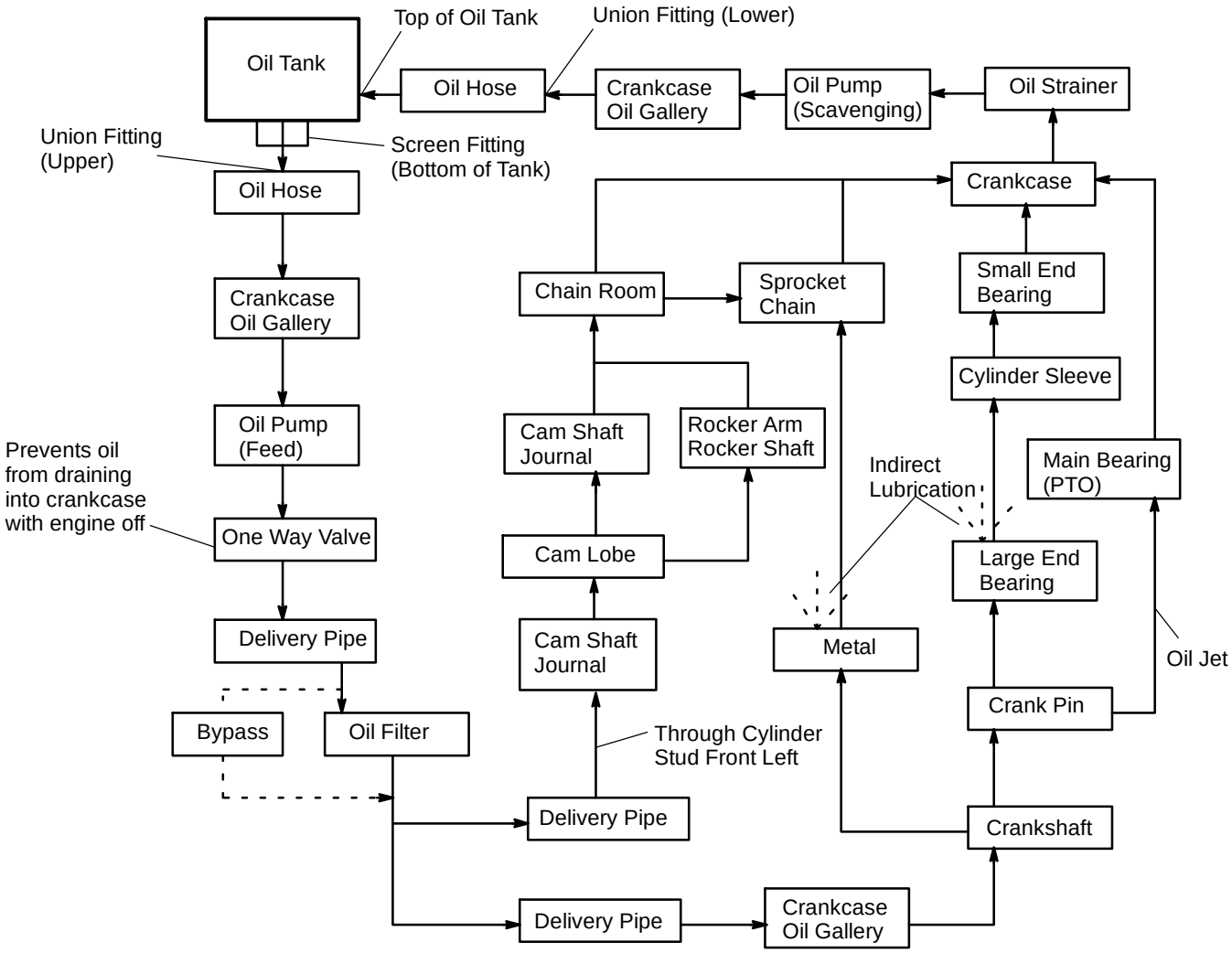
Residual oil from the lubrication of the crankshaft and connecting rod indirectly lubricates the cylinder wall, piston, rings, connecting rod small end bearing, piston pin, oil/water pump drive gears, cam chain and drive sprocket, and Magneto end crankshaft main bearing.

The one-way valve is located on the front left (PTO) side of the crankcase. The valve prevents oil in the tank from draining into the engine sump when the engine is off. The valve mechanism consists of a plunger, return spring, guide plug, and sealing washer. When the engine is running, oil pressure lifts the plunger off the seat, allowing oil flow. When the engine is off, spring pressure forces the plunger against the oil passage seat, preventing oil flow from the tank to the sump. The one-way valve requires very little maintenance. If engine oil drains into the sump when the engine is off, inspect the valve sealing surface for debris or damage. Inspect the return spring for distortion or damage.

EH50PL OIL FLOW DIAGRAM

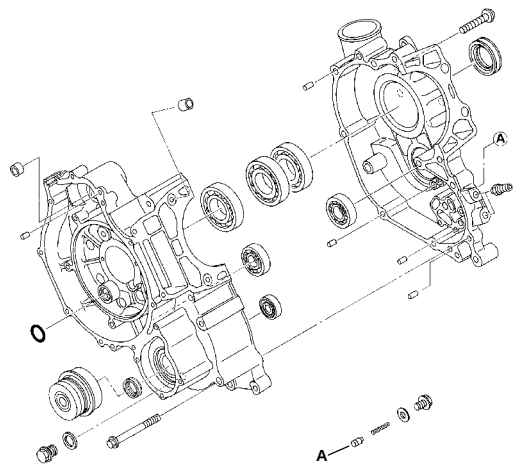


EH50PL Oil Flow Chart

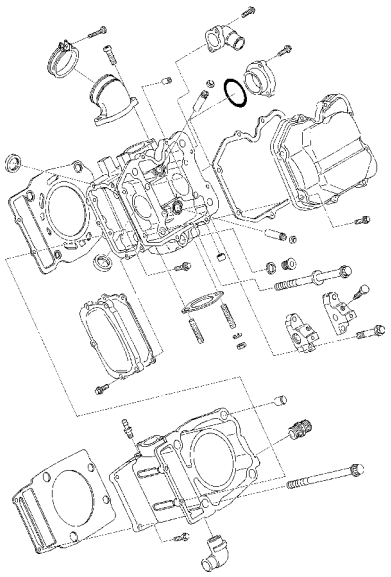


EH50PL ENGINE EXPLODED VIEW

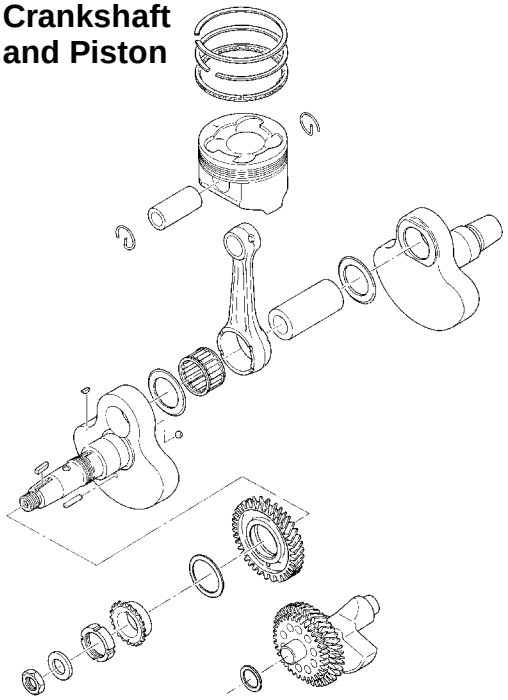
Crankcase



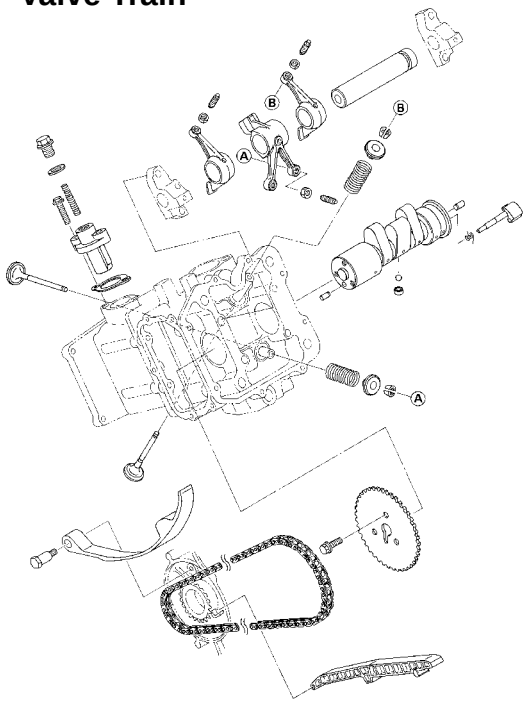
Cylinder/ Cylinder Head



Crankshaft and Piston



Valve Train



ENGINE REMOVAL

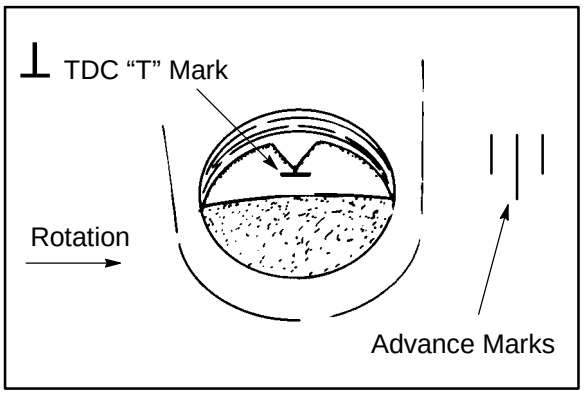
REFER TO PAGE 3.8 - 3.10 FOR ENGINE REMOVAL / INSTALLATION NOTES.

CAM CHAIN TENSIONER/ROCKER ARM/CAMSHAFT REMOVAL

1. Remove ignition timing inspection plug from recoil housing.

To position crankshaft at Top Dead Center (TDC) on compression stroke:

2. Rotate engine slowly in the direction of rotation watching intake valves open and start to close.
3. Continue to rotate engine slowly, watching camshaft sprocket marks and the mark in the timing inspection hole.

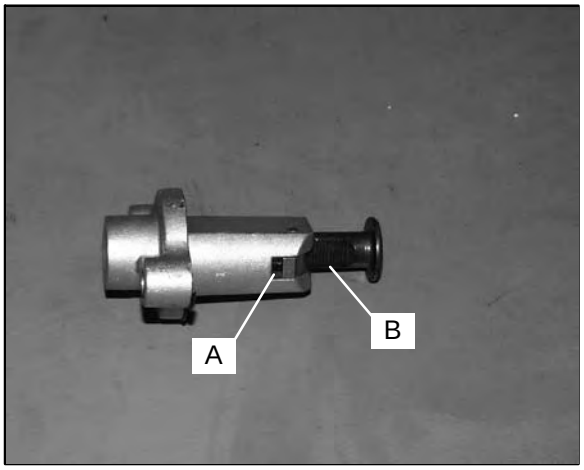


4. Align single (TDC) mark on flywheel with projection in inspection hole, and the cam sprocket pin (facing upward) aligned with the camshaft to crankshaft center line. **NOTE:** The cam lobe should be pointing down and valves should have clearance at this point.

5. Remove cam chain tensioner plug, sealing washer, and spring. **CAUTION:** The plug is under spring tension. Maintain inward pressure while removing.
6. Remove the two 6x25 mm cam chain tensioner flange bolts.
7. Tap lightly on tensioner body with a soft face hammer and remove tensioner.

CAM CHAIN TENSIONER INSPECTION

1. Pull cam chain tensioner plunger outward to the end of its travel. Inspect teeth on ratchet pawl (A) and plunger teeth (B) for wear or damage.
2. Push ratchet pawl and hold it. The plunger should move smoothly in and out of the tensioner body.
3. Release ratchet pawl and push inward on plunger. It should remain locked in position and not move inward.

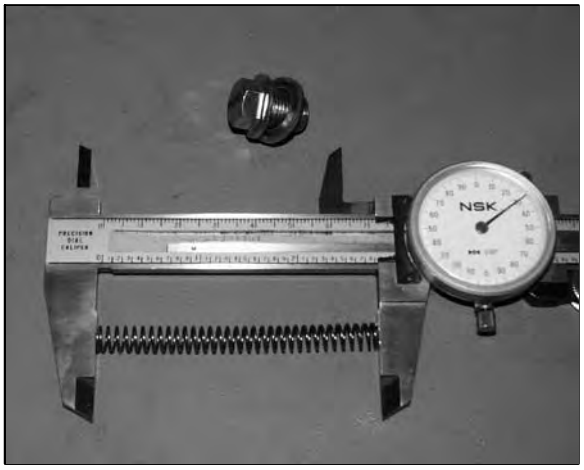


4. Measure free length of tensioner spring. Replace spring if excessively worn. Compare to specifications.

Tensioner Spring Free Length:

2.320″ (5.9 cm)

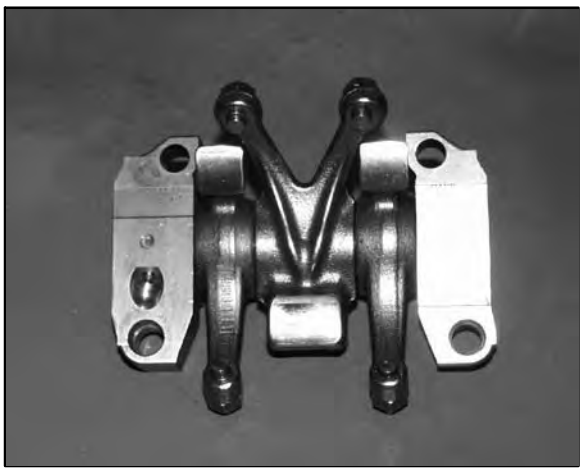
5. Replace entire tensioner assembly if any part is worn or damaged.



ROCKER ARM/SHAFT INSPECTION

1. Mark or tag rocker arms to keep them in order for assembly.

2. Inspect each rocker arm cam follower surface. If there is any damage or uneven wear, replace the rocker arm. **NOTE:** Always inspect camshaft lobe if rocker arms are worn or damaged.



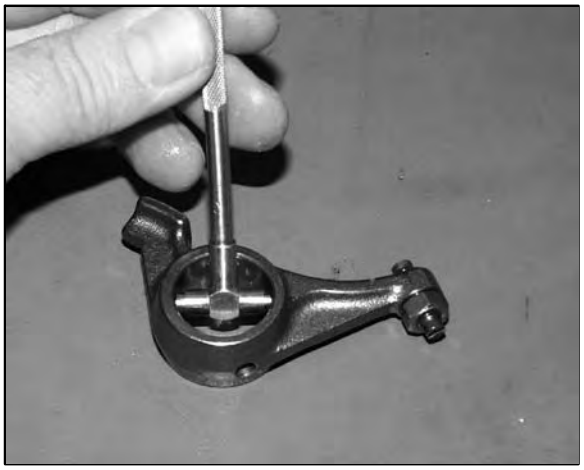
3. Measure O.D. of rocker shaft. Inspect it for wear or damage. Compare to specifications.

Rocker Shaft O.D.:

.8656-.8661″ (21.987-22.0 mm)

ROCKER ARM/SHAFT INSPECTION, CONT.

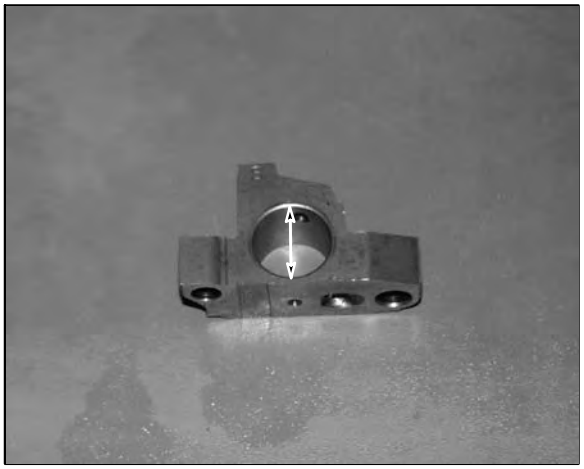
4. Measure I.D. of each rocker arm and compare to specifications.



Rocker Arm & Support I.D.:

.8669-.8678″ (22.020-22.041 mm)

5. Measure I.D. of both rocker arm shaft supports and visually inspect surface. Compare to specifications.
6. Subtract rocker shaft O.D. from rocker arm & shaft support I.D. This is the oil clearance. Compare to specifications.



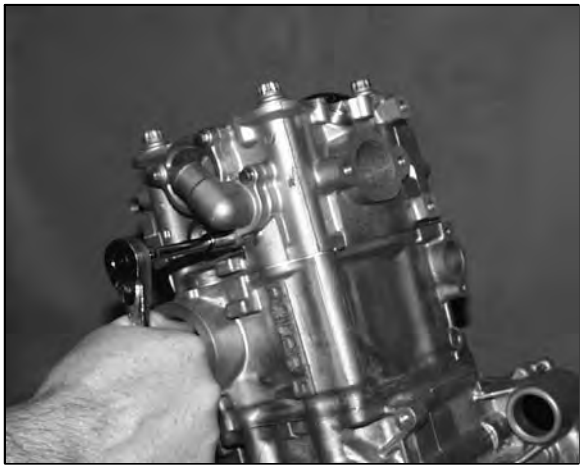
Rocker Shaft Oil Clearance:

Std: .0008-.0021″ (.020-.054 mm)
Limit: .0039″ (.10 mm)

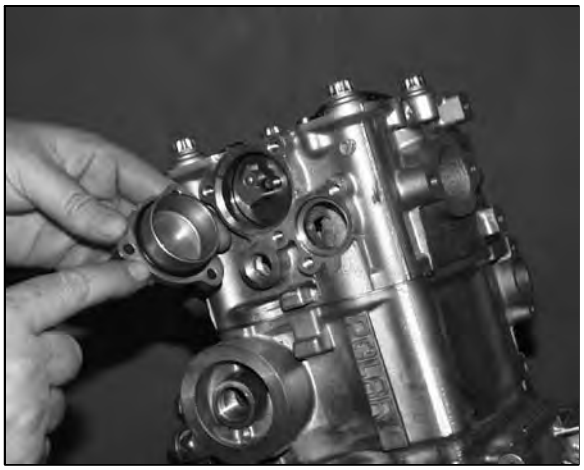
7. Inspect rocker adjuster screws for wear, pitting, or damage to threads of the adjuster or locknut. Replace all worn or damaged parts. **NOTE:** The end of the adjuster screw is hardened and cannot be ground or re-faced.

CAMSHAFT REMOVAL

1. Remove thermostat housing.
2. Remove camshaft sprocket inspection cover.
3. Loosen three camshaft sprocket bolts.



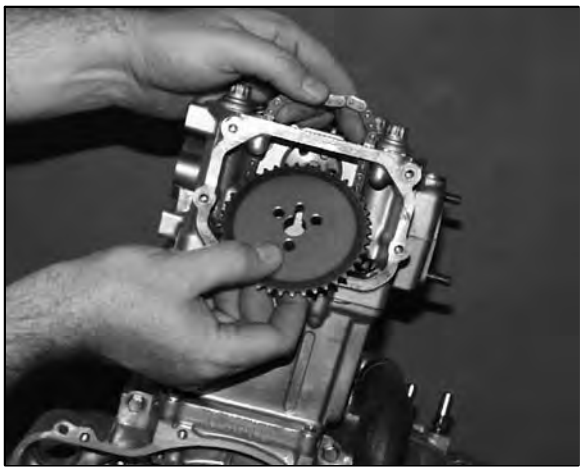
4. Remove camshaft end cap and O-Ring.



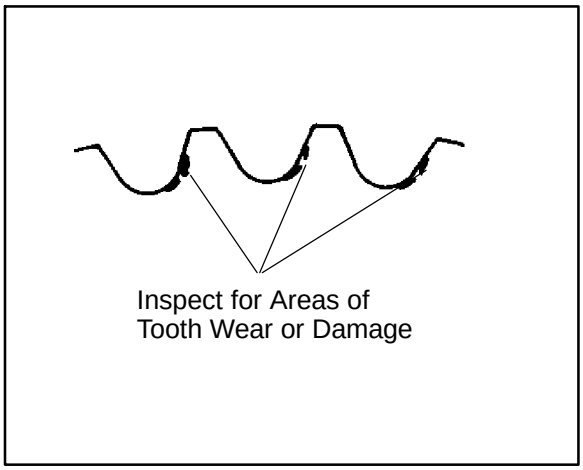
5. Inspect camshaft end cap (thrust face) for wear. Replace if worn or damaged.

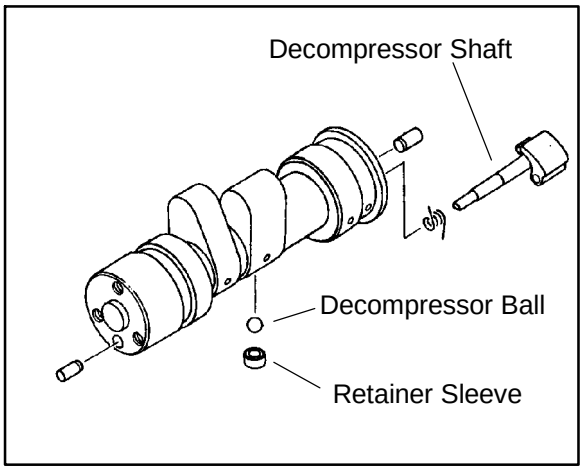
CAMSHAFT REMOVAL, CONT.

6. Place a clean shop towel in the area below cam chain sprocket and remove sprocket retaining bolts.
7. Slide camshaft inward to allow removal of cam sprocket and remove sprocket from camshaft and chain.



8. Secure cam chain with a wire to prevent it from falling into the crankcase.
9. Inspect cam sprocket teeth for wear or damage. Replace if necessary.
10. Slide camshaft out the PTO side of the cylinder head.





AUTOMATIC COMPRESSION RELEASE REMOVAL/INSPECTION

NOTE: The automatic compression release mechanism can be inspected and serviced without removing the camshaft from the cylinder head. The actuator ball in the camshaft is not replaceable. Replace the camshaft as an assembly if the actuator ball is worn or damaged.

1. Check release lever shaft for smooth operation throughout the entire range of rotation. The spring should hold the shaft weight against the stop pin. In this position, the actuator ball will be held outward in the compression release mode.
2. Remove release lever shaft and return spring.
3. Inspect shaft for wear or galling.
4. Inspect lobe on end of release lever shaft and actuator ball for wear and replace if necessary.

AUTOMATIC COMPRESSION RELEASE INSTALLATION

1. Slide spring onto shaft.
2. Apply engine oil to release lever shaft.

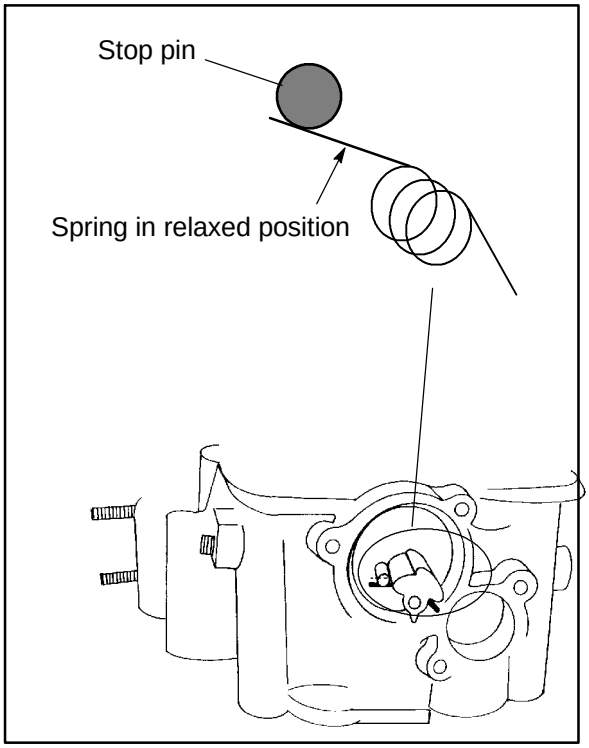
The actuator ball must be held outward to allow installation of the release lever shaft.

If Camshaft Is Removed From Engine:

3. Turn the camshaft until the actuator ball is in the lowest position and install the release lever shaft.

If Camshaft Is Installed In The Engine:

4. Use a small magnet to draw the actuator ball outward, or rotate the engine until the cam lobes face upward and install release lever shaft.
5. Position camshaft as shown at bottom of illustration at right.
6. Place arm of spring under stop pin as shown and push release lever inward until fully seated. *Do not* pre-wind the spring one full turn or the compression release will not disengage when the engine starts. Check operation of mechanism as outlined in step 1 of Removal (above).
   NOTE: When shaft is properly installed, actuator ball will be held in the “out” position. It is important to note that spring pressure is very light.

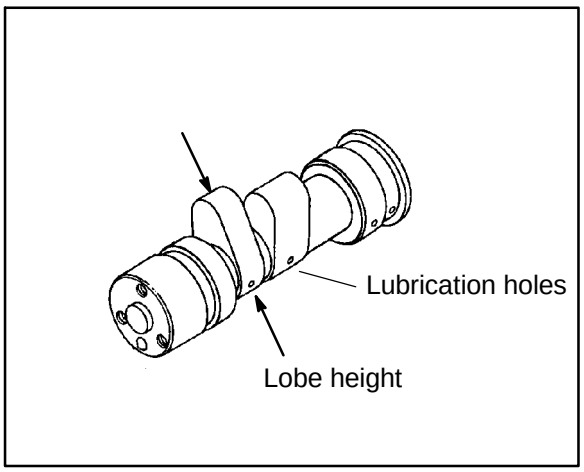


CAMSHAFT INSPECTION

1. Visually inspect each cam lobe for wear, chafing or damage.
2. Thoroughly clean the cam shaft, making sure the oil feed holes are not obstructed.
3. Measure height of each cam lobe using a micrometer. Compare to specifications.

Cam Lobe Height (Intake & Exhaust):

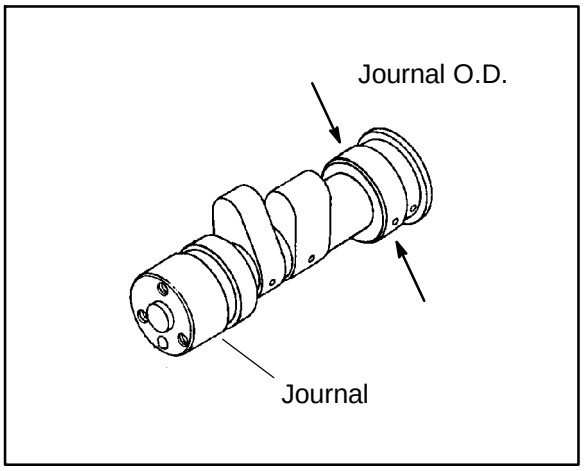
Std: 1.2884-1.2924″ (32.726-32.826 mm)
Limit: 1.2766″ (32.426 mm)



4. Measure camshaft journal outside diameter (O.D.)

Camshaft Journal O.D.:

Mag & PTO End: 1.4935-1.4941″
(37.935-37.950 mm)



5. Measure ID of camshaft journal bore.

Camshaft Journal I.D.:

Mag & PTO End: 1.4963-1.4970″
(38.005-38.025 mm)

6. Calculate oil clearance by subtracting journal OD from journal bore ID. Compare to specifications.

Camshaft Oil Clearance:

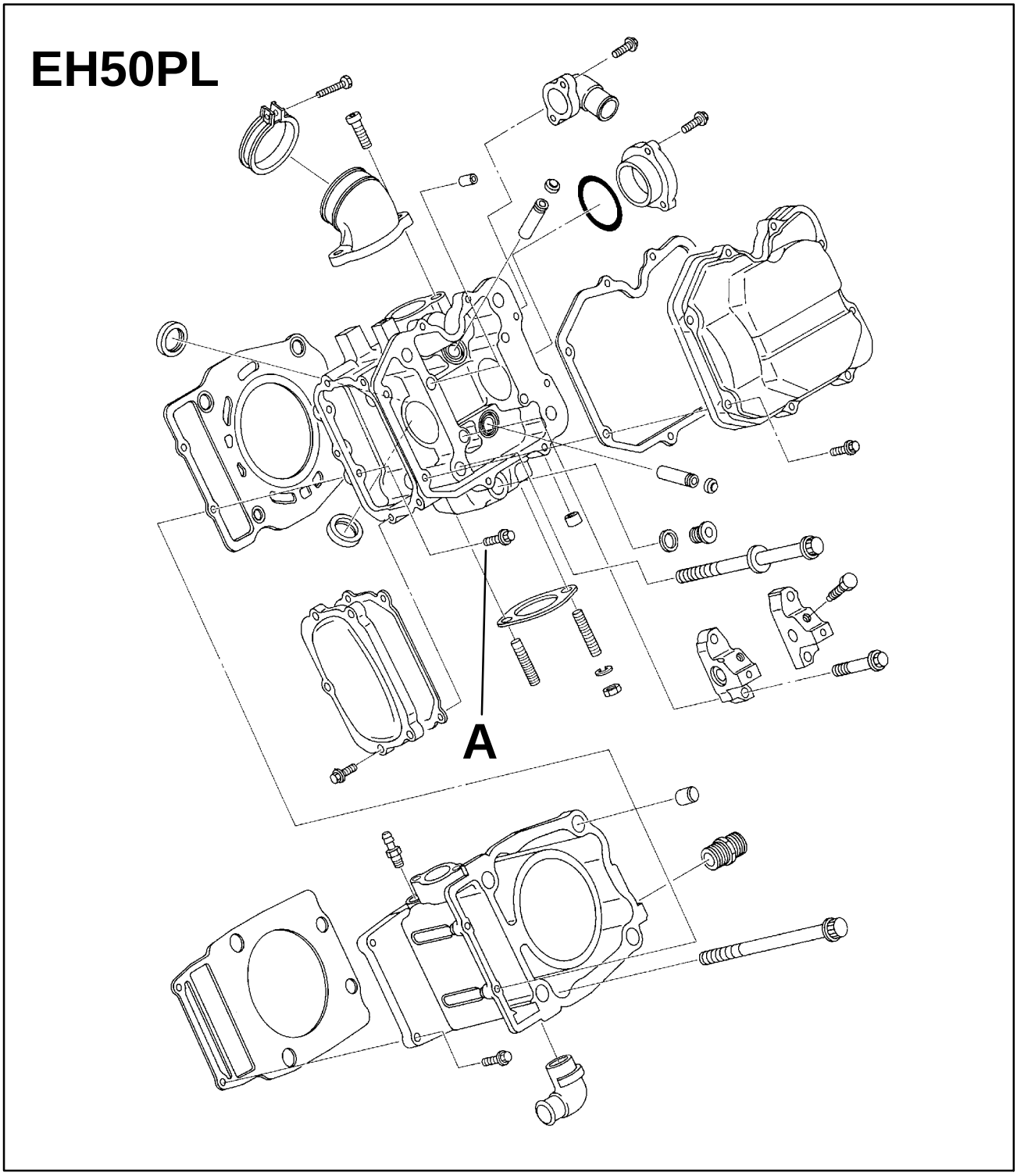
Std: .0022-.0035″ (.055-.090 mm)
Limit: .0039″ (.10 mm)

Replace camshaft if damaged or if any part is worn past the service limit.

Replace cylinder head if camshaft journal bore is damaged or worn excessively.

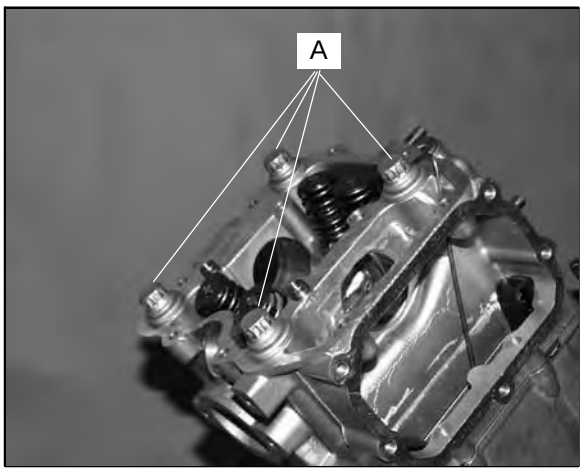
CYLINDER HEAD EXPLODED VIEW, EH50PL

1. Remove the two 6mm flange bolts (A) from cylinder head.



CYLINDER HEAD REMOVAL, CONT.

2. Loosen each of the four cylinder head bolts evenly 1/8 turn each time in a criss-cross pattern until loose.
3. Remove bolts (A) and tap cylinder head lightly with a plastic hammer until loose. **CAUTION:** Tap only in reinforced areas or on thick parts of cylinder head casting to avoid damaging the thread.
4. Remove cylinder head and head gasket.



CYLINDER HEAD INSPECTION

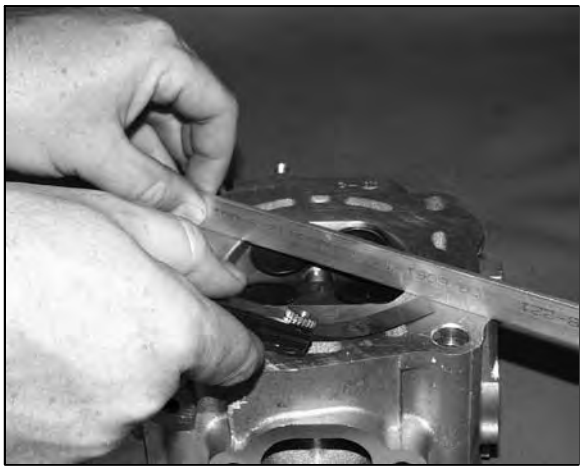
1. Thoroughly clean cylinder head surface to remove all traces of gasket material and carbon. **CAUTION:** Use care not to damage sealing surface.

CYLINDER HEAD WARPAGE

1. Lay a straight edge across the surface of the cylinder head at several different points and measure warpage by inserting a feeler gauge between the straight edge and the cylinder head surface. If warpage exceeds the service limit, replace the cylinder head.

Cylinder Head Warpage Limit:

.002″ (.05 mm)

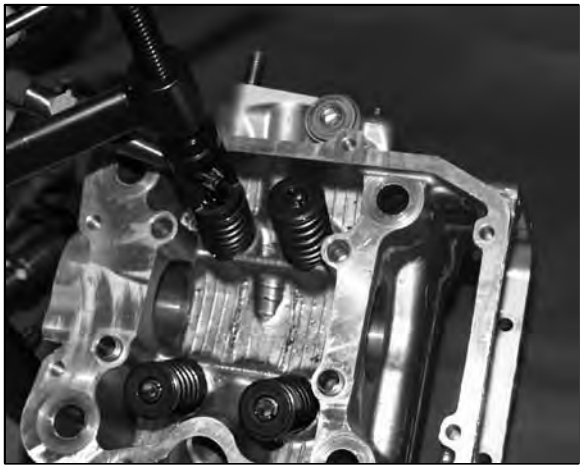


CYLINDER HEAD DISASSEMBLY

WARNING: Wear eye protection or a face shield during cylinder head disassembly and reassembly.

NOTE: Keep all parts in order with respect to their location in the cylinder head.

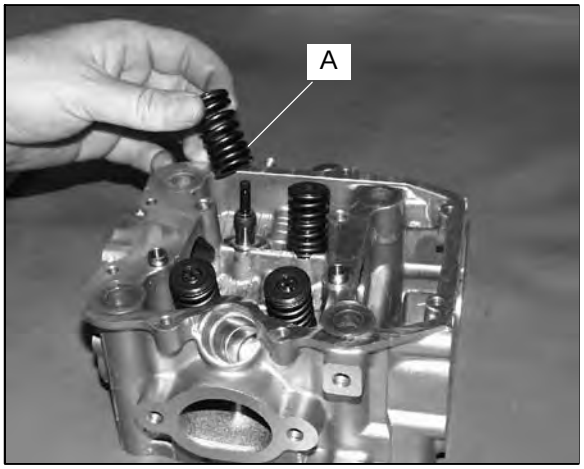
1. Using a valve spring compressor, compress the valve spring and remove the split keeper. **NOTE:** To prevent loss of tension, do not compress the valve spring more than necessary.



2. Remove spring retainer and spring.

NOTE: The valve springs should be positioned with the tightly wound coils against the cylinder head on progressively wound springs (A).

3. Push valve out, keeping it in order for reassembly in the same guide.

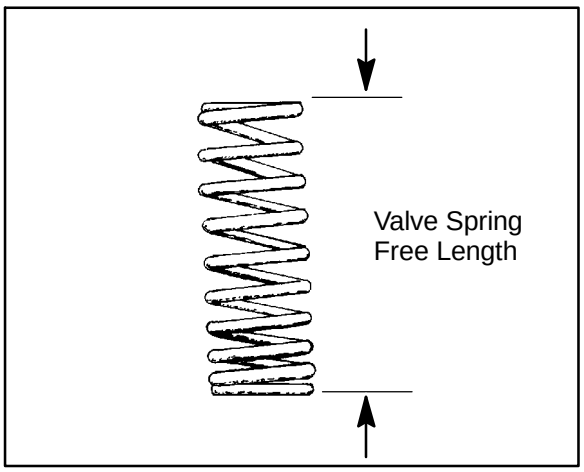


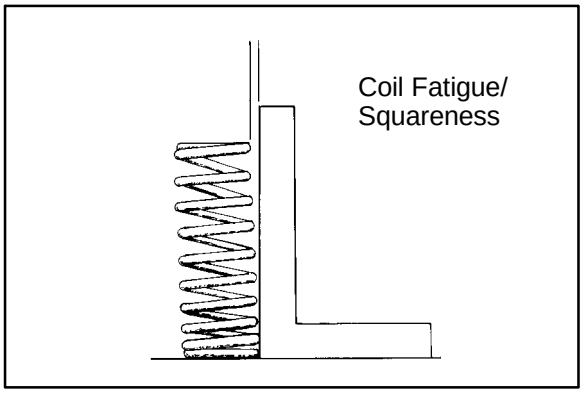
CYLINDER HEAD DISASSEMBLY, CONT.

4. Measure free length of spring with a Vernier caliper. Check spring for squareness. Compare to specifications. Replace spring if either measurement is out of specification.

Valve Spring Length:
Std: 1.654″ (42.0 mm)
Limit: 1.575″ (40.0 mm)

Squareness:
.075″ (1.9 mm)

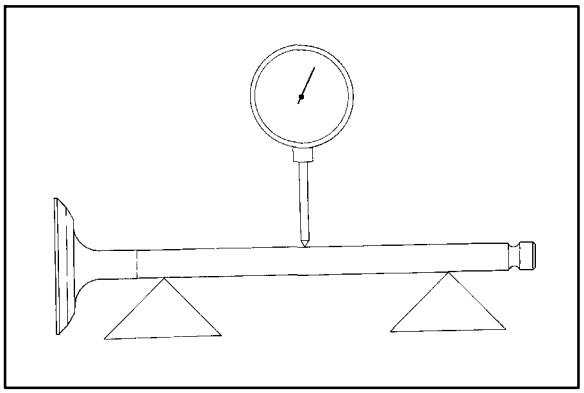




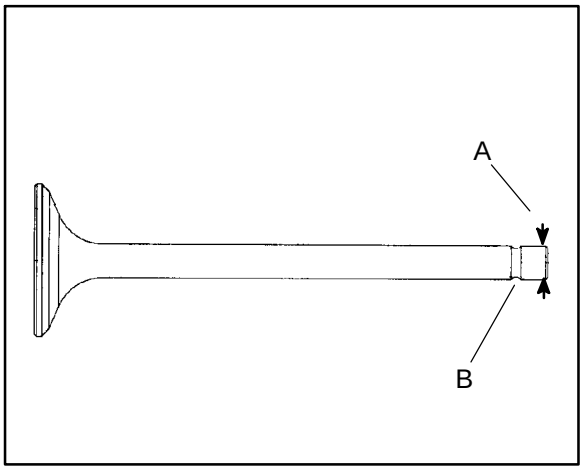
5. Remove valve seals. **CAUTION:** Replace seals whenever the cylinder head is disassembled. Hardened, cracked or worn valve seals will cause excessive oil consumption and carbon buildup.

VALVE INSPECTION

1. Remove all carbon from valve with a soft wire wheel.
2. Check valve face for runout, pitting, and burnt spots. To check for bent valve stems, mount valve in a drill or use “V” blocks and a dial indicator.

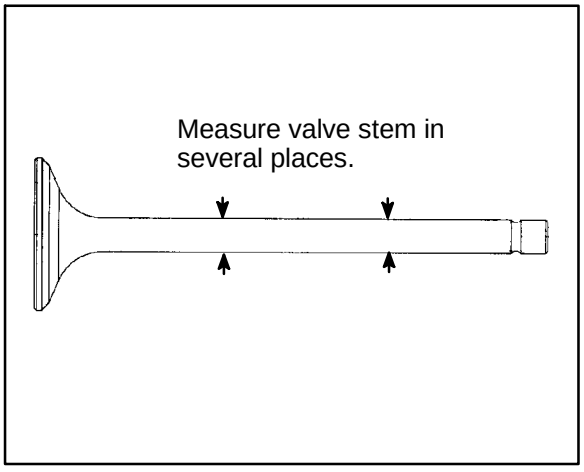


3. Check end of valve stem for flaring, pitting, wear or damage (A).
4. Inspect split keeper groove for wear or flaring of the keeper seat area (B). **NOTE:** The valves cannot be re-faced or end ground. They must be replaced if worn, bent, or damaged.



5. Measure diameter of valve stem with a micrometer in three places and in two different directions (six measurements total). Compare to specifications.

Valve Stem Diameter:
Intake: .2343-.2348″ (5.950-5.965 mm)
Exhaust: .2341-.2346″ (5.945-5.960 mm)

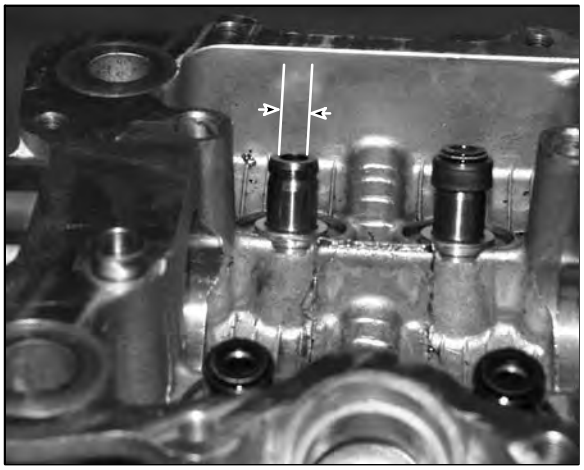


VALVE INSPECTION, CONT.

6. Measure valve guide inside diameter at the top middle and end of the guide using a small hole gauge and a micrometer. Measure in two directions, front to back and side to side.

7. Subtract valve stem measurement to obtain stem to guide clearance. **NOTE:** Be sure to measure each guide and valve combination individually.

8. Replace valve and/or guide if clearance is excessive. Compare to specifications.



Valve Guide I.D.:
.2362-.2367″ (6.0-6.012 mm)

NOTE: If valve guides are replaced, valve seats must be reconditioned. Refer to Valve Seat Reconditioning for procedure.

COMBUSTION CHAMBER

Clean all accumulated carbon deposits from combustion chamber and valve seat area with a soft wire brush.

VALVE SEAT RECONDITIONING

Valve Seat Inspection

Inspect valve seat in cylinder head for pitting, burnt spots, roughness, and uneven surface. If any of the above conditions exist, the valve seat must be reconditioned. See Valve Seat Reconditioning, page 3.33. *If the valve seat is cracked the cylinder head must be replaced.*

Cylinder Head Reconditioning

NOTE: Servicing the valve guides and valve seats requires special tools and a thorough knowledge of reconditioning techniques. Follow the instructions provided in the cylinder head service tool kit.

CAUTION: Wear eye protection when performing cylinder head service. Valve guide replacement will require heating of the cylinder head. Wear gloves to prevent burns.

Valve Guide Removal/Installation

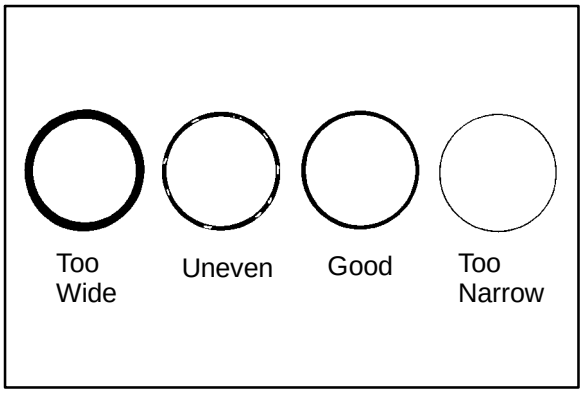
1. Remove all carbon deposits from the combustion chamber, valve seat and valve guide area before attempting to remove valve guides. **CAUTION:** Carbon deposits are extremely abrasive and may damage the valve guide bore when guides are removed.

2. Place new valve guides in a freezer for at least 15 minutes while heating cylinder head.

3. Heat cylinder head in an oven or use a hot plate to bring cylinder head temperature to 212° F (100° C). **CAUTION:** Do not use a torch to heat cylinder head or warpage may result from uneven heating. Head temperature can be checked with a pyrometer or a welding temperature stick.

VALVE SEAT RECONDITIONING, CONT.

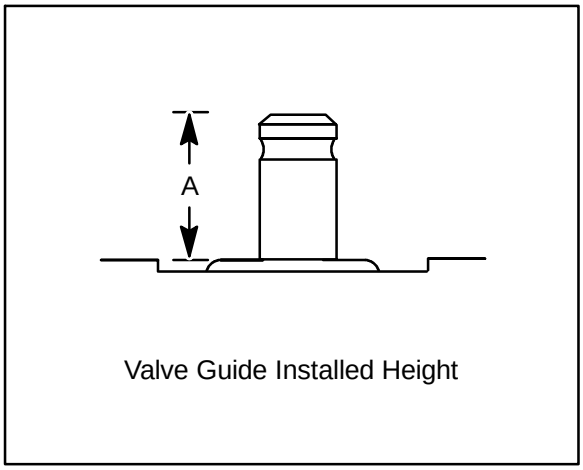
Follow the manufacturers instructions provided with the valve seat cutters in the Cylinder Head Reconditioning Kit (PN 2200634). Abrasive stone seat reconditioning equipment can also be used. Keep all valves in order with their respective seat.



NOTE: Valve seat width and point of contact on the valve face is very important for proper sealing. The valve must contact the valve seat over the entire circumference of the seat, and the seat must be the proper width all the way around. If the seat is uneven, compression leakage will result. If the seat is too wide, seat pressure is reduced, causing carbon accumulation and possible compression loss. If the seat is too narrow, heat transfer from valve to seat is reduced and the valve may overheat and warp, resulting in burnt valves.

1. When thoroughly heated, place cylinder head on blocks of wood which will allow the old guides to be removed.
2. Using valve guide driver, drive guides out of the cylinder head from the combustion chamber side. Be careful not to damage guide bore or valve seat when removing guides.
3. Place cylinder head on cylinder head table. **NOTE:** Be sure cylinder head is still at 212° F (100° C) before installing new guides.
4. Place a new guide in the valve guide installation tool and press guide in to proper depth. Check height of each guide above the cylinder head (A). **NOTE:** The guide can also be driven in to the proper depth. Inspect the guide closely for cracks or damage if a driver is used.

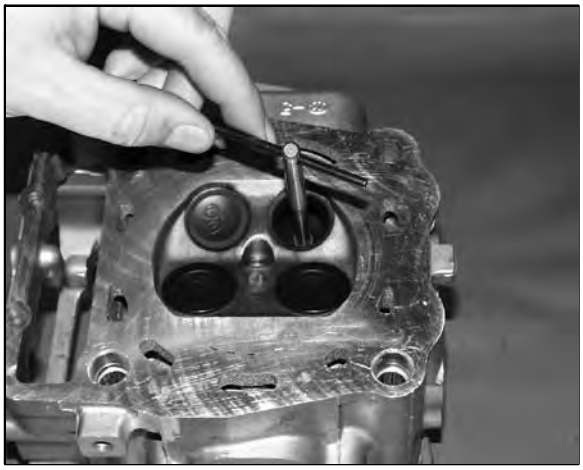
Valve Guide Height:
.689-.709″ (17.5-18.0 mm)



Valve Guide Installed Height

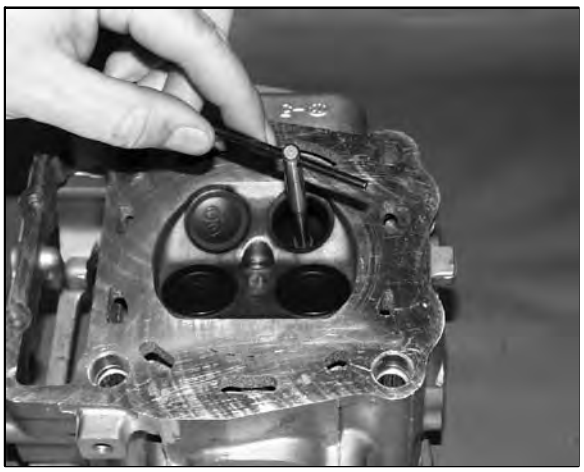
Reaming The Valve Guide

5. Allow cylinder head to cool to room temperature. Apply cutting oil to the reamer. Guides should be reamed from the valve spring side of the cylinder head. Ream each guide to size by turning the reamer clockwise continually. Continue to rotate reamer clockwise during removal of the tool.
6. Clean guides thoroughly with hot soapy water and a nylon brush. Rinse and dry with compressed air. Apply clean engine oil to guides.

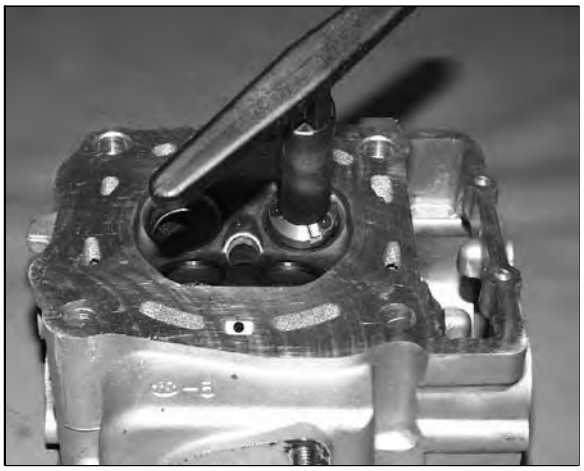


VALVE SEAT RECONDITIONING, CONT.

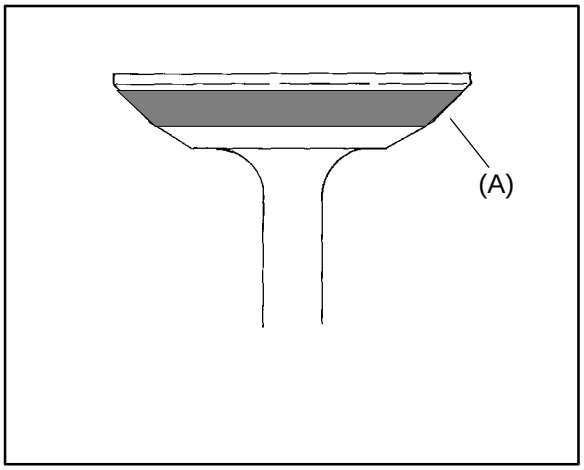
1. Install pilot into valve guide.
2. Apply cutting oil to valve seat and cutter.



3. Place 46° cutter on the pilot and make a light cut.
4. Inspect the cut area of the seat.
   - If the contact area is less than 75% of the circumference of the seat, rotate the pilot 180° and make another light cut.
   - If the cutter now contacts the uncut portion of the seat, check the pilot. Look for burrs, nicks, or runout. If the pilot is bent it must be replaced.
   - If the contact area of the cutter is in the same place, the valve guide is distorted from improper installation and must be replaced. Be sure the cylinder head is at the proper temperature and replace the guide.
   - If the contact area of the initial cut is greater than 75%, continue to cut the seat until all pits are removed and a new seat surface is evident. **NOTE:** Remove only the amount of material necessary to repair the seat surface.

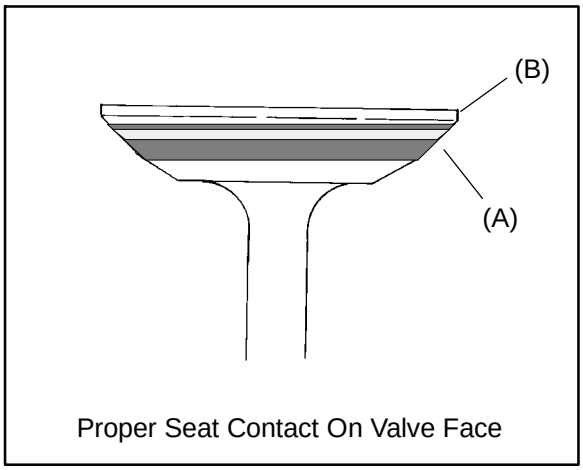


5. To check the contact area of the seat on the valve face, apply a thin coating of Prussian Blue™ paste to the valve seat. If using an interference angle (46°) apply black permanent marker to the entire valve face (A).
6. Insert valve into guide and tap valve lightly into place a few times.



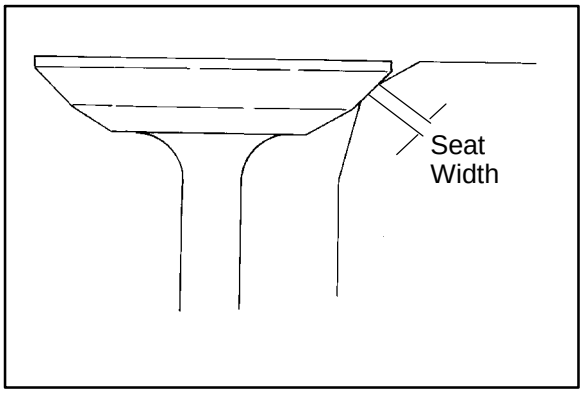
VALVE SEAT RECONDITIONING, CONT.

7. Remove valve and check where the Prussian Blue™ indicates seat contact on the valve face. The valve seat should contact the middle of the valve face or slightly above, and must be the proper width.
   - If the indicated seat contact is at the top edge of the valve face and contacts the margin area(B) it is too high on the valve face. Use the 30° cutter to lower the valve seat.
   - If too low use the 60° or 75° cutter to raise the seat. When contact area is centered on the valve face, measure seat width.
   - If the seat is too wide or uneven, use both top and bottom cutters to narrow the seat.
   - If the seat is too narrow, widen using the 45° cutter and re-check contact point on the valve face and seat width after each cut.



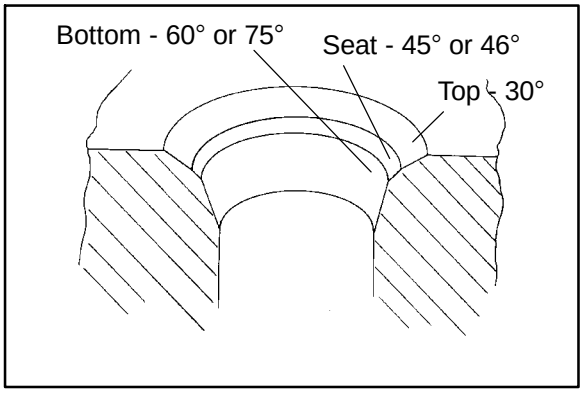
Proper Seat Contact On Valve Face

NOTE: When using an interference angle, the seat contact point on the valve will be very narrow, and is a normal condition. Look for an even and continuous contact point on the black marker, all the way around the valve face.



Valve Seat Width:

Intake Std: .028″ (.7 mm)
Limit: .055″ (1.4 mm)
Exhaust Std: .039″ (1.0 mm)
Limit: .071″ (1.8 mm)

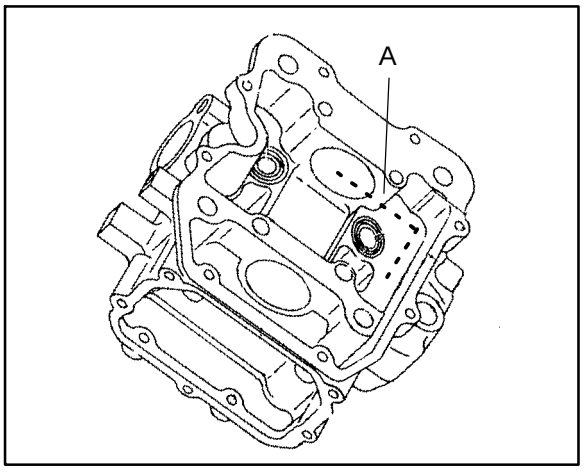


8. Clean all filings from the area with hot soapy water, rinse, and dry with compressed air.
9. Lubricate the valve guides with clean engine oil, and apply oil or water based lapping compound to the face of the valve. Lapping is not required with an interference angle.

VALVE SEAT RECONDITIONING, CONT.

10. Insert the valve into its respective guide and lap using a lapping tool or a section of fuel line connected to the valve stem.
11. Rotate the valve rapidly back and forth until the cut sounds smooth. Lift the valve slightly off of the seat, rotate 1/4 turn, and repeat the lapping process. Do this four to five times until the valve is fully seated, and repeat process for the other valve(s).

12. Clean cylinder head, valves, and camshaft oil supply passage (A) thoroughly.
13. If oil passage blind plug was removed, apply 3 Bond 1215 or equivalent sealer to the threads and install, torquing to 8 ft. lbs. (1.1 kg-m). **CAUTION:** Do not allow sealant to enter oil passage.
14. Spray electrical contact cleaner into oil passage and dry using compressed air.



CYLINDER HEAD ASSEMBLY

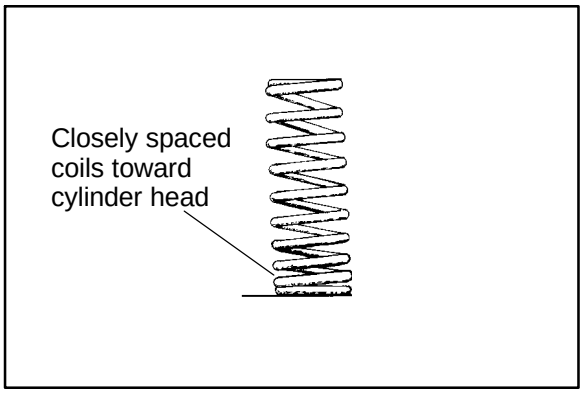
CAUTION: Wear eye protection during assembly.

NOTE: Assemble the valves one at a time to maintain proper order.

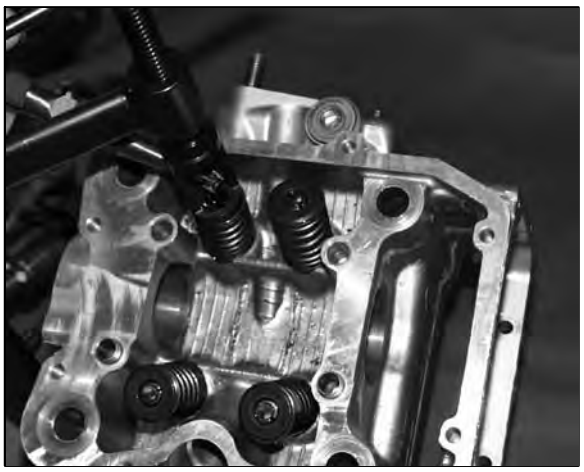
1. Install new valve seals on valve guides.
2. Apply engine oil to valve guides and seats.
3. Coat valve stem with molybdenum disulfide grease.
4. Install valve carefully with a rotating motion to avoid damaging valve seal.

CYLINDER HEAD ASSEMBLY, CONT.

5. Dip valve spring and retainer in clean engine oil and install spring with closely spaced coils toward the cylinder head.



6. Place retainer on spring and install valve spring compressor. Compress spring only enough to allow split keeper installation to prevent loss of spring tension. Install split keepers with the gap even on both sides.
7. Repeat procedure for remaining valve.
8. When all valves are installed, tap lightly with soft faced hammer on the end of the valves to seat the split keepers.



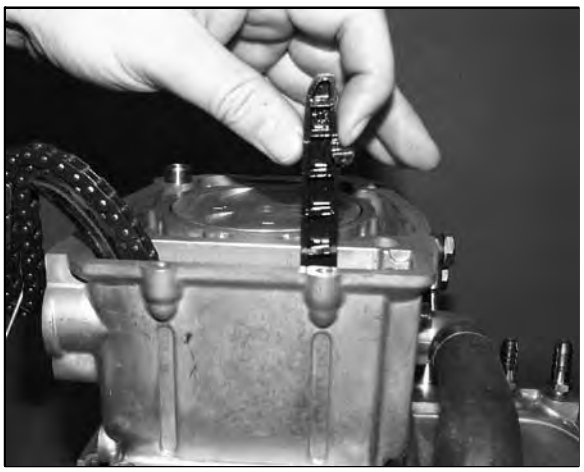
VALVE SEALING TEST

1. Clean and dry the combustion chamber area.
2. Pour a small amount of clean, high flash point solvent into the intake port and check for leakage around each intake valve. The valve seats should hold fluid with no seepage.
3. Repeat for exhaust valves by pouring fluid into exhaust port.

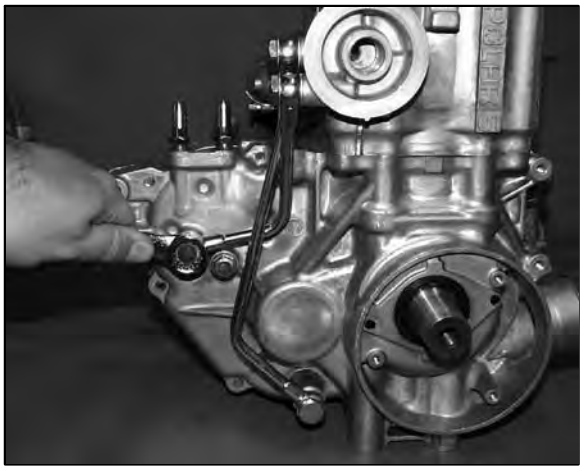
CYLINDER/PISTON REMOVAL AND INSPECTION

Follow engine disassembly procedures to remove valve cover, camshaft and rocker arms, and cylinder head.

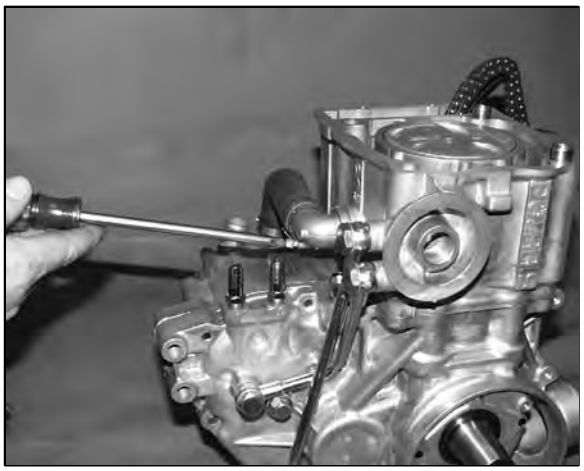
1. Remove cam chain guide at front of cylinder.



2. Loosen all four oil pipe banjo bolts and then remove the bolts and eight sealing washers. Remove the pipes.

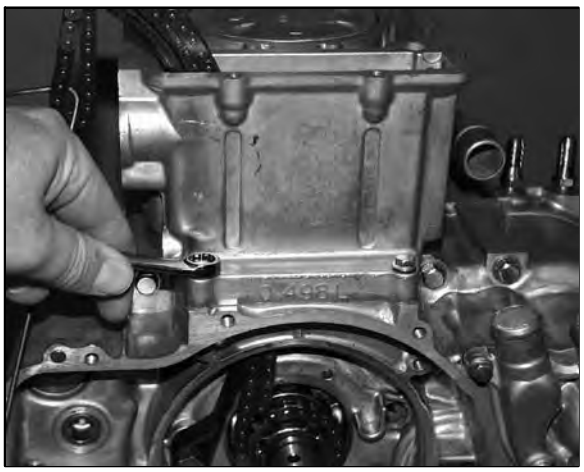


3. Loosen hose clamps and remove coolant inlet hose.



CYLINDER/PISTON REMOVAL AND INSPECTION, CONT.

4. Remove the two 6 mm cylinder base bolts.



5. Loosen each of the four large cylinder base bolts 1/4 turn at a time in a criss-cross pattern until loose and remove bolts.

The bolts are inside the water jacket.

6. Tap cylinder lightly with a plastic hammer in the reinforced areas only until loose.
7. Rock cylinder forward and backward and lift it from the crankcase, supporting piston and connecting rod. Support piston with piston support block PN 2870390.
8. Remove dowel pins from crankcase.

PISTON REMOVAL

1. Remove circlip. Note piston directional arrow pointing toward the right (Mag) side of engine.

2. Remove piston circlip and push piston pin out of piston. If necessary, heat the crown of the piston *slightly* with a propane torch. **CAUTION:** Do not apply heat to the piston rings. The ring may lose radial tension.

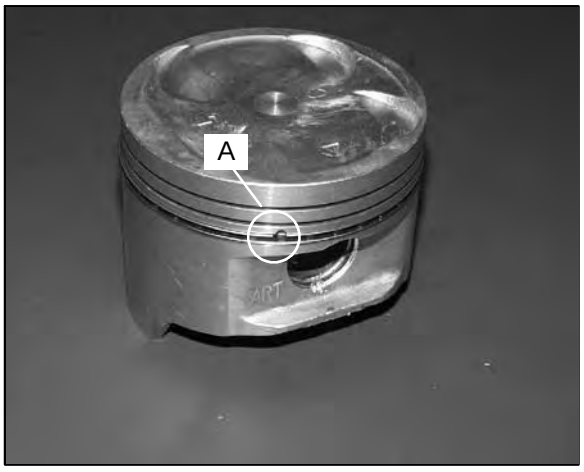
3. Remove top compression ring.

***Using a piston ring pliers**: Carefully expand ring and lift it off the piston. **CAUTION:** Do not expand the ring more than the amount necessary to remove it from the piston, or the ring may break.
***By hand:** Placing both thumbs as shown, spread the ring open and push up on the opposite side. Do not scratch the ring lands.

4. Repeat procedure for second ring.

The oil control ring is a three piece design consisting of a top and bottom steel rail and a center expander section. The top rail has a locating tab on the end which fits into a notch (A) in the upper oil ring land of the piston.

5. Remove the top rail first followed by the bottom rail.
6. Remove the expander.



CYLINDER INSPECTION

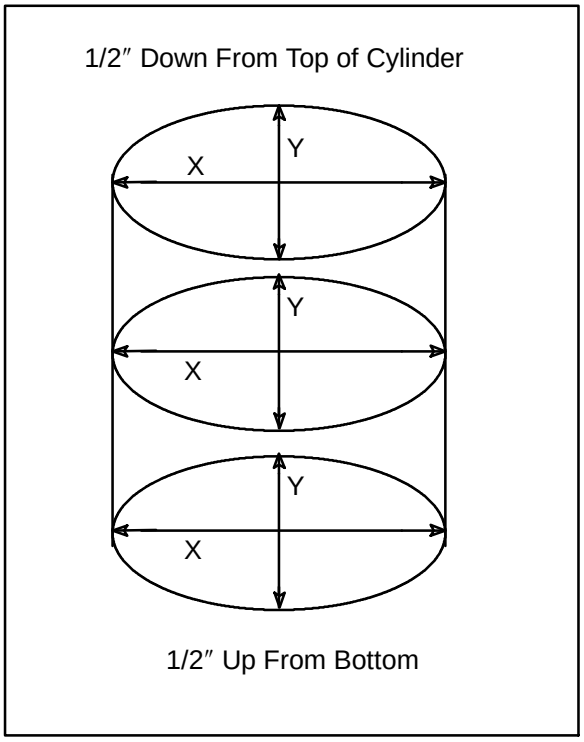
1. Remove all gasket material from the cylinder sealing surfaces.
2. Inspect the top of the cylinder for warpage using a straight edge and feeler gauge.

Cylinder Warpage:

.002″ (.05 mm)

3. Inspect cylinder for wear, scratches, or damage.

4. Inspect cylinder for taper and out of round with a telescoping gauge or a dial bore gauge. Measure in two different directions, front to back and side to side, on three different levels (1/2″ down from top, in the middle, and 1/2″ up from bottom).



CYLINDER INSPECTION, CONT.

5. Record measurements. If cylinder is tapered or out of round beyond .002, the cylinder must be re-bored oversize, or replaced.

Cylinder Taper
Limit: .002 Max.
Cylinder Out of Round
Limit: .002 Max.

Standard Bore Size:

3.6216-3.6224″ (91.99-92.01 mm)

PISTON-TO-CYLINDER CLEARANCE

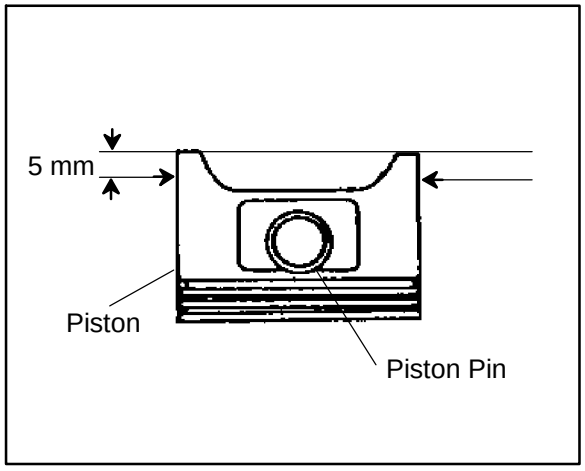
1. Measure piston outside diameter at a point 5 mm up from the bottom of the piston at a right angle to the direction of the piston pin.
2. Subtract this measurement from the maximum cylinder measurement obtained in step 5 above.

Piston to Cylinder Clearance

Std: .0006-.0018″ (.015-.045 mm)

Piston O.D.:

Std: 3.6206-3.6210″ (91.96-91.97 mm)

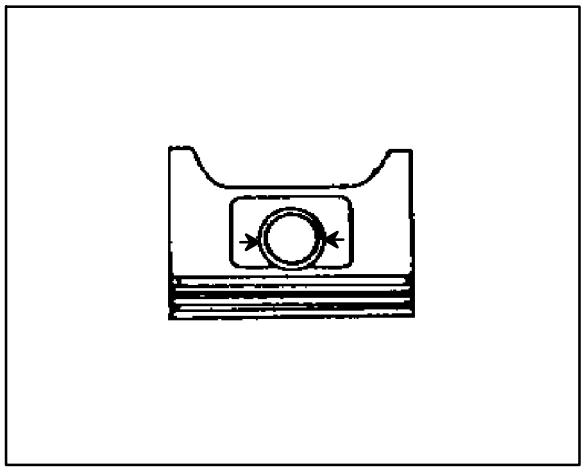


PISTON/ROD INSPECTION

1. Measure piston pin bore.

Piston Pin Bore:

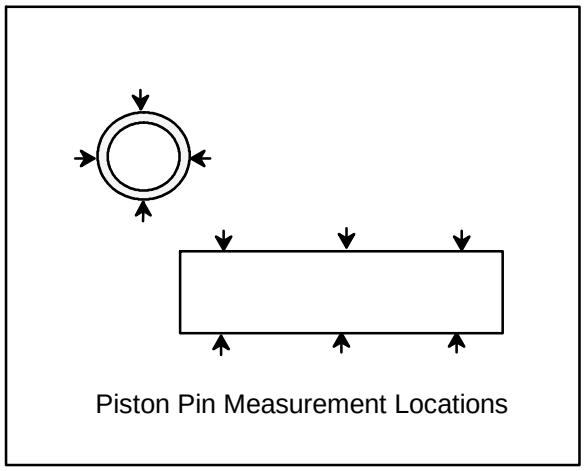
.9055-.9057″ (23.0-23.006 mm)



2. Measure piston pin O.D. Replace piston and/or piston pin if out of tolerance.

Piston Pin O.D.

.9053-.9055″ (22.994-23.0 mm)

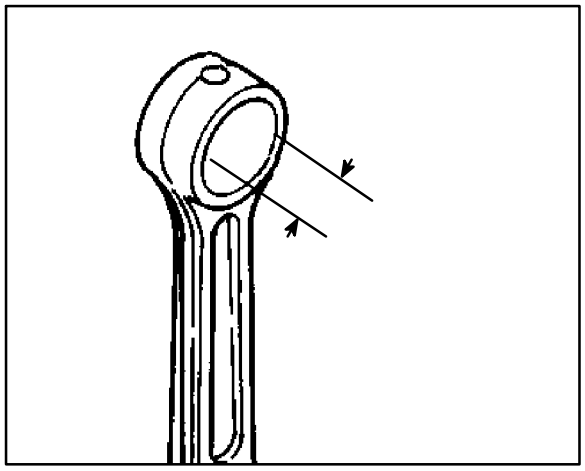


Piston Pin Measurement Locations

3. Measure connecting rod small end ID.

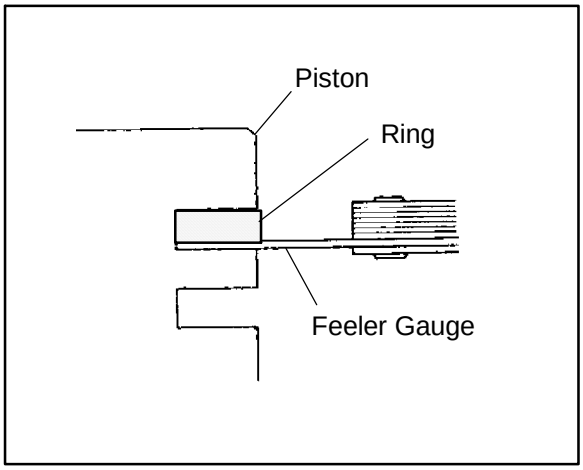
Connecting Rod Small End I.D.

.9058-.9063″ (23.007-23.020 mm)



PISTON/ROD INSPECTION, CONT.

4. Measure piston ring to groove clearance by placing the ring in the ring land and measuring with a thickness gauge. Replace piston and rings if ring-to-groove clearance exceeds service limits.



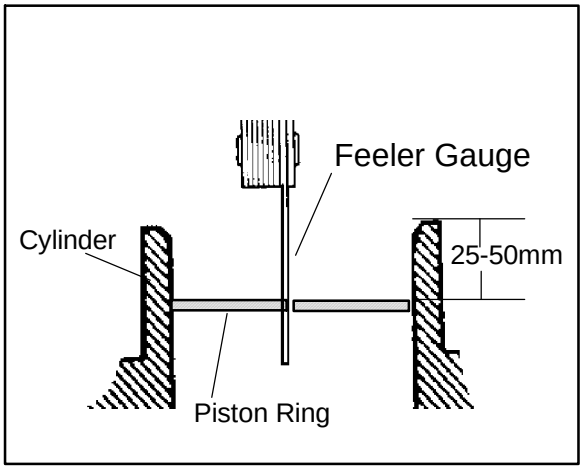
Piston Ring-to-Groove Clearance

Top Ring Std: .0016-.0031″ (.040-.080 mm)
Limit: .0059″ (15 mm)
Second Ring Std: .0012-.0028″ (.030-.070 mm)
Limit: .0059″ (15 mm)

PISTON RING INSTALLED GAP

1. Place each piston ring inside cylinder using piston to push ring squarely into place as shown at right.
2. Measure installed gap with a feeler gauge at both the top and bottom of the cylinder. **NOTE:** A difference in end gap indicates cylinder taper. The cylinder should be measured for excessive taper and out of round.
3. If the *bottom* installed gap measurement exceeds the service limit, replace the rings. If ring gap is below specified limit, file ring ends until gap is within specified range.

NOTE: Always check piston ring installed gap after reboring a cylinder or when installing new rings. A rebored cylinder should always be scrubbed thoroughly with hot soapy water, rinsed, and dried completely. Wipe cylinder bore with an oil rag immediately to remove residue and prevent rust.



Piston Ring Installed Gap

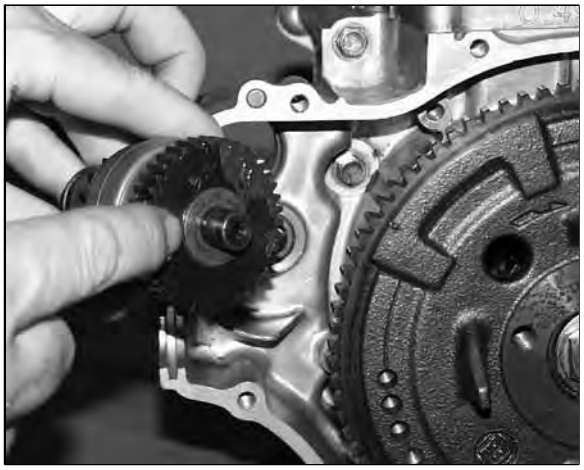
Top Ring
Std: .0079-.0138″ (.20-.36 mm)
Limit: .039″ (1.0 mm)
Second Ring
Std: .0079-.0138″ (.20-.36 mm)
Limit: .039″ (1.0 mm)
Oil Ring
Std: .0079-.0276″ (.20-.70 mm)
Limit: .059″ (1.5 mm)

CRANKCASE DISASSEMBLY

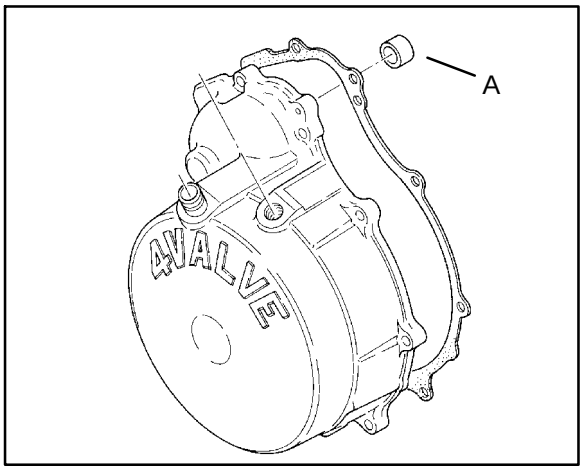
NOTE: The recoil starter, starter motor, starter drive, flywheel, stator, cam chain and sprockets can be serviced with the engine in the frame.

STARTER DRIVE REMOVAL/INSPECTION

1. Remove recoil housing bolts and remove housing.
2. Remove starter drive assembly. Note the thrust washer located at the rear of the drive mechanism.
3. Inspect the thrust washer for wear or damage and replace if necessary.



4. Measure the OD of the starter drive shaft on both ends and record.
5. Measure the ID of the bushing in the recoil housing (A) and in the crankcase and record. Measure in two directions 90° apart to determine if bushing is out of round. Calculate bushing clearance. Replace bushing if clearance exceeds the service limit.



Std. Bushing ID:
.4735″-.4740″ (11.11-12.04 mm)

Std. Shaft OD:
.470″-.472″ (11.93-11.99 mm)

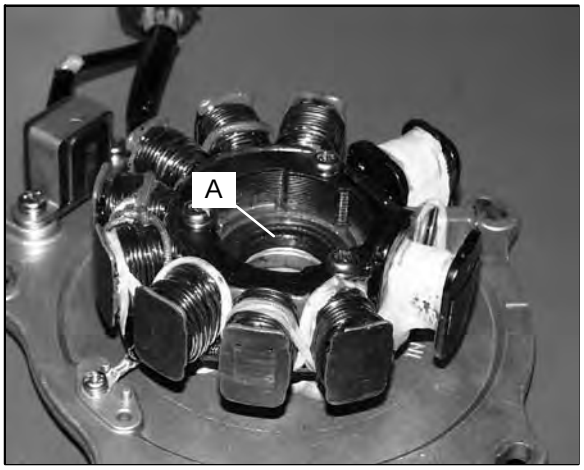
Starter Drive Bushing Clearance:
Std: .0015″-.004″ (.038-.102 mm)

Service Limit:
.008″ (.203 mm)

6. Inspect gear teeth on starter drive. Replace starter drive if gear teeth are cracked, worn, or broken.

FLYWHEEL/STATOR REMOVAL/INSPECTION

1. Remove flywheel nut and washer.
2. Install flywheel puller (PN 2870159) and remove flywheel. **CAUTION:** Do not thread the puller bolts into the flywheel more than 1/4″ or stator coils may be damaged.
3. Mark or note position of stator plate on crankcase.
4. Remove bolts and carefully remove stator assembly, being careful not to damage crankshaft bushing on stator plate.
5. Replace crankshaft seal.

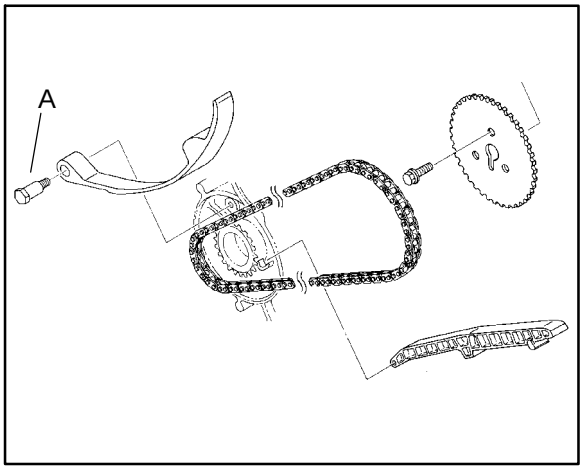


6. Remove oil passage O-Ring.

7. Remove large sealing O-Ring from outer edge of stator plate.

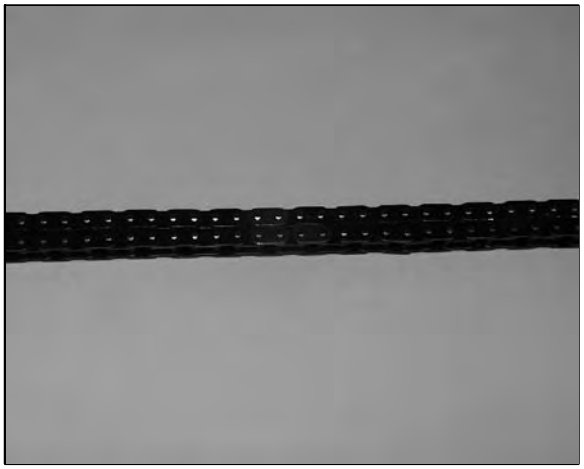
CAM CHAIN/TENSIONER BLADE

1. Remove bolt securing tensioner blade to crankcase (A).
2. Remove blade and inspect for cracks, wear, or damage.



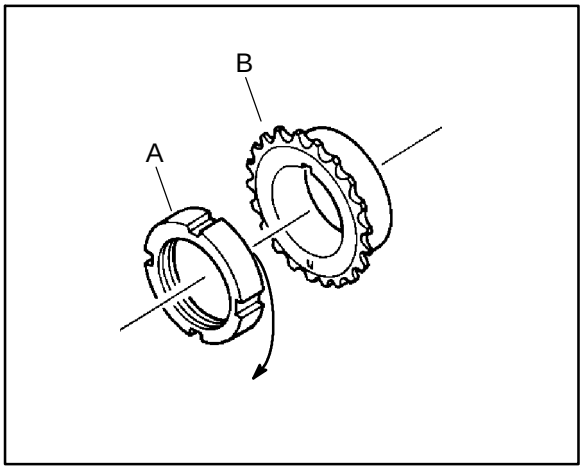
3. Remove cam chain. Inspect chain for worn or missing rollers or damage. Stretch chain tight on a flat surface and apply a 10 lb. (4.53 kg) load. Measure length of a 20 pitch section of chain. Replace if worn past service limit.

Chain Service Limit:
5.407″ (13.7 cm)



CAM CHAIN/TENSIONER BLADE, CONT.

4. Using the special socket, remove the crankshaft slotted nut (A). **NOTE:** The slotted nut is a left hand thread.
5. Remove cam chain drive sprocket (B) and Woodruff key from crankshaft.
6. Inspect sprocket teeth for wear or damage.
7. Inspect Woodruff key for wear.
8. Replace any worn or damaged parts.



ONE WAY VALVE

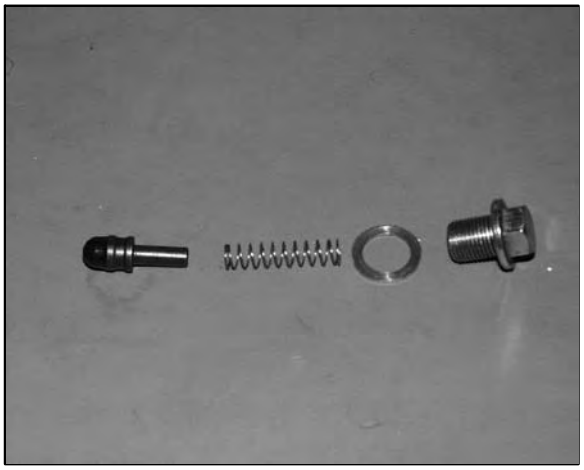
The one way valve prevents oil from draining out of the oil tank and into the crankcase when the engine is off. It must be clean and have adequate spring pressure in order to seal properly.

1. Remove cap bolt, sealing washer, spring, and one way valve from PTO side crankcase.
2. Inspect free length of spring and check coils for distortion.

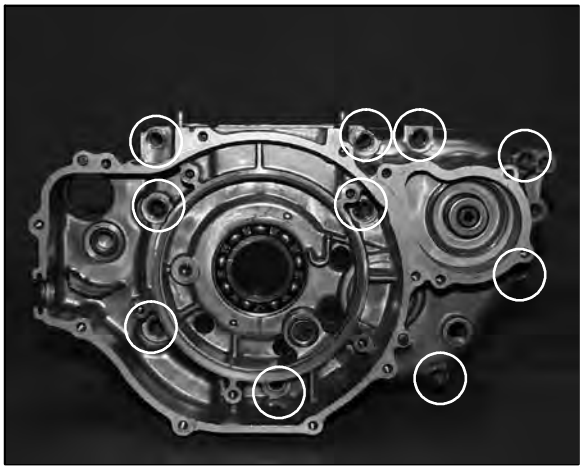
One Way Valve Spring Free Length:

Std: 1.450″ (3.68 cm)

3. Inspect valve for wear.
4. Check seat area for nicks or foreign material that may prevent proper sealing of valve.



CRANKCASE SEPARATION



1. Remove flange bolts (10) from magneto side crankcase evenly in a criss-cross pattern.

2. Separate crankcase by tapping with a soft faced hammer in reinforced areas.

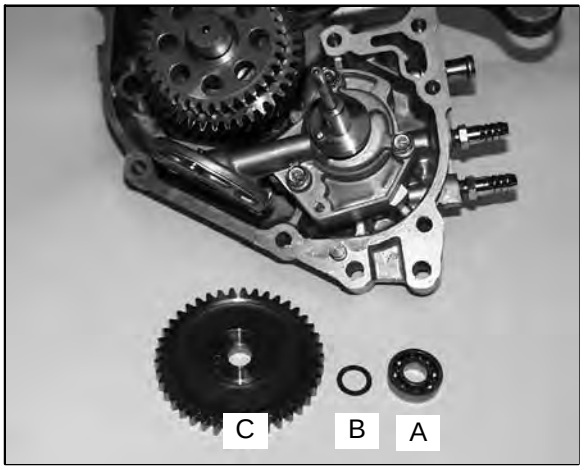
3. Tap lightly on balancer gear with a brass drift through the hole in the crankcase if necessary, to ensure the balancer shaft stays in the PTO side crankcase. Watch the gap along the crankcase mating surface and separate the crankcase evenly. It may also be necessary to tap the oil pump shaft lightly to separate the crankcase.

CAUTION: Do not strike the oil pump shaft at an angle or the shaft may bend, causing irreparable damage. Tap only *lightly* on the pump shaft if necessary.

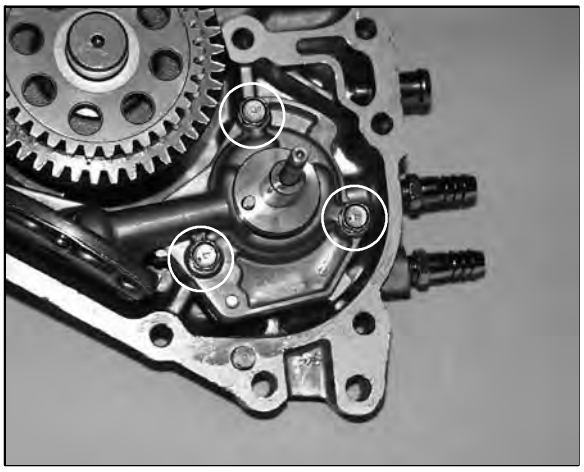
4. Remove the Mag (RH) crankcase from the PTO case.

OIL PUMP REMOVAL/INSPECTION

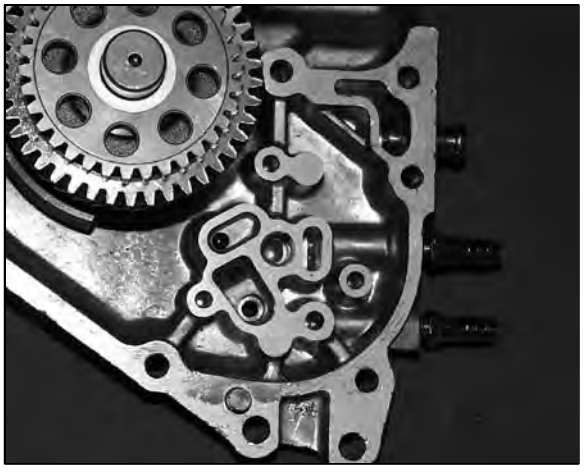
1. Remove pump shaft bearing (A) and thrust washer (B) from pump shaft.
2. Remove (2) bolts holding pump drive gear (C).
3. Inspect drive gear teeth for cracks, damage or excessive wear.



4. Remove three oil pump retaining bolts and pump.

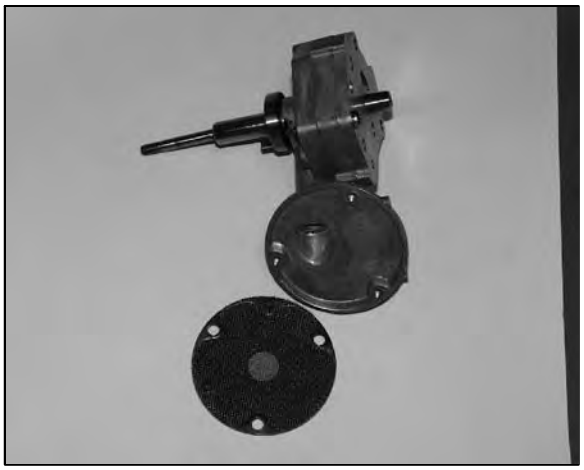


5. Inspect mating surface of crankcase and oil pump. Check for nicks, burrs, or surface irregularities.

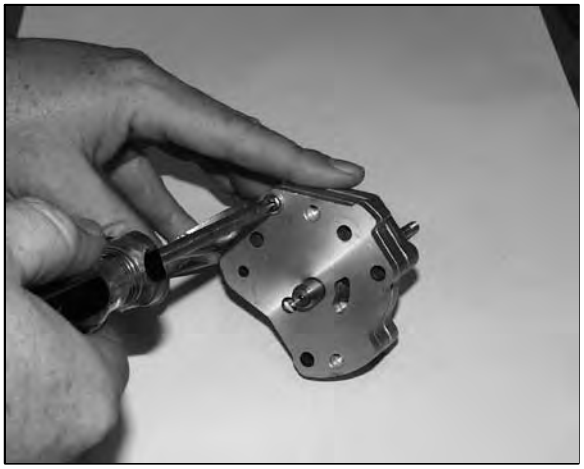


OIL PUMP REMOVAL/INSPECTION, CONT.

6. Remove the three screws and strainer screen from pump.
7. Clean screen thoroughly.



8. Remove pump body screw and feed chamber cover.

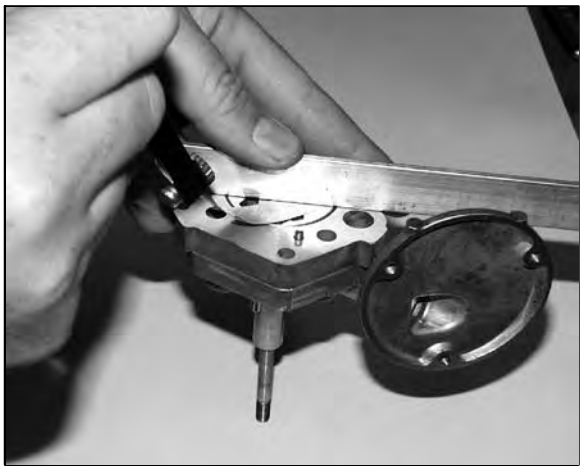


9. Measure pump end clearance using a feeler gauge and straight edge.

Pump End Clearance:

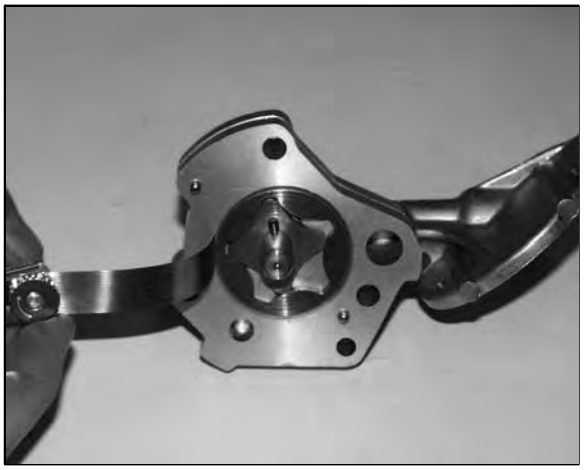
Std: .001-.003 (.0254-.0762 mm)

Wear Limit: .004 (.1016 mm)



OIL PUMP REMOVAL/INSPECTION, CONT.

10. Measure clearance between outer feed rotor and pump body with a feeler gauge.

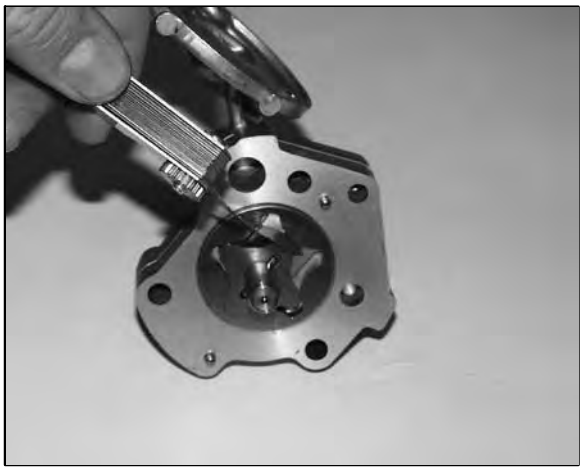


Outer Feed Rotor to Pump Body Clearance:

Std: .001-.003 (.0254-.0762 mm)

Wear Limit: .004 (.1016 mm)

11. Measure rotor tip clearance with a feeler gauge.



Rotor Tip Clearance:

Std: .005 (.127 mm)

Wear Limit: .008 (.2032 mm)

12. Remove inner and outer feed rotor and pump chamber body.
13. Repeat measurements for scavenge rotor.
14. Remove inner and outer scavenge rotor and inspect pump shaft for wear.

OIL PUMP ASSEMBLY

1. Clean and dry all parts thoroughly. Apply clean engine oil to all parts. *Do not* use gasket sealer on the pump body mating surfaces or oil passages will become plugged.
2. Install pump shaft and scavenge rotor drive pin.
3. Install outer scavenge rotor, inner scavenge rotor, and scavenge casing.
4. Install outer feed rotor and inner feed rotor drive pin.
5. Install inner feed rotor and feed chamber cover with screw.
6. Tighten screw securely.
7. Install screen on pump body.
8. Install oil pump on crankcase and torque bolts to 6 ft. lbs. (.828 kg-m).

Oil Pump Attaching Bolt Torque:
6 ft. lbs. (.828 kg-m)

COUNTER BALANCER SHAFT REMOVAL/INSPECTION

1. Remove the shim washer from the counter balancer shaft.

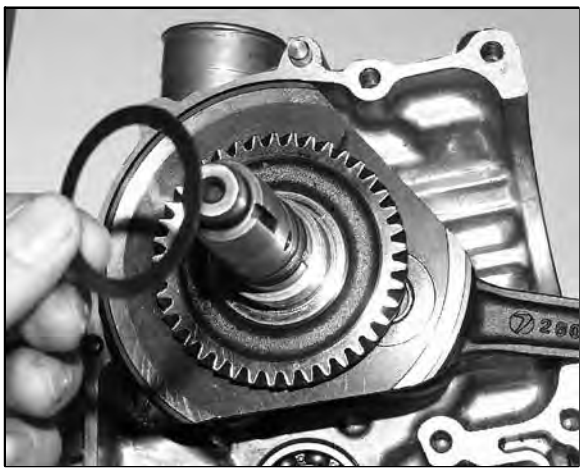
2. Note the alignment dots on the balancer and crankshaft gears, the marks must be aligned during reassembly.

3. Turn the shaft until balancer counter weights clear the crankshaft and remove the balancer shaft from the crankcase.
4. Inspect the balancer drive gear and pump shaft drive gear.
5. Replace the shaft if gear teeth are abnormally worn or damaged.
6. Inspect the balancer shaft bearings.

NOTE: Due to extremely close tolerances and minimal wear, the balancer shaft ball bearings must be inspected visually and by feel. Look for signs of discoloration, scoring or galling. Turn the inner race of each bearing. The bearings should turn smoothly and quietly. The outer race of each bearing should fit tightly in the crankcase. The inner race should be firm with minimal side to side movement and no detectable up and down movement.

CRANKSHAFT REMOVAL/INSPECTION

1. Remove the shim washer from the crankshaft.



2. Support the PTO side crankcase and crankshaft; press the crankshaft out. Be careful not to damage the crankcase mating surface or connecting rod.

3. Use a feeler gauge to measure the connecting rod big end side clearance.

Connecting Rod Big End Side Clearance:

Std: .0039-.0256″ (.1-.65 mm)
Limit: .0315″ (.80 mm)

4. Place the crankshaft in a truing stand or V-blocks and measure the runout on both ends with a dial indicator.

Max Runout: .0024″ (.06 mm)

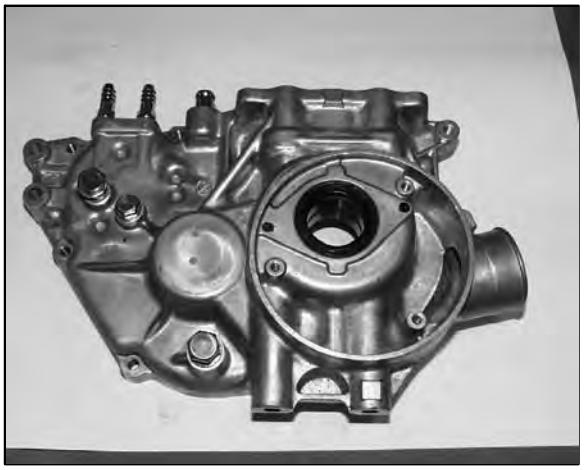
5. Measure the connecting rod big end radial clearance.

Big End Radial Clearance:

Std: .0004-.0015″ (.011-.038 mm)
Limit: .0020″ (.05 mm)

6. Inspect the crankshaft main bearing journals for scoring and abnormal wear.

CRANKCASE BEARING INSPECTION



1. Remove the seal from the PTO side crankcase.

2. Inspect the crankshaft main bearings, balancer shaft bearings, and pump shaft bearing.

NOTE: Due to extremely close tolerances and minimal wear, the bearings must be inspected visually, and by feel. Look for signs of discoloration, scoring or galling. Turn the inner race of each bearing. The bearings should turn smoothly and quietly. The outer race of each bearing should fit tightly in the crankcase. The inner race should be firm with minimal side to side movement and no detectable up and down movement.

3. Support the crankcase and drive or press the main bearings out of each crankcase.

4. To remove balancer shaft bearings and pump shaft bearing use a blind hole bearing puller.

NOTE: Bearings are stressed during the removal process and *should not* be re-used!

PUMP SHAFT OIL SEAL/ WATER PUMP MECHANICAL SEAL REMOVAL (ENGINE DISASSEMBLED)

NOTE: The water pump mechanical seal can be removed without removing the engine. Refer to Water Pump Mechanical Seal Installation.

Replace the pump shaft seal and water pump mechanical seal whenever the crankcase is disassembled.

1. Remove the pump shaft bearing from the Magneto (right hand) side crankcase.

2. Pry out the oil seal, noting the direction of installation with the spring side facing IN (toward inside of case).

3. Drive the water pump mechanical seal out of the crankcase from inside to outside. Note: The new mechanical seal must be installed after the crankcases are assembled, using a special tool. See Mechanical Seal Installation.

CRANKCASE INSPECTION

1. Remove all traces of gasket sealer from the crankcase mating surfaces. Inspect the surfaces closely for nicks, burrs or damage.
2. Check the oil pump and oil passage mating surfaces to be sure they are clean and not damaged.

BEARING INSTALLATION

NOTE: To ease bearing installation, warm the crankcase until hot to the touch. Place the bearings in a freezer.

1. Install the bearings so the numbers are visible.
2. Drive or press new bearings into the crankcases, using the proper driver. **CAUTION:** Press only on outer race of bearing to prevent bearing damage.
   - 70mm (2.755″) driver- For crankshaft main bearings.
   - 46mm (1.810″) For counter balancer bearings.
   - 28mm (1.100″) For pump shaft bearing.

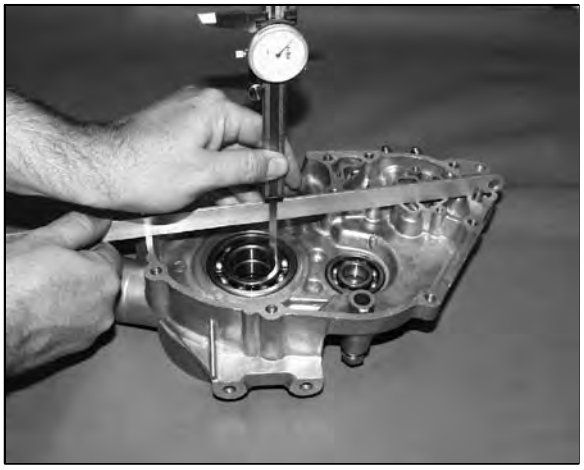
END PLAY INSPECTION/ADJUSTMENT

Before reassembling the crankcase,the following steps should be performed to determine the amount of crankshaft, counter balancer shaft, and pump shaft end play. Excessive end play may cause engine noise at idle and slow speeds. Too little play will side load the bearings which may lead to premature bearing failure.

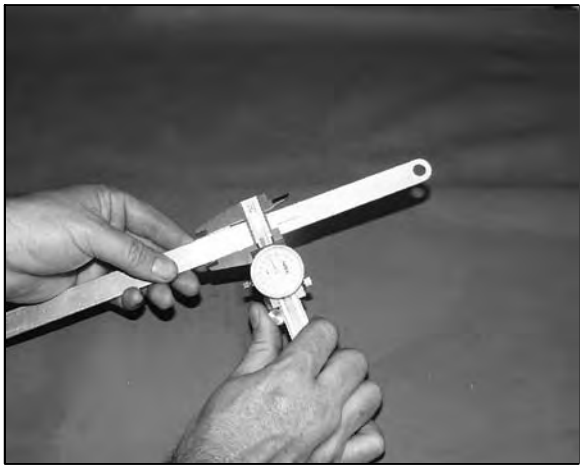
CRANKSHAFT END PLAY ADJUSTMENT

1. Make sure all bearings are firmly seated in the both Mag and PTO crankcase.

2. Measure the distance from the PTO crankcase mating surface to the main bearing using a dial caliper and a straight edge.



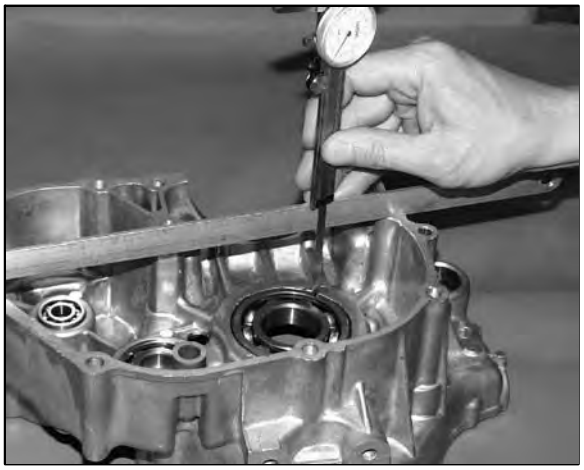
3. Subtract the thickness of the straightedge from the measurement obtained in Step 2 and record.



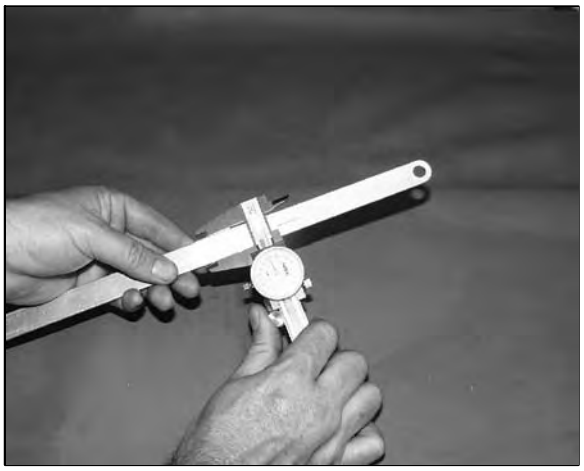
PTO Case Depth _____

CRANKSHAFT END PLAY ADJUSTMENT, CONT.

4. Measure the distance from the Magneto crankcase mating surface to the main bearing using the same method and record.



5. Subtract the thickness of the straightedge from the measurement obtained in Step 4 and record.

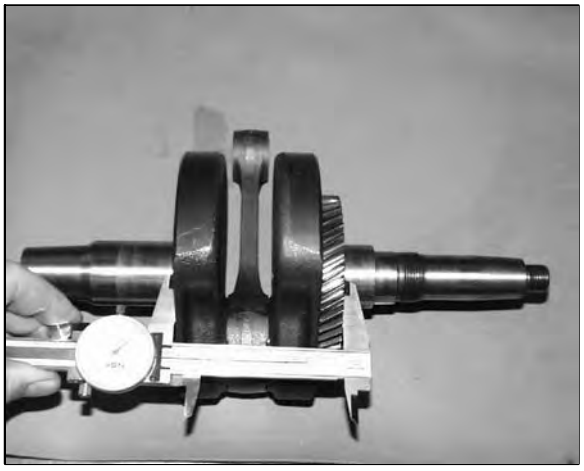


Mag Case Depth _____

6. Add the readings recorded in Step 3 and Step 5 and record below.

Total Case Width _____

7. Measure the width of the crankshaft at the bearing seats with a micrometer or dial caliper and record.



Crankshaft Width _____

8. Subtract the Crankshaft Width measured in Step 7 from the Total Case Width recorded in Step 6, and record below.

Total End Play _____

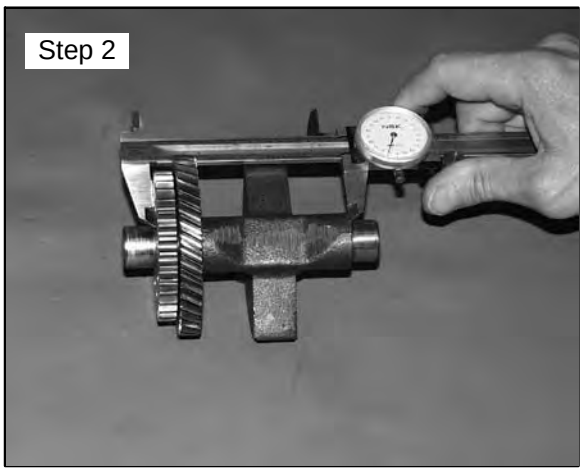
9. Subtract the thickness of the existing shim from the result of step 8 to determine if a different shim is required. The result must be within the specified range listed at right.

Crankshaft End Play:

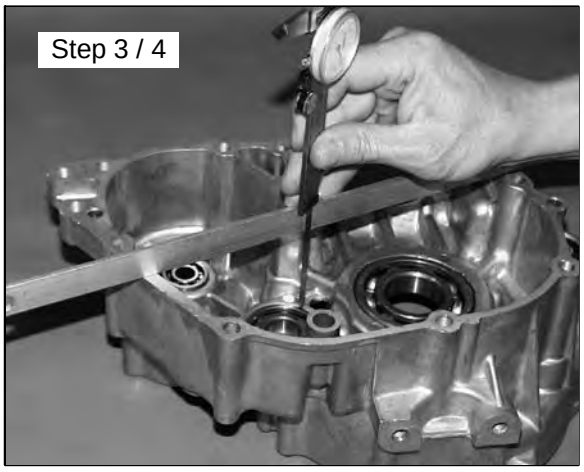
.008″-.016″ (.02-.04 cm)

COUNTER BALANCER SHAFT END PLAY ADJUSTMENT

1. Make sure all bearings are firmly seated in the crankcase.
2. Measure the width of the counter balancer shaft at the bearing seats with a dial caliper or micrometer, and record reading.



3. Measure the distance from the Mag crankcase mating surface to the balance shaft bearing using a dial caliper and a straight edge. Subtract the thickness of the straightedge and record.
4. Measure the distance from the PTO crankcase mating surface to the bearing using the same method outlined in Step 1, 2, and-3.



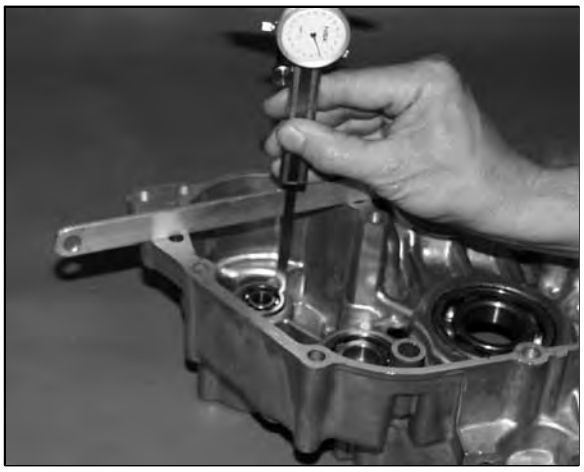
5. Add the readings obtained in Step 3 and Step 4.
6. Subtract the counter balancer shaft width measured in step 2 from the figure obtained in step 5.
7. Subtract the thickness of the existing shim from the result of step 6 to determine if a different shim is needed. The result must be within the specified range listed at right.

Counter Balancer Shaft End Play:

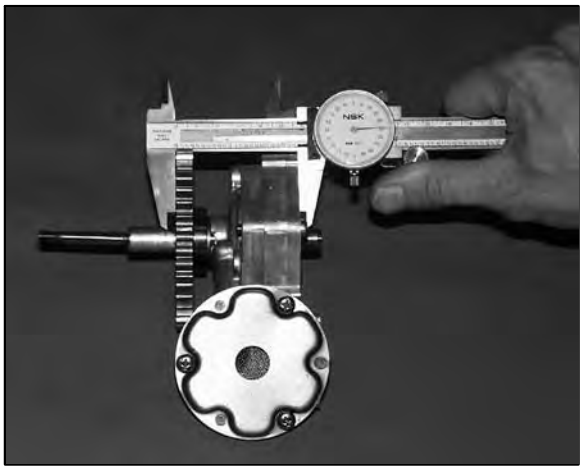
.008″-.016″ (.02-.04 cm)

PUMP SHAFT END PLAY ADJUSTMENT

1. Make sure the pump shaft bearing is firmly seated in the Magneto side crankcase.
2. Measure the distance from the magneto crankcase mating surface to the bearing using a dial caliper and a straight edge. Subtract the thickness of the straightedge and record.



3. Install the gear on the oil pump and measure the width of the pump and gear. Subtract this measurement from the measurement recorded in Step 2.
4. Subtract the thickness of the existing shim from the result of Step 3 to determine if a different shim is needed.

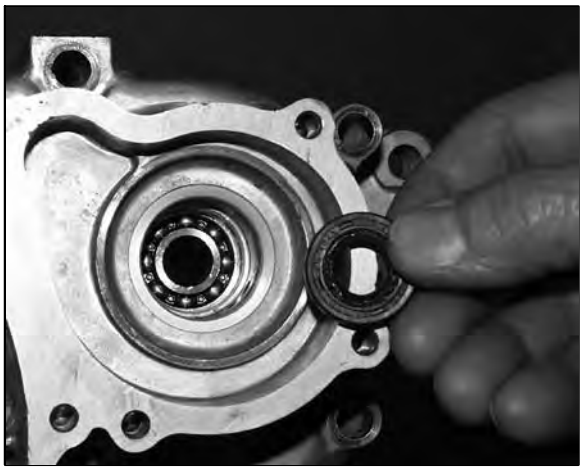


Pump Shaft End Play:

.008″-.016″ (.02-.04 cm)

PUMP SHAFT OIL SEAL INSTALLATION

1. Install the seal from the outside of the crankcase (water pump side) with the spring facing inward, toward the pump shaft bearing.
2. Drive or press the seal into place using a 25mm (.985″) seal driver, until flush with the outer edge of the seal bore.
3. Lubricate the seal lip with grease.



CRANKSHAFT/COUNTER BALANCE/OIL PUMP INSTALLATION

Lubricate all bearings with clean engine oil before assembly.

Use the crankshaft installation tool kit PN 2871283 to prevent damage to the crankshaft and main bearings during installation.

1. Install the crankshaft into the PTO side crankcase. Screw the threaded rod into the crankshaft until the threads are engaged a minimum of one inch (25.4mm).
2. Install the collar, washer, and nut onto the threaded rod. Hold the crankshaft and tighten the nut to draw the crankshaft into the main bearings until fully seated. Loosen the nut and remove the threaded rod from the crankshaft. If removal is difficult, install two nuts on the end of the threaded rod and tighten against each other.
3. Install the proper shim on the magneto end of the crankshaft.
4. Place the balancer shaft in the PTO crankcase aligning the timing marks on the crankshaft and balancer gears. Install the proper shim washer on the shaft.
5. Inspect the oil pump sealing surface on the crankcase. Apply a light film of engine oil to the surface and install the oil pump.

NOTE: Do not use gasket sealer on the pump mating surfaces.

NOTE: After engine is assembled and machine is readied for field operation, oil pump MUST be primed. Follow oil pump priming procedure on page 3.13.

Oil Pump Bolt Torque:
6. ft. lbs. (.828 kg-m)

6. Align the drive gear with the drive pin on the pump shaft and install the gear. Be sure the gear is fully seated and properly engaged.
7. Install the proper shim washer on the pump shaft.

CRANKCASE ASSEMBLY

1. Apply 3 Bond 1215 (P/N 2871557) to the crankcase mating surfaces. Be sure the alignment pins are in place.
2. Set the crankcase in position carefully to avoid damaging the pump shaft seal, and install the magneto end crankshaft installation tool (follow instructions provided with tool kit PN 2871283). Draw the crankcase halves together by tightening the nut on the tool and tapping lightly in the pump shaft area with a soft faced hammer to maintain alignment. Continually check alignment of the cases during installation, closing the gap equally until the surfaces are tightly seated.
3. Remove the tool.
4. Install the crankcase flange bolts and tighten in 3 steps following the pattern on page 3.2 to specified torque.

Crankcase Bolt Torque:
14 ft. lbs. (19-20 Nm)

Crankcase Sealant:
PN 2871557

WATER PUMP MECHANICAL SEAL INSTALLATION

1. Clean the seal cavity to remove all traces of old sealer.
2. Place a new mechanical seal in the seal drive collar, and install on the pump shaft.
3. Screw the guide onto the end of the pump shaft.
4. Install the washer and nut and tighten to draw seal into place until fully seated.
5. Remove the guide adaptor using the additional nut as a jam nut if necessary.

WATER PUMP MECHANICAL SEAL REMOVAL - ENGINE INSTALLED

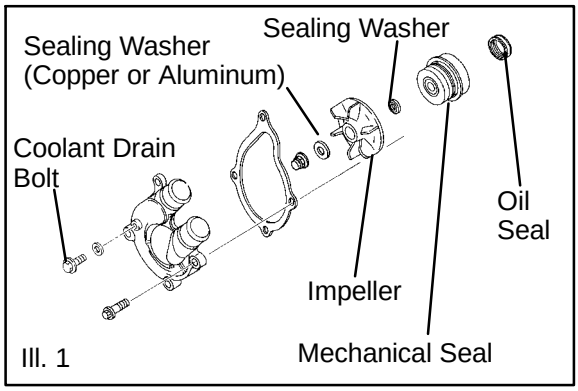
WATER PUMP MECHANICAL SEAL REMOVAL TOOL:2872105

REPLACEMENT T-HANDLE FOR 2872105: 2872106

This tool allows a technician to replace the mechanical water pump seal on EH50PL engines without removing the engine and splitting the cases.

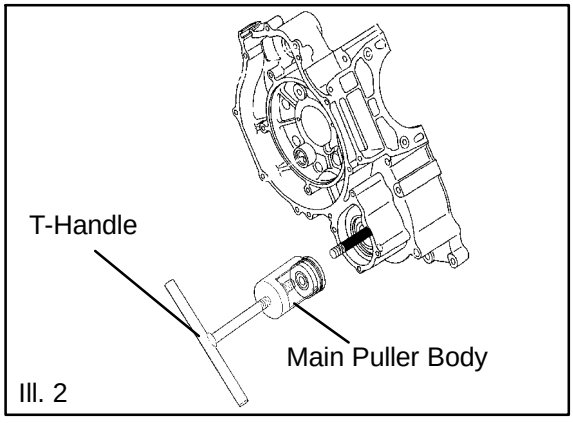
CAUTION: Improper or careless use of this tool or procedure can result in a bent water pump shaft. Pump shaft replacement requires engine removal and crankcase separation. Use caution while performing this procedure. Make sure that the puller is parallel to the shaft at all times. Do not place side loads on the water pump shaft or strike the puller or shaft in any way.

1. After the coolant has been drained, remove the water pump cover, impeller and the sealing washer. (Ill. 1)



Ill. 1

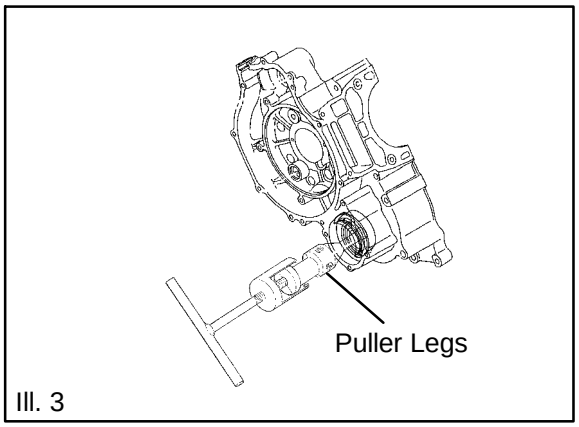
2. Slide the main puller body over the outer portion of the mechanical seal as shown in Ill. 2 and turn T-Handle clockwise until it contacts water pump shaft. Continue rotating until outer portion of mechanical seal is separated from the metal seal body.



Ill. 2

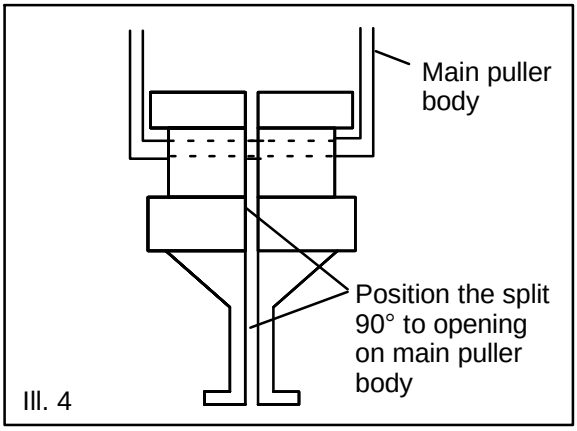
WATER PUMP MECHANICAL SEAL REMOVAL - ENGINE INSTALLED, CONT.

3. Insert the puller legs between the water pump drive shaft and the remaining portion of the mechanical seal. Attach the puller legs to the main puller body. Ill. 3



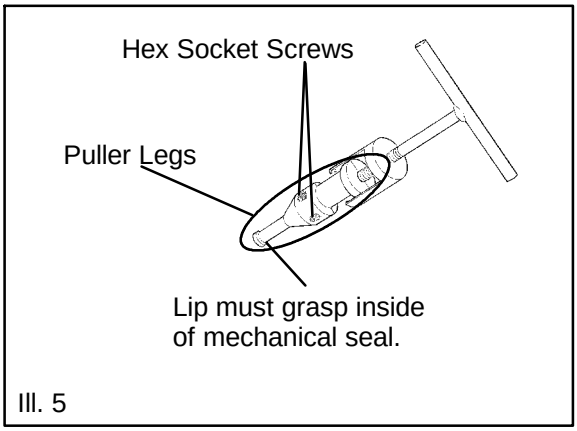
Ill. 3

4. Ensure that the split between the puller legs is fully supported by the main body of the tool (Ill 4).



Ill. 4

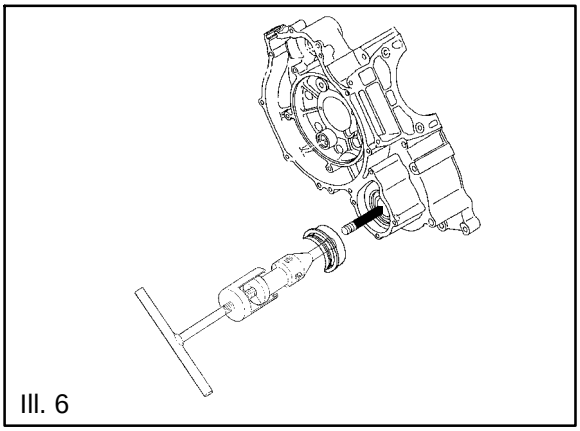
5. Tighten the hex socket screws on the puller legs sufficiently so the lip of the puller legs will grasp the mechanical seal. Ill. 5



Ill. 5

6. Turn the puller T-Handle clockwise until it contacts the water pump shaft. Continue rotating until the remaining portion of mechanical seal has been removed from the cases. Ill. 6 Pump shaft oil seal can also be replaced at this time if necessary.

7. Special tool (PN 5131135) is required to install the new mechanical seal. This tool is available separately and it is also included in the Crankshaft/Water Pump Seal Installation Kit (PN 2871283).


Ill. 6

ONE WAY VALVE INSTALLATION

Install the one way valve plunger, spring, and plug using a new sealing washer.

One Way Valve Plug Torque:

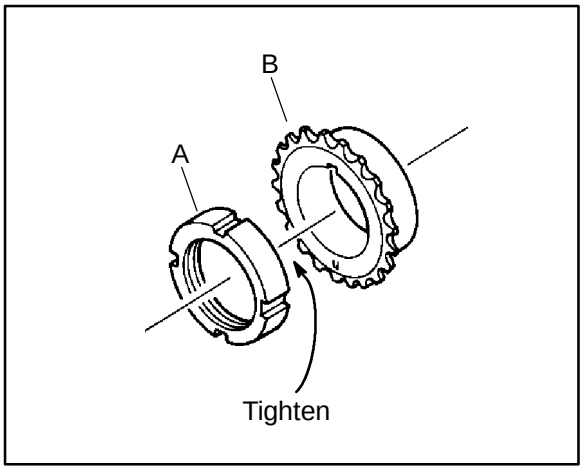
16 ft. lbs. (2.2 kg-m)

CAM CHAIN DRIVE SPROCKET INSTALLATION

1. Install the Woodruff key, drive sprocket, and slotted nut. Tighten the nut to the specified torque.

Slotted Nut Torque:

35-51 ft. lbs. (4.71-6.86 kg-m)



TENSIONER BLADE INSTALLATION

1. Install the tensioner blade and tighten the mounting bolt to specified torque.

Tensioner Blade Mounting Bolt Torque:

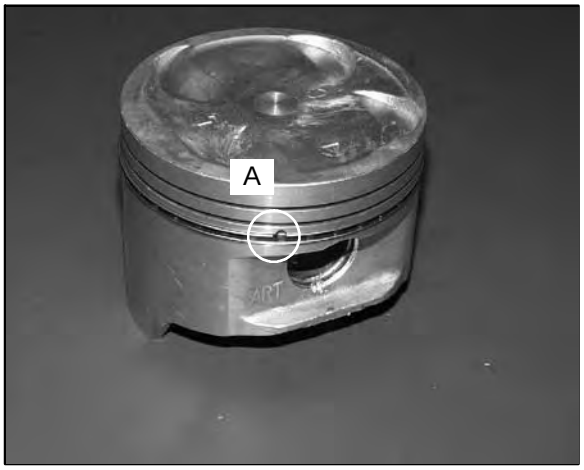
6 ft. lbs. (.828 kg-m)

PISTON RING INSTALLATION

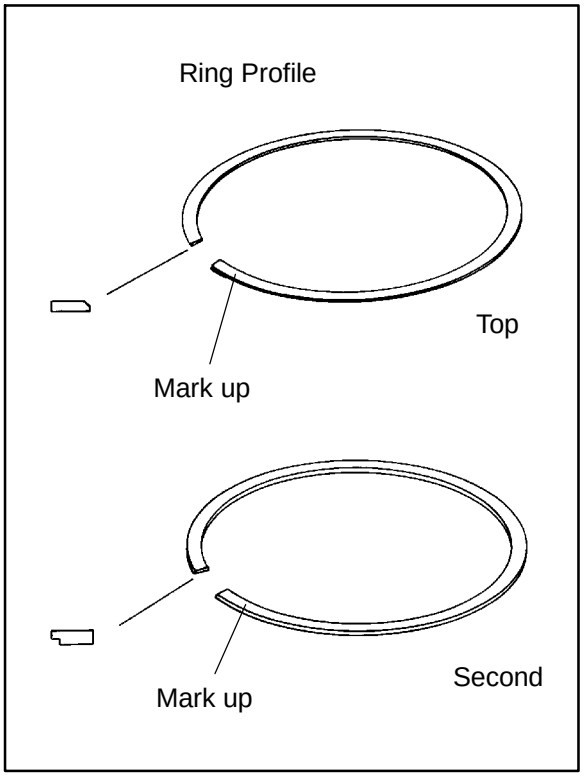
NOTE: Apply clean engine oil to all ring surfaces and ring lands. Always check piston ring installed gap before rings are installed on piston. See page 3.43. If the piston has been in service clean any accumulated carbon from the ring grooves and oil control ring holes.

1. Place the oil control ring expander in oil ring groove with the end gap facing forward. The expander has no up or down marking and can be installed either way. The ends should butt squarely together and must not overlap.
2. Install the oil ring top rail.

NOTE: The top rail has a locating tab to prevent rotation. The tab must be positioned in the notch on the side of the piston as shown (A).



3. Install the bottom rail with the gap at least 30° from the end of the expander on the side opposite the top rail gap.(See Ill.).
4. Install the second ring with the “R” mark facing up. Position the end gap toward the rear (intake) side of the piston.
5. Install the top ring (chrome faced) with the “R” mark facing up and the end gap facing forward (toward the exhaust). (See Ill.).
6. Check to make sure the rings rotate freely in the groove when compressed.

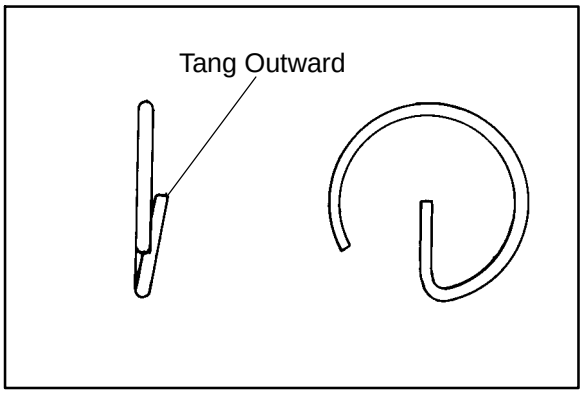


PISTON INSTALLATION

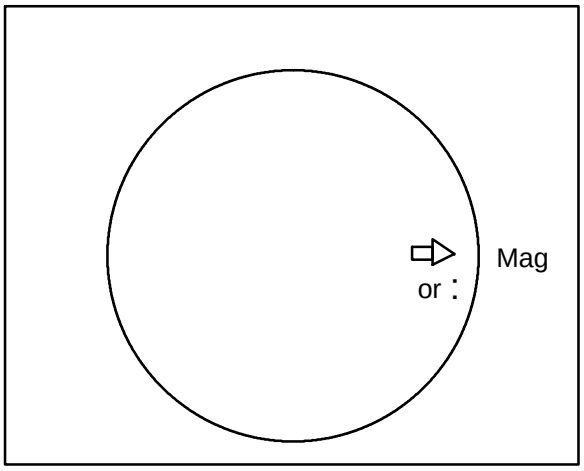
1. Clean the gasket surfaces on the cylinder and crankcase. Remove all traces of old gasket material.
2. Make sure the cylinder mounting bolt holes are clean and free of debris.
3. Install a new circlip on one side of the piston with the end gap facing *up* or *down,* and tang outward.

CAUTION: Circlips become deformed during the removal process. Do not re-use old circlips. Do not compress the new clip more than necessary upon installation to prevent loss of radial tension. Severe engine damage may result if circlips are re-used or deformed during installation.

4. Apply clean engine oil to the piston rings, ring lands, piston pin bore, piston pin, and piston skirt. Lubricate the connecting rod (both ends), balancer drive gear, and crankshaft main bearing area.

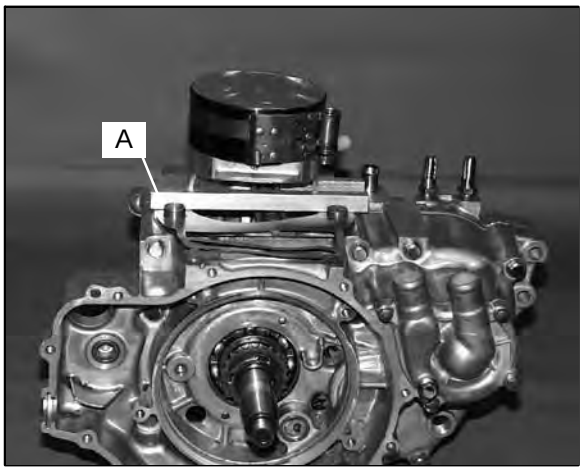


5. Install the piston on the connecting rod with the arrow or : mark facing the magneto (RH) end of the crankshaft. The piston pin should be a push fit in the piston.
6. Install the other circlip with the gap facing up or down and tang outward. (See Caution with step 3 above). Push the piston pin in both directions to make sure the clips are properly seated in the groove.



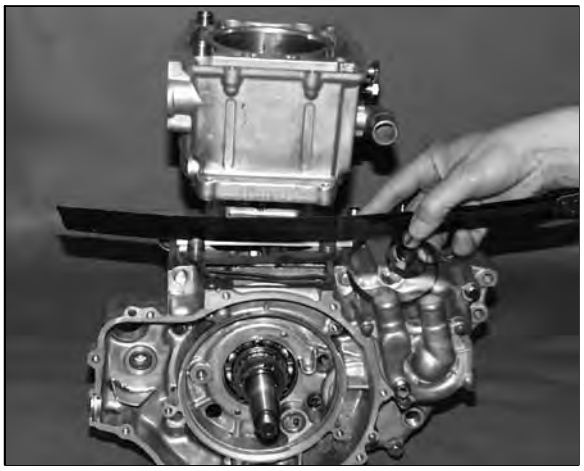
CYLINDER INSTALLATION

1. Place the dowel pins in the crankcase and install a new cylinder base gasket.
2. Position the piston support block PN 2870390 (A) beneath the piston skirt to support the piston during cylinder installation.
3. Apply clean engine oil to the ring compressor (Snap On™ PN RCL30) and install the compressor following manufacturers instructions. **CAUTION:** Make sure the oil control ring upper rail tab is positioned properly in the notch of the piston. Verify all ring end gaps are correctly located.



4. Apply clean engine oil liberally to the cylinder bore and tapered area of the sleeve. Install the cylinder with a slight rocking motion until the rings are captive in the sleeve.

5. Remove the ring compressor and support block.



6. Push the cylinder downward until fully seated on the base gasket.

CYLINDER INSTALLATION, CONT.

7. Apply a light film of oil to the threads and flange surface of the cylinder mounting bolts.

8. Install all four bolts finger tight. Rotate the engine and position the piston at BDC.

NOTE: If cam chain is installed, hold it up while rotating the engine to avoid damage to the chain, drive sprocket teeth, or tensioner blade.

9. Tighten the cylinder bolts in three steps in a criss cross pattern and torque to specifications.
10. Install the two 6mm bolts.

Cylinder Bolt Torque:

10mm - 46 ft. lbs. (6.348 kg-m)
6mm - 6 ft. lbs. (.828 kg-m)

CYLINDER HEAD INSTALLATION

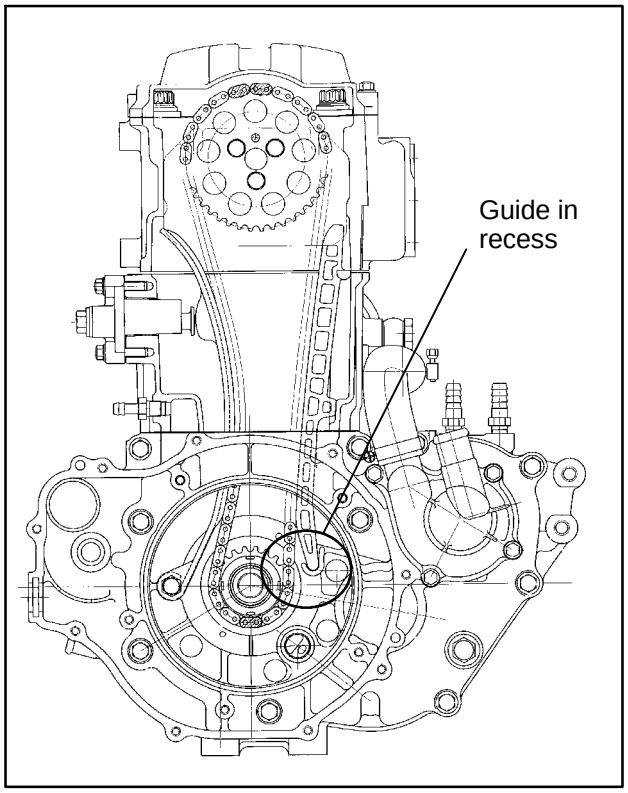
Clean the gasket surfaces on the cylinder head and cylinder. Remove all traces of old gasket material.
Refer to disassembly photos.

1. Install the cam chain tensioner guide. Be sure bottom end of guide is located properly in crankcase.

2. Install the two dowel pins and a new cylinder head gasket.

3. Place the cylinder head on the cylinder. Apply a film of engine oil to the cylinder head bolt threads and washers, and hand tighten the bolts.

The following procedure must be used to torque the cylinder head properly:



Torque all bolts evenly in a criss cross pattern

***Torque bolts to 22 ft. lbs. (3.04 kg-m)**

***Torque bolts to 51 ft. lbs. (7.04 kg-m)**

***Loosen bolts evenly 180° (1/2 turn)**

***Loosen bolts again another 180° (1/2 turn)**

***Torque bolts to 11 ft. lbs. (1.52 kg-m)**

***From this point, tighten bolts evenly 90° (1/4 turn)**

***Finally, tighten another 90° (1/4 turn)**

***Install two 6mm bolts and torque to 6 ft. lbs. (.828 kg-m)**

CAM CHAIN/CAMSHAFT INSTALLATION

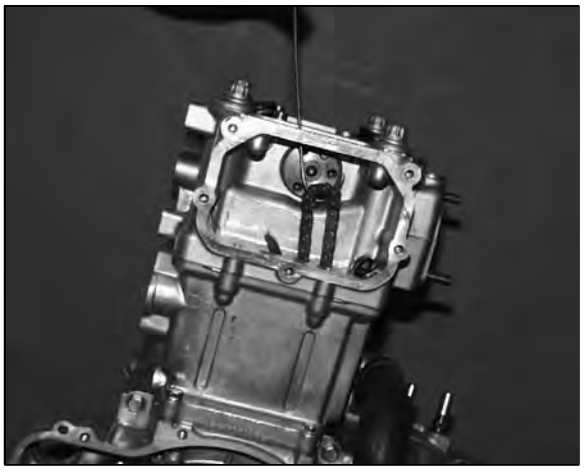
Install the cam chain over the crankshaft.

CAUTION: Serious engine damage may result if the camshaft is not properly timed to the crankshaft.

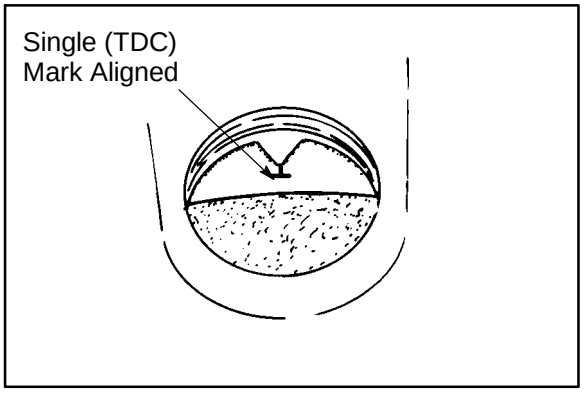
IMPORTANT CAMSHAFT TIMING NOTE: In order to time the camshaft to the crankshaft, the piston must be precisely located at Top Dead Center (TDC).

CAMSHAFT TIMING

1. Apply Polaris Premium Starter Drive grease to the camshaft main journals and cam lobes. Lubricate automatic compression release mechanism with clean engine oil. (To install the compression release mechanism, refer to page 3.23).
2. Install the camshaft with the lobes facing downward and the sprocket alignment pin facing upward.

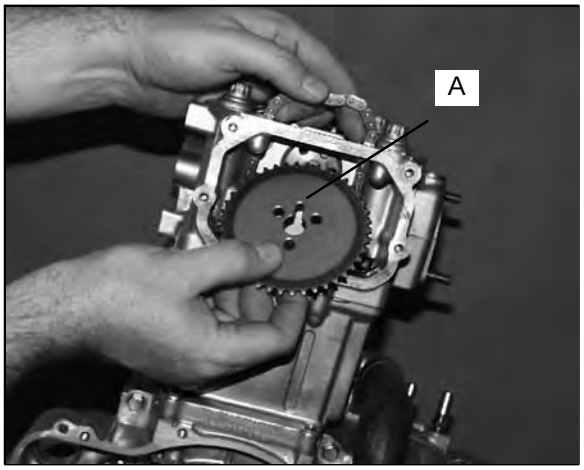


3. Disconnect the wire from the cam chain and rotate the engine to align the single (TDC) timing mark (Top Dead Center) on the flywheel with the notch in the timing inspection window. Be sure to use the *single* TDC mark when installing the cam. Do not use the advance marks. See Ill. on next page.

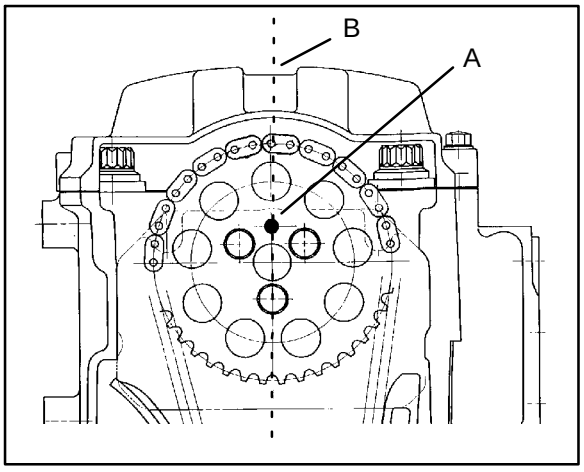


CAMSHAFT TIMING, CONT.

4. Loop the cam chain on the cam sprocket with the dots on the sprocket facing outward and the alignment pin notch facing directly upward.



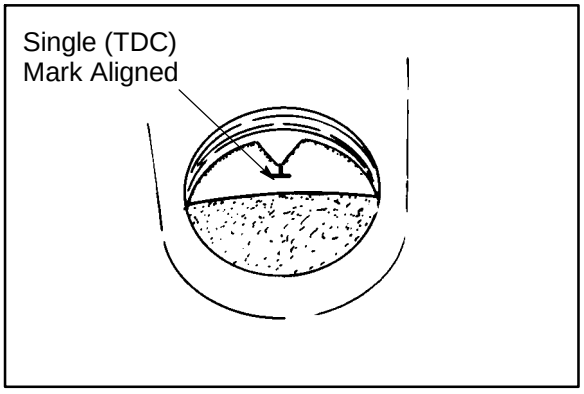
5. Before positioning the sprocket on the camshaft, check the position of the cam sprocket alignment pin. When the cam is positioned properly, the cam sprocket alignment pin (A) is directly in line with the crankshaft/camshaft centerline (B).
6. Install the sprocket on the camshaft. Apply Loctite 242 to the cam sprocket bolts and torque to specifications.



Cam Sprocket Bolt Torque:

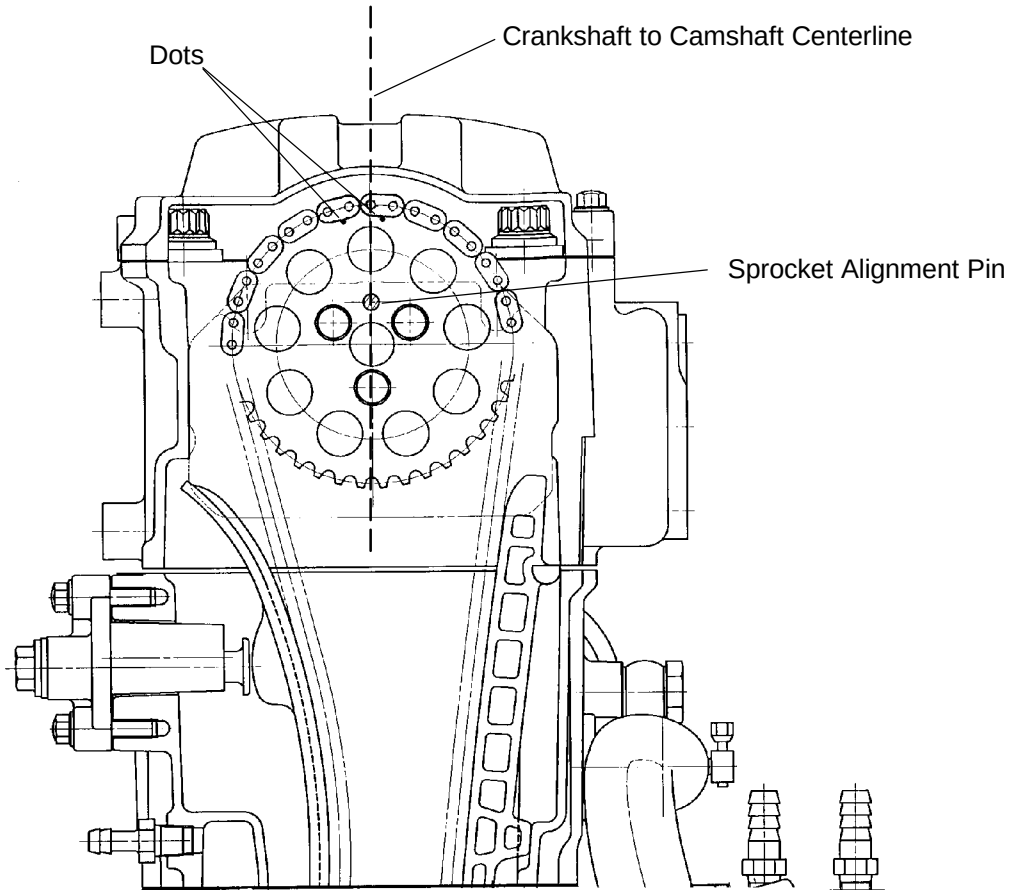
6 ft. lbs. (.828 kg-m)

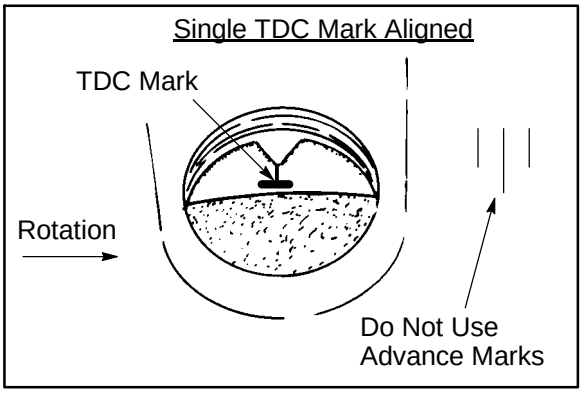
7. Verify TDC mark in timing inspection hole and alignment pin is directly in line with crankshaft to camshaft centerline. Refer to Ill. on following page.



8. Apply 3 Bond 1215 (P/N 2871557) to the camshaft end cap and install using a new O-Ring.
9. Check all cam timing marks to verify proper cam timing, and install the cam chain tensioner body with a new gasket.
10. After tensioner installation, rotate engine at least two revolutions and re-check marks/timing.

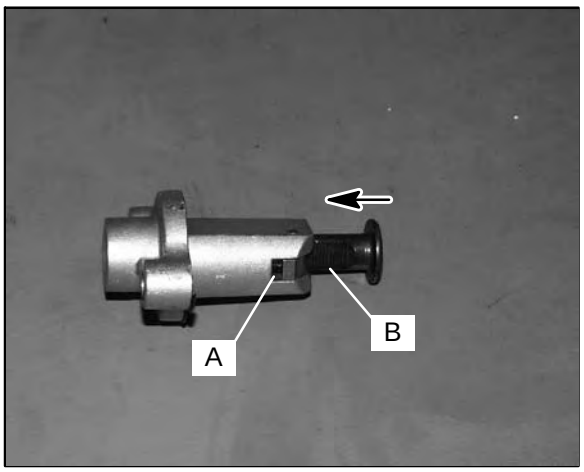
CAMSHAFT TIMING





CAM CHAIN TENSIONER INSTALLATION

1. Release the ratchet pawl (A) and push the tensioner plunger (B) all the way into the tensioner body.
2. Install the tensioner body with a new gasket and tighten the bolts.



Tensioner Bolt Torque:

6 ft. lbs. (.828 kg-m)

3. Install the spring, new sealing washer, and tensioner plug.

Tensioner Plug Torque:

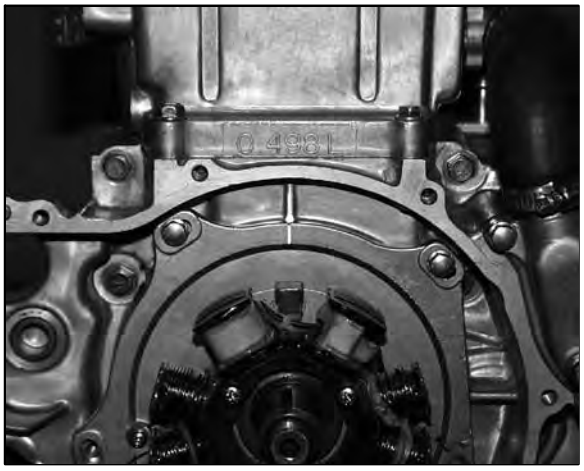
17 ft. lbs. (2.346 kg-m)

4. Slowly rotate engine two to three revolutions and re-check cam timing.

STATOR, FLYWHEEL AND STARTER DRIVE INSTALLATION

NOTE: The stator, flywheel, starter drive, and recoil can be assembled with the engine in the frame.

Stator



1. Apply a light film of grease to the crankshaft seal. Apply molybdenum disulfide grease or assembly lubricant to the crankshaft bushing.
2. Install a new O-Ring in the oil passage recess in the crankcase.
3. Apply 3 Bond 1215 (P/N 2871557) or an equivalent sealer to the stator plate outer surface and install a new O-Ring.
4. Install the stator plate being careful not to damage the seal. Align timing reference marks on the plate and crankcase. Be sure the plate is fully seated. NOTE: This is a static timing mark. Strobe timing should be performed after start up.

STATOR, FLYWHEEL AND STARTER DRIVE INSTALLATION, CONT.

5. Torque bolts evenly to specification.

Stator Plate Bolt Torque:

5.1-6.5 ft. lbs. (.68-.88 kg-m)

6. Seal stator wire grommet with 3 Bond 1215 or equivalent sealer.

Flywheel

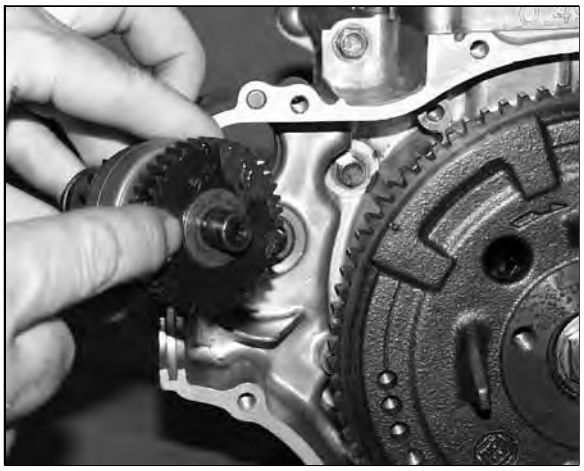
1. Install flywheel, washer, and nut. Torque flywheel to specification.

Flywheel Nut Torque:

58-72 ft. lbs. (7.85-9.81 kg-m)

Starter Drive

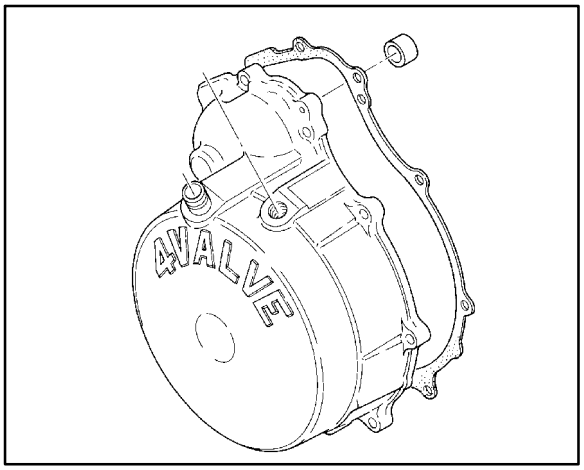
1. Be sure the washer is positioned on the back of the drive gear.



2. Apply starter drive grease to the drive bushing in the crankcase and all moving surfaces of the starter drive mechanism. Install the starter drive.
3. Install recoil housing gasket and recoil housing.

Starter Drive Grease:

PN 2871460



ROCKER SHAFT/ROCKER ARM ASSEMBLY INSTALLATION

1. Assemble rocker arms, rocker shaft, and shaft supports.
2. Install and tighten rocker arm shaft locating bolt.
3. Apply starter drive grease to the cam lobes and cam follower surfaces.
4. Rotate the engine until the cam lobes are pointing downward.
5. Be sure the dowel pins are in place and install the rocker shaft assembly.
6. Apply a light film of engine oil to the threads of the bolts and tighten evenly.

Rocker Shaft Support Tower Bolt Torque:

9 ft. lbs. (1.242 kg-m)

Rocker Shaft Locating Bolt Torque:

6 ft. lbs. (.828 kg-m)

7. Adjust valves according to the valve adjustment procedure found in Chapter 2, Maintenance.
8. Apply clean engine oil liberally to the valve springs, cam chain, rocker arms, and camshaft.
9. Place a new rocker cover gasket on the cylinder head and install the cover and bolts.

Rocker Cover Bolt Torque:

6 ft. lbs. (.828 kg-m)

THERMOSTAT INSTALLATION

Install the thermostat with one of the air bleed holes positioned next to the upper thermostat cover bolt hole as shown.

OIL PIPES

Install the oil pipes with new sealing washers. Tighten all bolts evenly to specified torque.

Oil Pipe Bolt Torque:

20 ft. lbs. (2.76 kg-m)

RECOIL DISASSEMBLY/INSPECTION

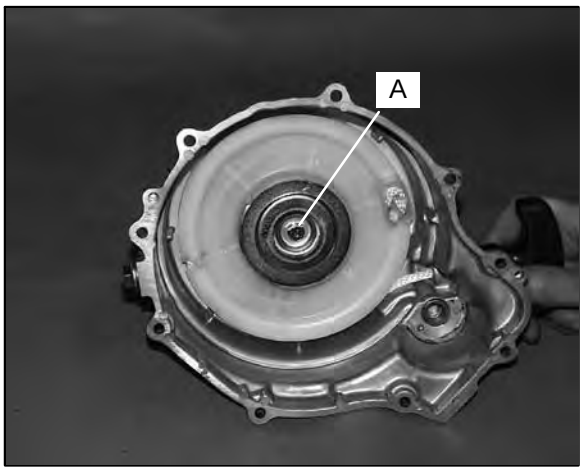
CAUTION: The recoil is under spring tension. A face shield and eye protection is required during this procedure.

Replace any parts found to be worn or damaged.

1. Remove bolts and recoil housing.

2. Pull recoil rope so it is extended approximately 12-18″.Check handle c-ring for proper tension, and the handle for cracks or damage which may allow water or dirt to enter the recoil housing through the rope. **NOTE:** The handle must seal tightly on the recoil housing to prevent water from entering.

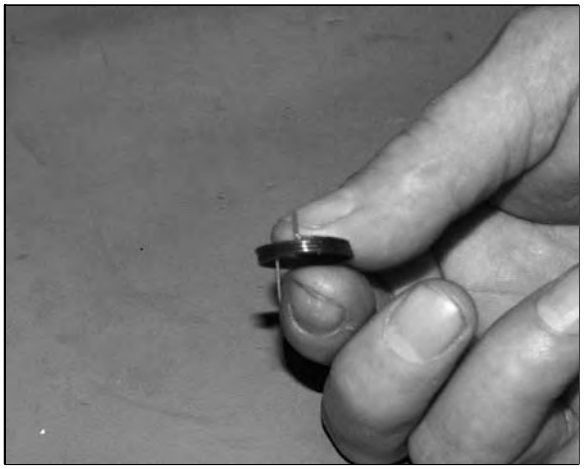
3. Remove center bolt from recoil friction plate (A).



4. Inspect plate for wear or damage. Inspect plate friction spring for wear, damage, and proper tension. The spring should fit tightly on friction plate.

5. Remove ratchet pawl with spring and inspect. Replace spring or ratchet pawl if worn, broken, or damaged.

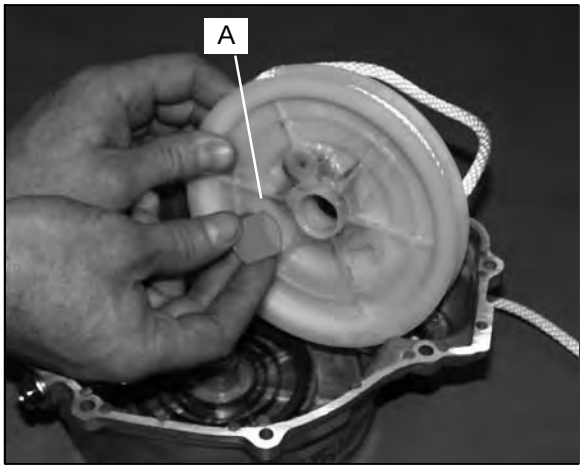
NOTE: Long arm of spring engages reel. Short end against pawl.



RECOIL DISASSEMBLY/INSPECTION, CONT.

6. Hold reel firmly in housing. Pull rope handle until 12-18″ of rope is exposed, and hold reel in place.
7. Place rope in notch on outer edge of reel. Release tension on hub and allow reel to unwind approximately 6-7 turns until spring tension is released.

8. Slowly and carefully remove reel from recoil housing making sure the spring remains in the housing. Inspect the reel hub and bushing (A) for wear.
9. Unwind rope and inspect for cuts or abrasions.
10. Inspect drive tab on hub return spring for damage. To remove hub return spring, hold outer coils in place with one hand and slowly remove spring one coil at a time from the inside out.
11. Pull knot out of of recoil reel. Untie knot. Remove rope from reel.

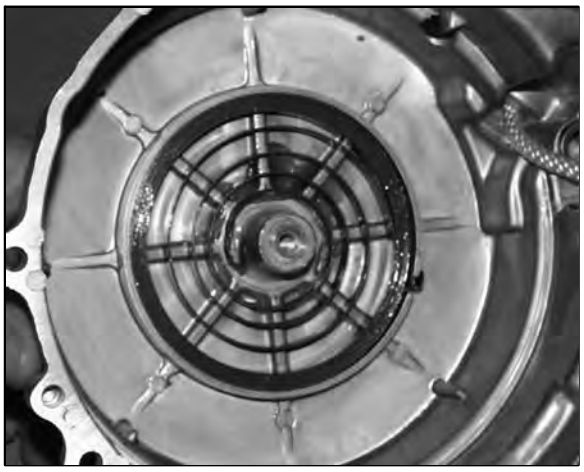


RECOIL ASSEMBLY

CAUTION: Be sure to wear a face shield and eye protection when performing this procedure.

To install a new spring:

1. Place spring in housing with the end positioned so the spring spirals inward in a counterclockwise direction. See photo at right.
2. Hold spring in place and cut retaining wire.

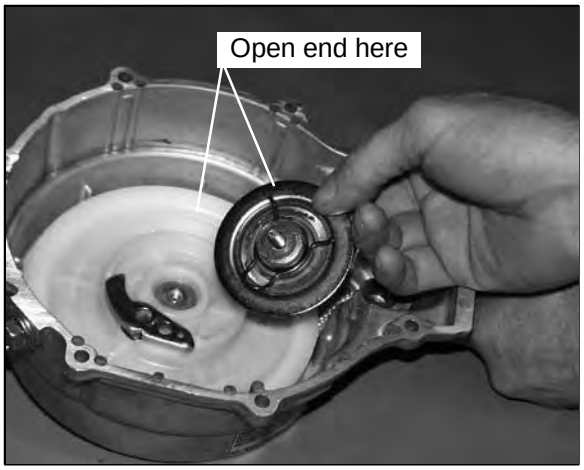


To reinstall an old spring:

1. Hook outer tab in place in recoil housing and wind spring in a counterclockwise direction one coil at a time while holding the installed coils in place.
2. Lubricate the spring with light lubricant such as Premium All Season Grease.

To complete recoil assembly:

1. Route rope through guide bushing in recoil housing and into reel. Tie a secure knot in end of the rope.
2. Wind rope counterclockwise onto the reel, as viewed from ratchet side of reel.
3. Lock rope into notch on outer edge of reel.
4. Apply a small amount of grease or equivalent to the center post of the housing and the bushing.
5. Install reel into housing making sure the spring drive tab on the reel engages the spring and the reel is fully seated in the housing.
6. Apply downward pressure on the reel and rotate counterclockwise approximately 6-7 turns to pre-wind the spring. Continue rotating counterclockwise until rope on outer edge aligns with rope guide bushing.
7. Release rope from notch and allow reel to rewind completely. If more pre-wind is required, place rope in notch and add additional turns of pre-wind.
8. Install ratchet pawl and return spring, with long leg of spring engaged in reel.
9. Reinstall friction plate. **NOTE:** The friction plate must be positioned with both end tabs of the friction spring opposite the ratchet pawl.
10. Torque friction plate retaining bolt to 5-6 ft. lbs. (7-9 Nm).
11. Reinstall recoil housing using a new gasket. Seal stator wire harness grommet with RTV silicone.



SPARK PLUG FOULING

- Spark plug cap loose or faulty
- Choke cable adjustment or plunger/cable sticking
- Foreign material on choke plunger seat or plunger
- Incorrect spark plug heat range or gap
- Carburetor inlet needle and seat worn
- Jet needle and/or needle jet worn or improperly adjusted
- Excessive carburetor vibration (loose or missing needle jet locating pins)
- Loose jets in carburetor or calibration incorrect for altitude/temperature
- Incorrect float level setting
- PVT system calibrated incorrectly or components worn or mis-adjusted
- Fuel quality poor (old) or octane too high
- Low compression
- Restricted exhaust
- Weak ignition (loose coil ground, faulty coil, stator, or ETC switch)
- ETC switch mis-adjusted
- Restricted air filter (main or pre-cleaner) or breather system
- Improperly assembled air intake system
- Restricted engine breather system
- Oil contaminated with fuel
- Restricted oil tank vent

TROUBLESHOOTING

Engine Turns Over But Fails to Start

- No fuel
- Dirt in fuel line or filter
- Fuel will not pass through fuel valve
- Fuel pump inoperative/restricted
- Tank vent plugged
- Carb starter circuit
- Engine flooded
- Low compression (high cylinder leakage)
- No spark (Spark plug fouled)

Engine Does Not Turn Over

- Dead battery
- Starter motor does not turn
- Engine seized, rusted, or mechanical failure

Engine Runs But Will Not Idle

- Restricted carburetor pilot system
- Carburetor misadjusted
- Choke not adjusted properly
- Low compression
- Crankcase breather restricted

Engine Idles But Will Not Rev Up

- Spark plug fouled/weak spark
- Broken throttle cable
- Obstruction in air intake
- Air box removed (reinstall all intake components)
- Incorrect or restricted carburetor jetting
- ETC switch limiting speed
- Reverse speed limiter limiting speed
- Carburetor vacuum slide sticking/diaphragm damaged
- Incorrect ignition timing
- Restricted exhaust system

Engine Has Low Power

- Spark plug fouled
- Cylinder, piston, ring, or valve wear or damage (check compression)
- PVT not operating properly
- Restricted exhaust muffler
- Carburetor vacuum slide sticking/diaphragm damaged
- Dirty carburetor

Piston Failure - Scoring

- Lack of lubrication
- Dirt entering engine through cracks in air filter or ducts
- Engine oil dirty or contaminated

TROUBLESHOOTING, CONT

Excessive Smoke and Carbon Buildup

- Excessive piston-to-cylinder clearance
- Wet sumping
- Worn rings, piston, or cylinder
- Worn valve guides or seals
- Restricted breather
- Air filter dirty or contaminated

Low Compression

- Decompressor stuck
- Cylinder head gasket leak
- No valve clearance or incorrectly adjusted
- Cylinder or piston worn
- Piston rings worn, leaking, broken, or sticking
- Bent valve or stuck valve
- Valve spring broken or weak
- Valve not seating properly (bent or carbon accumulated on sealing surface)
- Rocker arm sticking

Backfiring

- ETC or speed limiter system malfunction
- Fouled spark plug or incorrect plug or plug gap
- Carburetion faulty - lean condition
- Exhaust system air leaks
- Ignition system faulty:
  - Spark plug cap cracked/broken
  - Ignition coil faulty
  - Ignition or kill switch circuit faulty
  - Ignition timing incorrect
  - Sheared flywheel key
- Poor connections in ignition system
- System wiring wet
- Valve sticking
- Air leaks in intake
- Lean condition

COOLING SYSTEM TROUBLESHOOTING

Overheating

- Low coolant level
- Air in cooling system
- Wrong type of coolant
- Faulty pressure cap or system leaks
- Restricted system (mud or debris in radiator fins or restriction to air flow, passages blocked in radiator, lines, pump, or water jacket)
- Lean mixture (restricted jets, vents, fuel pump or fuel valve)
- Fuel pump output weak
- Restricted radiator (internally or cooling fins)
- Water pump failure
- Cooling system restriction
- Cooling fan inoperative or turning too slowly (perform current draw test)
- Ignition timing misadjusted
- Low oil level
- Spark plug incorrect heat range
- Faulty hot light circuit
- Thermostat stuck closed or not opening completely

Temperature Too Low

- Thermostat stuck open

Leak at Water Pump Weep Hole

- Faulty water pump mechanical seal (coolant leak)
- Faulty pump shaft oil seal (oil leak)