SY series

SERVICE MANUAL

6SY-STP2
6SY655
8SY-STP

P/N: 0BSYM-G00100

YANMAR®

MARINE ENGINES

NOTICE

The safety messages that follow have NOTICE level hazards.

Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit must be replaced.

ALWAYS tighten components to the specified torque. Loose parts can cause equipment damage or cause it to operate improperly.

Only use replacement parts specified. Other replacement parts may affect warranty coverage.

NEVER attempt to modify the engine design or safety features such as defeating the engine speed limit control or the diesel fuel injection quantity control.

Modifications may impair the engine's safety and performance characteristics and shorten the engine's life. Any alterations to this engine may void its warranty. Be sure to use Yanmar genuine replacement parts.

ALWAYS be environmentally responsible.

Follow the guidelines of the EPA or other governmental agencies for the proper disposal of hazardous materials such as engine oil, diesel fuel and engine coolant. Consult the local authorities or reclamation facility.

NEVER dispose of hazardous materials by dumping them into a sewer, on the ground or into ground water or waterways.

If any indicator illuminates during engine operation, stop the engine immediately. Determine the cause and repair the problem before you continue to operate the engine.

Make sure the engine is installed on a level surface. If a Yanmar Marine Engine is installed at an angle that exceeds the specifications stated in the Yanmar Marine Installation manuals, engine oil may enter the combustion chamber causing excessive engine speed, white exhaust smoke and serious engine damage. This applies to engines that run continuously or those that run for short periods of time.

LOCATION OF NAMEPLATES

The following figures show the location of regulatory and safety nameplates on Yanmar SY marine engines.

Engine Nameplate (Typical)

6SY Engines

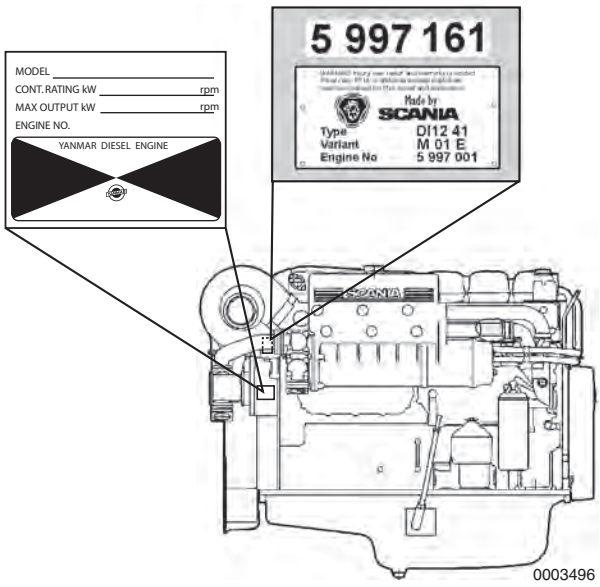


Figure 3-7

The typical location of the engine nameplates is shown for Yanmar 6SY Series marine engines **(Figure 3-7)**.

8SY Engines

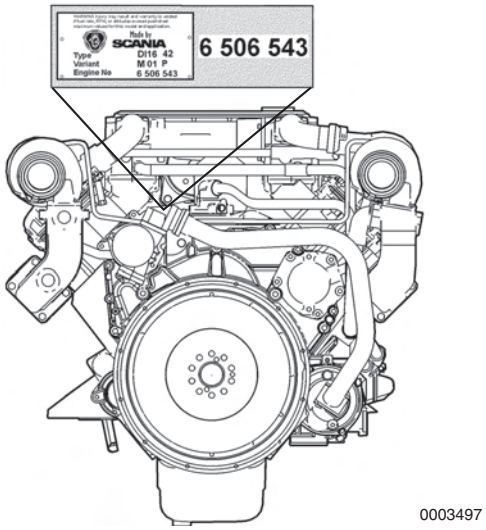


Figure 3-8

8SY Engines

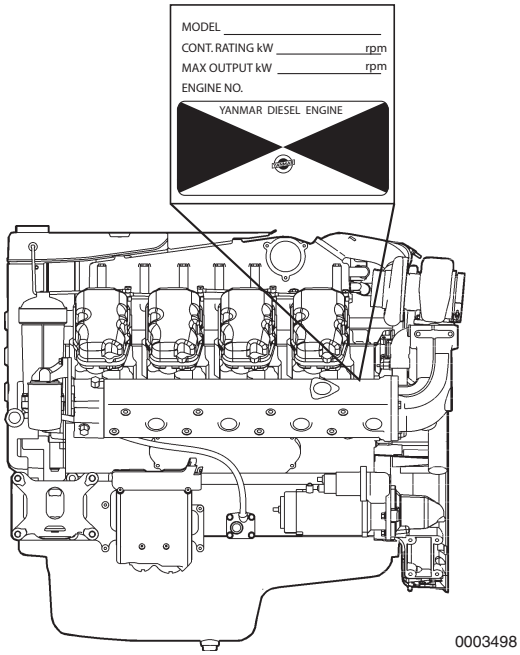


Figure 3-9

The typical location of the engine nameplates is shown for Yanmar 8SY Series marine engines **(Figure 3-8)** and **(Figure 3-9)**.

ABBREVIATIONS AND SYMBOLS

Abbreviations

A	ampere
AC	alternating current
ACEA	Association des Constructeurs Européens d'Automobilies
Ah	ampere-hour
API	American Petroleum Institute
ARB	Air Resources Board
ATDC	after top dead center
BDC	bottom dead center
BTDC	before top dead center
°C	degree Celsius
CARB	California Air Resources Board
CCA	cold cranking amp
cfm	cubic feet per minute
cm	centimeter
cm³	cubic centimeter
cm³/min	cubic centimeter per minute
cu in.	cubic inch
D	diameter
DC	direct current
DI	direct injection
DVA	direct volt adapter
EPA	Environmental Protection Agency
ESG	electronic speed governor
°F	degree Fahrenheit
fl oz	fluid ounce (U.S.)
fl oz/min	fluid ounce (U.S.) per minute
ft	foot
ft-lb	foot pound
ft-lbf/min	foot pound force per minute
g	gram
gal	gallon (U.S.)
gal/hr	gallon (U.S.) per hour
gal/min	gallon (U.S.) per minute
GL	gear lubricant
hp	horsepower (U.S.)
hr	hour
I.D.	inside diameter
ID	identification
IDI	indirect injection
in.	inch
in.Aq	inches Aqueous (water)
in.Hg	inches Mercury
in.-lb	inch pound
J	joule
JASO	Japanese Automobile Standards Organization
K	kelvin
kg	kilogram
kgf/cm²	kilogram force per square centimeter
kgf/m	kilogram force per meter
km	kilometers
kPa	kilopascal
kW	kilowatt
L	liter
L/hr	liter per hour
lb	pound
lbf	pound force
m	meter
mL	milliliter
mm	millimeter
mmAq	millimeter Aqueous (water)
MPa	megapascal
mV	millivolt
N	newton
N·m	newton meter
No.	number
O.D.	outside diameter
oz	ounce
Pa	pascal
PS	horsepower (metric)
psi	pound per square inch
qt	quart (U.S.)
R	radius
rpm	revolutions per minute
SAE	Society of Automotive Engineers
sec.	second
t	short ton 2000 lb
TBN	total base number
TDC	top dead center
V	volt
VAC	volt alternating current
VDC	volt direct current
W	watt

Symbols

°	degree
+	plus
-	minus
±	plus or minus
Ω	ohm
μ	micro
%	percent

Every 1000 Hours of Operation

Perform the following maintenance every 1000 hours of operation or 4 years, whichever comes first.

- **Adjust Unit Injectors / Rocker Arms**
- **Clean and Check the Seawater Passages**
- **Replace Alternator Belt**
- **Adjust Intake / Exhaust Valve Clearance**
- **Replace the Flexible Engine Mounts**

Every 2000 Hours of Operation

Perform the following maintenance every 2000 hours of operation or 8 years, whichever comes first.

- **Overhaul and Check Fuel Feed Pump**
- **Replace Rubber Fuel Hoses**
- **Clean Engine Oil Cooler**
- **Clean Seawater and Engine Coolant System**
- **Check the Wiring Connectors**

SPECIAL TORQUE CHART

Component		Torque	Lubricating Oil Application (Thread Portion and Seat Surface)	Reference Page
Rocker Arm Adjusting Screw Lock Nut		39 N·m (29 ft-lb)	-	*See Adjust Valve and Unit Injector Clearances on page 5-18*
Rocker Arm Shaft Support Bracket Bolt		105 N·m (77 ft-lb)	Not Applied	*See Install the Cylinder Head on page 5-34*
Rocker Arm Shaft Bolt		105 N·m (77 ft-lb)	Not Applied	
Cylinder Head Bolt	First tightening	60 N·m (44 ft-lb)	Applied	
	Second tightening	150 N·m (110 ft-lb)		
	Third tightening	250 N·m (184 ft-lb)		
	Fourth tightening	Plus 90°		
Unit Injector Fork Clamp Bolt (torque-turn)		20 N·m (133 in.-lb) plus 75°	Not Applied	
Injector Electrical Terminal Screw		2 N·m (283 in.-oz)	Not Applied	
Rocker Cover Bolt (Upper and Lower Cover)		26 N·m (230 in.-lb)	Not Applied	
Exhaust Manifold Bolt	6SY	59 N·m (44 ft-lb)	Not Applied	
	8SY	63 N·m (46 ft-lb)	Not Applied	
Turbocharger Bolt	6SY	50 N·m (37 ft-lb)	Not Applied	
	8SY	63 N·m (46 ft-lb)	Not Applied	
Lower Intake Manifold		26 N·m (230 in.-lb)	Not Applied	
Charge Air Cooler Bolt		26 N·m (230 in.-lb)	Not Applied	
Upper Intake Manifold	6SY	26 N·m (230 in.-lb)		
	8SY	50 N·m (37 ft-lb)	Not Applied	
Fuel Delivery Union Nut		20 N·m (133 in.-lb)	Not Applied	
Fuel Manifold Mounting Bolt		26 N·m (230 in.-lb)	Not Applied	
Fuel Return Banjo Bolt		11 N·m (97 in.-lb)	Not Applied	
Flywheel Mounting Bolt (torque-turn)		130 N·m (96 ft-lb) plus 90°	Not Applied	*See Install the Flywheel on page 5-54*
Flywheel Housing Bolt	M10	50 N·m (37 ft-lb)	Not Applied	*See Install the Flywheel Housing on page 5-53*
	M12	90 N·m (66 ft-lb)	Not Applied	
Timing Gear Plate Bolt - 6SY		63 N·m (46 ft-lb)	Not Applied	*See Install the Camshaft on page 5-78*
Tappet Mounting Bolt		32 N·m (24 ft-lb)	Not Applied	
Intermediate Gear Bolt (torque-turn)		50 N·m (37 ft-lb) plus 60°	Not Applied	
Camshaft Gear Bolt		63 N·m (46 ft-lb)	Not Applied	

6. Check and adjust the clearance of the appropriate valves using a feeler gauge.

Note: The intake valves are actuated by the short rocker arms and the exhaust valves by the long rocker arms. Make sure the valve bridge is resting correctly against the valves.

7. Check and adjust unit injector of the appropriate cylinder before rotating the crankshaft. Unit injectors can be adjusted using a special tool or a digital sliding caliper. *See Adjusting Unit Injectors on page 5-19.*
CAUTION! ***Use care when adjusting the unit injector if the dimension is outside the specification. The spring is under considerable tension and may cause personal injury if it is unexpectedly released.***
8. Mark the rocker arms with a permanent marker to identify the rocker arms that have been adjusted.
9. Rotate the flywheel and adjust the valves and unit injector for the next cylinder(s).

- **6SY:** Rotate the flywheel 120° (1/3 turn) and adjust the next cylinder.
- **8SY:** Rotate the flywheel 180° (1/2 turn) and adjust the next cylinders.

Repeat for the remaining cylinders per the order of adjustment tables. *See Order of Adjustment - 6SY on page 5-18* or *Order of Adjustment - 8SY on page 5-18*.

10. Install the upper rocker covers. Ensure the gasket is in good condition and in place. Tighten bolts to 26 N·m (230 in.-lb).

Specifications

Inspection Item	Intake	Exhaust
Valve Clearance	0.45 mm (0.018 in.)	0.70 mm (0.028 in.)

Adjusting Unit Injectors

Note: The PDE31 unit injector is adjusted using the setting tool (OEM Part No. 99 414) or a digital sliding caliper. The PDE32 unit injector is adjusted using the setting tool (OEM Part No. 99 442) or a digital sliding caliper.

Identifying Unit Injector

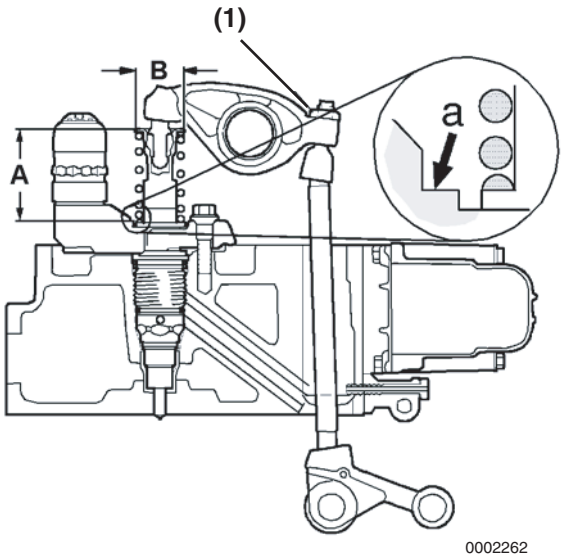


Figure 5-3

Measure spring diameter **(Figure 5-3, (B))** to identify the injector.

Unit Injector Identification

Inspection Item	PDE31	PDE32
Injector Spring Diameter **(B)**	36.5 mm (1.44 in.)	38.8 mm (1.53 in.)

Valve seat diameter **(Figure 5-19, (C))** can be adjusted by bottom-grinding using a 60° stone to make the seat diameter larger. Once the seat location has been corrected, grind and lap the seat angle to specification. *See Machine the Valve Seat Inserts on page 5-30* for specifications.

Grinding is needed if the valve and the valve seat do not contact correctly. Grind the valve face and / or valve seat only enough to return them to serviceable condition. Check valve recession after grinding.

If the valve or seat require grinding, lap the valve after grinding. Lap the valve face to the valve seat using a mixture of valve lapping compound and engine oil.

Be sure to thoroughly wash all parts to remove all grinding powder or compound.

Replace the Valve Stem Seals

1. Remove the valve.

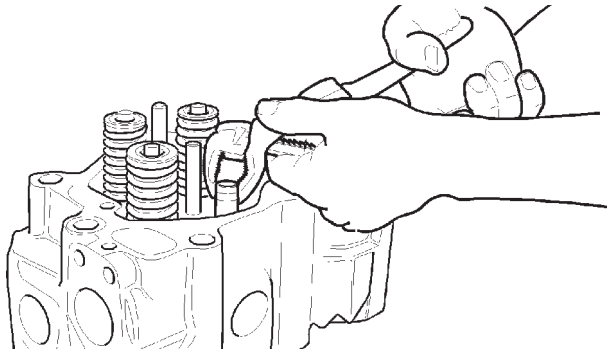


Figure 5-20

2. Remove valve stem seal with a pair of pliers **(Figure 5-20)**.
3. Install the valve.

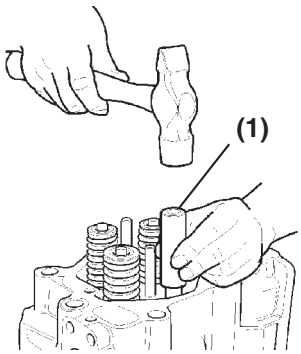


Figure 5-21

4. Carefully install new valve stem seal using an installer (OEM Part No. 99 323) **(Figure 5-21, (1))** and a hammer. **WARNING!** ***Avoid personal injury. ALWAYS wear safety glasses when servicing the engine.***

Replace the Valve Seat

Note: Oversize valve seat inserts are available if the valve seat bore has been damaged. See the parts catalog for available replacement parts.

Removal

1. Use a discarded valve that has been ground so that the diameter of the disc is slightly smaller than the inside diameter of the seat.

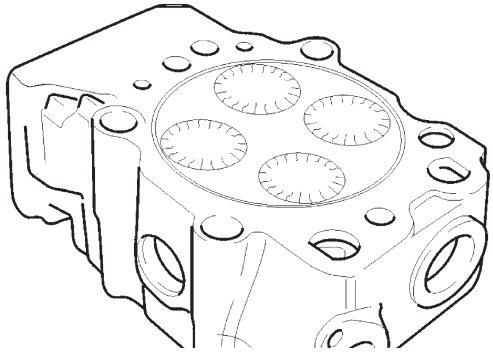


Figure 5-22

2. Install a valve and weld it to the valve seat **(Figure 5-22)**. Cool with water.

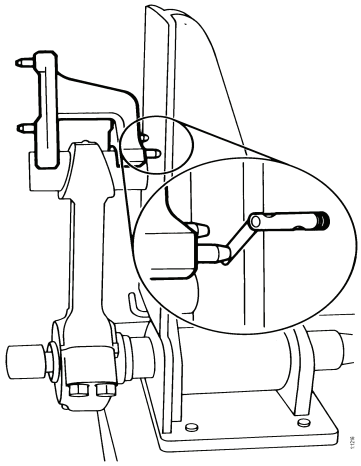


Figure 5-46

4. Place the gauge as shown in **Figure 5-46**. Use a feeler gauge to measure clearance between one gauge pin and the gauge surface to check connecting rod twist.

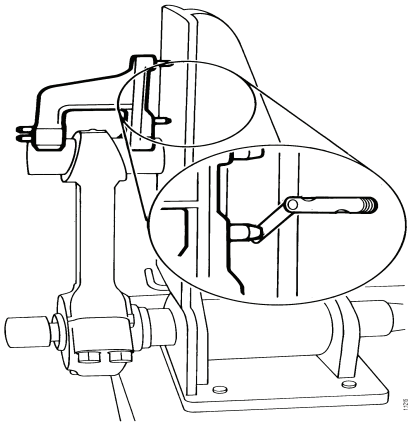


Figure 5-47

5. Place the gauge as shown in **Figure 5-47**. Use a feeler gauge to measure clearance between one gauge pin and the gauge surface to check connecting rod bend.

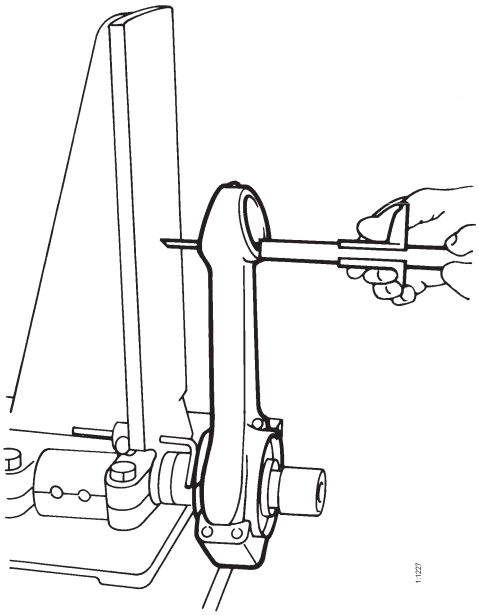


Figure 5-48

6. Check if the connecting rod is bent into an “S” shape. Measure the distance from the outside of the rod and the surface of the tool. Turn the connecting rod 180° and measure again **(Figure 5-48)**.

Connecting Rod Specifications

Inspection Item	6SY	8SY
Twist (Limit)	0.10 mm (0.004 in.)	0.05 mm (0.002 in.)
Bend (Limit)		
Bend - “S” Shape (Limit)	0.60 mm (0.024 in.)	4.5 mm (0.177 in.)

1 – Flywheel Housing
2 – Seal
3 – Bolt
4 – Washer
5 – Flange Bolt
6 – Flange Bolt
7 – Flange Bolt
8 – Cover
9 – Gasket
10 – Flange Bolt
11 – Timing Window Cover
12 – Lifting Eye
13 – Hexagon Nut
14 – Washer
15 – Stud
16 – Engine Speed Sensor
17 – Wire Connector
18 – Flange Bolt
19 – Clamp
20 – Clamp
21 – Bolt
22 – Crankshaft
23 – Timing Gear Plate
24 – Stud
25 – Pin
26 – Flange Bolt
27 – Cover
28 – O-Ring
29 – Crankshaft Gear
30 – Pin
31 – Ring Gear
32 – Flywheel
33 – Circlip
34 – Ball Bearing
35 – Bolt
36 – Washer
37 – Guide Sleeve

Figure 5-66

1 – Pushrod
2 – Tappet Shaft
3 – Circlip (4 used)
4 – Camshaft Gear, Right
5 – Thrust Washer
6 – Guide Flange
7 – Alignment Pin
8 – Guide Sleeve (2 used)
9 – Roller Tappet
10 – Camshaft, Right
11 – Front Camshaft Gear (left side only)
12 – Fuel Feed Pump Drive Gear
13 – Hydraulic Pump Drive Gear (if equipped)
14 – Camshaft, Left
15 – Camshaft Gear, Left
16 – Seawater Pump Gear
17 – Intermediate Gear Shaft
18 – Intermediate Timing Gear
19 – Oil Pump Gear
20 – Ball Bearing
21 – Snap Ring
22 – Spacer
23 – Gear, Optional Power Take-Off
24 – Spacer
25 – Intermediate Gear (2 used)
26 – Ball Bearing (4 used)
27 – Snap Ring (2 used)
28 – Shaft (2 used)
29 – Crankshaft Gear

Figure 5-81

Crankshaft Gear

Remove

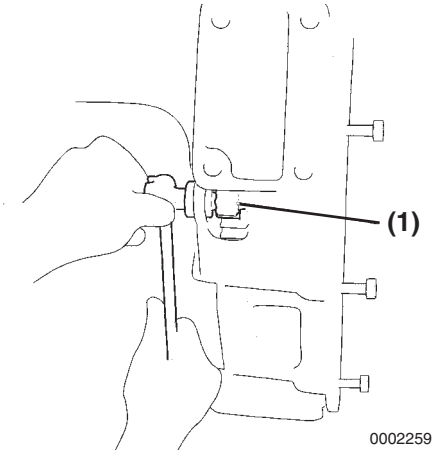


Figure 5-108

1. Use a flywheel turning tool **(Figure 5-108, (1))** to turn the crankshaft so that No. 1 cylinder is approximately at TDC on the compression stroke (both valve rocker arms loose). “Down TDC (0°)” will be visible in the lower timing window of the flywheel housing.
2. Remove the flywheel. *See Remove the Flywheel on page 5-51.*
3. Remove the flywheel housing. *See Remove the Flywheel Housing on page 5-53.*
4. Remove the intermediate gear(s). *See Intermediate Gear on page 5-62. NOTICE: Do not allow the crankshaft to turn while the timing gear train is disassembled.*

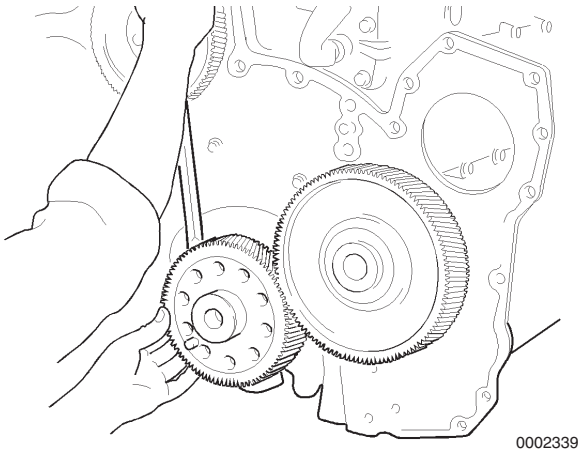


Figure 5-109

5. Remove the crankshaft gear. Use a puller or pry bar to remove the gear if necessary **(Figure 5-109)**.

Install

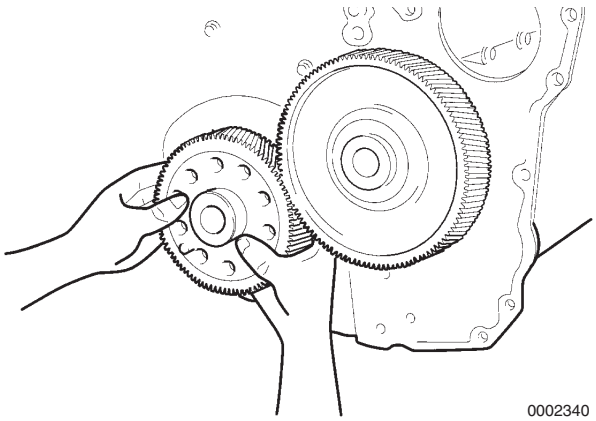


Figure 5-110

1. Install the crankshaft gear and guide pin **(Figure 5-110)**.
2. Install the intermediate gears. *See Intermediate Gear on page 5-62.*
3. Install the flywheel housing. *See Install the Flywheel Housing on page 5-53.*
4. Install the flywheel. *See Install the Flywheel on page 5-54.*
5. Check valve timing to verify installation. *See Check the Camshaft Timing on page 5-60.*

5. **6SY Engines:** Apply sealing agent (OEM Part No. 816 064 or equivalent) to cylinder block in the pattern shown **(Figure 5-135)**. The bead width should be 0.8 - 1.2 mm (0.032 - 0.047 in.). *NOTICE: Ensure that sealing agent is applied inside the bolt holes, but without allowing sealing agent into the crankcase. Excess sealing agent may block channels and nozzles, particularly around oil passages. Assembly must be completed within 25 minutes of the beginning of sealant application.*

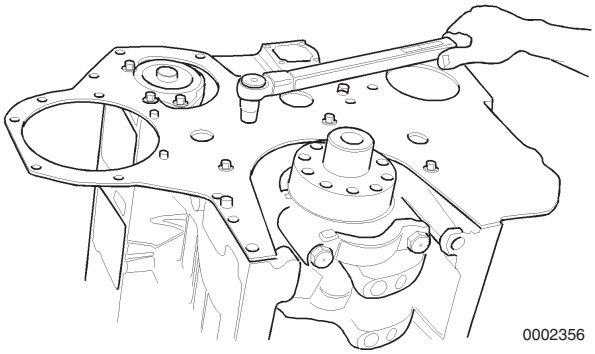


Figure 5-136

6. **6SY Engines:** Install timing gear plate on engine block. Tighten the bolts to 63 N·m (46 ft-lb).

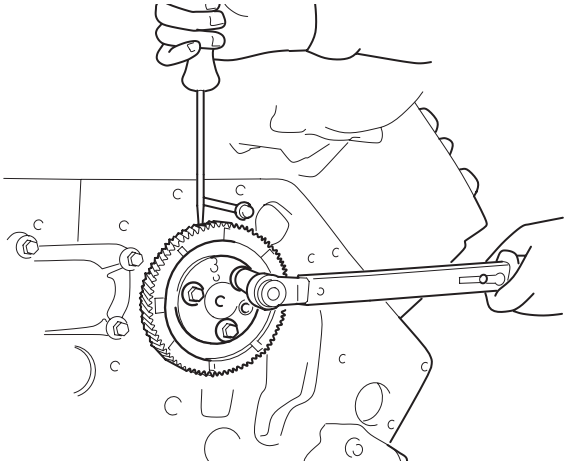


Figure 5-137

7. **8SY Engines:** Install front camshaft gear. Tighten bolts to 63 N·m (46 ft-lb).
8. **8SY Engines:** Install front gear housing. *See Install the Front Gear Housing - 8SY on page 5-62*.
9. Install camshaft gear(s). *See Camshaft Gear on page 5-67.*
10. Install intermediate gear(s). *See Intermediate Gear on page 5-62.*
11. Install flywheel housing. *See Install the Flywheel Housing on page 5-53.*
12. Install flywheel. *See Install the Flywheel on page 5-54.*

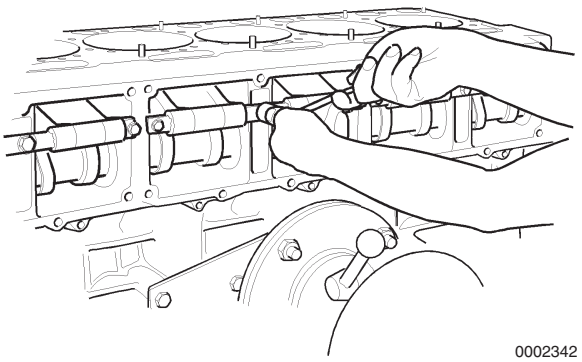


Figure 5-138

13. Lubricate valve tappets with clean engine oil and install in original locations. Tighten banjo bolts to 32 N·m (24 ft-lb) **(Figure 5-138)**. *NOTICE: The sealing surfaces must be absolutely clean and free from grease. Do not touch the surfaces after degreasing.*
14. Install camshaft covers using new gaskets.
15. **8SY Engines:**
    (a) Install the fuel manifolds. Tighten bolts to 26 N·m (230 in.-lb).
    (b) Install the coolant recovery tank and catwalk.
    (c) Install the connection pipe(s) between the charge air cooler and turbocharger.
    (d) Install the connection pipe between the charge air coolers.
16. Install the centrifugal oil cleaner assembly.
17. Install lower rocker covers, valve bridges, push rods and rocker shaft assemblies. *See Remove and Install Rocker Covers on page 5-23*.
18. Check valve timing to verify installation. *See Check the Camshaft Timing on page 5-60.*

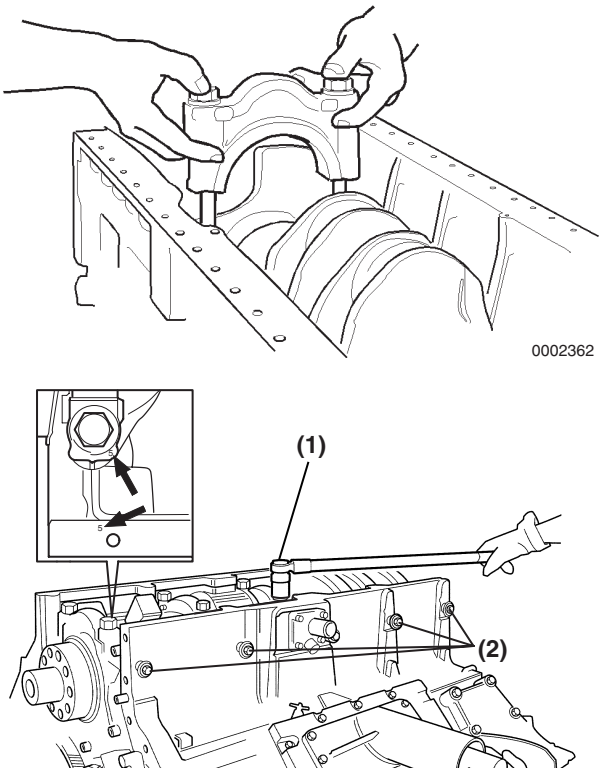


Figure 5-151

4. Install main bearing caps. Lubricate and tighten bearing cap bolts **(Figure 5-151, (1))** to specification.
5. **8SY:** Lubricate and install main bearing side bolts **(Figure 5-151, (2))** and tighten to specifications.

Main Bearing Bolt Torque

Item	6SY	8SY
Main Bearing Cap Bolts (torque-turn)	S/N: 6 513 632 and before: 50 N·m (37 ft-lb) plus 90°	90 N·m (66 ft-lb) plus 90°
	S/N: 6 513 633 and later: 200 N·m (148 ft-lb) plus 90°	
Main Bearing Side Bolts	-	180 N·m (133 ft-lb)

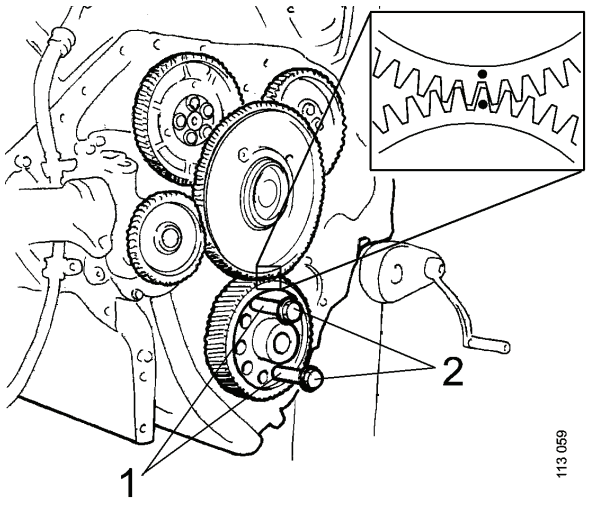
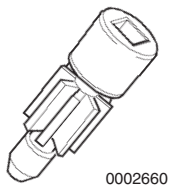
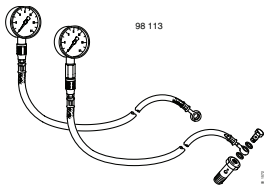
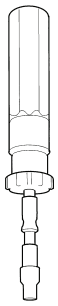


Figure 5-152

6. Install crankshaft gear and temporarily retain using two flywheel bolts **(Figure 5-152, (2))** and 50 mm (2 in.) spacers **(Figure 5-152, (1))**. Ensure the timing marks are aligned. *See Crankshaft Gear on page 5-69*.
7. Install pistons and connecting rods. Install piston cooling nozzles. *See Install the Piston and Connecting Rod on page 5-45.*
8. Install oil pump, oil suction pipe with strainer and the oil sump. *See Oil Pump on page 8-14*.
9. Install spacing sleeve on crankshaft journal. Install driver and crankshaft damper. Tighten to 135 N·m (100 ft-lb).
10. Install new seal in front cover/housing. *See Replace the Front Crankshaft Seal on page 5-90*.
11. Install front seal housing using a new gasket. *See Install the Front Gear Housing - 8SY on page 5-62*.
12. Install belt pulley and tighten bolts to:
    - **6SY:** 110 N·m (81 ft-lb)
    - **8SY:** 92 N·m (68 ft-lb)
13. Install flywheel housing. *See Install the Flywheel Housing on page 5-53*.
14. Install flywheel. *See Install the Flywheel on page 5-54*.
15. Install cylinder heads. *See Install the Cylinder Head on page 5-34.*

SPECIAL SERVICE TOOLS

Note: The tool numbers used in this section are either Yanmar or Scania part numbers. Yanmar part numbers are referred to as **Yanmar Part No.** and Scania part numbers are referred to as **OEM Part No.** Tools not having part numbers must be acquired locally.

No.	Tool Name	Applicable Model and Tool Size	Illustration
1	Unit Injector Adjustment Tool (For Adjusting Unit Injectors)	OEM Part No. 99 414 - PDE31 OEM Part No. 99 442 - PDE32	
2	Flywheel Turning Tool	OEM Part No. 99 309	
3	Slide Hammer (For Removing Unit Injectors)	OEM Part No. 87 596	
4	Fuel Pressure Gauge (For Measuring Fuel System Pressure)	OEM Part No. 98 113	
5	Torque Screwdriver (For Connecting Cables to Injector)	OEM Part No. 288 179	

6SY Engines

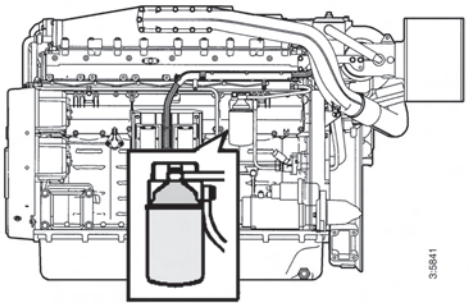


Figure 6-27

8SY Engines

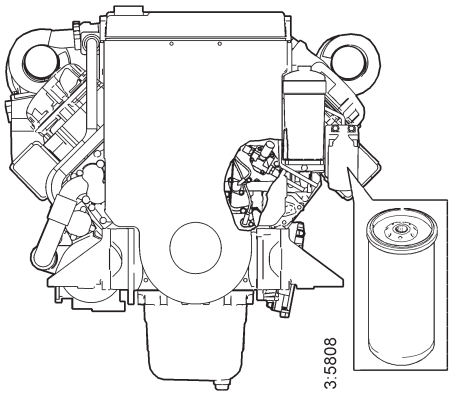


Figure 6-28

3. Clean the outside of the filter and remove it by turning it counterclockwise.
4. Install a new Yanmar filter and tighten by hand.
5. Bleed the fuel system. *See Bleed the Fuel System on page 6-17.*

Replace the Fuel Filter / Water Separator

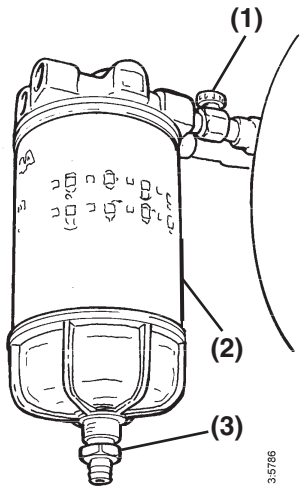


Figure 6-29

1. Close the fuel tank cock **(Figure 6-29, (1))**.
2. Loosen the drain plug **(Figure 6-29, (3))** at the bottom of the fuel filter / water separator and drain off any water and dirt.
3. Turn the filter container **(Figure 6-29, (2))** counterclockwise to remove.
4. Remove the old filter. Lubricate the seal, insert the new filter into the container and hand-tighten.
5. Turn the filter container clockwise to install.
6. Open the fuel tank cock **(Figure 6-29, (1))**.
7. After reassembling the fuel filter / water separator, vent air from the fuel system. *See Bleed the Fuel System on page 6-17.*

Replace Return Fuel Line

1. Disconnect the battery(s), negative (-) cable first.
2. Shut off all valves in the fuel supply system.
3. Open the bleeder valve and drain the fuel system by loosening the banjo screw on the back of the fuel manifold. Catch fuel in an appropriate container.

TESTS AND ADJUSTMENTS

Pressure Testing Cooling System and Filler Cap

Cooling System

Use a cooling system tester with connections compatible with the Yanmar SY series cooling system, such as Leitenberger TVK 138/3 (OEM Part No. 587 048 or similar tool).

1. Remove the coolant recovery tank filler cap. **WARNING!** ***NEVER remove the coolant filler cap if the engine is hot. Steam and hot engine coolant will escape and seriously burn you. Allow the engine to cool before attempting to remove the filler cap.***
2. Check that the lugs and sealing flange on the filler pipe are undamaged and free from anything that might prevent a good seal.
3. Check that the coolant level is correct. Fill with coolant as necessary. *See Drain, Flush and Fill the Engine with Engine Coolant on page 7-8.*

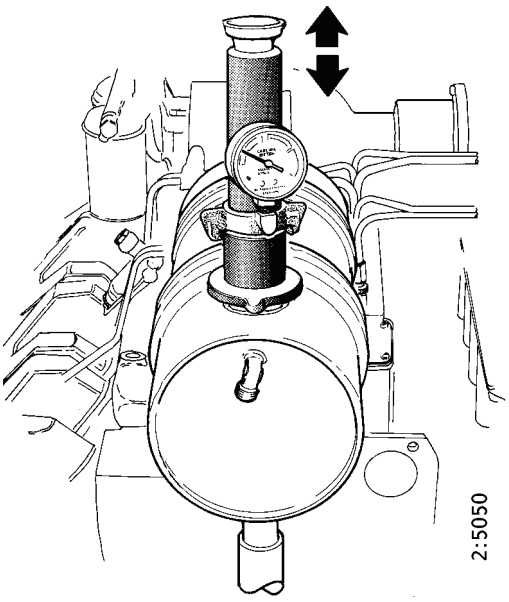


Figure 7-1

4. Install the tester and adapter in place of the radiator cap.
5. Pump until the pressure is 0.4 - 0.5 bar (5.8 - 7.3 psi) **(Figure 7-1)**.
6. If the pressure drops, there is leakage in the system. Start by checking all hoses and pipe connections.

Filler Cap

Note: Applies to cooling system with pressure cap.

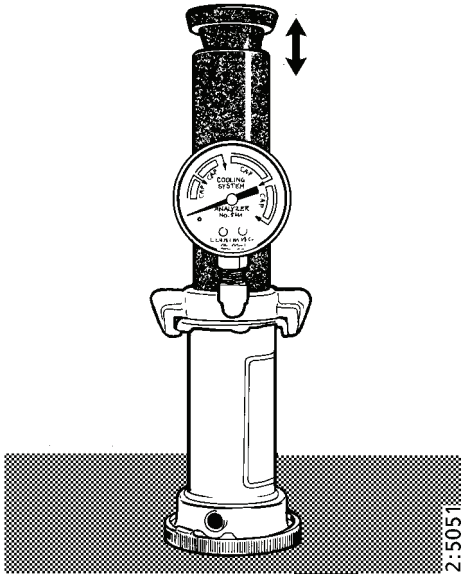


Figure 7-2

1. Connect the cap to the cooling system tester using the adapter for the cap.
2. Pump up the pressure until the cap opens **(Figure 7-2)**.
3. The tester needle should stop between 0.4 - 0.6 bar (5.8 - 8.7 psi) for pressure caps with an opening pressure of 0.5 bar (7.3 psi).

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Assemble the Seawater Pump

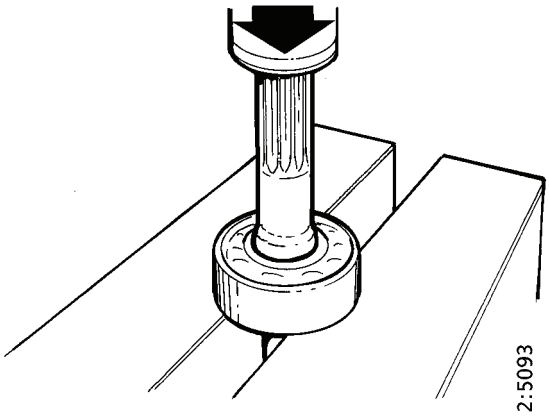


Figure 7-32

1. Place the bearing on parallel pieces in a press so that the inner race is also supported. Press the shaft to the correct position **(Figure 7-32)** and install the retaining rings.

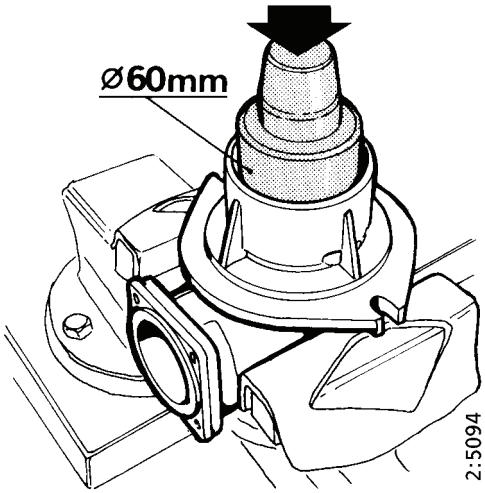


Figure 7-33

2. Mount the pump housing in a soft-jawed vise. Use a drift or tube with an outside diameter of 60 mm and tap a new seal into the housing. Install the seal so that the lip faces out **(Figure 7-33)**.

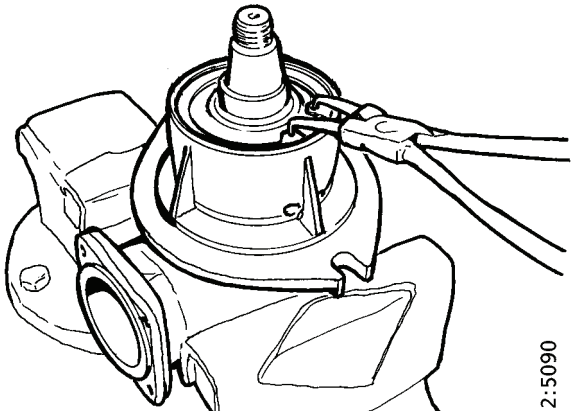


Figure 7-34

3. Tap the shaft and bearing into the housing until the bearing is against the shoulder in the housing. Install the retaining ring **(Figure 7-34)**.
4. Turn the housing in the vise. Push the deflector ring as far onto the shaft as possible.

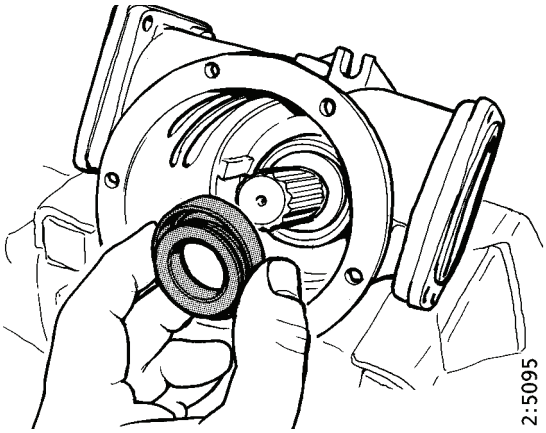


Figure 7-35

5. Install a new mechanical seal onto the shaft as follows:
   - Press the rubber sleeve into the seat in the housing **(Figure 7-35)**.
   - Apply a little oil around the outside of the ceramic ring and press it into the rubber sleeve with the flat surface facing out.
   - Push the rest of the mechanical seal components onto the shaft with the ceramic ring installed first.
   - Press the seal assembly in past the retaining ring groove and install a new retaining ring.

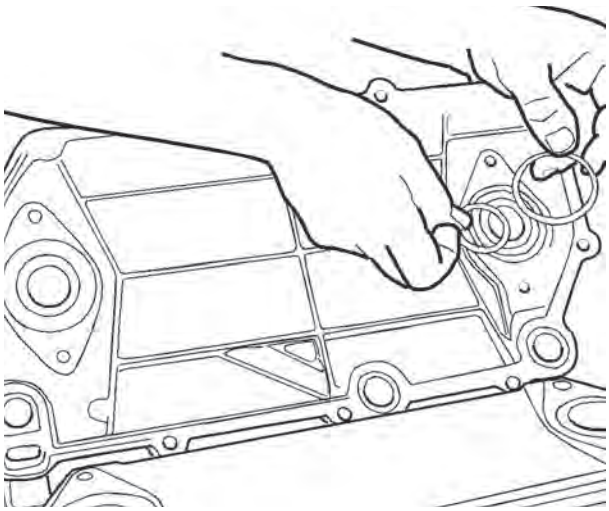
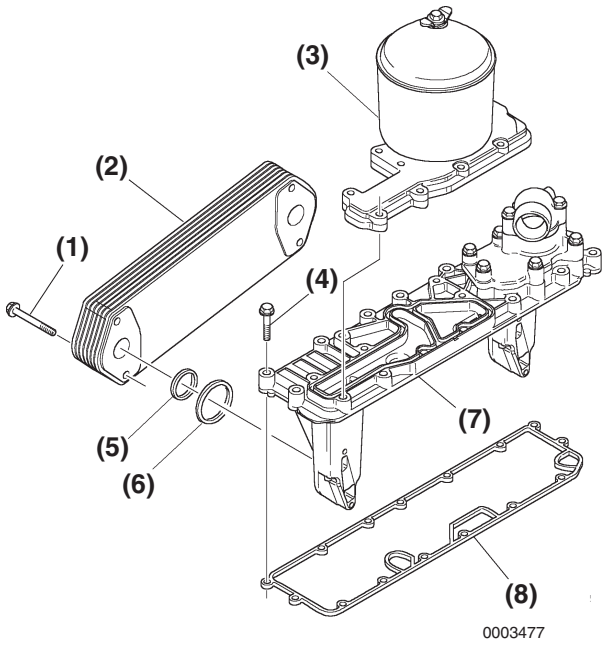


Figure 8-6

7. Install four new O-rings.
8. Arrach the oil cooler to the side cover. Tighten bolts to 26 N·m (230 in.-lb).
9. Install the oil cooler assembly and new gasket to the cylinder block.
10. Fill the engine with coolant.

8SY Engines



1 – Flange Bolt
2 – Oil Cooler
3 – Centrifugal Oil Cleaner Assembly
4 – Flange Bolt
5 – O-Ring
6 – O-Ring
7 – Oil Cooler Cover
8 – Gasket

Figure 8-7

1. Drain engine coolant into a suitable container.
2. Remove catwalk.
3. Remove pipe between charge air coolers.
4. Remove connection pipe to the closed crankcase ventilation.
5. Remove centrifugal oil cleaner assembly. *NOTICE: Lift oil cooler and cover assembly straight up without tipping to prevent oil from dripping into the cooling system.*
6. Remove the oil cooler cover and oil cooler assembly from the cylinder block.

Section 9

TURBOCHARGER

Radial Clearance

Take readings on both the turbine and compressor wheels.

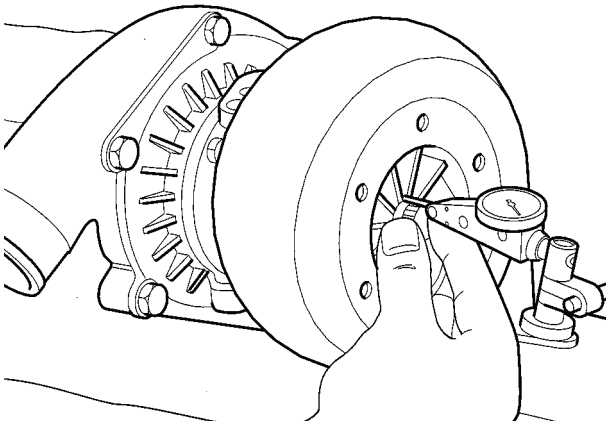


Figure 9-7

1. Place the tip of the dial indicator rocker against the turbine / compressor wheel.

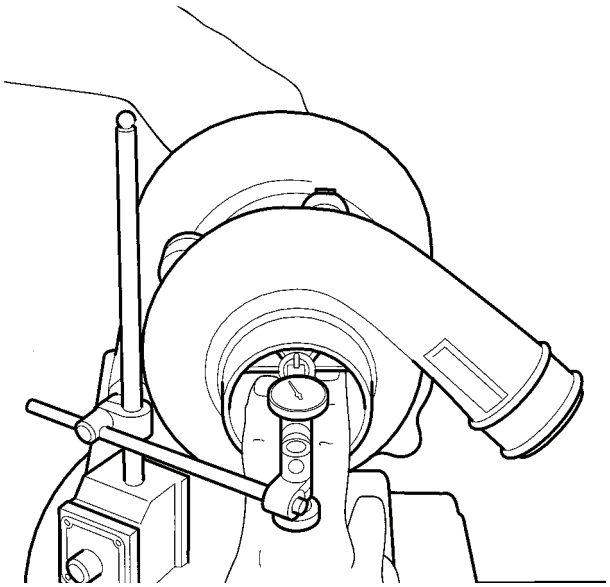


Figure 9-8

2. Pull up both ends of the shaft. Take a reading.
3. Press down both ends of the shaft. Take a reading. The difference between the readings is the radial clearance.
4. Repeat the test three times on each side.
5. If any of the wheels makes contact with the housing, despite the radial clearance reading, the turbocharger must be replaced.

Axial Clearance

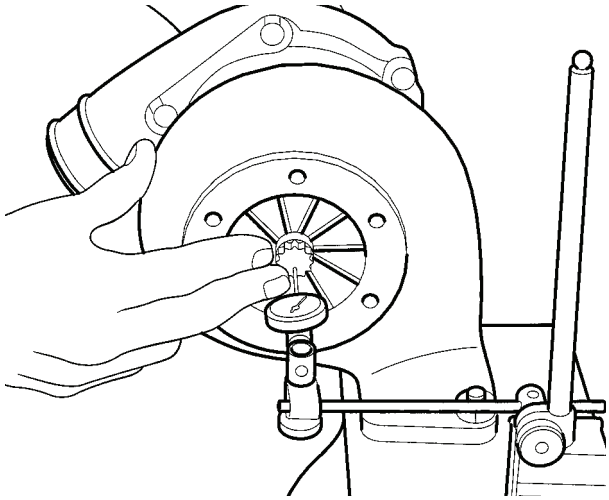


Figure 9-9

1. Place the tip of the dial indicator against the end of the shaft.
2. Press the shaft longitudinally back and forth and take a reading at the end positions. The difference between the readings is the axial clearance.
3. Repeat the test three times.

Specifications

Inspection Item	Engine	Limit
Turbocharger Shaft Radial Clearance	6SY	0.198 - 0.564 mm (0.0078 - 0.0222 in.)
	8SY	0.611 mm (0.0240 in.)
Turbocharger Shaft Axial Clearance	6SY	0.025 - 0.106 mm (0.001 - 0.004 in.)
	8SY	0.102 mm (0.004 in.)

REMOVE AND INSTALL STARTER MOTOR

1. Disconnect the battery(s), negative (-) cable first or turn off the battery master switch.

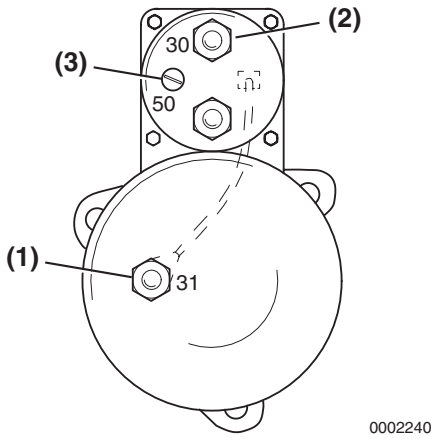


Figure 10-2

Note: The dotted conductor wire shows ground connection for the solenoid switch on 2-pin starter motors.

2. Disconnect ground cable **(Figure 10-2, (1))** if used.
3. Disconnect positive (+) cable **(Figure 10-2, (2))** and primary wire **(Figure 10-2, (3))**.
4. Move cables to one side.
5. Remove bolts holding the starter motor to the flywheel housing.
6. Carefully remove the starter motor. **WARNING! *The starter motor is heavy. Use care when removing the starter motor.***
7. Inspect the starter motor. *NOTICE: Check the starter pinion for damage. If the starter pinion is damaged, the flywheel ring gear must also be checked for damage.*
8. Clean the starter mounting area of the flywheel housing.
9. Install the starter motor.
10. Clean the cable connections.
11. Connect the cables to the appropriate terminals:
    - Primary wire **(Figure 10-2, (3))**. Tighten to 2 - 3 N·m (18 - 27 in.-lb).
    - Battery positive (+) **(Figure 10-2, (2))**. Tighten to 24 - 32 N·m (17 - 24 ft-lb).
    - Ground cable **(Figure 10-2, (3))**. Tighten to 16 - 20 N·m (142 - 177 in.-lb).
12. Connect the battery, negative (-) cable first, or return the master switch to the ON position.
13. Install any panels or housings removed to access the starter.
14. Operate starter to verify operation.

SPECIFICATIONS

Repair Specifications

Item	Bosch (65A)	Bosch (140A)
Manufacturer's Number	N1-28V 20/65A	T1-28V 70/14A
Output at 6000 RPM (alternator speed)	1800W	*
System Voltage	24 V, Negative Ground	24V, Negative Ground
Drive Ratio	3.5:1	*
Output Test Amperage@28 V	*	*
Output Test Voltage	27.5-28.5 V	*
Brush Length (Minimum)	7.5 mm (0.295 in.)	*
Slip Ring Diameter (Minimum)	26.8 mm (1.055 in.)	*
Rotor Resistance	8.4 - 8.8 ohms	*
Stator Resistance	0.3 ohm	*

** Not available at time of publication*

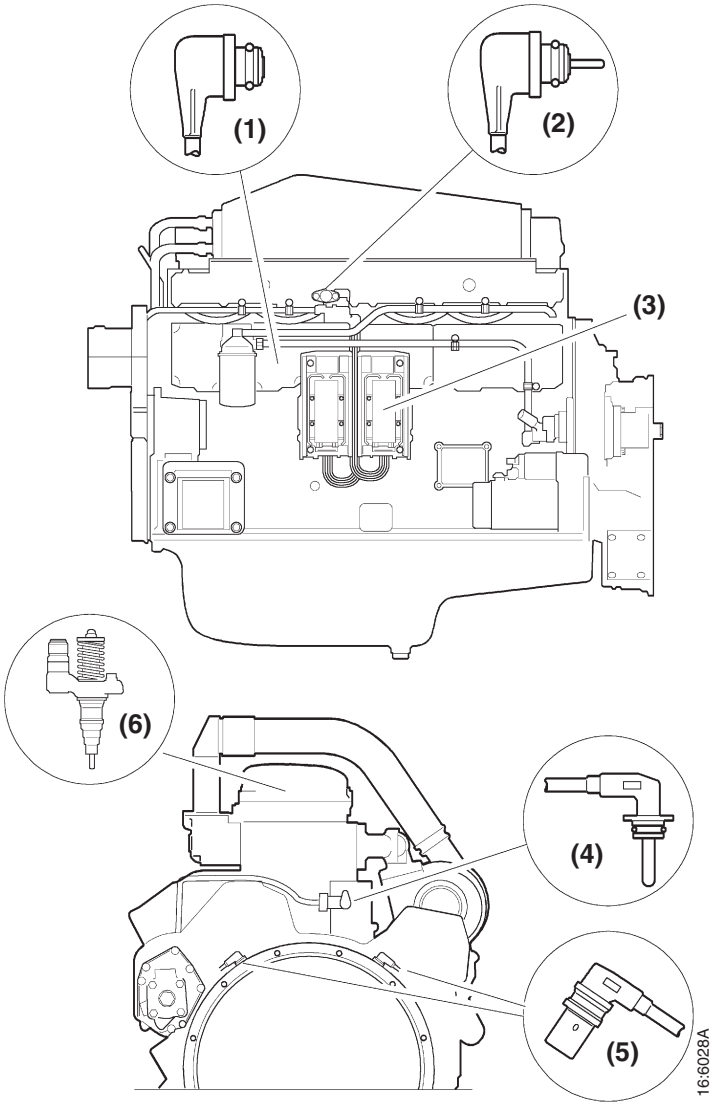
Special Torque Chart

Item	Bosch 65A	Bosch 140A
Belt Pulley Nut	65 N·m (48 lb·ft)	*

** Not available at time of publication*

Component Location

6SY Engines



1 – Oil Pressure Sensor
2 – Charge Air Pressure and Temperature Sensor
3 – EMS S6 Control Unit
4 – Coolant Temperature Sensor
5 – Engine Speed Sensor
6 – Unit Injector Solenoid Valves

Figure 12-2

Connector	Pin	Assignment	Detail
A9	4	Ground for oil pressure sensor	
A9	5	Not used	
A10	1	Voltage supply, +5V to the charge air pressure sensor	
A10	2	Input signal from the charge air pressure sensor. The control unit detects the voltage level between pins 2 and 3.	
A10	3	Ground for charge air pressure sensor	
A10	4	Input signal from the charge air temperature sensor. The control unit detects the voltage level between pins 3 and 4.	
A10	5	Not used	
B1	1	Voltage supply, +24V to the control unit	
B1	2	Ground connection for the control unit to chassis	
B1	3	Input signal +24V, from the ignition lock (when the key is in the drive position)	
B1	4	Not used	
B1	5	Not used	
B1	6	Voltage supply, +24V to the control unit	
B1	7	Ground connection for the control unit to chassis	
B1	8	Not used	
B1	9	CAN communication, H lead	
B1	10	CAN communication, L lead	
B2 (6SY / 8SY)	1	Voltage supply, +24V to unit injectors	8SY cylinder 1 6SY cylinder 1
B2 (6SY / 8SY)	2	Voltage supply, +24V to unit injectors	8SY cylinder 2 6SY cylinder 2
B2 (6SY / 8SY)	3	Not used	
B2 (6SY / 8SY)	4	Voltage supply, +24V to unit injectors	8SY cylinder 3 6SY cylinder 3
B2 (6SY / 8SY)	5	Voltage supply, +24V to unit injectors	8SY cylinder 4
B2 (6SY / 8SY)	6	Ground for unit injector	8SY cylinder 1 6SY cylinder 1
B2 (6SY / 8SY)	7	Ground for unit injector	8SY cylinder 2 6SY cylinder 2
B2 (6SY / 8SY)	8	Not used	
B2 (6SY / 8SY)	9	Ground for unit injector cylinder 3	8SY cylinder 3 6SY cylinder 3
B2 (6SY / 8SY)	10	Ground for unit injector cylinder 4	8SY cylinder 4
B3	1 - 2	Not used	
B4	1 - 2	Not used	
B5	1 - 2	Not used	
B6	1 - 2	Not used	
B7	1	Not used	

Section 13

TROUBLESHOOTING