# WORKSHOP MANUAL

# Marine Diesel Engine

## T4.165 - T4.180 - T4.200

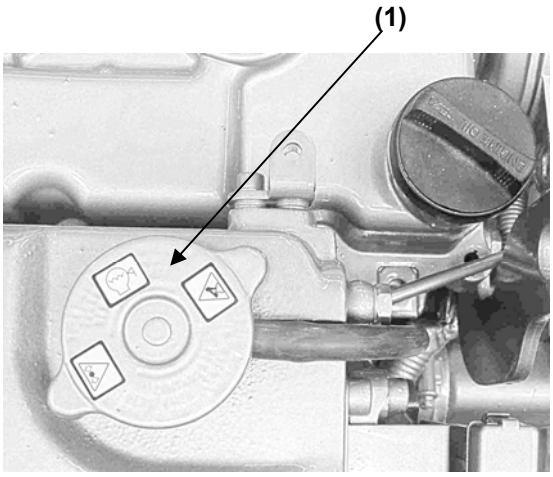
nanni diesel

energy in blue

60300199

684 [26.92"]
574 (22.6")
220 (8.7")
739 (29")
NANNIDIESEL T4.180 -ZF45A
PLAN D'ENCOMBREMENT
Ech.1/10
le 05-05-08
nannidiesel
110 (4.3")
1100 (43.3)
18.5 (0.73")
530 (20.87")
288 (11.34")
8°
125.5 (4.94")
75 (2.9")
140 (5.5")
13 (0.5")

## [4.2] Coolant level check and adjustment



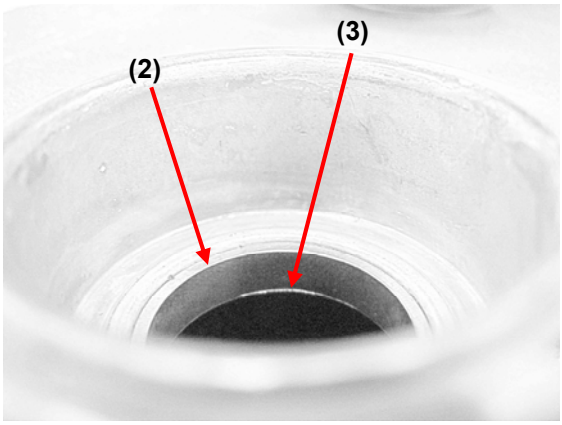

- Remove the cap from the heat exchanger (1) and check if the coolant level is just below the filling hole between the lower level of the filler neck (2) and indicator finger (3), representing the minimum and maximum level of liquid.
- If the coolant level is too low, find the reason why the liquid level has dropped.

**CASE 1**

If the liquid drop is due to evaporation, always top it with fresh water without limestone only.

**CASE 2**

If the liquid drop is due to leakage, always top off with a liquid of the same brand and type respecting the mixing ratio (50% freshwater and 50% pure antifreeze).

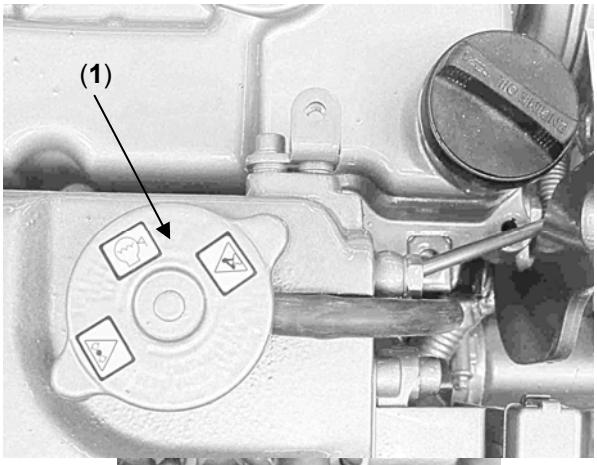


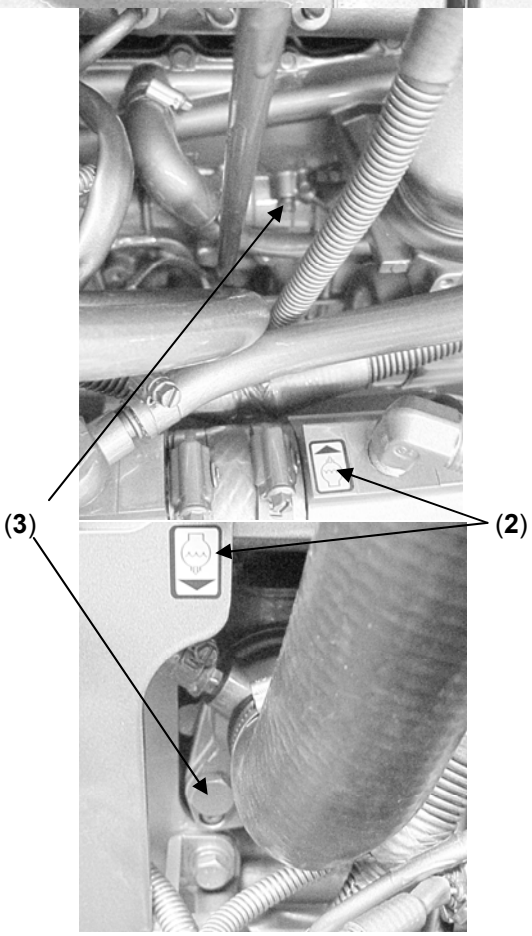

If the brand of coolant is unknown, drain the remaining liquid and fill with a new mixture of coolant properly proportioned. (50% freshwater and 50% pure antifreeze).

**⚠ WARNING**

- **Do not remove the cooler cap when the coolant temperature is too high. Then slightly loosen the cap to release the remaining pressure before complete removal.**
- **When filling the coolant,** bleed **the cooling system at various locations.**
- **Carefully close the heat exchanger cap. If the cap is loose or not closed, the coolant can escape and cause an engine to overheat.**
- **Do not use antifreeze and anti-tartar additive at the same time.**
- **Never mix different types or brands of coolant or antifreeze**

# [4.12] Coolant replacement:




**1. DRAIN ENGINE COOLANT**

**WARNING**

- **To avoid the risk of burn injuries, do not remove the filling cap while the engine and heat exchanger are hot. It may result in heated fluid and steam being spewed by pressure,** able result that heated fluid and steam are spewed by pressure **inside the heat exchanger.**

- Remove the heat exchanger filling cap (**1**).
- Loosen the engine drain plug, and drain the coolant from the engine. (15.5 litres)


Symbol for drain plug

- Close the drain plugs.

**Torque: 8 N m (82 kgf cm, 71 in. lbf)**

**2. ADD ENGINE COOLANT**

- Fill the radiator with a coolant carefully through the filling cap.

**IMPORTANT:**

- **Use a mixture of 50% pure antifreeze with 50% demineralised water. The total volume of coolant is 15.5 litres.**
- **If you prefer to use pre-mixed coolant its content ratio should be 50 % or up to 60 %. Beyond that, 60 % and up would deteriorate the cooling effectiveness of the coolant.**

**NOTICE:**

- **Do not use an alcoholic coolant and plain (non-demineralised) water alone. Otherwise, it may cause damage to engine cooling system.**

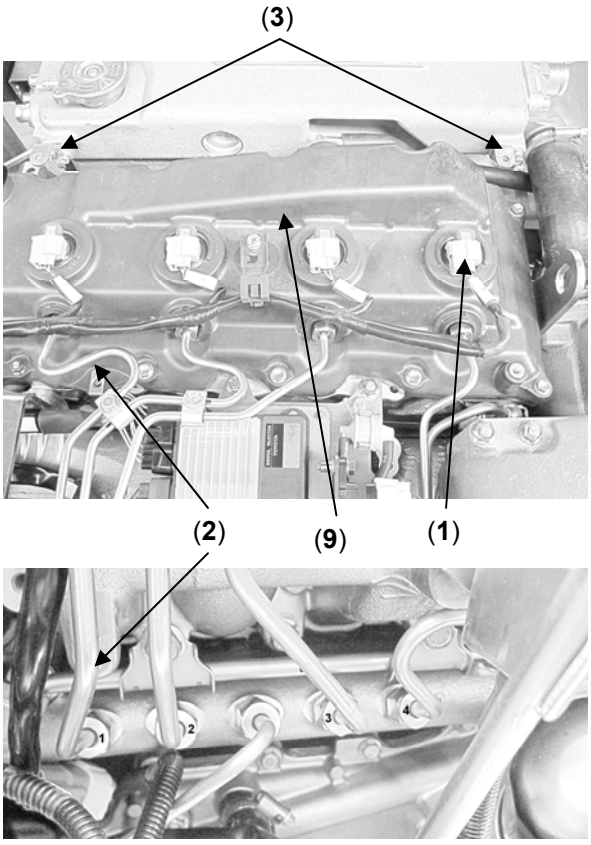
- Drain the air from the circuit (see procedure)
- Reset the heat exchanger filling cap.
- Start the engine to circulate the coolant.
- Wait until the coolant gets cold, then remove the filling cap again, and so check the coolant level inside the heat exchanger.

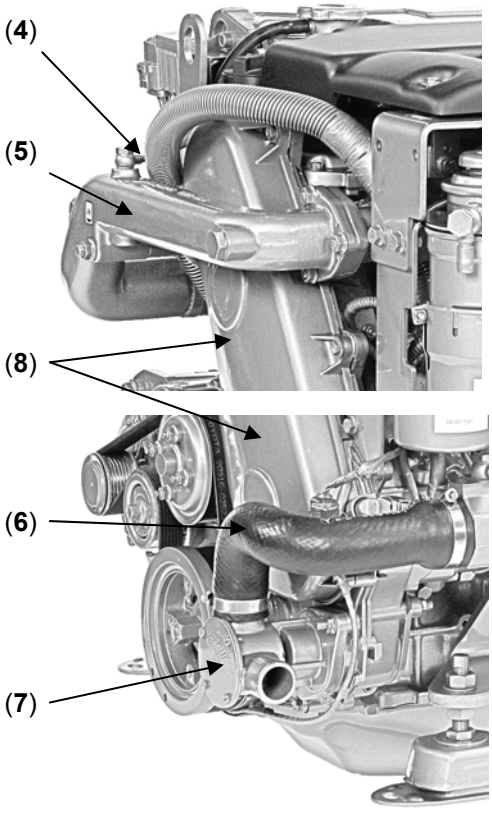
**HINT:**

**Refill the heat exchanger with the coolant if the coolant level is low**.

**3. INSPECT CHECK FOR ENGINE COOLANT**

# [4.18] TAPPET CLEARANCE (Control and adjustment):




**WARNING**

- **Before tappet inspection, make sure the fuel valves and sea water valves are all closed and secure. Make sure that engine power is OFF. Do not forget to install a panel to prevent risk of injuries.**

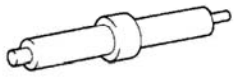
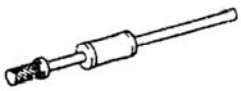
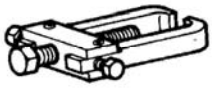
**1. BEFORE INSPECTION**

- Drain the coolant circuit (see concern chapter page 32)
- Remove the plastic cover.
- Disconnect the 4 injectors (**1**).
- Remove the 4 injection pipes (**2**).
- Unscrew the 4 screws and remove the 2 cover support (**3**)
- Unscrew the 2 banjo bolt and remove the water pipe (**4**)
- Unscrew the clamps and the 3 nuts and remove the water pipe (**5**)
- Unscrew the 2 clamps and remove the water pipe (**6**)
- Unscrew the 2 nuts and remove the sea water pump (**7**)
- Unscrew the 6 bolts and remove the timing belt cover (**8**)
- Unscrew the 12 bolts and remove the cylinder head cover (**9**).Be careful to the injectors seals.

## STANDARD TOOLS

| | |
|---|---|
| Belt tension Gauge | Standard tools |
| CO / CH Meter | Standard tools |
| Chain block | Standard tools |
| Compression gauge | Standard tools |
| Dial indicator | Standard tools |
| Feeler gauge | Standard tools |
| Hexagonal wrench (10mm) | Standard tools |
| Injection nozzle tester | Standard tools |
| Micrometer | Standard tools |
| Plastigage | Standard tools |
| Precision straight edge | Standard tools |
| Press | Standard tools |
| Radiator cap tester | Standard tools |
| Sandpaper #400 | Standard tools |
| Slide caliper | Standard tools |
| Steel square | Standard tools |
| Electronic tachometer | Standard tools |
| Timing light | Standard tools |
| Torque wrench | Standard tools |
| Vernier calipers | Standard tools |

# [5.2] SPECIAL TOOLS (LUBRICATION)

| | | | |
|---|---|---|---|
|  | | Clutch guide tool | TIMING GEAR CASE ASSEMBLY |
|  | **970312752** | Companion Flange Holding Tool | OIL COOLER ASSEMBLY<br>TIMING GEAR CASE ASSEMBLY |
|  | | Drive shaft Remover Attachment | TIMING GEAR CASE ASSEMBLY |
|  | | Differential Side Gear Shaft Puller | TIMING GEAR CASE ASSEMBLY |
|  | | (Shocker Set) | TIMING GEAR CASE ASSEMBLY |
|  | | Ball Joint Puller | TIMING GEAR CASE ASSEMBLY |

# [1.4] ENGINE MECANICAL SERVICE DATA

| | | |
|---|---|---|
| **Valve** | | |
| Valve stem diameter | Intake | 5.970 to 5.985 mm (0.2350 to 0.2356 in.) |
| | Exhaust | 5.960 to 5.975 mm (0.2346 to 0.2352 in.) |
| Valve face angle | | 44.5° |
| Margin thickness | STD Intake | 1.1 mm (0.043 in.) |
| | STD Exhaust | 1.2 mm (0.047 in.) |
| | Minimum Intake | 0.6 mm (0.024 in.) |
| | Minimum Exhaust | 0.7 mm (0.028 in.) |
| Valve overall length | STD Intake | 105.15 to 105.75 mm (4.1398 to 4.1634 in.) |
| | STD Exhaust | 105.02 to 105.62 mm (4.1347 to 4.1583 in.) |
| | Minimum Intake | 104.65 mm (4.1201 in.) |
| | Minimum Exhaust | 104.52 mm (4.1150 in.) |
| Valve stem oil clearance | STD Intake | 0.025 to 0.060 mm (0.0010 to 0.0024 in.) |
| | STD Exhaust | 0.035 to 0.070 mm (0.0014 to 0.0028 in.) |
| | Maximum Intake | 0.08 mm (0.0031 in.) |
| | Maximum Exhaust | 0.10 mm (0.0039 in.) |
| **Compression spring** | | |
| Deviation | Maximum | 2.0 mm (0.079 in.) |
| Free length | | 46.5 mm (1.831 in.) |
| Install tension at 33.1 mm (1.303 in.) | | 150 to 166 N (14.7 to 16.2 kgf, 33.7 to 37.3 lbf) |
| **Valve guide bush** | | |
| Bush inside diameter | | 6.010 to 6.030 mm (0.2366 to 0.2374 in.) |
| Protrusion height | | 10.3 to 10.7 mm (0.406 to 0.421 in.) |
| **Valve lifter** | | |
| Lifter diameter | | 30.966 to 30.976 mm (1.2191 to 1.2195 in.) |
| **Camshaft** | | |
| Circle run out | Maximum | 0.03 mm (0.0012 in.) |
| Camshaft lobe height | STD Intake | 47.180 to 47.280 mm (1.8575 to 1.8614 in.) |
| | STD Exhaust | 48.070 to 48.170 mm (1.8925 to 1.8965 in.) |
| | Maximum Intake | 46.76 mm (1.8409 in.) |
| | Maximum Exhaust | 47.92 mm (1.8866 in.) |
| Journal diameter | | 27.969 to 27.985 mm (1.1011 to 1.1018 in.) |
| Oil clearance | STD | 0.025 to 0.062 mm (0.0010 to 0.0024 in.) |
| | Maximum | 0.10 mm (0.0039 in.) |
| Thrust clearance | STD | 0.035 to 0.185 mm (0.0014 to 0.0073 in.) |
| | Maximum | 0.25 mm (0.0098 in.) |
| Camshaft backlash | STD | 0.035 to 0.089 mm (0.0014 to 0.0035 in.) |
| | Maximum | 0.189 mm (0.0074 in.) |
| **Connecting rod** | | |
| Thrust clearance | STD | 0.100 to 0.300 mm (0.0039 to 0.0118 in.) |
| | Maximum | 0.40 mm (0.0157 in.) |
| Oil clearance | STD | 0.036 to 0.054 mm (0.0014 to 0.0021 in.) |
| | Maximum | 0.10 mm (0.0039 in.) |
| Connecting rod bend | Maximum per 100 mm (3.94 in.) | 0.03 mm (0.0012 in.) |
| Connecting rod twist | Maximum per 100 mm (3.94 in.) | 0.15 mm (0.0059 in.) |
| Bush inside diameter | Mark A | 34.012 to 34.016 mm (1.3391 to 1.3392 in.) |
| | Mark B | 34.016 to 34.020 mm (1.3392 to 1.3394 in.) |
| | Mark C | 34.020 to 34.024 mm (1.3394 to 1.3395 in.) |

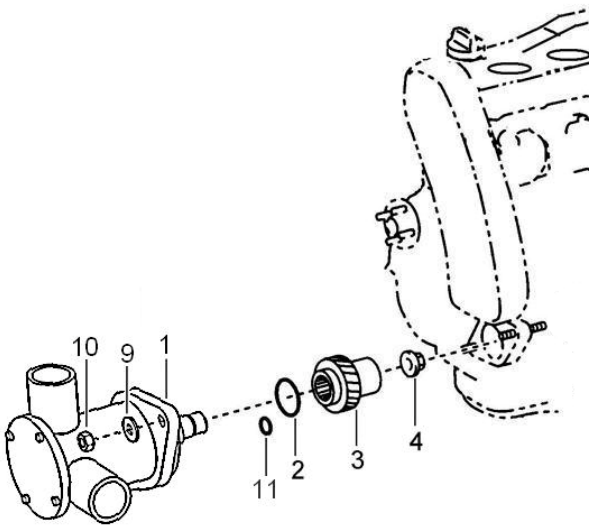
## 10) INSTALL TIMING BELT COVER

- Install the timing belt No. 1 cover with the 6 bolts.

**Torque:**
**6 N m (61 kgf cm, 53 in. lbf)**

## 11) REINSTALL COOLANT FRONT PIPE

## 12) REINSTALL THE SEA PUMP

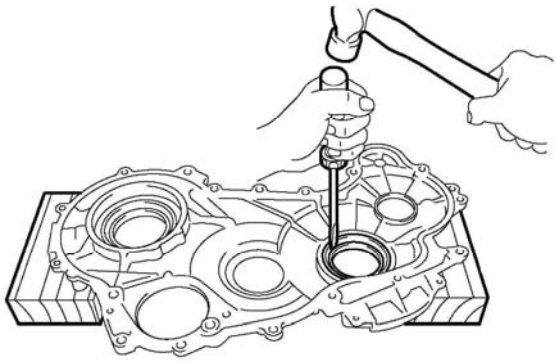



- Replace the O-Rings 11 and 2. (Make sure that they did not fall down during pump installation).
- Tight the nuts 10 after installation of the washer 9
- Install the suction hose
- Install the discharge hose

## 13) FILL THE ENGINE COOLANT

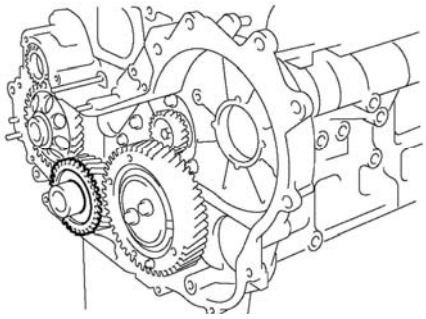
- refer to the concerned chapter.

## 14) CHECK FOR ENGINE COOLANT LEAKS



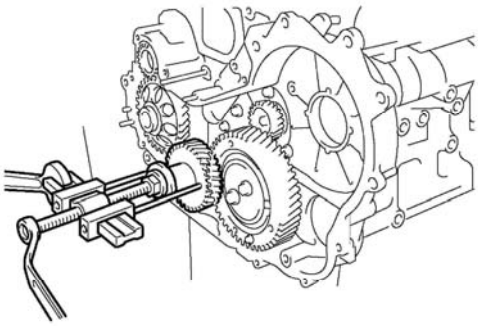
**16) REMOVE TIMING BELT COVER OIL SEAL**

- Remove the oil seal with a slotted−screwdriver and hammer.



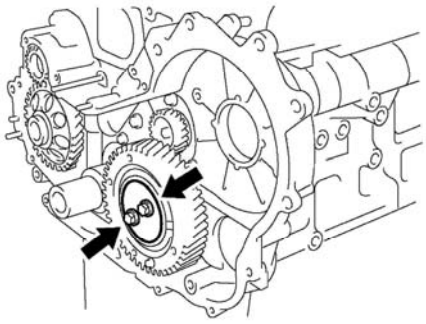
**17) REMOVE CRANKSHAFT POSITION SENSOR PLATE NO.1**

- Remove the crank angle sensor plate No.1



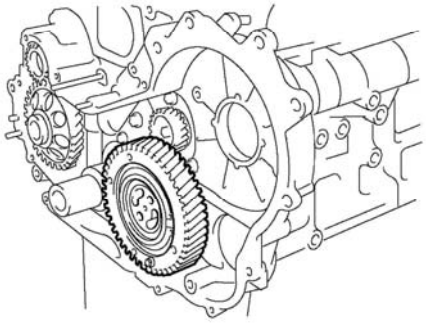
**18) REMOVE CRANKSHAFT TIMING GEAR OR SPROCKET**

- Using the special tool 970312374, remove the crankshaft timing gear.



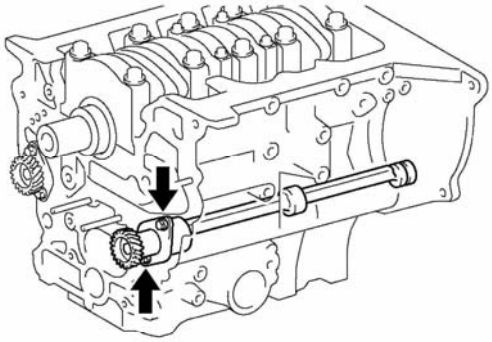
**19) REMOVE IDLE GEAR THRUST PLATE**

- Remove the 2 bolts and idle gear thrust plate.



**20) REMOVE IDLE GEAR NO.1**

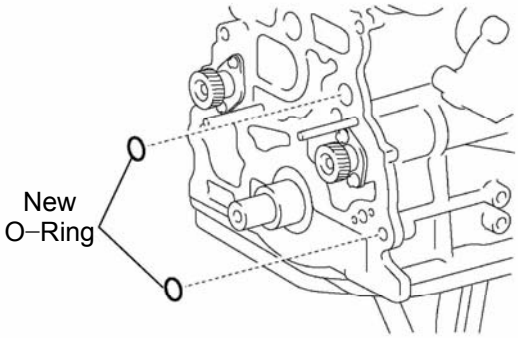
- Remove the idle gear No.1.



**44) INSTALL NO.1 BALANCING SHAFT SUB-ASSY**

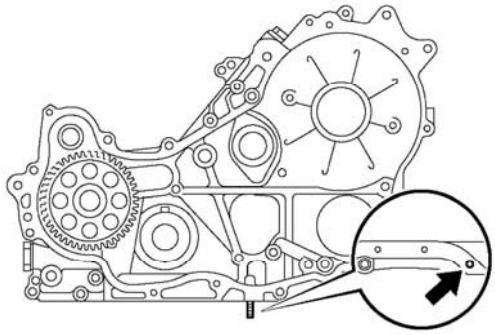
- Install the balancing shaft No.1 with the 2 bolts.

  **Torque: 13 N m (133 kgf cm, 10 ft lbf)**



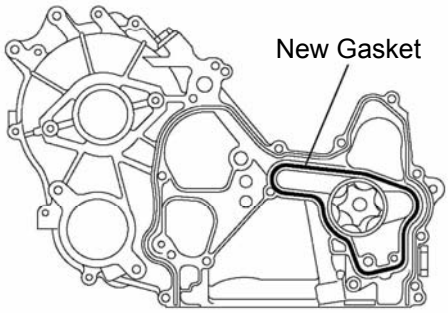

**45) INSTALL TIMING GEAR CASE ASSY**

- Install 2 new O-rings to the cylinder block.

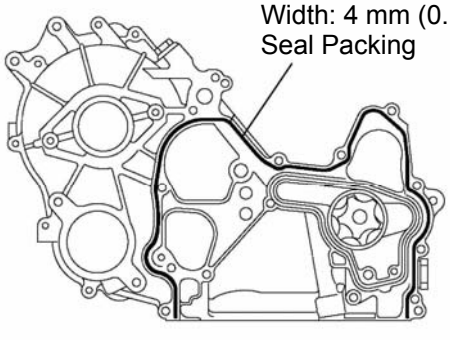


- Install the stud bolt.

  **Torque: 8.0 N m (82 kgf cm, 71 in. lbf)**




- Place a new gasket into the groove of the timing gear case as shown in the illustration.

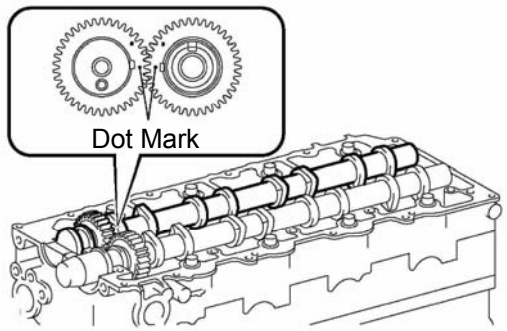



- Remove old seal packing (FIPG) from the timing gear case and cylinder block.
- Apply seal packing to the specific places described in the illustration.

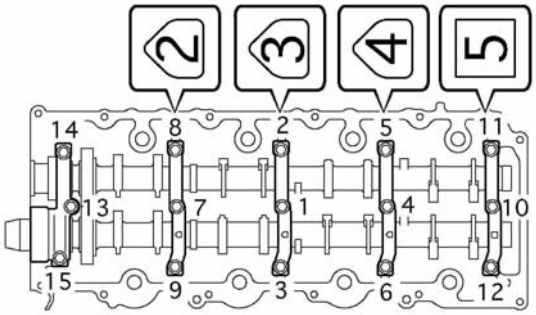
**Seal packing: Part No. 970312770 or equivalent**

**NOTICE:**

**Install the timing gear case within 3 minutes and tighten its bolts within 15 minutes after seal packing application is completed.**

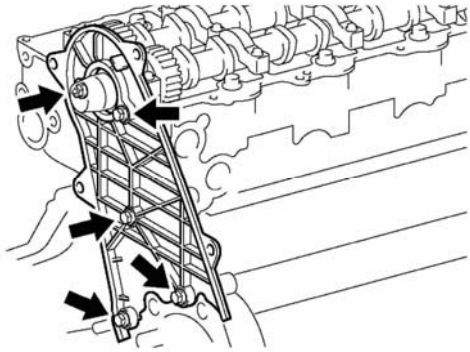



(3) Align the dot marks of the camshaft and cam shaft N°2 by meshing the 2 gears before placing the camshaft N°2.



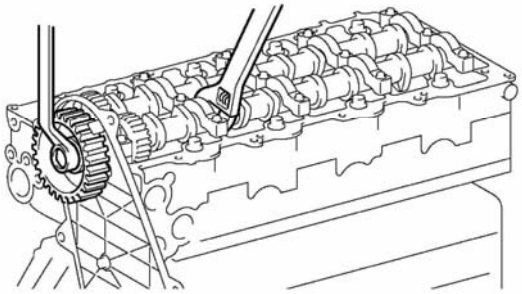

(4) Install the camshaft bearing cap as shown in the illustration.
(5) Tighten the 15 bolts for the camshaft bearing cap in the specified order described in the illustra tion.

**Torque: 19 N m (194 kgf cm, 14 ft lbf)**



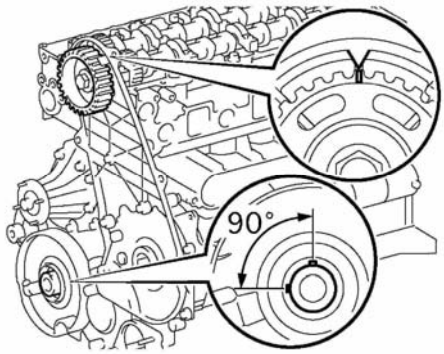
- Install the timing belt N°2 cover with the 4 bolts and nut.

**Torque: 10 N m (102 kgf cm, 7 ft lbf)**



- Install the camshaft timing pulley.
(1) Install the set key to the key groove of the camshaft.
(2) Align the set key with the key groove of the timing pulley.
(3) Hold the hexagonal portion of the camshaft, and install the timing pulley with the bolt.

**Torque: 98 N m (1,000 kgf cm, 72 ft lbf)**

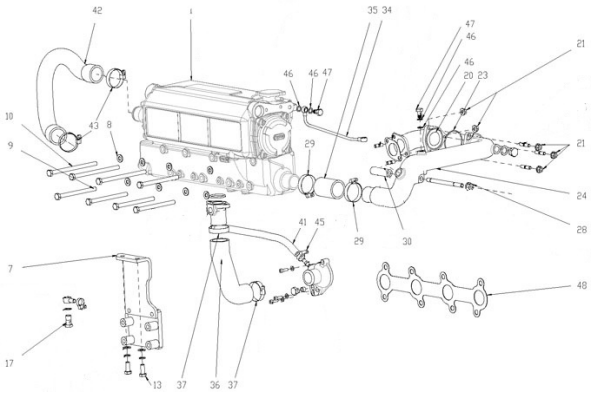



- Inspect the valve clearance.
(1) Lower the piston by rotating the crankshaft about 90° counter clockwise from the TDC
(2) Align the timing mark of the camshaft timing pulley with the arrow mark of the timing belt No.2 cover.

## 68) TIMING BELT REASSEMBLY

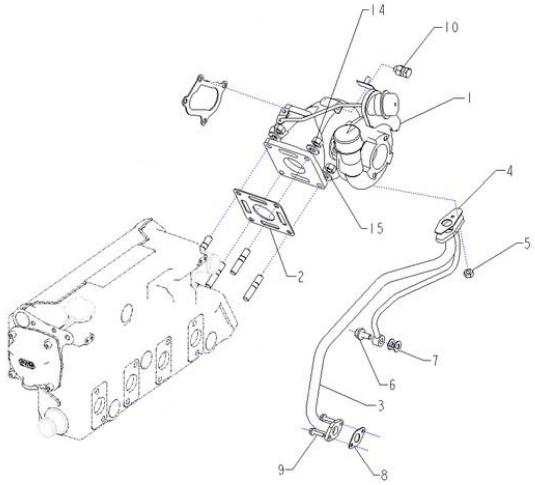
- see concerned chapter

## 69) HEAT EXCHANGE RE-INSTALLATION



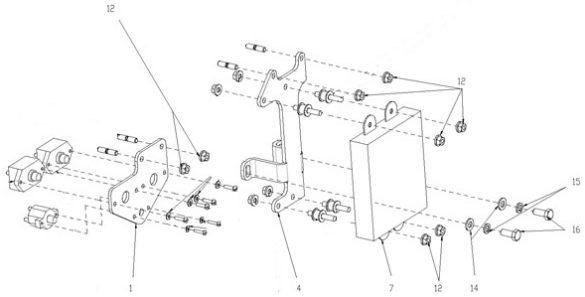
- Re-install the heat exchanger (1) with bolts (10) (9), washer (8) and a new gasket (48)
- Re-install spacer (30)
- Reinstall hose (34) with clamps (29)
- Re-install coolant pipe (24) with new o-ring (23)
- Tight the nuts (21) with washer and the clamps (29).
- Re-install the bleeding pipe (34) with hollow screw (47) and new washers (46).
- Re-install coolant pipe (41) with clamp (45) and hollow screw (17).
- Re-install hose (36) with clamps (37).
- Reinstall ECU support (7) with bolts (13).
- Re-install Water hose (42) with clamps (43).

## 70) TURBO CHARGER & MIXER RE-INSTALLATION



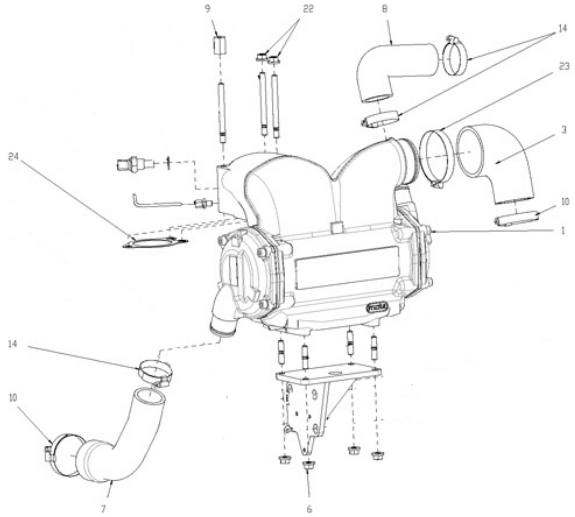
- Re-install the lubrication pipe (3) with new gasket (4), (7) and (8).
- Tight bolts (9) and hollow screw (6).
- Re-install turbocharger (1) with new gasket (2).
- Tight the nuts (14) with washers (15).
- Re-install the turbo charger cover (not on the drawing).

## 71) ECU BRACKET AND ECU RE-INSTALLATION

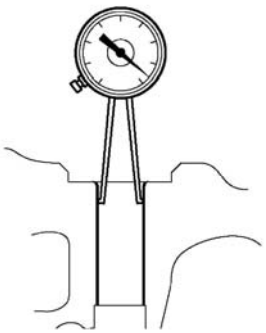


- Re-installation of the ECU support (4) with the 2 nuts (12), 2 bolts (16) and washers (15).
- Re-installation of the breakers support (1) with 2 nuts (12).
- Re-installation of the ECU with 4 nuts (12).

## 72) INTERCOOLER RE-INSTALLATION



- Re-install the intercooler (1) with new gasket (24).
- Tight the nuts (6), (9) and (22).
- Re-install the hose (7) with clamps (14) and (10).
- Re-install the hose (3) with clamps (10) and (23).
- Re-install the hose (8) with clamps (14).

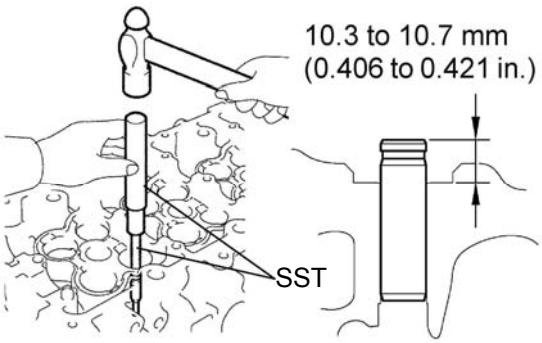


## 22. INSTALL INTAKE VALVE GUIDE BUSH

(a) Using a caliper gauge, measure the bush bore diameter of the cylinder head.
(b) Select a new guide bush ((Standard (STD) or oversize 0.05 (O/S 0.05)).

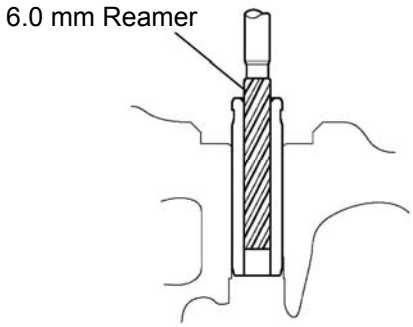
| Bush bore diameter mm (in.) | Bush size |
|---|---|
| 10.985 to 11.006 mm (0.4325 to 0.4333 in.) | Use STD |
| 11.035 to 11.056 mm (0.4344 to 0.4353 in.) | Use O/S 0.05 |

If the bush bore diameter of the cylinder head is greater than 11.006 mm (0.4333 in.), machine the bush bore to the dimension of 11.035 to 11.056 mm (0.4344 to 0.4353 in.).
If the bush bore diameter of the cylinder head is greater than 11.056 mm (0.4353 in.), replace the cylinder head.



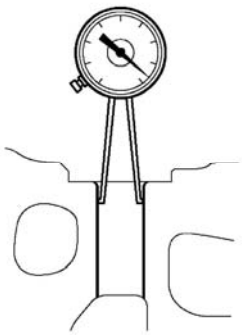

(c) Using special tools 970312733, 970312748 and a hammer, tap in a new guide bush to the specified protrusion height.

**Protrusion height:**
**10.3 to 10.7 mm (0.406 to 0.421 in.)**




(d) Using a sharp 6.0 mm reamer, ream the guide bush to obtain the specified standard clearance (See step 18) between the guide bush and valve stem.

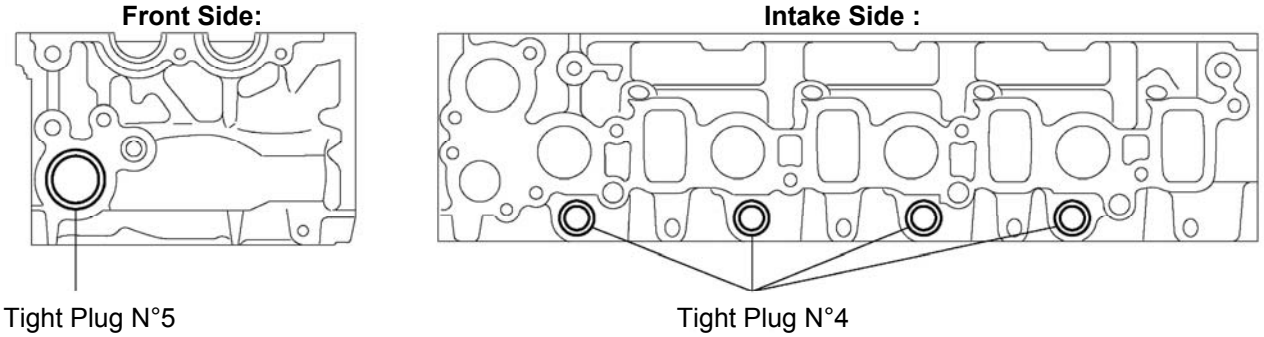
## 23. INSTALL EXHAUST VALVE GUIDE BUSH

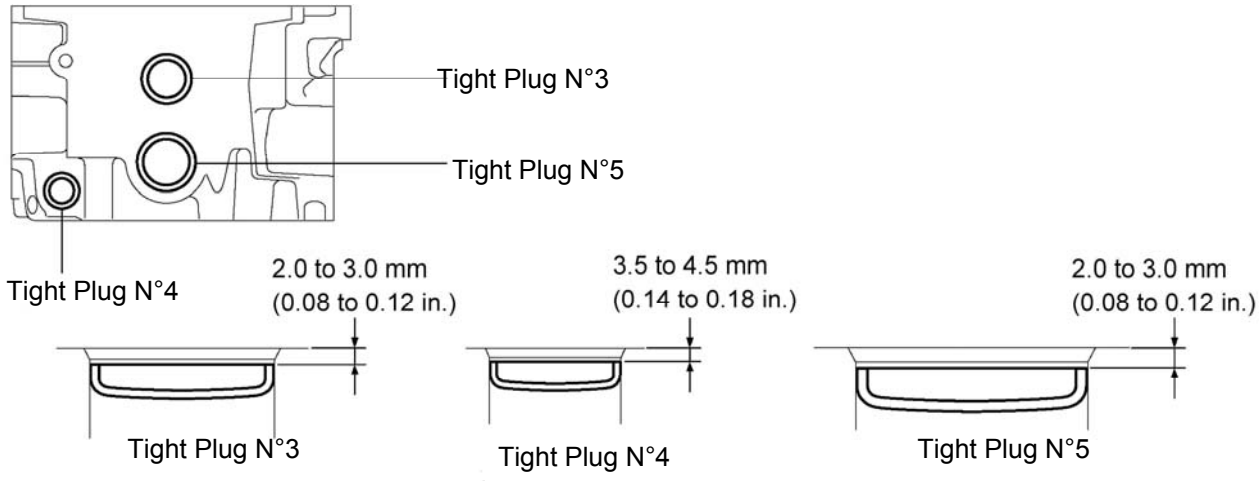


(a) Using a caliper gauge, measure the bush bore diameter of the cylinder head.
(b) Select a new guide bush (STD or O/S 0.05).

| Bush bore diameter mm (in.) | Bush size |
|---|---|
| 10.985 to 11.006 mm (0.4325 to 0.4333 in.) | Use STD |
| 11.035 to 11.056 mm (0.4344 to 0.4353 in.) | Use O/S 0.05 |

If the bush bore diameter of the cylinder head is greater than 11.006 mm (0.4333 in.), machine the bush bore to the dimension of 11.035 to 11.056 mm (0.4344 to 0.4353 in.).
If the bush bore diameter of the cylinder head is greater than 11.056 mm (0.4353 in.), replace the cylinder head.



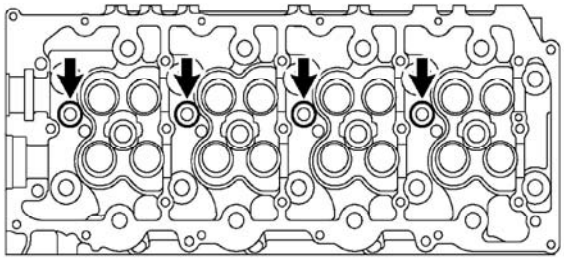

**35. INSTALL W/HEAD STRAIGHT SCREW PLUG N°1**

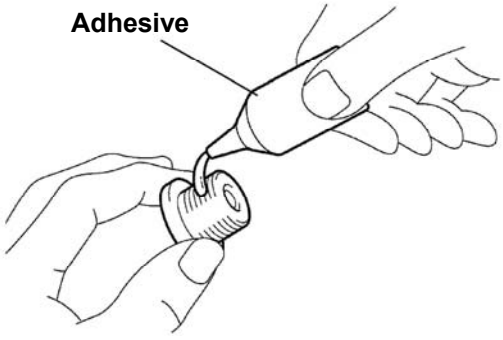
(a) Apply an adhesive to the end of the screw plug.

**Adhesive: THREE BOND 1324 or equivalent**

(b) Using a 6 mm hexagon wrench, install the screw plug.

**Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)**






**36. INSTALL SEMI-CIRCULAR PLUG**

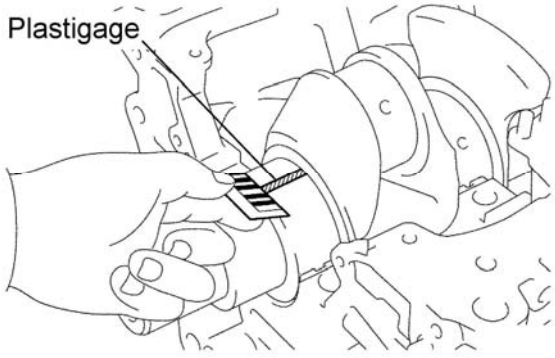
(a) Remove the oil seal packing (970312770).
  (1) Using a gasket scraper and razor blade, remove the old seal packing from the contact surface of the semicircular plug and cylinder head, and clean them.

(b) Apply seal packing to the semicircular plug.

**NOTICE:**

- **The semicircular plug must be installed within 3 minutes after seal packing application is completed.**
- **Prevent FIPG from being stuck to the camshaft thrust groove**.

(c) Install the semicircular plug to the cylinder head.

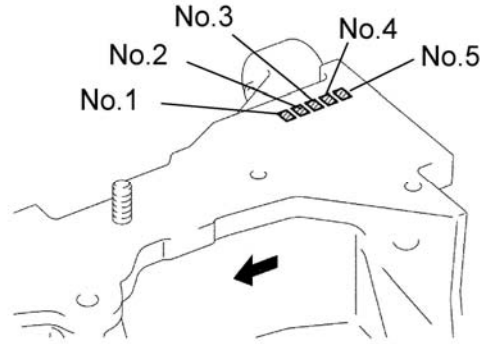



(j) Measure the “Plastigage” at its widest point.

**Standard oil clearance:**
**0.030 to 0.048 mm (0.0012 to 0.0019 in.)**
**Maximum clearance:**
**0.10 mm (0.0039 in.)**

If the oil clearance is greater than the maximum clearance, replace the bearings.

**HINT:**
**If replacing the cylinder block sub assembly, the bearing standard clearance will be:**
**0.030 to 0.048 mm (0.0012 to 0.0019 in.)**

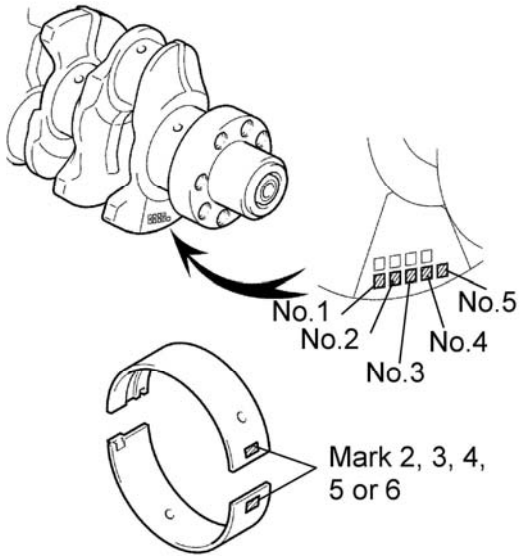



**HINT:**
**If using a standard bearing, replace it with one having the same number. If the number of the bearing cannot be determined, add together the numbers imprinted on the cylinder block and crankshaft, then select the bearing with the same number as the total. There are 5 sizes of standard bearings, marked 2, 3, 4, 5 and 6 accordingly.**

EXAMPLE:

| item | Number mark | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cylinder block | 1 | | | 2 | | | 3 | | |
| Crankshaft | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Use bearing | 2 | 3 | 4 | 3 | 4 | 5 | 4 | 5 | 6 |

Cylinder block ”2” + Crankshaft ”1”= Total number ”3” (Use bearing ”3” reference)




(k) Completely remove the “Plastigage”.

**Cylinder block main journal bore diameter:**

| | |
|---|---|
| Mark 1 | 75.000 to 75.006 mm (2.9528 to 2.9530 in.) |
| Mark 2 | 75.006 to 75.012 mm (2.9530 to 2.9532 in.) |
| Mark 3 | 75.012 to 75. 018 mm (2.9532 to 2.9535 in.) |

**Crankshaft journal diameter:**

| | |
|---|---|
| Mark 1 | 69.994 to 70.000 mm (2.7557 to 2.7559 in.) |
| Mark 2 | 69.988 to 69.994 mm (2.7554 to 2.7557 in.) |
| Mark 3 | 69.982 to 69.988 mm (2.7552 to 2.7554 in.) |

**Standard sized bearing center wall thickness:**

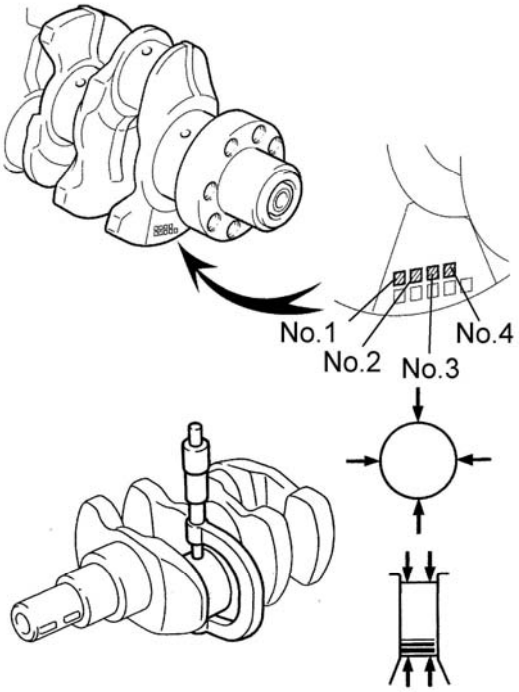
| | |
|---|---|
| Mark 2 | 2.482 to 2.485 mm (0.0977 to 0.0978 in.) |
| Mark 3 | 2.485 to 2.488 mm (0.0978 to 0.0980 in.) |
| Mark 4 | 2.488 to 2.491 mm (0.0980 to 0.0981 in.) |
| Mark 5 | 2.491 to 2.494 mm (0.0981 to 0.0982 in.) |
| Mark 6 | 2.494 to 2.497 mm (0.0982 to 0.0983 in.) |

**9. REMOVE CRANKSHAFT**

(a) Lift out the crankshaft.

(b) Remove the upper bearings and upper thrust washers from the cylinder block.

**HINT:**
**Arrange the main bearing caps, bearings and thrust washers in the correct order.**




(c) Inspect the crank pins.

(1) Using a micrometer, measure the outside diameter of each crank pin.

**Main journal diameter:**

| | |
|---|---|
| Mark 1 | 69.994 to 70.000 mm (2.75566 to 2.75590 in.) |
| Mark 2 | 69.988 to 69.994 mm (2.75543 to 2.75566 in.) |
| Mark 3 | 69.982 to 69.988 mm (2.75519 to 2.75543 in.) |

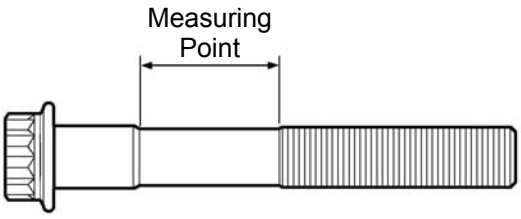
If the diameter is not as specified, check the oil clearance (See step 4). If necessary, grind or replace the crankshaft.

(2) Check each crank pin for taper and out-of-round as shown.

**maximum taper and out-of-round:**
**0.020 mm (0.0008 in.)**

If the taper and out-of-round is greater than the maximum, replace the crankshaft.

## 28. INSPECT CRANKSHAFT BEARING CAP BOLT

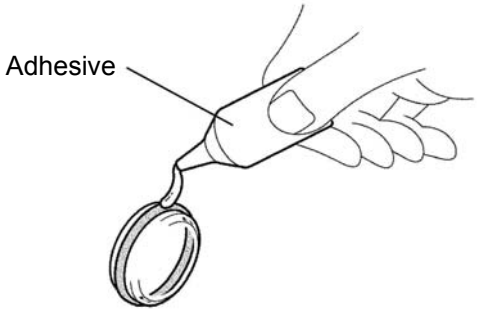



(a) Using vernier calipers, measure the minimum diameter of the compressed thread at the measuring point.

**Standard diameter:**
**13.500 to 14.000 mm (0.5315 to 0.5512 in.)**
**Minimum diameter:**
**12.60 mm (0.4961 in.)**

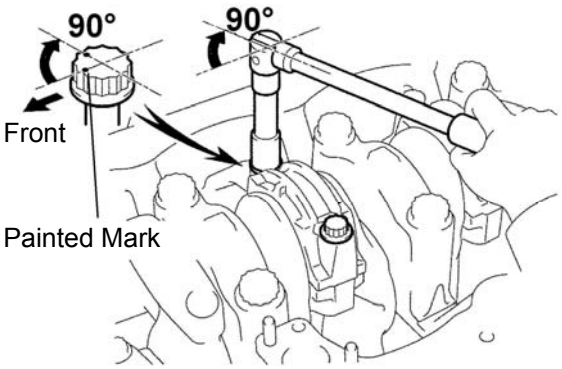
If the diameter is less than the minimum, replace the bolt.

## 29. INSTALL TIGHT PLUG




(a) Apply an adhesive around the tight plugs.
Adhesive:
THREE BOND 1324 or equivalent

**NOTICE:**
**Do not start the engine within 1 hour after the installation.**



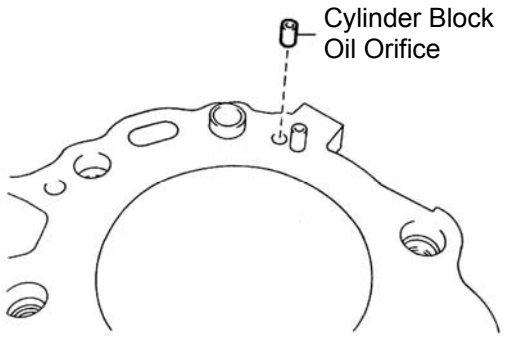

(2) Install and alternately tighten the bolts of the connecting rod cap in several passes.

**Torque:**
**35 N·m (357 kgf·cm, 26 ft·lbf)**

If any of the connecting rod cap bolts does not meet the torque specification, replace the cap bolts.

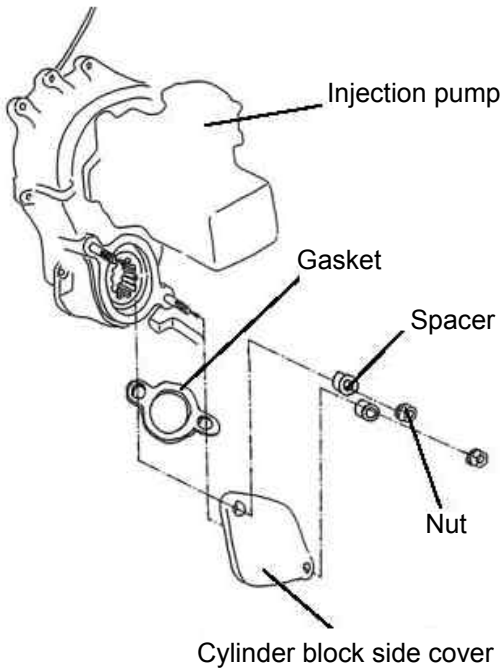
(3) Mark the front of the connecting rod cap bolts with paint.
(4) Retighten the connecting rod cap bolts 90° as shown in the illustration.
(5) Check that the painted mark is now at a 90° angle to the front.

(d) Check that the crankshaft turns smoothly.
(e) Check the connecting rod thrust clearance (See step 3).




**40. INSTALL CYLINDER BLOCK OIL ORIFICE**

(a) Install the cylinder block oil orifice to the cylinder block.




**41. REMOVE CYLINDER BLOCK SIDE COVER**

(a) Remove the 2 nuts, spacers, cylinder block side cover and gasket.

**42. INSTALL CYLINDER BLOCK SIDE COVER**

(a) Install the new gasket, cylinder block side cover, 2 spacers and 2 nuts.

**Torque:**
**29N·m(302kgf·m, 22ft·lbf)**

**NOTICE:**
**Do not reuse the gasket.**

**35. INSTALL SUPPLY PUMP ASSEMBLY**

(a) Remove the plug shown in the illustration, and then pour engine oil with 50 cc (3.05 cut in) into there.
(b) Set a new gasket and reset the plug.

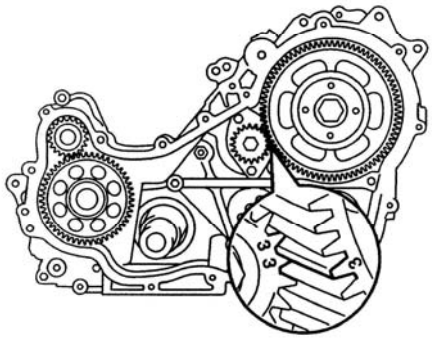
**Torque: 44 N m (449 kgf cm, 33 ft lbf)**

(c) Set a new O−ring to the supply pump.
(d) Temporarily install the supply pump with the 2 nuts and supply pump stay with the 4 bolts.
(e) Tighten the 2 nuts for the supply pump.

**Torque: 21 N m (214 kgf cm, 16 ft lbf)**

(f) Tighten the 2 bolts for the pump stay at the pump side first, and then rest the 2 bolts at cylinder block side likewise.

**Torque: 21 N m (214 kgf cm, 16 ft lbf)**



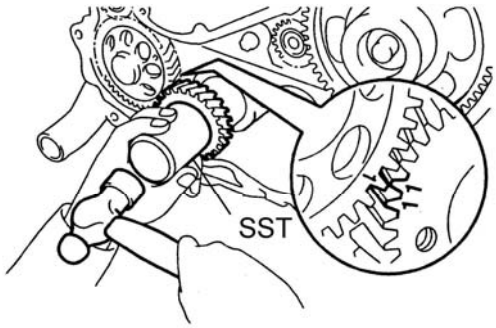
**36. INSTALL INJECTION GEAR**

(a) With matching the match marks of the injection gear and balance shaft driven gear No. 2, install the injection gear.

**NOTICE:**
**Fit key (protrusion) of the supply pump to its key −slot on the injection gear.**

(b) Set a new O−ring, and then temporarily install the nut. Under this condition, check a thrust clearance for the supply pump drive shaft by pushing the injection gear in back and forth direction with your hand.

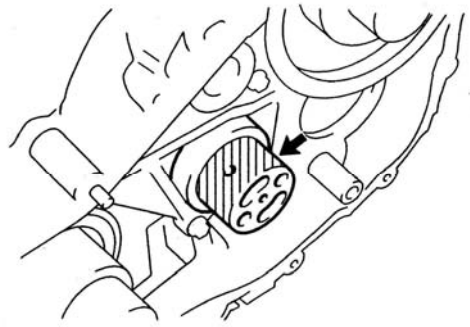
**Thrust clearance:**
**0.15 − 0.55 mm (0.0059 − 0.0217 in.)**




**HINT:**
**If there is no thrust clearance, remove the injection gear again and re−install it.**

**37. INSTALL CRANKSHAFT TIMING GEAR OR SPROCKET**

(a) With matching the match marks of the crankshaft timing gear and oil pump drive gear using special tool 970312742, install the crankshaft timing gear.



**38. INSTALL IDLE GEAR NO.1**

(a) Apply engine oil to specific place described in the illustration, install the idle gear shaft No. 1 to the cylinder block.

# 8. FUEL OIL SYSTEM

## [8.1] FUEL SYSTEM ON–BOAT INSPECTION

### 1. CHECK FUEL LEAK

**⚠ WARNING**

- **During ACTIVE TEST mode, engine speed and combustion noise increase, so pay attention.**
- **During ACTIVE TEST mode, fuel pressure increases, so take care not to expose your eyes, hands, or body to the escaped fuel.**

(a) Check that there are no leaks from any part of the fuel system at the engine stops. If there is fuel leakage, replace these parts.
(b) While cranking or start the engine, check that there are no leaks from any part of the fuel sys tem. If there is fuel leakage, replace these parts.
(c) Disconnect the return hose from the common rail.
(d) While cranking the engine, check fuel leaks from the return pipe. If there is fuel leakage, re place the common rail assembly.
(e) Connect the Engine Diagnosis Tool.
(f) Start the engine and start the Engine Diagnosis Tool.
(h) If you have no Engine Diagnosis Tool, open the throttle quickly and fully to increase the engine speed at maximum and keep it for 2 seconds. Repeat this operation several times.
(i) Check that there are no leaks from any part of the fuel system.

**NOTICE:**
**However, if the leakage from the return pipe is less than 10 cc (0.6 cu in.) in a minute, it is acceptable. If there is fuel leakage, replace these parts.**

(j) Reconnect the return hose to the common rail.

**9. INSTALL FUEL INLET PIPE SUB−ASSEMBLY**

**NOTICE:**

- **Also, if the supply pump is replaced, the fuel inlet pipe must be replaced.**
- **Beware of sticking dusts, dirt or any other materials onto the joint area of the fuel inlet pipe.**
- **Use special tool 70804009**

**10. INSTALL TIMING BELT**
**11. INSTALL TIMING BELT COVER**
(a) Install the timing belt cover with the 6 bolts.

**Torque:**
**6 N m (61 kgf cm, 53 in. lbf)**

**12. INSTALL GENERATOR BELT**
**13. ADD ENGINE COOLANT**
**14. CHECK FOR ENGINE COOLANT LEAKS**
**15. CHECK FUEL LEAK**

## [8.4] FUEL TEMPERATURE SENSOR REPLACEMENT

**1. REMOVE FUEL TEMPERATURE SENSOR**

(a) Disconnect the connector from the fuel temperature sensor.
(b) Remove the temperature sensor using the special tool 970313928.

**2. INSTALL FUEL TEMPERATURE SENSOR**

(a) Set a new O−ring to the fuel temperature sensor.
(b) Install the temperature sensor using special tool 970313928.

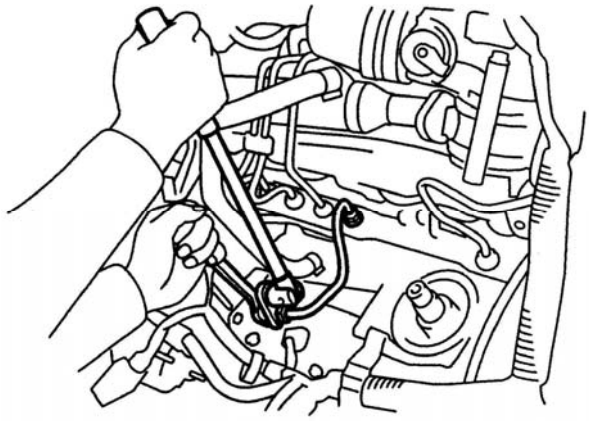
**Torque:**
**22 N m (225 kgf cm, 16 ft lbf)**

(c) Connect the connector to the temperature sensor.

**3. CHECK FUEL LEAK**

## [8.5] COMMON RAIL REPLACEMENT

**NOTICE:**
**When removing the injection pipes and fuel inlet pipe, clean them up with a brush and compressed air.**



**1. REMOVE OIL FILTER SUB−ASSEMBLY**
**2. REMOVE FUEL INLET PIPE SUB−ASSEMBLY**
(a) Remove the fuel inlet pipe using the special tool 70804009

**NOTICE:**
**After removing the fuel pipe, affix gum tape on the pump, common rail, and the whole injector installation area of the cylinder head cover to prevent dust from coming into them.**

**3. REMOVE INJECTION PIPE**