1413T–01

OVERHAUL

1. REMOVE NO. 1 ENGINE HANGER

(a) Remove the 2 bolts and engine hanger.

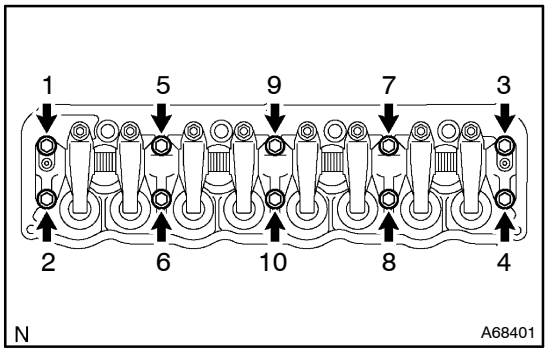
2. REMOVE NO. 2 ENGINE HANGER

(a) Remove the 2 bolts and engine hanger.

3. REMOVE OIL FILLER CAP SUB–ASSY

4. REMOVE CYLINDER HEAD COVER SUB–ASSY

(a) Remove the 4 bolts, 2 nuts, 6 cushions, head cover and gasket.



5. REMOVE VALVE ROCKER SHAFT ASSY

(a) Loosen the 8 lock nuts and adjusting screws.

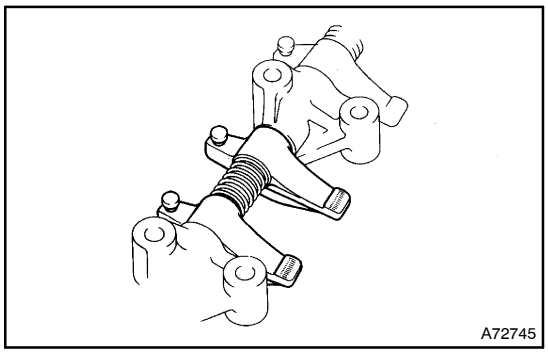
(b) Uniformly loosen the 10 bolts and remove them in several passes in the sequence shown in the illustration.

(c) Remove the rocker shaft assy.

(d) Remove the 8 push rods in order, beginning from the No.1 push rod.

HINT:

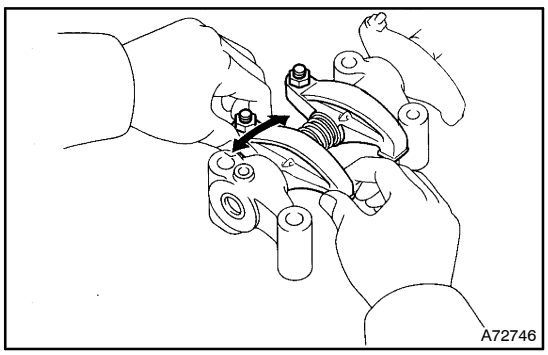
Arrange the push rods in the correct order.



6. INSPECT VALVE ROCKER SHAFT ASSY

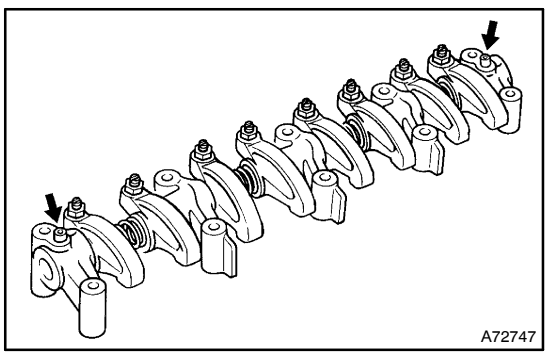
(a) Check the pad valve bridge contact surface of the rocker arm for wear.

If the contact surface is worn, replace the rocker arm.



(b) Check that each rocker arm smoothly turns.

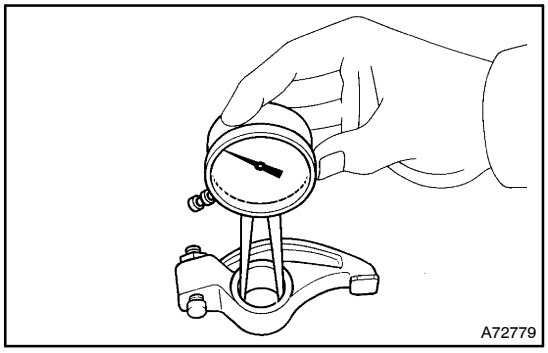
If the rocker arms do not turn smoothly, disassemble the rocker arm and shaft assy, and check the oil clearance.



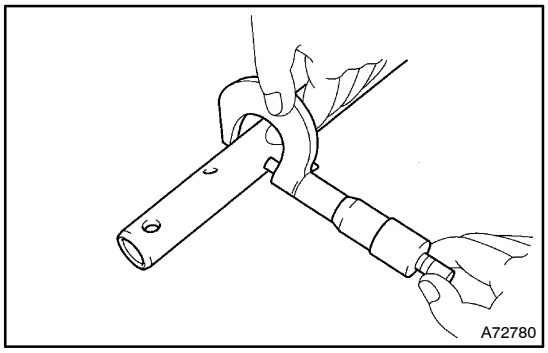
(c) Using a 5 mm hexagon wrench, remove the 2 bolts and gaskets, and disassemble the rocker arms and shaft.

HINT:

Arrange the disassembled parts in the correct order.



(d) Using a caliper gauge, measure the inside diameter of the rocker arm.
Rocker arm inside diameter:
18.512 – 18.533 mm (0.7288 – 0.7296 in.)



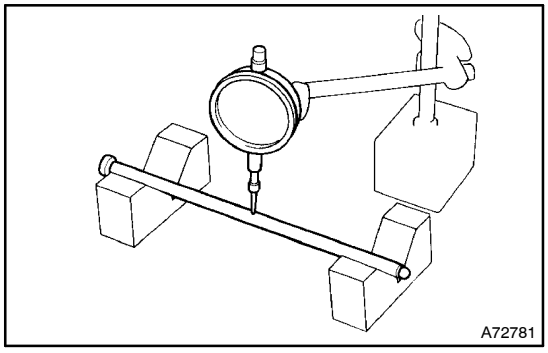
(e) Using a micrometer, measure the diameter of the rocker arm shaft.
Shaft diameter:
18.472 – 18.493 mm (0.7272 – 0.7281 in.)

(f) Subtract the rocker arm shaft measurement from the rocker arm measurement.
Standard oil clearance:
0.019 – 0.061 mm (0.0007 – 0.0024 in.)
Maximum oil clearance: 1.00 mm (0.0039 in.)

If the clearance is greater than the maximum, replace the rocker arm and shaft.

(g) Assemble the valve rocker arms and shaft with 2 new gaskets and the 2 bolts.

(h) Using a 5 mm hexagon wrench, tighten the 2 bolts.
Torque: 7.5 N·m (76 kgf·cm, 66 in.·lbf)

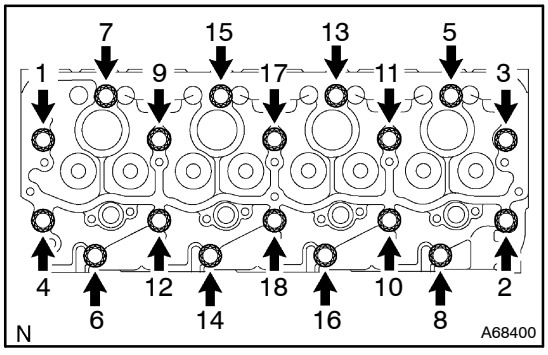


7. INSPECT VALVE PUSH ROD

(a) Place the push rod on V–blocks.

(b) Using a dial indicator, measure the circle runout at the center of the push rod.
Maximum circle runout: 0.50 mm (0.0197 in.)

If the circle runout is greater than the maximum, replace the push rod.



8. REMOVE CYLINDER HEAD SUB–ASSY

(a) Uniformly loosen the 18 cylinder head bolts and remove them in several passes in the sequence shown in the illustration.

NOTICE:

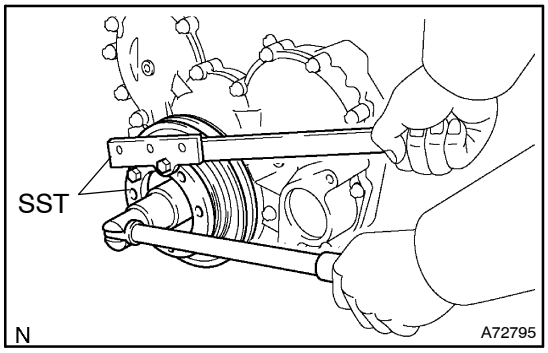
Removing the bolts in the incorrect order could result in warpage or cracks on the head.

(b) Lift the cylinder head from the dowels on the cylinder block, and place the cylinder head on wooden blocks on a bench.

HINT:

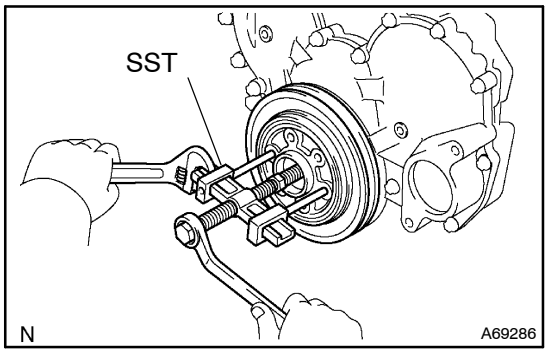
If the head is difficult to be lifted off, insert a screwdriver between the head and block, and pry the head off.

NOTICE:
Be careful not to damage the contact surfaces of the head and block.

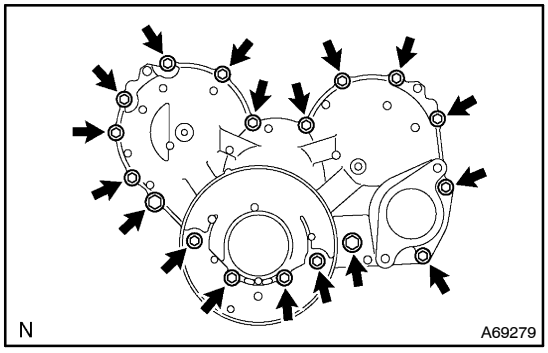


9. REMOVE CRANKSHAFT PULLEY

(a) Using SST, remove the pulley bolt.
SST 09213–58013 (90201–08131, 91111–50845), 09330–00021

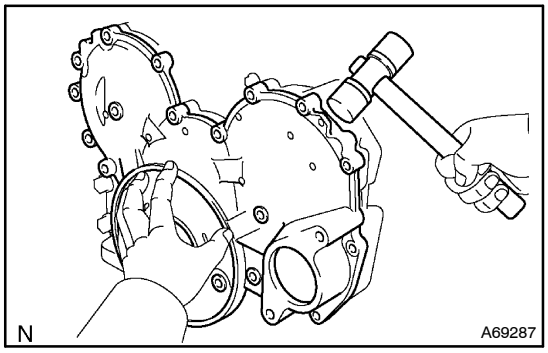


(b) Using SST, remove the pulley.
SST 09950–50013 (09951–05010, 09952–05010, 09953–05010, 09953–05020, 09954–05031)



10. REMOVE TIMING GEAR COVER

(a) Remove the 18 bolts.

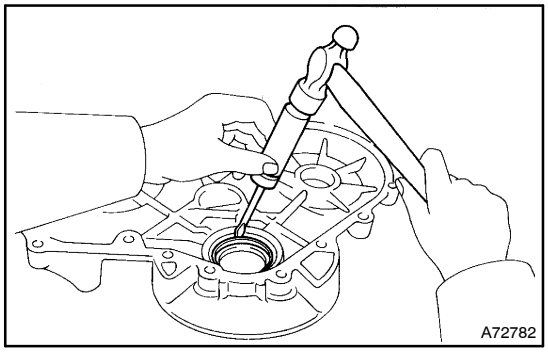


(b) Using a plastic–faced hammer, lightly tap out the gear cover.
(c) Remove the cover gasket.

NOTICE:
Be careful not to drop the injection pump drive gear.

11. REMOVE INJECTION PUMP DRIVE GEAR

(a) Using a plastic–faced hammer, lightly tap the gear to remove the drive gear.



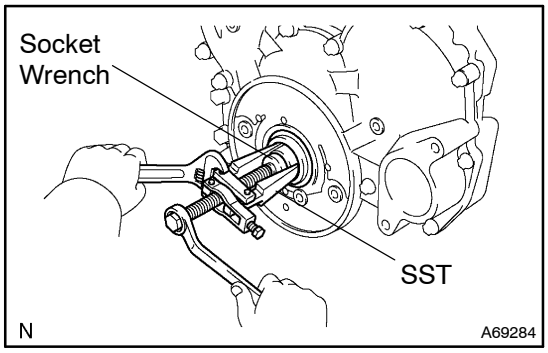
12. REMOVE TIMING GEAR COVER OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to remove the oil seal.

(a) If the timing gear cover is removed from the cylinder block:

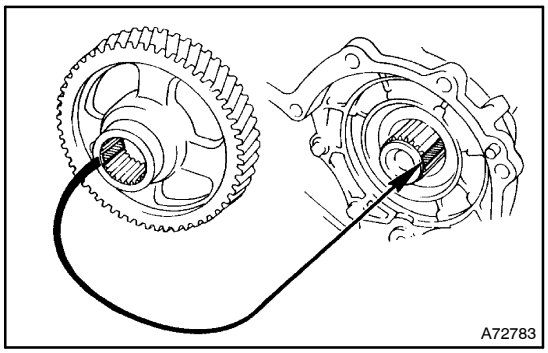
(1) Using a screwdriver and a hammer, tap out the oil seal.



(b) If the timing gear cover is installed to the cylinder block:

(1) Using SST and a socket wrench, remove the oil seal.

SST 09308–10010



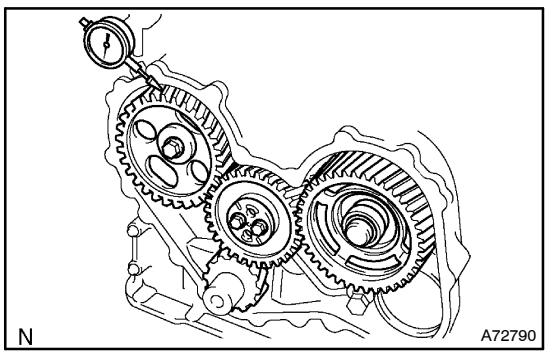
13. INSPECT TIMING GEAR BACKLASH

(a) Install the injection pump drive gear gear.

(1) Install the injection pump with the 2 nuts.

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

(2) Align the spline toothless portions of the injection pump drive gear and injection pump, and install the drive gear.



(b) Using a dial indicator, measure the backlash between each gear.

Standard backlash:

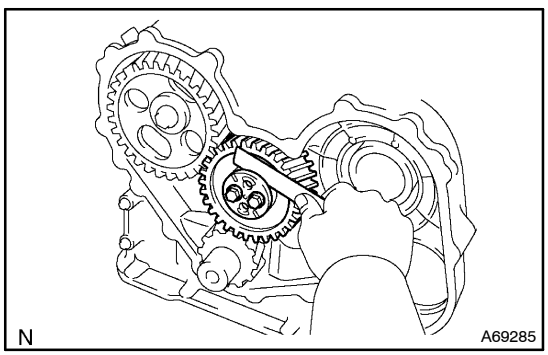
0.058 – 0.162 mm (0.0023 – 0.0064 in.)

Maximum backlash: 0.30 mm (0.0118 in.)

If the backlash is greater than the maximum, replace the gears as a set.

(c) Remove the injection pump drive gear.

(d) Remove the 2 nuts and injection pump.



14. INSPECT IDLE GEAR NO. 1 THRUST CLEARANCE

(a) Using a feeler gauge, measure the thrust clearance.

Standard thrust clearance:

0.060 – 0.170 mm (0.0024 – 0.0067 in.)

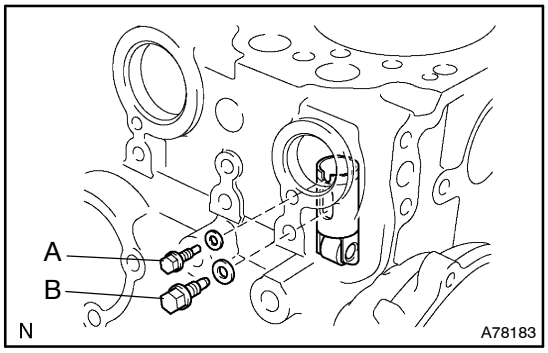
Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than the maximum, replace the thrust plate. If necessary, replace the idle gear and/or idle gear shaft.

15. REMOVE IDLE GEAR NO.1

(a) Remove the 2 bolts, thrust plate and idle gear.

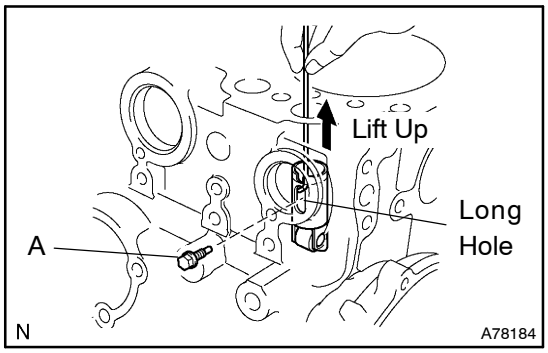
(b) Remove the union bolt and idle gear shaft.



16. REMOVE CAMSHAFT TIMING GEAR AND CAMSHAFT ASSY

(a) Displace the valve lifters.

(1) Remove the bolts (A and B) and gaskets.



(2) Using a wire, lift up the valve lifter until the long hole of the valve lifter moves up to the position of the installation hole for the bolt (A).

HINT:

If the lifter is lifted up too high, it may miss the position.

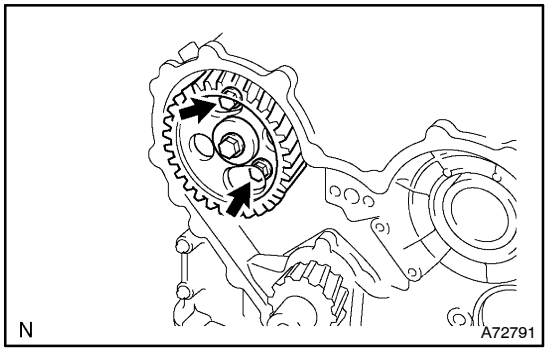
(3) Install the bolt (A).

(4) Check that the bolt (A) prevents the valve lifter from falling.

NOTICE:

Be careful not to scratch the valve lifter.

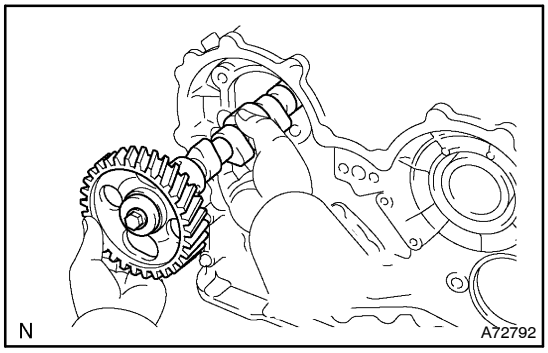
(b) Remove the 2 bolts holding the thrust plate to the cylinder block.

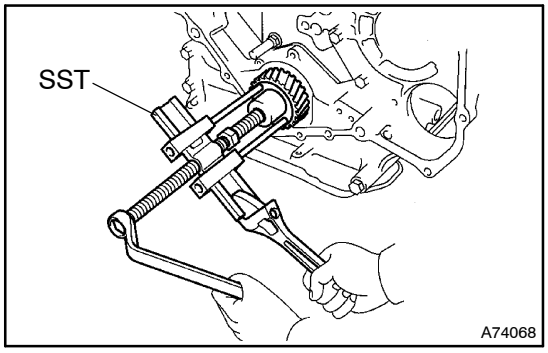


(c) Carefully pull out the camshaft and timing gear assy.

NOTICE:

Be careful not to damage the camshaft bearing.





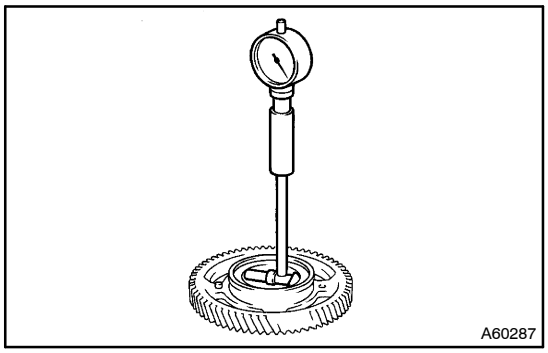
17. REMOVE CRANKSHAFT TIMING GEAR OR SPROCKET

(a) Using SST, remove the timing gear.
SST 09950–50013 (09951–05010, 09952–05010, 09953–05010, 09953–05020, 09954–05031)

18. INSPECT INJECTION PUMP DRIVE GEAR

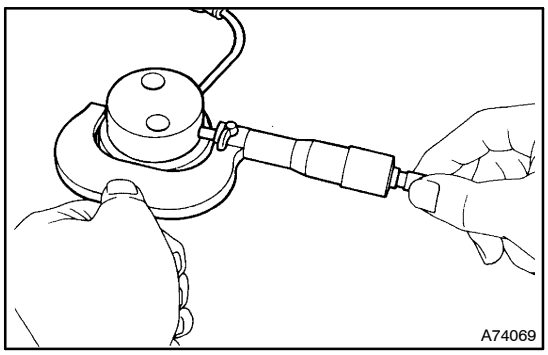
(a) Check that the bearing is not rough or worn.

If necessary, replace the drive gear (with bearing).



19. INSPECT IDLE GEAR NO. 1 OIL CLEARANCE

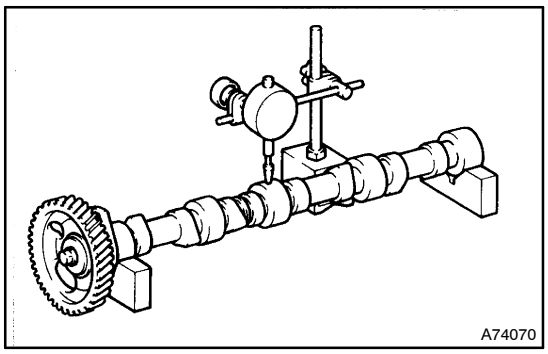
(a) Using a cylinder gauge, measure the inside diameter of the idle gear.
Idle gear inside diameter:
44.974 – 45.000 mm (1.7706 – 1.7717 in.)



(b) Using a micrometer, measure the diameter of the idle gear shaft.
Idle gear shaft diameter:
44.935 – 44.955 mm (1.7691 – 1.7699 in.)

(c) Subtract the idle gear shaft diameter measurement from the idle gear inside diameter measurement.
Standard oil clearance:
0.019 – 0.065 mm (0.0007 – 0.0026 in.)
Maximum oil clearance: 0.18 mm (0.0071 in.)

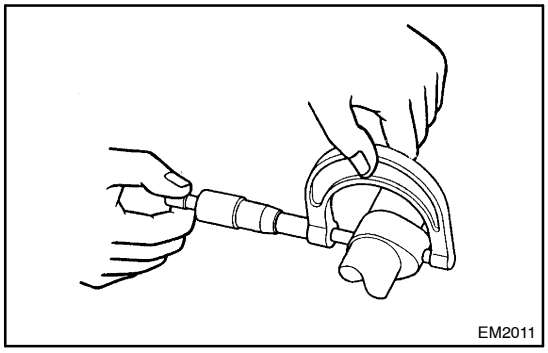
If the clearance is greater than the maximum, replace the gear and shaft.



20. INSPECT CAMSHAFT

(a) Inspect the camshaft for runout.
(1) Place the camshaft on V–blocks.
(2) Using a dial indicator, measure the circle runout at the center journal.
Maximum circle runout: 0.06 mm (0.0024 in.)

If the circle runout is greater than the maximum, replace the camshaft.



(b) Using a micrometer, measure the cam lobe height.

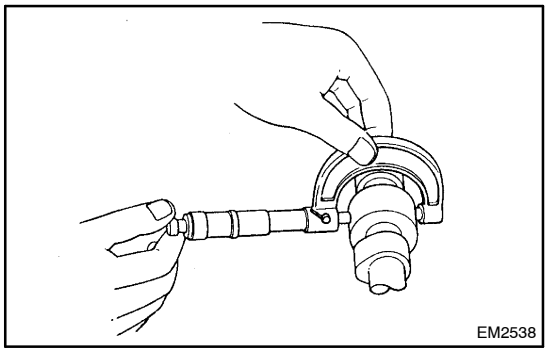
Standard cam lobe height:

Intake	44.879 – 44.969 mm (1.7669 – 1.7704 in.)
Exhaust	45.050 – 45.140 mm (1.7736 – 1.7772 in.)

Minimum cam lobe height:

Intake	44.44 mm (1.7496 in.)
Exhaust	44.62 mm (1.7567 in.)

If the cam lobe height is less than the minimum, replace the camshaft.

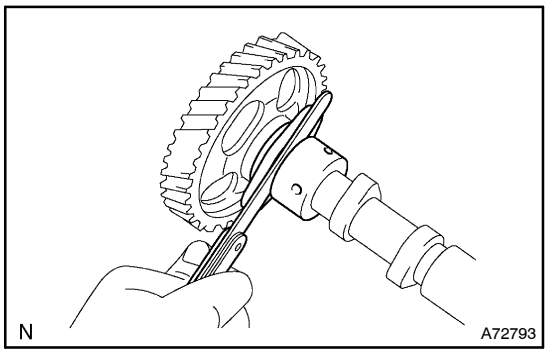


(c) Using a micrometer, measure the journal diameter.

Journal diameter (from front side):

No. 1	53.459 – 53.475 mm (2.1047 – 2.1053 in.)
No. 2	53.209 – 53.225 mm (2.0948 – 2.0955 in.)
No. 3	52.959 – 52.975 mm (2.0850 – 2.0856 in.)
No. 4	52.709 – 52.725 mm (2.0752 – 2.0758 in.)
No. 5	52.459 – 52.475 mm (2.0653 – 2.0659 in.)

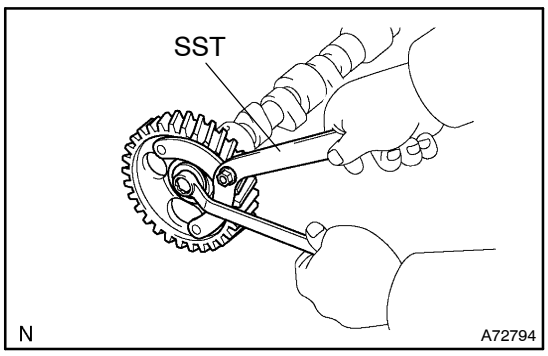
If the journal diameter is not within the specification, check the oil clearance (See page 14–38).



(d) Using a feeler gauge, measure the thrust clearance between the camshaft and thrust plate.

Standard clearance:
0.060 – 0.130 mm (0.0024 – 0.0051 in.)
Maximum clearance: 0.30 mm (0.0118 in.)

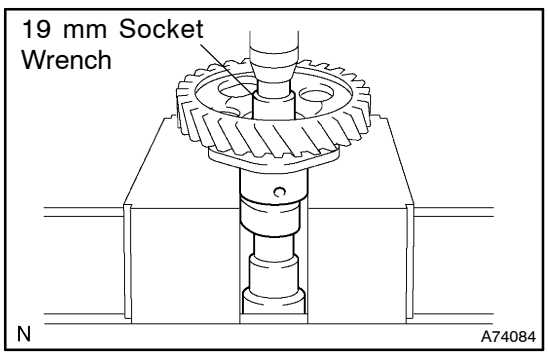
If the thrust clearance is greater than the maximum, replace the thrust plate. If necessary, replace the camshaft.



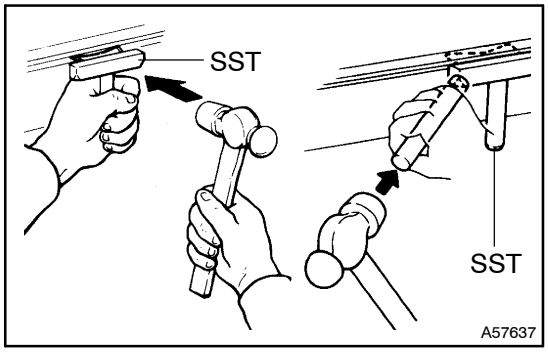
21. REMOVE CAMSHAFT TIMING GEAR OR SPROCKET

(a) Using SST, remove the bolt and plate washer.

SST 09960–10010 (09962–01000, 09963–01000)



(b) Using a 19 mm socket wrench and press, press out the camshaft.



22. REMOVE OIL PAN SUB–ASSY

(a) Remove the 17 bolts and 7 nuts.

(b) Insert the blade of SST between the oil pan and cylinder block, and cut off the applied sealer and remove the oil pan.

SST 09032–00100

NOTICE:

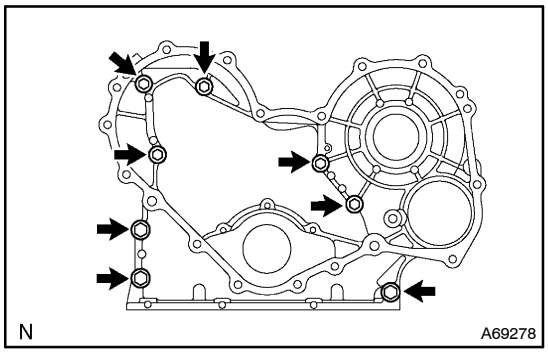
- **Do not use SST for the timing belt case side and rear oil seal retainer.**
- **Be careful not to damage the oil pan flange.**

23. REMOVE OIL STRAINER SUB–ASSY

(a) Remove the 2 bolts, 2 nuts and oil strainer.

24. REMOVE OIL PUMP OUTLET PIPE SUB–ASSY

(a) Remove the union bolt, 2 nuts, oil pipe and 3 gaskets.



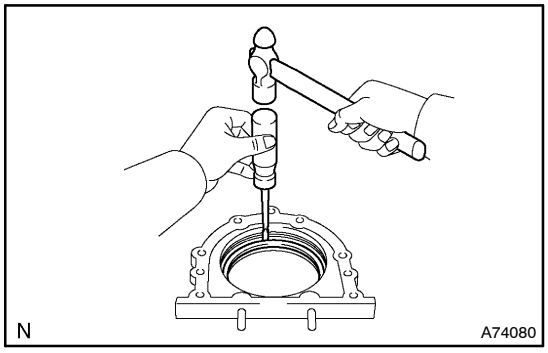
25. REMOVE TIMING GEAR CASE SUB–ASSY

(a) Remove the 8 bolts.

(b) Using a plastic–faced hammer, lightly tap out the timing gear case and gasket.

26. REMOVE ENGINE REAR OIL SEAL RETAINER

(a) Remove the 6 bolts, oil seal retainer and gasket.



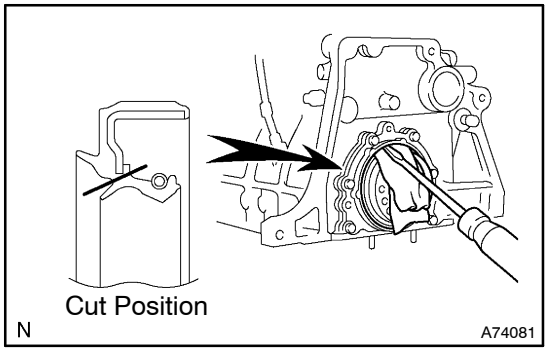
27. REMOVE ENGINE REAR OIL SEAL

HINT:

There are 2 methods ((a) and (b)) to remove the oil seal.

(a) If the rear oil seal retainer is removed from the cylinder block:

(1) Using a screwdriver and a hammer, tap out the oil seal.



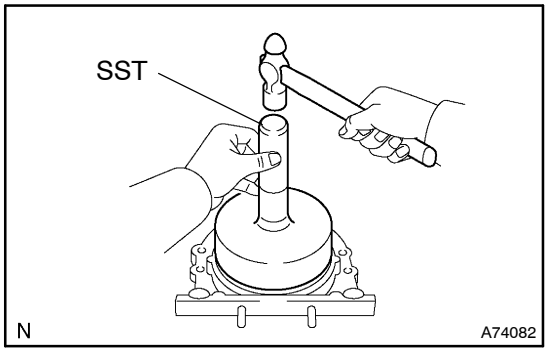
(b) If the rear oil seal retainer is installed to the cylinder block:

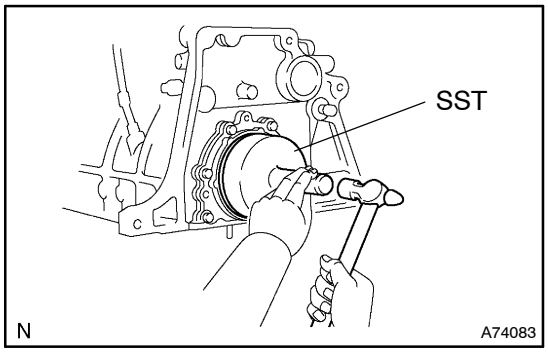
(1) Using a knife, cut off the oil seal lip.

(2) Using a screwdriver, pry out the oil seal.

NOTICE:

Be careful not to damage the crankshaft. Tape the screwdriver tip.





28. INSTALL ENGINE REAR OIL SEAL

HINT:

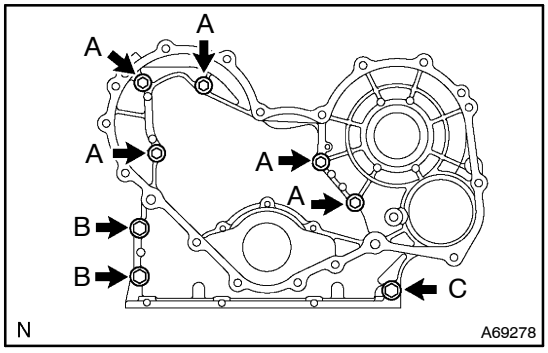
There are 2 methods ((a) and (b)) to install the oil seal.

(a) If the rear oil seal retainer is removed from the cylinder block:
  (1) Using SST and a hammer, tap in a new oil seal until its surface is flush with the rear oil seal retainer edge.
  SST 09223–56010
  (2) Apply MP grease to the oil seal lip.

(b) If the rear oil seal retainer is installed to the cylinder block:
  (1) Apply MP grease to a new oil seal lip.
  (2) Using SST and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
  SST 09223–56010

29. INSTALL ENGINE REAR OIL SEAL RETAINER

(a) Install a new gasket and the retainer with the 6 bolts.
Torque: 18.5 N·m (189 kgf·cm, 14 ft·lbf)



30. INSTALL TIMING GEAR CASE SUB–ASSY

(a) Install a new gasket and the timing gear case with the 8 bolts. Uniformly tighten the 8 bolts in several passes.
Torque:
18.5 N·m (189 kgf·cm, 14 ft·lbf) for 12 mm head bolt
44 N·m (449 kgf·cm, 32 ft·lbf) for 14 mm head bolt

HINT:

Bolt length:

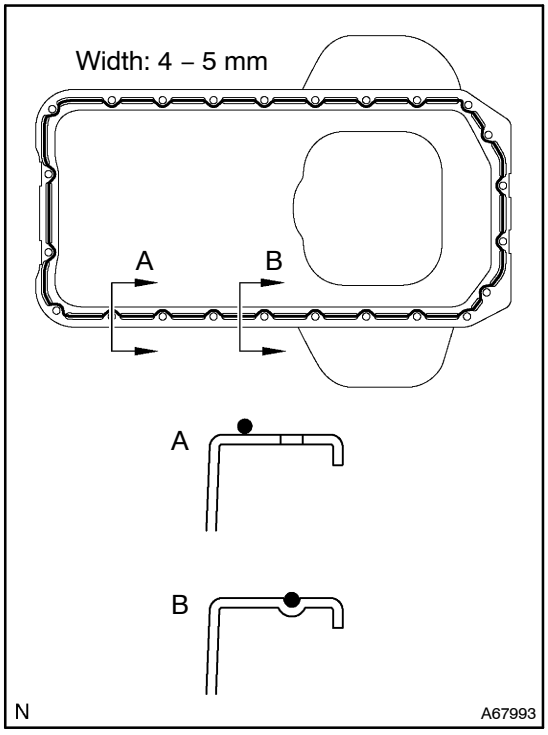
Item	Length
A for 12 mm head	25 mm (0.98 in.)
B for 14 mm head	60 mm (2.36 in.)
C for 14 mm head	85 mm (3.35 in.)

31. INSTALL OIL STRAINER SUB–ASSY

(a) Install a new gasket and the oil strainer with the 2 bolts and 2 nuts.
Torque: 18.5 N·m (189 kgf·cm, 14 ft·lbf)

32. INSTALL OIL PUMP OUTLET PIPE SUB–ASSY

(a) Install 3 new gaskets and oil pipe with the union bolt and 2 nuts.
Torque:
18.5 N·m (189 kgf·cm, 14 ft·lbf) for nut
50 N·m (510 kgf·cm, 37 ft·lbf) for union bolt



33. INSTALL OIL PAN SUB–ASSY

(a) Remove any old packing (FIPG) materials and be careful not to drop any oil on the contact surfaces of the oil pan and cylinder block.
  (1) Using a razor blade and a gasket scraper, remove all the old packing (FIPG) materials from the gasket surfaces and sealing groove.
  (2) Thoroughly clean all the components to remove all the loose materials.
  (3) Using a non–residue solvent, clean both sealing surfaces.

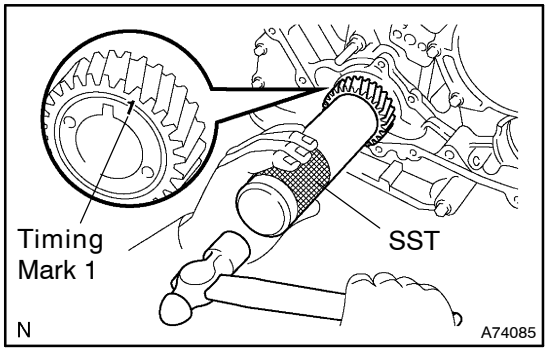
NOTICE:

Do not use a solvent which will affect the painted surfaces.

(b) Apply seal packing to the oil pan, as shown in the illustration.

Seal packing: Part No. 08826–00080 or equivalent
  (1) Install a nozzle which opening that has been cut by 4 – 5 mm (0.16 – 0.20 in.) to apply seal packing.
  (2) Assemble the parts within 5 minutes after application. Otherwise, the seal packing will be removed.
  (3) Immediately remove the nozzle from the tube and reinstall the cap.

(c) Install the oil pan with the 17 bolts and 7 nuts.
Torque: 18.5 N·m (189 kgf·cm, 14 ft·lbf)

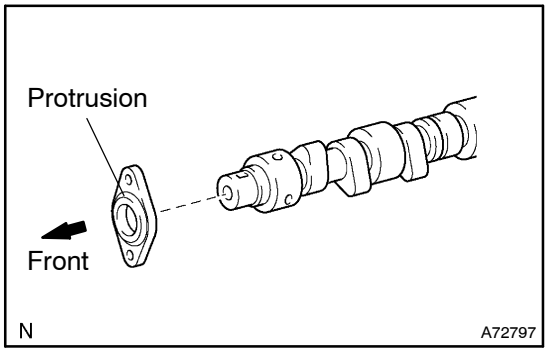


34. INSTALL CRANKSHAFT TIMING GEAR OR SPROCKET

(a) Place the crankshaft timing gear with timing mark 1 facing the forward.

(b) Align the set key on the crankshaft with the key groove of the crankshaft timing gear.

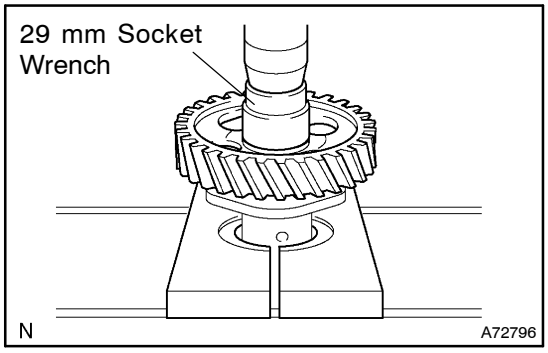
(c) Using SST and a hammer, tap in the timing gear.
SST 09608–06041



35. INSTALL CAMSHAFT TIMING GEAR OR SPROCKET

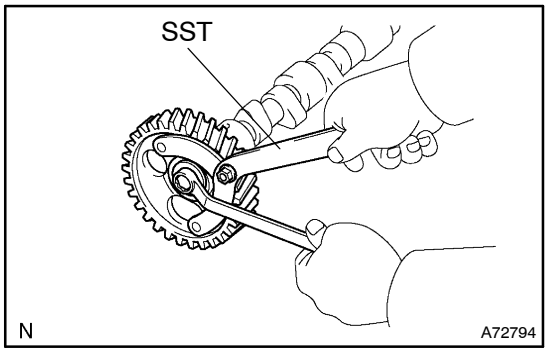
(a) Install the timing gear set key to the camshaft.

(b) Install the thrust plate to the camshaft, as shown in the illustration.

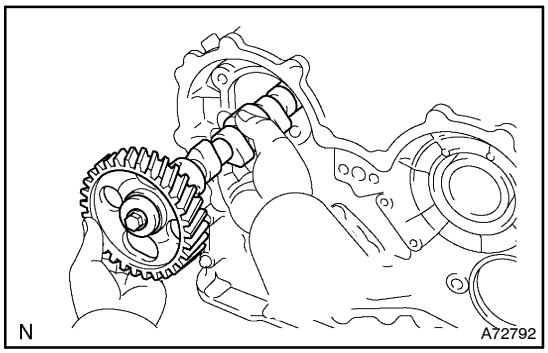


(c) Align the timing gear set key with the key groove of the timing gear.

(d) Using a 29 mm socket wrench and a press, press in the camshaft timing gear.



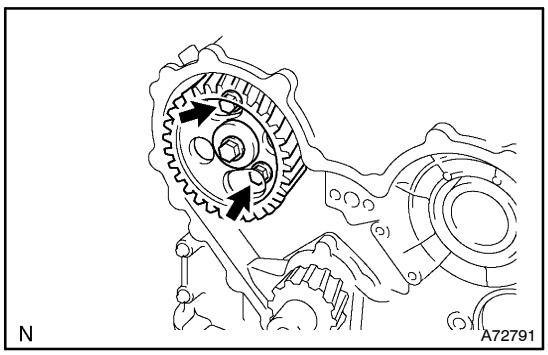
(e) Using SST, install the plate washer and bolt.
SST 09960–10010 (09962–01000, 09963–01000)
Torque: 57 N·m (581 kgf·cm, 42 ft·lbf)



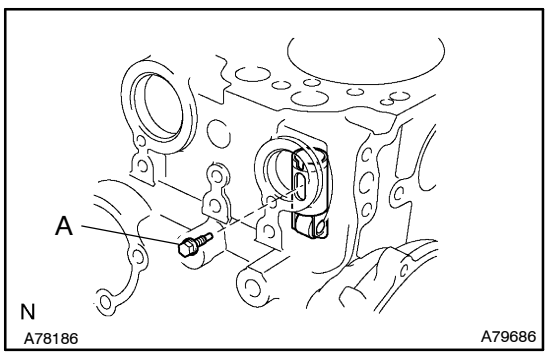
36. INSTALL CAMSHAFT TIMING GEAR AND CAMSHAFT ASSY

(a) Insert the camshaft into the cylinder block.

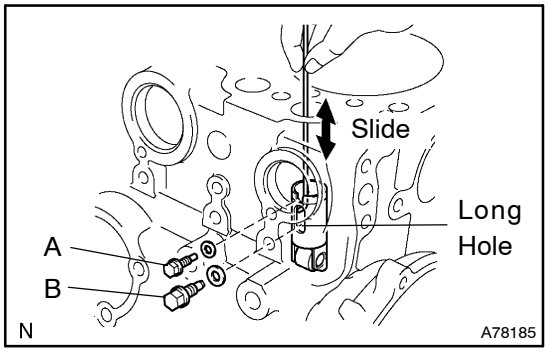
NOTICE:
Be careful not to damage the camshaft bearing.



(b) Install the thrust plate with the 2 bolts.
Torque: 18.5 N·m (189 kgf·cm, 14 ft·lbf)



(c) Displace the valve lifters.
(1) Remove the bolt (A).



(2) Install the bolts (A and B) with 2 new gaskets.

Torque:

9.4 N·m (96 kgf·cm, 83 in.·lbf) for 10 mm head bolt (A)

37.5 N·m (382 kgf·cm, 28 ft·lbf) for 12 mm head bolt (B)

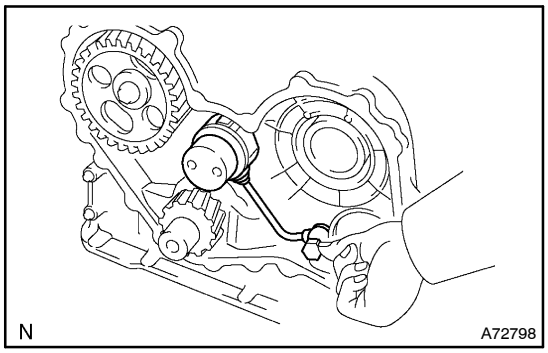
HINT:

When installing the bolt (B), check that the hole for the bolt (B) is aligned with the long hole of the valve lifter.

(3) Check that the valve lifter can move up and down within the limits of the long hole.

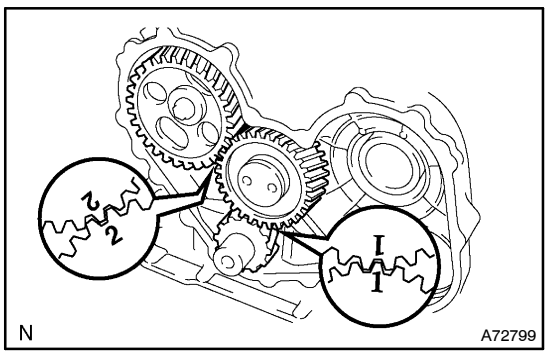
NOTICE:

Be careful not to scratch the valve lifter.



37. INSTALL IDLE GEAR NO.1

(a) Temporarily install the idle gear shaft with the union bolt.



(b) Align the idle gear timing marks 1 and 2 with crankshaft gear timing mark 1 and camshaft gear timing mark 2 respectively, and mesh the gears.

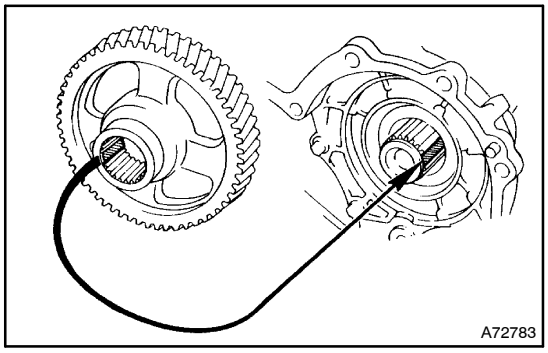
(c) Apply a light coat of engine oil on the threads and under the bolt heads.

(d) Install the thrust plate with the 2 bolts.

Torque: 47.5 N·m (484 kgf·cm, 35 ft·lbf)

(e) Tighten the union bolt.

Torque: 11 N·m (112 kgf·cm, 8 ft·lbf)



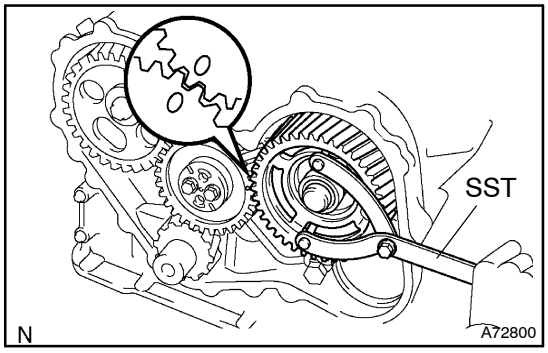
38. INSTALL INJECTION PUMP DRIVE GEAR

(a) Install the injection pump with the 2 nuts.

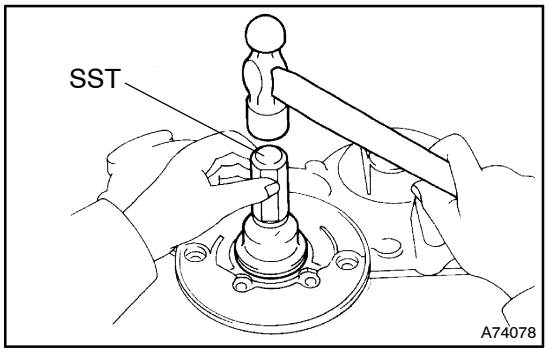
Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)

(b) Apply MP grease to the drive gear spline, bearing and injection pump spline.

(c) Align the spline toothless portions of the injection pump drive gear and injection pump.



(d) Using SST, align the idle gear timing mark 0 with the injection pump drive gear timing mark 0, and mesh the gears.
SST 09960–10010 (09962–01000, 09963–01000)

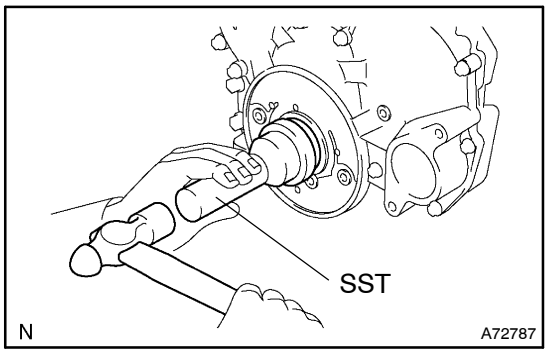


39. INSTALL TIMING GEAR COVER OIL SEAL

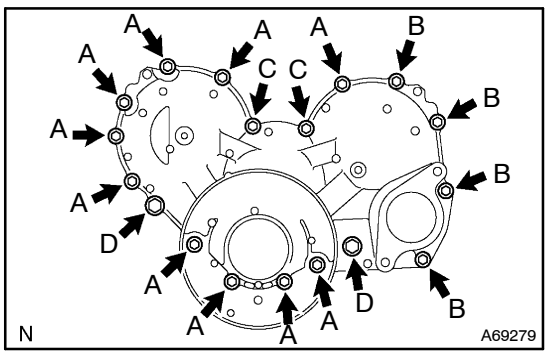
HINT:

There are 2 methods ((a) and (b)) to install the oil seal.

(a) If the timing gear cover is removed from the cylinder block:
(1) Using SST and a hammer, tap in a new oil seal until its surface is flush with the timing gear cover edge.
SST 09223–46011
(2) Apply MP grease to the oil seal lip.



(b) If the timing gear cover is installed to the cylinder block:
(1) Apply MP grease to a new oil seal lip.
(2) Using SST and a hammer, tap in the oil seal until its surface is flush with the timing gear cover edge.
SST 09223–46011



40. INSTALL TIMING GEAR COVER

(a) Install a new gasket and the timing gear cover.

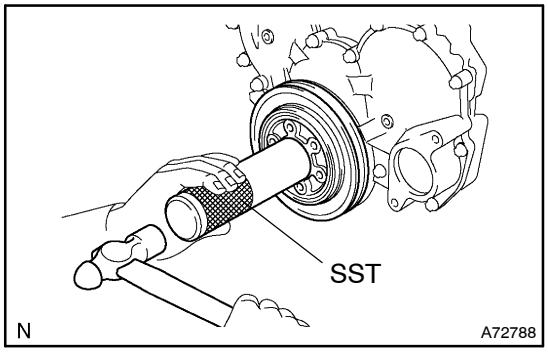
(b) Using a plastic–faced hammer, align the 2 knock pins of the oil pump, and lightly tap in the timing gear cover.

(c) Install the timing gear cover with the 18 bolts.
Torque:
18.5 N·m (189 kgf·cm, 14 ft·lbf) for 12 mm head bolt
44 N·m (449 kgf·cm, 32 ft·lbf) for 14 mm head bolt

HINT:

Bolt length:

Item	Length
A for 12 mm head	35 mm (1.38 in.)
B for 12 mm head	40 mm (1.57 in.)
C for 12 mm head	77 mm (3.03 in.)
D for 14 mm head	80 mm (3.15 in.)

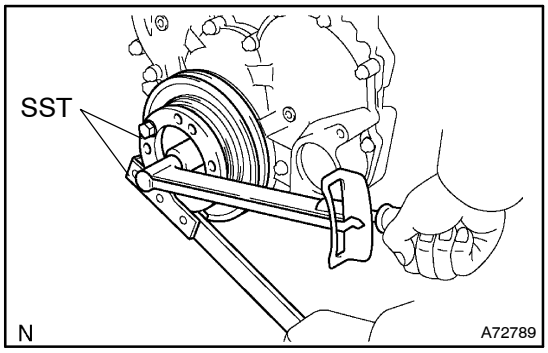


41. INSTALL CRANKSHAFT PULLEY

(a) Align the pulley set key with the key groove of the pulley.

(b) Using SST and a hammer, tap in the pulley.

SST 09608–06041

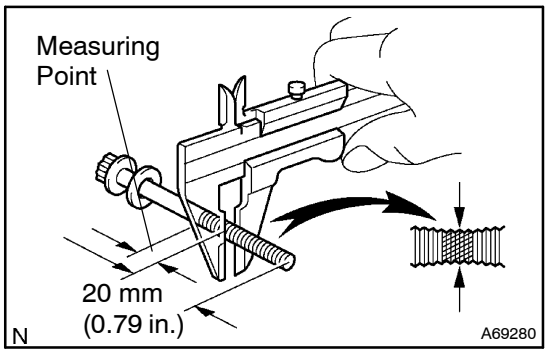


(c) Apply a light coat of engine oil on the threads and under the bolt head.

(d) Using SST, install the pulley bolt.

SST 09213–58013 (90201–08131, 91111–50845), 09330–00021

Torque: 294 N·m (3,000 kgf·cm, 217 ft·lbf)

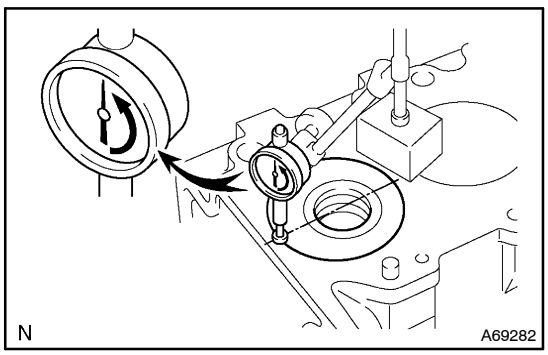


42. INSPECT CYLINDER HEAD SET BOLT

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

Standard outer diameter:
11.80 – 12.00 mm (0.4646 – 0.4724 in.)
Minimum outer diameter: 11.60 mm (0.4567 in.)

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



43. INSTALL CYLINDER HEAD SUB–ASSY

(a) Check the piston protrusions for each cylinder.

(1) Clean the cylinder block with solvent.

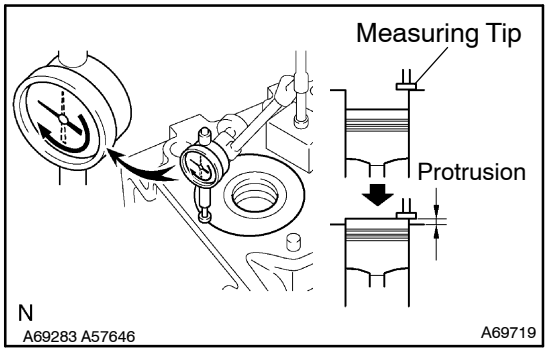
(2) Set the piston of the cylinder slightly before TDC to measure the protrusion.

(3) Place a dial indicator on the cylinder block, and set the measuring tip, as shown in the illustration.

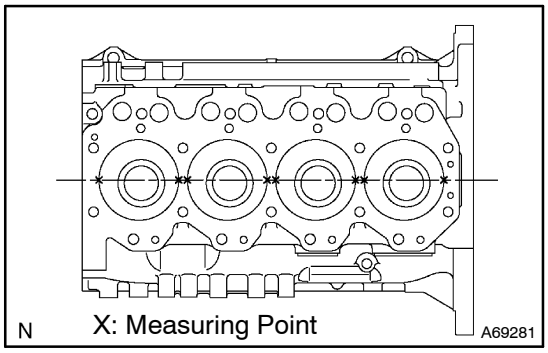
(4) Set the dial indicator at 0 mm (0 in.).

HINT:

- Use a dial indicator measuring tip, as shown in the illustration.
- Make sure that the measuring tip is square to the cylinder block gasket surface and piston head when taking the measurements.



(5) Find the position where the piston head protrudes most by slowly turning the crankshaft clockwise and counterclockwise.



(6) Measure each cylinder at 2 places, as shown in the illustration, making a total of 8 measurements.

(7) For the piston protrusion value of each cylinder, use the average of the 2 measurements of each cylinder.

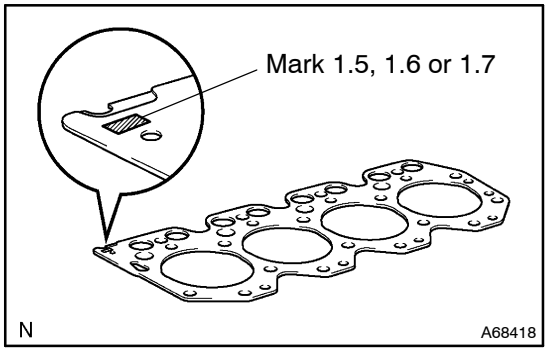
Piston protrusion:

0.535 – 0.984 mm (0.0211 – 0.0387 in.)

HINT:

When removing piston and connecting rod assembly:

If the protrusion is not as specified, remove the piston and connecting rod assy and reinstall it (See page 14–38).



(b) Select a new cylinder head gasket.

HINT:

There are 3 sizes of new cylinder head gaskets, marked 1.5, 1.6 or 1.7 accordingly.

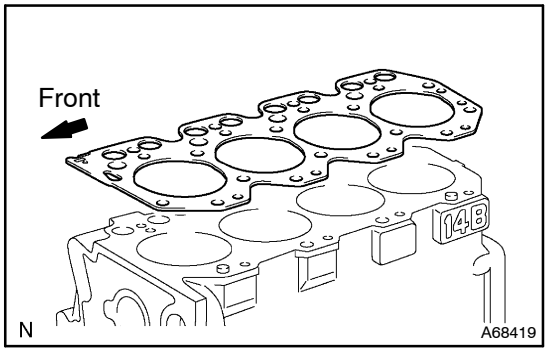
New installed cylinder head gasket thickness:

Mark 1.5	1.47 – 1.53 mm (0.0579 – 0.0602 in.)
Mark 1.6	1.57 – 1.63 mm (0.0618 – 0.0642 in.)
Mark 1.7	1.67 – 1.73 mm (0.0657 – 0.0681 in.)

(1) Select the largest piston protrusion value from the measurements, then select a new appropriate gasket according to the table below.

Piston protrusion:

Piston protrusion	Gasket size
0.535 – 0.785 mm (0.0211 – 0.0309 in.)	Use 1.5
0.785 – 0.885 mm (0.0309 – 0.0348 in.)	Use 1.6
0.885 – 0.985 mm (0.0348 – 0.0388 in.)	Use 1.7



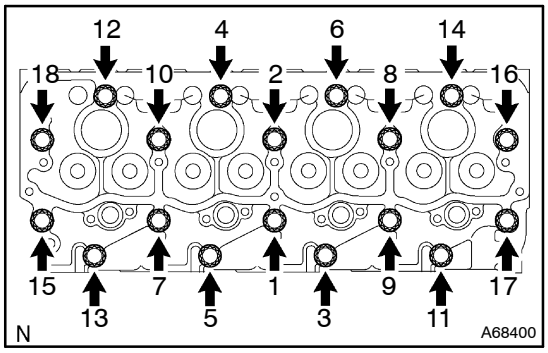
(c) Place the cylinder head on the cylinder block.

(1) Place the cylinder head gasket in the position on the cylinder block.

NOTICE:

Be careful of the installation direction.

(2) Place the cylinder head in the position on the cylinder head gasket.



(d) Install the cylinder head bolts.

HINT:

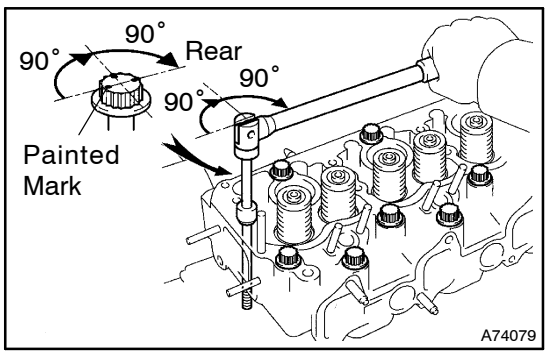
- The cylinder head bolts are tightened in 3 progressive steps (steps (2), (4) and (5)).
- If any of the bolts is broken or deformed, replace it.

(1) Apply a light coat of engine oil on the threads and under the heads of the cylinder head bolts.

(2) Install the 18 cylinder head bolts and uniformly tighten them in several passes in the sequence shown in the illustation.

Torque: 49 N·m (500 kgf·cm, 36 ft·lbf)

If any of the cylinder head bolts does not meet the torque specification, replace the cylinder head bolt.

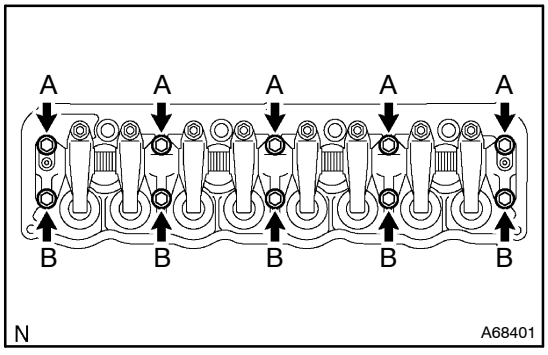


(3) Mark the front of the cylinder head bolt with paint.

(4) Retighten the cylinder head bolts by 90° in the sequence shown in the illustation.

(5) Retighten the cylinder head bolts by 90° additionally.

(6) Check that the painted mark is facing rearward at this time.



44. INSTALL VALVE ROCKER SHAFT ASSY

(a) Install the 8 push rods.

(b) Place the rocker shaft assembly on the cylinder head.

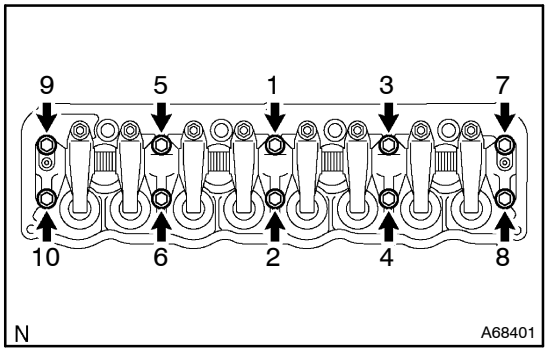
(c) Align the rocker arm adjusting screws with the heads of the push rods.

(d) Install the 10 bolts (A and B).

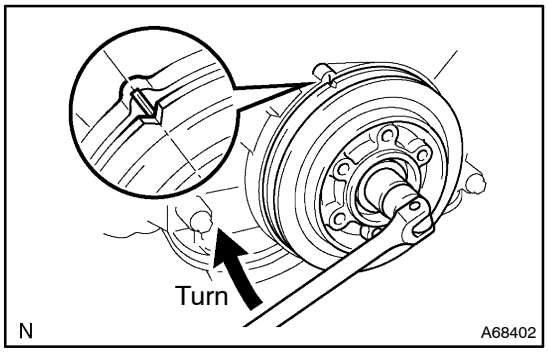
HINT:

Bolt length:

Item	Length
A	63 mm (2.48 in.)
B	53 mm (2.09 in.)



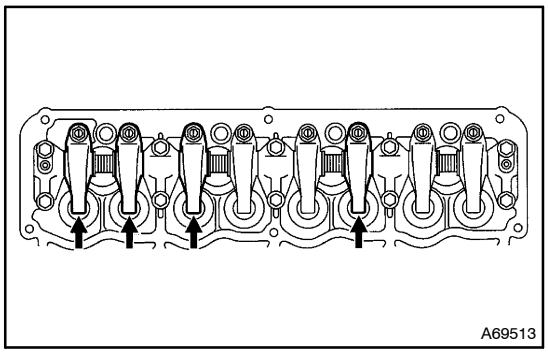
(e) Uniformly tighten the 10 bolts in several passes in the sequence shown in the illustation.
Torque: 25 N·m (255 kgf·cm, 18 ft·lbf)



45. INSPECT VALVE CLEARANCE

(a) Set the No. 1 cylinder to TDC/compression.
(1) Turn the crankshaft pulley clockwise, and align its groove with the groove of the timing gear cover.
(2) Check that the valve rocker arm on the No. 1 cylinder is loose and valve rocker arm on the No. 4 cylinder is tight.

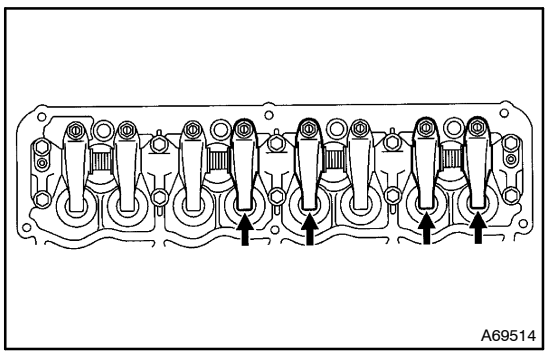
If not, turn the crankshaft 1 revolution (360˚) and align the marks.



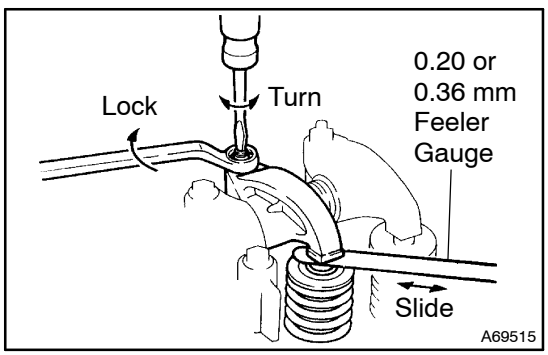
(b) Check only the valves indicated in the illustration.
- Using a feeler gauge, measure the clearance between the adjusting screw on the valve rocker arm and the valve stem cap.
- Record the out–of–specification valve clearance measurements.

Valve clearance (Hot):

Intake	0.20 mm (0.008 in.)
Exhaust	0.36 mm (0.014 in.)



(c) Turn the crankshaft pulley 1 revolution (360˚) and align the marks (See step (a)).
(d) Check only the valves indicated in the illustration. Measure the valve clearance (See step (b)).



46. ADJUST VALVE CLEARANCE

(a) Loosen the lock nut on the valve rocker arm, and loosen the adjusting screw.
(b) Insert a 0.20 mm (0.008 in.) feeler gauge for intake or a 0.36 mm (0.014 in.) feeler gage for exhaust between the adjusting screw on the valve rocker arm and the valve stem cap.
(c) Turn the adjusting screw on the valve rocker arm until the feeler gauge slides with a very slight drag, and lock the adjusting screw with the lock nut.

Torque: 18.5 N·m (189 kgf·cm, 14 ft·lbf)

(d) Recheck the valve clearance.

47. INSTALL CYLINDER HEAD COVER SUB–ASSY

(a) Install the gasket to the cylinder head cover.

(b) Install the cylinder head cover with the 4 bolts and 2 nuts. Uniformly tighten the bolts and nuts in several passes.

Torque: 10.5 N·m (107 kgf·cm, 8 ft·lbf)

48. INSTALL OIL FILLER CAP SUB–ASSY

49. INSTALL NO. 1 ENGINE HANGER

(a) Install the engine hanger with the 2 bolts.

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)

50. INSTALL NO. 2 ENGINE HANGER

(a) Install the engine hanger with the 2 bolts.

Torque: 37 N·m (380 kgf·cm, 27 ft·lbf)