1412C–01

OVERHAUL

HINT:

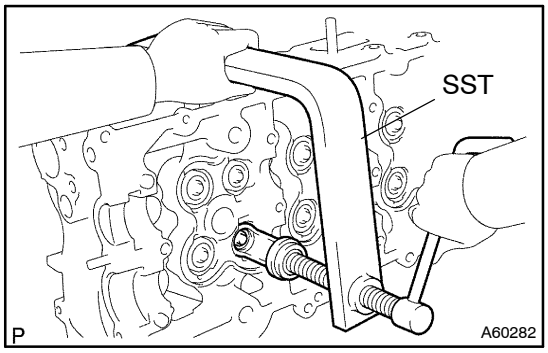
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets and oil seals with new ones.

1. REMOVE LIFTER, VALVE

(a) Remove the valve lifters.

HINT:

Arrange the valve lifters in correct order.



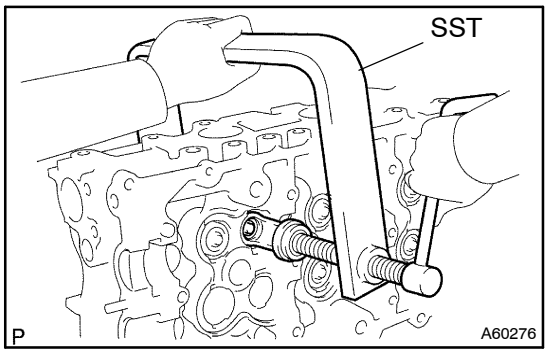
2. REMOVE INTAKE VALVE

(a) Using SST, compress the compression spring and remove the spring retainer lock.
SST 09202–70020 (09202–00020)

(b) Remove the spring retainer, compression spring, valve and plate washer.

HINT:

Arrange the valves, compression springs, plate washer and spring retainers in correct order.



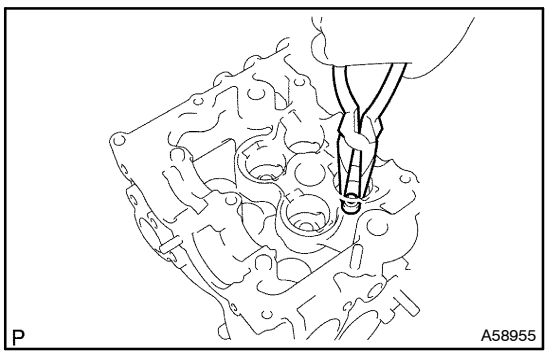
3. REMOVE EXHAUST VALVE

(a) Using SST, compress the compression spring and remove the spring retainer lock.
SST 09202–70020 (09202–00020)

(b) Remove the spring retainer, compression spring, valve and plate washer.

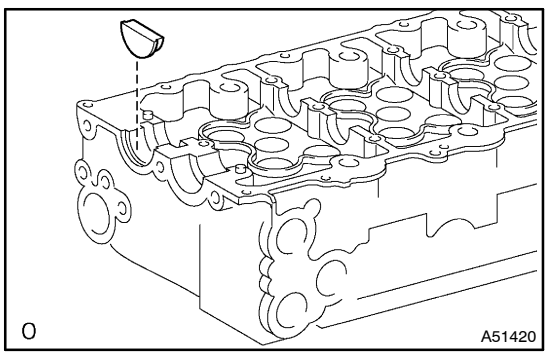
HINT:

Arrange the valves, compression springs, plate washer and spring retainers in correct order.

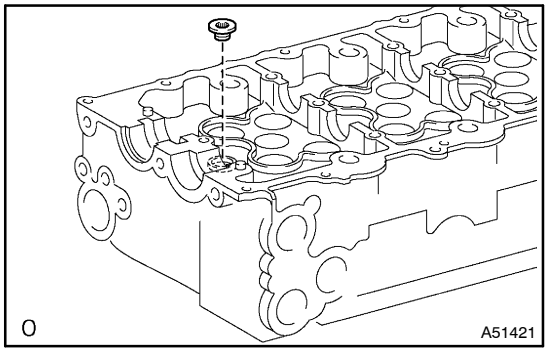


4. REMOVE VALVE STEM OIL O SEAL OR RING

(a) Using needle–nose pliers, remove the oil seal.



5. REMOVE SEMICIRCULAR PLUG



6. REMOVE W/HEAD STRAIGHT SCREW PLUG NO.1

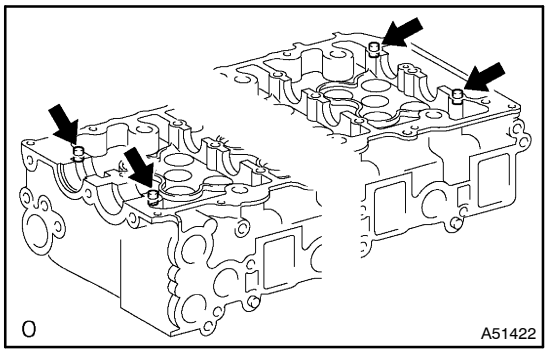
(a) Using a 6 mm hexagon wrench, remove the screw plug.

7. REMOVE STUD BOLT

(a) Remove the stud bolt from the cylinder head assy.

NOTICE:

It is not necessary to remove, if a replacement of the straight screw plug No. 1 is not needed.

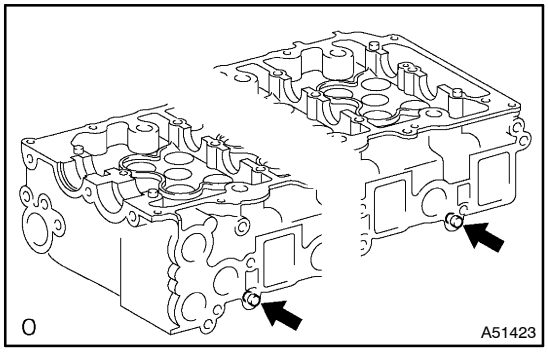


8. REMOVE RING W/HEAD PIN

(a) Remove the ring pin from the cylinder head assy.

NOTICE:

It is not necessary to remove, if a replacement of the ring pin is not needed.



9. REMOVE RING PIN

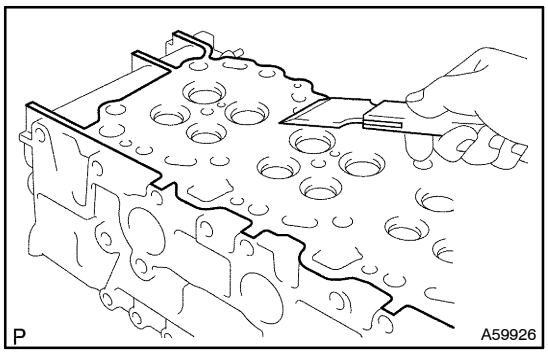
(a) Remove the ring pin from the cylinder head assy.

NOTICE:

It is not necessary to remove, if a replacement of the ring pin is not needed.

10. REMOVE TIGHT PLUG

(a) Remove the tight plug from the cylinder head assy.

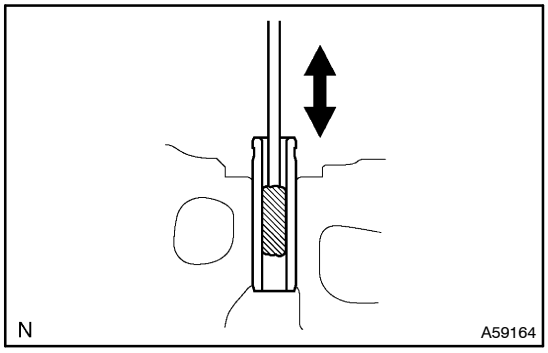


11. CLEAN CYLINDER HEAD SUB–ASSY

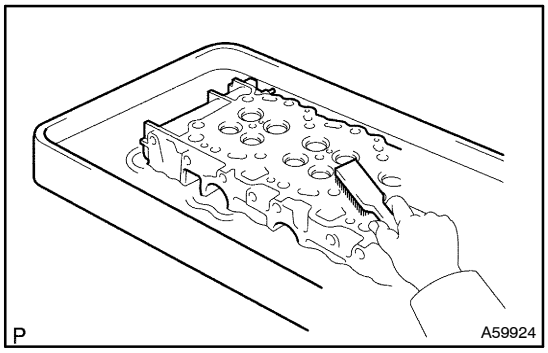
(a) Using a gasket scraper, remove all the gasket material from the cylinder block contact surface.

NOTICE:

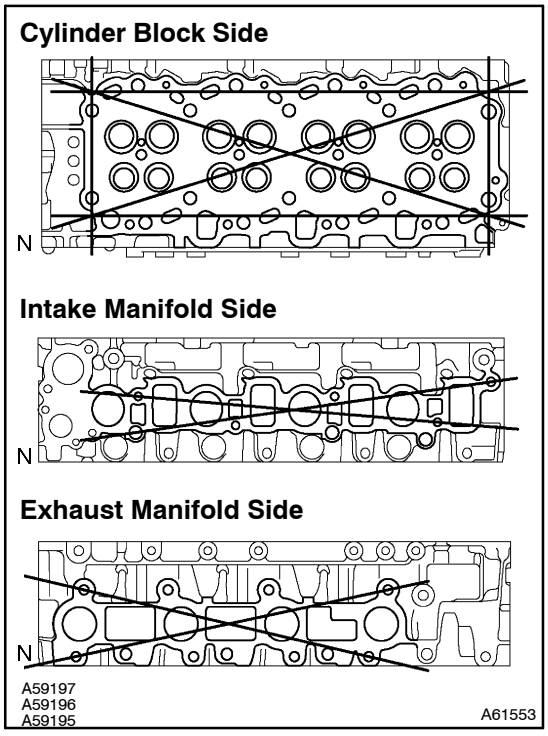
Be careful not to scratch the cylinder block contact surface.



(b) Using a valve guide bushing brush and solvent, clean all the guide bushes.



(c) Using a soft brush and solvent, thoroughly clean the cylinder head.



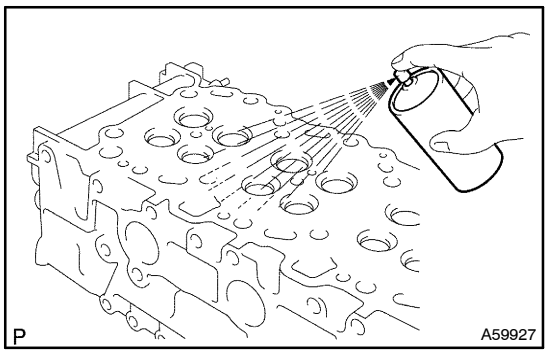
12. INSPECT CYLINDER HEAD SUB–ASSY

(a) Inspect for warpage.

(1) Using a precision straight edge and feeler gauge, measure a warpage for the contact surface of the cylinder block and intake and exhaust manifold.

Maximum warpage: 0.15 mm (0.0059 in.)

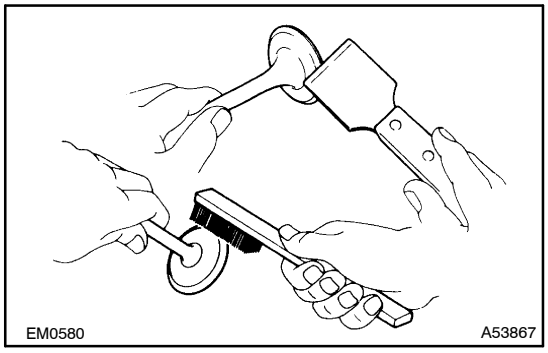
If the warpage is greater than the maximum, replace the cylinder head.



(b) Inspect for cracks.

(1) Using a dye penetrant, inspect the combustion chamber, intake and, exhaust ports and cylinder block surface for cracks.

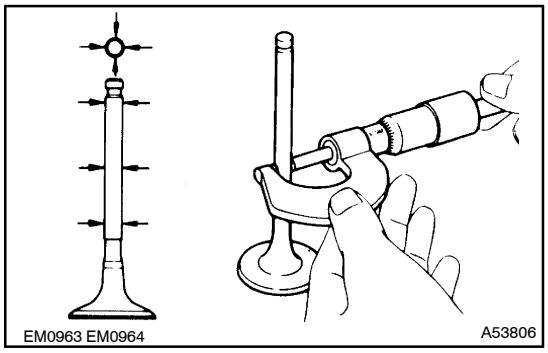
If there is a cracked, replace the cylinder head.



13. CLEAN INTAKE VALVE

(a) Using a gasket scraper, chip off any carbon from the valve head.

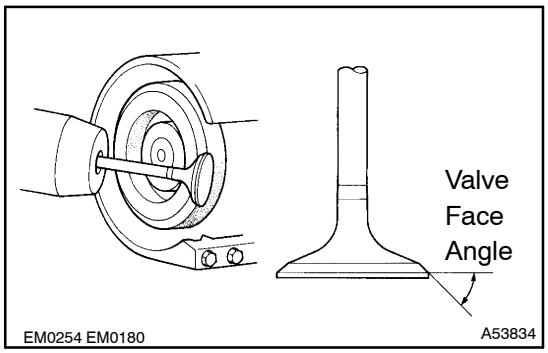
(b) Using a wire brush, thoroughly clean the valve.



14. INSPECT INTAKE VALVE

(a) Using a micrometer, measure the outside diameter of the valve stem.

Valve stem diameter:
5.970 – 5.985 mm (0.2350 – 0.2356 in.)

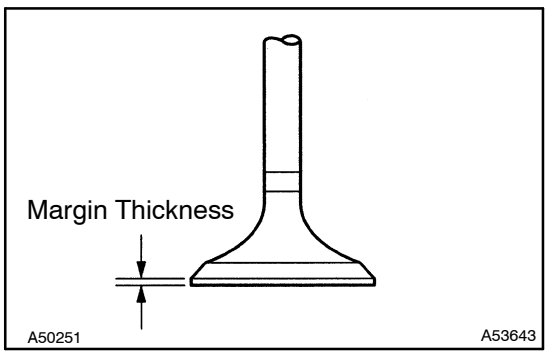


(b) Check the valve face angle.

(1) Grind the valve enough to remove carbon and eliminate pits.

(2) Check that the valve is ground to the correct valve face angle.

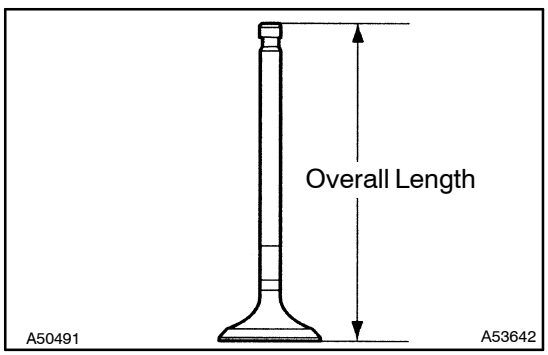
Valve face angle: 44.5°



(c) Check the valve head margin thickness.

Standard margin thickness: 1.1 mm (0.043 in.)
Minimum margin thickness: 0.8 mm (0.032 in.)

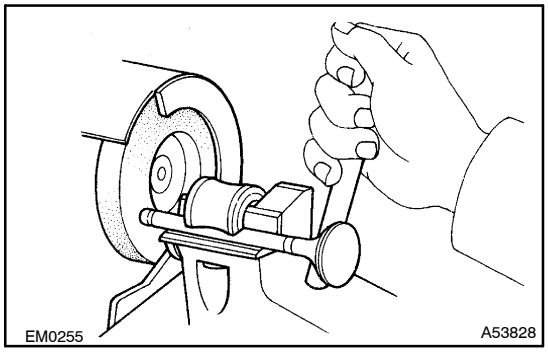
If the margin thickness is less than the minimum, replace the valve.



(d) Check the valve overall length.

Standard overall length:
105.15 – 105.75 mm (4.1398 – 4.1634 in.)
Minimum overall length: 104.65 mm (4.1201 in.)

If the overall length is less than the minimum, replace the valve.

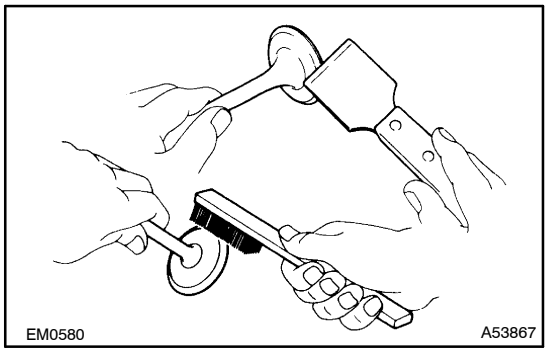


(e) Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.

NOTICE:

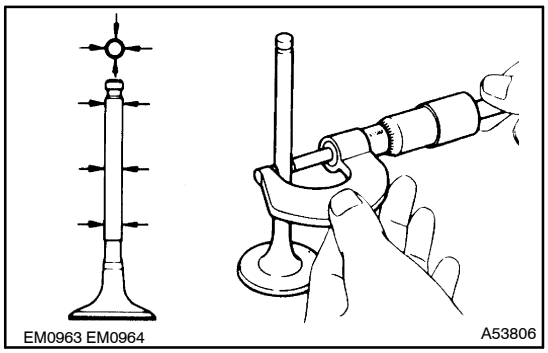
Do not grind off more than the minimum.



15. CLEAN EXHAUST VALVE

(a) Using a gasket scraper, chip off any carbon from the valve head.

(b) Using a wire brush, thoroughly clean the valve.

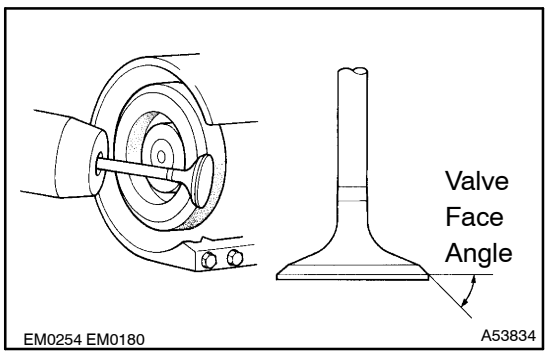


16. INSPECT EXHAUST VALVE

(a) Using a micrometer, measure the outside diameter of the valve stem.

Valve stem diameter:

5.960 – 5.975 mm (0.2346 – 0.2352 in.)

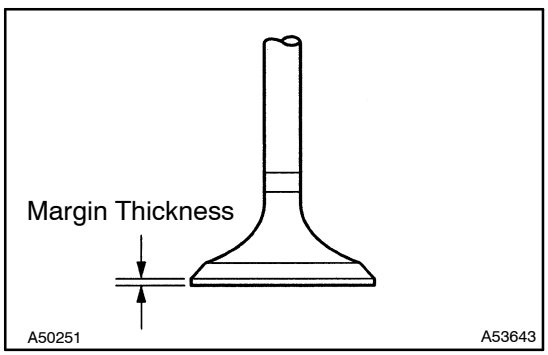


(b) Check the valve face angle.

(1) Grind the valve enough to remove carbon and eliminate pits.

(2) Check that the valve is ground to the correct valve face angle.

Valve face angle: 44.5°

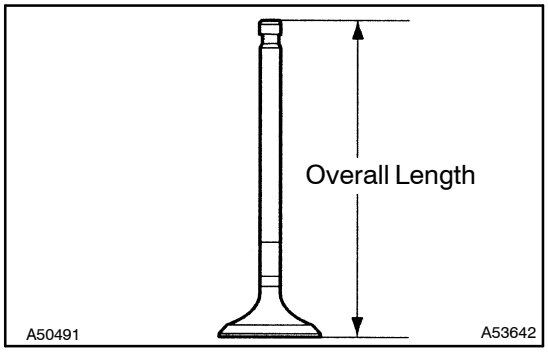


(c) Check the valve head margin thickness.

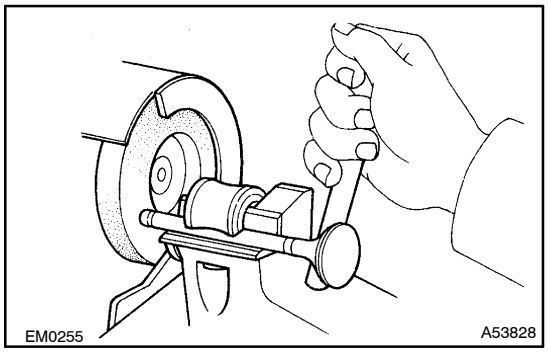
Standard margin thickness: 1.2 mm (0.047 in.)

Minimum margin thickness: 0.7 mm (0.028 in.)

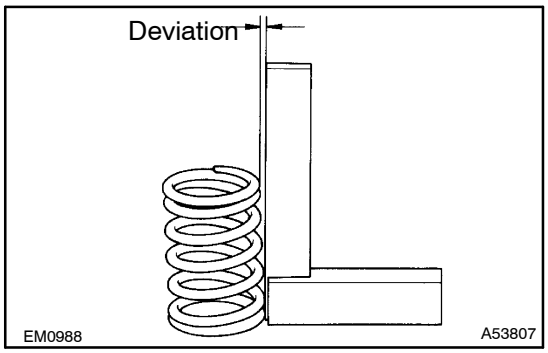
If the margin thickness is less than the minimum, replace the valve.



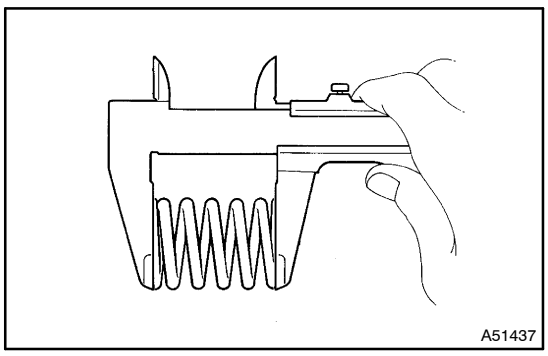
(d) Check the valve overall length.
Standard overall length:
105.02 – 105.62 mm (4.1347 – 4.1583 in.)
Minimum overall length: 104.52 mm (4.1150 in.)
If the overall length is less than the minimum, replace the valve.



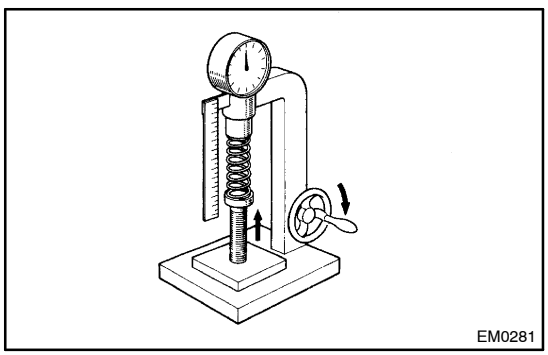
(e) Check the surface of the valve stem tip for wear.
If the valve stem tip is worn, resurface the tip with a grinder or replace the valve.
NOTICE:
Do not grind off more than minimum.



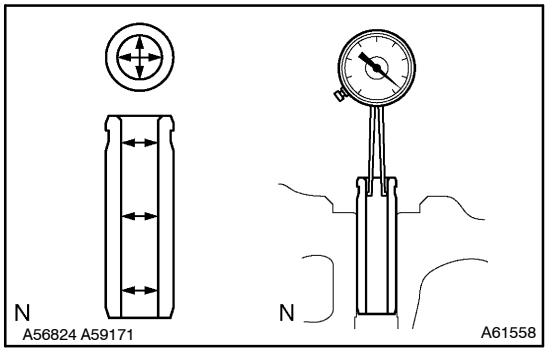
17. INSPECT INNER COMPRESSION SPRING
(a) Using a steel square, measure the deviation of the spring.
Maximum deviation: 2.0 mm (0.079 in.)
If the deviation is greater than the maximum, replace the spring.



(b) Using a vernier caliper, measure the free length of the spring.
Free length: 46.5 mm (1.831 in.)
If the free length is not as specified, replace the spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.
Installed tension (at 33.1 mm (1.303 in.)):
150.2 – 165.8 N (15.3 – 16.9 kgf, 33.7 – 37.3 ibf)
If the installed tension is not as specified, replace the spring.



18. INSPECT INTAKE VALVE GUIDE BUSH

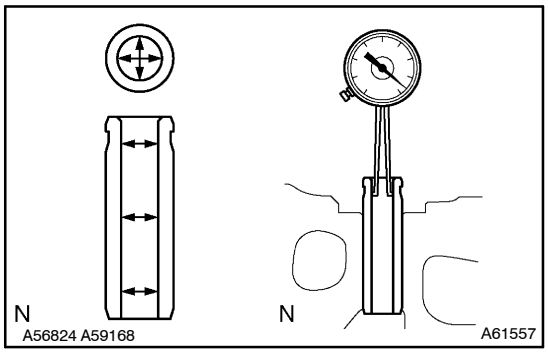
(a) Using a caliper gauge, measure the inside diameter of the guide bush.

Bush inside diameter:
6.010 – 6.030 mm (0.2366 – 0.2374 in.)

(b) Subtract the valve stem diameter measurement (See step 14) from the guide bush inside diameter measurement.

Standard oil clearance:
0.025 – 0.060 mm (0.0010 – 0.0024 in.)
Maximum oil clearance: 0.08 mm (0.0031 in.)

If the clearance is greater than maximum, replace the valve and guide bush (See steps 20 and 22).



19. INSPECT EXHAUST VALVE GUIDE BUSH

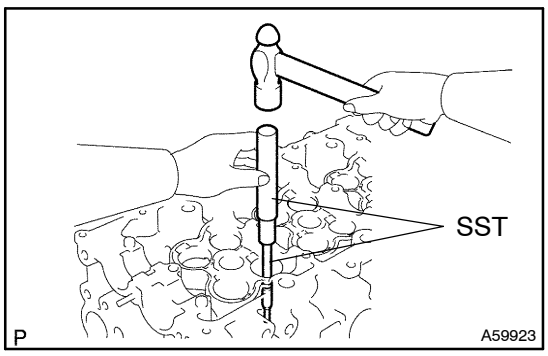
(a) Using a caliper gauge, measure the inside diameter of the guide bush.

Bush inside diameter:
6.010 – 6.030 mm (0.2366 – 0.2374 in.)

(b) Subtract the valve stem diameter measurement (See step 16) from the guide bush inside diameter measurement.

Standard oil clearance:
0.035 – 0.070 mm (0.0014 – 0.0028 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

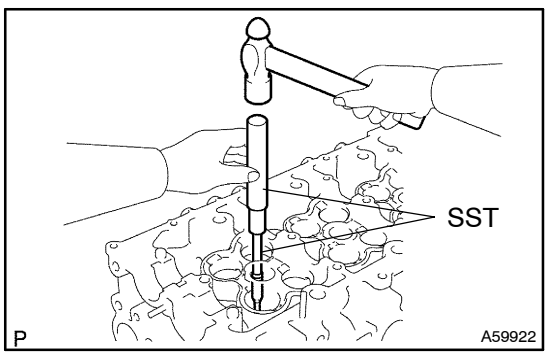
If the clearance is greater than maximum, replace the valve and guide bush (See steps 21 and 23).



20. REMOVE INTAKE VALVE GUIDE BUSH

(a) Using SST and a hammer, tap out the valve guide bushing.

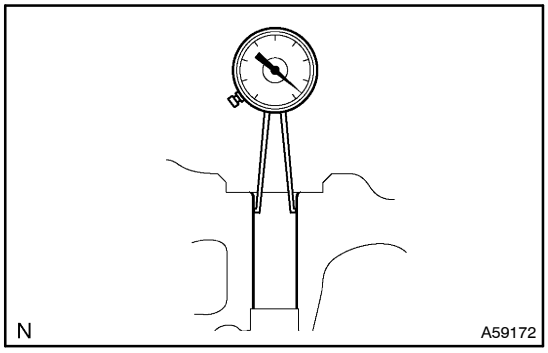
SST 09201–10000 (09201–01060), 09950–70010 (09951–07100)



21. REMOVE EXHAUST VALVE GUIDE BUSH

(a) Using SST and a hammer, tap out the valve guide bushing.

SST 09201–10000 (09201–01060), 09950–70010 (09951–07100)



22. INSTALL INTAKE VALVE GUIDE BUSH

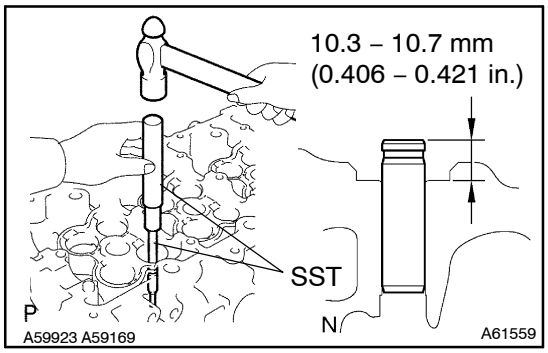
(a) Using a caliper gauge, measure the bush bore diameter of the cylinder head.

(b) Select a new guide bush (STD or O/S 0.05).

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

If the bush bore diameter of the cylinder head is greater than 11.044 mm (0.4348 in.), machine the bush bore to the dimension of 11.083 – 11.094 mm (0.4363 – 0.4368 in.).

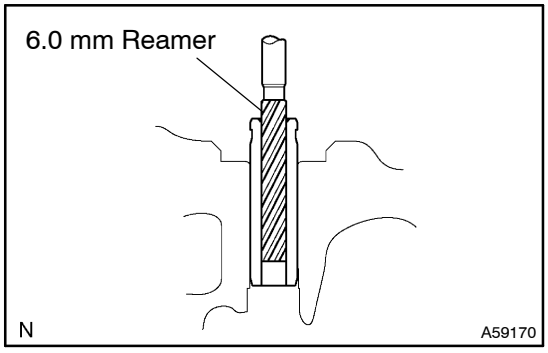
If the bush bore diameter of the cylinder head is greater than 11.094 mm (0.4368 in.), replace the cylinder head.



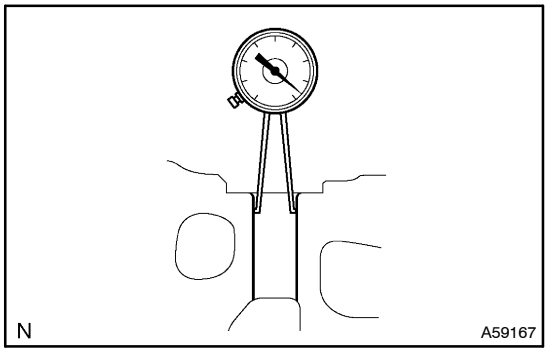
(c) Using SST and a hammer, tap in a new guide bush to the specified protrusion height.

SST 09201–10000 (09201–01060), 09950–70010 (09951–07100)

Protrusion height: 10.3 – 10.7 mm (0.406 – 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

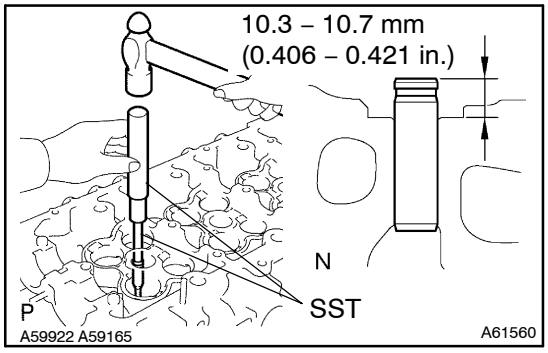
(a) Using a caliper gauge, measure the bush bore diameter of the cylinder head.

(b) Select a new guide bush (STD or O/S 0.05).

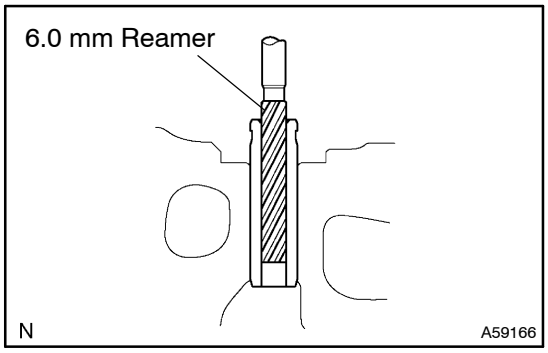
Bush bore diameter mm (in.)	Bush size
10.985 – 11.006 mm (0.4325 – 0.4333 in.)	Use STD
11.035 – 11.056 mm (0.4344 – 0.4353 in.)	Use O/S 0.05

If the bush bore diameter of the cylinder head is greater than 11.044 mm (0.4348 in.), machine the bush bore to the dimension of 11.083 – 11.094 mm (0.4363 – 0.4368 in.).

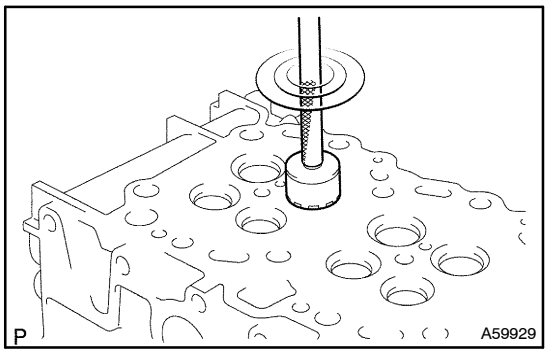
If the bush bore diameter of the cylinder head is greater than 11.094 mm (0.4368 in.), replace the cylinder head.



(c) Using SST and a hammer, tap in a new guide bush to the specified protrusion height.
SST 09201–10000 (09201–01060), 09950–70010 (09951–07100)
Protrusion height: 10.3 – 10.7 mm (0.406 – 0.421 in.)

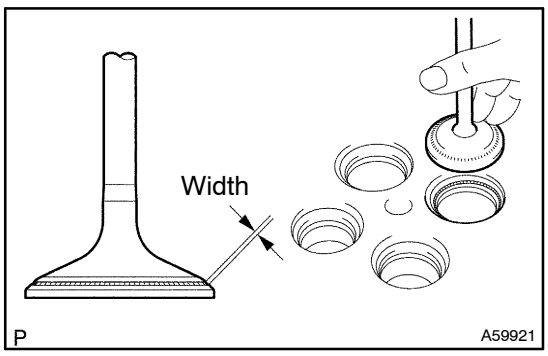


(d) Using a sharp 6.0 mm reamer, ream the guide bush to obtain the specified standard clearance (See step 19) between the guide bush and valve stem.



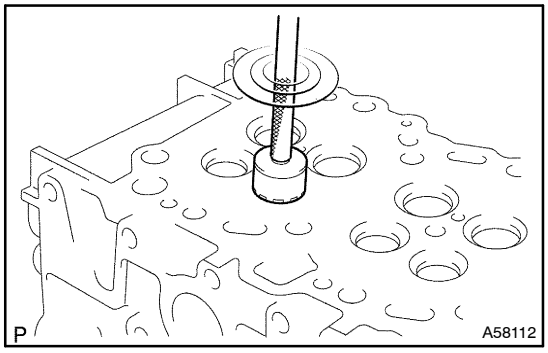
24. INSPECT INTAKE VALVE SEATS

(a) Using a 45° carbide cutter, resurface the valve seats. Clank swarf from the valve seats.



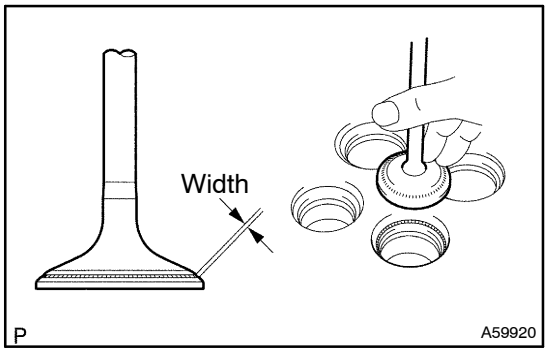
(b) Check the valve seating position.
(1) Apply a light coat of prussian blue (or white lead) to the valve face.
(2) Lightly press the valve against the seat. Do not rotate valve.

(c) Check the valve face and seat for the following:
(1) If blue appears 360° around the face, the valve is concentric. If not, replace the valve.
(2) If blue appears 360° around the valve seat, the guide and face are concentric. If not, resurface the seat.
(3) Check that the seat contact is in the middle of the valve face with the width:
Width: 1.2 – 1.6 mm (0.047 – 0.063 in.)



25. INSPECT EXHAUST VALVE SEATS

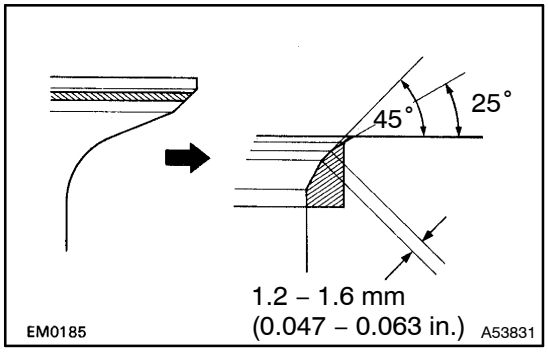
(a) Using a 45˚ carbide cutter, resurface the valve seats. Remove only enough metal to clean the seats.



(b) Check the valve seating position.
  (1) Apply a light coat of prussian blue (or white lead) to the valve face.
  (2) Lightly press the valve against the seat. Do not rotate valve.

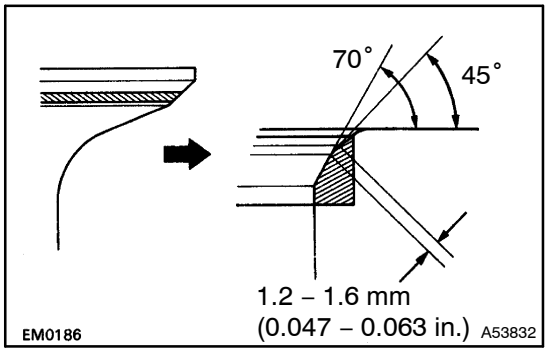
(c) Check the valve face and seat for the following:
  (1) If blue appears 360˚ around the face, the valve is concentric. If not, replace the valve.
  (2) If blue appears 360˚ around the valve seat, the guide and face are concentric. If not, resurface the seat.
  (3) Check that the seat contact is in the middle of the valve face with the width:

Width: 1.6 – 2.0 mm (0.063 – 0.079 in.)

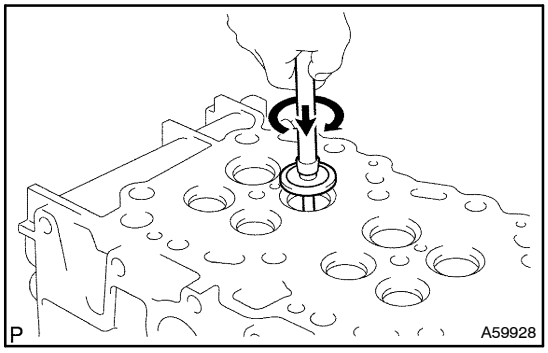


26. REPAIR INTAKE VALVE SEATS

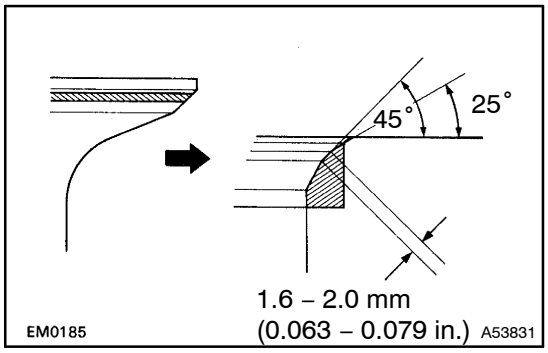
(a) If the seating is too high on the valve face, use a 25˚ and 45˚ cutters to correct the seat.



(b) If the seating is too low on the valve face, use 70˚ and 45˚ cutters to correct the seat.

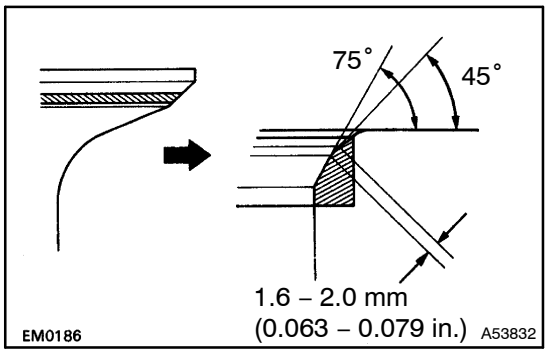


(c) Hand–lap the valve and valve seat with an abrasive compound.
(d) After hand–lapping, clean the valve and valve seat.

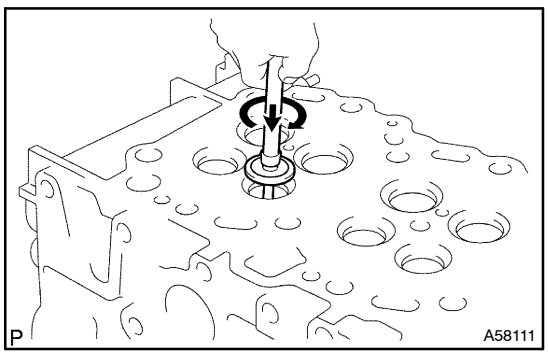


27. REPAIR EXHAUST VALVE SEATS

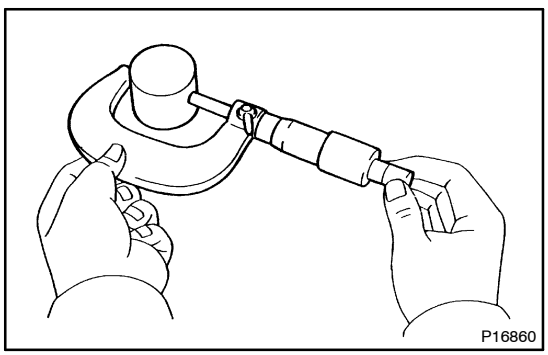
(a) If the seating is too high on the valve face, use a 25° and 45° cutters to correct the seat.



(b) If the seating is too low on the valve face, use a 75° and 45° cutters to correct the seat.

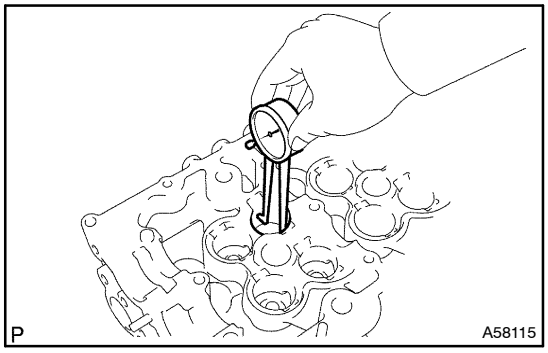


(c) Hand–lap the valve and valve seat with an abrasive compound.
(d) After hand–lapping, clean the valve and valve seat.



28. INSPECT LIFTER, VALVE

(a) Using a micrometer, measure the outside diameter of the lifter.
Lifter diameter:
30.966 – 30.976 mm (1.2191 – 1.2195 in.)



(b) Using a caliper gauge, measure the lifter bore diameter of the cylinder head.

Lifter bore diameter:

31.000 – 31.021 mm (1.2205 – 1.2213 in.)

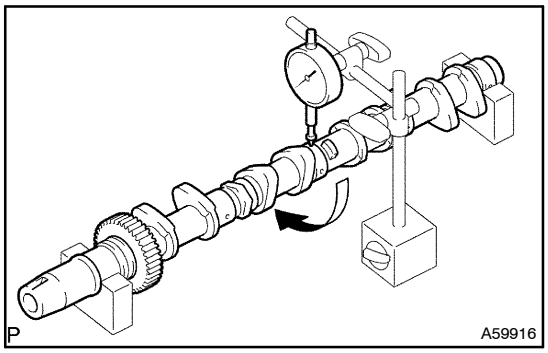
(c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.

Standard oil clearance:

0.024 – 0.055 mm (0.0009 – 0.0022 in.)

Maximum oil clearance: 0.095 mm (0.0037 in.)

If the oil clearance is greater than the maximum, replace the lifter. If necessary, replace the cylinder head.



29. INSPECT CAMSHAFT

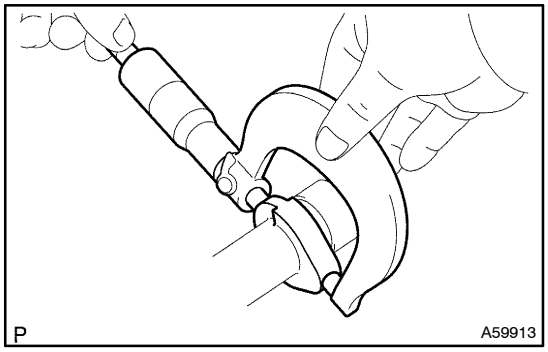
(a) Inspect the circle runout.

(1) Place the camshaft on V–blocks.

(2) Using a dial indicator, measure the circle runout at the center journal.

Maximum circle runout: 0.03 mm (0.0012 in)

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



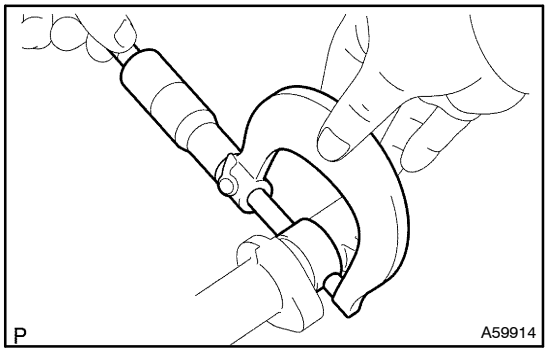
(b) Using a micrometer, measure the cam lobe height.

Standard cam lobe height:

47.180 – 47.280 mm (1.8575 – 1.8614 in.)

Minimum cam lobe height: 46.76 mm (1.8409 in.)

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



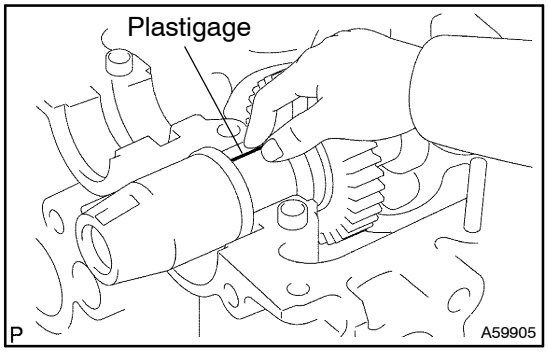
(c) Inspect the outsde diameter of journal of the camshaft.

(1) Using a micrometer, measure outsde diameter of the journal for the camshaft bearing.

Journal diameter:

27.969 – 27.985 mm (1.1011 – 1.1018 in.)

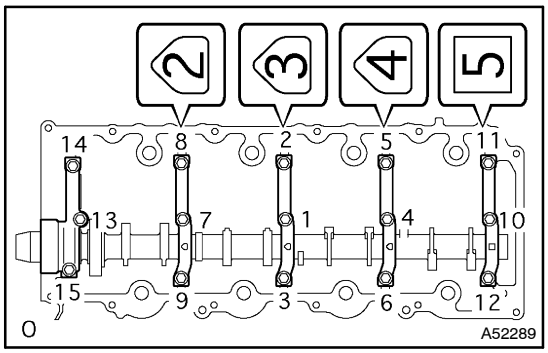
If the outsde diameter of journal is not as specified, check the oil clearance.



(d) Check the oil clearance.
(1) Clean the bearing caps and journals.
(2) Check the bearings for flaking and scoring.

If the bearings are damaged, replace the bearing caps and cylinder head as a set.

(3) Install the bearings to the bearing caps and cylinder head.
(4) Place the camshaft on the cylinder head.
(5) Lay a strip of Plastigage across each of the journals.



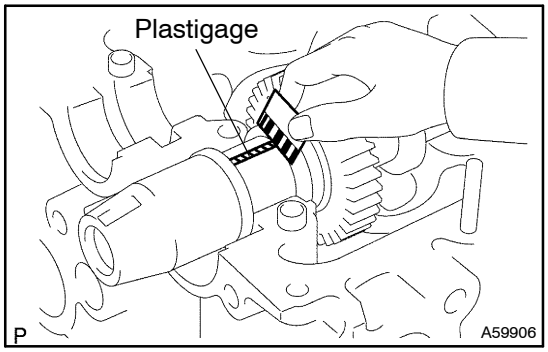
(6) Install the 5 bearing caps in their proper locations.
(7) Install and uniformly tighten the 15 bearing cap bolts, in the order described in the illustration.

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

NOTICE:

Do not turn the camshaft.

(8) Remove the bearing caps.



(9) Measure the plastigage at its widest point.

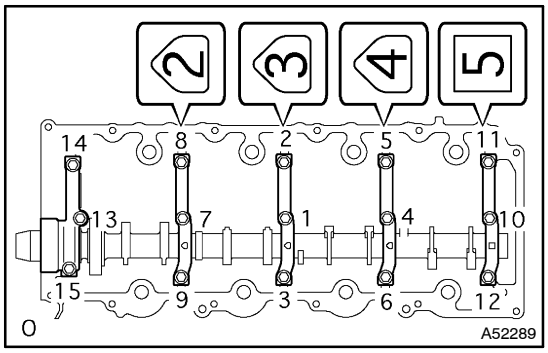
Standard oil clearance:

0.025 – 0.062 mm (0.0010 – 0.0024 in.)

Maximum oil clearance: 0.10 mm (0.0039 in.)

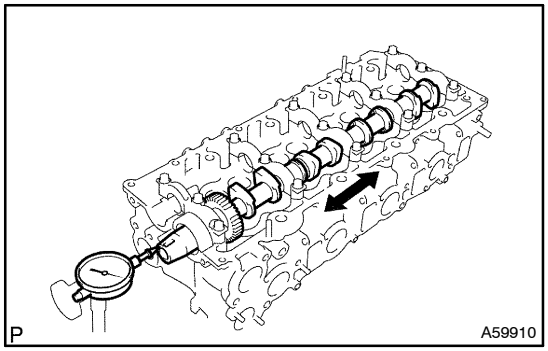
If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing cap and cylinder head as a set.

(10) Completely remove the plastigage.
(11) Remove the camshaft.



(e) Check the thrust clearance.
(1) Install the camshaft.
(2) Install the 5 bearing caps in their proper locations.
(3) Install and uniformly tighten the bearing cap bolts, in the order described in the illustration.

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



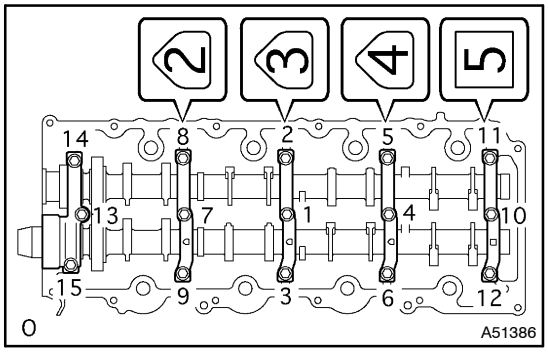
(4) Using a dial indicator, measure the thrust clearance by pushing the camshaft back and forth.

Standard thrust clearance:

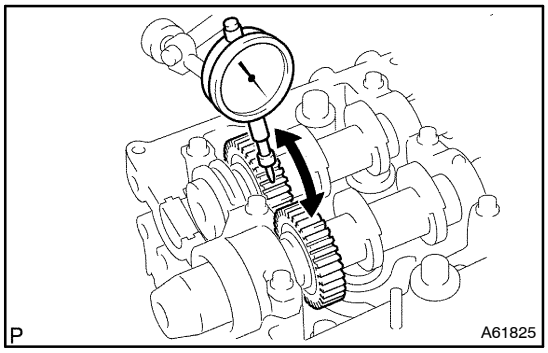
0.035 – 0.185 mm (0.0014 – 0.0073 in.)

Maximum thrust clearance: 0.25 mm (0.0098 in.)

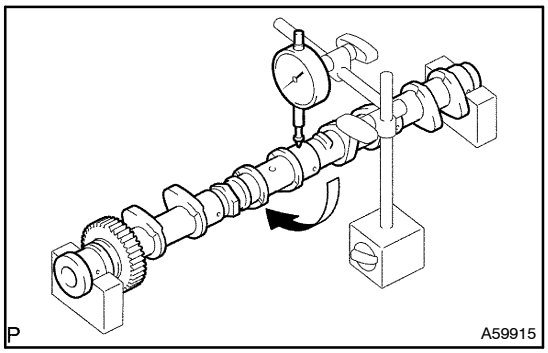
If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing cap and cylinder head as a set.



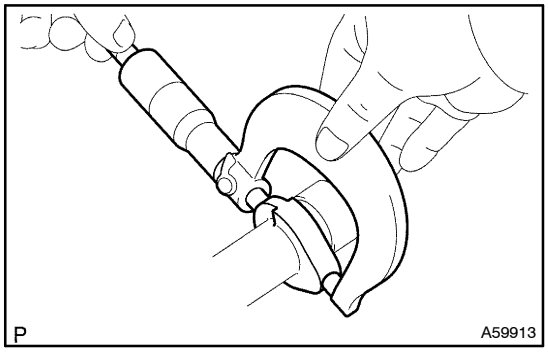
(f) Check the gear backlash.
(1) Install the 2 camshafts.
(2) Install the 5 bearing caps in their proper locations.
(3) Install and uniformly tighten the 15 bearing cap bolts, in the order described in the illustration.
Torque: 19 N·m (194 kgf·cm, 14 ft·lbf)



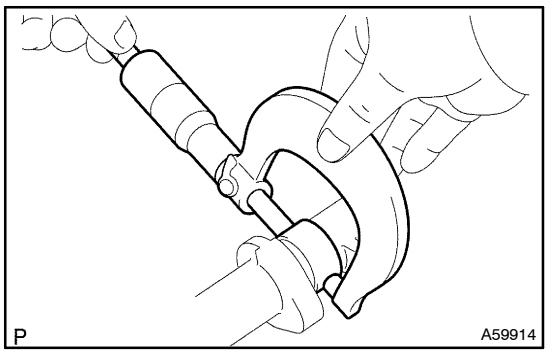
(4) Using a dial indicator, measure the backlash.
Standard backlash:
0.035 – 0.089 mm (0.0014 – 0.0035 in.)
Maximum backlash: 0.189 mm (0.0074 in.)
If the backlash is greater than maximum, replace the 2 camshafts.
(5) Remove the 2 camshafts.



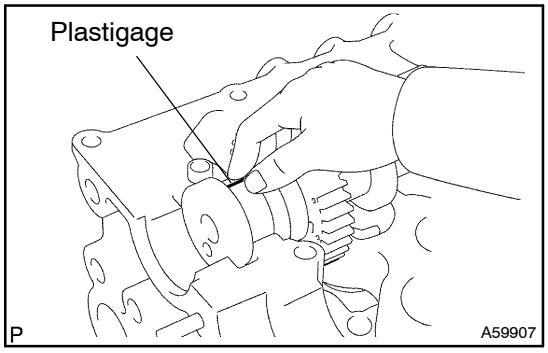
30. INSPECT NO.2 CAMSHAFT
(a) Inspect the circle runout.
(1) Place the camshaft on V–blocks.
(2) Using a dial indicator, measure the circle runout at the center journal.
Maximum circle runout: 0.03 mm (0.0012 in)
If the circle runout is greater than maximum, replace the camshaft.



(b) Using a micrometer, measure the cam lobe height.
Standard cam lobe height:
48.070 – 48.170 mm (1.8925 – 1.8965 in.)
Minimum cam lobe height: 47.92 mm (1.8866 in.)
If the cam lobe height is less than minimum, replace the camshaft.



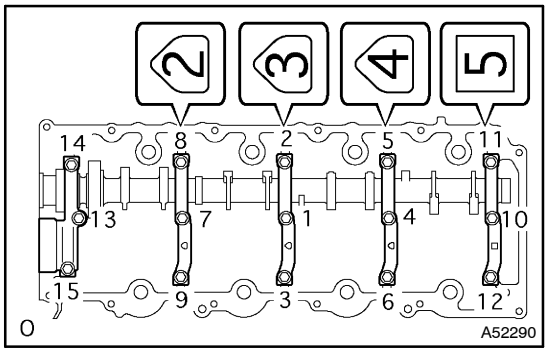
(c) Inspect the journal diameter of the camshaft.
(1) Using a micrometer, measure the journal diameter of the camshaft for the camshaft bearing.
Journal diameter:
27.969 – 27.985 mm (1.1011 – 1.1018 in.)
If the journal diameter is not as specified, check the oil clearance.



(d) Check the oil clearance.
(1) Clean the bearing caps and journals.
(2) Check the bearings for flaking and scoring.

If the bearings are damaged, replace the bearing caps and cylinder head.

(3) Install the bearings to the bearing caps and cylinder head.
(4) Place the camshaft on the cylinder head.
(5) Lay a strip of Plastigage across each of the journals.



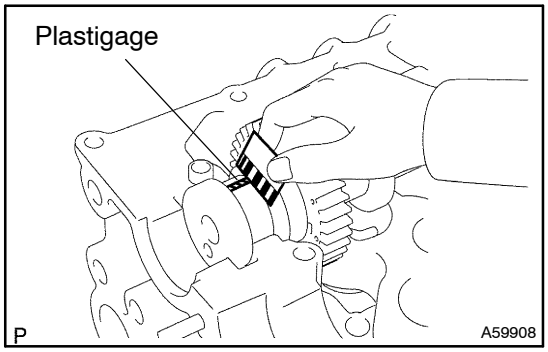
(6) Install the 5 bearing caps in their proper locations.
(7) Install and uniformly tighten the 15 bearing cap bolts, in the order described in the illustration.

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

NOTICE:

Do not turn the camshaft.

(8) Remove the bearing caps.



(9) Measure the plastigage at its widest point.

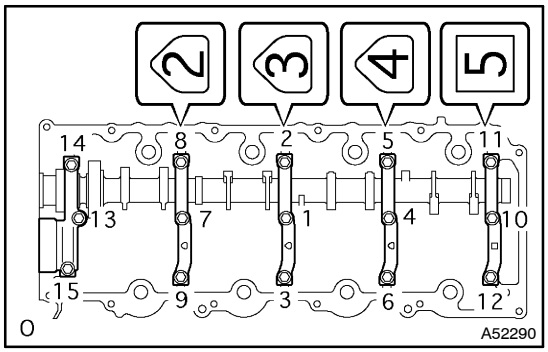
Standard oil clearance:

0.025 – 0.062 mm (0.0010 – 0.0024 in.)

Maximum oil clearance: 0.10 mm (0.0039 in.)

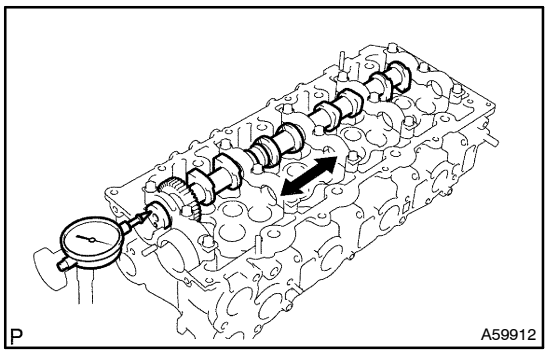
If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing cap and cylinder head as a set.

(10) Completely remove the plastigage.
(11) Remove the camshaft.



(e) Check the thrust clearance.
(1) Install the camshaft.
(2) Install the 5 bearing caps in their proper locations.
(3) Install and uniformly tighten the 15 bearing cap bolts, in the order described in the illustration.

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



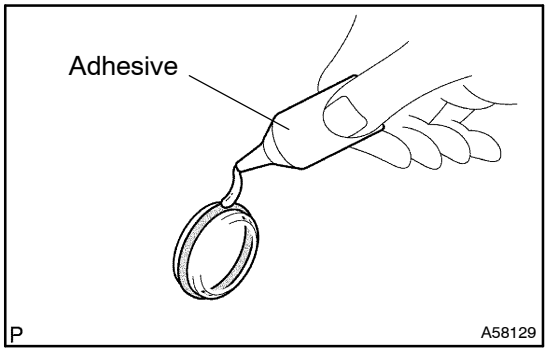
(4) Using a dial indicator, measure the thrust clearance by pushing the camshaft back and forth.

Standard thrust clearance:

0.035 – 0.185 mm (0.0014 – 0.0073 in.)

Maximum thrust clearance: 0.25 mm (0.0098 in.)

If the thrust clearance is greater than maximum, replace the camshaft. If necessary, replace the bearing cap and cylinder head as a set.



31. INSTALL TIGHT PLUG

(a) Apply an adhesive around tight plugs.

Adhesive:

Part No. 08833–00070, THREE BOND 1324 or equivalent

NOTICE:

Do not start the engine 1 hour after the installation.

(1) Using SST, tap in the tight plug No. 3 as shown in the illustration.

SST 09950–60010 (09951–00300), 09950–70010 (09951–07100)

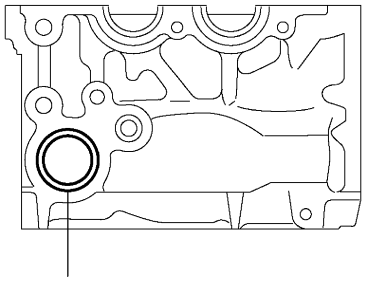
(2) Using SST, tap in the tight plug No. 4 as shown in the illustration.

SST 09950–60010 (09951–00200), 09950–70010 (09951–07100)

(3) Using SST, tap in the tight plug No. 5 as shown in the illustration.

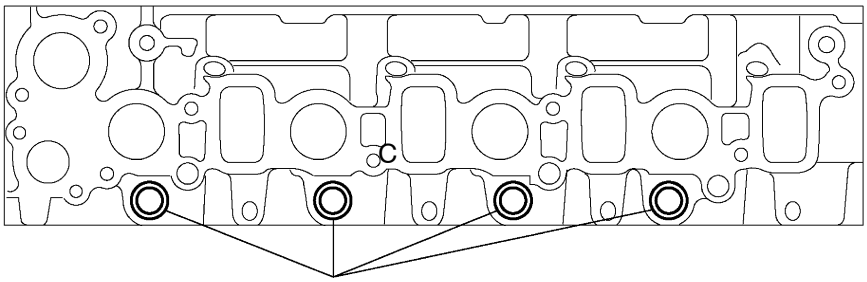
SST 09950–60010 (09951–00350), 09950–70010 (09951–07100)

Front Side :



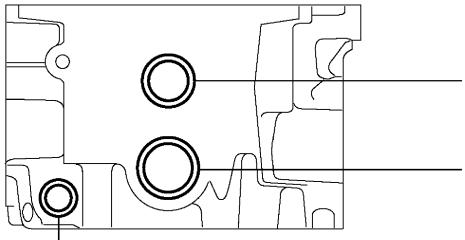
Tight Plug No.5

Intake Side :



Tight Plug No.4

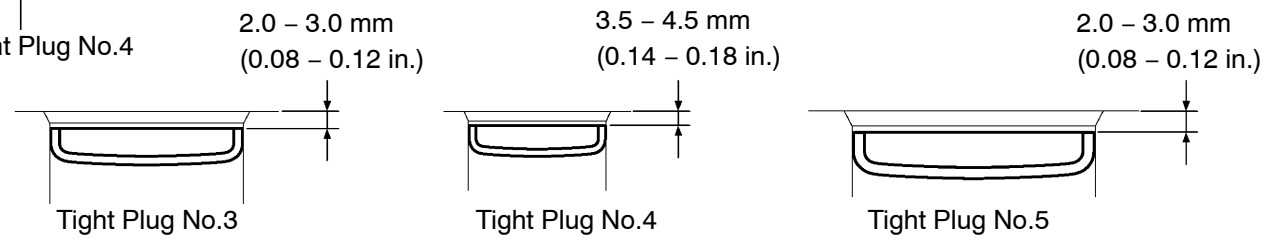
Rear Side :



Tight Plug No.3

Tight Plug No.5

Tight Plug No.4



O

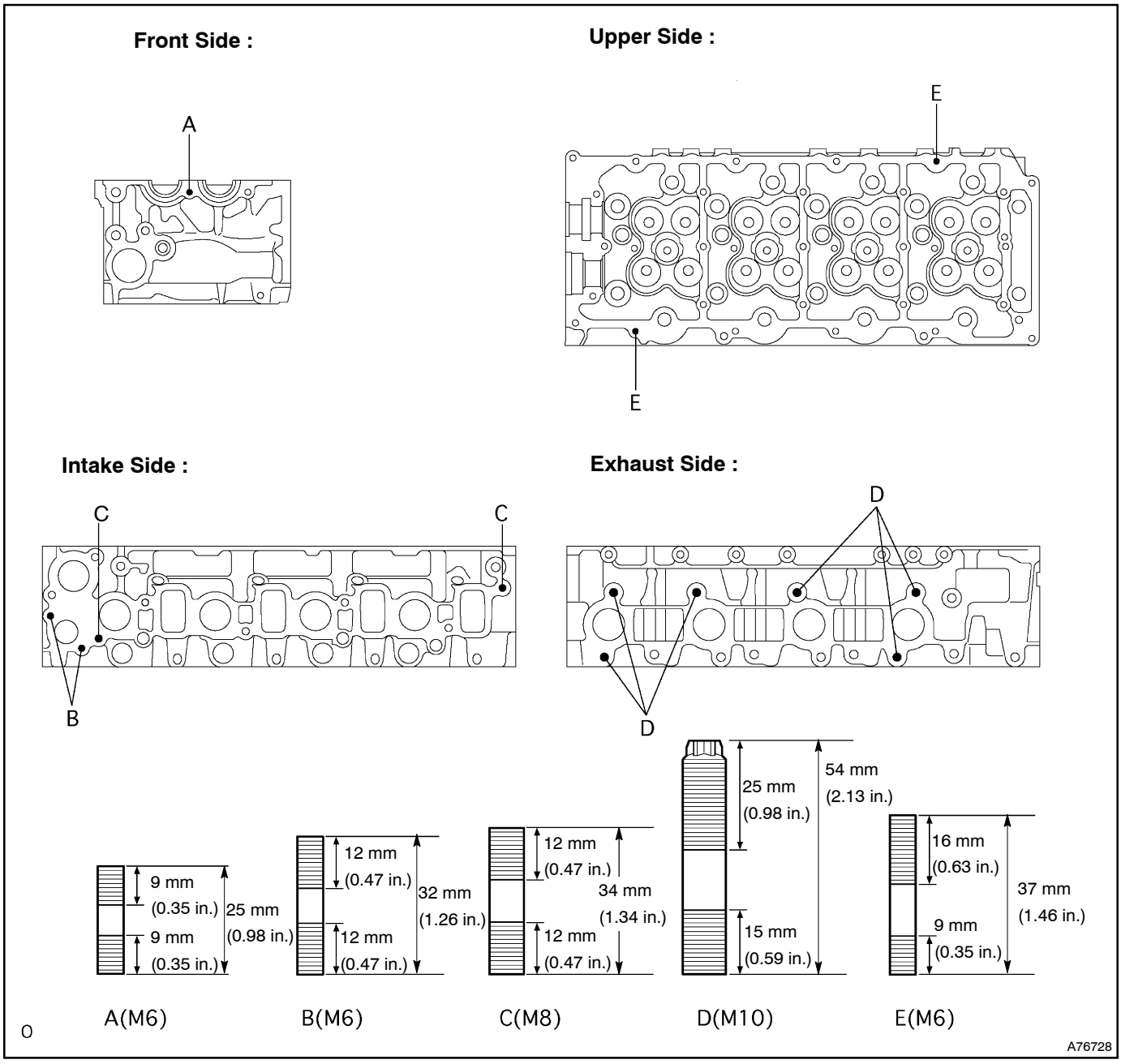
A70002

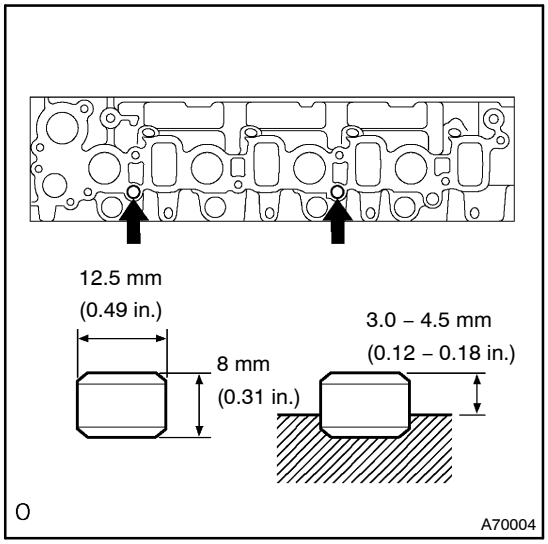
32. INSTALL STUD BOLT

(a) Install the stud bolts as shown in the illustration.

Torque:

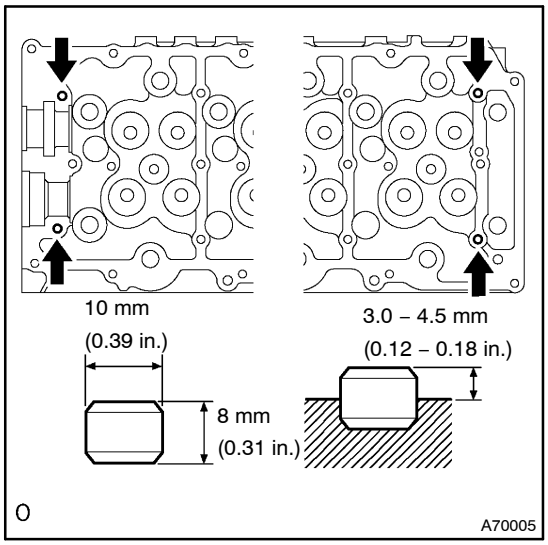
5 N·m (51 kgf·cm, 44 in.·lbf) for A
7 N·m (71 kgf·cm, 62 in.·lbf) for B
15 N·m (153 kgf·cm, 11 ft·lbf) for C
26 N·m (265 kgf·cm, 19 ft·lbf) for D
5 N·m (51 kgf·cm, 44 in.·lbf) for E





33. INSTALL RING PIN

(a) Install the ring pin to the cylinder head.



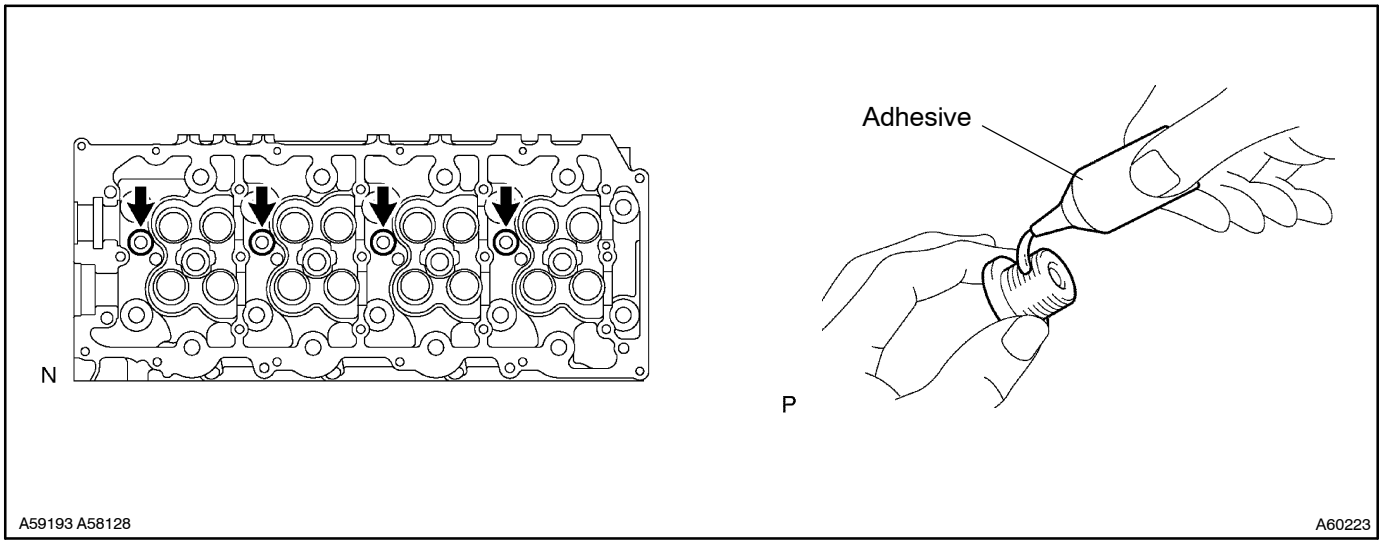
34. INSTALL RING W/HEAD PIN

(a) Install the ring w/ head pin to the cylinder head.

35. INSTALL W/HEAD STRAIGHT SCREW PLUG NO.1

(a) Apply an adhesive to the end of the screw plug.
Adhesive: Part No. 08833–00070, 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 SEMICIRCULAR PLUG

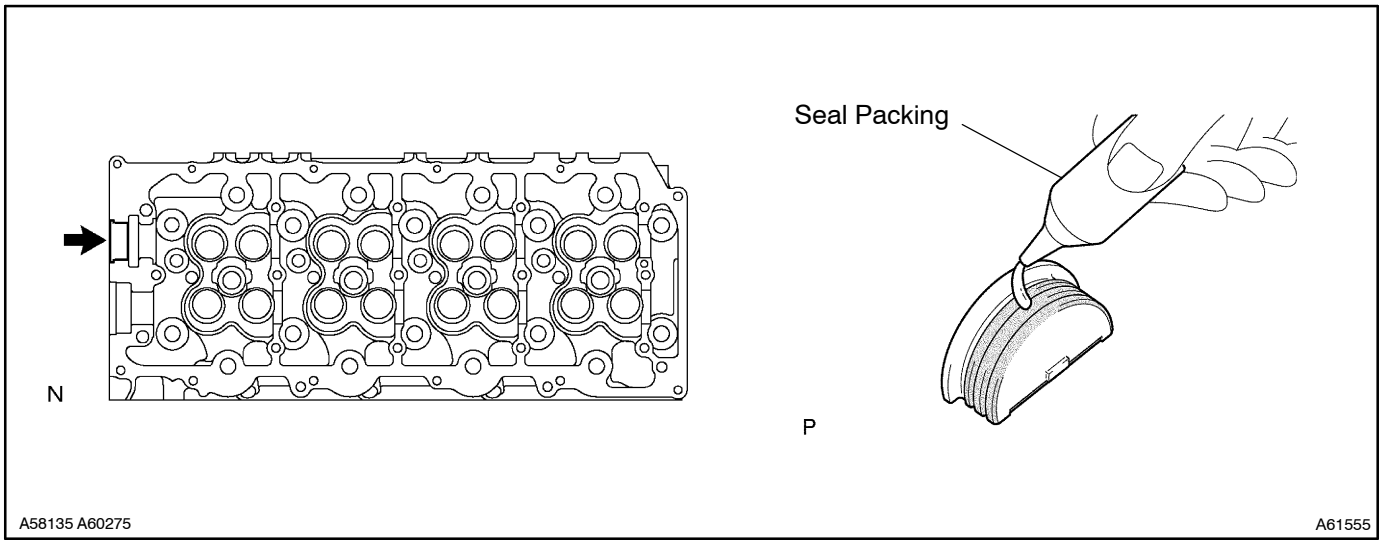
(a) Remove the oil seal packing (FIPG).
  (1) Using a gasket scraper and razor blade, remove the old seal packing from the contact surface of the semicircular plug and cylinder head, and clean them.

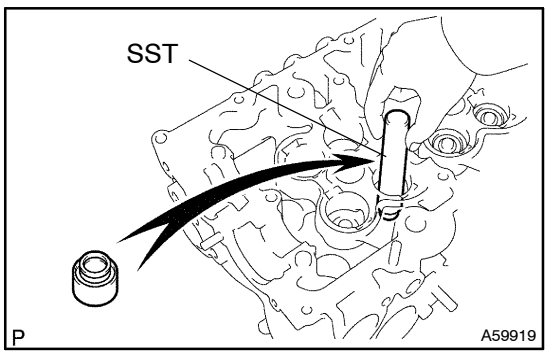
(b) Apply a seal packing to the semicircular plug.

NOTICE:

- **The semicircular plug must be installed within 3 minute form the compoletion of applying the seal packing.**
- **Prevent FIPG from being stuck to the camshaft thrust groove.**

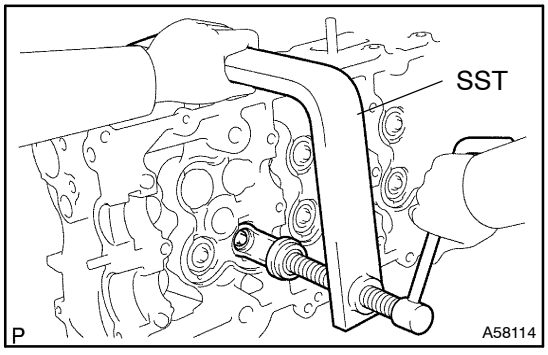
(c) Install the semicircular plug to the cylinder head.





37. INSTALL VALVE STEM OIL O SEAL OR RING

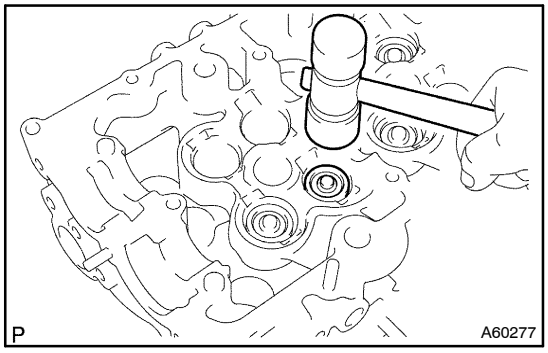
(a) Using SST, push in a new oil seal.
  SST 09201–41020



38. INSTALL INTAKE VALVE

(a) Install the valve, plate washer, compression spring and spring retainer.

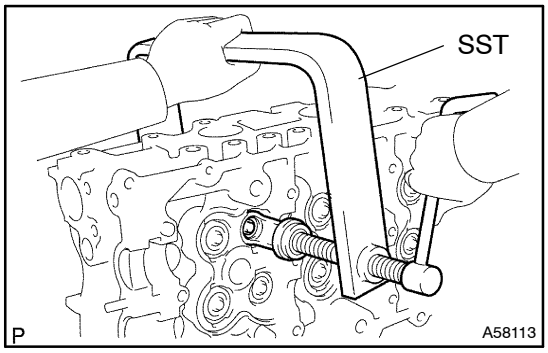
(b) Using SST, compress the compression spring and place the spring retainer lock and the valve stem.
  SST 09202–70020 (09202–00020)



(c) Using a plastic–faced hammer, tap in the valve stem tip until it fitted properly.

NOTICE:

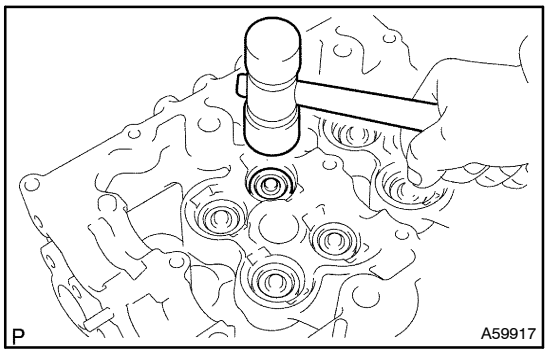
Be careful not do damage the valve stem tip.



39. INSTALL EXHAUST VALVE

(a) Install the valve, plate washer, compression spring and spring retainer.

(b) Using SST, compress the compression spring and place the spring retainer lock and the valve stem.
SST 09202–70020 (09202–00020)



(c) Using a plastic–faced hammer, tap in the valve stem tip until it fitted properly.

NOTICE:

Be careful not to damage the valve stem tip.

40. INSTALL LIFTER, VALVE

(a) Install the valve lifters.

(b) Check that the valve lifter rotates smoothly by hand.