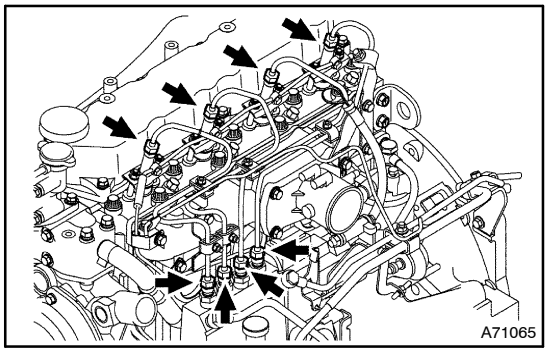
14148–01

OVERHAUL

1. REMOVE INTAKE AIR CONNECTOR

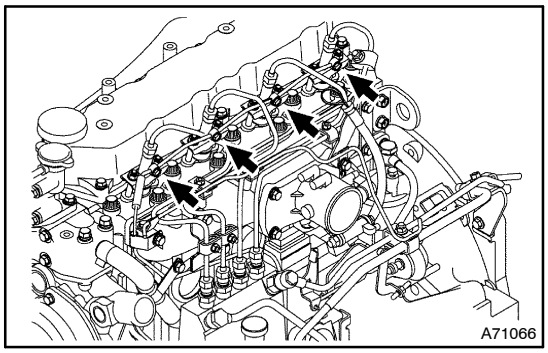


2. REMOVE INJECTION PIPE SET

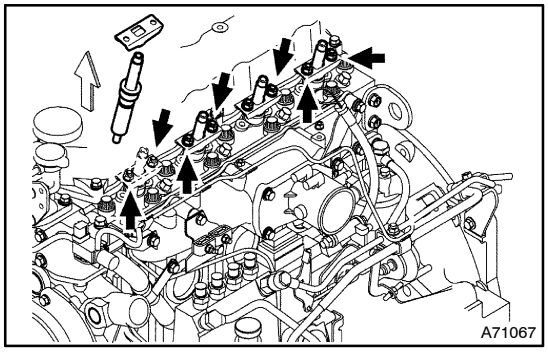
(a) Loosen the 8 union nuts on the 4 injection pipes.

NOTICE:

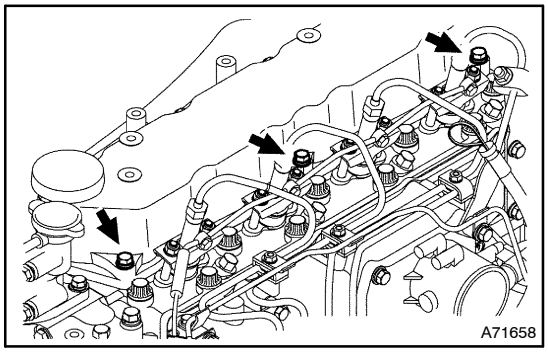
After removing the fuel pipe, put it in a vinyl bag and bind the vinyl bag with a rubber band to prevent foreign objects from getting into the injection nozzle inlet.



3. REMOVE NOZZLE LEAKAGE PIPE ASSY



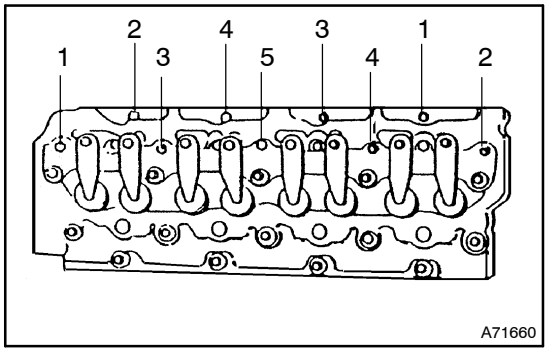
4. REMOVE NOZZLE HOLDER AND NOZZLE SET



5. REMOVE CYLINDER HEAD COVER SUB–ASSY

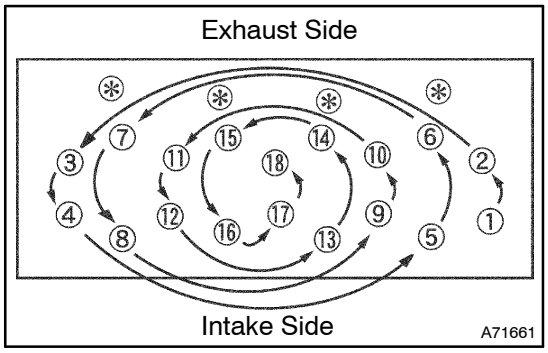
NOTICE:

Thoroughly clean the cylinder head cover before removing it to prevent foreign particles from getting in.



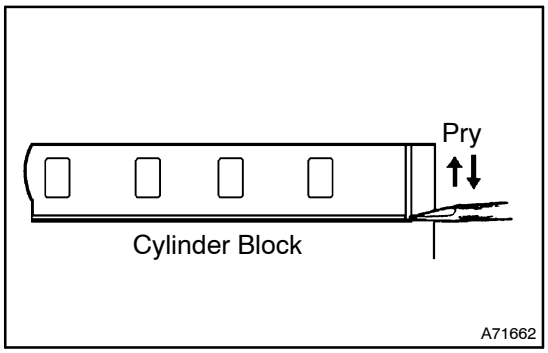
6. REMOVE CYLINDER HEAD AND VALVE ROCKER ARM ASSY

(a) Loosen the cylinder head additional bolts and rocker arm support bolts in the order as shown in the illustration.



(b) Loosen the cylinder head bolts little in 3 stages, in the order as shown in the illustration.

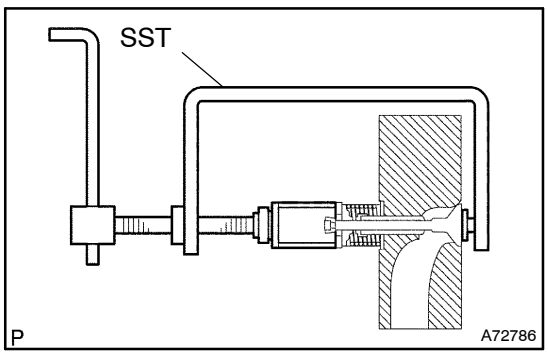
(c) Lift the cylinder head from the dowels on the cylinder block, and place the cylinder head on wooden blocks on a bench.



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

NOTICE:

Be careful not to damage the contact surfaces between the cylinder head and block.



7. REMOVE VALVE

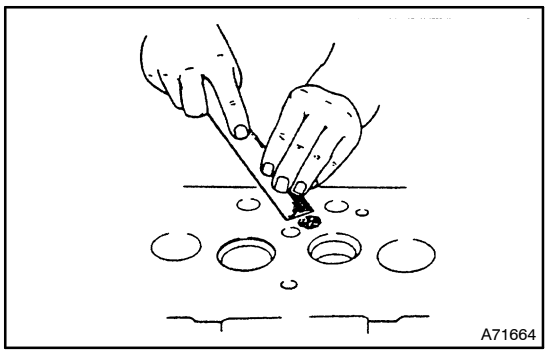
(a) Using SST, compress the compression springs and remove the 2 keepers.
SST 09202–70020 (09202–00030)

(b) Remove the spring retainer, 2 compression springs and valve.

(c) Remove the oil seal and spring seat.

HINT:

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



8. INSPECT CYLINDER HEAD SUB–ASSY

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

NOTICE:

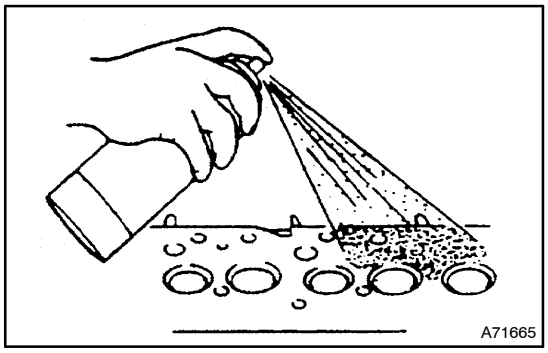
Be careful not to scratch the cylinder block contact surface.

(b) Using a wire brush, remove all the carbons from the combustion chambers.

NOTICE:
Be careful not to scratch the cylinder block contact surface.

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

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

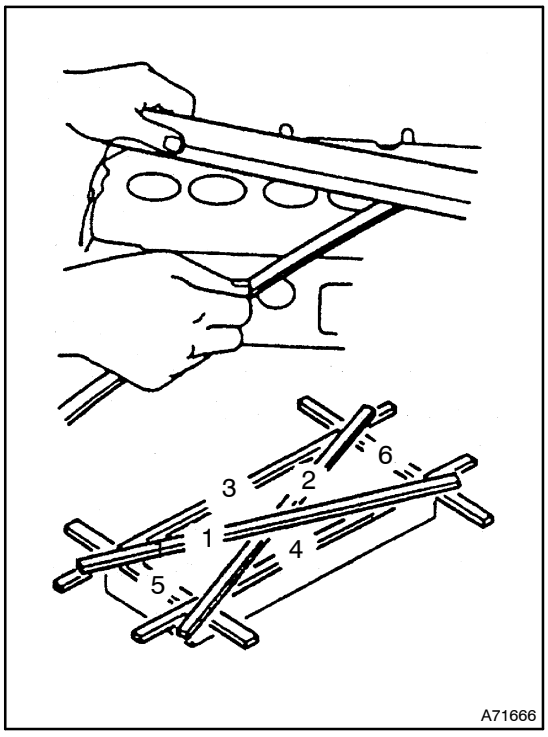


9. INSPECT CYLINDER HEAD SUB–ASSY

(a) Inspect for cracks.

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

If any of them have cracks, replace the cylinder head.



(b) Inspect the flatness.

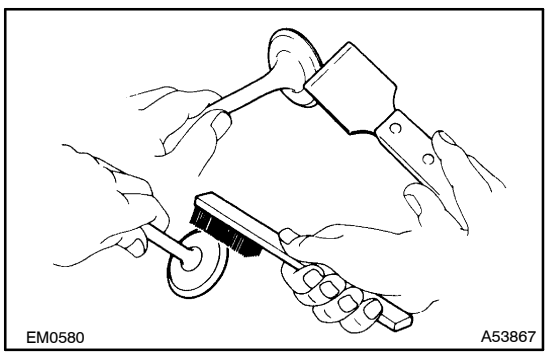
(1) Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

Standard warpage:

Longitudinal direction	0.05 mm (0.0020 in.) or less
Lateral direction	0.05 mm (0.0020 in.) or less

Maximum warpage: 0.10 mm (0.0039 in.)

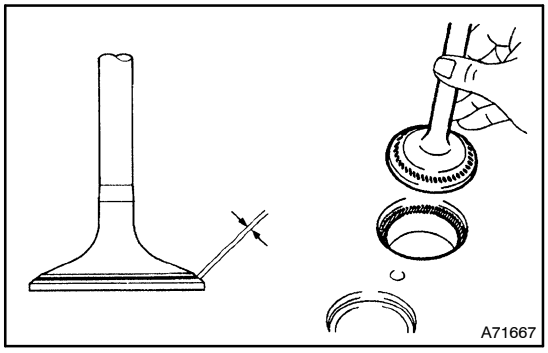
If the warpage is greater than the maximum, regrind the cylinder head.



10. CLEAN VALVE

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

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



11. INSPECT VALVE

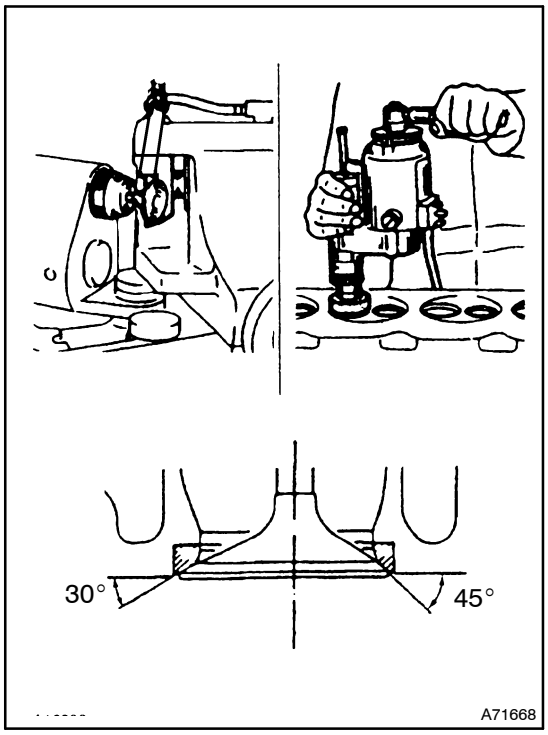
(a) Visually check the valves for damage, burns, carbons or warpage, and check the valve heads, valve stems and valve stem grooves for cracks.

If wear, burns, warpage or cracks are excessive, replace the valve.

(b) Check the valve seating condition.

(1) Lightly apply red lead marking compound to the valve face. Tapping and rotating the valve against the seat, check the seating condition.

If the red lead mark is not concentric or the compound is scrattered all around the valve face or seat, correct the valve face or the valve seat.



12. REPAIR VALVE SEAT

(a) Grind the valve and seat.

HINT:

- Grinding of valves should only be performed when hand–lapping, does not result in proper seating.
- When hand–lapping, always recheck the seating condition.

CAUTION:

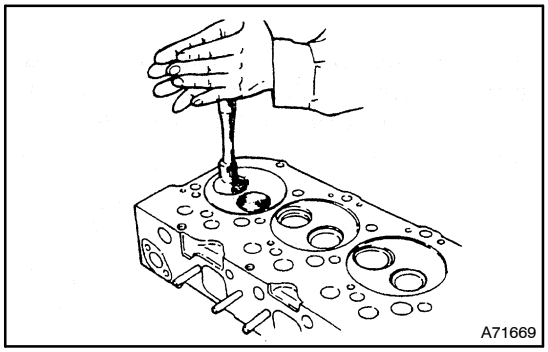
When grinding, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.

Valve seat angle:

Intake	29° 00' – 30° 00'
Exhaust	44° 00' – 45° 15'

Valve face angle:

Intake	29° 45' – 30° 15'
Exhaust	44° 45' – 45° 15'

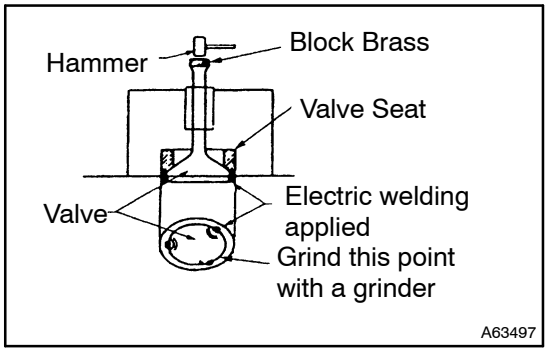


(b) Hand–lap the valve and valve seat.

(1) Lightly apply lapping compound to the valve face. Tap and rotate the valve against the seat.

HINT:

- After hand–lapping, clean off any lapping compound on the valves and valve seats.
- When hand–lapping, always recheck the seating condition.



13. REMOVE VALVE SEAT

(a) Cut the 3 places on the circumference of an unwanted valve and weld it to the valve seat.

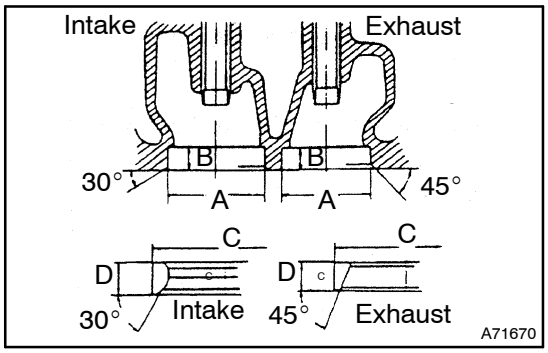
NOTICE:

To protect the lower surface of the cylinder head from welding spatters, be sure to apply grease before welding.

(b) Place a block brass on the top of the valve stem and strike it with a hammer to remove the valve seat.

CAUTION:

When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



14. INSTALL VALVE SEAT

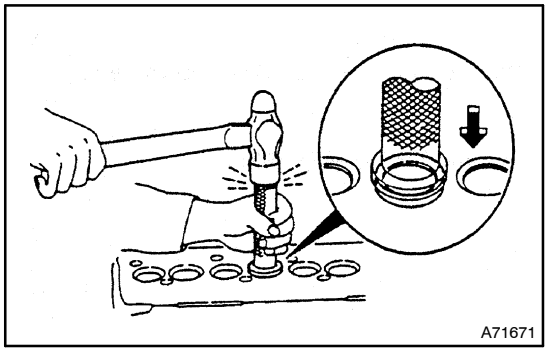
(a) Machine the valve seat according to the specified valve seat dimensions.

Cylinder head dimension:

Intake	A	46.500 – 46.516 mm (1.8307 – 1.8313 in.)
	B	8.800 – 9.000 mm (0.3465 – 0.3543 in.)
Exhaust	A	41.000 – 41.016 mm (1.6142 – 1.6148 in.)
	B	7.200 – 7.300 mm (0.2835 – 0.2874 in.)

Valve seat dimension:

Intake	C	46.585 – 46.600 mm (1.8341 – 1.8346 in.)
	D	7.500 – 7.700 mm (0.2953 – 0.3031 in.)
Exhaust	C	41.130 – 41.145 mm (1.6193 – 1.6199 in.)
	D	6.000 – 6.200 mm (0.2362 – 0.2441 in.)



(b) Heat the cylinder head to 80 – 100°C (176 – 212°F) with hot water. Cool the valve seat with dry ice for approximately 30 minutes.

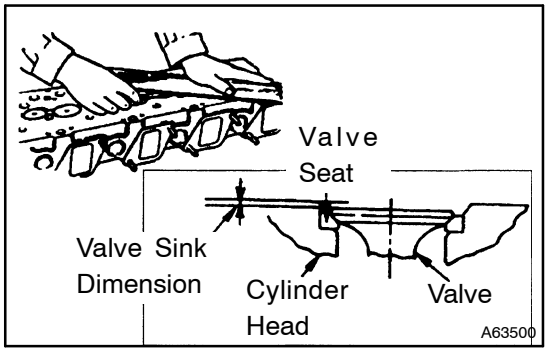
(c) Hold the valve seat with pincers and place it into the heated cylinder head. Lightly hitting the valve seat can easily fit them.

HINT:

When valve grinding the valve, always recheck the seating condition.

CAUTION:

- **Never touch the cooled valve seat with your bare hands.**
- **When hitting, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.**



15. INSPECT VALVE SINK

Standard dimension:

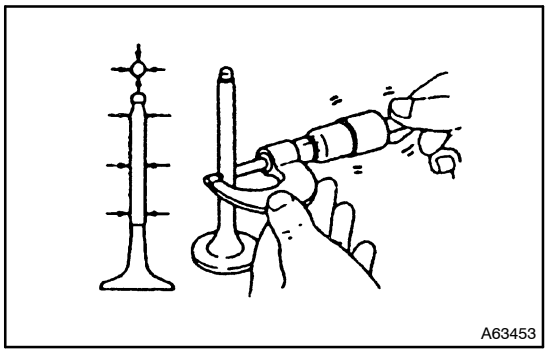
Intake	0.15 – 0.45 mm (0.0059 – 0.0177 in.)
Exhaust	0.47 – 0.77 mm (0.0185 – 0.0303 in.)

Maximum dimension:

Intake	0.55 mm (0.0217 in.)
Exhaust	0.87 mm (0.0342 in.)

HINT:

- If the valve heads are protruding from the cylinder head surface, the valve heads may hit against the pistons while the engine is running.
- When replacing the valve and valve seat, always recheck the seating condition.



16. REMOVE VALVE STEM AND VALVE GUIDE

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

Standard valve stem diameter:

Intake	8.95 – 8.97 mm (0.3524 – 0.3531 in.)
Exhaust	8.93 – 8.95 mm (0.3516 – 0.3524 in.)

Minimum valve stem diameter:

Intake	8.90 mm (0.3504 in.)
Exhaust	8.80 mm (0.3465 in.)

If the stem diameter is less than the minimum, replace the valve.

(b) Using a cylinder gauge, measure the inside diameter of the valve guide.

(c) Subtract the diameter measurement of the valve stem from the inside diameter measurement of the valve guide.

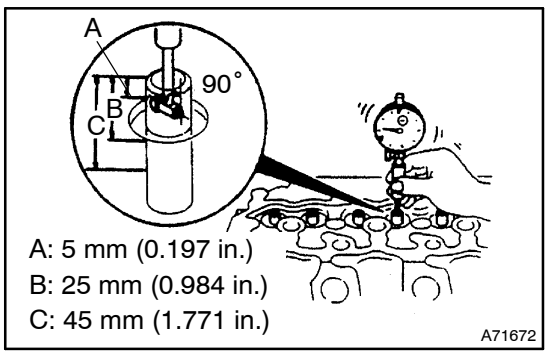
Standard oil clearance:

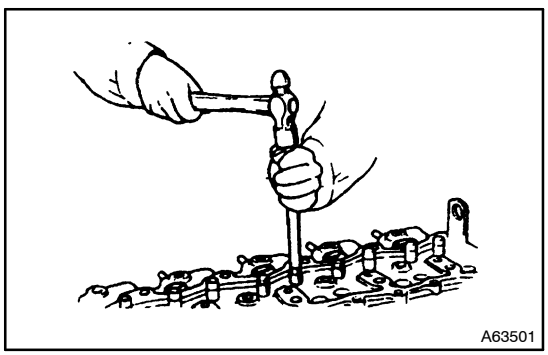
Intake	0.035 – 0.068 mm (0.0014 – 0.0027 in.)
Exhaust	0.050 – 0.083 mm (0.0020 – 0.0033 in.)

Maximum oil clearance:

Intake	A & B	0.10 mm (0.0039 in.)
	C	0.18 mm (0.0071 in.)
Exhaust	A & B	0.12 mm (0.0047 in.)
	C	0.20 mm (0.0079 in.)

If the oil clearance is greater than the maximum, replace the valve or valve guide.





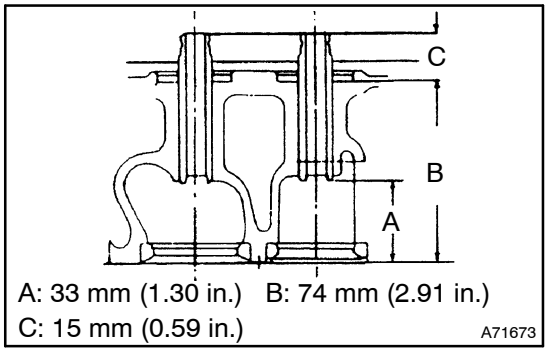
17. REMOVE VALVE GUIDE

(a) Remove the valve stem seal.

(b) Using a brass bar and a hammer, Strike out the valve guide out.

CAUTION:

When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



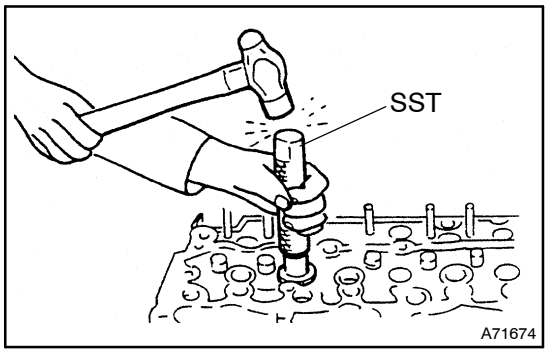
18. INSTALL VALVE GUIDE

(a) Press–fit a new valve guide straight allowing it to protrude, as shown in the illustration.
Protrusion height (C): 15 mm (0.59 in.)

HINT:
Apply engine oil lightly to the valve guide outer circumference before the installation.

19. REMOVE VALVE STEM SEAL

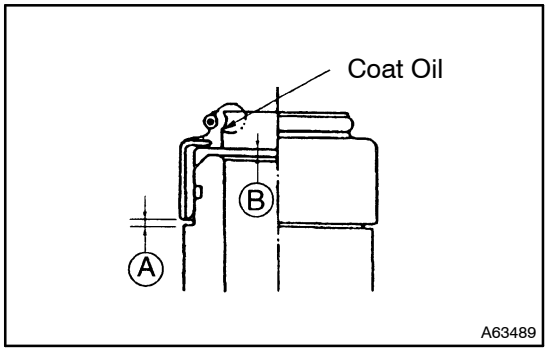
(a) Replace the stem seal when the valve guide is replaced or the seal clearance is excessive or the stem seal has been worn or damaged.



20. INSTALL VALVE STEM SEAL

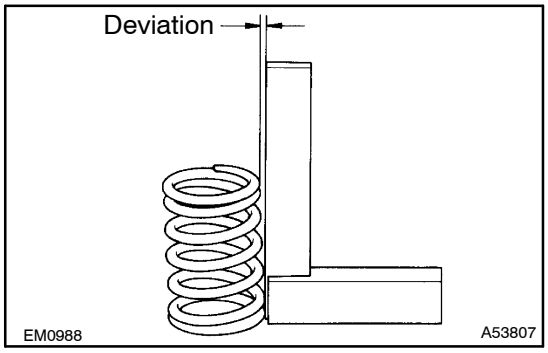
(a) Install the lower spring seat and valve to the cylinder head (for guide of SST), then apply engine oil to the lip of the stem seal and drive the guide with SST.
SST 09201–41020

CAUTION:
When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



HINT:

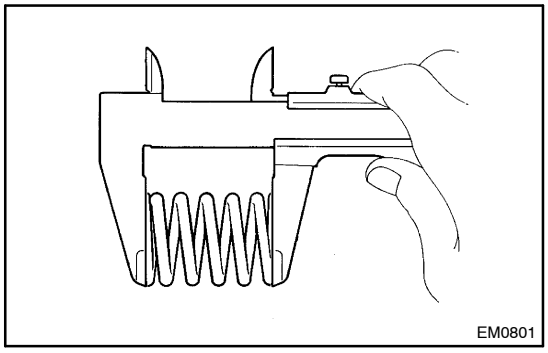
- After installing the valve stem seal, make sure that there are gaps (A) and (B) as shown in the illustration.
- Do not use the SST if its surface contacting the valve spring lower seat is deformed.
- Check that the seal has not been deformed or cracked after the installation.



21. INSPECT 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.

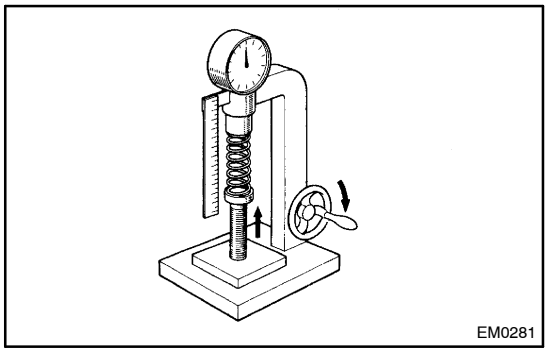

EM0801

(b) Using vernier calipers, measure the free length of the spring.

Free length:

Inner	61.0 mm (2.402 in.)
Outer	60.2 mm (2.370 in.)

If the free length is not as specified, replace the spring.

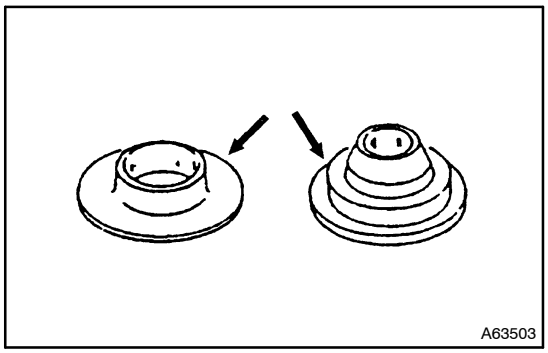

EM0281

(c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

Installed tension:

Item	Setting Height	Tension
Inner	43.0 mm (1.693 in.)	86.0 N (8.8 kgf, 19.3 lb)
Outer	45.5 mm (1.791 in.)	269.0 N (27.4 kgf, 60.5 lb)

If the installed tension is not as specified, replace the spring.


A63503

22. INSPECT VALVE SPRING SEAT

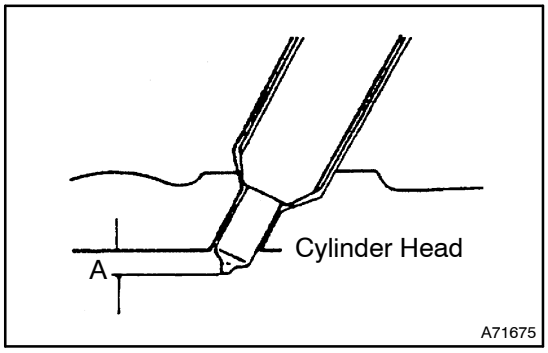
(a) Visually check the contact surface of the upper and lower valve spring seats.

If damage such as wear and scratches is excessive, replace the valve spring seat.

23. INSPECT CYLINDER HEAD COOLANT GALLERY FOR LEAKS

(a) Close all coolant holes, and apply air pressure of about 2.5 kg/cm^2 (36 lb/sq.in.) from one of the coolant holes. Immerse the cylinder head into the water, then check for air leakage.

If any leakage is found, replace the cylinder head.



A71675

24. INSPECT NOZZLE HOLDER AND NOZZLE SET

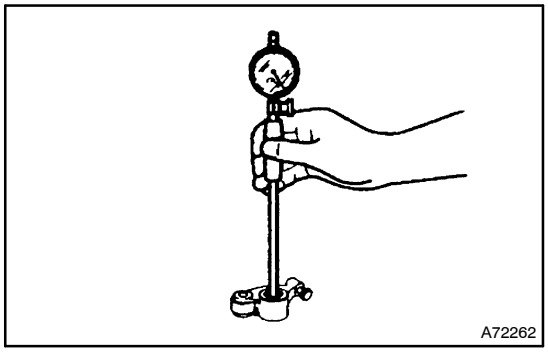
(a) Install the nozzle to the cylinder head. Using vernier calipers, measure the protrusion of the nozzle from the lower surface of the cylinder head.

Standard protrusion (A):

2.55 – 3.05 mm (0.1004 – 0.1201 in.)

Maximum protrusion (A): 3.05 mm (0.1201 in.)

If the protrusion is greater than the maximum, replace the nozzle.


A72262

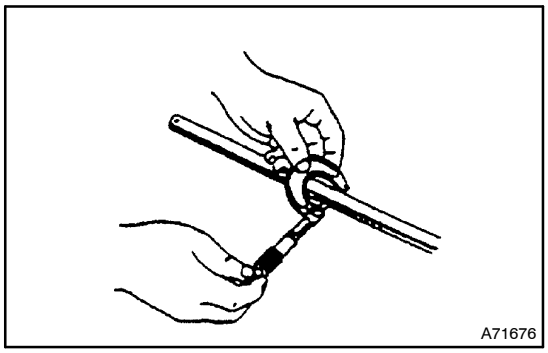
25. INSPECT OIL CLEARANCE BETWEEN VALVE ROCKER ARM AND SHAFT

(a) Using a cylinder gauge, measure the inside diameter of the rocker arm bush.

Standard bush inside diameter:
19.020 – 19.045 mm (0.7488 – 0.7498 in.)
Maximum bush inside diameter: 19.06 mm (0.7504 in.)

If the inside diameter is greater than the maximum, replace the bush.

HINT:
When installing a bush into the rocker arm, align the bush with the oil holes of the rocker arm.


A71676

(b) Using a micrometer, measure the outside diameter of the rocker arm shaft.

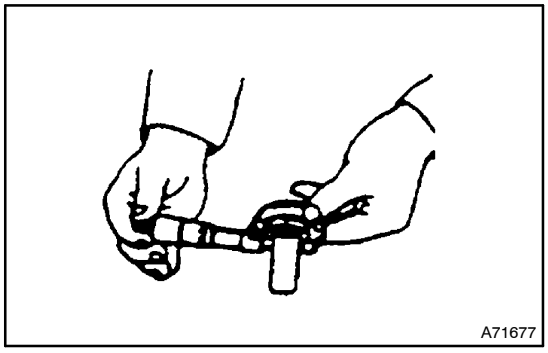
Standard shaft diameter:
18.966 – 18.984 mm (0.7467 – 0.7474 in.)
Minimum shaft diameter: 18.95 mm (0.7461 in.)

If the diameter is less than the minimum, replace the rocker arm.

(c) Subtract the diameter measurement of the rocker arm shaft from the inside diameter measurement of the rocker arm bush.

Standard oil clearance:
0.036 – 0.079 mm (0.0014 – 0.0031 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

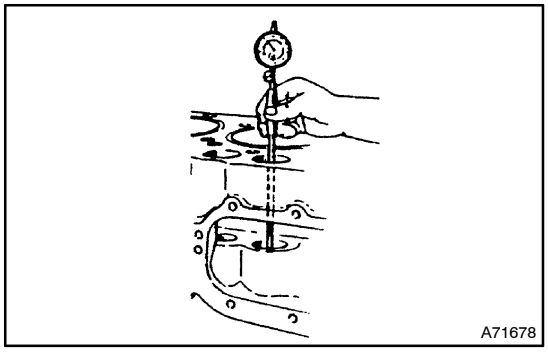
If the oil clearance is greater than the maximum, replace the rocker arm bush.


A71677

26. INSPECT OIL CLEARANCE BETWEEN VALVE LIFTER AND LIFTER BORE

(a) Using a micrometer, measure the lifter diameter.

Standard lifter diameter:
26.95 – 26.97 mm (1.0610 – 1.0618 in.)


A71678

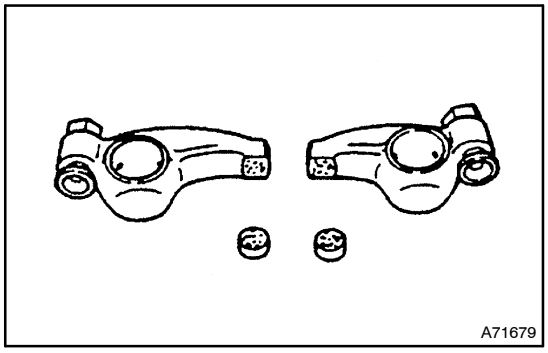
(b) Using a cylinder gauge, measure the lifter bore diameter.

Standard lifter bore diameter:
27.00 – 27.02 mm (1.0630 – 1.0638 in.)

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

Standard oil clearance:
0.025 – 0.071 mm (0.0010 – 0.0028 in.)
Maximum oil clearance: 0.10 mm (0.0039 in.)

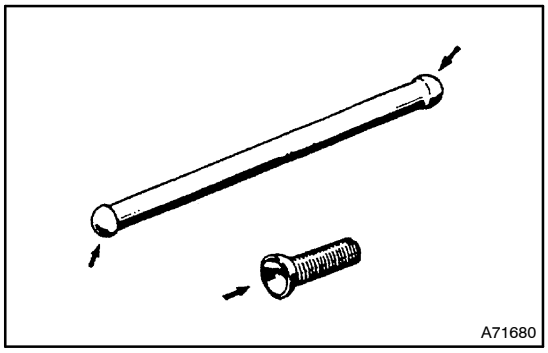
If the oil clearance is greater than the maximum, replace the lifter.



27. INSPECT OTHER VALVE SYSTEM PARTS

(a) Visually check the contact condition between the rocker arm and valve bridge.

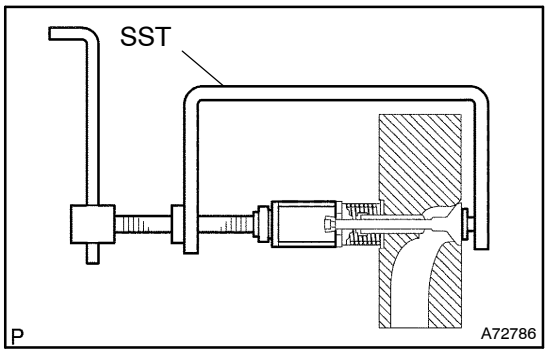
Replace the rocker arm and the valve bridge if damage such as wear and scratches is excessive. If there is only a minimal amount of wear, correct the surface with a resurfacer.



(b) Visually check the adjusting screw and push rod.

HINT:

Replace the adjusting screw if damage such as wear and scratches is excessive.



28. INSTALL VALVE

HINT:

If parts are reused, be sure to install them to their original position.

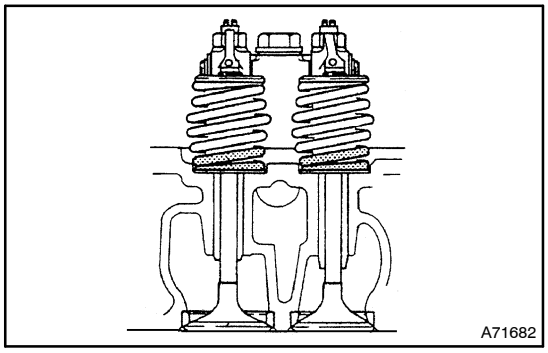
(a) Install the spring seat and a new oil seal.

(b) Apply engine oil to the valve stem. Then insert them into the valve guide installed in the cylinder head.

(c) Install the valve, the inner and outer springs and spring retainer.

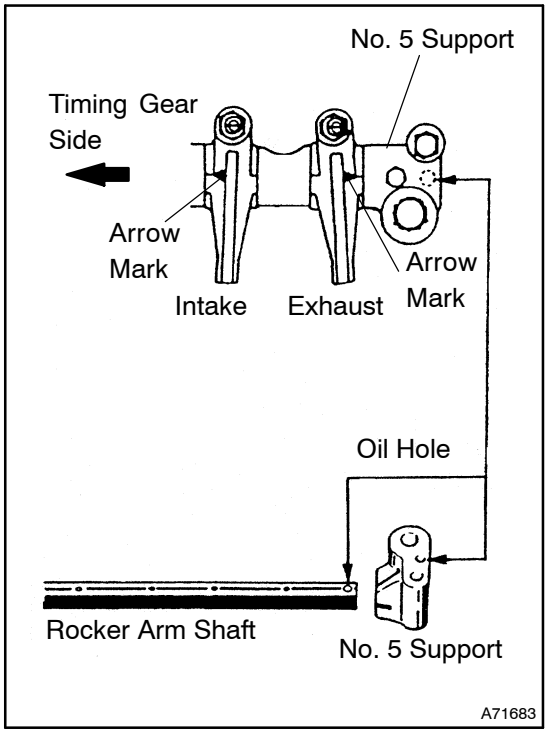
(d) Using SST, press–fit the spring retainer, then securely fit the 2 keepers.

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NOTICE:

- **Be sure to apply engine oil to the contact surface of the parts before the assembly.**
- **Be sure to place each valve in its original position.**
- **When the valve spring is compressed, be careful that the upper seat will not damage to the stem seal.**
- **Since this valve spring is evenly pitched, it can be installed with either end up.**



29. INSTALL VALVE ROCKER ARM

(a) Lubricate the rocker arm shaft and bush.

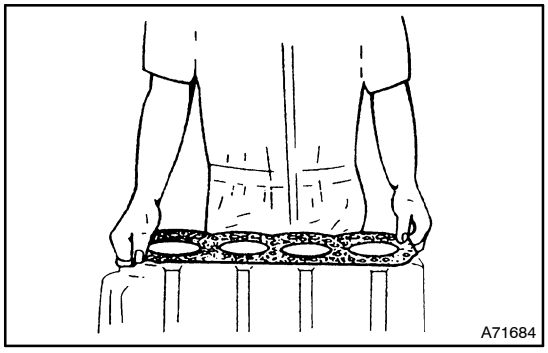
NOTICE:

Confirm that oil hole of the rocker arm assy No. 5 support aligns with the shaft oil hole. Improper installation will result in burning of the entire valve assy.

30. INSTALL VALVE LIFTER

(a) Apply engine oil to the valve lifter face and valve lifter guide.

(b) Install the valve lifters in the cylinder block in the correct order.



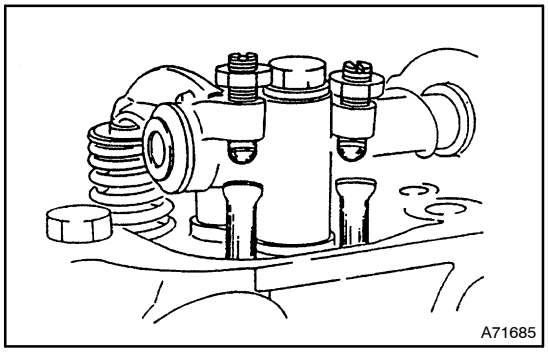
31. INSTALL CYLINDER HEAD AND VALVE ROCKER ARM ASSY

(a) Install a new cylinder head gasket.

NOTICE:

Always use a new cylinder head gasket after cleaning the surface of the cylinder head, cylinder block and head gasket and keep them free of all dirt, water and grease.

(b) Install the cylinder head over the dowels on the cylinder block.

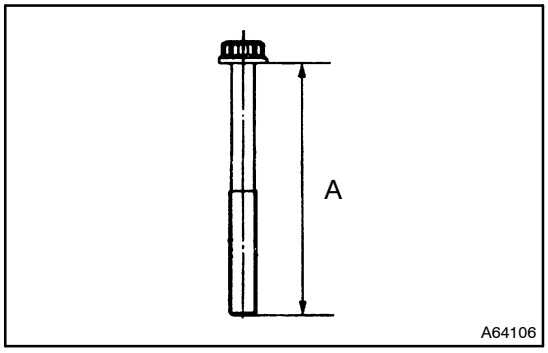


(c) Insert the push rods in the correct order after applying engine oil to both ends.

(d) Mount the rocker arm assy on the cylinder head, and make sure that the push rods interlock with the adjusting screws.

NOTICE:

Always loosen the lock nuts, and raise the adjusting screws fully to the top.



32. INSTALL CYLINDER HEAD BOLT

(a) Preparation

(1) Measure the length of the M12 head bolts.

Maximum bolt length (A):

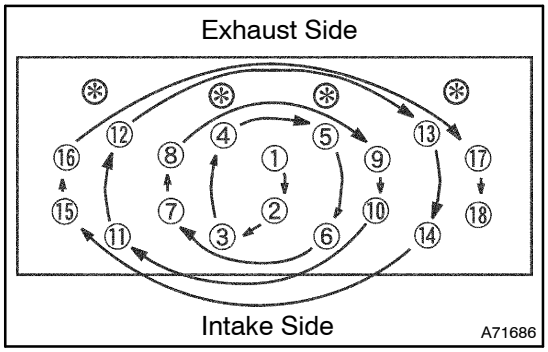
Bolt No.	Length (A)
1 – 13	118 mm (4.65 in.)
14 – 18	165 mm (6.50 in.)

If the length is greater than the maximum, replace them with new bolts.

(2) Make sure that no dirt or scratch is on the tightening surface of the cylinder head bolt.

(3) Apply clean engine oil to the bolt surface and bolt threads.

HINT:
Since the cylinder head bolts are unique to this engine, do not substitute ordinary bolts for them.



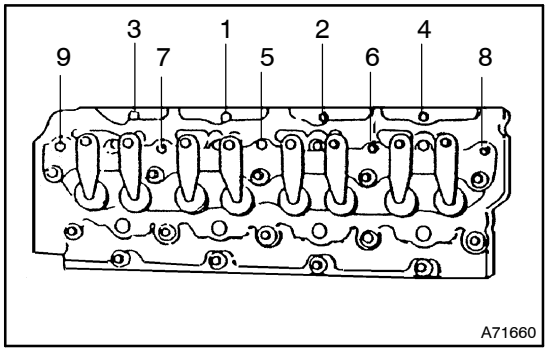
(b) Tighten the cylinder head bolt.

(1) Tighten M12 bolts No. 1 – No. 18 in the order shown in the illustration.

Torque: 132 N·m (1,350 kgf·cm, 97 ft·lbf)

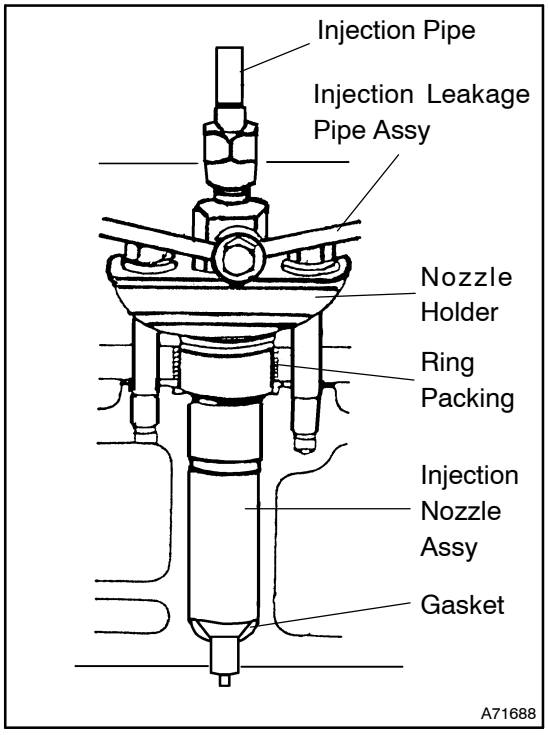
(2) After tightening bolt No. 18, check the torque again all through the bolts from No. 1 to No. 18.

HINT:
When adding torque, never untighten the nuts even if they have been overtightened.



(3) Tighten the cylinder head additional bolts and rocker arm support bolts little in 3 stages and in the numerical order as shown in the illustration.

Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)



33. INSTALL NOZZLE HOLDER AND NOZZLE SET

(a) Install a new gasket, ring packing and shim into the groove of the cylinder head, and then insert the injection nozzle assy.

NOTICE:

Apply engine oil to the O–ring , so that the O–ring will not be caught.

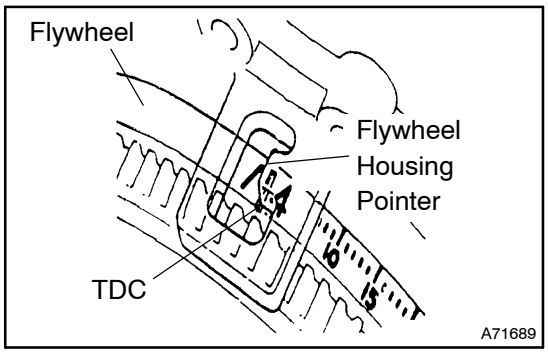
(b) Install the nozzle holder, and install the injection nozzle assy temporarily.

NOTICE:

- **Do not fix the nozzle holder before the injection pipe is temporarily installed.**
- **Be careful not to apply excessive force to the injection nozzle when applying the injection pipe oil seal to it. If the injection pipe oil seal and injection nozzle are moved even slightly, it may cause oil leakage or faulty assembling of the injection pipe.**

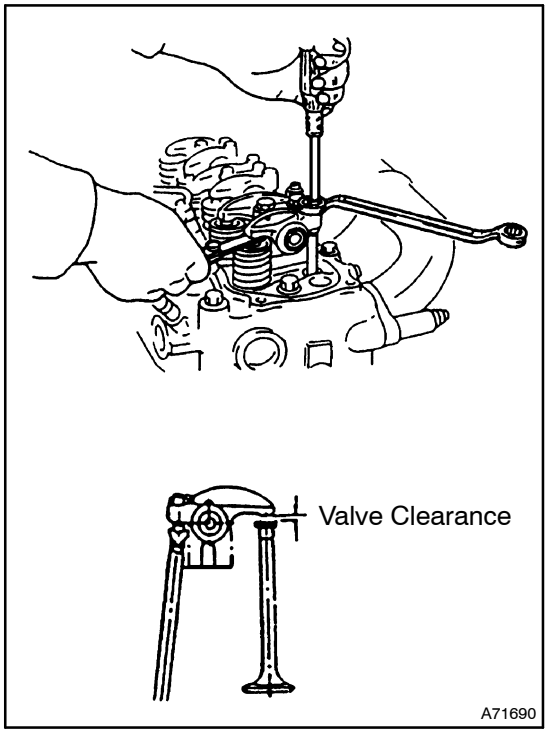
(c) Assemble the injection pipe temporarily, and tighten the installation bolt of the nozzle holder.

Torque: 15 N·m (150 kgf·cm, 11 ft·lbf)



34. ADJUST VALVE CLEARANCE

(a) Set the No. 1 piston to TDC on the compression stroke.



(b) With the No. 1 piston positioned at TDC on the compression stroke, using a feeler gauge, adjust the No. 1 valve clearance.

Valve clearance (Cold):

Intake	0.35 mm (0.014 in.)
Exhaust	0.55 mm (0.022 in.)

HINT:

The feeler gauge should move with a very slight pull.

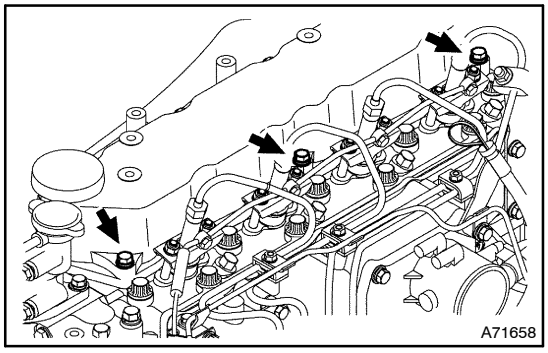
(c) Adjust the other valves.

(1) Turn the crankshaft 180° counterclockwise viewed from the flywheel side.

(2) Adjust the valve clearance for each cylinder in the firing order.

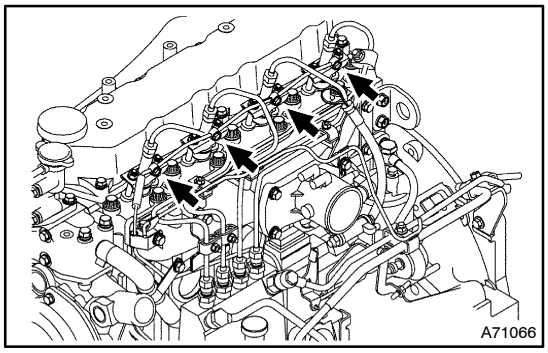
Firing order: 1 – 3 – 4 – 2

(A number of a cylinder is counted from the timing gear side)



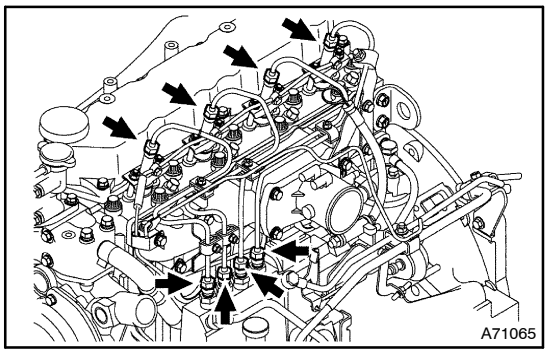
35. INSTALL CYLINDER HEAD COVER SUB–ASSY

(a) Tighten the 6 bolts.
Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)



36. INSTALL NOZZLE LEAKAGE PIPE ASSY

(a) Install 4 new gaskets and the leakage pipe with the 4 joint bolts.
Torque: 12.3 N·m (125 kgf·cm, 9 ft·lbf)



37. INSTALL INJECTION PIPE SET

(a) Install the injection pipe set, and tighten the union nuts.
Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)

38. INSTALL INTAKE AIR CONNECTOR