

## SECTION **EM**

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### MODIFICATION NOTICE:

#### **VG30E**

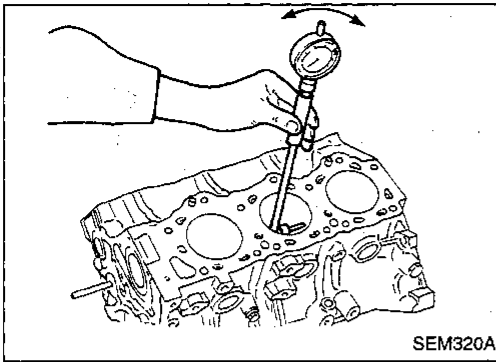
- The specification for piston-to-bore clearance has changed.
- The specification for the exhaust valve stem to guide clearance has changed.
- The specification for camshaft journal to bearing clearance has changed.

#### **KA24E**

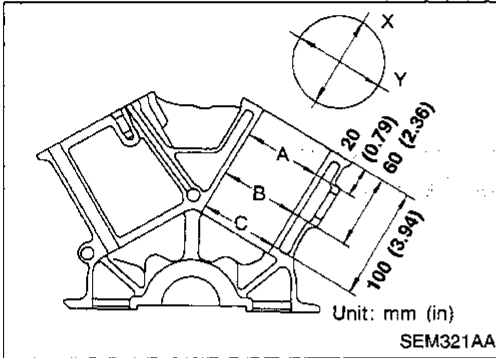
- All models adopt a common fuel tube and sub-fuel tube.
- The following specifications have changed:
  - a. Cylinder bore taper
  - b. Valve length
  - c. Valve lift
  - d. Piston pin outer diameter
  - e. Crankshaft main journal diameter, pin journal diameter, and center distance.

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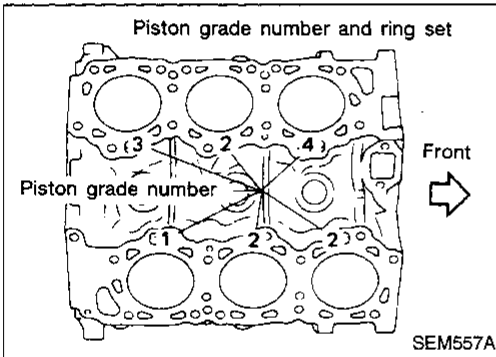
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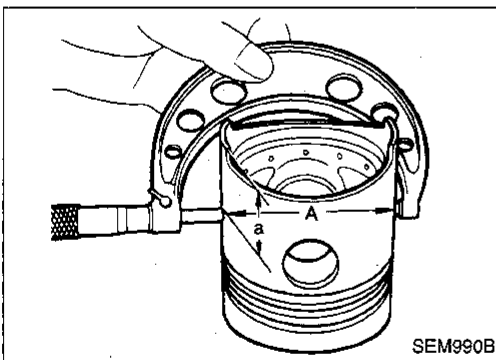
SEM320A



SEM321AA



SEM557A



SEM990B

## Inspection

### PISTON-TO-BORE CLEARANCE

- Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

**Standard inner diameter:**

**87.000 - 87.030 mm (3.4252 - 3.4264 in)**

**Wear limit:**

**0.20 mm (0.0079 in)**

If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

**Out-of-round (X - Y) standard:**

**0.015 mm (0.0006 in)**

**Taper (A - B or A - C) standard:**

**0.015 mm (0.0006 in)**

- Check for scratches and seizure. If seizure is found, hone it.

- If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block upper surface.

- Measure piston skirt diameter.

**Piston diameter "A":**

**Refer to SDS (EM-5).**

**Measuring point "a" (Distance from the bottom):**

**18 mm (0.71 in)**

- Check that piston-to-bore clearance is within specification.

**Piston-to-bore clearance "B":**

**0.025 - 0.045 mm (0.0010 - 0.0018)**

- Determine piston oversize according to amount of cylinder wear.

**Oversize pistons are available for service. Refer to SDS (EM-5).**

- Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".

**Rebored size calculation:**

$$D = A + B - C$$

where,

**D: Bored diameter**

**A: Piston diameter as measured**

**B: Piston-to-bore clearance**

**C: Honing allowance 0.02 mm (0.0008 in)**

- Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.

Inspection (Cont'd)

- 8. Cut cylinder bores.
  - When any cylinder needs boring, all other cylinders must also be bored.
  - Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
- 9. Hone cylinders to obtain specified piston-to-bore clearance.
- 10. Measure finished cylinder bore for out-of-round and taper.
  - Measurement should be done after cylinder bore cools down.

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**Inspection and Adjustment**

**CAMSHAFT AND CAMSHAFT BEARING**

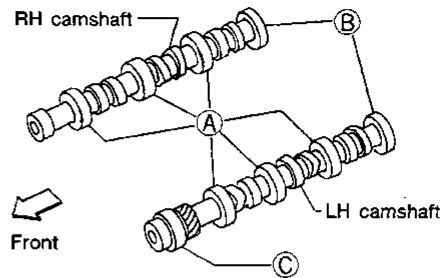
Unit: mm (in)

**VALVE**

**Valve guide**

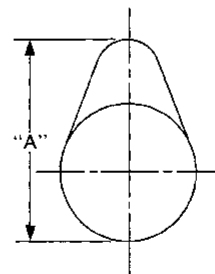
Unit: mm (in)

		Standard	Service
Valve guide	Outer diameter	Inner	11.023 - 11.034 (0.4340 - 0.4344)
		Exhaust	12.023 - 12.034 (0.4733 - 0.4738)
Valve guide	Inner diameter (Finished size)	Intake	7.000 - 7.018 (0.2756 - 0.2763)
		Exhaust	8.000 - 8.018 (0.3150 - 0.3157)
Cylinder head valve guide hole diameter	Intake	10.975 - 10.996 (0.4321 - 0.4329)	11.175 - 11.196 (0.4400 - 0.4408)
	Exhaust	11.975 - 11.996 (0.4715 - 0.4723)	12.175 - 12.196 (0.4793 - 0.4802)
Interference fit of valve guide	Intake	0.027 - 0.059 (0.0011 - 0.0023)	
	Exhaust		
Stem to guide clearance	Intake	0.020 - 0.053 (0.0008 - 0.0021)	0.10 (0.0039)
	Exhaust	0.030 - 0.053 (0.0012 - 0.0021)	
Valve deflection limit		—	0.20 (0.0079)



SEM893BA

	Standard	Max. tolerance
Camshaft journal to bearing clearance	0.060 - 0.105 (0.0024 - 0.0041)	0.15 (0.0059)
Inner diameter of camshaft bearing	Ⓐ: 47.000 - 47.025 (1.8504 - 1.8514)	—
	Ⓑ: 42.500 - 42.525 (1.6732 - 1.6742)	—
	Ⓒ: 48.000 - 48.025 (1.8898 - 1.8907)	—
Outer diameter of camshaft journal	Ⓐ: 46.920 - 46.940 (1.8472 - 1.8480)	—
	Ⓑ: 42.420 - 42.440 (1.6701 - 1.6709)	—
	Ⓒ: 47.920 - 47.940 (1.8866 - 1.8874)	—
Camshaft runout [TIR*]	Less than 0.04 (0.0016)	0.1 (0.004)
Camshaft end play	0.03 - 0.06 (0.0012 - 0.0024)	—



EM671

Cam height "A"

Intake	39.537 - 39.727 (1.5566 - 1.5641)
Exhaust	

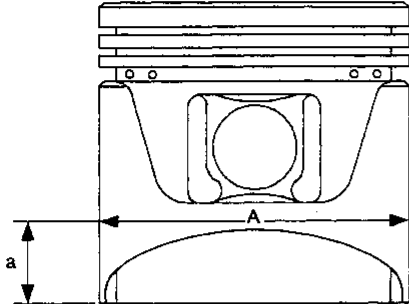
Wear limit of cam height	0.15 (0.0059)
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\*Total indicator reading

**PISTON, PISTON RING AND PISTON PIN**

**Available piston**

Unit: mm (in)



SEM891B

Piston skirt diameter "A"	
Standard	
Grade No. 1	86.965 - 86.975 (3.4238 - 3.4242)
Grade No. 2	86.975 - 86.985 (3.4242 - 3.4246)
Grade No. 3	86.985 - 86.995 (3.4246 - 3.4250)
0.25 (0.0098) oversize (Service)	87.215 - 87.265 (3.4337 - 3.4356)
0.50 (0.0197) oversize (Service)	87.465 - 87.515 (3.4435 - 3.4455)
"a" dimension	18 (0.71)
Piston pin hole diameter	20.969 - 20.981 (0.8255 - 0.8260)
Piston clearance to cylinder block	0.025 - 0.045 (0.0010 - 0.0018)

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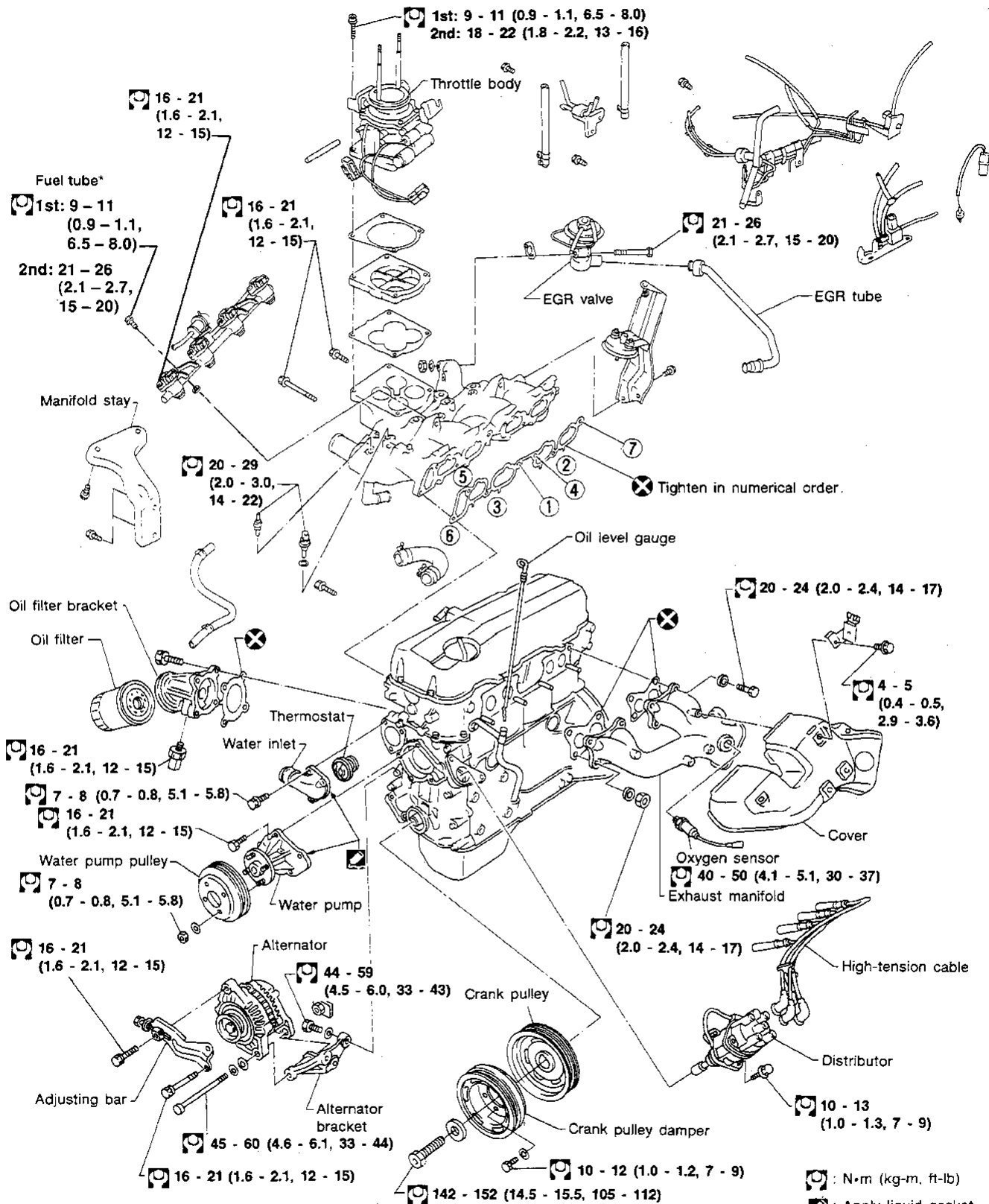
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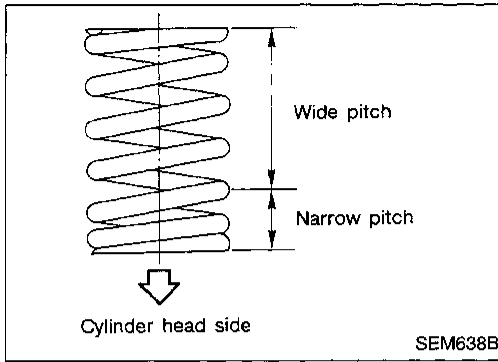
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\*For sub-fuel tube:

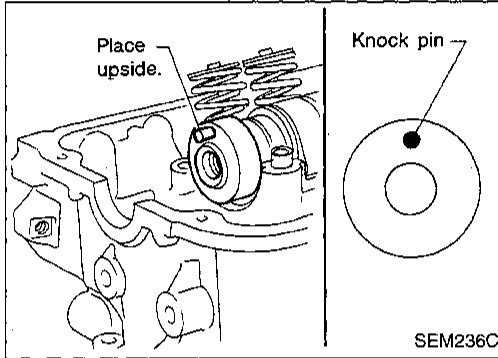
- ⊗ **1st: 3.1 - 4.2 (0.32 - 0.43, 2.3 - 3.1)**
- ⊗ **2nd: 6.3 - 8.3 (0.64 - 0.85, 4.6 - 6.1)**



**Assembly**

1. Install valve component parts.
  - Always use new valve oil seal. Refer to OIL SEAL REPLACEMENT.
  - Before installing valve oil seal, install inner valve spring seat.
  - Install outer valve spring (uneven pitch type) with its narrow pitch side toward cylinder head side.
  - After installing valve component parts, use plastic hammer to lightly tap valve stem tip to assure a proper fit.

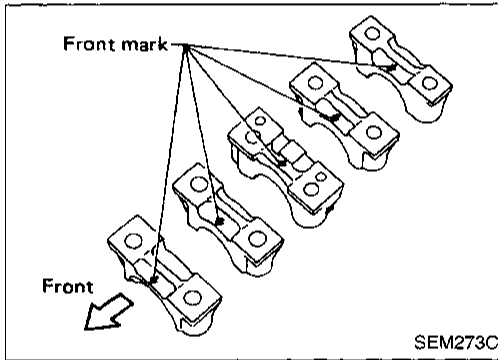
GI  
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2. Mount camshaft onto cylinder head, placing knock pin at front end to top position.

Apply engine oil to camshaft when mounting onto cylinder head.

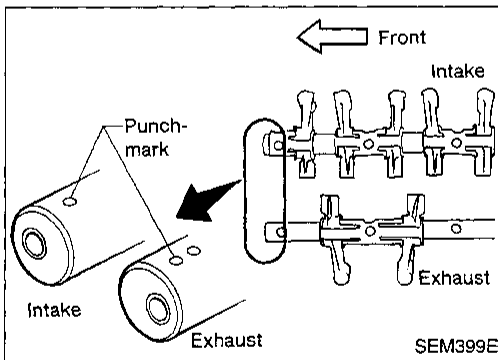
LC  
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3. Install camshaft brackets.

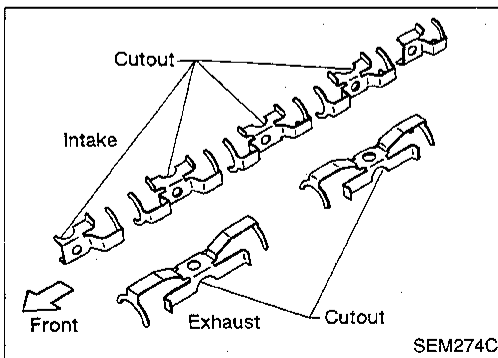
Front mark is punched on the camshaft bracket.

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4. Install rocker shaft with rocker arms.

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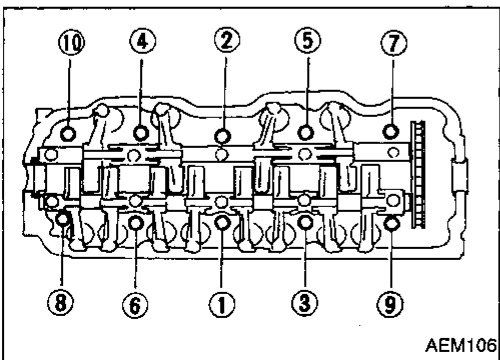
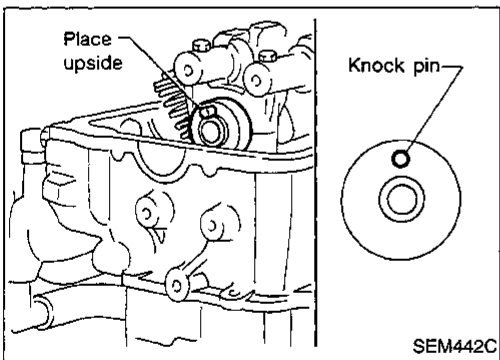
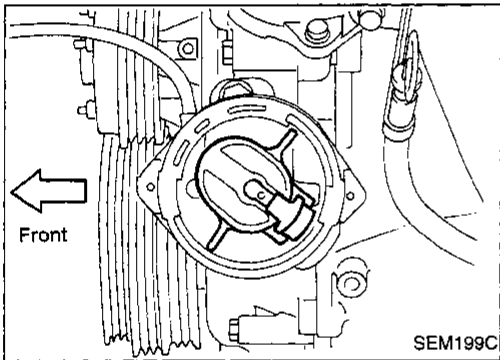
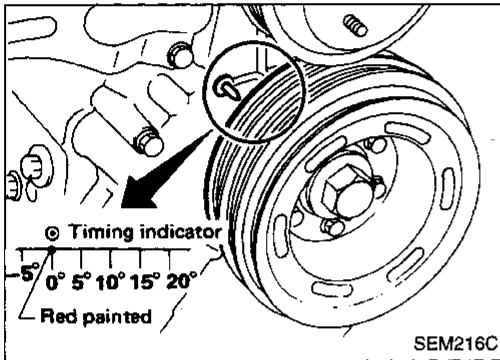
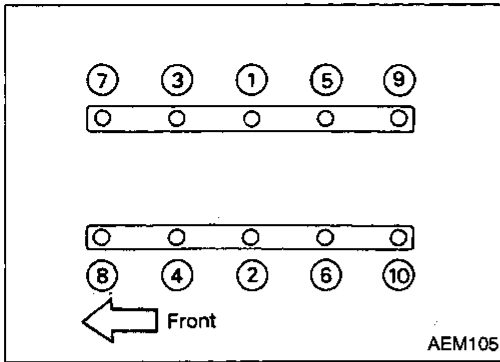
- Install retainer with cutout facing direction shown in figure at left.

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Assembly (Cont'd)

5. Tighten bolts as shown in figure at left.



Installation

1. Set No. 1 piston at TDC on its compression stroke as follows:

- (1) Align mark on crankshaft pulley with "0°" position and confirm that distributor rotor head is set as shown in figure.

(2) Confirm that knock pin on camshaft is set at the top.

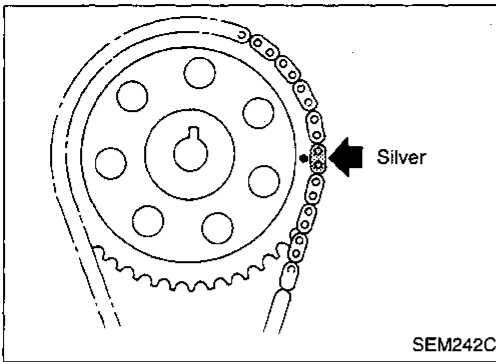
2. Install cylinder head with new gasket and tighten cylinder head bolts in numerical order.

- Do not rotate crankshaft and camshaft separately, or valves will hit piston heads.
- Tightening procedure

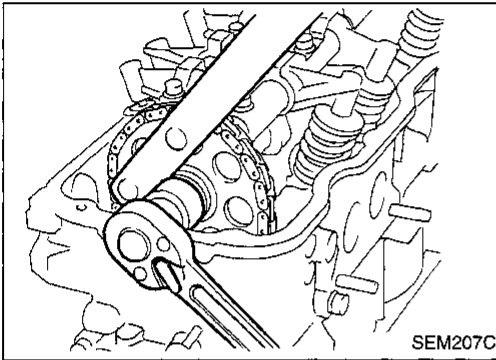
- (1) Tighten all bolts to 29 N·m (3.0 kg·m, 22 ft·lb).
- (2) Tighten all bolts to 78 N·m (8.0 kg·m, 58 ft·lb).
- (3) Loosen all bolts completely.
- (4) Tighten all bolts to 29 N·m (3.0 kg·m, 22 ft·lb).
- (5) Turn all bolts 80 to 85 degrees clockwise with an angle wrench, or if an angle wrench is not available, tighten all bolts to 74 to 83 N·m (7.5 to 8.5 kg·m, 54 to 61 ft·lb).



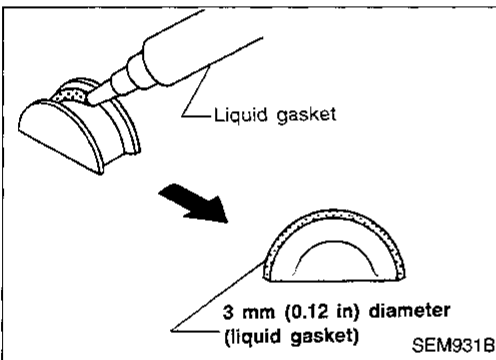
Installation (Cont'd)



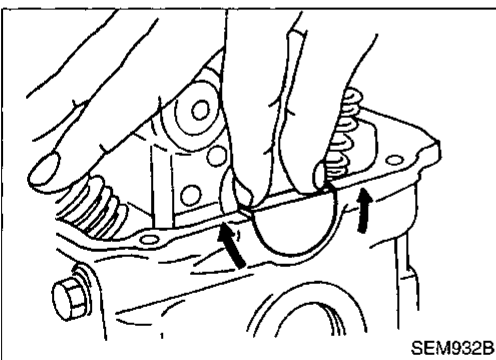
3. Set chain on camshaft sprocket by aligning each mating mark. Then install camshaft sprocket to camshaft.



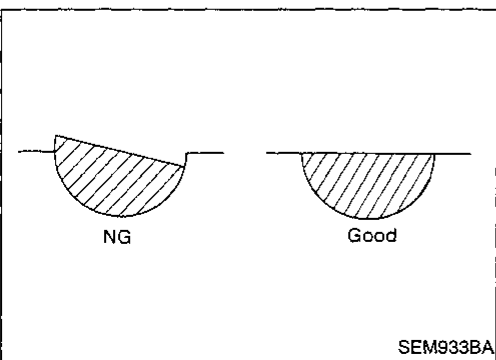
4. Tighten camshaft sprocket bolt.



5. Install rubber plugs as follows:  
 (1) Apply liquid gasket to rubber plugs.  
 • Rubber plugs should be replaced with new ones.  
 • Rubber plugs should be installed within 5 minutes of applying liquid gasket.

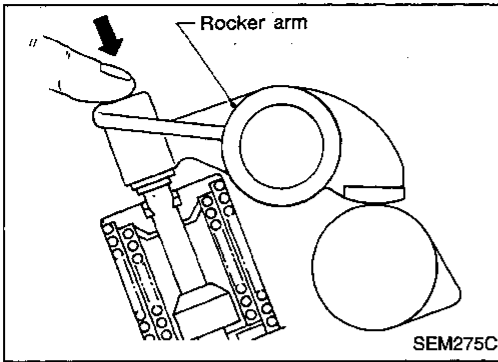


(2) Install rubber plugs, then move them with your fingers to uniformly spread the gasket on cylinder head surface.  
 • Rubber plugs should be installed flush with the surface.  
 • Do not start the engine for 30 minutes after installing rocker cover.  
 • Wipe clean excessive liquid gasket from cylinder head top surface.



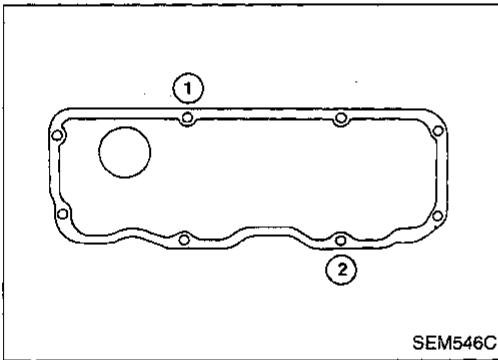
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## Installation (Cont'd)

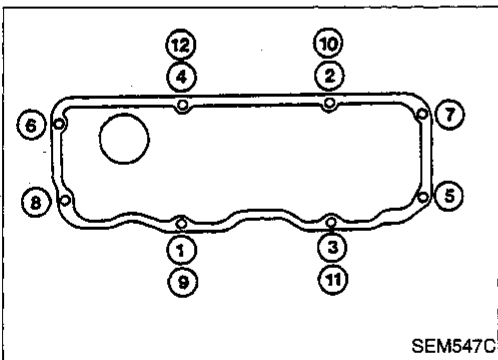


6. Check hydraulic valve lifter.
  - (1) Push hydraulic valve lifter forcefully with your finger.
    - **Be sure to check it with rocker arm in its free position.**
  - (2) If valve lifter moves more than 1 mm (0.04 in), air may be inside of it.
  - (3) Bleed air off by running engine at 1,000 rpm under no-load for about 20 minutes.
  - (4) If hydraulic valve lifters are still noisy, replace them and bleed air off again in the same manner as in step (3).

7. Install rocker cover.
  - **Be sure to avoid interference between rocker cover and rocker arm.**

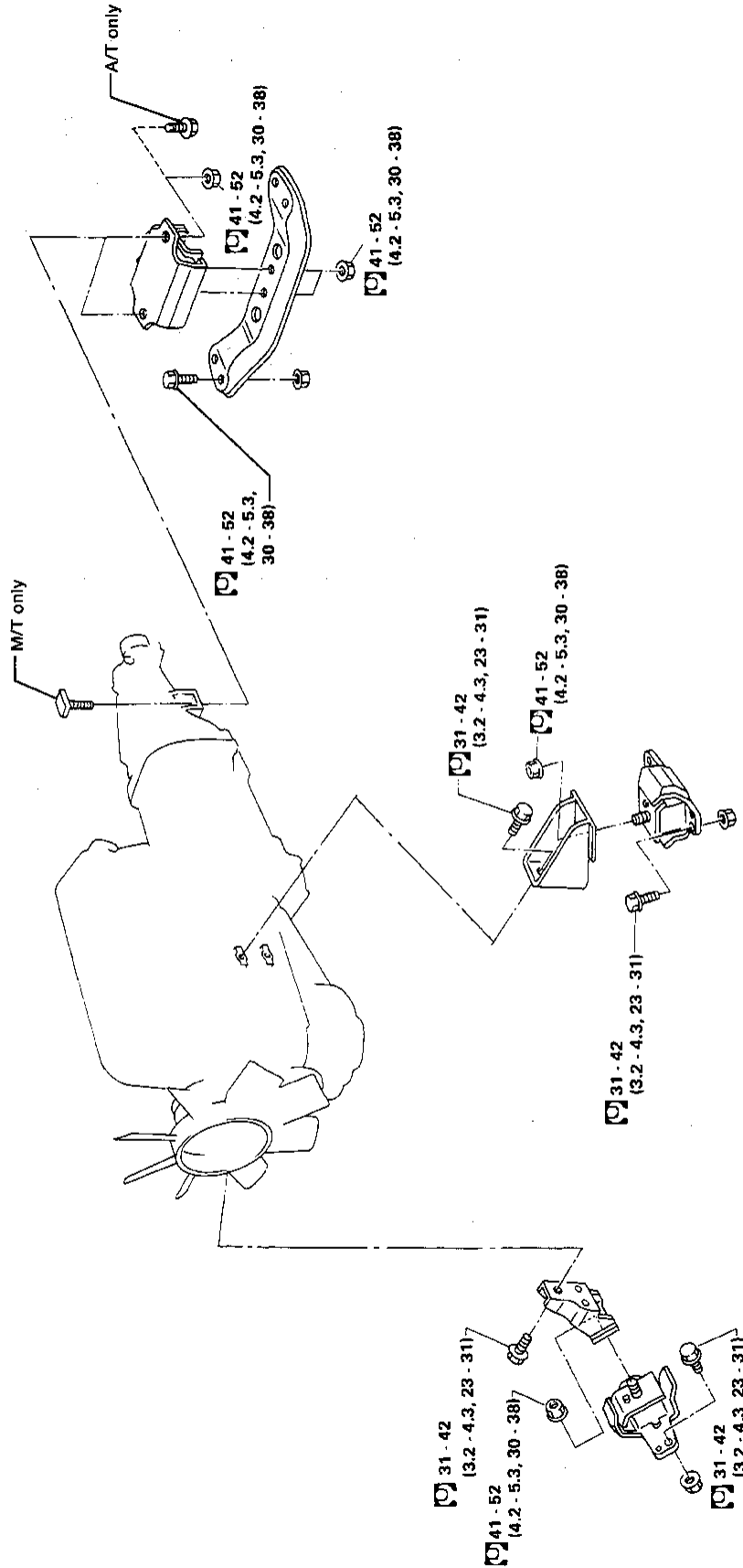


8. Tighten bolts as follows:
  - (1) Tighten 2 bolts to 3 N·m (0.3 kg-m, 2.2 ft-lb) temporarily in order shown in figure.



- (2) Then tighten bolts to 7 to 11 N·m (0.7 to 1.1 kg-m, 5.1 to 8.0 ft-lb) in order shown in figure.
9. Install any parts removed.

Note: When possible, separate engine from transmission in-vehicle



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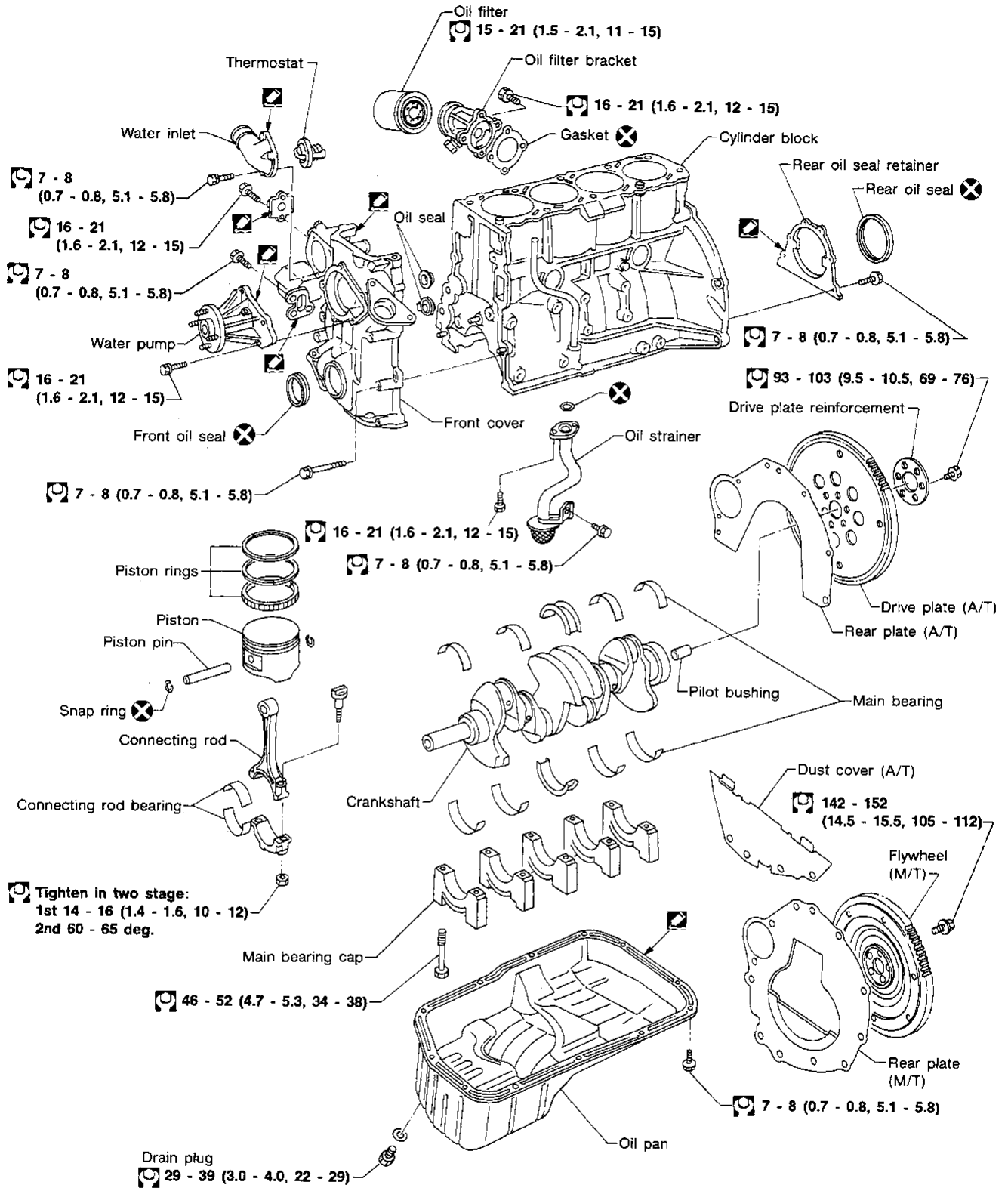
☐ : N·m (kg·m, ft·lb)

**WARNING:**

- a. Situate vehicle on a flat and solid surface.
- b. Place chocks at front and back of rear wheels.
- c. Do not remove engine until exhaust system has completely cooled off.  
Otherwise, you may burn yourself and/or fire may break out in fuel line.
- d. Before disconnecting fuel hose, release fuel pressure from fuel line.  
Refer to "Releasing Fuel Pressure" in EF & EC section.
- e. Be sure to hoist engine and transmission in a safe manner.
- f. For engines not equipped with engine slingers, attach proper slingers and bolts described in PARTS CATALOG.

**CAUTION:**

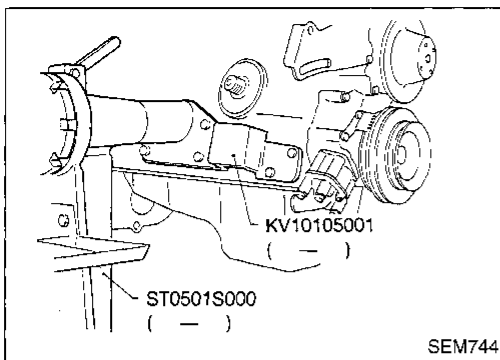
- When lifting engine, be careful not to strike adjacent parts, especially accelerator wire casing, brake lines, and brake master cylinder.
- In hoisting the engine, always use engine slingers in a safe manner.



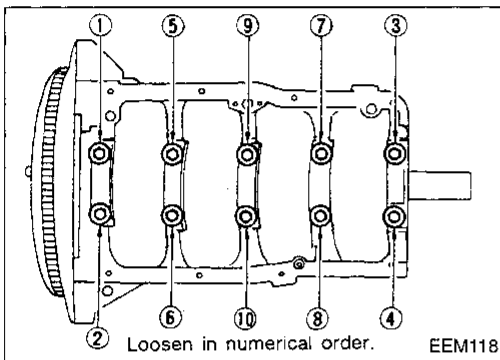
: N·m (kg-m, ft-lb)  
 : Apply liquid gasket.

Tighten in two stage:  
 1st 14 - 16 (1.4 - 1.6, 10 - 12)  
 2nd 60 - 65 deg.

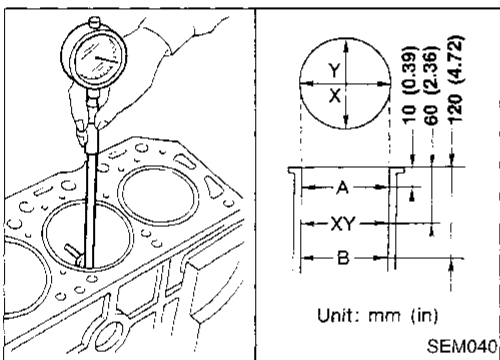
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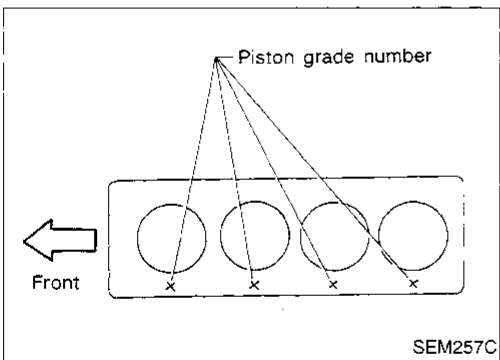
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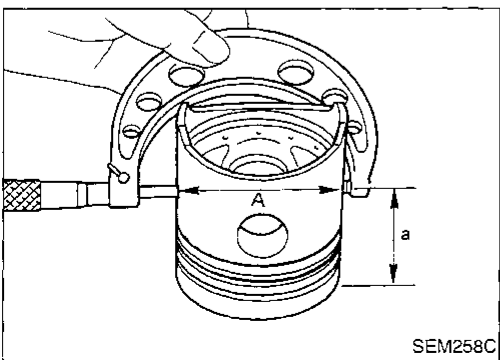
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SEM040



SEM257C



SEM258C

## Disassembly

### PISTON AND CRANKSHAFT

1. Place engine on a work stand.
2. Drain coolant and oil.
3. Remove oil pan.
4. Remove timing chain.
5. Remove water pump.
6. Remove cylinder head.
7. Remove pistons with connecting rod.
8. Remove bearing caps and crankshaft.
  - Before removing bearing caps, measure crankshaft end play.
  - Bolts should be loosened in two or three steps.

## Inspection

### PISTON-TO-BORE CLEARANCE

1. Using a bore gauge, measure cylinder bore for wear, out-of-round and taper.

**Standard inner diameter:**

**89.000 - 89.030 mm (3.5039 - 3.5051 in)**

**Wear limit: 0.2 mm (0.008 in)**

If it exceeds the limit, rebore all cylinders. Replace cylinder block if necessary.

**Out-of-round (X-Y) standard: 0.01 mm (0.0004 in)**

**Taper (A-B) standard: 0.015 mm (0.0006 in)**

2. Check for scratches and seizure. If seizure is found, hone it.

- If both cylinder block and piston are replaced with new ones, select piston of the same grade number punched on cylinder block upper surface.

3. Measure piston skirt diameter.

**Piston diameter "A":**

**Refer to SDS.**

**Measuring point "a" (Distance from the top):**

**52 mm (2.05 in)**

4. Check that piston-to-bore clearance is within specification.

**Piston-to-bore clearance "B":**

**0.020 - 0.040 mm (0.0008 - 0.0016 in)**

5. Determine piston oversize according to amount of cylinder wear.

**Inspection (Cont'd)**

Oversize pistons are available for service. Refer to SDS.

6. Cylinder bore size is determined by adding piston-to-bore clearance to piston diameter "A".

Rebored size calculation:

$$D = A + B - C$$

where,

D: Bored diameter

A: Piston diameter as measured

B: Piston-to-bore clearance

C: Honing allowance 0.02 mm (0.0008 in)

7. Install main bearing caps, and tighten to the specified torque to prevent distortion of cylinder bores in final assembly.
8. Cut cylinder bores.
  - When any cylinder needs boring, all other cylinders must also be bored.
  - Do not cut too much out of cylinder bore at a time. Cut only 0.05 mm (0.0020 in) or so in diameter at a time.
9. Hone cylinders to obtain specified piston-to-bore clearance.
10. Measure finished cylinder bore for out-of-round and taper.
  - Measurement should be done after cylinder bore cools down.

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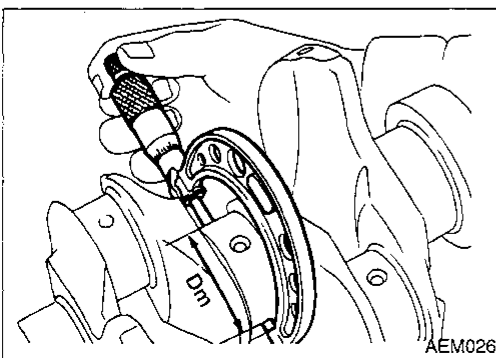
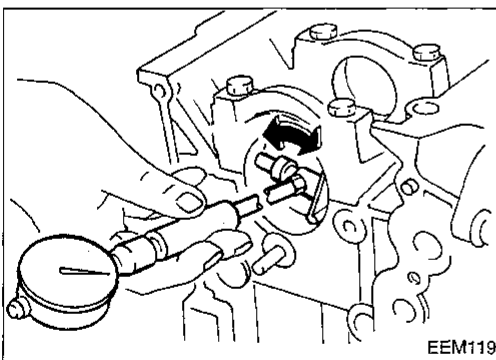
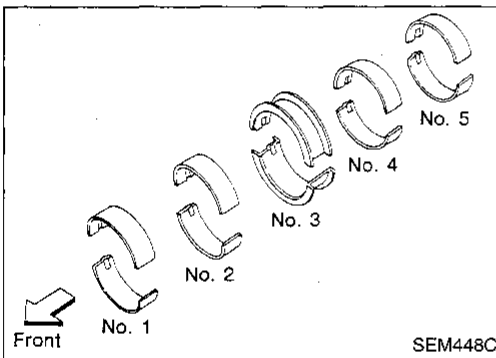
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**BEARING CLEARANCE**

**Method A (Using bore gauge and micrometer)**

**Main bearing**

1. Set main bearings in their proper positions on cylinder block and main bearing cap.

2. Install main bearing cap to cylinder block.

**Tighten all bolts in correct order in two or three stages. Refer to "Assembly".**

3. Measure inner diameter "A" of each main bearing.

4. Measure outer diameter "Dm" of each crankshaft main journal.

5. Calculate main bearing clearance.

$$\text{Main bearing clearance} = A - Dm$$

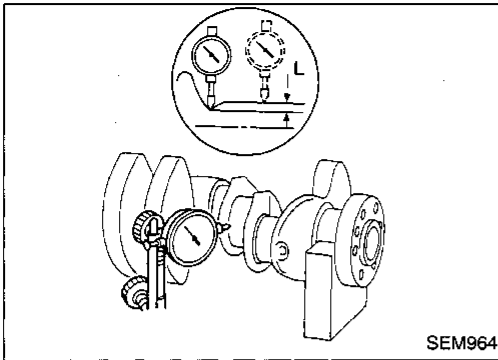
**Standard:**

$$0.020 - 0.047 \text{ mm (0.0008 - 0.0019 in)}$$

**Limit: 0.1 mm (0.004 in)**

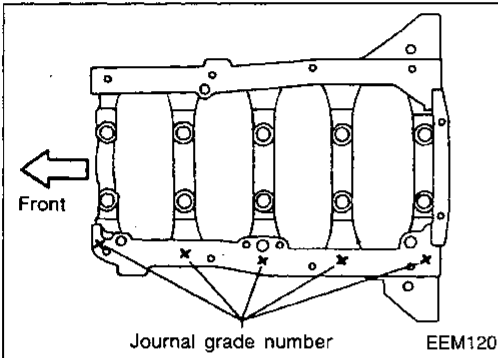
6. If it exceeds the limit, replace bearing.
7. If clearance cannot be adjusted within the standard of any bearing, grind crankshaft journal and use undersized bearing.

Inspection (Cont'd)



SEM964

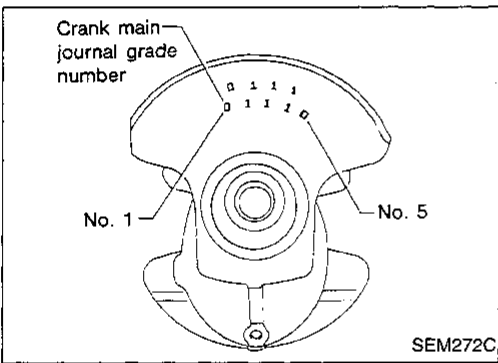
- a. When grinding crankshaft journal, confirm that "L" dimension in fillet roll is more than the specified limit.  
"L": 0.1 mm (0.004 in)
- b. Refer to SDS for grinding crankshaft and available service parts.



Journal grade number

EEM120

- 8. If crankshaft is reused, measure main bearing clearance and select thickness of main bearing.  
If crankshaft is replaced with a new one, it is necessary to select thickness of main bearings as follows:
  - a. Grade number of each cylinder block main journal is punched on the respective cylinder block. These numbers are punched in either Arabic or Roman numerals.



SEM272C

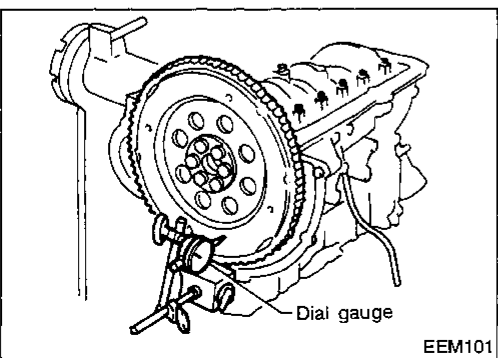
- b. Grade number of each crankshaft main journal is punched on crankshaft. These numbers are punched in either Arabic or Roman numerals.
- c. Select main bearing with suitable thickness according to the following example or table.

For example:

Main journal grade number: 1  
 Crankshaft journal grade number: 2  
 Main bearing grade number = 1 + 2  
 = 3 (Yellow)

Main bearing grade number and identification color:

		Main journal grade number		
		"0"	"1"	"2"
Crankshaft journal grade number	"0"	0 (Black)	1 (Brown)	2 (Green)
	"1" or "I"	1 (Brown)	2 (Green)	3 (Yellow)
	"2" or "II"	2 (Green)	3 (Yellow)	4 (Blue)



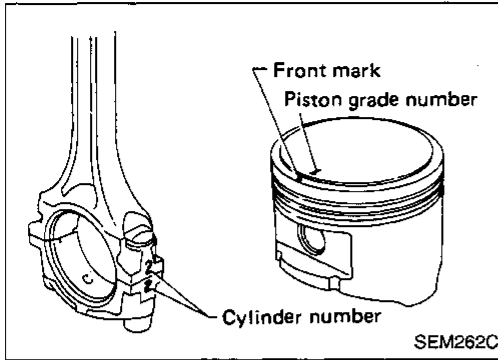
EEM101

FLYWHEEL/DRIVE PLATE RUNOUT

Runout (Total indicator reading):

Flywheel (M/T model)  
 Less than 0.1 mm (0.004 in)  
 Drive plate (A/T model)  
 Less than 0.1 mm (0.004 in)



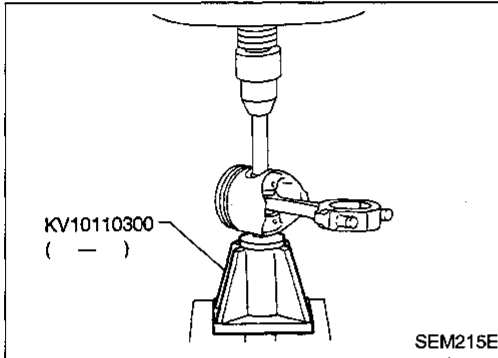


**Assembly**

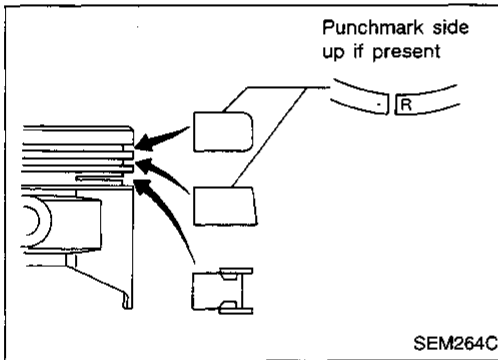
**PISTON**

- Heat piston to 60 to 70°C (140 to 158°F) and assemble piston, piston pin and connecting rod.
  - Align the direction of piston and connecting rod.
  - Numbers stamped on connecting rod and cap correspond to each cylinder.
  - After assembly, make sure connecting rod swings smoothly.

GI  
MA  
EM



LC  
EF &  
EC



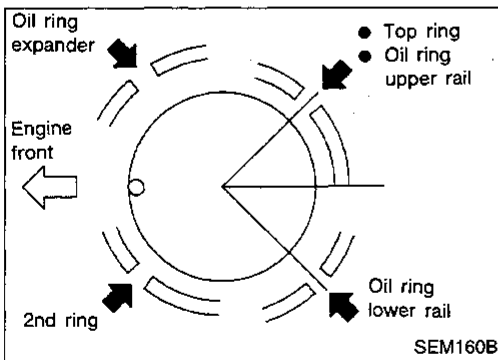
FE  
CL  
MT

- Set piston rings as shown.

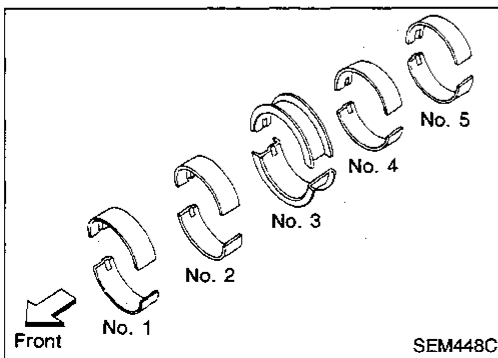
**CAUTION:**

- When piston rings are not replaced, make sure that piston rings are mounted in their original positions.
- When piston rings are being replaced and no punchmark is present, piston rings can be mounted with either side up.

AT  
TF  
PD



FA  
RA  
BR



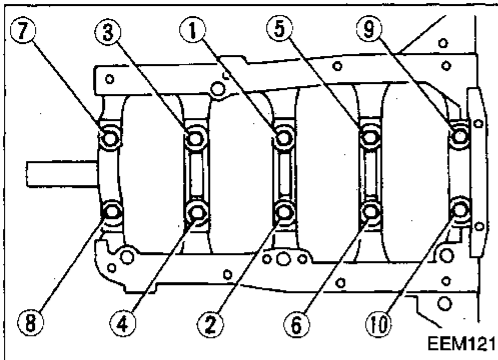
ST  
BF  
HA

**CRANKSHAFT**

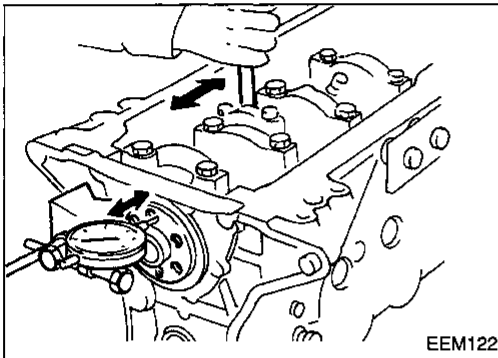
- Set main bearings in their proper positions on cylinder block and main bearing beam.
  - Confirm that correct main bearings are used. Refer to "Inspection" of this section.

EL  
IDX

## Assembly (Cont'd)



2. Install crankshaft and main bearing beam and tighten bolts to the specified torque.
  - Prior to tightening bearing cap bolts, place bearing cap in its proper position by shifting crankshaft in the axial direction.
  - Tighten bearing cap bolts gradually in two or three stages. Start with center bearing and move outward sequentially.
  - After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.



3. Measure crankshaft end play.

## Crankshaft end play:

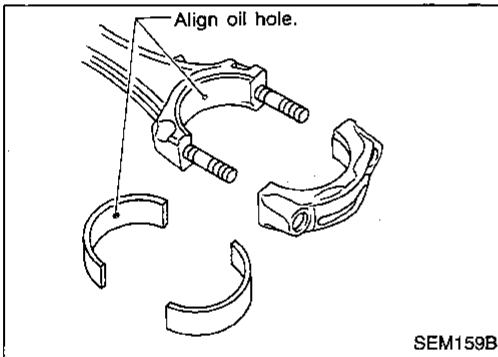
## Standard

0.05 - 0.18 mm (0.0020 - 0.0071 in)

## Limit

0.3 mm (0.012 in)

If beyond the limit, replace bearing with a new one.

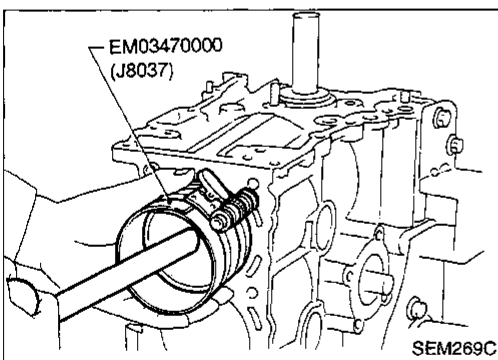


4. Install connecting rod bearings in connecting rods and connecting rod caps.

- Confirm that correct bearings are used.

Refer to "Inspection".

- Install bearings so that oil hole in connecting rod aligns with oil hole of bearing.

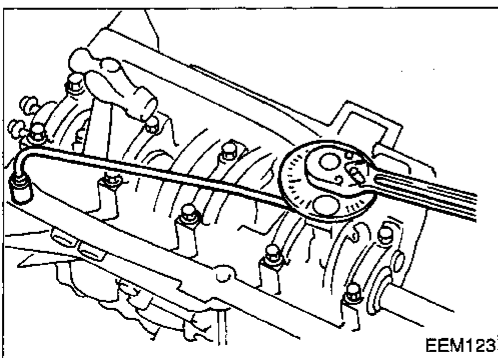


5. Install pistons with connecting rods.

- a. Install them into corresponding cylinders with Tool.

- Be careful not to scratch cylinder wall by connecting rod.

- Arrange so that front mark on piston head faces toward front of engine.



- b. Install connecting rod bearing caps.

Tighten connecting rod bearing cap nuts to the specified torque.

## Connecting rod bearing nut:

(1) Tighten to 14 to 16 N·m

(1.4 to 1.6 kg-m, 10 to 12 ft-lb).

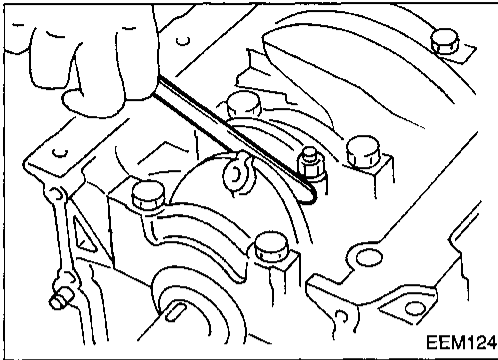
(2) Tighten bolts 60 to 65 degrees clockwise

with an angle wrench, or if an angle wrench

is not available, tighten them to

38 to 44 N·m (3.9 to 4.5 kg-m, 28 to 33 ft-lb).

**Assembly (Cont'd)**



6. Measure connecting rod side clearance.

**Connecting rod side clearance:**

**Standard**

**0.2 - 0.4 mm (0.008 - 0.016 in)**

**Limit**

**0.6 mm (0.024 in)**

If beyond the limit, replace connecting rod and/or crankshaft.

GI

MA

**EM**

LC

EF &  
EC

FE

CL

MT

AT

TF

PD

FA

RA

BR

ST

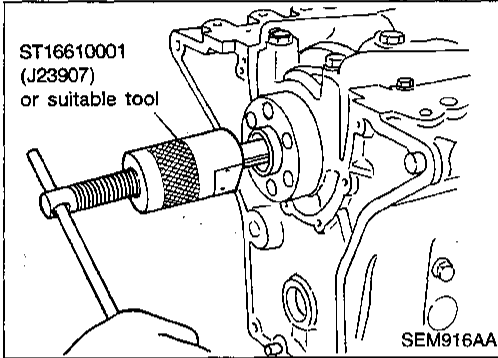
BF

HA

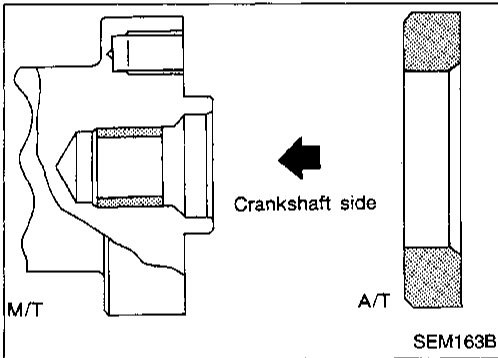
EL

IDX

**REPLACING PILOT BUSHING**



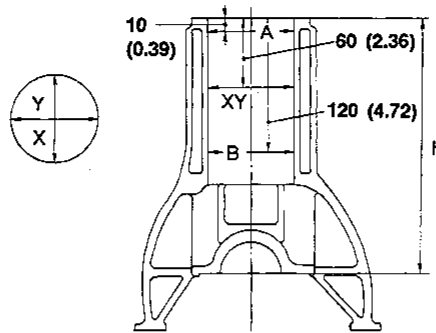
1. Remove pilot bushing (M/T) or pilot convertor (A/T).



2. Install pilot bushing (M/T) or pilot convertor (A/T).

Inspection and Adjustment

CYLINDER BLOCK



SEM400E

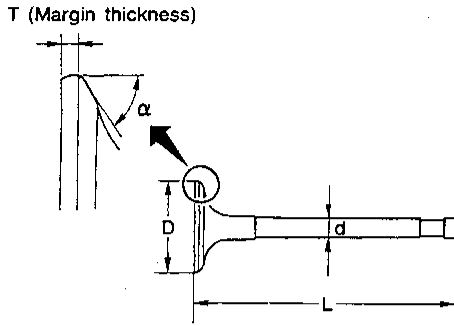
Unit: mm (in)

		Standard	Limit
Distortion		—	0.1 (0.004)
Cylinder bore	Inner diameter	Grade 1	89.000 - 89.010 (3.5039 - 3.5043)
		Grade 2	89.010 - 89.020 (3.5043 - 3.5047)
		Grade 3	89.020 - 89.030 (3.5047 - 3.5051)
	Out-of-round (X - Y)		Less than 0.015 (0.0006)
Taper (A - B)		Less than 0.01 (0.0004)	—
Difference in inner diameter between cylinders		Less than 0.05 (0.0020)	0.2 (0.008)
Piston-to-cylinder clearance		0.020 - 0.040 (0.0008 - 0.0016)	—
Cylinder block height (From crankshaft center)		246.95 - 247.05 (9.7224 - 9.7264)	0.2 (0.008)**

\* Wear limit  
 \*\* Total amount of cylinder head resurfacing and cylinder block resurfacing

Inspection and Adjustment (Cont'd)

VALVE



SEM188A

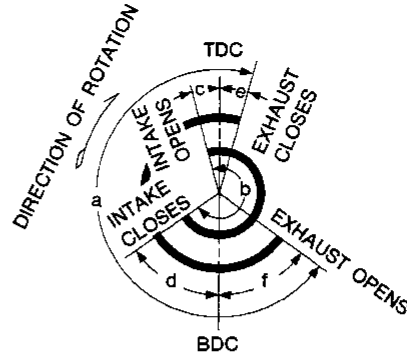
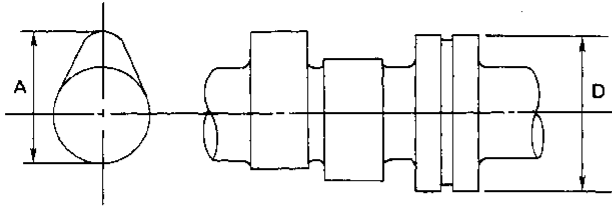
Unit: mm (in)

		Standard	Limit
Valve head diameter (D)	In.	34.0 - 34.2 (1.339 - 1.346)	—
	Ex.	40.0 - 40.2 (1.575 - 1.583)	—
Valve length (L)	In.	121.05 - 121.65 (4.7657 - 4.7894)	—
	Ex.	122.02 - 122.62 (4.8039 - 4.8275)	—
Valve stem diameter (d)	In.	6.965 - 6.980 (0.2742 - 0.2748)	—
	Ex.	7.948 - 7.960 (0.3129 - 0.3134)	—
Valve face angle (α)	In.	45°30'	—
	Ex.	45°30'	—
Valve head margin (T)	In.	1.15 - 1.45 (0.0453 - 0.0571)	0.5 (0.020)
	Ex.	1.35 - 1.65 (0.0531 - 0.0650)	
Valve clearance		0 (0)	

GI  
MA  
EM  
LC  
EF & EC  
FE  
CL  
MT  
AT  
TF  
PD  
FA  
RA  
BR  
ST  
BF  
HA  
EL  
IDX

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING



SEM568A

EM120

Unit: mm (in)

	Standard	Limit
Cam height (A)	44.839 - 45.029 (1.7653 - 1.7728)	—
Valve lift (h)	10.4 (0.409)	—
Wear limit of cam height	—	0.2 (0.008)
Camshaft journal to bearing clearance	0.045 - 0.090 (0.0018 - 0.0035)	0.12 (0.0047)
Inner diameter of camshaft bearing	33.000 - 33.025 (1.2992 - 1.3002)	—
Outer diameter of camshaft journal (D)	32.935 - 32.955 (1.2967 - 1.2974)	—
Camshaft runout	0 - 0.02 (0 - 0.0008)	—
Camshaft end play	0.07 - 0.15 (0.0028 - 0.0059)	0.2 (0.008)
Valve timing (Degree on crankshaft)	a	248
	b	240
	c	3
	d	57
	e	12
	f	56

PISTON, PISTON RING AND PISTON PIN

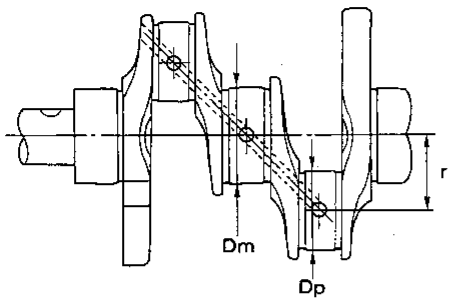
Piston pin

Unit: mm (in)

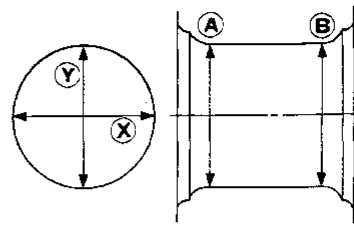
	Standard
Piston pin outer diameter	20.993 - 20.998 (0.8265 - 0.8267)
Pin to piston pin hole clearance	0.008 - 0.012 (0.0003 - 0.0005)
Piston pin to connecting rod clearance	-0.015 to -0.033 (-0.0006 to -0.0013)

Inspection and Adjustment (Cont'd)

CRANKSHAFT



Out-of-round (X - Y)  
Taper (A - B)



SEM394

EM715

Unit: mm (in)

Main journal diameter (Dm)	Grade	No. 0	59.967 - 59.975 (2.3609 - 2.3612)	
		No. 1	59.959 - 59.967 (2.3606 - 2.3609)	
		No. 2	59.951 - 59.959 (2.3603 - 2.3606)	
Pin journal diameter (Dp)	Grade	No. 0	49.968 - 49.974 (1.9672 - 1.9675)	
		No. 1	49.962 - 49.968 (1.9670 - 1.9672)	
		No. 2	49.956 - 49.962 (1.9668 - 1.9670)	
Center distance (r)		47.95 - 48.05 (1.8878 - 1.8917)		
Taper of journal and pin [(A) - (B)]	Journal	Standard	—	Limit 0.01 (0.0004)
	Pin	Standard	—	Limit 0.005 (0.0002)
Out-of-round of journal and pin [(X) - (Y)]	Journal	Standard	—	Limit 0.01 (0.0004)
	Pin	Standard	—	Limit 0.005 (0.0002)
Runout [TIR]*		Standard	—	Limit 0.10 (0.0039)
Free end play		0.05 - 0.18 (0.0020 - 0.0071)		Limit 0.3 (0.012)
Fillet roll		More than 0.1 (0.004)		

\* Total indicator reading

GI

MA

EM

LC

EF &  
EC

FE

CL

MT

AT

TF

PD

FA

RA

BR

ST

BF

HA

EL

IDX