

ENGINE MECHANICAL

SECTION **EM**

EM

MODIFICATION NOTICE:

GA engine

- The timing chain guide bolts and tightening torque have been changed.

SR engine

- The intake manifold, collector and rocker cover have been changed.
- The EGR system, crankcase ventilation oil separator and main bearing beam have been eliminated.
- The main bearing cap bolts tightening method has been changed.
- A roller rocker arm has been adopted.

CD engine

- The vacuum pump has been changed to a timing belt driven type.
- The EGR system has been added.
- The main bearing cap tightening torque has been changed.

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GA

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SR

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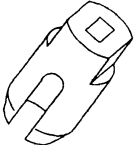
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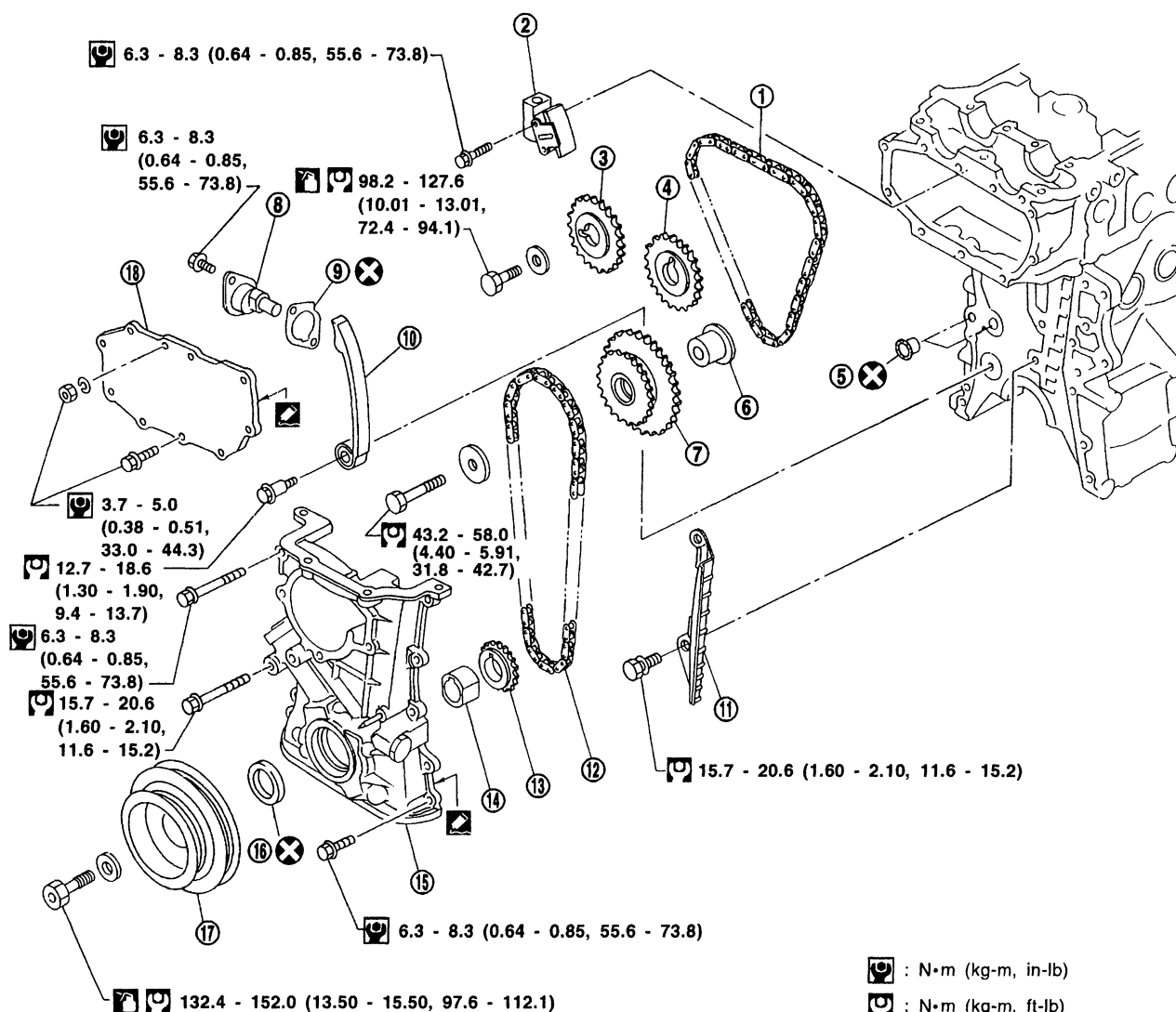
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PREPARATION

Special Service Tool

Tool number Tool name	Description	Engine application		
		GA	SR	CD
KV119E0010 Nozzle holder socket	 NT563	—	—	X

SEC. 111•120•130•135



: N•m (kg-m, in-lb)

: N•m (kg-m, ft-lb)

: Apply liquid gasket.

: Lubricate with new engine oil.

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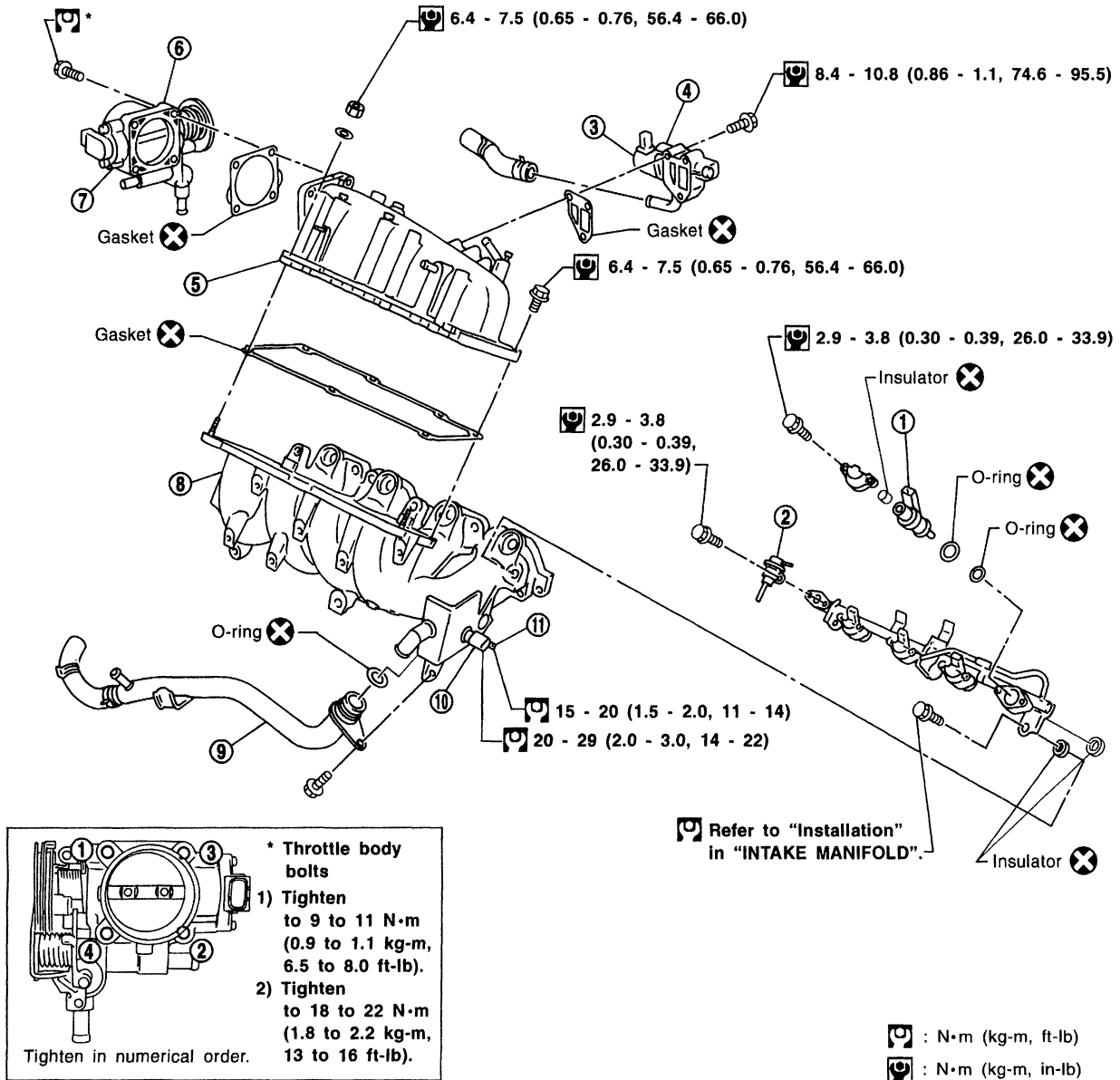
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|-------------------------------|---------------------------------|-----------------------------|
| ① Upper timing chain | ⑦ Idler sprocket | ⑬ Crankshaft sprocket |
| ② Upper chain tensioner | ⑧ Lower chain tensioner | ⑭ Oil pump drive spacer |
| ③ Camshaft sprocket (Intake) | ⑨ Gasket | ⑮ Front cover |
| ④ Camshaft sprocket (Exhaust) | ⑩ Slack side timing chain guide | ⑯ Oil seal |
| ⑤ O-ring | ⑪ Timing chain guide | ⑰ Crankshaft pulley |
| ⑥ Idler shaft | ⑫ Lower timing chain | ⑱ Cylinder head front cover |

[illegible]

- SEM376F

SEC. 140•163•164

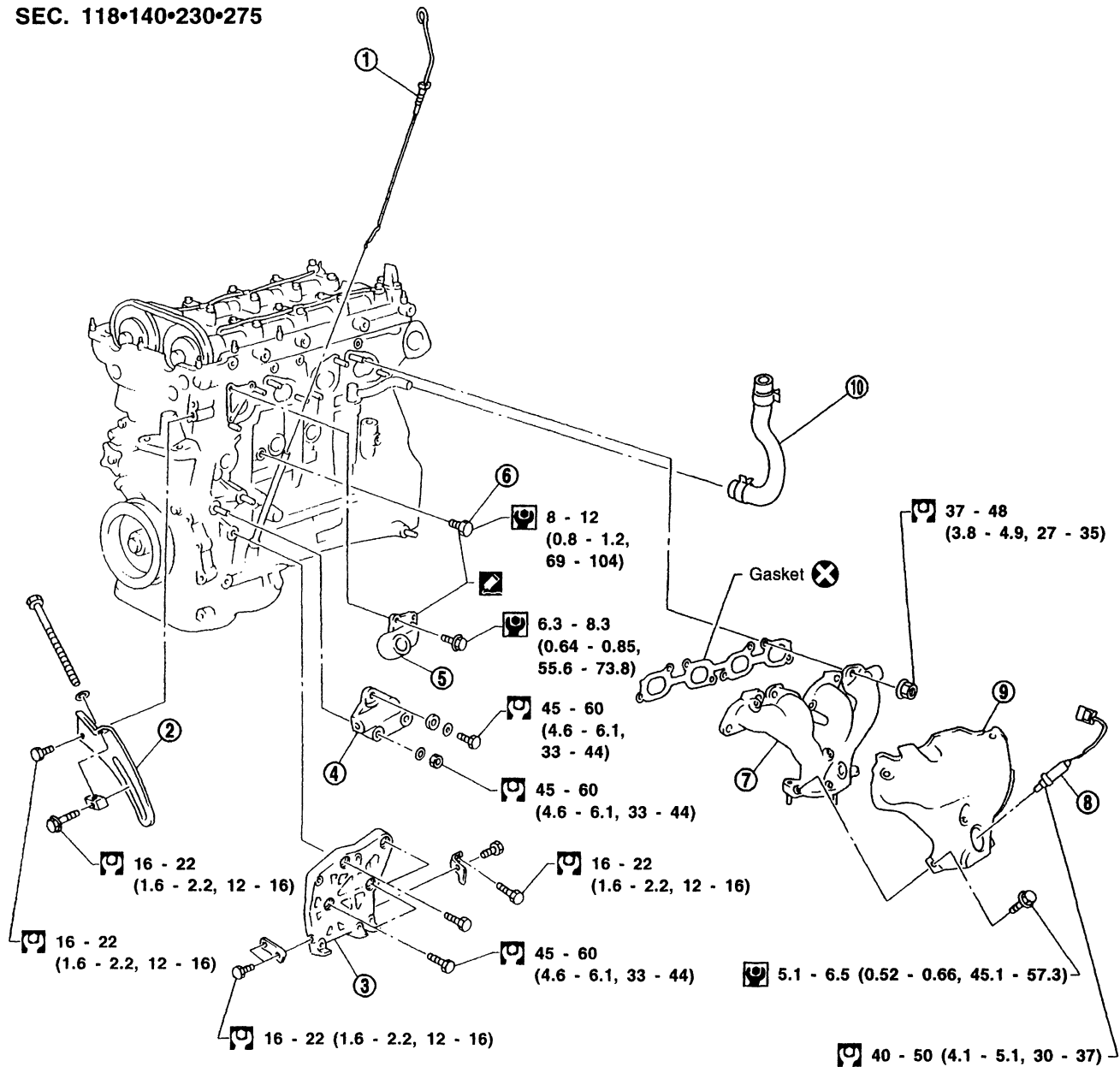
EM



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- | | | |
|----------------------------|-----------------------------|-------------------------------------|
| ① Injector | ⑤ Intake manifold collector | ⑨ Water pipe |
| ② Pressure regulator | ⑥ Throttle body | ⑩ Engine coolant temperature sensor |
| ③ IACV-AAC valve | ⑦ Throttle position sensor | ⑪ Thermal transmitter |
| ④ IACV-FICD solenoid valve | ⑧ Intake manifold | |

SEC. 118•140•230•275



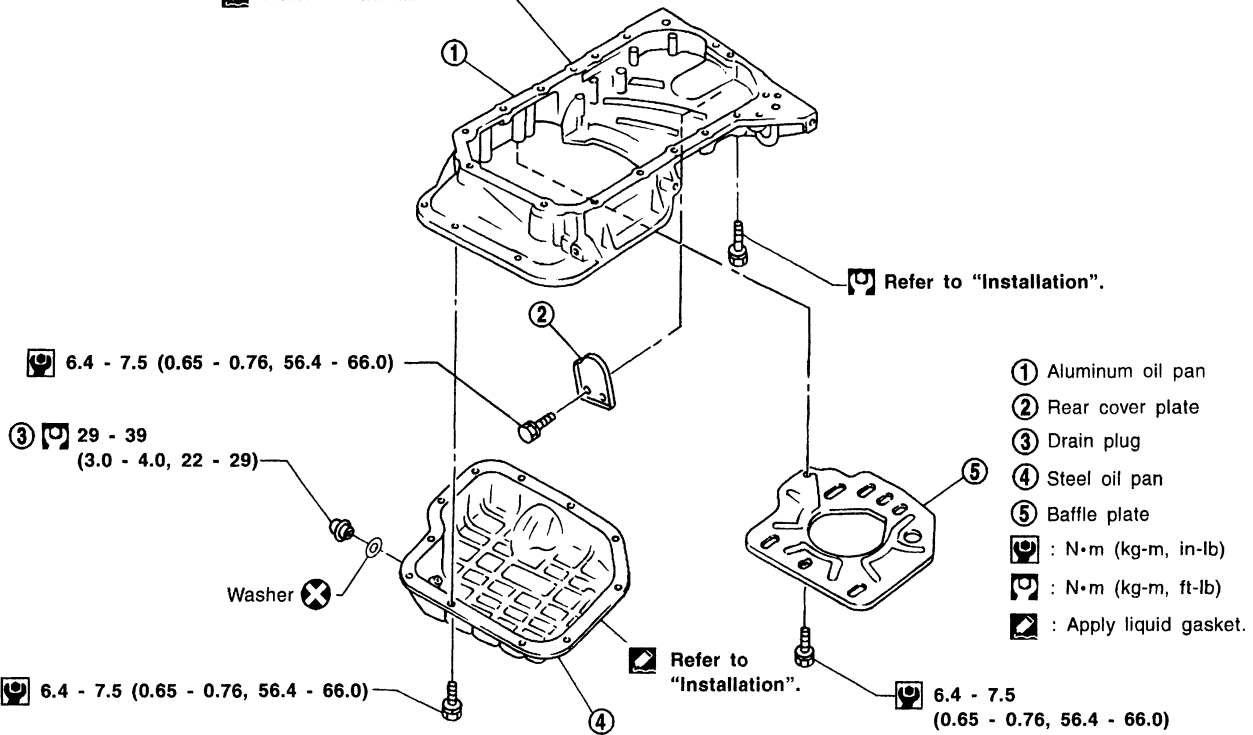
- : N•m (kg-m, in-lb)
- : N•m (kg-m, ft-lb)
- : Apply liquid gasket.

SEM378F

- | | | |
|----------------------------|--------------------|--------------------------|
| ① Oil level gauge | ⑤ Water outlet | ⑧ Heated oxygen sensor |
| ② Alternator adjusting bar | ⑥ Drain plug | ⑨ Exhaust manifold cover |
| ③ Compressor bracket | ⑦ Exhaust manifold | ⑩ Blow-by hose |
| ④ Alternator bracket | | |

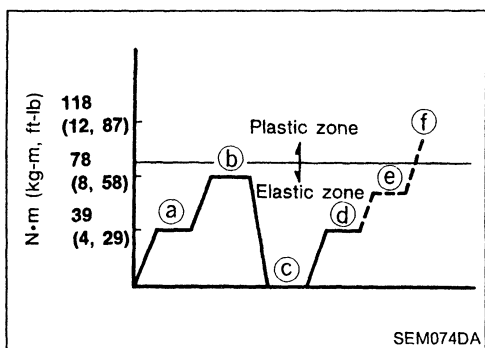
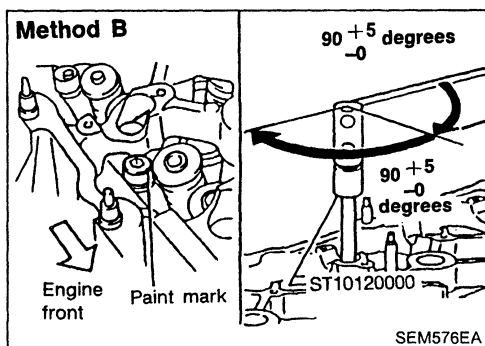
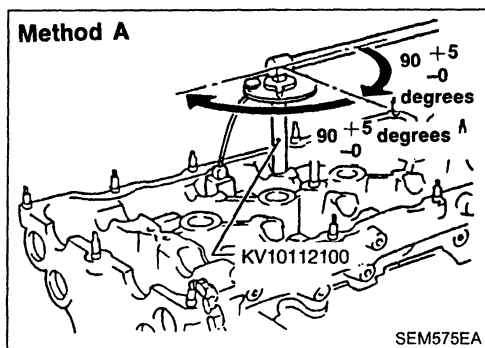
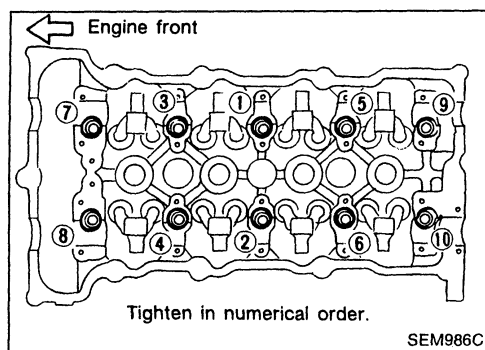
SEC. 110

Refer to "Installation".



EM

SEM379F



Installation

- Tightening procedure of cylinder head bolts
 - a. Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).
 - b. Tighten all bolts to 78 N·m (8.0 kg-m, 58 ft-lb).
 - c. Loosen all bolts completely.
 - d. Tighten all bolts to 39 N·m (4.0 kg-m, 29 ft-lb).
 - e. Method A: Turn all bolts 90 to 95 degrees clockwise with Tool or suitable angle wrench.
 - Method B: If angle wrench is not available, do the following. Mark the side of all bolts with paint marks facing the front of the engine. Then turn them 90 to 95 degrees clockwise.
 - f. Turn all bolts 90 to 95 degrees clockwise.
 - g. Ensure that paint mark on each bolt faces the rear of the engine. (Method B only)
- Do not turn any bolt 180 to 190 degrees clockwise all at once.

	Tightening torque N·m (kg-m, ft-lb)
(a)	39 (4.0, 29)
(b)	78 (8.0, 58)
(c)	0 (0, 0)
(d)	39 (4.0, 29)
(e)	90 - 95 degrees (90 degree preferred)
(f)	90 - 95 degrees (90 degree preferred)

Installation (Cont'd)

● Tightening procedure of camshaft bracket bolts

STEP 1:

RH camshaft

Tighten bolts ⑨ - ⑩ in that order then
tighten bolts ① - ⑧ in that order.

⌚: 2 N·m (0.2 kg-m, 1.4 ft-lb)

LH camshaft

Tighten bolts ⑪ - ⑫ in that order then
tighten bolts ① - ⑩ in that order.

⌚: 2 N·m (0.2 kg-m, 1.4 ft-lb)

STEP 2:

Tighten bolts in the specified order.

⌚: 6 N·m (0.6 kg-m, 4.3 ft-lb)

STEP 3:

Tighten bolts in the specified order.

Bolt type ① ②

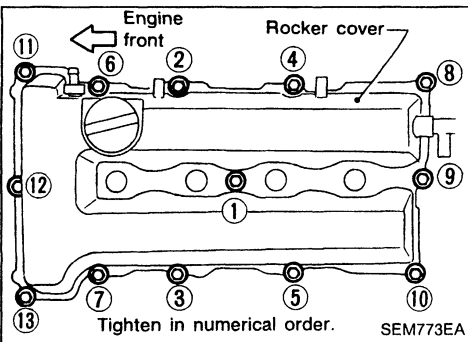
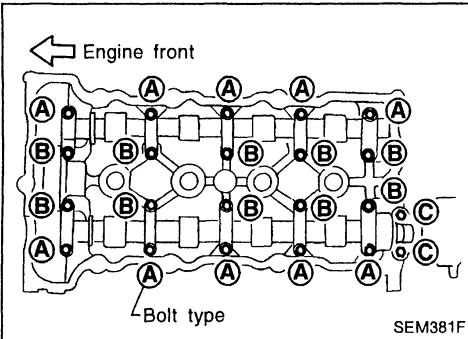
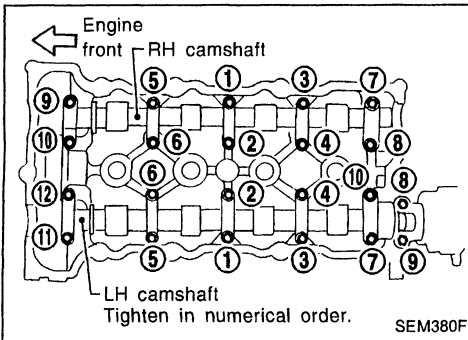
⌚: 9.8 - 11.8 N·m

(1.0 - 1.2 kg-m, 7.2 - 8.7 ft-lb)

Bolt type ③

⌚: 18 - 25 N·m

(1.8 - 2.6 kg-m, 13 - 19 ft-lb)



● Tightening procedure of rocker cover bolts

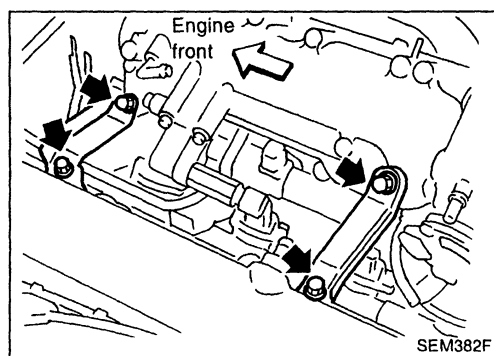
a. Tighten bolts ① - ⑩ - ⑪ - ⑬ - ⑧ in that order to 8 to 10 N·m (0.8 to 1.0 kg-m, 69 to 87 in-lb).

b. Tighten bolts ① through ⑬ in numerical order to 8 to 10 N·m (0.8 to 1.0 kg-m, 69 to 87 in-lb).

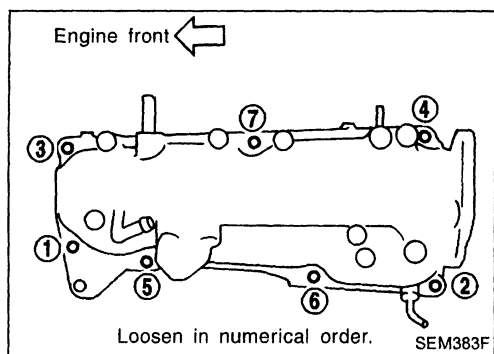
EM

Removal

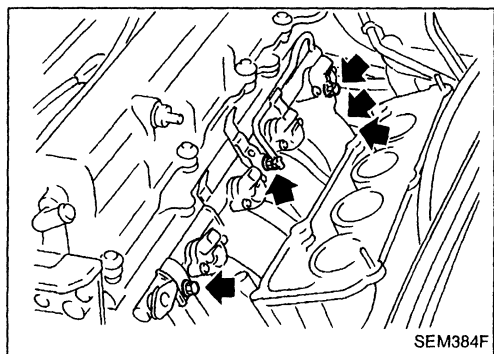
1. Release fuel pressure.
Refer to "Releasing Fuel Pressure" in EC section.
2. Remove engine undercover.
3. Remove front RH wheel and engine side cover.
4. Drain coolant.
5. Remove front tower bar.
6. Remove air duct from intake manifold.
7. Remove PCV hoses from rocker cover.
8. Remove vacuum hoses, fuel hoses, water hoses, wires, harnesses, connectors, etc. from intake manifold.
9. Remove drive belts and water pump pulley.
10. Remove power steering oil pump and oil pump bracket.
11. Remove power steering oil pump adjusting bar.
12. Remove oil filter bracket.



13. Remove intake manifold collector supports.



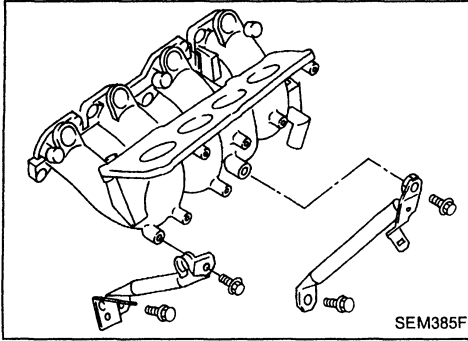
14. Remove intake manifold collector.



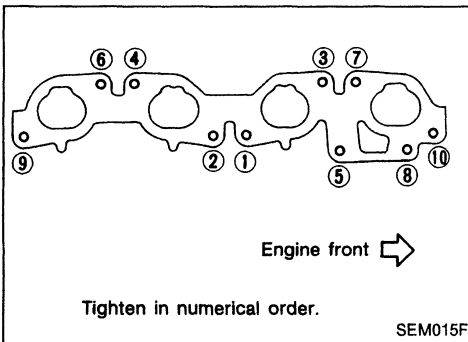
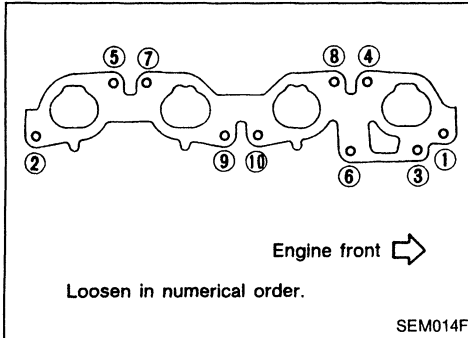
15. Remove harness connectors of engine coolant temperature sensor and thermal transmitter.
16. Remove fuel tube assembly.

Removal (Cont'd)

17. Remove intake manifold supports.



18. Remove intake manifold.

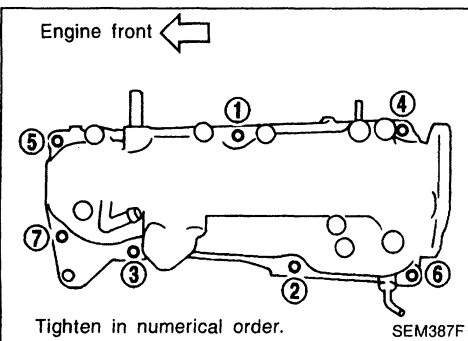


Installation

1. Install intake manifold.
2. Install intake manifold supports.



3. Install fuel tube assembly.
 - **Tighten bolts in two steps.**
 - 1st: 9.3 - 10.8 N·m (0.95 - 1.1 kg-m, 6.9 - 8.0 ft-lb)
 - 2nd: 21 - 26 N·m (2.1 - 2.7 kg-m, 15 - 20 ft-lb)
4. Connect harness connectors of engine coolant temperature sensor and thermal transmitter.



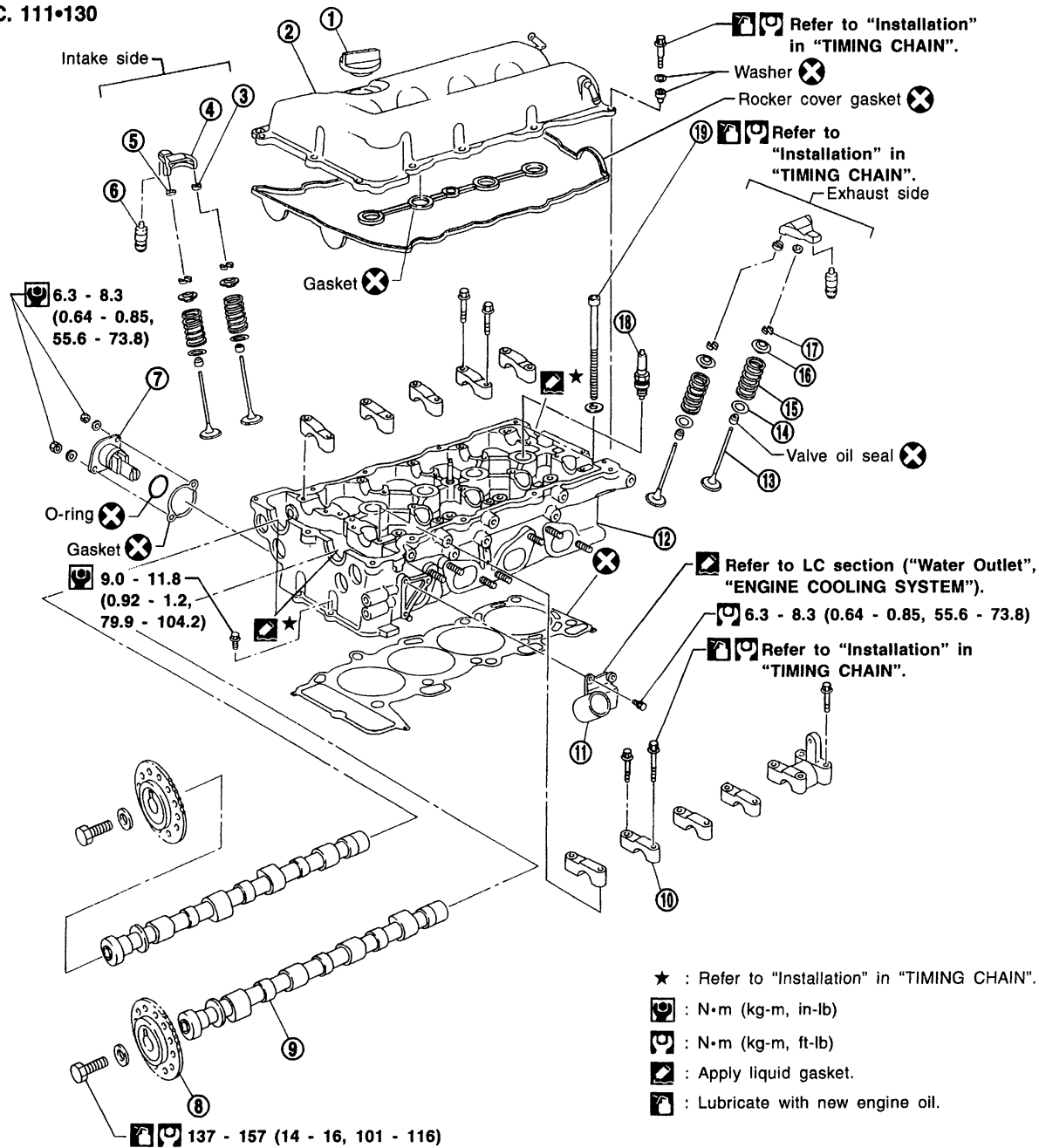
5. Install intake manifold collector and collector supports.

EM

Installation (Cont'd)

6. Reinstall any parts removed in reverse order of removal.

SEC. 111-130



EM

SEM388F

- ① Oil filler cap
- ② Rocker cover
- ③ Rocker arm guide
- ④ Rocker arm
- ⑤ Shim
- ⑥ Hydraulic lash adjuster
- ⑦ Chain tensioner

- ⑧ Camshaft sprocket
- ⑨ Camshaft
- ⑩ Camshaft bracket
- ⑪ Water outlet
- ⑫ Cylinder head
- ⑬ Valve

- ⑭ Valve spring seat
- ⑮ Valve spring
- ⑯ Valve spring retainer
- ⑰ Valve collet
- ⑱ Spark plug
- ⑲ Cylinder head bolt

SEC. 110•120•150

The diagram illustrates the assembly of an engine, showing the cylinder head, crankshaft, pistons, and oil pan. Components are numbered 1 through 24. Installation instructions are provided for various parts, including torque specifications and application of gasket or oil.

16 - 22 (1.6 - 2.2, 12 - 16)

6.3 - 8.3 (0.64 - 0.85, 55.6 - 73.8)

83 - 93 (8.5 - 9.5, 61 - 69)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

16 - 19 (1.6 - 1.9, 12 - 14)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

Refer to "Assembly".

Refer to "Assembly".

Refer to "Assembly".

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

29 - 39 (3.0 - 4.0, 22 - 29)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

6.4 - 7.5 (0.65 - 0.76, 56.4 - 66.0)

★ : Refer to LC section.

★★ : Refer to "Installation" in "OIL PAN".

N•m (kg-m, in-lb)

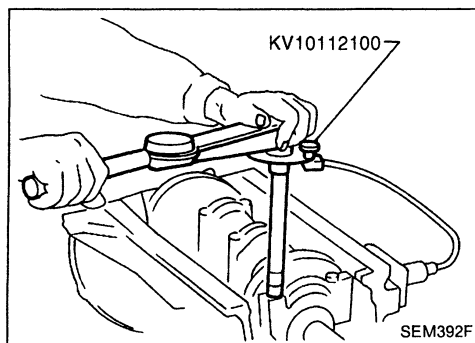
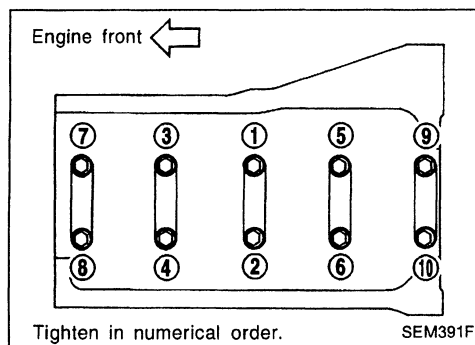
N•m (kg-m, ft-lb)

Apply liquid gasket.

Lubricate with new engine oil.

SEM389F

- SEM389F



Assembly

- Tightening procedure of main bearing cap bolts
- Apply new engine oil to thread of bearing cap bolts.
- Prior to tightening bearing cap bolts, shift crankshaft back and forth to properly seat the bearing cap.
- Tightening procedure
 - a. Tighten all bolts to 7 to 13 N·m (0.7 to 1.3 kg-m, 5.1 to 9 ft-lb).
 - b. Turn all bolts 75 to 80 degrees clockwise with Tool or suitable angle wrench.
 - c. Loosen all bolts completely.
 - d. Tighten all bolts to 32 to 38 N·m (3.3 to 3.9 kg-m, 24 to 28 ft-lb).
 - e. Turn all bolts 30 to 35 degrees clockwise with Tool or suitable angle wrench.
- If an angle wrench is not available, mark all bearing cap bolts on the side facing engine rear. Then, turn each bolt specified degrees clockwise. Confirm angle of degrees with a graduator, not by eye-measurement.
- After securing bearing cap bolts, make sure crankshaft turns smoothly by hand.

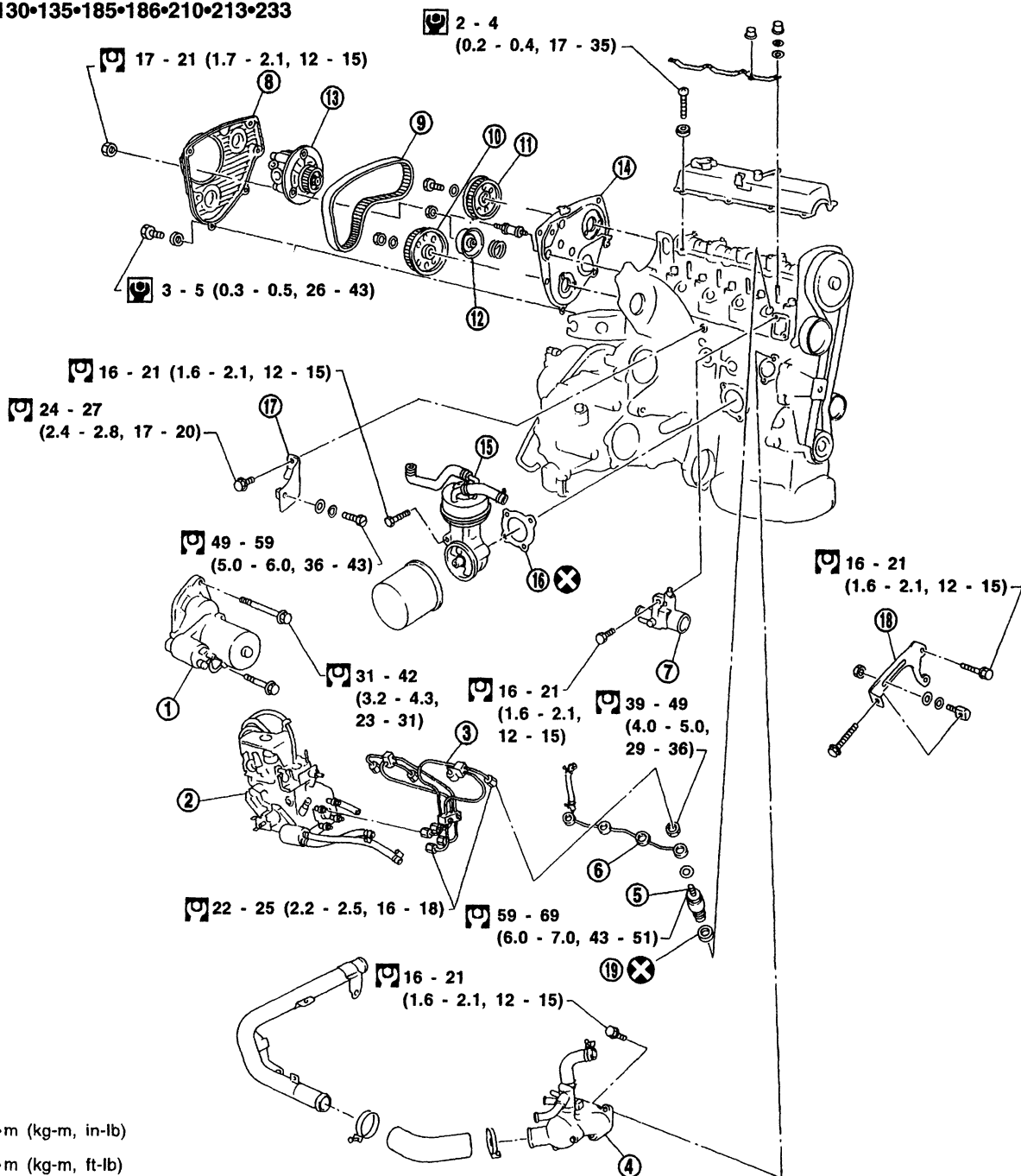
EM

OUTER COMPONENT PARTS

CD

Right side

SEC. 130•135•185•186•210•213•233



SEM396F

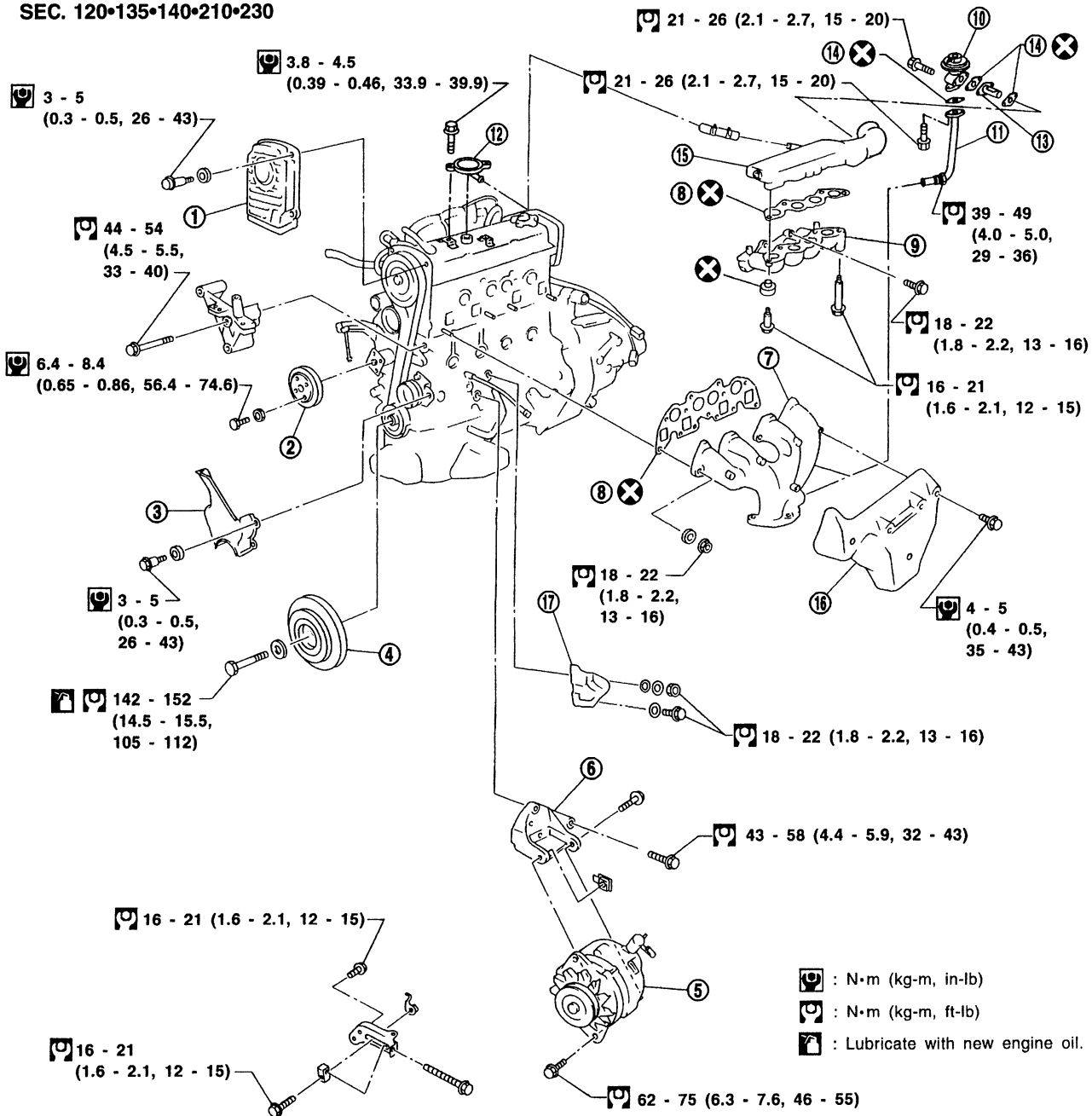
- ① Starter motor
- ② Injection pump
- ③ Injection tube
- ④ Thermostat housing
- ⑤ Injection nozzle
- ⑥ Spill tube
- ⑦ Water outlet

- ⑧ Belt cover
- ⑨ Timing belt
- ⑩ Injection pump sprocket
- ⑪ Rear camshaft sprocket
- ⑫ Tensioner
- ⑬ Vacuum pump
- ⑭ Rear back cover

- ⑮ Oil cooler
- ⑯ Gasket
- ⑰ Bracket
- ⑱ Power steering oil pump adjusting bar
- ⑲ Gasket

Left side

SEC. 120•135•140•210•230



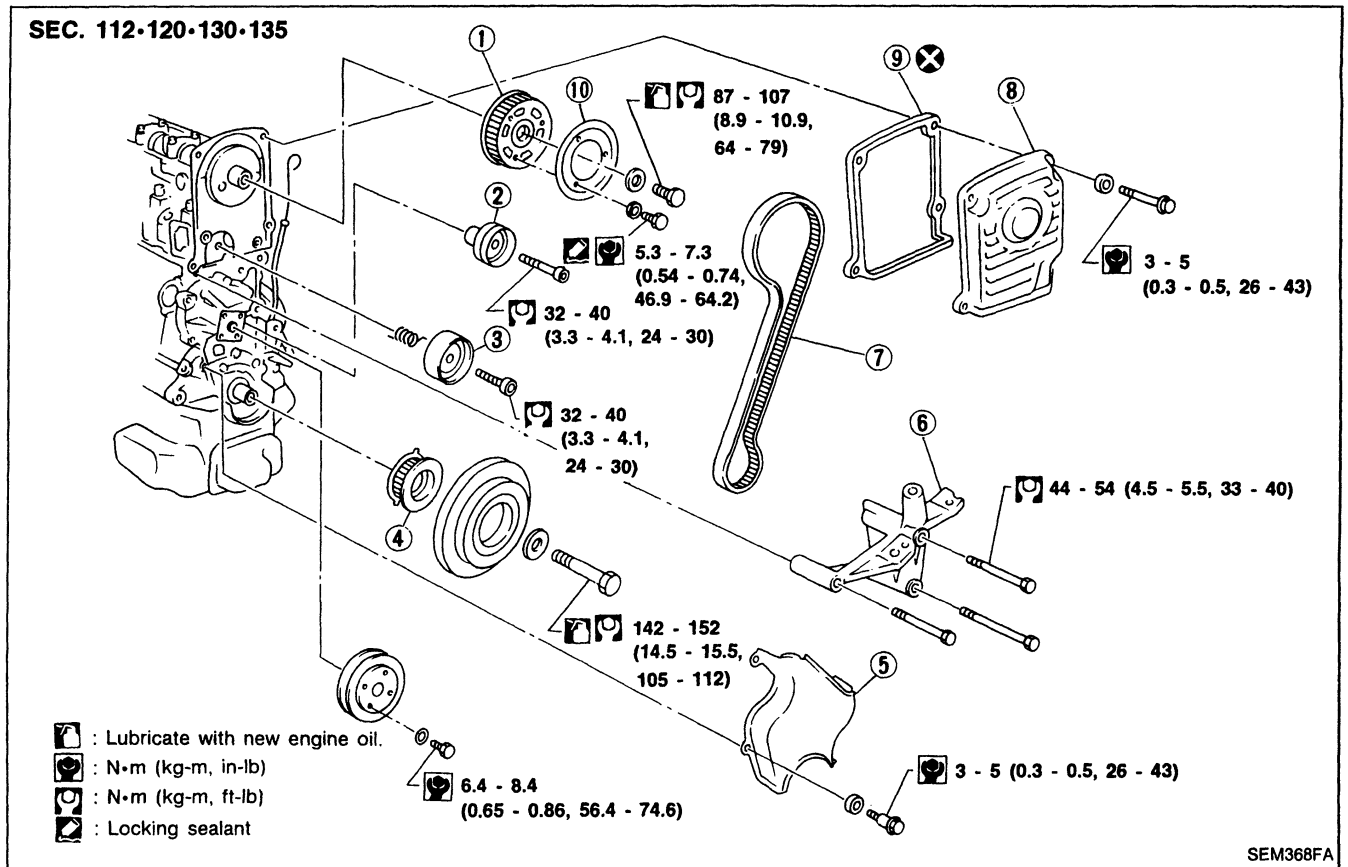
EM

- | | | |
|----------------------|-----------------------------|---|
| ① Belt cover upper | ⑦ Exhaust manifold | ⑬ EGR passage (To install, face EGR gas discharge port upward.) |
| ② Water pump pulley | ⑧ Gasket | ⑭ Gasket |
| ③ Belt cover lower | ⑨ Intake manifold | ⑮ Intake manifold collector |
| ④ Crankshaft pulley | ⑩ EGR valve | ⑯ Exhaust manifold cover |
| ⑤ Alternator | ⑪ EGR tube | ⑰ Heat insulator |
| ⑥ Alternator bracket | ⑫ Blow-by gas control valve | |

SEM374F

Camshaft Timing Belt

SEC. 112-120-130-135

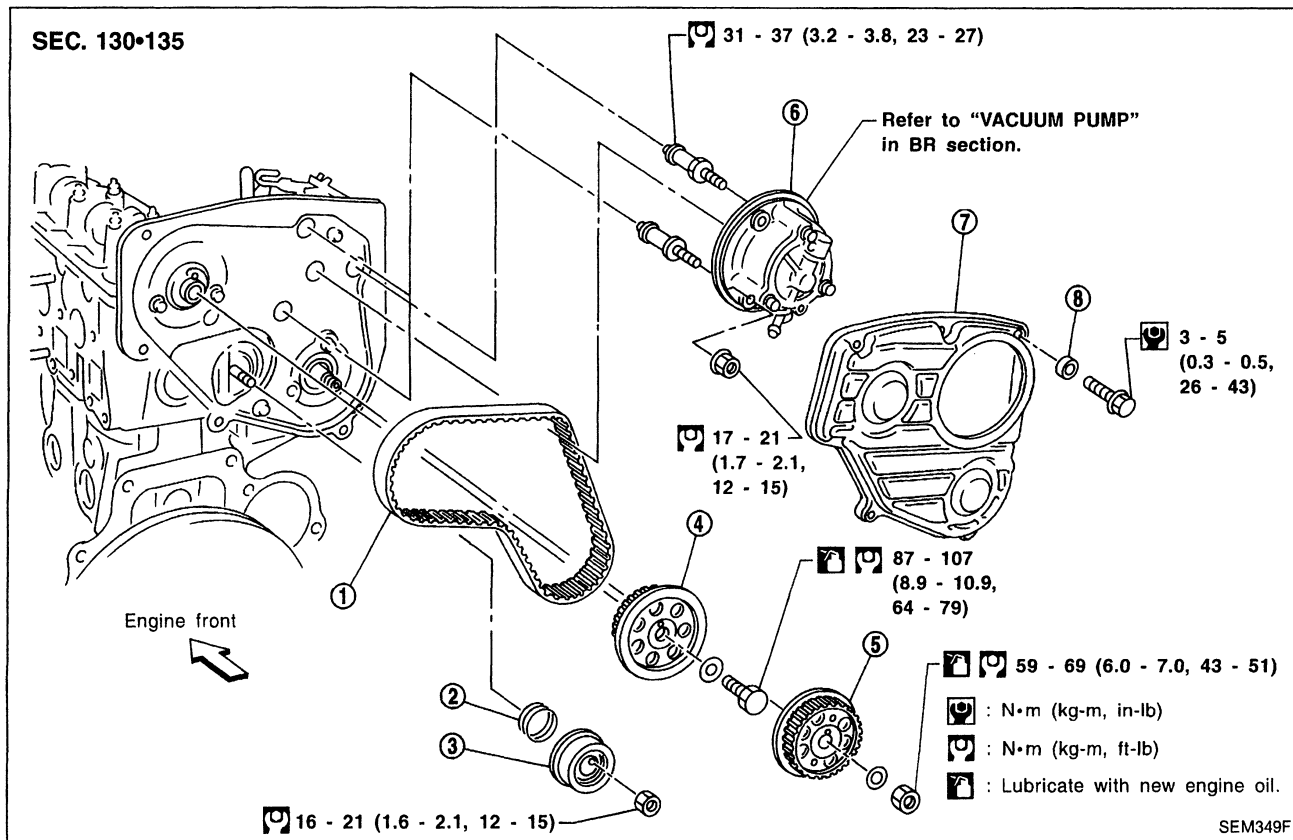


- ① Front camshaft sprocket
- ② Idler
- ③ Belt tensioner
- ④ Crankshaft sprocket

- ⑤ Belt cover lower
- ⑥ Belt cover center (Engine mounting bracket)
- ⑦ Timing belt

- ⑧ Belt cover upper
- ⑨ Gasket
- ⑩ Front camshaft sprocket plate

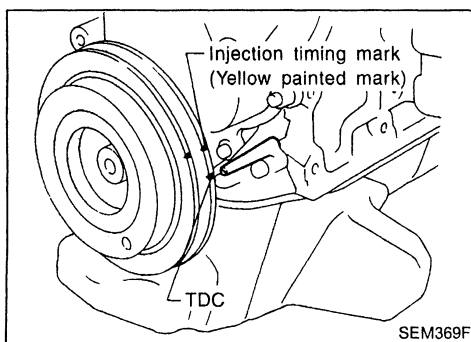
Injection Pump Timing Belt



- | | | |
|--------------------|---------------------------|---------------------|
| ① Timing belt | ④ Rear camshaft sprocket | ⑦ Timing belt cover |
| ② Tensioner spring | ⑤ Injection pump sprocket | ⑧ Grommet |
| ③ Tensioner | ⑥ Vacuum pump | |

REMOVAL

1. Remove battery from engine room.
2. Remove air cleaner case, air duct and resonator.
3. Disconnect all piping connections from vacuum pump. Refer to "VACUUM PUMP" in BR section.
4. Remove water pipe mounting bolt under injection pump timing belt cover, then remove water pipe.
5. Remove timing belt cover.



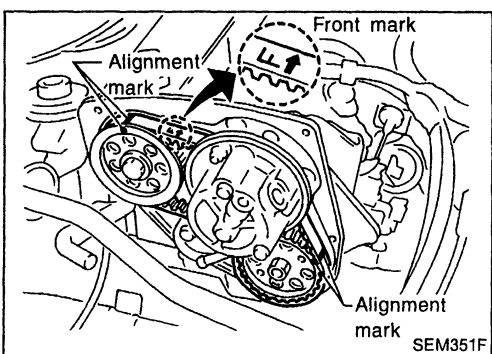
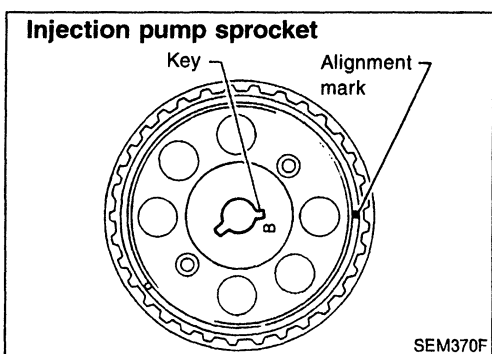
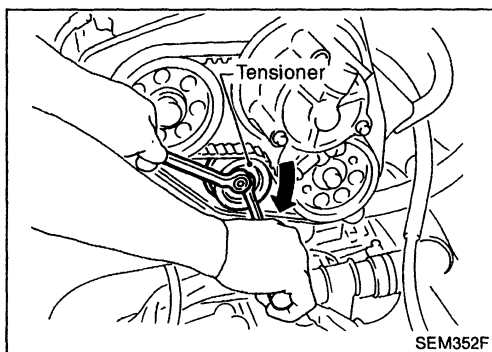
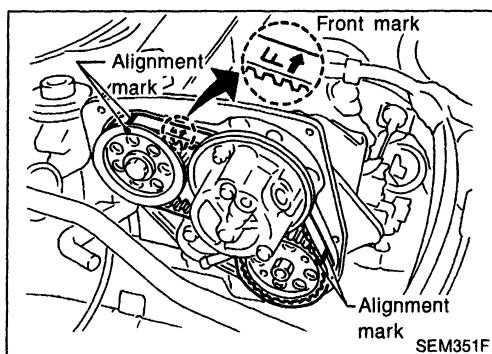
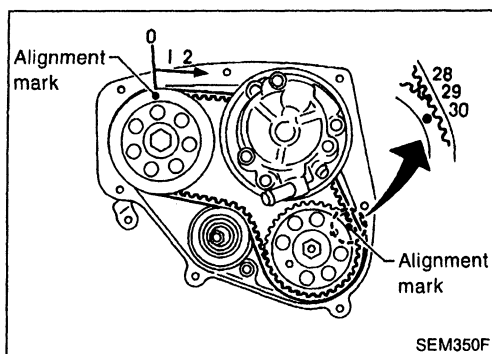
6. Set No. 1 cylinder at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)

TIMING BELT

CD

Injection Pump Timing Belt (Cont'd)

- Make sure that alignment marks of rear camshaft sprocket and injection pump sprocket are positioned as shown.



7. Apply alignment marks on the back of timing belt according to rear camshaft sprocket and injection pump sprocket alignment marks. Also apply a front mark on the back of timing belt.

8. Loosen tensioner mounting nut. Using a screwdriver, turn tensioner in direction of arrow to release belt tension.
9. Remove vacuum pump.
10. Remove timing belt.

INSTALLATION

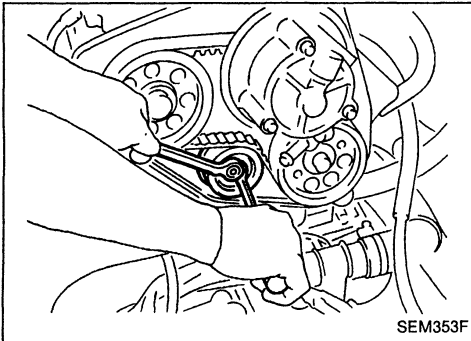
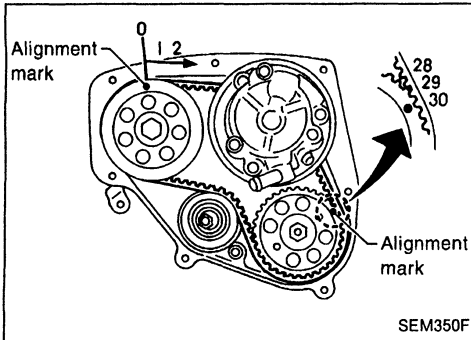
1. Confirm that No. 1 piston is set at TDC on its compression stroke. (TDC is indicated by crankshaft pulley notch without painted mark.)
- If injection pump sprocket was removed, confirm that it is re-installed as illustrated.

Identification of alignment:

Use mark "B"

2. Install timing belt.
 - 1) Set timing belt with the front mark facing front of engine.
 - 2) Install vacuum pump.
 - 3) Position timing belt matching the alignment marks with rear camshaft sprocket and injection pump sprocket alignment marks.

Injection Pump Timing Belt (Cont'd)



3. Adjust belt tension.

- 1) Loosen tensioner lock nut to apply tension to timing belt.
- Make sure that all sprocket and timing belt alignment marks are positioned as shown.

2) Rotate crankshaft clockwise two turns.

Do not turn crankshaft by camshaft sprockets.

- 3) Tighten tensioner lock nut while holding tensioner with a screwdriver.

Belt tension:

98 ± 49 N (10 ± 5 kg, 22 ± 11 lb)

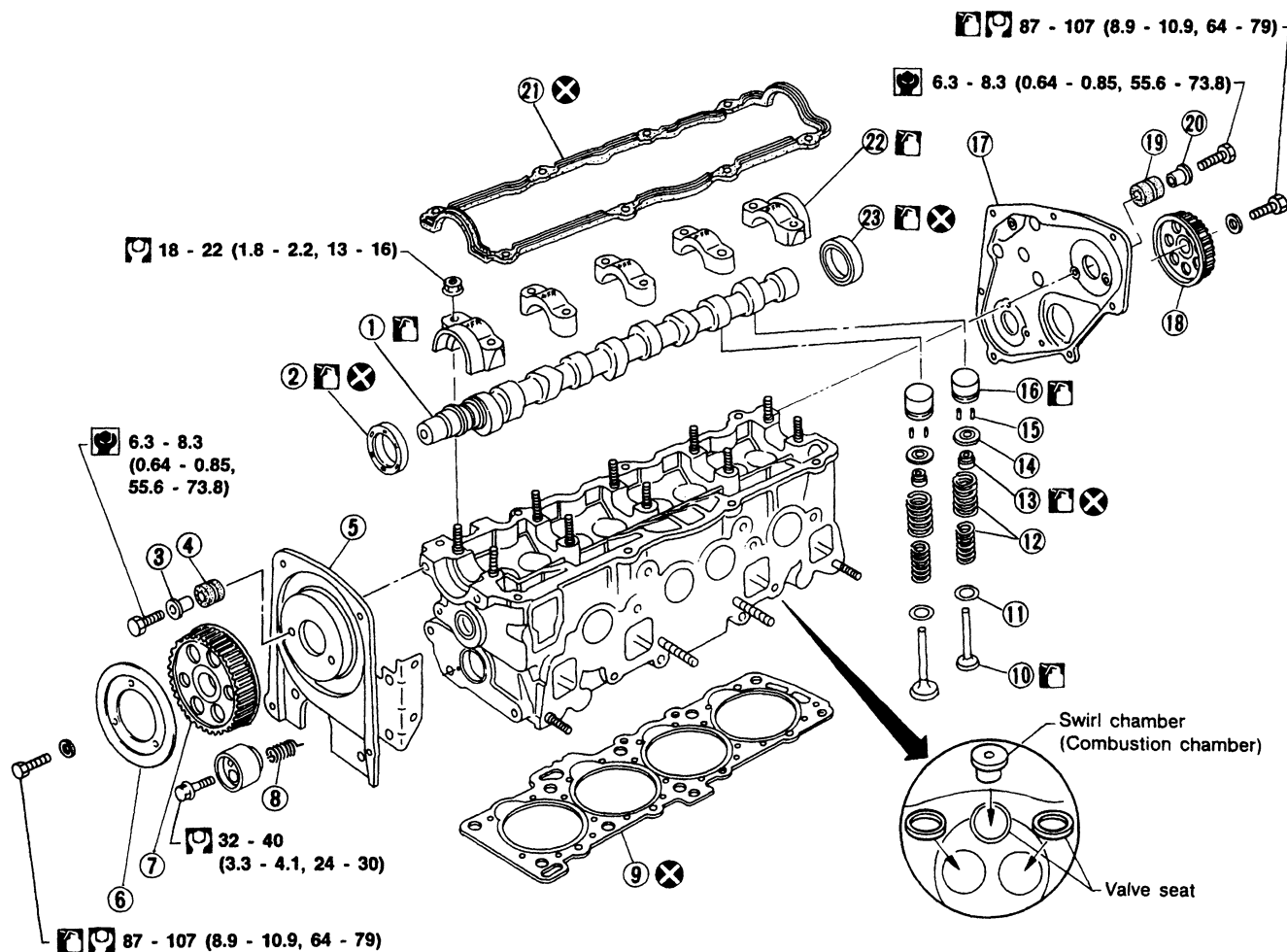
4. Install timing belt cover.
5. Install remaining parts in the reverse order of removal.

EM

CYLINDER HEAD

CD

SEC. 111-130-135

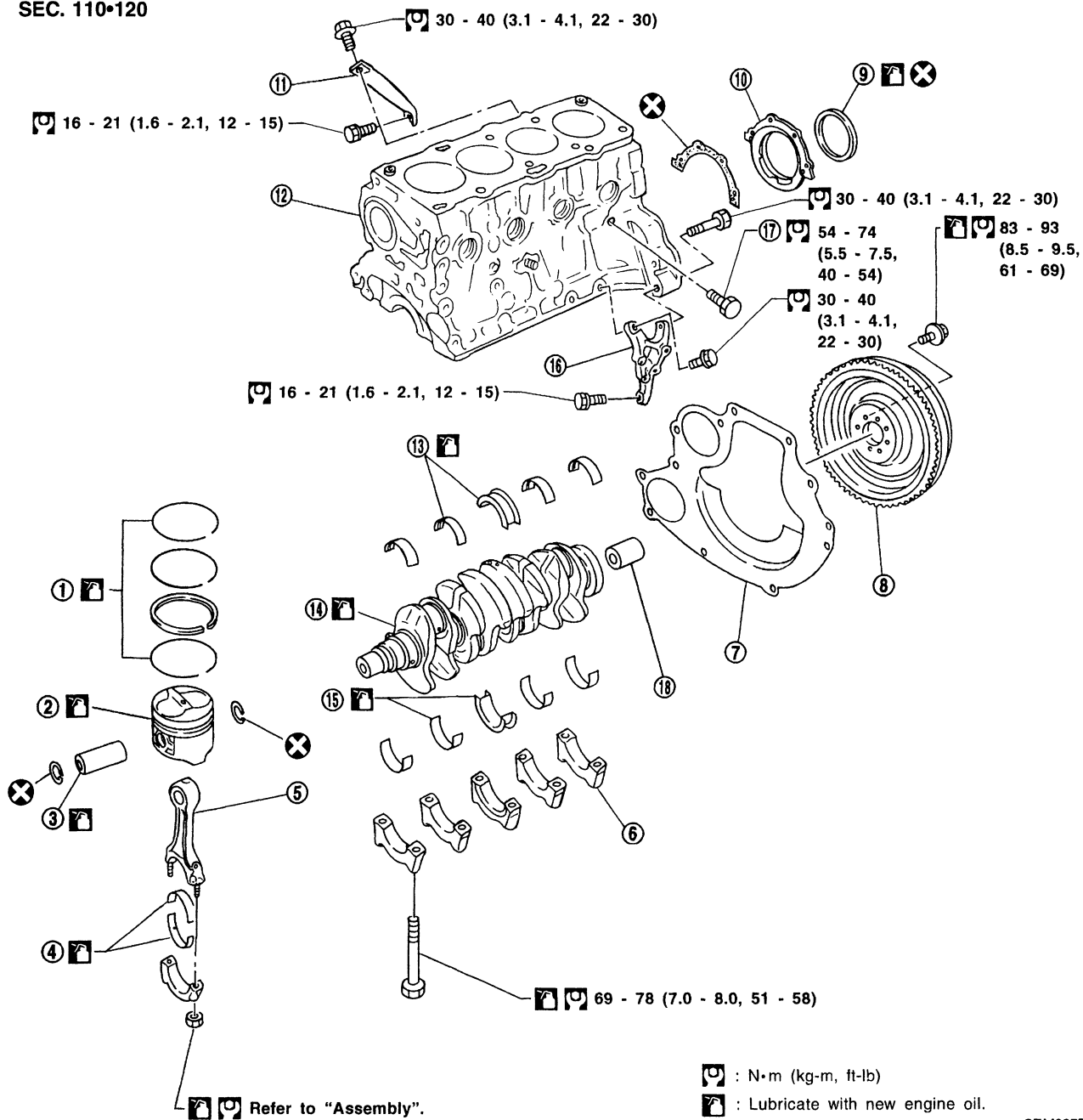


- : N•m (kg-m, in-lb)
- : N•m (kg-m, ft-lb)
- : Lubricate with new engine oil.

SEM356FA

- | | | |
|---------------------------------|---|--------------------------|
| ① Camshaft | ⑨ Selective cylinder head gasket | ⑯ Hydraulic valve lifter |
| ② Front oil seal | ⑩ Valve | ⑰ Rear back cover |
| ③ Collar | ⑪ Spring seat | ⑱ Rear camshaft sprocket |
| ④ Grommet | ⑫ Valve spring | ⑲ Grommet |
| ⑤ Front back cover | ⑬ Valve oil seal | ⑳ Collar |
| ⑥ Front camshaft sprocket plate | ⑭ Spring retainer (INT)/Valve rotator (EXH) | ㉑ Rocker cover gasket |
| ⑦ Front camshaft sprocket | ⑮ Valve cotter | ㉒ Cam bracket |
| ⑧ Spring | | ㉓ Rear oil seal |

SEC. 110•120



EM

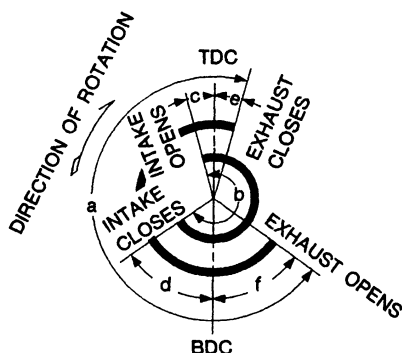
- ① Piston ring
- ② Piston
- ③ Piston pin
- ④ Connecting rod bearing
- ⑤ Connecting rod
- ⑥ Main bearing cap

- ⑦ Rear plate
- ⑧ Flywheel
- ⑨ Rear oil seal
- ⑩ Rear oil seal retainer
- ⑪ Gusset
- ⑫ Cylinder block

- ⑬ Main bearing
- ⑭ Crankshaft
- ⑮ Main bearing
- ⑯ Gusset
- ⑰ Drain plug
- ⑱ Pilot bushing

General Specifications

Valve timing



EM120
Unit: degree

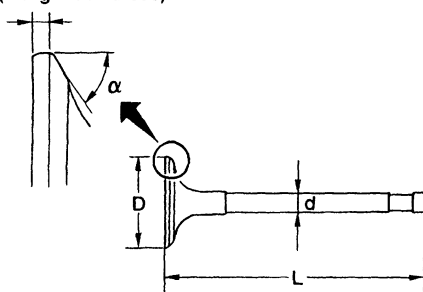
a	b	c	d	e	f
232°	244°	2°	62°	7°	45°

Inspection and Adjustment

VALVE

Unit: mm (in)

T (Margin thickness)



SEM188A

Valve head diameter "D"

Intake	34.0 - 34.3 (1.339 - 1.350)
Exhaust	30.0 - 30.3 (1.181 - 1.193)

Valve length "L"

Intake	98.19 - 98.61 (3.8657 - 3.8823)
Exhaust	99.11 - 99.53 (3.9020 - 3.9185)

Valve stem diameter "d"

Intake	5.965 - 5.980 (0.2348 - 0.2354)
Exhaust	5.945 - 5.960 (0.2341 - 0.2346)

Valve seat angle "α"

Intake	45°15' - 45°45'
Exhaust	

Valve margin "T"

Intake	1.1 (0.043)
Exhaust	1.3 (0.051)

Valve margin "T" limit

More than 0.5 (0.020)

Valve stem end surface grinding limit

Less than 0.2 (0.008)

Valve spring

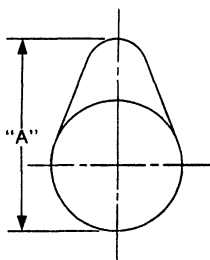
Free height	mm (in)	47.53 (1.8713)
Pressure	N (kg, lb) at height mm (in)	
Standard		519 - 571 (52.9 - 58.2, 116.7 - 128.4) at 27.0 (1.063)
Limit		493.05 (50.291, 110.838) at 27.0 (1.063)
Out-of-square	mm (in)	Less than 2.1 (0.083)

Inspection and Adjustment (Cont'd)

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Limit
Camshaft journal to bearing clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.15 (0.0059)
Inner diameter of camshaft bearing	28.000 - 28.021 (1.1024 - 1.1032)	—
Outer diameter of camshaft journal	27.935 - 27.955 (1.0998 - 1.1006)	—
Camshaft runout [TIR*]	Less than 0.02 (0.0008)	0.1 (0.004)
Camshaft sprocket runout [TIR*]	Less than 0.25 (0.0098)	—
Camshaft end play	0.055 - 0.139 (0.0022 - 0.0055)	0.20 (0.0079)



EM671

Cam height "A"

Intake	37.989 - 38.179 (1.4956 - 1.5031)
Exhaust	37.309 - 37.499 (1.4689 - 1.4763)
Wear limit of cam height	0.2 (0.008)
Valve lift	
Intake	10.0 (0.394)
Exhaust	9.2 (0.362)

*Total indicator reading

PISTON RING AND PISTON PIN

Piston ring

Unit: mm (in)

Side clearance	
Top	
Standard	0.040 - 0.080 (0.0016 - 0.0031)
Limit	0.2 (0.008)
2nd	
Standard	0.030 - 0.070 (0.0012 - 0.0028)
Limit	0.2 (0.008)
Ring gap	
Top	
Standard	0.20 - 0.30 (0.0079 - 0.0118)
Limit	1.0 (0.039)
2nd	
Standard	0.35 - 0.50 (0.0138 - 0.0197)
Limit	1.0 (0.039)
Oil	
Standard	0.20 - 0.60 (0.0079 - 0.0236)
Limit	1.0 (0.039)

Piston pin

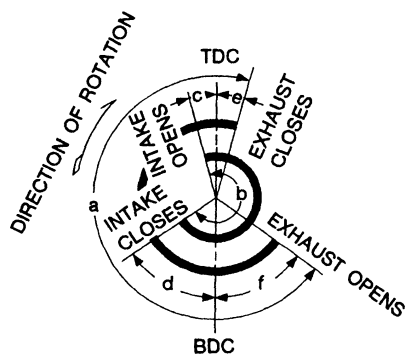
Unit: mm (in)

Piston pin outer diameter	21.989 - 22.001 (0.8657 - 0.8662)
Interference fit of piston pin to piston	0.002 - 0.006 (0.0001 - 0.0002)
Piston pin to connecting rod bushing clearance	
Standard	0.005 - 0.017 (0.0002 - 0.0007)
Limit	0.023 (0.0009)

* Values measured at ambient temperature of 20°C (68°F)

General Specifications

Valve timing



EM120
Unit: degree

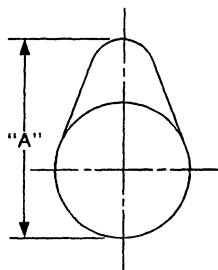
a	b	c	d	e	f
248°	232°	14°	38°	12°	56°

Inspection and Adjustment

CAMSHAFT AND CAMSHAFT BEARING

Unit: mm (in)

	Standard	Max. tolerance
Camshaft journal clearance	0.045 - 0.086 (0.0018 - 0.0034)	0.1 (0.004)
Inner diameter of camshaft bearing	30.000 - 30.021 (1.1811 - 1.1819)	—
Outer diameter of camshaft journal	29.935 - 29.955 (1.1785 - 1.1793)	—
Camshaft runout	Less than 0.02 (0.0008)	0.05 (0.0020)
Camshaft end play	0.115 - 0.188 (0.0045 - 0.0074)	—



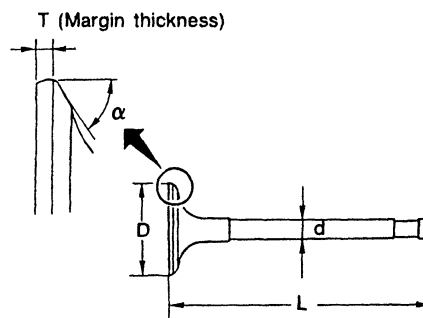
EM671

Cam height "A"

Intake	48.70 - 48.75 (1.9173 - 1.9193)
Exhaust	49.15 - 49.20 (1.9350 - 1.9370)

VALVE

Unit: mm (in)



SEM188

Valve head diameter "D"

Intake	39.0 - 39.3 (1.535 - 1.547)
Exhaust	32.0 - 32.3 (1.260 - 1.272)

Valve length "L"

Intake	99.53 - 99.97 (3.9185 - 3.9358)
Exhaust	99.38 - 99.82 (3.9126 - 3.9299)

Valve stem diameter "d"

Intake	6.965 - 6.980 (0.2742 - 0.2748)
Exhaust	6.945 - 6.960 (0.2734 - 0.2740)

Valve seat angle "α"

Valve seat angle "α"	45°30'
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Valve margin "T" limit

Valve margin "T" limit	0.5 (0.020)
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Valve stem end surface grinding limit

Valve stem end surface grinding limit	0.5 (0.020)
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Inspection and Adjustment (Cont'd)

Valve spring

Free height	mm (in)	
Outer		42.25 (1.6634)
Inner		36.57 (1.4398)
		Standard
Assembled height	mm/N (mm/kg, in/lb)	
Outer		35.1/164.76 (35.1/16.80, 1.382/37.04)
Inner		31.6/71.98 (31.6/7.34, 1.244/16.18)
Out-of-square "S"	mm (in)	
Outer		Less than 1.8 (0.071)
Inner		Less than 1.6 (0.063)

EM