

CHAPTER EN

ENGINE

Model F21C

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DSY100A
TSY100A
OCY100A
DMY100A
MPY100A
LSY100A
FSY100A
CSY100A
IEY100A
CPY100A
TUY100A

DATA AND SPECIFICATION

Model	F21C	
Type	Diesel, 4 cycle, 8 cylinder, V, overhead valve, water-cooled, direct injection	
Aspiration	Natural aspiration	
Bore and stroke	150 x 147 mm {5.91 x 5.79 in.}	
Piston displacement	20.781 L {1,268 cu.in.}	
Compression ratio	19.2: 1	
Firing order	1-8-4-2-7-3-6-5 (The cylinder numbers are counted in order from the timing gear side.)	
Direction of rotation	Counterclockwise viewed from flywheel	
Compression pressure	2.9–3.2 MPa {30–33 kgf/cm ² , 426–469 lbf/in. ² } at 200 r/min.	
Maximum revolution (at full load)	2,200 r/min.	
Idling revolution	500 - 550 r/min.	
Dry weight	Approx. 1,300 kg {2,866 lb}	
Valve seat angle	Intake	30°
	Exhaust	45°
Valve face angle	Intake	30°
	Exhaust	45°
Valve timing (flywheel travel)	Intake opens	14° before top dead center
	Intake closes	38° after bottom dead center
	Exhaust opens	52° before bottom dead center
	Exhaust closes	17° after top dead center
Valve clearance (when cold)	Intake	0.50 mm {0.0197 in.}
	Exhaust	0.70 mm {0.0276 in.}
Engine oil pump	Full forced pressure feed by gear pump	
Type	By gear	
Drive		
Engine oil cooler	Multi-plate type, water cooled	
Injection nozzle	Multi-hole nozzle type	
Type	1st : 14.7 MPa {150 kgf/cm ² , 2,133 lbf/in. ² }	
Valve opening pressure	2nd: 21.6 MPa {220 kgf/cm ² , 3,128 lbf/in. ² }	
Coolant pump	Forced circulation by volute pump	
Type	By gear	
Drive		
Thermostat	Wax type, bottom bypass system	
Type		
Injection timing (flywheel travel)	4° before top dead center for No. 1 cylinder of the compression stroke	

TROUBLESHOOTING

Symptom	Possible cause	Remedy/Prevention
Engine overheating	Coolant	
	• Insufficient coolant	Add coolant.
	• Defective thermostat	Replace thermostat.
	• Coolant overflow due to leakage of exhaust into cooling system	Repair.
	• Coolant leakage from cylinder head gasket ...	Replace gasket.
	• Defective coolant pump	Repair or replace.
	Radiator	
	• Clogged with rust or scale	Clean radiator.
	• Clogged with iron oxide due to leakage of exhaust into cooling system	Clean coolant passage and correct exhaust leakage.
	• Clogged radiator core due to mud or other debris	Clean radiator.
	• Defective radiator cap pressure valve	Replace radiator cap.
	Abnormal combustion	
	• Incorrect injection timing	Adjust injection timing.
	• Reduced injection pressure	Adjust injection pressure.
	• Poor fuel	Use good quality fuel.
• Poor nozzle spray	Adjust or replace nozzle.	
• Unsatisfactory automatic timer advance angle .	Repair or replace timer.	
Other problems		
• Defective or deteriorated engine oil	Change engine oil.	
• Unsatisfactory operation of oil pump	Replace or repair.	
• Insufficient oil	Add oil.	
• Brake drag	Repair or adjust.	
Excessive oil consumption	Pistons, cylinder liners, and piston rings	
	• Wear of piston ring and cylinder liner	Replace piston rings and cylinder liner.
	• Worn, sticking or broken piston rings	Replace piston rings and cylinder liner.
	• Insufficient tension on piston rings	Replace piston rings and cylinder liner.
	• Unsatisfactory braking in of piston rings	Replace piston rings and cylinder liner.
	• Unsuitable oil (viscosity too low)	Change oil as required and replace piston rings and cylinder liners.
	• Incorrectly fitted piston rings (upside down)	Replace piston rings.
• Gaps of piston rings in line with each other ...	Reassemble piston rings.	

<u>Symptom</u>	<u>Possible cause</u>	<u>Remedy/Prevention</u>
Excessive oil consumption	Valve and valve guides	
	• Worn valve stem	Replace valve and valve guide.
	• Worn valve guide	Replace valve guide.
	• Incorrectly fitted valve stem seal	Replace the stem seal.
	• Excessive lubricant on rocker arm	Check clearance of rocker arm and shaft.
	Excess oil feed	
	• Defective oil level gauge	Replace oil level gauge.
	• Oil level too high	Drain excess oil.
	Other problems	
	• Overcooled engine (low temperature wear) ...	Warm up engine before moving vehicle. Check cooling system.
• Oil leakage from miscellaneous parts	Repair.	
Piston seizure	Operation	
	• Abrupt stoppage of engine after running	Operate engine properly at high speed
	• Hill climbing using unsuitable gear	Select suitable gear.
	Oil	
	• Insufficient oil	Add oil.
	• Dirty oil	Change oil.
	• Poor quality oil	Replace with proper engine oil.
	• High oil temperature	Repair.
	• Low oil pressure	Repair.
	• Defective oil pump	Repair oil pump.
	• Reduced performance due to worn oil pump	Replace oil pump.
	• Suction strainer sucking air	Add oil and/or repair strainer.
	• Abnormal combustion	See Symptom: "Engine overheating".
Coolant	See Symptom: "Engine overheating".	
Lack of power	Injection pump	Refer to CHAPTER TE, TOTAL ELECTRONICS SYSTEM.
	Intake	
	• Clogged air cleaner	Clean element or replace element.
	Overheating	See Symptom: "Engine overheating".

Symptom	Possible cause	Remedy/Prevention
Lack of power	Fuel and nozzle	
	• Poor nozzle spray	Adjust or replace injection nozzle.
	• Clogged nozzle with carbon	Clean nozzle.
	• Wear or seizure of nozzle	Replace nozzle.
	• Air in fuel system	Repair and bleed air from fuel system.
	• Clogged fuel filter	Replace element.
	• Use of poor fuel	Use good quality fuel.
	Abnormal combustion	See Symptom: "Engine over-heating".
	Piston, cylinder liners, and piston rings	See Symptom: "Engine over-heating".
Difficult starting engine	Electrical system	
	• Discharged battery	Charge battery.
	• Defective wiring in starter circuit	Repair wiring of starter.
	• Loose or open-circuit battery cable	Tighten battery terminal connections or replace battery cable.
	• Broken glow plug or intake air heater (If fitted)	Replace.
	Injection pump	Refer to CHAPTER TE, TOTAL ELECTRONICS SYSTEM.
	Air cleaner	
	• Clogged element	Clean the element or replace the element.
	Fuel system	
	• No fuel in tank	Supply fuel and bleed air from fuel system.
	• Clogged fuel line	Clean fuel line.
	• Air sucked into fuel system through fuel line connections	Tighten fuel line connections.
• Clogged fuel filter	Replace element.	
• Loose connection in high-pressure line	Tighten sleeve nut of high-pressure line.	
• Water in fuel	Drain and clean fuel system.	

<u>Symptom</u>	<u>Possible cause</u>	<u>Remedy/Prevention</u>
Difficulty starting engine	Nozzles	
	• Seized nozzle Replace nozzle.	
	• Broken or fatigued nozzle spring Replace spring.	
	Oil system	
	• Oil viscosity too high Use proper viscosity oil, or install an oil immersion heater and warm up oil.	
	Other problems	
	• Seized piston Replace piston, piston rings, and liner.	
	• Seized bearing Replace bearing and/or crankshaft.	
	• Reduced compression pressure Overhaul engine.	
	• Ring gear damaged or worn Replace the ring gear and/or starter pinion.	
• Improperly adjusted or broken Adjust or replace the accelerator cable		
Rough idling	Injection pump	Refer to CHAPTER TE, TOTAL ELECTRONICS SYSTEM.
	Nozzles	
	• Uneven injection pressure Adjust.	
	• Poor nozzle spray Adjust or replace nozzle.	
	• Carbon deposit on nozzle tip Remove carbon.	
	• Seized needle valve Replace nozzle.	
	Engine proper	
	• Improper valve clearance Adjust valve clearance.	
	• Improper contact of valve seat Replace or repair valve and valve seat.	
	• Idling speed too low Warm up engine.	
• Compression pressure of cylinders Overhaul engine. markedly different from one another		
Leakage of exhaust	Cylinder head gasket	
	• Fatigued gasket (aging) Replace gasket.	
	• Damage Replace gasket.	
	• Improper installation Replace gasket.	

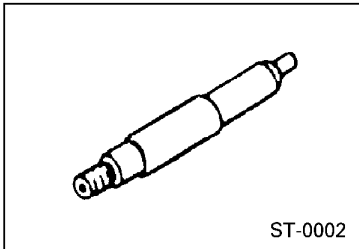
Symptom	Possible cause	Remedy/ Prevention
Leakage of exhaust	Cylinder head bolts	
	• Loose bolts	Tighten bolt.
	• Elongated bolts	Replace bolt.
	• Improper tightening torque or tightening sequence	Tighten properly.
	Cylinder block	
	• Cracking	Replace cylinder block.
	• Surface distortion	Repair or replace.
	• Fretting of cylinder liner insertion portion (insufficient projection of cylinder liner)	Replace cylinder liner or cylinder block.
	Cylinder head	
	• Cracking	Replace cylinder head.
	• Surface distortion	Repair or replace.
	Cylinder liners	
	• Cracking	Replace cylinder liner.
	• Corrosion	Replace cylinder liner.
	• Insufficient projection of cylinder liner	Replace cylinder liner.
Other problems		
• Incorrect injection timing	Adjust injection timing.	

ENGINE OVERHAUL CRITERIA

SPECIAL TOOL

Prior to starting an engine overhaul, it is necessary to have these special tools.

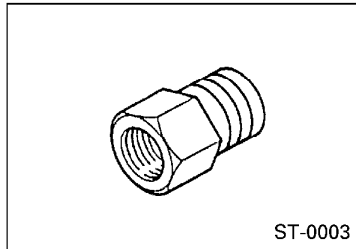
COMPRESSION GAUGE ADAPTER (A)



ST-0002

09552-1080

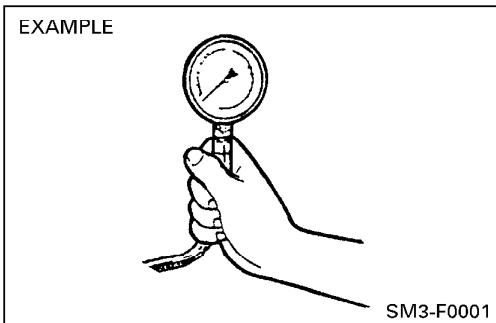
COMPRESSION GAUGE ADAPTER (B)



ST-0003

09552-1030
09552-1060] for F-Series

EXAMPLE



SM3-F0001

FACTORS TO DETERMINE THE ENGINE OVERHAUL.

LOW COMPRESSION PRESSURE

- a. Before measurement
 - a) Set the valve clearance to the correct value.
 - b) Idle the engine (Water temperature at 80°C {176°F}).
 - c) Charge the battery completely.
 - d) Remove the air cleaner.
- b. Measurement

Measure at nozzle holder hole.

 - a) Remove the nozzle holders.
 - b) Install the compression gauge adapter (A) and (B) into the nozzle holder hole.
 - c) While the starter switch is at the "OFF" position, disconnect the engine stop motor harness.
 - d) Connect a compression gauge to the gauge adapter.
 - e) Run the engine with the starter and measure the compression pressure.

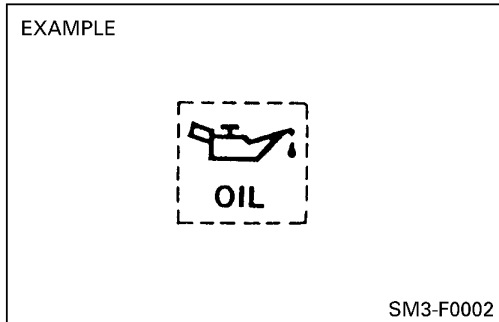
NOTE: Do not operate the starter for more than 15 seconds.

- f) Measure the compression pressure for each cylinder. If the compression pressure is low, be sure to repeat the measuring.

NOTE: Do not allow gas leakage from the seal face.

Unit: MPa {kgf/cm², lbf/in.²}

Engine models	Compression pressure		Difference between each cylinder	Engine speed (r/min)
	Standard	Limit		
F21C	2.9–3.2 {30–33, 427–469}	2.55 {26, 369}	0.294 {3, 43} or less	200



- c. After measurement
Make sure that the engine starter switch is in “OFF” position and then connect the engine stop motor harness.

WARNING

When the engine starter switch is “ON”, do not connect the engine stop motor connector. Connection operates the engine stop motor (motor link is at “OFF” position) and the lever may catch your finger.

ENGINE OIL PRESSURE

Check the oil pressure warning lamp when the oil and coolant temperature is hot [about 80°C {176°F}].

- a. If the warning lamp is lit, check the oil level.
- b. Check oil deterioration.
If oil quality is poor, replace with a suitable grade oil.
- c. Remove the oil pressure switch and install the oil pressure gauge.
- d. Measure the oil pressure at coolant temperature 80°C {176°F} or more.

Standard oil pressure: 49–490 kPa
{0.5–5.0 kgf/cm², 7.11–71.10 lbf/in.²}
Service limit: Less than 49 kPa {0.5 kgf/cm², 7.11 lbf/in.²}

S.A.E. GRADE	ATMOSPHERIC TEMPERATURE							
	-10	0	32	50	70	90	100	°F
	-23	-18	0	10	21	32	39	°C
40								
30								
20W-20								
15W-40								

OTHER FACTORS

- a. Increase of blowby gas
- b. Defective engine start
- c. Decrease of engine output
- d. Increase of fuel consumption
- e. Increase of engine noise
- f. Increase of oil consumption

ENGINE ASSEMBLY DISMOUNTING AND MOUNTING

IMPORTANT POINT – DISMOUNTING

DISMOUNT THE ENGINE ASSEMBLY.

1. Park the vehicle on level place, apply the parking brake, and block the wheels.
2. Tilt the cab.
3. Drain coolant from the radiator and cylinder block, and engine oil from the oil pan.

WARNING

To avoid the danger of burns, do not drain the coolant and engine oil while the engine and radiator are still hot.

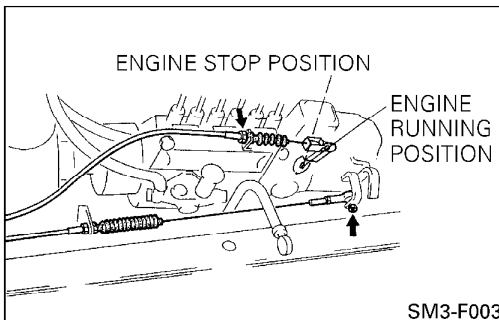
4. Disconnect the power steering hydraulic lines and drain fluid.

NOTE: Refer to CHAPTER PS, POWER STEERING for details.

5. Disconnect the engine stop cable.
 - a) Set the engine starter switch to the "ON" position.

NOTE:

- o Do not start the engine.
- o Clacking the engine stop inner cable by turning the engine starter switch to the "ON" position facilitate dismantling, mounting and adjustment of the cable.



- b) Make sure that the engine stop lever of the fuel injection pump is in the engine running position, then disconnect the connectors of the engine stop motor harness.
 - c) Set the engine starter switch to the "OFF" position.
6. Disconnect the electric lines, fuel lines, air lines, speedometer cable, accelerator control cables.

NOTE:

- o Disconnect the battery cable from the negative terminal (-) of the battery and then disconnect the electric lines.
- o Cover open ends of the pipes, hoses and pumps to prevent entry of dirt.

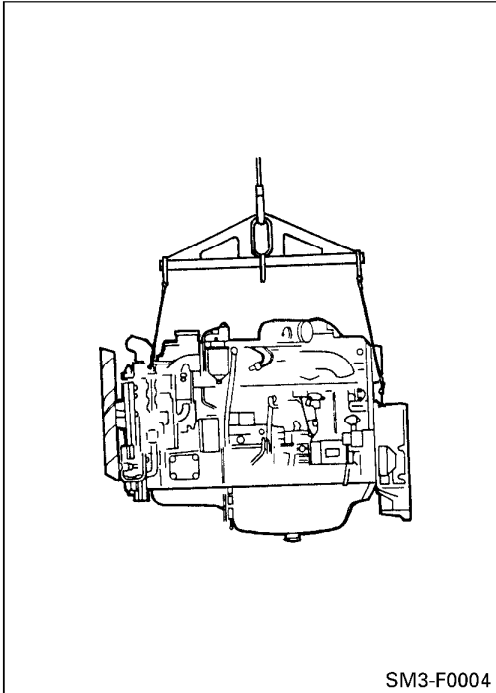
7. Disconnect the hoses (coolant, heater and air intake) and remove the radiator.

NOTE: Do not damage the radiator core.

8. Disconnect the air intake and exhaust lines.
9. Disconnect the transmission control and transmission with clutch housing from the flywheel housing.

NOTE: Refer to CHAPTER TC, TRANSMISSION CONTROL and CHAPTER TM, TRANSMISSION for details.

10. Remove the cab mounting member from the frame.



11. Connect a cable from an engine hanger to the hanger bracket (1 point) on the front of the engine, and to the hanger brackets (2 points) on the upper flywheel housing at the rear of the engine. Using a hoist, raise the hanger until there is a bit of slack in the cables.

Engine Weight: Refer to section DATA AND SPECIFICATIONS.

12. Remove the engine mounting fitting nuts (front and rear, both sides).
13. Lift the engine hanger so that the cables are fully tightened, and then, after checking that the cables are securely lit gently and remove the engine from the vehicle.

IMPORTANT POINTS – MOUNTING

MOUNT THE ENGINE ASSEMBLY.

Mount the engine assembly in the reverse order of dismounting.

NOTE: Check to see that there are no oil leaks, fuel leaks, coolant leaks or air leaks.

CONNECT THE ENGINE STOP CABLE.

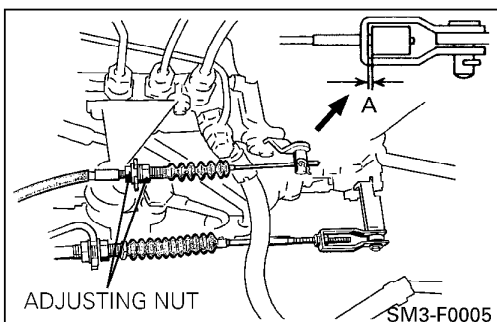
1. Set the engine starter switch to the "ON" position.

NOTE: Do not start the engine.

2. Connect the connectors of the engine stop motor harness.

WARNING

Do not connect the electric harness to the engine stop motor while the engine starter switch to the "OFF" or "ACC" position as this operates the engine stop motor instantaneously and the link lever of the engine stop motor and the engine stop lever of the injection pump move, resulting in your fingers being caught by the lever.

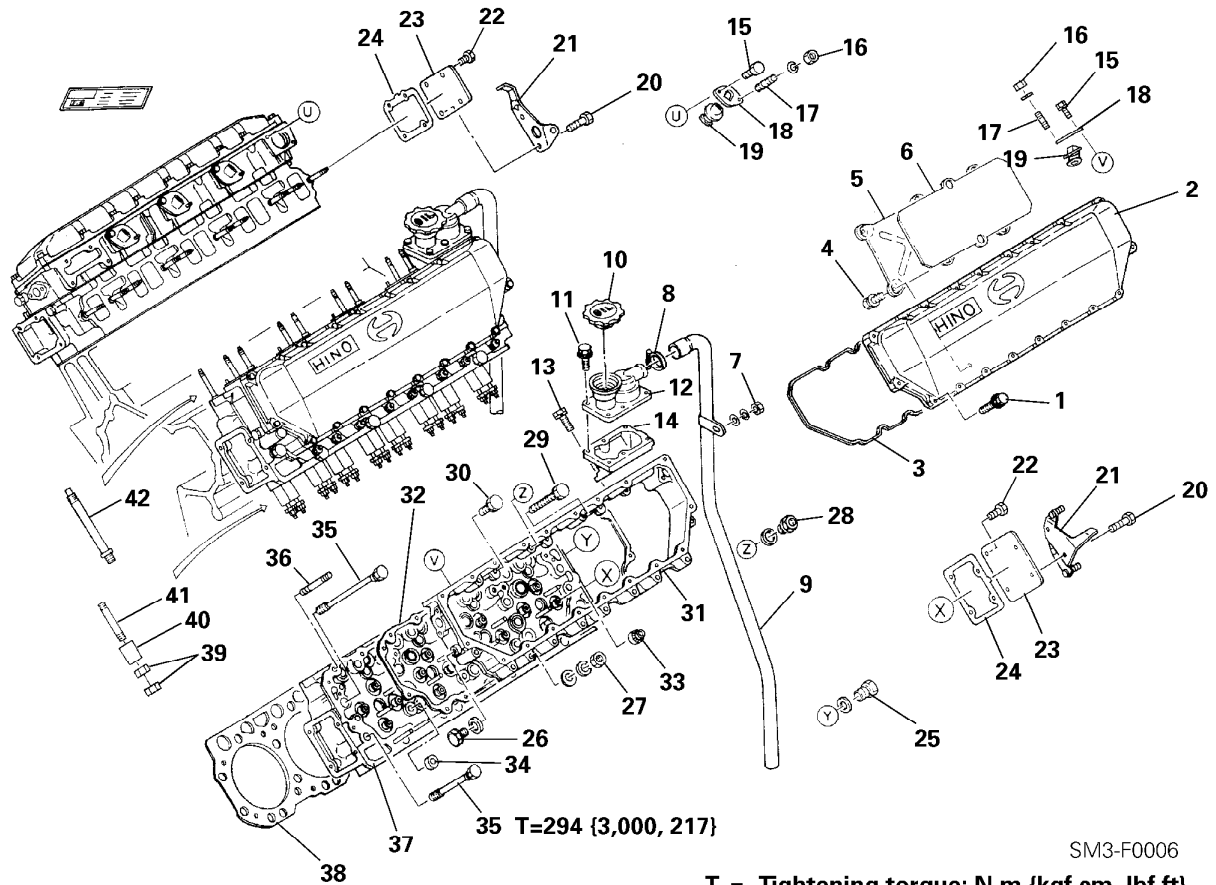


3. Connect and adjust the engine stop cable with adjusting nut so that the clearance "A" between the clevis and cable stopper is 1–3 mm {0.04–0.11 in.}.
4. Set the starter switch to the "OFF" position.

NOTE: After adjustment, confirm correct execution of engine start and stop.

ENGINE MOVING PARTS CYLINDER HEAD

OVERHAUL

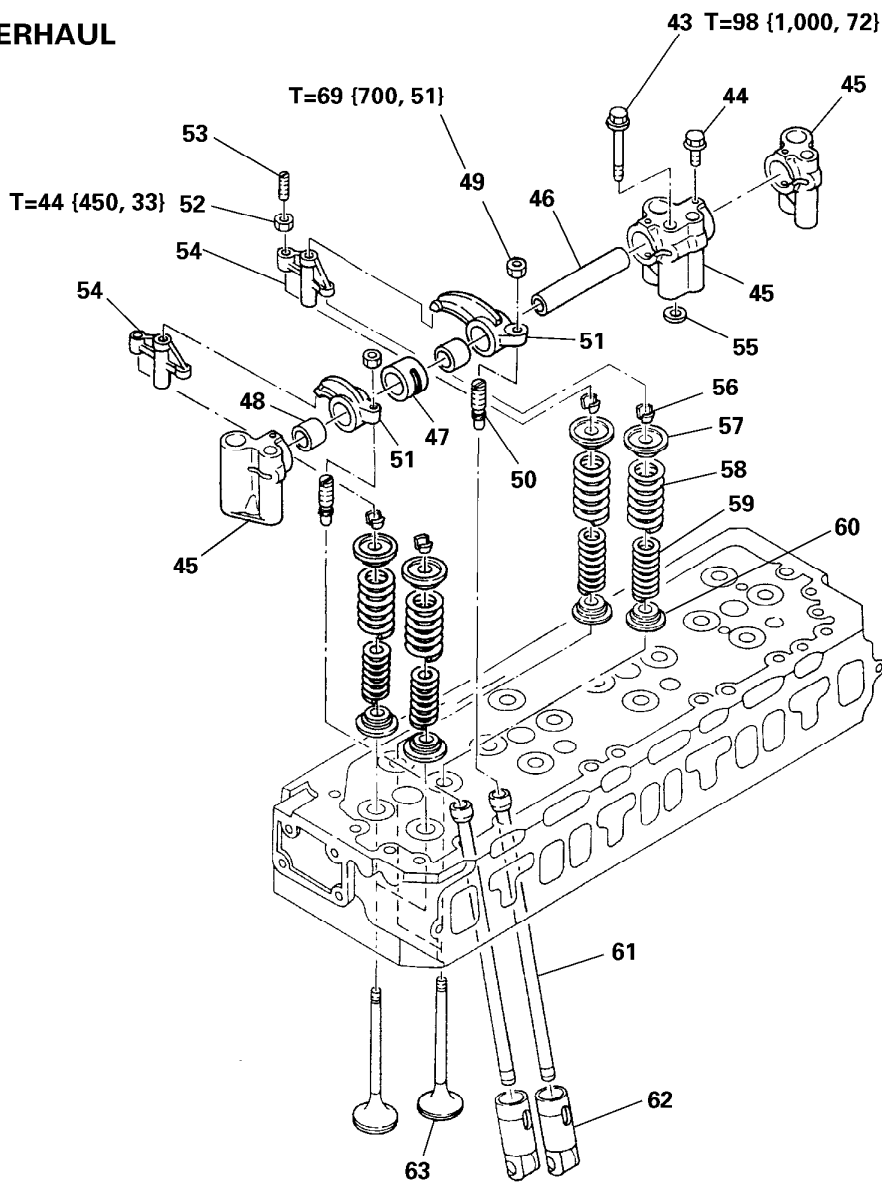


SM3-F0006

T = Tightening torque: N·m (kgf·cm, lbf·ft)

- | | | |
|-----------------------|----------------|--------------------------|
| 1. Bolt | 15. Bolt | 29. Bolt |
| 2. Head cover (upper) | 16. Nut | 30. Bolt |
| 3. Gasket | 17. Stud bolt | 31. Head cover (lower) |
| 4. Bolt | 18. Plate | 32. Gasket |
| 5. Rubber sand plate | 19. Oil seal | 33. Valve stem oil seal |
| 6. Sand rubber | 20. Bolt | 34. Collar |
| 7. Nut | 21. Plate | 35. Head bolt |
| 8. Clamp | 22. Bolt | 36. Stud bolt |
| 9. Ventilator hose | 23. Plate | 37. Cylinder head |
| 10. Oil filler cap | 24. Gasket | 38. Cylinder head gasket |
| 11. Bolt | 25. Plug | 39. Nut |
| 12. Ventilator | 26. Plug | 40. Spacer |
| 13. Bolt | 27. Nut | 41. Stud bolt |
| 14. Oil filler pipe | 28. Union bolt | 42. Stud bolt |

OVERHAUL



SM3-F0007

T = Tightening torque: N·m {kgf·cm, lbf·ft}

- | | |
|-------------------------|---------------------------|
| 43. Rocker support bolt | 54. Crosshead |
| 44. Bolt | 55. Plug |
| 45. Rocker arm support | 56. Valve spring retainer |
| 46. Rocker shaft | 57. Upper seat |
| 47. Collar | 58. Valve spring (outer) |
| 48. Bushing | 59. Valve spring (inner) |
| 49. Lock nut | 60. Lower seat |
| 50. Adjusting screw | 61. Push rod |
| 51. Rocker arm | 62. Valve lifter |
| 52. Lock nut | 63. Valve |
| 53. Adjusting screw | |