1. General Description

A: SPECIFICATION

	Model			2.5 L
Engine	Cylinder arrangement			Horizontally opposed, liquid cooled, 4-cylinder, 4-stroke gasoline engine
	Valve system mechanism			Belt driven Single overhead camshaft 4-valve/cylinder
	Bore × Stroke mm (in)			99.5 × 79.0 (3.917 × 3.110)
	Displacement cm^3 (cu in)			2,457 (150)
	Compression ratio			10.0
	Compression pressure (at 350 rpm) kPa (kg/cm^2, psi)			1,020 — 1,275 (10.4 — 13.0, 148 — 185)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Constant	Open	BTDC 0°
			Close	ABDC 58°
		Low speed	Open	BTDC 0°
			Close	ABDC –50°
		High speed	Open	BTDC 14°
			Close	ABDC 62°
	Exhaust valve timing		Open	BBDC 54°
			Close	ATDC 14°
	Valve clearance mm (in)		Intake	0.20±0.04 (0.0079±0.0016)
			Exhaust	0.25±0.04 (0.0098±0.0016)
	Idling speed [at neutral position on MT, or “P” or “N” position on AT] rpm		MT	650±100 (No load) 850±100 (A/C ON)
			AT	700±100 (No load) 850±100 (A/C ON)
	Ignition order			1 → 3 → 2 → 4
	Ignition timing BTDC/rpm		MT	10°±8°/650
			AT	15°±8°/700

NOTE:
US: undersize OS: oversize

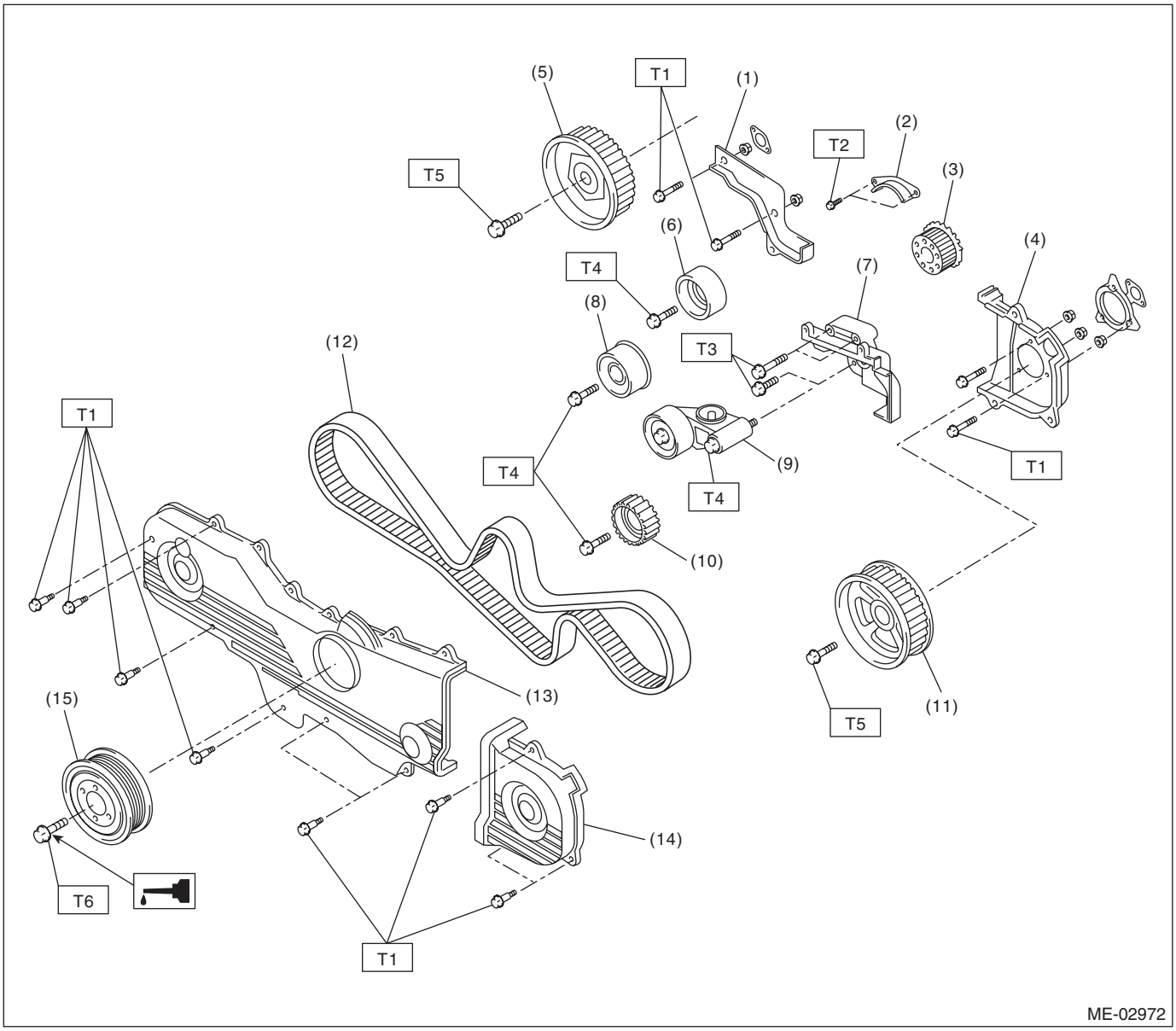
Belt tension adjuster	Protrusion of adjuster rod			mm (in)	5.2 — 6.2 (0.205 — 0.244)
Belt tensioner	Spacer O.D.			mm (in)	17.955 — 17.975 (0.7069 — 0.7077)
	Tensioner bushing I.D.			mm (in)	18.00 — 18.08 (0.7087 — 0.7118)
	Clearance between spacer and bushing			mm (in)	Standard: 0.025 — 0.125 (0.0010 — 0.0049)
					Limit: 0.175 (0.0069)
	Side clearance of spacer			mm (in)	Standard: 0.20 — 0.55 (0.0079 — 0.0217)
					Limit: 0.81 (0.0319)
Valve rocker arm	Clearance between shaft and arm			mm (in)	Standard: 0.020 — 0.054 (0.0008 — 0.0021)
					Limit: 0.10 (0.0039)
Camshaft	Bending limit			mm (in)	0.025 (0.0010)
	Thrust clearance			mm (in)	Standard: 0.030 — 0.090 (0.0012 — 0.0035)
					Limit: 0.10 (0.0039)
	Cam lobe height	Intake	Constant	mm (in)	Standard: 40.075 — 40.175 (1.5778 — 1.5817)
					Limit: 39.975 (1.5738)
			Low speed		Standard: 35.182 — 35.282 (1.3851 — 1.3891)
					Limit: 35.082 (1.3812)
			High speed		Standard: 40.315 — 40.415 (1.5872 — 1.5911)
					Limit: 40.215 (1.5833)
		Exhaust			Standard: 40.149 — 40.249 (1.5807 — 1.5846)
					Limit: 40.049 (1.5767)
	Camshaft journal O.D.			mm (in)	31.928 — 31.945 (1.2570 — 1.2577)
	Camshaft journal hole I.D.			mm (in)	32.000 — 32.018 (1.2598 — 1.2605)
	Oil clearance			mm (in)	Standard: 0.055 — 0.090 (0.0022 — 0.0035)
					Limit: 0.10 (0.0039)
Cylinder head	Surface warpage limit (Mating surface with cylinder block)			mm (in)	0.03 (0.001)
	Grinding limit			mm (in)	0.1 (0.004)
	Standard height			mm (in)	97.5 (3.84)
Valve seat	Seating angle				90°
	Contacting width		Intake	mm (in)	Standard: 0.8 — 1.4 (0.03 — 0.055)
					Limit: 1.7 (0.067)
			Exhaust		Standard: 1.2 — 1.8 (0.047 — 0.071)
					Limit: 2.2 (0.087)
Valve guide	Inside diameter			mm (in)	6.000 — 6.012 (0.2362 — 0.2367)
	Protrusion above head			mm (in)	Intake: 20.0 — 21.0 (0.787 — 0.827)
					Exhaust: 16.5 — 17.5 (0.650 — 0.689)
Valve	Head edge thickness		Intake	mm (in)	Standard: 0.8 — 1.2 (0.03 — 0.047)
					Limit: 0.6 (0.024)
			Exhaust		Standard: 1.0 — 1.4 (0.039 — 0.055)
					Limit: 0.6 (0.024)
	Stem outer diameter			mm (in)	Intake: 5.950 — 5.965 (0.2343 — 0.2348)
					Exhaust: 5.945 — 5.960 (0.2341 — 0.2346)
	Valve stem gap		Standard	mm (in)	Intake: 0.035 — 0.062 (0.0014 — 0.0024)
					Exhaust: 0.040 — 0.067 (0.0016 — 0.0026)
			Limit		— : 0.15 (0.0059)
	Overall length			mm (in)	Intake: 120.6 (4.75)
					Exhaust: 121.7 (4.79)

Valve spring	Free length		mm (in)	55.2 (2.173)
	Squareness			2.5°, 2.4 mm (0.094 in) or less
	Tension/ spring height	N (kgf, lb)/mm (in)	Set	235.3 — 270.7 (24 — 27.6, 52.9 — 60.8)/45.0 (1.772)
			Lift	578.9 — 639.9 (59.1 — 65.3, 130.3 — 143.9)/34.7 (1.366)
Cylinder block	Surface warpage limit (mating with cylinder head)		mm (in)	0.025 (0.00098)
	Grinding limit		mm (in)	0.1 (0.004)
	Standard height		mm (in)	201.0 (7.91)
	Cylinder inner diameter mm (in)	Standard	A	99.505 — 99.515 (3.9175 — 3.9179)
			B	99.495 — 99.505 (3.9171 — 3.9175)
	Taper	mm (in)	Standard	0.015 (0.0006)
			Limit	0.050 (0.0020)
	Out-of-roundness	mm (in)	Standard	0.010 (0.0004)
			Limit	0.050 (0.0020)
	Piston clearance	mm (in)	Standard	–0.010 — 0.010 (–0.00039 — 0.00039)
			Limit	0.030 (0.0012)
	Cylinder inner boring limit (diameter)		mm (in)	To 100.005 (3.9372)
Piston	Outer diameter mm (in)	Standard	A	99.505 — 99.515 (3.9175 — 3.9179)
			B	99.495 — 99.505 (3.9171 — 3.9175)
		0.25 (0.0098) OS		99.745 — 99.765 (3.9270 — 3.9278)
		0.50 (0.0197) OS		99.995 — 100.015 (3.9368 — 3.9376)
	Piston pin specified diameter		mm (in)	23.000 — 23.006 (0.9055 — 0.9057)
Piston pin	Outer diameter		mm (in)	22.994 — 23.000 (0.9053 — 0.9055)
	Clearance between piston and piston pin:		mm (in)	Standard: 0.004 — 0.008 (0.0002 — 0.0003) Limit: 0.020 (0.0008)
	Degree of fit			Piston pin must be fitted into position with thumb at 20°C (68°F).
Piston ring	Ring closed gap mm (in)	Top ring	Standard	0.20 — 0.35 (0.0079 — 0.0138)
			Limit	1.0 (0.039)
		Second ring	Standard	0.37 — 0.52 (0.0144 — 0.0203)
			Limit	1.0 (0.039)
		Oil ring	Standard	0.20 — 0.50 (0.0079 — 0.0197)
			Limit	1.5 (0.059)
	Ring groove gap mm (in)	Top ring	Standard	0.040 — 0.080 (0.0016 — 0.0031)
			Limit	0.15 (0.0059)
		Second ring	Standard	0.030 — 0.070 (0.0012 — 0.0028)
			Limit	0.15 (0.0059)
Connecting rod	Bend or twist per 100 mm (3.94 in) in length	mm (in)	Limit	0.10 (0.0039)
	Side clearance of large end	mm (in)	Standard	0.070 — 0.330 (0.0028 — 0.0130)
			Limit	0.4 (0.016)
Bearing of large end	Oil clearance mm (in)	Standard		0.016 — 0.044 (0.00063 — 0.0017)
		Limit		0.05 (0.0020)
	Bearing size (Thickness at center) mm (in)	Standard		1.492 — 1.501 (0.0587 — 0.0591)
		0.03 (0.0012) US		1.510 — 1.513 (0.0594 — 0.0596)
		0.05 (0.0020) US		1.520 — 1.523 (0.0598 — 0.0600)
		0.25 (0.0098) US		1.620 — 1.623 (0.0638 — 0.0639)
Bushing of small end	Clearance between piston pin and bushing	mm (in)	Standard	0 — 0.022 (0 — 0.0009)
			Limit	0.030 (0.0012)

Crankshaft	Bend limit		mm (in)	0.035 (0.0014)
	Crank pin	Out-of-roundness	mm (in)	0.003 (0.0001)
		Cylindricality	mm (in)	0.004 (0.0002)
		Grinding limit (dia.)	mm (in)	To 51.750 (2.0374)
	Crank journal	Out-of-roundness	mm (in)	0.005 (0.0002)
		Cylindricality	mm (in)	0.006 (0.0002)
		Grinding limit (dia.)	mm (in)	To 59.758 (2.3527)
	Crank pin outer diameter		mm (in)	Standard: 51.984 — 52.000 (2.0466 — 2.0472)
				0.03 (0.0012) US: 51.954 — 51.970 (2.0454 — 2.0461)
				0.05 (0.0020) US: 51.934 — 51.950 (2.0446 — 2.0453)
				0.25 (0.0098) US: 51.734 — 51.750 (2.0368 — 2.0374)
	Crank journal outer diameter		mm (in)	Standard: 59.992 — 60.008 (2.3619 — 2.3625)
				0.03 (0.0012) US: 59.962 — 59.978 (2.3607 — 2.3613)
				0.05 (0.0020) US: 59.942 — 59.958 (2.3599 — 2.3605)
				0.25 (0.0098) US: 59.742 — 59.758 (2.3520 — 2.3527)
	Thrust clearance		mm (in)	Standard: 0.030 — 0.115 (0.0012 — 0.0045)
				Limit: 0.25 (0.0098)
	Oil clearance		mm (in)	Standard: 0.010 — 0.030 (0.0001 — 0.0012)
				Limit: 0.40 (0.016)
Main bearing	Main bearing mm (in)	#1, #3		Standard: 1.998 — 2.011 (0.0787 — 0.0792)
				0.03 (0.0012) US: 2.017 — 2.020 (0.0794 — 0.0795)
				0.05 (0.0020) US: 2.027 — 2.030 (0.0798 — 0.0799)
				0.25 (0.0098) US: 2.127 — 2.130 (0.0837 — 0.0839)
		#2, #4, #5		Standard: 2.000 — 2.013 (0.0787 — 0.0793)
				0.03 (0.0012) US: 2.019 — 2.022 (0.0795 — 0.0796)
				0.05 (0.0020) US: 2.029 — 2.032 (0.0799 — 0.0800)
				0.25 (0.0098) US: 2.129 — 2.132 (0.0838 — 0.0839)

B: COMPONENT

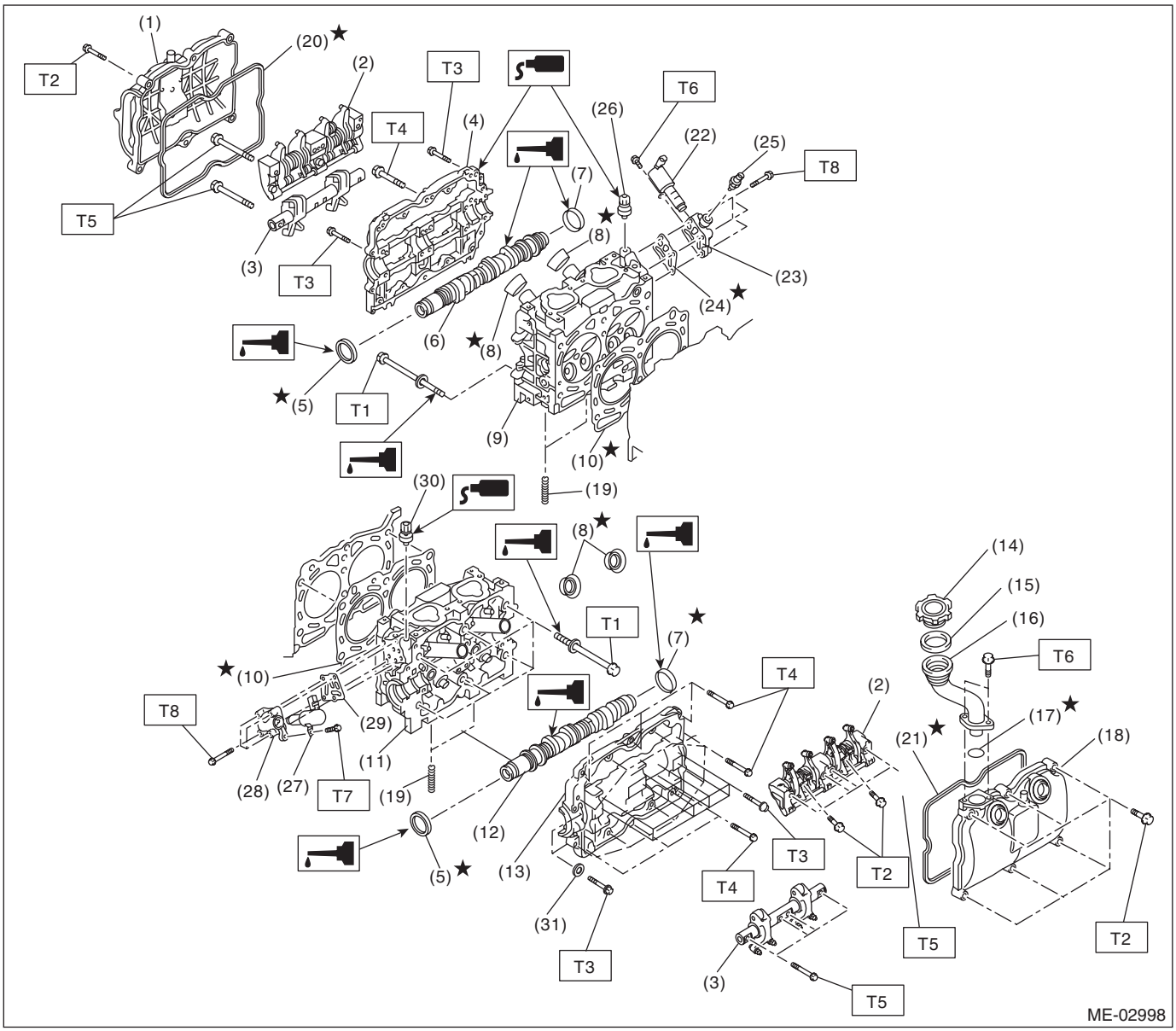
1. TIMING BELT



(1) Timing belt cover No. 2 (RH)
(2) Timing belt guide (MT model)
(3) Crank sprocket
(4) Timing belt cover No. 2 (LH)
(5) Cam sprocket No. 1
(6) Belt idler (No. 1)
(7) Tensioner bracket
(8) Belt idler (No. 2)
(9) Automatic belt tension adjuster ASSY
(10) Belt idler No. 2
(11) Cam sprocket No. 2
(12) Timing belt
(13) Front timing belt cover
(14) Timing belt cover (LH)
(15) Crank pulley

Tightening torque: N·m (kgf-m, ft-lb)
T1: 5 (0.5, 3.6)
T2: 9.75 (1.0, 7.2)
T3: 24.5 (2.5, 18.1)
T4: 39 (4.0, 28.9)
T5: 78 (8.0, 57.9)
T6: <Ref. to ME(H4SO)-42, INSTALLATION, Crank Pulley.>

2. CYLINDER HEAD AND CAMSHAFT

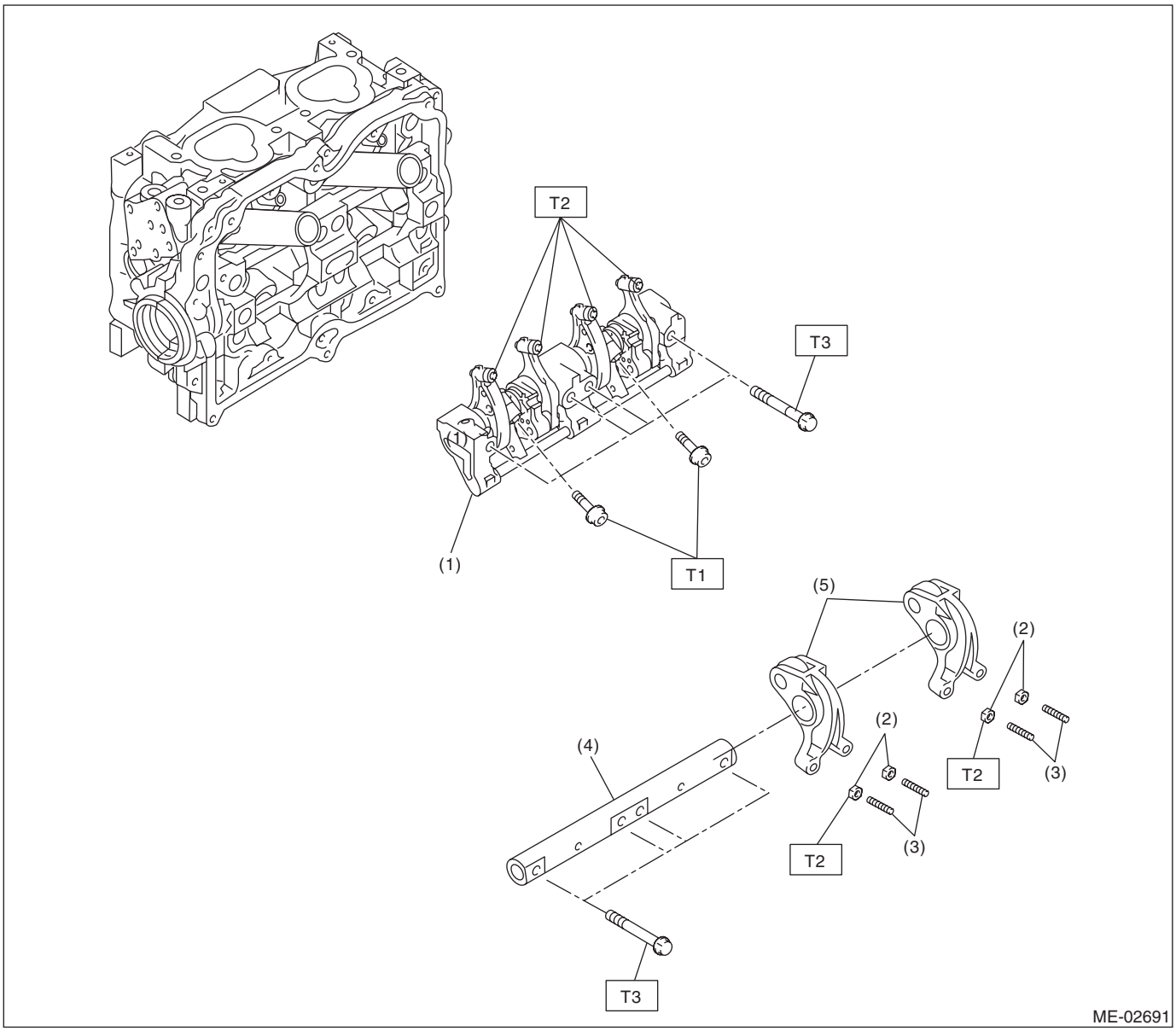


(1) Rocker cover (RH)
(2) Intake valve rocker ASSY
(3) Exhaust valve rocker ASSY
(4) Camshaft cap (RH)
(5) Oil seal
(6) Camshaft (RH)
(7) Plug
(8) Spark plug pipe gasket
(9) Cylinder head (RH)
(10) Cylinder head gasket
(11) Cylinder head (LH)
(12) Camshaft (LH)
(13) Camshaft cap (LH)
(14) Oil filler cap
(15) Gasket
(16) Oil filler duct
(17) O-ring
(18) Rocker cover (LH)
(19) Stud bolt
(20) Rocker cover gasket (RH)
(21) Rocker cover gasket (LH)
(22) Oil switching solenoid valve (RH)
(23) Oil switching solenoid valve holder (RH)
(24) Gasket
(25) Oil temperature sensor
(26) Variable valve lift diagnosis oil pressure switch (RH)
(27) Oil switching solenoid valve (LH)
(28) Oil switching solenoid valve holder (LH)
(29) Gasket
(30) Variable valve lift diagnosis oil pressure switch (LH)
(31) Seal washer

Tightening torque: N·m (kgf-m, ft-lb)

T1: <Ref. to ME(H4SO)-58, INSTALLATION, Cylinder Head.>
T2: <Ref. to ME(H4SO)-51, INSTALLATION, Valve Rocker Assembly.>
T3: 9.75 (1.0, 7.2)
T4: 18 (1.8, 13.0)
T5: 25 (2.5, 18.1)
T6: 6.4 (0.65, 4.7)
T7: 8 (0.8, 5.9)
T8: 10 (1.0, 7.4)

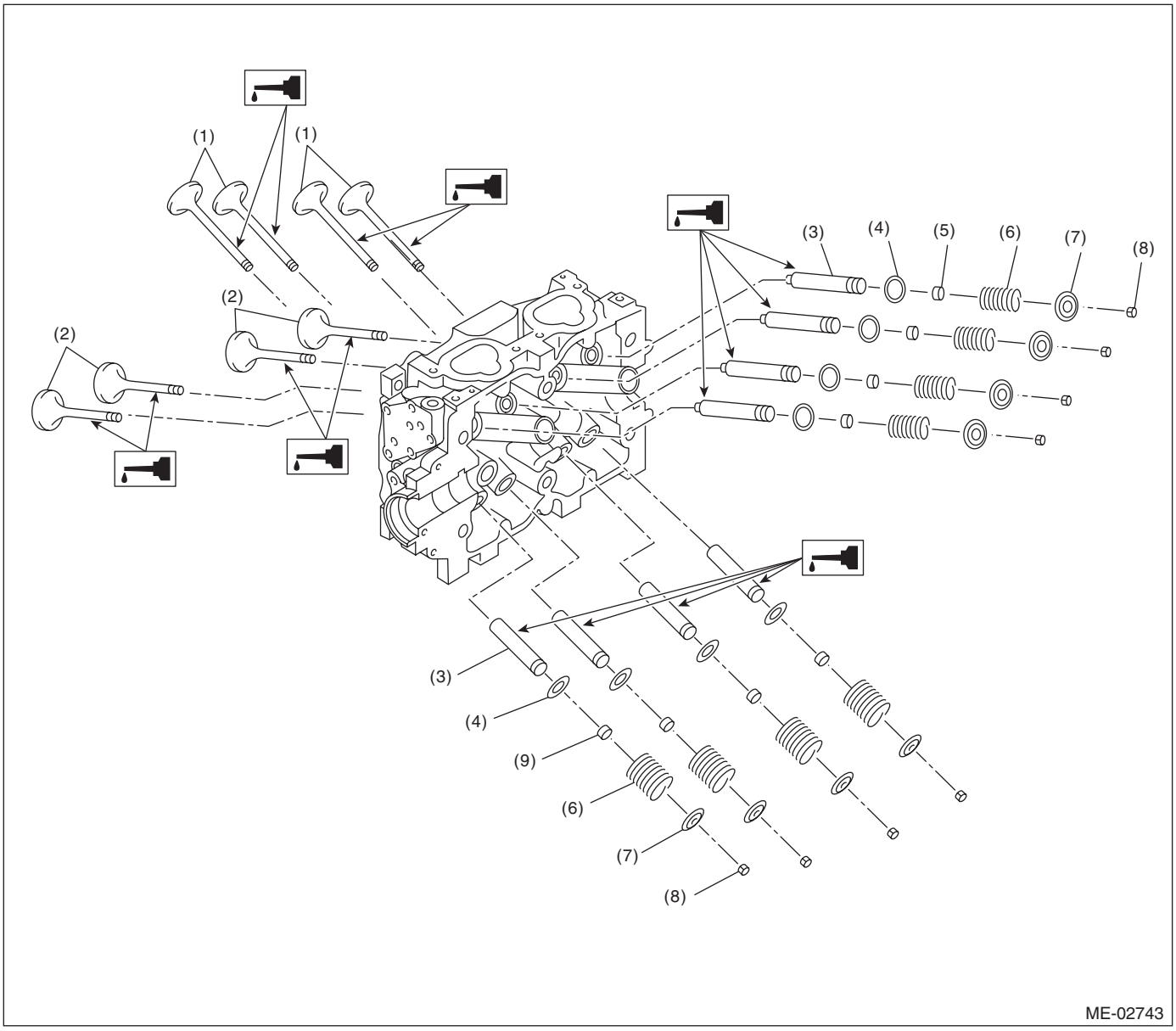
3. VALVE ROCKER ASSEMBLY



(1) Intake valve rocker arm ASSY
(2) Valve rocker nut
(3) Valve rocker adjusting screw
(4) Exhaust rocker shaft
(5) Exhaust valve rocker arm

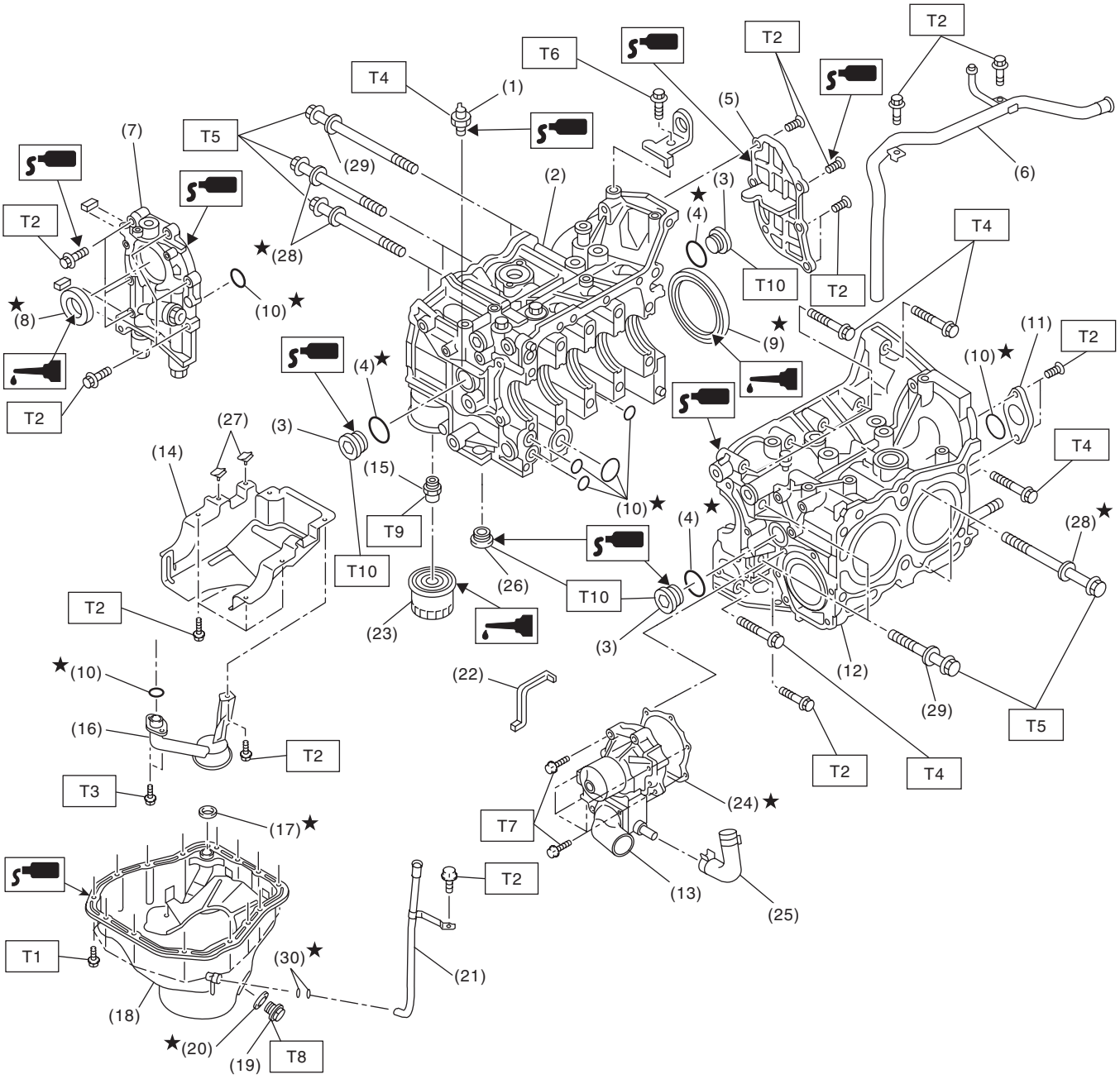
Tightening torque: N·m (kgf-m, ft-lb)
T1: 6 (0.6, 4.3)
T2: 9.75 (1.0, 7.2)
T3: 25 (2.5, 18.1)

4. CYLINDER HEAD AND VALVE ASSEMBLY



(1) Exhaust valve
(2) Intake valve
(3) Valve guide
(4) Valve spring seat
(5) Intake valve oil seal
(6) Valve spring
(7) Retainer
(8) Retainer key
(9) Exhaust valve oil seal

5. CYLINDER BLOCK

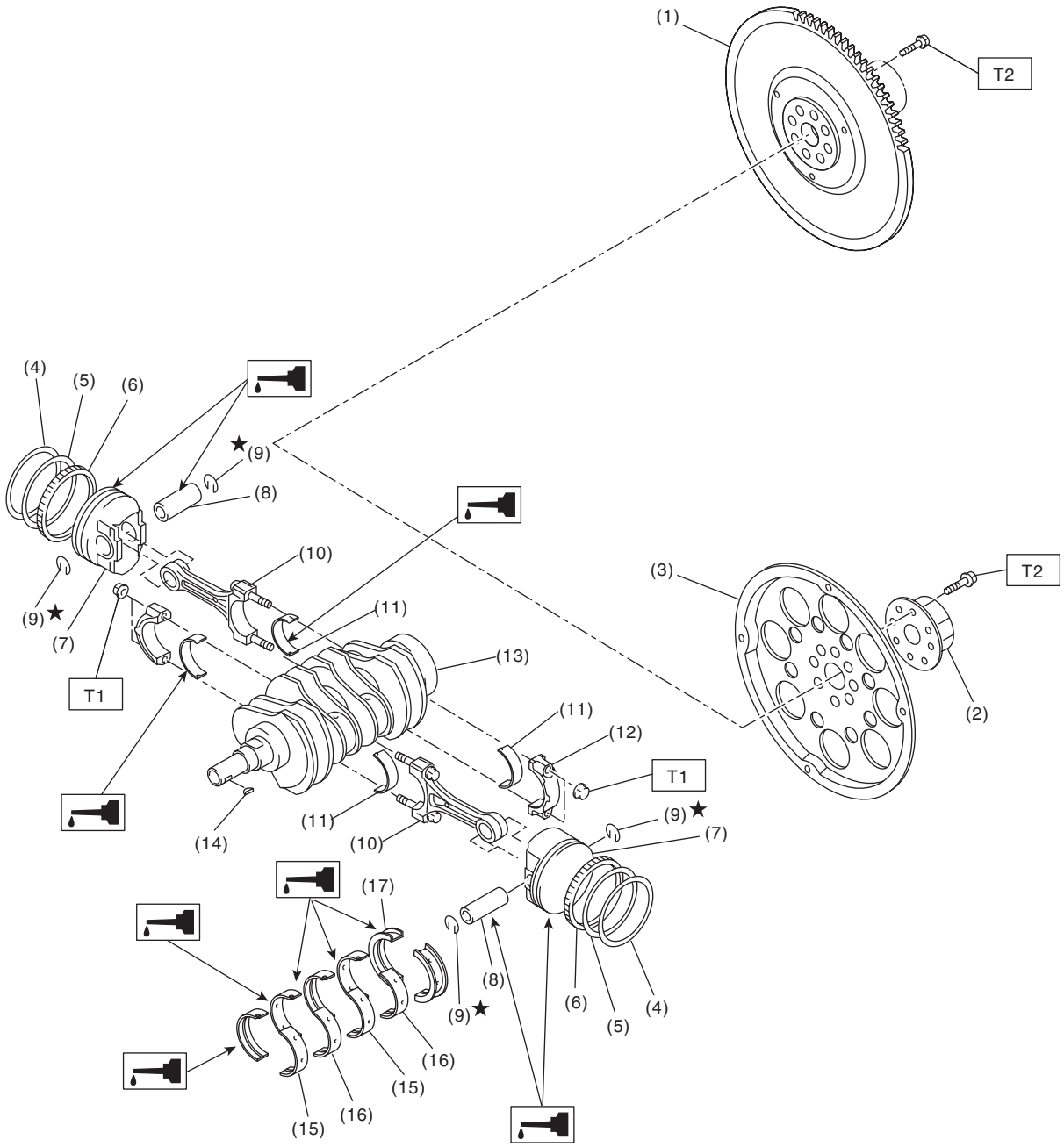


ME-03000

(1) Oil pressure switch
(2) Cylinder block (RH)
(3) Service hole plug
(4) Gasket
(5) Oil separator cover
(6) Water by-pass pipe
(7) Oil pump
(8) Front oil seal
(9) Rear oil seal
(10) O-ring
(11) Service hole cover
(12) Cylinder block (LH)
(13) Water pump
(14) Baffle plate
(15) Oil filter connector
(16) Oil strainer
(17) Gasket
(18) Oil pan
(19) Drain plug
(20) Metal gasket
(21) Oil level gauge guide
(22) Water pump sealing
(23) Oil filter
(24) Gasket
(25) Water pump hose
(26) Plug
(27) Seal
(28) Seal washer
(29) Washer
(30) O-ring

Tightening torque: N·m (kgf-m, ft-lb)	
T1:	*5 (0.5, 3.6)*
T2:	*6.4 (0.65, 4.7)*
T3:	*9.75 (1.0, 7.2)*
T4:	*25 (2.5, 18.1)*
T5:	*<Ref. to ME(H4SO)-69, INSTALLATION, Cylinder Block.>*
T6:	*16 (1.6, 11.6)*
T7:	*First 12 (1.2, 8.7)*
	Second 12 (1.2, 8.7)
T8:	*44 (4.5, 33)*
T9:	*45 (4.6, 33.3)*
T10:	*70 (7.1, 50.6)*

6. CRANKSHAFT AND PISTON

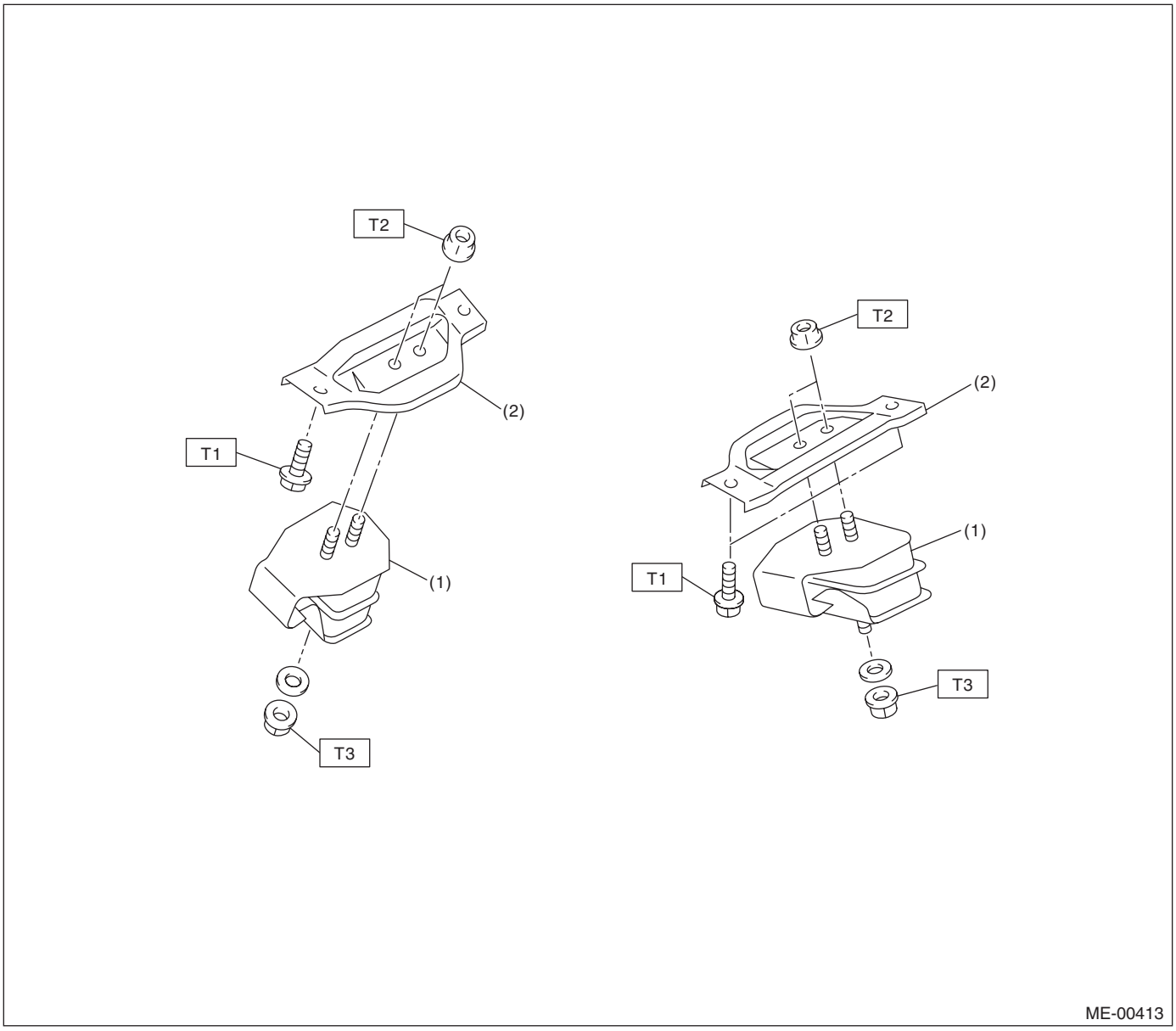


ME-02974

(1) Flywheel (MT model)
(2) Reinforcement (AT model)
(3) Drive plate (AT model)
(4) Top ring
(5) Second ring
(6) Oil ring
(7) Piston
(8) Piston pin
(9) Snap ring
(10) Connecting rod
(11) Connecting rod bearing
(12) Connecting rod cap
(13) Crankshaft
(14) Woodruff key
(15) Crankshaft bearing #1, #3
(16) Crankshaft bearing #2, #4
(17) Crankshaft bearing #5

Tightening torque: N·m (kgf-m, ft-lb)
T1: 45 (4.6, 33.3)
T2: 72 (7.3, 52.8)

7. ENGINE MOUNTING



(1) Front cushion rubber
(2) Front engine mounting bracket

Tightening torque: N·m (kgf-m, ft-lb)
T1: 35 (3.6, 25.8)
T2: 42 (4.3, 31.0)
T3: 85 (8.7, 63)

C: CAUTION

• Wear appropriate work clothing, including a cap, protective goggles and protective shoes when performing any work.
• Remove contamination including dirt and corrosion before removal, installation or disassembly.
• Keep the disassembled parts in order and protect them from dust and dirt.
• Before removal, installation or disassembly, be sure to clarify the failure. Avoid unnecessary removal, installation, disassembly and replacement.
• Vehicle components are extremely hot after driving. Be wary of receiving burns from heated parts.
• Be sure to tighten fasteners including bolts and nuts to the specified torque.
• Place shop jacks or rigid racks at the specified points.
• Before disconnecting connectors of sensors or units, be sure to disconnect the ground cable from the battery.
• All parts should be thoroughly cleaned, paying special attention to engine oil passages, pistons and bearings.
• Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
• Be careful not to let oil, grease or coolant contact the timing belt, clutch disc and flywheel.
• All removed parts, if to be reused, should be reinstalled in the original positions and directions.
• Bolts, nuts and washers should be replaced with new parts as required.
• Even if necessary inspections have been made in advance, proceed with assembly work while making rechecks.
• Remove or install the engine in an area where chain hoists, lifting devices, etc. are available for ready use.
• Be sure not to damage coated surfaces of body panels with tools, or not to stain seats and windows with coolant or oil. Place a cover over fender, as required, for protection.
• Prior to starting work, prepare the following:
Service tools, clean cloth, containers to catch coolant and oil, wire ropes, chain hoist, transmission jacks, etc.
• Lift-up or lower the vehicle when necessary. Make sure to support the correct positions.

D: PREPARATION TOOL

1. SPECIAL TOOL

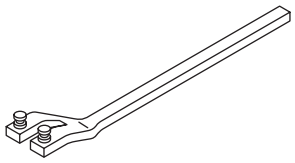
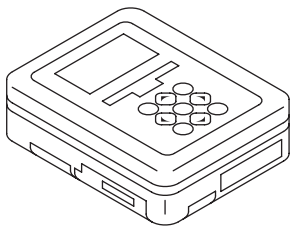
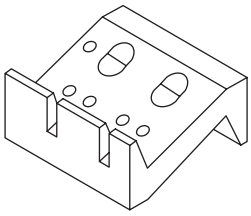
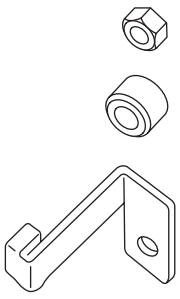
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18231AA010	18231AA010	CAM SPROCKET WRENCH	• Used for removing and installing cam sprocket. (LH side) • CAMSHAFT SPROCKET WRENCH (499207100) can also be used.
 ST1B020XU0	1B020XU0	SUBARU SELECT MONITOR KIT	Used for troubleshooting the electrical system.
 ST-498267800	498267800	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.

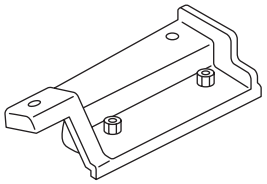
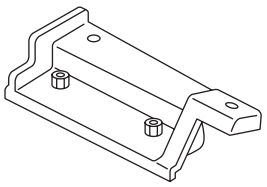
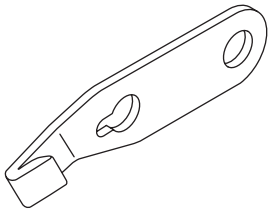
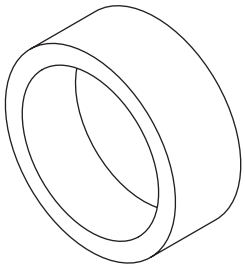
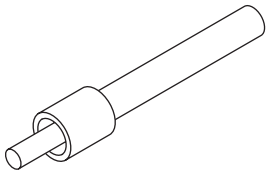
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498457000	498457000	ENGINE STAND ADAPTER RH	Used together with ENGINE STAND (499817100).
 ST-498457100	498457100	ENGINE STAND ADAPTER LH	Used together with ENGINE STAND (499817100).
 ST-498497100	498497100	CRANKSHAFT STOPPER	Used for removing and installing the flywheel and the drive plate.
 ST-498747300	498747300	PISTON GUIDE	Used for installing piston in cylinder.
 ST-498857100	498857100	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.

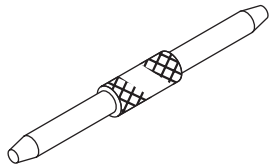
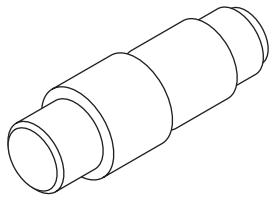
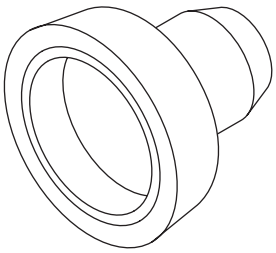
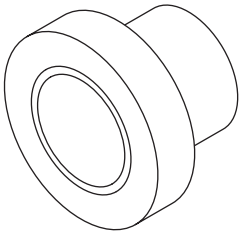
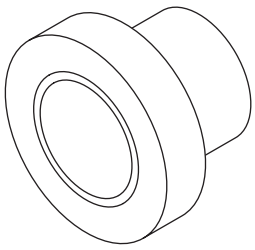
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499017100	499017100	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST-499037100	499037100	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499587500	499587500	OIL SEAL INSTALLER	• Used for installing camshaft oil seal. • Used together with OIL SEAL GUIDE (499597000).
 ST-499587700	499587700	CAMSHAFT OIL SEAL INSTALLER	Used for installing cylinder head plug.

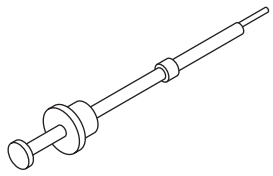
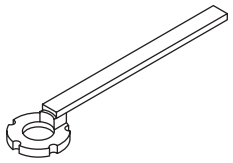
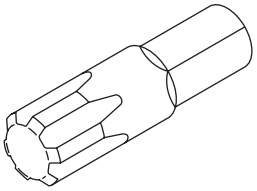
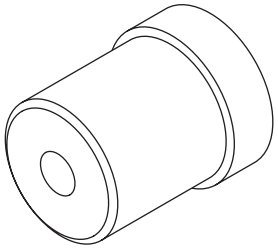
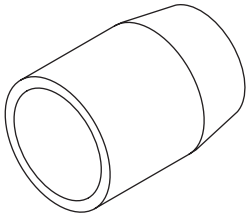
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499207400	499207400	CAM SPROCKET WRENCH	Used for removing and installing cam sprocket. (RH side)
 ST-499497000	499497000	TORX® PLUS	Used for removing and installing camshaft cap.
 ST-499587100	499587100	OIL SEAL INSTALLER	Used for installing oil pump oil seal.
 ST-499597000	499597000	OIL SEAL GUIDE	• Used for installing camshaft oil seal. • Used together with camshaft OIL SEAL INSTALLER (499587500).

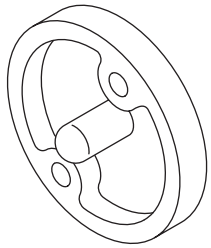
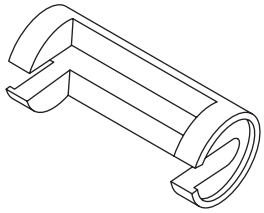
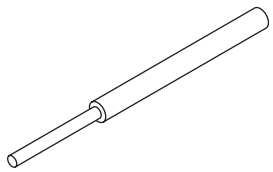
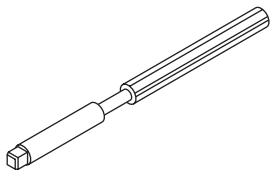
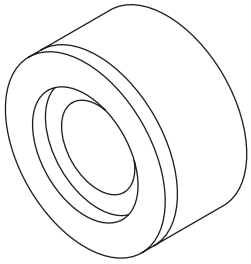
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST-499767200	499767200	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499767400	499767400	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499767700	499767700	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Intake side)

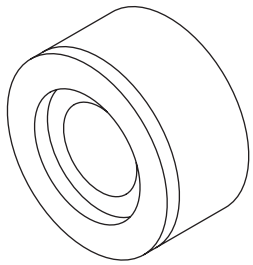
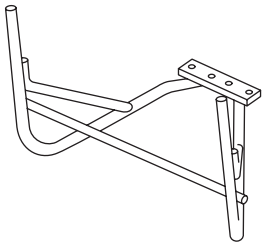
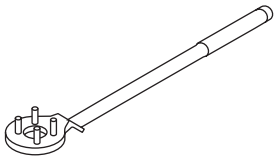
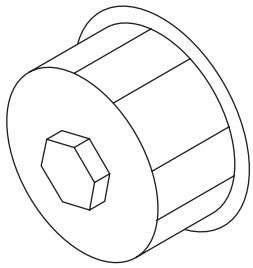
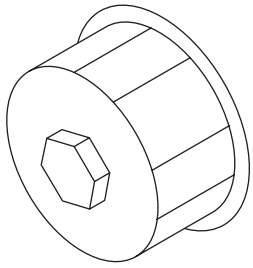
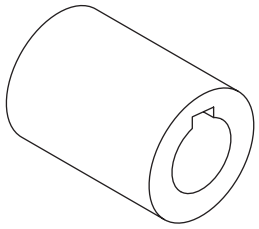
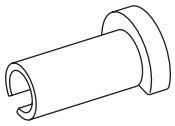
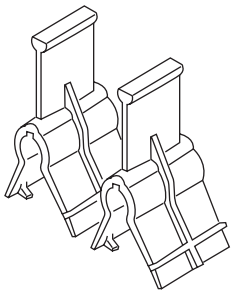
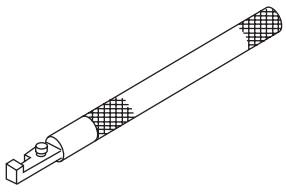
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499767800	499767800	VALVE GUIDE ADJUSTER	Used for installing valve guides. (Exhaust side)
 ST-499817100	499817100	ENGINE STAND	• Stand used for engine disassembly and assembly. • Used together with ENGINE STAND ADAPTER RH (498457000) & LH (498457100).
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
 ST18332AA000	18332AA000	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 68 mm (2.68 in))
 ST18332AA010	18332AA010	OIL FILTER WRENCH	Used for removing and installing oil filter. (Outer diameter: 65 mm (2.56 in))

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499987500	499987500	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for removing the quick connector.
 ST18354AA000	18354AA000	VALVE ROCKER HOLDER	Used for installing the valve rocker assembly (intake). (2 sets)
 ST18258AA000	18258AA000	SPRING INSTALLER	Used for installing the valve rocker assembly (intake).

2. GENERAL TOOL

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Vacuum gauge	Used for measuring negative pressure.
Oil pressure gauge	Used for measuring oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.
Timing light	Used for measuring ignition timing.

E: PROCEDURE

It is possible to conduct the following service procedures with engine on vehicle, however, the procedures described in this section are based on the condition that the engine is removed from vehicle.

- V-belt
- Timing belt
- Valve rocker assembly
- Camshaft
- Cylinder head