1. General Description

A: SPECIFICATION

Engine	Cylinder arrangement			Horizontally opposed, liquid cooled, 6-cylinder, 4-stroke gasoline engine
	Valve system mechanism			Chain driven, double overhead camshaft, 4-valve/cylinder
	Inside diameter × stroke mm (in)			92 × 91 (3.622 × 3.583)
	Displacement cm^3 (cu in)			3,630 (222)
	Compression ratio			10.5
	Compression pressure (350 rpm and fully open throttle): kPa (kgf/cm^2, psi)			1,275 — 1,471 (13.0 — 15.0, 185 — 213)
	Number of piston rings			Pressure ring: 2, Oil ring: 1
	Intake valve timing	Min. advance	Open	BTDC 40°
			Close	ABDC 24°
		Max. retard	Open	ATDC 10°
			Close	ABDC 74°
	Exhaust valve timing	Min. advance	Open	BBDC 44°
			Close	ATDC 4°
		Max. retard	Open	BBDC 4°
			Close	ATDC 44°
	Valve clearance mm (in)	Intake		$0.20^{+0.04}_{-0.06}$ ($0.0079^{+0.0016}_{-0.0024}$)
		Exhaust		0.35±0.05 (0.0138±0.020)
	Idle rpm [“P” or “N” range] rpm		No load	700±100
			A/C ON	805±100
	Ignition order			1 → 6 → 3 → 2 → 5 → 4
	Ignition timing BTDC/rpm			15°±8°/700

NOTE:
OS: Oversize US: Undersize

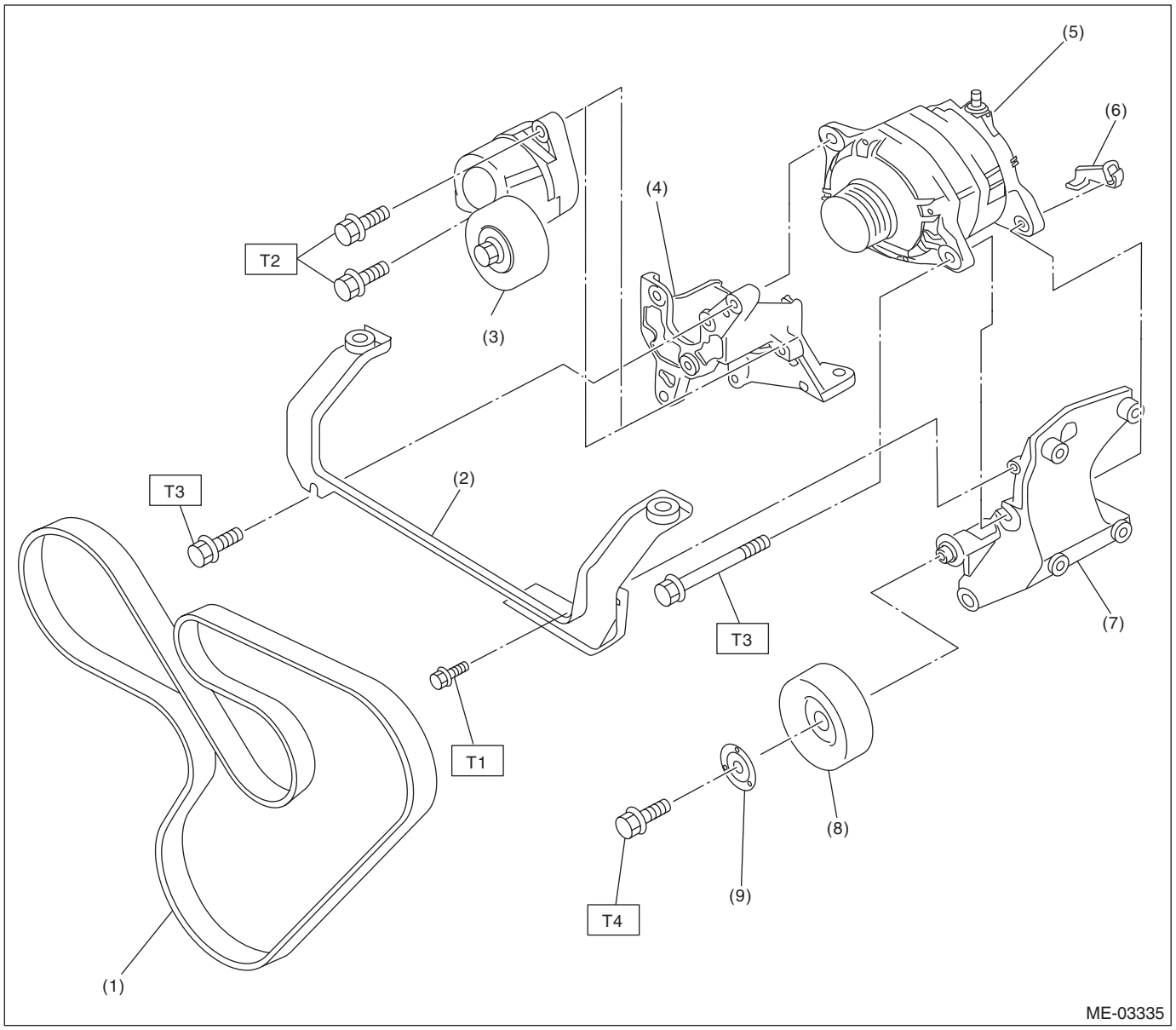
Camshaft	Thrust clearance mm (in)	Intake	Standard	0.075 — 0.135 (0.0030 — 0.0053)
		Exhaust	Standard	0.075 — 0.135 (0.0030 — 0.0053)
	Cam lobe height mm (in)	Intake	Standard	45.90 — 46.00 (1.8071 — 1.8110)
		Exhaust	Standard	44.65 — 44.75 (1.7579 — 1.7618)
	Cam base circle diameter mm (in)	Intake	Standard	36.00 (1.4173)
		Exhaust	Standard	36.00 (1.4173)
	Journal O.D. mm (in)	Front	Standard	37.946 — 37.963 (1.4939 — 1.4946)
		Except for front	Standard	25.946 — 25.963 (1.0215 — 1.0222)
	Oil clearance mm (in)		Standard	0.037 — 0.072 (0.0015 — 0.0028)
Cylinder head	Surface warpage limit (mating with cylinder block) mm (in)		Standard	0.02 (0.0008)
	Inner diameter of valve lifter hole mm (in)			32.994 — 33.016 (1.2990 — 1.2998)
	Standard height mm (in)			124±0.05 (4.88±0.0020)
Valve seat	Seating angle			90°
	Contacting width mm (in)	Intake	Standard	1.0 (0.039)
		Exhaust	Standard	1.5 (0.059)
Valve guide	Inside diameter mm (in)			5.500 — 5.512 (0.2165 — 0.2170)
	Protrusion above head	Intake mm (in)		8.6 — 9.0 (0.3386 — 0.3543)
		Exhaust mm (in)		10.7 — 11.1 (0.4213 — 0.4370)

Valve	Head edge thickness mm (in)	Intake		Standard	1.0 (0.039)
		Exhaust		Standard	1.2 (0.047)
	Stem outer diameter mm (in)	Intake			5.455 — 5.470 (0.2148 — 0.2154)
		Exhaust			5.445 — 5.460 (0.2144 — 0.2150)
	Stem oil clearance mm (in)	Intake		Standard	0.030 — 0.057 (0.0012 — 0.0022)
		Exhaust		Standard	0.040 — 0.067 (0.0016 — 0.0026)
	Overall length mm (in)	Intake			103.5 (4.075)
		Exhaust			103.2 (4.063)
	Outer diameter of valve lifter mm (in)				32.959 — 32.975 (1.2976 — 1.2982)
Valve spring	Free length mm (in)	Intake			41.51 (1.6342)
		Exhaust			41.51 (1.6342)
	Squareness	Intake			2.5°, 1.8 mm (0.071 in)
		Exhaust			2.5°, 1.8 mm (0.071 in)
Cylinder block	Standard height mm (in)				202 (7.95)
	Surface warpage limit (mating with cylinder head) mm (in)			Standard	0.02 (0.0008)
	Cylinder inner diameter mm (in)	Standard		A	92.005 — 92.015 (3.6222 — 3.6226)
				B	91.995 — 92.005 (3.6218 — 3.6222)
	Cylindricality mm (in)			Standard	0.030 (0.0012)
	Out-of-roundness mm (in)			Standard	0.010 (0.0004)
	Piston clearance mm (in)			Standard	–0.010 — 0.010 (–0.0004 — 0.0004)
Piston	Outer diameter mm (in)	Standard		A	92.005 — 92.015 (3.6222 — 3.6226)
				B	91.995 — 92.005 (3.6218 — 3.6222)
		0.25 (0.0098) OS			92.245 — 92.265 (3.6317 — 3.6325)
		0.50 (0.0197) OS			92.495 — 92.515 (3.6415 — 3.6423)
	Inner diameter of piston pin hole mm (in)			Standard	22.000 — 22.006 (0.8661 — 0.8664)
Piston pin	Outer diameter mm (in)			Standard	21.994 — 22.000 (0.8659 — 0.8661)
	Standard clearance between piston and piston pin mm (in)			Standard	0.004 — 0.008 (0.0002 — 0.0003)
Piston ring	Ring closed gap mm (in)	Top ring		Standard	0.20 — 0.35 (0.0079 — 0.0138)
		Second ring		Standard	0.40 — 0.50 (0.0157 — 0.0197)
		Oil ring		Standard	0.20 — 0.50 (0.0079 — 0.0197)
	Ring groove gap mm (in)	Top ring		Standard	0.040 — 0.080 (0.0016 — 0.0031)
		Second ring		Standard	0.030 — 0.070 (0.0012 — 0.0028)
		Oil ring		Standard	0.065 — 0.165 (0.0026 — 0.0065)
Connecting rod	Thrust clearance mm (in)			Standard	0.070 — 0.330 (0.0028 — 0.0130)
Bearing of large end	Oil clearance mm (in)			Standard	0.016 — 0.043 (0.0006 — 0.0017)
	Bearing size (Thickness at center) mm (in)	Standard			1.489 — 1.501 (0.0586 — 0.0591)
		0.03 (0.0012) US			1.507 — 1.515 (0.0593 — 0.0596)
		0.05 (0.0020) US			1.517 — 1.525 (0.0597 — 0.0600)
		0.25 (0.0098) US			1.617 — 1.625 (0.0637 — 0.0640)
Bushing of small end	Clearance between piston pin and bushing mm (in)			Standard	0 — 0.022 (0 — 0.0009)

Crankshaft	Crank pin and crank journal	Out-of-roundness mm (in)		0.005 (0.0002)
		Cylindricality mm (in)		0.006 (0.0002)
	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)	#1, #3, #5, #7	Standard	63.992 — 64.008 (2.5194 — 2.5200)
			0.03 (0.0012) US	63.962 — 63.978 (2.5182 — 2.5188)
			0.05 (0.0020) US	63.942 — 63.958 (2.5174 — 2.5180)
			0.25 (0.0098) US	63.742 — 63.758 (2.5095 — 2.5102)
		#2, #4, #6	Standard	63.992 — 64.008 (2.5194 — 2.5200)
			0.03 (0.0012) US	63.962 — 63.978 (2.5182 — 2.5188)
			0.05 (0.0020) US	63.942 — 63.958 (2.5174 — 2.5180)
			0.25 (0.0098) US	63.742 — 63.758 (2.5095 — 2.5102)
	Thrust clearance mm (in)		Standard	0.030 — 0.115 (0.0012 — 0.0045)
	Oil clearance mm (in)		Standard	0.010 — 0.030 (0.0004 — 0.0012)
Main bearing	Bearing size (Thickness at center) mm (in)	#1, #3, #5	Standard	2.000 — 2.013 (0.0787 — 0.0793)
			0.03 (0.0012) US	2.011 — 2.014 (0.0792 — 0.0793)
			0.05 (0.0020) US	2.021 — 2.024 (0.0796 — 0.0797)
			0.25 (0.0098) US	2.121 — 2.124 (0.0835 — 0.0836)
		#2, #4, #6	Standard	2.000 — 2.013 (0.0787 — 0.0793)
			0.03 (0.0012) US	2.015 — 2.018 (0.0793 — 0.0794)
			0.05 (0.0020) US	2.025 — 2.028 (0.0797 — 0.0798)
			0.25 (0.0098) US	2.125 — 2.128 (0.0837 — 0.0838)
		#7	Standard	1.996 — 2.009 (0.0786 — 0.0791)
			0.03 (0.0012) US	2.011 — 2.014 (0.0792 — 0.0793)
			0.05 (0.0020) US	2.021 — 2.024 (0.0796 — 0.0797)
			0.25 (0.0098) US	2.121 — 2.124 (0.0835 — 0.0836)

B: COMPONENT

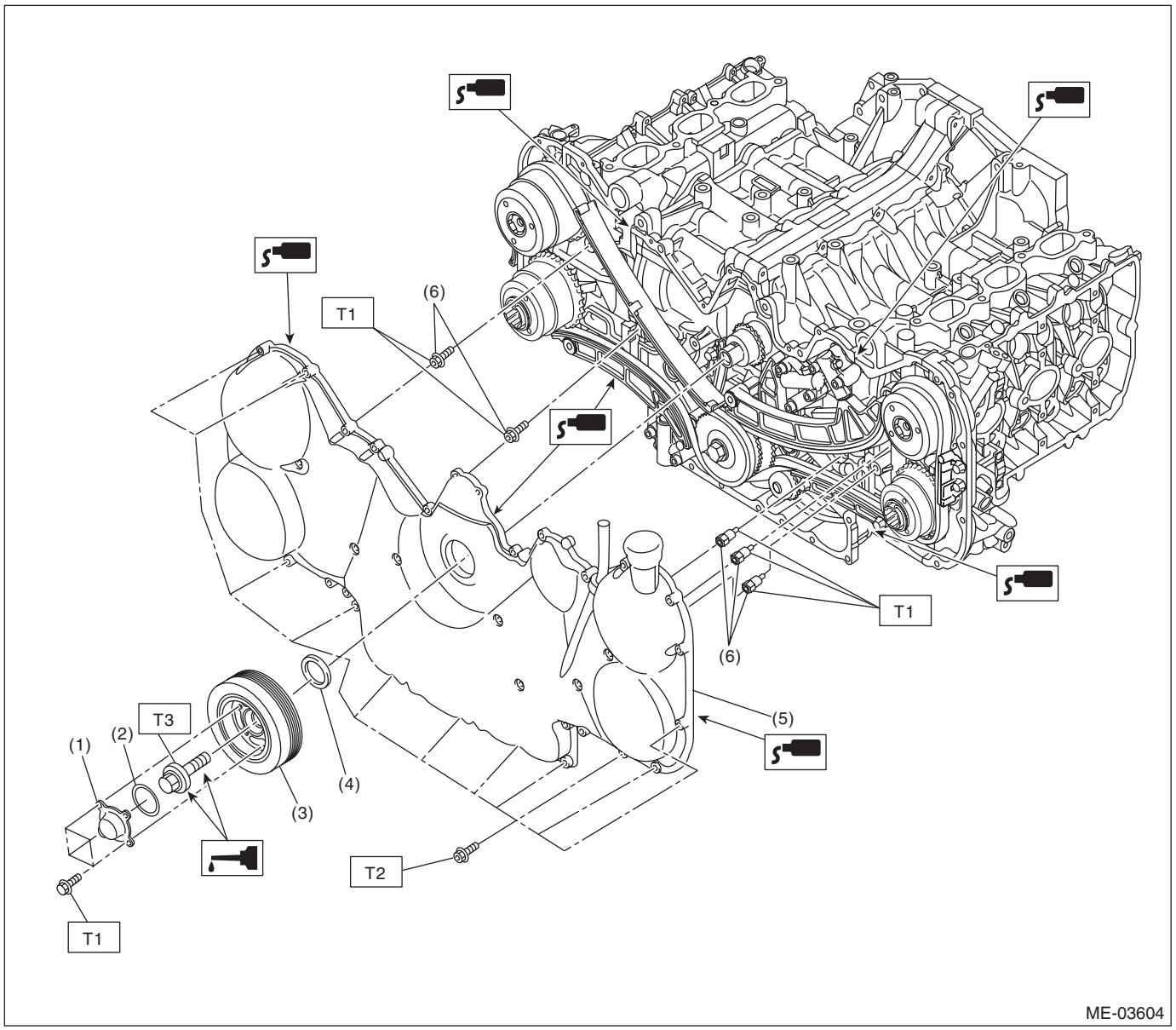
1. V-BELT



(1)	V-belt	(6)	Generator plate
(2)	Collector cover bracket	(7)	A/C compressor stay
(3)	Belt tension adjuster ASSY	(8)	Idler pulley
(4)	Power steering pump bracket	(9)	Idler pulley cover
(5)	Generator		

Tightening torque:N·m (kgf-m, ft-lb)
T1: 6.4 (0.7, 4.7)
T2: 20 (2.0, 14.8)
T3: 25 (2.5, 18.4)
T4: 33 (3.4, 24.3)

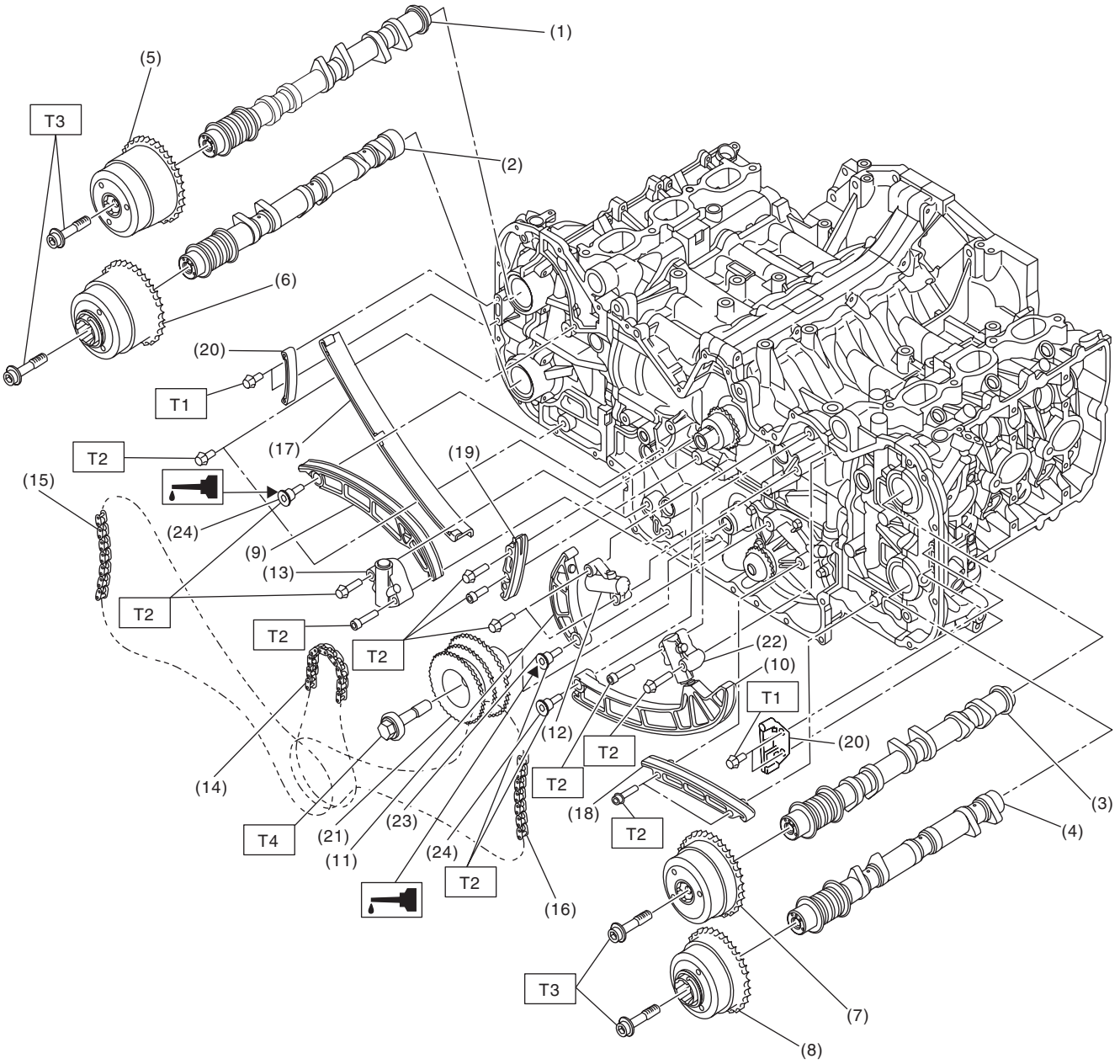
2. TIMING CHAIN COVER



(1) Crank pulley cover
(2) O-ring
(3) Crank pulley
(4) Oil seal
(5) Chain cover
(6) Bolt

Tightening torque:N·m (kgf-m, ft-lb)
T1: 6.4 (0.7, 4.7)
T2: 10 (1.0, 7.4)
T3: 195 (19.9, 143.8)

3. TIMING CHAIN



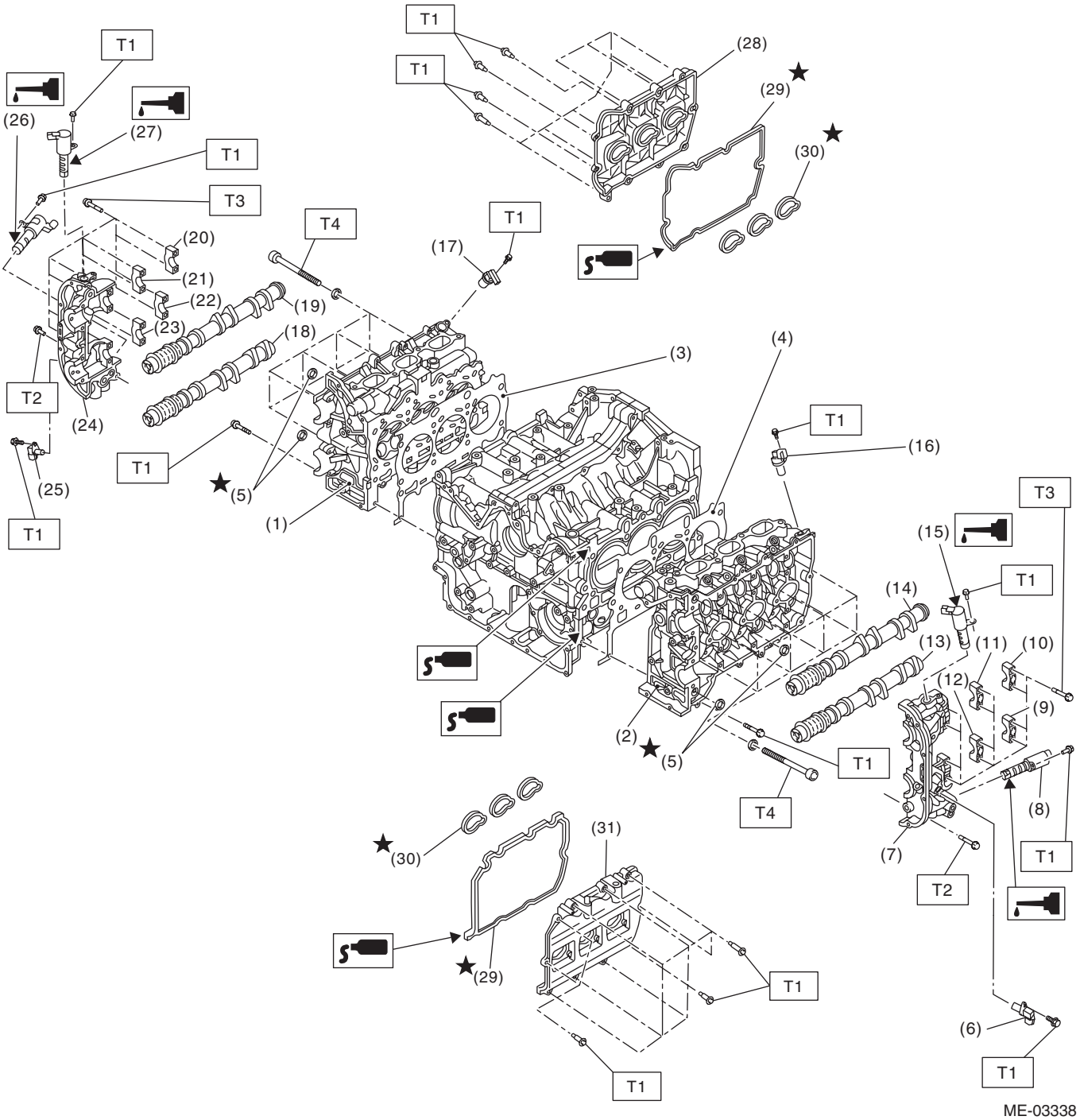
ME-03605

(1) Intake camshaft (RH)
(2) Exhaust camshaft (RH)
(3) Intake camshaft (LH)
(4) Exhaust camshaft (LH)
(5) Intake camshaft sprocket (RH)
(6) Exhaust camshaft sprocket (RH)
(7) Intake camshaft sprocket (LH)
(8) Exhaust camshaft sprocket (LH)
(9) Chain tensioner lever (RH)
(10) Chain tensioner lever (LH)
(11) Chain tensioner lever (Main)
(12) Chain tensioner (Main)
(13) Chain tensioner (RH)
(14) Timing chain (Main)
(15) Timing chain (RH)
(16) Timing chain (LH)
(17) Chain guide (RH)
(18) Chain guide (LH)
(19) Chain guide (Main)
(20) Chain guide (between cams)
(21) Idler sprocket
(22) Chain tensioner (LH)
(23) Chain tensioner lever shaft
(24) Chain tensioner lever shaft

Tightening torque:N·m (kgf-m, ft-lb)

T1: 6.4 (0.7, 4.7)
T2: 16 (1.6, 11.8)
T3: <Ref. to ME(H6DO)-73, Cam Sprocket.>
T4: 120 (12.2, 88.5)

4. CYLINDER HEAD AND CAMSHAFT

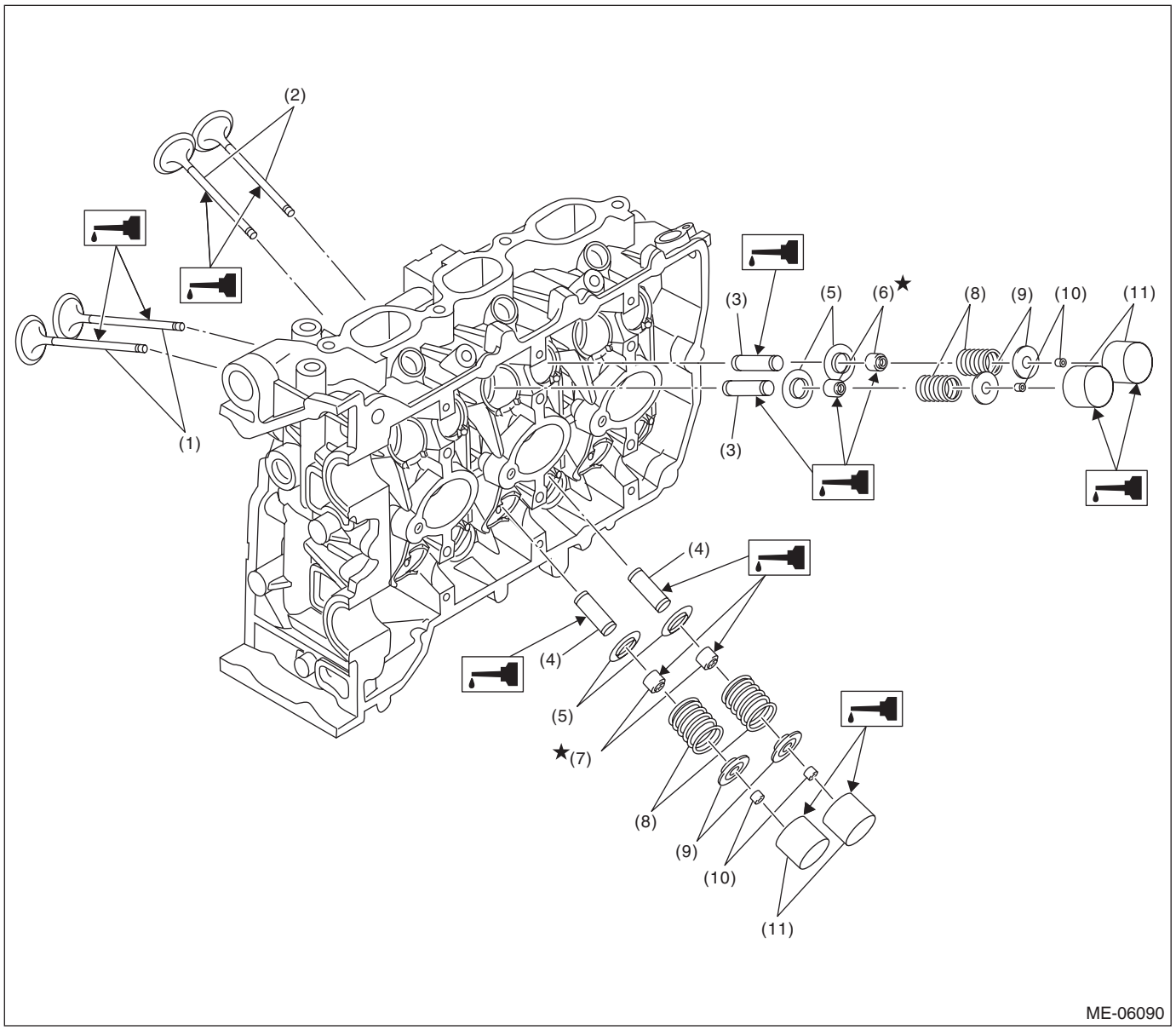


(1) Cylinder head (RH)
(2) Cylinder head (LH)
(3) Cylinder head gasket (RH)
(4) Cylinder head gasket (LH)
(5) O-ring
(6) Exhaust camshaft position sensor (LH)
(7) Front camshaft cap (LH)
(8) Exhaust oil flow control solenoid valve (LH)
(9) Exhaust camshaft cap (Rear LH)
(10) Intake camshaft cap (Rear LH)
(11) Intake camshaft cap (Center LH)
(12) Exhaust camshaft cap (Center LH)
(13) Exhaust camshaft (LH)
(14) Intake camshaft (LH)
(15) Intake oil flow control solenoid valve (LH)
(16) Intake camshaft position sensor (LH)
(17) Intake camshaft position sensor (RH)
(18) Exhaust camshaft (RH)
(19) Intake camshaft (RH)
(20) Intake camshaft cap (Rear RH)
(21) Intake camshaft cap (Center RH)
(22) Exhaust camshaft cap (Rear RH)
(23) Exhaust camshaft cap (Center RH)
(24) Front camshaft cap (RH)
(25) Exhaust camshaft position sensor (RH)
(26) Exhaust oil flow control solenoid valve (RH)
(27) Intake oil flow control solenoid valve (RH)
(28) Rocker cover (RH)
(29) Gasket
(30) Gasket
(31) Rocker cover (LH)

Tightening torque:N·m (kgf-m, ft-lb)

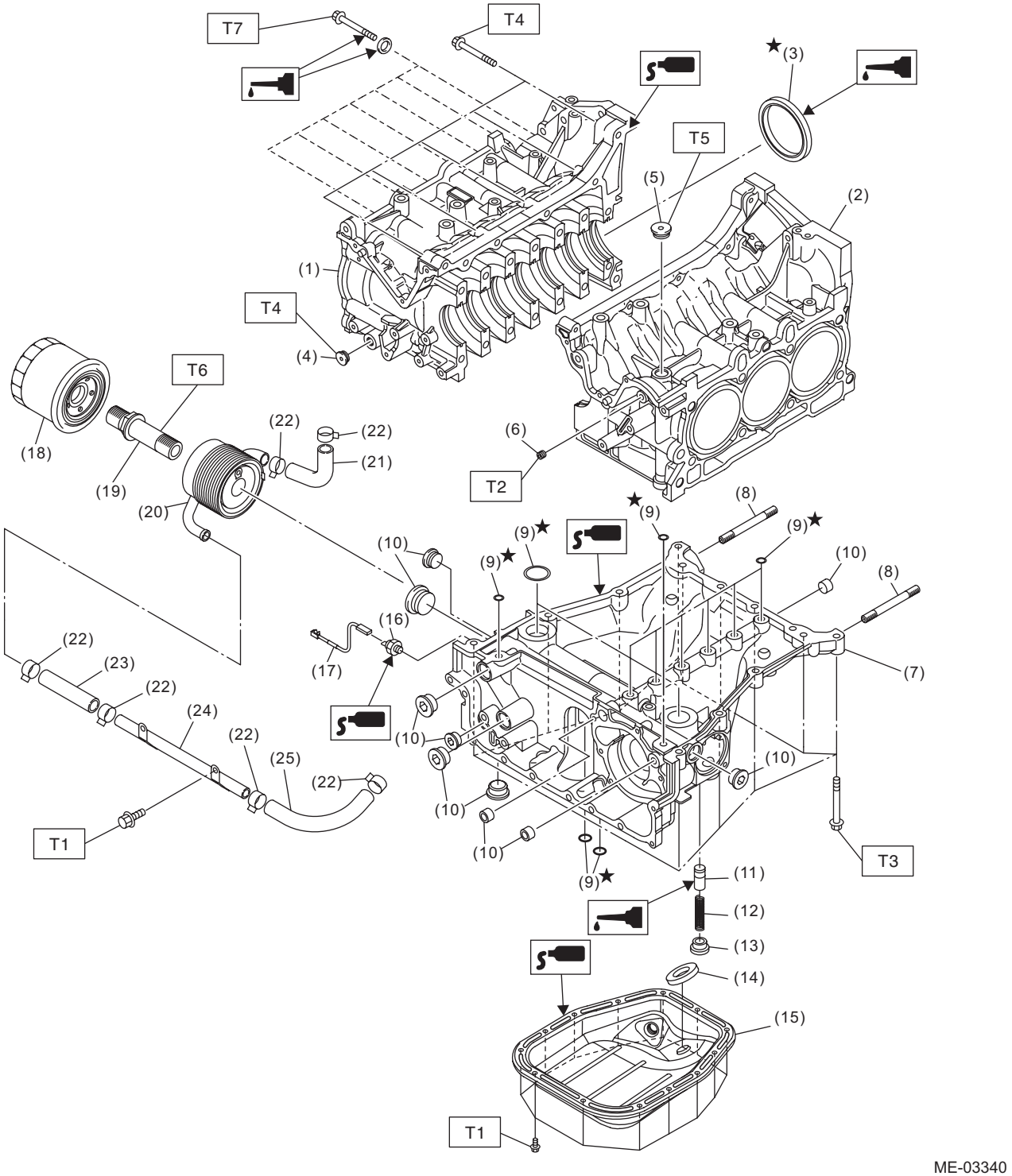
T1: 6.4 (0.7, 4.7)
T2: 9.75 (1.0, 7.2)
T3: 16 (1.6, 11.7)
T4: <Ref. to ME(H6DO)-82, Cylinder Head.>

5. CYLINDER HEAD AND VALVE ASSEMBLY



(1) Intake valve
(2) Exhaust valve
(3) Valve guide (Intake)
(4) Valve guide (Exhaust)
(5) Valve spring seat
(6) Stem seal (Intake)
(7) Stem seal (Exhaust)
(8) Valve spring
(9) Valve spring retainer
(10) Valve collet
(11) Valve lifter

6. CYLINDER BLOCK

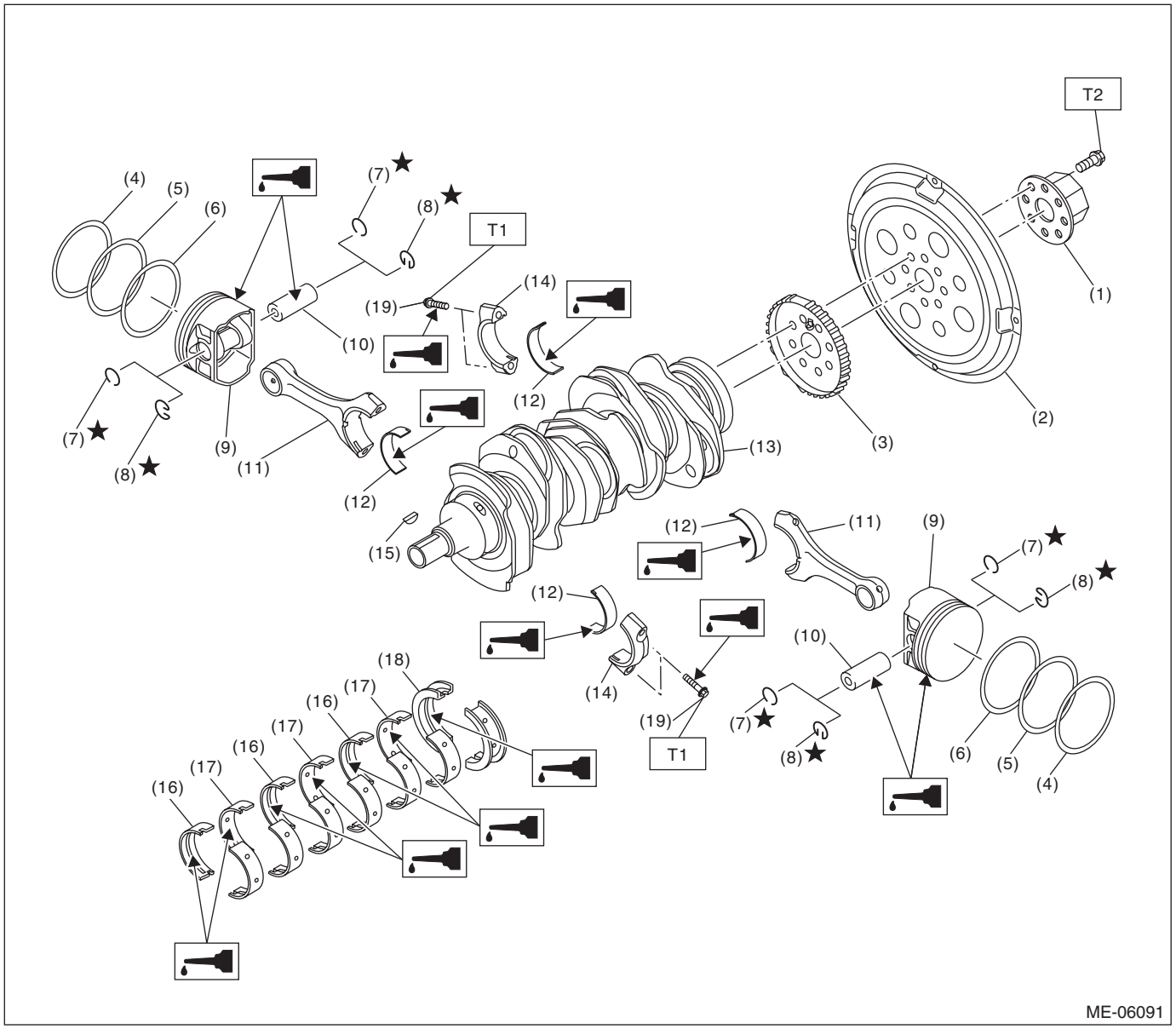


(1) Cylinder block (RH)
(2) Cylinder block (LH)
(3) Oil seal
(4) Plug
(5) Plug
(6) Orifice
(7) Oil pan upper
(8) Stud bolt
(9) O-ring
(10) Plug
(11) Relief valve
(12) Relief valve spring
(13) Relief plug
(14) Magnet
(15) Oil pan lower
(16) Oil pressure switch
(17) Oil pressure switch harness
(18) Oil filter
(19) Oil cooler connector
(20) Oil cooler
(21) Hose
(22) Clamp
(23) Hose
(24) Oil cooler pipe
(25) Hose

Tightening torque:N·m (kgf-m, ft-lb)

T1: 6.4 (0.7, 4.7)
T2: 17 (1.7, 12.5)
T3: 18 (1.8, 13.3)
T4: 25 (2.5, 18.4)
T5: 37 (3.8, 27.3)
T6: 54 (5.5, 39.8)
T7: <Ref. to ME(H6DO)-95, Cylinder Block.>

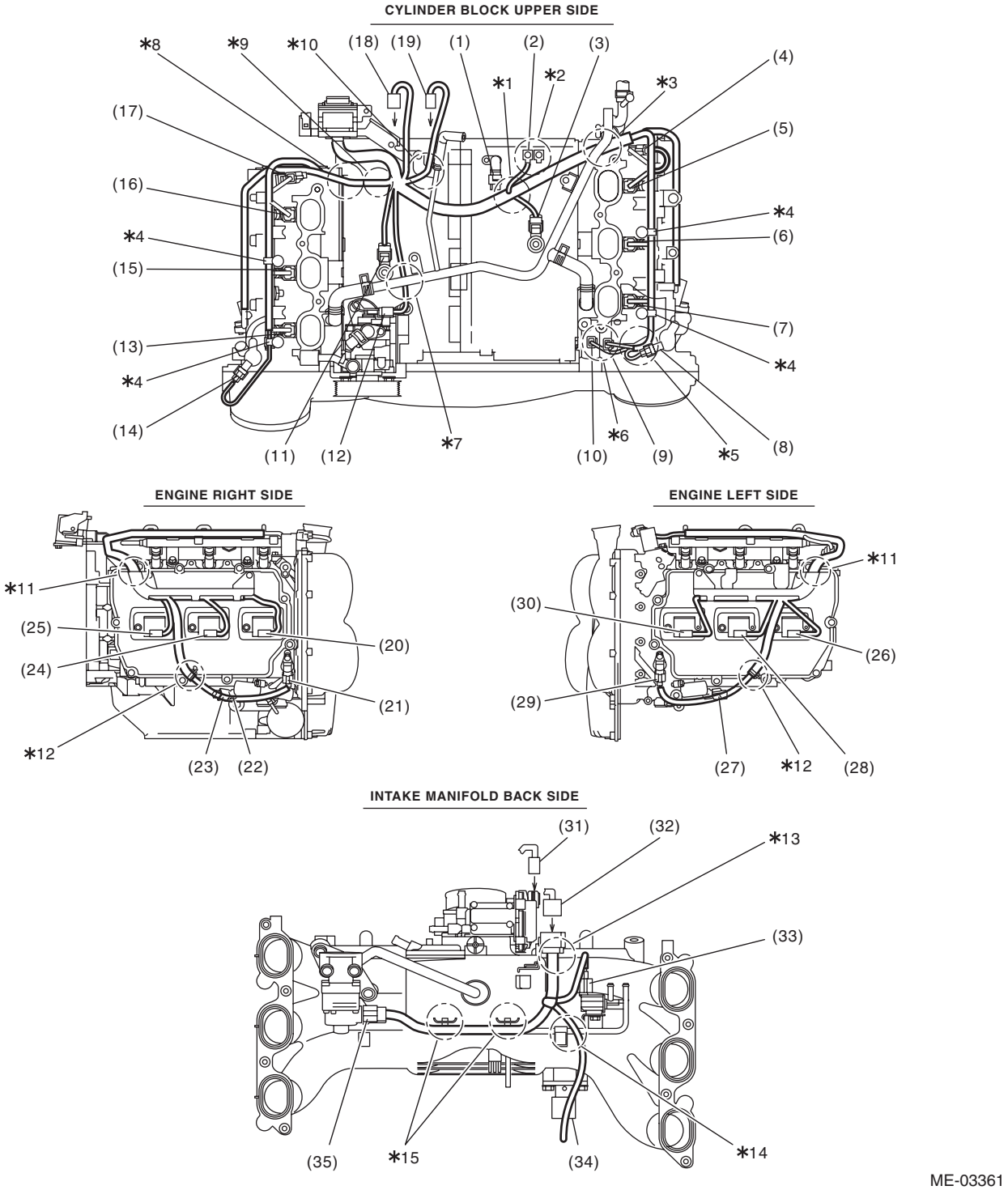
7. CRANKSHAFT AND PISTON



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

Tightening torque:N·m (kgf-m, ft-lb)
T1: 60 (6.1, 44.3)
T2: 90 (9.2, 66.4)

8. ENGINE HARNESS

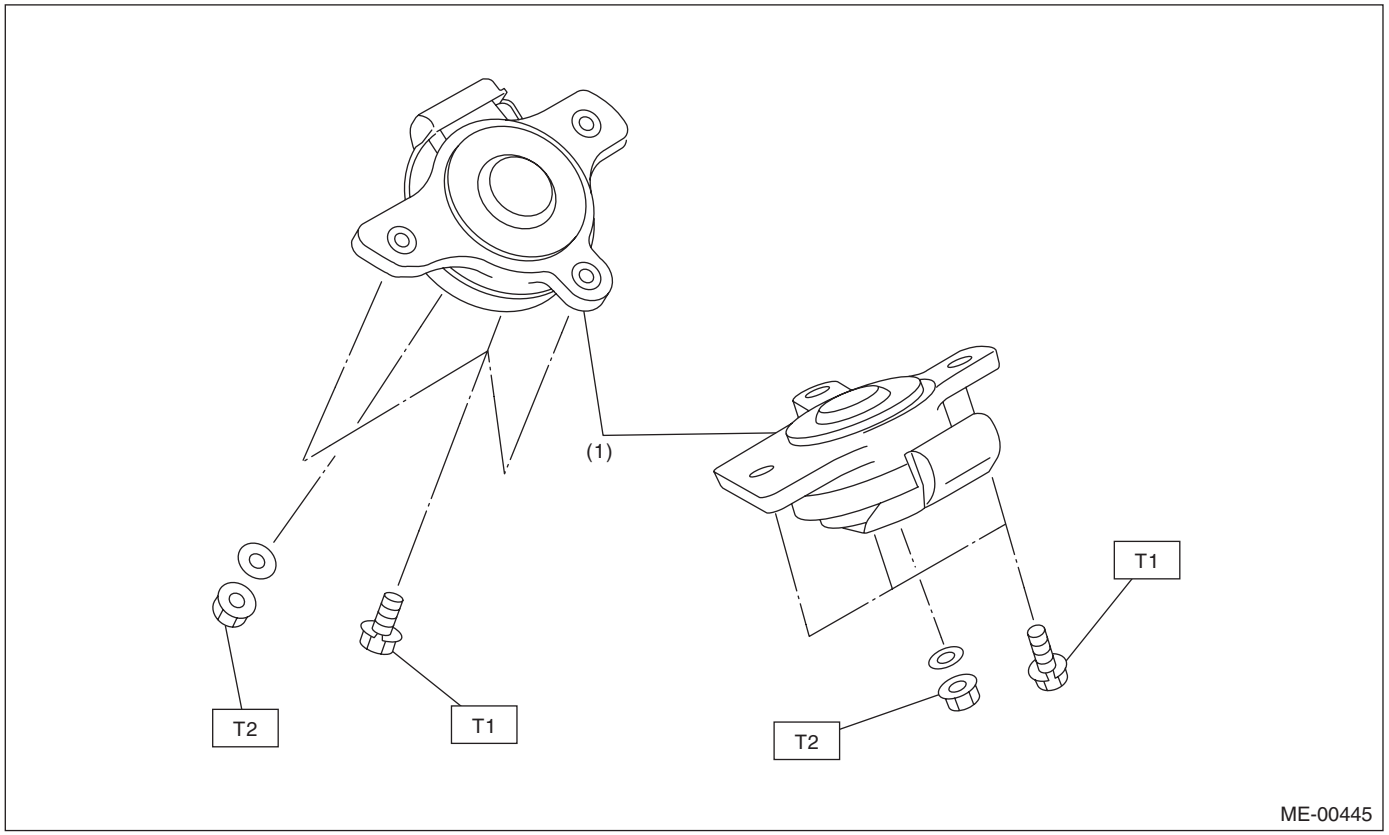


ME-03361

(1) Crankshaft position sensor connector
(2) Engine ground
(3) Knock sensor LH connector
(4) Intake camshaft position sensor LH connector
(5) #6 injector connector
(6) #4 injector connector
(7) #2 injector connector
(8) Intake oil flow control solenoid valve LH connector
(9) Oil temperature sensor connector
(10) Engine coolant temperature sensor connector
(11) Knock sensor RH connector
(12) Power steering switch connector
(13) #1 injector connector
(14) Intake oil flow control solenoid valve RH connector
(15) #3 injector connector
(16) #5 injector connector
(17) Intake camshaft position sensor RH connector
(18) Upper and lower joint connector (to intake manifold)
(19) Electronic throttle control connector (to intake manifold)
(20) #1 ignition coil connector
(21) Exhaust camshaft position sensor RH
(22) Oil pressure switch connector
(23) Exhaust oil flow control solenoid valve RH connector
(24) #3 ignition coil connector
(25) #5 ignition coil connector
(26) #6 ignition coil connector
(27) Exhaust oil flow control solenoid valve LH connector
(28) #4 ignition coil connector
(29) Exhaust camshaft position sensor LH connector
(30) #2 ignition coil connector
(31) Electronic throttle control connector (from cylinder block upper part)
(32) Upper and lower joint connector (from cylinder block upper part)
(33) Purge control solenoid valve connector
(34) Manifold absolute pressure sensor connector
(35) EGR valve connector

*1: Route the harness between the crankshaft position sensor and the knock sensor LH.
*2: Install the engine ground terminal so that it faces the rear of the vehicle.
*3: Route the harness under the heater hose pipe.
*4: Install the engine harness fixing clip to the fuel pipe stay.
*5: Route the harness from the cutout portion of the fuel pipe protector LH.
*6: Do not confuse the oil temperature sensor connector and the engine coolant temperature sensor connector.
*7: Route the harness under the heater hose pipe.
*8: Route the harness under the fuel pipe.
*9: Install the engine harness fixing clip to the fixing boss of the cylinder block.
*10: Route the harness over the heater hose pipe stay.
*11: Align the edges of the engine harness stay and the engine harness identification tape.
*12: Install the engine harness fixing clip to the fixing boss of the rocker cover.
*13: Install the engine harness fixing stay securely.
*14: Route the harness outside the fuel pipe.
*15: Install the engine harness fixing clip to the fixing stay of the intake manifold.

9. ENGINE MOUNTING



(1) Front cushion rubber

Tightening torque:N·m (kgf-m, ft-lb)
T1: 35 (3.6, 25.8)
T2: 75 (7.6, 55.3)

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.
- Before applying liquid gasket, completely remove the old liquid gasket and degrease it.
- Rotating parts and sliding parts such as piston, bearing and gear should be coated with oil prior to assembly.
- 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

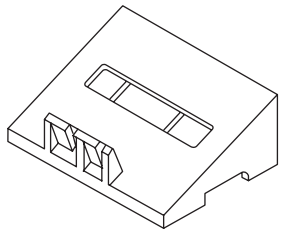
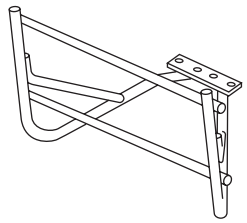
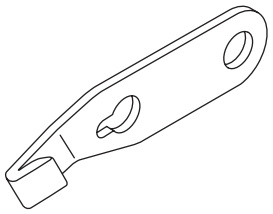
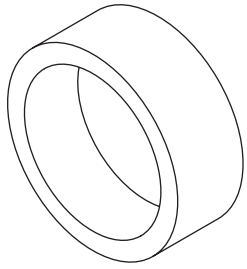
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18250AA010	18250AA010	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST18232AA000	18232AA000	ENGINE STAND	Used for disassembling and assembling engine.
 ST-498497100	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of drive plate when loosening / tightening crank pulley bolt.
 ST-398744300	398744300	PISTON GUIDE	Used for installing piston in cylinder.

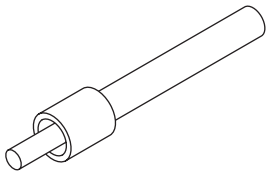
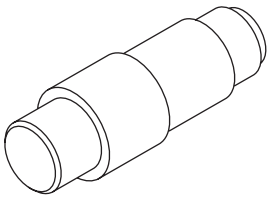
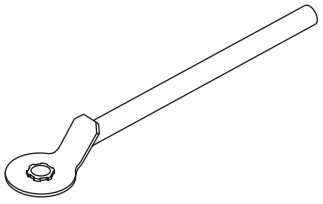
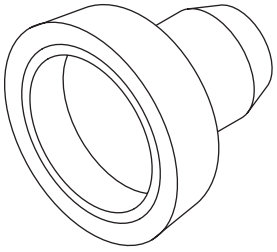
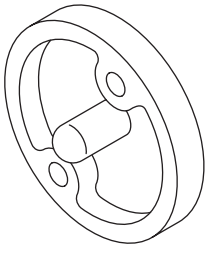
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499585500	499585500	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST18350AA000	18350AA000	CONNECTING ROD BUSHING REMOVER AND INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing camshaft sprocket.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used together with CRANKSHAFT OIL SEAL INSTALLER (499587200).

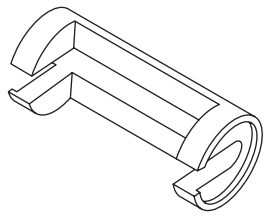
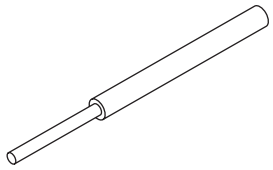
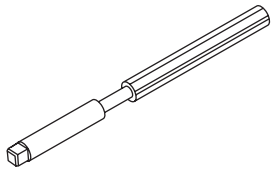
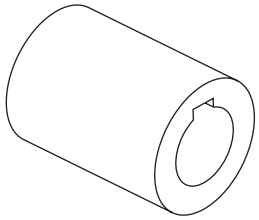
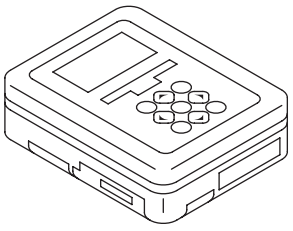
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST-499765700	499765700	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499765900	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST18252AA000	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST1B022XU0	1B022XU0	SUBARU SELECT MONITOR III KIT	Used for troubleshooting the electrical system.

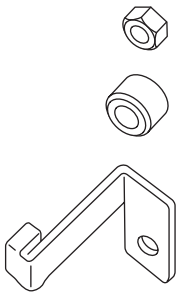
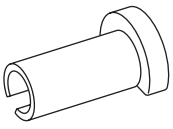
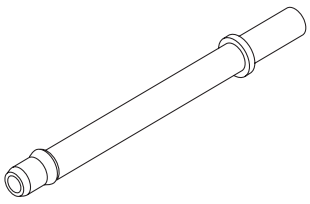
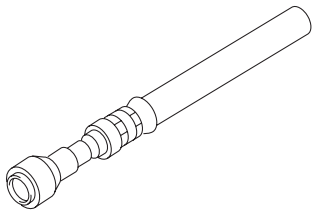
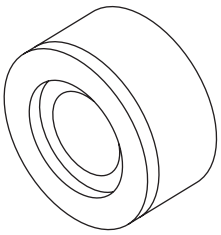
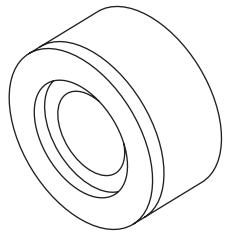
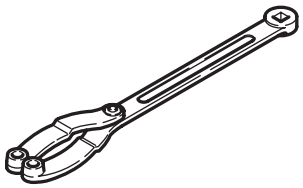
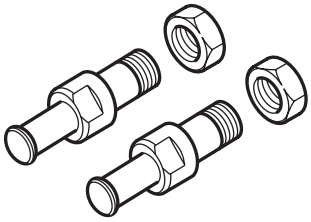
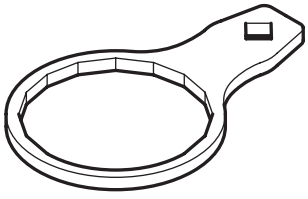
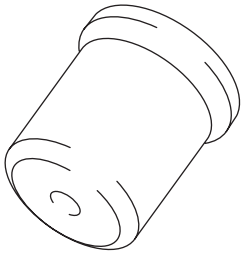
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST42099AE000	42099AE000	QUICK CONNECTOR RELEASE	Used for disconnecting quick connector of the engine compartment.
 ST18471AA000	18471AA000	FUEL PIPE ADAPTER	Used for measuring fuel pressure.
 ST42075AG690	42075AG690	FUEL HOSE	• Used for measuring fuel pressure. • This is a genuine Subaru part.
 ST18251AA050	18251AA050 (Newly adopted tool)	VALVE GUIDE ADJUSTER	Used for installing intake valve guides.

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18251AA060	18251AA060 (Newly adopted tool)	VALVE GUIDE ADJUSTER	Used for installing exhaust valve guides.
 ST18355AA000	18355AA000 (Newly adopted tool)	PULLEY WRENCH	• Used for stopping rotation of crank pulley when removing and installing crank pulley bolt. • Used for stopping rotation of idler sprocket when removing and installing idler sprocket bolt.
 ST18334AA000	18334AA000 (Newly adopted tool)	PULLEY WRENCH PIN SET	• Used for stopping rotation of crank pulley when removing and installing crank pulley bolt. • Used for stopping rotation of idler sprocket when removing and installing idler sprocket bolt.
 ST18332AA020	18332AA020 (Newly adopted tool)	OIL FILTER WRENCH	Used for removing and installing oil filter.
 ST-499585700	499585700 (Newly adopted tool)	OIL SEAL GUIDE	Used for installing the chain cover oil seal.

2. GENERAL TOOL

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.
Vacuum gauge	Used for measuring intake manifold vacuum.
Oil pressure gauge	Used for measuring engine oil pressure.
Fuel pressure gauge	Used for measuring fuel pressure.
TORX® socket (E12)	Used for removing and installing connecting rod cap.

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 chain