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)			89.2 × 80 (3.512 × 3.150)
	Displacement cm^3 (cu in)			3,000 (183)
	Compression ratio			10.7
	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 47°
			Close	ABDC 23°
		Max. retard	Open	ATDC 3°
			Close	ABDC 73°
	Exhaust valve timing		Open	BBDC 60°
			Close	ATDC 6°
	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	650±50
			A/C ON	770±50
	Ignition order			1 → 6 →3 → 2 → 5 → 4
	Ignition timing BTDC/rpm			15°±8°/650

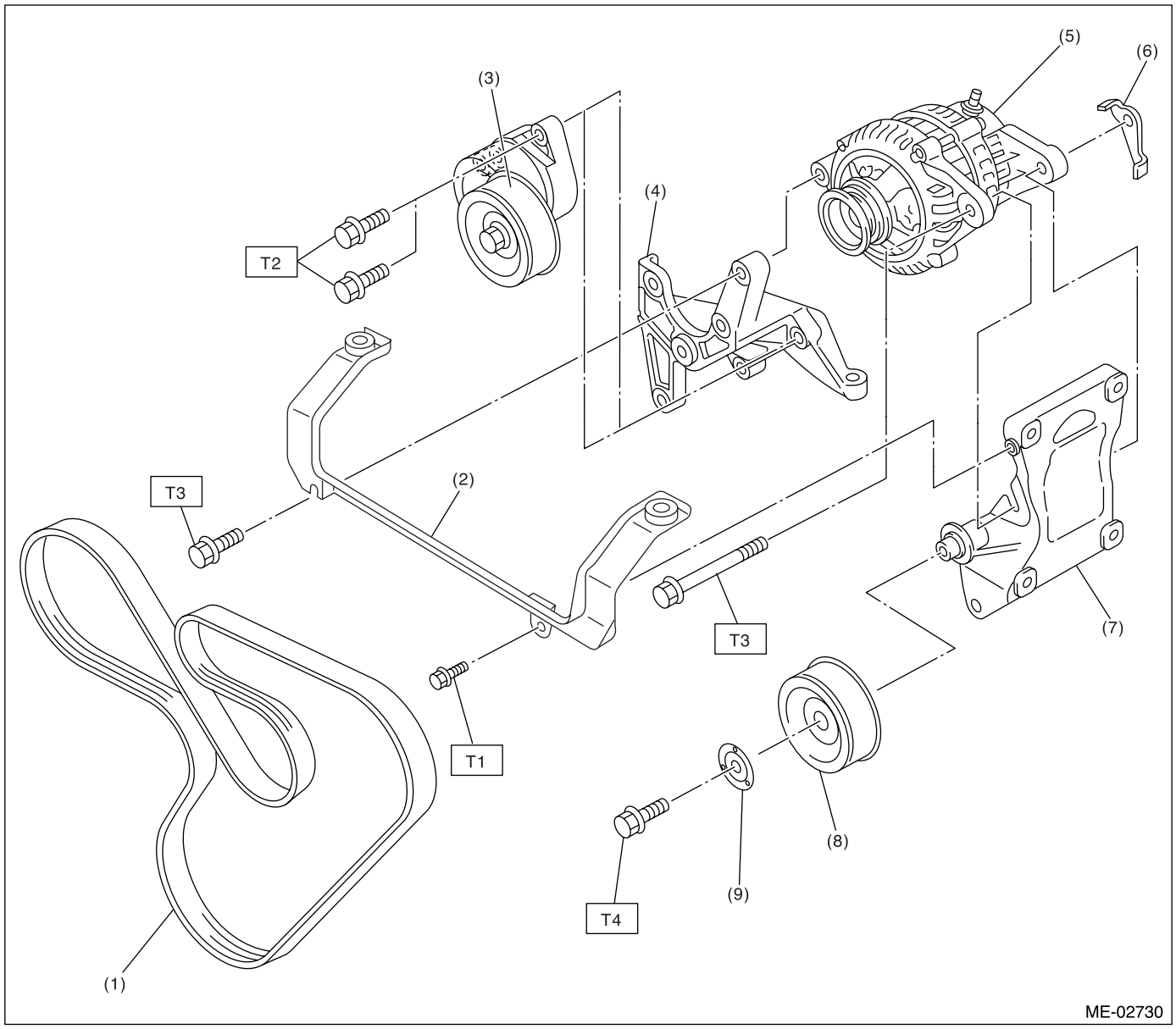
NOTE:
OS: Oversize US: undersize

Camshaft	Thrust clearance mm (in)	Intake			Standard	0.075 — 0.135 (0.0030 — 0.0053)
		Exhaust			Standard	0.030 — 0.090 (0.0012 — 0.0035)
	Cam lobe height mm (in)	Intake	HIGH		Standard	42.09 — 42.19 (1.6571 — 1.6610)
			LOW1		Standard	38.14 — 38.24 (1.5016 — 1.5055)
			LOW2		Standard	35.44 — 35.54 (1.3953 — 1.3992)
		Exhaust			Standard	41.65 — 41.75 (1.6398 — 1.6437)
	Cam base circle diameter mm (in)	Intake	HIGH		Standard	32.00 (1.2598)
			LOW1		Standard	31.84 (1.2535)
			LOW2		Standard	31.84 (1.2535)
		Exhaust			Standard	32.00 (1.2598)
	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	Flatness 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	Refacing 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 mm (in)					11.4 — 11.8 (0.449 — 0.465)
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				99.7 (3.925)
		Exhaust				105.2 (4.142)
	Outer diameter of valve lifter mm (in)					32.959 — 32.975 (1.2976 — 1.2982)
Valve spring	Free length mm (in)	Intake			Inner	39.55 (1.5571)
					Outer	41.18 (1.6213)
		Exhaust				46.32 (1.8236)
	Squareness	Intake			Inner	2.5°1.7 mm (0.067 in)
					Outer	2.5°1.8 mm (0.071 in)
		Exhaust				2.5°2.0 mm (0.079 in)
Cylinder block	Standard height mm (in)					202 (7.95)
	Cylinder inner diameter mm (in)	Standard			A	89.205 — 89.215 (3.5120 — 3.5124)
					B	89.195 — 89.205 (3.5116 — 3.5120)
	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	89.205 — 89.215 (3.5120 — 3.5124)
					B	89.195 — 89.205 (3.5116 — 3.5120)
		0.25 (0.0098) OS				89.445 — 89.465 (3.5215 — 3.5222)
		0.50 (0.0197) OS				89.695 — 89.715 (3.5313 — 3.5321)
	Inner diameter of piston pin hole				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	0.35 — 0.50 (0.0138 — 0.0197)
		Oil ring		Standard	0.20 — 0.60 (0.0079 — 0.0236)
	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	0.045 — 0.125 (0.0018 — 0.0049)
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		1.490 — 1.506 (0.0587 — 0.0593)
			0.03 (0.0012) US		1.509 — 1.513 (0.0594 — 0.0596)
			0.05 (0.0020) US		1.519 — 1.523 (0.0598 — 0.0600)
			0.25 (0.0098) US		1.619 — 1.623 (0.0637 — 0.0639)
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, #7	Standard		1.992 — 2.005 (0.0784 — 0.0789)
			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		1.996 — 2.009 (0.0786 — 0.0791)
			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)

B: COMPONENT

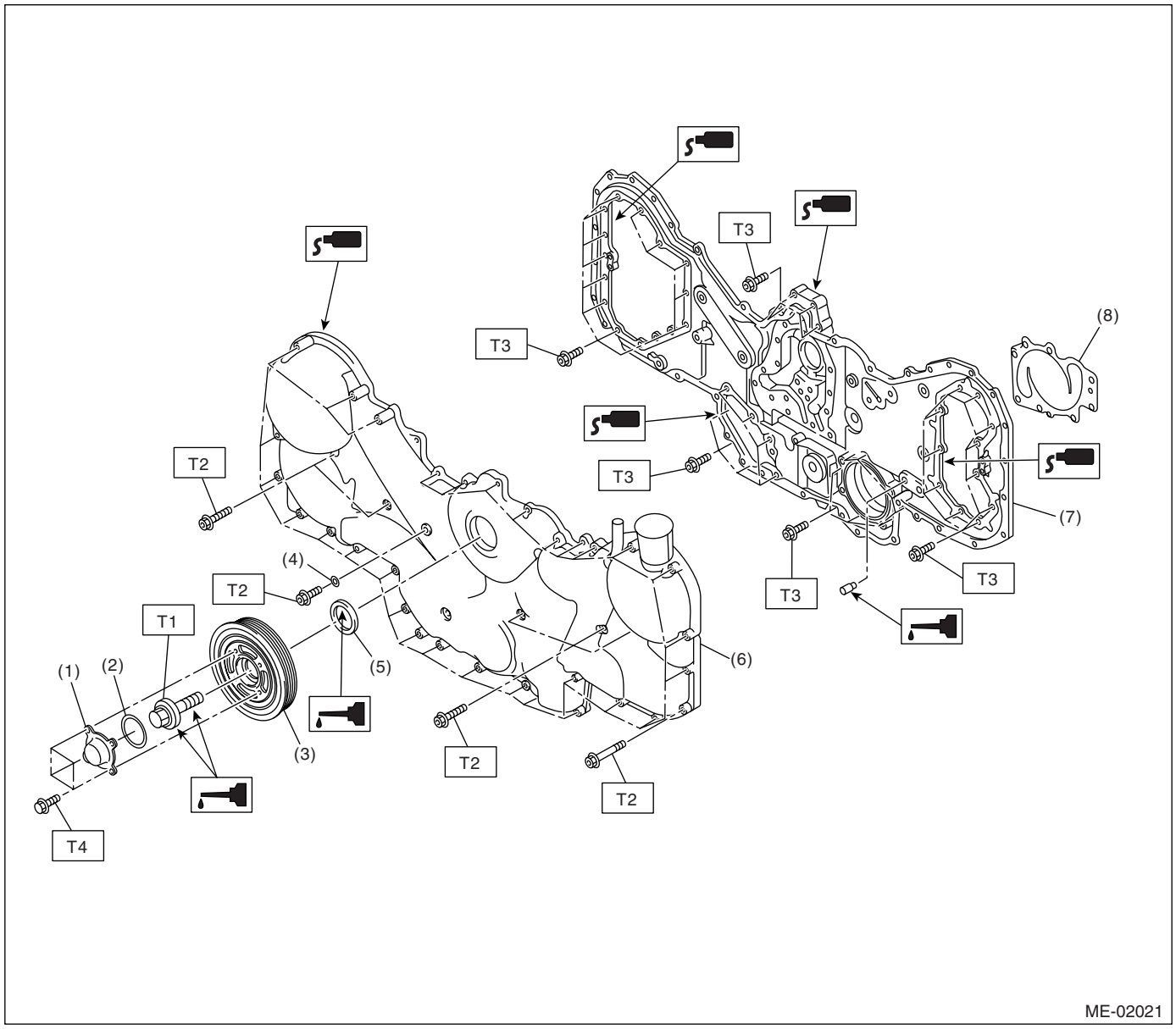
1. V-BELT



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

Tightening torque: N·m (kgf-m, ft-lb)
T1: 6.4 (0.65, 4.7)
T2: 20 (2.0, 14)
T3: 25 (2.5, 18)
T4: 33 (3.4, 24.3)

2. TIMING CHAIN COVER



(1) Crank pulley cover
(2) O-ring
(3) Crank pulley
(4) Sealing washer
(5) Oil seal
(6) Front chain cover
(7) Rear chain cover
(8) Water pump gasket

Tightening torque: N·m (kgf-m, ft-lb)

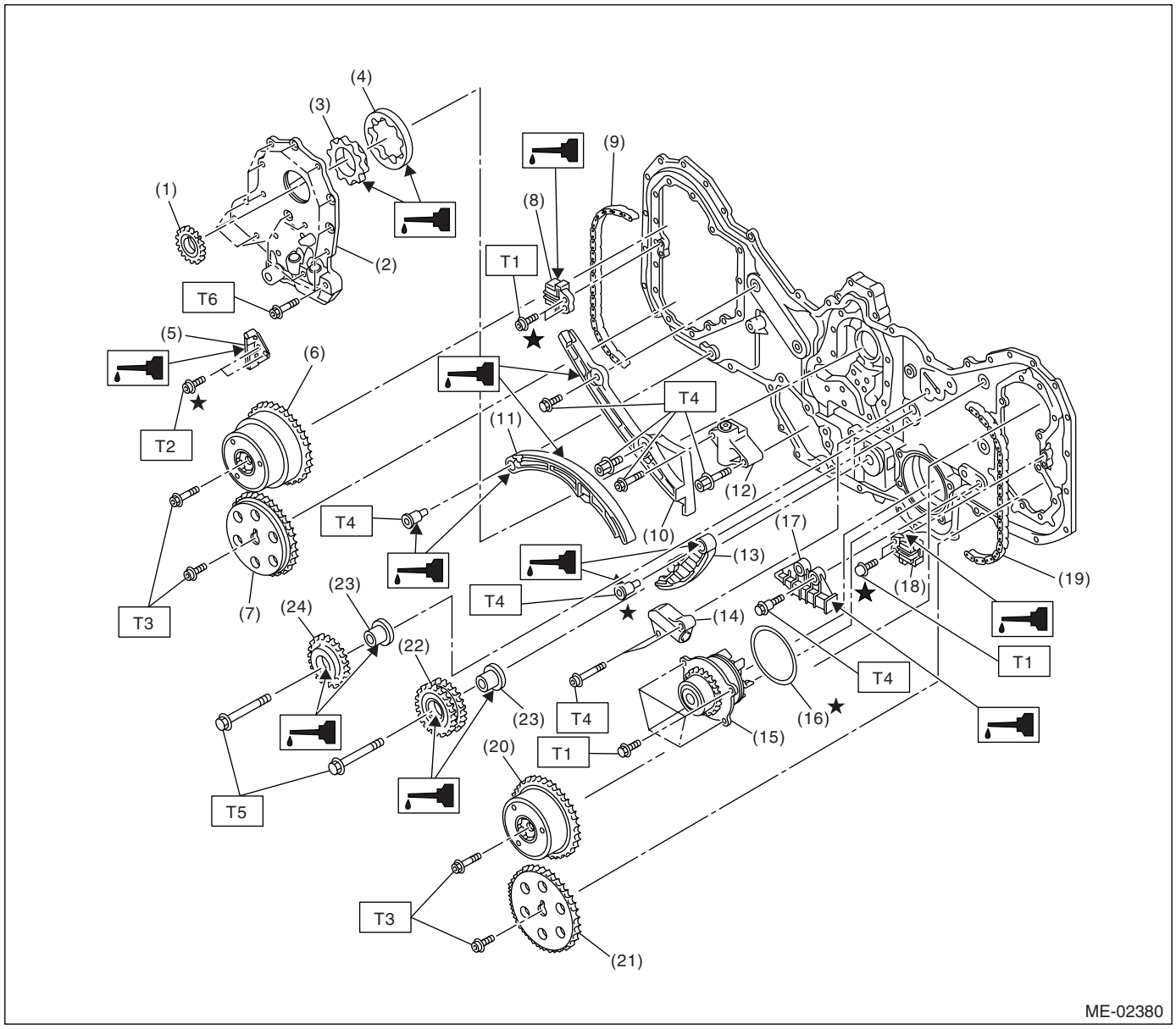
T1: <Ref. to ME(H6DO)-41, Crank Pulley.>

T2: <Ref. to ME(H6DO)-42, Front Chain Cover.>

T3: <Ref. to ME(H6DO)-51, Rear Chain Cover.>

T4: 6.4 (0.65, 4.7)

3. TIMING CHAIN

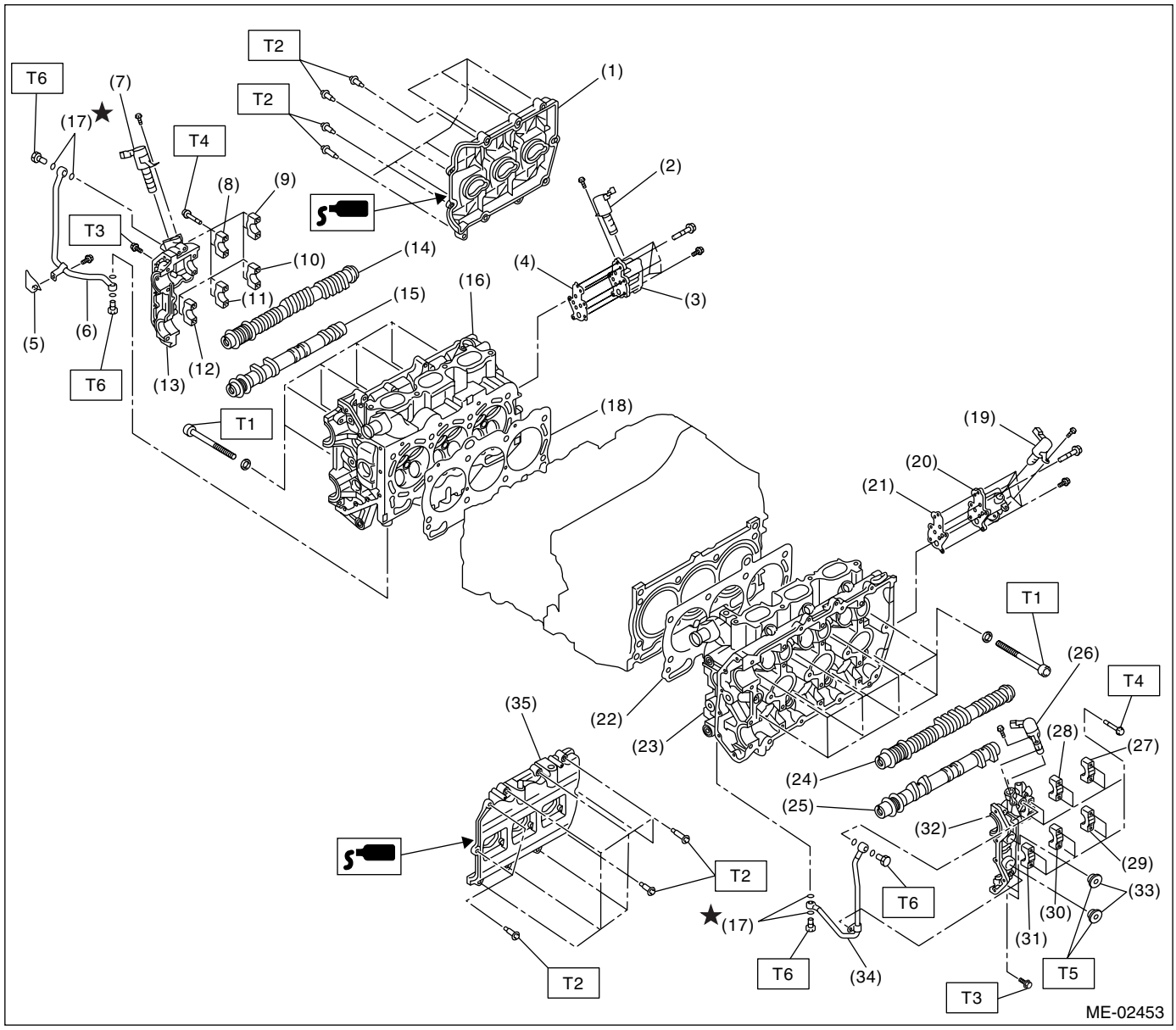


(1) Crank sprocket
(2) Oil relief case
(3) Inner rotor
(4) Outer rotor
(5) Chain guide (center)
(6) Intake cam sprocket (RH)
(7) Exhaust cam sprocket (RH)
(8) Chain guide (RH: between cams)
(9) Timing chain (RH)
(10) Chain guide (RH)
(11) Chain tensioner lever (RH)
(12) Chain tensioner (RH)
(13) Chain tensioner lever (LH)
(14) Chain tensioner (LH)
(15) Water pump
(16) O-ring
(17) Chain guide (LH)
(18) Chain guide (LH: between cams)
(19) Timing chain (LH)
(20) Intake cam sprocket (LH)
(21) Exhaust cam sprocket (LH)
(22) Idler sprocket (lower)
(23) Idler sprocket collar
(24) Idler sprocket (upper)

Tightening torque: N·m (kgf-m, ft-lb)

T1*: *6.4 (0.65, 4.7)
T2: 7.8 (0.8, 5.8)
T3: <Ref. to ME(H6DO)-49, Cam Sprocket.>
T4: 16 (1.6, 12)
T5: 69 (7.0, 50.6)
T6: <Ref. to LU(H6DO)-8, Oil Pump.>

4. CYLINDER HEAD AND CAMSHAFT

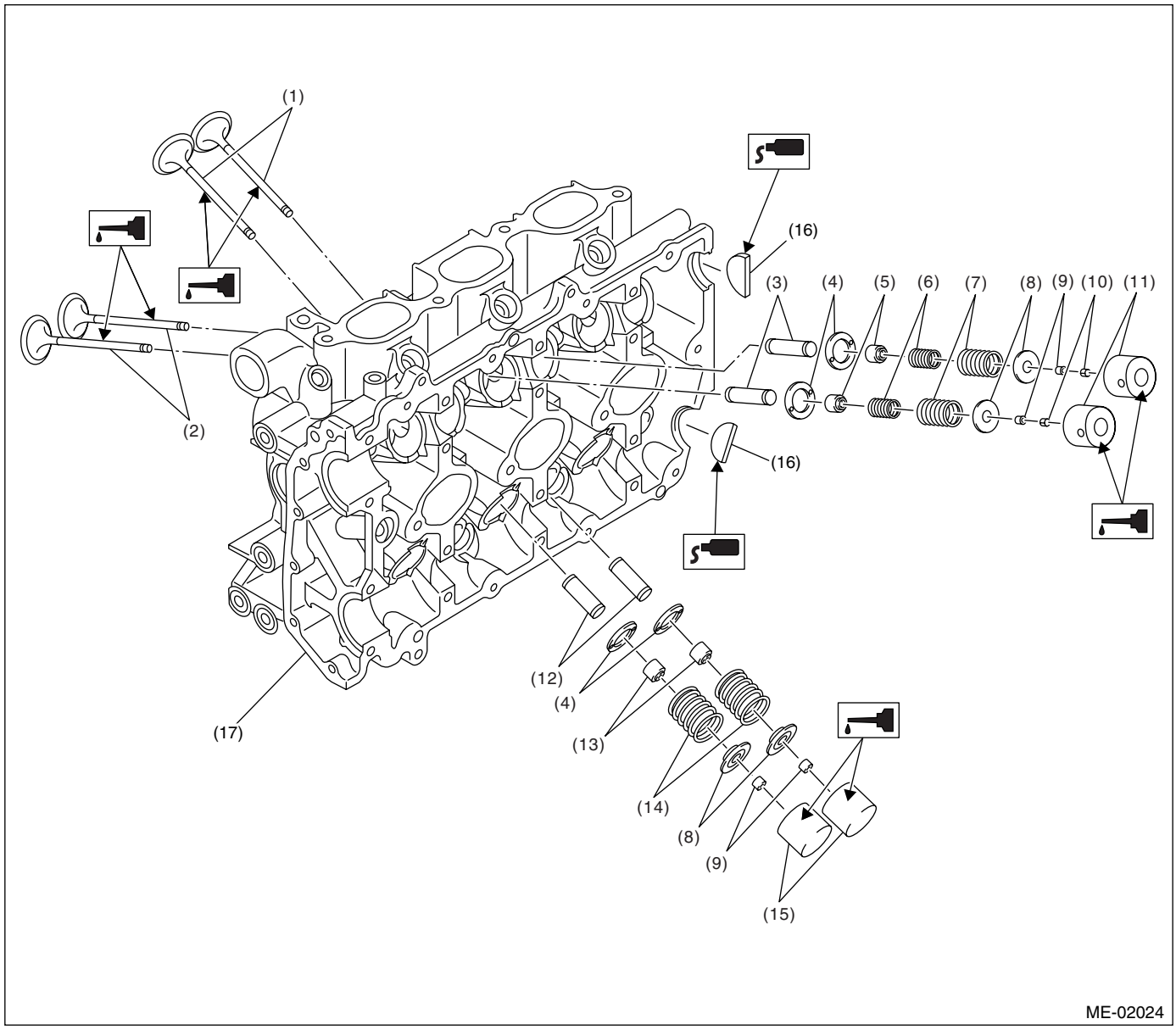


(1) Rocker cover (RH)
(2) Oil switching solenoid valve (RH)
(3) Oil switching solenoid valve holder (RH)
(4) Oil switching solenoid valve gasket
(5) Rear chain cover
(6) Oil pipe (RH)
(7) Oil flow control solenoid valve (RH)
(8) Intake camshaft cap (Center RH)
(9) Intake camshaft cap (Rear RH)
(10) Exhaust camshaft cap (Rear RH)
(11) Exhaust camshaft cap (Center RH)
(12) Exhaust camshaft cap (Front RH)
(13) Front camshaft cap (RH)
(14) Intake camshaft (RH)
(15) Exhaust camshaft (RH)
(16) Cylinder head (RH)
(17) Gasket
(18) Cylinder head gasket (RH)
(19) Oil switching solenoid valve (LH)
(20) Oil switching solenoid valve holder (LH)
(21) Oil switching solenoid valve gasket
(22) Cylinder head gasket (LH)
(23) Cylinder head (LH)
(24) Intake camshaft (LH)
(25) Exhaust camshaft (LH)
(26) Oil flow control solenoid valve (LH)
(27) Intake camshaft cap (Rear LH)
(28) Intake camshaft cap (Center LH)
(29) Exhaust camshaft cap (Rear LH)
(30) Exhaust camshaft cap (Center LH)
(31) Exhaust camshaft cap (Front LH)
(32) Front camshaft cap (LH)
(33) Plug
(34) Oil pipe (LH)
(35) Rocker cover (LH)

Tightening torque: N·m (kgf-m, ft-lb)

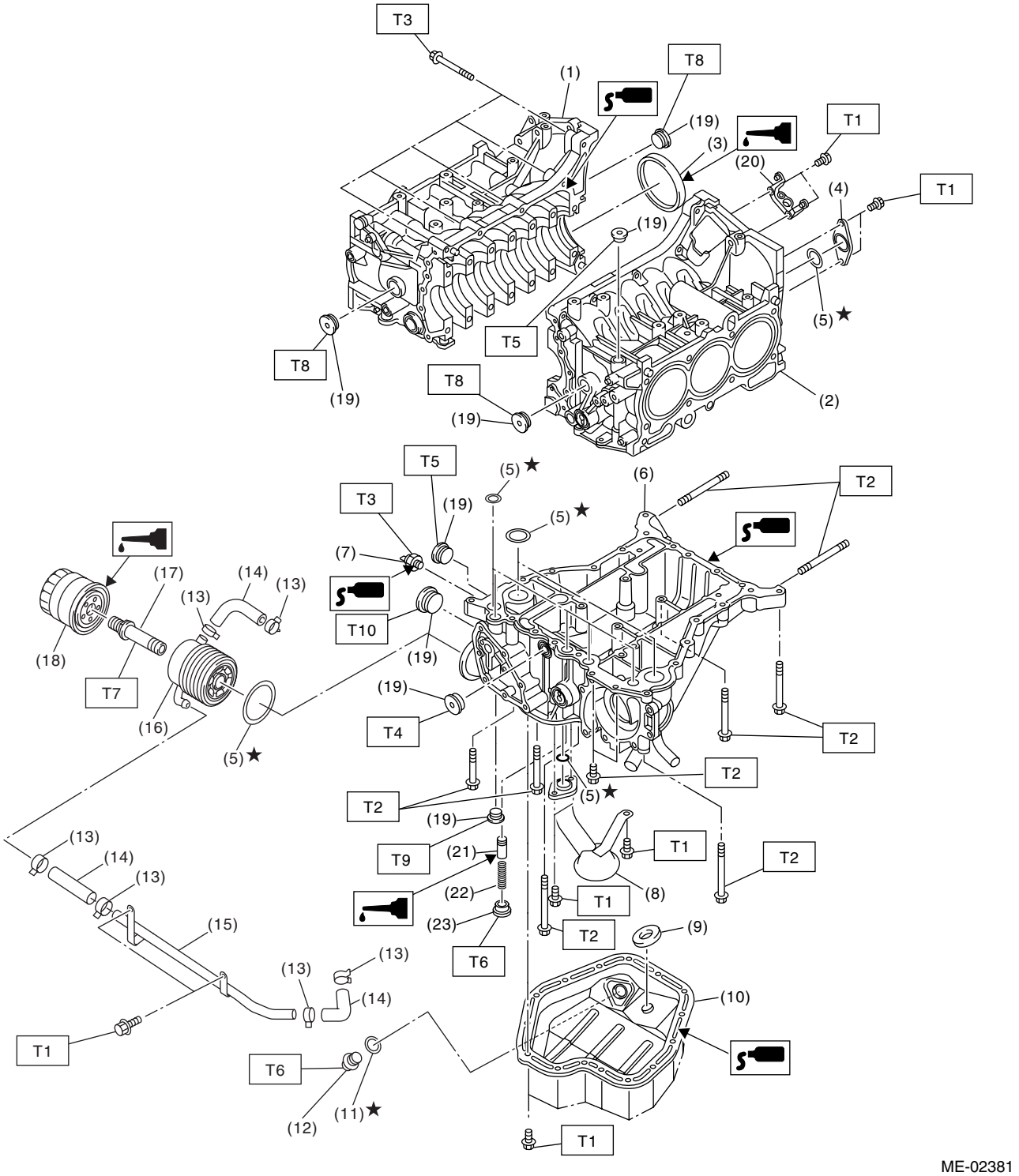
T1:	***<Ref. to ME(H6DO)-57, Cylinder Head.>***
T2:	***<Ref. to ME(H6DO)-53, Camshaft.>***
T3:	***<Ref. to ME(H6DO)-78, Oil Switching Solenoid Valve.>***
T4:	***6.4 (0.65, 4.7)***
T5:	***9.75 (1.0, 7.2)***
T6:	***16 (1.6, 12)***
T7:	***60 (6.1, 44)***
T8:	***29 (3.0, 21.4)***

5. CYLINDER HEAD AND VALVE ASSEMBLY



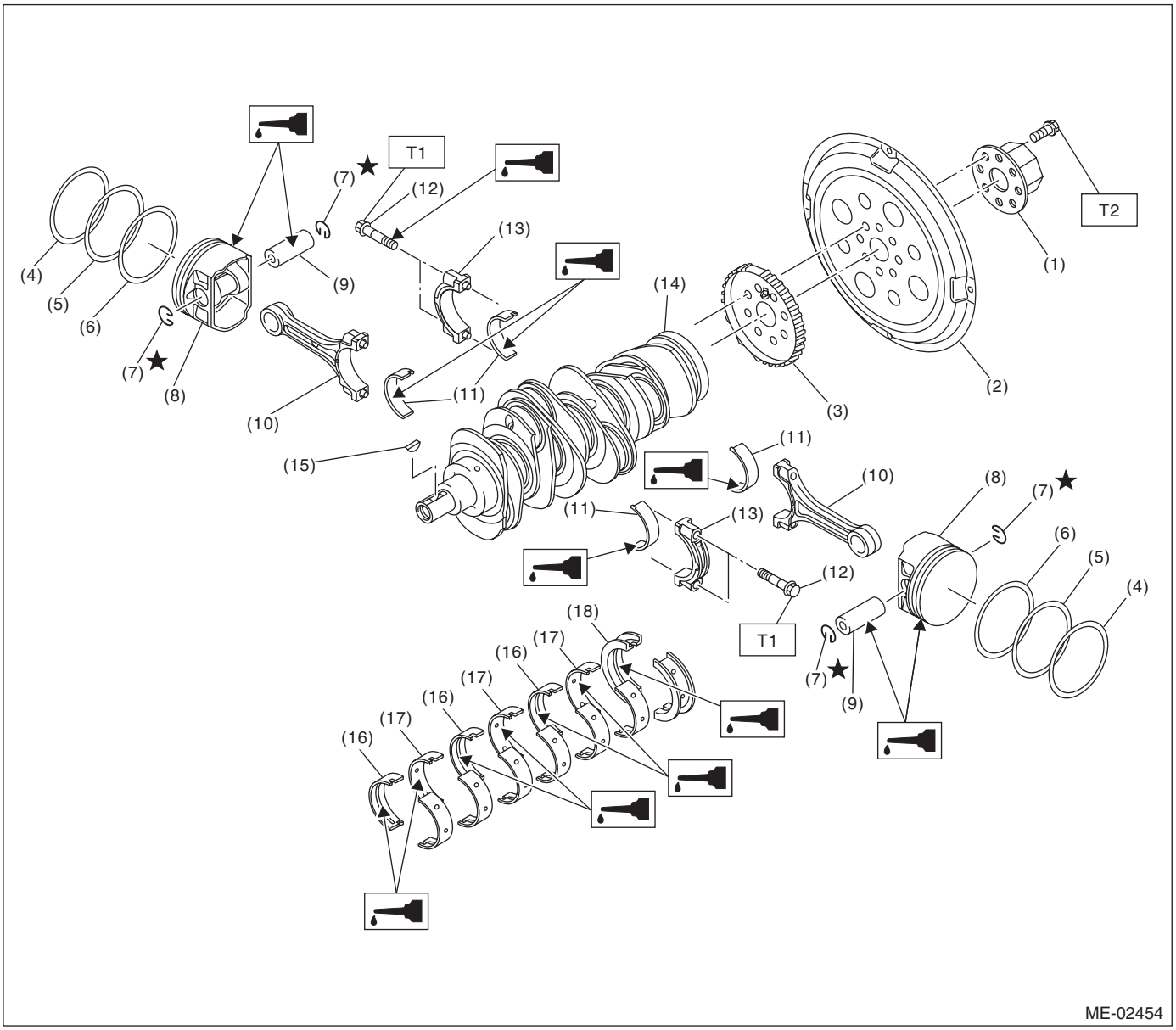
(1) Exhaust valve
(2) Intake valve
(3) Intake valve guide
(4) Valve spring seat
(5) Intake valve stem seal
(6) Valve spring (Inner)
(7) Valve spring (Outer)
(8) Retainer
(9) Retainer key
(10) Shim
(11) Valve lifter (Intake)
(12) Exhaust valve guide
(13) Exhaust valve stem seal
(14) Valve spring
(15) Valve lifter (Exhaust)
(16) Cylinder head plug
(17) Cylinder head

6. CYLINDER BLOCK



(1)	Cylinder block (RH)	(13)	Clamp	***Tightening torque: N·m (kgf-m, ft-lb)***
(2)	Cylinder block (LH)	(14)	Hose	***T1: 6.4 (0.65, 4.7)***
(3)	Rear oil seal	(15)	Oil cooler pipe	***T2: 18 (1.8, 13.3)***
(4)	Service hole cover	(16)	Oil cooler	***T3: 25 (2.5, 18)***
(5)	O-ring	(17)	Connector	***T4: 16 (1.6, 12)***
(6)	Oil pan upper	(18)	Oil filter	***T5: 37 (3.8, 27)***
(7)	Oil pressure switch	(19)	Plug	***T6: 44 (4.5, 33)***
(8)	Oil strainer	(20)	Crankshaft position sensor holder	***T7: 54 (5.5, 40)***
(9)	Magnet	(21)	Relief valve	***T8: 70 (7.1, 52)***
(10)	Oil pan lower	(22)	Relief valve spring	***T9: 23 (2.3, 17)***
(11)	Metal gasket	(23)	Plug	***T10: 90 (9.2, 67)***
(12)	Drain plug			

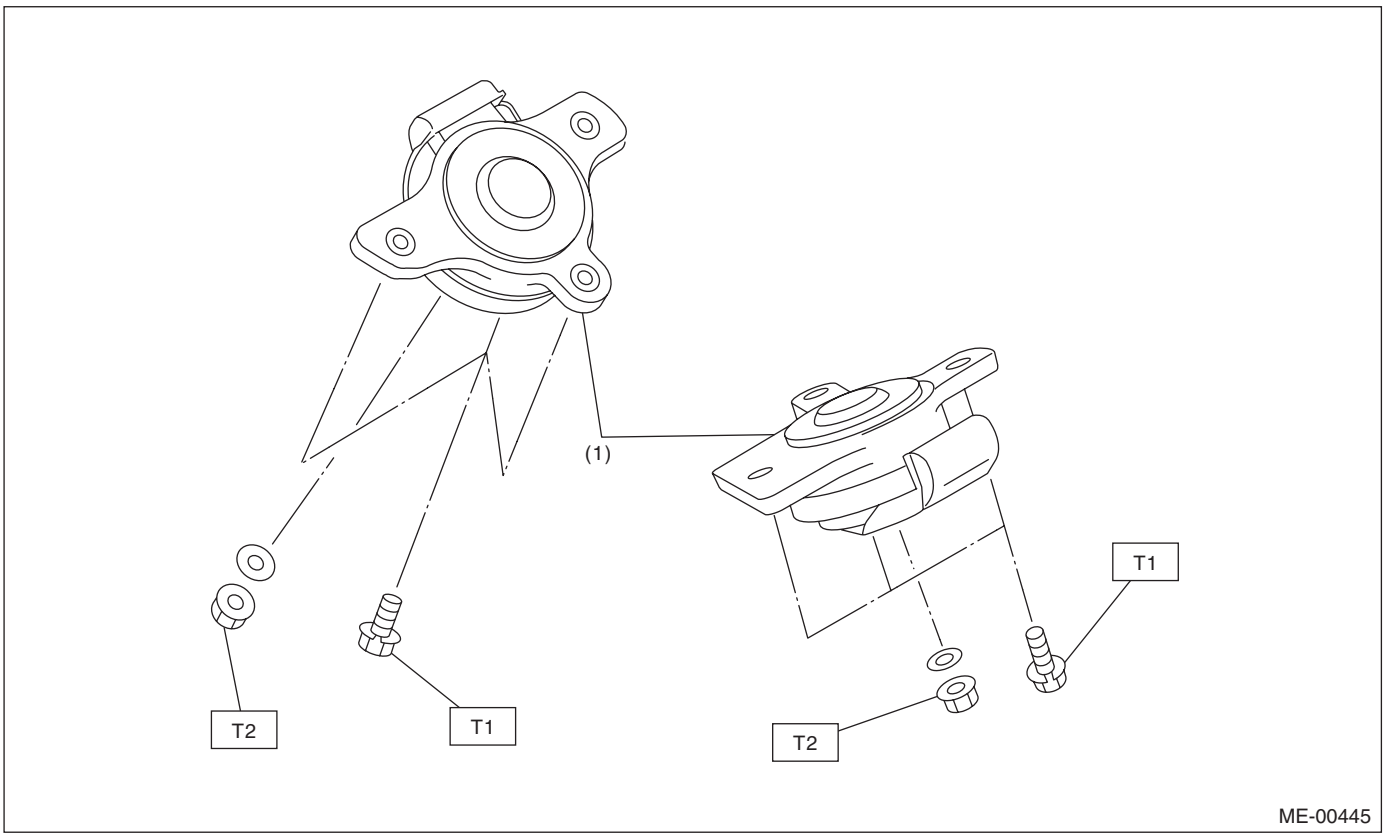
7. CRANKSHAFT AND PISTON



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

Tightening torque: N·m (kgf-m, ft-lb)
T1: 53 (5.4, 39)
T2: 81 (8.3, 60)

8. 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 work clothing, including a cap, protective goggles and protective shoes during operation.
- 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.
- Be careful not to burn yourself, because each part on the vehicle is hot after running.
- 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 ones 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

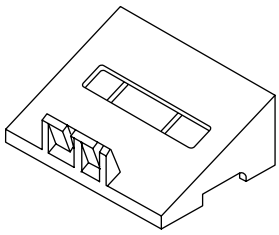
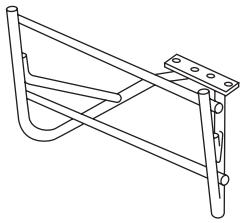
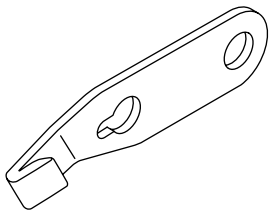
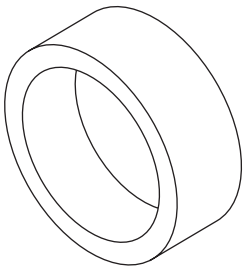
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18250AA010	18250AA010	CYLINDER HEAD TABLE	• Used for replacing valve guides. • Used for removing and installing valve spring.
 ST18232AA000	18232AA000	ENGINE STAND	Used for disassembling and assembling engine.
 ST-498497100	498497100	CRANKSHAFT STOPPER	Used for stopping rotation of flywheel or drive plate when loosening / tightening crank pulley bolt.
 ST18254AA000	18254AA000	PISTON GUIDE	Used for installing piston in cylinder.

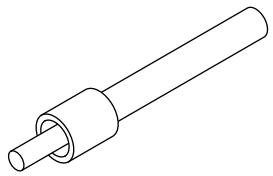
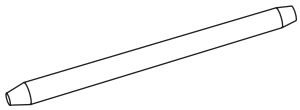
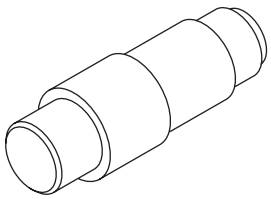
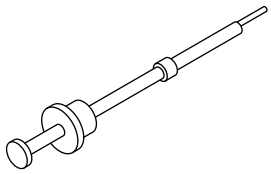
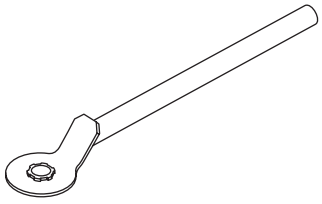
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499585500	499585500	VALVE OIL SEAL GUIDE	Used for press-fitting of intake and exhaust valve guide oil seals.
 ST18253AA000	18253AA000	PISTON PIN GUIDE	Used for installing piston pin, piston and connecting rod.
 ST18350AA000	18350AA000	CONNECTING ROD BUSHING REMOVER & INSTALLER	Used for removing and installing connecting rod bushing.
 ST-499097700	499097700	PISTON PIN REMOVER ASSY	Used for removing piston pin.
 ST-499977500	499977500	CAM SPROCKET WRENCH	Used for removing and installing intake cam sprocket.

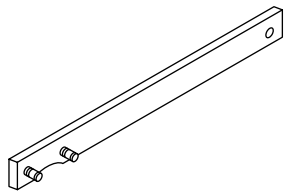
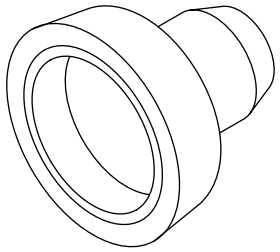
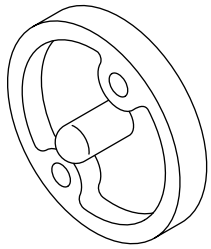
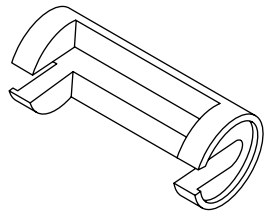
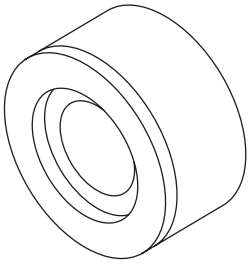
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18231AA020	18231AA020	CAM SPROCKET WRENCH	Used for removing and installing exhaust cam sprocket.
 ST-499587200	499587200	CRANKSHAFT OIL SEAL INSTALLER	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL GUIDE (499597100).
 ST-499597100	499597100	CRANKSHAFT OIL SEAL GUIDE	• Used for installing crankshaft oil seal. • Used with CRANKSHAFT OIL SEAL INSTALLER (499587200).
 ST-499718000	499718000	VALVE SPRING REMOVER	Used for removing and installing valve spring.
 ST18251AA040	18251AA040	VALVE GUIDE ADJUSTER	Used for installing valve guides.

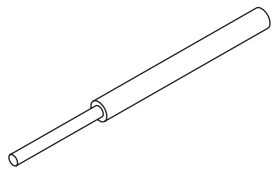
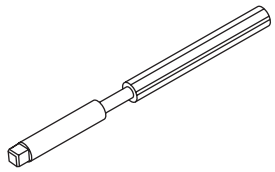
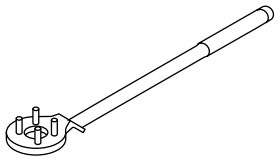
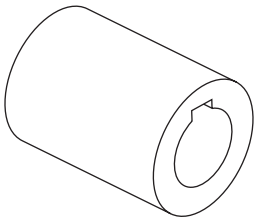
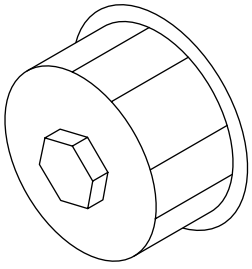
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST-499765700	499765700	VALVE GUIDE REMOVER	Used for removing valve guides.
 ST-499765900	499765900	VALVE GUIDE REAMER	Used for reaming valve guides.
 ST-499977100	499977100	CRANK PULLEY WRENCH	Used for stopping rotation of crank pulley when loosening/tightening crank pulley bolt.
 ST18252AA000	18252AA000	CRANKSHAFT SOCKET	Used for rotating crankshaft.
 ST-498547000	498547000	OIL FILTER WRENCH	Used for removing and installing oil filter.

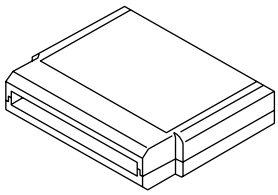
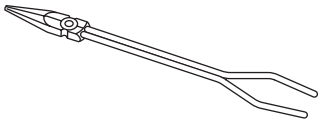
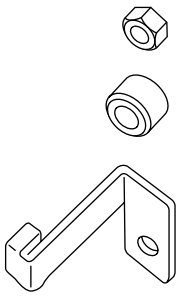
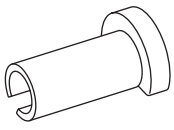
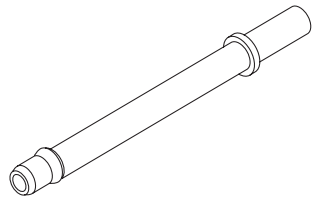
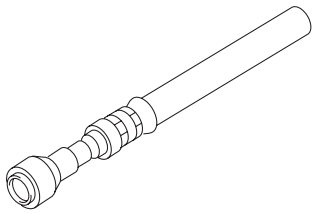
ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST18482AA010	18482AA010	CARTRIDGE	Troubleshooting for electrical system.
 ST22771AA030	22771AA030	SUBARU SELECT MONITOR KIT	Troubleshooting for electrical system.
 ST18233AA000	18233AA000	PISTON PIN SNAP RING PLIERS	Used for removing and installing snap ring of piston pin.
 ST-498277200	498277200	STOPPER SET	Used for installing automatic transmission assembly to engine.
 ST42099AE000	42099AE000	CONNECTOR REMOVER	Used for disconnecting quick connector of the engine compartment.

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 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.

2. GENERAL TOOL

TOOL NAME	REMARKS
Compression gauge	Used for measuring compression.

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.

- Camshaft
- Cylinder head