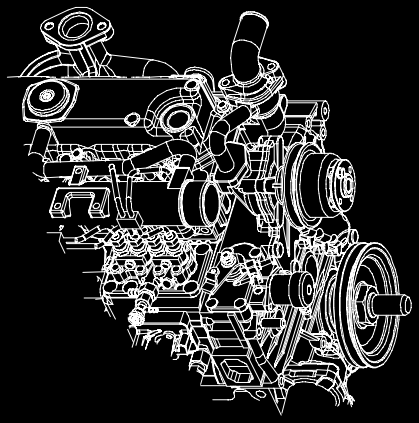
Carrier®

Diesel Engine



WORKSHOP MANUAL
for
V2203-DI
(26–00118, 26–00119, 26–00120)

62–10865 Rev B

Carrier TRANSICOLD

WORKSHOP MANUAL

DIESEL ENGINE

V2203-DI

(26-00118)(26-00119)(26-00120)

Beginning With Serial Number 4A0001

TABLE OF CONTENTS

SAFETY

SAFETY PRECAUTIONS

Your Carrier Transicold unit has been designed with the safety of the operator in mind. During normal operation, all moving parts are fully enclosed to help prevent injury. During all pre-trip inspections, daily inspections, and problem troubleshooting, you may be exposed to moving parts. Please stay clear of all moving parts when the unit is in operation and when the unit main power switch is in the START/RUN position.

Engine Coolant

The engine is equipped with a pressurized cooling system. Under normal operating conditions, the coolant in the engine and radiator is under high pressure and is very hot. Contact with hot coolant can cause severe burns. Do not remove the cap from a hot radiator. If the cap must be removed, do so very slowly in order to release the pressure without spray.

Battery

This unit is equipped with a lead-acid type battery. The battery normally vents small amounts of flammable hydrogen gas. Do not smoke when checking the battery. A battery explosion can cause serious physical harm and/or blindness.

SPECIFIC WARNING AND CAUTION STATEMENTS

To help identify the label hazards on the unit and explain the level of awareness each one carries, an explanation is given with the appropriate consequences:

⚠ DANGER

DANGER – warns against an immediate hazard which WILL result in severe personal injury or death.

⚠ WARNING

WARNING – warns against hazards or unsafe conditions which COULD result in severe personal injury or death.

⚠ CAUTION

CAUTION – warns against potential hazard or unsafe practice which could result in minor personal injury, or product or property damage.

NOTE

NOTE – gives helpful information that may help and avoid equipment and property damage.

The statements listed below are specifically applicable to this unit and appear elsewhere in this manual. These recommended precautions must be understood and applied during operation and maintenance of the equipment covered herein.

⚠ WARNING

Check the injection nozzle only after confirming that nobody is near the spray. If the spray from the nozzle contacts the human body, cells may be destroyed and blood poisoning may result.

⚠ WARNING

Beware of moving V-belt and belt driven components

⚠ WARNING

When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may discharge from the radiator, scalding anyone nearby.

⚠ WARNING

Check the injection nozzle only after confirming that nobody is near the spray. If the spray from the nozzle contacts the human body, cells may be destroyed and blood poisoning may result.

⚠ WARNING

Secure the starter to prevent it from moving when power is applied to it.

⚠ CAUTION

Do not remove the radiator cap until the coolant temperature is below its boiling point. Loosen the cap slightly to relieve excess pressure before removing the cap completely.

⚠ CAUTION

Stop the engine when attempting to check and change the fuel line.

⚠ CAUTION

Stop the engine when preparing to change the engine oil.

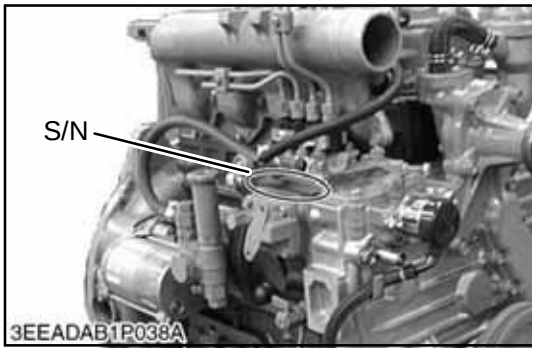
⚠ CAUTION

Never remove the radiator cap until coolant temperature is below its boiling point. Loosen the cap slightly to the first stop to relieve any excess pressure before removing the cap completely.

SECTION 1

General

1.1 ENGINE IDENTIFICATION



When contacting Carrier Transicold, always specify your engine model number and serial number.

The engine model and its serial number need to be identified before the engine can be serviced or parts replaced.

Engine Serial Number

The engine serial number is an identified number for the engine. It is marked after the engine model number.

It indicates month and year of manufacture as follows:

Serial Number

Y A 4321

Lower 4 digits in numerals

5th Digit Alpahbetical Letter (Month of Manufacture).

Alphabetical letter	A,B	C,D	E,F	G,H	J,K	L,M	N,P	Q,R	S,T	U,V	W,X	Y,Z
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

6th Digit Alpabetical Letter or Numerals (Year of Manufacture).

Alphabetical letter or numerals	W	X	Y	1	2	3	4	5	6	7	8	9
Year	98	99	00	01	02	03	04	05	06	07	08	09

Table 1-1. Model Chart

MODEL NUMBER	ENGINE TYPE	SERVICE ENGINE PART NUMBER	PRIMARY USE	REPLACES
V2203-DI-E2B-CTD-5	CT4-134-DI **(2200 RPM)**	26-00118-00	Vector	New
V2203-DI-E2B-CTD-7	CT4-134-DI **(1700 RPM)**	26-00119-00	Extra XT, Ultra XT, Ultra XTC, Multi-Temp, & Smart Air	26-00115-03SV
V2203-DI-E2B-CTD-4	CT4-134-DI **(2200 RPM)**	26-00119-02	Ultima 53 & Ultima XTC	26-00115-03SV
V2203-DI-E2BG-CTD-6	CT4-134-DI **(1800 RPM)**	26-00119-03	GENSET	26-00115-01 26-00119-01
V2203-M-DI-E2B-CTD-1	CT4-134-DI **(2200 RPM)**	26-00120-00	Ultima XT/ XTC	New
V2203-M-DI-E2B-CTD-2	CT4-134-DI **(1700 RPM)**	26-00120-01	Ultima XT/ XTC	New

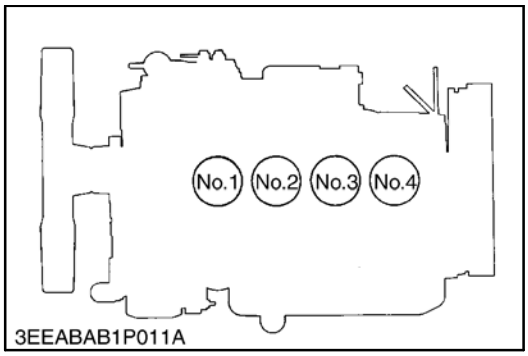
1.2 ENGINE SPECIFICATIONS

Table 1-2. Specification Chart

MODEL NUMBER		26-00118-00	26-00119-00	26-00119-01 or 26-00119-03	26-00119-02	26-00120-00	26-00120-01
TYPE		Vertical, Water-cooled, 4 cycle diesel engine					
NUMBER OF CYLINDERS		4					
BORE X STROKE mm X mm (in. X in.)		87 X 92.4 (3.43 X 3.64)					
TOTAL DISPLACEMENT cm^3 (cu.in.)		2197 (134.1)					
BRAKE HORSEPOWER SAE Intermittent HP kW (HP) / RPM		25.3 (34.2) / 1950	23.7 (31.8) / 1700	24.9 (33.4) / 1800	28.2 (37.8) / 2200	26.9 (36.0) / 2200	22.4 (30.0) / 1700
MAXIMUM SPEED RPM		Below 2170	Below 1920	Below 2000	Below 2420	Below 2420	Below 1920
IDLING SPEED RPM		-	-	-	-	-	-
COMBUSTION CHAMBER		Direct Injection					
INJECTION PUMP		Bosch “K” Type Mini Pump					
GOVERNOR		Centrifugal Ball Mechanical Governor					
INJECTION NOZZLE		Bosch “P” Type Hole Nozzle					
INJECTION TIMING (UNPRESSURIZED)		4.0° Before T.D.C.	6.0° Before T.D.C.	4.5° Before T.D.C.	6.5° Before T.D.C.	9.0 - 11.0° Before T.D.C.	6.0° Before T.D.C.
FIRING ORDER		1-3-4-2					
INJECTION PRESSURE (Valve Opening Pressure)	1st. STAGE	1.86 to 20.1 MPa (190 to 205 kgf/cm^2, 2702.3 to 2915.7 psi.)					
	2nd. STAGE	22.6 to 24.5 MPa (230 to 250 kgf/cm^2, 3271.2 to 3555.7 psi.)					
COMPRESSION RATIO		20.5 : 1					
LUBRICATION SYSTEM		Forced Lubrication by Pump					
OIL PRESSURE INDICATION		Electrical Type Switch					
LUBRICATION FILTER		Full Flow Synthetic Media Filter (Cartridge Type)					
COOLING SYSTEM		Pressurized Radiation, Forced Circulation With Water Pump					
STARTING SYSTEM		Electric Starting With Starting Motor					
		12V, 2.0 kW	12V, 2.0 kW	12V, 1.4 kW	12V, 2.0 kW	12V, 2.0 kW	12V, 2.0 kW
STARTING SUPPORT DEVICE		By Glow Plug In Combustion Chamber					
FUEL		Diesel Fuel No.2-D (ASTM D975)					
LUBRICATING OIL		*Quality Better Than CF Class (API), SAE 10W-30 or 15W-40					
LUBRICATING OIL CAPACITY		14.0 L (14.8 U.S. Quarts)	14.2 L (15.0 U.S. Quarts)				
Weight (DRY) kg (lbs.)		189.5 (417.8)	191.4 (422.0)	190.3 (419.6)	191.4 (422.0)		

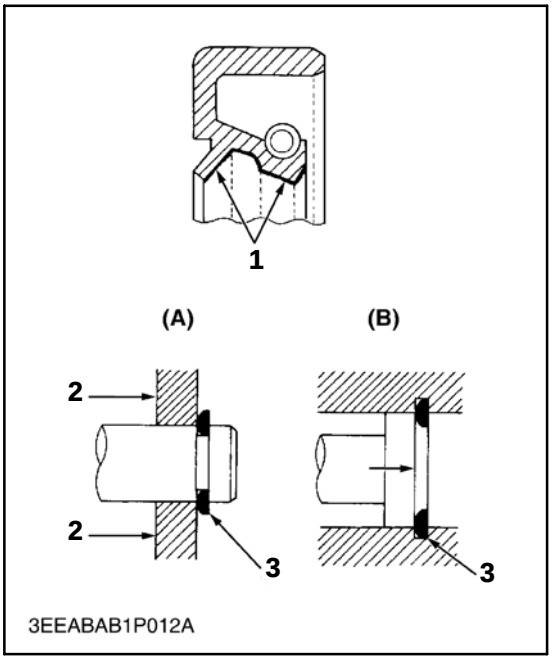
*See paragraph 1.8.6

1.3 CYLINDER NUMBER



The cylinder numbers of V2203-DI (26-00119) series engine are designated as shown above. The sequence of cylinder numbers is given as No.1, No. 2, No. 3, and No. 4 starting from the gear case end of the engine.

1.4 GENERAL PRECAUTIONS



1. Grease
2. Force
3. Place the Sharp Edge against the Direction of Force

A External Snap Ring
B Internal Snap Ring

During disassembly, carefully arrange removed parts in a clean area to prevent confusion later. Screws, bolts and nuts should be replaced in their original position to prevent reassembly errors.

When special tools are required, use KUBOTA genuine special tools. Special tools which are not frequently used should be made according to the drawings provided.

Before disassembling or servicing live wires, make sure to always disconnect the grounding cable from the battery first.

Remove oil and dirt from parts before taking any measurements.

Use only Carrier Transicold genuine parts for parts replacements to maintain engine performance and to ensure safety.

Gaskets and O-rings must be replaced during reassembly. Apply grease to new o-rings or oil seals before assembling.

When reassembling external or internal snap rings, position them so that the sharp edge faces against the direction from which force is applied.

A newly serviced or reassembled engine should be run-in with no load for 15 minutes. Serious damage to the engine may result otherwise.

1.5 TORQUE SPECIFICATIONS

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench. Several screws, bolts and nuts such as those used on the cylinder head must be tightened in the proper sequence and at the proper torque.

1.5.1 Torque Specifications For Special Use Screws, Bolts and Nuts

In removing and applying the screws, bolts and nuts marked with "*", a pneumatic wrench or similar tool, if employed, must be used with care. Failure to do so may result in stripped or seized screws, bolts and nuts.

When replacing "*" marked screws, bolt and nuts, apply engine oil to their threads and seats before reassembly.

The letter "M" in size and pitch means that the screw, bolt or nut dimension is metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.

Item	Size x Pitch	N.m	kgf.m	ft-lbs
Cylinder Head Cover Bolt	M6 x 1.0	6.9 to 11.3	0.7 to 1.15	5.1 to 8.32
*Cylinder Head Bolt	M11 x 1.25	93.1 to 98.0	9.5 to 10.0	68.7 to 72.3
*Main Bearing Case Bolt 1	M9 x 1.25	46.1 to 50.9	4.7 to 5.2	34.0 to 37.6
*Main Bearing Case Bolt 2	M10 x 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
*Flywheel Bolt	M12 x 1.25	98.09 to 107.8	10.0 to 11.0	72.3 to 79.5
*Connecting Rod Bolt	M8 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
*Rocker Arm Bracket Bolt	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
*Idle Gear Shaft Bolt	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Crank Pulley Mounting Nut	–	137.3 to 156.9	14.0 to 16.0	101.3 to 115.7
*Bearing Case Cover Bolt	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Glow Plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle Holder Clamp Bolt	–	25.5 to 29.4	2.6 to 3.0	18.8 to 21.7
Oil Switch Taper Bolt	PT1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection Pipe Retaining Nut	M12 x 1.5	14.7 to 24.5	1.5 to 2.5	10.8 to 18.1
Overflow Pipe Assembly Retaining Bolt	–	9.8 to 11.3	1.0 to 1.15	7.2 to 8.3
Camshaft Retaining Bolt	M8 x 1.25	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
Hi-idling Body	–	44.1 to 49.0	4.5 to 5.0	32.6 to 36.3

1.5.2 Torque Specifications For General Use Screws, Bolts and Nuts

	Standard Screw and Bolt Grade 4			Special Screw and Bolt Grade 7		
	N.m	kgf.m	ft-lbs	N.m	kgf.m	ft-lbs
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below

Punched Number	Screw And Bolt Material Grade
None or 4	Standard Screw And Bolt SS400, S20C
7	Special Screw And Bolt S43C, S48C (Refined)

1.6 TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference
Engine Does Not Start	No fuel	Replenish fuel	–
	Air in the fuel system	Vent Air	**1.8.4**
	Water in the fuel system	Change fuel and repair or replace fuel system	**1.8.4**
	Fuel pipe clogged	Clean	**1.8.4**
	Fuel filter clogged	Clean or change	–
	Excessively high viscosity fo fuel or engine oil at low temperature	Use specified fuel or engine oil	–
	Fuel with low cetane number	Use specified fuel	–
	Incorrect injection timing	Adjust	**5.1.1**
	Injection nozzle clogged	Replace	**1.8.8**
	Injection pump malfunctioning	Replace	–
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or Replace	–
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	– – – –
	Improper valve timing	Correct or replace timing gear	**2.2.4.h**
	Piston ring and cylinder worn	Replace	**2.3.3.d**
	Excessive valve clearance	Adjust	**1.8.7**
(Starter Does Not Run)	Battery discharged	Charge	
	Starter malfunctioning	Repair or replace	**6.2**
	Key switch malfunctioning	Repair or replace	–
	Wiring disconnected	Connect	–
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Clean or change	**1.8.4**
	Air cleaner clogged or dirty	Clean or change	–
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	–
	Injection pump malfunctioning	Replace	**5.1**
	Incorrect nozzle injection pressure	Replace	**1.8.8.a**
	Injection nozzle stuck or clogged	Replace	**1.8.8.c**
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level	**1.8.1**
	Piston ring and liner worn or ring stuck	Repair or replace	**2.3.3.d**
	Incorrect Injection timing	Adjust	**5.1.1**
	Deficient compression	Check the cylinder compression pressure and top clearance	**2.1.1**
Either Black or Dark Exhaust Gas Is Observed	Overload	Lesson load	–
	Low grade fuel used	Use specified fuel	–
	Fuel filter clogged	Clean or change	–
	Air cleaner clogged	Clean or change	–
	Deficient nozzle injection	Replace nozzle	**1.8.8**
Deficient Output	Incorrect injection timing	Adjust	**5.1.1**
	Engine's moving parts seem to be seizing	Repair or replace	–
	Injection pump malfunctioning	Replace	**5.1**
	Deficient nozzle injection	Replace nozzle	**1.8.8.b**
	Compression leak	Check the compression pressure and repair	**2.1.1**
	Gas leak from exhaust system	Repair or replace	–
	Air cleaner dirty or clogged	Clean or replace	–

1.6 TROUBLESHOOTING (Continued)

Symptom	Probable Cause	Solution	Reference
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction	**2.2.6.a**
	Oil ring worn or stuck	Replace	**2.3.3.d**
	Piston ring groove worn	Replace worn piston	**2.3.3.e**
	Valve stem and valve guide worn	Replace	**2.3.1.d**
	Crankshaft bearing, and crank pin bearing worn	Replace	**2.3.4**
	Oil leaking due to defective seals or packing	Replace	**–**
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Replace Injection pump	**5.1**
	Deficient nozzle injection	Replace nozzle	**1.8.8.c**
	Injection pump broken	Replace	**5.1**
Water Mixed into Lubricant Oil	Head gasket defective	Replace	**2.2.3.e**
	Cylinder block or cylinder head flawed	Replace	**–**
Low Oil Pressure	Engine oil level low	Replenish	**–**
	Oil strainer clogged	Clean	**–**
	Relief valve stuck with dirt	Clean	**3.1.2**
	Relief valve spring weak or broken	Replace	**3.1.2**
	Excessive oil clearance of crankshaft bearing	Replace	**2.3.4.d**
	Excessive oil clearance of crankpin bearing	Replace	**2.3.4.c**
	Excessive oil clearance of rocker arm	Replace	**2.3.1.k**
	Oil passage clogged	Clean	**–**
	Incorrect oil type	Use specified type of oil	**–**
	Oil pump defective	Repair or replace	**3.2**
High Oil Pressure	Incorrect oil type	Use specified type of oil	**–**
	Relief valve defective	Replace	**3.1.2**
Engine Overheated	Engine oil level low	Replenish	**–**
	Fan belt broken or elongated	Replace or adjust	**–**
	Coolant insufficient	Replenish	**–**
	Radiator net and radiator fin clogged with dust	Clean	**–**
	Inside of radiator corroded	Clean or replace	**–**
	Coolant flow route corroded	Clean or replace	**–**
	Radiator cap defective	Replace	**–**
	Overload running	Loosen load	**–**
	Head gasket defective	Replace	**2.2.3.e**
	Incorrect injection timing	Adjust	**–**
	Unsuitable fuel used	Use specified fuel	**–**
Low Battery Charge	Battery electrolyte level low	Replenish distilled water and charge	**–**
	Fan belt slips	Adjust belt tension or change belt	**–**
	Wiring disconnected	Connect	**–**
	Rectifier defective	Replace	**–**
	Alternator defective	Replace	**–**
	Battery defective	Change	**–**

1.7 SERVICING SPECIFICATIONS

1.7.1 Engine Body

Item		Factory Specification	Allowable Limit
Cylinder Head Surface	Flatness	–	0.05 mm/500mm 0.0020 in./ 19.69 in.
Compression Pressure		2.94 to 3.24 MPa/ 290 rpm 30 to 33 kgf/cm^2 290 rpm 427 to 469 psi/ 290 rpm	2.35 MPa/ 290 rpm 24kgf/cm^2 290 rpm 341 psi/ 290 rpm
Difference Among Cylinders		–	10% or less
Top Clearance		0.60 to 0.70 mm 0.0236 to 0.0276 in.	–
Valve Clearance (When Cold)		0.18 to 0.22 mm 0.0071 to 0.0087 in.	–
Valve Seat	Width (Intake)	2.12 mm 0.0835 in.	–
	Width (Exhaust)	2.12 mm 0.0835 in.	–
Valve Seat	Angle (Intake / Exhaust)	0.785 rad. 45°	–
Valve Face	Angle (Intake / Exhaust)	0.785 rad. 45°	–
Valve Stem to Valve Guide	Clearance	0.040 to 0.070 mm 0.0016 to 0.0028 in.	0.1 mm 0.0039 in.
Valve Stem	O.D.	7.960 to 7.975 mm 0.31339 to 0.31398 in.	–
Valve Guide	I.D.	8.015 to 8.030 mm 0.31555 to 0.31614 in.	–
Valve Recessing	Protrusion	0.05 mm 0.0020 in. to	–
	Recessing	0.15 mm 0.0059 in.	–
Valve Timing (Intake Valve)	Open	0.14 rad. (8°) before T.D.C.	–
	Close	0.35 rad. (20°) before T.D.C	–
Valve Timing (Exhaust Valve)	Open	0.87 rad. (50°) before B.D.C.	–
	Close	0.21 rad. (12°) before B.D.C	–

1.7.1 Engine Body (Continued)

Item		Factory Specification	Allowable Limit
Valve Spring	Free Length	41.7 to 42.2 mm 1.6417 to 1.6614 in.	41.2 mm 1.6220 in.
	Setting Load/ Setting Length	117.6 N / 35.0 mm 12.0 kgf / 35.0 mm 26.4 lbs. / 1.3780 in.	100.0N / 35.0 mm 10.2kgf / 35.0 mm 22.5lbs /1.3780 in
	Tilt	–	1.0 mm 0.039 in.
Rocker Arm Shaft to Rocker Arm	Clearance	0.016 to 0.045 mm 0.00063 to 0.00177 in.	1.0 mm 0.039 in.
Rocker Shaft	O.D.	13.973 to 13.984 mm 0.55012 to 0.55055 in.	–
Rocker Arm	I.D.	14.000 to 14.018 mm 0.55118 to 0.55189 in.	–
Push Rod	Alignment	–	0.25mm 0.0098 in.
Tappet to Tappet Guide	Clearance	0.020 to 0.062 mm 0.00079 to 0.00244 in.	0.07 mm 0.0028 in.
	O.D.	23.959 to 23.980 mm 0.94327 to 0.94410 in.	–
	I.D.	24.000 to 24.021 mm 0.94488 to 0.94571 in.	_
Timing Gear Crank Gear to Idle Gear	Backlash	0.0415 to 0.2211 mm 0.00163 to 0.00442 in.	0.15 mm 0.0059 in.
Idle Gear to Cam Gear	Backlash	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
Idle Gear to Injection Pump Gear	Backlash	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.	0.15 mm 0.0059 in.
Crank Gear to Oil Pump Gear	Backlash	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.	0.15 mm 0.0059 in.
Idle Gear	Side Clearance	0.12 to 0.48 mm 0.0047 to 0.0189 in.	0.9 mm 0.0039 in.
Idle Gear Shaft to Idle Gear Bushing	Clearance	0.025 to 0.066 mm 0.00098 to 0.00260 in.	0.1 mm 0.0039 in.
Idle Gear Shaft	O.D.	37.959 to 37.975 mm 1.49445 to 1.49508 in.	–
Idle Gear Bushing	I.D.	38.000 to 38.025 mm 1.49606 to 1.49704 in.	–

1.7.1 Engine Body (Continued)

Item		Factory Specification	Allowable Limit
Camshaft	Side Clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 In.
Camshaft	Alignment	–	0.01 mm 0.0004 in.
Cam (Lobe)	Height (Intake)	33.27 mm 1.3098 in.	33.22 mm 1.3709 in.
	Height (Exhaust)	33.47 mm 1.3177 in.	33.42 1.3158 in.
Camshaft Journal to Cylinder Block Bore	Clearance	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.00059 in.
Camshaft Journal	O.D.	39.934 to 39.950 mm 1.57221 to 1.57284 in.	–
Cylinder Block Bore	I.D.	40.000 to 40.025 mm 1.57480 to 1.57579	–
Piston Pin Bore	I.D.	25.000 to 25.013 mm 0.98425 to 0.98476 in.	25.05 mm 0.9862 in.
Second Ring to Ring Groove	Clearance	0.093 to 0.128 mm 0.0037 to 0.0050 in.	0.2 mm 0.0079 in.
Oil Ring to Ring Groove	Clearance	0.020 to 0.052 mm 0.0008 to 0.0020 in.	0.15 mm 0.0059 in.
Top Ring	Ring Gap	0.20 to 0.35 mm 0.0079 to 0.0138 in.	1.25 mm 0.0492 in.
Second Ring	Ring Gap	0.40 to 0.55 mm 0.0157 to 0.0217 in.	1.25 mm 0.0492 in.
Oil Rng	Ring Gap	0.20 to 0.40 mm 0.0079 to 0.0157 in.	1.25 mm 0.0492 in.
Connecting Rod	Alignment	–	0.05 mm 0.0020 in.
Piston Pin to Small End Bushing	Clearance	0.014 to 0.038 mm 0.00055 to 0.00150 in.	0.15 mm 0.0059 in.
Piston Pin	O.D.	25.002 to 25.011 mm 0.98433 to 0.98468 in.	–
Small End Bushing	I.D.	25.025 to 25.040 mm 0.98523 to 0.98582 in.	–
Crankshaft	Alignment	–	0.02 mm 0.00059 in.
Crankshaft Journal to Crankshaft Bearing1	Oil Clearance	0.040 to 0.118 mm 0.00157 to 0.00465 in.	0.2 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.35909 to 2.35984 in.	–
Crankshaft Bearing1	I.D.	59.980 to 60.039 mm 2.36142 to 2.36374 in.	–

1.7.1 Engine Body (Continued)

Item		Factory Specification	Allowable Limit
Crankshaft Journal to Crankshaft Bearing2	Oil Clearance	0.040 to 0.104 mm 0.00157 to 0.00409 in.	0.2 mm 0.0079 in.
Crankshaft Journal	O.D.	59.921 to 59.940 mm 2.35909 to 2.35984 in.	–
Crankshaft Bearing2	I.D.	59.980 to 60.025 mm 2.36142 to 2.36318 in.	–
Crankpin to Crankpin Bearing	Oil Clearance	0.025 to 0.087 mm 0.00098 to 0.00343 in.	0.2 mm 0.0079 in.
Crankpin	O.D.	46.959 to 46.975 mm 1.84878 to 1.84941 in.	–
Crankpin Bearing	I.D.	47.000 to 47.046 mm 1.85039 to 1.85220 in.	–
Crankshaft	Side Clearance	0.15 to 0.31 mm 0.0059 to 0.0122 in.	0.5 mm 0.0197 in.
Crankshaft Sleeve	Wear	–	0.1mm 0.0039 in.
Cylinder Bore (Standard)	I.D.	87.00 to 87.022mm 3.42519 to 3.42606 in.	0.15mm 0.0059 in.
(Oversize)	I.D.	87.250 to 87.272 mm 3.43503 to 3.43590 in.	0.15mm 0.0059 in.

1.7.2 Lubricating System

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	–	103kPa 1.0 kgf/cm^2 15 psi
	At Rated Speed	294 to 441 kPa 3.0 to 4.5kgf/cm^2 43 to 64 psi	245kPa 2.5kgf/cm^2 36 psi
Engine Oil Pressure Switch	Working Pressure	49 kPa 0.5kgf/cm^2 7 psi	–
Inner Rotor to Outer Rotor	Clearance	0.03 to 0.14 mm 0.0012 to 0.0055 in.	0.2 mm 0.0079 in.
Outer Rotor to Pump Body	Clearance	0.11 to 0.19 mm 0.0043 to 0.0075 in.	0.25 mm 0.0098 in.
Inner Rotor to Cover	Clearance	0.105 to 0.150 mm 0.00413 to 0.00591 in.	0.2 mm 0.0079 in.

1.7.3 Cooling System

Item		Factory Specification	Allowable Limit
V–Belt	Tension	7.0 to 9.0 mm (0.28 to 0.35 in.) deflection at 98N(10kgf, 22 lbs.) of force	–
Thermostat	Valve Opening Temperature (At Beginning)	80.5 to 83.5°C 176.9 to 182.3°F	–
	Valve Opening Temperature (Opened Completely)	95°C 203°F	–

1.7.4 Fuel System

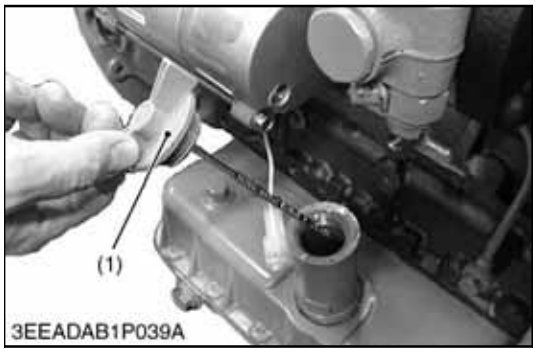
Item			Factory Specification	Allowable Limit
Injection Pump	V2203–DI–E2B–CTD–5	Injection Timing	0.06 to 0.08 rad. (3.25 to 4.75°) before T.D.C.	–
Injection Pump	V2203–DI–E2B–CTD–7	Injection Timing	0.09 to 0.12 rad. (5.25 to 6.75°) before T.D.C.	–
	V2203–DI–E2B–CTD–6		0.06 to 0.09 rad. (3.75 to 5.25°) before T.D.C.	–
	V2203–DI E2B–CTD–4		0.10 to 0.13 rad. (5.75 to 7.25°) before T.D.C.	–
Injection Pump	V2203–DI–E2B–CTD–1	Injection Timing	0.16 to 0.19 rad. (9.00 to 11.00°) before T.D.C.	–
	V2203–DI–E2B–CTD–2		0.09 to 0.12 rad. (5.25 to 6.75°) before T.D.C.	–

1.7.5 Electrical System

Item			Factory Specification	Allowable Limit
Starter				
Commutator	V2203-DI-E2B-CTD-6	O.D.	30.0 mm 1.181 in.	29.0 mm 1.142 in.
	V2203-DI-E2B-CTD-1, 2, 4, 5 & -7		35.0 mm 1.378 in.	34.0 mm 1.339 in.
Mica	V2203-DI-E2B-CTD-6	Undercut	0.50 to 0.80 mm 0.0197 to 0.0315 in.	0.20 mm 0.0079 in.
	V2203-DI-E2B-CTD-1, 2, 4, 5 & -7		0.50 to 0.90 mm 0.0197 to 0.0354 in.	0.20 mm 0.0079 in.
Brush		Length	0.15 mm 0.591 in.	11.0 mm 0.433 in.
Brush Holder and Holder Support		Resistance	Infinity	_
Glow Plug		Resistance	Approximately 1 OHM	_

1.8 CHECK AND MAINTENANCE

1.8.1 Checking Engine Oil Level



1. Level the engine.
2. To check the oil level, draw out the dipstick (1), wipe it clean, reinsert it, and draw it out again. Check to see that the oil level lies between the two notches.
3. If the level is too low, add new oil to the specified level.

NOTE

When adding oil to the crankcase, be sure that the fresh oil is the same type and viscosity as the oil that is already in the crankcase. Never mix two different types of oil. Never over fill a crankcase.

1.8.2 Checking Coolant Level

1. Remove the radiator cap and check to see that the coolant level is just below the port.

   With the recovery tank: Check to see that the coolant level lies between **FULL** and **LOW**.
2. If the coolant level is too low, check the reason for the lost coolant.

a. If coolant loss is due to evaporation, add only clean soft water.

b. If coolant loss is due to a leak, repair the leak, then add a coolant mixture of the same type and specification that is in the system. If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new mix.

⚠ CAUTION

Do not remove the radiator cap until the coolant temperature is below its boiling point. Loosen the cap slightly to relieve excess pressure before removing the cap completely.

NOTE

When adding coolant to the system, air must be vented from the engine coolant passages. Venting air can be accomplished by jiggling the upper and lower radiator hoses.

Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.

Do not use an antifreeze and scale inhibitor at the same time.

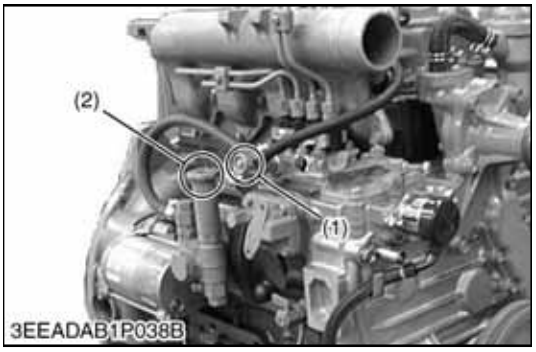
Never mix different types or brands of coolants.

1.8.3 Checking Fuel Hose

1. If the clamp is loose, apply oil to the threads and securely retighten it.
2. The fuel hose is made of rubber and ages regardless of the service period. Change the hose and clamps together every two years.
3. Change the fuel hose and clamps whenever any deterioration or damage is detected.
4. After the fuel hose and clamps have been changed, bleed air out of the fuel system.

⚠ CAUTION

Stop the engine when attempting to check and change the fuel line.



1.8.4 Bleeding Fuel System

1. Open the air vent cock (1) on top of the fuel injection pump.
2. Loosen the priming pump handle (2), and pump the handle until bleeding is completed.
3. Depress and twist the priming pump handle clockwise to lock into place.
4. Close the air vent cock (1).

NOTE

Always keep the air vent cock on the fuel injection pump closed except when bleeding the fuel system, or the engine may not run.

1.8.5 Checking V-Belt

Refer to Section NO TAG

1.8.6 Changing Engine Oil

⚠ CAUTION

Stop the engine when preparing to change the engine oil.

1. After warming up the engine, shut it off.
2. Place a pan underneath the engine.
3. Remove the drain plug, drain the engine oil completely.
4. Inspect the drain plug gasket. Replace if necessary.
5. Reinstall the drain plug.
6. Replace the oil filter with a new oil filter.
7. Fill the crankcase with new oil.
8. Check for the correct oil level. (Refer to Section 1.8.1)

NOTE

When changing to a different oil manufacturer or viscosity, be sure to remove all of the old oil completely. Never mix different types of oil.

Use only MIL-L-46152 / MIL-L-2104C or API classification CG-4 or CH-4 / CI oils.

Use the proper SAE Engine oil according to the ambient temperatures.

Above 25°C (77°F).....SAE 30 or 10W-30
0° to 25°C (32° to 77°F).....SAE 20 or 10W-30
Below 0°C (32°F).....SAE 10W or 10W-30

NOTE

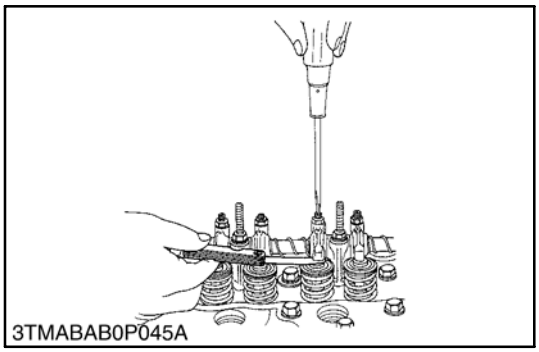
With emission controls now in effect, the CG-4 or CH-4 / CI lubricating oils have been developed for use of a low-sulfur fuel on-road vehicles engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CH-4 / CI lubricating oil with a high total base number. If the CG-4 lubricating oil is used with a high sulfur fuel, change the lubricating oil at shorter intervals.

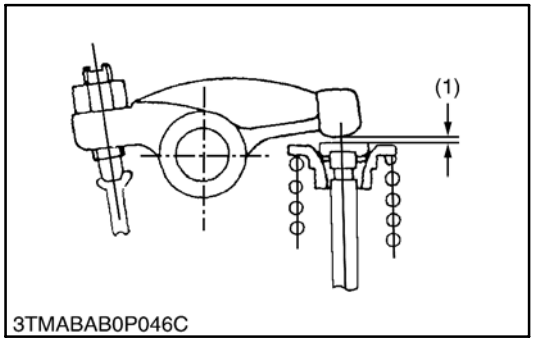
Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.

Lubricating Oil Class	Fuel	
	Low-sulfur	High-sulfur
CG-4	O	X
CH-4 or CI	O	X

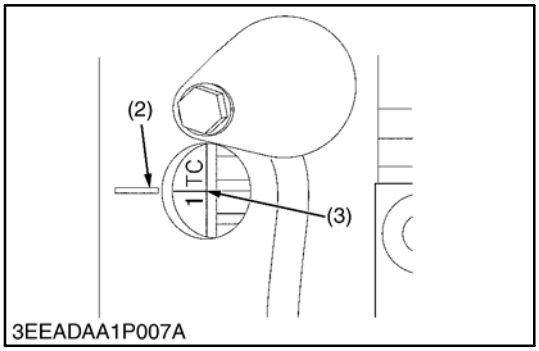
O : Recommended X : Not Recommended

1.8.7 Valve Clearance


3TMABAB0P045A



3TMABAB0P046C



3EEADAA1P007A

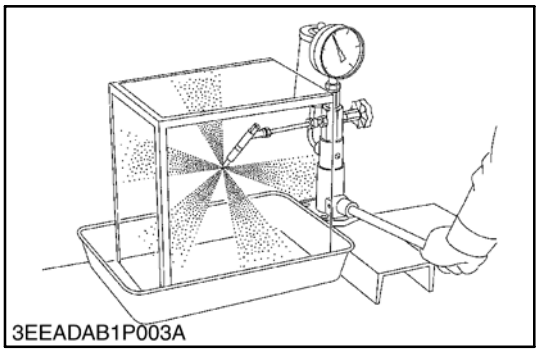
NOTE

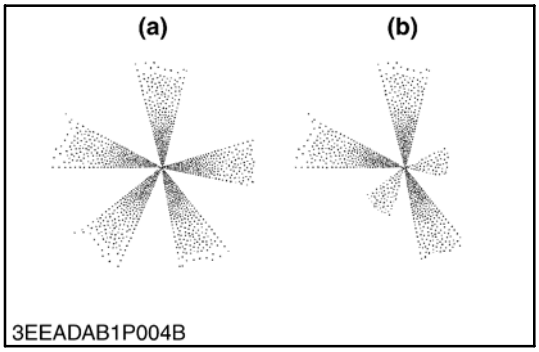
Valve clearance must be checked and adjusted when the engine is cold.

1. Remove the valve cover.
2. Align the "**1TC**" mark line (3) on the flywheel and projection (2) on the housing so that the Number 1 piston comes to compression or overlap top dead center (TDC).
3. Check the following valve clearance (1) marked with "*" using a feeler guage.
4. If the clearance is not within the factory specifications, adjust with the adjusting screw.

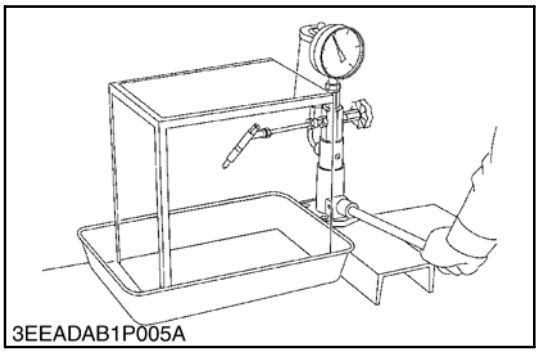
		Valve Arrangement	
Piston Location in Cylinder		IN.	EX.
When No. 1 piston is at TDC	No. 1	*	*
	No. 2	*	
	No. 3		*
	No. 4		
When No. 1 piston is at past TDC	No. 1		
	No. 2		*
	No. 3	*	
	No. 4	*	*

1.8.8 Fuel Injection





(a) Good **(b) Bad**



WARNING

Check the injection nozzle only after confirming that nobody is near the spray. If the spray from the nozzle contacts the human body, cells may be destroyed and blood poisoning may result.

1.8.8.a Fuel Injection Pressure

1. Set the injection nozzle in a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within factory specifications, replace the nozzle assembly.

Fuel Injection Pressure 1st Stage	Factory Specification	18.6 to 20.1 MPa 190 to 205 kgt/cm^2 2702 to 2916 psi

1.8.8.b Nozzle Spraying Condition

1. Set the injection nozzle in a nozzle tester and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the injection nozzle assembly.

1.8.8.c Valve Seat Tightness

1. Set the injection nozzle in a nozzle tester.
2. Raise the fuel pressure, and maintain 12.7MPa (130 kgf/cm^2, 1850 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly.

Valve Seat Tightness	Factory Specification	No fuel leak at 16.67MPa 170 kgf/cm^2 2418 psi

1.9 SPECIAL TOOLS

Additional tools may be found in the Carrier Transicold Performance Parts Service Tool Catalog Number 62-03213.

1.9.1 Diesel Engine Compression Tester (Glow Plug)

Part No. 07-00179-01 (Assembly)

Application: Use to measure diesel engine compression and diagnosis for major overhaul.

1.9.2 Adapter, Kubota 10 mm

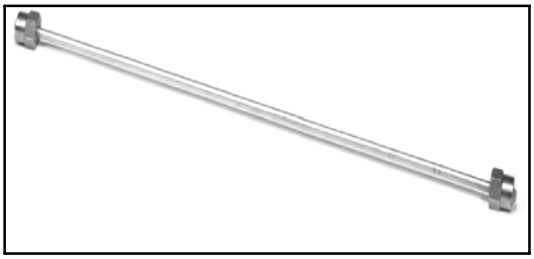
Part No. 07-00179-05
Application: Accessory for 07-00179-01

1.9.3 Tester Injector Nozzle

Part No. 07-00140-00
Application: Injector nozzle tester kit used for checking and adjusting of the fuel injectors in diesel engines.

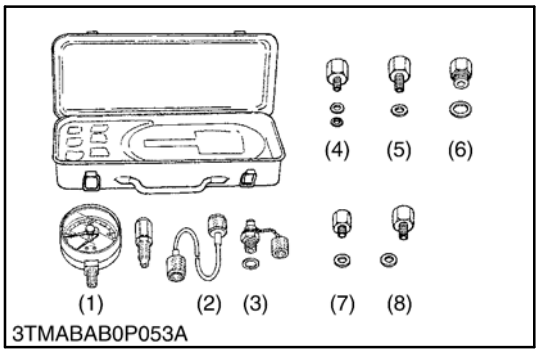
1.9.4 Replacement Bowl, Tester Injector Nozzle

Part No. 07-00140-10
Application: Accessory for 07-00140-00



1.9.5 Adapter, Injector Line

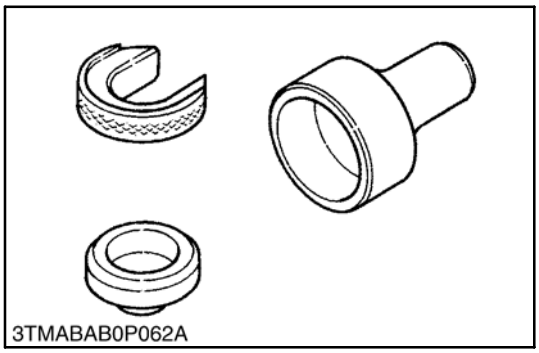
Part No. 07-00036-00
Application: Accessory for 07-00140-00



1. Guage
2. Adapter 2
3. Cable
4. Adapter 3
5. Threaded Joint
6. Adapter 4
7. Adaptor 1
8. Adaptor 3

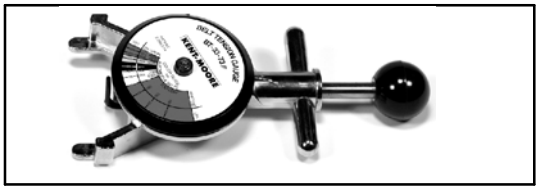
1.9.6 Oil Pressure Tester

Code No. 07916-32032
Application: Use to measure lubricating oil pressure.



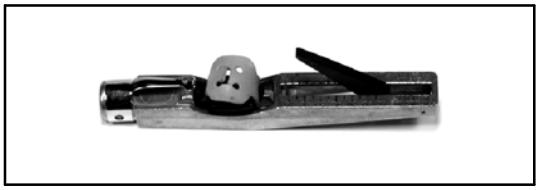
1.9.7 Auxiliary Socket For Fixing Crankshaft Sleeve

Code No. 07916-32091
Application: Use to fix the crankshaft sleeve of the diesel engine.



1.9.8 Guage, Belt Tension

Part No. 07-00203-00
Application: Used to adjust belt tension of all cogged V-belts.



1.9.9 Tester, Belt Tension

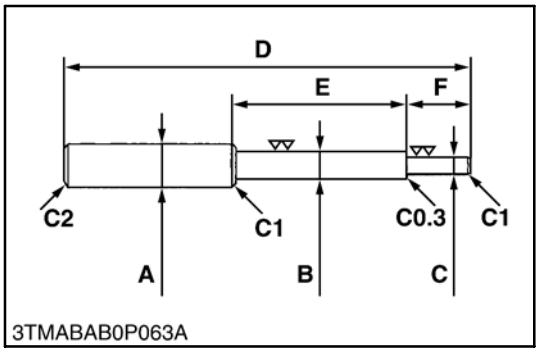
Part No. 07-00253-00
Application: Used to test belt tension.

1.9.10 Rubber Band

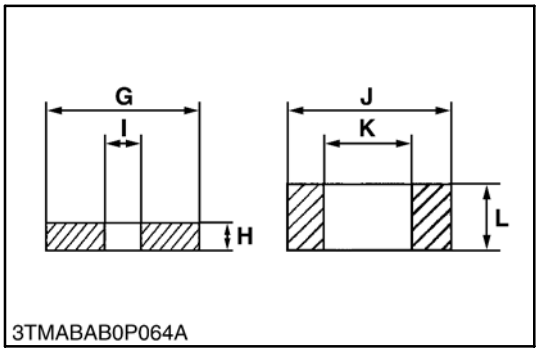
Part No. 07-00253-01
Application: Replacement part for belt tension tester (Part No. 07-00253-00)

1.9 SPECIAL TOOLS (Continued)

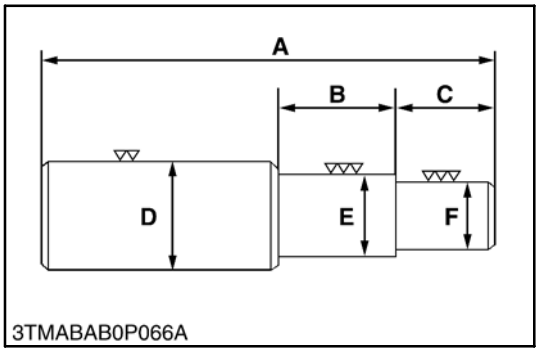
The following are drawings for special tools that may need to be fabricated.



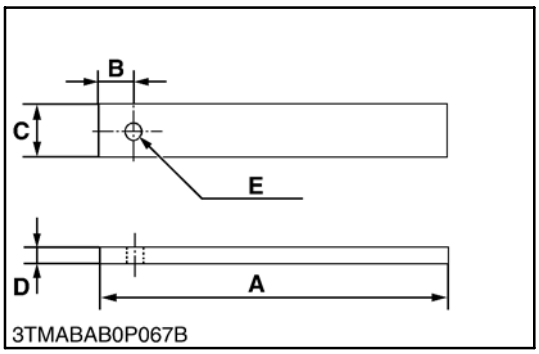
3TMABAB0P063A



3TMABAB0P064A



3TMABAB0P066A



3TMABAB0P067B

1.9.11 Valve Guide Replacing Tool

Application: Use to press out and press fit the valve guide.

A	20 mm dia. (0.79 in. dia.)
B	11.7 to 11.9 mm dia. (0.460 to 0.468 in. dia.)
C	6.5 to 6.6 mm dia. (0.256 to 0.259 in. dia.)
D	225 mm (8.86 in.)
E	70 mm (2.76 in.)
F	45 mm (1.77 in.)
G	25 mm (0.98 in.)
H	5 mm (0.197 in.)
I	6.7 to 7.0 mm dia. (0.263 to 0.275 in. dia.)
J	20 mm dia. (0.787 in. dia.)
K	12.5 to 12.8 mm dia. (0.492 to 0.504 in. dia.)
L	8.9 to 9.1 mm (0.350 to 0.358 in.)
C1	Chamfer 1.0 mm (0.039in.)
C2	Chamfer 2.0 mm (0.079in.)
C0.3	Chamfer 0.3 mm (0.012in.)

1.9.12 Bushing Replacing Tools

Application: Use to press out and press fit the bushing.

1. For small end bushing.

A	162 mm (6.38 in.)
B	35 mm (1.38 in.)
C	27 mm (1.06 in.)
D	35 mm dia. (1.38 in. dia.)
E	27.90 to 27.95 mm dia. (1.098 to 1.100 in. dia.)
F	25.00 to 25.01 mm dia. (0984 to 0.985 in. dia.)

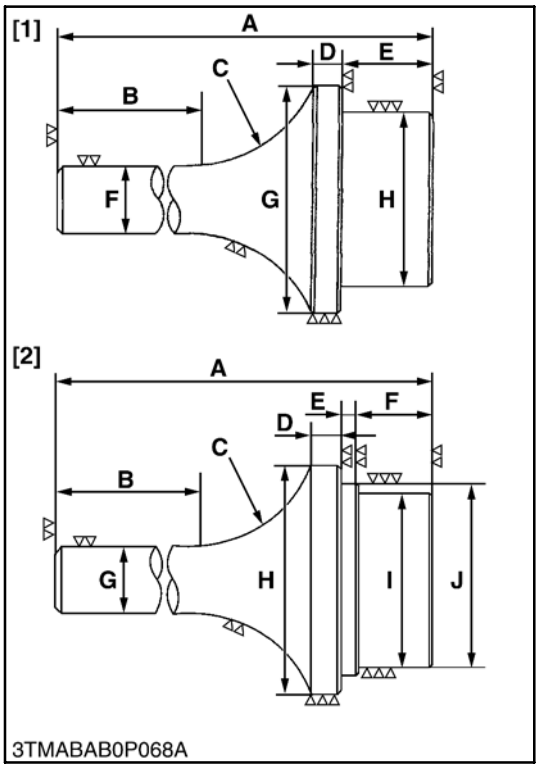
2. For idle gear bushing.

A	175 mm (6.89 in.)
B	40 mm (1.57 in.)
C	38 mm (1.49 in.)
D	45 mm (1.77 in.)
E	41.90 to 41.95 mm dia. (1.650 to 1.652 in. dia.)
F	37.95 to 37.97 mm dia. (1.494 to 1.495 in. dia.)

1.9.13 Flywheel Stopper

Application: Use to loosen and tighten the flywheel screw.

A	200 mm (7.87 in.)
B	20 mm (0.79 in.)
C	30 mm (1.18 in.)
D	8 mm (0.31 in.)
E	10 mm (0.39 in.)



1.9.14 Crankshaft Bearing 1 Replacing Tool

Application: Use to press out and press fit the crankshaft bearing No. 1

1. Extracting tool

A	130 mm (5.31 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm dia. (0.79 in. dia.)
G	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)
H	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)

2. Extracting tool

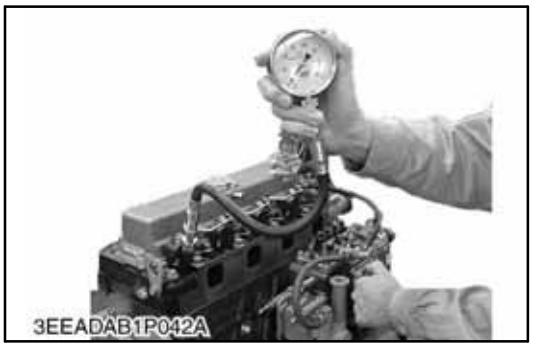
A	130 mm (5.31 in.)
B	72 mm (2.83 in.)
C	R40 mm (R1.57 in.)
D	10 mm (0.39 in.)
E	20 mm (0.79 in.)
F	20 mm (0.79 in.)
G	20 mm dia. (0.79 in. dia.)
H	68 mm dia. (2.68 in. dia.)
I	59.8 to 59.9 mm dia. (2.354 to 2.358 in. dia.)
J	64.8 to 64.9 mm dia. (2.551 to 2.555 in. dia.)

SECTION 2

ENGINE BODY

2.1 CHECKING AND ADJUSTING

2.1.1 Compression Pressure



1. Run the engine until it is warmed up.
2. Stop the engine and disconnect the **2P** connector from the stop solenoid to prevent fuel delivery to the engine.
3. Remove the the air cleaner, the muffler and all the glow plugs.
4. Install a compression tester with the adapter in one of the glow plug holes.
5. While cranking the engine with the starter measure the compression pressure.
6. Repeat steps 1 thru 5 for each cylinder.

7. If the measurement is below the allowable limit, add a small amount of oil to the cylinder thru the glow plug hole and measure the compression again.

a. If the compression pressure is still less than the allowable limit, check the top clearance, valves and cylinder head.

b. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

NOTE

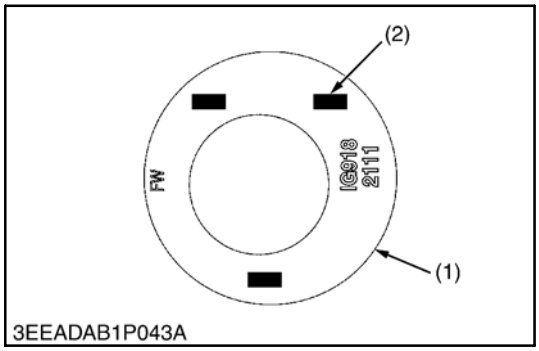
Check the compression pressure with the specified valve clearance

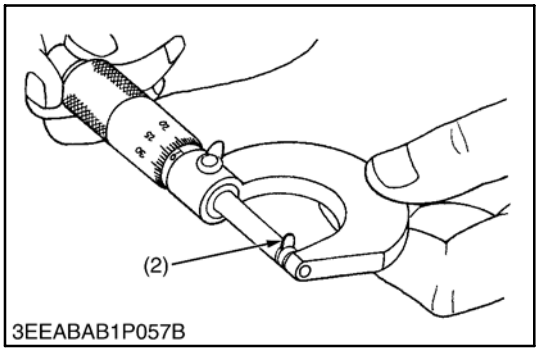
Always use a fully charged battery for performing this test.

Variances in cylinder compression values should be under 10%.

Compression Pressure	Factory Specification	2.94 to 3.24 MPa 30 to 33 kgt/cm^2 427 to 469 psi
	Allowable Limit	2.35 MPa 24 kgt/cm^2 341 psi

2.1.2 Top Clearance





1. Piston
2 Plastic gauge

1. Remove the valve cover. (Refer to Section 2.2.3.a)
2. Remove the cylinder head.
3. Move the piston (1) up and stick a strip of plastic gauge (2) on the piston head at three positions shown on the illustration.
4. Lower the piston and install the cylinder head. (Use a new cylinder head gasket and tighten the cylinder head bolts to the proper torque.
5. Turn the flywheel until the piston (1) passes through top dead center.
6. Remove the cylinder head and measure the plastic guage.
7. If the measurement is not within the factory specifications, check the clearances between the crank pin and bearing and between the piston pin and bushing.

Top Clearance	Factory Specification	0.60 to 0.70 mm 0.0236 to 0.0276 in.
Tightening Torque	Cylinder Head Bolts	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

2.2 DISASSEMBLING AND ASSEMBLING

2.2.1 Draining Coolant And Engine Oil

⚠ CAUTION

Never remove the radiator cap until coolant temperature is below its boiling point. Loosen the cap slightly to the first stop to relieve any excess pressure before removing the cap completely.

1. Open the coolant drain cock or remove the coolant drain plug and drain the coolant into a proper receptacle/bucket.
2. Remove the oil drain plug and drain the engine oil into a proper receptacle/bucket.

2.2.2 External Components

Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan, fan belt, alternator and starter.

When Reassembling

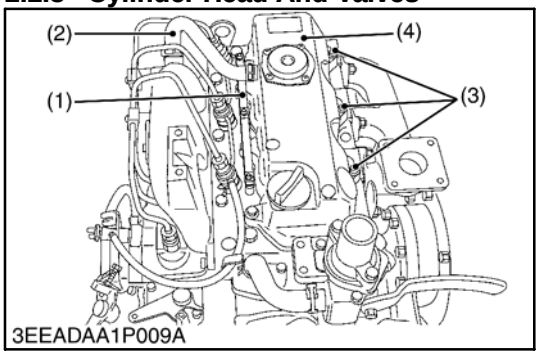
NOTE

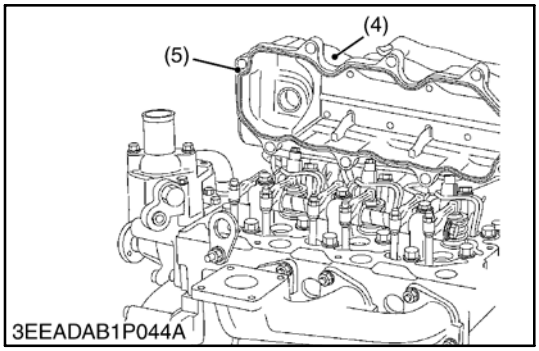
Check to see that there are no cracks on the belt surface.

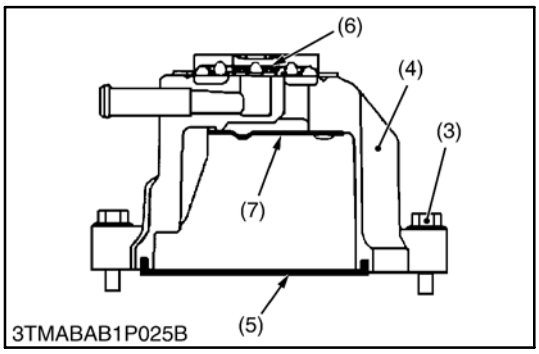
After reinstaling the fan belt, be sure to adjust the fan belt tension.

When reinstalling the fan, make sure that it is put on correctly.

2.2.3 Cylinder Head And Valves







1. Glow Plug Buss Bar
2. Breather Hose
3. Valve Cover Bolt
4.. Valve Cover
5. Valve Cover Gasket
6. Breather Valve
7. Plate

2.2.3.a Valve Cover

1. Remove the Glow Plug Buss Bar (1).
2. Remove the breather hose (2).
3. Remove the valve cover Bolts (3).
4. Remove the valve cover (4).

When Reassembling

Check to see that the valve cover gasket (5) is in good condition and in place.

Tightening Torque	Valve Cover Bolts	6.9 to 11.3 N·m 0.7 to 1.15 kgf·m 5.1 to 8.32 ft-lbs

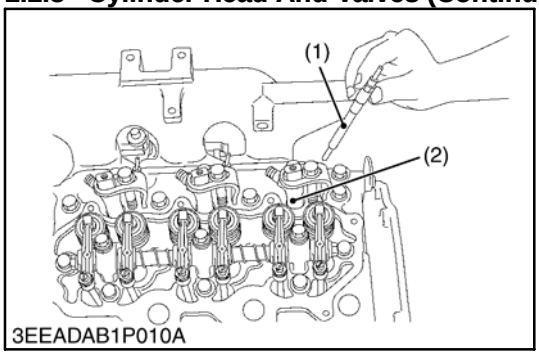
2.2.3.b Injection Pipes

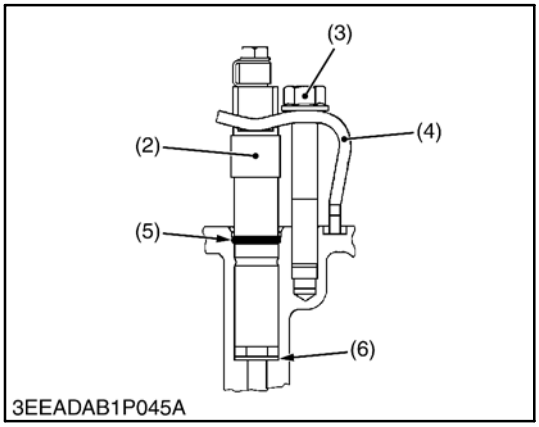
1. Loosen the bolts on the pipe clamps.
2. Detach the injection pipes.

When Reassembling

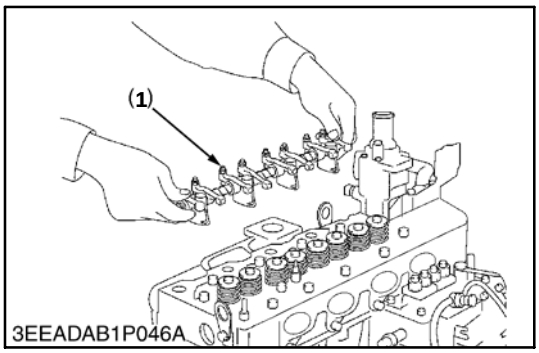
Blow out any debris that may be in the pipes.

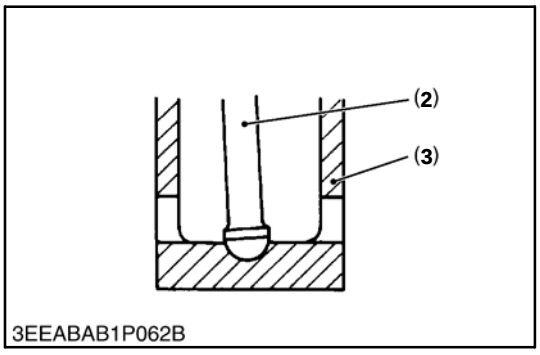
Tightening Torque	Injection Pipe Retaining Nut	14.7 to 24.5 N·m 1.5 to 2.5 kgf·m 10.8 to 18.1 ft-lbs





1. Glow Plug
2. Injection Nozzle Assembly
3. Nozzle Mounting Bolt
4. Nozzle Clamp
5. O-Ring
6. Copper Gasket





1. Rocker Arm Assembly
2. Push Rod
3. Tappet

2.2.3.c Nozzle Holder Assembly and Glow Plug

1. Remove the overflow pipe assembly.

2. Remove the glow plugs (1).

3. Remove the nozzle holder assemblies (2).

When Reassembling

Replace the copper gasket with a new one.

Tightening Torque	Nozzle Holder Clamp bolt	25.5 to 29.4 N·m 2.6 to 3.0 kgf·m 18.8 to 21.7 ft-lbs
	Overflow Pipe Assembly Retaining bolt	9.8 to 11.3 N·m 1.00 to 1.15 kgf·m 7.2 to 8.3 ft-lbs
	Glow Plug	19.6 to 24.5 N·m 2.0 to 2.5 kgf·m 14.5 to 18.1 ft-lbs
	Injection Nozzle Mounting Bolt	25.5 to 29.4 N·m 2.6 to 3.0 kgf·m 18.8 to 21.7 ft-lbs
	Glow Plug Terminal	0.98 to 1.77 N·m 0.10 to 0.18 kgf·m 0.72 to 1.30 ft-lbs

2.2.3.d Rocker Arm and Push Rod

1. Remove the rocker arm bracket mounting bolts.

2. Detach the rocker arm assembly (1).

3. Remove the push rods (3).

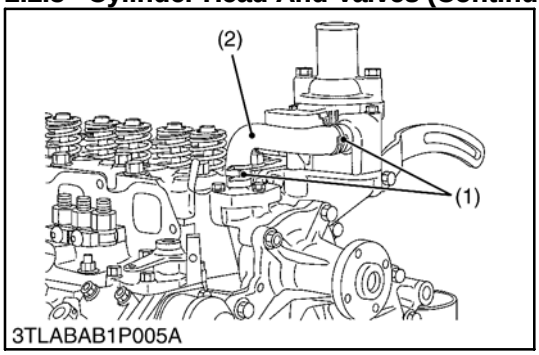
When Reassembling

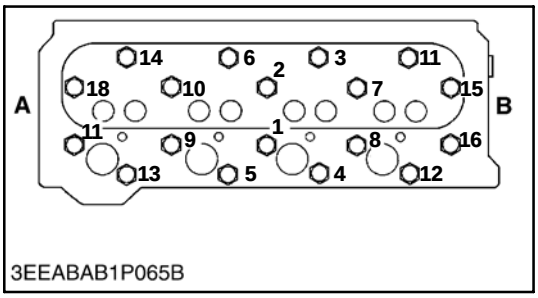
When putting the push rods (3) onto the tappets (4), check to see if the end is properly engaged with the dimples.

NOTE

After instaling the rocker arm, be sure to adjust the valve clearance. (Refer to Section 1.8.7)

Valve Clearance	Factory Specification	0.18 to 0.22 mm 0.0071 to 0.0086 in.
Tightening Torque	Rocker Arm Bracket Mounting Bolt	25.5 to 29.4 N·m 2.6 to 3.0 kgf·m 18.8 to 21.7 ft-lbs





1. Hose Clamp
2. Filter-Drier Inlet

A: Gear Case Side
B: Flywheel Side

2.2.3.e Cylinder Head

1. Loosen the hose clamp (1), and remove the water return pipe (2).
2. Remove the cylinder head bolts in the order of (**18**) to (**1**).
3. Lift up the cylinder head and remove.
4. Remove the cylinder head gasket (3).

When Reassembling

Replace the cylinder head gasket (3) with a new one.

Apply oil to, then re-install the cylinder head bolts.

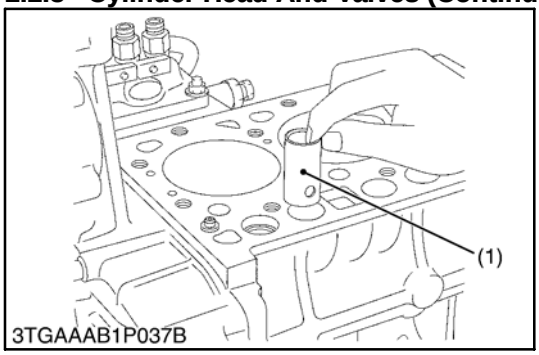
Tighten the cylinder head bolts in sequence starting from the center in the order of (**1**) to (**18**).

Tighten the head bolts uniformly or head warpage may occur.

Tightening Torque	Cylinder Head Bolt	93.1 to 98.0 N·m 9.5 to 10.0 kgf·m 68.7 to 72.3 ft-lbs

NOTE

When replacing the cylinder head gasket (3), be sure you are using a new gasket that matches the original gasket.



2.2.3.f Tappets

1. Remove the tappets (1) from the crankcase.

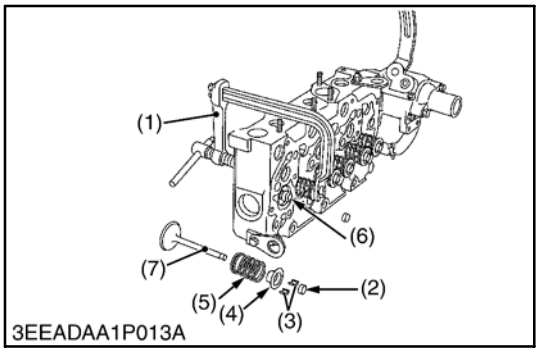
When Reassembling

Visually check the contact between the tappets (1) and individual cam lobes.

Coat the tappets with engine oil before installing them.

NOTE

When re-installing tappets into the engine, make sure that they are re-installed in their original location.



2.2.3.g Valves

1. Remove the valve caps (2).
2. Remove the valve spring collet (3), pushing the valve spring retainer (4) by the valve spring compressor (1).
3. Remove the valve spring retainer (4), valve spring (5) and valve stem seal (6).
4. Remove the valve.

When Reassembling

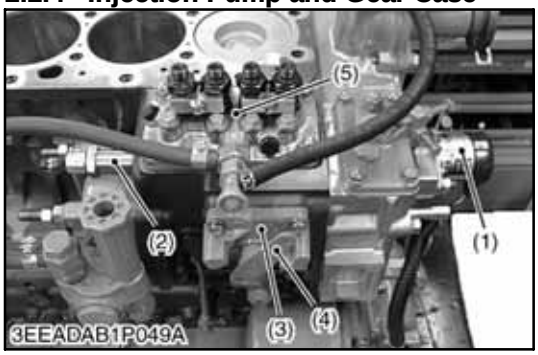
Clean the valve stem and the valve guide. Apply engine oil to the valve stem when reassembling.

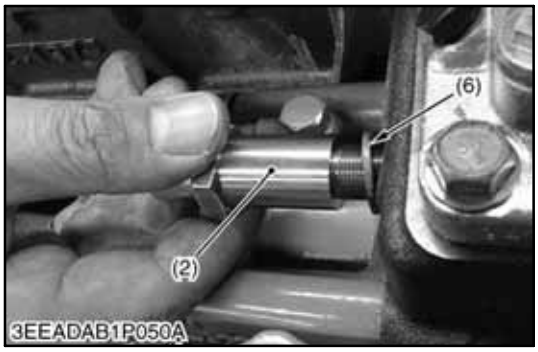
After installing the valve spring collets (3), lightly tap the stem with a plastic hammer to assure the collets have seated on the valve stem.

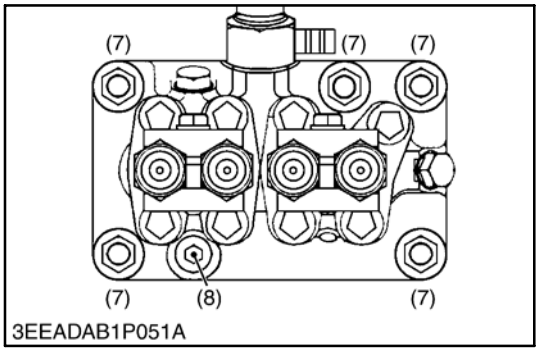
NOTE

When re-installing valves into the engine, make sure that they are re-installed in their original location.

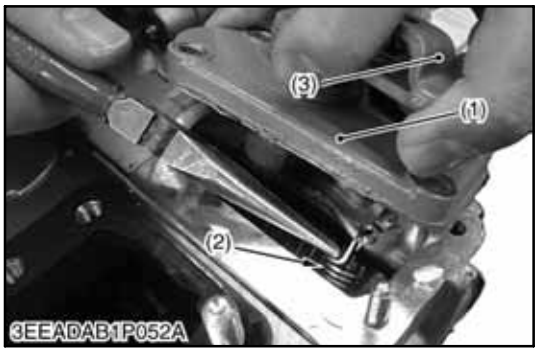
2.2.4 Injection Pump and Gear Case







1. Stop Solenoid
2. Hi-idling Body
3. Injection Pump Cover
4. Engine Stop Lever
5. Injection Pump
6. Hi-Idling Body Gasket
7. Flanged Bolt
8. Hexagon Socket Headed Bolt



1. Speed Control Plate
2. Governor Spring
3. Speed Control Lever

2.2.4.a Injection Pump – Models V2203-DI-E2B-CTD-2, CTD-4, CTD-5, CTD-6, CTD-7

1. Remove the stop solenoid (1) and hi-idling body (2).
2. Remove the injection pump cover (3) with the engine stop lever (4).
3. Disconnect the fuel hose.
4. Remove the injection pump (5).

NOTE

It is necessary to remove the injection pump (5) after removing the stop solenoid (1) and hi-idling body (2).

When Reassembling

Apply gasket sealer to both sides of the injection pump cover gasket and install the cover and cover gasket.

Install the stop solenoid (1) and the hi-idling body (2) after attaching the injection pump.

Replace the stop solenoid gasket and hi-idling body gasket (6) with a new one.

Replace the injection pump, being careful to orient the injection pump mounting bolts as shown in figure 3EEADAB1PO51A.

Tightening Torque	Hi-idling Body	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.6 to 36.3 ft-lbs

2.2.4.b Speed Control Plate – Models V2203-DI-E2B-CTD-2, CTD-4, CTD-5, CTD-6, CTD-7

1. Remove the mounting bolt/nut and lift up the speed control plate (1).
2. Disconnect the governor spring (2).
3. Remove the control plate.

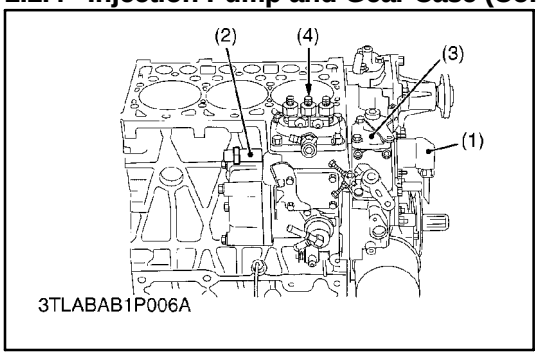
When Reassembling

Apply gasket sealer to both sides of the speed control plate gasket.

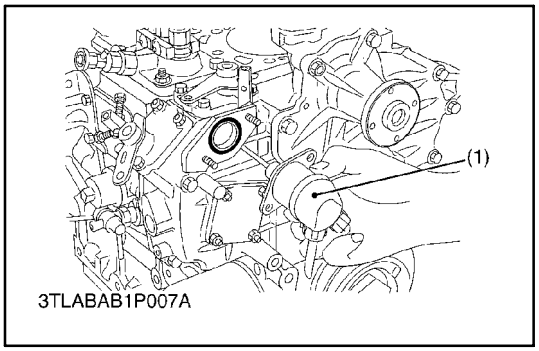
Check that the speed control lever (3) positions low idle, after assembling the governor spring.

Check that the speed control lever (3) returns to the high idle position rather than the low idle position, after moving the lever to the maximum speed position.

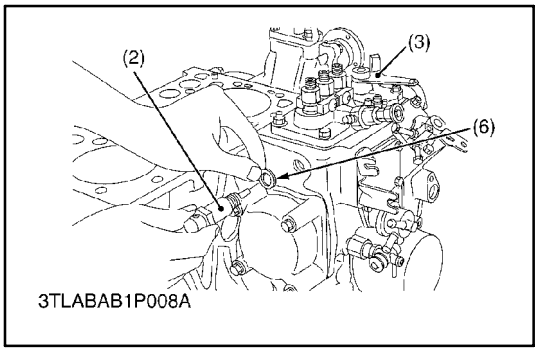
After assembling the engine, check the idling speed.



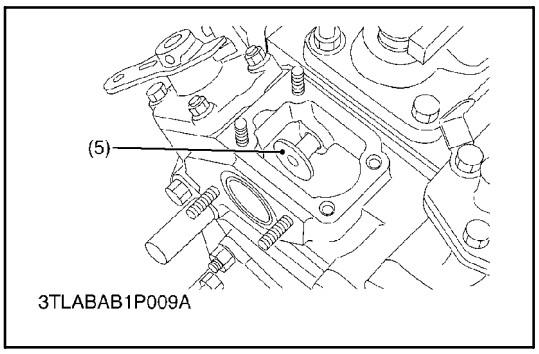
3TLABAB1P006A



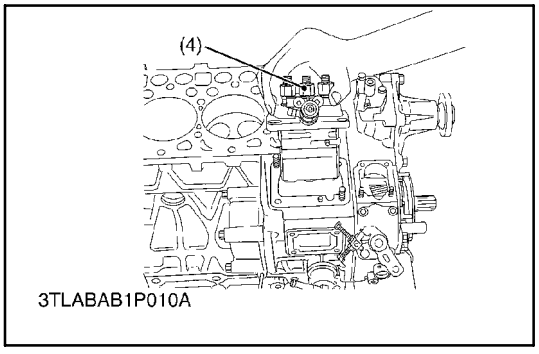
3TLABAB1P007A



3TLABAB1P008A



3TLABAB1P009A



3TLABAB1P010A

2.2.4.c Injection Pump - Model V2203-DI-E2B-CTD-1

1. Remove the stop solenoid (1) and hi-idling body (2).
2. Remove the engine stop lever (3) and stop solenoid guide (5).
3. Remove the injection pump assembly (4).

NOTE

Before removing the injection pump assembly (4), be sure to remove the stop solenoid (1), hi--idling body (2), engine stop lever (3) and stop solenoid guide (5).

When Reassembling

Install the injection pump into position first before attaching the stop solenoid (1), hi-idling body(2) and solenoid guide (5).

Replace the hi-idling body gasket (6) with a new one.

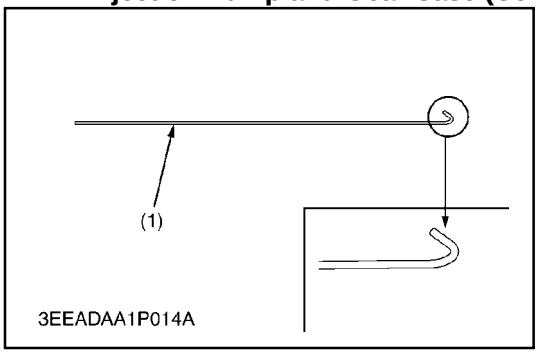
Install the solenoid guide (5) into position, then attach the stop lever (3) and check the stop lever for function.

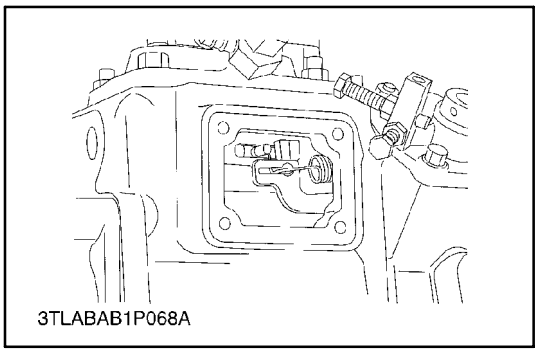
Attach the solenoid guide (5) and the engine stop lever (3) in their respective positions, the fit the idling limiter into place.

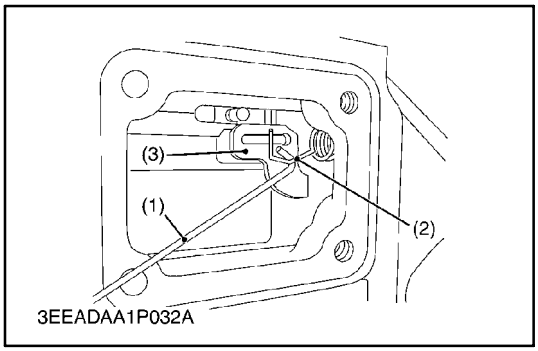
Install the stop solenoid (1) being careful to keep the O-Ring in place while inserting the push rod of the stop solenoid into the hole at the center of the solenoid guide (5).

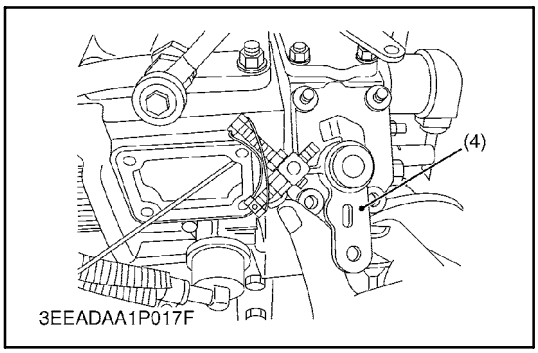
Tightening Torque	Hi-idling Body	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.6 to 36.3 ft-lbs

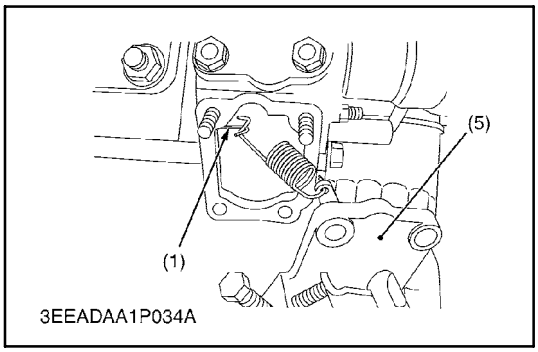
1. Stop Solenoid
2. Hi-idling Body
3. Stop Lever
4. Injection Pump Assembly
5. Stop Solenoid Guide
6. Hi-idling Body Gasket











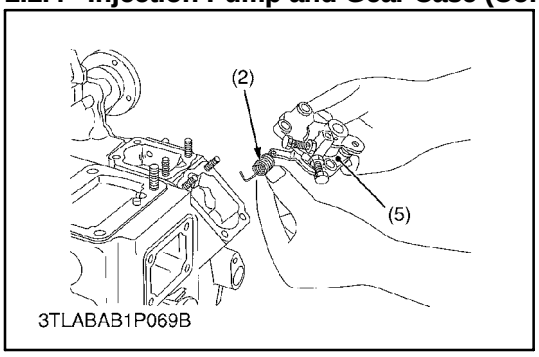
2.2.4.d Governor Springs and Speed Control Plate – Model V2203-DI- E2B-CTD-1

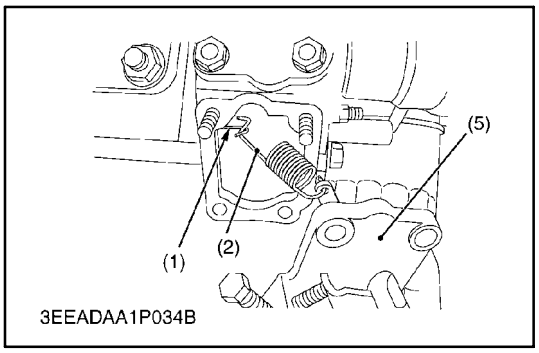
NOTE

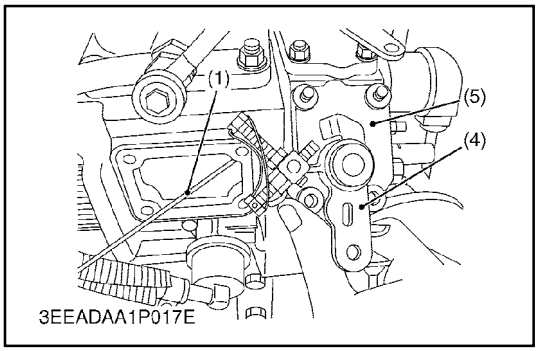
Specific Tool (1): A 1.2mm (.050 inch) diameter wire with a total length of 200mm (8 inch) with the tip bent into a hook as depicted in the illustration is required to hang the governor springs.

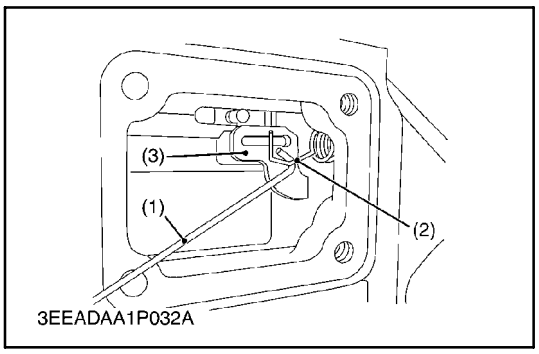
1. Remove the injection pump cover.
2. Remove the speed control plate (5) mounting nuts and bolts.
3. Using the Specific Tool (1), undo the the large governor spring (2) from the fork lever (3).
4. Set the speed control lever (4) as shown in the figure.
5. Remove the speed control plate (5), using care not to let the governor spring (2) disengage from the plate and fall into the gear case.

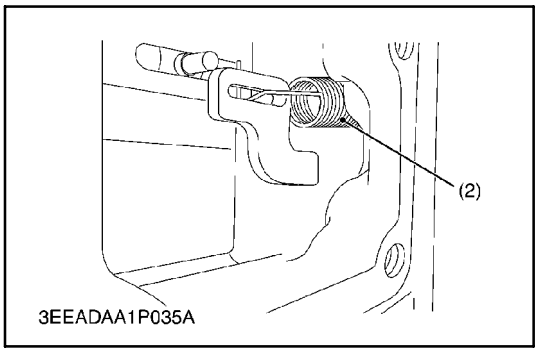
1. Specific Tool
2. Governor Spring
3. Fork Lever
4. Speed Control Lever
5. Speed Control Plate











2.2.4.d Governor Springs and Speed Control Plate – Model V2203-DI- E2B-CTD-1 (Continued)

When Reassembling

NOTE

A length of string passed thru the governor spring can be used to retrieve the spring if it unhooks from both the specific tool and the speed control plate.

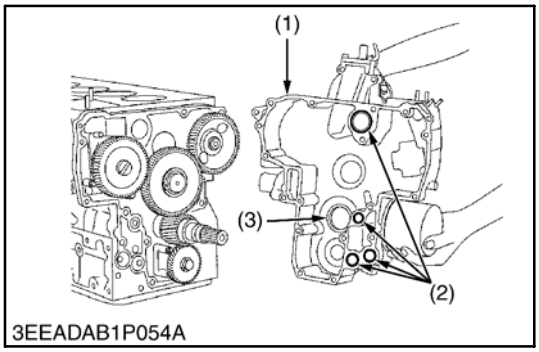
Begin reassembly by inserting the specific tool (1) thru the injection pump cover opening thru to the speed control plate opening.

1. Using the specific tool (1), capture the governor spring (2) and speed control plate (5) assembly.
2. Pull the governor spring (2) / speed control plate (5) assembly thru and secure it to the fork lever (3).
3. Seat and assemble the speed control (5) plate with two bolts and two nuts to the gear case.
4. Check the movement of the speed control lever (4).

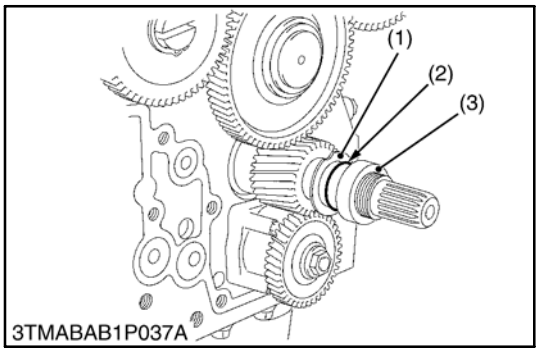
NOTE

The speed control lever (4) must be free to move from low idle position to maximum speed position and should always return to the high idle position.

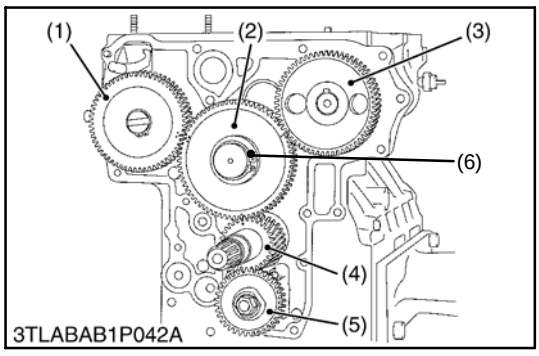
5. Finally, assemble the injection pump cover to the gear case.



1. Gear Case
2. O-ring
3. Oil Seal



1. Crankshaft Oil Slinger
2. O-ring
3. Crankshaft Collar



1. Injection pump gear
2. Idle gear
3. Cam gear
4. Crank gear
5. Oil pump drive gear
6. Idle gear snap ring

2.2.4.e Fan Drive Pulley

1. Lock the flywheel using the flywheel stopper
2. Remove the fan drive pulley mounting nut.
3. Remove the fan drive pulley with a gear puller.
4. Remove the feather key.

When Reassembling

Apply grease to the splines of the coupling.

Tightening Torque	Drive Pulley Mounting Nut	137.3 to 156.9 N·m 14.0 to 16.0 kgf·m 101.3 to 115.7 ft-lbs

2.2.4.f Gear Case

1. Remove the gear case.

When Reassembling

Apply grease to the crankshaft oil seal lip and take car not to roll the lip when installing the gear case.

Apply gasket sealant to both sides of the gear case gasket.

2.2.4.g Crankshaft Oil Slinger

1. Remove the crankshaft collar (3).
2. Remove the O-ring (2).
3. Detach the crankshaft oil slinger (1)

When Reassembling

Insert the crankshaft collar (3) after installing the gear case to the crankcase.

2.2.4.h Idle Gear

1. Detach the external snap ring. (6)
2. Remove the idle gear collar. (Between 6 & 2)
3. Remove the idle gear (2).

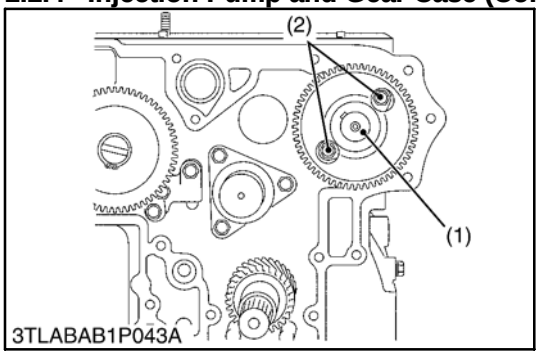
When Reassembling

Check to see each gear is aligned with its aligning mark.

Idle gear (2) and crank gear (4)

Idle gear (2) and cam gear (3)

Idle gear (2) and injection pump gear (1)



1. Camshaft
2. Camshaft retaining bolt

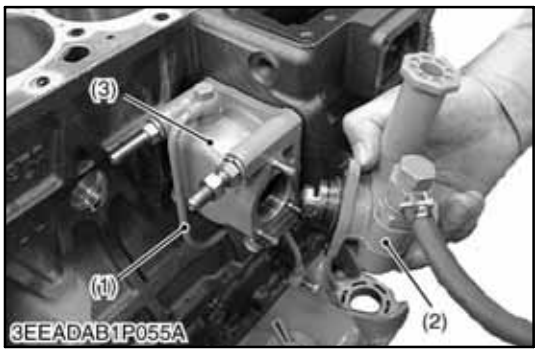
2.2.4.i Camshaft

1. Remove the camshaft retaining bolt (2) and pull the camshaft (1) out.

When Reassembling

Refer to installation of Idle Gear (Refer to Section 2.2.4.h).

Tightening Torque	Camshaft retaining bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs



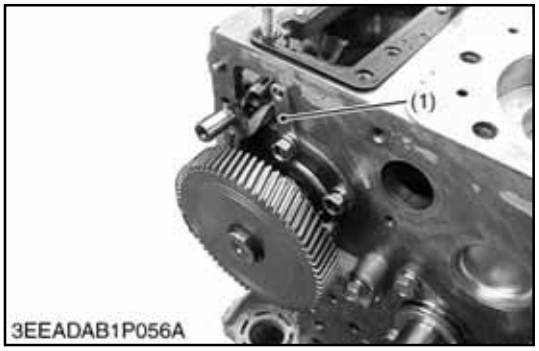
1. Oil Pipe
2. Fuel Feed Pump
3. Fuel Feed Pump Holder

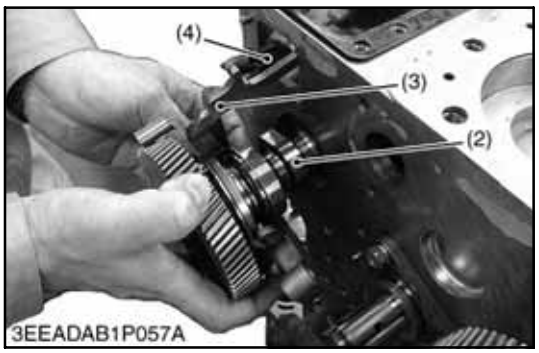
2.2.4.j Fuel Feed Pump Holder

1. Disconnect the oil pipe (1) and fuel pipe .
2. Remove the fuel feed pump (2).
3. Remove the fuel feed pump holder (3).

When Reassembling

Replace the O-rings with new O-rings.





1. Fuel camshaft stopper
2. Fuel camshaft
3. Fork Lever 1
4. Fork Lever 2

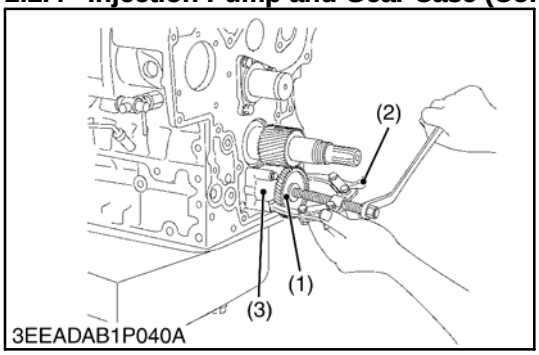
2.2.4.k Fuel Camshaft

1. Remove the fuel camshaft stopper (1).
2. Remove the fork lever holder bolt and remove the fuel camshaft (2) with the fork lever 1 (3) and 2 (4).

When Reassembling

Lubricate the fuel camshaft before installation.

2.2.4 Injection Pump and Gear Case (Continued)

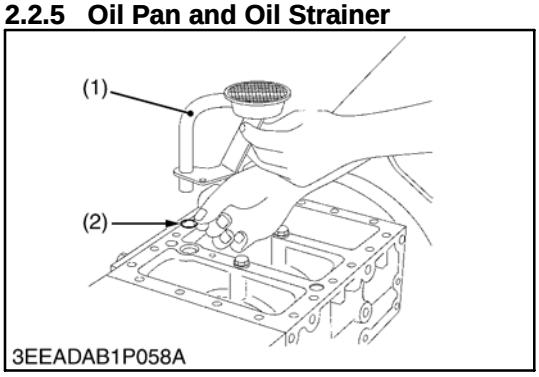


1. Oil Pump Drive Gear
2. Gear Puller
3 Oil Pump

2.2.4.l Oil Pump

1. Remove the nut.
2. Draw out the oil pump drive gear (1) with a gear puller (2).
3. Remove the four oil pump mounting bolts. Detach the oil pump (3).

2.2.5 Oil Pan and Oil Strainer



1. Oil Strainer
2. O-ring

2.2.5.a Oil Pan and Oil Strainer Removal

1. Remove the oil pan mounting bolts.
2. Remove the oil pan by lightly tapping the rim of the pan with a soft hammer.
3. Remove the oil pan gasket.
4. Remove the oil strainer (1) and O-ring (2).

When Reassembling

Check to see that the oil filter strainer (1) is clean.

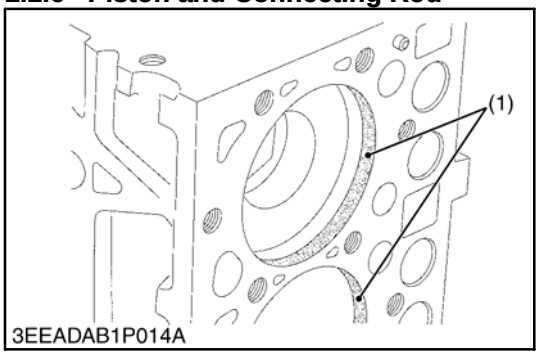
Visually check the O-ring (2), apply engine oil and install it to the pick-up tube.

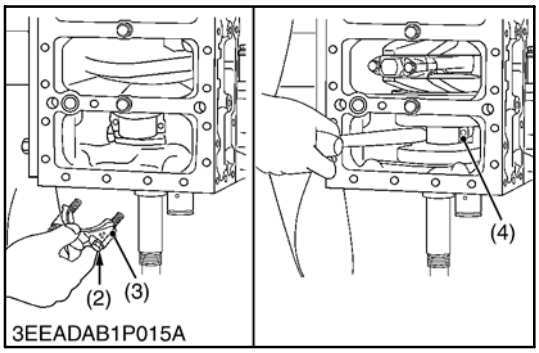
Install the strainer (1) and O-ring (2).

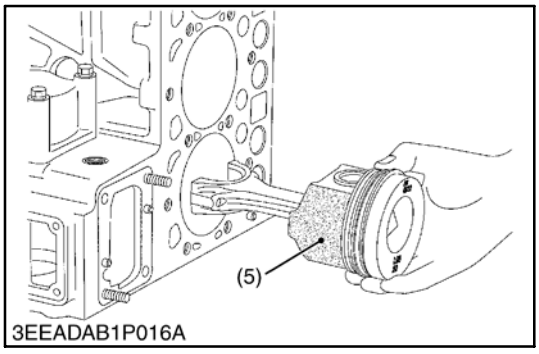
Apply gasket sealant to the oil pan side of the oil pan gasket and fit the gasket to the oil pan.

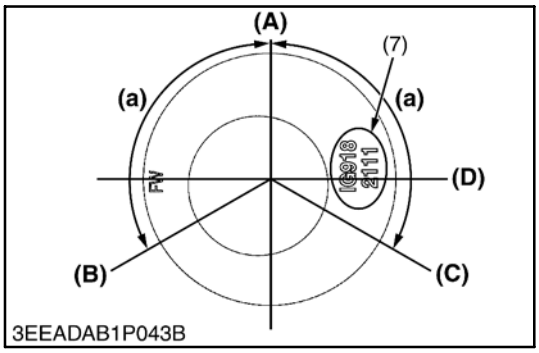
Install the oil pan to the engine, and tighten the oil pan bolts diagonally. Avoid uneven tightening of the oil pan mounting bolts. (Refer to Section 1.5.2 Torque Specifications)

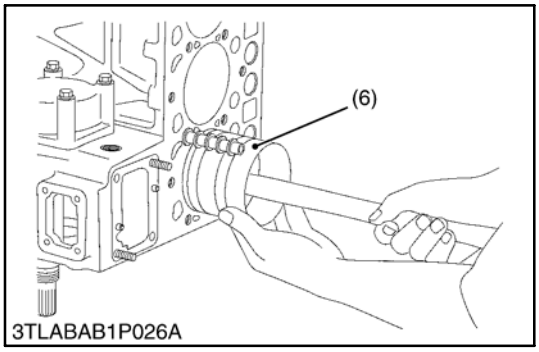
2.2.6 Piston and Connecting Rod











2.2.6.a Pistons

1. Completely remove the carbon ridge (1) at the top of the cylinder walls.
2. Remove the the connecting rod cap (3).
3. Turn the flywheel and bring the piston to top dead center.
4. Push the piston out by lightly tapping the connecting rod from the bottom of the crankcase with the grip of a hammer.
5. Repeat the procedure for the other three cylinders.

When Reassembling

Liberally coat the piston and piston rings with engine oil.

When inserting the piston into the cylinder, face the mark on the connecting rod to the injection pump.

NOTE

If re-installing the original piston assemblies into the engine be sure that they are returned to their original cylinder.

Place the piston rings with their gaps at 2.09 rad. (120°) from the piston pin's direction as shown.

Carefully insert the pistons into the cylinders using the piston ring compressor (6).

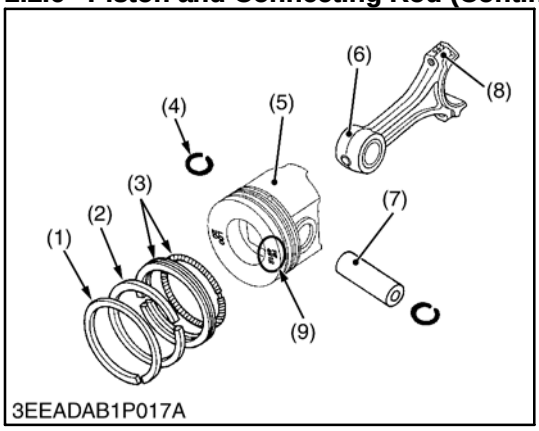
When inserting the piston into the cylinder avoid damaging the molybdenum disulfide coating on the piston skirt. This coating is useful in minimizing the clearance between the piston and cylinder.

When replacing a piston, use a replacement piston with the same code number. The piston ID mark (7) is on top of the piston.

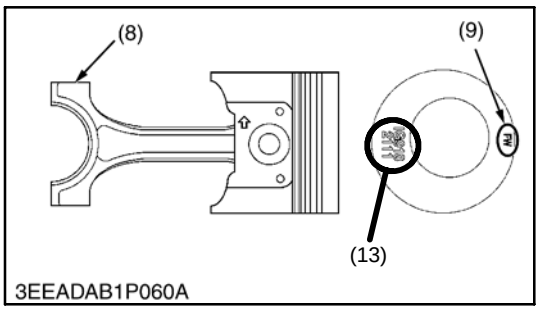
1. Carbon
2. Connecting Rod Bolt
3. Connecting Rod Cap
4. Connecting Rod
5. Molybdenum Disulfide Coating on Piston Skirt
6. Piston Ring Compressor
7. Piston ID Mark

(**A**) Top Ring Gap
(**B**) Second Ring Gap
(**C**) Oil Ring Gap
(**D**) Piston Pin Hole
(**a**) 2.09 rad. (120°)

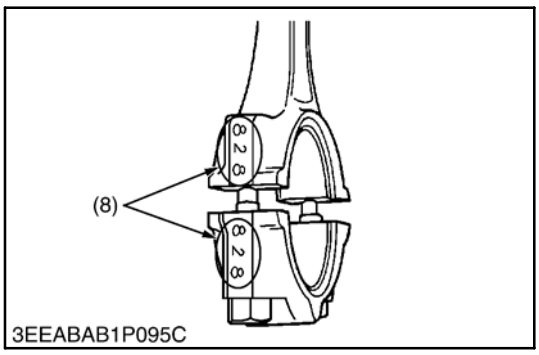
Tightening Torque	Connecting Rod Bolt	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.5 to 36.2 ft-lbs



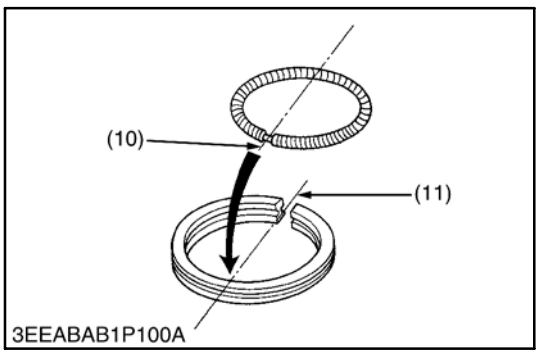
3EEADAB1P017A



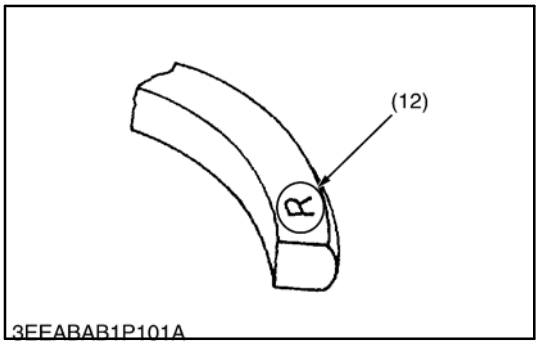
3EEADAB1P060A



3EEABAB1P095C



3EEABAB1P100A



3EEABAB1P101A

2.2.6.b Piston Ring and Connecting Rod

1. Remove the piston rings (1), (2), (3).
2. Remove the piston pin (7) and then seperate the connecting rod (6) from the piston (5).

NOTE

Mark both the connecting rod and piston so that if they are to be re-used that the original combination of parts will go back together. Do not interchange used parts.

When Reassembling

When installing the ring, assemble the rings so that the manufacturer's mark (12) near the gap faces the top of the piston (5).

When installing the oil control ring (3) onto the piston (5), place the expander joint (10) on the opposite side of the oil ring gap (11).

Apply engine oil to the piston pin (7).

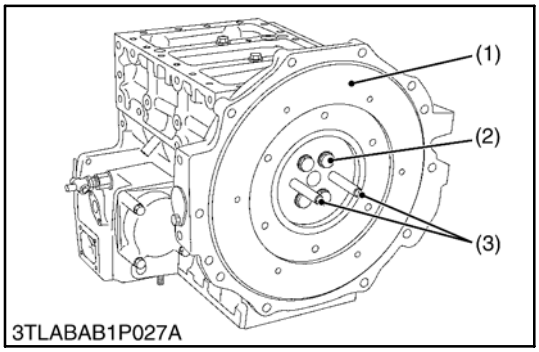
When assembling the connecting rod (6) to the piston (5), immerse the piston (5) in hot oil (80°C / 176°F) for 10 to 15 minutes, then assemble the piston, piston pin, and connecting rod.

NOTE

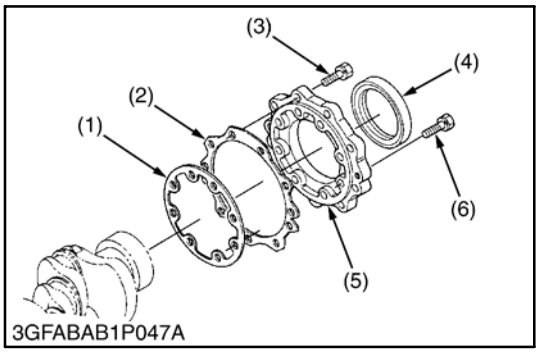
Assemble the piston (5) on to the connecting rod (6) with the FW mark (9) facing the flywheel end and the connecting rod mark (8) facing the injection pump side.

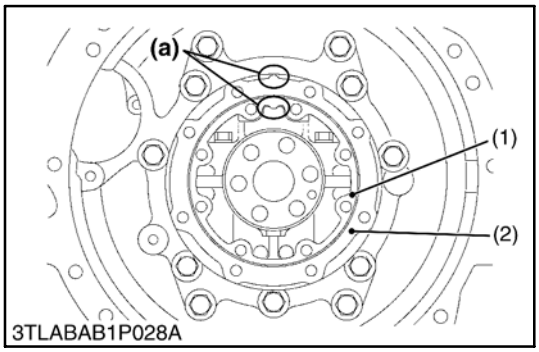
1. Top Ring
2. Second Ring
3. Oil Control Ring
4. Piston Snap Ring
5. Piston
6. Connecting Rod
7. Piston Pin
8. Mark
9. FW Mark
10. Expander Joint
11. Oil Ring Gap
12. Manufacturer's Mark
13. Piston ID Mark

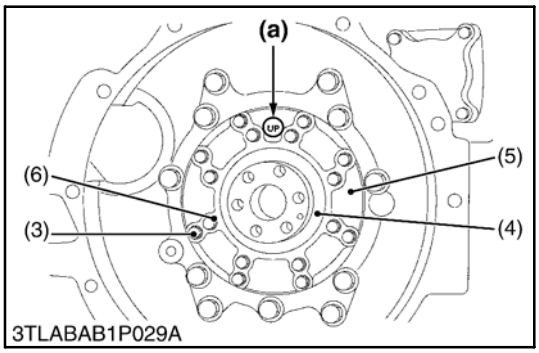
2.2.7 Crankshaft



1. Flywheel
2. Flywheel Bolt
3. Flywheel Guide Bolts







1. Bearing Case Gasket
2. Bearing Case Cover Gasket
3. Bearing Case Cover Mounting Bolt
4. Oil Seal
5. Bearing Case Cover
6. Bearing Case Cover Mounting bolt

(**a**). Top

2.2.7.a Flywheel

1. Prevent the flywheel (1) from rotating.
2. Remove two flywheel bolts (2).

NOTE

The use of air tools to remove the flywheel bolts may damage the threads in the crankshaft.

3. Install two flywheel guide bolts (3).
4. Remove all of the flywheel bolts (2).
5. Remove the flywheel (1) slowly along the flywheel guide bolts (3).

When Reassembling

Install two flywheel guide bolts (3).

Check to see that the mating surfaces of the crankshaft and flywheel are clean.

Apply engine oil to the flywheel bolts and install.

Tightening Torque	Flywheel Bolts	98.0 to 107.8 N·m 10.0 to 11.0 kgf·m 72.3 to 79.5 ft-lbs

2.2.7.b Bearing Case Cover

1. Remove the bearing case cover mounting bolts. First, remove the inside bolts (6) and then the outside bolts (3).
2. Bolt two of the removed bolts into the bolt hole of the bearing case cover (5) to remove it.

NOTE

The length of the inside and the outside bolts is different. When reassembling reinstall the appropriate bolt in the correct location.

When Reassembling

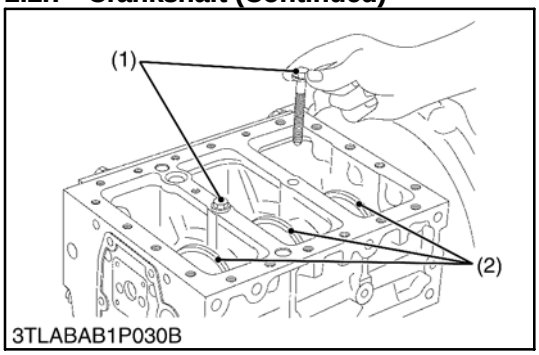
Fit the bearing case gasket (1) and the bearing case cover gasket (2) to the bearing case cover (5). Orient them correctly.

Install the bearing case cover (5), again orienting it correctly, using the “UP” mark (a).

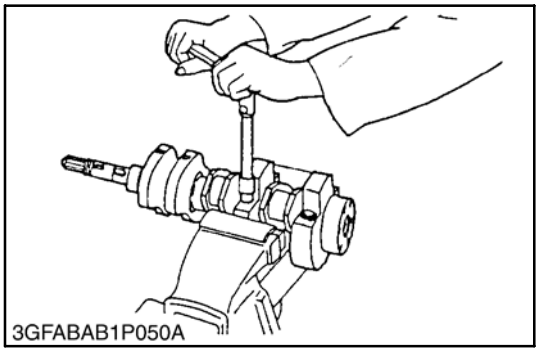
Apply oil to the oil seal, and take care that it is not rolled when installed.

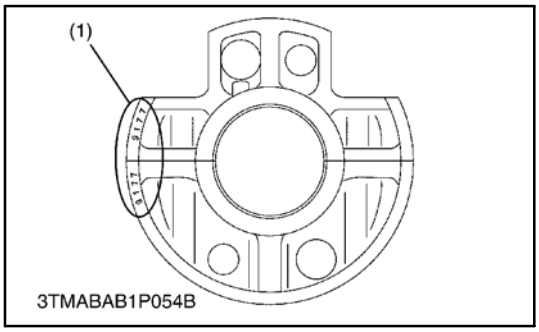
Tighten the bearing case cover bolts diagonally and evenly.

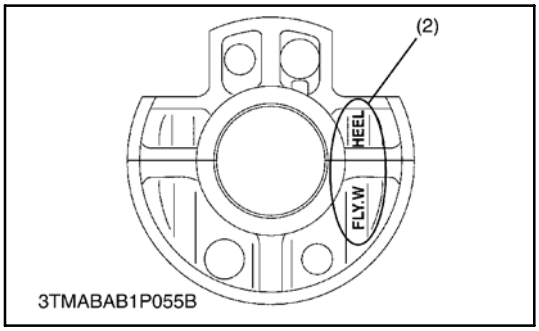
Tightening Torque	Bearing Case Cover Mounting bolt	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.3 ft-lbs

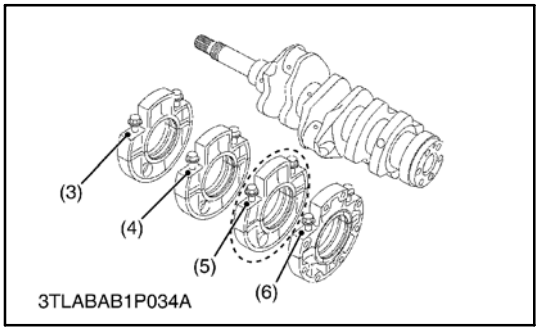


1. Main Bearing Case Bolt
2. Main Bearing Case









2.2.7.c Bearing Case Cover

NOTE

Before disassembling, check the side clearance of the crankshaft. Check it during reassembly.

1. Remove the three main bearing case bolts (1).
2. Pull out the crankshaft, being careful not to damage the crankshaft bearings (2).

Tightening Torque	Main Bearing Case bolt	68.6 to 73.5 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 ft-lbs

2.2.7.d Main Bearing Case Assembly

1. Remove the two main bearing case bolts (8), and remove the main bearing case assembly being careful with the thrust bearing (7) and crankshaft bearing.
2. Remove the remaining main bearing cases as above.

When Reassembling

Clean the oil passages in the main bearing case.

Apply clean engine oil to the bearings.

Install the main bearing case assemblies in their original locations. The diameters of the main bearing cases vary. Install them in order from the gear case end according to their markings (A,B,C).

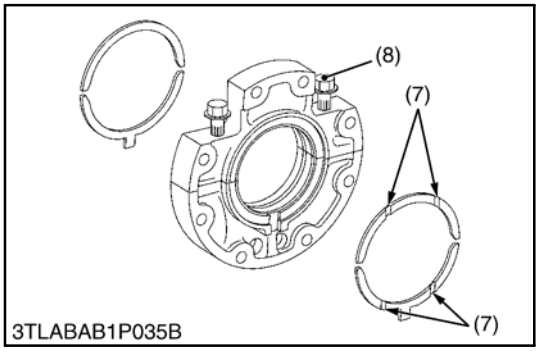
Match the alignment numbers (1) and mark (2) on the main bearing case.

When installing the main bearing case, face the mark “FLYWHEEL” to the flywheel.

Install the thrust bearing with its oil groove facing (7) outward.

Confirm that main bearing case moves smoothly after torquing the main bearing case bolt to specification.

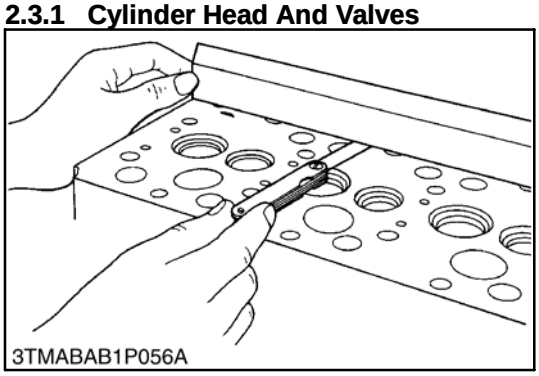
Tightening Torque	Main Bearing Case bolt	46.1 to 50.9 N·m 4.7 to 5.2 kgf·m 34.0 to 37.6 ft-lbs

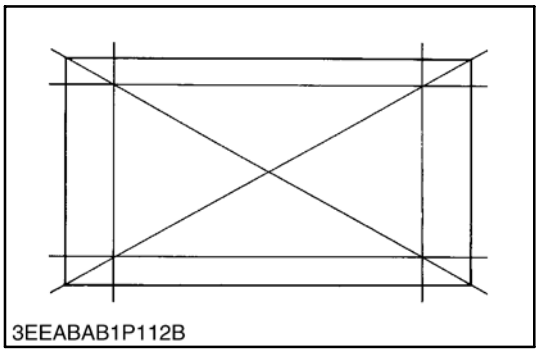


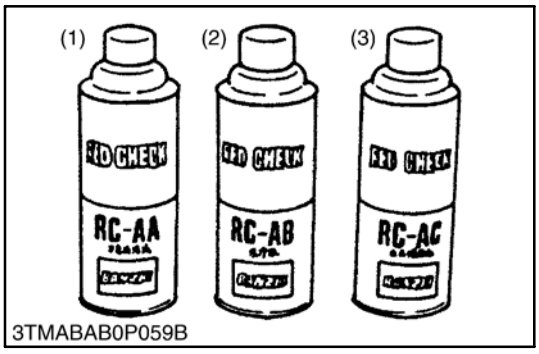
1. Alignment Number
2. Alignment Mark
3. A
4. B
5. C
6. No Mark
7. Oil Groove
8. Main bearing Case Bolt

2.3 SERVICING

2.3.1 Cylinder Head And Valves


3TMABAB1P056A


3EEABAB1P112B



3TMABAB0P059B

1. Red Dye
2. Detergent
3. White Developer

2.3.1.a Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head surface, in six locations as depicted in the drawing.
3. Measure any clearance between the straightedge and cylinder head with a feeler guage.
4. If the measurement exceeds the allowable limit, resurface or replace the head.

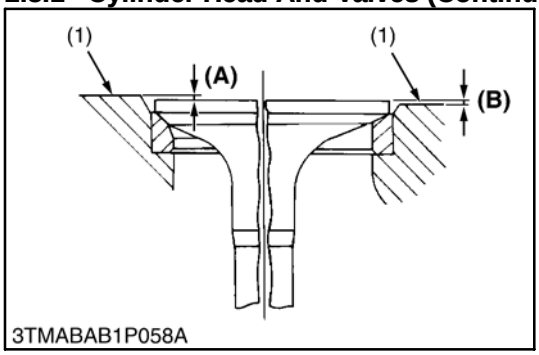
NOTE

Check the valve recessing after after resurfacing the head.

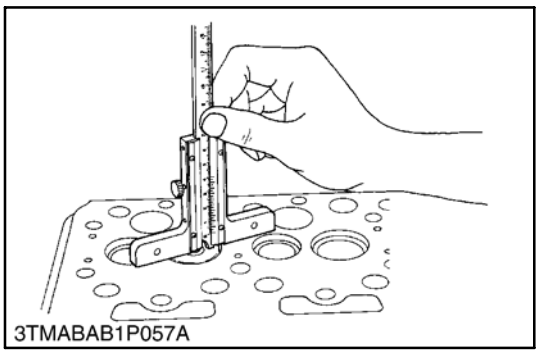
Cylinder Head Surface Flatness	Factory Specification	0.05mm over a span of 500mm 0.0020 in. over a span of 19.69 in.

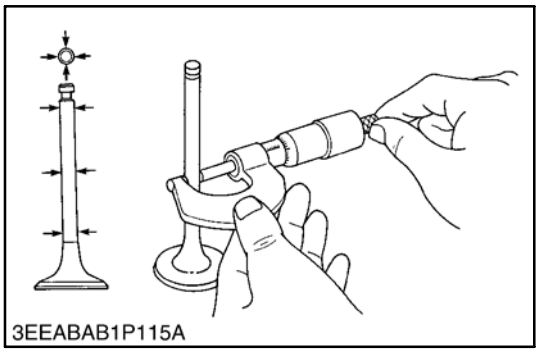
2.3.1.b Cylinder Head Cracks

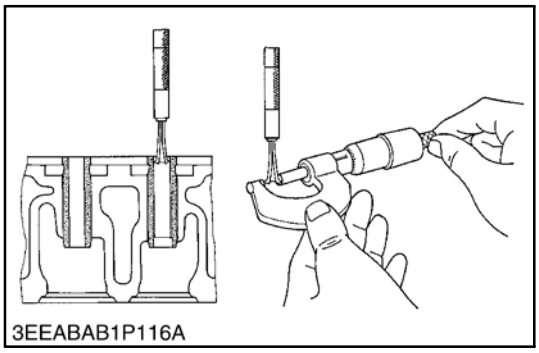
1. Cylinder head crack(s) can be found with using a non-destructive test procedure using a dye/penetrant kit.
2. Clean the cylinder head surface using a good quality degreaser and detergent (2).
3. Spray the cylinder head surface with the red liquid or dye (1). Let it sit on the surface for ten minutes.
4. Wash the dye off the head using the detergent (2) and dry the head.
5. Spray the white developer (3) on to the head.
6. Red marks will bleed through the developer identifying cracks in the head if they are present.



1. Cylinder Head Surface
(A) Recess
(B) Protrusion







2.3.1.c Valve Recessing

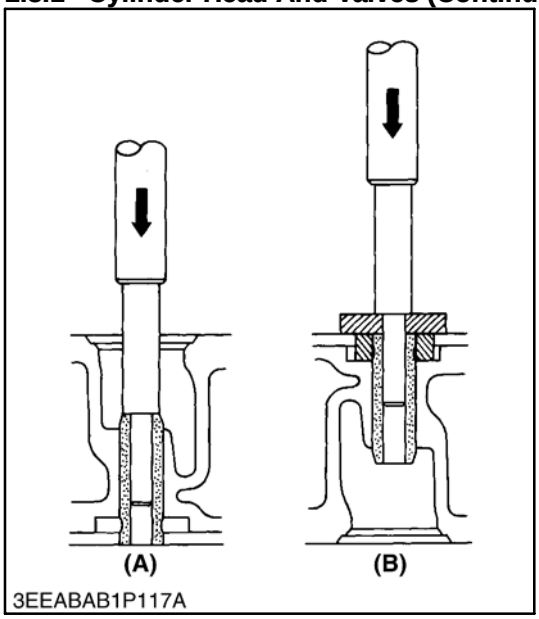
1. Clean the cylinder head surface (1), valve face and valve seat.
2. Insert the valve into the head, making certain that the valve is fully seated.
3. Measure the valve recessing with a depth guage.
4. If the measurement exceeds the allowable limit, replace the valve.
5. If the measurement still exceeds the allowable limit, replace the cylinder head.

Valve Recessing	Factory Specification	0.05 (protrusion) mm to 0.15 (recessing) mm 0.0020 (protrusion) in. to 0.0059 (recessing) in.
	Allowable Limit	0.04 (recessing) mm 0.0157 (recessing) in.

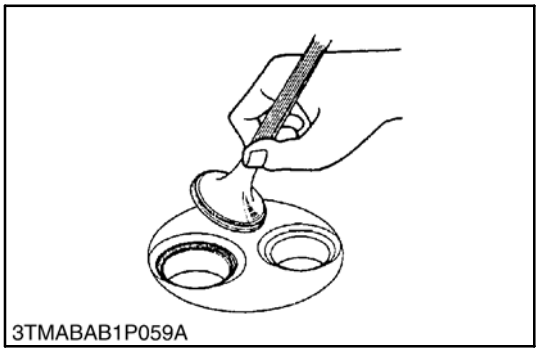
2.3.1.d Clearance Between Valve Stem And Valve Guide

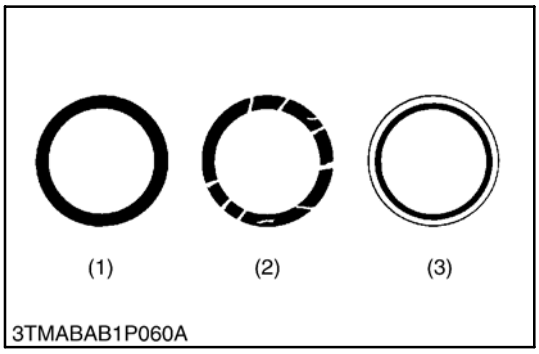
1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with a micrometer.
3. Measure the valve guide with a small hole guage, and calculate the clearance.
4. If the clearance exceeds the the allowable limit, replace the valves. If the clearance still exceeds the allowable limit, replace the valve guide.

Clearance Between Valve Stem and Guide	Factory Specification	0.050 to 0.070 mm 0.0020 to 0.0028 in.
	Allowable Limit	0.1 mm 0.0039 in.
Valve Stem O.D.	Factory Specification	7.960 to 7.975 mm 0.31339 to 0.314398 in.
Valve Guide I.D.	Factory Specification	8.015 to 8.030 mm 0.31555 to 0.31614 in.



(A) When Removing **(B)** When Installing





1. Correct
2. Incorrect
3. Incorrect

2.3.1.e Replacing Valve Guide

(A) (When removing)

1. Press out the used valve guide using a valve guide replacing tool.

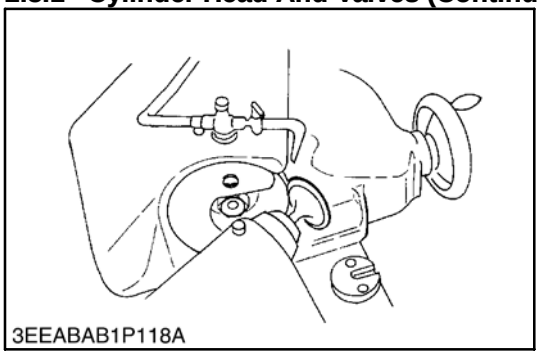
(B) (When installing)

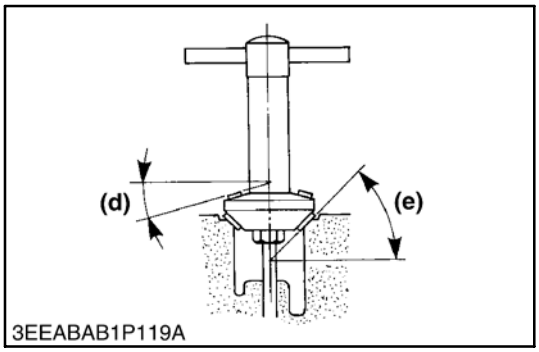
1. Clean a new valve guide and valve guide bore, then apply oil to them.
2. Press in a new valve guide using a valve guide replacing tool.
3. Ream the I.D. of the valve guide to the specified dimension (precisely).

Valve Guide I.D. Intake & Exhaust	Factory Specification	8.015 to 8.030 mm 0.31555 to 0.31614 in.

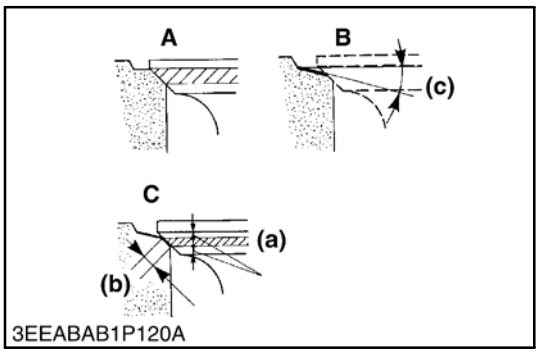
2.3.1.f Valve Seating

1. Coat the valve face lightly with prussian blue and put the valve on its seat to check the contact pattern
2. If the valve does not seat all the way around the valve seat, or the contact is less than 70%, correct the valve seating as outlined in paragraph 2.3.1.g.
3. If the valve contact does not comply with the reference value, replace the valve or correct the contact of valve seating.


3EEABAB1P118A



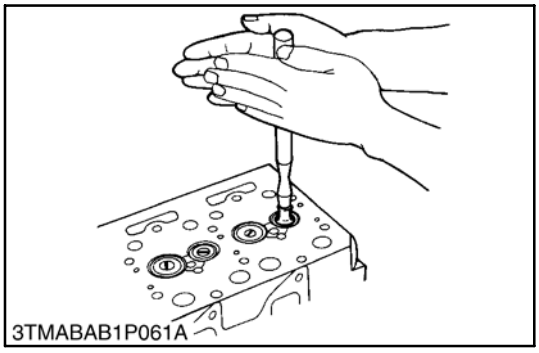
3EEABAB1P119A



3EEABAB1P120A

a. Identical Dimensions
b. Valve Seat Width
c. 0.523 rad.(30°) or 0.262 rad.(15°)
d. 0.262 rad.(15°) or 0.523 rad.(30°)
e. 0.785 rad.(45°) or 1.047 rad.(60°)

A. Check Correct
B. Correct Seat Width
C Check Contact


3TMABAB1P061A

2.3.1.g Correcting Valve and Valve Seat

NOTE

Before correcting the valve seat, make certain that the valve and valve guide are within factory specifications.

After correcting the valve seat, be sure to check the valve recessing.

(A) Correcting the Valve

1. Correct the valve with a valve grinder.

(B) Correcting the Valve Seat

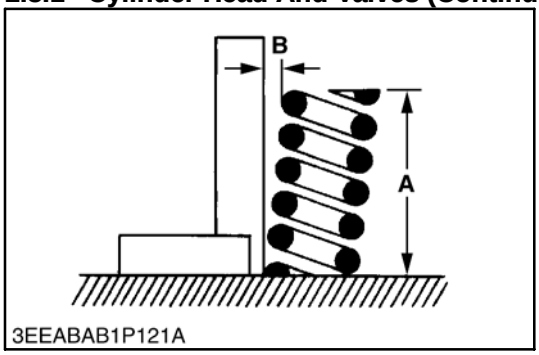
1. Slightly correct the valve seat surface with a 1.046 rad. (60°)(intake valve) or 0.785 rad. (45°)exhaust valve seat cutter
2. Resurface the seat surface with a 0.523 rad. (30°) valve seat cutter to the Intake valve seat and with a 0.262 rad. (15°) valve seat cutter to the exhaust valve seat so that the width is close to the specified valve seat width (2.12 mm, 0.0835 in.).
3. After resurfacing the seat, apply a thin film of valve lapping compound between the valve and the seat, then use a valve lapping tool to seat the valve to the valve seat.
4. Check the valve seating with prussian blue. The valve seating should show good contact all the way around.

2.3.1.h Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve lapper or bolt driver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the contact pattern, if it is less than 70%, repeat valve lapping again.

NOTE

When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.

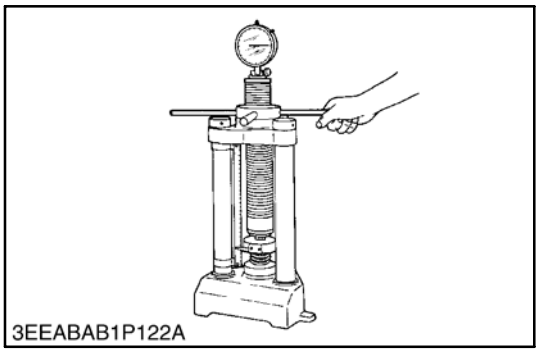


3EEABAB1P121A

2.3.1.i Free Length and Tilt of Valve Spring

1. Measure the free length **A** of the valve spring with vernier calipers. If the measurement is less than the allowable limit, replace the spring.
2. Put the valve spring on a surface plate, place a square on the side of the valve spring.
3. Check to see if the entire side is in contact with the square. Rotate the spring and measure for maximum tilt **B**. Check the entire surface of the valve spring for defects. If any are found, replace it.

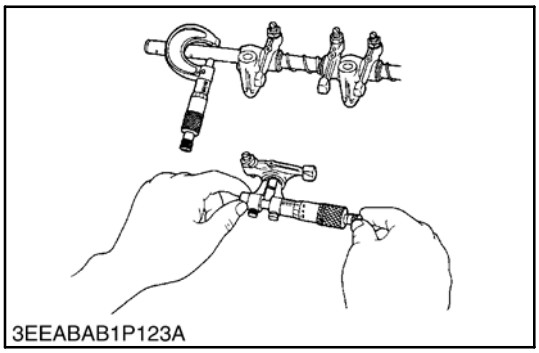
Free Length **A**	Factory Specification	41.7 to 42.2 mm 1.6417 to 1.6614 in.
	Allowable Limit	41.2 mm 1.6220 in.
Tilt **B**	Allowable Limit	1.0 mm 0.039 in.


3EEABAB1P122A

2.3.1.j Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the guage.
3. If the measurement is less than the allowable limit, replace it.

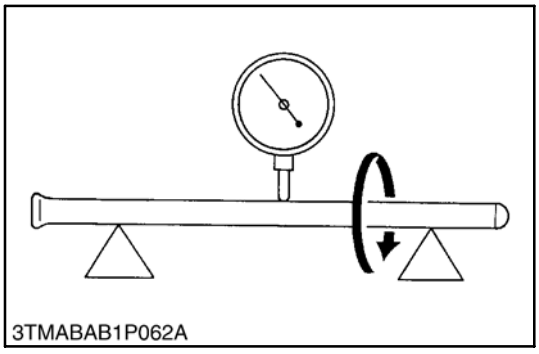
Setting Load / Setting Length	Factory Specification	117.6 N / 35 mm 12.0 kgf / 35 mm. 26.4 lbs. / 1.3780 in.
	Allowable Limit	100.0 N / 35 mm 10.2 kgf / 35 mm. 22.5 lbs. / 1.3780 in.


3EEABAB1P123A

2.3.1.k Oil Clearance Between Rocker Arm and Rocker Arm Shaft

1. Measure the rocker arm shaft O.D. with an outside micrometer.
2. Measure the rocker arm I.D. with a inside micrometer, then calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the rocker arm then measure the oil clearance again. If the clearance is still out of specification, replace the rocker arm shaft.

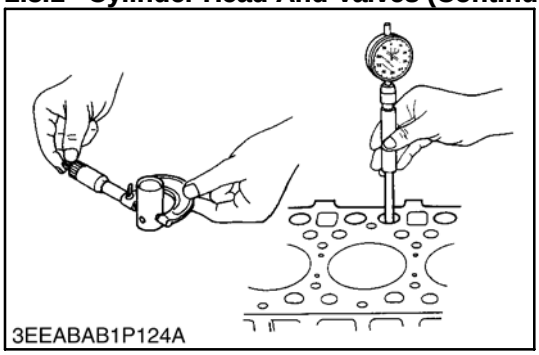
Oil Clearance Rocker Arm/ Shaft	Factory Specification	0.016 to 0.045 mm 0.00063 to 0.00177 in.
	Allowable Limit	0.10 mm 0.0039 in.
Rocker Arm Shaft O.D.	Factory Specification	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker Arm I.D.	Factory Specification	14.000 to 14.018 mm 0.55118 to 0.55189 in.


3TMABAB1P062A

2.3.1.l Push Rod Alignment

1. Place the push rod on V blocks
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push Rod Alignment	Allowable Limit	0.25 mm 0.0098 in.

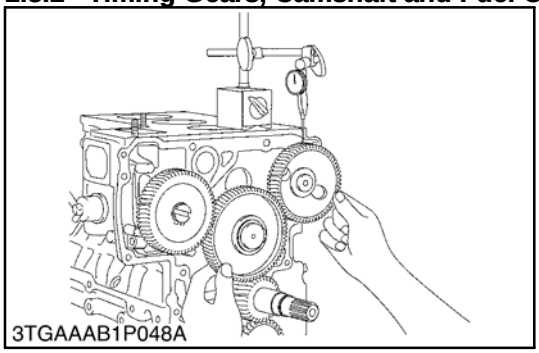


2.3.1.m Oil Clearance Between Tappet and Tappet Guide Bore

1. Measure the tappet O.D. with a micrometer.
2. Measure the I.D. of the tappet guide bore with a cylinder guage and calculate the clearance.
3. If the measurement exceeds the allowable limit, or the tappet is damaged, replace the tappet.

Oil Clearance Tappet/ Tappet Guide Bore	Factory Specification	0.020 to 0.062 mm 0.00079 to 0.00244 in.
	Allowable Limit	0.07 mm 0.0028 in.
Tappet O.D.	Factory Specification	23.959 to 23.980 mm 0.94327 to 0.94410 in.
Tappet Guide I.D.	Factory Specification	24.000 to 24.021 mm 0.94488 to 0.94571 in.

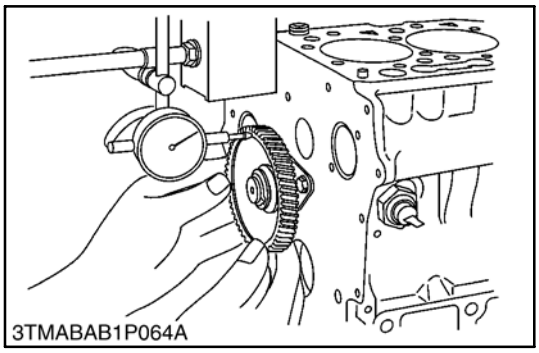
2.3.2 Timing Gears, Camshaft and Fuel Camshaft



2.3.2.a Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

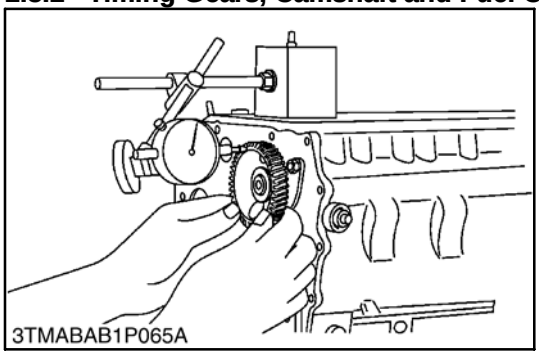
Backlash/ Idle Gear/ Crank Gear	Factory Specification	0.0415 to 0.1122 mm 0.00163 to 0.00442 in.
	Allowable Limit	0.15 mm 0.0059 in.
Backlash/ Idle Gear/ Cam Gear	Factory Specification	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable Limit	0.15 mm 0.0059 in.
Backlash/ Idle Gear/ Injection Pump Gear	Factory Specification	0.0415 to 0.1154 mm 0.00163 to 0.00454 in.
	Allowable Limit	0.15 mm 0.0059 in.
Backlash/ Crank Gear/ Oil Pump Gear	Factory Specification	0.0415 to 0.1090 mm 0.00163 to 0.00429 in.
	Allowable Limit	0.15 mm 0.0059 in.

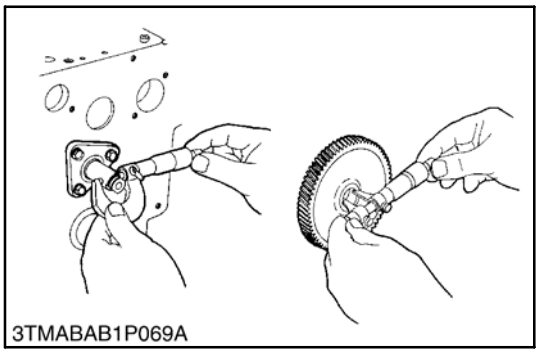


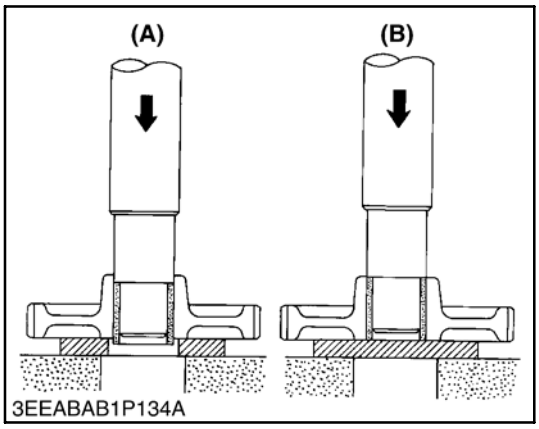
2.3.2.b Idle Gear Side Clearance

1. Set a dial indicator with its tip on the idle gear.
2. Move the gear front to rear to measure the side clearance.
3. If the measurement exceeds the allowable limit, replace the idle gear collar.

Idle Gear Side Clearance	Factory Specification	0.12 to 0.48 mm 0.0047 to 0.0189 in.
	Allowable Limit	0.9 mm 0.0354 in.







2.3.2.c Camshaft Side Clearance

1. Set a dial indicator with its tip on the camshaft.
2. Move the camshaft gear front to rear to measure the side clearance.
3. If the measurement exceeds the allowable limit, replace the camshaft stopper.

Camshaft Side Clearance	Factory Specification	0.07 to 0.22 mm 0.0028 to 0.0087 in.
	Allowable Limit	0.30 mm 0.0118 in.

2.3.2.d Idle Gear Shaft and Idle Gear Bushing Clearance

1. Measure the idle gear shaft O.D. with a micrometer.
2. Measure the idle gear bushing I.D. with an inside micrometer, and calculate the the clearance.
3. If the measurement exceeds the allowable limit, replace the bushing.

Idle Gear Shaft/-Bushing Clearance	Factory Specification	0.025 to 0.066 mm 0.00098 to 0.00260 in.
	Allowable Limit	0.1 mm 0.0039 in.
Idle Gear Shaft O.D.	Factory Specification	23.959 to 23.980 mm 0.94327 to 0.94410 in.
Idle Gear Shaft I.D.	Factory Specification	24.000 to 24.021 mm 0.94488 to 0.94571 in.

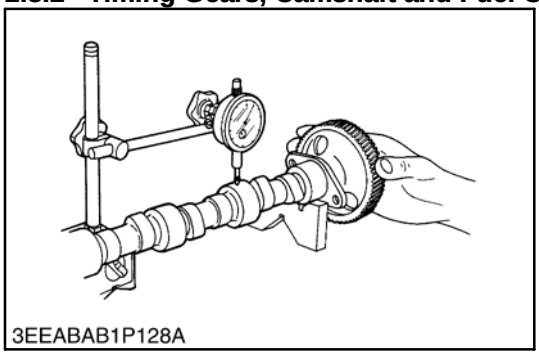
2.3.2.e Idle Gear Shaft and Idle Gear Bushing Clearance

(A) When Removing

1. Press out the bushing using an Idle Gear Bushing Replacing Tool.

(B) When Installing

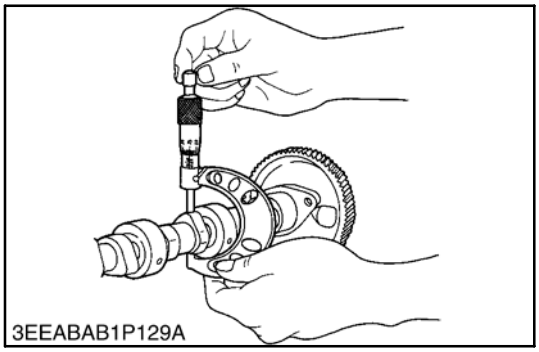
1. Clean a new idle gear bushing and the idle gear bore, and apply engine oil to both.
2. Using the idle gear replacing tool, press in the new bushing to the specified dimension (see **B**)


3EEABAB1P128A

2.3.2.f Camshaft Alignment

1. Support the camshaft with V blocks on a surface plate at both end journals.
2. Set a dial indicator with its tip on the intermediate journal.
3. Rotate the camshaft and measure for run-out.
4. If the measurement exceeds the allowable limit, replace the camshaft.

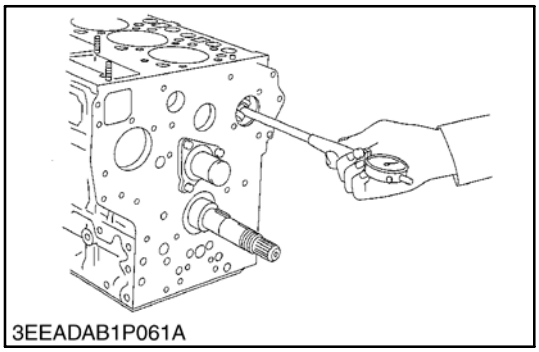
Camshaft Run-out	Allowable Limit	0.1 mm 0.0004 in.


3EEABAB1P129A

2.3.2.g Cam Height

1. Measure the cam lobe at its largest O.D. with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft.

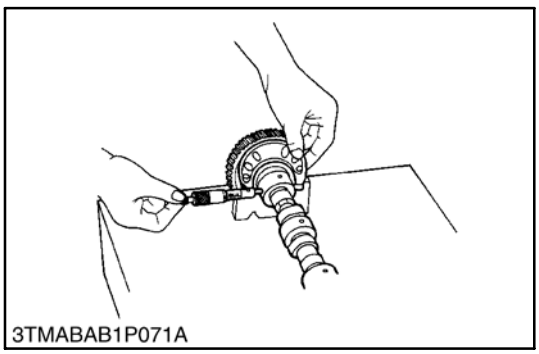
Cam Height Intake	Factory Specification	33.27 mm 1.3098 in.
	Allowable Limit	33.22 mm 1.3079 in.
Cam Height Exhaust	Factory Specification	33.47 mm 1.3177 in.
	Allowable Limit	33.42 mm 1.3158 in.


3EEADAB1P061A

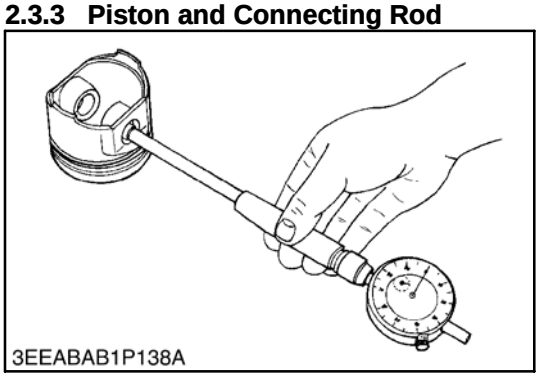
2.3.2.h Camshaft Oil Clearance

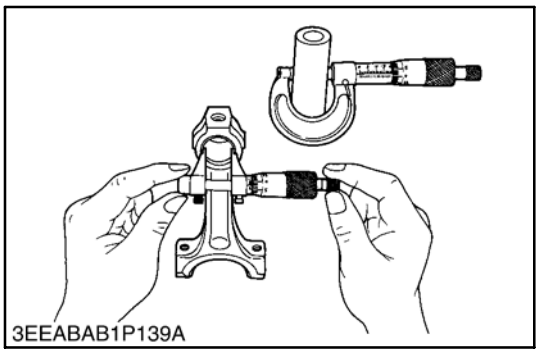
1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block camshaft bore I.D. with a cylinder guage, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the camshaft

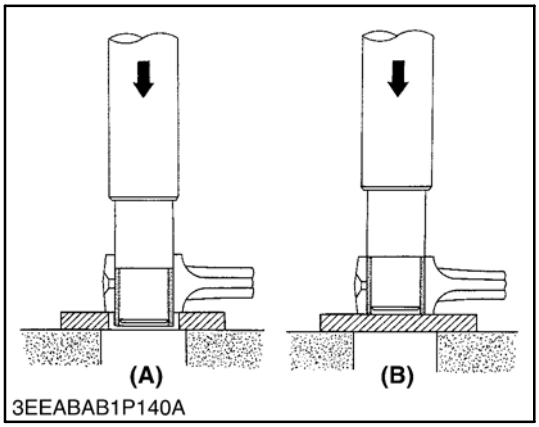
Camshaft Journal Clearance	Factory Specification	0.050 to 0.091 mm 0.0020 to 0.0036 in.
	Allowable Limit	0.15 mm 0.0059 in.
Camshaft Journal O.D.	Factory Specification	39.934 to 39.950 mm 1.57221 to 1.57284 in.
Camshaft Bore I.D.	Factory Specification	40.000 to 40.025 mm 1.57480 to 1.57579 in.


3TMABAB1P071A

2.3.3 Piston and Connecting Rod







2.3.3.a Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder guage.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston Pin Bore I.D.	Factory Specification	25.000 to 25.013 mm 0.98425 to 0.98476 in.
	Allowable Limit	25.05 mm 0.9862 in.

2.3.3.b Piston Pin and Bushing Clearance

1. Measure the piston pin O.D. with an outside micrometer.
2. Measure the connecting rod small end bushing I.D. with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the bushing. If the clearance is still excessive, replace the piston pin.

Piston Pin to Small End Bushing Clearance	Factory Specification	0.014 to 0.038 mm 0.00055 to 0.00150 in.
	Allowable Limit	0.15 mm 0.0059 in.
Piston Pin O.D.	Factory Specification	25.002 to 25.011 mm 0.98433 to 0.98468 in.
Small End Bushing I.D.	Factory Specification	25.025 to 25.040 mm 0.98523 to 0.98582 in.

2.3.3.c Replacing Connecting Rod Small End Bushing

(A) When Removing

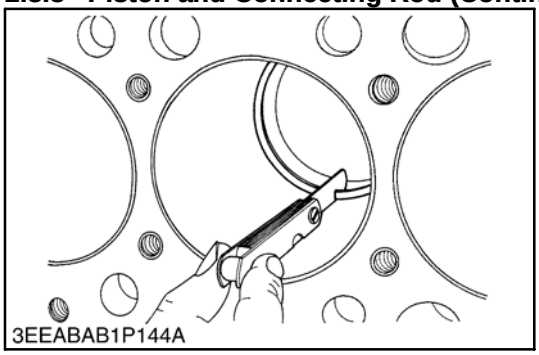
1. Press out the small end bushing using a Small End Bushing Replacing Tool.

(B) When Installing

1. Clean a new small end bushing and bore, and apply engine oil to both.
2. Using the small end bushing replacing tool, press in the new bushing to the specified dimension (see **B**).

NOTE

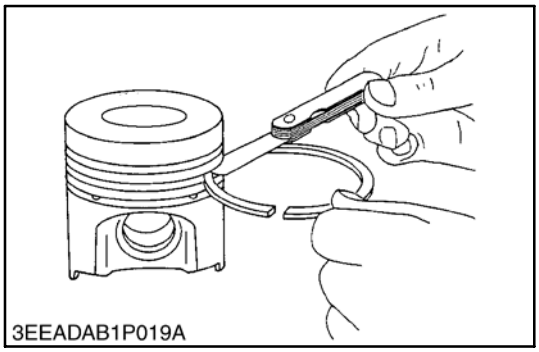
Be sure to align the bushing so that the oil hole in the bushing aligns with the oil port in the connecting rod.


3EEABAB1P144A

2.3.3.d Piston Ring Gap

1. Insert the piston ring into the lower part of the cylinder (the least worn section). Use the piston to square the ring in the cylinder.
2. Measure the ring gap with a feeler guage.
3. If the gap exceeds the allowable limit, replace the ring.

Top Ring (Keystone Type)	Factory Specification	0.20 to 0.35 mm 0.0079 to 0.0138 in.
	Allowable Limit	1.25 mm / 0.0492 in.
Second Ring	Factory Specification	0.40 to 0.55 mm 0.016 to 0.022 in.
	Allowable Limit	1.25 mm / 0.0492 in.
Oil Control Ring	Factory Specification	0.20 to 0.35 mm 0.0079 to 0.0157 in.
	Allowable Limit	1.25 mm / 0.0492 in.


3EEADAB1P019A

2.3.3.e Piston Ring to Groove Clearance

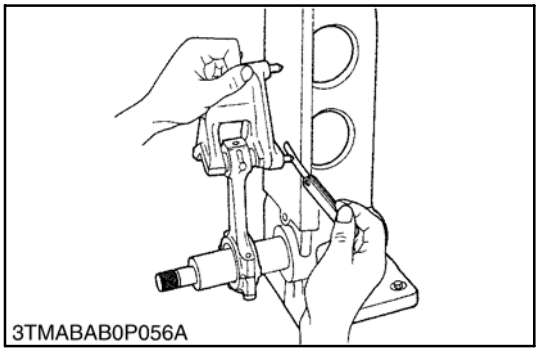
1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and its groove with a feeler guage (with the exception of the top ring, Keystone Type, which cannot be accurately measured with a feeler guage).
3. If the clearance exceeds the allowable limit, replace the ring.
4. If the clearance still exceeds the allowable limit after replacing the ring, replace the piston.

Second Ring	Factory Specification	0.93 to 1.28 mm 0.0037 to 0.0050 in.
	Allowable Limit	0.2 mm / 0.0079 in.
Oil Control Ring	Factory Specification	0.020 to 0.052 mm 0.0008 to 0.0021 in.
	Allowable Limit	0.15 mm / 0.0059 in.

2.3.3.f Connecting Rod Alignment

NOTE

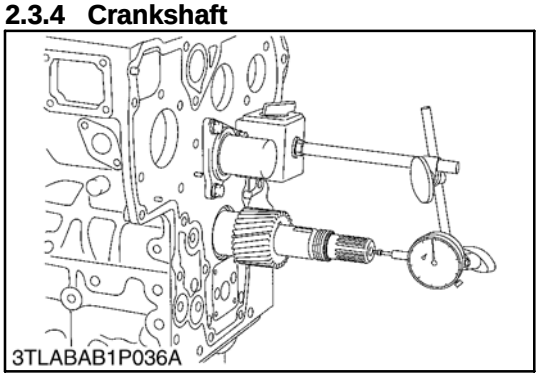
Since the I.D. of the connecting rod small end bushing is the basis of this procedure, check the bushing for wear before proceeding.

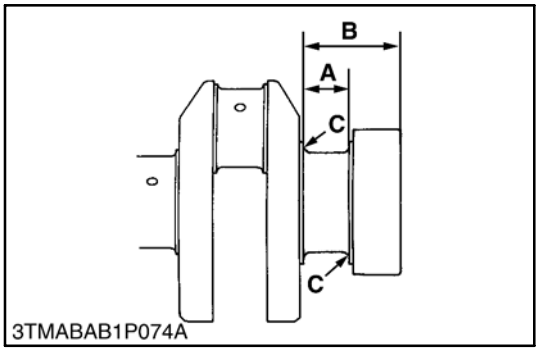

3TMABAB0P056A

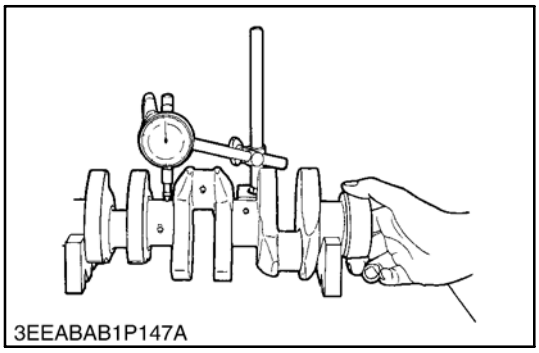
1. Install the piston pin into the connecting rod.
2. Install the connecting rod on the connecting rod alignment tool.
3. Put a guage over the piston pin and move it against the face plate.
4. If the guage does not fit squarely against the face plate, measure the space between the pin of the guage and the face plate.
5. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting Rod Alignment	Allowable Limit	0.05 mm / 0.0020 in.

2.3.4 Crankshaft







2.3.4.a Crankshaft End Clearance

1. Push on the end of the crankshaft to seat it toward the flywheel end of the engine block.
2. Attach, then zero a dial indicator on the forward end of the crankshaft.
3. Measure the end play by pulling the crankshaft forward.
4. If the measurement exceeds the allowable limit replace the thrustwashers.

Crankshaft Side Clearance	Factory Specification	0.15 to 0.31 mm 0.0059 to 0.0122 in.
	Allowable Limit	0.5 mm 0.0197 in.

(Reference)

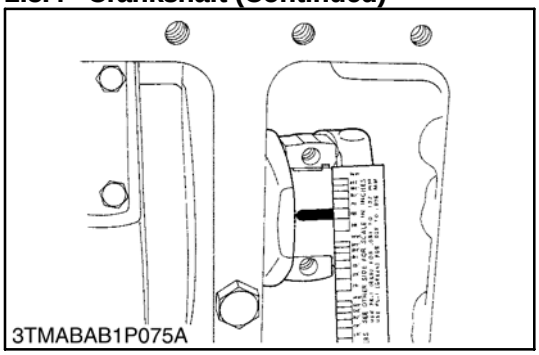
Oversize dimensions of crankshaft journal.

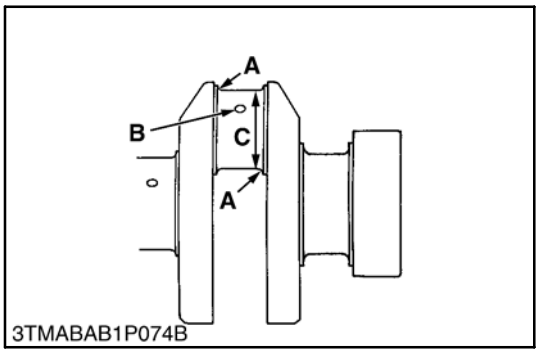
Oversize	0.2mm / 0.0008 in.	0.4mm / 0.0016 in.
Dimension **A**	26.20 to 26.25 mm 1.0315 to 1.0335 in.	26.40 to 26.45 mm 1.0394 to 1.0413 in.
Dimension **B**	54.5 to 54.7 mm 2.1456 to 2.1535 in.	54.6 to 54.8 mm 2.1496 to 2.1574 in.
Dimension **C**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
The crankshaft journal must be fine-finished to higher than 0.8-S.		

2.3.4.b Crankshaft Alignment

1. Support the crankshaft with V blocks on a surface plate at both end journals. Set a dial indicator with its tip on the intermediate journal, perpendicular to the journal.
2. Rotate the crankshaft on the V blocks and get the misalignment (half of the measurement).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft Alignment	Allowable Limit	0.02 mm 0.0008 in.





2.3.4.c Crankpin to Connecting Rod Bearing Clearance

1. Clean the crankpin and the connecting rod bearing.
2. Put a strip of plastigage on the center of the crankpin in each direction as shown in the figure.
3. Install the connecting rod cap and tighten the bolts to the specification. (Refer to 2.2.6.a)
4. Remove the cap again
5. Measure the amount of the flattening with the scale to get the clearance.
6. If the measurement exceeds the allowable limit replace the connecting rod bearing.
7. If the allowable limit is not attainable with a standard size bearing, install an undersize bearing by referring to the table below.

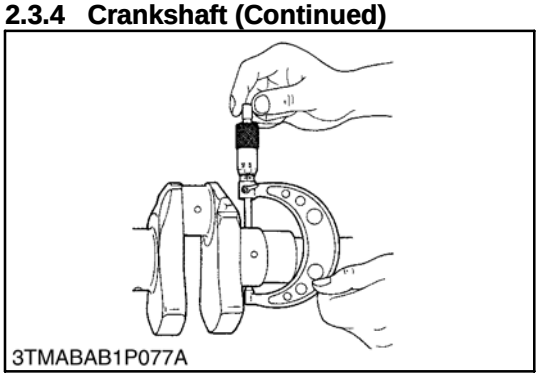
Crankpin/ Connecting Rod Clearance	Factory Specification	0.25 to 0.87 mm 0.00098 to 0.00343 in.
	Allowable Limit	0.2 mm 0.0079 in.

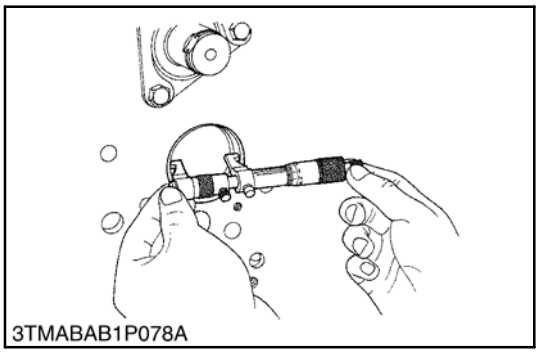
Crankpin O.D.	Factory Specification	46.959 to 46.975 mm 1.84878 to 1.84941 in.
Connecting Rod Bearing I.D.	Factory Specification	47.000 to 47.046 mm 1.85039 to 1.85220 in.

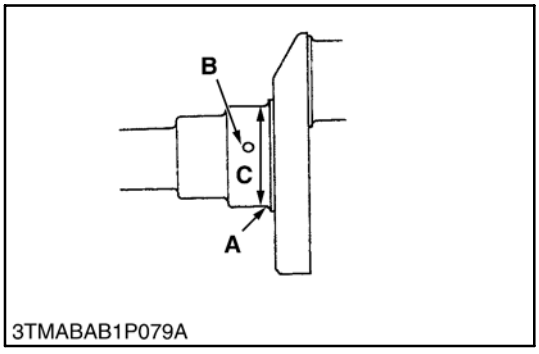
(Reference)

Undersize dimensions of crankpin journal.

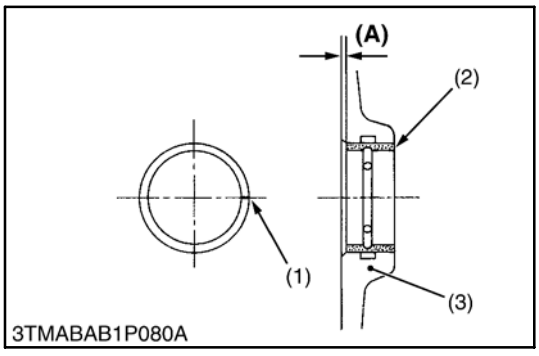
Oversize	0.2mm / 0.0008 in.	0.4mm / 0.0016 in.
Dimension **A**	3.3 to 3.7 mm 0.1299 to 0.1457 in.	3.3 to 3.7 mm 0.1299 to 0.1457 in.
Dimension **B**	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
Dimension **C**	46.759 to 46.775 mm 1.84091 to 1.84154 in. radius	46.559 to 46.575 mm 1.83303 to 1.83366 in. radius
The crankshaft journal must be fine-finished to higher than 0.8-S.		


3TMABAB1P077A


3TMABAB1P078A



3TMABAB1P079A



3TMABAB1P080A

1. Seam
2. Crankshaft Bearing#1
3. Cylinder Block

2.3.4.d Crankshaft Journal to Crankshaft Bearing #1 Clearance

1. Measure the O.D. of the crankshaft journal with an outside micrometer.
2. Measure the I.D. of crankshaft bearing #1 with an inside micrometer and calculate clearance.
3. If the clearance exceeds the allowable limit, replace crankshaft bearing #1.
4. If the allowable limit is not attainable with a standard size bearing, install an undersize bearing by referring to the table below.

Crankshaft Journal to #1 Bearing Clearance	Factory Specification	0.040 to 0.118 mm 0.00157 to 0.00409 in.
	Allowable Limit	0.2 mm 0.0079 in.
Crankshaft Journal O.D.	Factory Specification	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft Bearing Bearing I.D.	Factory Specification	59.980 to 60.039 mm 2.36142 to 2.36374 in.

(Reference) Undersize dimensions of crankshaft journal.

Oversize	0.2mm / 0.0008 in.	0.4mm / 0.0016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
Dimension **B**	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
Dimension **C**	59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
The crankshaft journal must be fine-finished to higher than 0.8-S.		

2.3.4.e Replacing Crankshaft Bearing #1

(A) When Removing

1. Press out the crankshaft bearing #1 (2) using a crankshaft bearing (1) replacing tool.

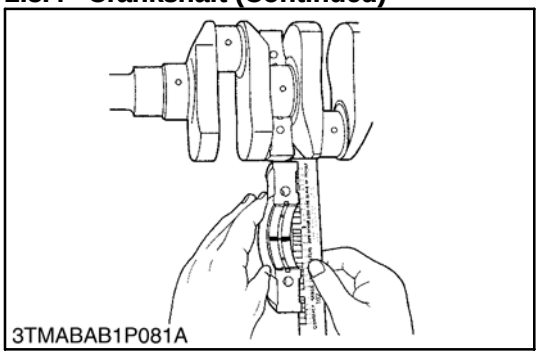
(B) When Installing

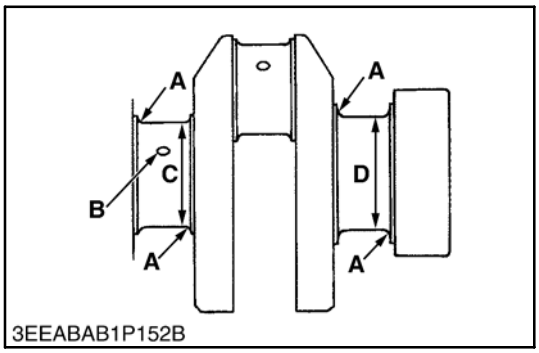
1. Clean a new crankshaft bearing #1 (2) and crankshaft journal bore, and apply engine oil to both.
2. Using the crankshaft bearing (1) replacing tool, press in the new bearing #1 (2) so that its seam (1) directs toward the exhaust manifold side.

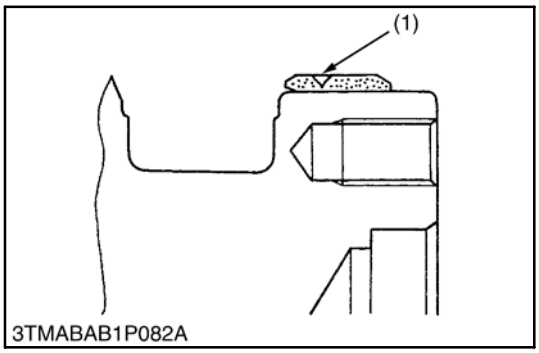
NOTE

Be sure to align the bushing so that the oil hole in the bushing aligns with the oil port in the connecting rod.

Dimension **A**	Factory Specification	4.2 to 4.5 mm 0.1654 to 0.1772 in.







2.3.4.f Crankshaft Journal to Crankshaft Bearing #2 Clearance

1. Put a strip of plastigage on the center of the crankshaft journal.
2. Install the bearing case and tighten the bolts to specification.
3. Remove the bearing case again.
4. Measure the amount of the flattening with the scale to get the clearance.
5. If the measurement exceeds the allowable limit replace crankshaft bearing #2.
6. If the allowable limit is not attainable with a standard size bearing, install an undersize bearing by referring to the table below.

NOTE

Be sure not to move the crankshaft while the bearing bolts are tightened.

Crankshaft Journal to #2 Bearing Clearance	Factory Specification	0.040 to 0.104 mm 0.00157 to 0.00409 in.
	Allowable Limit	0.2 mm 0.0079 in.
Crankshaft Journal O.D.	Factory Specification	59.921 to 59.940 mm 2.35909 to 2.35984 in.
Crankshaft Bearing Bearing I.D.	Factory Specification	59.980 to 60.025 mm 2.36142 to 2.36318 in.

(Reference)

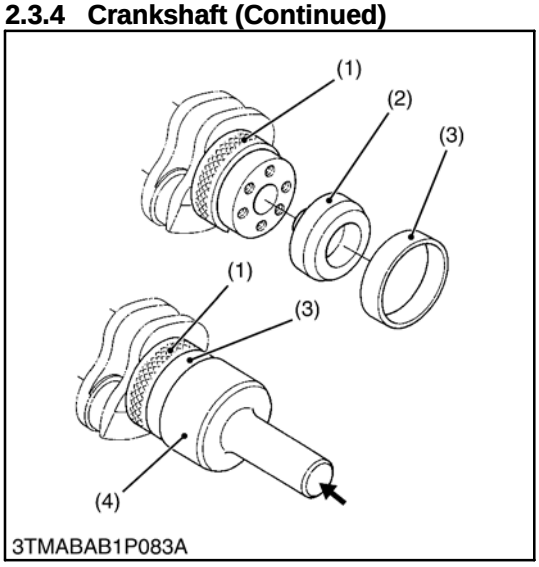
Undersize dimensions of crankshaft journal.

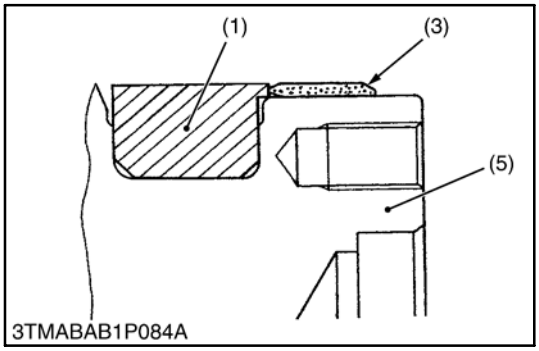
Oversize	0.2mm / 0.008 in.	0.4mm / 0.016 in.
Dimension **A**	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius	2.8 to 3.2 mm radius 0.1102 to 0.1260 in. radius
Dimension **B**	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius	1.0 to 1.5 mm radius 0.0394 to 0.0591 in. radius
Dimension **C**	59.721 to 59.740 mm 2.35122 to 2.35197 in.	59.521 to 59.540 mm 2.34335 to 2.34409 in.
The crankshaft journal must be fine-finished to higher than 0.8-S.		

2.3.4.g Crankshaft Sleeve Wear

1. Check the wear on the crankshaft sleeve (1).
2. If the wear exceeds the allowable limit or if the engine oil leaks, replace the crankshaft sleeve (1).

Sleeve Wear	Allowable Limit	0.1 mm 0.004 in.





1. Stopper
2. Sleeve Guide
3. Crankshaft Sleeve
4. Auxiliary Socket For Pushing
5. Crankshaft

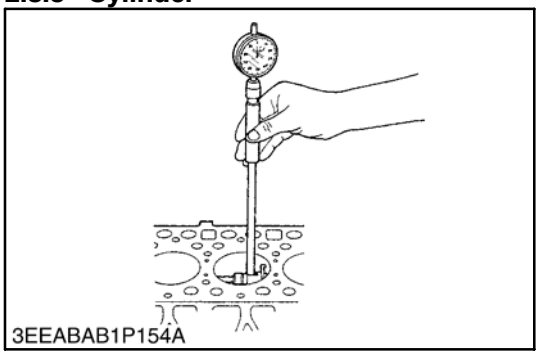
2.3.4.h Replacing Crankshaft Sleeve

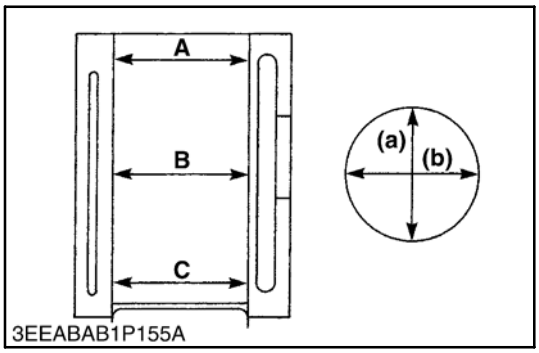
1. Remove the crankshaft sleeve (3) using a special-- use puller set.
2. Set the sleeve guide (2) to the crankshaft (5).
3. Set the stopper (1) to the crankshaft (5) as shown in the figure.
4. Heat the new sleeve to a temperature between 150 to 200°C (302 to 392°F), and fix the sleeve on the crankshaft (5) as shown in the figure.
5. Press fit the sleeve using the auxiliary socket for pushing (4).

NOTE

Install the sleeve with the largest chamfered surface facing outward.

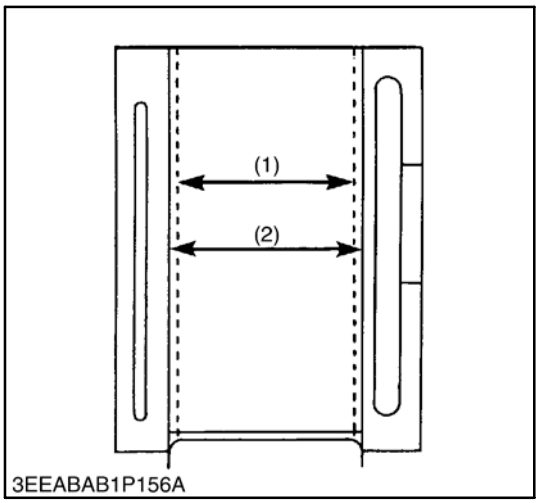
2.3.5 Cylinder





a. Top
b. Middle
c. Bottom (skirt)

a. Right-angled to Piston Pin
b. Piston Pin Direction



1. Cylinder I.D. (before correction)
2. Oversize Cylinder I.D.

2.3.5.a Cylinder Wear

1. Measure the I.D. of the cylinder at the six positions (see figure with a cylinder guage to find the maximum and minimum I.D.'s.

2. Determine the difference (maximum wear) between the maximum and minimum I.D.'s.

3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (refer to **Correcting Cylinder**)

4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder walls should be bored. (refer to **Correcting Cylinder**)

Cylinder I.D.	Factory Specification	87.000 to 87.022 mm 3.42519 to 3.42606 in.
Maximum Wear	Allowable Limit	0.15 mm 0.0059 in.

2.3.5.b Correcting Cylinder (Oversize +0.25 mm)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

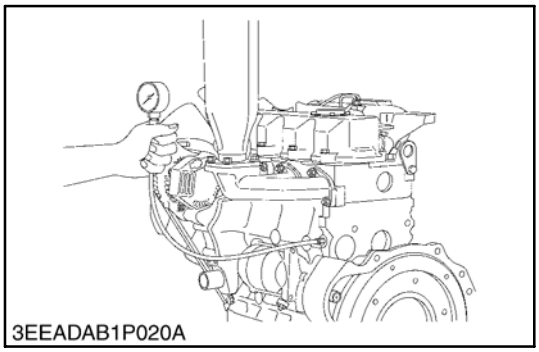
Cylinder I.D.	Factory Specification	87.250 to 87.272 mm 3.43503 to 3.43590 in.
Maximum Wear	Allowable Limit	0.15 mm 0.0059 in.
Finishing	Hone to 2.2 to 3.0 mm μR max. (0.00087 to 0.00118 in. μR max.)	

2. Replace the piston and piston rings with oversize (+0.25 mm) ones.

SECTION 3

LUBRICATING SYSTEM

3.1 CHECKING AND ADJUSTING



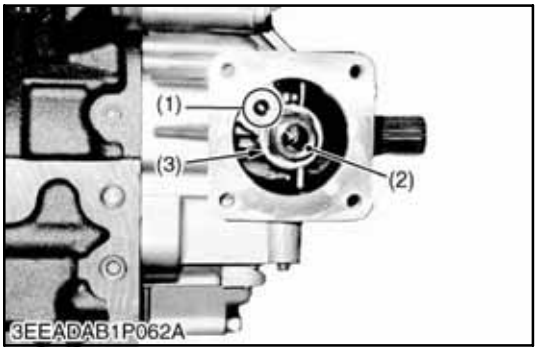
3.1.1 Engine Oil Pressure

1. Remove the engine oil pressure switch, and install an oil pressure gauge.
2. Start the engine. After warming up, read the oil pressure at idling and at rated speeds.
3. If the oil pressure is less than the allowable limit, check the following:
   - Engine oil sufficient
   - Oil pump defective
   - Oil strainer clogged
   - Oil filter cartridge clogged
   - Oil gallery clogged
   - Excessive oil clearance
   - Relief valve stuck

At Idle Speed	Allowable Limit	103 kPa 1.0 kgf/cm^2 15 psi
At Rated Speed	Factory Specification	294.2 to 441 kPa 3.0 to 4.5 kgf/cm^2 42.7 to 64 psi
	Allowable Limit	245 kPa 2.5 kgf/cm^2 36 psi

(When Reassembling)

After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

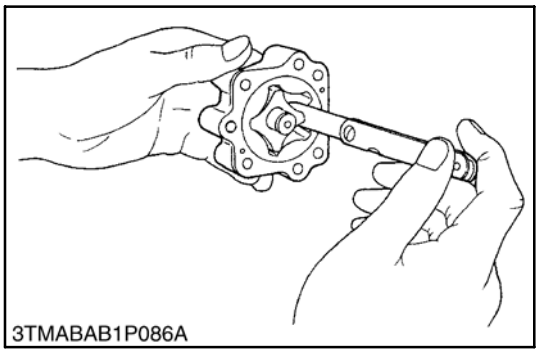


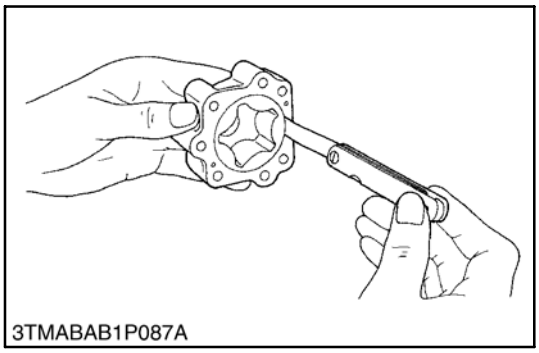
3.1.2 Relief Valve

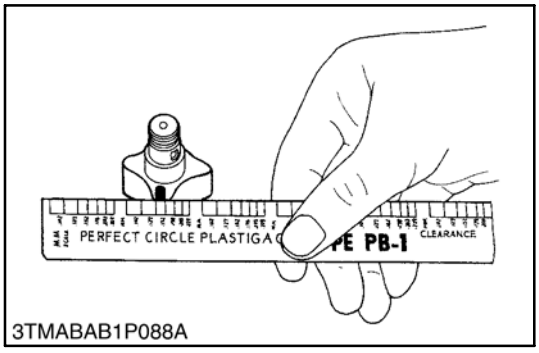
1. Remove the oil filter cartridge and the oil filter base.
2. Check the relief valve for dirt, and the seat and ball for damage.
3. If damaged, replace.
4. Check the free length of the spring.
5. If it is less than the allowable limit, replace.

Spring Free Length	Factory Specification	35 mm 1.38 in.
	Allowable Limit	30 mm 1.18 in.
Tightening Torque	Joint	39.2 to 49.0 N·m 4.0 to 5.0 kgf·m 29.0 to 36.3 ft-lbs.

3.2 SERVICING


3TMABAB1P086A


3TMABAB1P087A



3TMABAB1P088A

3.2.1 Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
3. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Inner/Outer Rotor Clearance	Factory Specification	0.03 to 0.14 mm 0.0012 to 0.0055 in.
Outer Rotor/ Pump Body Clearance	Factory Specification	0.11 to 0.19 mm 0.0043 to 0.0075 in.

3.2.2 Rotor to Cover Clearance

1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the bolts.
3. Remove the cover carefully, and read the plastigage.
4. If the clearance exceeds the factory specifications, replace the oil pump rotor assembly.

Rotor/Cover Clearance	Factory Specification	0.105 to 0.150 mm 0.00413 to 0.00591 in.

SECTION 4

COOLING SYSTEM

4.1 CHECKING AND ADJUSTING

⚠ WARNING

Beware of moving V-belt and belt driven components

4.1.1 Notched V-Belt Service

NOTE

A frayed, cracked or worn V-belt must be replaced. After installing a new belt, it is advisable to check the adjustment after running the unit for three or four hours. This will allow for the initial stretch, which is common on new belts. Once this initial stretch has taken place, the belt should be checked at regular intervals.

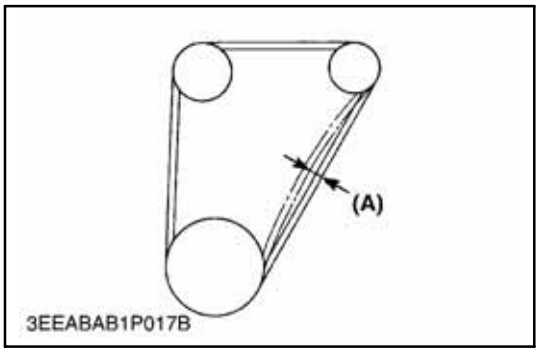
To replace or adjust the notched V-belt, do the following:

a. Replacing the V-Belt

1. Loosen the idler pivot bolt.
2. Replace the belt and adjust tension in accordance with the following steps.

b. Adjusting Tension

1. Measure the deflection **(A)**, by depressing the belt halfway between the fan drive pulley and alternator pulley at the specified force (Refer to1.7.3).



2. Use hand force only on the idler pulley to tighten belt. *Do not use a pry bar or excessive force as it may cause damage to the engine.*

Use of a belt tension gauge (Carrier Part # 07-00203-00) or a belt tension tester (Carrier Part # 07-00253-00) is advised.

3. When belt is at correct tension, tighten pivot bolt.

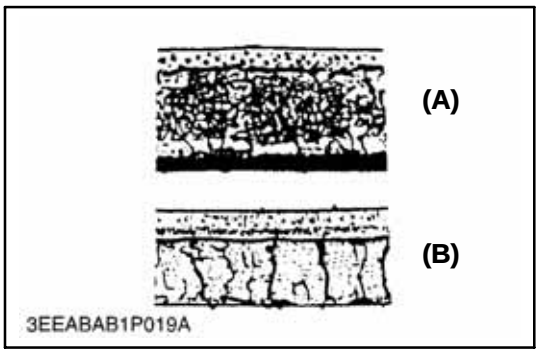
4.1.1a Poly V-Belt Service

a. Replacing the Poly-V-Belt

1. Apply the proper size socket to the crank pulley nut, then slowly rotate the crank. At the same time, use a flat, blunt object to guide the belt off the crank pulley towards radiator. Be careful not to damage grooves on the pulley.
2. Replace the Poly-V-Belt by positioning the belt on the water pump pulley, and while rotating the engine (as in step 1), use a flat, blunt object to guide the belt onto the crank pulley. Be careful not to damage grooves on the pulley or belt.

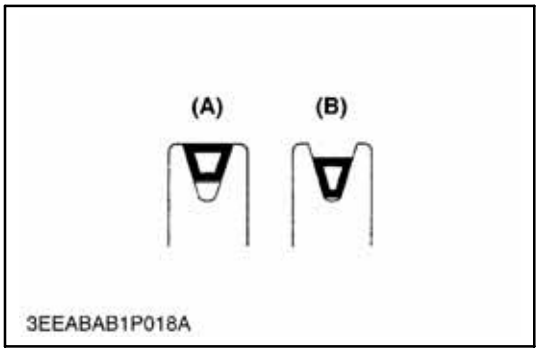
4.1.2 Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the belt is damage in any way, replace it.



A. Good **B.** Bad

3. Check if the belt is worn and sunk in the pulley groove.
4. If the fan belt is worn and deeply sunk in the pulley groove, replace it.



A. Good **B.** Bad

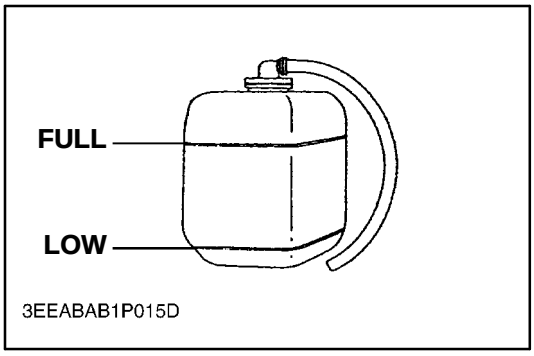
4.1.3 Checking Coolant Level

⚠ WARNING

When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may discharge from the radiator, scalding anyone nearby.

1. Remove the radiator cap and check to see that the coolant level is just below the port.

   With the recovery tank: Check to see that the coolant level lies between **FULL** and **LOW**.



2. If the coolant level is too low, check the reason for the lost coolant.

a. If coolant loss is due to evaporation, add only clean soft water.

b. If coolant loss is due to a leak, repair the leak, then add a coolant mixture of the same type and specification that is in the system. If the coolant brand cannot be identified, drain out all of the remaining coolant and refill with a totally new mix.

NOTE

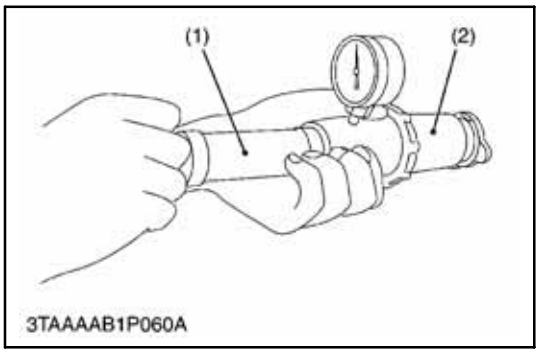
When adding coolant to the system, air must be vented from the engine coolant passages by jiggling the upper and lower radiator hoses.

Be sure to close the radiator cap securely. If the cap is loose or improperly closed, coolant may leak out and the engine could overheat.

Do not use an antifreeze and scale inhibitor at the same time.

Never mix different types or brands of coolants.

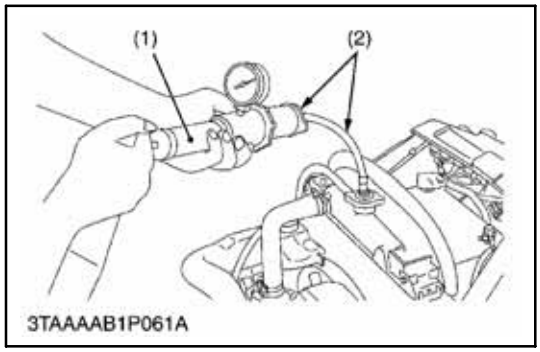
4.1.4 Radiator Cap



1. Attach the radiator cap to a pressure tester.
2. Apply pressure and observe the time for the pressure to fall.
3. If the measurement is less than the factory specification, replace the cap.

Pressure Falling Time	Factory Specification	More than 10 seconds for pressure fall from 88 to to 59kPa 0.9 to 0.6 kgf/cm^2 13 to 9 psi

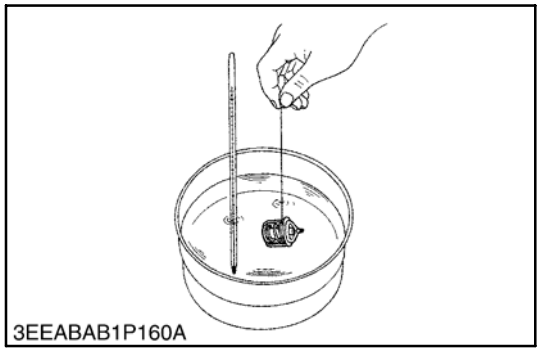
4.1.5 Radiator



1. Fill the radiator with water.
2. Attach the pressure tester to the radiator.
3. Apply pressure and look for leaks.
4. Repair/replace as necessary to assure that the specified pressure will hold.

Radiator Leakage Test	Factory Specification	157 kPa 1.6 kgf/cm^2 23 psi

4.1.6 Thermostat Opening Temperature

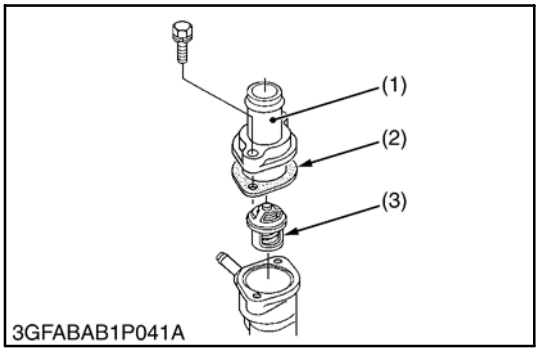


1. Suspend the thermostat in water by a string with one end of the string inserted between the valve and its seat.
2. Immerse the thermostat in water and raise the temperature of the water gradually.
3. With a thermometer, read the temperature of the water when the valve opens and leaves the string.
4. Continue heating the water, read the temperature of the water when the valve has opened approximately 6mm (0.236 in).
5. If the measurement is not within the factory specifications, replace the thermostat.

Thermostat Opening Temperature	Factory Specification	69.5 to 72.5°C 157.1 to 162.5°F
Thermostat Full Open Temperature	Factory Specification	85°C 185°F

4.2 SERVICING

4.2.1 Thermostat Assembly



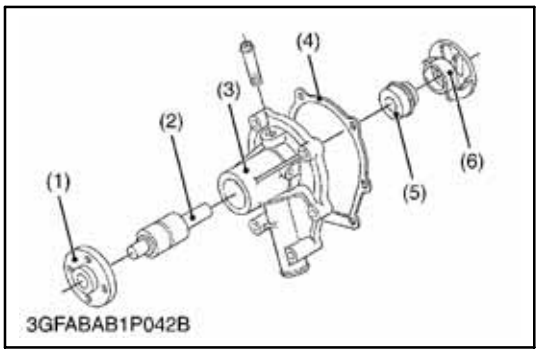
1. Thermostat Cover
2. Thermostat Cover Gasket
3. Thermostat Assembly

1. Remove the thermostat cover mounting bolts, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

(When Reassembling)

Apply a liquid gasket only at the thermostat cover side of the thermostat cover gasket (2).

4.2.2 Water Pump Assembly



1. Water Pump Flange
2. Water Pump Shaft
3 Water Pump Body
4. Water Pump Gasket
5. Mechanical Seal
6. Impeller

1. Remove the fan belt.
2. Remove the water pump pulley.
3. Remove the water pump from the gear case assembly.
4. Remove the water pump flange (1).
5. Press out the water pump shaft (2) with the impeller (6) on it..
6. Remove the impeller from the water pump shaft.
7. Remove the mechanical seal.

(When Reassembling)

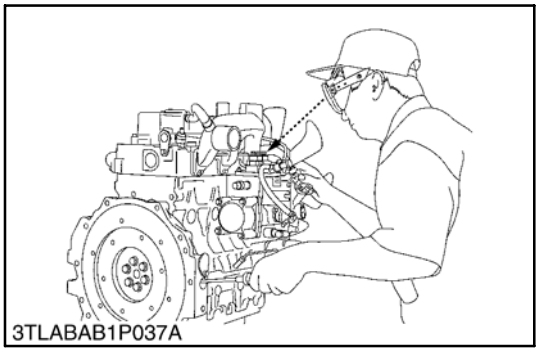
Replace the mechanical seal with a new one.

Apply a liquid gasket to both sides of the gasket (4).

SECTION 5

FUEL SYSTEM

5.1 CHECKING AND ADJUSTING



5.1.1 Injection Timing

1. Remove the injection pipes from the injection pump.
2. Move the speed control lever to the maximum speed position.
3. Turn the flywheel counterclockwise (facing the flywheel) until the fuel fills up the hole of the delivery valve holder for #1 cylinder.
4. Turn the flywheel further and stop turning when the fuel begins to flow over.
5. Open the view port on the flywheel bell housing and read the number on the flywheel. The number indicated is the timing value for the engine. (The flywheel has a mark '1TC' and marks every 5° of engine timing to 25° total).

Timing 26-00118-00	Factory Specification	0.06 to 0.08 rad. 3.25° to 4.75° B.T.D.C.
Timing 26-00119-00	Factory Specification	0.09 to 0.12 rad. 5.25° to 6.75° B.T.D.C.
Timing 26-00119-03	Factory Specification	0.06 to 0.05 rad. 3.75° to 5.25° B.T.D.C.
Timing 26-00119-02	Factory Specification	0.10 to 0.13 rad. 5.75° to 7.25° B.T.D.C.
Timing 26-00120-00	Factory Specification	0.16 to 0.19 rad. 9.00° to 11.00° B.T.D.C.
Timing 26-00120-01	Factory Specification	0.09 to 0.12 rad. 5.25° to 6.75° B.T.D.C.

NOTE

Injection timing adjustment is accomplished by adding or removing shims under the injection pump.

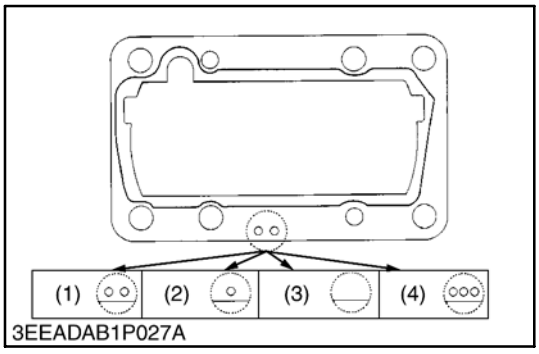
The timing advances by removing one shim and retards timing by adding the same shim.

The addition or removal of 0.05 mm (0.0020 in.) of shim, changes the injection timing by approximately 0.0087 rad. (0.5°).

The sealant should be applied to both sides of the soft metal gasket shim.

5.1.2 Shim Identification

Shims are available in thicknesses of 0.20 mm, 0.25 mm, 0.30 mm, and 0.35mm. Combine shims for adjustments.



1. 2-Holes: 0.20 mm shim
2. 1-Hole: 0.25 mm shim
3. 0-Holes: 0.30 mm shim
4. 3-Holes: 0.35 mm shim

5.1.3 Delivery Valves Fuel Seal

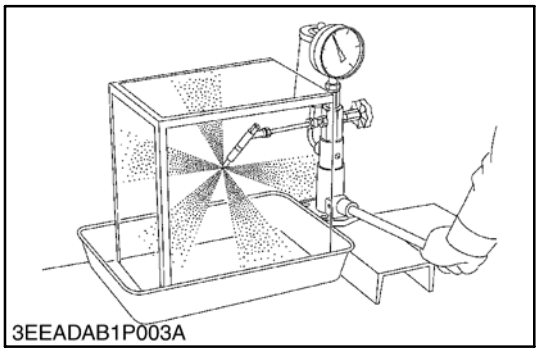
1. Remove the injection pipes, glow plugs, and the intake manifold, and install a compression guage.
2. With the speed control lever set at the full throttle position, turn the crankshaft counterclockwise until the fuel pressure is built up.
3. Release the pressure in the delivery chamber by rotating the crankshaft to bottom dead center. (turn the crankshaft 1.57 rad. (90°) clockwise from fuel timing set point)
4. If the pressure drop for 5 seconds exceeds the allowable limit, replace the delivery valve or pump assembly.
5. If the pressure does not build up, replace the pump element with a new one and test again.

Delivery Valve Fuel Tightness	Factory Specification	less than 981 kPa(10 kgf/cm2, 142 psi pressure drop from injection pressure for 10 seconds
	Allowable Limit	981 kPa(10 kgf/cm2, 142 psi pressure drop from injection pressure for 5 seconds

5.2 INJECTION NOZZLE

⚠ WARNING

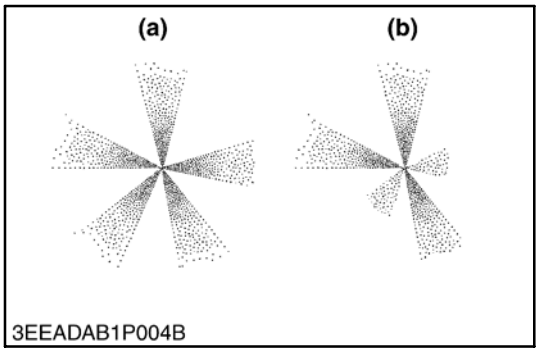
Check the injection nozzle only after confirming that nobody is near the spray. If the spray from the nozzle contacts the human body, cells may be destroyed and blood poisoning may result.



5.2.1 Nozzle Injection Pressure

1. Set the injection nozzle in a nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within factory specifications, replace the nozzle assembly.

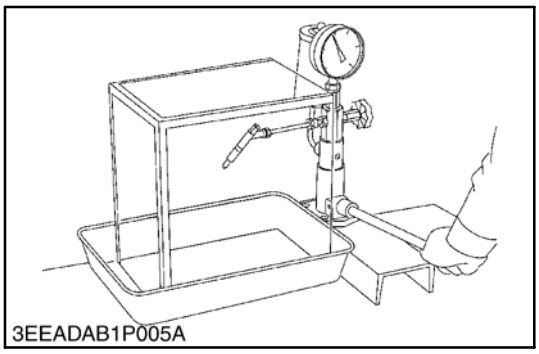
Fuel Injection Pressure 1st Stage	Factory Specification	18.6 to 20.1 MPa 190 to 205 kgt/cm^2 2702 to 2916 psi



(a) GOOD **(b) BAD**

5.2.2 Nozzle Spraying Condition

1. Set the injection nozzle in a nozzle tester and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the injection nozzle assembly.



5.2.3 Valve Seat Tightness

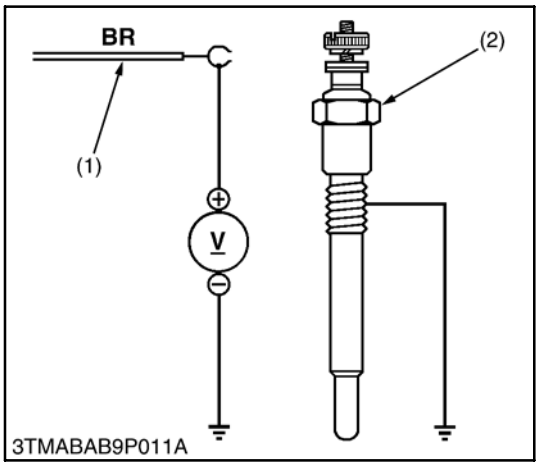
1. Set the injection nozzle in a nozzle tester.
2. Raise the fuel pressure, and maintain 12.7MPa (130 kgf/cm^2, 1850 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly.

Valve Seat Tightness	Factory Specification	No fuel leak at 16.67MPa 170 kgf/cm^2 2418 psi

SECTION 6

ELECTRICAL SYSTEM

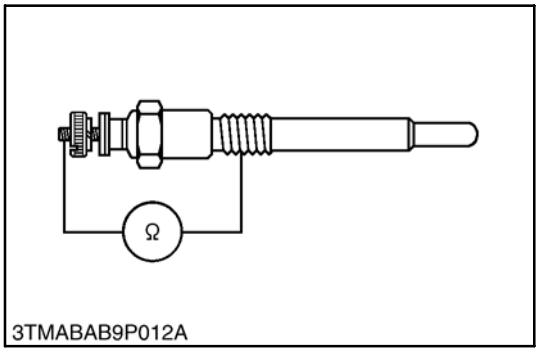
6.1 GLOW PLUG



1. Wiring Lead (Positive) 2 Glow Plug

6.1.1 Lead Terminal Voltage

1. Disconnect the glow plug wiring lead (1) from the glow plug (2).
2. Connect a voltmeter between the glow plug wiring lead (1) and a suitable ground on the engine.
3. Energize the glow plug lead and read the voltage.
4. Energize the glowplug lead, engage the starter at the same time and read the voltage.
5. If the voltage differs from the battery voltage in either case, the wiring harness or the switch(es) are faulty.

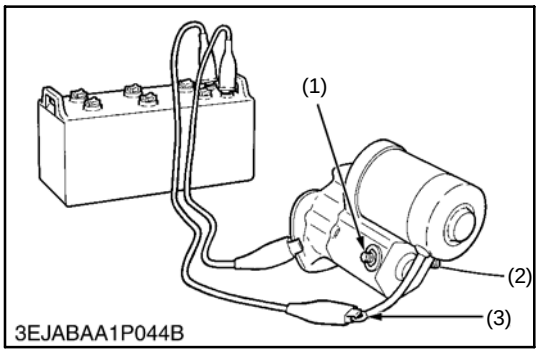


6.1.2 Glow Plug Continuity

1. Disconnect the glow plug wiring lead (1) from the glow plug (2).
2. Measure the resistance between the glow plug terminal and the engine body with an ohmmeter.
3. If 0 ohm is indicated, the glow plug may be short–circuited.
4. If the factory specification is not met the plug is also faulty.

Glow Plug Resistance	Factory Specification	Approximately 1.0 ohm

6.2 STARTER TEST



1. **C** Terminal
2. **B** Terminal
3. Connecting Lead

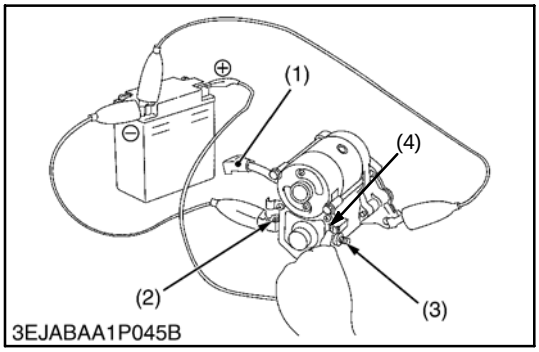
6.2.1 Motor Test

WARNING

Secure the starter to prevent it from moving when power is applied to it.

1. Disconnect the cable from the negative terminal on the battery
2. Disconnect the the positive cable and leads from the starter **B** terminal.
3. Remove the starter from the engine.
4. Disconnect the the connecting lead (3) from the starter solenoid **C** terminal (1).
5. Connect a jumper lead from the connecting lead (3) to the positive post on the battery.
6. Connect a jumper lead momentarily between the starter motor housing and the negative post on the battery.
7. If the starter does not run, check the motor.

Tightening Torque	**B** Terminal Nut	8.8 to 11.8 N·m 0.9 to 1.2 kgf·m 6.5 to 8.7 ft-lbs.



1. Connecting Lead
2. **C** Terminal
3. **S** terminal
4. **B** terminal

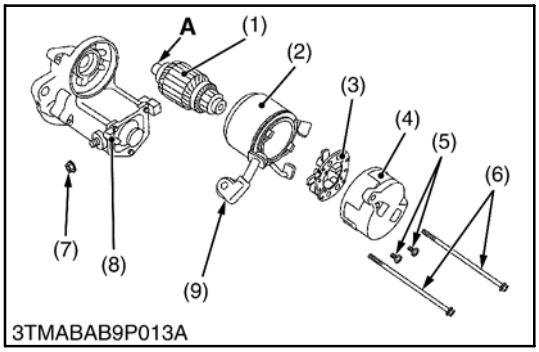
6.2.2 Magnetic Switch Test

1. Disconnect the cable from the negative terminal on the battery
2. Disconnect the the positive cable and leads from the starter **B** terminal.
3. Remove the starter from the engine.
4. Disconnect the connecting lead (1) from the starter solenoid **C** terminal (2).
5. Connect a jumper lead from the starter **S** terminal (3) to the positive battery post.
6. Momentarily, connect a jumper lead between the starter **C** terminal (2) and negative battery terminal.
7. If the pinion gear nose does not pop out, check the magnetic switch.

NOTE

This test should only be carried out for a 3 to 5 second time period and not longer.

6.3 STARTER DISASSEMBLY AND ASSEMBLY



1. Armature
2. Yoke
3. Brush Holder
4. End Frame
5. Screw
6. Screw
7. Nut
8. Magnetic Switch
9. Connecting Lead
A Spline Teeth

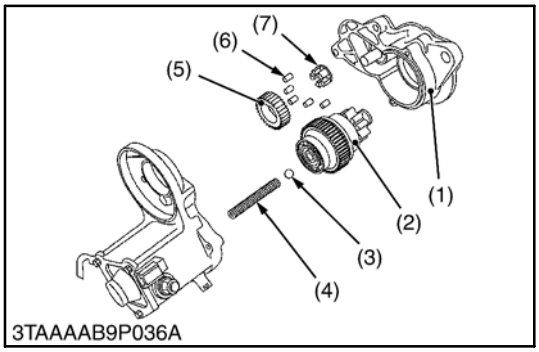
6.3.1 Disassembling Motor

1. Disconnect the connecting lead (9) from the solenoid (8).
2. Remove the screws (6), and then separate the end frame (4), yoke (2) and armature (1).
3. Remove the two screws (5), and then take out the brush holder (3) from the end frame (4).

When Reassembling

Apply grease to the spline teeth **A** of the armature (1).

Tightening Torque	Nut (7)	5.9 to 11.8 N·m 0.6 to 1.2 kgf·m 4.3 to 8.7 ft-lbs.



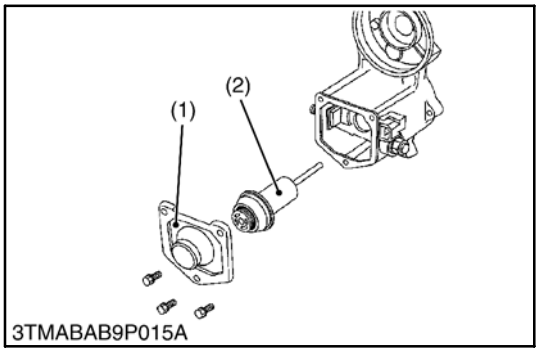
1. Drive End Frame
2. Overrunning Clutch
3. Ball
4. Spring
5. Gear
6. Roller
7. Retainer

6.3.2 Disassembling The Solenoid

1. Remove the drive end frame (1) mounting screws.
2. Take out the overrunning clutch (2), ball (3), spring (4), gear (5), rollers (6) and retainer (7).

When Reassembling

Apply grease to the gear teeth of the gear (5), overrunning clutch (2) and ball (3).

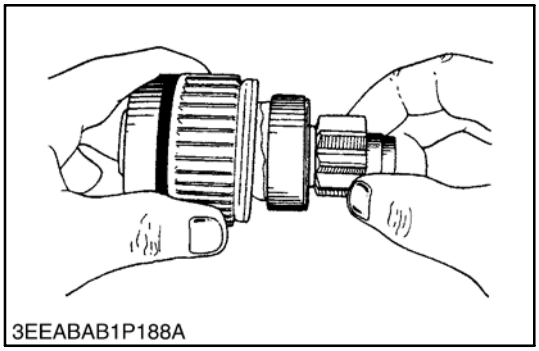


1. End Cover
2. Plunger

6.3.3 Plunger

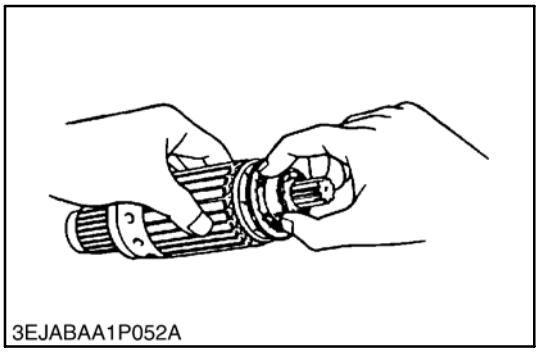
1. Remove the end cover (1).
2. Take out the plunger (2).

6.4 STARTER SERVICING


3EEABAB1P188A

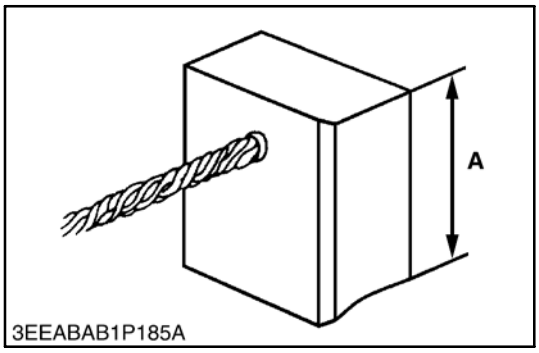
6.4.1 Overrunning Clutch

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not rotate in both directions, replace the overrunning clutch assembly.


3EJABAA1P052A

6.4.2 Armature Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

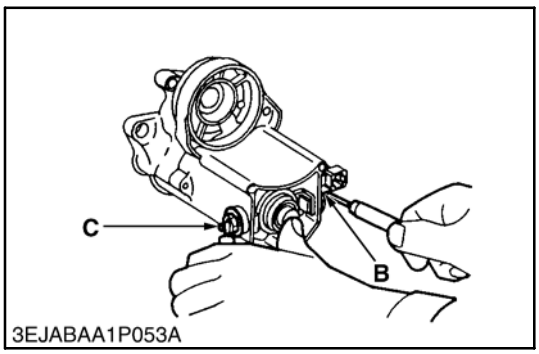


3EEABAB1P185A

6.4.3 Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery cloth.
2. Measure the brush length "**A**" with a vernier caliper.
3. If the length is less than the the allowable limit, replace the yoke assembly and the brush holder.

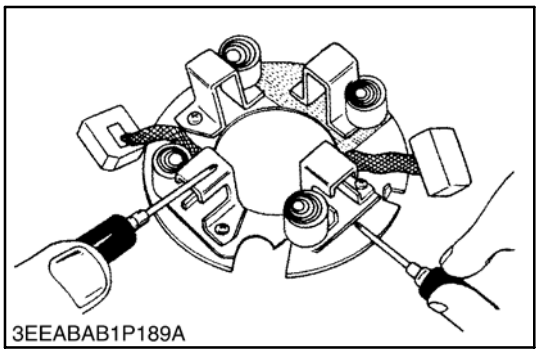
Brush Length **A**	Factory Specification	15.0 mm 0.591 in.
	Allowable Limit	11.0 mm 0.433 in.



3EJABAA1P053A

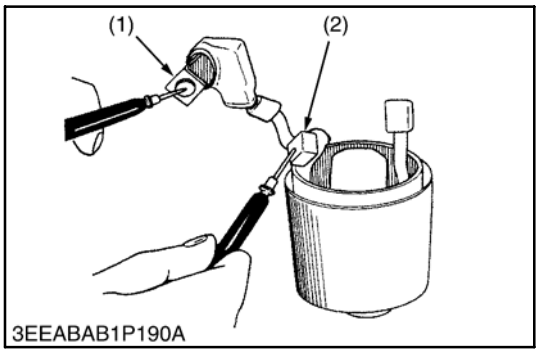
6.4.4 Solenoid

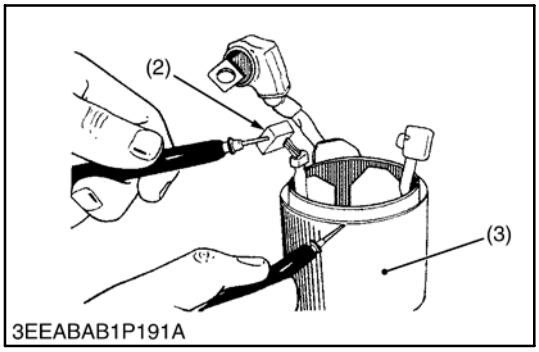
1. Check the continuity across the "**C**" terminal and the "**B**" terminal by pushing the plunger, then measuring resistance with an ohmmeter.
2. If there is no continuity, check the contacts.


3EEABAB1P189A

6.4.5 Brush Holder

1. Check the continuity across the brush holder and holder support with an ohmmeter.
2. If there is any continuity, replace the brush holder

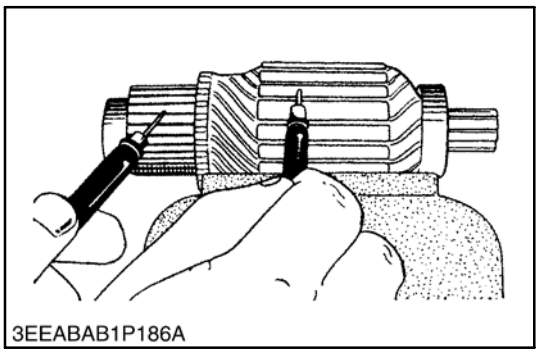


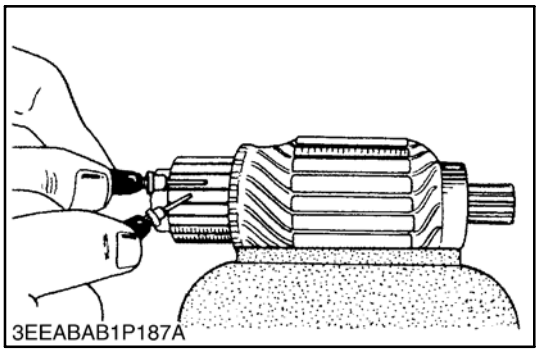


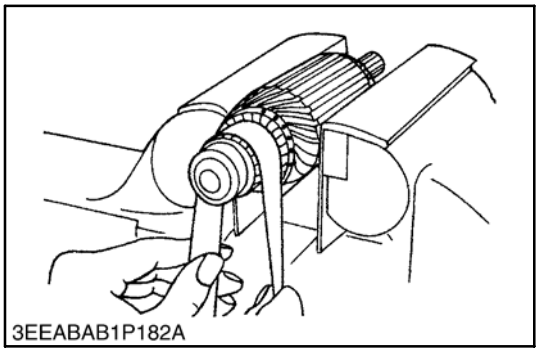
1. Lead
2 Brush
3 Yoke

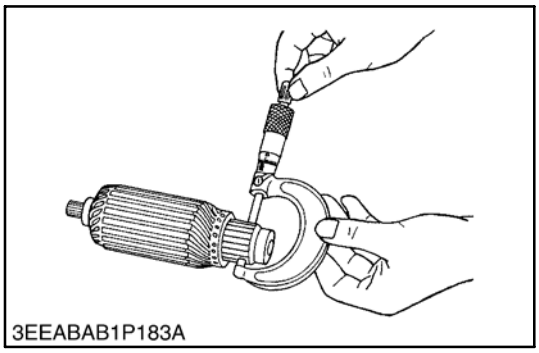
6.4.6 Field Coil

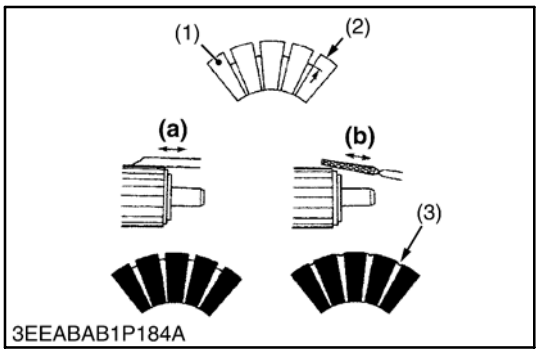
1. Check the continuity across the lead (1) and the brush with an ohmmeter.
2. If there is no continuity, replace the yoke assembly.
3. Check the continuity across the brush (2) and the yoke (3) with an ohmmeter.
4. If there is continuity, replace the yoke assembly.


3EEABAB1P186A


3EEABAB1P187A


3EEABAB1P182A


3EEABAB1P183A



3EEABAB1P184A

6.4.7 Armature

1. Check the continuity across the commutator and the armature with an ohmmeter.

2. If there is continuity, replace the armature.

3. Check the continuity across the segments of the commutator with an ohmmeter.

4. If there is no continuity, replace the armature.

6.4.8 Commutator and Mica

1. Check the contact pattern of the commutator for wear, and grind the commutator with emery cloth if it is slightly worn.

2. Measure the commutator O.D. with an outside micrometer at several points.

3. If the minimum O.D. is less than the allowable limit, replace the armature.

4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specifications.

5. Measure the mica undercut.

6. If the undercut is less than the allowable limit, correct it with a saw blade and chamfer the segment edges.

6.4.9 26-00119-00 / 26-00119-02 Starter Specification

Refer to Section1.7.5

6.4.10 26-00119-03 Starter Specification

Refer to Section1.7.5

1. Segment
2. Depth of Mica
3. Mica

(**a**). Correct
(**b**). Incorrect

INDEX

INDEX

North America
Carrier Transicold
700 Olympic Drive
Athens, GA 30601 USA
Tel: 1-706-357-7223
Fax: 1-706-355-5435

Mexico and Central America
Ejercito Nacional No. 418
Piso 9, Torre Yumal
Col. Chapultepec Morales
11570 Mexico, D.F.
Tel: (5255) 9126.0300
Fax: (5255) 9126.0373

Carrier
A United Technologies Company

Carrier Transicold Division,
Carrier Corporation
Truck/Trailer Products Group
P.O. Box 4805
Syracuse, N.Y. 13221 U.S.A.

www.carrier.transicold.com

Carrier TRANSICOLD