FOREWORD

This workshop manual has been prepared to provide information covering general service repairs for the S05C−B, S05C−TA and S05C−TB engines equipped on the Hino Motors,Ltd.

Applicable models: XZU404, 412, 414, 422, 424, 434 series

Please note that the publications below have also been prepared as relevant service manuals for the components and systems in this vehicles.

Manual Name	Pub. No.
• DUTRO Workshop Manual	S1−YXZE05A

All information in this manual is based on the latest product information at the time of publication. However, specifications and procedures are subject to change without notice.

CAUTION

This manual does not include all the necessary items about repair and service. This manual is made for the purpose of the use for the persons who have special techniques and certifications. In the cases that non−specialized or uncertified technicians perform repair or service only using this manual or without proper equipment or tool, that may cause severe injury to you or other people around and also cause damage to your customer's vehicle.

In order to prevent dangerous operation and damages to your customer's vehicle, be sure to follow the instruction shown below.

- Must read this manual thoroughly. It is especially important to have a good understanding of all the contents written in the PRECAUTION of "IN" section.
- The service method written in this manual is very effective to perform repair and service. When performing the operations following the procedures using this manual, be sure to use tools specified and recommended. If using non−specified or recommended tools and service method, be sure to confirm safety of the technicians and any possibility of causing personal injury or damage to the customer's vehicle before starting the operation.
- If part replacement is necessary, must replace the part with the same part number or equivalent part. Do not replace it with inferior quality.
- It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is important to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

INTRODUCTION

HOW TO USE THIS ENGINE REPAIR MANUAL

0108J–02

GENERAL INFORMATION

1. GENERAL DESCRIPTION

(a) This manual is made in accordance with SAE J2008.

(b) Generally repair operations can be separated in the following 3 main processes:
1. Diagnosis
2. Removing and Installing, Replacing, Disassembling, Installing and Checking, Adjusting
3. Final Inspection

(c) This manual explains ”Removing and Installing, Replacing, Disassembling, Installing and Checking, Adjusting”, but ”Final Inspection” is omitted.

(d) The following essential operations are not written in this manual, however these operations must be done in the practical situation.
(1) Operation with a jack or lift
(2) Cleaning of a removed part when necessary
(3) Visual check

2. INDEX

(a) An alphabetical INDEX is provided as a section on the end of the book to guide you to the item to be repaired.

3. PREPARATION

(a) Use of special service tools (SST) and special service materials (SSM) may be required, depending on the repairing condition. Be sure to use SST and SSM when they are required and follow the working procedure properly. A list of SST and SSM is in the Preparation section of this manual.

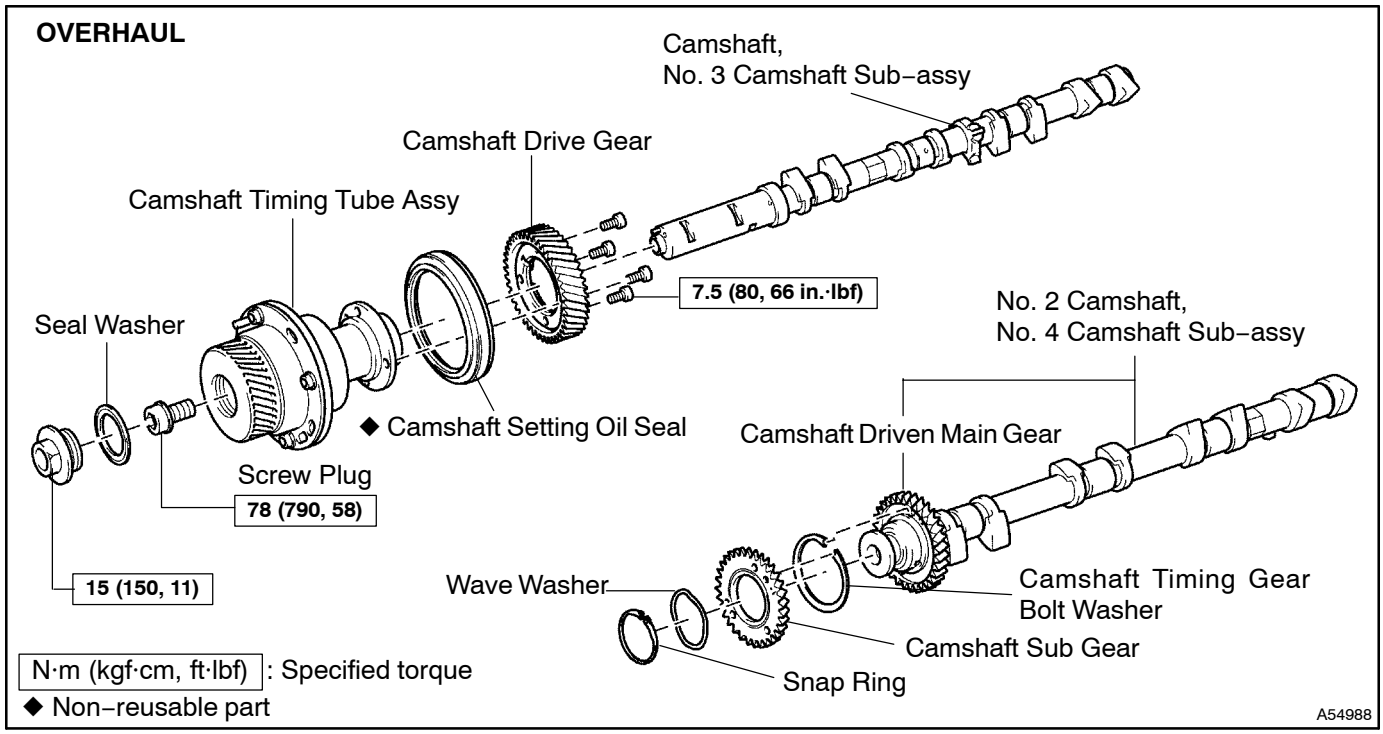
4. REPAIR PROCEDURES

(a) Component drawing is placed as the section or title when necessary.

(b) Illustrations of the parts catalog are placed as the ”disassembled parts drawing” so that it enables you to understand the fitting condition of the components.

(c) Non–reusable parts, grease applied parts, precoated parts and tightening torque are specified in the components drawing.

Example:



(d) Tightening torque, oil applying position, and non–reusable parts are described as important points in the procedure.

NOTICE:

There are cases where such information can only be indicated by an illustration. In that case, all the information such as torque, oil, etc. are described in the illustration.

(e) Installing procedure of operation items is performed in the reverse order of the removing, and only the important points are described.

(f) Only items with points are described in the procedure, and the operational portion and content are placed using an illustration. In the explanations, details of the operational method, standard value and notice are placed.

(g) There may be a case where the illustrations of similar models are used. In that case the details may be different from the actual vehicle.

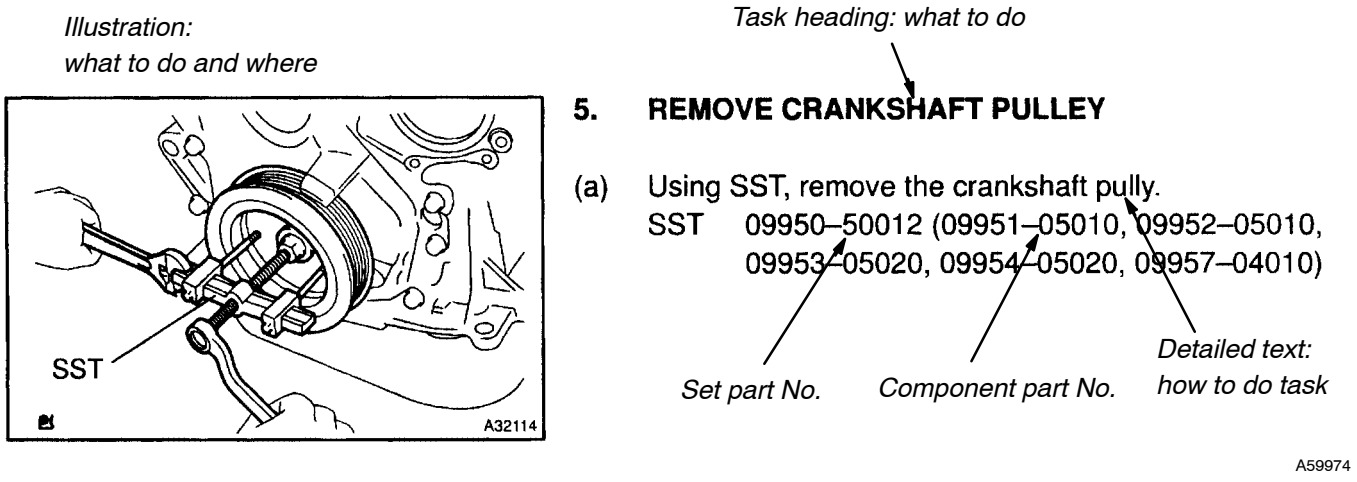
(h) The procedures are presented in a step–by–step format:

(1) The illustration shows what to do and where to do it.

(2) The task heading tells what to do.

(3) The detailed text tells how to perform the task and gives other information such as specifications and warnings.

Example:



HINT:

This format provides an experienced technician with a FAST TRACK to the necessary information. The task heading can be read at a glance when necessary, and the text below provides detailed information. Important specifications and warnings always stand out in bold type.

5. SERVICE SPECIFICATIONS

(a) Specifications are presented in bold type throughout the manual. You never have to leave the procedure to look up your specifications. The specifications are also found in the Service Specifications section for a quick reference.

6. TERMS DEFINITION

CAUTION	Indicate the possibility of injury to you or other people.
NOTICE	Indicate the possibility of damage to the components being repaired.
HINT	Provide additional information to help you perform the repair efficiently.

7. SI UNIT

(a) The UNITS given in this manual are primarily expressed according to the SI UNIT (International System of Unit), and alternately expressed in the metric system and in the English System.
Example:
Torque: 30 N·m (310 kgf·cm, 22 ft·lbf)

REPAIR INSTRUCTION FOR ENGINE REPAIR MANUAL

0108K–02

PRECAUTION

1. TO PREVENT FROM ENTERING FOREIGN SUBSTANCES

(a) When foreign substances such as dust, grain of sand or metallic dust enter inside of engine, it often causes functional failure of the engine.

(1) Precaution before disassembly.

- Remove adequately all sand and mud adhere to the outside of engine .

(2) Precaution at reassembly.

- Protect disassembled parts from dust by using vinyl sheet to cover.

2. TO PREVENT SCRATCHES ON THE PARTS

(a) The existence of scratches on the contact and revolving surfaces often causes oil leak and seisure.

(1) Precautions at disassembly and reassembly.

- When disassemble the contact surface of the parts, use plastic hummer striking lightly. (Do not pry out by screwdriver).
- When fix the parts to the vise, do not directly catch it in the vise. Fix the parts through aluminum bar.

3. TO CLEAN AND WASH THE PARTS

(a) Each parts needs to be well cleaned, washed, and dried by air, and apply specified oil before reassembly.

(1) Cleaning and washing by alkaline solvent is prohibited:

- Parts made of aluminum and rubber. (ex. cylinder head cover gasket etc.)

(2) Cleaning and washing by flushing oil (ex. kerosene, white gasoline etc.) is prohibited:

- Parts made of rubber. (ex. cylinder head cover gasket etc.)

4. POSITION AND DIRECTION OF EACH PARTS

(a) Each parts needs to be reassembled as the same position and direction as it disassembled.

(1) Precautions at disassembly and reassembly.

- Follow the directions when the manual designates to mark the matchmark and/or direction mark.
- Disassembled parts needs to be put in order as disassembled, not to change position and/or direction.
- Follow the directions when the manual instructs the position and direction.

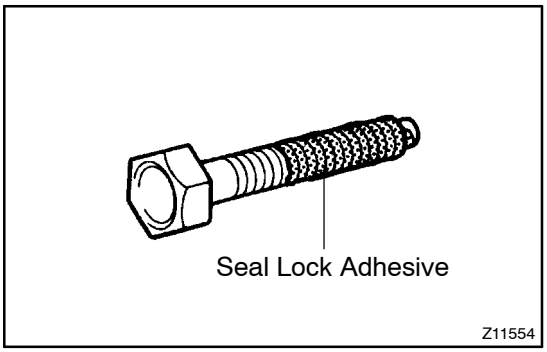
5. INSTALL ENGINE ASSEMBLY TO OVERHAUL STAND WHEN OVERHAUL THE ENGINE

6. PUT THE DISASSEMBLED PARTS IN ORDER AS THEY DISASSEMBLED

7. APPLY ENGINE OIL TO THE SLIDING AND ROTATING SURFACES

8. NON–REUSABLE PARTS SUCH AS GASKET AND SEAL NEEDS TO BE CHANGED TO THE NEW PARTS

9. BASIC REPAIR HINT



(a) Precoated Parts:

(1) Precoated parts are bolts, nuts, etc. that are coated with a seal lock adhesive at the factory.

(2) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.

(3) When reusing precoated parts, clean off the old adhesive and dry with compressed air. Then apply the specified seal lock adhesive to the bolt, nut or threads.

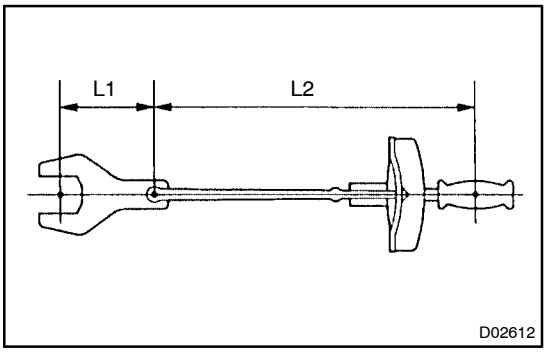
NOTICE:

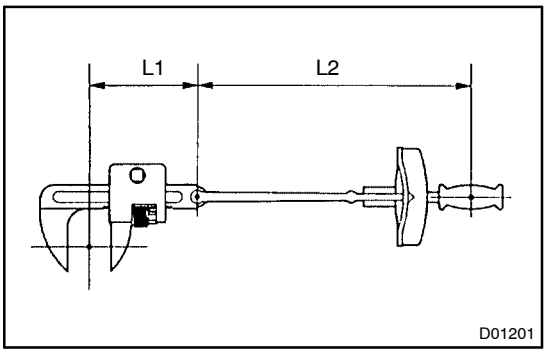
Do the torque checking with the lower limit value of the torque tolerance.

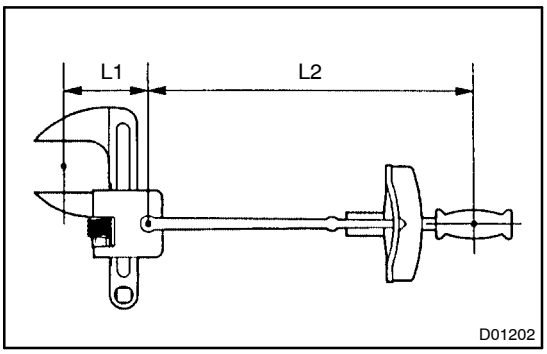
(4) Depending on the seal lock agent to apply, there may be a case where it is necessary to leave it for a specified time until it hardens.

(b) Gaskets:
When necessary, use a sealer on gaskets to prevent leaks.

(c) Bolts, Nuts and Screws:
Carefully observe all specifications for bolt tightening torques. Always use a torque wrench.







(d) Torque When Using Extension Tool with Torque Wrench:

(1) In case of tightening by extending the entire length of the torque wrench combined with SST or tool, if you tighten until the reading of the torque wrench reached the specified torque value, the actual torque becomes excessive.

(2) In this text, only the specified torque is described. In case of using SST or extension tool, find the reading of the torque wrench by the formula.

(3) Formula T' = T x L2/(L1 + L2)

T'	Reading of torque wrench {N·m (kgf·cm, ft·lbf)}
T	Torque {N·m (kgf·cm, ft·lbf)}
L1	Length of SST or tool (cm)
L2	Length of torque wrench (cm)

10. REMOVAL AND INSTALLATION OF FUEL CONTROL PARTS

(a) Place for Removing and Installing Fuel System Parts:

(1) Place with good air ventilation and without anything flammable such as welder, grinder, drill, electric motor or stove in the surroundings.

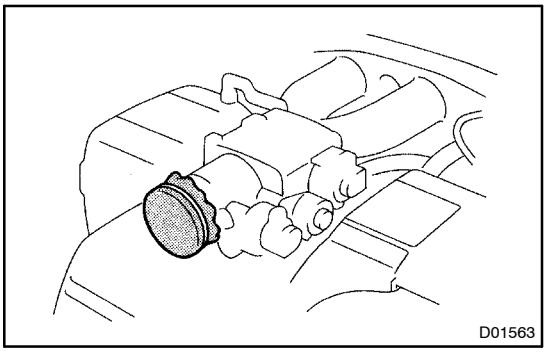
(2) Never work in a place like a pit or nearby pit as there is a possibility that vaporized fuel fills those places.

(b) Removing and Installing of Fuel System Parts:

(1) Prepare a fire extinguisher before starting the operation.

(2) For prevention of the static electricity, install a ground on the fuel changer, vehicle and fuel tank, and do not spray much water so as to prevent slipping.

(3) Never use any electric equipment like an electric motor or a working light as they may cause spark or high temperature.
(4) Never use an iron hammer as it may cause spark.
(5) Dispose the shop lag separately from any fuel deposit.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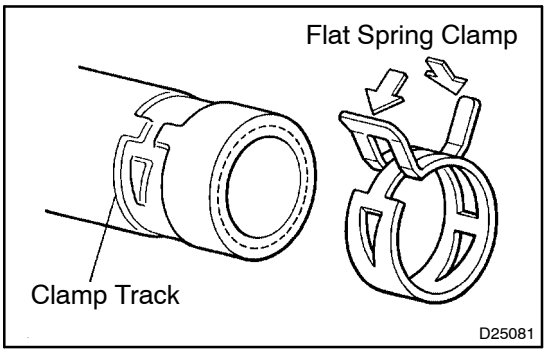
11. REMOVAL AND INSTALLATION OF ENGINE INTAKE PARTS

(a) If any metal tip is mixed in the inlet pass, that may give a bad effect to the engine and turbo charger.
(b) When removing and installing of the inlet system parts, close the opening of the removed inlet system parts and the engine with a clean shop lag or gum tape.
(c) When installing the inlet system parts, check that there is no mixing of a metal tip.



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12. HANDLING OF HOSE CLAMPS

(a) Before removing the hose, check the depth of inserting portion and the clamp position to restore it surely.
(b) Change a deformed or dented into a new one.
(c) In case of reusing the hose, install the clamp on the hose where it has a clamp track.
(d) For a flat spring type clamp, make it adjust by adding force to the arrow mark direction after the installation.

TERMS FOR ENGINE REPAIR MANUAL

ABBREVIATIONS USED IN THIS MANUAL

0108H–02

Abbreviations	Meaning
ABS	Anti–Lock Brake System
A/C	Air Conditioner
AC	Alternating Current
ACC	Accessory
ACIS	Acoustic Control Induction System
ACSD	Automatic Cold Start Device
A.D.D.	Automatic Disconnecting Differential
A/F	Air–Fuel Ratio
AHC	Active Height Control Suspension
ALR	Automatic Locking Retractor
ALT	Alternator
AMP	Amplifier
ANT	Antenna
APPROX.	Approximately
ASSY	Assembly
A/T	Automatic Transmission (Transaxle)
ATF	Automatic Transmission Fluid
AUTO	Automatic
AUX	Auxiliary
AVG	Average
AVS	Adaptive Variable Suspension
B+	Battery Voltage
BACS	Boost Altitude Compensation System
BAT	Battery
BDC	Bottom Dead Center
B/L	Bi–Level
B/S	Bore–Stroke Ratio
BTDC	Before Top Dead Center
BVSV	Bimetallic Vacuum Switching Valve
CB	Circuit Breaker
CCo	Catalytic Converter For Oxidation
CD	Compact Disc
CF	Cornering Force
CG	Center Of Gravity
CH	Channel
CKD	Complete Knock Down
COMB.	Combination
CPE	Coupe
CPS	Combustion Pressure Sensor
CPU	Central Processing Unit
CRS	Child Restraint System
CTR	Center
C/V	Check Valve
CV	Control Valve
CW	Curb Weight
DC	Direct Current
DEF	Defogger
DFL	Deflector

Abbreviations	Meaning
DIFF.	Differential
DIFF. LOCK	Differential Lock
D/INJ	Direct Injection
DLC	Data Link Connector
DLI	Distributorless Ignition
DOHC	Double Overhead Cam
DP	Dash Pot
DS	Dead Soak
DSP	Digital Signal Processor
DTC	Diagnostic Trouble Code
ECAM	Engine Control And Measurement System
ECD	Electronic Controlled Diesel
ECDY	Eddy Current Dynamometer
ECT	Electronic Control Transmission
ECU	Electronic Control Unit
ED	Electro–Deposited Coating
EDU	Electronic Driving Unit
EDIC	Electric Diesel Injection Control
EFI	Electronic Fuel Injection
E/G	Engine
EGR	Exhaust Gas Recirculation
EGR–VM	EGR–Vacuum Modulator
ELR	Emergency Locking Retractor
ENG	Engine
ESA	Electronic Spark Advance
ETCS	Electronic Throttle Control System
EVAP	Evaporative Emission Control
EVP	Evaporator
E–VRV	Electric Vacuum Regulating Valve
EX	Exhaust
FE	Fuel Economy
FF	Front–Engine Front–Wheel–Drive
F/G	Fuel Gauge
FIPG	Formed In Place Gasket
FL	Fusible Link
F/P	Fuel Pump
FPU	Fuel Pressure Up
FR	Front
F/W	Flywheel
FW/D	Flywheel Damper
FWD	Front–Wheel–Drive
GAS	Gasoline
GND	Ground
HAC	High Altitude Compensator
H/B	Hatchback
H–FUSE	High Current Fuse
HI	High
HID	High Intensity Discharge (Head Lamp)
HSG	Housing
HT	Hard Top
HWS	Heated Windshield System

Abbreviations	Meaning
IC	Integrated Circuit
IDI	Indirect Diesel Injection
IFS	Independent Front Suspension
IG	Ignition
IIA	Integrated Ignition Assembly
IN	Intake (Manifold, Valve)
INT	Intermittent
I/P	Instrument Panel
IRS	Independent Rear Suspension
ISC	Idle Speed Control
J/B	Junction Block
J/C	Junction Connector
KD	Kick–Down
LAN	Local Area Network
LB	Liftback
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LH	Left–Hand
LHD	Left–Hand Drive
L/H/W	Length, Height, Width
LLC	Long–Life Coolant
LNG	Liquified Natural Gas
LO	Low
LPG	Liquified Petroleum Gas
LSD	Limited Slip Differential
LSP & PV	Load Sensing Proportioning And Bypass Valve
LSPV	Load Sensing Proportioning Valve
MAP	Manifold Absolute Pressure
MAX.	Maximum
MIC	Microphone
MIL	Malfunction Indicator Lamp
MIN.	Minimum
MP	Multipurpose
MPI	Multipoint Electronic Injection
MPX	Multiplex Communication System
M/T	Manual Transmission
MT	Mount
MTG	Mounting
N	Neutral
NA	Natural Aspiration
NO.	Number
O2S	Oxygen Sensor
O/D	Overdrive
OEM	Original Equipment Manufacturing
OHC	Overhead Camshaft
OHV	Overhead Valve
OPT	Option
O/S	Oversize
P & BV	Proportioning And Bypass Valve
PCS	Power Control System
PCV	Positive Crankcase Ventilation

Abbreviations	Meaning
PKB	Parking Brake
PPS	Progressive Power Steering
PS	Power Steering
PTO	Power Take–Off
P/W	Power Window
R & P	Rack And Pinion
R/B	Relay Block
RBS	Recirculating Ball Type Steering
R/F	Reinforcement
RFS	Rigid Front Suspension
RRS	Rigid Rear Suspension
RH	Right–Hand
RHD	Right–Hand Drive
RLY	Relay
ROM	Read Only Memory
RR	Rear
RRS	Rear–Wheel Drive
RWD	Rear–Wheel Drive
SDN	Sedan
SEN	Sensor
SICS	Starting Injection Control System
SOC	State Of Charge
SOHC	Single Overhead Camshaft
SPEC	Specification
SPI	Single Point Injection
SRS	Supplemental Restraint System
SSM	Special Service Materials
SST	Special Service Tools
STD	Standard
STJ	Cold–Start Fuel Injection
SW	Switch
SYS	System
T/A	Transaxle
TACH	Tachometer
TBI	Throttle Body Electronic Fuel Injection
TC	Turbocharger
TCCS	Computer–Controlled System
TCV	Timing Control Valve
TDC	Top Dead Center
TEMP.	Temperature
TFT	Free–Tronic
TIS	Total Information System For Vehicle Development
T/M	Transmission
TRC	Traction Control System
TURBO	Turbocharge
TWC	Three–Way Catalyst
U/D	Underdrive
U/S	Undersize
VCV	Vacuum Control Valve
VENT	Ventilator
VIN	Vehicle Identification Number

Abbreviations	Meaning
VPS	Variable Power Steering
VSC	Vehicle Skid Control
VSV	Vacuum Switching Valve
VTV	Vacuum Transmitting Valve
VVT–i	Variable Valve Timing–intelligent
W/	With
WGN	Wagon
W/H	Wire Harness
W/O	Without
1ST	First
2ND	Second
2WD	Two Wheel Drive Vehicle (4 x 2)
3RD	Third
4TH	Fourth
4WD	Four Wheel Drive Vehicle (4 x 4)
4WS	Four Wheel Steering System
5TH	Fifth

0108I–02

GLOSSARY OF SAE AND HINO TERMS

This glossary lists all SAE–J1930 terms and abbreviations used in this manual in compliance with SAE recommendations, as well as their HINO equivalents.

SAE ABBREVIATIONS	SAE TERMS	HINO TERMS ( )––ABBREVIATIONS
A/C	Air Conditioning	Air Conditioner
ACL	Air Cleaner	Air Cleaner, A/CL
AIR	Secondary Air Injection	Air Injection (AI)
AP	Accelerator Pedal	–
B+	Battery Positive Voltage	+B, Battery Voltage
BARO	Barometric Pressure	HAC
CAC	Charge Air Cooler	Intercooler
CARB	Carburettor	Carburettor
CFI	Continuous Fuel Injection	–
CKP	Crankshaft Position	Crank Angle
CL	Closed Loop	Closed Loop
CMP	Camshaft Position	Cam Angle
CPP	Clutch Pedal Position	–
CTOX	Continuous Trap Oxidizer	–
CTP	Closed Throttle Position	LL ON, Idle ON
DFI	Direct Fuel Injection (Diesel)	Direct Injection (DI)
DI	Distributor Ignition	–
DLC1 DLC2 DLC3	Data Link Connector 1 Data Link Connector 2 Data Link Connector 3	1: Check Connector 2: Total Diagnosis Comunication Link (TDCL) 3: OBD II Diagnostic Connector
DTC	Diagnostic Trouble Code	Diagnostic Code
DTM	Diagnostic Test Mode	–
ECL	Engine Control Level	–
ECM	Engine Control Module	Engine ECU (Electronic Control Unit)
ECT	Engine Coolant Temperature	Coolant Temperature, Water Temperature (THW)
EEPROM	Electrically Erasable Programmable Read Only Memory	Electrically Erasable Programmable Read Only Memory (EEPROM), Erasable Programmable Read Only Memory (EPROM)
EFE	Early Fuel Evaporation	Cold Mixture Heater (CMH), Heat Control Valve (HCV)
EGR	Exhaust Gas Recirculation	Exhaust Gas Recirculation (EGR)
EI	Electronic Ignition	Distributorless Ignition (TDI)
EM	Engine Modification	Engine Modification (EM)
EPROM	Erasable Programmable Read Only Memory	Programmable Read Only Memory (PROM)
EVAP	Evaporative Emission	Evaporative Emission Control (EVAP)
FC	Fan Control	–
FEEPROM	Flash Electrically Erasable Programmable Read Only Memory	–
FEPROM	Flash Erasable Programmable Read Only Memory	–
FF	Flexible Fuel	–
FP	Fuel Pump	Fuel Pump
GEN	Generator	Alternator
GND	Ground	Ground (GND)

HO2S	Heated Oxygen Sensor	Heated Oxygen Sensor (HO_2S)
IAC	Idle Air Control	Idle Speed Control (ISC)
IAT	Intake Air Temperature	Intake or Inlet Air Temperature
ICM	Ignition Control Module	–
IFI	Indirect Fuel Injection	Indirect Injection (IDL)
IFS	Inertia Fuel–Shutoff	–
ISC	Idle Speed Control	–
KS	Knock Sensor	Knock Sensor
MAF	Mass Air Flow	Air Flow Meter
MAP	Manifold Absolute Pressure	Manifold Pressure Intake Vacuum
MC	Mixture Control	Electric Bleed Air Control Valve (EBCV) Mixture Control Valve (MCV) Electric Air Control Valve (EACV)
MDP	Manifold Differential Pressure	–
MFI	Multiport Fuel Injection	Electronic Fuel Injection (EFI)
MIL	Malfunction Indicator Lamp	Check Engine Lamp
MST	Manifold Surface Temperature	–
MVZ	Manifold Vacuum Zone	–
NVRAM	Non–Volatile Random Access Memory	–
O2S	Oxygen Sensor	Oxygen Sensor, O_2 Sensor (O_2S)
OBD	On–Board Diagnostic	On–Board Diagnostic System (OBD)
OC	Oxidation Catalytic Converter	Oxidation Catalyst Convert (OC), CCo
OP	Open Loop	Open Loop
PAIR	Pulsed Secondary Air Injection	Air Suction (AS)
PCM	Powertrain Control Module	–
PNP	Park/Neutral Position	–
PROM	Programmable Read Only Memory	–
PSP	Power Steering Pressure	–
PTOX	Periodic Trap Oxidizer	Diesel Particulate Filter (DPF) Diesel Particulate Trap (DPT)
RAM	Random Access Memory	Random Access Memory (RAM)
RM	Relay Module	–
ROM	Read Only Memory	Read Only Memory (ROM)
RPM	Engine Speed	Engine Speed
SC	Supercharger	Supercharger
SCB	Supercharger Bypass	E–ABV
SFI	Sequential Multiport Fuel Injection	Electronic Fuel Injection (EFI), Sequential Injection
SPL	Smoke Puff Limiter	–
SRI	Service Reminder Indicator	–
SRT	System Readiness Test	–
ST	Scan Tool	–
TB	Throttle Body	Throttle Body
TBI	Throttle Body Fuel Injection	Single Point Injection Central Fuel Injection (Ci)
TC	Turbocharger	Turbocharger
TCC	Torque Converter Clutch	Torque Converter

TCM	Transmission Control Module	Transmission ECU, ECT ECU
TP	Throttle Position	Throttle Position
TR	Transmission Range	–
TVV	Thermal Vacuum Valve	Bimetallic Vacuum Switching Valve (BVSV) Thermostatic Vacuum Switching Valve (TVSV)
TWC	Three–Way Catalytic Converter	Three–Way Catalytic (TWC) Manifold Converter CC_{RO}
TWC+OC	Three–Way + Oxidation Catalytic Converter	CC_R + CCo
VAF	Volume Air Flow	Air Flow Meter
VR	Voltage Regulator	Voltage Regulator
VSS	Vehicle Speed Sensor	Vehicle Speed Sensor
WOT	Wide Open Throttle	Full Throttle
WU–OC	Warm Up Oxidation Catalytic Converter	–
WU–TWC	Warm Up Three–Way Catalytic Converter	–
3GR	Third Gear	–
4GR	Fourth Gear	–

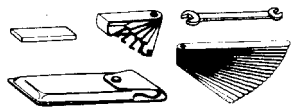
PREPARATION

INTAKE

022E2-01

PREPARATION

Recomended Tools

	09200–00010	Engine Adjust Kit	INTAKE MANIFOLD

Equipment

Precision straight edge	

ENGINE MECHANICAL

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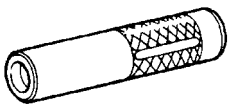
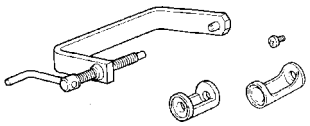
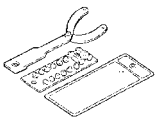
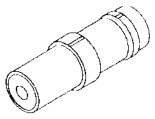
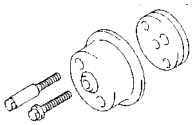
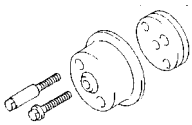
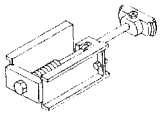
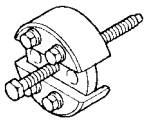
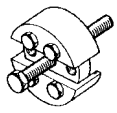
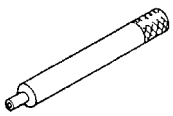
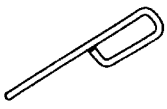
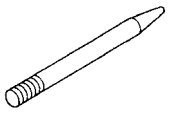
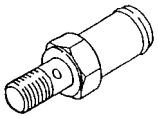
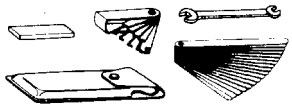
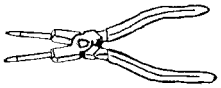
PREPARATION

SST

	09201–41020	Valve Stem Oil Seal Replacer	CAMSHAFT HOUSING AND CYLINDER HEAD
	09202–70020	Valve Spring Compressor	CAMSHAFT HOUSING AND CYLINDER HEAD
	09960–10010	Variable Pin Wrench Set	CAMSHAFT HOUSING AND CYLINDER HEAD
	09402–1480	Press sub–Assy	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09407–1030	Oil Seal Press	CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	09407–1040	Oil Seal Press	CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	09420–1720	Sylinder liner puller	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09420–1731	Oil Seal Puller	CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	09420–1742	Oil Seal Puller	CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	09444–1630	Gauge	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09472–1210	Bar	CAMSHAFT HOUSING AND CYLINDER HEAD
	09472–1620	Tool	PISTON, CRANKSHAFT AND CYLINDER BLOCK

	09481–1140	Guide	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09481–1340	Guide	CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	9001–24262	Check Bolt	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	9191–08252	Bolt	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	9800–06100	Steel Ball	CAMSHAFT HOUSING AND CYLINDER HEAD

Recomended

	09200–00010	Engine Adjust Kit	CAMSHAF HOUSING AND CYLINDER HEAD
	09905–00013	Snap Ring Pliers	TIMING GEAR

SSM

	08826–00080	Seal Packing Black or equivalent (FIPG)	CAMSHAFT HOUSING AND CYLINDER HEAD INTAKE MANIFOLD CRANCKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING
	08833–00070	”Adhesive 1324,” THREE BOND 1324 or equivalent	TIMING GEAR

Equipment

Abrasive compound	
Connecting rod aligner	
Cylinder gauge	
Dial gauge	
Dye penetrant	
Heater	
Micrometer	
Piston ring compressor	
Piston ring expander	
Precision straight edge	
Press	

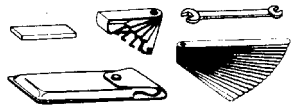
Press Sliding hammer	
Soft brush	
Solvent	
Spring tester	
Steam cleaner	
Steel square	
Straight edge	
Torch	
Torque wrench	
Valve guide bushing brush	
Valve seat cutter	
V–block	
Vernier calipers	
Wire brush	

EXHAUST

PREPARATION

022E3–01

Recomended Tools

	09200–00010	Engine Adjust Kit	EXHAUST MANIFOLD

Equipment

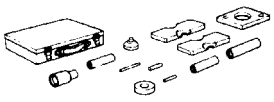
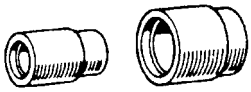
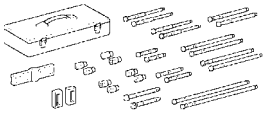
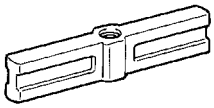
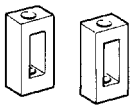
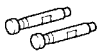
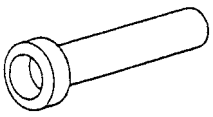
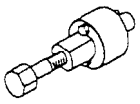
Precision straight edge	

COOLING

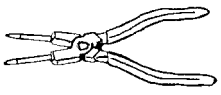
022E4–01

PREPARATION

SST

	09236–00101	Water Pump Overhaul Tool Set	WATER PUMP ASSY
	(09236–15010)	Bearing Stay	WATER PUMP ASSY
	09238–47012	Water Pump Bearing Remover & Replacer	WATER PUMP ASSY
	09950–50013	Puller C Set	WATER PUMP ASSY
	(09951–05010)	Hanger 150	WATER PUMP ASSY
	(09952–05010)	Slide Arm	WATER PUMP ASSY
	(09953–05010)	Center Bolt 100	WATER PUMP ASSY
	(09954–05021)	Claw No.2	WATER PUMP ASSY
	09482–2060A	Press	WATER PUMP ASSY
	09420–1820	Puller ASSY	WATER PUMP ASSY

Recomended Tools

	09905–00013	Snap Ring Pliers	WATER PUMP ASSY

Equipment

Vernier calipers	
Torque wrench	

LUBRICATION

022E5–01

PREPARATION

Equipment

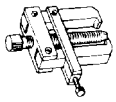
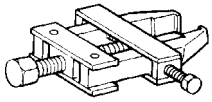
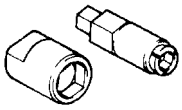
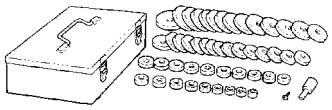
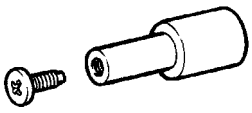
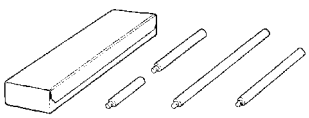
Dial gauge	
Micrometer	
Torque wrench	

STARTING & CHARGING

022E6–01

PREPARATION

SST

	09285–76010	Injection Pump Camshaft Bearing Cone Replacer	GENERATOR ASSY
	09286–46011	Injection Pump Spline Shaft Puller	GENERATOR ASSY
	09820–00021	Alternator Rear Bearing Puller	GENERATOR ASSY
	09820–00030	Alternator Rear Bearing Replacer	GENERATOR ASSY
	09820–63010	Alternator Pulley Set Nut Wrench Set	GENERATOR ASSY
	09950–60010	Replacer Set	STARTER ASSY GENERATOR ASSY
	(09951–00260)	Replacer 26	STARTER ASSY
	(09951–00390)	Replacer 39	STARTER ASSY
	(09952–06010)	Adapter	STARTER ASSY
	09950–70010	Handle Set	GENERATOR ASSY
	09820–00031	Alternator Rotor Rear Bearing Replacer	STARTER ASSY(S05C–B)

Recomended Tools

	09082–00040	Electrical Tester	STARTER ASSY GENERATOR ASSY

Equipment

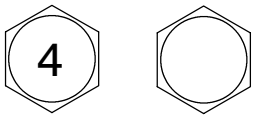
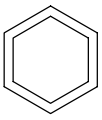
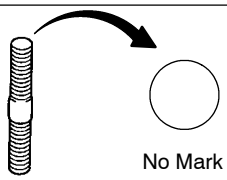
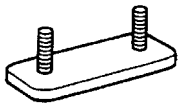
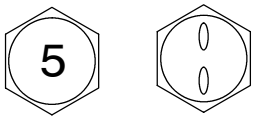
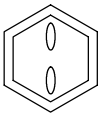
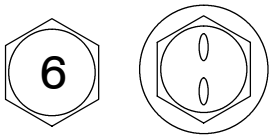
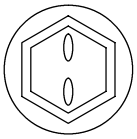
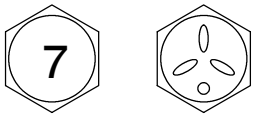
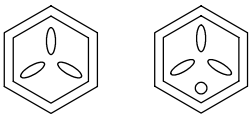
Ammeter (A)	
Battery specific gravity gauge	Except maintenance– free battery
Belt tension gauge	
Cylinder indicator	Commutator
Micro meter	Starter clutch
Plastic hammer	
Pull scale	Brush spring
Sandpaper	Commutator
Torque wrench	
Vernier calipers	Commutator, Brush, Rotor (Slip ring)

SERVICE SPECIFICATIONS

STANDARD BOLT

HOW TO DETERMINE BOLT STRENGTH

03096–06

Bolt Type				Class
Hexagon Head Bolt		Stud Bolt	Weld Bolt	
Normal Recess Bolt	Deep Recess Bolt			
 No Mark	 No Mark	 No Mark		4T
				5T
 w/ Washer	 w/ Washer			6T
				7T
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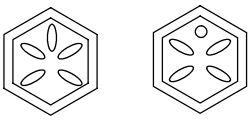
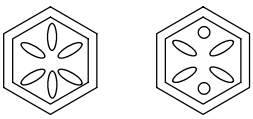
				9T
				10T
				11T

B06431

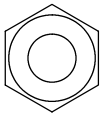
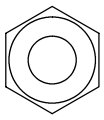
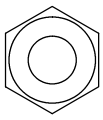
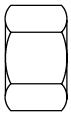
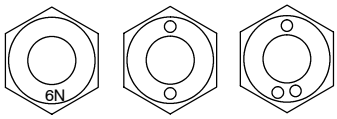
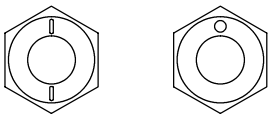
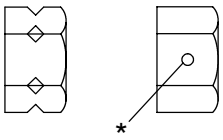
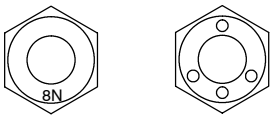
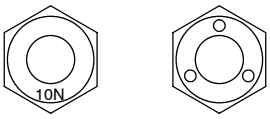
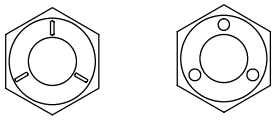
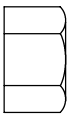
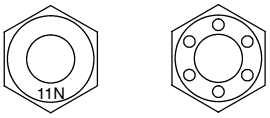
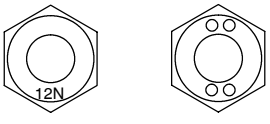
03097–07

SPECIFIED TORQUE FOR STANDARD BOLTS

Class	Diameter mm	Pitch mm	Specified torque					
			Hexagon head bolt			Hexagon flange bolt		
			N·m	kgf·cm	ft·lbf	N·m	kgf·cm	ft·lbf
4T	6	1	5	55	48 in.·lbf	6	60	52 in.·lbf
	8	1.25	12.5	130	9	14	145	10
	10	1.25	26	260	19	29	290	21
	12	1.25	47	480	35	53	540	39
	14	1.5	74	760	55	84	850	61
	16	1.5	115	1,150	83	–	–	–
5T	6	1	6.5	65	56 in.·lbf	7.5	75	65 in.·lbf
	8	1.25	15.5	160	12	17.5	175	13
	10	1.25	32	330	24	36	360	26
	12	1.25	59	600	43	65	670	48
	14	1.5	91	930	67	100	1,050	76
	16	1.5	140	1,400	101	–	–	–
6T	6	1	8	80	69 in.·lbf	9	90	78 in.·lbf
	8	1.25	19	195	14	21	210	15
	10	1.25	39	400	29	44	440	32
	12	1.25	71	730	53	80	810	59
	14	1.5	110	1,100	80	125	1,250	90
	16	1.5	170	1,750	127	–	–	–
7T	6	1	10.5	110	8	12	120	9
	8	1.25	25	260	19	28	290	21
	10	1.25	52	530	38	58	590	43
	12	1.25	95	970	70	105	1,050	76
	14	1.5	145	1,500	108	165	1,700	123
	16	1.5	230	2,300	166	–	–	–
8T	8	1.25	29	300	22	33	330	24
	10	1.25	61	620	45	68	690	50
	12	1.25	110	1,100	80	120	1,250	90
9T	8	1.25	34	340	25	37	380	27
	10	1.25	70	710	51	78	790	57
	12	1.25	125	1,300	94	140	1,450	105
10T	8	1.25	38	390	28	42	430	31
	10	1.25	78	800	58	88	890	64
	12	1.25	140	1,450	105	155	1,600	116
11T	8	1.25	42	430	31	47	480	35
	10	1.25	87	890	64	97	990	72
	12	1.25	155	1,600	116	175	1,800	130

03098–06

HOW TO DETERMINE NUT STRENGTH

Nut Type			Class
Present Standard Hexagon Nut	Old Standard Hexagon Nut		
	Cold Forging Nut	Cutting Processed Nut	
 No Mark			4N
 No Mark (w/ Washer)	 No Mark (w/ Washer)	 No Mark	5N (4T)
 6N			6N
		 *	7N (5T)
 8N			8N
 10N		 No Mark	10N (7T)
 11N			11N
 12N			12N

*: Nut with 1 or more marks on one side surface of the nut.

B06432

HINT:

Use the nut with the same number of the nut strength classification or the greater than the bolt strength classification number when tightening parts with a bolt and nut.

Example: Bolt = 4T

Nut = 4N or more

FUEL

030OA–02

TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf
Nozzle retaining nut x Nozzle holder body	63.7	650	47

INTAKE

030NN–02

SERVICE DATA

Intake manifold	Warpage	Maximum	0.20 mm (0.0079 in.)

ENGINE MECHANICAL

030NP–03

SERVICE DATA

Valve clearance		at cold Intake	0.30 mm (0.012 in.)
		Exhaust	0.45 mm (0.018 in.)
Timing gear	Main idler gear		
	Outside diameter of main idler gear shaft	STD	56.94 – 56.97 mm (2.2417 – 2.2429 in.)
	Inside diameter of main idler gear bushing	STD	57.00 – 57.03 mm (2.2441 – 2.2453 in.)
	Oil clearance between bushing and shaft	STD	0.030 – 0.090 mm (0.0012 – 0.0035 in.)
		Maximum	0.20 mm (0.0079 in.)
	Thrust clearance	STD	0.114 – 0.160 mm (0.0045 – 0.0063 in.)
		Maximum	0.20 mm (0.0078 in.)
	Sub idler gear		
	Outside diameter of sub idler gear shaft	STD	49.950 – 49.975 mm (1.9665 – 1.9675 in.)
	Inside diameter of sub idler gear	STD	50.000 – 50.025 mm (1.9685 – 1.9695 in.)
	Oil clearance between bushing and shaft	STD	0.025 – 0.075 mm (0.0010 – 0.0030 in.)
		Maximum	0.20 mm (0.0079 in.)
	Thrust clearance	STD	0.040 – 0.095 mm (0.0016 – 0.0037 in.)
		Maximum	0.30 mm (0.0118 in.)
	Camshaft idler gear		
	Outside diameter of camshaft idler gear shaft	STD	33.950 – 33.975 mm (1.3366 – 1.3376 in.)
		Minimum	33.80 mm (1.3307 in.)
	Inside diameter of camshaft idler gear	STD	34.000 – 34.015 mm (1.3386 – 1.3392 in.)
		Maximum	34.20 mm (1.3464 in.)
	Oil clearance between bushing and shaft	STD	0.025 – 0.065 mm (0.0010 – 0.0026 in.)
		Maximum	0.20 mm (0.0079 in.)
	Thrust clearance	STD	0.040 – 0.095 mm (0.0016 – 0.0037 in.)
		Maximum	0.30 mm (0.0118 in.)
	Backlash		
	Crankshaft gear x Main idler gear	STD	0.028 – 0.163 mm (0.0011 – 0.0064 in.)
		Maximum	0.30 mm (0.0118 in.)
	Main idler gear x Injection pump drive gear	STD	0.030 – 0.218 mm (0.0012 – 0.0086 in.)
		Maximum	0.30 mm (0.0118 in.)
	Injection pump drive gear x PS pump gear	STD	0.030 – 0.183 mm (0.0012 – 0.0072 in.)
		Maximum	0.30 mm (0.0118 in.)
	Main idler gear x Sub idler gear	STD	0.030 – 0.162 mm (0.0012 – 0.0064 in.)
		Maximum	0.30 mm (0.0118 in.)
	Sub idler gear x Oil pump gear	STD	0.030 – 0.131 mm (0.0012 – 0.0052 in.)
		Maximum	0.30 mm (0.0118 in.)
	Sub idler gear x Camshaft idler gear	STD	0.030 – 0.299 mm (0.0012 – 0.0118 in.)
		Maximum	0.30 mm (0.0118 in.)
	Camshaft timing gear x Camshaft idler gear	STD	0.028 – 0.163 mm (0.0011 – 0.0064 in.)
		Maximum	0.30 mm (0.0118 in.)
	Sub idler gear x Vacuum pump gear	STD	0.029 – 0.187 mm (0.0011 – 0.0074 in.)
		Maximum	0.30 mm (0.0118 in.)
Cyliner head	Warpage	STD	0.04 mm (0.0016 in.) or less for longitudinal direction 0.03 mm (0.0012 in.) or less for lateral direction
Cylinder head bolt	Length (Bolt number position: See page 14–3)		
		Maximum No. 1, 2, 8, 9, 10, 15, 16, 17	126.5 mm (4.9803 in.)
		No. 4, 5, 12, 13	156.5 mm (6.1614 in.)
		No. 3, 6, 11, 14, 18	187.5 mm (7.3819 in.)

Valve	Valve seat angle	Intake	30˚00' – 30˚30'
		Exhaust	44˚15' – 45˚45'
	Valve face angle	Intake	29˚45' – 30˚00'
		Exhaust	44˚45' – 45˚00'
	Valve sink dimension	STD Intake	0.55 – 0.85 mm (0.0217 – 0.0335 in.)
		Exhaust	1.30 – 1.60 mm (0.0512 – 0.0630 in.)
		Maximum Intake	1.20 mm (0.0472 in.)
		Exhaust	1.80 mm (0.0708 in.)
	Valve stem diameter	STD Intake	6.957 – 6.977 mm (0.2739 – 0.2747 in.)
		STD Exhaust	6.932 – 6.950 mm (0.2730 – 0.2736 in.)
		Minimum Intake	6.92 mm (0.2724 in.)
		Exhaust	6.85 mm (0.2700 in.)
	Valve stem oil clearance	STD Intake	0.023 – 0.058 mm (0.0009 – 0.0023 in.)
		Exhaust	0.050 – 0.083 mm (0.0020 – 0.0033 in.)
		Maximum Intake	0.12 mm (0.0047 in.)
		Exhaust	0.15 mm (0.0059 in.)
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
	Free length	STD Inner	64.6 mm (2.543 in.)
		Outer	75.7 mm (2.980 in.)
		Minimum Inner	61.6 mm (2.425 in.)
		Outer	72.7 mm (2.862 in.)
	Installed tension	Inner at 44.8 mm (1.764 in.)	128.5 N (13.1 kgf, 28.9 lb)
		Outer at 46.8 mm (1.843 in.)	313.8 N (32.0 kgf, 70.5 lb)
Manifold	Warpage	Maximum	0.20 mm (0.0079 in.)
Camshaft	Cam lobe height	STD Intake	50.600 mm (1.9921 in.)
		Exhaust	51.185 mm (2.0151 in.)
		Minimum Intake	49.967 mm (1.9672 in.)
		Exhaust	52.004 mm (2.0474 in.)
	Journal diameter	STD	39.959 – 39.975 mm (1.5732 – 1.5738 in.)
		Minimum	39.85 mm (1.5689 in.)
	Inside diameter of camshaft bearing	STD	40.00 mm (1.5748 in.)
		Maximum	40.15 mm (1.5807 in.)
	Oil clearance	STD	0.020 – 0.063 mm (0.0008 – 0.0025 in.)
		Maximum	0.063 mm (0.0025 in.)
	Circle runout	Maximum	0.10 mm (0.0039 in.)
	Thrust clearance	STD	0.110 – 0.296 mm (0.0043 – 0.0116 in.)
		Maximum	0.296 mm (0.0116 in.)
Camshaft gear bolt	Length		30.0 mm (1.181 in.)
Valve rocker arm and shaft	Valve rocker arm bushing inside diameter	STD	22.00 – 22.051 mm (0.8661 – 0.8681 in.)
		Maximum	22.08 mm (0.8693 in.)
	Valve rocker arm shaft outside diameter	STD	21.959 – 21.980 mm (0.8645 – 0.8654 in.)
		Minimum	21.92 mm (0.8630 in.)
	Oil clearance	STD	0.020 – 0.092 mm (0.0007 – 0.0036 in.)
		Maximum	0.16 mm (0.0063 in.)
Injection nozzle	Protrusion	STD	2.25 – 2.75 mm (0.0886 – 0.1083 in.)
		Maximum	2.75 mm (0.1083 in.)
Connecting rod	Rod bent	Maximum per 100 mm (3.94 in.)	0.05 mm (0.0020 in.)
	Rod twist	Maximum per 100 mm (3.94 in.)	0.05 mm (0.0020 in.)
	Bushing inside diameter	STD	37.015 – 37.025 mm (1.4573 – 1.4577 in.)
		Maximum	37.10 mm (1.4606 in.)
	Bushing oil clearance	STD	0.015 – 0.036 mm (0.0006 – 0.0014 in.)
		Maximum	0.08 mm (0.0031 in.)
	Rod big end inside diameter (w/o bearing)	STD	68.985 – 69.000 mm (2.7159 – 2.7165 in.)
		Maximum	69.00 mm (2.7165 in.)
	Rod big end inside diameter (w/ bearing)	STD	64.991 – 65.022 mm (2.5587 – 2.5599 in.)
		Maximum	65.022 mm (2.5599 in.)
	Rod big end oil clearance	STD	0.031 – 0.082 mm (0.0012 – 0.0032 in.)
		Maximum	0.20 mm (0.0079 in.)
	Thrust clearance	STD	0.20 – 0.52 mm (0.0079 – 0.0205 in.)
		Maximum	1.00 mm (0.0394 in.)

Connecting rod bolt	Length		82.5 mm (3.280 in.)
Piston and piston ring	Piston pin diameter	STD	36.989 – 37.000 mm (1.4563 – 1.4567 in.)
		Minimum	36.96 mm (1.4551 in.)
	Piston diameter		
	S05C–B:	STD	113.920 – 113.944 mm (4.4850 – 4.4860 in.)
		Minimum	113.920 mm (4.4860 in.)
	S05C–TA, S05C–TB:	STD	113.869 – 113.885 mm (4.4830 – 4.4837 in.)
		Minimum	113.869 mm (4.4830 in.)
	Piston oil clearance	STD	0.0515 – 0.0715 mm (0.0020 – 0.0028 in.)
	Piston pin boss inside diameter	STD	36.987 – 37.003 mm (1.4562 – 1.4568 in.)
		Minimum	37.05 mm (1.4587 in.)
	Clearance between piston pin boss and piston pin	STD	0.013 (T) – 0.014 (L) mm (0.0051 (T) – 0.0055 (L) in.)
		Maximum	–0.05 mm (–0.0020 in.)
	Piston ring groove width		
	S05C–B:	STD 1st	2.55 – 2.57 mm (0.1004 – 0.1012 in.)
		2nd	2.03 – 2.05 mm (0.0799 – 0.0807 in.)
		Oil	4.01 – 4.03 mm (0.1579 – 0.1586 in.)
		Maximum 1st	2.70 mm (0.1063 in.)
		2nd	2.20 mm (0.0866 in.)
		Oil	4.10 mm (0.1614 in.)
	S05C–TA, S05C–TB:	STD 1st	2.58 – 2.60 mm (0.1015 – 0.1023 in.)
		2nd	2.06 – 2.08 mm (0.0811 – 0.0818 in.)
		Oil	4.01 – 4.03 mm (0.1578 – 0.1586 in.)
		Maximum 1st	2.70 mm (0.1062 in.)
		2nd	2.20 mm (0.0866 in.)
		Oil	4.10 mm (0.1614 in.)
	Piston ring thickness	STD 1st	2.47 – 2.49 mm (0.0972 – 0.0980 in.)
		2nd	1.97 – 1.99 mm (0.0776 – 0.0783 in.)
		Oil	3.97 – 3.99 mm (0.1563 – 0.1571 in.)
		Maximum 1st	2.40 mm (0.0945 in.)
		2nd	1.90 mm (0.0748 in.)
		Oil	3.90 mm (0.1535 in.)
	Piston ring groove clearance		
	S05C–B:	STD 1st	0.06 – 0.10 mm (0.0024 – 0.0039 in.)
		2nd	0.04 – 0.08 mm (0.0016 – 0.0031 in.)
		Oil	0.02 – 0.06 mm (0.0008 – 0.0023 in.)
		Maximum 1st	0.30 mm (0.0118 in.)
		2nd	0.30 mm (0.0118 in.)
		Oil	0.20 mm (0.0079 in.)
	S05C–TA,S05C–TB:	STD 1st	0.09 – 0.13 mm (0.0035 – 0.0051 in.)
		2nd	0.07 – 0.11 mm (0.0016 – 0.0031 in.)
		Oil	0.02 – 0.06 mm (0.0007 – 0.0023 in.)
		Maximum 1st	0.20 mm (0.0078 in.)
		2nd	0.18 mm (0.0070 in.)
		Oil	0.13 mm (0.0051 in.)
	Piston ring end gap	STD 1st	0.30 – 0.40 mm (0.0118 – 0.0157 in.)
		2nd	0.50 – 0.65 mm (0.0197 – 0.0255 in.)
		Oil	0.15 – 0.30 mm (0.0059 – 0.0118 in.)
		Maximum 1st	1.50 mm (0.0591 in.)
		2nd	1.20 mm (0.0472 in.)
		Oil	1.20 mm (0.0472 in.)
Crankshaft	Crank pin diameter	STD	64.940 – 64.960 mm (2.5567 – 2.5575 in.)
		Minimum	63.80 mm (2.5118 in.)
	Circle runout	Maximum	0.15 mm (0.0059 in.)
	Main journal diameter	STD	79.94 – 79.96 mm (3.1472 – 3.1480 in.)
		Minimum for repair	79.80 mm (3.1417 in.)
		for use	78.80 mm (3.1024 in.)
	Main journal oil clearance	STD	0.051 – 0.102 mm (0.0020 – 0.0040 in.)
		Maximum	0.20 mm (0.0079 in.)
	Thrust clearance	STD	0.050 – 0.239 mm (0.0020 – 0.0094 in.)
		Maximum	0.50 mm (0.0197 in.)

Cylinder block	Warpage	STD	0.05 mm (0.0020 in.) or less
		Maximum	0.20 mm (0.0079 in.)
	Main bearing bore diameter (w/o bearing)	STD	84.985 – 85.000 mm (3.3459 – 3.3465 in.)
		Maximum	85.20 mm (3.3543 in.)
	Main bearing bore diameter (w/ bearing)	STD	80.00 mm (3.1496 in.)
		Maximum	80.30 mm (3.1614 in.)
Main bearing cap bolt	Length	STD	106.80 mm (4.2047 in.)
		Maximum	108.00 mm (4.2520 in.)
Cylinder liner	Protrusion		
		STD	0.01 – 0.08 mm (0.0004 – 0.0031 in.)
		Maximum	0.08 mm (0.0031 in.)
	Inside diameter		
		STD	113.988 – 114.012 mm (4.4877 – 4.4887 in.)
		Maximum	114.15 mm (4.4941 in.)
Flywheel	Grind limit		1.00 mm (0.0394 in.)
		Maximum deflection	0.04 mm (0.0016 in.)
	Warpage	STD	0.05 mm (0.0020 in.) or less
		Maximum	1.00 mm (0.0394 in.)
	Sliding surface play	Maximum	0.15 mm (0.0059 in.)

030O8–03

TORQUE SPECIFICATION

Part tightened		N·m	kgf·cm	ft·lbf
Rear end plate bolt		55	560	41
Oil pump x Cylinder block		28.5	290	21
Sub idler gear shaft x Cylinder block		108	1,100	80
Main idler gear shaft x Cylinder block		172	1,750	127
Camshaft gear x Camshaft		59 + 90°	600 + 90°	44 + 90°
Camshaft idler gear shaft x Cylinder head		108	1,100	80
Cylinder head x Cylinder block (Bolt number position: See page 14–3)				
	M12 bolt No. 1, 2, 8, 9, 10, 15, 16, 17	59 + 90° + 90°	600 + 90° + 90°	44 + 90° + 90°
	No. 4, 5, 12, 13	59 + 90° + 135°	600 + 90° + 135°	44 + 90° + 135°
	No. 3, 6, 11, 14, 18	59 + 90° + 180°	600 + 90° + 180°	44 + 90° + 180°
	M10 bolt No. 19, 20, 21	59	600	44
Camshaft bearing cap x Cylinder head		31	320	23
Valve rocker support x Cylinder head		28.5	290	21
Injection nozzle clamp bolt		25	250	18
Injection pipe nut (both end nipples)		39	400	29
Heater plug		25	250	18
Cylinder head cover x Cylinder head		28.5	290	21
Water pump x Cylinder block		28.5	290	21
Thermostat case x Cylinder head		28.5	290	21
Thermostat case x Water pump		55	560	41
Fan clutch (w/ cooling fan) x Water pump		11	110	8
Exhaust manifold x Cylinder head	Inner	59	600	44
	Outer	61	620	45
Intake manifold x Cylinder head		28.5	290	21
Power steering oil pump bolt		47	480	35
Engine mounting nut	Front Engine side	118	1,200	87
	Chassis side	74	750	55
	Rear	74	750	55
Main bearing cap x Cylinder block	1st	69	700	51
	2nd	Loosen	Loosen	Loosen
	3rd	69 + 90° + 45°	700 + 90° + 45°	51 + 90° + 45°
Connecting rod cap x Connecting rod		69 + 90° + 45°	700 + 90° + 45°	43 + 90° + 45°
Flywheel x Crankshaft	1st	186	1,900	137
	2nd	Loosen	Loosen	Loosen
	3rd	186	1,900	137
Oil pan bolt		28.5	290	21
Crankshaft pulley x Crankshaft		108	1,100	80
Drain plug		41	420	30

EXHAUST

030O3–02

SERVICE DATA

Exhaust manifold	Warpage	Maximum	0.20 mm (0.0079 in.)

COOLING

030O4–04

SERVICE DATA

Water Pump	Water Pump bearing	Refarence value	5 mm (0.020 in.)
	Water Pump pulley	Refarence value	6.3 mm (0.25 in.)
Thermostat	Valve opening temperature		80 – 84˚C (176 – 183˚F)
	Valve lift	at 95˚C (203˚F)	10 mm (0.39 in.) or more

LUBRICATION

030O5–04

SERVICE DATA

Oil pump	Backlach	STD	0.073 – 0.203 mm (0.0029 – 0.0081 in.)
		Maximum	0.3 mm (0.0118 in.)
	Shaft diameter	Driven gear shaft	18.064 – 18.082 mm (0.7112 – 0.7119 in.)
	Inside diameter	Driven gear bush	18.122 – 18.147 mm (0.7135 – 0.7144 in.)
	Driven gear clearance	STD	0.040 – 0.083 mm (0.0016 – 0.0032 in.)
		Minimum	0.15 mm (0.0059 in.)

STARTING & CHARGING

030O6–02

SERVICE DATA

Starter	Commutator		
	Diameter	STD	32.0 mm (1.260 in.)
		Minimum	30.0 mm (1.181 in.)
	Undercut depth	STD	0.7 mm (0.028 in.)
		Minimum	0.2 mm (0.008 in.)
	Brash length	STD	18.0 mm (0.709 in.)
		Minimum	12.0 mm (0.472 in.)
	Spring installed load	STD	42.2 – 51.0 N (4.3 – 5.2 kgf, 9.3 – 11.2 lbf)
		Minimum	22.5 N (2.3 kgf, 4.9 lbf)
	Magnetic switch		
	Resistance (M – C)	STD	0.16 – 0.19 Ω
	Resistance (M – body)	STD	0.84 – 0.94 Ω
	Starter clutch		
	Outside diameter	STD: A	26.0 mm (1.024 in.)
		STD: B	12.1 mm (0.476 in.)
		Minimum: A	25.88 mm (1.019 in.)
		minimum: B	12 mm (0.472 in.)
	Starter drive housing		
	Inside diameter	STD	26 mm (1.024 in.)
		Minimum	26.2 mm (1.031 in.) or more
	Starter motor housing		
	Inside diameter	STD	12.1 mm (0.476 in.)
		Minimum	12.3 mm (0.484 in.) or more
	Commutator end frame		
	Inside diameter	STD	12 mm (0.472 in.)
		Minimum	12.2 mm (0.480 in.)
Alternator	Rotor coil resistance at 20˚C (68˚F)	Open circuit	11.6 – 12.4 Ω
		Ground	10 MΩ at more
	Slip ring diameter	STD	14.2 – 14.4 mm (0.559 – 0.567 in.)
		Minimum	12.8 mm (0.504 in.)
	Brush exposed length	STD	9.5 – 11.5 mm (0.374 – 0.453 in.)
		Minimum	1.5 mm (0.059 in.)
IC regulator	Regulating voltage	at 115˚C (239˚F)	27.7 – 28.7 V

030O7–02

TORQUE SPECIFICATION

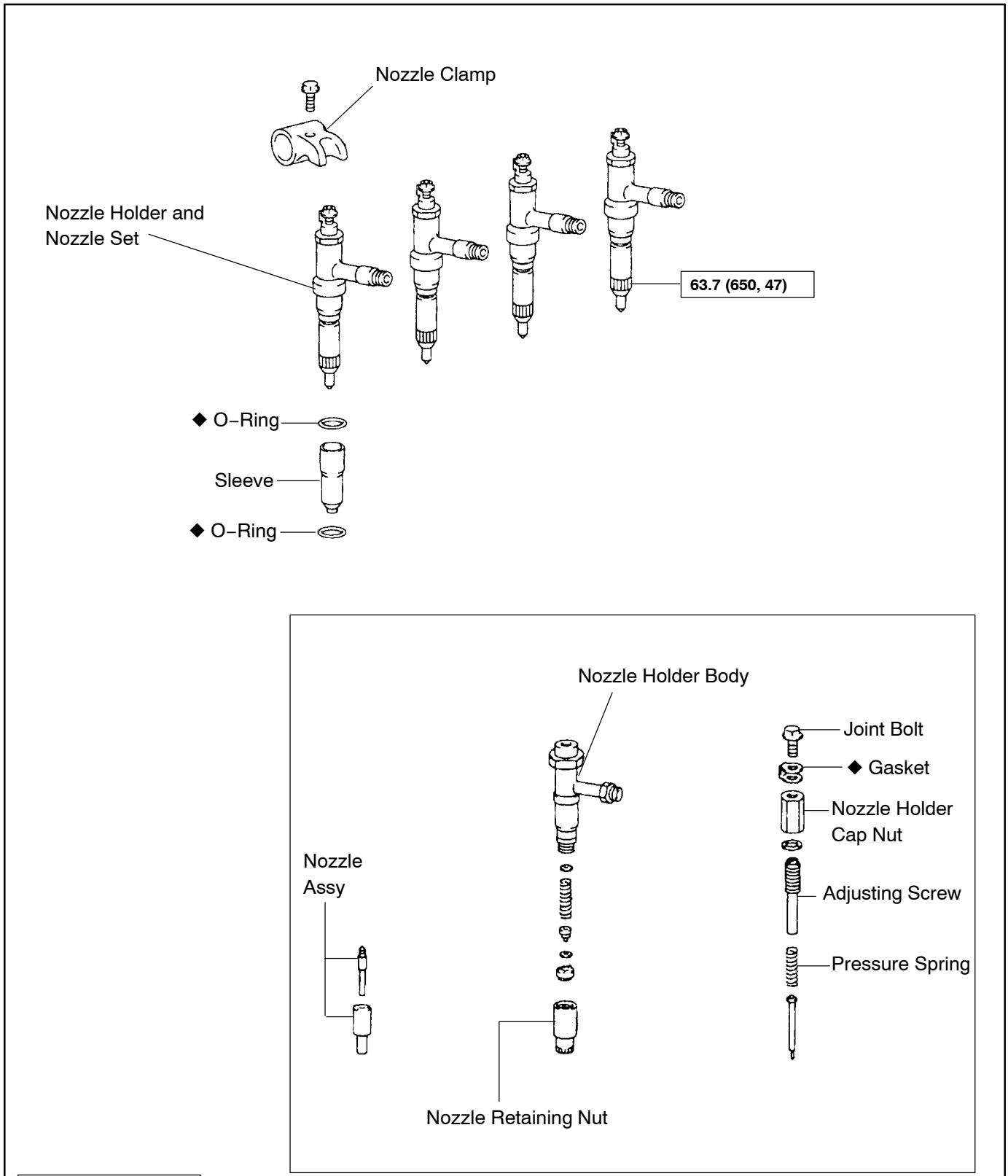
Part tightened		N·m	kgf·cm	ft·lbf
Motor housing x Starter drive housing		15	153	11
Magnetic switch x Starter drive housing		14.7	150	11
Commutator end frame x Starter drive housing		14.7	150	11
Commutator end frame x Brush holder		4.3	44	38 in.·lbf
Bearing retainer x Drive end frame		2.0	30	26 in.·lbf
Rectifier end frame with cord clip x Drive end frame	Nut A	4.5	46	40 in.·lbf
	Nut B	5.4	55	48 in.·lbf
Alternator pulley x Rotor		39	400	29
Rectifier holder x Lead wire on rectifier end frame	70 A Screw	1.96	20	17 in.·lbf
	Bolt	3.9	40	35 in.·lbf
IC regulator x Rectifier holder		2.0	20	18 in.·lbf
Brush holder x Rectifier holder		2.0	20	18 in.·lbf
Brush holder x IC regulator		2.0	20	18 in.·lbf
Rear end cover x Rectifier holder		5.4	55	48 in.·lbf
Terminal insulator x Rectifier holder		4.1	42	36 in.·lbf

FUEL

NOZZLE HOLDER AND NOZZLE SET

110R0–01

COMPONENTS

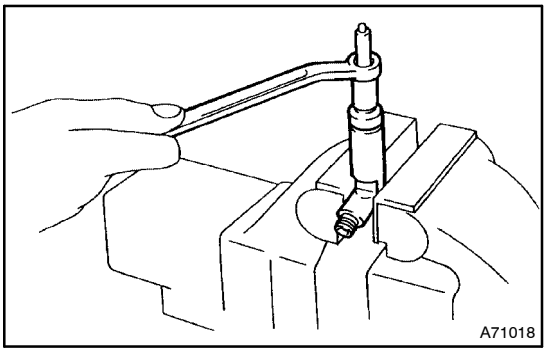


N·m (kgf·cm, ft·lbf) : Specified Torque
◆ Non–Reusable Part

A74294

110R1–01

OVERHAUL



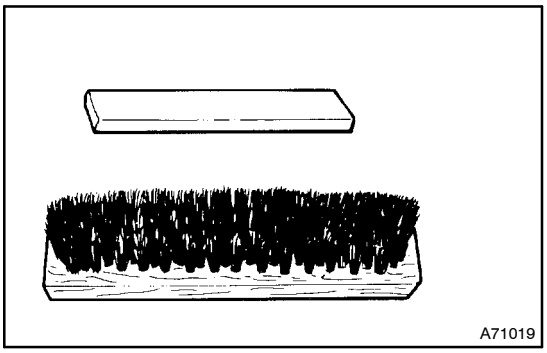
1. REMOVE NOZZLE ASSY

(a) Remove the nozzle holder retaining nut.

NOTICE:

When disassembling the nozzle, be careful not to drop the inner parts.

(b) Disassemble the nozzle holder and nozzle set, and remove the nozzle assy.

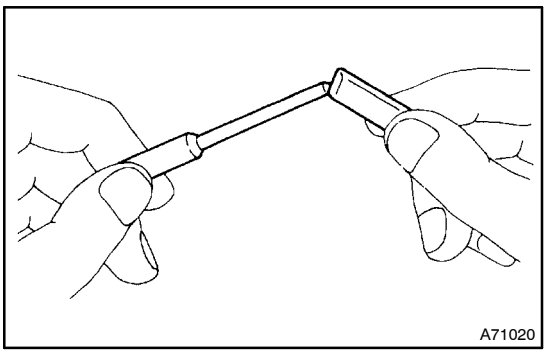


2. CLEAN NOZZLE ASSY

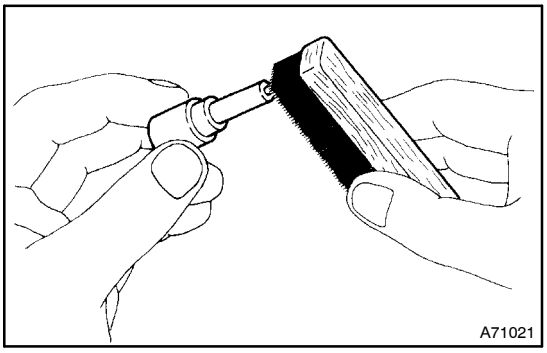
(a) Using a wooden stick and brass brush, clean the nozzle. Wash them in clean diesel fuel.

HINT:

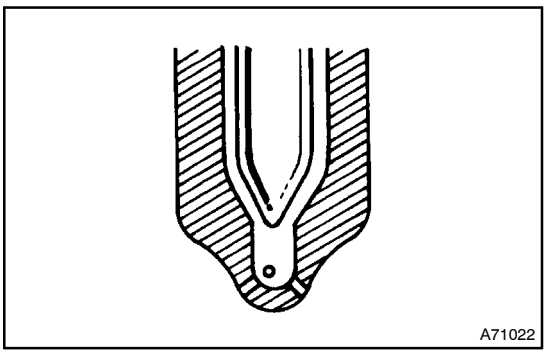
Do not touch the nozzle mating surfaces with your fingers.



(b) Using a wooden stick, remove the carbons adhering to the nozzle needle tip.

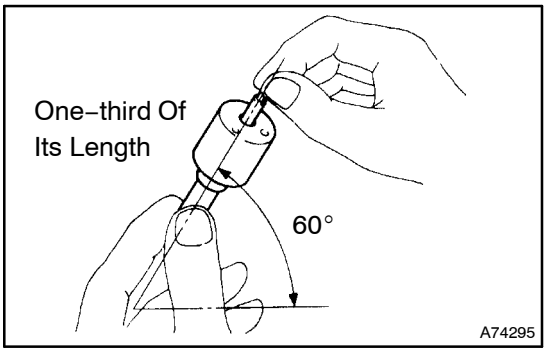


(c) Using a brass brush, remove the carbons from the exterior of the nozzle body (except lapped surface).



(d) Check the seat of the nozzle body for burns or corrosion.
(e) Check the nozzle needle tip for damage or corrosion.

If any of these conditions are present, replace the nozzle assy.



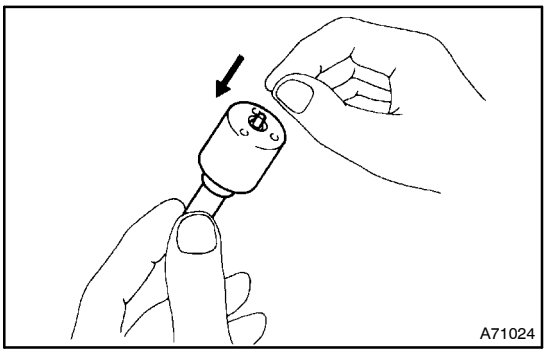
3. INSPECT NOZZLE ASSY

(a) Wash the nozzle in clean diesel fuel.

HINT:

Do not touch the nozzle mating surfaces with your fingers.

(b) Tilt the nozzle body about 60 degrees and pull the needle out about one–third of its length.
(c) When released, the needle should fall into the body vent smoothly by its own weight.



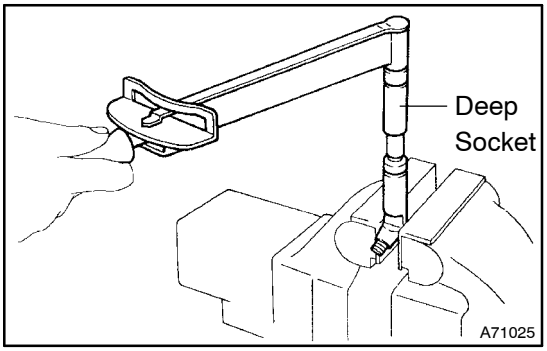
(d) Repeat this inspection, rotating the needle slightly each time. If the needle does not fall freely, replace the nozzle assy.

4. INSTALL NOZZLE ASSY

(a) Assemble the nozzle holder body, adjusting shim, capsule sub–assembly, adjusting shim, No. 1 pressure spring, distance piece, 2 straight pins and nozzle sub–assembly, and finger–tighten the retaining nut.

HINT:

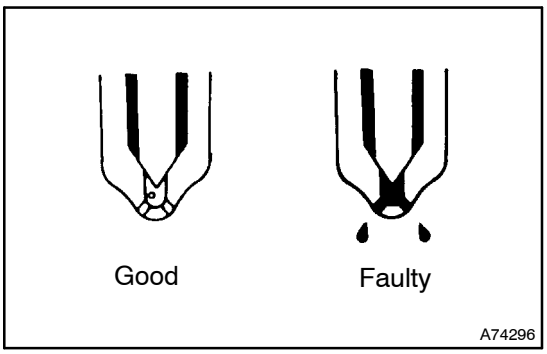
- Align the holes of the nozzle body, distance piece and nozzle holder body.
- When the thickness of the adjusting shim originally used is unclear, use a shim with 1.5 mm (0.56 in.) thickness instead.

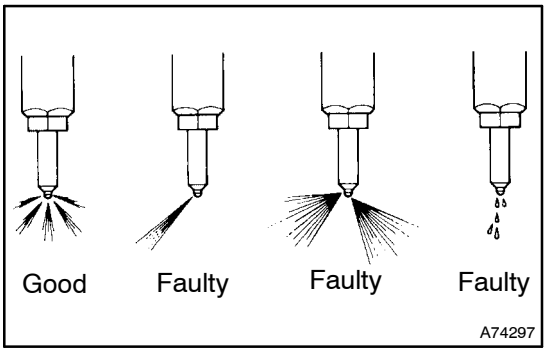


(b) Using a deep socket wrench, tighten the retaining nut.
Torque: 63.7 N·m (650 kgf·cm, 47 ft·lbf)

NOTICE:

Over–torquing could make the nozzle deformed, the needle stuck or other areas defective.





5. INSPECT NOZZLE HOLDER AND NOZZLE SET

(a) Check for leaks.

(1) While maintaining pressure at about 981 – 1,961 kPa (10 – 20 kgf/cm^2 142 – 284 psi) below No.1 opening pressure (adjust it by tester handle), check that there is no dripping from the injection hole or around the retaining nut for 10 seconds.

If there is dripping within 10 seconds, replace or clean and overhaul the nozzle assy.

(b) Check the spray pattern.

(1) The injection nozzle should shudder at a certain pumping speed between 15 – 60 times (old nozzle) or 30 – 60 times (new nozzle) per minute.

(2) Check the spray pattern during shuddering.

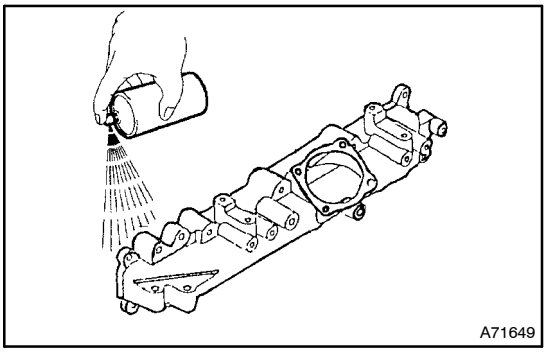
If the spray pattern is not correct during shuddering, replace or clean the nozzle.

INTAKE

INTAKE MANIFOLD

INSPECTION

1305Z–01



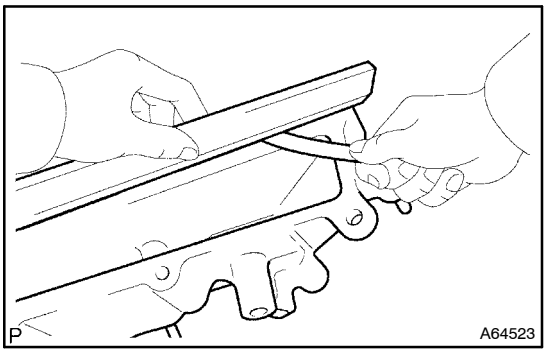
1. INSPECT INTAKE MANIFOLD

HINT:

Clean the intake manifold with a commercial cleaning agent before the inspection.

(a) Using a dye penetrate, check the intake manifold for cracks, using a dye penetrate.

If cracks are found, replace the manifold.



(b) Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

If warpage is greater than the maximum, replace the intake manifold.

(c) Visually check the seal surface of the intake manifold for deformation or wear.

If damage such as deformation and wear is excessive, replace the manifold.

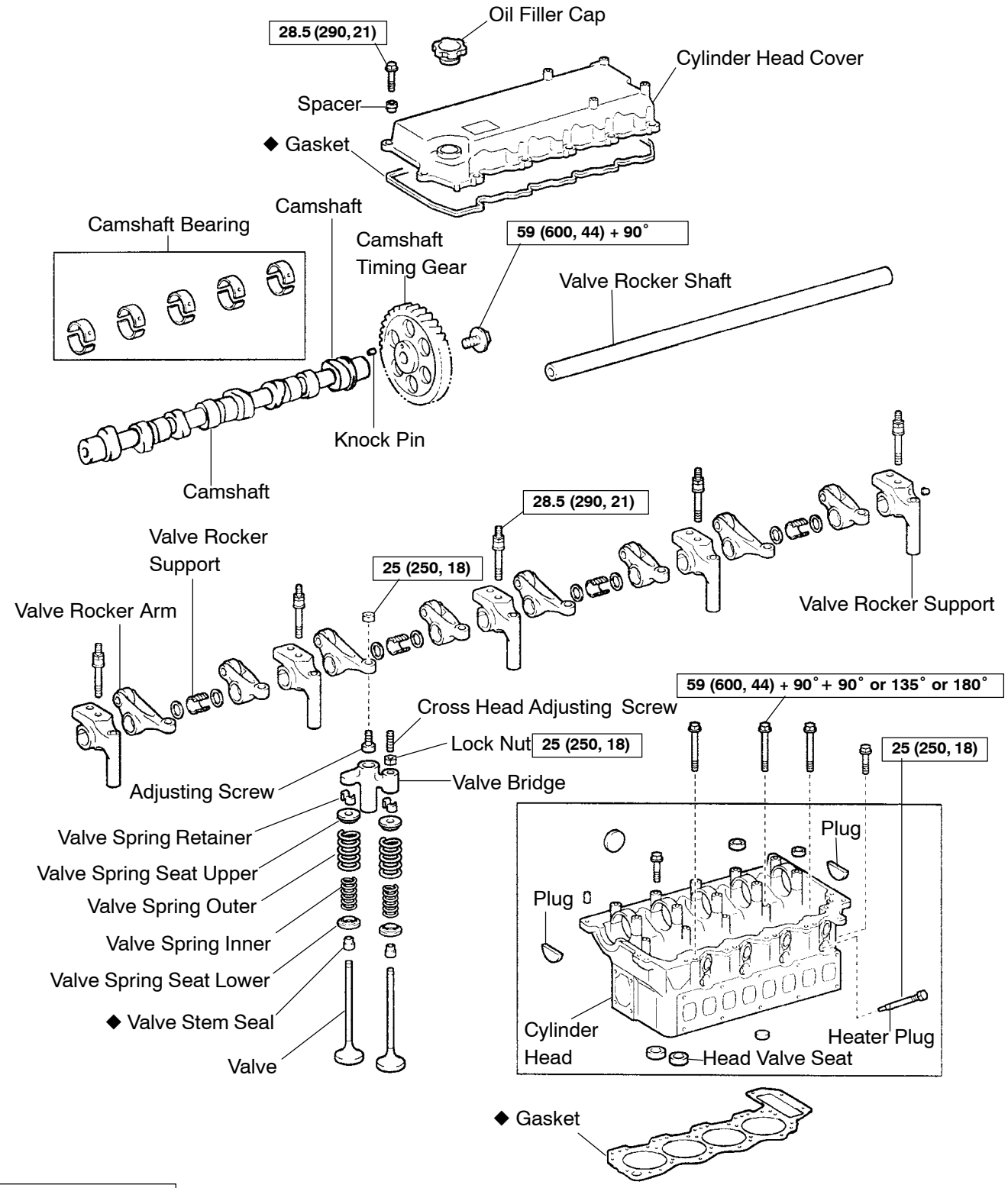
ENGINE MECHANICAL

CAMSHAFT HOUSING AND CYLINDER HEAD

COMPONENTS

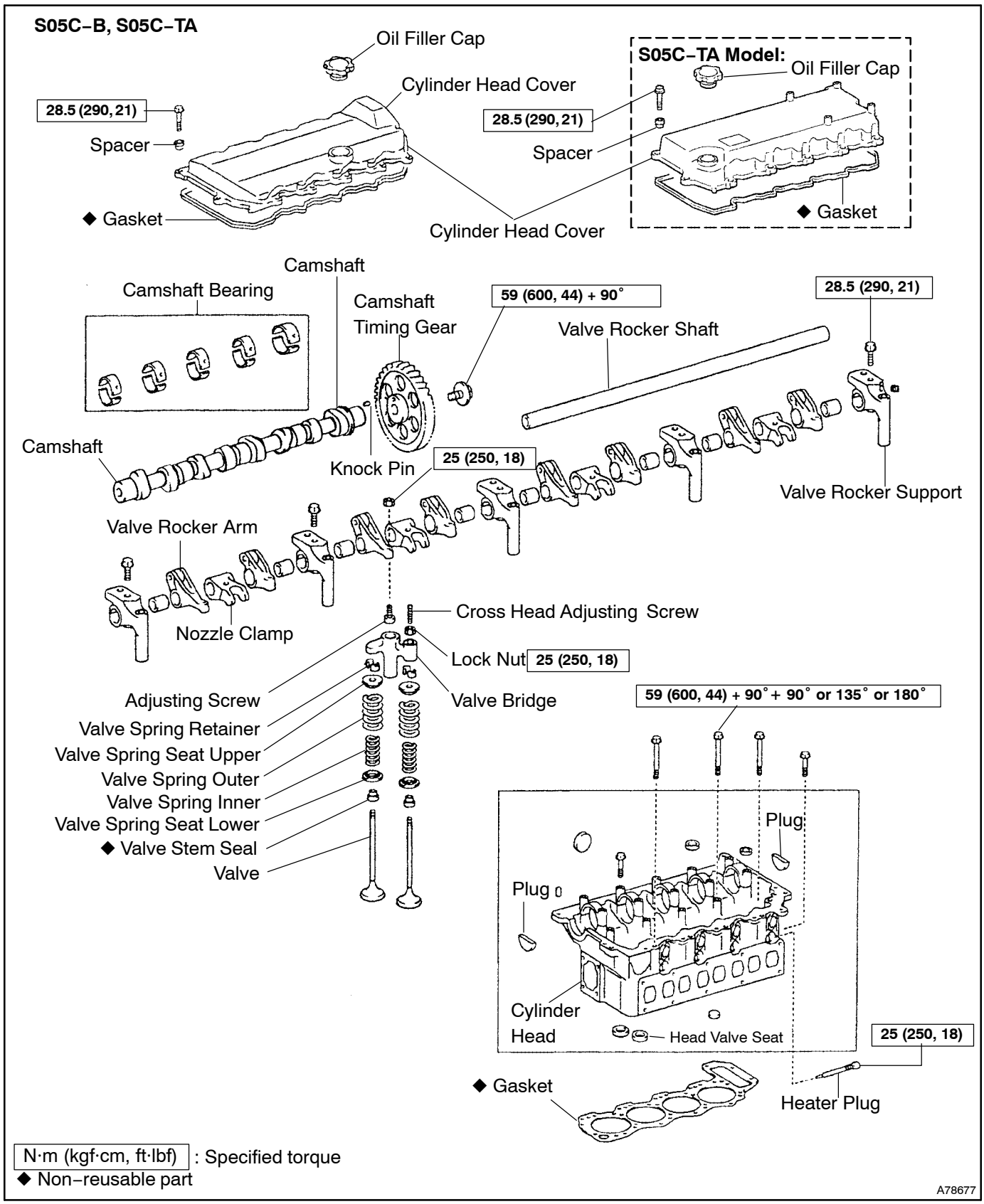
1417J–01

S05C–TB

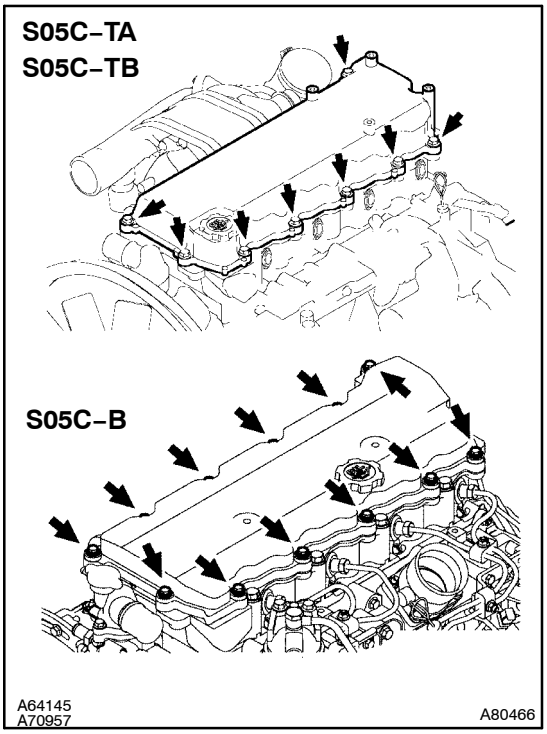


N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

A76574


S05C–B, S05C–TA
Oil Filler Cap
Cylinder Head Cover
28.5 (290, 21)
Spacer
◆ Gasket
Cylinder Head Cover
S05C–TA Model:
Oil Filler Cap
28.5 (290, 21)
Spacer
◆ Gasket
Camshaft
Camshaft Bearing
Camshaft Timing Gear
59 (600, 44) + 90°
28.5 (290, 21)
Valve Rocker Shaft
Camshaft
Knock Pin
25 (250, 18)
Valve Rocker Support
Valve Rocker Arm
Nozzle Clamp
Cross Head Adjusting Screw
Lock Nut
25 (250, 18)
Valve Bridge
Adjusting Screw
Valve Spring Retainer
Valve Spring Seat Upper
Valve Spring Outer
Valve Spring Inner
Valve Spring Seat Lower
◆ Valve Stem Seal
Valve
59 (600, 44) + 90° + 90° or 135° or 180°
Plug
Plug
Cylinder Head
Head Valve Seat
25 (250, 18)
◆ Gasket
Heater Plug
N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part
A78677

OVERHAUL



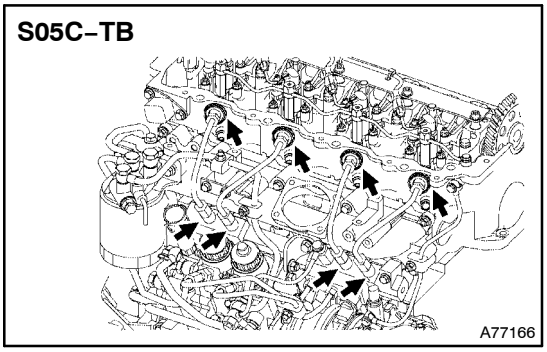
1. REMOVE CYLINDER HEAD COVER SUB–ASSY

NOTICE:

Clean all dust around the cylinder head cover before removing it to prevent foreign particles from getting in.

2. REMOVE INTAKE AIR CONNECTOR

(a) S05C–TA, S05C–TB:
Remove the 4 bolts and intake air connector.

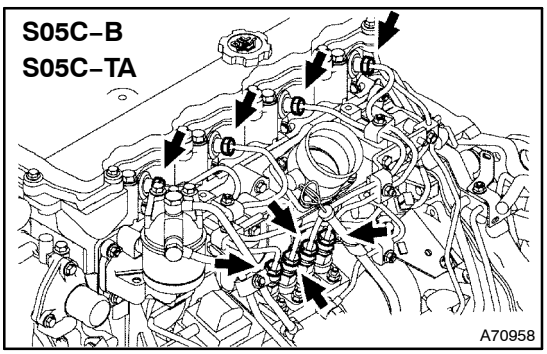


3. REMOVE INJECTION PIPE SET

(a) Loosen the 4 union nuts from the 4 injectors.

NOTICE:

- **After removing the fuel pipe, affix the gummed tape to the common rail for preventing dust.**
- **After removing the fuel pipe, put a vinyl bag and rubber band over the injectors inlet to prevent foreign particles from getting in.**

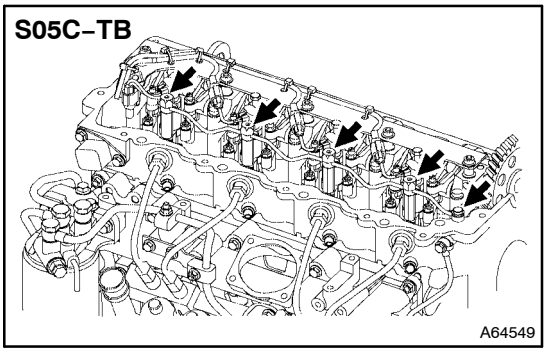


(b) Loosen the 4 union nuts from the 4 injection nozzles.

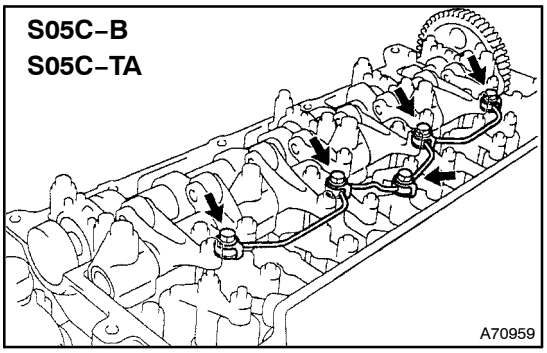
NOTICE:

After removing the fuel pipe, put it in a vinyl bag and bind the vinyl bag with a rubber band to prevent mixing foreign objects from getting into the injection nozzle inlet.

4. REMOVE NOZZLE HOLDER SEAL

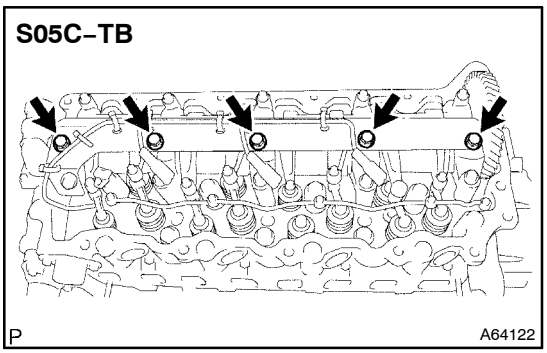


5. REMOVE NOZZLE LEAKAGE PIPE NO.1



6. REMOVE NOZZLE LEAKAGE PIPE

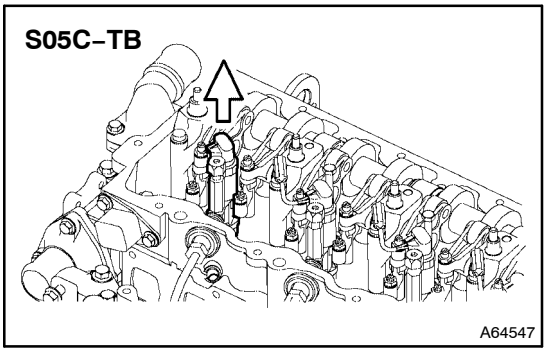
(a) Remove the 5 joint bolts, fuel return pipe and 5 gaskets.



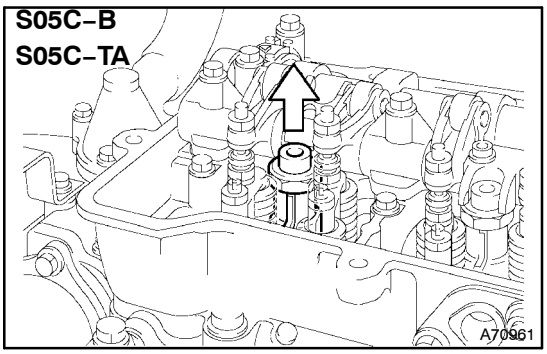
7. REMOVE INJECTOR HARNESS BRACKET

(a) Disconnect the injector connectors.

(b) Remove the 5 nuts and injector harness bracket.



8. REMOVE INJECTOR ASSY



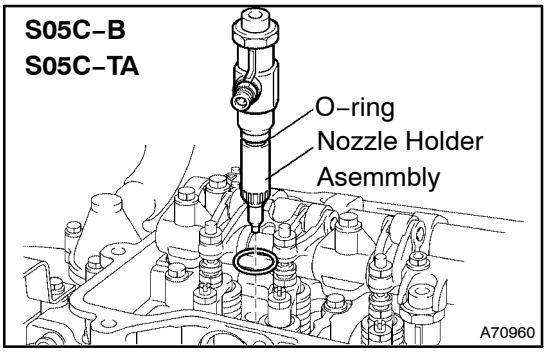
9. REMOVE INJECTION NOZZLE SUB–ASSY

(a) Loosen the injection pipe nut.

(b) Remove the injection pipe seal mounting bolts. Then, remove the injection pipe seal together with the injection pipe out of the cam housing.

(c) Remove the nozzle clamp bolt.

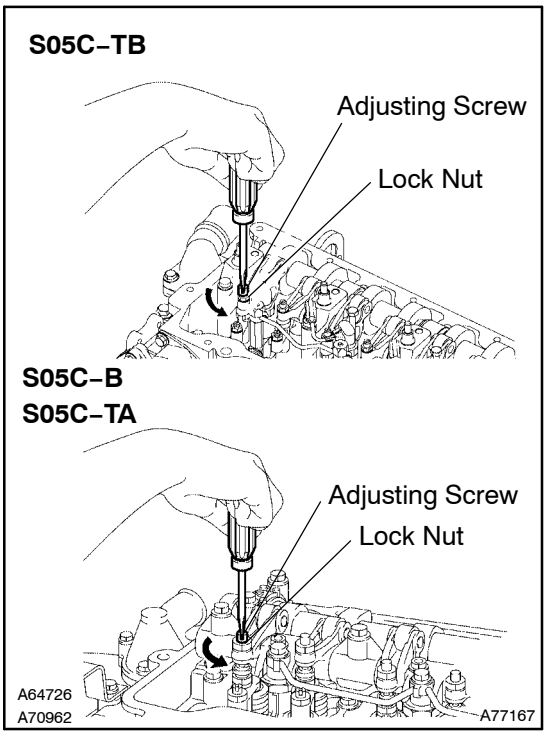
(d) Pull out the nozzle holder assembly, avoiding any interference.



(e) Remove the O–ring.

NOTICE:

Replace the 2 O–rings with a new ones.

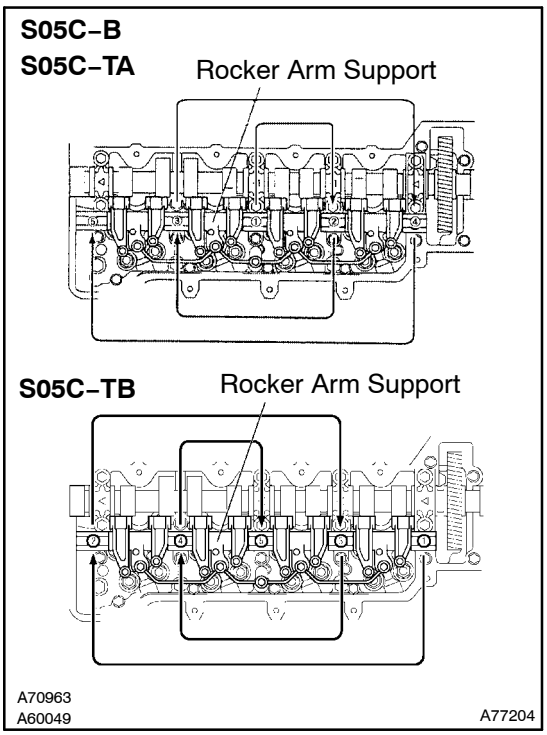


10. LOOSEN VALVE CLEARANCE ADJUSTING SCREW

(a) Loosen the lock nut on the top of the rocker arm, then wind up the adjusting screw completely.

HINT:

If the adjusting screw is left unwound, the rocker shaft may be bent when the rocker arm support is loosened.



11. REMOVE VALVE ROCKER ARM ASSY

(a) Remove the rocker arm support bolt in the order as shown in the illustration.

(b) Remove the valve bridge.

NOTICE:

When the rocker arm assembly is removed, the rocker arm and support tend to come off the rocker shaft. Be careful in handling.

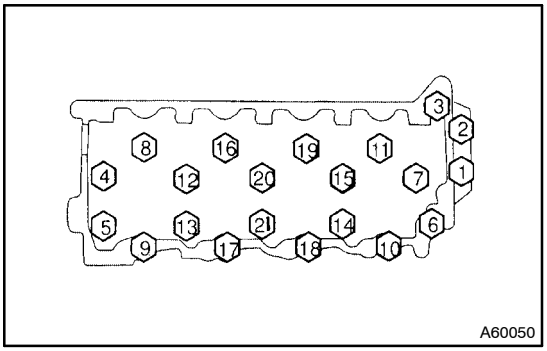
12. REMOVE CAMSHAFT

(a) Remove the cam bearing cap bolt.

(b) Remove the camshaft together with the gear.

NOTICE:

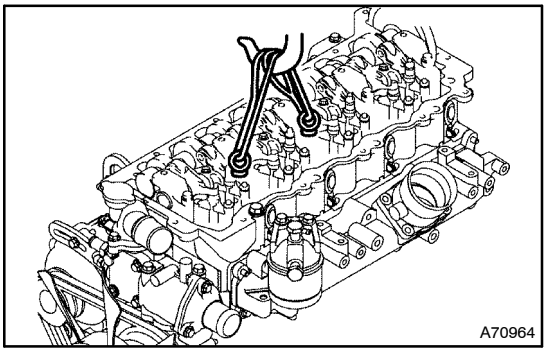
Be extremely careful not to drop any part into the interior of the engine.



13. REMOVE CYLINDER HEAD SUB–ASSY

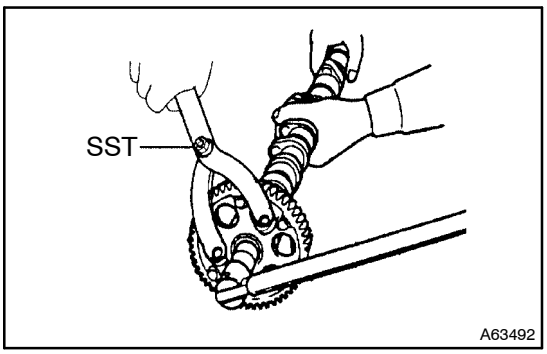
(a) Remove the cylinder head bolts in the order as shown in the illustration.

(b) Lift and remove the cylinder head from the cylinder block.



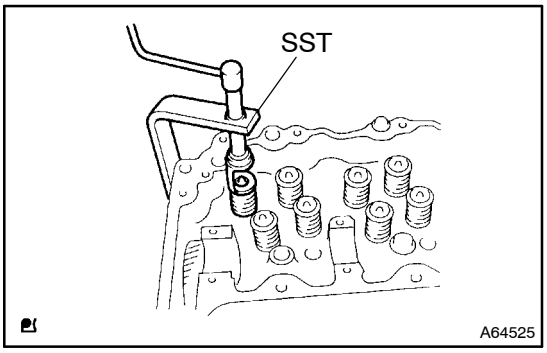
NOTICE:

- **Place a piece of wood under the cylinder head and table.**
- **When placing the cylinder head together with the injection nozzle, avoid contact between the injection nozzle and piece of wood.**
- **Check that there is no oil, water or gas leakage in the cylinder head gasket if overheated or not.**



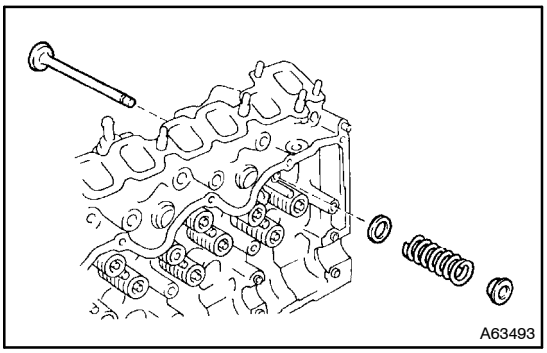
14. REMOVE CAMSHAFT TIMING GEAR

(a) Using SST, remove the timing gear.
SST 09960–10010 (09962–01000, 09963–01000)



15. REMOVE VALVE

(a) Using SST, press–fit the valve spring seat upper, then remove the valve spring retainer.
SST 09202–70020

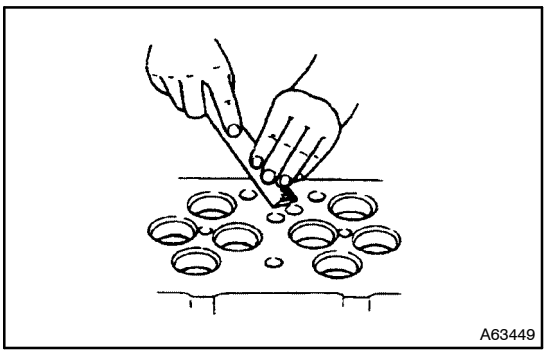


(b) Remove the valve spring seat upper, valve springs outer and inner.

(c) Remove the intake and exhaust valves from the cylinder head.

NOTICE:

- **Do not remove the valve guide and valve spring seat lower unless they need to be replaced.**
- **Align the removed parts in the order of the cylinder number.**



16. CLEAN CYLINDER HEAD SUB–ASSY

(a) Remove the gasket material.

(1) Using a gasket scraper, remove all the gasket materials from the cylinder block contact surface.

NOTICE:

Be careful not to scratch the cylinder block contact surface.

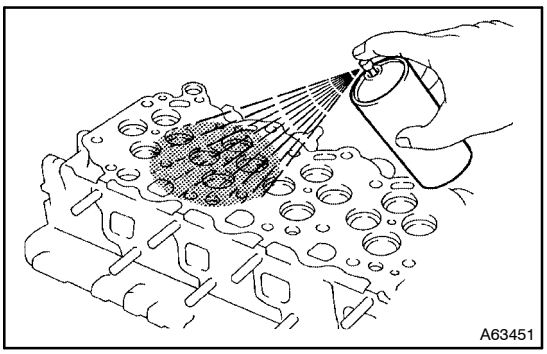
(b) Clean the intake and exhaust ports.
Using a wire brush, clean all the intake and exhaust ports.

NOTICE:

Be careful not to scratch the valve contact surface.

(c) Clean the valve guide.
Using a valve guide brush and solvent, clean all the valve guide.

(d) Clean the cylinder head.
Using a soft brush and solvent, thoroughly clean the cylinder head.

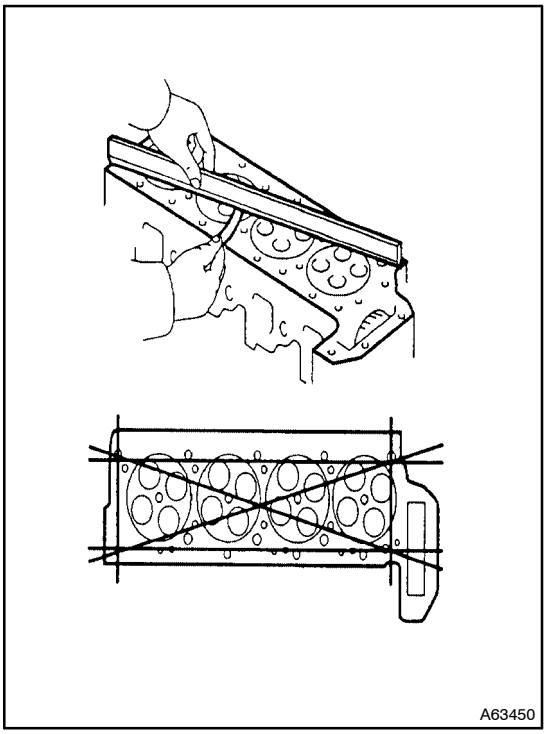


17. INSPECT CYLINDER HEAD SUB–ASSY

(a) Inspect for cracks.

(1) Using a dye penetrate, check the intake ports, exhaust ports and the surface contacting the cylinder block.

If cracks are found, replace the cylinder head.

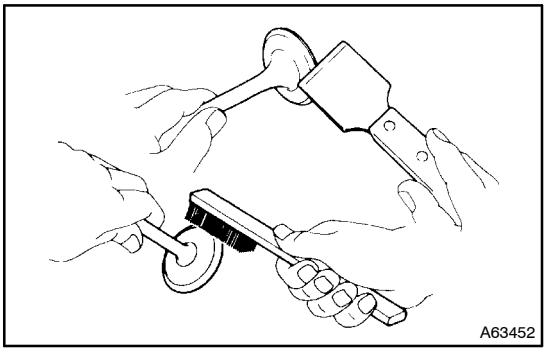


(b) Inspect for flatness.

(1) Using a precision straight edge and a feeler gauge, measure warpage of the surfaces that contact the cylinder block and the manifolds.

Standard warpage:
0.04 mm (0.0016 in.) or less for longitudinal direction
0.03 mm (0.0012 in.) or less for lateral direction
Maximum warpage: 0.20 mm (0.0079 in.)

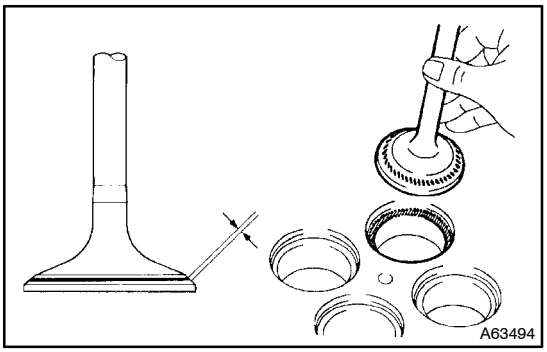
If the warpage is greater than the maximum, replace the cylinder head.



18. CLEAN VALVE

(a) Using a gasket scraper, chip off any carbons from the valve head.

(b) Using a wire brush, thoroughly clean the valve.



19. INSPECT VALVE

(a) Visually check the valves for damage, burns, carbons or warpage, and check the valve heads, valve stems and valve stem grooves for cracks.

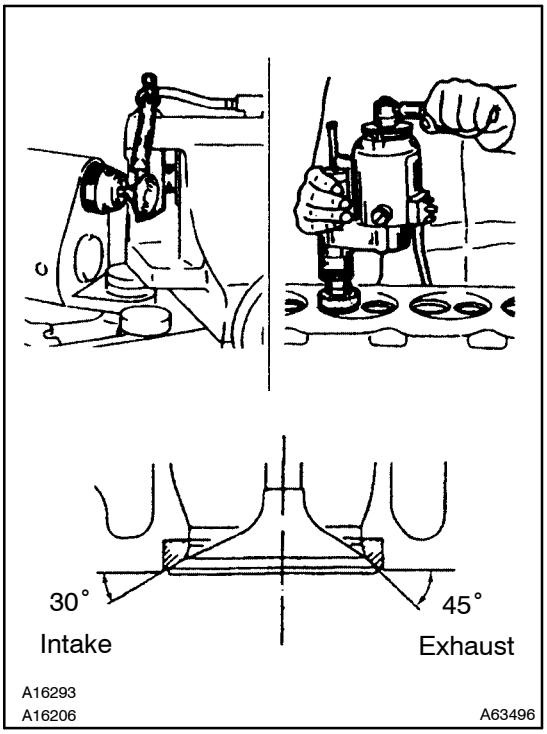
If wear, burns, warpage or cracks are excessive, replace the valves.

(b) Check the valve seating condition.

(1) Lightly apply red lead marking compound to the valve face.

(2) Tapping and rotating the valve against the seat, check the seating condition.

If the red lead mark is not concentric or the compound is scattered all around the valve face or seat, correct the valve face or the valve seat.



20. REPAIR VALVE SEAT

(a) Grind the valve and seat.

HINT:

- Grinding of valves should only be performed when hand–lapping, does not result in proper seating.
- When hand–lapping, always recheck the seating condition.

CAUTION:

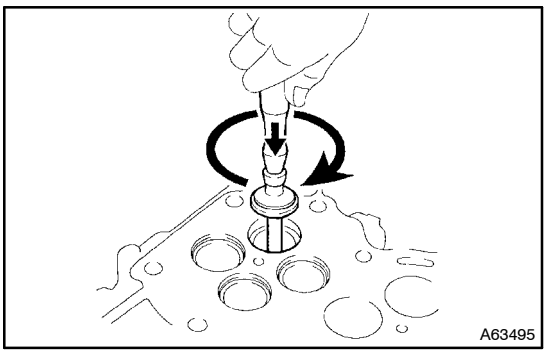
When grinding, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.

Valve seat angle:

Intake	30°00' – 30°30'
Exhaust	44°15' – 45°45'

Valve face angle:

Intake	29°45' – 30°00'
Exhaust	44°45' – 45°00'

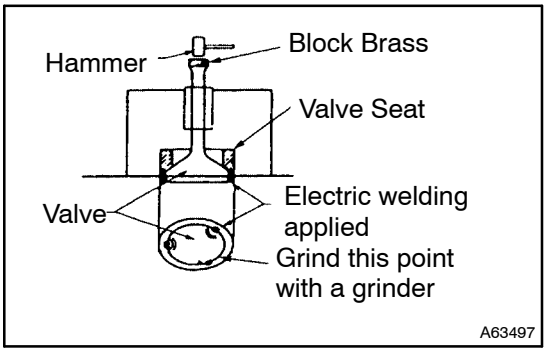


(b) Hand–lap the valve and valve seat.

(1) Lightly apply lapping compound to the valve face. Then, tap and rotate the valve against the seat.

HINT:

- After hand–lapping, clean off any lapping compound on the valves and valve seats.
- When hand–lapping, always recheck the seating condition.



21. REMOVE VALVE SEAT

(a) Cut the 3 places on the circumference of an unwanted valve and weld it to the valve seat.

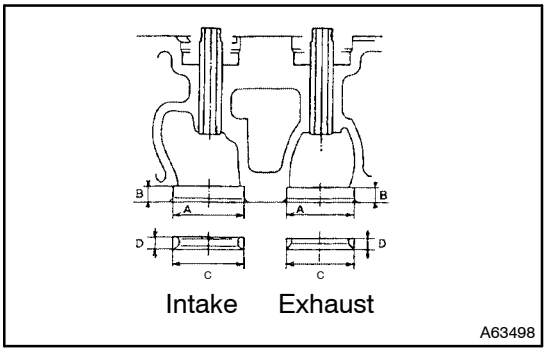
NOTICE:

To protect the lower surface of the cylinder head from welding spatters, be sure to apply grease before welding.

(b) Place a block brass on the top of the valve stem and strike it with a hammer to remove the valve seat.

CAUTION:

When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



22. INSTALL VALVE SEAT

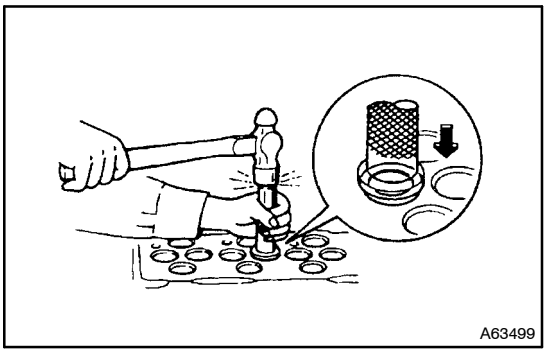
(a) Machine the valve seat according to the specified valve seat dimensions.

Cylinder head dimension:

Intake (A)	41.000 – 41.016 mm (1.6142 – 1.6148 in.)
Intake (B)	9.400 – 9.600 mm (0.3701 – 0.3780 in.)
Exhaust (A)	39.000 – 39.016 mm (1.5354 – 1.5361 in.)
Exhaust (B)	8.600 – 8.800 mm (0.3386 – 0.3465 in.)

Valve seat dimension:

Intake (C)	41.085 – 41.100 mm (1.6175 – 1.6181 in.)
Intake (D)	7.000 – 7.200 mm (0.2756 – 0.2835 in.)
Exhaust (C)	39.120 – 39.135 mm (1.5402 – 1.5407 in.)
Exhaust (D)	6.000 – 6.200 mm (0.2362 – 0.2441 in.)



(b) Heat the cylinder head to 80 – 100 °C (176 – 212 °F) with hot water. Cool the valve seat with dry ice for approximately 30 minutes.

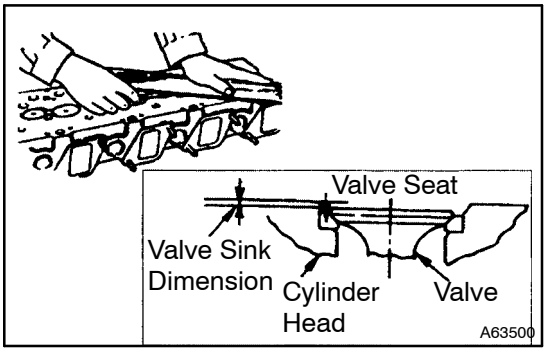
(c) Hold the valve seat with pincers and place it into the heated cylinder head. Lightly hitting the valve seat can easily fit them it.

HINT:

When valve grinding the valve, always recheck the seating condition.

CAUTION:

- **Never touch the cooled valve seat with your bare hands.**
- **When hitting, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.**



23. INSPECT VALVE SINK

Standard dimension:

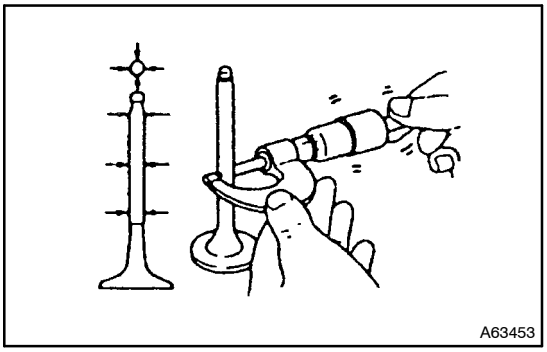
Intake	0.55 – 0.85 mm (0.0217 – 0.0335 in.)
Exhaust	1.30 – 1.60 mm (0.0512 – 0.0630 in.)

Maximum dimension:

Intake	1.2 mm (0.0472 in.)
Exhaust	1.8 mm (0.0708 in.)

HINT:

- If the valve heads are protruding from the cylinder head surface, the valve heads may hit against the pistons while the engine is running.
- When replacing the valve and valve seat, always recheck the seating condition.


A63453

24. INSPECT VALVE STEM AND VALVE GUIDE

(a) Using a micrometer, measure the diameter of the stem.

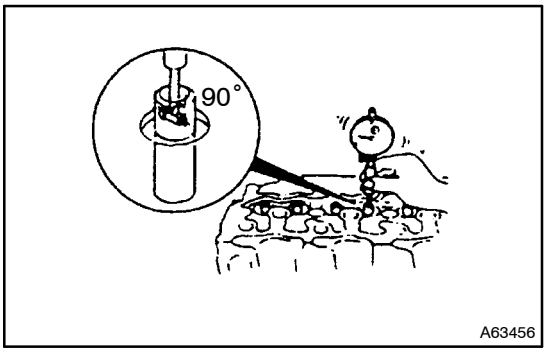
Standard valve stem diameter:

Intake	6.957 – 6.977 mm (0.2739 – 0.2747 in.)
Exhaust	6.932 – 6.950 mm (0.2730 – 0.2736 in.)

Minimum valve stem diameter:

Intake	6.92 mm (0.2724 in.)
Exhaust	6.85 mm (0.2700 in.)

If the stem diameter is less than the minimum, replace the valve.



A63456

(b) Using a cylinder gauge, measure the inside diameter of the valve guide.

(c) Calculate the oil clearance between the valve stem and valve guide.

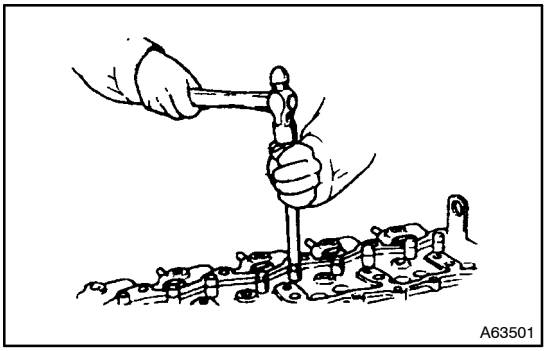
Standard oil clearance:

Intake	0.023 – 0.058 mm (0.0010 – 0.0022 in.)
Exhaust	0.050 – 0.083 mm (0.0020 – 0.0033 in.)

Maximum oil clearance:

Intake	0.12 mm (0.0047 in.)
Exhaust	0.15 mm (0.0059 in.)

If the oil clearance is greater than the maximum, replace the valve or valve guide.


A63501

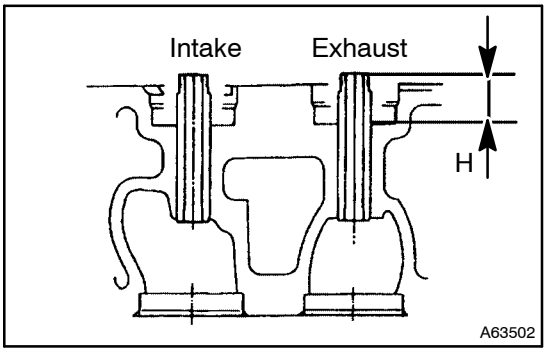
25. REMOVE VALVE GUIDE

(a) Remove the valve stem seal.

(b) Using a brass bar and a hammer, Strike out the valve guide.

CAUTION:

When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



A63502

26. INSTALL VALVE GUIDE

(a) Press–fit a new valve guide straight allowing it to protrude, as shown in the illustration.

Protrusion:

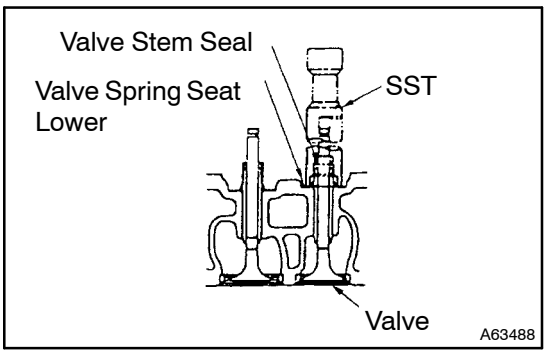
	Intake	Exhaust
H	20.9 mm (0.823 in.)	21.3 mm (0.839 in.)

HINT:

Apply engine oil lightly to the valve guide outer circumference before the installation.

27. REMOVE VALVE STEM SEAL

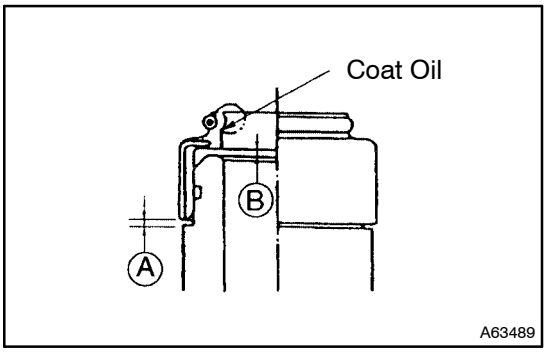
(a) Remove the valve stem seal when the valve guide is replaced or when seal clearance is excessive or the stem seal has been worn or damaged.



28. INSTALL VALVE STEM SEAL

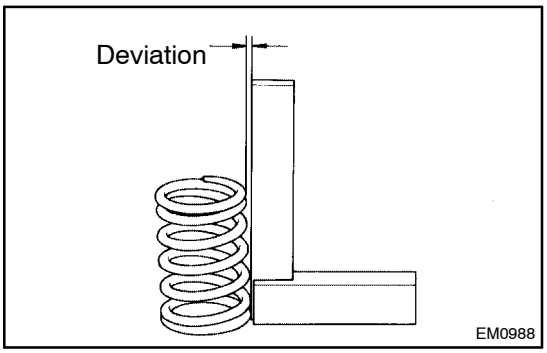
(a) Install the lower spring seat and valve to the cylinder head (for guide of SST), then apply engine oil to the lip of the stem seal and drive the guide with SST.
SST 09201–41020

CAUTION:
When striking, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



HINT:

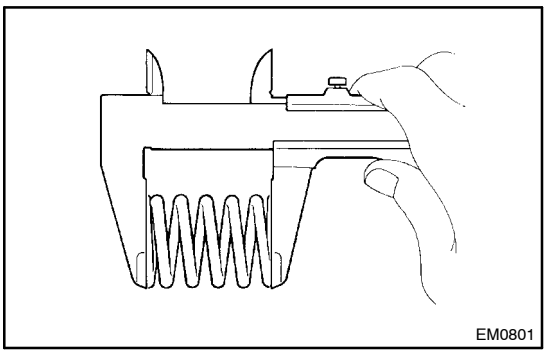
- After installing the valve stem seal, make sure the there are gaps (A) and (B) as shown in the illustration.
- Do not use SST if its surface contacting the valve spring lower seat is deformed.
- Check that the seal has not been deformed or cracked after the installation.



29. INSPECT VALVE SPRING

(a) Using a steel square, measure the deviation of the valve spring.
Maximum deviation: 2.0 mm (0.079 in.)

If the deviation is greater than the maximum, replace the valve spring.



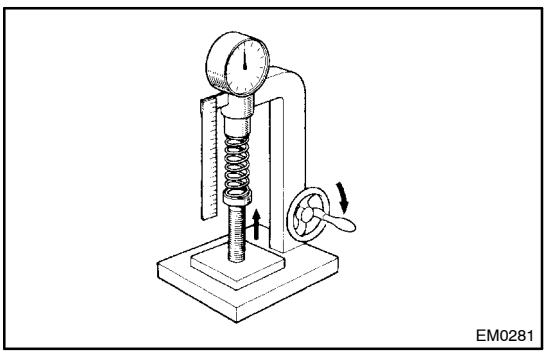
(b) Using vernier calipers, measure the free length of the valve spring.
Standard free length:

Inner spring	64.6 mm (2.543 in.)
Outer spring	75.7 mm (2.980 in.)

Minimum free length:

Inner spring	61.6 mm (2.425 in.)
Outer spring	72.7 mm (2.862 in.)

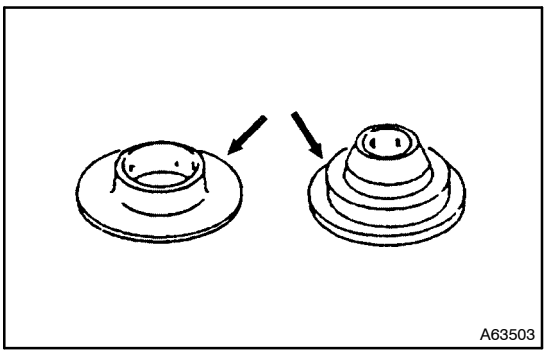
If the free length is less than the minimum, replace the spring.



(c) Using a spring tester, measure the tension of the valve spring at the specified setting height.
Install tension:

Item	Setting Height	Tension
Inner spring	44.8 mm (1.764 in.)	128.5 N (13.1 kgf, 28.9 lbf)
Outer spring	46.8 mm (1.843 in.)	313.8 N (32.0 kgf, 70.5 lbf)

If the installed tension is not as specified, replace the spring.



30. INSPECT VALVE SPRING SEAT

(a) Visually check the contact surface of the upper and lower valve spring seats.

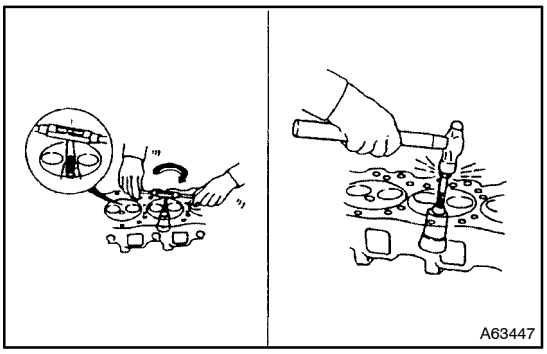
If damage such, as wear and scratches, is excessive, replace the valve spring seat.

31. INSPECT CYLINDER HEAD COOLANT GALLERY FOR LEAKS

(a) Close all coolant holes and apply air pressure of about 2.5 kgf/cm^2 (36 psi.) from one of the coolant holes.

(b) Immerse the cylinder head into the water, then check for air leakage.

If any leakage is found, replace the cylinder head.

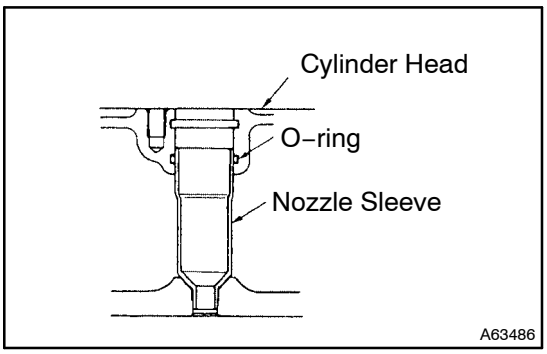


32. REMOVE NOZZLE SLEEVE

(a) Engage a tap to the nozzle sleeve from the bottom of the cylinder head. Screw in an appropriate bolt, then strike the bolt head with a hammer and tap out the nozzle sleeve.

CAUTION:

When tapping, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.



33. INSTALL NOZZLE SLEEVE

(a) Install a new O–ring to the nozzle sleeve insert hole of the cylinder head. Then apply seal packing to the bottom of a new nozzle sleeve, and insert it to the nozzle sleeve insert hole of the cylinder head.

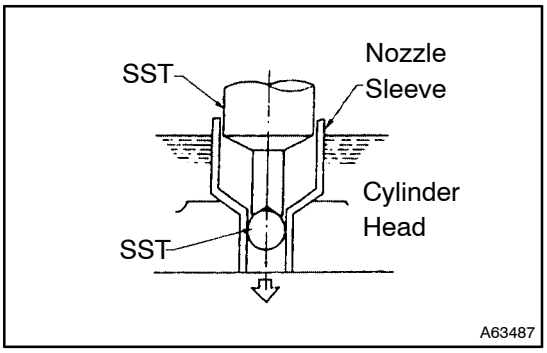
Seal packing: Part No. 08826–00080 or equivalent

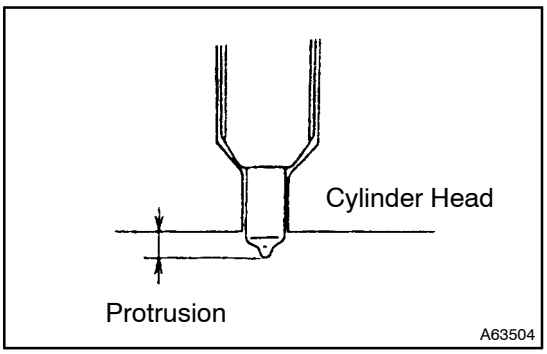
NOTICE:

Be sure to install a new O–ring. Reused O–rings may cause water or gas leakage and lead to overheating or cracked heads.

(b) Using SST, caulk the nozzle sleeve.

SST 09472–1210, 09800–6100





(c) Install the injector or injection nozzle to the cylinder head. Using vernier calipers, measure the protrusion of the injector from the lower surface of the cylinder head.

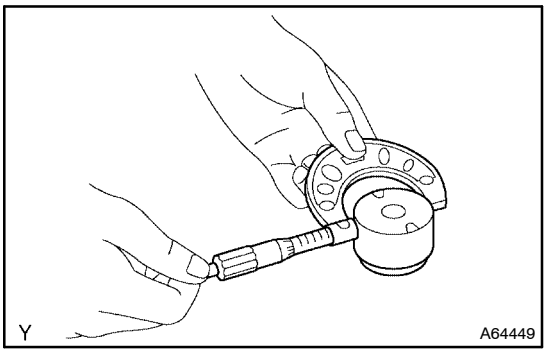
Protrusion:
S05C–TB

Standard	2.35 – 2.85 mm (0.0930 – 0.1122 in.)
Maximum	2.85 mm (0.1122 in.)

Protrusion:
S05C–B, S05C–TA

Standard	2.25 – 2.75 mm (0.0886 – 0.1083 in.)
Maximum	2.75 mm (0.1083 in.)

If the protrusion is greater than the maximum, replace the injector.



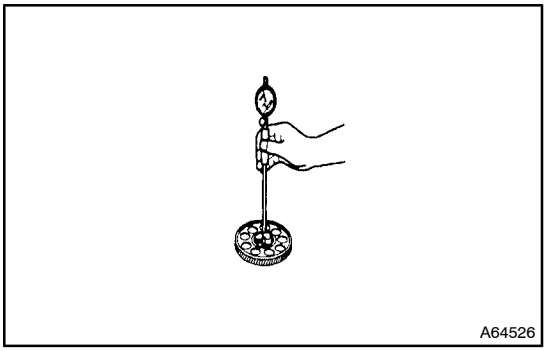
34. INSPECT OIL CLEARANCE BETWEEN CAMSHAFT IDLER GEAR SHAFT AND IDLER GEAR BUSH

(a) Using a micrometer, measure the shaft diameter of the idler gear shaft.

Shaft diameter:

Standard	33.950 – 33.975 mm (1.3366 – 1.3376 in.)
Minimum	33.80 mm (1.3307 in.)

If the outside diameter is less than the minimum, replace the idler gear shaft.



(b) Using a cylinder gauge, measure the inside diameter of the idler gear bush.

Inside diameter:

Standard	34.000 – 34.015 mm (1.3386 – 1.3392 in.)
Maximum	34.20 mm (1.3464 in.)

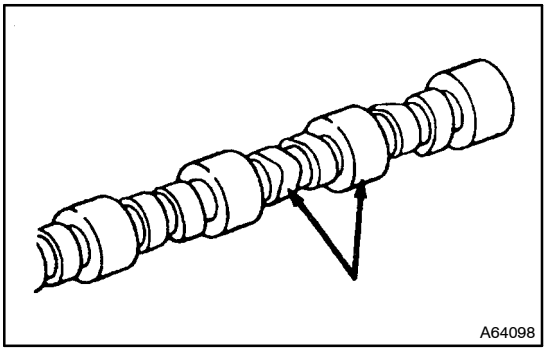
If the inside diameter is greater than the maximum, replace the idler gear.

(c) Calculate the oil clearance between the idler gear shaft and idler gear bush.

Oil clearance:

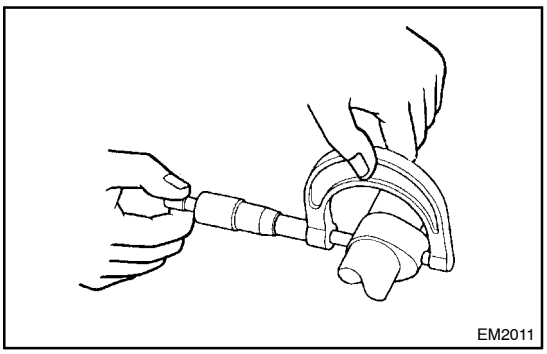
Standard	0.025 – 0.065 mm (0.0010 – 0.0026 in.)
Maximum	0.20 mm (0.0079 in.)

If the clearance is greater than the maximum, replace the idler gear shaft and/or idler gear bush.



35. INSPECT CAMSHAFT

(a) Visually check the camshaft surface for wear and scratches.


EM2011

(b) Using a micrometer, measure the cam lobe height.

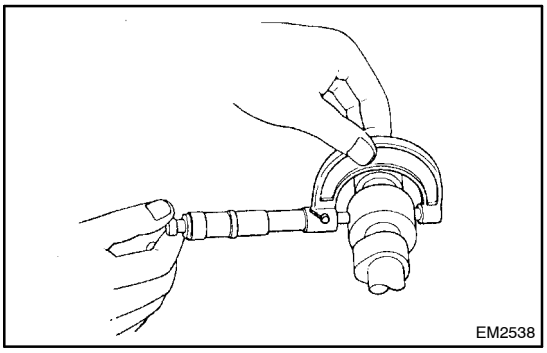
Standard cam lobe height:

Intake	50.067 mm (1.9711 in.)
Exhaust	52.104 mm (2.0153 in.)

Minimum cam lobe height:

Intake	49.967 mm (1.9672 in.)
Exhaust	52.004 mm (2.0474 in.)

If the lobe height is less than the minimum, replace the camshaft.


EM2538

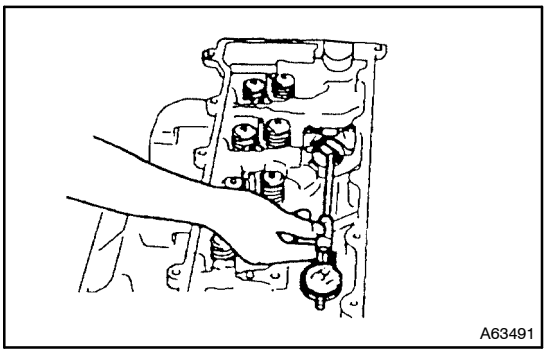
(c) Measure the oil clearance of the camshaft journal.

(1) Using a micrometer, measure the journal diameter of the camshaft.

Journal diameter:

Standard	39.959 – 39.975 mm (1.5732 – 1.5738 in.)
Minimum	39.85 mm (1.5689 in.)

If the jounal diameter camshaft is less than the minimum, replace the camshaft.


A63491

(2) Using a cylinder gauge, measure the inside diameter of the camshaft bearing.

Inside diameter:

Standard	40.00 mm (1.5748 in.)
Maximum	40.15 mm (1.5807 in.)

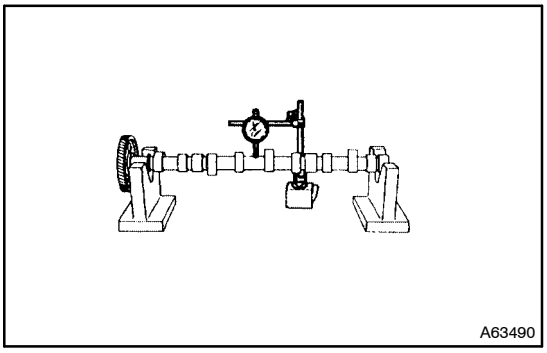
If the inside diameter is less than the minimum, replace the camshaft.

(3) Calculate the oil clearance from the above measurement.

Oil clearance:

Maximum	0.10 mm (0.0039 in.)

If the oil clearance is greater than the maximum, replace the camshaft or camshaft bearing.


A63490

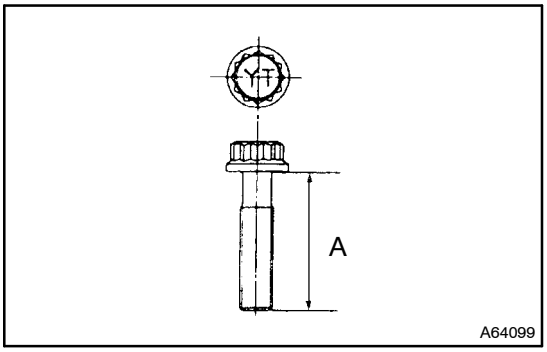
(d) Inspect the camshaft for circle runout.

(1) Place the camshaft on V–blocks.

(2) Using a dial gauge, measure the circle runout at the center journal.

Maximum circle runout: 0.10 mm (0.0039 in.)

If the circle runout is greater than the maximum, replace the camshaft.

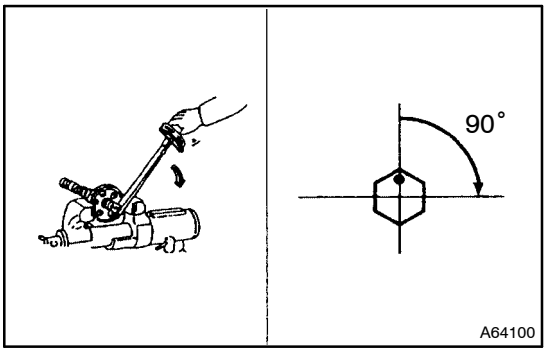


36. INSTALL CAMSHAFT TIMING GEAR

(a) Measure the length of the camshaft gear bolts.
Maximum length (A): 30.0 mm (1.181 in.)

If the length is greator than A, replace them with new bolts.

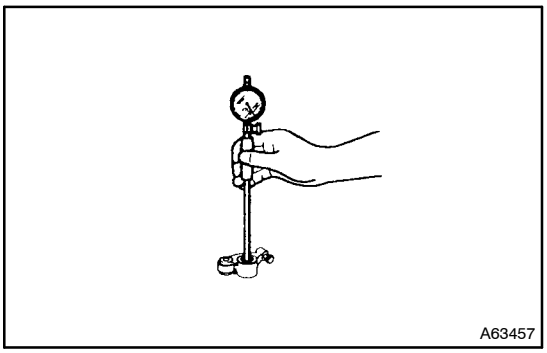
(b) Make sure that there is no dirt or scratch on the camshaft gear and tightening surface of the camshaft.



(c) Apply clean engine oil to the bolt seating and bolt thread, then tighten the bolt to the specified torque below.
Torque: 59 N·m (600 kgf·cm, 43 ft·lbf)

(d) Retighten them by 90° (1/4 turn).

HINT:
When adding torque, never untighten the nuts even if they have been over tightened.



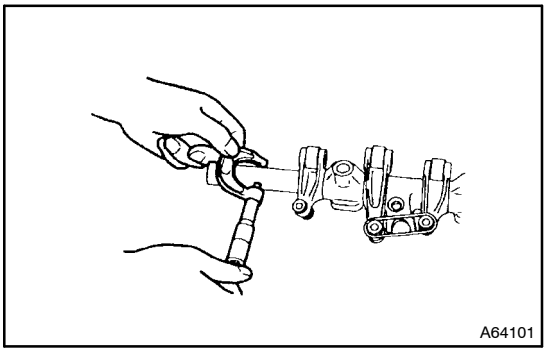
37. INSPECT OIL CLEARANCE BETWEEN VALVE ROCKER ARM AND SHAFT

(a) Using a cylinder gauge, measure the inside diameter of the rocker arm bushing.
Inside diameter:

Standard	22.000 – 22.051 mm (0.8661 – 0.8681 in.)
Maximum	22.080 mm (0.8693 in.)

If the diameter is greater than the maximum, replace the bush.
If the diameter is greater than the maximum, replace the bush.

HINT:
When installing a bush into the rocker arm, align the bush with the oil hole of the rocker arm.



(b) Using a micrometer, measure the outside diameter of the rocker arm shaft.
Shaft diameter:

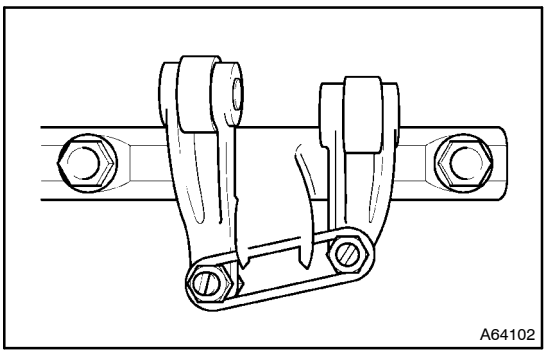
Standard	21.959 – 21.980 mm (0.8645 – 0.8654 in.)
Minimum	21.920 mm (0.8630 in.)

If the outside diameter is less than the minimum, replace the rocker arm.

(c) Calculate the oil clearance between the rocker arm bush and rocker arm shaft.
Oil clearance:

Standard	0.020 – 0.092 mm (0.0007 – 0.0036 in.)
Maximum	0.16 mm (0.0063 in.)

If the oil clearance is greater than the maximum, replace the rocker arm bush.



38. INSPECT VALVE ROCKER ARM AND VALVE BRIDGE

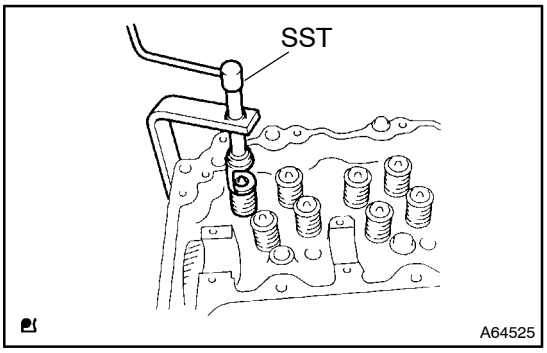
(a) Visually check the contact between the rocker arm and valve bridge.

Replace the rocker arm and the valve bridge if damage such as wear and scratches is excessive. If there is only a minimal amount of wear, correct the surface using a resurfacer.

(b) Visually check the adjusting screw thread.

HINT:

Replace the adjusting screw if damage such as wear and scratches is excessive.



39. INSTALL VALVE

(a) Apply engine oil to the intake and exhaust valve stems. Then insert them into the valve guide installed in the cylinder head.

(b) Install the valve inner and outer springs and valve spring seat upper.

(c) Using SST, press–fit the valve spring seat upper, then securely fit the valve spring retainer.

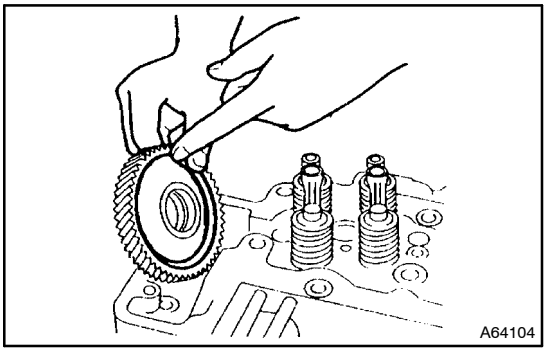
SST 09202–70020

HINT:

If parts are reused, be sure to install them to their original position.

NOTICE:

- **Be sure to apply engine oil to the contact surface of the parts before the assembly.**
- **Be sure to place each valve in its original position.**
- **When the valve spring is compressed, be careful that the upper seat will not damage to the stem seal.**
- **Since this valve spring is evenly pitched, it can be installed with either end up.**



40. INSTALL CAMSHAFT IDLER GEAR

(a) Install the idler gear shaft through a thrust plate, with the oil filler facing downward (See step 27).

(b) Tighten the idler gear shaft bolt to the specified torque below.

Torque: 108 N·m (1,100 kgf·cm, 80 ft·lbf)

41. INSPECT CAMSHAFT IDLER GEAR THRUST CLEARANCE

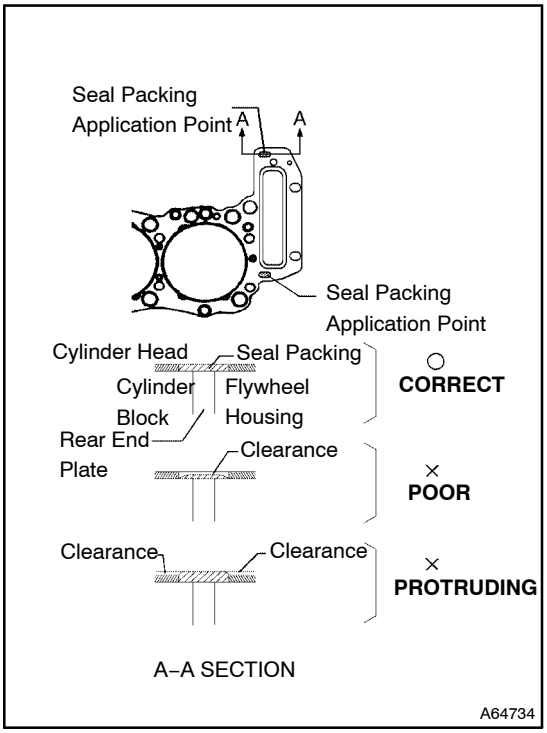
HINT:

After installing the idler gear, measure the clearance between the idler gear and thrust bearing by using a dial gauge.

Standard thrust clearance: 0.040 – 0.0095 mm (0.0016 – 0.0037 in.)

Maximum thrust clearance: 0.30 mm (0.0118 in.)

If the thrust clearance is greater than the maximum, replace the thrust bearing.



42. INSTALL CYLINDER HEAD GASKET

HINT:

- Do not reuse the head gasket for any reason, because it will cause the engine damage.
- Before installing the cylinder head gasket, remove dirt, moisture and oil on the cylinder head and cylinder block surface.
- The 8 water hole seal rings between the bores can be easily damaged. Do not touch them with your hands or other objects. Make sure that the seal rings are not loose or damaged.
- Since silicon material is used for the gear case print seal, make sure that there is no peeling before the assembly.

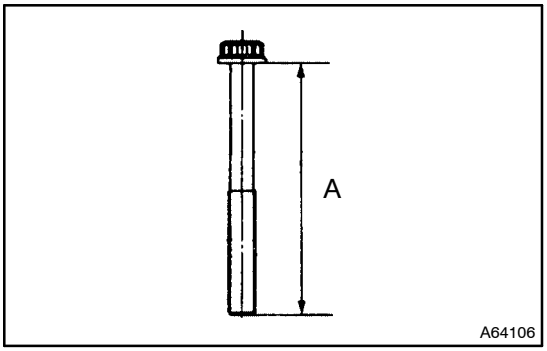
(a) Install the cylinder head gasket on the cylinder block and flywheel housing.

(b) Fill the hole on the back side of the cylinder head gasket with seal packing.

Seal packing: Part No. 08826–00080 or equivalent

HINT:

Make sure that the seal packing surface is flush with the cylinder head gasket upper surface.



43. INSTALL CYLINDER HEAD BOLT

(a) Preparation

(1) Measure the length of the M12 head bolts.

Maximum length (A):

A	Bolt Number
126.5 mm (4.9803 in.)	1, 2, 7, 8, 9, 10, 15, 16, 17
156.5 mm (6.1614 in.)	4, 5, 12, 13
187.5 mm (7.3819 in.)	3, 6, 11, 14, 18

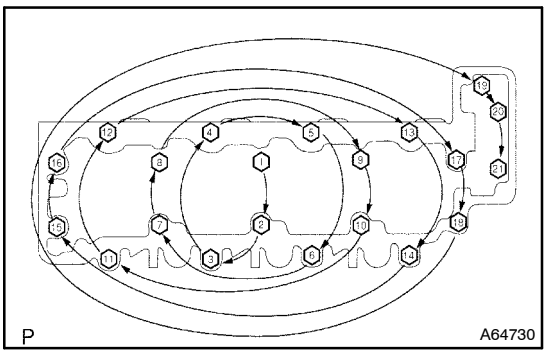
If the length is greater than the maximum, replace them with new bolts.

(2) Make sure that no dirt or scratch is on the tightening surface of the cylinder head bolt.

(3) Apply clean engine oil to the bolt surface and bolt threads.

HINT:

Since the cylinder head bolts are unique to this engine, do not substitute ordinary bolts for them.



(b) Tighten the cylinder head bolts.

(1) Tighten bolts No. 1 – No. 18 (M12) in the order shown in the illustration.

Torque: 59 N·m (600 kgf·cm, 44 ft·lbf)

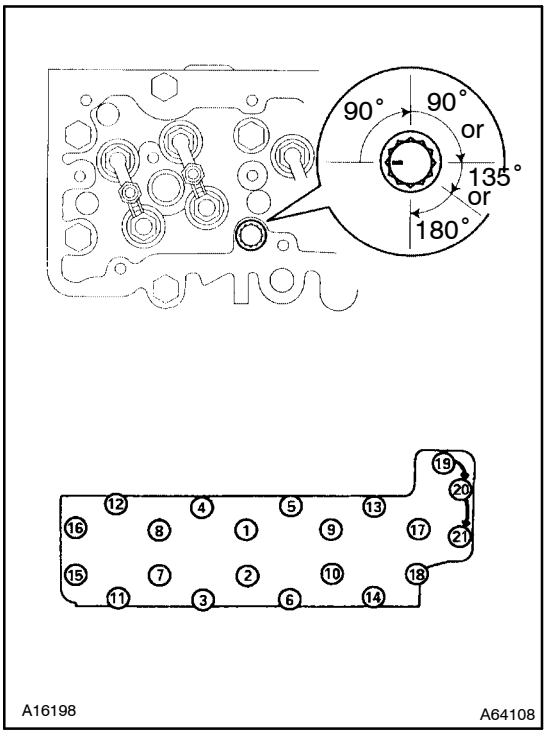
(2) After tightening bolt No. 18, check the torque again all through the bolts from No. 1 to No. 18.

(3) Mark the bolts with paint to indicate the same directions as shown in the illustration.

(4) Turn the bolts No. 1 – No. 18 by 90° (1/4 turn).

(5) Make sure that all paint marks face the same direction.

HINT:
When adding torque, never untighten the nuts even if they have been overtightened.



(6) Tighten the head bolts again (M12 bolts only) in the same sequence to their respective tightening angles.

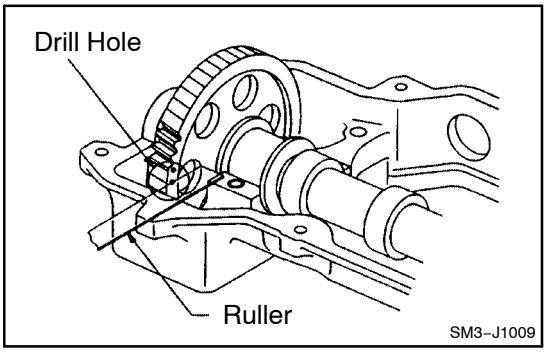
Tightening angle:

Tightening Angle	Head Bolt No.
90°	1, 2, 7, 8, 9, 10, 15, 16, 17
135°	4, 5, 12, 13
180°	3, 6, 11, 14, 18

HINT:
When adding torque, never untighten the nuts even if they have been over tightened.

(7) Tighten bolts No. 19 – No. 21 (M10) in the order shown in the illustration.

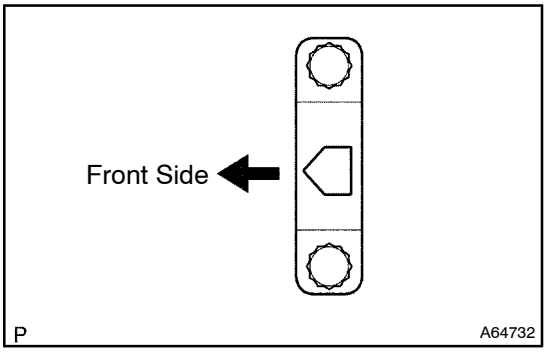
Torque: 59 N·m (600 kgf·cm, 44 ft·lbf)



44. INSTALL CAMSHAFT

(a) Install the camshaft into the cam housing so that two drill holes on the camshaft gear is located at left side and lower drill hole match with the camshaft housing upper face.

HINT:
Incorrect installation may damage the engine.

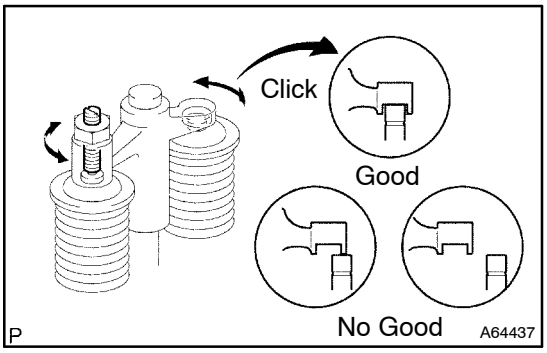


45. INSTALL CAMSHAFT BEARING CAP

(a) Adjust the orientation and position of the camshaft bearing and cam cap, and install them Do not tighten the bolt at this time.

HINT:

The stamp marks (triangle) of the camshaft bearing cap are directed to the front side of the engine, and they are arranged in order of 1 through 5 from the front side.



(b) Install the rocker arm assembly.

(1) Check that the valve bridge is properly installed on each valve.

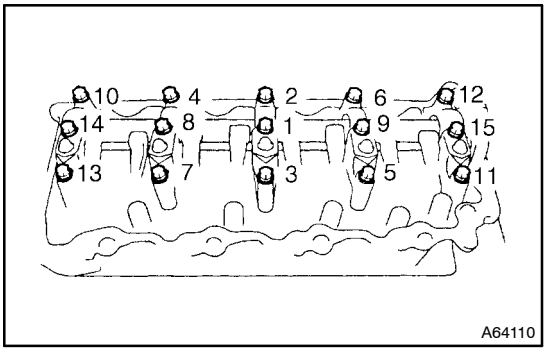
NOTICE:

- **To check the proper installation of the valve bridge, move it right and left by hand. If you hear click sound at this time, it means the valve bridge is properly installed.**
- **If the valve bridge is off the valve, it will push the upper seat. This will cause the valve to slip off.**

(2) Completely screw up the adjusting screw placed in the tip of the rocker arm.

NOTICE:

Apply engine oil to the cam part after the installation.



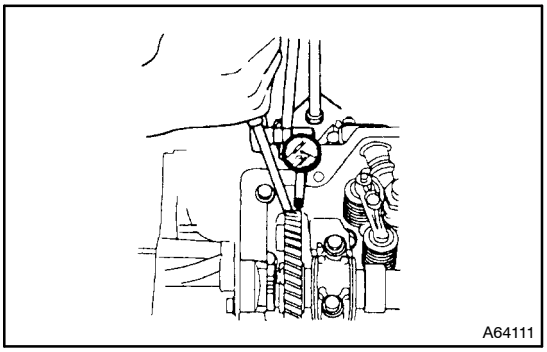
(c) Install the rocker arm assembly on the cylinder head.

(d) Check that the rocker arm is properly install on the valve bridge.

(e) Gradually tighten the rocker arm support bolts, dividing them into small groups, in accordance with the illustrated order.

NOTICE:

Check that the rocker arm moves smoothly after tightening the bolts.



46. INSPECT BACKLASH OF CAMSHAFT GEAR AND CAMSHAFT IDLER GEAR

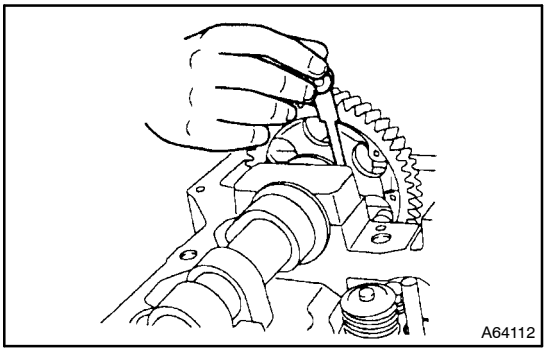
HINT:

Using a dial gauge, measure the backlash between the camshaft gear and camshaft idler gear.

Backlash:

Maximum	0.30 mm (0.0118 in.)

If the backlash is greater than the maximum, replace the camshaft gear.



47. INSPECT CAMSHAFT THRUST CLEARANCE

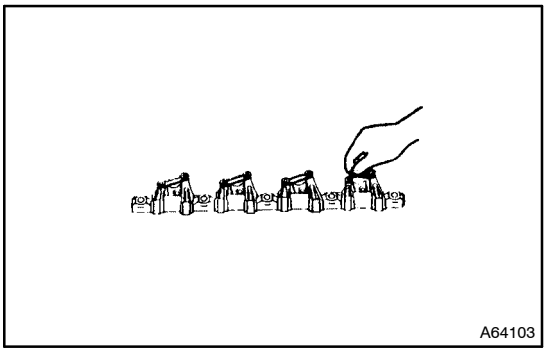
HINT:

Using a feeler gauge, measure the thrust clearance between the camshaft and camshaft bearing.

Thrust clearance:

Maximum	0.30 mm (0.0118 in.)

If the thrust clearance is greater than the maximum, replace the camshaft.



48. INSTALL VALVE ROCKER ARM ASSY

(a) Make sure of the correct direction of the rocker arm support and assemble the rocker arm assembly.

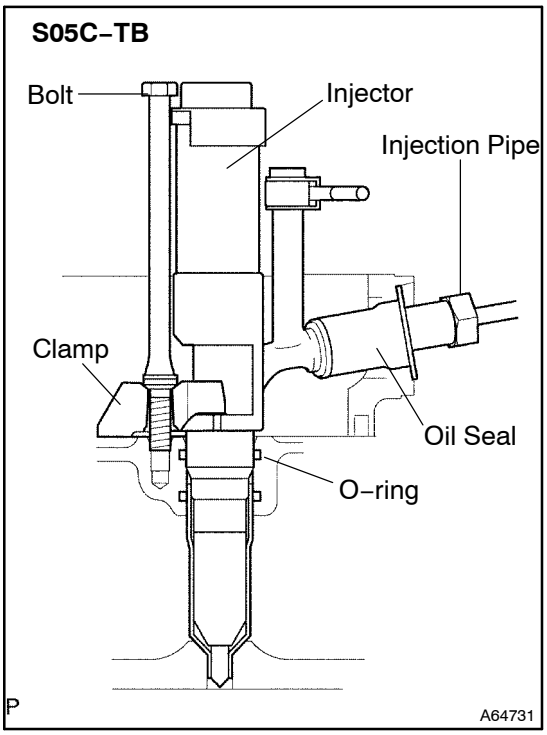
HINT:

Wrong mounting of the rocker arm support results in seizure of the valve mechanism due to incorrect lubrication.

(b) Wind up the adjusting screw of the rocker arm completely.

HINT:

If the adjusting screw is left unwound, the rocker shaft may be bent when the rocker arm support is tightened.



49. INSTALL INJECTOR ASSY

(a) Install a new O–ring into the groove of the cylinder head, and then insert the injector.

NOTICE:

Apply engine oil to the O–ring so that the O–ring will not be caught.

(b) Install the injector clamp and temporarily install the injector.

NOTICE:

Do not fix the injector clamp before the injection pipe is temporarily installed.

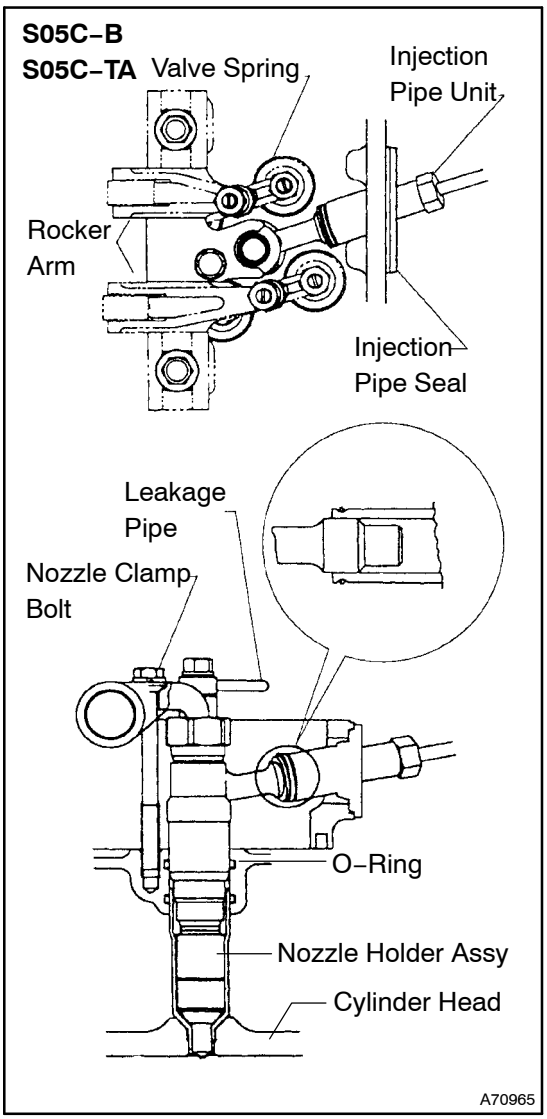
(c) Cover the injector with a new injection pipe oil seal, and then install the plate and nut.

NOTICE:

Be careful not to put excessive force to the injector when applying the injection pipe oil seal to it. If the injection pipe oil seal and injector are moved even slightly, it may cause oil leakage or faulty assembling of the injection pipe.

(d) Assemble the injection pipe temporarily, and completely tighten the installation bolt of the injector clamp.

Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)



50. INSTALL INJECTION NOZZLE SUB–ASSY

(a) Install a new O–ring into the groove of the cylinder head.

(b) Make sure that there is no dirt or foreign particles at the sealing part between the nozzle holder and related parts (O–ring, nozzle sleeve and injection pipe seal), and connecting part between the nozzle holder and nut of the injection pipe.

(c) Insert the nozzle holder, taking care not to make it in contact with the valve spring as shown in the illustration.

NOTICE:

Apply clean engine oil to the O–ring and be careful that the O–ring is not caught.

(d) Cover the end of the injection pipe seal with the nozzle holder as shown in the illustration, and tighten the bolts to fasten the injection pipe seal to the cam housing.

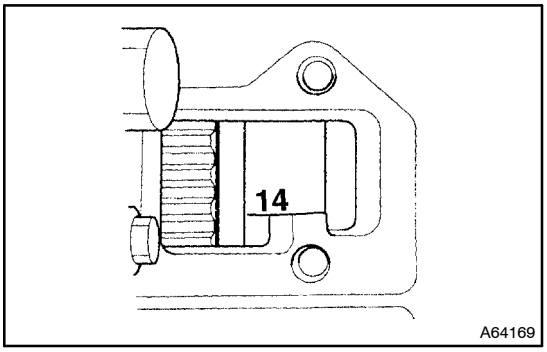
(e) Tighten the nut of the injection pipe provisionally.
Tighten the nozzle clamp bolt to the specified torque.
Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

NOTICE:

After tightening the bolt, make sure that the rocker arm moves smoothly.

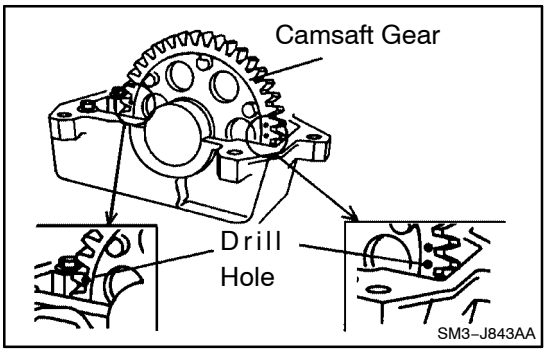
(f) Tighten the nut of the injection pipe to the specified torque.
Torque: 34.0 N·m (350 kgf·cm, 25 ft·lbf)

(g) Install the leakage pipe.



51. INSPECT VALVE CLEARANCE

(a) Turn the crankshaft to align mark 14 on the outer periphery of the flywheel with the pointer of the flywheel housing.



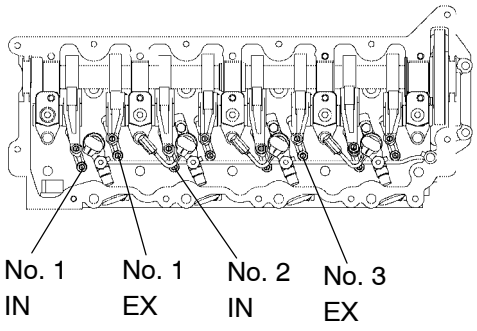
HINT:

Among three drill holes on the camshaft gear, when two drill holes are on horizontal position, and the rest of the drill hole is visible , the No.1 piston is at the Top Dead Center of the compression stroke.

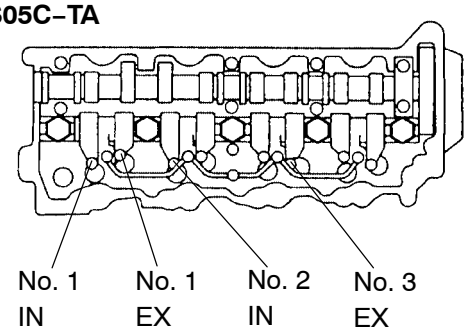
NOTICE:

If the rest of the drill hole is invisible by camshaft housing, the No.4 piston is at the Top Dead Center of the compression stroke.

S05C–TB



S05C–B
S05C–TA



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A77203

(b) Check only those valves indicated in the illustration with the No.1 piston in the top dead center.

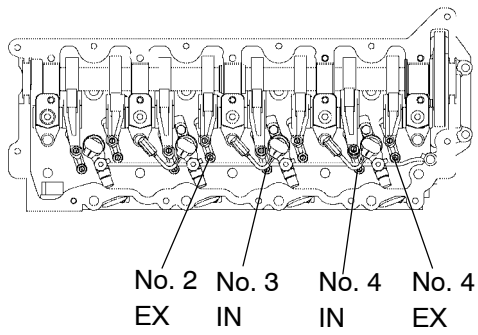
(1) Using a feeler gauge, measure the clearance between the valve lifter and camshaft.

Standard clearance:

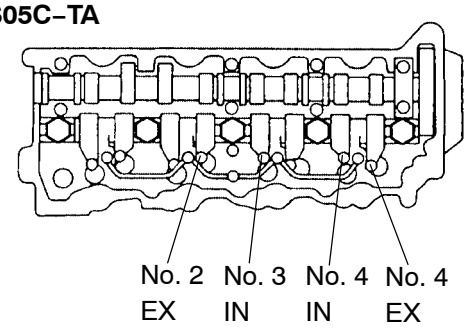
Intake	0.30 mm (0.012 in.)
Exhaust	0.45 mm (0.018 in.)

(2) Record the measurement of the valve clearance that is out of the specification.

S05C–TB



S05C–B
S05C–TA



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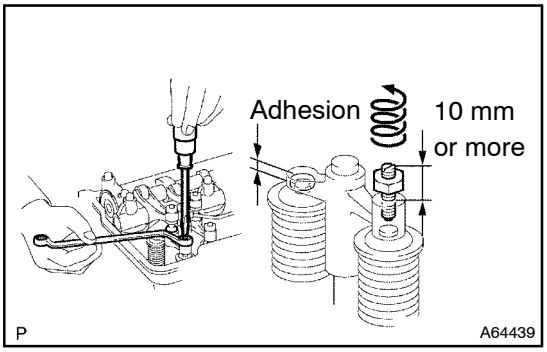
(c) Turn the crankshaft 1 revolution (360°) and align the marks as shown in the illustration.

(d) Check only the valves indicated in the illustration.
Measure the valve clearance with the No. 4 piston in the top dead center.

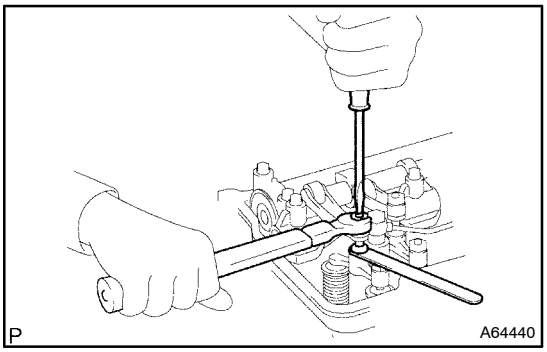


52. ADJUST VALVE CLEARANCE

(a) Loosen the adjusting screw nut of the valve bridge completely.

HINT:

- The adjusting screw must protrude by 10 mm (0.3931 in.) or more from the valve bridge upper surface.
- Unless the adjusting screw is completely loose to the valve stem, the following adjustments may be adversely affected.

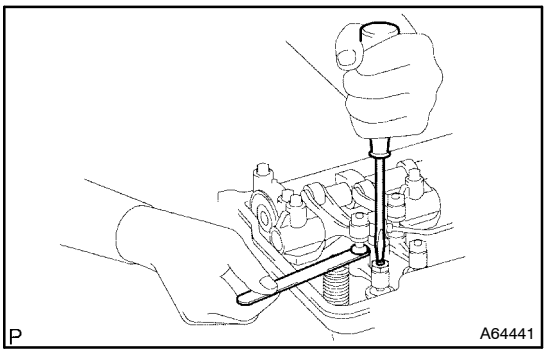


(b) Insert a feeler gauge between the rocker arm and valve bridge. Adjust the clearance with the adjusting screw of the rocker arm. Tighten the lock nut with the following torque.

Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

HINT:

The feeling of the feeler gauge during the clearance adjustment is the same as before.



(c) With the feeler gauge inserted, loosen the adjusting screw of the valve bridge. Make sure that the feeler gauge is not felt loose.

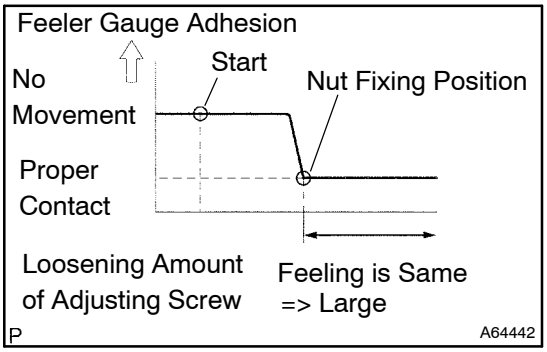
HINT:

If it is loose, repeat the following steps.

(d) Tighten the adjusting screw of the valve bridge until the feeler gauge dose not move.

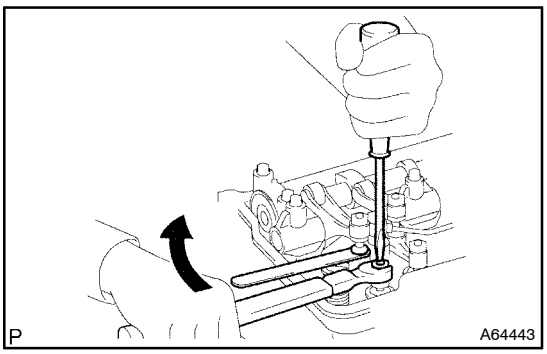
(e) While loosening the adjusting screw of the valve bridge gradually, adjust the valve clearance. Tighten the lock nut of the valve bridge when the feeler gauge is felt correct.

Torque: 25 N·m (250 kgf·cm, 18 ft·lbf)

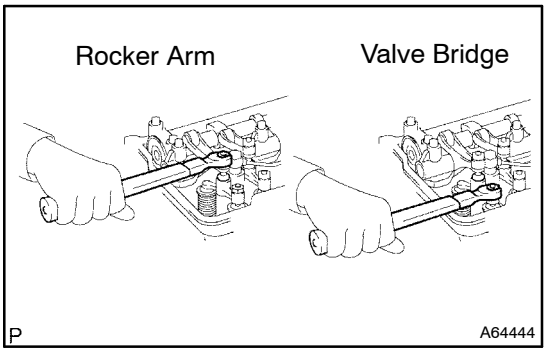


HINT:

- The feeling of the feeler gauge during the clearance adjustment is the same as before.
- Do not over loosen the adjusting screw will cause the valve bridge to come off from the valve stem. The feeler gauge may be excessive clearance between the adjusting screw of the valve bridge and the valve. This dose not allow for correct adjustment.

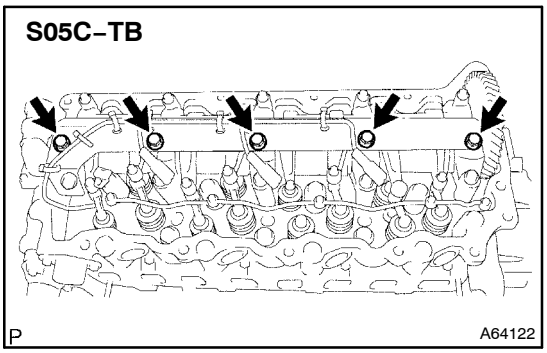


- The adjustable valve clearance, when either the No. 1 or No. 4 piston is at the TDC of the compression stroke, is shown in the following chart. After completing the valve clearance adjustment when the No.1 piston is at the TDC of the compression stroke, turn the crankshaft one complete revolution and make the No.4 piston be at the TDC of the compression stroke (The arrow printed on the camshaft points down and the underline is horizontal) and adjust the rest of the valve clearances.



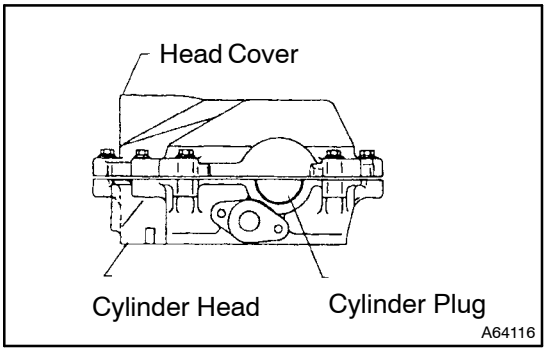
(f) Finally, tighten all the lock nuts of the rocker arm and the cross head by the following torques and make sure that they are all tight (the nuts do not turn).
Torque: 28 N·m (280 kgf·cm, 20 ft·lbf)

HINT:
Neverover tighten them.



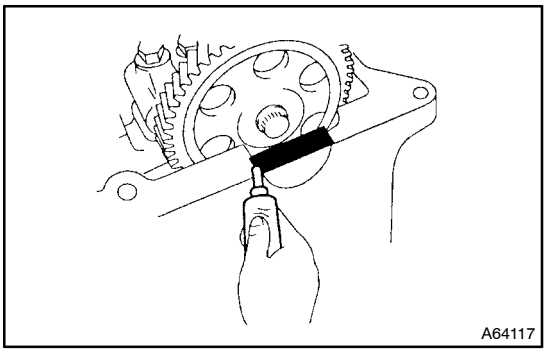
53. INSTALL INJECTOR HARNESS BRACKET

(a) Install the injector harness bracket with the 5 nuts.
(b) Connect the injector connector.
(c) Connect the wire harness connector.



54. INSTALL CYLINDER HEAD COVER SUB–ASSY

(a) Install the cylinder plugs at the front and rear ends of the cam housing. Clean the cylinder plugs and the mounting surface of the cam housing.



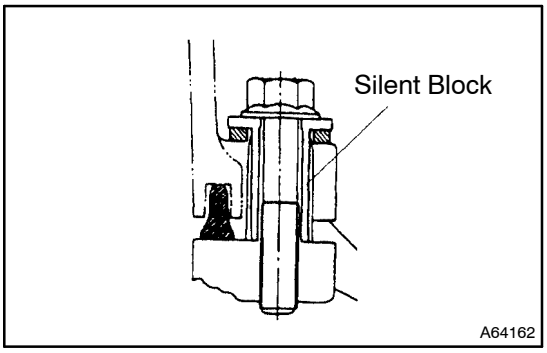
(b) Apply seal packing to the front and rear half circles of the cam housing, then install the cylinder plug within 20 minutes.
Seal packing: Part No. 08826–00080 or equivalent
Coating width: 1.5 – 2.5 mm (0.059 – 0.098 in.)

HINT:

- If more than 20 minutes have elapsed, clean off the seal packing completely and reapply the seal packing.
- Make sure to wipe off excessive liquid gasket.

(c) Apply seal packing to plug corner A at the front and rear ends of the cam housing.
(d) Install the cylinder head cover gasket into the gasket groove at the head cover lower surface.
(e) Insert the spacer from the head cover to the cam housing.
(f) Install the cylinder head cover to the cam housing immediately before mounting the head cover.

HINT:
If left more than 20 minutes have elapsed, clean off the liquid gasket completely and reapply the seal packing.

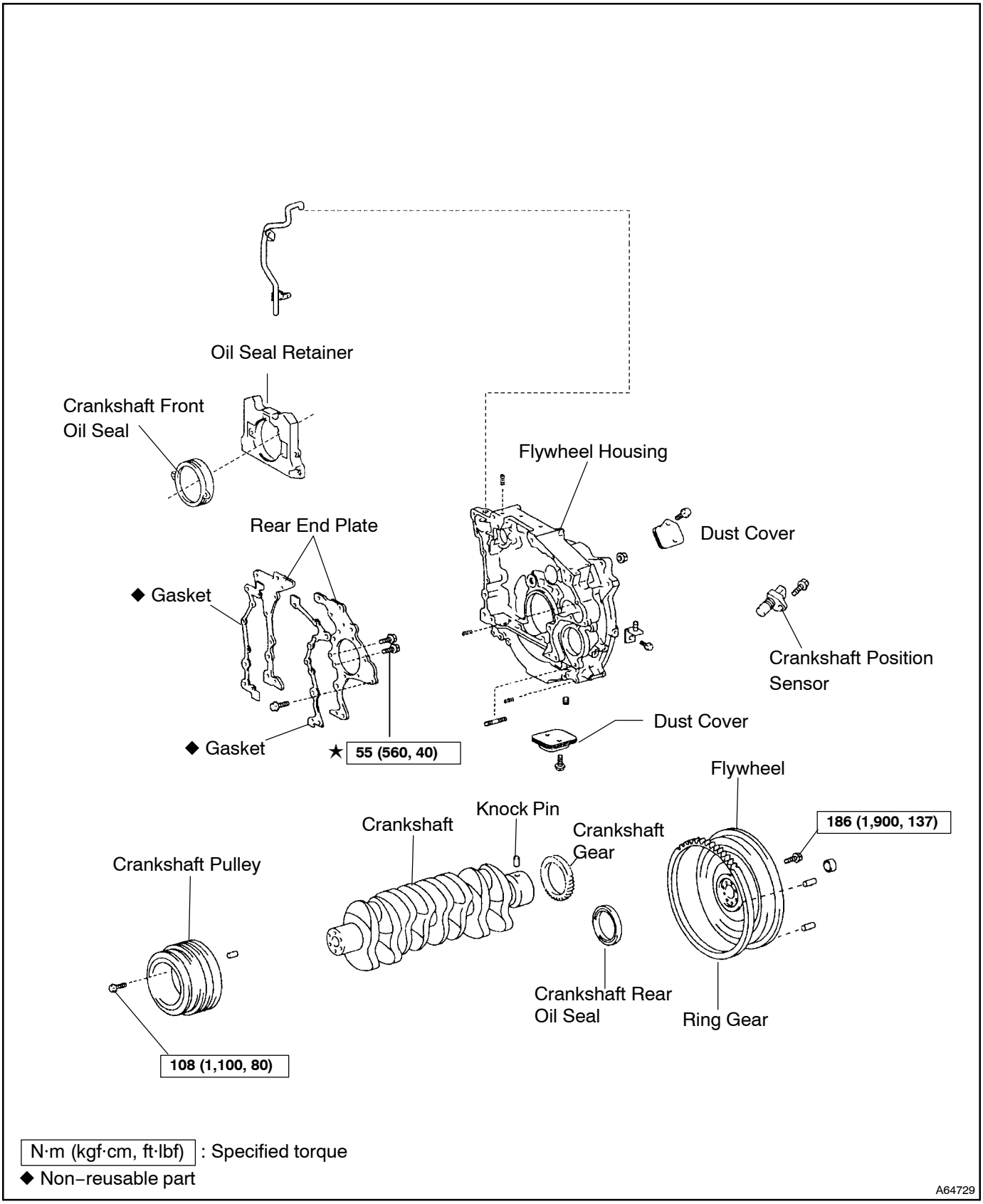


(g) Tighten the mounting bolt of the head cover through the silent block and fix the head cover on the cylinder head.
Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)

CRANKSHAFT FRONT END, OIL PAN, FLYWHEEL AND FLYWHEEL HOUSING

1417L–01

COMPONENTS

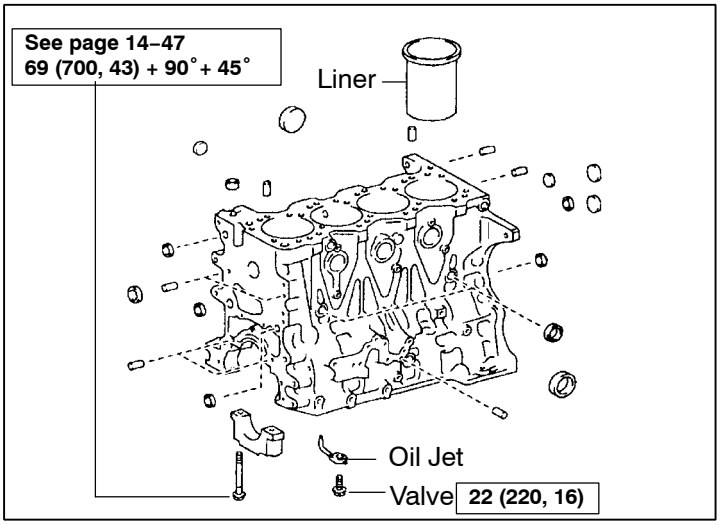


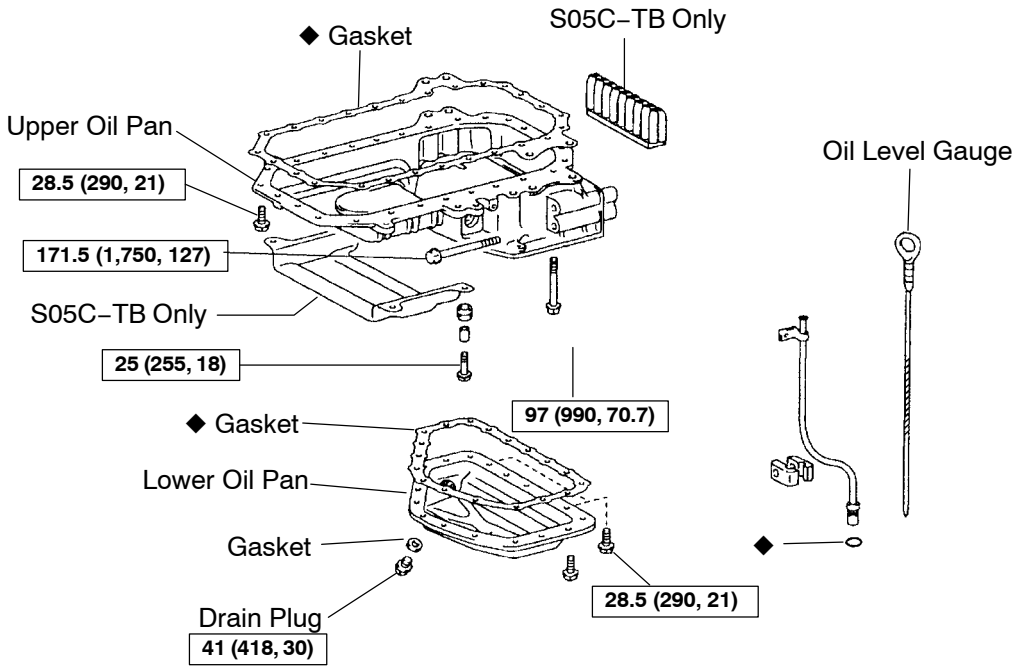
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

A64729

S05C–TA
S05C–TB

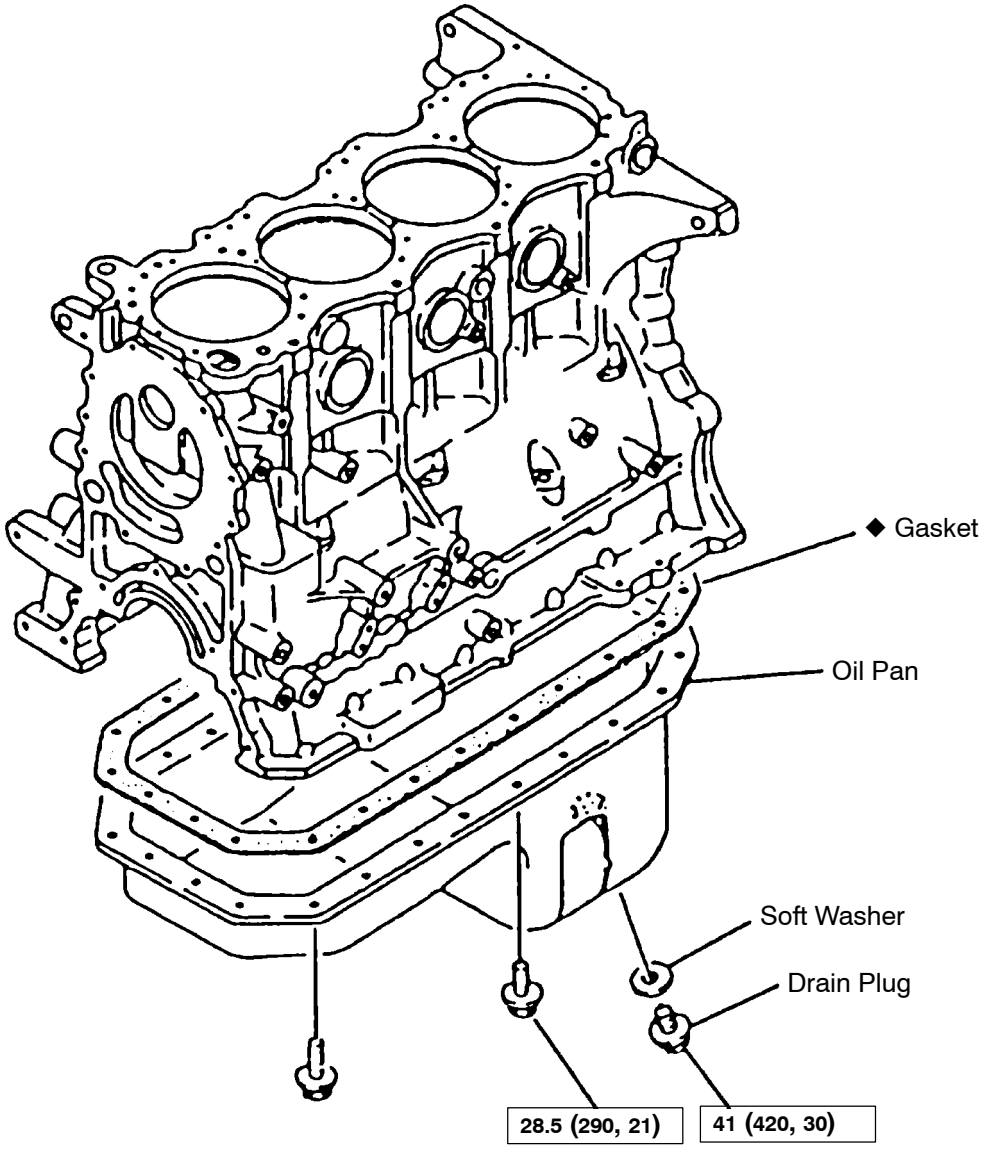




N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

A64140

S05C–B



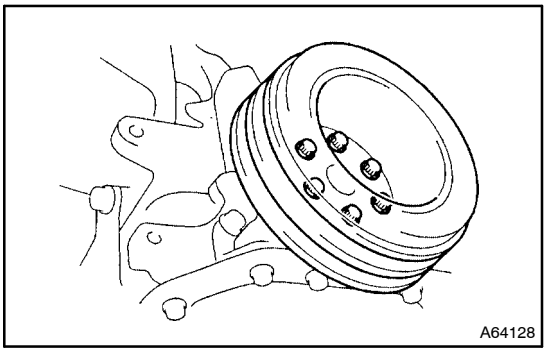
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

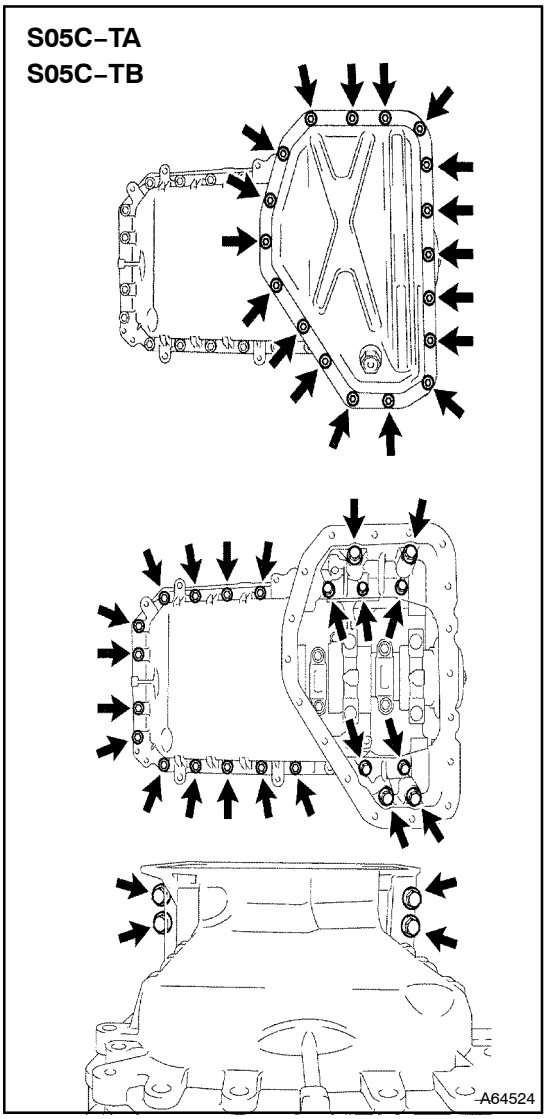
A70968

1417M–01

OVERHAUL

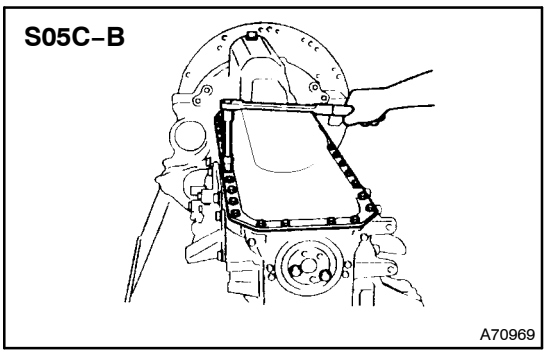


1. REMOVE CRANKSHAFT PULLEY

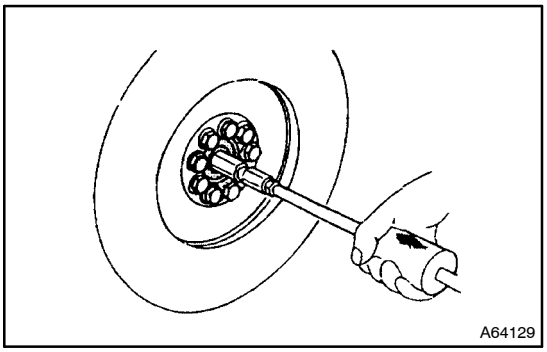


2. REMOVE OIL PAN

(a) Remove the oil pan cover.
(b) Remove the lower oil pan.
(c) Remove the upper oil pan.



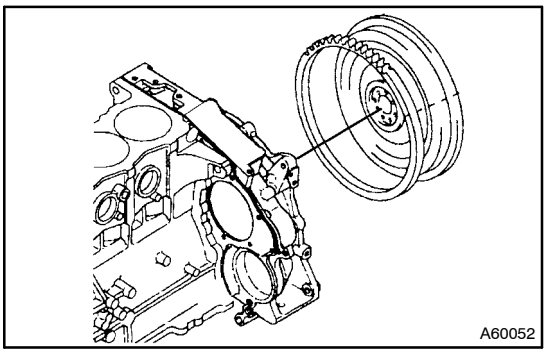
3. REMOVE OIL PAN AND OIL STRAINER



4. REMOVE FLYWHEEL SUB–ASSY

(a) Remove the pilot bearing.

(b) S05C–TB:
Remove the crankshaft position sensor from the flywheel housing.

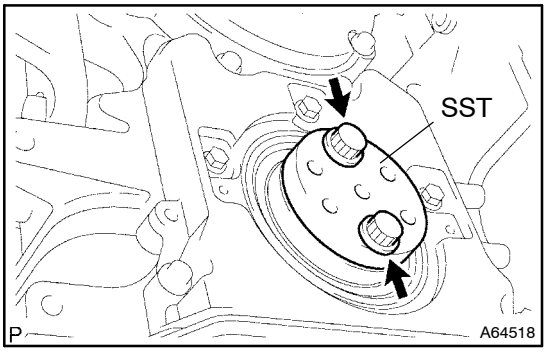


(c) Remove the flywheel mounting bolts.

(d) Hold a copper rod through the starter hole against the flywheel, and drive the rod lightly with a hammer to remove the flywheel from the crankshaft while rotating the crankshaft.

NOTICE:

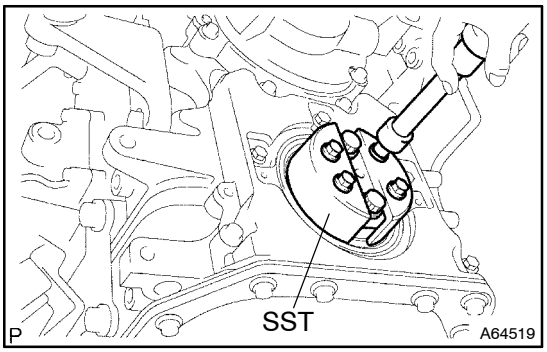
The flywheel is heavy. When removing, be careful not to drop it on your feet.



5. REMOVE CRANKSHAFT OIL SEAL

(a) Using SST, remove the crankshaft oil seals.
SST 09420–1731 (Front), 09420–1742 (Rear)

(1) Place SST (plate) at the crankshaft end with the crank pulley mounting bolts (front) or the flywheel mounting bolts (rear).

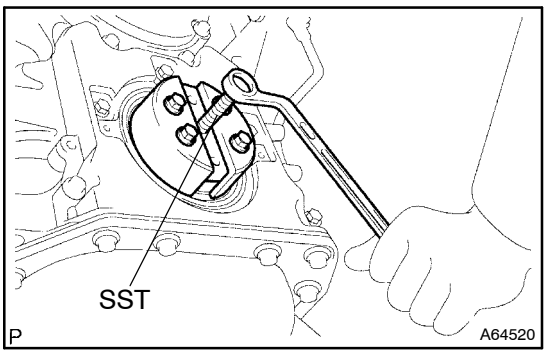


(2) Install SST (hook) to the crankshaft end with the supplied bolt.

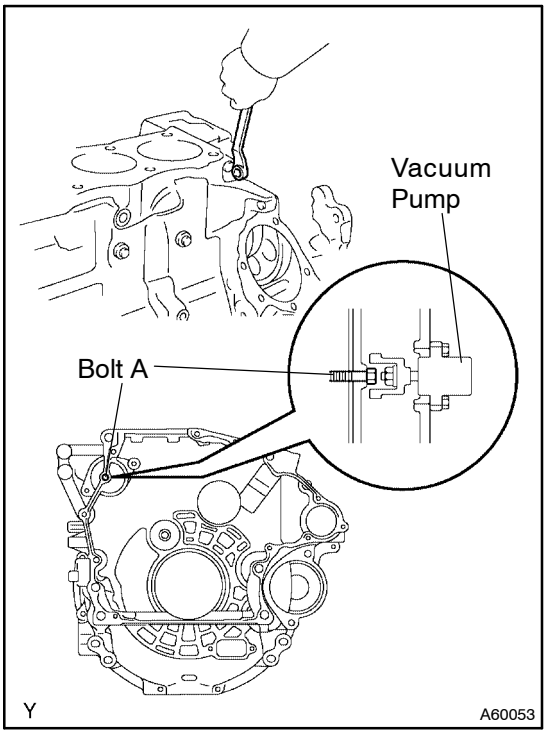
HINT:

Engage the hook with the oil seal notch.

(3) Remove the bolt installed in step (1).



(4) Install SST (center bolt) and tighten it to remove the oil seal.



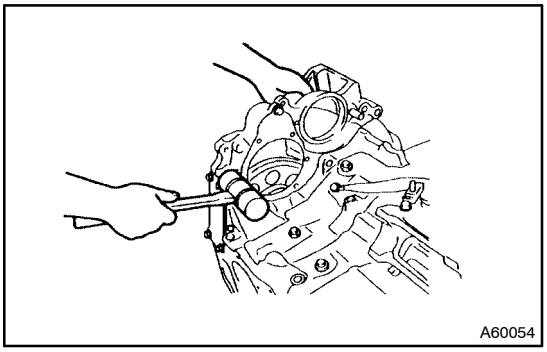
6. REMOVE FLYWHEEL HOUSING

(a) Remove the 2 front mounting bolts of the flywheel housing.

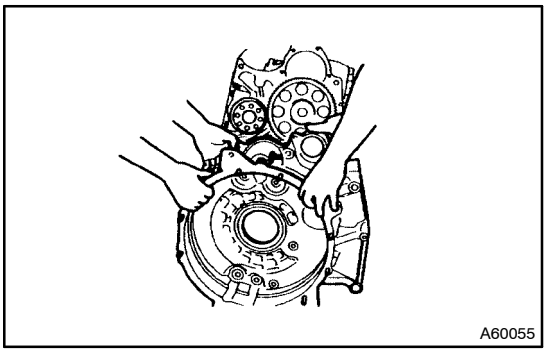
(b) Remove the rear mounting bolts of the flywheel housing.

HINT:

Before removing the flywheel housing, remember to loosen the bolt A.

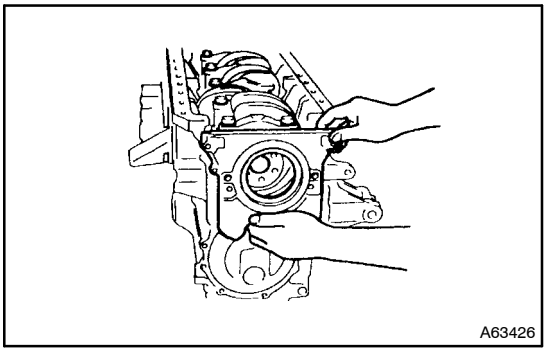


(c) Using a plastic–faced hammer, remove the flywheel housing by it lightly striking.

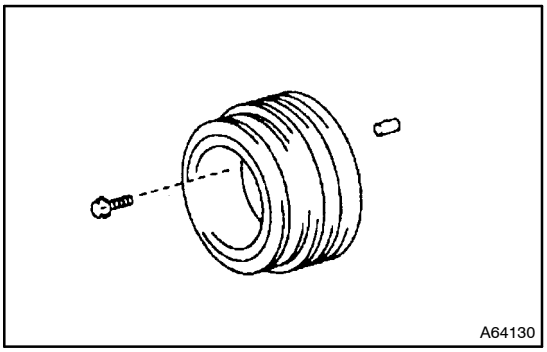


CAUTION:

The flywheel housing is heavy. When removing, be careful not to drop it on your feet.



7. REMOVE OIL SEAL RETAINER



8. INSPECT CRANKSHAFT PULLEY

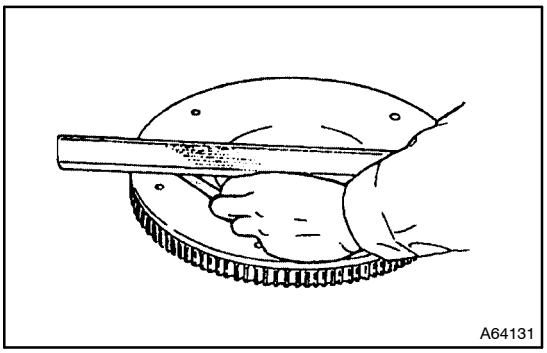
HINT:

Clean the torsional damper with a commercial cleaning agent before the inspection.

Use a cleaning agent that does not damage gum.

(a) Check if there are any cracks in the damper rubber section.

If the cracks are excessive, replace the pulley.



9. INSPECT FLYWHEEL SUB–ASSY

(a) Check the friction surface for damage.

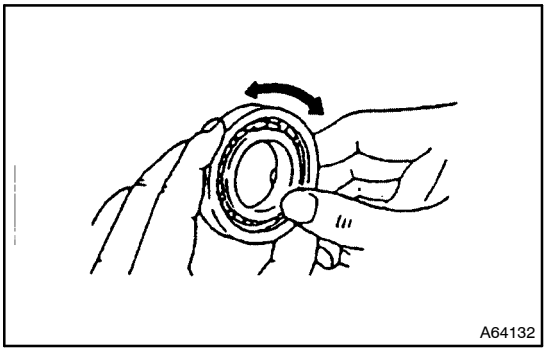
(b) Check the friction surface for distortion.

(c) Grinding and replacement should be performed as necessary.

Maximum deflection: 0.04 mm (0.0016 in.)

Grind limit: 1.00 mm (0.0394 in.)

If the flywheel is ground over the limit, replace it with a new one.



10. INSPECT PILOT BEARING

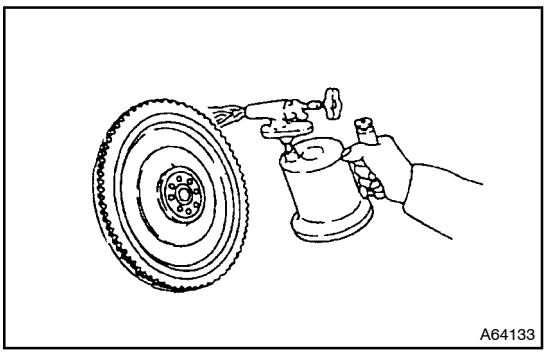
(a) Rotate the bearing lightly by hand, and check whether there is any abnormal noise or clatter and whether the balls run smoothly.

If there is any fault, replace the pilot bearing.

11. INSPECT FLYWHEEL RING GEAR

(a) Visually check the flywheel ring gear.

If damage such as wear and scratches is excessive, replace the part.


A64133

12. REMOVE FLYWHEEL RING GEAR

(a) Using a torch, heat the ring gear evenly to about 200°C (392°F) with a torch. Insert the ring gear periphery lightly, using a cushion bar to remove the gear.

CAUTION:

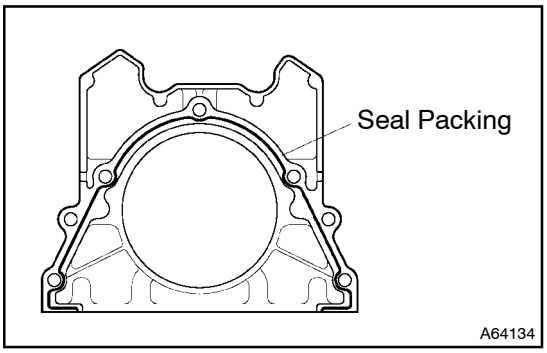
Never touch the ring gear or flywheel with your bare hands when they are hot.

13. INSTALL FLYWHEEL RING GEAR

(a) Using a torch, heat the ring gear evenly to about 200°C (392°F) with a touch. Insert the ring gear into the flywheel so that the chamfered side is facing upward.

NOTICE:

Do not overheat the ring gear.



A64134

14. INSTALL OIL SEAL RETAINER

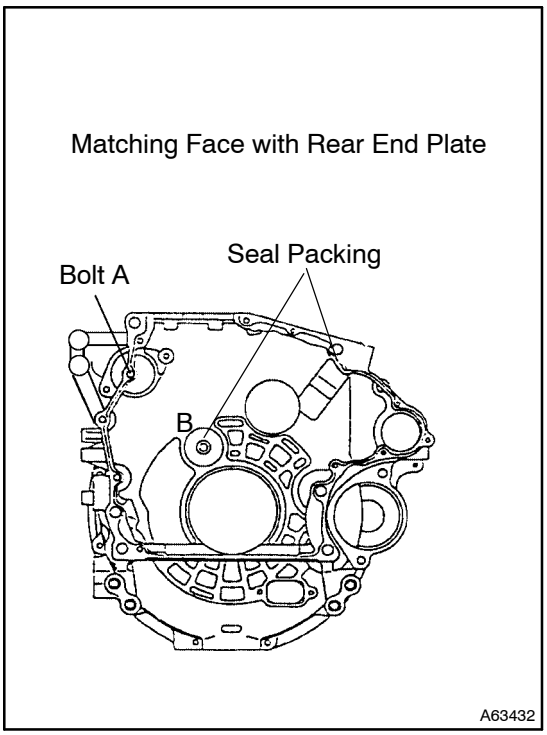
(a) Clean the cylinder block mounting surface of the oil seal retainer.

(b) Apply seal packing to the oil seal retainer, then install it to the cylinder block within 20 minutes.

Seal packing: Part No. 08826–00080 or equivalent

Coating width: 1.5 – 2.5 mm (0.059 – 0.098 in.)

If more than 20 minutes have elapsed, clean off the seal packing completely and reapply the seal packing.



A63432

15. INSTALL FLYWHEEL HOUSING

(a) Clean the rear end plate mounting surface of the flywheel housing.

(b) Apply seal packing to the flywheel housing, then install it to the rear end plate within 20 minutes.

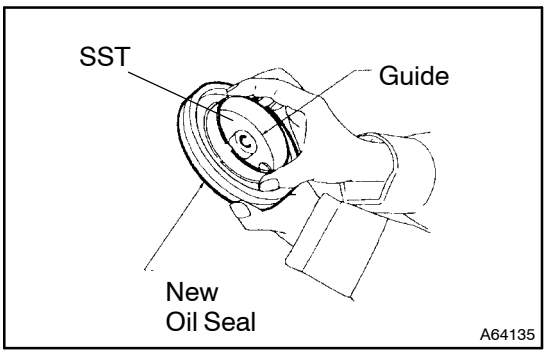
Seal packing: Part No. 08826–00080 or equivalent

Coating width: 1.5 – 2.5 mm (0.059 – 0.098 in.)

If more than 20 minutes have elapsed, clean off the seal packing completely and reapply the seal packing.

NOTICE:

Before installing the flywheel, remember to tighten the bolt A. Be sure to apply seal packing to the flywheel housing. Be sure to assemble the stud bolt on the block side. The flywheel is heavy. When installing, be careful not to drop it on your feet.

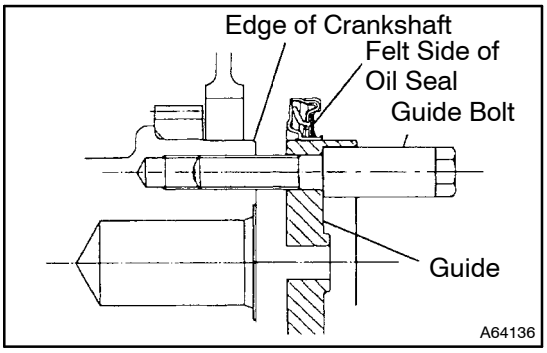


16. INSTALL CRANKSHAFT OIL SEAL

(a) Clean the edges and surface of the crankshaft and SST.

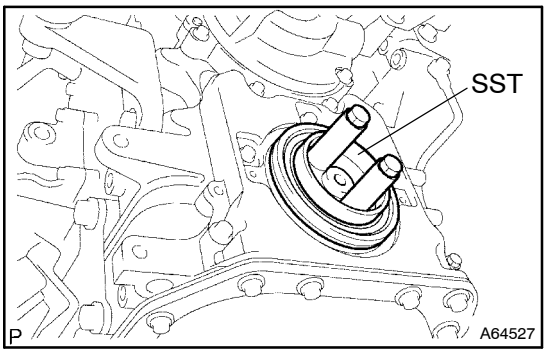
(b) Insert a new crankshaft oil seal into SST (guide of oil seal press).

SST 09407–1030 (Front), 09407–1040 (Rear)



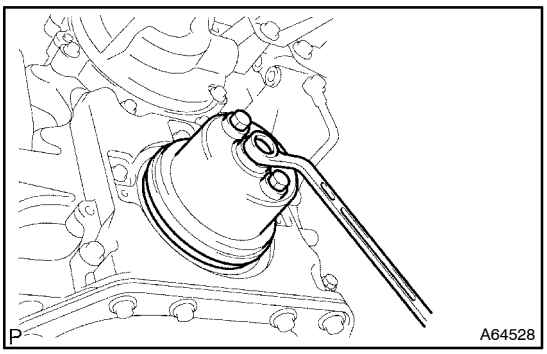
HINT:

Pay attention to the orientation of the oil seal (The felt side should face the outside of the cylinder block).



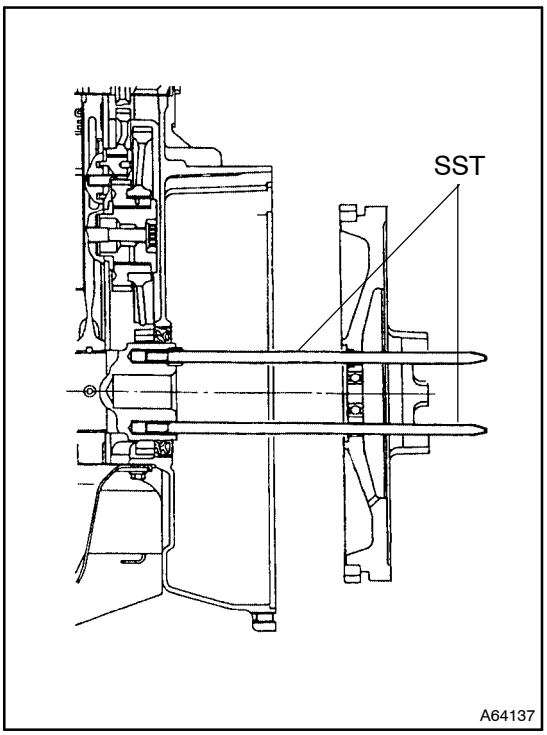
(c) Apply a little amount of engine oil to the seal portion of the shaft oil seal.

(d) Attach SST (oil seal press guide) with the oil seal onto the crankshaft with SST (attached guide bolt).



(e) Insert the oil seal press by adjusting the oil seal press hole to the guide bolt.

(f) Press the crankshaft oil seal inside by attaching the accompanying center bolt onto the oil seal press and tighten it until it stops.



17. INSTALL FLYWHEEL SUB–ASSY

(a) Make sure that there are no burns or dirt on the contact surface or in the threaded hole of the crankshaft or flywheel.

(b) Insert SST into the crankshaft.
SST 09481–1340

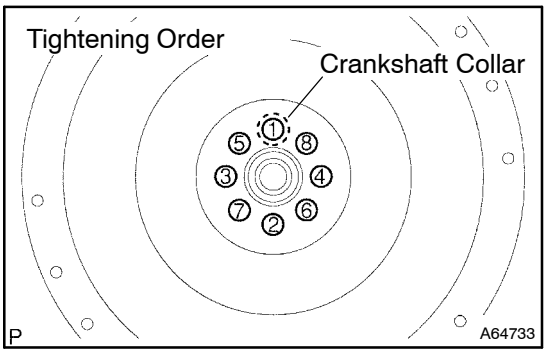
HINT:

Place one guide bar on one side of the collar knock and another on the opposite side of the collar knock.

(c) Insert the flywheel slowly until it contacts the collar knock in order to prevent impact on the guide bar. Adjust the position, then insert it completely.

CAUTION:

The flywheel is heavy. When installing, be careful not to drop it on your feet.

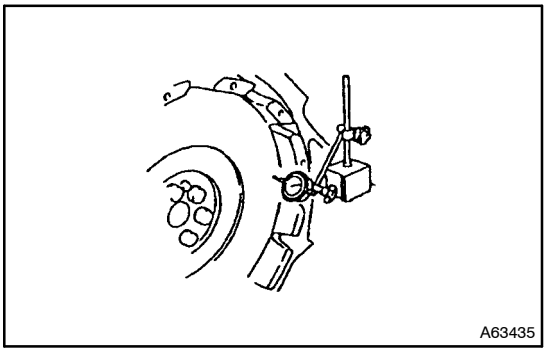


(d) Apply clean engine oil to the threads of the flywheel bolt and the flywheel bolt seat. Be sure to tighten 2 or 3 threads provisionally by hand. Then, tighten the flywheel bolts (6) with a low–torque impact wrench.

(e) Pull out the guide bar and tighten the remaining 2 flywheel bolts provisionally as in step (d).

(f) Tighten the flywheel bolts in the order shown in the illustration.
Torque: 186 N·m (1,900 kgf·cm, 137 ft·lbf)

(g) Loosen all the bolts and tighten them again.
Torque: 186 N·m (1,900 kgf·cm, 137 ft·lbf)

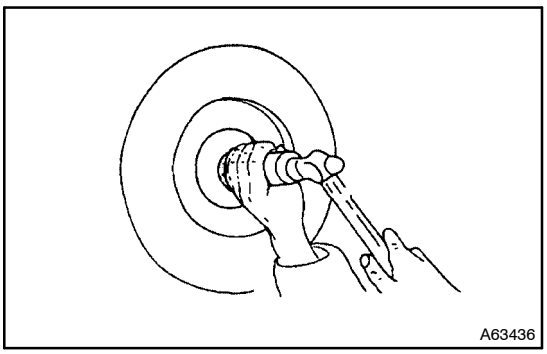


(h) Measure the sliding surface play of the flywheel.

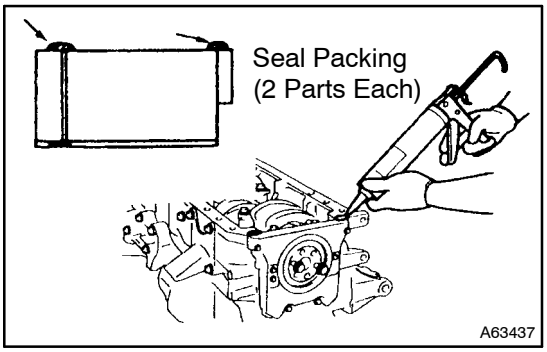
(1) Using a dial gauge, measure the runout of the flywheel.

Maximum runout: 0.15 mm (0.0059 in.)

If the runout is greater than the maximum, resurface the sliding surface.



(i) Install the pilot bearing.
(j) S05C–TB:
Install the crankshaft position sensor.



18. INSTALL OIL PAN

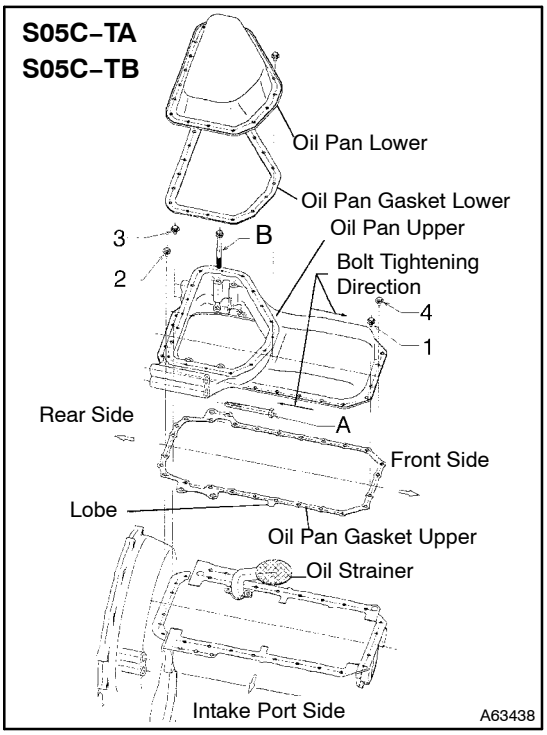
(a) Make sure that there is no deformation, impact marks or foreign particles on the mounting surface and stiffener surface of the upper oil pan.
(b) Place a guide pin of 70 mm (2.76 in.) or longer in the cylinder block.
(c) Apply seal packing to the front and back ends of the cylinder block lower surface.
Seal packing: Part No. 08826–00080 or equivalent
Coating width: 1.5 – 2.5 mm (0.059 – 0.098 in.)
(d) Install the upper oil pan gasket so that the protrusion will be on the flywheel housing side and the print seal surface will be on the cylinder block side.
(e) Install the upper oil pan.

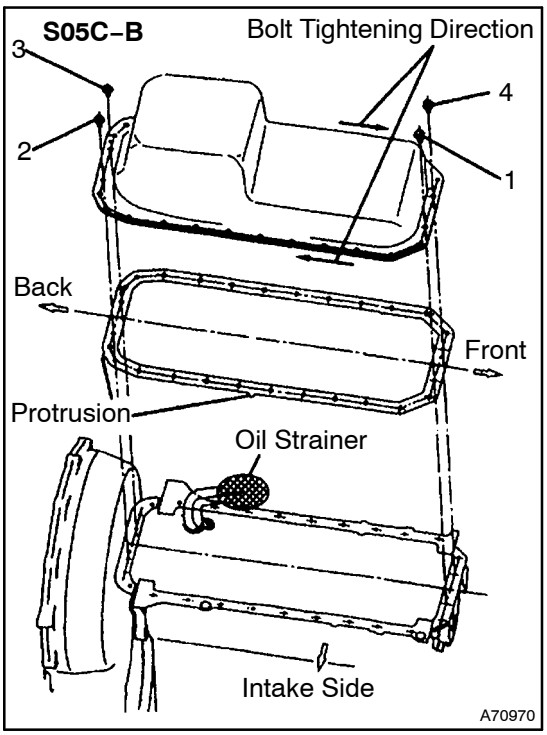
HINT:

- Install the upper oil pan along the guide pin.
- If more than 20 minutes have elapsed, clean off the seal packing.

(f) Tighten the upper oil pan installation bolts in the order 1 – 2 – 3 – 4 as shown in the illustration.
Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)
(g) Make sure that there is no deformation, impact marks or foreign particles on the mounting surface and stiffener surface of the lower oil pan.
(h) Finish tightening the bolts in the order shown in the illustration.
Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)

HINT:
Make sure that the washer is not on the flange.





(i) Install the upper oil pan gasket so that the protrusion will be on the flywheel housing side and the print seal surface will be on the cylinder block side.

(j) Install the upper oil pan.

HINT:

- Install the upper oil pan along the guide pin.
- If more than 20 minutes have elapsed, clean off the seal packing.

(k) Tighten the upper oil pan installation bolts in the order 1 – 2 – 3 – 4 as shown in the illustration.

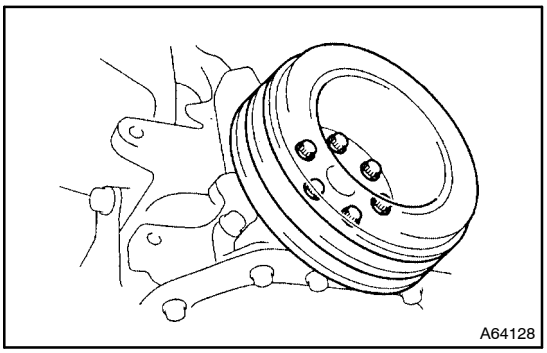
Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)

(l) Finish tightening the bolts in the order shown in the illustration.

Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)

HINT:

Make sure that the washer is not on the flange.



19. INSTALL CRANKSHAFT PULLEY

(a) Apply clean engine oil to the threads of the crankshaft pulley bolt. Be sure to tighten 2 or 3 threads provisionally by hand. Then, tighten the crankshaft pulley 6 bolts with a low–torque impact wrench.

(b) Tighten the crankshaft pulley bolts.

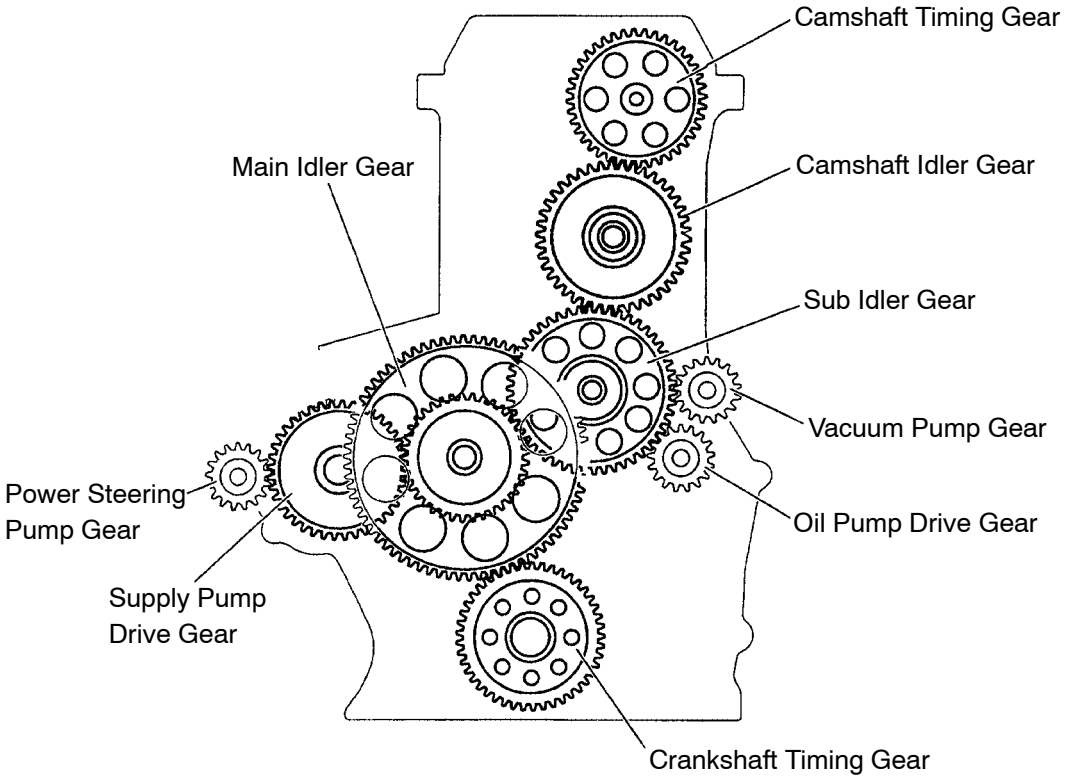
(c) Loosen all the bolts and tighten them again.

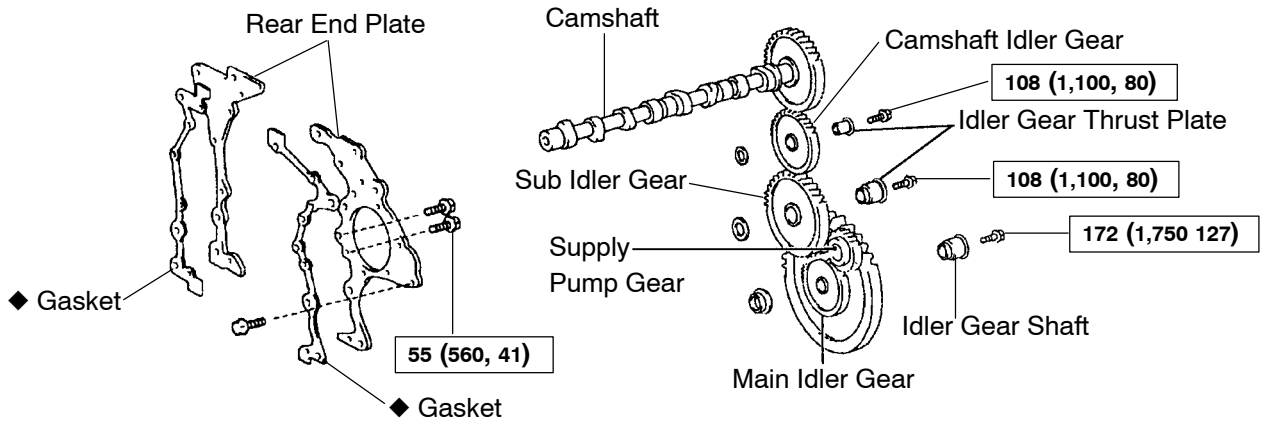
Torque: 108 N·m (1,100 kgf·cm, 80 ft·lbf)

TIMING GEAR

COMPONENTS

1417N–01





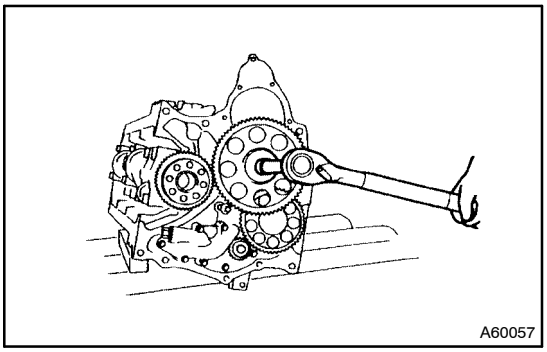
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non–reusable part

A64141

1417O–01

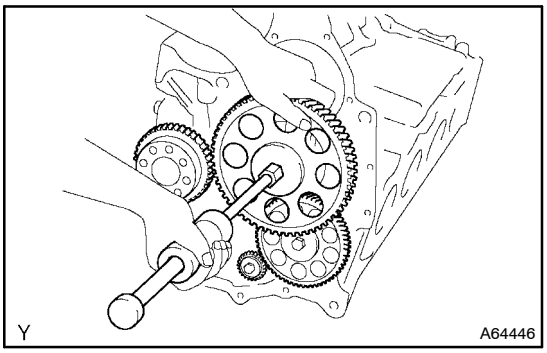
OVERHAUL



1. REMOVE MAIN IDLER GEAR

(a) Remove the mounting bolts of the main idler gear shaft.

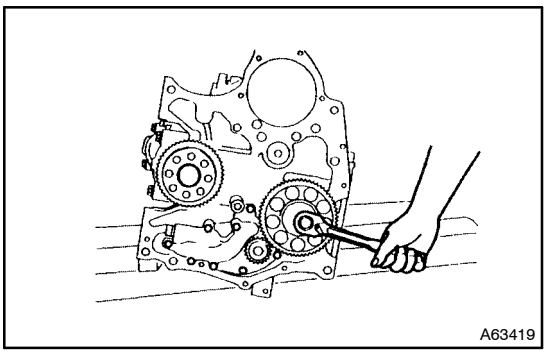
(b) Remove the main idler gear.



(c) Using a sliding hammer, drive out the main idler gear shaft.

(1) Check the teeth of each gear for wear and pitching.

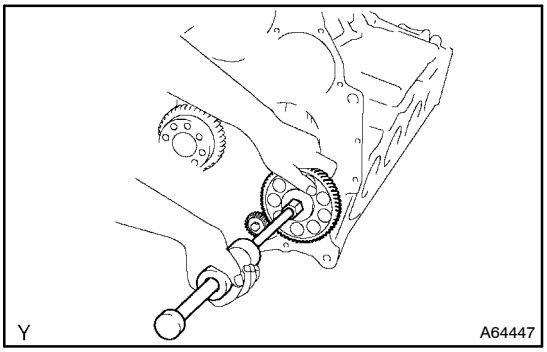
If there is damage, replace the gear.



2. REMOVE SUB IDLER GEAR

(a) Remove the mounting bolts of the sub idler gear shaft.

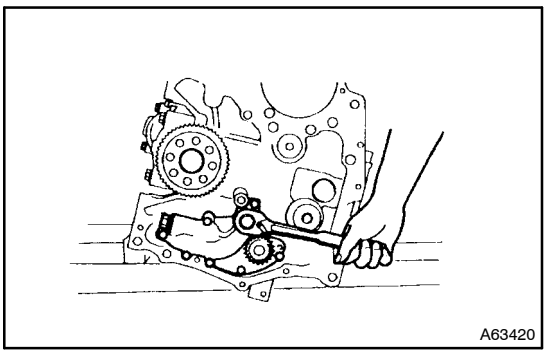
(b) Remove the sub idler gear.



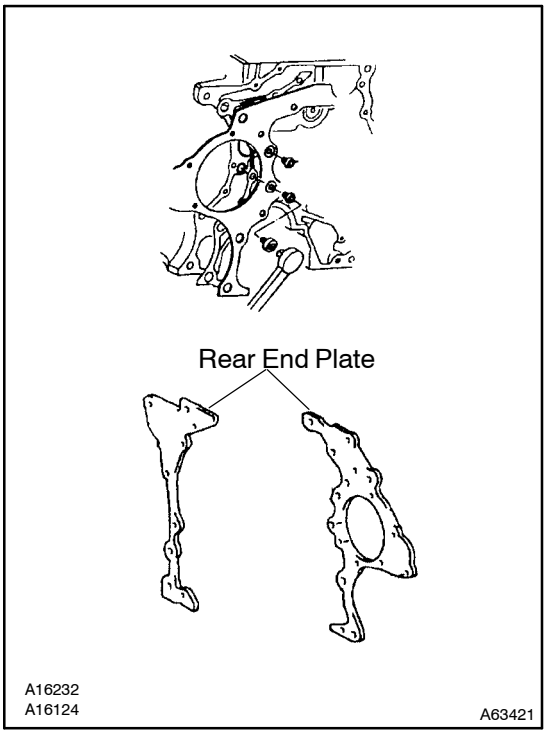
(c) Using a sliding hammer, drive out the sub idler gear shaft.

(1) Check the teeth of each gear for wear and pitching.

If there is damage, replace the gear.


A63420

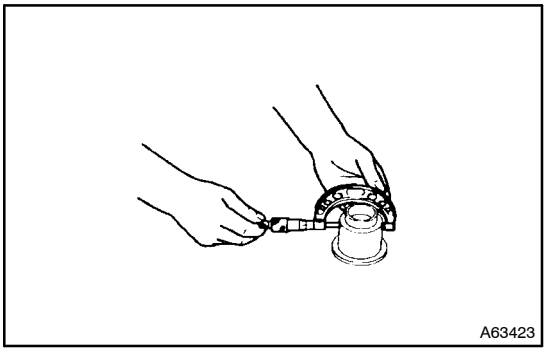
3. REMOVE OIL PUMP ASSY



A16232
A16124
A63421

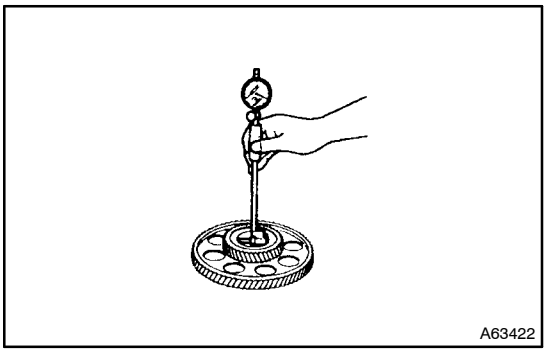
4. REMOVE REAR END PLATE

(a) Using a socket wrench, remove the 2 torx bolts adjacent to the supply pump drive shaft mounting section.


A63423

5. INSPECT OIL CLEARANCE BETWEEN MAIN IDLER GEAR BUSH AND SHAFT

(a) Using a micrometer, measure the diameter of the main idler gear shaft.
Standard shaft diameter:
56.94 – 56.97 mm (2.2422 – 2.2430 in.)

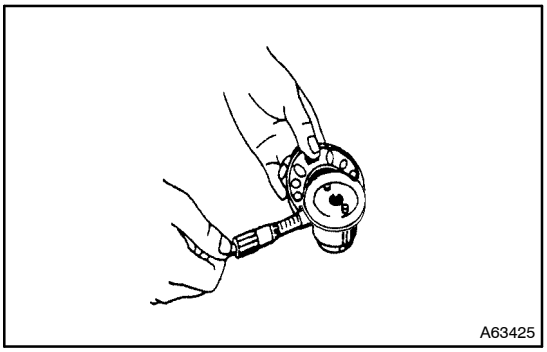

A63422

(b) Using a cylinder gauge, measure the inside diameter of the main idler gear bush.
Standard inside diameter:
57.00 – 57.03 mm (2.2441 – 2.2453 in.)

(c) Calculate the clearance from the above measurements.
Oil clearance:

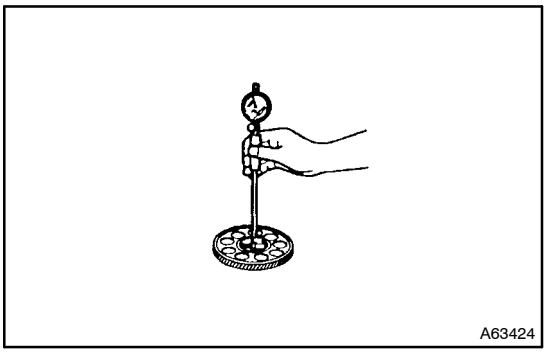
Standard	0.030 – 0.090 mm (0.0012 – 0.0035 in.)
Maximum	0.20 mm (0.0079 in.)

If the oil clearance is greater than the maximum, replace the main idler gear shaft and/or main idler gear bush.


A63425

6. INSPECT OIL CLEARANCE BETWEEN SUB IDLER GEAR BUSH AND SHAFT

(a) Using a micrometer, measure the outside diameter of the sub idler gear shaft.
Standard shaft diameter:
49.950 – 49.975 mm (1.9665 – 1.9675 in.)

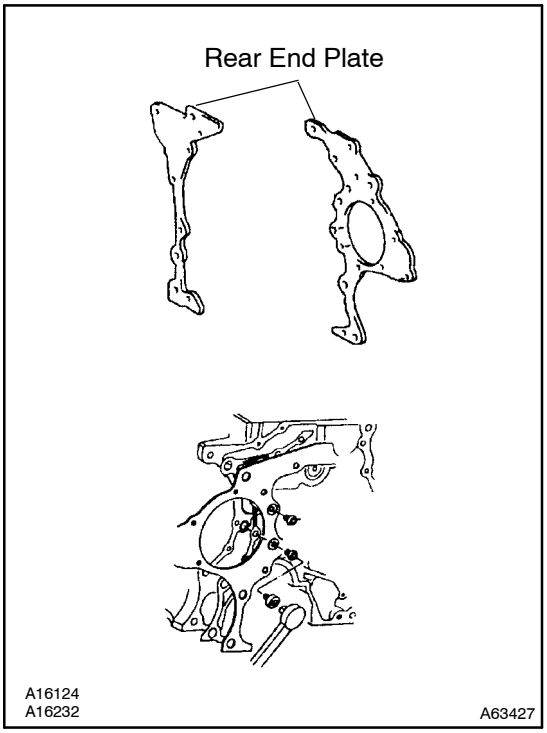

A63424

(b) Using a cylinder gauge, measure the inside diameter of the sub idler gear bush.
Standard inside diameter:
50.000 – 50.025 mm (1.9685 – 1.9695 in.)

(c) Calculate the oil clearance from the above measurements.
Oil clearance:

Standard	0.025 – 0.075 mm (0.0010 – 0.0030 in.)
Maximum	0.20 mm (0.0079 in.)

If the oil clearance is greater than the maximum, replace the sub idler gear shaft and/or sub idler gear bush.



A16124
A16232
A63427

7. INSTALL REAR END PLATE

(a) Insert a new gasket between the block and plate.

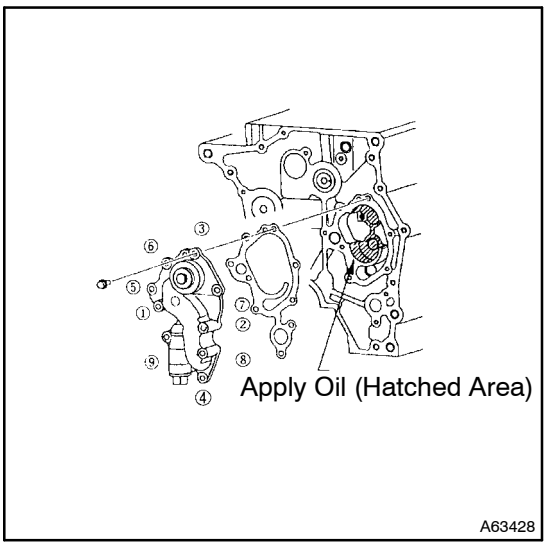
(b) Apply adhesive to threads of the 2 torx bolts.
Adhesive:
Part No. 08833–00070, THREE BOND 1324 or equivalent.

(c) Using a wrench, tighten the 2 torx bolts adjacent to the supply pump drive shaft mounting section to the specified torque below.
Torque: 55 N·m (560 kgf·cm, 40 ft·lbf)

(d) Tighten the 3 bolts as shown in the illustration to the specified torque below.
Torque: 55 N·m (560 kgf·cm, 40 ft·lbf)

HINT:

- Be careful that the gasket should not be moved off the proper place.
- Always use a new gasket.



8. INSTALL OIL PUMP ASSY

(a) Apply oil to the pump case and bearings of the block (hatched area) before installing the oil pump.

HINT:

Not applying oil may cause oil suction failure at start up, resulting in seizure and abnormality.

(b) To prevent misalignment of the gasket, apply engine oil to the gasket matching face of the block. Then, place and fix the gasket.

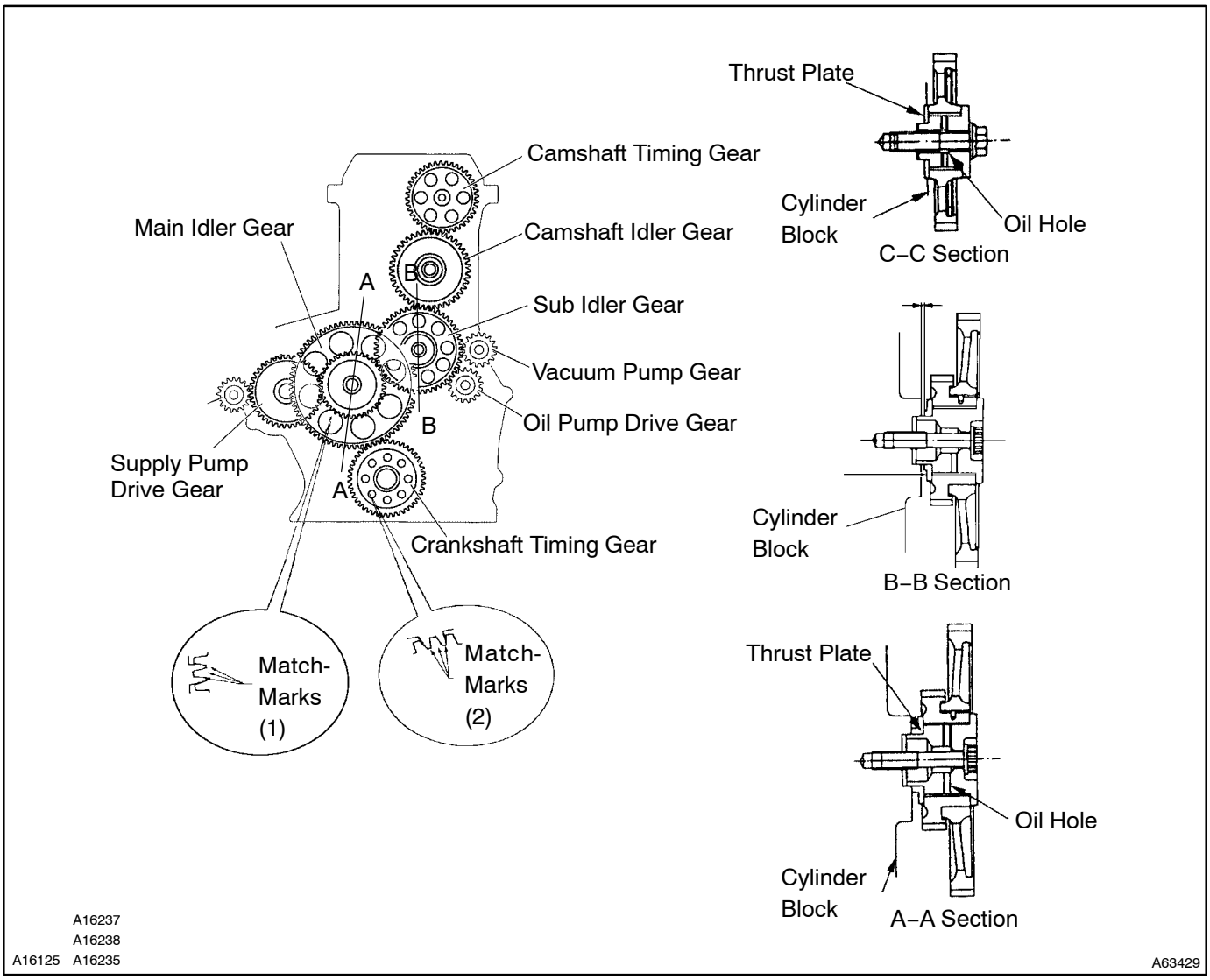
(c) Tighten the oil pump mounting bolts provisionally in the order as shown in the illustration. Then, retighten them.

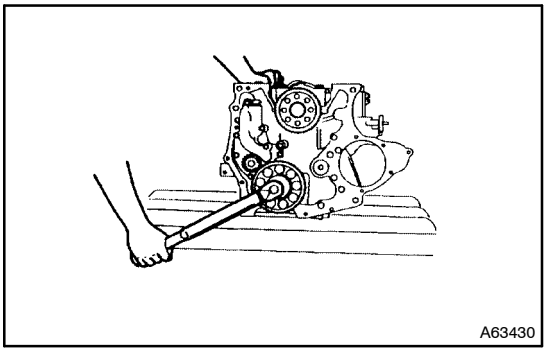
(d) Check that the gear rotates smoothly by hand after the installation.

HINT:

Be sure to observe the tightening order of the bolts, otherwise the oil pump will be damaged.

Torque: 28.5 N·m (290 kgf·cm, 21 ft·lbf)




A63430

9. INSTALL SUB IDLER GEAR

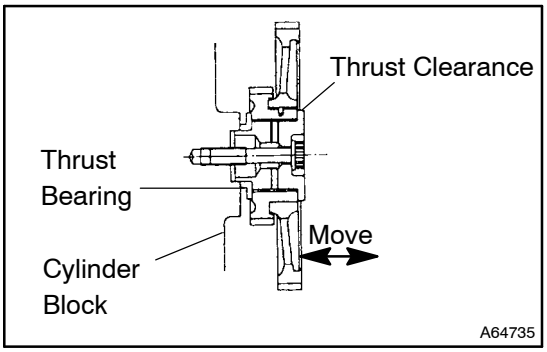
(a) Install the sub idler gear shaft through the thrust plate so that the lubrication hole faces downward.

(b) Install the sub idler gear.

(1) Apply engine oil to the seat and thread of the bolt.

(c) Tighten the mounting bolts of the sub idler gear shaft.

Torque: 108 N·m (1,100 kgf·cm, 80 ft·lbf)



A64735

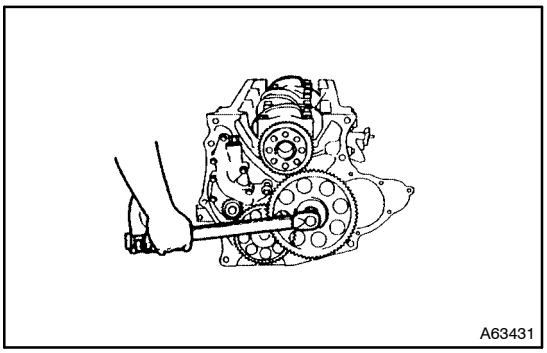
10. INSPECT SUB IDLE GEAR THRUST CLEARANCE

(a) Using a dial gauge, measure the clearance between the sub idler gear and thrust bearing.

Thrust clearance:

Standard	0.040 – 0.095 mm (0.0016 – 0.0037 in.)
Maximum	0.30 mm (0.0118 in.)

If the thrust clearance is greater than the maximum, replace the thrust bearing.


A63431

11. INSTALL MAIN IDLER GEAR

(a) Install the main idler gear shaft through the thrust plate so that the lubrication hole faces downward.

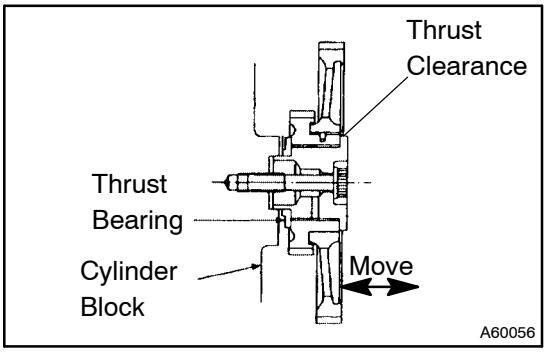
(b) Install the main idler gear.

HINT:

- Apply engine oil to the contact surface of the idler gear and idler gear shaft before the installation.
- Adjust the timing of the main idle gear to align it with the supply pump gear.

(c) Tighten the mounting bolts of the main idler gear shaft to the specified torque below.

Torque: 172 N·m (1,750 kgf·cm, 127 ft·lbf)



A60056

12. INSPECT MAIN IDLER GEAR THRUST CLEARANCE

(a) Using a dial gauge, measure the clearance between the main idler gear and thrust bearing.

Standard thrust clearance:

Standard	0.114 – 0.160 mm (0.0045 – 0.0063 in.)
Maximum	0.20 mm (0.0078 in.)

If the thrust clearance is greater than the maximum, replace the thrust bearing.

13. INSPECT TIMING GEAR BACKLASH

(a) Using a dial gauge, measure the backlash between the gears.

Backlash:

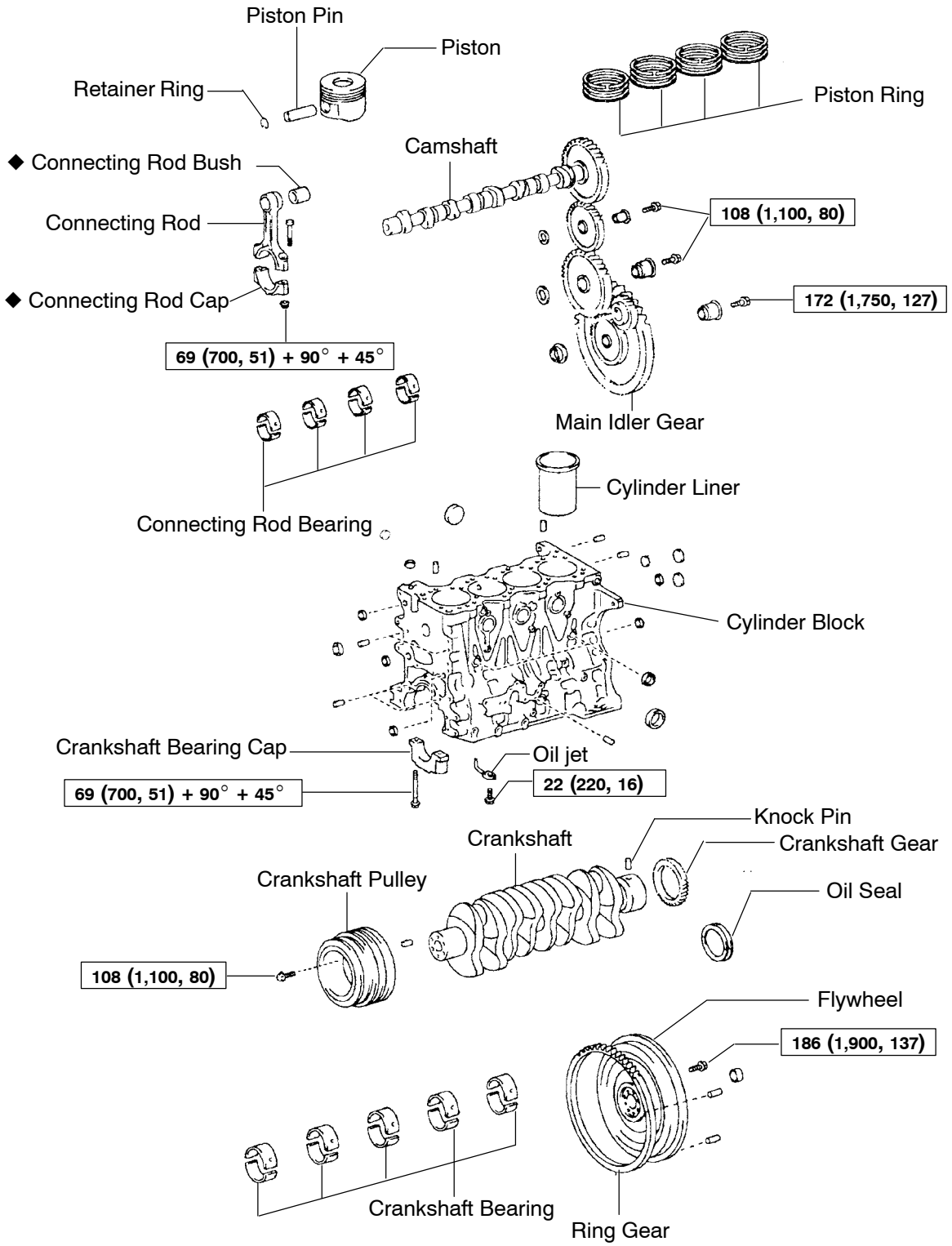
Item	Standard backlash	Maximum backlash
Crankshaft x Main idler	0.030 – 0.167 mm (0.0012 – 0.0065 in.)	0.30 mm (0.0118 in.)
Main idler x Injection pump or Supply pump	0.030 – 0.218 mm (0.0012 – 0.0085 in.)	
Injection pump or Supply pump x PS pump	0.030 – 0.183 mm (0.0012 – 0.0072 in.)	
Main idler x Sub idler	0.030 – 0.162 mm (0.0012 – 0.0063 in.)	
Sub idler x Oil pump	0.030 – 0.131 mm (0.0012 – 0.0051 in.)	
Sub idler x Camshaft idler	0.030 – 0.299 mm (0.0012 – 0.1693 in.)	
Camshaft idler x Camshaft timing	0.028 – 0.163 mm (0.0011 – 0.0064 in.)	
Sub idler x Vacuum pump	0.029 – 0.187 mm (0.0011 – 0.0073 in.)	

If the backlash is greater than the maximum, replace the gear.

PISTON, CRANKSHAFT AND CYLINDER BLOCK

1417P–01

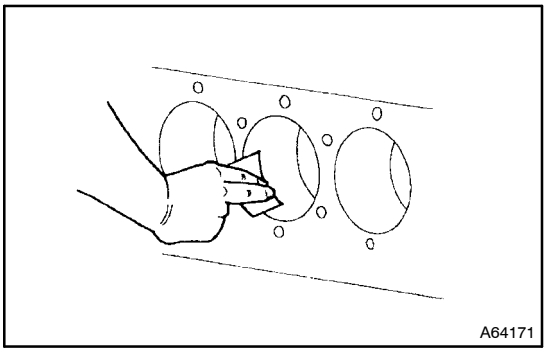
COMPONENTS



N·m (kgf·cm, ft·lbf) : Specified torque
◆ Non–reusable part

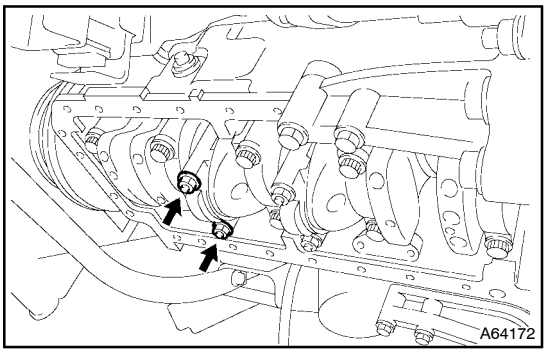
A78678

OVERHAUL



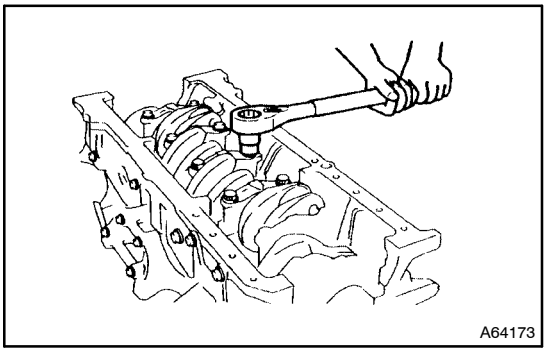
1. REMOVE PISTON AND CONNECTING ROD

(a) Remove the connecting rod bearing cap mounting bolts and pull out the pistons along with the connecting rods from the cylinder block upper side.



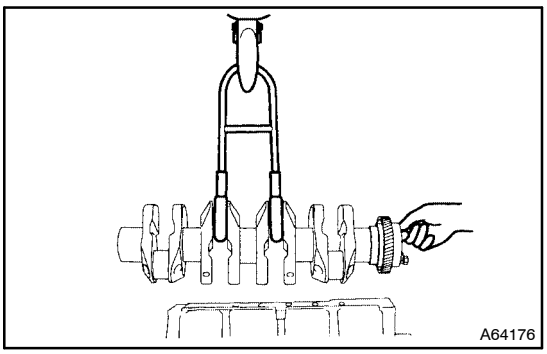
HINT:

- Before pulling out the pistons, remove carbon deposits from the upper end inside the cylinder liner with a scraper or an emery paper (recommended: No.150), working in a circular direction.
- When pulling out the pistons, be careful that the insides of the cylinder liners are not damaged by the connecting rod big ends.
- When pulling out the pistons, be careful that the nozzle of the cooling jet should not be deformed. If it is deformed, replace or correct it.
- When pulling out the pistons, be careful not to drop the connecting rod bearings from the connecting rod big ends, which may cause deformation or damage.
- Arrange the removed parts in the order of the cylinder numbers. Be careful not to change the combination of the connecting rod and cap.
- 2 pistons can be removed at a time (Nos. 1 and 4, Nos. 2 and 3).

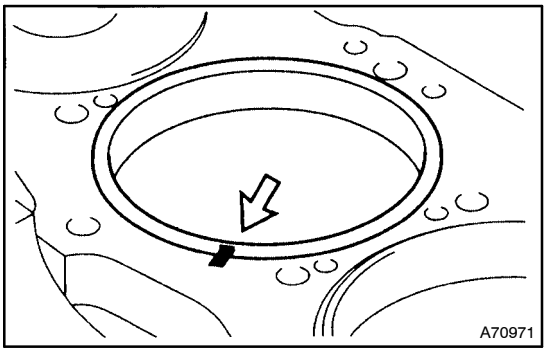


2. REMOVE CRANKSHAFT

(a) Remove the bearing cap mounting bolts.

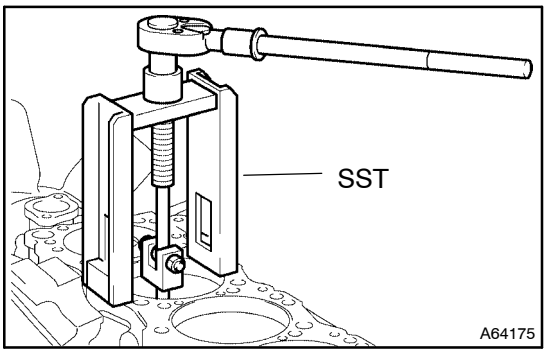


(b) Remove the crankshaft.



3. REMOVE CYLINDER LINER

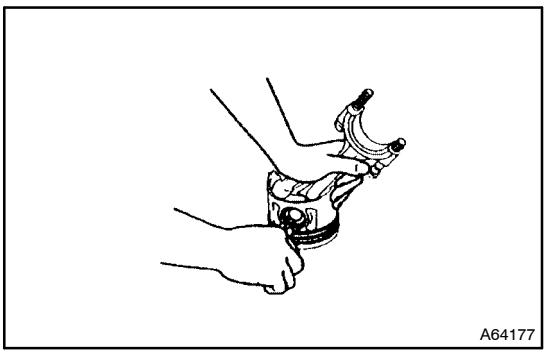
HINT:
Before removing the piston, put alignment marks on the cylinder liner and cylinder is bent by ”run–in”. When reusing the cylinder liner, misalignment with the cylinder block may concentrate stress on the thin part of the cylinder liner and it may be broken.



(a) Remove the cylinder liner.
If this is difficult, use SST.
SST 09420–1720
HINT:
Arrange the removed parts in the order of the cylinder numbers.

4. CLEAN CYLINDER BLOCK SUB–ASSY

(a) Rinse the cylinder block in a hot commercial alkaline solution, and remove oil from the cylinder block.
(b) Remove the alkaline solution from the cylinder block using a steam cleaner.
(c) If the water jacket is dirty, clean it as follows.
  (1) Rinse the cylinder block in a commercial acid solution.
  (2) After rinsing the cylinder block for a while, immerse it in the solution for approximately 30 minutes.
  (3) Pull out the cylinder block. After the solution has drained off, re–immerse the cylinder block in the solution and leave it for approximately 10 minutes.
  (4) Repeat step 3 until deposits are removed.
  (5) Remove the acid solution with hot water.
  (6) Immerse the cylinder block in the alkaline solution to neutralize the acid.
  (7) Finish by cleaning with a steam cleaner.
(d) When the cooling water passage and oil passage are cleaned completely, dry the cylinder block, press–fit a new blank cap and apply seal packing.


A64177

5. REMOVE CONNECTING ROD SUB–ASSY

(a) Using snap ring pliers, remove the retainer rings from the both ends of the piston pin.

CAUTION:

Removing the retainer rings may cause the retainer rings to fly up. Be sure to wear protective goggles.

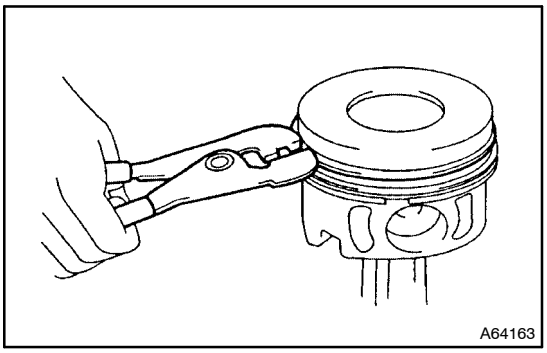
(b) Using a hammer, apply the reinforcing plate to the piston pin and punch out the piston pin.

HINT:

If it is difficult to punch out the piston pin, first immerse the piston and piston pin in hot water 80 – 90°C (176 – 194°F) for approximately 5 minutes to facilitate removal.

CAUTION:

Never touch the piston with your bare hands when it is hot.

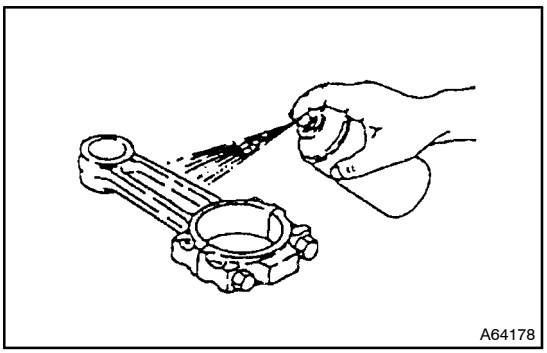

A64163

6. REMOVE PISTON RING

(a) Using a piston ring expander, remove the piston ring.

HINT:

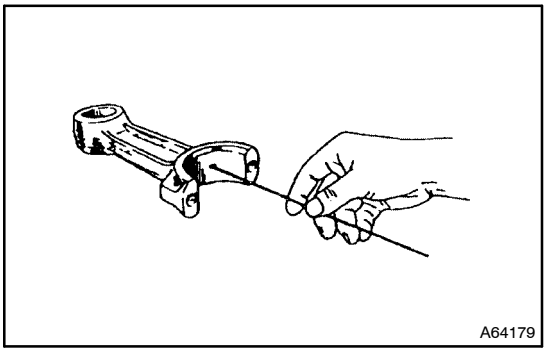
- Handle the piston rings carefully because they are made of a special casting which is easily broken.
- Arrange the piston rings in the order of the cylinder numbers.


A64178

7. INSPECT CONNECTING ROD SUB–ASSY

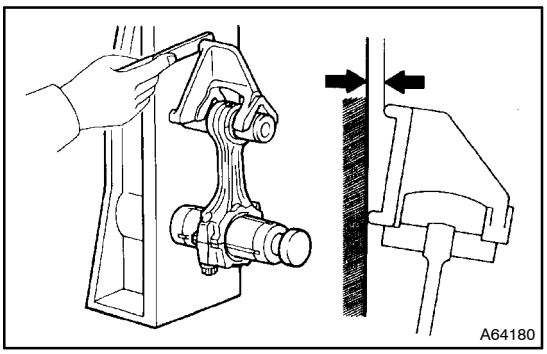
(a) Using dye penetrant examination or magnetic examination, check the connecting rod for cracks or damage.

If there are any cracks or damage, replace the connecting rod with a new one.


A64179

(b) Check that there is no clogging in the lubrication passage to the connecting rod small end.

If there is any clogging, blow air through the lubrication passage using an air gun, or clean by inserting a wire.



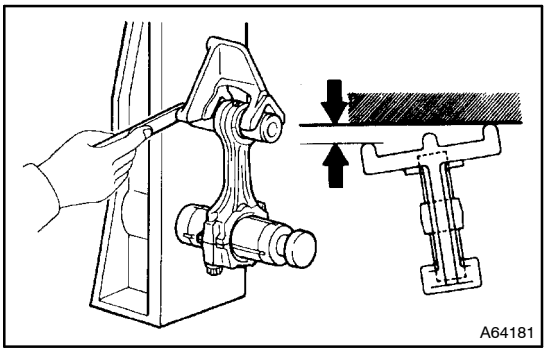
(c) Using a rod aligner and feeler gauge, check the connecting rod alignment.

(1) Check for bend.

Maximum bend:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If the bend is greater than the maximum, replace the connecting rod with a new one.

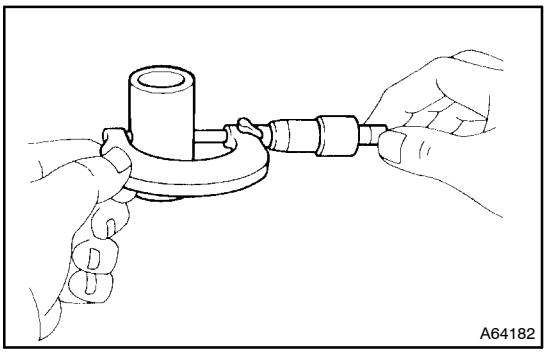


(2) Check for twist.

Maximum twist:

0.05 mm (0.0020 in.) per 100 mm (3.94 in.)

If the twist is greater than the maximum, replace the connecting rod with a new one.



8. INSPECT PISTON PIN

(a) Using a micrometer, measure the piston pin diameter.

Standard pin diameter:

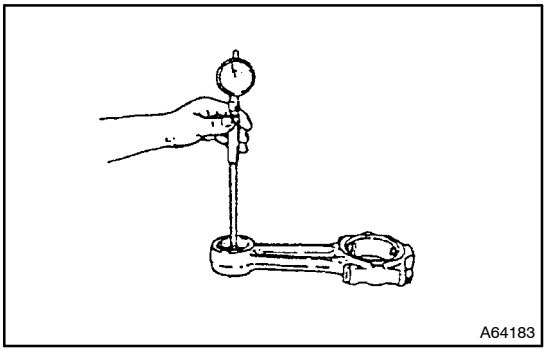
36.989 – 37.000 mm (1.453 – 1.4567 in.)

Minimum pin diameter: 36.96 mm (1.4551 in.)

If the diameter is less than the minimum, replace the piston pin with a new one.

HINT:

Never grind the piston pin, because the surface is coated with a special material.



9. INSPECT CONNECTING ROD SMALL END BUSH

(a) Using a cylinder gauge, measure the connecting rod bush inside diameter.

Standard inside diameter:

37.015 – 37.025 mm (1.4573 – 1.4577 in.)

Maximum inside diameter: 37.10 mm (1.4606 in.)

If the inside diameter is greater than the maximum, replace the connecting rod bush with a new one.

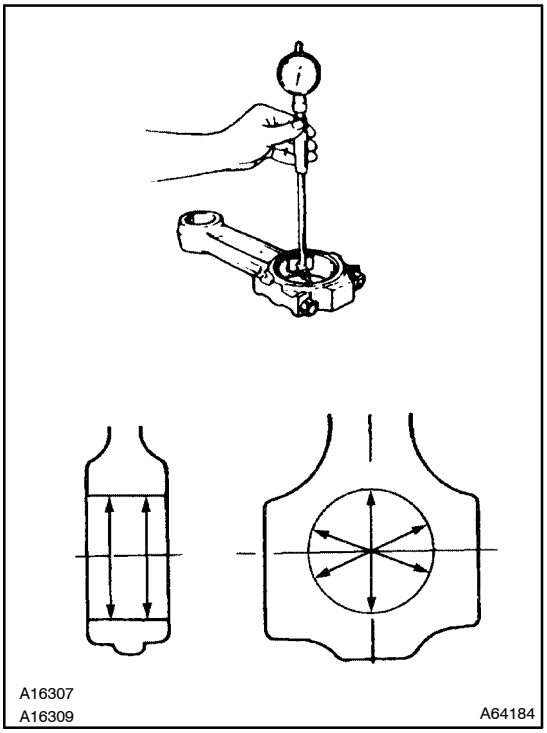
(b) Calculate the oil clearance between the piston pin and piston pin bush.

Standard oil clearance:

0.015 – 0.036 mm (0.0006 – 0.0014 in.)

Maximum oil clearance: 0.08 mm (0.0031 in.)

If the oil clearance is greater than the maximum, replace the piston with a new one.

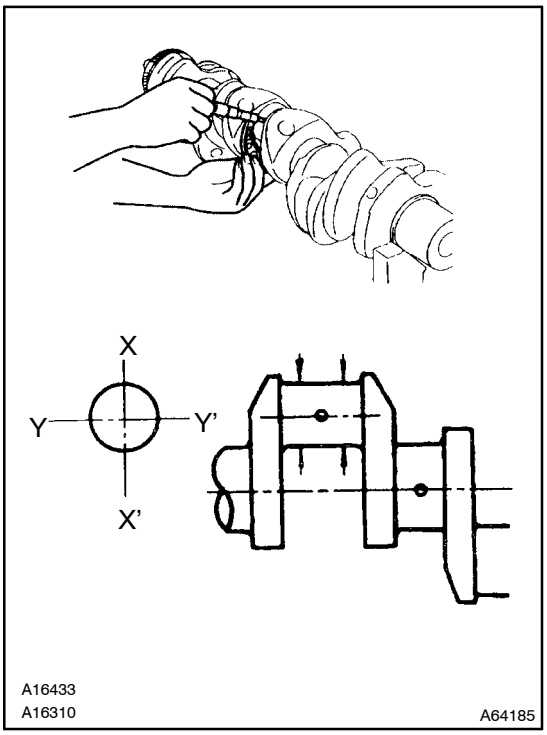


10. INSPECT CONNECTING ROD BIG END

(a) After tightening the connecting rod cap without bearing, using a cylinder gauge, measure the inside diameter of the connecting rod big end to calculate the roundness.

Standard inside diameter:
68.985 – 69.000 mm (2.7159 – 2.7165 in.)
Maximum inside diameter: 69.00 mm (2.7165 in.)

HINT:
For tightening of the connecting rod cap, see step 34.
If the diameter is greater than the maximum, replace the connecting rod big end a new one.

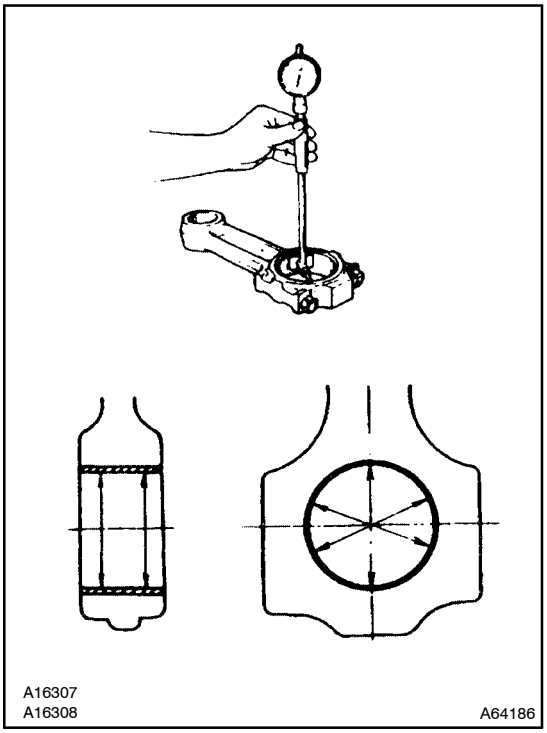


11. INSPECT CRANKSHAFT PIN AND BEARING

(a) Using a micrometer, measure the crankshaft pin diameter.

Standard crankshaft pin diameter:
64.940 – 64.960 mm (2.5566 – 2.5575 in.)
Minimum crankshaft pin diameter:
63.80 mm (2.5118 in.)

If the diameter is less than the minimum, replace the crankshaft pin a new one.



(b) Using a cylinder gauge, measure the connecting rod bearing inside diameter.

Standard inside diameter:
64.991 – 65.022 mm (2.5587 – 2.5599 in.)
Maximum inside diameter: 65.022 mm (2.5599 in.)

(c) Calculate the clearance between the crankshaft pin and connecting rod bearing.

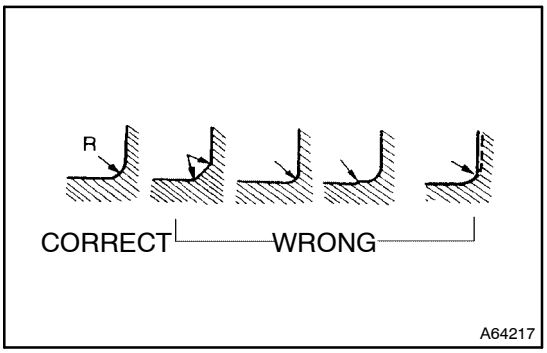
Standard clearance:
0.031 – 0.082 mm (0.0012 – 0.0032 in.)
Maximum clearance: 0.20 mm (0.0079 in.)

If the clearance is greater than the maximum, replace the connecting rod bearing with the correct one.

Undersize machining dimension: 2 sizes below

Undersize machining dimension:

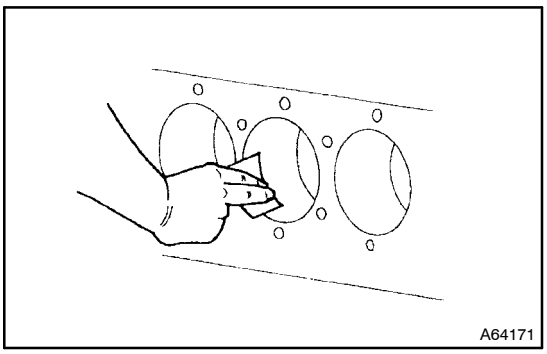
0.25 mm (0.0098 in.)	0.50 mm (0.0197 in.)



HINT:

Machined dimension of filet R

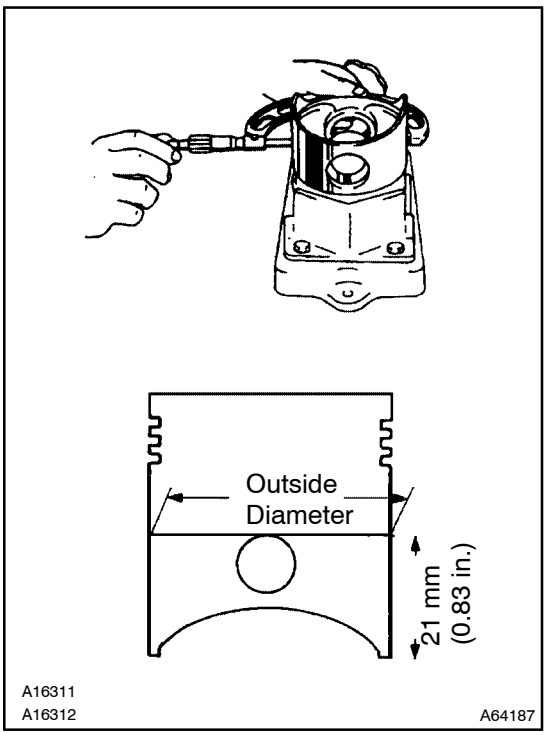
Crankshaft pin: 5.0 – 5.5 mm (0.20 – 0.21 in.)



12. INSPECT PISTON AND CYLINDER LINER

HINT:

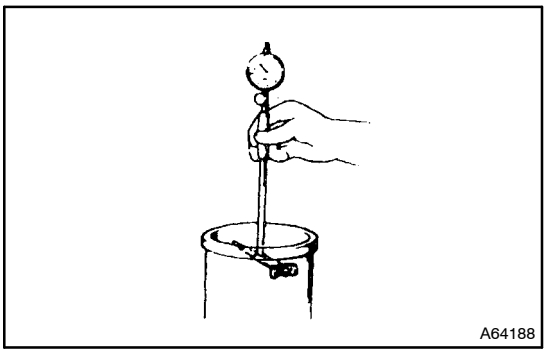
Before the measurement, remove carbon deposits from the upper end inside the cylinder liner with a scraper or an emery paper (recommended: No.150), working in a circular direction. Make sure that there is no scratches inside the cylinder liner.



(a) Using a micrometer, measure the piston diameter at the in the illustration points.

Standard piston diameter:
S05C–B:
113.920 – 113.944 mm (4.4850 – 4.4859 in.)
S05C–TA, TB:
113.869 – 113.885 mm (4.4830 – 4.4837 in.)
Minimum piston diameter: 113.869 mm (4.4850 in.)

If the piston diameter is less than the minimum, replace the piston with a new one.



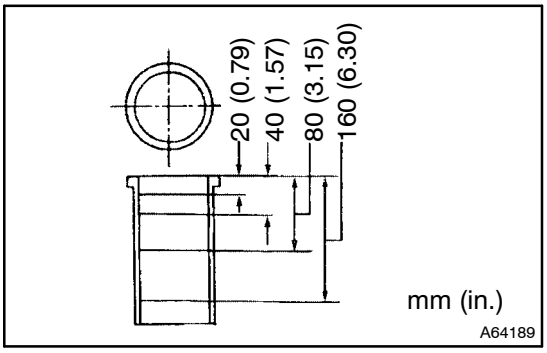
(b) Using a cylinder gauge, measure the cylinder liner inside diameter at the 4 points in the piston boss and thrust direction, as shown in the illustration.

Standard inside diameter:
113.988 – 114.012 mm (4.4877 – 4.4886 in.)
Maximum inside diameter: 114.15 mm (4.4910 in.)

If the inside diameter is greater than the maximum, replace the cylinder liner with a new one.

HINT:

- Apply the value measured at the most worn point to the cylinder liner inside diameter.
- If the cylinder liner is heavily wornor if only the piston ring must be replaced, correct the corrugation at the top of the cylinder liner.



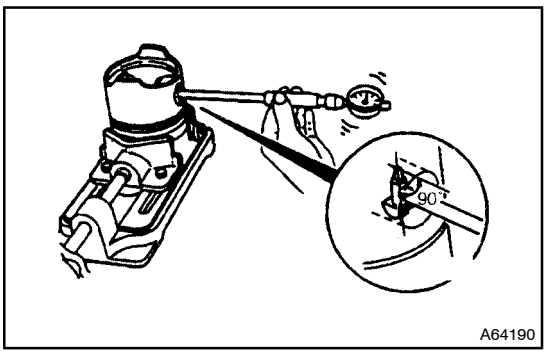
(c) Measure the clearance between the piston and cylinder liner.

Standard clearance:
S05C–B:
0.056 – 0.080 mm (0.0022 – 0.0031 in.)
S05C–TA, TB:
0.0515 – 0.0715 mm (0.0020 – 0.0028 in.)
Maximum clearance: 0.15 mm (0.0059 in.)

If the clearance is greater than the maximum, replace the cylinder liner and/or piston with a new one.

HINT:

Apply the value measured at the most worn point to the cylinder liner inside diameter.



13. INSPECT PISTON PIN BOSS

(a) Using a cylinder gauge, measure the piston pin boss inside diameter.

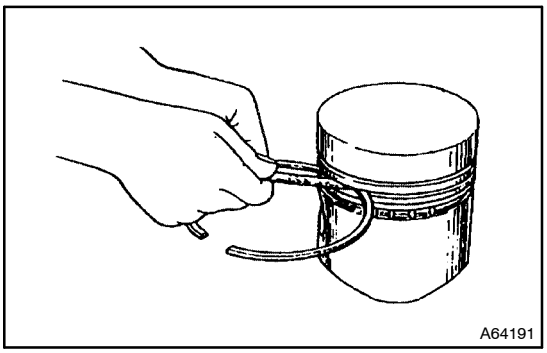
Standard piston pin boss inside diameter:
36.987 – 37.003 mm (1.4561 – 1.4568 in.)
Maximum piston pin boss inside diameter:
37.05 mm (1.4587 in.)

If the inside diameter is greater than the maximum, replace the piston with a new one.

(b) Calculate the clearance between the piston pin and the piston pin boss.

Standard clearance:
(–0.00051 (T) – 0.00055 (L) in.) –0.013 (T) – 0.014 (L) mm
Maximum oil clearance: 0.05 mm (0.0020 in.)

HINT:
T = tightening allowance, L = clearance
If the clearance is greater than the maximum, replace the piston or piston pin.



14. INSPECT PISTON RING AND PISTON RING GROOVE

(a) Insert the piston ring into the piston ring groove.

(b) Using a feeler gauge, measure the clearance between the piston ring and piston ring groove.

Clearance:
S05C–B

Item	Standard	Maximum
1st ring	0.06 – 0.10 mm (0.0024 – 0.0039 in.)	0.30 mm (0.0118 in.)
2nd ring	0.04 – 0.08 mm (0.0016 – 0.0031 in.)	0.30 mm (0.0118 in.)
Oil ring	0.02 – 0.06 mm (0.0008 – 0.0023 in.)	0.20 mm (0.0079 in.)

Clearance:
S05C–TA, TB

Item	Standard	Maximum
1st ring	0.09 – 0.13 mm (0.0035 – 0.0051 in.)	0.20 mm (0.0078 in.)
2nd ring	0.07 – 0.11 mm (0.0016 – 0.0031 in.)	0.18 mm (0.0070 in.)
Oil ring	0.02 – 0.06 mm (0.0007 – 0.0023 in.)	0.13 mm (0.0051 in.)

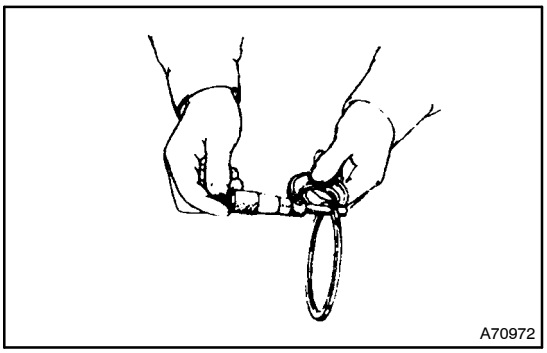
If the clearance is greater than the maximum, measure the width of the piston ring and piston ring groove individually and replace any parts that do not meet the limit with new ones.

Groove width:
S05C–B

Item	Standard	Maximum
1st ring	2.55 – 2.57 mm (0.1003 – 0.1011 in.)	2.70 mm (0.1062 in.)
2nd ring	2.03 – 2.05 mm (0.0799 – 0.0807 in.)	2.20 mm (0.0866 in.)
Oil ring	4.01 – 4.03 mm (0.1578 – 1586 in.)	4.10 mm (0.1614 in.)

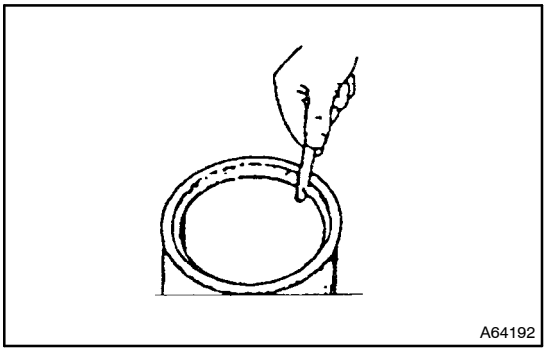
Groove width:
S05C–TA, TB

Item	Standard	Maximum
1st ring	2.58 – 2.60 mm (0.1015 – 0.1023 in.)	2.70 mm (0.1062 in.)
2nd ring	2.06 – 2.08 mm (0.0811 – 0.0818 in.)	2.20 mm (0.0866 in.)
Oil ring	4.01 – 4.03 mm (0.1578 – 1586 in.)	4.10 mm (0.1614 in.)


A70972

Ring thickness:

Item	Standard	Minimum
1st ring	2.47 – 2.49 mm (0.0972 – 0.0980 in.)	2.40 mm (0.0944 in.)
2nd ring	1.97 – 1.99 mm (0.0775 – 0.0783 in.)	1.90 mm (0.0748 in.)
Oil ring	3.97 – 3.99 mm (0.1562 – 0.1570 in.)	3.90 mm (0.1535 in.)


A64192

15. INSPECT PISTON RING GAP

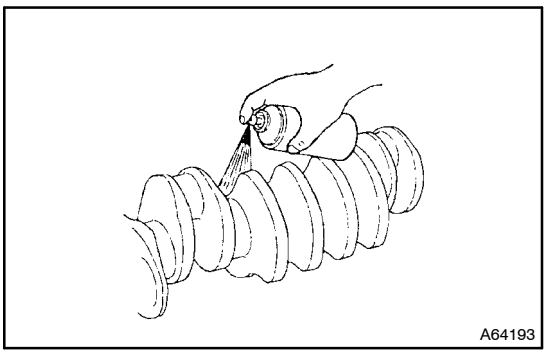
(a) Fit the piston ring into the cylinder liner.

(b) Using a feeler gauge, measure the end gap of the piston ring matching point.

Clearance:

Item	Standard	Maximum
1st ring	0.30 – 0.40 mm (0.0119 – 0.0157 in.)	1.50 mm (0.0590 in.)
2nd ring	0.50 – 0.65 mm (0.0197 – 0.0255 in.)	1.20 mm (0.0472 in.)
Oil ring	0.15 – 0.30 mm (0.0059 – 0.0118 in.)	1.20 mm (0.0472 in.)

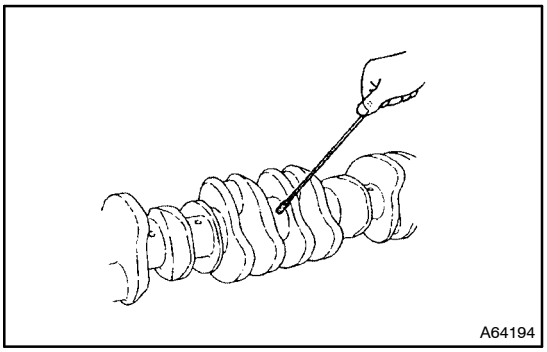
If the end gap is greater than the maximum, replace the piston ring with a new one.


A64193

16. INSPECT CRANKSHAFT

HINT:

Before the inspection, clean the crankshaft with a commercial cleaning agent and clean the lubrication passage using an air gun.


A64194

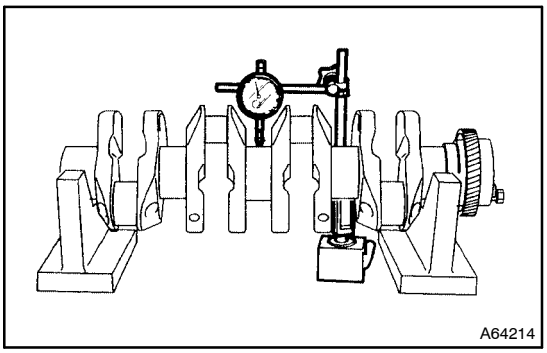
(a) Performing the dye penetrant test, and check the crankshaft for cracks.

HINT:

Pay special attention to the finished R section and oil hole of the crankshaft journal and crankpin.

(b) Visually check the condition of the crankshaft journal and pin for damage or wear.

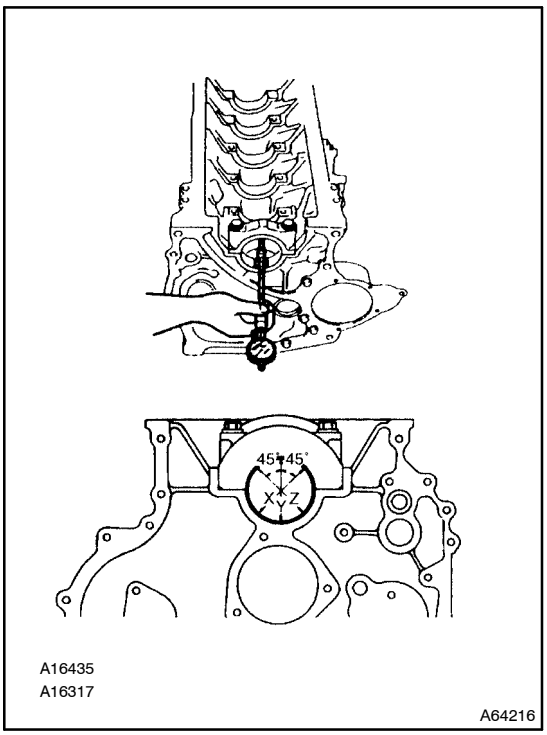
If any damage are found, replace the crankshaft with a new one.


A64214

(c) Inspect for circle runout.
  (1) Place the crankshaft on V–blocks.
  (2) Using a dial gauge, measure the circle runout of the crankshaft at the center journal.

  Maximum circle runout: 0.15 mm (0.0059 in.)

If the circle runout is greater than the maximum, replace the crankshaft with a new one.



A16435
A16317
A64216

17. INSPECT CRANKSHAFT BEARING CAP

(a) After tightening the main bearing caps without bearing, using a cylinder gauge, measure the inside diameter of the main bearing caps to calculate the roundness.

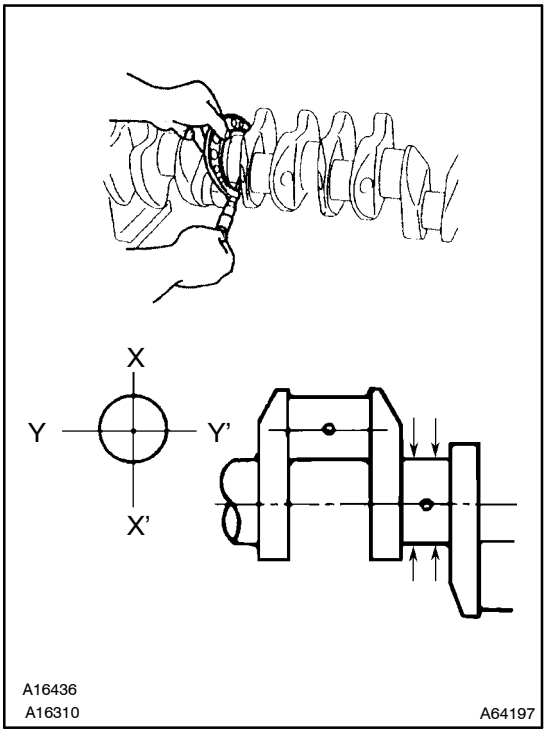
  Inside diameter:

Standard	84.985 – 85.000 mm (3.3459 – 3.3465 in.)
Maximum	85.20 mm (3.3543 in.)

If the inside diameter is greater than the maximum, carry out boring after overlay welding or replace the cylinder block with a new one.

HINT:

- When installing the main bearing caps, make sure to return them to the original position according to the number stamped on the caps. The main bearing caps together with the cylinder block are round.
- For tightening of the main bearing caps, see step 28.



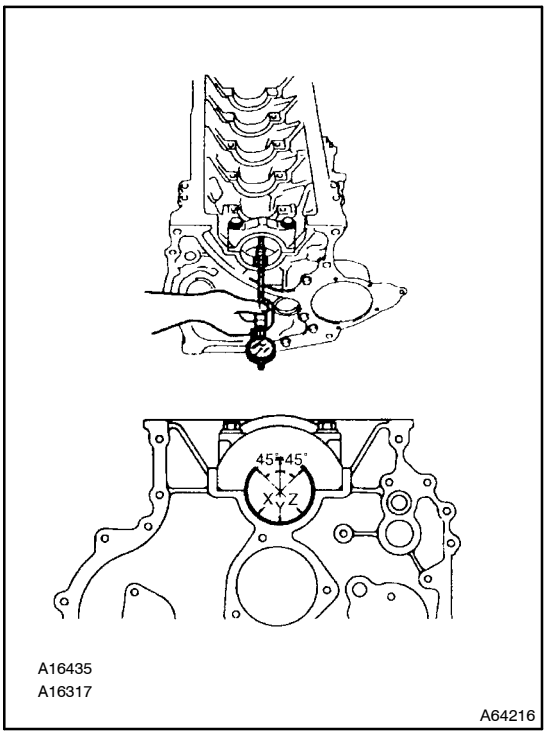
18. INSPECT CRANKSHAFT JOURNAL AND BEARING

(a) Using a micrometer, measure the main journal outside diameter.

Standard journal diameter:
79.940 – 79.960 mm (3.1472 – 3.1480 in.)
Minimum journal diameter:

Repair	79.80 mm (3.1417 in.)
Use	78.80 mm (3.1024 in.)

If the diameter is less than the minimum for use, replace the crankshaft with a new one.



(b) After installing and tightening the bearing caps, using a cylinder gauge, measure the bearing inside diameter.

Inside diameter:

Standard	80.00 mm (3.1496 in.)
Maximum	80.30 mm (3.1614 in.)

If the inside diameter is greater than the maximum, replace the bearing with a new one.

HINT:

- When installing the bearing caps, make sure to return them to the original position according to the number stamped on the caps. The bearing caps together with the cylinder block are round.
- For tightening of the bearing cap, see step 28.

(c) Calculate the oil clearance between the crankshaft journal and bearing.

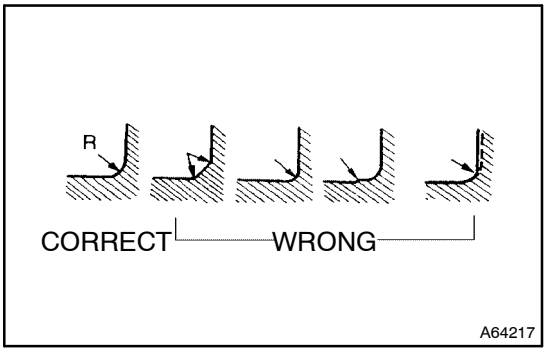
Oil clearance:

Standard	0.051 – 0.102 mm (0.0020 – 0.0040 in.)
Maximum	0.20 mm (0.0079 in.)

Undersize machining dimension:

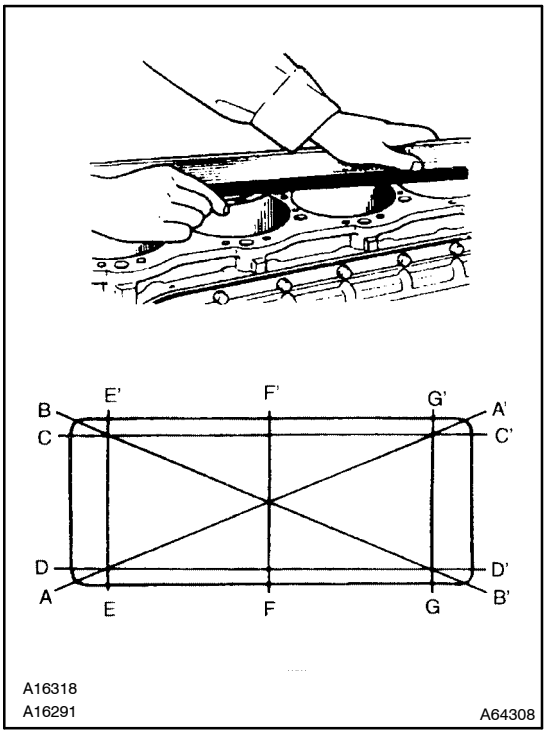
0.25 mm (0.0098 in.)	0.50 mm (0.0197 in.)

If the oil clearance is greater than the maximum, replace the bearing with a correct one.



HINT:
Make sure to replace the top and bottom main bearings as one set. The top and bottom main bearings must be round.
HINT:
Machined dimension of filet R

Main crankshaft journal:
5.0 – 5.5 mm (0.1969 – 0.2165 in.)



19. INSPECT CYLINDER BLOCK SUB–ASSY

(a) Remove the water gallery plug, and visually check the condition of the worn hole.

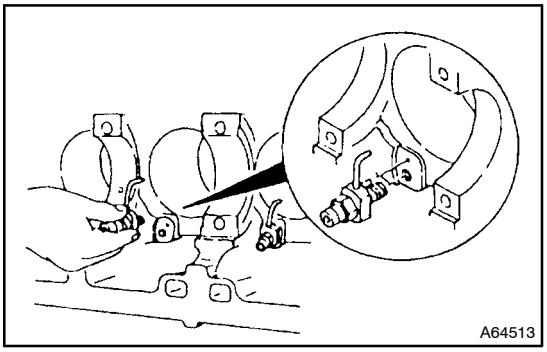
If the wear is excessive, replace the part with a new one. Also inspect the inside of the cylinder block, and clean the cylinder block main body with a commercial cleaning agent as required.

(b) Check the cylinder for cracks.
Check the cylinder block for cracks and perform the dye penetrant test.

If any cracks are found, replace the cylinder block with a new one.

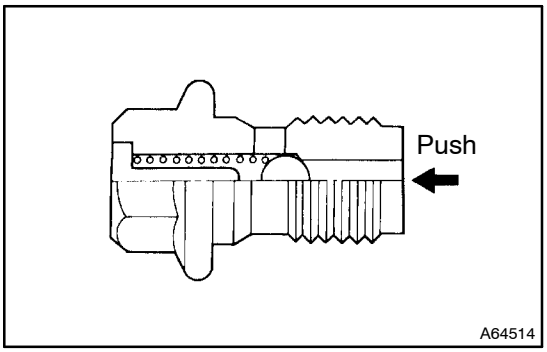
(c) Check the flatness of the cylinder block upper surface.
Using a straight edge and feeler gauge, measure the warpage of the surfaces contacting the cylinder head.
Standard warpage: 0.05 mm (0.0020 in.) or less
Maximum warpage: 0.20 mm (0.0079 in.)

If the warpage is greater than the maximum, replace the cylinder block with a new one.



20. REMOVE CHECK VALVE AND OIL JET

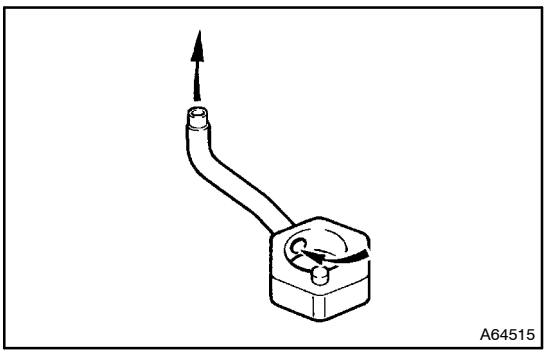
(a) Remove the 4 check valves and 4 oil jets.



21. INSPECT CHECK VALVE

(a) Using a wooden stick, push the valve and check if it is stuck.

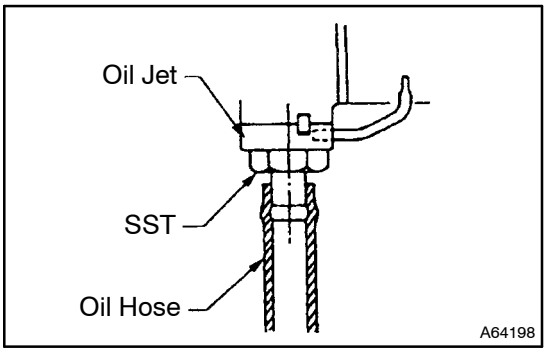
If stuck, replace the check valve.



22. INSPECT OIL JET

(a) Check the oil jet for damage or clogging.

If necessary, replace the oil jet.

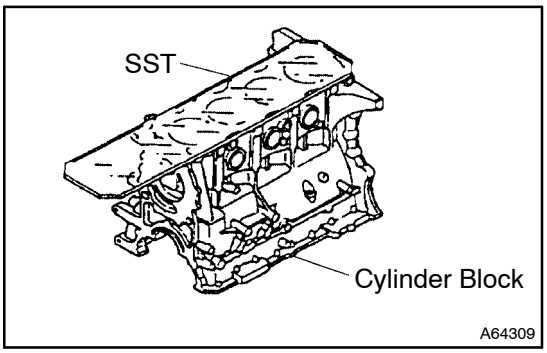


23. ADJUST OIL JET

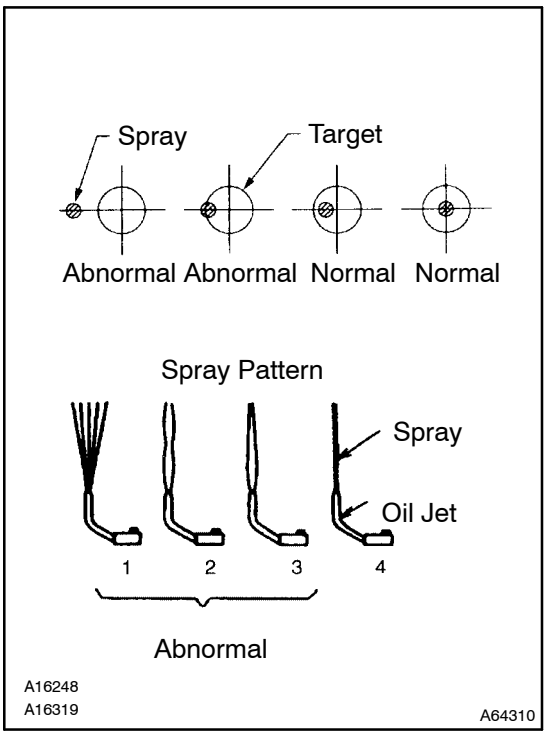
(a) Align the pin of the jet with the pin hole of the cylinder block.

(b) Using SST, install the jet with SST.
SST 9001–24262
Torque: 22 N·m (220 kgf·cm, 16 ft·lbf)

(c) Connect a commercial oil pump (hydraulic pressure: 2 kgf/cm^2 (28 lb/psi.)) to the SST using a hose.



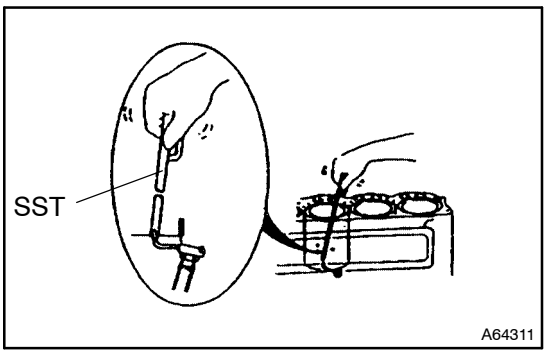
(d) Set the SST on the cylinder block upper surface against the dowel pin.
SST 09444–1630



(e) Start the oil pump, let the engine oil spray out the oil jet to check that the center of the jet flow is within the ø 7 mm (ø 0.27 in.) reference line of the gauge as well as to judge whether the jet flow is normal as shown in the illustration.

NOTICE:

- **Use new engine oil.**
- **Engine oil is flammable.**
- **This spray test should be performed in a well ventilated room and away from any open flames or electric sparks.**



If the center of the jet flow is out of the ø 7 mm (ø 0.27 in.) reference line of the gauge, adjust the jet sight using the SST.

(f) Remove the checking bolt after the inspection.
SST 09472–1620

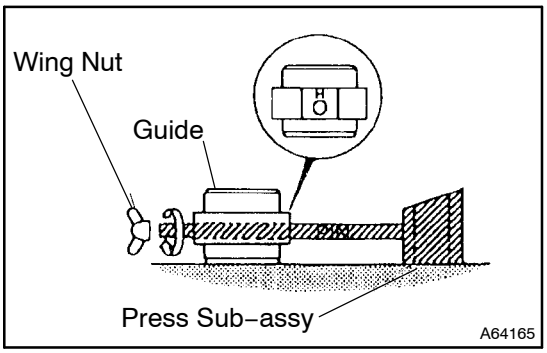
24. INSTALL CHECK VALVE AND OIL JET

(a) Align the pin of the jet with the pin hole of the cylinder block.

(b) Install the jet with the check valve.
Torque: 22 N·m (220 kgf·cm, 16 ft·lbf)

NOTICE:

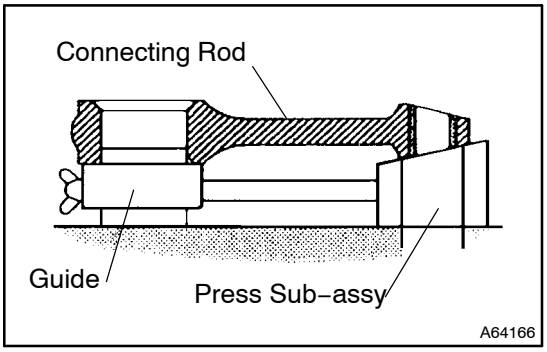
- **Always install the soft washer.**
- **When installing the piston, make sure that the oil jet is not struck by the piston when at bottom dead center.**



25. INSTALL CONNECTING ROD SMALL END BUSH

(a) Prepare the SST.
SST 09402–1480, 09481–1140, 9233–10360

(1) Assemble the guide and press sub–assy inserting its pin into the guide, then secure them with the wing nuts.

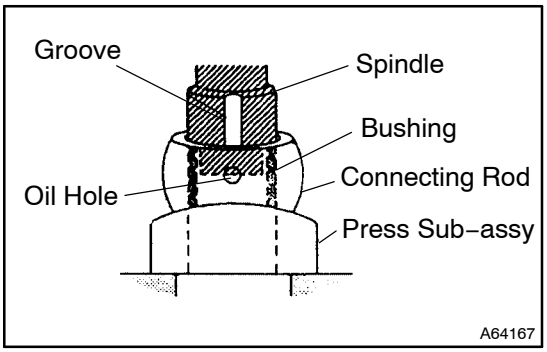


HINT:

- Bring lever ”H” punched on the guide above the pin.
- Make sure to align both supporting surfaces of the guide and press sub–assy flush on a flat plane.

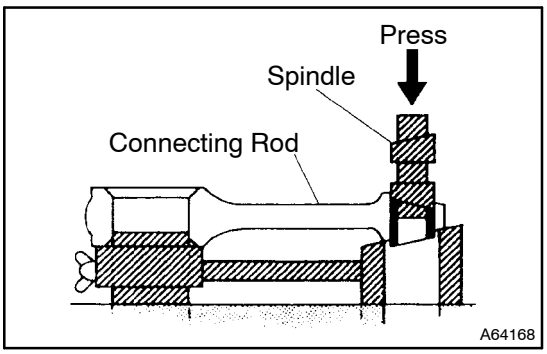
(b) Using SST, remove the bush.

(1) Set the connecting rod assembled without crankshaft pin bore bearing on the guide and press sub–assy.



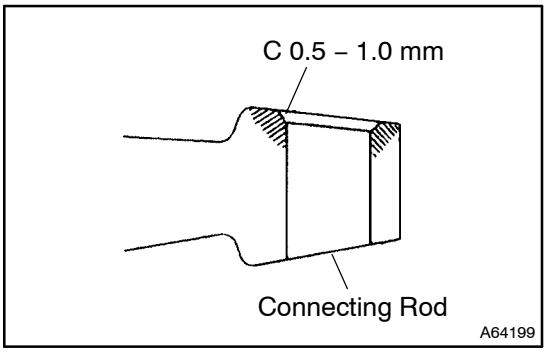
(2) Using a SST, install the spindle into the bush.
SST 09402–1540

HINT:
Align the grooving of the spindle with the oil hole of the bush.



(3) Using a press, remove the bush.

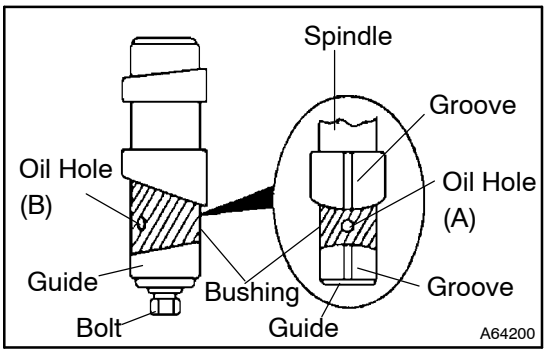
HINT:
Always operate the press slowly and smoothly.



(c) Assemble the bush.

(1) Chamfer one edge of the bush hole at the small end of the connecting rod uniformly by C 0.5 – 1.0 mm (0.0196 – 0.0393 in.)

HINT:
Irregular chamfering can cause out–of–roundness of the pressed bushing, which may result in jamming during insertion. Remove dust from the inner surface of the smaller hole.



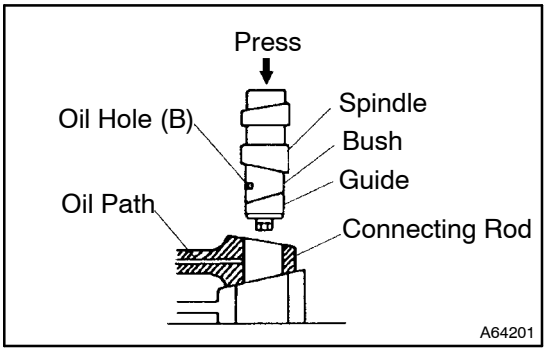
(d) Mount the bushing on the spindle.

SST 09402–1540, 09481–1540, 9191–08252

(1) Set the bushing and guide on the spindle, then secure them with the bolt.

Torque: 4.9 – 6.9 N·m (50 – 70 kgf·cm, 43 – 61 in.·lbf)

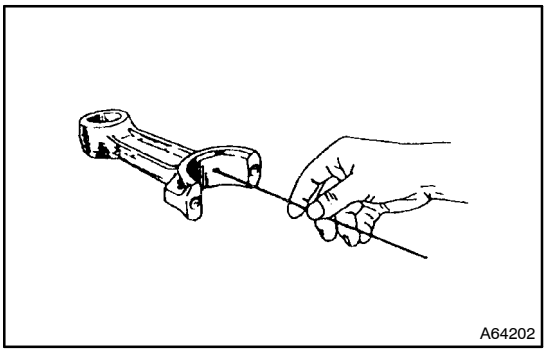
HINT:
Align oil hole (A) in the bushing with both groove or the spindle and guide, making sure that the oil hole (B) will meet with oil path in the connecting rod led from the big end bore in the rod.



(2) Apply fresh engine oil around the bush and guide.

(e) Install the bush in the connecting rod. Position the bush tool assembly so that the oil hole (B) aligns with the oil path through the connecting rod.

HINT:
Before installing, fully coat the bore in the connecting rod with fresh engine oil.

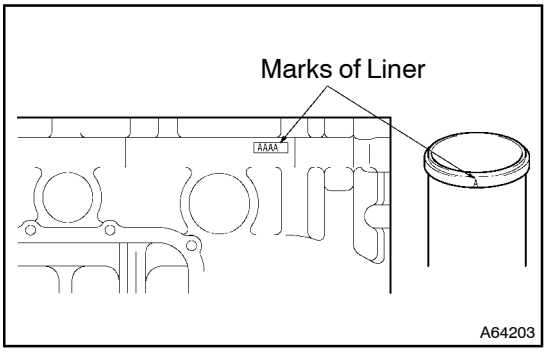


(f) Inspect the bush positioning after the installation.

(1) Make sure that the oil hole of the bush and the oil path of the connecting rod are suitably aligned allowing a 6 mm (0.23 in.) diameter rod to penetrate.

HINT:
Misalignment can lead to insufficient lubrication, which may result in seizure.

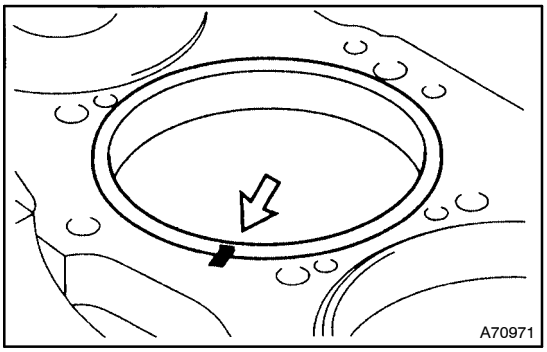
(2) Make sure that the bushing can be rotated by hand with–out rattling while a new piston pin is inserted in the piston pin.



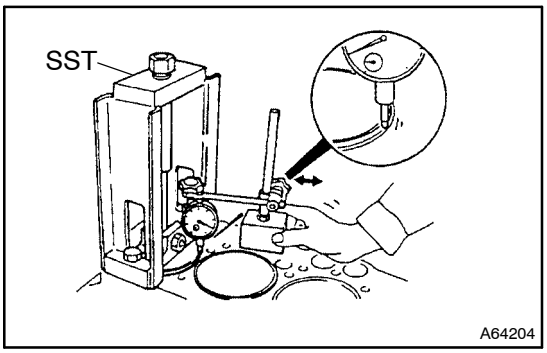
26. INSTALL CYLINDER LINER

HINT:

- When assembling the cylinder liner with the cylinder block, clearance can be set to three levels.
- When using a new cylinder liner, the upper surface and side surface of the cylinder block are stamped A, B or C. Insert a matching cylinder liner having the same symbol.



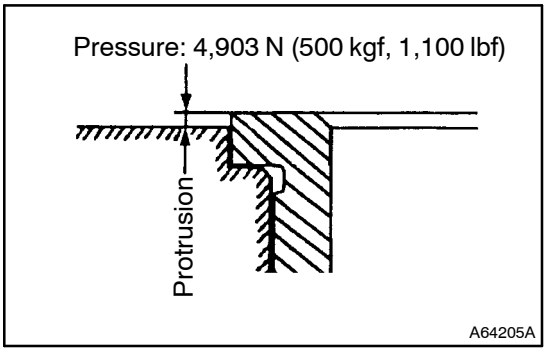
- When reusing a cylinder liner, install it according to the alignment marks made during removal. The cylinder liner is bent by ”run–in”. When reusing the cylinder liner, misalignment with the cylinder block may concentrate stress on the thin part of the cylinder liner and it may be broken.



27. INSPECT PROTRUSION OF CYLINDER LINER

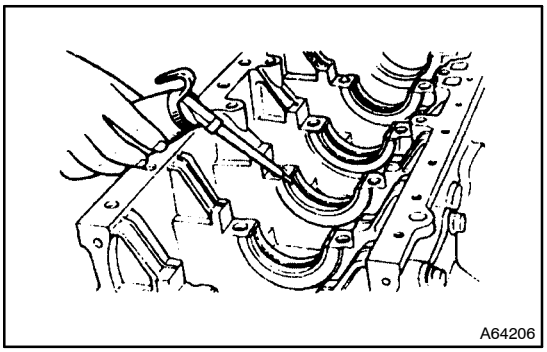
(a) Install SST onto the cylinder block.
SST 09420–1720

(b) Tighten the center bolt to the specified torque below to set the cylinder liner in the normal installation condition.
Torque: 9.8 N·m (100 kgf·cm, 87 in.·lbf)



(c) Using a dial gauge, measure the protrusion of the cylinder liner.
Standard protrusion:
0.01 – 0.08 mm (0.0004 – 0.0031 in.)
Maximum protrusion: 0.08 mm (0.0031 in.)

If the protrusion is greater than the maximum, replace the cylinder liner.



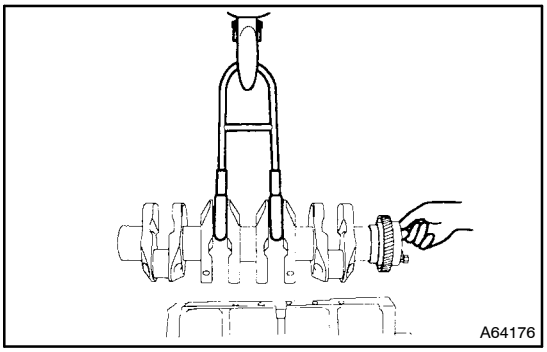
28. INSTALL CRANKSHAFT

(a) Install the main bearings onto the cylinder block and main bearing caps.

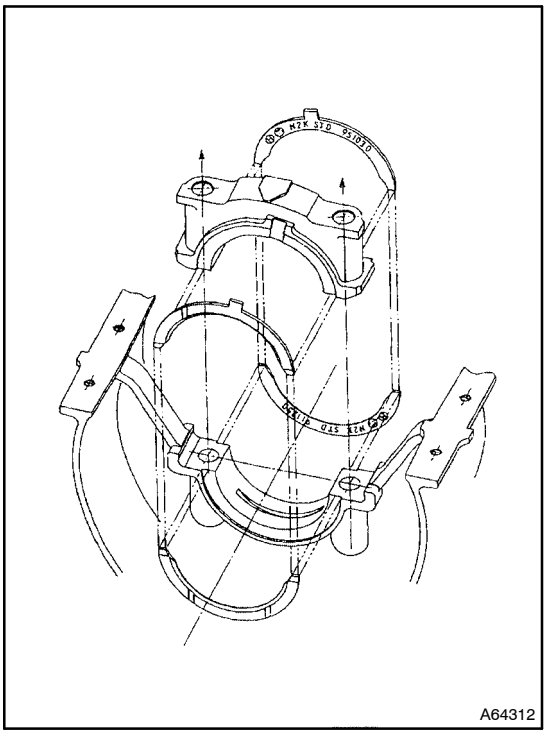
HINT:

- When reusing a bearing, make sure to reassemble the removed bearing as it was originally installed.
- Install the bearing with the oil hole on the block side and the bearing without the oil hole on the cap side.
- Match the bearing protrusion with the notch of the block or cap.

- After the installation, apply engine oil to the journal surfaces of the bearings.


A64176

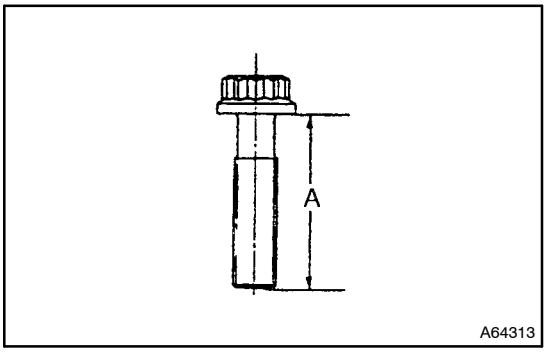
(b) Install the thrust washers onto the 4 points of the No. 2 journal of the cylinder block and either side of the bearing caps.
(c) Install the crankshaft onto the cylinder block.


A64312

HINT:
- When reusing a bearing, make sure to reassemble the removed bearing as it was originally installed.
- Install the thrust washers with the groove side (front) toward the crankshaft arm and with the part number stamp (back) toward the main bearing cap or cylinder block.
- Apply engine oil or grease to the back of the bearing to prevent looseness during installation.
- Fit the bearing to the mounting groove of the block and cap side.

(d) Install the bearing cap.

HINT:
Facing the arrow stamped on the cap forward, install it in the order of the stamped numbers.



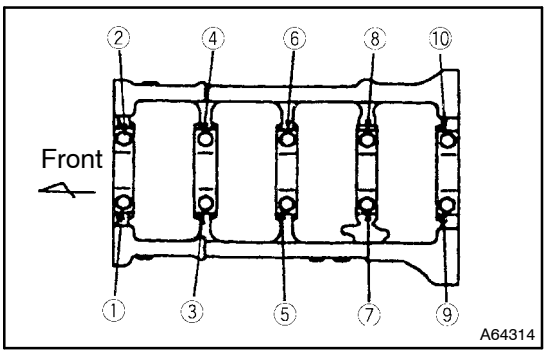
A64313

(1) Measure the length of the bearing cap bolts.
Length (A):

Standard	106.80 mm (4.2047 in.)
Maximum	108.00 mm (4.2520 in.)

If the length is greater than the maximum, replace them with new bolts.

(2) Apply clean engine oil to the bolt seat and bolt threads.



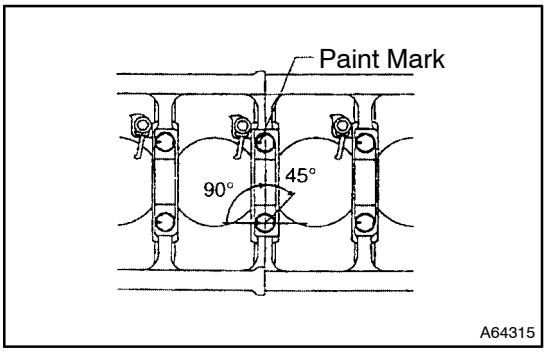
(3) Tighten the bolts in the order shown in the illustration.

Torque: 69 N·m (700 kgf·cm, 51 ft·lbf)

(4) Loosen all the bolts.

(5) Tighten the bolts as in step (3).

Torque: 69 N·m (700 kgf·cm, 51 ft·lbf)



(6) Mark the bolts with paint to indicate the same direction.

(7) Tighten the bolts by 90° (1/4 turn) in the same order as in step (5).

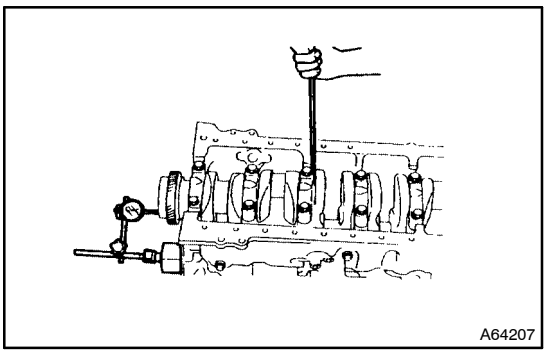
(8) Finally, retighten the bolts by 45° (1/8 turn) as in step (7).

(9) Make sure that all the paint marks face the same direction.

HINT:

When adding torque, never untighten the nuts even if they have been over tightened.

(10) After tightening, using a plastic–faced hammer, tap the front and back ends of the crankshaft to make a complete fit.



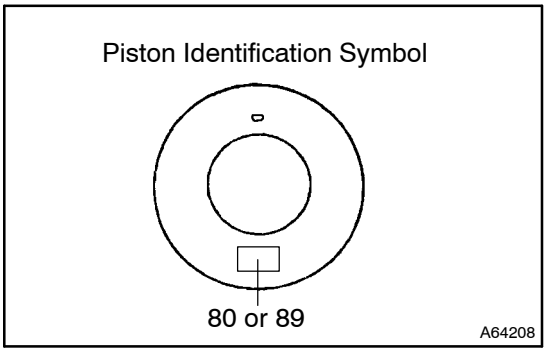
29. INSPECT CRANKSHAFT THRUST CLEARANCE

(a) Using a dial gauge, measure the crankshaft thrust clearance.

Thrust clearance:

Standard	0.050 – 0.239 mm (0.0020 – 0.0094 in.)
Maximum	0.50 mm (0.0197 in.)

If the thrust clearance is greater than the maximum, replace the thrust bearing with the oversized one of 0.25 mm (0.0098 in.).



30. INSTALL CONNECTING ROD SUB–ASSY

HINT:

- Before assembling the piston with the connecting rod, check whether the piston is specified for this engine
- Check should be performed using the engine compatible identification code on the top of the piston.

S05C–B:

Engine compatible identification code: 80

S05C–TA, TB:

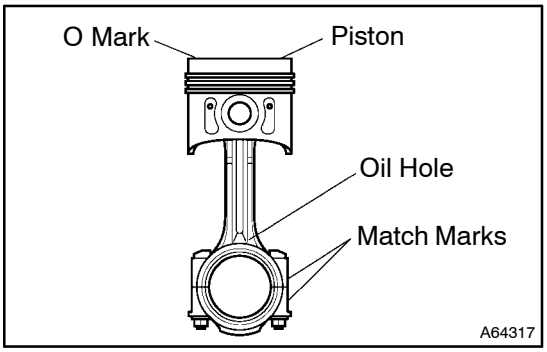
Engine compatible identification code: 89

(a) Install a new retainer ring onto one end of the piston boss.

HINT:

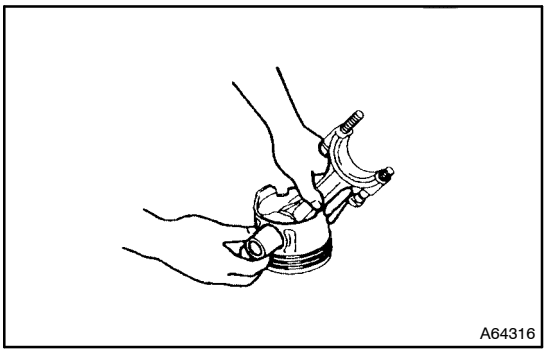
Installing the retainer ring may cause it to fly up. Be sure to wear protective goggles.

(b) Immerse the piston in hot water, 80 – 90°C (176 – 194°F) for approximately 5 minutes.



(c) Assemble the piston with the O mark being opposite to the connecting rod matchmark.

CAUTION:
Never touch the piston with your bare hands while it is hot.



(d) Insert the piston pin into the piston.

HINT:

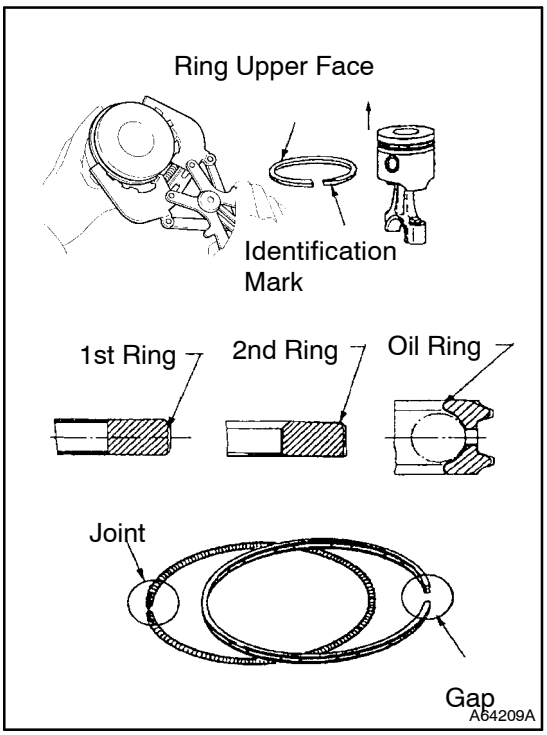
- Insert the piston pin from the piston boss attached to the retainer ring so that the ring groove is not damaged.

(e) Install a new retainer ring to the other end of the piston boss.

CAUTION:
Installing the retainer ring may cause it to fly up. Be sure to wear protective goggles.

HINT:

- When using an oversized piston, hone the liner so that the clearance between the cylinder liner and the piston.
- Prevent parts from damage by wrapping them in a cloth while they are being installed onto the cylinder block.
- Measure the entire length of the connecting rod bolt (see step 34).

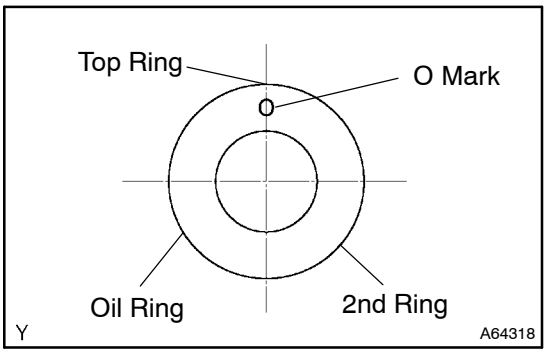


31. INSTALL PISTON RING

(a) Facing the identification marks on the piston ring upper surface, install them in the order of oil ring, 2nd ring and 1st ring using a piston ring expander.

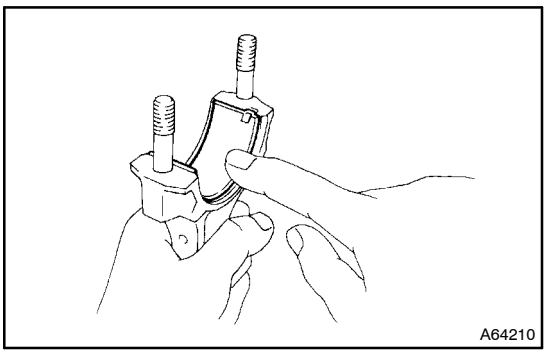
HINT:

- Never change the combination of the coil and oil ring.
- Connect the joint of the coil expander for the oil ring and install it inside the piston ring. Assemble the ring with the joint 180˚opposite to the matching point of the ring.



HINT:

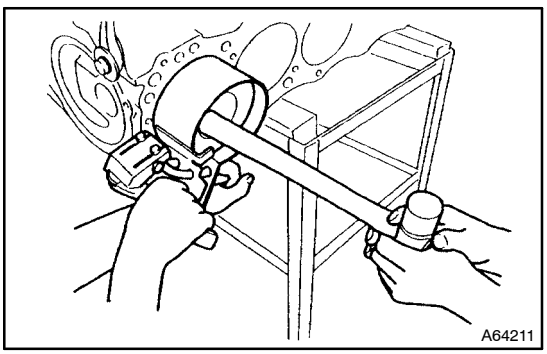
Position the matching points of the piston ring at an even distance. Be careful not to position at the piston boss.



32. INSTALL CONNECTING ROD BEARING

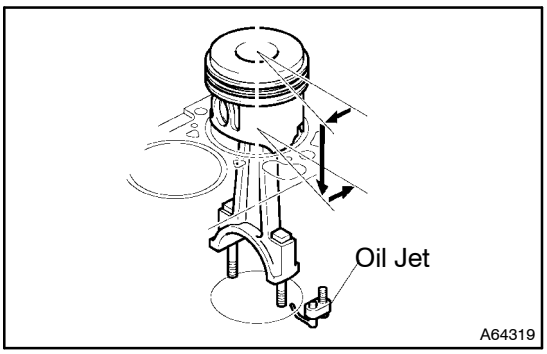
NOTICE:

- **When reusing the bearing, make sure to reassemble the removed bearing as it was originally installed.**
- **Install the bearing with the oil hole on the connecting rod side and the bearing without the oil hole on the cap side.**
- **Match the bearing protrusion with the notch of the connecting rod or cap.**



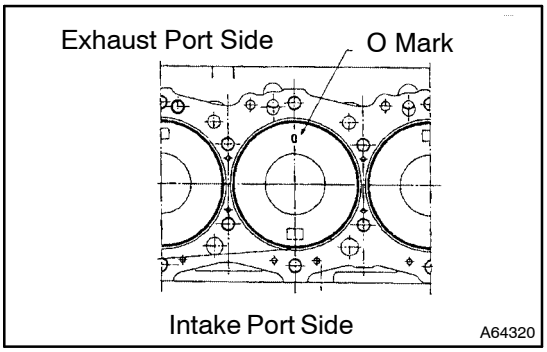
33. INSTALL PISTON AND CONNECTING ROD

(a) Using a piston ring compressor and a hammer handle, insert the piston through the connecting rod assembly into the cylinder block.

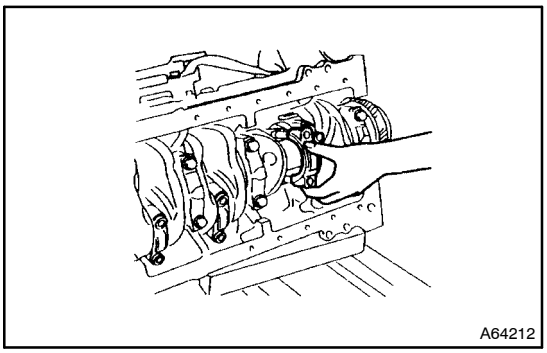


HINT:

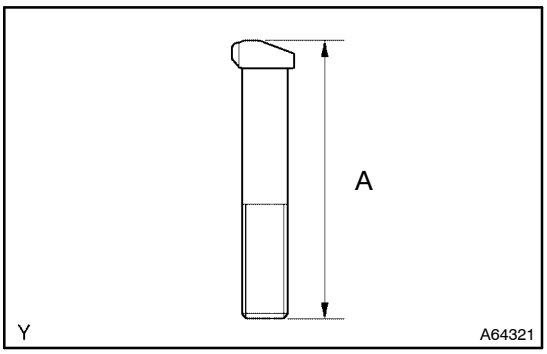
- Before the installation, apply engine oil to the piston pin, piston ring, cylinder liner and connecting rod bearing.
- Recheck the matching point of each piston ring.



- Make sure that the O mark on the piston is at the exhaust side.
- When inserting the piston, be careful that the oil jet is not struck by the connecting rod. If struck, make sure to re-check the sight of the oil jet.
- Also, do not damage the inside of the liner.



34. INSTALL CONNECTING ROD CAP

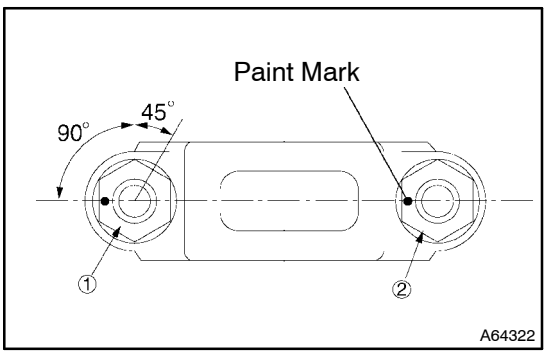


(a) Measure the length of the bolts.
Length (A):

Standard	81.5 mm (3.2086 in.)
Maximum	82.5 mm (3.2480 in.)

If the length is greater than the maximum, replace them with new ones.

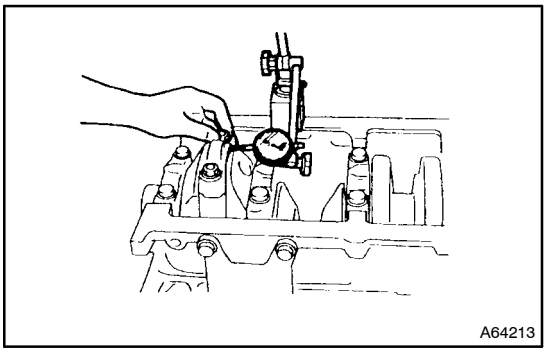
(b) Apply clean engine oil to the nut seat surface and bolt thread of the connecting rod cap.



(c) Tighten the connecting rod nut in the order shown in the illustration to the specified torque below.
(1) Tighten the connecting rod nuts 1 and 2 temporarily, dividing into small amount.
Torque: 69 N·m (700 kgf·cm, 50 ft·lbf)
(d) Mark the cap nut with paint to indicate the same direction.
(e) Tighten the cap nut by 90° (1/4 turn) in the same order as in step (c).
(f) Tighten the cap nut by 45° (1/8) turn as in step (e).
(g) Make sure that all paint marks face the same direction.

(h) Turn the crank to make the piston in the bottom dead center, and then check that the piston and oil jet nozzle of the block do not interfere each other.

HINT:
When adding torque, never untighten the nuts even if they have been overtightened.



35. INSPECT CONNECTING ROD THRUST CLEARANCE

(a) Using a dial gauge, measure the clearance between the connecting rod and crank pin end surface.

Standard thrust clearance:
0.20 – 0.52 mm (0.0079 – 0.0204 in.)
Maximum thrust clearance: 1.00 mm (0.0393 in.)

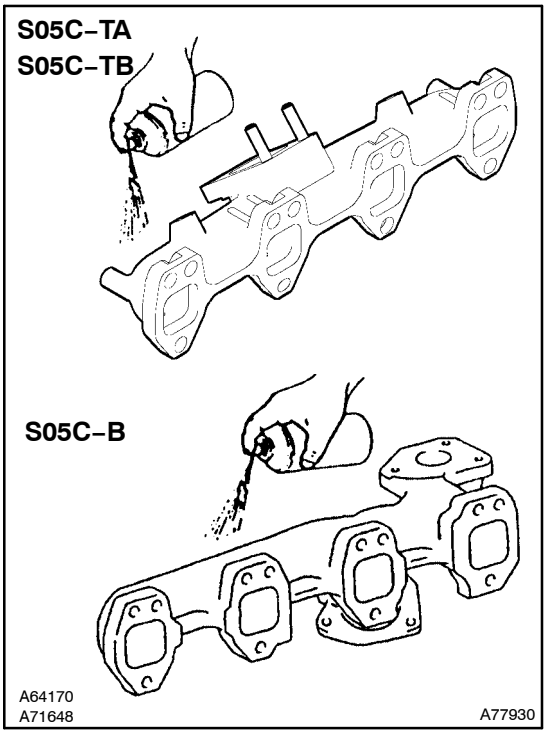
If the thrust clearance is greater than the maximum, replace the connecting rod.

EXHAUST

EXHAUST MANIFOLD

INSPECTION

1508L–01



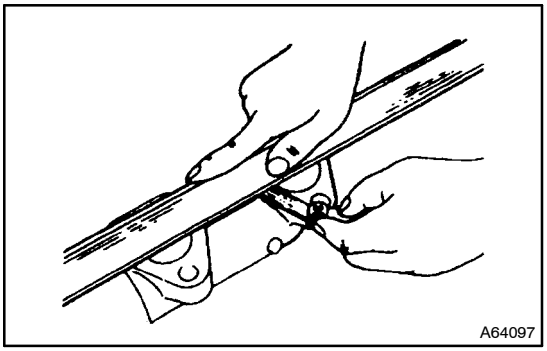
1. INSPECT EXHAUST MANIFOLD

HINT:

Clean the exhaust manifold with a commercial cleaning agent before the inspection.

(a) Using a dye penetrate, check the exhaust manifold for cracks.

If cracks are found, replace the manifold.



(b) Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head for warpage.

Maximum warpage: 0.20 mm (0.0079 in.)

If the warpage is greater than the maximum, correct the exhaust manifold by grinding it so that the warpage is within 0.1 mm (0.004 in.) per 2 flanges or 0.1 mm (0.004 in.) per flange.

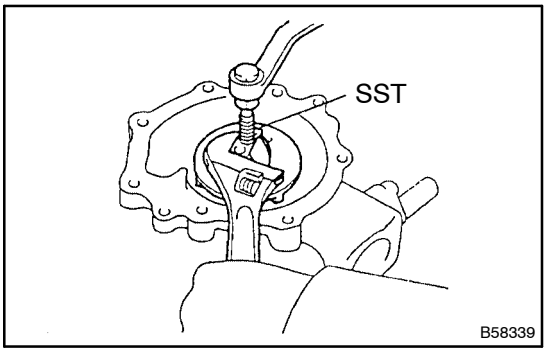
If damage such as deformation and wear is excessive, replace the manifold.

COOLING

WATER PUMP ASSY

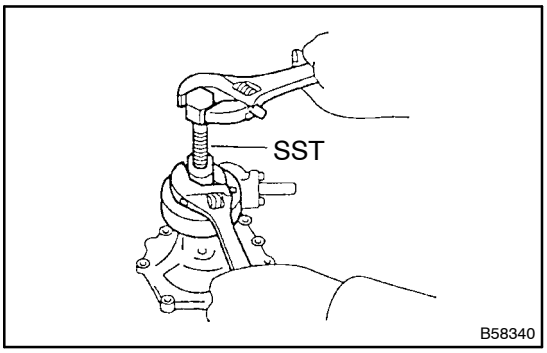
OVERHAUL

160KS–01



1. REMOVE WATER PUMP ROTOR

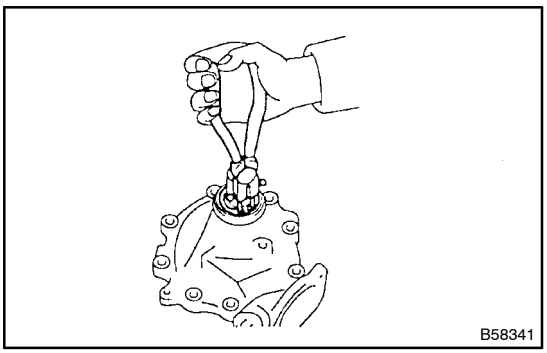
(a) Using SST, remove the rotor.
SST 09420–1820



2. REMOVE WATER PUMP PULLEY SEAT

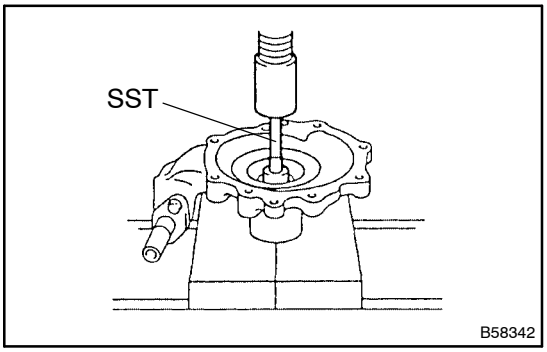
(a) Remove the 4 stud bolts.

(b) Using SST, remove the pulley seat.
SST 09950–50013 (09951–05010, 09952–05010, 09953–05010, 09954–05021)

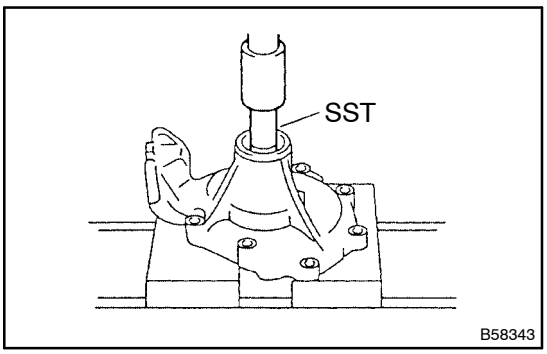


3. REMOVE WATER PUMP BEARING & SHAFT SUB–ASSY

(a) Using snap ring pliers, remove the snap ring.

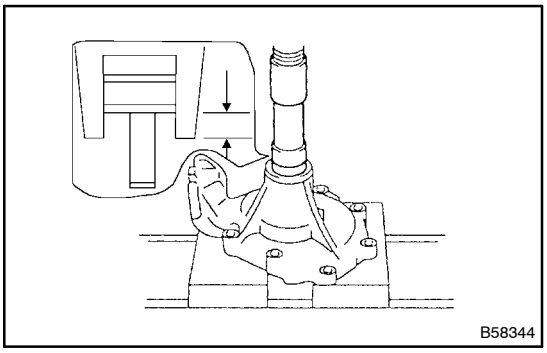


(b) Using SST and a press, press out the bearing and shaft.
SST 09236–00101 (09237–00050)



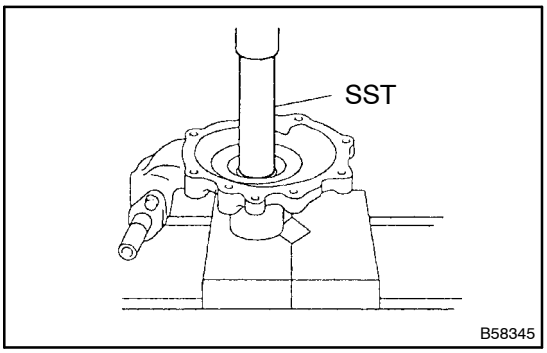
4. REMOVE WATER PUMP SEAL SET

(a) Using SST and a press, press out the seal.
SST 09236–00101 (09236–15010)



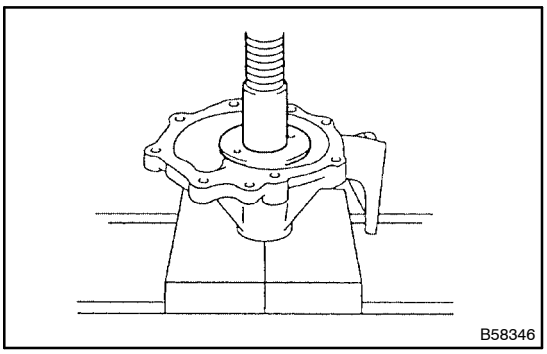
5. INSTALL WATER PUMP BEARING & SHAFT SUB–ASSY

(a) Using a press, press in the bearing and shaft into the place, as shown in the illustration.
SST 09482–2060A
Reference value: 5 mm (0.20 in.)



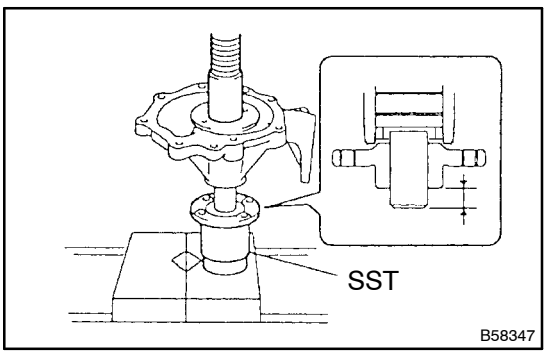
6. INSTALL WATER PUMP SEAL SET

(a) Using SST, install the seal set.
SST 09236–00101 (09237–00020)



7. INSTALL WATER PUMP ROTOR

(a) Using a press, press in the water pump rotor flush against the end of the bearing and shaft.



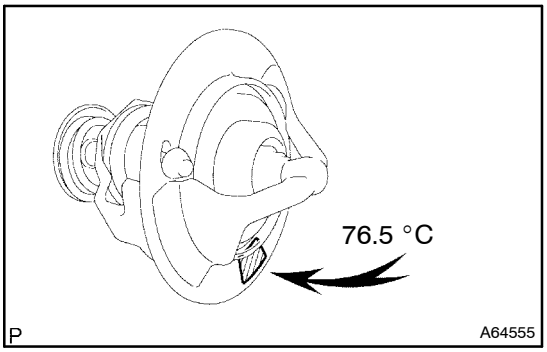
8. INSTALL WATER PUMP PULLEY SEAT

(a) Using SST and a press, press in the pump pulley set into the place, as shown in the illustration.
SST 09238–47012
Reference value: 6.3 mm (0.25 in.)

THERMOSTAT

INSPECTION

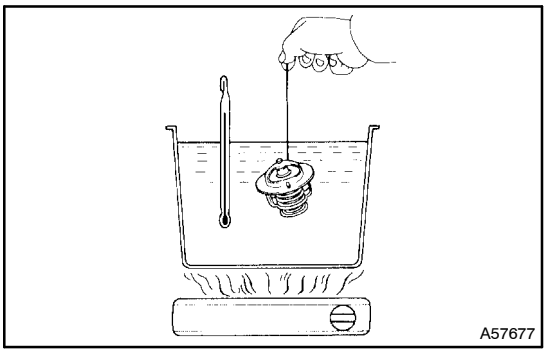
160KT–01



1. INSPECT THERMOSTAT CASE ASSY

HINT:

The thermostat is numbered with the valve opening temperature.



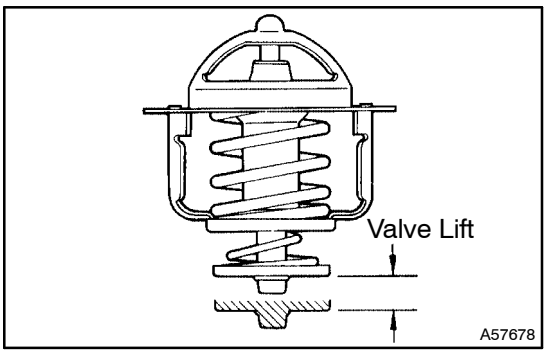
(a) Immerse the thermostat in water and gradually heat the water.

(b) Check the valve opening temperature.

Valve opening temperature:

74.5 – 78.5˚C (166 – 173˚F)

If the valve opening temperature is not as specified, replace the thermostat.



(c) Check the valve lift.

Valve lift: 10 mm (0.39 in.) or more at 90˚C (194˚F)

If the valve lift is not as specified, replace the thermostat.

(d) Check that the valve is fully closed when the thermostat is at low temperatures (below 40˚C (104˚F)).

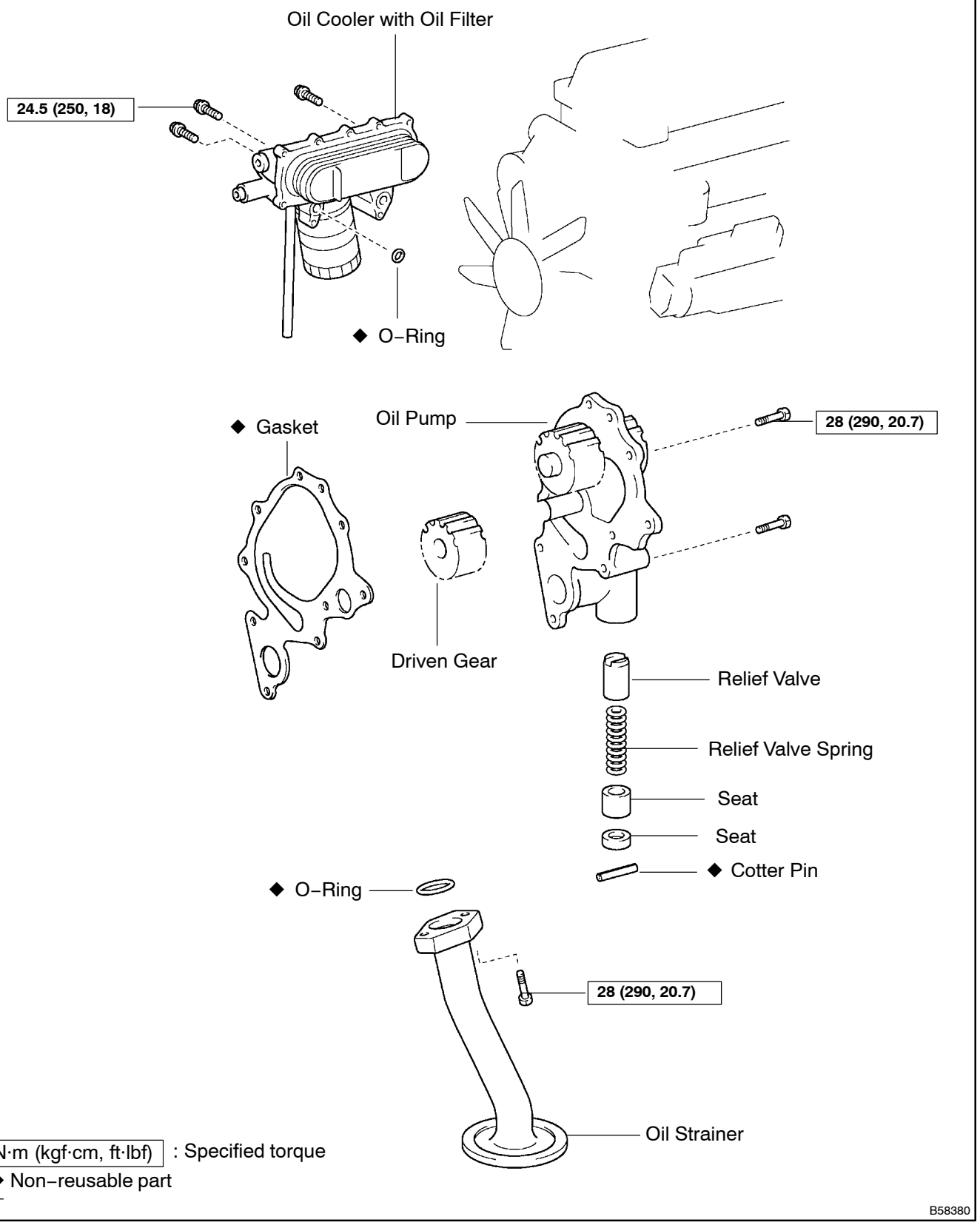
If not closed, replace the thermostat.

LUBRICATION

OIL PUMP ASSY

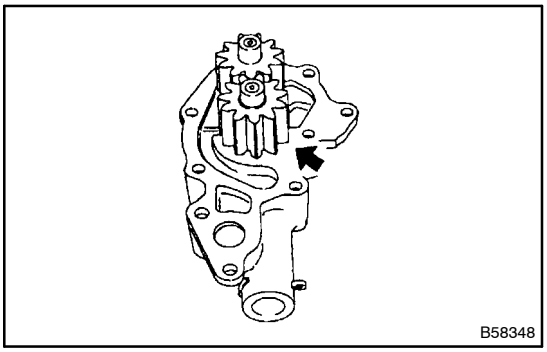
COMPONENTS

170EI–01



170EJ–01

OVERHAUL

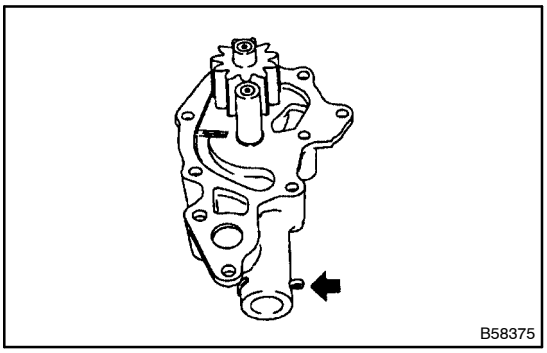


1. REMOVE OIL PUMP DRIVEN GEAR

(a) Remove the driven gear from the oil pump.

NOTICE:

Since the drive gear is a press–fit type, it can not be disassembled.



2. REMOVE OIL PUMP RELIEF VALVE

(a) Pull out the cotter pin, and remove the 2 seats, relief valve spring and safety valve.

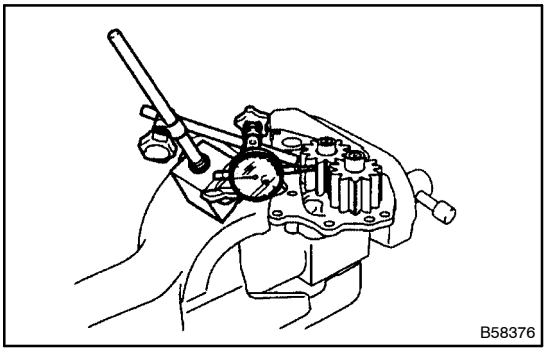
NOTICE:

Removing the cotter pin may cause the 2 seats and the relief valve spring to spring out. Be sure to wear protective goggles.

3. INSPECT OIL PUMP ASSY

(a) Visually check each part of the oil pump for damage or wear.

If damage or wear is excessive, replace the oil pump assembly with a new one.



(b) Inspect the backlash between the drive gear and driven gear.

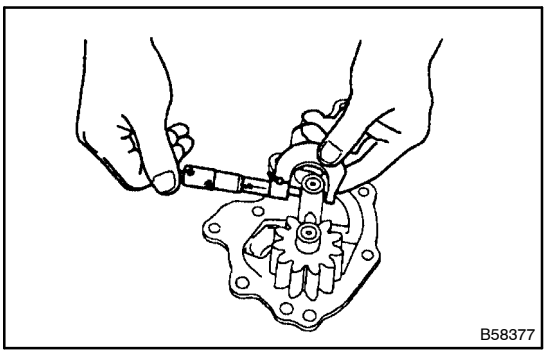
(1) Using a vise, fix the oil pump assembly.

(2) Using a dial gauge, measure the backlash between the drive gear and driven gear.

Backlash:

Standard	0.073 – 0.207 mm (0.0029 – 0.0081 in.)
Maximum	0.3 mm (0.0118 in.)

If the backlash is greater than the maximum, replace the oil pump assy with a new one.

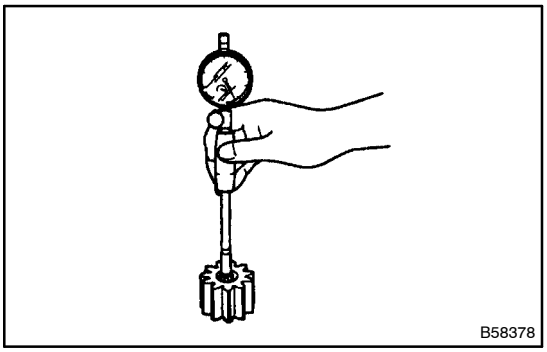

B58377

(c) Inspect the clearance between the diameter of the driven gear shaft and the inside diameter of the driven gear bush.

(1) Using a micrometer, measure the diameter of the driven gear shaft.

Shaft diameter:

18.064 – 18.082 mm (0.7112 – 0.7119 in.)


B58378

(2) Using a dial gauge, measure the inside diameter of the driven gear bush.

Inside diameter:

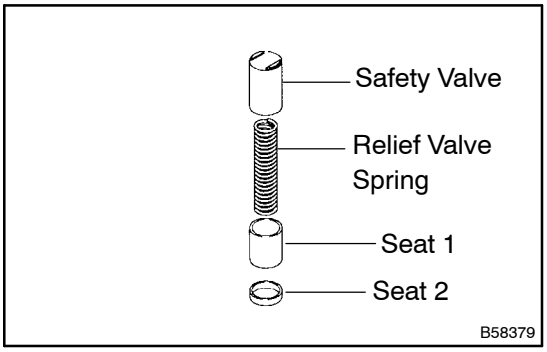
18.122 – 18.147 mm (0.7135 – 0.7144 in.)

(3) Calculate the difference between the diameter of the driven gear shaft and the inside diameter of the driven gear bush.

Clearance:

Standard	0.040 – 0.083 mm (0.0016 – 0.0032 in.)
Maximum	0.15 mm (0.0059 in.)

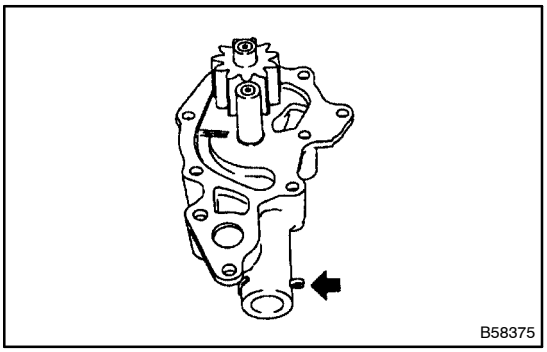
If the oil clearance is greater than the maximum, replace the oil pump assy or the driven gear bush.



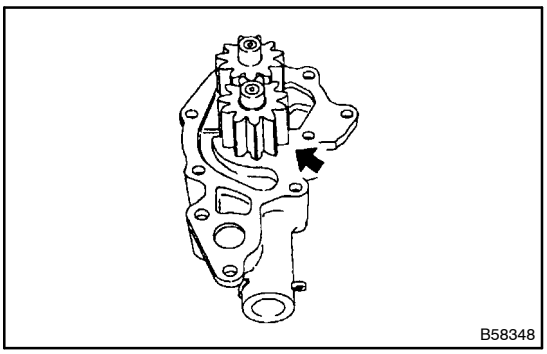
B58379

4. INSTALL OIL PUMP RELIEF VALVE

(a) Attach the relief valve, relief valve spring and 2 seats onto the oil pump assembly.


B58375

(b) Using a plastic–faced hammer, lightly tap the cotter pin.



5. INSTALL OIL PUMP DRIVEN GEAR

(a) Install the driven gear to the oil pump.

OIL COOLER

170EK–01

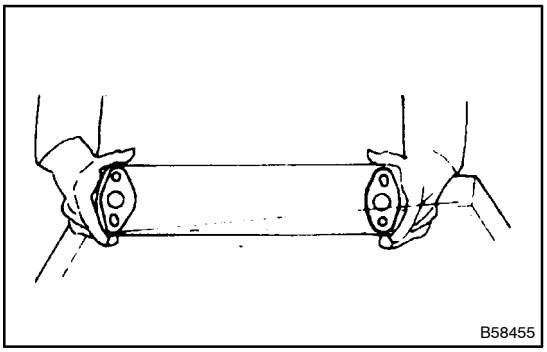
INSPECTION

1. INSPECT OIL COOLER

NOTICE:

Before the inspection, please refer to the following items.

- **Be sure to clean the oil cooler element and oil passage, using a commercial cleaning agent.**
- **Clean the metal parts using treated oil.**



(a) Carry out a pneumatic test for the oil cooler element.
Test pressure:6 kg/cm^2 (85.3 lb/sq.in.)
Test time: 1 minute

If defective, replace the oil cooler element with a new one.

(b) Visually check each part for damage or wear.

If the damage or wear is excessive, replace the safety valve with a new one.

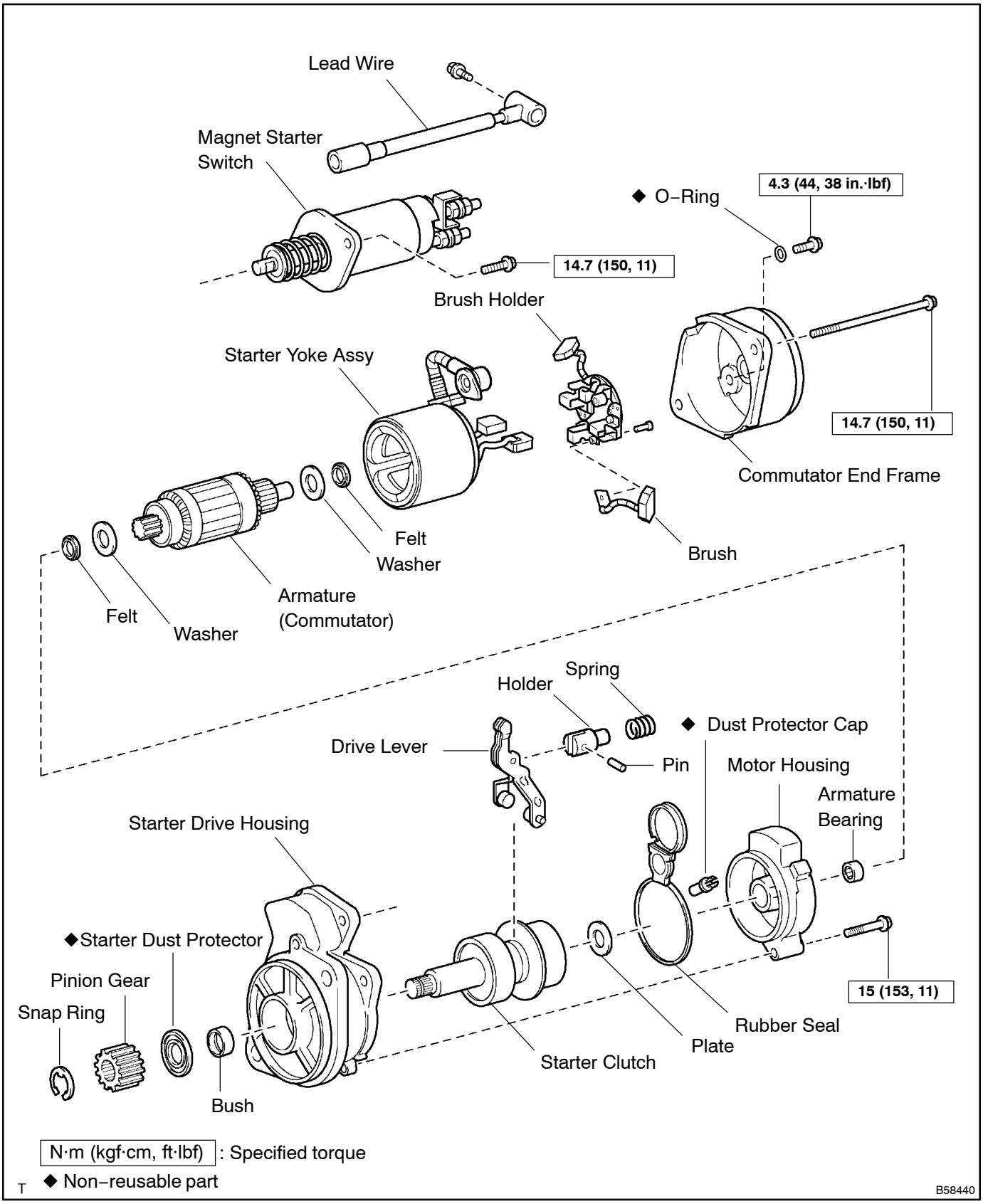
If the spring is flattened, replace the safety valve with a new one.

STARTING & CHARGING

STARTER ASSY

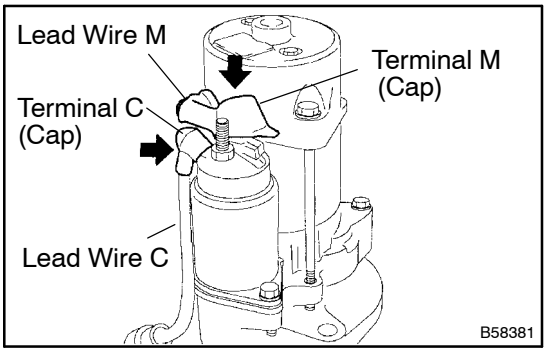
COMPONENTS

190LZ–01



190M0–01

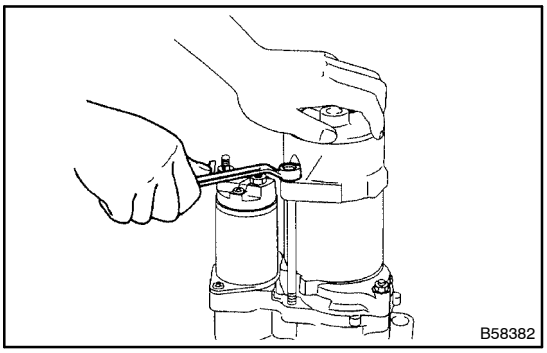
OVERHAUL



1. REMOVE STARTER YOKE ASSY

(a) Move the cap of terminal M, then remove the nut and lead wire M.

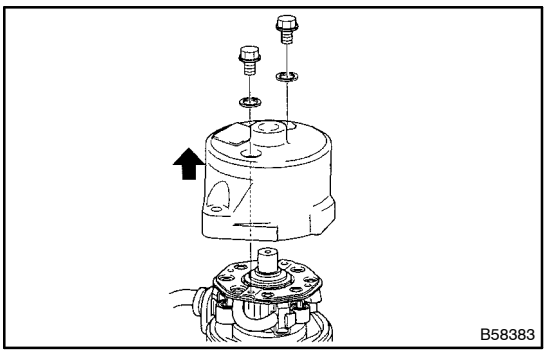
(b) Move the cap of terminal C, then remove the bolt.



(c) Remove the 2 through bolts, and pull out the starter yoke together with the armature.

HINT:

Hold the starter by hand so that it will not fall or drop.

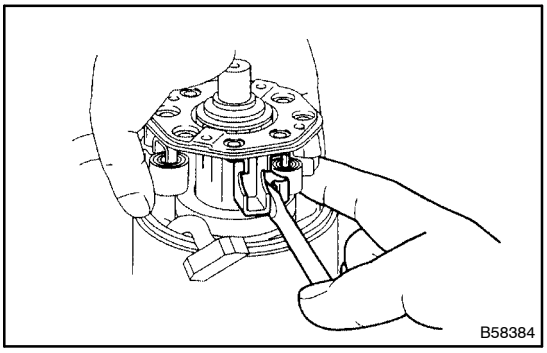


2. REMOVE STARTER COMMUTATOR END FRAME ASSY

(a) Remove the 2 screws, commutator end frame and O–ring.

HINT:

Holding lead wire M, remove the bracket rear by taking it upward.



3. REMOVE STARTER BRUSH HOLDER ASSY

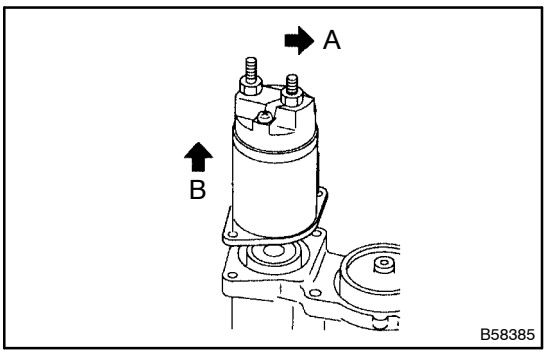
(a) Using a screwdriver, hold the spring tank back and disconnect the brush from the brush holder.

(b) Disconnect the 4 brushes, and remove the brush holder.

4. REMOVE STARTER ARMATURE ASSY

(a) Remove the armature from the starter yoke assy.

(b) Remove the felt and washer from the armature.



5. REMOVE MAGNET STARTER SWITCH ASSY

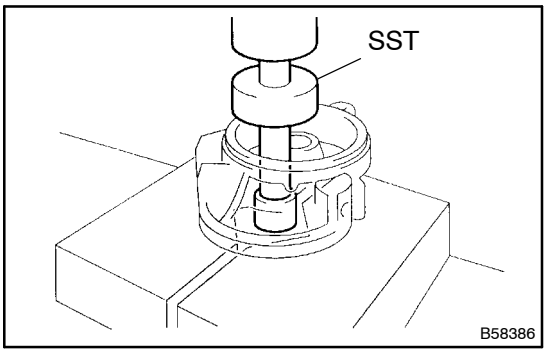
(a) Loosen the 2 bolts holding the magnet switch to the drive housing.

(b) Pull out the magnet switch in direction B by tilting the upper part of the main switch in the direction A, as shown in the illustration.

6. REMOVE MOTOR HOUSING

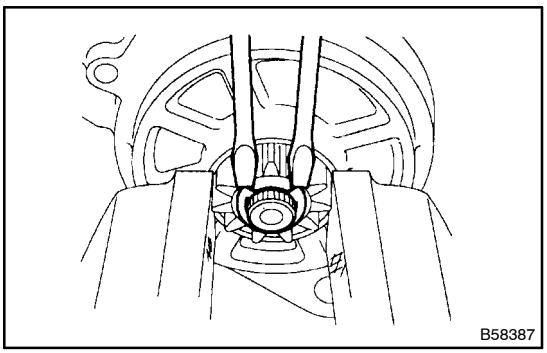
(a) Remove the bolt and motor housing.

(b) Remove the plate, spring and rubber seal from the drive housing.



7. REMOVE ARMATURE BEARING

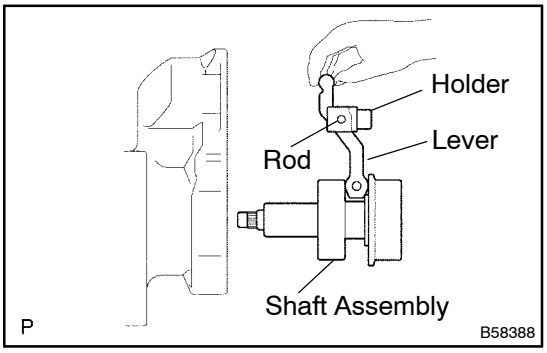
(a) Using SST, remove the bearing from the motor housing.
SST 09820–63010



8. REMOVE PINION GEAR

(a) Fix the pinion softly, place 2 screwdrivers against the both sides of the retainers opening port and then take the retainer off by tapping those handles ends lightly with a plastic hammer.

(b) Remove the pinion gear.



9. REMOVE STARTER CLUTCH SUB–ASSY

(a) Remove the starter clutch together with the drive lever from the starter drive housing.

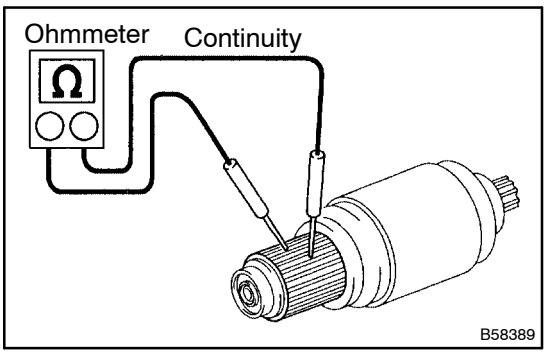
10. REMOVE STARTER PINION DRIVE LEVER

(a) Remove the lever and shaft assembly out simultaneously from the pinion case.

(b) Pull out the rod and remove the holder from the lever.

11. REMOVE STARTER DUST PROTECTOR

(a) Remove the protector by prying it with a screwdriver.



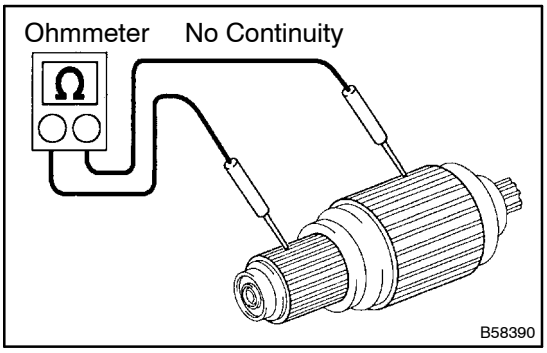
12. INSPECT STARTER ARMATURE ASSY

(a) If the surface of the commutator is dirty or burned, polish the part with sandpaper (#400) or replace the armature.

(b) Check the commutator open circuit.

(1) Using an ohmmeter, check that there is continuity between the segments of the commutator.

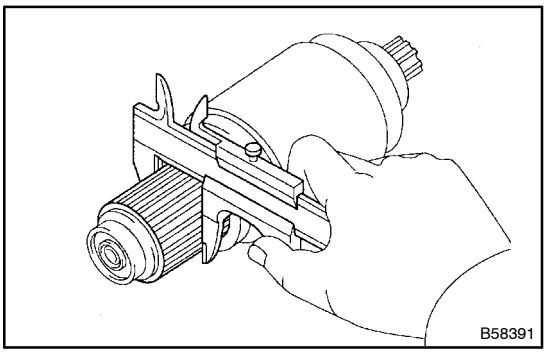
If there is no continuity between any segment, replace the armature assy.



(c) Check the commutator ground.

(1) Using an ohmmeter, check that there is no continuity between the commutator and armature coil core.

If there is continuity, replace the armature assy.



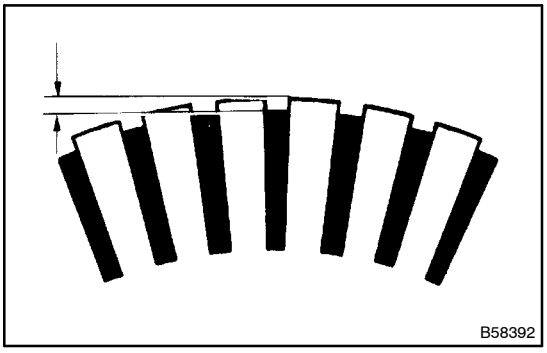
(d) Check the commutator diameter.

(1) Using vernier calipers, measure the commutator diameter.

Diameter:

Standard	Minimum
32.0 mm (1.260 in.)	30.0 mm (1.181 in.)

If the diameter is less than the minimum, replace the armature assy.



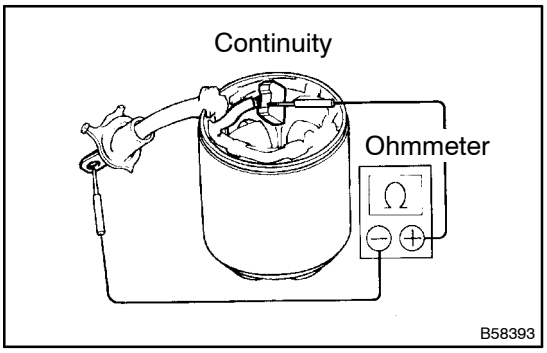
(e) Measure the undercut depth of the commutator.

(1) Check that the undercut depth is clean and free of foreign materials. Smooth out the edge.

Undercut depth:

Standard	Minimum
0.7 mm (0.028 in.)	0.2 mm (0.008 in.)

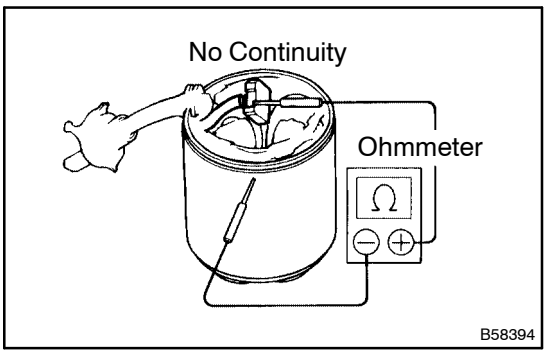
If the undercut depth is less than the minimum, correct it with a hacksaw blade.



13. INSPECT STARTER YOKE ASSY

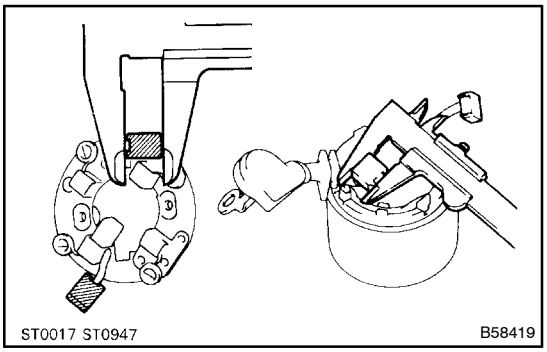
(a) Using an ohmmeter, check that there is continuity between the lead wire and field coil brush lead.

If there is no continuity, replace the starter yoke assy.



(b) Inspect for ground.
(1) Using an ohmmeter, check that there is no continuity between the field coil end and starter yoke.

If there is continuity, repair or replace the starter yoke assy.

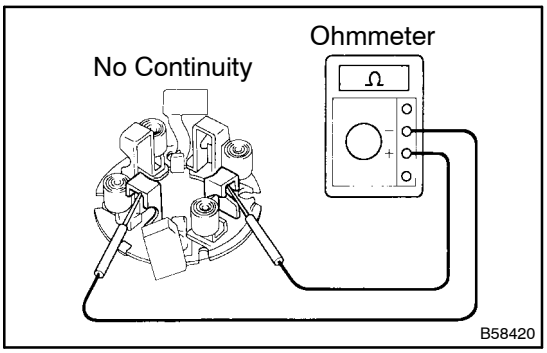


14. INSPECT BRUSH

(a) Using vernier calipers, measure the brush length.
Length:

Standard	Minimum
18 mm (0.709 in.)	12 mm (0.472 in.)

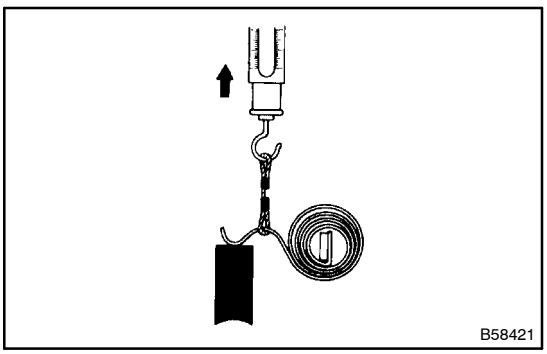
If the length is less than the minimum, replace the brush holder and starter yoke assy.



15. INSPECT STARTER BRUSH HOLDER ASSY

(a) Using an ohmmeter, check that there is no continuity between the positive (+) and negative (–) brush holders.

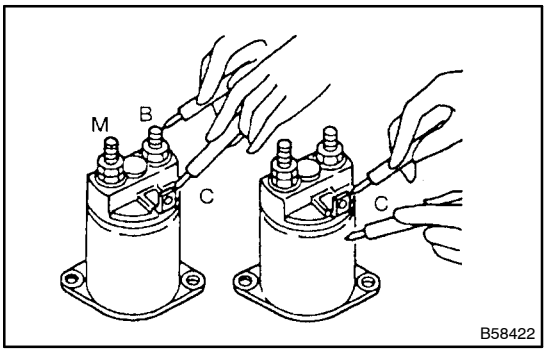
If there is continuity, repair or replace the brush holder.



(b) Take the pull scale reading instant the brush spring separates from the brush.
Installed load:

Standard	Minimum
42.2 – 51.0 N (4.3–5.2 kgf, 9.3–11.2 lbf)	22.5 N (2.3 kgf, 4.9 lbf)

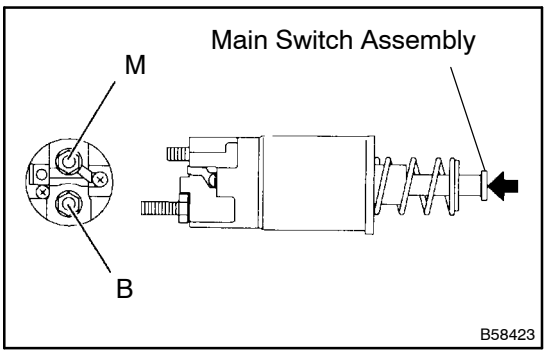
If the installed load is less than the minimum, replace the brush springs.



16. INSPECT MAGNET STARTER SWITCH ASSY

(a) Perform the pull–in coil open circuit test.
Using an ohmmeter, check that there is resistance between terminals M and C.
Standard resistance: 0.16 – 0.19 Ω

(b) Perform the hold–in coil open circuit test.
Using an ohmmeter, check that there is resistance between terminal M and the switch body.
Standard resistance: 0.84 – 0.94 Ω

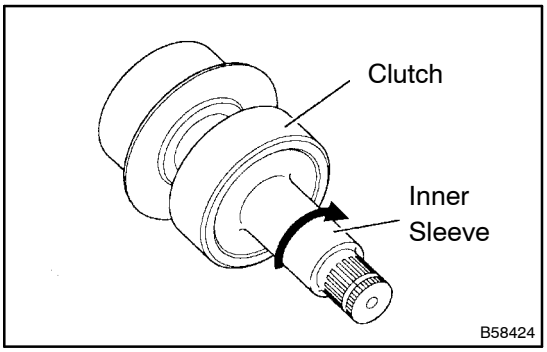


(c) Using an ohmmeter, check that there is continuity between terminals B and M.

If there is continuity, replace the magnet switch assy.

(d) Push the main switch assembly, using an ohmmeter, check that there is continuity between terminals B and M.

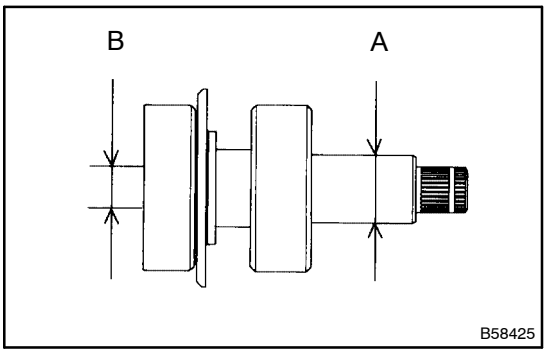
If there is no continuity, replace the magnet switch assy.



17. INSPECT STARTER CLUTCH SUB–ASSY

(a) With the clutch fixed, turn only the inner sleeve right and left.

(b) Check that the inner sleeve turns lightly in the arrow mark direction but does not turn in the opposite direction.

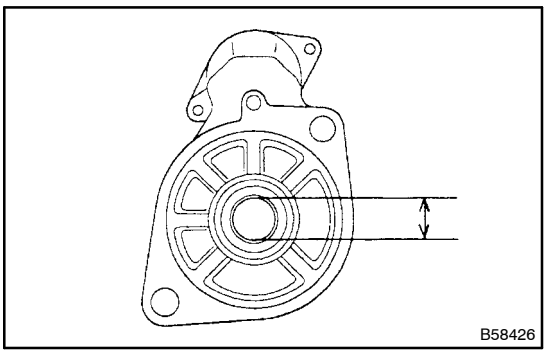


(c) Using a micrometer, check each diameter of the starter clutch.

Diameter:

Standard	Minimum
A: 26 mm (1.024 in.)	A: 25.88 mm (1.019 in.)
B: 12.1 mm (0.476 in.)	B: 12 mm (0.472 in.)

If the diameter is less than the minimum, replace the starter clutch.



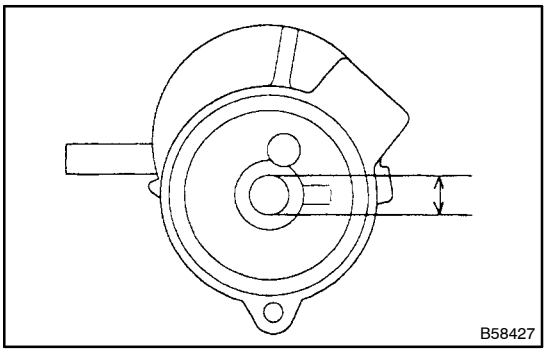
18. INSPECT DRIVE HOUSING

(a) Using a cylinder gauge, check the inside diameter of the starter drive housing bush.

Inside diameter:

Standard	Maximum
26 mm (1.024 in.)	26.2 mm (1.031 in.)

If the diameter is greater than the maximum, replace the drive housing.



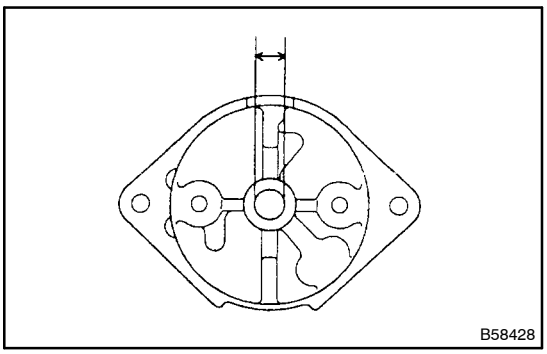
19. INSPECT MOTOR HOUSING

(a) Using a cylinder gauge, check the inside diameter of the motor housing bush.

Inside diameter:

Standard	Maximum
12.1 mm (0.476 in.)	12.3 mm (0.484 in.)

If the diameter is greater than the maximum, replace the motor housing.



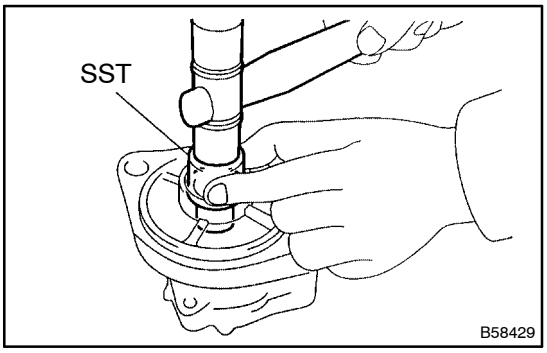
20. INSPECT STARTER COMMUTATOR END FRAME ASSY

(a) Using a cylinder gauge, check the inside diameter of the end frame bush.

Inside diameter:

Standard	Minimum
12.0 mm (0.472 in.)	12.2 mm (0.480 in.)

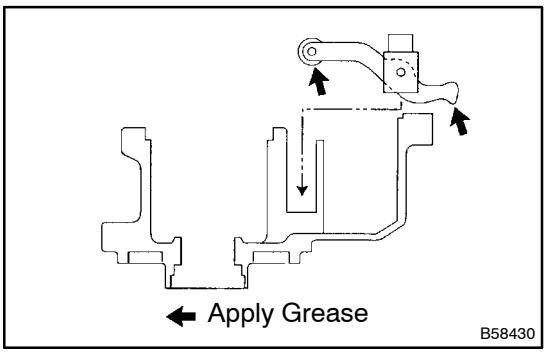
If the diameter is greater than the minimum, replace the frame.



21. INSTALL STARTER DUST PROTECTOR

(a) Using SST and a plastic–faced hammer, tap in the protector.

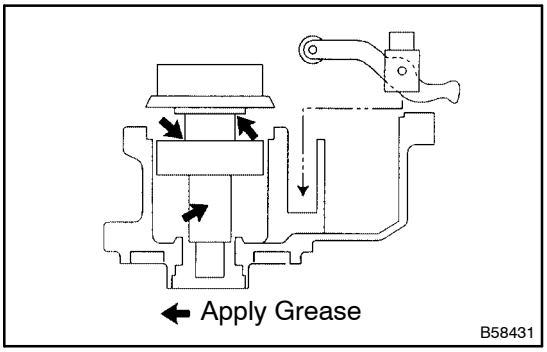
SST 09950–60010 (09951–00260, 09951–00390, 09952–06010)



22. INSTALL STARTER PINION DRIVE LEVER

(a) Install the holder to the drive lever with a pin.

(b) Apply grease to the portions of the drive lever.

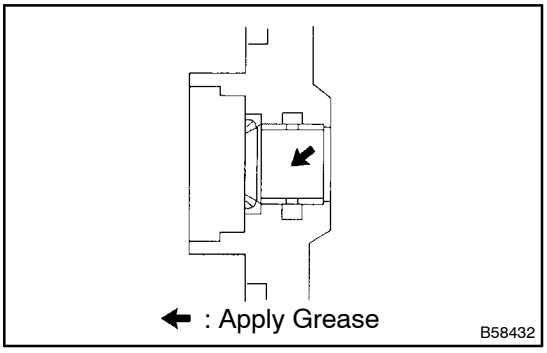


23. INSTALL STARTER CLUTCH SUB–ASSY

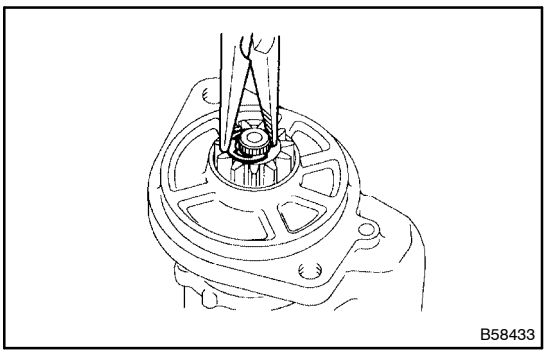
(a) Apply grease to the portions of the starter clutch, and install the drive lever together with it to the starter drive housing.

HINT:

Check that the starter clutch is in the depth, then lightly slides there.



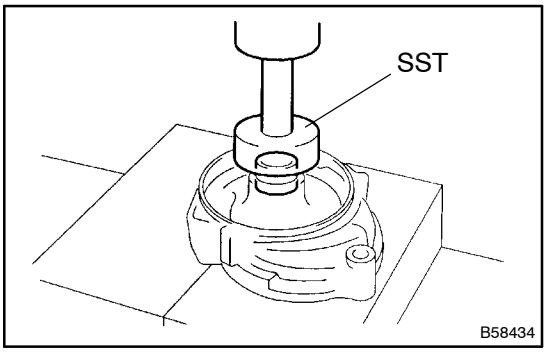
(b) Apply much grease to the extent that it would overflow from the reservoir of the start drive housing.



24. INSTALL PINION GEAR

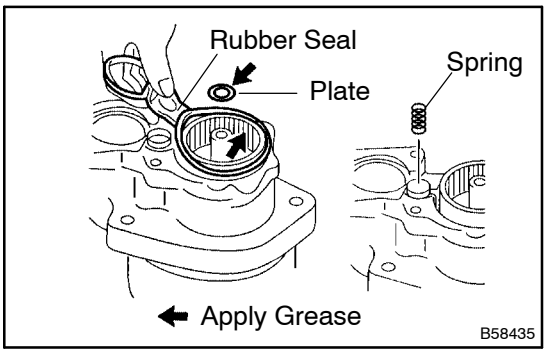
(a) Install the pinion gear to the shaft by tapping it uniformly.

(b) Using pliers, pinch a new retainer and the shaft, then press them in.



25. INSTALL ARMATURE BEARING

(a) Using SST and a press, install the bearing.
SST 09820–36010

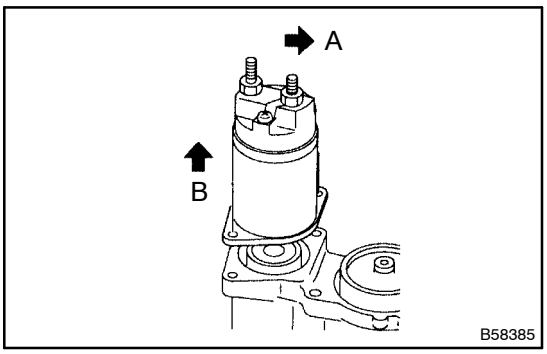


26. INSTALL MOTOR HOUSING

(a) Apply grease to the parts as shown in illustration.

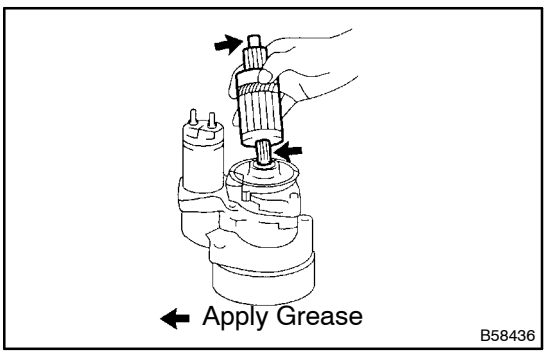
(b) Install a new rubber seal, spring and plate.

(c) Install the bolt and motor housing.
Torque: 15 N·m (153 kgf·cm, 11 ft·lbf)



27. INSTALL MAGNET STARTER SWITCH ASSY

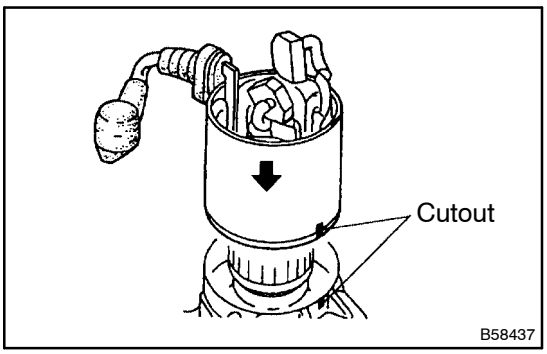
(a) Attach the drive lever to the upper port of the main switch in direction A, then install it with the 2 bolts by inserting it in direction B.
Torque: 14.7 N·m (150 kgf·cm, 11 ft·lbf)



28. INSTALL STARTER ARMATURE ASSY

(a) Apply grease to the portions of the armature as shown in illustration.

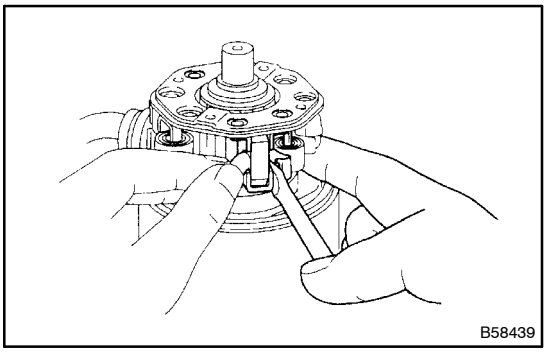
(b) Install the armature to the motor housing.



29. INSTALL STARTER YOKE ASSY

(a) Align the cutout of the starter yoke with the cutout of the motor housing.

(b) Install the starter yoke.



30. INSTALL STARTER BRUSH HOLDER ASSY

(a) Place the brush holder in position on the armature.

(b) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the 4 brushes.

31. INSTALL STARTER COMMUTATOR END FRAME ASSY

(a) Install the end frame 2 with the through bolts.
Torque: 14.7 N·m (150 kgf·cm, 11 ft·lbf)

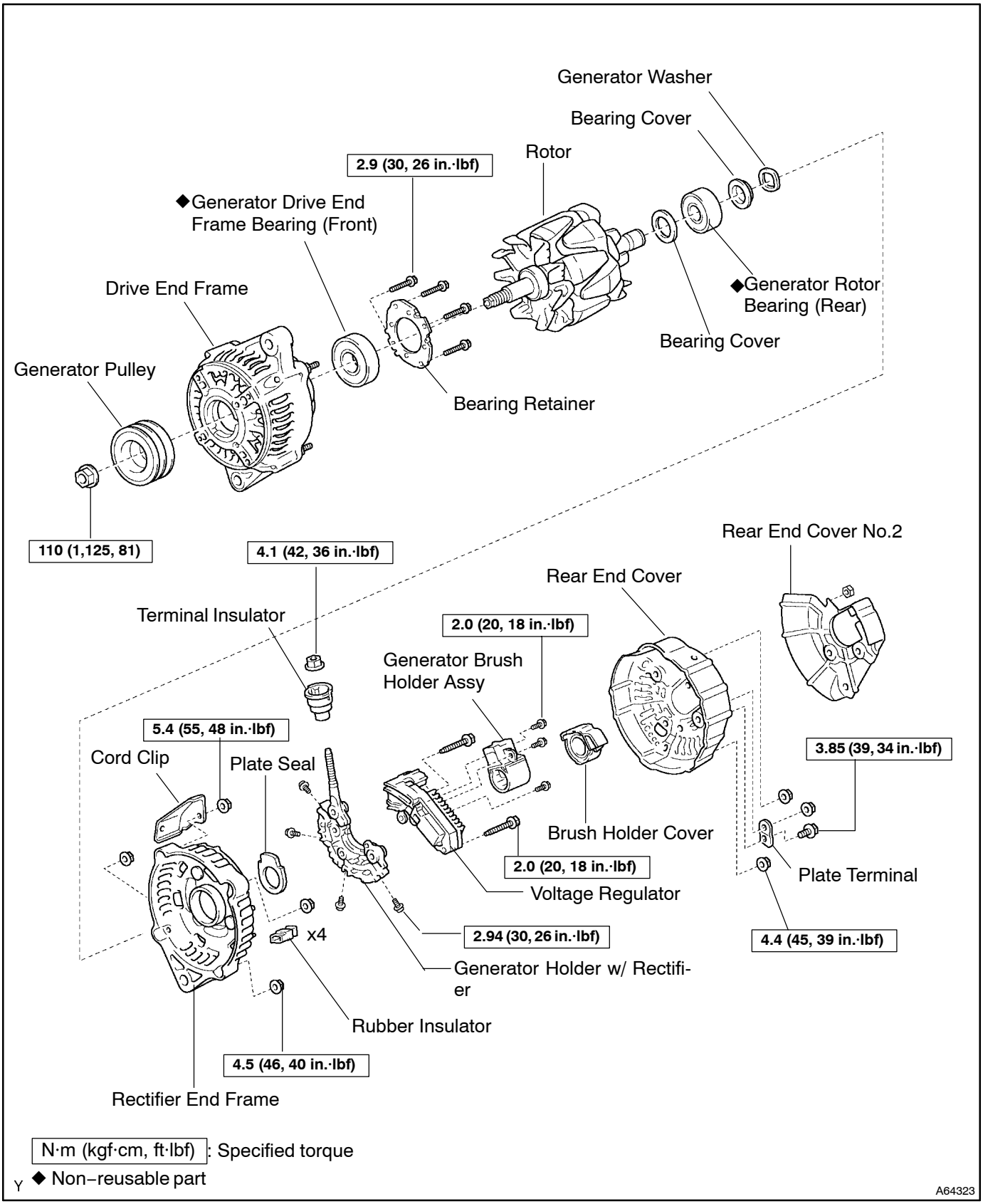
(b) Install a new O–ring to the screws.

(c) Install the 2 new screws with O–rings.
Torque: 4.3 N·m (44 kgf·cm, 38 in.·lbf)

GENERATOR ASSY

COMPONENTS

190M1–01



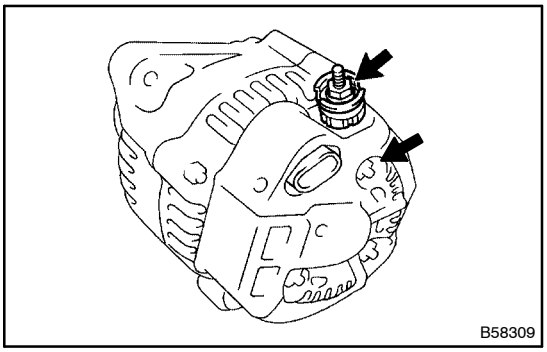
N·m (kgf·cm, ft·lbf) : Specified torque

Y ◆ Non–reusable part

A64323

190M2–01

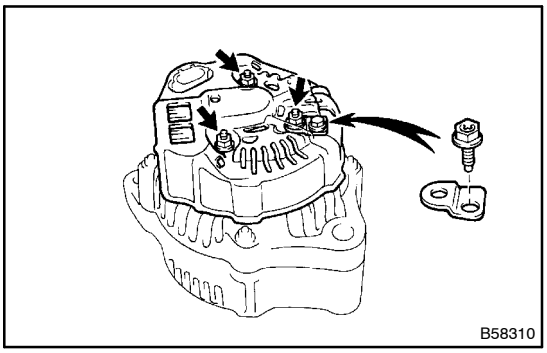
OVERHAUL



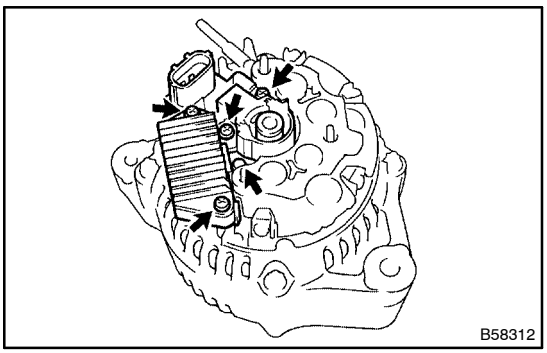
1. REMOVE REAR END COVER NO. 2

2. REMOVE REAR END COVER

(a) Remove the nut and terminal insulator.



(b) Remove the 3 nuts, bolt, plate terminal and rear end cover and brush holder cover.

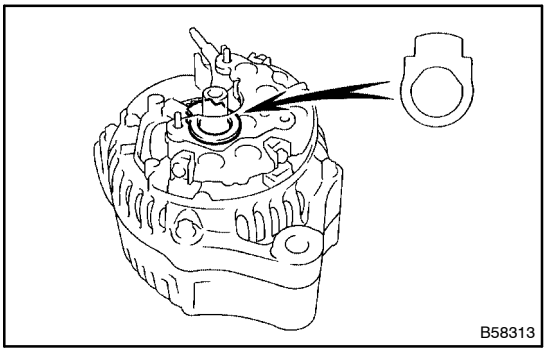


3. REMOVE GENERATOR BRUSH HOLDER ASSY

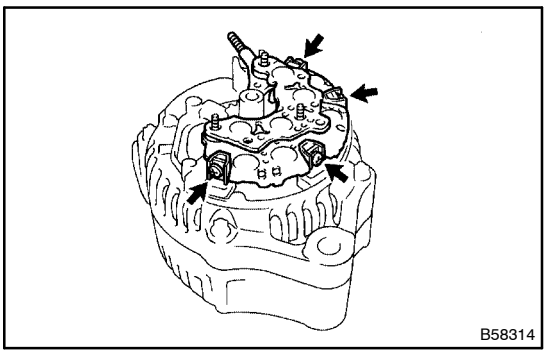
(a) Remove the 2 screws and brush holder.

4. REMOVE VOLTAGE REGULATOR

(a) Remove the 3 screws and voltage regulator.

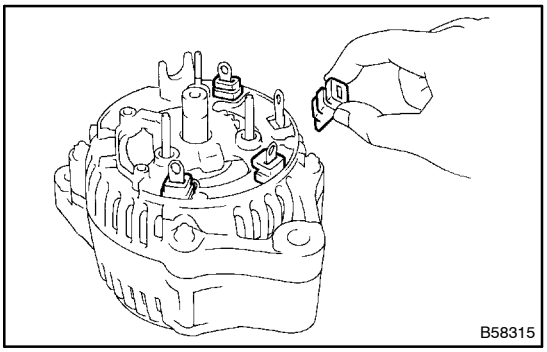


(b) Remove the plate seal from the rectifier end frame.

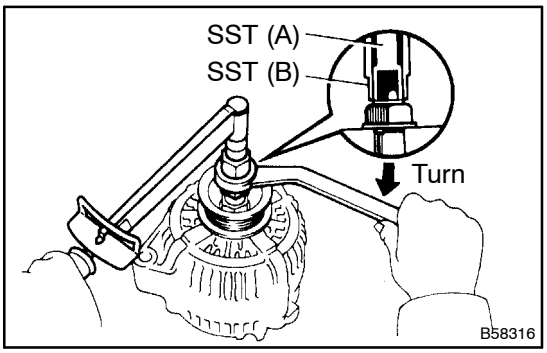


5. REMOVE GENERATOR HOLDER W/ RECTIFIER

(a) Remove the 4 screws and generator holder.



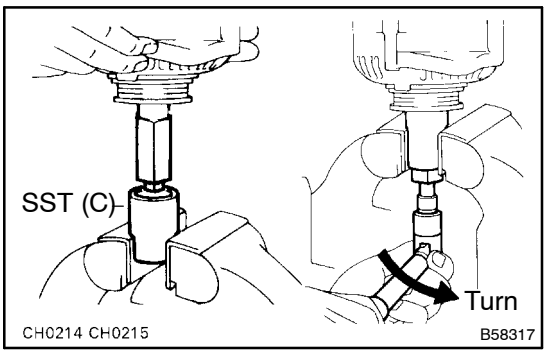
(b) Remove the 4 rubber insulators.



6. REMOVE GENERATOR PULLEY

(a) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.

(b) Check that SST (A) is secured to the rotor shaft.
SST 09820–63010



(c) As shown in the illustration, mount SST (C) in a vise, and attach the pulley nut to SST (C).

(d) To loosen the pulley nut, turn SST (A) in the direction shown in the illustration.

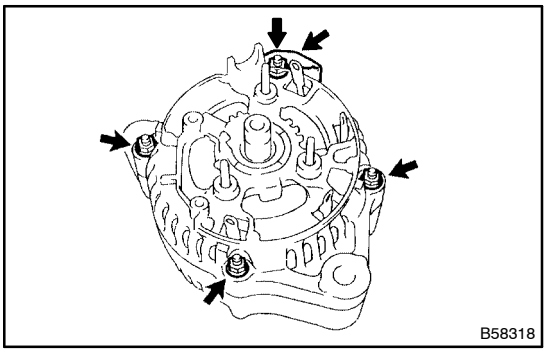
NOTICE:

To prevent damage to the rotor shaft, do not loosen the pulley nut more than one–half of a turn.

(e) Remove the generator from SST (C).

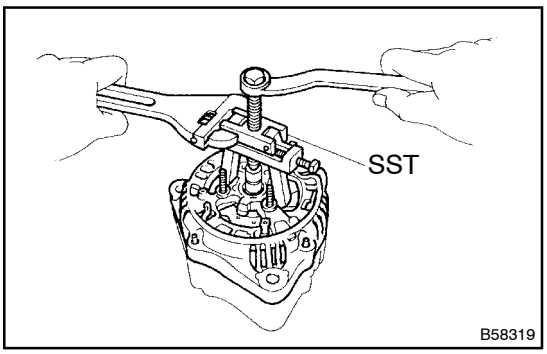
(f) Turn SST (B), and remove SST (A and B).

(g) Remove the pulley nut and pulley.

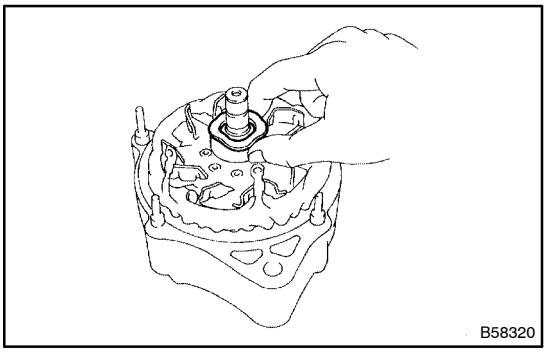


7. REMOVE RECTIFIER END FRAME

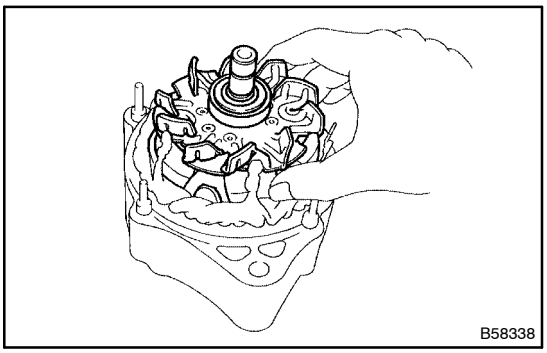
(a) Remove the 4 nuts and cord clip.



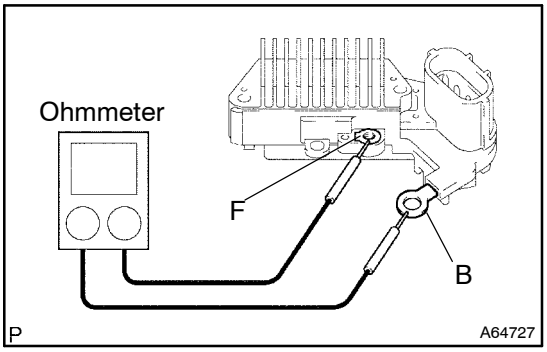
(b) Using SST, remove the rectifier end frame.
SST 09286–46011



(c) Remove the generator washer.



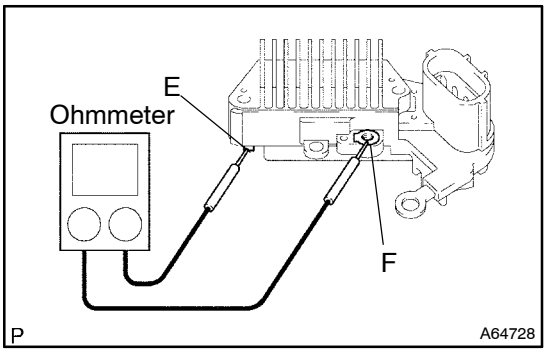
8. REMOVE GENERATOR ROTOR ASSY



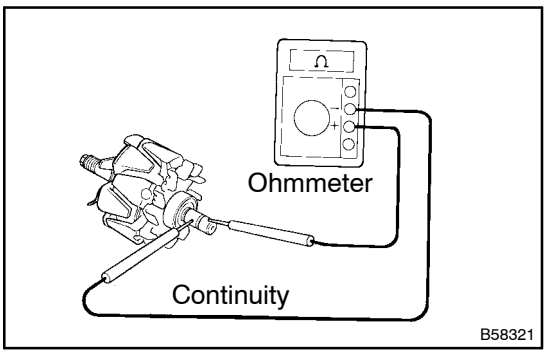
9. INSPECT VOLTAGE REGULATOR

(a) Using an ohmmeter, check the continuity between terminals F and B.
Standard:
When the positive and negative poles between terminals F and B are exchanged, there is continuity in one way but no continuity in another way.

If the continuity is not as specified, replace the regulator.



(b) Using an ohmmeter, check the continuity between terminals F and E.
Standard:
When the positive and negative poles between terminals F and E are exchanged, there is continuity in one way but no continuity in another way.



10. INSPECT GENERATOR ROTOR ASSY

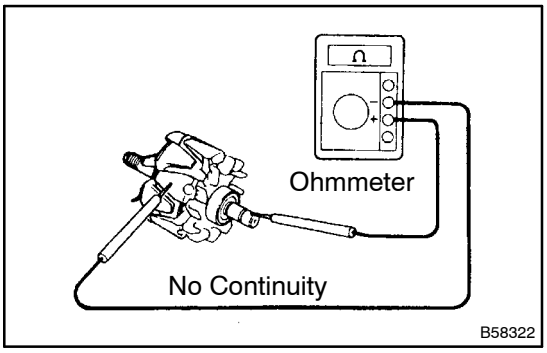
(a) Check the rotor for open circuit.

(1) Using an ohmmeter, check that there is continuity between the slip rings.

Standard resistance:

11.6 – 12.4 Ω at 20°C (68°F)

If there is no continuity, replace the rotor assy.



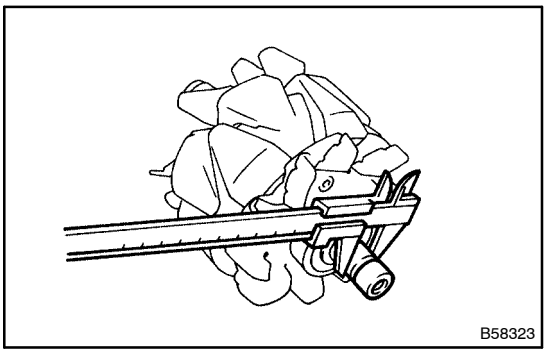
(b) Check the rotor for ground.

(1) Using an ohmmeter, check that there is no continuity between the slip ring and rotor.

Standard resistance:

10 MΩ or more at 20°C (68°F)

If there is continuity, replace the rotor assy.



(c) Check that the slip rings are not rough or scored.

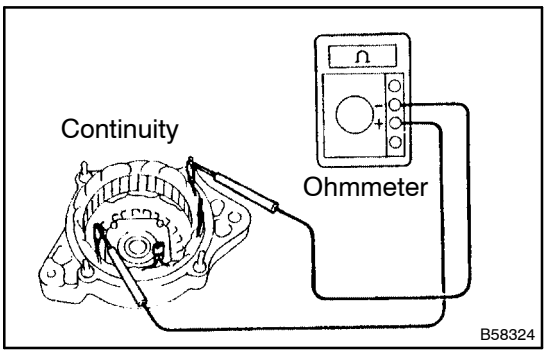
If rough or scored, replace the rotor.

(d) Using vernier calipers, measure the slip ring diameter.

Diameter:

Standard	14.2 – 14.4 mm (0.559 – 0.567 in.)
Minimum	12.8 mm (0.504 in.)

If the diameter is less than the minimum, replace the rotor assy.

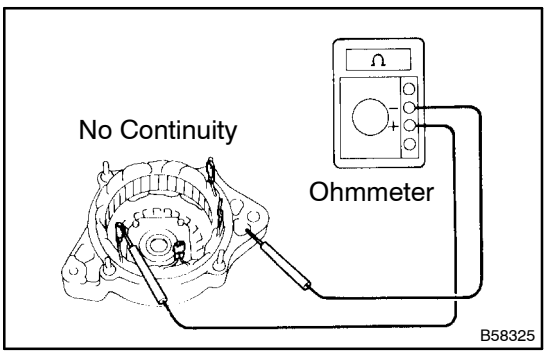


11. INSPECT DRIVE END FRAME

(a) Check the starter for open circuit.

(1) Using an ohmmeter, check that there is continuity between the coil leads.

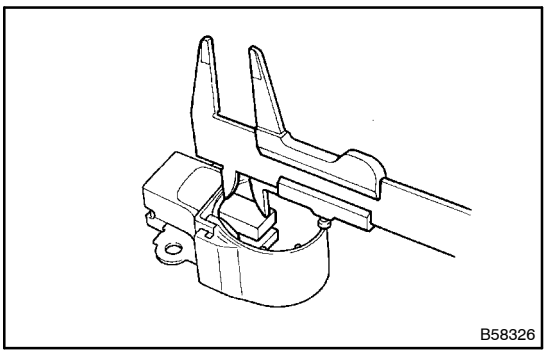
If there is no continuity, replace the drive end frame.



(b) Check the starter for ground.

(1) Using an ohmmeter, check that there is no continuity between the coil lead and drive end frame.

If there is continuity, replace the drive end frame.

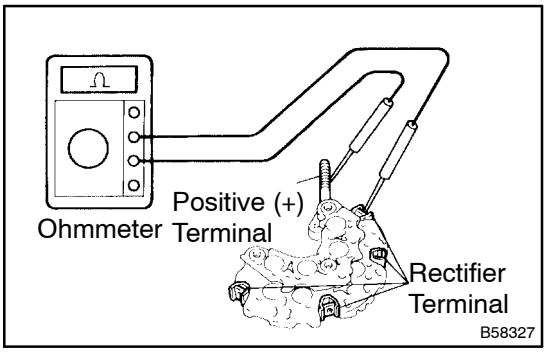


12. INSPECT GENERATOR BRUSH HOLDER ASSY

(a) Using vernier calipers, measure the exposed brush length.

Standard exposed length:
9.5 – 11.5 mm (0.374 – 0.453 in.)
Minimum exposed length: 1.5 mm (0.059 in.)

If the exposed length is less than the minimum, replace the brush holder assy.



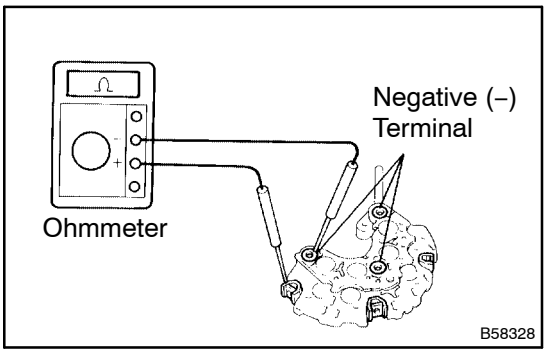
13. INSPECT GENERATOR BRUSH HOLDER ASSY

(a) Check the positive (+) rectifier.
  (1) Using an ohmmeter, connect one tester probe to the positive (+) terminal and the other to each rectifier terminal.
  (2) Reverse the polarity of the tester probes and repeat step (1).
  (3) Check that one shows continuity and the other shows no continuity.

If the continuity is not as specified, replace the rectifier holder.

(b) Check the negative (–) rectifier.
  (1) Using an ohmmeter, connect one tester probe to each negative (–) terminal and the other to each rectifier terminal.
  (2) Reverse the polarity of the tester probes and repeat step (1).
  (3) Check that one shows continuity and the other shows no continuity.

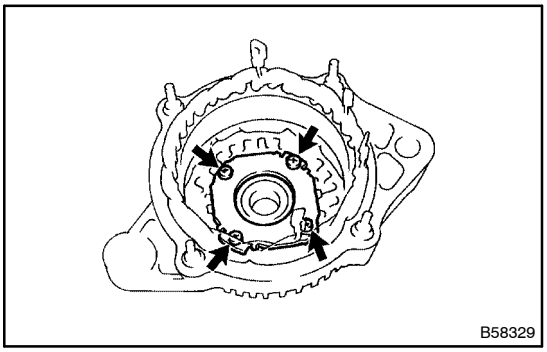
If the continuity is not as specified, replace the rectifier holder.



14. INSPECT BEARING

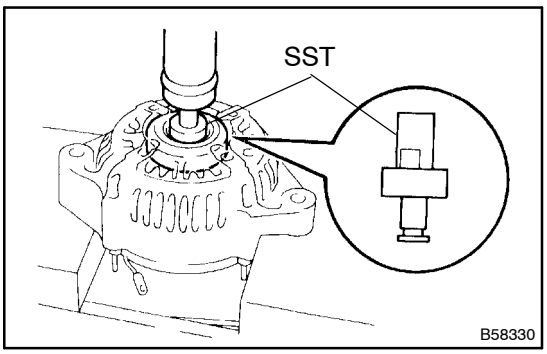
(a) Check that the bearing is not rough or worn.

If necessary, replace the bearing.

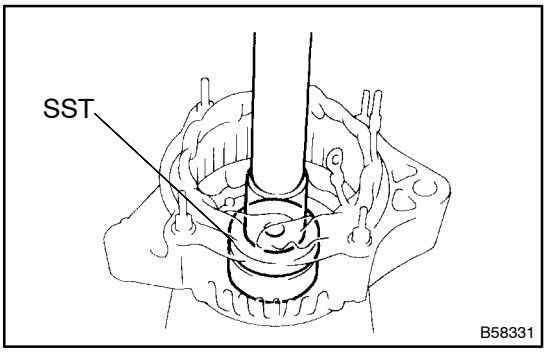


15. REMOVE BEARING (FRONT)

(a) Remove the 4 screws and bearing retainer.



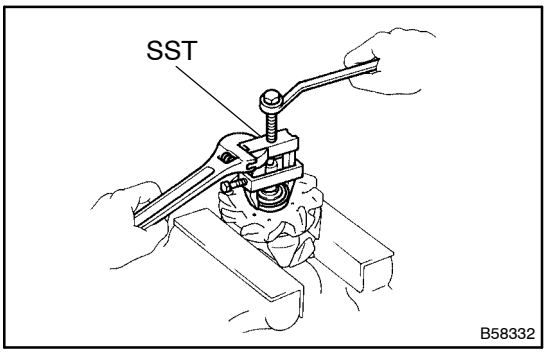
(b) Using SST and a press, press out the bearing.
SST 09950–60010, 09950–70010



16. INSTALL BEARING (FRONT)

(a) Using SST and a press, press in a new bearing.
Torque: 2.9 N·m (30 kgf·cm, 26 in.·lbf)

(b) Install the bearing retainer with the 4 screws.
Torque 2.9 N·m (30 kgf·cm, 26 in.·lbf)
SST 09950–60010, 09950–70010

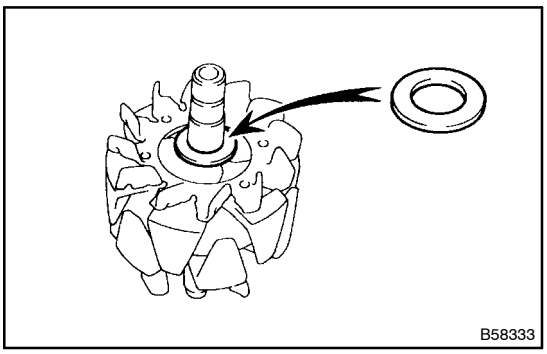


17. REMOVE BEARING (REAR)

(a) Using SST, remove the bearing cover (outside) and bearing.
SST 09820–00021, 09820–00030, 09825–76010

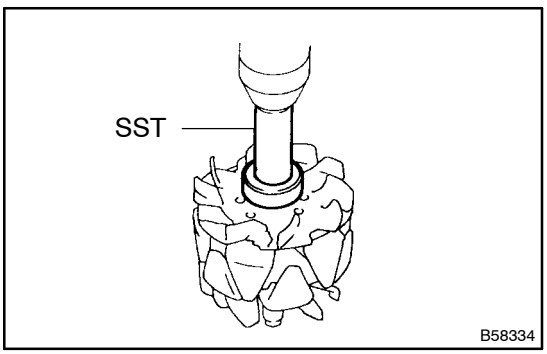
NOTICE:
Be careful not to damage the fan.

(b) Remove the bearing cover (inside).

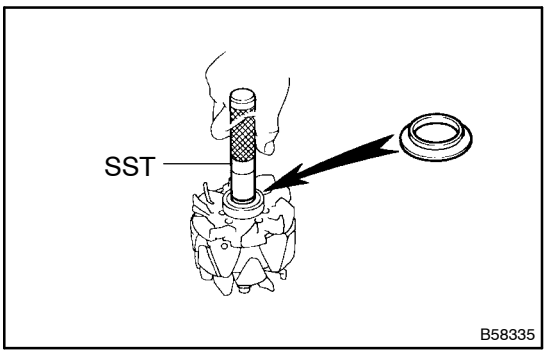


18. INSTALL BEARING (REAR)

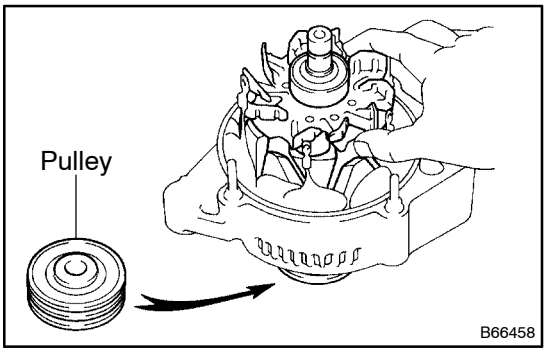
(a) Place the bearing cover (inside) on the rotor.



(b) Using SST and a press, press in a new bearing.
SST 09820–00031



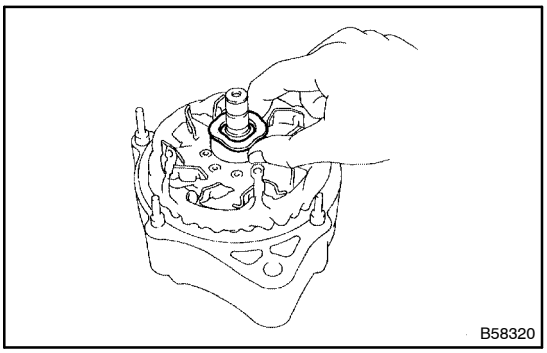
(c) Using SST, push in the bearing cover (outside).
SST 09285–76010



19. INSTALL GENERATOR ROTOR ASSY

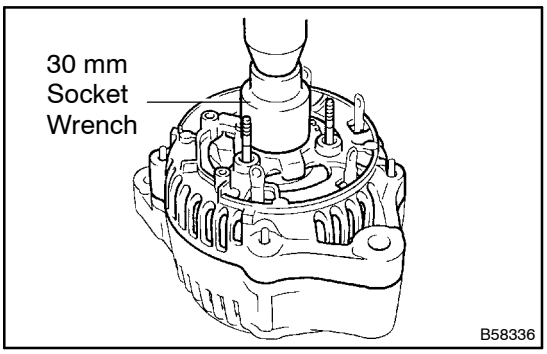
(a) Place drive end frame on pulley.

(b) Install the rotor to the drive end frame.

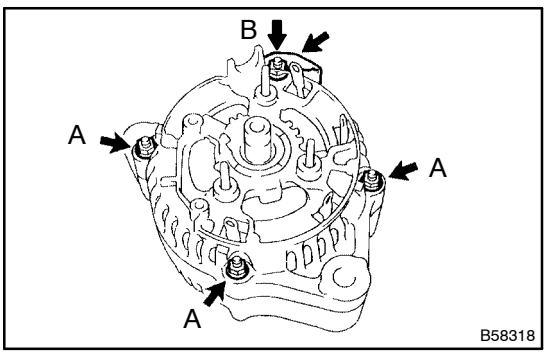


20. INSTALL RECTIFIER END FRAME

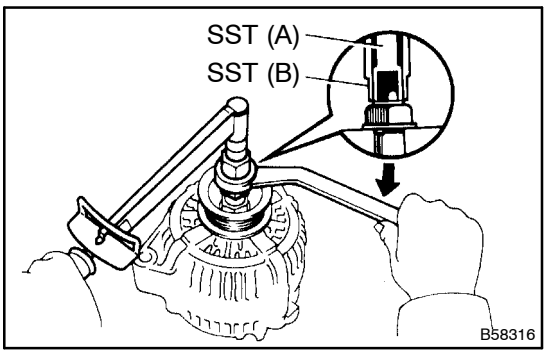
(a) Place the generator washer on the rotor.



(b) Using a 30 mm socket wrench and press, slowly press in the rectifier end frame.



(c) Install the cord clip and 4 nuts.
Torque:
4.5 N·m (46 kgf·cm, 40 in.·lbf) for A
5.4 N·m (55 kgf·cm, 48 in.·lbf) for B

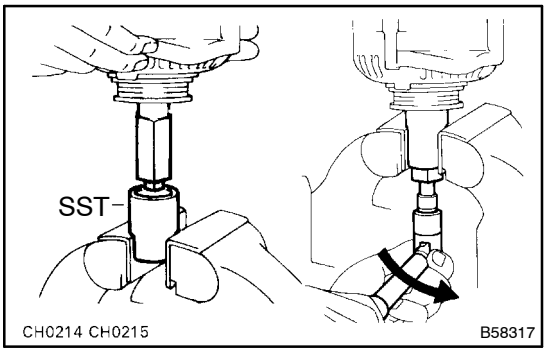


21. INSTALL GENERATOR PULLEY

(a) Install the pulley to the rotor shaft by tightening the pulley nut by hand.

(b) Hold SST (A) with a torque wrench, and tighten SST (B) clockwise to the specified torque.
SST 09820–63010
Torque 39 N·m (400 kgf·cm, 29 ft·lbf)

(c) Check that SST (A) is secured to the pulley shaft.

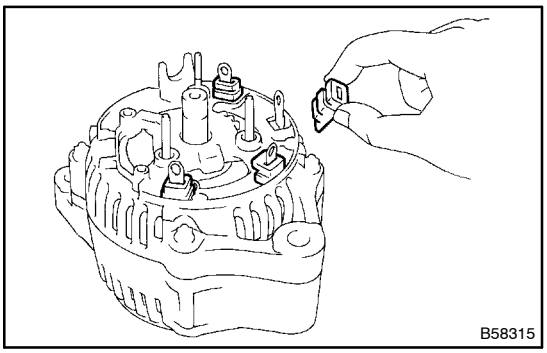


(d) As shown in the illustration, mount SST (C) in a vise and attach the pulley nut to SST (C).

(e) To torque the pulley nut, turn SST (A) in the direction shown in the illustration.
Torque 110.5 N·m (1,125 kgf·cm, 81 ft·lbf)

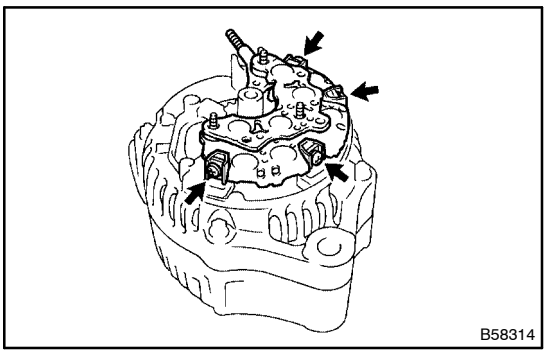
(f) Remove the generator from SST (C).

(g) Turn SST (B) and remove SST (A and B).

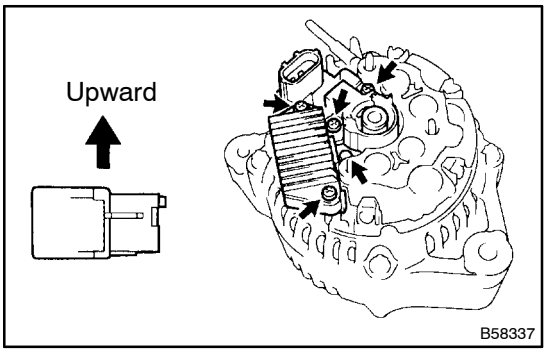


22. INSTALL GENERATOR HOLDER W/ RECTIFIER

(a) Install the 4 rubber insulators on the lead wires.



(b) Install the rectifier holder while pushing it with the 4 screws.
Torque 2.94 N·m (30 kgf·cm, 26 in.·lbf)



23. INSTALL VOLTAGE REGULATOR

(a) Install the voltage regulator with the 3 screws.
Torque 2.0 N·m (20 kgf·cm, 18 in.·lbf)

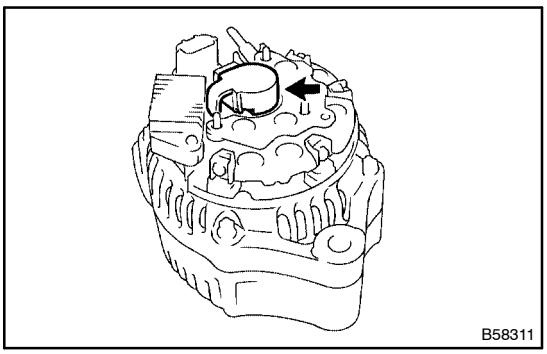
24. INSTALL GENERATOR BRUSH HOLDER ASSY

(a) Place the plate seal on the rectifier end frame.

(b) Install the brush holder with the 2 screws.
Torque: 2.0 N·m (20 kgf·cm, 18 in.·lbf)

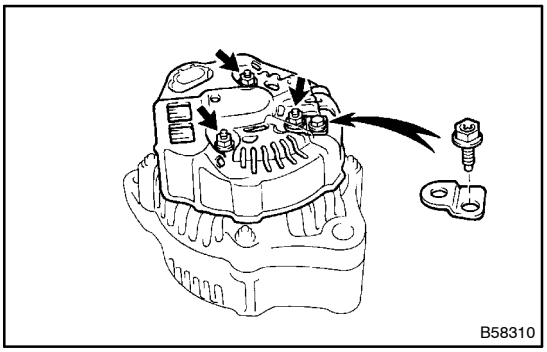
NOTICE:

Be careful of the holder installation direction.

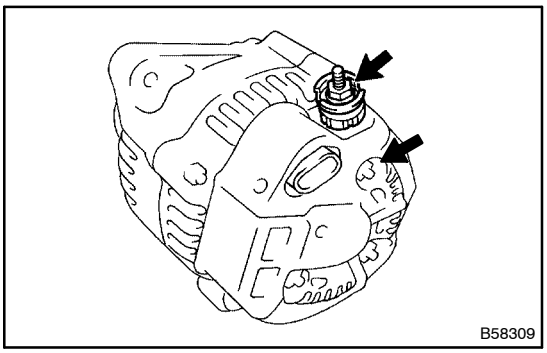


25. INSTALL REAR END COVER

(a) Place the brush holder cover on the brush holder.



(b) Install the rear end cover and plate terminal with the 2 nuts and bolt.
Torque:
3.85 N·m (39 kgf·cm, 34 in.·lbf) for bolt
4.4 N·m (45 kgf·cm, 39 in.·lbf) for nut



(c) Install the terminal insulator with the nut.
Torque: 4.1 N·m (42 kgf·cm, 36 in.·lbf)

26. INSTALL REAR END COVER NO. 2

(a) Install the generator rear end cover with the 2 nuts.

27. INSPECT GENERATOR ASSY

(a) Check that the pulley rotates smoothly.

ALPHABETICAL INDEX

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