

# FOREWORD

This workshop manual has been prepared to provide information covering general service repairs for the W04D–J engine equipped on the HINO DUTRO.

Applicable models: WU300, 340, 410 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.

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# INTRODUCTION

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# 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.

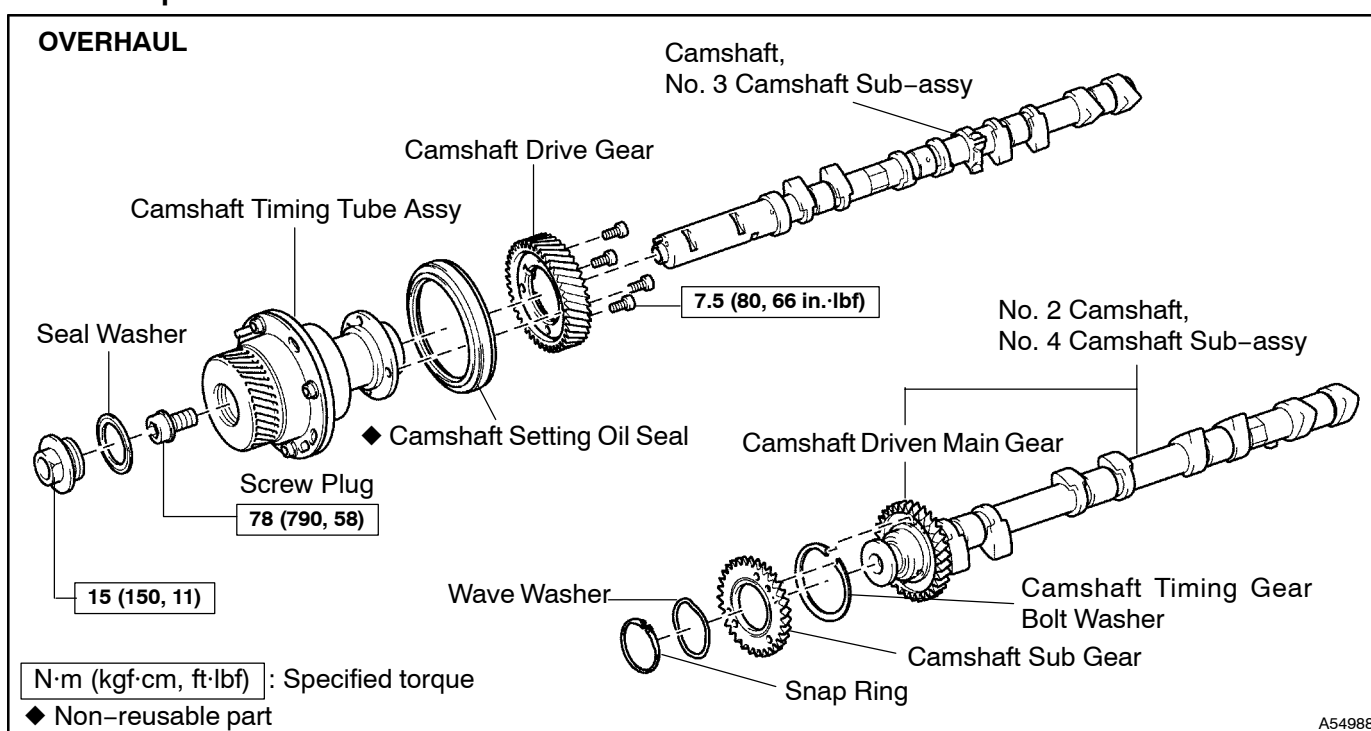
### 3. PREPARATION

- (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.

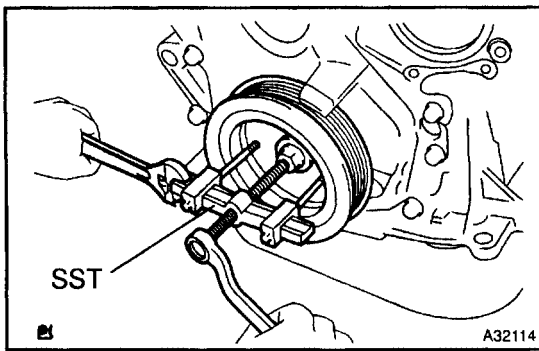
**NOTICE:**

**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:**

*Illustration:  
what to do and where*



*Task heading: what to do*

**5. REMOVE CRANKSHAFT PULLEY**

- (a) Using SST, remove the crankshaft pulley.  
**SST 09950-50012 (09951-05010, 09952-05010, 09953-05020, 09954-05020, 09957-04010)**

*Set part No.      Component part No.      Detailed text:  
how to do task*

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**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.

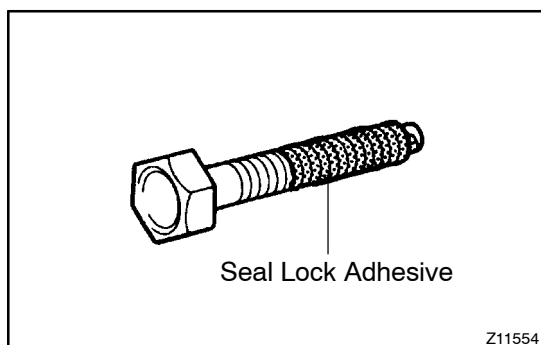
### 5. INSTALL ENGINE ASSEMBLY TO OVERHAUL STAND WHEN OVERHAUL THE ENGINE

### 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



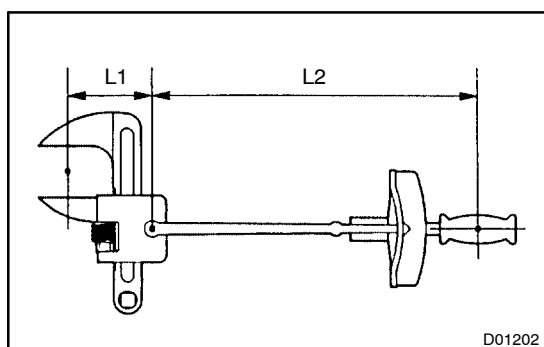
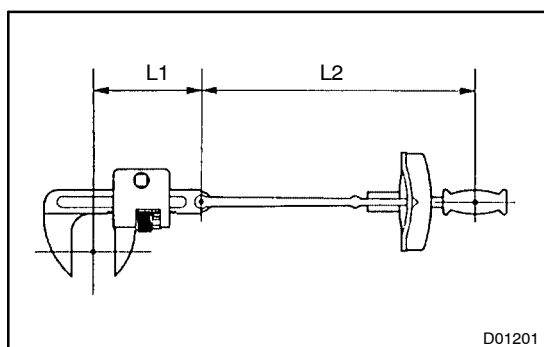
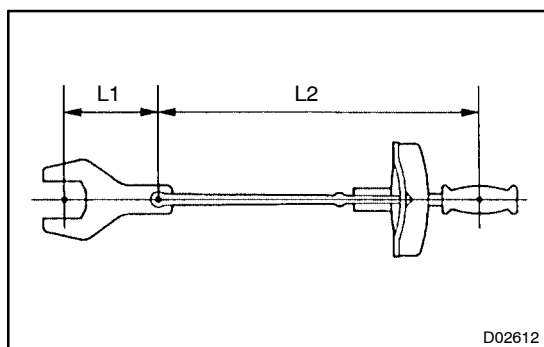
- (a) Precoated Parts:
- (1) Precoated parts are bolts, nuts, etc. that are coated with a seal lock adhesive at the factory.
  - (2) If a precoated part is retightened, loosened or caused to move in any way, it must be recoated with the specified adhesive.
  - (3) When reusing precoated parts, clean 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:

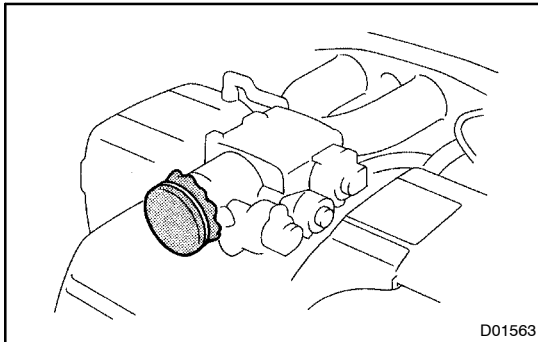
- (1) In case of tightening by extending the entire length of the torque wrench combined with SST or tool, if you tighten until the reading of the torque wrench reached the specified torque value, the actual torque becomes excessive.
- (2) In this text, only the specified torque is described. In case of using SST or extension tool, find the reading of the torque wrench by the formula.
- (3) Formula  $T' = T \times L2 / (L1 + L2)$

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**

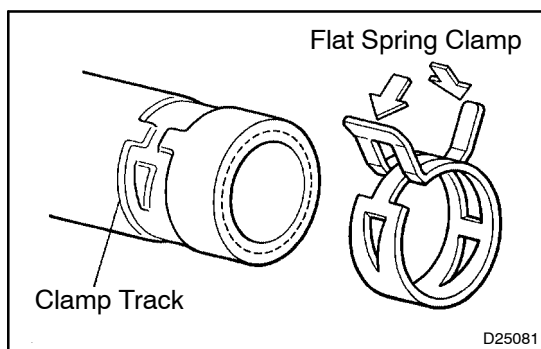
- (a) Place for Removing and Installing Fuel System Parts:
  - (1) Place with good air ventilation and without anything flammable such as welder, grinder, drill, electric motor or stove in the surroundings.
  - (2) Never work in a place like a pit or nearby pit as there is a possibility that vaporized 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 rag separately from any fuel deposit.



#### 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 rag or gum tape.
- (c) When installing the inlet system parts, check that there is no mixing of a metal tip.



#### 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

## INTRODUCTION - TERMS FOR ENGINE REPAIR MANUAL

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

## INTRODUCTION - TERMS FOR ENGINE REPAIR MANUAL

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

## 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 Communication 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)



## INTRODUCTION - TERMS FOR ENGINE REPAIR MANUAL

HO2S	Heated Oxygen Sensor	Heated Oxygen Sensor (HO <sub>2</sub> S)
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 <sub>2</sub> Sensor (O <sub>2</sub> S)
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 <sub>RO</sub>
TWC+OC	Three-Way + Oxidation Catalytic Converter	CC <sub>R</sub> + CC <sub>O</sub>
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	-

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# PREPARATION

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# FUEL

## PREPARATION

02269-01

### Equipment

Brass brush	
Injection nozzle tester	
Torque wrench	
Retaining nut wrench (Part No. 95092-10500 for DENSO made)	
Wooden stick	

# INTAKE PREPARATION

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## Recommended Tools

	09200-00010 Engine Adjust Kit	INTAKE MANIFOLD
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## Equipment

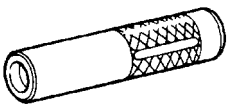
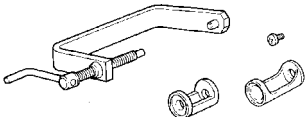
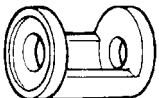
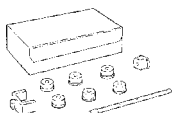

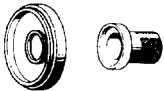
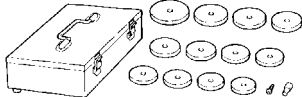

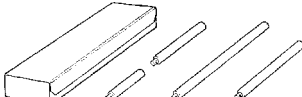

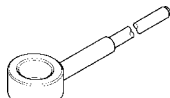
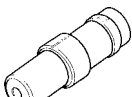
Dye penetrant	
Precision straight edge	

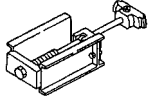
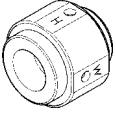

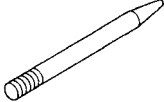
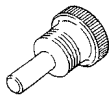

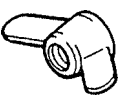
# ENGINE MECHANICAL

## PREPARATION


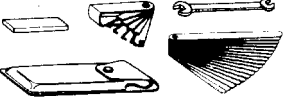
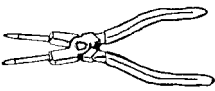
0226B-01

### SST

	09201-41020	Valve Stem Oil Seal Replacer	CYLINDER HEAD ASSY
	09202-70020	Valve Spring Compressor	CYLINDER HEAD ASSY
	(09202-00030)	Attachment	CYLINDER HEAD ASSY
	09215-00013	Crankshaft Bearing Remover & Replacer Set B	TIMING GEAR AND CAMSHAFT
	(09215-00461)	Camshaft Bearing Remover & Replacer	TIMING GEAR AND CAMSHAFT
	09223-78010	Crankshaft Oil Seal Replacer	CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING
	09950-60020	Replacer Set No.2	TIMING GEAR AND CAMSHAFT
	(09951-00750)	Replacer 75	TIMING GEAR AND CAMSHAFT
	09950-70010	Handle Set	TIMING GEAR AND CAMSHAFT
	(09951-07100)	Handle 100	TIMING GEAR AND CAMSHAFT
	09402-1450	Press Sub-Assembly	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09402-1460	Press Sub-Assembly	PISTON, CRANKSHAFT AND CYLINDER BLOCK

	09420-1460	Cylinder Liner Puller	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09481-1130	Guide	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09481-1140	Guide	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09481-1340	Guide	CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING
	09512-2100	Timing Setting	TIMING GEAR AND CAMSHAFT
	9191-08252	Bolt	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	9233-10360	Wing Nut	PISTON, CRANKSHAFT AND CYLINDER BLOCK

**Recommended Tools**

	09090-04020	Engine Sling Device	PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09200-00010	Engine Adjust Kit	CYLINDER HEAD ASSY(W04D-J) CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING TIMING GEAR AND CAMSHAFT PISTON, CRANKSHAFT AND CYLINDER BLOCK
	09905-00013	Snap Ring Pliers	PISTON, CRANKSHAFT AND CYLINDER BLOCK

**SSM**

	08826-00080	Seal Packing Black or equivalent (FIPG)	CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING
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**Equipment**

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

0226C-01

### Recommended Tools

	09200-00010 Engine Adjust Kit	EXHAUST MANIFOLD
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### Equipment

Dye penetrant	
Precision straight edge	

# COOLING

## PREPARATION

### SSM

0228D-01

	08826-00100 "Seal Packing 1282B," THREE BOND 1282B or equivalent (FIPG)	WATER PUMP ASSY
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### Equipment

Bolt Thread diameter: 10.0 mm (0.394 in.) Thread pitch: 1.5 mm (0.059 in.)	
Heater	
Press	
Steel pipe Length: More than 57 mm (2.24 in.) Inside diameter: 18 - 21 mm (0.71 - 0.83 in.) Outside diameter: Less than 29.5 mm (1.161 in.)	
Thermometer	

# LUBRICATION

## PREPARATION

0226E-01

### Equipment


Dial gauge	
Micrometer	
Torque wrench	
Vise	

# STARTING & CHARGING


## PREPARATION

0226J-01

### SST

	09820-00031 Alternator Rotor Rear Bearing Replacer	STARTER ASSY
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### Recommend Tools

	09082-00040 Electrical Tester	STARTER ASSY GENERATOR ASSY
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### Equipment

Dial indicator	
Micrometer	
Plastic hammer	
Press	
Pull scale	Brush spring
Sandpaper	Commutator
Soldering iron	
Torque wrench	
Vernier calipers	

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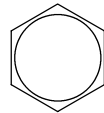
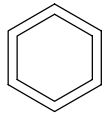
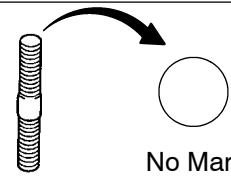
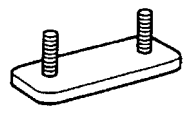

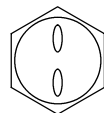
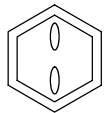

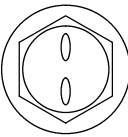
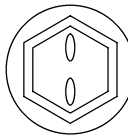










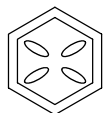
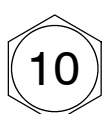

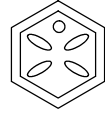


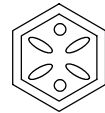
# SERVICE SPECIFICATIONS

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# STANDARD BOLT

## HOW TO DETERMINE BOLT STRENGTH

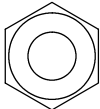
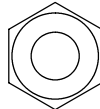
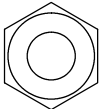
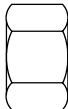

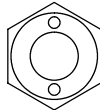
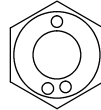
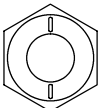
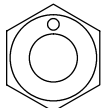
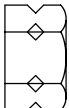
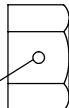

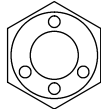

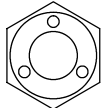
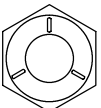
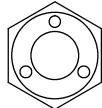
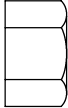

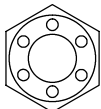

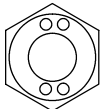
030Y3-03

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
		 		8T
				9T
	 			10T
	 			11T

**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

# 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
	 	  *	7N (5T)
 			8N
 	 	 No Mark	10N (7T)
 			11N
 			12N

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

## HINT:

B06432

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

W04D ENGINE REPAIR MANUAL (RM1010E)



**FUEL****TORQUE SPECIFICATION**

030YC-06

Part tightened	N·m	kgf·cm	ft·lbf
Nozzle holder body x Nozzle holder retaining nut	68.5	700	51

# INTAKE

## SERVICE DATA

030Y7-04

Intake manifold	Warpage	Maximum	0.20 mm (0.0079 in.)
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## ENGINE MECHANICAL

## SERVICE DATA

030YD-04

Cylinder head	Warpage	STD Longitudinal direction	0.05 mm (0.0020 in.) or less
		Lateral direction	0.05 mm (0.0020 in.) or less
		Maximum	0.10 mm (0.0039 in.)
Valve and valve seat	Valve seat angle	Intake	29° 00' - 30° 00'
		Exhaust	44° 00' - 45° 15'
	Valve face angle	Intake	29° 45' - 30° 15'
		Exhaust	44° 45' - 45° 15'
	Valve sink dimension	STD Intake	0.15 - 0.45 mm (0.0059 - 0.0177 in.)
		Exhaust	0.47 - 0.77 mm (0.0185 - 0.0303 in.)
		Maximum Intake	0.55 mm (0.0217 in.)
	Valve stem diameter	Exhaust	0.87 mm (0.0342 in.)
		STD Intake	8.95 - 8.97 mm (0.3524 - 0.3531 in.)
		Exhaust	8.93 - 8.95 mm (0.3516 - 0.3524 in.)
	Valve stem oil clearance	Minimum Intake	8.90 mm (0.3504 in.)
		Exhaust	8.80 mm (0.3465 in.)
		STD Intake	0.035 - 0.068 mm (0.0014 - 0.0027 in.)
Exhaust		0.050 - 0.083 mm (0.0020 - 0.0033 in.)	
Maximum Intake Position A & B		0.10 mm (0.0039 in.)	
	C	0.18 mm (0.0071 in.)	
	Exhaust Position A & B	0.12 mm (0.0047 in.)	
	C	0.20 mm (0.0079 in.)	
Valve spring	Deviation	Maximum	2.0 mm (0.079 in.)
		Inner	60.2 mm (2.370 in.)
	Free length	Outer	60.1 mm (2.366 in.)
Installed tension	Inner at 43.0 mm (1.693 in.)	86.0 N (8.8 kgf, 19.3 lb)	
	Outer at 45.5 mm (1.791 in.)	269.0 N (27.4 kgf, 60.5 lb)	
Nozzle holder and nozzle set	Nozzle protrusion	STD	2.25 - 3.05 mm (0.1004 - 0.1201 in.)
		Maximum	3.05 mm (0.1201 in.)
Valve rocker arm and shaft	Valve rocker arm bush inside diameter	STD	19.020 - 19.045 mm (0.7488 - 0.7498 in.)
		Maximum	19.06 mm (0.7504 in.)
	Valve rocker arm shaft diameter	STD	18.966 - 18.984 mm (0.7467 - 0.7474 in.)
		Minimum	18.95 mm (0.7461 in.)
	Oil clearance	STD	0.036 - 0.079 mm (0.0014 - 0.0031 in.)
	Maximum	0.10 mm (0.0039 in.)	
Valve lifter	Valve lifter diameter	STD	26.95 - 26.97 mm (1.0610 - 1.0618 in.)
	Valve lifter bore inside diameter	STD	27.00 - 27.02 mm (1.0630 - 1.0638 in.)
	Oil clearance	STD	0.025 - 0.071 mm (0.0010 - 0.0028 in.)
	Maximum	0.10 mm (0.0039 in.)	
Cylinder head bolt	Length	Maximum Bolt No. position 1 - 13	118 mm (4.65 in.)
		14 - 18	165 mm (6.50 in.)
Valve clearance	at cold	Intake	0.35 mm (0.014 in.)
		Exhaust	0.55 mm (0.022 in.)
Flywheel	Deflection	Maximum	0.04 mm (0.0016 in.)
	Grind limit		1.00 mm (0.0394 in.)
	Runout	Maximum	0.15 mm (0.0059 in.)

## SERVICE SPECIFICATIONS – ENGINE MECHANICAL

Timing gear	Idle gear and shaft			
	Shaft diameter	STD	49.950 – 49.975 mm (1.9665 – 1.9675 in.)	
	Gear bush inside diameter	STD	50.000 – 50.025 mm (1.9685 – 1.9695 in.)	
	Oil clearance between bush and shaft	STD	0.025 – 0.075 mm (0.0010 – 0.0030 in.)	
		Maximum	0.10 mm (0.0039 in.)	
	Gear thrust clearance	STD	0.040 – 0.100 mm (0.0016 – 0.0039 in.)	
		Maximum	0.15 mm (0.0059 in.)	
	Backlash			
	Crankshaft timing gear x Idle gear	STD	0.068 – 0.194 mm (0.0027 – 0.0076 in.)	
		Maximum	0.30 mm (0.0118 in.)	
	Idle gear x Injection pump drive gear	STD	0.065 – 0.232 mm (0.0026 – 0.0091 in.)	
		Maximum	0.30 mm (0.0118 in.)	
Idle gear x Oil pump drive gear	STD	0.065 – 0.182 mm (0.0026 – 0.0072 in.)		
	Maximum	0.30 mm (0.0118 in.)		
Camshaft timing gear x Oil pump drive gear	STD	0.065 – 0.182 mm (0.0026 – 0.0072 in.)		
	Maximum	0.30 mm (0.0118 in.)		
Camshaft	Cam lobe height			
		STD Intake	49.435 mm (1.9463 in.)	
		Exhaust	49.493 mm (1.9485 in.)	
	Minimum	Intake	48.90 mm (1.9252 in.)	
		Exhaust	48.95 mm (1.9272 in.)	
	Journal diameter	STD	No. 1	56.95 – 56.97 mm (2.2421 – 2.2429 in.)
			No. 2	56.75 – 56.77 mm (2.2342 – 2.2350 in.)
			No. 3	56.55 – 56.57 mm (2.2264 – 2.2272 in.)
		Minimum	No. 1	56.85 mm (2.2382 in.)
			No. 2	56.65 mm (2.2303 in.)
			No. 3	56.45 mm (2.2224 in.)
	Camshaft bearing inside diameter	STD	No. 1	57.00 – 57.07 mm (2.2441 – 2.2468 in.)
			No. 2	56.80 – 56.87 mm (2.2362 – 2.2390 in.)
No. 3			56.60 – 56.67 mm (2.2283 – 2.2311 in.)	
Oil clearance	STD	0.030 – 0.120 mm (0.0012 – 0.0047 in.)		
	Maximum	0.15 mm (0.0059 in.)		
Bent	Maximum	0.05 mm (0.0020 in.)		
Thrust clearance	STD	0.10 – 0.18 mm (0.0039 – 0.0071 in.)		
	Maximum	0.30 mm (0.0118 in.)		
Connecting rod	Rod bent	Maximum per 200 mm (7.87 in.)	0.10 mm (0.0039 in.)	
	Rod twist	Maximum per 200 mm (7.87 in.)	0.10 mm (0.0039 in.)	
	Bush inside diameter	STD	37.035 – 37.045 mm (1.4581 – 1.4585 in.)	
		Maximum	37.10 mm (1.4606 in.)	
	Bush oil clearance	STD	0.035 – 0.056 mm (0.0014 – 0.0022 in.)	
		Maximum	0.08 mm (0.0031 in.)	
	Rod big end inside diameter (w/o Bearing)	STD	65.985 – 66.000 mm (2.5978 – 2.5984 in.)	
		Maximum	66.06 mm (2.6008 in.)	
	Rod big end inside diameter (w/ Bearing)	STD	61.985 – 62.000 mm (2.4403 – 2.4409 in.)	
		Maximum	62.06 mm (2.4433 in.)	
Rod big end oil clearance	STD	0.031 – 0.082 mm (0.0012 – 0.0032 in.)		
	Maximum	0.12 mm (0.0047 in.)		
Thrust clearance	STD	0.20 – 0.52 mm (0.0079 – 0.0205 in.)		
	Maximum	0.60 mm (0.0236 in.)		
Connecting rod bolt	Length	STD	59.00 mm (2.3228 in.)	
		Maximum	60.00 mm (2.3622 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	STD	103.908 mm (4.0909 in.)
		Minimum	103.902 mm (4.0906 in.)
	Piston oil clearance	STD	0.0140 – 0.0172 mm (0.0056 – 0.0068 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	STD 1st	2.58 – 2.60 mm (0.1016 – 0.1024 in.)
			2.06 – 2.08 mm (0.0811 – 0.0819 in.)
		Oil	4.01 – 4.03 mm (0.1579 – 0.1587 in.)
			Maximum 1st
		2nd	2.20 mm (0.0866 in.)
			Oil
	Piston ring thickness	STD 1st	2.47 – 2.49 mm (0.0972 – 0.0980 in.)
			1.97 – 1.99 mm (0.0776 – 0.0783 in.)
Oil		4.97 – 4.99 mm (0.1957 – 0.1965 in.)	
		Maximum 1st	2.32 mm (0.0913 in.)
2nd		1.82 mm (0.0717 in.)	
		Oil	4.95 mm (0.1949 in.)
Piston ring groove clearance	STD 1st	0.09 – 0.13 mm (0.0035 – 0.0051 in.)	
		0.07 – 0.11 mm (0.0028 – 0.0043 in.)	
	Oil	0.02 – 0.06 mm (0.0008 – 0.0024 in.)	
		Maximum	0.30 mm (0.0118 in.)
	STD	0.30 – 0.42 mm (0.0118 – 0.0165 in.)	
		Maximum	1.20 mm (0.0472 in.)
Crankshaft	Crankshaft pin diameter	STD	61.940 – 61.960 mm (2.4386 – 2.4394 in.)
		Minimum	60.76 mm (2.3921 in.)
	Bent	Maximum	0.04 mm (0.0016 in.)
		Minimum for repair for use	72.74 mm (2.8638 in.)
	Main journal diameter	STD	72.94 – 72.96 mm (2.8716 – 2.8724 in.)
		Minimum for repair for use	71.76 mm (2.8252 in.)
	Main journal oil clearance	STD	0.039 – 0.090 mm (0.0015 – 0.0035 in.)
Thrust clearance	Maximum	0.13 mm (0.0051 in.)	
	STD	0.05 – 0.22 mm (0.0020 – 0.0087 in.)	
Maximum	0.40 mm (0.0157 in.)		
Cylinder block	Warpage	STD	0.05 mm (0.0020 in.) or less
		Maximum	0.10 mm (0.0039 in.)
	Main bearing bore diameter (w/o bearing)	STD	77.985 – 78.000 mm (3.0703 – 3.0709 in.)
		Maximum	78.20 mm (3.0787 in.)
	Main bearing bore diameter (w/ bearing)	STD	73.000 mm (2.8740 in.)
		Maximum	73.30 mm (2.8858 in.)
Main bearing cap bolt	Length	STD	94.00 mm (3.7008 in.)
	Maximum	95.20 mm (3.7480 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	104.003 – 104.018 mm (4.0946 – 4.0952 in.)
		Maximum	104.15 mm (4.1004 in.)

## TORQUE SPECIFICATION

Part tightened	N·m	kgf·cm	ft·lbf	
Cylinder head x Cylinder block	Cylinder head bolt	132	1,350	97
	Cylinder head Additional bolt	52	530	38
Nozzle holder and nozzle set x Cylinder head	15	150	11	
Cylinder head cover x Cylinder head	25	250	18	
Nozzle leakage pipe x Nozzle holder and nozzle set	12.3	125	9	
Injection pipe x Nozzle holder and nozzle set	19.6	200	14	
Injection pipe x Injection pump	19.6	200	14	
Flywheel housing x Cylinder block	117.7	1,200	87	
Flywheel x Crankshaft	186	1,900	137	
Oil pan x Cylinder block	22.5	230	17	
Oil pan x Flywheel housing	22.5	230	17	
Oil pan x Timing gear case	22.5	230	17	
Crankshaft pulley x Crankshaft	514.8	5,250	380	
Camshaft thrust plate x Cylinder block	24.5	250	18	
Idle gear shaft x Cylinder block	137.3	1,400	101	
Main bearing cap x Cylinder block	147.1	1,500	109	
Connecting rod cap x Connecting rod	122.6	1,250	90	

# EXHAUST

## SERVICE DATA

030Y8-04

Exhaust manifold	Warpage	Maximum	0.20 mm (0.0079 in.)
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# COOLING

## SERVICE DATA

030Y9-04

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****SERVICE DATA**

030YA-04

Oil pump	Backlash	STD	0.091 – 0.217 mm (0.0036 – 0.0085 in.)
		Maximum	0.30 mm (0.0118 in.)
	Drive gear shaft diameter	STD	18.088 – 18.106 mm (0.7121 – 0.7128 in.)
		Minimum	18.062 mm (0.7111 in.)
	Drive gear bush inside diameter	STD	18.146 – 18.173 mm (0.7144 – 0.7155 in.)
		Maximum	18.20 mm (0.7165 in.)
	Oil clearance between drive gear shaft and bush	STD	0.040 – 0.085 mm (0.0016 – 0.0033 in.)
		Maximum	0.10 mm (0.0039 in.)
	Driven gear shaft diameter	STD	17.979 – 17.997 mm (0.7078 – 0.7085 in.)
		Minimum	17.97 mm (0.7074 in.)
Driven gear bush inside diameter	STD	18.037 – 18.054 mm (0.7101 – 0.7108 in.)	
	Maximum	18.07 mm (0.7114 in.)	
Oil clearance between driven gear shaft and bush	STD	0.040 – 0.075 mm (0.0016 – 0.0030 in.)	
	Maximum	0.10 mm (0.0039 in.)	

**TORQUE SPECIFICATION**

Part tightened	N·m	kgf·cm	ft·lbf
Oil pump case sub-assy x Cylinder block	22.5	230	17

# STARTING & CHARGING

## SERVICE DATA

030YQ-04

### Starter assy

Starter armature assy	Commutator diameter	STD	32.8 mm (1.291 in.)
		Minimum	30.0 mm (1.181 in.)
	Commutator undercut depth	STD	0.5 – 0.8 mm (0.020 – 0.032 in.)
		Minimum	0.2 mm (0.008 in.)
Starter brush	Brush length	STD	18.0 mm (0.709 in.)
		Minimum	12.0 mm (0.472 in.)
Starter brush holder assy	Brush 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)
Magnet starter switch assy	Pull-in coil resistance (between terminal 30 and 50)	STD	0.12 – 0.15 $\Omega$
	Hold-in coil resistance (between terminal 50 and switch body)	STD	0.83 – 1.01 $\Omega$
Starter clutch sub-assy	Inner sleeve diameter (A)	STD	26.0 mm (1.024 in.)
		Minimum	25.9 mm (1.020 in.)
	Starter clutch diameter (B)	STD	12.1 mm (0.476 in.)
		Minimum	12.0 mm (0.472 in.)
Drive housing	Diameter of starter drive housing bush inside	STD	26.0 mm (1.024 in.)
		Maximum	26.2 mm (1.031 in.)
Motor housing	Diameter of motor housing bush inside	STD	12.1 mm (0.476 in.)
		Maximum	12.3 mm (0.484 in.)
Starter commutator end frame assy	Diameter of end frame bush inside	STD	12.0 mm (0.472 in.)
		Maximum	12.2 mm (0.480 in.)

### Generator assy

Rotor	Resistance between slip rings	STD	12.5 $\Omega$ at 20°C (68°F)
	Resistance between slip rings and rotor body at 20°C (68°F)	STD	More than 1 M $\Omega$
		Minimum	Less than 0.5 M $\Omega$
	Slip ring diameter	STD	34.5 mm (1.358 in.)
Minimum		33.5 mm (1.319 in.)	
Brush holder assembly	Brush exposed length	STD	21.0 mm (0.827 in.)
		Minimum	7.0 mm (0.276 in.)

# TORQUE SPECIFICATION

## Starter assy

Part tightened	N·m	kgf·cm	ft·lbf
Starter commutator end frame assy x Starter drive housing	14.7	150	11
Motor housing x Starter drive housing	15	155	11
Magnet starter switch assy x Starter drive housing	14.7	150	11
Starter commutator end frame assy x Starter brush holder assy	4.3	44	38 in.·lbf

## Generator assy

Part tightened	N·m	kgf·cm	ft·lbf
Bearing retainer x Front bracket	3.2 - 4.4	33 - 45	29 - 39 in.·lbf
Generator pulley x Rotor	96 - 127	980 - 1,300	71 - 94
Front bracket x Rear bracket	5.9 - 8.8	60 - 90	52 - 78 in.·lbf
Brush holder assembly x Rectifier holder	1.9 - 2.5	19 - 25	17 - 22 in.·lbf

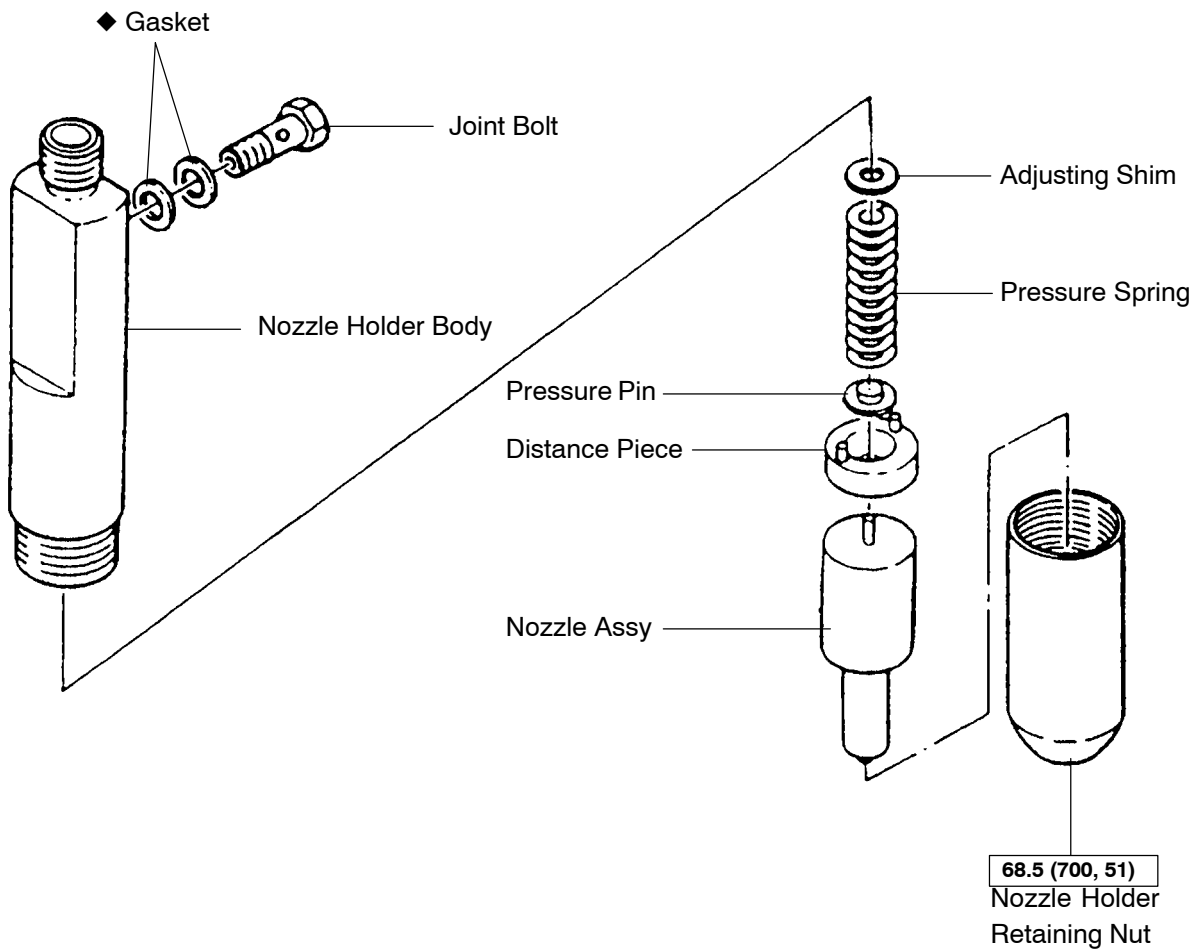
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# FUEL

NOZZLE HOLDER AND NOZZLE SET .....	11-1
COMPONENTS .....	11-1
OVERHAUL .....	11-2

# NOZZLE HOLDER AND NOZZLE SET COMPONENTS

110NZ-01

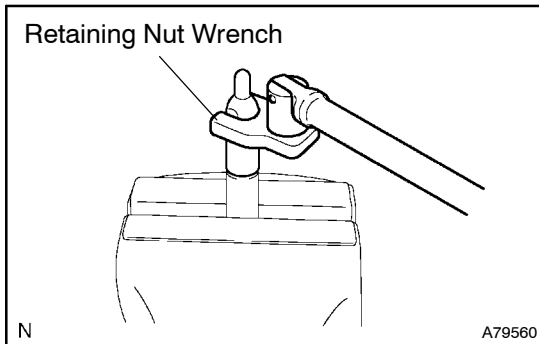


**68.5 (700, 51)** : Specified torque

◆ Non-reusable part

\* For use with SST

# OVERHAUL



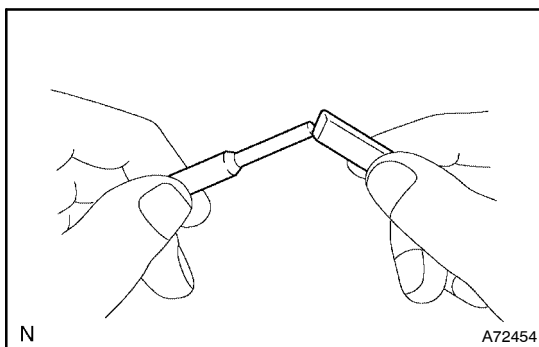
## 1. REMOVE NOZZLE ASSY

- (a) Using a retaining nut wrench, unscrew the retaining nut. Part No. 95092-10500 (DENSO made)

### NOTICE:

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

- (b) Remove the pressure spring, adjusting shim, pressure pin, distance piece and the nozzle assy.



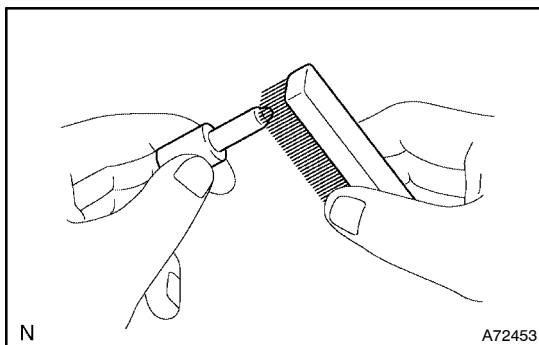
## 2. CLEAN NOZZLE ASSY

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

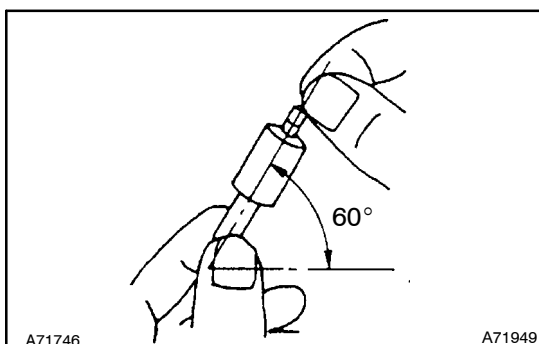
### NOTICE:

**Do not touch the nozzle mating surfaces with your fingers.**

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



- (c) Using a brass brush, remove the carbon from the exterior of the nozzle body (except lapped surface).
- (d) Check the nozzle body for burns or corrosion.
- (e) Check the nozzle needle tip for damage or corrosion.
- If any of these damages are found, replace the nozzle assy.



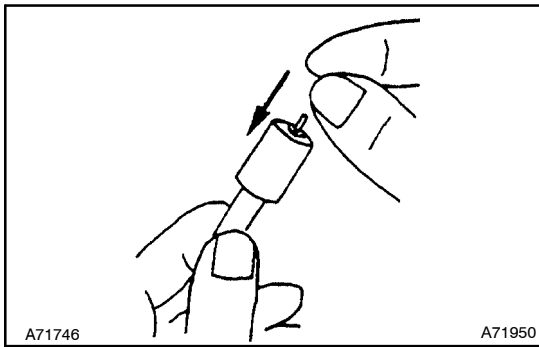
## 3. INSPECT NOZZLE ASSY

- (a) Wash the nozzle in clean diesel fuel.

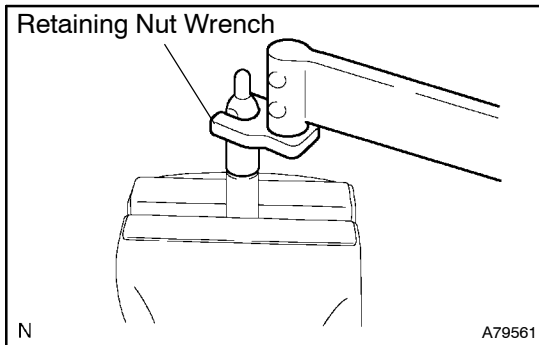
### NOTICE:

**Do not touch the nozzle mating surfaces with your fingers.**

- (b) Tilt the nozzle body about 60° and pull the needle out about one-third of its length.



- (c) Check that the needle falls into the body vent smoothly by its own weight when released.
- (d) Repeat this test, rotating the needle slightly every time. If the needle does not fall smoothly, replace the nozzle assy.



#### 4. INSTALL NOZZLE ASSY

- (a) Assemble the nozzle holder body, adjusting shim, pressure spring, pressure pin, distance piece, the nozzle assy and nozzle holder retaining nut, and tighten the nozzle holder body nut with your finger.
- (b) Using a retaining nut wrench, tighten the retaining nut. Part No. 95092-10500 (DENSO made)  
**Torque: 68.5 N·m (700 kgf·cm, 51 ft·lbf)**

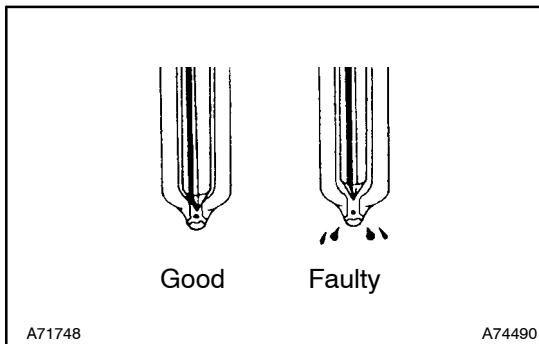
#### HINT:

Use a torque wrench with a fulcrum length of 30 cm (11.81 in.).

#### 5. INSPECT NOZZLE HOLDER AND NOZZLE SET

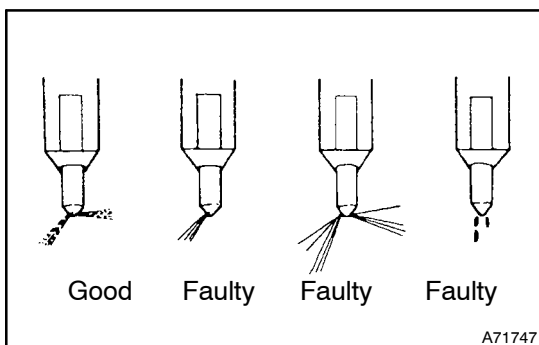
- (a) Check for leaks.
  - (1) While maintaining pressure at about 981 – 1,961 kPa (10 – 20 kgf/cm<sup>2</sup>, 142 – 284 psi) below opening pressure (adjust it by the tester handle), check that there is no dripping from the injection hole or around the retaining nut for 10 seconds.

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



- (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 while shuddering.

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





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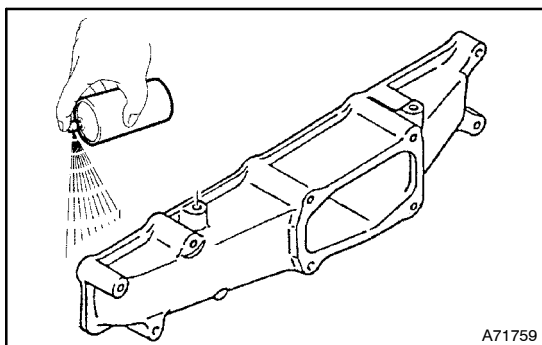
# INTAKE

INTAKE MANIFOLD .....	13-1
INSPECTION .....	13-1



# INTAKE MANIFOLD INSPECTION

1305E-01



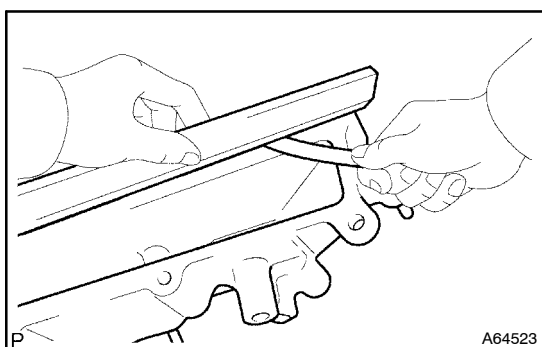
## 1. INSPECT INTAKE MANIFOLD

### HINT:

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

- (a) Using a dye penetrant, check the intake 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, 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.

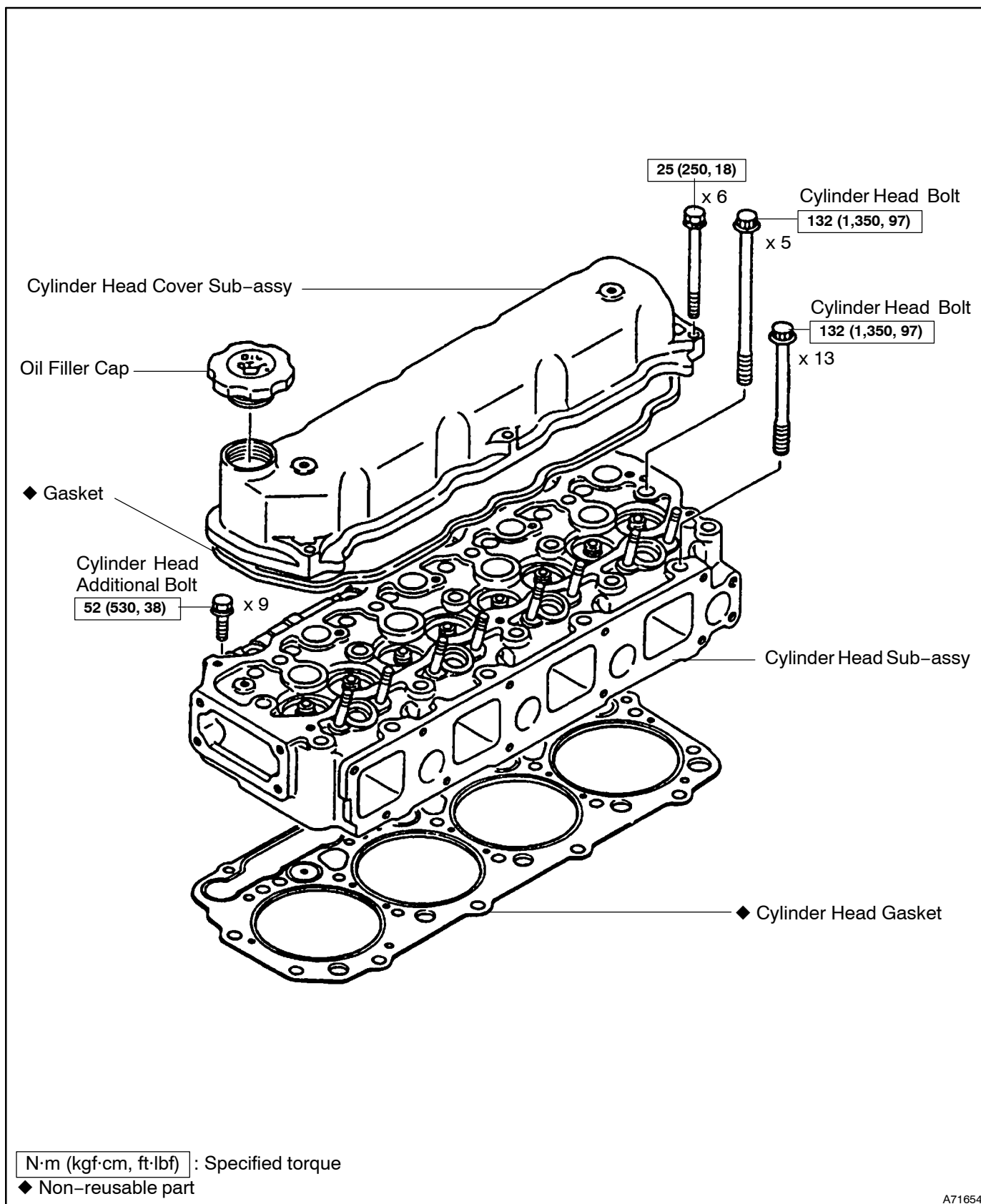
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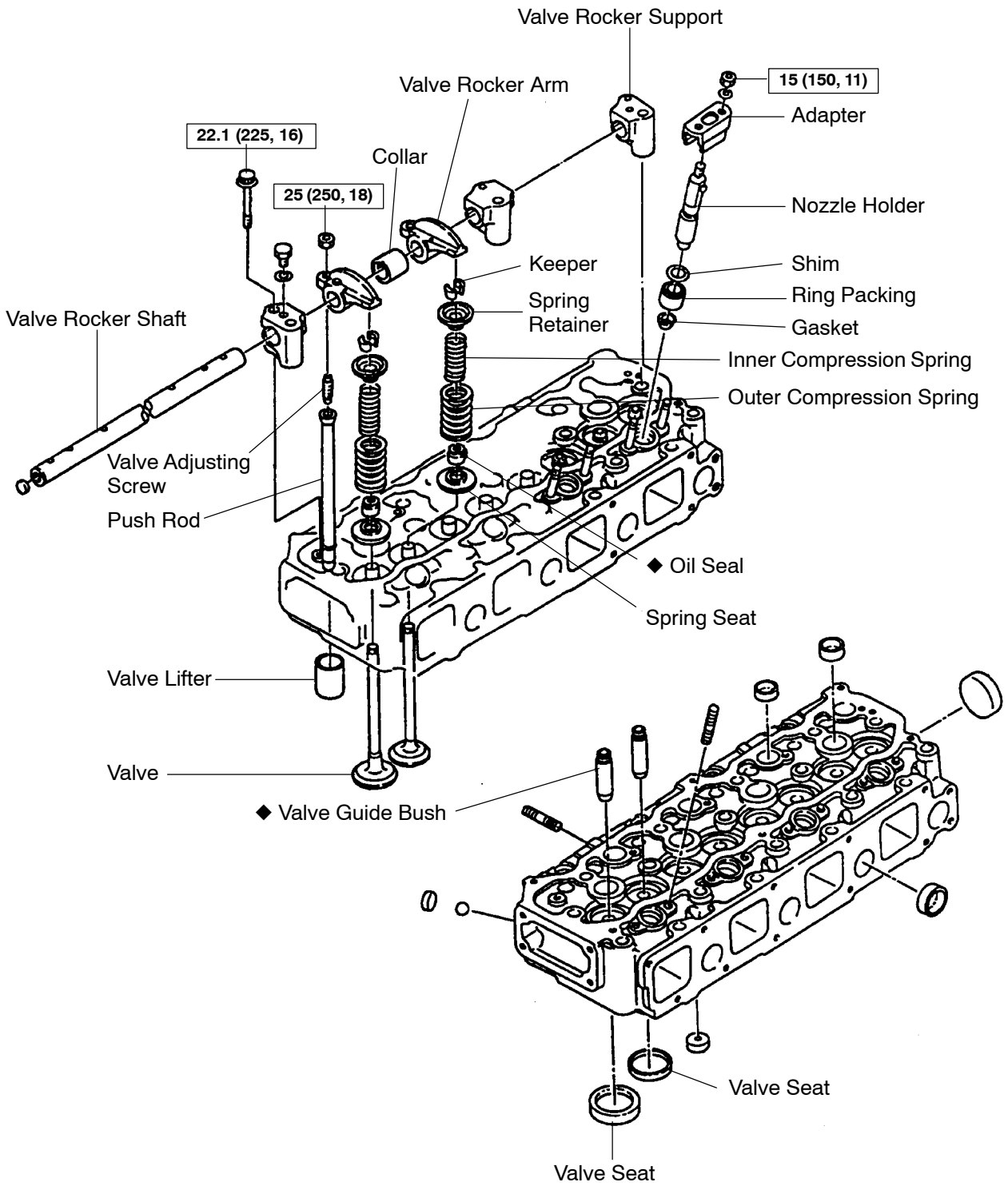
# ENGINE MECHANICAL

CYLINDER HEAD ASSY .....	14-1
COMPONENTS .....	14-1
OVERHAUL .....	14-3
CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING .....	14-17
COMPONENTS .....	14-17
OVERHAUL .....	14-18
TIMING GEAR AND CAMSHAFT .....	14-22
COMPONENTS .....	14-22
OVERHAUL .....	14-23
PISTON, CRANKSHAFT AND CYLINDER BLOCK .....	14-30
COMPONENTS .....	14-30
OVERHAUL .....	14-31

# CYLINDER HEAD ASSY COMPONENTS

14147-01



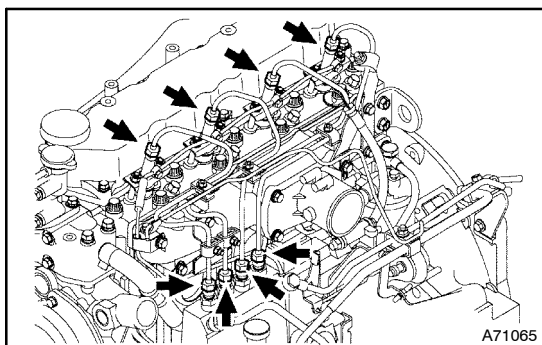


N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

# OVERHAUL

## 1. REMOVE INTAKE AIR CONNECTOR

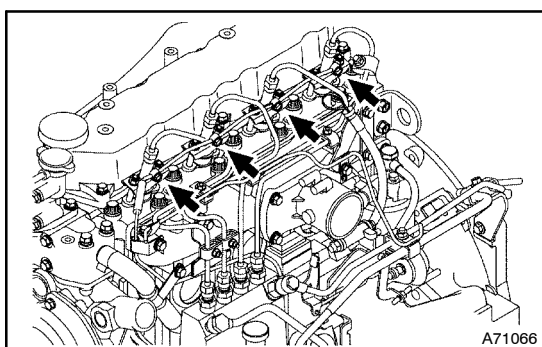


## 2. REMOVE INJECTION PIPE SET

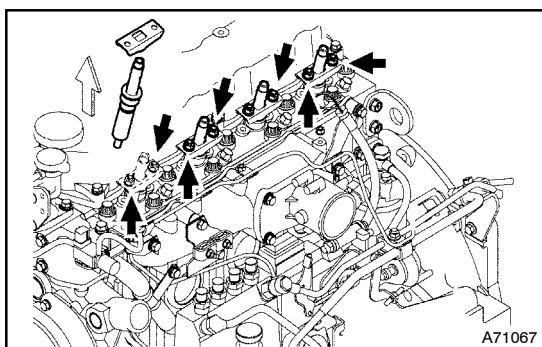
- (a) Loosen the 8 union nuts on the 4 injection pipes.

### NOTICE:

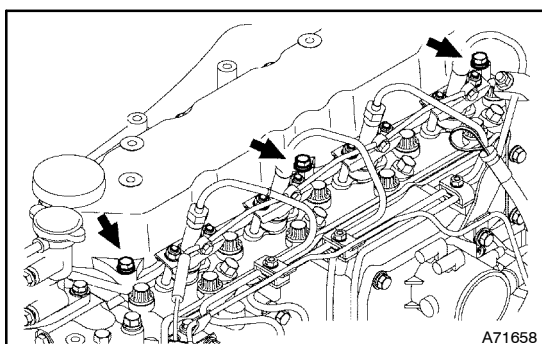
After removing the fuel pipe, put it in a vinyl bag and bind the vinyl bag with a rubber band to prevent foreign objects from getting into the injection nozzle inlet.



## 3. REMOVE NOZZLE LEAKAGE PIPE ASSY



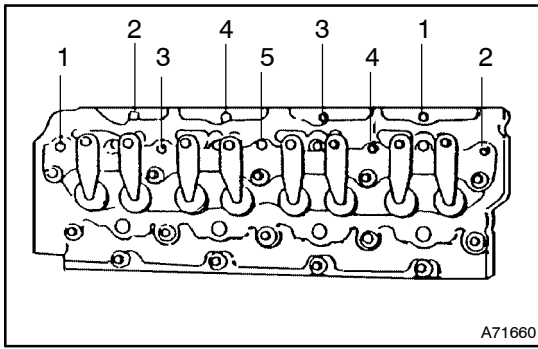
## 4. REMOVE NOZZLE HOLDER AND NOZZLE SET



## 5. REMOVE CYLINDER HEAD COVER SUB-ASSY

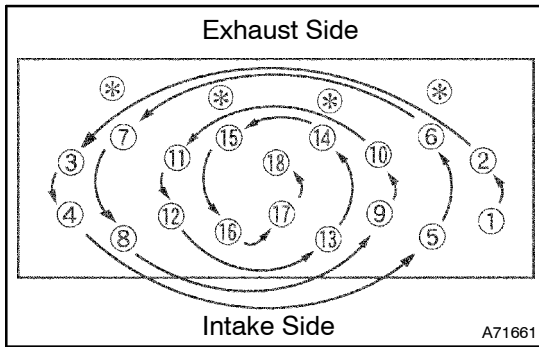
### NOTICE:

Thoroughly clean the cylinder head cover before removing it to prevent foreign particles from getting in.



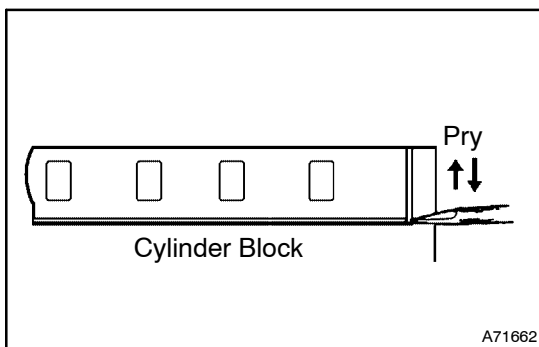
## 6. REMOVE CYLINDER HEAD AND VALVE ROCKER ARM ASSY

- (a) Loosen the cylinder head additional bolts and rocker arm support bolts in the order as shown in the illustration.



- (b) Loosen the cylinder head bolts little in 3 stages, in the order as shown in the illustration.

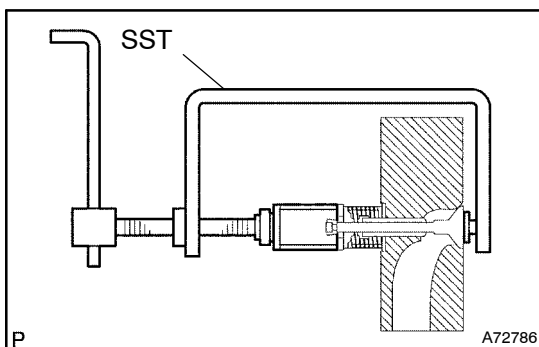
- (c) Lift the cylinder head from the dowels on the cylinder block, and place the cylinder head on wooden blocks on a bench.



If the cylinder head is difficult to be lifted, insert a screwdriver between the cylinder head and block to pry it up.

### NOTICE:

**Be careful not to damage the contact surfaces between the cylinder head and block.**



## 7. REMOVE VALVE

- (a) Using SST, compress the compression springs and remove the 2 keepers.

SST 09202-70020 (09202-00030)

- (b) Remove the spring retainer, 2 compression springs and valve.

- (c) Remove the oil seal and spring seat.

### HINT:

Arrange the valves, compression springs, spring seats and spring retainers in the correct order.

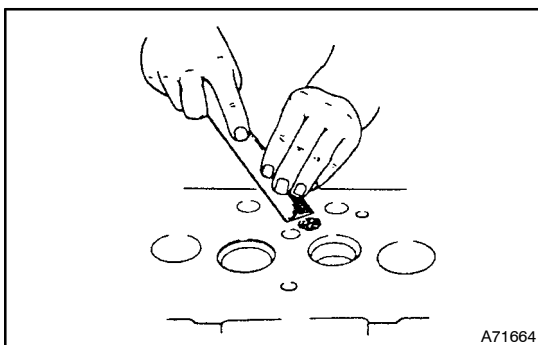
## 8. INSPECT CYLINDER HEAD SUB-ASSY

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

### NOTICE:

**Be careful not to scratch the cylinder block contact surface.**

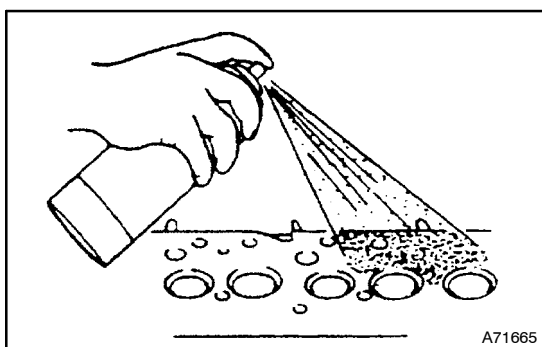
- (b) Using a wire brush, remove all the carbons from the combustion chambers.



**NOTICE:**

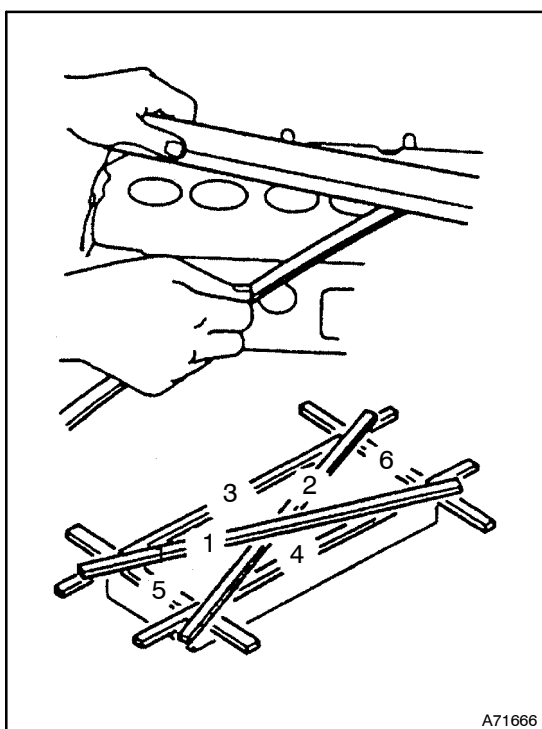
**Be careful not to scratch the cylinder block contact surface.**

- (c) Using a valve guide bushing brush and solvent, clean all the guide bushes.
- (d) Using a soft brush and solvent, thoroughly clean the cylinder head.

**9. INSPECT CYLINDER HEAD SUB-ASSY**

- (a) Inspect for cracks.
  - (1) Using a dye penetrant, check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks.

If any of them have cracks, replace the cylinder head.



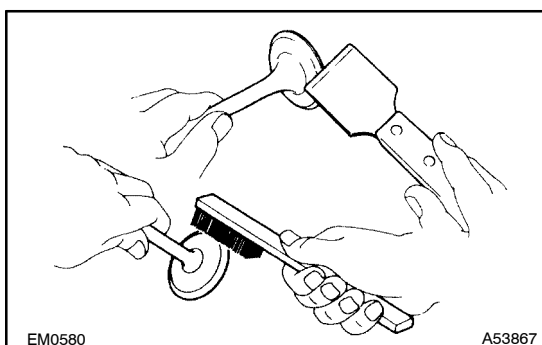
- (b) Inspect the flatness.
  - (1) Using a precision straight edge and feeler gauge, measure the surfaces contacting the cylinder block and the manifolds for warpage.

**Standard warpage:**

Longitudinal direction	0.05 mm (0.0020 in.) or less
Lateral direction	0.05 mm (0.0020 in.) or less

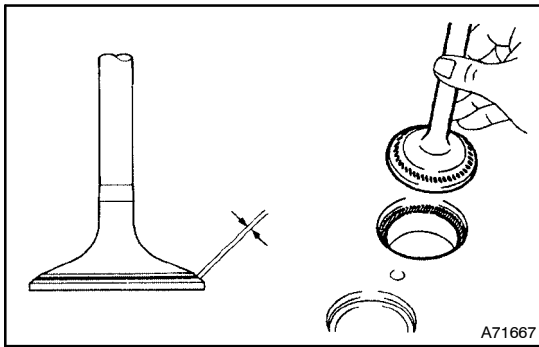
**Maximum warpage: 0.10 mm (0.0039 in.)**

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

**10. CLEAN VALVE**

- (a) Using a gasket scraper, chip off any carbons from the valve head.
- (b) Using a wire brush, thoroughly clean the valve.





## 11. INSPECT VALVE

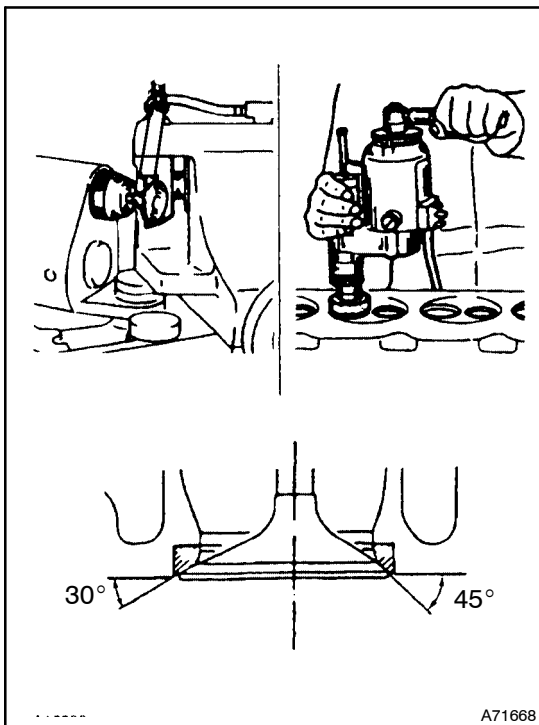
- (a) Visually check the valves for damage, burns, carbons or warpage, and check the valve heads, valve stems and valve stem grooves for cracks.

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

- (b) Check the valve seating condition.

- (1) Lightly apply red lead marking compound to the valve face. Tapping and rotating the valve against the seat, check the seating condition.

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



## 12. 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:**

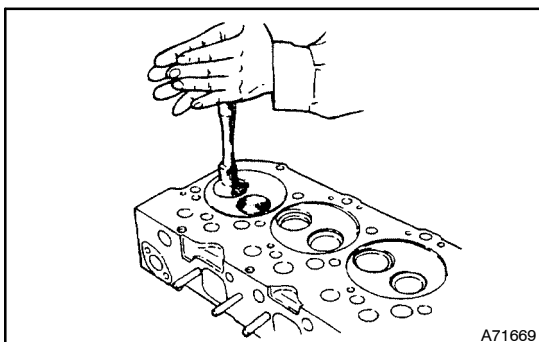
When grinding, a metal tip may fly off on impact. Wear safety glasses to protect your eyes.

**Valve seat angle:**

Intake	29° 00' - 30° 00'
Exhaust	44° 00' - 45° 15'

**Valve face angle:**

Intake	29° 45' - 30° 15'
Exhaust	44° 45' - 45° 15'

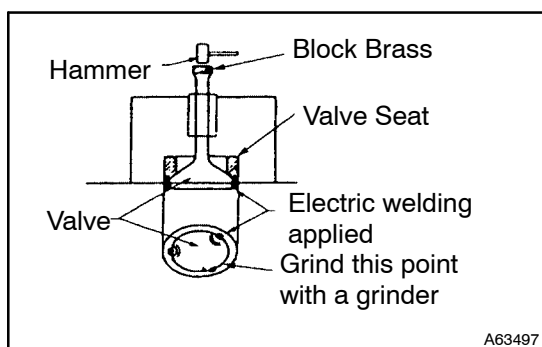


- (b) Hand-lap the valve and valve seat.

- (1) Lightly apply lapping compound to the valve face. 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.

**13. REMOVE VALVE SEAT**

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

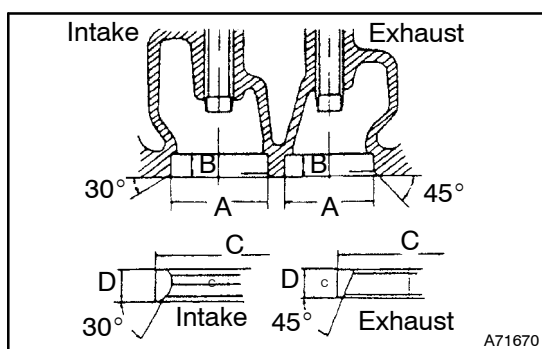
**NOTICE:**

**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.**

**14. INSTALL VALVE SEAT**

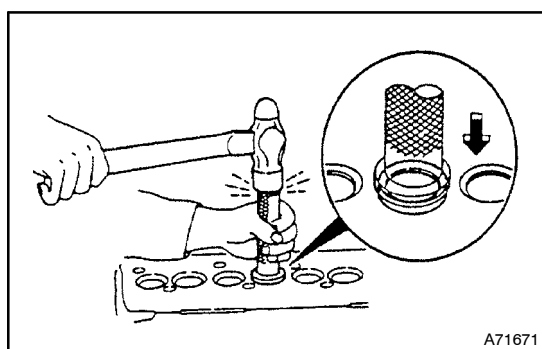
- (a) Machine the valve seat according to the specified valve seat dimensions.

**Cylinder head dimension:**

Intake	A	46.500 – 46.516 mm (1.8307 – 1.8313 in.)
	B	8.800 – 9.000 mm (0.3465 – 0.3543 in.)
Exhaust	A	41.000 – 41.016 mm (1.6142 – 1.6148 in.)
	B	7.200 – 7.300 mm (0.2835 – 0.2874 in.)

**Valve seat dimension:**

Intake	C	46.585 – 46.600 mm (1.8341 – 1.8346 in.)
	D	7.500 – 7.700 mm (0.2953 – 0.3031 in.)
Exhaust	C	41.130 – 41.145 mm (1.6193 – 1.6199 in.)
	D	6.000 – 6.200 mm (0.2362 – 0.2441 in.)



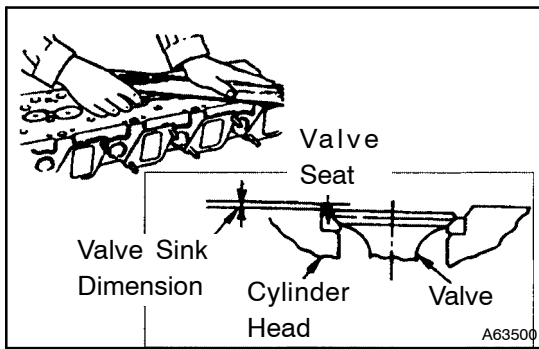
- (b) Heat the cylinder head to 80 – 100°C (176 – 212°F) with hot water. Cool the valve seat with dry ice for approximately 30 minutes.
- (c) Hold the valve seat with pincers and place it into the heated cylinder head. Lightly hitting the valve seat can easily fit them.

**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.**



**15. INSPECT VALVE SINK**

**Standard dimension:**

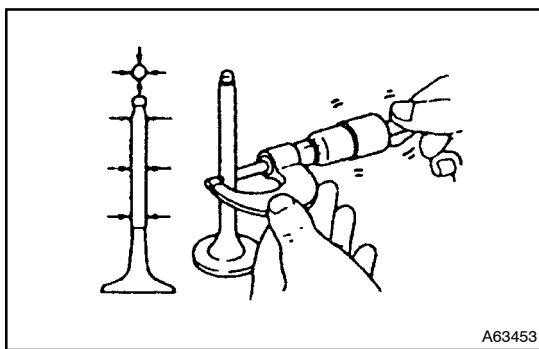
Intake	0.15 – 0.45 mm (0.0059 – 0.0177 in.)
Exhaust	0.47 – 0.77 mm (0.0185 – 0.0303 in.)

**Maximum dimension:**

Intake	0.55 mm (0.0217 in.)
Exhaust	0.87 mm (0.0342 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.



**16. REMOVE VALVE STEM AND VALVE GUIDE**

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

**Standard valve stem diameter:**

Intake	8.95 – 8.97 mm (0.3524 – 0.3531 in.)
Exhaust	8.93 – 8.95 mm (0.3516 – 0.3524 in.)

**Minimum valve stem diameter:**

Intake	8.90 mm (0.3504 in.)
Exhaust	8.80 mm (0.3465 in.)

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

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

(c) Subtract the diameter measurement of the valve stem from the inside diameter measurement of the valve guide.

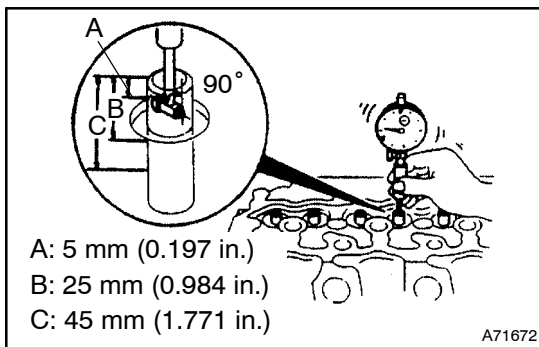
**Standard oil clearance:**

Intake	0.035 – 0.068 mm (0.0014 – 0.0027 in.)
Exhaust	0.050 – 0.083 mm (0.0020 – 0.0033 in.)

**Maximum oil clearance:**

Intake	A & B	0.10 mm (0.0039 in.)
	C	0.18 mm (0.0071 in.)
Exhaust	A & B	0.12 mm (0.0047 in.)
	C	0.20 mm (0.0079 in.)

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



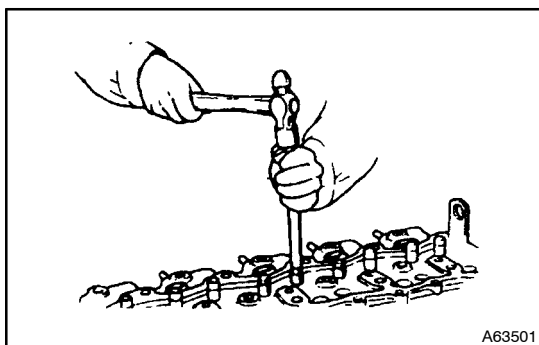
**17. REMOVE VALVE GUIDE**

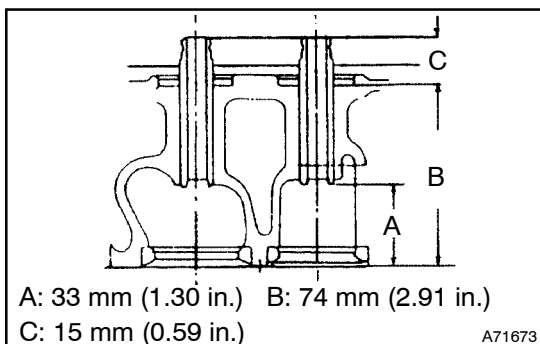
(a) Remove the valve stem seal.

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

**CAUTION:**

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



**18. INSTALL VALVE GUIDE**

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

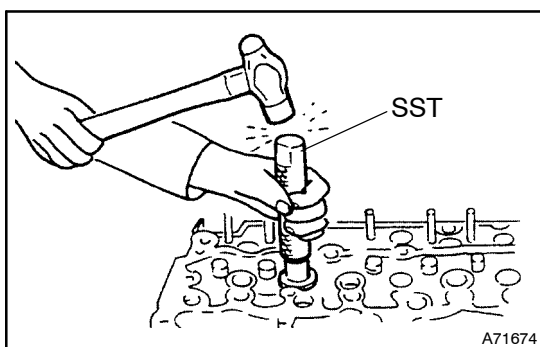
**Protrusion height (C): 15 mm (0.59 in.)**

**HINT:**

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

**19. REMOVE VALVE STEM SEAL**

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

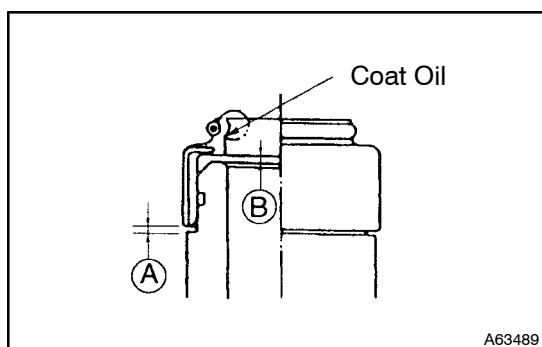
**20. INSTALL VALVE STEM SEAL**

- (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.

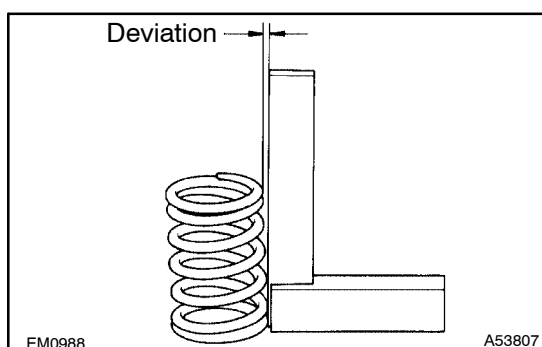
SST 09201-41020

**CAUTION:**

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

**HINT:**

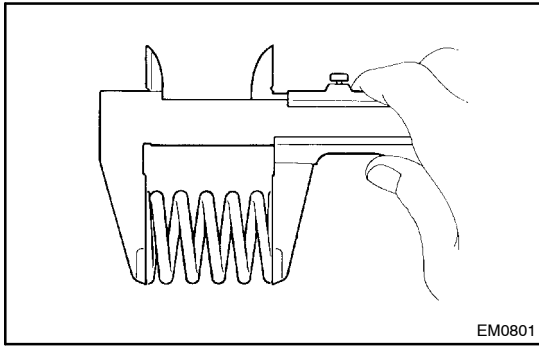
- After installing the valve stem seal, make sure that there are gaps (A) and (B) as shown in the illustration.
- Do not use the SST if its surface contacting the valve spring lower seat is deformed.
- Check that the seal has not been deformed or cracked after the installation.

**21. INSPECT COMPRESSION SPRING**

- (a) Using a steel square, measure the deviation of the spring.

**Maximum deviation: 2.0 mm (0.079 in.)**

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

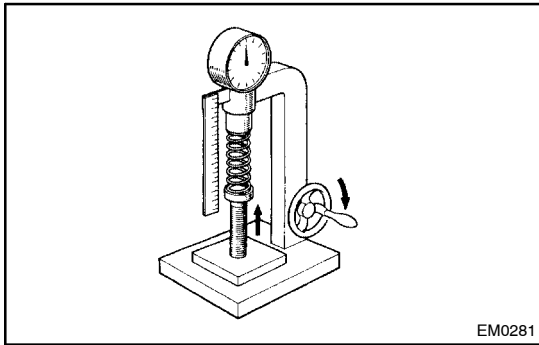


- (b) Using vernier calipers, measure the free length of the spring.

**Free length:**

Inner	61.0 mm (2.402 in.)
Outer	60.2 mm (2.370 in.)

If the free length is not as specified, replace the spring.

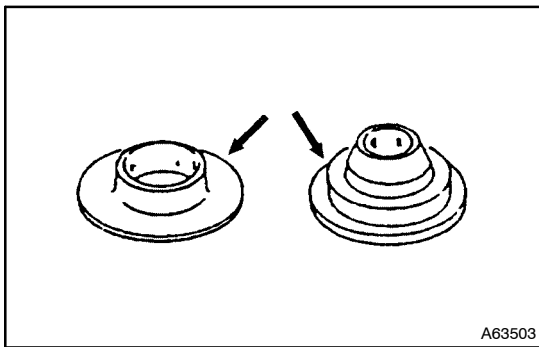


- (c) Using a spring tester, measure the tension of the valve spring at the specified installed length.

**Installed tension:**

Item	Setting Height	Tension
Inner	43.0 mm (1.693 in.)	86.0 N (8.8 kgf, 19.3 lb)
Outer	45.5 mm (1.791 in.)	269.0 N (27.4 kgf, 60.5 lb)

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



## 22. INSPECT VALVE SPRING SEAT

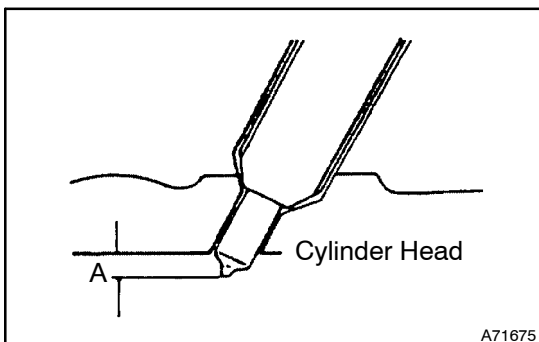
- (a) Visually check the contact surface of the upper and lower valve spring seats.

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

## 23. INSPECT CYLINDER HEAD COOLANT GALLERY FOR LEAKS

- (a) Close all coolant holes, and apply air pressure of about 2.5 kg/cm<sup>2</sup> (36 lb/sq.in.) from one of the coolant holes. Immerse the cylinder head into the water, then check for air leakage.

If any leakage is found, replace the cylinder head.



## 24. INSPECT NOZZLE HOLDER AND NOZZLE SET

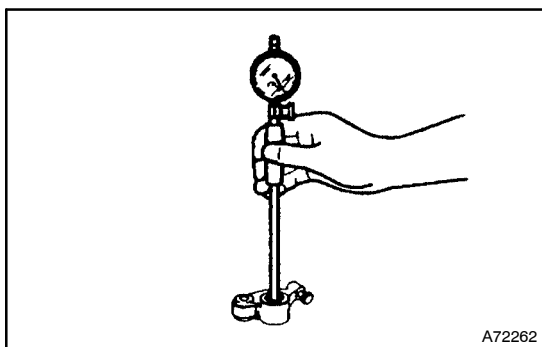
- (a) Install the nozzle to the cylinder head. Using vernier calipers, measure the protrusion of the nozzle from the lower surface of the cylinder head.

**Standard protrusion (A):**

**2.55 – 3.05 mm (0.1004 – 0.1201 in.)**

**Maximum protrusion (A): 3.05 mm (0.1201 in.)**

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



## 25. INSPECT OIL CLEARANCE BETWEEN VALVE ROCKER ARM AND SHAFT

- (a) Using a cylinder gauge, measure the inside diameter of the rocker arm bush.

**Standard bush inside diameter:**

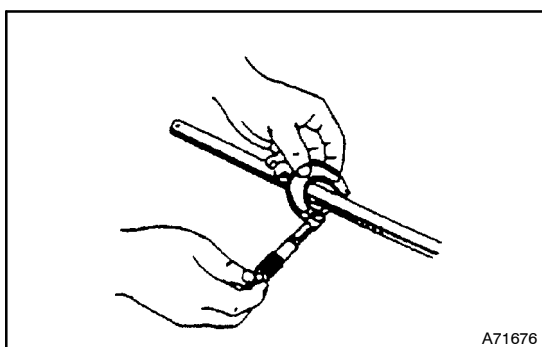
**19.020 – 19.045 mm (0.7488 – 0.7498 in.)**

**Maximum bush inside diameter: 19.06 mm (0.7504 in.)**

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

**HINT:**

When installing a bush into the rocker arm, align the bush with the oil holes of the rocker arm.



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

**Standard shaft diameter:**

**18.966 – 18.984 mm (0.7467 – 0.7474 in.)**

**Minimum shaft diameter: 18.95 mm (0.7461 in.)**

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

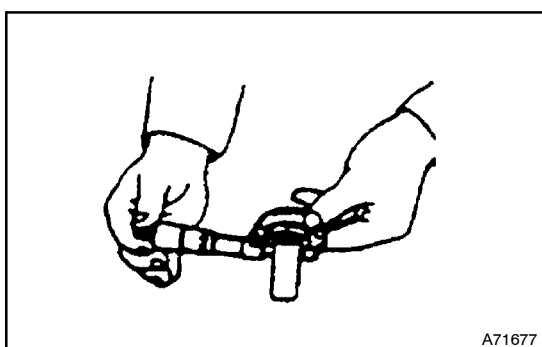
- (c) Subtract the diameter measurement of the rocker arm shaft from the inside diameter measurement of the rocker arm bush.

**Standard oil clearance:**

**0.036 – 0.079 mm (0.0014 – 0.0031 in.)**

**Maximum oil clearance: 0.10 mm (0.0039 in.)**

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

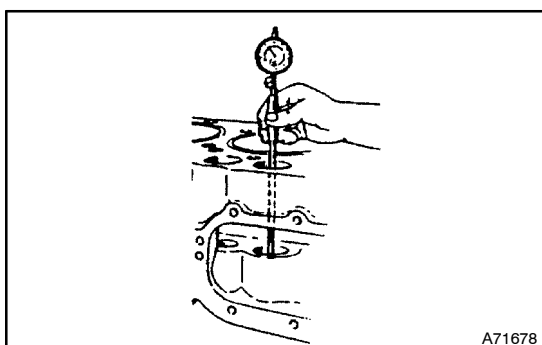


## 26. INSPECT OIL CLEARANCE BETWEEN VALVE LIFTER AND LIFTER BORE

- (a) Using a micrometer, measure the lifter diameter.

**Standard lifter diameter:**

**26.95 – 26.97 mm (1.0610 – 1.0618 in.)**



- (b) Using a cylinder gauge, measure the lifter bore diameter.

**Standard lifter bore diameter:**

**27.00 – 27.02 mm (1.0630 – 1.0638 in.)**

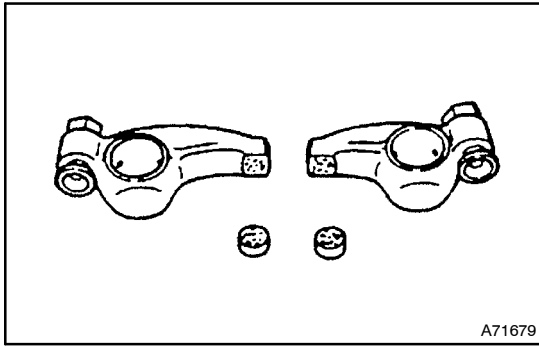
- (c) Subtract the lifter diameter measurement from the lifter bore diameter measurement.

**Standard oil clearance:**

**0.025 – 0.071 mm (0.0010 – 0.0028 in.)**

**Maximum oil clearance: 0.10 mm (0.0039 in.)**

If the oil clearance is greater than the maximum, replace the lifter.

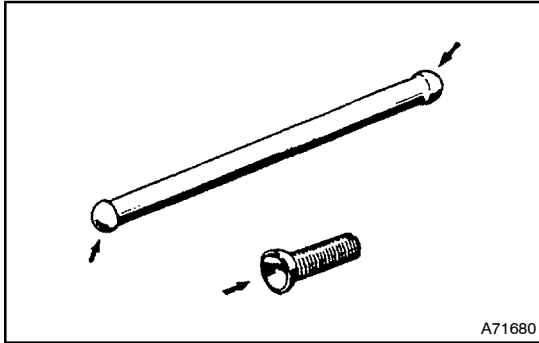


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## 27. INSPECT OTHER VALVE SYSTEM PARTS

- (a) Visually check the contact condition 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 with a resurfacer.

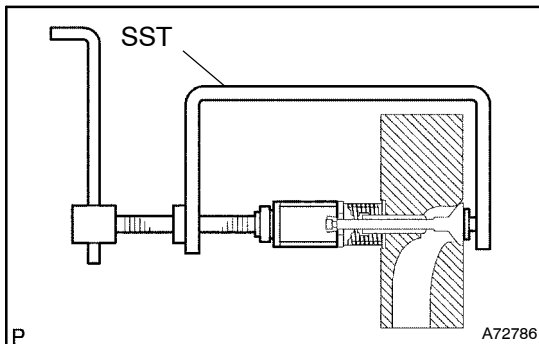


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- (b) Visually check the adjusting screw and push rod.

HINT:

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



A72786

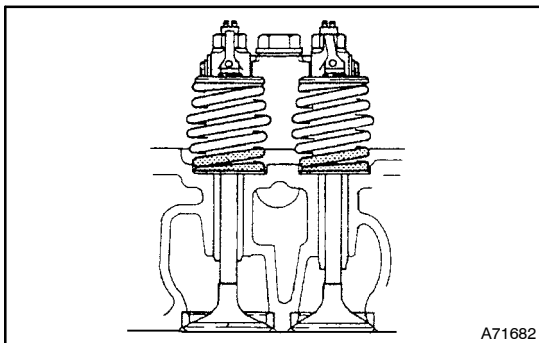
## 28. INSTALL VALVE

HINT:

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

- Install the spring seat and a new oil seal.
- Apply engine oil to the valve stem. Then insert them into the valve guide installed in the cylinder head.
- Install the valve, the inner and outer springs and spring retainer.
- Using SST, press-fit the spring retainer, then securely fit the 2 keepers.

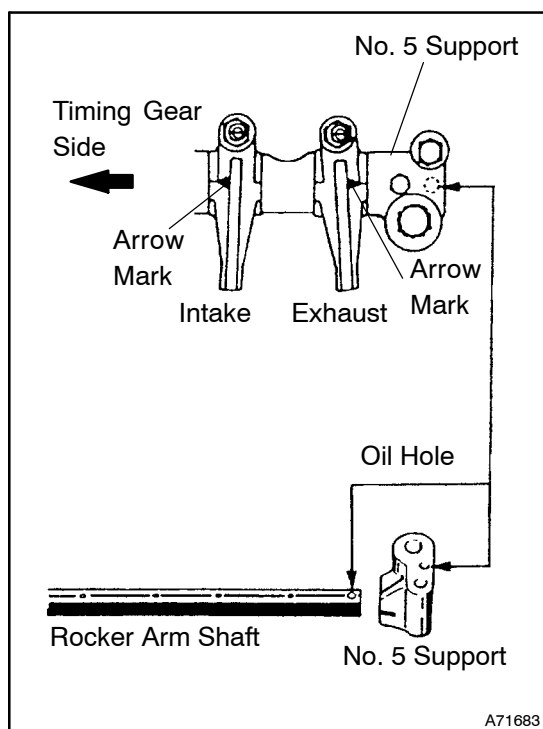
SST 09202-70020 (09202-00030)



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## 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.

**29. INSTALL VALVE ROCKER ARM**

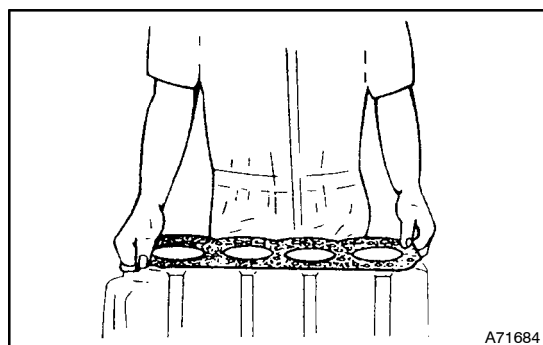
- (a) Lubricate the rocker arm shaft and bush.

**NOTICE:**

**Confirm that oil hole of the rocker arm assy No. 5 support aligns with the shaft oil hole. Improper installation will result in burning of the entire valve assy.**

**30. INSTALL VALVE LIFTER**

- (a) Apply engine oil to the valve lifter face and valve lifter guide.  
 (b) Install the valve lifters in the cylinder block in the correct order.

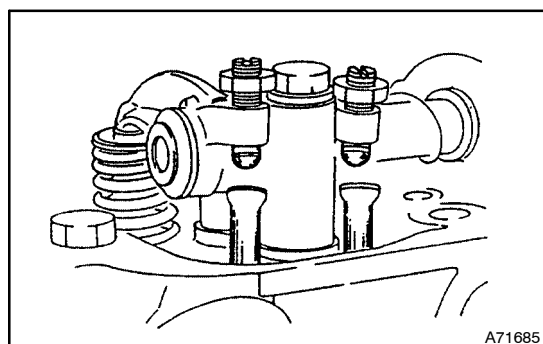
**31. INSTALL CYLINDER HEAD AND VALVE ROCKER ARM ASSY**

- (a) Install a new cylinder head gasket.

**NOTICE:**

**Always use a new cylinder head gasket after cleaning the surface of the cylinder head, cylinder block and head gasket and keep them free of all dirt, water and grease.**

- (b) Install the cylinder head over the dowels on the cylinder block.

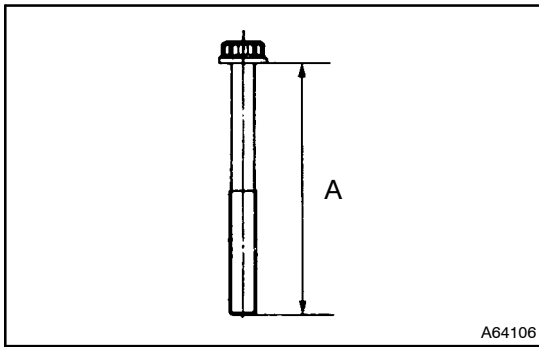


- (c) Insert the push rods in the correct order after applying engine oil to both ends.  
 (d) Mount the rocker arm assy on the cylinder head, and make sure that the push rods interlock with the adjusting screws.

**NOTICE:**

**Always loosen the lock nuts, and raise the adjusting screws fully to the top.**





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**32. INSTALL CYLINDER HEAD BOLT**

(a) Preparation

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

**Maximum bolt length (A):**

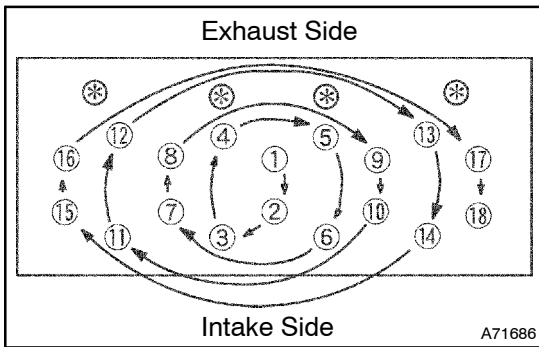
Bolt No.	Length (A)
1 - 13	118 mm (4.65 in.)
14 - 18	165 mm (6.50 in.)

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.



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(b) Tighten the cylinder head bolt.

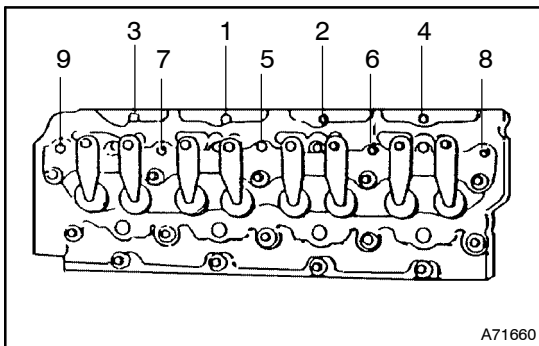
- (1) Tighten M12 bolts No. 1 - No. 18 in the order shown in the illustration.

**Torque: 132 N·m (1,350 kgf·cm, 97 ft·lbf)**

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

**HINT:**

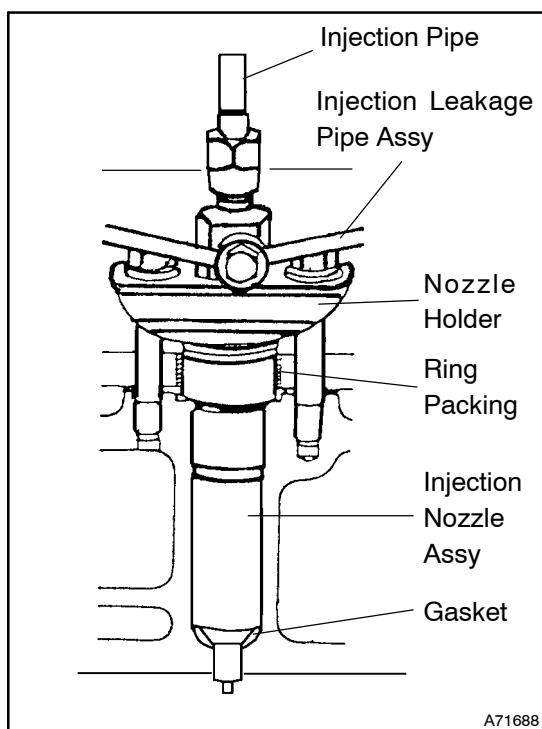
When adding torque, never untighten the nuts even if they have been overtightened.



A71660

- (3) Tighten the cylinder head additional bolts and rocker arm support bolts little in 3 stages and in the numerical order as shown in the illustration.

**Torque: 52 N·m (530 kgf·cm, 38 ft·lbf)**

**33. INSTALL NOZZLE HOLDER AND NOZZLE SET**

- (a) Install a new gasket, ring packing and shim into the groove of the cylinder head, and then insert the injection nozzle assy.

**NOTICE:**

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

- (b) Install the nozzle holder, and install the injection nozzle assy temporarily.

**NOTICE:**

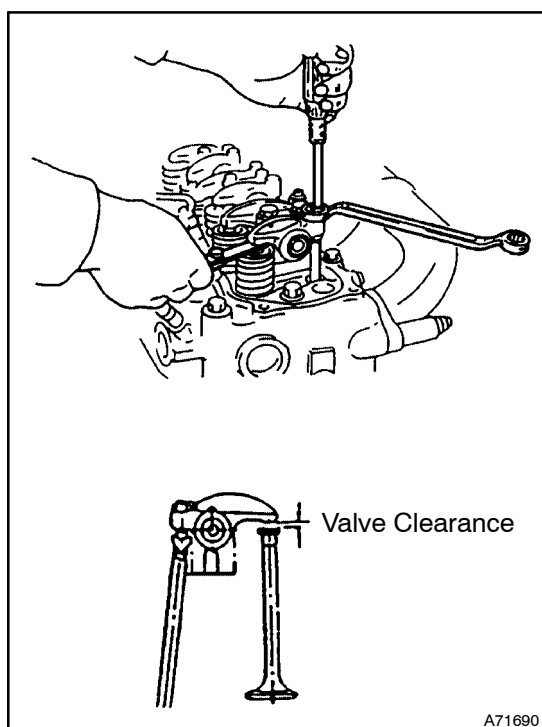
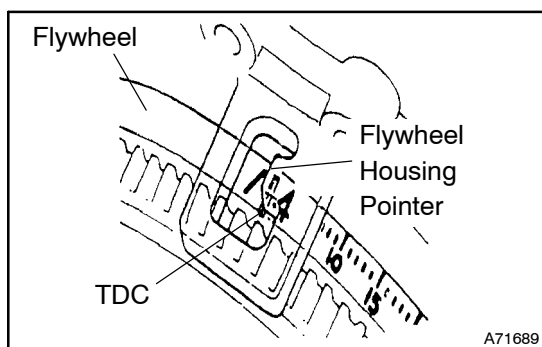
- Do not fix the nozzle holder before the injection pipe is temporarily installed.
- Be careful not to apply excessive force to the injection nozzle when applying the injection pipe oil seal to it. If the injection pipe oil seal and injection nozzle are moved even slightly, it may cause oil leakage or faulty assembling of the injection pipe.

- (c) Assemble the injection pipe temporarily, and tighten the installation bolt of the nozzle holder.

**Torque: 15 N·m (150 kgf·cm, 11 ft·lbf)**

**34. ADJUST VALVE CLEARANCE**

- (a) Set the No. 1 piston to TDC on the compression stroke.



- (b) With the No. 1 piston positioned at TDC on the compression stroke, using a feeler gauge, adjust the No. 1 valve clearance.

**Valve clearance (Cold):**

Intake	0.35 mm (0.014 in.)
Exhaust	0.55 mm (0.022 in.)

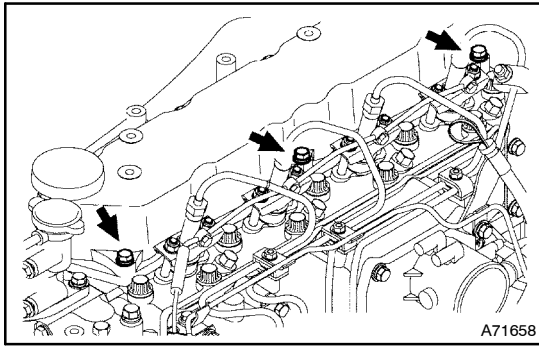
**HINT:**

The feeler gauge should move with a very slight pull.

- (c) Adjust the other valves.
- (1) Turn the crankshaft 180° counterclockwise viewed from the flywheel side.
  - (2) Adjust the valve clearance for each cylinder in the firing order.

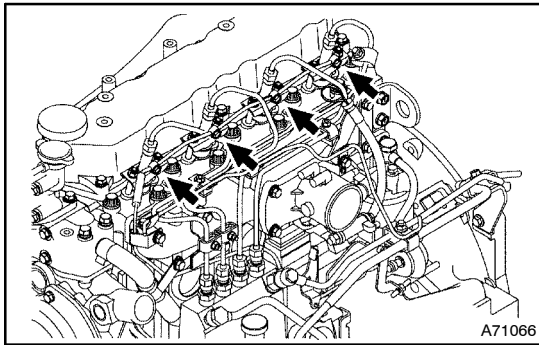
**Firing order: 1 - 3 - 4 - 2**

**(A number of a cylinder is counted from the timing gear side)**

**35. INSTALL CYLINDER HEAD COVER SUB-ASSY**

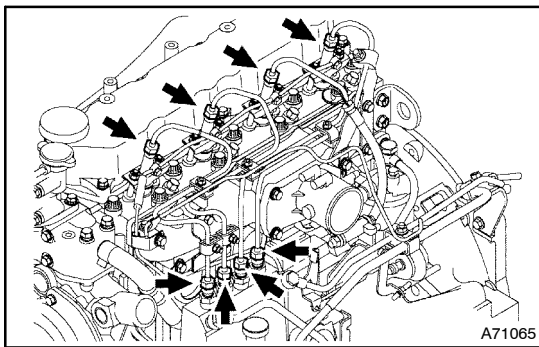
- (a) Tighten the 6 bolts.

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

**36. INSTALL NOZZLE LEAKAGE PIPE ASSY**

- (a) Install 4 new gaskets and the leakage pipe with the 4 joint bolts.

**Torque: 12.3 N·m (125 kgf·cm, 9 ft·lbf)**

**37. INSTALL INJECTION PIPE SET**

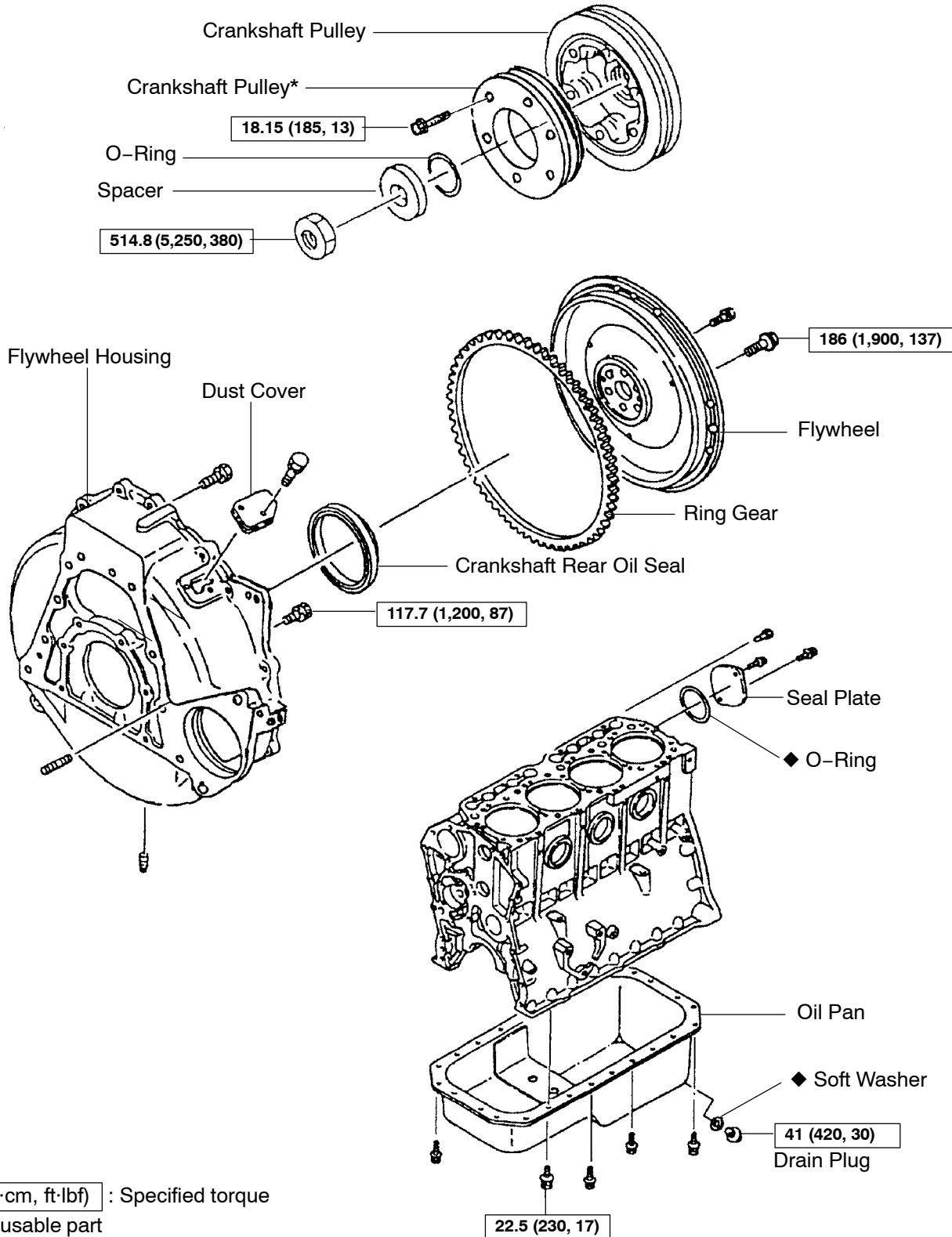
- (a) Install the injection pipe set, and tighten the union nuts.

**Torque: 19.6 N·m (200 kgf·cm, 14 ft·lbf)**

**38. INSTALL INTAKE AIR CONNECTOR**

# CRANKSHAFT PULLEY, OIL PAN AND FLYWHEEL HOUSING COMPONENTS

14149-01



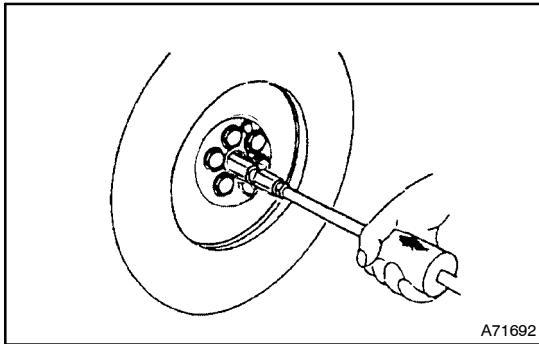
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

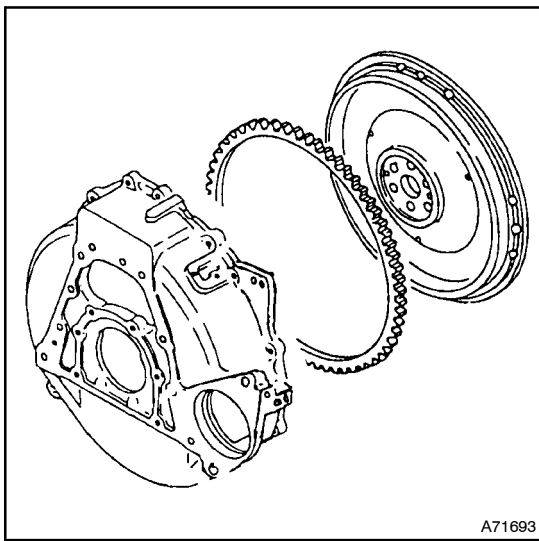
\* If so equipped

## OVERHAUL

1. REMOVE CRANKSHAFT PULLEY
2. REMOVE OIL PAN SUB-ASSY



3. REMOVE PILOT BEARING

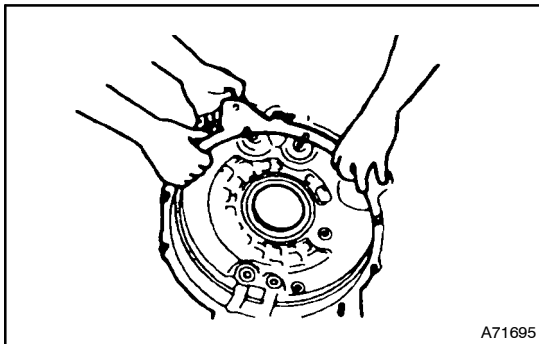


4. REMOVE FLYWHEEL SUB-ASSY

- (a) Remove the flywheel mounting bolts.
- (b) Hold a copper rod through the starter hole against the flywheel, and strike 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.

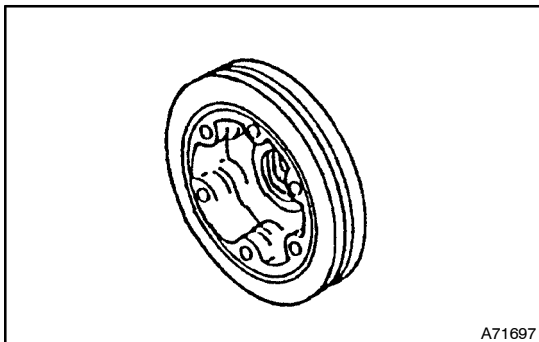


5. REMOVE FLYWHEEL HOUSING

- (a) Remove the rear mounting bolts of the flywheel housing.
- (b) Using a plastic-faced hammer, remove the flywheel housing by striking it lightly.

**CAUTION:**

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

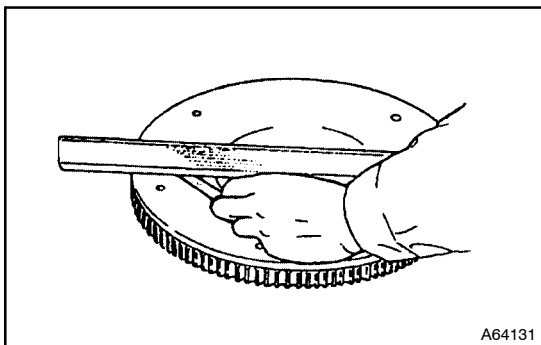


6. INSPECT CRANKSHAFT PULLEY

**HINT:**

- Clean the torsional damper with a commercial cleaning agent before 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



A64131

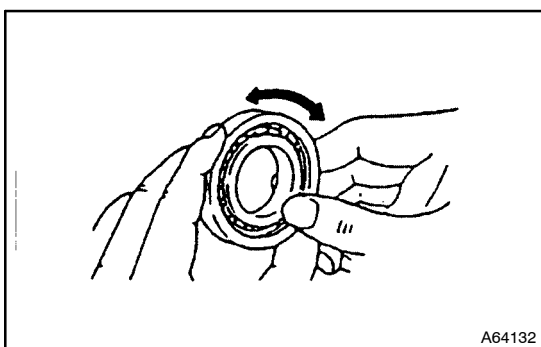
**7. INSPECT FLYWHEEL SUB-ASSY**

- (a) Check the friction surface for damage.
- (b) Check the friction surface for distortion.
  - (1) 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.



A64132

**8. INSPECT PILOT BEARING**

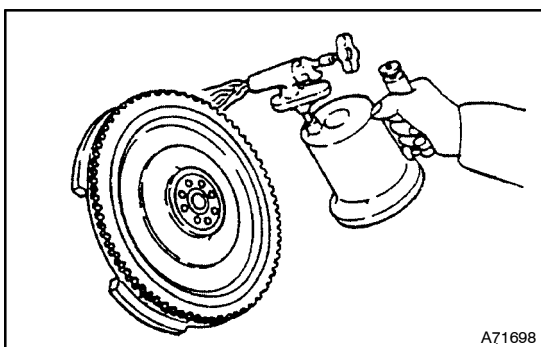
- (a) Rotate the bearing lightly by hand, and check whether there is any abnormal noise or clatter and whether the balls run smoothly.

If there is any fault, replace the pilot bearing.

**9. INSPECT FLYWHEEL RING GEAR**

- (a) Visually check the flywheel ring gear.

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



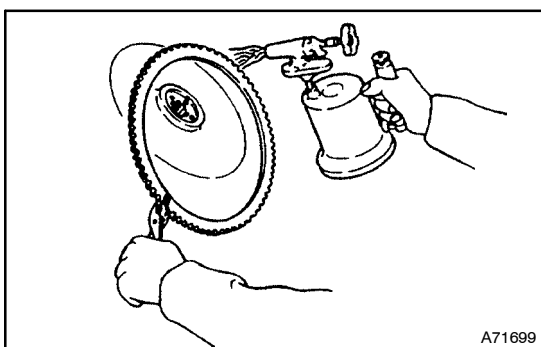
A71698

**10. REMOVE FLYWHEEL RING GEAR**

- (a) Using a torch, heat the ring gear evenly to about 200°C (392°F).
- (b) Using a metal rod as a pad, uniformly strike all around the ring gear in a uniform manner and remove the gear.

**CAUTION:**

**Be careful not to overheat the ring gear.**



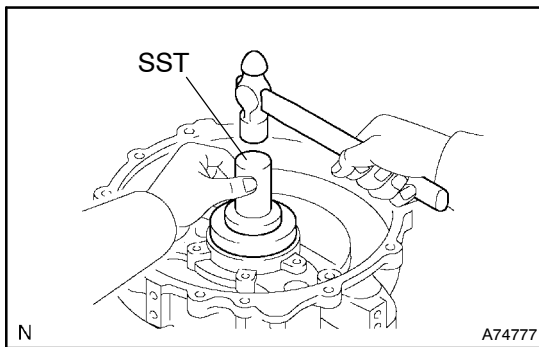
A71699

**11. INSTALL FLYWHEEL RING GEAR**

- (a) Using a torch, heat the ring gear evenly to about 200°C (392°F).
- (b) Using a metal rod, strike the ring gear onto the the fly-wheel with its chamfered gear teeth facing the block.

**NOTICE:**

**Be careful not to overheat the ring gear.**

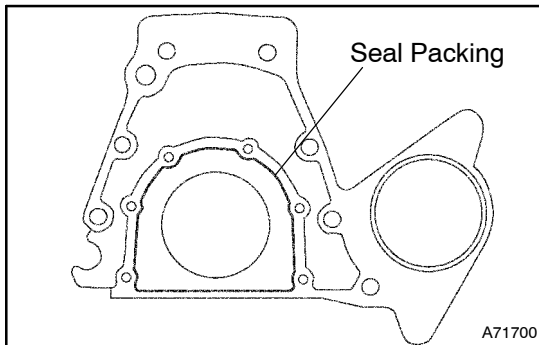
**12. INSTALL ENGINE REAR OIL SEAL**

- (a) Apply a small amount of clean engine oil on the outer periphery of the oil seal.
- (b) Using SST and a hammer, tap in oil seal to the flywheel housing, checking that it is flush with the end of the flywheel housing.

SST 09223-78010

**NOTICE:**

**Make sure that the lip of the oil seal is coated with the oil seal lubricating grease (lithium-based).**

**13. 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.)**

**Torque: 117.7 N·m (1,200 kgf·cm, 87 ft·lbf)**

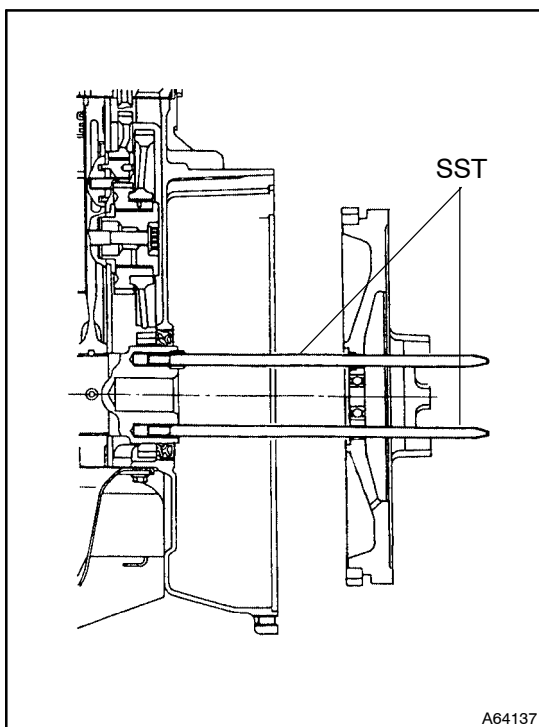
If left more than 20 minutes, clean off the seal packing completely and reapply the seal packing.

**NOTICE:**

**Before installing the flywheel, be sure to tighten the bolt A, apply seal packing to the flywheel housing, and be sure to assemble the stud bolt on the block side.**

**CAUTION:**

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

**14. 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 onto the crankshaft.

SST 09481-1340

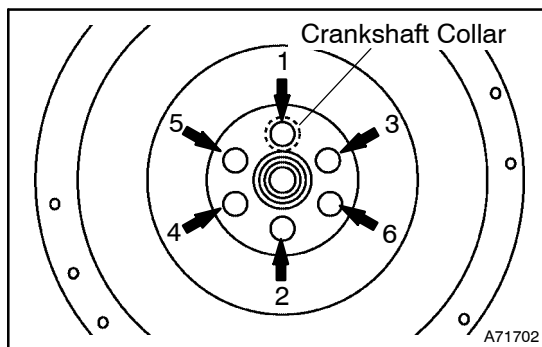
**HINT:**

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.

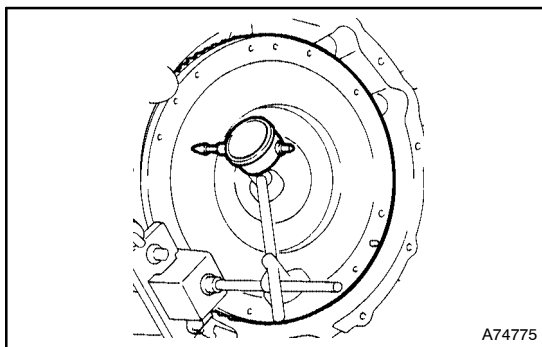
**CAUTION:**

**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 4 flywheel bolts 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.

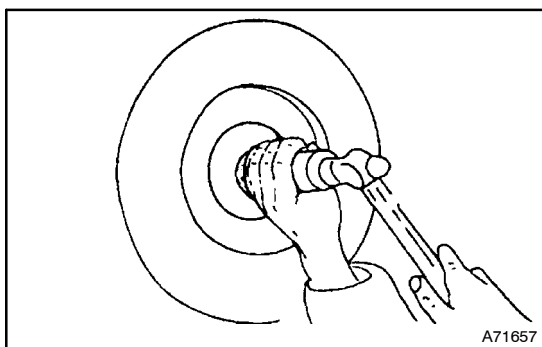
**Torque: 186 N·m (1,900 kgf·cm, 137 ft·lbf)**



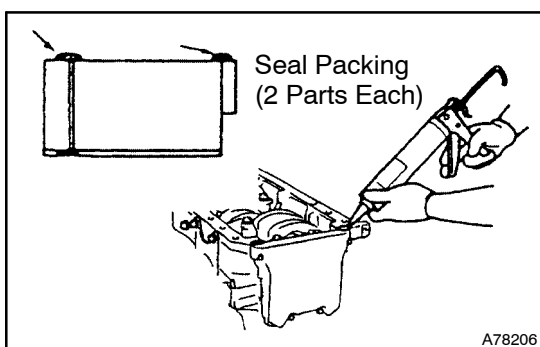
- (g) Measure the sliding surface play of the flywheel.
  - (1) Using a dial gauge, measure the runout of the flywheel.

**Maximum runout: 0.15 mm (0.0059 in.)**

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



## 15. INSTALL PILOT BEARING



## 16. INSTALL OIL PAN SUB-ASSY

- (a) Make sure that there is no deformation, impact marks or foreign particles on the mounting surface and that the surface of the upper oil pan is not stiffened.
- (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.)**

**Torque: 22.5 N·m (230 kgf·cm, 17 ft·lbf)**

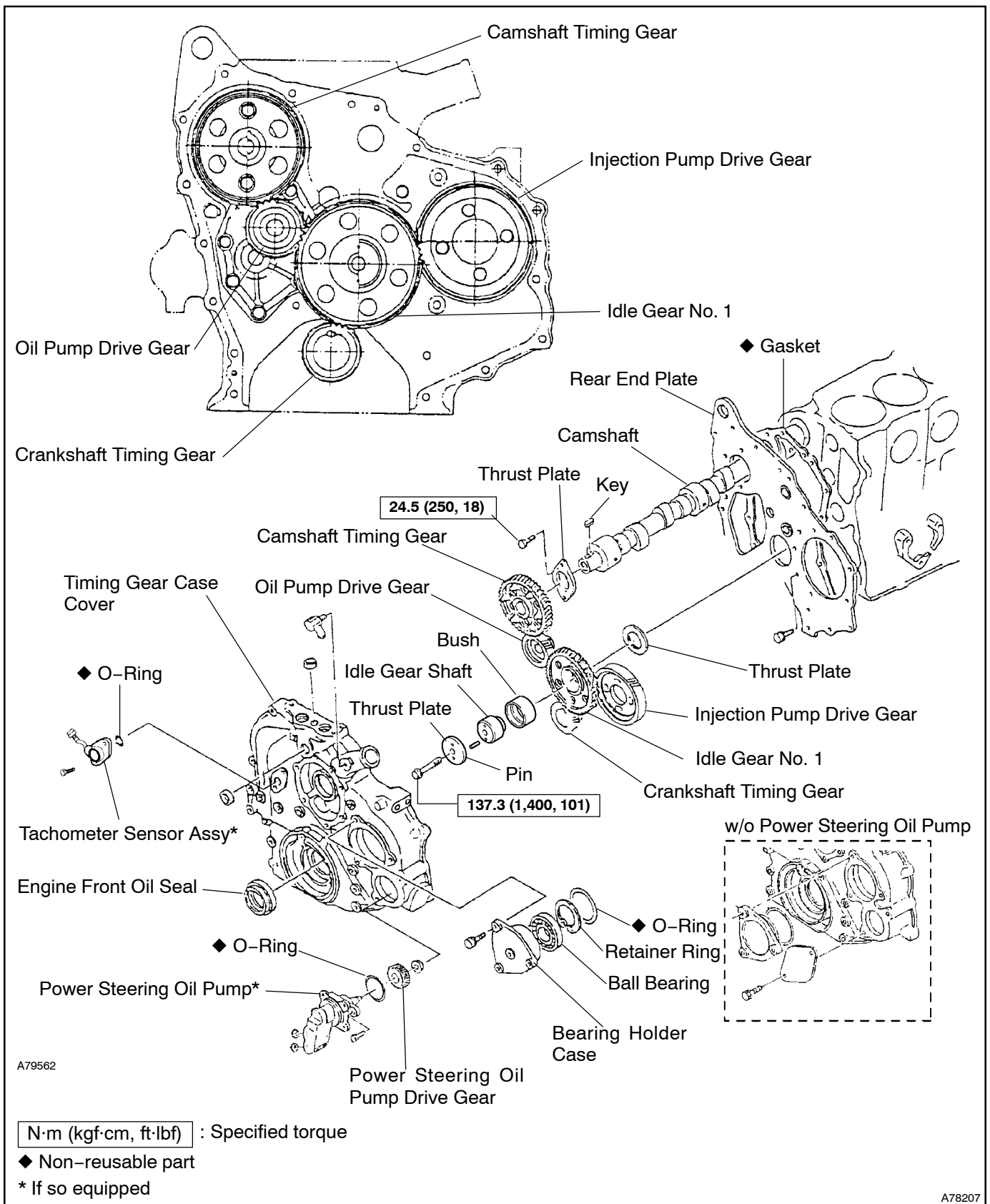
## 17. INSTALL CRANKSHAFT PULLEY

**Torque: 514.8 N·m (5,250 kgf·cm, 380 ft·lbf)**



# TIMING GEAR AND CAMSHAFT COMPONENTS

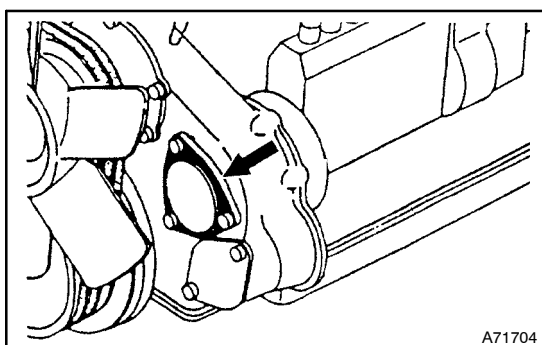
14143-01



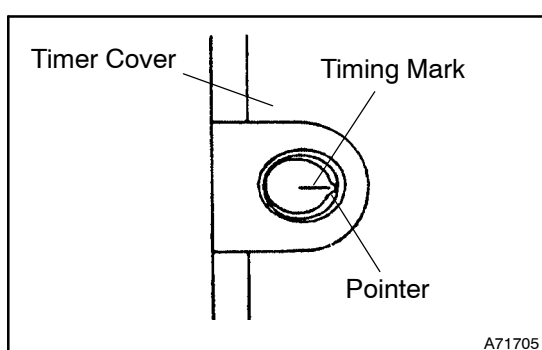
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# OVERHAUL

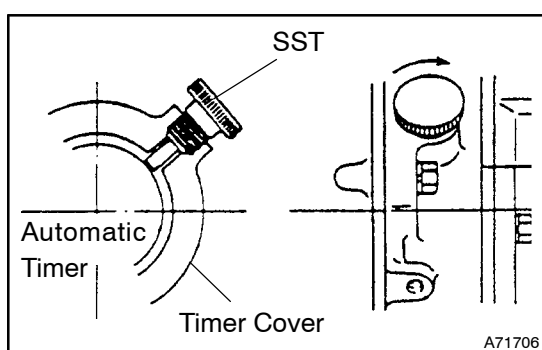


## 1. REMOVE BEARING HOLDER CASE OR SEAL PLATE



## 2. REMOVE INJECTION PUMP ASSY

- (a) Remove the inspection hole dust cover of the timer.
- (b) Turn the crankshaft clockwise viewed from the timing gear cover, in order to align the injection timing mark.



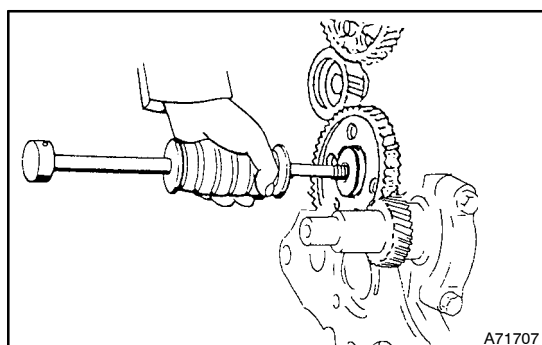
- (c) Using SST, lock the automatic timer.  
SST 09512-2100

### NOTICE:

**Do not loosen the injection pump drive gear fitting bolts.**

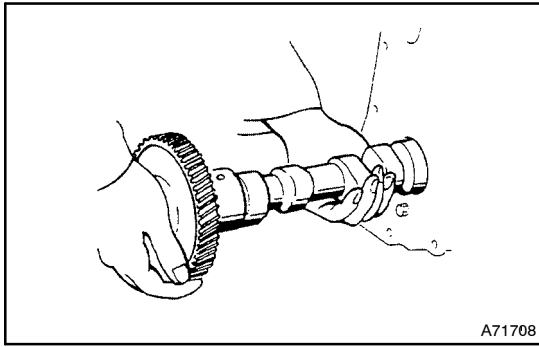
- (d) Remove the injection pump assy together with the timer cover.

3. REMOVE CRANKSHAFT PULLEY
4. REMOVE OIL PAN SUB-ASSY
5. REMOVE OIL STRAINER SUB-ASSY
6. REMOVE OIL PUMP ASSY
7. REMOVE TIMING GEAR COVER



## 8. REMOVE IDLE GEAR SHAFT

- (a) Using a sliding hammer, drive out the idle gear shaft.

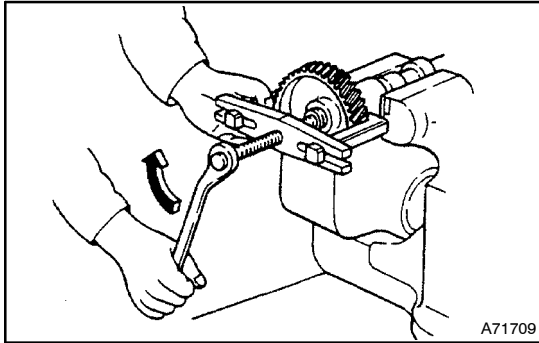


### 9. REMOVE CAMSHAFT AND TIMING GEAR ASSY

- (a) Remove the thrust plate set bolts, and pull out the camshaft together with the gear.

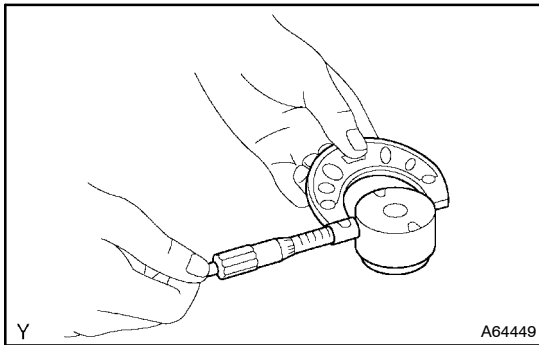
#### NOTICE:

**Pull out the camshaft by slowly turning it, so as not to damage the bearings.**



### 10. REMOVE CAMSHAFT TIMING GEAR

- (a) Mount the camshaft with a vice through wooden plates.  
 (b) Remove the bolt and plate washer.  
 (c) Using a gear puller, remove the gear.

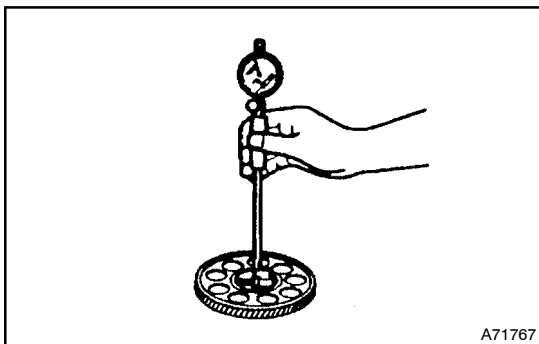


### 11. INSPECT OIL CLEARANCE BETWEEN IDLE GEAR AND SHAFT

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

**Standard shaft diameter:**

**49.950 - 49.975 mm (1.9665 - 1.9675 in.)**



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

**Standard inside diameter:**

**50.000 - 50.025 mm (1.9685 - 1.9695 in.)**

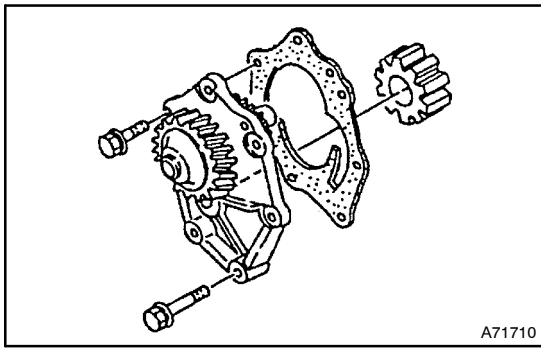
- (c) Subtract the diameter measurement of the idle gear shaft from the inside diameter measurement of the idle gear bush.

**Standard oil clearance:**

**0.025 - 0.075 mm (0.0010 - 0.0030 in.)**

**Maximum oil clearance: 0.10 mm (0.0039 in.)**

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



A71710

**12. INSTALL OIL PUMP ASSY**

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

**HINT:**

If no oil is applied, oil suction failure may be caused at start-up, which results in seizure and abnormality.

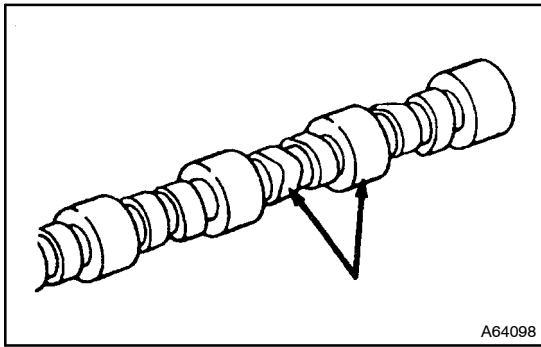
- (b) To prevent misalignment of the gasket, apply engine oil to the gasket matching face of the block. Then, place and fix the gasket.
- (c) Tighten the oil pump mounting bolts provisionally in the order as shown in the illustration. Then retighten them.

**Torque: 22.5 N·m (230 kgf·cm, 17 ft·lbf)**

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

**HINT:**

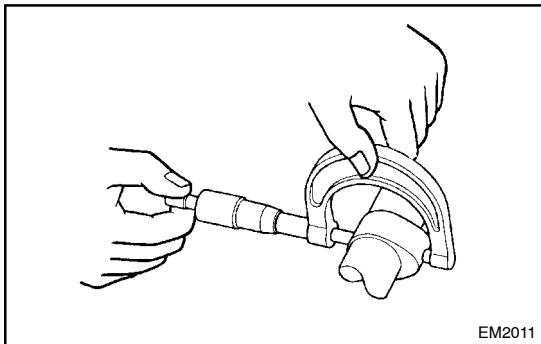
Be sure to observe the tightening order of the bolts, otherwise the oil pump will be damaged.



A64098

**13. 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	49.435 mm (1.9463 in.)
Exhaust	49.493 mm (1.9485 in.)

**Minimum cam lobe height:**

Intake	48.90 mm (1.9252 in.)
Exhaust	48.95 mm (1.9272 in.)

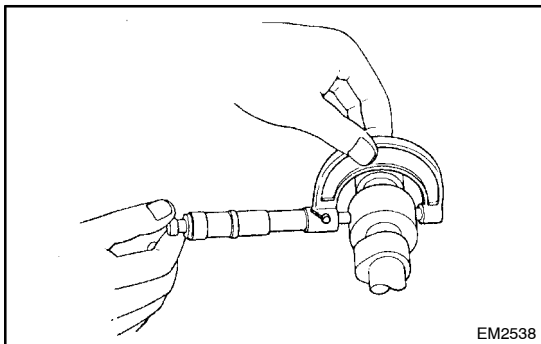
If the lobe height is less than the minimum, replace the camshaft.

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

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

**Standard journal diameter:**

No. 1	56.95 - 56.97 mm (2.2421 - 2.2429 in.)
No. 2	56.75 - 56.77 mm (2.2342 - 2.2350 in.)
No. 3	56.55 - 56.57 mm (2.2264 - 2.2272 in.)

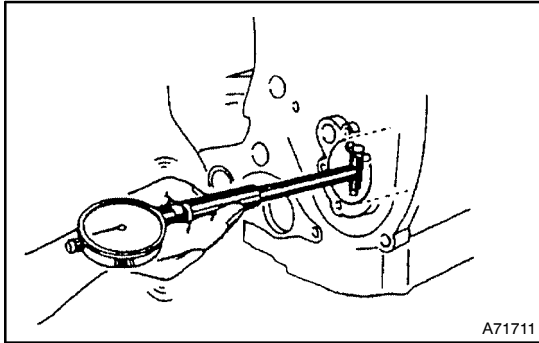


EM2538

**Minimum journal diameter:**

No. 1	56.85 mm (2.2382 in.)
No. 2	56.65 mm (2.2303 in.)
No. 3	56.45 mm (2.2224 in.)

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



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

**Standard inside diameter:**

No. 1	57.00 – 57.07 mm (2.2441 – 2.2468 in.)
No. 2	56.80 – 56.87 mm (2.2362 – 2.2390 in.)
No. 3	56.60 – 56.67 mm (2.2283 – 2.2311 in.)

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

- (d) Subtract the journal diameter measurement of the camshaft from the inside diameter measurement of the camshaft bearing.

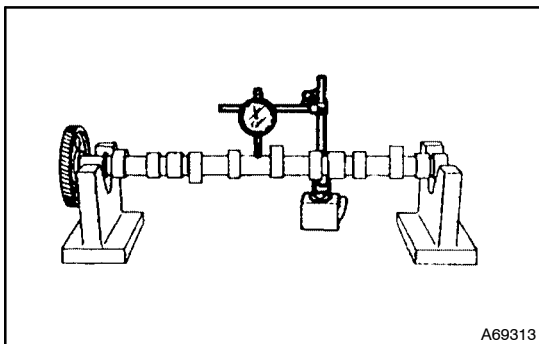
- (1) Calculate the oil clearance from the above measurement.

**Standard oil clearance:**

**0.030 – 0.120 mm (0.0012 – 0.0047 in.)**

**Maximum oil clearance: 0.15 mm (0.0059 in.)**

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

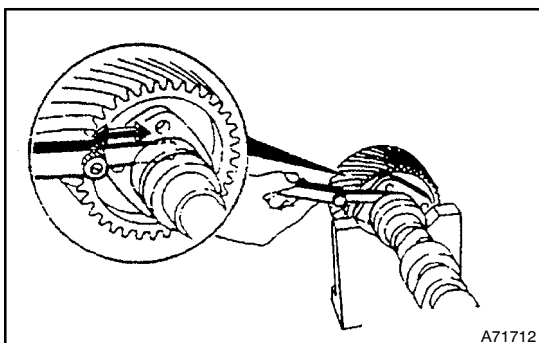


- (e) Inspect the camshaft for bend.

- (1) Place the camshaft on V-blocks.  
 (2) Using a dial gauge, measure the bend at the center journal.

**Maximum bend: 0.05 mm (0.0020 in.)**

If the bend is greater than the maximum, replace the camshaft.



- (f) Inspect the camshaft thrust clearance.

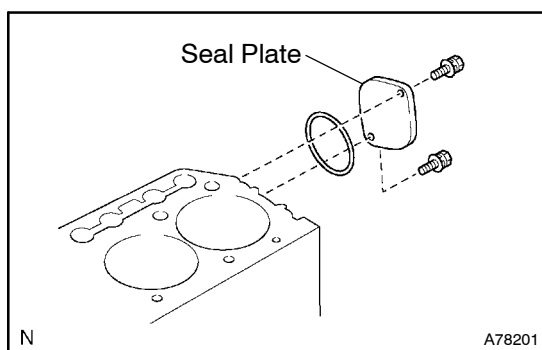
- (1) Using a feeler gauge, measure the clearance between the camshaft and thrust plate.

**Standard thrust clearance:**

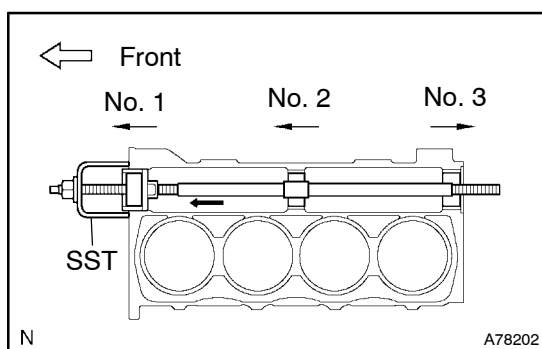
**0.10 – 0.18 mm (0.0039 – 0.0071 in.)**

**Maximum thrust clearance: 0.30 mm (0.0118 in.)**

If the thrust clearance is greater than the maximum, replace the thrust bearing and/or gear.

**14. REPLACE CAMSHAFT BEARING**

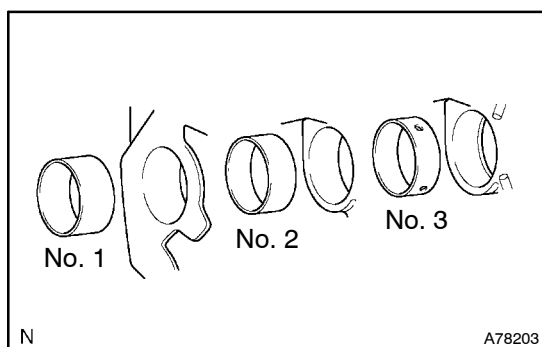
- (a) Remove the 2 bolts, seal plate and O-ring.



- (b) Using SST, remove the bearings.  
SST 09215-00013 (09215-00461)

**HINT:**

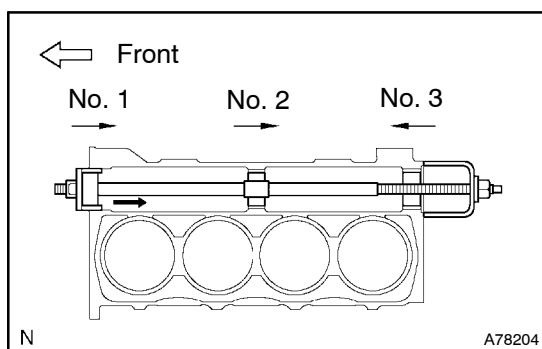
- Pull out the No. 1 bearing toward the front.
- Pull out the No. 2 bearing toward the front.
- Pull out the No. 3 bearing toward the rear.



- (c) Using SST, install new bearings.

- (1) No. 3 bearing only:

Align the oil holes of the bearing with the oil holes of the cylinder block.

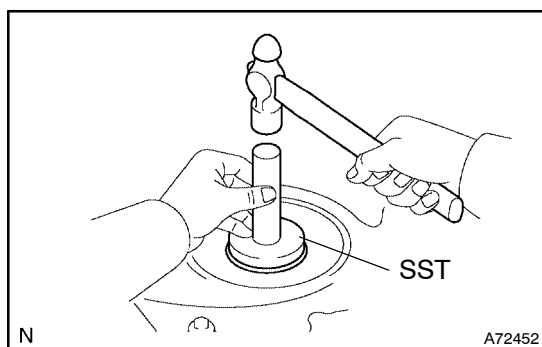


- (2) Using SST, install the bearings.

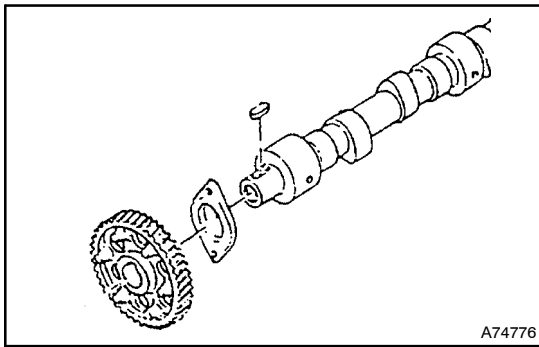
SST 09215-00013 (09215-00461)

**HINT:**

- Push in the No. 3 bearing from the rear.
  - Push in the No. 2 bearing from the front.
  - Push in the No. 1 bearing from the front.
- (d) Recheck the camshaft oil clearance (See step 13 (c)).
- (e) Install a new O-ring and the seal plate with the 2 bolts.

**15. REPLACE ENGINE FRONT OIL SEAL**

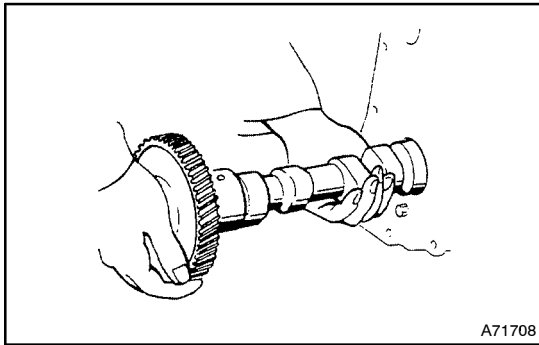
- (a) Using a screwdriver, pry out the oil seal.
- (b) Using SST and a hammer, tap in a new oil seal.  
SST 09950-60020 (09951-00750), 09950-70010 (09951-07100)

**16. INSTALL CAMSHAFT TIMING GEAR**

(a) Install the thrust plate and timing gear to the camshaft.

**HINT:**

Heat the gear in hot water (approx. 200°C (392°F)), then using a press, install the gear to the camshaft.

**17. INSTALL CAMSHAFT AND TIMING GEAR ASSY**

(a) Lubricate all the journals of the camshaft.

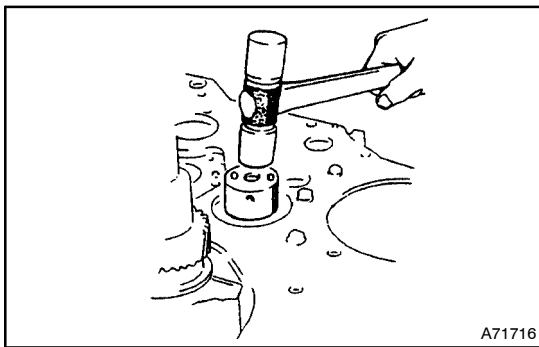
(b) Insert the camshaft into the cylinder block.

**NOTICE:**

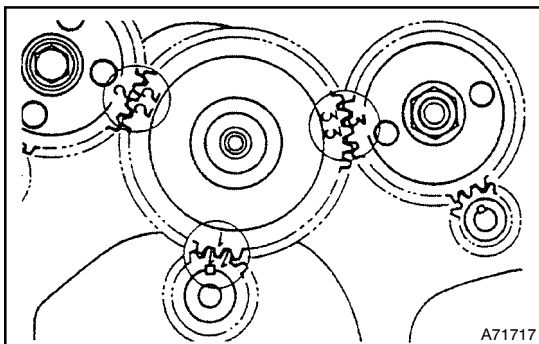
**Insert the camshaft while slowly turning it, so that the bearing will not be damaged.**

(c) Tighten the 2 bolts of the thrust plate.

**Torque: 24.5 N·m (250 kgf·cm, 18 ft·lbf)**

**18. INSTALL IDLE GEAR NO.1**

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



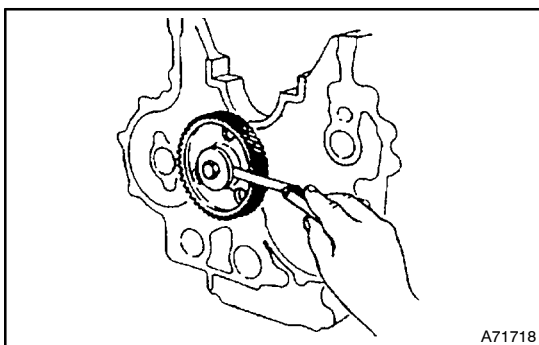
(b) Install the idle gear.

**HINT:**

- Apply engine oil to the contact surface of the idle gear and idle gear shaft before the installation.
- Be sure that the timing marks of the crankshaft timing gear, camshaft timing gear, injection pump drive gear and idle gear are aligned correctly.

(c) Tighten the mounting bolts of the idle gear shaft.

**Torque: 137.3 N·m (1,400 kgf·cm, 101 ft·lbf)**

**19. INSPECT IDLE GEAR NO. 1 THRUST CLEARANCE**

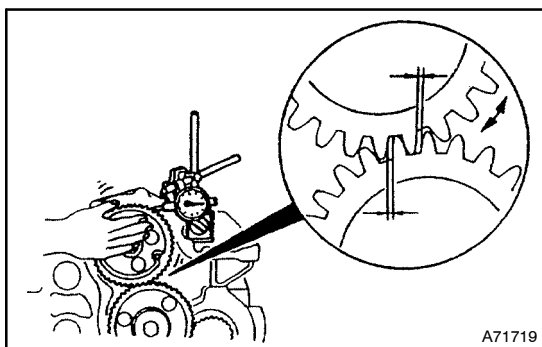
(a) Using a feeler gauge, measure the clearance between the idle gear and thrust bearing.

**Standard thrust clearance:**

**0.040 - 0.100 mm (0.0016 - 0.0039 in.)**

**Maximum thrust clearance: 0.15 mm (0.0059 in.)**

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



## 20. INSPECT TIMING GEAR BACKLASH

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

### Standard backlash:

Crankshaft timing gear x Idle gear	0.068 - 0.194 mm (0.0027 - 0.0076 in.)
Idle gear x Injection pump drive gear	0.065 - 0.232 mm (0.0026 - 0.0091 in.)
Idle gear x Oil pump drive gear	0.065 - 0.182 mm (0.0026 - 0.0072 in.)
Camshaft timing gear x Oil pump drive gear	

### Maximum backlash: 0.30 mm (0.0118 in.)

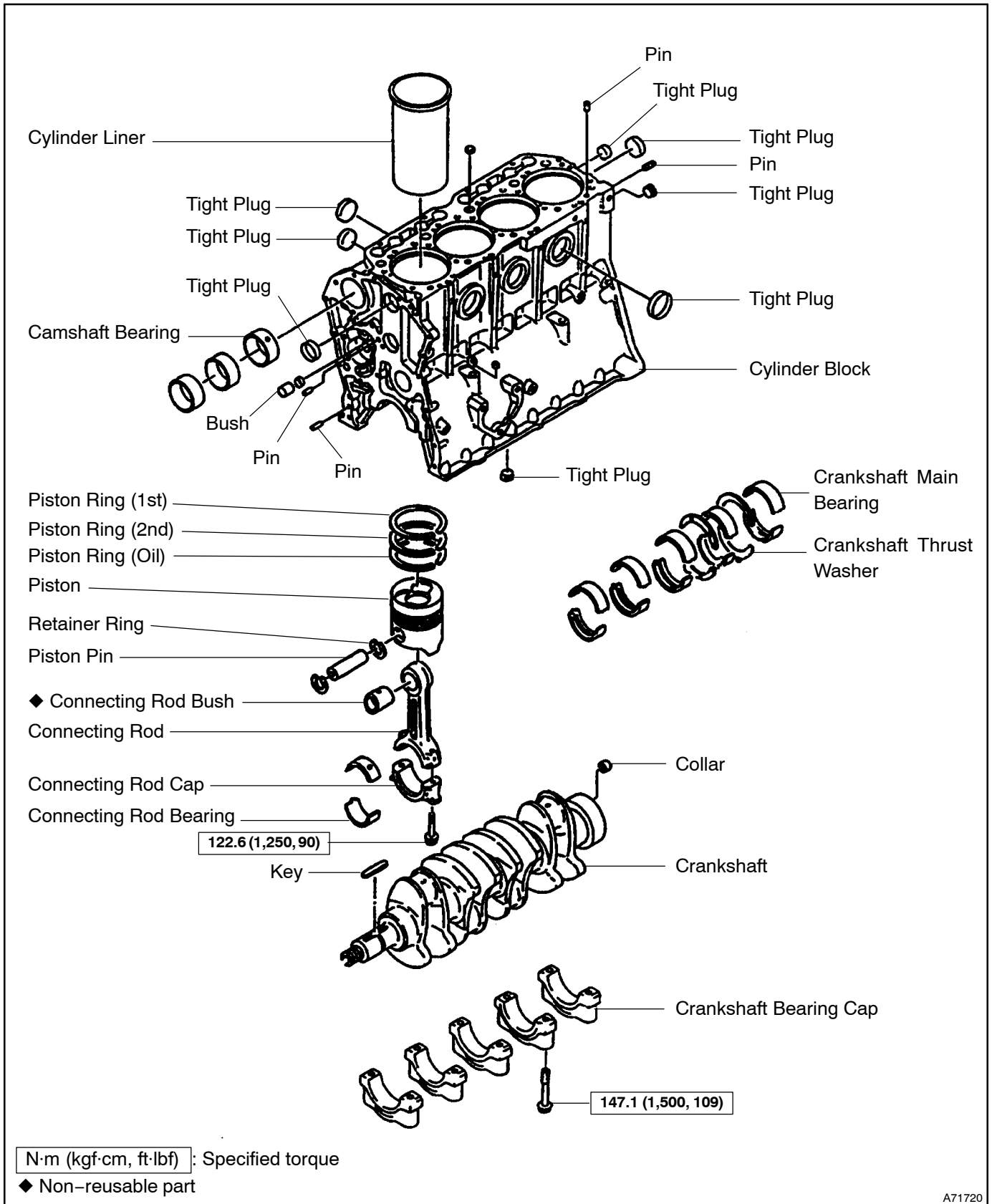
If the backlash is greater than the maximum, replace the gear.

21. INSTALL TIMING GEAR COVER
22. INSTALL OIL PUMP ASSY
23. INSTALL OIL STRAINER SUB-ASSY
24. INSTALL OIL PAN SUB-ASSY
25. INSTALL CRANKSHAFT PULLEY
26. INSTALL INJECTION PUMP ASSY
27. INSTALL BEARING HOLDER CASE OR SEAL PLATE

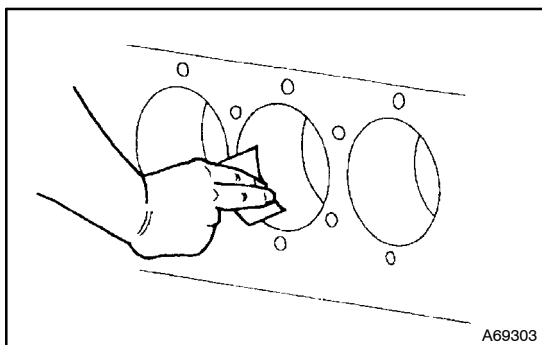


# PISTON, CRANKSHAFT AND CYLINDER BLOCK COMPONENTS

14145-01



# OVERHAUL

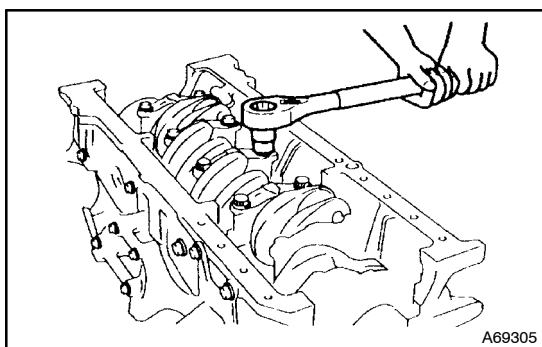


## 1. REMOVE PISTON AND CONNECTING ROD

- (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.

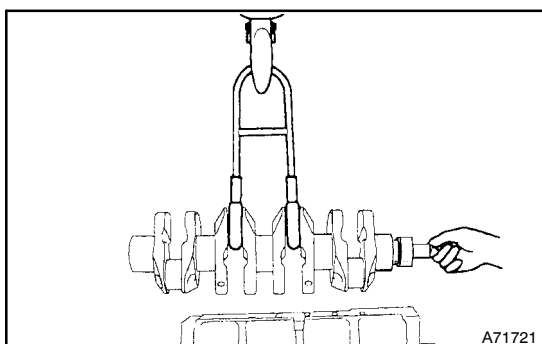
### HINT:

- 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 not to drop the connecting rod bearings from the connecting rod big ends, which may cause deformation or damage.
- Arrange the removed parts in 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).

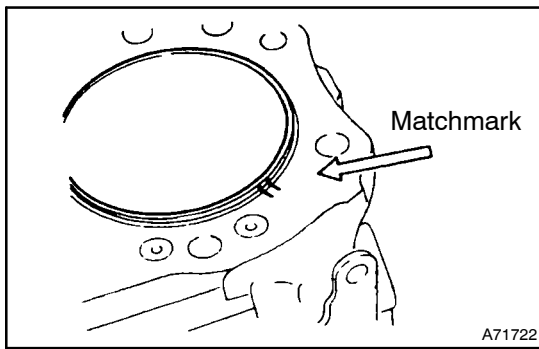


## 2. REMOVE CRANKSHAFT

- (a) Remove the bearing cap mounting bolts.



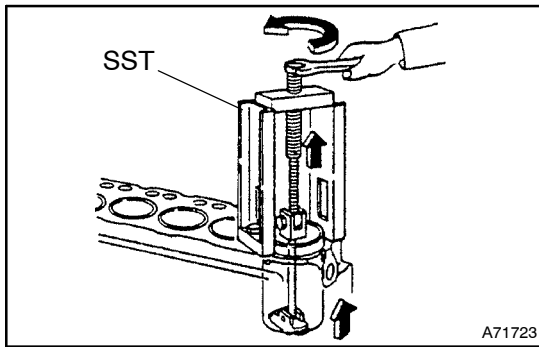
- (b) Remove the crankshaft.



### 3. REMOVE CYLINDER LINER

#### HINT:

Before removing the piston, put matchmarks 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 break.



- (a) Remove the cylinder liner can be pulled out by hand. If this is difficult, use the SST.

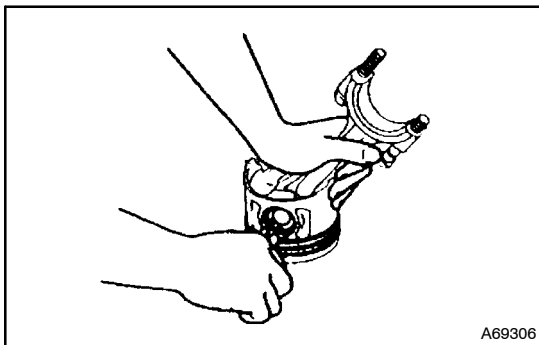
SST 09420-1460

#### HINT:

Arrange the removed parts in the order of the cylinder numbers.

### 4. CLEAN CYLINDER BLOCK

- (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-immerses 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.



### 5. REMOVE CONNECTING ROD SUB-ASSY

- (a) Using snap ring pliers, remove the retainer rings from 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.**

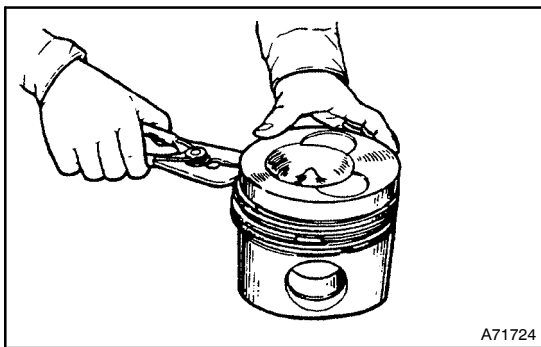
- (b) Using a hammer, apply the reinforcing plate to the piston pin and punch out the piston pin.

#### 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.**



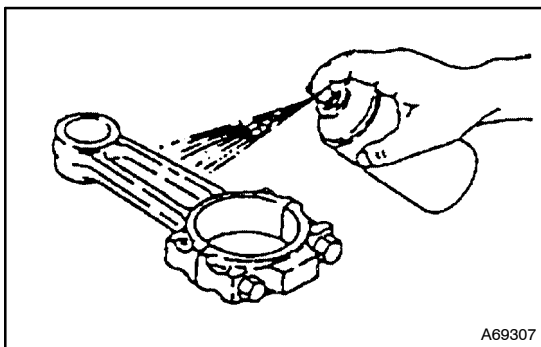
A71724

**6. REMOVE PISTON RING SET**

(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.

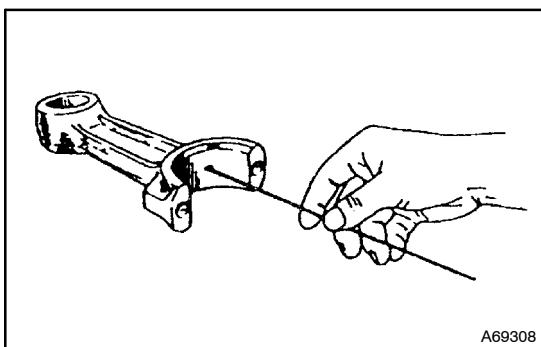


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**7. INSPECT CONNECTING ROD SUB-ASSY**

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

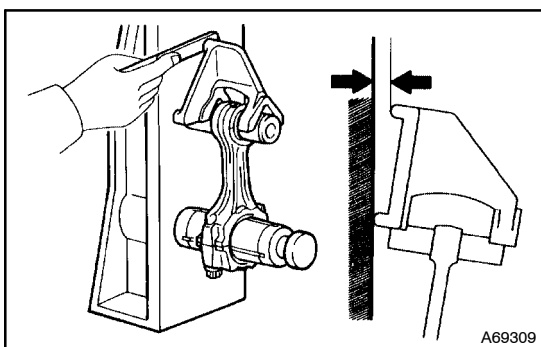
If there are any cracks or damage, replace the connecting rod with a new one.



A69308

(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.



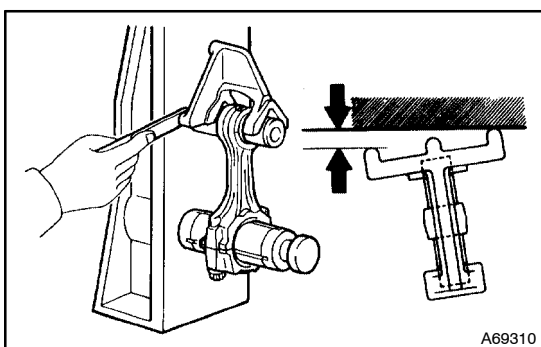
A69309

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

(1) Check for bend.

**Maximum bend:****0.10 mm (0.0039 in.) per 200 mm (7.87 in.)**

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

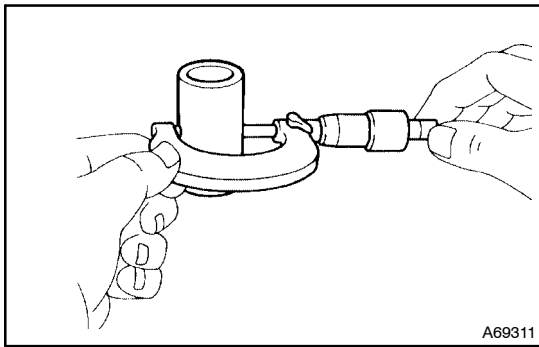


A69310

(2) Check for twist.

**Maximum twist:****0.10 mm (0.0039 in.) per 200 mm (7.87 in.)**

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

**8. INSPECT PISTON PIN**

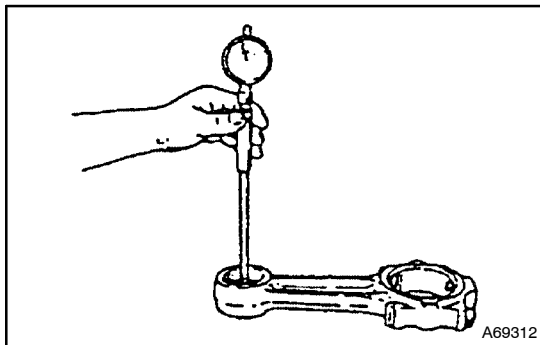
- (a) Using a micrometer, measure the piston pin diameter.

**Standard piston pin diameter:****36.989 – 37.000 mm (1.4563 – 1.4567 in.)****Minimum piston 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.

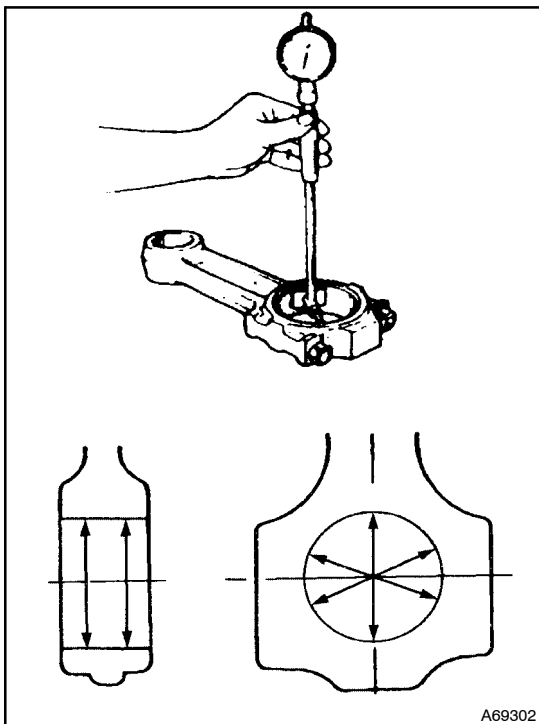
**Standard bush inside diameter:****37.035 – 37.045 mm (1.4581 – 1.4585 in.)****Maximum bush inside diameter: 37.10 mm (1.4606 in.)**

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

- (b) Subtract the diameter measurement of the piston pin from the inside diameter measurement of the connecting rod bush.

**Standard oil clearance:****0.035 – 0.056 mm (0.0014 – 0.0022 in.)****Maximum oil clearance: 0.08 mm (0.0031 in.)**

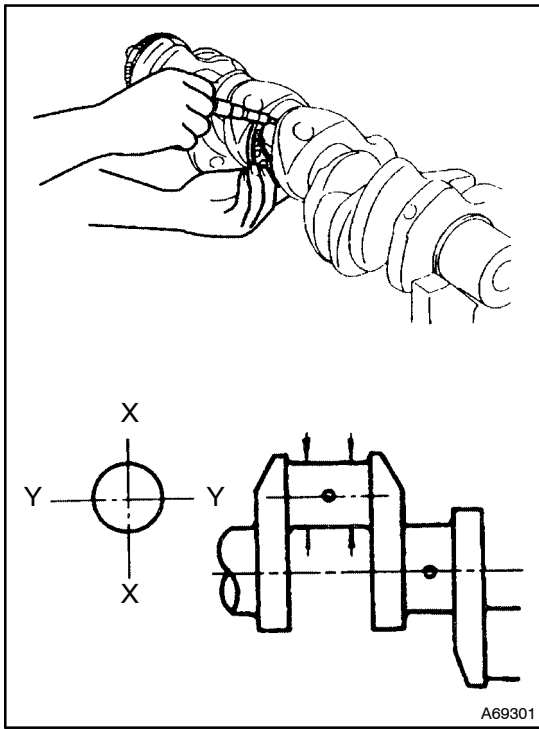
If the oil clearance is greater than the maximum, replace the piston with a new one.

**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 big end inside diameter (w/o Bearing):****65.985 – 66.000 mm (2.5978 – 2.5984 in.)****Maximum big end inside diameter (w/o Bearing):****66.06 mm (2.6008 in.)****HINT:**

For tightening of the connecting rod cap, see step 29.



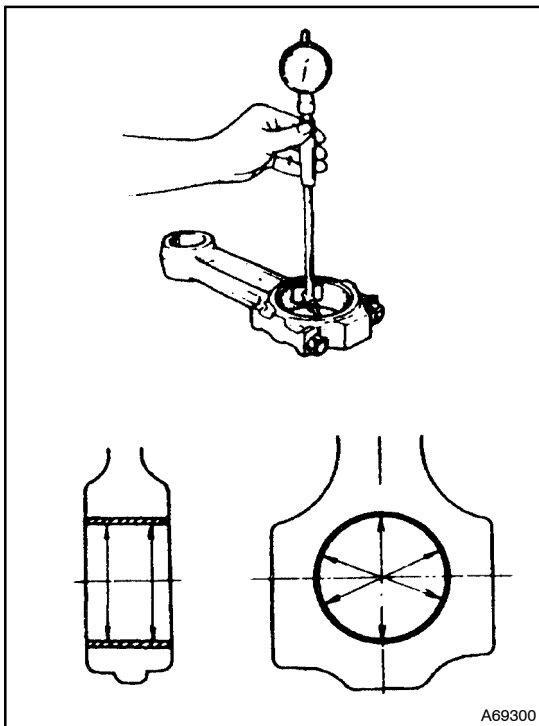
**11. INSPECT CRANKSHAFT PIN AND BEARING**

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

**Standard pin diameter:**

**61.940 – 61.960 mm (2.4386 – 2.4394 in.)**

**Minimum pin diameter: 60.76 mm (2.3921 in.)**



- (b) Using a cylinder gauge, measure the connecting rod big end inside diameter.

**Standard big end inside diameter (w/ Bearing):**

**61.985 – 62.000 mm (2.4403 – 2.4409 in.)**

**Maximum big end inside diameter (w/ Bearing):**

**62.06 mm (2.4433 in.)**

- (c) Subtract the diameter measurement of the crankshaft pin from the inside diameter measurement of the connecting rod big end.

**Standard clearance:**

**0.031 – 0.082 mm (0.0012 – 0.0032 in.)**

**Maximum clearance: 0.12 mm (0.0047 in.)**

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

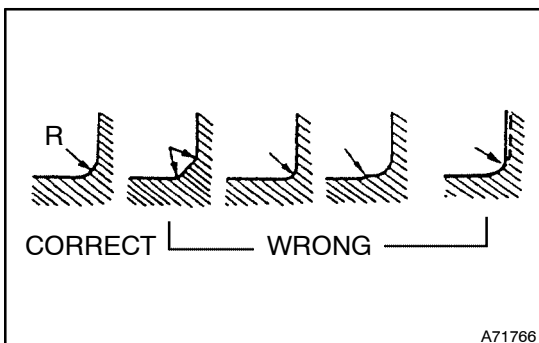
Undersize machining dimension: 4 sizes below

0.25 mm (0.0098 in.)

0.50 mm (0.0197 in.)

0.75 mm (0.0295 in.)

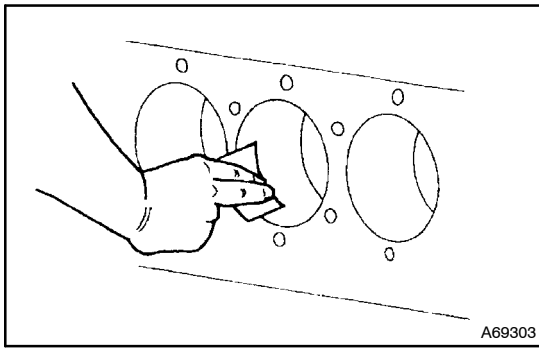
1.00 mm (0.0394 in.)



**HINT:**

Machined dimension of fillet R

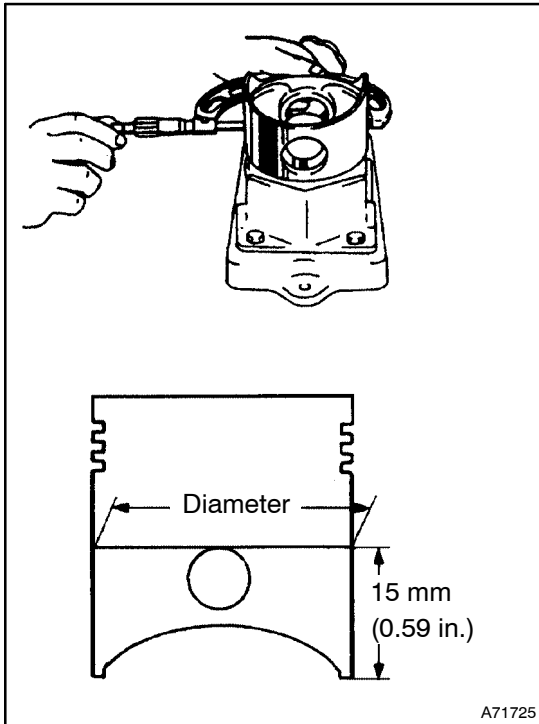
**Crankshaft pin: 3.50 – 4.00 mm (0.1378 – 0.1575 in.)**



## 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.

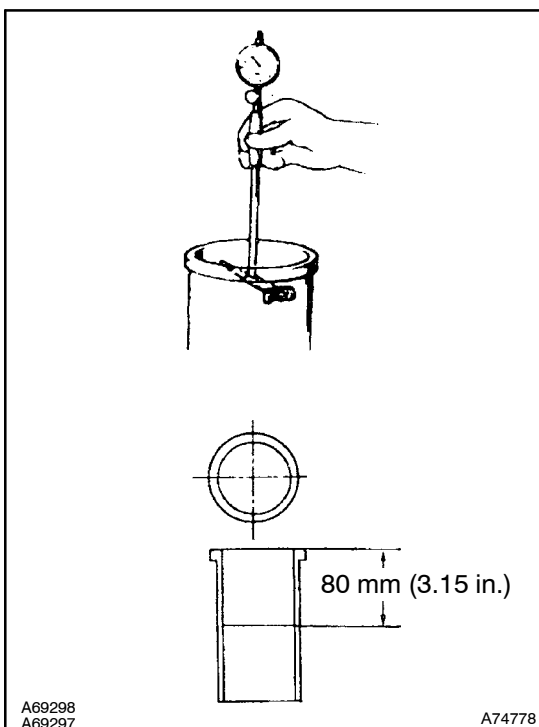


- (a) Using a micrometer, measure the piston diameter at the points in the illustration.

**Standard piston diameter: 103.908 mm (4.0909 in.)**

**Minimum piston diameter: 103.902 mm (4.0906 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:**

**104.003 – 104.018 mm (4.0946 – 4.0952 in.)**

**Maximum inside diameter: 104.15 mm (4.1004 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 worn or if only the piston ring must be replaced, correct the corrugation at the top of the cylinder liner.

- (c) Subtract the piston diameter measurement from the cylinder liner inside diameter measurement.

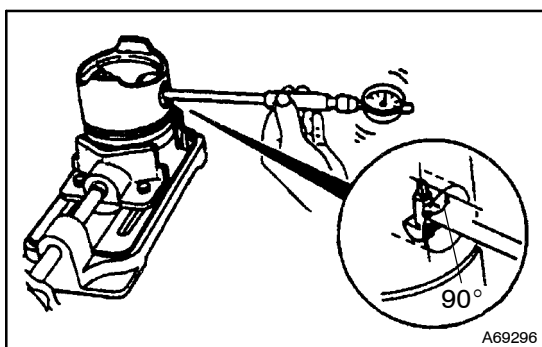
**Standard oil clearance:**

**0.0140 – 0.0172 mm (0.0055 – 0.0068 in.)**

If the clearance is greater than the standard, 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 (1.4562 – 1.4568 in.)**

**Maximum piston pin boss inside diameter:**

**37.05 mm (1.4587 in.)**

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

- (b) Subtract the diameter measurement of the piston pin from the inside diameter measurement of the piston pin boss.

**Standard oil clearance:**

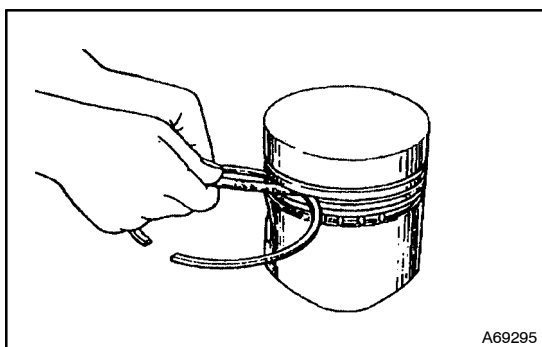
**0.013 (T) – 0.014 (L) mm (0.00051 (T) – 0.00055 (L) in.)**

**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.

**Standard groove clearance:**

1st	0.09 – 0.13 mm (0.0035 – 0.0051 in.)
2nd	0.07 – 0.11 mm (0.0028 – 0.0043 in.)
Oil	0.02 – 0.06 mm (0.0008 – 0.0024 in.)

**Maximum groove clearance: 0.30 mm (0.0118 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.

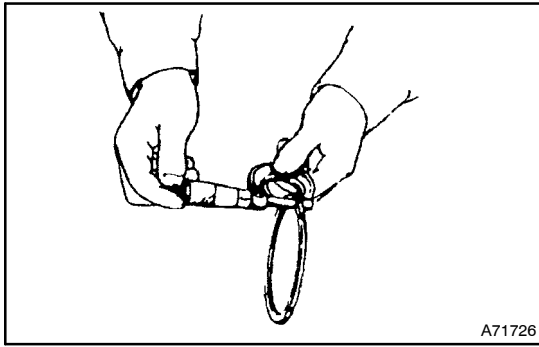
**Standard groove width:**

1st	2.58 – 2.60 mm (0.1016 – 0.1024 in.)
2nd	2.06 – 2.08 mm (0.0811 – 0.0819 in.)
Oil	4.01 – 4.03 mm (0.1579 – 0.1587 in.)

**Maximum groove width:**

1st	3.10 mm (0.1220 in.)
2nd	2.20 mm (0.0866 in.)
Oil	4.08 mm (0.1606 in.)





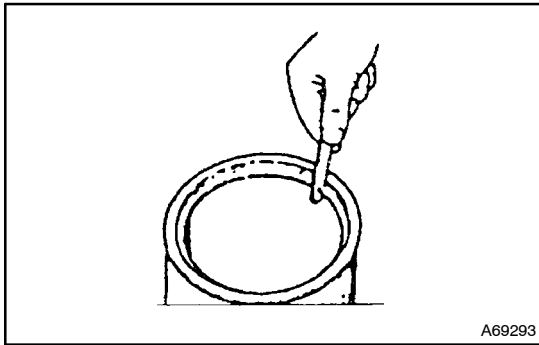
A71726

**Standard ring thickness:**

1st	2.47 – 2.49 mm (0.0972 – 0.0980 in.)
2nd	1.97 – 1.99 mm (0.0776 – 0.0783 in.)
Oil	4.97 – 4.99 mm (0.1957 – 0.1965 in.)

**Maximum groove width:**

1st	2.32 mm (0.0913 in.)
2nd	1.82 mm (0.0717 in.)
Oil	4.95 mm (0.1949 in.)



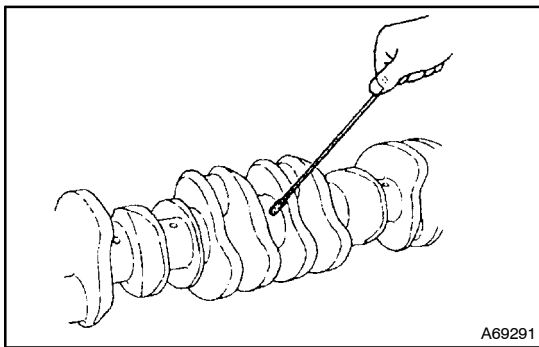
A69293

**15. INSPECT PISTON RING END 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.

**Standard end gap: 0.30 – 0.42 mm (0.0118 – 0.0165 in.)****Maximum end gap: 1.20 mm (0.0472 in.)**

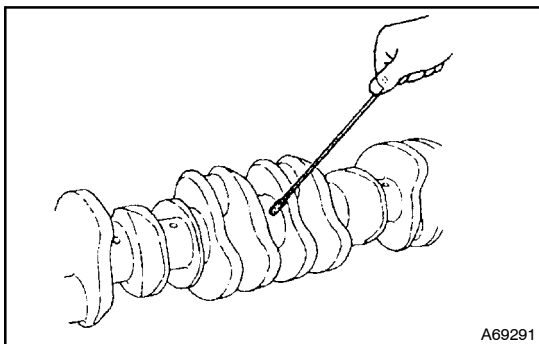
If the end gap is greater than the maximum, replace the piston ring with a new one.



A69291

**16. INSPECT CRANKSHAFT****HINT:**

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



A69291

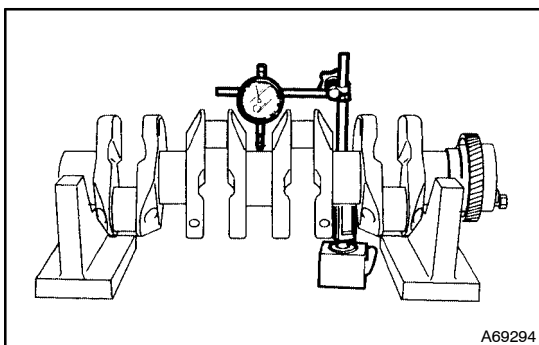
- (a) Performing the dye penetrant test, and check the crankshaft for cracks.

**HINT:**

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

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

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



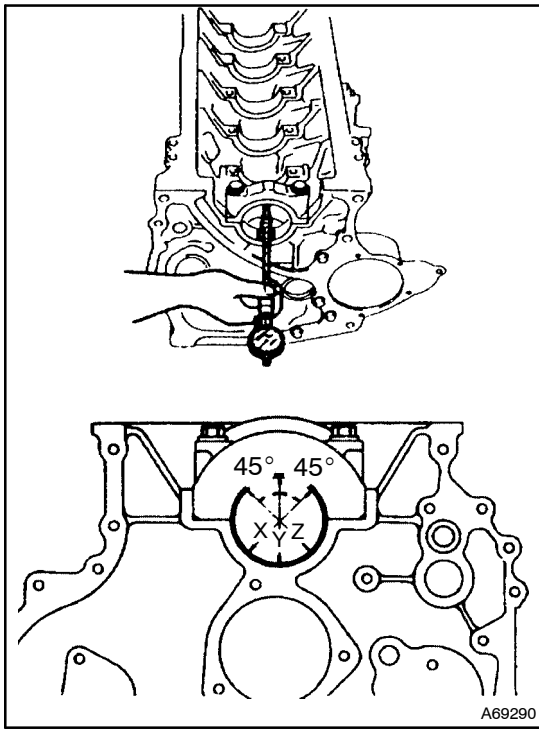
A69294

- (c) Inspect for bend.

- (1) Place the crankshaft on V-blocks.
- (2) Using a dial gauge, measure the bend of the crankshaft at the center journal.

**Maximum bend: 0.04 mm (0.0016 in.)**

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



**17. INSPECT CRANKSHAFT BEARING CAP**

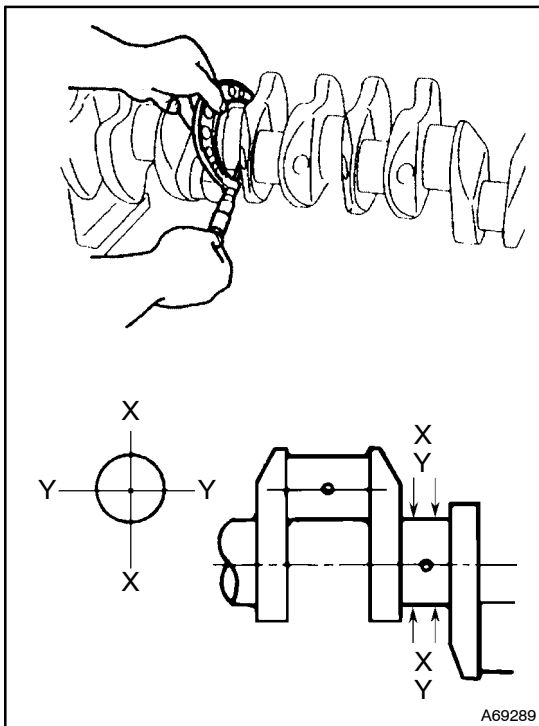
- (a) After tightening the main bearing caps without bearing, using a cylinder gauge, measure the bore diameter of the main bearing caps to calculate the roundness.

**Standard bore diameter (w/o Bearing):**  
**77.985 – 78.000 mm (3.0703 – 3.0709 in.)**  
**Maximum bore diameter (w/o Bearing):**  
**78.20 mm (3.0787 in.)**

If the bore 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 23.



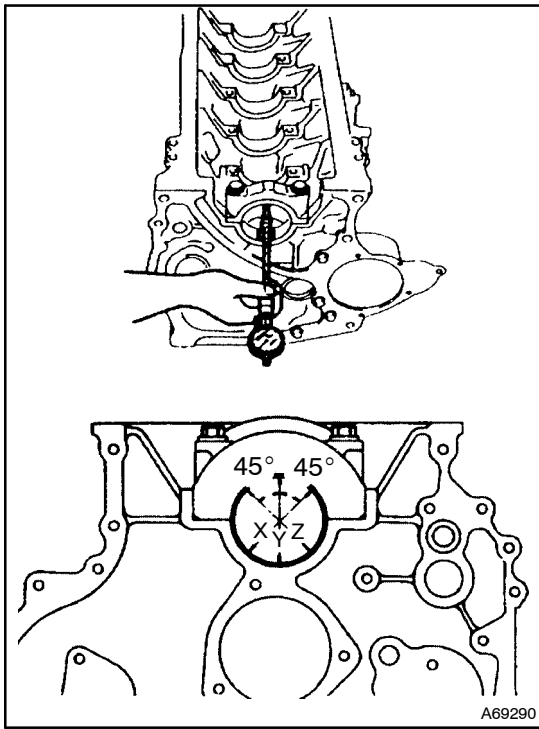
**18. INSPECT CRANKSHAFT JOURNAL AND BEARING**

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

**Standard journal diameter:**  
**72.94 – 72.96 mm (2.8716 – 2.8724 in.)**  
**Minimum journal diameter:**

Repair	72.74 mm (2.8638 in.)
Use	71.76 mm (2.8252 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.

**Standard bearing inside diameter:**

**73.000 mm (2.8740 in.)**

**Maximum bearing inside diameter:**

**73.30 mm (2.8858 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 23.

- (c) Subtract the crankshaft journal diameter measurement from the bearing inside diameter measurement.

**Standard oil clearance:**

**0.039 – 0.090 mm (0.0015 – 0.0035 in.)**

**Maximum oil clearance: 0.13 mm (0.0051 in.)**

HINT:

Undersize machining dimension: 4 sizes below

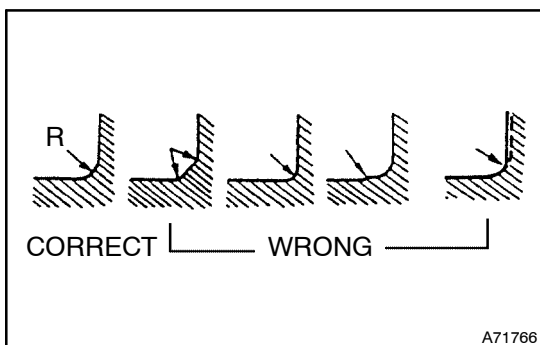
0.25 mm (0.0098 in.)

0.50 mm (0.0197 in.)

0.75 mm (0.0295 in.)

1.00 mm (0.0394 in.)

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



HINT:

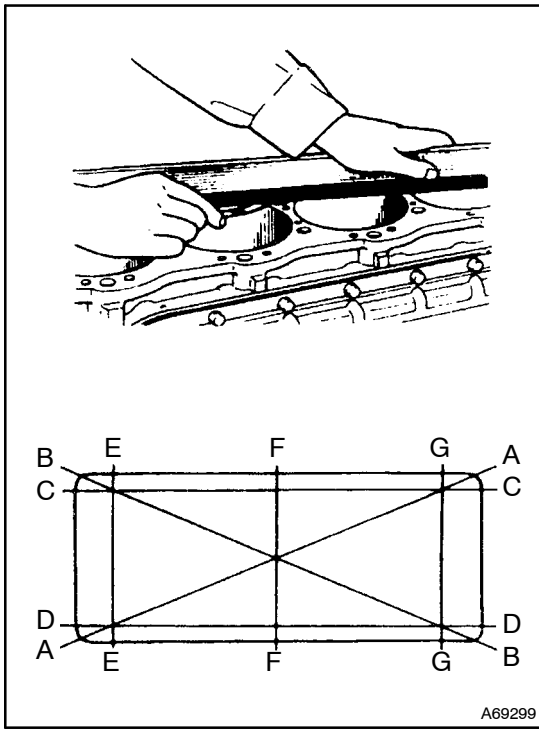
Make sure to replace the top and bottom main bearings as one set. The top and bottom main bearings must be round.

HINT:

Machined dimension of fillet R

**Main crankshaft journal:**

**3.00 – 3.50 mm (0.1181 – 0.1378 in.)**



**19. INSPECT CYLINDER BLOCK**

(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.

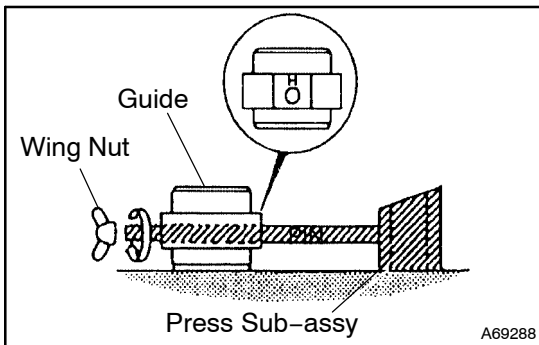
If any cracks are found, replace the cylinder block with a new one.

(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: 0.10 mm (0.0039 in.)**

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

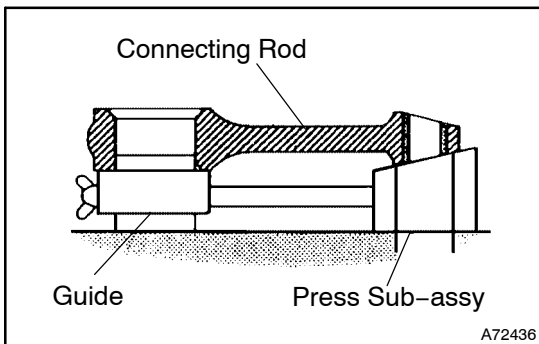


**20. REPLACE CONNECTING ROD SMALL END BUSH**

(a) Prepare SST.

SST 09402-1450 (press sub-assy), 09481-1130 (guide), 9233-10360 (wing nut)

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

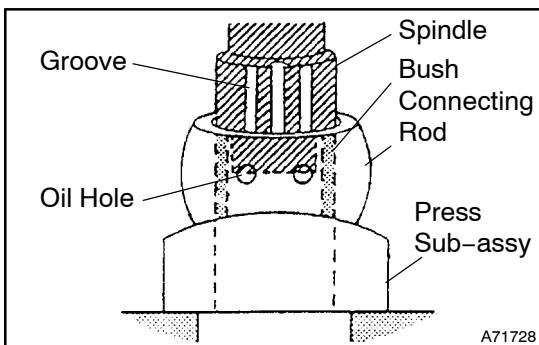


**HINT:**

- Bring the lever W punched on the guide above the pin.
- Make sure to align both supporting surfaces of the guide and press sub-assy flatly on a plane.

(b) Using the SST, remove the bush.

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

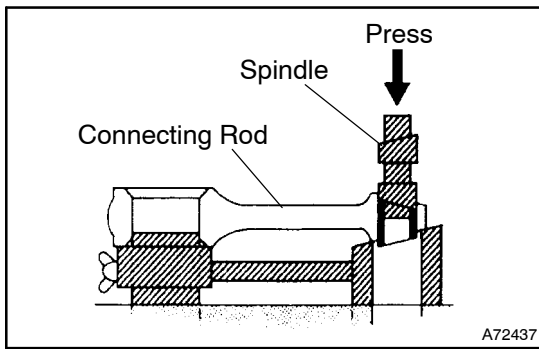


(2) Using SST, install the spindle into the bush.

SST 09402-1460 (press sub-assy)

**HINT:**

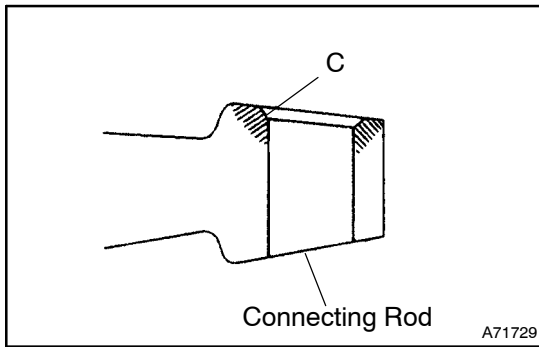
Align the groove of the spindle with the oil hole of the bush.



(3) Using a press, remove the bush.

HINT:

Always operate the press slowly and smoothly.

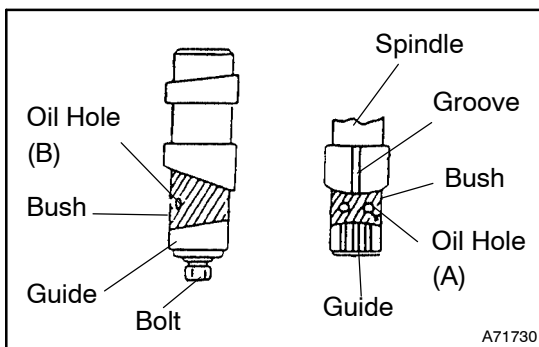


(c) Assemble the bush.

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

HINT:

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



(d) Mount the bush on the spindle.

SST 09402-1460 (press sub-assy), 09481-1140 (guide), 9191-08252 (bolt)

(1) Set the bush 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:

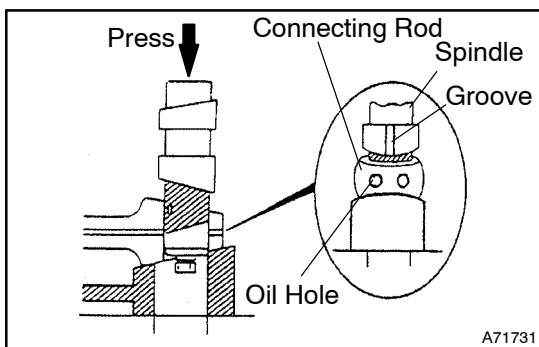
Align oil hole (A) in the bush with both groove or the spindle and guide, and make sure that oil hole (B) will meet with oil path in the connecting rod led from the big end bore in the rod.

(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.



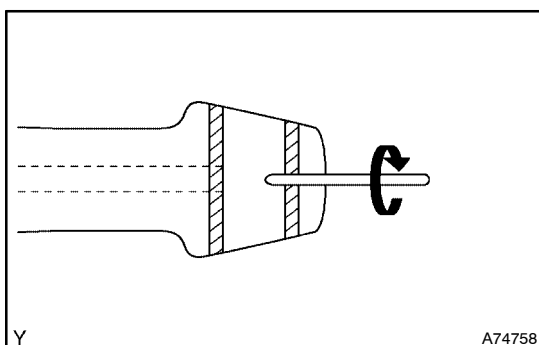
(f) Inspect the bush position after the installation.

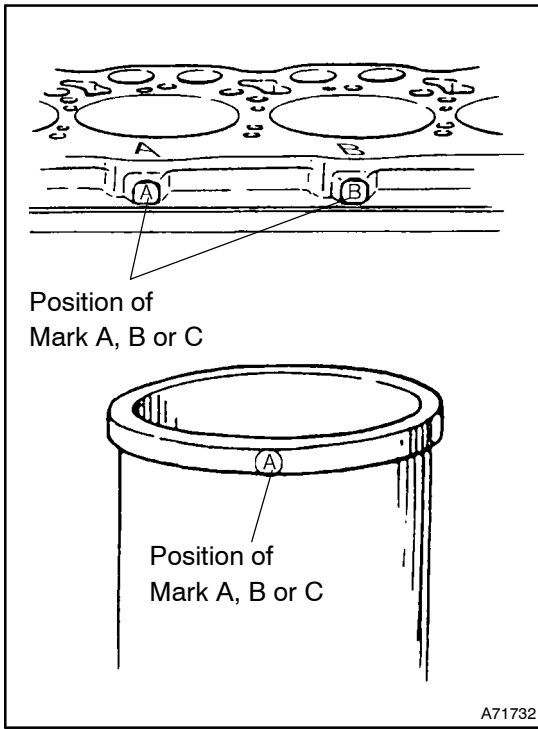
(1) Make sure that the oil hole of the bush and the oil path of the connecting rod are suitably aligned allowing a 3 mm (0.12 in.) diameter rod to penetrate.

HINT:

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

(2) With a new piston pin inserted in the piston pin, make sure that the bush can be rotated by hand without rattling.

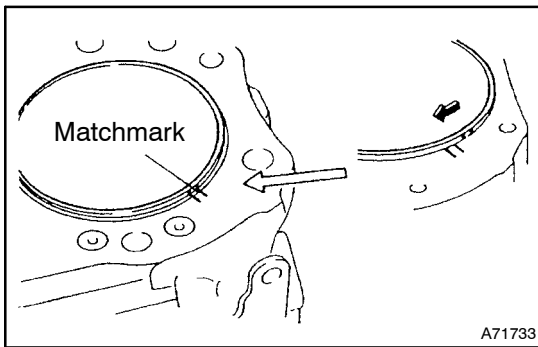




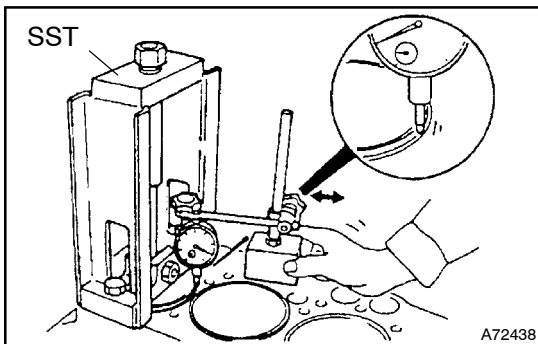
## 21. INSTALL CYLINDER LINER

### 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.

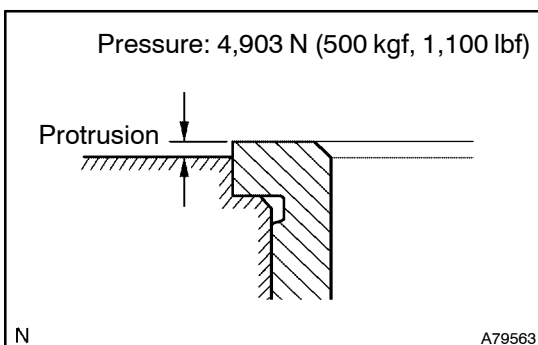


- When reusing a cylinder liner, install it according to the matchmarks made during the removal. The cylinder liner is bent by "run-in". When reusing the cylinder liner, misalignment with the cylinder block may concentrate stress on the thin part of the cylinder liner and it may be broken.



## 22. INSPECT PROTRUSION OF CYLINDER LINER

- Install SST onto the cylinder block.  
SST 09420-1460
- Tighten the center bolt to the specified torque below to set the cylinder liner in the normal installation condition.  
**9.8 N·m (100 kgf·cm, 87 in·lbf)**



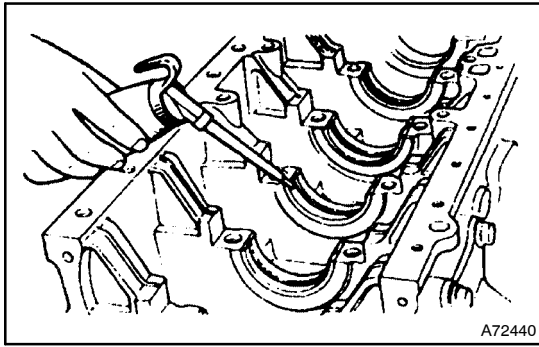
- Using a dial gauge, measure the protrusion of the cylinder liner.

### Standard protrusion:

**0.01 – 0.08 mm (0.0004 – 0.0031 in.)**

**Maximum protrusion: 0.08 mm (0.0031 in.)**

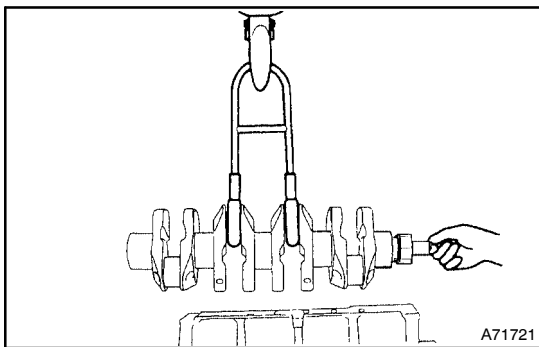
If the protrusion is greater than the maximum, replace the cylinder liner.

**23. INSTALL CRANKSHAFT**

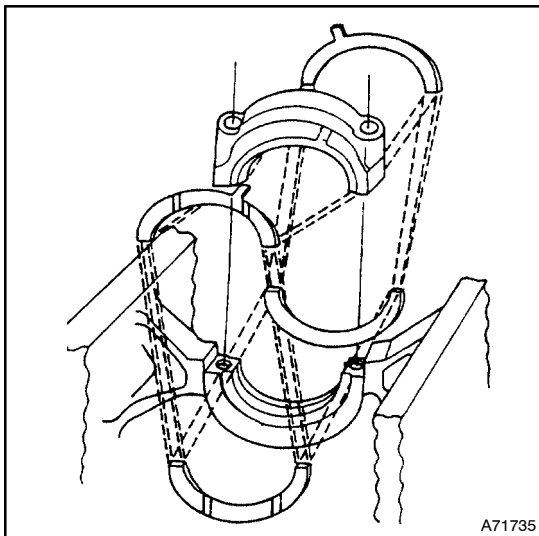
- (a) Install the main bearings onto the cylinder block and main bearing caps.

**HINT:**

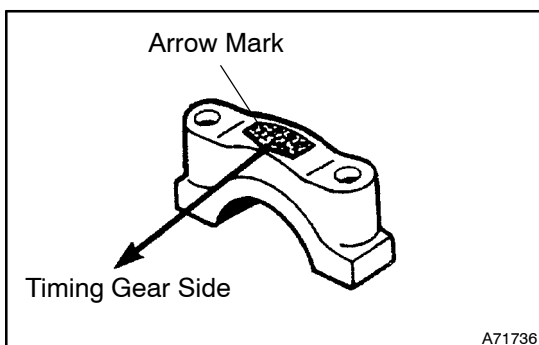
- When reusing a bearing, make sure to reassemble the removed bearing as it was originally installed.
- Install the bearing with the oil hole on the block side and install the bearing without the oil hole on the cap side.
- Match the bearing protrusion with the notch of the block or cap.
- After the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



- (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.

**HINT:**

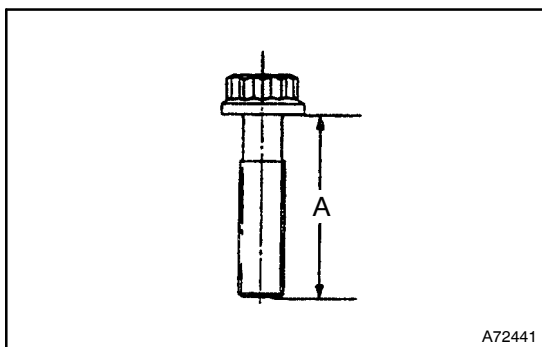
- When reusing a bearing, make sure to reassemble the removed bearing as it was originally installed.
- Install the thrust washers with the groove side (front) toward the crankshaft arm and with the part number stamp (back) toward the main bearing cap or cylinder block.
- Apply engine oil or grease to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



- (d) Install the bearing cap.

**HINT:**

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



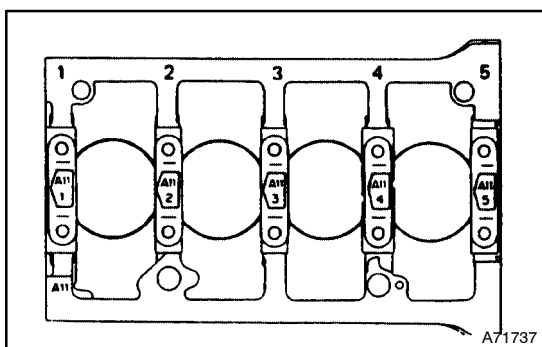
- (1) Measure the length of the bearing cap bolts.

**Standard length (A): 94.00 mm (3.7008 in.)**

**Maximum length (A): 95.20 mm (3.7480 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.

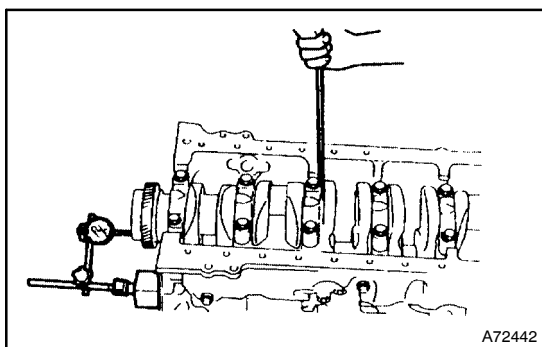
Tightening order: 3 – 2 – 4 – 1 – 5

**Torque: 147.1 N·m (1,500 kgf·cm, 109 ft·lbf)**

HINT:

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

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



#### 24. INSPECT CRANKSHAFT THRUST CLEARANCE

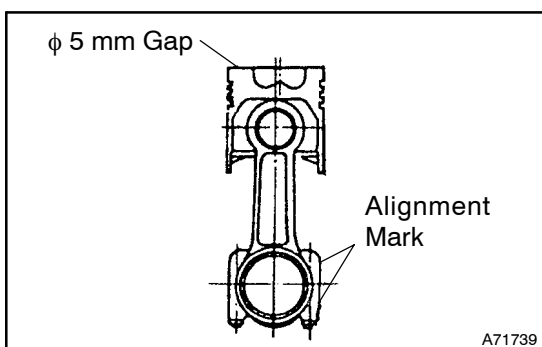
- (a) Using a dial gauge, measure the crankshaft thrust clearance.

**Standard thrust clearance:**

**0.05 – 0.22 mm (0.0020 – 0.0087 in.)**

**Maximum thrust clearance: 0.40 mm (0.0157 in.)**

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



#### 25. INSTALL CONNECTING ROD SUB-ASSY

- (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.

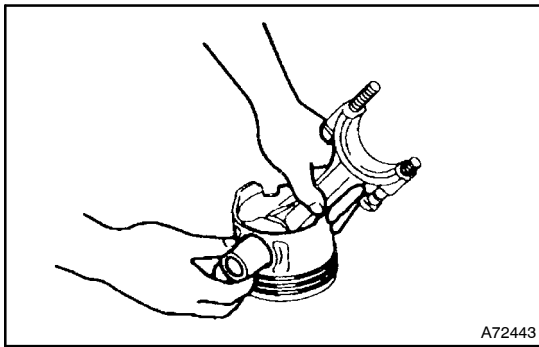
- (b) Immerse the piston in hot water (80 – 90°C (176 – 194°F)) for approx. 5 minutes.

- (c) Assemble the piston with the φ 5 mm (0.20 in.) gap being opposite to the connecting rod alignment mark.

**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:

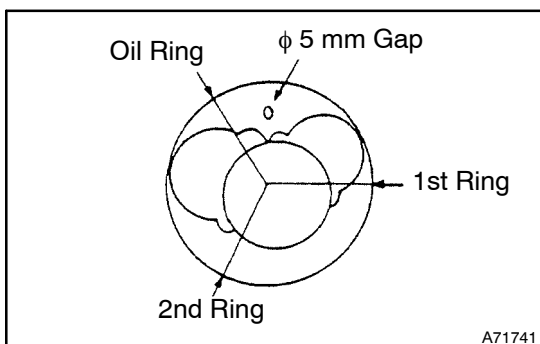
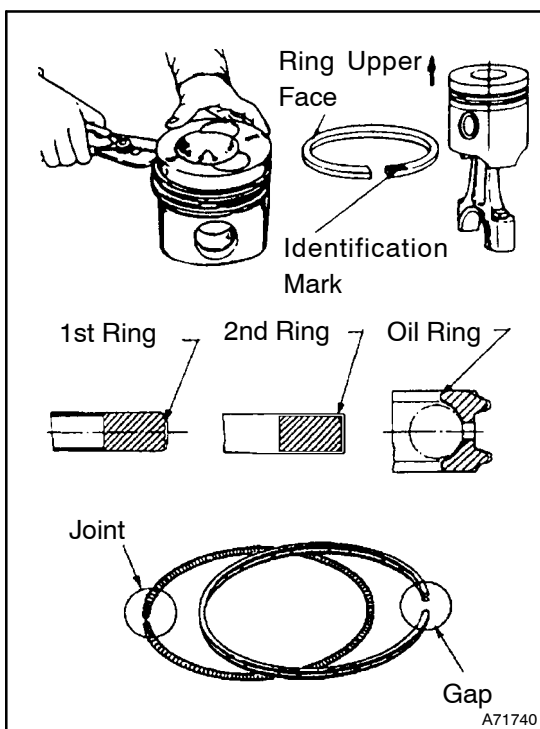
- When using an oversized piston, hone the liner so that the clearance between the cylinder liner and the piston becomes the standard value.
- Prevent parts from damage by wrapping them in a cloth while they are being installed onto the cylinder block.

## 26. INSTALL PISTON RING SET

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

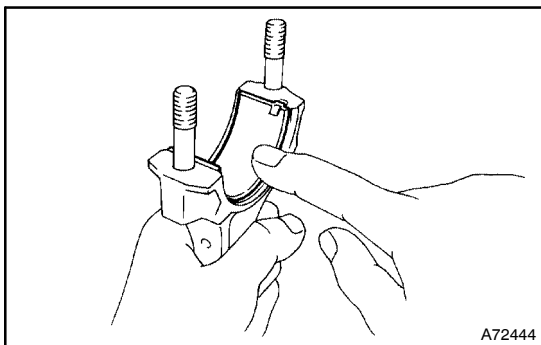
HINT:

- 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:

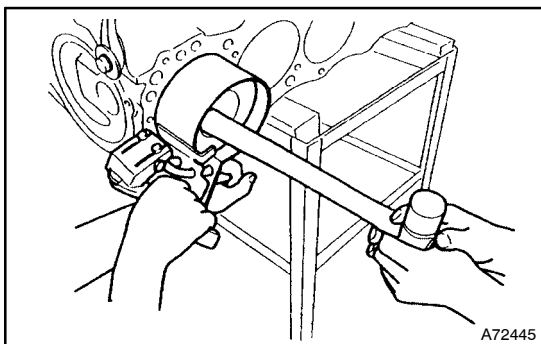
Position the matching points of the piston ring at an even distance. Be careful not to position at the piston boss.



## 27. INSTALL CONNECTING ROD BEARING

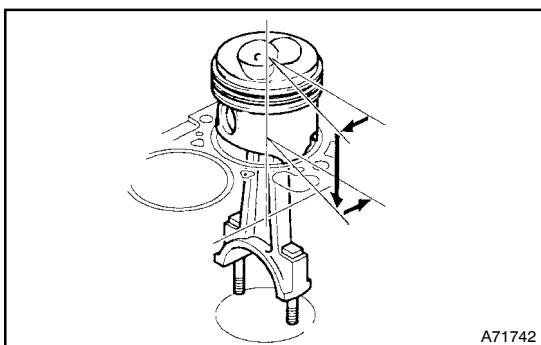
### NOTICE:

- 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 install the bearing without the oil hole on the cap side.
- Match the bearing protrusion with the notch of the connecting rod or cap.



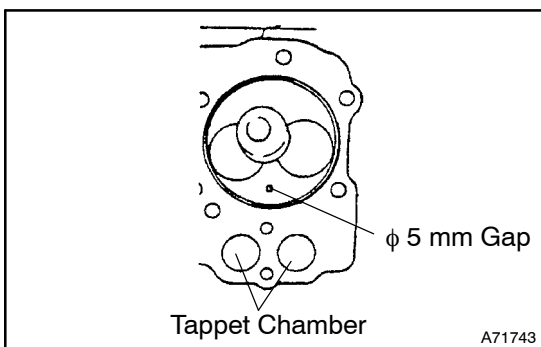
## 28. INSTALL PISTON AND CONNECTING ROD

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

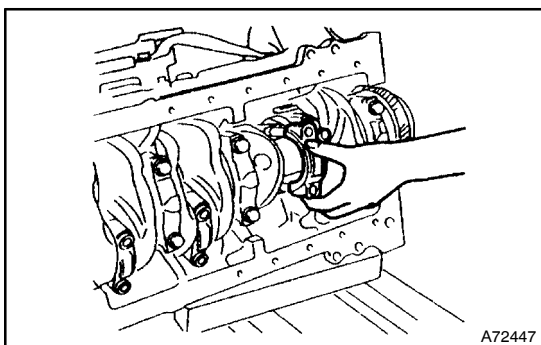


### HINT:

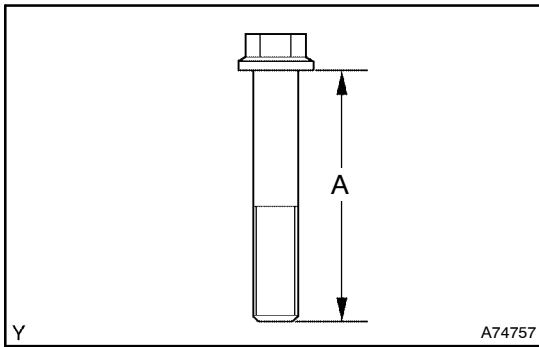
- Before the installation, apply engine oil to the piston pin, piston ring, cylinder liner and connecting rod bearing.
- Recheck the matching point of each piston ring.



- Make sure that the  $\phi$  5 mm (0.20 in.) gap on the piston is at the tappet chamber side.
- Do not damage the inside of the liner.



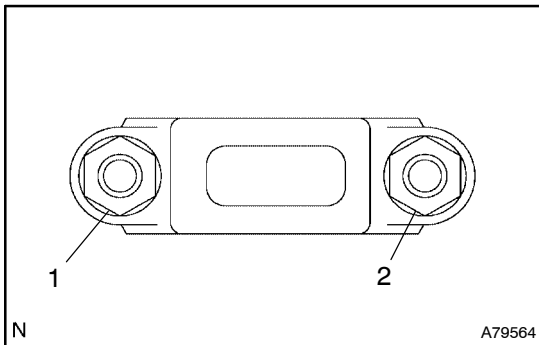
## 29. INSTALL CONNECTING ROD CAP



- (a) Measure the length of the bolts.  
**Standard length (A): 59.00 mm (2.3228 in.)**  
**Maximum length (A): 60.00 mm (2.3622 in.)**

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

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



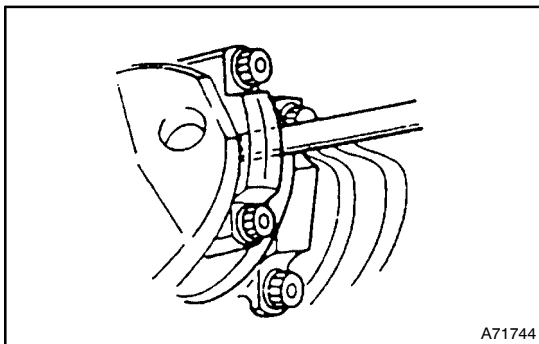
- (c) Tighten the connecting rod nut in the order shown in the illustration to the specified torque below.

- (1) Tighten the connecting rod nuts 1 and 2 temporarily, dividing into small amount.

**Torque: 122.6 N·m (1,250 kgf·cm, 90 ft·lbf)**

HINT:

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



### 30. INSPECT CONNECTING ROD THRUST CLEARANCE

- (a) Using a feeler gauge, measure the clearance between the connecting rod and crankshaft pin end surface.

**Standard thrust clearance:**

**0.20 - 0.52 mm (0.0079 - 0.0205 in.)**

**Maximum thrust clearance: 0.60 mm (0.0236 in.)**

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

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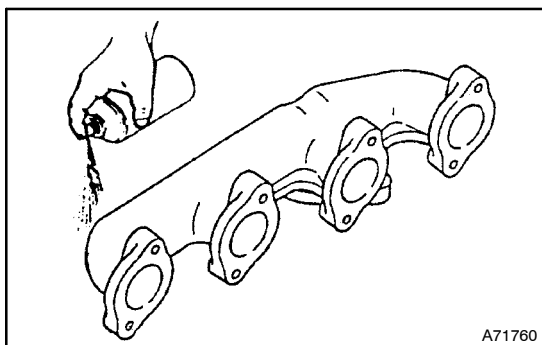
# EXHAUST

EXHAUST MANIFOLD .....	15-1
INSPECTION .....	15-1



# EXHAUST MANIFOLD INSPECTION

1507V-01



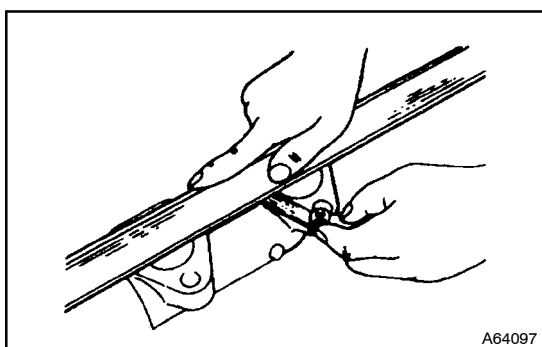
## 1. INSPECT EXHAUST MANIFOLD

### HINT:

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

- (a) Using a dye penetrant, 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.

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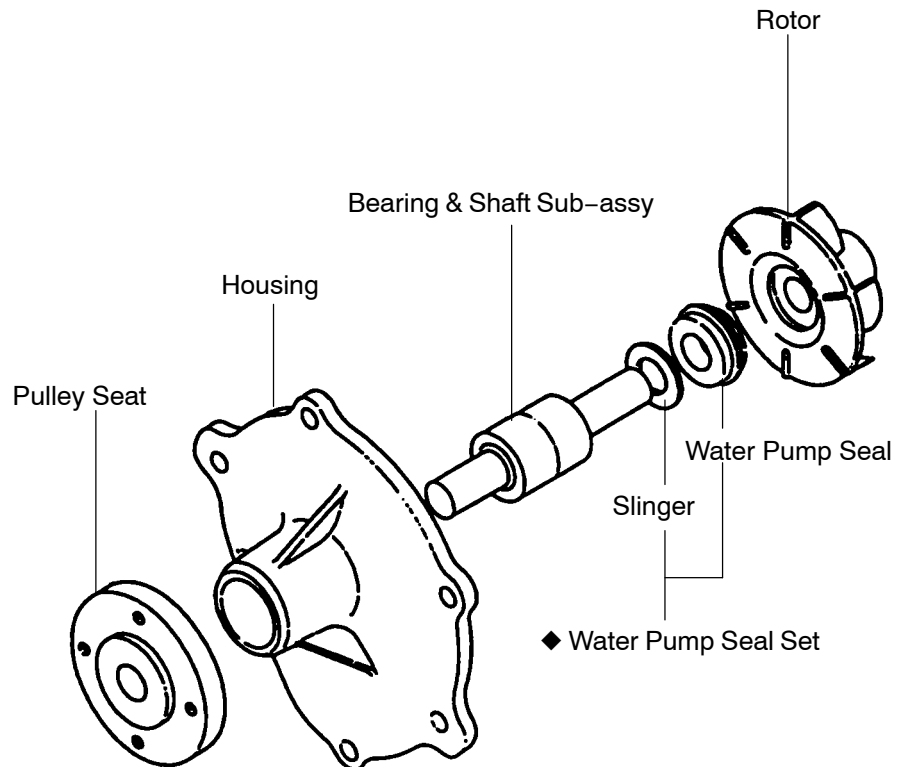
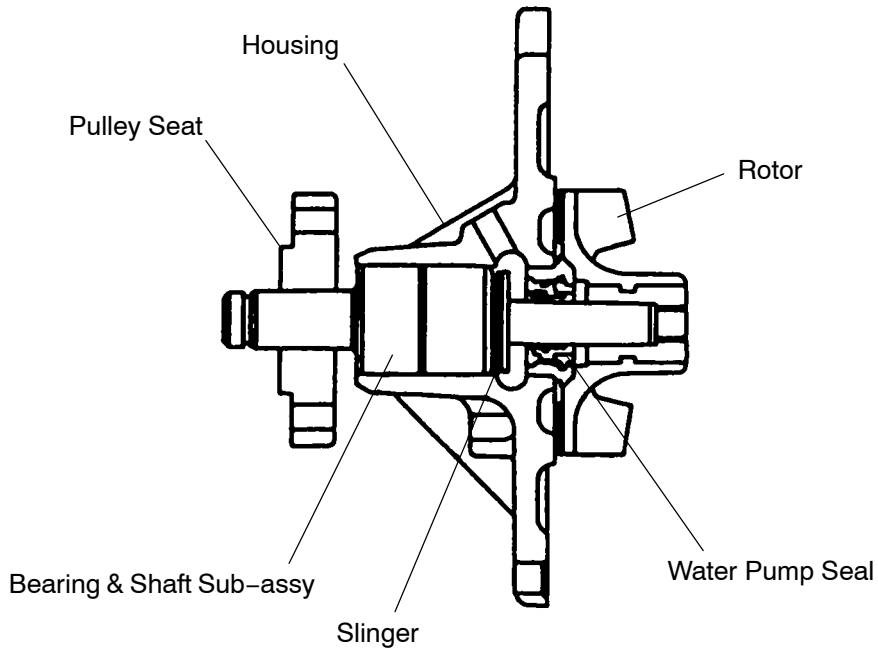
# COOLING

WATER PUMP ASSY .....	16-1
COMPONENTS .....	16-1
OVERHAUL .....	16-2
THERMOSTAT .....	16-4
INSPECTION .....	16-4



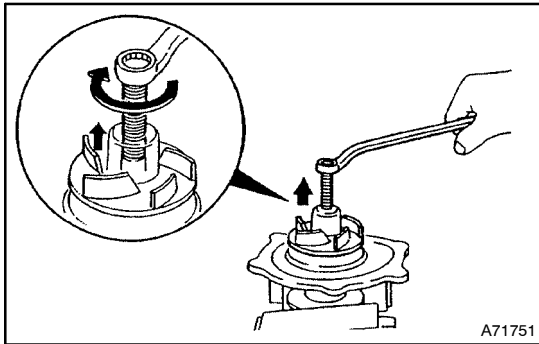
# WATER PUMP ASSY COMPONENTS

160IP-01



◆ Non-reusable part

# OVERHAUL

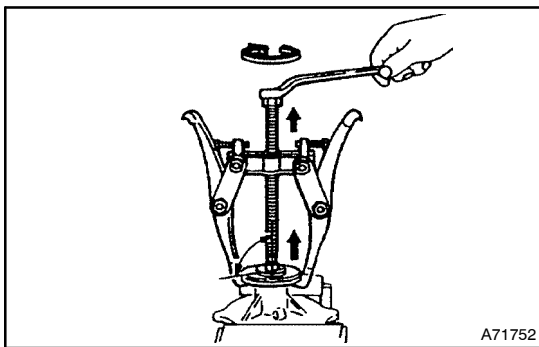


## 1. REMOVE WATER PUMP ROTOR

- (a) Using a bolt, remove the rotor by screwing in a bolt.

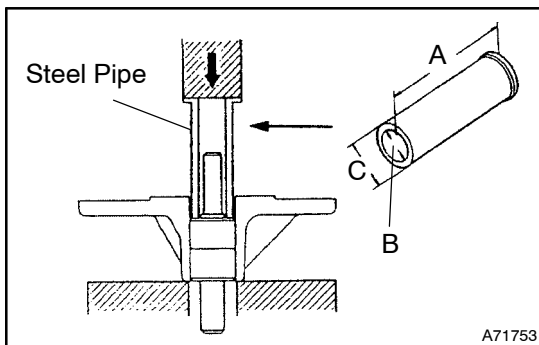
### Bolt size:

Thread diameter	10.0 mm (0.394 in.)
Thread pitch	1.5 mm (0.059 in.)



## 2. REMOVE WATER PUMP PULLEY SEAT

- (a) Using a puller, remove the pulley seat.

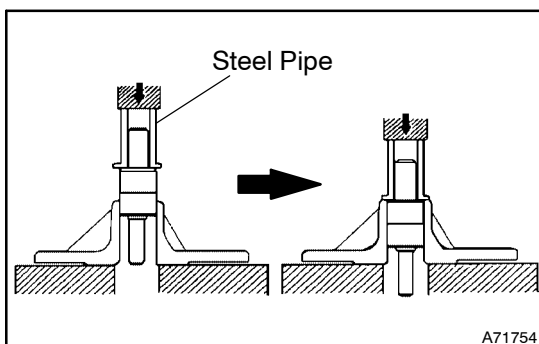


## 3. REMOVE WATER PUMP BEARING & SHAFT SUB-ASSY

- (a) Using a steel pipe and press, press out the bearing & shaft sub-assy.

### Steel pipe dimension:

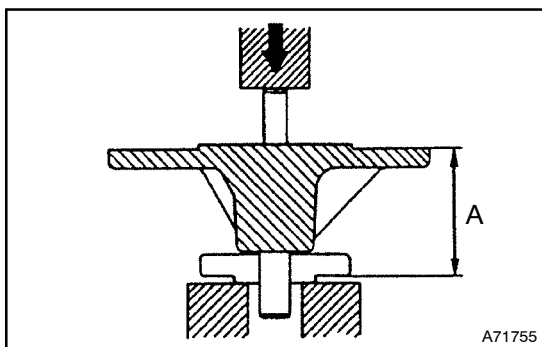
Length (A)	More than 57 mm (2.24 in.)
Inside diameter (B)	18 - 21 mm (0.71 - 0.83 in.)
Outside diameter (C)	Less than 29.5 mm (1.161 in.)



## 4. INSTALL WATER PUMP BEARING & SHAFT SUB-ASSY

- (a) Using a steel pipe and press, press in the bearing & shaft sub-assy.

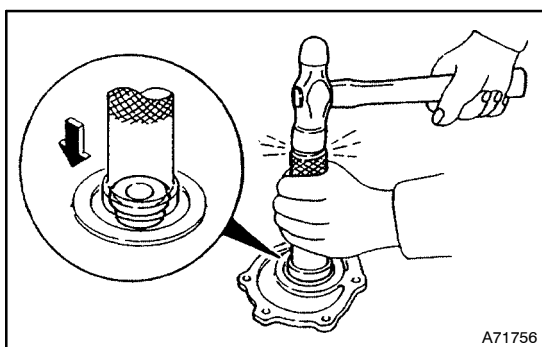




### 5. INSTALL WATER PUMP PULLEY SEAT

- (a) Using a press, press in the pulley seat into place as shown in the illustration.

**Dimension (A): 61.5 mm (2.421 in.)**

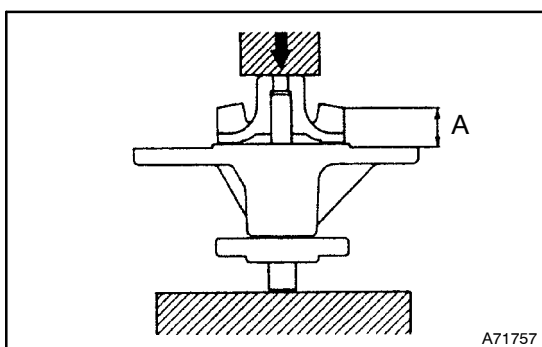


### 6. INSTALL WATER PUMP SEAL SET

- (a) Apply seal packing to a new seal outside circumference and water pump body.

**Seal packing: Part No. 08826-00100 or equivalent**

- (b) Using a hammer, tap in the slinger and seal.



### 7. INSTALL WATER PUMP ROTOR

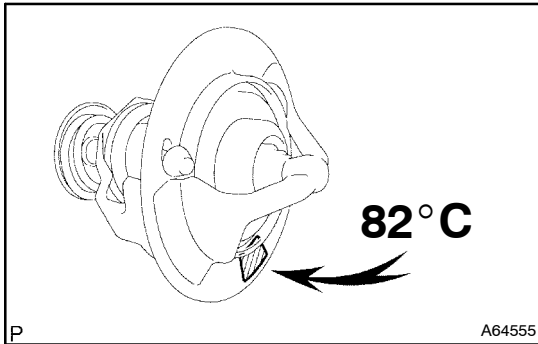
- (a) Using a press, press in the rotor into place as shown in the illustration.

**Dimension (A): 20.7 - 21.0 mm (0.815 - 0.827 in.)**

### 8. INSPECT WATER PUMP ASSY

- (a) Check that the rotor rotates smoothly

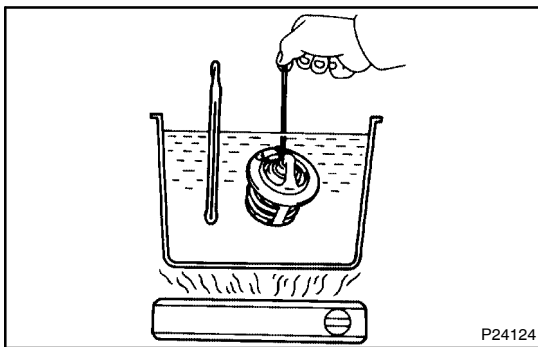
# THERMOSTAT INSPECTION



## 1. INSPECT THERMOSTAT

### HINT:

The thermostat is numbered with the valve opening temperature.

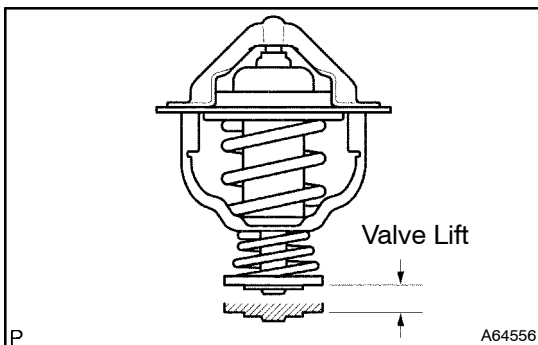


(a) Immerse the thermostat in water and gradually heat the water.

(b) Check the valve opening temperature.

**Valve opening temperature: 80 – 84 °C (176 – 183 °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 95 °C (203 °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 temperature (below 40 °C (104 °F)).

If the valve not closed, replace the thermostat.

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# LUBRICATION

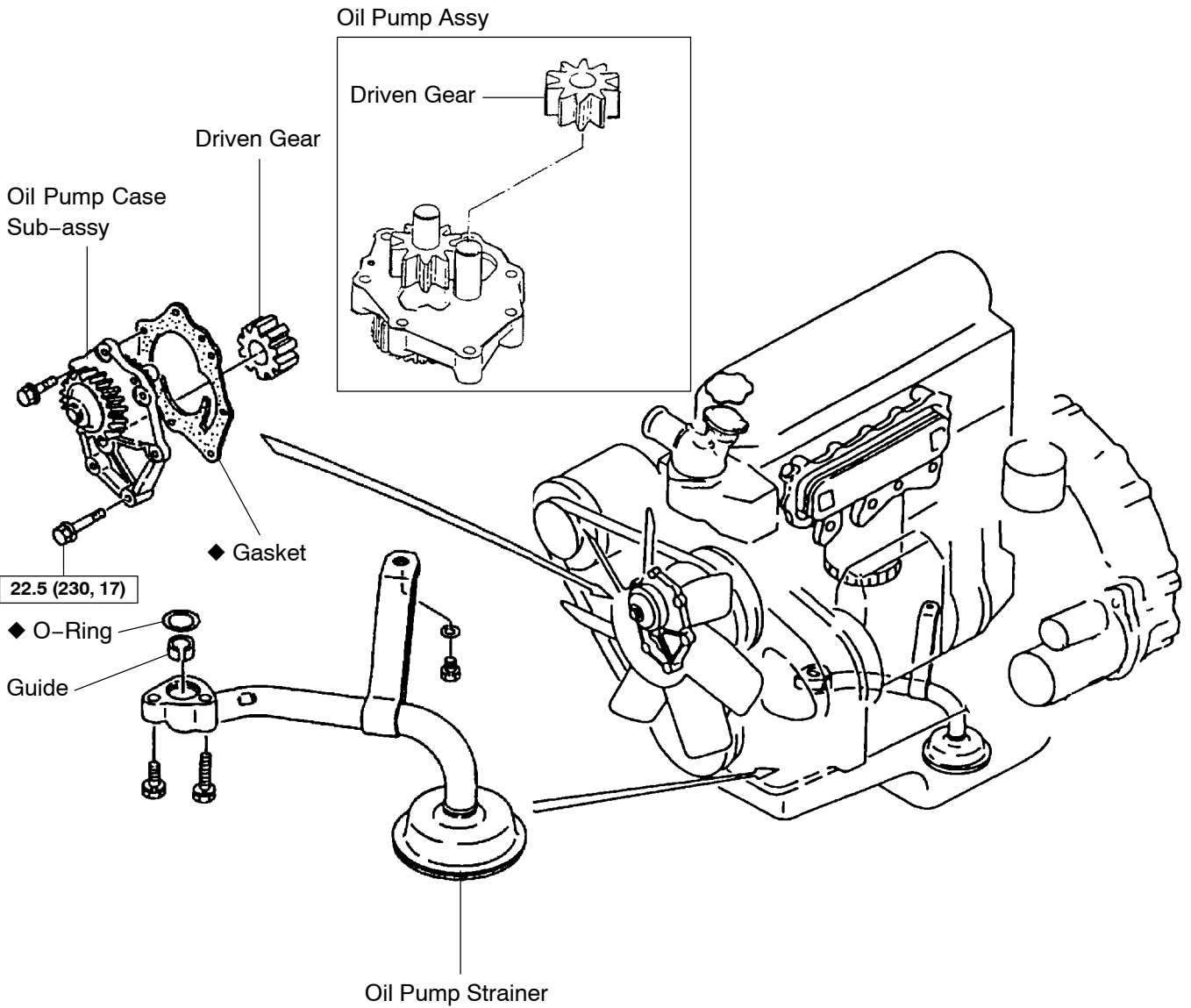
OIL PUMP ASSY .....	17-1
COMPONENTS .....	17-1
OVERHAUL .....	17-2
OIL COOLER ASSY .....	17-4
INSPECTION .....	17-4



# OIL PUMP ASSY COMPONENTS

170D0-01

## EXAMPLE



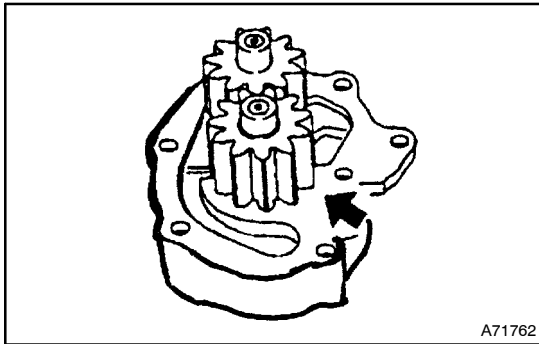
N·m (kgf·cm, ft·lbf) : Specified torque

◆ Non-reusable part

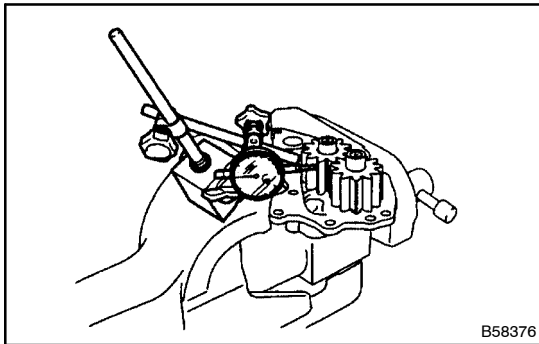
## OVERHAUL

### 1. REMOVE OIL PUMP ASSY

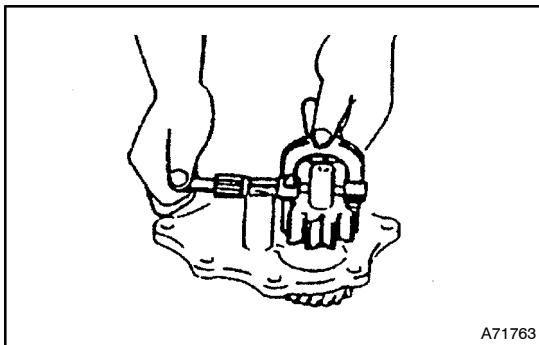
- (a) Remove the 7 bolts, the oil pump assy, drive gear and gasket.



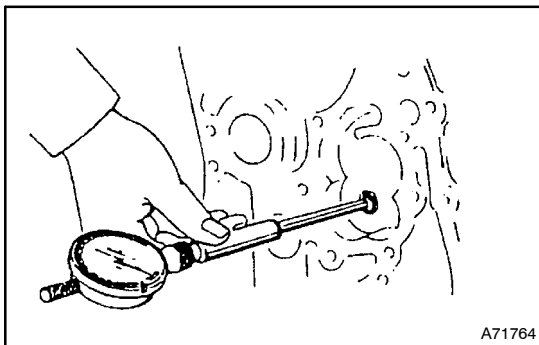
A71762



B58376



A71763



A71764

### 2. 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.

### 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 assy with a new one.

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

- (1) Using a vise, fix the oil pump assy.
- (2) Using a dial gauge, measure the backlash between the drive gear and driven gear.

#### Standard backlash:

**0.091 - 0.217 mm (0.0036 - 0.0085 in.)**

**Maximum backlash: 0.30 mm (0.0118 in.)**

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

- (c) Inspect the clearance between the drive gear shaft and driven gear bush.

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

#### Standard shaft diameter:

**18.088 - 18.106 mm (0.7121 - 0.7128 in.)**

**Minimum shaft diameter: 18.062 mm (0.7111 in.)**

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

#### Standard bush inside diameter:

**18.146 - 18.173 mm (0.7144 - 0.7155 in.)**

**Maximum bush inside diameter: 18.20 mm (0.7165 in.)**

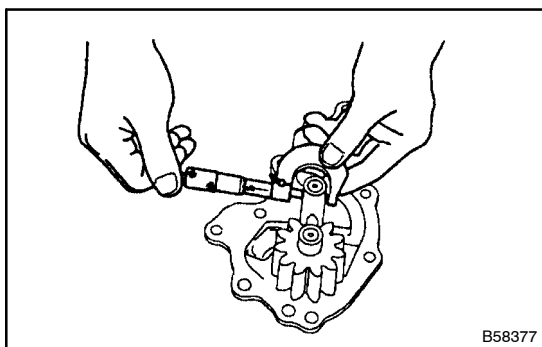
- (3) Subtract the diameter measurement of the drive gear shaft from the inside diameter measurement of the drive gear bush.

#### Standard clearance:

**0.040 - 0.085 mm (0.0016 - 0.0033 in.)**

**Maximum clearance: 0.10 mm (0.0039 in.)**

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



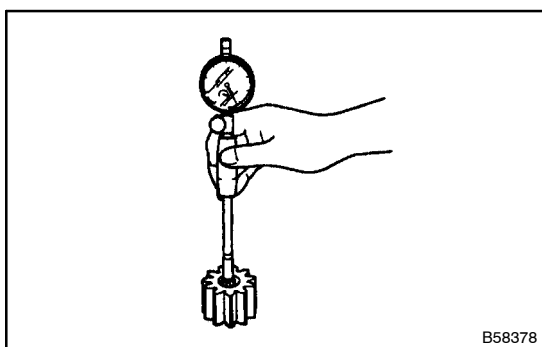
- (d) Inspect the clearance between the driven gear shaft and driven gear bush.

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

**Standard shaft diameter:**

**17.979 – 17.997 mm (0.7078 – 0.7085 in.)**

**Minimum shaft diameter: 17.97 mm (0.7075 in.)**



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

**Standard bush inside diameter:**

**18.037 – 18.054 mm (0.7101 – 0.7108 in.)**

**Maximum bush inside diameter: 18.07 mm (0.7114 in.)**

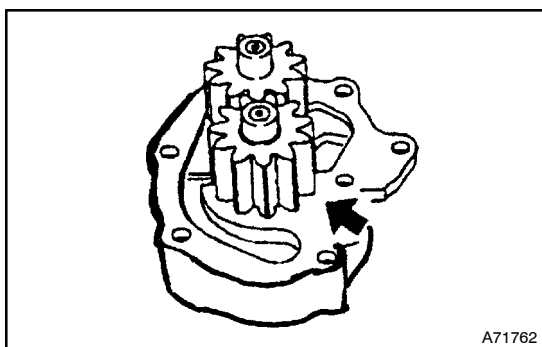
- (3) Subtract the diameter measurement of the driven gear shaft from the inside diameter measurement of the driven gear bush.

**Standard clearance:**

**0.040 – 0.075 mm (0.0016 – 0.0030 in.)**

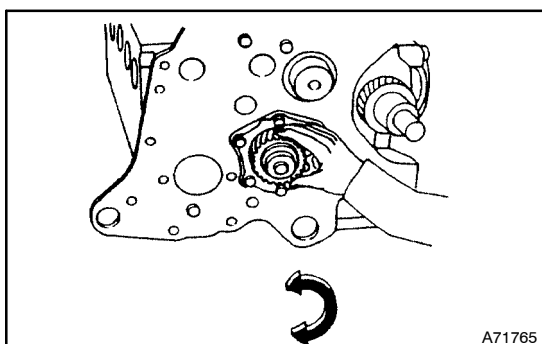
**Maximum clearance: 0.10 mm (0.0039 in.)**

If the clearance is greater than the maximum, replace the drive gear shaft or the driven gear.



#### 4. INSTALL OIL PUMP DRIVEN GEAR

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



#### 5. INSTALL OIL PUMP ASSY

- (a) Apply oil liberally to the cylinder block case and bearing before installing the oil pump

- (b) Tighten the 7 bolts.

**Torque: 22.5 N·m (230 kgf·cm, 17 ft·lbf)**

- (c) Confirm smooth rotation of the oil pump.

# OIL COOLER ASSY INSPECTION

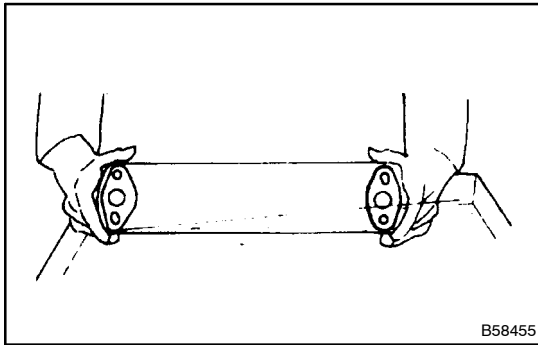
170D2-01

## 1. INSPECT OIL COOLER ASSY

### 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<sup>2</sup> (85.3 lb/sq.in.)**

**Test time: 1 min.**

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.

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# STARTING & CHARGING

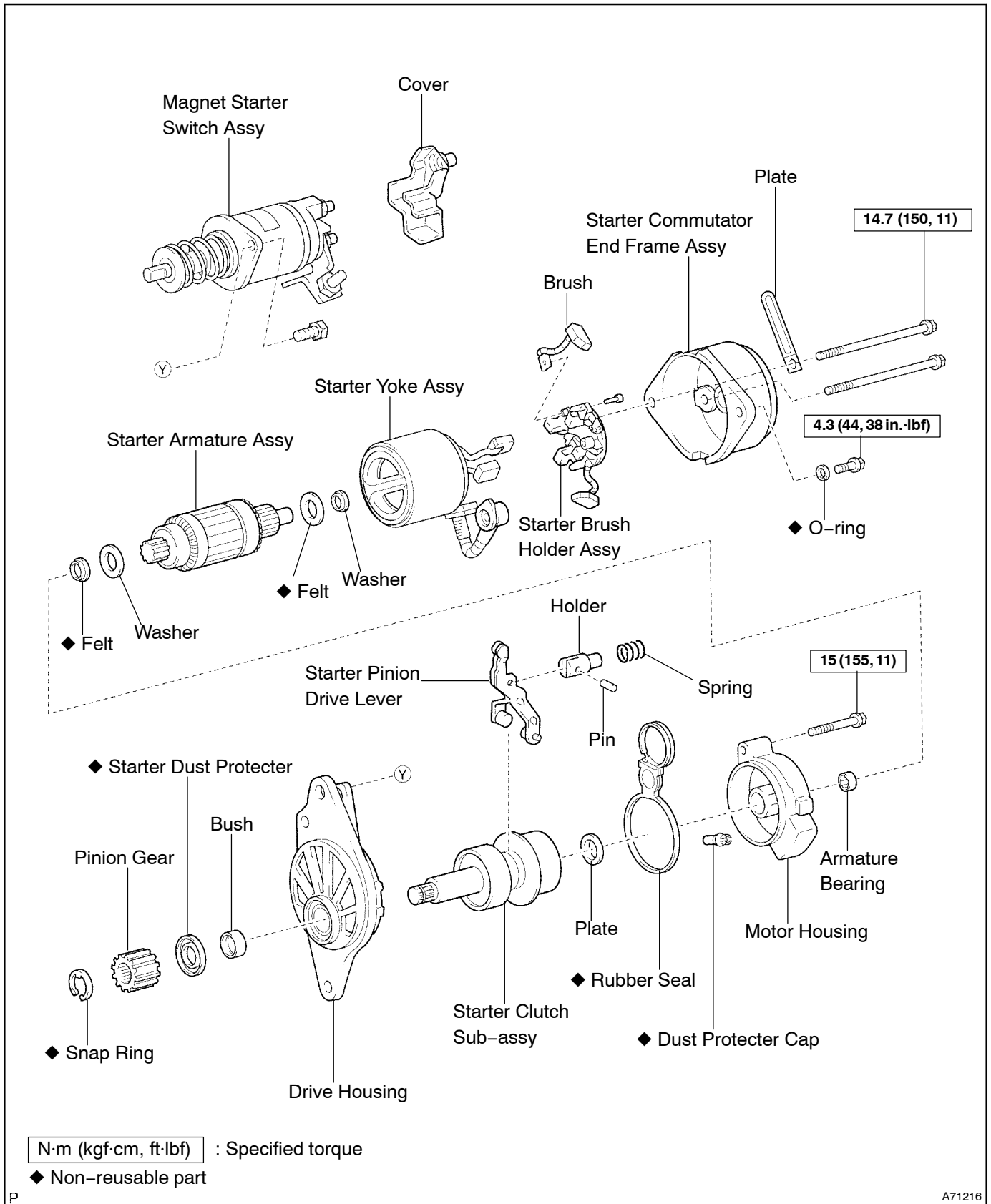
STARTER ASSY .....	19-1
COMPONENTS .....	19-1
OVERHAUL .....	19-2
GENERATOR ASSY .....	19-10
COMPONENTS .....	19-10
OVERHAUL .....	19-11



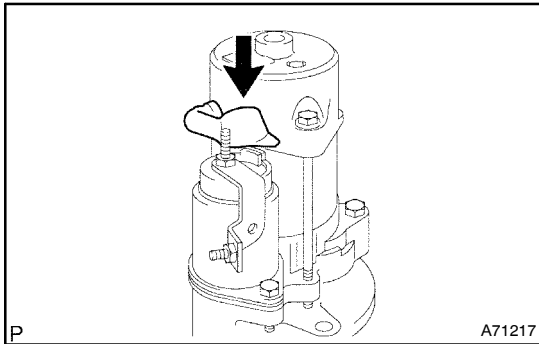


# STARTER ASSY COMPONENTS

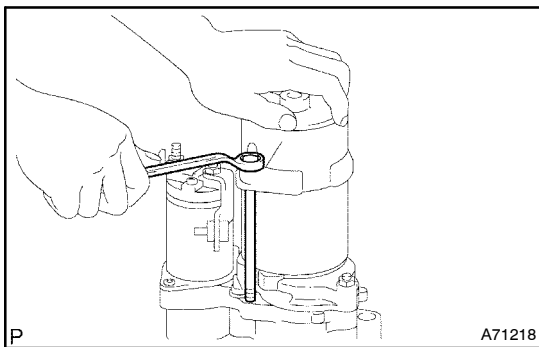
190KF-01



# OVERHAUL



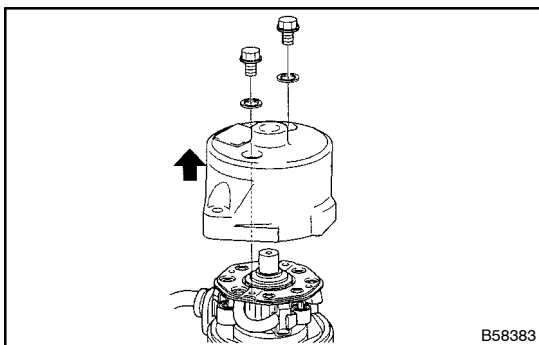
1. **REMOVE STARTER YOKE ASSY**
  - (a) Remove the cap, nut and lead wire.



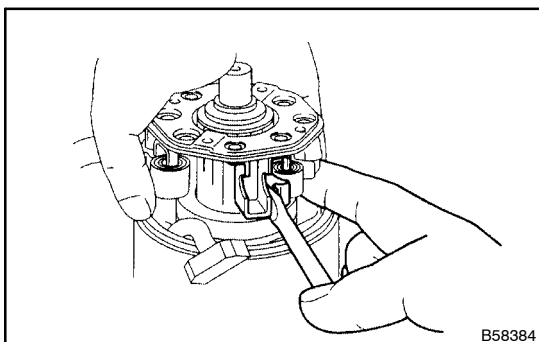
- (b) Remove the 2 through bolts, and pull out the starter yoke together with the armature.

**HINT:**

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



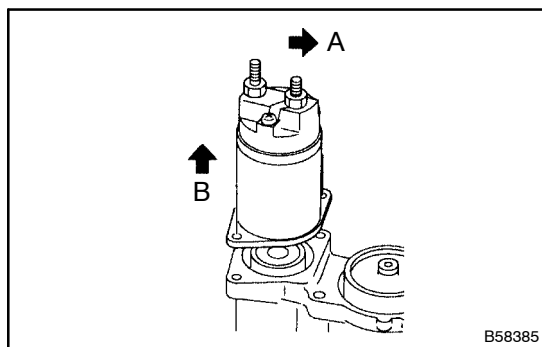
2. **REMOVE STARTER COMMUTATOR END FRAME ASSY**
  - (a) Remove the 2 screws, commutator end frame and O-ring.



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**

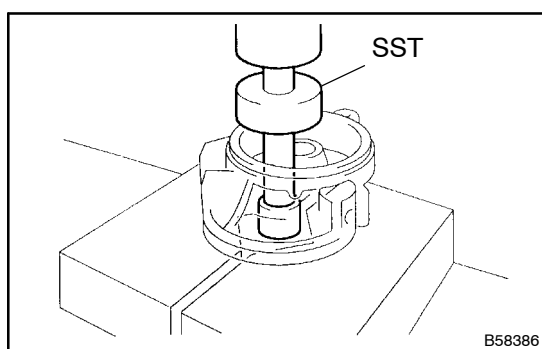
- (a) Remove the armature from the starter yoke assy.
  - (b) Remove the felt and washer from the armature.

**5. REMOVE MAGNET STARTER SWITCH ASSY**

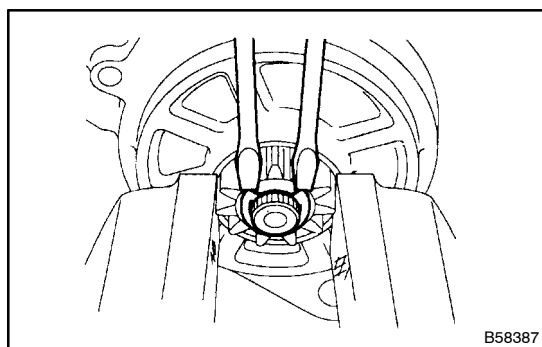
- (a) Loosen the 2 bolts holding the magnet switch to the drive housing.
- (b) Pull out the magnet switch in direction B by tilting the upper part of the main switch in direction A, as shown in the illustration.

**6. REMOVE MOTOR HOUSING**

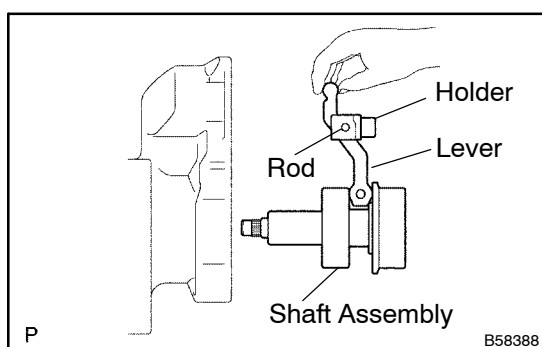
- (a) Remove the bolt and motor housing.
- (b) Remove the plate, spring and rubber seal from the drive housing.

**7. REMOVE ARMATURE BEARING**

- (a) Using SST and a press, remove the bearing from the motor housing.  
SST 09820-00031

**8. REMOVE PINION GEAR**

- (a) Using 2 screwdrivers, remove the snap ring and pinion gear.

**9. REMOVE STARTER CLUTCH SUB-ASSY**

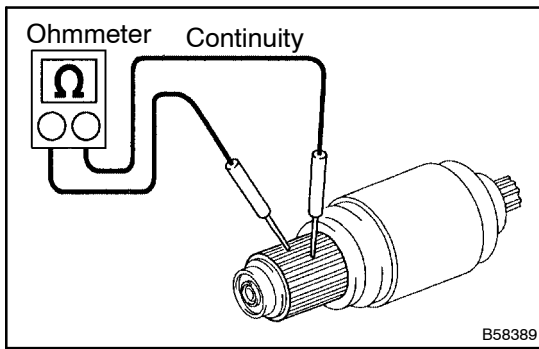
- (a) Remove the starter clutch together with the drive lever from the starter drive housing.

**10. REMOVE STARTER PINION DRIVE LEVER**

- (a) Remove the lever and shaft assembly 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.



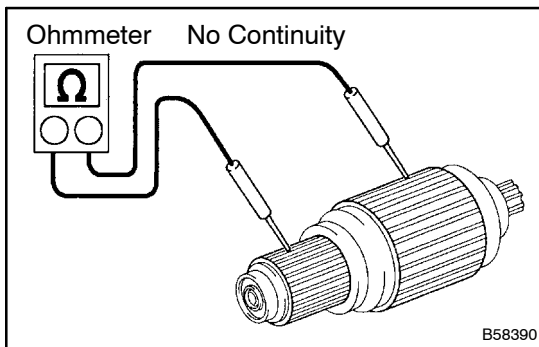
## 12. INSPECT STARTER ARMATURE ASSY

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

(a) Check the commutator open circuit.

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

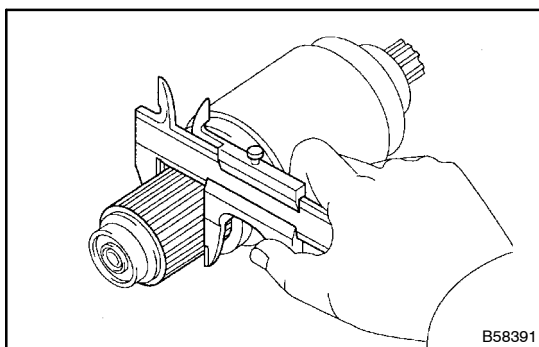
If there is no continuity between any segment, replace the armature assy.



(b) 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.



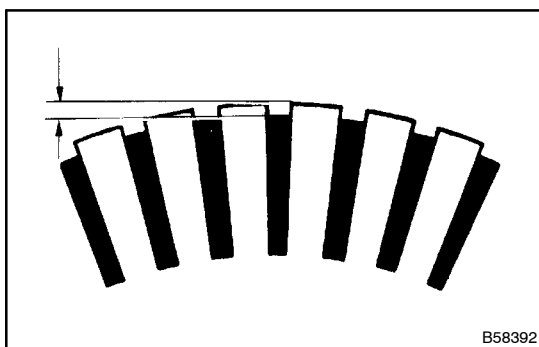
(c) Check the commutator diameter.

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

**Standard diameter: 32.8 mm (1.291 in.)**

**Minimum diameter: 30.0 mm (1.181 in.)**

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



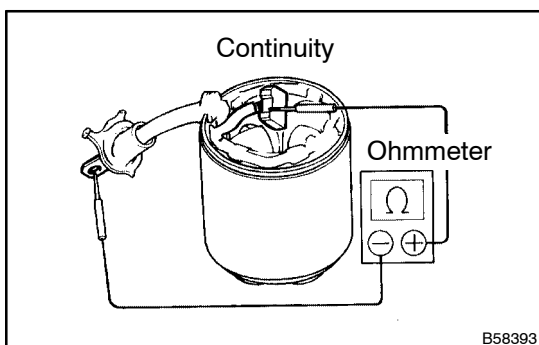
(d) Measure the undercut depth of the commutator.

**Standard undercut depth:**

**0.5 - 0.8 mm (0.020 - 0.032 in.)**

**Minimum undercut depth: 0.2 mm (0.008 in.)**

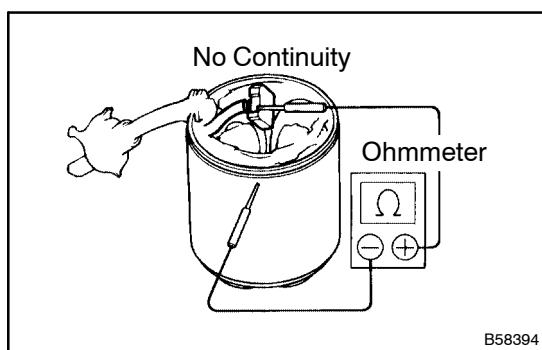
If the undercut depth is less than the minimum, correct it with a hacksaw blade.



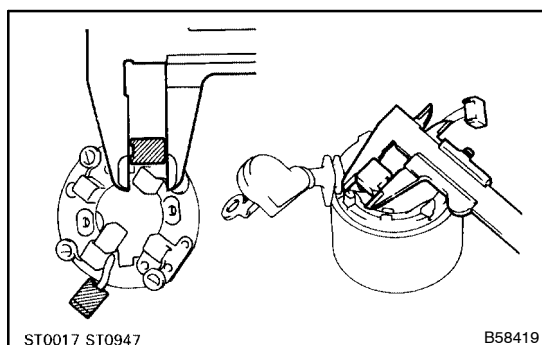
## 13. INSPECT STARTER YOKE ASSY

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

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



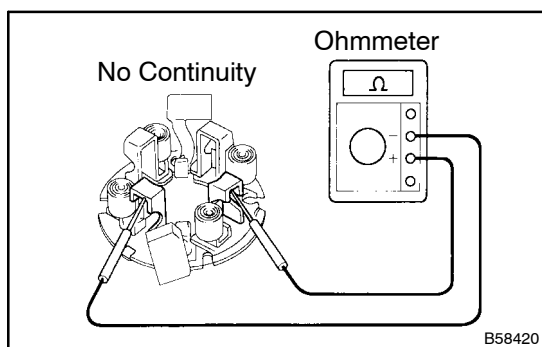
#### 14. INSPECT BRUSH

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

**Standard brush length: 18.0 mm (0.709 in.)**

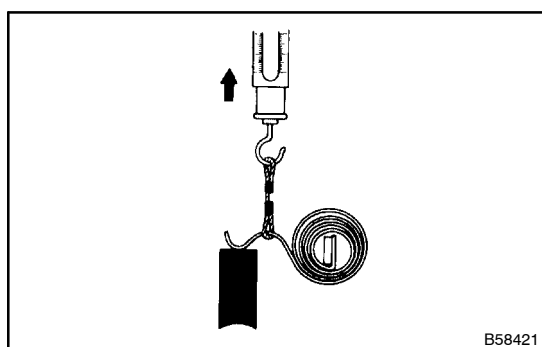
**Minimum brush length: 12.0 mm (0.472 in.)**

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 assy.



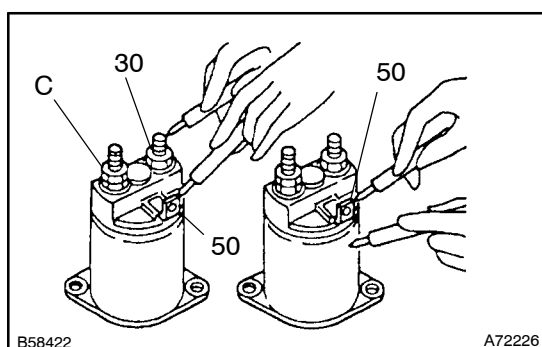
- (b) Take the pull scale reading the instant brush spring separates from the brush.

**Standard installed load:**

**42.2 – 51.0 N (4.3 – 5.2 kgf, 9.3 – 11.2 lbf)**

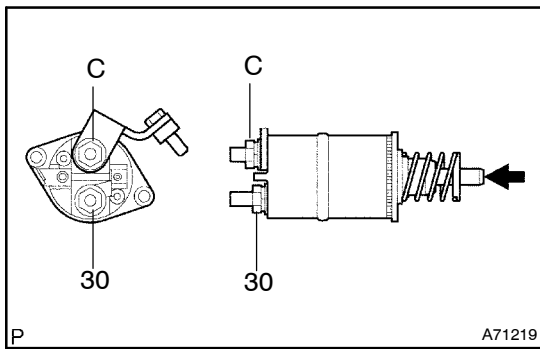
**Minimum installed load: 22.5 N (2.3 kgf, 4.9 lbf)**

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

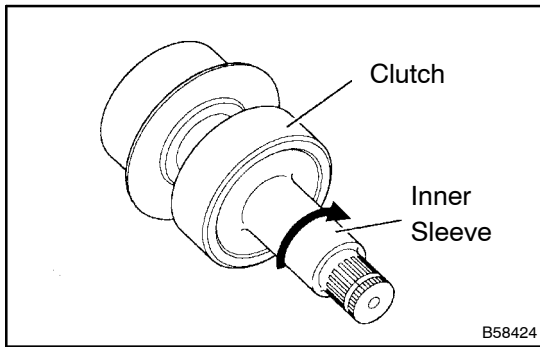


#### 16. INSPECT MAGNET STARTER SWITCH ASSY

- (a) Inspect the pull-in coil. Using an ohmmeter, check that there is resistance between terminals 30 and 50.
- Standard resistance: 0.12 – 0.15  $\Omega$**
- (b) Inspect the hold-in coil. Using an ohmmeter, check that there is resistance between terminal 50 and the switch body.
- Standard resistance: 0.83 – 1.01  $\Omega$**

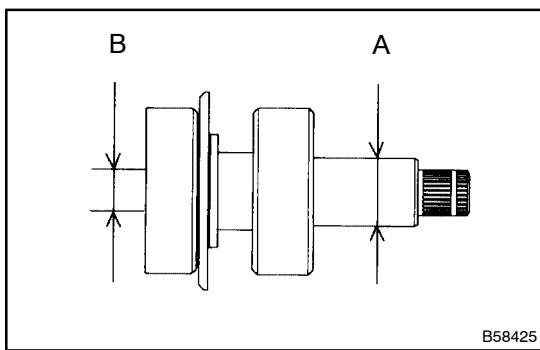


- (c) Using an ohmmeter, check that there is no continuity between terminal C and 30.  
If there is continuity, replace the magnet switch assy.
- (d) Push the main switch assembly, when using an ohmmeter, check that there is continuity between terminal C and 30.  
If there is no continuity, replace the 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 outside diameter of the starter clutch.

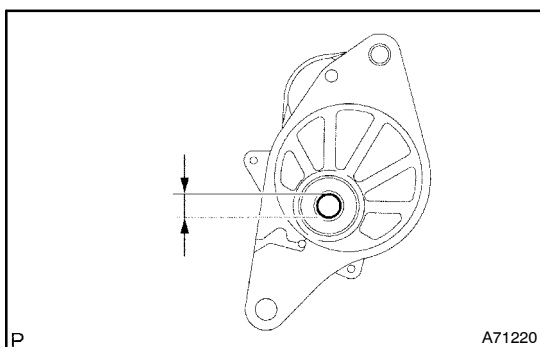
**Standard diameter:**

A	26.0 mm (1.024 in.)
B	12.1 mm (0.476 in.)

**Minimum diameter:**

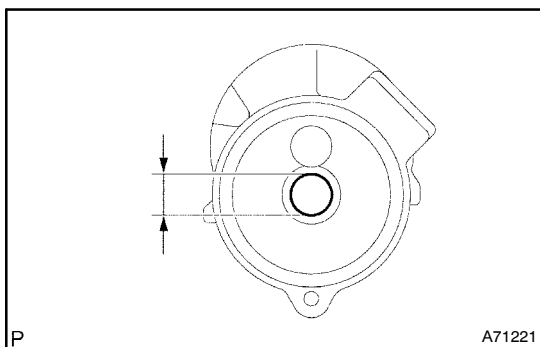
A	25.88 mm (1.019 in.)
B	12.0 mm (0.472 in.)

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



**18. INSPECT DRIVE HOUSING**

- (a) Using a cylinder gauge, check the inside diameter of the drive housing bush.  
**Standard diameter: 26.0 mm (1.024 in.)**  
**Maximum diameter: 26.2 mm (1.031 in.)**  
If the diameter is greater than maximum, replace the drive housing.

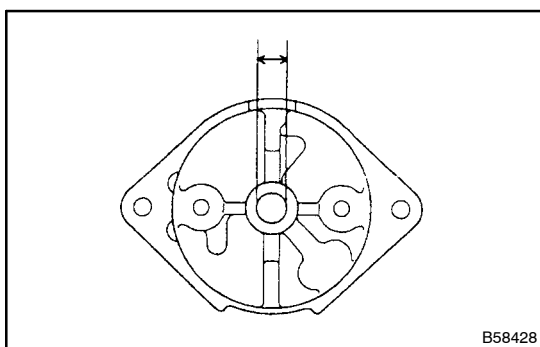
**19. INSPECT MOTOR HOUSING**

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

**Standard diameter: 12.1 mm (0.476 in.)**

**Maximum diameter: 12.3 mm (0.484 in.)**

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

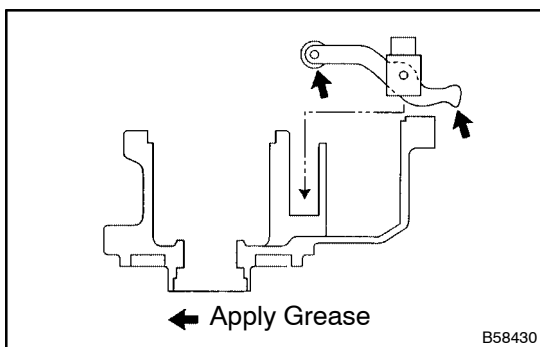
**20. INSPECT STARTER COMMUTATOR END FRAME ASSY**

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

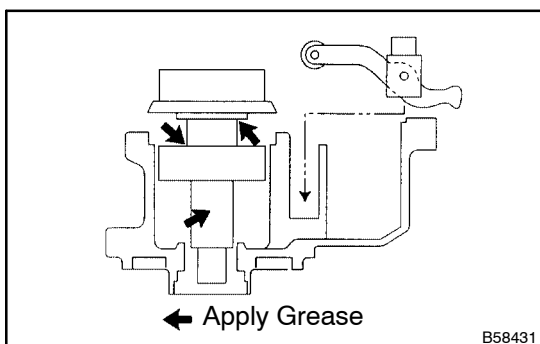
**Standard diameter: 12.0 mm (0.472 in.)**

**Maximum diameter: 12.2 mm (0.480 in.)**

If the diameter is greater than maximum, replace the commutator end frame assy.

**21. INSTALL STARTER DUST PROTECTOR****22. INSTALL STARTER PINION DRIVE LEVER**

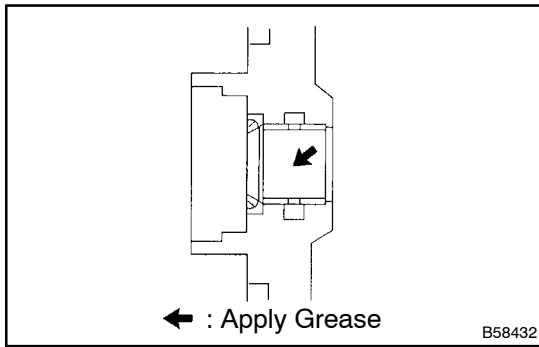
- (a) Install the holder to the drive lever with a pin.  
 (b) Apply grease to the portions of the drive lever.

**23. INSTALL STARTER CLUTCH SUB-ASSY**

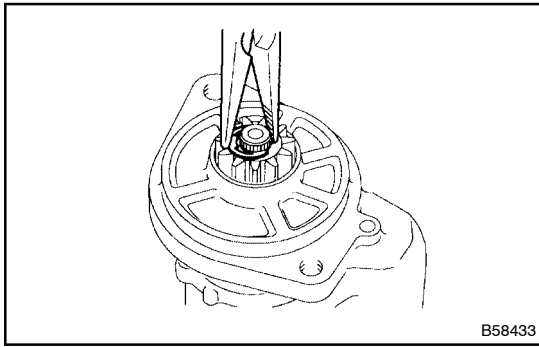
- (a) Apply grease to the portions of the starter clutch, and install the drive lever together with it to the starter drive housing.

**HINT:**

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

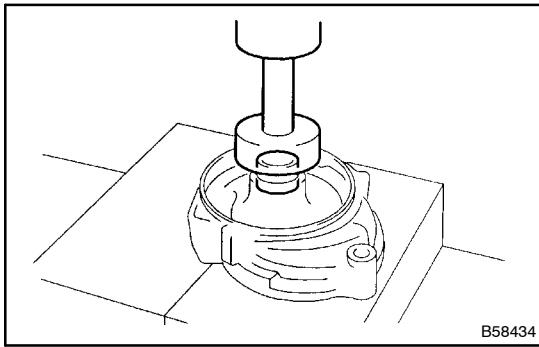


- (b) Apply much grease to the extent that it would overflow from the reservoir of the start drive housing.



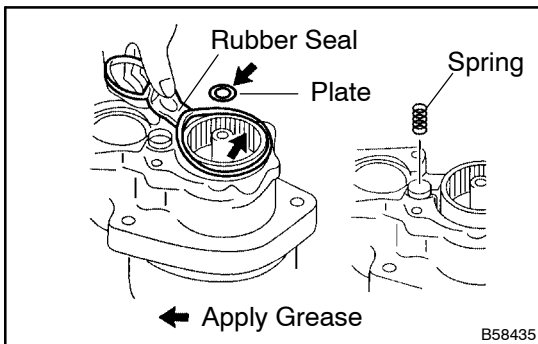
#### 24. INSTALL PINION GEAR

- (a) Install the pinion gear and new snap ring.



#### 25. INSTALL ARMATURE BEARING

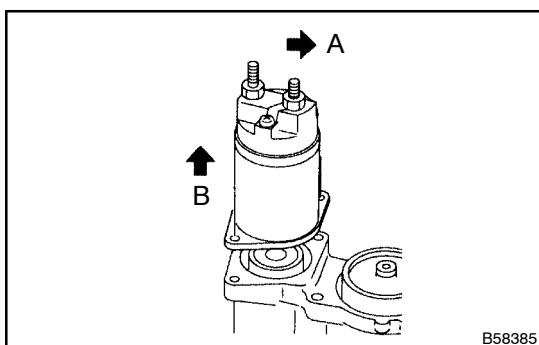
- (a) Using a press, install the bearing.



#### 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)**

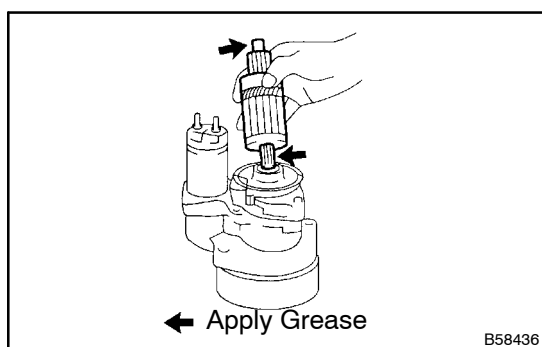


#### 27. INSTALL MAGNET STARTER SWITCH ASSY

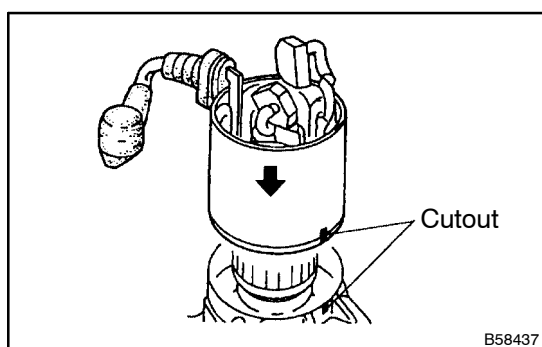
- (a) Attach the drive lever to the upper port of the main switch, in the direction A, then install it with the 2 bolts by inserting it the direction B.

**Torque: 14.7 N·m (150 kgf·cm, 11 ft·lbf)**

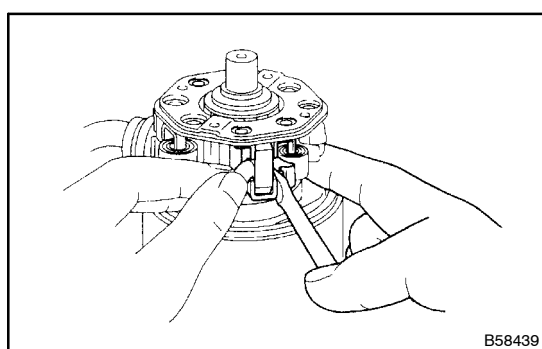


**28. INSTALL STARTER ARMATURE ASSY**

- (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**

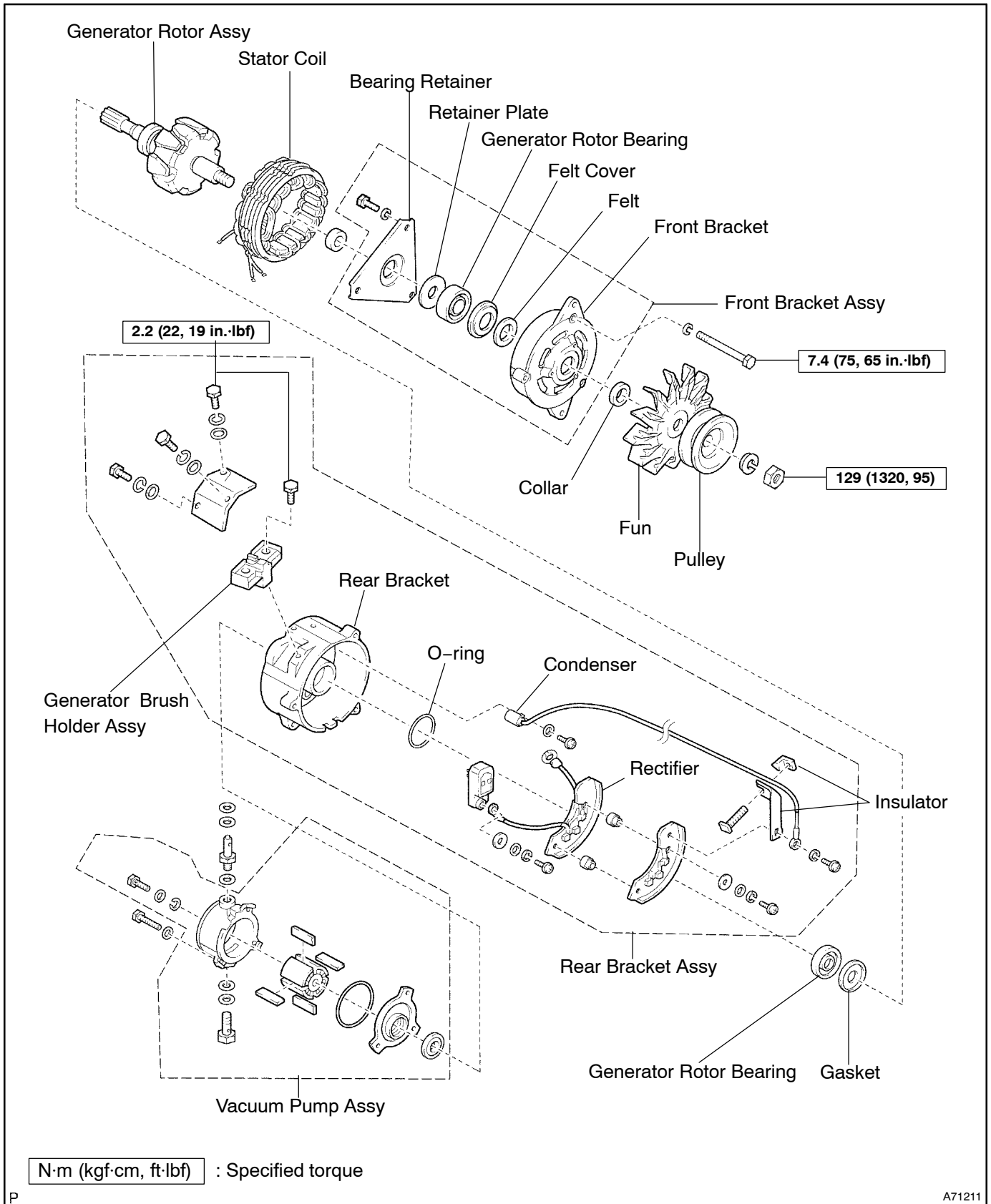
- (a) Place the brush holder on the armature.
- (b) Using a screwdriver, hold the brush spring back, and connect the brush into the brush holder. Connect the 4 brushes.

**31. INSTALL STARTER COMMUTATOR END FRAME ASSY**

- (a) Install the end frame and the 2 through bolts.  
**Torque: 14.7 N·m (150 kgf·cm, 11 ft·lbf)**
- (b) Install 2 new O-rings and the 2 screws to the end frame.  
**Torque: 4.3 N·m (44 kgf·cm, 38 in·lbf)**

# GENERATOR ASSY COMPONENTS

190KH-01



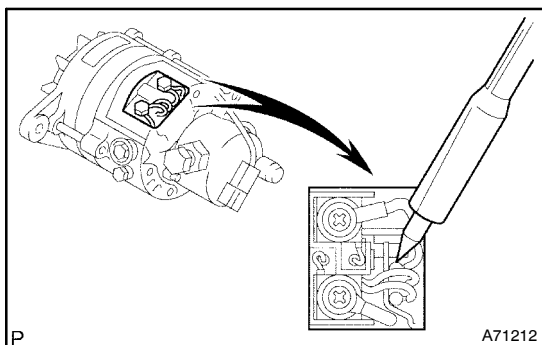
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## OVERHAUL

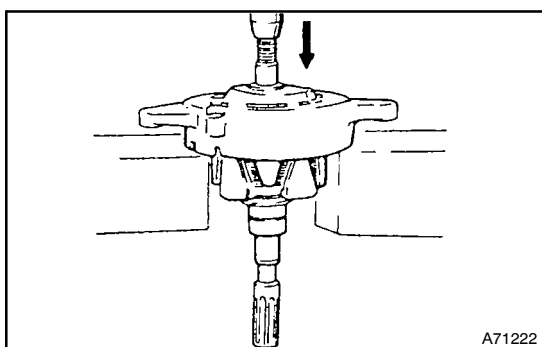
### HINT:

The following procedure is published important points for the generator overhaul.



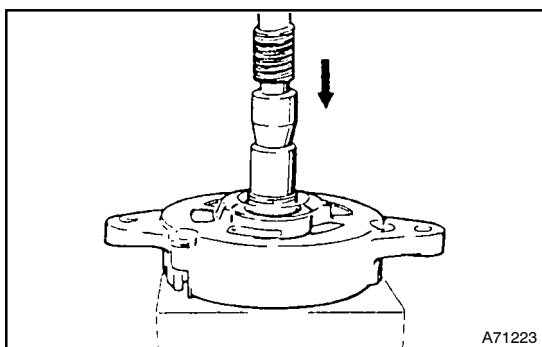
### 1. REMOVE GENERATOR BRUSH HOLDER ASSY

- (a) Unsolder the lead wire from the regulator.
- (b) Remove the brush holder assembly.



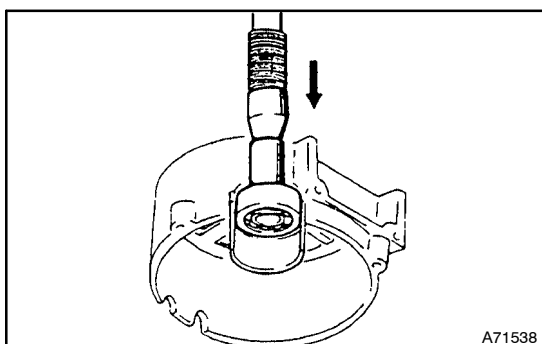
### 2. REMOVE GENERATOR ROTOR ASSY

- (a) Using a press, press out the rotor.

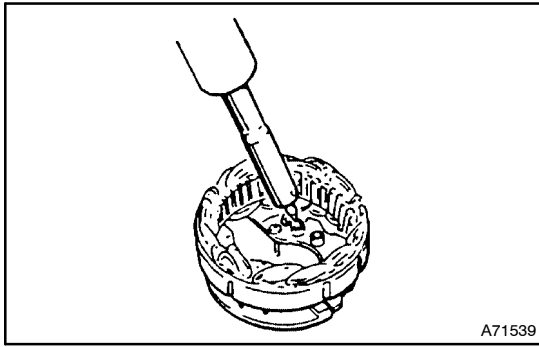


### 3. REMOVE GENERATOR ROTOR BEARING

- (a) Using a press, press out the front ball bearing.

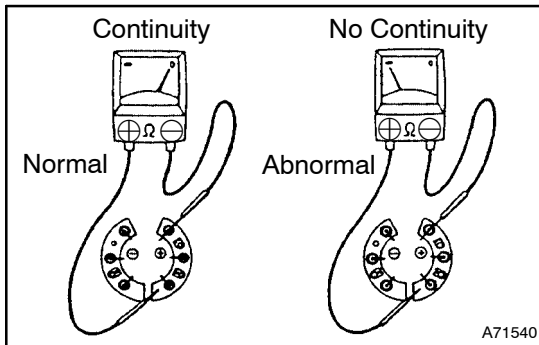


- (b) Using a press, press out the rear ball bearing.



#### 4. REMOVE STATOR COIL

- (a) Unsolder the each terminal of the stator coil and remove the stator coil.

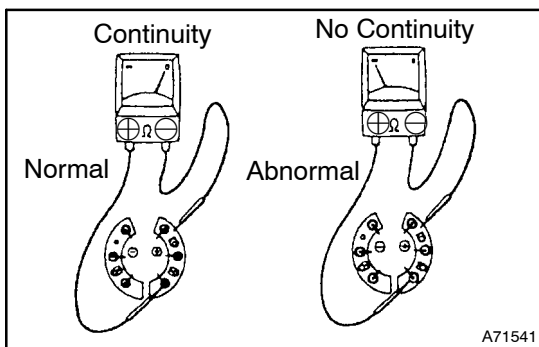


#### 5. INSPECT RECTIFIER

- (a) Check the positive side rectifier.

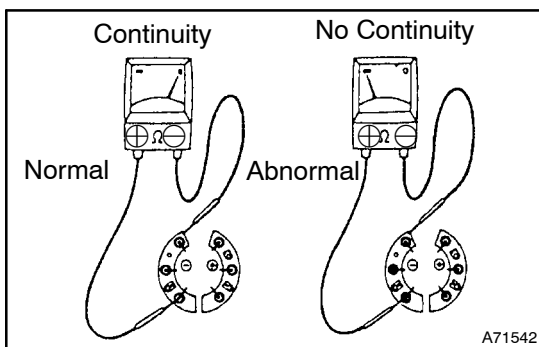
- (1) Connect the ohmmeter positive (+) lead to the rectifier holder and the (-) lead to the rectifier terminal.

If there is no continuity, replace the rectifier.



- (2) Connect the ohmmeter positive (+) lead to the rectifier terminal and the (-) lead to the rectifier holder.

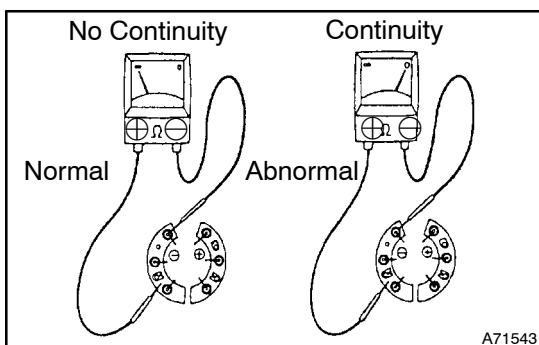
If there is no continuity, replace the rectifier.



- (b) Check the negative side rectifier.

- (1) Connect the ohmmeter positive (+) lead to the rectifier terminal and the (-) lead to the rectifier holder.

If there is no continuity, replace the rectifier.



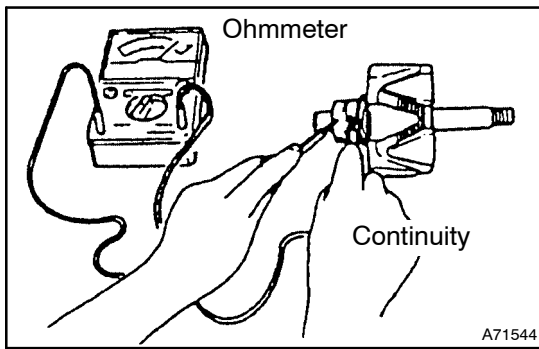
- (2) Connect the ohmmeter positive (+) lead to the rectifier terminal and the (-) lead to the rectifier holder.

If there is continuity, replace the rectifier.

#### 6. INSPECT GENERATOR ROTOR ASSY

- (a) Check that the slip rings are not rough or scored.

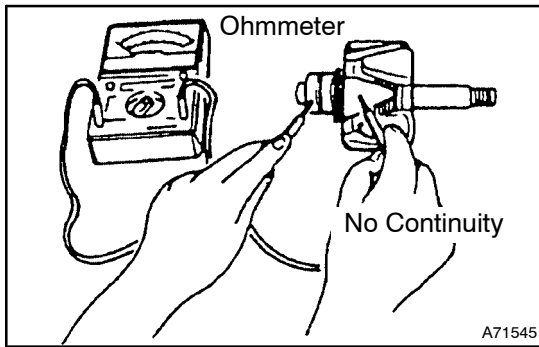
If rough or scored, replace the rotor assy.



- (b) Check for open circuit.
- (1) Using an ohmmeter, check that there is continuity between the slip rings.

**Standard resistance: 12.5  $\Omega$  at 20°C (68°F)**

If there is no continuity, replace the rotor assy.

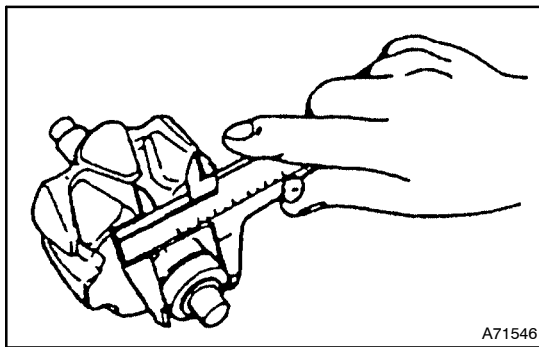


- (c) Check for ground.
- (1) Using an ohmmeter, check that there is no continuity between the slip ring and rotor body.

**Standard resistance: 1 M $\Omega$  or more at 20°C (68°F)**

**Minimum resistance: 0.5 M $\Omega$  or more at 20°C (68°F)**

If there is continuity, replace the rotor assy.

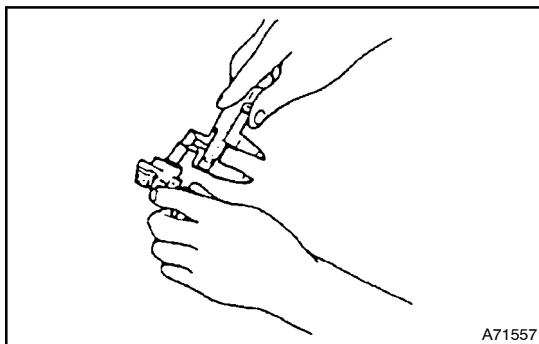


- (d) Using vernier calipers, measure the slip ring diameter.

**Standard diameter: 34.5 mm (1.358 in.)**

**Minimum diameter: 33.5 mm (1.319 in.)**

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



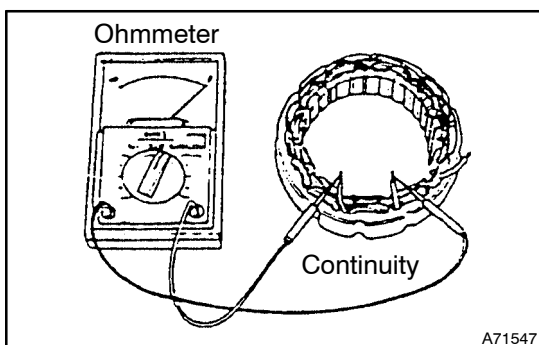
## 7. INSPECT GENERATOR BRUSH HOLDER ASSY

- (a) Using vernier calipers, measure the exposed brush length.

**Standard exposed length: 21.0 mm (0.827 in.)**

**Minimum exposed length: 7.0 mm (0.276 in.)**

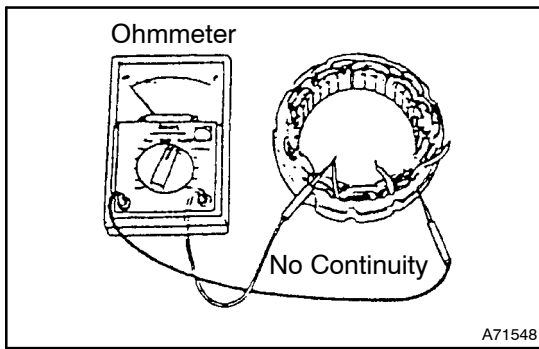
If the exposed length is less than minimum, replace the brush holder assy.



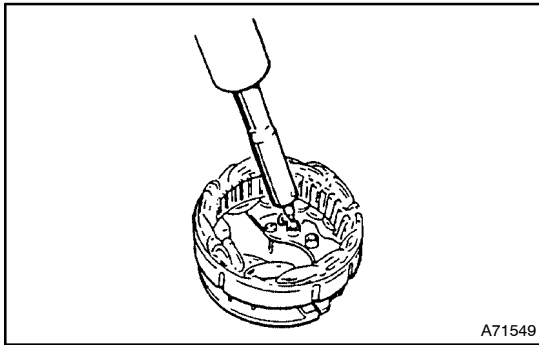
## 8. INSPECT STATOR COIL

- (a) Check for open circuit.
- (1) Using an ohmmeter, check that there is continuity between the coil leads.

If there is no continuity, replace the stator coil.

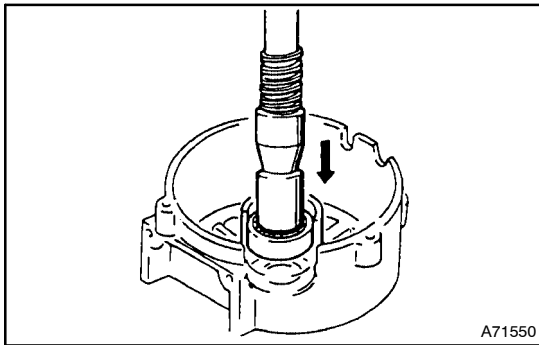


- (b) Check for ground.
- (1) Using an ohmmeter, check that there is no continuity between the coil lead and stator coil body.
- If there is continuity, replace the stator coil.



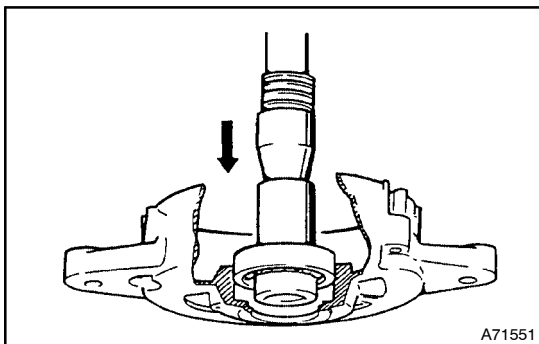
## 9. INSTALL STATOR COIL

- (a) Install the stator coil and solder each terminal of the stator coil.

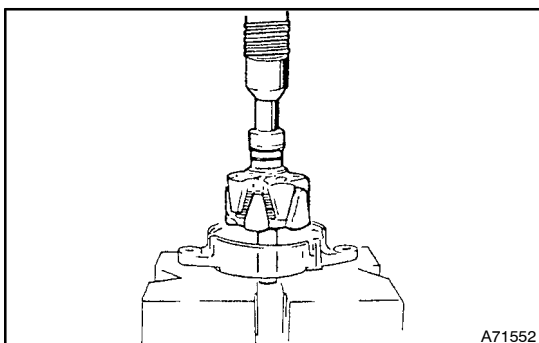


## 10. INSTALL GENERATOR ROTOR BEARING

- (a) Using a press, press in a new rear ball bearing.

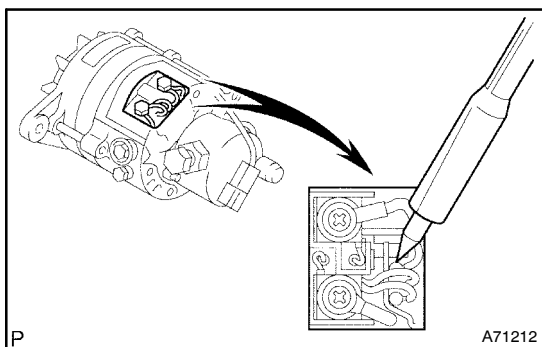


- (b) Using a press, press in a new front ball bearing.



## 11. INSTALL GENERATOR ROTOR ASSY

- (a) Using a press, press in the rotor into the front bracket.

**12. INSTALL GENERATOR BRUSH HOLDER ASSY**

- (a) Install the brush holder assembly.
- (b) Solder the lead wire to the regulator.

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