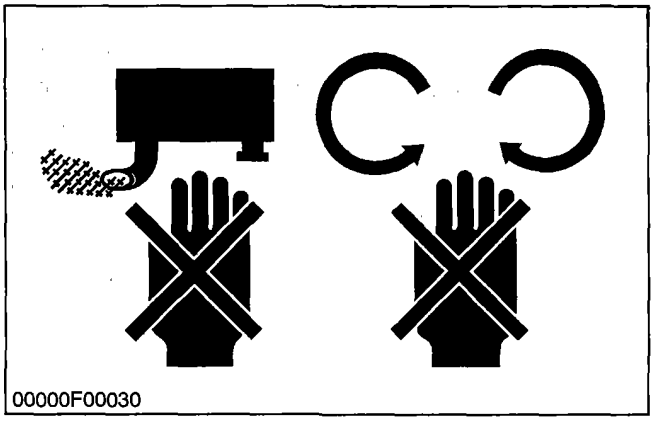

00000F00021

SAFETY STARTING

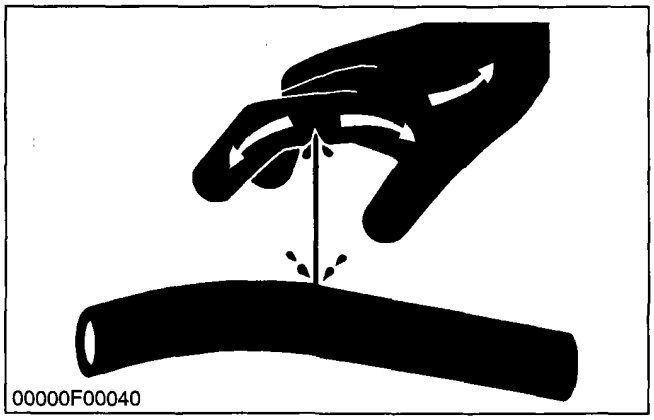
(1) Do not start the engine by shorting across starter terminals.
(2) Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

00000Z00031

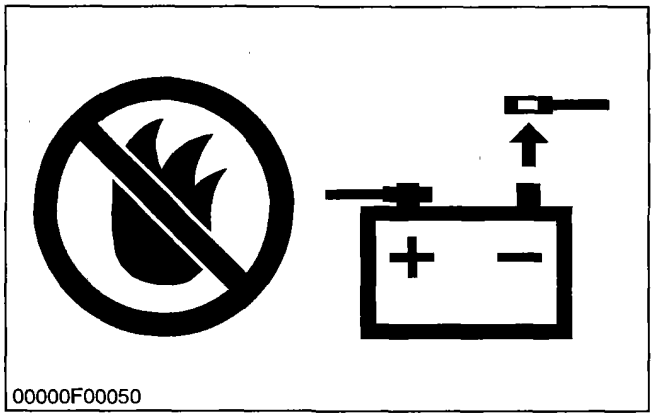

00000F00030

SAFETY WORKING

(1) Do not work on the engine while under the influence of alcohol, medication, or other substances or while fatigued.
(2) Wear close fitting clothing and safety equipment appropriate to the job.
(3) Use tools appropriate to the work. Makeshift tools, parts, and procedures are not recommended.
(4) When servicing is performed together by two or more persons, take care to perform all work safely.
(5) Do not touch the rotating or hot parts while the engine is running.
(6) Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Only remove radiator cap when cool enough to touch with bare hands. Slowly loosen the cap to first stop to relieve pressure before removing completely.
(7) Escaping fluid (fuel or hydraulic oil) under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting hydraulic or fuel lines. Tighten all connections before applying pressure.
(8) Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.


00000F00040

00000Z00041

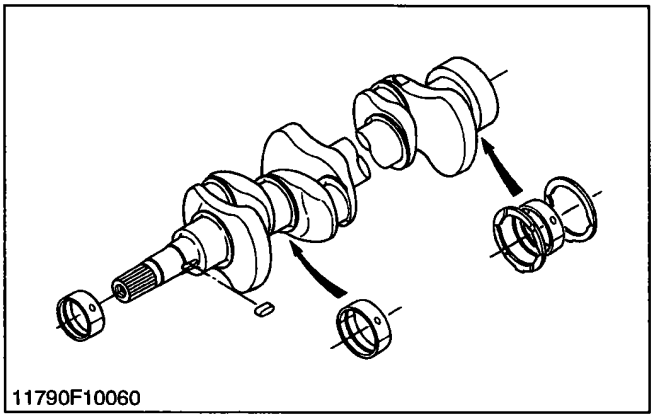

00000F00050

AVOID FIRES

(1) Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.
(2) To avoid sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
(3) Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.
(4) Make sure that no fuel has been spilled on the engine.

00000Z00050

[3] CRANKSHAFT


11790F10060

The crankshaft with the connecting rod converts the reciprocating motion of the piston into the rotating motion.

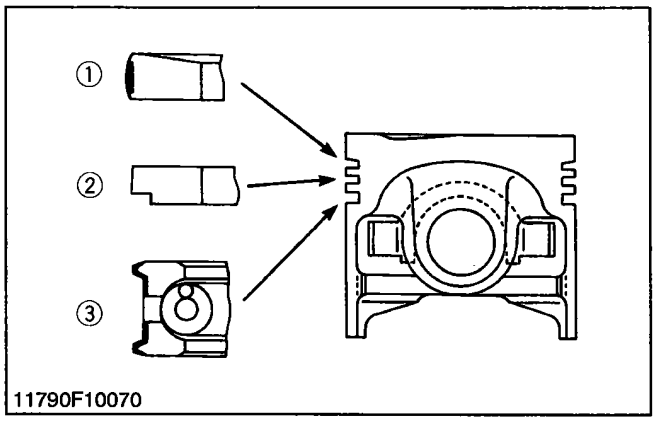
The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance.

The front journal is supported by a solid type bearing, the intermediate journal by a split type, and the rear journal by a split type with thrust bearings.

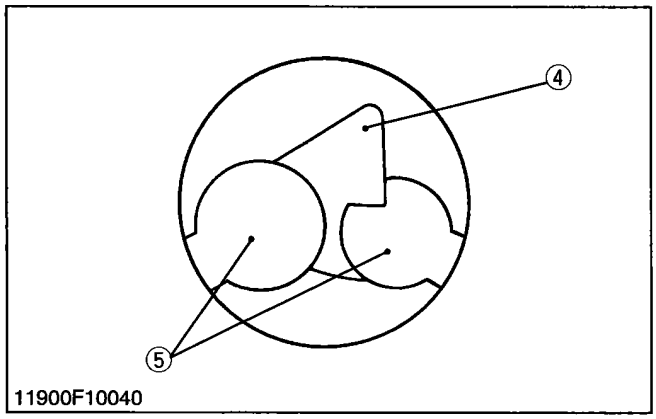
The crankshaft is provided with an oil gallery, through which engine oil is fed to the crankpin portion, and lubricates it.

11790M10040

[4] PISTON AND PISTON RINGS



11790F10070



11900F10040

The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a concave head.

Three rings are installed in grooves in the piston.

The top ring (1) is a keystone type, which can stand against heavy loads, and the barrel face on the ring fits well to the cylinder wall.

The second ring (2) is an undercut type, which effectively prevents the oil from being carried up.

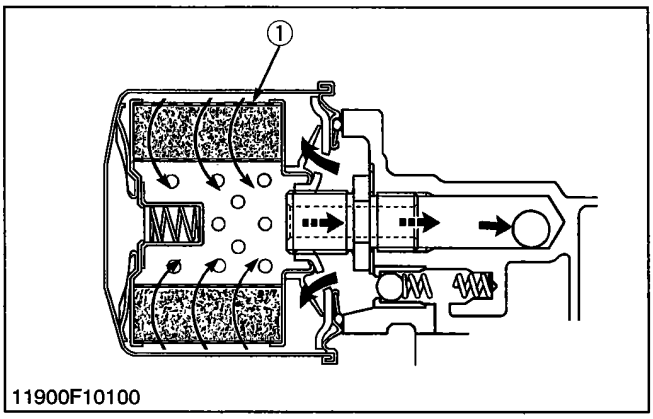
The oil ring (3) has chamfered contact faces and an expander ring, which increase the pressure of the oil ring against the cylinder wall.

Several grooves are cut on the top land to help heat dissipate and to prevent scuffing.

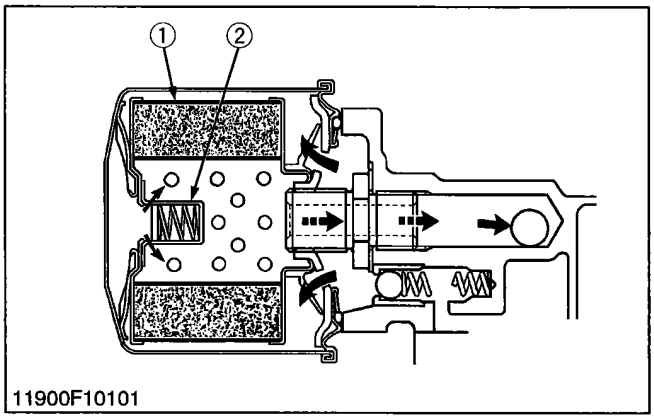
(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Depression
(5) Valve Recess

11900M10041

[4] OIL FILTER CARTRIDGE



11900F10100



11900F10101

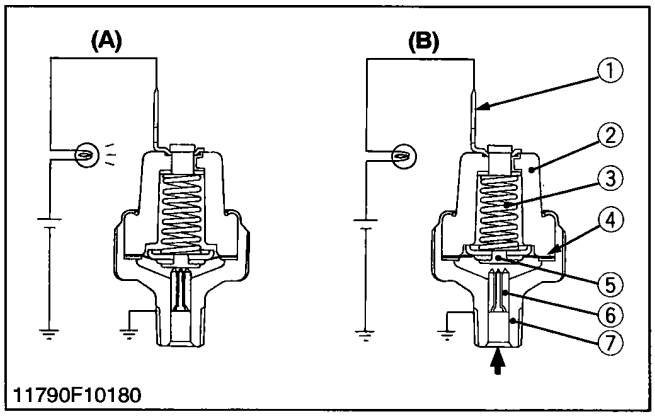
Impurities in engine oil can cause to wear and seize components as well as impairing the physical and chemical properties of the oil itself. Impurities contained in force-fed engine oil are absorbed on the filter paper for removal as they pass through the filter element (1).

When the filter element is clogged and the oil pressure in inlet line builds up by 98 kPa (1.0 kgf/cm^2, 14 psi) more than the outlet line, the bypass valve (2) opens and the oil flows from inlet to outlet bypassing the filter element.

(1) Filter Element
(2) Bypass Valve

11900M10120

[5] OIL PRESSURE SWITCH



11790F10180

The oil pressure switch is mounted on the cylinder block, to warn the operator that the lubricating oil pressure is poor.

If the oil pressure falls below 49 kPa (0.5 kgf/cm^2, 7 psi), the oil warning lamp will light up, warning the operator. In this case, stop the engine immediately and check the cause of pressure drop.

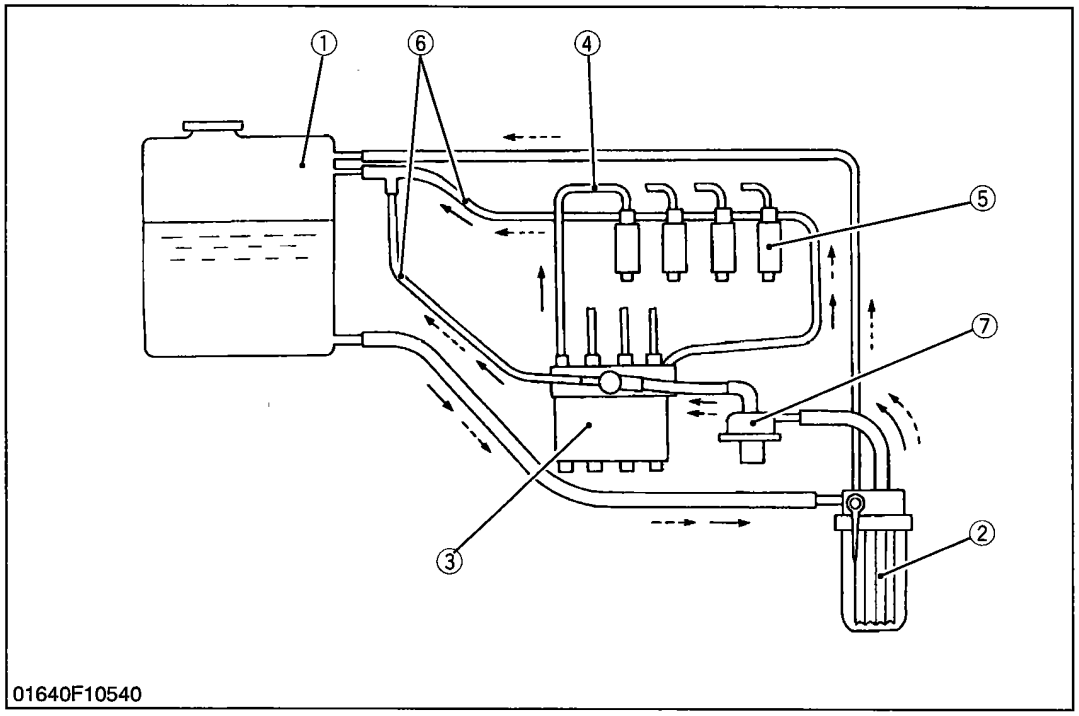
(1) Terminal
(2) Insulator
(3) Spring
(4) Rubber Gasket
(5) Contact Rivet
(6) Contact
(7) Oil Switch Body

(A) At Oil Pressures of 49 kPa (0.5 kgf/cm^2, 7 psi) or Less
(B) At Proper Oil Pressure

11790M10152

5 FUEL SYSTEM

[1] GENERAL



01640F10540

(1) Fuel Tank
(2) Fuel Filter
(3) Injection Pump
(4) Injection Pipe
(5) Injection Nozzle
(6) Fuel Overflow Pipe
(7) Fuel Feed Pump

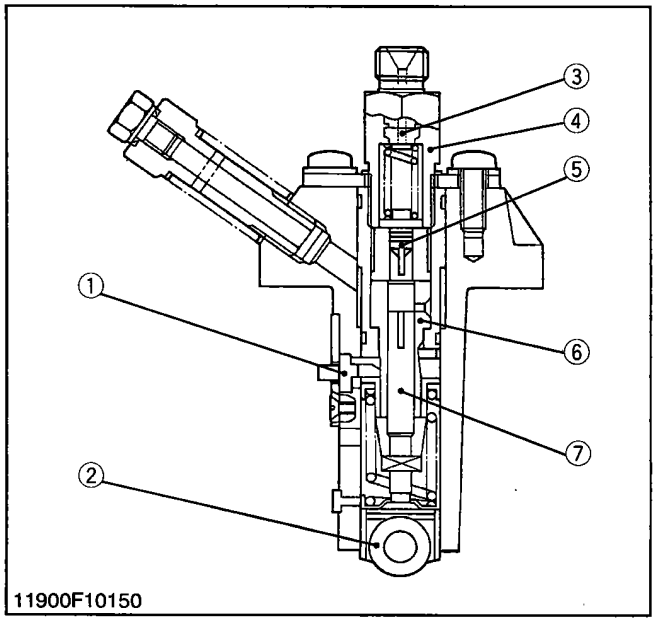
Fuel from the fuel tank (1) passes through the fuel filter (2), and then enters the injection pump (3) after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.73 to 14.71 MPa, 140 to 150 kgf/cm^2, 1991 to 2133 psi), of the injection nozzle (5) is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle (5) lubricates the moving parts of the plunger inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (6) from the upper part of the nozzle holder.

11900M10151

[2] INJECTION PUMP



11900F10150

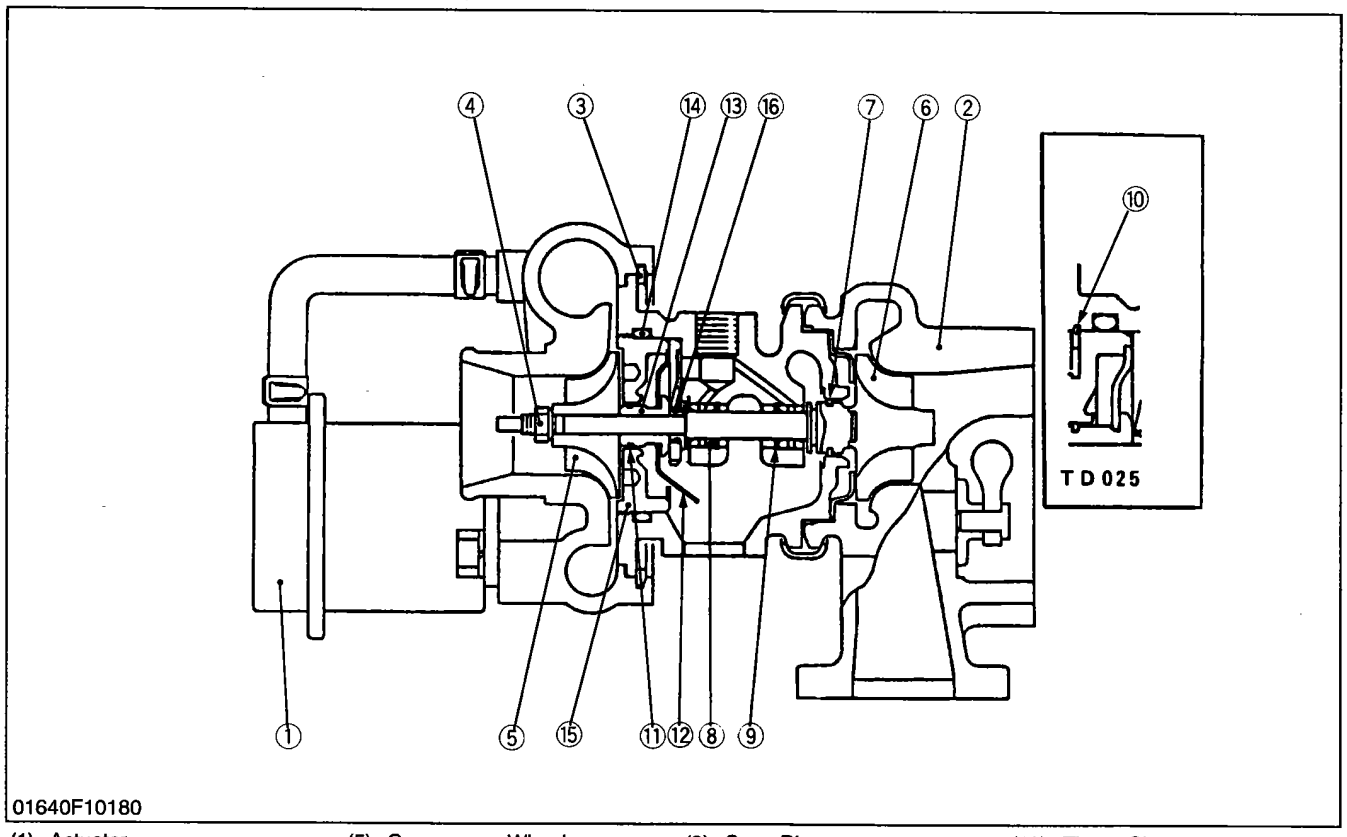
A Bosch MD type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (7) with a left-hand lead reciprocates via the tappet roller (2) by means of the fuel camshaft, causing the fuel to be delivered into the injection nozzle.

(1) Control Rack
(2) Tappet Roller
(3) Dumping Valve
(4) Delivery Valve Holder
(5) Delivery Valve
(6) Cylinder
(7) Plunger

11900M10170

7 TURBO CHARGER SYSTEM



01640F10180

(1) Actuator
(2) Turbine Housing
(3) Snap Ring
(4) Lock Nut
(5) Compressor Wheel
(6) Turbine Wheel
(7) Piston Ring
(8) Bearing
(9) Snap Ring
(10) Snap Ring (TD025)
(11) Piston Ring
(12) Oil Deflector
(13) Thrust Sleeve
(14) O-ring
(15) Thrust Bearing
(16) Thrust Ring

This turbo charger consists basically of a centrifugal compressor mounted on a common shaft with a double flow turbine driven by exhaust gas from the engine.

The turbo charger is capable of supplying far more air to the engine than for a non-supercharged engine, which is without such a charger.

In applications where the boost pressure is relatively low, the turbo charger is capable of reducing the smoke concentration, the concentration in the cylinder, fuel consumption, and deterioration in performance at elevated terrain by increasing the amount of air to the engine.

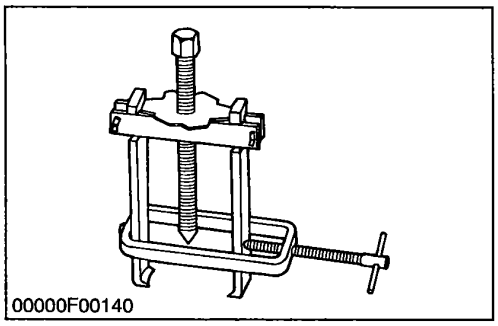
In applications where the boost pressure is high, the charger is capable of providing a large increase in engine output by increasing the amount of air into the engine, in addition to the above mentioned advantages.

01640M10070

Timing Gear

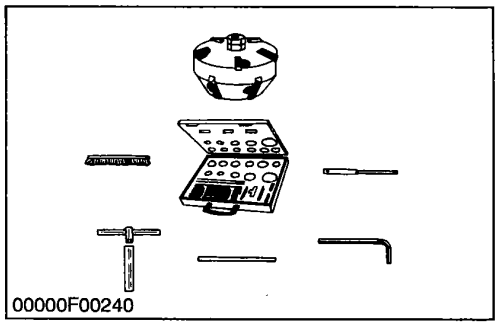
Item	Factory Specification	Allowable Limit
Timing Gear Backlash		
Crank Gear-Idle Gear 1	0.032 to 0.115 mm 0.0013 to 0.0045 in.	0.15 mm 0.0059 in.
Idle Gear 1-Cam Gear	0.036 to 0.114 mm 0.0014 to 0.0045 in.	0.15 mm 0.0059 in.
Idle Gear 1-Injection Pump Gear	0.034 to 0.116 mm 0.0013 to 0.0046 in.	0.15 mm 0.0059 in.
Idle Gear 1-Idle Gear 2	0.0033 to 0.117 mm 0.0013 to 0.0046 in.	0.15 mm 0.0059 in.
Idle Gear 2-Governor Gear	0.030 to 0.117 mm 0.0012 to 0.0046 in.	0.15 mm 0.0059 in.
Clearance between Idle Gear Shaft and Idle Gear Bushing		
Idle Gear 1	0.020 to 0.054 mm 0.0008 to 0.0021 in.	0.10 mm 0.0039 in.
Idle Gear Bushing I.D.	26.000 to 26.021 mm 1.0236 to 1.0244 in.	–
Idle Gear Shaft 1 O.D.	25.967 to 25.980 mm 1.0223 to 1.0228 in.	–
Idle Gear 2	0.020 to 0.054 mm 0.0008 to 0.0021 in.	0.10 mm 0.0039 in.
Idle Gear Bushing I.D.	26.000 to 26.021 mm 1.0236 to 1.0244 in.	–
Idle Gear Shaft 2 O.D.	25.967 to 25.980 mm 1.0223 to 1.0228 in.	–
Idle Gear Side Clearance		
Idle Gear 1	0.20 to 0.51 mm 0.0079 to 0.0200 in.	0.8 mm 0.0315 in.
Idle Gear 2	0.20 to 0.51 mm 0.0079 to 0.0200 in.	0.8 mm 0.315 in.

01640S10480


00000F00140

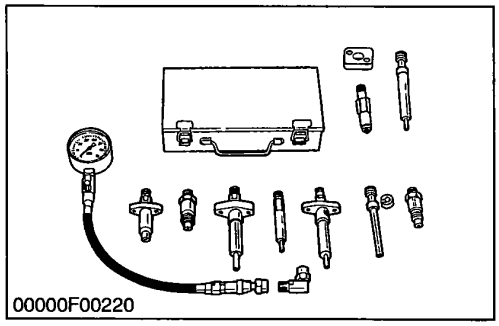
Special-use Puller Set
Code No: 07916-09032
Application: Use for pulling out bearings, gears and other parts.

01640S10190


00000F00240

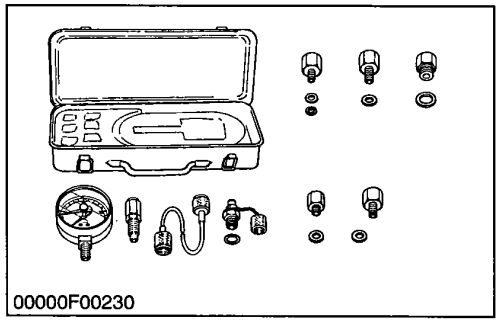
Valve Seat Cutter Set
Code No: 07909-33102
Application: Use for correcting valve seats.

01640S10200


00000F00220

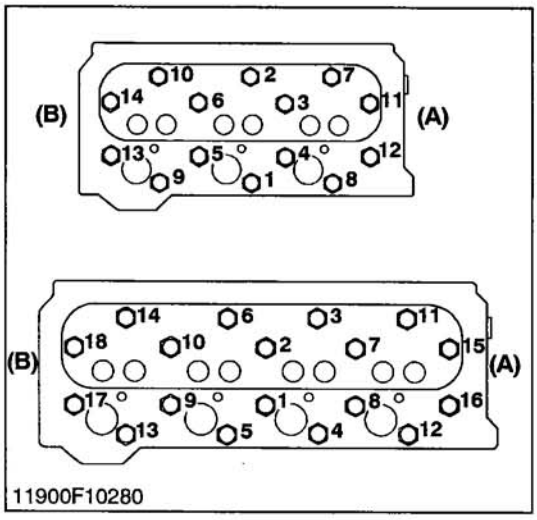
Diesel Engine Compression Tester
Code No: 07909-30207
Application: Use for measureing diesel engine compression pressure.

01640S10210


00000F00230

Oil Pressure Tester
Code No: 07916-32031
Application: Use for measureing lubricating oil pressure.

01640S10220



11900F10280

Cylinder Head

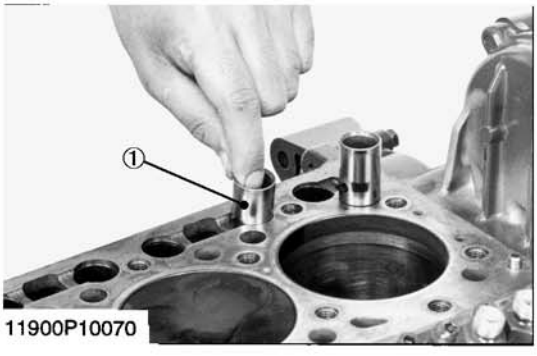
1. Loosen the pipe band, and remove the water return pipe.
2. Remove the cylinder head screws in the order of (14, 18) to (1), and remove the cylinder head.
3. Remove the cylinder head gasket and O-ring.

(When reassembling)

- Replace the head gasket with a new one.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head screwsgradually in the order of (1) to (14, 18) after applying engine oil.
- Retighten the cylinder head screws after running the engine for 30 minutes.

(A) Gear Case Side **(B) Flywheel Side**

11900S10072



11900P10070

Tappets

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

(When reassembling)

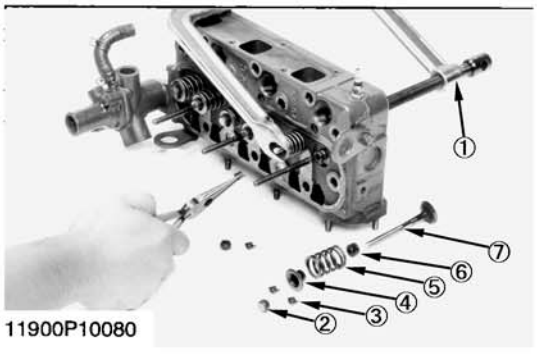
- Before installing the tappets, apply engine oil thinly around them.

■ IMPORTANT

- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet

11900S10081



11900P10080

Valves

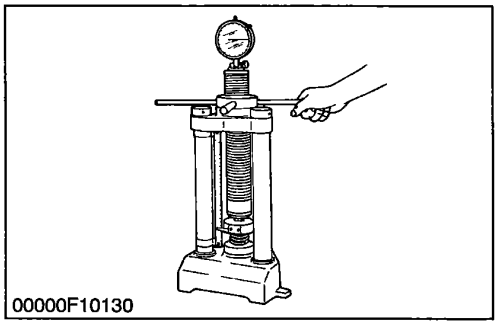
1. Remove the valve cap (2).
2. Remove the valve spring collet (3) with a valve lifter.
3. Remove the valve spring retainer (4), valve spring (5) and valve (7).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

(1) Valve Lifter
(2) Valve Cap
(3) Valve Spring Collet
(4) Valve Spring Retainer
(5) Valve Spring
(6) Valve Stem Seal
(7) Valve

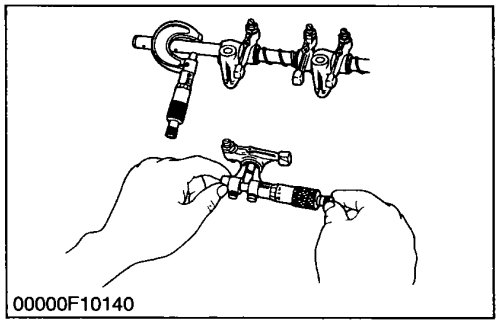
11900S10091


00000F10130

Valve Spring Setting Load

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

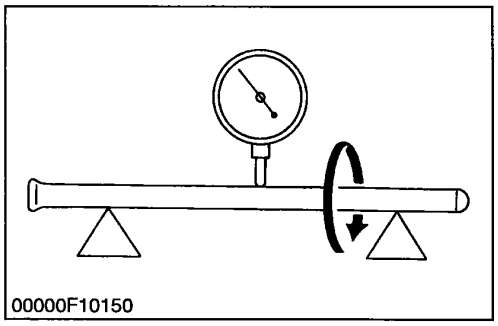
00000S10092


00000F10140

Oil Clearance between Rocker Arm Shaft and Beraing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

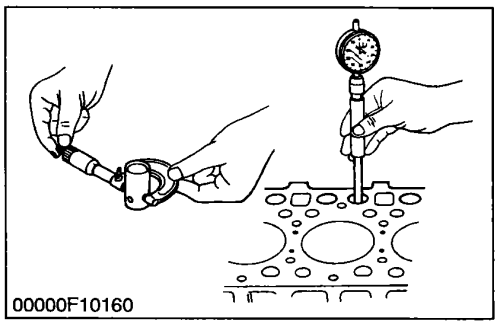
00000S10102


00000F10150

Push Rod Alignment

1. Check the both end of the push rod for cracks, damage and unusual wear.
2. Measure the bending of the push rod with a dial indicator.
3. If the measurement exceeds the allowable limit, replace the push rod.

00000S10111

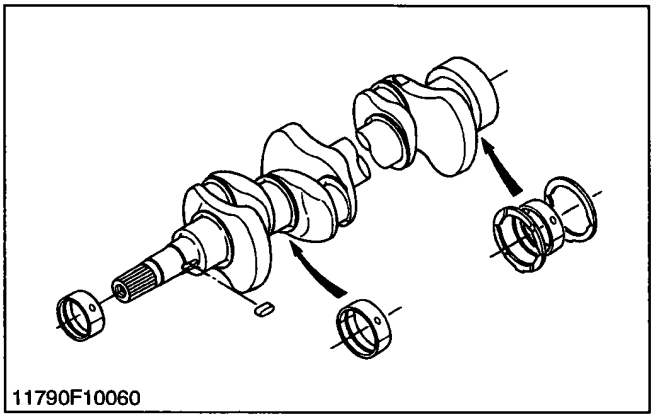

00000F10160

Oil Clearance between Tappet and Tappet Guide Bore

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

00000S10122

[3] CRANKSHAFT


11790F10060

The crankshaft with the connecting rod converts the reciprocating motion of the piston into the rotating motion.

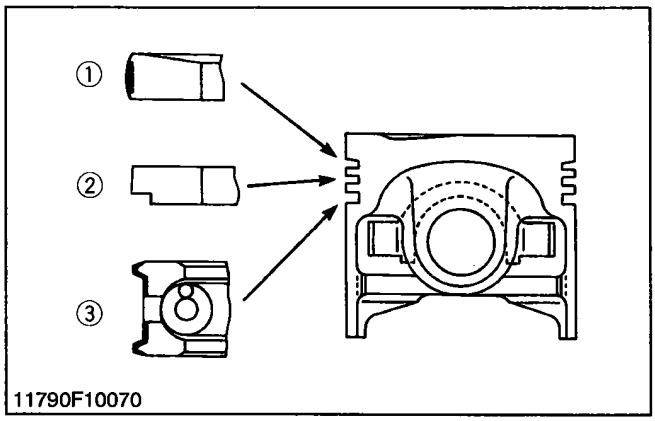
The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance.

The front journal is supported by a solid type bearing, the intermediate journal by a split type, and the rear journal by a split type with thrust bearings.

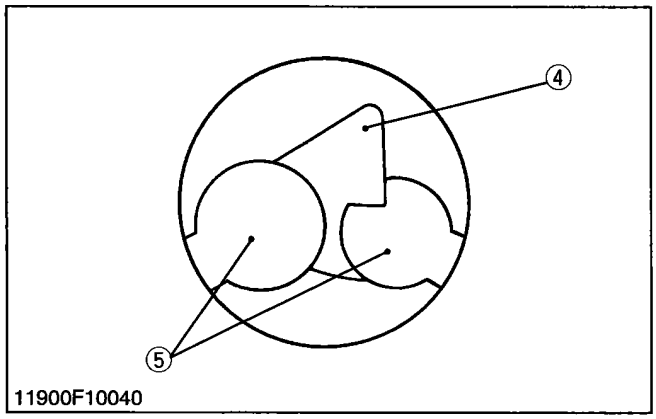
The crankshaft is provided with an oil gallery, through which engine oil is fed to the crankpin portion, and lubricates it.

11790M10040

[4] PISTON AND PISTON RINGS



11790F10070



11900F10040

The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a concave head.

Three rings are installed in grooves in the piston.

The top ring (1) is a keystone type, which can stand against heavy loads, and the barrel face on the ring fits well to the cylinder wall.

The second ring (2) is an undercut type, which effectively prevents the oil from being carried up.

The oil ring (3) has chamfered contact faces and an expander ring, which increase the pressure of the oil ring against the cylinder wall.

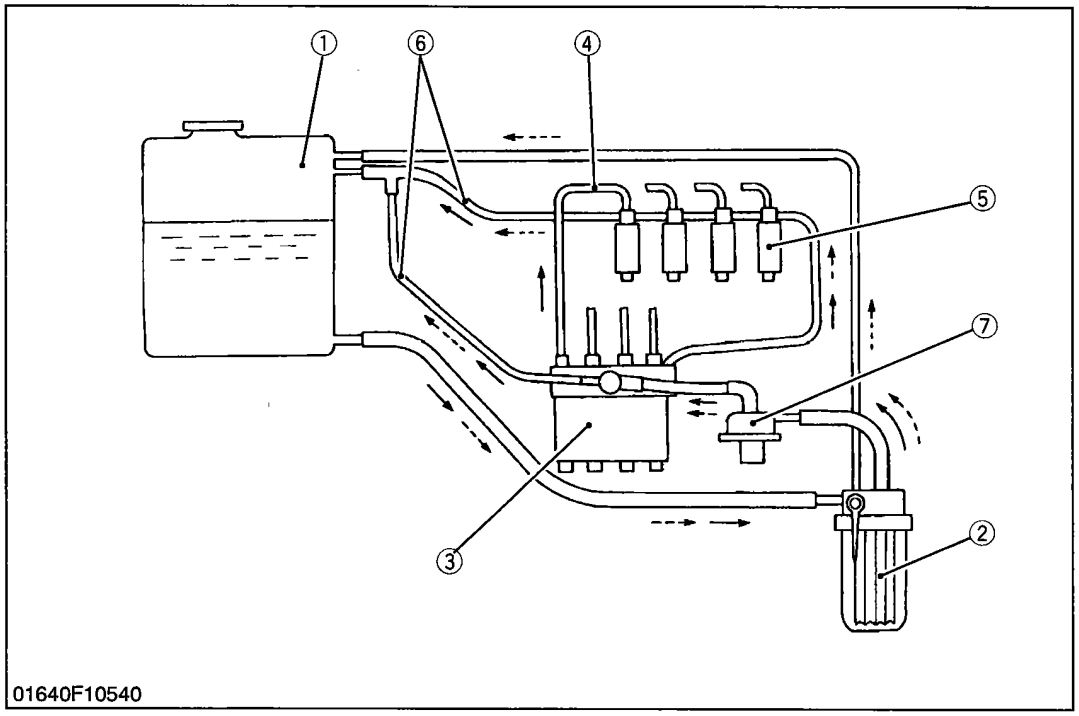
Several grooves are cut on the top land to help heat dissipate and to prevent scuffing.

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Depression
(5) Valve Recess

11900M10041

5 FUEL SYSTEM

[1] GENERAL



01640F10540

(1) Fuel Tank
(2) Fuel Filter
(3) Injection Pump
(4) Injection Pipe
(5) Injection Nozzle
(6) Fuel Overflow Pipe
(7) Fuel Feed Pump

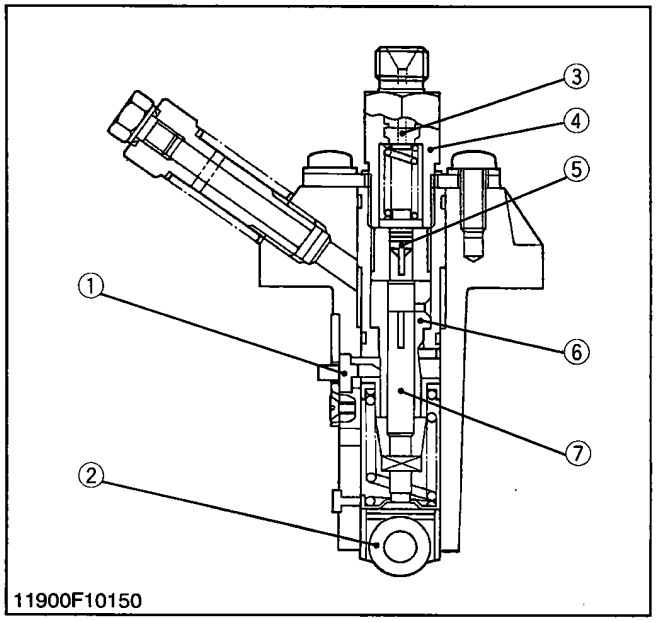
Fuel from the fuel tank (1) passes through the fuel filter (2), and then enters the injection pump (3) after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.73 to 14.71 MPa, 140 to 150 kgf/cm^2, 1991 to 2133 psi), of the injection nozzle (5) is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle (5) lubricates the moving parts of the plunger inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (6) from the upper part of the nozzle holder.

11900M10151

[2] INJECTION PUMP



11900F10150

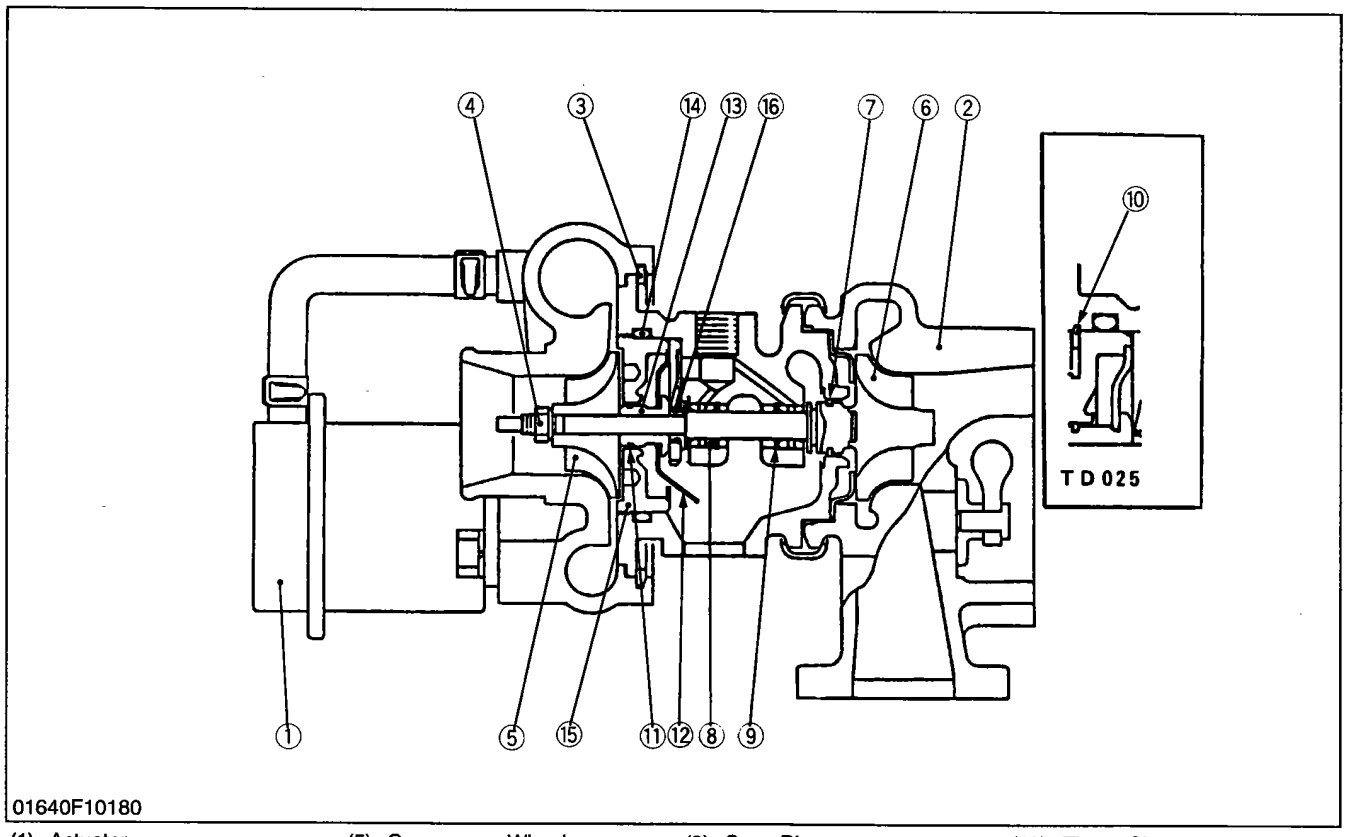
A Bosch MD type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (7) with a left-hand lead reciprocates via the tappet roller (2) by means of the fuel camshaft, causing the fuel to be delivered into the injection nozzle.

(1) Control Rack
(2) Tappet Roller
(3) Dumping Valve
(4) Delivery Valve Holder
(5) Delivery Valve
(6) Cylinder
(7) Plunger

11900M10170

7 TURBO CHARGER SYSTEM



01640F10180

(1) Actuator
(2) Turbine Housing
(3) Snap Ring
(4) Lock Nut
(5) Compressor Wheel
(6) Turbine Wheel
(7) Piston Ring
(8) Bearing
(9) Snap Ring
(10) Snap Ring (TD025)
(11) Piston Ring
(12) Oil Deflector
(13) Thrust Sleeve
(14) O-ring
(15) Thrust Bearing
(16) Thrust Ring

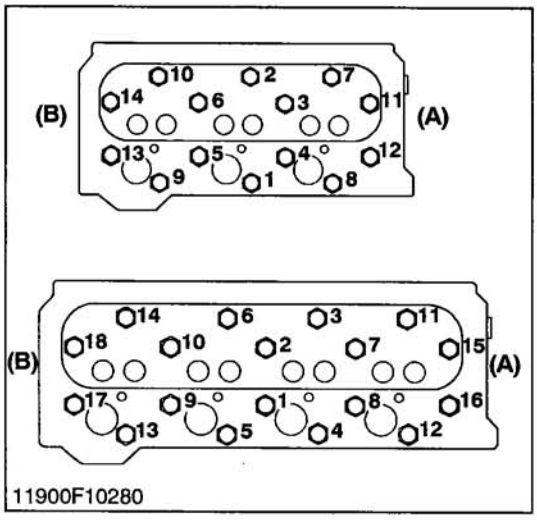
This turbo charger consists basically of a centrifugal compressor mounted on a common shaft with a double flow turbine driven by exhaust gas from the engine.

The turbo charger is capable of supplying far more air to the engine than for a non-supercharged engine, which is without such a charger.

In applications where the boost pressure is relatively low, the turbo charger is capable of reducing the smoke concentration, the concentration in the cylinder, fuel consumption, and deterioration in performance at elevated terrain by increasing the amount of air to the engine.

In applications where the boost pressure is high, the charger is capable of providing a large increase in engine output by increasing the amount of air into the engine, in addition to the above mentioned advantages.

01640M10070



11900F10280

Cylinder Head

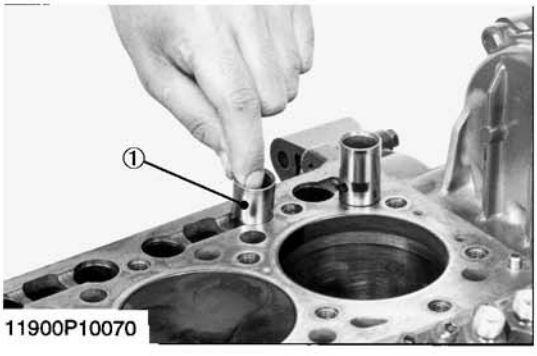
1. Loosen the pipe band, and remove the water return pipe.
2. Remove the cylinder head screws in the order of (14, 18) to (1), and remove the cylinder head.
3. Remove the cylinder head gasket and O-ring.

(When reassembling)

- Replace the head gasket with a new one.
- Install the cylinder head, using care not to damage the O-ring.
- Tighten the cylinder head screwsgradually in the order of (1) to (14, 18) after applying engine oil.
- Retighten the cylinder head screws after running the engine for 30 minutes.

(A) Gear Case Side **(B) Flywheel Side**

11900S10072



11900P10070

Tappets

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

(When reassembling)

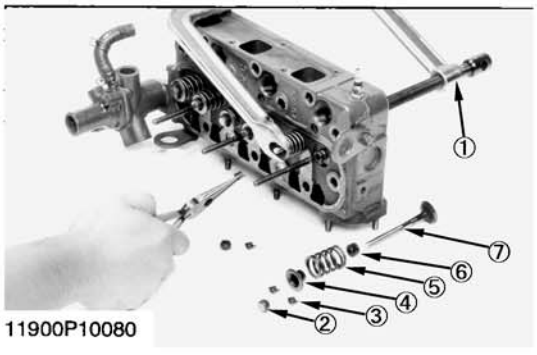
- Before installing the tappets, apply engine oil thinly around them.

■ IMPORTANT

- **Mark the cylinder number to the tappets to prevent interchanging.**

(1) Tappet

11900S10081



11900P10080

Valves

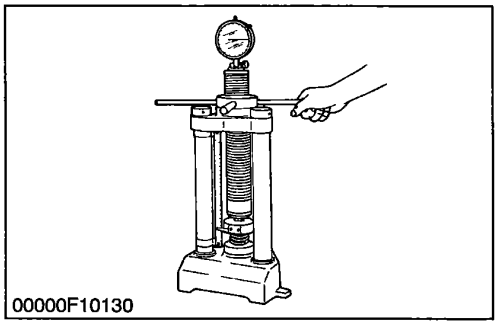
1. Remove the valve cap (2).
2. Remove the valve spring collet (3) with a valve lifter.
3. Remove the valve spring retainer (4), valve spring (5) and valve (7).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently
- After installing the valve spring collets, lightly tap the stem to assure proper fit with a plastic hammer.

(1) Valve Lifter
(2) Valve Cap
(3) Valve Spring Collet
(4) Valve Spring Retainer
(5) Valve Spring
(6) Valve Stem Seal
(7) Valve

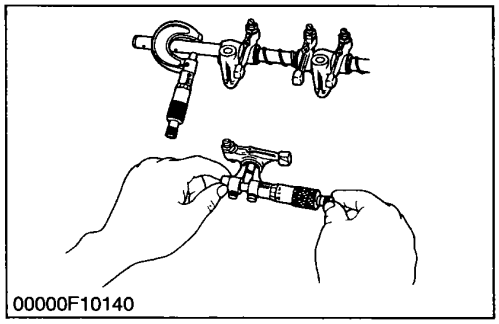
11900S10091


00000F10130

Valve Spring Setting Load

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

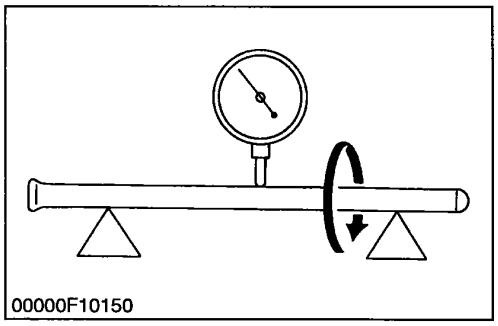
00000S10092


00000F10140

Oil Clearance between Rocker Arm Shaft and Beraing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

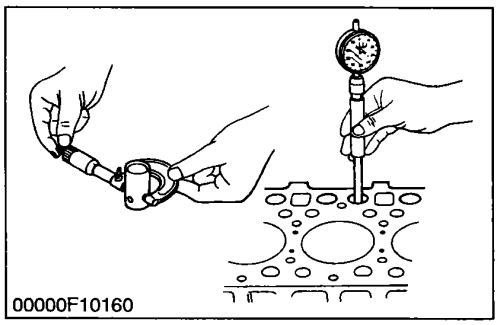
00000S10102


00000F10150

Push Rod Alignment

1. Check the both end of the push rod for cracks, damage and unusual wear.
2. Measure the bending of the push rod with a dial indicator.
3. If the measurement exceeds the allowable limit, replace the push rod.

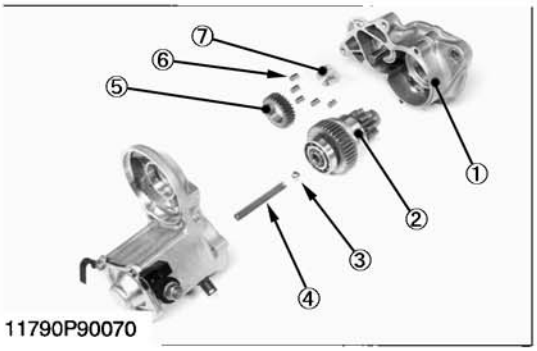
00000S10111


00000F10160

Oil Clearance between Tappet and Tappet Guide Bore

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

00000S10122



11790P90070

Disassembling Magnet Switch

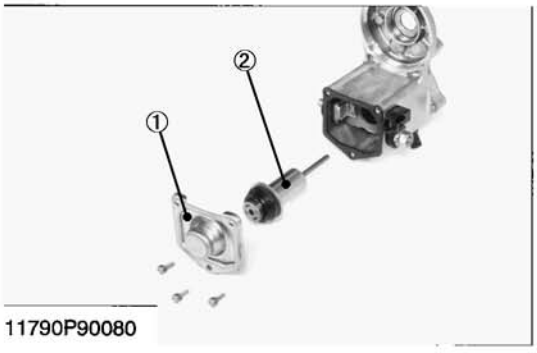
1. Remove the drive end frame (1) mounting screws.
2. Take out the over running clutch (2), ball (3), spring (4), gear (5), rollers (6) and retainer (7).

(When reassembling)

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

(1) Drive End Frame
(2) Over Running Clutch
(3) Ball
(4) Spring
(5) Gear
(6) Roller
(7) Retainer

11790S90210



11790P90080

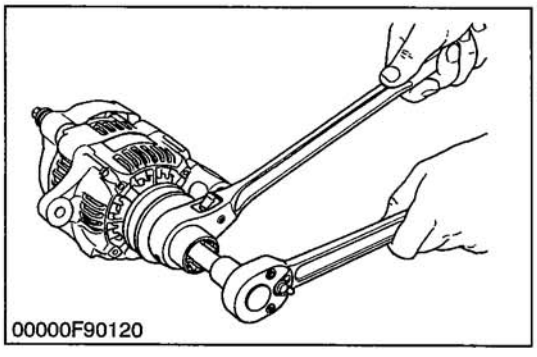
Plunger

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

(1) End Cover
(2) Plunger

11790S90220

[2] ALTERNATOR


00000F90120

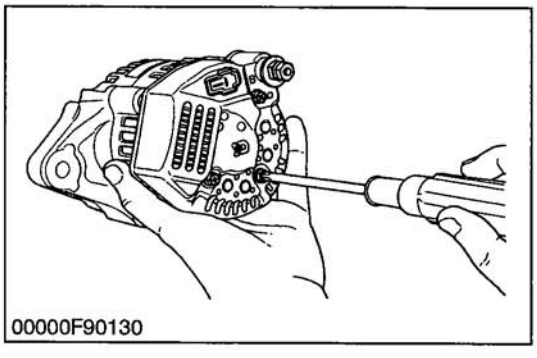
Pulley

1. Secure the hexagonal end of the pulley shaft with a double-ended ratchet wrench as shown in the figure, loosen the pulley nut with a socket wrench and remove it.

(When reassembling)

Tightening torque	Pulley nut	58.3 to 78.9 N·m 5.95 to 8.05 kgf·m 43.0 to 58.2 ft-lbs

00000S90080


00000F90130

Rear End Cover

1. Unscrew the three rear end cover screws and the **B** terminal nut, and remove the rear end cover.

00000S90090