SPECIFICATIONS

ENGINE SPECIFICATIONS

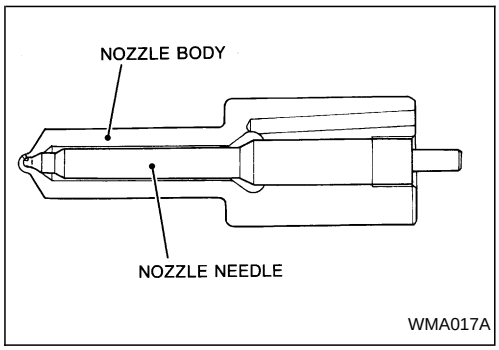
Item	Engine model	PF6TB-21	PF6TB-22	PF6TC
Max. output (SAE)	kW {PS}/rpm	257 {350}/2,100		279 {380}/2,100
Type		Diesel		
Aspiration system		Turbocharger with intercooler		
Cooling method		Water cooled		
Number of cylinders and cylinder arrangement		6, in-line		
Stroke cycle		4		
Combustion chamber		Direct fuel injection		
Valve mechanism		Overhead		
Cylinder liner		Dry		
Bore x stroke	mm (in)	133.0 x 150.0 (5.24 x 5.91)		
Total displacement	cm^3 (cu in)	12,503 (763)		
Compression ratio		16.5		
Cylinder compression	kPa {kgf/cm^2, psi}/rpm	3,040 {31, 441}/200±20		
Max. engine speed under full load conditions		2,480		2,300
Idle speed		430 - 530	550 - 570	510 - 610
Number of piston rings	Compression ring	2		
	Oil ring	1		
Valve timing	Intake, Open (B.T.D.C.)	16°		
	Intake, Closed (A.B.D.C.)	20°		
	Exhaust, Open (B.B.D.C.)	52°		
	Exhaust, Closed (A.T.D.C.)	12°		
Lubrication system: Valve clearance mm (in)	Intake	0.30 - 0.40 (0.012 - 0.016)		
	Exhaust	0.30 - 0.40 (0.012 - 0.016)		
Lubrication system: Lubrication system		Forced-circulation type		
Lubrication system: Oil pump	Type	Gear pump		
	Discharge amount ℓ (Imp gal)/rpm	174 (38-1/4)/2,300		
	Relief valve opening pressure kPa {kgf/cm^2, psi}	1,177 {12.0, 171}		
Lubrication system: Oil filter	Type, Full-flow	Paper element type		
	Type, By-pass	Paper element type		
	Replacement method	Disassembly type		
	Short valve opening pressure kPa {kgf/cm^2, psi}	98 - 137 {1.0 - 1.4, 14 - 20}		
Lubrication system: Oil cooler	Type	Water cooled flat tube type		
	Number of cores	5		
	Short valve opening pressure kPa {kgf/cm^2, psi}	304 - 343 {3.1 - 3.5, 44 - 50}		
Lubrication system: Regulator valve opening pressure	kPa {kgf/cm^2, psi}	392 - 432 {4.0 - 4.4, 57 - 63}		
Lubrication system: Lubrication oil capacity ℓ (Imp gal)	System total capacity	29 (6-3/8)		
	Oil pan, H-level	21 (4-5/8)		
	Oil pan, L-level	14 (3-1/8)		

TIGHTENING TORQUE

Unit: N·m {kgf·m, ft·lbf}

Item				Tightening torque	Remarks
Basic mechanical system	Valve clearance adjusting screw lock nut			34 - 44 {3.5 - 4.5, 25 - 33}	
	Cylinder head bolt	Snug torque (1st)		88 - 98 {9.0 - 10.0, 65 - 72}	
		Tightening angle (2nd)	L = 147 mm (5.79 in)	85° - 95°	
			L = 119 mm (4.69 in)	70° - 80°	
	Cylinder head sub bolt	1st		34 {3.5, 25}	
		2nd		44 - 54 {4.5 - 5.5, 33 - 40}	
	Air intake manifold mounting bolt and nut			49 - 54 {5.0 - 5.5, 36 - 40}	
	Exhaust manifold mounting nut			29 - 44 {3.0 - 4.5, 22 - 33}	
	Crank damper mounting bolt			98 - 108 {10.0 - 11.0, 72 - 80}	
	Compression gauge bolt			25 - 29 {2.5 - 3.0, 18 - 22}	
Lubrication system	Oil pan drain plug			98 - 127 {10.0 - 13.0, 72 - 94}	
	Oil filter	Full-flow type	Center bolt	59 - 69 {6.0 - 7.0, 43 - 51}	
			Drain plug	16 - 22 {1.6 - 2.2, 12 - 16}	
		Bypass type	Center bolt	59 - 69 {6.0 - 7.0, 43 - 51}	
			Drain plug	16 - 22 {1.6 - 2.2, 12 - 16}	
Fuel system	Injection pump drive coupling	Coupling bolt and nut		103 - 113 {10.5 - 11.5, 76 - 83}	
		Cotter bolt		147 - 167 {15.0 - 17.0, 108 - 123}	
	Injection nozzle retaining nut			59 - 78 {6.0 - 8.0, 43 - 58}	
	Nozzle holder assembly mounting bolt			25 - 29 {2.5 - 3.0, 18 - 22}	
	Fuel filter	Cartridge type		Apply film of engine oil to gasket and screw on until gasket contacts engine, then tighten 3/4 turn by hand or UD genuine filter wrench	
		Bypass type	Center bolt	59 - 69 {6.0 - 7.0, 43 - 51}	
			Drain plug	16 - 22 {1.6 - 2.2, 12 - 16}	
Air intake and exhaust system	Turbocharger	Model TD45	Turbine housing and center housing mounting V-band lock nut N·m {kgf·m, ft·lbf}	17.0 {1.73, 12.5} → Loosen → 13.7 {1.40, 10.1}	
			Compressor housing and back plate clamp mounting bolt N·m {kgf·m, ft·lbf}	9.0 - 11.3 {0.92 - 1.15, 6.7 - 8.3}	
		Model GT45	Turbine housing and center housing mounting V-band lock nut N·m {kgf·cm, in·lbf}	12.7 - 14.7 {130 - 150, 113 - 130}	
			Compressor housing and back plate mounting bolt N·m {kgf·cm, in·lbf}	10.3 - 12.3 {105 - 125, 91 - 109}	
		Model GT42	Turbine housing and center housing mounting V-band lock nut N·m {kgf·cm, in·lbf}	12.7 - 14.7 {130 - 150, 113 - 130}	
			Compressor housing and back plate mounting bolt N·m {kgf·cm, in·lbf}	10.3 - 12.3 {105 - 125, 91 - 109}	

4. Pull the nozzle needle from the nozzle body.



NOTE

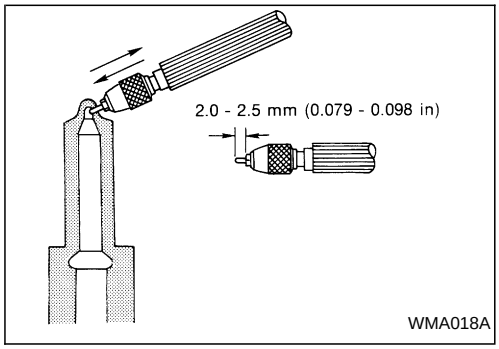
- **Do not use the nozzle needle in another nozzle body.**

5. Remove carbon from around the openings by using the corner of a hard piece of wood. Do not use waste or any other material to push carbon into the openings.

6. Removing carbon in openings
   Use the pin vice (99727 Z5005) and wire to clean the openings.

Unit: mm (in)

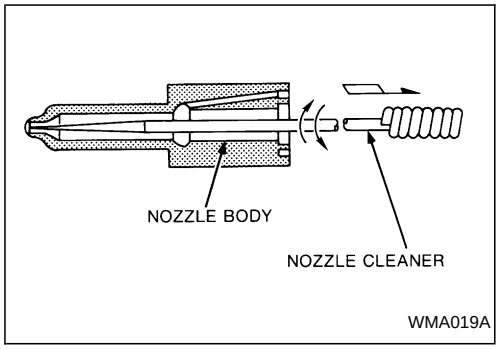
Nozzle identification mark	Number of injection nozzle holes	Injection nozzle hole diameter	Wire diameter
K4	6	0.31 (0.0122)	0.29 (0.0114)
K6		0.27 (0.0106)	0.26 (0.0102)
K8	7	0.26 (0.0102)	0.25 (0.0098)



- Allowing too much wire to protrude at the tip of the holder will permit the wire to bend inside the nozzle, in which case withdrawal proves difficult. The wire should protrude no more than 2.0 to 2.5 mm (0.079 to 0.098 in).
- Carefully push the carbon into the nozzle. Too much force will bend the wire. Proceed slowly.

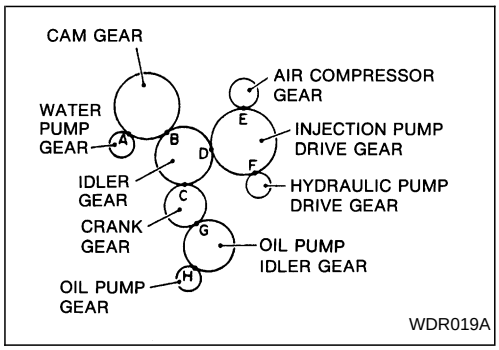
- Remove carbon at the inside end of the openings with the nozzle cleaner (99726 Z5000).
  Exercise care to avoid damaging the surface which the nozzle needle contacts. The use of compressed air may clog the openings with foreign particles.

7. Tighten the retaining nut.
   T : 59 - 78 N·m {6.0 - 8.0 kgf·m, 43 - 58 ft·lbf}



20. Measure the backlash of the gear train.

NOTE
- **Measure the backlash by inserting fuse wire between the gears.**
- **When the air compressor and water pump have been removed, temporarily install them and measure the gear backlash.**
- **Check that the backlash for each gear is within the service limit.**



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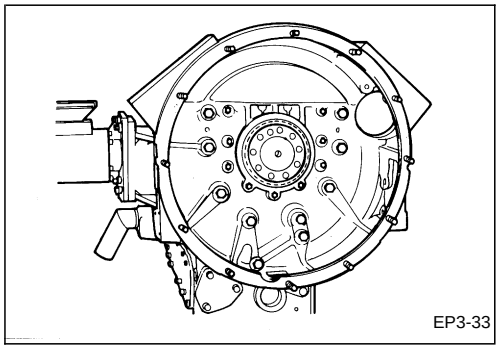
Unit: mm (in)

Location	Maintenance standard	Service limit
A.B.C.D.E.F	0.065 - 0.135 (0.0026 - 0.0053)	—
G.H	0.085 - 0.215 (0.0033 - 0.0085)	—

21. Install the rear oil slinger and flywheel housing.

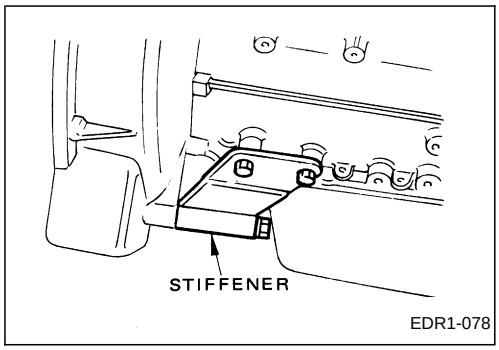
M8
T : 21 N·m {2.1 kgf·m, 15 ft·lbf}
M12
T : 71 N·m {7.2 kgf·m, 52 ft·lbf}

NOTE
- **When an engine rear PTO is equipped, be sure to install the special PTO parts prior to installing the flywheel housing.**
- **Install the flywheel housing by suspending it with a belt using a hoist.**


EP3-33

22. Install the right and left stiffeners.

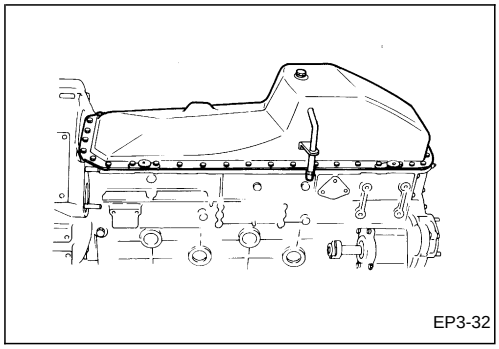
Housing side
T : 74 - 88 N·m {7.5 - 9.0 kgf·m, 54 - 65 ft·lbf}
Block side
T : 98 - 137 N·m {10.0 - 14.0 kgf·m, 72 - 101 ft·lbf}



EDR1-078

23. Turn the engine upside down and install the oil pan. Apply a coat of liquid gasket to the contacting surfaces. Fasten twice.

T : 21 N·m {2.1 kgf·m, 15 ft·lbf}


EP3-32

Unit: mm (in)

Position	Item	Maintenance standard	Service limit	Remarks
Push rod	Length	236.73 (9.3201)		
	Deviation	Less than 0.3 (0.012)	0.5 (0.020)	
Cam follower	Outside diameter	23.945 - 23.965 (0.9427 - 0.9435)	23.85 (0.9390)	
	Clearance between cam follower and hole	0.03 - 0.08 (0.0012 - 0.0031)	0.20 (0.0079)	
Others	Valve clearance adjusting sequence			

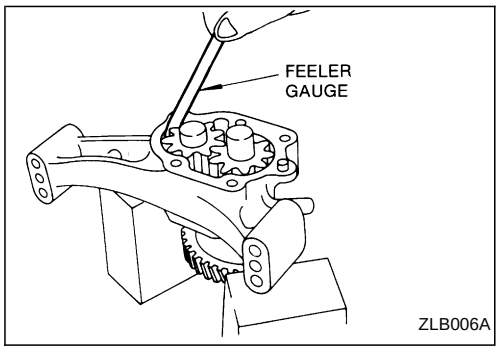
Cylinder No.	1		2		3		4		5		6	
Valve arrangement	1	2	3	4	5	6	7	8	9	10	11	12
	IN	EX	IN	EX	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 piston at TDC on compression stroke	●	●		●	●			●	●			
No. 6 piston at TDC on compression stroke			●			●	●			●	●	●

TIGHTENING TORQUE

Unit: N·m {kgf·m, ft·lbf}

Item			Tightening torque
Cylinder head bolt	Snug torque (1st)		88 - 98 {9.0 - 10.0, 65 - 72}
	Tightening angle (2nd)	L = 147 mm (5.79 in)	85° - 95°
		L = 119 mm (4.69 in)	70° - 80°
Cylinder head sub bolt		1st	34 {3.5, 25}
		2nd	44 - 54 {4.5 - 5.5, 33 - 40}
Rocker shaft mounting bolt			34 - 49 {3.5 - 5.0, 25 - 36}
Exhaust manifold mounting nut			29 - 44 {3.0 - 4.5, 22 - 33}
Air intake manifold mounting nut			49 - 54 {5.0 - 5.5, 36 - 40}
Nozzle holder assembly mounting bolt			25 - 34 {2.5 - 3.5, 18 - 25}
Injection tube		Pump side	29 - 39 {3.0 - 4.0, 22 - 29}
		Nozzle side	25 - 34 {2.5 - 3.5, 18 - 25}
Spill tube mounting bolt			10 - 18 {1.0 - 1.8, 7.2 - 13.0}
Turbocharger mounting nut			34 - 44 {3.5 - 4.5, 25 - 33}
Rocker arm adjusting screw lock nut			34 - 44 {3.5 - 4.5, 25 - 33}
Rocker shaft stopper bolt			8 - 13 {0.8 - 1.3, 5.8 - 9.4}

- Measure the tip clearance between the tips of the pump gears (the drive and idler gears) and the body, and record it.



- Stick a fuse on a tooth surface of the idler gear and rotate the gear. Then calculate the backlash of the pump gear from the squeezed amount of the fuse, and record it.

INSPECTION

- Clean all disassembled parts in cleaning solvent. Check for scratches, cracks or damage and replace faulty parts.
- If measurement indicates that the service limit has exceeded, repair or replace faulty parts.

Clearances and backlash of pump gears

Unit: mm (in)

Item	Maintenance standard	Service limit
Side clearance (Clearance between side faces of gear and case)	0.05 - 0.11 (0.0020 - 0.0043)	0.15 (0.0059)
Tip clearance (Clearance between tooth crest and case)	0.07 - 0.19 (0.0028 - 0.0075)	—
Idler gear and head gear backlash	0.085 - 0.215 (0.0033 - 0.0085)	0.50 (0.0197)

Clearance between spindle and idler gear bushing

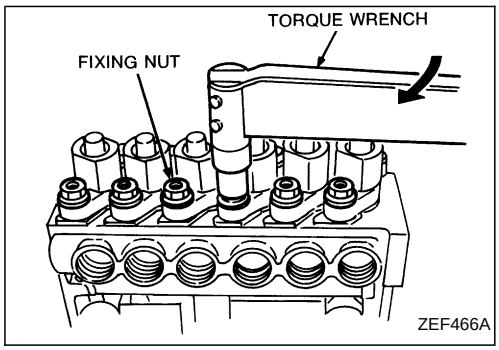
Unit: mm (in)

Maintenance standard	Service limit
0.01 - 0.04 (0.0004 - 0.0016)	0.20 (0.0079)

㊺ Nut

Gradually and evenly tighten the sleeve flanges' two fixing nuts to the specified torque using a torque wrench.

T : 39 - 44 N·m {4.0 - 4.5 kgf·m, 29 - 33 ft·lbf}

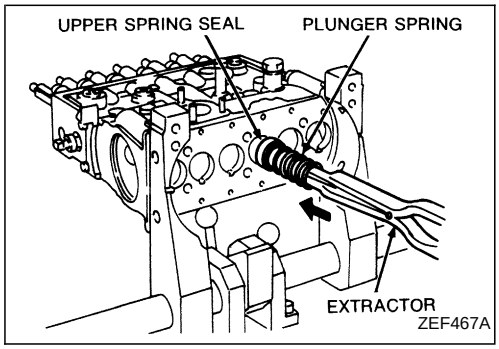


㊷ Spring

Attach the upper spring seat to the plunger spring and then insert them into the pump housing using the extractor (157921-5620).

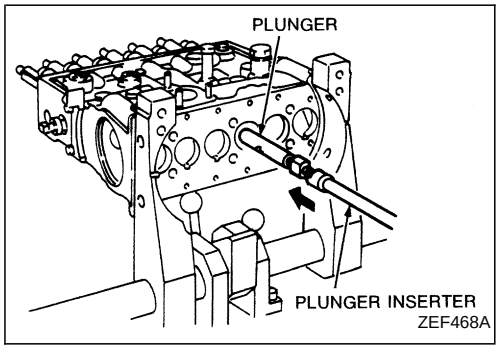
NOTE

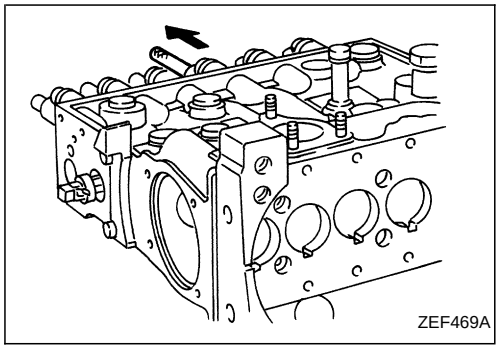
- **If the upper spring seats are not inserted straight into the pump housing, they will catch during insertion and cannot be withdrawn.**
  Do not scratch the housing during the above procedure.



㊶ Plunger

Partially insert the plunger into the plunger barrel using the plunger inserter (157922-4721) and push out the plunger guide (157922-3920) by pushing the plunger.



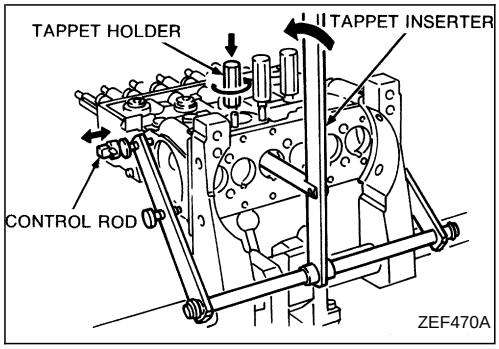


㊳ Tappet assembly

Operate the tappet inserter lever and move the control rod backwards and forwards while pushing the tappet assembly until the plunger collar enters the control sleeve groove.

NOTE

- **If the seat drops down between the lower spring seat and the tappet, repeat the above procedure.**



HOW TO USE THIS SECTION

This section describes the inspection and service procedures for the ‘‘electronic governor system’’, which is a control system for the PF6TB engine.
This section contains the system’s main control functions, additional functions, and structure and operation of each unit in the system.
This section also contains the action to be taken at the time of an abnormal status or diagnosis, and for troubleshooting.
Basic procedures for inspections and services are described under ‘‘BASIC OPERATION’’. Inspection and maintenance work should be done according to the described procedures.

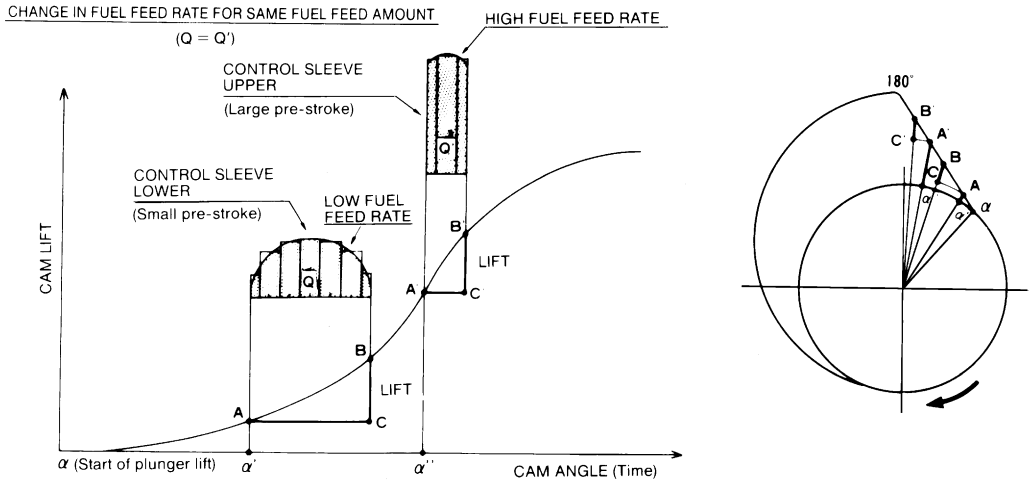
Abbreviations used in this section

Abbr.	Description		Abbr.	Description
OSC	Oscillate		W/L	Warning light
MDL	Middle (Midpoint)		M/V	Magnetic valve
SIG	Signal		P/L	Pilot light
GND	Ground		SW	Switch
SLD	Shield		PCM	Pressure control modulator valve
ACT	Actuator			

Engine model

Type	Engine model
Type I	PF6TB-21
Type II	PF6TB-22
Type III	PF6TC

<Relation between Fuel Feed Rate and Position of Control Sleeve>



EET4-014

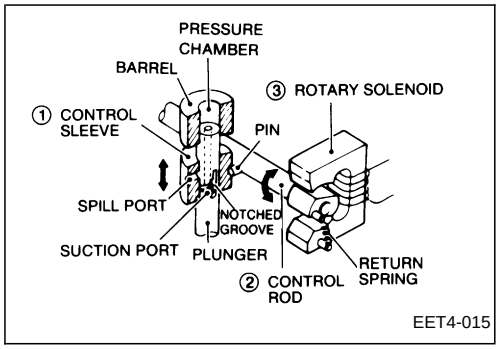
Change in fuel feed rate for same fuel feed amount

When the control sleeve is at the top, the pre-stroke is at its maximum, and as the plunger lift speed is fast, the fuel feed time can be made shorter. This means that the amount of fuel fed per unit time is larger and the fuel feed rate is higher.
On the other hand, when the control sleeve is at the bottom, the pre-stroke is at its minimum, and as the plunger lift speed is slow, the fuel feed time is longer. This means that the amount of fuel fed per unit time is smaller and the fuel feed rate is lower.
Under normal operating conditions, for low speed, the control sleeve is at the top to give a high fuel feed rate, and at high speed, the control sleeve is moved to the bottom to prevent the fuel feed rate from becoming too high.

<Pre-stroke Control Mechanism>

The pre-stroke control mechanism consists of the following.

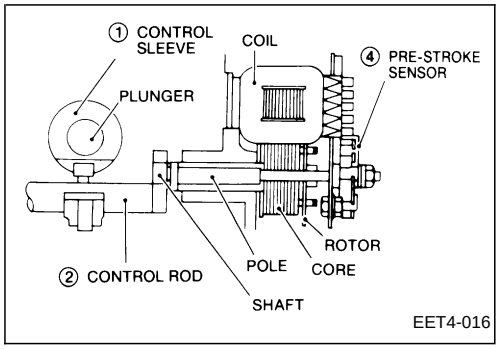
① The control sleeve that is moved up and down by the control rod inside the barrel
② The control rod that rotates and moves the control sleeve with a pin
③ The rotary solenoid that rotates the control rod



EET4-015

④ The pre-stroke sensor that always feeds back the movement of the rotary solenoid to the control unit

When the control sleeve goes up, the pre-stroke becomes larger, and when it goes down, the pre-stroke becomes smaller.



EET4-016

DIAGNOSIS

When any errors are found in the electronic control system, identify which system has the error and the cause of the error through the following diagnosis.

DIAGNOSIS USING WARNING LIGHT (INCLUDING DIAGNOSIS MEMORY)

Ground the diagnosis switch (dealer mode) to perform diagnosis using warning light. Errors are indicated by flashes (Morse code). When the diagnosis switch circuit is open (user mode), errors can be roughly indicated by light ON, light flash, or light OFF.
The diagnosis must be done with engine running.

Error indication		Error	Cause	Backup function	Return ability	Remarks
User mode (open)	Dealer mode (short)					
Light OFF	0 - 1	Normal	—	—	—	During engine operation
Light ON	0 - 1		—	—	—	During engine off
Light OFF	Light OFF	Power voltage is abnormal	Low battery voltage Fuse is blown	—	Equipped	Engine does not start

Diagnosis of sensor system

Error indication		Error	Cause	Backup function	Return ability	Remarks
User mode (open)	Dealer mode (short)					
Light ON	1 - 3	Rack sensor system	Rack voltage is below 0.5V or above 4.5V	Electronic governor: stop engine Prestroke: fix rack position VNT: PCM valve OFF (vane full open) [Type I only]	Not equipped	Driving is possible in limp home mode
Light flash	1 - 4	Timing (back-up) sensor system	The pulse number of timing (back-up) sensor is less than the pulse number of engine speed sensor	Electronic governor: Normal control	Equipped	No pulse or short circuit of the sensor
Light flash	1 - 6		Circuit resistance including harness is above 10 kΩ			Open circuit of sensor system, not detected during engine operation
Light flash	1 - 5	Engine speed sensor system	The pulse number of timing (back-up) sensor is less than the pulse number of engine speed sensor	Electronic governor: Normal control by calculating engine speed with backup sensor	Equipped	No pulse or short circuit of the sensor, one engine revolution per 6 pulses
Light flash	1 - 7		Circuit resistance including harness is above 10kΩ			Open circuit of sensor system, not detected during engine operation
Light flash	2 - 1	Engine coolant temperature sensor system	Sensor voltage is below 0.1V or above 4.88V	Control by fixing engine coolant temperature at 80°C (176°F)	Equipped	
Light flash	2 - 2	All-speed sensor system	Sensor voltage is below 0.1V or above 4.65V	Run by constant acceleration (roughly equal to idling)	Not equipped	Detect during PTO operation

CHECK 3 Inspection of governor actuator resistance

1) Because the governor actuator and the rack sensor are installed onto the fuel injection pump rear end, all related wiring harnesses must also be checked.
- Turn the key switch to OFF. Disconnect connectors E-34 and E-35 at the rear of the fuel injection pump.
- Measure resistance between all the pairs of terminals at both connectors. Check for insulation between each terminal and the fuel pump body.

	Terminal No.	Resistance [Ω]	Remarks
Governor actuator	ACT1 ⊕ - ACT1 ⊖	9 - 10	
	ACT2 ⊕ - ACT2 ⊖	9 - 10	
	ACT1 ⊕ - ACT2 ⊕	Approx. 0	
	ACT1 ⊖ - ACT2 ⊖	Approx. 0	
Rack sensor	OSC - MDL	14 - 16	
	MDL - GND1	19 - 21	
	MDL - GND2	19 - 21	
	OSC - GND1	30 - 37	
	OSC - GND2	30 - 37	
	GND1 - GND2	Approx. 0	
Back-up sensor	SIG - GND	2.1 k - 2.5 k	Type I only
All terminals - Fuel injection pump body		∞	
All terminals - Positions other than above terminals		∞	

2) Judgment

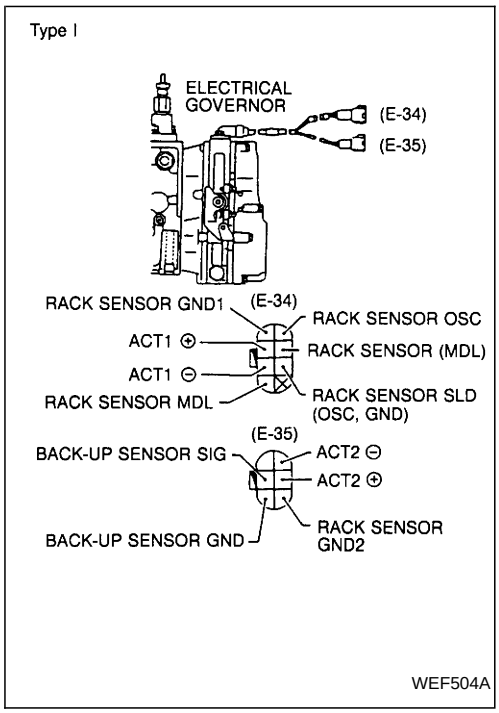
Resistance: Refer to above.

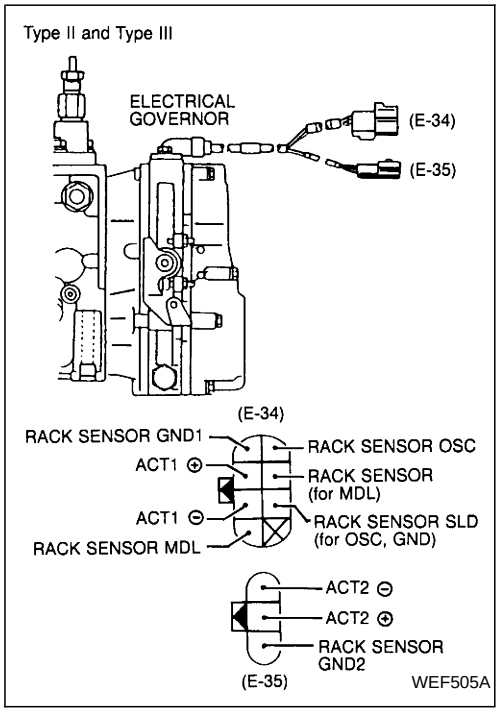
- Resistance is normal. → Check wiring harness. Go to CHECK 4 .
- Open/short circuit in the wiring harness or the resistance is abnormal. → Governor actuator failed. → Replace the governor actuator (fuel injection pump assembly).

NOTE
- **Replacement of the fuel injection pump assembly must be done following the procedures in BASIC OPERATION, item 2, Alignment of marks.**
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**

CHECK 4 Inspection of wiring harness between control unit and governor actuator

1) Turn the key switch to OFF.
2) Disconnect the wiring harness connectors from the control unit.
3) Check for open/short circuit in the wiring harnesses between the main harness connector terminals and the engine harness connector terminals.



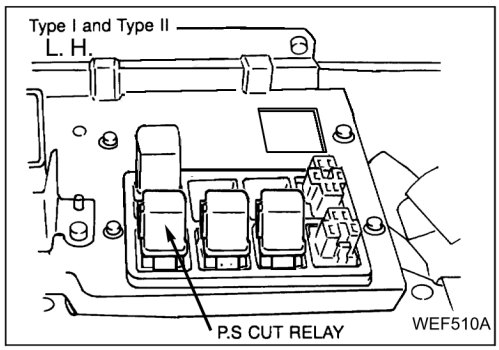


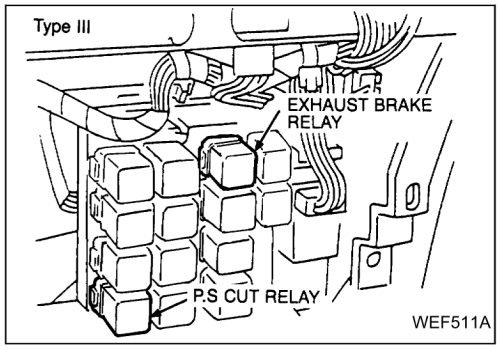
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**

CHECK 3 Inspection of pre-stroke cut relay

1) Remove the pre-stroke cut relay from the relay box.
2) Check the relay operation.
3) Judgment
- Operation is normal. → Wiring harness failed. → Repair or replace the wiring harness.
- Operation is abnormal. → Relay failed. → Replace the pre-stroke cut relay.

NOTE
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**





CHECK 4 Inspection of pre-stroke actuator

1) For the details of the operation method and resistance value, refer to 4-1, Action for pre-stroke sensor error CHECK 2 .

2) Judgment
- Resistance is normal. → Check the wiring harness. Go to CHECK 5 .
- Wiring harness is open/shorted, or resistance is abnormal. → Pre-stroke actuator failed. → Replace the pre-stroke actuator (fuel injection pump assembly).

NOTE
- **Harness check at the connector must be done following the procedures in BASIC OPERATION, item 2, Alignment of marks.**
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**

CHECK 5 Inspection of wiring harness between control unit and pre-stroke actuator

1) Turn the key switch to OFF.
2) Disconnect the harness connector from the control unit.
3) Check for open/short circuit between each pair of terminals of the main harness connector and engine harness connector.

NOTE
- **Harness check at the connector must be done following the procedures in BASIC OPERATION, item 1, Inspection of wiring harnesses.**

2) Judgment

Specified resistance: Refer to above.

- Resistance is normal. → Engine speed sensor is normal. → Go to CHECK 4 .
- Open/short circuit, or the resistance is abnormal. → Engine speed sensor failure. → Replace engine speed sensor.

NOTE

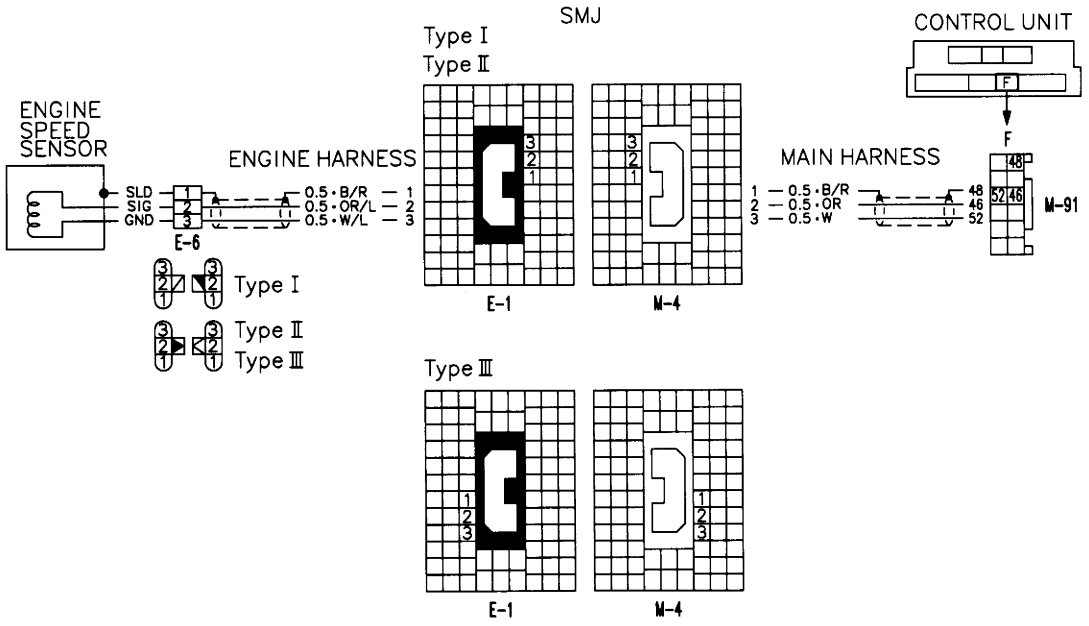
- **Replacement of engine speed sensor must be done following the procedures in BASIC OPERATION, item 4, Setting procedure of engine speed sensor.**
- **After completing each operation, carry out troubleshooting with the diagnostic light and confirm that there is no abnormality.**

CHECK 4 **Inspection of wiring harness between control unit and engine speed sensor**

1) Check for open/short circuit in the wiring harnesses between each terminal of the main harness connectors, and the engine harness connectors.

NOTE

- **Harness check at the connector must be done following the procedures in BASIC OPERATION, item 1, Inspection of wiring harnesses.**



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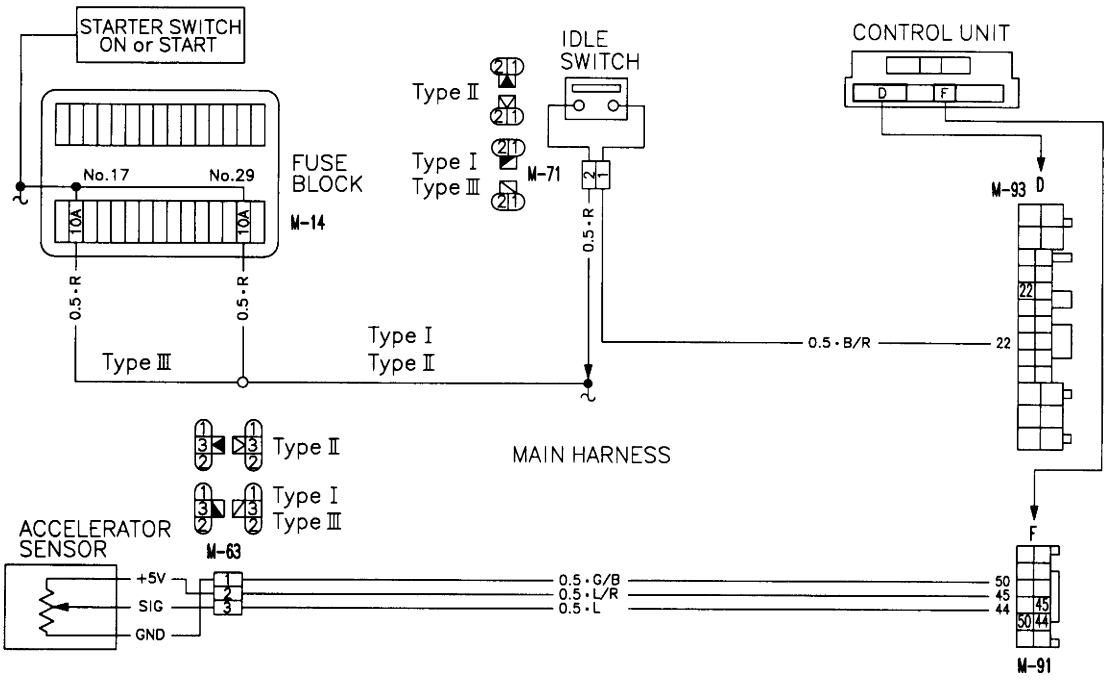
2) Judgment

- Wiring harness is open/shorted. → Repair or replace the wiring harness.
- Wiring harness is normal. → Control unit failed. → Replace the control unit.

NOTE

- **When the control unit is failed, be sure to find the cause of trouble and repair it before replacing the control unit.**
- **After completing each operation, carry out troubleshooting with the diagnostic light and confirm that there is no abnormality.**



4) Judgment
- Wiring harness is open/shorted. → Repair or replace the wiring harness.
- Wiring harness is normal. → Accelerator sensor failed (idle switch). → Replace the accelerator sensor.

NOTE
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**

CHECK 5 Inspection of wiring harness between control unit and accelerator sensor

1) For inspection procedure, refer to CHECK 4 .
2) Judgment
- Wiring harness is open/shorted. → Repair or replace the wiring harness.
- Wiring harness is normal. → Control unit failed. → Replace the control unit.

NOTE
- **When the control unit is failed, be sure to find the cause of trouble and repair it before replacing the control unit.**
- **After completing each operation, carry out trouble-shooting with the diagnostic light and confirm that there is no abnormality.**

16. ACTION FOR ATMOSPHERIC PRESSURE SENSOR ERROR [LIGHT FLASH: 3-8] (TYPE II ONLY)

[1] Inspection items

- Atmospheric pressure sensor (supply voltage and output voltage)
- Wiring harness (open/short circuit)
- Final confirmation

[2] Operation procedure