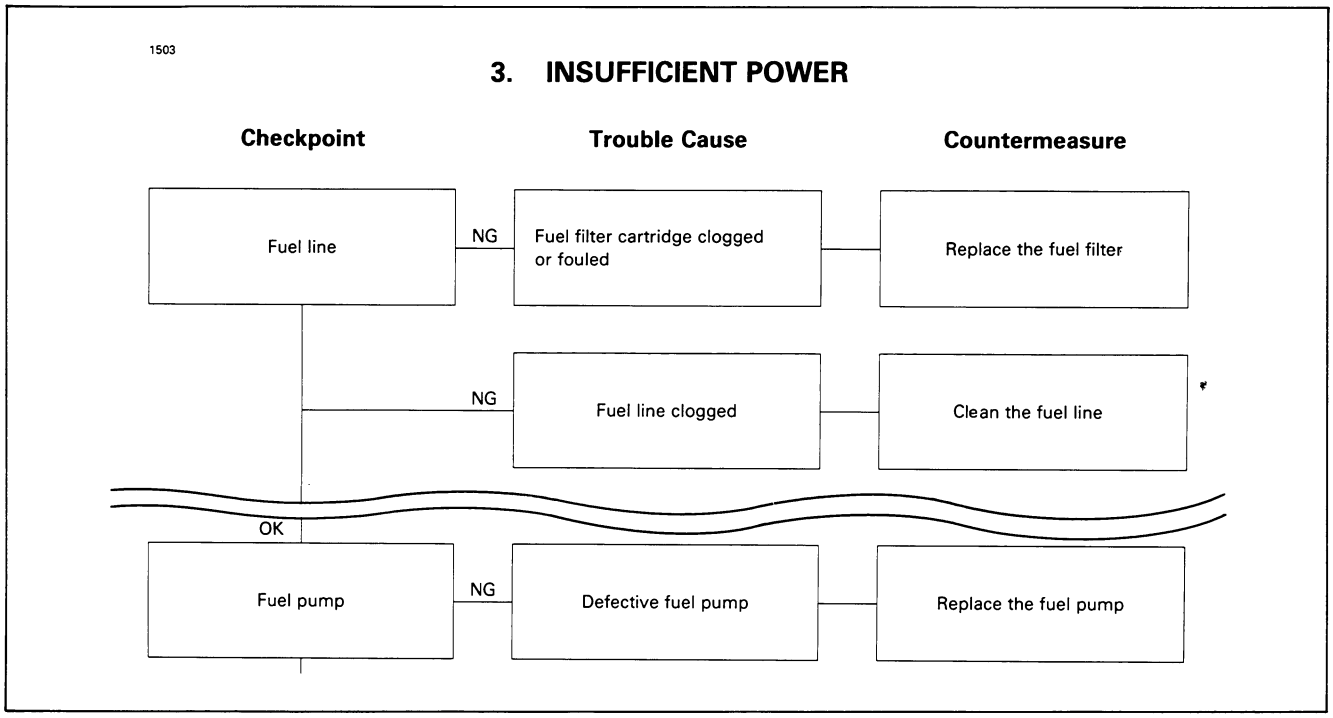
TROUBLESHOOTING

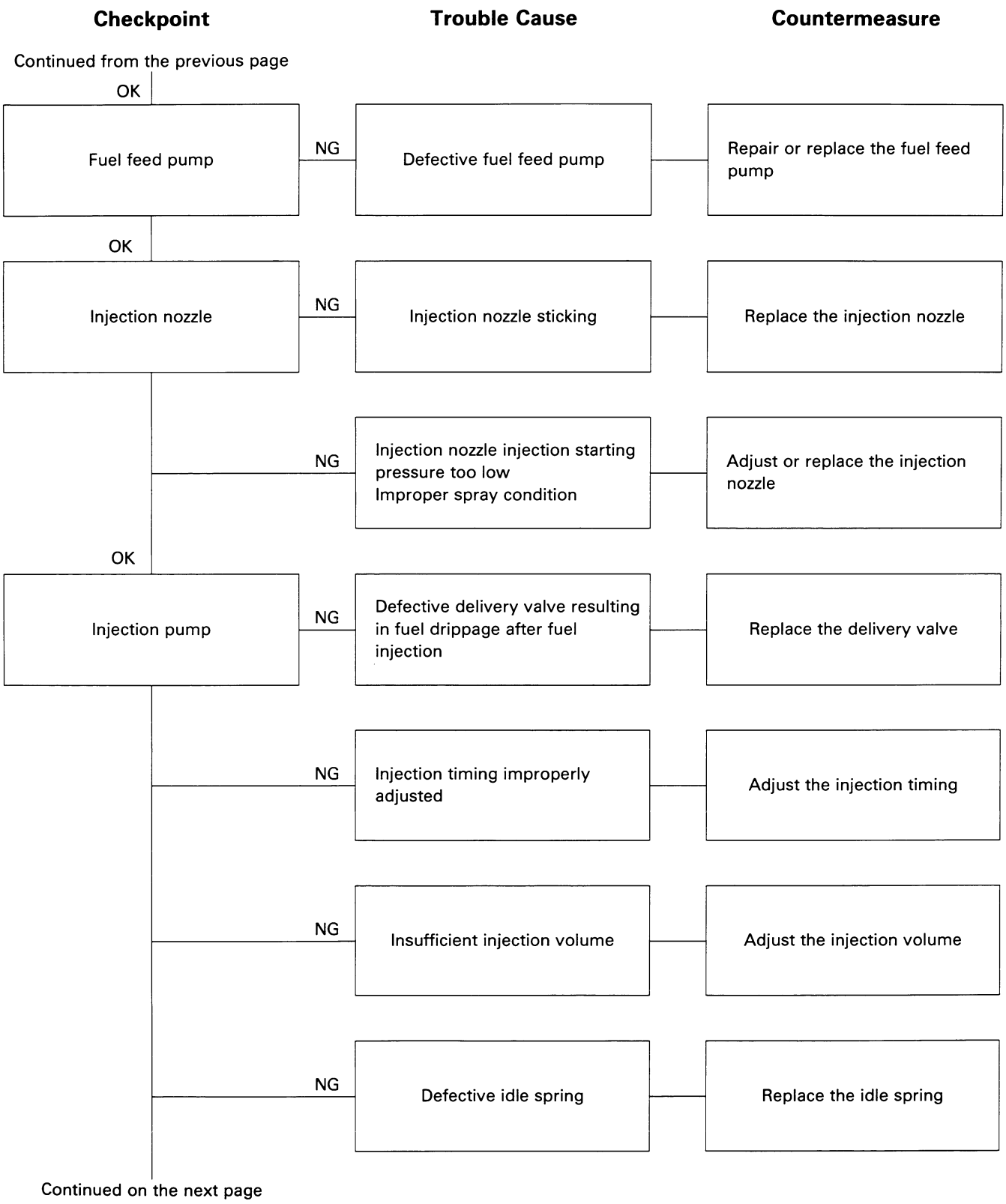
Refer to the following troubleshooting charts to quickly pinpoint and repair engine problems.

1. This Section is divided into ten Sub-Sections.
   Refer to the Table of Contents.
2. Each troubleshooting chart has three headings arranged from left to right.

Example:

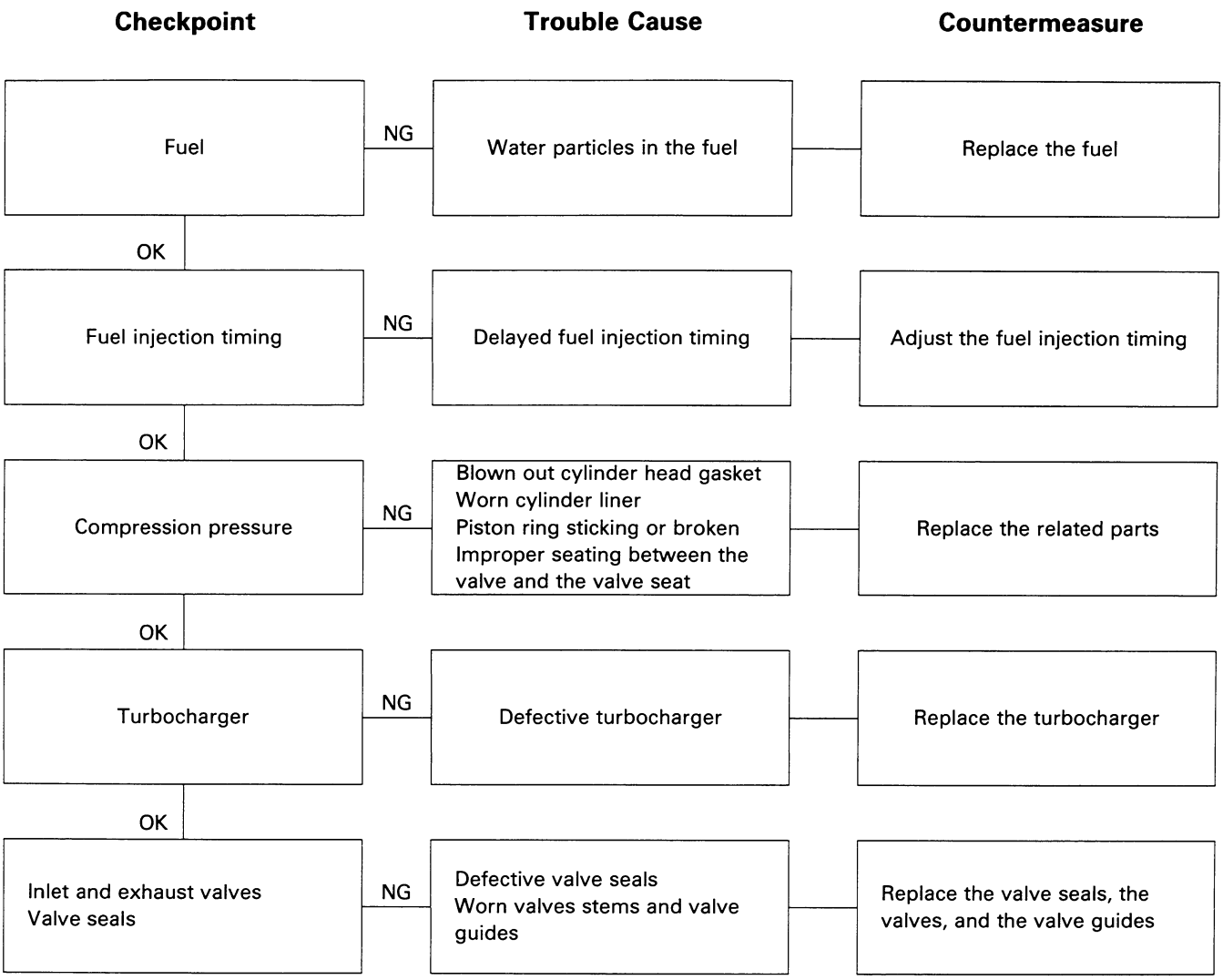


3. Easily checked areas are presented at the beginning of the troubleshooting chart. Procedures become more complex as the chart progresses.
4. It is suggested that you work from the beginning of the troubleshooting chart. Do not start from the middle.
5. It is possible that a seemingly apparent engine problem is not related to the engine.
   For example, the engine may appear to have insufficient power. This could be caused by dragging brakes or a slipping clutch instead of an engine malfunction.
   Refer to the other troubleshooting charts if required.
6. Optional equipment and variations are included in the troubleshooting charts.
   If the vehicle you are servicing is not equipped with a particular option or variation, noted in the "Checkpoint" frame, disregard the frame and move on to the next one.


Checkpoint
Trouble Cause
Countermeasure
Continued from the previous page
OK
Fuel feed pump
NG
Defective fuel feed pump
Repair or replace the fuel feed pump
OK
Injection nozzle
NG
Injection nozzle sticking
Replace the injection nozzle
NG
Injection nozzle injection starting pressure too low
Improper spray condition
Adjust or replace the injection nozzle
OK
Injection pump
NG
Defective delivery valve resulting in fuel drippage after fuel injection
Replace the delivery valve
NG
Injection timing improperly adjusted
Adjust the injection timing
NG
Insufficient injection volume
Adjust the injection volume
NG
Defective idle spring
Replace the idle spring
Continued on the next page

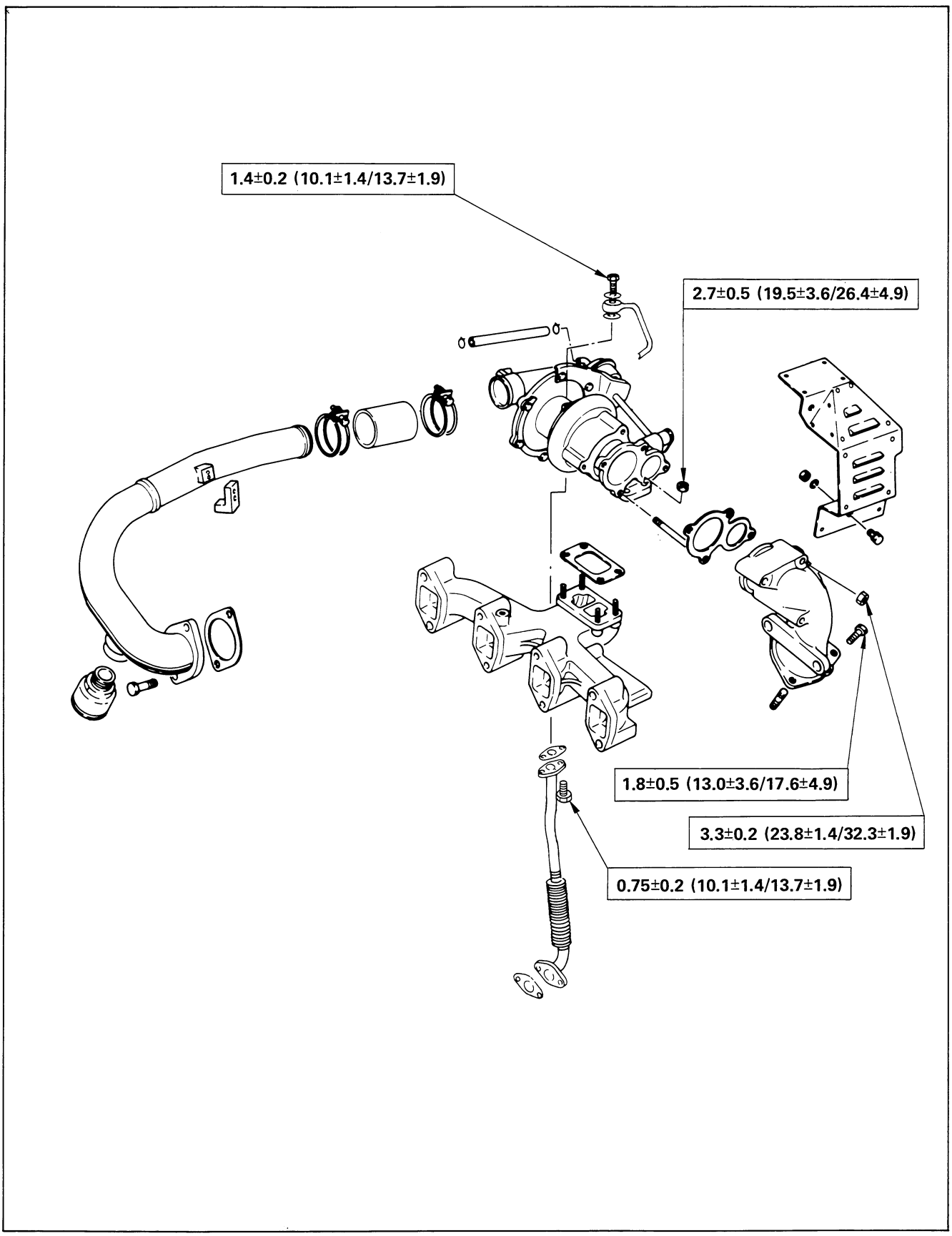
1507

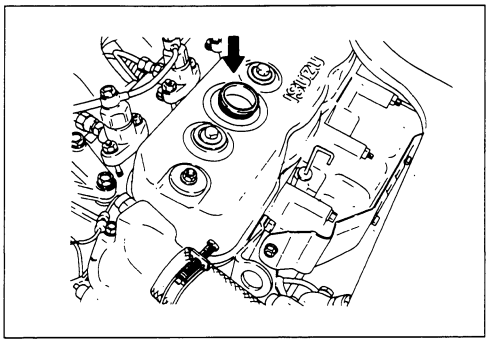
7. WHITE EXHAUST SMOKE



Turbocharger [IHI RHB-6]

kg·m(lb.ft/N·m)





Engine Oil Replenishment

Draining

1. Remove the drain plug to completely drain the engine oil.
   Do this while the engine is hot.
2. Replace the drain plug.
3. Tlighten the drain plug to the specified torque.

Drain Plug Torque	kg·m(lb.ft/N·m)
9.7 ± 1.9 (70.2 ± 13.7/95.1 ± 18.6)	

Replenishment

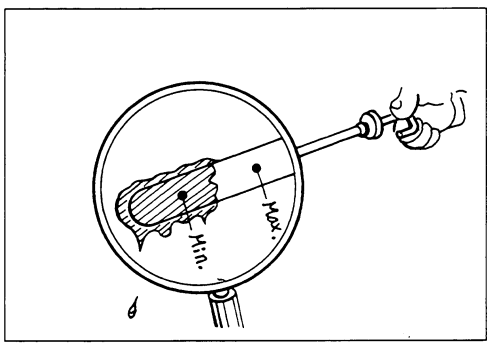
1. Remove the filler cap.
2. Pour the specified engine oil into the crankcase through the oil filter.
3. Replace the filler cap.

Crankcase and Filler Oil Capacity (Reference)
Disposable Spin-On Cartridge Element lit(US/UK gal)

Engine	4BC2 & 4BE1	4BD1	4BD1T
Crankcase & filter	6.3 — 7.0 (1.67 — 1.85/ 1.30 — 1.54)	6.8 — 7.5 (1.80 — 1.98/ 1.50 — 1.65)	7.6 — 8.3 (2.01 — 2.19/ 1.67 — 1.83)
Crankcase only	5.1 — 5.8 (1.35 — 1.53/ 1.12 — 1.28)	5.6 — 6.3 (1.48 — 1.66/ 1.23 — 1.30)	6.4 — 7.1 (1.69 — 1.88/ 1.41 — 1.56)

Replaceable Paper Element

Engine	4BC2 & 4BE1	4BD1	4BD1T
Crankcase & filter	5.9 — 6.6 (1.56 — 1.74/ 1.30 — 1.45)	6.4 — 7.1 (1.69 — 1.88/ 1.41 — 1.51)	—
Crankcase only	5.1 — 5.8 (1.35 — 1.53/ 1.12 — 1.28)	5.6 — 6.3 (1.48 — 1.66/ 1.23 — 1.30)	—



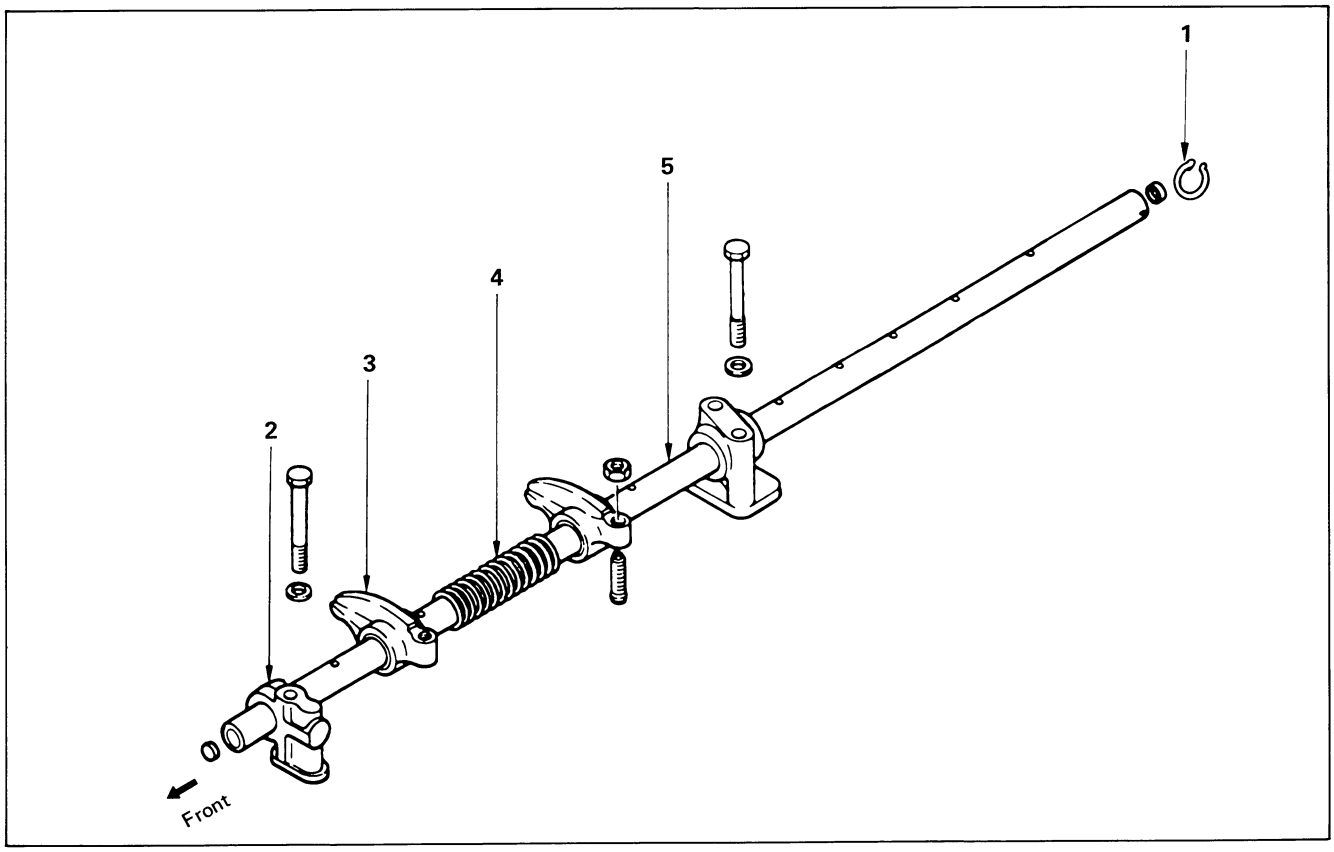
4. Start the engine and allow it to idle for a few minutes.
5. Stop the engine.
6. Use the dipstick to check the oil level.

   If the oil level is below the "MIN" line, add oil through the oil filler.

   If the oil level is above the "MAX" line, drain off the excess oil through the drain plug.

MINOR COMPONENTS

ROCKER ARM SHAFT AND ROCKER ARM



Disassembly Steps

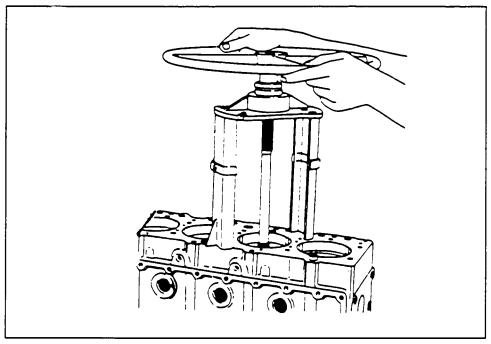
▲ 1. Rocker arm shaft snap ring
▲ 2. Rocker arm shaft bracket
3. Rocker arm
4. Rocker arm shaft spring
5. Rocker arm shaft

Important Operations

1. Rocker Arm Shaft Snap Ring

2. Rocker Arm Shaft Bracket

1) Use a pair of snap ring pliers to remove the snap ring.
2) Remove the rocker arm shaft bracket.



Cylinder Liner Replacement

Cylinder Liner Removal

1. Set the cylinder liner remover ① to the cylinder liner.
2. Check that the remover shaft ankle ② is firmly gripping the cylinder liner bottom edge ③.
3. Slowly turn the remover shaft handle ④ clockwise to pull the cylinder liner free.

   Cylinder Liner Remover : 9-8523-1169-0

   Ankle : (4BC2, 4BD1, & 4BD1T) 9-8523-2557-0
   (4BE1) 5-8840-2108-0

Note:

Take care not to damage the cylinder body upper face during the cylinder liner removal procedure.

Cylinder Liner Grade Selection and Standard Fitting Interference

Accurately measured fitting interference and proper cylinder liner grade selection are extremely important.

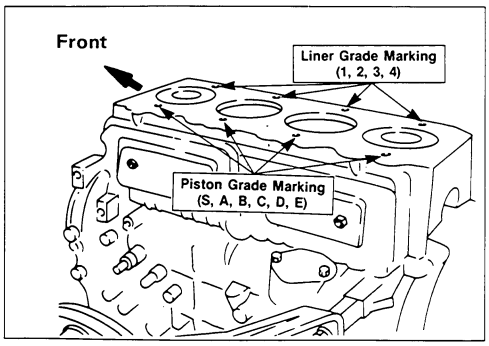
If the cylinder liner fitting interference is too small, engine cooling efficiency will be adversely affected.

If the cylinder liner fitting interference is too large, it will be difficult to insert the cylinder liner into the cylinder body.

Standard fitting interference	mm(in.)	0.001 — 0.019 (0.00004—0.00075)

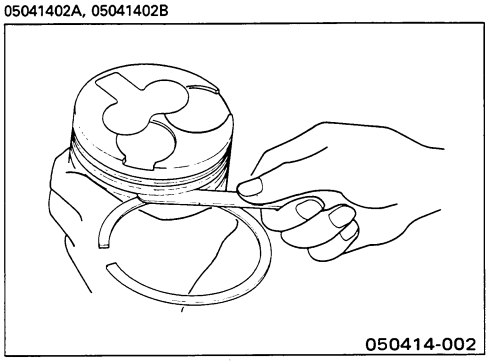
There are two methods by which liners can be selected.

Mothod I



The cylinder block deck has been marked during production to indicate the correct liner. The liner grade (i.e. 1, 2, 3, 4) is indicated in permanent ink.

05041402A, 05041402B



Piston Ring and Piston Ring Groove Clearance

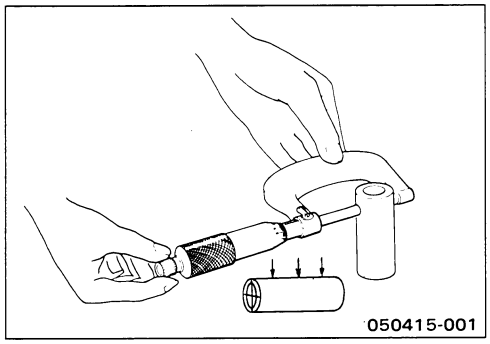
1. Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.

Piston Ring and Piston Ring Groove Clearance mm(in)

	Engine	Standard
1st Compression Ring	4BC2 & 4BE1	0.045 — 0.070 (0.0033 — 0.0043)
	4BD1 & 4BD1T	0.105 — 0.130 (0.0041 — 0.0051)
2nd Compression Ring	4BC2 & 4BE1	0.030 — 0.055 (0.0012 — 0.0022)
	4BD1 & 4BD1T	0.040 — 0.075 (0.0016 — 0.0030)
Oil Ring	All	0.030 — 0.070 (0.0012 — 0.0028)

2. Visually inspect the piston ring grooves.

   If a piston ring groove is damaged or distorted, the piston must be replaced.



PISTON PIN

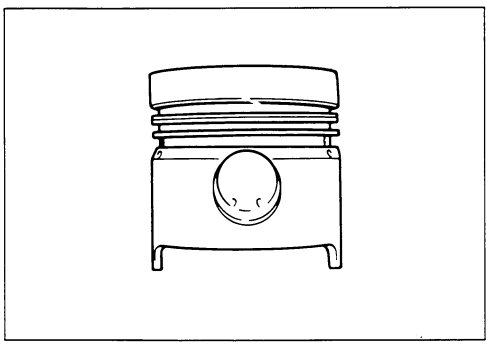
Piston Pin Diameter

Use a micrometer to measure the piston pin outside diameter at several points.

If the measured value is less than the specified limit, the piston pin must be replaced.

Piston Pin Diameter mm(in)

Standard	Limit
35.000 — 35.005 (1.3780 — 1.3781)	34.95 (1.3760)

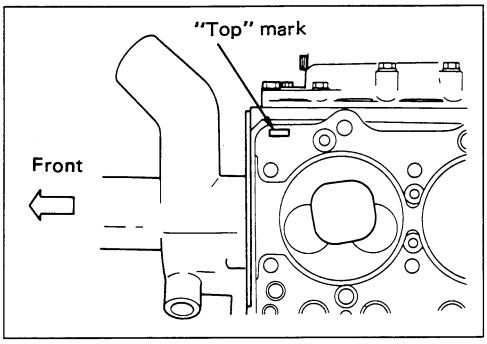


Piston Pin and Piston Clearance

Use an inside dial indicator to measure the piston pin hole (in the piston).

Piston Pin Interference mm(in)

	Standard
4BC2 & 4BD1	0.005 — 0.008 (0.0002 — 0.0003)
4BE1 & 4BD1T	0.005 — 0.018 (0.0002 — 0.0007)



28. Cylinder Head Gasket

1) Clean the cylinder body upper side and the cylinder head lower side.
2) Install the cylinder head gasket with the "TOP" mark facing up and toward the front of the engine.

Note:

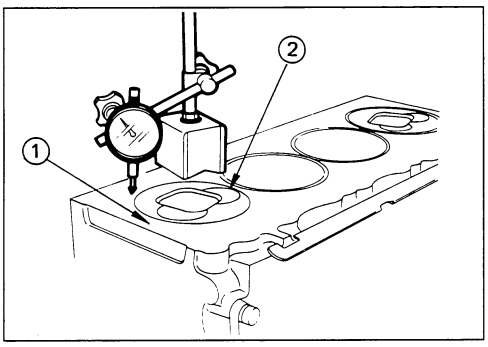
Refer to "CYLINDER HEAD GASKET SELECTION" for the 4BE1 engine.

CYLINDER HEAD GASKET SELECTION (4BE1)

Cylinder head gasket thickness is determined by the maximum cylinder head projection from the cylinder body at top dead center.

Correct cylinder gasket thickness is important. Installing the wrong thickness gasket can result in greatly reduced engine performance.

There are three cylinder head gaskets available.



Piston Head Projection Measurement

1) Carefully remove carbon deposits and gasket residue from the piston top face and the cylinder body upper surface.
2) Use a dial indicator and stand to measure the piston head projection from the cylinder body at the two measuring points ① and ② shown in the illustration.
3) Calculate the average of the two measured values (individual cylinder piston head projection).
4) Repeat Steps 2 and 3 for the remaining three cylinders.
5) Note the cylinder having the greatest cylinder head projection.

   This figure will determine the cylinder head gasket thickness.

Cylinder Head Gasket Availability mm(in)

Gasket Grade Mark	Piston Projection	(Reference) Gasket Thickness
Ⓐ	0.688 — 0.770 (0.0271 — 0.0303)	1.95 (0.077)
Ⓑ	0.771 — 0.812 (0.0303 — 0.0319)	2.00 (0.079)
Ⓒ	0.813 — 1.000 (0.0320 — 0.0394)	2.05 (0.081)

0600

LUBRICATING SYSTEM

060101

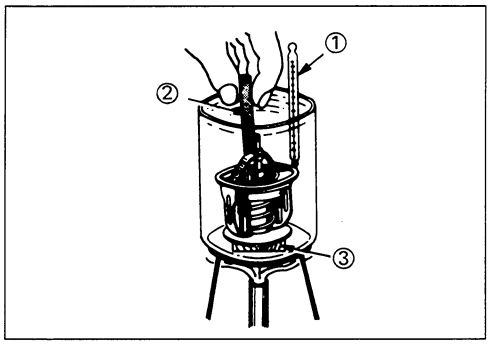
MAIN DATA AND SPECIFICATIONS

Item		
Lubricating method		Full flow pressure circulation
Oil pump type		Trochoid | Gear
Delivery volume	lit(US/UK gal)/min	39.5 (10.4/8.69) | 47.6 (12.5/10.5)
Pump speed	rpm	1,750
Delivery pressure	kg/cm²(psi/kPa)	4 (56.9/392)
Oil temperature	°C(°F)	80 (180) | 50 (125)
Engine oil		SAE 30
		CC or CD (For 4BC2, 4BE1 and 4BD1) CD (For 4BD1T)
Oil pressure switch operating pressure	kg/cm²(psi/kPa)	0.2 — 0.5 (2.8 — 7.1/19.6 — 49.0)
Oil filter type		Full-flow replaceable paper element type or disposal spin-on cartridge type
Safety valve opening pressure	kg/cm²(psi/kPa)	1 (14.2/98)
Oil cooler type		Water cooled
Oiling jet regulating valve opening pressure	kg/cm²(psi/kPa)	1.8 — 2.2 (25.6 — 31.3/176 — 216)

THERMOSTAT

INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.



Operating Test

1. Completely submerge the thermostat in water.
2. Heat the water.
   Stir the water constantly to avoid direct heat being applied to the thermostat.
3. Check the thermostat initial opening temperature.

Thermostat Initial Opening Temperature °C(°F)

		Standard
All 4BC2 All 4BE1 4BD1 1987 and later 4BD1T 1989 and later	Primary valve	80 — 84 (176 — 183)
	Secondary valve	80 — 87 (181 — 189)
4BD1 1986 and earlier		80 — 84 (176 — 183)
4BD1T 1988 and earlier		

4. Check the thermostat valve lift at 95°C (203°F).

Thermostat Valve Lift at 95°C (203°F) mm(in)

	Standard
All 4BC2 and 4BE1	Primary Valve 10 (0.39) or more Secondary Valve 8.5 (0.33) or more
4BD1 1987 and earlier	
4BD1T 1989 and later	
4BD1T 1986 and earlier	10 (0.39) or more
4BD1T 1989 and later	

① Thermometer
② Agitating rod
③ Wooden piece

INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

Identifiction Numbers: 101401-0422 (Standard)

[4BD1 Engine]

Pre-stroke : No. 1 plunger 3.6 ± 0.05 mm

Injection order : 1 — 3 — 4 — 2 (interval 90° ± 30″) Plungers are numbered from the drive side

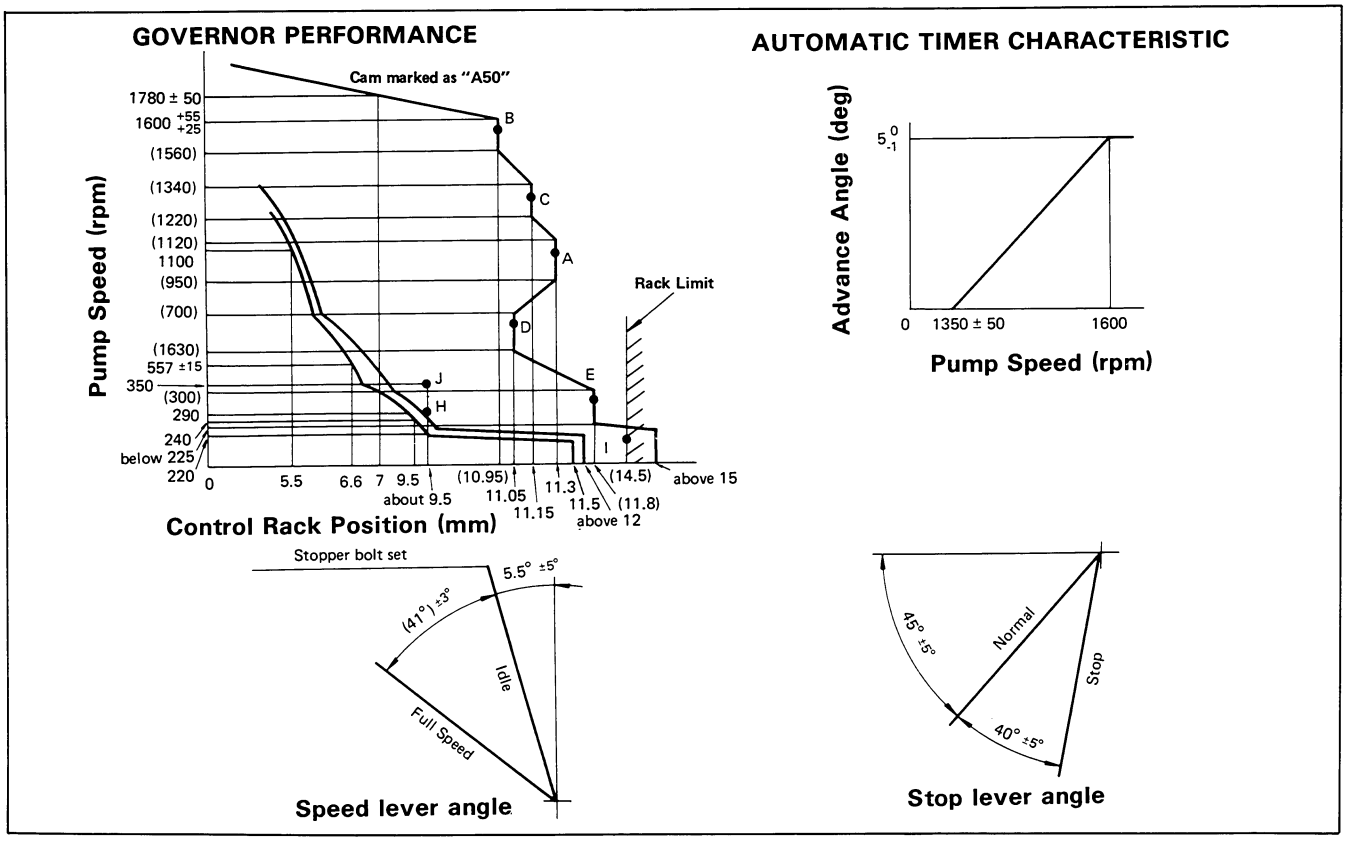
Tappet clearance : More than 0.3 mm with all cylinder

Injection Volume

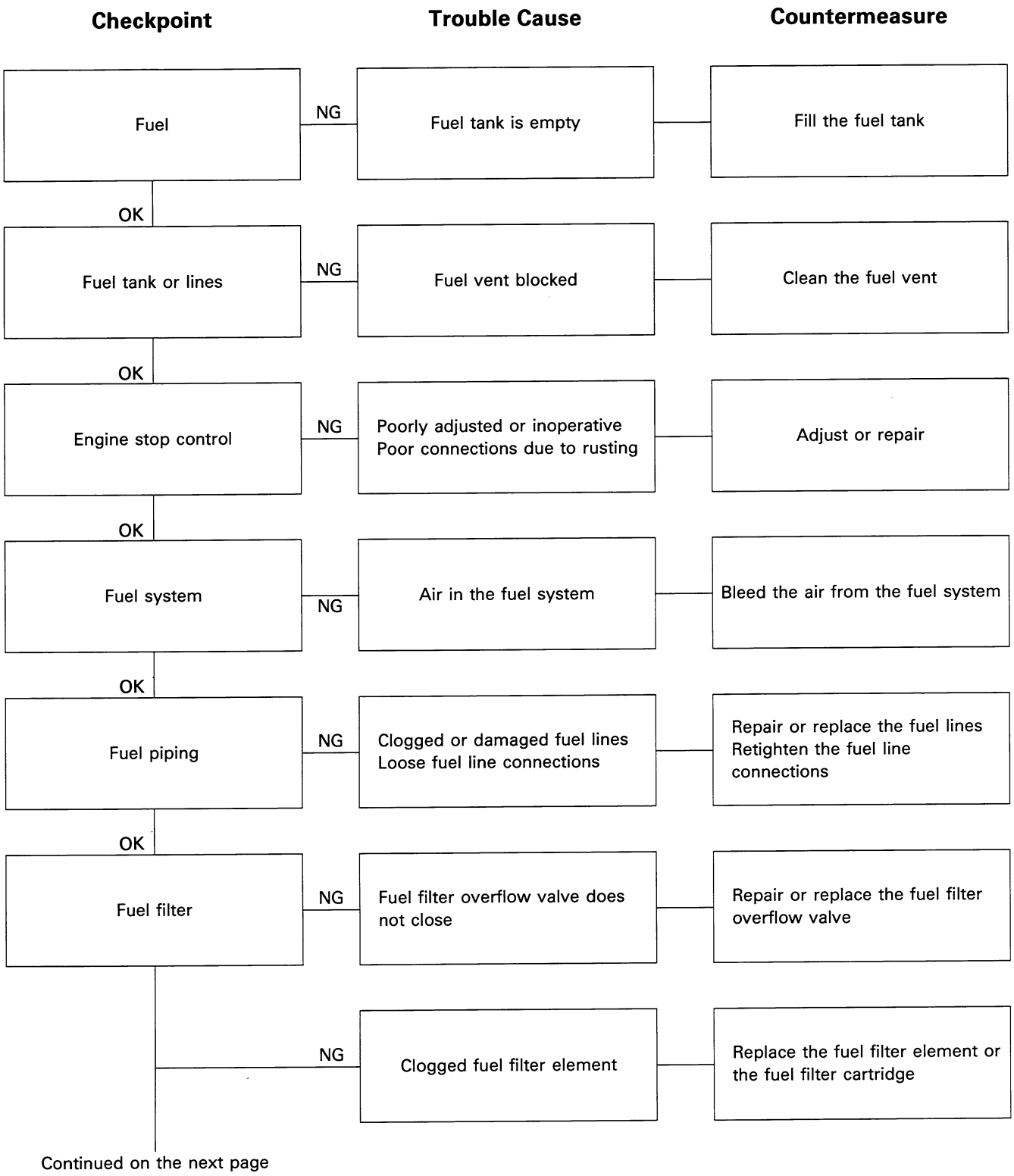
Adjusting point	Control rack position (mm)	Pump speed (r.p.m.)	Strokes	Injection volume (cc/1000 st.)	Variance (%)	Fixed	Remarks
	11.2	950	1000	65.2 — 68.2	± 2.5	Rack	Basic
H	About 9.5	290	1000	6.7 — 9.3	±14.0	Rack	
A	R1 (11.2)	950	1000	65.7 — 67.7	—	Lever	Basic
B	10.8	1600	1000	61.7 — 64.9	—	Lever	
C	11.1	1300	1000	69.1 — 72.3	—	Lever	
D	11.95	650	1000	48.0 — 51.2	—	Lever	
E	11.3	500	1000	47.0 — 51.0	—	Lever	
I	14.5	150	1000	95.0 — 103.0	—	Lever	(Rod limit)

Timing Advance Specification

Pump Speed (rpm)	1350 ± 50	1600
Degree for Angle of Lead (deg.)	Start 0	$5\ ^{0}_{-1}$



1. HARD STARTING



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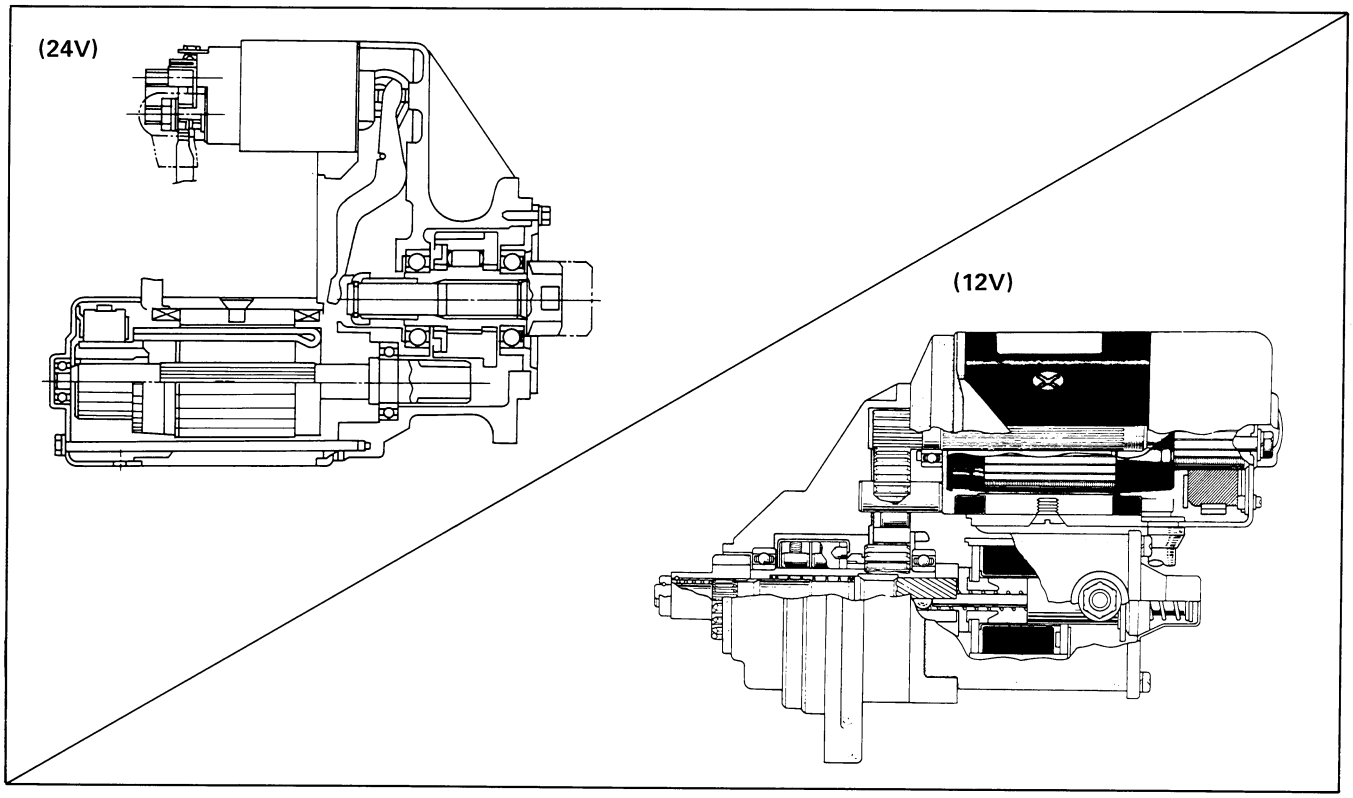
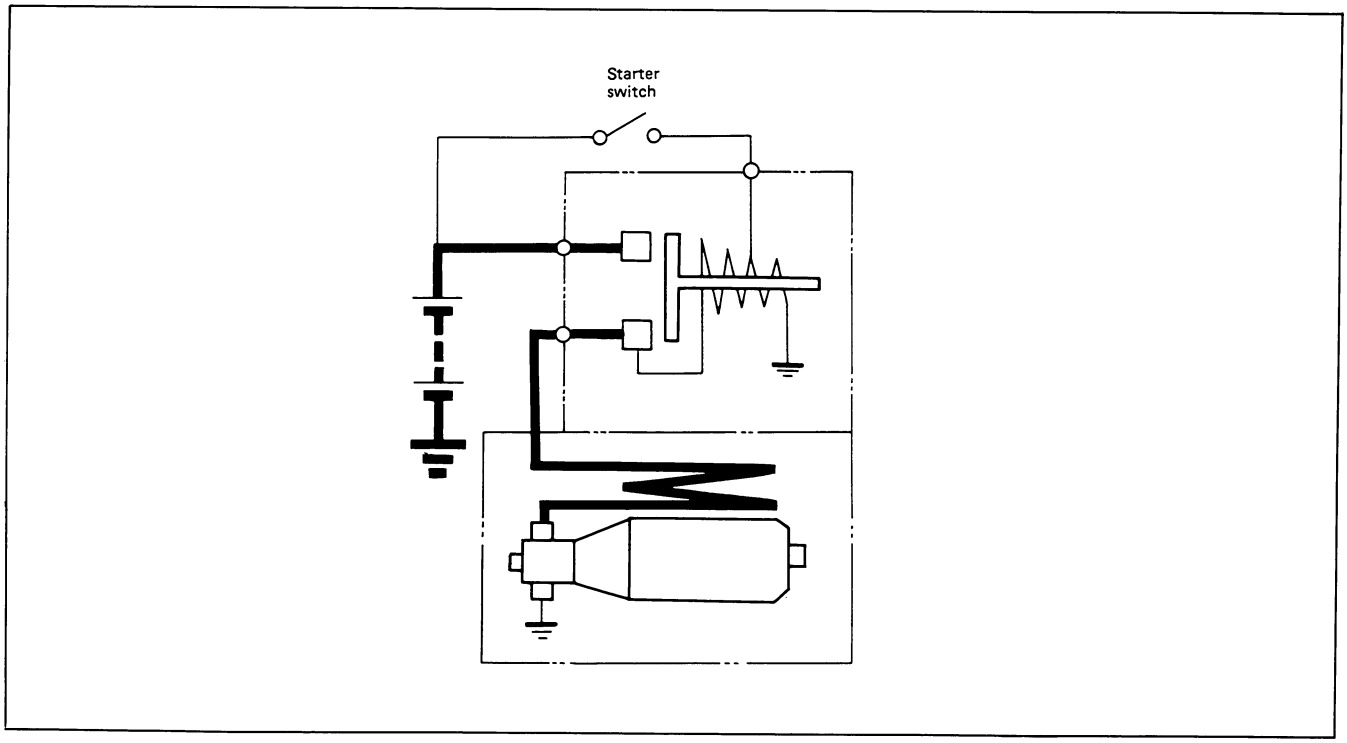
STARTER MOTOR





The starter motor circuit is composed of a 4-pole 4-brush type direct current series motor, starter switch with safety lock, etc. The starter motor circuit utilizes negative ground polarity.

3. Connect the circuit tester ① (or voltmeter V2) as shown in the illustration.
4. Set the variable resistor ③ to zero.
5. Slowly increase the resistance of the variable resistor toward the build-up point.

   Measure the voltage between E and F.

   As long as the resistance is below the build-up point, the voltage reading should be stable and less than two volts.

   When the resistance exceeds the build-up point, the voltage reading should be two volts or greater.

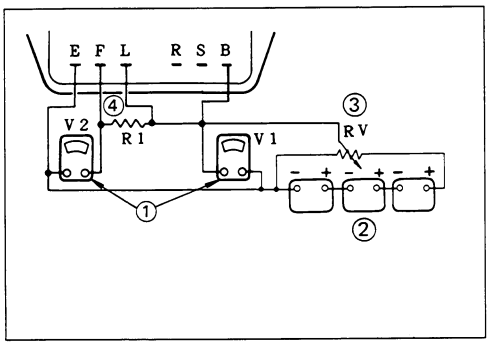
   If the voltage does not exceed two volts after reaching the build-up point, the IC regulator must be replaced.

6. Return the variable resistor ③ to zero.
7. Connect the circuit tester (or voltmeter V1) as shown in the illustration.
8. Measure the voltage at terminals S, L, and E.
9. Slowly increase the resistance of the variable resistor.

   Note the point at which the voltage quickly builds up to between 2 and 6 volts.

   This will indicate the point at which the voltage regulator begins to function.

   If the measured voltage is outside the specified range, the voltage regulator must be replaced.



10. Repeat Steps 3 through 5 to measure the voltage between terminals B, L, and E.

    Refer to the wiring diagram.

    The regulator voltage should be between 0.5 and 3 volts higher than the measured voltage.

    If the regulator voltage is outside this range, the voltage regulator must be replaced.