ANHUI CHERY AUTOMOBILE CO., LTD

CAC478/480 GASOLINE ENGINE
Instruction Book on Using and Maintenance

Catalogue

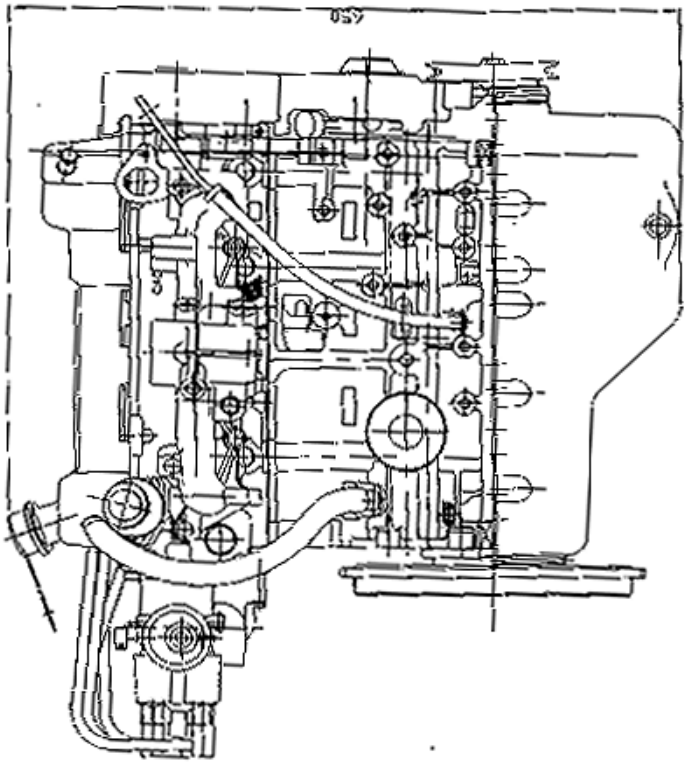
Foreword

CAC478、CAC480 series vehicle gasoline engines , which are the products introduced from Ford (Britain) corporation CVH production line, are made by Anhwei chelly automobile Corp. Products are made up of carburetor type, single-point electric control fuel injection type and electric control fuel injection type , which may meet the requirements for different performance and emission.

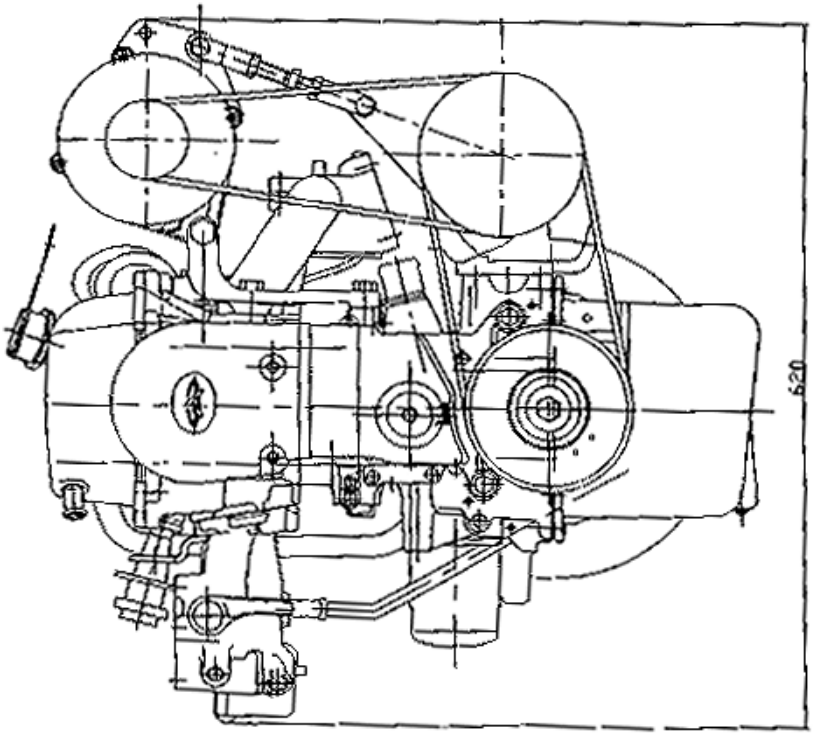
Single-point electric control fuel injection system and multipoint electric control fuel injection system of the above engines are developed though the joint effort with Italy M & M Corp.

With advanced product performance, reliable structure，CAC478、CAC480 series automobile gasoline engines may be applied for both car and light-duty vehicles.

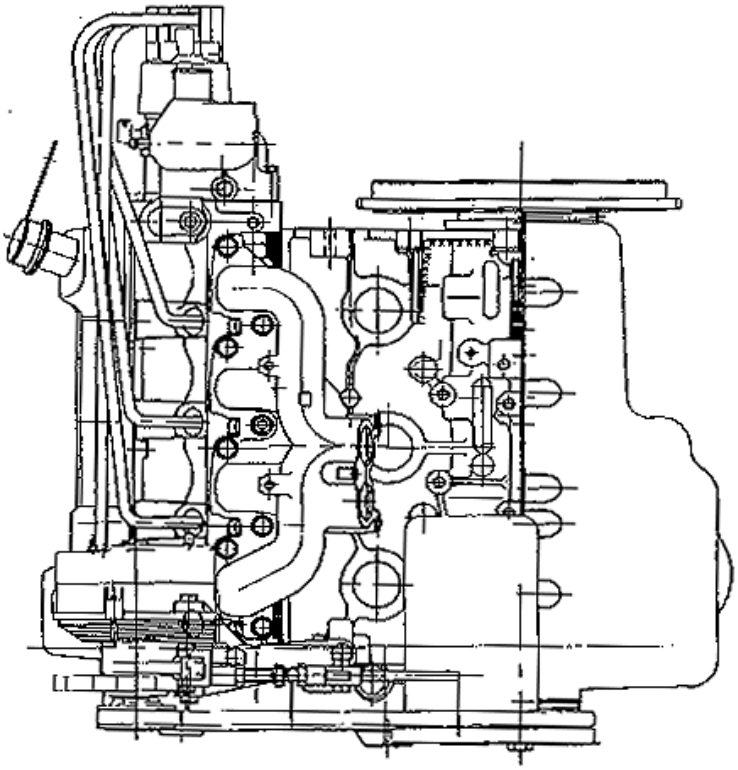
Specifications, covering major parameters, structural features, assembly and adjustment, common operation repair and maintenance, trouble shooting for CAC478, CAC480 carburetor and single-point electric control fuel injection engine, may be referred by mechanic, driver, technologist and management section .



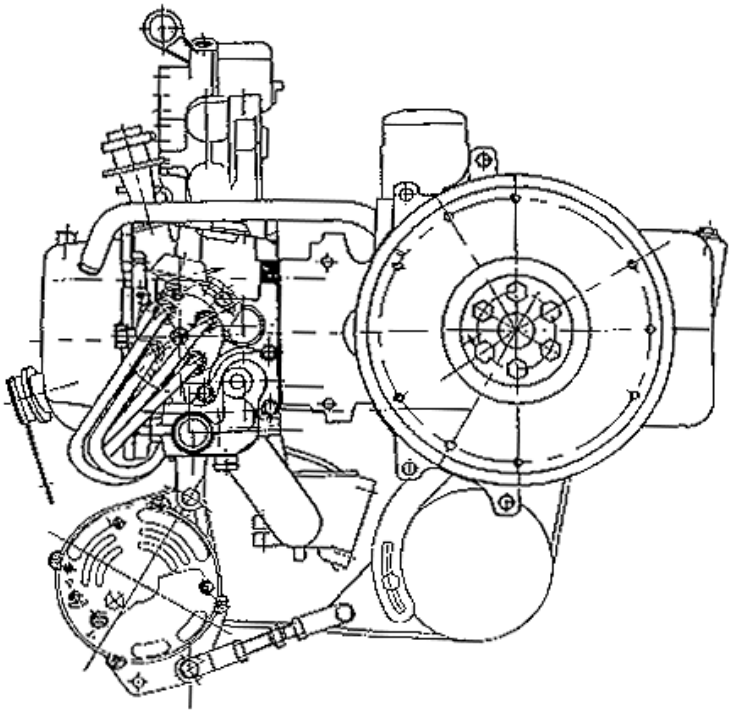
Carburetor engine left view



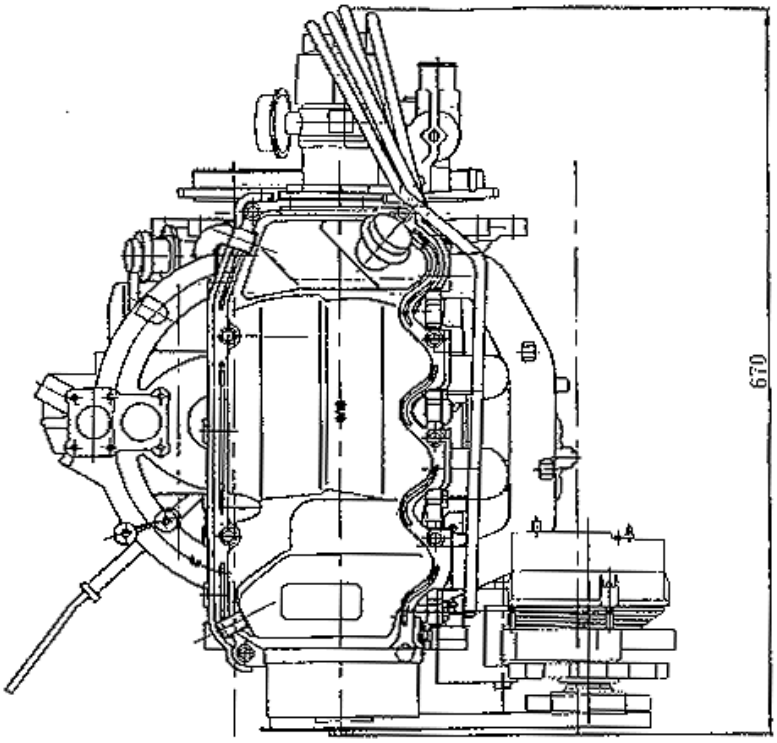
Carburetor engine frontal



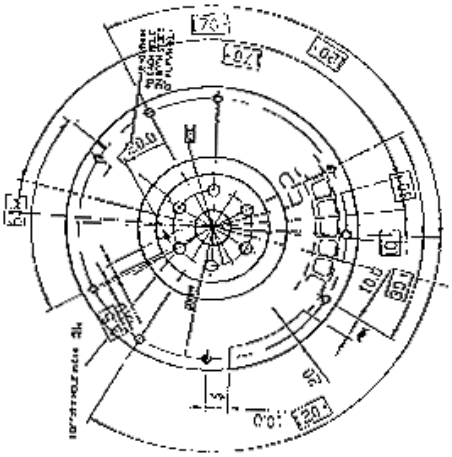
Carburetor engine right view



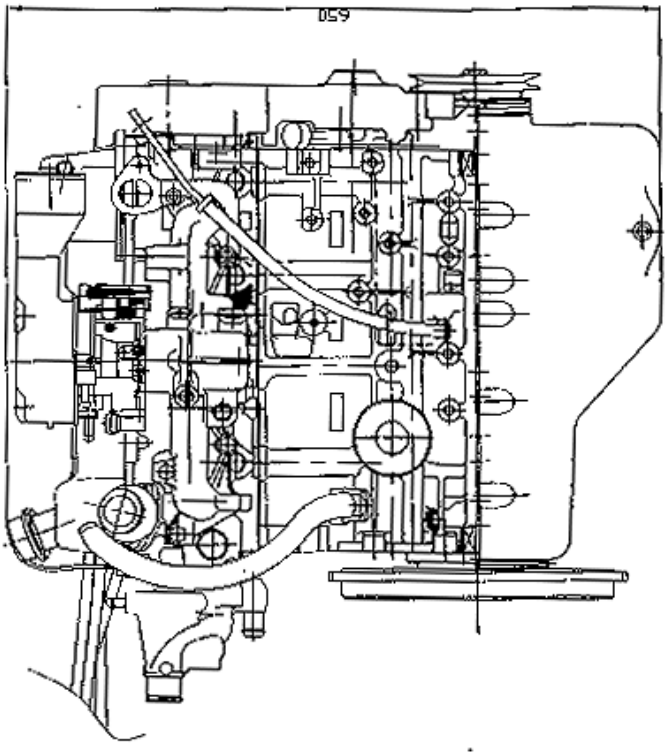
Carburetor engine back view



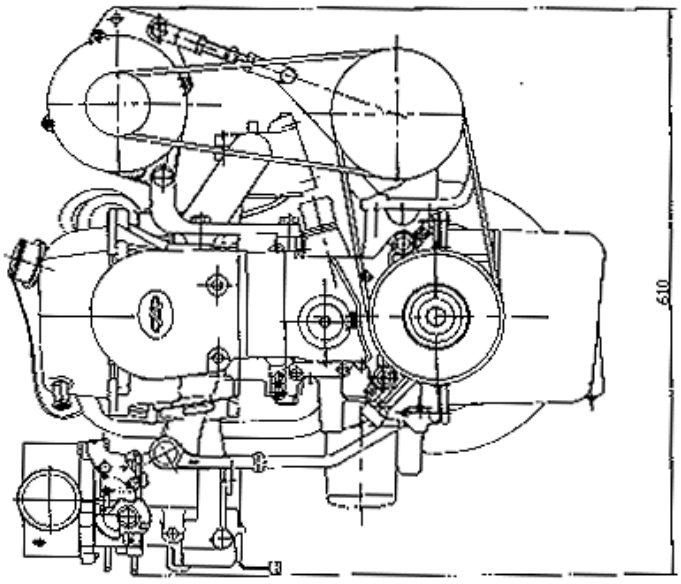
Carburetor engine overlook view



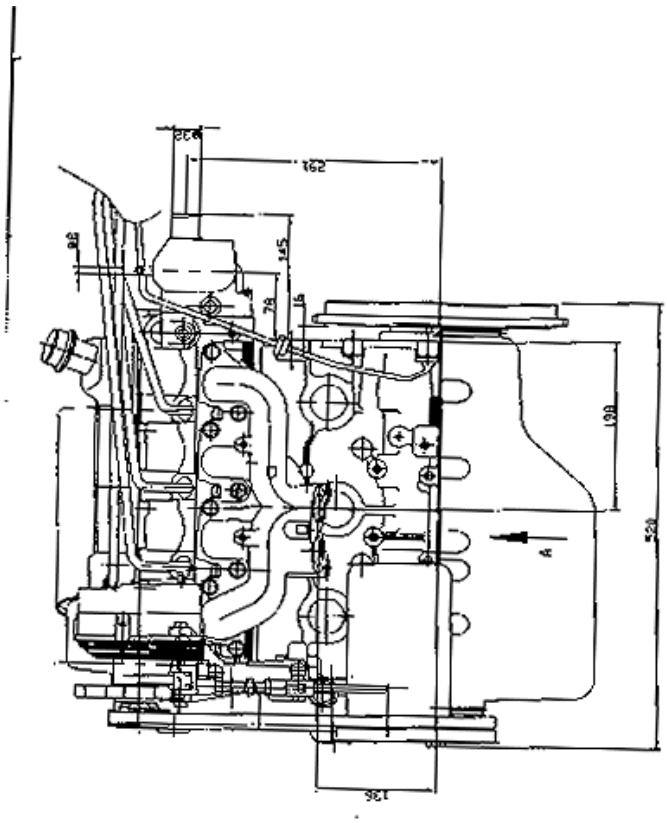
Carburetor flywheel rear side jointing size illustration



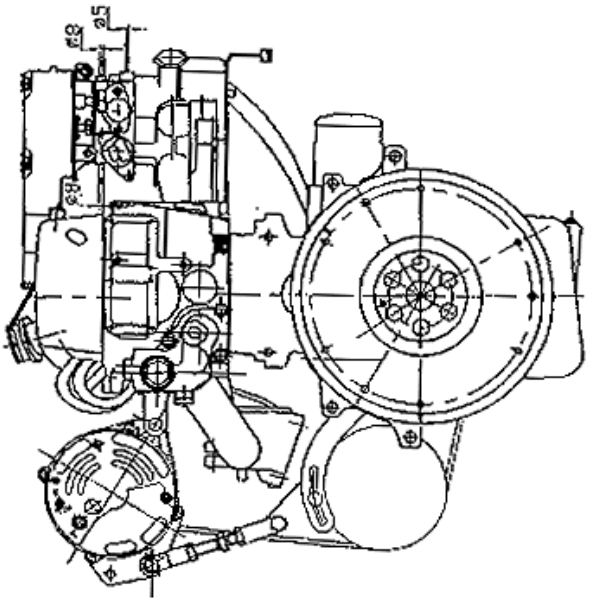
EI engine left view



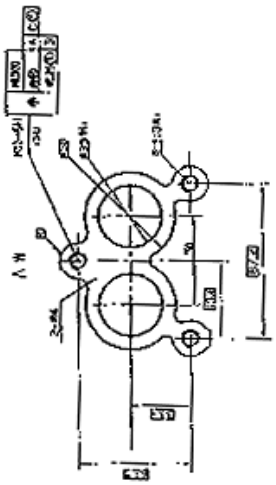
EI engine front end

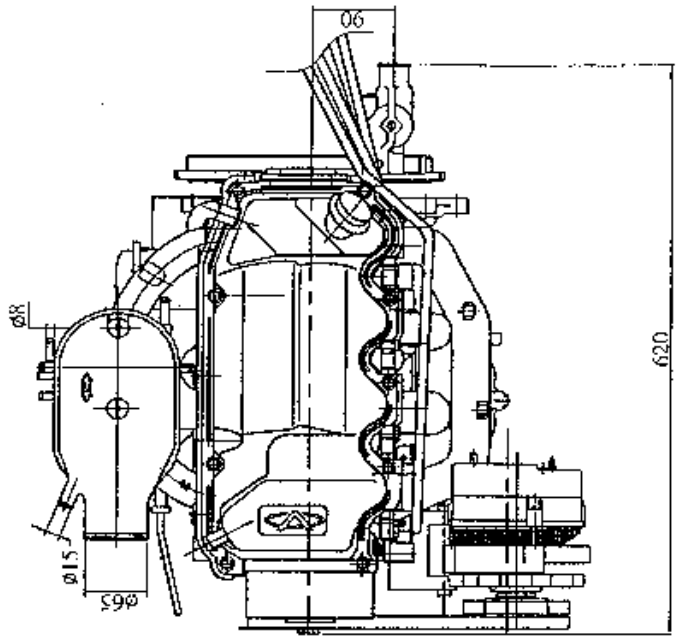


EI engine right view

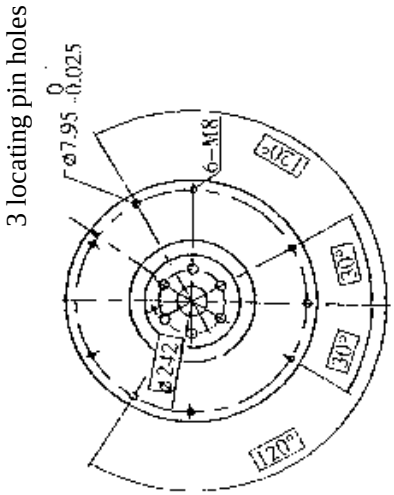


EI engine back view

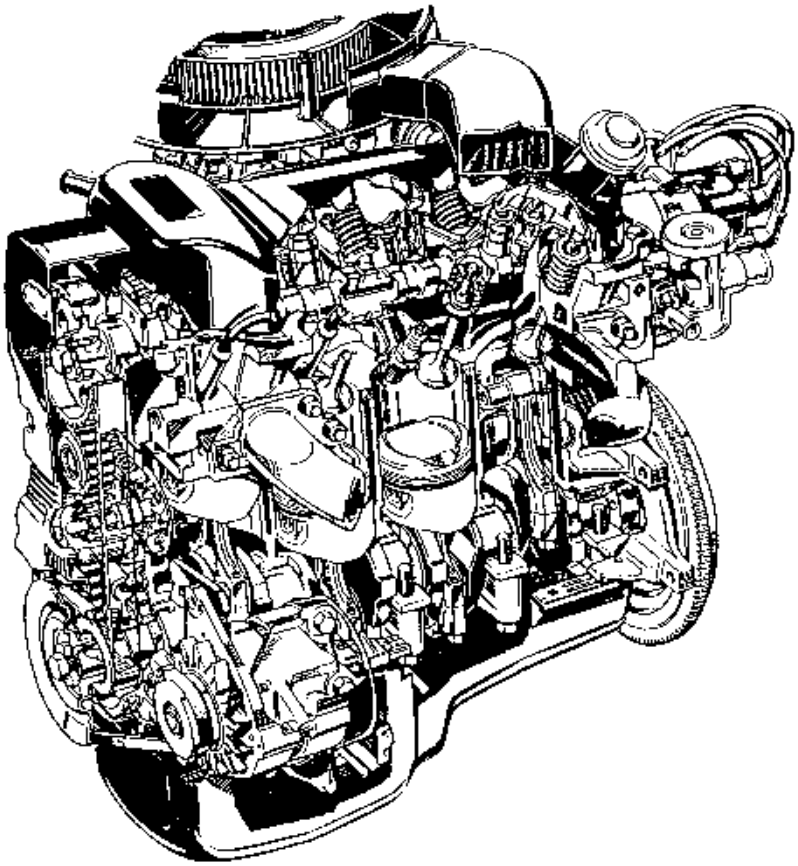




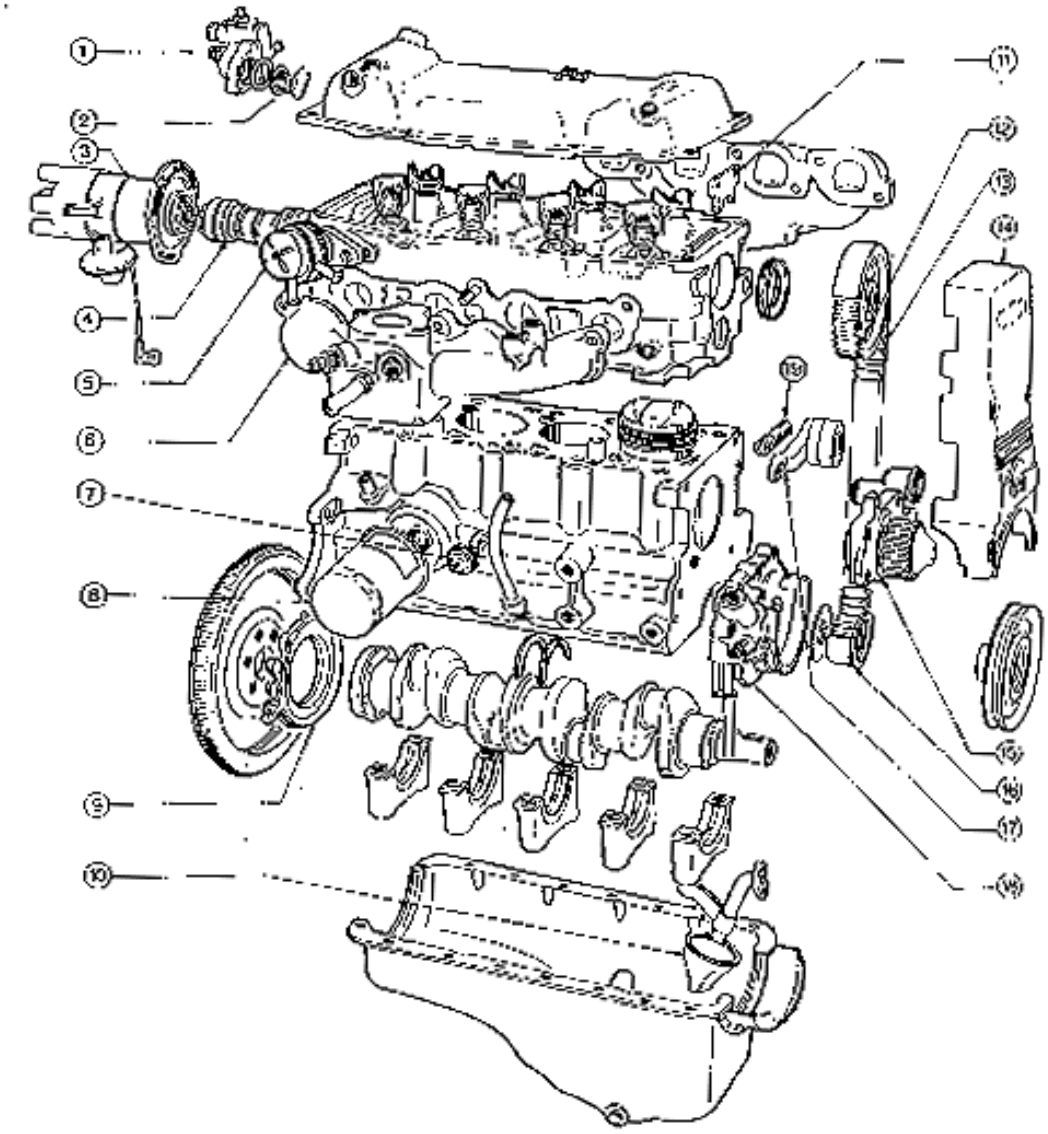
EI engine overlook view



EI engine flywheel rear end jointing size



Carburetor engine exploded view



1、 temperature regulator seat assembly
2、 temperature regulator seat
3、 distributor
4、 camshaft assembly
5、 fuel pump assembly
6、 air intake manifold assembly
7、 fuel pressure switch
8、 oil filter assembly
9、 rear oil sealing carrier assembly
10、oil collector assembly
11、camshaft thrust plate
12、camshaft timing gear
13、timing belt
14、upper\ lower timing gear cap assembly
15、water pump assembly
16、camshaft timing gear
17、tensioner pulley assembly
18、oil pump assembly
19、camshaft oil sealing

Main engine technical indexes and operation parameters

	CAC478C	CAC480C	CAC480M
Type	Line,4-cyl, four strokes, water-cooling	←	←
Cylinder bore diameter(mm)	77.24	79.94	←
Stroke(mm)	74.30	79.52	←
Total displacement(L)	1.392	1.596	←
Compression ratio	9.5：1	9.75：1	9.75：1
Nominal power/RPM (kW/r/min)(Total power)	54/5500	60/5500	62/5500
Output maximum torque/RPM (Nm/r/min)(Total power)	105/3000-3500	128/3000-3500	128/3000-2500
Minimum fuel consumption of total power for external characteristic (g/KW • h)	298	290	285
Fuel supply system	Carburetor	←	Single-point electric control fuel injection
Combustion chamber shape	Wedge type	Hemisphere type	Hemisphere type
Cylinders Working Order	1-3-4-2	←	←
Direction of crankshaft rotation	Clockwise(Viewed from the front)	←	←
Lubrication	Mechanical lubrication+Splash feed	←	←
Idling speed r/min	850±50	←	900±50
Emission(Idling)CO	2%	←	1.2%
Weight (kg)	105	108	108
Overall dimensions (Length * width * highness) (mm)	670×630×650	670×630×650	620×610×650
Ignition angle at idle (Crankshaft angle ，Before top dead center)	7° ±1°	7° ±1°	10° ±1°
Valve timing(Crankshaft angle)			
Intake valve opened	Before top dead center18°	←	←
Intake valve closed	After bottom dead center50	57°	←
Exhaust valve opened	before bottom dead center 61°	60°	←
Exhaust valve closed	After top dead center 7°	15°	←

Application parameters：

Lubricant(With temperature at - 10℃ or more)		SAE10W/30—50(grade SF)
Gasoline		93#(SH0041) Common unleaded Gasoline
Engine oil pressure	Idling	100kPa min
	2000r/min(80℃)	280kPa min
Engine oil capacity (L)		3.86(New oil filter)
Oil pump pressure regulator starts to open(pressure) kPa		440±20
Engine oil filter by-pass valve starts to open (pressure) kPa		78—118
Coolant		50%Glycol+50%Soft water(Rate by volume)
Coolant capacity (Total)(L)		8
Thermo-sister	Starts to open (Temperature) ℃	85—89
	Fully open(temperature)℃	99—102
Expansion tank pressure cap pressure kPa		160
Fan diameter (mm)		280
Fan speed r/min		Ⅰspeed 1500 Ⅱspeed 2800
Air filter		1GD129607G

Engine structural features

1.Cylinder block：Made from gray cast iron. Without bibcock. Without cylinder liner.5 main bearing seats. Main Intermediate bearing anti-thrust. Main bearing caps are retained by spigot. Main bearing bolts of 12.9 grade.

2.Cylinder head：Made from aluminum alloy. Intake and exhaust valve seats and valve guides strutting.6 camshaft supports. Without camshaft bushing. with fuel pump, Push rod and distributor，Thermo-sister in cylinder head for Carburetor engine. with thermo-sister in cylinder head for Electric control engine. Cylinder cover bolts of 10.9 grade.

3.Piston：made from eutectic aluminum silicon. Anti-expansion steel-strutted skirt. Ellipse head and skirt. Cone head. Barrel skirt.

4.Piston ring：First compression ring of ductile cast iron. With excircle sprayed molybdenum. Ground ring with barrel surface.
Second compression ring is of twist type. made from alloy cast iron.
Steel strip combination oil ring. With scape blade excircle chroming.

5.Piston pin：Low carbon steel. Surface carbonizing and quenching. Semi-floating structure(Interference fit with small end of connecting rod. Clearance fit with piston pin hole.

6.Connecting rod：Forged steel. Flat insection. Without small end bushing. Connecting rod stem and cover are retained by 2 spring dowels. Piston and cylinder block is lubricated by oil spray from connecting rod bearing bore drill. Connecting rod bolts of 12.9 grade.

7.Crankshaft：4 balance weight. Ductalloy. Normalizing treatment.

8.Bearing bushing：Connecting rod bushing,Main bearing bushings and thrust washers are all made of tin&aluminium duplex metal. Two pieces of thrust washer. They are mounted in cylinder block.

9.Flywheel：It is made of ductalloy. May be fitted with 190 and 210 clutch. Casted with crankshaft speed signal disk.

10.Camshaft：It is made of alloy cast iron. Cam and fuel pump eccentric cam high frequency quenching treatment. 5 supports. Camshaft thrust spacer is made from low carbon steel. Surface carbonitriding .

11.Rocker arm：Low carbon steel、Stamping. Surface carbonitriding. Rocker arm stud of 10.9 grade.

12.Hydraulic lifting rod：The surface contacting cam is quenched. The contact face with rocker arm is made of low carbon steel. Surface carbonitriding，Both contact face are circular-arc.

13.Intake valve seat：It is made of alloy cast iron.

14.Exhaust valve seat：Iron base powder metallurgy. Quench treatment.

15.Valve guide：It is made from alloy cast iron.

16.Valve： Intake valve：Made from 4Cr9Si2. With smaller end of conical surface quenched，With conical surface angle 45°.With large nest seat in the valve head for hemispherical combustion chamber.
Exhaust valve：4Cr9Si2-21-4N. With conical surface angle 45°.With smaller end quenched.

17.Gear：Made from iron base powder metallurgy.

18.Timing belt：Made from cyaniding butadiene-acrylonitrile rubber.

19.Intake manifold：Made from Aluminum alloy. With mixture warm upped by water jacket. Electric heated intake manifold is optional.
20.Exhaust manifold：Made from ductalloy or black cast iron.
21.Oil pan：Stamping ，Low carbon steel. Oil pool is in the front of cylinder block.
22.Oil pump：Rotor type. Case is made of aluminum alloy.
Speed ratio 1∶1，With pressure relief valve in oil pump.
23.Engine oil filter：Full flows type spinning filter. With by-pass valve in it.
24.Fuel pump：Diaphragm type. Driven by upper camshaft eccentric cam. Electric fuel pump for electric control engine. In fuel tank.
25.Push rod：Made from low alloy steel，Carbonization & quench treatment. Only applied for carburetor engine.
26.Water pump：Centrifugal type，Cast iron impeller，Aluminum alloy case，Driven by timing belt through gear.
Speed ratio 1.053∶1.
27.Thermosister：Wax type.
28.Thermosister seat：Aluminum alloy，With overflow valve，overflow pipe and micro-circulation tube.
29.Carburetor：Pierbort 2E3 carburetor. Throttle valve body for 480M 30MM12 Imported part.
30.Spark plug：K7RTC
31.Non-contact distributor：Driven by the rear end of camshaft，Type is FDW451& JFD459.Only applied for carburetor engine.
32.Ignition controller：Type are ZJ5701—HG & KH—3A.Only applied for carburetor engine.
33.Generator：14V 90A，Type are JFZ1913—4 or JFZ1813—2B.
34.Starter：12V 0.95KW QDY1258 or SD6RA78.
35.ECU：I.A.W.6F Imported Only for 480M engine.

Engine maintenance：

Daily maintenance	—— Check lubricant level
	—— Check coolant level
	—— Check bolt for loosing
	—— Check for leaking (oil, water, air)
Per8000km	—— Replace engine oil and oil filter
	—— Clean air filter，check air intake tube for cracking
	—— Check PCV valve
	—— Check spark plugs
Per16000km	—— Check accessories drive belt
	—— Check timing belt and tension pulley
	—— Check radiator and hoses for leaking
Per30000km	—— Replace fuel filter
Per32000km	—— Replace spark plug
	—— Check high-tension wire
Per45000km	—— Check lambda sensor function
Per48000km	—— Replace corrosion preventive coolant and clean cooling system
	—— Replace air filter
Per64000km	—— Replace timing belt

CAC478、480Contents and intervals for Constant maintenance

×1000km	8	16	24	30	32	45	48	60	64
Replace engine oil	☆	☆	☆		☆		☆		☆
Replace oil filter	☆	☆	☆		☆		☆		☆
Clean air filter core	☆	☆	☆		☆		☆		☆
Check spark plugs	☆	☆	☆		☆		☆		☆
Replace air filter core and clean case							☆		
Check accessory driving belts		☆			☆		☆		☆
Check radiator and hoses for leaking		☆			☆		☆		☆
Replace spark plugs					☆				☆
Replace timing belt									☆
Replace fuel filter				☆				☆	
Check high-tension wires					☆				☆
Check lambda sensor function						☆			
Check timing belt and tension pulley		☆			☆		☆		☆
Check PCV valve	☆	☆	☆		☆	☆	☆		☆

For severe conditions of application, maintenance intervals should be shortened according to specific conditions.

Engine removal and assembly procedure

【1】、Positioning no.1 cylinder top dead center (compression)

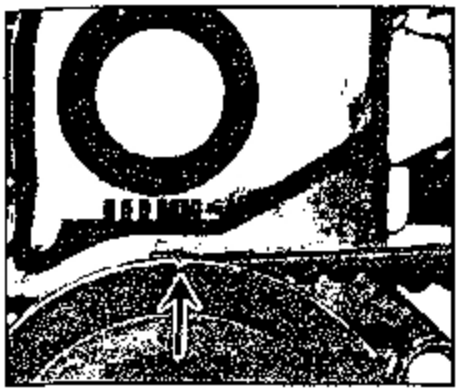


Fig.1

——Remove two M6×55 flange-shaped bolts, remove upper timing gear cover.
——Install a wrench on crankshaft pulley bolt, rotate crankshaft Clockwise (viewed from the direction of pulley) until the TDC notch on crankshaft pulley aligns with the TDC mark (0) on timing gear cover.
Note：Before rotation，spark plugs may be removed to reduce effort.

Fig.2

——Check whether the TDC mark on the camshaft gear aligns with the mark on the front end of cylinder head. If not aligned, rotate crankshaft one turn，aligning the TDC mark on the camshaft gear with the TDC mark on the front end of cylinder head，engine should be at no.1 cylinder TDC .
——With crankshaft pulley and lower timing gear removed，position no.1 cylinder at TDC as following:
Rotate crankshaft, aligning the TDC mark on the crankshaft gear shaft with the TDC mark on the oil pump case. Check whether the TDC mark on camshaft gear aligns with the TDC mark on the front end of cylinder head. if not aligned, rotate crankshaft one turn，aligning the TDC mark on camshaft gear with the TDC mark on the front end of cylinder head.

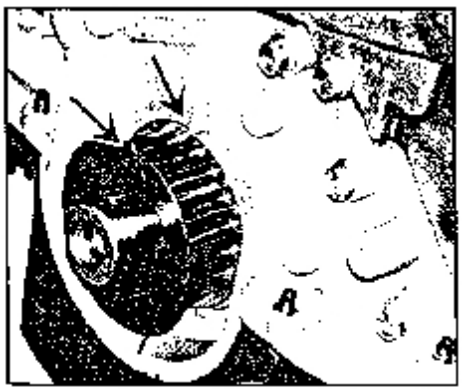


Fig.3

【2】、Upper and lower timing gear cover assemblies removal and installation

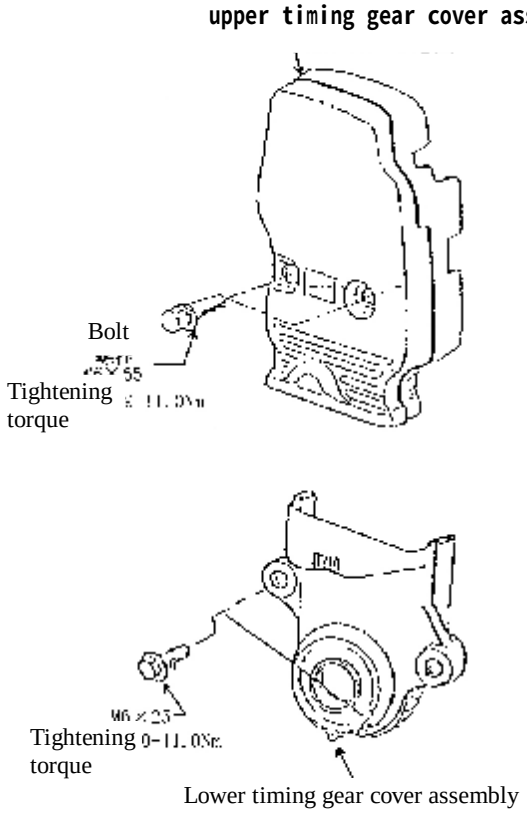


Fig.4

Removal:
——Loosen and remove 2 bolts for upper timing gear cover assembly.
——Remove upper timing gear cover and seal assembly.
——Remove seal gasket and shot nail from upper timing gear cover.
——Remove crankshaft pulley.
——Loosen and remove 2 bolts for lower timing gear cover assembly.
——Remove lower timing gear cover and seal gasket assembly.
——Remove shot nail and seal gasket from lower timing gear cover.
Installation:
——Clean lower timing gear cover.
——Mount new seal gasket with shot nail or glue on lower timing gear cover.
——Install lower timing gear cover and seal gasket on crankshaft，finger screw in 2 bolts and tighten to 9.0—11Nm.
——Clean upper timing gear cover.
——Mount new seal gasket with shot nail or glue on lower timing gear cover.
——Install upper timing gear cover seal gasket with 2 bolts on cylinder block，tightening torque is 9—11Nm.

【3】、Crankshaft pulley removal and installation

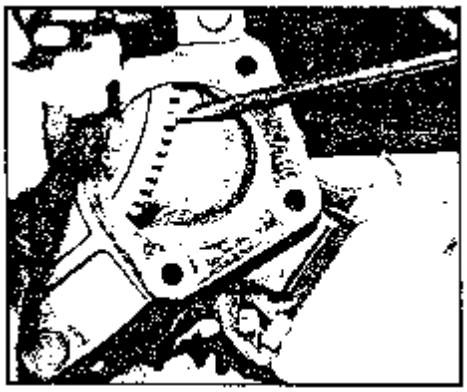


Fig.5

Removal:
——If engine is equipped with starter，remove three M10×30 or M10×35 bolts and remove starter.
——Block flywheel ring gear with a appropriate screwdriver or lever, preventing crankshaft from rotating.
——Loosen crankshaft pulley mounting bolts，remove bolt and cushion block.
——Pull out pulley, if necessary, puller may be used.

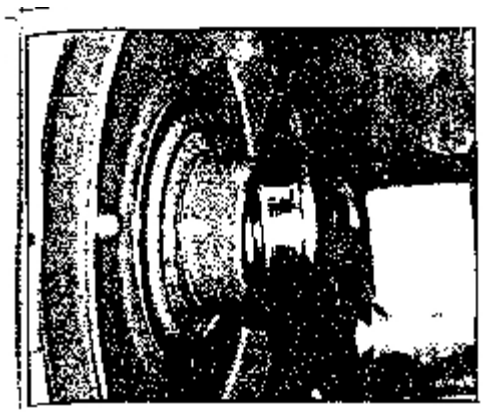


Fig.6

Installation：

——Clean pulley and crankshaft journal，remove the oil in pulley groove .

——Install pulley on crankshaft journal, aligning keyway with semicircular key.

——Slip cushion block onto bolts and finger screw in.

——Block flywheel ring gear with screwdriver, preventing crankshaft from turning.

——Tighten bolts to 100—115Nm.

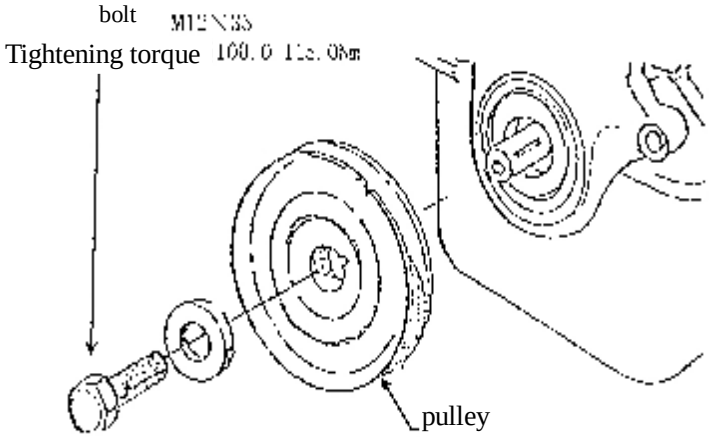


Fig. 7

【4】、Valve cover and seal gasket removal and installation

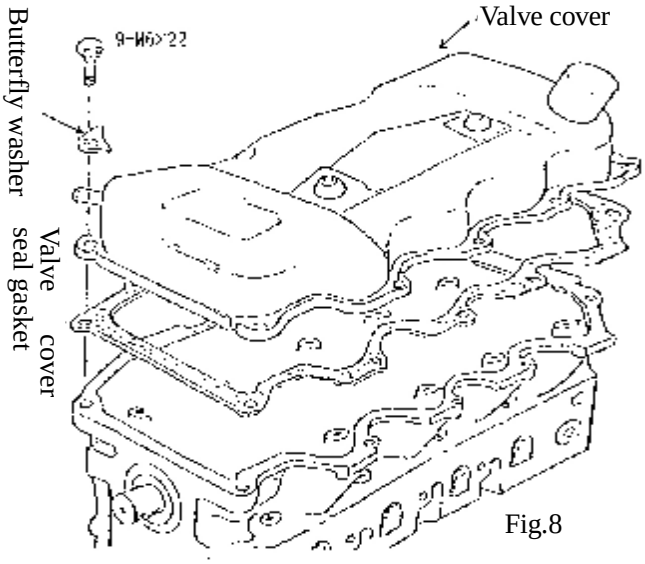


Fig.8

Removal：

——Remove 9 bolts and butterfly gasket.

——Remove valve cover and seal gasket assembly.

——Remove seal gasket.

Fig.9

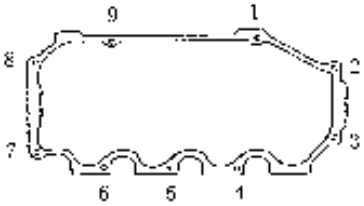


Fig. 10

Installation：
——Clean cylinder head and valve cover contacting surface.
——Push the wedge of valve cover seal gasket into appropriate valve cover groove, integrating valve cover with seal gasket.

——Install valve cover and seal gasket assembly on cylinder head.
——Install 9 hexagon head bolts of long column end with butterfly gasket，finger screw them into cylinder head.
——Tighten bolts in two steps in order as diagram showed.
Step 1：Tighten to 4.0—6.0Nm
Step 2：Tighten to 8.0—10.0Nm

【5】、Timing belt removal, installation and adjustment

Fig.11

Removal：
——Rotate crankshaft to no.1 cylinder compression TDC.
——Loosen 2 tension pulley mounting bolt (as arrow indicated in diagram)，push tension pulley aside with a large screwdriver.
——To release belt tension，tighten 2 tension pulley mounting bolts with tension pulley in this position.
——To reuse belt，mark the direction of belt rotation and make reference mark on crankshaft gear and camshaft gear matching teeth，remove belt from camshaft gear, water pump gear and crankshaft gear.

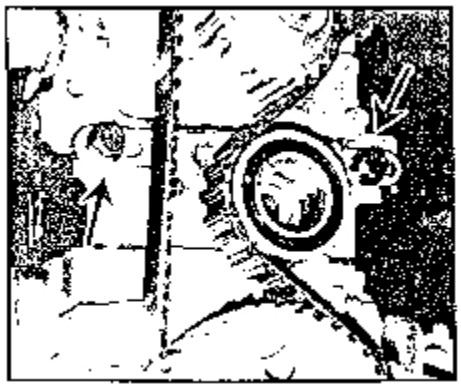


Fig.12

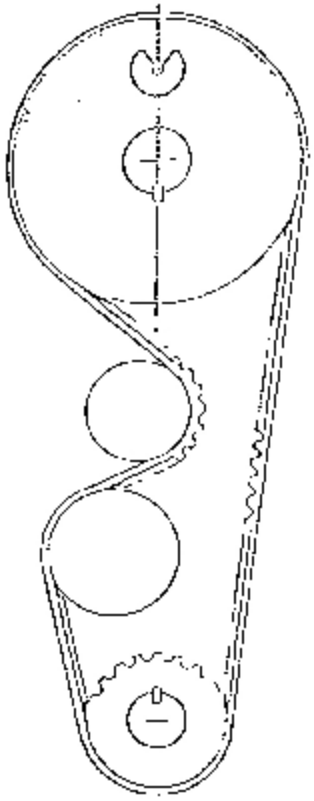


Fig.13

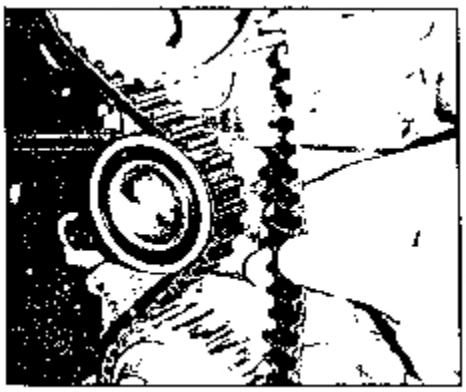


Fig.14

Note：With belt removed， don't turn gear excessively，or piston head and valve may be damaged for contacting.

——If belt need to be reused ， check for improper wear ,delaminate crack (particularly at the foot of teeth) or dirt. If lightly suspected, replace it.

Installation and adjustment：

——Crankshaft should be positioned at no.1 cylinder TDC， if necessary, crankshaft may only be turned slightly for adjustment and blocked at flywheel ring gear.

——Engage timing belt tooth with crankshaft grooves， and pull belt up straight to the right engaging belt with cam gear grooves. During the installation of used belt, insure belt is in the right direction and match belt with appropriate tooth.

With belt installed, 2 gears should not make any movement.

——Pull belt around tension pulley carefully， engage belt tooth with gear teeth grooves.

Recheck both gears, there should be no movement.

——Loosen 2 tension pulley mounting bolts，push tension pulley right to the extreme (viewed from the direction of pulley)，tighten 2 tension pulley mounting bolts and loosen crankshaft locking device.

——Rotate crankshaft clockwise (viewed from the pulley end) 2 turns until no.1 cylinder reaches its TDC of compression.

——Grab the midway of the right side belt between crankshaft gear and camshaft gear with thumb and forefinger. If belt tension is as specified, belt may be twisted 90°.

To adjust belt tension，loosen 2 tension pulley mounting bolts and push tension pulley right side using screwdriver as push rod，then tighten mounting bolts and rotate crankshaft. Recheck tension. It may take 2- 3 times before tension is as specified. After adjustment, tighten tension pulley mounting bolts to 16—20Nm.

——It is only a approximate method to adjust belt， and belt tension should be checked as soon as possible by professionals with special tools .

【6】、Tension pulley, crankshaft gear and camshaft gear removal, check and installation

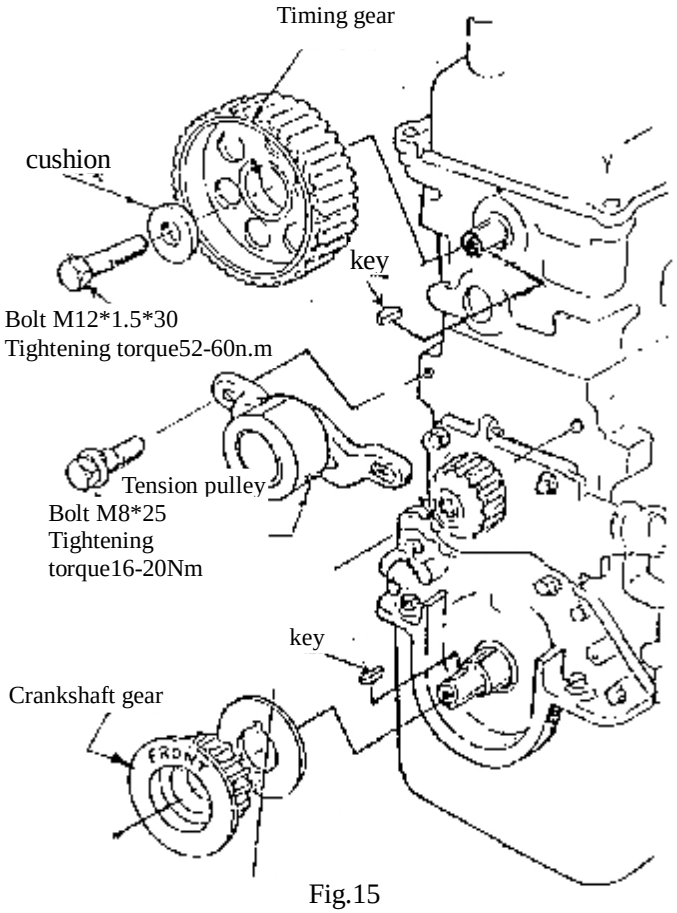


Fig.15

1. Tension pulley

Removal:

——Rotate crankshaft to no.1 cylinder compression TDC.

——Remove belt.

——Loosen 2 tension pulley mounting bolts, push tension pulley aside to release belt tension with a large screwdriver.

——Remove 2 mounting bolts and take out tension pulley.

Installation:

——Check bearing for rotating freely by turning tension pulley, bearing end play and radial clearance, if suspected, replace appropriate parts immediately.

——Crankshaft should be positioned at no.1 cylinder compression TDC.

——Install belt tension pulley, finger screw in 2 mounting bolts, then tighten to 16—20Nm.2.Camshaft gear.

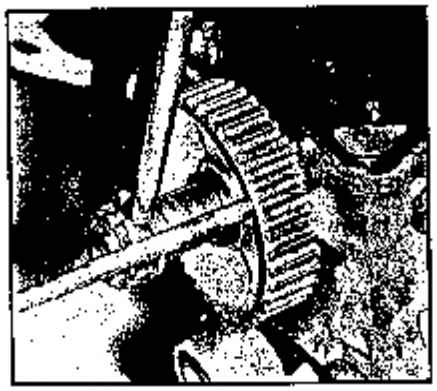


Fig.16

Removal:

——Rotate crankshaft to no.1 cylinder compression TDC

——Remove belt.

——Insert a lever into one of the camshaft gear holes to block camshaft, then loosen gear bolt and remove bolt and cushion block.

Note: During reinstallation, new bolt should be applied , remove camshaft gear.

——Camshaft gears are not permitted to be exchanged between 478 engine and 480 engine, during replacement, the mark on the original gear should be referred.

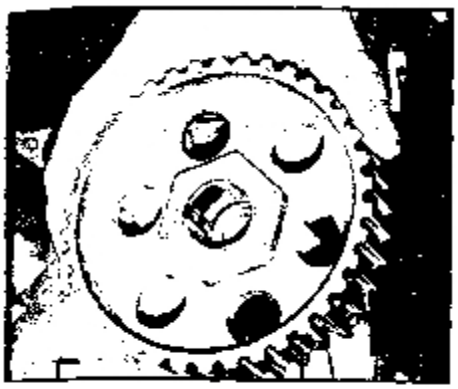


Fig.17

Installation：

——Check gear tooth for wear, pitting or scratch.
——Install camshaft semicircular key，protrusion should be 1.64—2.11mm.
——Install camshaft gear on camshaft with new bolt though cushion block，new bolt should be pre-pasted and tightened to 52—60Nm.——Check whether crankshaft is positioned at compression TDC.

3.Crankshaft gear
Removal：
——Block crankshaft and remove belt.
——Pull out crankshaft gear with puller or 2 large screwdrivers，then remove semicircular key.
Installation：
——Check gear tooth for wear, pitting or scratch.
——Install semicircular key，protrusion should be 1.392—1.739mm.
——Install shim with curved face side forward.
——Install crankshaft gear with boss side forward, and then press crankshaft gear onto boss using a assistant pulley and pulley bolt.

【7】、Camshaft oil seal removal and installation

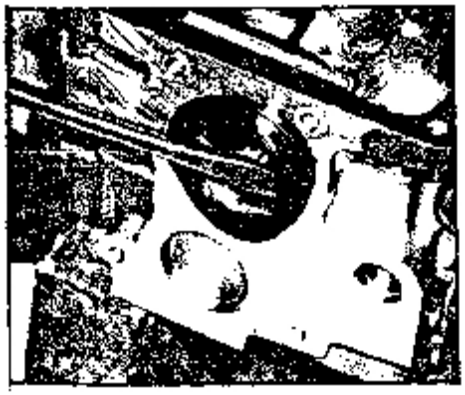


Fig.18

Removal：
——Remove camshaft gear.
——Note the direction of oil seal installation, pry out oil seal from the oil seal hole in cylinder head，be sure not damage the oil seal hole.
Installation：
——Clean the oil seal hole in cylinder head ,apply clean engine oil on oil seal edge and camshaft oil seal journal，install oil seal on oil seal journal carefully，push oil seal in perpendicularly into place with a appropriate cushion block and used camshaft gear bolt. An appropriate socket wrench may be used to push oil seal into place.

【8】、Valve mechanism and cylinder head removal, check and installation

1.Valve mechanism for 478 and 480 engine：

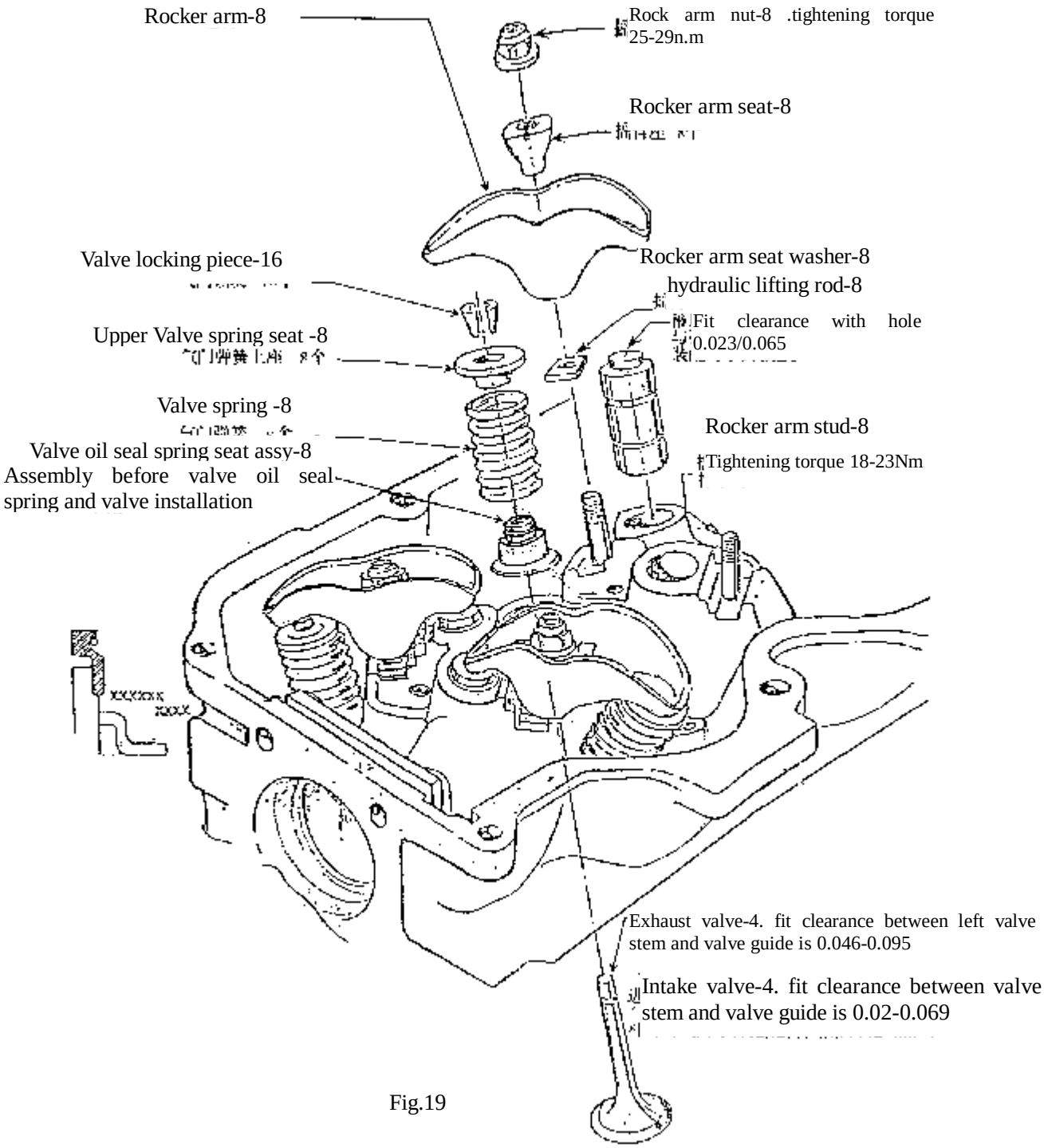


Fig.19

2.Cylinder cover bolts removal and cylinder head assembly installation

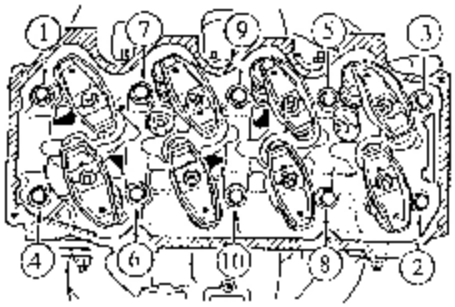


Fig.20

Cylinder head bolts removal：
——Rotate camshaft until keyway is rightly upside.
——Loosen cylinder cover bolts in order as specified in diagram.
——Note： Cylinder cover bolts must be replaced after removed and are not permitted to reuse.

Cylinder head assembly reinstallation：
——Check whether cylinder head contact surface roughness is 0.15mm or less.

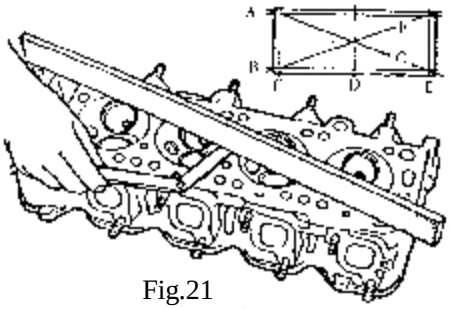


Fig.21

——Clean the tapped holes in cylinder block，there should not be deposits in tapped hole， or fluid pressure resulting from bolts screwing may possibly results in cylinder block cracking.
——Rotate crankshaft until no.1 cylinder piston is 20mm or so under the deck of cylinder block to keep the valves in cylinder head assembly from contacting piston head.

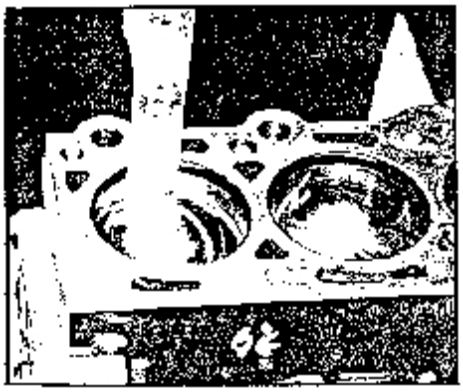
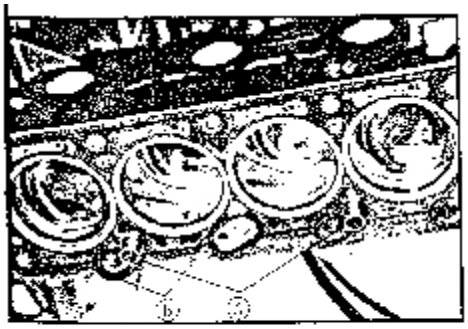


Fig.22

——Match cylinder head gasket with dowels.
Note：For cylinder head gasket mark, 2 tooth indicates 478，1 teeth indicates 480 ,and position cylinder head gasket with part number side upside.



A dowel B cylinder head gasket

Fig.23

——Install cylinder head into place with camshaft keyway perpendicularly downward.
Note：Cylinder head gasket may only be used once ，gasket should be replaced if cylinder head is removed.

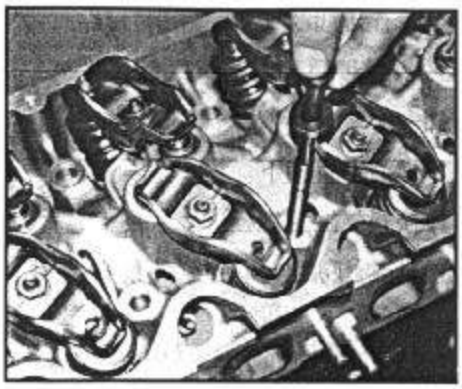


Fig.24

——Install new cylinder head bolts and washers into bolt holes, screw in by hand.

——Tighten cylinder head bolts in four steps in the order as diagram specified.

Step 1：Tighten to 20—40Nm

Step 2：Tighten to 40—60Nm

Step 3：Rotate 90°

Step 4：Rotate 90°

During rotating, torque- angle torque wrench or line plotting methods may be applied.

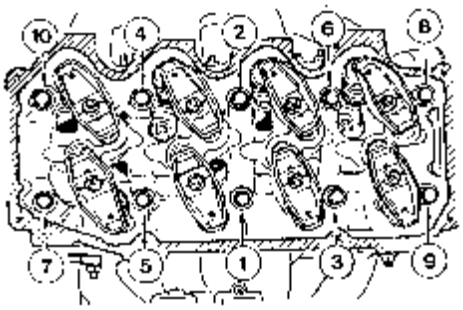


Fig.25

3.Rocker arm mechanism and hydraulic lifting rod removal and installation

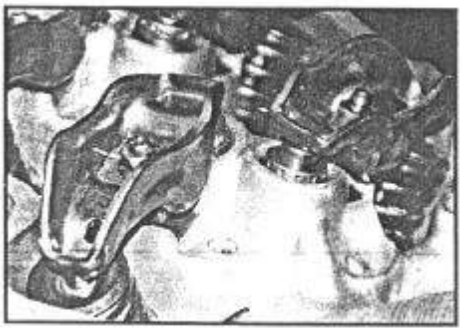


Fig.26

Rocker arm mechanism：

removal：

——Loosen rocker arm nuts，remove nuts.

——Remove rocker arm supports.

——Remove rocker arms.

——Remove rocker arm support shims.

——Put each group of rocker arm and rocker arm support into the same plastic bag for reference，rocker arm nuts are not permitted to reused after removed.

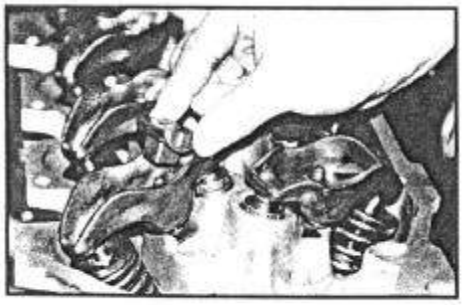


Fig.27

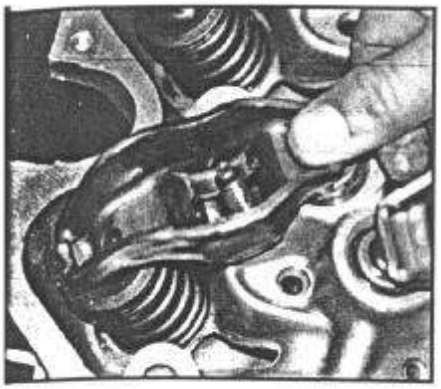


Fig.28

Installation：

——Check rocker arm contact surface for abnormal wear，replace rocker arm if necessary.

——Pull rocker arm support washers onto rocker arm double end studs.

——Lubricate rocker arms and rocker arm supports with engine oil.

——Install rocker arm, rocker arm support，then finger screw in new nut， tighten to 25—29Nm.

Note：Before installing each rocker arm and tightening nut， appropriate hydraulic lifting rod should be at the lowest position.

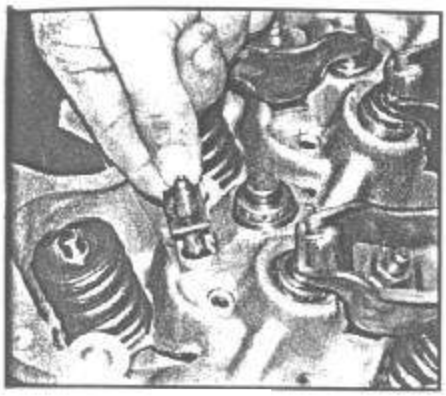


Fig. 29

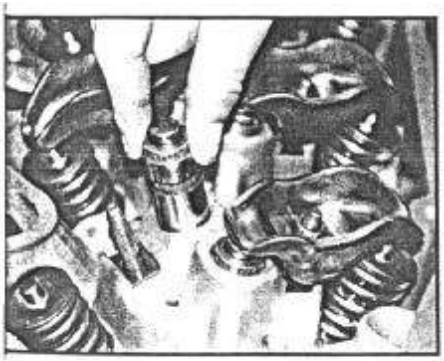


Fig.30

Hydraulic lifting rod：

——Removal：

——Remove hydraulic lifting rods ,in order, and put them into container filled with oil preventing them from leaking.

——Check both hydraulic end contact face for abnormal wear or scratch，

If needed, replace hydraulic lifting rod.

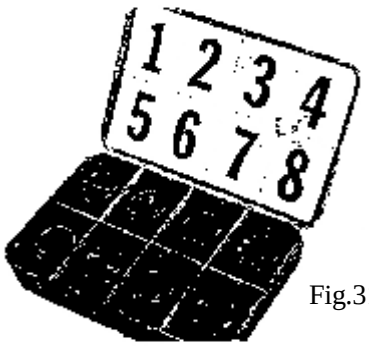


Fig.31

Hydraulic lifting rod installation：

——Hydraulic lifting rod size：

Grade	Lifting rod outside diameter	Cylinder head lifting rod hole diameter	clearance
Standard	Φ22.200—Φ22.212	Φ22.25±0.015	0.023—0.065
T25	Φ22.454—Φ22.466	Φ22.50±0.015	0.023—0.065

——Apply hyperbolical gear lubricant or engine oil on lifting rod, lifting rod outside diameter and lifting rod ends, install lifting rods in original order into the holes in the cylinder head.

4.Camshaft and camshaft thrust spacer removal and installation

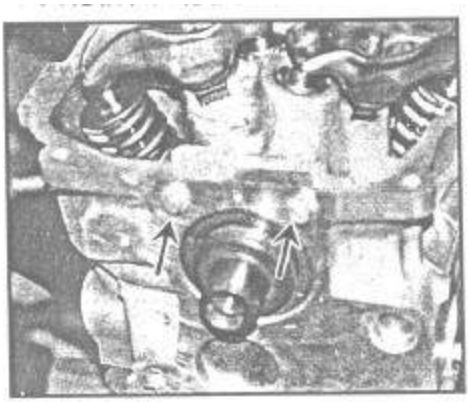


Fig.32

Removal：

——Measure camshaft end play，clearance should be 0.049—0.129mm.

——Loosen thrust washer bolt，remove thrust washer bolt(as shown in diagram).

——Remove thrust washer.

——Pull camshaft assembly out from the rear end of cylinder head，don't damage the camshaft hole in Cylinder head.

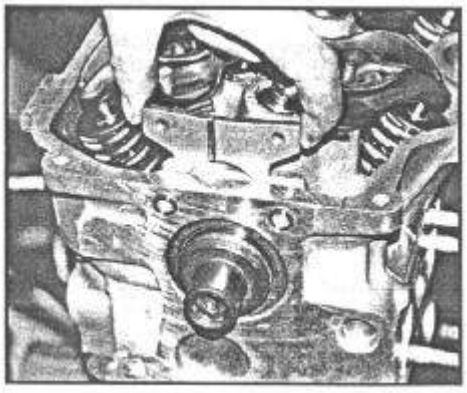


Fig.33

Inspection：

——Check camshaft cam and journal for wear，if worn out, replace it.

——If camshaft end play exceeds specification, replace thrust washer.

——Measure the diameter of the camshaft hole in cylinder head ，or check journal to hole movement with camshaft，if hole is worn excessively, camshaft may only be replaced.

——Cam height：

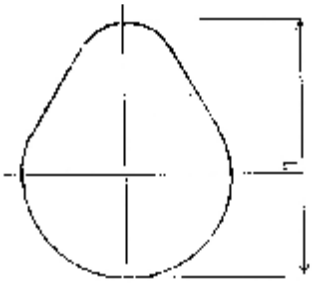


Fig.34

Unit：Mm

	Intake cam T	Exhaust cam T
478	38.305	37.289
480	38.602	37.586
478E	38.305	37.289
480E	37.559	37.559

Note：480 camshaft may only be used on 480M.

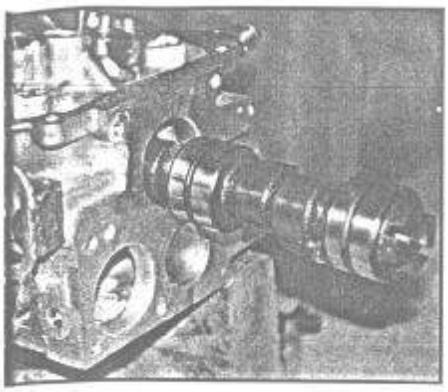


Fig.35

——Camshaft journal and cylinder head cam bearing hole size：

(1) Standard size mm

Camshaft journal number	Camshaft journal diameter	Cylinder head bearing hole diameter
1	44.74—44.76	44.783—44.808
2	44.99—45.01	45.033—45.058
3	45.24—45.26	45.283—45.308
4	45.49—45.51	45.533—45.558
5	45.74—45.76	45.783—45.808

(2). Over size (0.38) mm

mm

Camshaft journal number	Camshaft journal diameter	Cylinder head bearing hole diameter
1	45.12—45.14	45.163—45.188
2	45.37—45.39	45.413—45.438
3	45.62—45.64	45.663—45.688
4	45.87—45.89	45.913—45.938
5	46.12—46.14	45.163—45.188

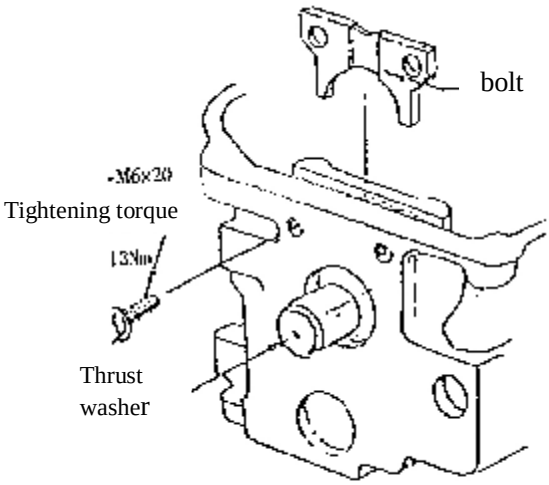


Fig. 36

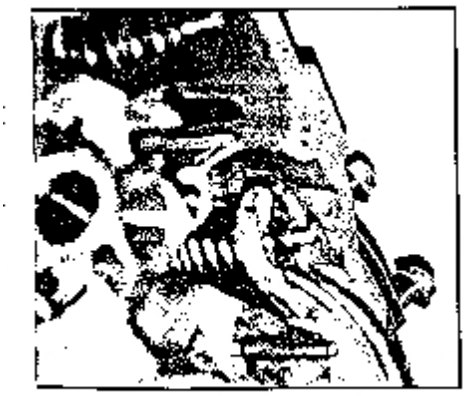


Fig. 37

Installation：

——If camshaft needs to be replaced, check the shape of the rear end of camshaft to select appropriate camshaft.

——Before installation，apply hypoid gear oil or engine oil on camshaft cams, assembly camshaft from behind the cylinder head forward.

——Apply engine oil on camshaft thrust spacer，insert thrust washer into the groove in the cylinder head.

——Screw 2 bolts into thrust washer tapped holes, tightening torque is 9—13Nm.

——Check camshaft end play，end play should be as specified.

——When the hydraulic lifting rod of oversize 0.25 is applied, camshaft must be selected, or the hydraulic lifting rod may be stuck.

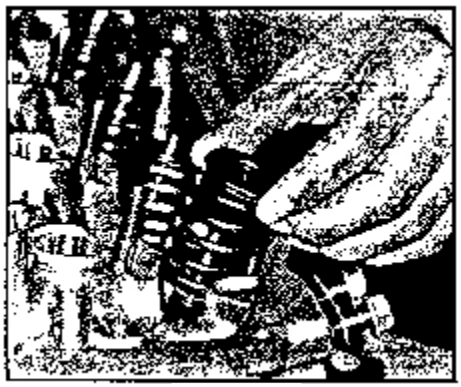


Fig.38

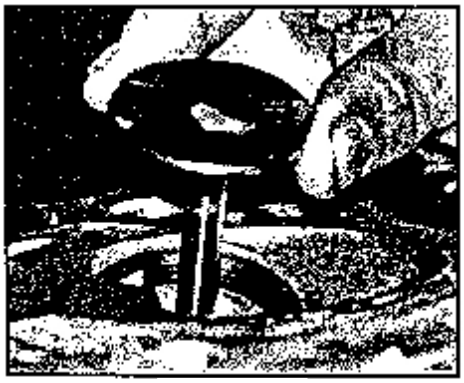


Fig. 39

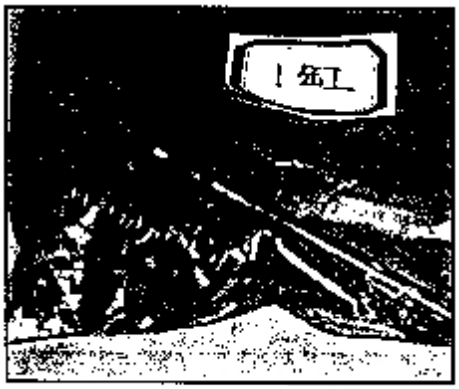


Fig. 40

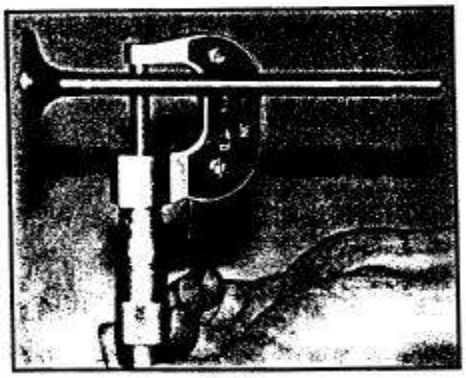


图 41

5.Valve, valve spring, valve oil seal, spring seat assembly removal and

installation：

Removal：

Using special tools for valve compression, take out valve locking pieces, don't compress spring excessively, compress spring enough to slip locking pieces out of its stroke, or valve stem may be bent.

If valve locking pieces do not come out during spring compression, remove compression tools, put an appropriate pipe on spring seat， so the valve locking piece will not be impacted. Put a wooden block on valve head (with cylinder head combustion chamber facing workbench), and then strike pipe end with hammer.

Reinstall special tools for valve spring compression, locking pieces may be taken out. After locking piece is taken out, remove compression tools by unbolting slowly.

——Remove valve spring seat and valve spring，take out valve oil seal spring seat assembly with screwdriver， and valve oil seal spring seat must be replaced.

——Overturn cylinder head ，remove intake and exhaust valves.

——Keep each set of valve, valve locking pieces, valve spring, spring seat in the same plastic bag and mark numbers on it, so the parts may be installed in the original place.

——Valve standard sizes and clearance：

Unit：Mm

grade	Intake valve			Exhaust valve		
	Valve stem diameter	Valve guide hole diameter	Clearance	Valve stem diameter	Valve guide hole diameter	Clearance
standard	8.043+0 -0.018	8.063-8.094	0.02-0.069	8.017+0 -0.018	8.063-8.094	0.046-0.095
oversize0.4	8.443+0 -0.018	8.463-8.494		8.417+0 -0.018	8.463-8.494	

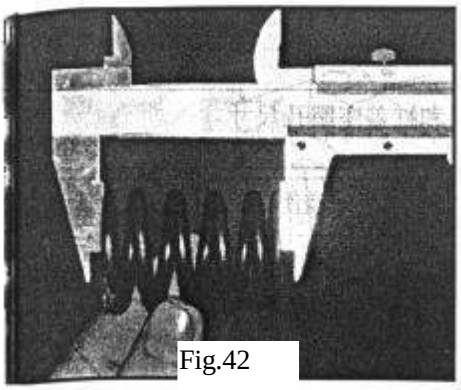


Fig.42

图 42

——Measure valve spring free length and spring force:

Compression (mm)	Spring load (N)	Spring free length
L_1=37.084	422	L_0=47.2
L_2=27.7	892.7	
L_3=27.0	945	

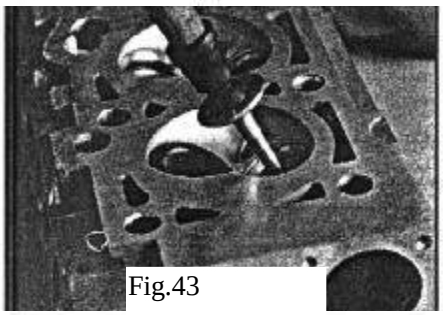


Fig.43

——Grinding the valve and the valve seat with the valve conical angle(Intake valve and exhaust valve):

44° 30′ — 45° 30′

valve seat sealing width:

1.75 — 2.32mm

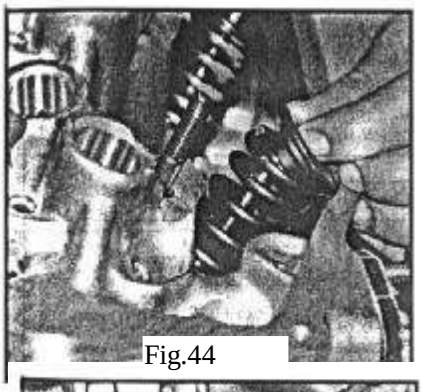


Fig.44

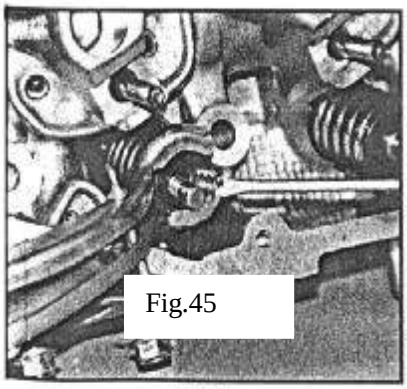


Fig.45

图 45

Installation:

——Before installation, make sure that cylinder head has been cleaned without any grinding material on cylinder head, valve or valve guide .

——Lubricate the valve stem and guide with clean engine oil.

——Install the valve. notice that the intake and exhaust valve for 478 and 480 are not interchangeable .refer to the previous valve mark for valve assembly.

——Press the valve spring assembly with oil seal onto the top of valve guide. apply engine oil on the intake and exhaust valve guide edge where the valve seals are installed for preventing valve lock piece groove from damaging oil seal lip. You may protect the valve lock groove with tape and remove the tape after installing the valve.

——Install the valve spring and spring seat. Compress the spring seat to expose the lock piece groove with a special compression tool. Then put the lock pieces into it and release the compression tool slowly and remove the tool .

——Put the cylinder head on a wood lump after all lock pieces are assembled. And tap the small head of the valve stem with a plastic or copper hammer to fit for the valve mechanism.

6.the sizes for intake valve, intake valve seat, exhaust valve seat and valve guide

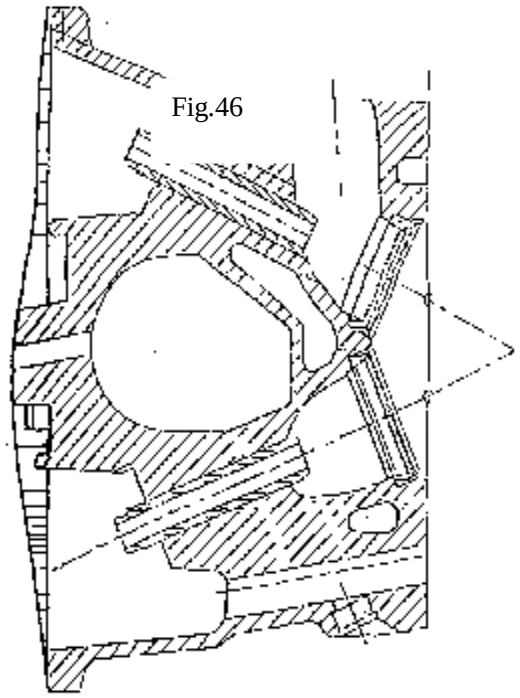


Fig.46

图 46

—the size of intake valve seat and cylinder head valve seat hole

—

	Diameter. of intake valve seat	Diameter of the cylinder head valve seat hole	press fit clearance
Standard 478	41.877+0.01 -0.01	41.763+0.025 0	0.079—0.124
oversize 0.5	42.377+0.01 -0.01	42.263+0.025 0	
oversize 1.0	42.877+0.01 -0.01	42.763+0.025 0	
Standard 480	43.877+0.01 -0.01	44.763+0.025 0	0.079—0.124
oversize 0.5	44.377+0.01 -0.01	44.263+0.025 0	
oversize 1.0	44.877+0.01 -0.01	44.763+0.025 0	

the size of exhaust valve seat and cylinder head valve seat hole

	Diameter. of intake valve seat	Diameter of the cylinder head valve seat hole	—press fit clearance
Standard 478	35.377+0.01 -0.01	35.263+0.025 0	0.079—0.124
oversize 0.5	35.877+0.01 -0.01	35.763+0.025 0	
oversize 1.0	36.377+0.01 -0.01	36.263+0.025 0	
Standard 480	38.377+0.01 -0.01	38.263+0.025 0	0.079—0.124
oversize 0.5	38.877+0.01 -0.01	38.763+0.025 0	
oversize 1.0	39.377+0.01 -0.01	39.263+0.025 0	

——the size of valve guide and valve guide hole

Level	The valve guide hole	The diameter. of linder head tube hole	press fit clearance
Standard	13.555 0 -0.01	13.481-13.519	0.026-0.07
oversize	14.305 0 -0.01	14.231-14.269	
oversize	14.505 0 -0.01	14.481-14.519	

【9】: Removal and installation of the piston and rod assembly.

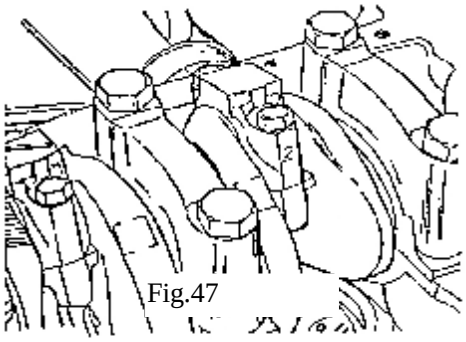


Fig.47

图 47

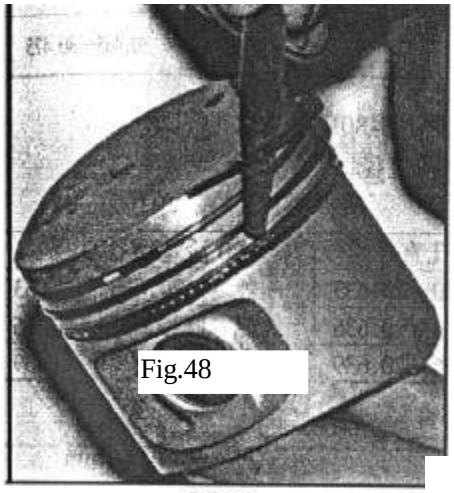
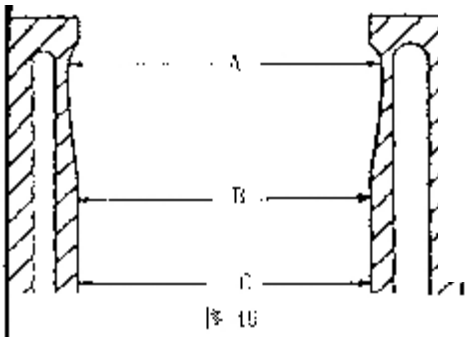


Fig.48

图 48



Removal:

——Remove the crankshaft to the bottom dead center of the cylinder. Check and make sure that there is a cylinder mark on the connecting rod and its cap. or make a mark on each cylinder before removal.

——Remove the connecting rod bolts and remove the rod cap. Take the connecting rod bushing out and stick on cylinder marks and labels on the upper or lower halves.

——Push the connecting rod and piston out of the cylinder with a hammer wood handle. Take the piston and rod out.

——Remove the piston ring with a special tool or the piece of feeler gauge. And make labels on each cylinder and upper and lower halves.

——Press the piston pin out of the piston hole and connecting rod small end with a press . Then put the piston, piston ring and piston pin together.

Cleaning and inspection:

——Clean and remove the carbon deposits from the piston, piston ring and piston pin.

——Clean and remove the carbon deposits from the upper cylinder bore.

——Measur cylinder bore. unit: mm

Fig.49

U

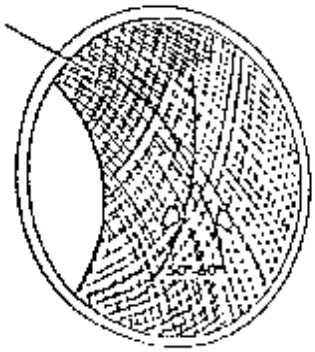


图 50

		478 cylinder bore		480 cylinder bore
			1	79.94—79.95
			2	79.95—79.96
			3	79.96—79.97
			4	79.97—79.98
			A	80.23—80.24
			B	80.24—80.25
			C	80.25—80.26
For maintenance	standard	77.745—77.755	standard	79.965—77.975
	Increase 0.29	77.525—77.535	oversize 0.29	80.245—80.255
	Increase 0.5	77.745—77.755	oversize 0.5	80.466—80.475

——Grind the cylinder bore with the service gauge and the figured

twins angle is 50°—60°.

——Measure the diameter of each piston of the carburetor engine.

Measurement should be taken at the position 10mm to the bottom

skirt. For 480E piston, measurement should be taken at the

g.50

position 19mm to the bottom skirt.

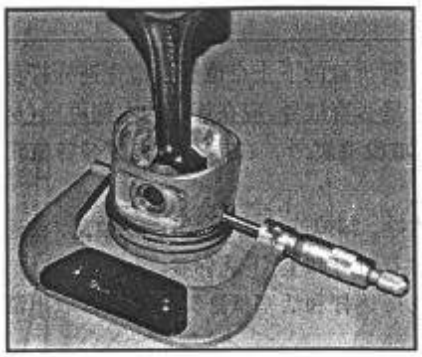


Fig.51

unit：mm

		478 dia. of piston skirt(mm)	488 dia. of piston skirt (mm)	480E *dia. of piston skirt (mm)
factory group	1	77.19—77.20	79.91—79.92	79.915—79.925
	2	77.20—77.21	79.92—79.93	79.925—89.935
	3	77.21—77.22	79.93—79.94	79.935—79.945
	4	77.22—77.23	79.94—79.95	79.945—79.955
Factory repair	A	77.48—77.49	80.20—80.21	80.205—80.215
	B	77.49—77.50	80.21—80.22	80.215—80.225
	C	77.50—77.51	80.22—80.23	80.225—80.235
Spare parts *	standard	77.21—77.235	79.93—79.955	79.965—79.975
	oversize 0.29	77.49—77.515	80.21—80.235	80.245—80.255
	oversize 0.5	77.71—77.735	80.43—80.455	80.465—80.475

480M piston should be applied on 480E engine

——Measure the diameter. of the hole of piston pin

unit：mm

478 diameter of the piston pin hole		480 diameter. of the piston pin hole	
White	20.630—20.633	White	20.630—20.633
Red	20.633—20.636	Red	20.633—20.636
Blue	20.636—20.639	Blue	20.636—20.639

——Measure the diameter. of piston pin

unit：mm

478 diameter. of the piston pin hole		480 diameter. of the piston pin hole	
White	20.622—20.625	White	20.622—20.625
Red	20.625—20.628	Red	20.625—20.628
Blue	20.628—20.631	Blue	20.628—20.631

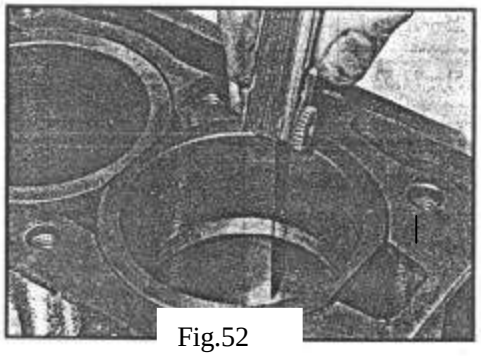


Fig.52

——Measure cotter intermission of piston ring

first compression ring 0.30—0.50mm

second compression ring 0.30—0.50mm

Steel combination oil ring 0.40—1.40mm

——Measure the piston ring end play in the piston groove

unit：mm

	piston ring height	piston ring groove size	Fit clearance
first compression ring	$1.60^{0}_{-0.012}$	$1.6^{+0.06}_{+0.04}$	0.050—0.082
second track compression ring	$2.0^{0}_{-0.012}$	$2.0^{+0.06}_{+0.04}$	0.050—0.082
Oil control ring blade	0.61±0.025	$4.0^{+0.03}_{0.01}$	0.01—0.23
oil control ring	2.68±0.05		
Cast iron oil control ring	$4.0^{-0.015}_{-0.025}$	$4.0^{+0.03}_{+0.01}$	0.025—0.055

——Measure the crosshead end bore of the connecting rod $\Phi 20.589\ ^{+0.02}_{0}$

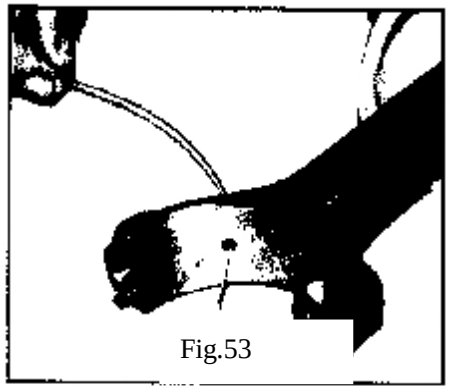


Fig.53

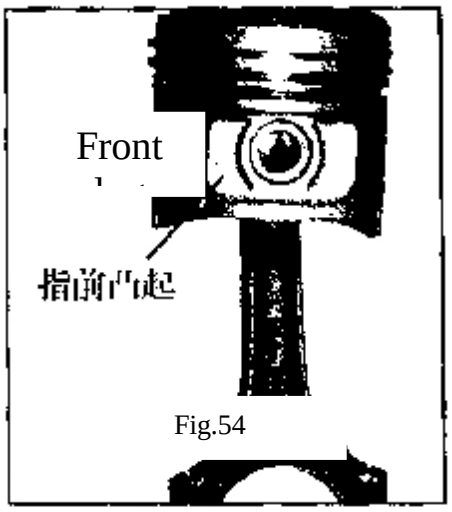


Fig.54

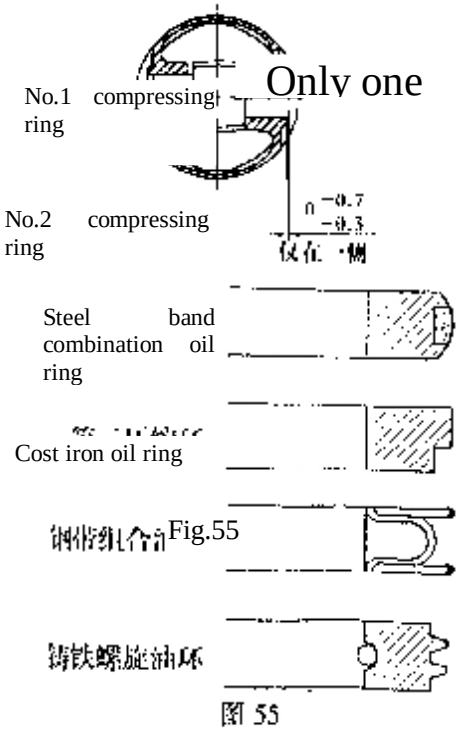


Fig.55

——Check and make sure that the oil injection hole of the connecting rod large end is not blocked. The outside diameter is Φ1mm.

Installation:

——Need not to divide into groups for the piston weight, piston pin holes and the accessory piston skirt. Before assembling, check the piston head mark and make sure that it is in accord with cylinder No.4.

——Heat the small end of connecting rod to 230°—400℃, and apply SAE50 engine oil or graphite colloid oil on the outer circumference of the piston pin hole. Then press the piston pin into the hole of connecting rod small end and piston pin. One end of the piston pin may be 0.7mm mostly out of the pin hole or 0.3mm mostly in the seat. And plug the other end of it into the pin seat.

The piston head means the front arrow. The outer end of piston pin means the front lug, which should has a same direction with “F” near the large end of the connecting rod.(with ‘480’ mark on some blanks and the mark side forward.)

——After the piston, piston pin, and the connecting rod are put together, print and sculpture the cylinder numbers with the 3mm words on the top of piston, the connecting rod and the left side of rod cap(viewed from the front). Be sure not to be deformed on the connecting side during printing.

——The dimension of piston ring.

478 piston ring		480 piston ring	
Paint marker (group)	Size of gauge	Paint marker (group)	Size of gauge
Yellow paint +no paint (standard)	77.22	No paint (standard)	79.94
Yellow paint+ purple paint (oversize 0.29)	77.51	Purple paint (oversize 0.29)	80.23
Yellow paint +blue paint (oversize 0.5)	77.72	Blue paint (oversize 0.5)	80.44

——When installing the piston ring, the mark side should be put up and the second compression ring outside cut section should be put down and remember not to the contrary. Firstly the oil controlling ring, then the second compression ring, and finally the first compression ring. As assembling the ring, its maximum tension should be inferior to the diameter of the cylinder(+1. 65mm), or the ring would be deformed and broken. The two cotters of the steel band combination oil ring and oil control spacer ring should be parted with a angle of 120°. And the cotters of cast iron oil ring and screw spacer ring should be parted with a interval of 180°. The piston should rotate freely in the ring groove without blocking.

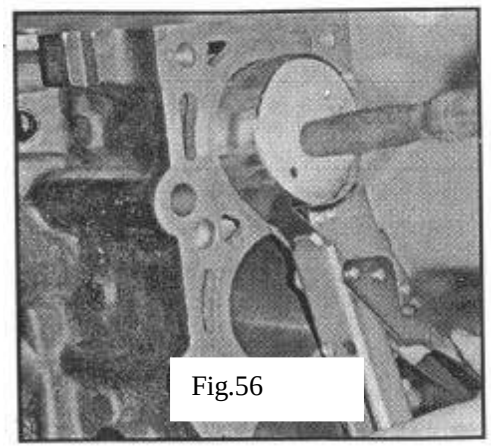


Fig.56

图 56

Installation of the piston and rod assembly：

Apply engine oil on piston, piston ring and cylinder bore. Stagger 120° among the first compression ring, the second ring and oil ring cotter, then install piston rod into cylinder bore. push the piston an rod assembly by hammer into the cylinder bore.

——Apply engine oil on the connecting rod bushing. Mount connecting rod cap. Retain connecting rod body and cap with two elastic retaining pins.

——Tighten connecting rod bolt to 30—36Nm. apply engine oil on the bolt head and bolt threads before installation.

——The side play of big end is 0.092—0.268mm。

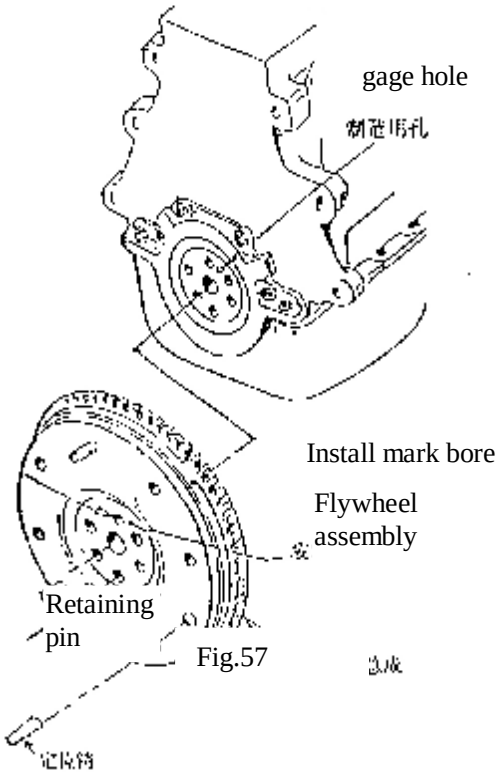


Fig.57

图 57

【10】The removal and installation of flywheel assembly and carrier assembly of real
crankshaft oil seal

1). The removal and installation of flywheel assembly

removal：

——Remove six M10 bolts and replace bolts.

——Remove flywheel. Check if there is crack in the surface of clutch plate. Check ring gear teeth for crack ,wear, pitting .

Installation：

——The press fit clearance of gear ring and flywheel is 0.48—0.86mm. The gear ring should be pressed when heated to 300℃.

——The retaining hole of flywheel and the retaining journal of crankshaft is of clearance fit. clearance is 0.012—0.074mm. Try to push it lightly after centering. Don't strike the crankshaft by the hammer.

——During assembling, align the installation mark hole and fabrication hole on the crankshaft. Screw in 6 new bolts by hand. Bolts should have sealant on them. Tightening torque is 82—92Nm.

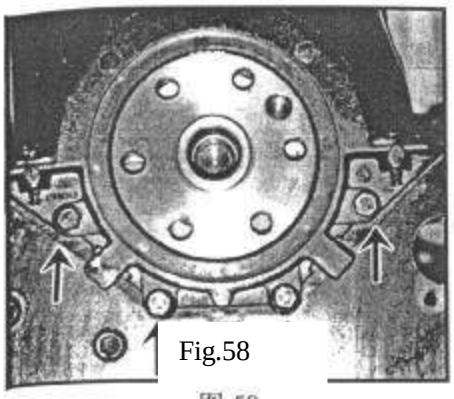


Fig.58

图 58

2). The removal and installation of carrier assembly of the real oil seal:

Removal：

——Remove 4 bolts (as arrow indicates).

——Take out carrier assembly of the real oil seal

——Remove carrier sealing gasket of the real oil seal

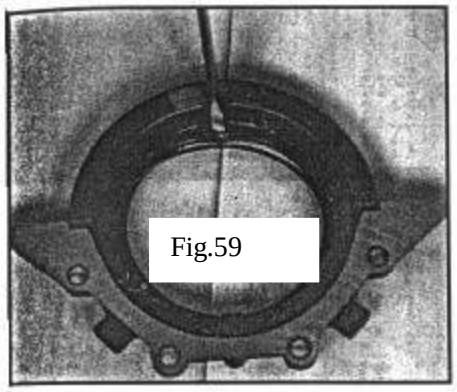


Fig.59

图 59

——Use chisel or screwdriver to pry the real oil seal from the carrier of the real seal oil. Note: please don't damage the carrier of real oil seal.

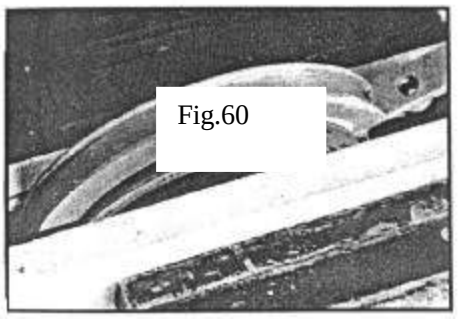


Fig.60

图 60

Installation：

——Position the carrier on the vise which is equipped with wood on the jaw.

——Align rear oil seal carrier hole with the part number side of oil seal outward .press oil seal into rear oil seal carrier with vise.. The magnitude of interference for real oil seal and carrier hole is 0.26—0.50mm.

——Install new sealing gasket of real oil seal carrier .

——Install real oil seal carrier assembly. Before assembling, wrap a piece of plastic piece on the crankshaft to avoid damaging oil seal. At the same time, apply engine oil on oil seal edge and journal for oil seal .

——Measure the roughness of lower oil seal carrier surface and oil pan flange surface of cylinder block. It should be adjusted to the range of ±0.26mm.

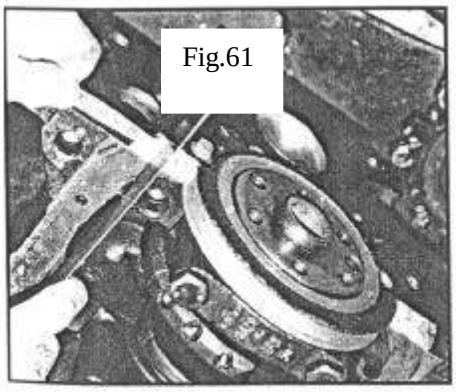


Fig.61

图 61

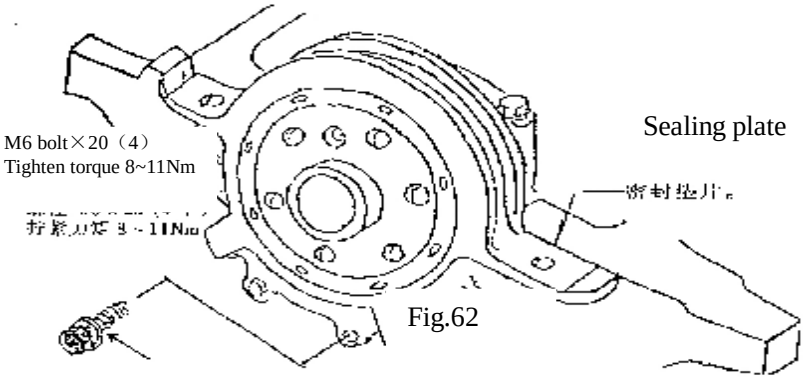


Fig.62

图 62

——Tighten four M6 bolts to 8.0 —11.0Nm。

——Remove the plastic piece.

【11】. Removal and installation crankshaft, crankshaft thrust washer, halves and main bearing cap

g. 62

al:

Before removing, check the end play of crankshaft first.

Use the plunger of dial indicator to contact bearing face of the crankshaft (lightly compressing).

Push the crankshaft away from the contacting tip. Adjust dial indicator to zero and then use post to push the crankshaft towards contacting tip as much as possible. Check dial indicator. The reading is end play. The end play of the crankshaft should be 0.092—0.303mm.

If dial indicator is not available, the end play of the crankshaft may be checked by feeler leaf. Between the third main bearing cap and crankshaft, it should be checked by feeler leaf (push and pull crankshaft)。

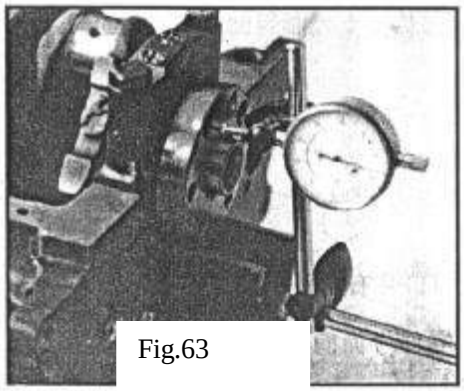


Fig.63

图 63

——Loosen main bearing bolt and stud，(start with the middle bearing cap), take out the bolt and stud, remove main bearing cap and the other shell of main bearing bushings. The other shell of main bearing bushing is still kept in main bearing cap.

——Remove the crankshaft.

——Remove the thrust plates of crankshaft (two pieces) from the cylinder block.

Check：

——Check main journal and main bearing bushing clearance .

Clean the main journal of crankshaft, inner bore of main bearing cap and main bearing bushings with non-woven. Put plastic clearance gauge on the main journal paralleling with the generatrix of main journal. Its length should be a little shorter than the width of main journal.

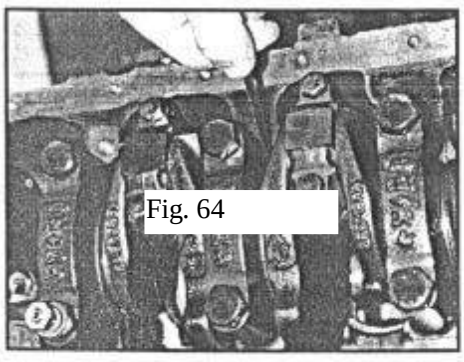


Fig. 64

图 64

Note: Don’t rotate the crankshaft!

Mount the main bearing cap. Screw the bolt of main bearing cap by hand. Tighten to 90—100Nm. Don't rotate the crankshaft.

Remove main bearing bolt. Take out the main bearing cap

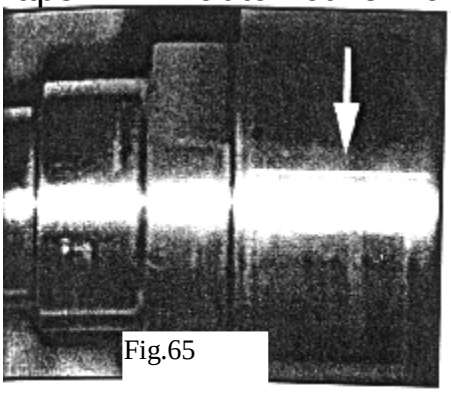


Fig.65

carefully. Arrange them according to the sequence. Read the bearing clearance according to the proportion stated in the cover of plastic clearance gauge. Check the bearing clearance from the third main bearing and extending to the two sides. The clearance of main bearing is 0.011—0.058m m.

——Check clearance of connecting rod bearing

Use the above method to check clearance of connecting rod bearing. Clearance of connecting rod bearing is 0.006—0.06mm.

——The size of connecting rod journal and connecting rod bushing: unit: mm

Level	The diameter of connecting rod journal Φ	The thickness of connecting rod bushing
standard	47.89—47.91	1.480—1.487
Undersize 0.025	47.89—47.91	1.492—1.499
undersize 0.25	47.64—47.66	1.605—1.612
undersize 0.5	47.39—47.41	1.730—1.737
undersize 0.75	47.14—47.16	1.855—1.862
undersize 1.0	46.89—46.91	1.980—1.987

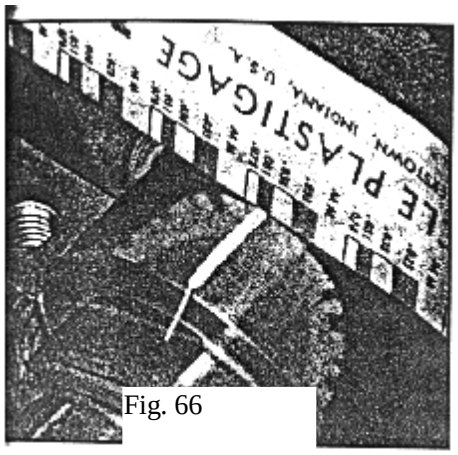


Fig. 66

——The size of main journal and main bearing half:

unit: mm

Level	The diameter. of main journal	The diameter of main bearing bore of cylinder body	The thickness of main bearing half shell
Standard	57.98—58.00	62.2935±0.0065	2.131—2.138
oversize 0.4	57.98—58.00	62.6935±0.0065	2.331—2.338
undersize 0.002	57.98—58.00	62.2935±0.0065	2.141—2.148
undersize 0.25	57.73—57.75	62.2935±0.0065	2.256—2.263
ze 0.50	57.48—57.50	62.2935±0.0065	2.381—2.388
ze0.75	57.23—57.25	62.2935±0.0065	2.506—2.513
undersize 0.25 oversize 0.4	57.73—57.75	62.6935±0.0065	2.456—2.463
undersize 0.50 oversize 0.4	57.48—57.50	62.6935±0.0065	2.581—2.588
undersize 0.75 oversize 0.4	57.23—57.25	62.6935±0.0065	2.706—2.713

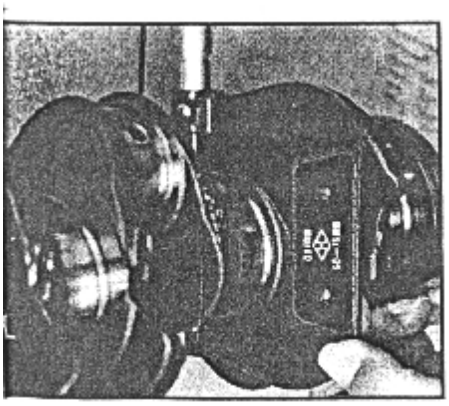


Fig. 67

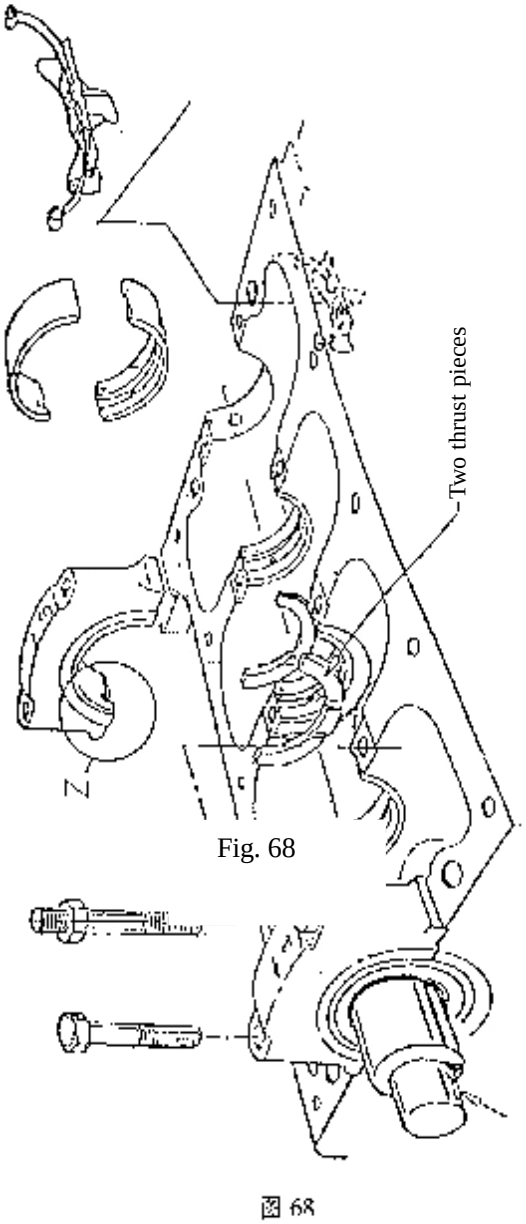


Fig. 68

图 68

—the size of crankshaft thrust, thrust washer and cylinder block thrust： unit：mm

level	The size of cylinder body thrust	The size of crankshaft thrust	The thickness of thrust washer
standard	24±0.03	28.825—28.875	2.326±0.025
oversize 0.38	24±0.03	29.205—29.255	2.516±0.025

Installation：

——Before installation, use the second screw tap taps the threaded hole in cylinder body, especially the threaded hole of cylinder head bolt and main bearing bolt.

The threads of cylinder head bolt is M10×1.5—6H，the threaded hole of main bearing bolt is M12×1.75—6H。

——The installation of crankshaft woodruff key

Drive the semicircular key into key groove lightly. The magnitude of interference for key and key groove is 0.00—0.051mm。After the semicircular key is installed, check the protrusion height. It should be 1.392—1.739mm.

——Crankshaft thrust washers are two pieces. They are only installed on the front and back thrust surface of cylinder block.

Before installation, apply the engine oil on the surface with oil groove of thrust washer. position the surface with oil groove towards the cylinder body and the surface with oil groove towards crankshaft.

——During installing crankshaft, engine oil should be applied main journal, connecting rod journal, thrust surface and bearing half.

——The character like 1,2,3,4,5 are casted on the top of main bearing cap and also an arrow. During assembling, install them from the front according to the sequence. At the same time, have the arrow pointing to the front end surface of cylinder block. The width of main bearing cap 1,2,4,5 is same, but the width of main bearing cap 3 is larger than others.

The main bearing cap is retained by rabbet. It is press fit between rabbet and cylinder body. The press fit clearance is 0.025—0.145mm. After installation, the surface of the first and the fifth main bearing caps should be even or lower than the front and back end surface of cylinder body.

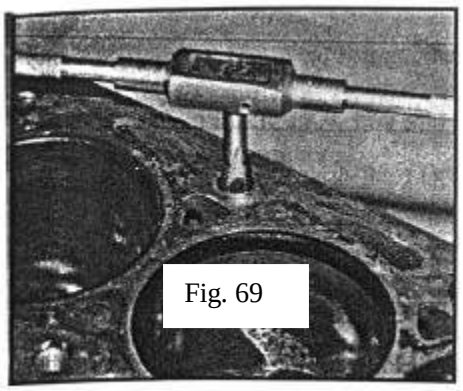


Fig. 69

图 69

——Nine main bearing bolts are hex head flange side bolts, and one is stud. For horizontal engine, the stud is mounted in the left threaded hole of the second main bearing cap (see from the front) which is for installing the carrier of oil collector. For the vertical engine, it should be mounted on the left threaded hole of the forth main bearing cap (see from the front).

Before installing the main bearing bolt, engine oil should be applied on the joint surface of head end.

The main bearing bolt and stud should be screwed by hand first and tightened to 90—100Nm.

——The max rotating torque of the crankshaft (with piston rod assembly) is 16Nm.

【12】. The removal and installation of oil baffle assembly

Removal：

——Take out the oil baffle assembly from the right of the back end of the cylinder body.

Installation：

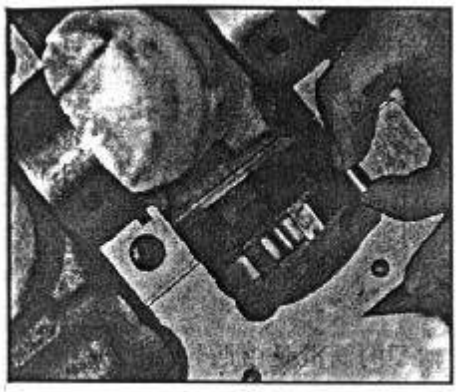
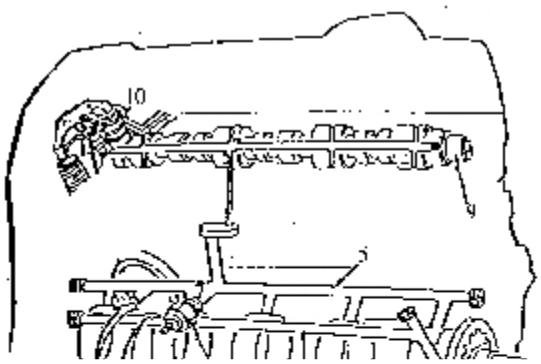


图 70

——Install the oil baffle assembly from the right of the back end of the cylinder body (viewed from the front). The oil baffle assembly should be tensioned. The spring should be lower than the flange surface of cylinder block oil pan.

【13】. Engine oiling system:

1). The description of the oiling system:



1. rotary oil pump assembly
2. oil collector
3. oil pan
4. assistant oil passage of cylinder
5. main oil passage of cylinder lifter
6. oil pump pressure relief valve
7. fuel filter
8. oil pressure sensor
9. camshaft
10. Hydraulic valve lifter

fig. 71

2. 机油泵总成
3. 油底壳
4. 缸体副油道
5. 缸体主油道
7. 机油滤清器
8. 油压传感器
9. 凸轮轴
10. 液压挺杆

图 71

Fig. 72

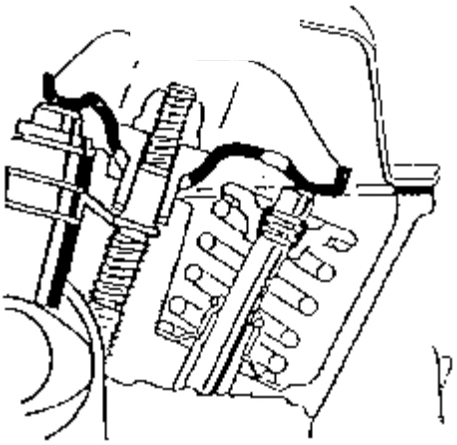


图 72

Through oil collector (2), the rotary oil pump(1) which is installed in the front end of crankshaft draws oil from oil pan (3) and pressurizes. The pressure oil comes into the full flow type oil filter through the assistant oil passage (4) on the left of cylinder body (viewed from the front). The pressure relief valve (6) is installed inside the oil pump case to control main oil passage pressure . The pressure relief valve will be opened under the pressure within 440kPa±20kPa. The filtered oil comes out from the center hole of oil filter and comes into the main oil passage of engine (5) through the center hole of filter connector.

From the main oil passage, oil lubricates the main bearing through the bore in the cylinder body and lubricates the connecting rod bearing through oil passage in the crankshaft.

There is a small oil port in the connecting rod bearing bore near the exhaust side in the connecting rod body. The oil sprays out from this small oil port to lubricate the piston pin and cylinder bore.

Oil pressure sensor (8) is located near the oil filter. It is connected with the main oil passage by a inner oil passage. Oil is provided to the third journal of camshaft through this oil passage.

Other journals of camshaft are lubricated by the oil provided by the middle oil passage of camshaft. Two sides of the middle oil passage are sealed by steel ball.

Hydraulic lifter oil comes from oil gallery on cylinder head, which is supplied from oil channel on camshaft neck

The oil provided by the oil port inside the hydraulic valve lifting rod lubricates the contact face

of valve rocker and hydraulic valve lifting rod.

The oil to lubricate the rocker carrier is provided by the oil passage of cylinder head.

The contact face of the tip end of valve and rocker is lubricated by splashing.

2) The removal and installation of oil pan：

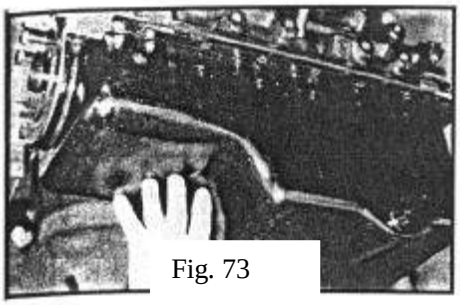


Fig. 73

图 73

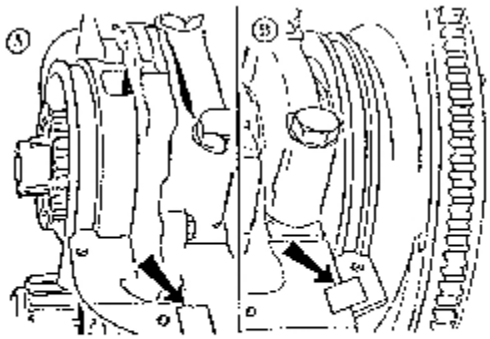
removal：

——Loosen drain plug and drain oil

——Loosen eighteen M6×20 bolts

——Take out the sealing gasket of oil pan

——Check if the left and right reinforced plates are still clipped on the back face of oil pan flange face



A 曲轴箱至机油泵壳体

B 曲轴箱至后油封支架

A. crankshaft to oil pump shell

B. crankshaft to rear oil seal carrier

fig. 74

Installation：

——Apply locite 598 sealant and G Y409 anaerobic sealant on the joint place between flange surface of oil pan of cylinder body and oil pump case, and carrier of real oil seal.

——Put the new rubber seal gasket on the cylinder body and have the two sides of sealing gasket enter into the grooves of carrier of real oil seal and oil pump.

——Install the oil pan with the two sides of sealing gasket in the grooves of oil pan.

)olt with washer indicated

ıt.)

——Tighten bolts to 5.0—8.0Nm according to the sequence of the left figure.

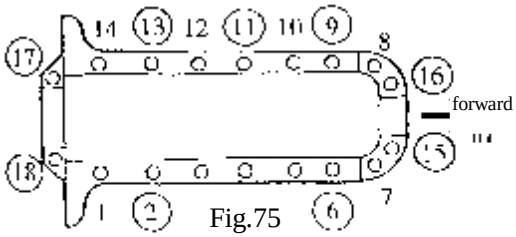


Fig.75

——Replace the sealing gasket of drain plug. Screw in the drain plug by hand and tighten to 21—25Nm.

The removal and installation of oil collector assembly

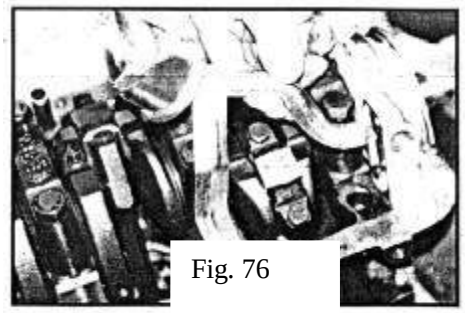


Fig. 76

图 76

removal：

——Loosen locknut of oil collector assembly and take out the nut and flat washer

——Loosen carrier bolts and take out the bolts。

——Loosen flange face bolt of oil collector (two) and take out the two bolts with spring washers

rque
m

Installation：

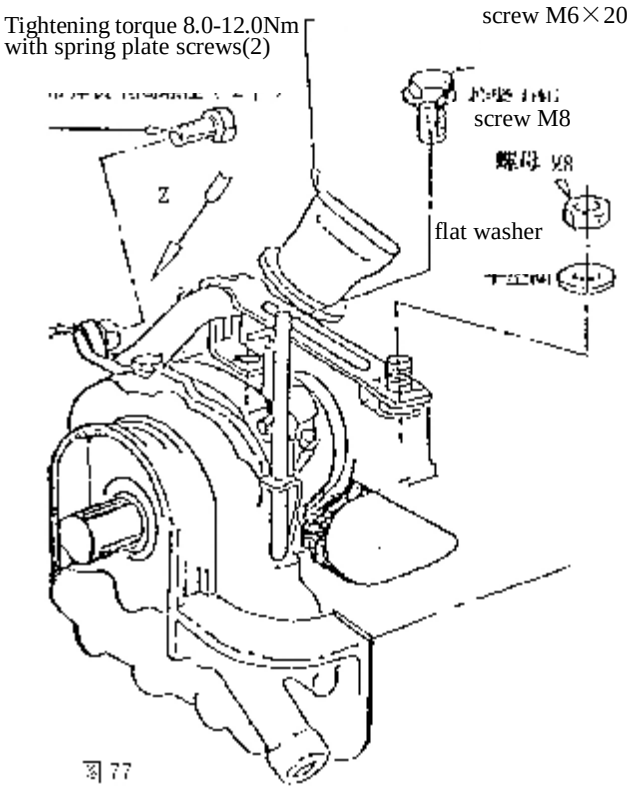


图 77

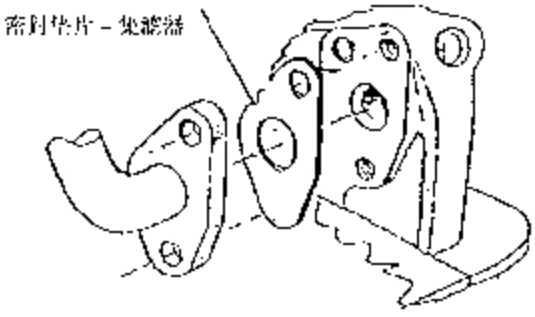


图 78

——Install a new sealing gasket of oil collector on the flange face of oil pump and then install oil collector assembly. Screw two bolts with gasket by hand.

——Screw the oil collector carrier into the cylinder body with M8 bolt. At the same time, hitch the carrier into the stud which is in the left of the second bearing cap. Install the flat washer and screw in the nut by hand.

——Tighten the flange face bolt of oil collector to 8.0—12.0Nm.

——Tighten carrier bolt to 17—23Nm

——Tighten the locknut to 17—23Nm

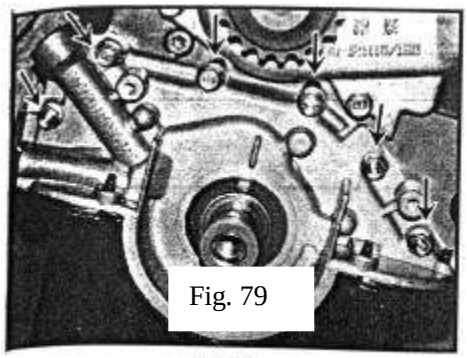


Fig. 79

图 79

4. The removal and installation of oil pump with oil seal assembly

removal：

——Loosen six M6×30 hexagonal flange surface bolts. Remove the bolts (as the figure indicates)

——Remove oil pump with oil seal assembly

——Pry out the front oil seal of crankshaft by screwdriver or chisel. Note: Don’t damage the front oil seal bore.

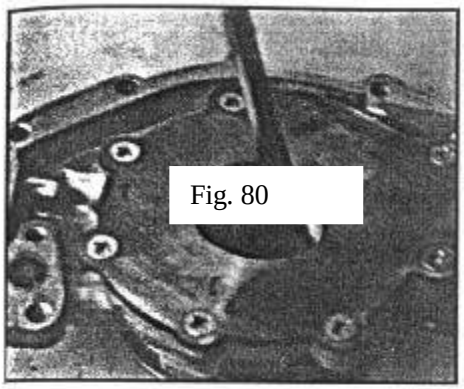


Fig. 80

图 80

——Remove seven M6 countersunk head screws (as the arrow in figure indicates)

——Remove oil pump cover

Fig. 81

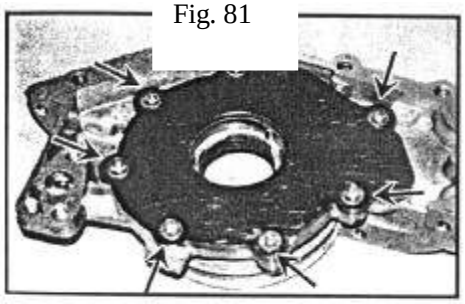


图 81

——Take out the inner and outer rotor

Fig. 82

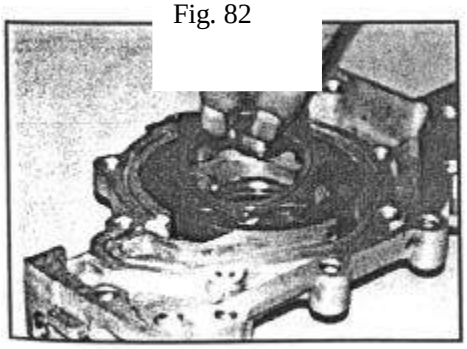


图 82

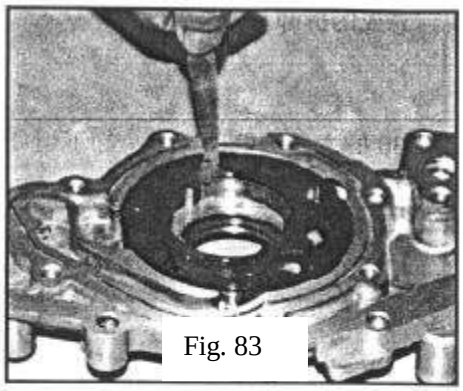


Fig. 83

图 83

——Check the clearance between outer rotor of oil pump and case bore of oil pump.

The clearance between outer rotor of oil pump and case bore of oil pump should be 0.06—0.19mm.

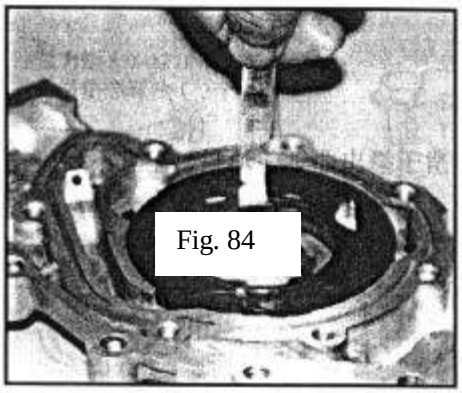


Fig. 84

图 84

——Check the radial clearance between inner rotor and outer rotor of oil pump.

The radial clearance between inner rotor and outer rotor of oil pump should be 0.05—0.18mm.

——Check the end play of rotor

The end play of rotor should be 0.014—0.100mm.

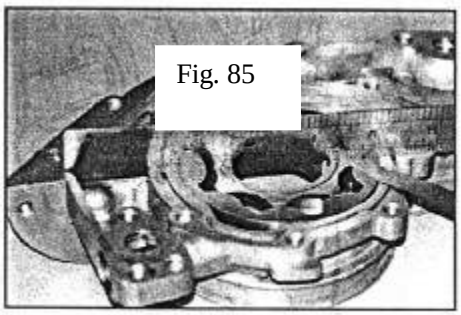


Fig. 85

图 85

——Remove horizontal hexagonal socket head plug (small one)

——Take out the spring of relief valve and plunger of relief valve.

——Check the spring load and free length

spring free length is 46mm。

spring load is 32.8N±2N when the length is 29mm.

installation length of relief valve spring is 38.5mm.

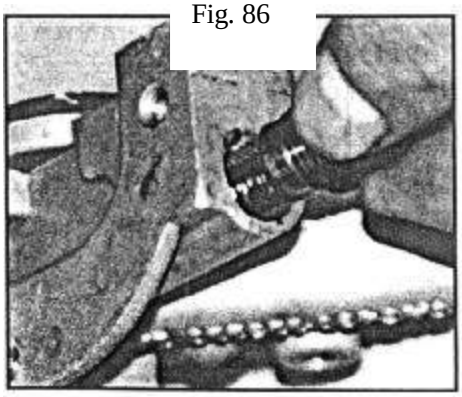


Fig. 86

图 86

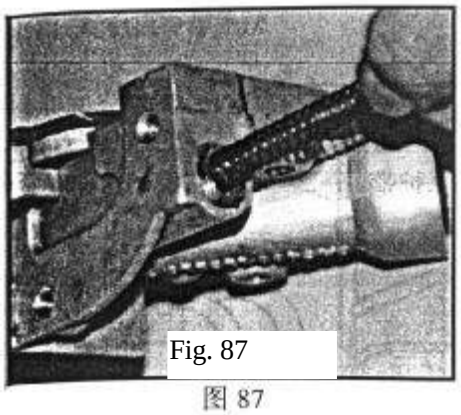


Fig. 87
图 87

——If relief valve spring is not to specification, it must be replaced.

Installation：

——Install the outer and inner rotor into the oil pump house ensuring the installation mark of outer and inner rotor upward.

——Install oil pump cover on oil pump. Tighten seven chamfer head screws. tightening torque is 7-10Nm.

——Install relief valve and relief valve spring into the oil pump bore.

——Screw 3/8″ plug screw into the oil pump house. keep it in place. tightening torque is 20-25Nm.

——Stick the new oil pump sealing gasket on the front end of cylinder block.

——Install the oil pump into the front end of crankshaft. center the inner bore of inner rotor Before installation.

——Screw six mounting bolts by hand.

——Check and adjust the roughness of lower surface of oil pump and flange surface of cylinder block oil pan. It should be within the range:±0.26mm.

——Tighten the retaining bolt of oil pump to 8-11Nm.

——Apply the engine oil on the oil seal journal of crankshaft.

——Wrap a plastic tape on the oil seal journal of crankshaft avoiding to damage the edge of front crankshaft oil seal .

——Apply engine oil on the edge of front crankshaft oil seal. Press the oil seal in place using appropriate socket or sleeve and crankshaft pulley and pulley bolt and washers.

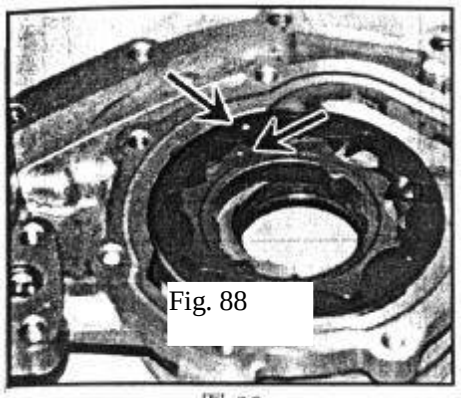


Fig. 88
图 88

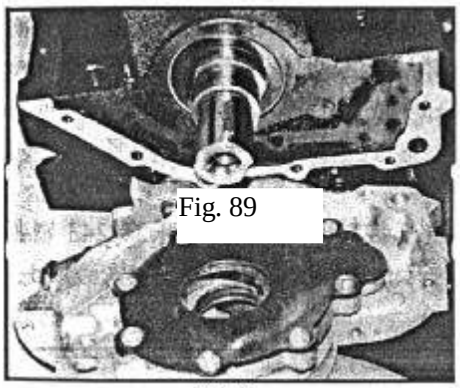


Fig. 89
图 89

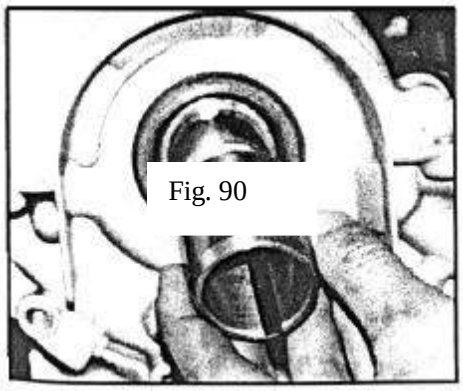


Fig. 90
图 90

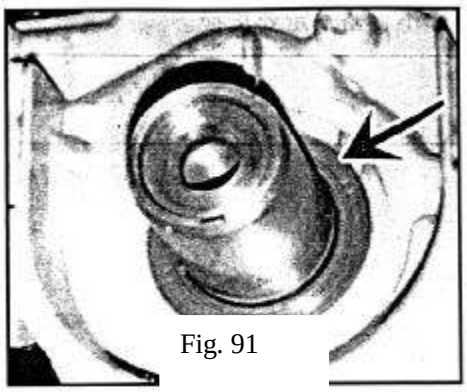


Fig. 91

图 91

——Remove the thin plastic protective tape

tightening torque 18.0-25.0Nm

5. removal and installation of oil filter and oil pressure sensor.

Removal：

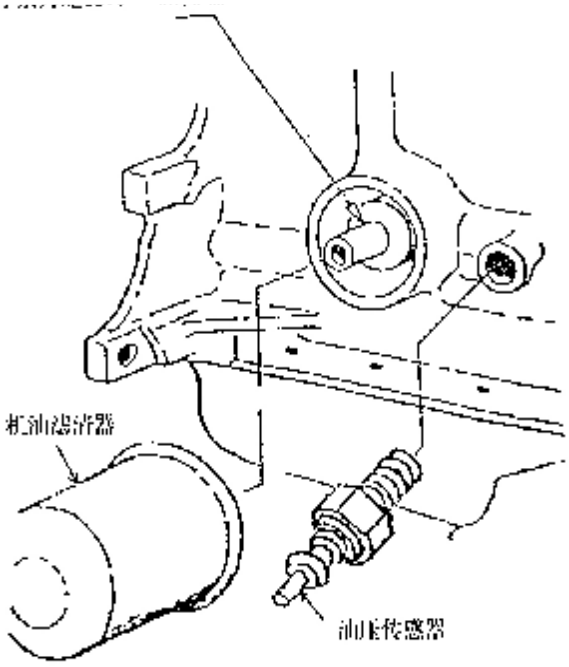


图 92

——Remove the oil filter. rotate oil filter counterclockwise during removal.

——Remove the oil pressure sensor

Installation：

——Apply engine oil on the sealing gasket of oil filter and screw into the connector. Tightening torque is 12－17Nm. Or screw into oil filter by hand. once rubber sealing gasket contacts cylinder block, tighten another 3/4－1 turns.

——Apply Lotite 243 sealant and screw it to the main oil passage of cylinder block. Tightening torque is 25－29Nm.

The threaded hole of oil pressure sensor is 1/4″－18NPTF.

The operating voltage of oil pressure sensor is 6－24V.

The starting warning pressure is 30±15kPa.

【14】 Engine cooling system

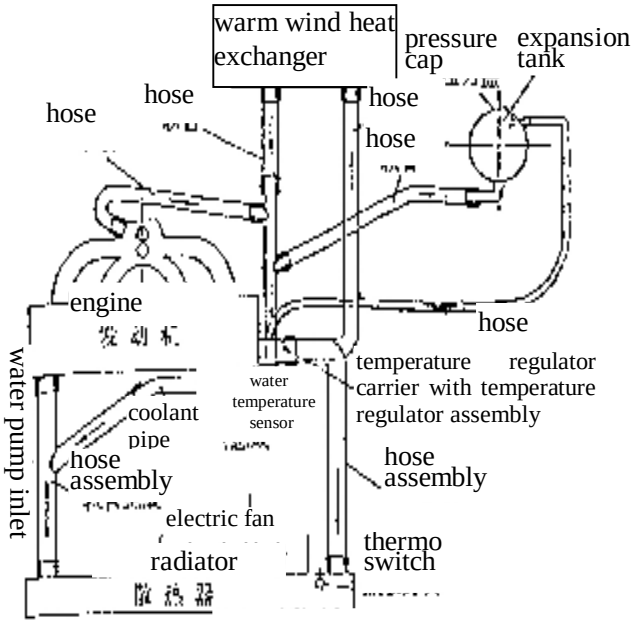


Fig. 93

1) Description for cooling system

The cooling system is of pressure system. It includes water pump driven by timing belt, crosscurrent radiator, expansion tank, pressure cap, thermostat and electric fan, fan shroud.

When engine coolant temperature is low, water pump draws the coolant in the left water room of radiator and pump it to the cylinder block, cylinder head and intake manifold after pressurizing, going from the local circulation pipe of the thermostat seat to the warm air heat exchanger, and then from heat exchanger back to water pump inlet. The coolant back from intake manifold joins the heat exchanger and then backs to water pump inlet.

When engine coolant temperature reaches the point for thermostat to open, the coolant for cooling cylinder block, going through the opened thermostat , combusting chamber and behind the valve seat , will go into the right water room of radiator from the drain pipe of thermostat seat. For being cooled by electric fan blowing ,the coolant is already cooled When it reaches the left water room,.

When engine works under normal working temperature, coolant will expand. so the relief valve in the thermostat seat opens. The coolant enters the expansion tank from overflow tube. After the system is cooled, the coolant comes back to the inlet of water pump from expansion tank.

The electric fan operation is controlled by thermo switch installed in the right water room of radiator. When the contactpoint of thermo switch closes, the electric fan operates. Water temperature sensor is at the back of the cylinder head at exhaust pipe side.

—cooling system parameters：

total system capacity (L)8
engine capacity(L)3.3
radiator capacity(L)2.1
expansion tank capacity(L)0.4

radiator
front face area 0.202 ㎡
radiation area 8.93 ㎡

thermostat
opening temperature 85°－89°

electric fan
diameter. 280mm
blade quantity 6
operating voltage 9－16V
RPM Grade Ⅰ 1500r/min
Grade Ⅱ 2800r/min

thermo switch
operating temperature
Grade Ⅰ 95 $^{+2}_{-3}$ ℃
Grade Ⅱ 102±3℃
cut off temperature
Grade Ⅰ ≤84℃

water pump
diameter. of impeller 72mm
speed ratio 1.053：1

pressure cap
operating pressure 160kPa

water temperature sensor

resistance Ω	temperature℃
70	159±21.3
90	86.7±11
110	52.3±6.3
124	28.2±2.8

wide opening temperature 89°－102° Grade Ⅱ≤91℃
Operating voltage 12V

——Coolant draining ：

(1) remove pressure cap of expansion water tank

(2) connect a container under the radiator. Remove the outlet hose of radiator or open the drain plug of radiator.

——Cleaning cooling system：

(1) drain the coolant and then close the drain plug of radiator or install the outlet hose of radiator

(2) add clean water into the max water level of expansion tank and install the pressure cap

(3) start engine and keep idling., warm engine to normal working temperature and stop engine cooling down.

(4) drain water

(5) repeat step(2)—(4) until the water drained is the same as clean water.

(6) If the previous coolant application and replacement is not to specification, do some cleaning as the following method:

a. drain coolant

b. remove outlet hose of radiator. Insert the water supply hose into the inlet of radiator until the water drained is clean.

c. Connect the hose connected to water supply to the water outlet of thermostat seat to wash the engine until the water drained from the water pump inlet is clean.

d. If radiator is too dirty, it may be washed from the reverse direction. Connect the hose connected to the water supply to the water outlet of thermostat seat to wash the engine until the water coming out from the water pump inlet is clean.

——Add coolant

(1)Before adding coolant, check if the drain plug of radiator is closed and if the pipeline is connected and tight

(2)remove the pressure cap and add coolant by the filler of expansion tank slowly. Since the expansion tank is in the highest point of cooling system, with the coolant level raising, the air in the system will be discharged into the expansion tank. Adding coolant slowly may discharge the air.

(3) keep adding coolant until coolant level reaches the “maximum” line. install the filler cover to avoid coolant splashing.

(4) Start engine and keep idling. Warm engine to normal working temperature. fan starts to run. Observe the water thermometer and check if engine is overheated. If the coolant level of expansion tank drops quickly, d add coolant to the “maximum” line to reduce the air circulation in the system.

(5) Stop engine to cool engine completely(one night if possible). remove pressure cap and check coolant level ,fill coolant to the “maximum” line.

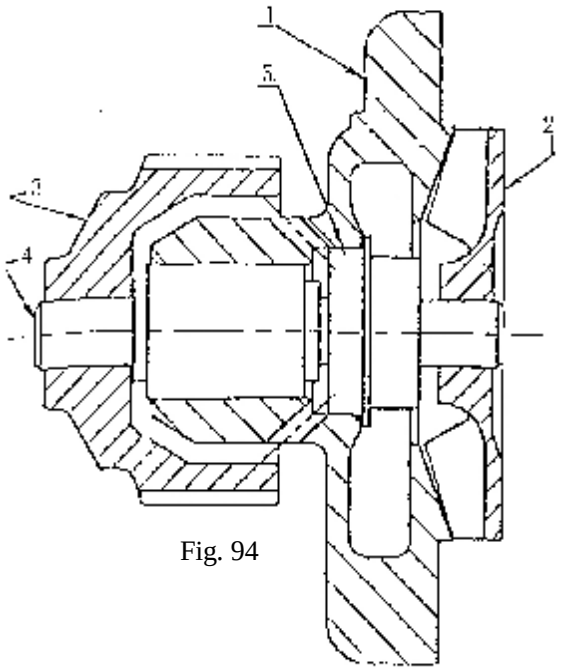


Fig. 94

图 94

2) The removal and installation of water pump assembly

——The structure of water pump assembly

1—water pump case
2—water pump impeller
3—water pump gear
4—water pump bearing
5—water pump seal (ceramics—black lead)

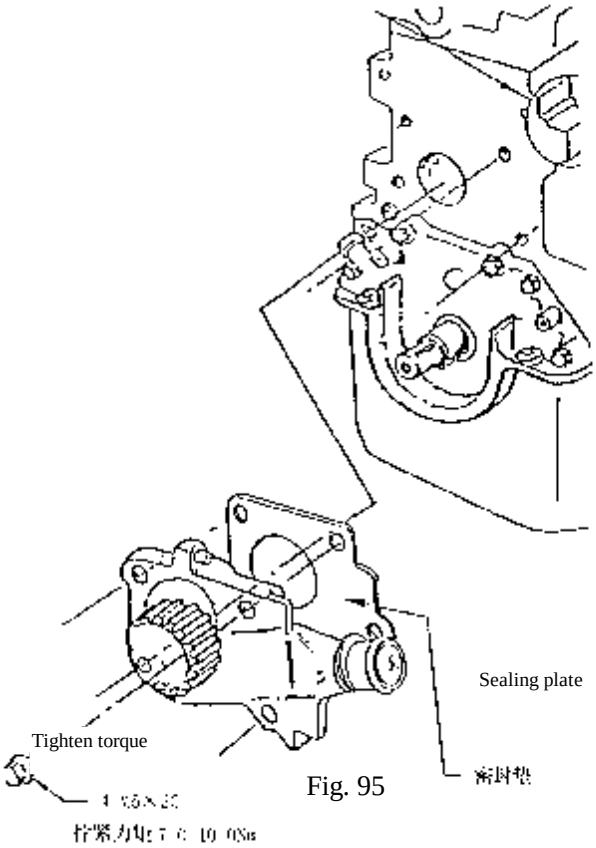


Fig. 95

图 95

Removal：

——Loosen and remove four bolts from the front end of cylinder block

——Remove water pump assembly

——Remove sealing gasket of water pump

Installation：

——Install new sealing gasket of water pump on the water pump

——Install the water pump assembly inside the cylinder block and screw in four retaining bolt by hand, then tighten to 7.0—10.0Nm.

Note: The water pump assembly may not be serviced. When water seal or bearing is damaged, the water pump assembly should be replaced

3) The removal and installation of thermostat seat with thermostat assembly

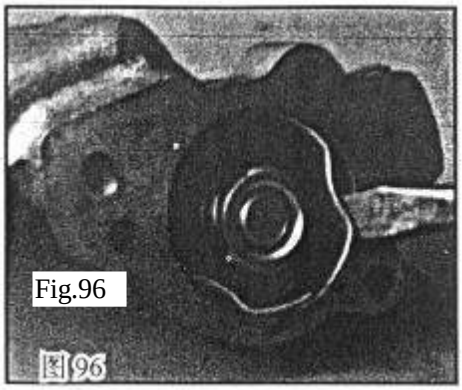


Fig.96

——Loosen three M6×40 bolts and remove them
——Remove thermostat seat with thermostat assembly
——Pry out spring clip by chisel or screwdriver

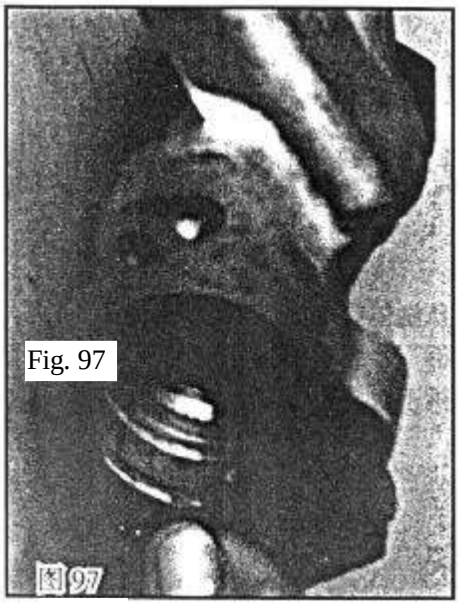
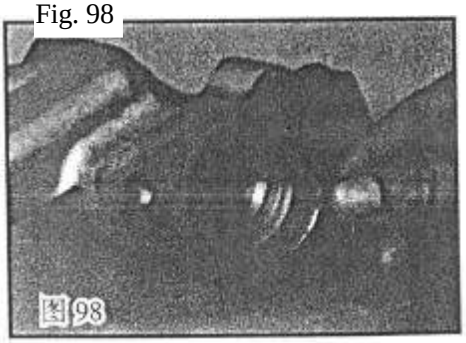


Fig. 97

——Take out the thermostat

——Take out sealing gasket
——Remove sealing gasket of thermostat seat

Fig. 98



Measure the opening temperature of thermostat in hot water.

Fig. 99

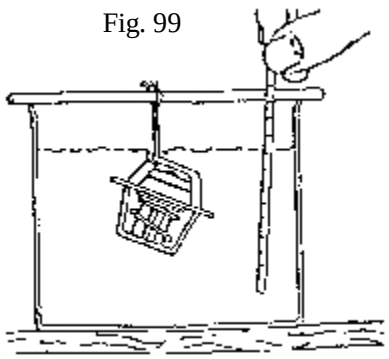


图 99

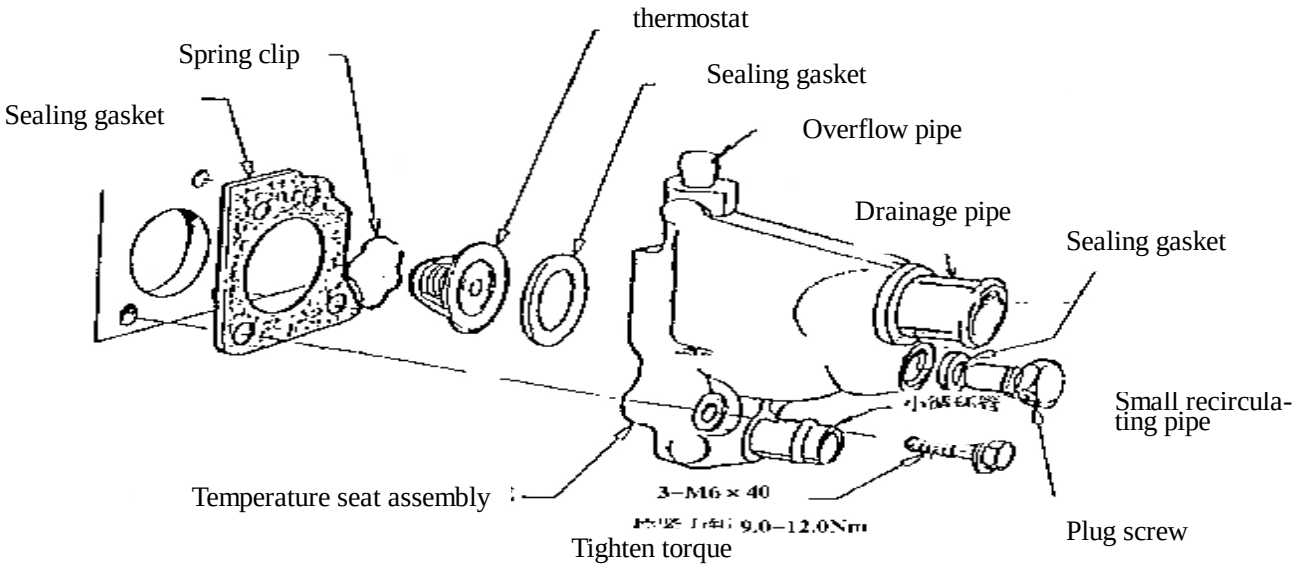


Fig.100

Assembly:

——Clip the thermostat seat, and put the rubber seal ring into the thermostat hole.
——Install the thermostat(with spring outward)
——Install spring clip, ensure that the clip is clipped in the thermostat seat groove.
——Install the sealing gasket of the new thermostat seat on the thermostat assembly with a bolt.
——Install the thermostat together with thermostat assembly into the rear end hole of cylinder head. Finger screw in 3 bolts and tighten to 9-12Nm.
——Tighten the hex head plug with the sealing gasket on . tightening torque is 38-42Nm.
——For the engine equipped with electrical heater ,install air intake preheating switch .tightening torque is 38-42Nm.

3. removal and assembly of the water temperature sensor.

Removal:

——Remove the water temperature sensor(at the exhaust side , under the rear lug).

Assembly:

——Before installation, apply the lotite sealant 243 onto the bolt threads .finger screw in and tighten to 7.0-10.0Nm .

【15】: The intake and exhaust system of the engine.

1. Description for the intake and exhaust system of carburetor engine.

The intake system of Carburetor Engine 478 and 480 includes: air filter, Intake hose, Guide cover, Carburetor, Intake hose, Intake air preheating hose of Positive Crankcase Ventilation（PCV）, and so on.

——air filter type is 1GD129607G, and its basic parameters are as the following:

Filtering area: 100cm2 nominal air flow(L): 600±150

filtering efficiency: ≥99% filtering resistance: 2kPa

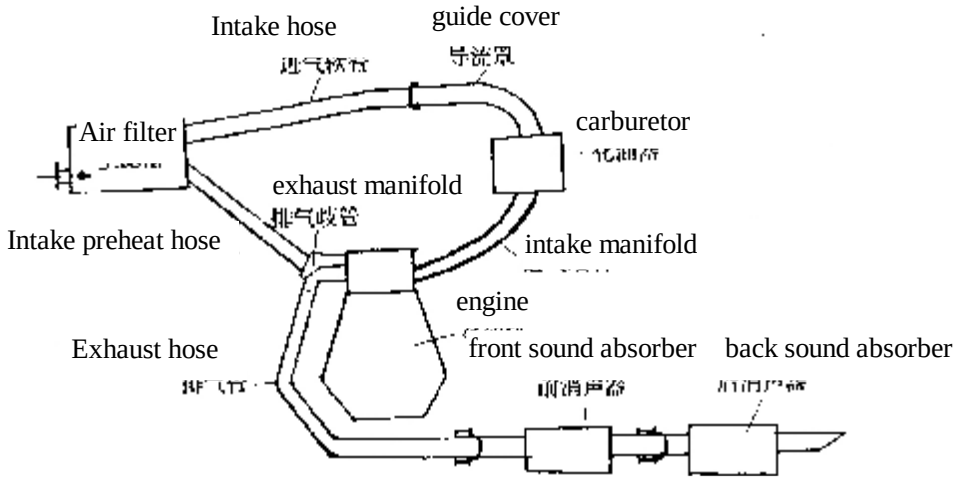


Fig. 101 intake and exhaust system arrangement of carburetor engine

——The air filter is equipped with a intake air temperature controller. When the temperature is low, the hot air intake valve controlled by the temperature controller will open and the hot air, flowing by the exhaust manifold, will be directed into the air filter from the intake preheating hose to supply more hot air and facilitate the fuel atomization during cold winter. As temperature is high , valve is shutted off and the hot air is not permitted to enter the air filter.

——Carburetor(see Fuel System)

The exhaust system of the carburetor engine 478 and 480 includes Exhaust Manifold, Heat Insulation Cover, Exhaust Hose, Front Muffler, Rear Muffler.

2. Description for the Exhaust System of Engine 2.480M:

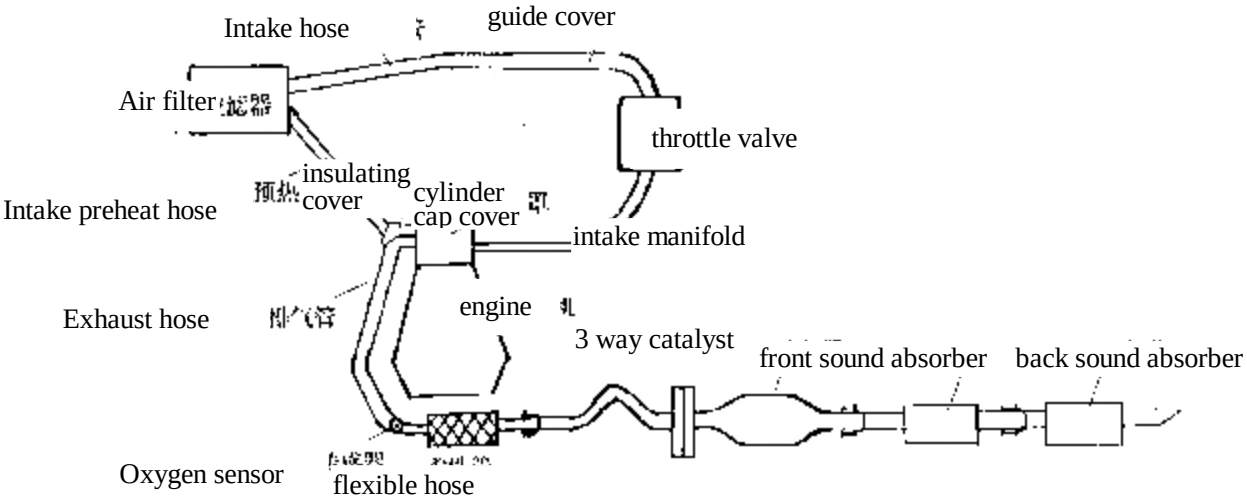


Fig.102 intake and exhaust system schematic drawing of engine 480M

The Intake System of Engine 480M includes: air filter, Intake Hose, Guide Cover, Throttle Valve, Intake Manifold, Intake air preheating hose of Positive Crankcase Ventilation（PCV）and so on.

——Air filter type is 1GD　129　607G, and its basic parameters are as follows:

Filtering area: 100cm2　　nominal air flow(L): 600±150

filtering efficiency: ≥99%　　filtering resistance: 2kPa

——The air filter is equipped with a intake air temperature controller. When the temperature is low, the hot air intake valve controlled by the temperature controller will open and the hot air, flowing by the exhaust manifold, will be directed into the air filter from the intake preheating hose to supply more hot air and facilitate the fuel atomization during cold winter. As temperature is high , valve is shutted off and the hot air is not permitted to enter the air filter.

——See "CAC480M Engine's single port injection system" to know about the throttle valve.

The exhaust system of Engine 480M includes Exhaust Manifold, Heat Insulation Cover, Exhaust Hose, Oxygen Sensor, Flexible Hose, Three-Way Catalyst Converter, Front Muffler, Rear Muffler.

Removal and assembly of the Intake Manifold Assembly and Front lifting Lug:

1. The Intake Manifold Assembly of the Carburetor Engine.

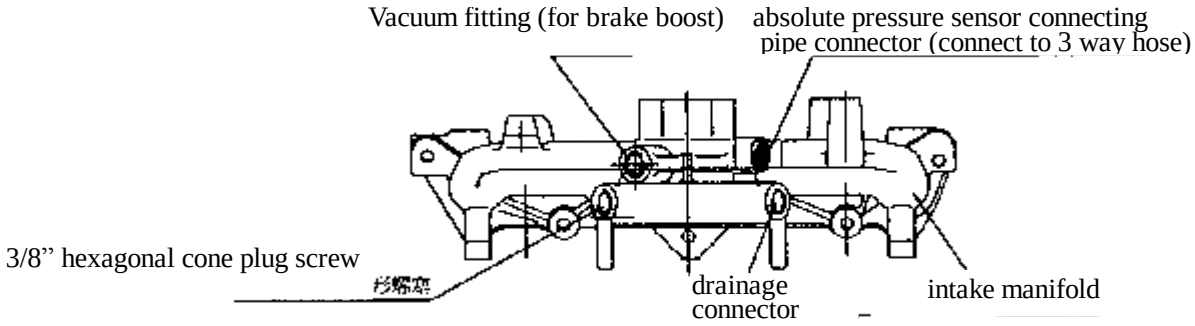


Fig 103 composing of intake manifold assembly of carburetor engine

2. Description for the Intake Manifold Assembly of Engine 480M:

The Intake Manifold Assembly includes: Water Hose, Vacuum Fitting, Water Temperature Gauge Sensor, and Electric Heater. The water hose fitting is connected to the water hose of the throttle valve body. The left vacuum fitting is connected to the PCV valve, and the right vacuum fitting is connected to the absolute pressure sensor. And the vacuum fitting from the intake manifold's branch is applied on the entire brake system, the water temperature sensor is connected to ECU .

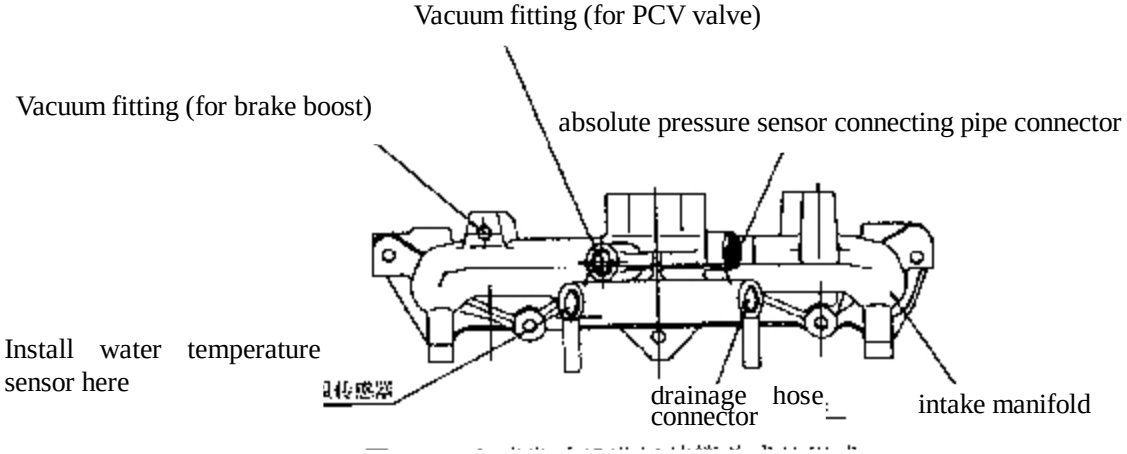


Fig.104 composing of intake manifold assemble of electric injection engine

The intake manifold ‘s air may be preheated by the electrical heater as well as by coolant. As the coolant’s temperature is lower than 60°, the electronic heater will be energized to facilitate the cold starting.

The electrical heater’s energizing or deenergizing is controlled by the intake preheating switch and relay.

The intake preheating switch is installed in the M22 bolt hole in the thermostat seat(with the hole plugged by plug screw for carburetor engine).

The intake preheating switch’s operation parameters:

Switching off temperature: 63±4°

Switching on temperature: ≥52°

Operation voltage: 6—24V

Electrical heater parameters:…

Voltage: 15V

Initial current: ≤75A

Cold resistance: 0.2—0.4Ω

temperature after 12-second energizing: ＞60℃

temperature after 180-second energizing: ＞135℃

3.3 Removal and assembly for the intake manifold assembly and front lifting lug:

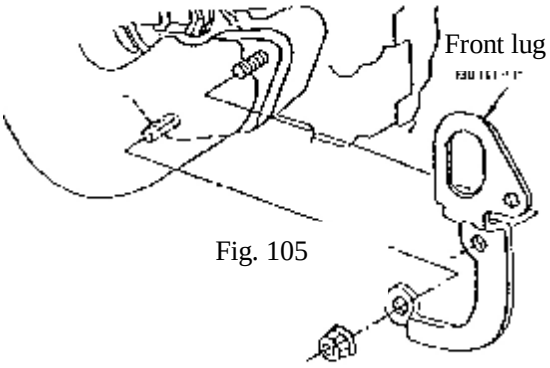


Fig. 105

图 105

Removal:

——Loose and remove two M8 lock nuts from the right front lifting lug.

——Remove the front lifting lug.

——Loose and remove the remaining four M8 lock nuts.

——Remove the intake manifold.

——Remove the intake manifold sealing gasket.

——Remove six studs with equal length using two M8 nuts.

Assembly:

——Apply lotite sealant 201 on the cylinder head bolt threads and screw six studs into the cylinder head.

——Assemble the new sealing gasket onto the studs.

——Install the intake manifold assembly.

——Install the front lifting lug onto the right two studs.

——Finger screw in nuts and tighten to16-20Nm.

4. The removal and assembly for the exhaust manifold, heat insulation cover and rear lifting lug:

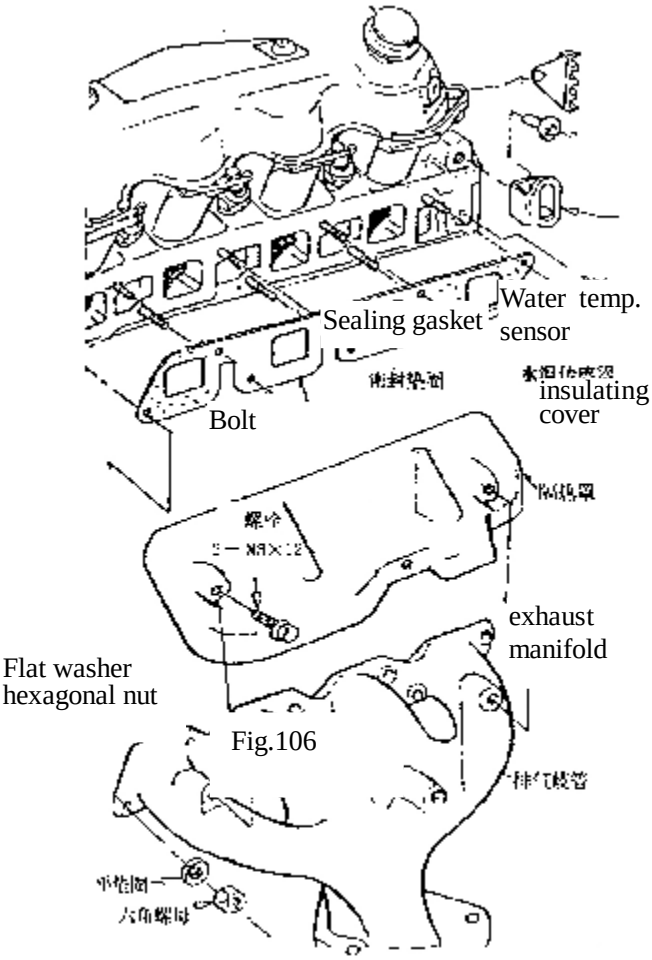


Fig.106

Removal:

－Loose and remove the M12×25 allen screw, and remove the rear lug .

－Loose and remove two M8×12 screw and remove the heat insulation cover .

－Loose and remove 8 M8 lock nuts and washers.－remove the exhaust manifold.

－Remove the exhaust manifold sealing gasket.－Remove eight M8 studs of same length.

Assembly:

－screw in 8 M8 studs of same length and tighten them with two nuts.

－Assemble the new exhaust manifold sealing gasket.

－Install the exhaust manifold.

－Put the washers onto the studs and tighten lock nuts with hands, tightening torque is 14-17Nm .

－Assemble the heat insulation cover and tighten two bolts with hands ,tightening torque is 14-19Nm .

－install the rear lug and tighten allen screw with hands , tightening torque is 50-60Nm.

5. for oxygen sensor and 3 way catalyst Converter, See “CAC480M Engine’s single port injection system”

【16】 Positive Crankcase Ventilation（PCV）system of engine.

1. Description for PCV system of the Carburetor engine:

PCV system is a closed system.

The leaking air of piston from the Crankcase goes to the cylinder head cover through the PCV hose. The exhaust gas enters the intake manifold passing the 3-way pipe after throttled by the absolute pressure pipe connector. The gas in the crankcase enter the 3 -way pipe through the guide cover to ventilate the crankcase.

The PCV system includes oil baffle assembly, PCV pipe—cylinder block, absolute pressure transmission hose connector, 3-way connector, valve chamber cover, connecting hose, ventilation hose. See the above for Removal and Assembly of oil baffle assembly and valve chamber cover assembly.

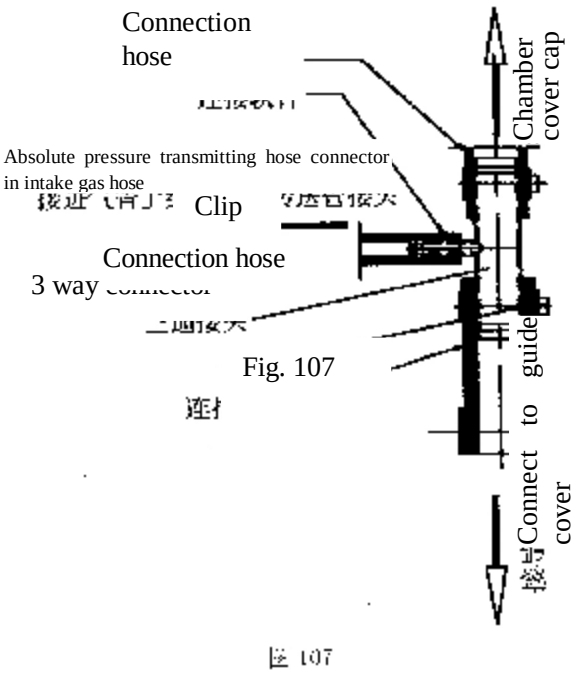
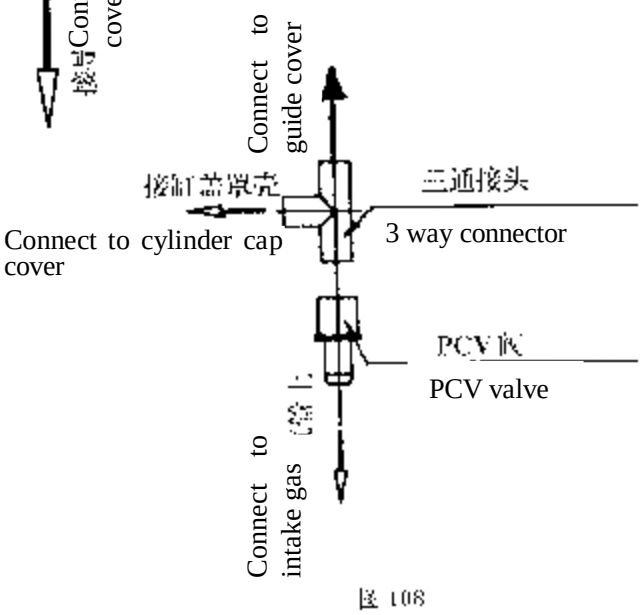


Fig. 107

2. Description for PCV system of 480M engine

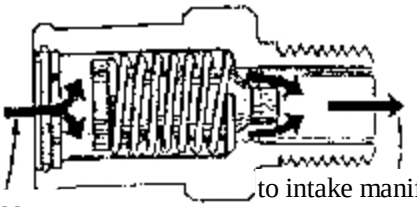


2.1 Description of PCV system.

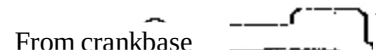
The PCV system is a closed system.

The leaking air of piston goes to the rear cylinder head cover from the Crankcase through the PCV hose. PCV valve is connected to the intake manifold. Meantime, a Φ15 hose in the front of the valve chamber cover assembly is connected to the guide cover and PCV valve by the 3-way connector through a hose.

The PCV system includes oil baffle assembly, PCV pipe——cylinder block, PCV hose, PCV valve, 3-way connector, valve chamber cover, connecting hose, and ventilation hose.



the operation condition of low speed-high vacuity



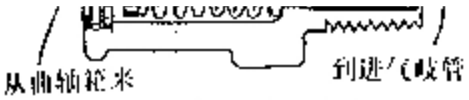
the operation condition of high speed- low vacuity

Fig.109

2.2 PCV valve's function:

under the low speed condition, the vacuum of intake manifold is very high, which keep the valve closed, and only a small opening exists to allow the gas pass through. Therefore it won't change the mixture rate. Under high speed condition, the vacuum of intake manifold decreases, and the spring forces the valve to open to allow more gas in the crankcase flow into intake manifold.

the PCV valve is designed to open fully enough to allow the gas exhaust from the crankcase under high speed or low speed conditions.



高速 工况——低真空度

图 109

【17】. Fuel supply system of the carburetor engine.

1. Fuel supply system of the carburetor engine.

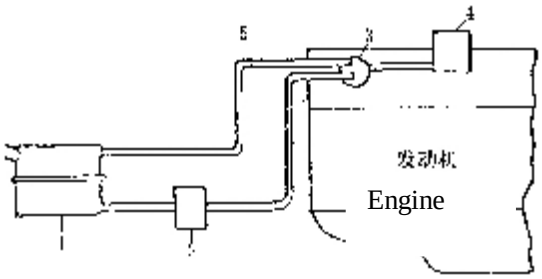


图 110 发动机燃料供给系统示意图

1.汽油箱 2.汽油滤清器 3.汽油泵

4.化 器 5.回油管

1.1 Description of the fuel supply system.

The fuel in the tank flows into oil filter pumped by the fuel pump and goes into carburetor after being filtered through fuel pump . A amount of fuel returns to the tank through return pipe .

for engine
np

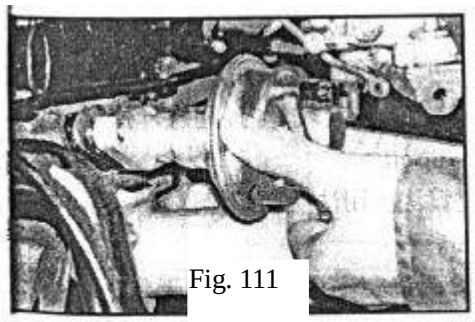


Fig. 111

图 111

1.2 Removal and assembly of the fuel pump:

——Remove two M8 lock nuts.

——Take out the fuel pump.

——Remove the fuel pump sealing gasket.

——pull out the push rod.

Fig.113

——Remove the studs of same length .

Assembly:

——submerge the push rod into the engine oil or pour engine oil into the rod's hole of the cylinder head and install the push rod into the hole. The gap between push rod and hole is 0.035-0.055mm.

——screw in the studs into the threaded hole and tighten with the nuts.

——install fuel pump with the manufacturer mark and part number forward.

——Tighten the lock nuts with hands. tightening torque is 14-18Nm.

Idle and overdrive cut-off valve

Thermo time control valve

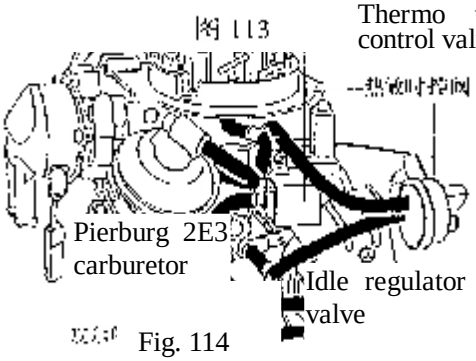


Fig. 114

1.3 Carburetor.

basic parameters:

Pierburg 2E3 carburetor:

	CAC478	CAC480
Larger throat pipe diameter	20/24	22/26
Mixing chamber size	28/30	28/30

Installation:

Use studs, nuts, and washers to connect the transition flange with intake manifold. Screw the studs into intake manifold and tighten them with nuts. tightening torque is 8-10Nm.

Adjustment: The carburetor adjustment mentioned in this introduction only specifies the idle speed adjustment and CO adjustment . The other adjustment and service should be done by professionals.

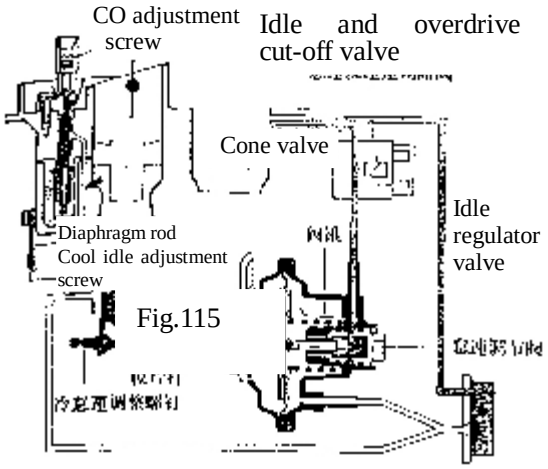


Fig.115

图 115

——Adjustment of Peirburg 2E3 carburetor:

Idle speed adjustment:

Rotating the screw inward will increase idle speed. Rotating the screw outward will decrease idle speed.

CO adjustment:

Rotating the CO screw inward will enrich the mixture . Rotating the screw outward will make the mixture lean.

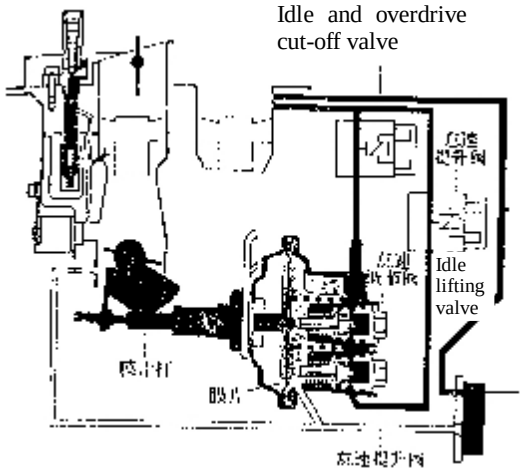


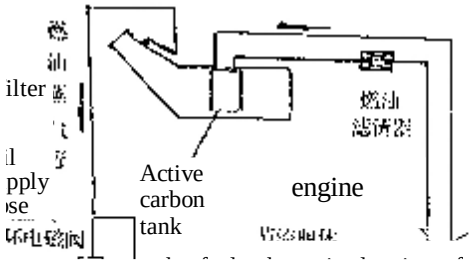
图 116

Idling up(Idle speed adjustment with A/C on):

if engine is equipped with an A/C system, idle speed should be raised if the A/C is on during idling.

by adjusting idle adjustment screw of the idle up actuator valve, idle speed may be adjusted to the specified valve under load .

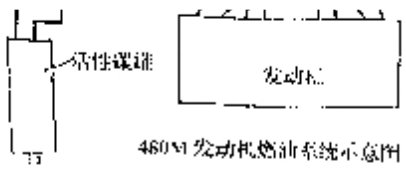
2.1 Description for fuel system.



chematic drawing of engine 480M fuel system

the fuel pump in the fuel tank supplies fuel, though fuel filter, to the fuel injector in the throttle valve body. the redundant fuel returns to the fuel tank . The vapor from the fuel tank goes into the charcoal canister by fuel vapor pipe and is sucked into air intake pipe though the fuel vapor recirculation solenoid valve which is controlled by ECU. For more detailed information, See "CAC480M Engine's single port injection system" .

2.2 for more details of the Fuel pump, fuel vapor recirculation solenoid valve and charcoal canister, see "CAC480M Engine's single port injection system" section.



480M 发动机燃油系统示意图

图 117 480M 发动机燃油系统示意图

【18】 Engine electrical system.

The electrical system includes battery, alternator, starter, breakerless distributor, ignition controller, spark plug, high-power ignition coil, high pressure assembly, water temperature sensor, oil pressure switch, electric fan, thermo switch, and idle speed solenoid valve of carburetor.

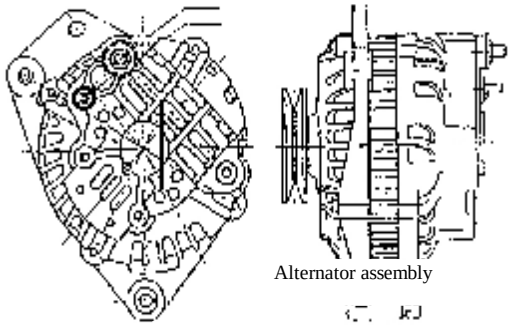


Fig. 118

1. Alternator.

Output voltage: 14V

Rated output current: 90A

B+Output D+ to the charging indicator filling-in bit

——battery is not permitted to be connected to alternator with the polarities reversed.

——insure that the ground wire between the alternator and chassis are tightly connected.

——it is forbidden to ground the power supply wire while the alternator is under working condition, the wiring harness will be burn away.

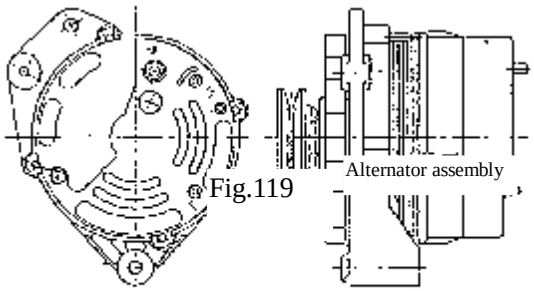


Fig.119

——while the alternator is under working condition, it is not allowed to disconnect the alternator connector B from battery, or the voltage caused will damage the transistor or other elements.

——To test the diodes, the voltage applied should be not beyond 40V.

——during servicing the alternator, apply enough No.2 lithium base grease into the alternator sealing bearing for the operation period before the next service.

——The electronic regulator needs no service and may only be replaced if damaged.

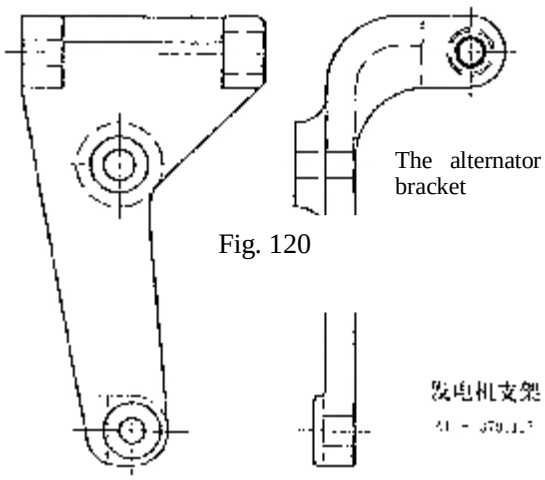


Fig. 120

——The alternator type is: JFZ1913—4 and JFZ1813—ZB.

——The alternator bracket for vehicle is quite different from the one for independent assembly . The former is applied on the engine equipped with A/C compressor.

——The left figure is the alternator bracket for the vehicle.

——the corresponding alternators are not exchangeable.

图 120

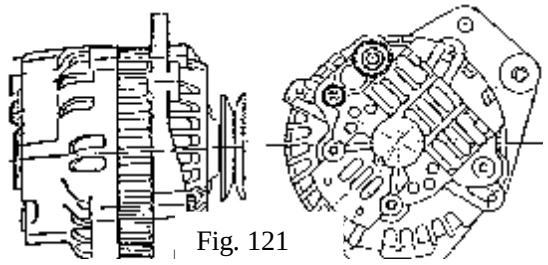


Fig. 121

The JFZ1913—4 alternator for independent assembly.

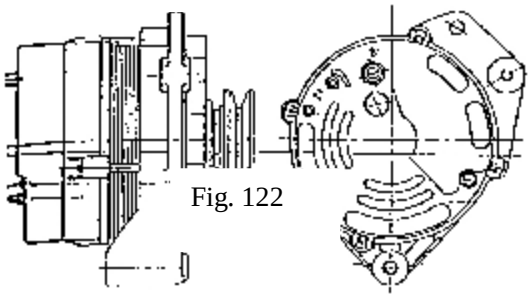


Fig. 122

The JFZ18D13 ZB alternator for independent assembly.

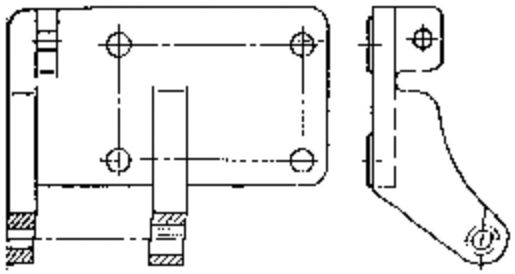


Fig. 123

The alternator bracket for independent assembly.

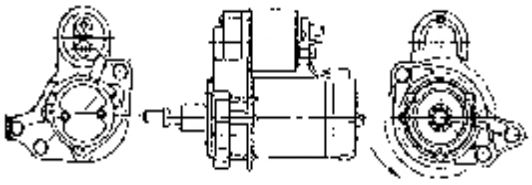


Fig. 124

tightening torque for bolt installation is 40±4Nm.

2. Starter.

Rated output:	0.95kW
Speed range:	1000-1800r/min
Voltage:	12V
Type:	QDY1258
	SD6RA78

——the flywheel gear ring for vehicle and the one for independent engine assembly are different and also the starter gear modulus are different ,, so different starters need to be applied..

——The left figure indicates SD6RA78.

——The

——The left chart is QDY1258
——When checking starter, you should clean carbon brush. Its surface should not have dust and calibrator, and the brush can move freely in the carbon brush carrier. Change them if the brush and carrier are damaged severely.
——Clean the commutator's surface with clean cloth. And engage the commutator if its surface is not smooth and round.
——As assembling carbon brush, make sure the brush spring is pressed on the brush correctly.
——Pay more attention to keep the wire bayonet clip clean. Make sure there's no oil fouling and water. Or the voltage drop is too high, and the engine doesn't work.

Fig. 125

3. Spark plug.
Type: K7RTC
Tighten torque: 17.0-33.0Nm

Fig. 126

4.Ignition controller
Type: ZJ5701F-HB or KH-3A.

5. Breakerless distributor
Type: FDW451(with ZJ5701F-HB Ignition controller) or JFD459(with KH-3A Ignition controller)

Removing:
——Turn the crankshaft to cylinder 1's TDC.
——Before removing, check and make sure the cylinder head and distributor flange have line marks. If not, make a mark on the cylinder head and flange so as to assemble in the previous position.

Ignition module assembly
Fig. 127

Fig. 128

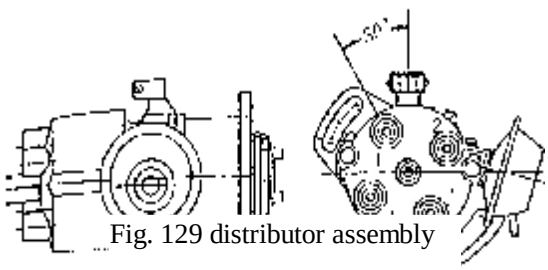


Fig. 129 distributor assembly

——Loosen and remove two M6× 20 bolts.
——Remove the distributor.
——remove the distributor's "O "seal.

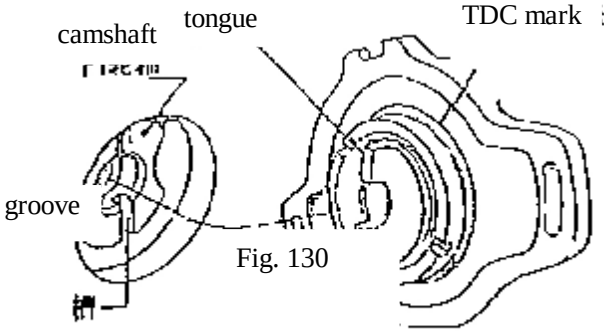


Fig. 130

图 130

Assembly:
——Insure that the engine is set correctly with No.1 Cylinder at TDC.
——install new "O" seal.
——Rotate distributor to align the lug with the No. 1 cylinder TDC mark on the distributor flange. install the distributor inserting the lug into the camshaft groove.
——Rotate distributor to align the mark on distributor flange with the mark on cylinder head.
——Tighten two bolts to 5.0—7.0Nm.

6. High tension ignition wire assembly:

The high tension ignition wire assembly is mounted on the cylinder wire bracket which is installed on the valve cover , also cylinder wire and coil wire clips exist between the distributor and cylinder wires bracket.

有分缸和高压线线夹。 Slave cylinder and high pressure wiring harness

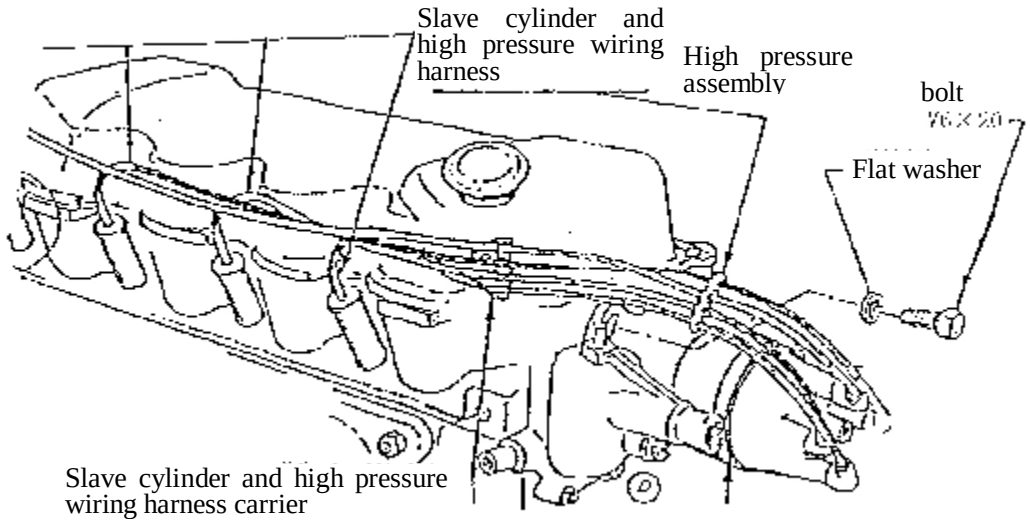
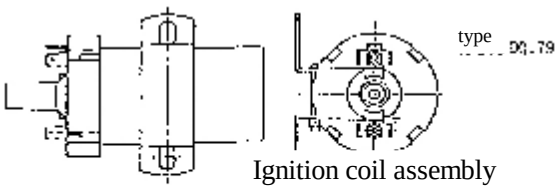


Fig. 131



Ignition coil assembly

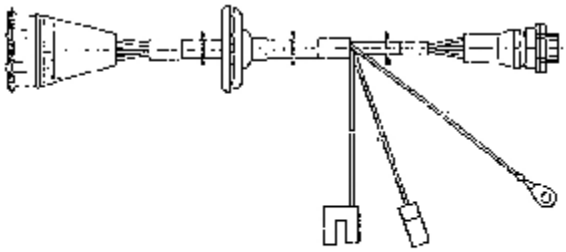
Fig. 132

点火线圈总成

图 132

7. Ignition coil assembly.

Connector wiring harness assembly.



插接线束总成

图 133

8.

sembly

Carburetor engine faults ,causes and corrections

1.engine does not run during starting:

Cause	correction
(1). Battery wires are loose or corroded	reconnect or replace the wires .
(2). Battery is discharged or damaged	recharge or replace the battery .
(3). Starter circuits is opened or loosed or not energized	energize or replace the harness
(4). Starter solenoid valve or switch is damaged	replace starter solenoid valve or switch
(5). Starter is damaged	replace starter
(6). Flywheel gear ring or starter pinion is loosed or damaged	replace flywheel gear ring or starter
(7). No engine ground wire or ground wire is disconnected	connect or replace the ground wire

2. engine runs but no spark exists during starting:

Cause	correction
(1). No fuel in fuel tank	fuel the tank
(2). No fuel in the carburetor float chamber	keep trying to start engine
(3). Battery is discharged(engine run slowly)	recharge or replace battery
(4). Battery wire connector is loosed or corroded	reconnects or replace battery
(5). Ignition parts is damp or damaged	replace ignition parts
(6). Ignition part harness is opened ,loosed or not energized.	Reconnect or replace harness
(7). Spark plug is burned away, damaged or Spark plug gap is not correct.	Replace spark plug
(8). Main mechanism is damaged(for example, camshaft)	check and service
(9). Fuel pump is damaged	replace pump
(10).Carburetor float chamber needle valve is binding or oil strainer is blocked	check, service and clean
(11).Idle cut-off valve does not open	check circuit and solenoid

3. difficult to start for engine when temperature is low:

Cause	correction
(1). Battery discharged	recharge battery
(2). Battery connector loosed or corroded	connect or replace the battery wires.
(3). Spark plug is corroded , damaged or the Spark plug gap is not right.	Replace spark plug
(4). Other ignition system problem s	check and service
(5). Low cylinder compression pressure	sent to service spot for check and service

4. difficult to start for engine when temperature is high:

Cause	correction
(1). Air filter is dirty or blocked	clean air filter core or replace case
(2). low cylinder compression pressure	sent to service spot for check and service
(3). Hydraulic valve lifting rod is damaged	replace the lifting rod

5. The starter noise or rough engagement.

Cause	correction
(1). Flywheel gear ring or starter's pinion loose or broken	replace flywheel gear ring or starter
(2). Starter retaining bolt loose or missing	tighten retaining bolt or replace bolt
(3).the parts in Starter worn out or damaged	replace starter

6.Engine stalls right away after started.

Cause	Correction
(1). Ignition coil connection loose or damaged	connect ignition coil or replace ignition coil
(2). Vacuum leakage in intake manifold	replace sealing gasket or replace connecting pipe
(3) carburetor float position not proper	check carburetor float or needle valve
(4). mail measuring orifice blocked	check and clean mail measuring orifice
(5). Idle cut-off valve damaged and not open	check circuit and solenoid
(6). Idle speed too low	adjust engine idle speed
(7). idle speed fuel outlet port or transition port blocked	check and clean

7.Rough engine idle speed

Cause	Correction
(1). Air filter core blocked	clean or replace
(2). vacuum leakage in Intake manifold or relevant hose	check and service
(3). Spark plug corroded, damaged or Spark plug gap not correct	replace spark plug
(4). Hydraulic valve lifting rod damaged	replace the lifting rod
(5). Idle speed fuel outlet port or transition port blocked	check and clean
(6). fast idling adjustment not correct	check fast idling spring for fallout ,readjustment.
(7). Low or unstable Cylinder compression pressure	check and service

(8). Timing belt tightening incorrectly	adjust timing belt tension
(9). Idle mixture too rich or lean	adjust carburetor idle mixture adjustment screw

8. engine Stalls during idling:

Cause	Correction
(1). Low idle speed	adjust idle speed
(2).fuel outlet port or transition port for Idle speed blocked	check and clean
(3). Choke not open or out of work	check choke system
(4). carburetor float position not proper	check carburetor float or needle valve
(5). Spark plug corroded , damaged or Spark plug gap not right.l	replace spark plug
(6). High tension wire damaged	replace high tension wire
(7). Ignition timing not correct	adjust ignition timing
(8). Hydraulic valve lifter damaged	replace Hydraulic valve lifting rod
(9). low or unstable cylinder compression pressure	check and service
(10). PCV hose loose, leaking, or damaged	connect or replace

9. engine Stalls within operation speed range

Cause	Correction
(1). Fuel filter blocked	replace fuel filter
(2). Fuel pump working incorrectly or low output pressure	replace fuel pump
(3). Tank ventilation hole clogged or fuel hose clogged	dredge the hose
(4). Carburetor float needle valve binding	service or replace
(5). Intake manifold or connecting hose vacuum leakage	check, service or replace
(6). Spark plug corroded , damaged or Spark plug gap abnormal	replace spark plug
(7). High pressure wire damaged	replace
(8). Ignition coil damaged	replace
(9). Low or abnormal cylinder compression pressure	measure pressure and service

10. Engine accelerates hesitately

Cause	Correction
(1). Intake manifold or connecting hose vacuum leaking	service and check
(2). Fuel filter clogged	replace fuel filter
(3). Fuel pump damaged. Or low fuel outlet pressure	replace fuel pump
(4). Carburetor acceleration pump clogged or diaphragm	clean or replace accelerator pump diaphragm damaged
(5). Part-load fuel way clogged	clean and service
(6). Spark plug corroded, damaged or Spark plug gap abnormal	replace spark plug

11.Engine speed is not as specified

Cause	Correction
(1). Intake manifold or connecting hose vacuum leaking	service and check
(2). Fuel filter blocked	replace fuel filter
(3). Fuel pump damaged. Or low fuel outlet pressure	replace fuel pump
(4). Fuel Tank ventilation pipe blocked or fuel hose blocked	dredge the hose
(5). Throttle valve not widely open	adjust
(6). Choke not widely open or auto-choke damaged	adjust or service

12. Engine power is not enough.

Cause	Correction
(1). Incorrect Ignition timing	check or adjust distributor
(2). Incorrect Timing belt assembly or incorrect belt tension	adjust ‘teeth’ belt tension or tension pulley.
(3). Carburetor float chamber level too low or fuel intake strainer blocked	check and clean carburetor float needle valve and strainer
(4). Throttle valve not widely open	adjust
(5). Choke not widely open or auto-choke damaged	adjust or service
(6). Fuel filter blocked	replace
(7). Abnormal or too low cylinder compression pressure	check and service
(8). Spark plug corroded , damaged or Spark plug gap abnormal	replace spark plug
(9). Intake manifold or connecting hose vacuum leaking	check or service

13. Carburetor backfire.

Cause	Correction
(1). Engine ignited too late	check or adjust distributor
(2). Incorrect Timing belt assembling or inadequate belt tension	adjust 'teeth' belt tension and tension pulley
(3). Carburetor fuel level too low or mixture too lean	check and adjust float chamber needle valve
(4). Carburetor measuring orifice blocked or float chamber watery	clean
(5). Spark plug overheated or too much carbon deposits	adjust and service
(6). Intake valve sealing not well	check and service
(7). Intake manifold or connecting hose vacuum leakage	check and service

14. Oil pressure warning light is illuminated during engine running.

Cause	Correction
(1). Engine oil level too low or not correct	fill in engine oil or apply correct engine oil
(2). Oil pressure warning light woks abnormally	replace Oil pressure warning light
(3). Engine temperature too high	see No. 17.
(4). Engine bearing or fuel pump worn out	check, service or replace
(5). Fuel pump relief valve binding or spring deformed	check or replace
(6). Oil collector blocked or loose	clean or replace or tighten

15. Engine self ignited.

Cause	Correction
(1). Too high idle speed, too lean mixture or fast idle gear out of work	adjust idle speed or fast idle boost
(2). Incorrect fuel grade	use fuel of correct grade
(3). Too much carbon deposits in Spark plug or combustion chamber	clean carbon deposits
(4). Idle cut-off valve not works or circuit trouble	service or replace
(5). Choke and throttle valve out of work	check relevant connecting mechanism

16. Engine noise.

(1). Preigniton or knocking occursduring accelerating or under heavy load

Cause	Correction
a. Incorrect ignition timing	check 'teeth' belt tension, tension pulley or distributor
b. Incorrect fuel grade	use fuel of correct grade
c. Intake manifold or connecting hose vacuum leakage	check and service
d. Too much carbon deposits in Spark plug or combustion chamber carbon severely	clean carbon deposits

(2). whistle noise:

Cause	Correction
a. Intake manifold sealing gasket leaks	replace sealing gasket or tighten bolts
b. Exhaust manifold sealing gasket leaks or exhaust pipe sealing gasket leaks	replace sealing gasket or tighten bolts
c. Vacuum hose leaks	replace
d. Cylinder head gasket burned badly	check and replace

(3). Knocking or spanking noise

Cause	Correction
a. Hydraulic valve lifter works abnormally	check and replace
b. Valve mechanism or camshaft worn out	check and service
c. Timing belt or tension pulley worn out	replace
d. Abnormal accessories ie. alternator or water pump	check, service and replace

(4). Knocking or hammering noise.

Cause	Correction
a. Connecting rod bushing worn out(generally severe knocking, May be relieved under load.)	check and service
b. Main bearing half shell worn out(booming or knocking noise, may be relieved under load.)	check and service
c. Piston knocking (apparent with engine cold)	check and service
d. Alternator or water pump accessories damaged	check and service

17. Engine is overheated.

Cause	Correction
(1). No sufficient coolant in the cooling system	add coolant
(2). thermostat damaged	replace
(3). Radiator core blocked or air inlet cogged	clean or replace radiator
(4). Radiator electrical fan or coolant temperature sensor abnormal	check, service and replace
(5). Expansion tank pressure cap damaged	replace
(6). Water pump leaks or damaged	service or replace
(7). ignition timing too late	adjust ignition timing

(8). Air exists in cooling system	bleeding the air
(9). Too lean mixture	adjust carburetor

18. Engine is too cold

Cause	Correction
(1). themostat damaged	replace thermostat
(2). Water temperature sensor damaged	replace water temperature sensor

19. Too much fuel consumption

Cause	Correction
(1). Air filter blocked	replace air filter core
(2). Too high idle speed	adjust idle speed
(3). Choke not widely open or auto-choke damaged	djust or service
(4). Load enrichment diaphragm damaged or vacuum pipe blocked	check and replace
(5). Carburetor acceleration pump ball valve continuously leaks	check accelerator pump ball valve mechanism parts
(6). Fuel pipe leaks	correct fuel pipe connector leakage
(7). cylinder compression pressure decreases	check engine
(8). Incorrect ignition timing	adjust ignition timing
(9). Too low tire pressure	inflate the tire

CAC480M Engine's single port injection system

One. summarize

The system, referred as " λ Speed Density" type(running speed, air density, mixture control), is designed to perform the control for injection and distributorless ignition.

According to the following figure(figure 134) of Single Port Injection System, three basic parts are included as the following:

1. "I.A.W.6F。" Injection System ECU.
2. "20MM12" Single Port Injection System throttle valve body.
3. two "BAE 800 AK" Ignition coil.

The whole system includes fuel pump, fuel filter, RPM sensor, absolute pressure sensor, λ sensor and so on.

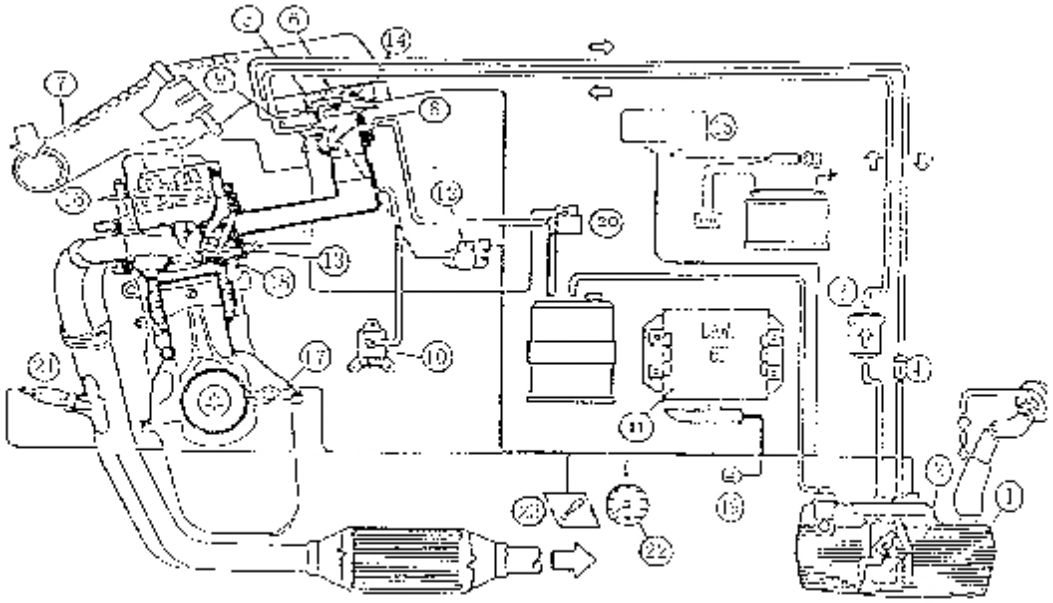


Fig. 134 single port injection system

1. fuel tank 2. fuel pump 3. fuel filter
4. check valve 5. fuel pressure regulator 6. fuel injector
7. air filter 8. fuel vapor connecting pipe 9.engine idle speed actuator
10. absolute pressure sensor 11. injection/ignition system ECU
12. throttle valve position sensor 13. water sensor 14. intake temperature sensor
15. injection/ignition system dual relay 16. ignition coil
17. tacho / TDC sensor 18. spark plug 19. CHECK-UP1 diagnostic port
20. fuel vapor recirculation solenoid 21. λ sensor
22. tachometer 23. IAW system warning indicator

Two. Operation principle:

Single Port Injection System is applied on the vehicle equipped with 3 way catalyst converter .the system insures air/fuel mixture ratio in the vicinity of the ideal air/fuel ratio.

The ideal air/fuel ratio is important for catalyst converter to work normally. The aim having the catalyst converter installed is to reduce harmful exhaust emission. The λ sensor, analyzing oxygen content in exhaust gas continuously , may ensure getting ideal mixture . If air/fuel ration is not ideal, ECU may adjust the mixture consistence continuously by measuring fuel intake in progression.

Fuel system(fuel pump, fuel filter, pressure regulator) offers the fuel of 1 bar to fuel injector.

The fuel Injection value is proportional to the air sucked into the engine . also the fuel is injected into intake manifold synchronously with TDC . under some specified condition , the amount of fuel needed for engine circulation is too small to measure, the system may perform a asynchronous injection (inject once instead of the normal injection ever several TDCs).

Ignition controller with inductive discharging is of electrostatic discharge type(distributorless). Ignition

advance is calculated by a basic chart(pressure, revolution) and trimmed by engine load, water temperature, and air temperature. In addition, it may perform dynamic ignition advance to stabilize idle speed. Engine idle speed actuator adjusts the by-pass pipe opening to keep idle value constant . And engine idle actuator is consisted of linear stepper motor.

Generally, ECU receives input signal and operates output actuating device to integrate idle speed, spray, ignition's control. Moreover, HCMOS microprocessor, with wonderful static-prevention and high-speed calculation ability and low power consumption, may fulfill the following functions:

• the diagnosis for resuming system operation. As a sensor fails, the diagnosis system may resumes the operation using the stored value preset..

• diagnosis for faulty Actuator condition

• Even if stopped, as a system part fails , the warning indicator will be energized and the information of fail type will be stored.

• during service, diagnostic tester may be connected and actuator may be operated to check for failure.

1. "I.A.W 6F……" ECU

Read the square figure (figure 135), ECU processes all sensor signals related with running parameters:

• Intake manifold absolute pressure
• The TDC and revolution of cylinder 1,4 and 2,3
• Throttle valve open position
• Intake air temperature
• Engine coolant temperature
• A/C compressor switch signal
• Oxygen (λ) sensor signal (millivolt signal)

By this way, calculate air charge (process absolute pressure, air temperature, speed, and throttle valve position signal) and use output circuit to control the following:

• control fuel injector switch on time for calculating fuel feed.
• control by-pass air volume and ignition advance for stepper motor compensating to control idle speed.
• control two high pressure ignition coil, and ignition energy of cylinder 1,4 and 2,3.
• control fuel vapor recirculation solenoid switch on/off

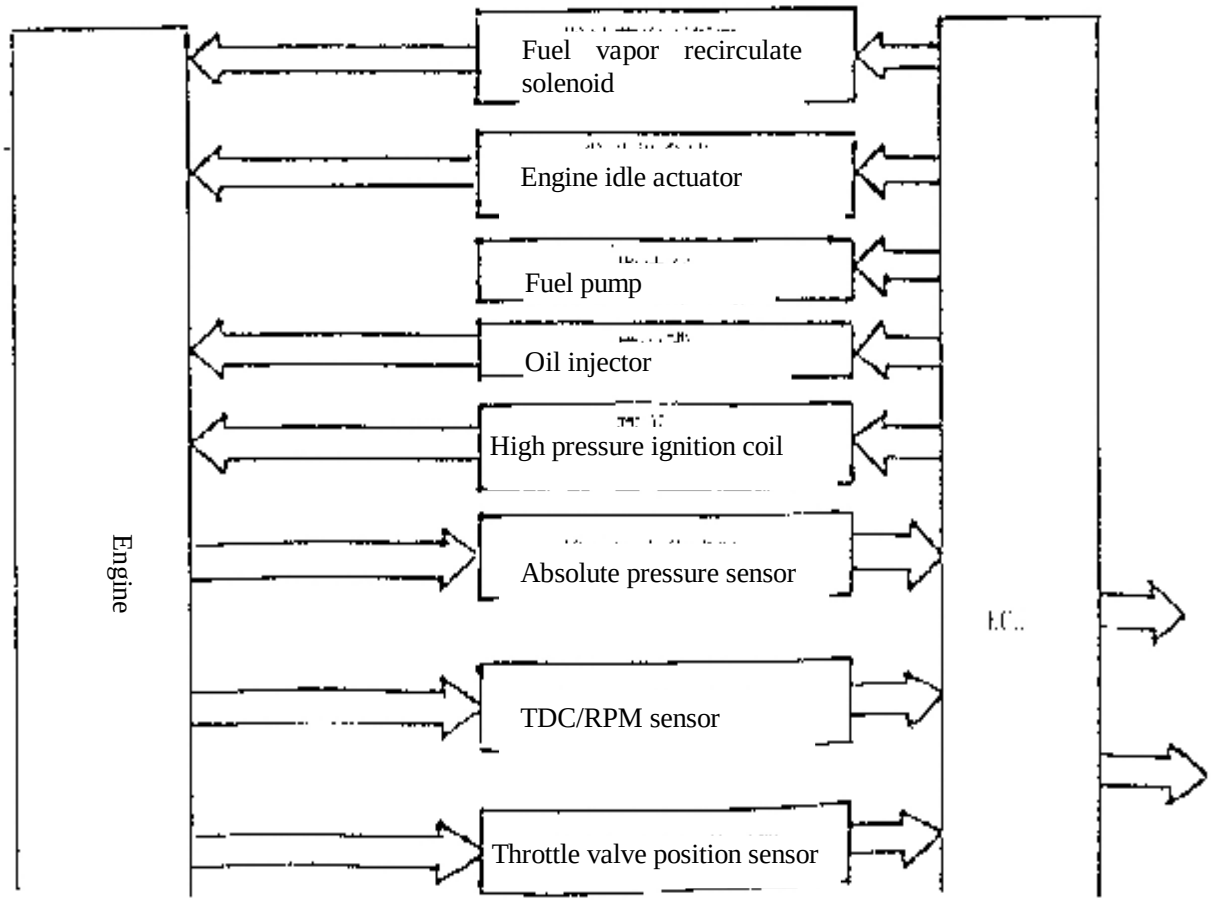
also ECU features a complete self diagnostic for input sensor and output actuator. The diagnosis may be performed by connecting CHE CK—UP1 with system and the failures detected will be shown on the screen. For instance:

• all sensor are shorted or opened, including pressure, air, water, throttle valve, λ sensor, TDC/RPM sensor (signal sequence is missing).
• Engine idle speed actuator (stepper motor) doesn't work.
• stepper motor, fuel injector, and fuel pump circuits are shorted
• high pressure ignition coil, fuel vapor recirculation solenoid is shorted or opened.

main parameters are shown according to the requirements: speed, water temperature, injection time, ignition advance , intake manifold pressure, throttle valve position, battery voltage, stepper motor position(steps).

when engine is stopped and ignition switch is on, ECU may perform active diagnostic function, which may operate ECU microprocessor to check whether the following accessories are running well or not: fuel pump, fuel injector, and fuel vapor recirculation solenoid. After service, you may erase trouble code stored. To check stepper motor, technician needs to start the engine before checking.

ECU memory stores a series of emergency parameters for resuming operation. The emergency function may insure that cars may be drive home or sent to service center. the emergency parameters are indicated by special LED.



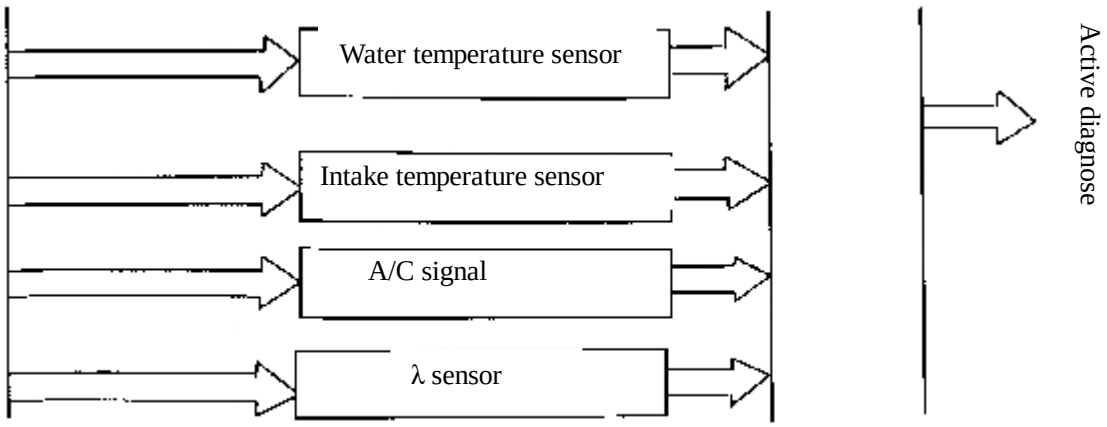


Fig. 135 The control-illustration for single Port Injection System

According to λ sensor signal, ECU will automatically revise C0 parameter(close loop). When λ sensor fails, ECU may work under open loop.

2. Single Port Injection System Throttle Valve "30MM12"

"30MM12" throttle valve is one of the main system parts. Most sensors and actuators are assembled in the throttle valve. Throttle valve features small accessories, compact structure, and an bran-new inner geometry structure to better the fuel atomization from fuel injector and get the most proper mixture for optimizing engine performance. Throttle valve is installed on intake manifold.

Throttle valve casting are consisted of upper and lower bodies. Upper body(cap) is for arranging fuel passages, and the lower body is for controlling engine air intake volume. Fig. 136 indicates the throttle valve structure.

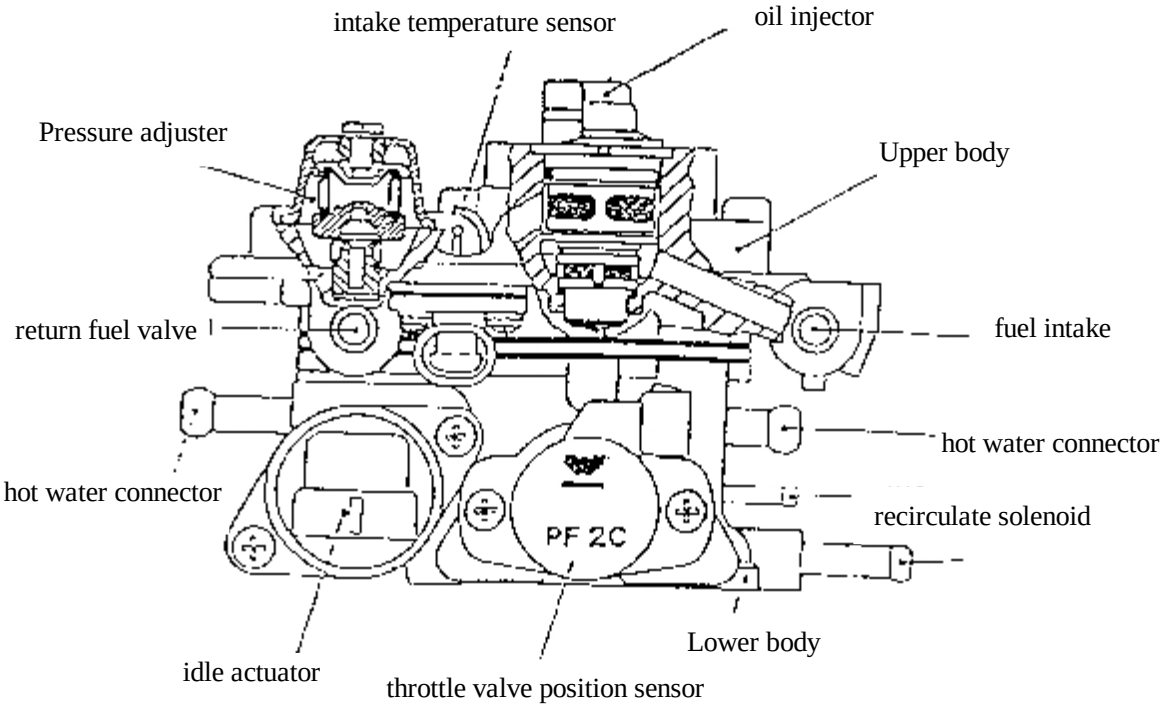


Fig. 136 throttle valve structure

2.1 Upper body(fue accessories

The following accessories and engine air filter are installed on the upper body of throttle valve.

- fuel system pipe and fuel return pipe
- fuel pressure regulator
- bottom-supplying fuel injector IWM
- intake air temperature sensor.

——Fuel pressure regulator

As engine is running, fuel pump supplies fuel (fuel supply volume of pump is about 80L/h) through filter and pipe to fuel pressure regulator(chart 137). The regulator is designed to keep the specified fuel pressure at 1bar(0.9-1bar), and redundant fuel will recirculate flowing into fuel tank. Fuel will clean and cool injector during recirculation.

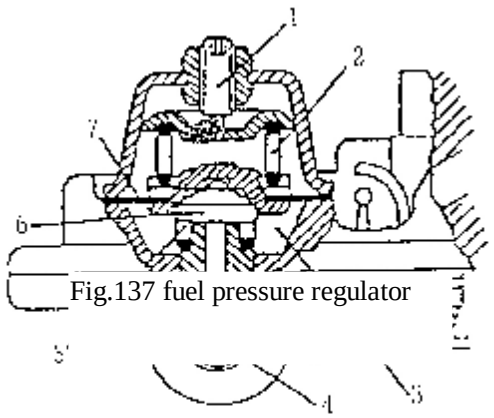


Fig.137 fuel pressure regulator

图 137 燃油压力调节器

5. spring
6. sealing valve
7. diaphragm

——working procedure of Fuel pressure regulator .

Spring (2) applies pressure on the diaphragm(7) connected to sealing valve(6) keeping cavum closed between fuel delivery pipe and fuel return pipe(4).

whe fuel pressure in pipe(3) exceeds 1 bar , pressure on diaphragm(7) will overcome spring(2) resistance, then diaphragm goes up raising sealing valve up to allow redundant fuel to flow back and returns to proper work pressure.

during producing, fuel pressure regulator pressure is calibrated by socket head bolt and will never changed under any circumstance.

——Fuel injector

1. socket head regulator screw
2. spring
3. fuel output pipe
4. fuel return pipe

IWM523 fuel injector applied in the system is of the shortened type of the first generation. It is entirely made of stainless steel and superior in the function. The advantage may be embodied when the commercial fuel containing corrosive material is applied. figure 138 shows fuel injector structure and some technical parameters.

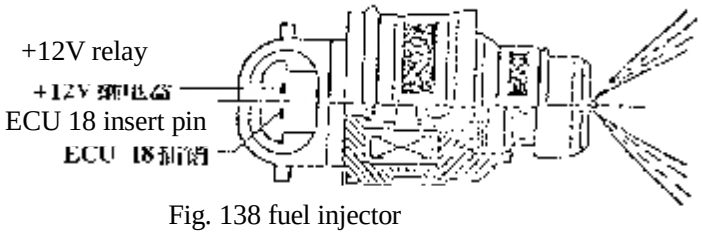


Fig. 138 fuel injector

Technical parameters:
－winding resistance
R=1.8Ω+/-10%(20℃)
－power supply voltage
V=6-16V
－spraying shape
angle 30～90°
－operating temperature
-30～+110℃.

when fuel injector is not operating, it is sealed and doesn't allow fuel drain. Fuel needed by engine, is controlled by ECU(supplied electricity by relay (87))directly. And ECU decides the open time of each intake order and fuel injection duration.

Fuel injection time is controlled by the following measures:

-synchronous(for normal operation) .injector opening corresponds with every TDC.

-not synchronous (for idling, cut-off, low speed, start operation).injector opening is completely controlled by time and not related to TDC signal.

ECU has a basic current control circuit to control fuel injector. The circuit produces the maximal current(signal) at the first control order speed up the opening of injector. Once maximum current is attained , the circuit will automatically change to and keep the current I=1A±0.3 A(Mean).

Injection duration is showed on the 2-dimension figure as a function of engine speed and intake manifold absolute pressure . After engine warming up or speed turns to be stable, injection duration is 1～4mS.

Injection duration is increasing basically under special operation condition, such as accelerating, cold starting, engine warming up. As accelerator pedal is released, fuel will be cut off.(ti=0mS). Running condition and readjusting condition may be changed according to water/ intake air temperature or A/C condition.

——intake air temperature sensor "ATS05"

It is consisted of N.T.C.(Negative Temperature Coefficient) thermo resistance and 2-way junction box that are installed in the plastic setting molding case. Sensor resistance will changed with intake air temperature.

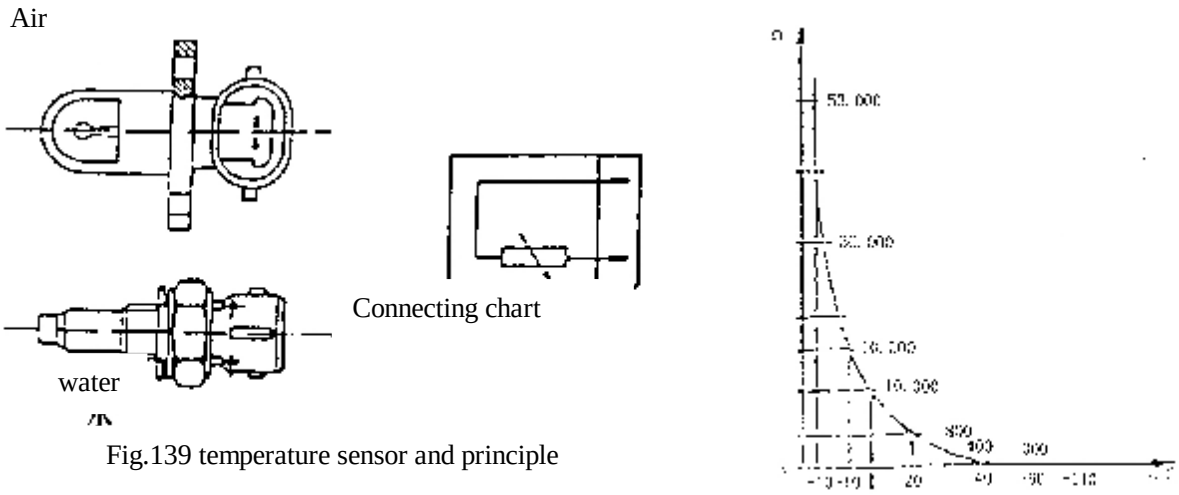


Fig.139 temperature sensor and principle

2.2 Lower body(air system)—description and function of accessories

Excepted that connecting throttle valve to accelerator pedal by a lever, the following parts should be installed on the lower body.

- throttle valve position sensor
- stepper motor
- hot water loop near the throttle valve and idle air by-pass
- absolute pressure signal port in the lower throttle valve (necessary to be connected with pressure sensor)
- PCV recirculation pipe

——throttle valve position sensor "PF2C".

figure 140 shows the position sensor case structure ,also the relationship between output characteristic, output signal and throttle valve opening ange.

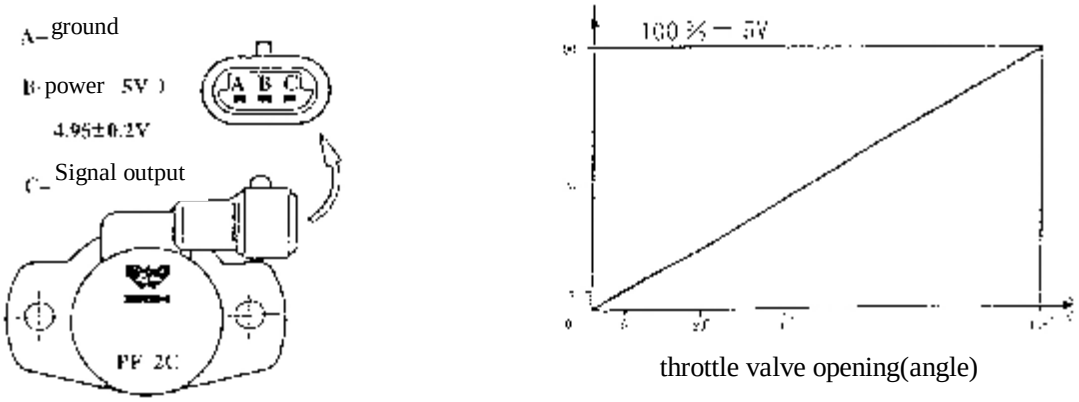


Fig. 140 throttle valve position sensor and operation chart

- Sensor component is consisted of a potentiometer. The slipping ruler of potentiometer is driven directly by accelerator pedal which is proportional with throttle valve opening.
- the potentiometer is inserted into plastic case with two baffles on the bracket. There are two

holes in the bracket for installing the potentiometer on throttle valve.

• there is spline on the shaft. the spine provides data about throttle position. The data is used to confirm idle operation condition(accelerator pedal released), full load(accelerator pedal depressed) and accelerating or decelerating conditions.

• with absolute pressure sensor out of work, the position sensor will function when working condition comes back.

• ECU supplies 5V voltage to the variable resistance terminal of throttle valve potentiometer . And potentiometer output voltage varies with throttle valve position.

• sensor needs not adjustment(through assembling hole), for ECU program may self adjust to minimum impedance(2° to 14°).

Warning——the following order should be taken during potentiometer replacement:

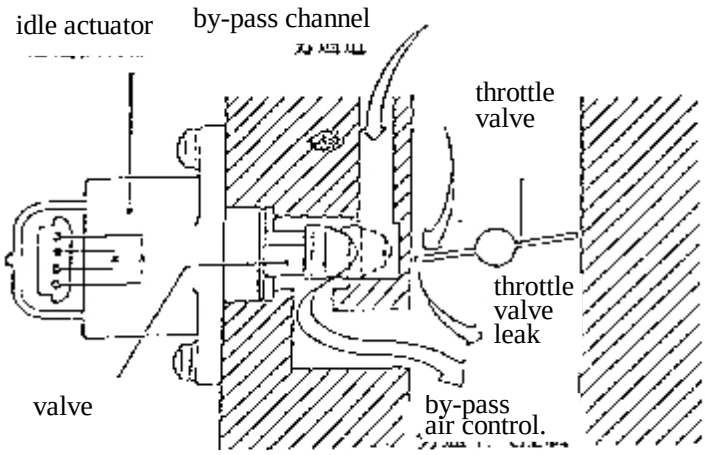
1. tighten mounting bolt on the new potentiometer.
2. turn ignition key to the MAR before connecting line to the potentiometer, and wait for several minutes.
3. turn ignition key to Stop.
4. connect wire to the potentiometer's insert hole.
5. insert CHECK-UP1 tester. Turn ignition key to CN and erase trouble display.
6. keep connection until throttle valve position displayed on the screen is 2°～14°. If the parameter is above 14°, you should check throttle cable and make sure it's correct (not very tight). Or it needs to be adjusted again.

Notice: Don't adjust the potentiometer bolt if it does not return to the specified value of throttle valve opening angle. The potentiometer should be replaced because it fails.

——engine idle speed actuator(idle control stepper motor)

Idle control stepper motor is a position actuator of high precision and high distinguishability(+/-50r/min) for controlling idle speed.

It is consisted of stepper motor and screw rod-type reduction gear. The reduction gear converts the valve rotating into linear movement. Stepper motor receives the signal from ECU and makes valve shaft move by screw rod changing air by-pass passage(see figure 8). Then engine air intake will change during idling. It will vary with coolant water temperature whether air intake is increasing or decreasing, which keeps speed stable. Engine minimum idle air intake is set by adjusting throttle valve opening when by-pass channel is closed completely. Be sure not to touch mixture adjustment bolt. Engine maximum idle air intake is set by valve returning position , i.e. about 200 steps (8mm travel). The operation steps is the function of engine conditions(preheating cycle, electrical load, A/C working condition, engine running (hot)).



feature parameter

spiral resistance

$R = 50\Omega + / - 10\Omega(20)$

operation temperature

$-40℃ \sim 85℃$

Fig. 141 Idle step motor and air by-pass valve

If stepper motor needs to be replaced, remove the positive connector first and replace actuator. Then turn ignition key to position 1(accessory position), ECU will readjust actuator position(to limit switch) and adjust for steps according to engine water temperature so as to adjust idle speed with valve linear (axial direction)movements(forward or backward).

Only CHECK-UP1 tester may be applied to check whether it's running properly.

3.1MARWAL low pressure fuel pump "MSS070"

The fuel pump in this system is atmospheric positive shift (see figure. 142). It is designed to work with ethyl as its standard fuel and equipped with a check valve and a pressure override valve (vibration pressure is 2.6bar). It is installed inside the fuel tank and equipped with a fuel filter.

Fuel pump supplies the fuel to fuel injectors and is controlled directly by ECUD to ensure:

nector

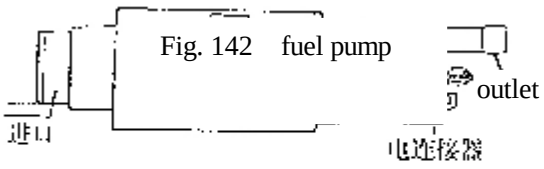


Fig. 142 fuel pump

• The fuel pump will close when engine speed drops under the minimum starting speed or engine stops.

• The fuel pump signal is timed. once ignition switch is on and engine is not started , there will be a fuel pump signal within 10 seconds.

• Under the engine running and starting conditions, the fuel pump signal will not change.

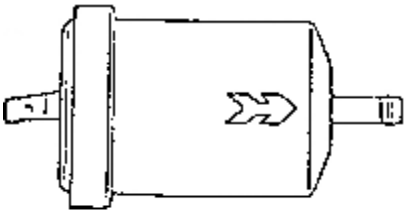


Fig. 143 fuel filter

3.2 fuel filter

Fuel filter (see drawing 143) is connected between fuel pump and the fuel intake port of the throttle valve body. It comprises an aluminum case and a bracket with a stainless steel in it. for the high sensitivity of fuel injector and the the existence of external impurities being in the fuel system, it is necessary to use the high-efficiency paper filter core.

4.1water temperature sensor "TS05"

during cold starting and engine warming, ECU enrich the mixture according to the signal (see figure 6) from the sensor. When engine is warmed enough for fan to reach the operation range, the enrichment is zero.

4.2 speed, top dead center and **S**ynchro pickup "CVM01" see figure. 144

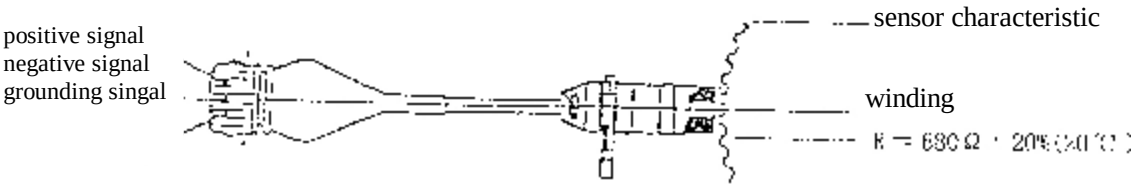


Fig. 144 tacho sensor

Sensor is mounted on the cylinder block by a mounting bracket. When it detects the impulses produced by the teeth (60—2) in the flywheel (see figure. 143), engine speed may be calculated accurately by the signal impulses produced by the 58 teeth which are arranged equally with a interval of 6°.

The RPM sensor position in the flywheel (signal wheel) is on the surface of the twentieth tooth before the top dead center of the cylinder 1, 4, the angle between it and the top dead center of cylinder 2, 3 is 80°, on the opposite of the fiftieth teeth (tooth counting begins from the tooth-missed area), except for deciding cylinder 1,4 and cylinder 2,3 TDC, the sensor signal (see figure. 144) is also used in the microprocessor:

—— Control ignition (ignition advance and ignition delay)

—— generate signal for the RPM counter

—— detect two missed teeth to confirm the synchronous position every engine revolution

Without the signal or the corresponding synchronous signal (60—2 signals/revolution), ECU cannot be operated.

timing:

Rotate the engine pulley(2) to keep cylinder 1 and cylinder 4 at TDC, i.e. the mark on the pulley (2) and the mark (3 and 4) on the timing wheel cover of engine must be matched (see figure. 145).

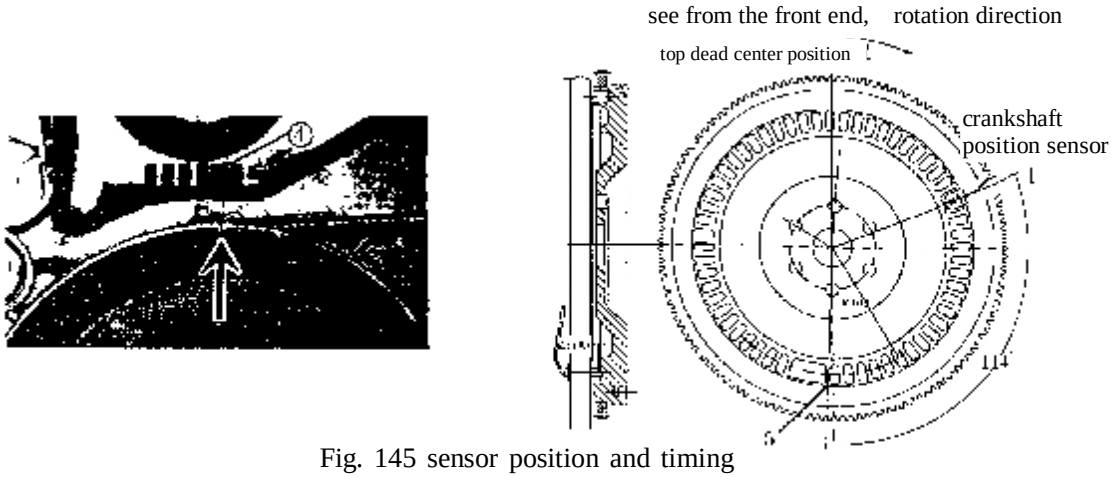


Fig. 145 sensor position and timing reference point

speed/ TDC sensor

Check if the sensor is located in the twentieth tooth after the breach in the flywheel signal panel

1— speed/ TDC sensor(crankshaft position sensor)

2— pulley

3— TDC reference point on the pulley

4— TDC reference point on the timing gear cover

5— synchronous tooth

Check the air gap between the sensor and flywheel:

Magnetic thickness gauge is used for checking the air gap between the sensor and flywheel. Measurement should be made at least at three different teeth with a equal interval of 120° . The value should be 2±0.6mm.

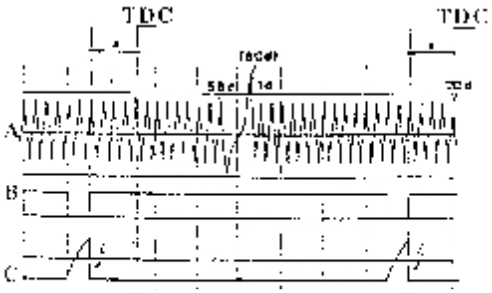


Fig. 146 magnetic sensor output signal wave

图 146 电磁传感器输出信号波形

A. speed sensor signal

B.ECU power signal

C. current circle for primary coil circuit

a. ignition advance angle relative to cylinder 1 TDC

4.3 absolute pressure sensor

The sensing element of absolute pressure sensor is printed in a ceramic membrane by the wheatstone bridge silk PCB. One side of the membrane is absolute reference vacuum and the other side is actual vacuum of the intake manifold. The signal (piezoresistance type) produced by the distortion of ceramic membrane which is installed in the bracket is magnified by the circuit located in the carrier before being transferred to ECU.

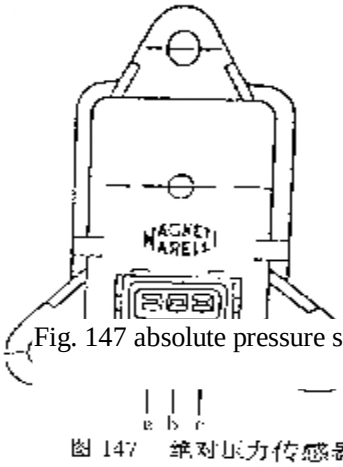


Fig. 147 absolute pressure sensor

图 147 绝对压力传感器

3-way connector (figure. 147)
a. supply 5V voltage
b. negative pole signal
c. positive pole signal

When engine is shut down, the sensitive membrane will bent according to the value of atmospheric pressure (mmHg). After the ignition switch is switched on, the actual atmospheric pressure may be obtained by this method.

When engine is running, the vacuum will produce a mechanical effect on the ceramic membrane of the sensor resulting in the change of resistance.

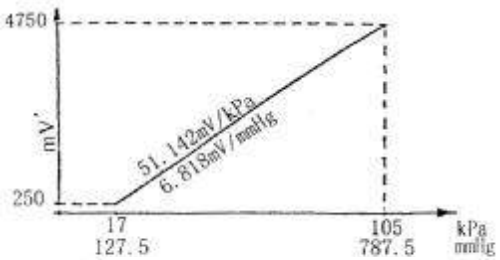


Fig.148 sensor output

for ECU supplies a absolutely constant 5V voltage , the change of output voltage caused by the change of resistance is indicated in figure. 148.

Sensor supplies the most important data to ECU for calculating the intake air volume. When the pressure signal is P ＜97mmHg or P＞783mm Hg，if the throttle valve position sensor doesn't fail, the operation comeback will be performed according to the throttle valve angle and speed value stored in the calibration scale. If throttle valve fails, only one comeback value may be applied—— about 442mmHg.

Note: If absolute pressure sensor needed to be replaced, the connecting pipe must have the same diameter and length as the original pipe.

5 ignition advance calculation and high voltage distribution

The system uses two high tension ignition coils and assigns ignition voltages directly to spark plugs by static electricity (distributorless ignition) directly. Connector and controlling triode are comprised in the ECU injection system and connected to ECU connector 1 and connector 19 . (figure. 149).

When ECU microprocessor identifies the signals of two tooth-missed signals , it will begin to count tooth. cylinder 1 or cylinder 4 TDC comes after 20 teeth are counted .cylinder 2 or cylinder 3 TDC comes after 50 teeth are counted (determine by pair).

ECU calculate the primary coil conductivity of cylinder 1, 4 or cylinder 2, 3 and ignition advance according to the gained parameters (pressure, rpm) and calculate the dynamic compensation according to the engine working condition.

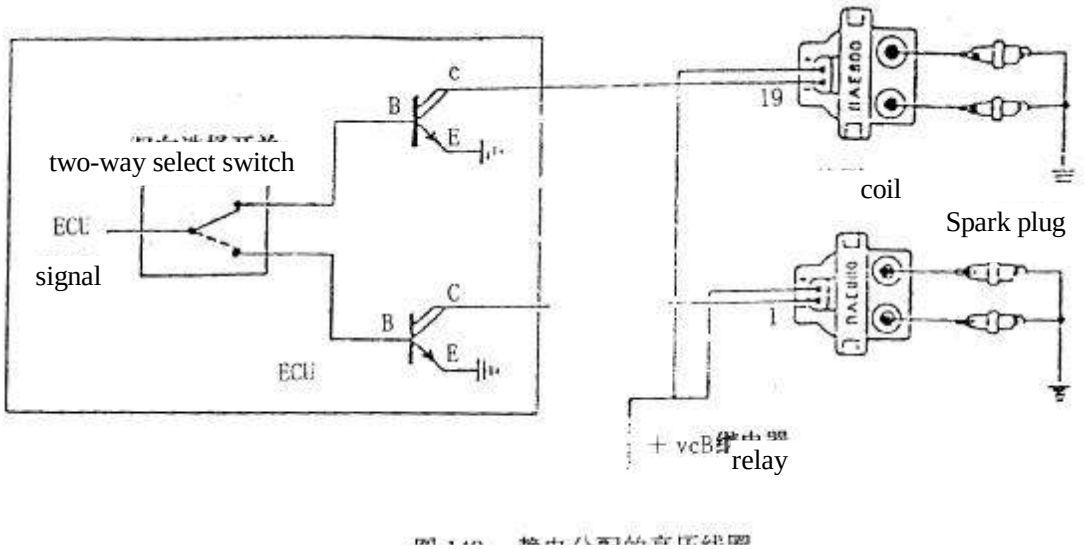


Fig. 149 high pressure coil of electrostatic distribution

the following is for checking primary coil and secondary coil resistance.

R1=0.55Ω+/-10% (20℃) R2=7400Ω+/-10% (20℃)

The base ignition advance value in the chart is determined after several adjustments according to the coolant temperature and air temperature. one filter restricts the change of two continuous TDCs, Under a specified condition, ignition advance will be compensated dynamically.

Base ignition advance value ,as a function of manifold absolute pressure and engine speed, is inserted into two-dimension diagram .

At a rather low speed, ignition advance remains fixed. The positive and negative change of ignition advance between two continuous TDCs is limited by two calibration values.

The dynamic compensating of ignition advance occurs under the following conditions:

—— during idling or running without rpm fluctuations

—— during acceleration and deceleration shut

—— when shutten off

—— during over speeding

during idling, the engine rpm is 900±50r/min，and ignition advance is 10° ±1° (Engine is already warmed and with no electrical load).

6 zirconium λ sensor is designed to detect the oxygen in exhaust emission

In endothermal engine, the combustion is produced by the reaction of hydrogen and oxygen and then emits heat. Fuel is composed of hydrocarbons. It includes carbon atom and hydrogen atom which are combined together by different modes (paraffin, olefine, aromatics).

The main products of the air and fuel combusting are carbon dioxide (CO_2), vapor (H_2O), carbon monoxide (CO) and a small percent of unburned hydrocarbon (HC) and nitrogen oxide (NO_x). The last two are measured by ppm.

For the pollution problem, only carbon monoxide exists largely in the form of bulk.

Nitrogen oxides is composed of the oxidized mixture. The main ingredients are as following:

dinitrogen oxide, nitrogen monoside (NO), nitrogen dioxide

NO_x is the traditional symbol for these oxide. NO covers over 95% of them.

In order to minimize pollution (CO、HC and NO_x)，“λ sensor” is installed into the system to detect the oxygen content in exhaust emission.

The signal coming from the sensor is sent to ECU for adjusting the mixing ratio of air and fuel, ensuring the catalytic converter work under the optimal condition.

The sensor is located in the first section of exhaust pipe, in front of the catalytic converter.

It is enclosed by ceramic zirconia body (1) with thin platinum plate at one end. The latter one is inserted in a protecting boot and installed in a metallic body (3). The protective casing works for the further protection and has the sensor in the exhaust manifold.

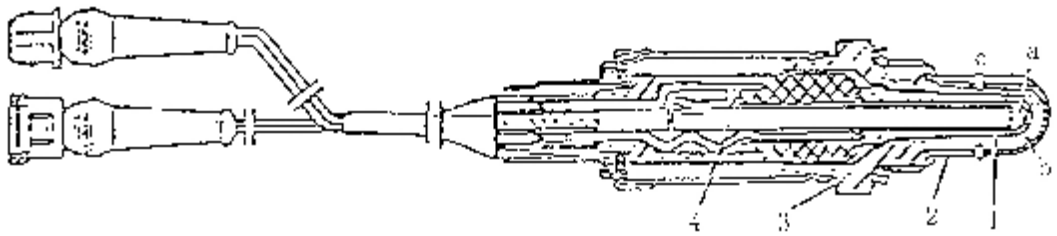


Fig. 150 oxygen sensor

The outside of the ceramic body(b) is exposed to the exhaust emission and the inside (a) is exposed to ambient atmosphere. The working principle of sensor is as following: When the temperature is over 300℃，the ceramic material will be the conductor of ferric oxide. Under this condition, if the percentage content of the oxygen in the two sides of sensor (a, b) are not the same, the voltage difference will occur in the two sides. The difference of measured oxygen content in two ambient (at the side of air and at the side of exhaust) tells ECU that the remainin oxygen content in the exhaust is not propriate for ensuring the combustion with no harmful exhaust products produced

The ceramic material under 300℃ is non-linear, therefore the sensor doesn't send the useful signal. ECU has a special function, i.e. stop adjusting the mixture during engine warming (open loop operation).

the sensor is equipped with a heating unit (4) to reach the operation temperature as soon as possible. When the current flows over the heating unit, it shortens the time for ceramic becoming the conductor of iron and may have the sensor installed in the relatively rear area of exhaust pipe.

λ sensor inspection：

to check all sensors and actuators, injection system ECU has a complete high-efficiency self-diagnosis system. When failure occurs, the warning light will turn on.

Warning：Before checking exhaust emission or λ sensor, check：

1. The warning light should go out, or use CHECK—UP1 diagnosis instrument to determine the failure and adjust it for correct operation.

2. little difference exists between the working parameter showed on CHECK—UP1 and the actual engine condition.

3. The fuel pressure should be the specified value (0.9—1.0bar). When the pump stops, no sudden pressure drop occurs (pressure sealing).

4. When the fuel pump operates, CHECK—UP1 performs to stop engine and recycle oil circuit.

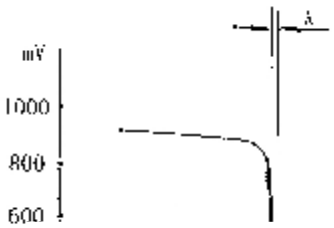


Fig.151 λ sensor signal

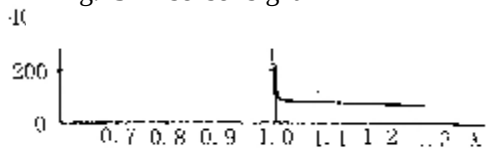
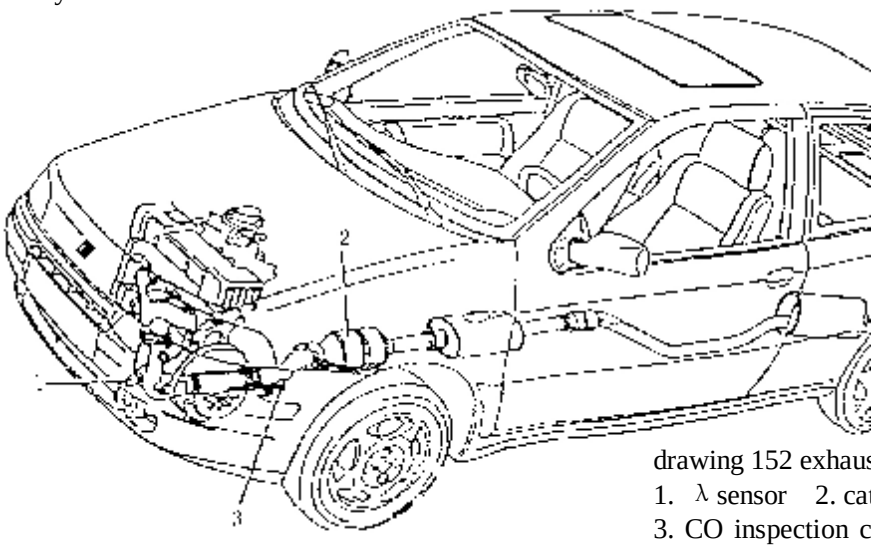


图 151 λ 传感器信号

Injection system ECU may adjust automatically, therefore it may compensate for the system failure caused by the engine degradation. According to the signal of λ sensor (figure 151)，in the precondition of without any exterior interference, the mixture can be automatically adjusted to the perfect value electronically.

• When engine is idling with no electrical load and λ controlling is functioning(close loop)，select LAMBDA CHECK to check if the slipping ruler on the CHEC K—UP1 diagnosis tool is in the middle of two base points .

7 catalytic converter



drawing 152 exhaus
1. λ sensor 2. ca
3. CO inspection c
catalytic converter

Exhaust emission is controlled by λ sensor and the above relative systems and three-way catalytic converter.

Catalytic converter may damp the three contaminations in the exhaust: unburned hydrocarbon (HC), carbon monoxide(CO) and nitrogen oxide (NO_x).

two kinds of complicated chemical reactions exist in the catalytic converter: the oxidation of carbon monoxide and hydrocarbon changing into carbon dioxide and water; nitrogen oxide changing into nitrogen.

note：Using leaded gasoline may damage the catalytic converter and weaken its catalytic capability so that it does not function completely for the system. And the damage is irremediable. The weakening of the catalytic converter capability for the chemical reaction should not occur within 80 thousand kilometers or five years.

Besides lead, the unburned fuel in the converter is another factor for the catalytic converter failure.

In the catalytic converter, the temperature is 800℃. Even so，if fuel only remains in the converter for 30 seconds , the combustion caused by the fuel will damage the converter .sometimes, a few-second stay of the fuel in the converter may result in irremediable damage. Therefore, it is very necessary to insure the ignition system high performance.

during repairing and testing, be sure to avoid unplugging the spark wire when engine is operating. If it is needed to do this kind of test, it is suggested to replace the converter temporarily with a pipe and perform the test.

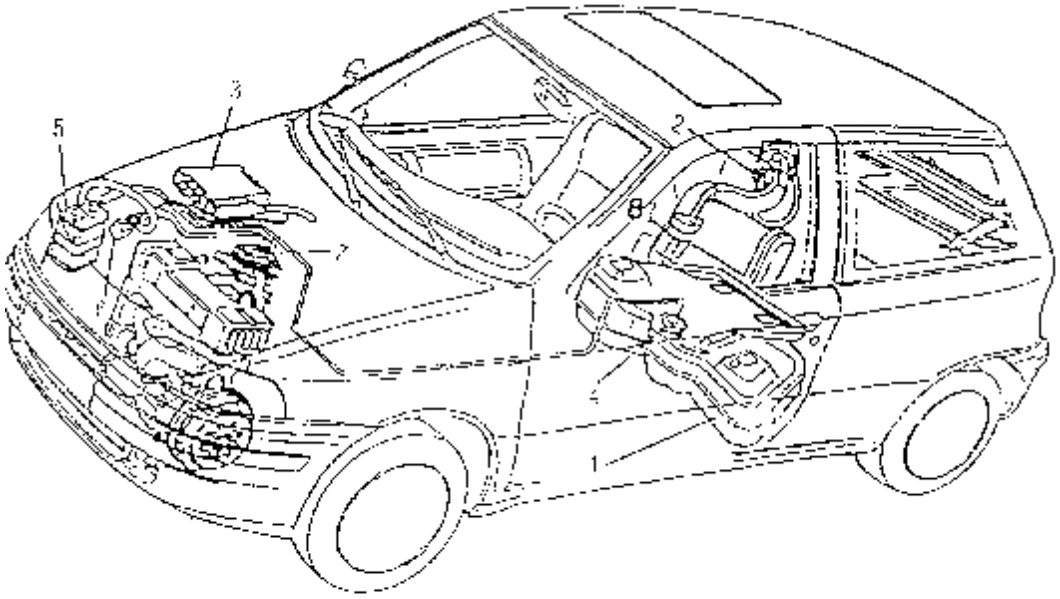


Fig.153 part position of anti-fuel vaporization system

1. fuel tank (with sealing fuel tank cap)
2. Two-way check valve
3. injection/ ignition (ECU)
4. Multi-function valve
5.charcoal canister(in the engine compartment)
6. fuel vapor recirculation solenoid
7.throttle valve body
8. Expansion chamber

the fuel tank ventilation style applied on the system is “close loop” type. It prevents the vapor coming from the fuel tank and fuel supply system from emitting into the atmosphere. thus the small quantity of carbon compound in the fuel vapor is prevented from emitting and polluting the atmosphere .

The operation during engine doesn’t run (figure. 154)

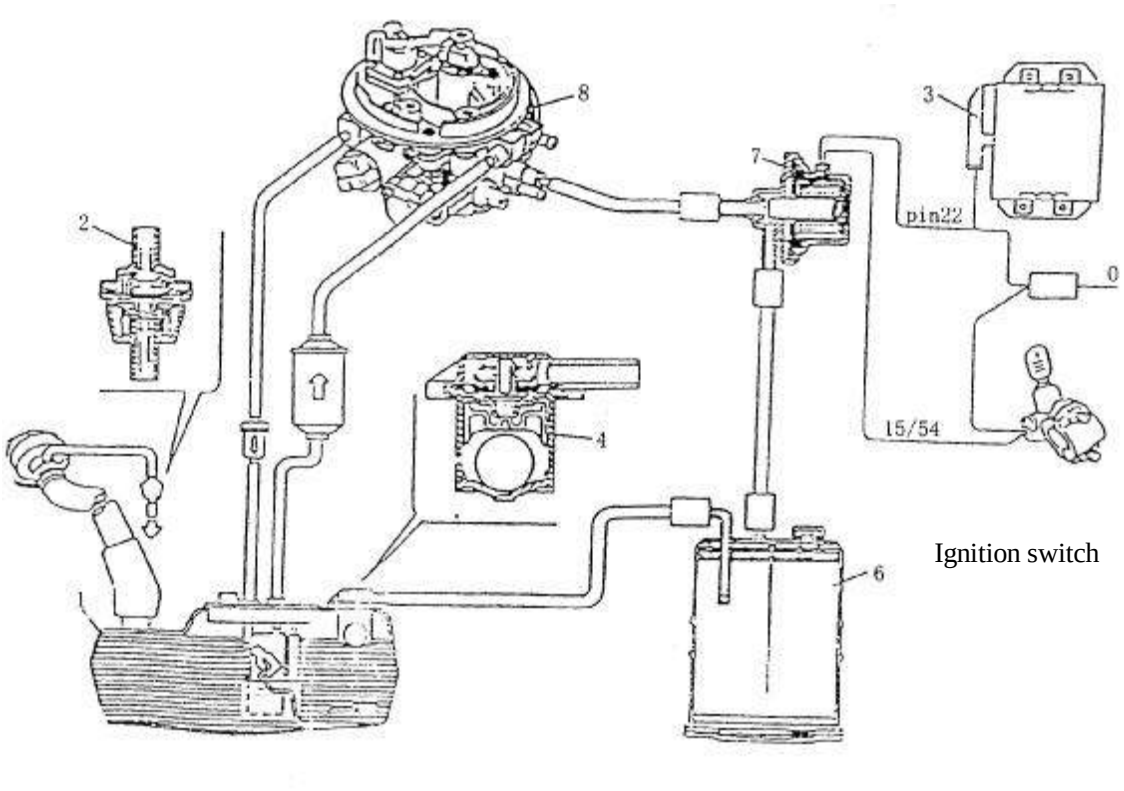


Fig. 154 principle drawing of anti-fuel vaporization system

1. fuel tank 2. Two-way check valve 3. fuel Injection pressure system
4.multi-function valve 6. charcoal canister
7. fuel vapor recirculation solenoid 8.throttle valve body

After long time since engine stopped, the temperature in the fuel tank will rise (Since the vehicle doesn't move, the dynamic ventilation is not enough.) and the pressure in the fuel tank will rise.

—— When the fuel tank is full, the multi-function valve 4 is closed. The fuel cannot flow into charcoal canister 6, therefore it doesn't damage charcoal canister.

If the pressure in the fuel tank (1) rises beyond the specified value, two-way check valve (2) will open reducing the pressure in the fuel tank.

If necessary, the valve may open reversely to vent inward when the fuel tank is vacuumed.

—When the fuel level is at middle or low , when it exceeds a specified pressure, the multi-function valve (4) will permit the fuel vapor to reach the charcoal canister (6) and be absorbed by the activated carbon granule.

The operation when engine is running (figure. 155)。

Solenoid (7) is powered on by ignition switch and is controlled by the injection system ECU directly by the following modes: When the valve is open, the vacuum in engine will suck the vapor collections in the charcoal canister into the lower part of throttle valve. When powered off, the valve will close to prevent the λ sensor from sucking the vapor when it doesn't work.

8 fuel vapor recirculation solenoid valve (condensing chamber EC1)

the fuel vapor recirculation solenoid valve is designed to regulate the vapor volume(from the charcoal canister) controlled by ECU. When the solenoid valve is deenergized ,the valve closes.

Its operation is controlled by ECU as following:

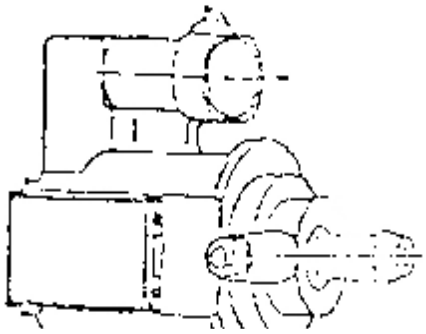


Fig.155 solenoid

图 155 电磁阀

• Under the starting condition , the solenoid keeps close preventing the fuel vapor from richening the mixture until the specified engine coolant temperature is reached.

•during engine's running, ECU sends a square wave signal to the solenoid. The signal is used to control the fuel vapor recirculation valve by energizing or deenergizing it. By this way, ECU controls the fuel vapor volume to intake manifold preventing the mixture density from changing dramatically.

• under a specified working condition：

—— the throttle valve is at idling position

—— speed is lower than the specified

—— the solenoid does not function When the intake pipe pressure is lower/ higher than the specified value, the solenoid remains close to improve the engine performance.

—— fuel cut-off switch

the switch is located in the right side of driver. It will cut off the fuel supply for the injection system by switching off the ground wire for fuel pump..

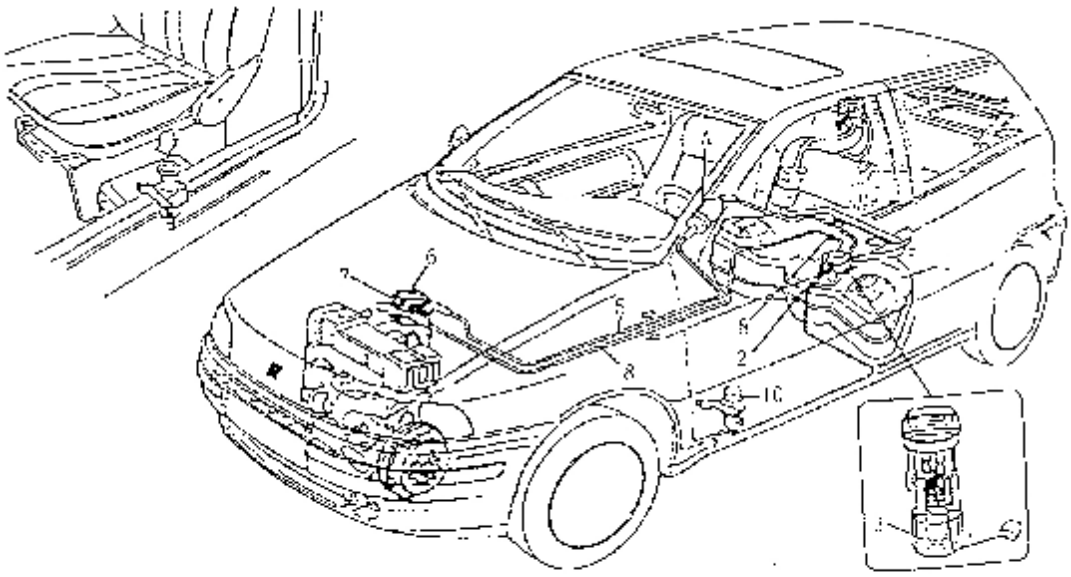


Fig.156

1.fuel tank 2.fuel pump (submerged in fuel tank) 3. Filter screen prefilter (installed in the inlet of fuel pump)
4.fuel filter 5.fuel delivery pipe 6.fuel injector(installed in the throttle valve)
7.pressure regulator 8.fuel return pipe
9.fuel recirculation check valve (stop backflowing) 10.fuel cut-off switch

working principle：

The steel ball ,which is installed in the cone seat, is generally locked by the neighboring magnet attraction. Under the specified accelerating load, the steel ball is released from the magnetism stillness and begins to move up the cone seat with the travel of the movement depending on the cone angle .

a quick-release mechanism exists on the top of the ball. the mechanism circuit is closed under the normal condition, . When the mechanism is stricken by the ball resulting in the position variation, it will vary from the closed circuit(NC) to the opened circuit(NO) and cut off the ground wire of fuel pump simultaneously.

For the impact from any direction of the three vertical directions, the switch will fuction under the condition of more than the peak value: 12g which is equivalent to the working condition of 25km/h or so.

The switch may be reset by pressing the reset button. The reset button is protected by a flexible cover (protecting the button from the influence from the external material and from the necessity of resetting).

Warning: Touching the surface lightly. If fuel is smelt or fuel system leaking is present, do not turn on the switch. The leaking area should be located first and recovered avoiding firing.

if leaking does not exist on the surface, it may be restarted. Press the button to restart the fuel pump.

Relay of system power supply

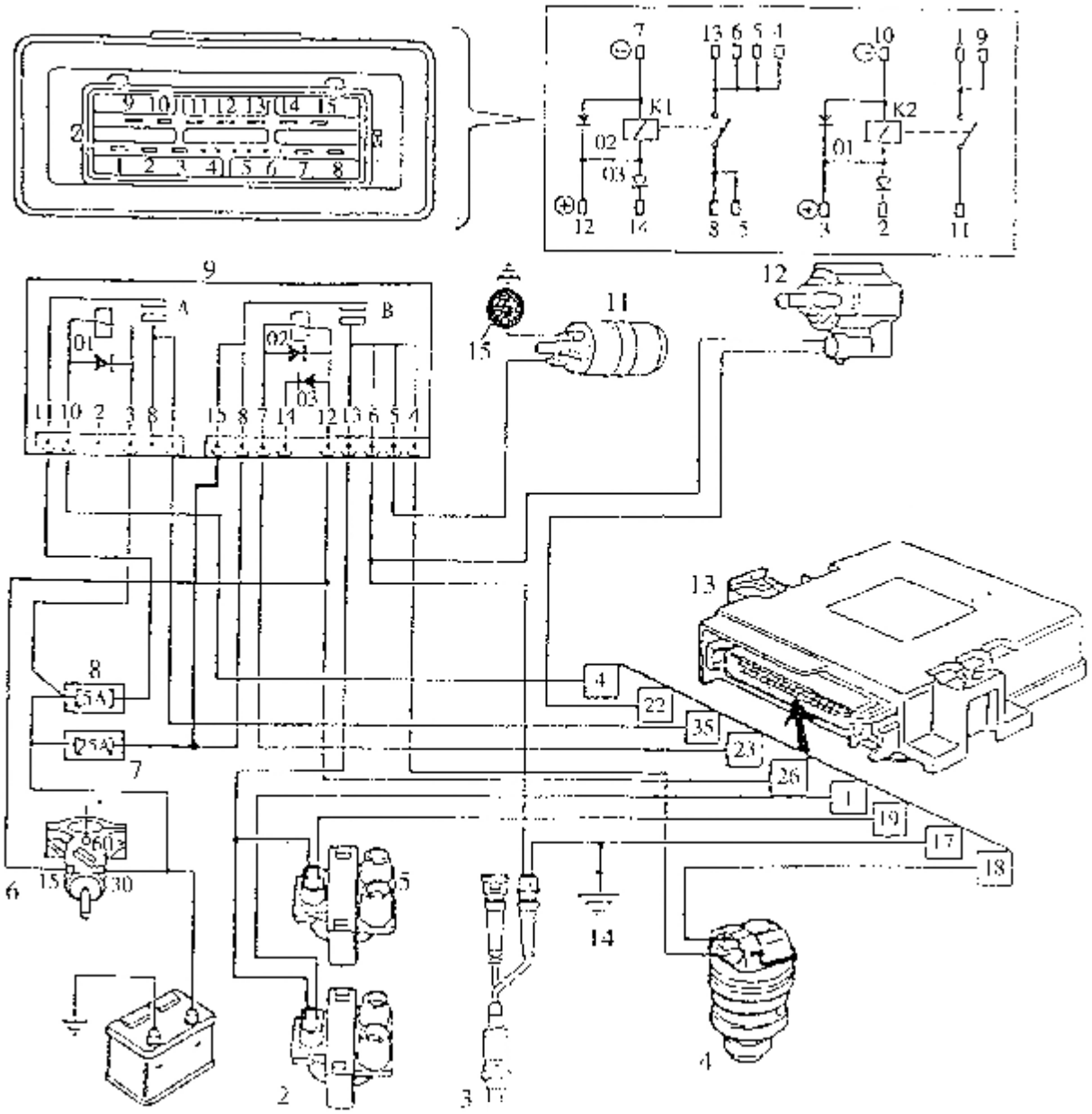


Fig.157

1. battery
3.1# ignition coil (cylinder 1、4)
3. λ sensor
4.fuel injector
5.2# ignition coil (cylinder 2、3)
6.ignition switch
7.25A system insurance
8.5A ECU fuse
9.dual relays (A—ECU，B—fuel pump)
11.fuel pump
12. fuel vapor recirculation solenoid
13.ECU
14.main ground wire of engine
15.fuel cut-off switch

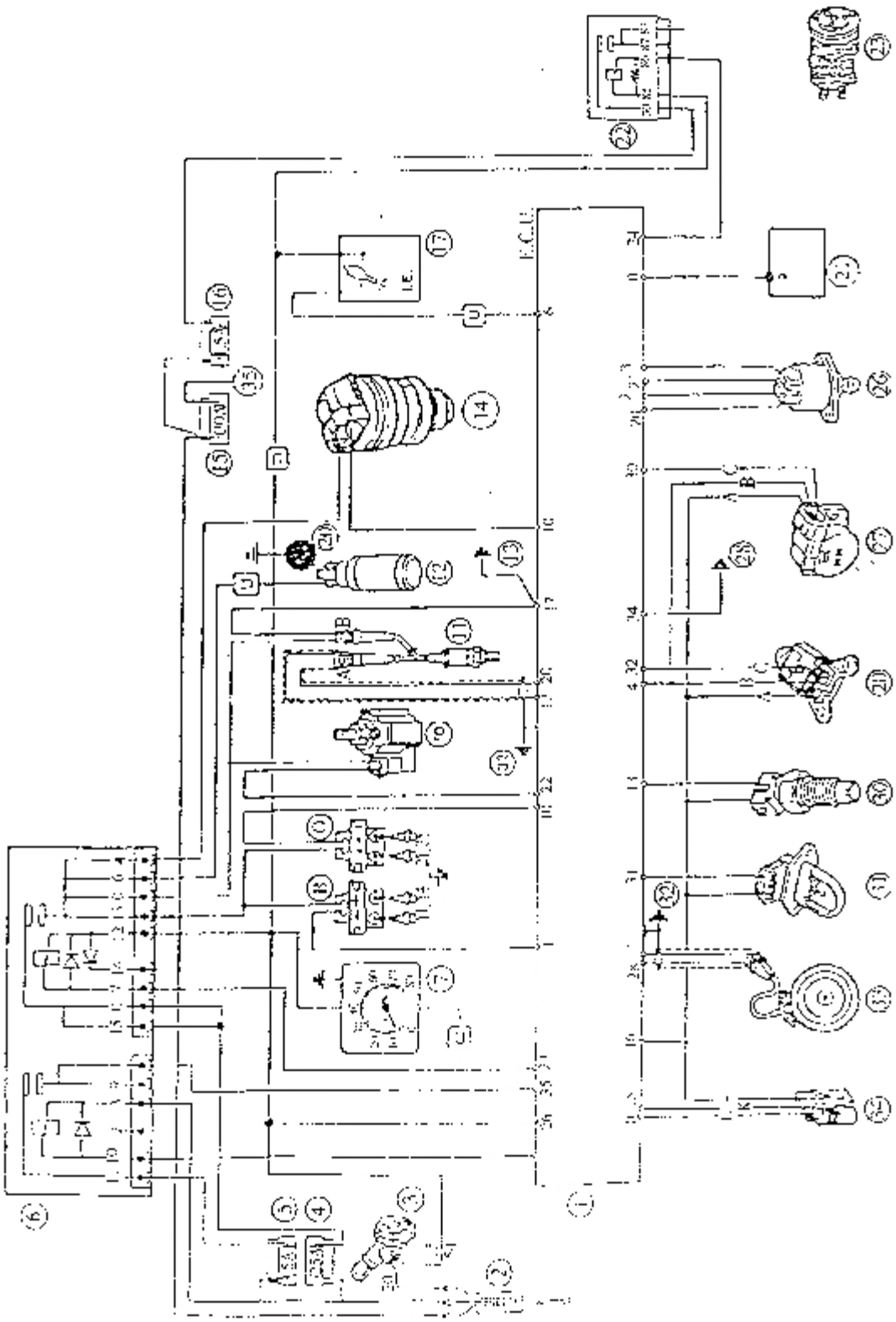


Fig. 158

3. circuit illustration

1.injection/ignition system ECU
2.battery
3.ignition switch
4.25A system fuse
5.5A ECU fuse
6.dual relays
7.revolution counter
8. ignition coil 1(cylinder 1、4)
9. ignition coil 2(cylinder 2、3)
recirculation solenoid
11. λ sensor
12.electric fuel pump
13.main ground wire of engine
14. fuel injector
15.30A A/C fan fuse
16.7.5AA/C fuse
17.injection system warning light (on the instrument panel)
20.fuel cut-off switch
21.A/C control unit
22.A/C compressor relay
23.A/C compressor
26.engine idling actuator
27.throttle valve position sensor
28.main ground wire of engine
29.absolute pressure sensor10. fuel vapor
30.water temperature sensor
31.intake air temperature sensor
32.ground wire for ECU block shield
33.speed/ TDC sensor
34.CHECK—UP1 diagnosis socket
35.A/C fan relay
U front cable junction box

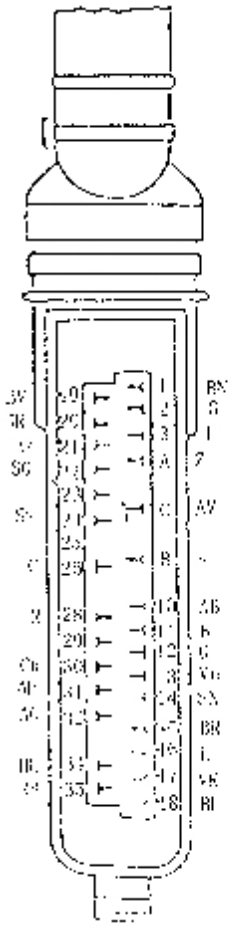


Fig. 159
35-way connection line

ECU I/0 function
1. primary signal for ignition coil
2.B phrase idling actuator signal
3.D phrase idling actuator signal
4.protect relay signal
5.without connection line
6.warning light energizing signal
7.without connection line
8.A/C input signal (see note)
9.without connection line
10.diagnosis socket L connection line
11.tacho sensor negative input
12. λ sensor negative input
13.water temperature sensor negative input
14. pressure sensor/throttle valve potentiometer 5A power supply
15. diagnosis socket K connection line
16.water temperature/air/pressure sensor and ground wire of throttle valve position sensor
17. main ground wire of engine
18.fuel injector signal
19. primary signal for ignition coil 2
20.A phrase idling speed actuator signal 21.C phrase idling speed actuator signal
22.fuel vapor solenoid signal
23.fuel pump relay/ speed counter signal
24.A/C relay signal (see note)
25.without connection line
26.ignition switch input (15/24)

27.without connection line
28.speed sensor positive input
29. λ sensor positive input
30.throttle valve potentiometer signal input
31.intake air temperature sensor signal input
32.absolute pressure sensor signal input
33.without connection line
34.main ground wire of engine
35.ignition switch +12V power supply input

A/C I/O may only be supplied to the vehicle equipped with A/C and the ECU of the corresponding engine, i.e. the vehicle of single-point injection with A/T.

4 . system service

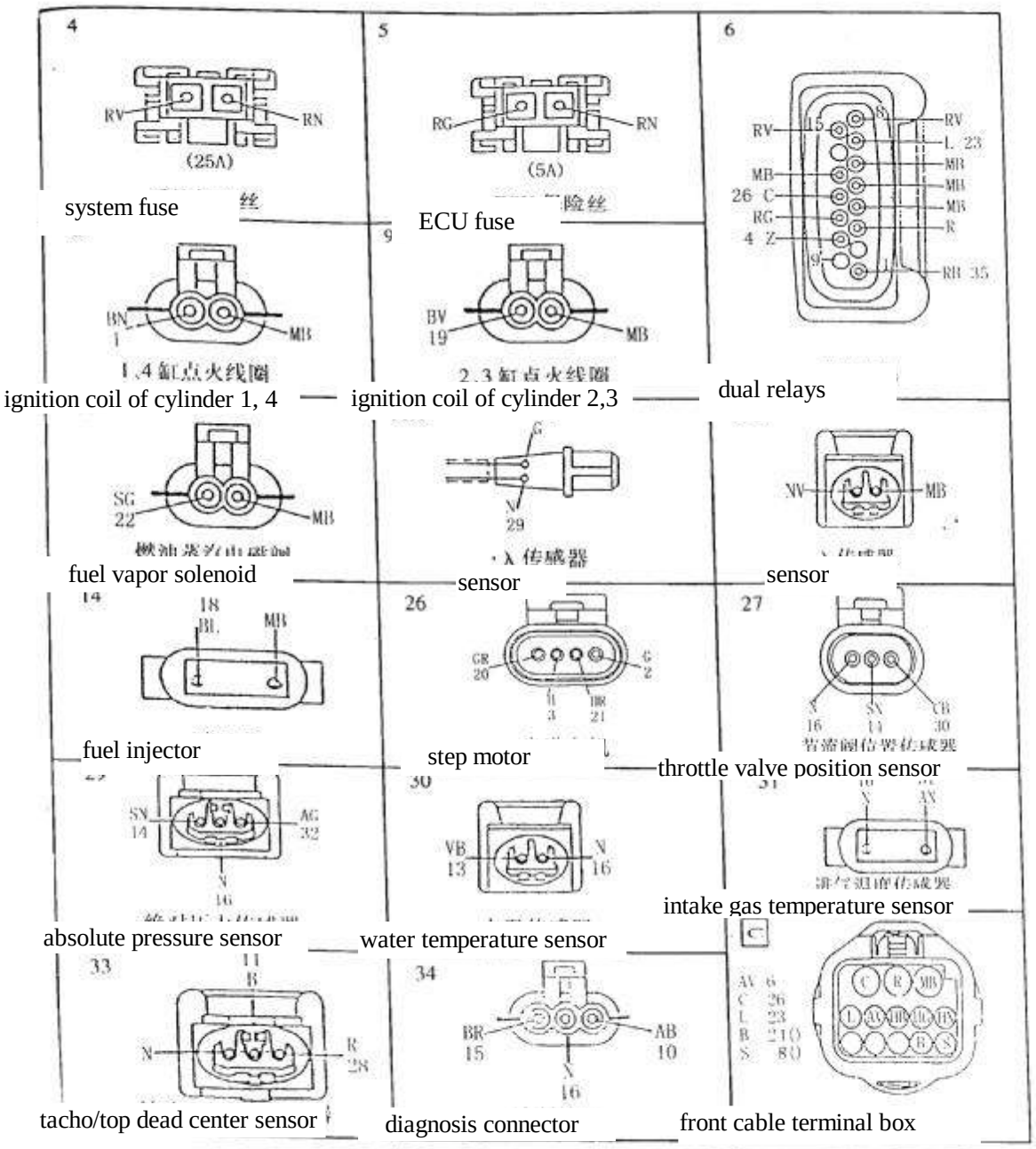


Fig.160 0

(*) A/C input and signal (if euipped)

Note：1) All connector are viewed from the intake side of the cable

2) Cable color and number indicates the 35-pin ECU connector connection of injection system

1. A. W. 6F the installation position in engine of single point injection/ ignition system

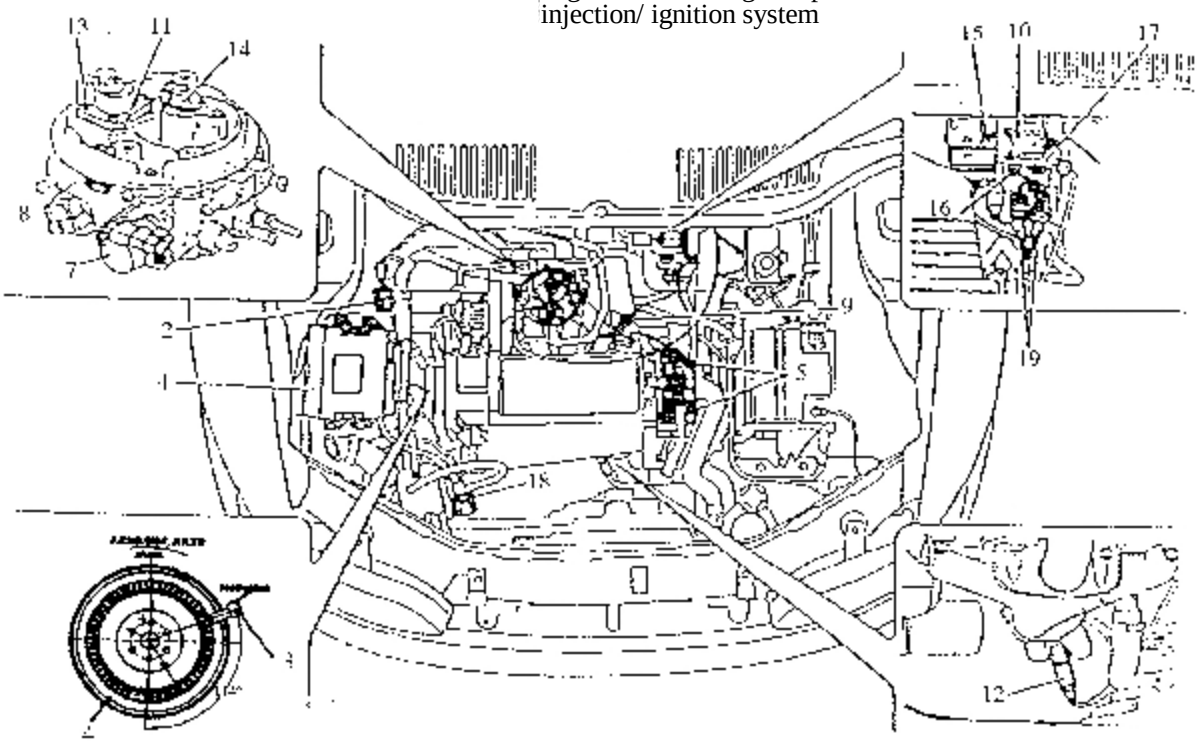


Fig. 161

1.injection/ignition ECU2 diagnosis passage
3.speed/ TDC sensor
4.engine flywheel
5.ignition coil with dual high-pressure connector
7.throttle valve position sensor
8.idling speed actuator
9.water temperature sensor
10.absolute pressure sensor
11.intake air temperature sensor
12. λ sensor
13.fuel pressure regulator
14.fuel injector
15.dual relays (for ECU and fuel pump)
16.25A injection/ ignition system fuse
17.5A ECU fuse
18. fuel vapor recirculation solenoid
19. λ sensor connector

self-diagnosis system:

the information is stored permanently, even when the power is cut off. the following self-diagnosis may be achieved:

——speed/ TDC sensor
——opened or shorted absolute pressure sensor circuit
——opened or shorted water temperature sensor circuit t
——opened or shorted intake air temperature sensor circuit
——opened or shorted throttle valve position sensor circuit
——faulted (malfunctional) actuator signal

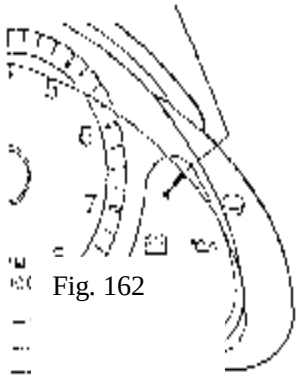


Fig. 162

——engine idling speed actuator doesn't work
——shorted fuel injector +12V circuit
——opened or shorted ignition coil circuit
also, monitor the following failure：
——with engine cycling start or engine working, signal wheel is not synchronous.
——opened or shorted λ sensor circuit
——opened fuel pump circuit

If a sensor failure(except the speed sensor/ TDC sensor) is indicated, ECU will substitute the preset value for the input data from the faulted sensor to keep engine operating. Also ECU will store the failure in the memory permanently. At the same time, the sensor will be kept out of the system until the sensor signal matches the signal from ECU again.

If the actuator or the corresponding signal channel fails, the above program is also applied.

When a failure is detected and the corresponding substitute value is applied, the warning light on the instrument panel will turn on.

Warning light will go out only when the component was replaced by the dealer or the failure is non long-term .

No matter whether the failure is long-term, the failure data will be stored permanently in the memory.

communicate with CHECK—UP1 actively

Fig. 163

Connecting CHECK—UP1 diagnosis tool to the system may fulfill the following operations:

——display the short-term or long-term malfunctions or parameters
—— active diagnosis：
—— fuel injector
—— fuel pump
——
ignition module
—— idling
speed actuator
I.A.W
system warning light
—— fuel
vapor recirculation solenoid

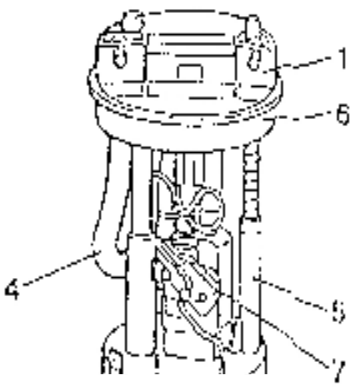


Fig.164

Removal and reinstallation for fuel pump:
Fuel pump is installed inside the fuel tank.
Removal procedure is as following:

—— switch off the power supply

—— remove quick release fuel

Outlet pipe and fuel return pipe

Remove and reinstall filter

—— loosen and remove the filter mounting bolt from the bracket

—— remove the sealing clip of fuel pipe from the filter

—— during operating, use an appropriate container to collect the fuel drained

The fuel filter must be replaced every 30,000km.

Note: The filter must not be installed reversely , it must be replaced even for the reverse installation of short time. The arrow on the case indicates the direction of fuel flow .

replace oxygen sensor or λ sensor:

—— remove the electric connections (1) and (2) from the λ sensor

—— remove λ sensor from the case

——during reassembling, grease should be applied on threads. antiseize boron nitrogen grease is recommended.

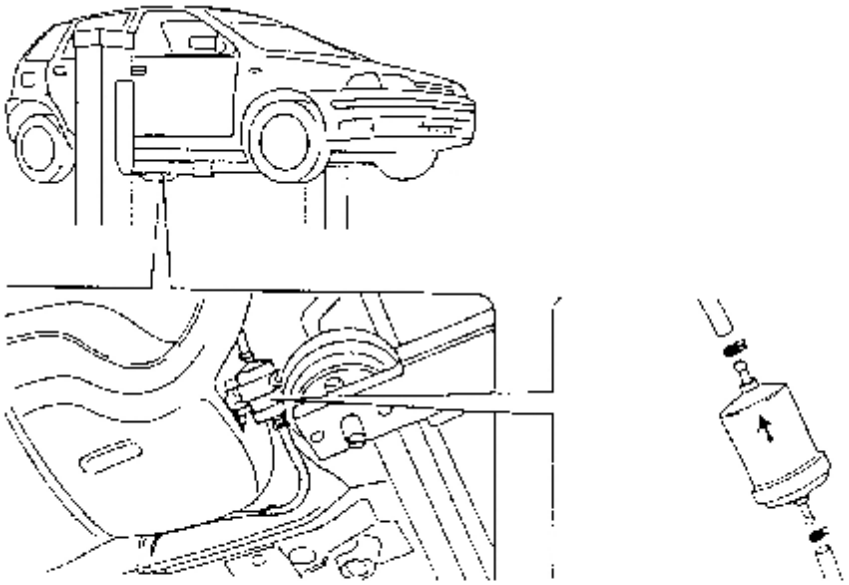


Fig. 165

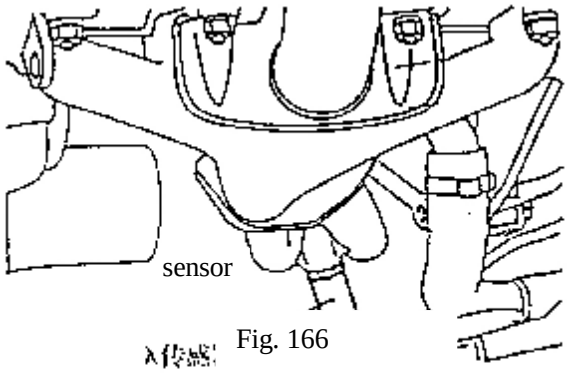


Fig. 166

图 166

tightening torque 0.5—0.6Nm

at ambient temperature, The resistance indicated by digital multimeter should be 2.5—4.5Ω.

Note: Even though little lead exists in the fuel, the sensor may fail soon. the function inspection is specified every 45,000km and 90,000km.

The throttle valve cable adjustment

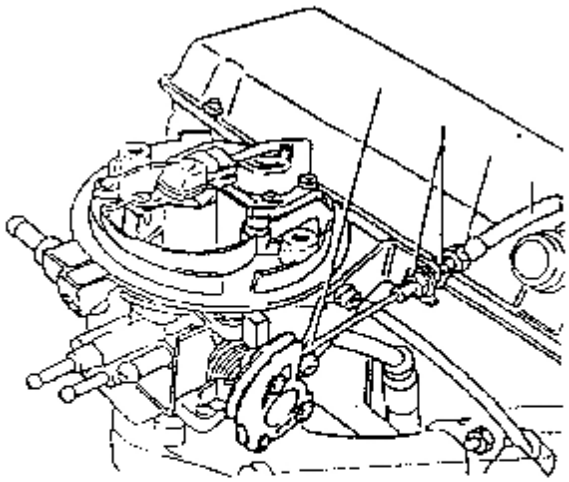


图 167

Adjust the throttle cable according to the following:

—— Loosen two lock nuts(2)，hexagonal lever(3) is retained in the protective sleeve

—— tighten or loosen hexagonal lever (3) to adjust the end position of protective boot (4) insuring the cable (1) is not too loose or too tight when pedal is released.

—— tighten the two lock nuts (2) in the hexagonal lever (3)

—— depress accelerator pedal fully. Check for throttle valve operation while it is fully open.

5.malfaction, cause and correction

Malfuction	cause	Correction
Vehicle cannot start	Fuel pump. fuel injector IVM523	check for operation by CHECK—UP1
	Tachometer senser.	Check wring, sensor resistance and installation of the sensor.
	Dual relays	Check for function, connector connection and blown fuse.
	35——pin connection	Check for the wiring connection to ECU.
Difficult to start; idling speed too high or too low	Engine idling speed control solenoid.	check for solenoid operation and 4—pin connection by CHECK—UP1.
warning light on During idling,	λ sensor	Check for the wiring, proper sensor tightening torque and the sensor heater's operation
warning light on for a long time	Diagnosis warning light	Check for the signal wiring grounding.
warning light doesn't turn on	Diagnosis warning light	The bulb is broken or circuit is open
Rough idling at high temperature.	Throttle valve sensor or water temperature sensor	the throttle valve opening angle and water temperature signal displayed by CHECK—UP1 should match the engine operation.
Rough idling at low temperature.	coolant temperature sensor or intake air temperature sensor	The temperature indicated should be in the vicinity of the ambient temperature.
Idle intermittent wave	1—throttle valve body 30MM4	1.check the throttle valve cable for proper adjustment, smooth movement. 2.if the throttle valve cable is correctly adjusted and may move smoothly, remove it. Check the throttle valve for resistance by turning it with a hand (for friction); 3.display the throttle valve position by CHECK—UP1. If both 1 and 2 are correct and engine speed is still high , while CHECK—UP1 displays "angle is greater than the allowable angle", then the malfunction is positively determined. It is necessary to replace the throttle valve potentiometer. If the angle is within the specified range, sensor wiring and connector should be checked.
Idling speed fluctuates continuously at high temperature.	1.throttle valve body 1.2 seal 1.3 vacuum connection	1. check the above item 1,2,3 for intermittent idling speed functions; 1.2 check the seal between cylinder head and throttle valve body; 1.3check the vacuum lines to the two vacuum passages, which are of absolute pressure. check the fuel vapor **recirculation** passages, which are connected to the throttle valve body and intake manifold. Check the vacuum tube sealing in intake manifold for brake servo .
Vehicle performance deteriorates	1—fuel supply system	1. Check for fuel supply. If fuel pressure is 1±0.1bar, it is ok; 2. If malfunction still remains after upper throttle body (30mm12) is replaced, with a pressure regulator in the upper throttle body, check fuel filter and fuel pipes.