

ENGINE MAIN MECHANICAL UNIT



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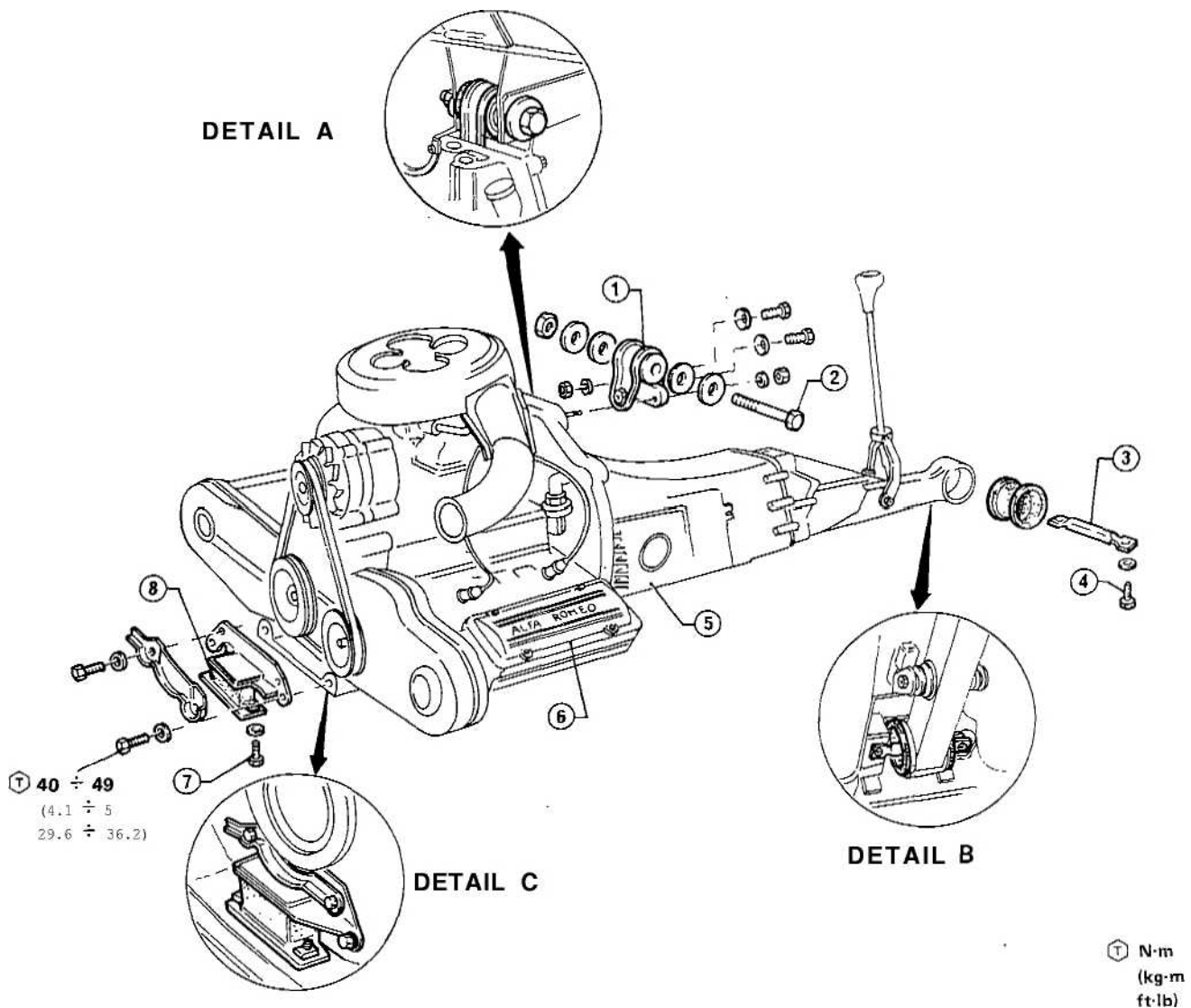
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01

DRIVE UNIT REMOVAL AND INSTALLATION

REMOVAL

Drive unit supports

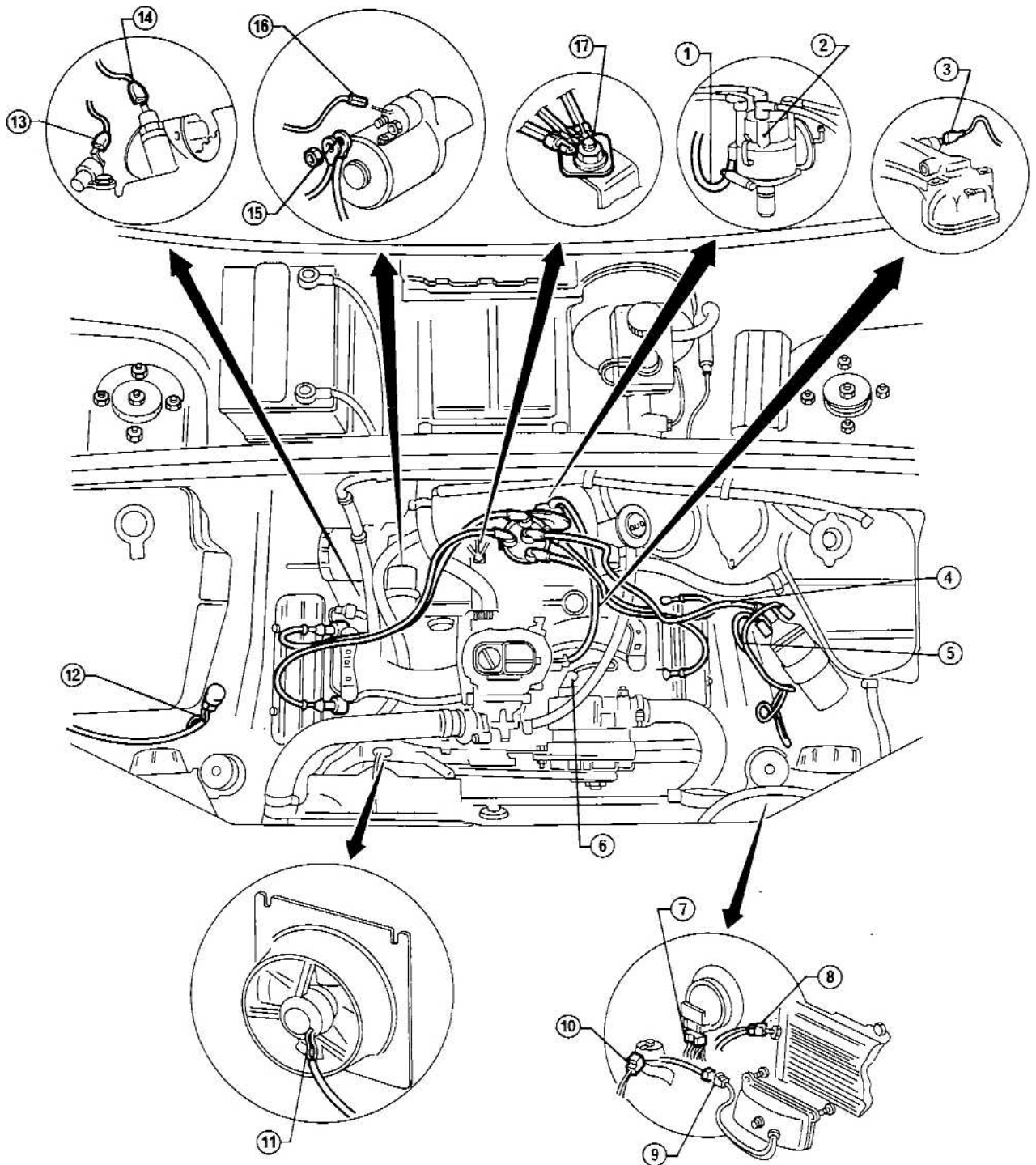


- 1 Drive unit central support
- 2 Central support to body fixing bolt
- 3 Rear support pin
- 4 Rear support to body fixing screws
- 5 Gearbox casing
- 6 Engine unit
- 7 Engine front support to crossmember fixing screw
- 8 Engine front support

Detail A Central support
 Detail B Rear support
 Detail C Front support

Ⓣ N-m
 (kg·m
 ft·lb)

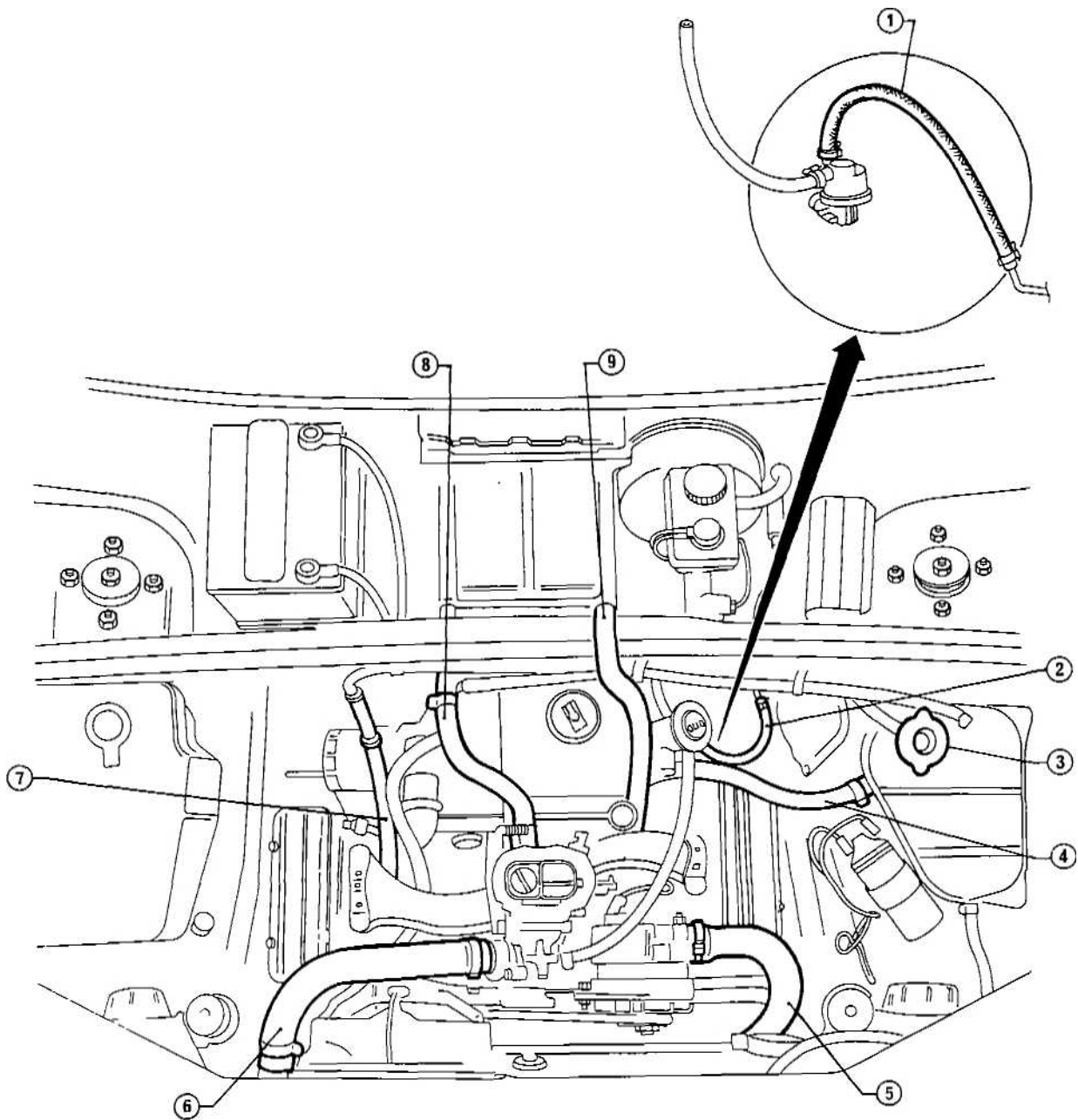
Engine compartment -Electric wires disconnections



- | | | | |
|---|--|----|--|
| 1 | Ignition inductor cable | 10 | Horn cables |
| 2 | Ignition distributor | 11 | Electric fan supply cable |
| 3 | Cooling temperature transmitter cable | 12 | Windshield and rear window washers pump cables |
| 4 | Coil high voltage cable | 13 | Water temperature thermal contact cable |
| 5 | Tachometer and coil low voltage cables | 14 | Oil pressure manual contact cable |
| 6 | Alternator and alternator warning light supply cable | 15 | Starter supply cables |
| 7 | Head lamps cables | 16 | Energization cable |
| 8 | Electric fan thermal switch cables | 17 | Earth cable on engine cover |
| 9 | Foglamps cables | | |

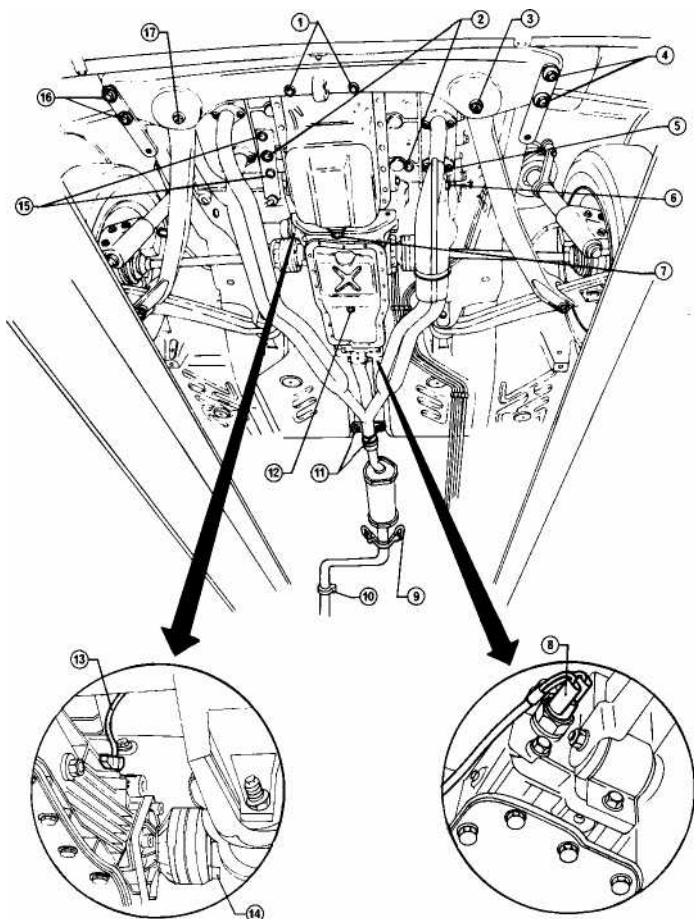
ENGINE MAIN MECHANICAL UNIT

Engine compartment -Piping release



- 1 Fuel pipe
- 2 Clutch oil supply pipe
- 3 Expansion tank plug
- 4 Air bleeder into crankcase
- 5 Sleeve for water return from radiator
- 6 Sleeve for water delivery to radiator
- 7 Servobrake vacuum pipe
- 8 Hot water to heater supply pipe
- 9 Heater water return pipe

Disconnections to be made from beneath the car



- 1 Engine front support to crossmember fixing screws
- 2 Coolant drain plugs
- 3 Cross member to left strut connecting bolt
- 4 Cross member to body fixing screws
- 5 Exhaust manifold flange nuts
- 6 Hot air intake bracket nut
- 7 Engine oil drain plug
- 8 Reverse light cable
- 9 Exhaust pipe support retaining rings

- 10 Exhaust pipe Clamp screw
- 11 Gear box rear support fixing screws
- 12 Gear box oil drain plug
- 13 Speedometer cable
- 14 Drive shaft screws
- 15 Bracket r..s
- 16 Cross member to body fixing screws
- 17 Moe jointing cross member - transverse link

During engine removal from car, it is necessary to remove engine and gearbox - differential as single unit.

Put the vehicle on the auto lift and engage first gear.

WARNING:

Great care is required when dealing with a hot engine.

1. Operating from passenger compartment inside withdraw knob of gearbox lever, then remove the two lever bellows.

2. Remove the hood (refer to: Group 56 - Hoods).

3. Working from inside the engine compartment, disconnect the battery earth cable.

4. Disassemble the air filter as follows:

(1) Disconnect the corrugated air intake pipes from the air filter by taking off the fixing clamps.

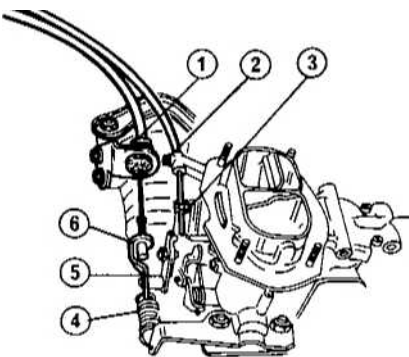
(2) Disconnect the blow-by pipes. Then remove the filter (Refer to: Group 04 Air Filter - Removal).

5. Disconnect accelerator and starter controls as follows:

(1) Extract the retaining ring $\text{\textcircled{R}}$, slip the return spring off its clamps and take off the slotted adjuster from the throttle control lever.

(2) Release accelerator cable together with bracket $\text{\textcircled{a}}$ unscrewing the two securing screws located on intake manifold.

(3) Disconnect hose and sheath of starter control of operating on sheath securing screw and on starter control lever screw



- | | |
|-----------|------------------|
| 1 Bracket | 4 Spring |
| 2 screw | 5 Retaining ring |
| 3 Screw | 6 Adjuster |

6. With reference to the figure on page 01-3 disconnect the following electric cables, preferably as indicated :

- earth cable from the engine rear cover
- high voltage cable , from the coil
- low voltage and tachometer cables from coil
- alternator and warning light supply cable , from the alternator
- water temperature thermal contact cable ~, from the thermal contact on the right hand head
- electric fan supply cable 11 , from the fan
- windshield and rear window washers pump cables from the pump
- starter motor supply 05 and energization 16 cables from the starter motor
- oil pressure switch cable 14 , from manual contact on the rear cover
- electric fan thermal contact cable , from the thermal contact on radiator
- fog lamp supply cables from fog lamp connectors
- head lamp supply cables from the headlamps
- horn supply cables , from the horns
- water temperature transmitter cable $\text{\textcircled{a}}$, from the transmitter on the intake manifold
- electronic ignition inductor cable $\text{\textcircled{O}}$, from distributor
- remove ignition distributor cap $\text{\textcircled{Q}}$ together with spark plug cables
- oil level sensor cable, from level rod (for models fitted with check control, only)

CAUTION:

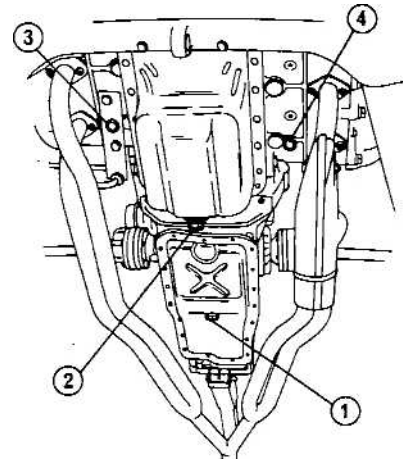
Unfix the electrical cables from their clamps, separate them from the drive unit so as not to impede its removal.

7. Unscrew and remove the coolant expansion tank plug.

8. Raise the car and from beneath remove the right hand drain plu and then the left hand drain plug under the cylinder block and drain off the coolant; screw the plugs again

after draining.

9. Depending on what is to be done, drain the oil from the oil sump by removing the plug $\text{\textcircled{O}}$ and, if necessary, drain the oil from the gearbox by removing the drain plug . Screw the plugs again after draining.

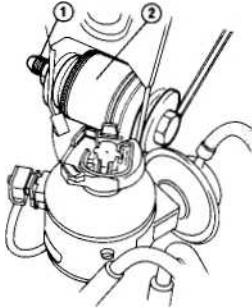


- 1 Gearbox oil drain plug
- 2 Engine oil drain plug
- 3 Right head coolant drain plug
- 4 Left head coolant drain Plug

10. Lower the vehicle and with reference to figure of page 01-4, disconnect the following pipes and couplings, preferably as indicated:

- hot water to heater delivery pipe , from the supply manifold
- water from heater return pipe , from the water pump intake
- delivery pipe $\text{\textcircled{R}}$ to block from the water pump intake
- water delivery coupling $\text{\textcircled{R}}$, to radiator
- radiator water return coupling , from the water pump intake
- fuel inlet line , from supply pump
- clutch oil delivery hose 20, from pipe union (properly plug the hose)
- servobrake vacuum intake pipe , from the suction manifold.

11. Loosen bolt securing engine central support to body.



1 Bolt 2 Central support

12. Raise the car and from beneath, with reference to figure of page 01-5, carry out the following removals:

(1) Disconnect revers lights cable 08.

(2) Disconnect speedometer wire 13 from gearbox casing by taking off the retaining ring.

(3) Remove securing nut ① of warm air intake support bracket to camshaft support rear cover.

(4) Disengage exhaust gas manifolds from the right and left head by unscrewing the nuts ②.

(5) Disconnect exhaust pipe on the car rear side by unscrewing the exhaust pipe end section connecting clamp screw 10, then remove it from flexible support.

(6) Unscrew screws 14 connecting right and left drive shafts, to right and left differential shafts, and disengage them.

(7) Unscrew the two engine anti-shake bar support bracket attachment screws 15 and position under the drive unit a column lifter fitted with a suitable supporting bracket to take part of the drive unit's weight.



(8) Loose and remove the two screws ③ fixing the engine front support to cross member,

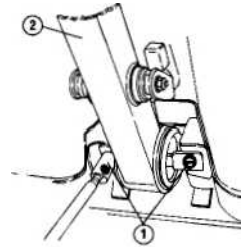
(9) Loose and remove the remaining screws ④ and 16 fixing the front cross member to the body, Loose the bolt 17 securing right strut to cross member.

(10) Unscrew and remove the bolt ⑤ connecting the front cross member to the left strut; then disengage the strut from the cross member.

(11) Swing the front cross member round as shown in the illustration to allow the drive unit to be taken out downwards.



(12) With reference to the following illustration. Unscrew and remove the two screws ⑥ fixing the drive unit rear support ⑦ to the body.

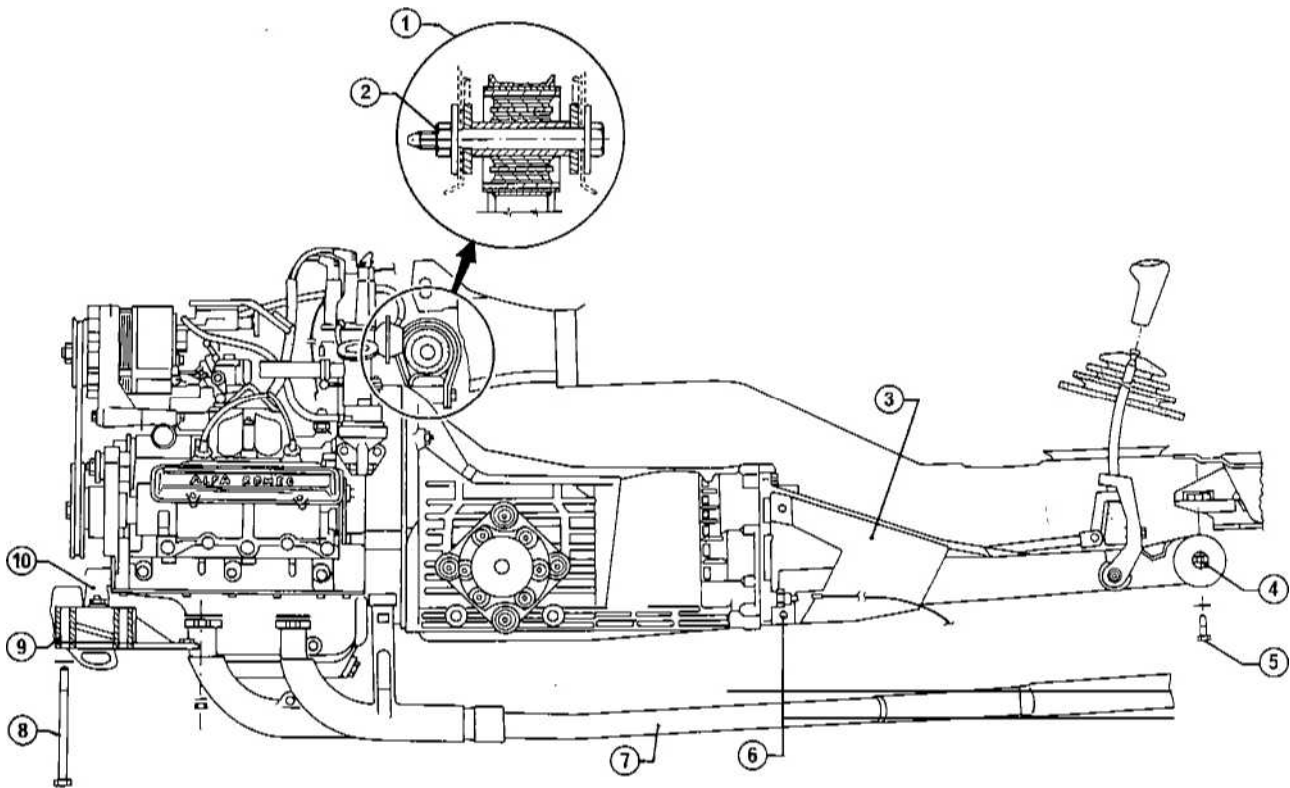


1 Screws 2 Rear support

(13) Remove bolt fixing engine central support to body, unloosened at step 11.

(14) Lower column lift and take the drive unit out from the engine compartment.

INSTALLATION



- | | |
|---------------------------------|--------------------------------------|
| 1 Central support | 6 Bolt securing gearbox rear support |
| 2 Central support securing bolt | 7 Exhaust pipe |
| 3 Rear support | 8 Engine cross member securing screw |
| 4 Pin | 9 Engine support cross member |
| 5 Rear support securing screw | 10 Front elastic support |

CAUTION:

Drive unit assembly must be performed in such a way that the gearbox rear support and the engine front support are not respectively upwards and longitudinally pre-loaded.

Referring to preceding illustration, follow as indicated.

1. Raise the drive unit with the column lifter used for disassembly until the centre support axis (D) is at about the halfway point of the body slot and tighten the relevant bolt-@.

Connect the left strut to the engine support cross member and fasten the cross member in position to the body with the screws a8

2. Fasten the front support in position to the cross member tightening the correct screws.

3. Remove the lifter and unloose the lower bolt © securing the gearbox to the rear support.

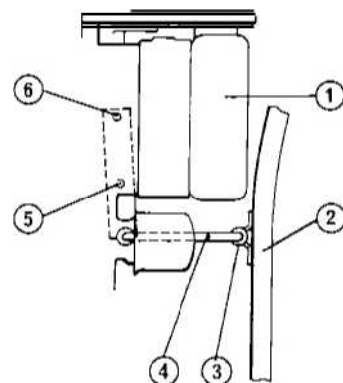
4. Put the rod in the rear support, positioning it on its body clamping points and screw up the screws 5.

5. Screw up the drive shafts to differential shafts joint screws in oil with the prescribed torque.

Tightening torque
Drive shafts to differential shafts connection screws
 33 - 36 N·m
 (3.4 = 3.7 kg·m
 24.58 : 26.75 ft·lb)

6. Assemble the exhaust pipe
 7. Clamp the lower bolt securing the rear support to the gearbox.
 8. With reference to the following

illustration put the side rod in the support on the right side rail then tighten, first, screw second, screw



- | | |
|-----------------------|------------|
| 1 Right cylinder head | 4 Side rod |
| 2 Right side rail | 5 Screw |
| 3 Support | 6 Screw |

9. Complete the unit assemble carrying out the disassembly operations in reverse order, with particular attention to the following steps.
 (1) By means of a spanner, tighten to the prescribed indicative torque, the union connecting hose to clutch control pipe.

O: Tightening indicative torque relevant to hose union to pipe.
 15 19 N•m
 (1.5 - 1.9 kg-m
 10.84 - 13.78 ft•lb)

(2) Check the engine oil level corresponds to the MAX mark on the dipstick, and the gearbox oil level reaches the lower edge of the filler hole. If necessary, top up with the

prescribed oil:
 Engine oil
 AGIP Sint 2000 10W50
 IP Super Motor Oil 10W50
 Gearbox oil differential:
 AGIPFI Rotra HP SAE 80W90
 IP Pontiax HD 80W90

(3) Bleed the clutch hydraulic system (See Unit 12 - Hydraulic System Bleeding) and if necessary top up the oil level to the MAX mark on the tank with the prescribed fluid (AGIP F1 Brake Fluid Super HD or IP Auto Fluid FR).
 (4) Top up the coolant with the prescribed liquid.

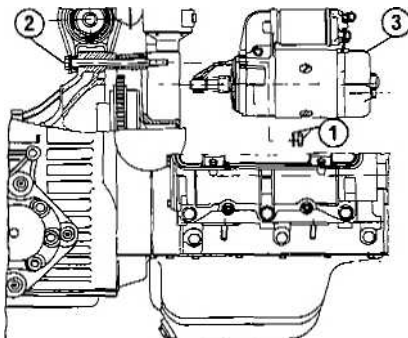
Summer
 Potable water
 Winter
 Antifreeze (See Unit 07 General Directives)
 (5) Adjust the accelerator cable (See Unit 04 Accelerator Wire Adjust-
 (6) With the engine at running heat, check its idling. For any tuning up required, see Unit 00 Engine Maintenance - Ignition and Feed System.

SEPARATION AND ASSEMBLY OF THE UNITS

SEPARATION

With the drive unit on the rotatory stand fitted with suitable supporting equipment, separate the engine unit from the gearbox unit for the purpose of replacement or overhaul of the two units and of the clutch, as follows:

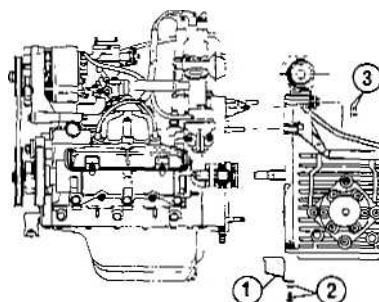
1. Unscrew and take off the nuts and washers from the starter motor securing screws and remove the starter motor from the engine unit.



1 Nut and washer 3 Starter motor
 2 Screw

2. Remove the lower cover protecting the engine flywheel after disassembling the screws and washers securing the lower cover to the engine rear cover and to the gearbox.
 3. Unscrew and remove the remaining nuts and washers and complete the separation of the two units.

Withdraw the thrust bearing from its support on the gearbox so as not to damage it.



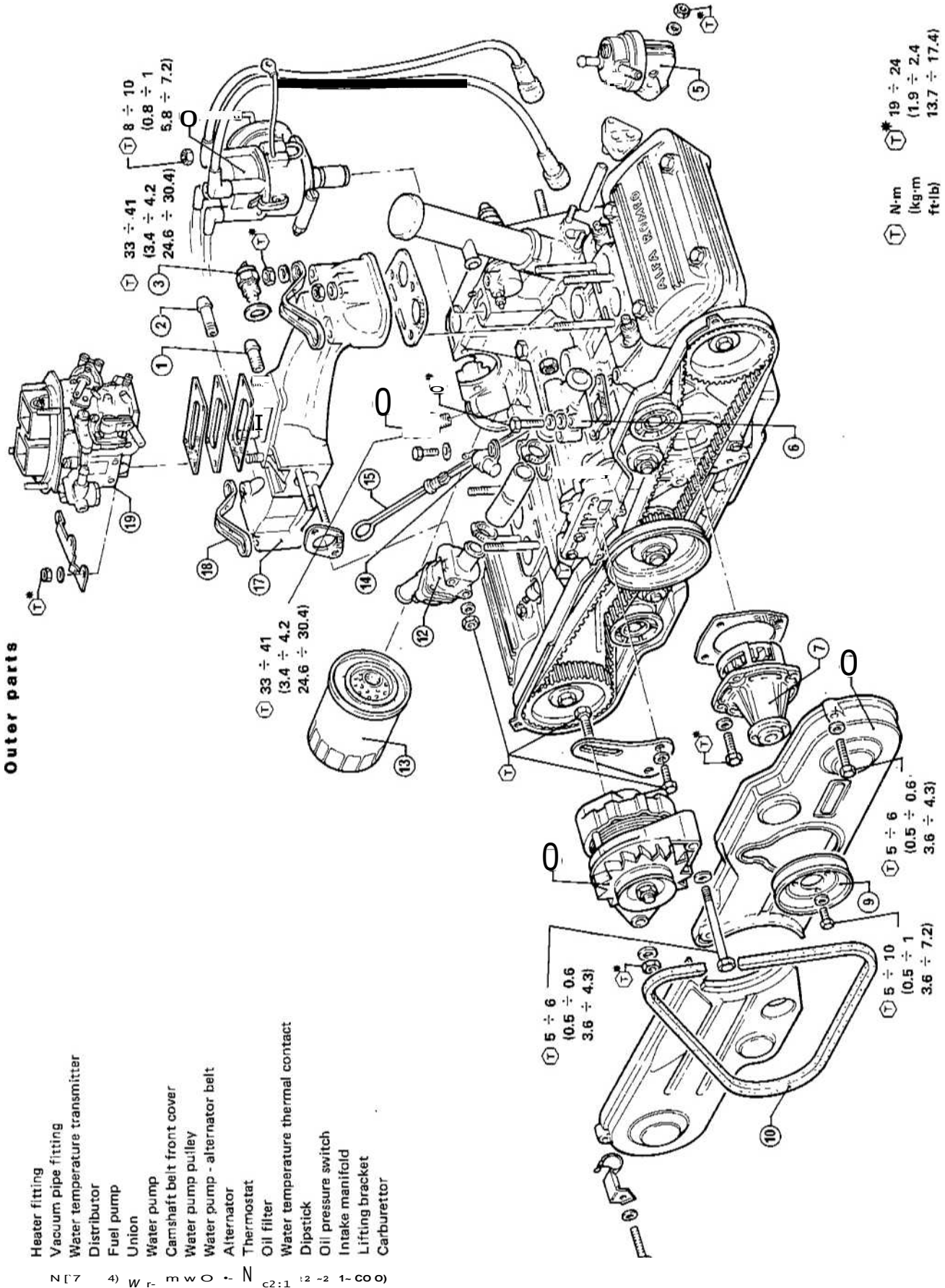
1 Lower cover 3 Nut and washer
 2 Screw and washer

ASSEMBLY

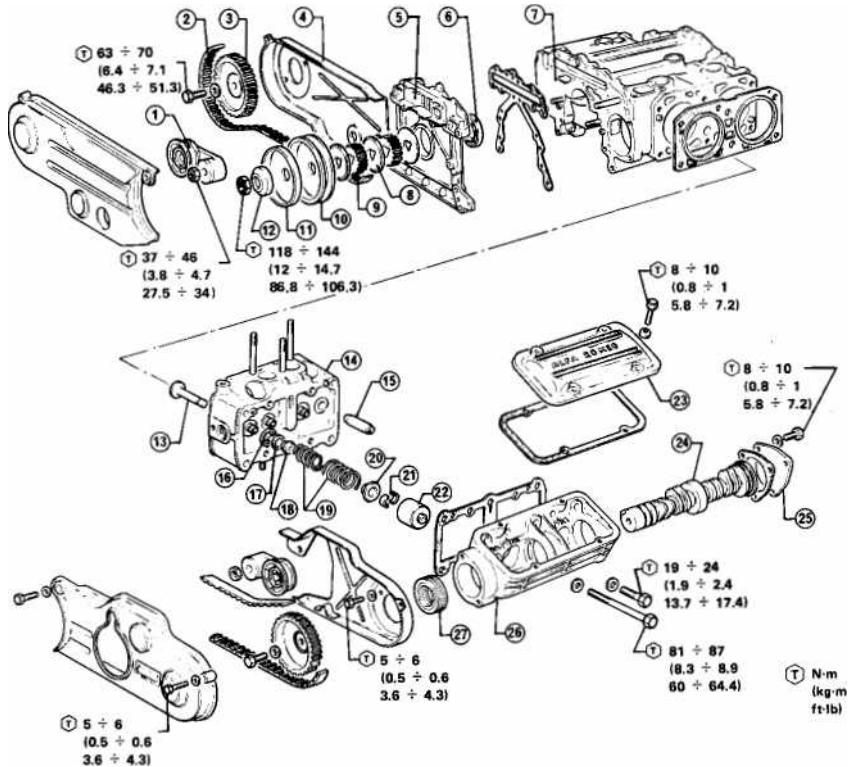
1. Lubricate the direct drive shaft working seat with the prescribed grease (Grease Molykote paste G).
 2. Perform assembly operations in the reverse order to the separation, tightening connecting nuts and bolts to the prescribed torque.

O: Tightening torque
 Nuts and bolts connecting the two units
 39 = 48 N•m
 (4 = 4.9 kg-m
 28.92 : 35.43 ft•lb)

ENGINE DISASSEMBLY



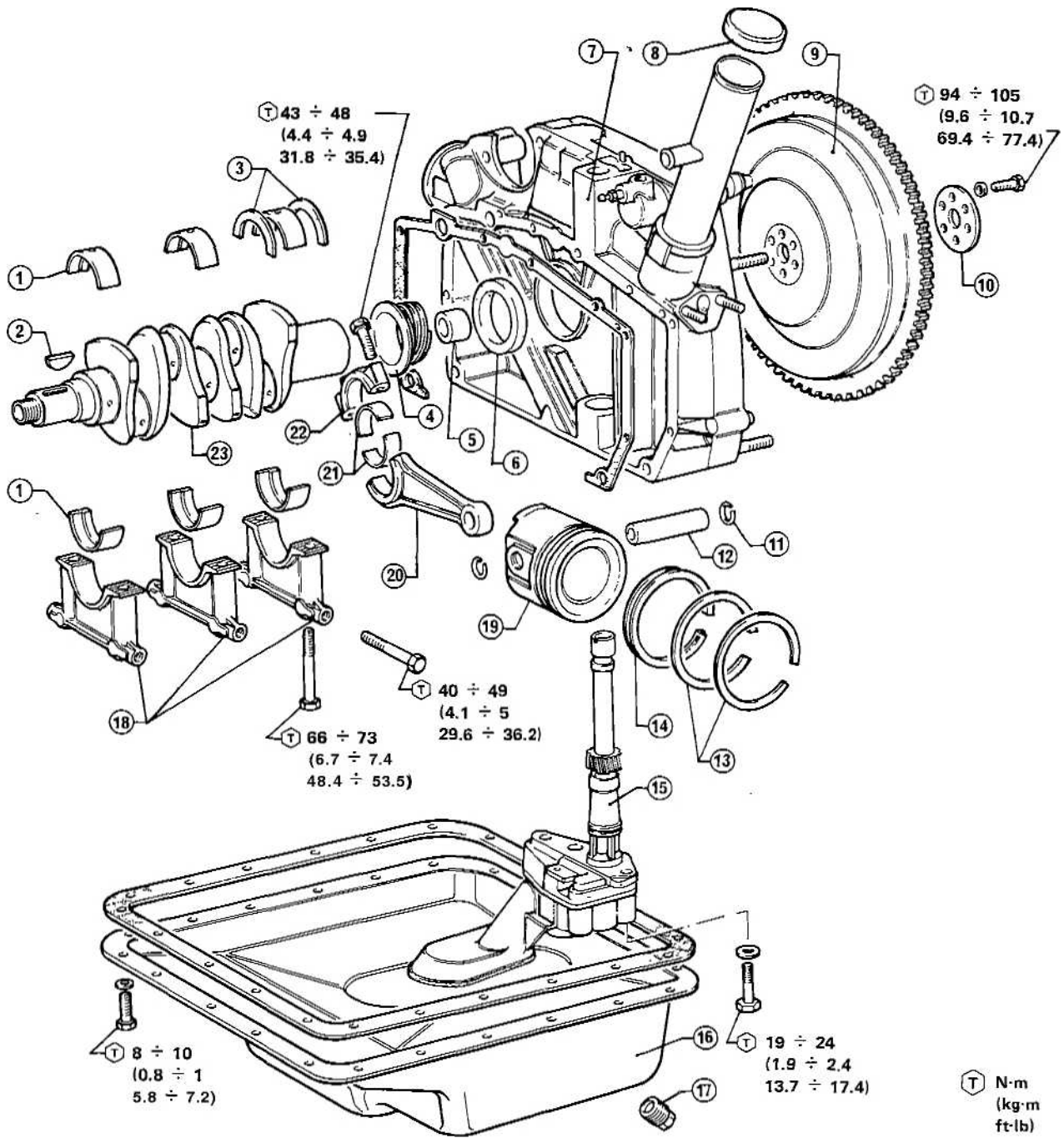
Internal parts



- | | | | |
|----|--------------------------|----|------------------|
| 1 | Jockey pulley | 15 | Valve guide |
| 2 | Camshaft belt | 16 | Lower spring wet |
| 3 | Pulley | 17 | Washer |
| 4 | Camshaft belt rear cover | 18 | Seal cap |
| 5 | Engine front cover | 19 | Springs |
| 6 | Seal ring | 20 | Spring seat |
| 7 | Block | 21 | Cotters |
| 8 | Spacer | 22 | Cup |
| 9 | Pulley | 23 | Cover |
| 10 | Pulley | 24 | Camshaft |
| 11 | Spacer | 25 | Cover |
| 12 | Washer | 26 | Camshaft support |
| 13 | Valve | 27 | Seal ring |
| 14 | Cylinder head | | |

T N-m
(kg-m
ft-lb)

Internal parts



- | | |
|--------------------|----------------------------|
| 1 Main bearings | 13 Compression rings |
| 2 Woodroff key | 14 Oil scraper ring |
| 3 Thrust half-ring | 15 Oil pump |
| 4 Oil pump gear | 16 Oil sump |
| 5 Bush | 17 Engine oil drain plug |
| 6 Seal ring | 18 Main bearing caps |
| 7 Rear cover | 19 Piston |
| 8 Oil plug | 20 Connecting rod |
| 9 Flywheel | 21 Connecting rod bearings |
| 10 Washer | 22 Connecting rod cap |
| 11 Lock ring | 23 Crankshaft |
| 12 Fin | |

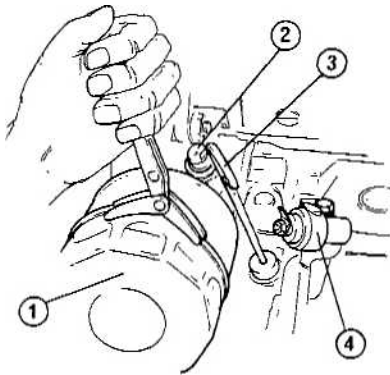
PRELIMINARIES

1. Remove drive unit from car according to procedures: Drive Unit Removal and Installation.
2. Remove gearbox unit and clutch unit from engine according to procedures: Separation and Assembly of the units.

ENGINE UNIT

1. Sequentially remove following parts:

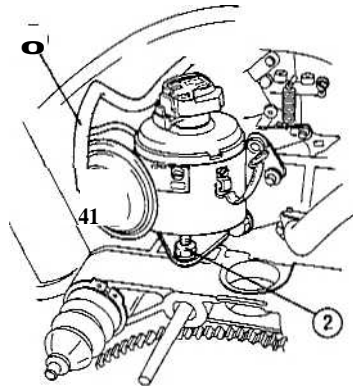
Oil filter using proper spanner
 Dipstick
 Pressure switch for minimum oil pressure check
 Thermal contact for water temperature check from right cylinder head.



1 Oil filter 3 Dipstick
 2 Pressure switch 4 Thermal contact

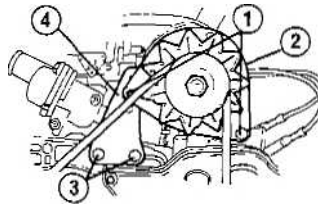
2. Remove sparking plugs using proper box spanner.

3. Remove distributor assembly.
 - (1) Disconnect vacuum advance pipe from carburettor.
 - (2) Loosen distributor securing nut and withdraw distributor from rear cover.



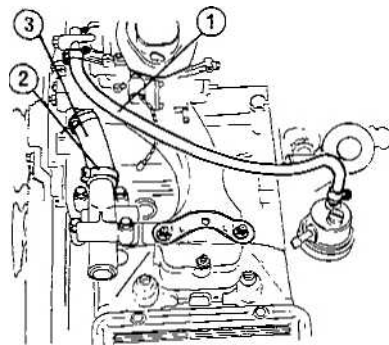
1 Vacuum advance pipe
 2 Distributor securing nut

4. Remove alternator.
 - (1) Loosen securing bolts fixing alternator and remove driving belt.
 - (2) Complete bolts removal and take out alternator
 - (3) Unscrews screws and remove bracket.



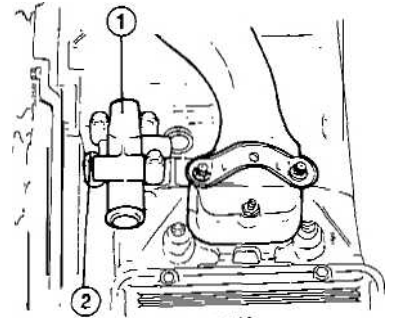
1 Bolts 3 Screws
 2 Alternator 4 Bracket

5. Remove pipings.
 - (1) Loosen screws of clamps and remove fuel supply pipe
 - (2) Loosen screws of water system coupling clamp and remove coupling.



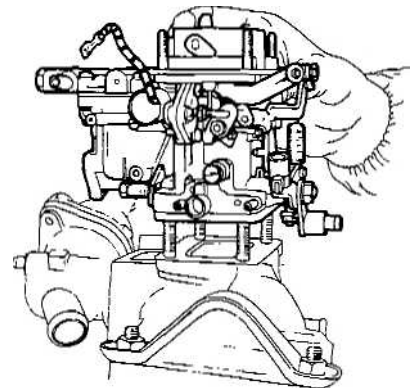
1 Fuel pipe 3 Coupling
 2 Clamp

6. Unscrew and remove screws fixing union to block, then remove the union.

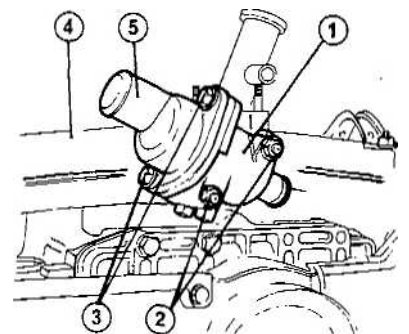


1 Pipe union 2 Screws

7. Remove carburettor
 - (1) Unscrew the four nuts with securing washers carburettor to intake manifold.
 - (2) Remove the accelerator cable return spring securing bracket, carburettor, relevant gaskets and spacer.



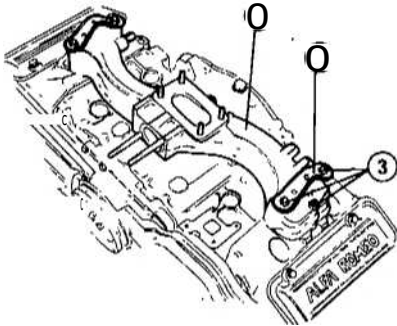
8. Remove thermostat
 - (1) Unscrew screws, remove cover g and thermostat.
 - (2) Unscrew nuts 2 and remove thermostat housing 1 from intake manifold



1 Thermostat housing 3 Screws
 2 Nuts 4 Intake manifold
 5 Cover

9. Remove intake manifold

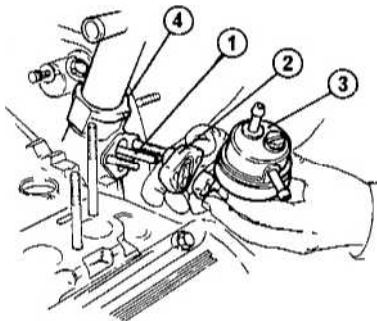
- (1) Unscrew nuts remove engine lifting bracket and manifold
- (2) Remove water temperature transmitter from intake manifold.



1 Intake manifold 3 Nuts
2 Bracket

10. Remove fuel pump assembly

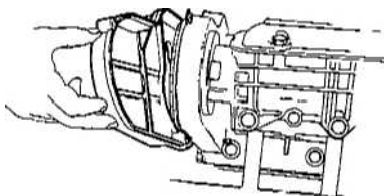
- (1) Unscrew nuts with washers securing fuel pump to block rear cover
- (2) Remove pump, spacer and pump control push rod



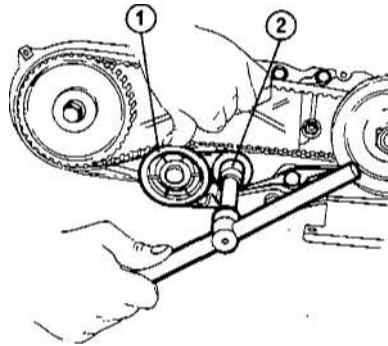
1 Push rod 3 Pump
2 Spacer 4 Cover

11. Remove camshaft driving toothed belts.

- (1) Loosen securing screws and remove two camshaft driving front belts guards.



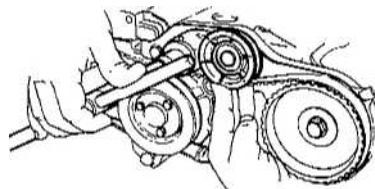
- (2) Unscrew right belt stretcher (2) securing nut and press on jockey pulley 11 to overcome belts tension load; lock nut by fixing belt stretcher in the "loose belt" position.



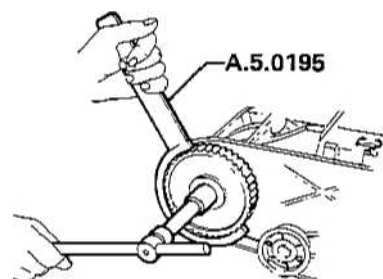
1 Jockey pulley 2 Belt stretcher

- (3) Withdraw belt from pulley on camshaft and on driving shaft, respectively.

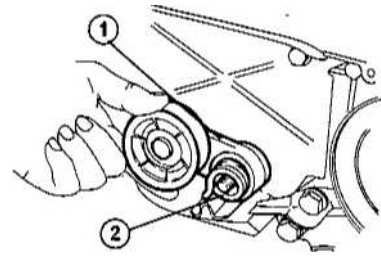
- (4) Repeat procedure for left head camshaft driving belt.



- 12. Unscrew screws securing pulleys to camshafts preventing their rotation by toothed spanner A.5.0195, then remove pulleys.



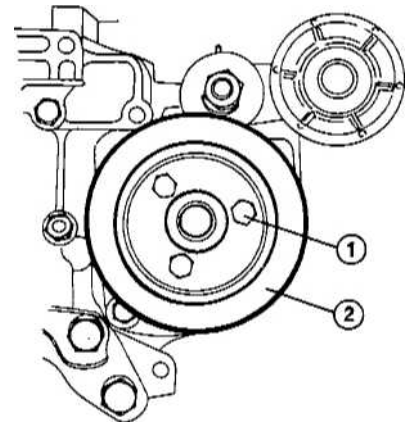
- 13. Unscrew securing nut and remove right belt stretcher and spring



1 Belt stretcher 2 Spring

14- Remove camshaft driving belts rear covers.

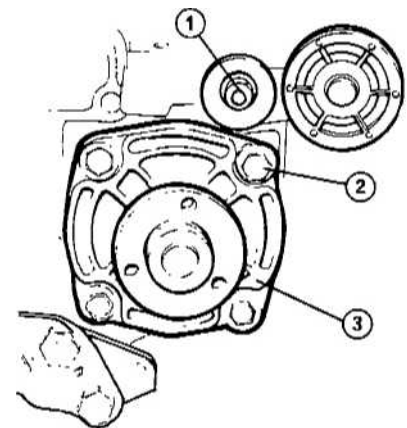
- 15. Remove water pump assembly. (1) Unscrew screws with washers securing water pump hub and remove pump driving pulley.



1 Screws 2 Pulley

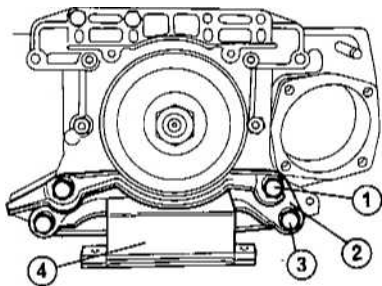
- (2) Unscrew screws securing water pump to block and remove pump with gasket.

- 16. Unscrew nut and remove right jockey pulley.



1 Nut 3 Water pump
2 screws

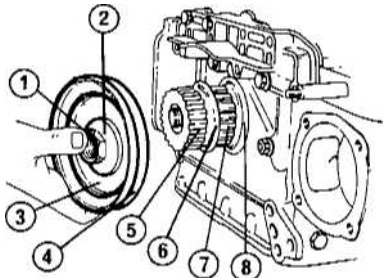
17. Lock flywheel by tool A.2.0378.
 18. Unscrew screws 0 and R, remove guard @ and engine front support 4 .



- 1 Screw 3 Screw
 2 Guard 4 Front support

19. Remove pulleys from crankshaft.

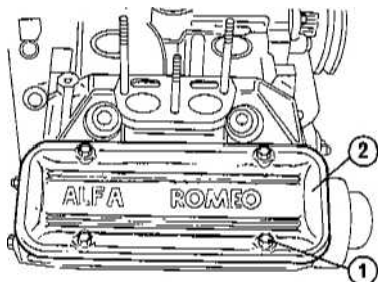
- (1) **Unscrew nut** 1a.
 (2) **Sequentially remove washer** 0 and spacer 1, water pump and alternator driving pulley R, right head camshaft drive toothed pulley 0, spacer 1 left head camshaft drive toothed pulley and pilot belt washer R.



- 1 Nut 5 Toothed pulley
 2 Washer 6 Spacer
 3 Spacer 7 Toothed pulley
 4 Pulley 8 Washer

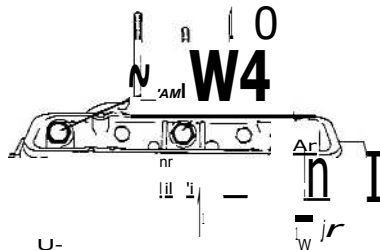
20. Remove flywheel locking tool, previously fitted.

21. Remove cylinder heads.
 (1) Unscrew screws R fixing covers R to camshaft supports; remove covers with relevant gaskets.



- 1 Screws 2 Cover

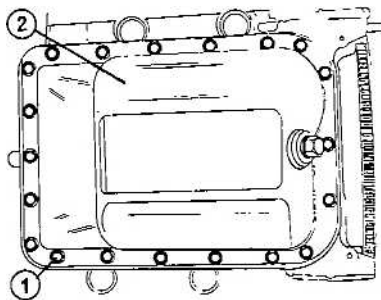
- (2) Suck oil from camshaft supports tanks with a suitable syringe.
 (3) Unscrew screws 0 and R securing cylinder heads to block; remove heads with relevant gaskets.



- 1 Screws 2 Screws

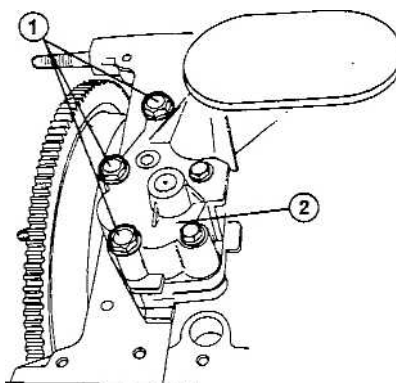
22. Remove oil sump.

- (1) Unscrew screws with washers 1 securing oil sump to block.
 (2) Remove oil sump and relevant seal gasket.
 (3) If required remove sealant marks on sump and block.



- 1 Screws 2 Oil sump

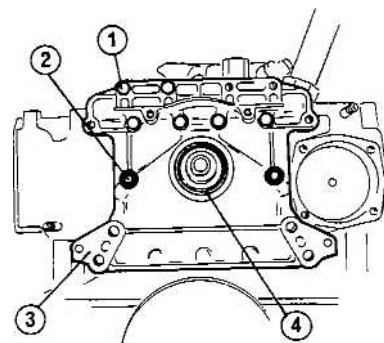
23. Remove oil sump assembly.
 (1) Unscrew screws with washers 1 securing oil pump R to block rear cover.



- 1 Screws 2 Oil pump

- (2) Withdraw upward pump from block.

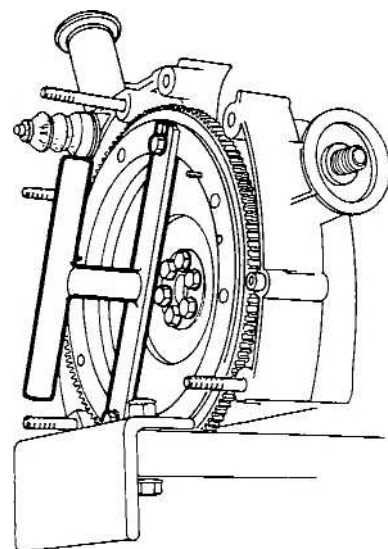
24. Remove block front cover.
 (1) Unscrew screws and nuts with washers securing cover and remove cover with relevant gasket.
 (2) Remove front oil retaining ring R from cover by lever with a screwdriver.
 Replace ring at assembly.



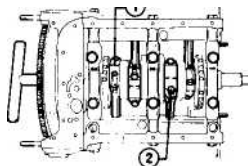
- 1 Screws 3 Block front cover
 2 Nuts 4 Oil retaining ring

25. Remove pistons and connecting rods.

- (1) Fit to flywheel a tool which allows crankshaft rotation.

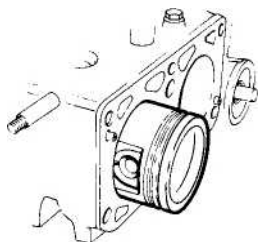


- (2) Turn crankshaft to permit access to screws securing connecting rod caps.
 (3) Unscrew and remove screws 0 and connecting rod caps 10.



- 1 Connecting rod caps
2 Screws

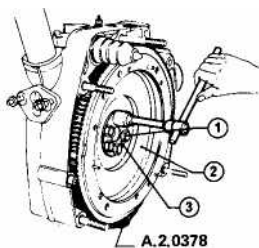
(4) Withdraw pistons together with connecting rods, from the side of the block.



(5) Remove connecting rod bearings from connecting rod big end and cap.



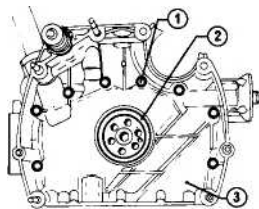
26. Remove flywheel.
(1) Remove tool previously, secured to flywheel which allowed rotation.
(2) Lock flywheel by tool A.2.0378.
(3) Unscrew screws 10 securing flywheel to crankshaft, remove securing lock washer 8 and flywheel (D).



- 1 Screws
2 Flywheel
3 Washer

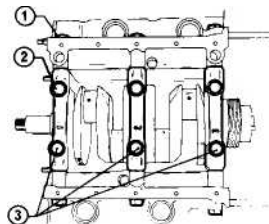
27. Remove block rear cover.
(1) Unscrew screws 0 with washers securing rear cover to block, remove cover 03 and relevant gasket.

(2) Withdraw crankshaft oil retaining ring 1 (from cover levering with a screwdriver. Replace ring at re-assembly.



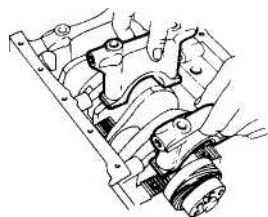
- 1 Screw
2 Oil retaining ring
3 Block rear cover

28. Remove crankshaft.
(1) Unscrew screws 0 securing main bearing caps 30 to block and then screws 02 with washers securing main bearing caps to relevant supports.

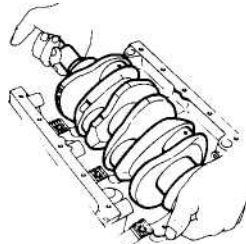


- 1 Screws
2 Screws
3 Main bearing caps

(2) Remove lower caps and lower main bearings.



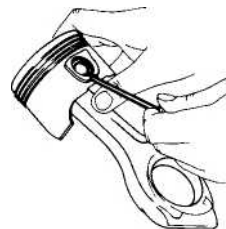
(3) Remove crankshaft from block and upper caps. Mark their position in case of reuse in assembly.



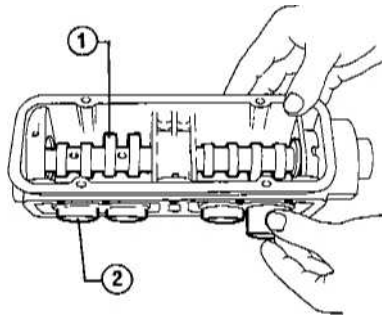
29. Remove thrust half-rings on third support (flywheel side).

PISTONS AND CONNECTING RODS

1 Withdraw two piston pin lock ring by a screwdriver.



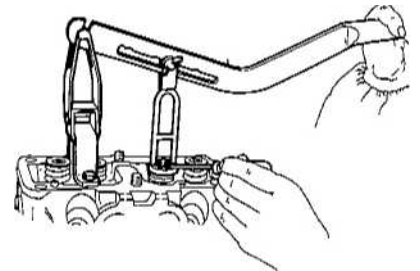
2. Withdraw piston pin.
3. Withdraw compression rings and oil scraper ring from piston.



1 Camshaft 2 cups

5. Withdraw front oil retaining ring from its seat on camshaft support using a screwdriver.

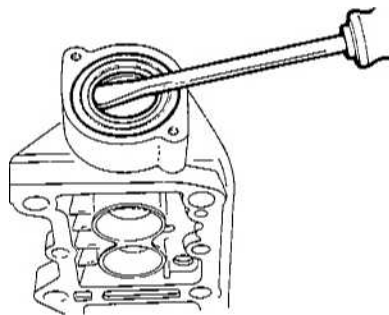
8. Acting on lever A.3.0324 compress springs and withdraw valve stem cotters using a screwdriver.
9. Sequentially remove upper caps, outer and inner springs, boots from intake valves, washers and lower cups.
10. Repeat removal procedure for each valve.



11. Withdraw yoke from head support tool and take out valves from head lower side.

CYLINDER HEADS

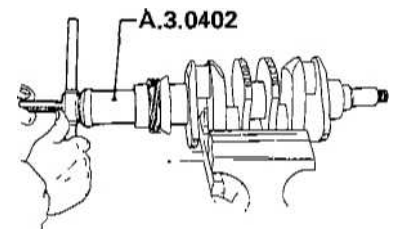
1. Secure head to support stand A.2.0195 connected to fork A.2.0226 previously clamped in a vice,
2. Unscrew screws 2 securing camshaft rear cover 3 to support 0; remove cover with seal gasket.
3. Loosen and remove screws 4 with washers fixing camshaft support to cylinder head; remove support with relevant gasket.



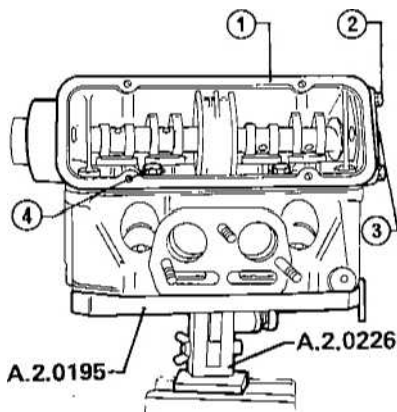
CRANKSHAFT

1. Clamp cranksaht in vice.
2. Secure puller A.3.0402 to shaft and withdraw rear guide bushing from crankshaft.

6. Fit tools A.3.0321, A.3.0324 and A.3.0103/6, used for valves removal, to head.
7. If not already done, insert valves retaining yoke 0 into cylinder head support tool A.2.0195.

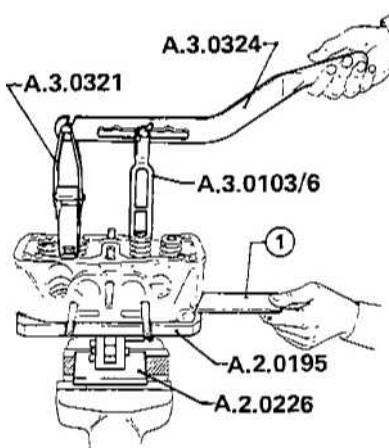


3. Withdraw oil pump and distributor control gear by using proper plate and press.

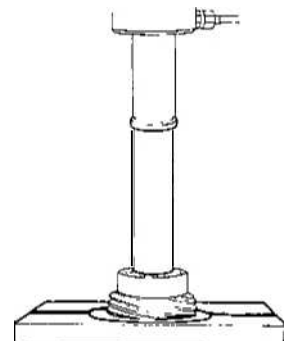


1 Support 2 Screws 3 Cover 4 Screws

4. Remove cups from housing on support, then camshaft with drawing from rear side.



1 Yoke

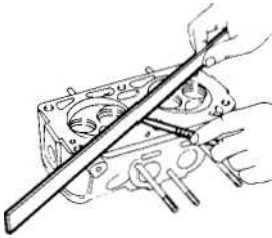


CHECKS AND INSPECTIONS

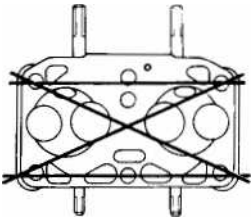
CYLINDER HEADS AND VALVES

INSPECTION OF CYLINDER HEAD LOWER SURFACE

1. Visually check the cylinder head for cracks or flaws.
2. Check flatness of the head lower surface.



positioning the tool as shown below.



Max. flatness error of cyl. head lower surface: 0.03 mm (0.0012 in)

If the head lower surface shows excessive warpage, then both heads will need grinding.

Head's min. height after grinding: 77.25 mm (3.0413 in)

Exceeding the specified allowed limit will cause severe malfunctioning of the engine.

3. Check the head lower surface for perfect smoothness.

Max. allowed roughness value
1.6 pm (6.29 - 10⁻³ in)

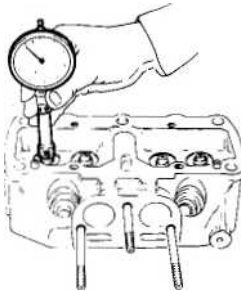
Max. allowed parallelism error
0.05 mm (1.968 - 10⁻³ in)

VALVE GUIDE

Measure the clearance between valve guide and valve stem.
If clearance exceeds the specified limit, replace worn parts.

Determining clearance

1. Measure the diameter of the valve stem with a micrometer in three places and in directions orthogonal to one another.
2. Measure the valve guide bore with adial gauge.



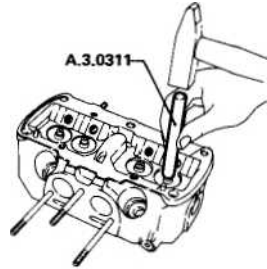
3. Compute the play by subtracting the maximum stem diameter reading from the valve guide bore value.

Max. allowed valve stem-to-guide play:

Intake: 0.07 mm (0.0027 in)
Exhaust: 0.09 mm (0.0035 in)

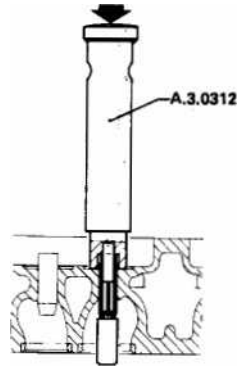
Replacement

1. Visually check valve guides making sure they do not show any scores or evidence of pitting; further ensure they are not deformed or out of their original assembly position.
2. If necessary, remove worn guides using tool A.3.0311.

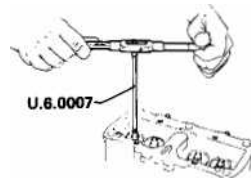


3. Fit new valve guides using tool A.3.0312.

The use of this special tool will ensure protruding of the guides above the lower cup's resting surface.



4. Ream valve guides using Reamer U.6.0007 in order to size the holes according to the specified diameter and then measure the valve guides bore.



Valve guide bore:
8.013 _ 8.031 mm
(0.3155 = 0.3162 in)

5. Afterward it will be necessary to slightly adjust the seats through

grinding, in order to ensure exact guide/seat perpendicularity as well as proper valve working position.

VALVE SEATS

1. Check valve seats for any scores, cracks or burrs and make sure they are properly fitted in their respective recess on the cylinder head.
2. If necessary, mount the head on tool A.2.0226 and regrind the valve seats using the proper tool.

This operation may be performed as long as there is sufficient grinding allowance that will permit eliminating the existing flaws while keeping the specified profile; contrarywise, valve seats will have to be replaced. For relevant procedure see paragraph: "Valve Seat Replacement".

(1) Regrind valve contact face till all evidence of wear has been removed and following taper is obtained :

$$0 = 90^\circ - 90^\circ 30'$$

of dimension "a" on the "0" reference diameter.

0 Reference diameter:

- Intake = 37.3 mm (1.4685 in)
- Exhaust = 31.9 mm (1.2559 in)

"a" dimension at max. regrinding limit:

$$2.9 \text{ mm (0.1142 in)}$$

(2) Machine the valve seat upper face still the 0 reference diameter position obtained through the previous operation is reached, attaining the specified α taper.

Taper of valve seat upper face
 $\alpha = 120^\circ$

(3) Machine the seat inner face till dimension "b" of the valve contact face is restored, attaining the specified γ taper.

Height of inner face:

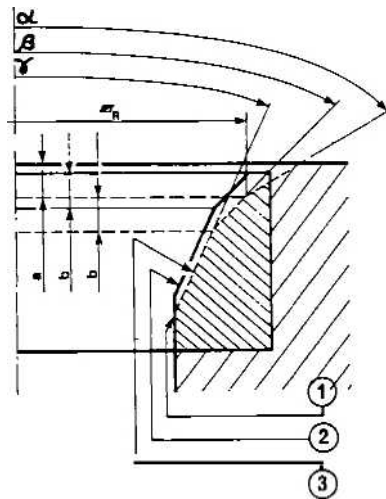
Intake: $b = 1.07 - 1.37 \text{ mm}$
 (0.0421 - 0.0539 in)

Exhaust: $b = 1.26 - 1.56 \text{ mm}$
 (0.0496 - 0.0614 in)

Taper of valve seat lower face:

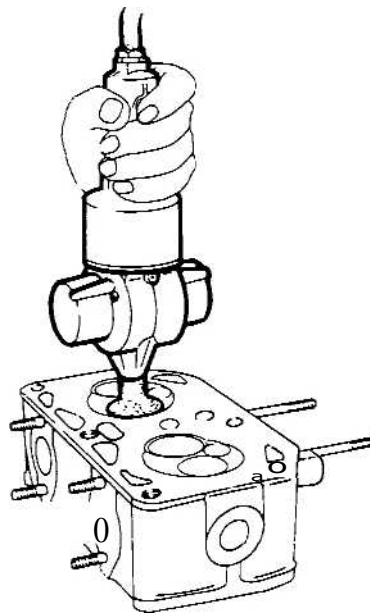
Intake: $\gamma = 50^\circ$

Exhaust: $\gamma = 30^\circ$



1 Valve seat 3 Profile after max. regrinding
 2 Original profile

(4) **Having completed all machining, lap valve seats with proper tool.**



For seat lapping use the proper lapping compound (SIPAL AREXONS Carbo-silicium for valves - Std. no. 4100-31502).

Valve seat replacement

1. Remove worn valve seats using the proper tool.
2. With a set of new valve seats verify that dimensions shown in the following table are complied with:

	Valve	Engine 1200 1350 1500
Valve seat outer diameter mm (in)	e.	38.875 - 38.9 (1.5305 - 1.5315)
		33.375 - 33.4 (1.3140 - 1.3150)
Diameter of valve Seat recess mm (in)	e.	38.8 - 38.825 (1.5276 - 1.5285)
		33.3 - 33.325 (1.3110 - 1.3120)

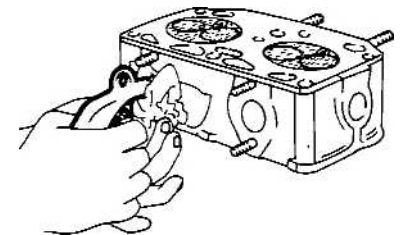
i. = intake valve
 e. = exhaust valve

3. Oven preheat the head at 140°C (284°F).
4. Fit new valve seats using the proper tool.

Checking valve tightness

When replacing guides, after regrinding and lapping of seats, it is advisable to test valve tightness - with valves and sparkplugs duly mounted - according to the following procedure:

1. Mount the head on tool A.2.0226 and A.2.0195 previously secured in a vice.
2. Fill the combustion chamber with gasoline.
3. Let some low-pressure air into the intake ducts and check for presence of air bubbles in the gasoline.



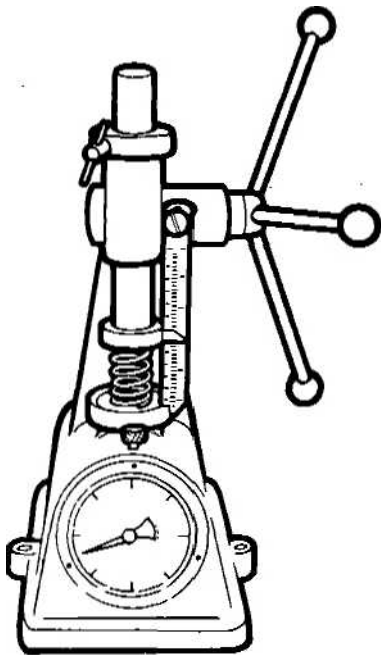
4. Follow the same procedure and check tightness of the exhaust valves by letting low pressure air into the exhaust valve ducts.
5. Should there be some leaks, ascertain that valves are properly fitted in their seats and then repeat above tightness tests; if the results are negative, valve seats will need relapping as indicated in paragraph: Checks and Inspections - Cylinder Heads and Valves - 'Valve Seats.

SPRINGS

Visually check the springs for cracks and make sure they are not out-of-square if the evidenced flaws suggest it, check the technical data of the inner and outer springs and then with a dynamometer verify that their length under load falls within the values shown in the following table:

Spring	Engine		
	1200	1350	1500
Load N (kg ; lb)	0.	425.32 - 452.76 (43.4 - 46.2 ; 95.68 - 101.85)	
		194.53 ; 208.25 (19.85=21.25 ; 43.76 - 46.85)	
Length under load mm (in)	0.	25.25 (0.9941)	
		23.25 (0.9153)	

o. = outer spring
i. = inner spring



CUPS

Check that the outer surface of the cups as well as the upper surface on which cams work, show no scores, no evidence of pitting or abnormal wear. Further verify that- calking of the

cup's nut is intact and that the cup has retained its original punching position.

CAUTION:

Do not remove the valve clearance adjusting screw from the cup.

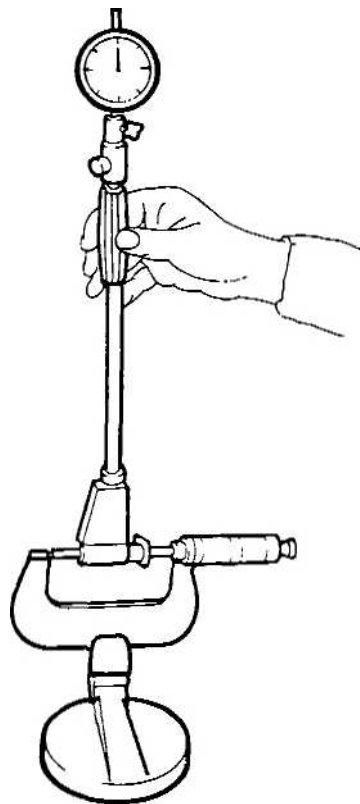
VALVES

Check and make sure that valves do not show any scores, burns or evidence of sticking with their corresponding cylinder head seats (forming a step); if they do, replace them.

CAMSHAFT SUPPORT

1. Visually check the seats of camshaft cups and journals for scores and for any evidence of pitting or abnormal wear.

(1) Reset reamer to testing dimension.



(2) Measure the diameter of camshaft bearings.



Diameter of camshaft bearings

Front = 35.015 = 35.040 mm

(1.3785 = 1.3795 in)

Centre = 46.500 46.525 mm

(1.8307 = 1.6317 in)

Rear = 47.000 - 47.025 mm

(1.8504 - 1.8514 in)

(3) Following the same procedure, measure the diameter of the four cup seats and determine the relevant fitting play.

Diameter of cup seats

36.00 = 36.025 m m

(1.4173 : 1.4183 in)

Max. cup-to-seat play

0.1 mm (0.0039 in)

CAMSHAFT

1. Carefully examine working surfaces of cams and of camshaft journals making sure that there are no scores, no evidence of seizure, overheating or abnormal wear.

2. With a micrometer measure the diameter of camshaft journals.

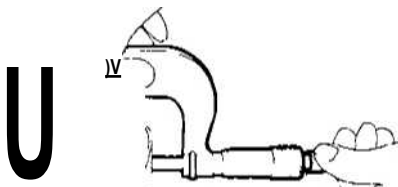
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MAIN AND CONNECTING ROD BEARINGS

Thoroughly clean the main and connecting rod bearings and visually check them for scores as well as for any evidence of seizure.

In case of excess wear, replace all bearings. When fitting connecting rod bearings to the crankshaft, be sure to use matching parts, i.e. belonging to the same size class; for this purpose they are identified by same colour dots on the side of the half-bearing and on the relevant crank pin of the shaft. Applicable dimensions and tolerances are shown in: Service Data and Specifications "Connecting rod bearings" and "Main bearings" charts.

micrometer. For relevant dimensions and tolerances see: Service Data and Specifications - "Piston" chart.



4. In case the connecting rod piston assembly has been disassembled, check the piston pin seats on the connecting rod small end as well as on the piston pin bosses for excess wear.

5. Should parts not be replaced and therefore used again, remember that working surfaces - especially that of the piston pin seat on the piston - must be totally free of any scores, even the slightest one.

The piston pin must always be replaced.

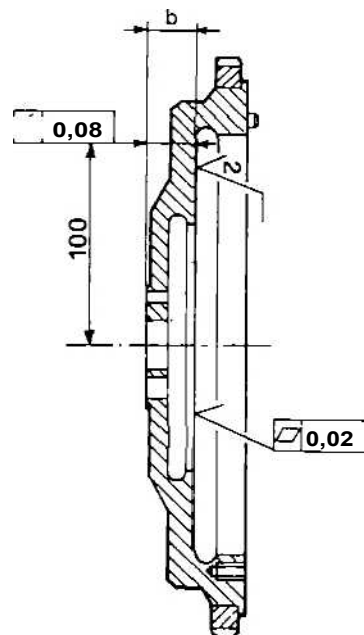
FLYWHEEL

1. Verify that teeth of gear are not in any way chipped or- show any evidence of pitting; contrarywise, replace the flywheel.

2. Check the clutch driven plate contact surface on the flywheel for any scores, chips or evidence of overheating. Before doing so, however, make sure that the contact surface has not been previously ground and that the amount of material available for removal is going to be sufficient for elimination of the existing flaws.

For this purpose, verify that dimension "b" shown in the chart is greater than the min. specified limit and that the removable stock will allow surfacing as required.

Min. limit of dimension "b"
20.95 mm (0.8248 in)



Surface grinding must be performed in accordance with the roughness, flatness and parallelism tolerances shown in the above chart.

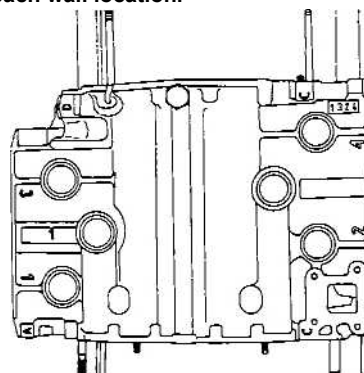
CYLINDER BLOCK

1. Visually check cylinder block for cracks or excess wear of sliding surfaces.
2. Check cylinder walls surfaces for roughness.

Max. allowed roughness of cylinder

0.5 $\sqrt{R_a}$ wall surface $4\mu\text{m}(20.10-6-39.10-6)$ in)

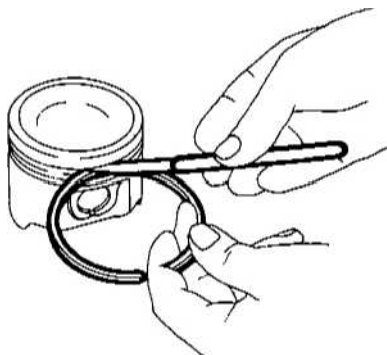
3. See to which size class the cylinder walls refer to and then proceed to check them by measuring them. Cylinder walls are selected according to their inner diameter and are divided into five different classes: A, B, C, D, and E. The class identifying letters are stamped on the cylinder block upper surface next to each wall location.



PISTONS AND CONNECTING RODS

1. Visually check pistons and connecting rods for cracks, scores and evidence of excess wear.

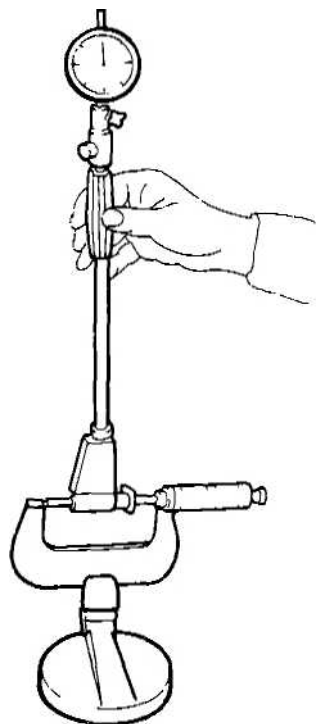
2. Measure the play between the rings and their seats in the piston. For relevant dimensions and tolerances see: Service Data and Specifications - "Pistons" and "Piston Rings" charts.



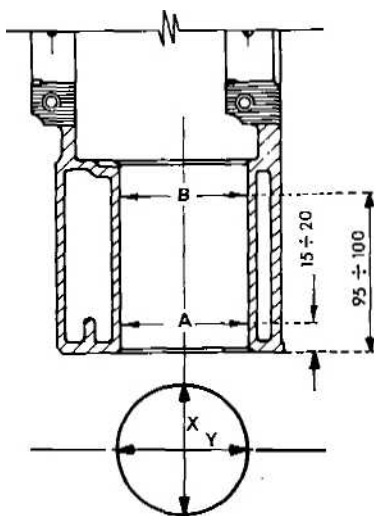
3. Check piston diameter with a

Dimensions relevant to each class are shown in: Service Data and Specifications "Cylinder block" chart.

(1) Reset the reamer by means of a micrometer.



(2) Measure the diameter at the recommended depth and then determine taper and out-of-round of cylinders walls.



Cylinder wall max. taper:
 $A - B = 0.02 \text{ mm (0.00079 in)}$
 Cylinder wall max. out-of-round:
 $X - Y = 0.02 \text{ mm (0.00079 in)}$

(3) Compare actual values D with nominal ones C of each size class and then determine the cylinders walls max. wear.

Cylinder wall max. wear:
 $C - D = 0.04 \text{ mm (0.00157 in)}$

4. If the dimensions thus established are not within tolerance, cylinders walls must be rebored keeping in mind that three different oversize pistons are available as spare parts; this means that the diameter of walls will have to be in accordance with the tolerances shown in: Service Data and Specifications "Cylinder block" chart.

(1) Mount main bearing caps on the cylinder block and tighten screws as specified in: "Engine assembly - Engine unit".

Then proceed to bore cylinder walls so as to stay within the tolerances shown in: Service Data and Specifications - "Cylinder block" chart.

Lapping must be performed so that tool marks cross each other at an angle of 90° ' 120°

(2) If wear does not exceed the specified limit but pistons and spring rings need replacing because of some flaws or damage, cylinders walls will need at least to be lapped; in this case measure the diameter of the walls in order to identify the new size class to which they belong and that will have to be kept in mind during piston fit operations, regardless of the letter stamped on the cylinder block. Should lapping cause a size class change, cylinder wall will no longer be identifiable through the letter stamped on the cylinder block which, therefore, must be erased in order to avoid mistakes during future operations.

PISTON - CYLINDER WALL FIT

1. When original parts are involved, they will be selected by matching each cylinder wall identification letter that is stamped on cylinder block upper surface to the piston that has the same letter stamped on its head or a coloured dot painted on the inside of its crown, according to the following schedule:

Engine	Wall identifying letter	Piston identifying letter and colour
1200	A	A - blue
	B	B - pink
1350	C	C - green
1500	D	D - yellow
	E	E - white

If the letter stamped on the cylinder block has been previously erased, matching will take place according to the identification letter stamped on the piston that needs replacing; in this instance, it is advisable to make a double check and measure the cylinder wall diameter.

2. When oversize walls are used, they will be matched to the relevant completely assembled pistons, namely with compression rings and oil scraper ring, which are available as spare parts according to the following oversize scale: G.2 - 0.4 - 0.6 mm (0.0078 - 0.0157 - 0.0236 in).

ENGINE ASSEMBLY




PRECAUTIONS

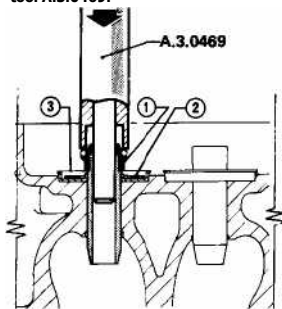
1. Apply engine oil to all bearings and sliding surfaces prior to assembly operations.
2. Use new gaskets, oil seal rings, and spring rings.
3. Tighten all screws and bolts according to specified torques.
4. Apply proper sealant to the following components:
 - Oil sump gasket, cylinder block side
Cement Std. No. 3522-00040
DOW CORNING Silastick 732 RTV
 - Plugs of water galleries in cylinder block and cyl. heads
Cement Std. No. 3524-00011
LOCTITE 601 (green)

Before applying sealant, remove all traces of old sealant and of oil from all surfaces.

CYLINDER HEADS

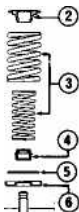
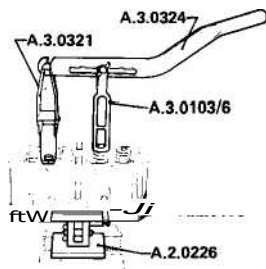
Having completed all recommended checks and inspections as well as replacement of defective or damaged parts, proceed to assemble the cylinder head using specific tools in addition to those used during disassembly operations as mentioned in the preceding chapter.

1. Secure the head on mounting base A.2.0195 and A.2.0226 previously locked in a vice.
2. Fit lower cups  and washers  in the seats located on the head upper surface.
3. Fit seal caps  on valve guides tool A.3.0469.



1 Seal cap
T. ^washer
3 Lower cup

4. Fit valves in head seats and close up the tool with the valve retaining yoke.
5. Having completed the reassembly, fit on valve stems: the inner and outer springs 30, the upper cups 20, and the cotters (j); the latter ones with the help of tools A.3.0103/6, A.3.0321 and A.3.0324. Springs must be fitted with their narrow pitch end resting on the cylinder head.
6. Having completed the reassembly withdraw valve tightness lamina and proceed to check valve tightness following the procedure described in: Checks and Inspections - Cylinder heads and valves.

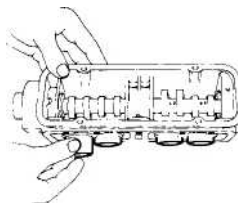


- | | |
|-------------|-------------|
| 1 Cotters | 4 Seelcap |
| 2 Upper cup | 5 Washer |
| 3 Springs | 6 Lower cup |

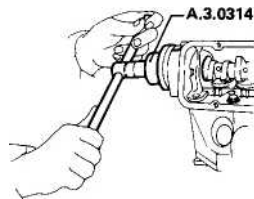
7. Fit camshaft into the support going in from the rear side.



8. Fit cups into the camshaft support seats.
Before doing so, be sure to apply engine oil to the cups and to the camshaft.



9. Fit the camshaft support with suitable gasket to the cylinder head and tighten the four screws in bias sequence, without fully locking them.
10. Fit the camshaft seal ring using tool A.3.0314.
Before doing so, be sure to apply engine oil to the rings sealing lip, its outer surface, and to its working seat.



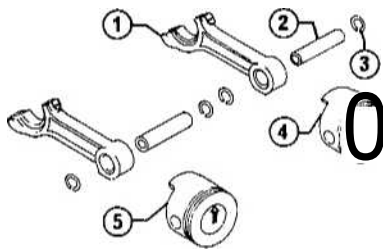
11. Fit the rear cover, with relevant new gasket, to the support and secure it by tightening the three screws.

PISTONS AND CONNECTING RODS

1. Select pistons as described in: Checks and Inspections - Pistons - Cylinder Wall Fit.

Cylinder wall to piston play
 Standard 0.03 - 0.05 mm
 (0.0012 : 0.0020 in)
 Oversize 0.03 - 0.06 mm
 (0.0012 : 0.0024 in)

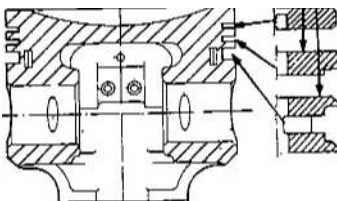
2. Apply engine oil to piston pin, to the connecting rod small end, and to the piston pin supports.
3. Fit the connecting rod's small end between the piston pin supports ensuring that holes are perfectly aligned in order to allow proper piston pin fit.
4. Fit the piston pin into the piston and connecting rod and then lock it with two spring rings
 - a. Position pistons so that the arrow stamped on their crown points in the direction of engine rotation, namely: upward for the right head pistons and downward for the left head pistons.
 - b. Fit connecting rods in the pistons so that the position of matching identification numbers and arrows corresponds to that shown in the below Figure.





- 1 Connecting rod
- 2 Piston pin
- 3 Spring ring
- 4 Left head piston (No. 2 and 4)
- 5 Right head piston (No. 1 and 3)

5 With the help of a suitable special pliers, fit piston rings in the piston seat making sure that the marking stamped on the flat surface of the rings faces upwards.

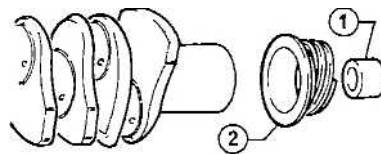
MARKING



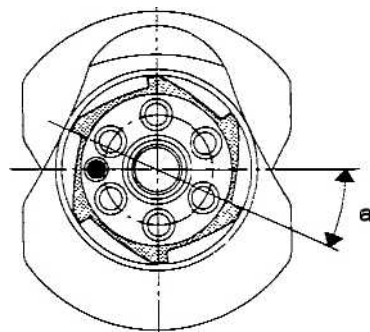
CRANKSHAFT

1. Fit rear bushing and oil pump drive gear on the crankshaft.
 - (1) Fit the crankshaft rear bushing  by means of tool A.3.0450.
 - (2) Heat the oil pump and distributor drive gear to 150°C (302°F).
 - (3) Shrink the gear  on the crankshaft positioning it so that the axis of the flywheel centering dowel and the front surface of one of the gear's form the specified angle.

Positioning of crankshaft rear gear
 $a = 221 - 26^\circ$



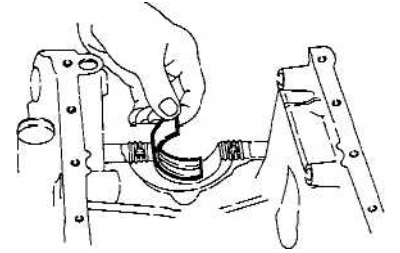
- 1 Bush
- 2 Pump drive gear



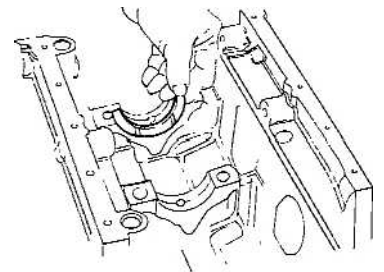
ENGINE UNIT

1. Fit crankshaft on cylinder block.
 - (1) Fit main bearings on relevant main bearings supports and lubricate

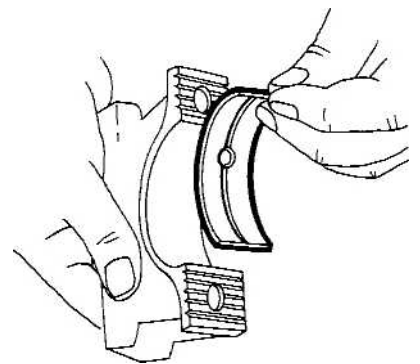
them with oil. Select bearings according to the diameter of crankshaft journals.




- (2) Fit thrust half-rings on the relevant seat obtained in the third main bearings support. Make sure that these half-rings are fitted with oil channels facing the crankshaft shoulders.



- (3) Place crankshaft on main bearing supports.
2. Fit main bearing caps on cylinder block,
 - (1) Fit main bearings to main bearing caps and lubricate them with oil.



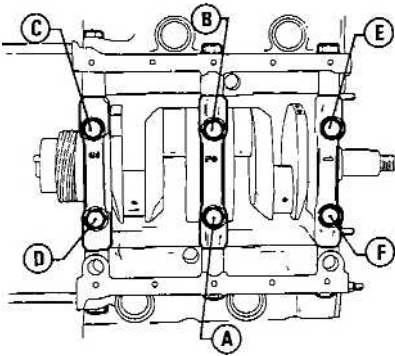
- (2) Fit main bearing caps: front (see markings), centre (~), and rear , fitted with relevant bearings, on cylinder block supports. Coat supports with engine oil and tighten oiled screws without fully locking them.
- (3) Tighten screws securing the main bearing caps to the relevant cylinder block supports in two or three

successive steps, according to specified torque and sequence (from A to F).

Tightening torque

Caps to cylinder supports securing screws:

6 6 : 73 N · m
 (6.7 = 7.4 kg · m
 46.4 ' 53.5 ft·lb)

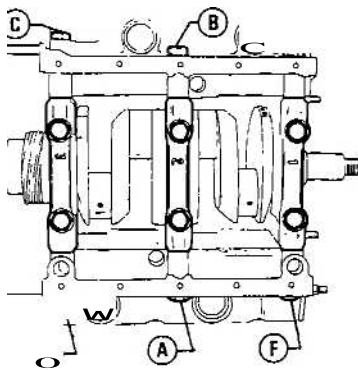


(4) **Subsequently** tighten screws securing the main bearing caps to the cylinder block in two or three successive steps, according to specified torque and sequence (from A to F).

TO: Tightening torque

Caps to cylinder block supports securing screws

40-49 N·m
 (4.1 : 5 kg·m
 29.6 _ 36.2 ft·lb)



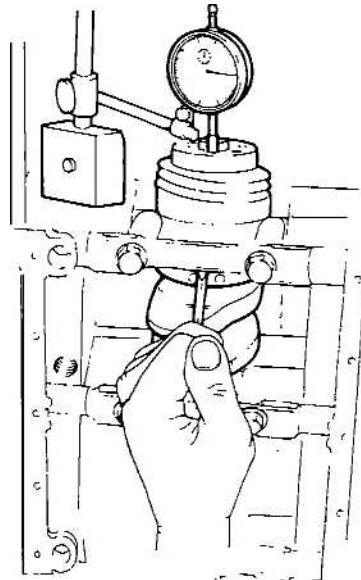
Having completed tightening of all screws, apply engine oil to the supports and rotate the crankshaft by hand.

3. Check crankshaft end play.
 (1) **Attach a centesimal dial gauge** with magnetic base to the cylinder

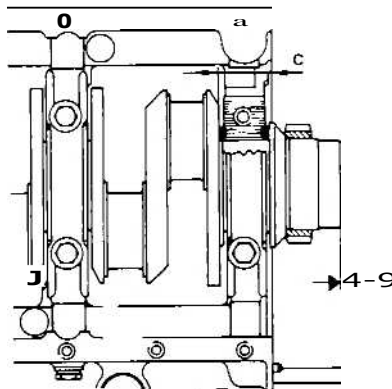
block having the gauge's indicating finger touch the crankshaft parallel-wise to the shaft's axis.

(2) Using a screwdriver, move the crankshaft along its axis and check the gauge's reading to ensure that "g" end play is within specified values.

Crankshaft end play
 0.35 mm (0.0137 in)

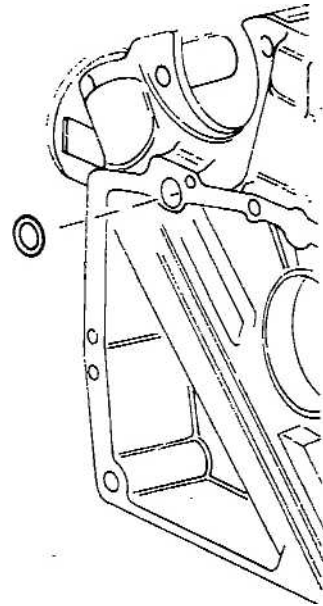


(3) If the shaft has not been previously reground and therefore the value established as per step above is greater than the specified value, it is possible to regrind the shoulders of the rear journal till its "c" length is such that it will allow fitting of the oversize thrust half-rings available as spare parts.



Rear journal "c" length
 28.764 : 28.804 mm .
 (1.1324 - 1.1340 in)

4. Fit seal ring in the main oil gallery of the cylinder block rear cover.

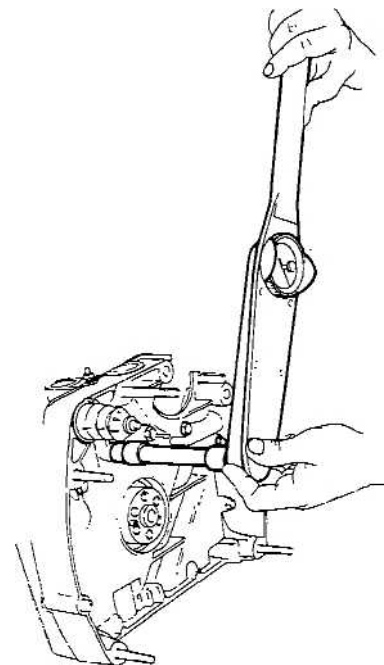


5. Fit rear cover, with relevant gasket, on the cylinder block. Tighten all cover retaining screws according to specified torque.

OT : Tightening torque

Rear cover retaining screws

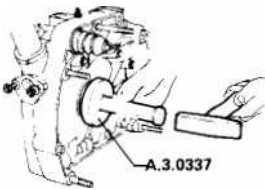
19= 24 N·m
 (1.9 --2.4 kg · m
 13.7 - 17.4 [ft.lb](#))



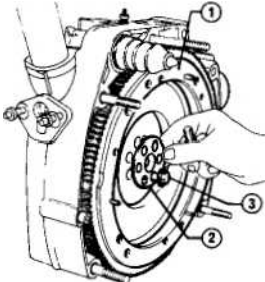
6. Fit crankshaft oil seal ring using tool A-3.0337.

a. **Apply engine oil to the ring's** sealing lip, its external surface as well as to its working seat.

- b. Carefully check correct positioning of ring during reassembly.



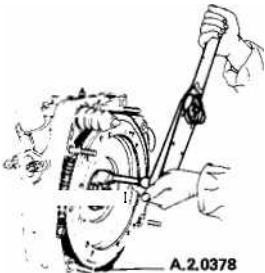
7. Fit engine flywheel.
 (1) Position flywheel on crankshaft and, having fitted the relevant lockwasher, tighten all screws without fully locking them.



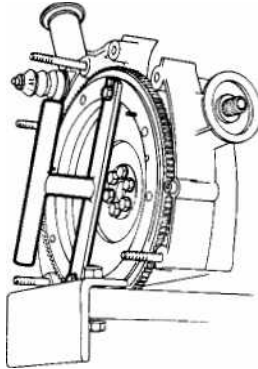
1 Flywheel
 2 Lockwasher
 3 Screw

- (2) Using a tool A.2.0378, stop crankshaft from rotating.
 (3) Tighten retaining screws according to specified torque. Prior to fitting, coat screws with engine oil.

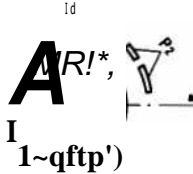
O: Tightening torque
 Flywheel to crankshaft retaining screws:
 94 = 105 N-m
 (9.6' 10.7 kg-m
69.4 _ 77.4 ft-lb)



8. Fit a suitable tool on the flywheel that will allow crankshaft rotation and then remove the previously fitted stopper.

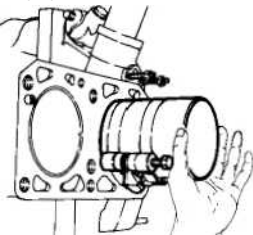


9. Fit pistons and connecting rods.
 (1) Fit piston rings into pistons so that cuts are set in a stagger, as shown below.

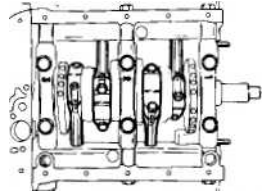


P_1 position of top compression ring
 P_2 position of lower compression ring
 P_3 scraper ring position as piston pin axis
 dd thrust direction

- (2) Fit previously selected half-rings on connecting rod big ends and on corresponding caps.
 (3) Fit pistons and connecting rods into corresponding cylinders using the proper universal tool.



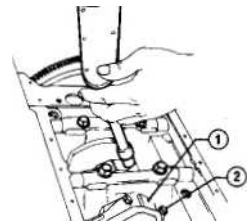
- a. When fitting the pistons, arrange them with the arrow stamped on their crown pointing in the same direction as that of engine rotation, namely: upward for right head pistons and downward for left head pistons.
 b. The position of the connecting rod big end must be such as to allow reading of the identification number.



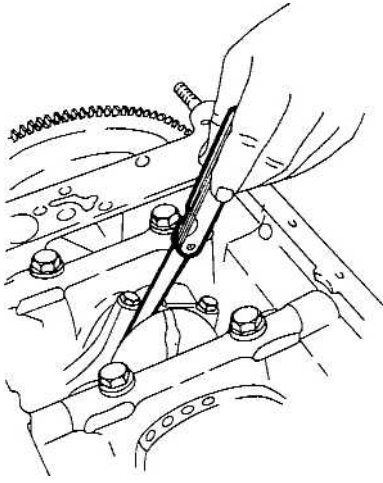
- (4) Fit connecting rod caps with relevant half-bearings onto connecting rod big ends, tightening screws according to specified torque.
 a. In order to have access to the screw, suitably rotate the crankshaft.
 b. Before tightening the screws, use a thickness gauge to check the play between the crankshaft shoulder and the rod-cap profile.

Play between crankshaft and rod-cap profile
 0.15 mm (0.0059 in)

O7: Tightening torque
 Caps to con. rod big end retaining screws:
 43 = 48 N-m
**(4.4 = 4.9 kg-m
 31.8 = 35.4 ft-lb)**



1 Connecting rod
 2 Screw



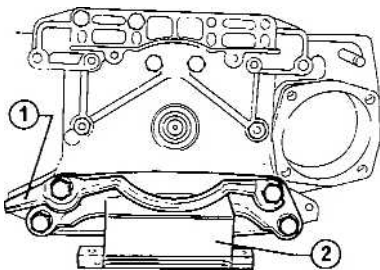
10. Fit front cover, with proper gasket, to cylinder block and tighten screws and nuts according to specified torque.

Tightening torque

Front cover to cylinder block retaining screws:

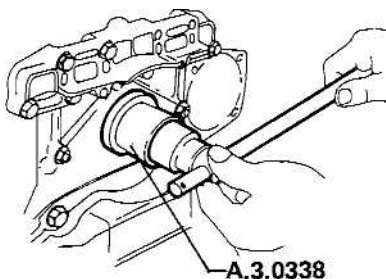
19 i 24 N-m
(1.9 - 2.4 kg-m
13.7 - 17.4 ft.lb)

11. Fit the engine front support and the pulley's lower guard the cover.










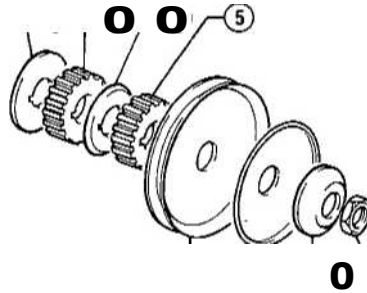
1 Pulley's guard 2 Front support

12. Fit crankshaft oil seal front ring using tool A.3.0338. Before doing so, apply a coating of engine oil to the ring's sealing lip and work surface.



A.3.0338

13. Fit crankshaft front pulleys.
(1) Key the below mentioned parts according to the indicated sequence: the belt guide washer , the left head camshaft drive toothed pulley , the spacer , the right head camshaft drive toothed pulley , the water pump and alternator drive pulley , the spacer , and the washer 



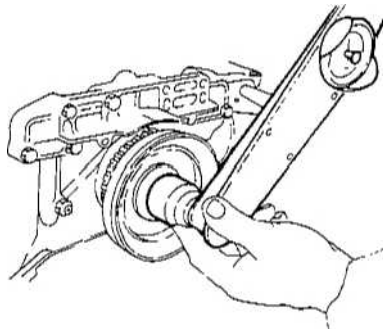
- | | |
|----------|------------------|
| 1 Nut | 5 Toothed pulley |
| 2 Washer | 6 Spacer |
| 3 Spacer | 7 Toothed pulley |
| 4 Pulley | 8 Washer |

(2) After having suitably locked flywheel rotation, tighten pulley retaining nut according to specified torque.

-T Tightening torque

Pulleys to cylinder block retaining nut:

118 _ 144 N-m
(12= 14.7 kg-m
86.8 = 106.3 ft.lb)



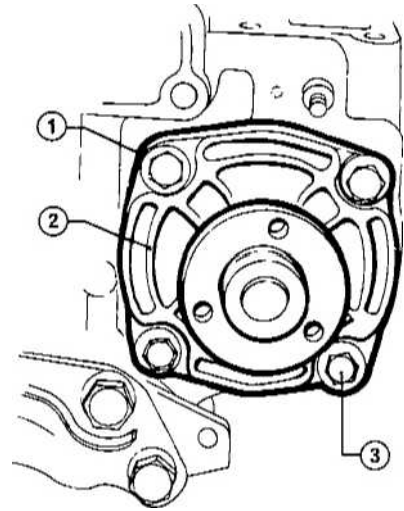
14. Fit the water pump.

- (1) Fit new gasket on pump.
- (2) Fit pump, without pulley, on cylinder block.
- (3) Fit screws with washers and tighten them to specified torque value.

pT Tightening torque




Screws securing water pump

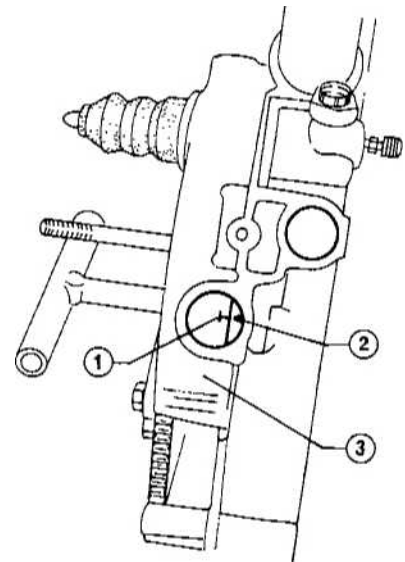
19 - 24N.m
(1.9 = 2.4 kg-m
13.7 - 17.4 ft.lb)



1 Gasket 3 Screw
2 Pump

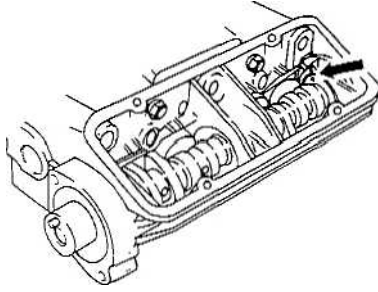
15. Fit cylinder heads.

(1) Turn crankshaft till the piston in No. 1 cylinder is set at Top Dead Center in the compression stroke; this correct positioning is further ensured by the "T" notch  on the flywheel matching with the reference 2  on the rear cover .



1 Notch 3 Cylinder block rear cover
2 Reference

(2) Align the references shown on the camshaft rear journal and on the support rear side panel.



(3) Fit cylinder heads, with relevant gaskets, on the cylinder block.

By extremely careful during this assembly operation in order to avoid that opened valves, projecting above the head surface, might strike the cylinder block surface and thus be damaged.

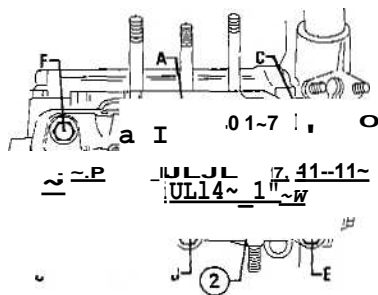
(4) Position and then tighten the six cylinder heads retaining screws in two or three successive steps, according to the specified torque and sequence (from A to F).

(5) Tighten screws securing the camshaft support to the cylinder heads.

T(-): Tightening torque

Head to cylinder block retaining screws:

81 - 87 N·m
(8.3 - 8.9 kg·m)
60 - 64.4 ft·lb)



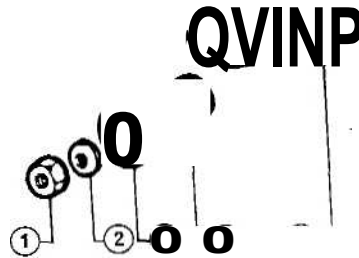
1 Head retaining screw
2 Camshaft support retaining screw

In case of in-car tightening, use extension spanner A.5.0198 in accordance with the following tightening torques:

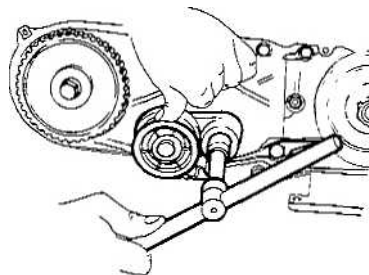
for torque spanner with 300 mm (11.811 in) lever arm:
57=62 N·m
(5.8 = 6.3 kg·m)
41.9 = 45.6 ft·lb)

for torque spanner with 400 mm (15.748 in) lever arm
62 67 N·m
(6.3 - 6.8 kg·m)
45.6 = 49.2 ft·lb)

16. Fit camshaft belts rear covers.
17. Fit belt tensioner assemblies on the cylinder block pins according to the following sequence: supports 5, spring, washers and washers. Lock belt jockey pulley assemblies with relevant nuts after having pre-loaded belt jockey pulley in order to allow for belt passage.



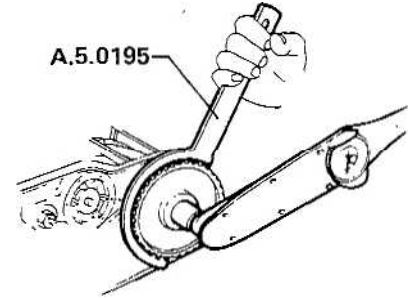
1 Nut
2 Washer
3 Washer
4 Spring
5 Support



18. Fit camshaft driving belts.

(1) Fit camshaft drive pulleys and tighten the retaining screw to specified torque being careful, at the same time, to stop pulley rotation by means of toothed spanner A.5.0195.

O: Tightening torque
Camshaft pulley retaining screw:
63 - 70 N·m
(6.4 = 7.1 kg·m)
46.3 = 51.3 ft·lb)



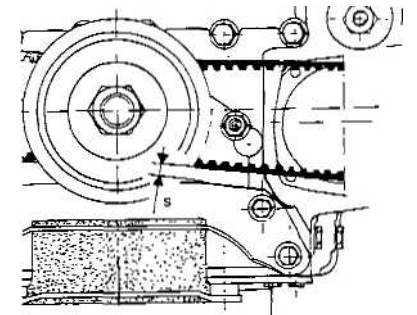
(2) Verify that the crankshaft's angular position corresponds to the Top Dead Center of cylinder No.1, as previously mentioned for heads assembly.

(3) Rotate camshaft by means of toothed spanner A.5.0195 till the reference stamped on the support's rear side panel is aligned with the one stamped on the shaft's rear journal.

(4) Key camshaft drive belts on the crankshaft inner pulleys and on the pulleys of both camshafts. Belt keying must take place with the belt pulling section, opposite the jockey pulleys, fully stretched.

(5) Check that "s" clearance between the camshaft belt and the profile of the engine front support is not below the specified min. value; if it is, modify the profile of the support till it meets the specified value.

"S" min. clearance between camshaft belt and engine from mounting
9 mm (0,3543 in)



(6) Completely loosen the belt jockey pulley lock nuts and then tighten them again.

(7) Turn the crankshaft a few times in its working direction so that the belts may take up their final position.

(8) Act on the camshaft till cams are disengaged; loosen the belt jockey pulley lock nut and then retighten it according to specified torque.

- O: Tightening torque
 Belt jockey pulley lock nut
 (with cold engine)
 37 - 46 N·m
 (3.8 4 4.7 kg·m
 27.5 ' . 34 ft·lb)

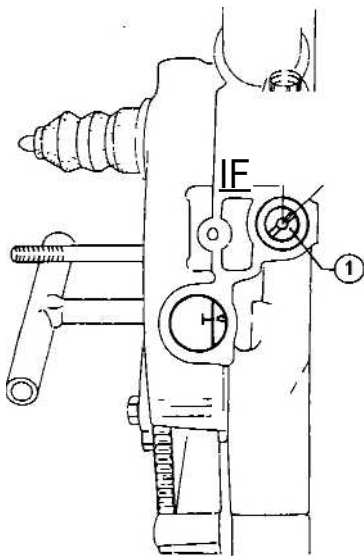
19. Fit oil pump.

(1) Turn crankshaft till piston No. 1 is at Top Dead Center in the compression stroke, as mentioned for heads reassembly.

(2) Turn the pump drive shaft so that the next rotation, which will follow mating of the pump drive gear with that on the crankshaft, will position the distributor coupling according to the specified angle.

Apply a coating of engine oil to the drive shaft.

Distributor coupling positioning
 $\alpha = 22^\circ$



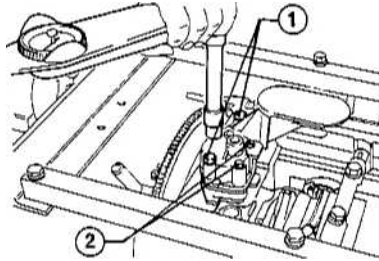
1 Distributor coupling

(3) Fit the oil sump pump on rear cover and tighten screws according to specified torque.

Tightening torque
 Oil sump to rear cover retaining screws
 19-24 N·m
 (1.9 2.4kg.m
 13.7 ~ 17.4 ft·lb)

(4) Tighten retaining screws (2) between pump body and support according to specified torque.

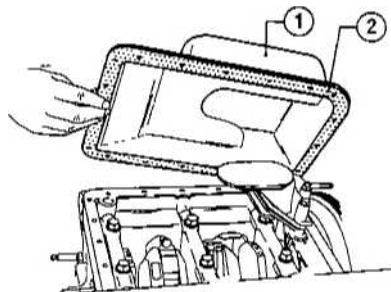
- Q: Tightening torque
 Pump body to support retaining screws:
 8 10 N·m
 (0.8 : 1 kg·m
 5.8 - 7.2 ft·lb)



1 Pump to rear cover retaining screws
 2 Pump body to support retaining screw

(5) Reassemble oil sump with proper gasket (2) and tighten all retaining screws. Before doing so, evenly apply the specified cement to the gasket (Cement Std. No. 3522-00040 DOW CORNING Silastik 732 RTV).

Before applying the sealant, remove all traces of old sealant and of oil from all surfaces.



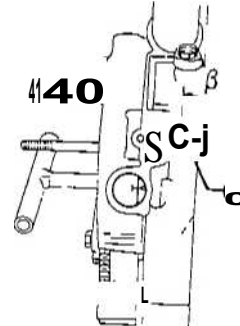
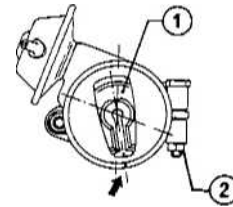
1 Oil sump 2 Gasket

20. Fit distributor on rear cover.

(1) Turn the distributor's shaft so that the rotor arm (10) is positioned on the reference mark stamped on the distributor's body.

The rotor arm (10) should point toward the No. 1 cylinder. This position corresponds to ignition in No. 1 cylinder and to correct coupling of the oil pump and distributor shafts.

(2) If necessary, correct misalignment of the rotor arm with the reference mark stamped on the distributor's body by rotating the latter and then tightening the lock nut (6) securing the distributor to the cylinder block rear cover.



1 Rotor arm 3 Distributor shaft
 2 Distributor lock nut -coupling

21. Adjust clearance of intake and exhaust valves while engine is cold. The relevant procedure is described in Group 00 - Engine Maintenance.

Valve clearance (cold engine):

Intake

0.35 4 0.40 mm
 (0.0138 - 0.0157 in)

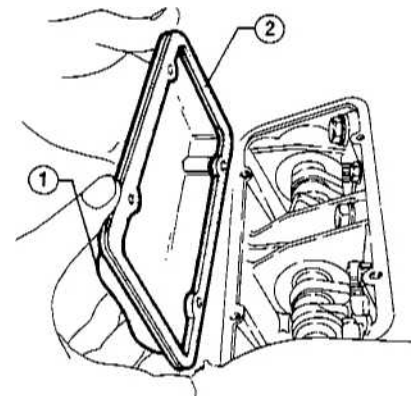
Exhaust

0.45 0.50 mm
 (0.0177 = 0.0197 in)

22. Fill chambers of camshaft supports with engine oil.

Oil quantity required for fill-up
 0.250 kg (0.5511 lb)
 in each chamber

23. Fit support covers with relevant gaskets (2).



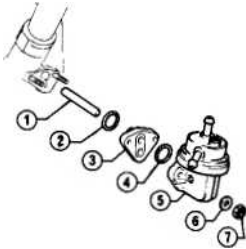
1 Cover 2 Gaskets

24. Fit fuel pump to the engine rear cover.

- (1) Fit spacer 30 with relevant gaskets 20 and (8) on the two studs connecting the pump to the rear cover.
- (2) Coat with oil the pump drive plunger rod (9) and fit it into place.
- (3) Fit the pump body 50 and secure it with the two retaining nuts 0, according to specified torque.

(O): Tightening torque

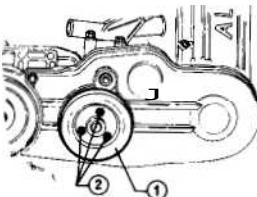
Fuel pump retaining screws
 19 = 24 N·m
 (1.9 = 2.4 kg·m
 13.7 = 17.4 ft·lb)



- | | |
|---------------|-------------|
| 1 Plunger rod | 5 Fuel pump |
| 2 Gasket | 6 washer |
| 3 Spacer | 7 Nut |
| 4 Gasket | |

25. Fit the camshafts belts front plastic covers.

26. Fit pulley (Don water pump hub and lock it into place with relevant screws 02 .

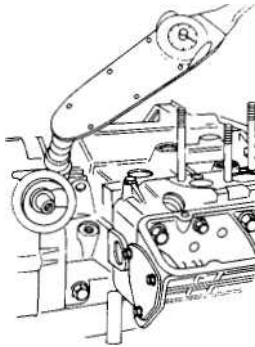


- 1 Pulley 2 Screw

27. Tighten the oil pressure switch on engine rear cover according to specified torque.

(D): Tightening torque

Oil pressure switch:
33-141 N·m
 (3.4 = 4.2 kg·m
24.6 = 30.4 ft·lb)



28. Fit the intake manifold assembly with relevant gaskets and then the engine lifting brackets.

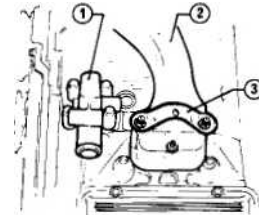
(D): Tightening torque

Central intake manifold
19 = 24 N·m
 (1.9 = 2.4 kg·m
13.7 = 17.4 ft·lb)

29. Fit the water inlet union (D on the cylinder block.

(~): Tightening torque

Water inlet union on cylinder block
19 + 24 N·m
 (1.9 = 2.4 kg·m
13.7 = 17.4 ft·lb)



- 1 Manifold
 2 Union
 3 Bracket

30. Fit temperature transmitter on intake manifold rear side.

(CT): Tightening torque

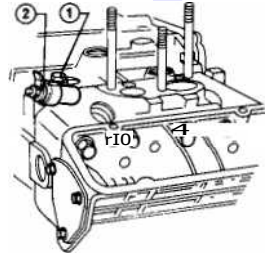
Water temperature transmitter
33 = 41 N·m
 (3.4 = 4.2 kg·m
24.6 = 30.4 ft·lb)

31. Lock thermal contact with screw to right head.

or: Tightening torque

Thermal contact on right head
33 = 41 N·m
 (3.4 - 4.2 kg·m

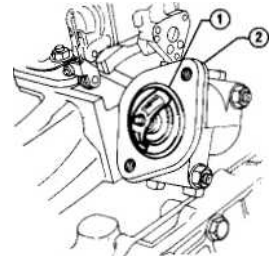
24.6 = 30.4 ft·lb)



- 1 Screw 2 Thermal contact

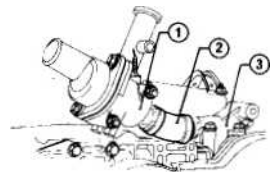
32. Fit on intake manifold the thermostat housing 02, thermostat 0, and cover with relevant gasket.

The thermostat must be positioned with the arrow pointing in the flowing direction of the water.



- 1 Thermostat 2 Housing

33. Fix the cooling system coupling (0) between thermostat housing 0 and water inlet union on the cylinder block; tighten screws of securing clamp.

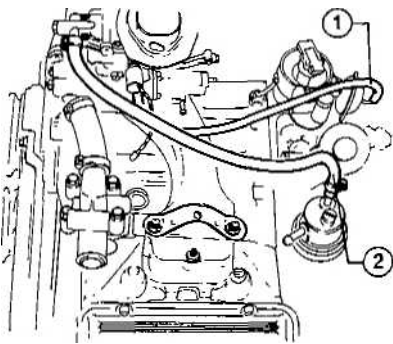


- 1 Thermostat housing 2 Coupling
 3 Union

34. Assemble carburetor with spacer and the interposed gaskets on intake manifold studs.

T : Tightening torque
 Carburetor nuts
 19 _ 24 N·m
 (1.9 - 2.4 kg-m
 13.7 [17.4ft.lb](#))

35. Perform following connections.
 Fuel supply pipe from fuel pump to carburettor.
 Vacuum advance pipe from carburettor and advance controller located on distributor.



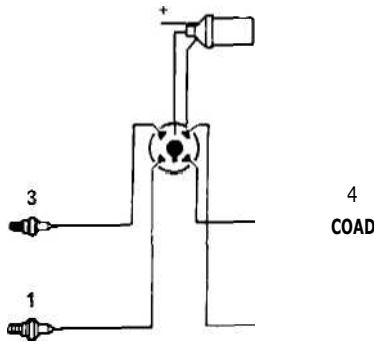
1 Advance pipe 2 Fuel supply pipe

36. Fit oil filter by manually tightening it and insert dipstick.
 37. By means of adapter A.5.0115 fit spark plugs tightening them according to specified torque.

Tightening torque
 Spark plugs:
 2 5 : 34 N·m
 (2.5 : 3.5 kg-m
 18.1 25.3 [ft.lb](#))

38. Secure cap to distributor body with relevant springs, then connect ignition cables between spark plugs and distributor cap, securing them to relevant clamps.

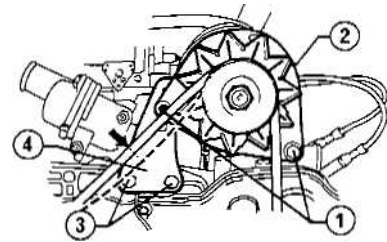
Cables connection must take place according to the ignition sequence of cylinders.



39. Fit alternator and control belt.
 (1) Secure bracket ® to engine front- cover and tightening the relevant screw® 3
 (2) Position alternator on engine support and tighten bolts 10 without fully locking them.

(3) Key alternator and water pump drive belt on relevant pulleys.
 (4) Adjust belt tension according to specified value and then lock bolts. For **adjusting procedure refer to Group 00 - Engine Maintenance.**

Load : 7 8 . 4 0 N (8 k g) (17.4 Ib)
 Arrow: 15 mm (0.5905 in)



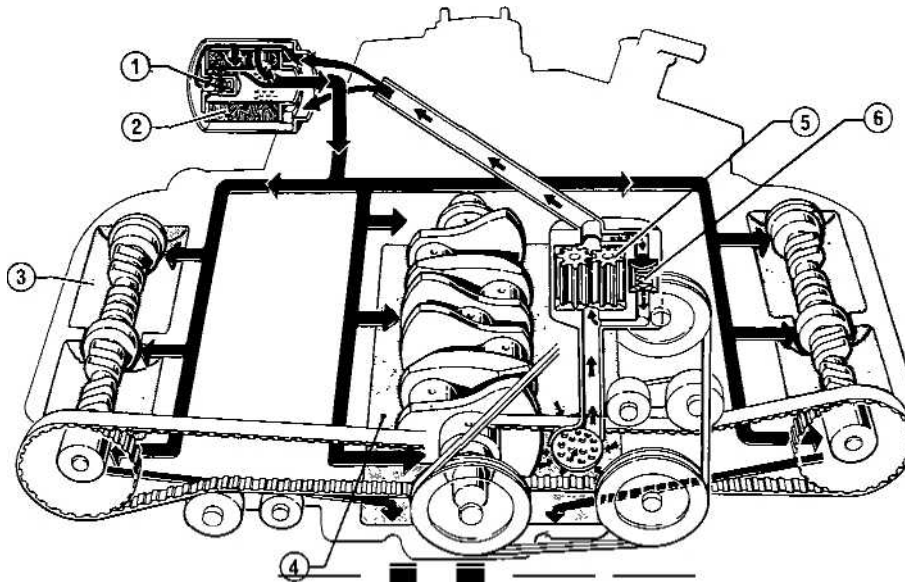
1 Bolts 3 screws
 2 Alternator 4 Bracket

40. Fill the engine with specified engine oil (AGIP Sint 2000 10W50 or IPSuperMotorOil 10W50).

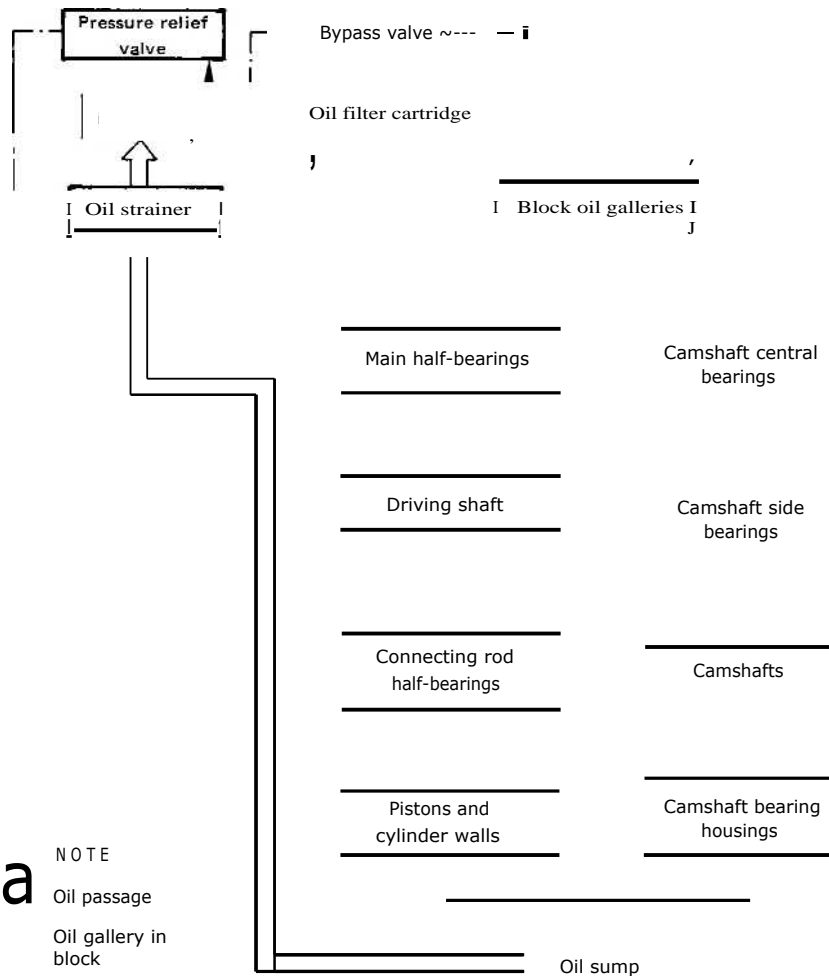
Oil quantity required for fill-up
 3.6 kg (7.93 lb)

ENGINE LUBRICATION SYSTEM

DESCRIPTION



- 1 Bypass valve
- 2 Oil filter cartridge
- 3 Camshaft bearing housing
- 4 Oil sump
- 5 Gear pump
- 6 Pressure relief valve



- NOTE**
- a** Oil passage
 - Oil gallery in block
 - Return
 - Bypass passage

The engine is pressure lubricated by means of a gear pump. The pump is mounted on the rear cover of the engine and is actuated by a shaft which is driven by a gear fitted to the crankshaft.

The maximum oil pressure is adjusted by means of a proper valve fitted on the pump.

Oil is completely filtered in the suction head by a strainer then by a filter with cartridge placed on the oil passage and provided with a bypass safety valve, should the cartridge become clogged.

The oil filter, on the engine rear cover, has unions for the recirculation of the oil vapours at minimum and high running.

The insufficient oil pressure is indicated on the combination meter by means of a warning light connected to a manual contact inserted on the main oil gallery of the block.

OIL PUMP

OIL PRESSURE CHECK

1. Start engine and heat oil to 90°C (194°F).
2. Remove oil pressure checking manual contact.
3. Fit gauge to manual contact hole.
4. Start engine and record oil pressure as shown on gauge.

ENGINE MAIN MECHANICAL UNIT

Engine	Engine speed r.p.m.	Oil pressure kPa ₂ (bar, kii/cm ² , psi)
1200	800	117.7 ±274.6 (1.18 ±2.75, 1.2±2.8, 17.07 ±39.82)
1350		
1500	5500	411.8 ±568.7 (4.12 - 5.59 4.2 - 5.8, 59.74 ±82.49)

5. Remove gauge and refit manual contact.

If the oil pressure value is not within the limits shown in table, the oil pump is to be checked.

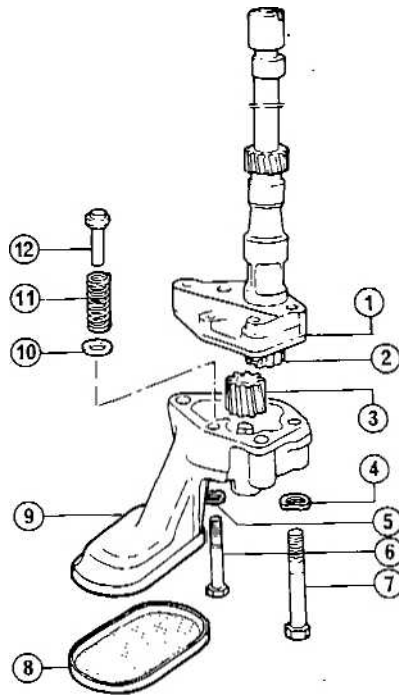
REMOVAL

Remove fuel pump from cover (see: Engine Disassembly - Engine Unit).

1. Drain engine oil and remove oil sump. If required, tap with a wooden mallet on attachment side of sump to block.
2. Unscrew screws and withdraw pump from its seat.

DISASSEMBLY AND ASSEMBLY

1. Unscrew screws securing pump body to pump support.
2. Withdraw driven gear valve, spring and washer.
3. Reassemble pump carrying out the above procedure but in the reverse sequence. Slightly tighten screws without locking fully home.
4. Manually rotate driving shaft checking for crawling and regular rotation.



- | | |
|-----------------|-------------|
| 1 Upper support | 7 Screw |
| 2 Driving gear | 8 Strainer |
| 3 Driven gear | 9 Pump body |
| 4 Washer | 10 Washer |
| 5 Screw | 11 Spring |
| 6 Screw | 12 Valve |

CHECKS AND INSPECTIONS

1. Check gears for wear, ensure that teeth are free from cutting or chipping or that wear is regular and not excessive on all the face length.
2. Check driven gear pin for indications of seizing and cutting.
3. Carry out same check as above for the pressure regulator valve, additionally ensuring that it slides in its seat on pump body without crawling. If the spring of the pressure regulator valve is supposed to have yielded, also considering the trouble shown, replace valve.
4. Check that driving gear is correctly positioned on driving shaft of oil pump and that crankshaft driving gear has the pin regularly fitted.
5. Finally check working surfaces of shaft and rear cover, of driving cam of fuel push rod, and the attachment point to the distributor for cutting and signs of seizure.

INSTALLATION

1. Lubricate driving shaft with engine oil as per step 4.
2. Refit oil pump carrying out procedure detailed in: Engine As-

sembly Engine Unit.

3. Tighten screws securing pump to engine rear cover then screws fastening pump body to pump support to the specified torque value.

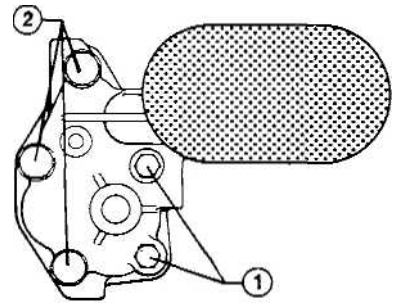
~: Tightening torque

Screws securing pump to engine rear cover

19 : 24 N-m
(1.9 - 2.4 kg-m
13.7 -17.4 ft-lb)

Screws fastening pump body to pump support

8 : 10 N-m
(0.8 = 1 kg-m
5.8 = 7.2 ft-lb)

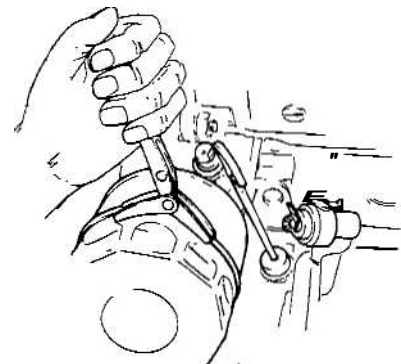


- 1 Screw fastening pump to pump support
- 2 Screw securing pump

4. Fill engine with the specified engine oil (AGIP Sint 2000 10W50 or IP Super Motor Oil 10W50).

OIL FILTER REPLACEMENT

1. Drain hot oil of engine from sump.
2. Remove filter using proper tool.



3. Fit a new filter of the prescribed type. Manually screw in the filter.
4. Fill engine with prescribed engine oil. After fitting new filter, let engine run for a few minutes and check for oil leakages.

SERVICE DATA AND SPECIFICATIONS

TECHNICAL DATA

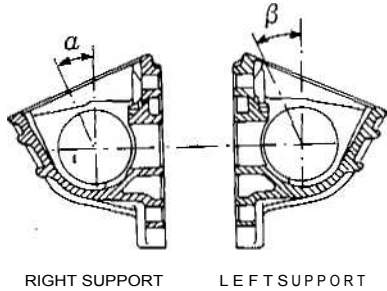
ENGINES DATA

		Engine		
		1200	1350	1500
		305.00	305.02	305.04
Cycle		Otto/4 Stroke		
Numbers of cylinders		4 horizontally opposed		
Cylinder identification		Left head		Right head
Bore - Stroke				
Displacement	mm (in)	80 x 59 (3.15 x 2.32)	80 x 67.2 (3.15 x 2.65)	84 x 67.2 (3.31 x 2.65)
	cm ³ (cu.in)	1186 (72.37)	1351 (82.44)	1490 (90.93)
Combustion chamber volume	cm ³ (cu.in)	37 (2.26)	42.2 (2.6)	46.5 (2.84)
Compression ratio		9	9	9
Power DIN	Max specific kW (HP)	50 (68) 42 (57.3)	58(79) 43 (58.4)	62(84) 41.6 (56.3)
		to 6000 r.p.m.	to 6000 r.p.m.	to 5800 r.p.m.
Max Torque DIN	Nm)kgm;ftlb)	90(9.2;66.56) to 3200 r.p.m.	111(11.3;82.1) to 3500 r.p.m.	121(12.3;89.5) to 3500 r.p.m.
Piston mean speed (1)	m/s (Ws)	11.8)38.71)	13.4 (43.96)	13)42.65)
Cylinder compression (2)	kPa (kg/cm ² ; bar; p.s.i.)		1029.6 (10.5; 10.3; 149.39)	
	Min. pressure			
	Max difference in pressure between cylinders		98)1; 0.98; 14.21)	
Oil pressure (3)	kPa (kg/cm ² ; bar;p.s.i.)		117.68=274.60 (1.2=2.8; 1.18=2.75; 17.07=39.83	
	to 800 r.p.m.		411.89=568.81 (4.2=5.8;4.12=5.69; 59.74=82.50)	
	to 5500 r.p.m.			
Oil consumption (4)	g (oz)		600 (21.16)	

- (1) At men power output r.p.m.
- (2) Values to be read in these conditions:
 - engine at operating temperature
 - fully opened throttles
 - engine cranked by starter motor, sparking plugs removed
- (3) Values to be read at engine operating temperature (oil at 90°C = 194°F)
- (4) Maximum consumption in 1,000 km (621 Mi)

INSPECTION AND ADJUSTMENT

CAMSHAFT SYSTEM



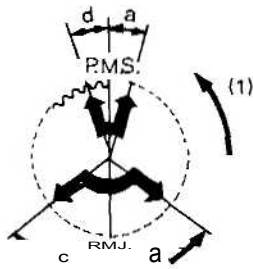
Unit: mm (in)

Engine		
306.00	1200	305.02
		1350
		305.04
		1500

Camshaft		531.364	531.364	531.364
Tappet clearance	Intake	0.35 = 0.40 (0.0138" - 0.0157")		
	Exhaust	0.45-0.50 (0.0177" - 0.0197")		
Value of the angle of timing marks on camshaft supports	Right support	23°		
	Left support	23°		

All values are with cold engine

CHECKING VALVE OPENING AND CLOSING ANGLES



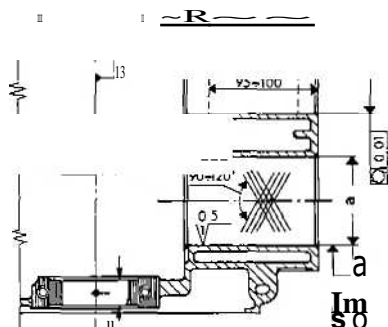
Unit: mm (in)

		Engine	
		1200	
		305.00	305.02
Valve clearance for checking	mm (in)	0.7 (0.0276)	
Opening BTDC	a	12°	
Closing ABDC	b	48°	
Valve clearance for checking	mm (in)	0.7 (0.0276)	
Opening BTDC	c	45°	
Closing ABDC	d	7°	

(1) Crankshaft rotation ACW seen from flywheel side.

ENGINE MAIN MECHANICAL UNIT

CYLINDER BLOCK



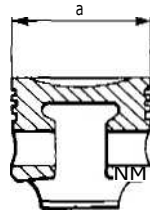
Unit: mm (in)

Inspection data			Engine		
			1200	1350	1500
Cylinder bore "a"	Standard	Class A	80.00t80.01 (3.1496 5-3.1500)	84.00t84.01 (3.3071-3.3075)	
		Class B	80.01 ~80.02 (3.1500 ~ 3.1504)	84.01 84.02 (3.3075 = 3.3079)	
		Class C	80.02-80.03 (3.1504-3.1508)	84.02 G-84.03 (3.3079 ~ 3.3083)	
		Class D	80.03-80.04 (3.1508 ± 3.1512)	84.03 : 84.04 (3.3083 = 3.3087)	
		Class E	80.04=80.05 (3.1512=3.1516)	84.04 = 84.05 (3.3087 = 3.3091)	
	Oversize	1st	80.20 =80.21 (3.1575 X3.1579)	84.20 -84.21 (3.3150 3.3154)	
2nd		80.40-80.41 (3.1654-3.1658)	84.40 = 84.41 (3.3229 = 3.3233)		
3rd		80.60 = 80.61 (3.1733-3.1737)	84.60 = 84.61 (3.3307 -3.3311)		
Out-of-square between cylinder bore centreline and centreline of main bearings			0.05 (0.00197)		
Taper and out-of-round limit		Standard	0.01 (0.00041)		
		Max	0.02 (0.0008)		
Cylinder bore surface roughness			0.5-10 1·10 ³ (0.0197~10 ³ ~ 0.0394~10 ³)		
Cylinder bore grinding angle			90° -120°		
Main bearing diameter "b"		Front	63.663 : 63.673 (2.5064 ~ 2.5068)		
		Rear			
		Central	63.673-63.683 (2.5068_ 2.5072)		
Width of rear main bearing support "c"			23.68 ± 23.73 (0.9323' 0.9343)		

ENGINE MAIN MECHANICAL UNIT

PISTONS, COMPRESSION RINGS AND PINS

Pistons



Unit: mm (in)

	tuuspec LUU11 data		Engin		
			1200	1350	1500
Piston diameter " a " (1)	Standard	Class A (Blue)	79.96 -79.97 (3.1480 - 3.1484)		83.96 - 83.97 (3.3055 - 3.3059)
		Class B (Pink)	79.97 f79.98 (3.1484-3.1488)		83.97 - 83.98 (3.3059 - 3.3063)
		Class C (Green)	79.98-79.99 (3.1488-3.1492)		83.98 -83.99 (3.3063 - 3.3067)
		Class D (Yellow)	79.99 - 80.00 (3.1492 e-3.14961)		83.99 - 84.00 (3.3067 - 3.3071)
		Class E (White)	80.00 G-80.01 (3.1496 -3.1500)		84.00-84.01 (3.3071 f3.3075)
	Oversize	1st	80.15-80.17(3_1555-3.1563)		84.15-84.17 (3.3130 =3.3138)
2nd		80.35-80.37 (3.1634-3.1642)		84.35f84.37 (3.3209-3.3217)	
3rd		80.55-80.57 (3.1713-3.1720)		84.55-84.57 (3.3287 -3.3296)	
First compression ring groove height "c"			1.525 - 1.545 (0.0600 - 0.0610)	1.525 - 1.550 (0.0600 - 0.0610)	
			1.525 =1.545 (0.0600 - 0.0608)	(2)	1.525 - 1.545 (0.0600 0.0608)
				1.775 =1.800 (0.0699 - 0.0709)	(3)
Second compression ring groove height "d"			1.775 - 1.795 (0.0699 - 0.0707)	1.775 - 1.795 (0.0699-0.0707)	1.775 - 1.796 (0.0699 - 0.0707)
				(2)	
				(3)	
Oil scraper ring groove height "c"			4.015 G-4.035 (0.1581 - 0.1589)	4.015 - 4.040 (0.1581 -0.1590)	4.015 e-4.035 (0.1581 -0.1589)
				(2)	
				4.015 - 4.035 (0.1581 - 0.1589):	(3)
Pin seat bore "b"			21.002-21.006 (0.8269-0.8270)		

- (1) To be measured to right angle to the piston pin at 17 mm (0.6693 in) from piston skirt
- (2) Borg0 Piston
- (3) Mondial Piston

ENGINE MAIN MECHANICAL UNIT

Compression rings



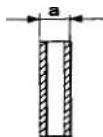
Unit: mm (in)

inspection data		Engine		
		1200	1350	1500
Ring thickness "b"	First compression ring	1.478=1.490 (0.0582=0.0587)		
	Second compression ring	1.728=1.740 (0.0680=0.0685)		
	Oil scraper ring	3.978=3.990 (0.1566=0.1571)		
Ring gap "a" (1)	First compression ring	0.30=0.45 (0.0118=0.0177)	0.30=0.45 (0.0118=0.0177) (2) 0.30-0.50(0.0118'.0.0197) (3)	
	Second compression ring	0.30-0.45 (0.0118 ' 0.0177)	0.30=0.45 (0.0118=0.0177) (2) 0.30=0.50)0.0118=0.0197) (3)	
	Oil scraper ring	0.25=0.40.(0.0098 _ 0.0157)	0.25=0.40 (0.0098-0.0157) (2) 0.25=0.50 (0.0098=0.0197) (3)	
	Limit gap for each ring	¹ (0.03941)		

(1) To be measured inside the cylinder bore or inside a ring gauge

- (2) Borgo ring
- (3) Goatee ring

Pin



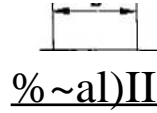
Unit: mm (in)

Inspection date		Engine		
		1200	1350	1500
Pin diameter "a"		20.996-21.000 (0.8266 ' 0.8268)		
Pin-piston slack	Standard	0.002=0.01 (00001 ' 0.0004)		
	Ma mum	0.018 (0.0007)		

ENGINE MAIN MECHANICAL UNIT

CONNECTING ROD AND CONNECTING ROD BEARINGS

Connecting rod



% ~ a) II

Unit: mm (in)

Inspection data	Engine		
	1200	1350	1500
Small end bush bore diameter "a"	21.007 i 21.015 (0.8270 - 0.8274)		
Big end bore diameter "b"	52.696 - 53.708 (2.0746 * 2.1145)		

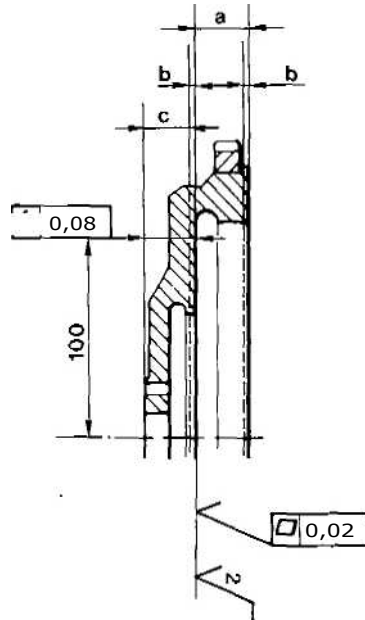
Connecting rod bearings

Unit: mm (in)

Inspection data			Engine			
			1200		1350	1500
	Standard		Blue	1.831 - 1.835 (0.0721 - 0.0722)	Blue	1.830 - 1.836 (0.0720 - 0.0722)
			Red	1.827 - 1.831 (0.0719 - 0.0721)	Red	1.826 ^k - 1.832 (0.0719 - 0.0721)
Connecting rod bearing thickness	Oversize		1st	1.966 ~ 1.962 (0.0770 - 0.0772)		
			2nd	2.083 - 2.089 (0.0820 - 0.0822)		
			3rd	2.210-2.216 (0.0870: 0.0872)		
			4th	2.337 2.343(0.0920-0.0922)		

ENGINE MAIN MECHANICAL UNIT

FLYWHEEL



Unit: mm (in)

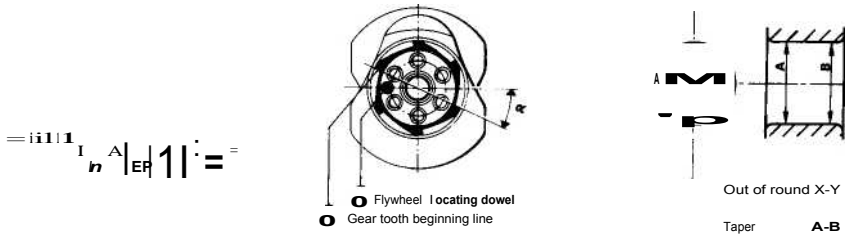
Inspection data		Engine		
		1 200	1 350	1 500
Regrinding dimensions (1)	a	24.0 - 24.2 (0.9449 - 0.9528)		
	b	C 0.2 (0.0079)		
	c	> 20.95 (0.8248)		
Parallelism of the driven plate contact face compared with flywheel-to-crankshaft support face (as read at a 100 mm radius)		0.08 (0.0031)		
Maximum out-of-flat of driven plate contact face		0.02 (0.0008,		
Surface roughness of driven plate contact face		2.1 0 ³ (0.0787~10 ³)		

- (1) The depot of regrinding, dimension "b", must be the same both on clutch driven plate contact face and on the face of the register for the clutch cover, so that dimension "a" kept constant. Dimension "c" must not be lower than the specified limit.

ENGINE MAIN MECHANICAL UNIT

CRANKSHAFT, THRUST RINGS AND MAIN BEARINGS

Crankshaft



Unit: mm (in)

Inspection data			Engine			
			1200	1350	1500	
Main journal diameter "d"	Standard		59.944=59.957 (2.3600=2.3605)			
	Undersize	2nd	59.690 = 59.703 (2.3500=2.3505)			
		3rd	59.436=59.449 (2.3400=2.3405)			
		4th	59.182=59.195 (2.3300=2.3305)			
Crank pin diameter "e"	Standard	Blue	49.984=49.992 (1.9679=1.9682)			
		Red	49.992_ 50.000 (1.9682 = 1.9685)			
	Undersize	1st	49.733=49.746 (1.9580=1.9585)			
		2nd	49.479=49.492 (1.9480=1.9485)			
		3rd	49.226.49.238 (1.9380=1.9385)			
	4th	48.971=48.984 (1.9280=1.9285)				
Rear main journal length "c"	Standard		28.51 =28.55 (1.1224= 1.1240)			
	Oversize		28.764–28.804 (1.1324+1.1340) (1)			
Fillet radii "r"	Main journals		1.8=2 (0.0709=0.0787)			
	Rear main journal		1.5= 1.7 (0.0591 0.0669)			
	Crank pins		2.8=3 (0.1102=0.1181)			
Length of fillet radii portions "f"	Front main journals		2.11 =2.81 (0.0831 0.1106)			
Length of parallel portion "a"	Central main journal		24.05= 24.15 (0.9469 _ 0.9508)			
	Rear main journal		24.22=24.32 (0.9535-0.9575)			
Surface roughness of main journals and crankpin			0.16-10 (0.63-10')			
X-V Ovality and limit for taper A-B of main journals and crankpins	Standard		0.006 (0.00024)			
	Maximum		0.02 (0.0008)			
Max. error of parallelism between crankpins and main journals			0.015 (0.0006)			
Max. misalignment among main journals			0.02 (0.0008)			

ENGINE MAIN MECHANICAL UNIT

Unit: mm (in)

Inspection data	Engine		
	1200	1350	1500
Max. misalignment between the centrelines of the two pairs of crankpins and the journals centreline	0.25 (0.0098,		
Max. out-of-square between thrust ring face and main journals	0.03 (0.00121		
Rear crankshaft bush diameter "b"	16.065	16.080 (0.6325 - 0.6331)	
Fitment of rear crankshaft gear "U" (distributor/oil pump drive)	22° - 26°		

(1) Re-cutting equally spaced on both shoulders

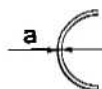
Thrust rings



Unit: mm (in)

Inspection data	Engine		
	1200	1350	1500
Thickness "a"	Standard		
	2.310 : 2.362 (0.0909 -- 0.0930)		
Oversize		2.437 : 2.489 (0.0959 • 0.0980)	

Main -bearings



Unit: mm (in)

Inspection data	Engine			
	1200	1350	1500	
Thickness "a"	Standard			
	1.832 : 1.841 (0.0721 - 0.0724)			
	Oversize	1st	1.959 - 1.968 (0.0771 0.0775)	
		2nd	2.086 : 2.095 (0.0821 0.0825)	
		3rd	2.213 - 2.222 (0.0871 0.0875)	
4th		2.340: 2.349 (0.0921 ; 0.0925)		

ENGINE MAIN MECHANICAL UNIT

CAMSHAFT SUPPORT, CAMSHAFT AND TAPPET BUCKET

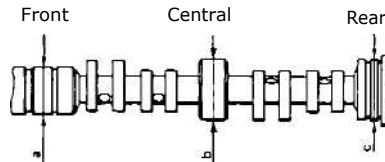
Camshaft support

W-H.

Unit: mm (in)

Inspection data		Engine		
		1200	1350	1500
Bore of camshaft journal bearing diameter "a"	Front	35.015 ± 35.040 (1.3786 - 1.3795)		
	Central	46.500±46.525 (1.8307±1.8 317)		
	Rear	47.000 G-47.025 (1.8504 ± 1.8 514)		
Seat tappet bucket diameter "b"		36.000 -36.025(1.4173- 1.4 83)		

Camshaft



Unit: mm (in)

Inspection data		Engine		
		1200	1350	1500
Cam height	Intake Exhaust	8 . 5 (0.3346)		
Camshaft journal diameter	Front "a"	34.940 - 34.956 (1.3756'- 1.3762)		
	Central "b"	46.440 -46.456(1.8283± 1.8290)		
	Rear "c"	46.940±46.956 (1.8480- 1.8487)		

Tappet bucket

a

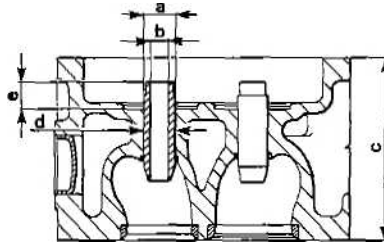
Unit: mm (in)

Inspection data	Engine		
	1200	1350	1500
Diameter "a"	35.973 - 35.989 (1.4163 ± 1.4169)		

ENGINE MAIN MECHANICAL UNIT

CYLINDER HEAD, VALVES AND SPRINGS

Cylinder head

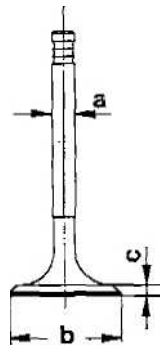


Unit: mm (in)

Inspection data		Engine		
		1200	1350	1500
Valve guide seat diameter "d"		13.000	13.018 (0.5118±0.5125)	
Valve guide O.O. "a"	Standard	13.050 = 13.068 (0.5138- 0.5145)		
	Spare	13.064 =13.082 (0.5143= 0.5150)		
Diameter of valve guide bore "b"		8.013: 8.031 (0.3155 : 0.3162)		
Valve guide protrusion "e"		9.8 -- 10 (0.3858 ± 0.3937)		
Min. cylinder head thickness after resurfacing "c"		77.25 (3.04131 (1)		
Max. error of parallelism between head surfaces		0.05 (0.00201		
Max. out of flat		0.03 (0.0012)		
Surface roughness		1.6 1 0 (0.0630.10)		

(1) Resurfacing of cylinder head with hemispherical combustion chamber must be done on both banks of the same engine

Valves

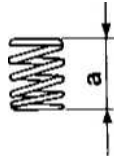


Unit: mm (in)

		Engine		
		1200	1350	1500
Valve stem diameter "a"	Intake	7.9a5 - 8.000 (0.3144 - 0.3150)		
	Exhaust	7_968=7.983 (0.3137 :-0.3143)		
Valve head diameter "b"	Intake	38.00 - 38.20 (1.4961 - 1.5040)		
	Exhaust	33.00 - 33.20 (1.2992 V 1.3071)		

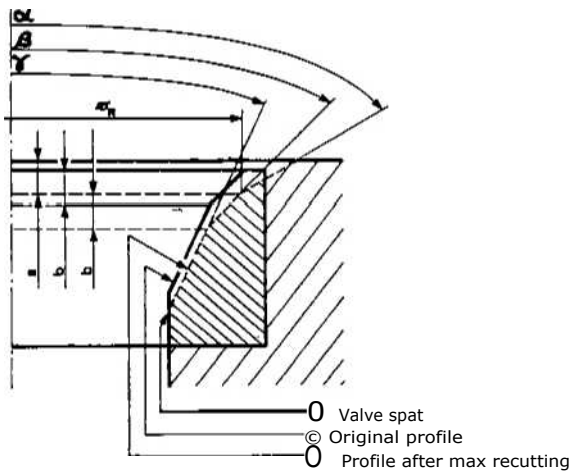
ENGINE MAIN MECHANICAL UNIT

Springs



		Engine		
		1200	1350	1500
Length of valve spring with valve open "a"	mm (in)	Outer spring 25.25 (0.9941)		
		Inner spring 23.25 (0.9154)		
Spring rating at length "a"	N (kg) (lb)	Outer spring 425.32 - 452.76 (43.4 46.2) (95.68 - 101.85)		
		Inner spring 194.53-208.25 (19.85 :21.25) (43.76f46.85)		

VALVE SEAT RECUTTING



Unit: mm (in)

		Engine		
		1200	1350	15001
Reference diameters "O _R "	Intake	37.3 (1.4685)		
	Exhaust	31.9 (1.2559)		
Cut limit of valve seat top surface "a"		2.9 (0.1142)		
Cut limit of valve seat mating surface "b"	Intake	1.07	1.37 (0.0421- 0.0539)	
	Exhaust	1.26 ≈ 1.56 (0.0496 -0"0614)		
Valve seat top surface limit angle "CLX'		120°		
Valve seat mating surface limit angle "0":		90" ' 90° 30		
Valve seat inner face limit angle "Y'	Intake	50°		
	Exhaust	30°		

ENGINE MAIN MECHANICAL UNIT

FITMENT PLAYS OR INTERFERENCE FITS

Unit: mm (in)

Inspection data		Engine			
		1200	1350	1500	
Cylinder bore/piston play	Standard	0.03 - 0.05 (0.0012 - 0.0020)			
	Oversize	0.03 - 0.06 (0.0012 - 0.0024)			
-First compression ring		<i>0.035 - 0.072</i>			
		0.035 - 0.067 (0.0014 - 0.0026)	(0.0014 - 0.0028) ⁽¹⁾		0.035 ~ 0.067 (0.0014 - 0.0026)
Ring/groove end float	Second compression ring	0.035 - 0.067 (0.0074 - 0.0026)	(0.0014 - 0.0028) ⁽¹⁾ 0.035 - 0.067 ⁽²⁾ (0.0014 - 0.0026)		0.036 - 0.067 (0.0014 : 0.0026)
	Oil scraper ring	0.025 - 0.057 (0.0010 - 0.0022)	<i>0.025 - 0.062</i> (0.0010 - 0.0024) ⁽¹⁾ 0.025 ~ 0.057 ⁽²⁾ (0.0010 - 0.0022)		0.025 - 0.057 (0.0010 - 0.0022)
	Maximum for each ring	0.1 (0.0039)			
Pin/small end play		0.007 - 0.019 (0.0003 - 0.0007)			
Pin/seat bore play	Standard	0.002 - 0.010 (0.0001 - 0.0004)			
	Maximum	0.018 (0.0007)			
Main bearing to-journal play	Front and rear	0.024 - 0.065 (0.0009 - 0.0026)			
	Central	0.034 - 0.075 (0.0013 - 0.0030)			
	Maximum (with bearing in seat)	0.1 (0.0039)			
Connecting rod bearing-to-crankpin play	Standard	Red/Blue <i>0.034</i> - 0.662 (0.0013 ~ 0.0024)	Red/Blue 0.032 - 0.064 (0.0013 - 0.0025)		
	Maximum (with bearing in seat)	0.090 (0.0035)			
Crankshaft end float	Standard	0.056 - 0.25 (0.0022 - 0.0098)			
	Max	0.35 (0.0138)			
End float of big end bearing	Standard	0.24 - 0.392 (0.0079 - 0.0164)			
	Max	0.45 (0.0177)			
Radial clearance between camshaft and bearing	Front	0.059 ~ 0.100 (0.0023 - 0.0039)			
	Central	0.044 - 0.085 (0.0017 - 0.0033)			
	Rear	0.044 - 0.085 (0.0017 - 0.0033)			
Camshaft end float		0.10 - 0.33 (0.0039 - 0.0130)			
Radial clearance between tappet bucket and seat in camshaft support	Standard	0.011 - 0.052 (0.0004 ~ 0.0020)			
	Max	0.1 (0.0039)			

ENGINE MAIN MECHANICAL UNIT

Inspection data			Engine		
			1200	1350	1500
Valve stem-to guide play	Intake	Standard	0.013 - 0.046 (0.0005 - 0.0018)		
		Max	0.07 (0.0027)		
	Exhaust	Standard	0.030 = 0.063 (0.0012 = 0.0025)		
		Max	0.09 (0.0035)		
Valve guide-to-seat interference fit		Standard	0.032 = 0.068 (0.0013 = 0.0027)		
		Spare	0.046 = 0.082 (0.0018 = 0.0032)		
(1) Borgo Piston (2) Mondial Piston					

TEMPERATURES

Part	Temperature
Oil pump/distributor drive gear for shrinking onto the crankshaft	150°C (302°F)

GENERAL SPECIFICATIONS

FLUIDS AND LUBRICANTS

Application	Type	Denomination	Q.ty kg (lb)
Engine oil when full	OIL	AGIP SINT 2000 10W50 Std.rd 3631-69352	3.15 (6.94)
Filter		IP Super Motor Oil 10W50 Std.rd 3631-69353	0.45 (0.99)
Engine oil and filter routine maintenance			3.6 (7.94)
Camshaft supports chests (1)			0.250 (0.55) (2) into each chest

- (1) Applicable only in the case of supports dismantling
 (2) This quantity relates to chests supply, completely drain, up to drain holes level

SEALING COMPOUNDS

Application	Type	Denomination	Q.ty
Joint face, cylinder block-to-oil sump	CEMENT	DOW CORNING: Silastick 732 RTV Std. no. 3522-00040	--
Plugs of water galleries in cylinder block and head	CEMENT	LOCTITE 601 (green) Std. no. 3524-00011	--

- (1) Before applying LOCTITE, remove all traces of old Loctite and degrease threads using trichlorethylene or chloroethene

ENGINE MAIN MECHANICAL UNIT

GRINDINGS

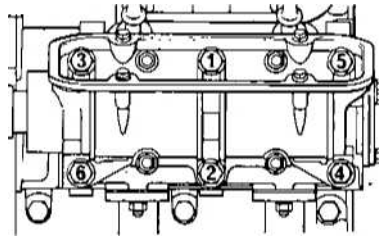
Application	Type	Denomination	Q.ty
Grinding valves and valves seats		SIPAL AREXONS: Carbosilicon for valves Std. no. 4100-31502	—

TIGHTENING TORQUES

Item	Unit	N-m	kq-m	ft-lb
Rear (front) cover securing screws to cylinder block		19 - 24	1.9 - 2.4	13.7 r 17.4
Retaining screw, pulley to camshaft (with oil)		63 = 70	6.4 = 7.1	46.3 = 51.3
Main bearings cap screws (with oil)		66 - 73	6.7 - 7.4	48.4 = 53.5
Main bearing cap transverse screws (with oil)		40 _ 49	4.1 _ 5	29.6- 36.2
Flywheel retaining screws (with oil)		94 = 105	9.6 _ 10.7	69.4 = 77.4
Connecting rod screws		43 _ 48	4.4 = 4.9	31.8 = 35.4
Retaining nut, driving pulley to crankshaft		118 _ 144	12 = 14.7	86.8 _ 106.3
Nut securing belt tensioner to crankcase	Engine cold	37 = 46	3.8 - 4.7	27.5 = 34
	Engine warm	29 = 35	3 _ 3.6	21.7 = 26
Oil pressure switch		33 - 41	3.4 = 4.2	24.6 = 30.4
Cylinder heads to block screws (1)		81 _ 87	8.3 _ 8.9	60.4 64.4
Water intake manifold screws		19 _ 24	1.9 = 2.4	13.7 = 17.4
Screws (nuts) securing oil (fuel) pump to engine rear cover		19 _ 24	1.9 = 2.4	13.7 = 17.4
<i>Carburetor</i> nuts		19 = 24	1.9 _ 2.4	13.7 = 17.4
Screws securing oil pump to oil pump support		8 - 10	0.8 + 1	5.8 = 7.2
Screws securing water pump to crankcase		19 _ 24	1.9 = 2.4	13.7 = 17.4
Water temperature transmitter on intake manifold		33 - 41	3.4 _ 4.2	24.6 r 30.4
Intake manifold nuts		19 = 24	1.9 _ 2.4	13.7 i 17.4
Thermal contact on right head		33 _ 41	3.4 _ 4.2	24.6 = 30.4
Spark plugs tightening		25 T 34	2.5 _ 3.5	18.1 r 25.3

ENGINE MAIN MECHANICAL UNIT

- (1) After having heated engine until intervention of radiator cooling electric fan, on cold engine, loosen, oil and tighten the six screw securing heat to base by following the order shown in figure



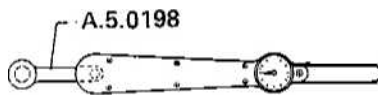
- (1) In the event of in-car tightening of head nuts with the aid of the extension A.5.0198 to be applied as shown, the torque specifications are:

torque spanner having a 300 mm (1 1.84 in) lever arm

N·m 57 = 62
 kg·m 5.8 = 6.3
 lb·ft 41.9 ~ 45.6

torque spanner having a 400 mm (15.75 in) lever arm

Nm 62 67
 kg·m 6.3 6.8
 lb·ft 45.6 ~ 49.2



TROUBLE DIAGNOSIS AND CORRECTIONS

Condition	Probable cause	Corrective action
I. Noisy engine Knocking of crankshaft and bearing	Excessive crankshaft end play	Replace thrust bearing
Piston and connecting rod knocking	<ul style="list-style-type: none"> • Fit wrong • Pin float 	Adjust Adjust
Camshaft knocking	<ul style="list-style-type: none"> • Excessive valve play • Tappet buckets wrong fit • Weakened valve spring 	Adjust Replace Replace
Water pump knocking	Improper shaft end play	Replace water pump assembly
I I. Other mechanical trouble Seized valve seat	<ul style="list-style-type: none"> • Improper valve clearance • Weakened valve spring 	Replace and adjust Replace

ENGINE MAIN MECHANICAL UNIT

Condition	Probable cause	Corrective action
Excessively worn cylinder and piston	<ul style="list-style-type: none"> • Worn fit surfaces • Poor oil quality • Dirty air cleaner • Too rich misture 	<p>Adjust or replace</p> <p>User proper oil</p> <p>Replace filter</p> <p>Adjust or replace carburettor</p>
Faulty connecting rod	<ul style="list-style-type: none"> • Shortage of engine oil • Poor engine oil quality • Worn or out-of-round crankpin • Wrong connecting rod bearing-to-crankpin coupling 	<p>Add or replace oil</p> <p>Check oil level on daily basis</p> <p>Use proper oil</p> <p>Grind or replace</p> <p>Replace</p>
Faulty crankshaft bearing	<ul style="list-style-type: none"> • Shortage of engine oil • Poor engine oil quality • Worn or out-of-round crankshaft journal • Wrong connecting rod bearing-to-coupling 	<p>Add or replace oil</p> <p>Check oil level on daily basis</p> <p>Use proper oil</p> <p>Grind or replace</p> <p>Replace</p>
Belt tensioner knocking	Wrong belt stretching	Restore stretch
Faulty timed	Wear of oil pump control gear	Replace
Oil leakage	<ul style="list-style-type: none"> • Loosen engine oil drain plug • Oil leakage from sump gasket • Oil leakage from camshaft supports gasket • Oil leakage from engine gaskets and seal rings • Oil leakage from oil filter gasket 	<p>Tighten</p> <p>Replace gasket</p> <p>Replace gasket</p> <p>Replace gasket</p> <p>Screw in filter</p>
Decreased of pressure	<ul style="list-style-type: none"> • Dirty pression regulator valve • Poor-engine oil quality 	<p>Clean</p> <p>Replace</p>

SPECIAL SERVICE TOOLS

Tool number	Tool name	Refer to page
A.2.0195	Base for cylinder head support	01-17 01-19 01-24
A.2.0226	Yoke for cylinder head support 	01-17 01-19 01-24
A.2.0378	Tool for locking the flywheel	01-15
A.3.0103/6	Yoke to remove and refit valves 	01-17 01-24
A.3.0311	Puller of valve guides 	01-18
A.3.0312	Driver of intake valve guides 	01-18
A.3.0314	Driver of timing gear cover Seal	01-24
A.3.0321	Support for removing and fitting valves 	01-17 01-24
A.3.0324	Lever for removing and refitting the valves	01-17 01-24