## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER

**GENERAL SPECIFICATIONS**

| Year | Displ. | | Carburetor | HP at RPM | Torque (Ft. Lbs. at RPM) | Compr. Ratio | Bore | | Stroke | |
|---|---|---|---|---|---|---|---|---|---|---|
| | cu. ins. | cc | | | | | in. | mm | in. | mm |
| 1970 S90 | 107.4 | 1760 | 2-Bbl. | 102@5200 | 116@3000 | 10.6-1 | 3.21 | 81.5 | 3.32 | 84.4 |
| 1971-72 S90 | 107.4 | 1760 | 2-Bbl. | 102@5200 | 105@3000 | 8.2-1 | 3.21 | 81.5 | 3.32 | 84.4 |
| 1970-71 100LS | 107.4 | 1760 | 2-Bbl. | 115@5600 | 119@3200 | 10.2-1 | 3.21 | 81.5 | 3.32 | 84.4 |
| 1972-73 100LS&GL | 114.2 | 1871 | 2-Bbl. | 110@5500 | 120@3500 | 8.2-1 | 3.31 | 84 | 3.32 | 84.4 |

### ENGINE IDENTIFICATION

Engine number is die stamped on left side of engine block at clutch housing. On 100 LS and GL models, engine number is preceded by two letters which identify year model and transmission type.

**Engine Identification 100 LS & GL**

| Man. Trans. | Auto. Trans. |
|---|---|
| ZY (1970-71) | ZT (1970-71) |
| ZL (1972) | ZK(1972) |
| ZM (1973) | ZW (1973) |

### ENGINE REMOVAL

*NOTE — A hoist, with block-and-tackle and pit, or suitable frame-contact jack is necessary for removal operation.*

1) Remove hood and apron below front bumper. Disconnect battery. Disconnect hoses and strap from air cleaner, and remove air cleaner.

2) Set center heater lever at "WARM", remove radiator cap, unscrew plug from bottom of radiator and plug from front of engine (between alternator and crankshaft pulley), and drain coolant. Replace plugs and radiator cap after coolant has drained.

3) Disconnect choke cable, accelerator linkage, breather hose from radiator, and heater hose from intake manifold.

4) Pull coil wire from distributor cap and disconnect electrical lead from condenser.

5) Remove radiator and heater hoses from thermostat housing, remove radiator; then, disconnect brake servo vacuum hose at manifold, if equipped.

6) Remove alternator belt, then unbolt and detach fan with mountings.

7) Separate exhaust pipe from muffler and exhaust manifold. Remove pipe from vehicle.

8) Disconnect alternator, marking wiring for reinstallation. Disconnect starter.

9) Unscrew oil filter. Unbolt axle drive shafts and crossmembers. Unscrew speedometer cable from transmission. Remove back-up light switch, brake lines, gearshift cable, clutch cable, gearshift linkage (adjacent to master cylinder), and ground lead from transmission. Disconnect and plug fuel line from fuel pump, disconnect wiring from idle cut-off valve (if equipped), four-pole regulator, thermostat, and oil pressure switch.

10) Remove guard plate from right front engine mount. Raise engine (and transmission) slightly and unbolt front engine mounts, then unbolt transmission mount. Lower engine from vehicle.

*NOTE — If jack assembly is used for engine removal, grille must be removed.*

11) To install, reverse removal procedures, tightening nuts and bolts to specifications.

*NOTE — If alternator is replaced on removed engine, ensure mounting nut faces forward. If nut faces starter, alternator removal will not be possible with engine in vehicle.*

### EXHAUST MANIFOLD REMOVAL

1) With exhaust pipe and air cleaner removed from manifold, unbolt exhaust manifold heat shroud.

2) Unscrew eight mounting nuts and remove exhaust manifold.

*NOTE — When installing, ensure notches in gaskets face downward and beaded edge toward outside.*

### INTAKE MANIFOLD REMOVAL

1) After loosening hose clamps remove coolant hose from between thermostat and intake manifold.

2) Pull vacuum hose off carburetor fitting. Disconnect fuel pump-to-carburetor fuel line at pump. Disconnect air breather hose from manifold. From underside of manifold, remove manifold support bolt.

3) Unbolt and remove intake manifold.

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

### CYLINDER HEAD REMOVAL

1) Remove alternator and bracket, distributor cap, and spark plug wires.

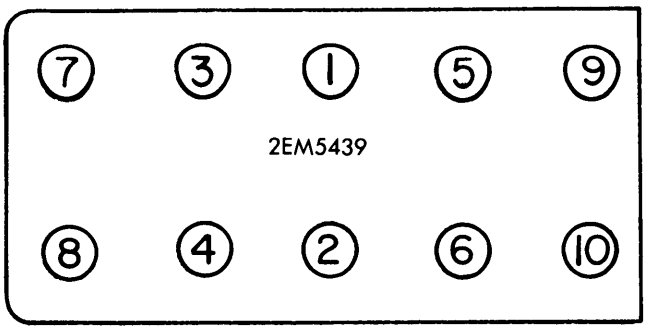
2) Remove cylinder head cover.

3) Unscrew oil filter and oil pressure switch. Remove both manifolds as previously described. Detach thermostat housing.

4) Remove breather line from water pump and head by unbolting flange on head and metal coupler on pump.

5) Detach water pump, fuel pump, and distributor.

6) Loosen all rocker arm nuts until arms move freely. Unscrew cylinder head mounting bolts in sequence shown in illustration. Remove cylinder head.




HEAD TIGHTENING SEQUENCE

**VALVES**

| Engine & Valve | Head Diam. | Face Angle | Seat Angle | Seat Width | Stem Diameter | Stem Clearance | Valve Lift |
|---|---|---|---|---|---|---|---|
| S90, 100 LS & GL | | | | | | | |
| Int. | 1.496" | 45° | 45° | .0866-.1181" | .35315" | .00118" | ..... |
| Exh. | 1.299" | 45° | 45° | .0866-.1181" | .35236" | .00197" | ..... |

### VALVE ARRANGEMENT

I-E-I-E-I-E-I-E (front to rear).

### VALVE GUIDE SERVICING

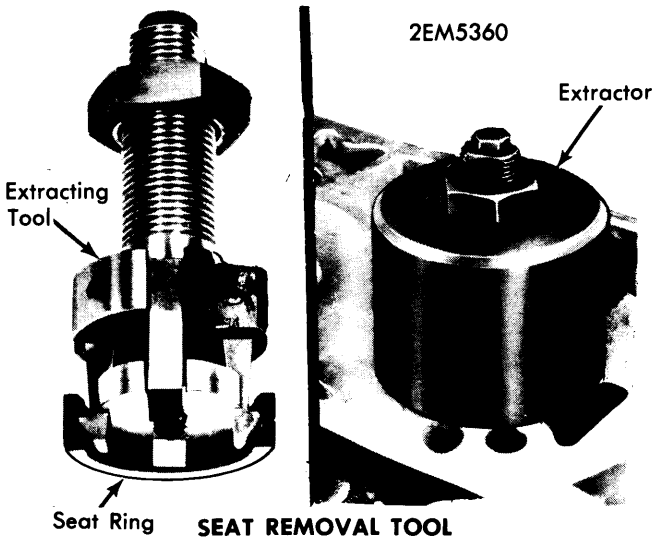
1) Heat cylinder head in oil bath to approximately 248°F. Using suitable tool, drive guides out from bottom of head.

2) Allow head to cool to room temperature. Check valve bores with dial gauge. Guide interference fit should be at least .00028".

3) Select replacement guides, as necessary. Insert spring washer in groove of replacement guide.

*NOTE — 1970-72 models, valve guides vary in diameter: Intake, 0.35"; Exhaust, 0.39".*

4) Lightly grease cylinder head bores and reheat head in oil bath to approximately 248°F. Drive in guides until they rest against spring washers.




SEAT REMOVAL TOOL

### VALVE STEM OIL SEALS

A new type valve stem oil seal is being installed in series production from engine numbers 8920 063 031, 8921 000 001, and 8910 000 001. Install valve seal guide sleeve and press seal on until it bottoms. Remove valve seal guide.

### VALVE SEAT INSERTS

1) Set up special seat turning tool (F 4, or equivalent), as shown in illustration. Place tool vertically and position cutter on center of cylindrical side of seat insert.

2) Attach suitable crank; turn cutter until groove is cut large enough to take up claws of extractor, as in illustration.

3) Heat cylinder head in oil bath to approximately 248°F. Remove nut from cutter; turn hex head of tool screw until claws are firmly in place.

4) Place extracting attachment, as shown, in place; replace and turn nut until seat is extracted.

5) Reheat head, chill seat inserts and drive into head.

### ROCKER ARM ASSEMBLY

1) Unscrew rocker arm nuts and remove rocker arms.

2) Fasten suitable counterholder to rocker studs and press down on valve spring with appropriate tool.

3) Remove spring retainers and release springs. Remove springs (outer and inner) and spring caps. Keep components in proper order for reassembly.

4) Pry off valve seals and remove rotocap or disc from valves. Remove rocker studs and place aside together with tappet guides.

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

### VALVE CLEARANCE ADJUSTMENT

1) Allow engine to reach normal operating temperature. Remove air cleaner, cylinder head cover, spark plugs, and distributor cap, as necessary.

2) Jack up one front wheel and place transmission in 4th gear. Turn raised wheel until No. 1 piston is at TDC of compression stroke, with valves of No. 4 cylinder overlapped. Both valves of No. 1 cylinder should be closed.

3) Adjust valves in firing order: 1-3-4-2. Turn adjusting nut on each rocker arm until appropriate clearance is reached:

| Application | Cold Gap | Warm Gap |
|---|---|---|
| S90 | | |
| Intake | .004" | .006" |
| Exhaust | .010" | .012" |
| 100LS & GL | | |
| Intake | .004" | .008" |
| Exhaust | .014" | .016" |

**PISTONS, PINS, RINGS**

| Engine | PISTONS | PINS | | RINGS | | |
|---|---|---|---|---|---|---|
| | Clearance | Piston Fit | Rod Fit | Rings | End Gap | Side Clearance |
| S90 | .015" | .00047-.0008" | Press Fit | 1<br>2<br>Oil | .012-.018"<br>.010-.016"<br>.012-.018" | .0032-.0044"<br>.0013-.0014"<br>.0020-.0011" |
| 100 LS & GL | .012" | .00047-.0009" | Press Fit | 1<br>2<br>Oil | .03937"<br>.03937"<br>.03937" | .006"<br>.006"<br>.006" |

### PISTON & ROD ASSEMBLY

1) Remove oil pan. Counterhold crankshaft (at flywheel) and remove crankshaft pulley retaining nut. Detach crankshaft pulley.

2) Unscrew retaining bolts from timing cover, remove chain tensioner, and remove guide strip. Remove camshaft gear mounting screw and remove gear together with timing chain.

3) Mark flywheel and crankshaft for reassembly, then unbolt and remove flywheel.

4) If necessary, remove transmission drive shaft guide gearing, using suitable extractor.

5) Unbolt both flange couplings and remove oil tube. Remove oil pump retaining screw and pull pump out of block.

6) Unscrew connecting rod bearing caps and set aside for reinstallation. Push rod and piston assemblies out toward cylinder head side.

### PISTON PIN REPLACEMENT

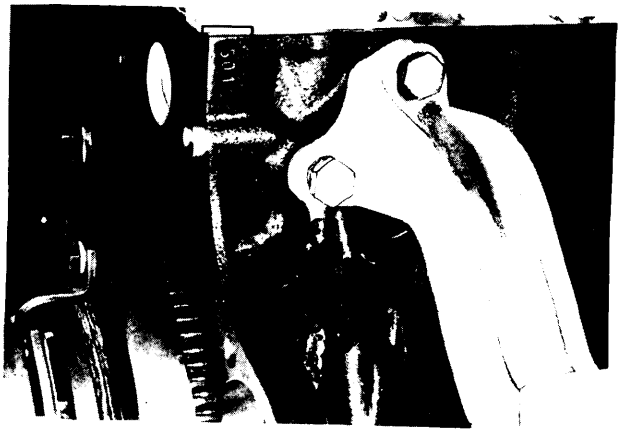
1) Remove circlip. Heat piston and pin assembly to approximately 140°F. Using suitable driver, remove pin from piston and rod.

2) Measure pin diameter and rod bushing wear. If measurements exceed specifications, replace components.

3) Replace pin using same procedure as for removal. Lock pin in place with snap ring.

### FITTING PISTONS

1) Gauge cylinder bores at three levels (top, middle, bottom), then repeat procedure at 90° to first measurements. If amount of wear is greater than .0016" (Super 90) or .00315" (100LS) from specifications, rebore cylinders and install oversize pistons.



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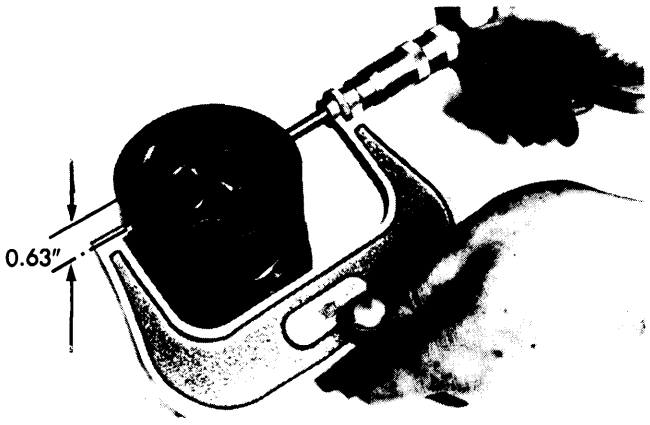
CYLINDER CODE MARK

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MEASURING PISTON OD

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

*NOTE — Cylinder sizes of new, as well as exchange engines are die stamped on starter end of block just below cylinder head.*

**Standard Pistons & Cylinder Dia. (1760 cc Engine)**

| Piston Dia. (In.) | Cylinder Dia. (In.) | Stamp Code |
|---|---|---|
| 3.2074 | 3.2086 | 500 |
| 3.2078 | 3.2090 | 501 |
| 3.2082 | 3.2094 | 502 |
| 3.2086 | 3.2098 | 503 |

**Oversize Pistons & Cylinder Dia. (1760 cc Engine)**

| Piston Dia. (In.) | Cylinder Dia. (In.) | Stamp Code |
|---|---|---|
| 3.2177 | 3.2188 | 576 |
| 3.2181 | 3.2192 | 577 |
| 3.2184 | 3.2196 | 578 |
| 3.2275 | 3.2287 | 201 |
| 3.2279 | 3.2291 | 202 |
| 3.2283 | 3.2295 | 203 |
| 3.2472 | 3.2484 | 251 |
| 3.2476 | 3.2488 | 252 |
| 3.2480 | 3.2492 | 253 |

**Standard Pistons & Cylinder Dia. (1871 cc Engine)**

| Piston Dia. (In.) | Cylinder Dia. (In.) | Stamp Code |
|---|---|---|
| 3.3062 | 3.3074 | 401 |
| 3.3066 | 3.3078 | 402 |
| 3.3070 | 3.3082 | 403 |

**Oversize Pistons & Cylinder Dia. (1871 cc Engine)**

| Piston Dia. (In.) | Cylinder Dia. (In.) | Stamp Code |
|---|---|---|
| 3.3161 | 3.3173 | 426 |
| 3.3165 | 3.3177 | 427 |
| 3.3169 | 3.3181 | 428 |
| 3.3259 | 3.3271 | 451 |
| 3.3263 | 3.3275 | 452 |
| 3.3267 | 3.3279 | 453 |
| 3.3456 | 3.3468 | 501 |
| 3.3460 | 3.3472 | 502 |
| 3.3464 | 3.3476 | 503 |

2) If reusing pistons, measure OD approximately 0.63" from bottom of piston and at 90° to pin bore. Piston wear which exceeds .0016" (Super 90) or .00158" (100LS) from specifications, necessitates replacement.

3) Check piston ring side clearance and end-gap. Replace rings which exceed specifications. Install rings with side marked "Top" facing up. Space end-gaps so that gaps are staggered and are not parallel with block center line.

4) Check piston pins as previously described. Check connecting rod bushings: Small end diameter is .9249" (1970-71), .9488" (1972-73); large end (bearing cap installed) is 1.063".

5) Apply thin coat of oil to cylinder surfaces. Slide piston and rod assembly into proper bores (with ring compressor attached), with arrow mark, on top edge of piston, facing forward.

6) Position connecting rod bearings, install new rod cap nuts and bolts and torque to specifications.

**CRANKSHAFT MAIN & CONNECTING ROD BEARINGS**

| | MAIN BEARINGS | | | | CONNECTING ROD BEARINGS | | |
|---|---|---|---|---|---|---|---|
| Engine | Journal Diam. | Clearance | Thrust Bearing | Crankshaft Endplay | Journal Diam. | Clearance | Sideplay |
| S90,100 LS & GL | 2.3622" | .00158-.00394" | No. 4 | .0028-.0075" | 1.88976" | .00118-.00331" | .00433-.0090" |

### CRANKSHAFT REMOVAL

1) Remove oil pan and front pulley. Remove timing cover and camshaft sprocket (with timing chain), *see procedures in Timing Chain Replacement.*

2) Mark relative position of flywheel to crankshaft, then unbolt and remove flywheel. If necessary, use extractor to draw out transmission drive shaft guide bearing.

3) Disconnect oil line at oil pump and block. Unscrew oil pump retaining bolt and pull pump out of block.

4) Unscrew connecting rod bearing caps, remove bearings from rods, and push out piston assemblies. *NOTE — Keep all parts in proper sequence for reinstallation.*

5) Unscrew main bearing cap screws and carefully remove caps with bearings. Extract seal ring (flywheel side) at rear of block.

6) Lift out crankshaft and carefully remove rear oil seal.

7) When reinstalling crankshaft gear, heat gear to approximately 140°F and slide onto crankshaft. Fit Woodruff key in position. *See Main Bearing Service concerning bearing replacement and/or fit.*

*CAUTION — On 100 LS and GL engines, number four main bearing cap has a weaker dowel pin boss on one side. If during assembly this boss is broken, entire engine block must be replaced. Main bearing caps are matched to specific block and cannot be interchanged.*

### MAIN BEARING SERVICE

1) Remove main bearings from block by pressing to one side with fingertips.

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

2) Clean bearing faces and connecting rod journals. Place Plastigage axially on the journal. Install rod cap in position and tighten bolts to specifications. *NOTE – Do not turn crankshaft during this operation.*

3) Remove rod cap and measure width of Plastigage with scale provided. Corresponding number on scale represents bearing clearance. Repeat procedure for other connecting rod journals. Replace bearings and rework journals as necessary.

4) Install main bearing caps, with bearings, to block (crankshaft not installed). Tighten cap bolts to specifications. Insert suitable gauge and determine wear on main bearings. Procedure may be repeated for connecting rod bearings.

5) Bearings are available in three undersizes of .010" increments.

6) Install crankshaft to block and repeat Plastigage method to determine main bearing clearance. If main bearing replacement is required, replace entire set (five bearings).

### ENGINE FRONT COVER & OIL SEAL

If front oil seal leakage is determined, seal may be replaced without removing timing cover, as follows:

1) Remove crankshaft pulley. Carefully pry out seal using screwdriver.

2) Apply suitable lubricant to lips of new seal and outer edge of seal. Place seal in position with open end facing engine. Using suitable tool (SM-3, or equivalent), press in seal.

3) If timing cover is removed, press new seal into position from inside, until seal rests against stop.

### REAR MAIN BEARING OIL SEAL SERVICE

1) To install rear main bearing oil seal, place seal on suitable seal installer (10.3) and slide it on crankshaft by hand with sealing lip facing crankshaft.

2) Insert two flywheel mounting bolts through assembly ring. Tighten bolts until seal reaches stop. Remove assembly ring.

### CAMSHAFT REMOVAL

1) With crankshaft and piston assemblies removed, as previously described, unscrew oil pressure valve from inside block.

2) Unscrew camshaft guide flange mounting screws and remove flange from front of block.

3) Screw handle (or other suitable device) into camshaft and remove by carefully pulling upward (block in vertical position).

4) When installing new, or exchange, camshaft, apply Molykote to bearing and cam surfaces to improve run-in process.

### CAMSHAFT END THRUST

1) Install camshaft and sprocket. Tighten stretch screw until sprocket rests against flange of camshaft. Check camshaft for ease of operation.

2) Check camshaft endplay with dial indicator. Maximum permissible endplay is .004". If limit is exceeded, install new camshaft flange.

| VALVE TIMING | | | | |
|---|---|---|---|---|
| | INTAKE | | EXHAUST | |
| Engine | Open (BTDC) | Close (ABDC) | Open (BBDC) | Close (ATDC) |
| S90 | 6° | 38° | 41° | 5° |
| 100LS & GL | 5° | 37° | 39° | 3° |

### TIMING CHAIN REPLACEMENT

1) Unscrew timing cover mounting bolts and remove cover. Bend open lockplate and unscrew hydraulic chain tensioner plug, insert screwdriver, or similar tool and turn plunger to the left, to prevent plunger from springing out.

2) Unscrew chain tensioner and guide rail. Remove camshaft sprocket together with timing chain.

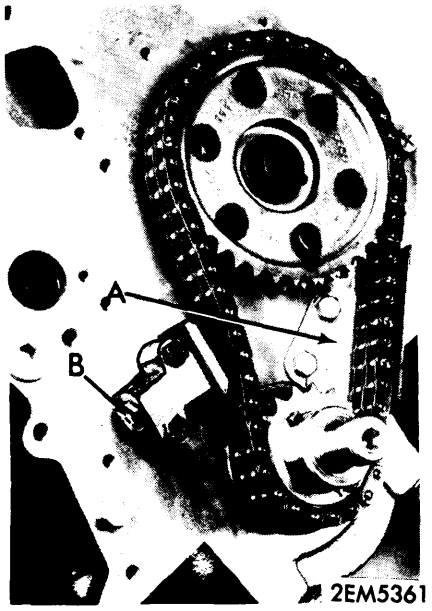
3) Use replacement chain with straight links (do not use indented links). Place chain on gear with aligning marks in proper position, *see Valve Timing.*

4) Place base plate of tensioner in position and install tensioner, with plunger. Torque holding screws to specifications.

5) Unlock plunger with screwdriver, by turning left. Check to ensure free movement of plunger. Continue turning counterclockwise, as necessary, as spring and automatic adjuster are built into plunger.

*NOTE – From engine numbers ZY 006 201, ZM 002 975, ZZ 063 327, ZX 025 352 and ZV 018 208, a new automatic release chain tensioner is installed. To release plunger, press slide fully into tensioner body.*

6) Screw in plunger plug with lockplate. Torque plug to specification.




A – Guide Rail B – Tensioner Plug

**TIMING CHAIN ASSEMBLY**

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

### VALVE TIMING

1) Remove camshaft sprocket mounting bolt, as it is necessary to remove sprocket when installing chain.

2) Turn camshaft sprocket until punched tooth is in exact alignment with notch in guide rail, as illustrated.

3) Carefully remove camshaft sprocket; when doing so, do not turn camshaft.

4) Turn crankshaft until No. 1 cylinder is at TDC of compression stroke. Place chain over gear and position camshaft sprocket in timing chain such that it is possible to slide sprocket onto camshaft with marks in alignment.

5) Torque camshaft sprocket stretch screw to specification.

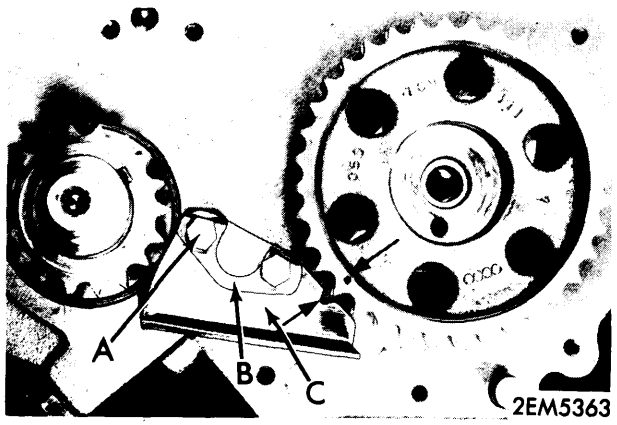
6) Replace chain tensioner, as described previously.

7) Recheck No. 1 piston at TDC, of compression stroke, and ensure proper valve overlap on No. 4 cylinder.

8) Set valves of No. 1 cylinder **without clearance**, or turn adjusting nut until valves are slightly raised.

9) Place dial indicator with slight pretension on intake valve. Set gauge at "ZERO". Continue turning crankshaft clockwise until gauge shows a valve stroke of .040".

10) Timing is correct if timing mark of front pulley shows approximately 6°BTDC. If timing as checked on No. 1 cylinder is within specifications, gap of all valves may be adjusted without checking timing at other cylinders.




A — Hex Screw
C — Guide Rail
B — Lock Plate

**ALIGNING CAMSHAFT SPROCKET**

## ENGINE OILING

### ENGINE OILING SYSTEM

Engine lubrication is accomplished through forced oil circulation. Oil is sucked out of oil pan through pump, fed through a pressure line to oil filter, then into main channels. Rocker lever bearings are lubed from center camshaft bearing, fed through vertical bore in block.

**Crankcase Capacity** — 4.25 qts.

**Oil Filter** — Replaceable spin-on type.

**Normal Oil Pressure** — 14 psi minimum; 85 psi maximum.

## ENGINE COOLING

### WATER PUMP

1) Remove fan belt, drain coolant, and unbolt metal hose connection from water pump.

2) Loosen hose clamps and remove water hoses from pump.

3) Unscrew three mounting bolts and remove pump.

**Thermostat** — 181°F (summer) or 189°F (winter).

**Cooling System Capacity** — 8 qts.

### ENGINE NOTES

After installation of new cylinder head, do not drive vehicle at top speed for approximately 150 miles, to prevent scoring cylinder surface.

## 1970-73 AUDI S90, 100 LS & GL 4 CYLINDER (Cont.)

### TIGHTENING SPECIFICATIONS

| Application | Ft. Lbs. (mkg) |
|---|---|
| Exhaust Manifold-to-Head | 17 (2.4) |
| Intake Manifold-to-Head | 17 (2.4) |
| Intake Manifold Support | 14 (2.0) |
| Oil Line (Pump-to-Block) | 7 (1.0) |
| Rocker Adjusting Nuts | 11-36 (1.5-5.0) |
| Breather Flange (Head) | 7 (1.0) |
| Camshaft Guide Flange | 18 (2.5) |
| Timing Chain Guide Rail | 9 (1.2) |
| Intake Manifold Bolt | 18 (2.5) |
| Chain Tensioner-to-Block | 9 (1.2) |
| Rocker Studs | 72 (1.0 max.) |
| No. 5 Bearing Cap (Hex Bolts) | 58 (8.0) |
| No. 5 Bearing Cap (Allen Screws) | 47 (6.5) |
| Bearing Caps (In Steps) | 58 (8.0) |
| Engine Mount-to-Block | 30 (4.2) |
| Engine Mount-to-Carrier | 43 (6.0) |
| Chamshaft Sprocket-to-Chamshaft | 58 (8.0) |
| Oil Pump-to-Block | 18 (2.5) |
| Connecting Rod Cap Bolts | |
| Before Engine No. ZY 006 474, ZT 002 215 and ZL 000 001 | 30-32 (4.1-4.4) |
| From Engine No. ZY 006 474, ZT 002 215 and ZL 000 001 | 40-43 (5.5-5.9) |
| Crankshaft Pulley | 130-180 (18-25) |
| Chain Tensioner Plug | 4-7 (0.5-1.0) |
| Oil Pressure Relief Valve | 18-25 (2.5-3.5) |
| Head Bolts (In Steps) | |
| Step 1 | 29 (4.0) |
| Step 2 | 43 (6.0) |
| Step 3 | 58 (8.0) |
| Step 4 | 65 (9.0) |
| Timing Cover | 7 (1.0) |
| Oil Pan | |
| 8mm Bolts | 11 (1.5) |
| 6mm Bolts | 6 (0.8) |