TYPE 1 4 CYLINDER

ENGINE CODING

ENGINE IDENTIFICATION

Engine identification is determined by first digits of serial number. Engine serial number is stamped on crankcase under generator support flange

Application	Engine Code
Type 1 (1584 cc)	AJ

ENGINE, CYLINDER HEAD & MANIOLD

ENGINE

Removal – 1) Remove air cleaner. Drain oil. Disconnect hoses between fan housing and heat exchangers. Disconnect battery ground, coil wires, alternator, and oil pressure switch.

2) Disconnect fuel injection wiring harness from coil, injectors, crankcase, temperature sensors, air intake distributor and other related parts. Make sure to index mark each wire for reinstallation.

3) From under vehicle, disconnect starter electrical wires. Disconnect fuel line from pressure regulator and plug hose. Unhook back-up lights.

4) Disconnect throttle cable. Remove small cover plates over preheater pipe connections. On models equipped with automatic stick shift, disconnect lead and vacuum hose from control valve. Disconnect transmission lines and plug. Disconnect heater control cables. Disconnect heater ducting at front of heat exchangers.

5) On models equipped with automatic stick shift, remove four converter to drive plate bolts. Remove nuts from lower engine mounting studs. Place a jack under engine and raise until squarely seated against crankcase. Remove left side upper mounting bolt and right side nut and bolt. Slide engine rearward until clear. Lower jack and continue to pull engine to rear.

NOTE – *After engine has been removed, install a retainer to bell housing to keep torque converter in place.*

Installation – To install, reverse removal procedure and note: Lubricate transmission input shaft and clutch release bearing. Also, lightly lubricate starter (Bosch only) drive bushing with multi-purpose grease. Adjust clutch free play. Make sure ignition timing and accelerator control linkage are properly adjusted.

INTAKE MANIFOLD

Removal – 1) Remove fan housing. Disconnect preheating pipes at flanges. Remove injectors, intake air sensor and air intake distributor from crankcase.

2) Remove nuts holding manifold. Disconnect all air and vacuum hoses from air intake distributor. Be sure to index each item for reinstallation.

3) Disconnect exhaust line from EGR valve by removing mounting nuts. Lift off manifold with intake air distributor.

Installation – To install, reverse removal procedure and replace gaskets where necessary.

CYLINDER HEAD

NOTE – *Engine must be removed from vehicle, and manifolds removed, before removing cylinder heads. If cylinders are not to be removed, use retaining device to keep cylinders from pulling free.*

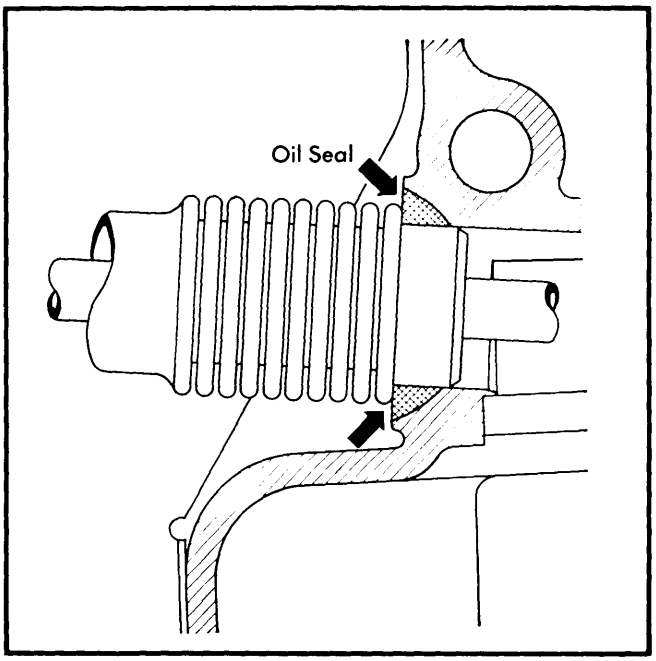

Fig. 1 Push Rod Tube Installation with Detail of Seal Fit

Removal – 1) Remove engine and intake manifold as previously outlined. Remove muffler and heat exchangers. Disconnect spark plug wires at spark plugs. Remove deflector cover plates from under cylinder cover plates and remove cylinder cover plates.

2) On fuel injected engines remove lower left side warm air duct. Remove bolt securing thermostat to bracket and unscrew thermostat from control rod. Disconnect rod from control lever at top.

3) Remove rocker arm cover with gasket and remove rocker arm assemblies. Remove push rods, keeping in order for reassembly. Loosen cylinder head nuts gradually working in sequence from outside toward center and remove cylinder head.

Installation – 1) Install new seals on pushrod tubes. Install cylinder head with new cylinder seals and position pushrod tubes with seams facing upward. Push head onto cylinders to hold pushrod tubes.

2) Install cylinder head washers and nuts to studs and tighten just enough to hold head and pushrod tubes in place. Tighten nuts evenly in sequence shown in *Fig. 2 "A"* to 7 ft. lbs. (1 mkg), then tighten in sequence shown in *Fig. 2 "B"* to final torque. Reverse removal procedure for remaining components and adjust valve clearance.

TYPE 1 4 CYLINDER (Cont.)

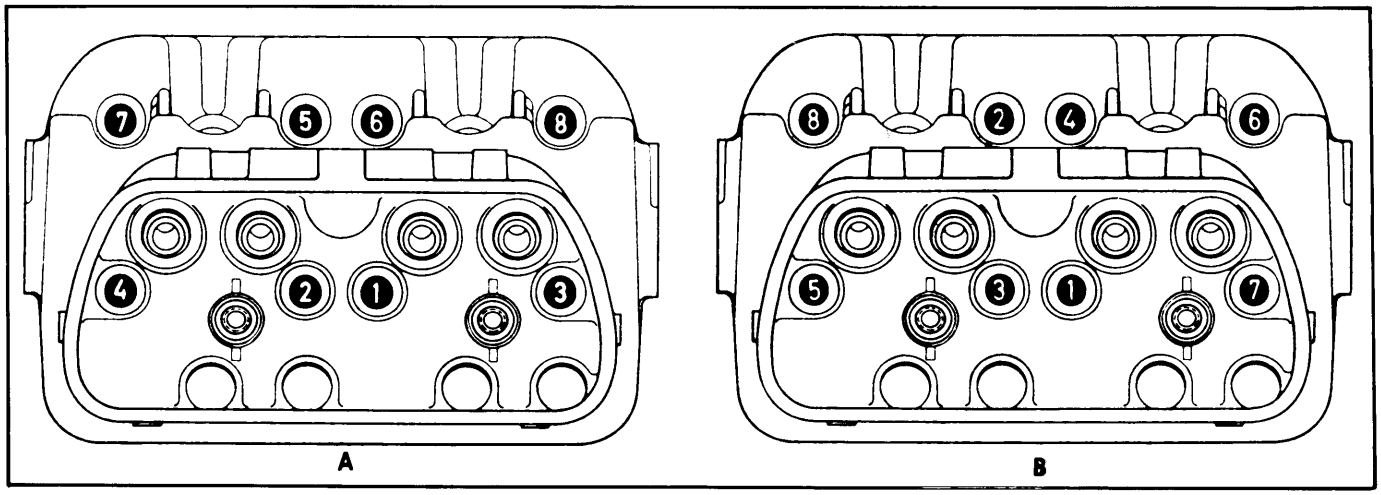

Fig. 2 Initial (A) and Final (B) Cylinder Head Tightening Sequence

VALVES

VALVE ARRANGEMENT

E-I-I-E (front to rear), both banks.

VALVE GUIDE SERVICING

1) Place valve in valve guide with stem flush with end of guide. With dial indicator, measure valve rock at valve head. If rock exceeds .031" replace valve guide or valve. Valve guide with inside machined shoulder is exhaust.

2) Valve guides are a press fit in the cylinder head and should be replaced only with special equipment. Threads should be cut in the old guide and a threaded puller fitted. Guide should be withdrawn and replaced with a press and reamed for proper stem clearance.

CAUTION – *Do NOT use a hammer and drift for guide replacement due to the danger of damage to the cylinder head.*

VALVE STEM OIL SEALS

Coat valve stems with molybdenum-disulfide paste and insert in cylinder head. Slide valve stem seal ring over valve stem and install spring, retainer and keeper.

VALVE SPRINGS

NOTE – *Valve spring may be removed with cylinder head installed. Apply constant air pressure (minimum 85 psi) to cylinder through spark plug hole to hold valve in place while compressing spring.*

Removal – Remove cylinder head cover and rocker arm shaft. Install suitable valve spring compressor tool (VW311H with cylinder head removed, VW653/2 with cylinder head installed). Compress spring retainer and spring and remove valve keepers. Release compressor and remove spring retainer and spring.

Installation – Install valve, spring, stem seal ring and spring retainer. Note that closely spaced coils of spring are against cylinder head. Compress spring with suitable compressor and install keepers.

ROCKER ARM ASSEMBLY

Removal – Clean exterior of rocker arm cover and remove from head. Remove rocker arm shaft retaining nuts and lift off shaft assembly. Remove end clips and washers from shaft and slide off rocker arms and supports.

Installation – To install, reverse removal procedure noting that slotted side of rocker arm supports point upward and beveled end is toward outside of head.

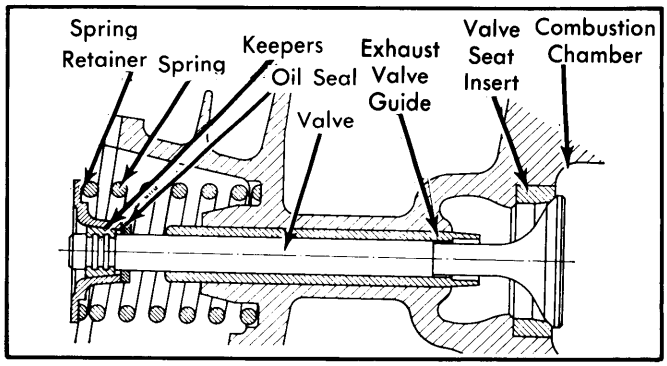

Fig. 3 Sectional View of Valve with Related Parts

VALVE CLEARANCE ADJUSTMENT

Perform adjustment with engine cold. Turn crankshaft until No. 1 cylinder is at TDC position and distributor rotor points to No. 1 cylinder position. Loosen lock-nut and adjust rocker arm adjusting screw until valve clearance is .006" (.15 mm). Check clearance between adjusting screw and valve stem of both valves. Turn crankshaft 90° while noting rotor travel. Adjust valves of Nos. 2, 3 and 4 in turn.

TYPE 1 4 CYLINDER (Cont.)

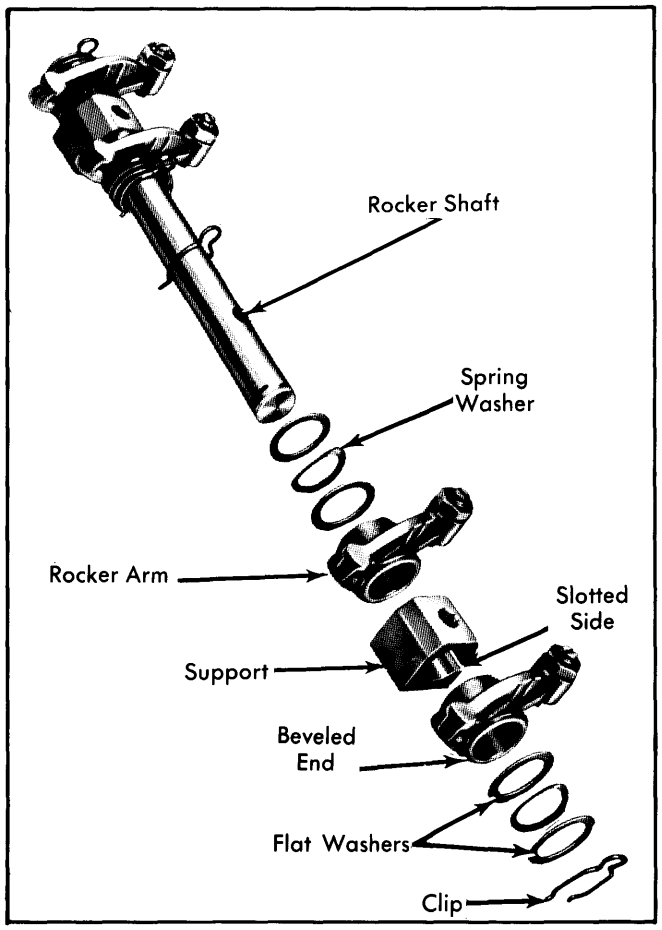

Fig. 4 Expanded View of Rocker Arm Assembly

PISTONS, PINS & RINGS

CYLINDERS

Removal – Remove engine and remove cylinder head. NOTE – *Mark cylinders to insure they are reinstalled in original position.* Remove deflector plates from bottom of cylinders and pull cylinders from pistons.

Installation – 1) Check seating surfaces of cylinders on both ends. Make sure seating areas are perfectly clean and true before installing cylinders. Stagger ring gaps 90° apart so that oil ring gap faces upward when cylinder is installed.

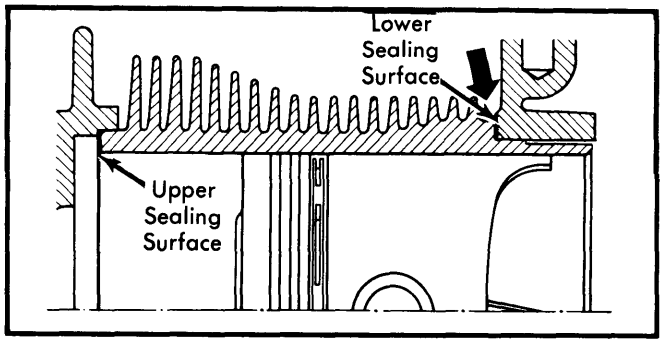

Fig. 5 Cylinder Sealing Surfaces

2) Apply oil to cylinder, piston, rings and piston pin. Compress rings with suitable ring compressor (VW123). Install new sealing gasket on crankcase side and slide cylinder over piston.

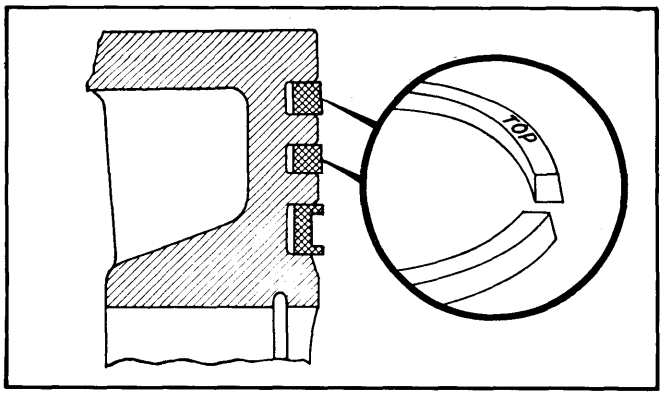

Fig. 6 Installation of Compression Rings 1 and 2

3) Make sure studs do not contact cooling fins when cylinder is completely seated against crankcase. Install cylinder deflector plates and remaining components in reverse of removal.

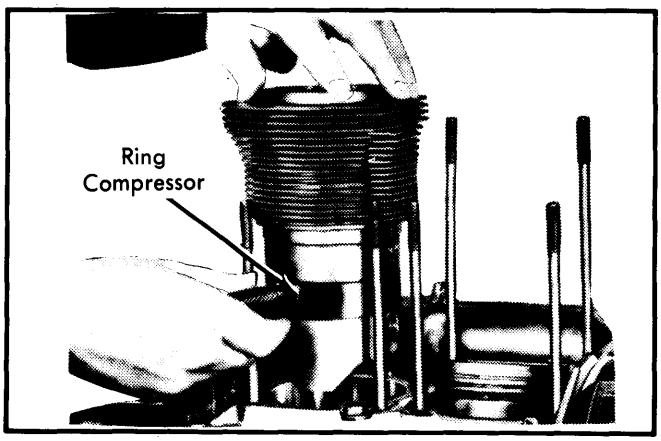

Fig. 7 Cylinder Installation

FITTING PISTONS

1) With piston and cylinder removed, measure clearance between piston and cylinder. Check piston size at bottom of skirt and 90° to piston pin. Check cylinder size at several points throughout cylinder, using largest reading to determine clearance.

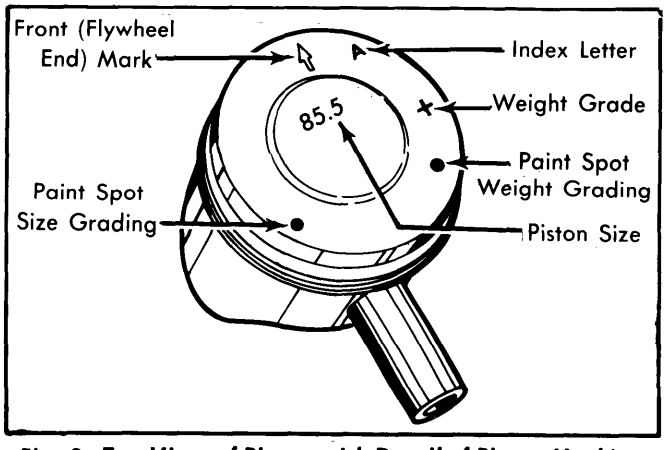

Fig. 8 Top View of Piston with Detail of Piston Markings

TYPE 1 4 CYLINDER (Cont.)

2) If clearance exceeds .008" (.20 mm) replace piston and cylinder as a set. New piston must be of same weight grade as original or within 10 g of original piston weight. Piston size, weight and installation position are marked on top of piston.

NOTE – *Piston alone may be replaced with one of matching size. Only pistons of same size and weight grade should be installed in same engine.*

3) New piston rings are size graded to match piston-cylinder sets. Measure ring gap with ring installed approximately ¼" from bottom of cylinder.

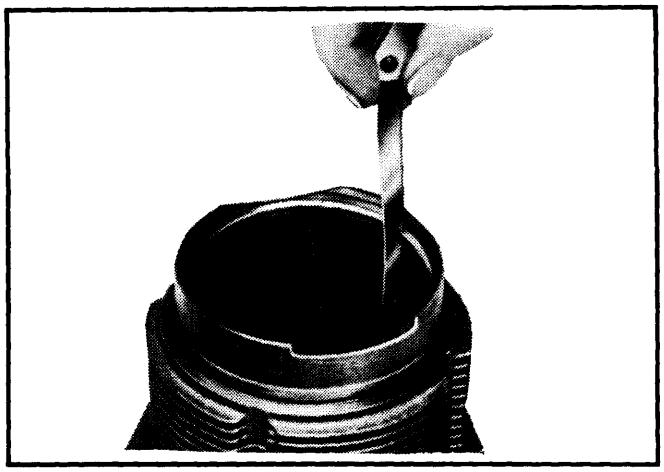

Fig. 9 Checking Piston Ring End Gap

4) Install rings on piston and measure ring side clearance using feeler gauge. If clearance exceeds .005" (.12 mm) on top ring or .004" (.10 mm) on second or oil ring, piston must be replaced.

PISTON PINS

Removal – Remove cylinders and mark pistons before removing for proper installation. Using suitable pliers (VW122b), remove piston pin circlips and push piston pin out of piston using suitable tool (VW207).

Installation – 1) Check fit of pin in piston. Piston pin should be light push fit with piston 68-167°F. If pin is too loose, both pin and piston must be replaced. Check clearance of pin in rod. If clearance exceeds .0016" (.04 mm) replace piston pin and rod bushing. See Piston Pin Bushing Replacement.

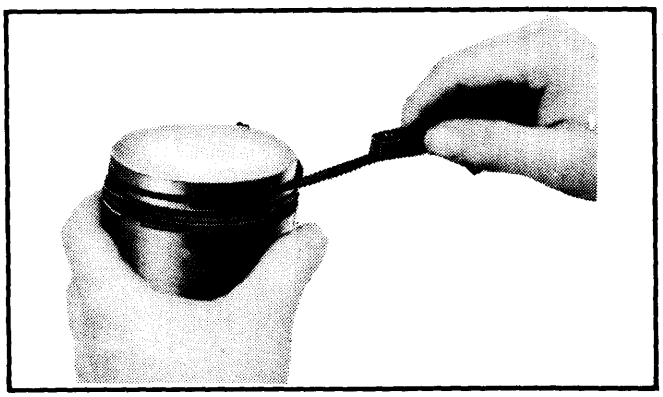

Fig. 10 Checking Piston Ring Side Clearance

2) Install one circlip in piston on side facing flywheel. Position piston on connecting rod and push piston pin through piston. Replace remaining circlip. NOTE – *Piston may be heated to ease pin installation.* Replace remaining components in reverse of removal.

PISTON PIN BUSHING REPLACEMENT

1) At normal temperature, piston pin should push fit in connecting rod. If side clearance is felt with a new pin installed, bushing must be replaced and reamed to correct fit with a new piston pin.

2) Press bushing out using a suitable mandrel and components. Install new bushing using same procedure and tools used for removal.

3) Drill through oil holes in connecting rod. Use handreamer to fit pin into bushing. Bushing should be free of chatter marks when reaming is completed. Piston pin should push fit into bushing without oil. Clearance must be .0004-.0008" (.01-.02 mm).

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

CRANKCASE DISASSEMBLY

NOTE – *Crankcase must be taken apart to replace connecting rods, connecting rod bearings and main bearings. It is also necessary to disassemble crankcase to remove crankshaft, camshaft and camshaft bearings.*

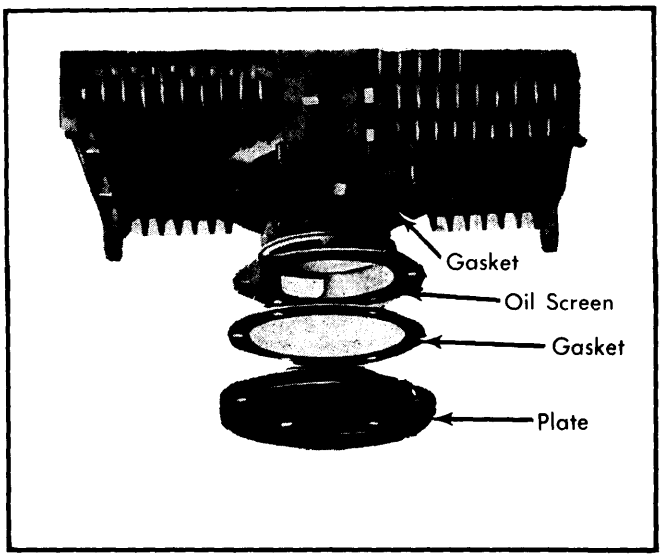

Fig. 11 Bottom View Showing Oil Strainer and Components

1) With engine removed from vehicle, remove cylinder heads, cylinders and pistons as previously outlined. Remove oil strainer cover and screen. Remove flywheel or drive plate, distributor, fuel pump, distributor drive shaft with washers, and oil cooler.

TYPE 1 4 CYLINDER (Cont.)

2) Remove front pulley using suitable puller (VW203). Remove generator support housing and metal shroud from front of engine. Remove oil pump cover and pull pump from crankcase with suitable puller (VW201). Remove nuts and bolts securing crankcase halves and separate.

CAUTION — *Never pry between crankcase flanges to separate the halves. Use a rubber mallet to loosen halves.*

3) Remove camshaft and crankshaft. Remove crankshaft oil seal and cam plug. Remove bearing halves from both sides of crankcase and remove bearing dowel pins from left half of crankcase (if required). Remove cam bearings and oil pressure relief valve.

CRANKCASE ASSEMBLY

4) Install camshaft with "O" on cam gear centered between 2 teeth with punch marks on crankshaft gear. Install cam plug using sealer. Spread a thin coat of sealer on mating edges of crankcase halves, making sure that sealer does not enter oil passages.

6) Check crankshaft for freedom of movement. Install oil pressure relief valve. Install pistons, cylinders and cylinder heads as previously outlined. Install all components except distributor drive in reverse order of removal.

7) Set engine to number 1 firing position. Place distributor drive washer on a long screwdriver and drop into place at bottom of distributor drive hole. Insert distributor drive with slot at 90° to crankshaft and small segment of slot toward pulley *(See Fig. 12).*

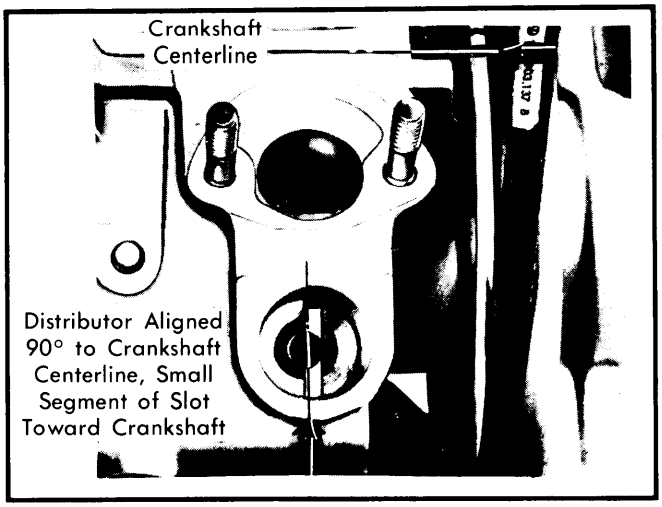

Fig. 12 Distributor Drive Installation

MAIN & CONNECTING ROD BEARING SERVICE

1) Split crankcase and remove crankcase and connecting rod assembly as previously outlined. Attach crankshaft to a suitable holding fixture (VW310A). Remove Woodruff key, oil thrower and number 4 bearing. Remove connecting rods and bearings. Remove snap ring from end of crankshaft.

2) Press distributor drive gear, spacer and crankshaft gear from crankshaft. Remove number 3 bearing. Thoroughly clean crankshaft and blow out all oil passages with compressed air. Check crankshaft for maximum runout of .0011" (.03 mm). Check crankshaft journals for maximum out-of-round of .0011" (.03 mm). If beyond limit, crankshaft must be ground.

3) Main and connecting rod bearings are available in .010" (.254 mm), .020" (.508 mm) and .030" (.762 mm) undersize after crankshaft regrinding. Inspect connecting rod pin bushings for excess wear and replace if required. *See Piston Pin and Piston Pin Bushing Replacement.*

4) Check connecting rod for twist and bending. If replacement is required, difference in weight between old and new connecting rod must not exceed 10 grams. Check main and connecting rod bearing clearance using Plastigage method. Crankcase halves must be properly torqued. DO NOT turn crankshaft when checking clearance.

5) Install bearing shells so that tangs engage notches in rod bore. Coat bearing surfaces with lubricant and install rod and cap so that forged mark on rod is UP when positioned as installed in engine. Tighten to specifications and check rod side clearance.

6) Lubricate and install number 3 main bearing on crankshaft with dowel pin hole toward flywheel end. Heat crankshaft gear and press on over Woodruff key so that chamfer in gear bore is toward number 3 bearing. Install spacer, distributor gear over Woodruff key, and snap ring.

7) Lubricate and install number 4 bearing with groove toward oil deflector and install oil deflector. Lubricate and install number 1 bearing on crankshaft and place lower half of number 2 in position in left half of crankcase. Ensure that dowel pin engages hole in shell properly.

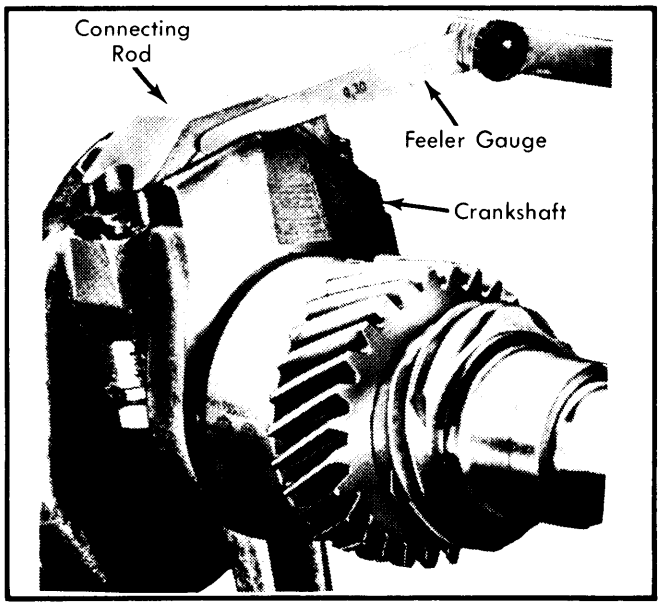

Fig. 13 Using a Feeler Gauge to Check Connecting Rod Side Clearance

8) Place crankshaft and rod assembly in position in left half of crankcase, aligning timing marks on crankshaft and camshaft gears. Turn bearings so that alignment holes properly engage dowels in left half of crankcase. Install right half of crankcase.

TYPE 1 4 CYLINDER (Cont.)

THRUST BEARING ALIGNMENT

1) Crankshaft end play must be adjusted with crankshaft oil seal removed. Install 2 shims and tighten flywheel in position. Measure end play as illustrated. Correct end play should be .003-005" (.08-.13 mm) with a wear limit of .006" (.15 mm).

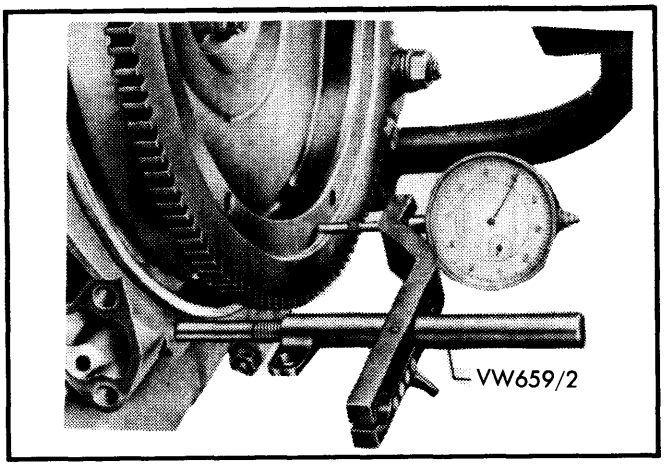

Fig. 14 Checking Crankshaft End Play with Dial Gauge

2) Shims are available in 5 thicknesses from .0095" (.24 mm) to .0142" (.36 mm) Sizes are etched (mm) on shims. Select and add third shim to provide proper end play and install along with oil seal and flywheel. Recheck end play.

MAIN BEARING OIL SEAL SERVICE

Removal & Installation – Remove flywheel and pry out old seal. Clean recess in crankcase and coat with a thin film of sealer. Install new seal with suitable installer (VW 240D). Ensure that seal is seated squarely in crankcase recess. Lubricate contact surface of seal and install flywheel.

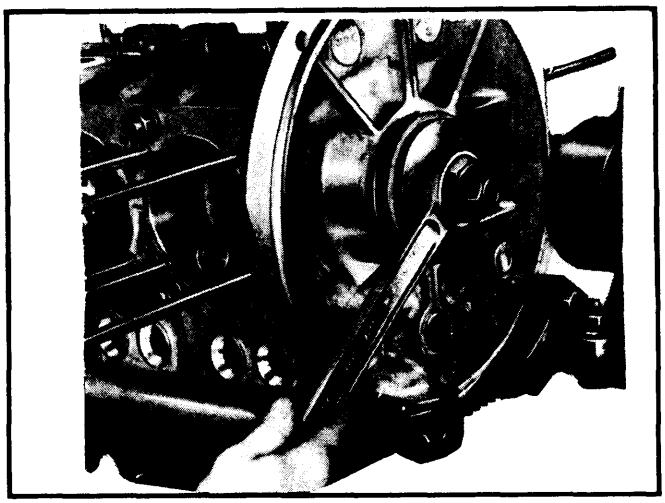

Fig. 15 Crankshaft Oil Seal Installation with Special Tool

CAMSHAFT

CAMSHAFT

With camshaft removed from crankcase assembly, inspect camshaft gear rivets for tightness. Check for maximum runout on number 2 journal of .0016" (.04 mm). Check lobes and journals for excessive wear. Maximum journal wear is .0015" (.038 mm). Check backlash between camshaft and crankshaft gears. If more than .002" (.05 mm), camshaft gears with different pitch radius are available. Pitch radius is stamped on inner face of gear.

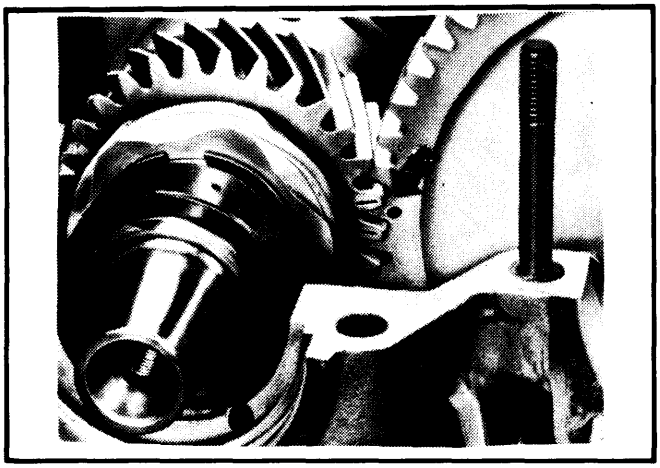

Fig. 16 Correct Position of Camshaft Timing Gear

CAMSHAFT END THRUST

Camshaft end play is checked with camshaft installed in crankcase half. Measure back and forth movement of camshaft with a dial indicator. If end play exceeds .006" (.15 mm), replace camshaft or camshaft bearings. Correct end play is .0016-.0051" (.04-.13 mm).

VALVE TIMING

Install camshaft with "O" stamped in tooth on outside of camshaft gear between two teeth with punch marks on crankshaft gear.

ENGINE OILING

Oil Capacity – 2.6 qts.

Normal Oil Pressure – 28 psi at 2500 RPM

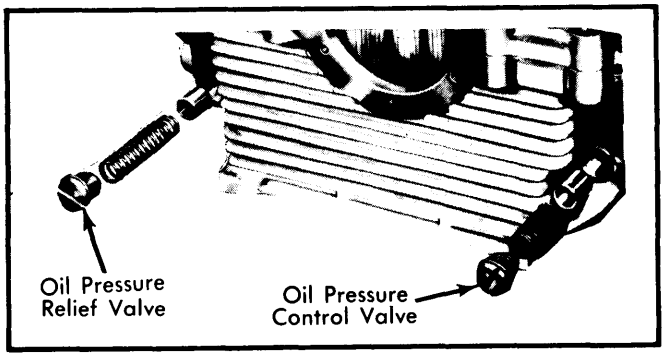

Fig. 17 Oil Pressure Regulator Valves Location

TYPE 1 4 CYLINDER (Cont.)

Pressure Regulator Valves – Oil pressure relief valve, used to protect oil cooler from excessive pressure, is located in crankcase to rear of oil pan. Oil pressure control valve, used to control oil pressure to bearings, is located in crankcase forward of oil pan. Oil pressure relief spring should have length of 1.73" (42.4 mm) at 12.3-16.0 lbs. (5.5-7.3 kg) load. Oil pressure control spring should be .795" (20.2 mm) long at 6.8-8.4 lbs. (3.1-3.8 kg) load.

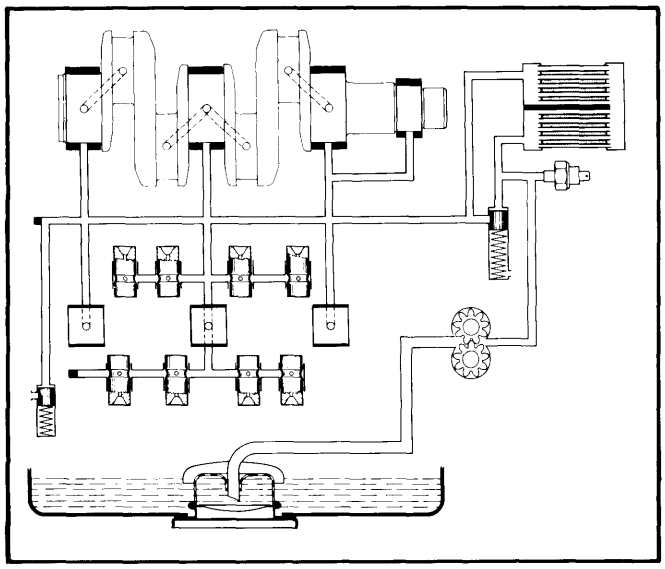

Fig. 18 Engine Lubrication Circulation Diagram

ENGINE OILING SYSTEM

A gear type oil pump mounted at the pulley end of the engine is driven by the camshaft. Oil is picked up through a strainer in the crankcase sump and pumped through an oil cooler into the engine oil passages.

OIL PUMP

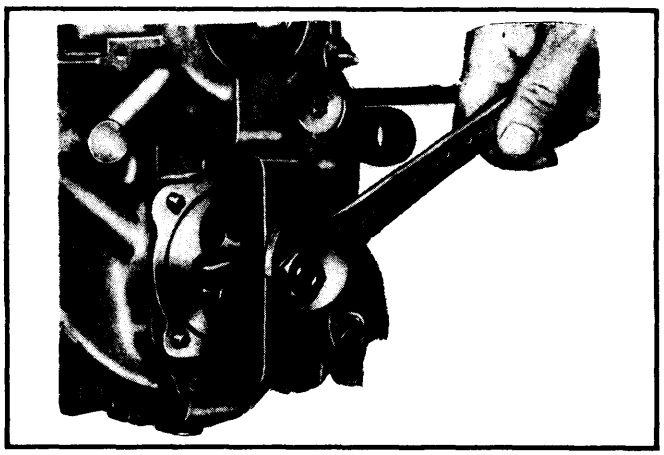

Fig. 19 Removing Oil Pump with Puller Tool

Removal & Installation – 1) With engine out of car, remove sealing nuts from pump cover and remove cover. Remove oil pump gears and cover gasket.

2) Attach suitable puller (VW201) and extract oil pump housing. Check gears for excess backlash and end clearance. Check housing for wear. To install, use new gasket and install pump while hand turning upper shaft to engage its drive dog in the camshaft. Install remaining parts on studs and use new sealing nuts with plastic facings toward pump cover.

Oil Pump Specifications

Application	Inches (mm)
Gear Backlash	0-.008 (0-.20)
End Play Without Gasket (Max.)	.004 (.10)

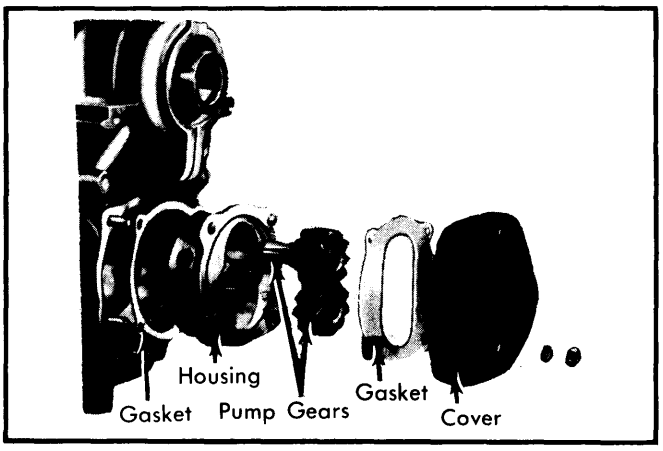

Fig. 20 View of Partially Disassembled Oil Pump

ENGINE COOLING

COOLING SYSTEM

Engine is cooled by a radial fan mounted on end of generator and inside of upright shroud. Fan draws air in through large hole in fan shroud. Air is then directed over finned cylinders and cylinder heads by deflector plates. A thermostat is mounted under cylinders number one and two. Thermostat operates by opening and closing deflector plates in fan shroud.

AIR DUCTS, FAN HOUSING & CONTROL FLAPS

Partical Removal – 1) Remove alternator drive belt. Remove air cleaner and intake air sensor. Remove accelerator cable from guide tube. Remove alternator mounting bracket. Disconnect ignition cables, any hoses, air ducts, or wires that might prevent fan housing upward movement.

2) Remove oil cooler cover bolt and bolt holding fan housing to oil cooler flange. Take off cover and air duct. Remove screws from each end of fan housing. Remove thermostat. Pry off spring clip, separate connecting link from left control flap. Raise fan housing and remove intake manifold and alternator.

TYPE 1 4 CYLINDER (Cont.)

NOTE – *For complete removal of components, continue with remaining procedures. It is easier to remove remaining components with engine removed.*

3) Remove fresh air to heat exchangers distributing hoses. Remove crankshaft pulley cover plate and preheater rear cover plates. Free lower air ducting from crankcase and heat exchangers.

4) Slide alternator mounting bracket off support stand. Remove fan housing screws, lift up fan housing and remove. Both control flaps can be removed by unhooking return spring and removing mounting screws in lower part of fan housing.

Installation – To install components, reverse removal procedure.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Year	Displ.		Carburetor	HP at RPM	Torque (Ft. Lbs. at RPM)	Compr. Ratio	Bore		Stroke	
	cu. ins.	cc					in.	mm	in.	mm
1979 Type 1 AJ	96.9	1584	Fuel Inj.	48@4200	73@2800	7.3-1	3.36	85.5	2.72	69

PISTONS, PINS, RINGS

Engine	PISTONS	PINS		RINGS		
	Clearance In. (mm)	Piston Fit In. (mm)	Rod Fit In. (mm)	Rings	End Gap In. (mm)	Side Clearance In. (mm)
1584 cc	.0016-.0024 (.041-.061)	.0004-.0008① (.010-.020)	②	1	.012-.018 (.20-.45)	.0028-.0039 (.07-.10)
				2	.012-.018 (.30-.45)	.0020-.0028 (.05-.07)
				3	.010-.016 (.25-.40)	.0012-.0020 (.030-.050)

① – Wear limit .0016" (.040 mm). ② – Push fit at room temperature.

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS

Engine	MAIN BEARINGS				CONNECTING ROD BEARINGS		
	Journal Diam. In. (mm)	Clearance In. (mm)	Thrust Bearing	Crankshaft End Play In. (mm)	Journal Diam. In. (mm)	Clearance In. (mm)	Side Play In. (mm)
1584 cc							
Journal No. 1	2.1641-2.1649 (54.97-54.99)	.0016-.004 (.04-.10)	No. 1	.003-.005 (.069-.131)	2.1646-2.1654 (54.98-55.00)	.0008-.0028 (.02-.07)	.004-.016 (.10-.40)
2	2.1641-2.1649 (54.97-54.99)	.001-.0035 (.03-.09)					
3	2.1641-2.1649 (54.97-54.99)	.0016-.004 (.04-.10)					
4	1.5740-1.5748 (39.98-40.00)	.002-.004 (.05-.10)					

TYPE 1 4 CYLINDER (Cont.)

ENGINE SPECIFICATIONS (Cont.)

VALVES							
Engine & Valve	Head Diam. In. (mm)	Face Angle	Seat Angle	Seat Width In. (mm)	Stem Diameter In. (mm)	Stem Clearance In. (mm)	Valve Lift In. (mm)
1584 cc							
Int.	1.40 (35.6)	44°	45°	.051-.063 (1.3-1.6)	.3126-.3130 (7.94-7.95)	.009-.011 (.23-.27)	.....
Exh.	1.19 (30.2)	45°	45°	.067-.079 (1.70-2.00)	.3508-.3512 (8.91-8.92)	.009-.011 (.23-.27)	.....

VALVE SPRINGS			
Engine	Free Length In. (mm)	PRESSURE Lbs. @ In. (kg @ mm)	
		Valve Closed	Valve Open
1584 cc Int. & Exh.	.....	117-135@1.22 (53-61@31.0)	.....

CAMSHAFT			
Engine	Journal Diam. In. (mm)	Clearance In. (mm)	Lobe Lift In. (mm)
1584 cc	.9839-.9843 (24.99-25.00)	.0008-.002 (.02-.05)	.....

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs. (mkg)
Cylinder Head	23 (3.2)
Connecting Rod	22-25 (3.0-3.5)
Crankcase Halves (8 mm)	14 (2.0)
Crankcase Halves (12 mm)	18 (2.5)
Rocker Shaft-to-Cylinder Head	14-18 (2.0-2.5)
Oil Pump-to-Crankcase	14 (2.0)
Oil Drain Plug	25 (3.5)
Oil Strainer-to-Crankcase	5 (.7)
Flywheel-to-Crankshaft	253 (35.0)
Clutch-to-Flywheel	18 (2.5)
Converter-to-Driveplate	18 (2.5)
Engine-to-Transmission	22 (3.0)
Generator Pulley	40-47 (5.5-6.5)
Crankshaft Pulley	29-36 (4.0-5.0)
Fan Nut	40-47 (5.5-6.5)