

Workshop Manual

924

Volume I
Engine

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This workshop manual describes all of the important operations for which special instructions are required to assure proper completion. This manual is essential for the shop foremen and mechanics, who need this information to keep the vehicles in a safe operating condition. The basic safety rules, of course, also apply to repairs on vehicles without exception.

The information is grouped according to repair numbers which are identical to the first two digits of the repair time and warranty code.

The repair group index on page 1, an alphabetical index and the register table are quick guides to find information in the manual.

Descriptions of design and function can be found in the service training course reference material.

This workshop manual will be kept up to date with workshop bulletins, which will be made part of the manual from time to time. We recommend that these workshop bulletins be filed in the special folder provided for this purpose.

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Cylinder head		Light alloy
Valve seat inserts (shrink-fit)		Intake: gray cast iron Exhaust: cast steel
Valve guides		Press-fitted, special bronze
Valve arrangement		1 intake, 1 exhaust overhead, in-line
Exhaust valve		With reinforced seat
Valve springs		2 coil springs per valve
Valve timing		By overhead camshaft and cam followers
Camshaft		Case hardened steel
Camshaft bearings		In cylinder head without bearing shells
Camshaft drive		Toothed belt and tensioning roller
Valve clearance:	Intake mm	0.20
engine warm, oil temp. about	Exhaust mm	0.45
80 °C (175 °F)		
Valve clearance:	Intake mm	0.10
(cold engine)	Exhaust mm	0.40
Timing with 1 mm valve clearance	Intake opens	5° before TDC
	Intake closes	37° after BDC
	Exhaust opens	43° before BDC
	Exhaust closes	7° after TDC
Engine cooling		Pressurized cooling system, electric fan with thermo switch
Engine lubrication		
Lubrication		Pressure lubricating system with rotary (sickle type) gear pump
Oil filter		Full flow
Oil pressure	bar/psi	5 to 7/ 71-100 at 80-100 °C (176-212 °F) and 5000 rpm
Oil pressure gauge		Indicator lamp (pressure gauge as optional extra)
Max. oil temperature		150 °C (302 °F)
Oil consumption	ltr/1000 km	up to 1.5
Exhaust system		Double pipes up to primary muffler; primary, center and final mufflers (California cars have catalytic converter instead of primary muffler)
Heating		Warm water heater with heat exchanger and blower
Fuel system		CIS fuel injection
Fuel supply		Electric delivery pump
Emission Control		<u>49 States + Canada</u> <u>California</u> Air injection Catalytic Converter Exhaust gas recirculation Exhaust gas recirculation

Fuel octane requirement		Regular, 91 RON (unleaded only in Calif. cars)
		<u>49 States/Canada</u> <u>California</u>
Fuel consumption, city (mpg)		20 18
Fuel consumption, highway (mpg)		30 27
 Electrics		
Battery voltage	V	12
Battery capacity	Ah	63
Alternator output	Watts	1050 (75 A)
Ignition		Bosch breakerless transistor ignition
Spark plugs		Bosch W 200 T 30
Spark plug gap		0.6 - 0.8 mm (0.028 - 0.032 in.)
Spark plug connector		Without series connected spark gap
Firing order		1 - 3 - 4 - 2
Basic ignition setting		10° ATDC (on crankshaft) at 925 ± 75 rpm vacuum hose connected
Body Type		Integral, 2-door, all steel body, front fenders bolted, opening rear window, retractable headlights, removable roof section optional
 Dimensions (at DIN curb weight)		
Overall length	mm/in.	4320 / 170.1
Width	mm/in.	1685 / 66.3
Height	mm/in.	1270 / 50
Wheelbase	mm/in.	2400 / 94.5
Track, front (5 1/2 J 14 rim)	mm/in.	1418 / 55.9
(aluminum 6 J 14 rim)	mm/in.	1418 / 55.9
Track, rear (5 1/2 J 14 rim)	mm/in.	1372 / 54.0
(aluminum 6 J 14 rim)	mm/in.	1372 / 54.0
Ground clearance	mm/in.	150 / 5.9

TECHNICAL DATA

(Adjusting specifications and wear limits are listed in each individual repair group) data with asterisks (*) apply to 1977 1/2 model

Engine

Engine code 49 States and Canada Calif. only		924 XH * 924 XG 924 XF * 924 XE
No. of cylinders		4
Bore	mm/in.	86.5 / 3.41
Stroke	mm/in.	84.4 / 3.32
Displacement	cm ³ /in. ³	1984 / 121.06
Compression ratio		8.0 : 1 * 8.5 : 1
Max. engine power (Net SAE J 245) at engine speed	HP rpm	95.4 * 110 5500 * 5750
Max. torque (Net SAE J 245) at engine speed	ft lbs rpm	109.2 * 111.3 3000 * 3500
Max. engine speed	rpm	6500
Engine weight (dry)	kg / lbs	142 / 313

Engine Design

Type	Water-cooled, 4 cylinder, 4 stroke, in-line internal combustion engine
Crankcase	Cast iron crankcase with aluminum oil pan
Crankshaft	Forged steel
Crankshaft bearings	5 plain bearings
Connecting rods	Forged steel
Conrod bearings	Plain bearings
Piston pin bearing	Press-fit bronze bush
Pistons	Cast light alloy
Piston pins	Floating pins with circlips
Piston rings	2 compression and 1 oil scraper rings

Cylinder head		Light alloy
Valve seat inserts (shrink-fit)		Intake: gray cast iron Exhaust: cast steel
Valve guides		Press-fitted, special bronze
Valve arrangement		1 intake, 1 exhaust overhead, in-line
Exhaust valve		With reinforced seat
Valve springs		2 coil springs per valve
Valve timing		By overhead camshaft and cam followers
Camshaft		Case hardened steel
Camshaft bearings		In cylinder head without bearing shells
Camshaft drive		Toothed belt and tensioning roller
Valve clearance:	Intake mm	0.20
engine warm, oil temp. about	Exhaust mm	0.45
80 °C (175 °F)		
Valve clearance:	Intake mm	0.10
(cold engine)	Exhaust mm	0.40
Timing with 1 mm valve clearance	Intake opens	5° before TDC, * 4° BTDC
	Intake closes	37° after BDC, * 44° ABDC
	Exhaust opens	43° before BDC, * 44° BBDC
	Exhaust closes	7° after TDC, * 4° ATDC
Engine cooling		Pressurized cooling system, electric fan with thermo switch
Engine lubrication		
Lubrication		Pressure lubricating system with rotary (sickle type) gear pump
Oil filter		Full flow
Oil pressure	bar/psi	5 to 7/ 71-100 at 80-100 °C (176-212 °F) and 5000 rpm
Oil pressure gauge		Indicator lamp and pressure gauge
Max. oil temperature		150 °C (302 °F)
Oil consumption	ltr/1000 km	up to 1.5
Exhaust system		Double pipes up to primary muffler; primary, center and final mufflers (California cars have catalytic converter instead of primary muffler) * all with catalytic converter
Heating		Warm water heater with heat exchanger and blower
Fuel system		CIS fuel injection
Fuel supply		Electric delivery pump

1977 1977 1/2

Emission Control	49 States + Canada	Calif.	49 States + Canada	Calif.
Air injection	X			X
Exhaust gas recirculation	X	X	X	X
Catalytic converter		X	X	X

Ground clearance (at total permissible weight) mm/in. 125 / 4.9

Front overhang angle (limited by spoiler) 23°

Rear overhang angle (limited by bumper) 26° 30'

Weights

Curb weight kg/lbs 1190 / 2623

Max. axle load kg/lbs 1400 / 3087

Max. axle load, front kg/lbs 650 / 1433

Max. axle load, rear kg/lbs 840 / 1852

Max. load capacity kg/lbs 210 / 463

Max. roof load, including roof rack kg/lbs 35 / 77

Max. trailer load
without trailer brakes * kg/lbs 500 / 1103
with brakes * kg/lbs 800 / 1764

Max. overall towing weight (curb weight + max. load capacity + max. trailer load) kg/lbs 2200 / 4851

Max. tongue weight kg/lbs 30 / 66

* up to grades of 16%

Filling Capacities

Engine (level checked with oil dipstick acc. to Owner's Manual) HD oils to API classification SD or SE, viscosity: summer SAE 30, winter SAE 20. At continuous temperatures betw. - 15° and 0° C SAE 20 W 20, or SAE 10 W for continuous temperatures below - 15° C

Engine oil change with filter change about 5.28 US qts (4.4 Imp. qts or 5.0 liters)
without filter change about 4.75 US qts (3.95 Imp. qts or 4.5 liters)

Engine coolant about 8 liters (8.4 US qts / 7 Imp. qts)

Transmission and differential about 2.6 ltr (2.75 US qts) hypoid SAE 80 API Spec GL 4 (equivalent to MIL - L 2105)

Fuel tank about 62 ltr (16.4 US gals/13.6 Imp. gal) of which 5 ltr reserve

Brake fluid reservoir about 0.2 ltr (.21 US qt/.18 Imp. qt)

Windshield washer reservoir about 2.0 ltr (2.1 US qts/1.8 Imp. qts)

Headlight washer reservoir about 6.4 ltr (6.8 US qts/5.6 Imp. qts)

Ground clearance (at total permissible weight)	mm/in.	125 / 4.9
Front overhang angle (limited by spoiler)		23°
Rear overhang angle (limited by bumper)		26° 30'

Weights

Curb weight	kg/lbs	1190 / 2623
Max. axle load	kg/lbs	1400 / 3087
Max. axle load, front	kg/lbs	650 / 1433
Max. axle load, rear	kg/lbs	840 / 1852
Max. load capacity	kg/lbs	210 / 463
Max. roof load, including roof rack	kg/lbs	35 / 77
Max. trailer load		
without trailer brakes *	kg/lbs	500 / 1103
with brakes *	kg/lbs	800 / 1764
Max. overall towing weight (curb weight + max. load capacity + max. trailer load)	kg/lbs	2200 / 4851
Max. tongue weight	kg/lbs	30 / 66

* up to grades of 16%

Filling Capacities

Engine (level checked with oil dipstick acc. to Owner's Manual)	HD oils to API classification SD or SE, viscosity: summer SAE 30, winter SAE 20. At continuous temperatures betw. - 15° and 0° C SAE 20 W 20, or SAE 10 W for continuous temperatures below - 15° C
Engine oil change	with filter change about 5.28 US qts (4.4 Imp. qts or 5.0 liters) without filter change about 4.75 US qts (3.95 Imp. qts or 4.5 liters)
Engine coolant	about 8 liters (8.4 US qts / 7 Imp. qts)
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Fuel tank	about 62 ltr (16.4 US gals/13.6 Imp. gal) of which 5 ltr reserve
Brake fluid reservoir	about 0.2 ltr (.21 US qt/.18 Imp. qt)
Windshield washer reservoir	about 2.0 ltr (2.1 US qts/1.8 Imp. qts)
Headlight washer reservoir	about 6.4 ltr (6.8 US qts/5.6 Imp. qts)

PERFORMANCE *

	<u>Manual transmission</u>	<u>Automatic transmission</u>
Top speed	kph / mph 185 / 115	180 / 112
Acceleration 0 - 60 mph	seconds 12.5	
for 1/4 mile	seconds 18.7	
for 1 km	seconds 33.0	

* at curb weight + half max. load capacity

PERFORMANCE

Top speed	kph / mph	185 / 115	* 192/120
Acceleration 0 - 60 mph **	seconds	12.5	* 11,5
for 1/4 mile **	seconds	18.7	* 17,9
for 1 km **	seconds	33.0	* 32,6

** at curb weight + half max. load capacity

REGISTRATION OF SUPPLEMENTS FILED FOR WORKSHOP MANUAL

Please file the supplements according to repair groups and make appropriate entries in the table below.

Supplement No.	Filing Date	Signature
I	—	—
II		
III		
IV		
V		
VI		
VII		
VIII		
IX		
X		
XI		
XII		
XIII		
XIV		

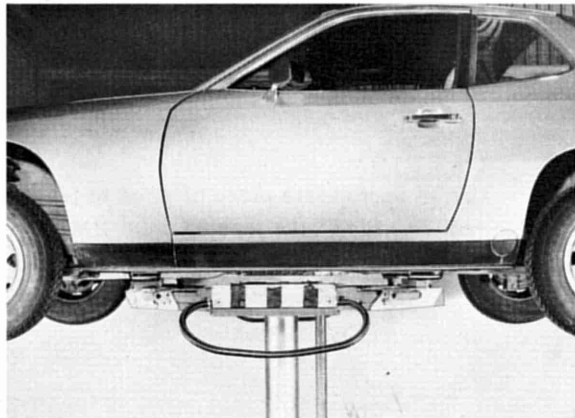
LIFTING CAR

1. Lifting with hoist

Be sure to use lift points shown.

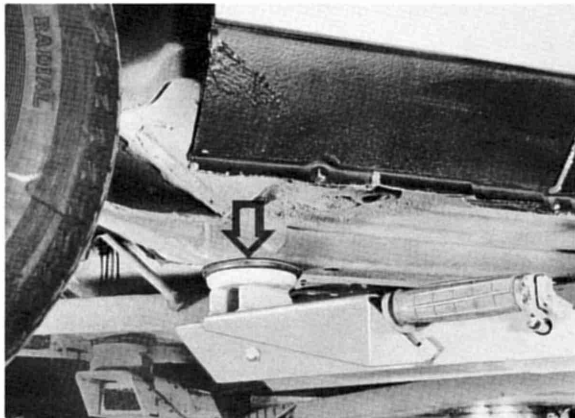
CAUTION

When driving car on hoist platform, make sure that there is sufficient space between hoist and car.



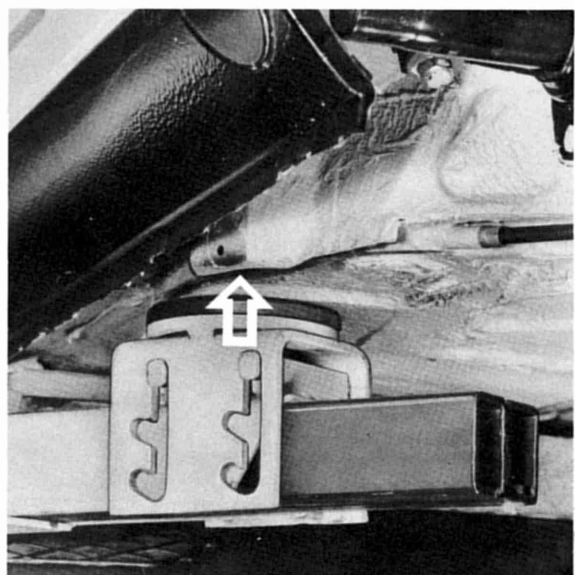
Front

Place lift pad on inboard side member.



Rear

Place lift pad on side reinforcement bracket.

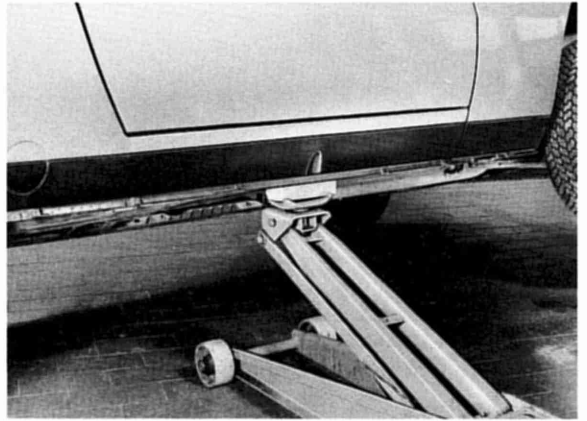


2. Lifting with floor jack

Place jack below jacking points only.
Never raise car on engine oil pan or transmission, since this could cause serious damage.

CAUTION

Use an appropriate piece of wood to prevent damage to the jacking point flange.



ENGINE -
ASSEMBLY

TOLERANCES AND WEAR LIMITS

		New Size	Wear Limit
Cooling			
Thermostat opening temperature		80 - 93 ^o C or 85 - 102 ^o C (176 - 200 ^o F or 185 - 216 ^o F)	
Radiator cap			
High pressure valve	opens at	0.9 - 1.15 bar (12.8 - 16.4 psi)	
Low pressure valve	opens at	0.06 - 0.1 bar (0.9 - 1.4 psi)	
Oil Circuit			
Oil consumption	ltr/1000 km		1.5
Oil pressure (only for SAE 20 W 20 oils) at 80 ^o C (176 ^o F) oil temp. and 2000 rpm		3 - 6 bar (43 - 85 psi)	2.0 bar (28 psi)
Oil dipstick			
Top mark	capacity	5.3 ltr. (5.6 US qts/4.66 qts)	
Bottom mark	capacity	3.7 ltr. (3.9 US qts/3.26 Imp. qts)	
Oil pump			
Housing/gears	end play	0.03 - 0.07 mm (0.001 - 0.002 in.)	
Gears	radial play	0 - 0.13 mm (0 - 0.005 in.)	
Oil filter			
Bypass valve	opens at	2.2 - 3.2 bar (31.3 - 42.6 psi)	
Oil pressure valve	opens at	0.3 - 0.6 bar (4.3 - 8.5 psi)	
Valve Timing			
Camshaft bore	inside dia.	26.00 - 26.021 mm (1.0236 - 1.0245 in.)	
Camshaft	dia.	25.94 - 25.96 mm (1.0213 - 1.0181 in.)	
Camshaft	end play	0.05 - 0.16 mm (0.002 - 0.006 in.)	0.2 mm (0.008 in.)
Camshaft	runout	measured at center brg. brgs 1 + 5 on V-blocks	max. 0.02 mm (0.0008 in.)
Cam follower bore	inside dia.	38.5 - 38.525 mm (1.515 - 1.517 in.)	
Cam follower	dia.	38.45 - 38.47 mm (1.5138 - 1.5146 in.)	

		New Size	Wear Limit
Cylinder Head and Valves			
Cylinder head surface	distortion		max. 0.1 mm (0.004 in.)
Valves:			
a) intake	seat width	2.2 - 3.0 mm (0.087 - 0.118 in.)	
b) exhaust	seat width	2.2 - 3.0 mm (0.087 - 0.118 in.)	
c) intake	seat angle	45°	
d) exhaust	seat angle	45°	
Valve guides:			
Intake and exhaust	inside dia.	9.000 - 9.015 mm (0.3543 - 0.3549 in.)	
Valve stem:			
Intake	dia.	8.97 mm (0.353 in.)	
Exhaust	dia.	8.95 mm (0.352 in.)	
Valve guide/valve stem clearance			
Intake		0.4 mm (0.0157 in.)	0.8 mm (0.0315 in.)
Exhaust		0.5 mm (0.020 in.)	1.0 mm (0.04 in.)
Compression	pressure	8 - 11 bar (114 - 156 psi)	6 bar (85 psi)
Pressure difference betw. individual cylinders			max. 3 bar (43 psi)
Pistons and Connecting Rods			
Cylinder/piston	clearance	0.03 mm (0.0011 in.)	0.08 mm (0.0031 in.)
Weight difference of pistons in one engine	repairing		max. 14 grams
Pistons rings	side clearance	0.04 - 0.07 mm (0.0016 - 0.0028 in.)	0.1 mm (0.004 in.)
Piston rings	gap	0.3 - 0.5 mm (0.012 - 0.020 in.)	1.0 mm (0.04 in.)
Connecting rod weight	standard	815 - 927 grams	
Permissible weight difference of connecting rods in one engine	new	8 grams	
	repairing	8 grams	
Connecting rod bushing	dia.	24.012 - 24.018 mm (0.9454 - 0.9456 in.)	
Piston pin	dia.	23.996 - 24.000 mm (0.9447 - 0.9449 in.)	
Connecting rod bushing/piston pin	radial play	0.01 - 0.02 mm (0.0004 - 0.0008 in.)	

		New Size	Wear Limit
Crankshaft and Crankcase			
Crankshaft (measured at 2nd, 3rd or 4th bearing, bearings 1 and 5 on V- blocks)	runout		max. 0.06 mm (0.0024 in.)
Connecting rod bearing journal	dia.	47.95 - 47.97 mm (1.888 - 1.889 in.)	
Connecting rod bearing/crankshaft	radial play	0.02 - 0.07 mm (0.0008 - 0.603 in.)	0.1 mm (0.004 in.)
	end play	0.05 - 0.08 mm (0.0020 - 0.0012 in.)	0.4 mm (0.016 in.)
Crankshaft bearing journal	dia.	63.95 - 63.97 mm (2.518 - 2.519 in.)	
Crankshaft bearing/crankshaft	radial play	0.02 - 0.08 mm (0.0008 - 0.0031 in.)	0.16 mm (0.006 in.)
Crankshaft bearing 3/crankshaft	end play	0.1 - 0.19 mm (0.004 - 0.007 in.)	0.25 mm (0.010 in.)
Cylinder bore	out-of-round		0.04 mm (0.0016 in.)
Crankcase main bearing bore	dia.	68.000 - 68.019 mm (2.6771 - 2.6779 in.)	
Clutch			
Clutch disc (measured at 200 mm dia.)	lateral runout		max. 0.6 mm (0.024 in.)
Clutch play at pedal		20 to 25 mm (0.79 - 0.98 in.)	

TORQUE SPECIFICATIONS FOR ENGINE

Location	Description	Threads	Grade	Torque	
				Nm	ft lb
Cyl. head cover to cylinder head	Nut	M 6	8	8	5.8
Camshaft bearing cover to cyl. head	Bolt	M 6	8.8	10	7
Camshaft bearing cover to cyl. head	Nut	M 8	8	16 - 21	11, 6-15, 2
Cylinder head to crankcase	Socket head bolt	M 12	10.9	10 cold 12 warm from 1980 model see page 15-4	72 86 11
Oil pressure sensor to cylinder head	With Curil sealant	M 10 x 1		15	11
Drive belt gear	Bolt	M 12 x 1.5	10.9	80	58
Chain tensioner to thermostat hsg.	Bolt	M 10	8.8	40	29
Heater flange to cylinder head	Bolt	M 6 x 35	8.8	10	7
Thermostat cover	Bolt	M 6	8.8	10	7
Thermostat to cylinder head	Bolt	M 8 x 35 M 8 x 25	8.8	20	14
Water pump pulley to hub	Bolt	M 8 x 12	8.8	20	14
Spark plugs		M 14 x 1.25		30	22
Distributor	Nut	M 8	8	20 - 22	14 - 16
Temperature sensor		M 10 x 1		8	6
Intake manifold and transport bracket to cylinder head	Bolt/nut	M 8 x 72 M 8	8.8 8	24 20	17 14

Location	Description	Threads	Grade	Torque	
				mkg	ft lb
Exhaust manifold to cylinder head	Thermag nut	M 8	8	2.5	18
Exhaust manifold guard	Thermag nut	M 8	8	2	14
Drive belt guard to cylinder head	bolt	M 6 x 25	8.8	1	7
Throttle housing to intake manifold	Allen head bolt	M 8 x 40	8.8	2.2	16
Drive belt guard to oil pump	bolt	M 6 x 25	8.8	1	7
Water pump to crankcase	bolt	M 8 x 72 M 8 x 65	8.8	2.2	16
Water pump to crankcase	bolt	M 6 x 35 M 6 x 45	8.8	0.9	7
Oil drain plug		M 26 x 1.5	5.8	4	29
Oil pan to crankcase	Allen head bolt	M 6	8.8	0.8	6
Oil pan to crankcase	Allen head bolt	M 8	8.8	1.5	11
Flywheel to crankshaft	bolt	M 12 x 1.5 f	10.9	9	65
Pulley to crankshaft	bolt	M 16 x 1.5	10.9	25	180
Pulley to toothed gear	Allen head bolt	M 8	8.8	2	14
Cover to oil pump	bolt	AM 6		0.8	6
Oil pump to crankcase	bolt	M 6	8.8	1	7
Oil intake line to crankcase	bolt	M 6	8.8	1	7
Oil intake line to crankshaft bearing cap	bolt	M 6	8.8	1	7
Oil filter flange to crankcase		3/4" UNF		until tight 14 max. 2	

Location	Description	Threads	Grade	Torque	
				mkg	ft lb
Oil filter				2.5-3.5	18-25
Bearing cap to crankcase	bolt	M 12	10.9	8	58
Bearing cap no. 5 to crankcase	Allen head bolt	M 10	12.9	6.5	47
Engine support to engine block	bolt	M 10	8.8	4.2	30
Engine mount to engine support	self-locking nut	M 12 x 1.5	8	6.1	44
Engine mount to body	self-locking nut	M 10	8	4.2	30
Bell housing to engine	bolt	M 12	8.8	7.5	54
Bell housing to engine	bolt	M 10	8.8	4.5	33
Catalytic converter to exhaust pipe	nut	M 8	8	2.0	14
Heat shield to catalytic converter	bolt	M 6	8.8	1.0	7
EGR filter support to crankcase	bolt	M 8	8.8	2.0	14
EGR filter to filter support	bolt	M 8	8.8	2.0	14
Air pump bracket to crankcase	bolt	M 10	10.9	4.5	33

TOOLS



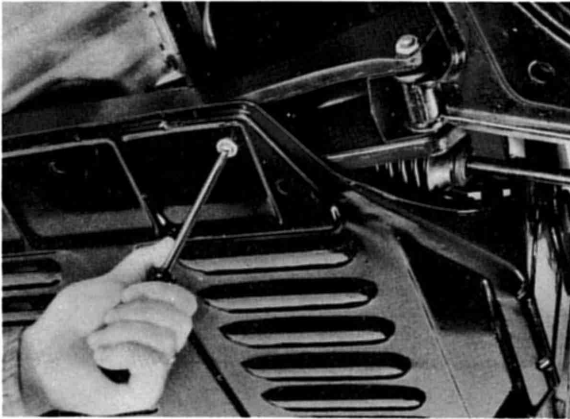
No.	Description	Special Tool	Remarks
1	Chain sling	US 1105	

REMOVING AND INSTALLING ENGINE

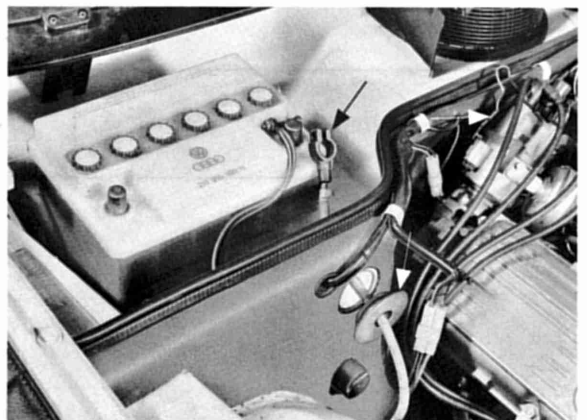
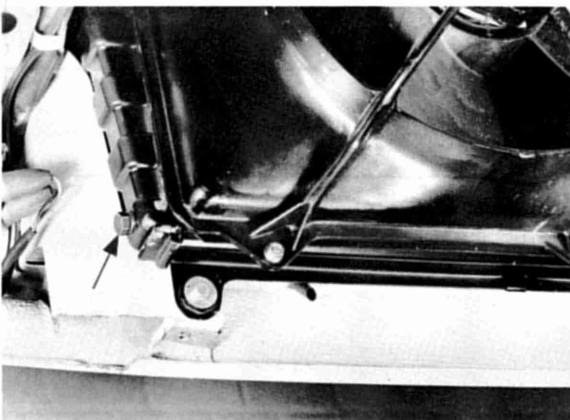
The engine must be lifted out.

Removing

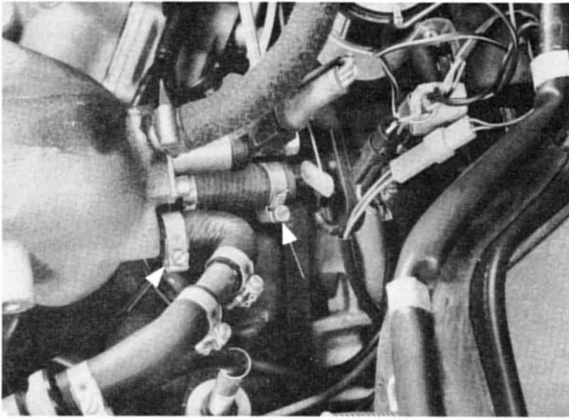
1. Disconnect battery ground cable.
2. Raise car at jacking points.
3. Remove engine protection plate.
6. Detach windshield washer hose at T-adaptor.
7. Disconnect electrical connector of engine compartment light.
8. Remove hood.



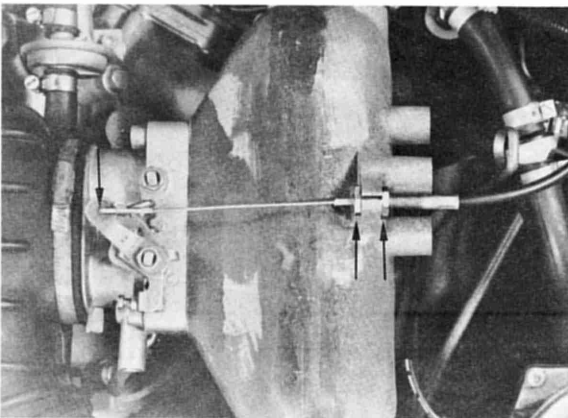
4. Set heater control lever to warm position (fully open) and remove pressure cap.
5. Drain coolant at plug on radiator, and loosen and remove coolant hoses.
10. Take windshield washer tank off and place it behind right-hand headlight.
11. Take alternator cooling hose off.
12. Disconnect starter wire (arrow) at positive (+) pole, puncture rubber grommet in fire wall and pull wire through. Bend open wire clip on inside of right-hand fender. Separate multiple plug at engine harness, disconnect wire at terminal 1 of distributor and ground wire at ignition coil.



13. Detach hose between brake booster and intake connection, loosen hose clamp at heater regulating valve and pull off valve (heater regulating valve and control cable remain in car).



14. Detach throttle cable from throttle valve and support.



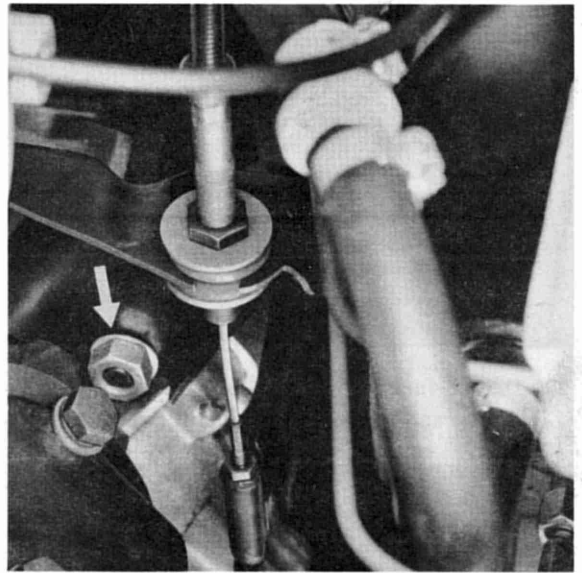
15. Pull out oil dipstick.

16. Disconnect crankcase vent hose at intake manifold.

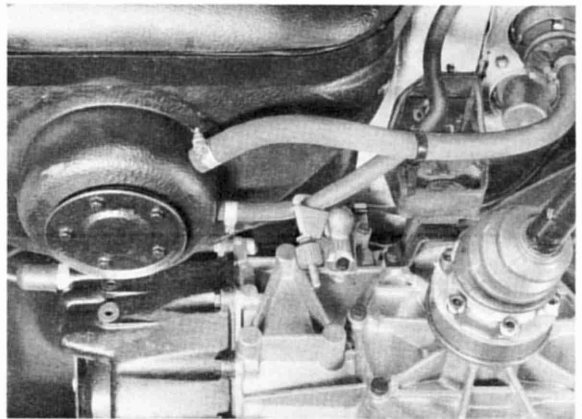
17. Disconnect electrical connector at mixture control unit.

18. Remove air duct between throttle housing and mixture control unit

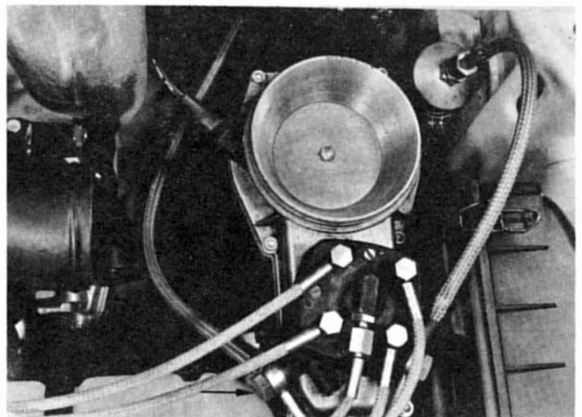
19. Loosen and detach clutch cable at holder, remove counternut (arrow).

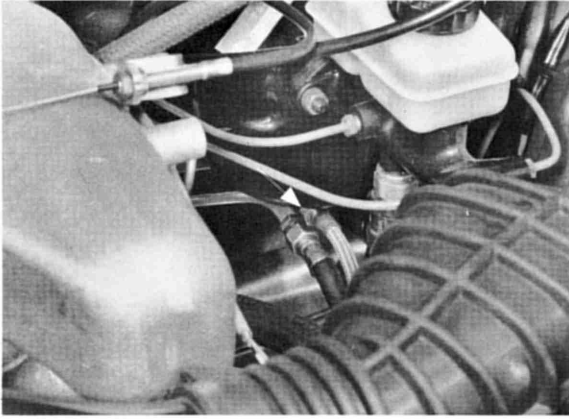


20. Clamp return fuel line shut at fuel tank with a standard pinching clamp.

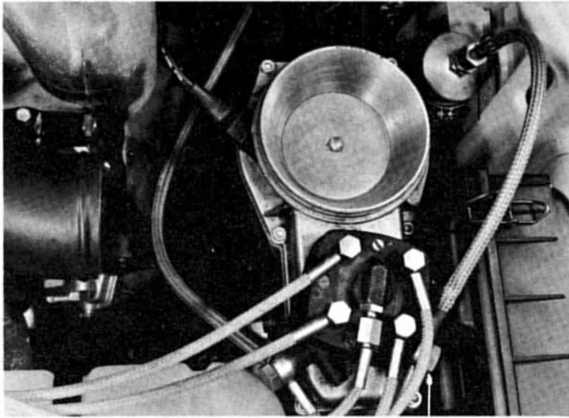


21. Detach fuel return line at mixture control unit. Remove electrical connector from mixture control unit.



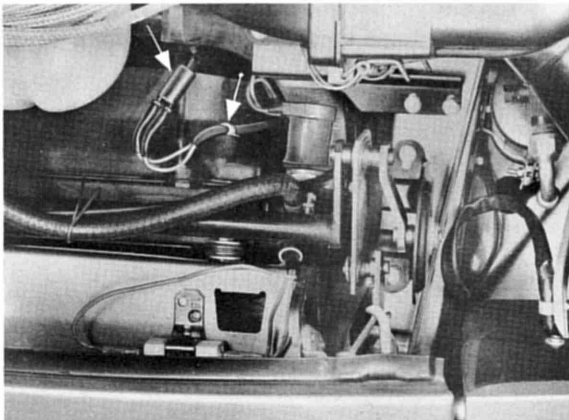


22. Detach fuel feed line at fuel filter (dark arrow) and mixture control unit (white arrow).

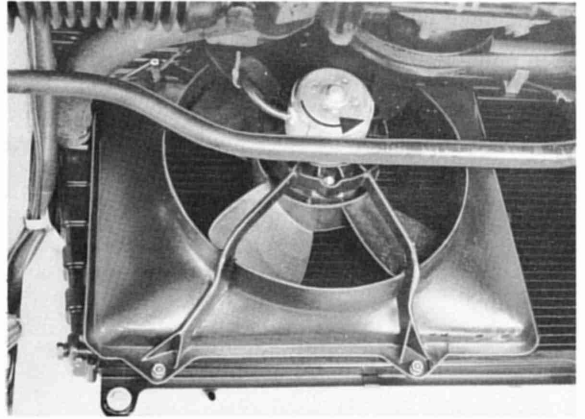


23. Detach fuel injection lines at mixture control unit and lay aside.

24. a) Detach electrical connector at fan motor harness (arrows).

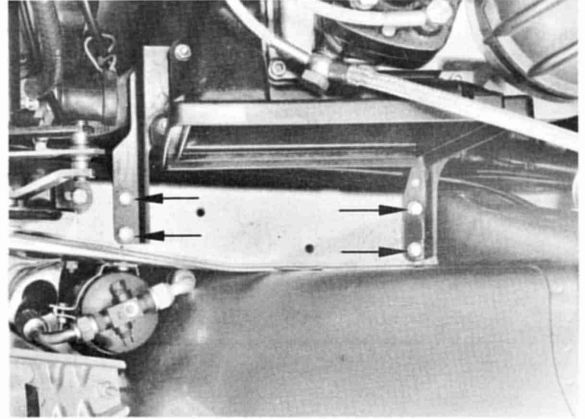


- b) Remove fan motor with fan shroud.

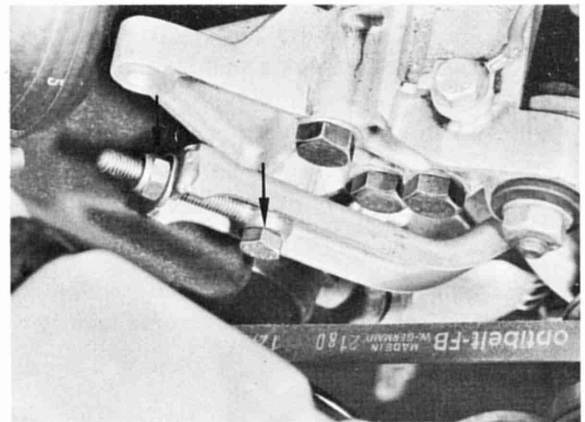


25. For cars with air conditioning:

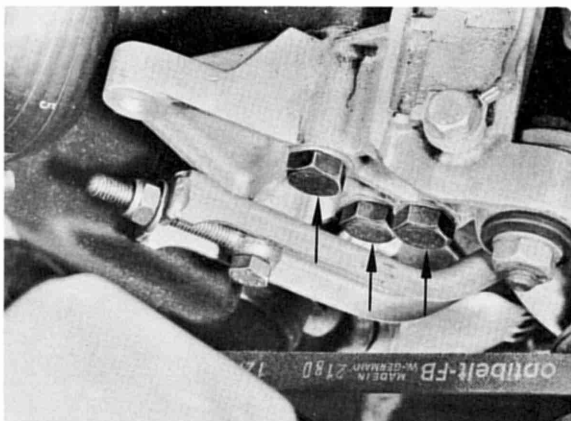
- a) Remove entire mixture control unit with filter housing.



- b) Take V-belt off compressor



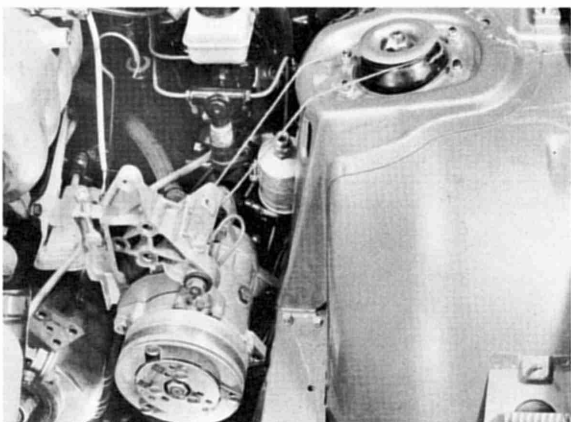
c) Loosen compressor mounting bolts.



d) Take compressor off bracket and lay aside.

CAUTION

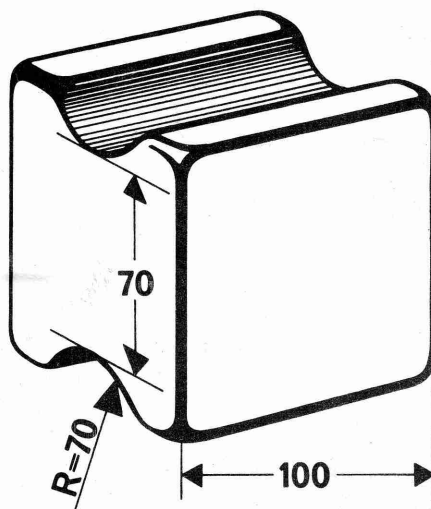
Do not disconnect compressor hoses.
If compressor hoses are disconnected, system must be evacuated and recharged.



e) Detach holder for refrigerant hoses (black arrow)

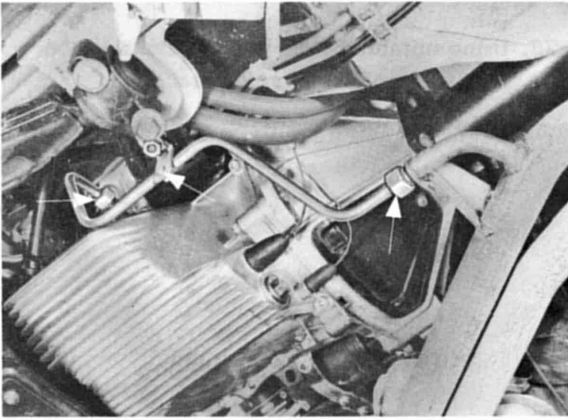


26. Using suitable block, support central tube at front tunnel reinforcing brace.

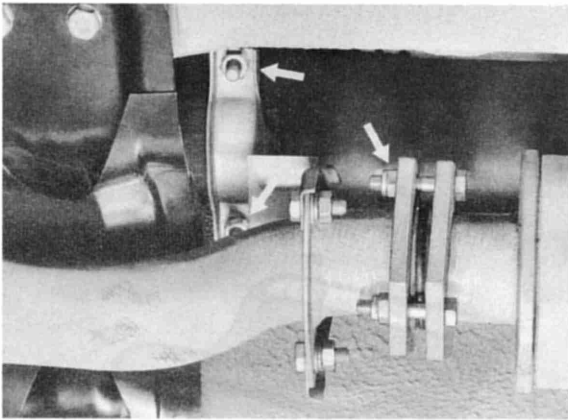


WOOD BLOCK

27. Remove exhaust gas recirculation line (arrows)

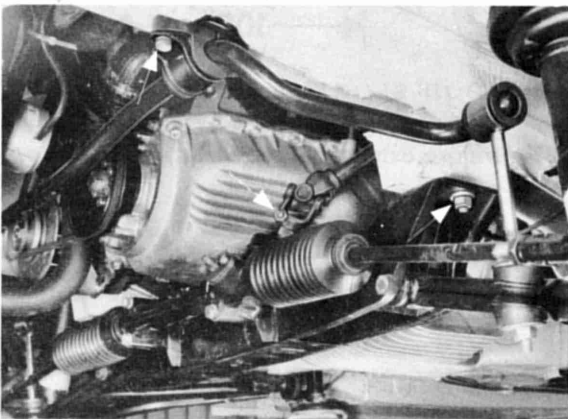


28. Detach front exhaust pipe at exhaust manifold and connecting flange at primary muffler.

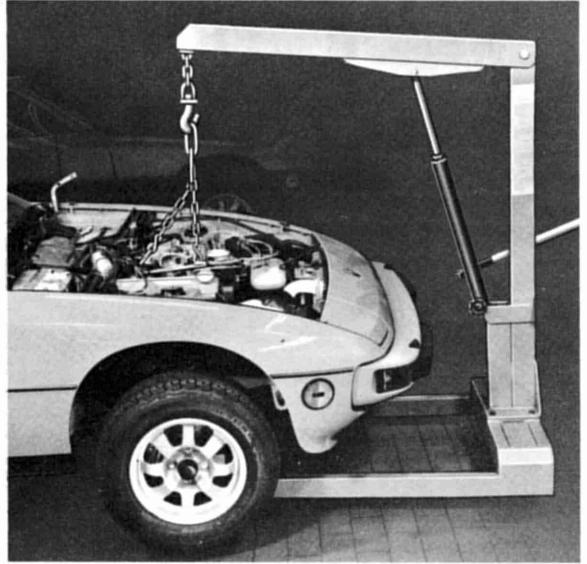


29. Detach guard.

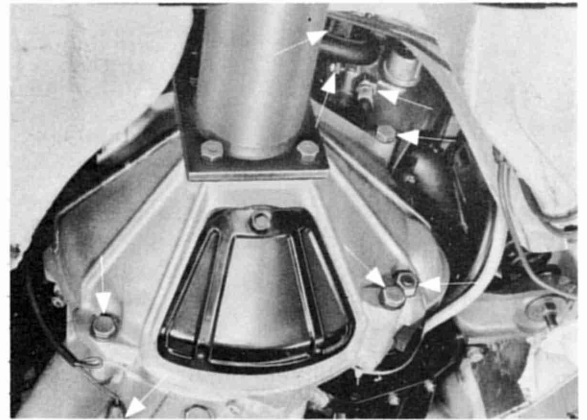
30. Disconnect universal joint at steering rack (arrow). Remove cross member and disconnect stabilizer at frame on both sides.



31. Attach chain US 1105 to lift points on engine. Using universal floor crane, lift engine slightly to tension chain.



32. Disconnect electrical connectors, detach hose and loosen clutch bell housing bolts.



33. Remove entire left hand engine mount (as seen in driving direction). Loosen lower right hand engine mount.

34. Lift engine out carefully by lifting and turning at same time.

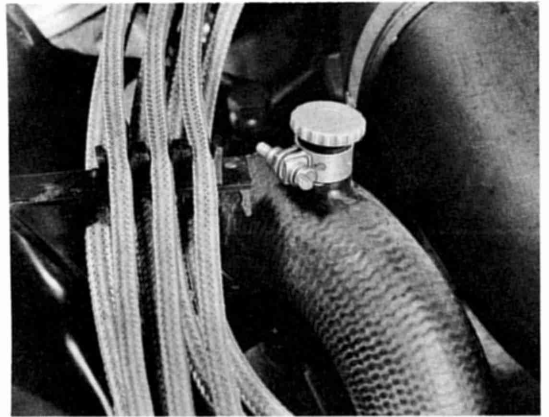
CAUTION

Lift engine carefully to avoid damaging propeller shaft, clutch or body.

34. Remove bolts for rubber/metal damper on vehicles with automatic transmission.



5. Loosen hose clamp and remove vent plug.



35. Lift engine out carefully by lifting and turning at same time.

CAUTION

Lift engine carefully to avoid damaging propeller shaft, clutch or body.

6. Start engine and run it at high idle speed for about 1 minute. If there are no air bubbles in the coolant leaving the vent opening, insert plug and tighten hose clamp.

7. Check coolant level when engine is at operating temperature and add more coolant until level is at inspection level on compensating tank.

Installing

Note the following for installations.

1. Tighten nuts and bolts to specified torques.

2. Add coolant.

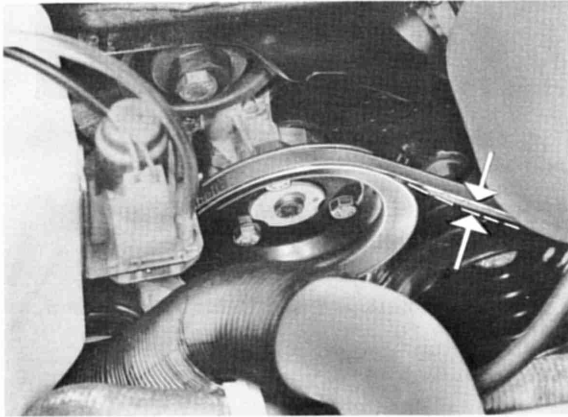
3. Open heater wide.

4. Add coolant until level is at mark on compensating tank.

ALTERNATOR V-BELT, CHECKING AND ADJUSTING

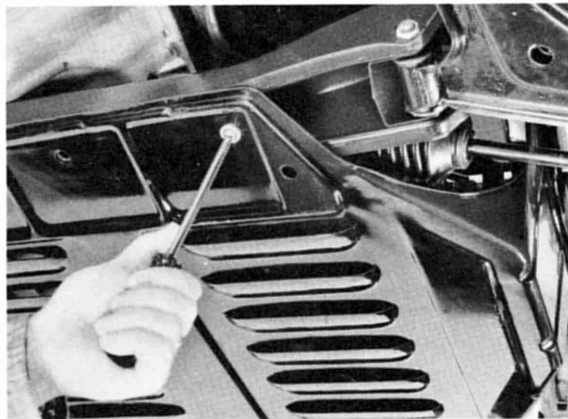
Checking

Press down on V-belt at arrows.
Check that belt depresses 5 - 10 mm.
(3/16 - 3/8 in.)

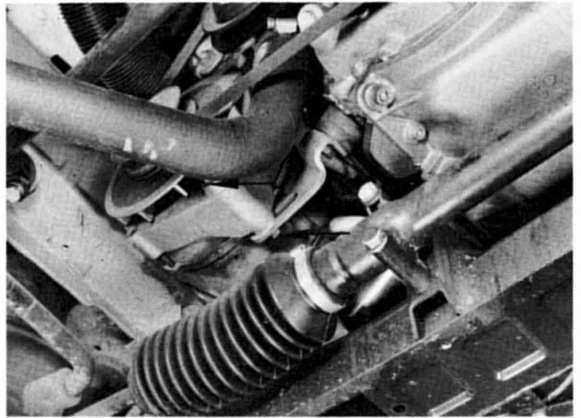


Adjusting

1. Remove engine protection plate.



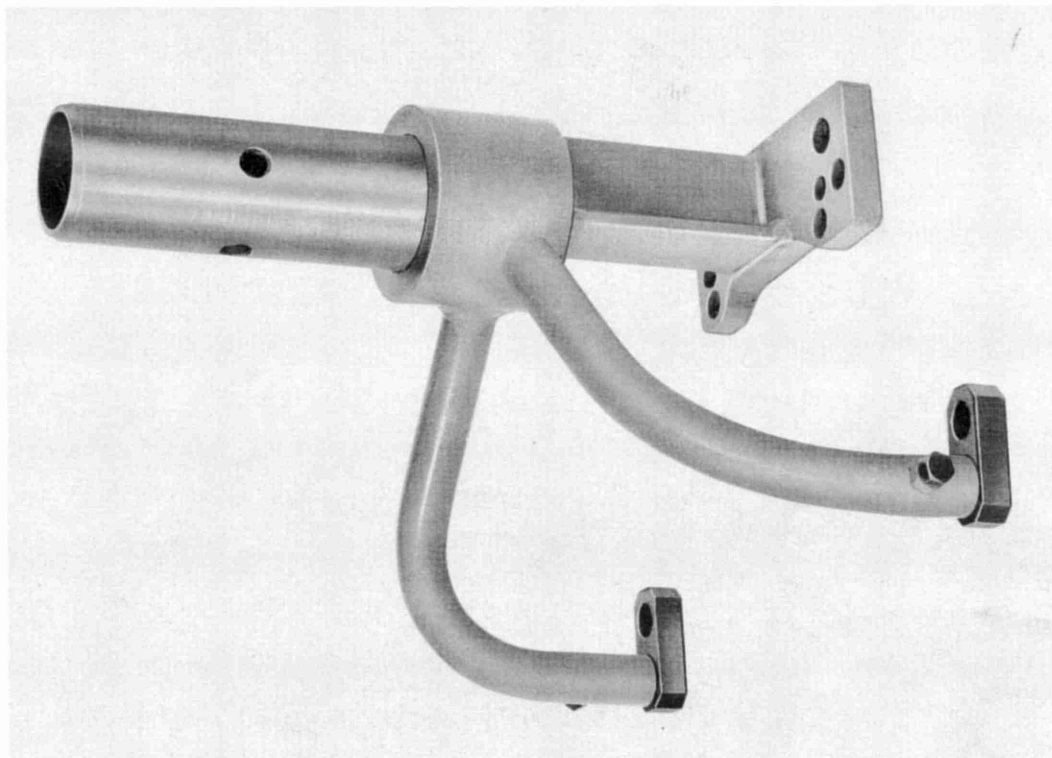
2. Loosen nut and bolt (arrows).



3. Tighten or loosen belt by moving alternator with suitable lever.

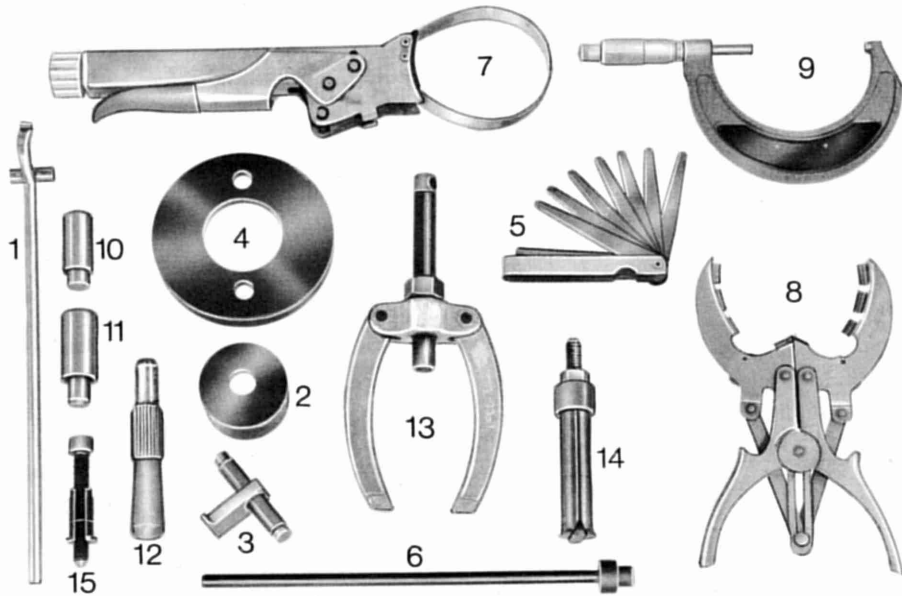
ENGINE -
CRANKSHAFT,
CAMSHAFT,
CRANKCASE

TOOLS

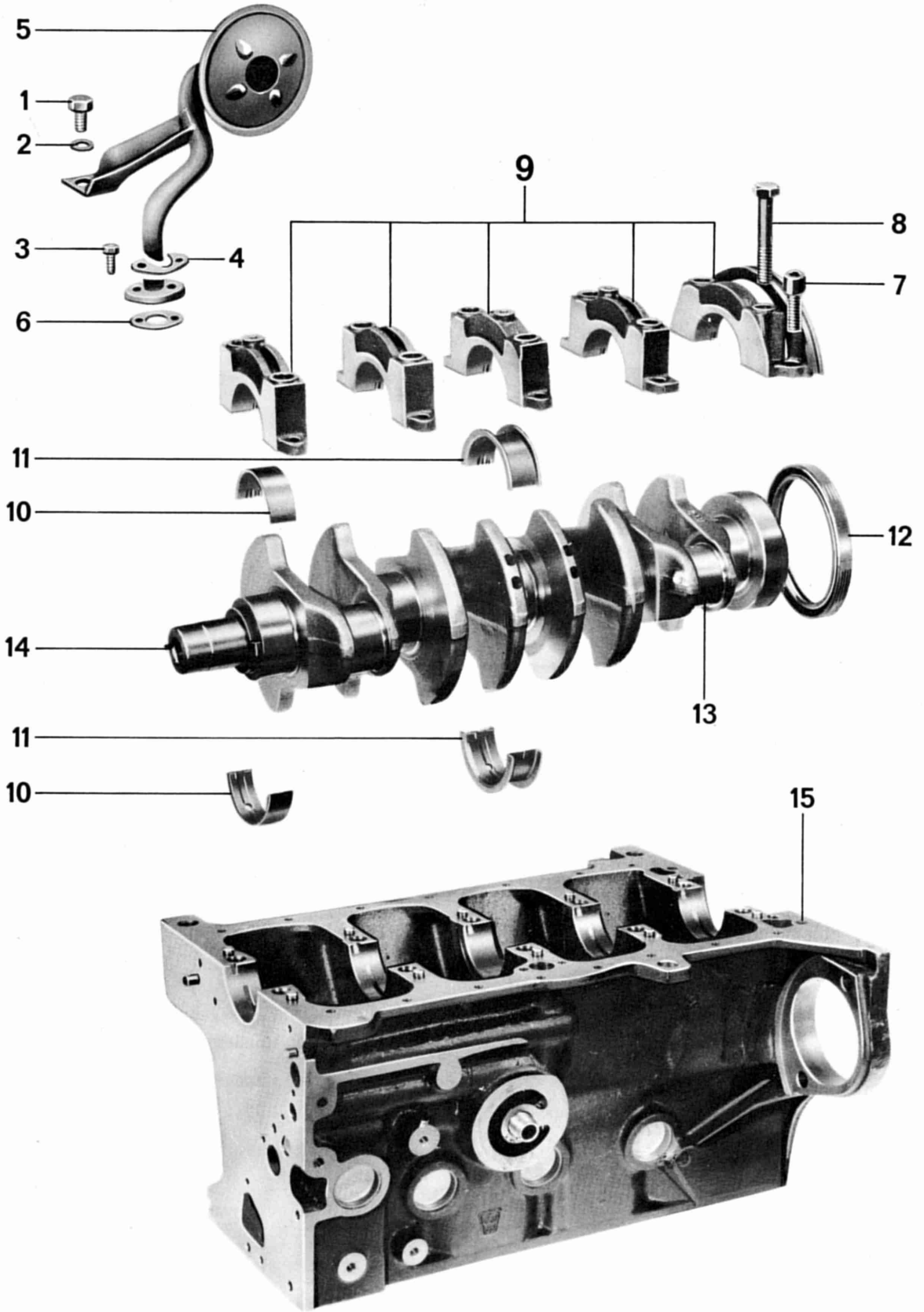


No.	Description	Special Tool	Remarks
1	Assembly stand	VW 540	

TOOLS

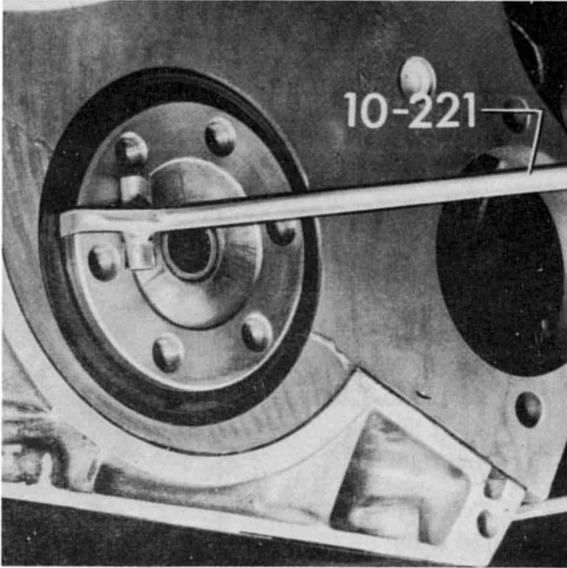


No.	Description	Special Tool	Remarks
1	Oil seal extractor		or screw driver
2	Oil seal installer	2033	
3	Flywheel retainer	10 - 201	
4	Oil seal installer (flywheel end)	10 - 9	
5	Feeler gage		standard
6	Piston pin drift	VW 207 c	
7	Piston ring compressor	US 1008 A	
8	Piston ring pliers		standard
9	Micrometer 75 - 100 mm		standard
10	Needle bearing installing drift	9124	
11	Oil seal drift	9123	
12	Clutch pilot	US 219	
13	Puller spindle	US 1039	
14	Puller	US 1088	
15	Puller	10-202	



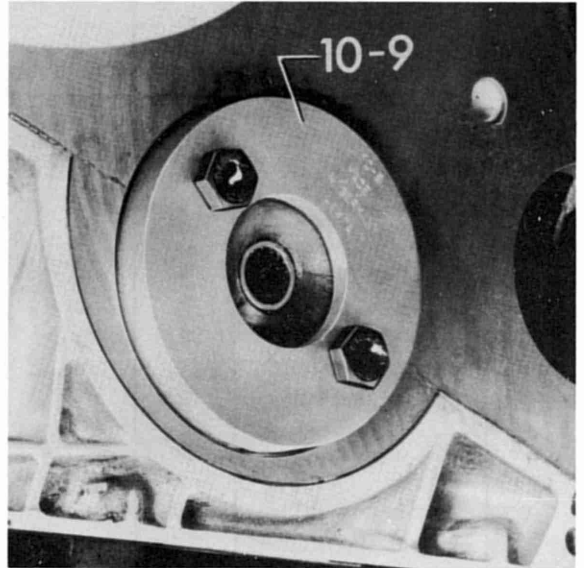
No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Hex head bolt	1		Torque to 1 mkg (7 ft lb)	
2	Washer	1			
3	Hex head bolt	2		Torque to 1 mkg (7 ft lb) lock	
4	Lockplate	1		Replace	
5	Oil pipe	1		Check	
6	Gasket	1		Replace	
7	Allen head bolt	2		Torque to 6.5 mkg (47 ft lb) first tighten	
8	Hex head bolt	10		Torque to 8 mkg (58 ft lb)	
9	Bearing caps	5		Position correctly, coat mating surface of bearing 5 with a sealing compound	
10	Bearing shell 1, 2, 4 and 5	8	Mark before removing	Bearing shell in caps - not grooved. Bearing shell in crankcase - grooved, do not mix shells	
11	Bearing shell 3, thrust bearing	2	Mark before removing	Bearing shell in caps not grooved. Bearing shell in crankcase grooved. Do not mix shells	
12	Oil seal	1		Replace	
13	Crankshaft	1			
14	Oil pump drive ring	1		Heat drive ring to 200- 230 ^o C (140-160 ^o F). Align tabs of drive ring with crankshaft throws. Bevelled edge of tab must face outward	
15	Roll pin	1		Check for tight fit	
16	Crankcase	1			

REMOVING AND INSTALLING CRANKSHAFT OIL SEAL
(Flywheel End)



Removing flywheel end oil seal

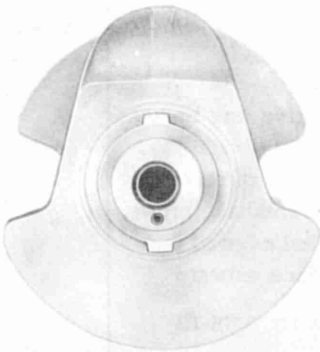
10 - 221 or screwdriver



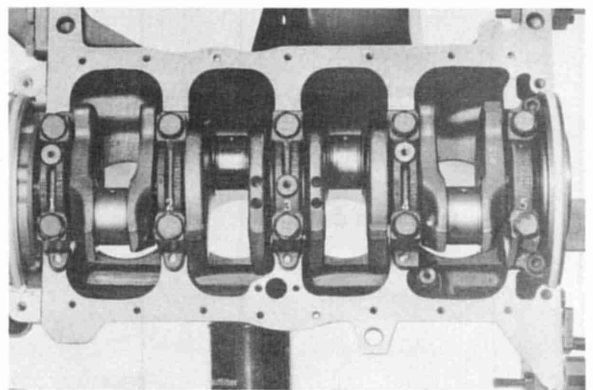
Installing flywheel end oil seal

OIL PUMP DRIVE RING, INSTALLING

Heat new drive ring to about 200-230° C (140-160° F). Align tabs of drive ring with crankshaft throws. Bevelled edge of tab must face outward.



BEARING CAP INSTALLATION

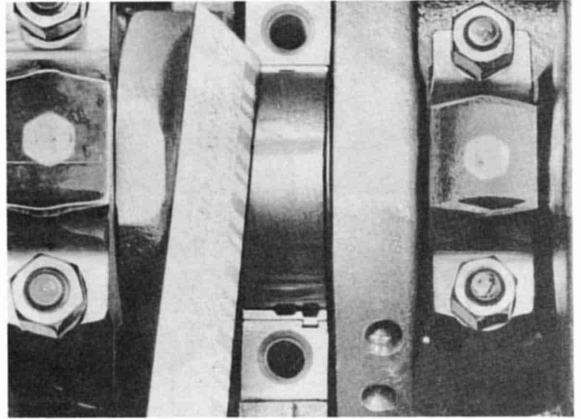


Bearing 1 - pulley end
Bearing 5 - flywheel end

CHECKING CRANKSHAFT BEARING PLAY

The "Plastigage" method is a simple way of checking bearing play - even with crankshaft installed in car.

Plastigage is available in three different sizes for measuring ranges from 0.025 to 0.23 mm (0.0001 - 0.009 in.)



Type	Color	Measuring Range
PG-1	green	0.025 to 0.075 mm (0.001-0.003 in.)
PR-1	red	0.05 to 0.15 mm (0.002-0.006 in.)
PB-1	blue	0.10 to 0.23 mm (0.004-0.009 in.)

Checking Crankshaft End Play

Checking Bearing Play

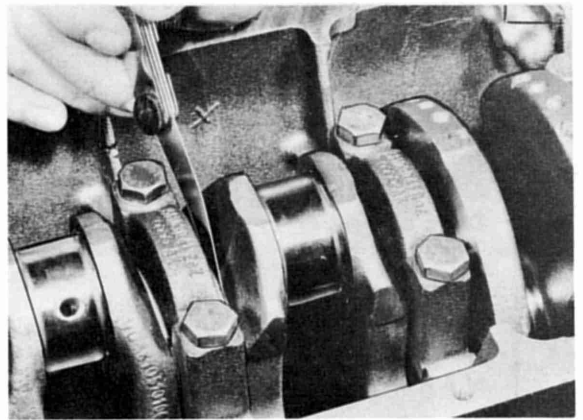
1. Remove main bearing caps.
2. Clean bearing shell and crankshaft journal.
3. Measure clearance with Plastigage.

Caution

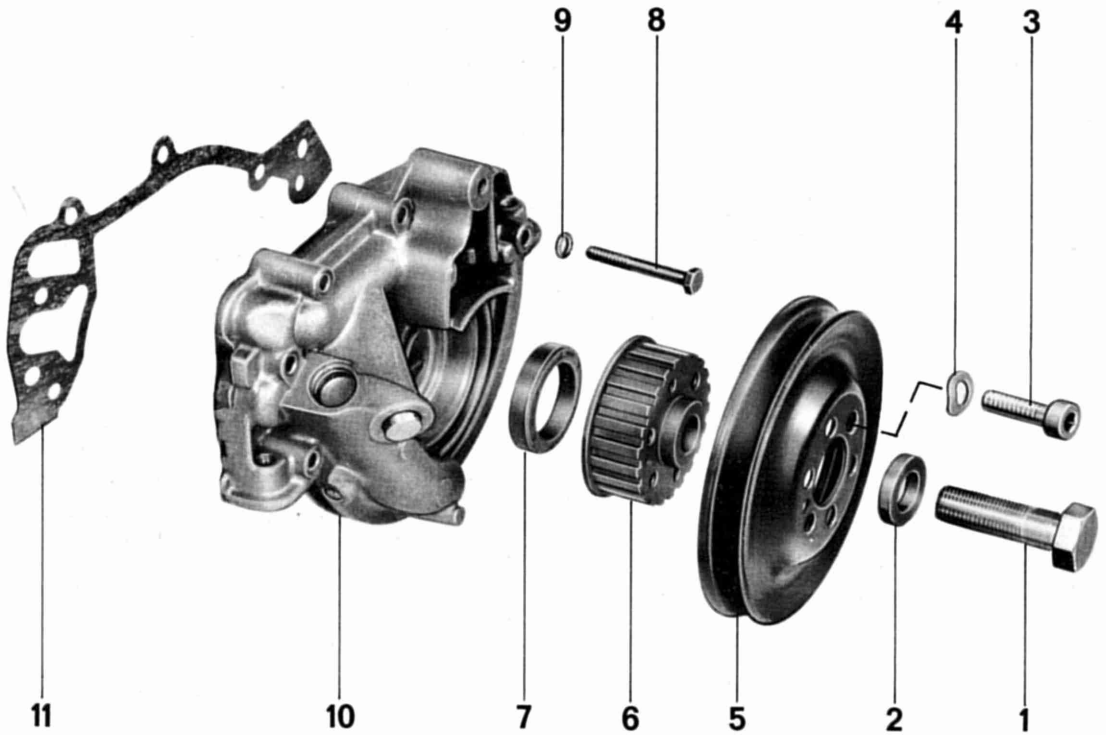
Do not turn crankshaft.

The end play is measured on bearing 3 (thrust bearing) with a feeler gage.

Play of new bearings: 0.10 to 0.19 mm
Wear limit: 0.25 mm

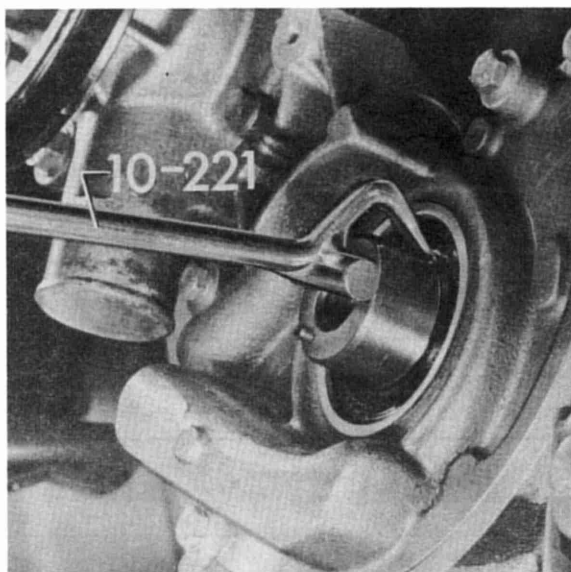


4. Play of new bearings: 0.02 to 0.08 mm
(0.0008-0.003 in.)
Wear limit: 0.16 mm (0.006 in.)

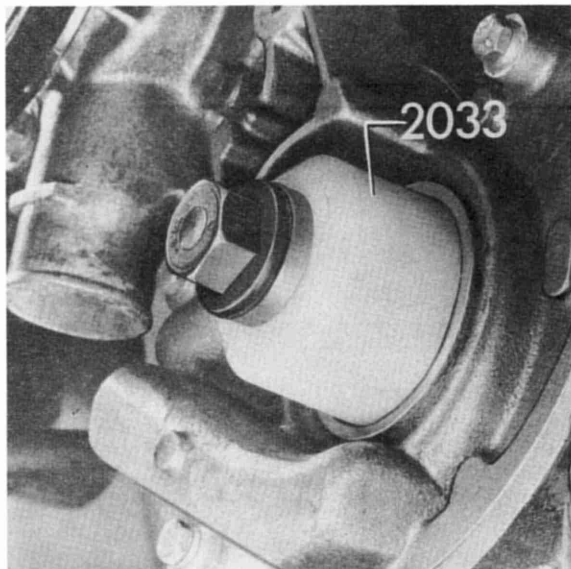


No.	Description	Qty.	Note when		Special Instructions
			Removing	Installing	
1	Bolt	1		Torque to 25 mkg (181 ft lb)	
2	Washer	1			
3	Allen head bolt	6		Torque to 2 mkg (14 ft lb)	
4	Washer	6			
5	Pulley	1			
6	Drive belt pulley	1			
7	Oil seal	1		Replace	
8	Bolt M 6 x 40	5		Torque to 1 mkg (7 ft lb)	
	Bolt M 6 x 35	1		Torque to 1 mkg (7 ft lb)	
9	Washer	6			
10	Oil pump	1			
11	Gasket	1		Replace	

REMOVING AND INSTALLING CRANKSHAFT OIL SEAL (Pulley End)



Remove pulley end oil seal (with 10-221 or screwdriver)

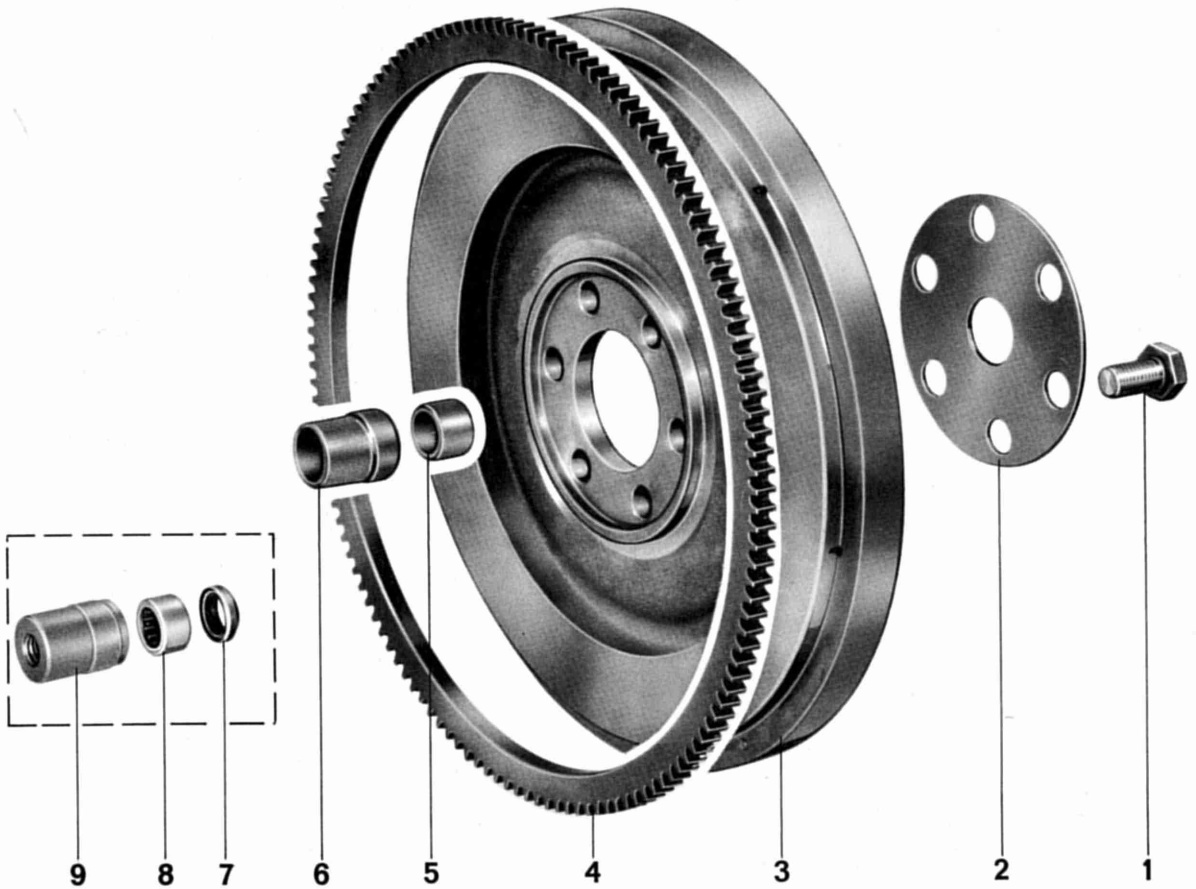


Install pulley end oil seal.

Press in to stop.

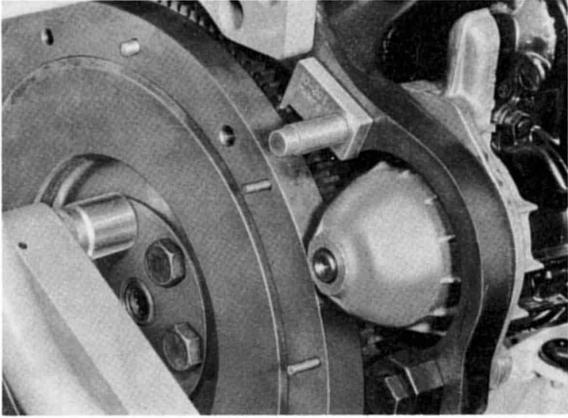
UNDERSIZE CRANKSHAFTS FOR REPAIRS (Dimensions in mm)

Size	Crankshaft main Bearing Journal	Maximum Out of round	Crankshaft connecting rod journal	Maximum Out of round
	Diameter		Diameter	
Standard	64,00 - 0,03 - 0,05	0,03	48,00 - 0,03 - 0,05	0,03
1st undersize	63,75 - 0,03 - 0,05	0,03	47,75 - 0,03 - 0,05	0,03
2nd undersize	63,50 - 0,03 - 0,05	0,03	47,50 - 0,03 - 0,05	0,03
3rd undersize	63,25 - 0,03 - 0,05	0,03	47,25 - 0,03 - 0,05	0,03

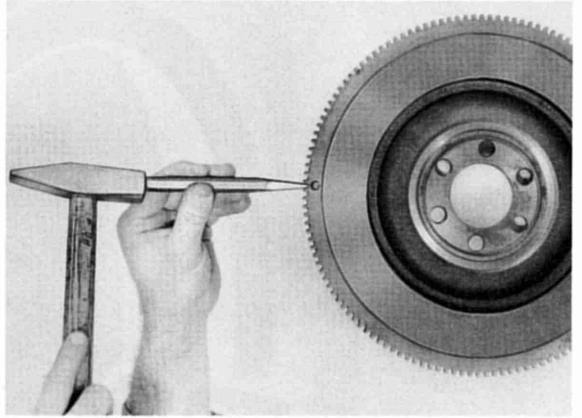


No.	Description	Qty.	Removing	Note When Installing	Special Instructions
1	Bolt	1		Torque to 9 mkg (65 ft lb)	
2	Washer	1			
3	Flywheel	1		Note mark	
4	Ring gear	1			
5	Needle bearing (version I)	1		Side with lettering faces out	
6	Bearing sleeve (version I)	1			
7	Seal (version II)	1			Version II bearing can be installed in place of version I
8	Version bearing (version II)	1			
9	Bearing sleeve (version II)	1			

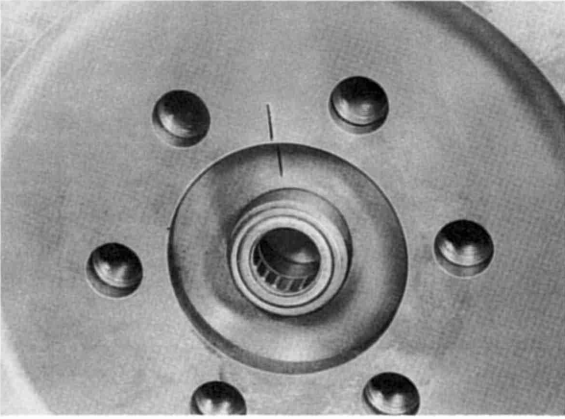
REMOVING AND INSTALLING FLYWHEEL



Use Special Tool 10 - 201 for loosening and tightening.



- Heat new starter gear ring to about 120°C and install on flywheel up to stop.



Marks on flywheel and crankshaft must align.

REMOVING AND INSTALLING NEEDLE BEARING

Removing

Note

Needle bearing can be replaced without removal of engine. Clutch must be removed first. See Repair Manual - Group 30.

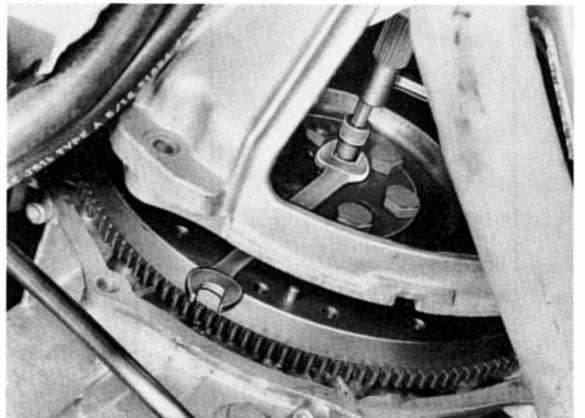
Pull out needle bearing with Special Tool 10-202.

REPLACING RING GEAR

- Drill ring gear near flywheel joining surface. Using chisel, open a notch on inside edge of ring gear to release tension. Remove ring gear.

CAUTION

Do not damage flywheel.



Installing

Drive in needle bearing up to stop with Special Tool 9124.



For version II drive in seal up to stop with Special Tool 9123.

Grease capacity:

Use about 3 grams of lithium grease NLGI grade number 3 such as, for example, "Shell cyprina grease 3". Unsuitable greases would damage needle bearings.



REMOVING AND INSTALLING BEARING SLEEVE

Removing

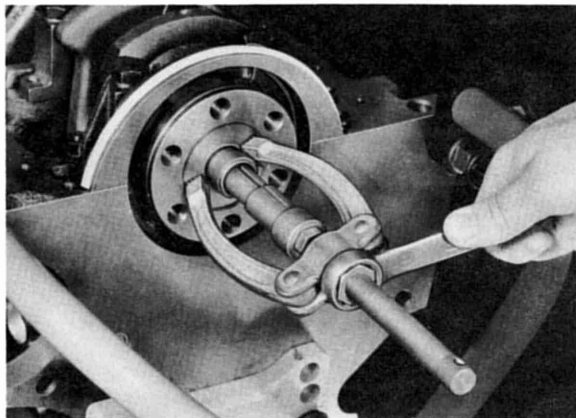
Note

Bearing sleeve can be replaced without removing engine. The following preparations are necessary.

- a) Removal of clutch and flywheel
- b) Lowering of rear axle support
- c) Detachment of clutch bell housing.
(see Repair Manual - Group 30)

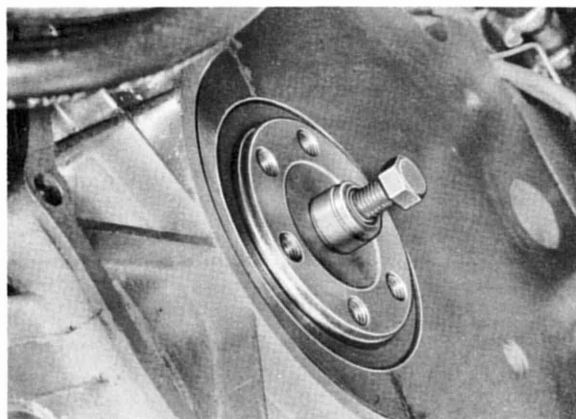
Version I

Pull out bearing sleeve with US 1088.



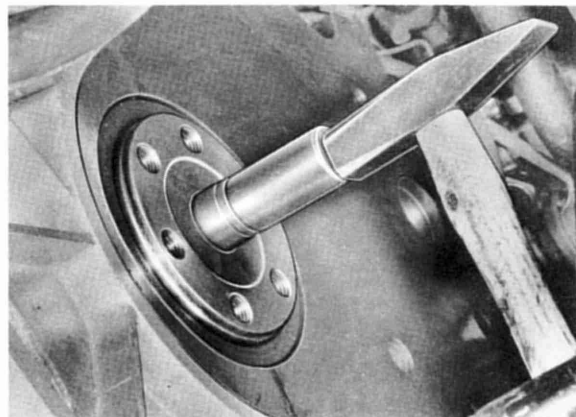
Version II

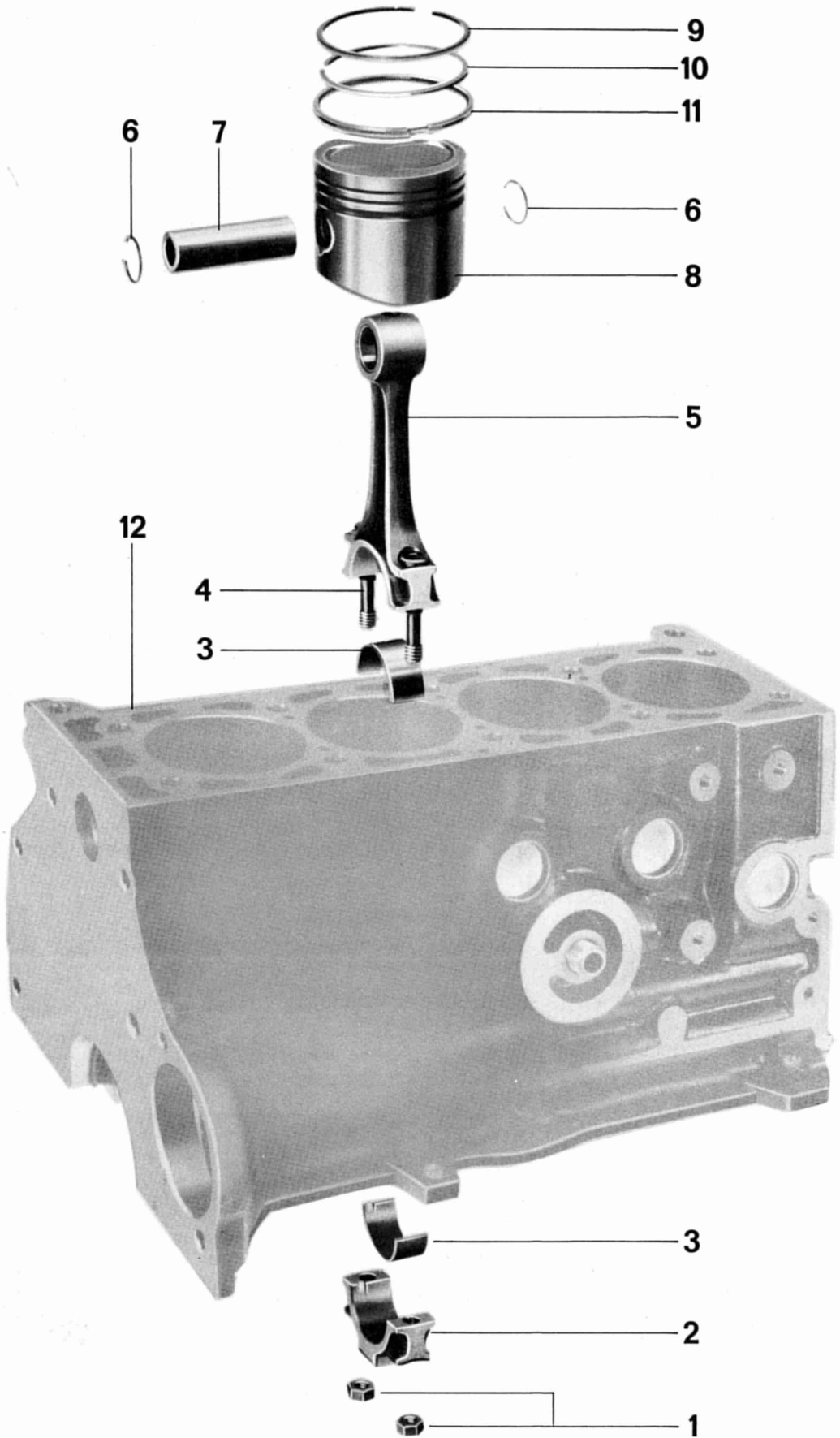
Pull out bearing sleeve with M 12 x 65 hexagon head bolt.



Installing

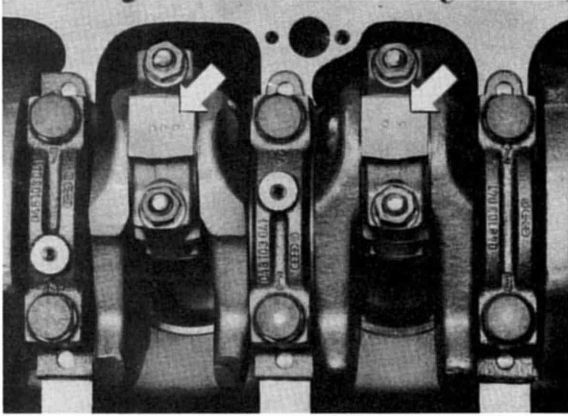
Drive in bearing sleeve up to stop with Special Tool 9123.



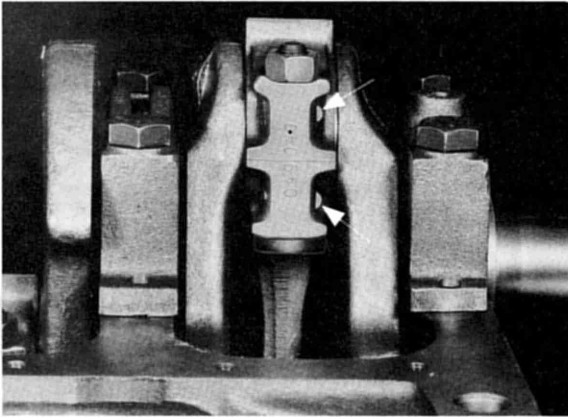


No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Connecting rod nut	8		Replace, lubricate bearing surface, torque to 6 mkg (43 ft lb)	
2	Connecting rod cap	4	Mark	Position correctly	
3	Bearing shell	8	Mark	Position correctly, do not mix up, make sure of tight fit in tabs	
4	Connecting rod bolt	8		Always replace	
5	Connecting rod	4			
6	Circlip	8	Lever out		
7	Piston pin	4		If hard to install, heat piston to about 60° C (65° F)	
8	Piston	4		Lubricate slightly	
9	Piston ring Groove 1 Stright edge ring with inside chamfer	4		Offset gaps 120° to each other	
10	Piston ring Groove 2 Tapered face	4		Offset gaps 120° to each other	
11	Piston ring Groove 3 Spring-loaded oil scraper ring	4		Offset gaps 120° to each other	
12	Cylinder block	1	Check for wear	Check cylinder bore, note hone group mark	

DISASSEMBLING / ASSEMBLING

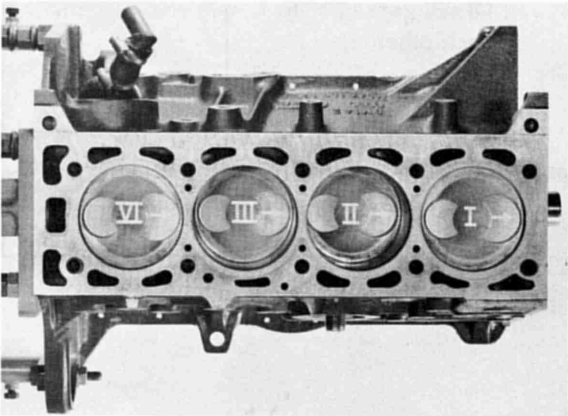


Mark conrod / cylinder location.



Note

Code numbers on connecting rod and cap on one side, cast bosses (arrows) face pulley end



Marking piston

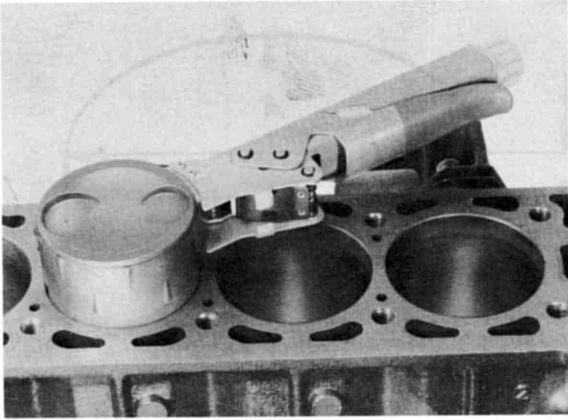
- mark with matching cylinders as shown.
Arrows face pulley.



Lever circlip out.



Remove and install piston pin.

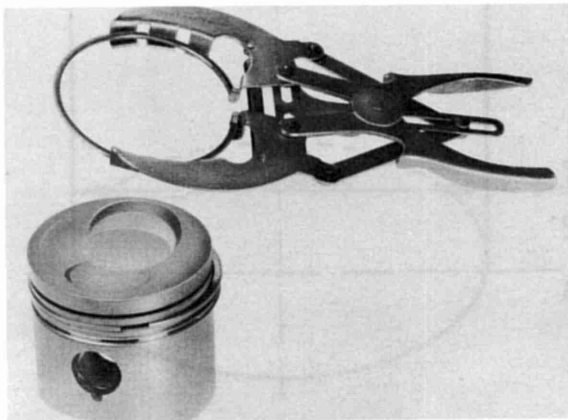


Install piston with US 1008 A

Ring gap new: 0.3 - 0.5 mm (0.012 - 0.020 in.)
 Wear limit: 1.0 mm (0.039 in.)



Check piston ring side clearance.



Play of new parts 0.04-0.07 mm (0.002-0.003 in.)
 Wear limit: 0.1 mm (0.039 in.)

Remove and install piston rings.

"Top" mark must face piston crown.



Check connecting rod bearing clearance

1. Remove connecting rod cap, clean bearing shell and conrod journal. Measure clearance with Plastigauge.

CAUTION

Do not turn crankshaft

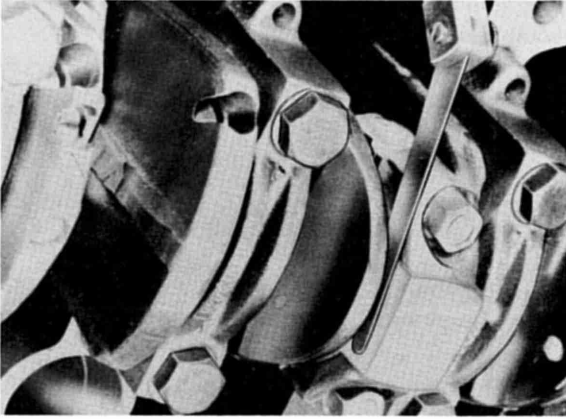
Play of new parts: 0.02-0.07 mm (0.0008 - 0.003 in.)

Wear limit: 0.10 mm (0.004 in.)



Check piston ring end gap

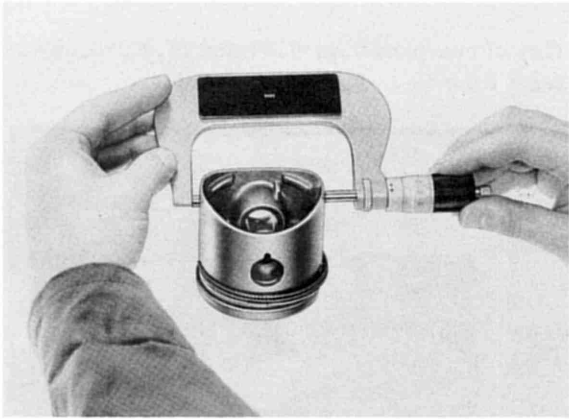
Slide ring into cylinder about 15 mm (5/8 in.)



Checking connecting rod side clearance

Side clearance: 0,05-0,3 mm (0.002-0.012 in.)

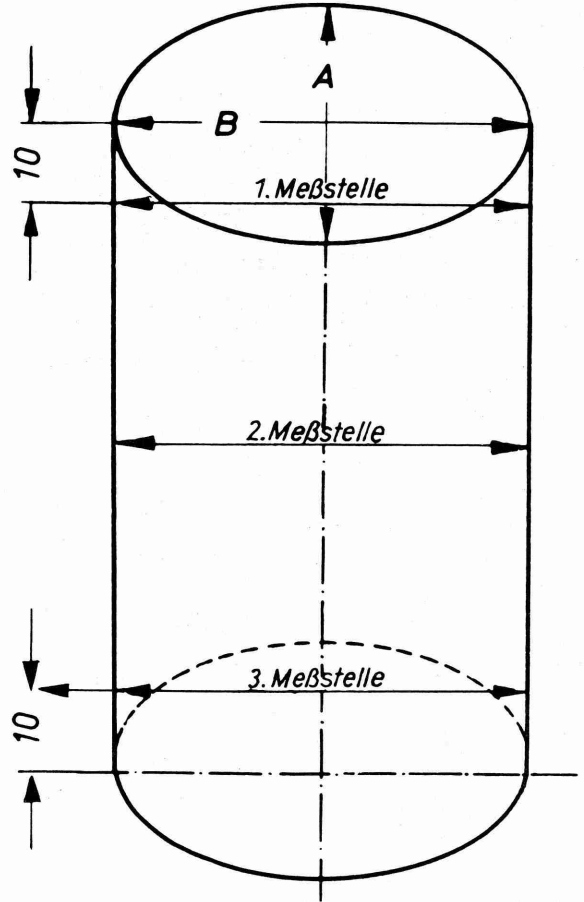
Wear limit: 0,4 mm (0.016 in.)



Checking pistons

Measure about 16 mm from bottom edge and at right angle to piston pin.

Max. difference from piston diameter in table (pg. 13-19): 0,04 mm (0.0016 in.)



Checking cylinder bore

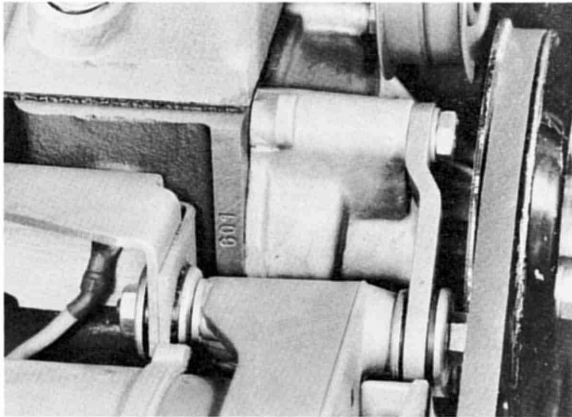
Measure at points 1, 2 and 3, first in direction A then direction B

- 1 - 10 mm (3/8 in.) from top
- 2 - middle of cylinder wall
- 3 - 10 mm (3/8 in.) from bottom

Max. difference from cylinder bore in table (page 13 - 19): 0,08 mm (0.003 in.)

Note

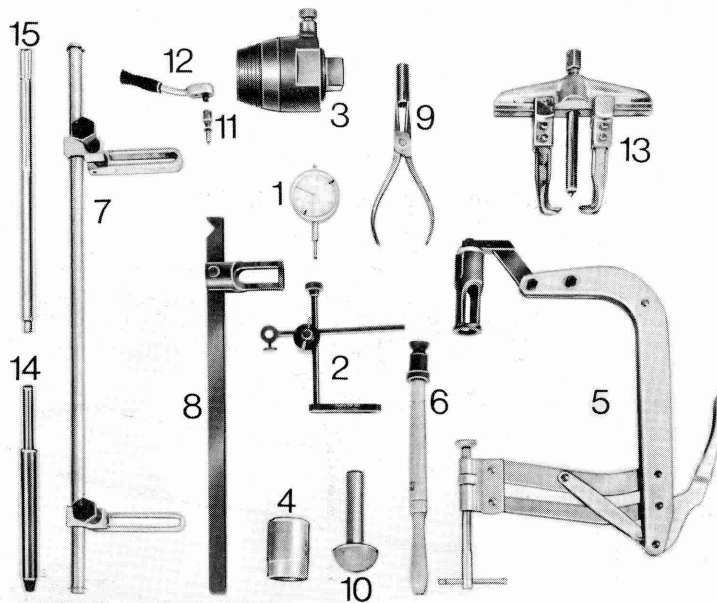
The honing group code is stamped in the engine block on the starter end immediately below the cylinder head in accordance with the following table.



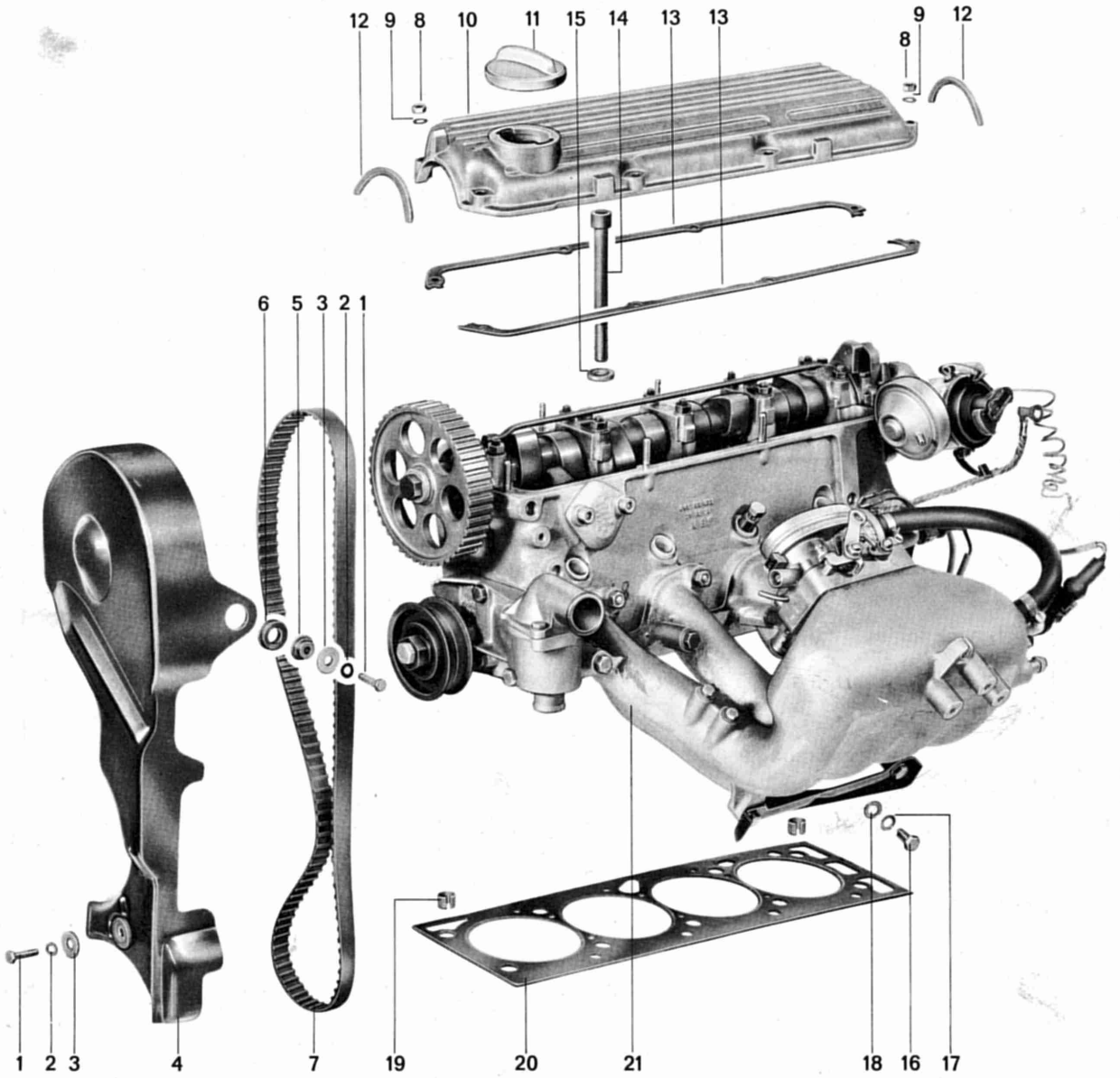
Size	Honing Group Code	Cylinder Bore (mm)	Piston Diameter (mm)	
			Mahle	KS
Standard	601	86.5 $\begin{matrix} + 0.015 \\ + 0.005 \end{matrix}$	86.48	
	602	86.5 $\begin{matrix} + 0.025 \\ + 0.015 \end{matrix}$	86.49	± 0.007
	603	86.5 $\begin{matrix} + 0.035 \\ + 0.025 \end{matrix}$	86.50	
1st oversize	626	86.75 $\begin{matrix} + 0.015 \\ + 0.005 \end{matrix}$	86.73	
	627	86.75 $\begin{matrix} + 0.025 \\ + 0.015 \end{matrix}$	86.74	± 0.007
	628	86.75 $\begin{matrix} + 0.035 \\ + 0.025 \end{matrix}$	86.75	
2nd oversize	651	87.00 $\begin{matrix} + 0.015 \\ + 0.005 \end{matrix}$	86.98	
	652	87.00 $\begin{matrix} + 0.025 \\ + 0.015 \end{matrix}$	86.99	± 0.007
	653	87.00 $\begin{matrix} + 0.035 \\ + 0.025 \end{matrix}$	87.00	

ENGINE -
CYLINDER HEAD,
VALVE DRIVE

TOOLS



No.	Description	Special Tool	Remarks
1	Dial gauge	US/026 or /027	
2	Dial gauge holder	VW 387	
3	Extractor for oil seal of camshaft	2002 or 2085	
4	Thrust plate for installation of camshaft oil seal	10 - 203	
5	Valve removal/installation tools	US 1020 and US 1020/1	
6	Valve grinder		standard
7	Lever for replacing valve stem seals	2036	
8	Lever	VW 541/1	
9	Pliers for pulling off valve stem seal	10 - 218 or 3047	
10	Thrust plate for installation of valve stem seal	10 - 204 plus US 9018	
11	Hexagon wrench socket	US 8005	
12	1/4" ratchet for adjustment of valve clearance	W 166	or Snap-on 1/4 "ratchet or equivalent
13	Extractor	US 1078	
14	Driver	US 4408	
15	Reamer	US 4413	

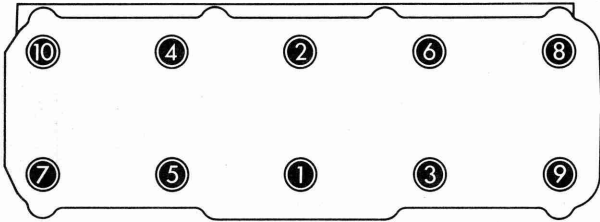


No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Bolt	3		Torque to 10 Nm (7 ft lb)	
2	Washer	3			
3	Plain washer	3			
4	Drive belt cover	1			
5	Grommet	3			
6	Rubber bushing	3			
7	Drive belt	1		Check	
8	Nut	8		Torque to 8 Nm (6 ft lb)	
9	Washer	8			
10	Cyl. head cover	1			
11	Oil filler cap	1			
12	Gasket	2		Replace	
13	Gasket	2		Replace	
14	Phillips screw	10		Torque to 100 Nm cold (72 ft lb) 120 Nm warm (86 ft lb)	from 1980 model see page 15 - 4
15	Plain washer	10		Chamfered side faces up	
16	Bolt	1			
17	Washer	1			
18	Plain washer	1			
19	Centering bushing	2		Check for proper fit	
20	Cyl. head gasket	1		Replace, install correctly	
21	Cylinder head	1			

REMOVING AND INSTALLING CYLINDER HEAD

The cylinder head can be taken off without removing the engine.

The engine block has 2 centering bushings to facilitate installation of head.



See figure for tightening sequence.
Opposite sequence for loosening.

Torque specifications:

warm: 120 Nm (86 ft lb)

cold: 100 Nm (72 ft lb)

Note

If the cylinder head was removed, the cylinder head bolts must be retorqued after about 1000 miles/1600 km.

Warm up engine.

Using loosening sequence, loosen cylinder head bolts about 30° and retorque one at a time to 120 Nm (86 ft lb).

REMOVING AND INSTALLING CYLINDER HEAD (from 1980 Model)

Identification:

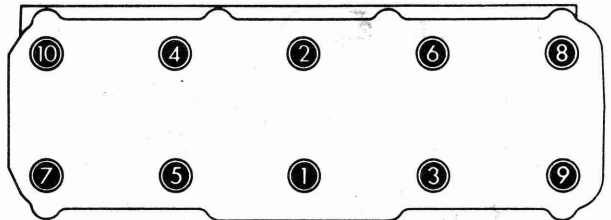
Polygon socket head bolts for cylinder head.

The cylinder head can be taken off without removing the engine.

The engine block has 2 centering bushings to facilitate installation of head.

Tightening Cylinder Head Bolts

Requirement: engine cold.



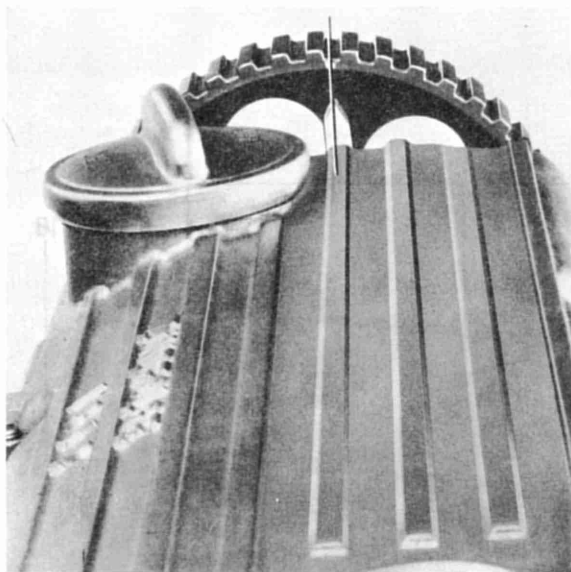
See figure for tightening sequence.
Opposite sequence for loosening.

1. Lubricate threads of cylinder head bolts with oil slightly and tighten bolts in specified sequence to 65 Nm (47 ft lb).
2. Mark position of cylinder head bolts.
3. Tighten cylinder head bolts 180 degrees (1/2 turn) in specified sequence.

Note

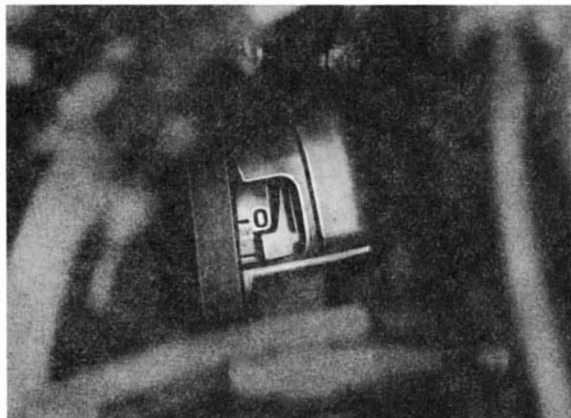
The cylinder head bolts do not have to be re-tightened after installation.

INSTALLING DRIVE BELT



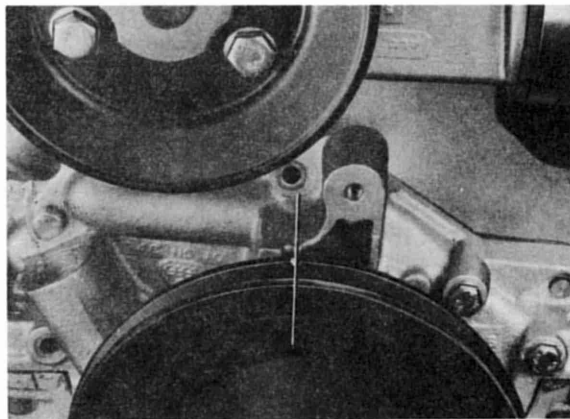
Camshaft sprocket position

Mark on camshaft sprocket and indicator on cylinder head cover must align with each other.



Crankshaft position (engine installed)

TDC mark on flywheel and clutch housing must align with each other.

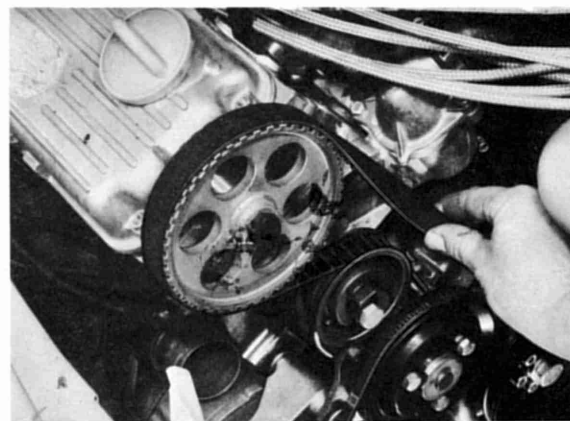
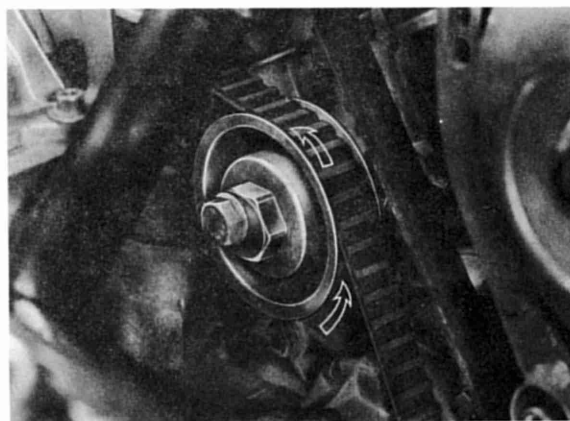


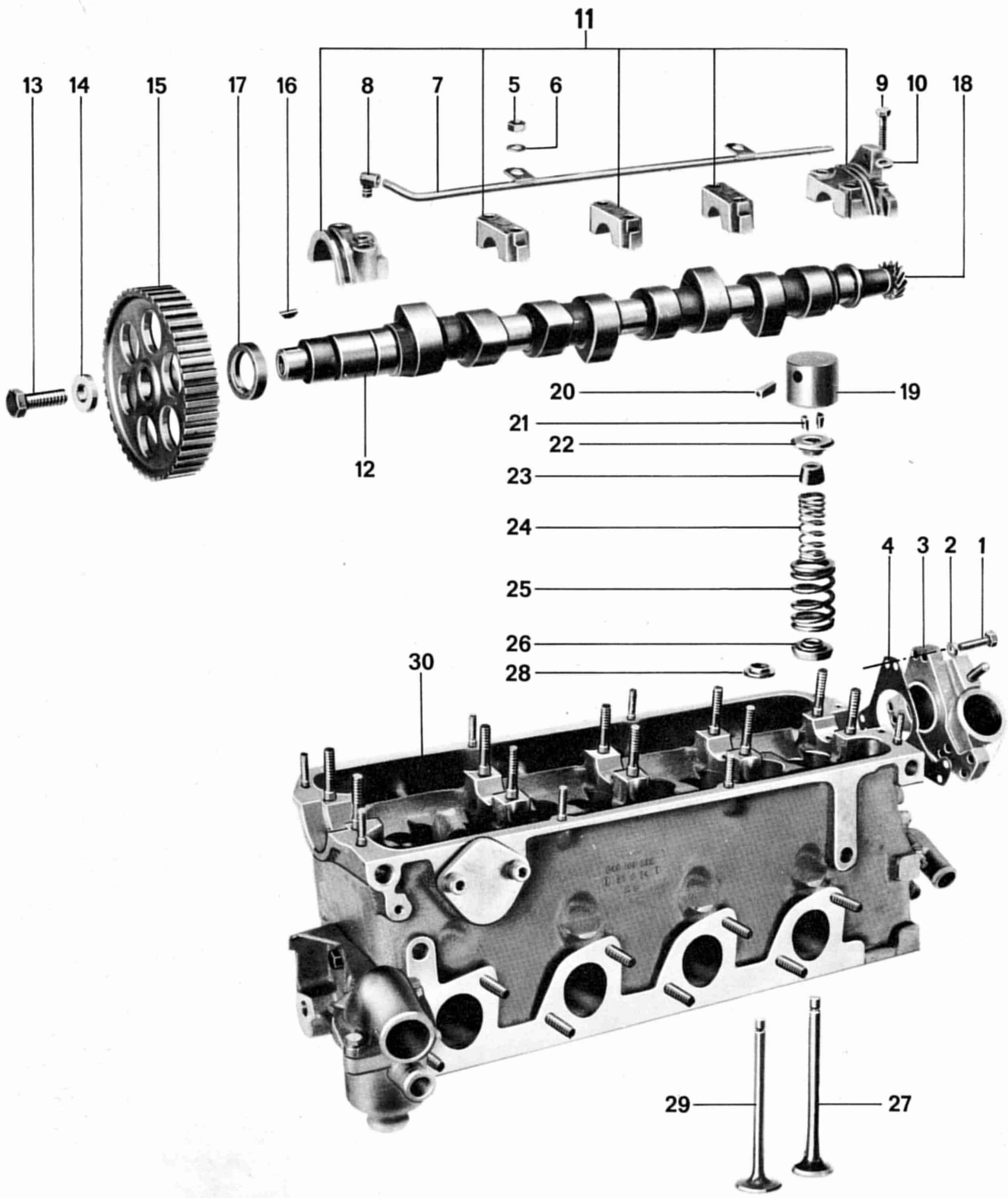
Crankshaft Position (engine removed)

Notch in pulley and pointer on oil pump housing must align with each other.

Adjusting tension

Turn tensioning roller in direction of arrow. It must be just barely possible to twist the drive belt 90° when holding belt at a point midway between the camshaft and crankshaft sprocket with thumb and index finger.





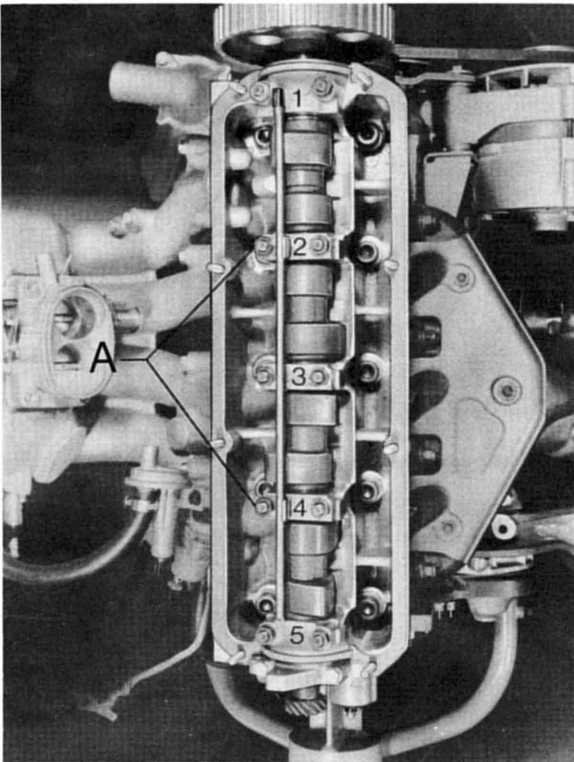
No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Bolt	3		Torque to 1 mkg (7 ft lb)	
2	Washer	3			
3	Housing, distributor drive	1			
4	Gasket	1		Replace	
5	Nut	10		Torque to 1.6 - 2.1 mkg (11, 6-15, 2 ft lb)	
6	Washer	10			
7	Camshaft lubrication tube	1		Clean, check oil bores	
8	Connector	1		Check, replace if necessary	
9	Bolt	2		Torque to 1 mkg (7 ft lb)	
10	Washer	2			
11	Bearing cap	5			
12	Camshaft	1		Oil lobe surface	
13	Bolt	1		Torque to 8 mkg (58 ft lb)	
14	Plain washer	1			
15	Camshaft sprocket	1		Watch position when installing toothed belt	
16	Woodruff key	1		Check for proper fit	
17	Oil seal	1		Replace	
18	Drive gear, distributor	1		Note assembly information	see page 15 - 11
19	Tappet	8	Mark, do not mix up		
20	Adjusting screw	8			
21	Valve keeper	16			

No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
22	Spring retainer, upper	8			
23	Valve stem seal	8		Always replace	
24	Valve spring, inner	8		Tight windings face cyl. head	
25	Valve spring, outer	8			
26	Rotocap, exhaust valve only	4			
27	Exhaust valve	4			
28	Spring retainer, lower (intake valve)	4			
29	Intake valve	4			
30	Cylinder head	1			

REMOVING AND INSTALLING CAMSHAFT

Removing

1. Remove camshaft lubrication tube (replace nuts "A" hand tight)



2. Remove bearing caps 5, 1 and 3.
3. Loosen bearing caps 2 and 4 crosswise alternately.

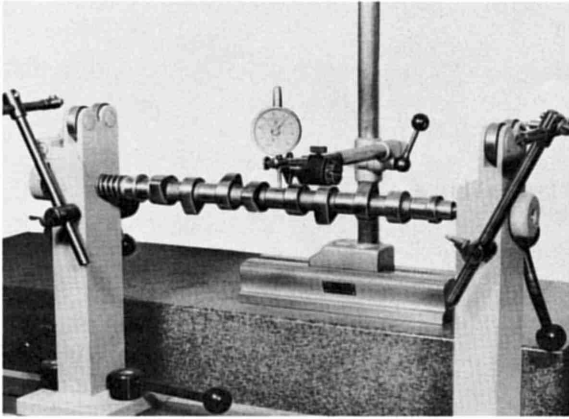
Installing

Note

When installing bearing caps note off-center position of bore. First place caps in position to check the proper installation position.

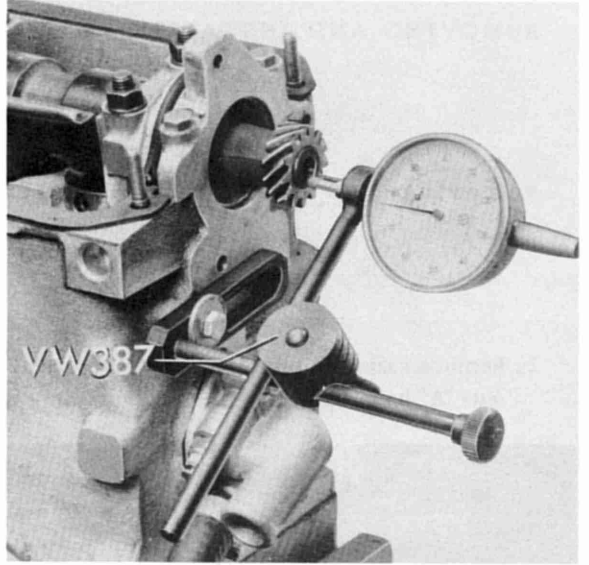
1. Tighten bearing caps 2 and 4 crosswise alternately.
2. Install bearing caps 5, 1 and 3.
3. Install camshaft lubrication tube (this requires loosening again nuts "A" on bearing caps 2 and 4).

CHECKING CAMSHAFT



Check camshaft runout.

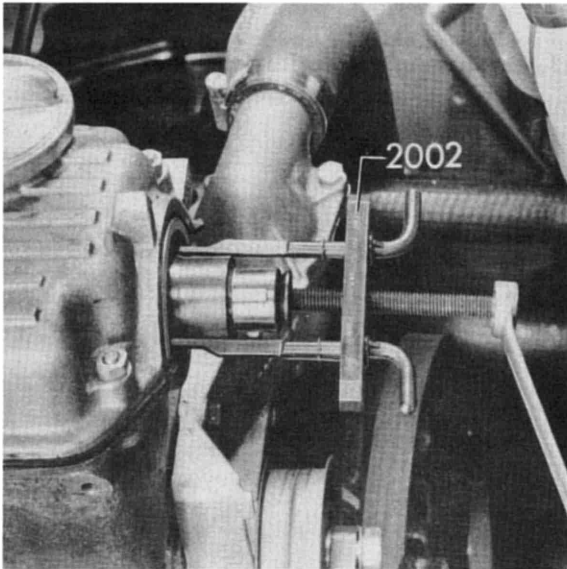
Max. 0.02 mm on center bearing.



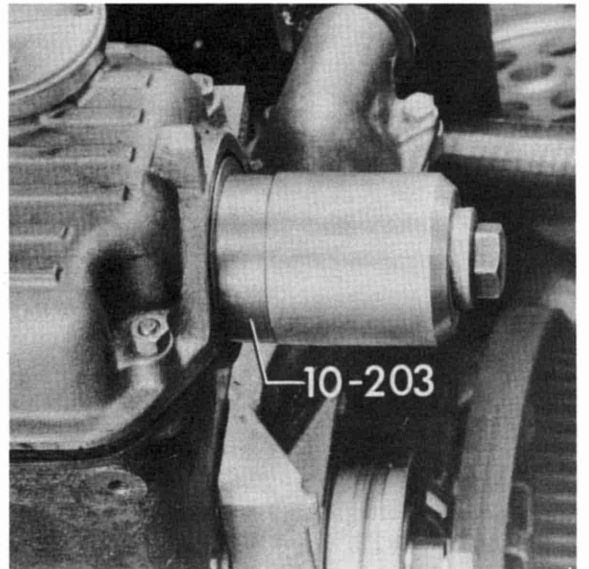
Check camshaft end play.

Max. 0.2 mm.

REMOVING AND INSTALLING CAMSHAFT OIL SEAL



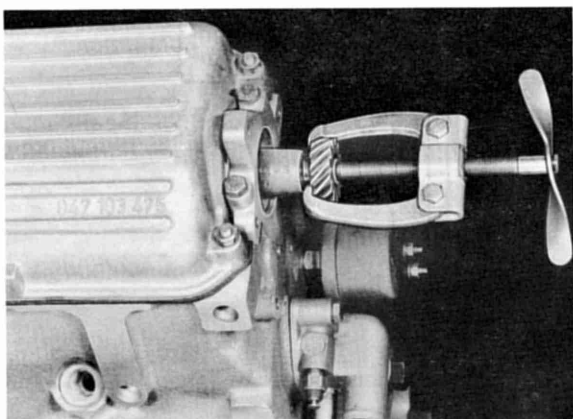
Remove camshaft oil seal.



Install camshaft oil seal.

Press in up to stop.

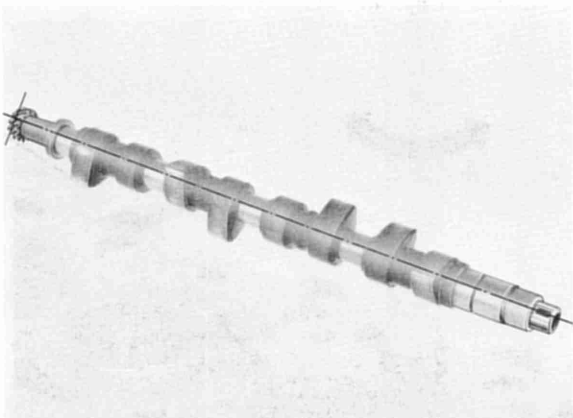
REMOVING AND INSTALLING DISTRIBUTOR DRIVE GEAR

**Removing**

Pull off drive gear with a standard puller.

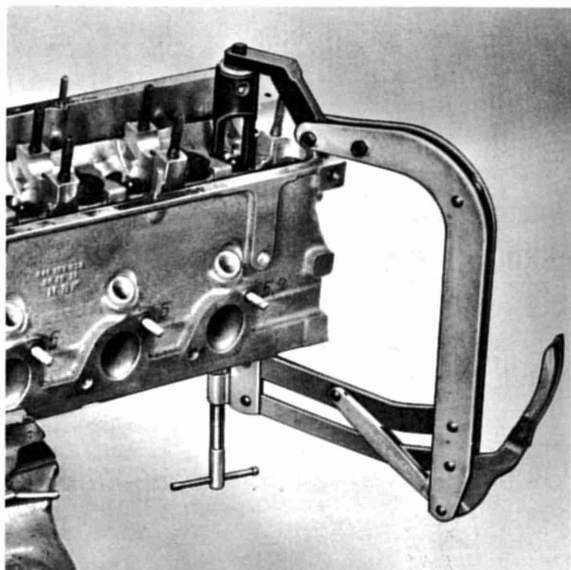
Installing

1. Align drive gear so that center of a tooth is in line with opposite groove.



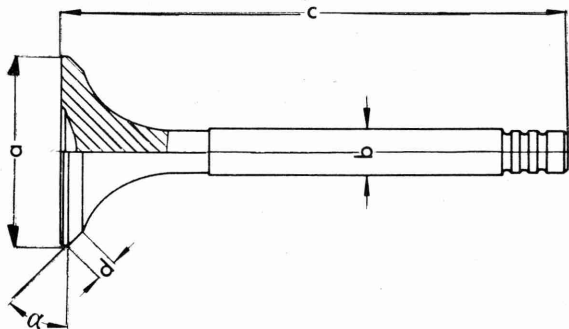
2. Knock on drive gear cold against stop with a suitable pressure pad.

Removing and Installing Valve Springs



Closed coils of inner valve spring face cylinder head.

Valve Dimensions



Intake Valve

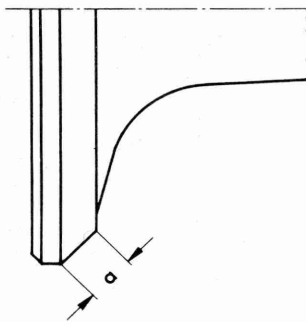
- a - 38, *40 mm dia.
- b - 8.97 mm dia.
- c - 137.2 mm
- d - 2.2₀ - 3.0 mm
- 45°

Exhaust Valve

- a - 33 mm dia.
- b - 8.95 mm dia.
- c - 136.95 mm
- d - 2.2₀ - 3.0 mm
- 45°

* Model 77 1/2

Machining Intake Valves

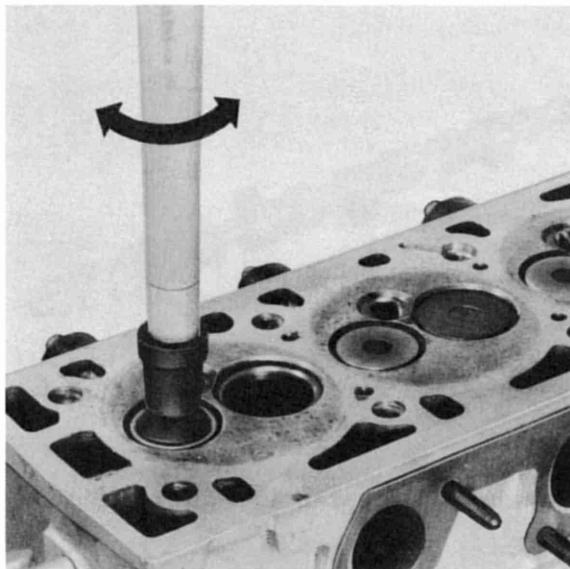


Dimension (a) should never be larger than 3.5 mm.

CAUTION

Exhaust valves may not be machined.
Only hand lapping is permissible.

Hand Lapping Valves



Lap valve while lifting and turning at the same time.

CAUTION

Remove all traces of abrasive paste after lapping.

Lapping in is not absolutely necessary for perfectly machined valve seat inserts and new valves.

MACHINING VALVE SEATS

Valve seats showing traces of wear or burnt spots can be machined until reaching wear limit depth "b". If depth "b" is exceeded the cylinder head must be replaced, since valve clearance could no longer be adjusted to specifications. Valve seat inserts cannot be replaced with normal workshop facilities.

Intake Valve Seat

- a - 36.5, *38.5 mm dia.
- b - max. 3.5, * 3.3 mm

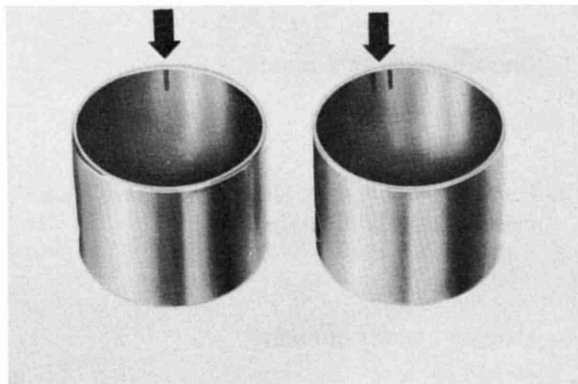
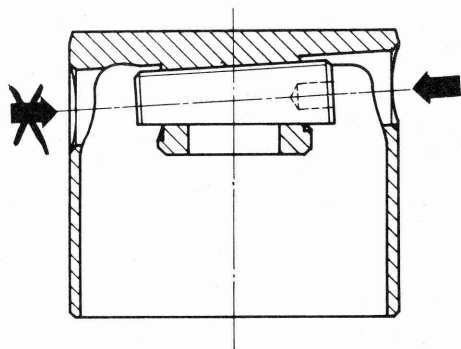
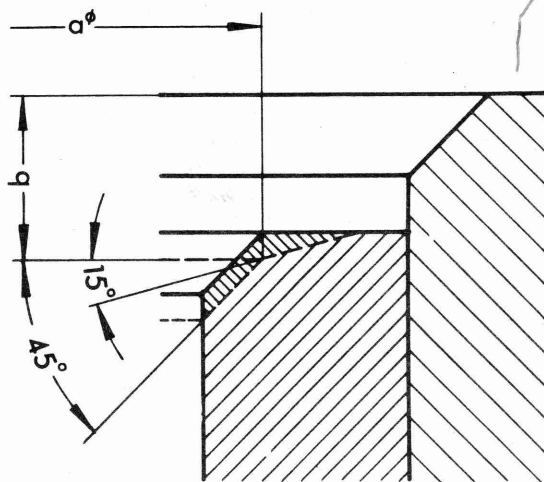
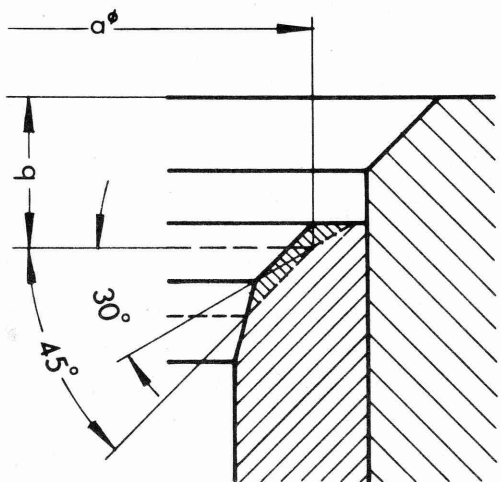
*Model 77 1/2

Exhaust Valve Seat

- a - 31.5 mm dia.
- b - max. 3.9 mm

CAUTION

If a valve seat has been machined, the valve adjusting screw must be replaced with adjusting screw 046 109 453 C (previously with white marking, now with no marking).



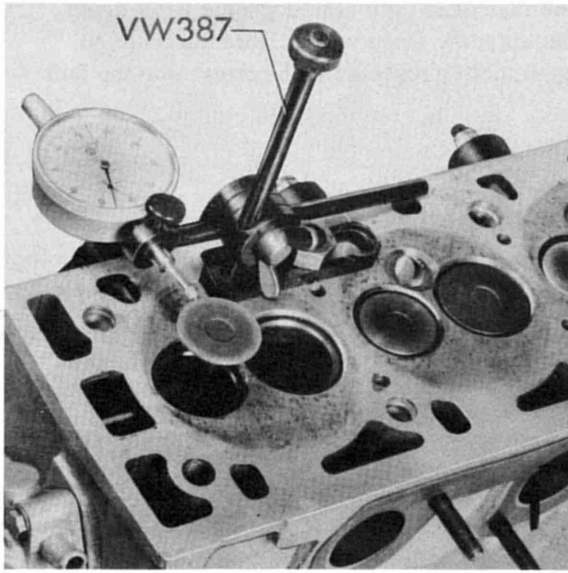
Tightening Valve Adjusting Screw

Note tightening direction.

Marking Tappet

Adjusting screws with three different thicknesses are standard; therefore do not mix up the tappets.

CHECKING VALVE GUIDES



When reworking valves/seats valve guides must be checked for wear. This is particularly true for engines with high mileage.

If wear is excessive, cylinder head must be replaced, until such time when repair procedures are published.

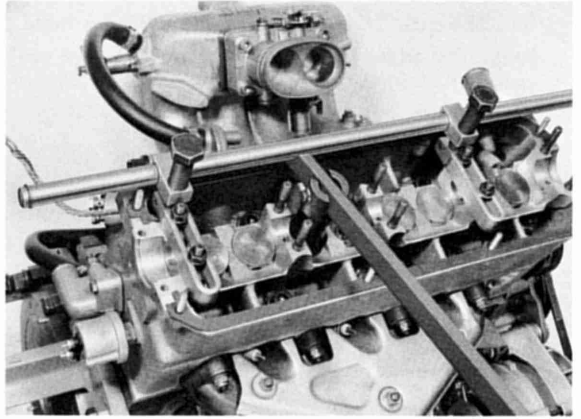
Checking

1. Clean guide with a broach.
2. Place new valve in guide. End of valve stem must be flush with guide.
3. Measure amount of rock.

Intake valve guide: max. 0.8 mm

Exhaust valve guide: max. 1.0 mm

REMOVING AND INSTALLING VALVE STEM SEAL (Cylinder Head Installed)

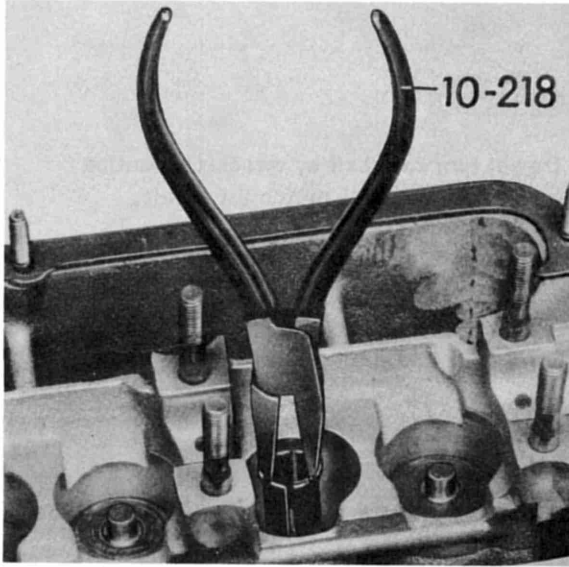


Removing

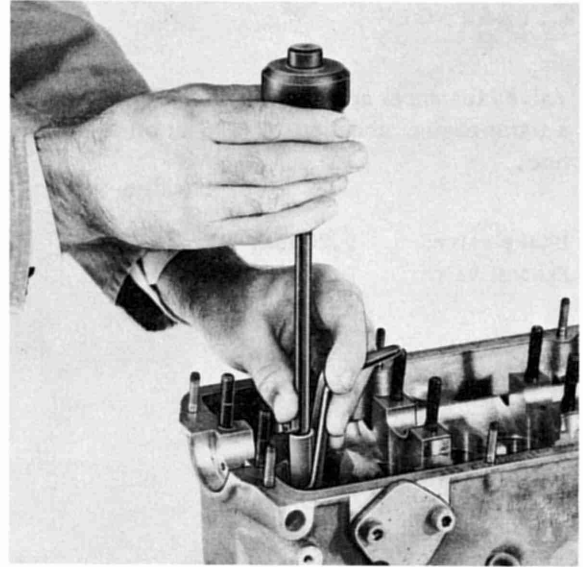
1. Remove camshaft and tappets.
2. Remove spark plugs.
3. Move piston of each cylinder to "BDC". Install VW 652 or similar pressure hose and apply constant pressure.
4. Remove valve springs.

Note

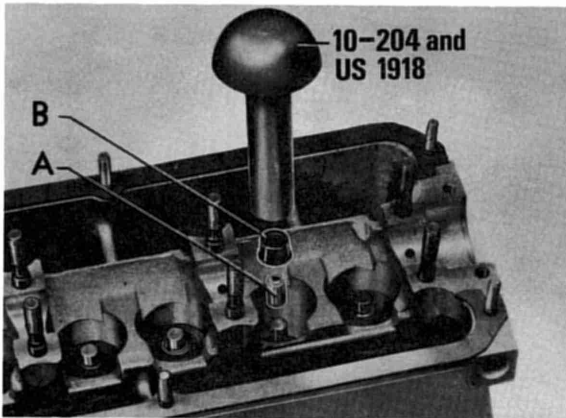
Loosen stuck valve keepers by tapping installation lever with a hammer.



Pull off valve stem seals.



Pull off valve stem seals with Special tool 3047.



Install valve stem seals.

Place plastic sleeve (A) on valve stem. Lubricate valve stem seal (B). Push seal carefully onto valve guide with a mandrel.

Caution

Valve stem seals must always be replaced. Do not install seal without using plastic sleeve as valve stem seals will be damaged and cause excessive engine oil consumption.

Plastic sleeve A is included in valve stem seal replacement kit.

CHECKING AND ADJUSTING VALVE CLEARANCE

Valve clearances are checked and adjusted on a warm engine: about 80°C (176°F) oil temperature.

Intake valve: 0,20 mm
Exhaust valve: 0,45 mm

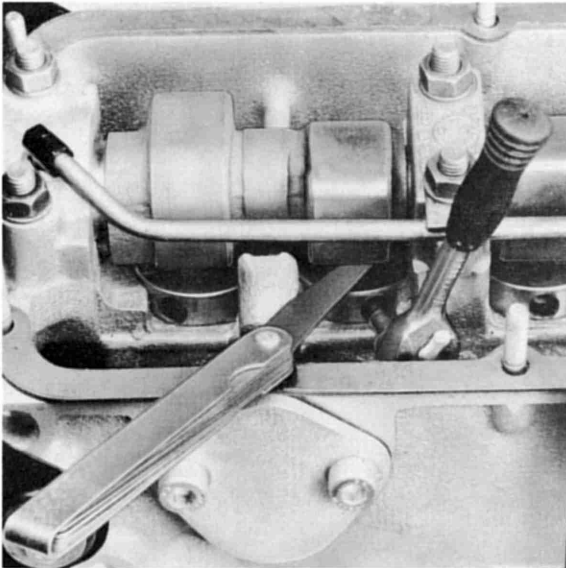
Basic Valve Clearance Setting
(when reconditioning engines etc.)

Cold Engine

Intake valve: 0,10 mm
Exhaust valve: 0,40 mm

ADJUSTING VALVE CLEARANCE

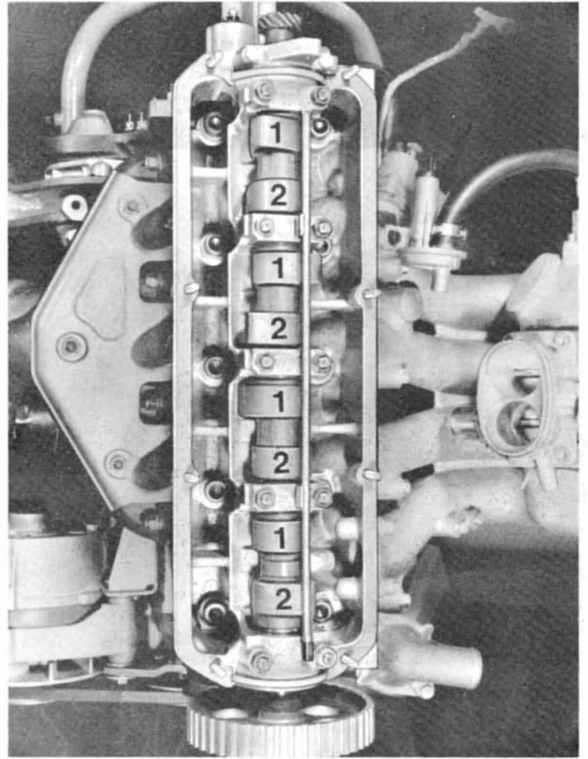
1. Remove cylinder head cover.
2. Turn crankshaft until the cam lobes of the cylinder to be adjusted point upward.



CAUTION

Do not turn camshaft by sprocket mounting bolt, since this will stretch drive belt.

Arrangement of valves



1 = exhaust

2 = intake

3. Check valve clearance, if necessary correct with complete turns of the adjusting screw (one turn of the adjusting screw will change valve clearance by 0,05 mm).

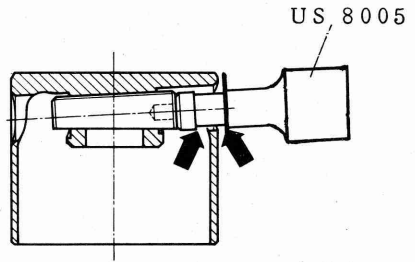
CHECKING LOCATION OF ADJUSTING SCREW

CAUTION

After adjusting valve clearance be sure that edge of tappet is in line with green area of US 8005.

Note

Camshaft must be removed to replace valve adjusting screws.



The following adjusting screws are available:

Note

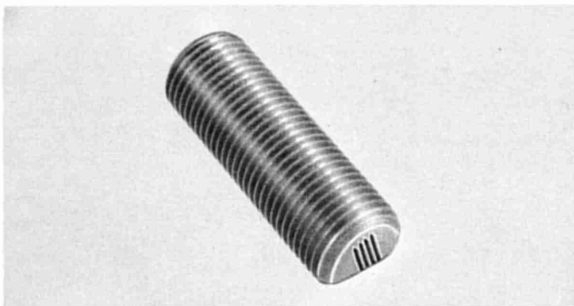
After screws identified with paint are used up only screws with notch marks will be supplied.

The adjusting screw (part no. 046 109 453 C) however, will still be supplied without any identification (formerly dot of white paint).

New adjusting screw	Identification	Old adjusting screw	Identification
Part No.		Part No.	
046.109.453 D	1 notch	046.109.453 B	blue
046.109.453 E	2 notches	046.109.453 A	red
046.109.453 F	3 notches		
046.109.453 G	4 notches	046.109.453	yellow
046.109.453 C	no notches	046.109.453 C	white

The number of notches indicates thickness of valve adjusting screws.

High notch number = thick adjusting screw.



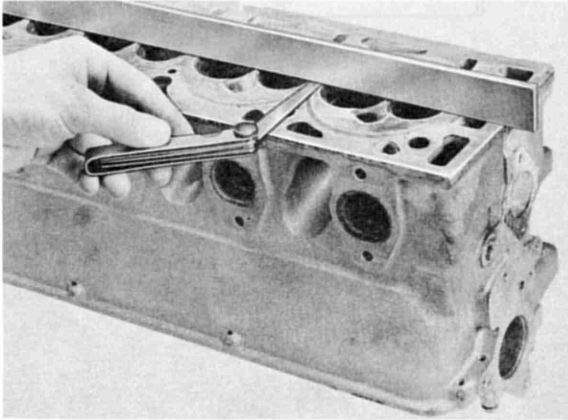
Note

If cylinder head has been repaired, i.e. valves replaced and ground or camshaft replaced, valve clearance must be checked and adjusted on warm engine after about 1,000 miles/1600 km. After repairs on cylinder head valve clearance can also be adjusted on cold engine. Final check must be on a warm engine.

Checking cylinder head for distortion

Check sealing surface of cylinder head for distortion with a feeler gage and ruler or straight edge

Max. permissible distortion: 0.1 mm/0.004 in.



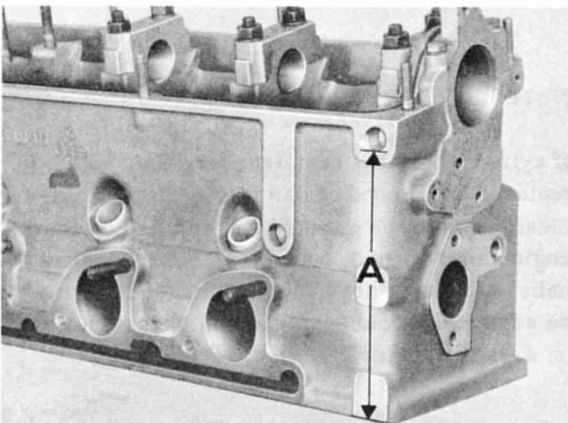
Cylinder heads with a distorted sealing surface can be repaired by machining.

Machining cylinder head

Only machine cylinder head sealing surface until it is refinished.

Note wear limit for cylinder head sealing surface.

Wear limit A = 139.55 mm/5.494 in.



Machining note:

Max. allowable surface roughness + waviness = 0.015 mm/0.0006 in.

REPLACING VALVE GUIDES

Note

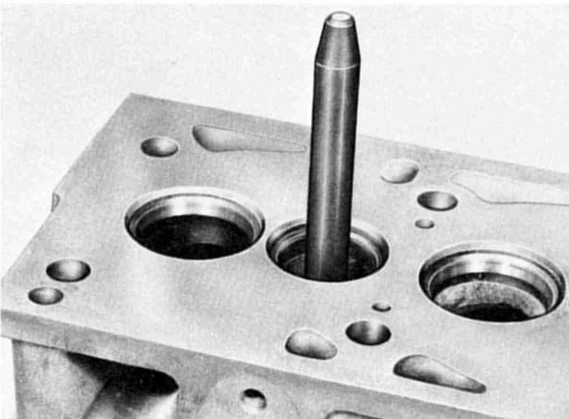
Cylinder heads with cracks between valve seats or between a valve seat and spark plug threads can still be used without risk of a shorter service life, if the cracks are not wider than 0.5 mm max. or if only the first spark plug threads are damaged.

1. Clean and inspect cylinder head. Heads, in which the valve seats can no longer be machined, are not suitable for replacement of valve guides.

2. Press out worn valve guides from combustion chamber side. Note identification code of removed guide. Valve guides with different identification codes can be installed in one cylinder head.

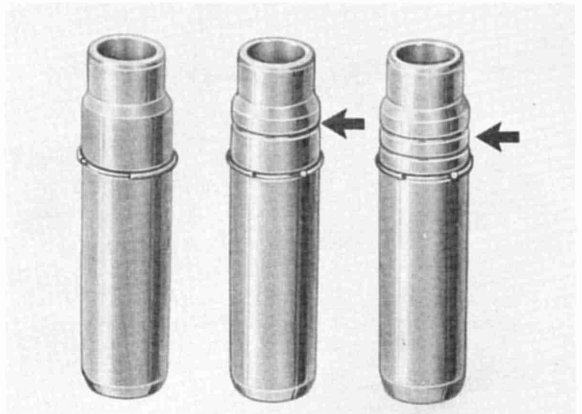
3. Select suitable replacement repair guide from following table.

Repair Guide with Circlip	Code for Production and Repair Guides	Outside Diameter (mm)
Intake 048 103 415 A	no groove	+ 0.039 14,04 (s 6)
Exhaust 046 103 415 A	no groove	+ 0.028
Intake 048 103 419 A	one groove	+ 0.039 14,24 (s 6)
Exhaust 046 103 419 A	one groove	+ 0.028
Intake 048 103 423 A	two grooves	+ 0.039 14,44 (s 6)
Exhaust 046 103 423 A	two grooves	+ 0.028



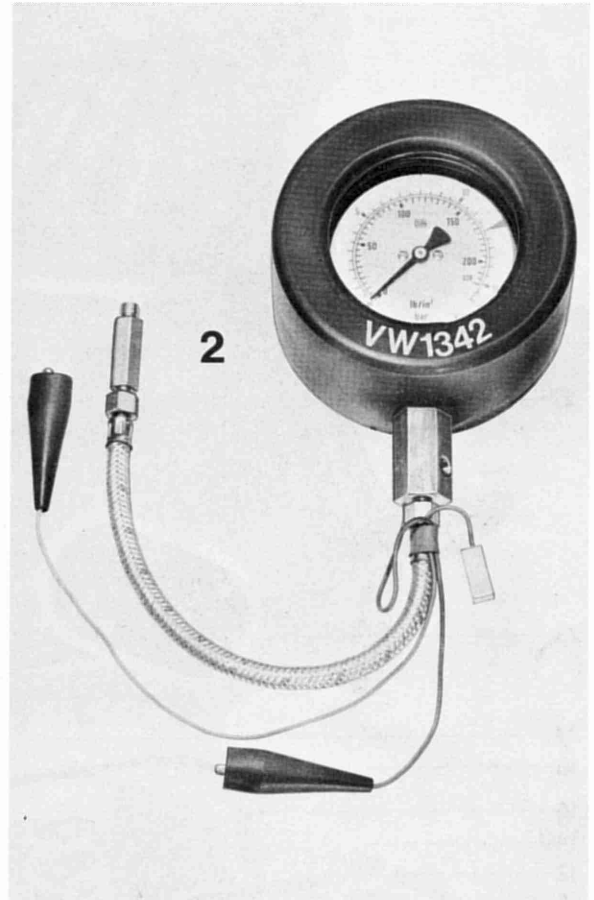
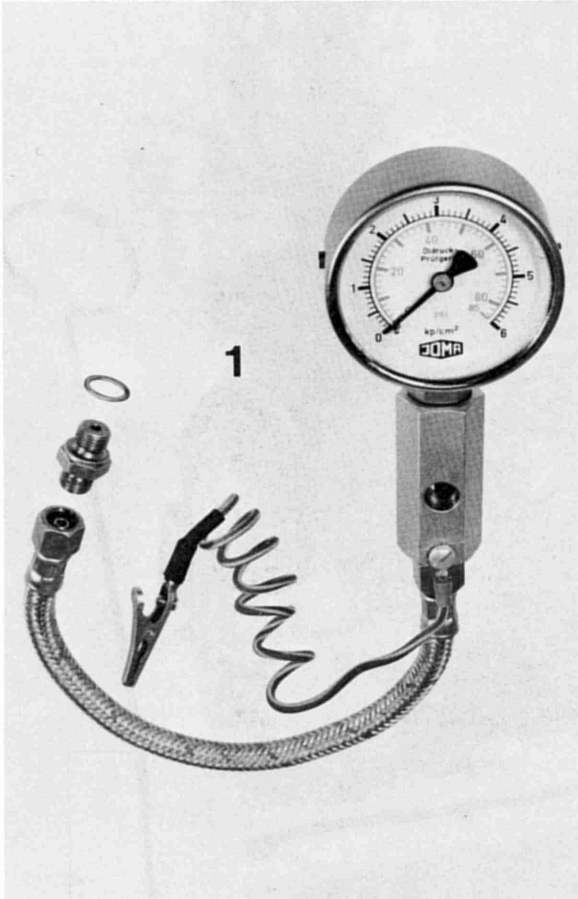
Note

During repairs, installed valve guides must have the same codes as those replaced.

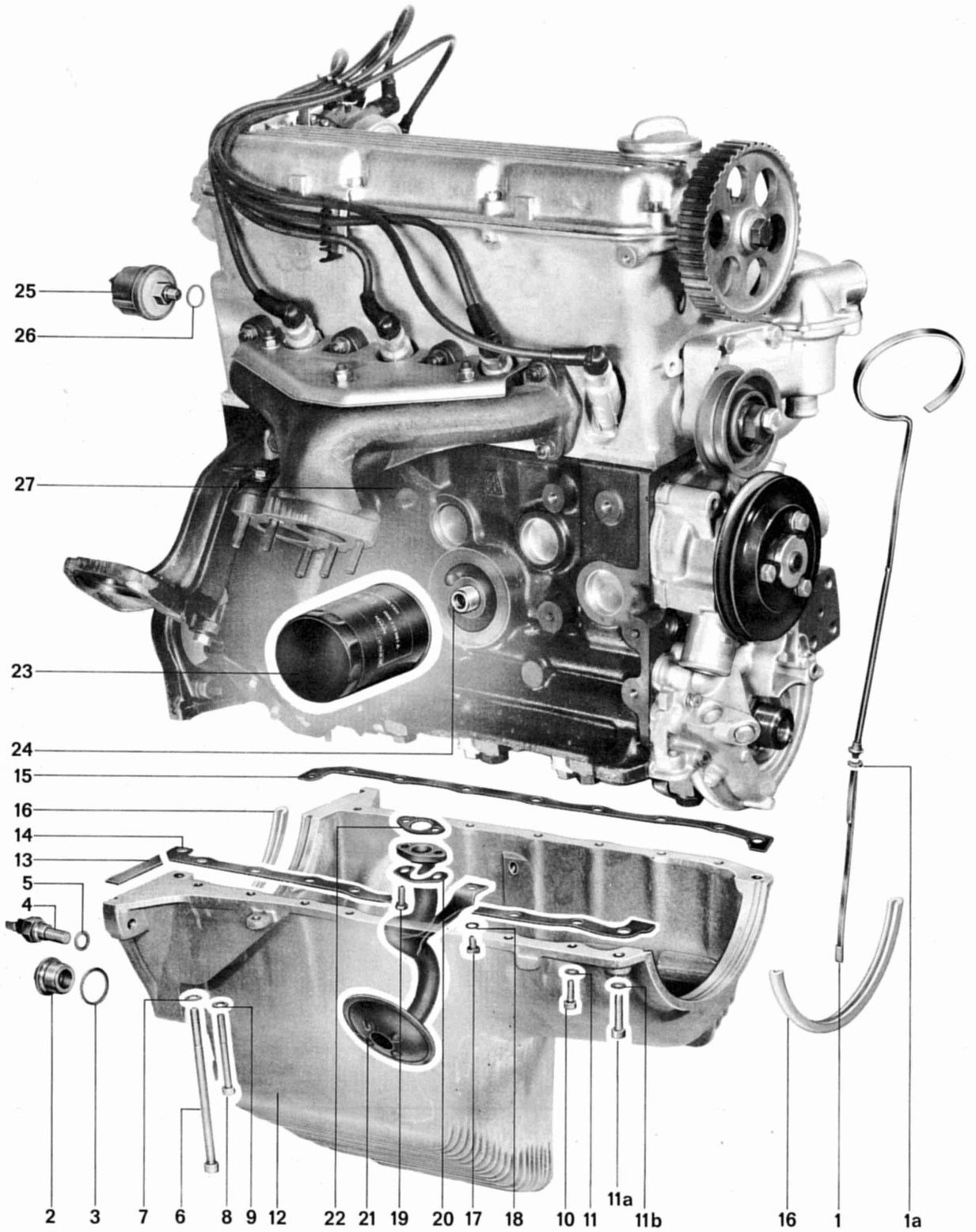


ENGINE-
LUBRICATION SYSTEM

TOOLS



No.	Description	Special Tool	Remarks
1	Oil pressure tester		standard
2	Oil pressure tester	VW 1342	

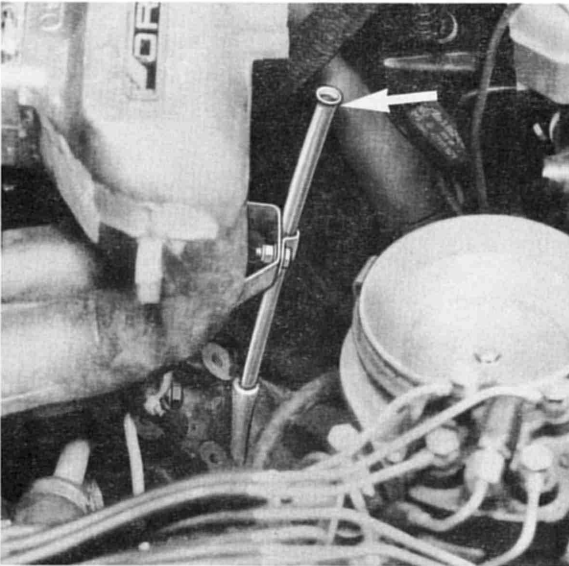


No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Oil dipstick	1			
1a	Seal	1		Check, replace if necessary	
2	Plug	1		Torque to 4 mkg (29 ft lb)	
3	Seal	1		Replace	
4	Temperature sensor	1			
5	Seal	1		Replace	
6	Allen head bolt M 8 x 140	2		Torque to 1.5 mkg (11 ft lb)	
7	Washer	2			
8	Allen head bolt M 6 x 60	2		Torque to 0.8 mkg (5 ft lb)	
9	Washer	2			
10	Allen head bolt M 6 x 18	13		Torque to 0.8 mkg (5 ft lb)	
11	Washer	13			
11	Allen head bolt M 8 x 30	2			
11b	Plain washer B 8 x 15	2			
12	Oil pan	1	Can be removed and installed without removing engine. Detach steering at cross member and removing entire cross member. Loosen bolts of left engine support slightly.		
13	Gasket	1		Replace	
14	Gasket	1		Replace, apply sealing compound to both ends	
15	Gasket	1		Replace, apply sealing compound to both ends	

No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
16	Gasket	2		Replace, apply sealing compound to both ends, check for proper fit	
17	Bolt	1		Torque to 1 mkg (7 ft lb)	
18	Washer	1			
19	Bolt	2		Torque to 1 mkg (7 ft lb) lock with a lock-plate	
20	Lockplate	1		Replace	
21	Suction line	1		Clean thoroughly	
22	Gasket	1		Replace	
23	Oil filter	1	Loosen with standard tool	Note installation instructions on oil filter	
24	Adaptor	1		Max. torque 2 mkg (14 ft lb) until tight fit	
25	Sensor, oil pressure gauge	1		Torque to 1.5 mkg (11 ft lb) Apply thin coat of Curil to threads	
26	Seal	1		Replace	
27	Engine block	1			

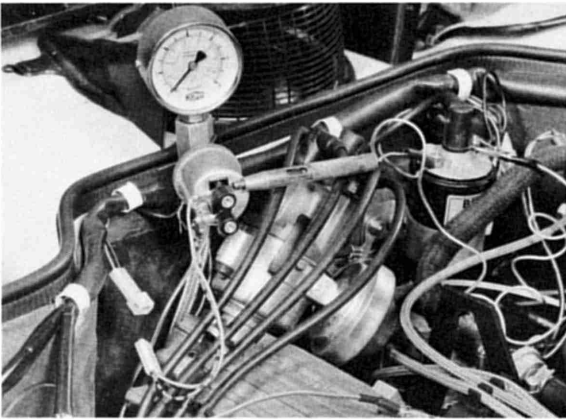
INSTALLING OIL DIPSTICK GUIDE TUBE WITH LOCKING COMPOUND

1. Remove grease from surfaces receiving locking compound.
2. Install correctly positioned guide tube against stop with Loctite No. 270, 638 or 648. Black paint dot (arrow) on guide tube faces out.
3. Tighten clamp for guide tube immediately.

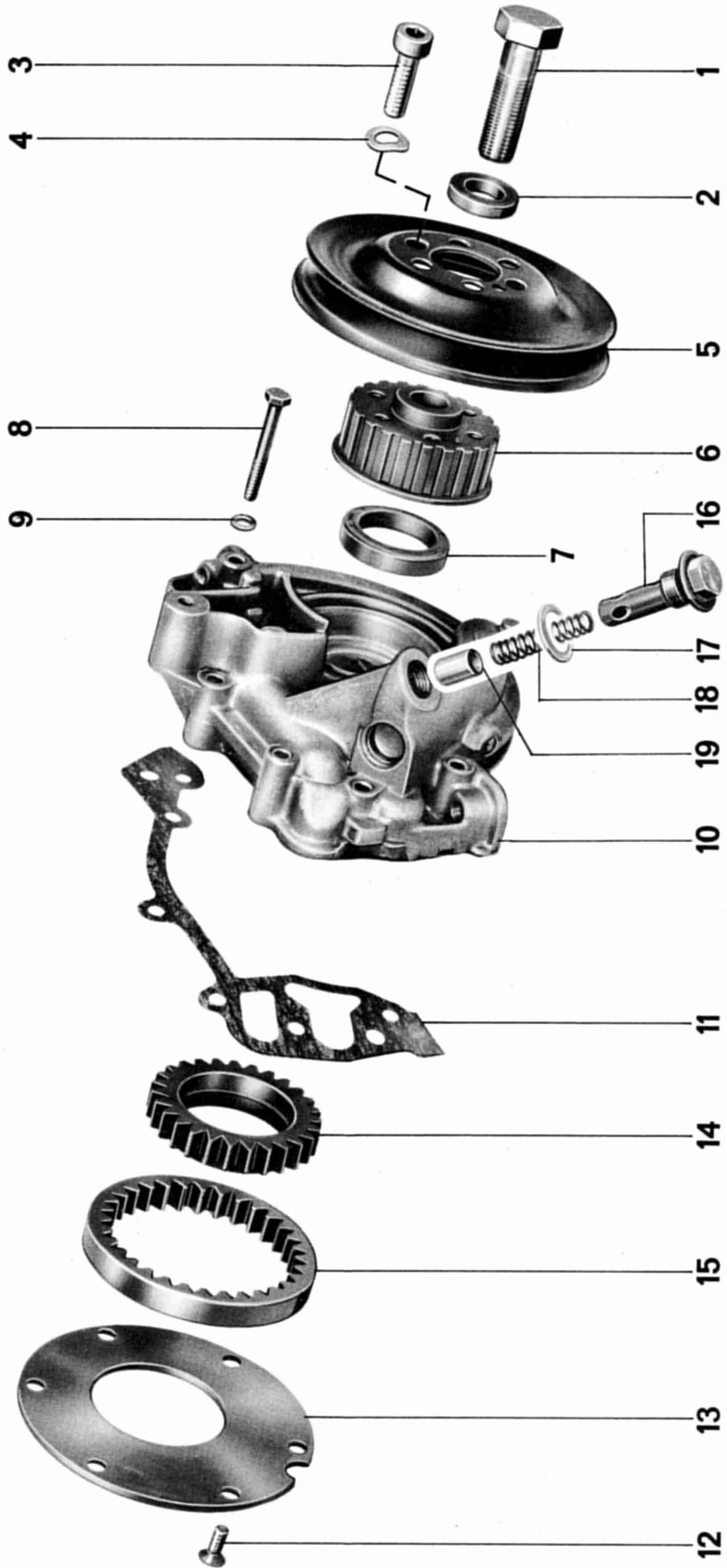


CHECKING OIL PRESSURE AND OIL PRESSURE SWITCH

1. Remove oil pressure switch and install tester.
2. Install tester in cylinder head in place of the oil pressure switch; connect test lamp to oil pressure switch terminal (Wk) and ignition coil terminal 15. Turn ignition on; test lamp should light. If not, replace the switch.



3. Start engine; test lamp must go out. Stop engine. Lamp must light again at a pressure between 0.3 and 0.6 bar (4.3 and 8.5 psi).
4. Start engine. The oil pressure must be at least 2 bar (28 psi) at 2000 rpm and oil temperature of 80° C (176° F)

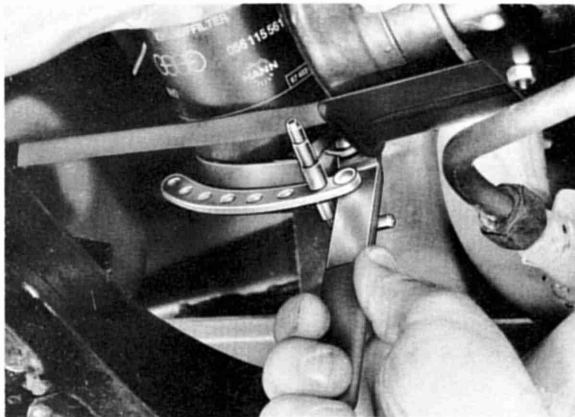


No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Bolt	1		Torque to 25 mkg (181 ft lb)	Note different lengths
2	Washer	1			
3	Allen head bolt	6		Torque to 2 mkg (14, 5 ft lb)	
4	Washer	6			
5	Pulley, v-belt	1			
6	Pulley, drive belt	1			
7	Seal	1		Replace	
8	Bolts M 6 x 40	5		Torque to 1 mkg (7 ft lb)	
	M 6 x 35	1		Torque to 1 mkg (7 ft lb)	
9	Washer	6			
10	Oil pump housing	1			
11	Gasket	1		Replace	
12	Countersunk screw	6		Torque to 0.8 mkg (6 ft lb)	
13	Cover	1		If worn, grind or replace	
14	Oil pump gear, inner	1		Replace together with pump outer gear only	
15	Oil pump gear, outer	1		Replace together with pump inner gear only	
16	Oil pressure relief valve housing	1		Torque to 4.0 mkg (26 ft lb)	
17	Seal	1		Replace	
18	Spring	1			
19	Piston	1		Check piston and bore in housing for seizure marks, replace piston if necessary	

REMOVING AND INSTALLING OIL FILTER

Removing

Loosen oil filter with US 4462 or equivalent.



Installing

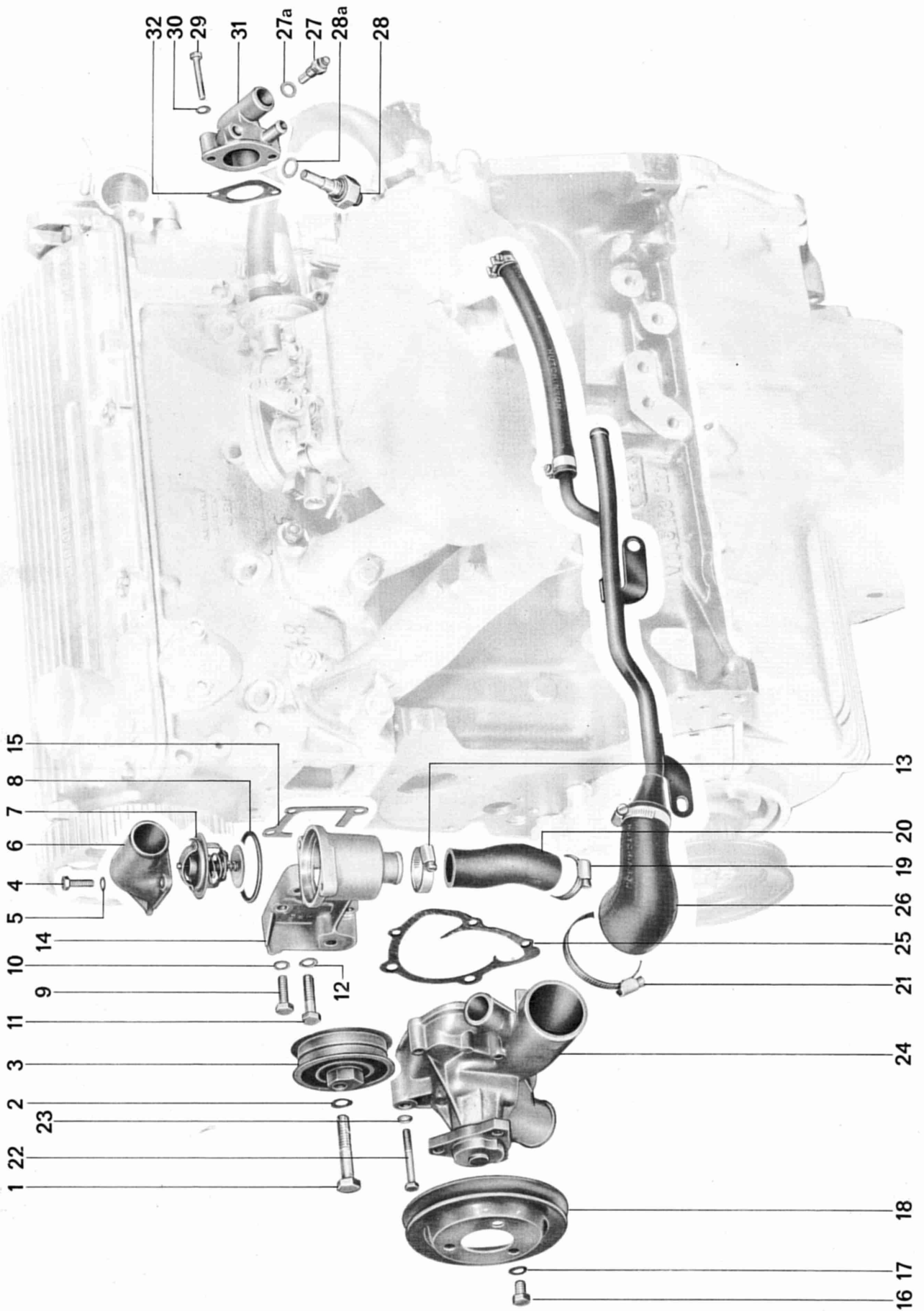
1. Check that sealing surface on engine block is in perfect condition.
2. Lubricate rubber seal lightly.
3. Screw in oil filter by hand and check for leaks.

ENGINE -
COOLING SYSTEM

TOOLS



No.	Description	Special Tool	Note
1	Tester	VW 1274	Snap-on ST-255 A or equivalent



No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Bolt M 10 x 55	1	First take off drive belt guard and drive belt	Torque to 4 mkg (29 ft lb)	
2	Washer	1			
3	Tensioning roller	1			
4	Bolt	2		Torque to 1 mkg (7 ft lb)	
5	Washer	2			
6	Thermostat housing, upper	1			
7	Thermostat	1			
8	O-ring	1		Replace, check for proper fit	
9	Bolt M 8 x 25	2		Torque to 2 mkg (14 ft lb)	
10	Washer	2			
11	Bolt M 8 x 35	2		Torque to 2 mkg (14 ft lb)	
12	Washer	2			
13	Hose clamp	1			
14	Thermostat housing, lower	1			
15	Gasket	1		Remove pieces of gasket and replace	
16	Bolt	3		Torque to 2 mkg (14 ft lb)	
17	Washer	3			
18	Pulley, v-belt	1			
19	Hose clamp	1			
20	Hose	1		Check, replace if necessary; Check for proper fit	
21	Hose clamp	1			

No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
22	Bolt M 6 x 45	2		Torque to 0.9 mkg (6 ft lb)	
	Bolt M 6 x 35	1		Torque to 0.9 mkg (6 ft lb)	
	Bolt M 8 x 65	1		Torque to 2.2 mkg (16 ft lb)	
	Bolt M 8 x 72	1		Torque to 2.2 mkg (16 ft lb)	
23	Washer A 8	2			
	Washer A 6	3			
24	Water pump	1		Check shaft for smooth running; replace entire pump if damaged or leaking	
25	Gasket	1		Remove pieces of gasket and replace	
26	Coolant pipe with hoses	1			
27	Coolant tempera- ture sensor	1		Torque to 0.8 mkg (6 ft lb)	
27a	Seal	1		Replace	
28	Thermo time switch (cold starting)	1		Torque to 2.8 mkg (20 ft lb)	
28a	Seal	1		Replace	
29	Bolt M 6 x 35	2		Torque to 1 mkg (7 ft lb)	
30	Washer	2			
31	Flange	1			
32	Gasket	1		Remove pieces of old gasket and replace	

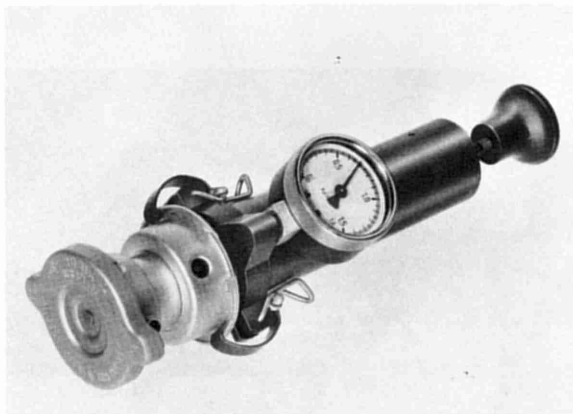
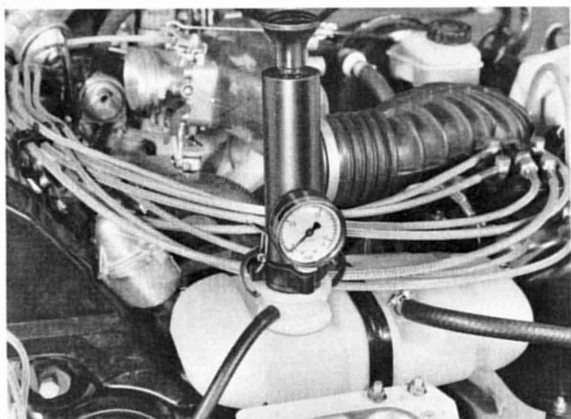
CHECKING COOLING SYSTEM AND RADIATOR CAP

Use tester VW 1274 to check the cooling system for leaks and check operation of high pressure valve in the radiator cap.

Checking Cooling System

Test only on engine at operating temperature.

1. Mount tester on coolant expansion tank.
2. Pump tester up to about 1 bar (14 psi).
If this pressure does not decrease within 5 minutes, the cooling system is tight.

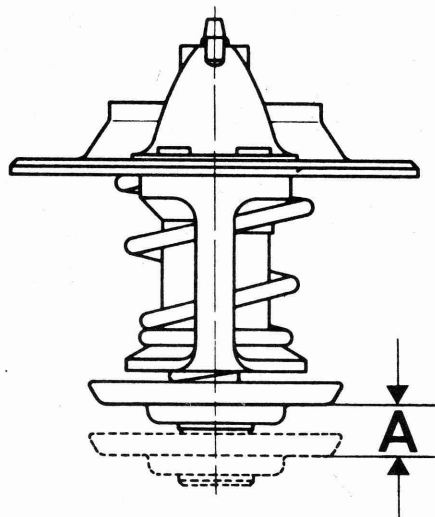


Checking coolant thermostat

Heat coolant thermostat in warm water bath.
Opening begins: approx. $82^{\circ}\pm 2^{\circ}\text{C}$ ($180^{\circ}\pm 3.5^{\circ}\text{F}$)
or: approx. $87^{\circ}\pm 2^{\circ}\text{C}$ ($189^{\circ}\pm 3.5^{\circ}\text{F}$)
as of April 17, 1979

Opening ends: approx. 93°C (200°F)
or: approx. 102°C (216°F)
as of April 17, 1979

Opening stroke (A) at least 8 mm/0.31 in.

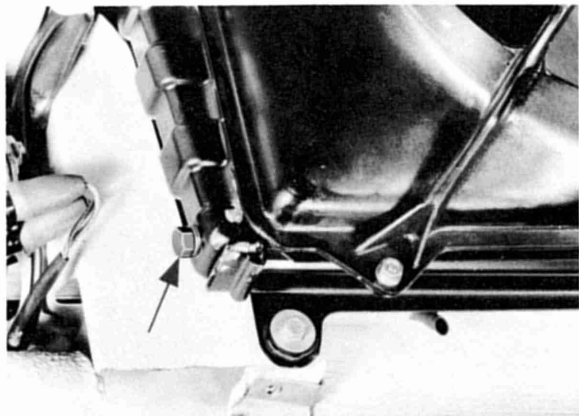


CHECKING RADIATOR CAP

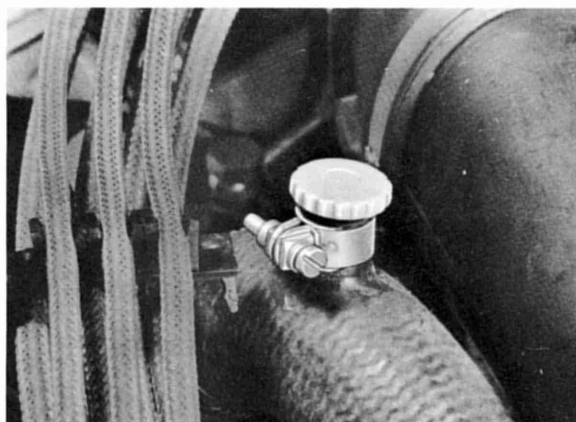
1. Mount radiator cap on the tester.
2. Pump tester until high pressure valve in cap opens. The high pressure valve should open at 0.9 and 1.15 bar (12.8-16.4 psi).

REPLACING COOLANT AND BLEEDING COOLING SYSTEM

1. Drain coolant (only if engine is cold). Set heater lever at "warm" and unscrew drain plug on radiator.



2. Install drain plug with a new gasket. Tightening torque 15 Nm (11 ft lb). Set heater lever at "warm" and remove bleeder plug. Add coolant slowly until coolant level remains steady at "max." mark on expansion tank. (Refer to "Capacities" in Technical Data for coolant volume).



3. Start engine and run at fast idle speed to reach the operating temperature (until radiator fan has switched on and off).

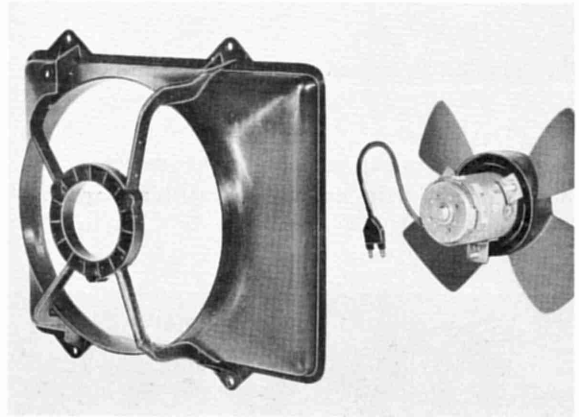
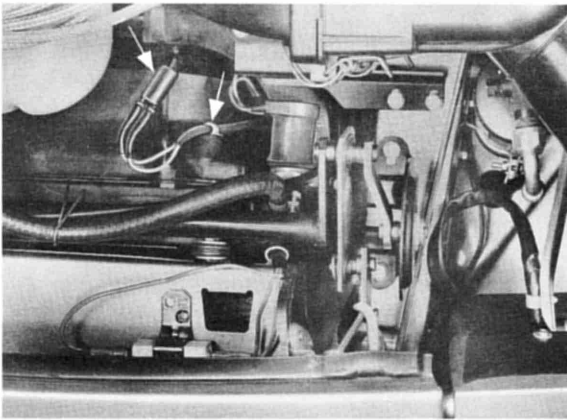
When no more air bubbles are visible in bleeder opening, insert plug and tighten hose clamp. Check coolant level, adding coolant if necessary.

COOLANT MIXTURE RATIO

Protection down to	Antifreeze	Water	Antifreeze	Water
- 25 °C	40 %	60 %	2.8 ltr.	4.2 ltr.
- 30 °C	45 %	55 %	3.2 ltr.	3.8 ltr.
- 35 °C	50 %	50 %	3.5 ltr.	3.5 ltr.

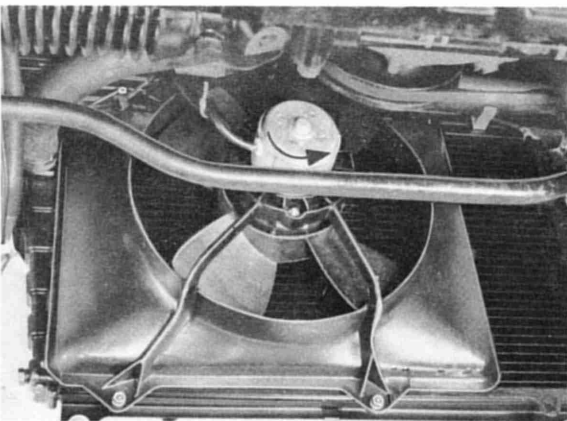
REMOVING AND INSTALLING FAN

1. Detach electrical connector at fan motor harness (arrow) and remove clip.

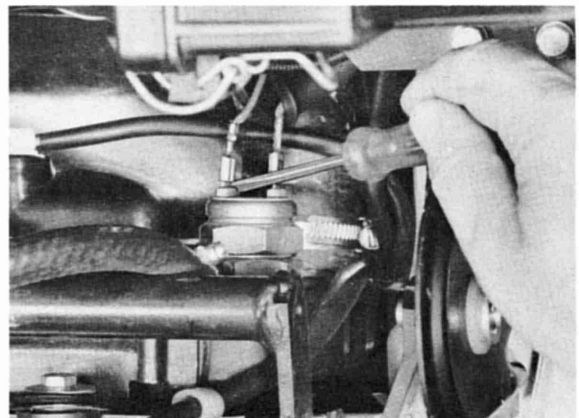


For cars with a front stabilizer the fan must be taken off of the fan ring while still in the car.

2. Loosen four bolts and remove fan ring with fan.



4. Install the fan so that the water drain hole in the fan motor faces down. Position wire harness properly. After installation check fan's direction of rotation. Remove rubber cap on the thermo switch and bridge thermo-switch terminals with a screwdriver or similar tool.

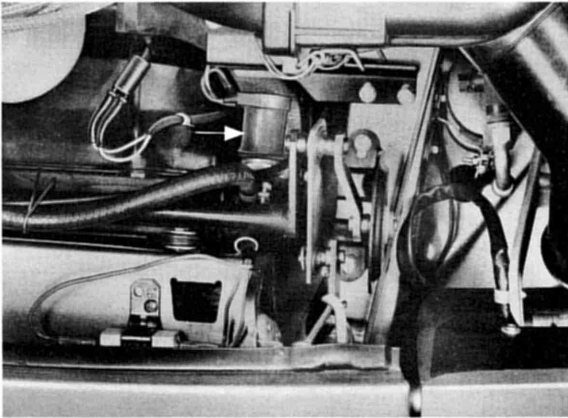


3. Take fan off fan ring.

The fan must turn clockwise as seen from the front.

REMOVING AND INSTALLING THERMO SWITCH

1. Place a pan underneath car.
2. Slide rubber cap back on thermo switch, disconnect wires and unscrew switch (wrench size 30 mm).



3. Add coolant after installation.
-

CHECKING THERMO SWITCH

1. Remove thermo switch.



2. Connect ohmmeter to the flat plugs of the switch; place switch in a warm water bath.

The ohmmeter should read 0 ohms at a temperature of about 92°C and ∞ ohms when the coolant has returned to about 87°C .

REMOVING AND INSTALLING RADIATOR

Removing

1. Disconnect battery.

2. Remove expansion tank cap.

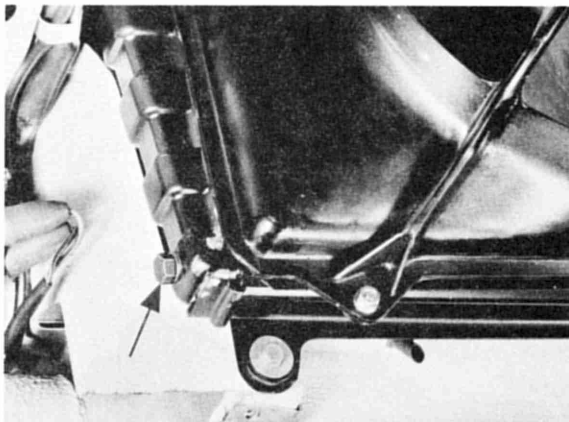
Caution

Pressurized cooling system. If engine is warm, turn cap to first notch and let excessive pressure escape. Then unscrew cap completely.

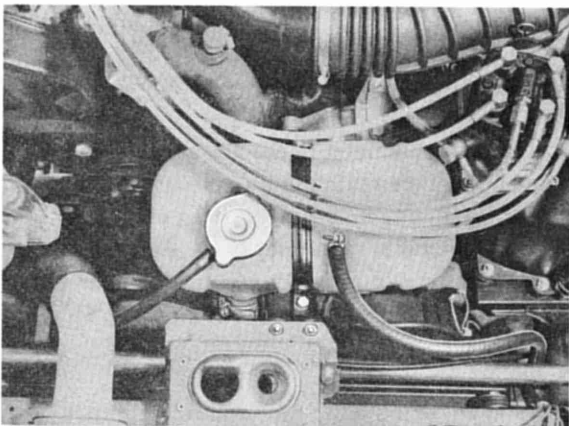
3. Remove engine protection plate.



4. Drain coolant at plug on radiator. If all coolant is to be drained, open heater control valve fully.

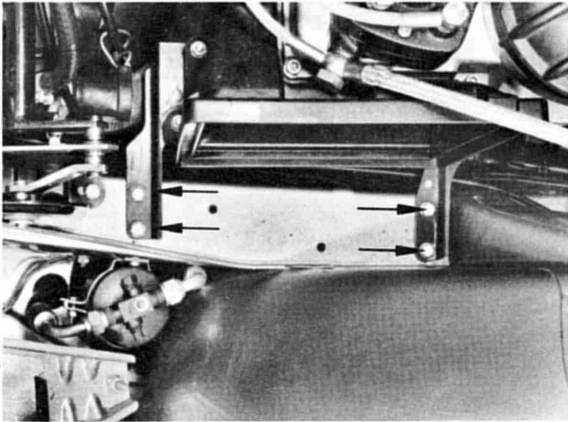


5. Remove expansion tank with bracket and hoses.



6. On cars with air injection also remove air cleaner housing with holder.

7. Detach mixture control unit with filter housing and place to one side.



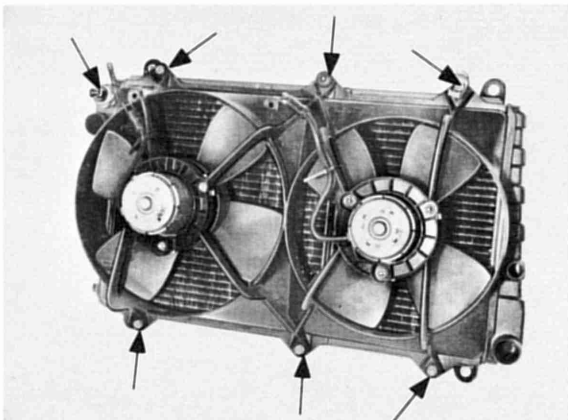
8. Take off air guide for alternator cooling.

9. Remove windshield washer tank and place to one side.

10. Disconnect wires, detach harness at radiator.

11. Loosen 4 mounting screws and remove radiator from above.

12. Unscrew fan housing with electric fan at radiator.



13. Unscrew thermostitch.

Installing

1. Replace thermostitch seal.

2. Check hose connection and radiator for leaks.

Note

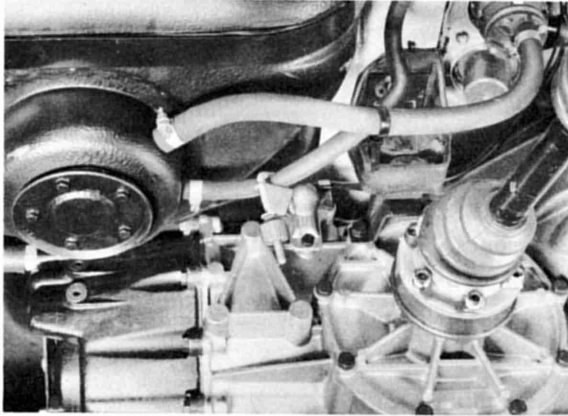
Always replace porous, brittle or swollen coolant hoses.

FUEL -
SUPPLY

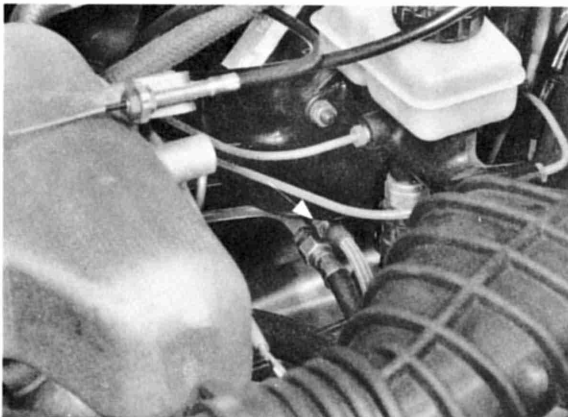
CHECKING FUEL PUMP DELIVERY RATE

Fuel filter and power supply must be in perfect condition for this test.

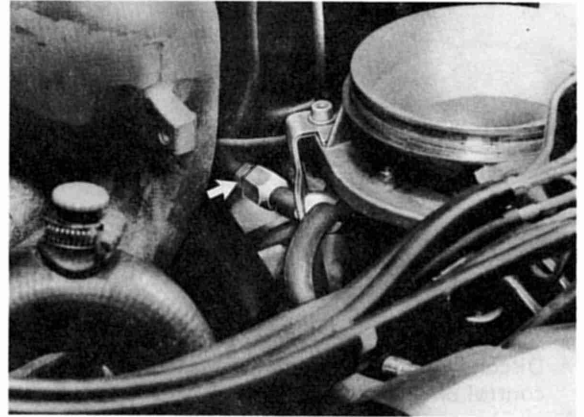
1. Clamp fuel return line at fuel tank with standard hose clamp.



2. Disconnect fuel return line between fuel distributor and fuel tank at threaded connection.

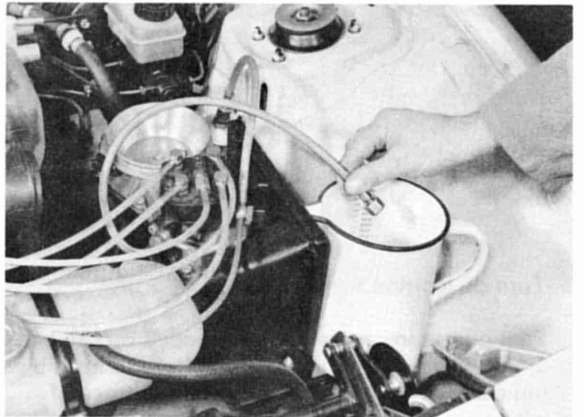


Old version



New version

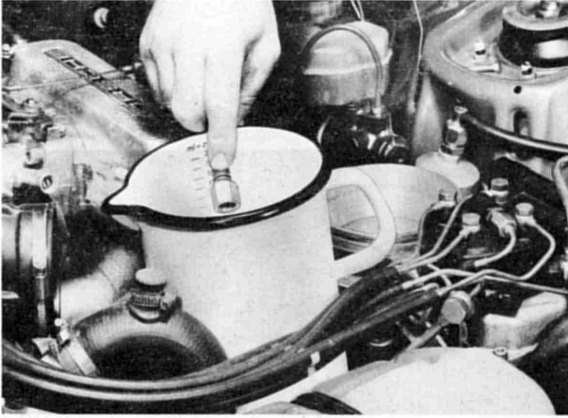
3. Hold end of return line in measuring container (size about 1500 cc).



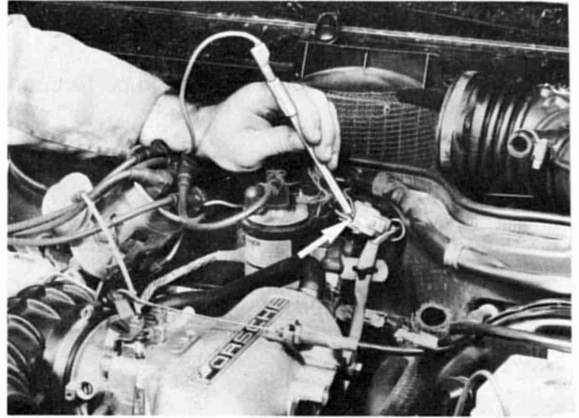
The new version with fuel line is shorter so that cowl must be removed from mixture control unit for testing.

Note

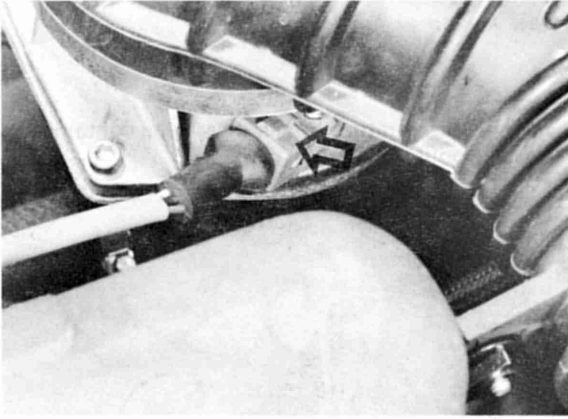
Don't bend fuel line.



4. Disconnect wire plug on safety contact of mixture control unit.



6. Delivery rate should be at least 750 cc in 30 seconds.



5. Turn on ignition for 30 seconds.

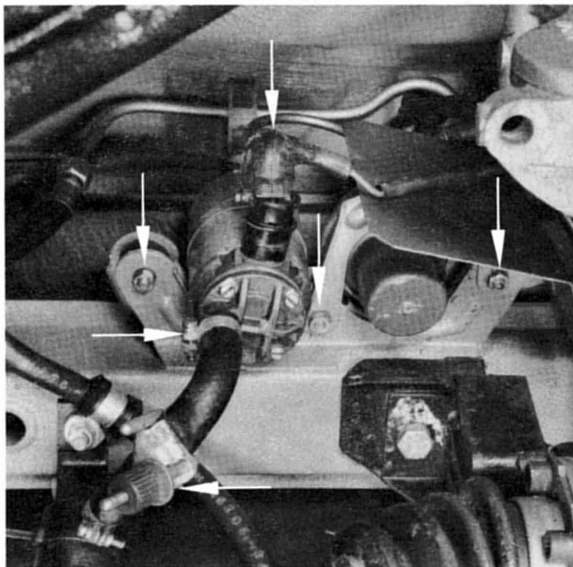
Fuel pumps in cars from 1979 models on can be operated by supplying battery voltage to multiple pin plug terminal 7 (red/white) with a piece of wire.

The ignition need not to be turned on in this case.

REMOVING AND INSTALLING FUEL PUMP

Removing

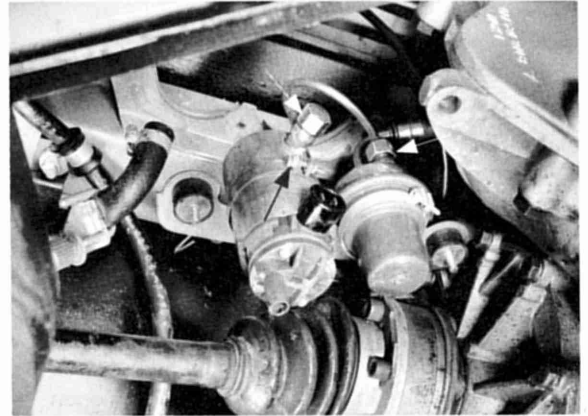
1. Detach ground cable at battery.
2. Clamp fuel suction hose with standard hose clamp.
3. Loosen hose clamp.
4. Disconnect wire connector.
5. Loosen mounting nuts and remove guard.



6. Take fuel pump with accumulator out of console.

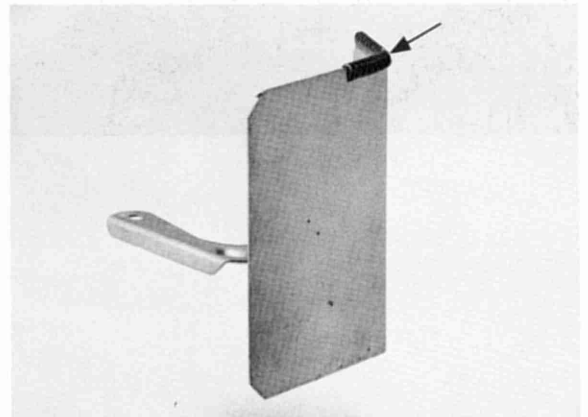
7. Detach fuel line; counterholding is essential.

8. Loosen strap and remove fuel pump.



Installing

1. Always use new seals.
Torque to 20 Nm (14 ft lb).
2. Make sure that protective strip fits on guard correctly.



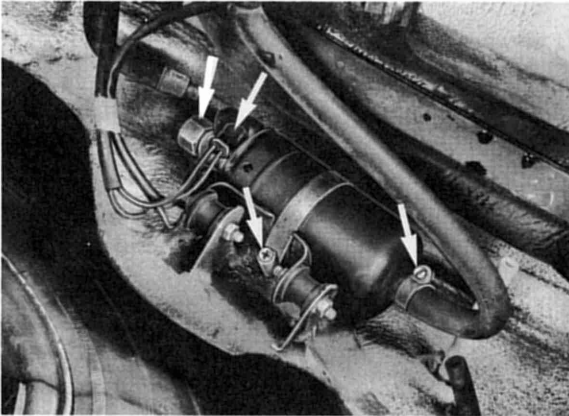
REMOVING AND INSTALLING FUEL PUMP (from 1977 Models)

Note

Conform with safety regulations when working on fuel system.

Removing

1. Clamp fuel suction hose with standard hose clamp.
2. Disconnect electric wires.
3. Loosen hollow union bolt or coupling nut, while counterholding with a narrow (machined) open-end wrench.
4. Loosen hose clamps and remove fuel pump.



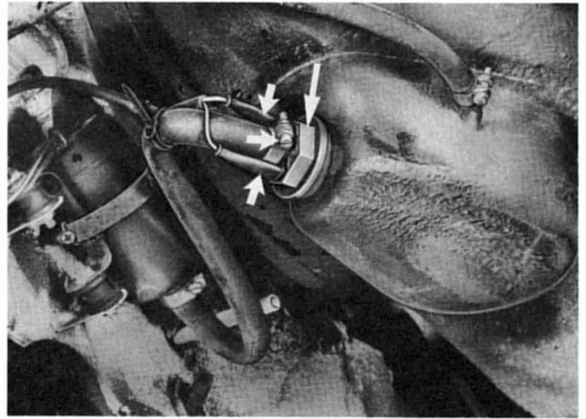
REMOVING AND INSTALLING INITIAL DELIVERY FUEL PUMP (IN-TANK PUMP)

Note

Conform with safety regulations when working on fuel system.

Removing

1. Draw off fuel.
2. Disconnect wire connectors, loosen hose clamp and remove in-tank pump. Catch escaping fuel.

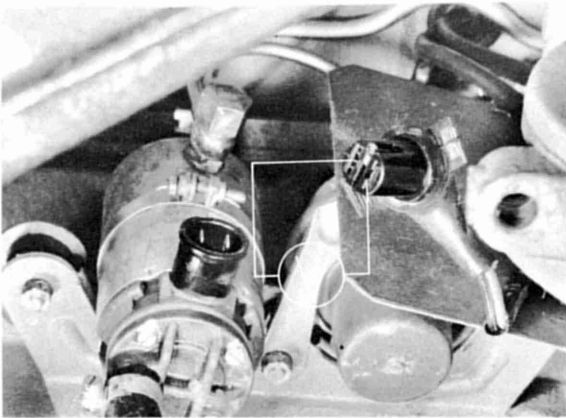


Installing

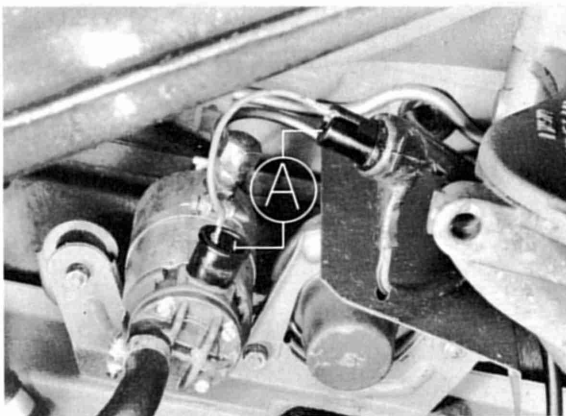
1. Always use new gasket.
2. Torque in-tank pump to 36 - 44 Nm (26-32 ft lb).

CHECKING ELECTRIC FUEL PUMP (electric test)

1. Disconnect electrical connector at air flow sensor.
2. Disconnect electrical connector at fuel pump.
3. Turn on ignition.
4. Attach voltmeter as shown.
Check that voltage is at least 11.5 V



5. Measure current consumption with ammeter.
Check that current is not more than 8.5 A.



Note

If current consumed is higher than specified, replace fuel pump.

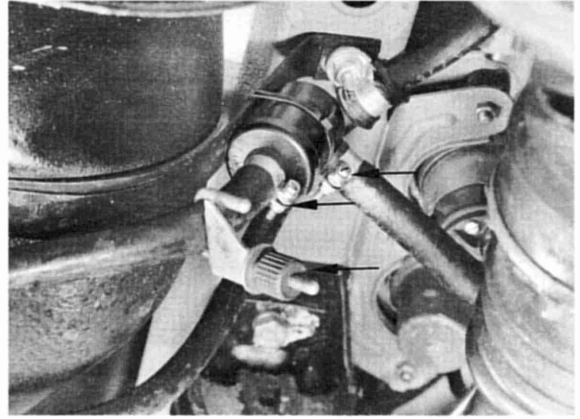
REMOVING AND INSTALLING FUEL FILTER (NEAR TANK)

Removing

1. Clamp suction line with standard hose clamp.
2. Loosen hose clamps and cut strap.

Installing

Use new strap.



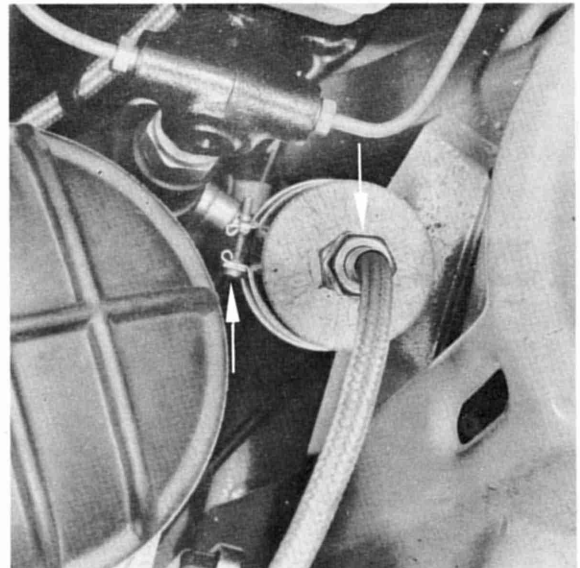
REMOVING AND INSTALLING FUEL FILTER (ENGINE COMPARTMENT)

Removing

1. Clean filter connections.
2. Loosen strap.
3. Detach fuel lines; counterholding is essential. Catch escaping fuel.

Installing

1. Make sure to install with arrow on filter pointing in direction of flow (toward mixture control unit).
2. To prevent damaging filter, don't tighten strap too tight.



TOOLS



No.	Description	Special Tool	Note
1	Wrench for tank sending unit	2012	

REMOVING AND INSTALLING FUEL TANK SENDING UNIT

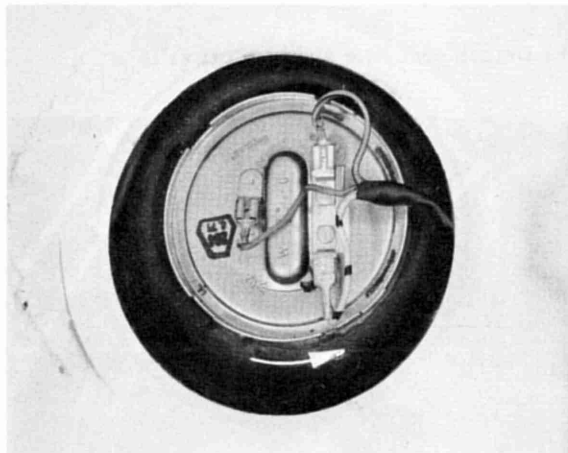
Removing

1. Remove floor lining.
2. Remove plastic cover.
3. Disconnect wires.
4. Loosen sending unit with special tool 2012.



Installing

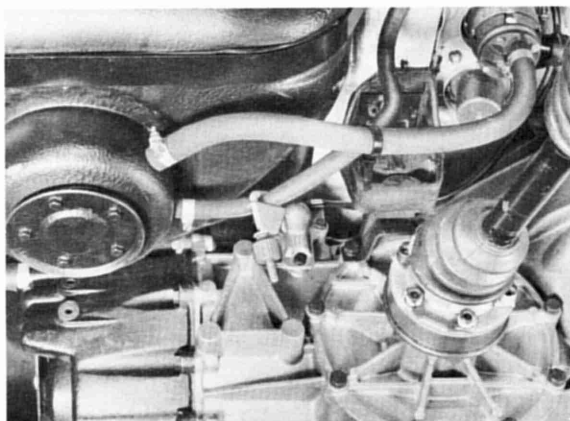
1. Use new seal.
2. Connect wire plugs as follows:
 - brown
 - G purple/black
 - W yellow/black



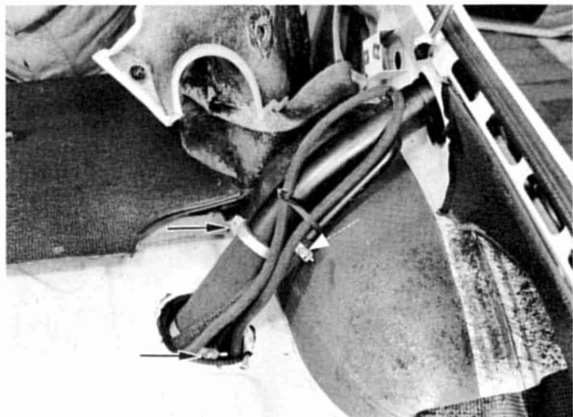
REMOVING AND INSTALLING FUEL TANK

Removing

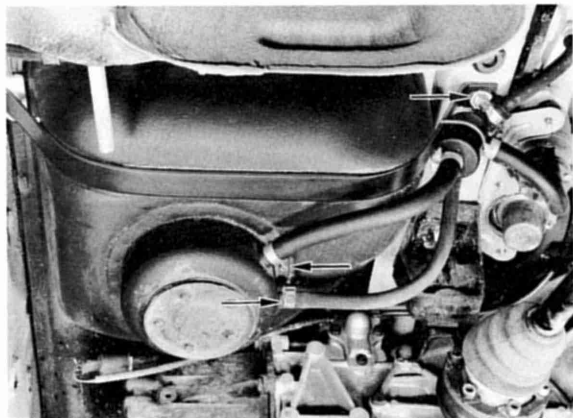
1. Disconnect ground at battery.
2. Remove final muffler and transmission.
3. Drain fuel; clamp return hose with standard hose clamp. Detach suction hose at fuel pump and drain fuel into an appropriate container.
4. Remove luggage compartment lining.
5. Remove cover in luggage compartment.
6. Disconnect wires at tank sending unit.
7. Loosen side trim and remove fuel filler pipe cover.



8. Detach vent hose and hose clips.



9. Detach fuel hoses and remove fuel tank from below.



Installing

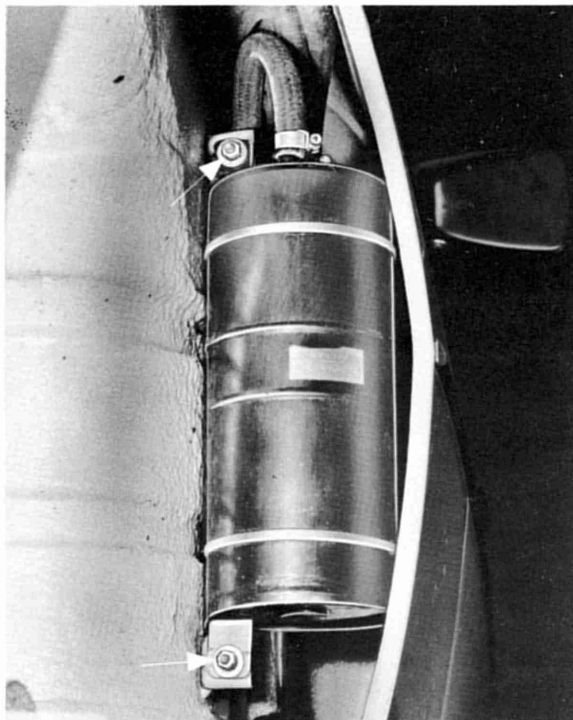
1. When installing, slide the protruding hoses into the tank opening.
2. Make sure that vent hoses are located around the tank correctly. Check routing of hoses.

REMOVING AND INSTALLING CHARCOAL FILTER

Charcoal filter is located underneath left front fender.

Removing

1. Unscrew nuts and pull cannister out forward.
2. Loosen hose clamps and pull off hoses.



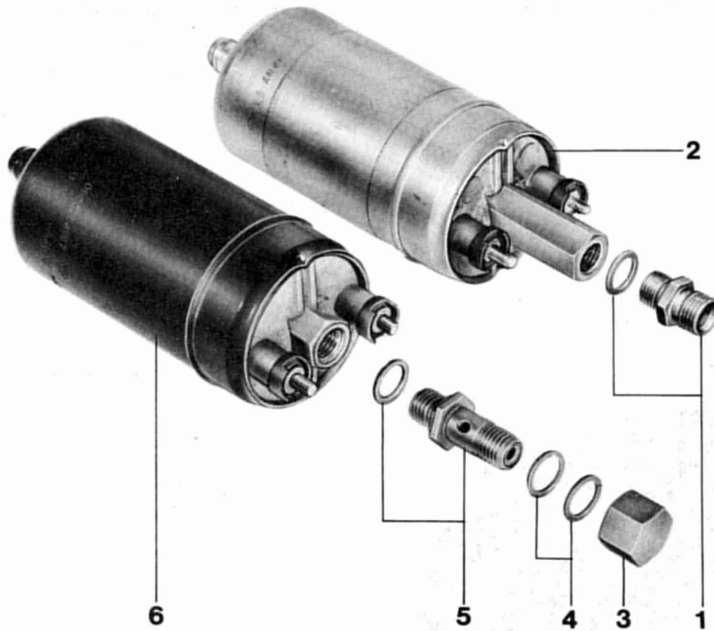
Installing

Connect hoses as follows:

- Hose 1 (front connection) fresh air
- Hose 2 (center connection) from fuel tank
- Hose 3 (rear connection) to crankcase vent/
air cleaner housing



ARRANGEMENT OF CHECK VALVES ON FUEL PUMPS



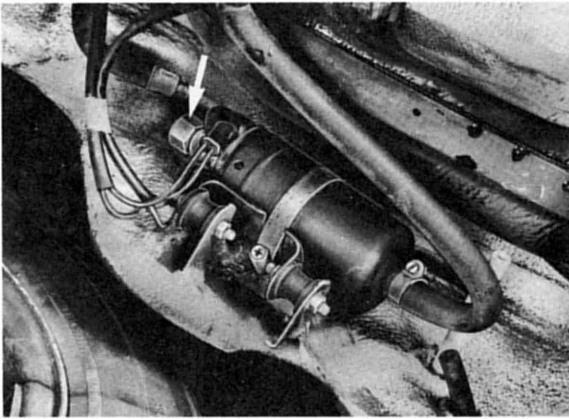
No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Check valve with seal (for pressure line with coupling nut)	1		Always replace seal; torque to 20 Nm (14 ft lb)	
2	Fuel pump, long neck version with integrated check valve	1			
3	Cap nut	11		Torque to 20 Nm (14 ft lb)	
4	Seal	2		Always replace	
5	Check valve with seal (for ring line)	1		Always replace seal; torque to 20 Nm (14 ft lb)	
6	Fuel pump, short neck version	1			

REPLACING CHECK VALVE

Important: Conform with safety regulations when working on fuel system!

Removing

1. Clamp fuel feed hose with standard hose clamp and detach pressure side hose on fuel pump by loosening hollow union bolt or coupling nut. Catch escaping fuel.



2. Loosen check valve, while counterholding on hexagon of fuel pump with a narrow (machined) open-end wrench.

Installing

1. Screw in new check valve with new seal. This check valve is installed in addition to the check valve integrated in a long neck version fuel pump.
2. Install fuel line with ring and new seals, and secure with cap nut.

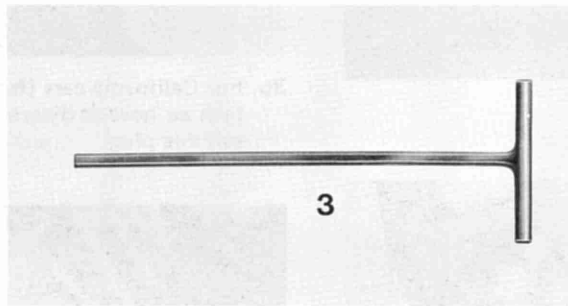
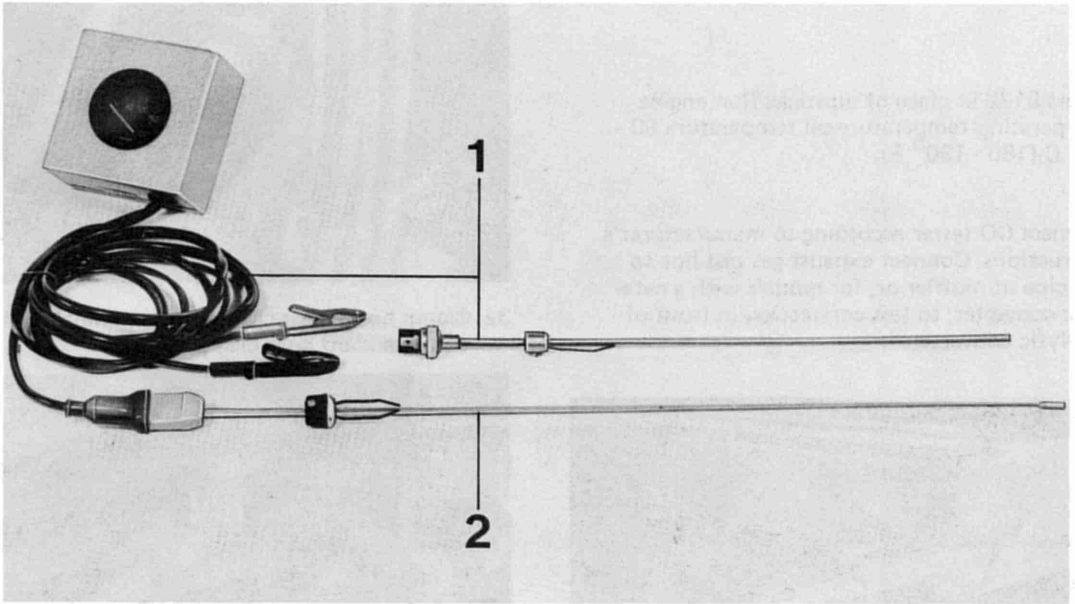
Important: Make sure fuel hose is positioned correctly and cannot rub prior to tightening cap nut.

3. Remove hose clamp and check for leaks. Install guard again.

FUEL MIXTURE

ADJUSTING IDLE SPEED / CO

TOOLS



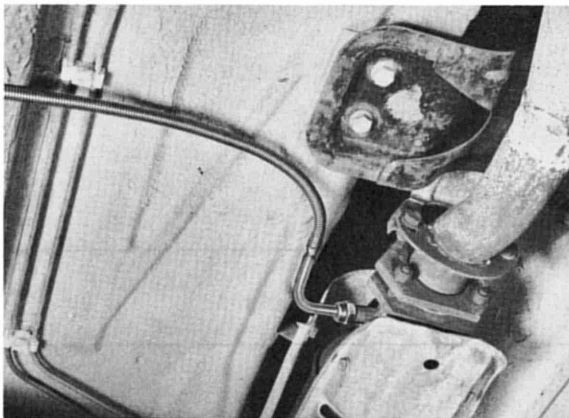
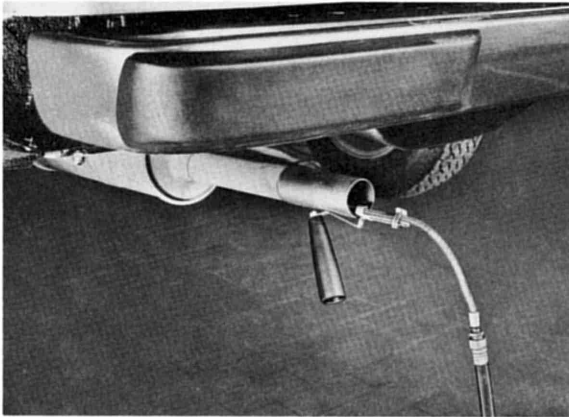
No.	Description	Special Tool	Remarks
1	Oil temperature tester	9122	
2	Testing sensor	9122/1	in conjunction with long oil dipstick
3	Adjusting wrench	P 377	

ADJUSTING IDLE SPEED/CO

Note

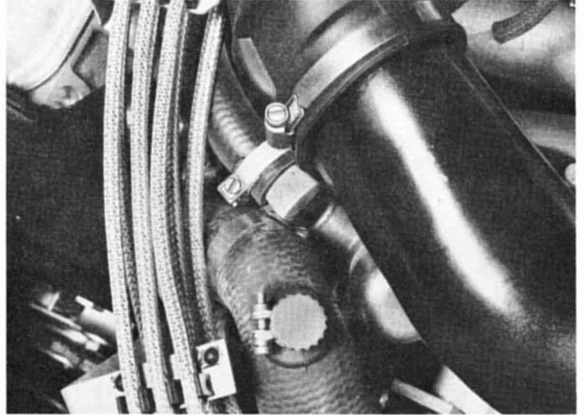
Engine must be in perfect running condition and ignition timing must be set properly for these adjustments.

1. Insert 9122 in place of dipstick. Run engine to operating temperature-oil temperature 80 - 90°C (180 - 190°F).
2. Connect CO tester according to manufacturer's instructions. Connect exhaust gas test line to tail pipe of muffler or, for models with a catalytic converter, to test connection in front of catalytic converter.

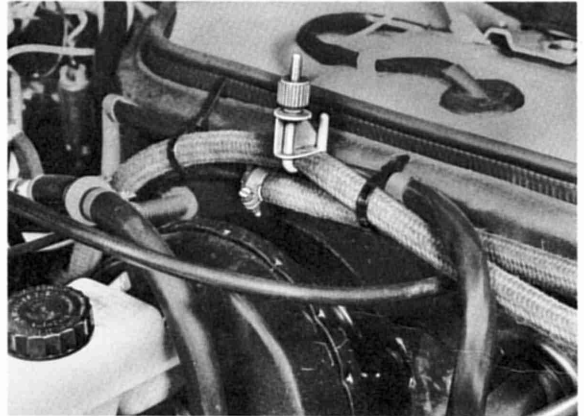


Only applicable to cars with catalytic converter.

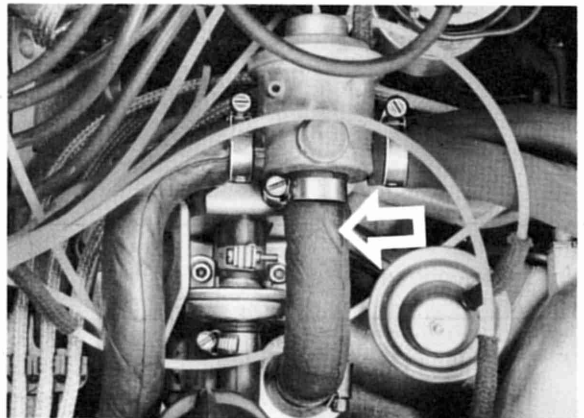
3. Detach air injection hose and plug end of hose (where applicable).



- 3a. Clamp hose to air cleaner and charcoal filter with standard hose clamp.



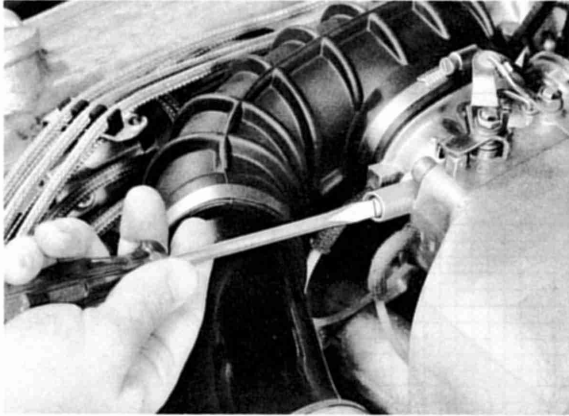
- 3b. For California cars (from model 77 1/2) detach air hose at diverter valve and insert a suitable plug.



4. Turn idle speed screw on throttle housing until specified rpm is reached (850 - 1000 rpm).

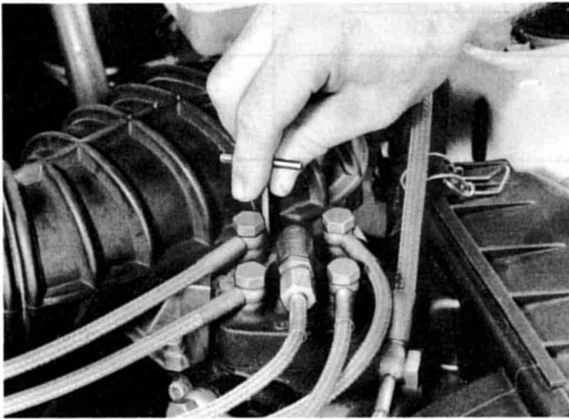
Note

Use separate tachometer from tester or similar.



5. Remove plug in mixture control unit, between fuel distributor and venturi, or puncture plastic cap with a small screwdriver and remove upward.

6. Insert adjusting wrench P 377.

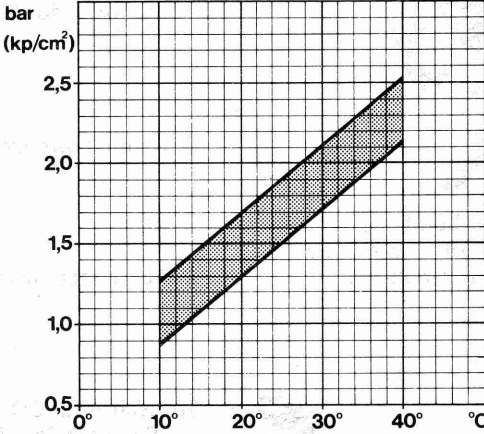


CAUTION

Observe the following points:

- a) Always make CO adjustments from lean to rich. For example, if the mixture is too rich, first turn the CO adjusting screw counter-clockwise further than necessary and then clockwise to specified setting.
 - b) Never press down on adjusting wrench during adjustments (engine will stall).
 - c) Turn the CO adjusting screw only slightly, since the smallest turn will change the CO level considerably.
7. Turn clockwise for richer mixtures, counter-clockwise for leaner mixtures.
 8. Remove wrench.
 9. Accelerate engine briefly.
 10. Wait until CO tester reacts.
See page 25 - 4 b for CO specifications.
Repeat adjusting procedures if necessary.
 11. Recheck idle speed, correcting if necessary.
 12. Insert plug again or secure CO adjusting screw with a new blue plastic cap after completing adjustments.

TESTING AND ADJUSTING SPECIFICATIONS
(1976 to 1980 Models)

Test Step	Test/Adjust Specifications	Special Instructions
Electric fuel pump Delivery rate	at least 750 cc in 30 sec.	
Control pressure "cold" (at ambient temp.)	<p>Diagram for warm-up regulator Part No. 063 133 403 Bosch No. 0438. 140.011</p> 	
Control pressure "warm"	3.4 to 3.8 bar	
System pressure Test value Adjust value	<p>4.5 to 5.2 bar 4.7 to 4.9 bar</p>	
Leak test (engine warm)	<p>Pressure accumulator Pressure accumulator 20 cc 40 cc</p>	
<p>minimum after 10 minutes 20 minutes</p>	<p>1.3 bar 2.0 bar 1.1 bar 1.7 bar</p>	
Fuel injectors Opening pressure	2.5 to 3.6 bar	

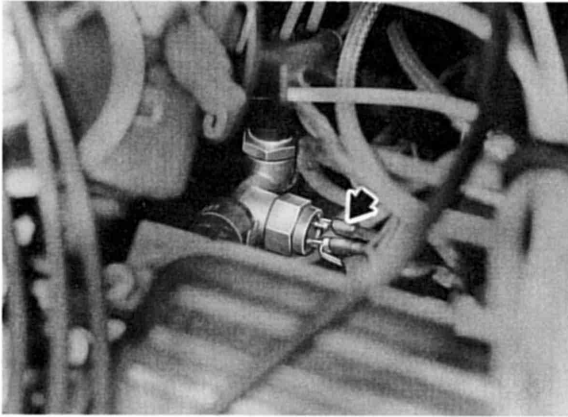
TESTING AND ADJUSTING SPECIFICATIONS
 (1981/1982 Models with Oxygen Sensor)

Test Step	Testing/Adjusting Specifications	Special Instructions
Electric fuel pump Delivery rate	at least 750 cc in 30 sec.	
Control pressure "cold" (at ambient temperature)	Diagram for warm-up regulator Part No. 477 133 403 Bosch No. 0438. 140. 088	
Control pressure "warm"	3.4 . . . 3.8 bar	
System pressure Test value Adjusting value	4.5 . . . 5.2 bar 4.7 . . . 4.9 bar	
Leak test (engine warm) Pressure after 10 min. after 20 min.	Pressure accumulator 40 cc at least 2.0 bar at least 1.7 bar	
Fuel injectors Opening pressure	2.5 . . . 3.6 bar	

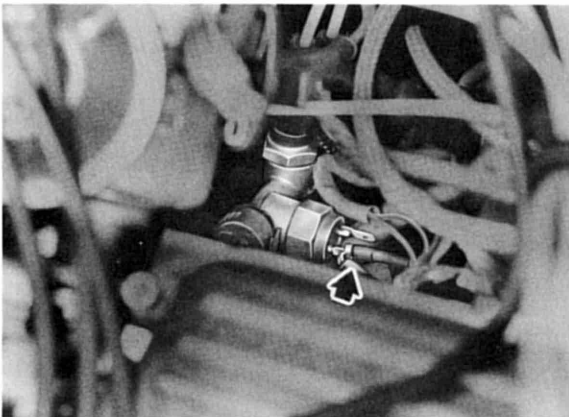
HIGH ALTITUDE ADJUSTMENT ON ENGINE XE - MODEL 77 1/2

Air pump control must be modified as follows for operation of car in high altitude states.

1. Disconnect wire (arrow) at temperature switch.



2. Attach disconnected wire to vacant terminal of second wire (arrow).



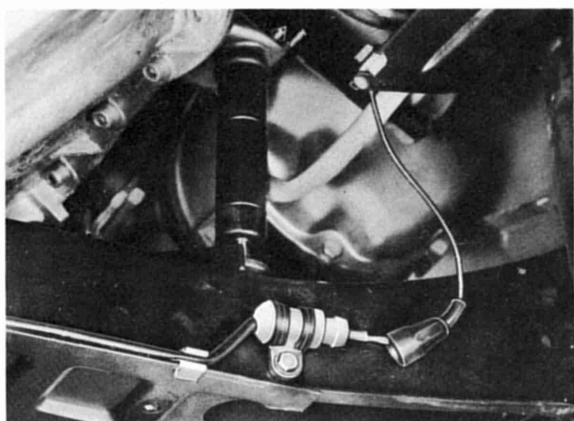
This prevents operation of temperature switch.

ADJUSTING IDLE SPEED / CO 1980 Models

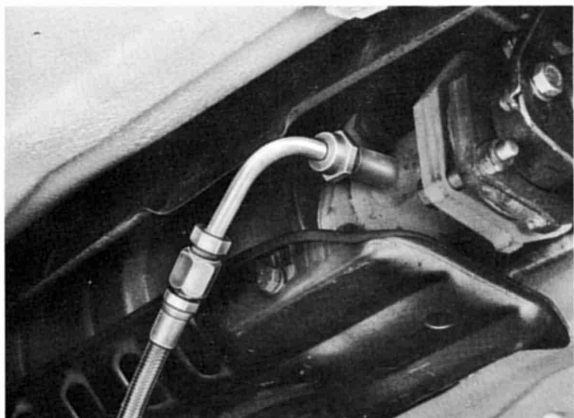
Note

Engine must be in perfect running condition and ignition timing must be set properly for these adjustments.

1. Pull off rubber cap from plug connection for oxygen sensor and plug.



2. Connect exhaust gas test line to test connection of catalytic converter.



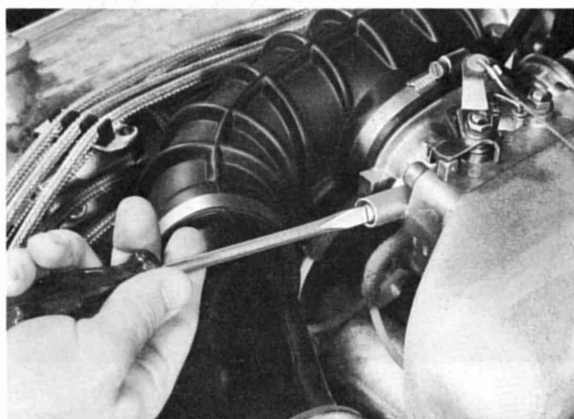
3. Run engine to operating temperature (oil temperature approx. 80 - 90°C / 180 - 190°F). Use special tool P 9122.

4. Connect CO tester according to manufacturer's instructions.

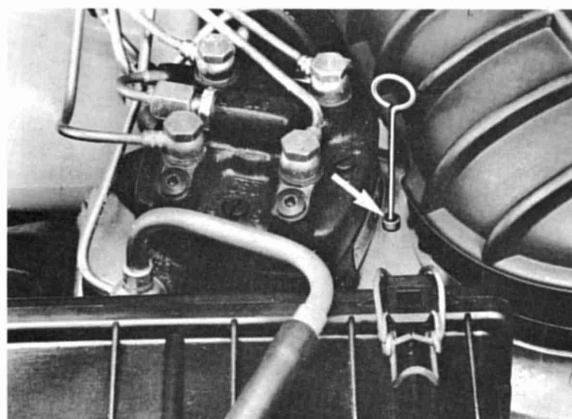
5. Turn idle speed screw on throttle housing until specified rpm is reached (radiator fan not running).

Note

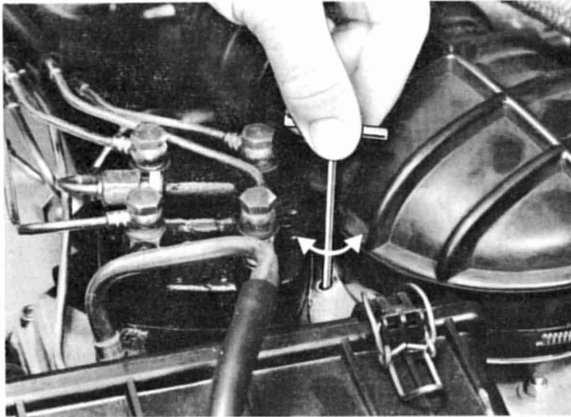
Use separate tachometer from tester or similar.



6. Remove plug in mixture control unit, between fuel distributor and venturi.



7. Insert adjusting wrench P 377.



CAUTION

Observe the following points:

- a) Always make CO adjustments from lean to rich. For example, if the mixture is too rich, first turn the CO adjusting screw counterclockwise further than necessary and then clockwise to specified setting.
 - b) Never press down on adjusting wrench during adjustments (engine will stall).
 - c) Turn the CO adjusting screw only slightly, since the smallest turn will change the CO level considerably.
 - d) Make adjustments as quickly as possible to prevent intake ports from becoming too hot.
8. Turn clockwise for richer mixtures, counterclockwise for leaner mixtures.
 9. Remove wrench.
 10. Accelerate engine briefly.
 11. Wait until CO tester reacts (radiator fan not running).
See page 25 - 4 b for CO specifications.
Repeat adjusting procedures if necessary.
 12. Recheck idle speed, correcting if necessary.
 13. Insert plug again in mixture control and re-connect plug for oxygen sensor after completing adjustments.
 14. Coat threads of capped nut for test connection on catalytic converter with Bosch VS 140 16 Ft grease.

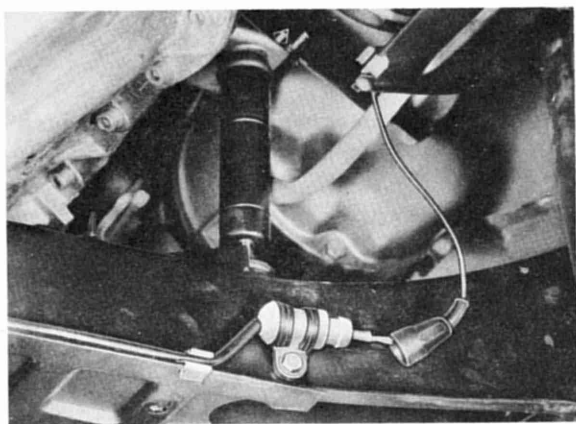
ADJUSTING IDLE SPEED/CO (from 1981 Models)

Note

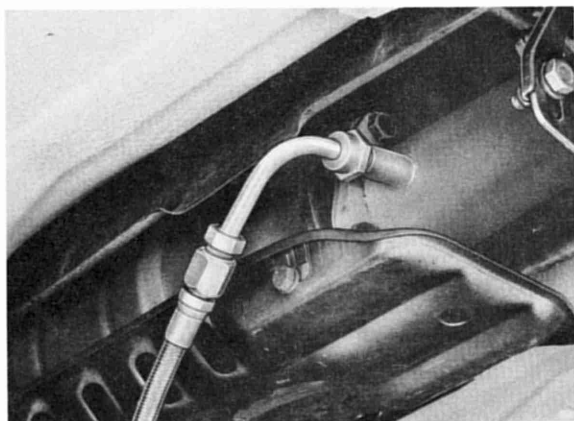
Adjusting Requirements:

Engine must be in perfect running condition and ignition timing must be set properly.

1. Pull off rubber cap on oxygen sensor plug and detach plug connector.



2. Connect CO test line on test connection of catalytic converter.



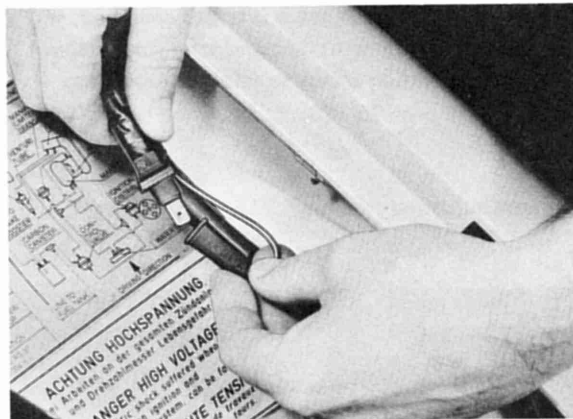
3. Run engine to operating temperature (oil temperature 80° to 90° C/ 176° to 194° F). Apply special tool 9122.

4. Connect CO tester according to manufacturer's instructions.

Note

The electronic idle stabilizer (EIS) will change the ignition timing and consequently CO level and idle speed, so that EIS must be placed out of operation for following test.

5. Disconnect plug in engine compartment on left wheel house wall above ignition control unit.



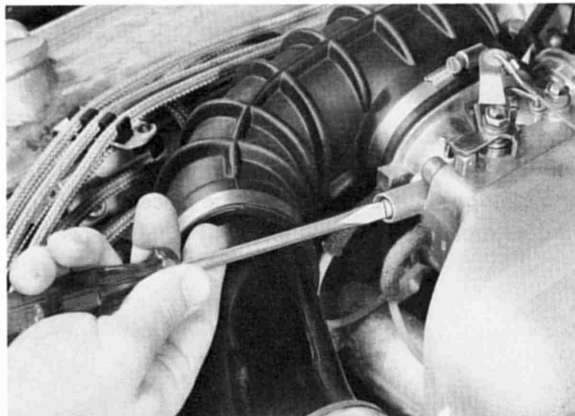
6. Turn control screw or bypass screw on throttle housing until specified speed is reached.

Note

It is important to switch off fan motor and a/c compressor during adjustments.

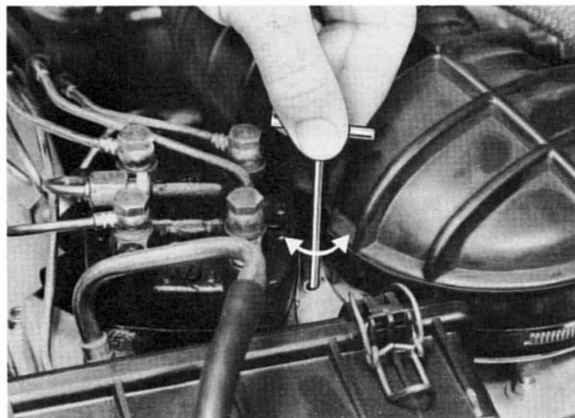
Important

Use separate tachometer from tester or similar.



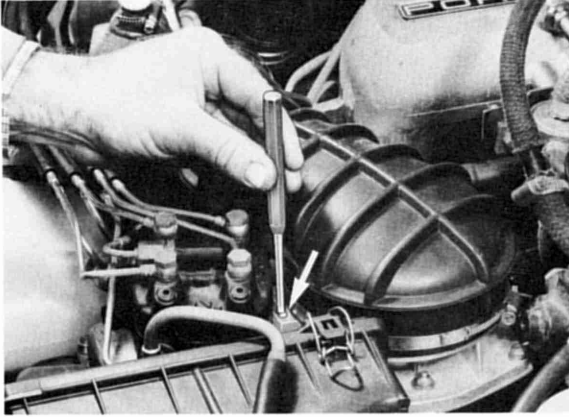
7. Check CO setting. If value is not as specified, remove mixture control unit and take steel ball out of bore providing access to mixture regulating screw. See page 25 - 28.

8. Insert adjusting wrench P 377.

**Caution!**

Observe the following points:

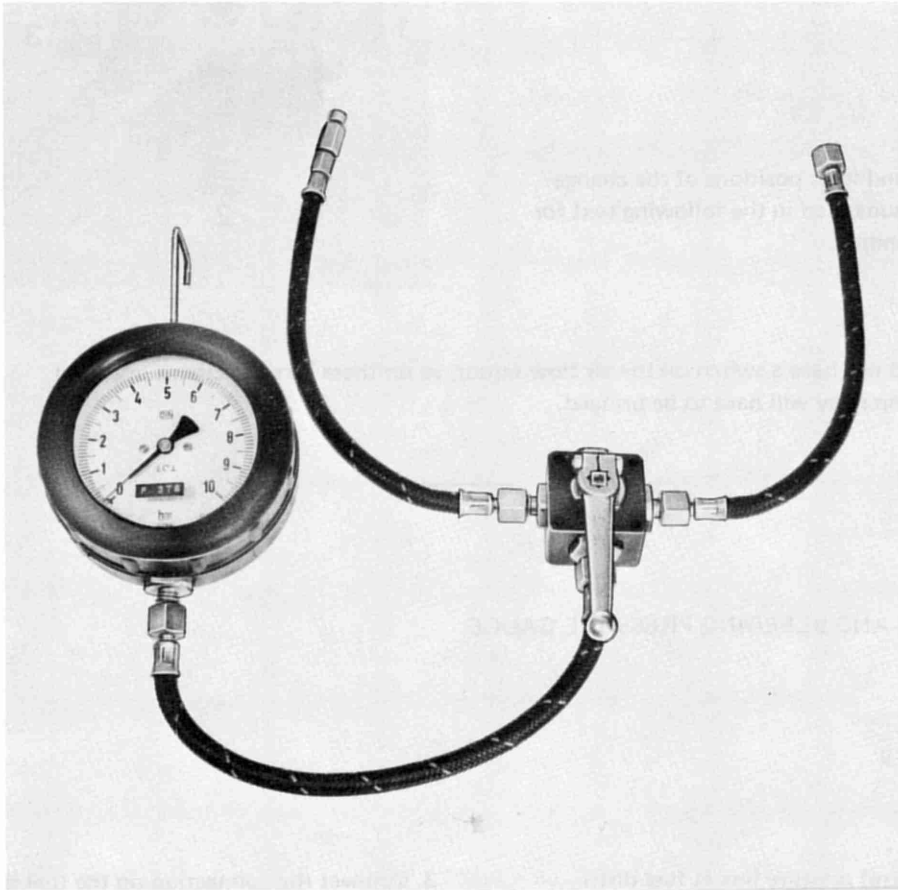
- a) Always make CO adjustments from lean to rich. For example, if the mixture is too rich, first turn mixture regulating screw counterclockwise further than necessary and then clockwise to specified setting.
 - b) Never press down on adjusting wrench during adjustments (engine will stall).
 - c) Turn the regulating screw only slightly, since the smallest turn will change the CO level considerably.
 - d) Make adjustments as quickly as possible to avoid excessive heat in intake ports.
9. Turn clockwise for richer mixtures. Turn counterclockwise for leaner mixtures.
 10. Remove wrench.
 11. Accelerate engine briefly.
 12. Wait until CO tester displays exhaust gas concentration at idle speed.
See page 25 - 4 for adjusting value.
Repeat adjusting procedures if necessary.
 13. Recheck idle speed, correcting if necessary.
 14. Plug bore providing access to mixture regulating screw with a steel ball after finishing adjustments.



15. Coat threads of cap nut for test connection on catalytic converter with Bosch VS 140 16 Ft or Optimoly HT grease.

16. Connect plug of EIS.

TOOLS



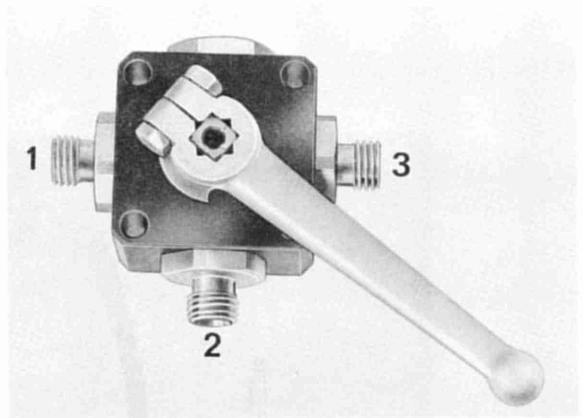
No.	Description	Special Tool	Remarks
1	Pressure tester	P 378	or use VW 1318 with US 8024

CHECKING PRESSURES

General Information

The tester is mounted in the control line between the fuel distributor and control pressure regulator.

The terminals and lever positions of the change-over valve are numbered in the following text for better understanding.

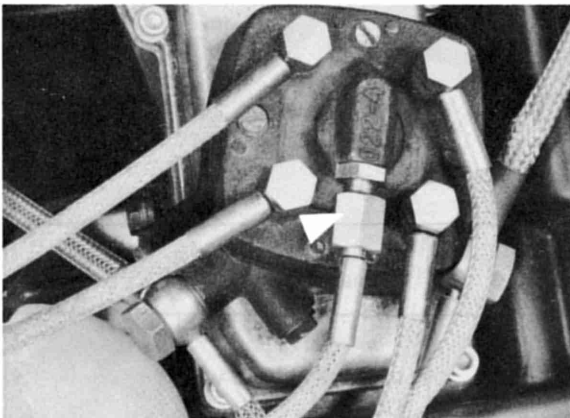


1979 models do not have a switch on the air flow sensor, so on these cars the circuit operated by the fuel pump relay will have to be bridged.

CONNECTING AND BLEEDING PRESSURE GAUGE

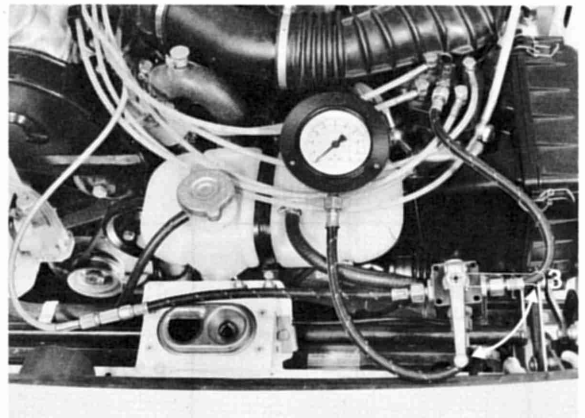
Connecting

1. Unscrew control pressure line at fuel distributor.



2. Connect control pressure line to hose line connection 1 of change-over valve.

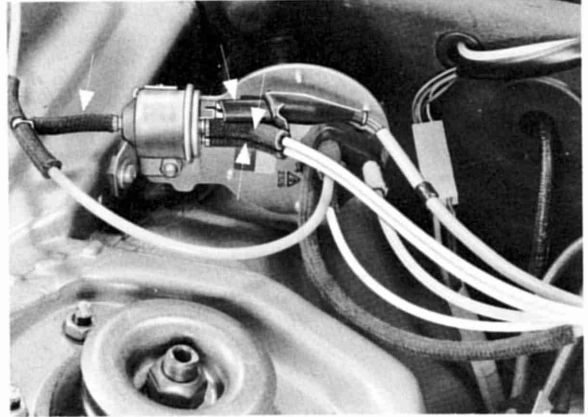
3. Connect the connection on the fuel distributor with the hose line from connection 3.



REMOVING AND INSTALLING TWO-WAY VALVE

Removing

Detach vacuum hoses and wire plugs. Unscrew mounting screw. Remove two-way valve.

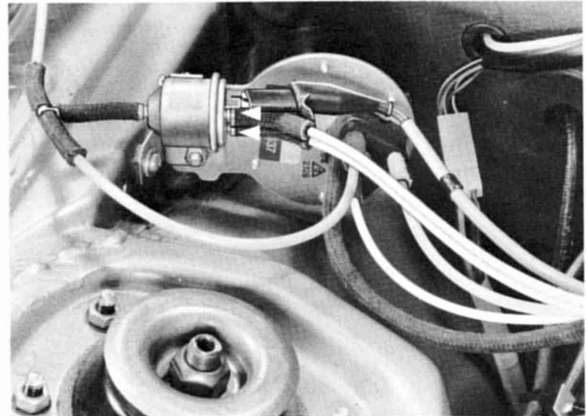


Installing

Connect vacuum hoses as follows:

Upper connection on two-way valve to throttle valve housing (marked with a red ring).

Lower connection on two-way valve to diverter valve (marked with a blue ring).



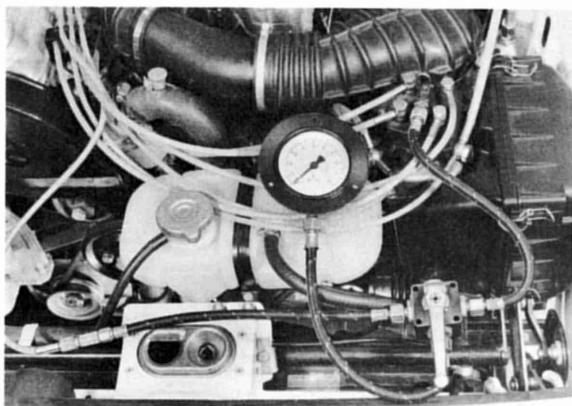
Bleeding

1. Disconnect electrical connector at air flow sensor terminal.
2. Disconnect electrical connector at control pressure regulator, so that the control pressure regulator will not heat up.
3. Let pressure gauge hang down (stretched hose line) and turn on ignition.
4. Move operating lever of the change-over valve between positions 2 and 3 about 5 times at intervals of 10 seconds.

CHECKING "COLD" CONTROL PRESSURE

This test must be performed on a cold engine. This test is absolutely essential for starting or warm-up difficulties.

1. Move change-over valve to position 2.



2. Disconnect electrical connector at air flow sensor terminal.

3. Disconnect electrical connector at control pressure regulator, so that the control pressure regulator will not heat up.

4. Turn ignition on.

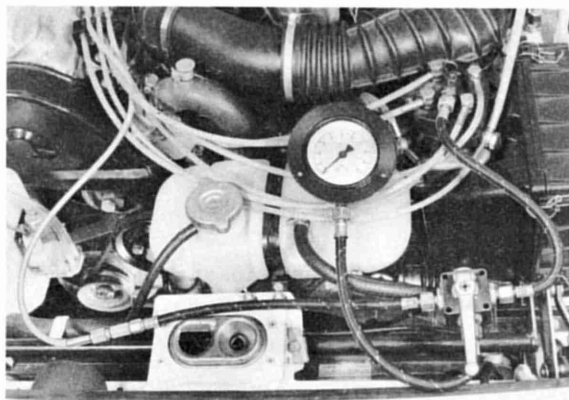
5. Refer to the graph of the testing and adjusting specifications on page 25 - 4 and 25 - 4 a for pressure data at immediate outside temperatures.

6. Replace the control pressure regulator if measurements are out of specifications.

CHECKING "WARM" CONTROL PRESSURE

Engine can be warm or cold.

1. Move change-over valve to position 2.



2. Connect electrical connector to control pressure regulator.

3. Disconnect electrical connector at air flow sensor terminal.

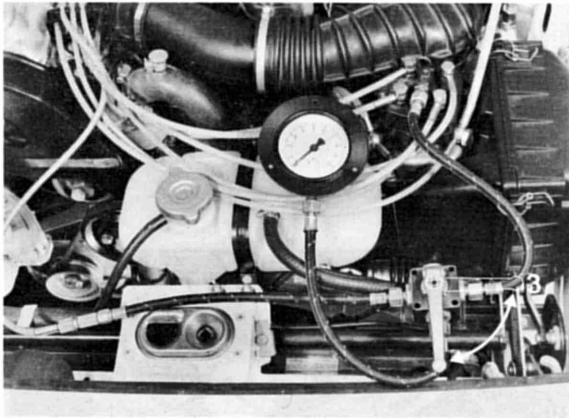
4. Turn on ignition and allow control pressure regulator to heat up. When needle on gauge stops rising, take reading.

- The final pressure must correspond with the specification on page 25 - 4 and 25 - 4 a. If not, replace the control pressure regulator.

CHECKING SYSTEM PRESSURE

The fuel supply, electric fuel pump and fuel filter must be in perfect condition for this test.

- Move change-over valve to position 3.



- Disconnect electrical connector at air flow sensor terminal.

- Turn ignition on.

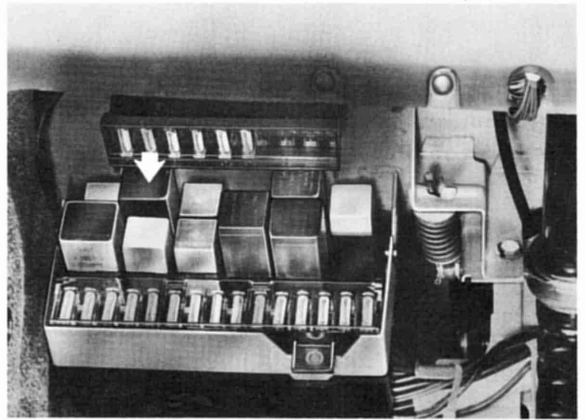
- See page 25 - 4 and 25 - 4 a for specifications. If specifications are not met, adjust pressure by changing shims of system pressure regulating piston.

ACTIVATING FUEL PUMP CIRCUIT FOR TESTING (from 1979 model)

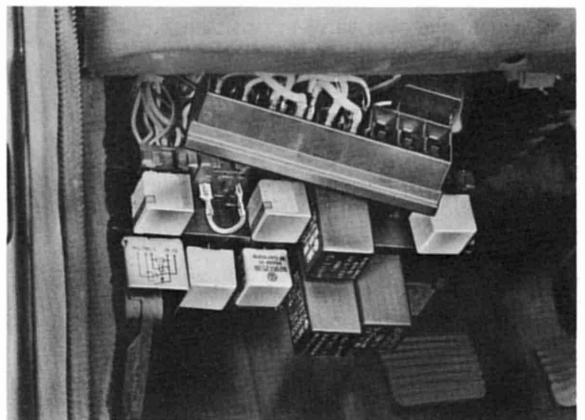
Note

Pull electric connectors off of control pressure regulator and auxiliary air regulator, so that these parts will not heat up during subsequent test.

- Loosen and detach relay plate.
- Pull fuel pump relay off of relay plate.



- Bridge terminals 30 and 87 with a piece of wire. Fuel pump should run.

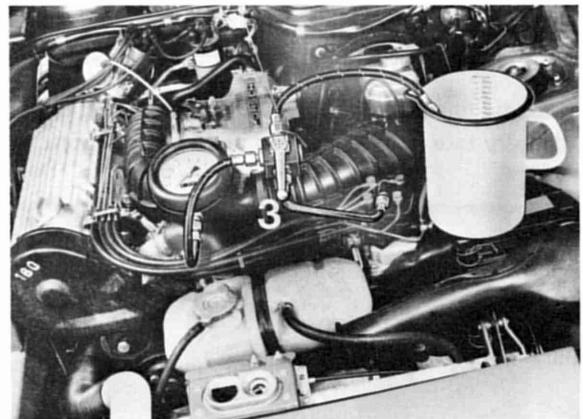
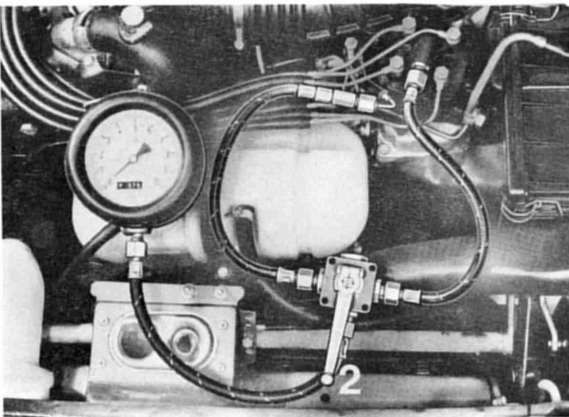


CHECKING FUEL DELIVERY RATE FOR CONTROL PRESSURE CIRCUIT

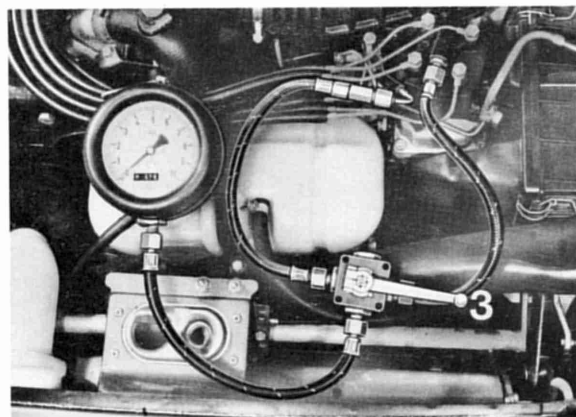
Testing Requirements: Fuel pump in perfect running condition.

Checking

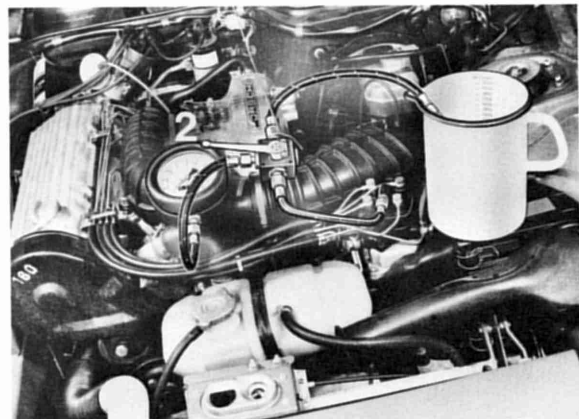
1. Connect and bleed pressure meter P 378.



2. Turn valve to position 3.

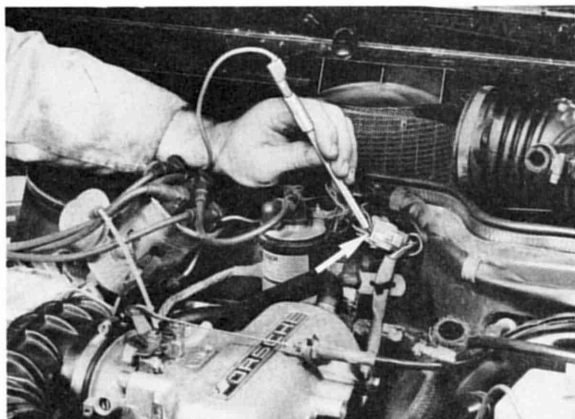


4. Turn on ignition. Turn valve to position 2 and let fuel pump(s) run exactly 1 minute by pulling off two-pin plug on mixture control unit. The fuel pump(s) in cars from 1979 models can be run by supplying battery voltage to multiple-pin plug terminal 7 (red/white) with a piece of wire. The ignition need not be turned on.



3. Disconnect left hose from special tool P 378 at feed line to control pressure regulator and hold in a measuring glass (capacity at least 500 cc).

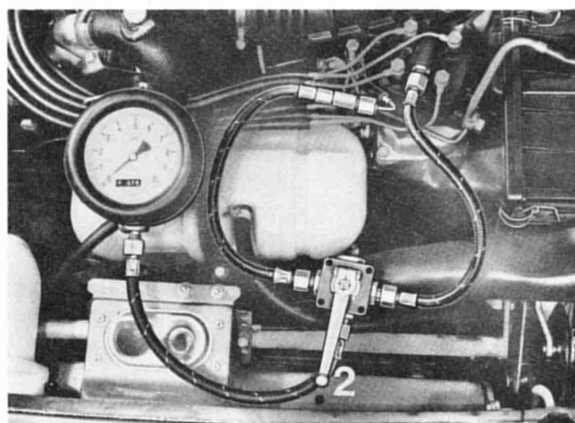
CHECKING ENTIRE FUEL SYSTEM FOR LEAKS



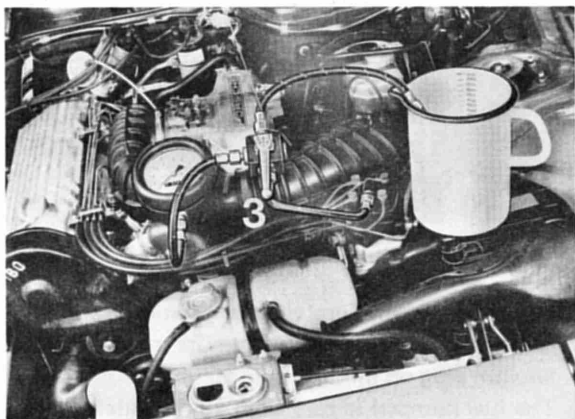
Note

Check on a warm engine, but not immediately after engine was run hot.

1. Turn valve to position 2.



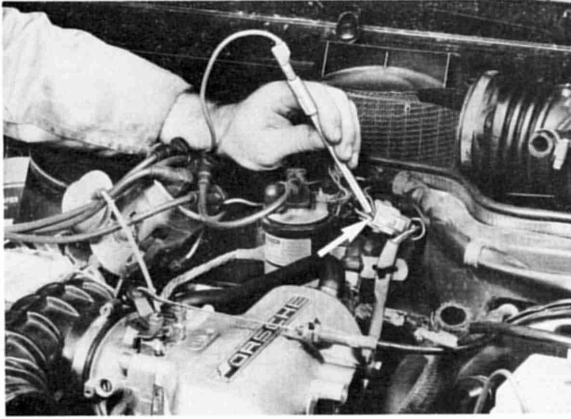
5. Stop by turning valve to position 3 and measure delivery rate. Test value: 160 to 240 cc/minute.



2. Turn on ignition. Detach plug on air flow sensor contact. Fuel pump (s) run.

The fuel pump(s) in cars from 1979 models can be run by supplying battery voltage to multiple-pin plug terminal 7 (red/white) with a piece of wire. The ignition need not be turned on.

If measured value is not same as specified value, the cause is in the fuel distributor. Replace fuel distributor.



Possible Causes in System Pressure Circuit:

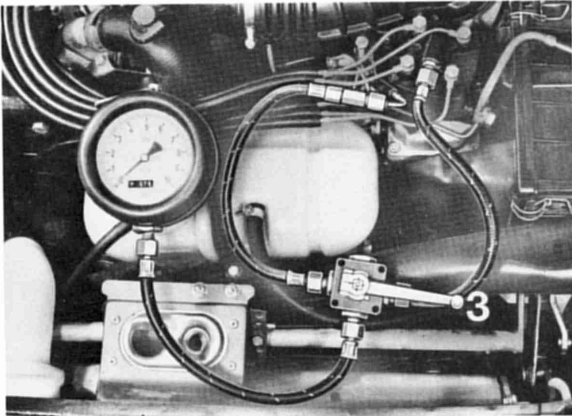
Check valve of fuel pump leaks.
O-ring in system pressure regulator leaks.
Fuel injectors leak.
Start valve leaks.

Fuel injectors and start valve must be inspected separately. Replace check valve of fuel pump and O-ring of system pressure regulator in fuel distributor separately and repeat test.

3. Turn off ignition (detach wire on battery supply from 1979 models) after reaching "warm" control pressure and observe pressure drop on pressure gauge. Pressure will drop quickly at first and then become stabilized. If pressure continues to drop quickly (see testing and adjusting specifications), repeat test with disconnected control pressure circuit to limit possible causes. Turn valve to position 3 for this.

Possible Causes in Control Pressure Circuit:

Control pressure regulator leaks.
Control pressure reducing valve leaks.



If results are the same, leak is in system pressure circuit.

If results of second test are okay, leak is in control pressure circuit.

REMOVING AND INSTALLING MIXTURE CONTROL UNIT

Removing

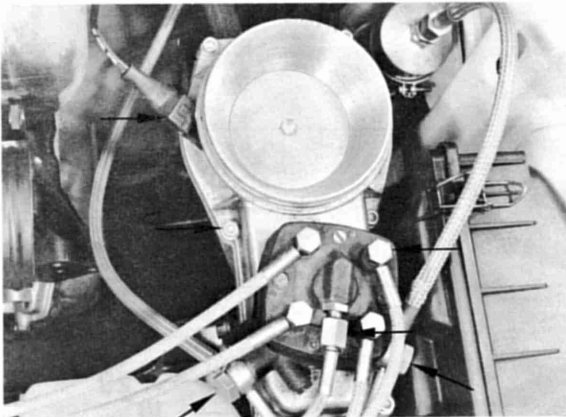
1. Disconnect battery.
2. Remove rubber boot from air sensor.
3. Clean fuel distributor thoroughly in area of fuel connections.
4. Detach wire plugs, injection lines, control pressure line, fuel return line and fuel feed line.

Note

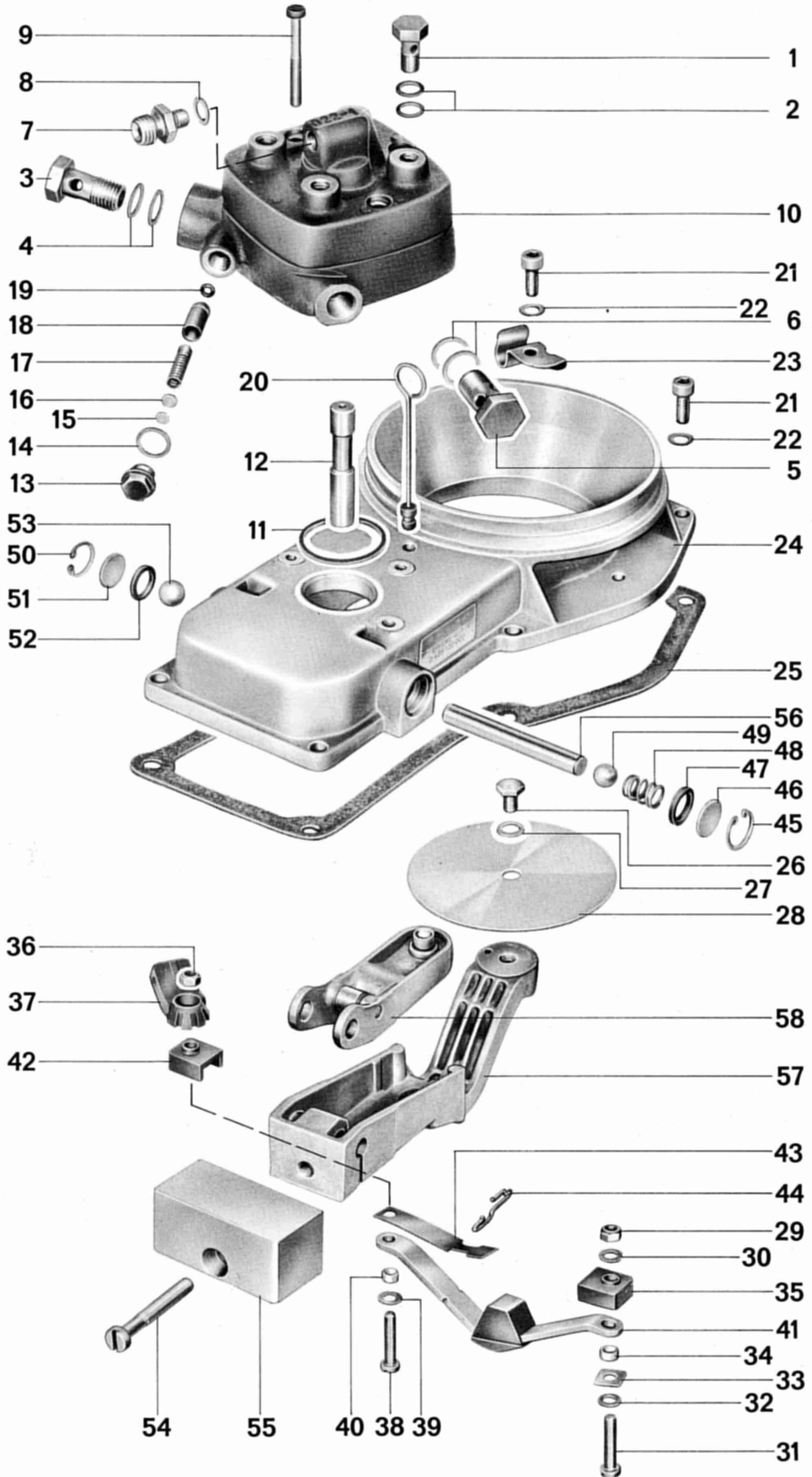
Catch escaping fuel.

Installing

Always use new seals for fuel connections.



5. Loosen 6 Allen head bolts and remove mixture control unit.

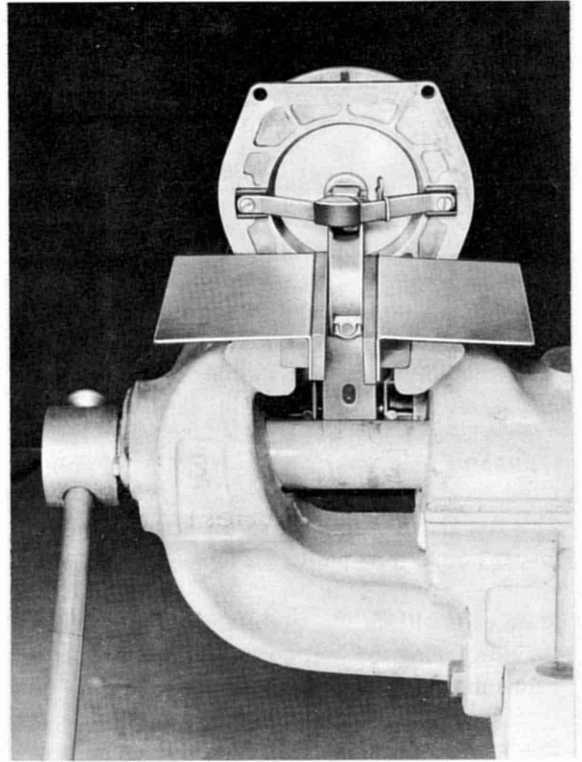


DISASSEMBLING AND ASSEMBLING MIXTURE CONTROL UNIT

REMOVING AND INSTALLING SENSOR PLATE

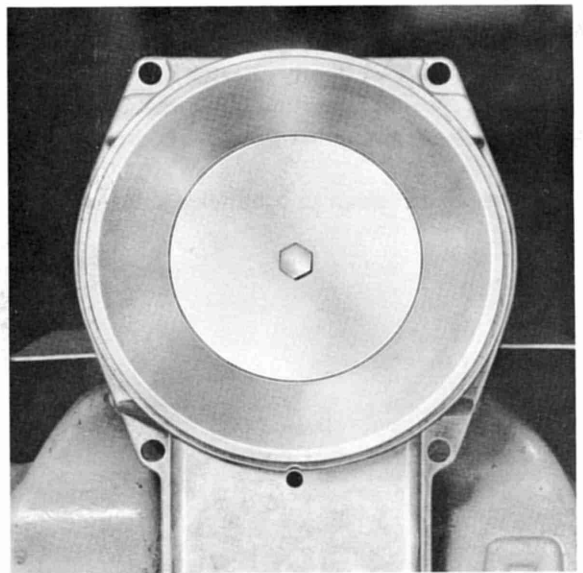
Removing

1. Remove mixture control unit.
2. Using vise jaw protectors, clamp mixture control unit in vise. Clamp vertically at bend on narrow part of operating lever.
3. Loosen sensor plate mounting bolt and remove sensor plate.



Installing

1. Clamp mixture control unit horizontally. Coat sensor plate mounting screw with "Loctite" or equivalent. Place new and/or absolutely level sensor plate in center of operating lever and tighten screw slightly by hand.
2. Measure gap between sensor plate and venturi. There must be an even gap of about 0.10 mm (0.004 in.) around the sensor plate.



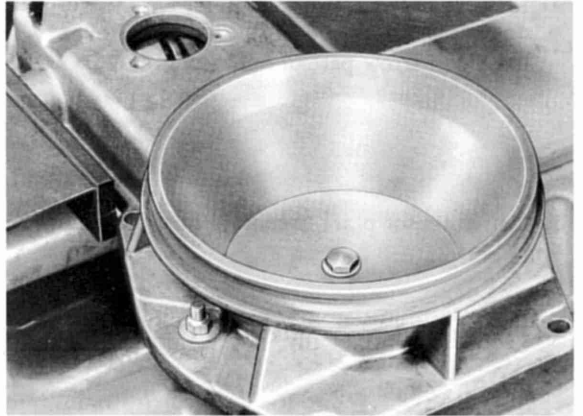


Caution

This test requires that the sensor plate be at proper height (rest position).

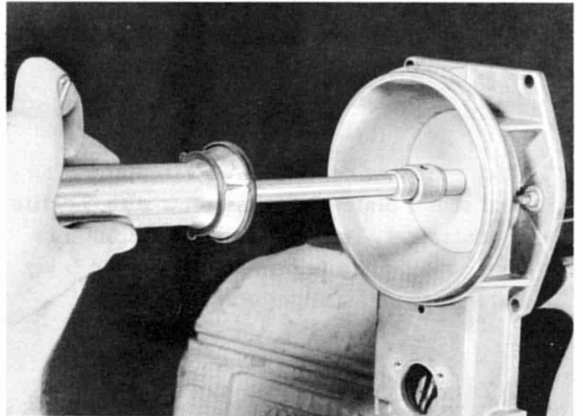
Plate off position: The plate's upper edge on the side facing the fuel distributor is 0 to 0.5 mm below the beginning of the taper.

The height adjustment can be corrected by bending the wire bracket.



- Using vise jaw protectors, clamp mixture control unit vertically. Clamp at bend on narrow part of operating lever; the housing must move somewhat toward the vise.

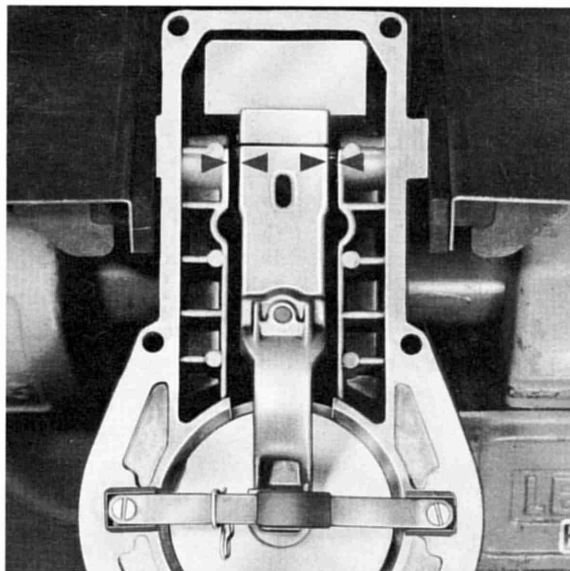
Tighten air sensor to 0.55 mkg (4 ft lb)



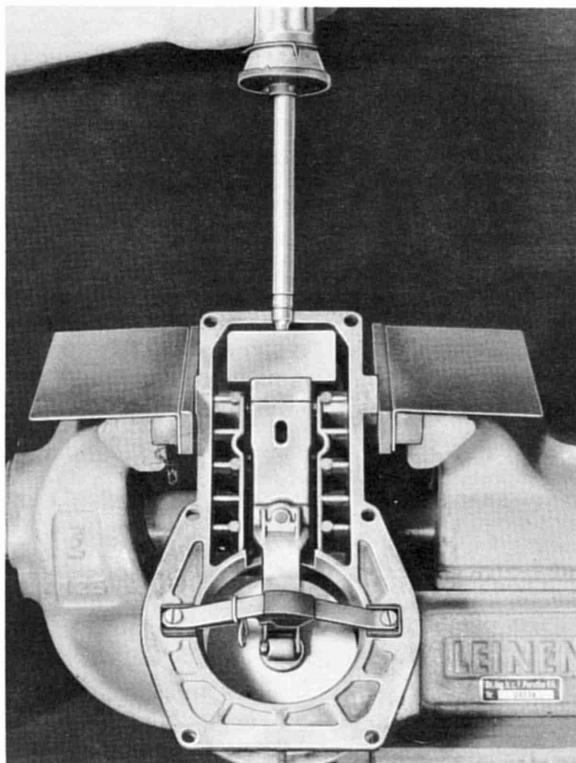
- Recheck sensor plate position.

LOCATING OPERATING LEVER WITH PIVOT LEVER IN AIRFLOW SENSOR HOUSING

1. Coat mounting screw on counterweight with "Loctite" or equivalent and tighten screw slightly.
2. Center operating lever in airflow sensor housing.



3. Tighten mounting screw to 0.50 mkg (4 ft lb)



BASIC ADJUSTMENT OF MIXTURE CONTROL SCREW AFTER REPLACEMENT OF PIVOT LEVER

Caution

This test requires that the sensor plate be adjusted correctly (rest position).

1. Install mixture control unit.
2. Bleed fuel system . (Remove injectors and hold over a container, operate sensor plate by hand several times).
3. Using adjusting wrench P 377 first turn mixture control screw counterclockwise by 1 - 2 turns.
4. Turn on ignition, disconnect electrical connector at air flow sensor.
5. Turn mixture control screw clockwise until injectors just begin to spray. From this position turn idle mixture screw counterclockwise one half turn.

Install injectors again.

Important

Never apply any pressure on the adjusting wrench during adjustments, since this would change the injection rate.

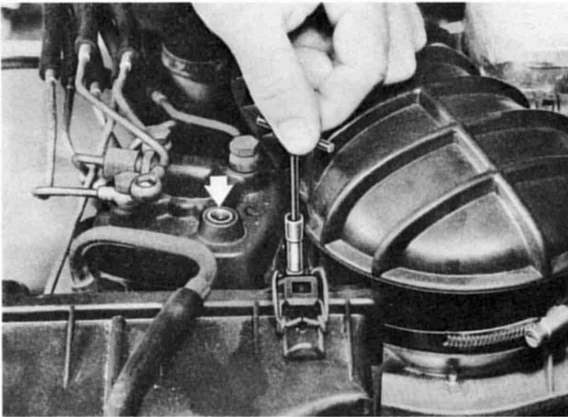
6. Run engine to operating temperature 80 to 90 °C (180-190°F) oil temperature, and adjust idle speed and CO level to final specifications.

BASIC ADJUSTMENT OF MIXTURE CONTROL UNIT INITIAL START

Note

This test requires that the sensor plate be adjusted correctly (rest position).

1. Unscrew one injection line on fuel distributor.
2. Bridge electrical safety circuit.
3. Turn mixture control screw slowly, without applying pressure on adjusting wrench P 377, until fuel just begins to leave the open outlet (arrow) of the fuel distributor. From this position turn mixture control screw counterclockwise one half turn.

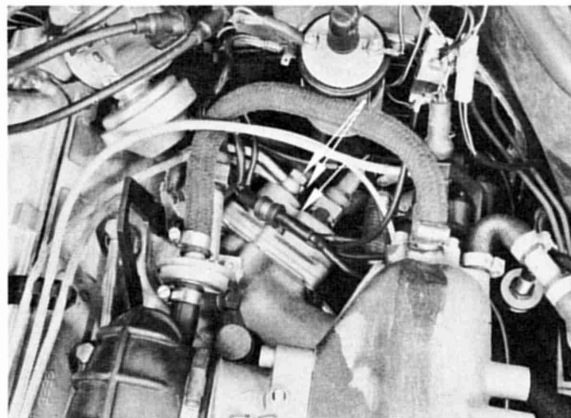


4. Connect injection line again. Run engine to operating temperature (approx. 80° C/176° F oil temperature) and adjust idle speed and CO level to final specifications.

REMOVING AND INSTALLING WARM-UP REGULATOR

Removing

1. Disconnect wire connectors at warm-up regulator.
2. Loosen hollow bolts of fuel lines.
3. Loosen 2 Allen head bolts and remove warm-up regulator.



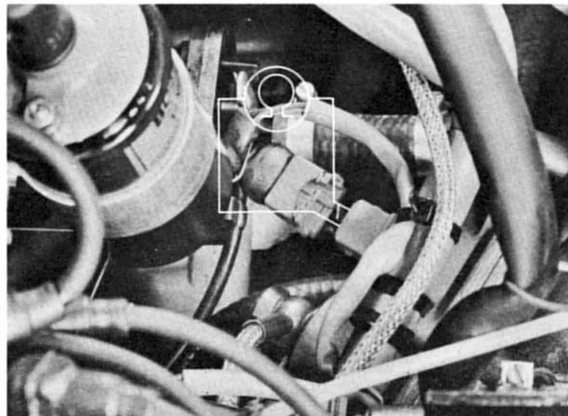
Installing

Torque specifications:

- | | |
|-------------------|--------------------|
| Lower hollow bolt | 1.0 mkg (7 ft lb) |
| Upper hollow bolt | 1.5 mkg (11 ft lb) |

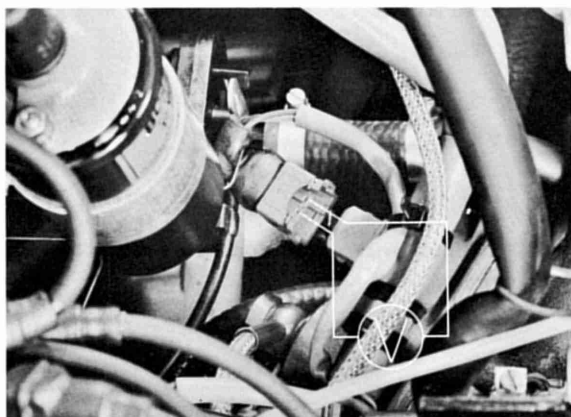
CHECKING WARM - UP REGULATOR - WARM ENGINE
(Oil temperature min. 50° C / 120° F)

1. Disconnect wire connectors at warm-up regulator.
2. Disconnect electrical connector at air flow sensor. Turn on ignition.
3. Check power supply with voltmeter at disconnected plug. Voltage min. 11.5 V.



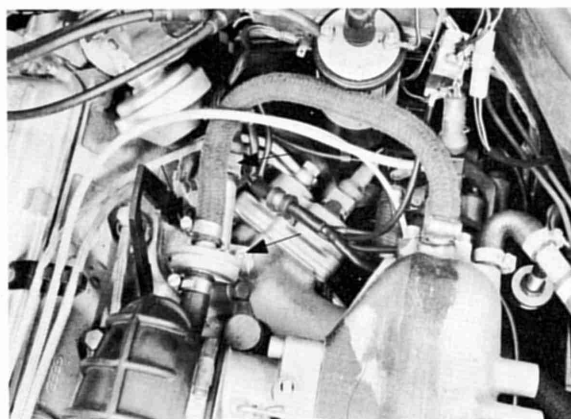
4. Check heating coil, resistance of heating coil approx. 20 Ohm.

If heating coil has open circuit, replace warm-up regulator.



REMOVING AND INSTALLING AUXILIARY AIR REGULATOR

1. Disconnect electrical connector at auxiliary air valve.
2. Loosen hose clamps and pull off hoses.
3. Loosen Allen head bolts and remove auxiliary air regulator.



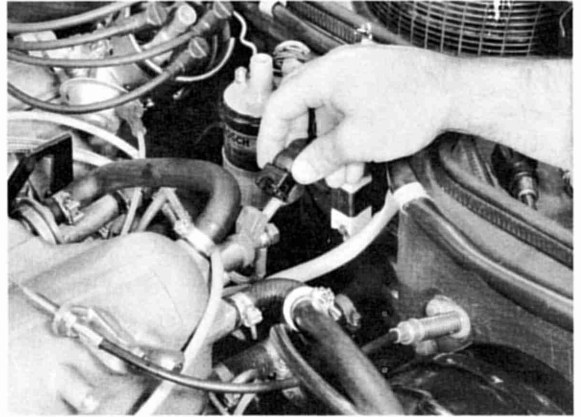
CHECKING AUXILIARY AIR REGULATOR Cold Engine

1. Detach hose at auxiliary air regulator.
2. Check visually that air passage is open.
(Use a mirror and flashlight, if necessary)
3. Disconnect electrical connector at air flow sensor.
4. Turn on ignition.
Air passage must be closed after about 5 min.

CHECKING THERMO TIME SWITCH

Cold Engine

1. Disconnect electrical connector at cold start valve.
2. Connect voltmeter to electrical connector.
3. Disconnect high tension wire at ignition coil and operate starter.
4. Voltmeter must deflect for about 1 - 8 sec. Replace thermo time switch if necessary.



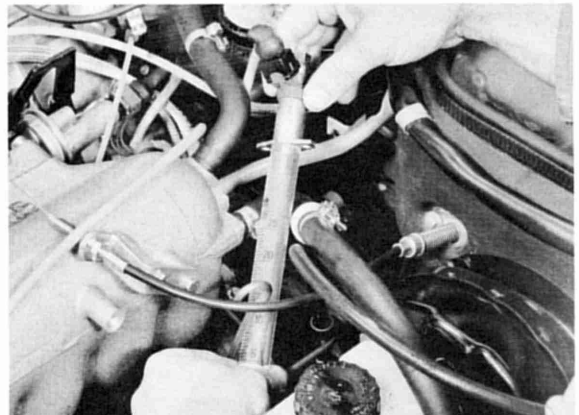
Note

Thermo time switch will operate at about $+ 35^{\circ}\text{C}$ (95°F). Voltmeter may not deflect if test is at higher temperature.

CHECKING COLD START VALVE OPERATION

Cold Engine

1. Remove cold start valve. Fuel line and electrical connector remain connected.
2. Disconnect high tension line at ignition coil.
3. Hold cold start valve in an appropriate container.
4. Turn on ignition and have a second person operate the starter. Valve must give off an even conical fuel pattern for about 1 - 8 sec.

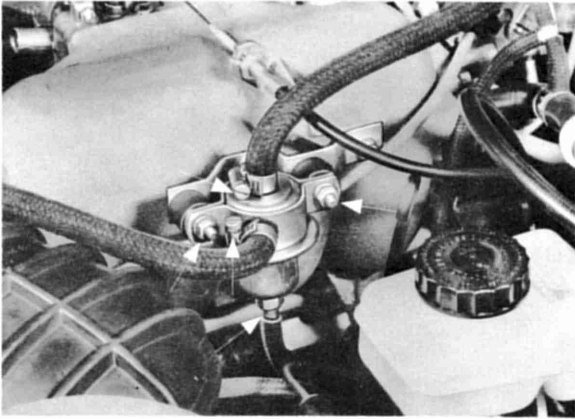


CHECKING COLD START VALVE FOR LEAKS

1. Leave ignition turned on.
2. Disconnect electrical connector at air flow sensor (pump running).
3. Wipe jet of start valve dry. This jet must not leak at all within a minute's time.

Replace a malfunctioning or leaky start valve.

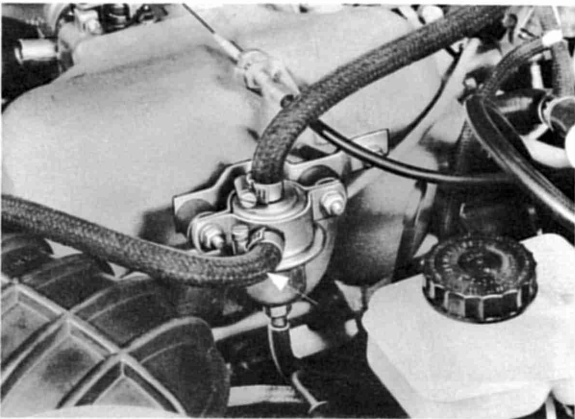
REMOVING AND INSTALLING DECELERATION VALVE



Removing

1. Loosen hose clamps and detach vacuum hoses.
2. Loosen nuts and remove deceleration valve.

CHECKING OPERATION OF DECELERATION VALVE



1. Detach hose between valve and intake manifold at valve and insert plug in open hose end.
2. Start engine. Bring engine briefly to about 350^o rpm. Shut throttle valve quickly.
3. Check with finger for suction at hose connection. Replace valve if suction cannot be felt.

CHECKING COLD START VALVE FOR LEAKS

1. Leave ignition turned on.

2. Disconnect electrical connector at air flow sensor (pump running).

3. Wipe jet of start valve dry. This jet must not leak at all within a minute's time.

Replace a malfunctioning or leaky start valve.

CHECKING OPERATION OF HOT START VALVE (Reduction of Control Pressure During Hot Start)

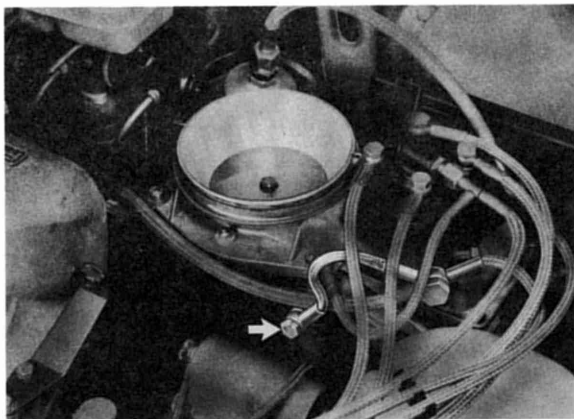
Requirements:

Warm engine. Coolant temperature $60^{\circ}\text{C}/140^{\circ}\text{F}$ or more.

1. Connect pressure tester and set switching valve at position 2.
2. Operate starter to open hot start valve and drop control pressure. Specification: 0.5 to 0.7 bar/0.6 to 0.8 kg/cm^2 (note **brief** delay in time).
3. If necessary, replace hot start valve or check temperature switch, i.e. temperature switch must have open circuit.

CHECKING HOT START VALVE FOR LEAKS

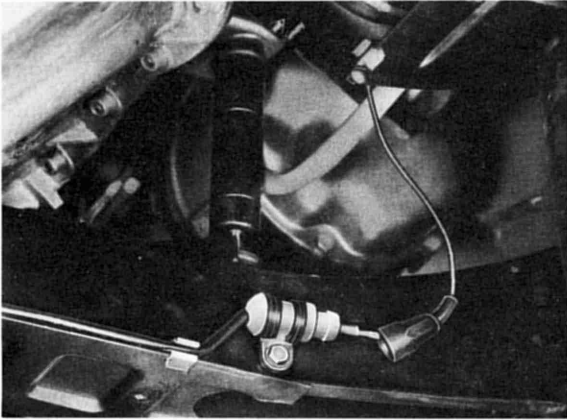
1. Detach and plug fuel return line.
2. Bridge fuel pump relays.
3. Hot start valve must be absolutely tight, i.e. no fuel should escape from fuel return connector.



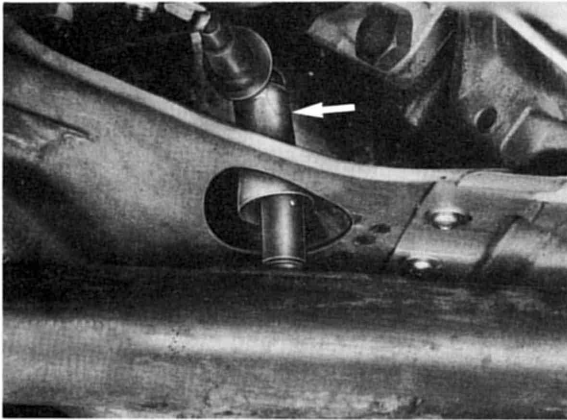
REMOVING AND INSTALLING OXYGEN SENSOR

Removing

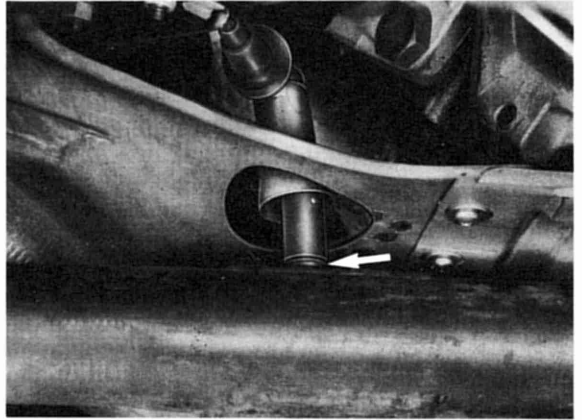
1. Lift car.
2. Pull off rubber cap from oxygen sensor plug and plug.



3. Pull off plug from oxygen sensor.



4. Unscrew oxygen sensor.



Installing

1. Coat threads of oxygen sensor with Bosch paste VW 140 16 Ft.

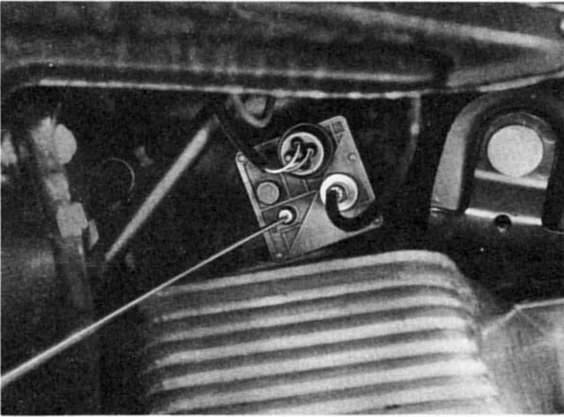
Note

Be careful that paste does not enter slot of sensor.

2. Tighten sensor to specified torque. Reference value: 50 to 60 Nm (36 to 43 ft lb).

RESETTING ELAPSED MILEAGE SWITCH

An elapsed mileage switch for the oxygen sensor is installed on the left engine carrier. After a distance of 30,000 miles it will turn the oxygen sensor indicator light ON. Each time the oxygen sensor is replaced, the elapsed mileage switch must be reset to zero.

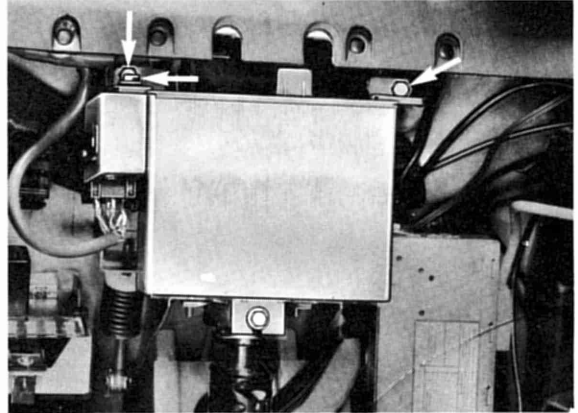


1. Lift car.

2. Press in reset button of elapsed mileage switch against the stop with a piece of approx. 3 mm dia. wire. This will reset the counter to zero and restore the oxygen sensor indicator lamp to its normal operation.

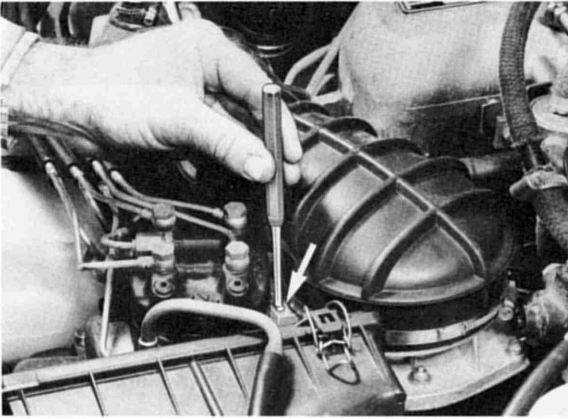
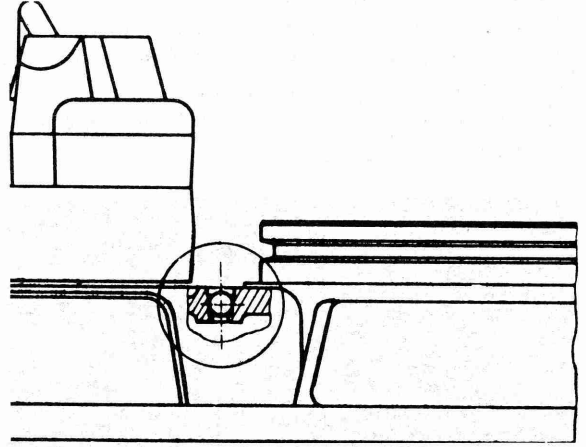
REMOVING AND INSTALLING CONTROL UNIT FOR OXYGEN SENSOR

Loosen three screws on control unit. Pull off plugs and remove control unit.



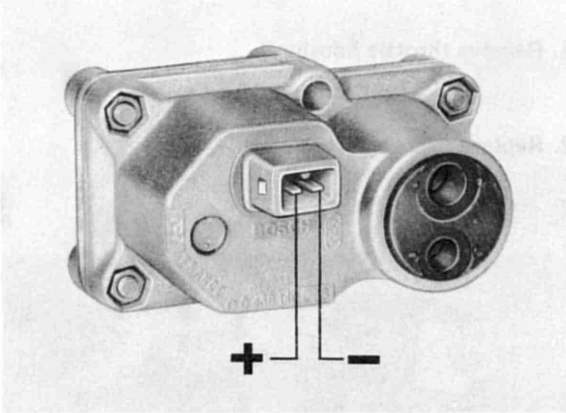
**CORRECTING CO VOLUME ADJUSTMENT ON MIXTURE CONTROL UNIT
(FROM 1981 MODELS)**

1. Remove complete mixture control unit.
2. Knock ball plug out of airflow sensor's bottom with a 2 mm drift.
3. Knock ball plug into airflow sensor housing against stop with a correct size drift after adjusting CO volume.



CHECKING CONTROL PRESSURE REGULATOR (WITH TEMPERATURE SWITCH)
(from 1981 Models)

Note polarity of plug connections for tests on control pressure regulator.
See figure for positive and negative connections.



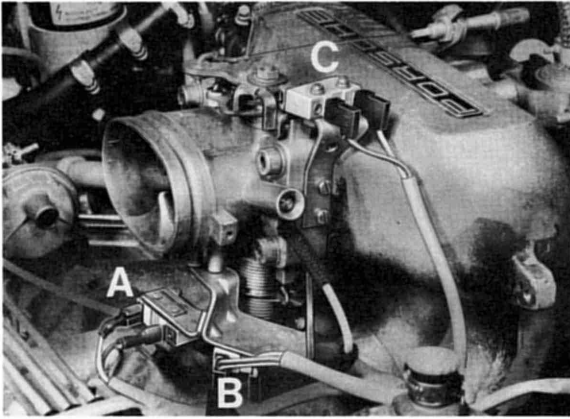
Check resistance of heating coil and temperature switch.

At 13^o C (55^o F) and below = 26 ohms.

At 17^o C (63^o F) and above = 10 ohms.

Replace control pressure regulator if necessary.

ARRANGEMENT OF MICROSWITCHES



A - Acceleration enrichment and idle stabilization

B - Switching off oxygen sensor

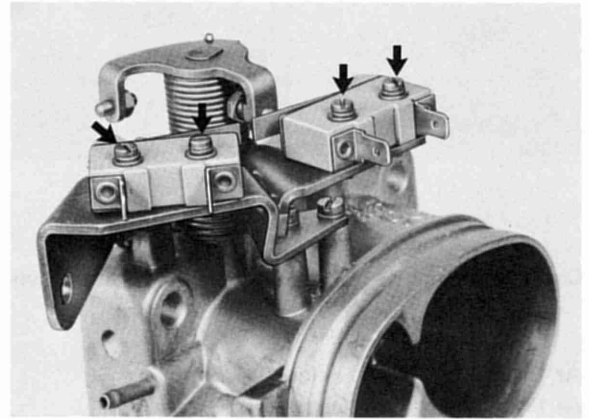
C - Acceleration enrichment

REMOVING AND INSTALLING MICROSWITCHES

Note

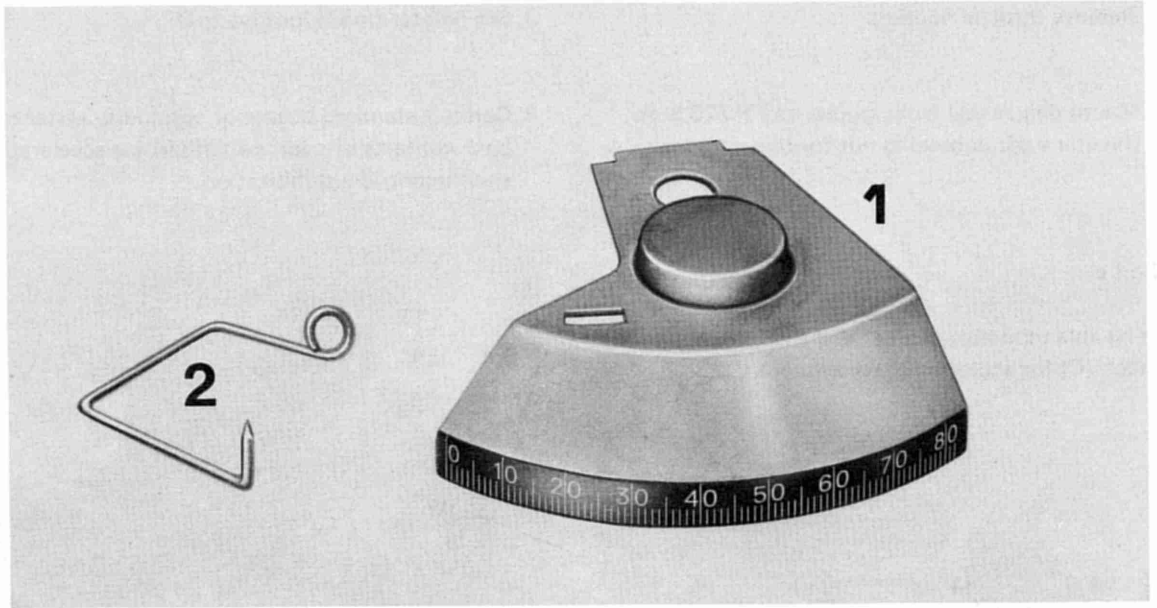
It is essential to mark wire plugs for microswitches before removing, to avoid mix-ups later.

1. Remove throttle housing.
2. Replace microswitches.



3. Adjust microswitches (see page 25 - 31).

TOOLS



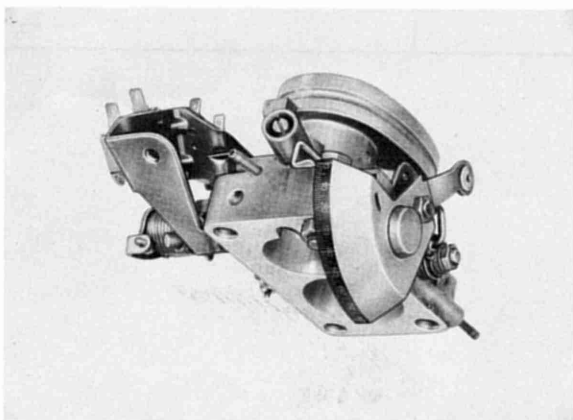
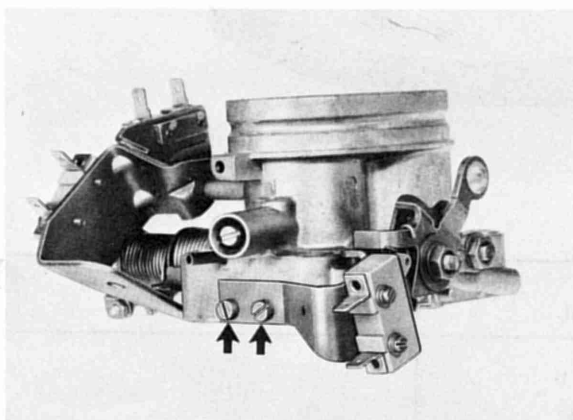
No.	Description	Special Tool	Remarks
1	Degree dial	from P 228 b	
2	Pointer		Made locally

CHECKING SETTING OF MICROSWITCHES

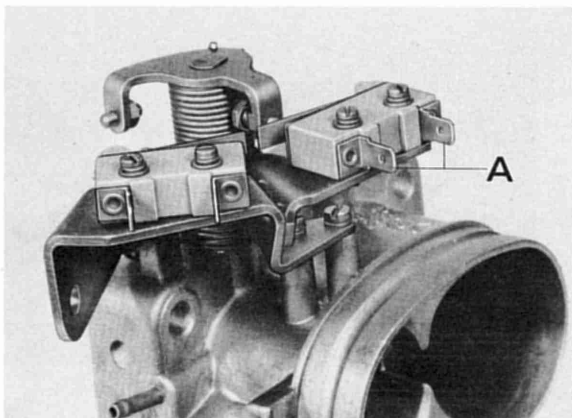
1. Remove throttle housing.
2. Mount degree dial from special tool P 228 b on throttle shaft, loosening nut for this purpose.

Note

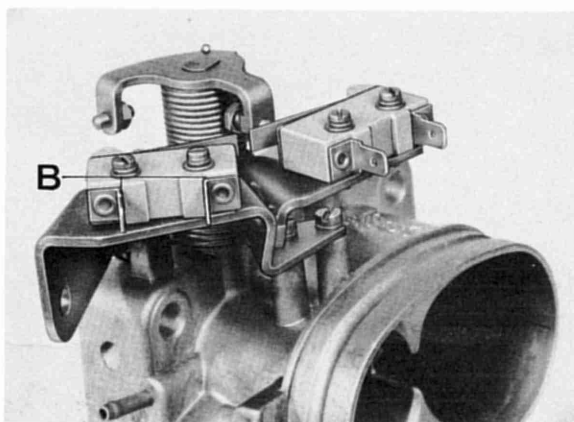
To be able to mount degree dial first unscrew micro-switch (C) for accelerating enrichment.



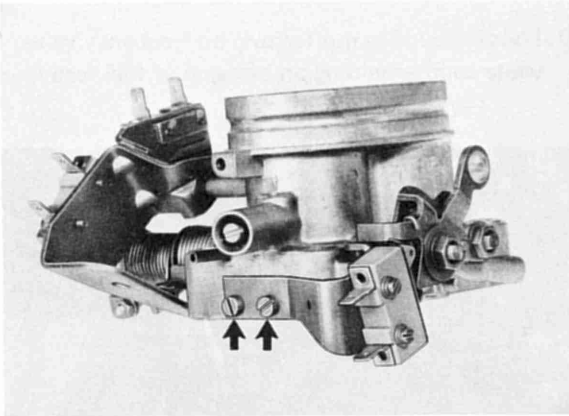
3. Set pointer (made locally) to 0° .
4. Connect standard buzzer or continuity tester on both contacts of microswitch (A) for accelerating enrichment/idle stabilization.



5. Operate throttle until microswitch opens. Switching point should be $8 \pm 1^{\circ}$. Adjust if necessary.
6. Connect microswitch (B) for switching off oxygen sensor on buzzer as described above. Microswitch should close at $55 \pm 1^{\circ}$. Adjust if necessary.



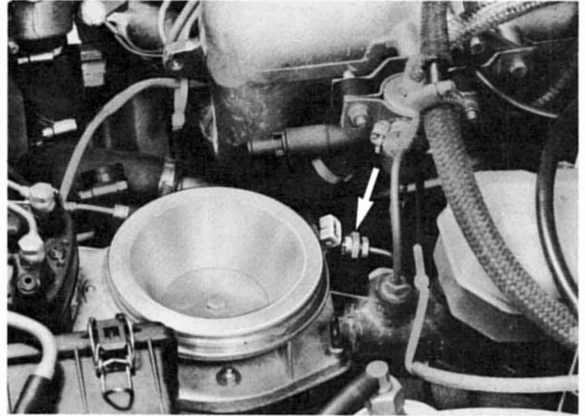
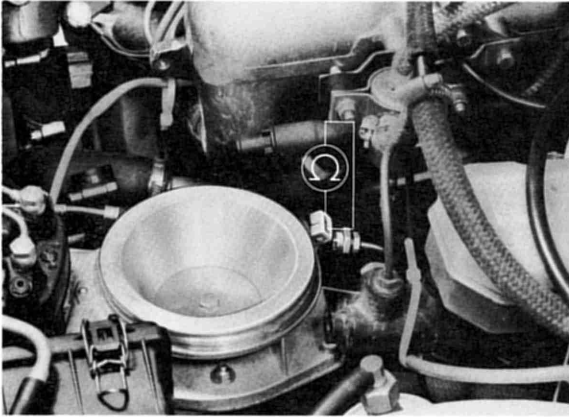
7. Remove degree dial and pointer. Install microswitch (C) for accelerating enrichment.



8. Adjust microswitch so that switching point takes place before throttle opens.

CHECKING FREQUENCY VALVE FOR OXYGEN SENSOR CONTROL

1. Detach wire connectors.
2. Connect ohmmeter on frequency valve.
2. Loosen coupling nut (arrow) on frequency valve, while counterholding on hexagon of fuel feed line.



Coil resistance: 2 to 3 ohms.

3. Replace frequency valve if necessary.

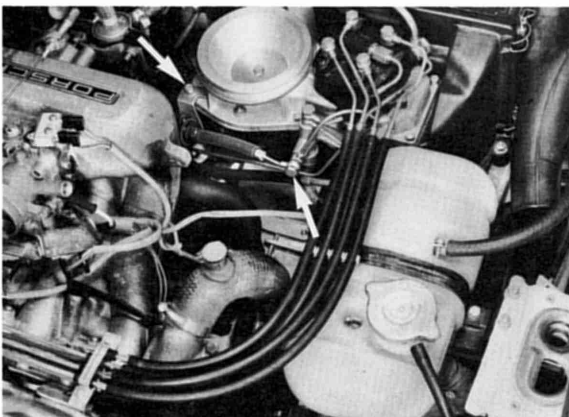
Installing

Frequency valve plug must face up, i.e. toward engine cover, when installed.

REMOVING AND INSTALLING FREQUENCY VALVE

Removing

1. Loosen fuel return line on solenoid and bracket for frequency valve.

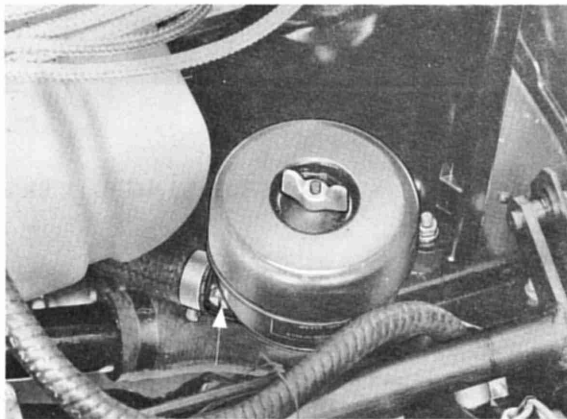


EXHAUST SYSTEM

REMOVING AND INSTALLING FILTER FOR AIR PUMP

Removing

Loosen clamp and remove air filter.



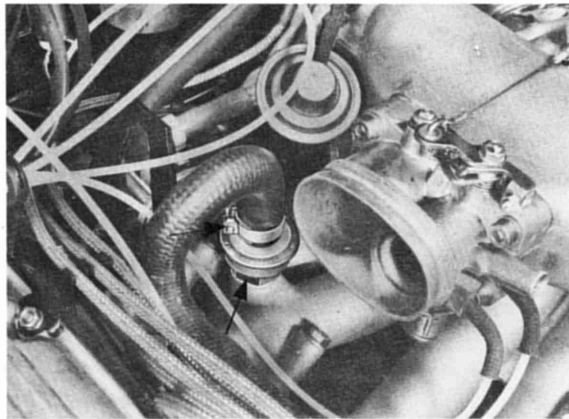
Installing

Make sure that air filter is not in contact with any other part.

REMOVING AND INSTALLING CHECK VALVE

Removing

1. Remove bellows on throttle housing.
2. Loosen clamp and pull off hose.
3. Detach check valve and remove with gasket.

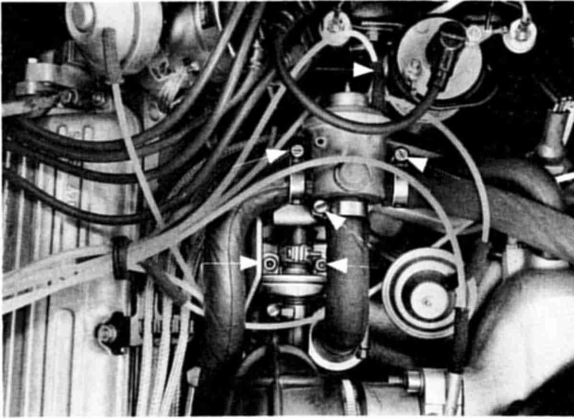


Installing

Use new gasket.

CHECKING CHECK VALVE

Check valve must open only in direction of air injection and be closed in opposite direction.

REMOVING AND INSTALLING DIVERTER VALVE

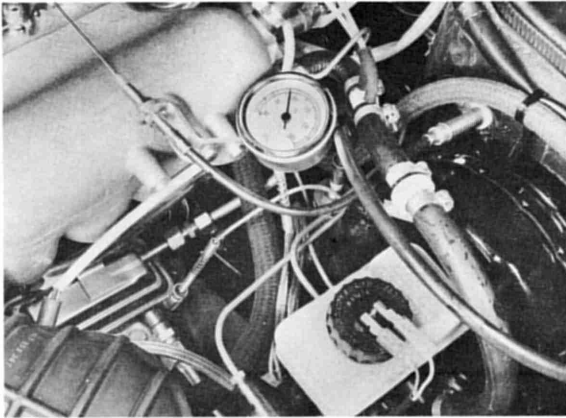
Loosen vacuum hose, hose clamps and socket head screws, and remove valve.

CHECKING OPERATION OF CATALYTIC CONVERTER (California only)

A catalytic converter test requires that engine be warm, so that catalytic converter is working. This means an oil temperature of 80 to 90 °C (180 - 190 °F). Test must be made immediately after reaching this temperature.

Checking

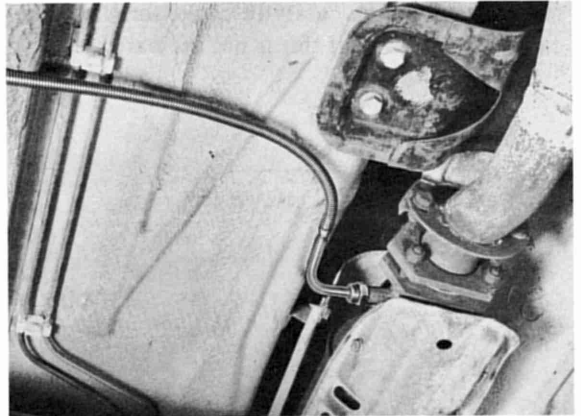
1. Run engine to operating temperature:
80 - 90 °C (180-190 °F) oil temperature.
Use special tool P 9122 or US 8125



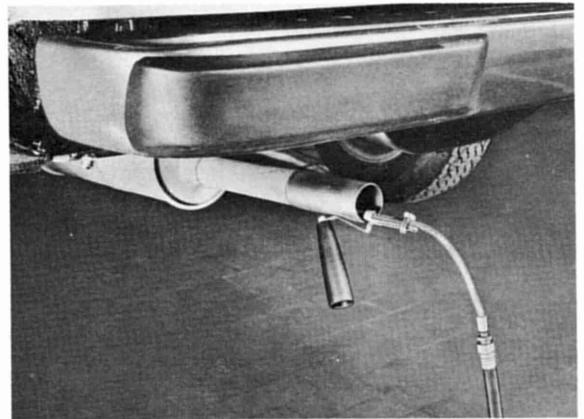
2. Connect CO-tester according to manufacturer's instructions.

Caution

Connect exhaust gas analyzer probe to test connection in front of catalytic converter.
Use of exhaust gas probe VW 1311.



3. Run engine at idle speed.
4. Read CO level on instrument.
Adjust CO % if CO level is higher than 0.7 %.
5. Connect exhaust gas test line to tail pipe of muffler and read CO level on instrument.



Test values: Before catalytic converter (at probe connection)
CO = max. 0.7 %
After catalytic converter (at tail pipe)
CO = max. 0.4 %

Caution

Value after catalytic converter must always be smaller than before catalytic converter. Replace catalytic converter if this is not the case.

CHECKING OPERATING OF EXHAUST GAS RECIRCULATION VALVE

1. Remove exhaust gas recirculation valve.

 2. Apply vacuum to vacuum connection and check whether ball of valve lifts from its seat.
-

EXHAUST GAS RECIRCULATION ELAPSED MILEAGE SWITCH

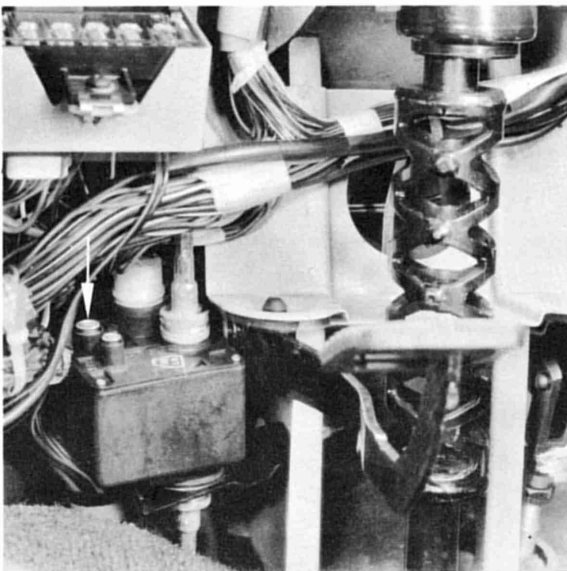
All models are equipped with exhaust gas recirculation (EGR) to control exhaust gas emissions.

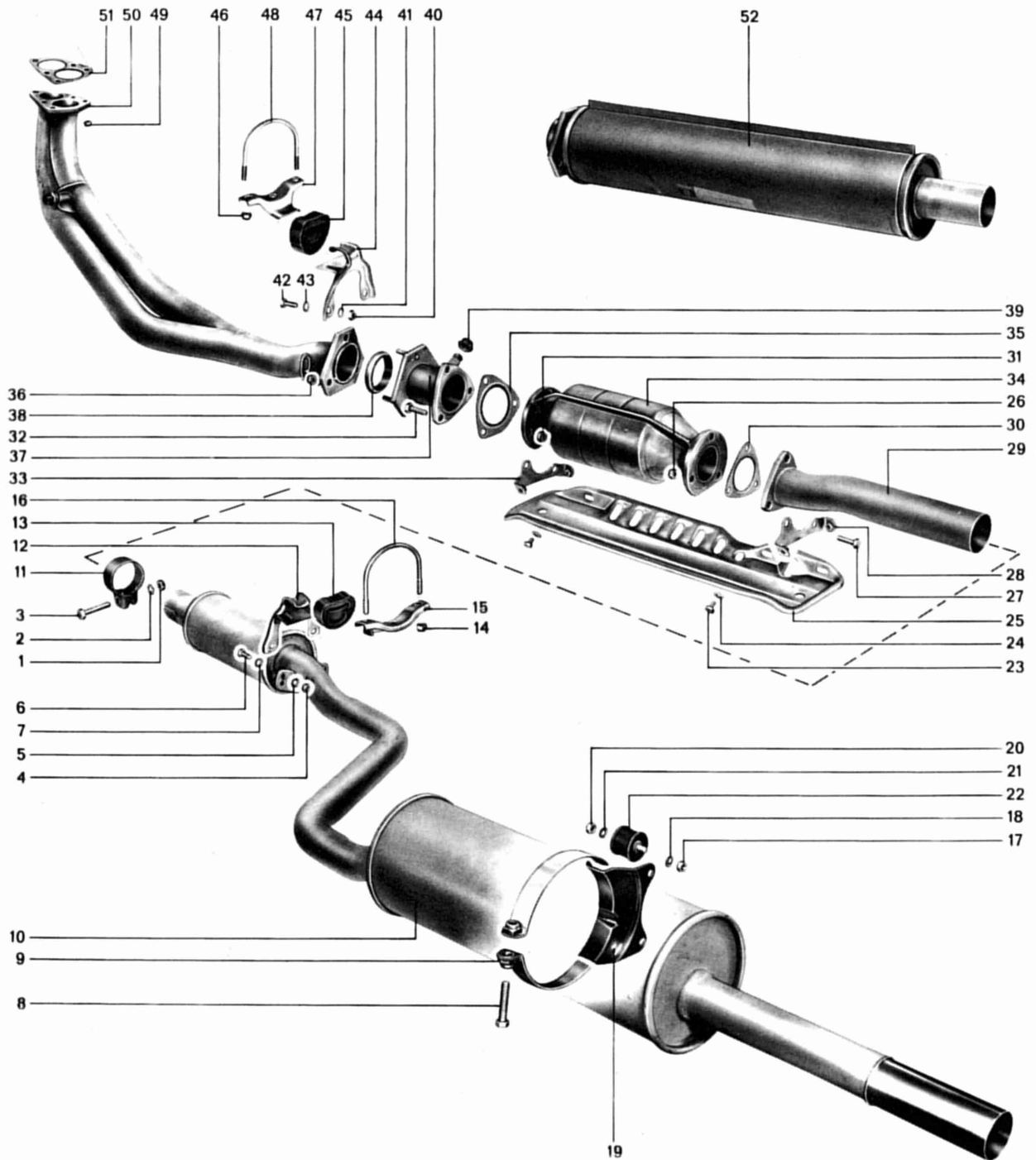
The EGR system is subject to a certain amount of wear and consequently must be inspected or replaced after a certain period of operation.

To monitor the period of operation, an elapsed mileage switch is installed behind the speedometer, which will light up the "EGR" indicator lamp in the instrument panel after a distance of 30 000 miles.

The elapsed mileage switch must be returned to zero after completing the inspection of the exhaust gas recirculation system. This is done by pressing the pin on the housing to the stop with an appropriate tool (small screwdriver, punch or other tool).

The "EGR" indicator lamp should no longer be on when engine is running.





No.	Description	Qty.	Note when		Special Instructions
			Removing	Installing	
1	Nut M 10	1			
2	Lockwasher M 10	1			
3	Bolt M 10 x 50	1			
4	Nut M 8	2			
5	Lockwasher	2			
6	Bolt	2			
7	Washer	2			
8	Bolt	1			
9	Strap	1			
10	Final muffler	1		Check, replace if necessary	
11	Clamp	1			
12	Holder	1		Position correctly	
13	Rubber mount	1		Check, replace if necessary	
14	Nut, self-locking	2		Replace, torque 2 mkg (14 ft lb)	
15	Holder	1			
16	Bracket	1			
17	Nut	2			
18	Lockwasher	2			
19	Rear holder	1			
20	Nut	2			
21	Lockwasher	2			
22	Rubber/metal mount	2		Check, replace if necessary	
23	Bolt	4			
24	Washer	4			

No.	Description	Qty.	Note when		Special Instructions
			Removing	Installing	
25	Lower guard	1			
26	Nut, self-locking	3			
27	Bolt	3			
28	Holder	1			
29	Pipe	1			
30	Gasket	1		Replace	
31	Nut, self-locking	3		Replace	
32	Bolt	3			
33	Holder	1			
34	Catalytic converter	1		Position correctly	
35	Gasket	1		Replace	
36	Nut, self-locking	3		Replace	
37	Adaptor	1		Position correctly	
38	Seal	1			
39	Plug nut	1			
40	Nut	2			
41	Lockwasher	2			
42	Bolt	2			
43	Washer	2			
44	Holder	1		Position correctly	
45	Rubber mount	1		Check, replace if necessary	
46	Nut, self-locking	2		Replace	
47	Holder	1		Position correctly	

No.	Description	Qty.	Note when		Special Instructions
			Removing	Installing	
48	Bracket	1			
49	Nut, self-locking	5		Replace, torque 2 mkg (14 ft lb)	
50	Front exhaust pipe	1			
51	Gasket	1		Replace	
52	Primary muffler (only Europe)	1		Check, replace if necessary	

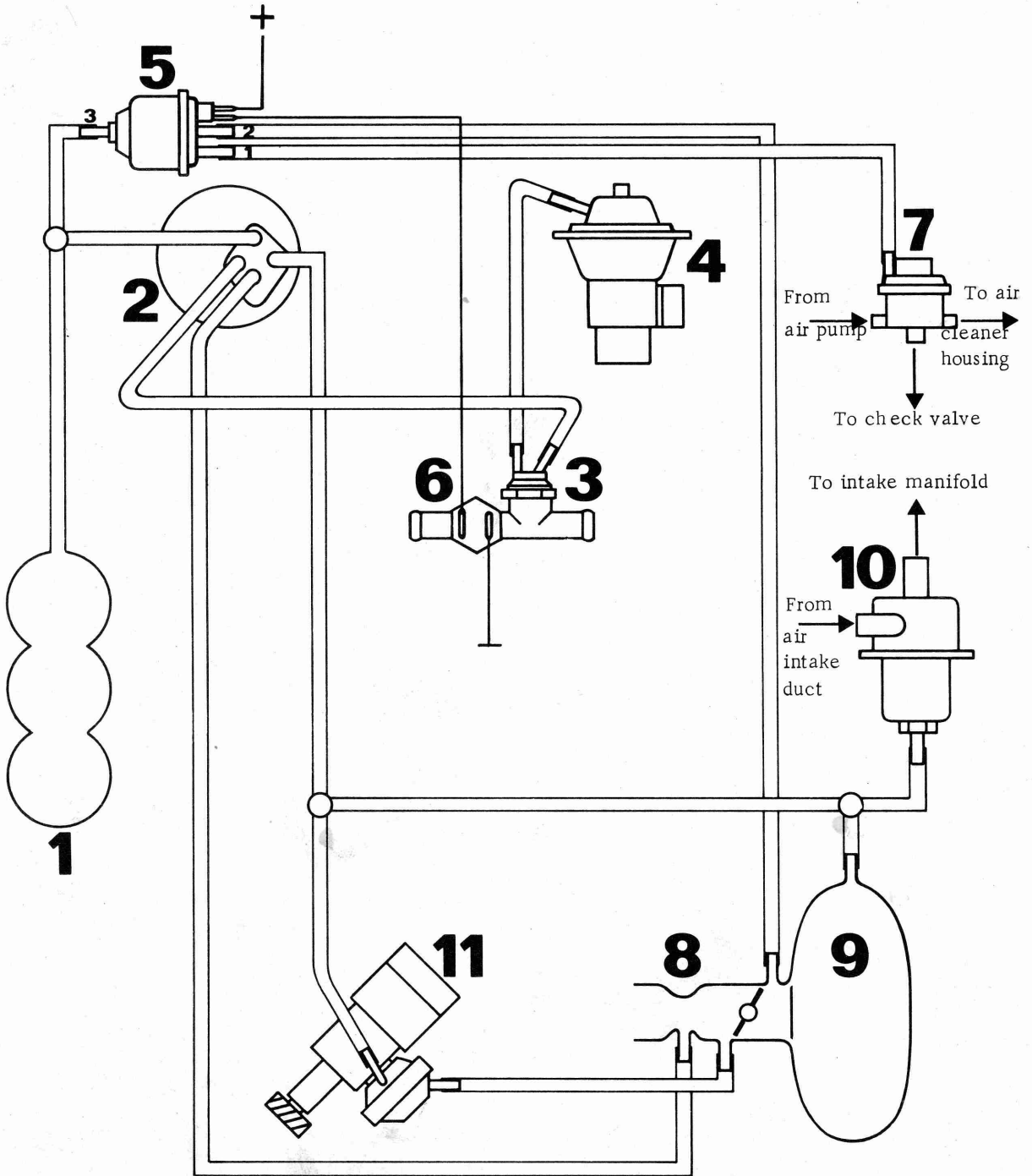
DISASSEMBLY AND ASSEMBLY NOTES

Main muffler suspension

Top installation holes for manual transmission.

Bottom installation holes for automatic transmission (marked with " A ").

LAYOUT OF EMISSION CONTROL SYSTEM (From Model 77 1/2)



- 1 - Vacuum tank
- 2 - Vacuum amplifier
- 3 - Temperature valve for EGR
- 4 - Exhaust gas recirculation (EGR) valve
- 5 - Two-way valve for air injection - California only
- 6 - Temperature switch
- 7 - Diverter valve - California only
- 8 - Throttle valve housing
- 9 - Intake manifold
- 10 - Deceleration valve - Manual Transmission only
- 11 - Ignition distributor

Note

Engine cold

Temperature switch is closed, two-way valve is energized.

Vacuum connections 1 (blue ring) and 3 are connected allowing vacuum from vacuum tank to operate diverter valve at all times.

When vacuum is applied to diverter valve, diverter valve directs air flow to exhaust manifold.

Engine at operating temperature

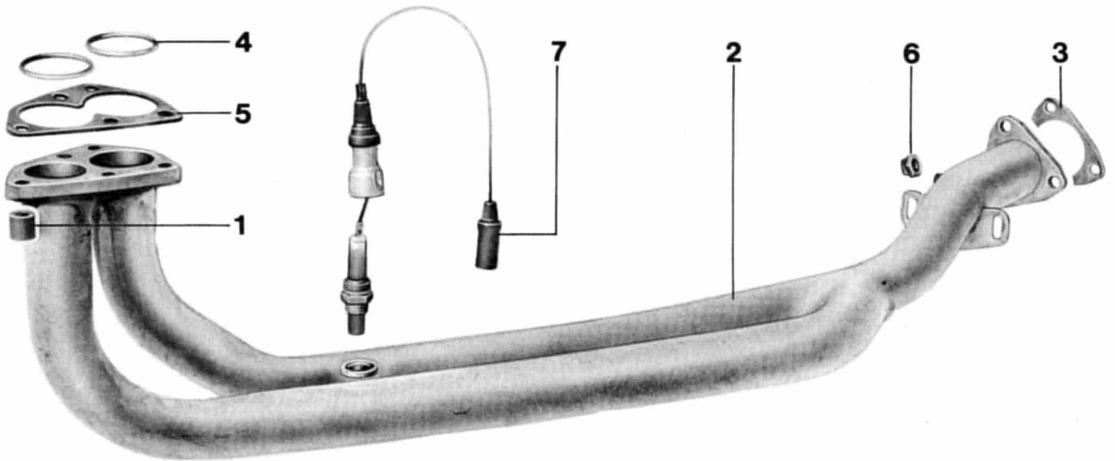
Temperature switch is open, no current at two-way valve.

Vacuum connections 1 (blue ring) and 2 (red ring) are connected allowing vacuum from throttle housing to operate diverter valve depending on throttle position.

At low throttle opening vacuum applied to diverter valve directs air flow to exhaust manifold.

When throttle is open, there is no vacuum to operate diverter valve so airflow is directed into air cleaner housing.

INSTALLING GASKETS ON FRONT EXHAUST PIPE



No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Socket nut	5		Check, replace if necessary, Coat with Optimoly HT	
2	Exhaust pipe	1			
3	Gasket	1		Replace	
4	Seal	2		Replace	
5	Intermediate plate	1			
6	Cap nut	1			
7	Oxygen sensor	1		Torque to 50 - 60 Nm (36 - 43 ft lb)	

Installing Instructions:

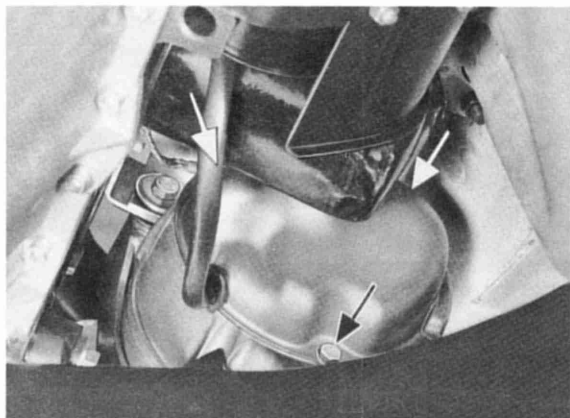
1. Place exhaust pipe together with mounted intermediate plate and seals on exhaust manifold.
2. Coat threads of cap nut and threads of oxygen sensor with Bosch VS 140 16 Ft (Order No. 5964080105) or Optimoly HT.

Keep paste out of slots in oxygen sensor.

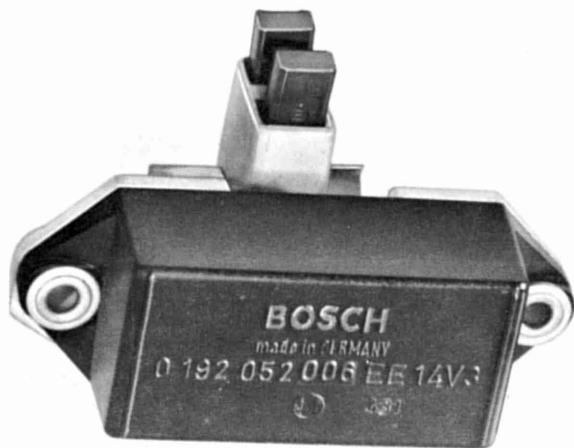
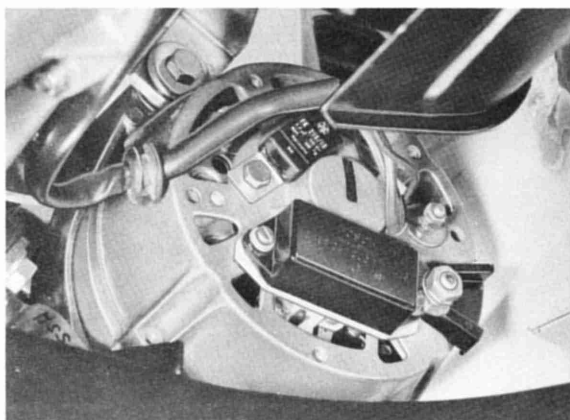
STARTER ,
POWER SUPPLY

REMOVING AND INSTALLING VOLTAGE REGULATOR

1. Disconnect battery.
2. Pull hose off connector on alternator guard.
3. Unscrew oil filter.
4. Remove guard after unscrewing the three hexagon head screws.



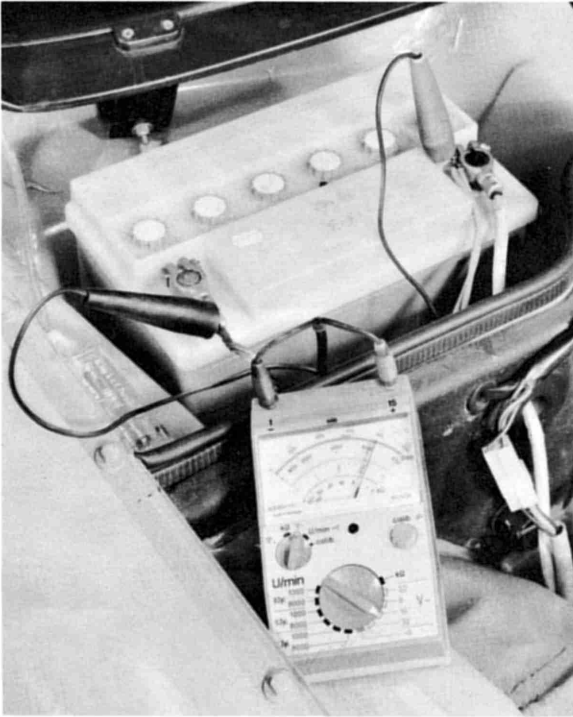
5. Unscrew voltage regulator.



6. Be careful of ground strap when installing guard.

MEASURING REGULATOR VOLTAGE

1. Connect voltmeter to battery.



2. Start engine, adjust speed to about 2000 rpm, turn on rear window defogger and headlights.
3. Read voltage. Specifications: 13,5 to 14,5 V. If measured voltage is not within this range, change electronic voltage regulator and repeat measurement.

Note

To change electronic voltage regulator, see page 27 - 1.

If specifications are still not met, remove and check alternator.

IGNITION SYSTEM

EQUIPMENT TABLES

Ignition Coil

Type/Model	Version	Remarks
924	046 905 105	with two ballast resistors (0.4 Ohm and 0.6 Ohm)

Distributor

Type/Model	Version	Remarks
924	047 905 205 (without speed governor)	centrifugal and vacuum advance and retard control (breakerless)
924 from model 77 1/2	047 905 205 C (without speed governor)	

Spark Plugs

Type/Model	Version	Remarks
924	Bosch W 200 T 30 (W 6 D) Beru 200 / 14/ 3 A (14 - 6 D)	0.7 mm electrode gap; torque 30 Nm (22 ft lb) without series connected spark gap

Control Unit

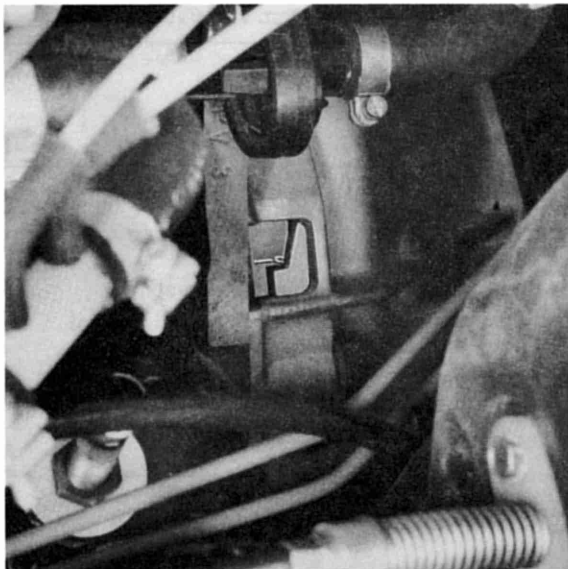
Type/Model	Version	Remarks
924	046905 351	Bosch transistor ignition

Plug Connectors

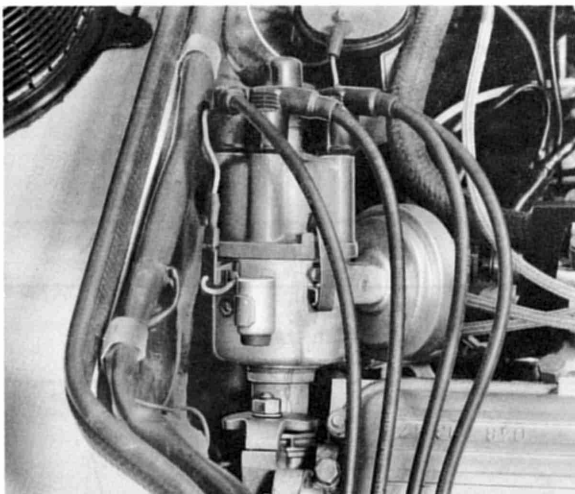
Type/Model	Version	Remarks
924		Without series connected spark gap

REMOVING AND INSTALLING DISTRIBUTOR

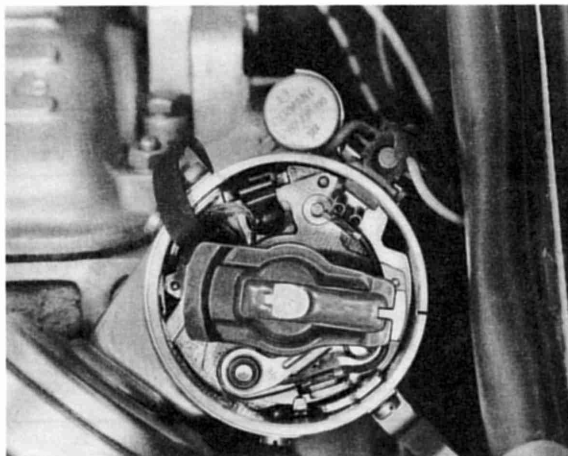
1. Set cylinder 1 at TDC.



2. Remove distributor cap, disconnect vacuum hose and wires, unscrew distributor hexagon nuts and remove distributor.



3. When installing the distributor rotor make sure that it faces the cylinder 1 mark on the distributor housing.

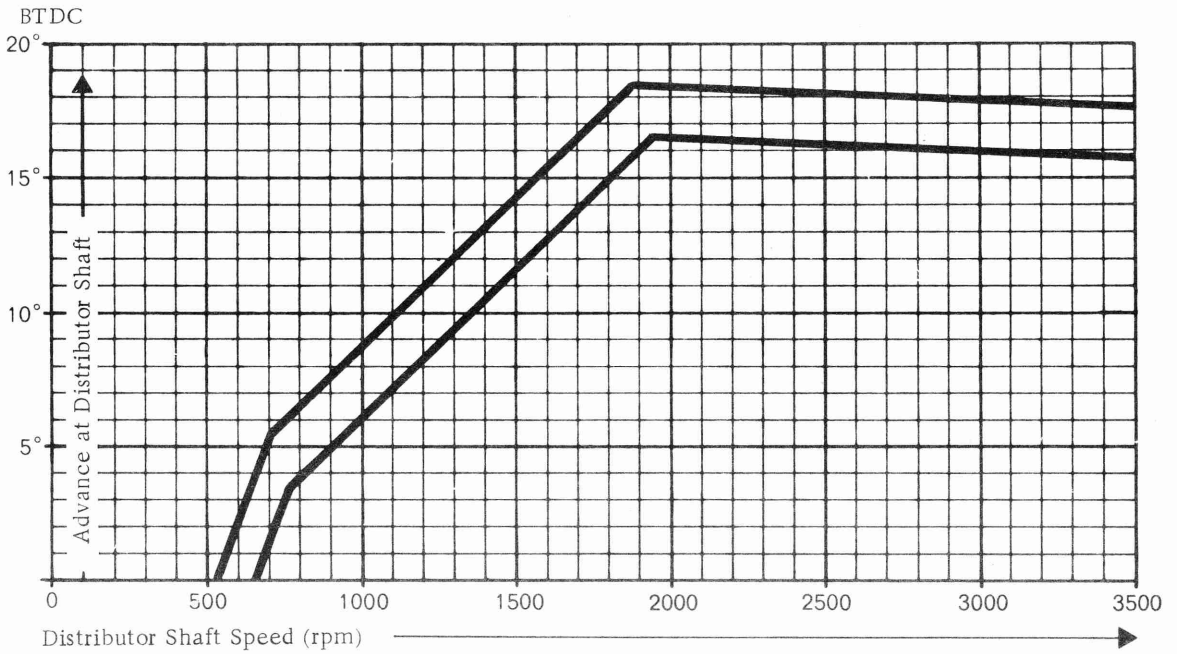


4. Adjust ignition timing.

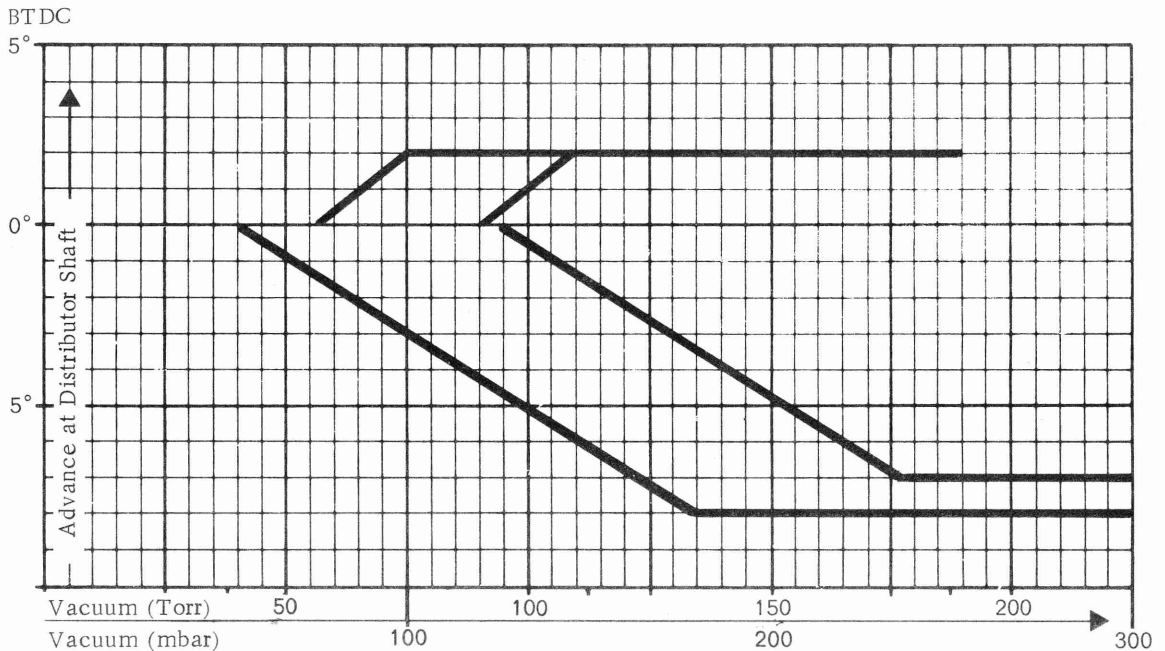
CHECKING DISTRIBUTOR

Remove distributor and mount it on a test bench. Read the corresponding ignition angles at different engine speeds and vacuum values, and compare them with the ignition advance curves. A distributor in perfect condition will have its advance /retard specifications fall within the respective chart lines.

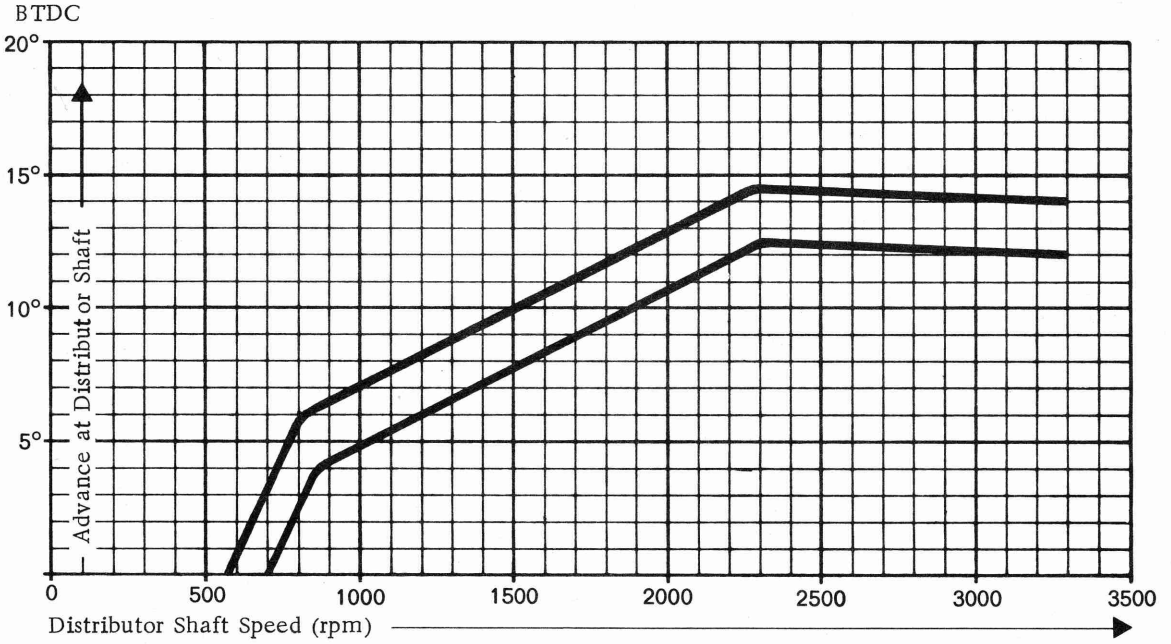
CENTRIFUGAL ADVANCE CURVE



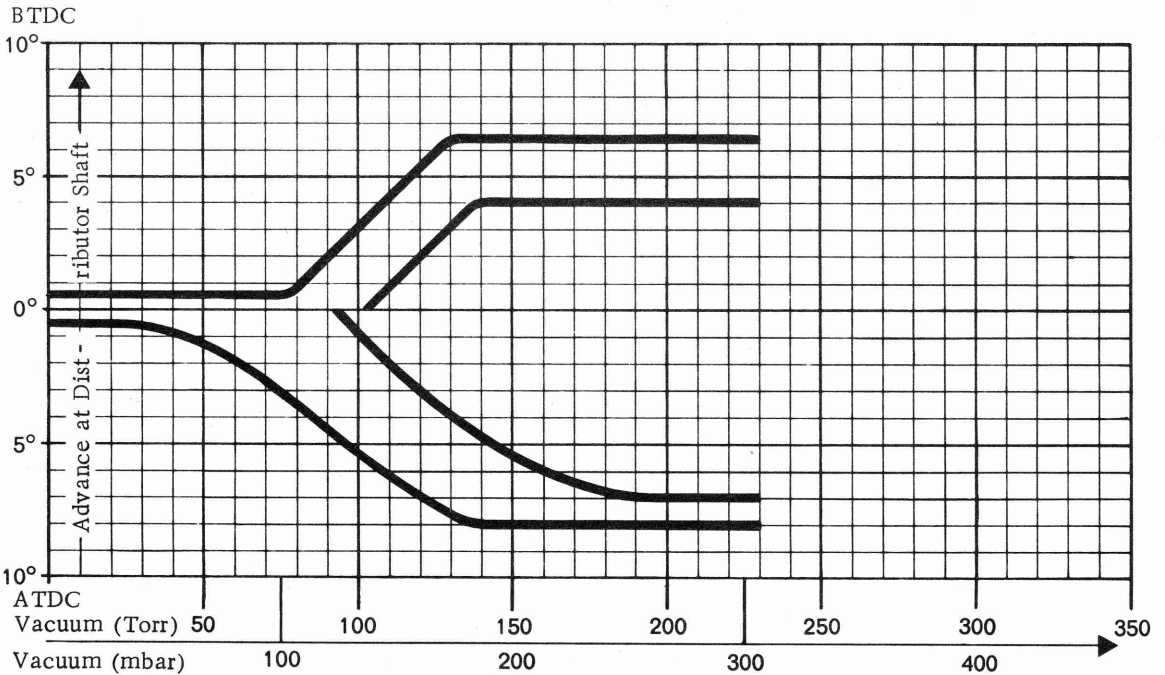
VACUUM ADVANCE CURVE



CENTRIFUGAL ADVANCE CURVE - MODEL 77 1/2



VACUUM ADVANCE CURVE - MODEL 77 1/2



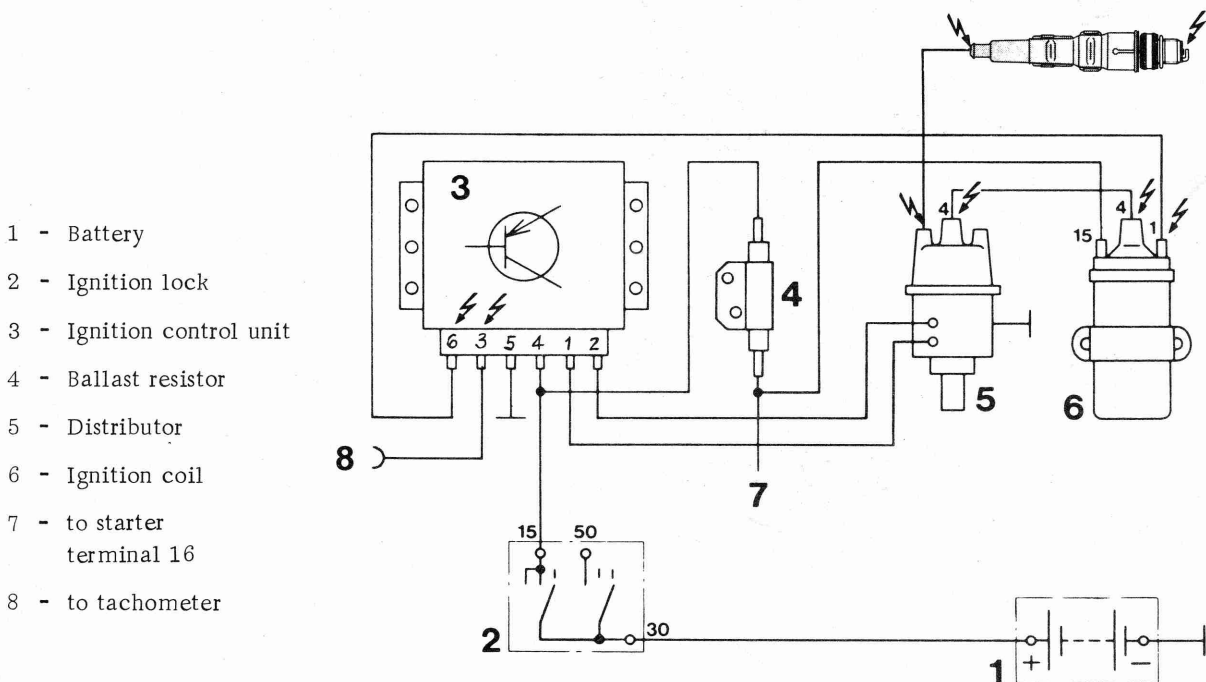
DANGERS OF ELECTRONIC IGNITION SYSTEMS

The 924 is equipped with an electronic ignition system. The ignition output of this transistorized ignition coil ignition system is so high, that with the engine running there could be dangerous current in the system. Consequently, any work on the ignition system requires that the ignition be turned off or the battery ground cable disconnected. Such jobs would include the following:

1. Connecting engine testing equipment (timing light, tachometer, ignition oscilloscope etc.).
2. Replacement of ignition system parts (spark plugs, ignition coil, distributor, ignition cables etc.)

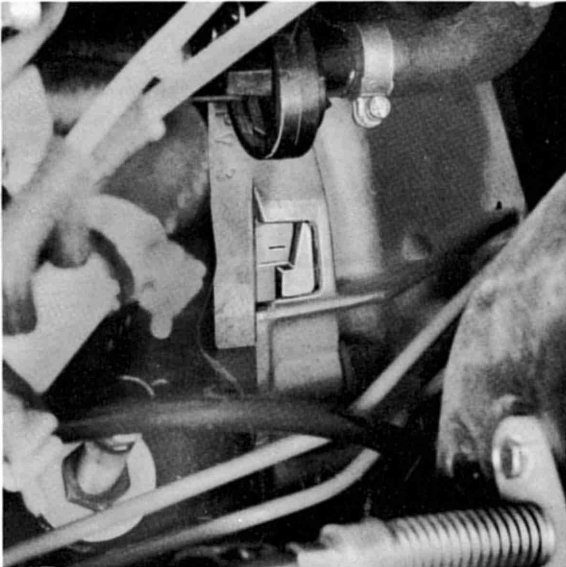
If testing the ignition system or making engine adjustments requires turning on the ignition, dangerous voltage will be on the primary and secondary side of the entire system. Thus the danger is not only present at the individual parts of the ignition system (for example, distributor, ignition coil, ignition control unit, ignition cables etc.), but even on the line leading from the ignition control unit to the tachometer, the plug connections and any testing equipment connected.

The dangerous points are marked with high tension arrows in the lay-out plan below.



ADJUSTING IGNITION TIMING

1. Run engine to operating temperature (oil temperature about 80 to 90°C (180 - 190°F).
2. Connect engine tester.
3. Leave vacuum hoses on distributor.
4. Connect timing light. The timing mark (-) on flywheel must align with reference edge at idle speed of 925 ± 75 rpm. Loosen and turn distributor to change ignition timing.



The timing mark is equivalent to an ignition timing of 10° ATDC.

Note

Ignition timing should not exceed 42° at an engine speed of about 4500 rpm with the vacuum hoses disconnected. Use a distributor test machine to check this specification.

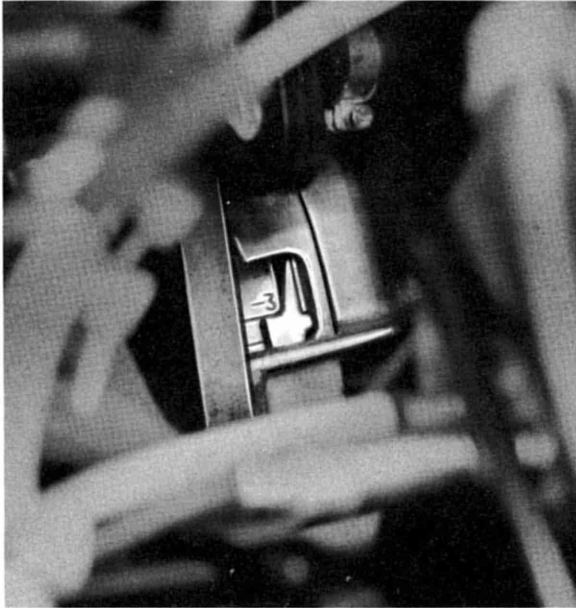
WARNING

Ignition must be off when connecting tester to ignition coil.

Note

The dwell angle need not be measured to adjust the ignition timing.

The ignition timing has been modified starting with Model 77 1/2. With vacuum hoses connected at distributor and idle speed of 950 ± 50 rpm the mark designated 3 (3° ATDC) on the flywheel must align with the reference edge.



At an engine speed between 4500 and 5000 rpm and with the vacuum hoses disconnected, the ignition timing must not exceed 41° .

TROUBLESHOOTING ELECTRONIC IGNITION SYSTEM
(BOSCH TRANSISTORIZED IGNITION COIL IGNITION SYSTEM)

This test requires the following:

Battery fully charged, fuel in tank, engine or ambient temperature between 0 and +40^o C (32 and 104^oF). Temperature has considerable influence on test values.

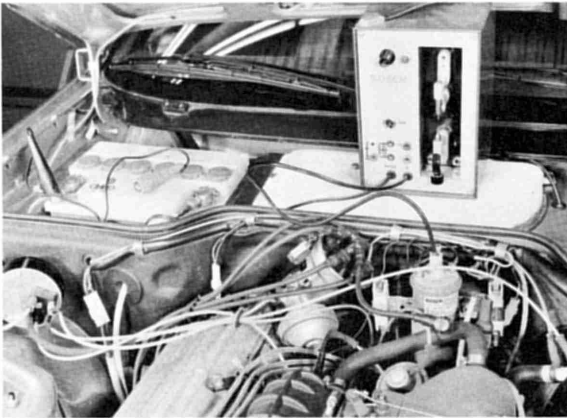
Pay strict attention to the information concerning dangers of electronic ignition systems.

Starter turns, engine will not start or has poor output.

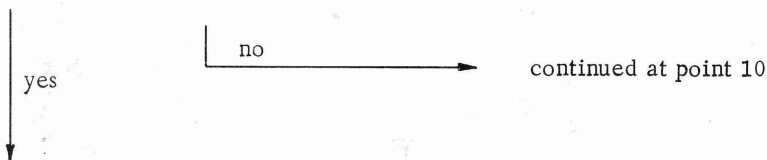
1. Connect spark gap tester to ignition coil terminal 4 and set at 12 mm. Start engine and check for 12 mm spark.

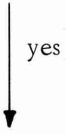
Note

If illustrated tester is not available, use equivalent type designed for electronic or high energy ignition. Be sure to follow tester manufacturer's instructions and observe cautions on page 28 - 5.

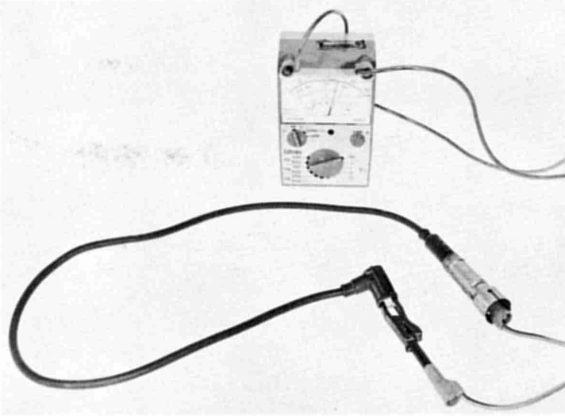


Spark OK?

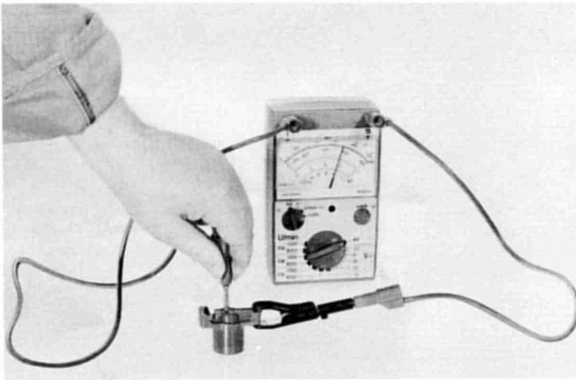




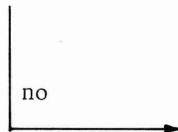
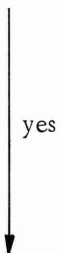
2. Check distributor cap, distributor rotor, ignition lines and spark plugs (Warning: ignition off). Resistance of spark plug wire including connector: approximately 6 k Ohm



Resistance of distributor rotor: approx. 5 k Ohm



Spark at spark plug



Repair high tension side

3. Check ignition timing

Timing good?

yes



no



Adjust ignition timing

4. Check fuel system

Engine receiving sufficient fuel?

yes



no



Repair fuel system

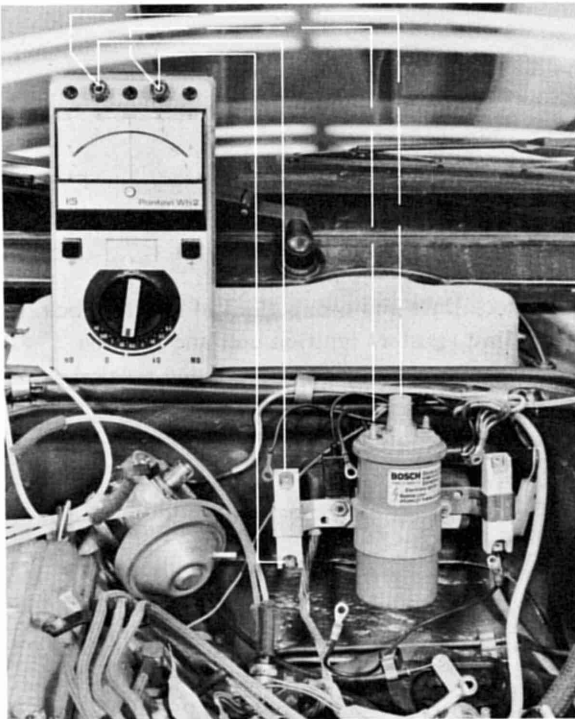
5. Check ballast resistors and ignition coil
(Ignition off, wires disconnected at resistors
and ignition coil)

Ballast resistor (0.4 Ohm): 0.35 to 0.45 Ohm

Ballast resistor (0.6 Ohm): 0.55 to 0.65 Ohm

Ignition coil primary (between terminals 1 and 15): 1.0 to 1.35 Ohm

Ignition coil secondary (between terminals 1 and 4): 5.5 to 8.0 k Ohm



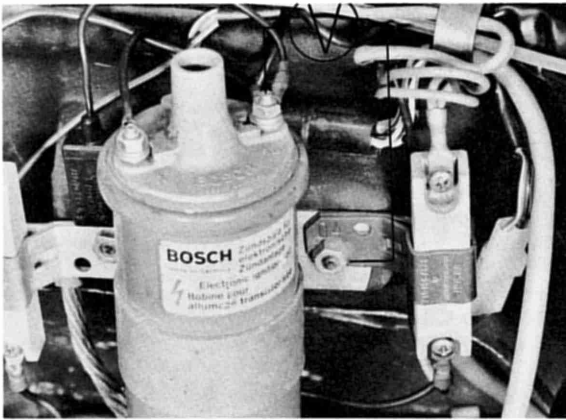
Resistance good?

yes
↓

no
→

Replace ballast resistors or ignition coil

6. Check voltage at ignition coil terminal 15 against ground (ignition on).
Voltage min. 5 V at battery voltage of min. 11 V (checked simultaneously)



Voltage value good?

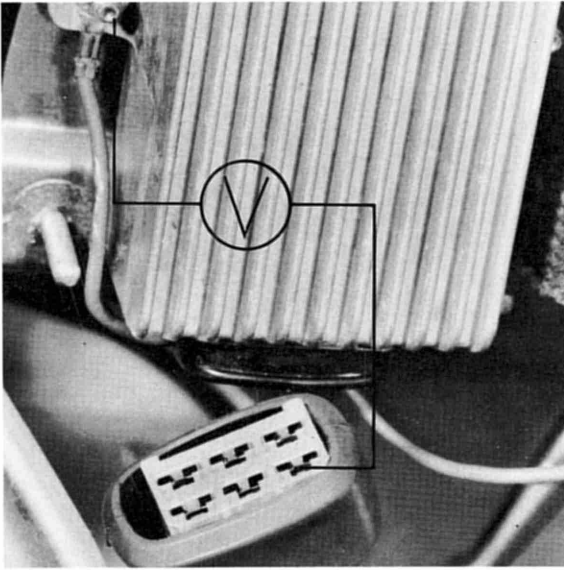
yes
↓

no
→

Check lines and connections of ignition lock, ballast resistor, ignition coil and ignition control unit for voltage drop, and repair.

yes
↓

7. Check voltage at ignition control unit terminal 4 against ground (ignition on).
Voltage must equal battery voltage.



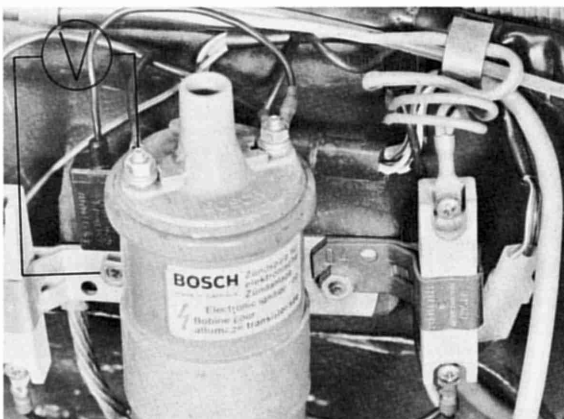
Voltage valve good?

yes
↓

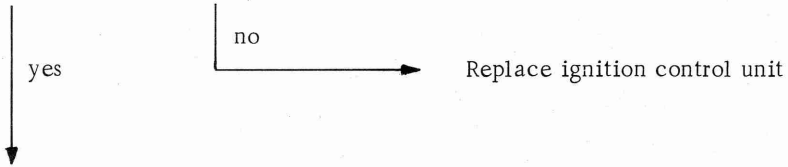
no →

Check line from ignition lock to ignition control unit for voltage drop, and if necessary repair.

8. Check voltage at ignition coil terminal 1 against ground (ignition on).
Voltage max. 2.0 V

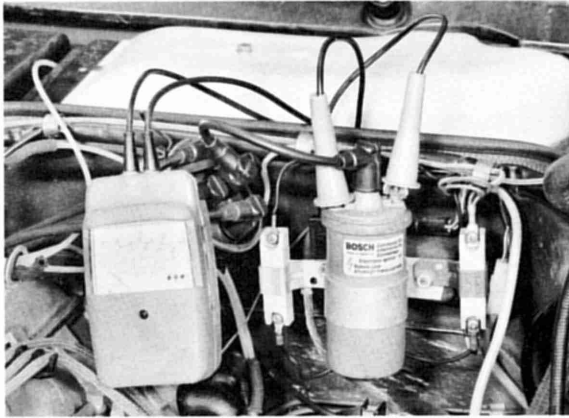


Voltage value good?

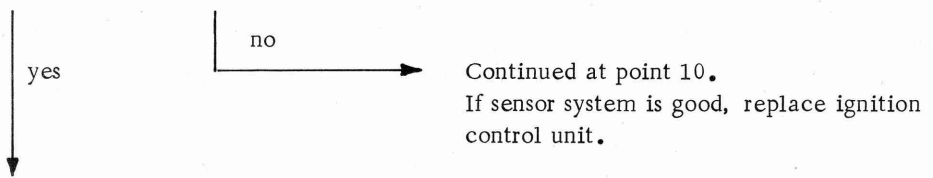


9. Check dwell angle.

Dwell angle: 52° to 70° at 1500 ± 50 rpm
Dwell angle: 42° to 68° at 5000 ± 50 rpm

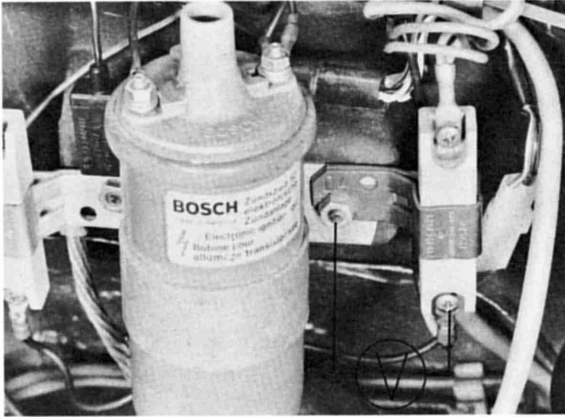


Dwell angle good?

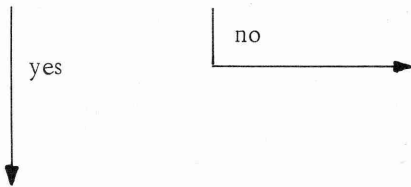


Engine must start and/or engine output must be good, otherwise there is a mechanical defect.

10. Check starting voltage. Connect voltmeter at ballast resistor shown (0,4 Ohm). Operate starter. Voltmeter must show battery voltage.

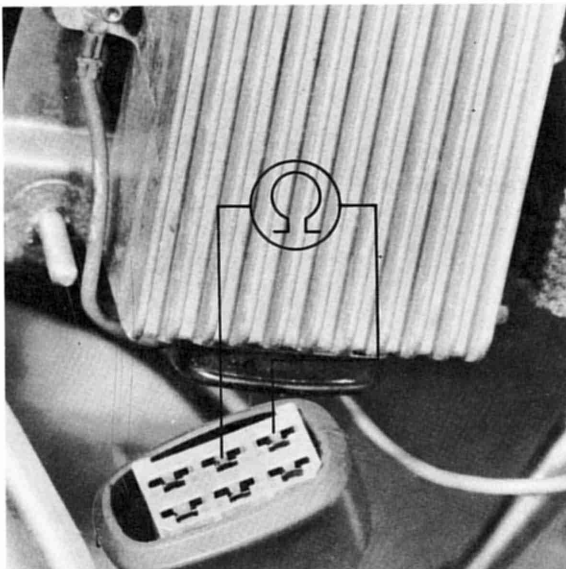


Starting voltage good?

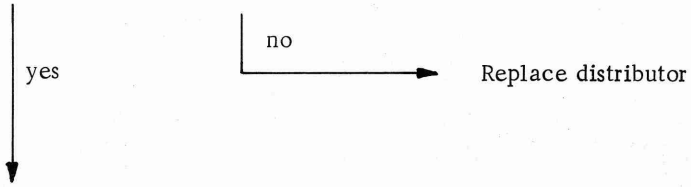


Look for open circuit between battery and ballast resistor or at starter solenoid

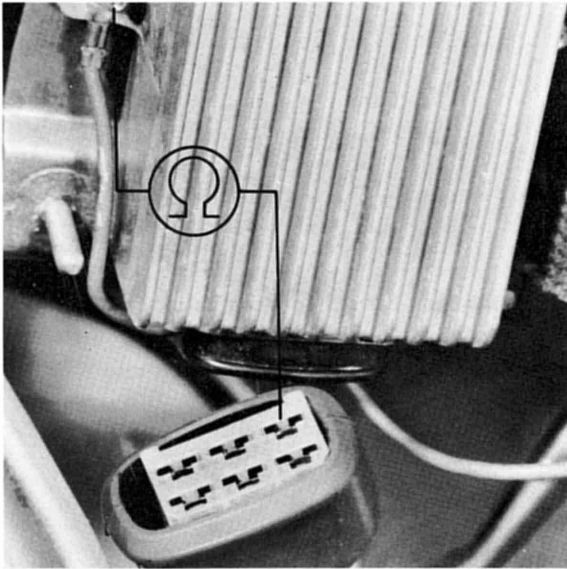
11. Measure distributor sensor resistance including sensor line at disconnected ignition control unit plug between terminals 1 and 2 (ignition off). Resistance: 890 to 1285 Ohm



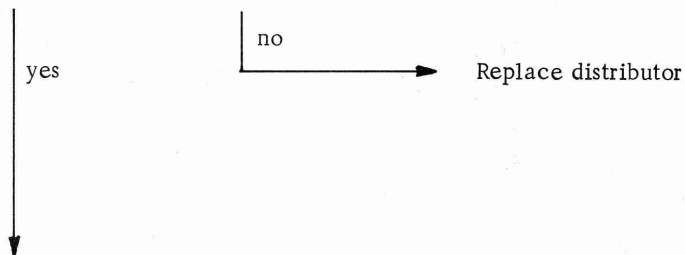
Resistance value good?

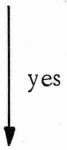


12. Check distributor sensor coil (including sensor line) for ground short at disconnected ignition control unit plug between terminal 1 and vehicle ground terminal 2 and vehicle ground (ignition off)

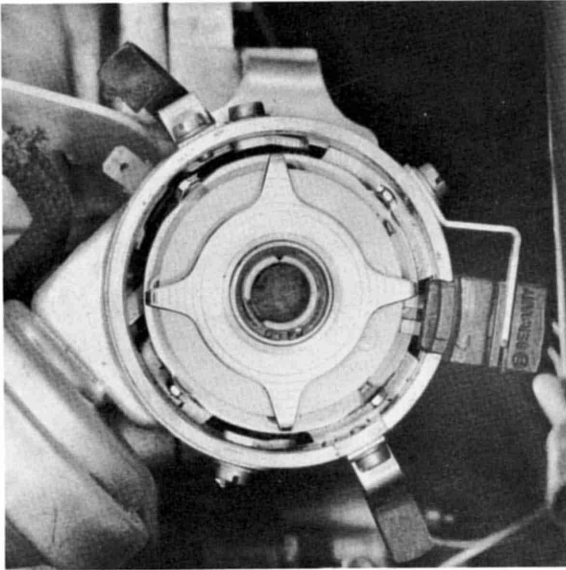


Resistance: ∞ (maximum)?

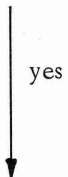




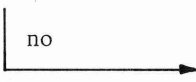
13. Check distributor sensor system for mechanical damage.
Visual inspection: Gap between rotor and stator?



Distributor sensor good?



continued at point 5

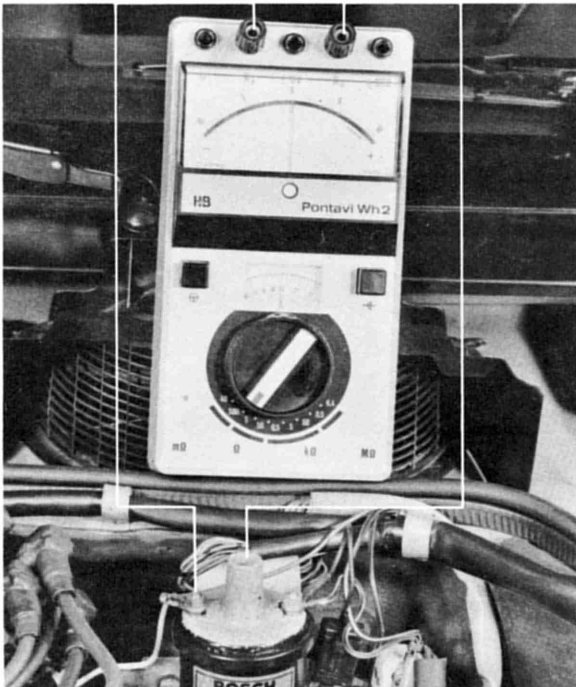


Replace distributor

CHECKING IGNITION SYSTEM

Checking ignition coil

Connect ohmmeter between terminals 1 and 15
(primary resistance) and terminals 1 and 4
(secondary resistance).
(ignition off)



Ignition coil	Primary resistance	Secondary resistance
046 905 105	1,0 to 1,35 Ohm	5,5 to 8,0 kOhm

Checking Spark Plug Connectors with Series Connected Spark Gap

This test does not have to include checking the resistance, since the series connected spark gap installed in the plug connector acts as an interruption at low voltages.

Keep a set of new spark plug connectors and spark plug wires on hand and install them on a trial basis if a defect in a plug connector is suspected (starting difficulties, ignition failures, radio interference). When applying this method an entire spark plug wire must always be exchanged against a new one, in order to determine a defective plug connector.

EQUIPMENT TABLES - 1980 Models

Ignition Coil

Type/Model	Version	Remarks
924	046 905 105	with resistor wire

Distributor

Type/Model	Version	Remarks
924	477 905 205 A	centrifugal and vacuum advance and retard, breakerless

Spark Plugs

Type/Model	Version	Remarks
924	Bosch WR 6 DS Beru RS 37	0.7 + 0.1 mm (0.028 + 0.004 in.) electrode gap 30 Nm (22 ft lb) torque

Control Unit

Type/Model	Version	Remarks
924	046 905 351	Bosch transistor ignition

Plug Connectors

Type/Model	Version	Remarks
924		without series connected spark gap

ADJUSTING IGNITION TIMING - 1980 Models

Note

Ignition must be off when connecting tester to ignition coil.

The dwell angle need not be measured to adjust the ignition timing.

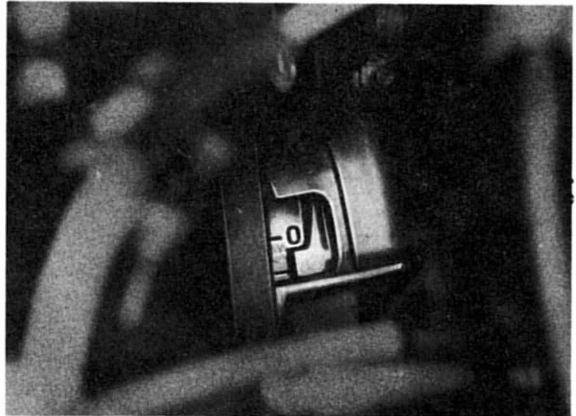
1. Run engine to operating temperature (oil temperature about 80 to $90^{\circ}\text{C}/176$ - 194°F).

2. Connect engine tester.

Specifications: $0^{\circ} = \text{TDC}$ at 950 ± 50 rpm
with vacuum hoses

3. Leave vacuum hoses on distributor.

4. Connect timing light. The timing mark on flywheel must align with reference edge at idle speed.



Loosen and turn distributor to change ignition timing.

CHECKING IGNITION RETARD/ADVANCE - 1980 Models

Requirements:

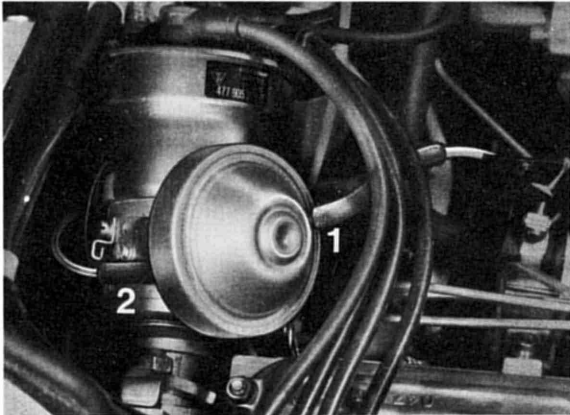
Ignition timing set to specifications.

1. Centrifugal Advance
(vacuum hoses disconnected)

At engine speed of approx. 2500 rpm ignition timing must be between 19° and 25° before TDC or between 29° and 35° before TDC at approx. 4500 rpm.

2. Vacuum Retard/Advance
(checked at idle speed)

Retard



- 1 - Advance
2 - Retard

Pull off vacuum hoses.

Adjust speed to 950 ± 50 rpm. Ignition timing must be between 8° and 10° before TDC.

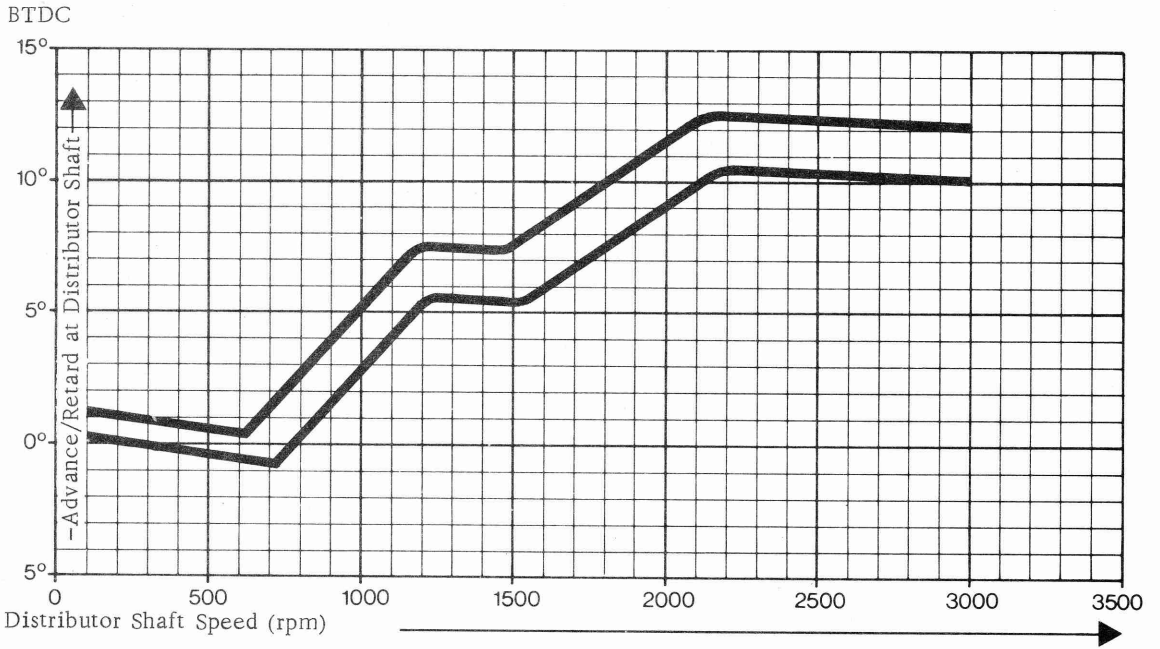
Advance

Move vacuum hose from connection 2 of vacuum unit to connection 1. Adjust engine speed to 950 ± 50 rpm. Ignition timing must be between 16° and 22° before TDC.

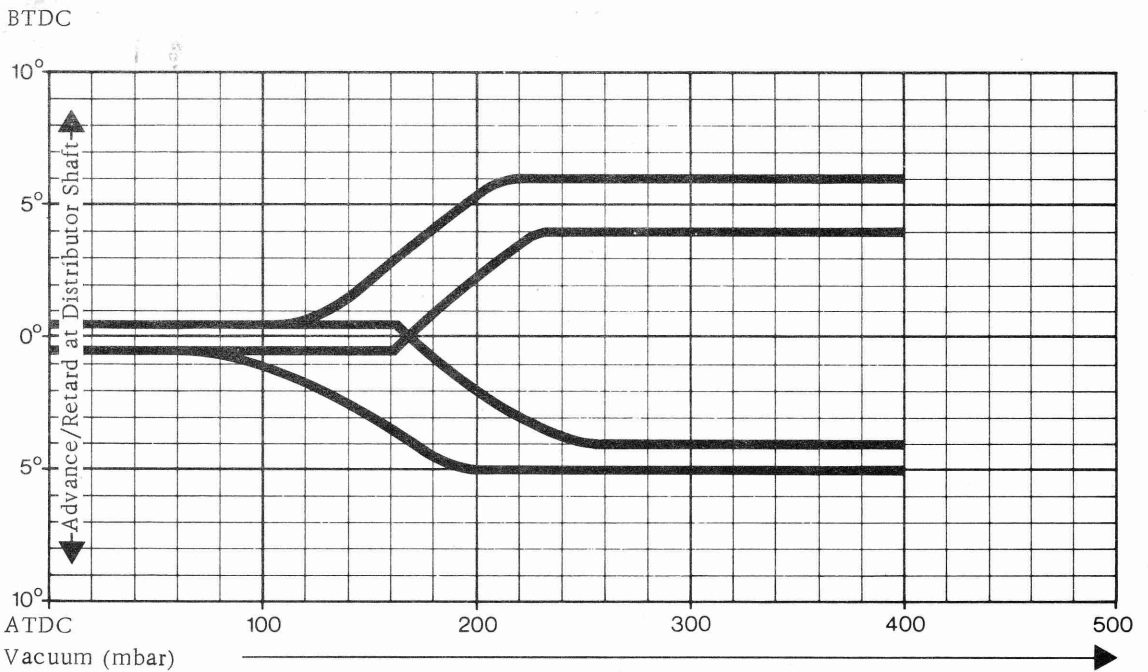
Adjust idle speed after connecting vacuum hoses.

If specified test values are not reached, remove and test distributor in a tester.

CENTRIFUGAL ADVANCE CURVE - Model 80



VACUUM RETARD/ADVANCE CURVE - Model 80



EQUIPMENT TABLES FROM 1981 MODELS

Ignition Coil

Type/Model	Version	Remarks
924	211 905 115 B	without resistor wire

Distributor

Type/Model	Version	Remarks
924	477 905 203	centrifugal and vacuum advance and retard control (breakerless)

Spark Plugs

Type/Model	Version	Remarks
924	Bosch WR 6 DS Beru RS 37	0.7 + 0.1 mm electrode gap Torque to 30 Nm (22 ft lb)

Control Unit

Type/Model	Version	Remarks
924	211 905 351	Transistor ignition (TCI-H) (hybrid)

EIS Control Unit (Idle Stabilization)

Type/Model	Version	Remarks
924	477 906 083	

Plug Connectors

Type/Model	Version	Remarks
924		without series connected plug gap

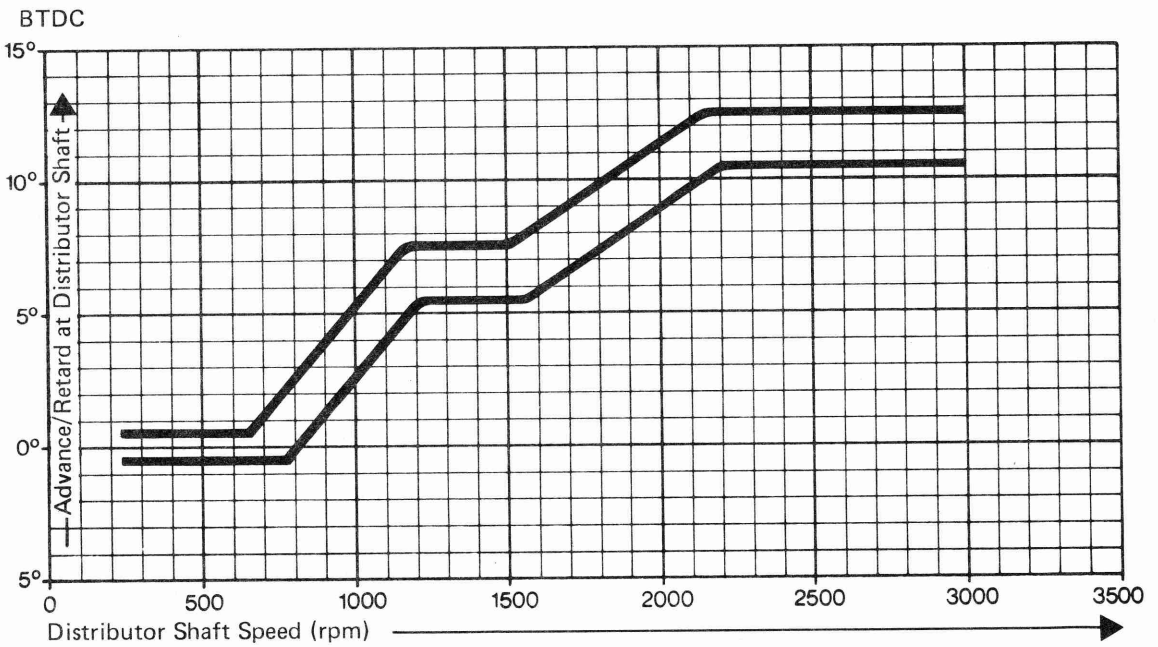
IGNITION SYSTEM 924 from 1981 Models

The cars of Type 924 have an ignition system with a Hall transmitter and idle stabilizer, instead of the former induction transmitter. This changes the centrifugal control curve slightly.

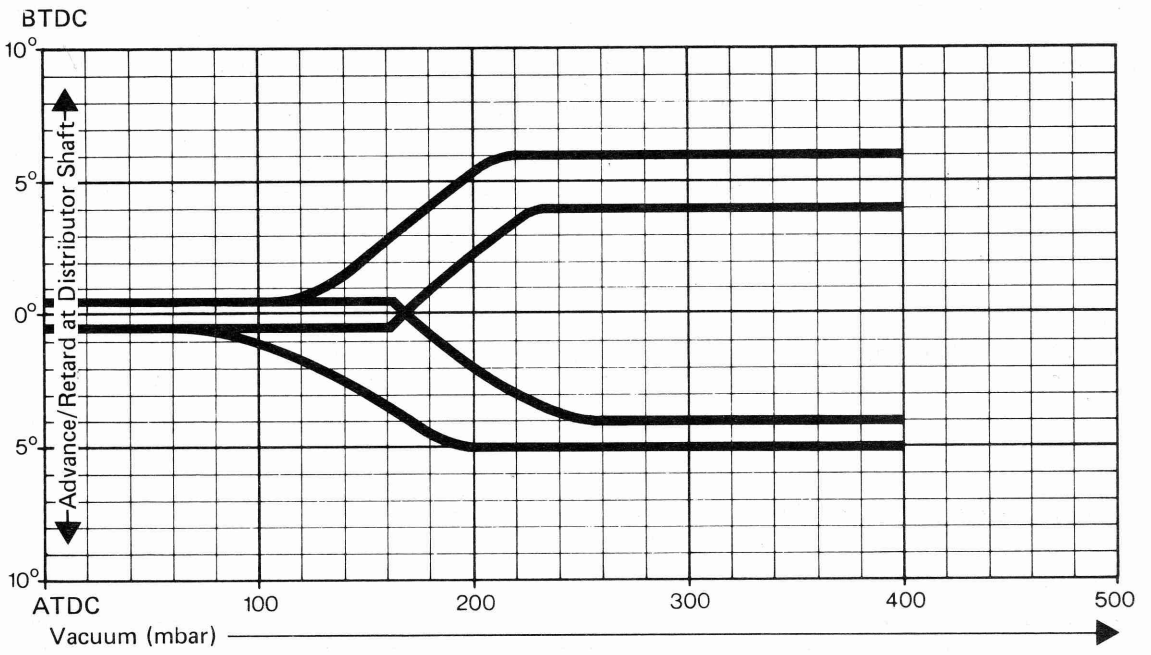
Note

Testing and adjusting specifications are identical with those for 1980 models.

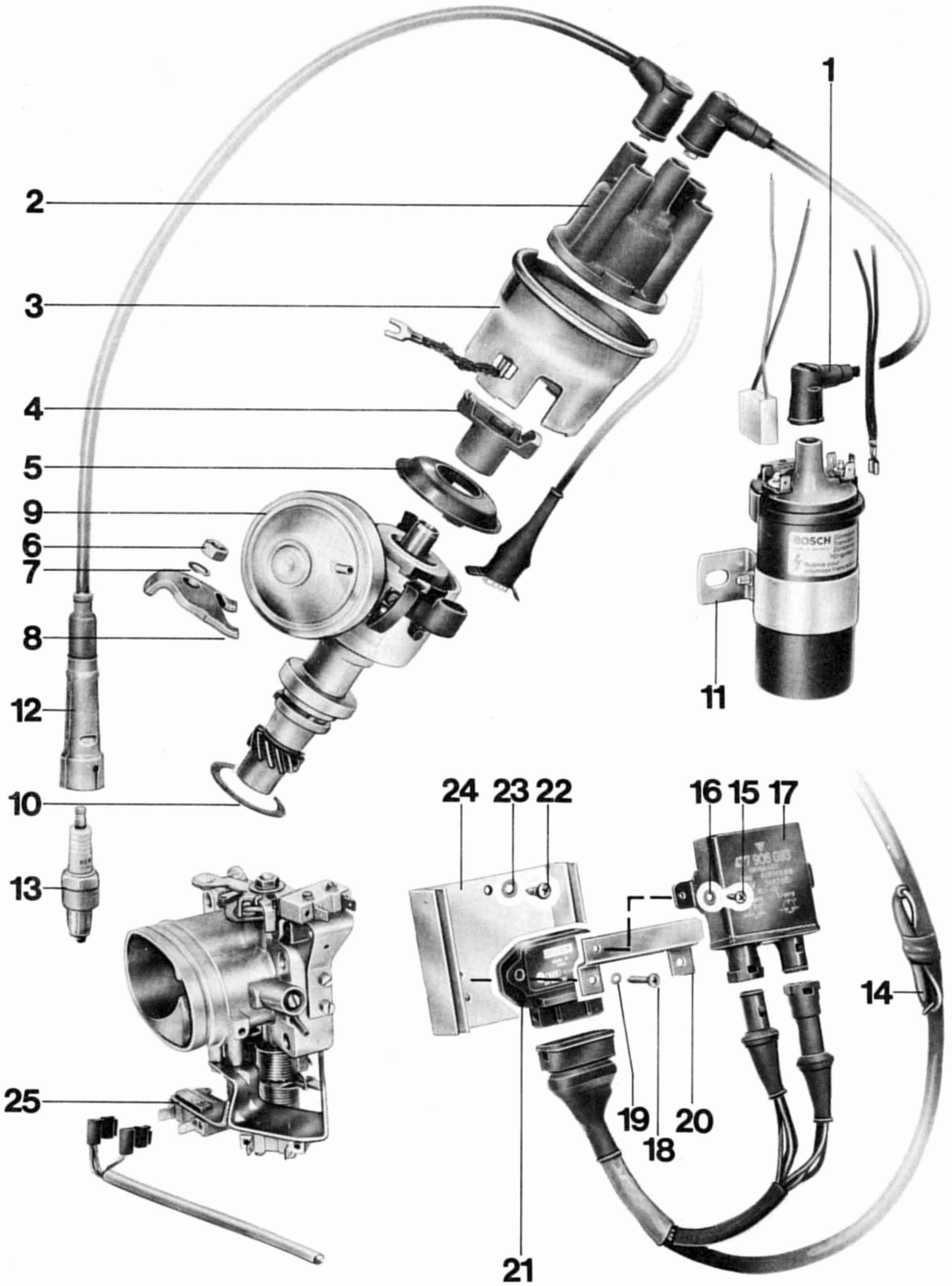
CENTRIFUGAL ADVANCE CURVE - FROM 1981 MODELS



VACUUM RETARD/ADVANCE CURVE - FROM 1981 MODELS



TCI-H IGNITION SYSTEM



No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
1	Ignition lead	1			
2	Distributor cap	1			
3	Shield	1			
4	Distributor rotor	1			
5	Dust cap	1			
6	Nut M 8	1			
7	Washer 8 x 15	1			
8	Hold down	1			
9	Distributor	1			
10	Gasket	1			
11	Ignition coil	1			
12	Plug connector	4			
13	Spark plug	4			
14	Idle stabilizer conn. point	1			
15	Screw B 4.2 x 16	2			
16	Washer B 5	2			
17	EIS control unit	1			
18	Screw M 4 x 18	2			
19	Washer B 4	2			

No.	Description	Qty.	Note When		Special Instructions
			Removing	Installing	
20	Bracket	1			
21	Hall control unit	1			
22	Screw 4.8 x 16	3			
23	Washer B 5	3			
24	Heat sink	1			
25	Microswitch for idle stabilizer on throttle	1			

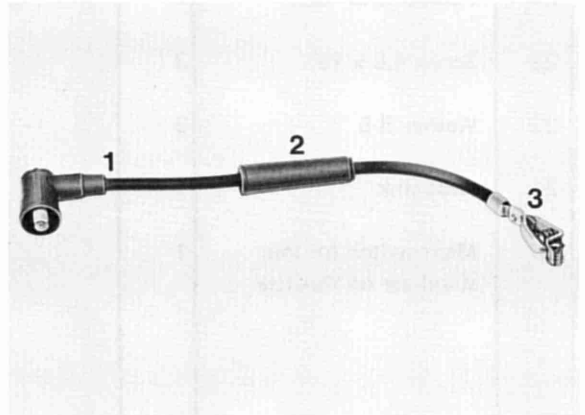
Note

Observe the following safety measures to avoid damage while working on TCI-H ignition systems.

1. Only connect and disconnect testers and leads with ignition turned off.
2. Spring retainers of removed distributor and dust caps must not hang in sensor system while cranking engine.
3. Never connect a capacitor on the ignition coil.
4. Specified ignition coil must not be replaced with a conventional ignition coil.
5. Connect terminal 4 of ignition coil with ground via a locally made high voltage lead or pull off Hall control unit plug, if engine has to be operated at starter speed, without it running.



The high voltage lead must be fitted with a shielding sleeve of at least 2 k-ohms.

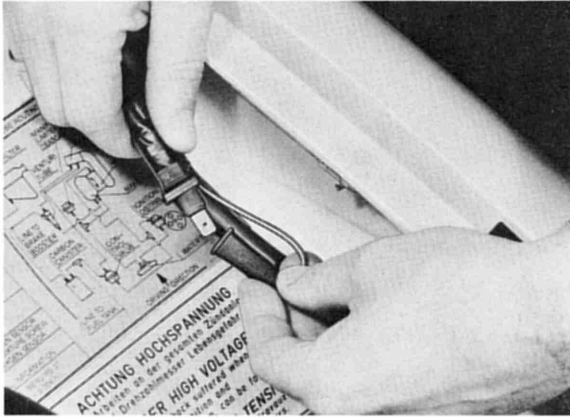


- 1 Ignition lead
- 2 Shielding sleeve
- 3 Wire connector

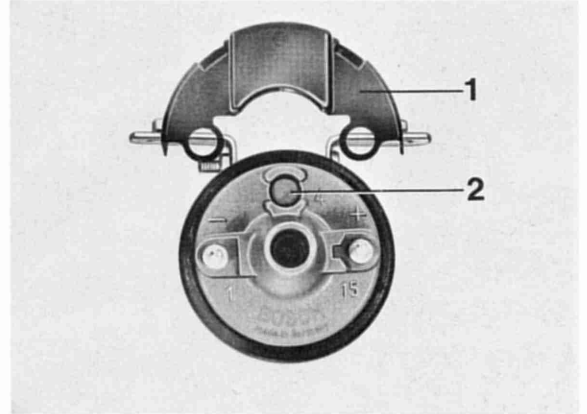
6. Starting can be helped with voltage only up to 16 volts.

Note

Idle speed and CO will be changed by the EIS control unit (electronic idle stabilizer). Consequently the EIS control unit must be disconnected for testing and adjustments. This is done by detaching the plug in the engine compartment on left wheel housing.



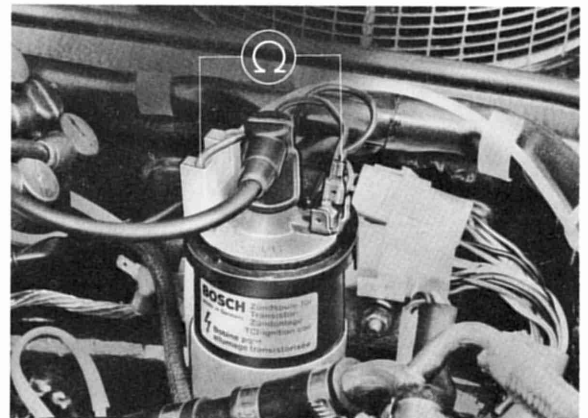
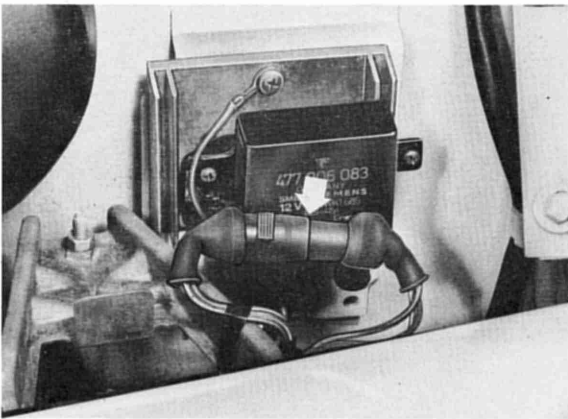
When the ignition system is defective, the EIS control unit can be disconnected from the ignition system for troubleshooting by pulling off both plugs on control unit and connecting them.



1 Cap

2 Plug

3. Measure resistance between term. 1 and term. 15.



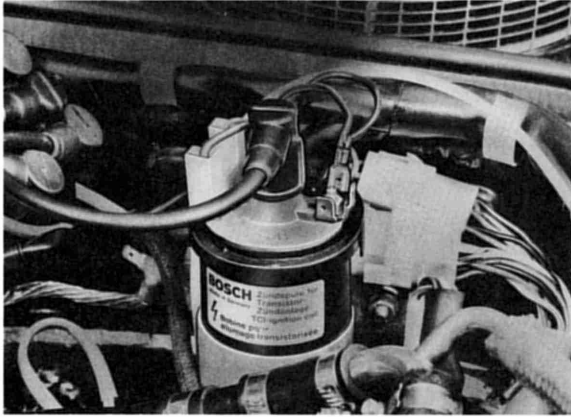
Checking Ignition Coil

1. Disconnect wires on ignition coil.

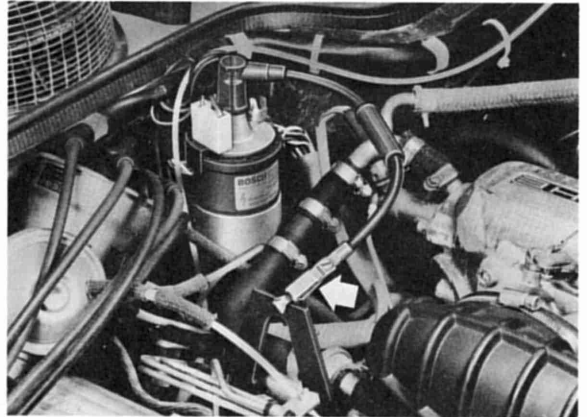
2. Take off cap on ignition coil and check, whether plug is missing or sealing compound has run out. Replace Hall control unit and ignition coil when plug is missing.

Specifications: 0.52 to 0.76 ohm

4. Measure resistance between term. 1 and term. 4.



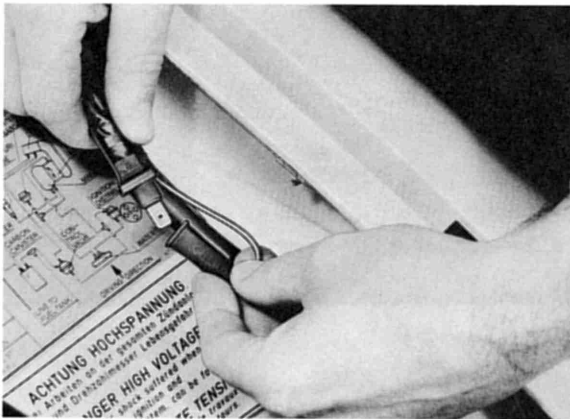
Specification: 2.4 to 3.5 k-ohms



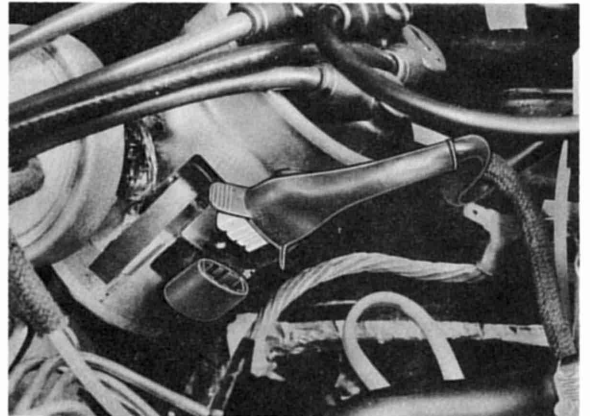
3. Pull off Hall transmitter plug on distributor.

Checking Hall Control Unit

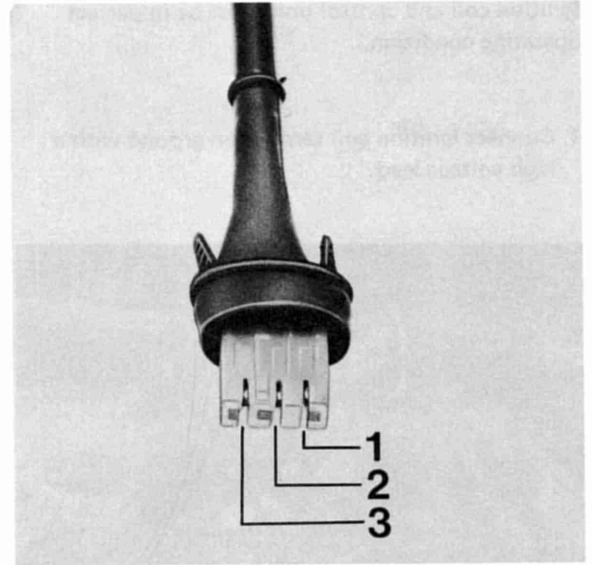
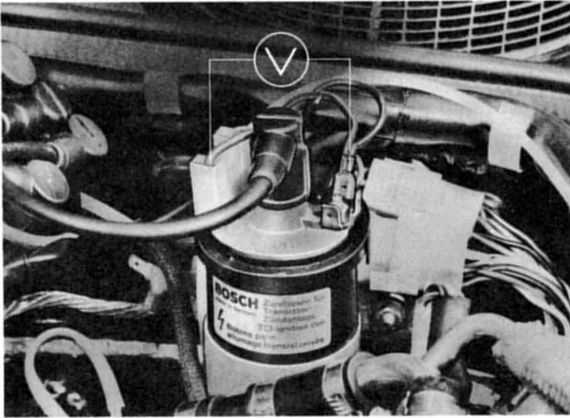
1. Detach idle stabilizer plug.



2. Connect ignition coil term. 4 on ground with a high voltage lead.



4. Connect voltmeter on ignition coil term. 15 and term. 1.



5. Turn on ignition.

Voltmeter should display 5 to 6 volts for approx. 1 second and then drop to 0 volt.

6. Touch center wire (green) of Hall transmitter plug disconnected on distributor on ground briefly, using a piece of wire.

Voltage should rise as for turning on ignition and then drop again to 0 volt.

1 H + (red/black)

2 H J (green)

3 H - (brown/white)

7. Measure voltage between both outside wires H + and H - on plug with ignition turned on. Voltage should be at least 10 volts.

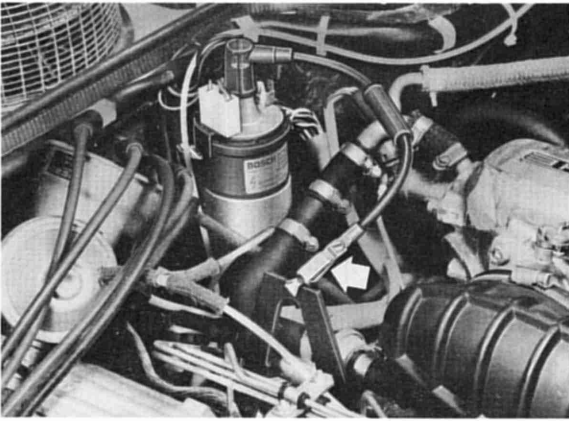
Replace Hall control unit when measured values deviate from specifications.

CHECKING HALL TRANSMITTER

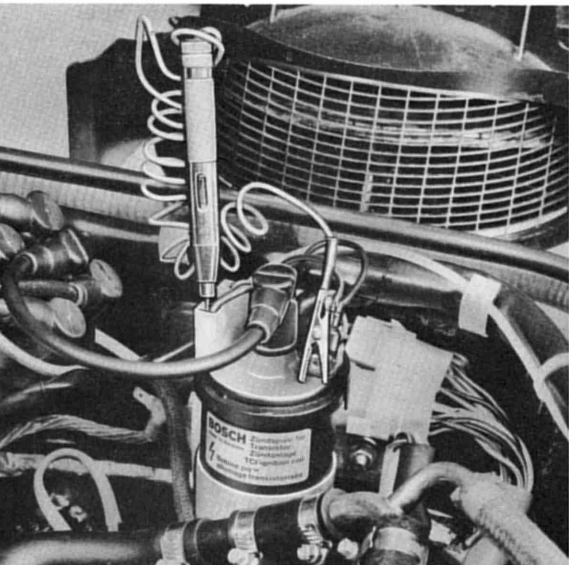
Requirements:

Ignition coil and control unit must be in perfect operating condition.

1. Connect ignition coil term. 4 on ground with a high voltage lead.



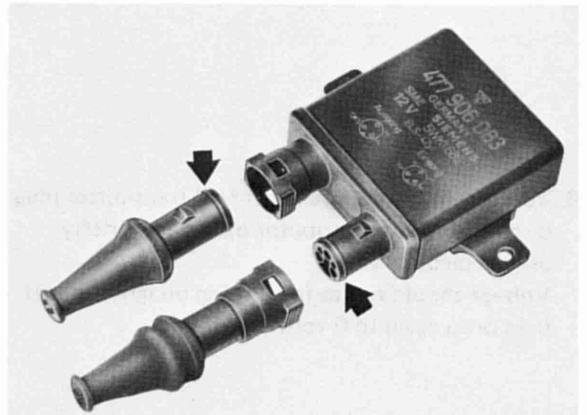
2. Connect test lamp between term. 15 and term. 1.



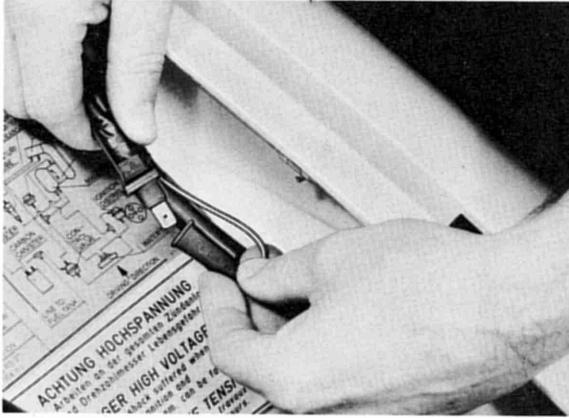
3. Test lamp should flicker while operating the starter. If not, Hall transmitter is defective and distributor must be replaced.

CHECKING EIS CONTROL UNIT (IDLE STABILIZER)

1. Visually inspect both plugs of EIS control unit for good seating of contact pins and corrosion. Check O-rings for damage and, if necessary, replace before connecting plugs.



2. Connect engine tester (engine temperature at least 60° C/140° F).
3. Detach idle stabilizer plug.



4. Set back idle speed to approx. 700 rpm.
5. Connect idle stabilizer plug.
Idle speed should rise to approx. 800 rpm. This is the result of the ignition timing control moving in direction of advance, as triggered by the EIS control unit.
6. Detach idle stabilizer plug and adjust idle speed to 750 - 800 rpm.
7. Connect plug.

Replace EIS control unit, if specified test values are not reached.