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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
28	Circlip	1			
29	Thrust ring	1			
30	Restoring spring	2		Use only spring fitting distributor	
31	Distributor cam	1			
32	Circlip	2			
33	Flyweight	2		Use only parts fitting distributor	2.4-2/2
34	Washer	2			
35	Distributor shaft	1			
36	Releasing contacts	1			

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DISASSEMBLY AND ASSEMBLY OF IGNITION DISTRIBUTOR

Disassembly

1 - Remove contact breakers.
2 - Remove vacuum governor.
3 - Remove releasing contacts.
4 - Mark installation position of fly weights.
5 - Mark installation position of driver claw in relation to distributor shaft and distributor housing.

6 - Knock out pin for driver claw with a drift.

7 - Remove driver claw, watch out for location and number of washers.

Checkup

1 - If the radial play between the distributor shaft and the distributor housing is too large, replace distributor shaft and correct axial play by means of compensating washers. If the bushings of the distributor housing show too much wear, replace complette distributor.

2 - If the contact breaker plate shows too much tipping play, replace contact breaker plate. If the wear is shown on the distributor housing itself, replace distributor.

Assembly

The following points must be observed:

1 - Lubricate distributor shaft.

2 - Watch out for correct position and number of steel and fabric washers on distributor shaft. Compensate axial play.

3 - Slide driver claw on distributor shaft observing its installation position.

4 - Attach fly weights acc. to installation marks.

REMOVAL AND INSTALLATION OF IGNITION DISTRIBUTOR DRIVE SHAFT

Removal

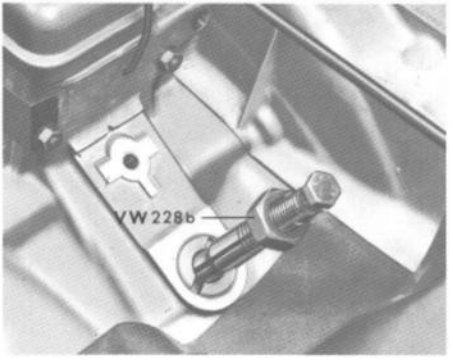
1 - Remove spacing spring from drive shaft.

2 - Pull ignition distributor drive shaft out in upward direction using puller VW 228b and turning to the left.

3 - Remove washer from under ignition distributor drive shaft.

(Caution! Do not drop!)

On the installed engine, the washer can be removed with a magnet. On the removed engine, turn crankcase by approx. 180° so that the washer will drop out.



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Installation

The following points must be observed:

1 - Check helical teeth of ignition distributor drive shaft for wear. If wear of helical teeth is excessive, be sure to check teeth of ignition distributor drive gear.

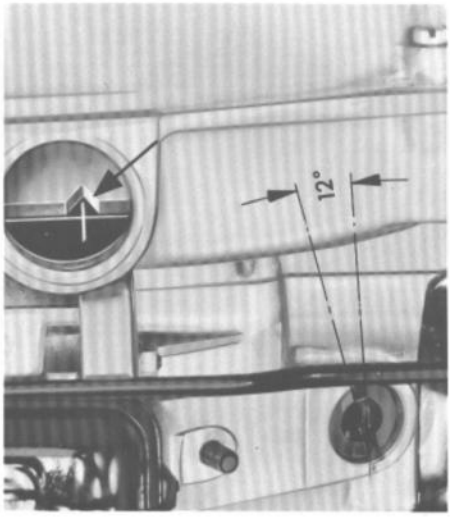
2 - Check wahers under ignition distributor drive shaft for wear; use new washers, if required.

3 - Adjust cylinder 1 to firing point.

At that moment, the exhaust valve on cylinder 3 will close and the inlet valve will begin to open.

4 - Install ignition distributor drive shaft.

The offset slot in the top end of the distributor drive shaft should be at an angle of approx 12° in relation to the longitudinal axis of the engine; the smaller sector faces towards vehicle outside.



5 - Install spacing spring.

When installing the distributor shaft in 1.8 liter engines, beginning with 1974 models, use the 7.5° mark instead of the indicated TDC mark.

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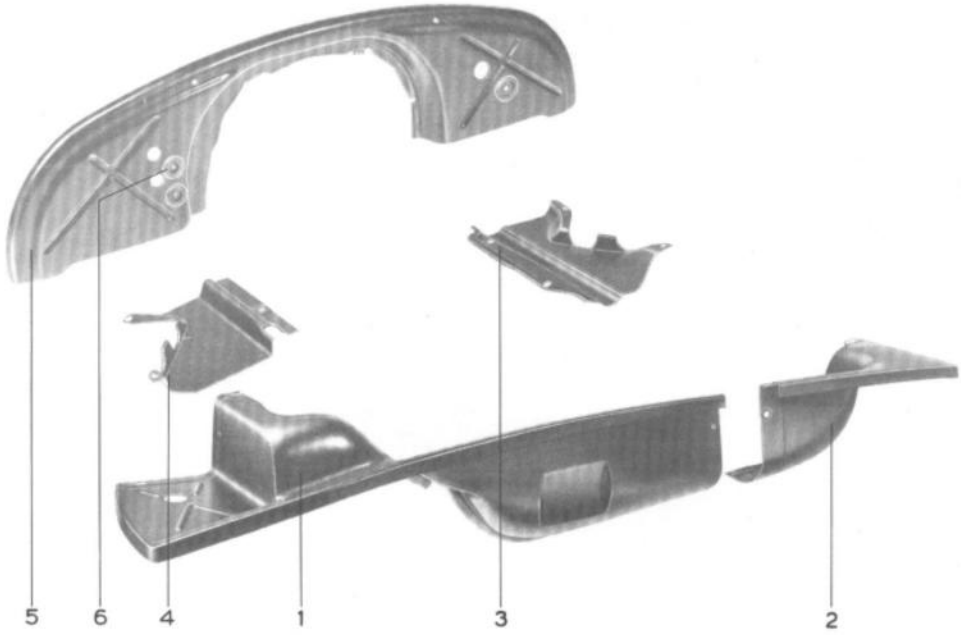

No.	Designation	Each	Observe during: Removal / Installation	Special Instr.
1	Engine cover plate front right	1		
2	Engine cover plate front left	1		
3	Warm air guide bottom left	1		
4	Warm air guide bottom right	1		
5	Engine cover plate rear	1		
6	Bushing	3		

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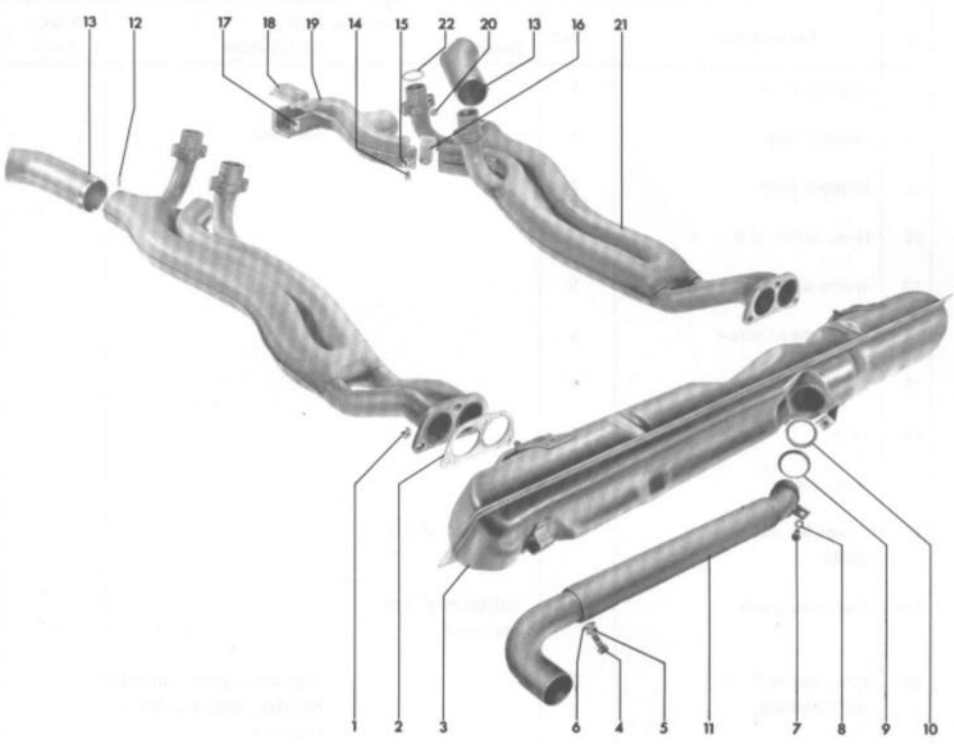

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. nut M 8, self-locking	6			
2	Seal	2		Replace	
3	Exhaust muffler	1	Exchange if heavily rusted		
4	Hex. screw M 6	1			
5	Spring washer	1			
6	Washer	1			
7	Hex. screw M 6	1			
8	Washer	1			

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
9	Sealing cone	1			
10	Sealing ring	1		Replace	
11	Damper pipe	1			
12	Hex. screw M 6	2			
13	Warm air elbow	2			
14	Cheesehead screw	4			
15	Washer	4			
16	Clip	2			
17	Hex. screw	4			
18	Cover for warm air guide	2	Different at left and right		
19	Warm air guide	2	Different at left and right		
20	Hex. nut M 8 self-securing	8		Tighten slightly, install muffler, then tighten as required.	
21	Heat exchanger	2	Different at left and right, check for damage, refinish sealing surfaces, if required		
22	Sealing ring	4		Replace	

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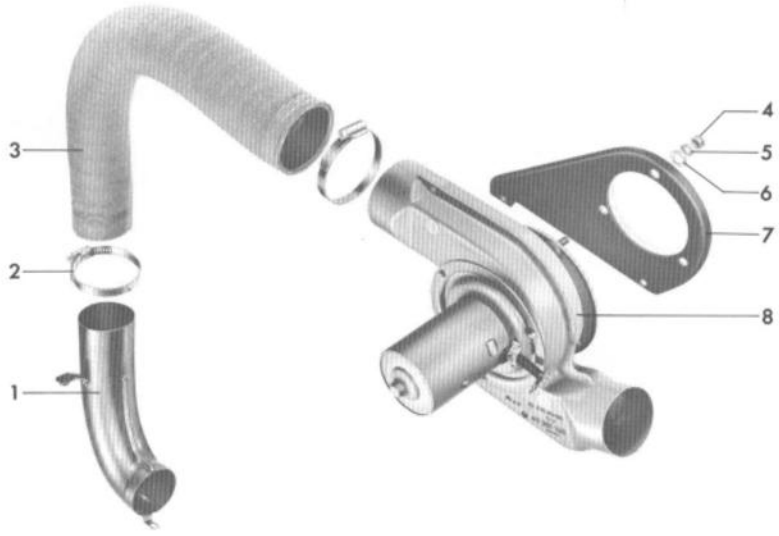

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Connection pipe	2			
2	Hose clip	5			
3	Heating air hose	2			
4	Hex. nut M 6	4			
5	Spring ring	4			
6	Washer	4			
7	Holding plate	1			
8	Heating air blower	1			

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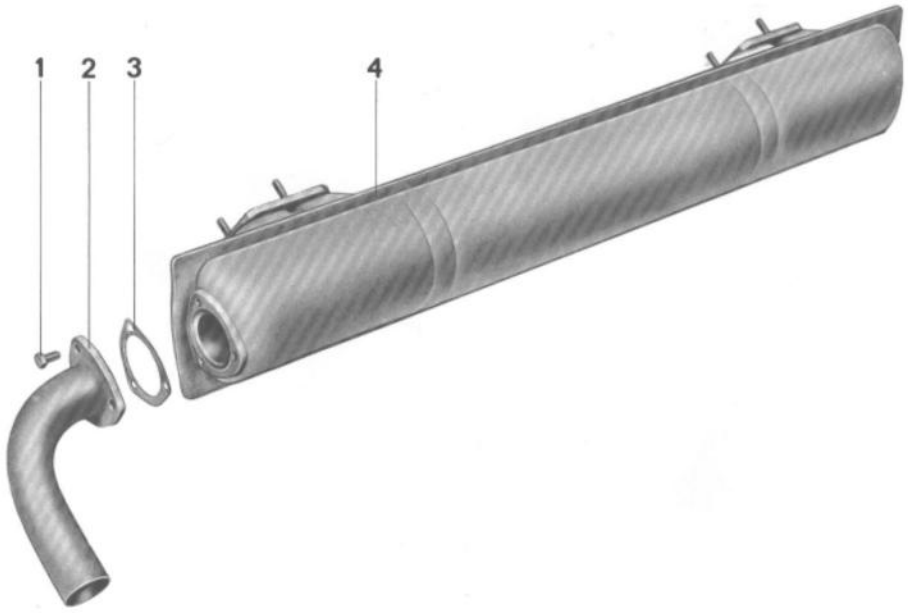
Effective with 1974 Models



Nr.	Description	Qty	Note when removing / installing	Reverences
1	Bolt	3		
2	Tail pipe	1		
3	Gasket	1	Replace	
4	Muffler	1		

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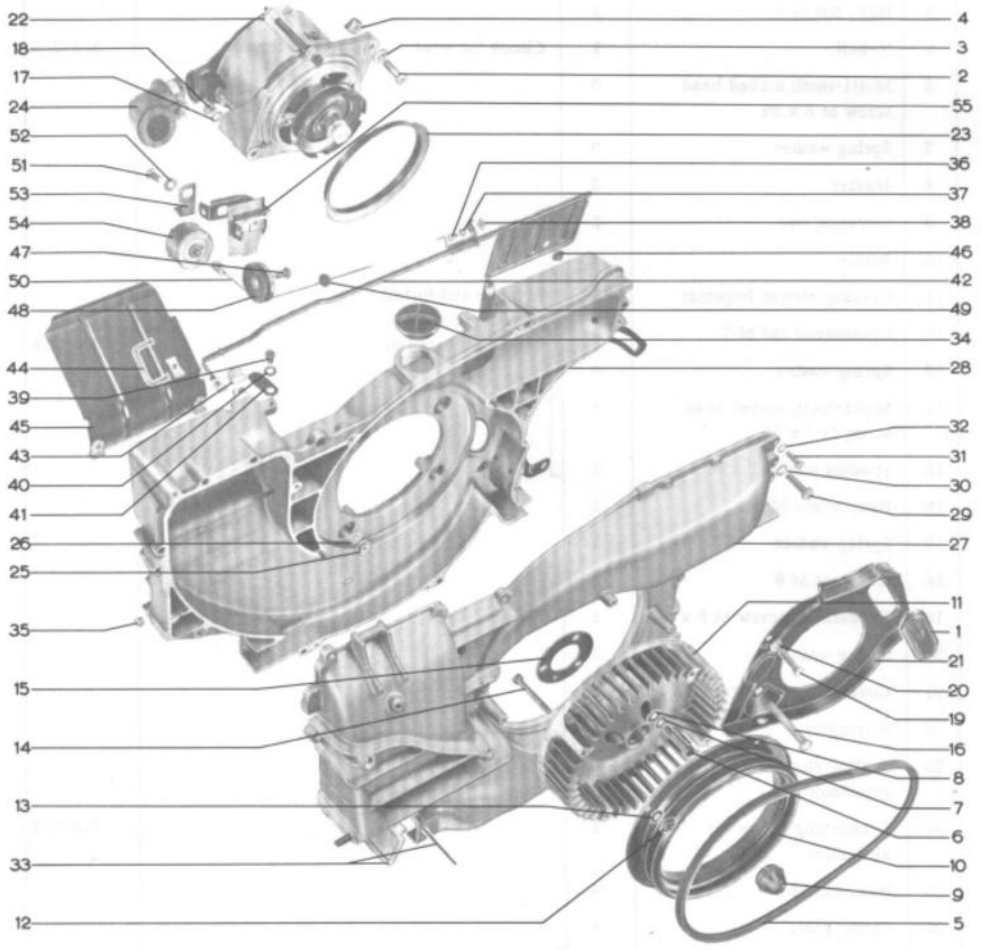

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cover for cover plate	1			
2	Multi-tooth socket head screw M 8	1			
3	Spring washer	1			
4	Hex. nut M 8	1			
5	V-belt	1	Check for wear	Adjust tension	3.3-2/1
6	Multi-tooth socked head screw M 8 x 39	3			
7	Spring washer	3			
8	Washer	3			
9	Covering cap	1			
10	Pulley	1			
11	Cooling blower impeller	1	Remove and install together (parts are balanced together)		
12	Squarehead nut M 7	4			3.3-2/2
13	Spring washer	4			
14	Multi-tooth socket head screw M 7 x 52	4			
15	Spacing washer	1			
16	Hex. screw M 8	1			
17	Spring washer	1			
18	Hex. nut M 8	1			
19	Cheesehead screw M 6 x 30	1			
20	Spring washer	1			
21	Cover plate for altern.	1			
22	Alternator	1			
23	Sealing ring for alternator	1			
24	Connecting elbow for alternator	1			3.3-2/2
25	Hex. nut M 8	4			
26	Spring plate	4			
27	Cooling blower housing half, rear	1	Remove and install together		3.3-2/2
28	Cooling blower housing half, front	1			
29	Hex. screw M 8 x 30	3			

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
30	Spring washer	3			
31	Cheesehead screw M 6 x 20	7			
32	Spring plate	7			
33	Closing flap for air return	2			
34	Sight hole cover	1			
35	Plug	1			
36	Hex. screw M 4 x 8	1			
37	Washer	1			
38	Square nut	1			
39	Cheesehead screw M 6 x 10	2			
40	Spring washer	2			
41	Holding spring for shaft	2			
42	Throttle valve right with shaft	1		Adjust	3.3-2/3
43	Bearing piece	2			
44	Handle for throttle valve	1			
45	Throttle valve left	1			
46	Plug	1			
47	Hex. screw M 6	1			
48	Roller for cooling air control	1			
49	Sealing washer	1			
50	Cable for cooling air control	1			
51	Hex. screw M 8 x 15	1			
52	Washer	1			
53	Washer for thermostat	1			
54	Thermostat	1			3.3-2/3
55	Holder for thermostat	1			

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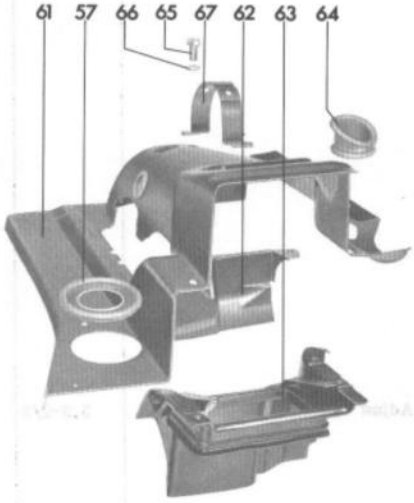

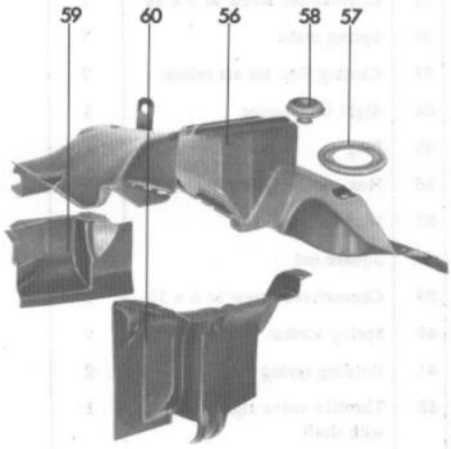

No.	Designation	Each	Observe during: Removal / Installation	Spec. Instr.
56	Cylinder jacket right	1		
57	Bushing for connecting pipe	2		
58	Bushing for cable	1		
59	Warm air guide right front	1		
60	Warm air guide right rear	1		
61	Cylinder jacket left	1		
62	Warm air guide left front	1		
63	Warm air guide left rear	1		
64	Protective cap for oil pressure switch	1		
65	Hex. screw M 6	2		
66	Spring washer	2		
67	Starp for ignition coil	1		

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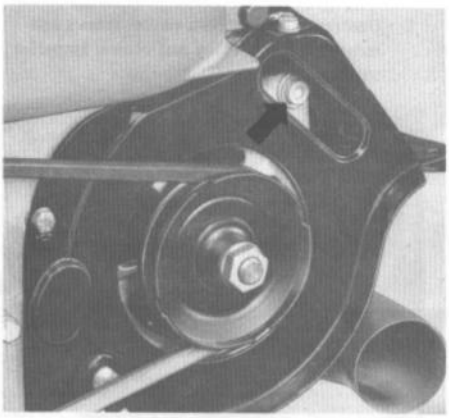
CHECKING AND ADJUSTING OF V-BELT TENSION

Checking V-belt Tension

The V-belt tension is correct when the V-belt can be depressed in the center by approx. 15 mm (.6 in.) by energetic thumb pressure.

The belt should not show any traces of excessive wear, such as frayed edges or slit flanks. Oily belts can often be made again fit for use by washing in a P-3 solution and subsequent thorough rinsing in clear water. Do not use gasoline.



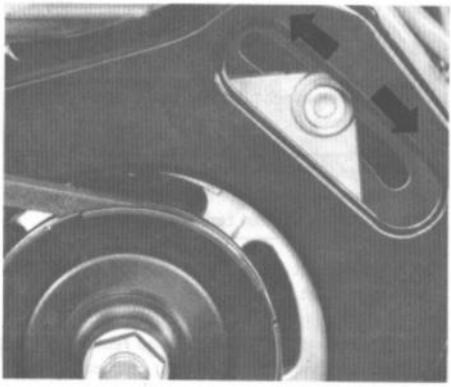
Adjusting V-belt Tension

1 - Remove cover for cover plate.

2 - Loosen multi-tooth socket screw M 8.

3 - Adjust tension of V-belt so that the belt can be depressed by approx. 15 mm (.6 in.) by energetic thumb pressure. For this purpose, push alternator to the left or right.

4 - Tighten screw.



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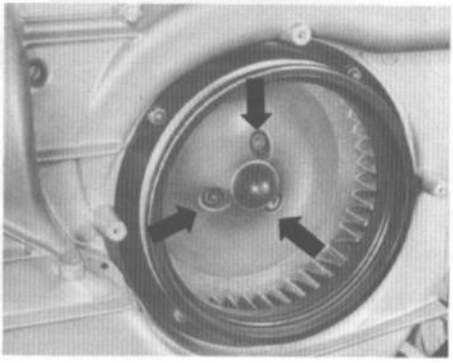
REMOVAL AND INSTALLATION OF COOLING BLOWER HOUSING

Removal

1 - Unscrew 3 multi-tooth socket screws and remove V-belt pulley and blower impeller together.



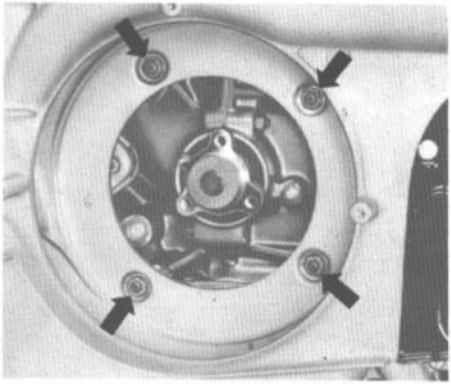
2 - Remove spacing washer.

3 - Remove cover plate for alternator and generator.

> Note:
> The cooling blower housing can also be taken off without removing generator.

4 - Disconnect cable for cooling air control from shaft.

5 - Unscrew 4 hex. nuts M 8 and remove cooling blower housing halves front and rear together.

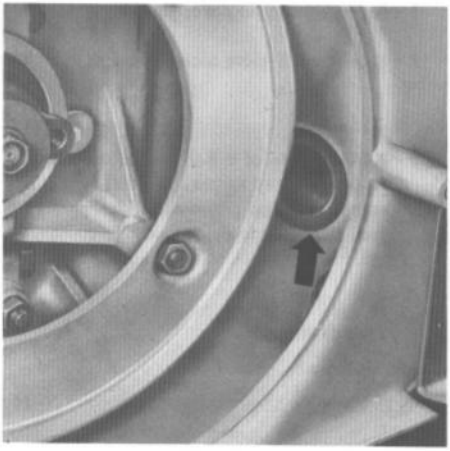


Installation

For installation proceed as follows:

1 - Adjust throttle flap for cooling air control.

2 - Attach elbow for alternator into front cooling blower housing half.



3 - Adjust V-belt tension.

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REPLACING COOLING BLOWER IMPELLERS

The cooling blower impellers are now supplied with the TDC mark only. The appropriate ignition timing notch must be made prior to installation.

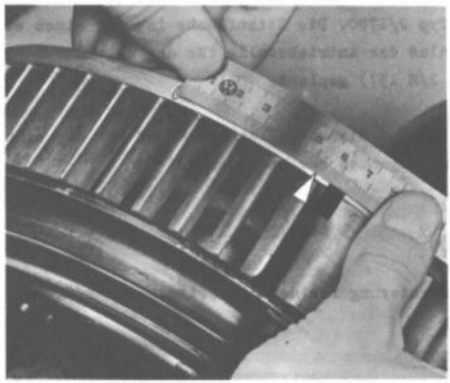
27° timing mark = 52.5 mm along the circumference
7.5° timing mark = 14.6 mm along the circumference

Making Timing Notch

1. Scratch-mark location of timing mark (from TDC) with aid of a vlexible measuring tape.

2. Make timing notch with a triangular file.

3. Mark notch with red paint.



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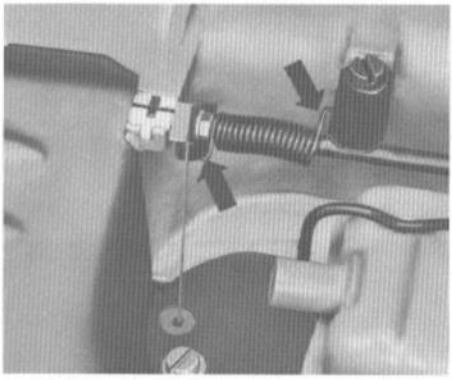
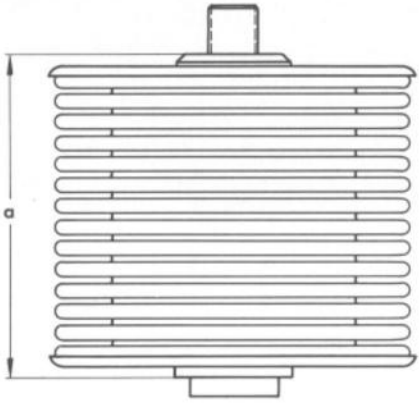
AUTOMATIC COOLING AIR CONTROL





Removal

After loosening holding springs, the righthand throttle flap with shaft can be removed and the lefthand throttle flap can be disconnected.

Installation

The restoring spring should rest with its bent ends against the holding spring lug and behind the cable guide.

Adjustment

1 - Assemble all control parts, lubricate joints and bearing points with paste on molybdenum disulfide base.

2 - Push throttle flaps into closing position and tighten cable control.

Checking Thermostat

Heat thermostat in water. At 65-70°C (149-158°F) water temperature the pressure capsule lenght (a) should be at least 46 mm (1.81 in.).

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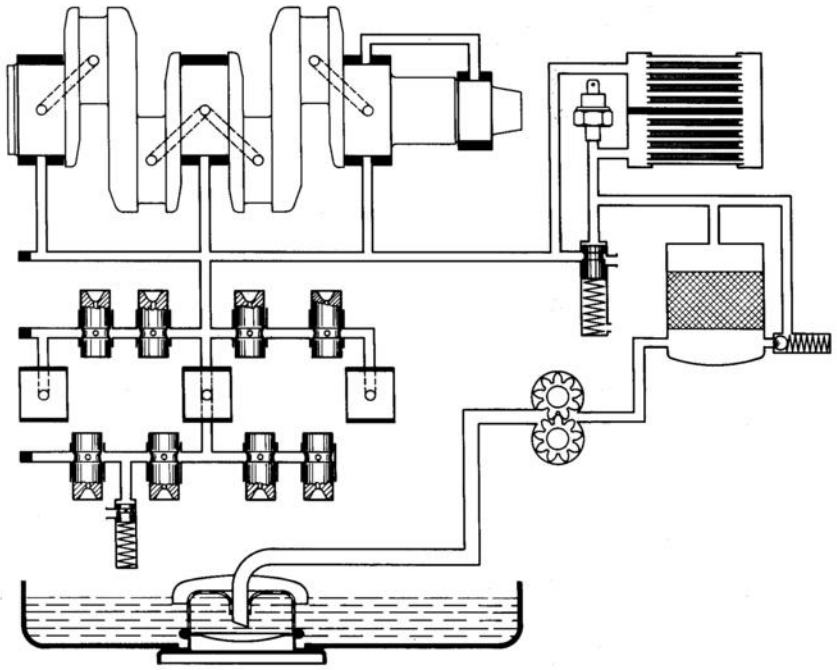
DESCRIPTION

The oil is sucked by the oil pump and through the oil strainer out of the crankcase and is forced via the oil filter and oil cooler into the oil duct. Part of the oil arrives at the crankshaft bearings and flows from there through holes in the crankshaft to the conrod bearings. Some of the oil will flow to the camshaft bearings. The remaining oil flows through the hollow push rods into the rocker arm bores and lubricates the pertinent bearings. Splash oil and oil fog will lubricate the valve stem and will then flow through the protective tubes of the push rods back into the crankcase. Cylinder walls, pistons and piston pins are lubricated by centrifugal lubrication. The engine oil returning from all lubricating points and from the oil pressure control valve at end of oil circuit collects at the bottom of the crankcase and is then again circulated by the pump.



Oil Capacities:

with oil filter change..... 3.5 lits.
without oil filter change..... 3.0 lits.

Oil Dipstick:

top mark - max. capacity
bottom mark - min. capacity (approx. 2.5 lits.)

Oil Pressure:

(measured on oil pressure switch; only for oil grade SAE 30)
at 70°C (158°F) oil temperature
at 2, 500 rpm ..... approx. 3.0 kg/cm^2 (42 psi)
(min. 2.0 kg/cm^2 = 28 psi)

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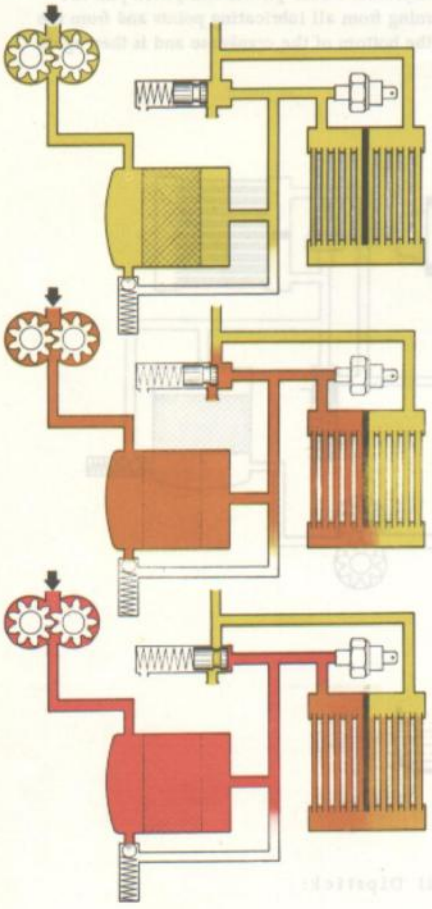
Oil Pressure Valves:



The flow of the engine oil through the oil cooler is controlled by the oil relief valve in front of the oil cooler as follows:

a - The oil is cold and thick:

Oil pressure very high.
Piston in lowest position.
Oil flows directly to lubricating points.

b - The oil is warming up and becomes thinner:

Oil pressure drops.
Oil flows directly and partially through oil cooler to lube points.

c - Oil is at operating temperature and thin:

Oil pressure low.
Piston in highest position.
Oil can flow only through oil cooler to lube points.

The lateral oil pressure relief valve at end of oil circuit will maintain the oil pressure within range of crankshaft and camshaft bearings to approx. 2 kg/cm^2 (28 psi).

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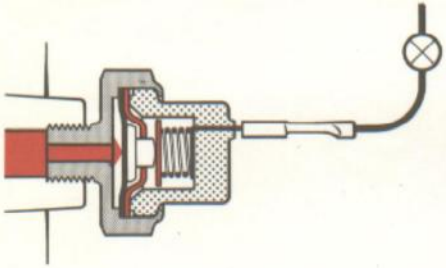
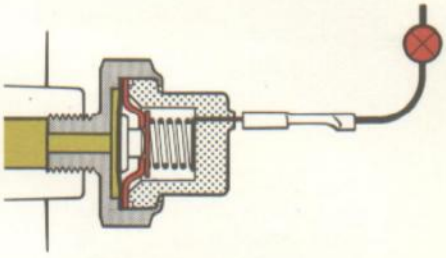
Oil Pressure Switch:

The oil pressure switch serves to control the oil pressure.



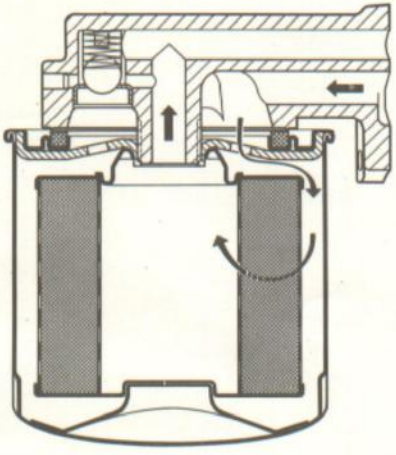
a - Oil pressure increases when engine is started:
Contact opens (0.15-0.45 kg/cm^2 = 2-6.4 psi).
Control lamp extinguishes.



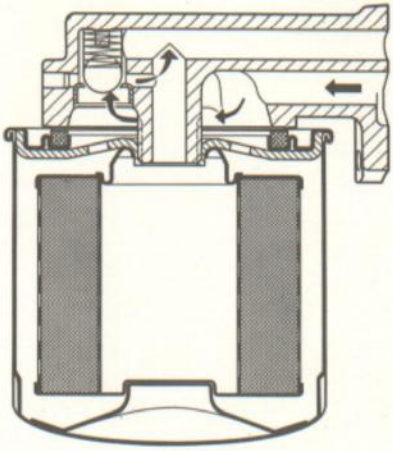
b - Oil pressure too low with the engine running:
Contact closes.
Control lamp lights up.

Oil Filter:

The oil filter is in the main flow and stops even the smallest contaminations. A ball valve in the oil filter flange guarantees the oil supply of the engine even when the oil filter is clogged.



a - Normal oil flow.



b - Oil flow with oil filter clogged.

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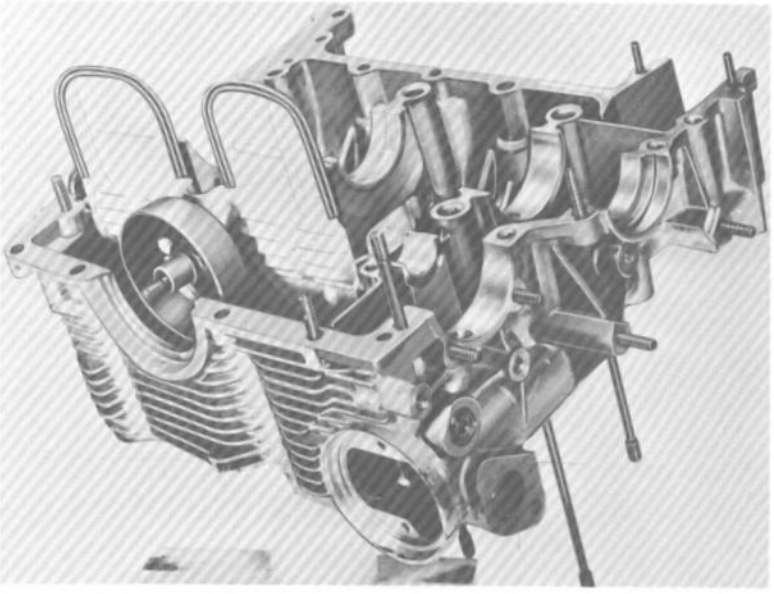
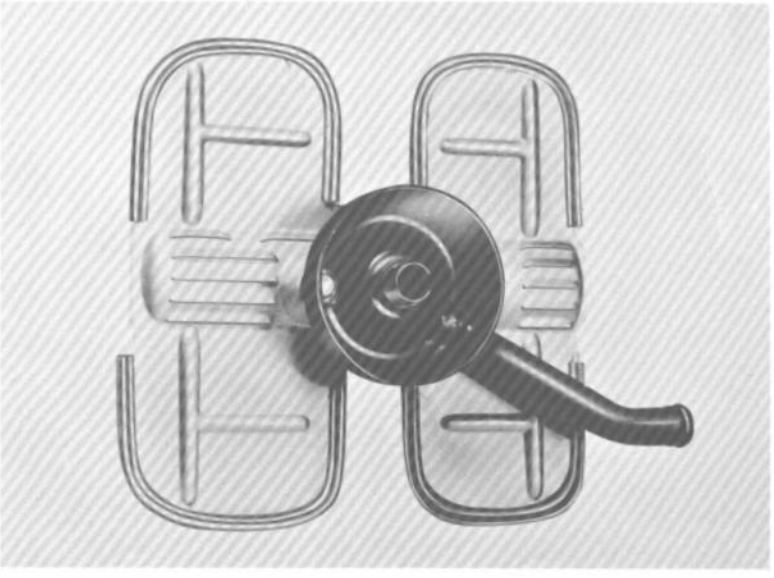
DESCRIPTION

Beginning with the 1972 model, the engines are equipped with an oil baffle plate. The baffle plate ensures that the oil pick-up tube remains immersed in oil at all times. The baffle plate has a contoured gasket and is bolted to the oil pick-up tube.





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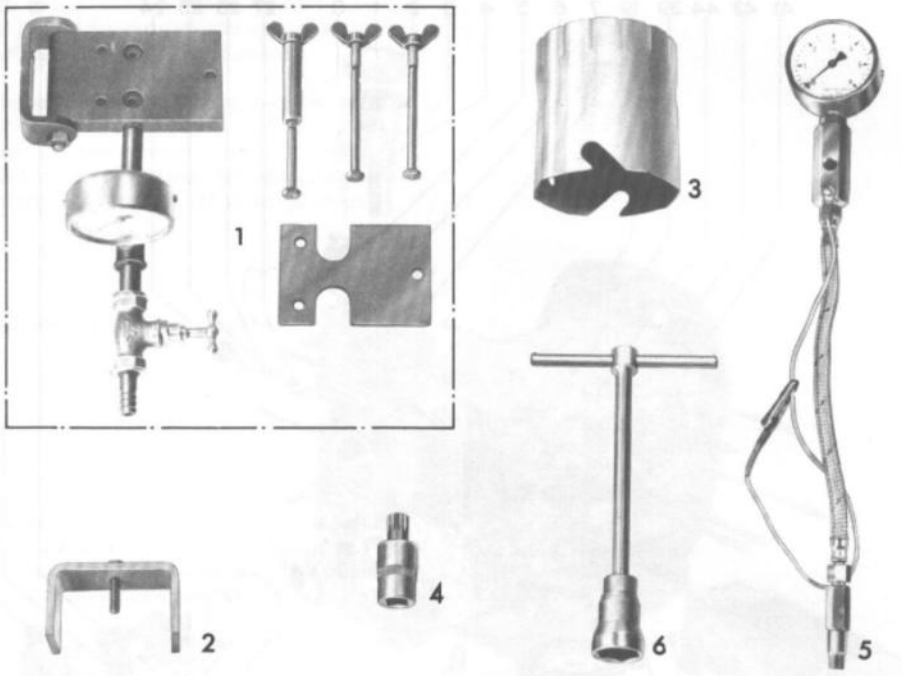
TOOLS



No.	Designation	Special Tool	Explanations
1	Tester for oil cooler	VW 661/2	
2	Puller for oil pump cover	VW 803	
3	Spanner for oil filter		Commercial
4	Insert for multi-tooth socket screw M 14		Commercial
5	Tester for oil pressure and oil pressure switch		
6	Oil pressure switch spanner		Commercial

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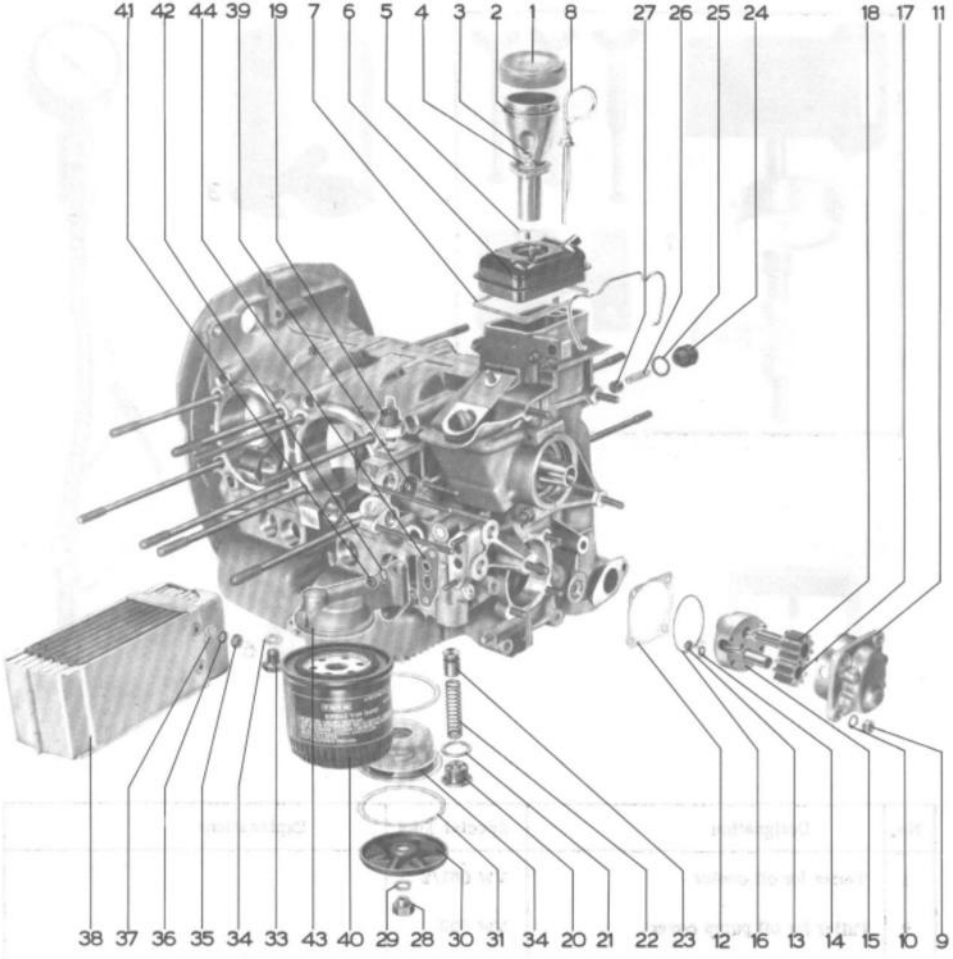

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cover for oil filler	1			
2	Oil filler	1			
3	Hex. nut M 6	2			
4	Spring washer	2			
5	Seal for oil filler	1		Replace	
6	Oil vent	1			
7	Seal	1		Replace	
8	Oil dipstick	1			
9	Hex. nut M 8	4		Tighten to 2.0 mkg (14.5 ft.lbs.)	
10	Spring washer	4			
11	Oil pump housing	1	Check for wear		4.1-3/1
12	Seal for oil pump housing	1		Replace	
13	Hex. nut M 6, self-securing	4			
14	Spring washer	4			
15	Oil pump cover	1	Pull off with VW 803, check for wear	Grind scored cover flat	
16	Sealing ring for oil pump cover	1		Replace, lubricate	
17	Oil pump gear	1			
18	Drive shaft	1			
19	Oil pressure switch	1			
20	Closing screw M 22 x 1.5	1			
21	Sealing ring	1		Replace	
22	Spring	1	Check for spring tension		
23	Piston for oil relief valve	1	Check for wear		4.1-4/1
24	Closing screw M 16 x 1.5	1	with insert for multi-tooth socket screw M 14, loosen and tighten		
25	Sealing ring	1		Replace	
26	Spring	1	Check spring tension		
27	Piston for oil pressure control valve	1	Check for wear		4.1-4/1
28	Closing nut M 8	1		Tighten to max. 1.3 mkg (9.4 ft.lbs.)	
29	Sealing ring	1		Replace	
30	Oil strainer closing cover	1		Sealing surface must be plane	

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
31	Seal	2		Replace	
32	Oil strainer	1		Clean	
33	Closing screw	1		Tighten to 2.2 mkg (15.9 ft.lbs.)	
34	Sealing ring	1		Replace	
35	Hex. nut M 6	3			
36	Spring washer	3			
37	Washer	3			
38	Oil cooler	1	Check with VW 661/2 for damage and leaks		4.1-4/1
39	Sealing ring for oil cooler	2		Replace	
40	Oil filter	1	Loosen and tighten with special spanner (1.5 mkg = 10.8 ft.lbs.)		4.1-4/3
41	Hex. nut M 8	2			
42	Spring washer	2			
43	Intermediate flange for oil filter	1			
44	Seal	1		Replace	

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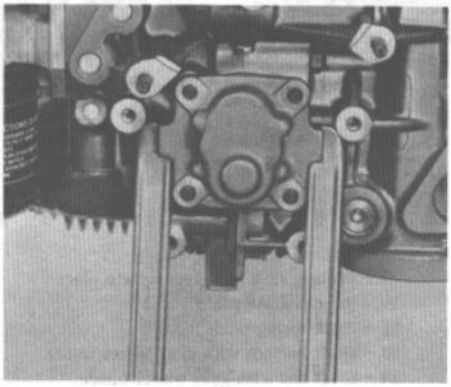
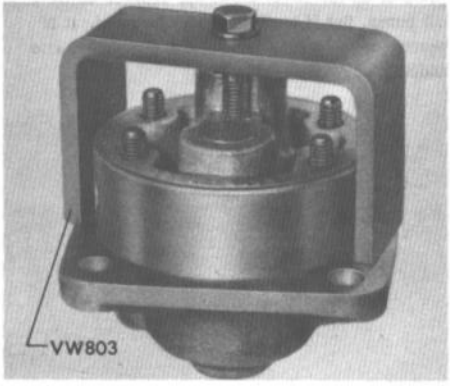
REMOVAL AND INSTALLATION OF OIL PUMP

Removal

1 - Remove oil pump with 2 mounting levers.



2 - Pull oil pump cover with puller VW 803.



Checkup

1 - Check oil pump housing and oil pump cover, in particular bearing points of gear wheels prior to installation for wear. Scored parts will result in unpermissible pressure losses.

2 - Check contact surface for oil pump on crankcase for cleanliness and damage.

Installation

The following points must be observed:

1 - Lubricate gear wheel and drive shaft and insert into oil pump housing.

2 - Install oil pump cover with lubricated rubber sealing ring into housing.

3 - Following assembly, check gear wheels for perfect running.

4 - Install oil pump with new seal into crankcase. The journal of the drive shaft should be in alignment with the slot in the camshaft gear.

5 - Center oil pump by two crankshaft revolutions and tighten hex. nuts.

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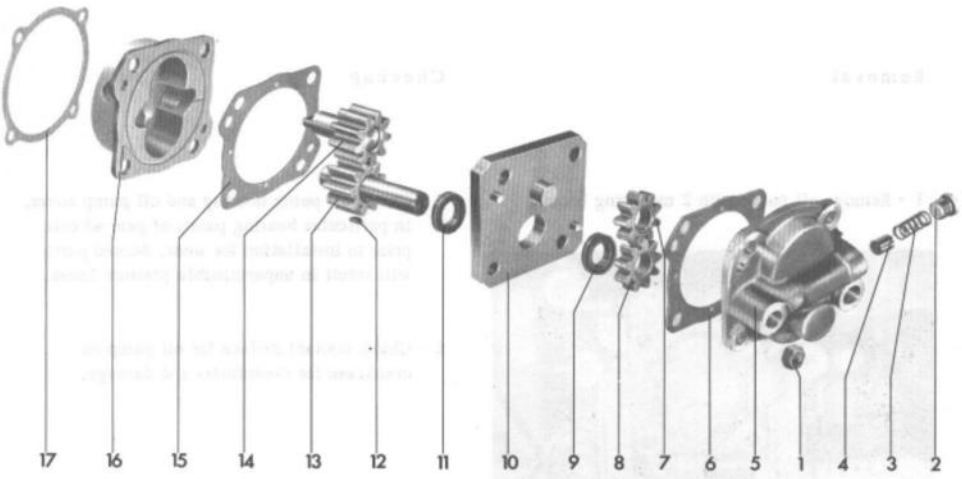
REMOVAL AND INSTALLATION OF DOUBLE OIL PUMP SPORTOMATIC



1 - Sealing nut M 8
2 - Closing screw
3 - Spring
4 - Piston
5 - Cover
6 - Seal for intermediate plate and cover
7 - Gear wheel outside top
8 - Gear wheel outside bottom
9 - Sealing ring for intermediate plate
10 - Intermediate plate
11 - Plate spring
12 - Shaft bottom with gear wheel inside
13 - Shaft top with gear wheel inside
14 - Housing for double oil pump
15 - Seal for oil pump housing

Removal

Remove plate spring prior to pulling off intermediate plate, so that the sealing rings in intermediate plate are not damaged.

Checkup

If damage on the housing, on the intermediate plate or on the cover shows up, replace entire oil pump. But if leaks are to be repaired, it is permitted to replace seals and sealing rings also individually.

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REMOVAL AND INSTALLATION OF OIL PRESSURE VALVES

Removal

A binding piston can be pulled out after screwing in a tap.

Installation

1 - Check piston and bore in housing for score marks. Remove score marks carefully and replace piston, if required.

2 - Checking spring.

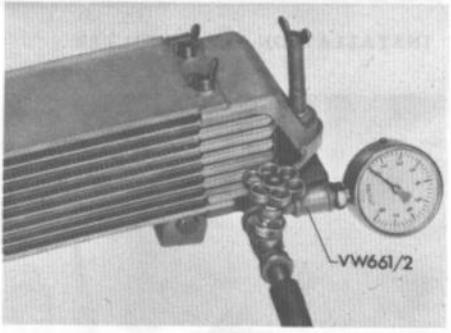
	Oil relief valve, bottom	Oil pressure control valve, lateral
Spring lenght loaded	23.4 mm (0.92 in.)	16.8 mm (0.66 in.)
Load	11.1 kg (24.5 lbs.)	4.35 kg (9.59 lbs.)

3 - To prevent any damage to bore in housing be sure that the upper end of the spring does not wipe against housing.

Remark:

Check oil relief valve in the event of trouble in the oil circuit, but definitely if the oil cooler leaks. If the piston binds at TDC there is the danger that the oil cooler will develop a leak when the oil is thick. Binding at BDC will cause the oil to flow directly into the crankcase and lubrication of the warm engine will then be insufficient.

CHECKING THE OIL COOLER



1 - Check oil cooler for leaks and tight seat of all welded plates. Test pressure 6 kg/cm^2 (85 psi). Tester for oil cooler: VW 661/2 (self-made).

2 - Leaking oil cooler: check oil relief valve.

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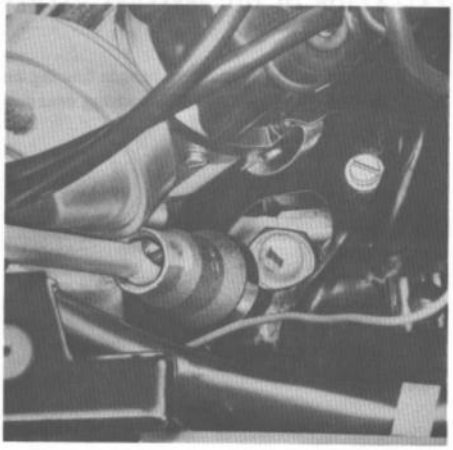
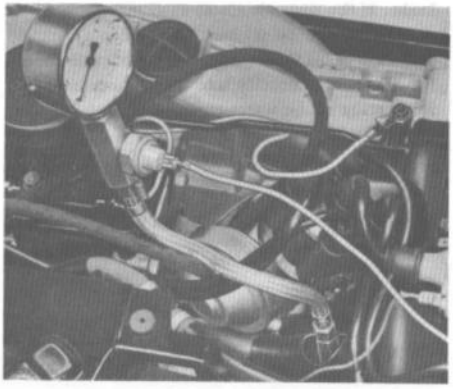
CHECKING THE OIL PRESSURE SWITCH





The check is made with the engine at operating temperature, using a plain tester with pressure gauge and inspection lamp.

1 - Unscrew oil pressure switch and screw into tester.

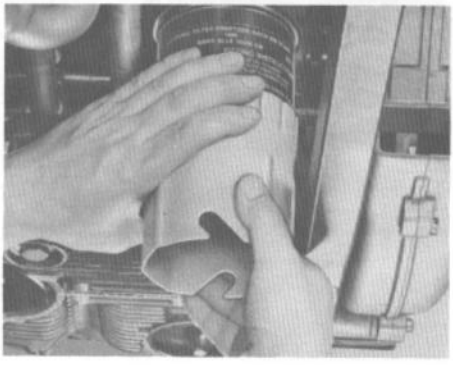
2 - Insert tester into crankcase instead of oil pressure switch and connect inspection lamp to oil pressure switch on the one hand and to terminal 15 of the ignition coil on the other. Switch on ignition, the inspection lamp should light up. If the lamp does not light up, replace switch.

3 - Start engine. Watch pressure rise on pressure gauge with growing speed, while the lamp extinguishes. The contact of the switch should remain closed and the lamp should light up as long as the oil pressure is still under 0.15-0,45 kp/cm^2 (2-6.4 psi).

4 - Stop engine. The lighting up of the inspection lamp might be delayed somewhat, since the oil pressure will drop only slowly.

5 - The oil pressure switch is sealed by means of the tapered threads. Upon installation, the switch should not be tightened excessively to prevent any damage to threads.

INSTALLATION OF OIL FILTER



1 - Check sealing surface on flange for oil filter for cleanliness.

2 - Lubricate rubber seal slightly.

3 - Screw filter in manually until seal is seated.

4 - Tighten oil filter with spanner.

5 - Fill up with engine oil.

6 - Start engine and check for leaks.

7 - Check oil level and fill up with oil, if required.

Remark:
Washing and cleaning of oil filter is not permitted.

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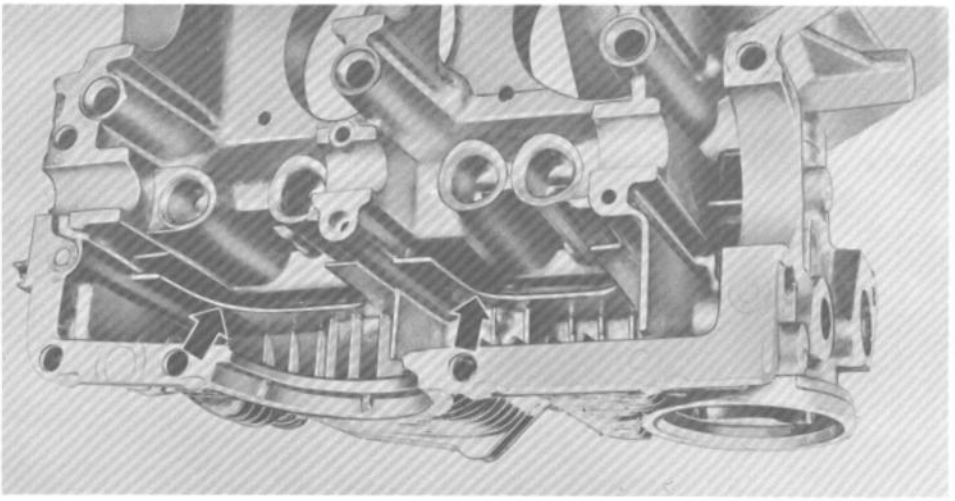
INSTALLING CONTOURED GASKET

Installation

When installing contoured gasket to the oil baffle plate, use a silicone adhesive.

Subsequent Installation

Subsequent installation is possible beginning with engine No. W 0 074 387. Engines manufactured as of this number are equipped with a modified oil pick-up tube and a circumferential retaining rib.



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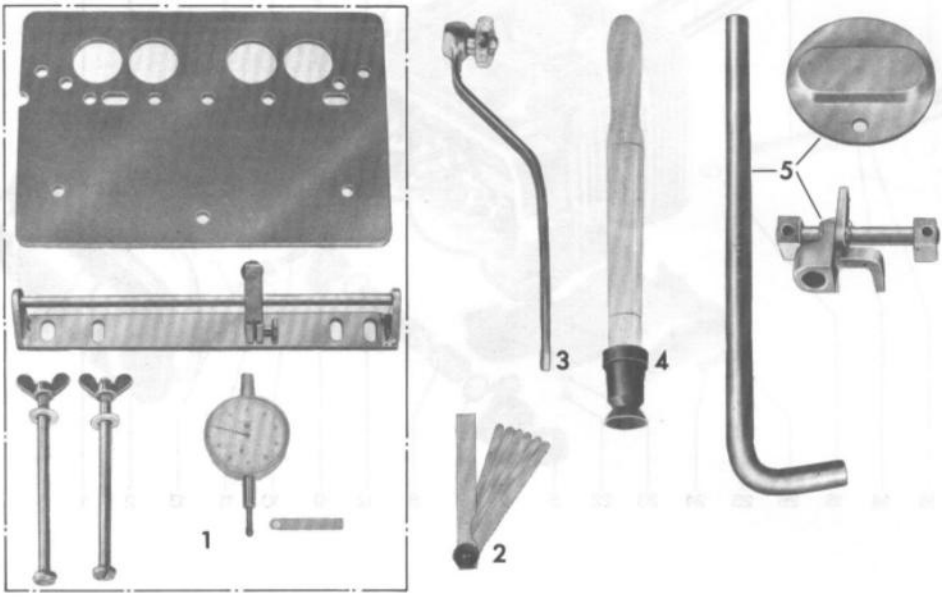
TOOLS



No.	Designation	Special Tool	Explanations
1	Clamping plate with wear-measuring instruments for valve guides	VW 689/1	
2	Feeler gauge		Commercial
3	Valve adjusting spanner		Commercial
4	Valve grinder		Commercial
5	Valve spring pusher	VW 311 s	

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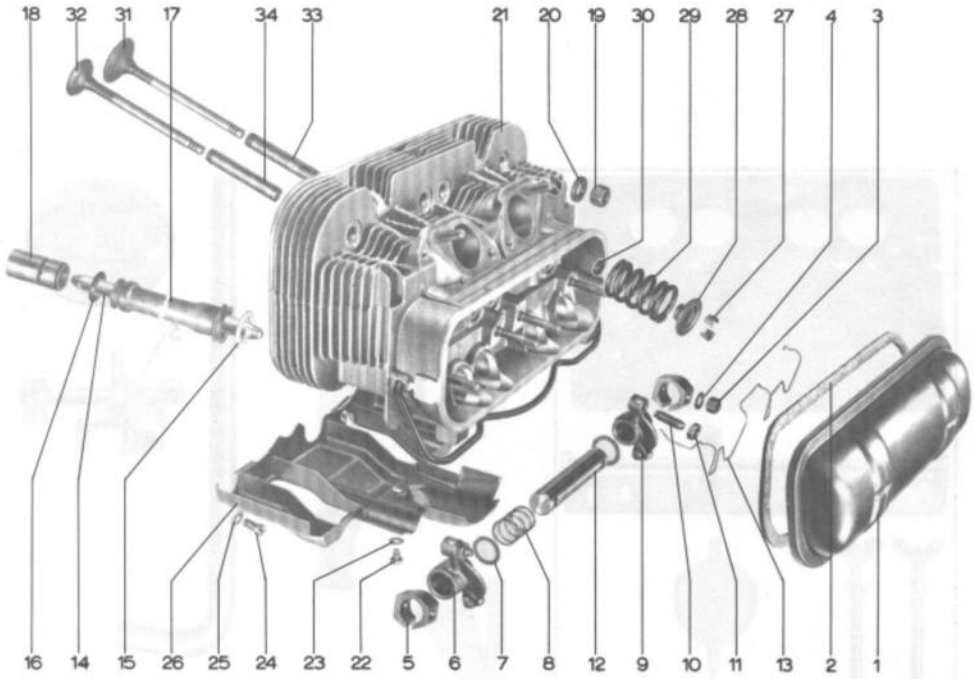

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cylinder head cover	2		Replace	
2	Gasket for cylinder head cover	2			
3	Hex. nut M 7	8		Tighten to 1.4 mkg (10.1 ft.lbs.)	
4	Spring plate	8			
5	Bearing piece	8	Check for wear and scoring marks	Slot facing downwards	
6	Exhaust rocker arm	4	Check for wear and scoring marks		5.1-2/1
7	Thrust washer	8			
8	Spring	4			

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
9	Inlet rocker arm	4	Check for wear and scoring marks		
10	Valve adjusting screw	8			5.1-3/3
11	Hex. nut M 8 x 1	8			
12	Rocker lever shaft	4	Check for wear and scoring marks		
13	Securing clip for protective tubes	2		Observe installation position	
14	Push rod	8	Check for out-of-true		
15	Sealing ring white	8		Replace	
16	Sealing ring black	8		Replace	
17	Protective tube for push rod	8			
18	Tappet	8	Check for wear and scoring marks	Install with engine oil	
19	Hex. nut M 10	16		Observe sequence during tightening, tighten to 3.2 mkg (23.1 ft.lbs.)	5.1-2/2
20	Washer	16			
21	Cylinder head	2	Cylinder head right with tapped hole for temp. feeler		5.1-2/2
22	Cheesehead screw M 5 x 10	2			
23	Washer	2			
24	Cheesehead screw M 6	4			
25	Washer	4			
26	Baffle plate	2	Different at left and right		
27	Valve cone piece	16	Fit, if play is excessive		5.1-3/1
28	Valve spring disk	8			
29	Valve spring	8			5.1-3/1
30	Oil deflecting ring	8		Replace, lubricate	
31	Inlet valve	4	Check seat surface and stem for wear with valve spring pusher VW 311s and refinish, if required		
32	Exhaust valve	4			5.1-3/1
33	Inlet valve guide	4	Check with wear measuring instrument VW 689/1		
34	Exhaust valve guide				5.1-2/2

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Checkup

1 - Check tappet face and stem for wear and scoring marks.

Tappet: 23.96-23.98 mm dia. (.9433-.9441")
Wear limit: 23.93 mm (.9421")

2 - Check push rod between two holding devices for deformations.

Out-of-true: max. 0.3 mm (.0118")

3 - Check rocker arm, bearing pieces and rocker arm shaft for wear.

Rocker arm:	20.00-20.02 mm dia. (.7874-.7882")
Wear limits:	20.04 mm dia. (.7890")
Rocker arm shaft:	19.95-19.97 mm dia. (.7854-.7862")
Wear limit:	19.93 mm dia. (.7846")

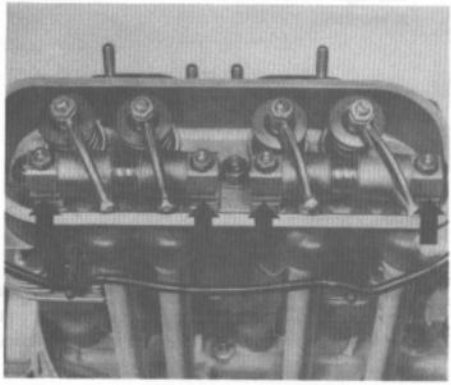
If the axial thrust surface of the rocker arms or bearing pieces are showing score marks, refinishing with fine emery cloth is permitted.

Installation

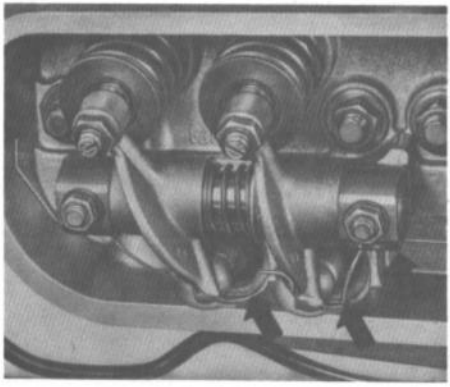
1 - Insert tappet with engine oil.

2 - Slide protective tubes with new sealing rings up to stop. Do not damage sealing rings.

3 - Slide bearing pieces on rocker arm shaft in such a manner that the slots will face downwards and the broken edges outwards when settling on studs.



4 - The securing clip for the protective tubes should enter the slots of the bearing pieces and should rest on bottom edges of protective tubes.



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INSPECTION AND INSTALLATION OF CYLINDER HEAD

Checkup

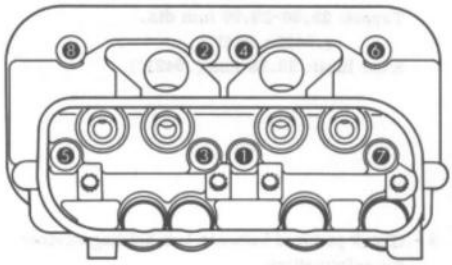
1 - Check cylinder heads for cracks in combustion areas and exhaust ducts as well as for leaks on cylinder support. Replace damaged cylinder heads.

2 - Check spark plug threads and studs for damage and tight seat. Install helicoil thread inserts, if required.

Installation

1 - Replace sealing ring for cylinder head.

2 - Pre-tension cylinder head nuts slightly at first and then tighten well in correct sequence.



3 - Screw on baffle plate.

CHECKING VALVE GUIDES

When repairing engines with leaking valves it is not enough to refinish or replace the valve seats and the valves, but it is also required to check the valve guides for wear and replace the guides, if required. This checkup is particularly important on engines which have been running for a long time and on exhaust valve guides.

If wear is too high, replace cylinder head until a repair method is recommended.

1 - Remove residue with a cleaning tool.

2 - Place cylinder head on clamping plate for cylinder head VW 689/1 (self-made) - with combustion chamber ends up - end screw down together with measuring bridge.

3 - Insert dial gauge into holder and attach dial gauge extension.

4 - Place new valve into guide to be checked and hold in such a manner that the stem end is flush with guide.

5 - Adjust dial gauge and determine rocker play.

	Intake valve guide	Exhaust valve guide	Wear limit
Rocker play	0.45 mm (.0177")	0.45 mm (.0177"	0.9 mm (.0354")
ID	8.00-8.02 mm (.3150-.3158")	9.00-9.02 mm (.3543-.3551")	8.06-9.06 mm (.3173-.3567")

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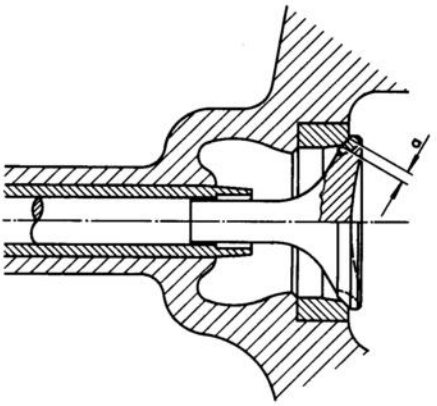
Valve seats showing evidence of wear or burnoff can be refinished as long as the permissible seat width is maintained and the 15° chamfer at its outer circumference does not exceed the OD of the valve seat ring. If it does, replace engine head with a new or overhauled part. Exchanging valve seat rings is impossible with conventional shop means, since the rings have been inserted in a chilled condition.

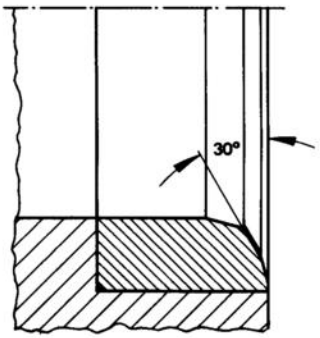


Width of valve seats (a) :

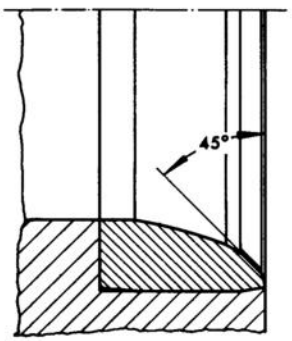
Intake	1.8-2.2 mm (.0709-.0866 in.)
Exhaust	2.0-2.5 mm (.0787-.0984 in.)

Sequence

1 - Finish 30° surface for inlet valve.



2 - Finish 45° surface for exhaust valve.



These seats must be finished with particular care to guarantee a perfect concentric seat. The material removal should be restricted to a minimum to prevent early unusability of the rings. The refinishing must be terminated as soon as the entire seat surface has been coverred.

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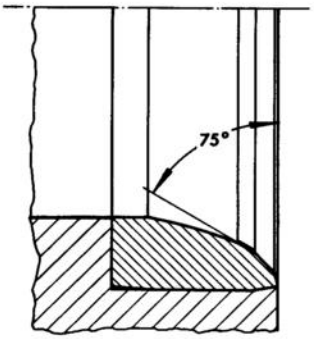
3 - Refinish 75° surface.

Chamfer bottom edge of exhaust valve seat ring slightly.

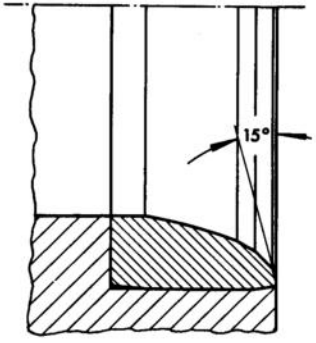


3 - Refinish 75° surface.

Chamfer bottom edge of exhaust valve seat ring slightly.

4 - Refinish 15° surface.

Finish upper edge of seat ring until the specified seat width is obtained.



5 - The valve seat can be checked with a new valve.

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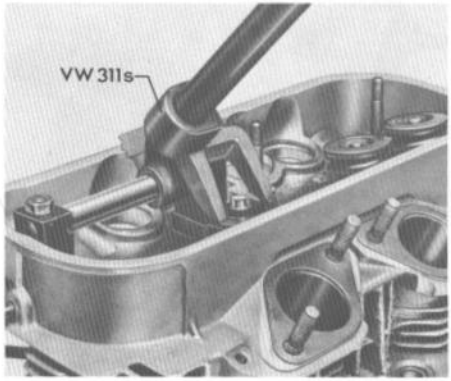
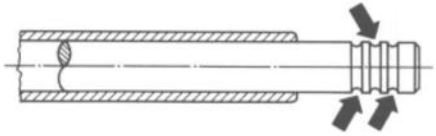
REMOVAL AND INSTALLATION OF VALVES

Removal

1 - Remove valves with valve spring pusher VW 311 s.



2 - After extended operation, some burr may develop at the contact surfaces of the valve keepers, which must be removed with a smooth file prior to pulling out valve.

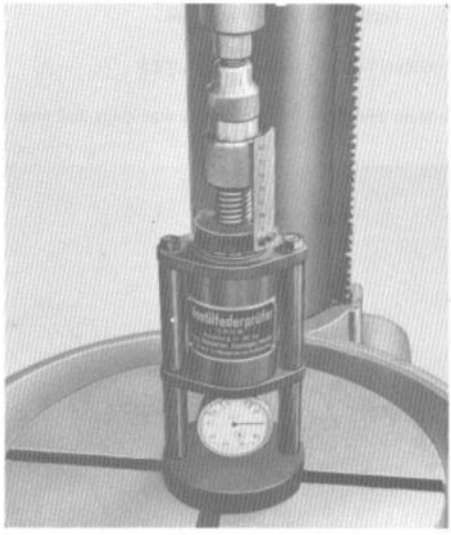


Checkup

1 - Check tension of valve springs.
Lenght under load: 30.0 mm (1.2")
Load: 72.5-83.5 kg (160-184 lbs.)

2 - Check valve keepers. Valve keepers with score marks can be ground down at separating surfaces until the valve can still be turned with the valve keepers compressed.

3 - Check valves for wear, particularly seat and stems. When no refinishing of seat on the machine is required, grind in valves on valve seat rings.



Installation

1 - Coat valve stem with molybdenum disulfide paste and insert valve into guide.

2 - Slide oil scraper ring on valve stem.

3 - Install valves with valve spring pusher VW 311 s.

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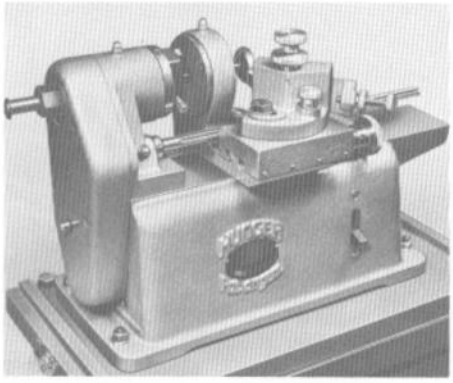
REFINISHING VALVES

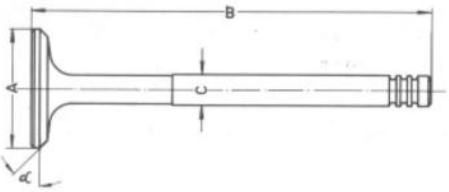


Valves on which the valve seat surface shows evidence of wear or burnout, can be refinished on a valve cone refacing machine or a valve cone grinder.

	Intake valve	Exhaust valve
A	39.1-39.3 mm dia. (1.5394-1.5472")	32.7-33.0 mm dia. (1.2874-1.2992")
B	116.8-117.3 mm (4.5984-4.6181")	117.0-117.5 mm (4.6063-4.6260")
C	7.94-7.95 mm dia. (.3126-.3130")	8.91-8.92 mm dia. (.3508-.3512")
d	29° 30'	45°

For 1.8 liter engines beginning with 1974 models

	Intake valve	Exhaust valve
A	40.8-41 mm dia. (1.60-1.61 ")	33.7-34 mm dia. (1.32-1.33 ")
B	117.0-117.5 mm (4.606-4.626")	116.8-117.5 mm (4.598-4.626")
C	7.94-7.95 mm dia. (.3126-.3129 ")	8.91-8.92 mm dia. (.3507-.3511 ")
d	29° 30'	45°



CHECKING FOR LEAKS

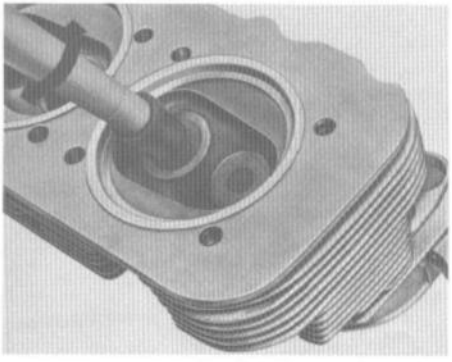
Valves can be checked for leaks by establishing a contact pattern.

Contact Pattern

1 - Coat valve cone surface slightly with surface ink.
2 - Place valve into valve guide and rotate under slight pressure on valve seat by approx. 1/4 turn.
3 - Lift valve from seat. The contact pattern will then show which spot did not support the valve. Refinish valves, if required.

GRINDING-IN OF VALVES

With perfectly finished valve seat rings and new valves, grinding-in is not necessarily required.



1 - Coat one valve seat with grinding paste and insert valve into guide.

2 - Place rubber sucker with handle on valve disk and rotate valve while grinding. Score marks on seats can be prevented by constantly lifting and uniformly turning of valve during the grinding.

Caution!

Carefully remove grinding paste following grinding operation.

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VALVE CLEARANCE

Valve clearance should be checked or adjusted only when the engine is cold.

Valve clearance: Intake 0.15 mm (0.006 in.)
Exhaust 0.15 mm (0.006 in.)

When the engine is warming up, the clearance will at first increase and will finally return to the set values when the operating temperature is attained. Inspections during the specified intervals must be completed with particular care.

Adjustment of the valves will have the desired succes only if the valves are perfectly sealing, if there is no unpermissible play on the valve guides and if the stem ends are not worn out.

Insufficient clearance:

Burning of valves or valve seats.
Distortion of valve stem.
Irregular performance by reduced compression.
Irregular running of engine.
Alternations to engine timing.

Excessive clearance:

Increase in noise from valve gear.
Irregular running of engine.
Alternation of engine timing.
Unsatisfactory performance by insufficient filling of cylinders.

ADJUSTMENT OF VALVES

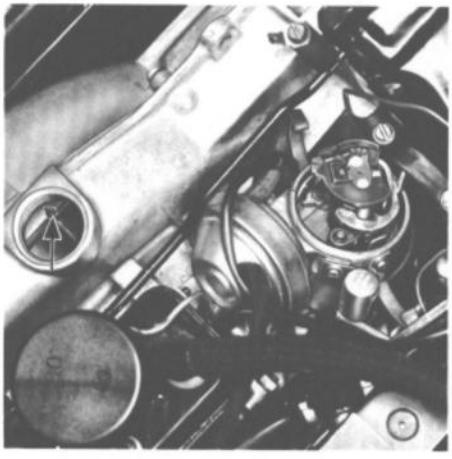
Valve clearance is adjusted in the firing order 1-2-3-4 Cylinder.

The piston of the cylinder to be adjusted must be at TDC of the compression stroke, because both valves will then be closed.

1 - Set no. 1 piston at firing point (white notch, i.e., TDC mark).

2 - Check valve clearance with feeler gauge.

Intake 0.15 mm (0.006 in.)
Exhaust 0.15 mm (0.006 in.)



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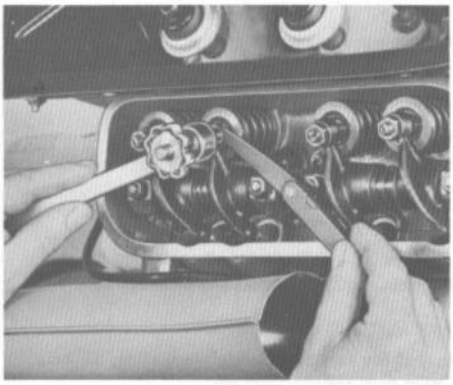
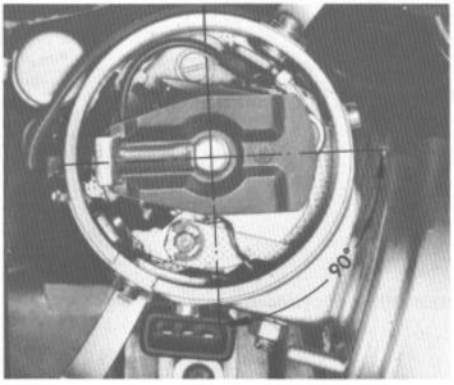


3 - Adjust valve clearance with valve adjusting spanner and feeler gauge.

The valve clearance is set correctly when the feeler gauge can be smoothly inserted in between the adjusting screw and the valve stem. Inserting the feeler gauge with more or less force would be wrong.

4 - Hold adjusting screws and tighten counter nuts.

5 - Check adjustment.



6 - For additional adjustment of valves on cylinder 2, 3 and 4, keep turning crankshaft to the left until the finger of the distributor rotor is offset by 90° in each case.

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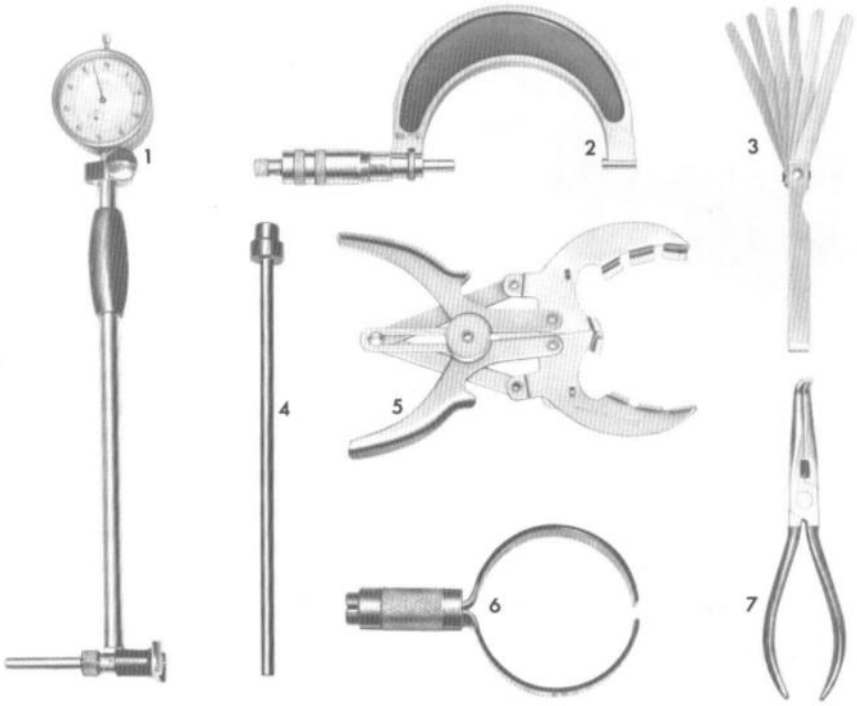
TOOLS



No.	Description	Special Tool	Remarks
1	Inside micrometer, 75-100 mm		
2	Micrometer, 75-100 mm		
3	Feeler gauge set		Standard item
4	Piston pin mandrel	VW 207c	
5	Piston ring pliers		Standard item
6	Piston ring compressor (or universal piston ring compressor)	US 1008a	90 mm dia. Standard item
7	Circlip pliers, angular		Standard item

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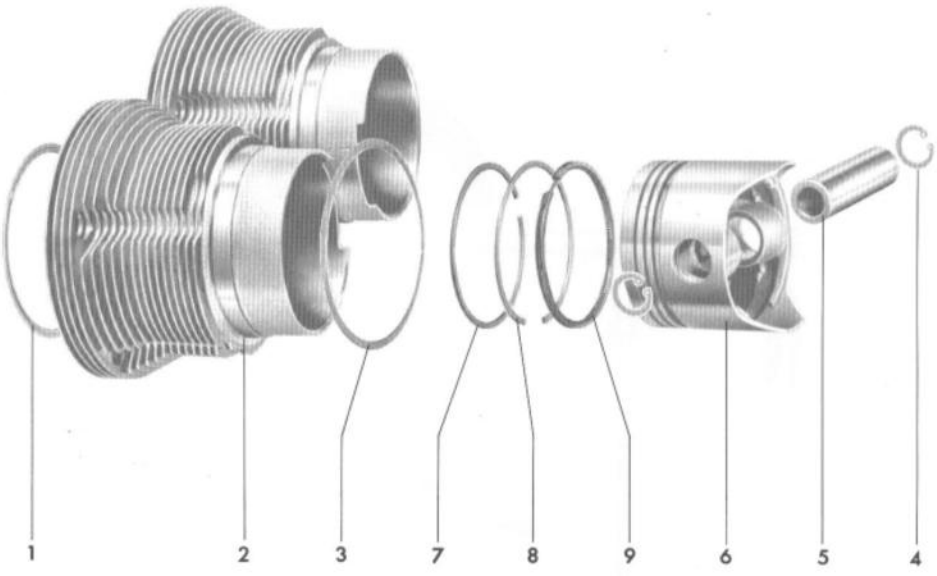

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Sealing ring between cylinder and cyl.head	4		Replace	
2	Cylinder	4	Mark installation position, check	Observe pairing with pertinent piston, lubricate	5.2-2/1
3	Sealing ring between cylinder and crankcase	4		Replace	
4	Locking ring	8	Fit with circlip pliers		
5	Piston pin	4	with piston pin mandrel VW 207c		5.2-3/4
6	Piston	4	Mark installation position	Observe pairing with pertinent cyl., heat for fitting piston pin, lubr.	5.2-3/1
7	Piston ring stop (Ferrox insert)	4	Remove and install with piston ring pliers only	Observe installation position and clearance, use piston ring strap VW 123d	5.2-3/2
8	Piston ring bottom (baffle ring)	4			
9	Oil scraper ring with hose spring	4			

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REMOVAL AND INSTALLATION OF CYLINDERS

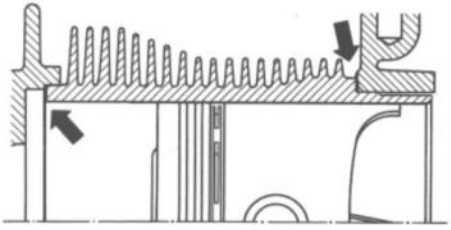
Removal

Mark cylinders prior to removal to eliminate any confusion during installation.

Checkup

1 - Check cylinder for wear, exchange against cylinder with pertinent piston of same size class, if required.

2 - Cylinder seat in crankcase and cylinder head, seat surfaces on cylinder and sealing rings must be kept absolutely clean during installation. Foreign bodies at such points may result in distortions of cylinders and leaks.



Note:

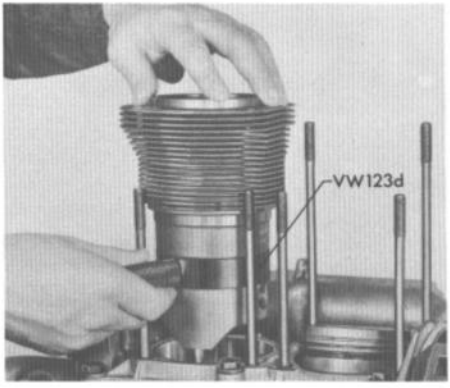
The pairing size is indicated by coloured dots (blue, pink, green) on top cooling fin.

Installation

1 - Lubricate piston and piston pin.

2 - Compress piston rings with piston ring strap VW 123d. Watch out for uniform alignment of gaps on piston ring. The gap of the oil scraper ring should always be on top.

3 - Fit cylinder with cylinder bore lubricated. The studs on the crankcase may not touch the cooling fins of the cylinders.



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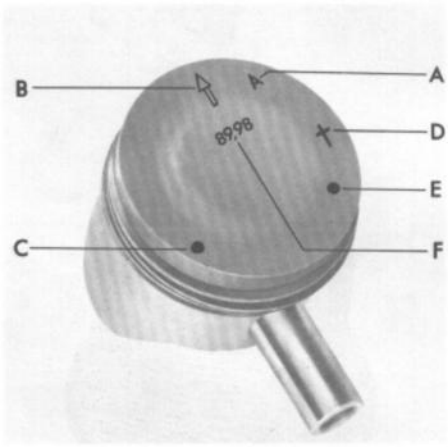
REMOVAL AND INSTALLATION OF PISTONS

Removal

1 - Mark piston to eliminate any shifting or Confusion during reinstallation.



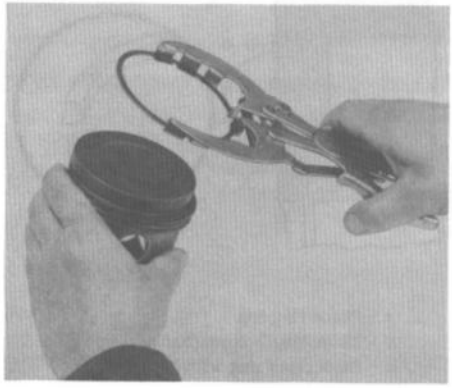
2 - Remove locking rings for piston pin with circlip pliers.

3 - Remove piston pin with mandrel VW 207c.

4 - If required, remove piston rings with piston ring pliers.

Installation

1 - Clean piston. Remove major oil carbon residue in piston ring grooves without damaging metallic surface. Bad contact pattern and one-sided formation of residue on piston skirt vertically in relation to piston pin axis may be the result of badly angled connecting rods.



2 - Check piston for wear, use a new piston of pertinent size class, if required. The weight difference between pistons should not exceed max. 10 grams.

Marking of Piston

A - The letter next to the arrow designates the index of the spare parts number of the pertinent piston and serves as a differentiating mark.

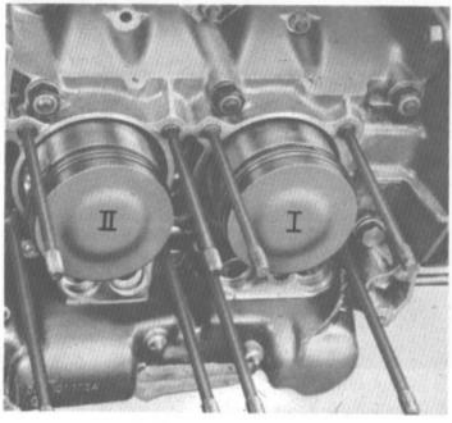
B - Arrow (punched-in) indicates that the piston must be installed in the direction of the arrow toward flywheel.

C - Indication of paired size by colour dot (blue, pink, green).

D - Statement of weight class (+ or -) punched-in or printed.

E - Indication of weight class by colour dot (brown = -weight, grey = +weight).

F - Indication of piston size in mm.



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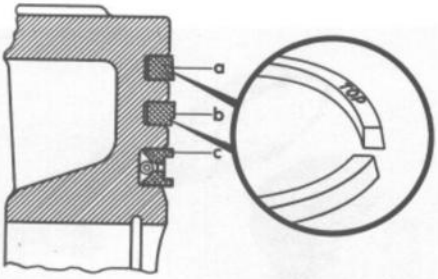
3 - Fit piston and oil scraper rings. Check clearance on gap of rings. For this purpose, slide ring at right angle into bottom cylinder opening (BDC), approx. 4-5 mm (0.16.0.2") from cylinder rim, with the piston assisting. Measure clearance with feeler gauge.

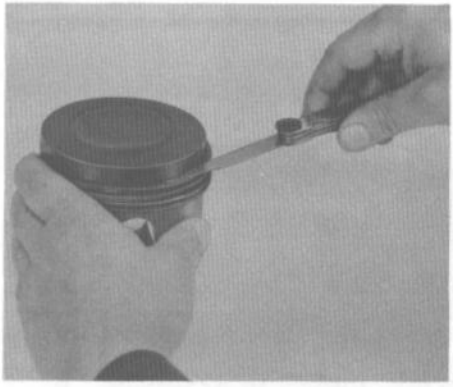
	Width of gap in mm	Wear limit in mm
Piston ring top	0.35-0.55 (.0138-.0217")	0.90 (.0354")
Piston ring bottom	0.30-0.55 (.0118-.0217")	0.90 (.0354")
Oil scraper ring	0.25-0.40 (.0098-.0157")	0.95 (.0374")



4 - Position piston rings with piston ring pliers only.

The designation "TOP" of piston rings should point to piston head.

a - Piston ring top
b - Piston ring bottom (baffle ring)
c - Oil scraper ring with hose spring



5 - Check vertical clearance of rings in ring grooves with feeler gauge.

	Vertical clearance in mm	Wear limit in mm
Piston ring top	0.06-0.09 (.0024-.0035")	0.12 (.0047")
Piston ring bottom	0.04-0.07 (.0016-.0028")	0.10 (.0039")
Oil scraper ring	0.02-0.05 (.0008-.0020")	0.10 (.0039")

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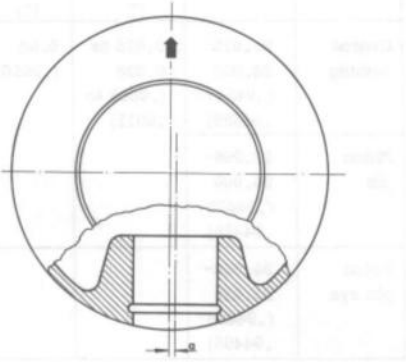
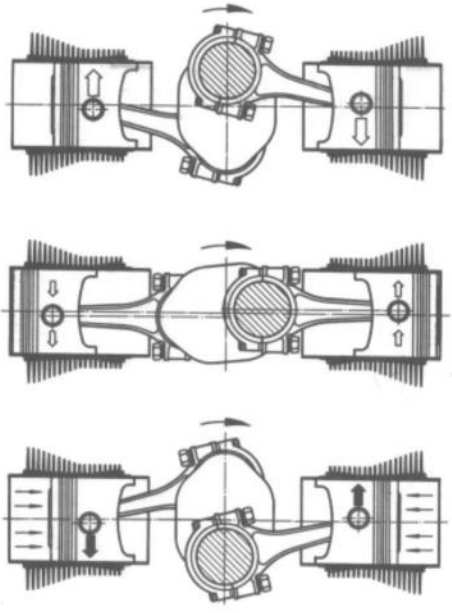
6 - Insert locking rings on pistons of cylinders 1 and 2 on side facing flywheel, on pistons of cylinders 3 and 4 on impeller side.

Center offset of piston pin bore
a = 0.5 mm (.0197")



The piston pin eyes in the piston are offset. When installing the piston, be sure that the arrow or the letters "front" are facing the flywheel.

The offset of the piston head will cause the conrod to change its inclination and the piston to change its contact surface already prior to reaching the piston TDC. Since in this position the combustion has not yet started, the pertinent lateral forces will still be low. The piston will therefore lean smoothly against the other cylinder wall, and not suddenly. This will reduce the chatter noises which occur when the change in pressure will tip the piston, particularly when the piston clearance is high.



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7 - Check and fit piston pin. Depending on occuring tolerances, the piston pin may already slide easily by hand into the piston when it is still cold. This is absolutely normal, even if the piston pin should fall out by its own weight. There is no reason to replace the piston pin, the piston or both, in such a case.

	mm dia. (" dia.)	Clearance in mm (")	Wear limit in mm (")
Conrod bushing	24.015-24.024 (.94547-.94582)	0.015 to 0.028 (.0006 to .0011)	0.04 (.0016)
Piston pin	23.996-24.000 (.94472-.94488)		
Piston pin eye	24.000-24.005 (.94488-.94498)		

If the clearance between the piston pin and the conrod bushing approaches the wear limit of 0.04 mm (.0016"), replace piston pin and fit into a new conrod bushing.

The piston should be heated, whenever a pin does not easily enter the piston. Heat piston to approx. 80°C (176°F) then, slide in piston manually with mandrel VW 207c and without stopping against stop on locking ring.

Insert second locking ring. The locking ring should be seated perfectly and all-around in the pertinent groove of the piston pin eye.

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CHECKING CLEARANCE BETWEEN CYLINDER AND PISTON

Measure clearance not with a feeler gauge but determine by measuring both, the cylinder and the piston.

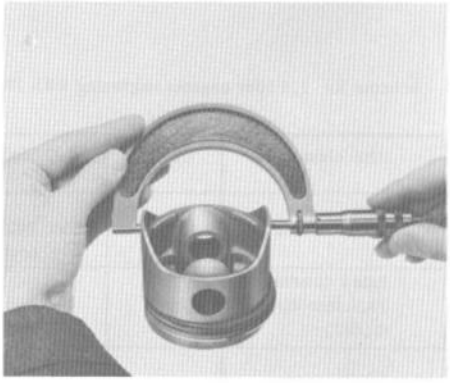
Installation clearance in mm (")	Wear limit in mm (")
0.04-0.06 (.0016 .0024)	0.2 (.0079)

For 1.8 liter engines beginning with 1974 models

Installation clearance in mm (")	Wear limit in mm (")
0.015-0.045 (.0006-.0018	0.2 mm (.0079)

The cylinder is measured with an internal measuring device which has been set first in a screw cage in relation with the size of the cylinder. Measure approx. 10-15 mm (0.4 0.6") below top edge of cylinder.

The rated dia. of the piston is punched in on the top of the piston head. Measurements are made at bottom end of skirt in vertical relation to piston pin axis.



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The subdivision of the cylinders and the pertinent pistons in three different size classes is as follows:

Size class	Colour	Cylinder mm dia.	Pert. piston mm dia.
Standard size Rated dimension 90.0 mm dia. (3.54")	Blue	89.990-89.999 (3.54292-3.54327")	89.95 (3.54134")
	Pink	90.000-90.009 (3.54331-3.54366")	89.96 (3.54173")
	Green	90.010-90.020 (3.54370-3.54409")	89.97 (3.54212")
1st Oversize Rated dimension 90.5 mm dia. (3.56")	Blue	90.490-90.499 (3.56260-3.56295")	90.45 (3.56103")
	Pink	90.500-90.509 (3.56299-3.56334")	90.46 (3.56142")
	Green	90.510-90.520 (3.56338-3.56377")	90.47 (3.56181")
2nd Oversize Rated dimension 91.0 mm dia. (3.58")	Blue	90.990-90.999 (3.58229-3.58264")	90.95 (3.58071")
	Pink	91.000-91.009 (3.58268-3.58303")	90.96 (3.58110")
	Green	91.010-91.020 (3.58307-3.58346")	90.97 (3.58149")

Scheme for 1.8 liter engines beginning with 1974 model

Size class	Colour	Cylinder mm dia.	Pert. piston mm dia.
Standard size	Blue	92,992 - 93,008 (3.66110-3.66173")	92.97 (3.66023")
Rated dimension 93,0 mm dia. (3.66")	Pink	93,002 - 93,018 (3.66149-3.66212")	92.98 (3.66063")
1st Oversize Rated dimension mm dia.			
2nd Oversize Rated dimension mm dia.			

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When the measuring of piston and the pertinent cylinder shows that the operational clearance approaches the value of 0.2 mm (.0079), exchange piston and cylinder together against a set of the same size class (standard size or oversize). The difference of weight of the pistons in one engine should not exceed max. 10 grams. Pistons, with cylinders showing traces of wear, should not be replaced individually. If the pertinent cylinder of a damaged system shows no evidence of wear, the installation of a new piston of the pertinent paired size will often be adequate.
Since the compression ratio must be maintained when reground cylinders are installed, the pertinent oversized pistons are dimensioned pertinently lower. Dimension piston head/piston pin eye.

Caution!

Only cylinders and pistons of the same size class may be installed in one and the same engine.

In addition to the wear test, the oil consumption of the engine is also decisive for the decision whether to install new pistons and cylinders. If the consumption exceeds 1 lit./1,000 km (0.3 US gal/6,200 miles), overhauling the engine is generally required.

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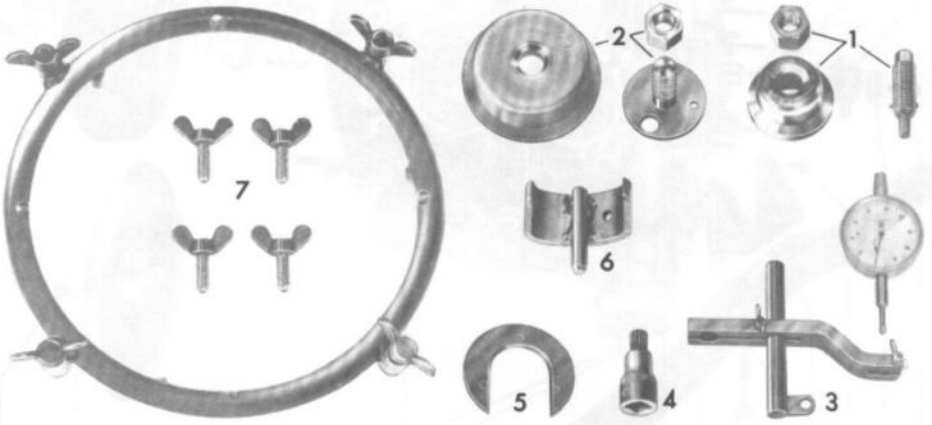
TOOLS



No.	Designation	Special Tools	Explanations
1	Fitting tool for crankshaft sealing ring (impeller end)	VW 190	
2	Fitting tool for crankshaft sealing ring (fly wheel end)	VW 191	
3	Dial gauge holder	VW 659/2	
4	Insert for multi-teeth socket screw M 12		Commercial
5	Plate for impeller hub	VW 185	
6	Holding clip for flywheel	VW 215c	
7	Holding ring for carrier plate	VW 184	

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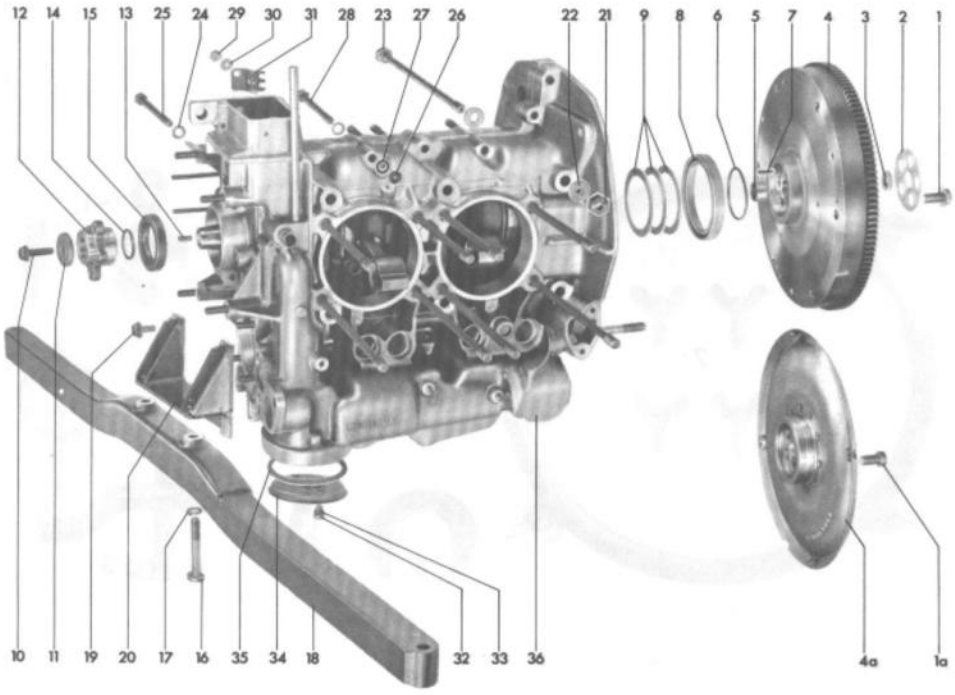

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. screw M 12 x 1.5, self-securing	5		Tighten to 11.0 mkg (79.5 ft. lbs.)	
1a	Multi-tooth socket screw M 12 x 1.5	5	Sportomatic only	With insert M 12, tighten to 8.5 mkg (61.5 ft. lbs.)	
2	Washer	1		Replace	
3	Felt ring for needle bearing	1		Moisten with engine oil	
4	Flywheel	1	Check for wear		6.1-2/1
4a	Carrier plate	1	Sportomatic only	with holding ring VW 184	
5	Needle bearing	1			
6	Rubber sealing ring for flywheel	1		Replace, lubricate slightly	
7	Clamping sleeve	1			

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
8	Sealing ring for crankshaft 95 mm dia. (3.7")	1		Replace, lubricate slightly, install with fitting tool VW 191	6.1-3/1
9	Spacing washer	3		Determine thickness of washer by measuring axial play with dial gauge holder VW 659/2	6.1-2/2
10	Hex. screw M 8 x 30 self-securing	1		Tighten to 3.2 mkg (23.1 ft. lbs.)	
11	Washer	1			
12	Hub for impeller	1	Pull off with 3 screws M 8 and plate VW 185		6.1-3/1
13	Plate spring	1			
14	Rubber sealing ring for hub	1		Replace, lubricate slightly	
15	Sealing ring for crankshaft 62 mm dia. (2.4")	1		Replace, lubricate slightly, use fitting tool VW 190	6.1-3/1
16	Hex. socket screw	2			
17	Spring ring	2			
18	Engine mount	1			
19	Hex. screw M 8, self-securing	4		Tighten to 3.0 mkg (21.7 ft. lbs.)	
20	Support for engine mount	1			
21	Sealing nut M 10 x 1.25	6		Sealing ring outwards, tighten to 3.0 mkg, replace damaged nuts, coat with sealing compound D 3	
22	Washer	12			
23	Hex. screw M 10 x 1.25 x 213	6		Coat screw heads with sealing compound D 3	
24	Sealing ring	1		Replace	
25	Hex. screw M 8 x 113 oil tube attachment	1			
26	Hex. nut	10		Tighten to 2.0 mkg (14.5 ft. lbs.)	
27	Spring washer	20			
28	Hex. screw M 8	5			
29	Hex. nut M 6	2			
30	Spring washer	2			
31	Ignition cable holder	1			

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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
32	Hex. screw M 6	2			
33	Sealing ring	2		Replace	
34	Cover for oil pan	1			
35	Sealing ring for cover	1		Replace	
36	Crankcase	1	Check for wear		6.1-3/2

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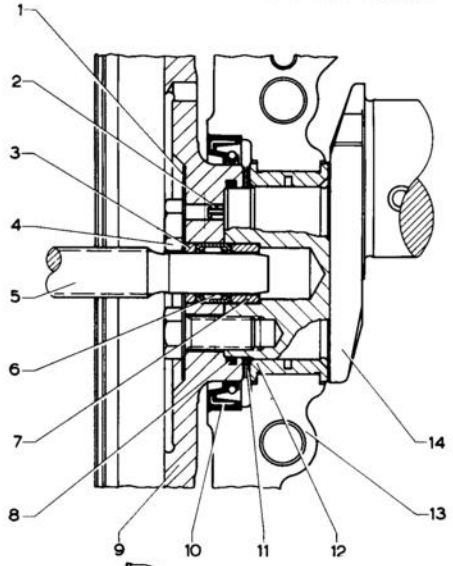
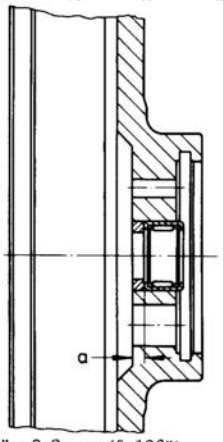
CHECKING AND INSTALLING FLYWHEEL

1 - Washer
2 - Clamping sleeve
3 - Felt ring
4 - Hex. screw
5 - Drive shaft
6 - Needle bearing
7 - Spacing ring
8 - Rubber sealing ring for flywheel
9 - Flywheel
10 - Sealing ring for crankshaft
11 - Spacing washers
12 - Crankshaft bearing 1
13 - Crankcase
14 - Crankshaft





"a" = 3.2 mm (0.126")

Checkup

1 - Check flywheel for perfect toothing. Damaged teeth can be turned off from clutch end up to max. 2 mm (.08"). Following the deburring, chamfer tips of teeth again.

2 - Check bores for hex. screws and clamping sleeve. If bores are worn out, replace flywheel.

3 - Watch out for correct seat of needle bearing.

4 - The contact surface for the clutch lining must be free from oil, grease and preservation agents, clean, if required.

Installation

1 - Grease needle bearing in flywheel only with approx. 0.2 cm^3 (0.012 cu.in.) multi-purpose grease, if bearing has been washed. Moisten felt ring with engine oil. Wipe off excess lubricant.

2 - When tightening hex. bolts, hold flywheel with holding clamp VW 215c.

3 - Adjust axial play of crankshaft.

4 - Lubricate running surface for sealing ring.

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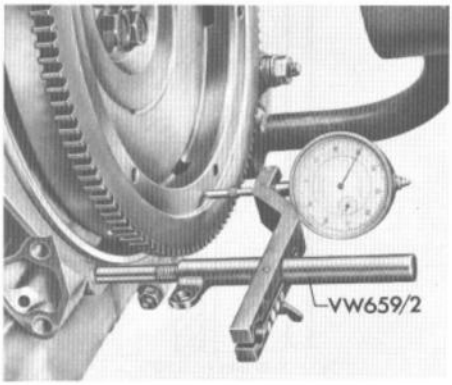
AXIAL PLAY OF CRANKSHAFT

Checking the Axial Play

The axial play of the crankshaft is 0.07 to 0.13 mm (.0028-.0051"). Wear limit is 0.15 mm (.0059"). The axial play is measured with the engine assembled and the flywheel screwed on.

1 - Screw dial gauge holder VW 659/2 (self-made) to an engine attachment stud of the crankcase.

2 - Move crankshaft back and forth in axial direction. The axial play is indicated on a dial gauge.



Adjusting the Axial Play

1 - Install flywheel with two spacing washers (but without sealing rings for crankshaft and flywheel).

2 - Screw dial gauge holder VW 659/2 (self-made) with one dial gauge to crankcase.

3 - Move crankshaft back and forth in axial direction. Read axial play on dial gauge.

4 - Compute thickness of third spacing washer:
Measuring result
- 0.10 mm mean axial play
= 3rd spacing washer.

5 - Remove flywheel.

6 - Insert sealing rings for crankshaft and flywheel, as well as felt ring.

7 - Install flywheel with all three spacing washers and new supporting ring.

8 - Check axial play again.

Spacing washers are provited in the following sizes:

0.24 mm (.0094")	0.34 mm (.0134")
0.30 mm (.0118")	0.36 mm (.0142")
0.32 mm (.0126")	0.38 mm (.0150")

The thickness of each washer is etched in for proper identification. Measure thickness with screw gauge, if required. Always install three spacing washers for the required total thickness.

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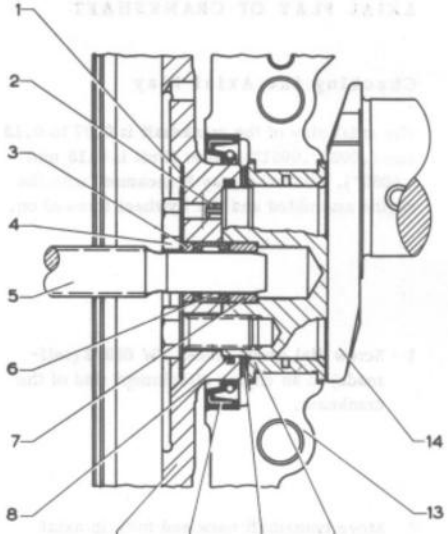
CHECKING AND INSTALLING FLYWHEEL

1 - Washer
2 - Clamping sleeve
3 - Felt ring
4 - Hex. screw
5 - Drive shaft
6 - Needle bearing
7 - Spacing ring
8 - Rubber sealing ring for flywheel
9 - Flywheel
10 - Sealing ring for crankshaft
11 - Spacing washers
12 - Crankshaft bearing 1
13 - Crankcase
14 - Crankshaft



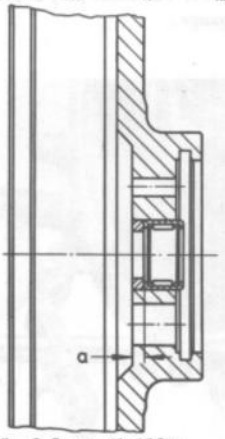
Checkup

1 - Check flywheel for perfect toothing. Damaged teeth can be turned off from clutch end up to max. 2 mm (.08"). Following the deburring, chamfer tips of teeth again.

2 - Check bores for hex. screws and clamping sleeve. If bores are worn out, replace flywheel.

3 - Watch out for correct seat of needle bearing.

4 - The contact surface for the clutch lining must be free from oil, grease and preservation agents, clean, if required.



"a" = 3,2 mm (0.126")

Installation

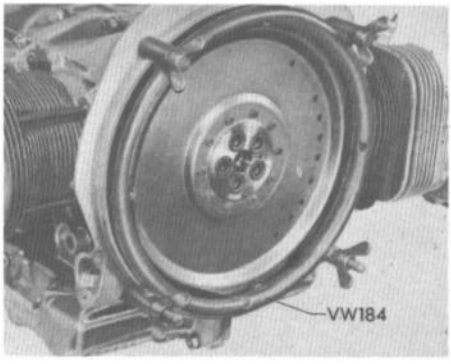
1 - Grease needle bearing in flywheel only with approx. 0.2 cm^3 (0.012 cu.in.) multi-purpose grease, if bearing has been washed. Moisten felt ring with engine oil. Wipe off excess lubricant.

2 - When tightening hex. bolts, hold flywheel with holding clamp VW 215c.

3 - Adjust axial play of crankshaft.

4 - Lubricate running surface for sealing ring.

Remark:
On engines of vehicles with a Sportomatic transmission, the flywheel is replaced by a carrier plate screwed to the crankshaft with five multi-tooth socket screws. The felt ring and the needle bearing in the flywheel are also eliminated. When loosening and tightening the multi-tooth socket screws, hold carrier plate with holding ring VW 184.



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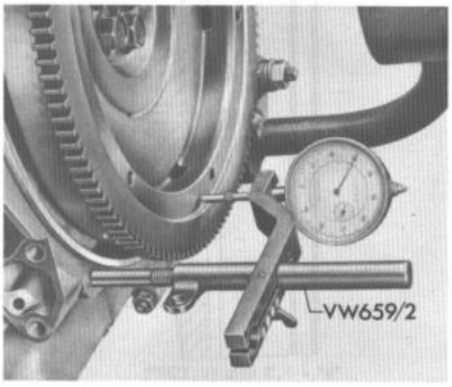
AXIAL PLAY OF CRANKSHAFT

Checking the Axial Play

The axial play of the crankshaft is 0.07 to 0.13 mm (.0028-.0051"). Wear limit is 0.15 mm (.0059"). The axial play is measured with the engine assembled and the flywheel screwed on.

1 - Screw dial gauge holder VW 659/2 (self-made) to an engine attachment stud of the crankcase.

2 - Move crankshaft back and forth in axial direction. The axial play is indicated on a dial gauge.



Adjusting the Axial Play

1 - Install flywheel with two spacing washers (but without sealing rings for crankshaft and flywheel).

2 - Screw dial gauge holder VW 659/2 (self-made) with one dial gauge to crankcase.

3 - Move crankshaft back and forth in axial direction. Read axial play on dial gauge.

4 - Compute thickness of third spacing washer:
Measuring result
- 0.10 mm mean axial play
= 3rd spacing washer.

5 - Remove flywheel.

6 - Insert sealing rings for crankshaft and flywheel, as well as felt ring.

7 - Install flywheel with all three spacing washers and new supporting ring.

8 - Check axial play again.

Spacing washers are provited in the following sizes:

0.24 mm (.0094")	0.34 mm (.0134")
0.30 mm (.0118")	0.36 mm (.0142")
0.32 mm (.0126")	0.38 mm (.0150")

The thickness of each washer is etched in for proper identification. Measure thickness with screw gauge, if required. Always install three spacing washers for the required total thickness.

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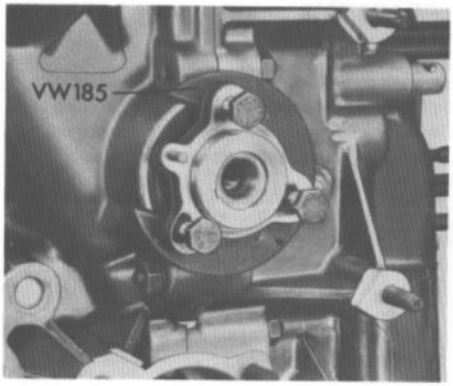
REMOVAL AND INSTALLATION OF SEALING RINGS FOR CRANKSHAFT

Removal

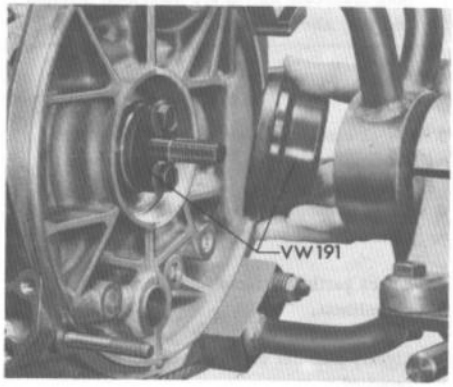
Prior to removing sealing ring on impeller end, force off impeller hub with the assistance of plate VW 185.



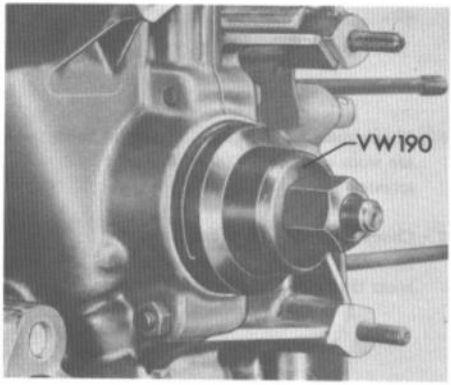
Installation

1 - Clean seats for sealing rings in crankcase and coat thinly with sealing compound. Chamfer outer edges with scraper, if required, so that the circumference of the sealing rings is not damaged. Remove chips.

2 - Insert new sealing ring on flywheel end with fitting tool VW 191. For this purpose, screw tool into crankshaft and tighten guide piece with sealing ring attached. The sealing ring should be seated on the base of the recess of crankcase and should not be out of alignment.



3 - Insert new sealing ring on impeller end with fitting tool VW 190.



4 - Lubricate running surfaces for sealing rings on flywheel or impeller hub, respectively.

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DISASSEMBLY AND ASSEMBLY OF CRANKCASE

Disassembly

Loosen righthand crankcase half with assistance of a rubber hammer. The parting surfaces of the housing may not be damaged by sharp-edged objects, for example a screw driver.

Checkup

> Caution!
>
> Both crankcase halves are machined together and may also be exchanged only together.

1 - Check crankcase for external damage and cracks.

2 - Clean parting surfaces with solvent from residue of old sealing compound.

3 - Check parting surfaces for planeness and cleanliness.

4 - Lightly chamfer edges of bearing bores, if required.

5 - Flush oil ducts and blow out with compressed air.

6 - Check studs for tight seat. If tapped holes are worn out, Heli-Coil inserts may be screwed in.

7 - Check tapped bores in housing.
Dia: 24.00-24.02 mm (.9449-.9457")
Wear limit: 24.05 mm dia. (.9469")

8 - Assemble crankcase and tighten to specified torques. Check housing bores for crankshaft bearing with internal measuring gauge and screw gauge.

Bore in crankcase	mm dia. (" dia.)	Wear limit mm dia. (" dia.)
Crankshaft bearings 1-3	70.00-70.02 (2.7559-2.7567")	70.03 (2.7571")
Crankshaft bearing 4	50.00-50.03 (1.9685-1.9697")	50.04 (1.9701")
Camshaft bearings 1-3	27.50-27.52 (1.0827-1.0835")	27.54 (1.0843")
Sealing ring flywheel end	95.00-95.05 (3.7401-3.7421")	
Sealing ring impeller end	62.00-62.05 (2.4409-2.4429")	
Oil pump housing	70.00-70.03 (2.7559-2.7571")	

Assembly

1 - Coat parting surfaces of housing halves uniformly thin with sealing compound. Never permit sealing compound to enter the oil ducts of the crankshaft and camshaft bearings.

2 - Assemble housing halves and lightly screw down fastening screw for oil intake pipe with new sealing ring first.

3 - Then screw on sealing nuts M 10 x 1.25 with the sealing ring on the outside and tighten.

4 - Then tighten hex. nuts M 8 and M 6.

5 - Rotate crankshaft to check for easy running.

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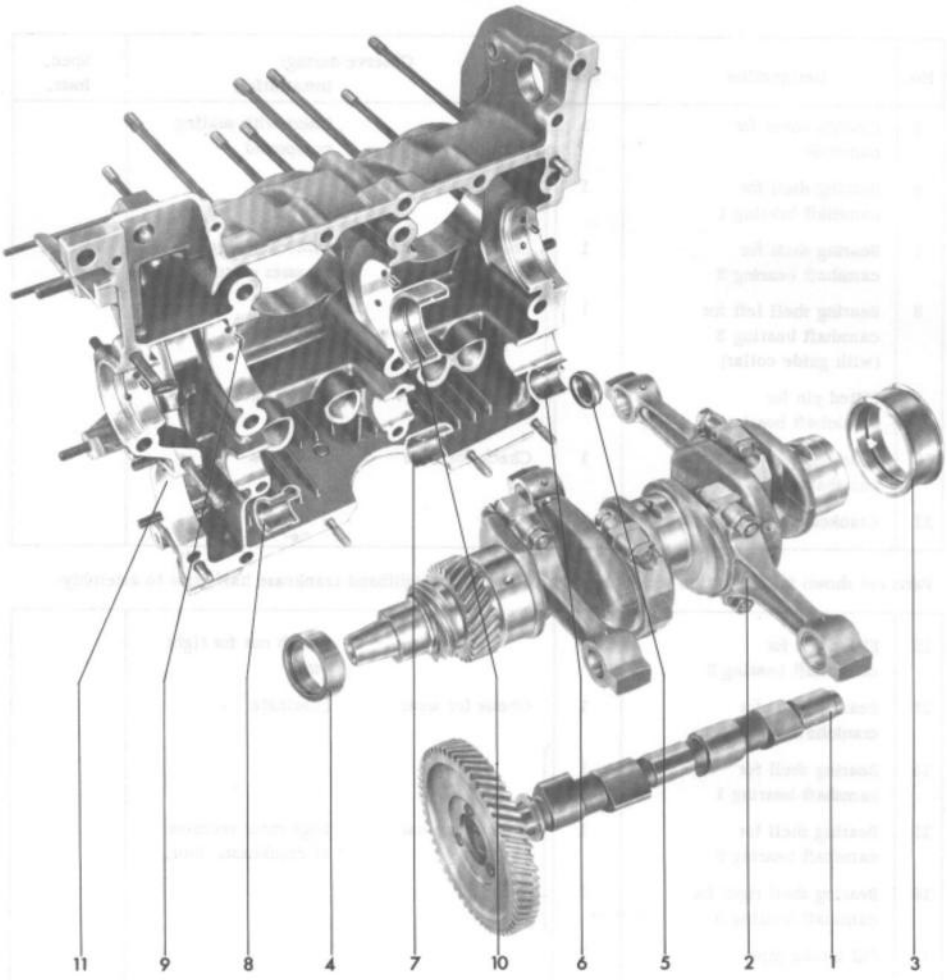

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Camshaft		Check for wear	Watch our for pairing and installation position in relation to crankshaft	6.2-2/1
2	Crankshaft with conrods				6.2-2/2
3	Crankshaft bearing I		Check for wear	Lubricate, bore for fitted pin points toward flywheel	
4	Crankshaft bearing 4		Check for wear	Lubricate, groove points toward impeller	

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No.	Designation	Each	Observe during: Removal	Installation	Spec. Instr.
5	Closing cover for camshaft	1		Insert with sealing compound	
6	Bearing shell for camshaft bearing 1	1			
7	Bearing shell for camshaft bearing 2	1	Check for wear	Lubricate, lugs enter recesses of crankcase	
8	Bearing shell left for camshaft bearing 3 (with guide collar)	1			
9	Fitted pin for crankshaft bearing	4		Watch out for tight seat	
10	Bearing shell for camshaft bearing 2	1	Check for wear	Lubricate	
11	Crankcase housing left	1			

Parts not shown in illustration which must be inserted into righthand crankcase half prior to assembly:

12	Fitted pin for crankshaft bearing 2	1		Watch out for tight seat	
13	Bearing shell for crankshaft bearing 2	1	Check for wear	Lubricate	
14	Bearing shell for camshaft bearing 1	1			
15	Bearing shell for camshaft bearing 2	1	Check for wear	Lugs enter recesses of crankcase, lubr.	
16	Bearing shell right for camshaft bearing 3	1			
17	Oil intake pipe	1			
18	Sealing ring for oil intake pipe	1		Replace	

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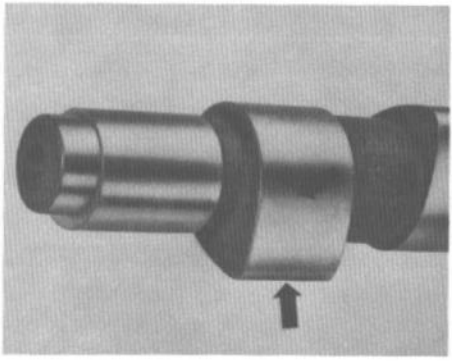
INSPECTION AND INSTALLATION OF CAMSHAFT

Checkup

1 - Check riveting of camshaft gear and camshaft.

2 - Check camshaft for wear on bearing points and cams. (Starting zone uneven, cam contact surface in axial direction showing angular wear).

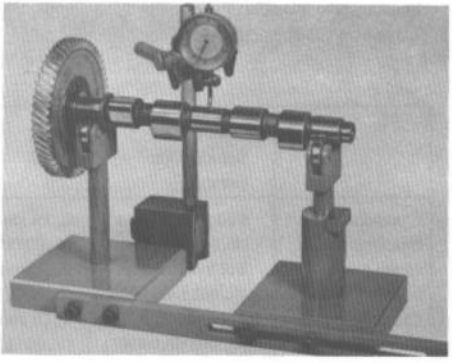


3 - Check camshaft for out-of-true.

During installation (new): max. 0.02 mm (.0008")

Wear limit: max. 0.04 mm (.0016")

(measured on center bearing; bearing 1 and 3 on V-blocks)



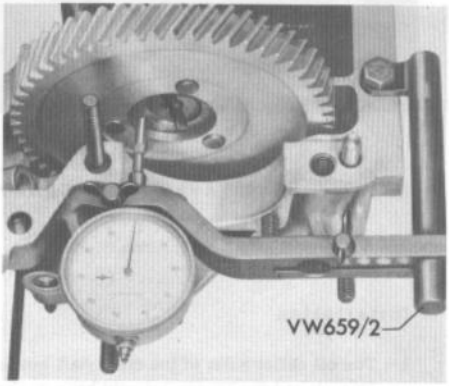
4 - Check camshaft gear for wear and perfect contact pattern.

5 - Check axial play.

The axial play on guide bearing is:

0.04-0.13 mm (.0016-.0051")

Wear limit: 0.16 mm (.0063")



6 - Check backlash along entire circumference of camshaft gear.

The backlash between camshaft and crankshaft gear is: 0.00-0.05 mm (.002"). The camshaft gear has the correct size, when the play is hardly felt and when the camshaft does not rise when the crankshaft is turned backwards. To facilitate establishing the specified play, camshafts with camshaft gears are available in several sizes carrying different part numbers. The gears are marked on the surface facing the cams by punched-in numbers, for example, -1, 0, +1, +2 etc. The number indicates by how many 1/100 mm the pitch circle radius differs from the drawing dimension 0.

Caution!
Do not confuse the numeral 0 with the symbol 0 which serves for adjusting the timing gears. The crankshaft gears require no differentiation and no identification.

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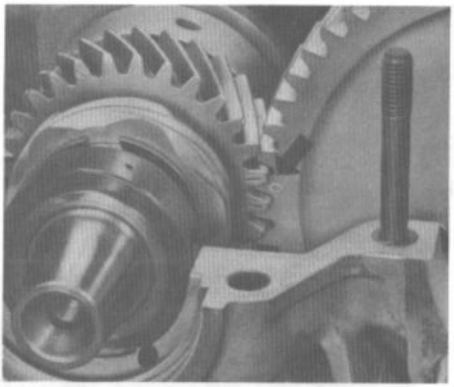


Installation

Install camshaft gear in such a manner that the tooth marked with 0 is located between the two teeth of the crankshaft gear which are identified by a punch mark.

INSTALLING PREASSEMBLED CRANKSHAFT

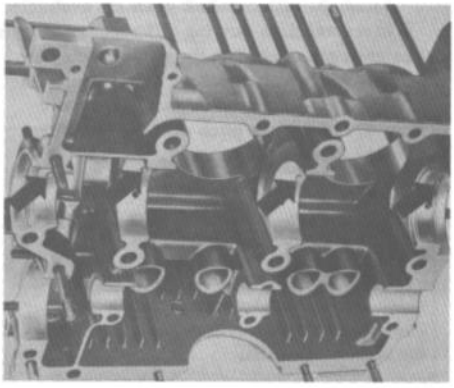
Installation

1 - The oil outlet holes of the crankshaft bearing journals and the bearings should have no sharp edges. If metallic foreign bodies are embedded in main bearings, remove with sharp scraper. Do not damage bearing shell.

2 - Check set pins for tight seat.

3 - Watch out for perfect fit of set pins in crankshaft bearings.

4 - Observe markings of timing gears when installing camshaft.



Bearing play, taking bearing pressure through housing into account:

	During installation (new)	Wear limit
Crankshaft bearings 1+3	0.04-0.10 mm (0.0016-0.0039")	0.18 mm (0.0071")
Crankshaft bearing 2	0.03-0.09 mm (0.0012-0.0035")	0.17 mm (0.0067")
Crankshaft bearing 4	0.05-0.10 mm (0.002-0.0039")	0.19 mm (0.0075")

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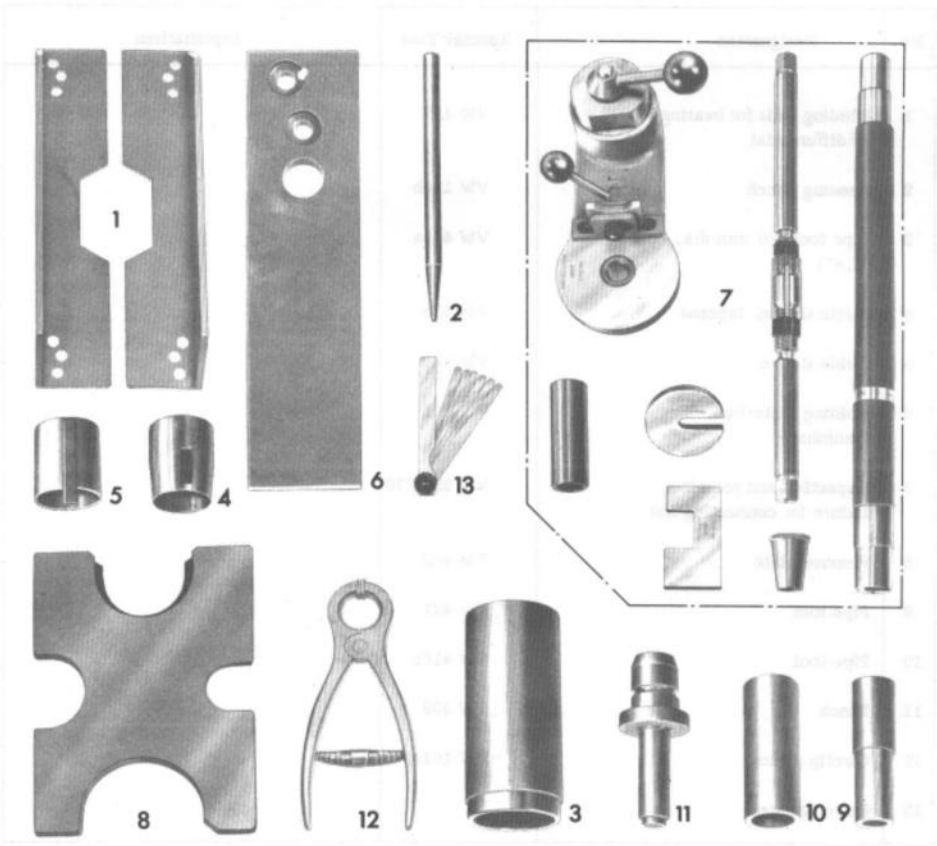
TOOLS



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