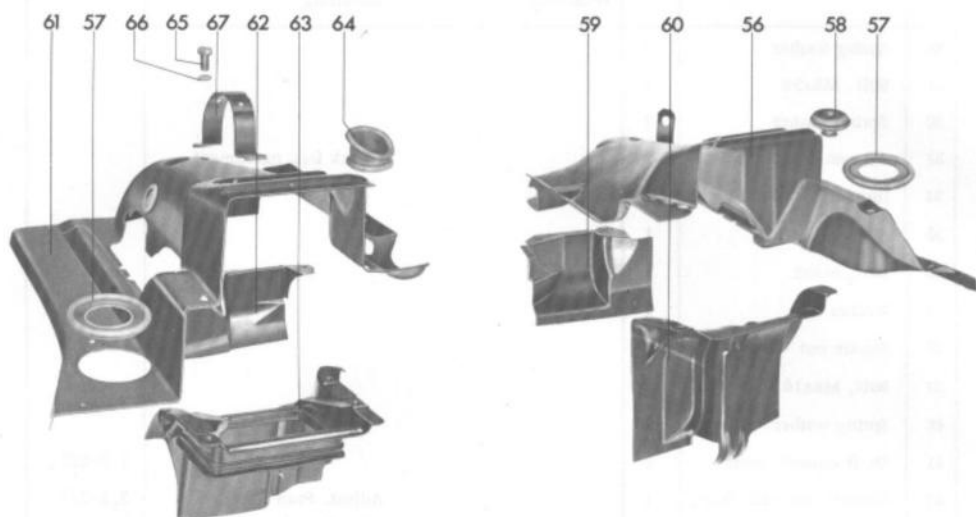


No.	Description	Qty	Note when		References
			removing	installing	
30	Spring washer	3			
31	Bolt, M6x20	7			
32	Spring washer	7			
33	Air non-return flap	2		Check free movement	
34	Inspection hole cover	1			
35	Plug	1			
36	Bolt, M4x8	1			
37	Washer	1			
38	Square nut	1			
39	Bolt, M6x10	2			
40	Spring washer	2			
41	Shaft support spring	2			3, 3-2/2
42	Control flap with shaft, right side	1		Adjust. Push flap into closed position and tighten cable	3, 3-2/3
43	Support bearing	2			
44	Control flap link	1			
45	Control flap, left side	1			
46	Buffer	1			
47	Bolt, M6	1			
48	Cooling air control cable pulley	1		Check free movement	
49	Sealing grommet	1			
50	Cooling air control cable	1	Detach prior to removal of cooling blower housing		
51	Bolt, M8x15	1			
52	Washer	1			
53	Thermostat washer	1			
54	Thermostat	1		Test through submersion in water	3, 3-2/3



No.	Description	Qty	Note when		References
			removing	installing	
56	Cylinder shroud, right	1			
57	Connecting duct grommet	2			
58	Cable grommet	1			
59	Warm air duct, right front	1			
60	Warm air duct, left front	1			
61	Cylinder shroud, left	1			
62	Warm air duct, left front	1			
63	Warm air duct, left rear	1			
64	Oil pressure switch protector	1			
65	Bolt, M6	2			
66	Spring washer	2			
67	Ignition coil strap				

CHECKING AND ADJUSTING V-BELT TENSION

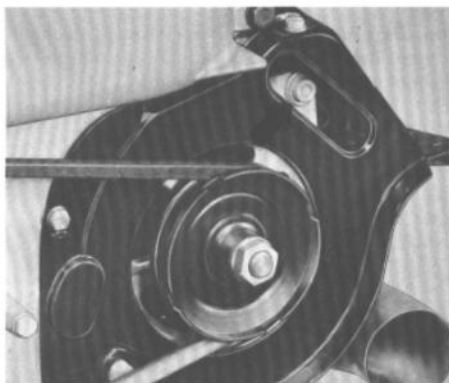


Fig. 1



Fig. 2

REMOVING AND INSTALLING COOLING AIR BLOWER HOUSING

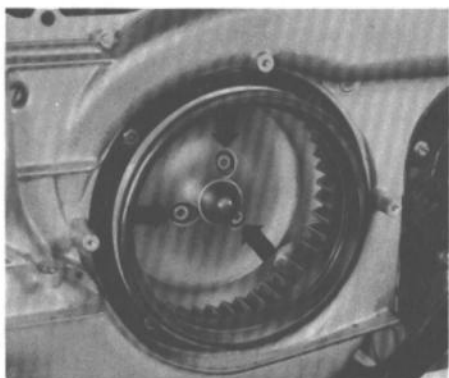


Fig. 3

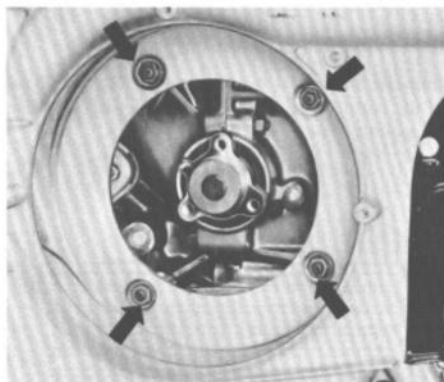
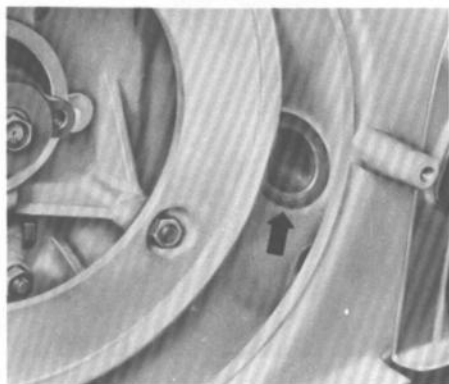


Fig. 4

NOTE

The cooling air blower can be removed with alternator installed.

Removing and Installing Cooling Air Blower Housing

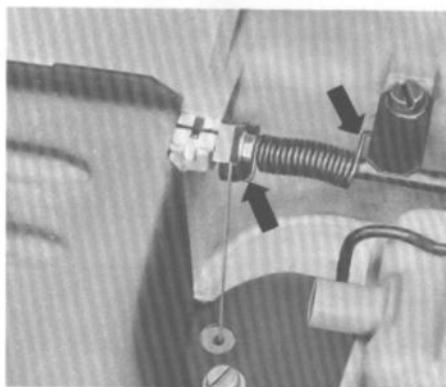


Removal

Upon removal of the shaft support spring, the right control flap and shaft can be taken out and the left control flap disconnected.

Installation

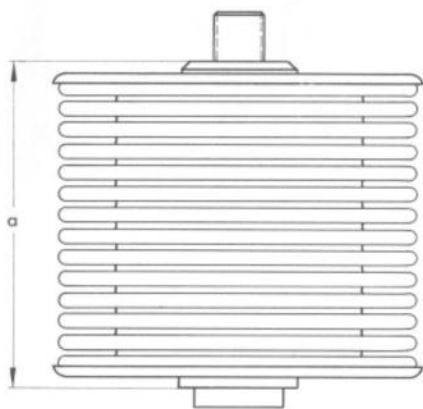
The bent ends of the return spring must rest against the casting lug for the shaft support spring on one side, and behind the control cable guide on the other.



THERMOSTATIC COOLING AIR CONTROL

Checking Thermostat

Immerse thermostat in warm water. The length (a) of the unit should be at least 46 mm with water temperature 65-70° C



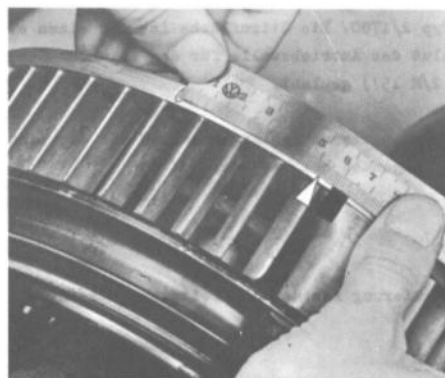
REPLACING COOLING BLOWER IMPELLERS

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

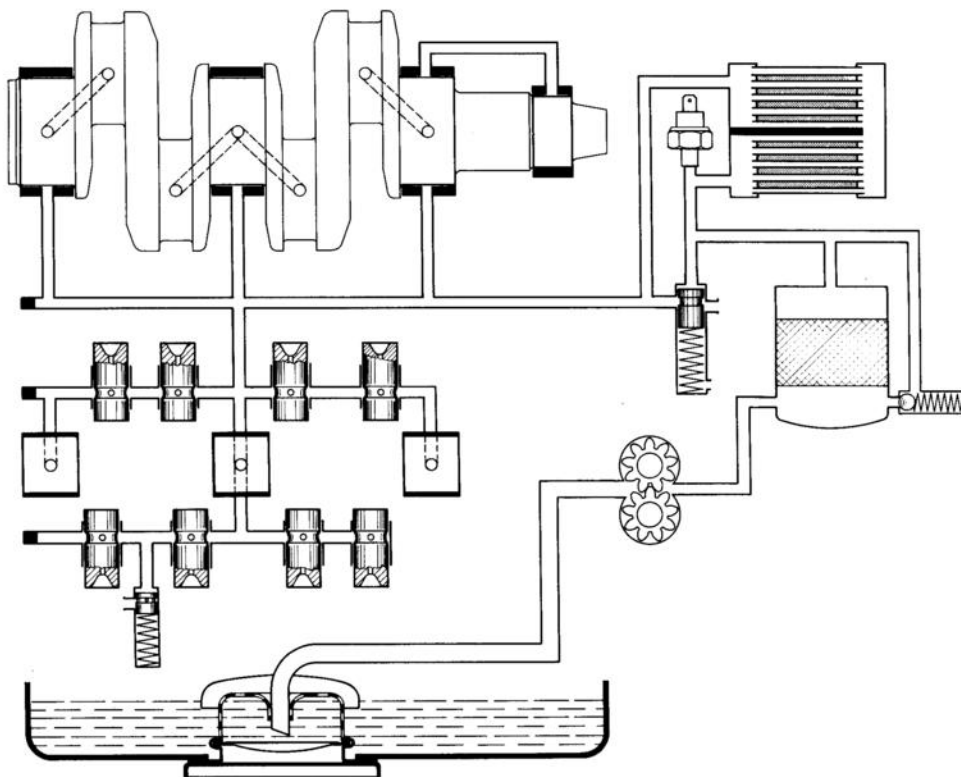
Making Timing Notch

1. Scratch-mark location of timing mark (from TDC) with aid of a flexible measuring tape.
2. Make timing notch with a triangular file.
3. Mark notch with red paint.



DESCRIPTION

The oil pump draws oil from the crankcase sump, through a screen, and forces it into the oil galleries through the oil filter and oil cooler. Part of the oil flows to the crankshaft main bearings and from there to the connecting rod bearings through passages in the crankshaft. The remainder of the oil flows through the hollow push rods to passages in the rocker arms where it lubricates the rocker arm bushings. Valve stems are lubricated through oil splash and oil mist. The oil returns to the crankcase sump through push rod cover tubes. The cylinder walls, pistons, and piston pins are also splash-lubricated. Oil returning from all lubricating points (and the oil pressure relief valve located at the end of the oil circuit) collects in the crankcase sump from where it is again picked up by the oil pump.



Oil capacity:

with oil filter change 3,5 ltrs.
without oil filter change 3,0 ltrs.

Oil dipstick:

upper mark - max. level
lower mark - min. level (3,0 ltrs)

Oil pressure:

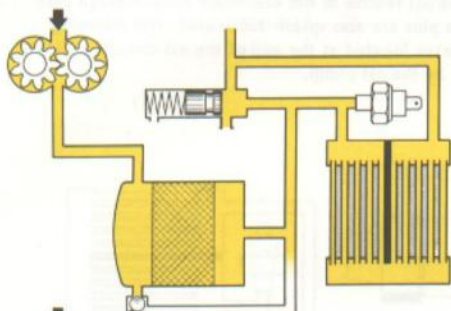
(measured at oil pressure switch; applies only
to SAE 30 oils)
oil temperature of 70° C
at 2500 rpm: 4,4 bar (4,5 atm)
min. 2,0 bar (2,0 atm)

Oil Pressure Control Valves

The flow of oil through the oil cooler is controlled by a pressure relief valve which is located ahead of the oil cooler.

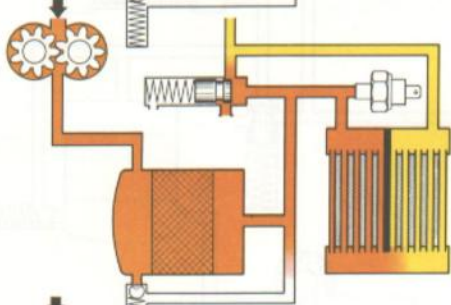
a - When the oil is cold and thick,

oil pressure is very high,
control plunger in lowest position,
oil flows directly to lubricating points.



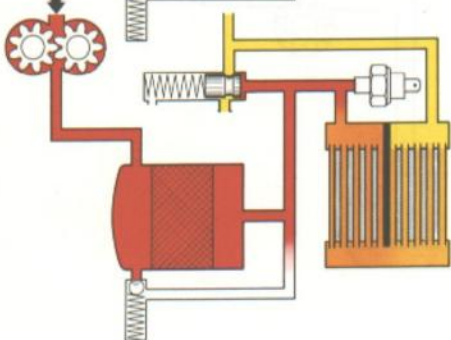
b - As the oil warms up and becomes thinner,

oil pressure decreases,
oil flows to lubricating points in part directly,
and in part through the oil cooler.



c - As the oil is at operating temperature and thin,

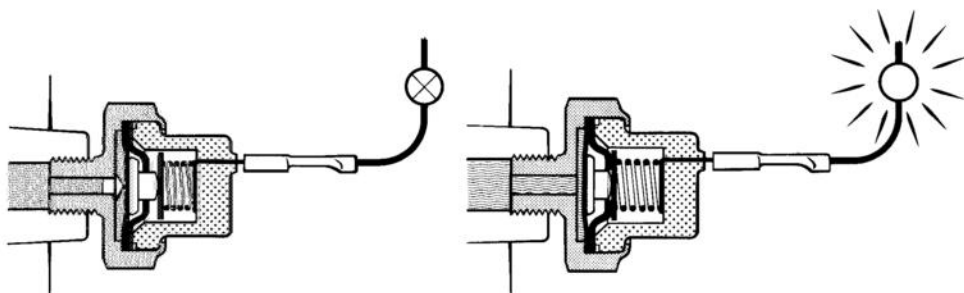
oil pressure is low,
control plunger in highest position,
oil is forced to pass through oil cooler prior to
reaching the lubricating points.



An oil pressure control valve, located at the end of the oil circuit, maintains an oil pressure of approx. 2,0 bar (2,0 atm) within the crankshaft and camshaft bearing areas.

Oil Pressure Switch

The oil pressure switch and warning light indicates low oil pressure in the oil circuit.

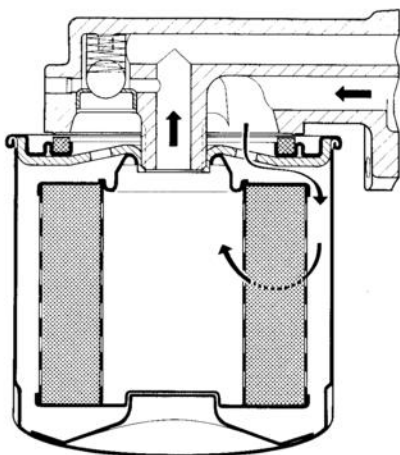


a - Oil pressure rises when engine is started:
contact opens between 0.15 and 0.44 bar
(0.15-0.45 atm),
warning light goes out.

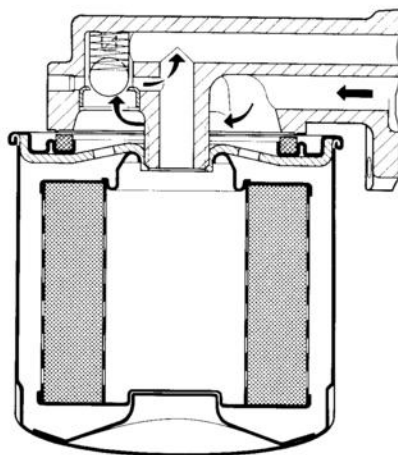
b - If oil pressure is too low with engine running:
contact closes,
warning light goes on.

Oil Filter

The full-flow oil filter entraps even very small dirt particles. A bypass valve in the oil filter base ensures that the oil will continue to flow even if the filter should become clogged.

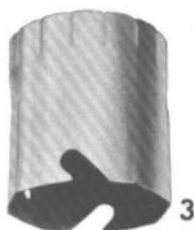
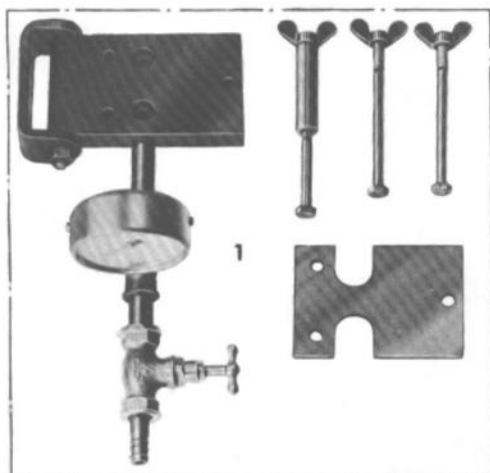


a - Normal oil path.

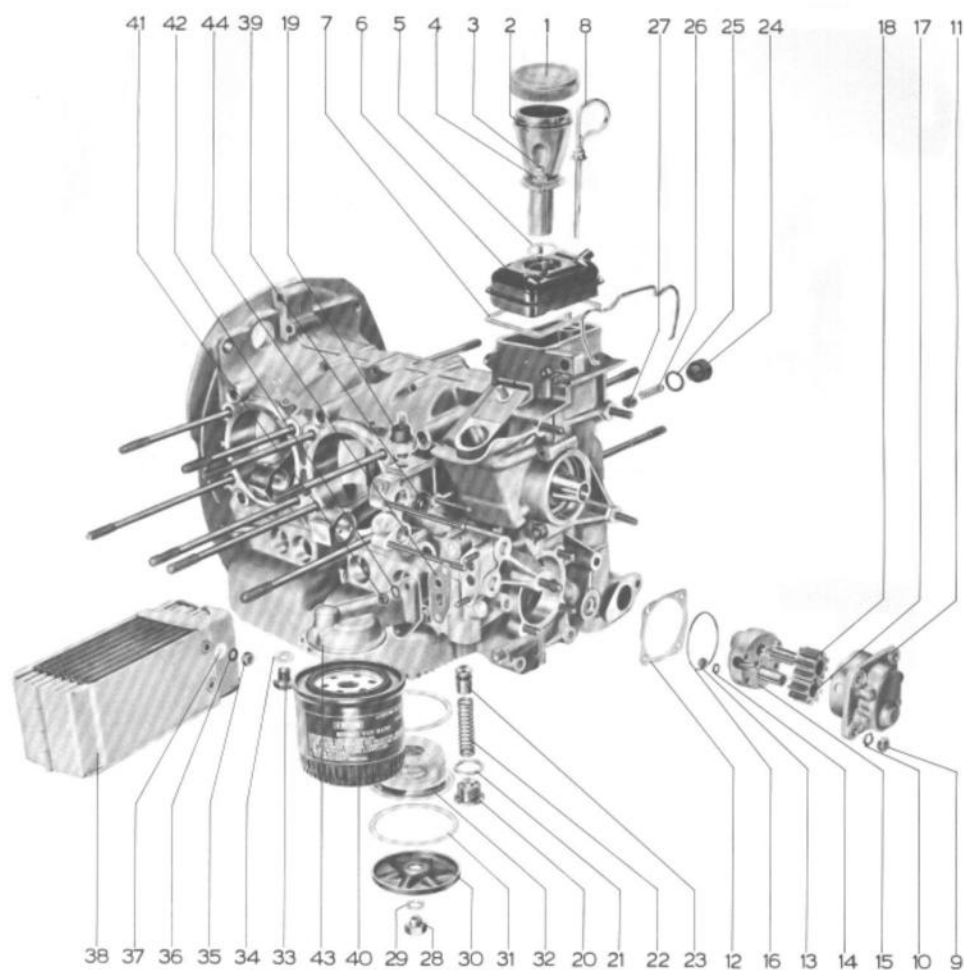


b - Oil bypassing a clogged filter.

TOOLS



No.	Description	Special Tool	Remarks
1	Oil cooler tester	VW 661/2	
2	Oil pump cover puller	VW 803	
3	Oil filter socket		Local purchase item
4	Internal head socket, M 14		Local purchase item
5	Oil pressure and oil pressure switch test set		
6	Oil pressure switch wrench		Local purchase item



No.	Description	Qty	Note when		References
			removing	installing	
1	Oil filler cap	1			
2	Oil filler neck	1			
3	Nut, M6	2			
4	Spring washer	2			
5	Oil filler gasket	1		Replace	
6	Oil breather	1			
7	Gasket	1		Replace	
8	Dipstick	1			
9	Nut, M8	4		Torque to 19,6 Nm (2,0 mkg)	
10	Spring washer	4			
11	Oil pump housing	1	Use 2 levers. Check for wear (esp. pump gear seats).	Clean gasket area. Turn crankshaft twice to center pump, tighten nuts.	Fig. 1
12	Oil pump housing gasket	1		Replace	
13	Self-locking nut, M6	4			
14	Spring washer	4			
15	Oil pump cover	1	Use VW 803 puller. Check for traces of wear.		Fig. 2
16	Pump cover O-ring	1		Replace. Oil.	
17	Pump gear	1	Check for wear.	Oil. Check for free movement.	
18	Pump drive shaft	1	Check for wear.	Oil. Lug must be flush with slot in camshaft.	
19	Oil pressure switch	1			4, 1-3/1
20	Plug, M22x1.5				

No.	Description	Qty	Note when		References
			removing	installing	
21	Gasket	1		Replace	Fig. 3
22	Spring for oil pressure relief valve (bottom)	1		Check: spring length compressed: 39,0 mm load: 66,7-86,3 N (6,8-8,8 kg)	
23	Pressure relief plunger	1	Check for wear	Carefully smooth scoring marks. Pull out with thread tap, if necessary	
24	Plug, M16x1,5	1	Use internal head socket M14		
25	Gasket	1		Replace	
26	Spring for oil pressure control valve (side)	1		Check: spring length compressed: 16,8 mm; load: 42,7 N (4,35 kg)	
27	Pressure control plunger	1	Check for wear	Carefully smooth scoring marks. Pull out with thread tap, if necessary	
28	Retaining nut, M8	1		Max. torque 12,7 Nm (1,3 mkg)	
29	Gasket	1		Replace	
30	Oil Strainer cover	1		Gasket surface must be straight. Clean thoroughly	
31	Gasket	2		Replace	
32	Oil strainer	1		Clean. Check for damage	
33	Drain plug	1		Torque to 21,6 Nm (2,2 mkg)	
34	Gasket	1		Replace	
35	Nut, M6	3			
36	Spring washer	3			
37	Washer	3			
38	Oil cooler	1	Check shrouding for firm attachment. Check for leaks with oil cooler tester VW 661/2, test pressure 5,9 bar (6,0 atm). If defective, check oil pressure relief valve.		
39	Oil cooler gasket	2		Replace	

No.	Description	Qty	Note when		References
			removing	installing	
40	Oil filter	1		Clean sealing surface and oil lightly. Tighten oil filter with oil filter socket	4.1-3/2
41	Nut, M6	2			
42	Spring washer	2			
43	Oil filter base	1		Clean sealing surface	
44	Gasket	1		Replace	

Removing Oil Pump

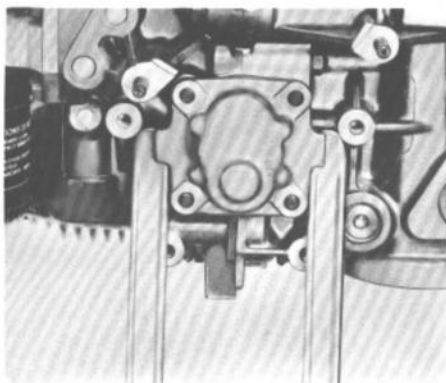


Fig. 1



Fig. 2

Checking Oil Cooler

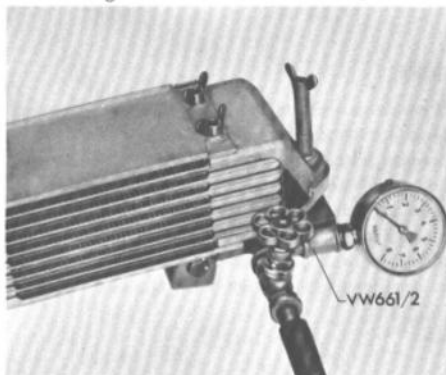
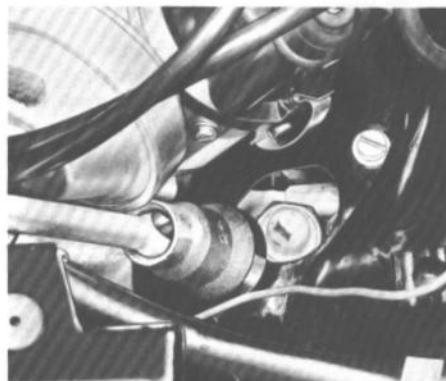


Fig. 3

Checking Oil Pressure Switch

The test is accomplished with engine at operating temperature using a standard tester with pressure gauge and warning lamp.

- 1 - Remove oil pressure switch and screw into tester,



- 2 - Install tester in crankcase in place of the oil pressure switch. Connect warning lamp between oil pressure switch and terminal 15 in the ignition coil. Switch the ignition on; lamp must light. If the lamp does not light, replace switch.



- 3 - Start engine. Observe that pressure will rise on the pressure gauge and the light will go out as the engine rpm increase. The switch contact should remain closed and the lamp lit as long as the oil pressure is below 0,15-0,44 bar (0,15-0,45 atm).
- 4 - Stop engine. A slight delay may occur before the lamp lights up as drops slowly.
- 5 - The tapered threads seal the oil pressure switch. The switch should not be overly tightened to prevent damaging the treads.

Installing Oil Filter



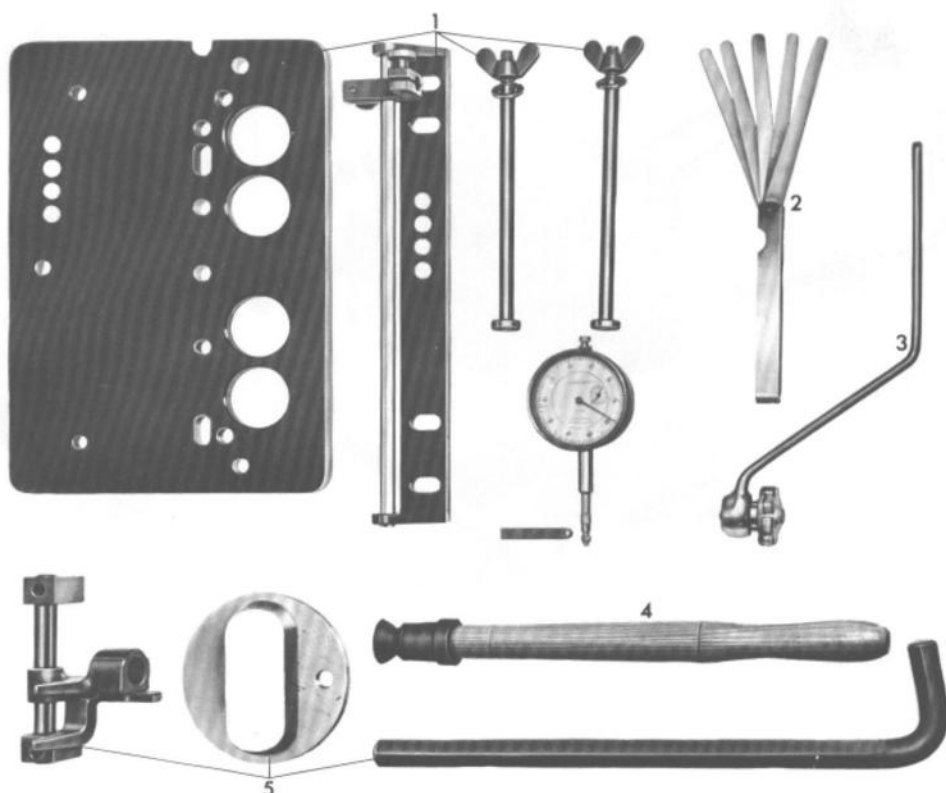
CAUTION

Washing and cleaning of the oil filter is not permissible!

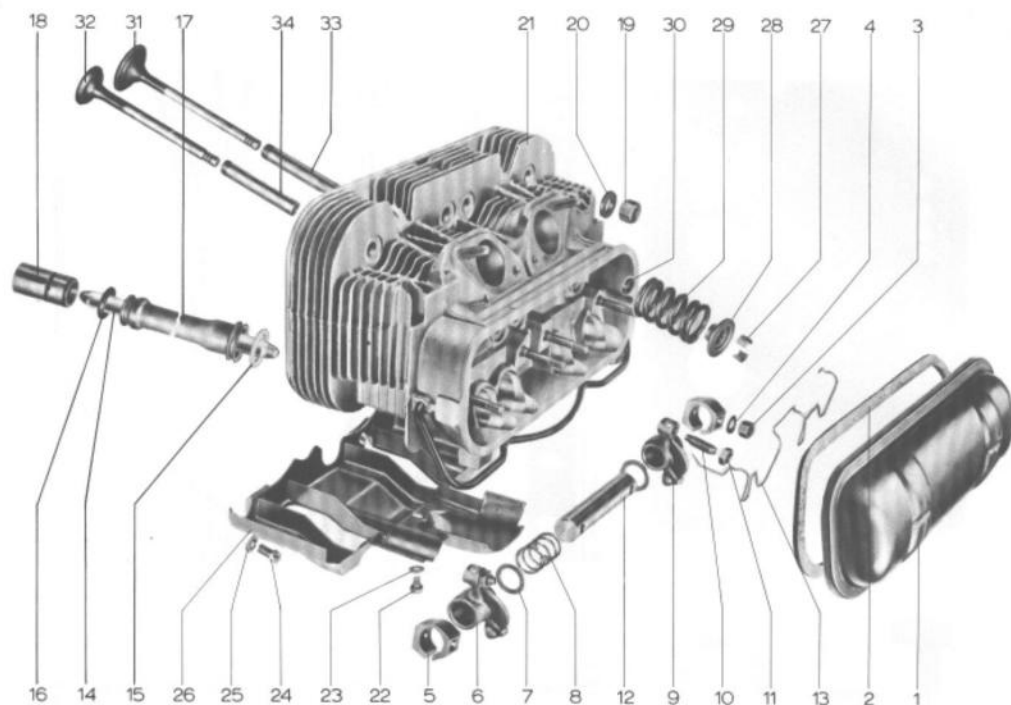
NOTE

If problems occur in the oil circuit, and whenever leaks are found in the oil cooler, check the pressure relief valve. If the pressure relief plunger is stuck in the upper end of its cylinder, cold, thick oil may cause a leak in the oil cooler. If the plunger is stuck in the lower part of its cylinder, oil will flow directly into the crankcase resulting in insufficient lubrication in a warm engine.

TOOLS



No.	Description	Special Tool	Remarks
1	Assembly plate and valve guide tester	US 4404 A	
2	Feeler gauge		Local purchase item
3	Valve adjuster		Local purchase item
4	Valve lapper		Local purchase item
5	Valve spring depressor	VW 311 s	



No.	Description	Qty	Note when		References
			removing	installing	
1	Cylinder head cover	2	Clean		Fig. 7
2	Gasket for cylinder head cover	2		Replace when leaking or damaged	
3	Nut, M7	8		Torque to 13.7 Nm (1.4 mkg)	
4	Spring washer	8			
5	Bearing support	8	Check for wear or scoring marks	Cutout faces down, chamfered edge outward	

No.	Description	Qty	Note when		References
			removing	installing	
6	Exhaust rocker arm	4	Check for wear and scoring marks. New: 20,00-20,02 mm dia. Wear limit: 20,04 mm dia.	Smooth grooves worn into side thrust flanks with fine-grit emery cloth.	Fig. 6
7	Thrust washer	8			
8	Spring	4			
9	Intake rocker arm	4	Check for wear and scoring marks. New: 20,00-20,02 mm dia. Wear limit: 20,04 mm dia.	Smooth grooves worn into side thrust flanks with fine-grit emery cloth.	
10	Valve adjusting screw	8	Replace if binding.		
11	Nut, M8x1	8	Replace if binding.		
12	Rocker arm shaft	4	Check for wear and scoring marks. New: 19,95-19,97 mm dia. Wear limit: 19,93 mm dia.		
13	Push rod cover tube retaining clip	2		Must engage bearing support slots and rest on lower edges of the cover tubes.	
14	Pushrod	8	Mount on centers to check for runout max. 0,3 mm		
15	O-ring, red	8		Replace	
16	O-ring, black	8		Replace	
17	Push rod cover tube	8		Push fully in to stop	
18	Tappet	8	Check for wear and scoring marks	Install lubricated with engine oil	
19	Nut, M10	16		Watch tightening sequence. Tighten lightly at first, then torque to 31,4 Nm (3,2 mkg).	Fig. 5
20	Washer	16			

No.	Description	Qty	Note when		References
			removing	installing	
21	Cylinder head	2		Check for cracks in combustion chambers and exhaust ports, also for leakage along cylinder contact surfaces. Check spark plug threads and studs for damage or tightness. If necessary, install Heli-coil inserts.	
22	Screw, M5x10	2			
23	Washer	2			
24	Screw, M6	4			
25	Washer	4			
26	Baffle	2		Left and right not same	
27	Valve keeper	16		Replace if peened	
28	Valve cap	8			
29	Valve spring	8		Check spring tension: compressed length: 30 mm; test load: 711, 2-818, 1 N (72, 5-83, 5 Kp)	
30	Oil deflector	8		Replace. Install oiled	
31	Intake valve	4	Use spring depressor VW 311s. Check seat for burn spots or wear, reface if necessary.	Coat stem with molybdenum disulfide paste	Fig. 1
32	Exhaust valve	4	Remove burrs from valve keeper seat.		Fig. 4 Fig. 2
33	Intake valve guide	4			
34	Exhaust valve guide	4	Check with wear indicator US 4400 A		5.1-2/2

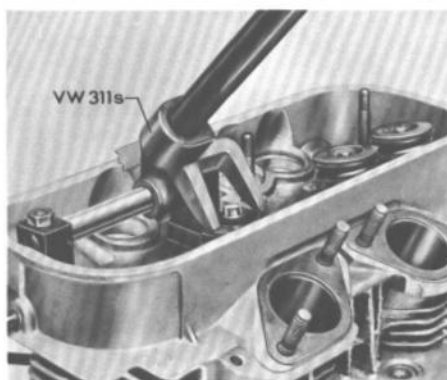


Fig. 1

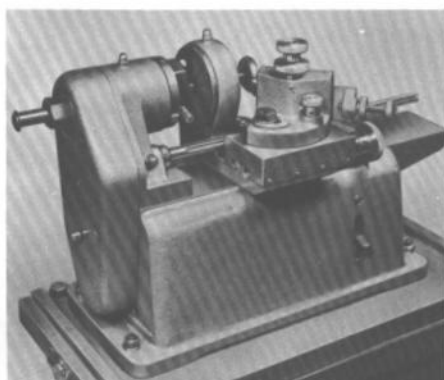


Fig. 4

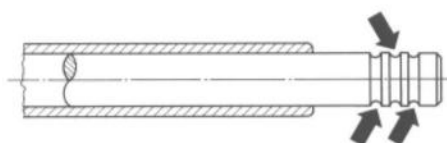


Fig. 2

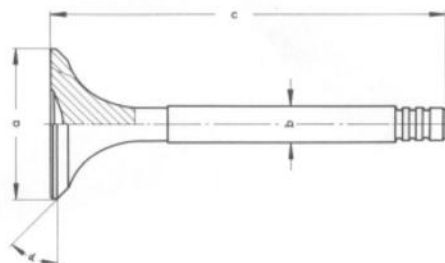


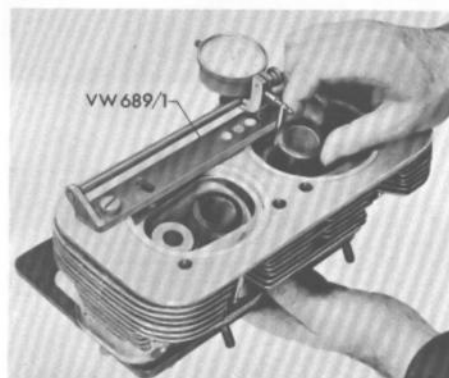
Fig. 3

	Intake Valve	Exhaust Valve
a	41.8-42.2 mm dia.	35.8-36.2 mm dia.
b	116.8	117
c	7.94-7.95 mm dia.	8.91-8.92 mm dia.
	45°	45°

CHECKING VALVE GUIDES

When reconditioning engines which had burned valves, it is necessary not only to reface or replace valve seats and valves, but also to check and replace the valve guides, as far as necessary. This check is especially important in high mileage engines (exhaust valve guides).

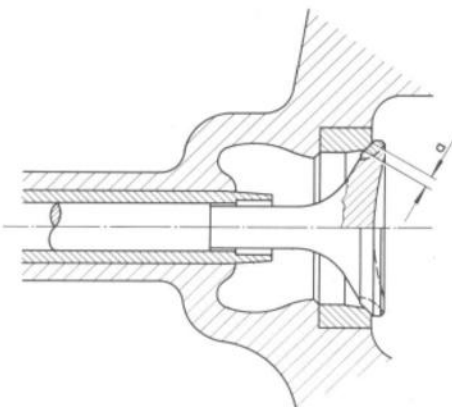
If excessive wear is noted, replace the cylinder head (until service instructions are published).



- 1 - Remove deposits with cleaning reamer.
- 2 - Place cylinder head on clamping plate US 4404 A and fasten with gauge bracket.
- 3 - Place new valve in guide. The valve stem end must reach to end of guide.
- 4 - Determine side play.

	Intake valve guide	Exhaust valve guide	Wear limit
Side play	0,30 mm		1,2 mm
Inside diameter	8,00 - 8,02mm dia.	9,00 - 9,02mm dia.	8,06 - 9,06mm dia.

REFACING VALVE SEATS



Valve seats showing wear or burned spots can be refaced as long as the permissible seat width can be maintained and the 15° chamfer at its outer circumference does not exceed the outside diameter of the valve seat insert. If it does, replace cylinder head with a new or overhauled unit. The valve seat inserts cannot be replaced with conventional shop tools because the inserts are shrunk in.

Valve seat width (a):

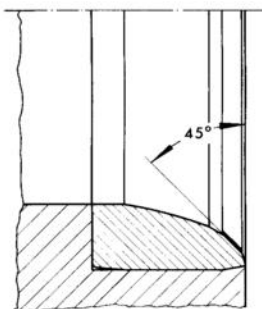
Intake = 1,8 - 2,2 mm

Exhaust = 2,0 - 2,5 mm

WORK PROCEDURE

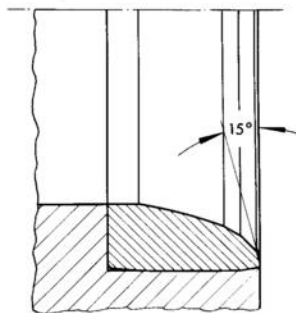
Preparing 45° surface:

This surface must be finished with special care so that a good concentric seat is made. Remove as little base metal as possible to prevent premature unserviceability of the valve seat insert. For this reason, discontinue the work as soon as the whole seat surface has been cleaned.



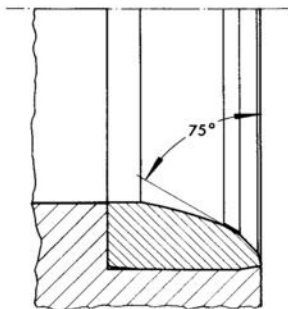
Preparing 15° surface:

Machine the upper edge of the valve seat insert until specified seat width is obtained.



Preparing 75° surface:

Lightly chamfer bottom edge of exhaust valve seat insert.



CHECKING VALVES FOR LEAKS

Valves can be checked for leaks by producing seat contact patterns.

Contact Print

- 1 - Lightly coat valve face with Prussian blue.
- 2 - Place valve in valve guide and turn about 1/4 turn under light pressure.
- 3 - Take valve out. Check contact pattern for poorly sealing areas. If necessary, recondition valves.

LAPPING VALVES

Lapping is not necessarily required if the valve seat inserts are well finished and new valves used.

- 1 - Coat one valve seat with grinding paste and place valve in valve guide.
- 2 - Lap valve with lapping tool. Seat grooving can be avoided by frequently lifting and repositioning the valve during the lapping operation.

CAUTION: Thoroughly remove grinding paste after the lapping operation.

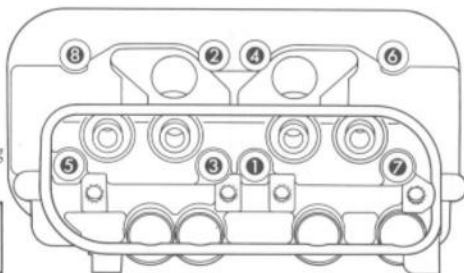


Fig. 5

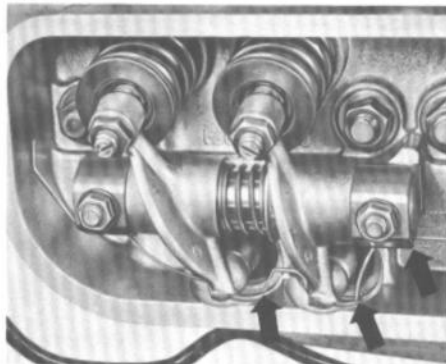
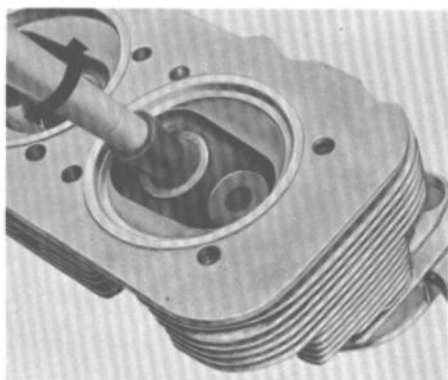


Fig. 6

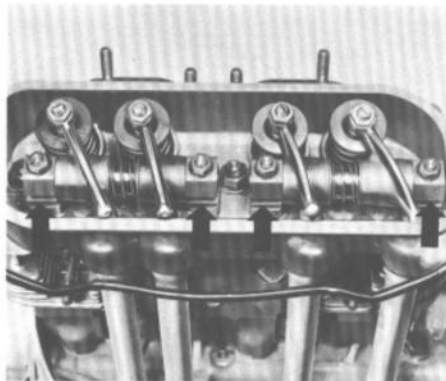


Fig. 7

ADJUSTING VALVES

Valve clearance can be adjusted when engine temperature has changed to that of the surrounding air.

Valve clearance: Intake = 0,15 mm Exhaust = 0,20 mm

The adjustment should be carried out with care and at specified intervals.

Proper valve clearance adjustment can be achieved only if the valve stems are not excessively loose in their guides and the valve stem ends are not worn unevenly.

Tight valve clearance will result in the following:

- burnt valves and valve seats
- warped valves
- poor engine performance due to loss of compression
- unevenly running engine
- offset valve timing

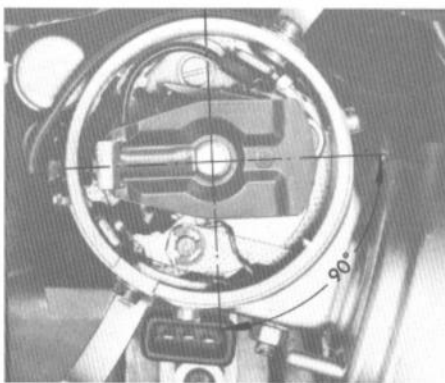
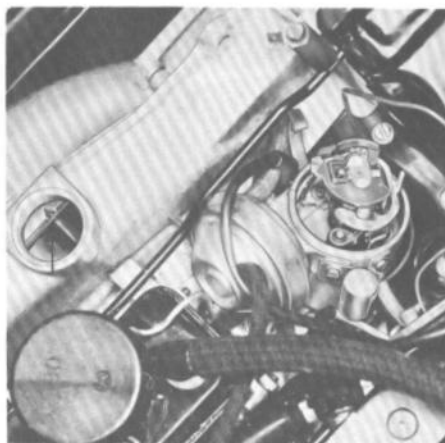
Loose valve clearance will result in the following:

- considerable valve noise
- unevenly running engine
- offset valve timing
- poor engine performance

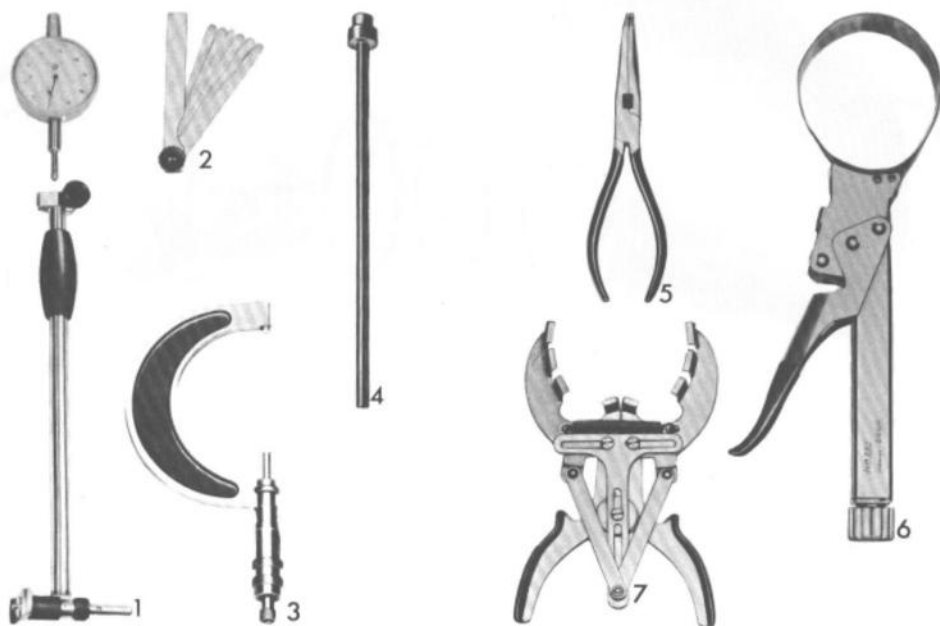
Adjusting Valves

Follow cylinder sequence 1 - 2 - 3 - 4.

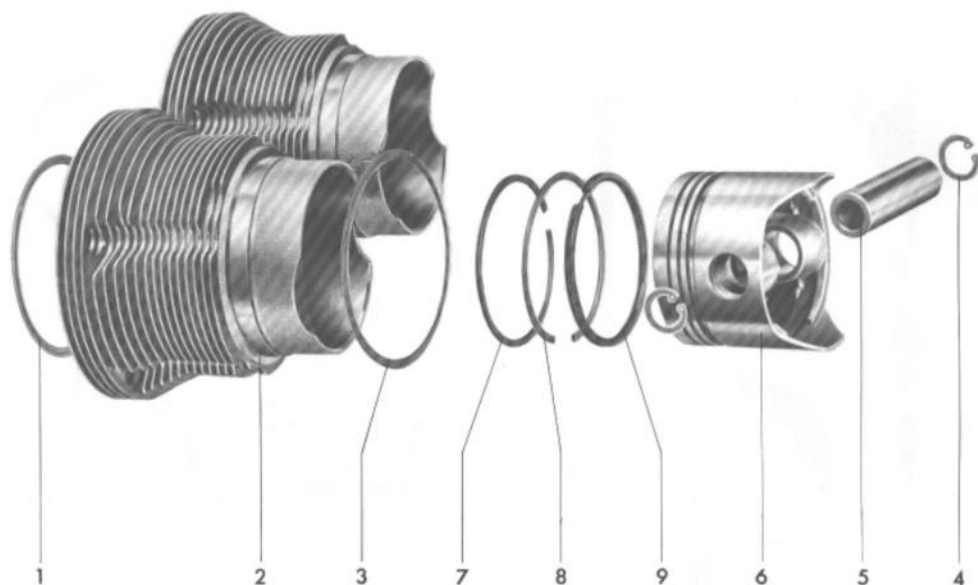
- 1 - Bring piston in cylinder 1 to firing point.
- 2 - Check valve clearance with feeler gauge:
Intake = 0,15 mm
Exhaust = 0,20 mm
The feeler gauge should pass snugly between the valve stem and the adjusting screw.
- 3 - Turn crankshaft to the left 90° at a time to adjust valves in cylinders 2, 3, and 4.



TOOLS



No.	Description	Special Tool	Remarks
1	Inside micrometer	VW 207c	Local purchase item
2	Micrometer, 75 - 100 mm range		
3	Feeler gauge		
4	Piston pin driver		
5	Piston ring expander		
6	Piston ring compressor		
7	Lock ring pliers, offset		



No.	Description	Qty	Note when		Remarks
			removing	installing	
1	Cylinder head gasket	4		Replace.	Fig. 1
2	Cylinder	4	Mark installed position. Check wear; if necessary, install new cylinder and piston of same size group.	Cylinder seat in crankcase and cylinder head, as well as seating surfaces in cylinder, and gasket surfaces must be perfectly clean since foreign particles will lead to leaks. Coat with oil. Stud-bolts must not be in contact with cooling fins. Use piston ring compressor.	Fig. 10
3	Cylinder base gasket	4		Replace.	Fig. 1
4	Circlip	8	Use circlip pliers.		Fig. 9
5	Piston pin	4	Use piston pin driver VW 207c	Coat with oil. If pin is tight, heat piston to approx. 80°C.	

No.	Description	Qty	Note when		Remarks
			removing	installing	
6	Piston	4	Mark installed position. Check wear.	Observe mating with cylinder. Heat when installing piston pin. Coat with oil. Clean piston ring grooves. Max. weight difference is 10 g. CAUTION: Do not interchange pistons of 74 KW (100 HP) engine, marked GB, with those of the 70 KW (95 HP) engine, marked GA.	Fig. 2 Fig. 7 Fig. 8 Fig. 11 Fig. 12
7	Top piston ring	4)		Fit rings. Check ring gap.	Fig. 3
8	Bottom piston ring	4)		"Top" must face piston head.	Fig. 4
9	Oil scraper ring	4)		Check ring side play. Stagger piston ring gaps.	Fig. 5

CHECKING CYLINDERS

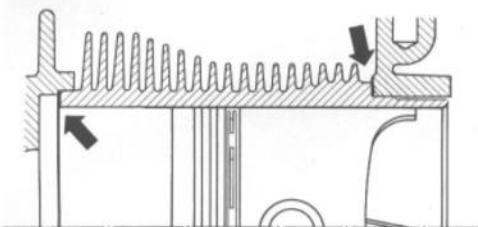


Fig. 1

NOTE

Paint mark indicating size group is located on top cooling fin.

REMOVING PISTONS

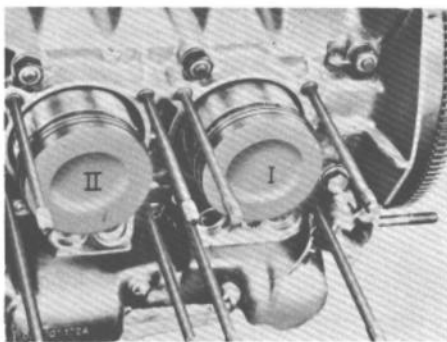


Fig. 2

PISTON MARKINGS



A - Letter adjacent to arrow corresponds with index of spare part number of respective piston; it serves as an identification mark.

B - Arrow (embossed) shows direction piston must be installed towards flywheel.

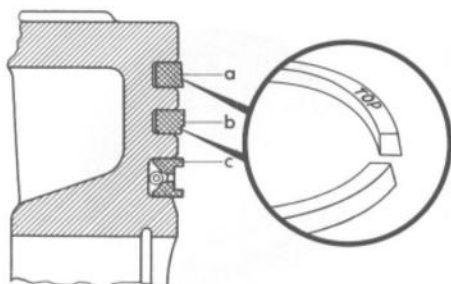
C - Paint mark indicating size group (blue, pink).

D - Weight group indication (+ or -) embossed or ink-stamped.

E - Weight group indication by paint mark (brown = - weight, grey = + weight).

F - Piston size in mm.

CHECKING PISTONS



a - Upper compression ring
b - Lower compression ring
c - Oil ring, with spring

Fig. 3



Fig. 4

	Gap mm	Wear Limit mm
Upper compression ring	0.35-0.55	0.90
Lower compression ring	0.35-0.55	0.90
Oil ring	0.25-0.40	0.95



Fig. 5

	Side Clearance mm	Wear Limit mm
Upper compression ring	0.04-0.07	0.12
Lower compressing ring	0.04-0.07	0.10
Oil ring	0.02-0.05	0.10

Inspect and fit pistons. Depending on given tolerance stackup, some piston pins can be pushed into the cold piston by hand. This is fully normal even if the pin should slide out of the piston under its own weight. It is therefore not appropriate in such cases to replace either the piston pin or piston or both.

	Diameter mm	Clearance mm	Wear Limit mm
Piston pin bushing, dia.	24,015-24,024	0.015 to 0.028	0.04
Piston pin, dia.	23,996-24,000		
Piston pin bore in piston	24,000-24,005		

Replace piston pin and bushing when wear limit is reached.

CHECKING CYLINDER TO PISTON CLEARANCE

The cylinder bore is measured with an inside micrometer; the inside micrometer must first be adjusted to the given cylinder bore with the aid of a caliper-type micrometer.



Fig. 6
Measure the cylinder bore approx. 10-15 mm below the top edge of cylinder.

Installed Clearance	Wear Limit
0.02 - 0.05 mm	0.2 mm



Fig. 7
Piston diameter (new) is stamped into the piston head. Measurements are made at the lower end of skirt, perpendicular to the piston pin axis.