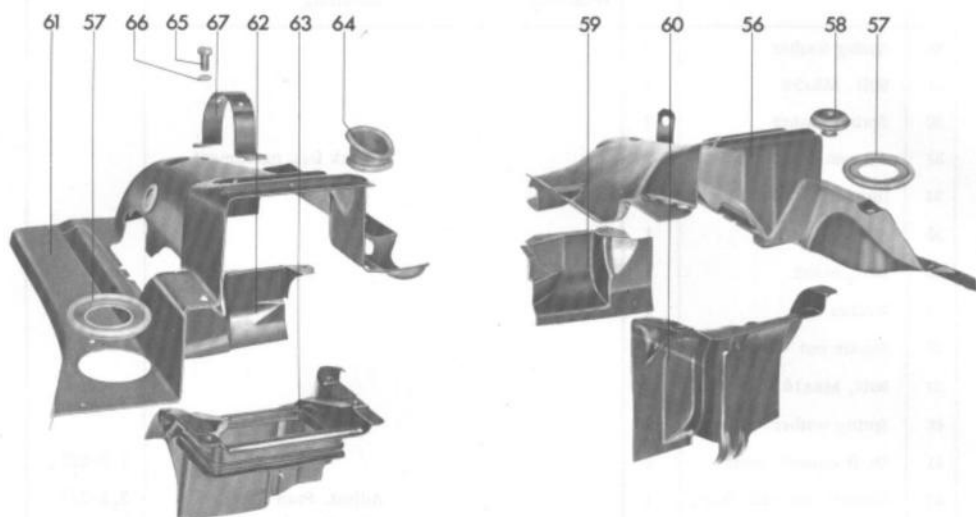


No.	Description	Qty	Note when		References
			removing	installing	
30	Spring washer	3			
31	Bolt, M6x20	7			
32	Spring washer	7			
33	Air non-return flap	2		Check free movement	
34	Inspection hole cover	1			
35	Plug	1			
36	Bolt, M4x8	1			
37	Washer	1			
38	Square nut	1			
39	Bolt, M6x10	2			
40	Spring 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

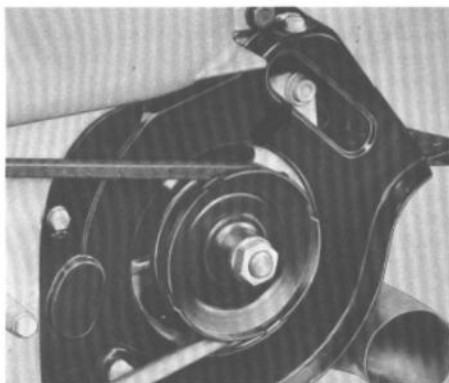


Fig. 1



Fig. 2

REMOVING AND INSTALLING COOLING AIR BLOWER HOUSING

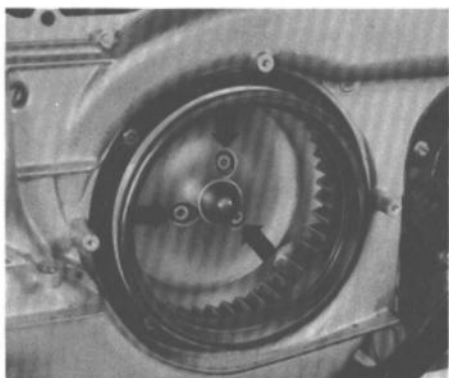


Fig. 3

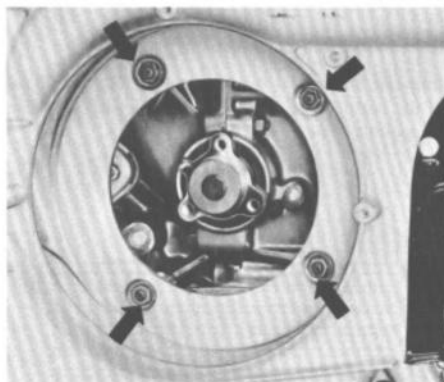
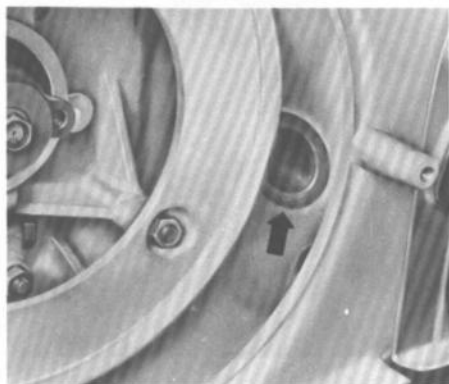


Fig. 4

NOTE

The cooling air blower can be removed with alternator installed.

Removing and Installing Cooling Air Blower Housing

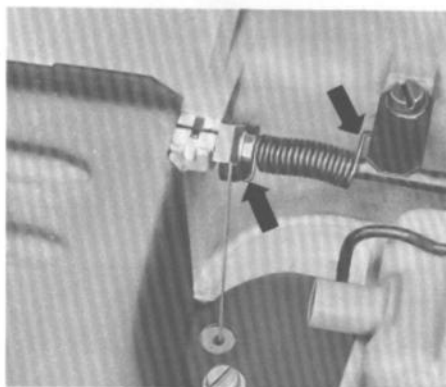


Removal

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

Installation

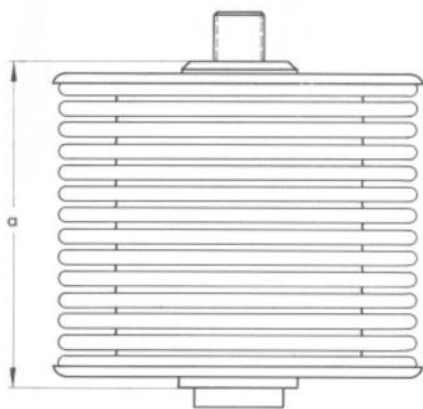
The bent ends of the return spring must rest against the casting lug for the shaft support spring on one side, and behind the control cable guide on the other.



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



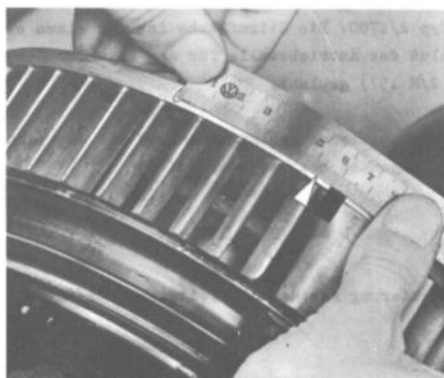
REPLACING COOLING BLOWER IMPELLERS

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

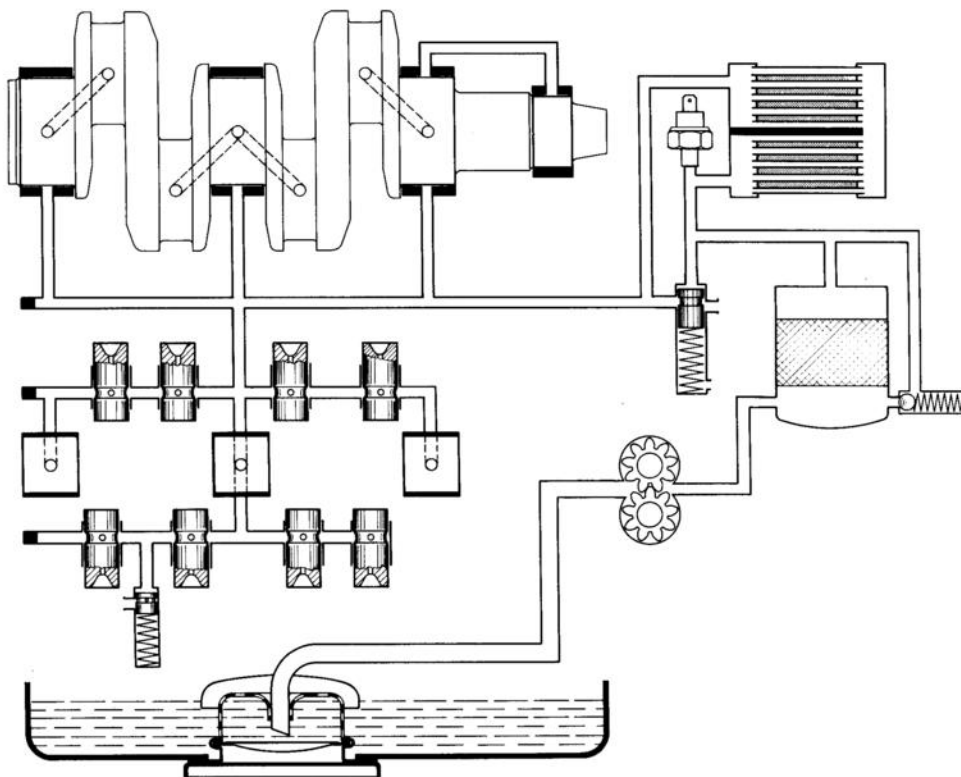
Making Timing Notch

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:

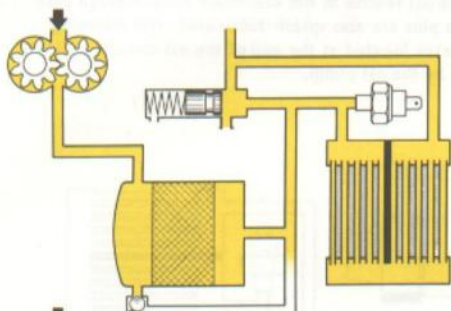
(measured at oil pressure switch; applies only
to SAE 30 oils)
oil temperature of 70° C
at 2500 rpm: 4,4 bar (4,5 atm)
min. 2,0 bar (2,0 atm)

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.

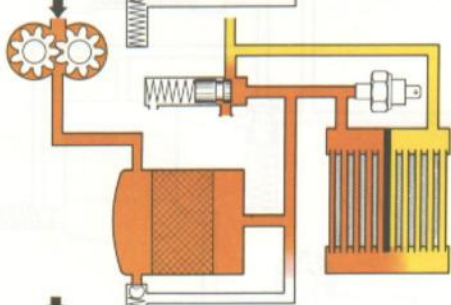
a - When the oil is cold and thick,

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



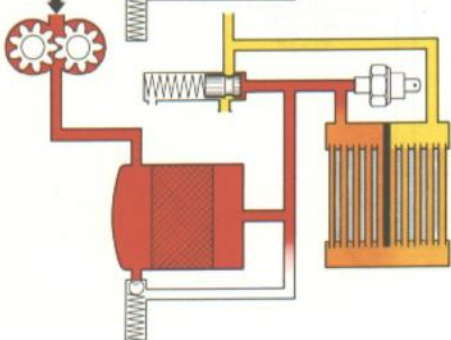
b - As the oil warms up and becomes thinner,

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,

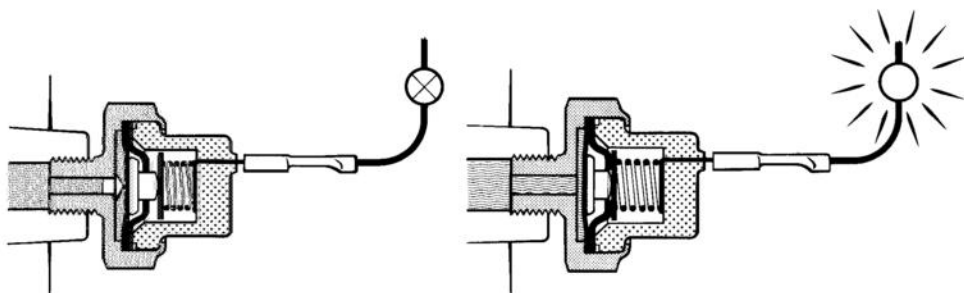
oil pressure is low,
control plunger in highest position,
oil is forced to pass through oil cooler prior to
reaching the lubricating points.



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.

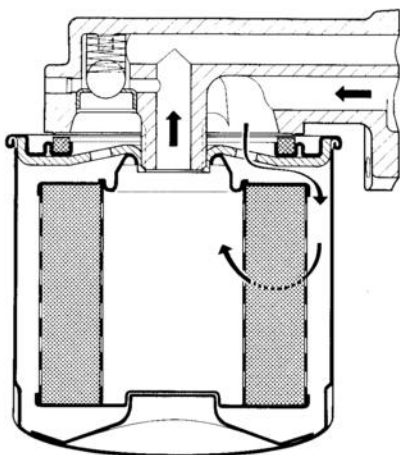


a - Oil pressure rises when engine is started:
contact opens between 0.15 and 0.44 bar
(0.15-0.45 atm),
warning light goes out.

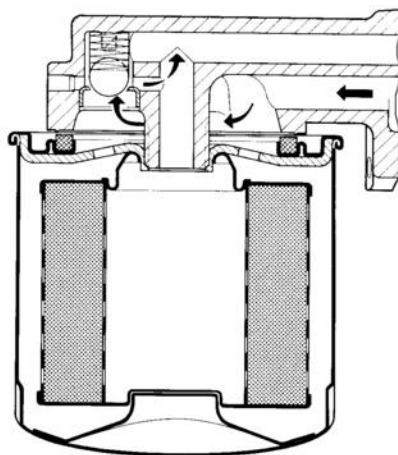
b - If oil pressure is too low with engine running:
contact closes,
warning light goes on.

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.

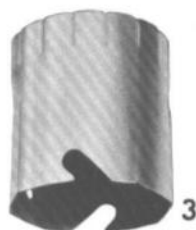
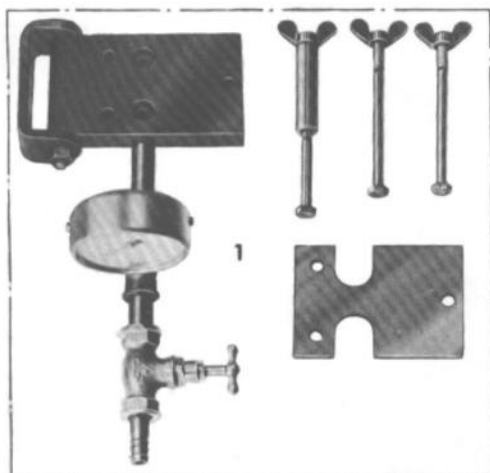


a - Normal oil path.

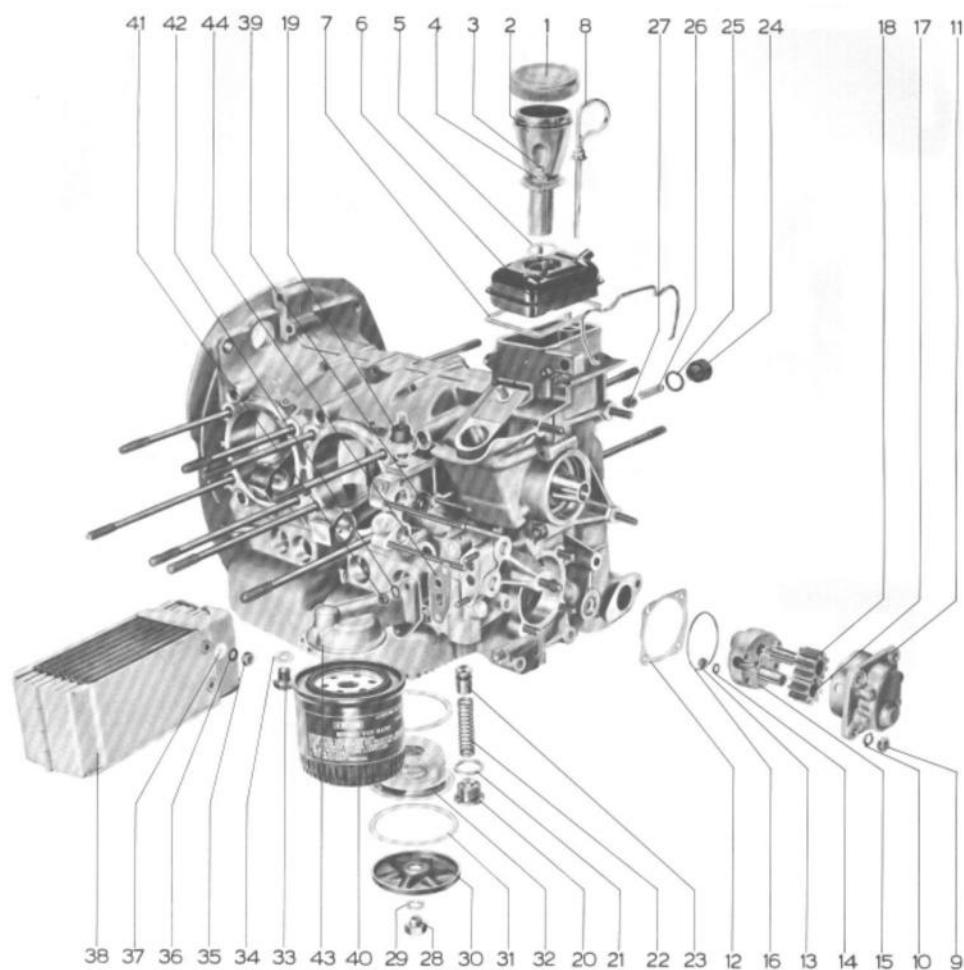


b - Oil bypassing a clogged filter.

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

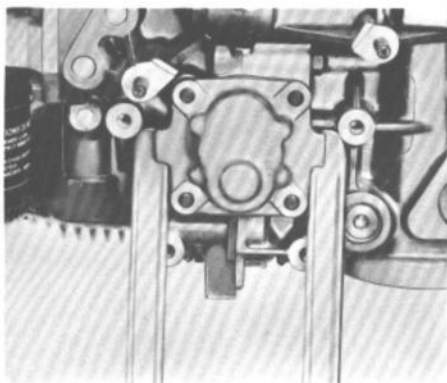


Fig. 1



Fig. 2

Checking Oil Cooler

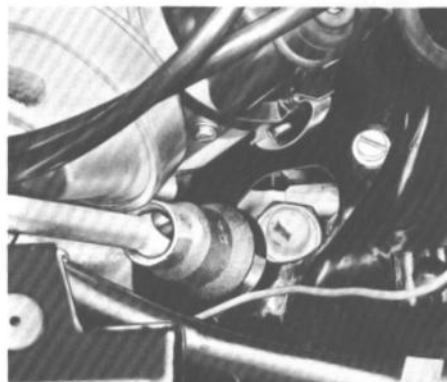


Fig. 3

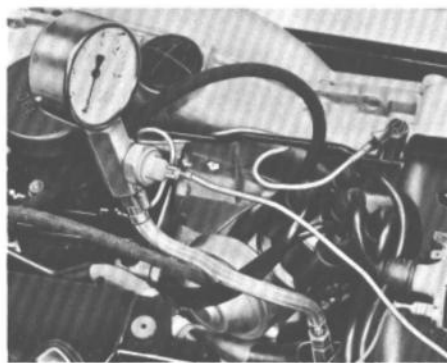
Checking Oil Pressure Switch

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



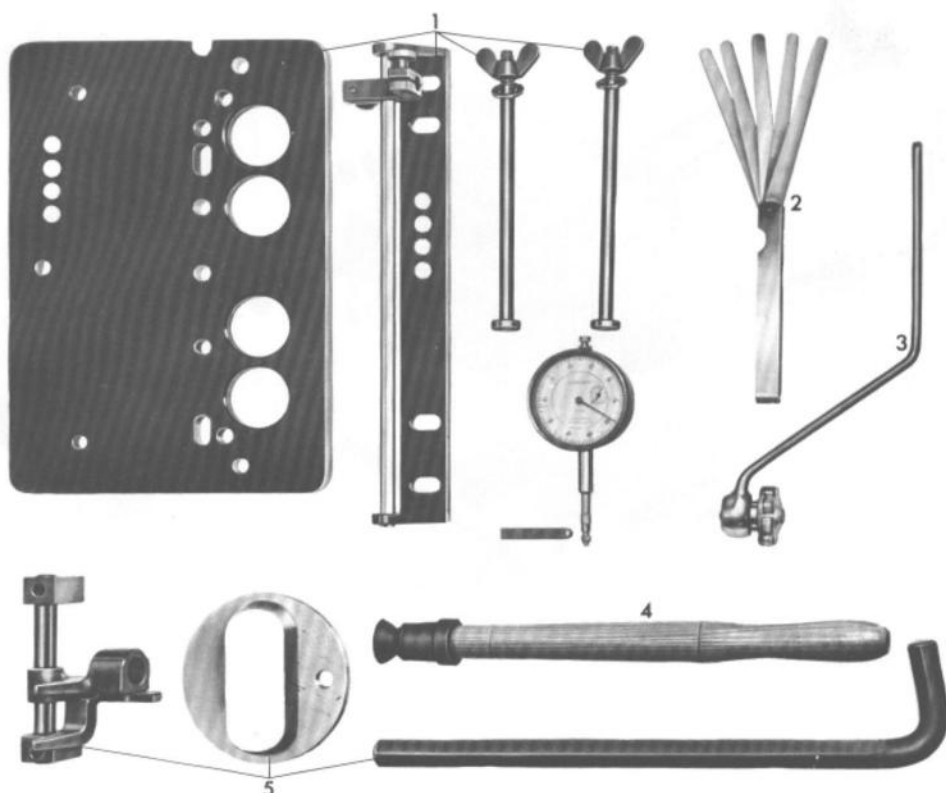
CAUTION

Washing and cleaning of the oil filter is not permissible!

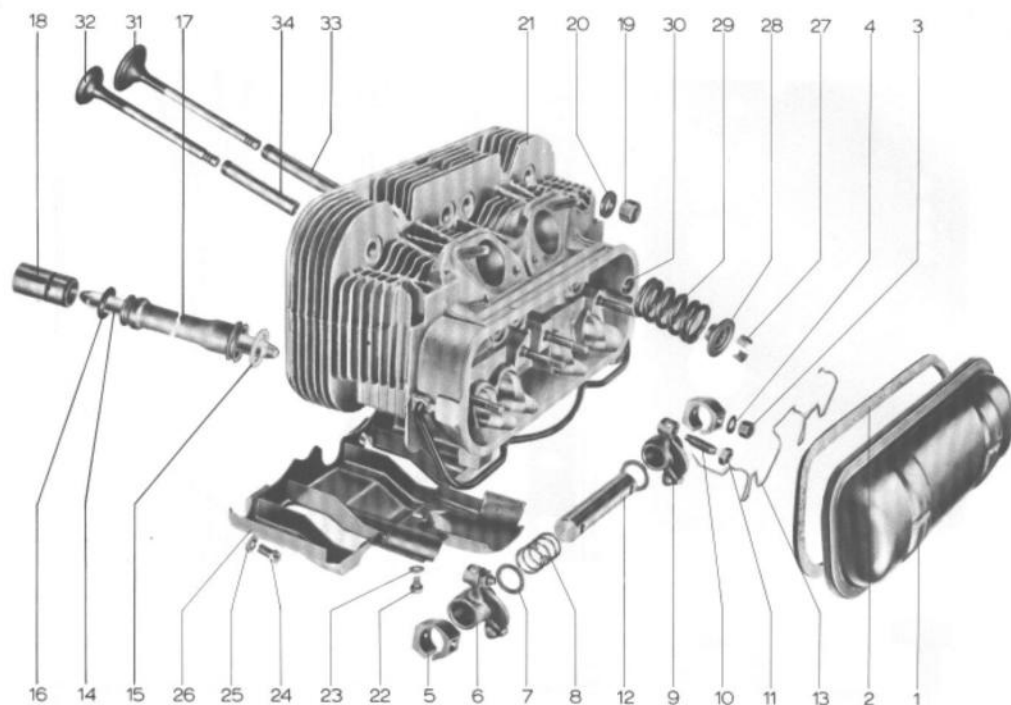
NOTE

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

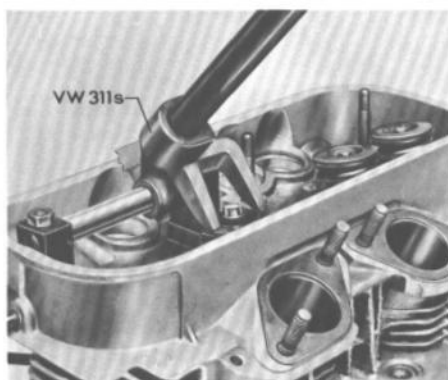


Fig. 1

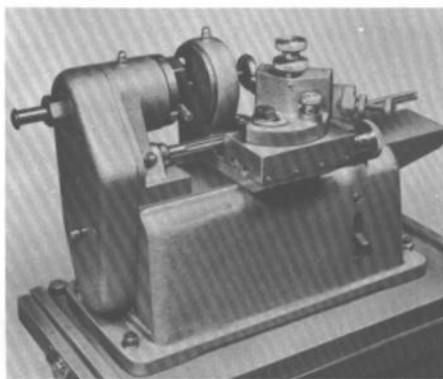


Fig. 4

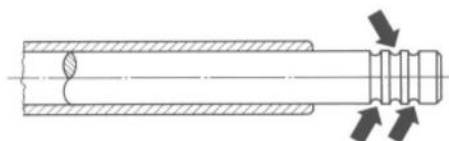


Fig. 2

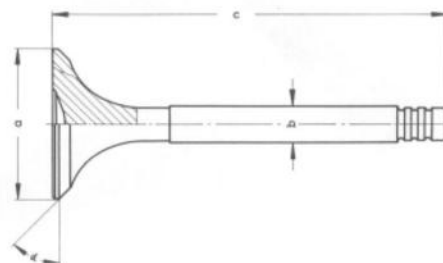


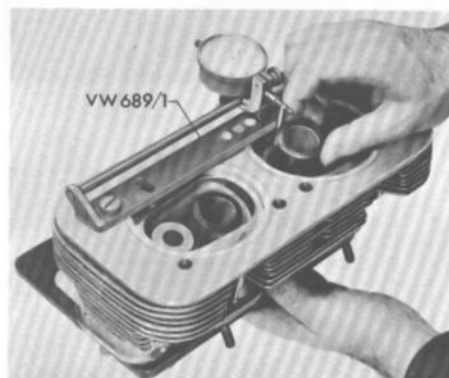
Fig. 3

	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).

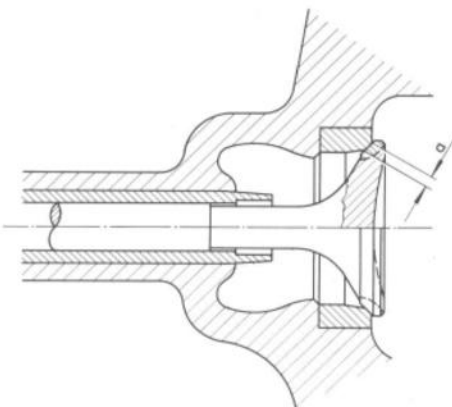
If excessive wear is noted, replace the cylinder head (until service instructions are published).



- 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):

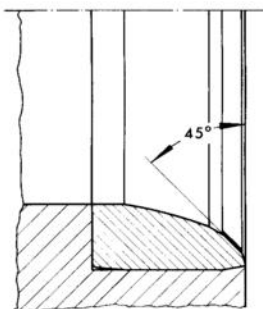
Intake = 1,8 - 2,2 mm

Exhaust = 2,0 - 2,5 mm

WORK PROCEDURE

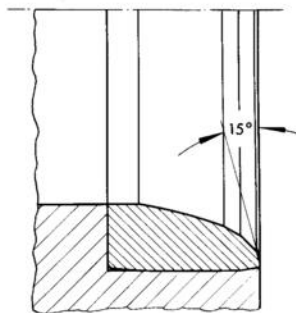
Preparing 45° surface:

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.



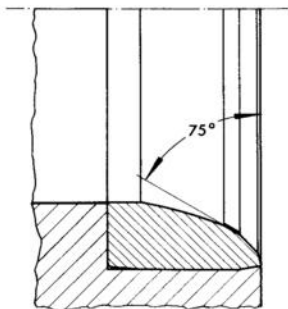
Preparing 15° surface:

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.

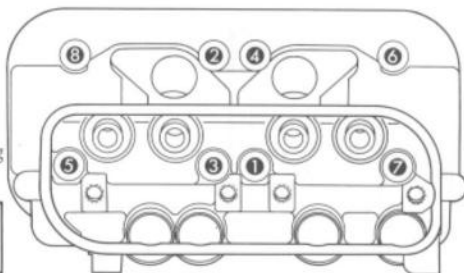


Fig. 5

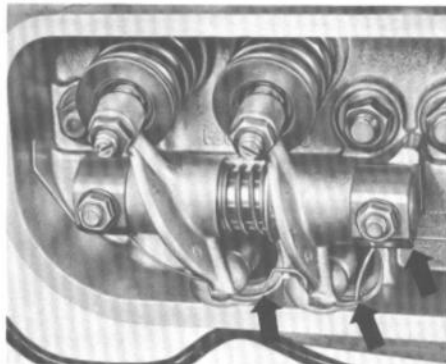
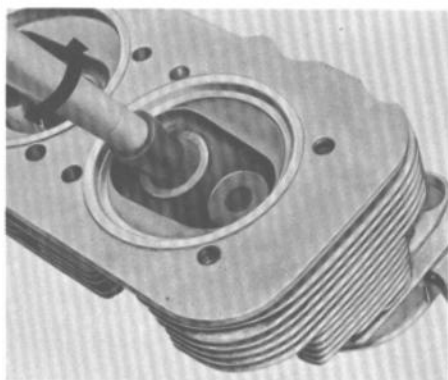


Fig. 6

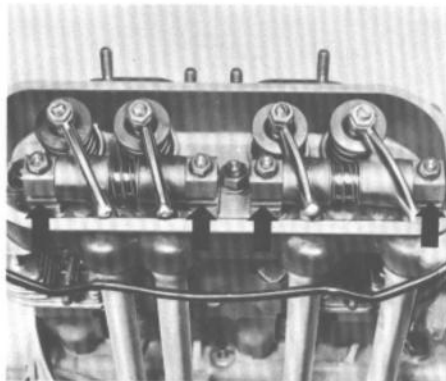


Fig. 7

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

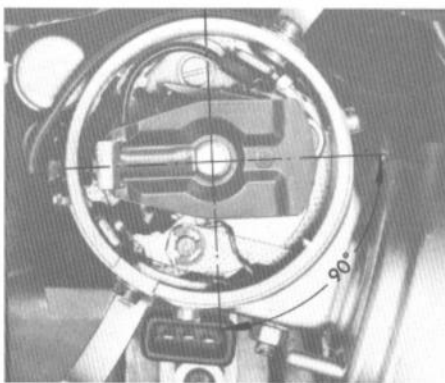
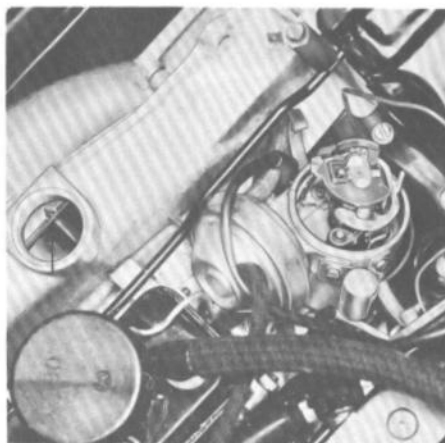
Loose valve clearance will result in the following:

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

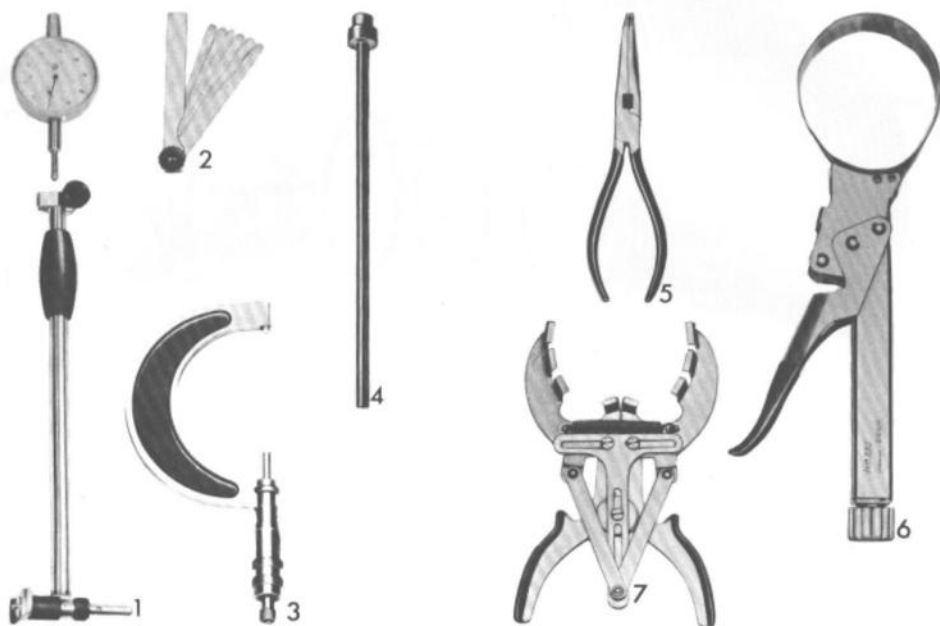
Adjusting Valves

Follow cylinder sequence 1 - 2 - 3 - 4.

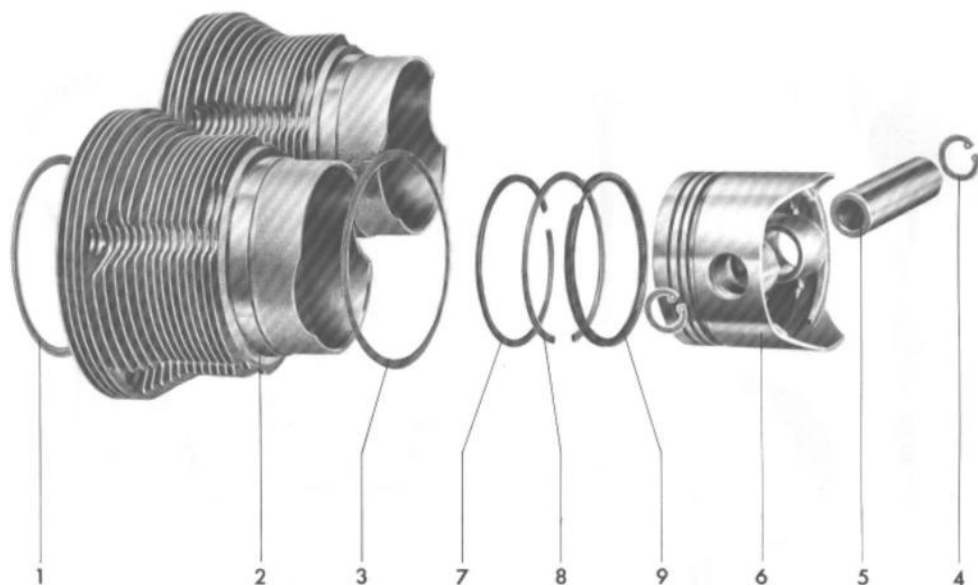
- 1 - Bring piston in cylinder 1 to firing point.
- 2 - Check valve clearance with feeler gauge:
Intake = 0,15 mm
Exhaust = 0,20 mm
The feeler gauge should pass snugly between the valve stem and the adjusting screw.
- 3 - Turn crankshaft to the left 90° at a time to adjust valves in cylinders 2, 3, and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

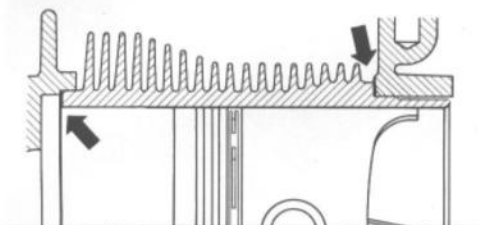


Fig. 1

NOTE

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

REMOVING PISTONS

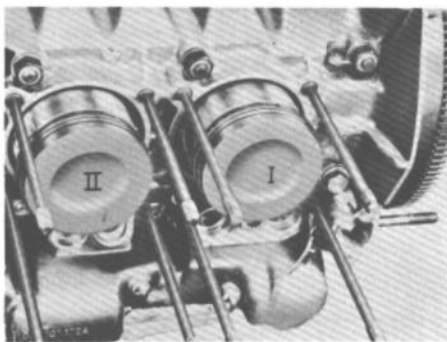


Fig. 2

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.

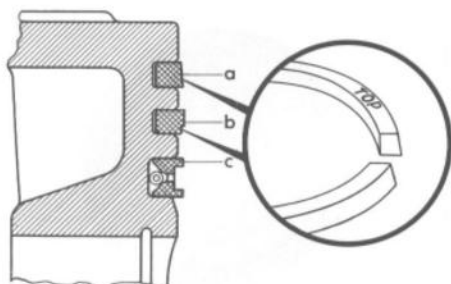
C - Paint mark indicating size group (blue, pink).

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.

Cylinders and pistons are matched in size groups shown in the chart below:

Size Group	Color Code	Cylinder Diameter mm	Matching Piston Diameter mm
Standard size Nominal dia. 94.0 mm			
1st oversize Nominal dia. mm			
2nd oversize Nominal dia. mm			

If the measurement reveals that clearance between piston and cylinder is close to 0.2 mm, replace piston and cylinder with a set of same size group (standard or oversize). The weight of pistons in a given engine should not differ more than 10 g. Damaged pistons from cylinders which show traces of wear should not be replaced alone. However, if the given cylinder shows no traces of wear, its piston may be replaced alone with one of the respective size group.

To maintain normal compression ratio, bored out cylinders are fitted with oversize pistons of lower height (measured between piston pin hole and piston head).

NOTE

Only cylinders and pistons of one given size group may be installed in a given engine.

Engine oil consumption together with wear, is a determining factor in replacing pistons and cylinders. If the oil consumption exceeds 1 liter per 1000 km, it is generally an indication for the need of engine overhaul.

INSTALLING PISTONS



Fig. 8

A poor contact pattern and uneven carbon formation can be caused by a distorted connecting rod.



Fig. 9



Fig. 10

NOTE
74 KS (100 HP) engine

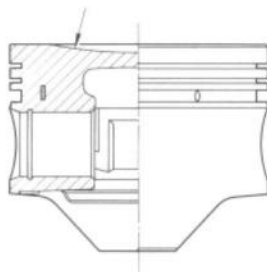


Fig. 11

70 KW (95 HP) engine

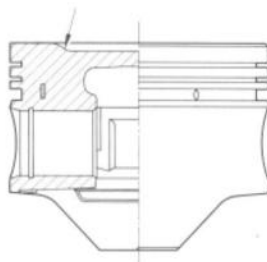
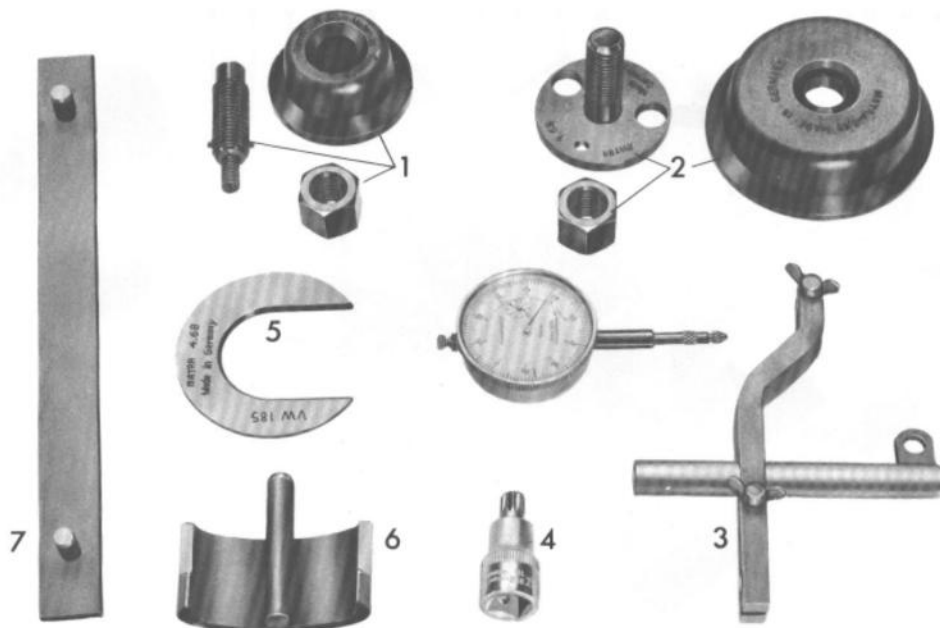
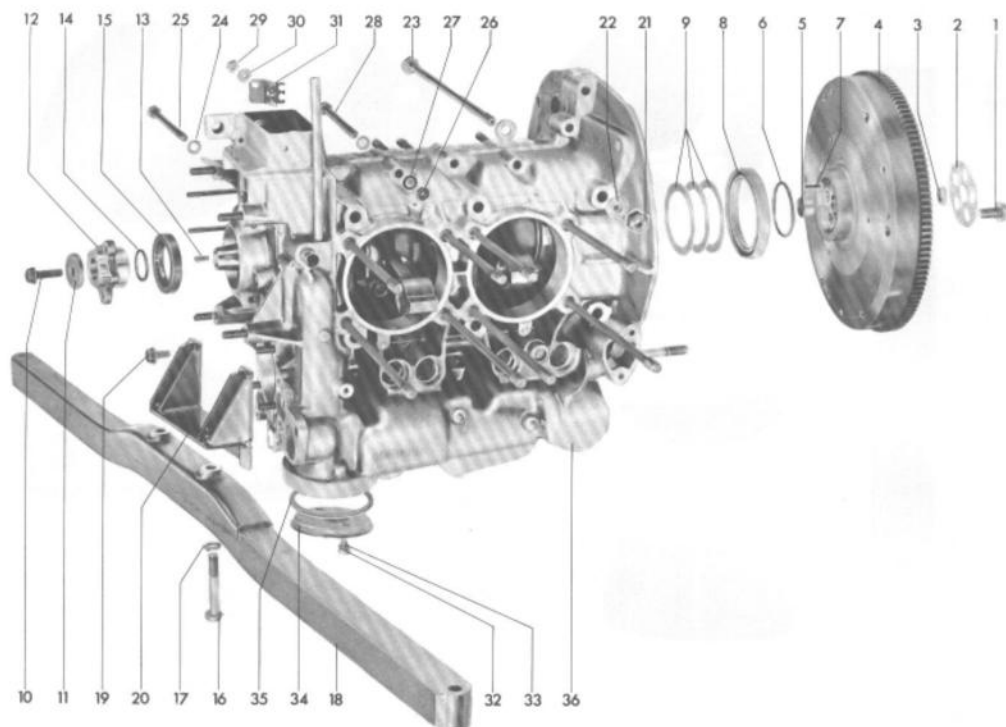


Fig. 12

TOOLS



No.	Description	Special Tool	Remarks
1	Crankshaft oil seal installer, blower pulley side	VW 190	Local purchase item
2	Crankshaft oil seal installer, flywheel side	VW 191	
3	Dial gauge holder	VW 659/2	
4	Internal head socket, M12		
5	Blower hub remover	VW 185	
6	Flywheel lock	VW 215c	



No.	Description	Qty	Note when		Remarks
			removing	installing	
1	Bolt, self locking, M 12x1,5	5		Torque to 107,9 Nm (11,0 mkg)	
2	Washer	1		Replace.	
3	Felt ring, for needle bearing	1		Dip in oil.	
4	Flywheel	1	Damaged teeth can be machined up to max.2 mm on the clutch side. Machine chamfer into teeth. Replace flywheel if bolt holes are enlarged. Check needle bearing for good seating.	Clutch contact surface must be free of grease or oil. Oil running surface of oil seal. Use flywheel lock VW 215c.	6,1-2/1 Fig. 1

No.	Description	Qty	Note when		Remarks
			removing	installing	
5	Needle bearing	1		Lubricate if it was washed. Note entry depth.	
6	Flywheel O-ring	1		Replace. Lubricate.	
7	Rollpin	1		Replace flywheel if rollpin is loosely seated.	
8	Flywheel oil seal, 95 mm dia.	1		Replace. Lubricate lightly. Install with installer VW 191, all the way in. Do not cant.	Fig. 3
9	Spacers	3		Determine thickness by adjusting end play with dial gauge holder VW 659/2.	6, 1-2/2
10	Bolt, self-locking, M 8x30	1		Torque to 31,4 Nm (3,2 mkg).	
11	Washer	1			
12	Blower impeller hub	1	Use 3 M8 bolts and VW 185.		Fig. 2
13	Woodruff key	1			
14	O-ring for hub	1		Replace. Lubricate lightly.	
15	Crankshaft oil seal, 65 mm dia.	1		Replace. Lubricate lightly. Use installer VW 190.	Fig. 4
16	Internal head bolt	2			
17	Lock washer	1			
18	Engine support	1			
19	Bolt, self-locking, M8	4		Torque to 29,4 Nm (3,0 mkg).	
20	Bracket for engine support	1			
21	Self-sealing nut, M10x1,25	6		Sealing ring faces outward. Torque to 19,6 Nm (2,0 mkg). Replace damaged nuts. Coat with sealing compound D3.	
22	Washer	12			

No.	Description	Qty	Note when		Remarks
			removing	installing	
23	Bolt, M10x1,25x213	6		Coat bolt heads with sealer D3.	
24	Gasket	1		Replace.	
25	Bolt, M8x113, oil pipe securing	1			
26	Bolt, M8	10		Torque to 19.6 Nm (2.0 mkg)	
27	Spring washer	20			
28	Bolt, M8	5			
29	Bolt, M6	2			
30	Spring washer	2			
31	Ignition cable support	1			
32	Bolt, M6	2			
33	Gasket	1		Replace.	
34	Oil sump cover	1			
35	Sump cover gasket	1		Replace	
36	Crankcase	1	Use rubber mallet; avoid damaging joint surfaces through use of sharp-edged tools.	Check for external damage and cracks. Clean joining surfaces with cleaning solvents. Check flatness bevel edges of bearing bores if necessary. Flush oil galleries and blow thru with air. Check stud bolts for tightness.	6, 1-2/1

CHECKING FLYWHEEL

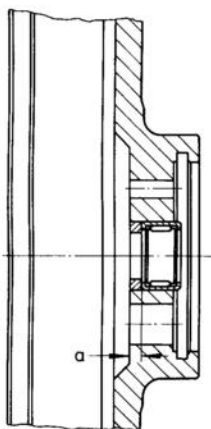


Fig. 1 "a" = 3,2 mm

Bore in Crankcase	Diameter mm	Wear Limit (Dia. mm)
Crankshaft bearings 1 - 3	70,00-70,02	70,03
Crankshaft bearing 4	50,00-50,03	50,04
Camshaft bearings 1 - 3	27,50-27,52	27,54
Oil seal, flywheel end	95,00-95,05	
Oil seal, blower impeller end	62,00-62,05	
Oil pump housing	70,00-70,03	

CHECKING AND ASSEMBLING
CRANKCASE

- 1 - Check cam follower bores in housing.
Diameter: 24,00-24,02 mm
Wear limit: 24,05
- 2 - Join crankcase halves and torque as specified.
Check bearing bores in housing with inside
micrometer and micrometer caliper.

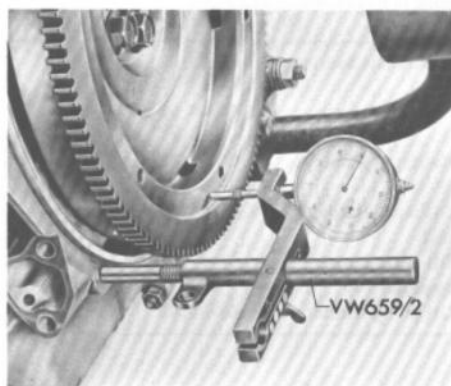
Reassembly

- 1 - Evenly coat crankcase joining surfaces with
sealer. Make sure that no sealer enters the oil
galleries of crankshaft and camshaft bearings.
- 2 - Join crankcase halves and first lightly tighten
oil suction pipe retaining bolt using a new gasket.
- 3 - Install M10x1,25 self-sealing nuts with sealing
rings facing outward, and tighten.
- 4 - Tighten M8 and M6 nuts.
- 5 - Turn crankshaft to check for free rotation.

CRANKSHAFT END PLAY

End play: New: 0,07 - 0,13 mm
Wear limit: 0,15 mm

- 1 - Move crankshaft back and forth axially. End play can be seen on the dial gauge.



- 6 - Install oil seals for flywheel and blower impeller side, and felt ring.

- 7 - Install flywheel with three shims and new washer plate.

- 8 - Recheck end play.

Shims are available in following thicknesses:

0,24 mm	0,34 mm
0,30 mm	0,36 mm
0,32 mm	0,38 mm

Thickness of individual shims is etched in. If necessary, measure thickness with a micrometer. Always install three shims of thicknesses amounting to the required total thickness.

Adjusting End Play

- 1 - Install flywheel with 2 shims but leave oil seal for flywheel and blower impeller off.
- 2 - Install dial gauge holder VW 659/2 and dial gauge on crankcase.
- 3 - Move crankshaft back and forth axially and read end play on gauge.
- 4 - Determine thickness of third shim:

Reading on dial gauge
- 0,10 mean end play
= third shim thickness
- 5 - Remove flywheel.

REMOVING AND INSTALLING CRANKSHAFT OIL SEALS

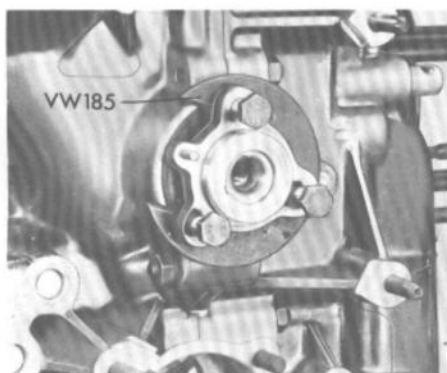


Fig. 2



Fig. 4

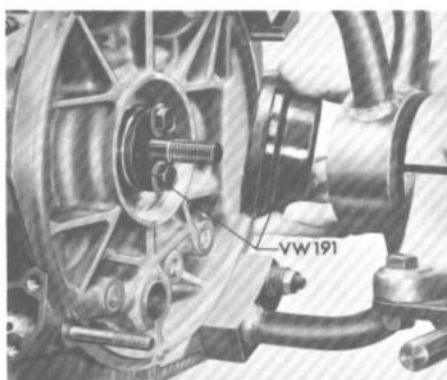
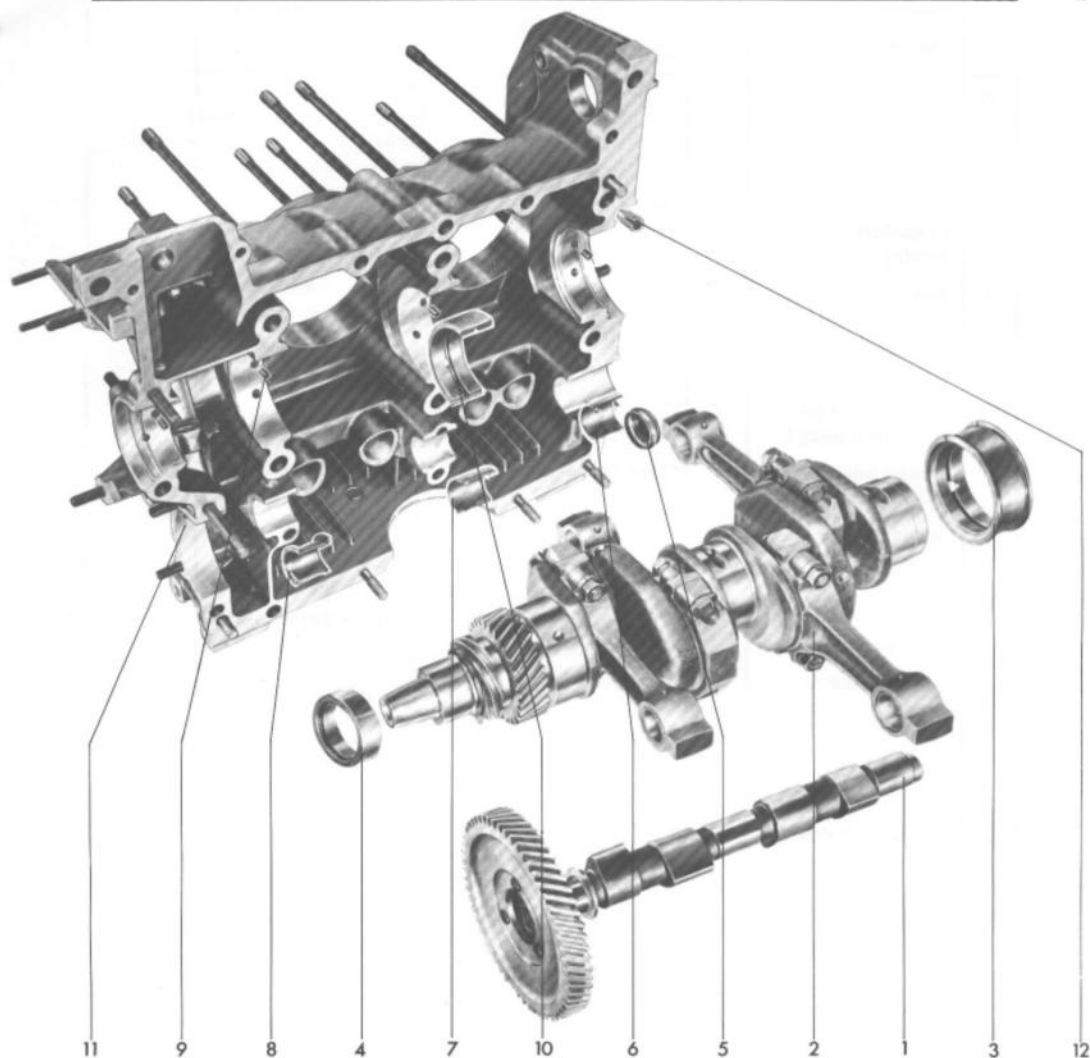


Fig. 3



No.	Description	Qty	Note when		Remarks
			removing	installing	
1	Camshaft	1	Check rivets which secure timing gear to camshaft. Check bearing journals and cam lobes for wear. Check timing gear for contact pattern and wear.	Check runout: new = max. 0,02 mm; wear limit = max. 0,04 mm (measured at center journal). Check end play at thrust bearing: 0,04-0,13 mm; wear limit = 0,16 mm. Check pairing and timing with crankshaft. Check gear backlash over entire timing gear circumference.	Fig. 1 Fig. 2 Fig. 3 Fig. 4 26,2-2/2

No.	Description	Qty	Note when		Remarks
			removing	installing	
2	Crankshaft with connecting rods	1		Oil holes in crankshaft journals and bearings should not have sharp edges. Check for firm seating of dowel pins in bearings.	
3	Crankshaft bearing 1	1	Check for wear,	Lubricate. Dowel pin hole is on flywheel side.	
4	Crankshaft	1	Check for wear,	Lubricate. Groove is on blower impeller side.	
5	Camshaft end plug	1		Install with gasket compound.	
6	Bearing insert for camshaft bearing 1	1			
7	Bearing insert for camshaft bearing 2	1	Check for wear,	Lubricate. Protrusions fit into notches in crankcase.	
8	Bearing insert, left, for camshaft bearing 3 (with shoulder)	1			
9	Dowel pin for crankshaft bearing	4		Check for tightness.	Fig. 5
10	Bearing insert for crankshaft bearing 2	1	Check for wear,	Lubricate.	
11	Crankcase half, left side	1		Crankcase with circumferential retaining web for oil splash shield.	Fig. 6
12	Vibration limiter	6	The following parts are not shown in the illustration but must be installed in right crankcase half prior to assembly:		
13	Dowel pin for crankshaft bearing 2	1		Check for tightness.	
14	Bearing insert for crankshaft bearing 2	1	Check for wear,	Lubricate.	
15	Bearing insert for camshaft bearing 1	1			
16	Bearing insert for camshaft bearing 2	1	Check for wear,	Protrusions fit into notches in crankcase. Lubricate.	
17	Bearing insert, right, for camshaft bearing 3	1			
18	Oil suction pipe	1			
19	Gasket for oil suction pipe	1		Replace.	
20	Oil splash shield	1			

Checking and Installing Camshaft

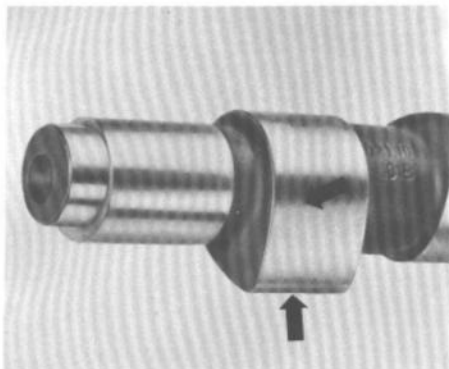


Fig. 1

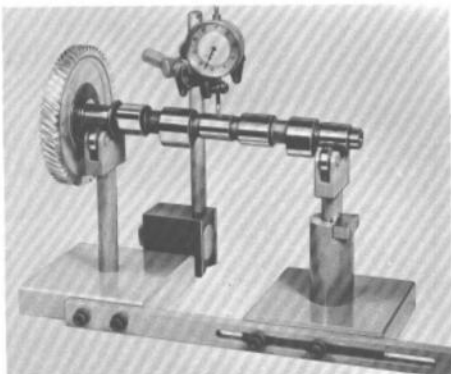


Fig. 2

Checking runout:

When new: max. 0,02 mm

Wear limit: max. 0,04 mm

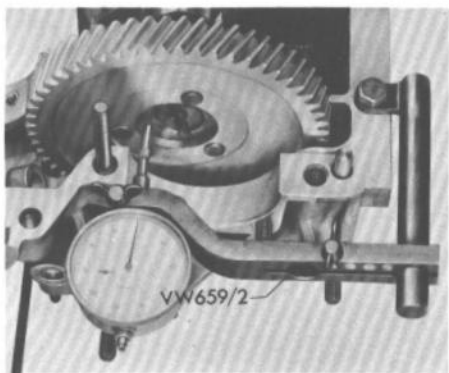


Fig. 3

Checking end play: (at thrust bearing)

When new: 0,04 - 0,13 mm

Wear limit: 0,16 mm

Gear backlash should be checked over the entire circumference of the timing gear.

Gear backlash between timing and crankshaft gears is 0,00 - 0,05 mm.

The timing gear is of right size when backlash can hardly be felt and the timing gear does not lift when the crankshaft is turned in reverse direction.

Camshafts with timing gears machined to several sizes are available under several different part numbers and thus ease the task of attaining proper gear backlash during assembly.

The timing gears are marked on the side facing the camshaft with stamped numerals such as "-1", "0", "+1", "+2", etc. The numerals indicate by 1/100 mm how the pitch circle radius differs from the blueprint dimension "0".

NOTE

Do not confuse the numeral 0 with the symbol 0 which is a timing mark.

Crankshaft gears are furnished in one size and bear no size markings.

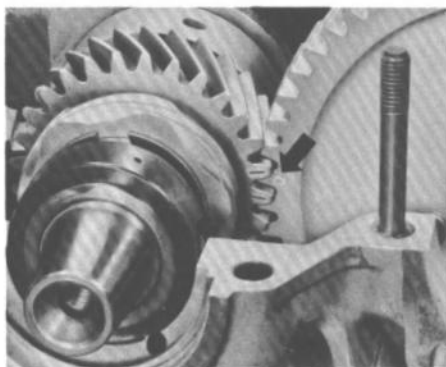


Fig. 4

Installing Preassembled Crankshaft

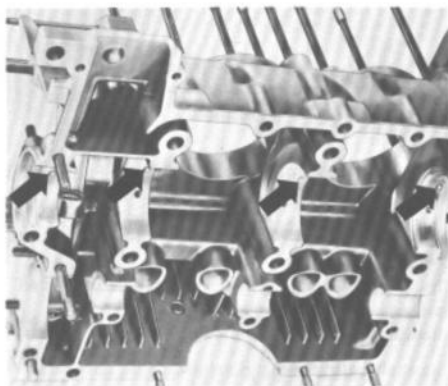


Fig. 5

Bearing clearance with bearings under crankcase pressure:

	When New	Wear Limit
Crankshaft bearings 1 and 3	0,04-0,10 mm	0,18 mm
Crankshaft bearing 2	0,03-0,09 mm	0,17 mm
Crankshaft bearing 4	0,05-0,10 mm	0,19 mm

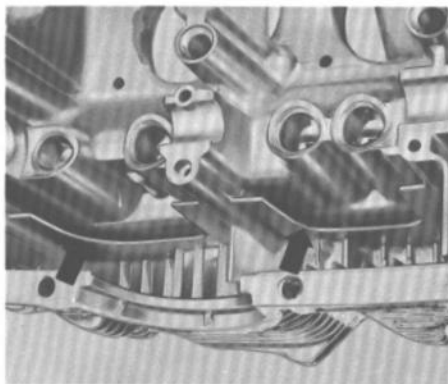
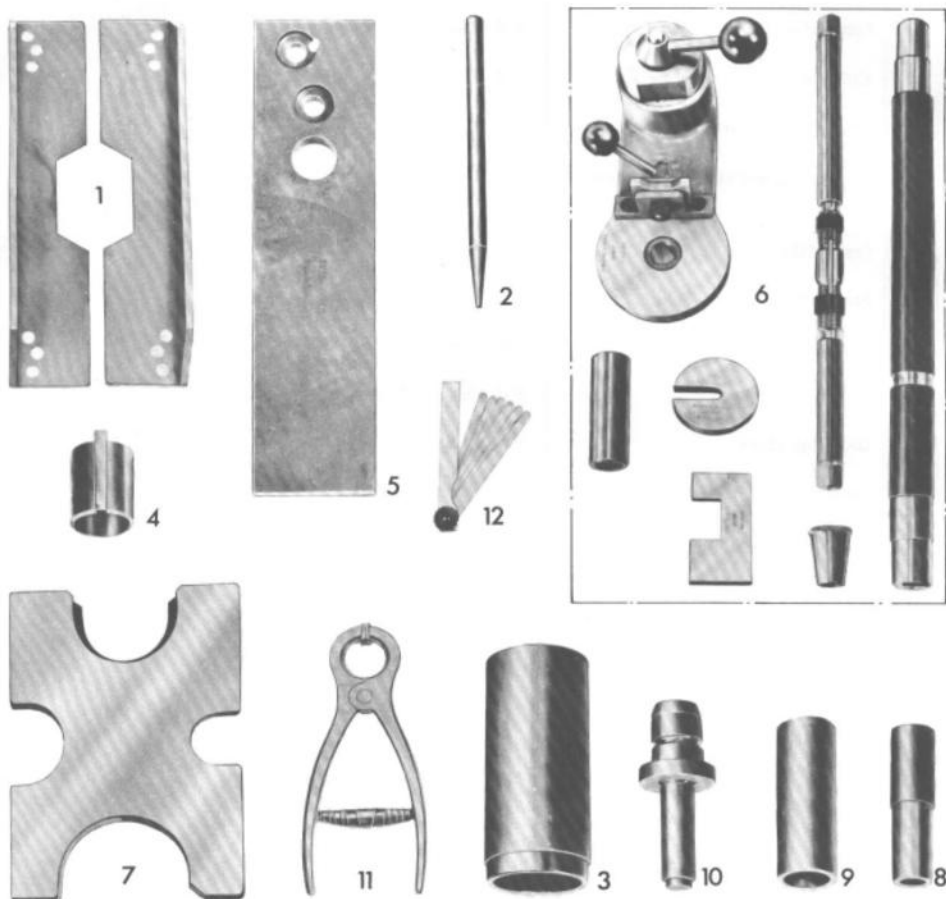
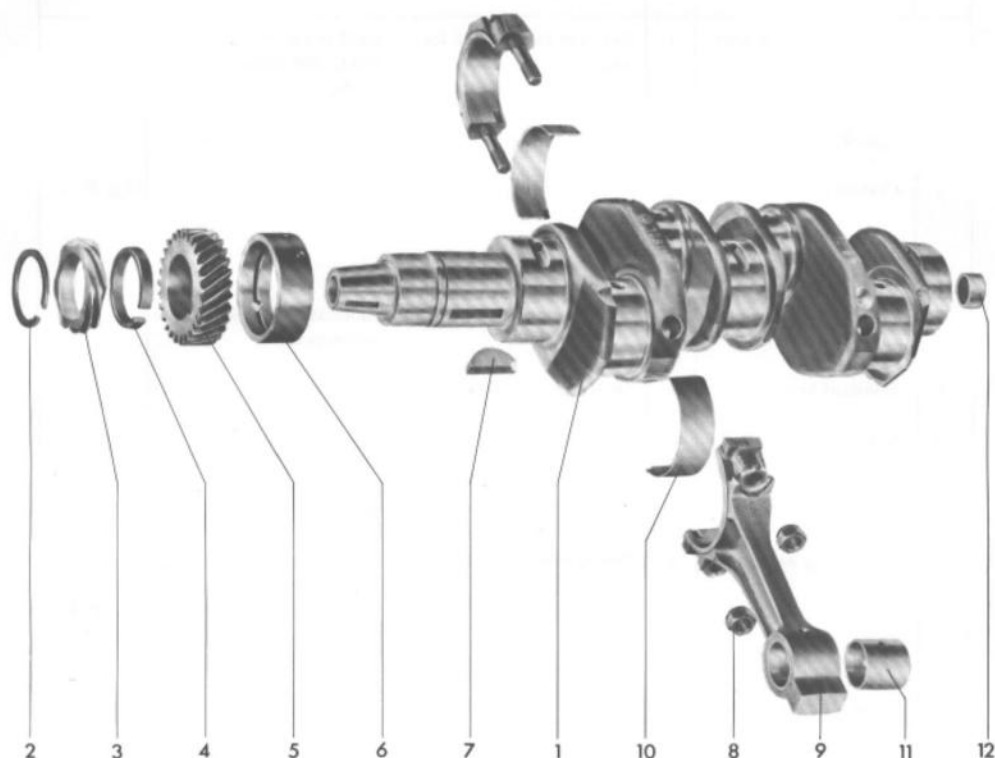


Fig. 6

TOOLS



No.	Description	Special Tool	Remarks
1	Press adapter plates (for differential bearings)	VW 457	
2	Notching punch	VW 124a	
3	Press tube, 60 mm dia.	VW 415a	
4	Guide sleeve, tapered	VW 428a	
5	Crankshaft support plate	VW 801	
6	Connecting rod aligning and reaming set	VW 214f/70	
7	Press plate	VW 402	
8	Press tube	VW 421	
9	Press tube	VW 416b	
10	Press block	VW 409	
11	Lock ring pliers	VW 161a	
12	Feeler gauge set		



No.	Description	Qty.	Note when		Remarks
			removing	installing	
1	Crankshaft	1	Check for wear. Sound test for cracks.	Blow through oil galleries with air. Check for runout. Don't store without oiling or greasing. Minor scuff marks in crankshaft gear or distributor drive gear can be removed with care.	6.3-2/2
2	Lock ring	1	Use VW 161a, VW 415a, VW 428a.		Fig. 1

No.	Description	Qty	Note when		Remarks
			removing	installing	
3	Distributor drive gear	1	Use VW 457. Check for wear.	Heat to ca. 80° C. Use 415a, VW 428a. Check teeth.	Fig. 2 Fig. 4
4	Spacer	1			
5	Crankshaft gear	1	Use press and VW 457.	Heat to approx. 80° C. Chamfer faces bearing 3. Use VW 415a, VW 428a. Check teeth.	Fig. 2
6	Crankshaft bearing 3	1	Check for wear.	Lubricate. Dowel hole faces counterweight.	
7	Woodruff key	1	Replace when damaged.		
8	Nut for connecting rod bolt	8		Replace. Torque to 32.4 Nm (3,3 mkg). Contact surface oiled. Lock with punch.	Fig. 8
9	Connecting rod	4	Check with VW 214f.	Max. weight difference 6g. Note installation position and weight. Measure side play with crankshaft in VW 801 support plate.	Fig. 6 6, 3-3/2 -3/3 Fig. 7
10	Connecting rod insert	8	Check for wear.	Lubricate.	
11	Piston pin bushing	4	Check for wear. Use VW 402, VW 409, VW 416b, VW 421.	Use VW 402, VW 409, VW 421. Piston pin must enter under light finger pressure.	Fig. 9 Fig. 5
12	Spacer	1			

DISASSEMBLING AND PREASSEMBLING CRANKSHAFT

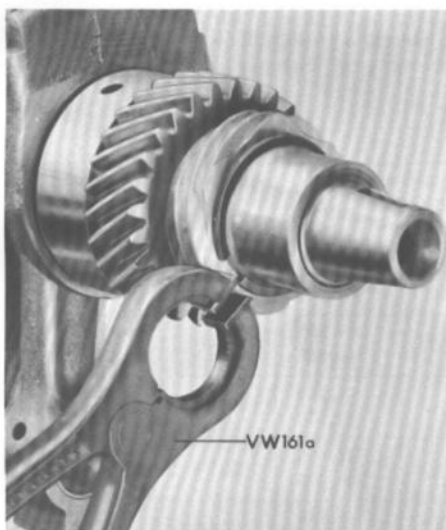


Fig. 1

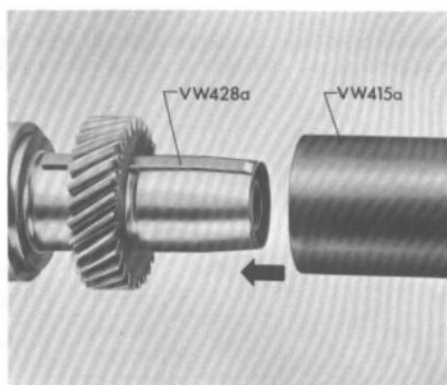


Fig. 3

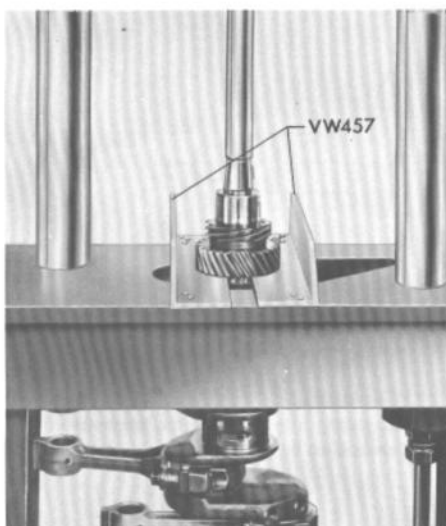


Fig. 2

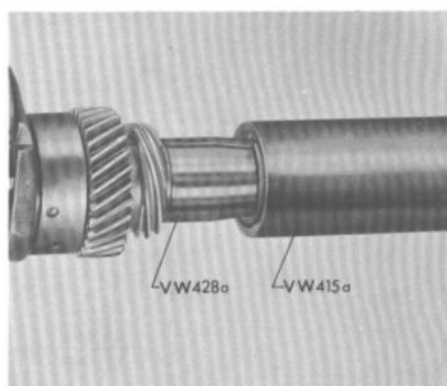


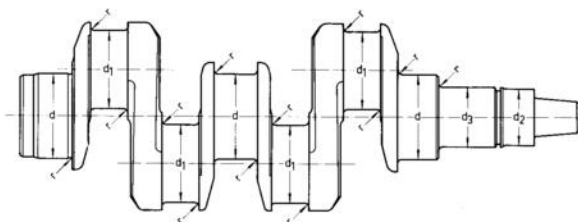
Fig. 4

Runout at bearings 2 and 3 (bearing 1 and 3 on V-block)	Bearing journal out of round	Un- balance
max. 0,02 mm	max. 0,03mm	max. 12 cmg

RECONDITIONING CRANKSHAFT

Crankshafts requiring reconditioning should be sent to the factory, if possible, for best results. If it should not be possible to do so, the following specifications must be observed:

	Main bearing journals 1, 2, and 3 (d)		Crankpin journals (d1)		Main bearing journal 4 (d2)	
	Nominal dia. mm	Lapped dia. mm	Nominal dia. mm	Lapped dia. mm	Nominal dia. mm	Lapped dia. mm
Standard	60.00	59.990 59.971	50.00	49.996 49.983	40.00	40.000 39.984
1st undersize	59.75	59.740 59.721	49.75	49.746 49.733	39.75	39.750 39.734
2nd undersize	59.50	59.490 59.471	49.50	49.496 49.483	39.50	39.500 39.484
3rd undersize	59.25	59.240 59.221	49.25	49.246 49.233	39.25	39.250 39.234



$$d_3 = \frac{42.006}{41.995} \text{ mm dia} \quad r = \frac{2.5}{2.0} \text{ mm}$$

Careful grinding of main bearing and crankpin journal radii will greatly affect the service longevity of the crankshaft. A radius of 2.5 mm is to be aimed for. The radii areas must be polished smooth.

Do not recondition bearing inserts under any circumstances.

Make sure upon completion of grinding that the oil passages have no sharp edges. If necessary, break the edges lightly.

The crankshaft gear and distributor drive gear must be installed on the crankshaft with an interference fit of 42.006/41.995 mm dia. If repeated removal and installation of these gears has resulted in the loss of the interference fit, it can be recovered by chroming or metal spraying in the respective areas.

The crankshaft can be checked for cracks by sound testing. Check the crankshaft for whip after the sound test.

CHECKING AND INSTALLING CONNECTING RODS

Check connecting rods weight.

Connecting rods used in a given engine must not differ in weight by more than 6 g.

NOTE

Connecting rods cannot be reconditioned.

The installed weight groups are also available in the spare parts program.

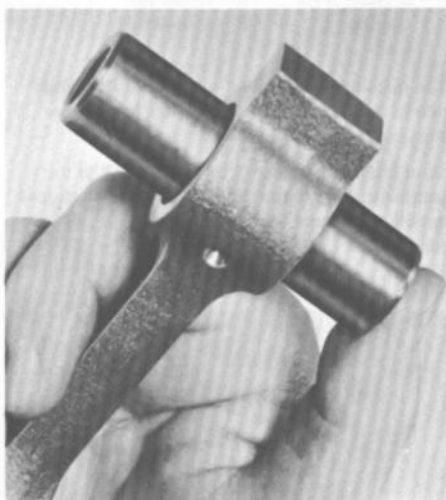


Fig. 5

The connecting rod must be so assembled that the code numbers on parting surfaces of connecting rod and cap are on the same side.

Minor binding (occurring in the bearing insert halves when the connecting rod bolts are tightened) can be relieved by lightly tapping both sides of the connecting rod with a hammer.

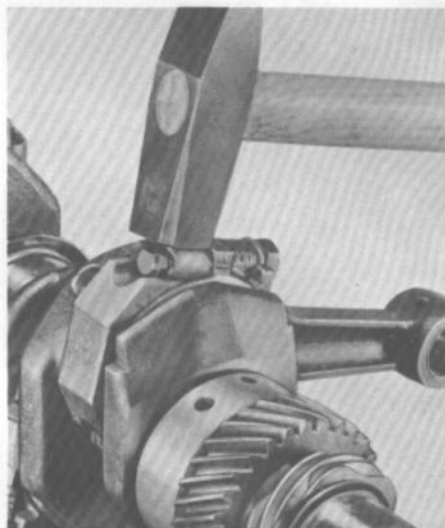


Fig. 6

The connecting rod must swing down under its own weight. In no case may the bearings be reworked or reset.

Side Clearance

When new: 0,1-0,4 mm

Wear Limit: 0,7 mm

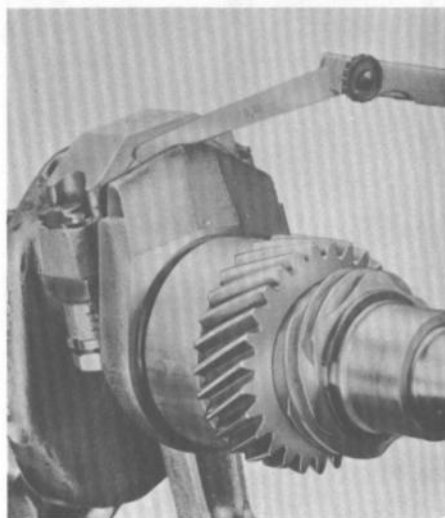


Fig. 7

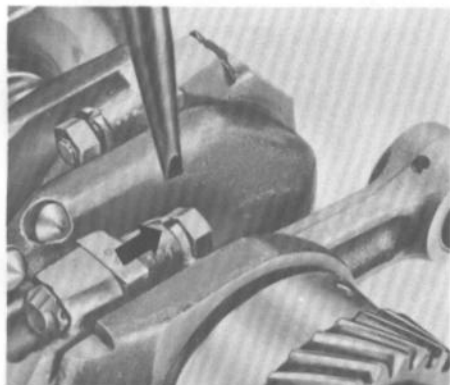


Fig. 8

RECONDITIONING CONNECTING RODS

Connecting rods which are slightly bent or have worn piston pin bushings should be straightened and have new bushings installed.

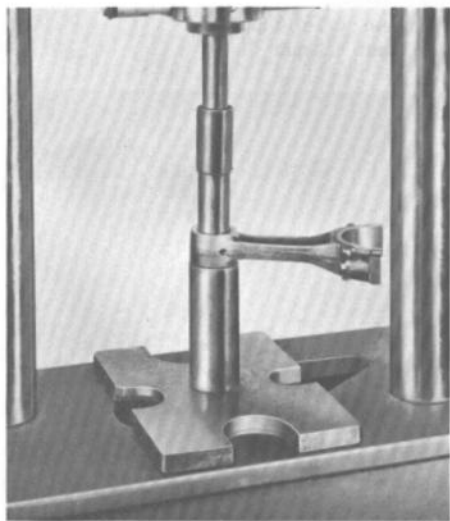
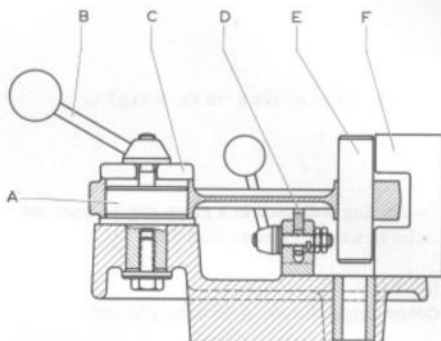


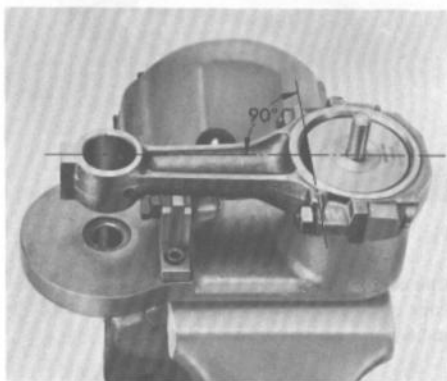
Fig. 9

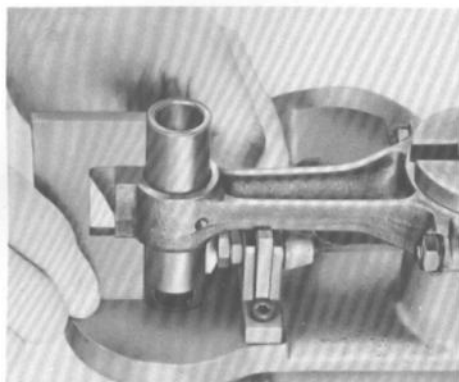


- | | |
|-------------------|----------------|
| A - Mandrel | D - Support |
| B - Locking lever | E - Piston pin |
| C - Washer | F - Template |

The mandrel A should be turned until its milled side is at right angles to the center line of the connecting rod.

After installing washer C tighten lever B to the point where the connecting rod can still be turned in both directions.
Support D is left loose.





Insert pin E into the connecting rod and press it with two fingers against the mandrel A in such way that no canting occurs between the mandrel and connecting rod or connecting rod bushing and pin.

Check connecting rod for twist and parallelism with the aid of the template (the illustration shows inspection for parallelism).

If the connecting rod is misaligned, tighten lever B and straighten with the aid of the bar.

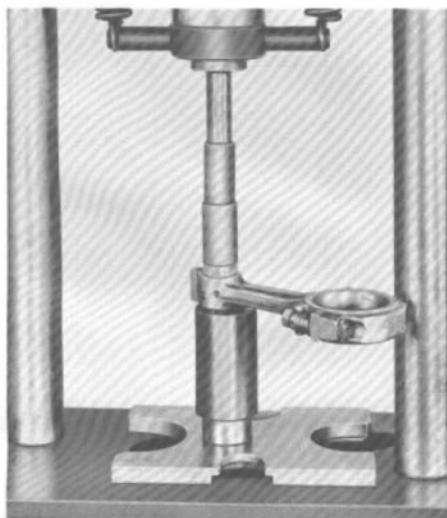


Fig. 10



Insert shaft of reamer through the connecting rod small end and the respective hole in the working fixture whereby the conical bushing will center the small end of the connecting rod.

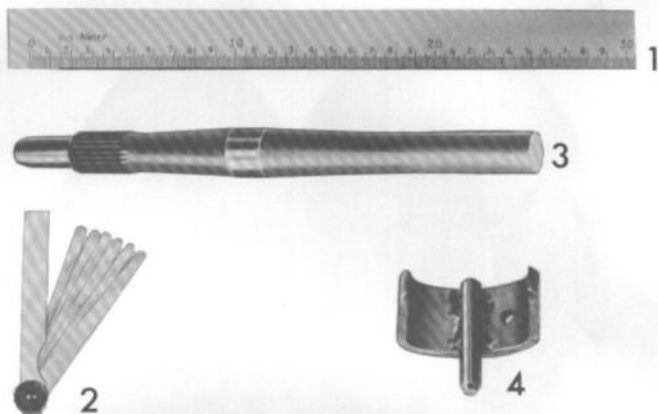
Tighten lever B and support D.

Inside diameter of piston pin bushing:	24,015 - 24,024 mm
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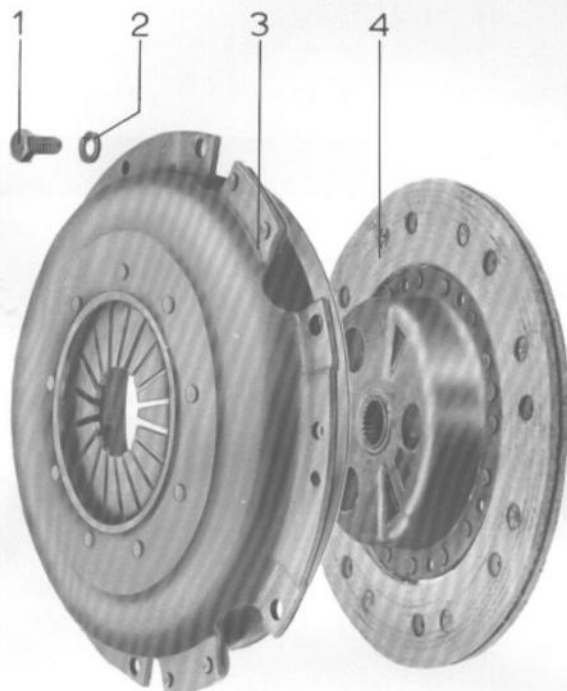
The inner surface of the bushing must be free of scoring or chatter marks. The piston pin must enter under light finger pressure with lubrication. It is improper to install an oversize piston pin in cases where the bushing has been reamed too much; in such cases install new bushing and ream it to correct size.

Recheck parallelism and twist, this time using the piston pin. Any still existing misalignment can be corrected with the aid of a bar inserted into the connecting rod small end.

TOOLS



No.	Description	Special Tool	Remarks
1	Steel ruler		At least 200 mm long.
2	Feeler gauge set		Local purchase item
3	Input shaft (shortened)		
4	Flywheel lock	VW 215c	



No.	Description	Qty	Note when		Remarks
			removing	installing	
1	Bolt, M8x15	6	Loosen bolts crosswise one or two threads at a time.	Torque crosswise to 23,5 Nm (2,5 mkg).	
2	Lock washer	6			
3	Clutch assembly	1	Mark installed position.	Check rivets. Clean seating surface in flywheel. Check for wear. Surface cracks or scoring can be corrected by grinding or milling.	Fig. 1 7.1-2/1
4	Clutch plate	1	Check for wear.	Check splines. Clutch plate should slide easily on input shaft without undue play. Check rivets and side runout. Coat input shaft splines with molybdenum disulfide powder. Align with input shaft.	Fig. 2 7.1-2/2

Removing Clutch

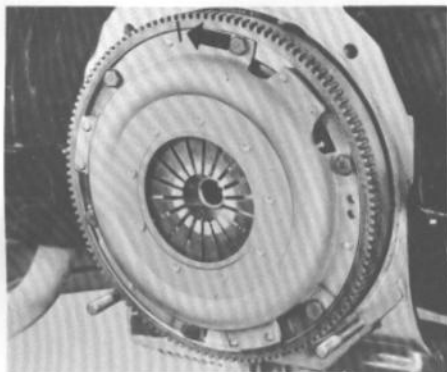
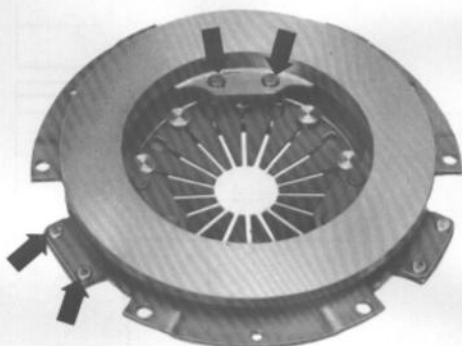


Fig. 1

Check spring plate connections between pressure plate and cover for cracks.
Check rivets for firm seating.

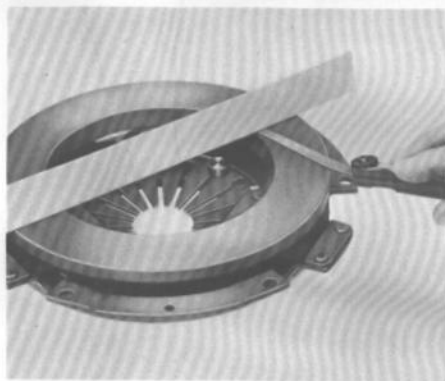
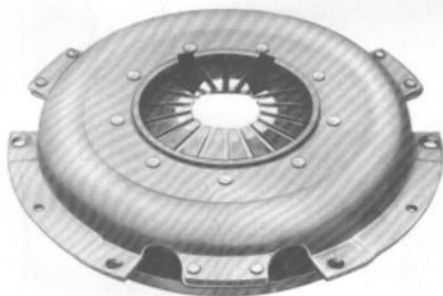
Clutches with damaged or loose rivets must be replaced.



Checking Clutch

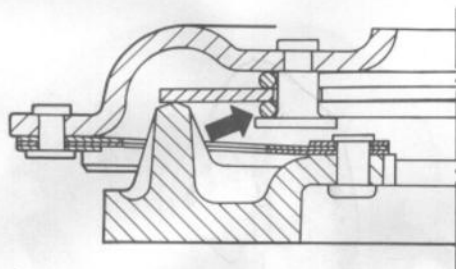
Check tips of diaphragm spring fingers for scoring at the throwout bearing contact surface. Score marks up to 0,3 mm depth are harmless.

Check pressure plate contact surface for cracks, hot spots, and wear. Pressure plates which are bent inward up to 0,3 mm are still serviceable.



The diaphragm spring is held between two wire rings with the aid of rivets.

Clutches showing wear at the rivets heads or wire ring should be replaced.



Installing Clutch

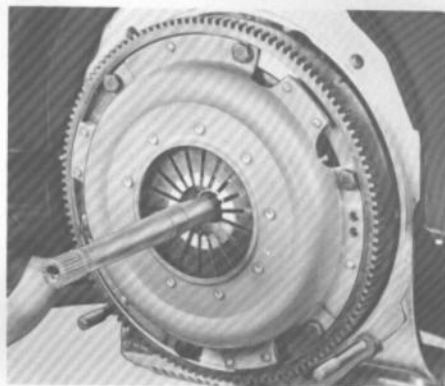


Fig. 3

Checking Clutch Plate

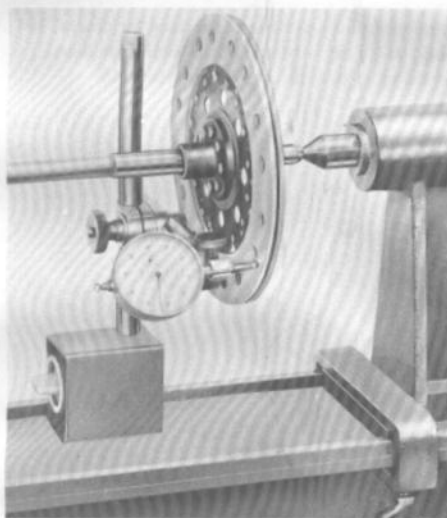


Fig. 2

Permissible side runout: 0,5 mm
(Measured at the 210 mm dia. point).