Motor und Kupplung
Engine and Clutch
Moteur et Accouplement
Motore e Frizione

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The engine is an air-cooled, six-cylinder, four-cycle flat six Otto engine. The crankshaft is mounted in 8 bearings of the two-part light metal alloy crankcase. Three single cylinders are horizontally arranged at the right and left of the crankcase. The overhead valves are installed in V-shape in each cylinder head. They are controlled by an overhead camshaft. The rocker arms and the two camshafts are each mounted in a common camshaft housing for three cylinders. Both camshafts are driven by chains from the crankshaft via an intermediate shaft. On the cylinder heads a triple down-draft carburetor with the pertinent intake pipes is provided for each cylinder bank. The engine and the transmission are mounted together. The unit is installed at the rear of the vehicle with the engine in front of the transmission (mid-engine design).

COOLING

Cooling is by means of an axial blower, consisting of an impeller and the blower housing. The center of the blower housing holds the support for the alternator, the impeller with the V-belt pulley is attached at its shaft end. The hub and the outer ring of the blower housing are connected to each other by means of four supporting vanes. The blower housing is positioned in the body of the crankcase by means of a set pin and held in position by a clamp. The blower delivers the air required for cooling the engine, the oil cooler, the alternator, as well as the fresh air for the heating system of the car. The cooling air flows through the upper plastics-molded air guides to the cylinders and to the cylinder heads. Baffle plates provide for uniform distribution of the cooling air. A duct incorporated into the upper air guide leads the air flow directly to the oil cooler. The connection for the fresh air delivery to the heat exchangers is on both sides of the blower housing.

OIL CIRCUIT

The engine is lubricated by a dry sump system with forced circulation by means of a geared pump driven by the intermediate shaft. The gear pump is divided into a pressure pump and a larger suction pump. The oil is filtered through an oil strainer, which is accessible from below and pumped to an oil tank attached to the body. The pressure pump will take the oil from there and supply the lubricating points. When the oil is cold, it is taken directly to the bearing points, when it is hot, it is first taken through the oil cooler under the control of a thermostat. The changeover temperature is at approx. $80^{\circ}C$ ($176^{\circ}F$). The oil cooler consists of light metal alloy laminations and is located in the cooling air flow. A safety valve with 8 kg/cm^2 (113 psi) protects the oil cooler against excess pressure. The pressure relief valve at the output end of the oil cooler restricts the oil pressure within range of lubricating points to $5.4\ ^{+1.0}_{-0.6}\ kg/cm^2$ ($76.8\ ^{+14.2}_{-8.5}$ psi). A main flow filter is connected to the oil tank return line.

A bypass valve installed in the supporting bracket (tankfilter) restricts the pressure differential between the filter input and output to 0.7 - 0.8 kg/cm^2 (10.0 - 11.4 psi). The crankcase is vented via hoses from the housing to the oil tank and from the filler neck to the air filter housing. A built-in flame trap cartridge protects against backfiring. The oil filler neck, the dipstick and the oil filter are accessible from engine compartment.

CYLINDER HEAD

The heavily ribbed single cylinder heads are light metal alloy (Y-alloy) chilled castings. Valve seats and valve guides are shrunk-fit. The overhead valves are aligned in V-shape, the intake valve at an angle of 27° in upward direction, the exhaust valve at an angle of 32° in downward direction.

TIMING SYSTEM

The overhead valves suspended in V-shape are timed by an overhead camshaft via rocker arms. The rocker arms and the two camshafts are each mounted in a common camshaft housing for three cylinders. Both camshafts are driven by the crankshaft via chains and an intermediate shaft. The chain tension is automatically controlled by two hydraulic chain tensioners. The lubrication of the three camshaft bearings as well as the lubrication of the rocker arms and the rocker arm shafts is via an oil splash pipe installed in the camshaft housing. The oil splash pipe is connected to the main oil duct in the crankcase via a flexible hose.

CYLINDERS

The cylinders are provided with cooling ribs, they are special grey iron castings and can be individually replaced with the pertinent pistons.

PISTONS

The light metal alloy pistons with steel inserts are provided with 2 tapered compression rings and one oil slot hose spring ring. The piston pins are floatingly supported in conrod eye and secured by locking rings laterally in piston.

CRANKCASE

The split light metal alloy crankcase with vertical center division is a die casting. The two housing halves are machined together and for this reason cannot be replaced individually.

CRANKSHAFT

The crankshaft is forged in three planes with six throws. Following the machining, the crankshaft is "tenifer" treated. The main bearings 1 to 7 are using split, thinwalled multi-component bearing shells. Bearing 1 on flywheel end of crankshaft is designed as a flanged bearing for absorbing the axial play. Bearing 8 is a closed aluminum bushing with a running surface of hard lead. Bearing shells 1 to 7 are positioned by means of a lug and groove; bearing 8 by means of a holding pin. The oil for the connecting rod pins is fed through bearings 1 and 8 into the crankshaft. Main bearings 1 to 8 are receiving their oil via individual ducts from main flow duct. The flywheel is a malleable casting and is attached to the inner face of the crankshaft by means of six cheesehead bolts with multiple inside teeth (M 12 x 1.25).

CONNECTING RODS

The connecting rods are steel forgings with I-shaped shank cross section. The bearing caps are attached by means of two fitted bolts (M 10 x 1.25) designed as expansion screws and the pertinent hexagon nuts. The piston pin bushing is a pressed-in bronze alloy.

CLUTCH

The single plate dry clutch between the engine and the main gearbox is fitted to the flywheel. The spring-loaded driven plate is lined on both sides and slides on the splined input shaft in axial direction. The diaphragm spring is centered with clutch in flywheel. In engaged condition, the driven plate is pressed by the clutch pressure plate against the flywheel under the influence of the spring force of the diaphragm spring. The power connection between the engine and the transmission is thereby established. The throwout fork with the clutch pressure bearing guided on a sleeve is mounted in the transmission housing. The clutch pressure bearing requires no servicing. When declutching, the clutch is actuated via the clutch pedal, the clutch cable, the throwout fork and the clutch pressure bearing. The clutch pressure bearing will press against the plates of the diaphragm spring, shifting them in axial direction. The resulting deflection of the diaphragm spring will lift the clutch pressure plate from the driven plate and the connection between engine and transmission is then separated. Clutch surface is restricted to

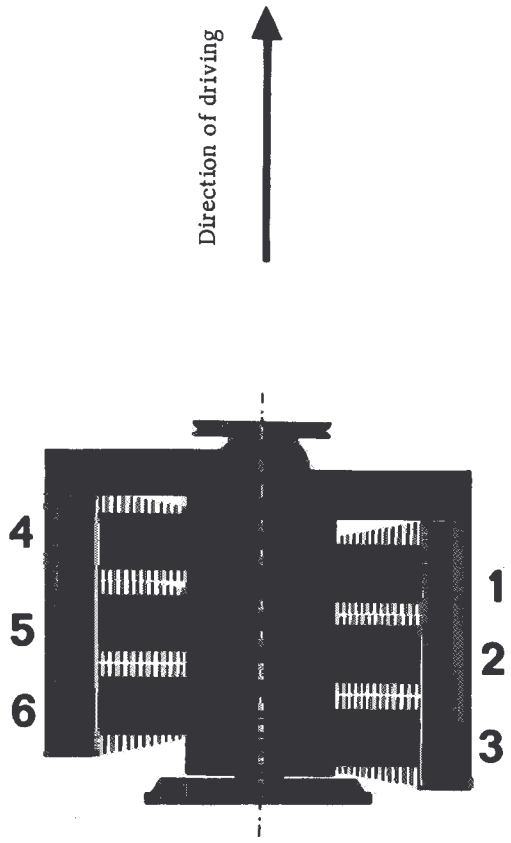
adjusting the specified pedal play of 20-25 mm (0.8-1.0 in.) with increasing wear of clutch lining, as well as to adjusting the pedal restriction.

TECHNICAL DATA

Type	Air-cooled four-stroke gasoline engine with clutch, transmission and rear axle combined into one unit arranged at rear of vehicle in mid-engine design
Number of cylinders	6
Cylinder arrangement	Horizontal, 3 cylinders each opposed (flat six)
Bore	80 mm dia. (3.15")
Stroke	66 mm (2.598")
Total piston displacement	1,991 cc (121.4 cu. in.)
Compression ratio	8.6:1
Performance (DIN)	110 HP at 5,800 rpm
(SAE)	125 HP at 5,800 rpm
Max. torque (DIN)	16 mkp (116 ft/lb) at 4,200 rpm
(SAE)	131 ft/lb
Mean piston speed	12.45 m/s (40.9 ft/sec) at 5,680 rpm
Octane number	96 ROZ (Research Method)
Total weight dry	approx. 179 kp (395 lbs)
Cooling	Air-cooled by axial blower on alternator
Blower drive	from crankshaft by V-belt transmission ratio 1:1.3
Delivered air volume	1,050 lits/sec (277 US gal/sec) at 5,800 rpm
Lubrication	Dry sump forced circulation
Oil cooling	Oil cooler on crankcase in blower air stream
Oil filter	in main stream
Oil pressure indication	Pilot lamp in combination instrument
Oil capacity with filter	9 lits (2.4 US gal)
Sportomatic	11 lits (2.9 US gal) initial filling 9 lits (2.4 US gal) at oil change
Oil consumption	1 liter/1,000 km (0.26 US gal/6,200 miles)
Cylinder head	One each per cylinder with cast-on cooling ribs, aluminum alloy (Y-alloy)
Valve seat ring	Shrunk-in, alloyed grey casting
Valve guide	Shrunk-in, of special brass
Spark plug threads	Cut into cylinder head
Valve timing	one overhead camshaft per cylinder bank and rocker arm
Valves	1 Intake and 1 exhaust valve per cylinder
Exhaust valve	sodium-filled with hard-faced seat
Arrangement	overhead in V-shape
Valve clearance Intake:	0.10 mm (.0039") with cold engine
Exhaust:	
Valve springs	2 coil springs per valve
Compression	9 - 11 kp/sq. cm (128 - 156 psi)
(Pressure should be uniformly distributed on all cylinders.)	(With throttle valves open, all spark plugs removed, engine oil temperature at least 60°C = 140°F, crank with starter.) Cable plug on switchgear removed.

Valve timing with 1 mm clearance	
Intake opens	15° BTDC
Intake closes	29° ABDC
Exhaust opens	41° BBDC
Exhaust closes	5° BTDC
Cylinders	Single cylinders, special grey casting with cooling ribs
Pistons	Light metal alloy with steel inserts
Piston pins	Floating, secured by circlips
Piston rings	2 Compression rings, 1 oil ring
Crankcase	Split, with vertical center division by crankshaft and camshaft bearing
Camshaft	Grey casting, 3 plein bearings directly in camshaft housing
Camshaft drive	Chain drive
Crankshaft	Forged
Crankshaft bearings	8 Plain bearings
Main bearings 1 - 7	Split, half shells, three-component bearings
Main bearing 1	Guide bearing
Main bearing 8	Aluminum bushing with hard lead running surface
Connecting rods	Forged, with I-shaped shank cross section
Conrod bearings	Split, half shells, three-component bearings
Piston pin bearings	pressed-in bronze bushing
Clutch	
Type	Single-plate dry clutch M 215 K - Fichtel a. Sachs
Total contact area	203 sq. cm (31.5 sq. in.)
Ignition	Heavy-duty battery capacitor ignition (BHKZ)
Ignition transformer	Bosch
Ignition distributor	Marelli S 112 BX
Timing	35° BTDC at 6,000 rpm
Firing order	1 - 6 - 2 - 4 - 3 - 5
Ignition timing	By centrifugal governor
Dwell, point gap	40° ± 3° or 0.4 mm (.016")
Spark plugs	Beru 240/14/3, Bosch W 230 T 30
Electrode gap	0.6 mm (.024 in.)

DESIGNATION OF CYLINDERS



FIRING ORDER 1 - 6 - 2 - 4 - 3 - 5

TIGHTENING TORQUES FOR ENGINE

Location	Designation	Threads	Grade	Tightening torque mkp (ft-lb)
Screw bolts crankshaft half	Self-securing hex. nut	M 8	8 G	2.2 - 2.5 (15.9-18.1)
Screw bolts crankshaft half Bearing points	Tie bolts	M 10	-	3.5 (25.3)
Connecting rod bolts	Hex. bolt	M 10x1.25	-	5.0 (36.2)
Cylinder head	Cheesehead screws (hex.socket)	M 10	-	3.0 - 3.3 21.7 - 23.9
Camshaft housing on cylinder heads	Hex. nuts and 3 each hex. socket nuts	M 8	8 G	2.2 (15.9)
Nut on camshaft	Hex. nut	M 27x2	-	10.0 (72.3)
Rocker arm shafts	Cheesehead screw	M 6	-	1.8 (13.0)
Flywheel attachment	Multi-teeth socket screw	M 12x1.5	-	15.0 (108.5)
V-belt pulley on crankshaft	Hex. bolt	M 12x1.5	8 G	8.0 (57.9)
V-belt pulley on alternator	Hex. nut	M 14x1.5	-	4.0 (28.9)

SPECIAL TOOL LIST

Piston heater	P 1a
Piston pin mandrel	P 2a
Piston ring compressor	P 8
Valve spring adjuster	P 10b
Screwdriver socket	P 74
Allen-head adapter for cylinder head nuts	P 119
T-wrench for intake stacks	P 120a
Cylinder head retainer	P 140
Valve compressor plate	P 200
Engine bench mount	P 201
Camshaft wrench	P 202
Camshaft nut adapter	P 203
Plug gauge	P 206
Dial gauge holder	P 207
Fan belt pulley wrench	P 208
Crankshaft mount	P 209
Sprocket wheel dowel extractor	P 212
Valve feeler gauge	P 213
Chain tensioner clamp	P 214
Adjusting ring	P 214b
Oil seal installer	P 215
Heat exchanger box wrench	P 217
Flywheel bushing installer	P 218
Connecting rod supports	P 221
Timing chain supports	P 222
Spark plug wrench	Local purchase item
Flywheel bolt tightening adapter	Local purchase item
Rocker arm tightening torque wrench	Local purchase item
Socket adapter	Local purchase item
Puller	VW 202
Coupling plate holder (sportomatic)	VW 184

Removing

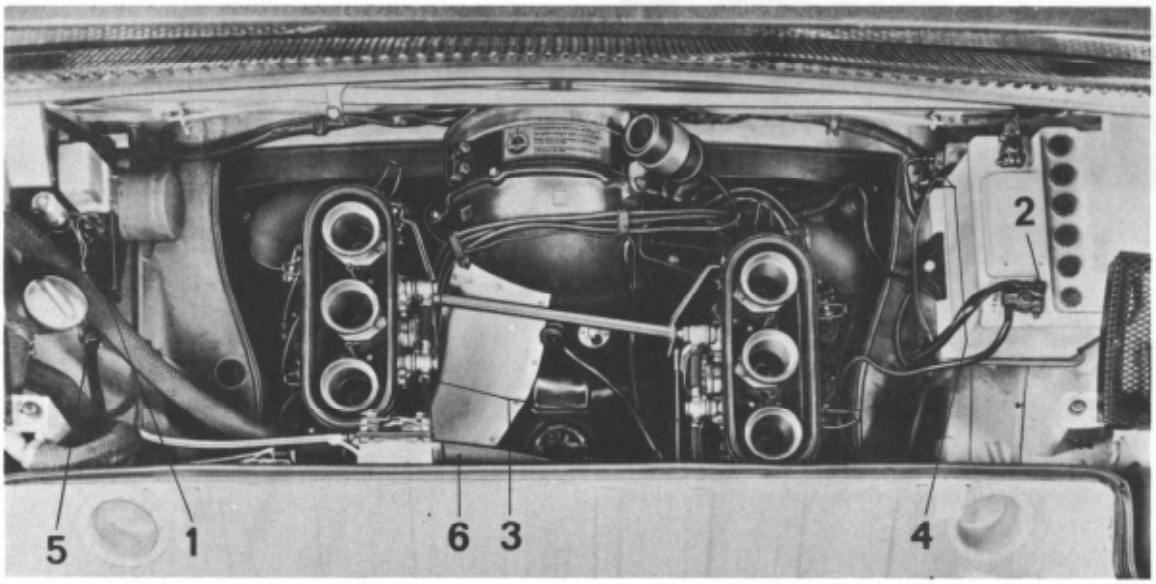
Engine and transmission are removed and installed as one assembly.

1. Disconnect both battery cables negative first.

2. Take off air cleaner and remove oil tank vent hose.

3. Detach fuel hose from carburetor. Loosen and remove oil breather hose from oil filler neck.

4. Remove the multiple connector plugs.



1 Multiple connector

2 Allen-head screw

3 Carburetor fuel inlet line

4 Multiple connector at trigger unit

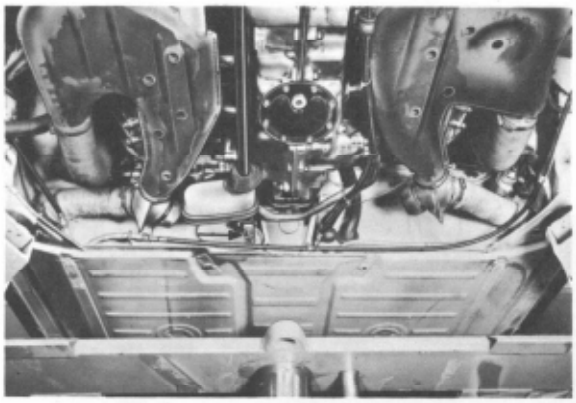
5 Wire retainer

6 Oil breather hose

5. Raise the car.

6. Remove muffler shroud.

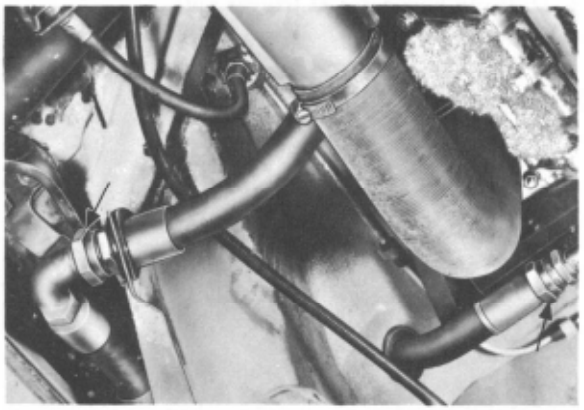
7. Remove cover and unscrew shift rod holder.



8. Take off dust cap. Remove nuts and take off support bracket. Take out shift rod.

9. Remove hot air ducts, flaps and control cables.

10. Disconnect oil hoses from oil tank and allow oil to drain.



11. Remove clutch cable adjusting nut and cable pulley retaining nut. Bend holding plate and pull clutch cable forward.

12. Disconnect speedometer drive cable. Remove carburetor control linkage from cross shaft. Detach throttle pull rod and remove from holder.

13. Disconnect universal shafts from transmission.

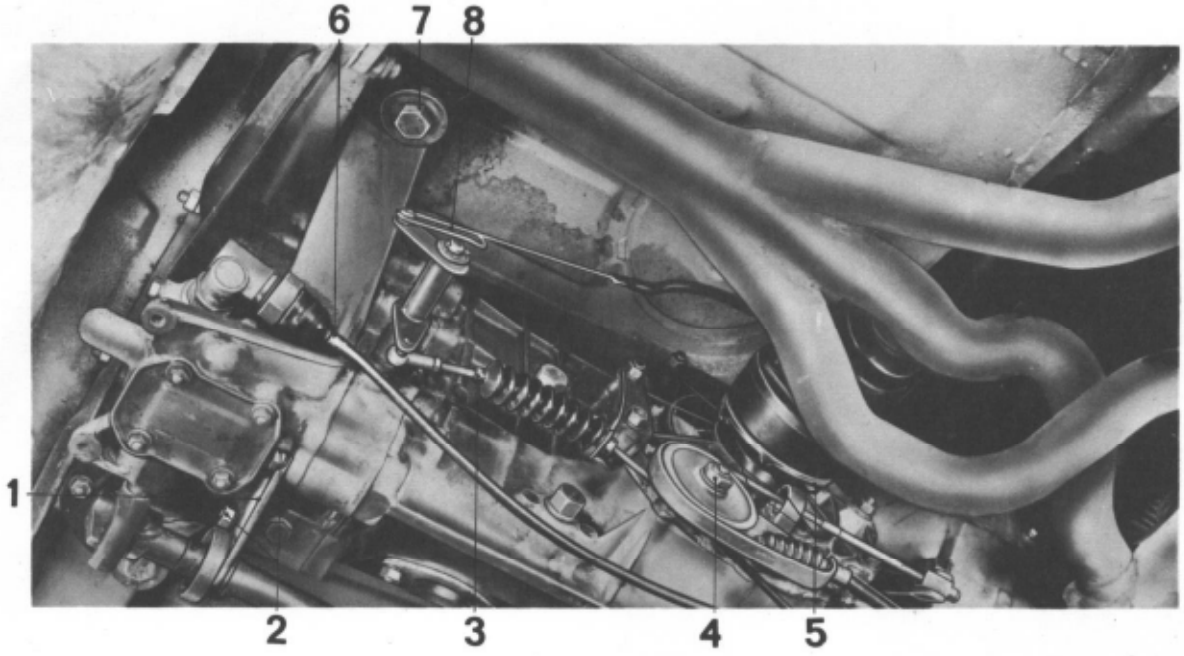
14. Remove ground strap from luggage pan.

15. Remove wire from backup light switch.

16. Lower vehicle slightly. Slide floor jack with adaptor plate into position so that adaptor plate slightly supports the power train assembly.

17. Remove M10 nuts from transmission support.

18. Remove engine support.



1 Support

2 Nut, M8

3 Throttle cable

4 Nut for cable pulley

5 Allen-head bolt

6 Speedometer drive cable

7 Nut for transmission support

8 Throttle pull rod

19. Move universal shafts aside, then carefully lower the power train assembly.

Installing

During installation, not the following:

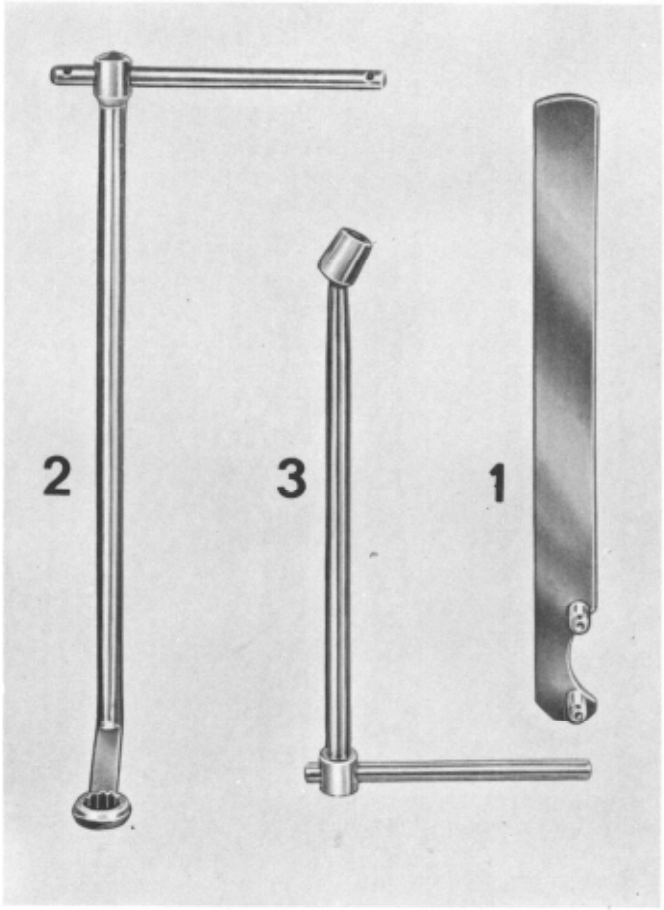
1. Check clutch throw-out bearing for wear before bolting engine to transmission.

2. Lightly coat the throw-out bearing guide tube, drive shaft splines, and starter shaft bushing with molykote type lubricant.

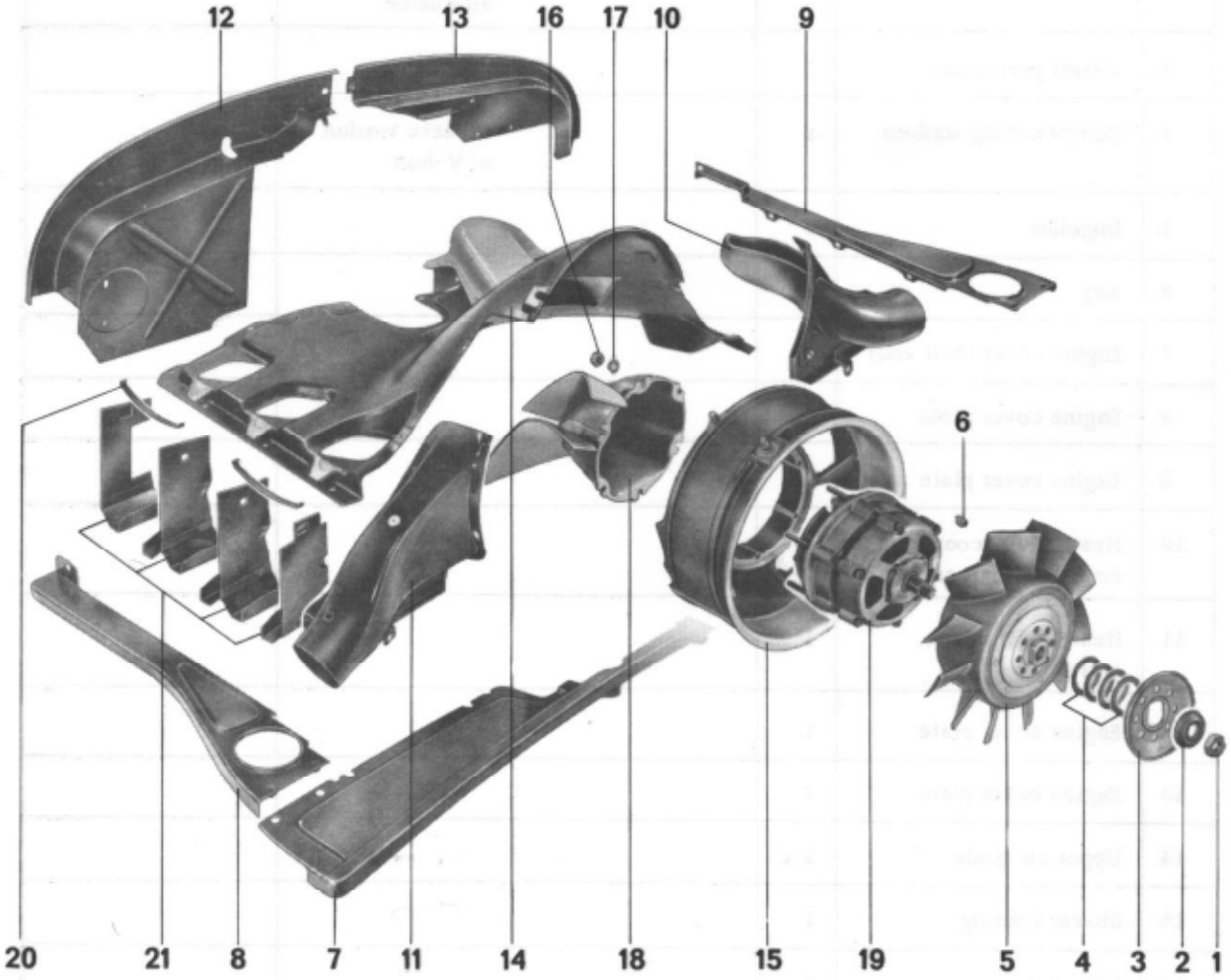
3. When positioning the power train assembly make sure that electrical wires are not jammed or pinched.
   Caution
   Check for chaffed electrical wires or fuel hoses and replace as necessary.

4. Adjust clutch free play.

TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	V-belt pulley wrench	P 208	
2	Wrench	P 217	
3	Swivel wrench	P 120a	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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. nut	1			
2	Clamping cap	1		Observe make of alternator	
3	V-belt pulley half	1			
4	Compensating washers	x		Observe tension of V-belt	
5	Impeller	1			
6	Key	1			
7	Engine cover (belt end)	1			
8	Engine cover plate	1			
9	Engine cover plate	1			
10	Heating air scoop with cover plate, rear right	1			
11	Heating air scoop, rear left	1			
12	Engine cover plate	1			
13	Engine cover plate	1			
14	Upper air guide	1			
15	Blower housing	1			
16	Hex. nut	6			
17	Undulated washer	6			
18	Hub extension	1			
19	Alternator	1			
20	Leaf spring	4			
21	Baffle plate	8			

CHECKING AND ADJUSTING V-BELT TENSION

Checking

The V-belt tension is correct if the V-belt can be depressed lightly with the thumb about 1 to 1.5 cm (.4-.6 in.) at the center of the belt between the two pulleys.

Cracked V-belts or V-belts with frayed edges should be replaced. Oily V-belts can often be reused if washed in an industrial detergent and rinsed thoroughly. Do not use gasoline for cleaning V-belts.

Adjusting

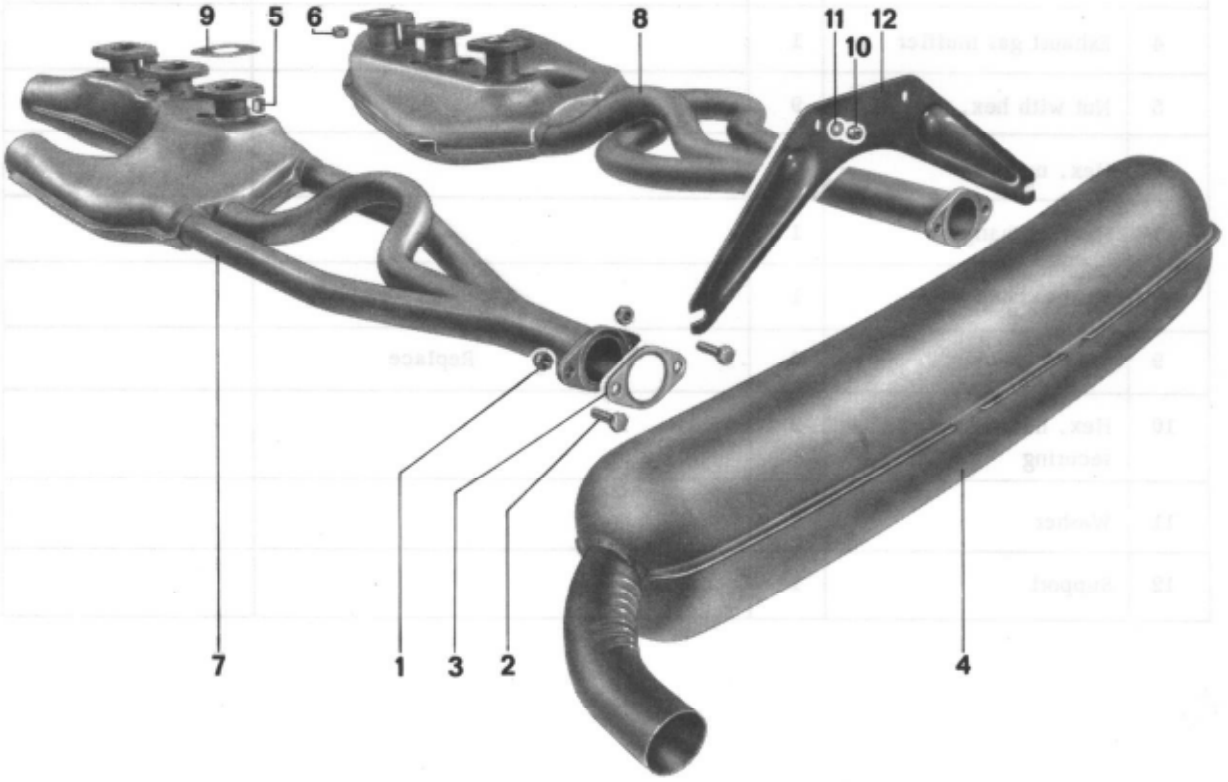
1. Loosen hex. nut for V-belt pulley. Use special tool P 208 and remove one half of V-belt pulley.

Note

Do not drop shim washers.

2. Adjust V-belt tension as required by removing or adding shim washers.

   It is recommended to start basic adjustment with 5 shim washers between pulley halves, followed by making the necessary adjustments.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No.	Designation	Each	Observe during: Removal / Installation	Spec. Instr.
1	Hex. nut, self-securing	4		
2	Hex. bolt	4		
3	Seal	2	Replace	
4	Exhaust gas muffler	1		
5	Nut with hex. socket	9		
6	Hex. nut	3		
7	Heat exchanger	1		
8	Heat exchanger	1		
9	Seal	6	Replace	
10	Hex. nut, self-securing	2		
11	Washer	2		
12	Support	1		

OIL CIRCUIT

The type 2000 engine has dry sump lubrication. The oil circuit contains two independent oil pumps, housed in the crankcase. One pump draws oil completely free from air bubbles from a separate oil tank, where it has been allowed to settle, for distribution by way of the main oil circuit to the main bearings. The other pump extracts contaminated oil from the crankcase through a strainer for delivery to the oil tank via a filter. Since this pump operates at reduced efficiency when delivering oil containing air bubbles, its dimensions have been pertinently enlarged.

A thermostat is placed at the entry to the main oil circuit to regulate the flow of oil. If the oil temperature drops below 80°C (176°F), a valve operated by the thermostat closes to prevent oil from circulating through the oil cooler and the oil will pass directly to the bearings. When the temperature rises above 80°C (176°F) the valve opens and oil flows through the cooler prior to reaching the bearings.

A pressure relief valve (7) and a safety valve (4) are installed in the main oil duct. The pressure relief valve comprises a spring and piston in the righthand half of the crankcase. If the oil pressure in the circuit rises above $5.4 \begin{smallmatrix} +1.0 \\ -0.6 \end{smallmatrix}$ kg/cm^2 ($76.8 \begin{smallmatrix} +14.2 \\ -8.5 \end{smallmatrix}$ psi), the pressure relief valve opens and the oil is allowed to pas directly into the crankcase. In addition to the pressure relief valve a safety valve is mounted in the lefthand crankcase half immediately following the oil pump. This valve operates in the event of a defective pressure relief valve to prevent damage to the oil cooler and possibly to the filter or the hoses.

Each main bearing is supplied with oil by a separate passage from the main oil circuit. Main bearings 1 and 8 are designed to supply oil continuously under pressure to the center of the crankshaft. The crankshaft is drilled through its center, so that oil can reach the connecting rod bearings.

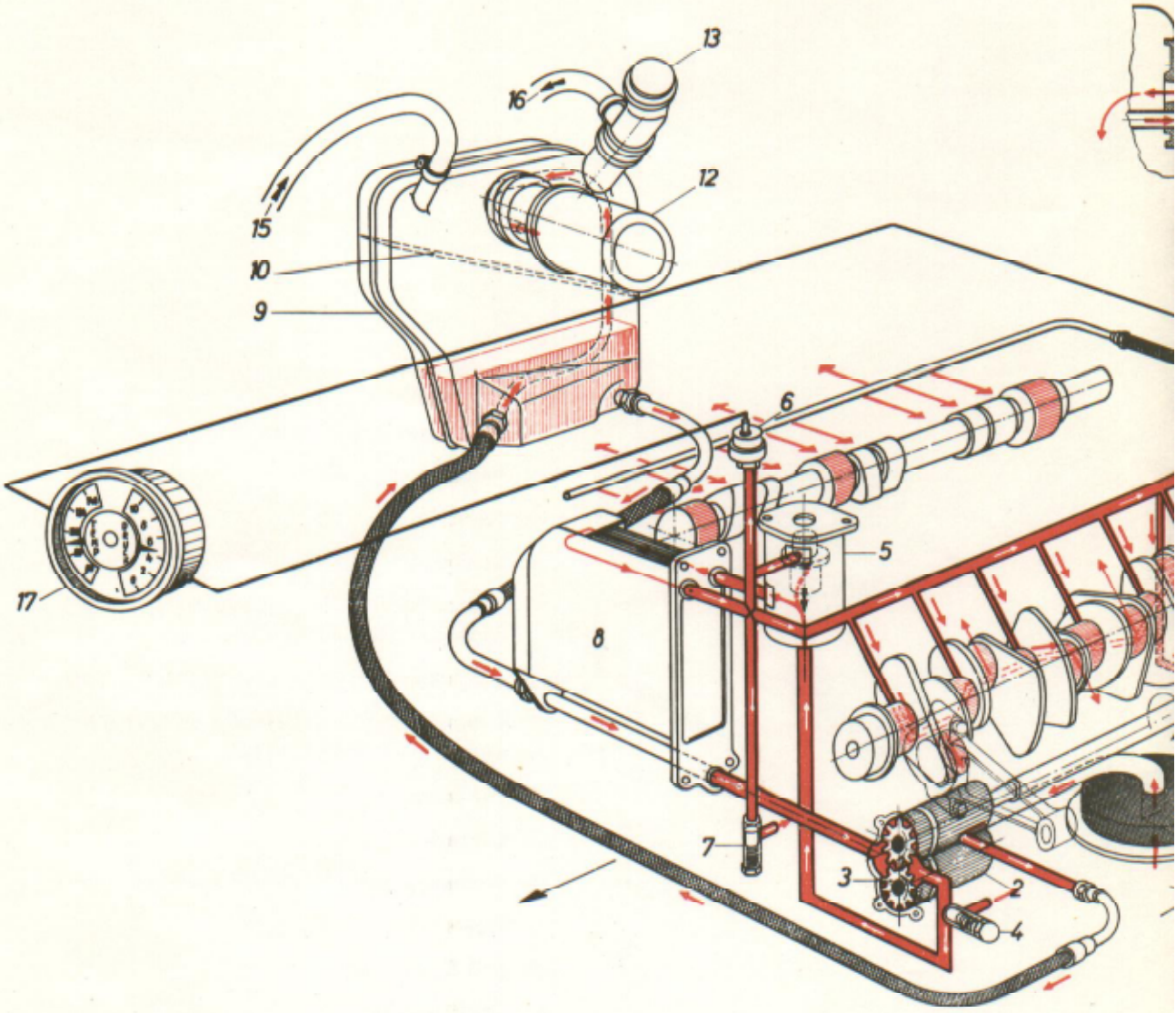
The front bearing of the intermediate shaft is supplied with oil via a duct, while the rear bearing of the intermediate shaft receives its oil through the center of the intermediate shaft. A small hole at the rear face allows oil to reach and lubricate the fitted axial bearing.

At the end of the main duct in the righthand and lefthand crankcase half is one connecting point each for an oil hose to the camshaft housing. It supplies the camshaft and the rocker arms with the required oil. The camshaft housings are provided with aluminum tubes. These tubes carry three holes each of approx. 3 mm dia. through which the oil flows to the bearing points of the camshaft. The six holes of approx. 1 mm dia. which are also in these tubes serve for spraying lube oil on the cam sliding surface. Three additional holes in the aluminum pipes serve to spray oil against the intake valve covers from which the oil drips on the rocker arms and the valve stem.

The oil is collected in the lower part of the camshaft housing and returns from there to the crankcase by two oil return pipes. The suction pump then returns the oil to the oil tank through a flexible hose. A tube in the oil tank adjacent to the hose connection points conveys the oil through a pipe to the base of the oil filter. The oil filter is a throw-away filter and is unscrewed from its base after a specified period of service and then replaced.

From the base of the oil filter the oil flows through the filter housing and filter cartridge under pressure to the center of the filter where it is cleaned from contaminations and is then returned to the oil tank.

For safety reasons the base and the filter are provided with one valve each. These valves serve the purpose of guiding the oil directly to the oil tank as soon as the flow pressure through the filter rises to above 2 kg/cm^2 (15 psi). These valves will prevent any interruption of the oil flow caused by contamination of the filter or clogging of the outlet duct.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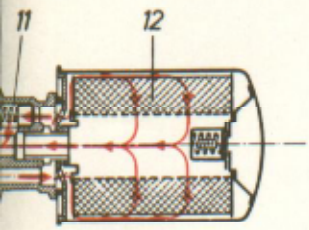
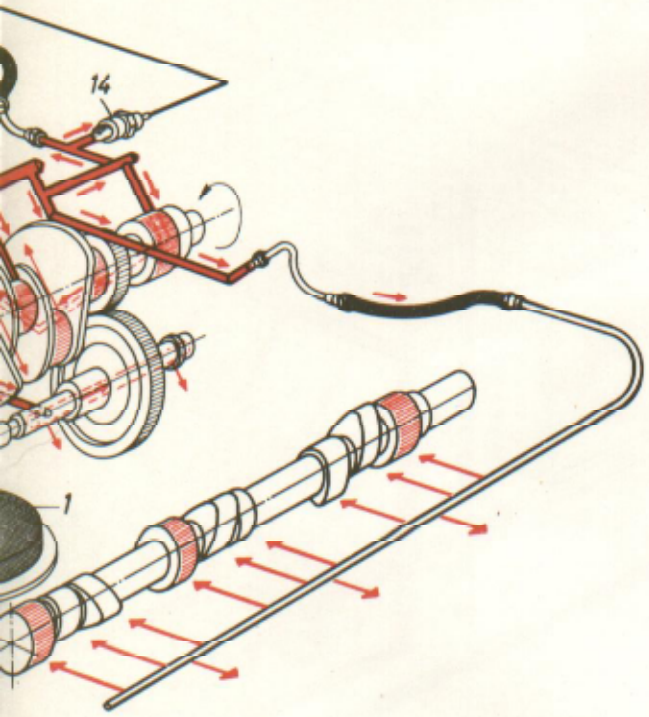




1 Oil strainer (crankcase)

2 Return pump

3 Pressure pump

4 Safety valve (opening pressure p = 8 kg/cm^2 = 113 psi)

5 Thermostat (opens to pass oil through cooler at approx. 80 °C = 176 °F)

6 Oil pressure gauge

7 Pressure relief valve (opening pressure p = 6.2 $\pm$ 0.8 kg/cm^2 = 88.2 $\pm$ 11.4 psi)

8 Oil cooler

9 Oil tank

10 Perforated plate (to prevent foaming)

11 Bypass valve

12 Full flow oil filter

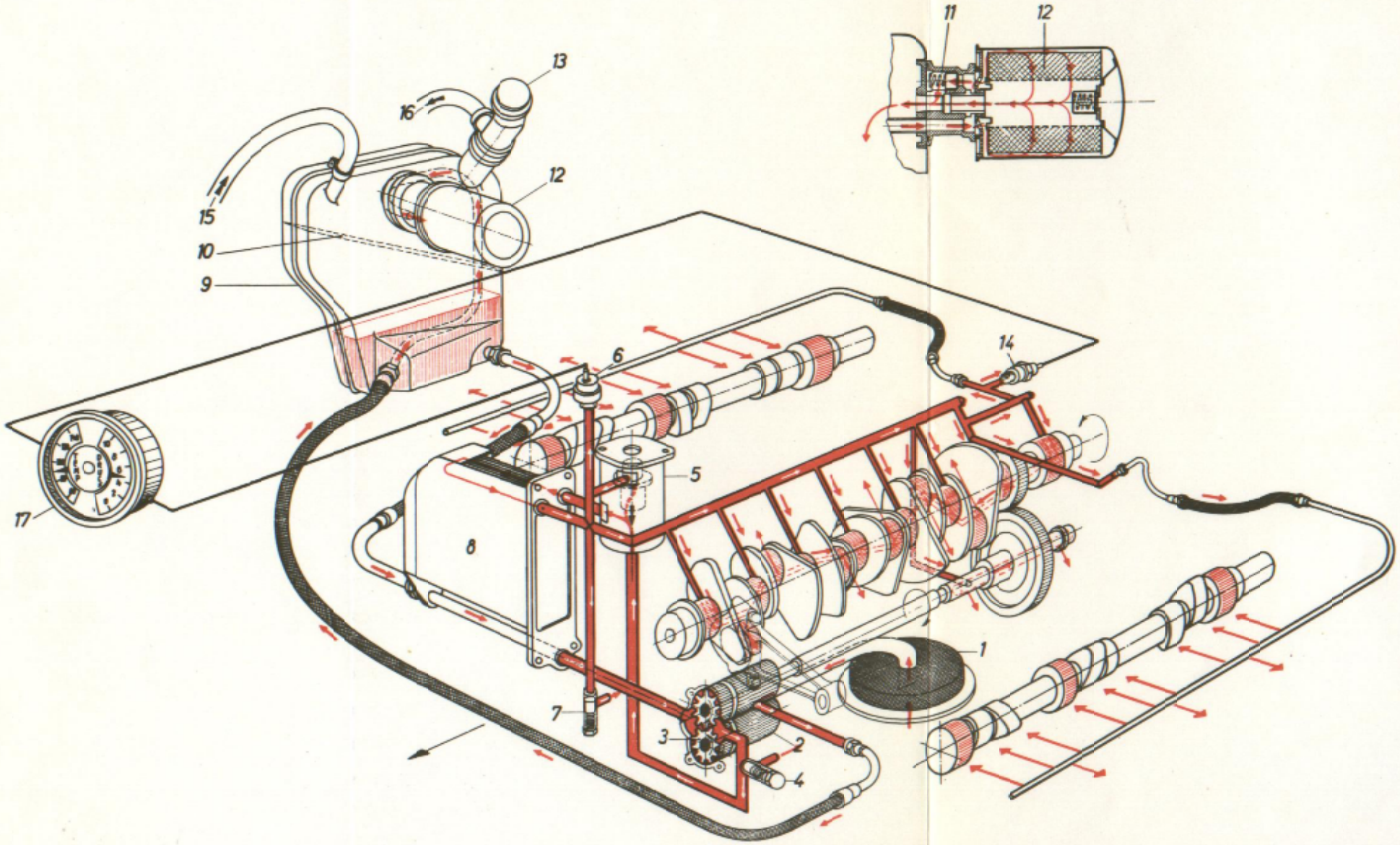
13 Oil filler pipe

14 Oil temperature gauge

15 Crankcase breather into oil tank

16 Oil tank breather to air filter

17 Combination oil pressure and temperature indicator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The oil cooler can be replaced only when the engine is removed.

Removing

1. Remove both carburetors with intake manifolds.

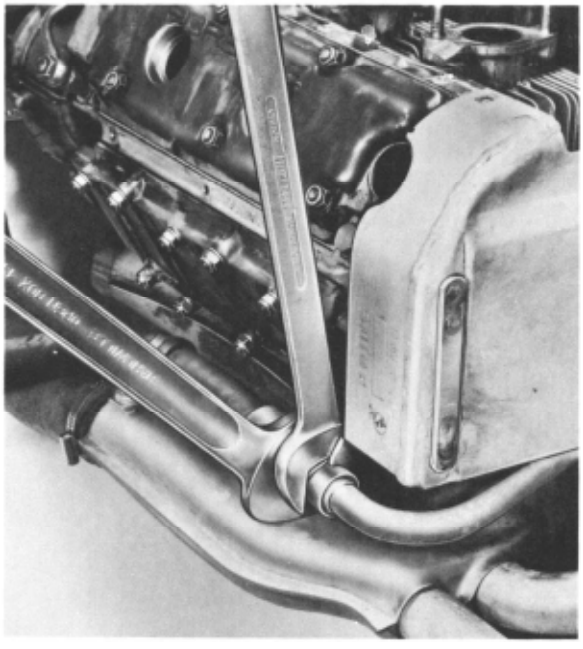
2. Remove upper air shroud retaining bolts and remove shroud.

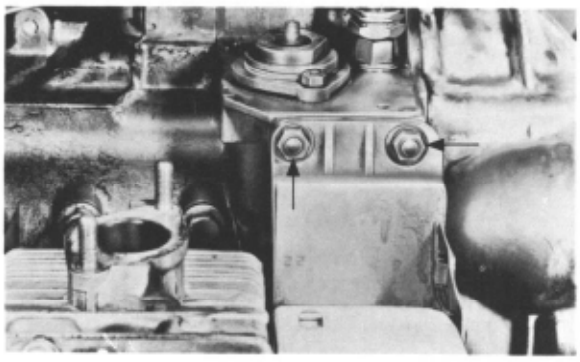
3. Remove forward shroud section.

4. Remove side shroud section.

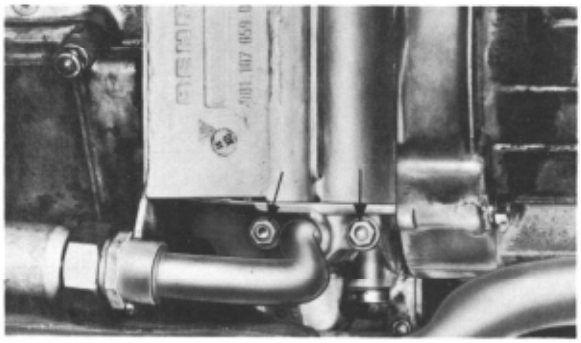
Caution
Hold connecting tube with a wrench to prevent damage when disconnecting the inlet line from the oil cooler assembly.

5. Detach oil line.





6. Remove upper and lower retaining nuts from oil cooler. Remove oil cooler.

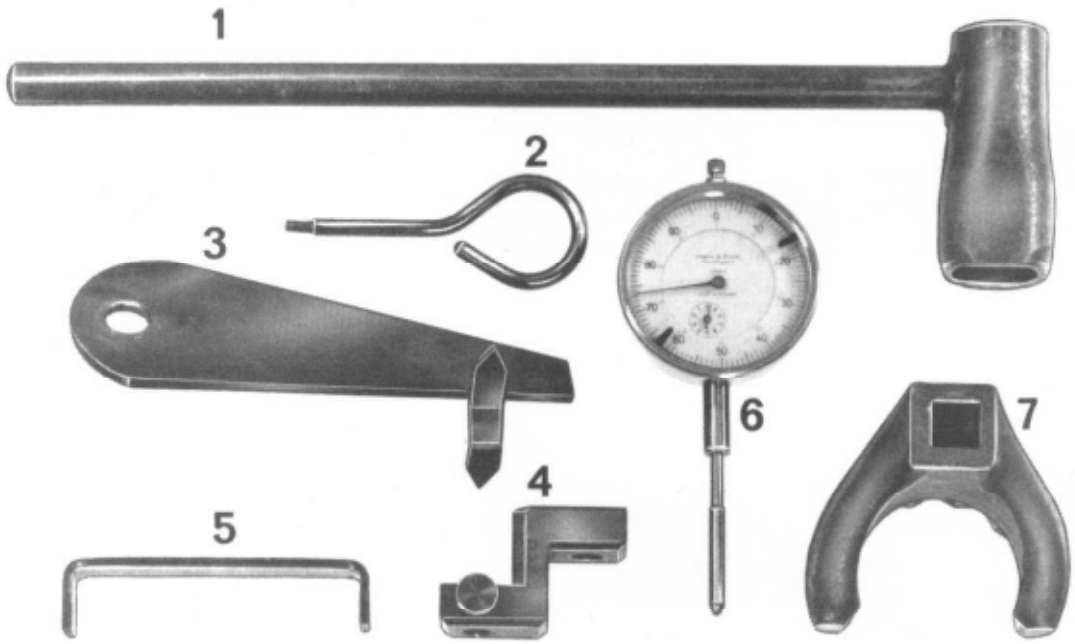


Installing

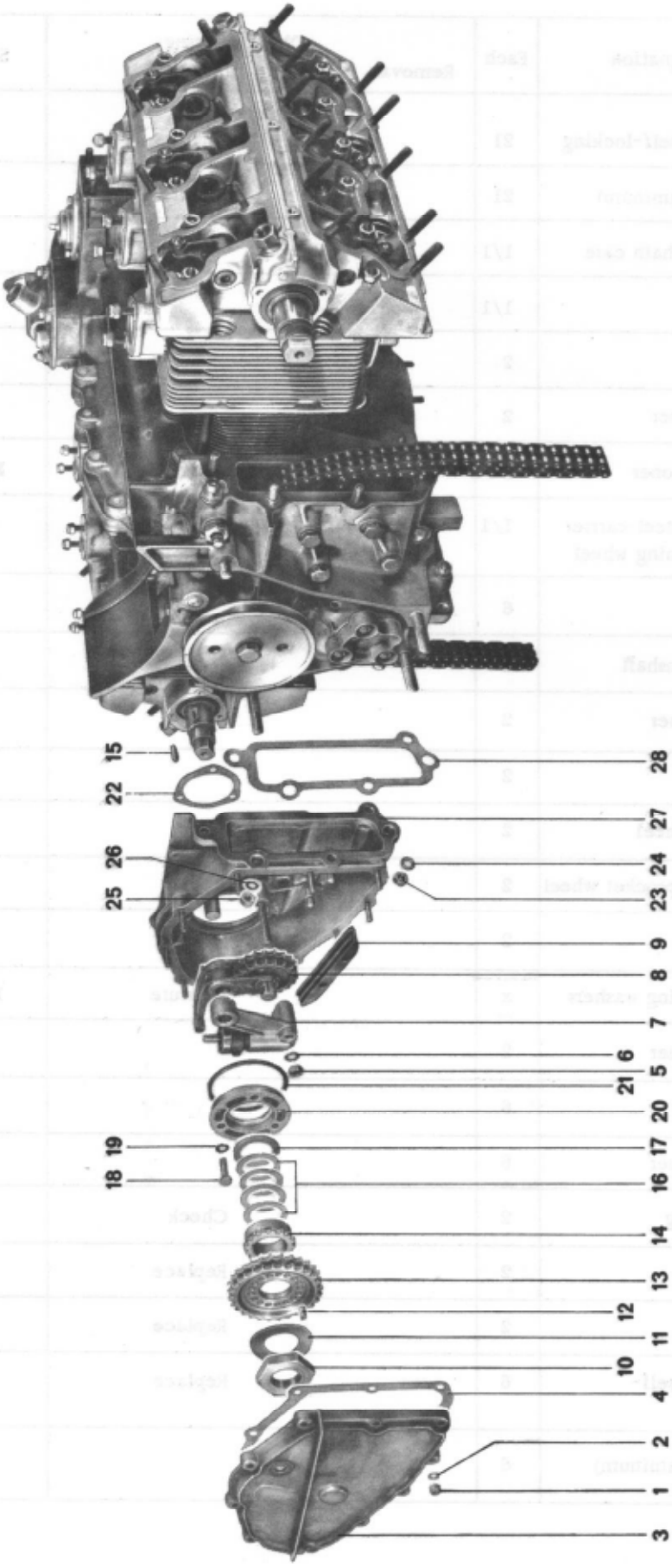
1. Use new O-rings in oil cooler.

2. When positioning the oil cooler on crankcase, make sure O-rings are correctly seated.

TOOLS



No.	Designation	Special Tool	Explanation
1	Spanner for camshaft	P 202	
2	Puller	P 212	
3	Indicator		self-made, not absolutely required
4	Dial gauge holder	P 207	
5	Clamp for chain tensioner	P 214	
6	Dial gauge		commercial
7	Spanner for camshaft nut	P 203	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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
1	Hex. nut, self-locking	21		Replace	
2	Washer (aluminum)	21		Replace	
3	Cover for chain case	1/1			
4	Seal	1/1			
5	Hex. nut	2			
6	Spring washer	2			
7	Chain tensioner	2		Check	14.1-2/3
8	Sprocket wheel carrier with tensioning wheel	1/1			
9	Slide rail	6			
10	Nut for camshaft	2			
11	Spring washer	2			
12	Cyl. pin	2			
13	Sprocket wheel	2			
14	Flange to sprocket wheel	2			
15	Key	2			
16	Compensating washers	x		Measure	14.1-1/8
17	Thrust washer	2			
18	Hex. screw	6			
19	Spring washer	6			
20	Sealing ring	2		Check	
21	O-ring	2		Replace	
22	Seal	2		Replace	
23	Hex. nut, self-locking	6		Replace	
24	Washer (aluminum)	6			

No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
25	Hex. nut	4			
26	Spring washer	4			
27	Chain case	1/1	Check		
28	Seal	2	Replace		

INSPECTION AND INSTALLATION OF CHAINCASE

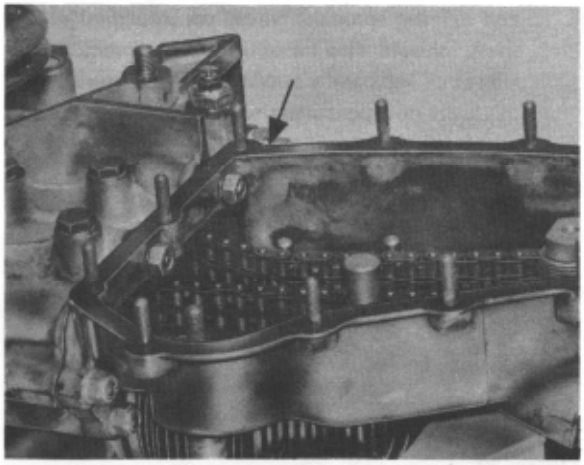
Checkup

1. Check sprocket wheel carrier bolt in chain case for tight seat.

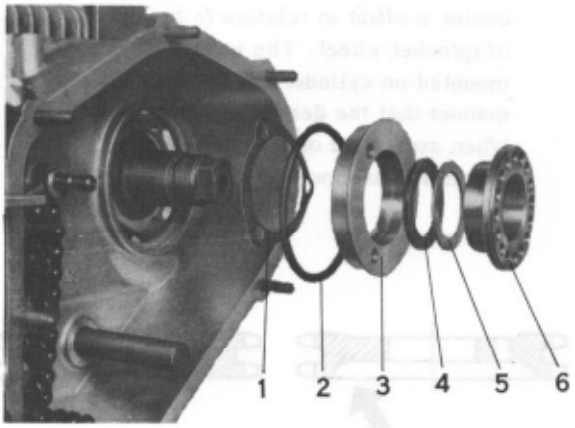
Installation

1. Use new seal between chain case and crankcase.

2. Attach chain case with aluminum washers and new, self-securing nuts. Inside, the chain case is attached with corrugated washers and standard nuts M 8. Tighten fastening nuts of chain case to specified torque.



3. Install seal between camshafts and chain case in sequence shown below.



1 Seal
2 O-ring
3 Sealing ring
4 Thrust washer
5 Compensating washer
6 Flange to sprocket wheel

The axial play of the camshaft is permanently set by the sealing ring and the thrust washer and cannot be changed.

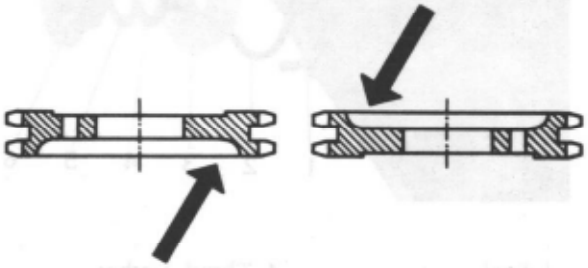
Remark:

If the sealing ring should show evidence of wear, the installation of a new sealing ring will provide the specified axial play.

INSTALLATION OF CAMSHAFT DRIVE

1. Slide thrust washer and number of removed compensating washers on camshaft, place half-round key into camshaft and fit sprocket wheel flange. (The sprocket wheel flange is the same for both ends.)

2. The sprocket wheel on the camshaft is the same for both ends, but the chain path center is offset in relation to holding flange of sprocket wheel. The sprocket wheel is mounted on cylinder end 1-3 in such a manner that the deeper recess faces the rear. When assembled on cylinder end 4-6, the deeper recess should face forward.

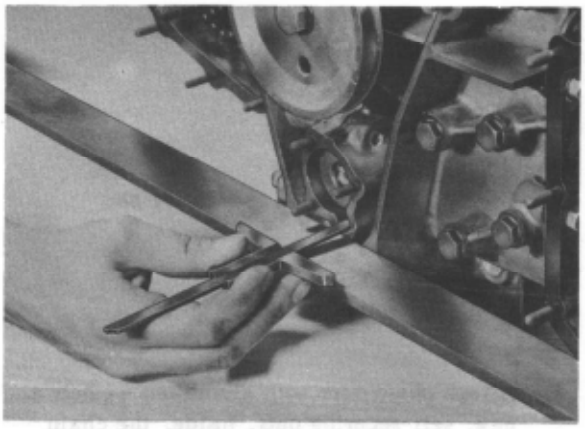


Cylinder end 1-3 Cylinder end 4-6

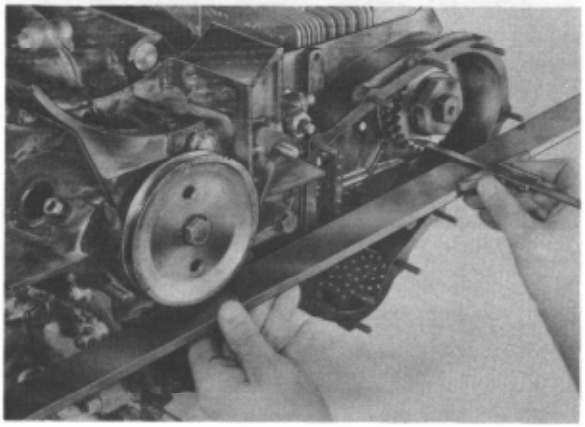
3. Tighten sprocket wheels with special tool P 202 and P 203 to specified torque.

4. Measure sprocket wheels for parallel alignment.
The deviation from parallel alignment of the driving sprocket wheel on the intermediate shaft to the driven sprocket wheel on the camshaft should not exceed max. 0.25 mm (.010 in.). Prior to measuring, slide intermediate shaft and camshaft in axial direction toward flywheel so that the guide collar of the bearings abuts.

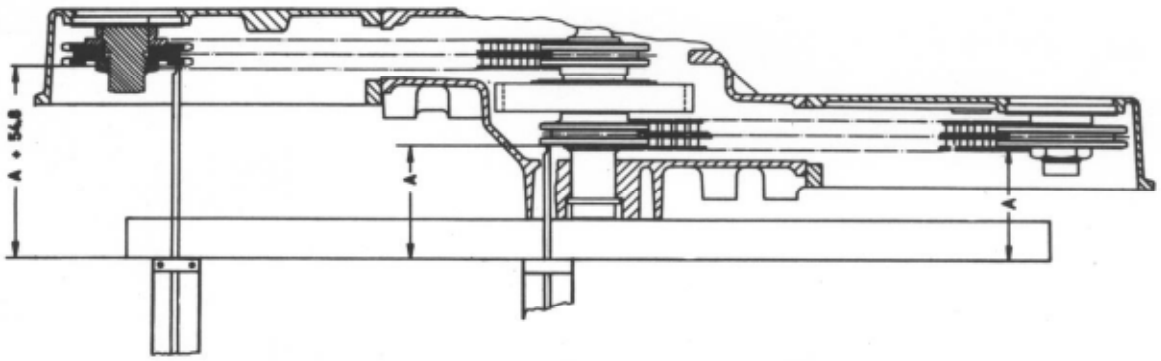
5. Use depth gauge for measuring and a straightedge through the bore underneath intermediate shaft toward face end of front driving sprocket wheel on intermediate shaft (dimension A).



6. This dimension "A", face end engine to face end driving sprocket wheel on intermediate shaft, should also be obtained on sprocket wheel of lefthand camshaft. If not, remove or insert compensating washers between the receiving flange of the sprocket wheel and the thrust washer.



7. The driving sprocket wheel on the intermediate shaft for the righthand camshaft is offset to the rear by 54.8 mm (2.16"). These 54.8 mm must be added to the measured dimension "A" to obtain the distance from face end engine to face end sprocket wheel of righthand camshaft.

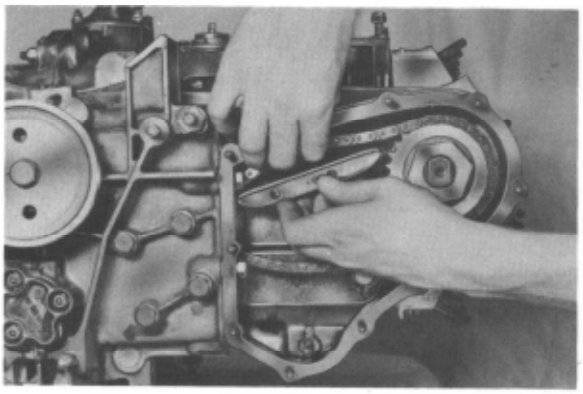


Measured dimension "A" = 78.7 mm

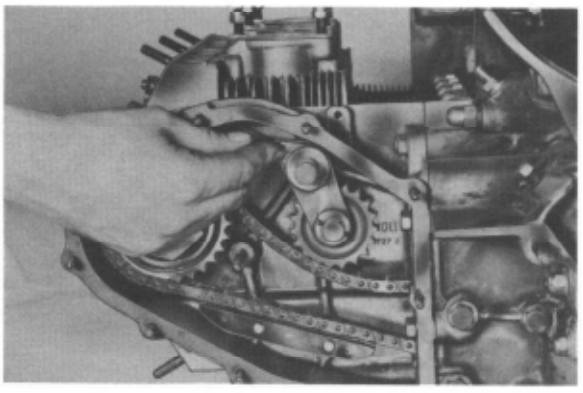
Distance straightedge to face end lefthand sprocket wheel = 78.7 mm

78.7 mm
+ 54.8 mm

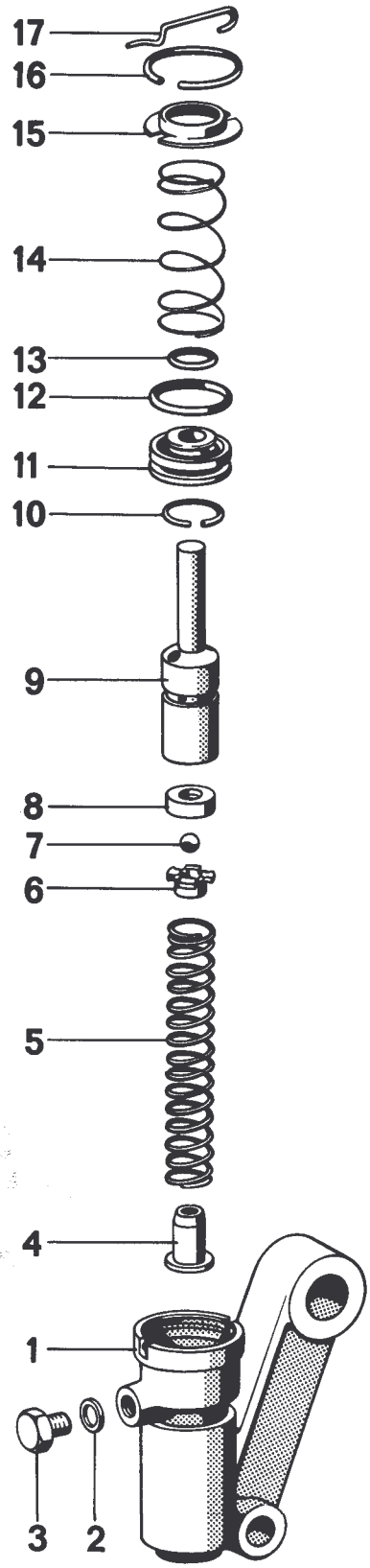
Distance straightedge to face end righthand sprocket wheel =133.5 mm



8. Slide rails in chain case on holding bolts until the rail enters the grooves of the holding bolt. The longer end of the slide rails should face the sprocket wheel of the camshaft.



9. Mount chain tensioning wheel with guide lever. Be sure that the drilled bearing bolts are always pointing upwards with the recess supplying oil to the sprocket wheel, so that the splash oil flows well into recess.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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Chain tensioner housing	2			
2	Sealing ring	2			
3	Venting screw	2		Blow out venting hole	
4	Spring guide	2			
5	Compression spring	2			
6	Cage for ball valve	2			
7	Ball	2			
8	Intermediate piece	2		Mount with sides correctly aligned	
9	Piston	2		Check for wear and replace, if required	
10	Circlip	2			
11	Piston	2		Check for easy running	
12	O-ring	2		Replace and lubricate	
13	O-ring	2		Replace and lubricate	
14	Compression spring	2			
15	Spring retainer	2		Mount with crown on top	
16	Circlip	2			
17	Clip	2			

ASSEMBLY, INSPECTION AND INSTALLATION OF CHAIN TENSIONER

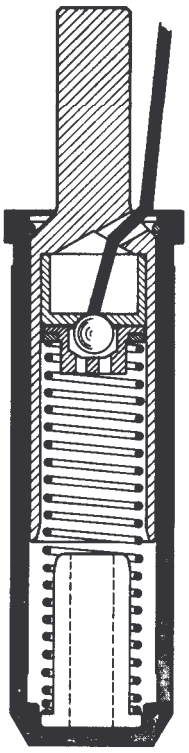
Assembly

Observe absolute cleanliness when assembling chain tensioner.

1. Assemble chain tensioner up to Item 10.

2. Clamp chain tensioner into a vise. In this position, fill oil storage area up to overflow with engine oil HD 30.

3. Use steel wire (approx. 1 mm dia.) with bent end as shown in illustration and push through bore on piston against ball. Move piston in range of stroke up and down until no more air bubbles are coming out at bores. fill oil chamber with oil up to overflow and clamp chain tensioner into vise in such a manner that the outside venting screw is at an upward angle of approx. 20° in relation to the oil chamber.



4. Mount aluminum piston, which requires placing adjusting ring P 214b on aluminum piston. Simultaneously open venting screw on housing and push piston with adjusting ring down until adjusting ring rests on edge of chain tensioner housing. Close venting screw immediately again so that the oil supply remains in the oil supply tank.

5. Completely assemble chain tensioner.

Checkup

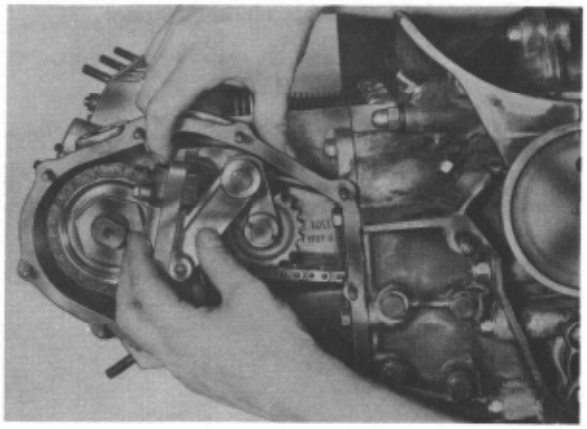
Load piston of chain tensioner to 5.5 kp (12.1 lbs). The piston should not be pushed in more than 10 mm (0.39") in the course of 5-10 min. loading period.

Installation

1. When installing a new chain tensioner, be sure that the chain tensioner is pushed on the sprocket wheel carrier only to the extent that the piston support is covered by the chain tensioner arm for half its length. Then turn circlip above spring clip sufficiently to permit removing the spring clip. Slide tensioner completely on bolt of sprocket carrier and attach.

2. Place pressure piston in BDC position prior to installing a reconditioned chain tensioner. Clamp chain tensioner into vise in such a manner that the pressure piston will be pushed into BDC position when the vise is slowly closed. (Do not close vise too quickly, so that the rubber sealing rings are not damaged and the oil can escape from the supply area).

3. Hold pressure piston in this position under pretension using special tool P 214 and install chain tensioner.

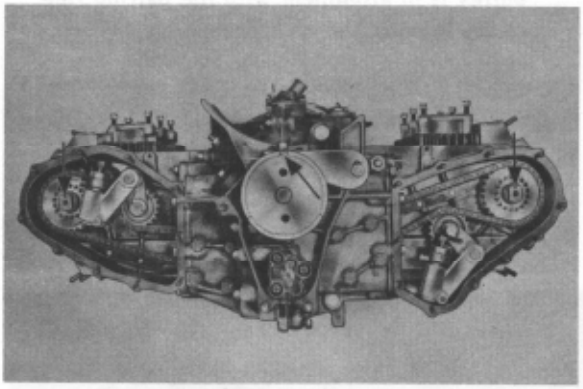


ADJUSTING THE TIMING

1. Turn crankshaft until mark Z 1 on pulley is accurately aligned with the parting line of the crankcase.

2. Turn both camshafts with special tool P 202 until the punch marks on face end of camshaft are accurately above the vertical center (refer to illustration with arrow).

Remark!
Be sure that the valves are not abutting against piston head when the crankshaft or the camshaft are turned. If resistance is experienced, move the respective part back immediately and adjust countershaft accordingly.



3. By adjusting the mark Z 1 on the pulley in relation to the parting line with the punch marks of the camshaft pointing upwards, the engine is at its basic adjustment for firing point cylinder 1 and overlap cylinder 4.

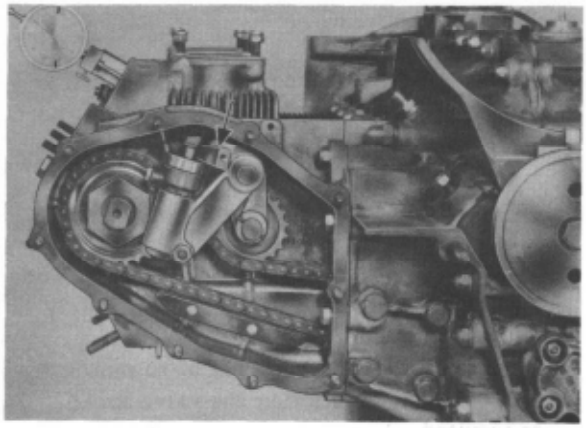
4. In the position described above one bore on the sprocket wheel is accurately in alignment with one bore on the sprocket wheel flange and the locating pin can be inserted.

5. Attach fastening nut for sprocket wheels with corrugated washers and tighten to 10 mkp (72.3 ft. lbs.).

6. Adjust valve clearance (0.10 mm) at least at intake valve cylinder 1.

7. Mount dial gauge holder with dial gauge. The base of the dial gauge should rest accurately on edge of spring retainer.
Set dial gauge with feeler pin to 10 mm (0.39") preload to follow the valve stroke as required.

8. Preload chain tensioner with screw driver on end to be measured and retain with suitable piece of metal placed between the chain tensioner housing and the sprocket wheel carrier (to prevent lowering of chain tensioner while measuring).
Keep turning crankshaft to an accurate 360°, so that the marking Z 1 (TDC) on pulley is again in alignment with the parting line on the crankcase, (Overlap TDC) read dial gauge.

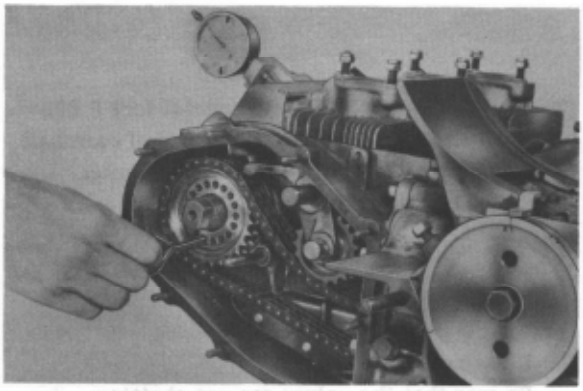


Intake valve lift in overlap TDC with 0.1 mm valve clearance.

Engine Type 914/6 (901/36, 37, 38, 39) Desired adjusting value	2.3-2.7 mm (.09-.11 in.) 2.5 mm (0.10 in.)

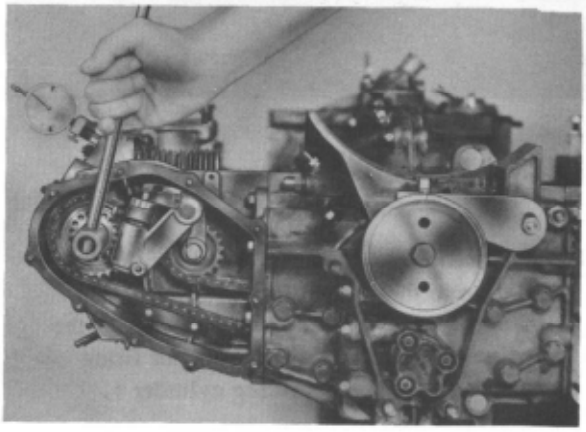
If this value is not attained and the dial gauge shows a higher or lower figure, proceed as follows:

9. Loosen fastening nut with corrugated washer and remove, pull out cylindrical pin with special tool P 212.



10. Check again whether the mark on the pulley is in alignment with the parting line of the housing.

11. Turn camshaft with special tool P 202 until the dial gauge indicates the desired adjusting value.



12. In this position the locating hole of the sprocket wheel is in accurate alignment with a hole of the sprocket wheel flange. Insert locating pin into this hole. Then attach spring washer with nut and tighten to specified torque.

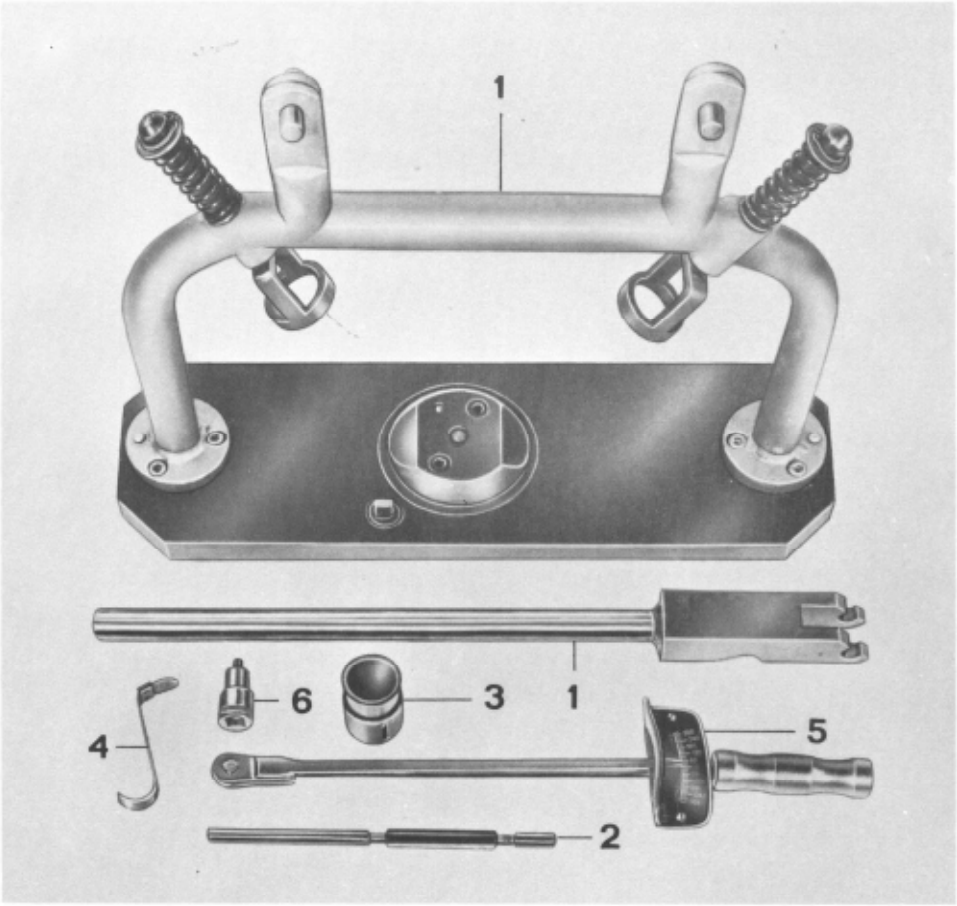
13. Turn crankshaft for two revolutions - two times 360° - and read dial gauge again. If the desired adjusting value is not yet attained, repeat process descriebed above once again.

14. Set cylinder 4 to firing point (Overlap cylinder 1). The marking Z 1 (TDC) should be in alignment with the parting line of the housing.

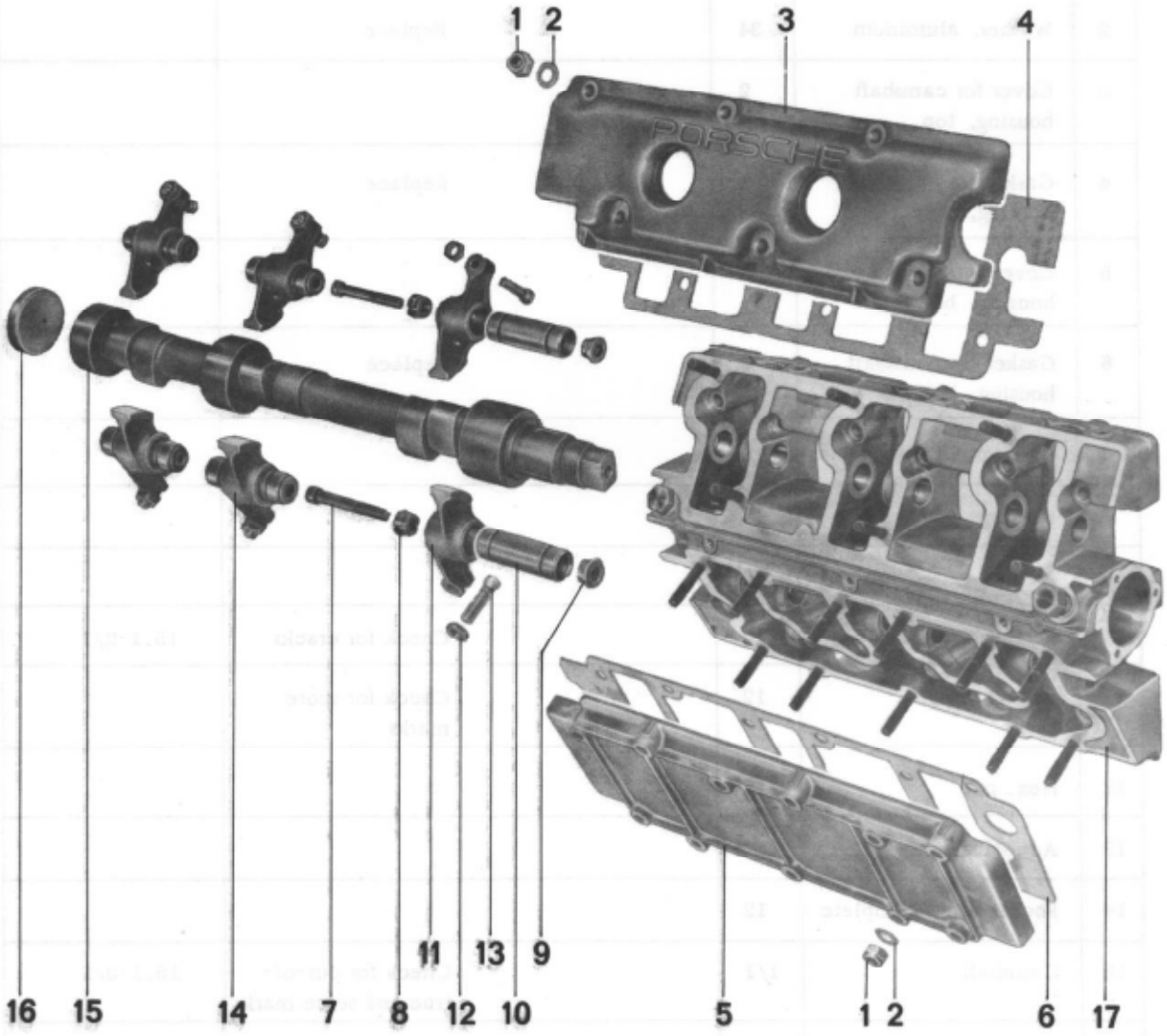
15. Repeat adjusting procedure as described under Item 6 to Item 13 on cylinder 4.

16. When the timing periods are correctly set, remove metal piece holding chain tensioner in position.

TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Valve spring compressor plate	P 200	
2	Valve guide plug gauge	P 206	
3	Valve spring adjuster	P 10b	
4	Feeler gauge	P 213	
5	Torque wrench (for tightening rocker arm shafts)	--	Local purchase item
6	Socket	--	Local purchase item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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. nut, self-locking	34		Replace	
2	Washer, aluminum	34		Replace	
3	Cover for camshaft housing, top	2			
4	Gasket for camshaft housing, top	2		Replace	
5	Cover for camshaft housing, bottom	3			
6	Gasket for camshaft housing, bottom	2		Replace	
7	Cheesehead screw	12			
8	Bushing	12			
9	Nut	12			
10	Rocker arm shaft	12		Check for cracks	15.1-2/1
11	Rocker arm	12		Check for score marks	
12	Hex. nut	12			
13	Adjusting screw	12			
14	Rocker arm, complete	12			
15	Camshaft	1/1		Check for out-of-true and score marks	15.1-3/1
16	Closing cap	2			
17	Camshaft housing	2			

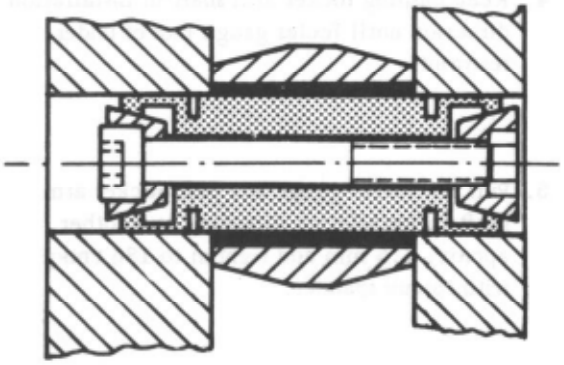
REMOVAL AND INSTALLATION OF ROCKER ARMS AND ROCKER ARM SHAFTS

Removal

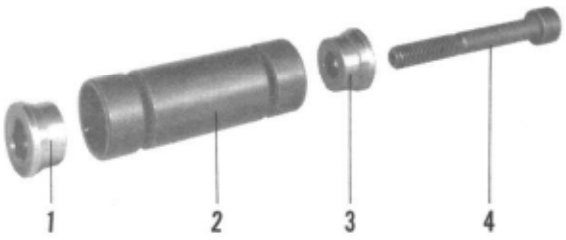
1. Remove rocker arms and mark for proper reassembly of mating slide surfaces.

Checkup

The rocker arm shafts is designed in such a manner that the two conical members (nut and bushing) expand in relation to the conical surfaces at the end of the rocker arm shaft when the hex. socket screw is tightened, so that the end pieces will be widened. This in turn protects the rocker arm shaft against rotating and shifting. Clamping the rocker arm shaft in this manner in the bearing bore of the camshaft housing will also make the inner chamber oil-tight in outward direction.



1. Assemble removed rocker arm shaft and tighten hex. socket screw lightly. Check whether end pieces of rocker arm shaft are showing cracks.



1 Conical member (nut)
2 Rocker arm shaft
3 Conical member (bushing)
4 Cheesehead screw

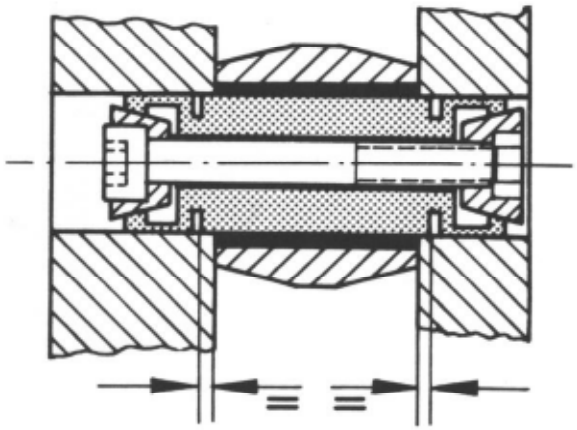
2. Check rocker arm shaft and bushing for wear.

	Running play
Rocker arm bushing	18.02-18.03 mm
Wear limit	18.05 mm
Rocker arm shaft	17.99-18.00 mm
Wear limit	17.97 mm
	Axial play
Rocker arm width	25.80-25.90 mm
Wear limit	25.70 mm
Width in camshaft housing	26.00-26.16 mm
Wear limit	26.25 mm

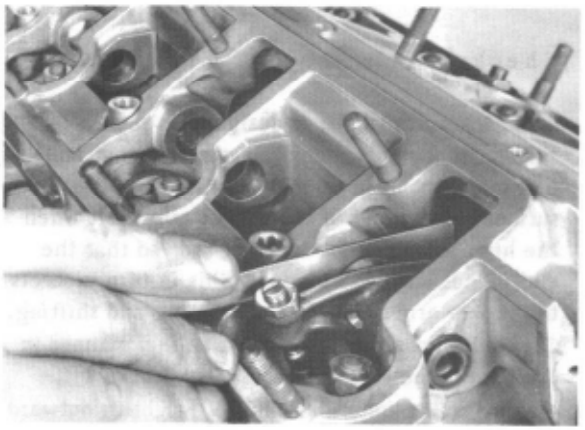
Installation

1. Insert marked or new rocker arm and rocker arm shafts.
   Caution!
   The outer rocker arm shafts should always be installed in such a manner that the head of the hex. socket screw points toward cylinder 2 or cylinder 5.

2. Center alignment of rocker arm shafts.
   The machined grooves on the rocker arm shaft must be centered in such a manner that they project uniformly in bearing bore of camshaft housing. With a properly installed rocker arm shaft the grooves are approx. 1.5 mm (.06") inside housing bore. The center position is best determined by means of a feeler gauge as follows.



3. Insert rocker arm shaft until a feeler gauge can be introduced between the camshaft housing and the rocker arm into the groove of the rocker arm shaft.



4. Keep pushing rocker arm shaft in installation direction until feeler gauge moves under restraint.

5. Pull out feeler gauge and push rocker arm shaft in installation direction by another approx. 1.5 mm and tighten to 180 cmkp with torque spanner.

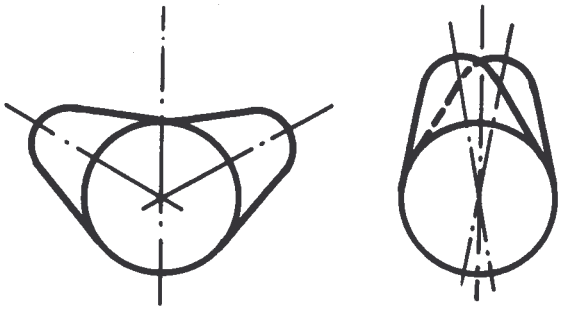
INSPECTION AND INSTALLATION OF CAMSHAFT

Checkup

		Running play	Wear limit
Bearing dia. Camshaft Bearing dia. Camshaft housing	46.926-46.942 mm (1.8475-1.8481") 46.967-46.992 mm (1.8499-1.8501")	0.025-0.066 mm (.0010-.0026")	0.10 mm (.0039")
Axial play		0.15-0.20 mm (.0059-.0079")	0.40 mm (.016")
Out-of-true on center bearing (between centers)			max. 0.02 mm (.0008")

Installation

Note:
As a result of the same direction of rotation the cam position of the two camshafts differs. Make sure that the camshafts are mounted in proper lateral relationsship.



Cylinder bank 1-3 Cylinder bank 4-6

1. Install camshafts and check for easy running.

INSPECTION AND INSTALLATION OF CAMSHAFT HOUSING

Checkup

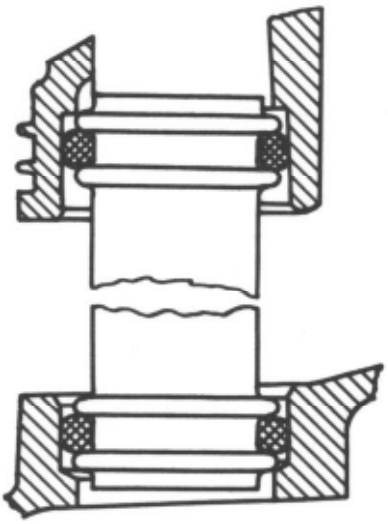
Remark:
The camshaft housing is designed for mounting on any cylinder bank. Be sure that the closing cap for the camshaft bearing bore is mounted on correct end. Also note that the centering screw for the oil splash pipe as well as the intermediate piece for the oil hose connection are properly installed.

1. Blow out oil splash tube with compressed air, making sure that no splash hole is clogged.

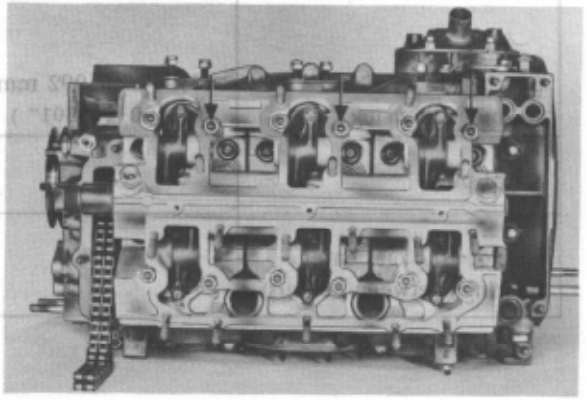
2. Check whether oil splash pipe is installed in camshaft housing in correct position (3 splash holes should point toward intake valve cap.)

Installation

1. Coat sealing surface of camshaft housing with sealing compound Teroson Atmosit or the like. Place camshaft housing with oil return pipe on cylinder head an tighten lightly with several nuts.



2. The shape of the camshaft housing requires the use of three socket head nuts on cylinder heads.



3. Tighten nuts of camshaft housing in steps and crosswise to specified torque.

4. When tightening the camshaft housing, insert camshaft into bearing bore and rotate to check for easy running. If the camshaft binds, apply different sequence for tightening camshaft housing to permit unrestricted rotation.

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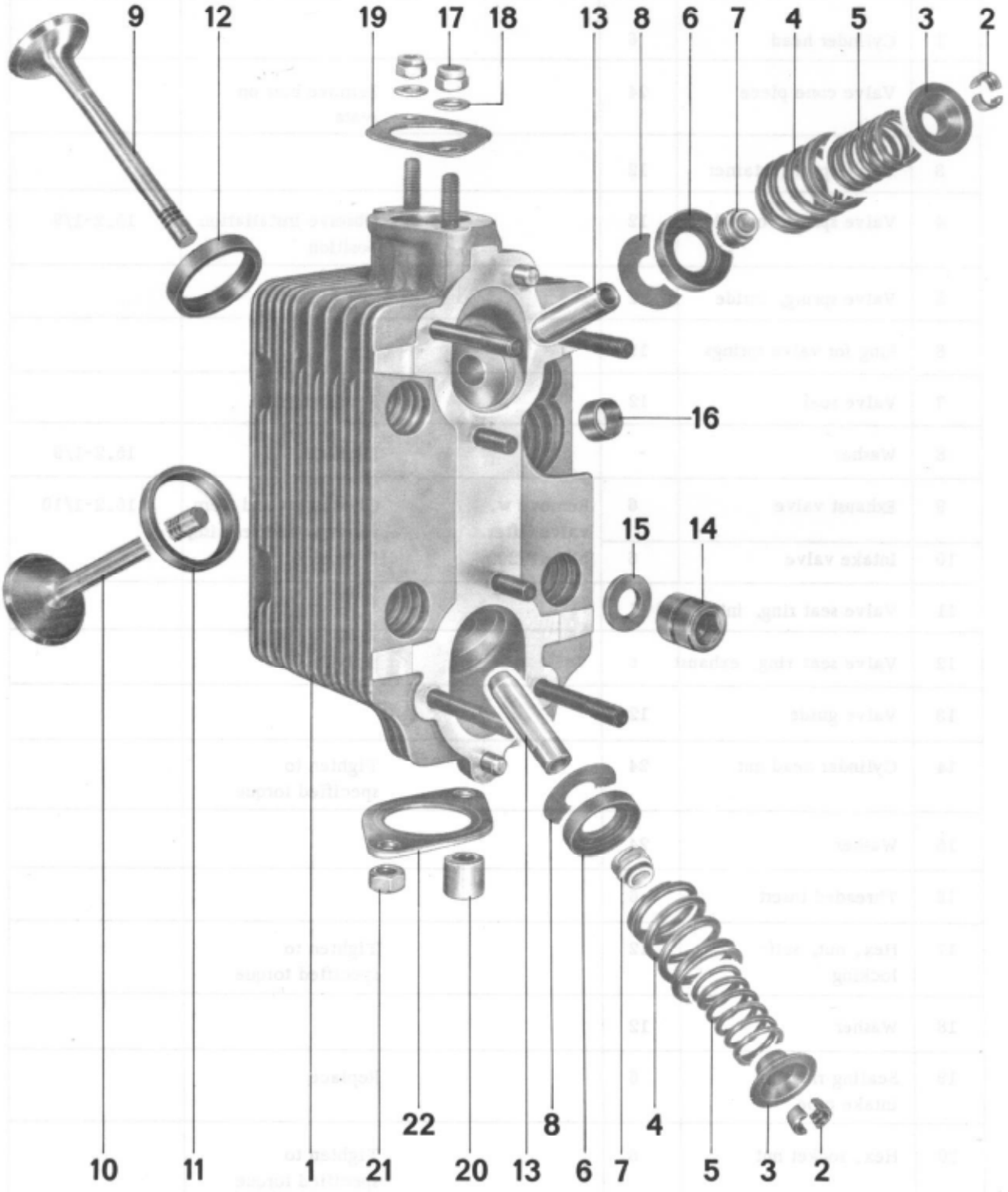
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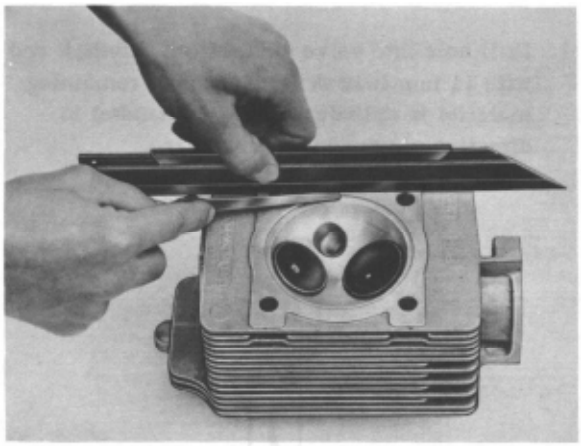
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cylinder head	6			
2	Valve cone piece	24		Remove burr on seats	
3	Valve spring retainer	12			
4	Valve spring, outside	12		Observe installation position	15.2-1/9
5	Valve spring, inside	12			
6	Ring for valve springs	12			
7	Valve seal	12		Replace	
8	Washer	-		Measure	15.2-1/9
9	Exhaust valve	6	Remove w. valve lifter plate P 200	Check seat and stem for wear and refinish, if required	15.2-1/10
10	Intake valve	6			
11	Valve seat ring, intake	6			
12	Valve seat ring, exhaust	6			
13	Valve guide	12			
14	Cylinder head nut	24		Tighten to specified torque	
15	Washer	24			
16	Threaded insert	6			
17	Hex. nut, self-locking	12		Tighten to specified torque	
18	Washer	12			
19	Sealing ring for intake pipe	6		Replace	
20	Hex. socket nut	6		Tighten to specified torque	
21	Hex. nut	6		similar to 20	
22	Seal	6		Replace	

INSPECTION AND INSTALLATION OF CYLINDER HEAD

Checkup

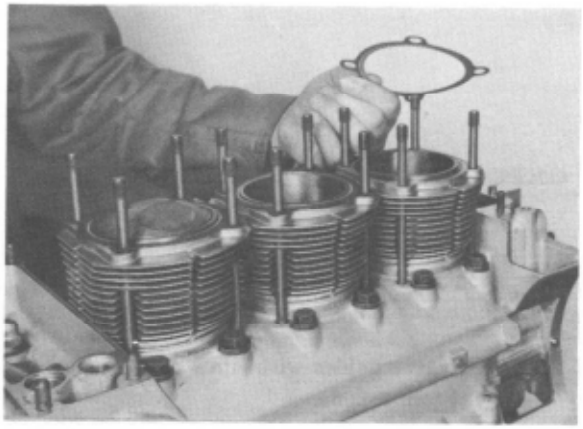
Do not refinish the two sealing surface on cylinder head (cylinder head/camshaft housing and cylinder head/cylinders). Distortions up to 0.15 mm of bearing surface for cylinders are permitted (illustration). If this dimension is exceeded, replace cylinder head.



Installation

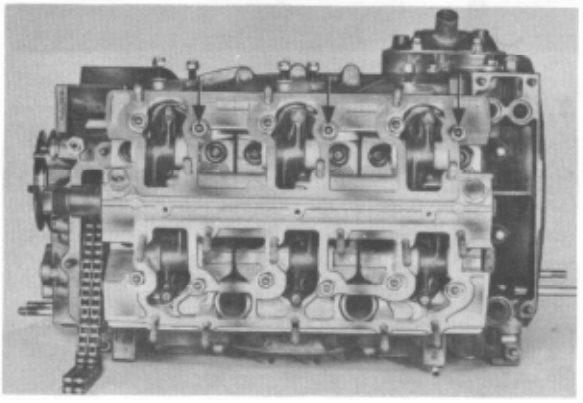
1. Check sealing surfaces of cylinder heads and clean carefully.

2. Position cylinder head gasket with perforation toward cylinder and position cylinder head. Attach hex. socket nut, but do not yet tighten.



3. The bearing surface on the cylinder head is simultaneously the sealing surface for the camshaft housing. No special seal is installed, the sealing surfaces of the cylinder head are coated with a sealing compound (for example Teroson Atmosit).

4. Position camshaft housing together with oil return pipe, position corrugated washers, attach nuts, but do not yet tighten. The camshaft housing has 3 nuts with 8 mm hex. socket.



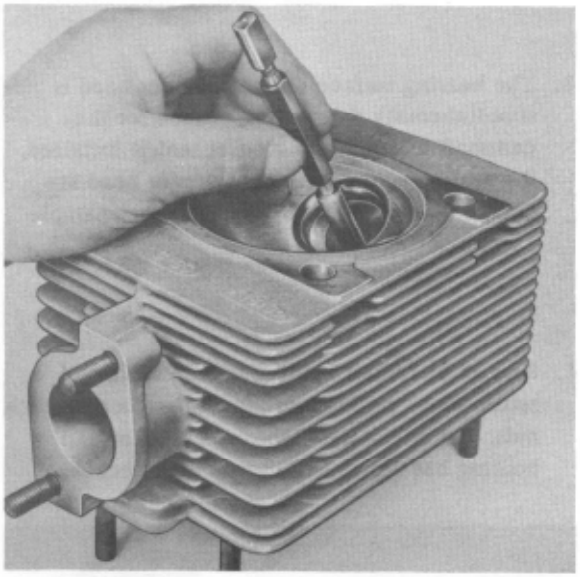
5. Tighten cylinder head nuts uniformly to specified torque.

6. Tighten nuts on camshaft housing uniformly to specified torque, while inserting camshaft into bearing bores to check for easy rotation.

CHECKING VALVE GUIDES

Checkup

1. Check valve guides with limit plug gauge, special tool P 206.



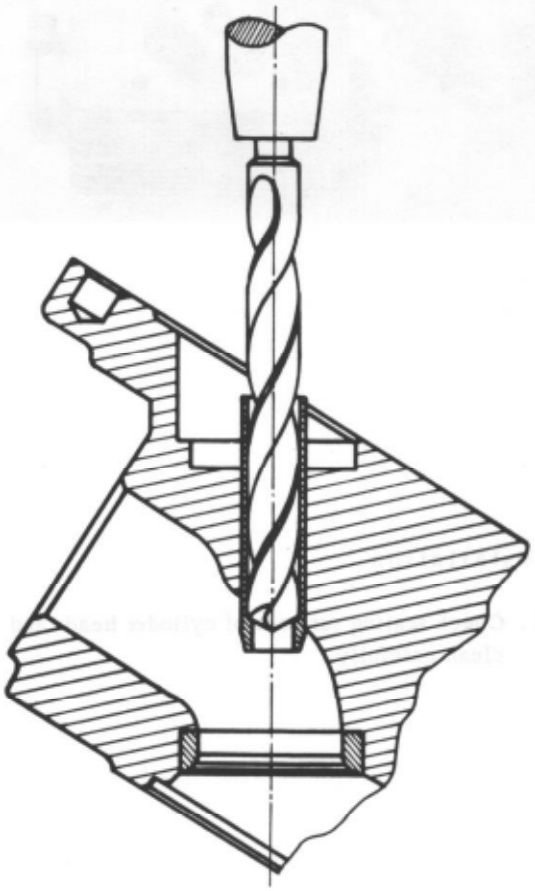
2. Valve guide cannot be replaced with conventional workshop tools. Send cylinder head for reconditioning to factory or exchange.

REPLACING VALVE GUIDES

The valve guides are pressed into the cylinder head. Replacing the valve guides requires a pertinently equipped workshop and the respective tools.

Removal

1. Drill hole into valve guides from camshaft end with 11 mm twist drill. Knock out remaining material in cylinder head with mandrel in direction of combustion chamber.



2. Clamp cylinder head at proper angle into vise for drilling valve guides (intake valve 27°; exhaust valve 32°).

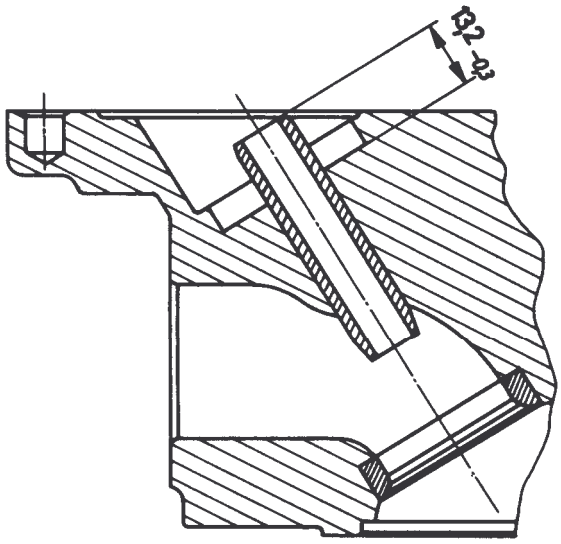
Installation

New oversize valve guides must be used and pertinently fitted for installation.

1. Accurately/bores in cylinder head for receiving valve guides. / measure

2. Turn oversize valve guides on lathe at OD in accordance with bore in cylinder head. The pressfit allowance for intake and exhaust valve guide is 0.03-0.06 mm.

3. Press valve guides into cylinder head from camshaft end. Use tallow for greasing.



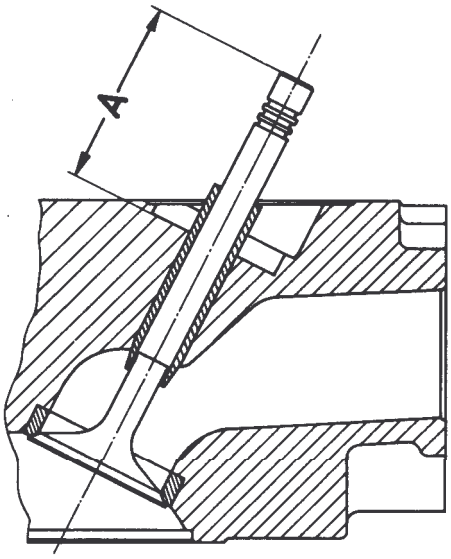
4. Enlarge valve guides to dimension 9.000-9.015 mm by means of broach.

REFINISHING VALVE SEATS

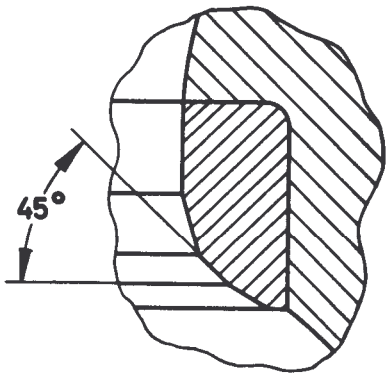
Valve seats with wear or burn marks can be refinished as long as the permissible width for the 45° seat is maintained and the projecting valve stem without washers rests against the cylinder head in accordance with specified limits. If not, the cylinder head must be exchanged. Exchanging the valve seat rings with conventional shop tools is not possible.

Reference dimension A

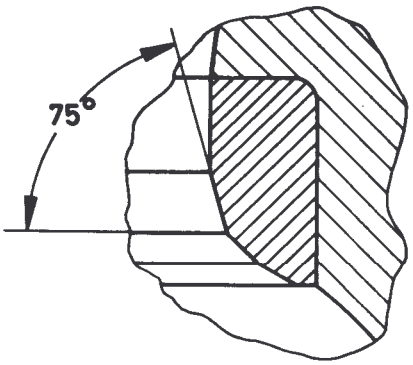
Intake	47.15-47.85 mm
Exhaust	(1.8563-1.8839")
Wear	48.35 mm (1.8644")



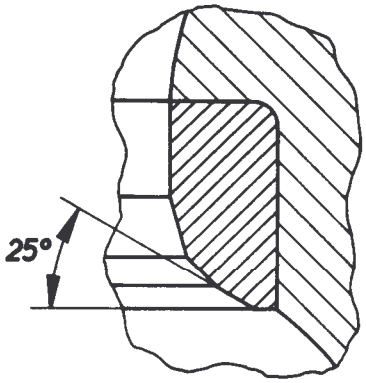
1. Refinishing 45° seat.
   This seat must be handled with particular care to obtain a perfectly centered seat without chatter marks. Removal of material should be restricted to a minimum to prevent attaining the wear limit for the valve seat rings too early. Refinishing must be stopped as soon as the entire seat surface has been machined.



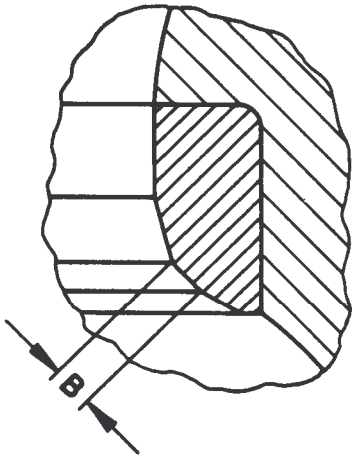
2. Refinishing 75° seat.
   The 75° compensating cutter will easily cut the bottom edge of the valve seat.



3. Refinishing 25° seat.
   Cut top edge of seat with 25° compensating cutter until the specified seat width is attained.



Intake valve Seat width B	Exhaust valve Seat width B
1.25 ± 0.1 mm (.0492 ± .0039")	1.55 ± 0.1 mm (.0610 ± .0039")



REPLACING VALVE SEAT RINGS

Workshops with pertinent equipment should replace valve seat rings as described below.

1. Cut valve seat ring with Bosch grinder until it is free of cylinder head.

2. Knock out valve seat ring.

3. Accurately measure bore D 1.

4. Refinish oversize valve seat ring on lathe along OD in accordance with bore in cylinder head. The pressure allowance for intake valve seats is 0.14 to 0.18 mm (.0055-.0071"), for exhaust valve seats 0.16 to 0.20 mm (.0063-.0079").

5. Heat cylinder head to approx. 200°C (392°F).

6. Insert valve seat rings with suitable mandrel.

7. Permit cylinder head to cool down slowly to ambient temperature.

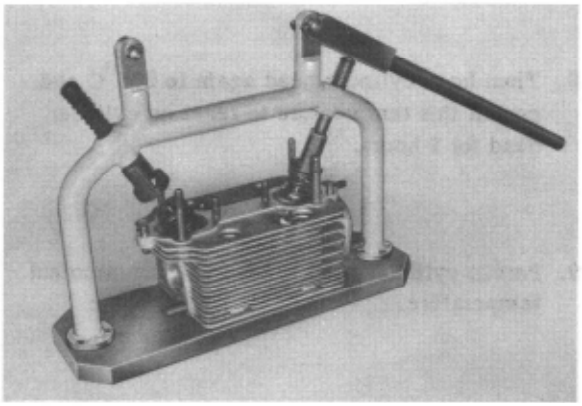
8. Then heat cylinder head again to 200°C and permit this temperature to react on cylinder head for 2 hours.

9. Permit cylinder head to cool down to ambient temperature.

REMOVAL AND INSTALLATION OF VALVES

Removal

1. Remove valves with valve lifting plate P 200.



2. Remove valve spring with adjusting washers.

3. Remove any burr on seats of valve cone pieces by means of a smooth file prior to pulling out valves.

Checkup

1. Check valve spring with commercial spring tester. Check without spring support and without valve spring retainer.

Spring	Length unloaded	Length loaded	Load
external	41.8 mm (1.65")	35 mm (1.38")	17.5 ± 1 kp (38.6 ± 2.2 lbs.)
internal	38.4 mm (1.51")	35.5 mm (1.40")	6.5 ± 0.8 kp (14.3 ± 1.8 lbs.)

2. For used springs a deviation of ± 5% of the load is permitted. Replace valve springs, if these values are not attained.

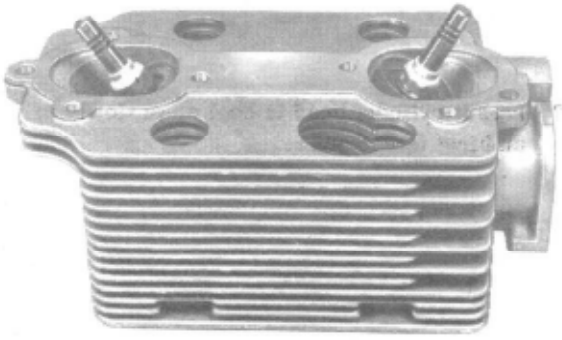
3. Check valve cone pieces. Replace valve cone pieces showing score marks.

4. Check valves, in particular seat and stem. Check valve stem for out-of-true (max. 0.01 mm). Refinish seat on valve grinding machine, grind in valves on valve seat rings and check for leaks.

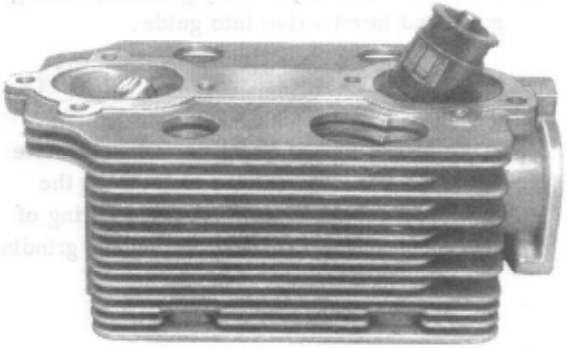
Installation

1. Coat valve stem with MoS_2 paste and insert valve into guide.

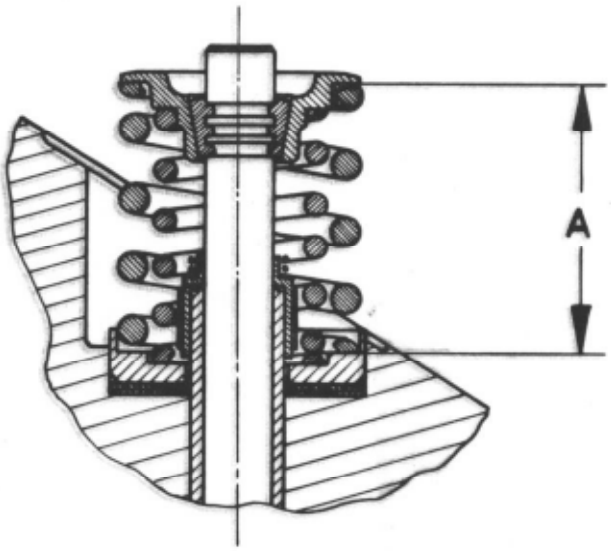
2. Position sealing caps on intake and exhaust valve.



3. Install special tool P 10b with the adjusting washer, spring support, spring retainer and the two cone pieces for pertinent valve.



4. Read dimension "A" on special tool P 10b and correct, if required, by adding or removing compensating washers.



Dimension "A"

Installation length of intake valve spring	36 ± 0.3 mm (1.42 ± .01")
Installation length of exhaust valve spring	36 ± 0.3 mm

5. Install valve springs. The outer valve spring is progressive, the more closely coiled windings should rest against cylinder head. The installation position of the inner valve spring is unimportant.

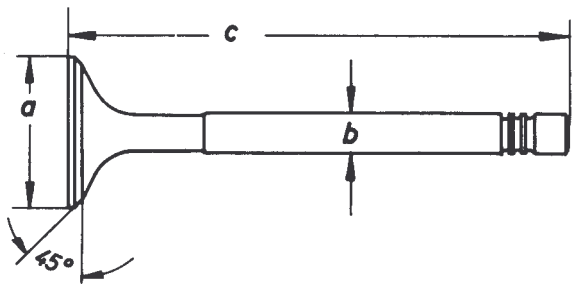
Remark: The valve springs for intake and exhaust valve are of uniform design.

REFINISHING OF VALVES

1. Valves with their cone seat surface showing wear or burn marks can be refinished on a valve cone turning machine or a valve cone grinding machine.

2. Valves with dented stem end must be replaced.

3. Valves with distorted stem, seizing marks and damaged seat for valve cone pieces must be replaced. Straightening or grinding of valve stems is not permitted.



	Intake valve mm	Exhaust valve mm
a	42 ± 0.1 ($1.654 \pm .004$")	38 ± 0.1 ($1.496 \pm .004$")
b	8.97 - 0.012 (.3531-.0005")	8.95 - 0.012 (.3524-.0005")
c	114 ± 0.2 ($4.4882 \pm .008$")	113.5 ± 0.2 ($4.4685 \pm .008$")

GRINDING-IN OF VALVES

1. Coat valve seat with finely grained grinding paste and insert valve into guide.

2. Place rubber sucker on valve disk and rotate valve for grinding. Riffled surfaces on the seat can be prevented by repeated lifting of valve and uniform rotation during the grinding.

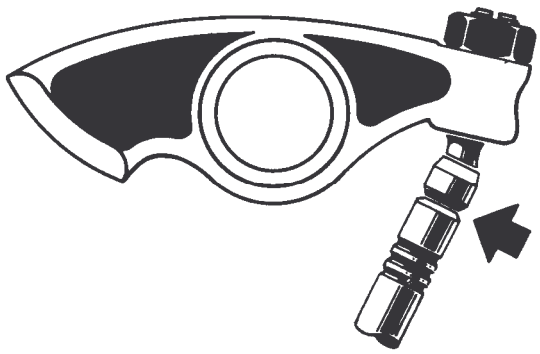
3. The grinding paste is soluble in water and should be protected against admixtures of oil and grease. All engine parts should therefore be carefully cleaned with water after the grinding, followed by drying and proper lubrication prior to assembly.

VALVE CLEARANCE

Check or adjust valve clearance only when the engine is cold.

Valve clearance on cold engine:	Inlet	0.1 mm (0.004 in.)
	Exhaust	0.1 mm (0.004 in.)

The valve clearance is checked with a feeler gauge between the valve stem and the ball cap of the adjusting screw.



To attain accurate valve adjustment, the valves must seat properly and the valve guide clearance must be within tolerance.

Valve clearance too small:

Burnt valves and valve seats

Distorted valves

Rough running engine

Timing off

Valve clearance too large:

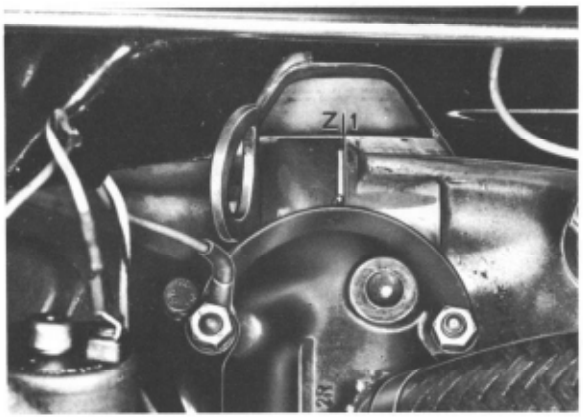
Valve clatter

Rough running engine

Timing off

ADJUSTING VALVES

The valves are adjusted in the firing order sequence 1-6-2-4-3-5. The piston of the respective cylinder must be at top dead center of the compression stroke, at which time both valves will be closed. The TDC marks of the individual cylinders are marked on the flywheel (in the Sportomatic version on the driven plate of the torque converter) or on the belt pulley.



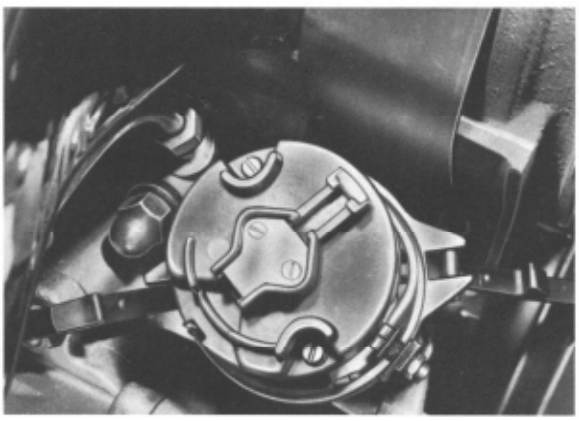
1. Remove left heat exchanger.

2. Remove heater hose on right heat exchanger.

3. Loosen self-locking hex. nuts on cover of camshaft housing and remove cover.

4. Remove spark plugs.

5. Bring cylinder 1 to TDC (mark Z 1)



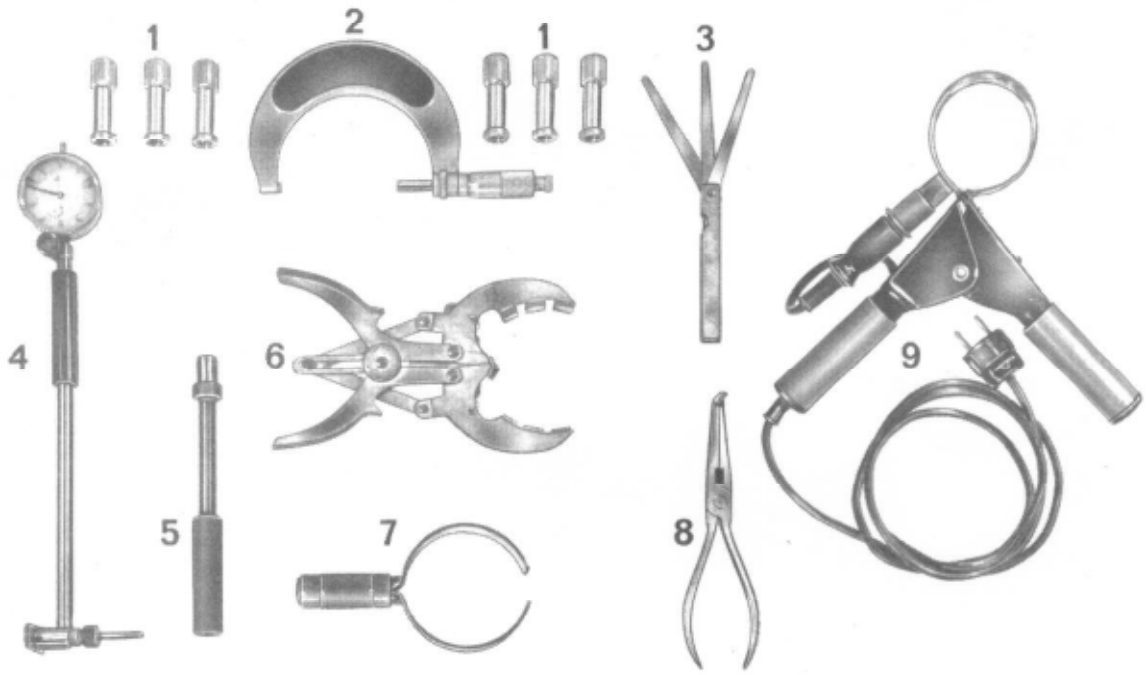
6. Check and adjust valve clearance with special tool P 213.

7. By turning the crankshaft at the hex. bolt (19 mm) of the belt pulley up to the next 120° mark, the next cylinder in the firing order can be set to TDC. Check and adjust valve.

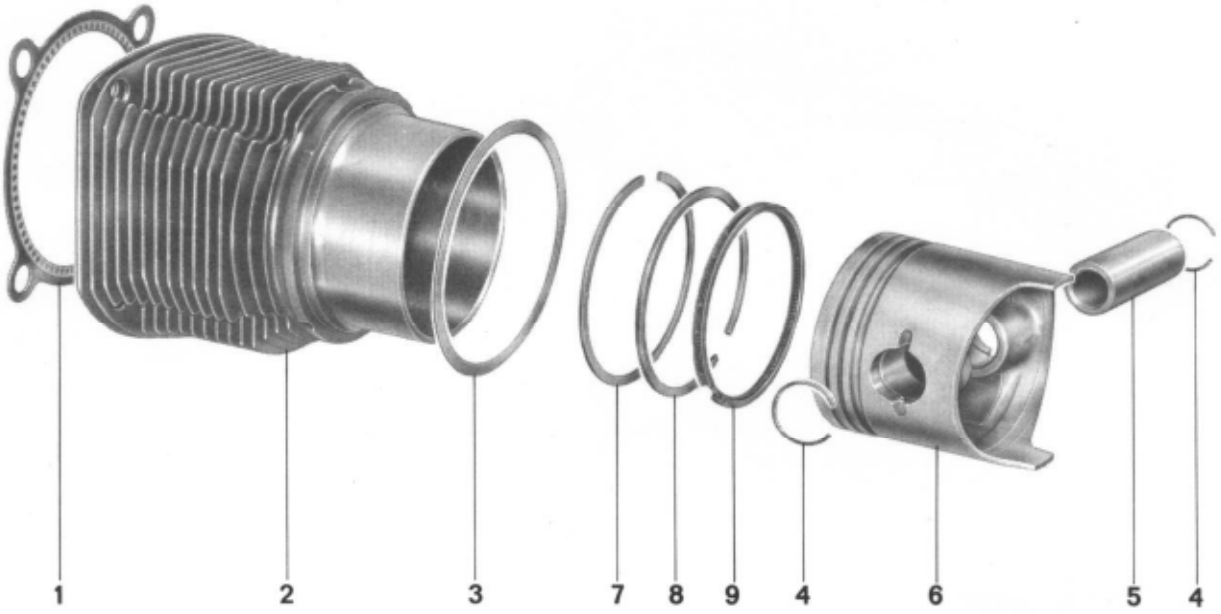
Note!

Keep turning engine in direction of rotation (installed engine will run counter-clockwise, in reference to driving direction).

TOOLS



No.	Designation	Special Tools	Explanations
1	Holding nut for cylinder	P 140	
2	Screw gauge 75-100 mm	-	commercial
3	Feeler gauge	-	commercial
4	Internal measuring instrument 75-100 mm		commercial
5	Piston pin mandrel	P 2a	
6	Piston ring pliers	_	commercial
7	Piston ring strap	P 8	
8	Circlip pliers, offset	-	commercial
9	Electric piston warmer	P 1a	



No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
1	Cylinder head gasket	6		Replace	
2	Cylinder	6	Mark installation position, check	Observe pairing with pertinent piston, lubricate, observe cylinder height	16.1-2/1
3	Cylinder base seal	6		Replace	
4	Locking ring	12			
5	Piston pin	6			
6	Piston	6	Mark installation position, heat to approx. 80°C (176°F) with spec. tool P 1a	Observe pairing with pertinent cylinder. Heat piston to approx. 80°C and lubricate	
7	Tapered compression ring groove I	6	Remove and install only with piston ring pliers	Observe installation position (top), side and gap clearance	16.1-3/2
8	Tapered compression ring groove II	6		Use piston ring strap special tool SW P 8	16.1-3/1
9	Oil slot hose spring ring groove III	6			16.1-2/2

REMOVAL AND INSTALLATION OF CYLINDERS

Removal

Prior to removal, mark cylinder and piston as installed with the numbers 1 to 6 to eliminate any displacement or confusion during reassembly.

Checkup

1. Check cylinder for wear.

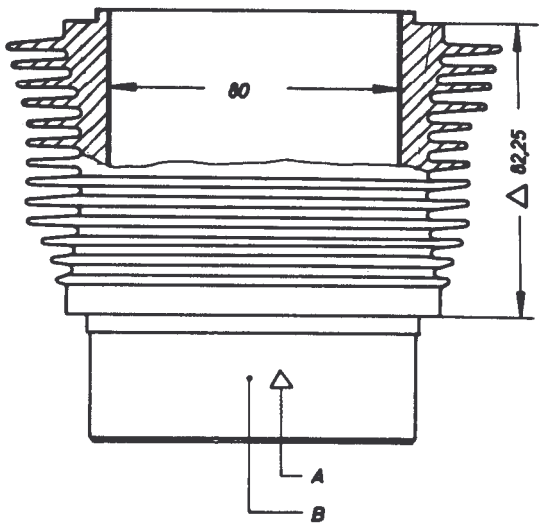
2. The cylinder seat on crankcase and in cylinder head should be absolutely clean on sealing surfaces. Foreign bodies on seat surfaces will result in distortions of cylinder and leaks.

3. Use new seal on cylinder base.
   Note:
   The tolerance groups for cylinder heights are stamped with ink on cylinder base. The installation height of the cylinders, that is, the dimensions between the bearing surface on crankcase and those on cylinder head are divided into two groups.

Cylinder height

Mark	Cylinder height mm
5	82.200-82.225 (3.2362-3.2372")
6	82.225-82.250 (3.2372-3.2382")

Use only cylinders with uniform installation height for one and the same cylinder bank.

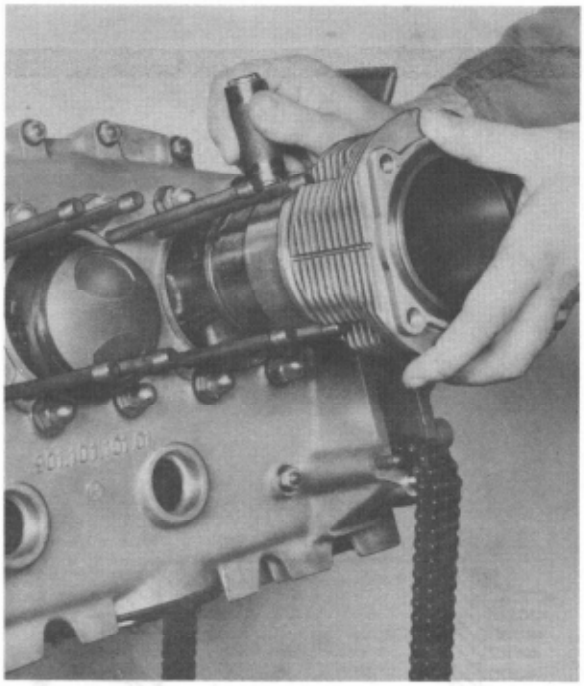


A Tolerance group for cylinder height
B Tolerance group for cylinder dia.

Installation

1. Lubricate pistons and piston rings.

2. Compress piston rings with piston ring strap special tool P 8. Watch out for uniform offset of piston ring gaps. The gap of the oil wiper ring should always point upwards.



3. Lubricate cylinder running surface and fit cylinder. Align cylinder on studs.

4. To eliminate any shifting of cylinders when cranking the engine, special tool P 140 may be used.

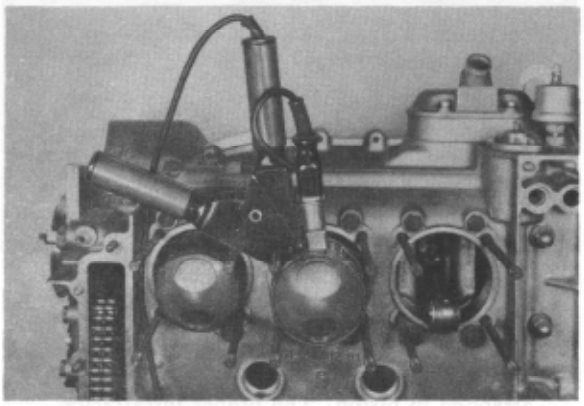
REMOVAL AND INSTALLATION OF PISTONS

Removal

Prior to removal, mark pistons as installed with the numbers 1 to 6.

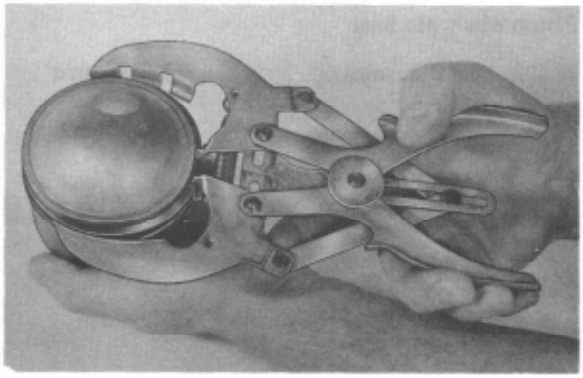
1. Remove locking rings for piston pin. Be sure that the locking rings do not drop into crankcase.

2. Heat piston with special tool P 1a to approx. 80°C (176°F).



3. Remove piston pin with piston pin mandrel, special tool P 2a, remove piston.

4. Remove piston rings, if required. Piston ring pliers will be needed.



Installation

1. Clean pistons. Remove major oil residue on piston head and in piston ring grooves without damaging metallic surface. Bad contact pattern and one-sided formation of residue on piston skirt vertical in relation to piston pin axis may be caused by badly aligned connecting rods.

2. Check piston for wear. In the event of an exchange, be sure that pistons and cylinders can be exchanged only together.

3. Fit piston and oil scraper rings, check play on ring gap. For this purpose, slide ring at right angle into bottom cylinder opening, approx. 10 mm (0.4") away from bottom cylinder rim, using piston as an aid. Measure play with feeler gauge.

Piston made by Mahle and Schmidt	Gap width mm	Wear limit mm
Piston ring groove I	0.30-0.45 (.0118-.0177")	0.90 (.0354")
Piston ring groove II	0.30-0.45 (.0118-.0177")	0.90 (.0354")
Oil scraper ring III	0.25-0.40 (.0098-.0157")	1.00 (.0393")

4. Fit piston rings with piston ring pliers only. The designation (top) should always point toward piston head.

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

Mahle Pistons

	Vertical clearance mm	Wear limit mm
Piston ring groove I	0.08-0.11 (.0032-.0043")	0.15 (.0059")
Piston ring groove II	0.05-0.08 (.0020-.0032")	0.15 (.0059")
Oil scraper ring III	0.03-0.06 (.0012-.0024")	0.10 (.0039")

Schmidt Pistons

Piston ring groove I	0.07-0.10 (.0028-.0039")	0.15 (.0059")
Piston ring groove II	0.04-0.07 (.0016-.0028")	0.15 (.0059")
Oil scraper ring III	0.02-0.05 (.0008-.0020")	0.10 (.0039")

6. Insert locking ring on one side of piston.

The piston pin bore in piston is symmetrically arranged in piston. The proper installation position of the piston is indicated by the valve pockets in the piston head. On Schmidt pistons the larger valve pocket (intake valve) must be installed pointing upwards. On Mahle pistons there is only a flat which must be installed pointing upwards.

Piston pin - pin boss

	Pin boss dia. mm	Pin dia. mm
	22.000 (0.86614")	22.000 (0.86614")
+	0.005 to 0 (.00020 to 0")	0 to - 0.004 (0 to .00016")

The pistons and the piston pins are no longer colour-coded.

7. The piston pin is heated to approx. 40°C (104°F), lubricated and then manually inserted without stopping into piston which has been heated to approx. 80°C (176°F) in an oil bath or with a piston heater, against stop on locking ring.

8. Insert second locking ring. The locking ring should fit perfectly into the pertinent groove of piston pin boss. The opened end of the locking ring should point toward piston head or into opposite direction.

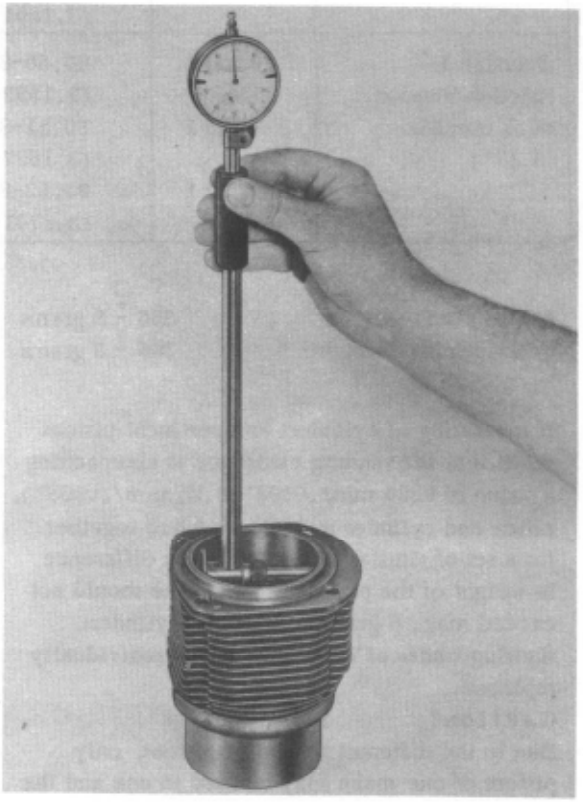
The piston pin may slide already in the piston when it is still cold. This is quite normal. There is no reason in such a case to replace the piston pin, the piston or both.

CHECKING CLEARANCE BETWEEN CYLINDER AND PISTON

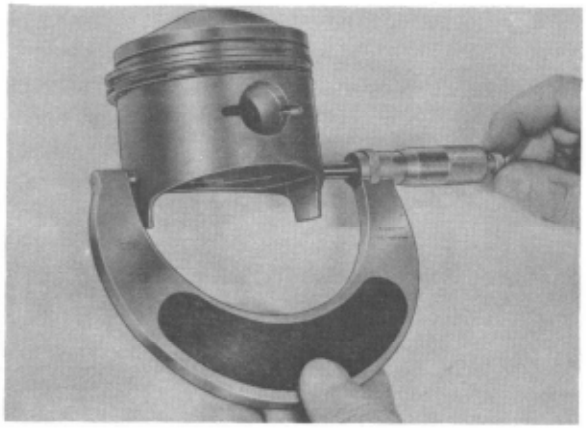
The running clearance of the piston is not measured with a feeler gauge, but by measuring the cylinder and the piston.

Installation clearance in mm	Wear limit in mm
0.025-0.045 (Mahle)	0.24
(.0010-.0018")	(.0094")
0.035-0.055 (Schmidt)	0.25
(.0014-.0022")	(.0098")

The cylinders should be measured with an internal measuring instrument, set first with a micrometer in accordance with measuring group of cylinder. The measuring group is stamped on cylinder base. The cylinder is considered worn, when the measured dimension is 0.1 mm (.0039") above rated dimension.



The rated dia. of the piston is characterized by the dimensional group punched in on piston head. Measurements are made by means of a micrometer on measuring point D 1.
A piston is considered worn, when the measured dimension is 0.1 mm (.0039") under rated dimension.



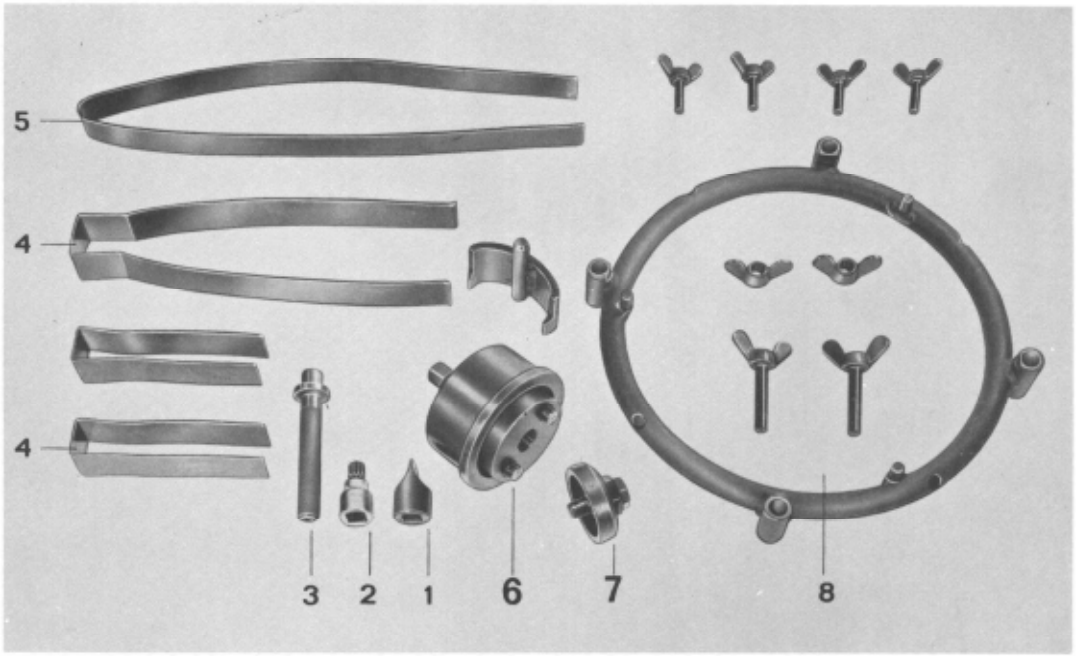
Size Class	Dim. Group	Cylinder dia. mm (in.)	Mahle Piston dia. D1 mm (in.)	Schmidt Piston dia. D1 mm (in.)
Normal size Rated dimension 80.0 mm dia. (3.15")	0	80.00-80.01 (3.1496-3.1500)	79.97 tol. (3.14843)	79.96 tol. (3.14804)
	1	80.01-80.02 (3.1500-3.1504)	79.98 ± 0.005 (3.14882 ± .00020)	79.97+0.006 (3.14843+.00024)
	2	80.02-80.03 (3.1504-3.1508)	79.99 (3.14921)	79.98-0.007 (3.14882-.00028)
Oversize 1 Rated dimension 80.5 mm dia. (3.17")	0 KD 1	80.50-80.51 (3.1693-3.1697)	80.46 (3.1677)	80.46 (3.1677)
	1 KD 1	80.51-80.52 (3.1697-3.1701)	80.47 (3.1681)	80.47 (3.1681)
	2 KD 1	80.52-80.53 (3.1701-3.1705)	80.48 (3.1685)	80.48 (3.1685)

Mahle piston weight: 356 ± 3 grams
Schmidt piston weight: 366 ± 3 grams

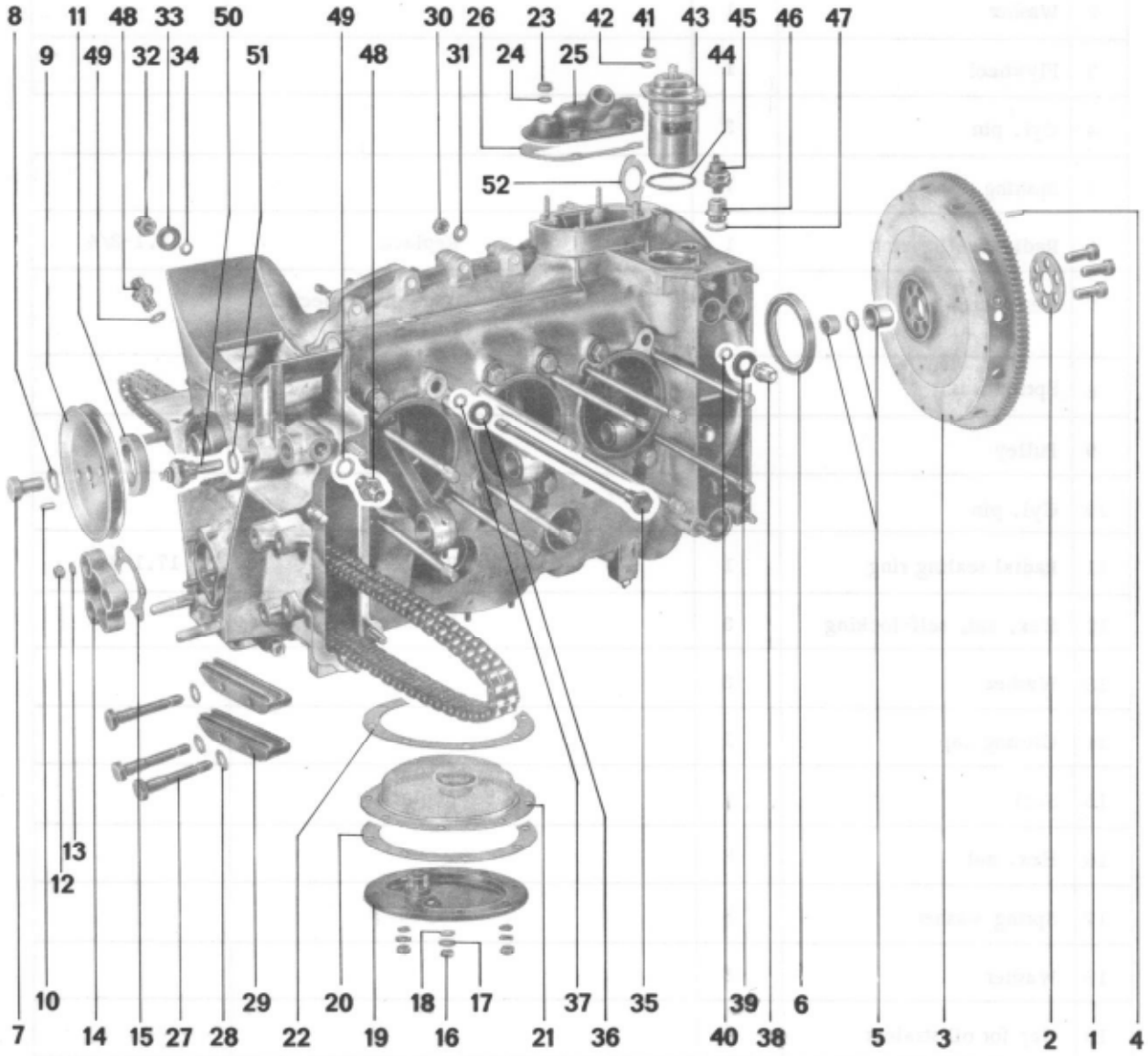
If measuring of cylinders and pertinent pistons shows that the running clearance is approaching a value of 0.24 mm/.0094" (0.25 mm/.0098"), piston and cylinder must be matched together for a set of similar size group. The difference in weight of the pistons in an engine should not exceed max. 6 grams. Pistons of cylinders showing traces of wear may not be individually replaced.

Caution!
Due to the different weight of pistons, only pistons of one make may be used in one and the same engine.

TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Socket	P 74	
2	Socket (for tightening flywheel bolts)		Local purchase item
3	Bushing driver	P 218	
4	Connecting rod holder	P 221	
5	Timing chain holder	P 222	
6	Oil seal installer	P 215	
7	Oil seal installer	P 216	
8	Clutch disc support ring	VW 184	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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cheesehead screw (internal multi-teeth)	6		Tighten to specified torque	
2	Washer	1			
3	Flywheel	1			
4	Cyl. pin	3			
5	Bushing	1			
6	Radial sealing ring	1		Replace	17.1-3/4
7	Hex. screw	1		Tighten to specified torque	
8	Spring washer	1			
9	Pulley	1			
10	Cyl. pin	1			
11	Radial sealing ring	1		Replace	17.1-3/4
12	Hex. nut, self-locking	3		Replace	
13	Washer	3			
14	Closing cap	1			
15	Seal	1		Replace	
16	Hex. nut	8			
17	Spring washer	8			
18	Washer	8			
19	Cap for oil strainer	1			
20	Seal	1		Replace	
21	Oil strainer	1			
22	Seal	1		Replace	
23	Hex. nut	4			

No.	Designation	Each	Observe during: Removal / Installation	Spec. Instr.
24	Washer	4		
25	Cap for breather	1		
26	Seal	1	Replace	
27	Bolt for slide rail	8		
28	Sealing ring	8	Replace	
29	Slide rail	6		17.1-3/3
30	Hex. nut, self-locking	21	Tighten to specified torque, replace	
31	Washer	21		
32	Cap nut	13	Tighten to specified torque	
33	Washer	24		
34	Round cord ring	24		
35	Bolt for crankcase	11		
36	Washer	-		
37	Round cord ring	-	Replace	
38	Cap nut	-	Tighten to specified torque	
39	Washer	-		
40	Round cord ring	-	Replace	
41	Hex. nut	2		
42	Spring washer	2		
43	Oil temperature controller	1		
44	Sealing ring	1	Replace	
45	Oil pressure switch	1		

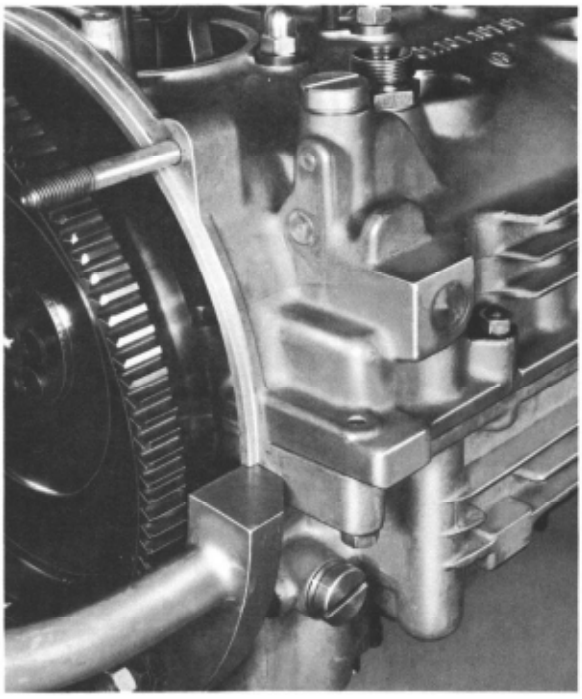
No.	Designation	Each	Observe during: Removal / Installation	Special Instr.
46	Reduction piece	1		
47	Sealing ring	1	Replace	
48	Screw connection	2		
49	Sealing ring	2	Replace	
50	Tele-thermometer transmitter	1		
51	Sealing ring	1	Replace	
52	Eye	1		

REMOVING AND INSTALLING PRESSURE RELIEF AND SAFETY VALVES

Removing

1. Remove cap screw with special tool P 74.

2. Take out spring and piston.



Installing

1. Check bore in housing and piston for scoring. If piston is scored, polish carefully or replace if necessary.

2. Check spring.

3. Oil the piston lightly before installing.

4. Replace copper washer.

Note
Same type of spring and piston is used for both the pressure relief and safety valves.
A copper washer is used to seal the pressure relief valve (in right crankcase half), and the safety valve located in the left crankcase half.

Specifications for the pressure relief and safety valve springs:

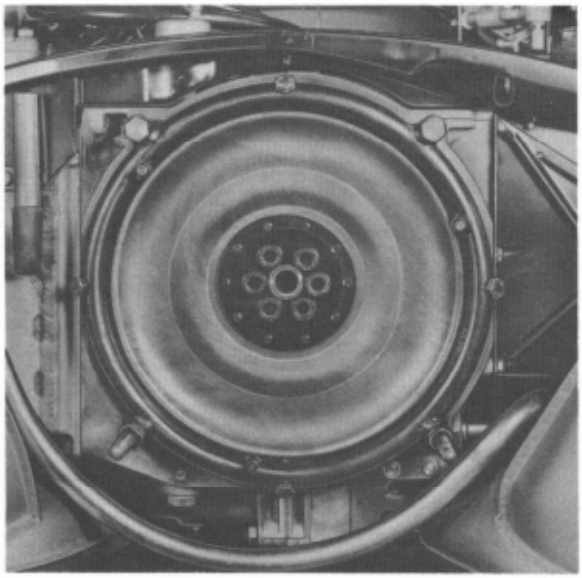
Free lenght	70 mm (2.76 in.)
Wire thickness	1.8 mm (0.07 in.)
Outer spring diameter	12.2 mm (0.48 in).
Spring force when compressed to 52 mm	10.6 kp (23.4 lbs)
Spring force when compressed to 46 mm	14.1 kp (31.1 lbs)
Compressed lenght	33.3 mm (1.31 in.)

REMOVAL AND INSTALLATION OF FLYWHEEL

Removal

1. Crankshaft and flywheel are both balanced to 0 as a spare part. This eliminates the need for marking the flywheel during removal.

2. On engines with Sportomatic, use special tool VW 184 for loosening carrier plate. The holding bushings of the special tool VW 184 must be refinished slightly so that the special tool rests against the carrier plate and the screws for the carrier plate can be attached.



Checkup

1. Check flywheel for perfect toothing. Damaged teeth can be machined off clutch end up to max. 1.6 mm (.06").

2. Check bearing surface of flywheel and centering flange and replace flywheel, if damaged.

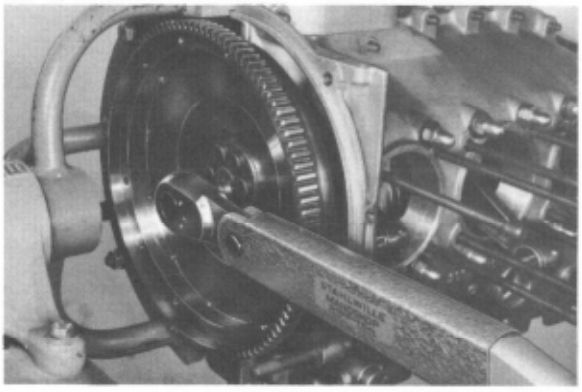
3. Check needle bearing for wear.

Installation

1. Lubricate needle bearing with multi-purpose grease.

2. Flywheel can be assembled in one position only, since the bearings are offset in relation to each other.

3. Tighten fastening screw in steps and uniformly to specified torque.



CHECKING AND RECONDITIONING FLYWHEEL

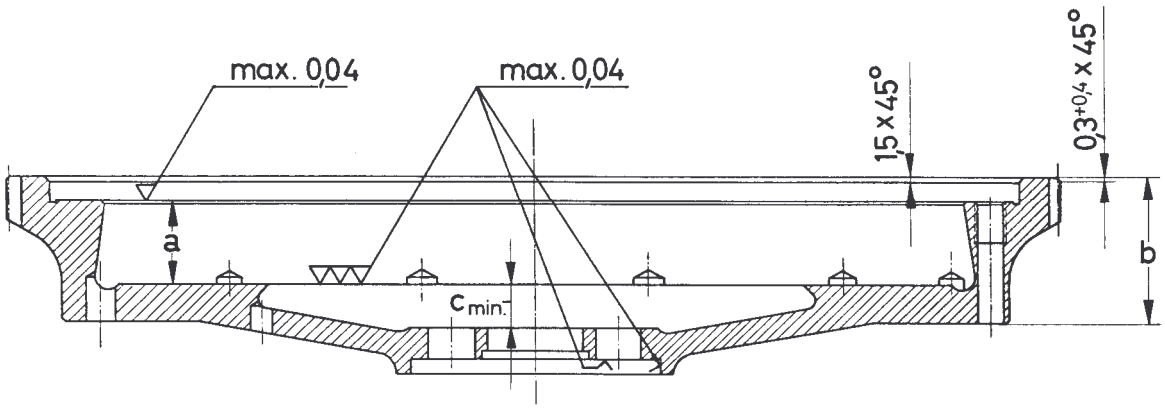
General

Flywheels which are scored or burned can be reconditioned on a lathe.

The pressure plate mounting surface of the flywheel should also be machined to maintain dimension "a" (see sketch).

Reconditioning

1. Mount the flywheel in lathe chuck. Using a dial gauge, measure lateral runout at the pressure plate mounting surface. Maximum lateral runout should be from 0 mm to 0.01 mm (0 - 0.0004 in.).
2. Machine the clutch contact and pressure plate mounting surfaces.
3. Smoothen the surfaces with fine emery cloth after machining.



Measuring Point	Dimension (new)	Reconditioning Stage				Tolerance
		1	2	3	4	
a	22.5 mm (0.886 in.)	22.5 mm (0.886 in.)	-	-	-	+ 0.2 mm (0.008 in.)
b	39.0 mm (1.535 in.)	38.6 mm (1.520 in.)	38,2 mm (1.504 in.)	37.8 mm (1.488 in.)	37.4 mm (1.472 in.)	± 0.2 mm (0.008 in.)
c	Wear limit = 11.000 mm (0.433 in.)					

Note

Dimension "c" (see sketch and table) must not be exceeded since this could allow the clutch disc to rub against the flywheel retaining bolts.

Damaged gear teeth on the clutch side may be machined to a depth of 1.6 mm (0.063 in.).

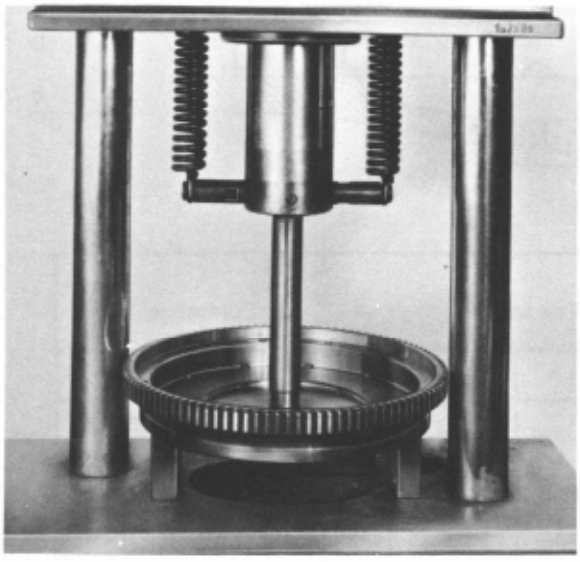
REPLACING FLYWHEEL BUSHING

The flywheel bushing is pressed in from the crankshaft side.

Replacement is best accomplished with the aid of a hydraulic press.

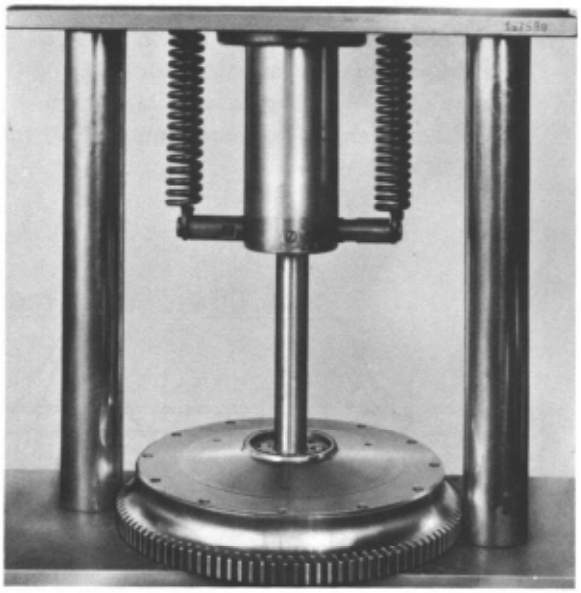
Removing

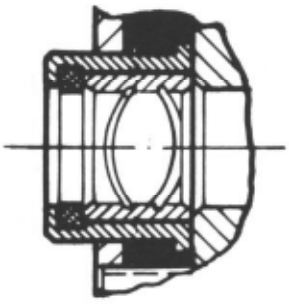
(Press out bushing from clutch side)



Installing

(Press out bushing from crankshaft side)

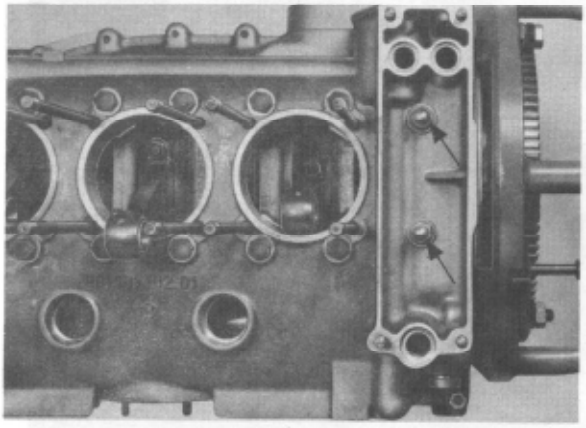




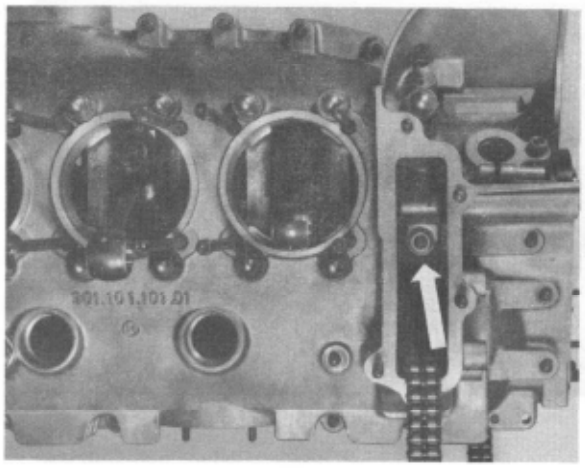
DISASSEMBLY AND ASSEMBLY OF CRANKCASE

Disassembly

1. Loosen crankcase fastening bolts.
   Caution!
   Remove both nuts from the studs at bearing 1. These studs are accessible within the oil cooler flange in the direction from righthand crankcase half.



Remove the through-bolts and studs of bearing 7 located within the left chain housing.



2. Loosen righthand crankcase half with assistance of rubber hammer. Do not damage parting surfaces of crankcase by sharp-edged items, such as screw drivers.

Checkup

1. Check crankcase for damage and cracks.

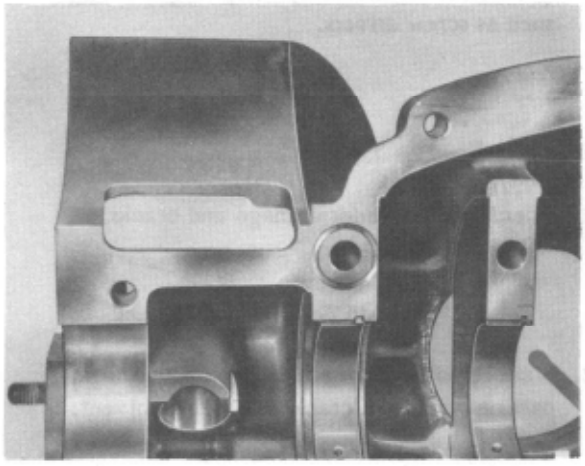
2. Wash remainders of sealing compound from parting surface of crankcase with a solvent.

3. Check parting surfaces for planeness and cleanliness.

4. Lightly chamfer edges on main bearing seats and on parting surfaces.

5. Clean all oil ducts. A round wire brush is best. Then flush entire oil duct system with cleaning gasoline and blow out with compressed air. Check whether air is coming out of all oil outlet holes.

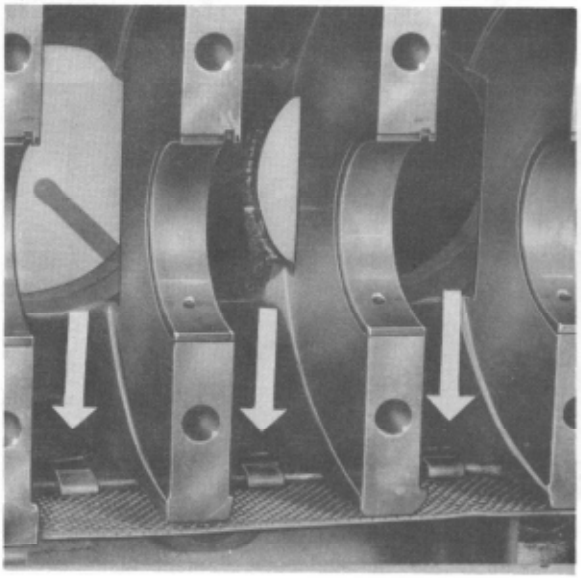
6. Clean relief groove on righthand crankcase half on main bearing 7.



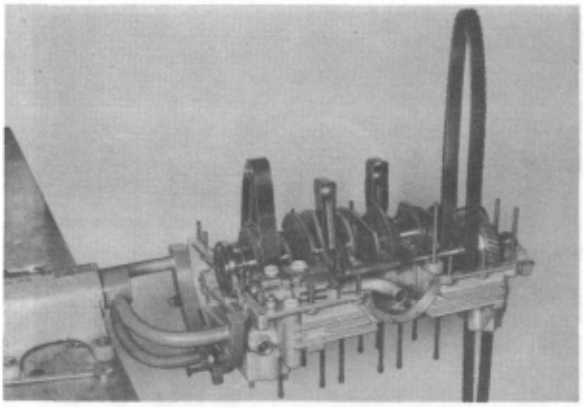
7. Check studs for tight seat.

Assembly

1. Check strainer in crankcase for perfect condition and accurate attachment.



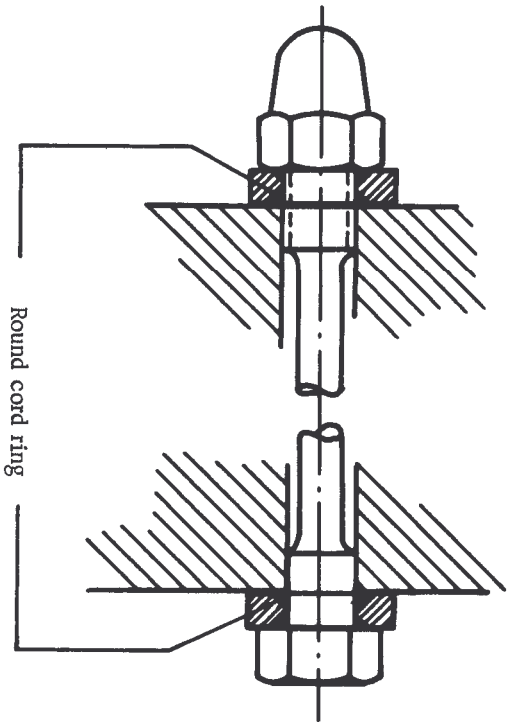
2. Clamp holding straps for connecting rod an chain.



3. Coat parting surface thinly with sealing compound. Be sure that no sealing compound enters the bearing seats.

4. Position lefthand crankcase half.

5. Preassemble through-bolts. First place the double chamfer washer onto the bolt in such a manner that the smoother surface faces the crankcase, then slide round cord ring in position. Push the through bolts in from righthand crankcase. Fit round cord ring with washer and nut.

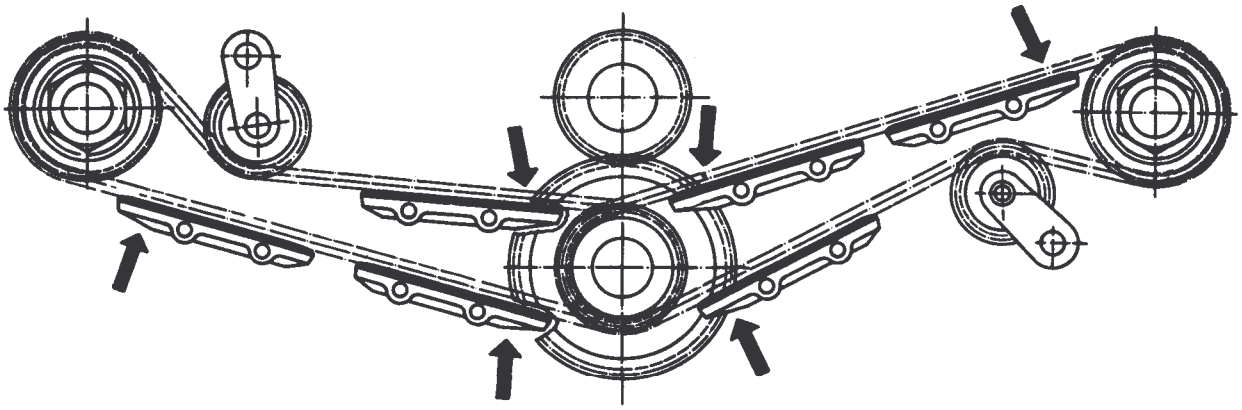


6. Fit round cord ring, washer and nut for bearing 1 under flange of oil cooler, as well as washer and nut on stud in lefthand chainway for attaching main bearing 7.

7. Tighten through-bolts and studs for attachment of bearings uniformly and crosswise to specified torque.

8. Place 8 mm aluminum washers and new hex. nuts (self-locking) on all crankcase retaining studs and tighten to specified torque.

9. Install guide rails in crankcase in such a manner that the long ends of the guide rails are facing the pertinent sprocket wheel. Screw bolts down uniformly and make sure that the slide rails are not distorted.



REMOVAL AND INSTALLATION OF SEALING RINGS FOR CRANKSHAFT

SEALING RING BEARING 8

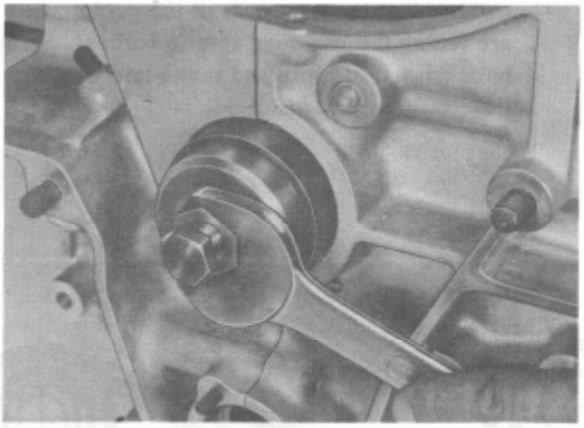
Removal

1. Deform sealing ring on recess of bearing 8 with mandrel or cape chisel and push out with screw driver.

Installation

1. Clean seat for sealing ring in bearing. Chamfer outer edges with scraper slightly, so that the circumference of the sealing ring is not damaged. Remove chips.

2. Lightly coat running surface for radial sealing ring with oil and install radial sealing ring with installing tool P 216.



SEALING RING BEARING 1

Removal

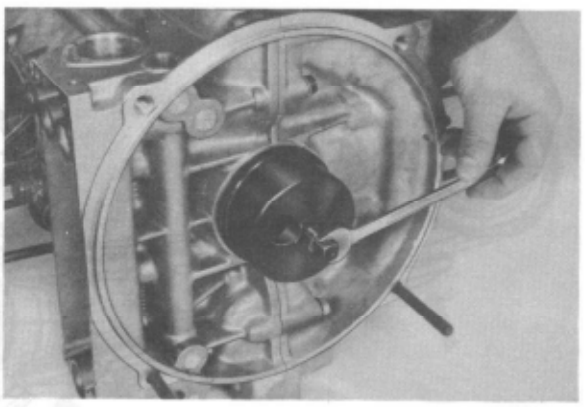
1. Deform sealing ring on recess of crankcase with mandrel or cape chisel and push out with screw driver.

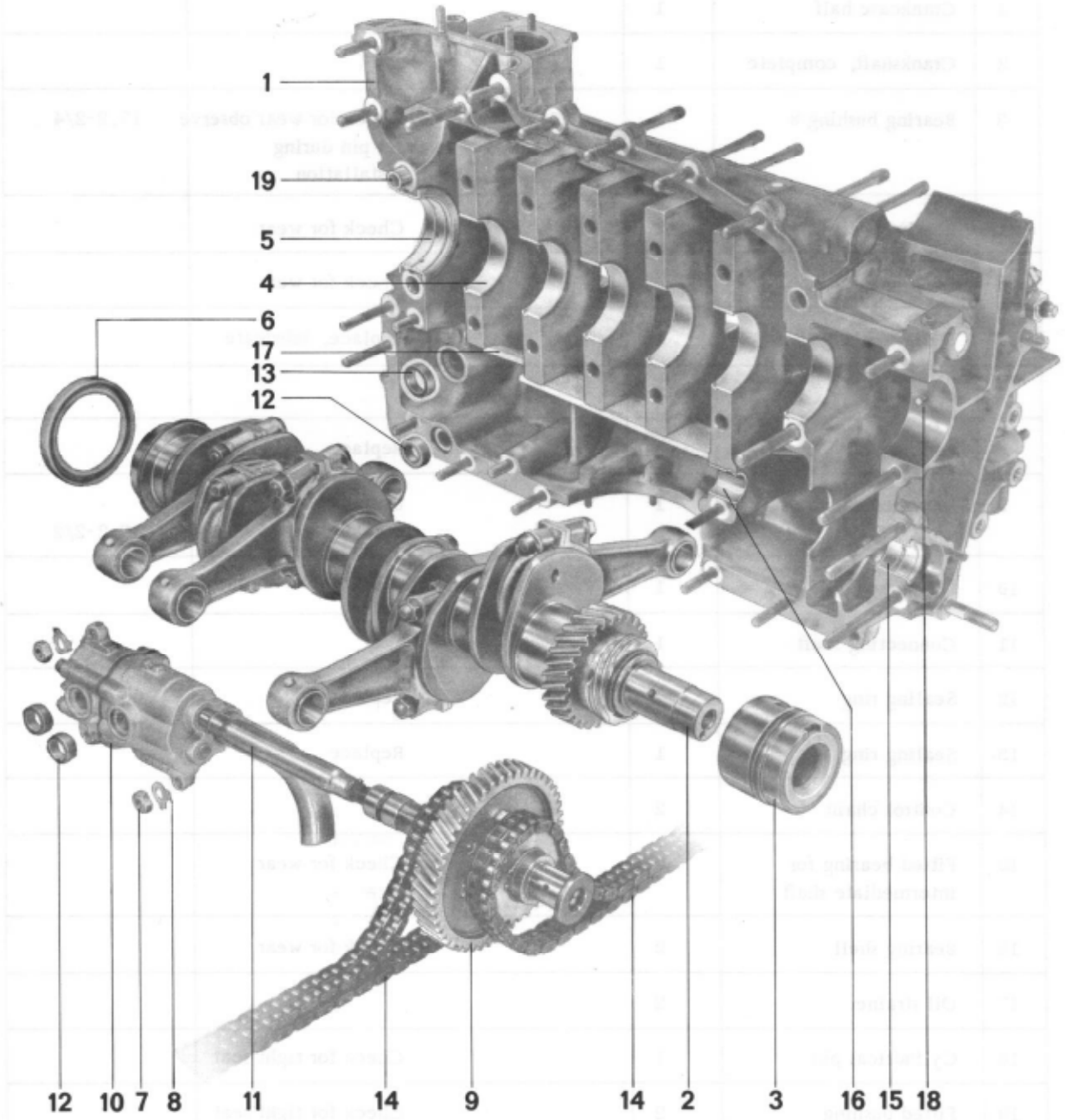
Installation

1. Check running surface of sealing lip on crankshaft.

2. Clean seat for sealing ring in crankcase. If required, chamfer outer edge with scraper and remove chips.

3. Coat sealing ring on outer circumference thinly with sealing compound and press in with pressing-in tool P 215. The sealing ring should be flush with crankcase.
   Caution!
   The axial play of the crankshaft is provided by main bearing 1.

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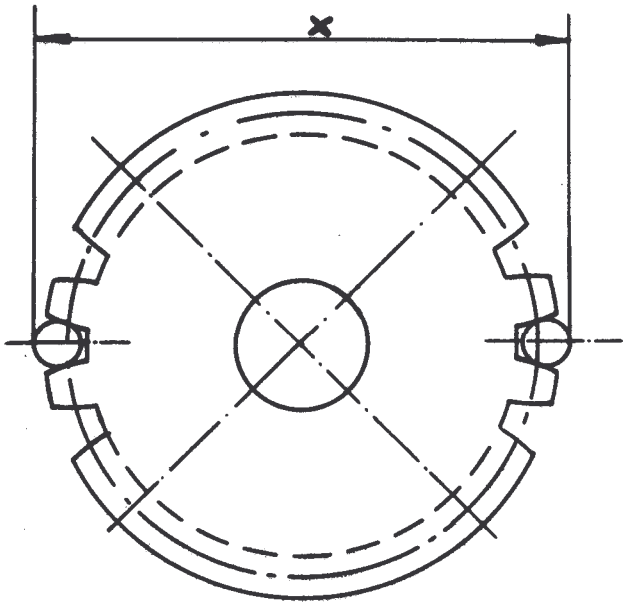
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
1	Crankcase half	1			
2	Crankshaft, complete	1			
3	Bearing bushing 8	1		Check for wear observe set pin during installation	17.2-2/4
4	Bearing shell 2-7	12		Check for wear	
5	Bearing shell I	2		Check for wear	
6	Radial sealing ring	1		Replace, lubricate	
7	Hex. nut	3			
8	Lock washer	3		Replace	
9	Intermediate shaft	1		Observe pairing with crankshaft	17.2-2/2
10	Oil pump	1			
11	Connecting shaft	1			
12	Sealing ring	2		Replace	
13	Sealing ring	1		Replace	
14	Control chain	2			
15	Fitted bearing for intermediate shaft	2		Check for wear	
16	Bearing shell	2		Check for wear	
17	Oil strainer	2			
18	Cylindrical pin	1		Check for tight seat	
19	Fitted bushing	2		Check for tight seat	

INSPECTION AND INSTALLATION OF INTERMEDIATE SHAFT

Checkup

1. Check intermediate shaft gear for wear. Measure intermediate shaft gear by means of steel rollers of 4.5 mm dia. (o.18").



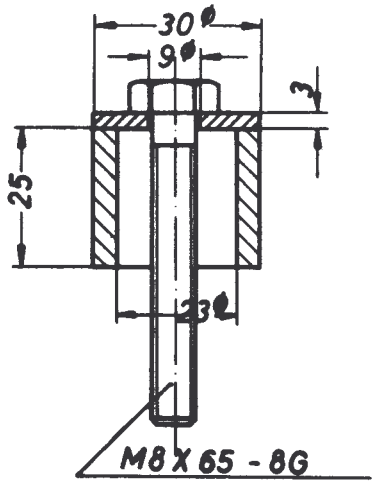
If dimension x is less than 136.5 mm (5.374"), the intermediate shaft gear and the drive gear on the crankshaft must be replaced.

If the intermediate shaft gear carries the designation 1, the dimension x may not be less than 136.55 mm (5.376"). In addition to this dimensional inspection, the sight test for wear is of course of considerable importance. In each case, replace the intermediate shaft and the drive gear on the crankshaft.

Caution!
The intermediate shaft with the screwed-on gear wheel and the two sprocket wheels is a spare part and can be exchanged only as a complete assembly.

2. On engines with a long service life or following a general reconditioning of the engine (also in the event of bearing damage) the aluminum plug on the face end of the intermediate shaft must be removed and the oil bore must be cleaned from residue.

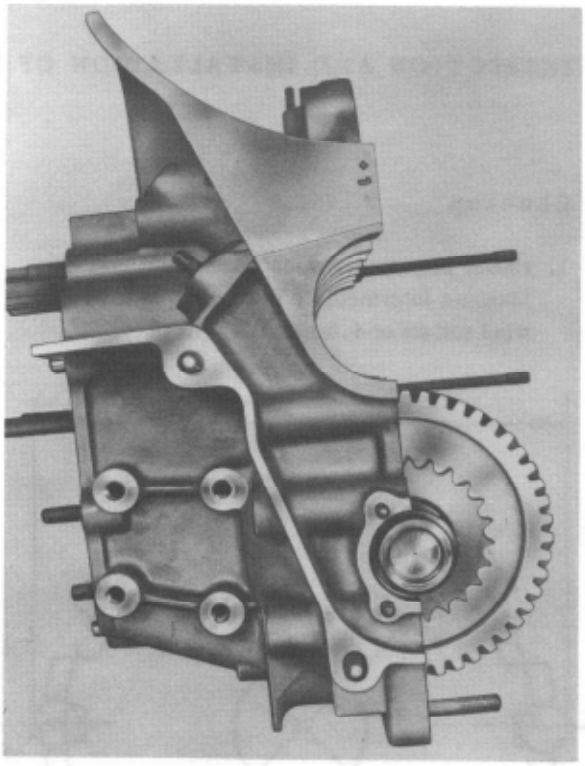
3. Drill 6.4 mm dia. (.25") hole into aluminum plug in center and cut M 8 threads. Pull aluminum plug with the self-made tool and clean oil hole in intermediate shaft. Then fit new aluminum plug.



Installation

1. Gear wheels and crankcase may be paired in relation to each other only as shown in the table below.

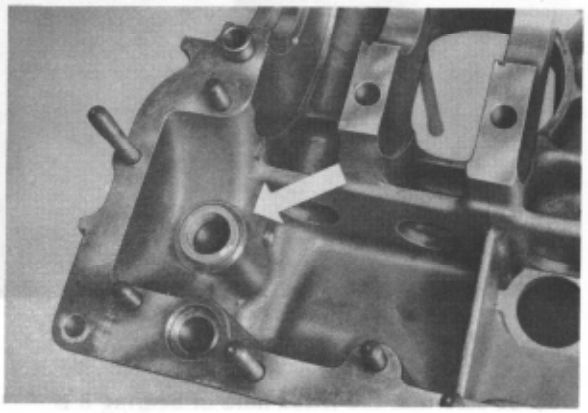
   The identification number (0 or 1) is punched into lefthand crankcase half underneath alternator support.

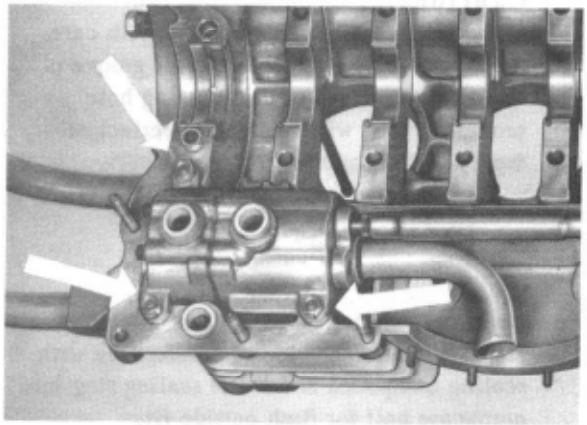


Shaft Spacing mm (in.)	Crankcase Designation	Drive Gear on Crankcase Designation	Intermediate Shaft Gear Designation	Backlash
103.975-103.990 (4.0935-4.0941)	0	0	0	0.029-0.049 (.00114-.00193)
		Installation still permissible		
		1	0	0.016-0.042 (.00063-.00165)
		0	1	0.017-0.043 (.00067-.00169)
103.990-104.000 (4.0941-4.0945)	1	1	0	0.012-0.041 (.00047-.00161)
		Installation still permissible		
		0	1	0.025-0.049 (.00098-.00193)
		1	0	0.025-0.048 (.00098-.00189)

2. Place intermediate shaft with connecting shaft and oil pump, but without control chains, into crankcase. Attach oil pump and check whether intermediate shaft, connecting shaft and oil pump are running true in relation to each other. If operation is out-of-true, exchange gear connections to obtain true running characteristics.

3. Install control chains and position sealing ring on oil duct between righthand crankcase and oil pump. Attach oil pump with nuts and new lock washers. Bend lock washers.

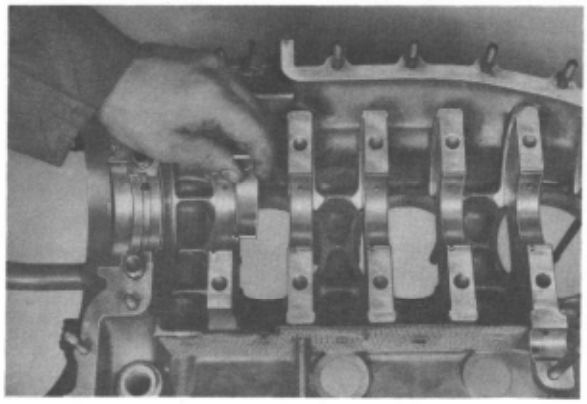




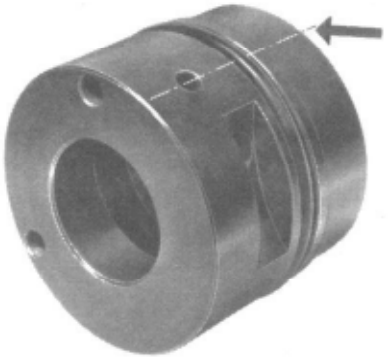
INSTALLATION OF PREASSEMBLED CRANKSHAFT

Installation

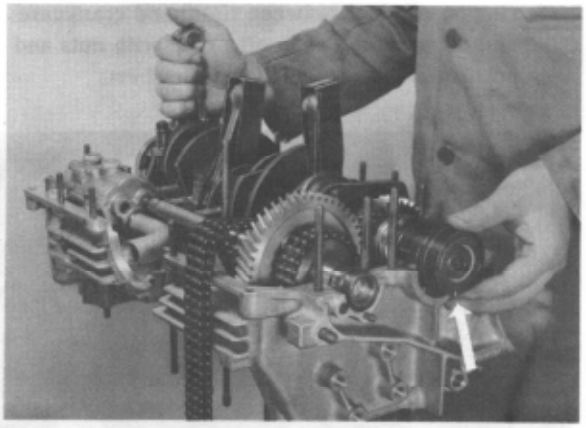
1. When positioning main bearing shells, be sure that the locating lug of the bearing shells rests in the recess groove of the bearing block. Check whether the oil holes in the bearing shell half are in alignment with the holes in the righthand crankcase half.



2. Provide bearing 8 with new round cord ring and new oil sealing ring. Mark center hole on face end of bearing.



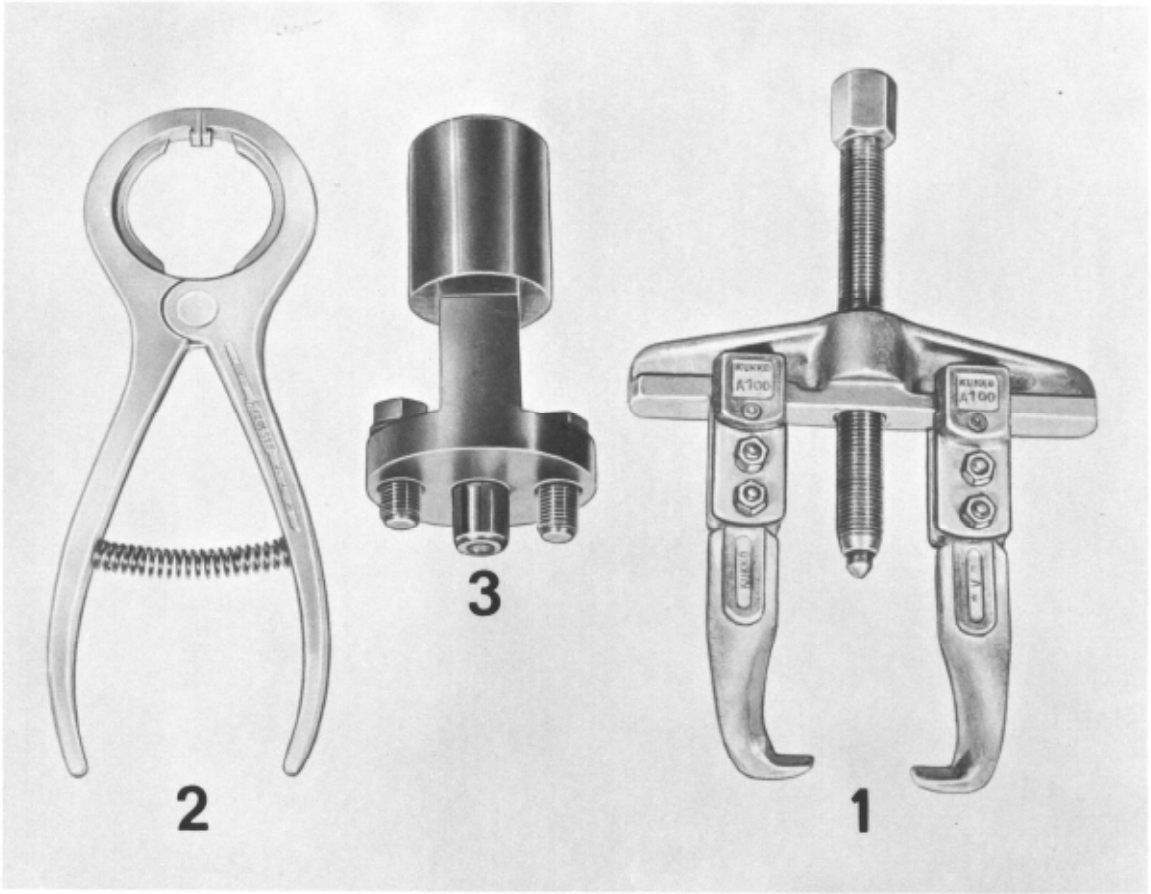
3. When installing crankshaft, protect connecting rods of cylinder 1 and 2 against displacement by means of special tool P 221



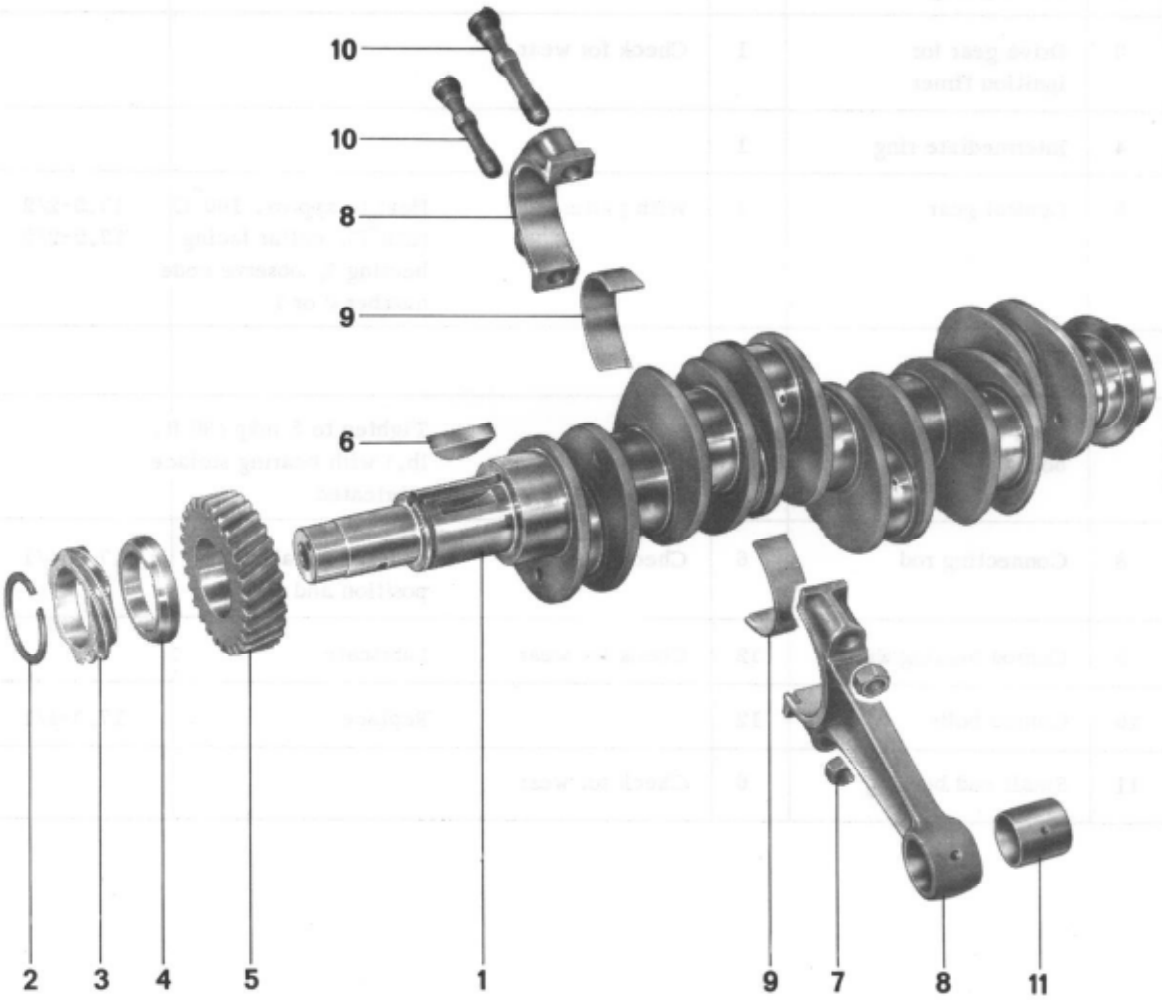
4. Be sure that the fitted hole of bearing 8 is connected to set pin in crankcase.
   Caution!
   If the assembly is not completed with care, the set pin may enter into the oil groove of the bearing instead of the locating hole provided. This will impair the perfect oil supply of the engine.

5. Coat shaft sealing ring between crankshaft and flywheel on outside circumference with sealing compound and insert sealing ring into crankcase half for flush outside fit.

TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Puller	VW 202	
2	Lock ring plier	-	Local purchase item
3	Crankshaft holding fixture	P 209	


10
10
8
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2
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1
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7
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11

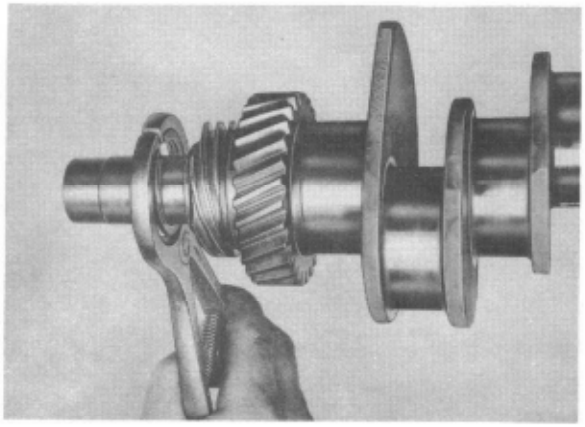
No.	Designation	Each	Observe during: Removal	Installation	Special Instr.
1	Crankshaft	1	Check for wear		17.3-3/1
2	Locking ring	1			
3	Drive gear for ignition timer	1	Check for wear		
4	Intermediate ring	1			
5	Control gear	1	With puller	Heat to approx. 100°C (212°F), collar facing bearing 7, observe code number 0 or 1	17.3-2/2 17.2-2/2
6	Key	1			
7	Hex. nut for conrod bolt	12		Tighten to 5 mkp (36 ft. lb.) with bearing surface lubricated	
8	Connecting rod	6	Check	Observe installation position and weight	17.3-4/1
9	Conrod bearing shell	12	Check for wear	Lubricate	
10	Conrod bolts	12		Replace	17.3-4/1
11	Small end bushing	6	Check for wear		

DISASSEMBLY AND ASSEMBLY OF CRANKSHAFT

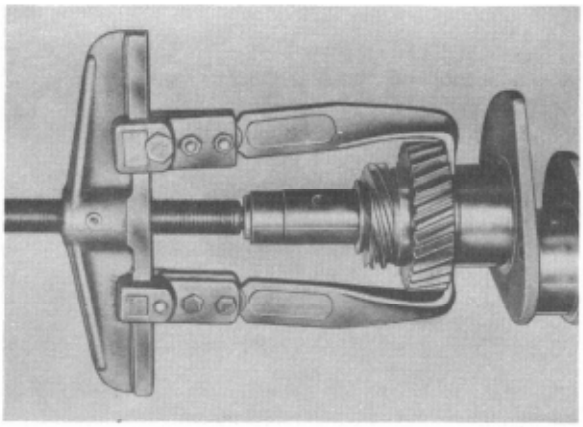
Disassembly

1. Clamp crankshaft with holding fixture special tool P 209 into support VW 310a.

2. Remove locking ring on ignition distributor drive gear with circlip pliers.



3. Pull ignition distributor drive gear, intermediate ring and control gear with puller. Remove key, if required.



Slight seizing marks on seat surfaces may be carefully removed. But do not damage press-fit.

Checkup

1. Check crankshaft for wear, out-of-true and cracks (resonance test). If required, replace crankshaft or grind.

Check crankshaft out-of-true on bearing 4 and 8. Place bearings 1 and 7 on V-blocks	Bearing journals out-of-true	Unbalance
max. 0.03 mm (.0012")	max. 0.03 mm	max. 10 cmg.

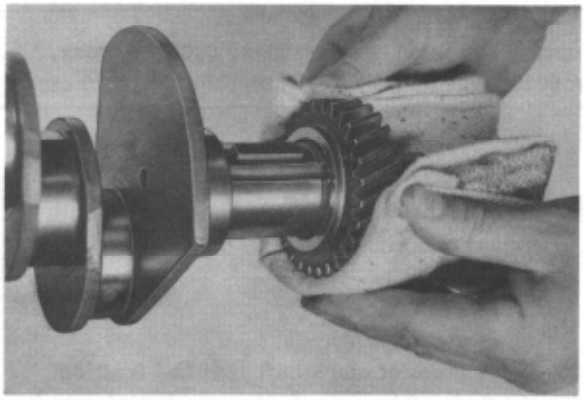
2. Clean crankshaft and blow out oil ducts with compressed air.

3. Check bores of crankshaft gear and ignition distributor drive gear for traces of seizing and check contact pattern on gear tooth flanks.

Assembly

1. Insert key for control gear and ignition distributor drive gear.

2. Heat control gear in oil bath to approx. 100°C (212°F) and slide on crankshaft, with the collar facing crankshaft bearing 7. Fit intermediate ring.



3. Heat ignition distributor drive gear to approx. 80°C (176°F) and fit. Watch out for good seat.

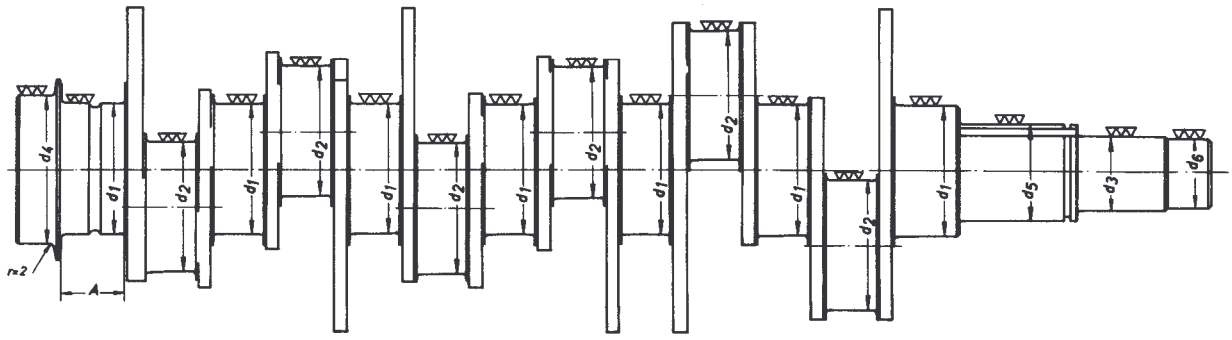
4. Mount locking ring with circlip pliers. Check gears for good seat when cold.

RECONDITIONING CRANKSHAFT

Crankshafts which require regrinding should be sent to the factory, whenever possible, since this will ensure an accurate and expert job. Above all, because the crankshafts must be tenifer-treated after the grinding.

In cases in which the crankshaft cannot be shipped for special reasons, the following data apply:

Carefull grinding of the fillets on the crankshaft and conrod bearing pins is of decisive importance for the life of the crankshaft. Following the grinding, round oil holes to a 0.5 radius. If required, sharp edges must be smoothed down to a radius of 0.2 to 0.5 mm (.008-.020"). Apply tenifer treatment to crankshaft. 120 minutes at 570 °C and quenching in water of approx. 90 °C (194 °F).



Degree of wear	Crankcase bore diameter (bearings 1-8)		All main bearings d 1 and connecting rod bearings d 2 on crankshaft	Main bearing diameter d 3 on crankshaft bearing 8	Shoulder diameter	Timing gear seat diameter d 5	Bearing surface diameter d 6	Guide bearing width A
Std.	Normal 62.000 - 62.019 (2.4409" - 2.4417")	Oversize 62.269 - 62.250 (2.4515" - 2.4508")	56.990 - 56.971 (2.2437- 2.2429")	30.993 - 30.980 (1.2202 - 1.2197")	65.000 - (2.5591") 64.981 (2.5583")	42.013 - (1.6540") 42.002 (1.6536")	29.993 - (1.1808") 29.960 (1.1795")	28.000 - (1.1024") 28.052 (1.1044")
0,25			56.740 - 56.721 (2.2338 - 2.2331")	30.743 - 30.730 (1.2104 - 1.2098")				
0,50			56.490 - 56.471 (2.2240 - 2.2232")	30.493 - 30.480 (1.2005 - 1.1999")				
0,75			56.240 - 56.221 (2.2141 - 2.2134")	30.243 - 30.230 (1.1906 - 1.1901")				

Following the tenifer treatment, polish all bearing pins and thrust surfaces and ferroflux crankshaft.

After grinding a reconditioned crankshaft, remove plugs out of oil ducts. Clean oil ducts thoroughly and close again by new plugs.

INSPECTION AND INSTALLATION OF CONNECTING RODS

Checkup

1. Check connecting rods for external damage. If connecting rod is damaged or the small end bushing is worn, replace connecting rod.

2. The conrod bolts are designed as expanding bolts and can be used only once.

3. Checking the connecting rod weight:
The difference in weight of the connecting rods for one engine should not exceed 9 grams.
Weight of connecting rod: connecting rod complete, but without bearing shells.

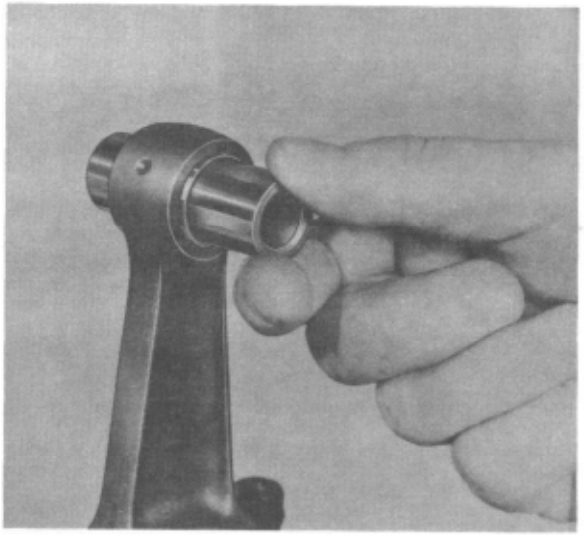
4. 12 Weight groups are available for installation. When ordering spare parts, weight damaged connecting rod and determine its code number on the basis of its weight. Then determine spare parts number on basis of code number for pertinent connecting rod weight group and state in order.

Weight group table

Connecting rod weights in grams		Weight group
from	to	Code No.
551	560	2
560	569	5
569	578	8
578	587	11
587	596	14
596	605	17
605	614	20
614	623	23
623	632	26
632	641	29
641	650	32
650	659	35

The code number for the connecting rod weight is stamped on connecting rod blade of new connecting rod.

5. Check small end bushing. In a new bushing, the piston pin should slide under light finger pressure.



Installation

1. Install and lubricate connecting rod bearing shells after carefully cleaning all parts, then assemble connecting rod.

3. Tighten connecting rod bolts to 5 mkp (36 ft. lb.) (threads and bearing surface of nut lubricated).

2. The code numbers on parting surface of connecting rod top should be on one end.

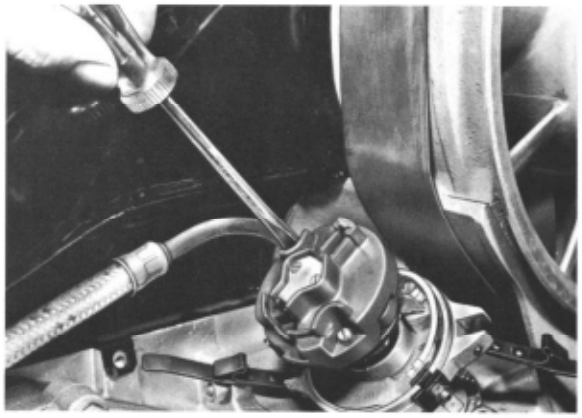
4. The connecting rods are inserted with engine oil and should slide easily under their own weight. Any refinishing or realigning of bearings is not permitted.

ADJUSTING TIMING

1. Adjust dwell angle to $40^{\circ} \pm 3^{\circ}$.

2. Complete basic ignition adjustment:

3. Loosen fastening screws for distributor rotor and remove rotor.



4. Check breaker points. Badly burnt or soiled contact breaker points should be replaced.

5. Connect dwell meter and check dwell.

Note!

Connect dwell meter only to terminal 1 of ignition distributor. Never connect dwell meter to terminal 15, since this would damage the instrument.

6. Pull wire from electromagnetic starting valve, since otherwise fuel will flow out of the cold starting device hose.

7. Adjust dwell angle to $40^{\circ} \pm 3^{\circ}$ at starter speed. Check again at idle speed.

8. To change the point gap or dwell angle, loosen the front fastening screw of the breaker point base plate with a screw driver. Adjust and tighten.

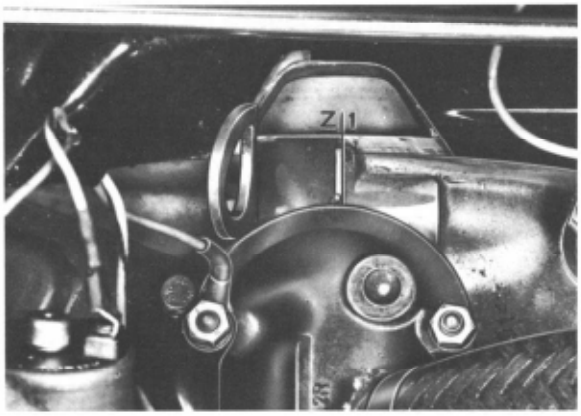
9. Check the timing. Changing the point gap or dwell angle will also change the timing.

ADJUSTING TIMING

1. Adjust dwell angle to $40^{o} \pm 3^{o}$.

2. Complete basic ignition adjustment:

   a. Align no. 1 cylinder TDC mark (Z 1) on flywheel with parting joint of housing.



   b. Remove distributor cap and distributor rotor.

   c. Loosen clamping bolt on distributor retainer.

   d. Connect 12 Volt test light with one lead to terminal 1 of the distributor and the other to ground.

   e. Turn on ignition.

   f. Turn distributor clockwise until contact breakers are closed, then turn slowly in opposite direction until the points begin to open and the test light goes on.

   g. Tighten clamping bolt on the distributor retainer.

3. Run engine until at operating temperature.

4. Connect stroboscopic timing light in accordance with manufacturer's instructions.

5. Run engine at idling speed. Aim stroboscopic timing light at flywheel through inspection hole in transmission housing, then increase speed; the TDC mark (Z 1) should now move to the right seen in driving direction. The timing is correct if the 35^{o} mark on the flywheel aligns with the parting joint of the housing at 6000 rpm.

INSPECTING MARELLY S 112 BX DISTRIBUTOR

Distributor Spark Advance Curve (Distributor installed)

Engine	max.	3° ATDC
at 2,000 rpm		15°-19° BTDC
at 3,000 rpm		19°-23° BTDC
at 4,000 rpm		24°-28° BTDC
at 5,000 rpm		28°-32° BTDC
at 6,000 rpm		35° BTDC

The cutout speed of the speed governor with distributor installed should be between 6,400 and 6,600 rpm.

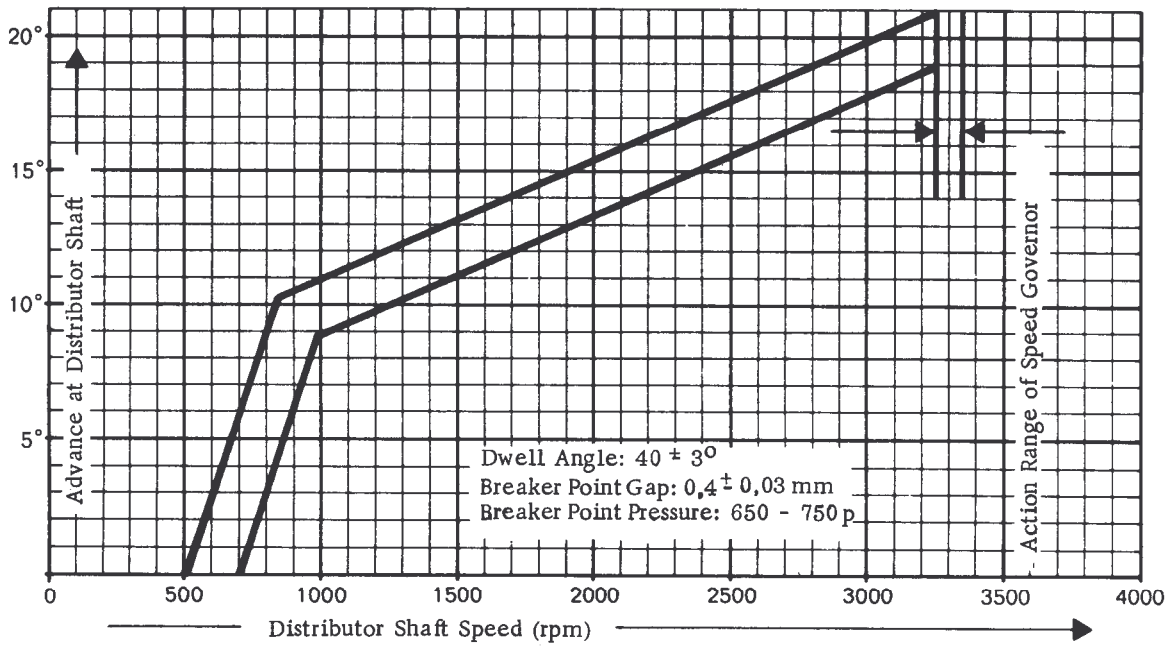
INSPECTING DISTRIBUTOR ON TEST STAND

The advance curve diagram permits checking the advance curve of the ignition distributor on a test stand.

On the distributor test stand the cutout speed is between 3,250 and 3,350 rpm, that is, 100 rpm higher than when the distributor is installed (less vibrations).

DISTRIBUTOR SPARK ADVANCE CURVE (Distributor on test stand)

TYPE: MARELLI S 112 BX DISTRIBUTOR FOR ENGINE TYPE 914/6



INSPECTING BOSCH DISTRIBUTOR 0231 159 008 JFDR 6 (R) (Installed)

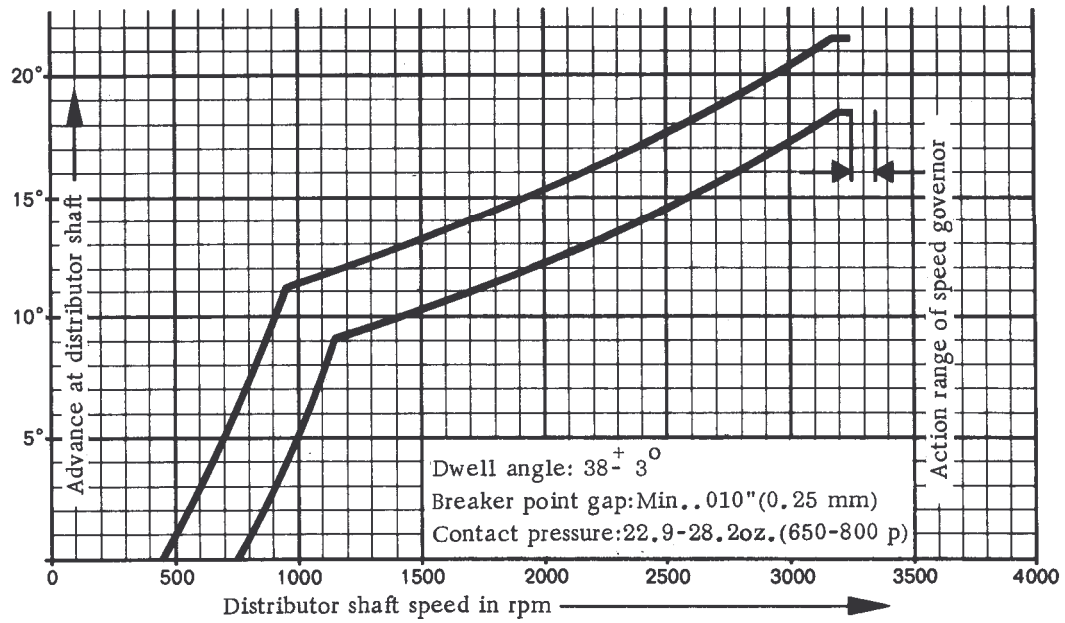
As of April 1970 the engines of Type 914/6 are equipped with Bosch ignition distributors. As with earlier models the timing is set to 35° BTDC at 6,000 rpm. This value applies both to the engine under load or under no-load.

Distributor Spark Advance Curve (Distributor installed)

at:	6,000 rpm	33° to 35° BTDC
	4,600 rpm	27° to 29° BTDC
	3,000 rpm	28° to 22° BTDC
Idle speed:	900 ± 50 rpm	2° to 4° ATDC

DISTRIBUTOR SPARK ADVANCE CURVE (Distributor on test stand)

TYPE: BOSCH 0 231 159 008 J FDR 6 (R) DISTRIBUTOR FOR ENGINE TYPE 914/6



Caution

On the test stand, the adjusting curve of the ignition distributor may be checked only with normal battery ignition.

DISTRIBUTOR SPARK ADVANCE CURVE

vehicle stationary	max.	3° after TDC
at 2,000 rpm		15° - 19° BTDC
at 3,000 rpm		19° - 23° BTDC
at 4,000 rpm		24° - 28° BTDC
at 4,000 rpm		28° - 32° BTDC
at 6,000 rpm		35° BTDC

The governed engine speed with the distributor should be between 6,400 and 6,600 rpm.

CHECKING DISTRIBUTOR ON TEST STAND

The advance curve diagram permits checking the advance curve of the ignition distributor on a test stand.

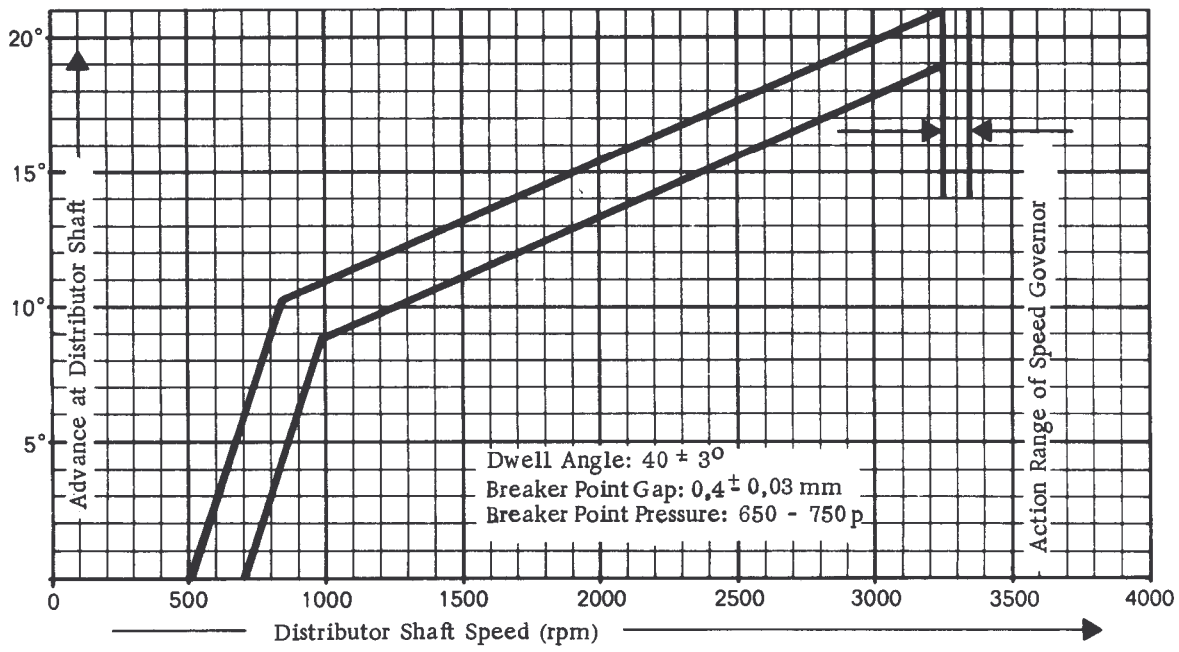
On the test stand, the goverened speed is between 3,250 and 3,340 rpm (distributor shaft speed) i. e. approximately 100 engine rpm higher than with the distributor installed (less vibrations).

ADJUSTING CURVE OF IGNITION DISTRIBUTOR MARELLI

Type S 112 BX for Engine Type 914/6

IGNITION ADVANCE CURVE FOR MARELLI DISTRIBUTOR

Type S 112 BX FOR TYPE 914/6 ENGINES



REPLACING IGNITION BREAKER POINTS

The breaker point base plate and arm can only be replaced as a unit, since they are riveted together. To replace the points, the distributor must be removed.

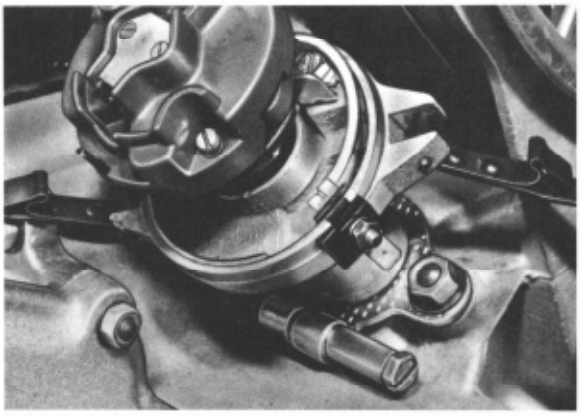
1. Remove air filter.

2. Remove distributor cap.

3. Remove wire from distributor terminal No. 1.

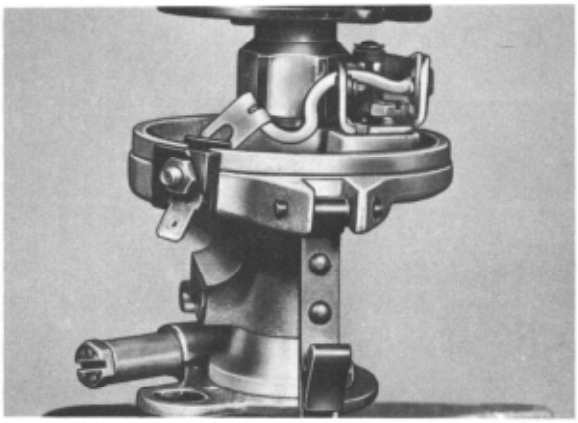
4. Bring number 1 cylinder to TDC (Z 1) and mark position of distributor rotor.

5. Loosen hex. nut of retaining plate with wrench P120b and remove distributor.



6. Loosen rotor fastening screws and remove rotor.

7. Replace breaker point set.



8. Adjust point gap to 0.4 mm (.016 in.) and dwell angle to $40^{o} \pm 3^{o}$.

9. Check timing.

REMOVING AND INSTALLING DISTRIBUTOR

Removal

1. Remove distributor cap.

2. Detach Lead No. 1 from distributor.

3. Align No. 1 cylinder TDC mark (Z 1) on the flywheel with parting joint of housing.

4. Loosen clamping bolt on distributor retainer.

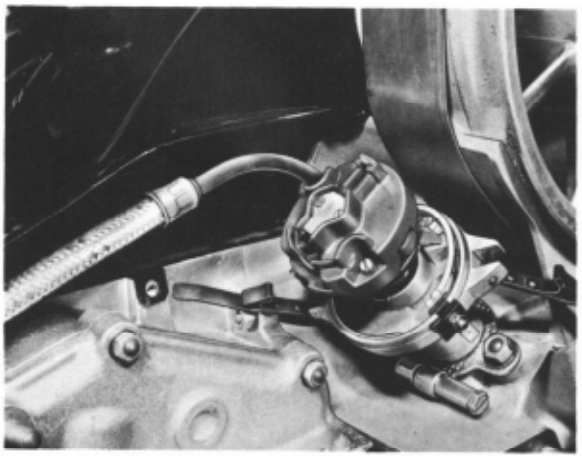
5. Remove distributor.

Installing

1. Check gear on distributor shaft for damage and wear. Check radial play of distributor shaft.

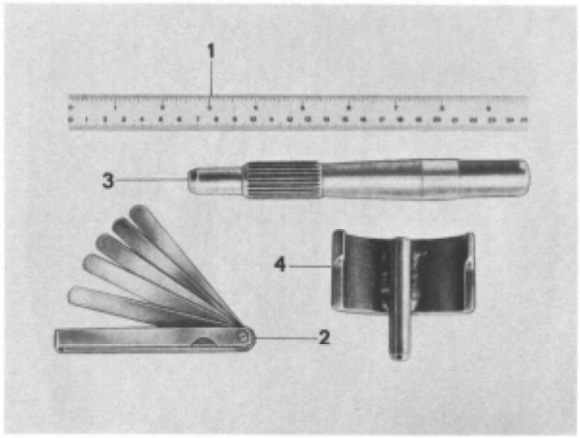
2. Install new O-ring in groove on distributor housing (apply light coat of oil to O-ring).

3. Insert distributor so that the terminal for lead No. 1 points forward (direction of travel). The rotor should point, approximately, toward the center of the blower housing retaining strap.

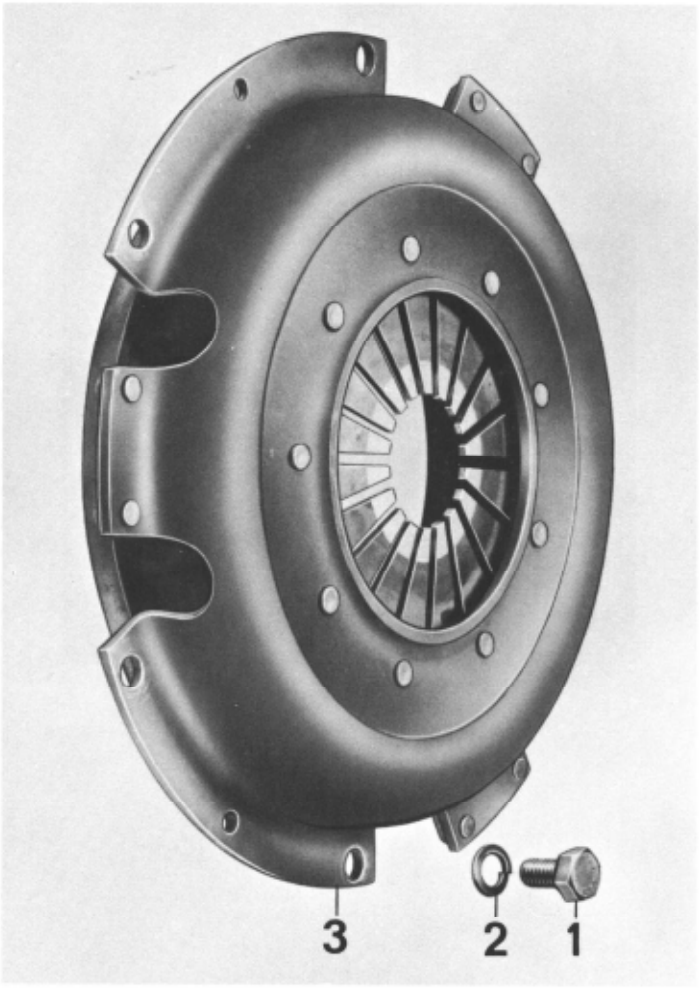


4. Adjust ignition timing (see page 18.1-1/2).

TOOLS



Nr.	Description	Special Tool Nr.	Remarks
1	Metal straight edge		At least 200 mm (7.8 in.) long
2	Feeler gauge		
3	Pilot shaft		Shortened drive shaft
4	Flywheel retainer	VW 215c	



Nr.	Description	Qty.	Note when		Special instructions see
			Removing	Installing	
1	Bolt	6	Loosen evenly in criss-cross pattern	Tighten in criss-cross pattern. Tighten to correct torque.	
2	Lock washer	6			
3	Clutch pressure plate	1			

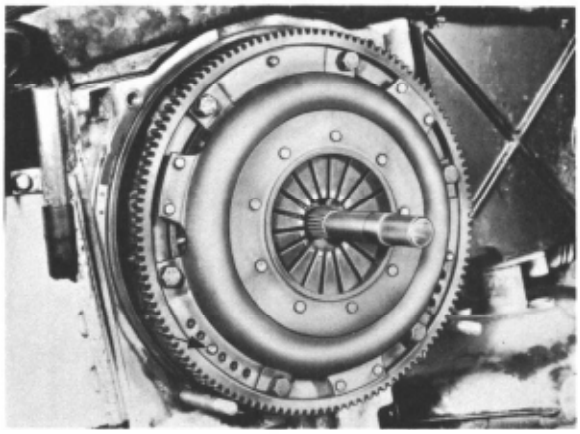
REMOVING AND INSTALLING CLUTCH

Removing

1. Remove engine and separate from transmission.
2. Loosen clutch pressure plate retaining bolt in a criss-cross pattern (to prevent damage to the pressure plate).
3. When the spring pressure is relieved, remove bolts and clutch disc.

Installing

1. Clean the clutch disc contact surface of flywheel (use emery cloth if necessary). Check for wear and replace if damaged or excessively worn.
2. Check clutch disc lining wear, lateral runout and condition of the spring components.
3. Check clutch pressure plate.
4. Lightly coat needle bearing and flywheel with molykote or similar lubricant.
5. Install clutch disc using a universal pilot shaft or a shortened drive shaft to make sure it is centered.
6. Position clutch pressure plate on dowels in flywheel.



7. Install retaining bolts. Hand tighten evenly in a criss-cross pattern. Torque to specification.

CHECKING CLUTCH DISC

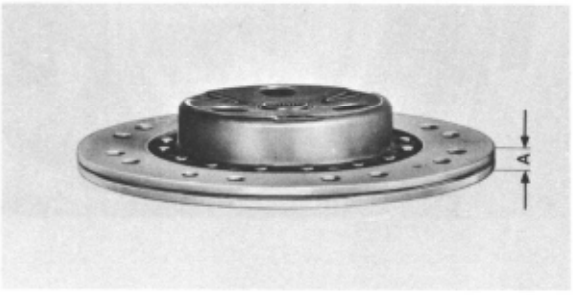
1. Inspect splines. The clutch disc should slide freely on the splines of the drive shaft without play.

2. Check rivets, replacing clutch disc if damaged or loose.

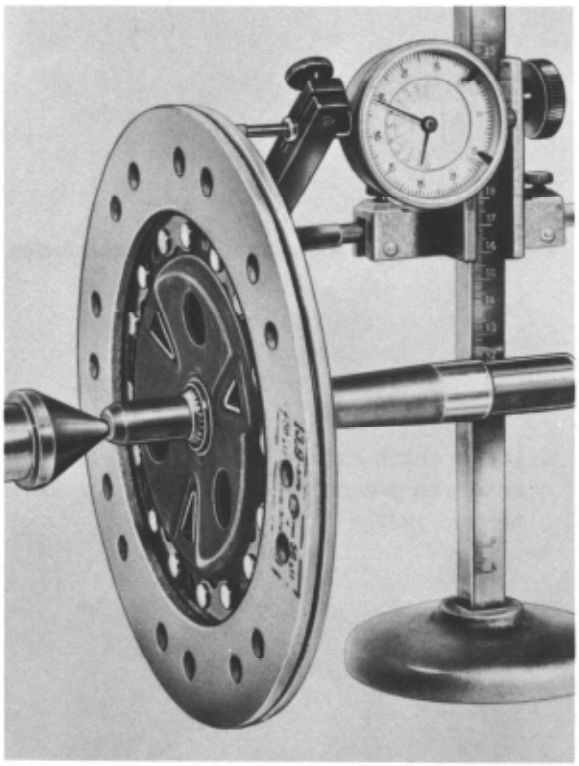
3. Check clutch lining. If the lining is excessively oil soaked, burned or otherwise damaged, replace the clutch disc.

Note
Hair-line cracks in the lining surface between the rivets are not harmful.

4. Check clutch lining thickness.
Clutch disc with riveted linings:
Uncompressed thickness (dimension A) =
9.7 - 10.1 mm (0.382 - 0.398 in.)



5. Check clutch disc for lateral runout. Maximum runout is 0.6 mm (0.024 in.).



6. Check torsion damper for firm seating and check spring supporting plates for cracks. Replace clutch disc if necessary.

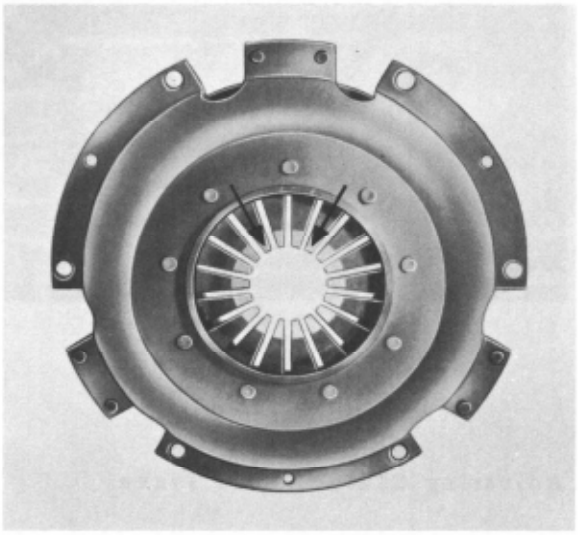
Note
Clutch disc linings cannot be replaced. If linings are excessively worn, replace the entire clutch disc.

CHECKING CLUTCH PRESSURE PLATE

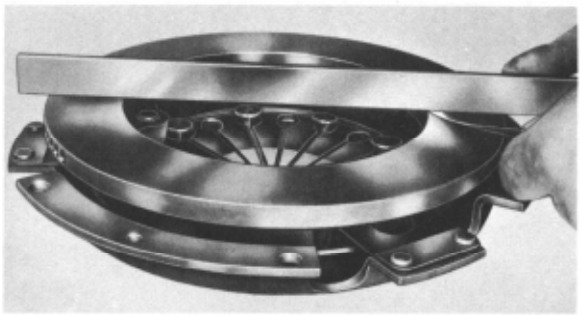
The Fichtel & Sachs M 215 K clutch pressure plate cannot be repaired or overhauled.

1. Clean the clutch.

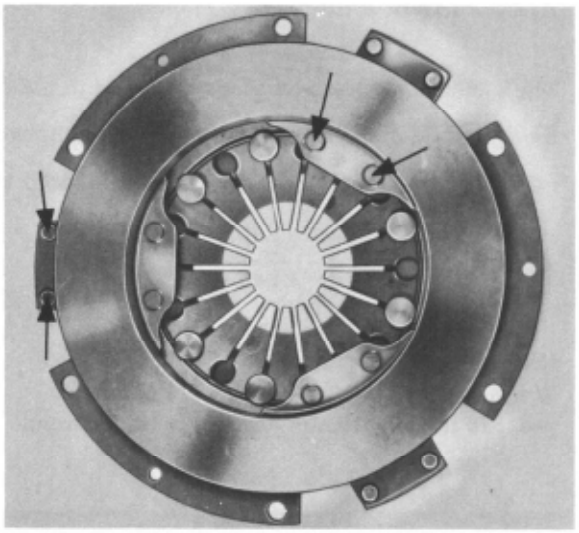
2. Check diaphragm spring segments for wear in the throw-out bearing contact area. Maximum wear 0.3 mm (0.012 in.).



3. Check pressure plate contact surface for cracks, burn spots and wear. Pressure plates can have up to 0.3 mm (0.012 in.) deflection (warpage). See illustration.

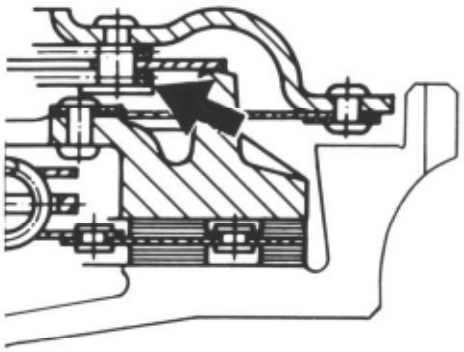


4. Check diaphragm spring connections and spring housing for cracks. Check that rivet seats are secure. Clutch pressure plate assembly with damaged or loose rivets must be replaced.



5. The diaphragm spring pivots on two wire rings which are attached to the spring housing by a rivetted assembly.

   Clutch pressure plates with worn rivet heads or worn wire rings must be replaced.



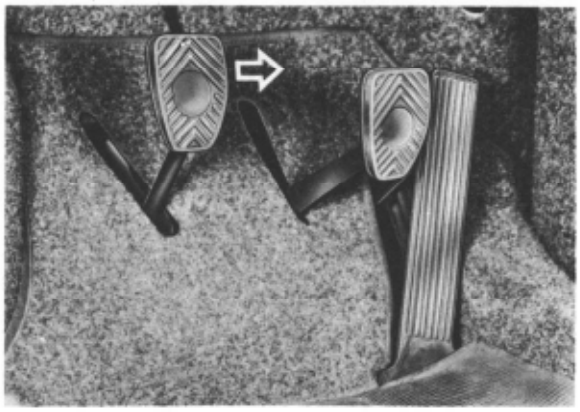
6. Before installing, lightly coat the diaphragm spring seat at the wire ring seating surface with Molykote or similar lubricant.

ADJUSTING CLUTCH

The clutch is actuated by a cable located in the center tunnel and when seen in driving direction leads to the right side of the transmission. The cable movement reverses on a supporting pulley and moves the clutch lever to the rear to disengage the clutch. The cable end is threaded to make necessary adjustments.

Checking Clutch Free Play

Clutch pedal free play is 15 - 20 mm (approx. 3/4 in.). Free play is measured by pulling the pedal in the direction of arrow (see illustration).



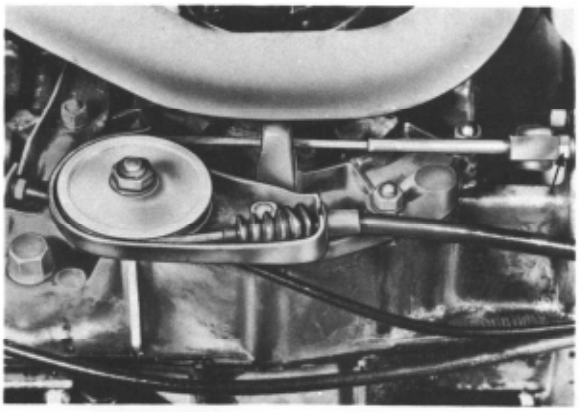
Adjusting Clutch Free Play

Turn the self-locking nut at the rear end of the cable until the correct pedal free play is obtained.

Note
It may be necessary to hold the threaded cable end with pliers.

Checking Clutch Pedal Travel

The pedal travel check should be made with the transmission warm. When the clutch pedal is depressed to the stop, reverse gear should engage without gear clash.



Adjusting Clutch Pedal Travel

1. Remove rubber mat.
2. Loosen both pedal stop retaining bolts.
3. Slide the pedal stop up or down until the reverse can be engaged without gear clash.
4. Tighten retaining bolts. Re-check pedal travel and re-install rubber mat.