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

PORSCHE

Workshop-Manual

914
914/6

DR.-ING. h. c. F. PORSCHE KG STUTTGART-ZUFFENHAUSEN

This publication contains the essential removal, installation and adjustment procedures for the Porsche 914-914/6 vehicles sold in the USA and Canada.

Components and procedures described in this manual are identical for both types unless differences are pointed out in the text.

It is assumed that the reader is familiar with basic automotive repair procedures. Special tools required in performing certain service operations are identified in the manual and recommended for usw. Use of tools or procedures other than those recommended in this repair manual may be detrimental to the vehicle's safe operation as well as the safety of the person servicing the vehicle.

The Porsche 914 - 914/6 Workshop Manual is divided into 8 volumes. The volumes are subdivided into 10 Main Groups as follows:

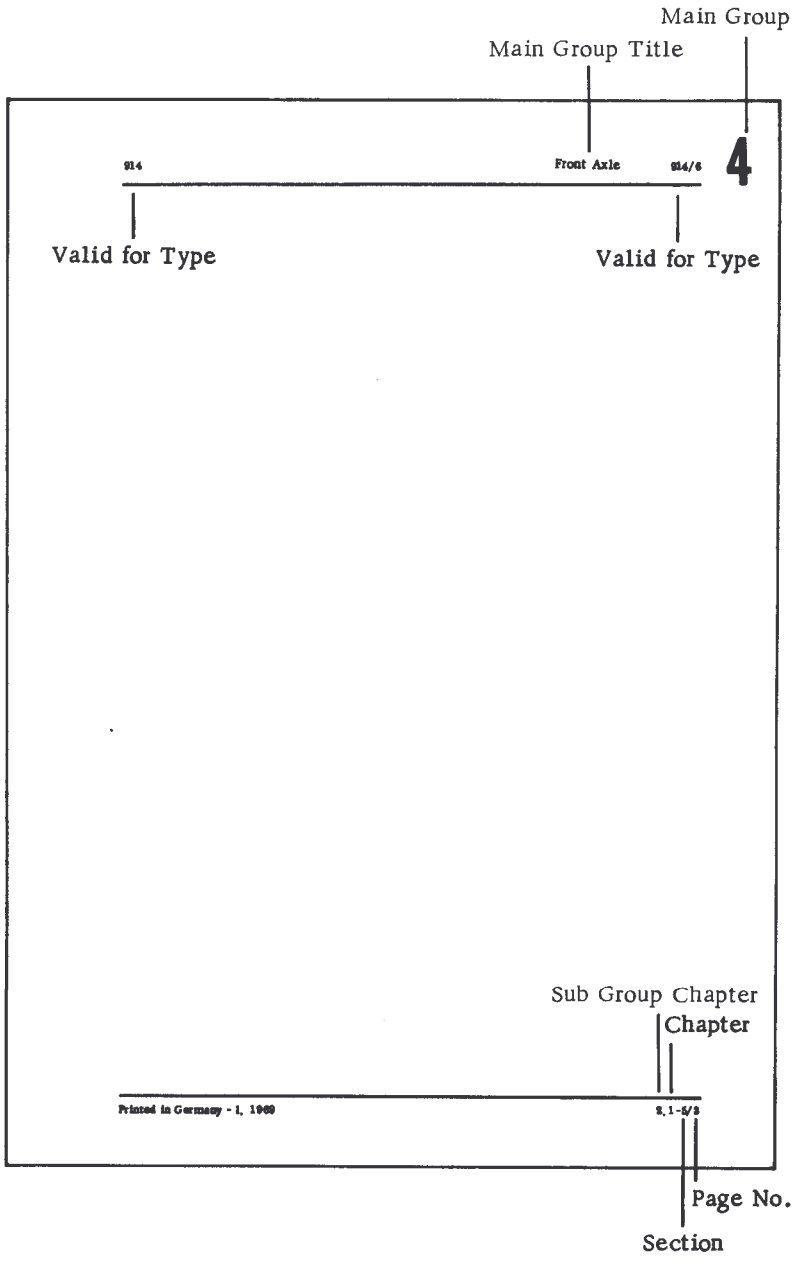
1st Volume	Engine and Clutch - 914	Main Group No. 1
2nd Volume	Fuel System - 914	Main Group No. 2
3rd Volume	Engine and Clutch - 914/6	Main Group No. 1
	Fuel System - 914/6	Main Group No. 2
4th Volume	Transmission	Main Group No. 3
5th Volume	Front Axle	Main Group No. 4
	Rear Axle	Main Group No. 5
6th Volume	Brakes, Wheels, Tires	Main Group No. 6
	Pedal System and Levers	Main Group No. 7
	Maintenance, Specifications	Main Group No. 0
7th Volume	Body	Main Group No. 8
8th Volume	Electrical System	Main Group No. 9

The binders have a transparent plastic pocket on the spine into which the appropriate volume title can be inserted.

To find the individual repair operations, each main group is subdivided into "Chapters" and "Sections". Every main group is provided with a very detailed table of contents. Refer to example on next page.

The repair operations described in this Workshop Manual are based on the Type 914 vehicle. Repair operations which apply to Type 914/6 vehicles are described separately. The type vehicle to which the repair operation applies is given on the top left or right of the page.

When certain repair operations are similar for both type vehicles, the procedures are described together and the minor differences for the 914/6 emphasized by notes and remarks.



Technical Information

The "Technical Information" pages which are published from time to time should be filed in chronological order at the beginning of the respective Main Groups of the Workshop Manuals.

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Assembly Instructions, Technical Data etc. for the 914 are contained in Sections 0 to 7, those for the 914/6 in Sections 10 to 18.

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Service Instructions, technical data, etc. for Type 914/1.7 are contained in groups 0 thru 7; for Type 914/6 in groups 10 thru 19; and for Type 914/2.0 in groups 20 thru 27.

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The engine installed in the VW-Porsche 914 is an air-cooled four-cylinder, four-cycle flat four engine with electronically controlled gasoline injection, horizontally opposed cylinders and overhead valves. Attachment to the gearbox is by means of four screws. The power unit, that is, the gearbox and the engine - is attached at the front to the body side members by means of an engine support screwed to the crankcase and at the rear to a cross member by means of rubber-metal antivibration mounts.

Ignition System

The ignition system is a battery system with one ignition coil and one ignition distributor for automatic firing point control under the influence of centrifugal forces and a vacuum. The ignition system transforms the battery voltage from 12 Volts to the required ignition voltage and the ignition distributor feeds that voltage to each of the four spark plugs in the correct sequence and in the accurate firing order. The distributor is driven by the crankshaft via a worm gear and a distributor shaft.

Cooling

Cooling is by means of a radial blower. The impeller of the cooling blower is attached to the crankshaft hub by means of three screws. The blower sucks the air through the opening in the cooling blower housing, forcing it across the heavily ribbed cylinders and cylinder heads. The air flows through guide plates surrounding the cylinder heads and cylinders. Some of the fresh cooling air is used for the heating system and is heated on the exhaust pipes via heat exchangers.

A thermostat under cylinders 1 and 2 actuates two flaps in the inlet ducts of the front halves of the cooling blower housing via cable controls. The flaps control the cooling air volume, so that the cold engine will heat up faster and the operating temperature will remain as uniformly as possible under all loads. The air volume for the heating system is not influenced by these controls.

Oil Circuit

Lubrication is by means of forced circulation including a special oil cooling system.

The geared oil pump is at the input end of the camshaft and is driven by the latter. The oil is taken from the lowest point of the crankcase and forced into the oil ducts via the horizontal oil cooler. One portion of the oil is forced through the crankshaft bearings into the hollow crankshaft to lubricate the conrod bearings, another lubricates the camshaft bearings, a third will flow through the hollow push rods to the rocker arms to lubricate the rocker arm bearings and the valve stems. The cylinder walls, pistons and piston pins are lubricated by splash lubrication.

Impurities are held back by an oil filter in the main flow and by a strainer at the lowest point of the crankcase. When the oil filter is contaminated, a ball valve in the oil filter flange will open and will guide the oil flow directly to the bearing points.

The oil cooler is flanged laterally to the crankcase and is cooled by the air sucked up by the blower. It is installed in the oil line un such a manner that the oil delivered by the pump is forced to flow through the cooler prior to reaching the individual lube points. As a result of the cooling, the oil will keep its full lubricating properties even at high outside temperatures and under max. loads of the engine.

When the oil is cold and therefore more sluggish, a relief valve will cause the oil to flow directly into the oil ducts, partially by-passing the oil cooler. An oil pressure control valve at the end of the circuit will keep the oil pressure in the range of the crankshaft and camshaft bearings to approx. 2.0 kg/cm^2 (24.5 psi).

An automatic switch for the oil pressure pilot lamp is installed in the pressure line between the oil pump and the oil cooler and will open an electric contact at a pressure between 0.15-0.45 kg/cm^2 (2.13-6.4 psi) to break the current for the pilot lamp.

When the ignition is switched on and when the oil pressure is too low, the lamp will light up.

Cylinder Head

Two cylinders each carry a common, removable and heavily ribbed light metal cylinder head with shrunk-fit valve seat rings and valve guides. The valves are suspended overhead. The exhaust valves are clad with particularly high-grade chrome nickel steel.

Timing System

The camshaft is mounted in the crankcase at three points in split steel bearings with babbitt metal running surface and is driven by the crankshaft via helical spur gears. Bearing 3 absorbs the axial thrust of the camshaft. The camshaft gear wheel is made of light metal alloy and is riveted to the camshaft. The valves are timed by cams via tappets, push rods and rocker arms. Each cam is alternately actuating one valve each of two opposed cylinders.

Cylinders

The four cylinders are special castings and of uniform design, permitting individual replacement together with the pertinent piston. The cooling air flows past cooling ribs for the required heat exchange.

Pistons

The light metal pistons with steel inserts carry two compression rings and one oil scraper ring. A hose spring is fitted between the oil scraper ring and the piston. The piston pins are floatingly mounted in the connecting rod eye and are laterally secured in the piston by means of locking rings.

Crankcase

The split crankcase is a light metal alloy die casting. Both halves are machined together and may also be replaced together only.

Crankshaft

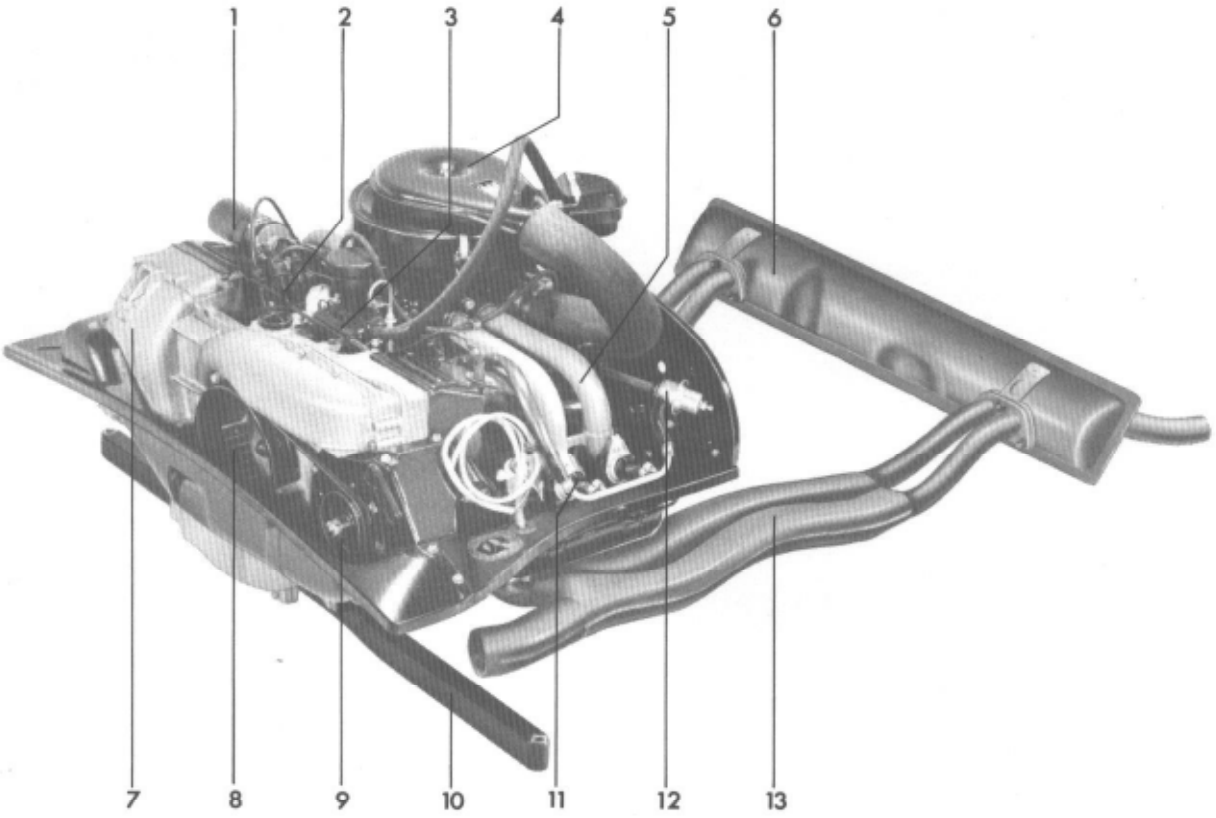
The crankshaft is a symmetrical forging, all bearing points are induction-hardened. The shaft is supported in the crankcase in four bearings. Bearings 1, 3 and 4 are aluminum bushings with lead-coated running surface. Bearing 2 - seen from clutch end - is a split three-component bearing. Bearing 1 simultaneously absorbs the axial thrust of the crankshaft. The flywheel with toothing for the starter is held by five screws and secured against distortion. The drive gears for the camshaft and the ignition distributor are secured by a spring washer. The hub for the cooling blower gear wheel rests on a cone and is attached by means of a spring washer and a hexagon screw. The crankshaft is sealed at the flywheel and blower gear end by means of lip sealing rings.

Connecting Rods

The four connecting rods are steel forgings with I-shaped conrod shank. They are mounted on the crankshaft in replacable three-component bearings and are provided with steel bushings with lead bronze running surface for the piston pins.

Clutch

The single plate dry clutch between the engine and the main gearbox is fitted to the flywheel. The clutch disk is lined on two sides and slides on the splined input shaft of the transmission in axial direction. The clutch cover, the clutch pressure plate and the diaphragm spring are concentrically screwed to the flywheel. In engaged condition, the clutch disk is pressed by the clutch pressure plate against the clutch facing of the flywheel by the spring force of the diaphragm spring. The power connection between the engine and the transmission is thereby established.



1 - Ignition coil
2 - Ignition distributor
3 - Oil breather
4 - Oil bath air filter
5 - Intake pipe
6 - Exhaust nozzle
7 - Cooling blower housing
8 - Cooling blower impeller
9 - Alternator
10 - Engine mount
11 - Injection valve
12 - Pressure regulator
13 - Heat exchanger

CRANKCASE VENTILATION (from 1972 model)

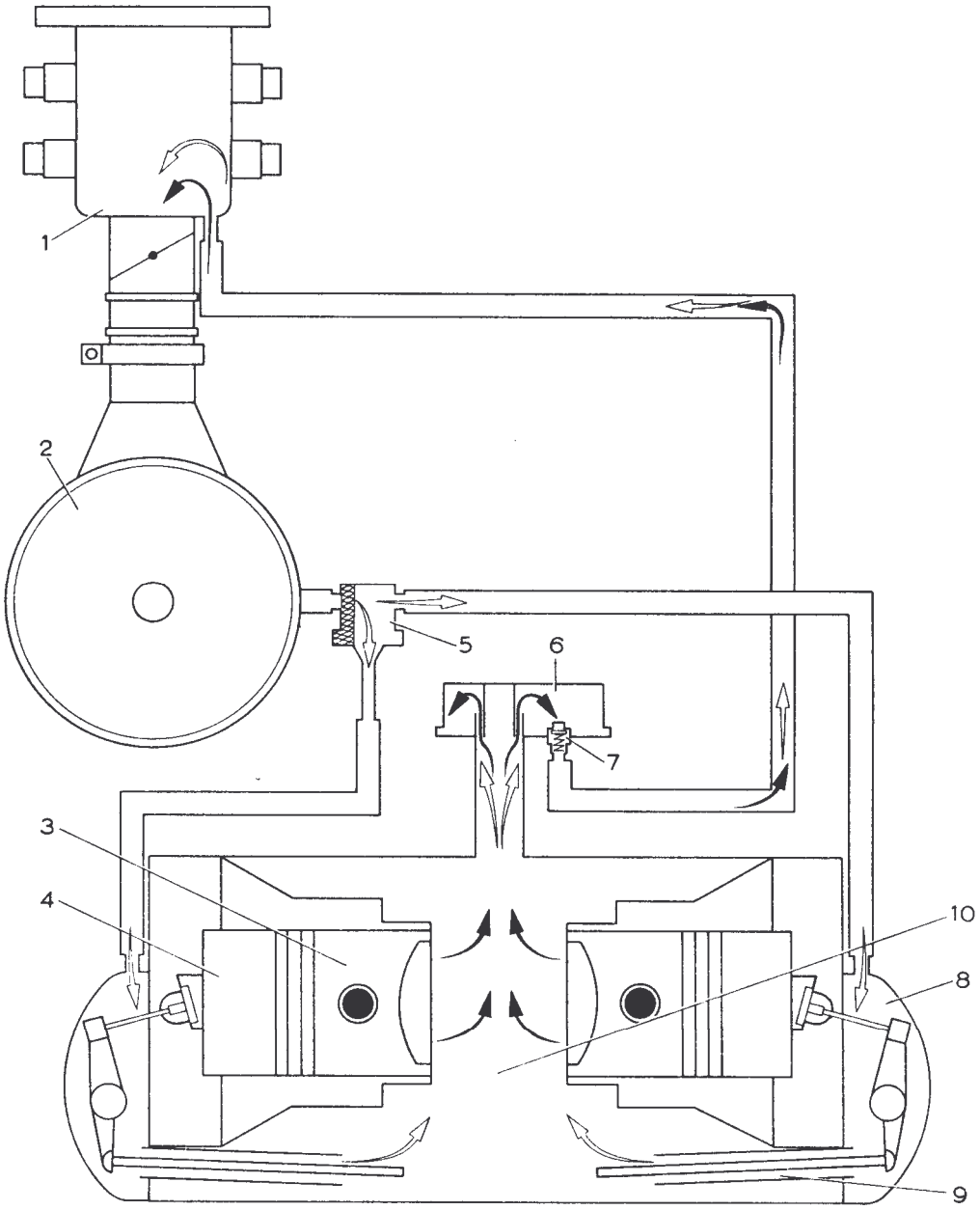
Crankcase ventilation has been considerably improved in the engine by ducting fresh air from the air filter. This modification reduces crankcase condensation and icing at low outside temperatures.

DESCRIPTION

Fresh air is ducted from the air filter (white arrows) to the cylinder head valve covers and then through the pushrod tubes to the crankcase where it combines with the crankcase fumes (black arrows). This mixture is then drawn into the induction system and burned in the cylinders.

The flow of fresh air is regulated by a vacuum-controlled valve located between the crankcase breather and intake manifold. The valve operates on manifold vacuum which, in turn, varies with throttle position and engine speed.

A flame trap, located behind the air cleaner, prevents flashback into the crankcase.



1 - Intake air distributor manifold
2 - Air cleaner
3 - Piston
4 - Combustion chamber
5 - Flame trap
6 - Oil breather
7 - Control valve
8 - Valve cover
9 - Pushrod tube
10 - Crankcase

ENGINE CHANGES BEGINNING WITH 1974 MODELS

Beginning with 1974 models, the 1.7 liter engines have been replaced with 1.8 liter engines.

The 1.8 liter engines differ from the 1.7 liter engines in the following component areas:

1 - Cylinder heads	modified ports and combustion chambers
2 - Valves	larger diameter
3 - Valve adjusting screws and rocker arms	larger diameter
4 - Pistons and cylinders	larger diameter
5 - Ignition system	modified spark advance and ignition timing
6 - Clutch	higher clutch plate pressure
7 - Exhaust muffler	changed tail pipe location
8 - Piston pins	changed wall thickness

Detailed information may be found in the respective sections of the workshop manual. Modifications for the 1.8 liter engines are always listed after the information pertaining to the 1.7 liter engines.

Distributor - 1975 Models

AFC Fuel Injected Engine

The distributor centrifugal spark advance vacuum retard curves are identical to the 1975 specifications (vacuum spark advance is not used).

Engine speed is controlled by the distributor rotor with a built-in speed switch (except California). California vehicles have a separate speed switch that limits the fuel supply.

Distributor rotor without speed limiter

Distributor rotor with speed limiter

TABLE OF ENGINES

Model Year	Code	Displ. cm^3	Output DIN HP at rpm (SAE net)	Stroke/Bore mm	Compression Ratio	Fuel System	Version
1970	W	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1971	W	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1972	EA	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1973	EA	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
	EB	1679	72/5000 (69)	66/90	7.3 : 1	MPC	California
	GA	1971	95/4900 (91)	71/94	7.6 : 1	MPC	USA
1974	EC	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	USA
	GA	1971	95/4900 (91)	71/94	7.6 : 1	MPC	USA
1975	EC-a	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	USA
	EC-b	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	California
	GC-a	1971	88/4900 (84)	71/94	7.6 : 1	MPC	USA
	GC-b	1971	88/4900 (84)	71/94	7.6 : 1	MPC	California

(Differing specifications for 1.8-liter engines beginning with 1974 are shown in parentheses)

TECHNICAL DATA

Type	aircooled 4-stroke gasoline injection engine, with transmission and differential integrated into a single rear-mounted unit.
Code letter	W, EA, EB, (EC: 76 HP)
Number of cylinders	4
Cylinder arrangement	2 cylinders each opposed, flat flour
Bore	90 mm (3.543") dia (93 mm 3,66")
Stroke	66 mm (2.598")
Total piston displacement	1679 cc (102.5 cu.in.) (1795 cc 109,53 cu.in.)
Compression ratio	8.2 EB: 7.3 (EC: 7.3)
Max. horsepower (DIN)	80 HP at 4900 rpm (EC: 76/4800) EB: 72/5000
(SAE)	85 HP at 5000 rpm
Max. torque (DIN)	13.50 mkg (97.65 ft.lb.) at 2700 rpm (EC: 13/3400) EB: 12.4/2700
(SAE)	13,75 mkg (99,45 ft.lb.) at 3500 rpm
Mean piston speed	10.8 m/s (35.4 ft/sec) at 4900 rpm
Octane rating required	98 RON (Research Method) EB: 91 RON (EC: 91 RON)
Total weight, dry	approx. 126 kg (278 lbs.)
Ignition	battery ignition 27° BTC at 3500 rpm with vacuum hoses detached (7,5° BTC at 800-900 rpm with vacuum hoses detached)
Firing order	1-4-3-2
Spark advance type	centrifugal and vacuum
Dwell angle	44° - 50°
Spark plugs	14 mm (long thread), heat range 175
Electrode gap	0.6 mm (0,0236")
Cooling	aircooled by radial blower on crankshaft
Delivery volume	approx. 800 lits/sec (211 US gal) at n (engine) = 4600 rpm
Lubrication	forced feed by gear pump
Oil cooling	oil cooler in blower air stream
Oil filter	in main stream
Oil pressure indic	by pilot lamp
Oil capacity	3.5 lits (0.92 US gal) with oil filter change 3.0 lits (0.79 US gal) without oil filter change
Oil consumption	0,5-1,0 lits/1,000 km (0.13-0.26 US gal/6,214 miles)
Cylinder Head	one each for 2 cylinders with cast-on cooling ribs, aluminum alloy
Valve seat rings	shrunk-in, sintered steel
Valve guides	shrunk-in, special brass
Spark plug threads	cut into cylinder head
Valve timing	1 camshaft under crankshaft, tappets, push rods and rocker arms guided in housing
Valves	1 inlet and 1 exhaust valve per cylinder
Exhaust valve	with hard-faced seat
Arrangement	overhead
Clearance: Inlet	0.15 mm (0.006") with cold engine
Exhaust	0.15 mm (0.006") with cold engine
Valve springs	1 spring per valve

Valve timing with 1 mm (.04") valve clearance:	
Intake opens	12° BTDC
Intake closes	42° ABDC
Exhaust opens	43° BTDC
Exhaust closes	4° ATDC
Cylinders	individual cylinders, special grey iron casting with cooling ribs
Center distance	124.5 mm (4.90")
Pistons	light metal alloy with steel insert
Piston pin	floating, secured by circlips
Piston rings	2 compression rings 1 oil scraper ring
Crankcase	split, with vertical center division by crankshaft and camshaft bearings, aluminum alloy
Camshaft	grey casting, 3 plane bearings
Camshaft bearings	thin-walled steel half shells with babbitt metal running surface
Camshaft drive	spur gears, helical
Crankshaft	forged, fine steel, 4 plane bearings
Main bearings 1, 3 and 4	aluminum sleeves with lead-coated running surface
Main bearing 2 (center bearing)	half shells, three-component bearing
Main bearings 1-3	60 mm dia. (2.36")
Main bearing 4	40 mm dia. (1.87")
Conrod bearing	55 mm dia. (2.17")
Flywheel	forged, with starter ring gear, one-piece
Connecting rods	forged, with I-shaped shank cross section
Conrod bearings	thin-walled half shells, three-component bearings
Piston pin bearings	pressed-in steel bushing with lead-bronze running surface
Clutch	Diaphragm spring clutch
Type	single-plate dry clutch
Total facing area	375 cm^2 (47.3 sq.in.)

(Differing specifications for 1.8-liter engines beginning with 1974 are shown in parentheses)

TOLERANCES AND WEAR LIMITS

The term of "wear limit" indicates parts which are coming close to or are attaining the indicated value and are not to be reinstalled during an overhaul. When determining the wear limit of pistons and cylinders, the oil consumption of the pertinent engine must be taken into account.

		Upon installation (new)	Wear limit
Cooling			
Thermostat	Opening temp.	65-70°C (149-158°F)	
Impeller/V-belt pulley	Unbalance	max. 5 cmg	
Oil Circuit			
1 - Oil pressure (for SAE 30 grades only) at 70°C (158°F) oil temp.: at 2,500 rpm	Pressure	approx. 3 kg/cm² (43 psi)	2 kg/cm² (28 psi)
2 - Spring f. oil pressure relief valve Lenght under load: 39,0 mm (1.535")	Load	6,8 - 8,8 kg (14.98-19.38 lbs)	
3 - Spring f. oil pressure contr. valve Lenght under load: 16.8 mm (.661")	Load	4.35 kg (9.59 lbs)	
4 - Oil pressure switch opens at	Pressure	0.15-0.45 kg/cm² (2.13-6.40 psi)	
Cylinder Head with Valves			
1 - Depth of cylinder seat in cylinder head		5.4-6.5 mm (.213-.256")	
2 - Combustion chamber capacity		51.1-52.6 cc (52-53.5 cc) (3.12-3.21 cu.in.)	
3 - a) Rocker arm	ID	20.0-20.02 mm (.7874-.7882") dia.	20.04 mm (.7890") dia.
b) Rocker arm shaft	Dia	19.95-19.97 mm (.7854-7862") dia.	19.93 mm (.7846") dia.
4 - Valve spring Lenght under load 30.0 mm (1.18")	Load	72.5-83.5 kg (159.8-184.1 lbs)	
5 - Valve seat a) Inlet	Width	1.8-2.2 mm (.0708-.0866")	
b) Exhaust	Width	2.0-2.5 mm (.0787-.0984")	
c) Inlet	Seat angle	30°	
d) Exhaust	Seat angle	45°	
e) External correction angle		15°	
f) Internal correction angle		75°	
6 - Valve guides Inlet	ID	8.00-8.02 mm dia. (.3150-.3158")	8.06 mm dia. (.3173")
Exhaust	ID	9.00-9.02 mm dia. (.3543-.3551")	9.06 mm dia. (.3567")
7 - Valve stem Intake	Dia.	7.94-7.95 mm dia. (.3126-.3130")	7.90 mm dia. (.3110")
Exhaust	Dia.	8.91-8.92 mm dia. (.3508-.3512")	8.87 mm dia. (.3492")
	out-of-round	max. 0.01 mm (.00039")	
8 - Valve guide - valve stem Inlet and exhaust	Rocker play	max. 0.45 mm (.0177")	0.9 mm (.0354")
9 - Valve disk Inlet	Dia.	39.0 mm dia. (1.54")	(41.0 mm dia.)
Exhaust	Dia.	33.0 mm dia. (1.30")	(34.0 mm dia.)

		Upon installation (new)	Wear limit
10 - Valve clearance (cold) Inlet	Adjustment	0.15 mm (0.006")	
Exhaust	Adjustment	0.15 mm (0.006")	
11 - Compression pressure (with throttle valve open and engine at operating temp., all plugs unscrewed, with practically no-loss pressure gauge in plug seat, cranking with starter)	Pressure	9.0-11.0 kp/cm^2 (128-156 psi)	7.0 kp/cm^2 (100 psi)
Pressure difference between individual cylinders		max. 1.5 kg/cm^2 (21.3 psi)	
Cylinders and Pistons			
2 Excess sizes, each with 0.5 mm (.0197") higher dia.			
1 - Cylinder	out-of-round	max. 0.01 mm (.0004)	
2 - Cylinder/Piston	Clearance	0.04-0.06 mm (0.015-0.045) (.0016-.0024")	0.20 mm (.0079")
3 - a) Upper piston ring	Side clearance	0.06-0.09 mm (.0024-.0035")	0.12 mm (.0048")
b) Lower piston ring	Side clearance	0.04-0.07 mm (.0016-.0028")	0.10 mm (.0039")
4 - Oil scraper ring	Side clearance	0.02-0.05 mm (.0008-.0020")	0.10 mm (.0039")
5 - a) Upper piston ring	Gap width	0.35-0.55 mm (.0138-.0216")	0.90 mm (.0354")
b) Lower piston ring	Gap width	0.30-0.35 mm (.0118-.0138")	0.90 mm (.0354")
6 - Oil scraper ring	Gap width	0.25-0.40 mm (.0098-.0157")	0.95 mm (.0374")
7 - Piston weight			
- Weight (brown)		472-480 grams	
+ Weight (grey)		480-488 grams	
8 - Weight difference of pistons of one engine		max. 4 grams	max. 10 grams *)
*) In the event of repairs			
Crankcase			
1 - Bore for crankshaft bearings		70.00-70.02 mm	70.03 mm
a) Bearings 1-3	Dia.	dia. (2.7559-2.7567")	dia. (2.7571")
b) Bearing 4	Dia.	50.00-50.04 mm dia. (1.9685-1.9701")	50.04 mm dia. (1.9701")
2 - Bore for sealing ring/ flywheel end	Dia.	95.00-95.05 mm dia. (3.7402-3.7422")	
3 - Bore for sealing ring/ blower gear end	Dia.	62.00-62.05 mm dia. (2.4409-2.4429")	
4 - Bore for camshaft bearing	Dia.	27.50-27.52 mm dia. (1.0827-1.0835")	

		Upon installation (new)	Wear limit
5 - Bore for oil pump housing	Dia.	70.00-70.03 mm dia. (2.7559-2.7571")	
6 - Bore for tappet.....	Dia.	24.00-24.02 mm dia. (.9449-.9457")	24.05 mm dia. (.9469")
Camshaft			
1 - Bearings 1-3.....	Dia.	24.99-25.00 mm dia. (.9839-.9843")	
2 - Measured on center bearing (1st and 3rd bearing point on V-blocks).	Out-of-true	max. 0.02 mm (.0008")	0.04 mm (.0016")
3 - Camshaft/camshaft bearings (including bearing pressure through housing.....	Radial play	0.02-0.05 mm (.0008-.0020")	0.12 mm (.0048")
Guide bearing	Axial play	0.04-0.13 mm (.0016-.0051")	0.16 mm (.0063")
4 - Camshaft gear.....	Backlash	0.00-0.05 mm (.00-.0020")	
5 - Tappet	Dia.	23.96-23.98 mm dia. (.9433-.9441")	23.93 mm dia. (.9421")
6 - Housing bore/tappet.....	Radial play	0.02-0.06 mm (.0008-.0024")	0.12 mm (.0047")
7 - Push rod	Out-of-true	max. 0.3 mm (.0118")	
Crankshaft with Connecting Rods			
3 Undersizes, with dia. reduced in 0.25 mm (.0098") steps			
1 - a) Bearings 1-3	Dia.	59.97-59.99 mm dia. (2.3610-2.3618")	
b) Bearing 4.....	Dia.	39.98-40.00 mm dia. (1.5740-1.5748")	
c) Connecting rod bearing	Dia.	54.98-55.00 mm dia. (2.1646-2.1654")	
2 - Crankshaft on 2nd and 4th bearing point (1st and 3rd bearing point on V-blocks.....	Out-of-true		0.02 mm (.0008")
3 -	Unbalance	max. 12 cmg	
4 - Main bearing pin.....	Out-of-true		0.03 mm (.0012")
5 - Conrod bearing pin	Out-of-true		0.03mm (.0012")
6 - Crankshaft/main bearing (including bearing pressure through housing)		0.05-0.10 mm	0.18 mm
a) Bearings 1 and 3.....	Radial play	(.0020-.0039")	(.0071")
b) Bearing 2.....	Radial play	0.03-0.09 mm (.0012-.0035")	0.17 mm (.0067")
c) Bearing 4.....	Radial play	0.05-0.10 mm (.0020-.0039")	0.19 mm (.0075")
7 - Crankshaft/main bearing 1.....	Axial play	0.07-0.13 mm (.0028-.0051")	0.15 mm (.0059")

		Upon installation (new)	Wear limit
8 - Crank pin/conrod	Radial play	0.02-0.07 mm (.0008-.0028")	0.15 mm (.0059")
	Axial play	0.10-0.40 mm (.0039-.0157")	0.70 mm (.0276")
9 - Conrod weight			
- Weight (white)		746-752 grams	
+ Weight (black).....		769-775 grams	
10 - Weight difference of conrods of one engine.....		max. 6 grams	
11 - Piston pins	Dia.	23.996-24.000 mm dia. (.94472-.94488")	
12 - Small end bushing.....	Dia.	24.015-24.024 mm dia. (.94547-.94582")	
13 - Piston pin/small end bushing.....	Radial play	0.02-0.03 mm (.0008-.0012")	0.04 mm (.0016")
14 - Fly wheel (measured in center of clutch area).....	Lat.wobble	max. 0.4 mm (.0157")	
	Out-of-balance	max. 20 cmg	
Shoulder for sealing ring	OD	74.9-75.1 mm dia. (2.949-2.957")	74.4 mm dia. (2.929")
Refinishing of tooth width			max. 2 mm(.08")
15 - Driven plate.....	Unbalance	max. 5 cmg	
Clutch			
1 - Total clutch pressure	Pressure	420-480 kg (420-485 kg) (926-1, 058 lbs)	
2 - Total clutch unbalance		max. 15 cmg	
3 - Clutch pressure plate	Out-of-true		0.10 mm (.0039")
4 - Clutch disk..... (measured at 210 mm dia. = 463")	Lat. wobble	max. 0.5 mm (.0197")	

MAINTENANCE

Complete the following maintenance and lubrication jobs in accordance with valid service instructions:

1 - Air filter:	Check, clean base and fill in fresh oil.
2 - Fuel filter:	Replace.
3 - Ignition distributor:	Lubricate, check contact points and replace, if required. Adjust timing angle and firing point.
4 - Spark plugs:	Clean, check spark gap and adjust, check compression pressure.
5 - Exhaust system:	Check for damage.
6 - V-belts:	Check and tighten, if required, or replace.
7 - Engine:	Check oil level and replenish, if required or change oil.
8 - Full-flow oil filter:	Replace.
9 - Valves:	Adjust valve clearance and replace seals for cylinder head cover.
10 - Engine:	Sight test for leaks.
11 - Clutch:	Adjust clutch play.

TIGHTENING TORQUES

Designation	Threads	mkg	ft.lbs.
1 - Screws for universal shaft	M 8 x 1.25	4.5	32.5
2 - Nuts for transmission support	M 8	2.0	14.5
3 - Nuts for engine support (body)	M 10	3.0	21.7
4 - Screws for torque converter	M 8	3.0	21.7
5 - Nuts for engine attachment to transmission	M 10	3.0	21.7
6 - Spark plugs	M 14 x 1.25	3.5	25.3
7 - Nut for small pulley	M 14 x 1.5	6.0	43.4
8 - Screws for blower impeller	M 8	2.0	14.5
9 - Nuts for oil pump	M 8	2.0	14.5
10 - Oil drain plug	M 12 x 1.5	2.2	15.9
11 - Closing nut for oil strainer cover	M 8	1.3	9.4
12 - Nuts for rocker arm shaft	M 7	1.4	10.1
13 - Cylinder head nuts	M 10	3.2 [1)]	23.1
14 - Screws for engine support (crankcase)	M 8	3.0	21.7
15 - Screw for blower wheel hub	M 8	3.2	23.1
16 - Screws for flywheel	M 12 x 1.5	11.0	79.6
17 - Screws for carrier plate	M 12 x 1.5	8.5	61.5
18 - Screws and nuts for crankcase halves	M 8	2.0	14.5
19 - Nuts for crankcase halves	M 10 x 1.25	3.3 [3)]	23.9
20 - Conrod nuts	M 9 x 1	3.3 [2)]	23.9
21 - Screws for clutch	M 7	2.0	14.5

1) For tightening sequence refer to 5.1-2/2

2) Replace, contact surface oiled

3) Sealing ring outwards

SPECIAL TOOLS

1	Engine support for garage jack	VW 612/4
2	Clamping support	VW 313
3	Holder	VW 307a
4	Actuating fixture for carburetor	VW 798/2
5	Puller for starter bushing	VW 228b
6	Tester for oil cooler	VW 661/2
7	Puller for oil pump cover	VW 803
8	Clamping plate with wear measuring instrument for valve guides	VW 689/1
9	Valve spring pusher	VW 311s
10	Piston pin mandrel	VW 207c
11	Piston ring strap	VW 123d
12	Fitting fixture for crankshaft sealing ring (impeller end)	VW 190
13	Fitting fixture for crankshaft sealing ring (flywheel end)	VW 191
14	Dial gauge holder	VW 659/2
15	Plate for impeller hub	VW 185
16	Holding clip for flywheel	VW 215c
17	Holding ring for driven plate	VW 184
18	Holding bars for bearings of differential	VW 457
19	Notch punch	VW 124a
20	Tube section, 60 mm dia.	VW 415a
21	Guide sleeve, tapered	VW 428
22	Guide sleeve	VW 427
23	Holding plate for crankshaft	VW 801
24	Conrod testing and friction fixture	VW 214f/70
25	Pressure plate	VW 402
26	Tube section	VW 421
27	Pressure ram	VW 409
28	Circlip spreader	VW 161a
29	Tube section	VW 416b
30	Riveting tool for clutch disk	VW 783

TRIAL RUN AND THE CHECKING OF ENGINES

General

Test benches for checking engines with injection systems require an electric fuel pump, a fine filter and the means to return the fuel flowing out of pressure regulator back into the tank. It will be of advantage to combine the required parts, as well as a fuel tank, a special fuel measuring instrument and a bracket for the control unit on one frame. (For do-it-yourself instructions refer to 0.4 - 3/1).

The trial run and the checking of an engine comprise the following points:

1 - Initial check

2 - Running-in

3 - Measuring fuel consumption

4 - Performance test

5 - Final check

Proceed likewise when checking basically or partially reconditioned engines. Using a test bench with hydraulic brake will be of advantage. The brake permits governing the engine load and matching the load to the requirements of the performance and consumption test.

Initial Check

a - Adjustment of valve clearance

b - Adjustment of contact points and ignition

c - Checking V-belt tension

d - Filling in 3.5 liters of engine oil

e - Test injection system according to checklist with tester EFAW 19 and adapter EFAW 243, or tester EFAW 238, respectively. (For the performance test, always include the control unit and the pressure feeler which belong to the engine.)

Running-in

Prior to starting, crank engine several times manually.
Following the starting, the green oil pressure pilot lamp should extinguish with increasing speed. If not, the oil pump has not sucked up oil and the bearing points and sliding surfaces are not receiving the required lubrication.

The red pilot lamp for the alternator should also extinguish when the idling speed increases. During the running-in period, check fuel pump and lines for leaks. The checkup should also include the pressure in the fuel ring line.
The running-in period of the engine on the test bench can generally be restricted to 30 minutes, which are divided up as follows:

10 minutes at 1500 rpm with 3-5 kg (6.6-11 lbs) load,

20 minutes at 2500 rpm with 6-10 kg (13-22 lbs)load.

Measuring the Fuel Consumption

Toward the end of the 30 minutes test run, check fuel consumption. At given engine speeds an load (refer to table) the flow rates permit judging the fuel consumption.

Engine speed rpm	Brake load kg (lbs)	Flow rate for 100 cm^3 in seconds
2900	6.5 (14.3)	49-51
5000 at full throttle	min.	13.0-13.8

Performance Check

After measuring the fuel consumption, measure the engine performance. The ratings are shown in the power diagram. To take manufacturing tolerances and differences in the test conditions into account, a deviation of $\pm$ 5% is permitted.

The measured performance is converted to 760 mm mercury and 20°C by the following formular:

$$\boxed{P_o = P_e \cdot f} \ (PS_o)$$

$$P_e = \frac{F \cdot n}{1000} \ (PS_e)$$

$$f = \frac{760}{b} \cdot \sqrt{\frac{273 + t}{293}} \ (-)$$

In which:

F	(kg)	= brake load
n	(rpm)	= engine speed
P_e	(PS_e)	= effective engine performance (measured)
P_o	(PS_o)	= normal engine performance
t	(°C)	= intake air temperature
b	(mm mercury)	= air pressure
f	(-)	= correction factor

In addition to diagrams for taking weather conditions into account, the Workshop Manual M contains instructions, which must be observed when measuring the performance of VW engines.

Final Check

a - Adjust idling speed with the engine warm

b - Check for oil leaks.

Following the full load and fuel consumption measurements, check whether engine is oil-tight. Pay special attention to tube protecting tappet, oil pump, oil cooler, cylinder head cover and parting line of housing.

c - Testing the compression pressure.

The compression pressure is tested with a compression tester, with the throttle valve open and the engine at aperating temperature. Unscrew all spark plugs and crank engine with starter.

d - Final check

Prior to installing engine into vehicle, check valve clearance and V-belt tension. The oil bath air filter should be cleaned and filled with the specified quantity of oil.

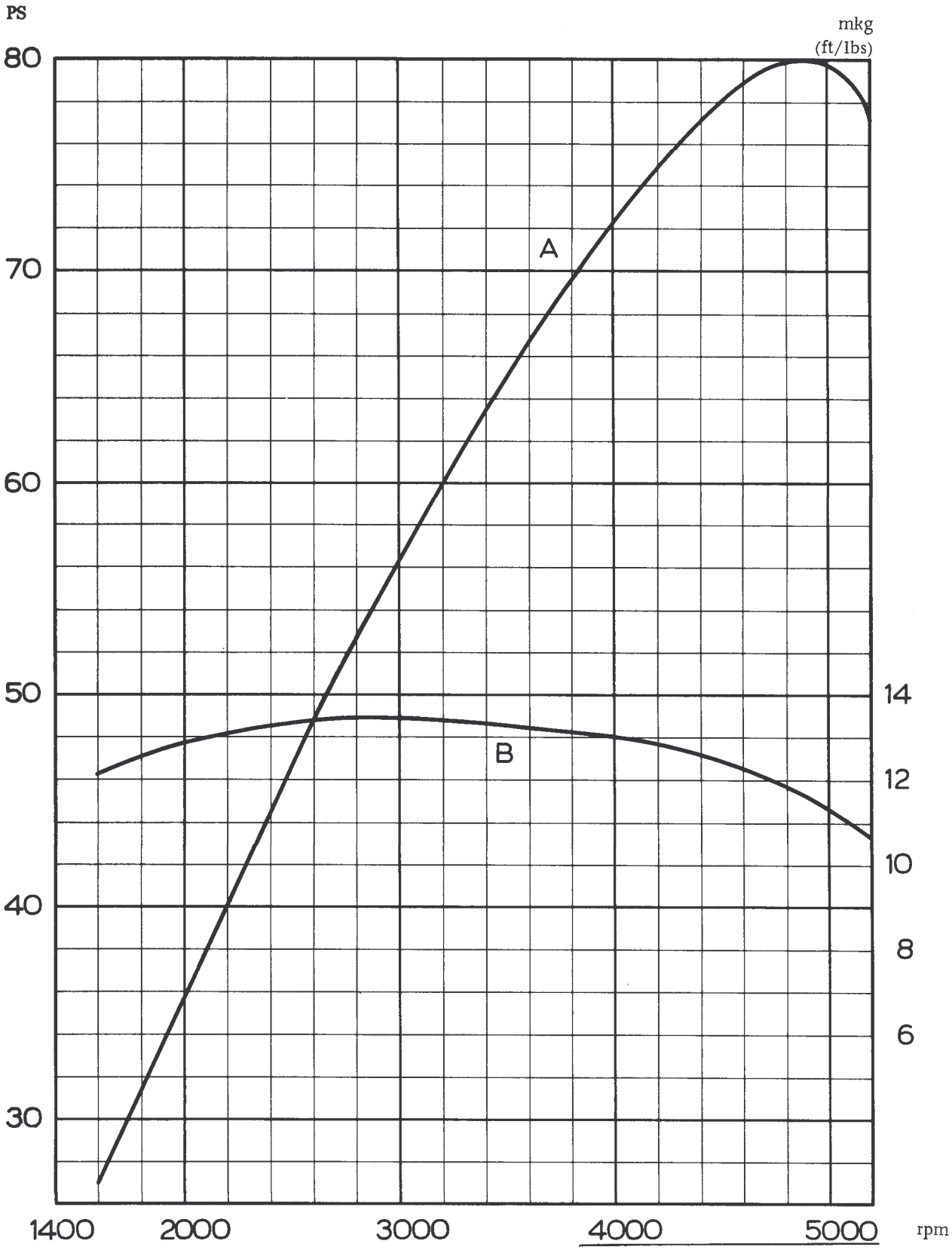
e - Reservation of engines

Engines which are laid up for extended periods should be given a special treatment to prevent corrosion damage. Remnants of fuel and combustion gases are gradually chemically aggressive with regard to the working surfaces of cylinders, to valve guide surfaces etc. Spraying anti-corrosion oil into the intake air distributor during the final revolutions of the engine prior to shut-off or through the spark plug holes provide protection against such attacks. Engines should also be sprayed externally with anti-corrosion oil.

Measuring Output on Dynamometer

Output and fuel consumption can be measured on a dynamometer. Test conditions and ratings are shown on the respective rated value cards.

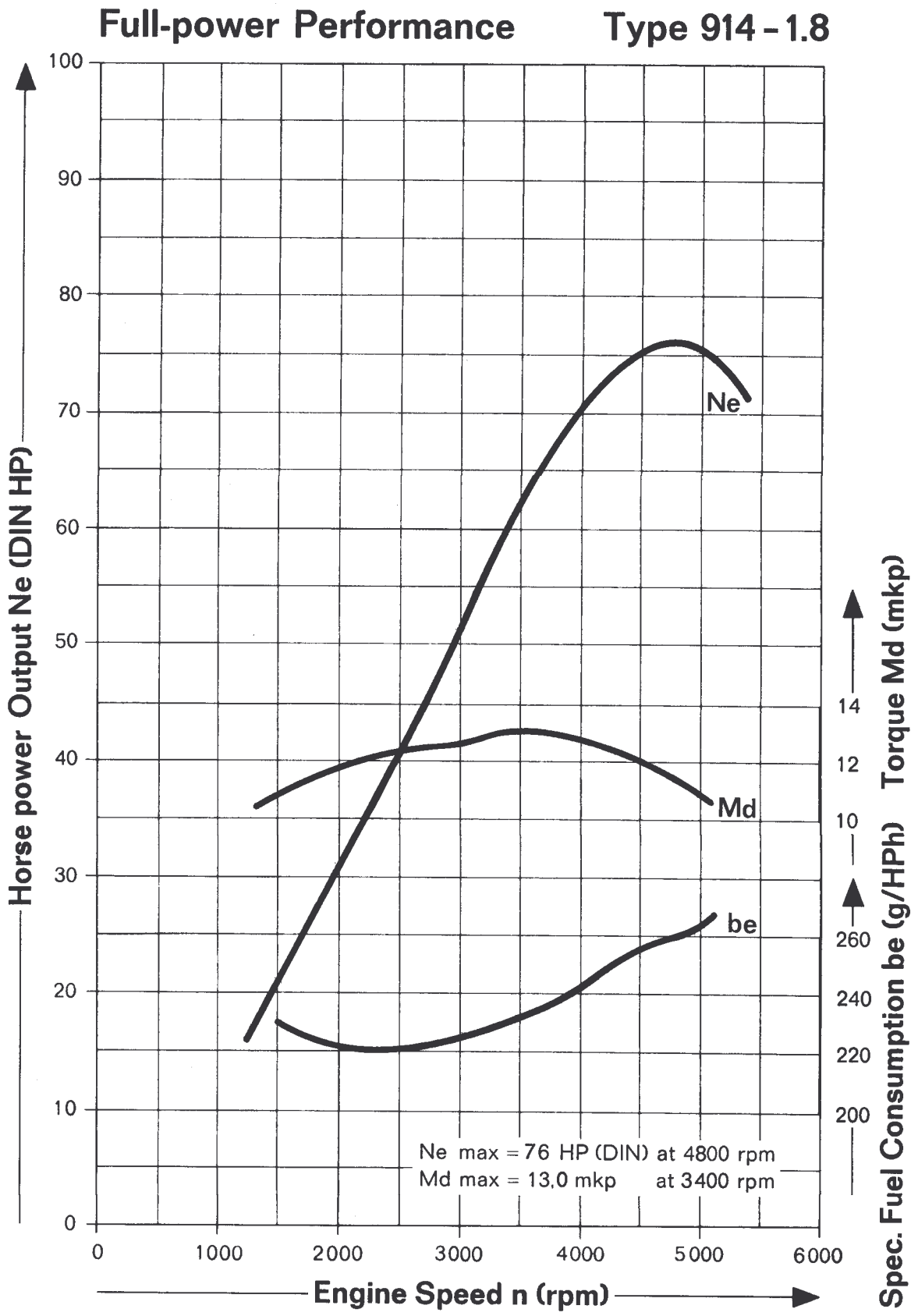
PERFORMANCE DIAGRAM



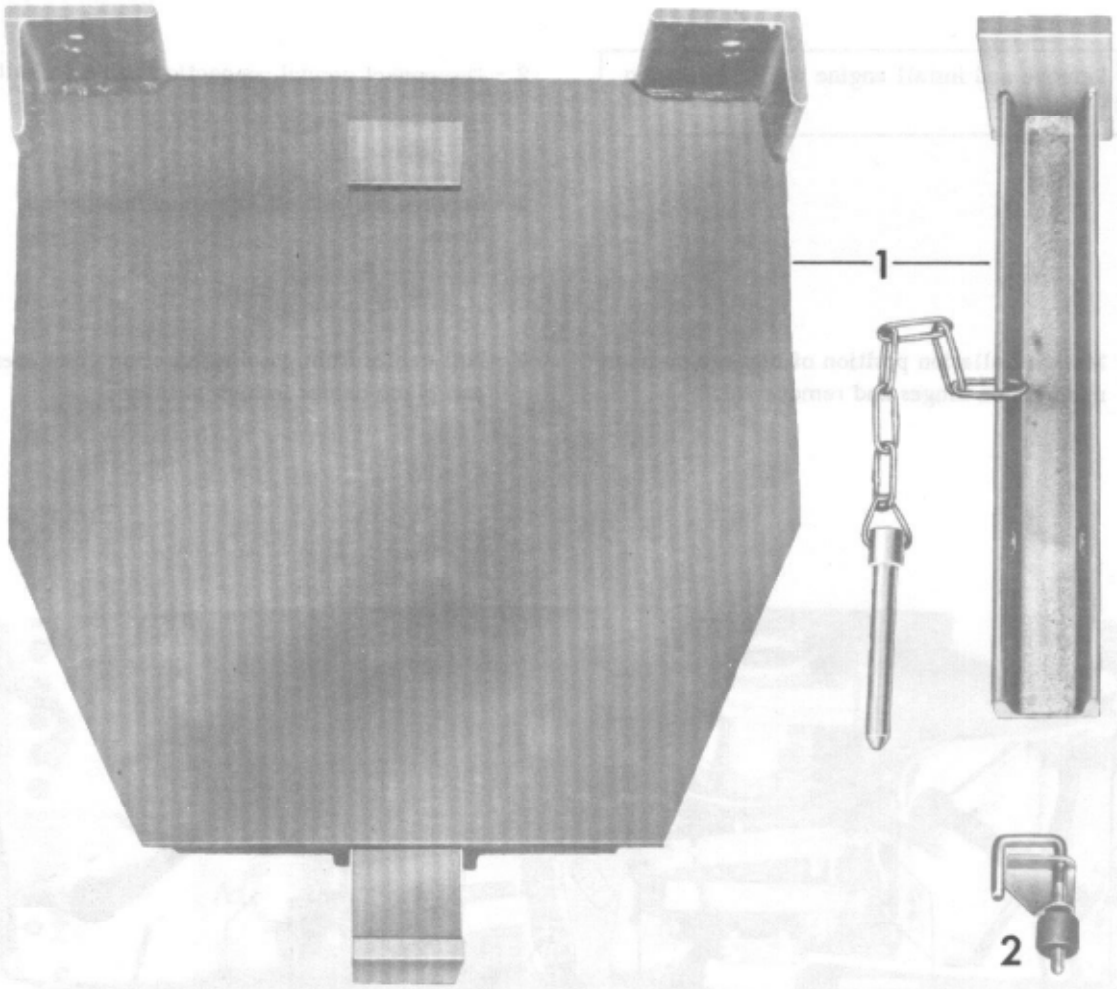
A-Pe = performance (HP)
B-Md = torque (mkg/ft/lbs)

1 mkg = 7.233 ft/lbs

PERFORMANCE DIAGRAM



TOOLS



No.	Designation	Special tools	Explanations
1	Engine support for garage jack with extension for transmission	VW 612/4 VW 612/3	
2	Clamp for fuel hose		commercial

Removal:

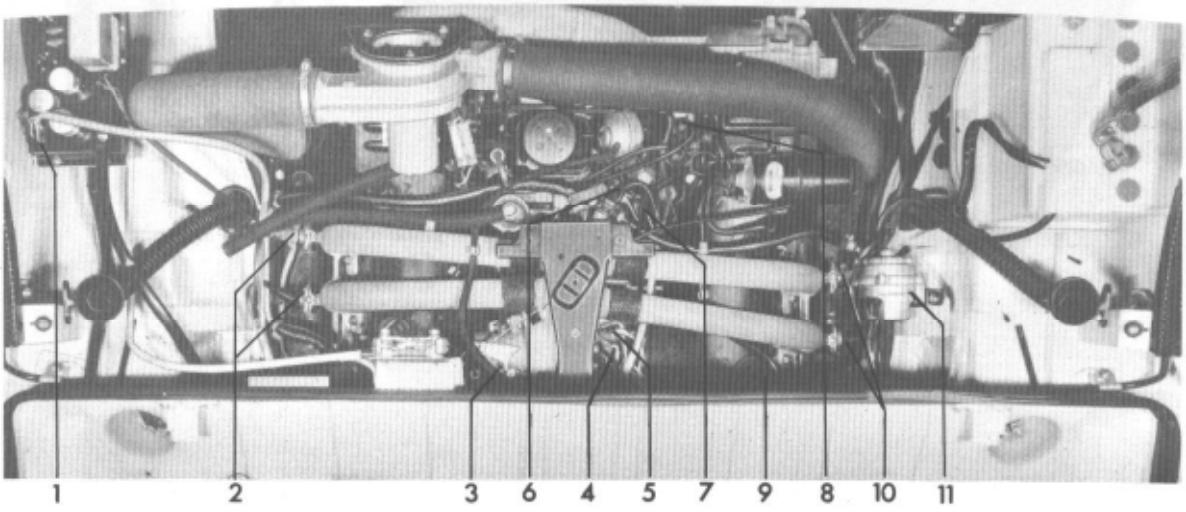
Remove and install engine and transmission together.

1 - Mark installation position of luggage compartment lid on hinges and remove lid.

2 - Disconnect ground connection cable on battery.

3 - Remove oil bath air filter and heating air hoses.

4 - Pull cables from gasolin injection components and place cables in high position.

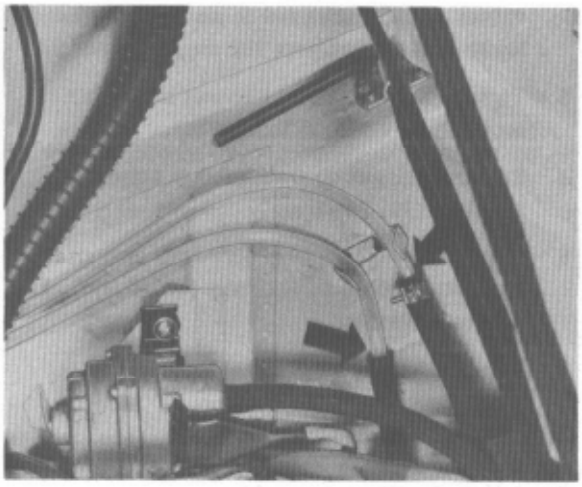


Connections for Gasolin Injection:

1 - Voltage supply relay 4-pole
2 - Two injection valves left 2-pole
3 - One throttle valve switch 4-pole
4 - Temperature feeler 1-pole
5 - Mass connections 3-pole
6 - Cold starting valve 2-pole
7 - Thermal switch 1-pole
8 - Ignition distributor release contact 3-pole
9 - Temperature feeler 1-pole
10 - Two injection valves right 2-pole
11 - Pressure feeler 4-pole

5 - Disconnect throttle valve cable and push through engine cover plate.

6 - Unbend metal plate and separate fuel hoses on connecting points near to pressure feeler and close.



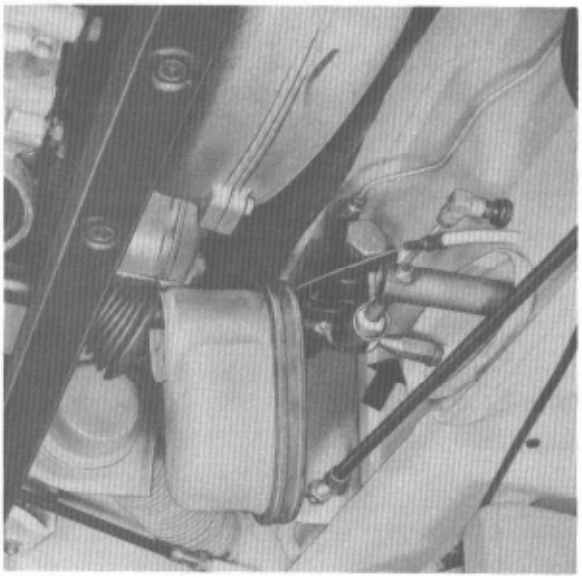
7 - Unscrew hex nut for attaching starter.

8 - Raise vehicle.

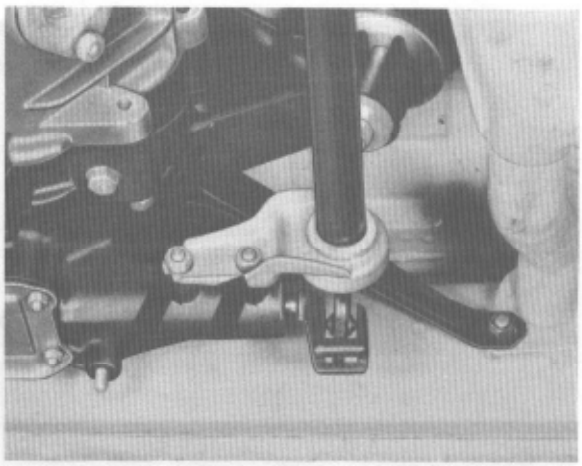
9 - Remove exhaust muffler molding.

10 - Remove lower components for warm air flow.

11 - Remove protective cab and unscrew shift rod holder.

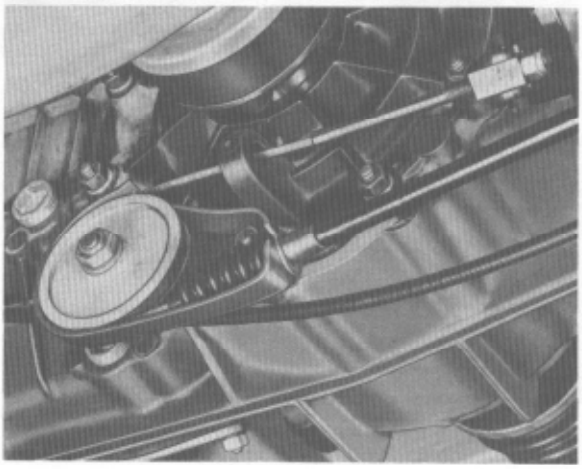


12 - Pull off protective cabs, unscrew hex bolt with ball (arrow) and remove rear shift rod.



13 - Remove heater flap box with hoses and cables.

14 - Loosen adjusting nut and hex nut for guide roller, bend holding plate and pull clutch cable forward.



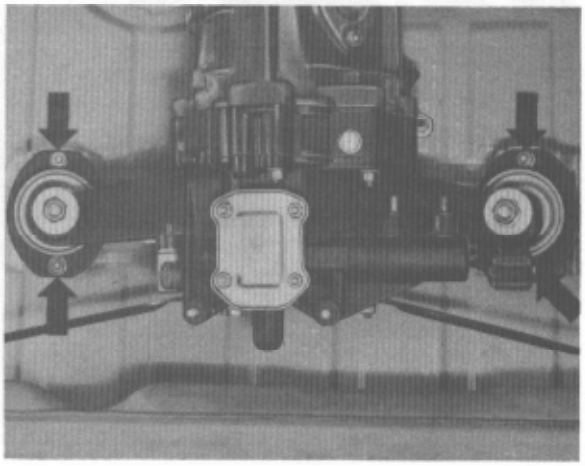
15 - Loosen drive shaft for speedometer and pull forward.

16 - Remove starter and loosen earth connection strap on luggage pan.

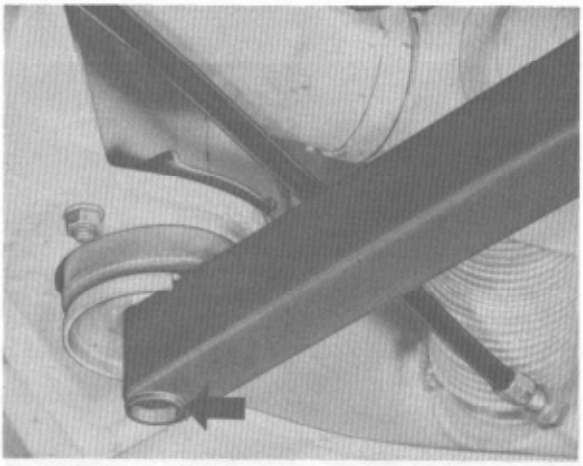
17 - Loosen universal shafts on transmission and suspend with wire hooks on body.

18 - Lower vehicle slightly. Place garage jack with engine support VW 612/4 in combination with transmission extension VW 612/3 under engine/transmission unit and raise again slightly.

19 - Unscrew 4 hex nut M 8 on transmission support.



20 - Unscrew hexagon socket screws M 10 left and right on engine mount.



21 - Carefully lower engine/transmission unit.

Installation:

During installation, the following points must be observed:

1 - Prior to attaching transmission to engine on vehicles with manual gearbox:

a - Check clutch throwout bearing for wear (do not wash out, only wipe off).

b - Coat guide bushing of throwout bearing, splining input shaft and bushing for starter shaft lightly with MOS_2-paste.

2 - When positioning the engine/transmission unit, be sure that the fuel lines near the injection valves are not squeezed in and that the hand brake cables are above the engine mount.

3 - Tighten hexagon socket screws on engine mount to 3.0 mkg (21.7 ft/lbs)

4 - Tighten hex nut on transmission support to 2.0 mkg (14.5 ft/lbs).

5 - Tighten hexagon socket screws of universal shaft attachment to 4.5 mkg (325 ft/lbs). Use new lock washers.

6 - Adjust free play of clutch.

7 - Pull engine compartment seal into proper position.

8 - Adjust throttle valve cable.

9 - Connect cable and protective rubber caps carefully.

For disassembly and assembly proceed as follows:

Disassembly

1 - Drain engine oil

2 - Remove exhaust muffler and heat exchanger

3 - Remove rear engine cover plate

4 - Remove intake distributor with intake pipe and injection valves

5 - Remove oil filler neck with oil vent

6 - Remove ignition distributor

7 - Remove front engine cover plate

8 - Remove impeller

9 - Remove cooling blower housing with alternator

10 - Remove engine mount

11 - Remove cylinder jackets with warm air guides front and rear

12 - Remove oil cooler

13 - Remove oil filter

14 - Remove oil pump

15 - Remove rocker arm shafts with push rods, protective tubes and tappets

16 - Remove cylinder heads

17 - Remove cylinders and pistons

18 - Remove clutch and flywheel

19 - Disassemble crankcase

20 - Remove camshaft and crankshaft with connecting rods

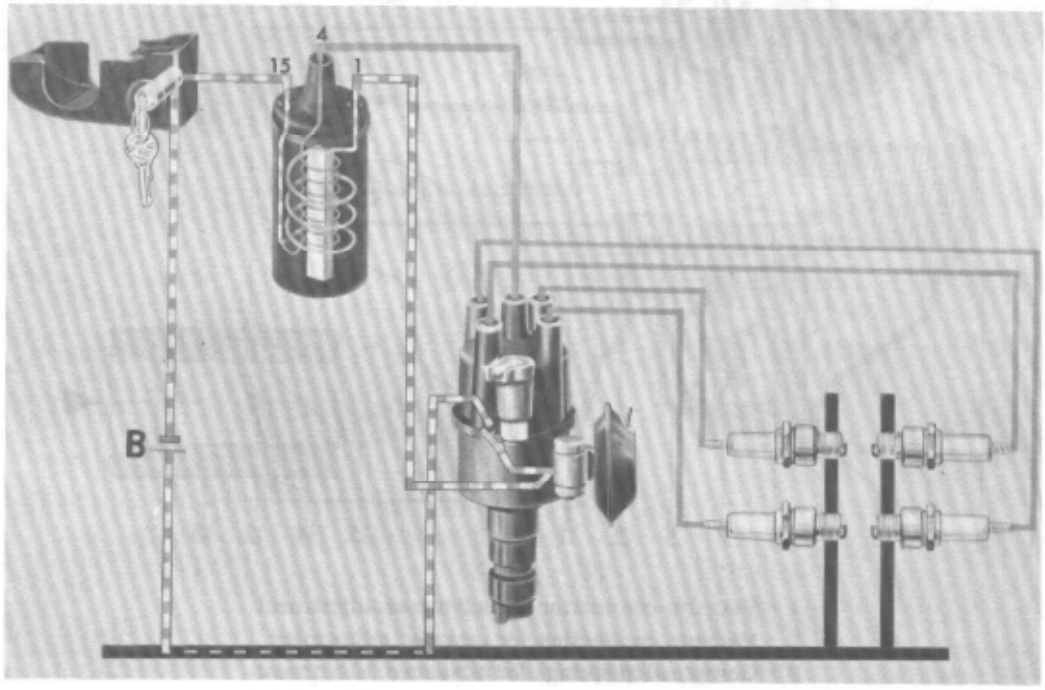
Assembly

For assembly proceed vice versa. The following sections provide instructions which should be particularly observed during assembly.

DESCRIPTION

Ignition System

The ignition system operates as a battery ignition with an ignition coil and an ignition distributor with automatic firing point adjustment. The battery voltage is transformed to the required ignition voltage of 15, 000 - 20, 000 volt in the ignition coil, similar to a transformer as follows: The distributor shaft with the contact breaker cams driven by the crankshaft opens the breaker contact shortly before the piston has attained an upper TDC in the cylinder to be fired. As a result, the current in the primary winding of the ignition coil is interrupted. The magnetic field established by the current suddenly collapses and thereby induces the ignition voltage in the secondary winding. This ignition voltage travels via an ignition cable to the rotor of the ignition distributor which, at this moment, is accurately opposite the contact in the ignition distributor head to which the spark plug of the cylinder to be ignited is connected. A spark can jump at the electrodes of the spark plug to ignite the compressed fuel/air mixture in the cylinder.



Ignition Coil

The ignition coil consists of a laminated iron core, which carries a primary winding consisting of a few windings of heavy wire outside and a secondary winding consisting of numerous windings of thin wires inside. The one end of the primary winding is connected to the battery together with the secondary winding via terminal 15. The other end of the primary winding is connected to ground via terminal 1 and the contact breaker points. The secondary winding leads to the high voltage line connection.

Ignition Distributor

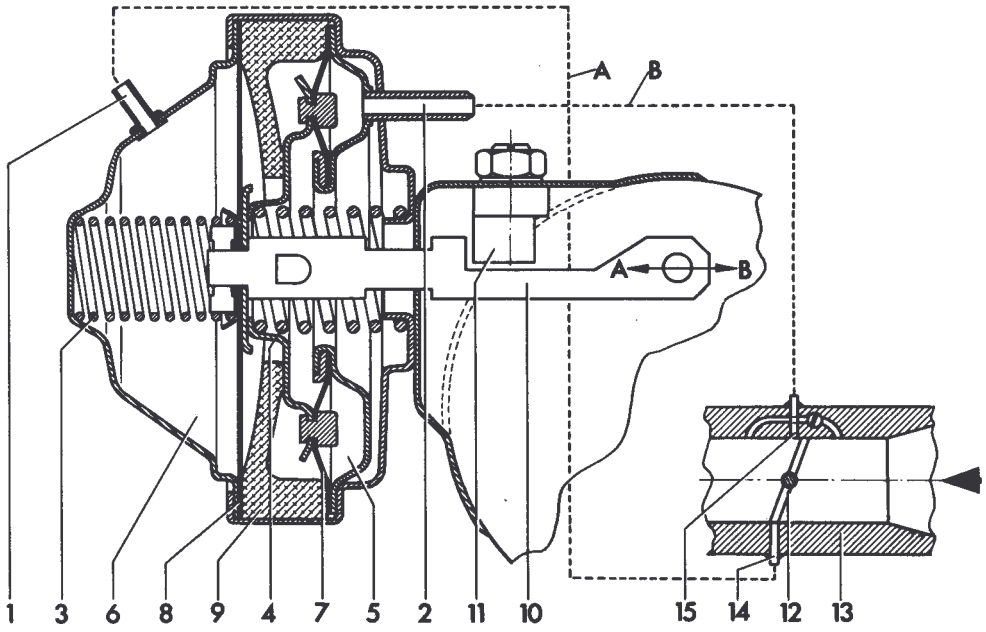
The distributor serves the purpose of feeding the ignition current to each of the four spark plugs in the correct sequence and at the accurate firing moment.

A centrifugal and double-acting combination vacuum control installed in the ignition distributor will automatically adjust the most favourable firing point for each speed and load of the engine.

a - Centrifugal Adjustment

Two flyweights on a supporting plate are forced outwards at increasing speed. This will turn the breaker cam in the direction of rotation of the drive shaft via a lever. Restoring springs will pull the flyweight in their rest position back when the speed drops.

b - Vacuum Adjustment



1 - Vacuum connection for advanced adjustment
2 - Vacuum connection for retarded adjustment
3 - Compression springs for advanced adjustment
4 - Compression springs for retarded adjustment
5 - Vacuum chamber (angular) for retarded adjustment
6 - Vacuum chamber for advanced adjustment
7 - Diaphragm for retarded adjustment
8 - Diaphragm for advanced adjustment
9 - Supporting ring
10 - Pull rod
11 - Adjusting cam for restricting retarded adjustment
12 - Throttle valve
13 - Intake duct (intake distributor)
14 - Vacuum tapping point advanced adjustment
15 - Vacuum tapping point retarded adjustment

The vacuum tapped in front of and behind the throttle valve is taken in separate lines to the two vacuum chambers inside the vacuum box. The diaphragm of these chambers actuate the contact breaker plate via a pull rod either with the direction of rotation of the distributor shaft in the direction of "retarded ignition" or against the direction of rotation in the direction of "advanced ignition".

The vacuum for the adjustment in the direction of "retarded ignition" required for idling speed is tapped behind the completely closed throttle valve with the vacuum acting on the contact breaker plate via the angular vacuum diaphragm.

When the throttle flap is opened, the vacuum in the tapping hole located in front of the throttle valve dominates and the contact breaker plate is adjusted in the direction of "advanced ignition".

Spark Plugs

Since spark plugs are constantly subject to very high electrical, mechanical, chemical and particulary thermic stresses, the startability, the idling speed characteristic, the acceleration and the maximum output of an engine depend to a great extent on the selection of the proper plug. In addition to the mechanical and electrical properties of a spark plug, the thermal value is of considerable importance. The thermal value indicates the heat-carrying capacity. The higher this capacity, the higher the resistance against spontaneous ignition (pre-ignition), and the lower the resistance against contamination. These characteristics are reversed in spark plugs with lower thermal values.

EQUIPMENT LIST

Ignition Coil

Type	Version	Remarks
914	022905115	12 volts

Ignition Distributor

Type	Type of Advance	Version
914	Centrifugal weights and double-action vacuum unit	022905205 D
914 from engine Nr. W 0007334	Centrifugal weights and double-action vacuum unit	022905205 E
914 from engine Nr. W 0039126	Centrifugal weights and double-action vacuum unit	022905205 F (same as E except with speed limiter)
914/1,8 (AFC)	Centrifugal weights and double-action vacuum unit	022905205 AA (with speed limiter)
914/1,8 (AFC)	Centrifugal weights and single-action vacuum unit	022905205 AB (without speed limiter)

Spark Plugs

Type	Spark Plug Type (*)	Remarks
914	BERU 175/14/3 BOSCH W 175 T2	M 14x1, 25x19,0 threads
914/1,8 from 1975 model	BERU 175/14/3 L BOSCH W 175 M 30	M 14x1, 25x19, 0 threads

(*) Or else VW-Approved spark plugs of appropriate heat range of other spark plug manufacturers.

MAINTENANCE

Ignition Coil:

Keep insulating cap clean and dry.

Ignition Distributor:

1 - Sight test of breaker contact for pitting and humps, replace if required.

2 - Grease slide piece of contact lever with some multi-purpose grease.

3 - Lubricate bearings of contact breaker and lube felt of distributor shaft with a few drops of engine oil.

4 - Sight test of distributor head for cleanliness, cracks and traces of leakage current, clean or replace, if required.

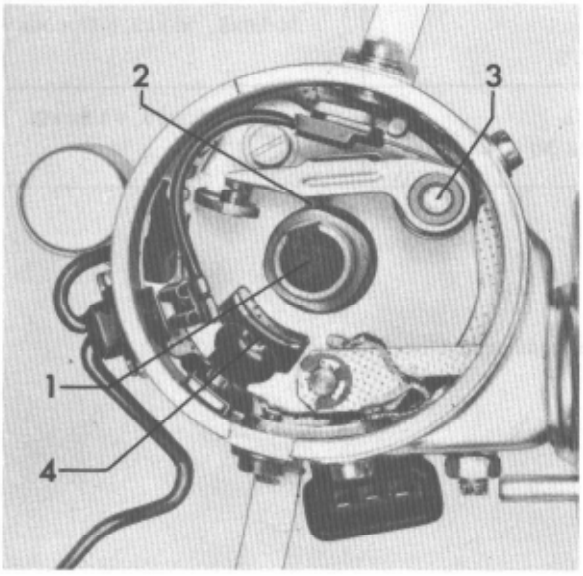
5 - Check timing angle and adjust.

6 - Check firing point adjustment and correct.

Spark Plugs:

Clean, check electrode gap and adjust.

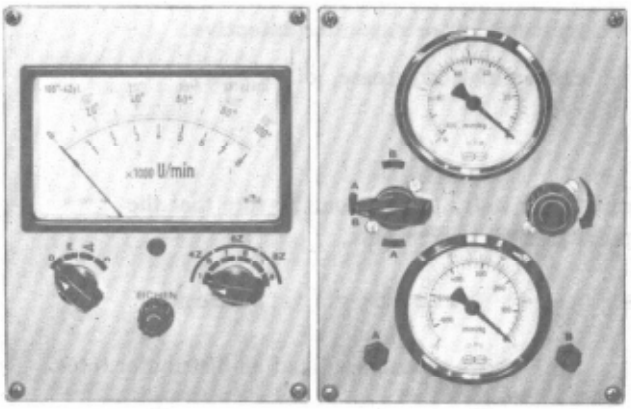
Special Instructions:



1 - Lubricate felt in ignition distributor shaft (1) and the bearings of the contact breaker (3) regularly with a few drops of engine oil.

2 - The slide piece on the contact breaker lever should be greased with multi-purpose grease. To prevent any grease from touching the contact surfaces, the grease should just cover the tip of a thin chip of wood and should be applied into the corner between the slide piece and the contact breaker lever (2) against the ball (4).

TESTING EQUIPMENT



2 3

4

1

No.	Designation	Special tool	Explanations
1	Stroboscopic lamp		
2	Timing angle speed tester		
3	Vacuum measuring instrument		Measuring ranges 0-100 and 0-600 mm mercury
4	Actuating device for carburetor	VW 798/2	Self-made

TESTING AND ADJUSTING CONTACT BREAKER POINTS

Testing Contact Breaker Points

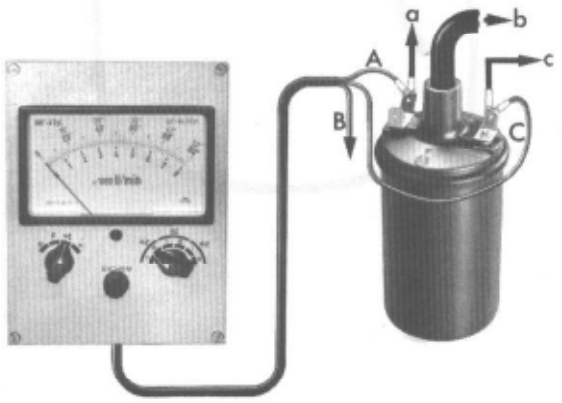
In the course of time, contact breaker points are subject to burn-off, which deveclops in the shape of small humps and pits (contact creep with DC). This will generally not interrupt operation. But if the contacts are badly burnt, the must be replaced. A sight test permits conclusions concerning faults in the ignition system.

1 - Pits and humps with bright contact surfaces:	normal wear.
2 - Greyish colour of contact surfaces:	insufficient contact gap and contact pressure (rated value 400-600 g).
3 - Bluish colour of contact surfaces:	Ignition coil or capacitor defective.
4 - Yellow or black porous scares:	contamination (grease, oil or dust).

Note

Prior to installing new contacts, blow out inside of distributor well. In addition, be sure that the distributor head is clean and dry inside and out, to prevent creeping currents.

Adjusting Breaker Contacts with Timing Angle Measuring Instrument



a - to ignition lock (15)
b - to ignition distributor (4)
c - to ignition distributor (1) (breaker contact)

A - red clip
B - black clip
C - green clip

1 - Remove distributor head an distributor rotor.

2 - Check breaker contact points. Badly burned off, soiled or heat-tinted contacts must be replaced.

3 - Set contact gap to approx 0.4 mm and make sure that the contact surfaces are plane in relation to each other.

Caution!
Contact surfaces should never be touched by grease or oil.

4 - Connect timing angle measuring instrument and calibrate.

Note concerning connection diagram:

When connecting other timing measuring instruments, be sure to read the respective Operating Instructions!

5 - Run engine at 1000 to 1200 rpm and read value.

Adjusting value: 44-50° or 49-55 %
Wear limit: 42-58° or 47-64 %

Wear limit means that the timing angle need not be adjusted as long as it is between 42 and 58° or 47 and 64 %.

6 - Run engine at 2000 to 2500 rpm and read values again.

Renember:

Small contact gap = large timing angle
Large contact gap = small timing angle

Evaluation of measuring results:

The contact gap should not be below 0.3 mm. If timing angle measurements show that a smaller gap would be required (measured with feeler gauge), a mechanical fault in the distributor is indicated.

If the speed is raised during measuring (to approx 2000-2500 rpm), the timing angle indicated should not change considerably (max. ±1°). Larger deviations indicate fault in the distributor, for example worn bearings or runout distributor cams.

Restless, jerky motions of the needle are generally caused by burned-out and unuseable contact breaker points.

Caution!

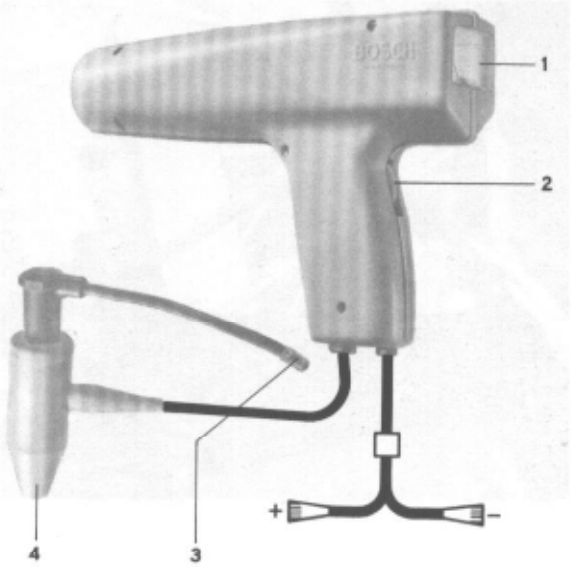
Upon adjustment of the braker contact points be sure to adjust the firing point again, since a change of the contact gap by 0.1 mm correspond to a change of the firing point by approx. 3° crankshaft.

ADJUSTMENT OF FIRING POINT WITH STROBOSCOPIC LAMP

1 - Prior to each adjustment of the firing point, be sure to check the timing angle of the contact breaker points and adjust, if required.

2 - Be sure that the engine oil temperature is between 60 and 70° C. (140 and 158° F).

3 - Check whether the markings are easily seen (mark by a colour stripe, if required).



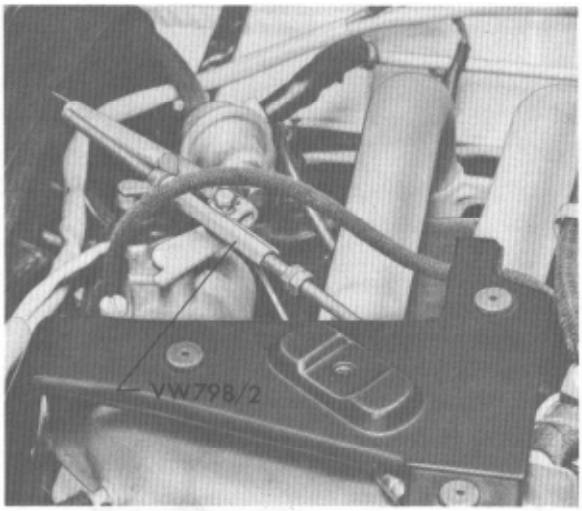
1 - Timing angle measuring instrument
2 - Adjusting wheel
3 - to ignition cable cylinder 1
4 - in ignition distributor cap cylinder 1

4 - Connect stroboscopic lamp and revolution counter in accordance with instructions of manufacturer (into ignition line of cylinder 1). On stroboscopic lamps with adjusting angle measuring instrument be sure that the adjusting wheel in the grip of the stroboscopic lamp is turned back against the zero stop.

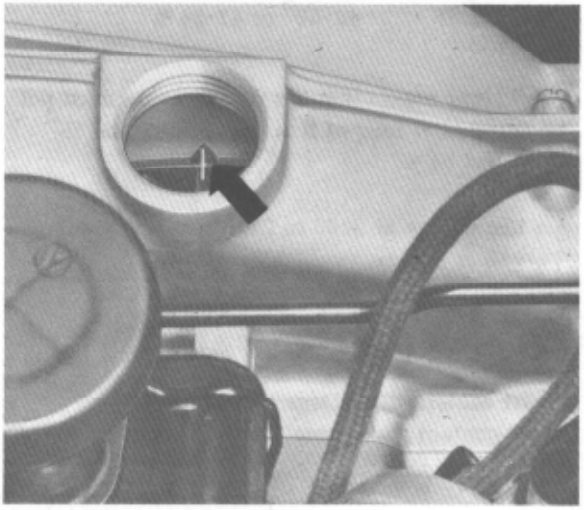
5 - Pull both vacuum hoses from vacuum box of distributor.

6 - Run engine at 3500 rpm and direct stroboscopic lamp against impeller.

The required speed can be adjusted by means of fixture VW 798/2 (self-made).



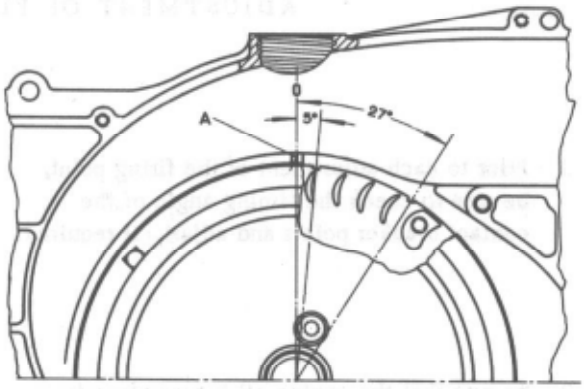
The firing point of all four cylinders is correctly adjusted when the red 27° mark on the impeller is in alignment with the reference mark on the cooling blower housing.



7 - Correct faulty adjustments by turning the ignition distributor.

Note:

The impeller has two notches. The indicate:



27° before TDC = red
5° before TDC = black
A = notch in cooling blower housing

The black 5° mark serve only for the basic adjustment of the firing point with the engine stopped following an assembly and checking the adjusting curves.

ADJUSTING IGNITION TIMING - 1.8 LITER ENGINES

The following ignition timing specifications for 1.8 liter, 1974-model engines differ from those shown on pages 2.3 - 1/3 and 1/4:

1. With vacuum hoses detached run engine at idle speed and note the following engine rpm:

   AFC injection engine: 800 - 900 rpm

   1975 Models with AFC fuel injected engines also have a distributor with a single action vacuum control.

2. Turn distributor until the mark on the blower impeller lines up with the notch on the cooling blower housing when flashed with the stroboscopic timing light.

   When so adjusted, the correct ignition timing of 7.5° BTC is attained.

(The ignition advance monitor, built into the stroboscopic timing light, must be switched off during this test.)

The blower impeller on the 1.8 liter engines has only the 7.5° timing mark.

CHECKING AUTOMATIC ADJUSTMENT OF FIRING POINT

Checking the Centrifugal Timer

The effect of the centrifugal timer can be observed by turning the attached distributor rotor manually and clockwise. Upon release, the rotor should automatically return to its starting position, the opposite stop. If not, the conclusion would be that the centrifugal timer is either contaminated or the spring tension of the restoring springs has declined.

The centrifugal adjustment of the built-in ignition distributor can be tested by means of an adjusting angle measuring instrument in combination with a revolution counter:

Note

An accurate inspection of the ignition adjusting curve is possible only on an ignition distributor test bench.

1 - Connect stroboscopic lamp with adjusting angle measuring device or adjusting angle measuring instrument, as well as the revolution counter, in accordance with the instruction of the pertinent Operating Instructions of the respective manufacturer.

1 - Adjusting angle measuring instrument
2 - Adjusting wheel
3 - to ignition cable cylinder 1
4 - in ignition distributor cap cylinder 1

2 - Check basic adjustment of firing point and correct, if required.

3 - Pull both vacuum hoses from vacuum box of ignition distributor.

4 - Run engine at max. 900 rpm and flash black 5^{o} mark.

5 - Determine the deviations from the basic ignition adjustment resulting from the absent vacuum connections by means of the adjusting wheel on the adjusting angle measuring instrument. Renember difference.

6 - Increase speed slowly. The begin of the adjustment is indicated by the shifting of the notch. For rated values refer to 2.3-2/3.

7 - Adjust speed to values given on table. Use adjusting wheel on adjusting angle measuring instrument to "return the notch to mark in blower housing". Read adjustment in degrees on measuring instrument. Deduction of the difference (item 5) will show the centrifugal adjustment.

8 - If the test values are not in agreement with the rated values, repair the adjusting device of the ignition distributor (make operable, replace weak springs) or replace distributor.

Checking the Vacuum Control Unit

The effect of the vacuum control unit can be checked by placing the previously removed vacuum hoses back on the engine now running at increased speed. The engine speed should rise considerably.

Caution!

On double-acting vacuum control units the advanced and retarded adjustment is checked separately, with the vaccum hose being pulled off the box which is not checked!

Vacuum adjustment "retarded"

1 - Connect stroboscopic lamp with adjusting angle measuring device and switch vacuum tester between the "retard box" of the ignition distributor and vacuum line to carburetor.

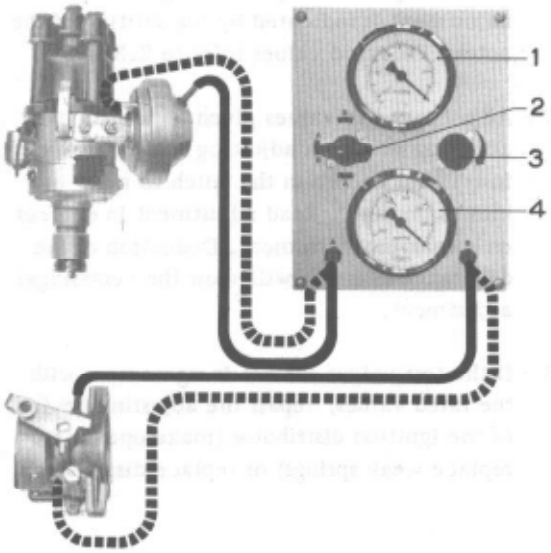
2 - Pull vacuum hoses from vacuum box.

3 - Run engine at 3500 rpm.

4 - Flash black mark. Read adjusting angle on adjusting angle measuring device and renember.

5 - Place vacuum hose for advance box on retard box.

6 - The difference between the adjusting angle now indicated and the remembered value is the vacuum adjustment "retarded".



1 - Vacuum indication 0-100 mm mercury
2 - Change-over valve
3 - Control valve
4 - Vacuum indication 0-600 mm mercury

Vacuum adjustment "advanced"

1 - Connect vacuum tester between "advance box" and vacuum line.

2 - Pull vacuum line from "retard box".

3 - Run engine at 3500 rpm and flash black mark (vacuum control valve must be opened).

4 - Read adjusting angle on adjusting angle measuring instrument and remember.

5 - Close vacuum control valve.

6 - The difference between the adjusting angle now indicated an the remembered value is the vacuum adjustment "advance".

7 - If differences from the values stated in the table are shown during the test, proceed with the following checkup:

a - Check contact breaker plate for smooth operation, disassemble distributor, if required, and make contact breaker plate operable.

b - Check vacuum line and vacuum box for leaks and replace, if required.

IGNITION TIMING DATA FOR INSTALLED DISTRIBUTORS

(Component identification is shown in tables on page 2.2-1/1)

Distributor Type	Beginning RPM	Centrifugal Change		Ending RPM Degrees	Vacuum Change		Direction of timing change
		RPM Degrees	RPM Degrees		Beginning mm Hg	Ending mm Hg Degrees	
022 905 205 D	1050-1200	1500	2000	2900	100-130	200 11-14	Advanced
		14-17	17-20	22-27	60-100	150 8-12	Retarded
022 905 205 E+F	700-1050	1500	2000	3000	100-130	200 11-14	Advanced
		10-15	14-19	22-27	60-100	150 8-12	Retarded
022 905 205 J	700-1100	1500		3000	100-130	180-200 11-13	Advanced
		10-15		22-27			

NOTE:

Engine speed and degree values are with reference to the crankshaft.

Read ignition timing changes in relation to the white notch, i.e., TDC mark.

Check timing advance and retard separately, with vacuum hose removed. Observe instructions on page 2.3-2/1.

Beginning with engine No. W 0039 126 all distributors are equipped with a speed-limiting rotor. The speed limiter becomes effective at 5750 - 5950 rpm by short-circuiting the rotor to ground.

Checking Centrifugal Advance - 1.8 liter engines beginning with 1974 models

1. Remove vacuum hoses and check ignition timing, readjusting if necessary.

2. Increase rpm slowly and adjust to the first specification in the table.

3. Turn adjusting knob in tester until the mark on the blower impeller is even with the notch in the housing.

   Add 7.5° to the timing angle shown in the tester and compare the sum of both with the specifications shown in the table.

   Proceed by setting the next higher rpm and continuing in same way.

Checking Vacuum Advance - 1.8 liter engines beginning with 1974 models

Accomplish the test as outlined on page 2.3-2/2. However, the single 7.5° mark is to be used in the 1.8 liter engines instead of the mentioned black mark.

4 - Read adjusting angle on adjusting angle measuring instrument and remember.

5 - Close vacuum control valve.

6 - The difference between the adjusting angle now indicated an the remembered value is the vacuum adjustment "advance".

7 - If differences from the values stated in the table are shown during the test, proceed with the following checkup:

a - Check contact breaker plate for smooth operation, disassemble distributor, if required, and make contact breaker plate operable.

b - Check vacuum line and vacuum box for leaks and replace, if required.

ADJUSTING VALUES FOR INSTALLED IGNITION DISTRIBUTOR

(For equipment lists refer to 2.2-1/1)

Ignition distributor type	Centrifugal adjustment begin rpm	rpm degree	rpm degree	end rpm degree	Vacuum adjustment begin mm mercury	end mm mercury	direction of adjustment
022 905 205 A	1000-1200	1500	2200	2900	100-130	190 12-15	advanced
		9-12	15-18	22-25	60-100	150 8-10	retarded
022 905 205 B	1000-1200	1500	2100	2900	100-130	190 12-15	advanced
		14-17	14-17	22-25	60-100	150 8-10	retarded

Note:

All data on speed an degress are with reference to crankshaft.

Use black mark for checking the adjustment.

Check advanced and retarded adjustment of vacuum control unit separately, pulling the hose from the box not tested, observe instructions on page 2.3-2/1!

TIMING ADVANCE SPECIFICATIONS FOR INSTALLED DISTRIBUTORS 1.8 LITER ENGINES BEGINNING WITH 1974 MODELS

Distributor	Beginning RPM Degrees	Centrifugal Advance		Termination RPM Degrees	Beginning mbar (mmHG)	Termination mbar (mmHG) Degrees	Direction of Change
		RPM Degrees	RPM Degrees				
022 905 205AA	980 - 1180	1500 14,5 - 19	2500 23,5 - 26,5	3400 29 - 32	120 - 160 (90-120)	240 - 267 (180 - 200) 9-12	advance
022 905 205 AB	980 - 1180	1500 14,5-19	2500 23,5-26,5	3400 29 - 32	73 - 160 (55-120)	193 - 254 (145-190)	retard
					73 - 160 (55-120)	193 - 254 145-190)	retard

TEST IN THE EVENT OF FAULTS

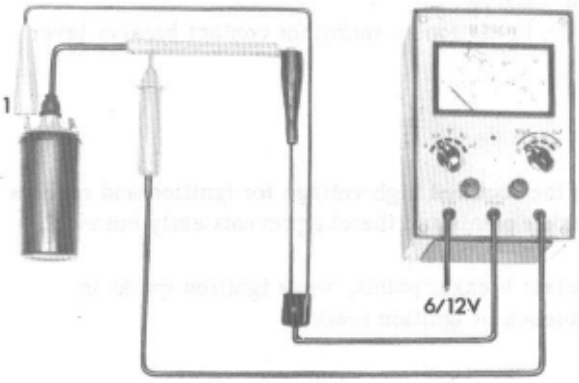
Testing the Ignition Coil

1 - Clean insulating cap and keep dry to eliminate arcing and creeping currents.

2 - Check flat plug for tight seat to eliminate voltage losses.

3 - Check ignition output with ignition coil tester.

Connect tester as shown in illustration. Operation is shown in the pertinent Operating Instructions.



Operation:

The high voltage end of the ignition coil (terminal 4) is loaded with a resistance and operated with a constant impulse sequence of the test instrument. The ignition voltage resulting from this load is measured. An approximate value is 18, 000 V (18 kV .

4 - If no ignition coil tester is available, test as follows:

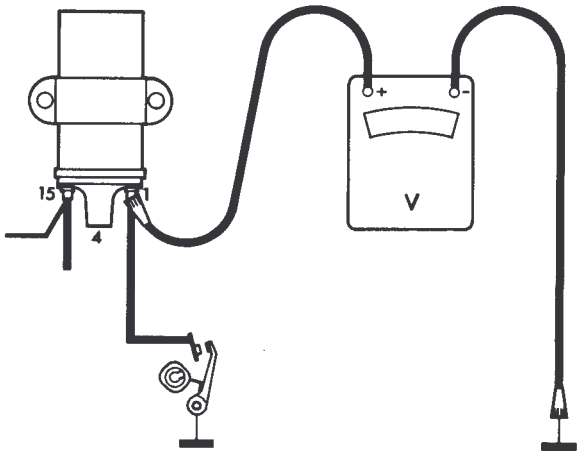
First loosen cable from terminal 4 on ignition distributor cap (central cable) and hold against an earth connection at a distance of approx. 10 mm (0.4 inches). The test should be made with insulating pliers. When cranking the engine with the starter, a spark should jump from the cable end to mass. When there is no spark, first measure voltage on terminal 15 of ignition coil with a voltmeter. In a 12 volt system, the voltage should be at least 9 volts.

If the voltage is above that value, check with voltmeter or an inspection lamp on terminal 1 of ignition coil (connection to ignition distributor) whether no voltage is available with the contacts closed and voltage with the contacts open. If the voltmeter does not deflect even with the contact breaker points open (ignition distributor has no short circuit), the ignition coil is interrupted an should be replaced.

Testing the Contact Breaker Points (electrically)

Connect voltmeter to terminal 1 of ignition coil and to mass. Crank engine until the contact breaker points in the ignition distributor are closed. The indicator should deflect. Open contact breaker points - the indicator should not deflect. If the indicator does not deflect with the contact breaker points closed, the contacts are either contaminated or burned.

But if the indicator deflects with the contacts opened the ignition distributor has a short circuit. Check the following points:



1 - Capacitor
2 - Cable passage
3 - Cable
4 - Insulation on spring for contact breaker lever

Checking the Capacitor

The capacitor has a considerable influence for attaining the required high voltage for ignition and reduces simultaneously sparking when separating the contact breaker points and thereby prevents early burn-off.

A defective capacitor is indicated by heavily burned contact breaker points, weak ignition sparks in combination with starting troubles or by the complete absence of ignition sparks.

Defective ignition capacitors are extremely rare.

Capacitors can be checked for shorts by means of an inspection lamp:

Pull cable 1 to ignition distributor on ignition coil. Connect an inspection lamp between terminal 15 of ignition coil and cable 1 on ignition distributor. With the contact breaker points open and the ignition switched on, the lamp should not light up, if it does, the capacitor has a short.

There are testers in which in addition the insulation resistance, the capacity and the series resistance on the capacitor can be determined. When such testers are used, always observe pertinent Operation Instructions.

For replacement use only capacitors of the specified type, since capacitors with different capacities may have unfavourable influence on breaker contact points (see Spare Parts Catalogue .

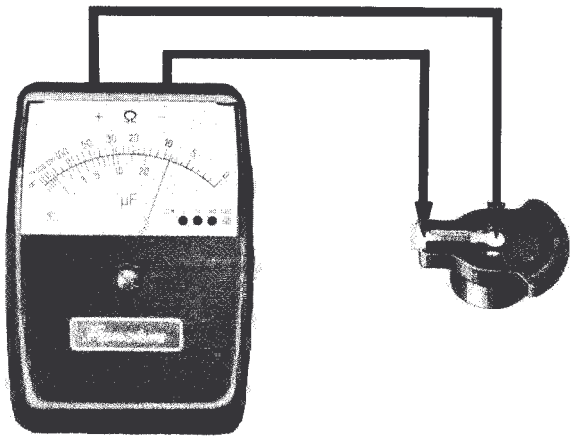
Checking Suppression Resistors

The resistance of ignition lines with copper core is too low to suit the radio suppression regulations of some countries. For this reason, suppression resistors are installed into spark plugs and into distributor rotors. In addition, upon installation of an automobile radio the plugs of the ignition lines are suppressed in many cases.

These suppression resistors may be the cause for misfiring.

1 - Checking distributor rotor with an ohmmeter.

The suppressed distributor rotor has a cast-in resistor which may be of a size of up to 10 k ohm. If a higher value is shown, replace distributor rotor.

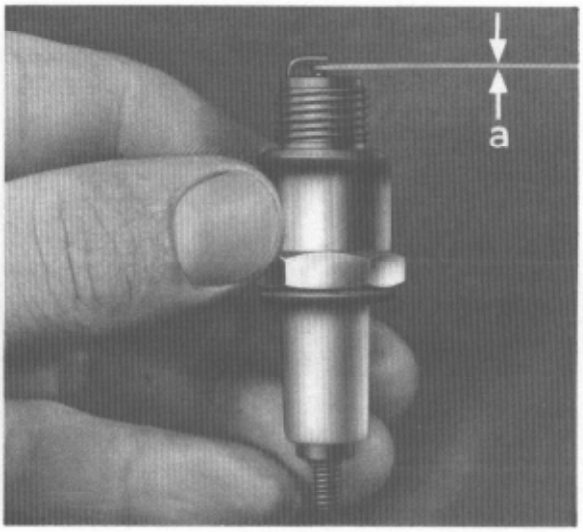


2 - Checking spark plugs and ignition line plugs with an ohmmeter.

The resistance rating of a spark plug or ignition line plug may be max 5-10 k ohm.

CHECKING DISASSEMBLED COMPONENTS OF IGNITION SYSTEM

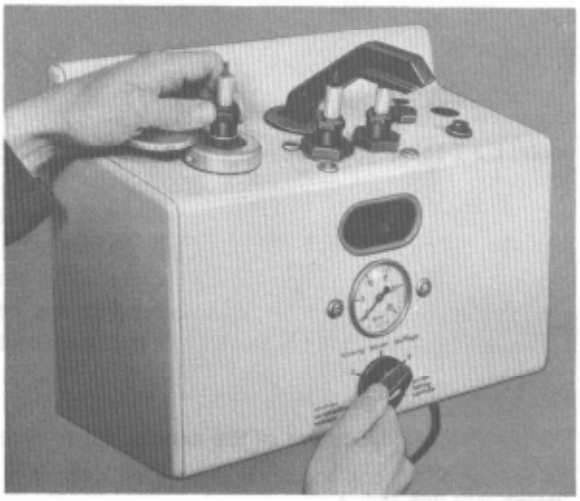
Checking Spark Plugs



In operation, the electrode gap of the spark plugs will increase by natural burn-off. If the gap is too large, the plug may fail. In addition, there may be ignition troubles by contaminated plugs.

The electrode gap is measured with a spark plug gauge and the earth electrode is bent to the specified value "a".

"a" = 0.7 mm (.0275 inch)



Spark plugs are checked for perfect operation by means of testers, in which the spark must jump under pressure (6-8 kg/cm^2 = 85-122 psi) and can be observed through a sight hole.

Most of these equipments can also be used for cleaning spark plugs. An older principle is using a sand jet. Modern equipment uses special cleaning agents.

Contaminated plugs may be cleaned only with a cleaning unit. Steel brushes and similar tools are not suited for cleaning spark plugs.

Checking the Ignition Distributor on Test Bench

The cam offset, the vacuum adjustment, the centrifugal adjustment and the timing angle can be checked on an ignition timer test bench. Various test benches of this type are available. The following equipment applies to all of them:

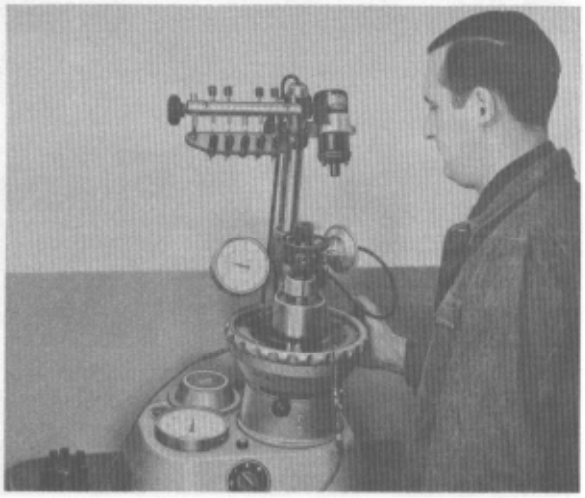
Controllable drive motor, revolution counter, vacuum pump and vacuum measuring instrument, which must have an additional measuring range of 0-100 mm mercury for ignition distributors installed in VW engines.

The foolowing test sequence will be suitable:

1 - Attach ignition distributor, watch out for quiet operation.

2 - Test timing angle (refer to 2.3-1/2). If required, adjust contact gap and thereby the timing angle.

3 - Set speed to max. 500 rpm, watching out that the centrifugal adjustment has not yet begun.



4 - Check vacuum boxes for leaks. With the vacuum line closed, a vacuum of 100 mm mercury should remain constant for approx. 1 minute.

5 - When the vacuum drops, check advanced and retarded adjustment separately, keeping the connection of the untested box open. Adjust as many points of vacuum curve as possible and read the actually attained adjusting values on scale of test bench. The measured values should be within the hatched fields of the adjusting curve. If they are outside, repeat measurements with a new vacuum box.

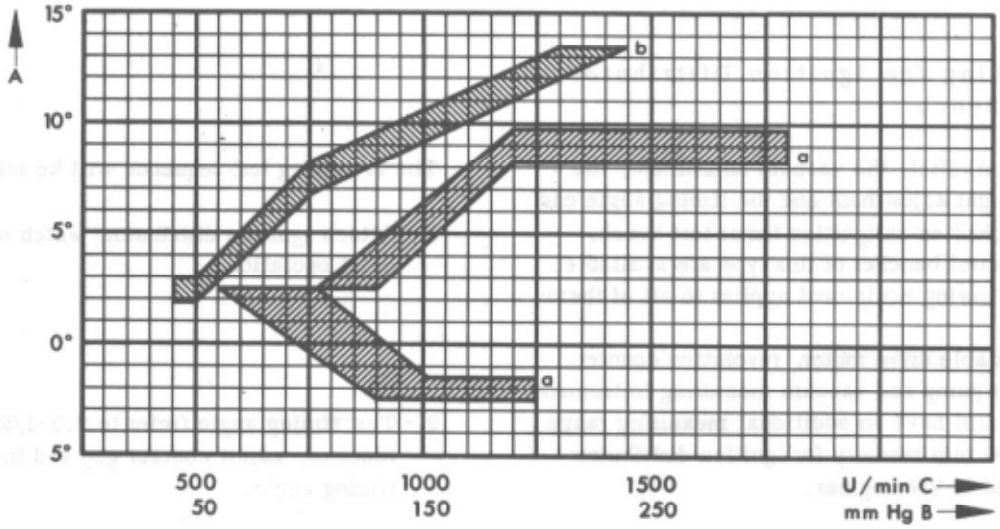
6 - Check speed-dependent adjusting curve. Here too, the measured values should remain within the hatched fields of the adjusting curve.

ADJUSTING CURVES FOR REMOVED IGNITION DISTRIBUTORS

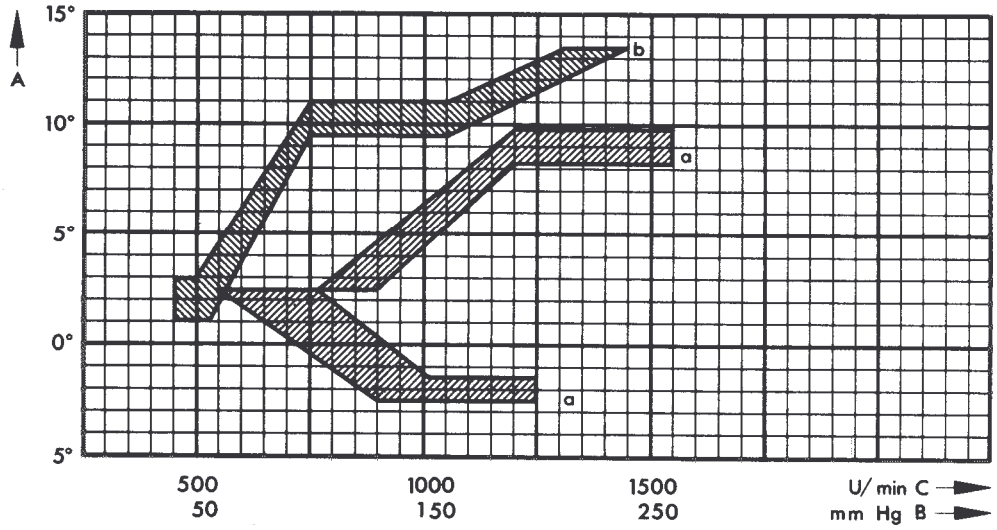
A - Adjustment in degrees distributor shaft
B - Vacuum in mm mercury
C - rpm on distributor shaft
a - Vacuum adjusting curve
b - Centrifugal adjusting curve

The adjustment of the centrifugal force is measured starting from 1500 rpm with declining speed.

Bosch 022 905 205 A



Bosch 022 905 205 B



TOOLS

No.	Designation	Special Tool	Explanations
1	Puller for starter bushing	VW 228b	

REMOVAL AND INSTALLATION OF IGNITION DISTRIBUTOR

Removal

1 - Disconnect both cables between ignition coil and ignition distributor. Pull vacuum hoses from vacuum box.

2 - Remove distributor head.

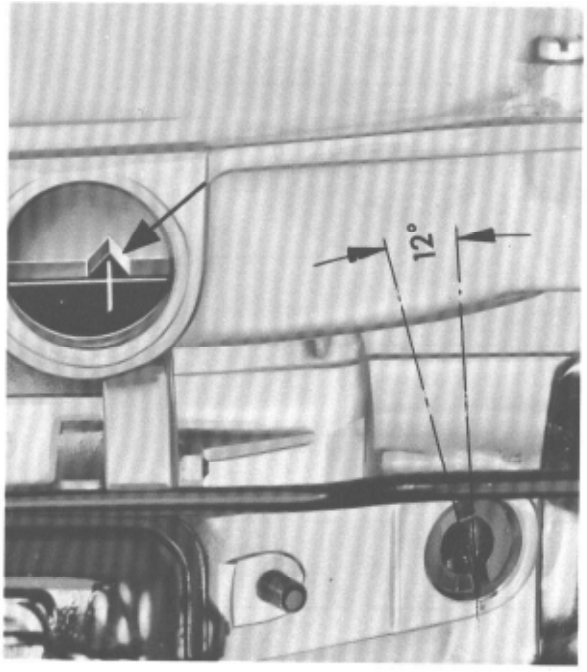
3 - Loosen screw on holder for ignition distributor.

4 - Remove ignition distributor.

5 - Cover opening in crankcase.

Installation

1 - Adjust Cylinder 1 to firing point. The white notch, i.e., the TDC mark, should coincide with the reference mark. The offset slot in the top end of the distributor drive shaft should be at an angle of approx 12° in relation to the longitudinal axis of the engine; the smaller sector faces towards vehicle outside.

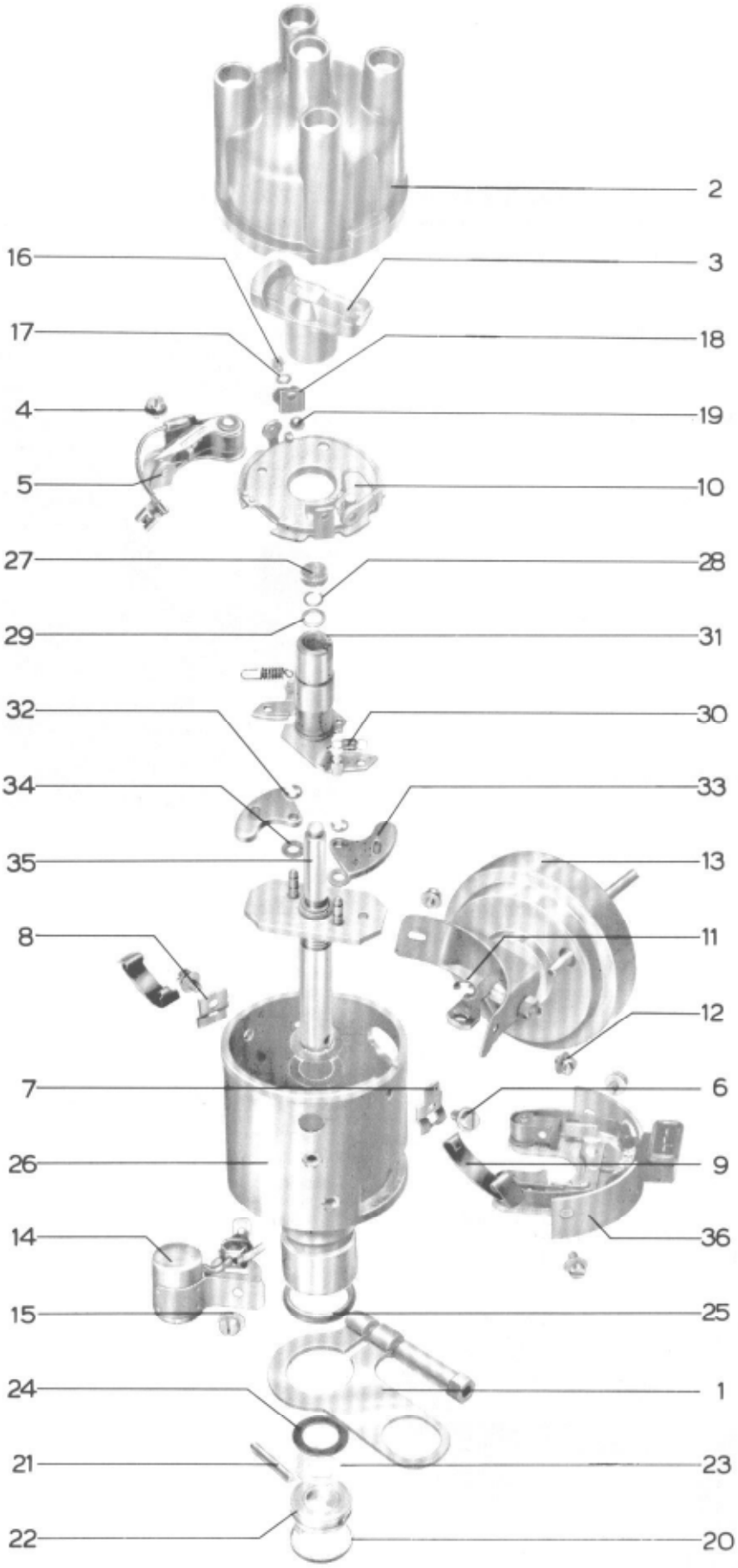


2 - Turn distributor rotor on ignition distributor until it points toward the mark for cylinder 1 on distributor housing.

3 - Insert ignition distributor.

4 - Adjust ignition.

When installing the distributor in 1.8-liter engines, beginning with the 1974 models, use the 7.5° mark instead of the indicated TDC mark.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No.	Designation	Each	Observe during: Removal	Observe during: Installation	Special Instr.
1	Holder for ignition distributor	1			
2	Ignition distributor head	1		Watch out for cracks, traces of creeping currents and for perfect condition of carbon	
3	Distributor rotor	1			
4	Fastening screw for contact breaker	1			
5	Contact breaker	1		Replace, adjust gap	
6	Cheesehead screw	2			
7	Fastening plate with lug for holding spring	1		Install close to cutout in ignition distributor housing	
8	Fastening plate for holding spring	1			
9	Holding spring	2			
10	Contact breaker plate	1		Grease with multi-purpose grease on running surfaces	
11	Circlip for pull rod attachment	1			
12	Cheesehead screw	2			
13	Vacuum box	1		Check for leaks	
14	Capacitor	1			2.3-3/2
15	Cheesehead screw	1			
16	Cheesehead screw	1			
17	Spring ring	1			
18	Holding spring for ball	1		Grease with multi-purpose grease	
19	Ball	1			
20	Circlip for driver claw	1			
21	Pin for driver claw	1			
22	Driver claw	1		Watch out for correct position	2.4-2/2
23	Compensating washer 0.1 mm	1		Should rest against claw	
24	Fiber washer	1		Should rest against distributor housing	
25	Rubber sealing ring	1		Replace	
26	Distributor housing	1	Do not wash bushings w. gasoline		
27	Felt washer	1		Soak with engine oil	

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

DISASSEMBLY AND ASSEMBLY OF IGNITION DISTRIBUTOR

Disassembly

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

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

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

Checkup

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

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

Assembly

The following points must be observed:

1 - Lubricate distributor shaft.

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

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

4 - Attach fly weights acc. to installation marks.

REMOVAL AND INSTALLATION OF IGNITION DISTRIBUTOR DRIVE SHAFT

Removal

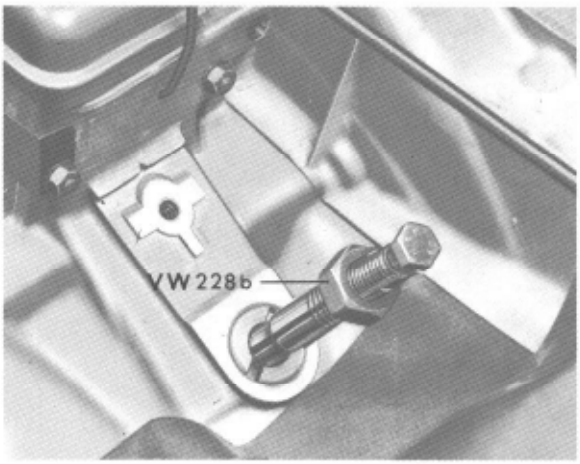
1 - Remove spacing spring from drive shaft.

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

3 - Remove washer from under ignition distributor drive shaft.

(Caution! Do not drop!)

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



Installation

The following points must be observed:

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

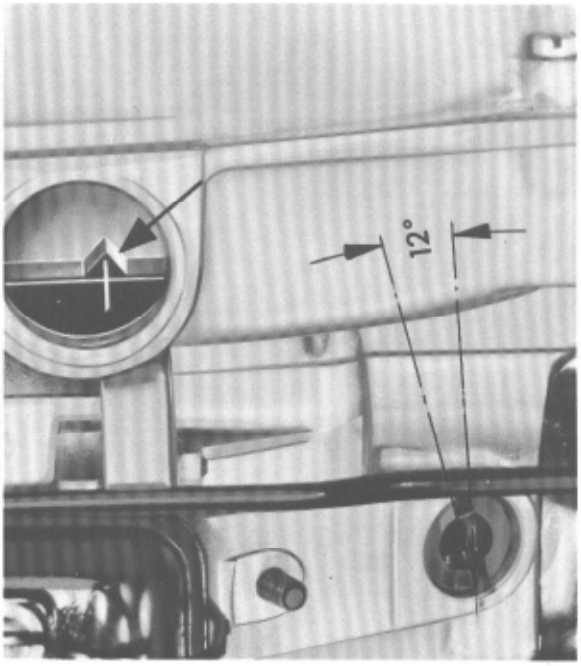
2 - Check wahers under ignition distributor drive shaft for wear; use new washers, if required.

3 - Adjust cylinder 1 to firing point.

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

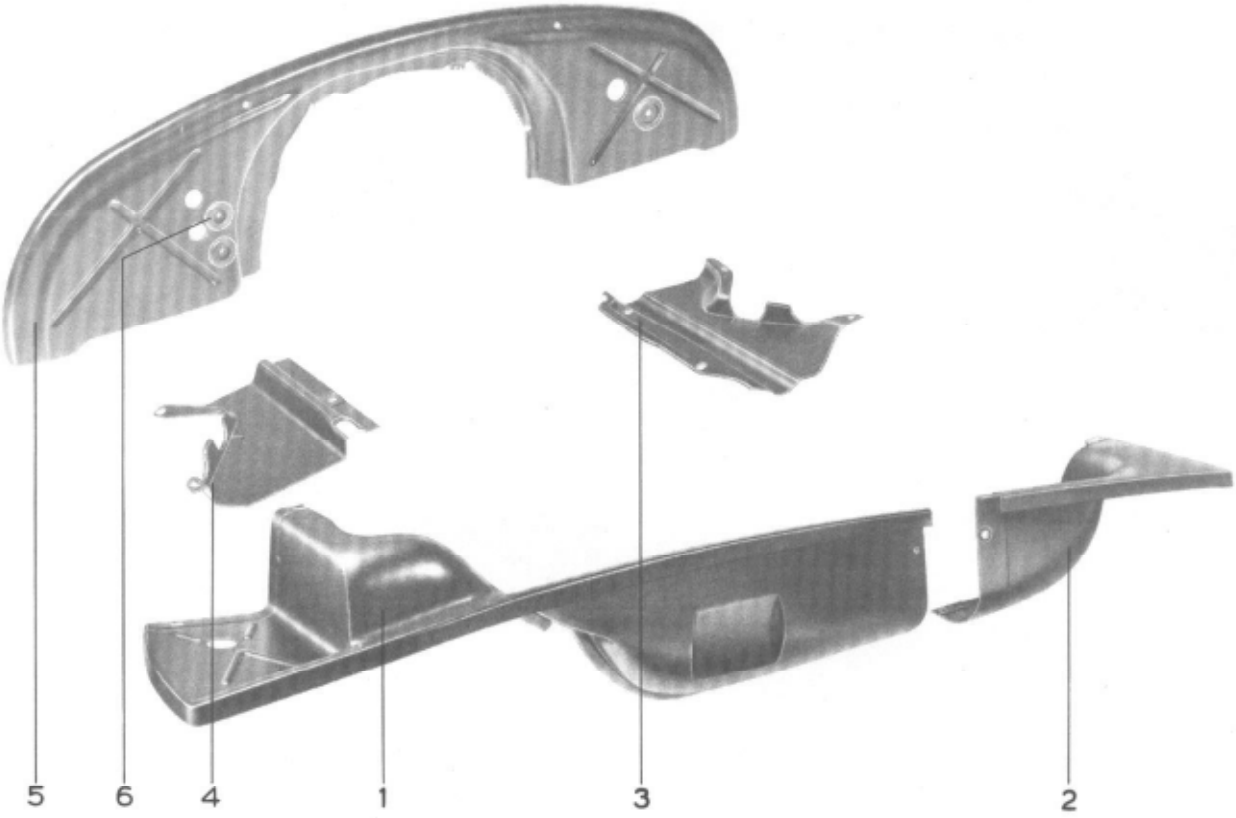
4 - Install ignition distributor drive shaft.

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

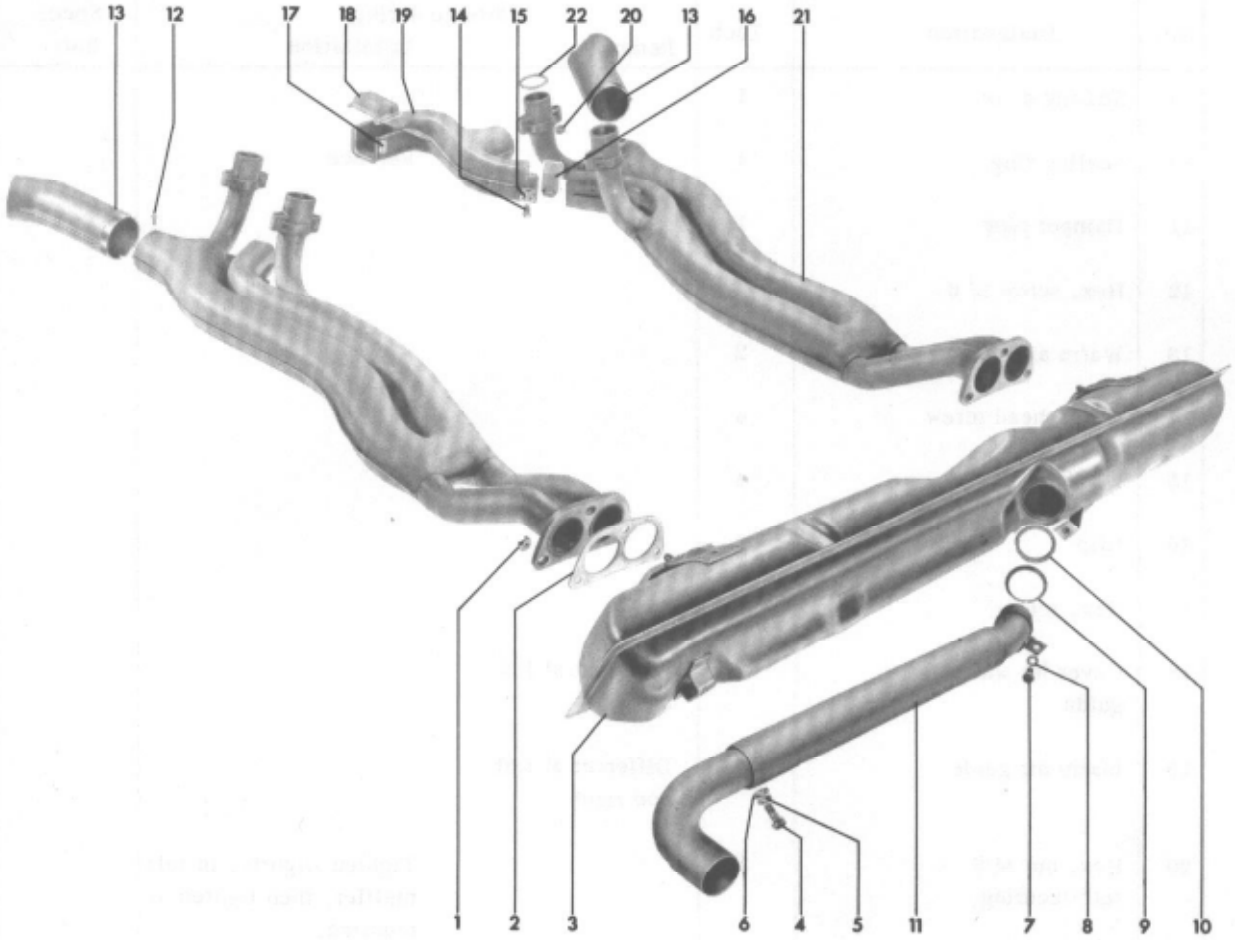


5 - Install spacing spring.

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

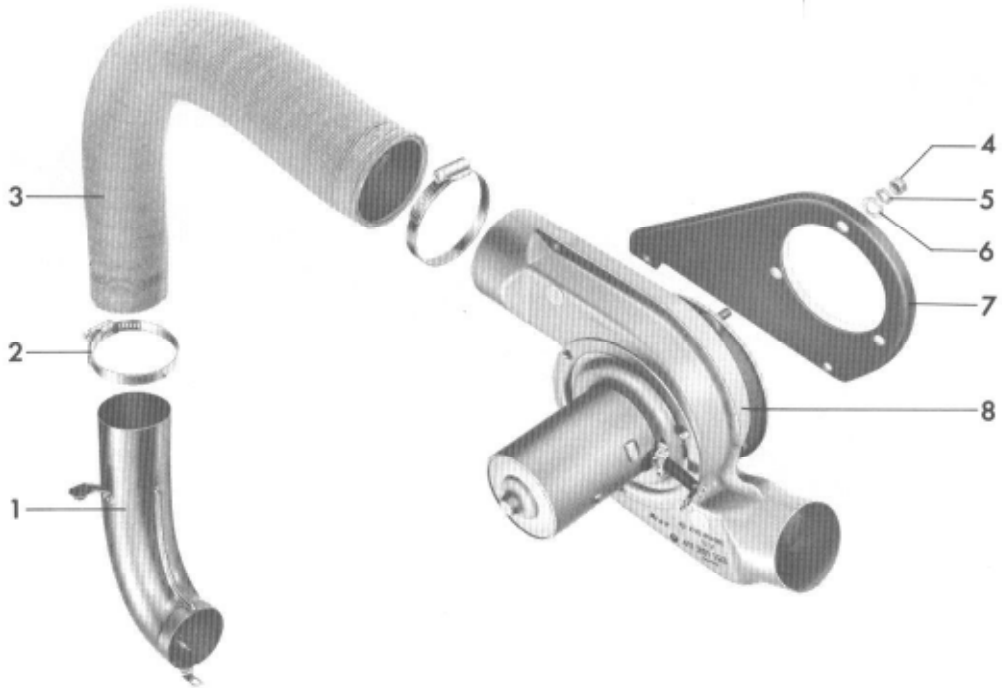


No.	Designation	Each	Observe during: Removal / Installation	Special Instr.
1	Engine cover plate front right	1		
2	Engine cover plate front left	1		
3	Warm air guide bottom left	1		
4	Warm air guide bottom right	1		
5	Engine cover plate rear	1		
6	Bushing	3		



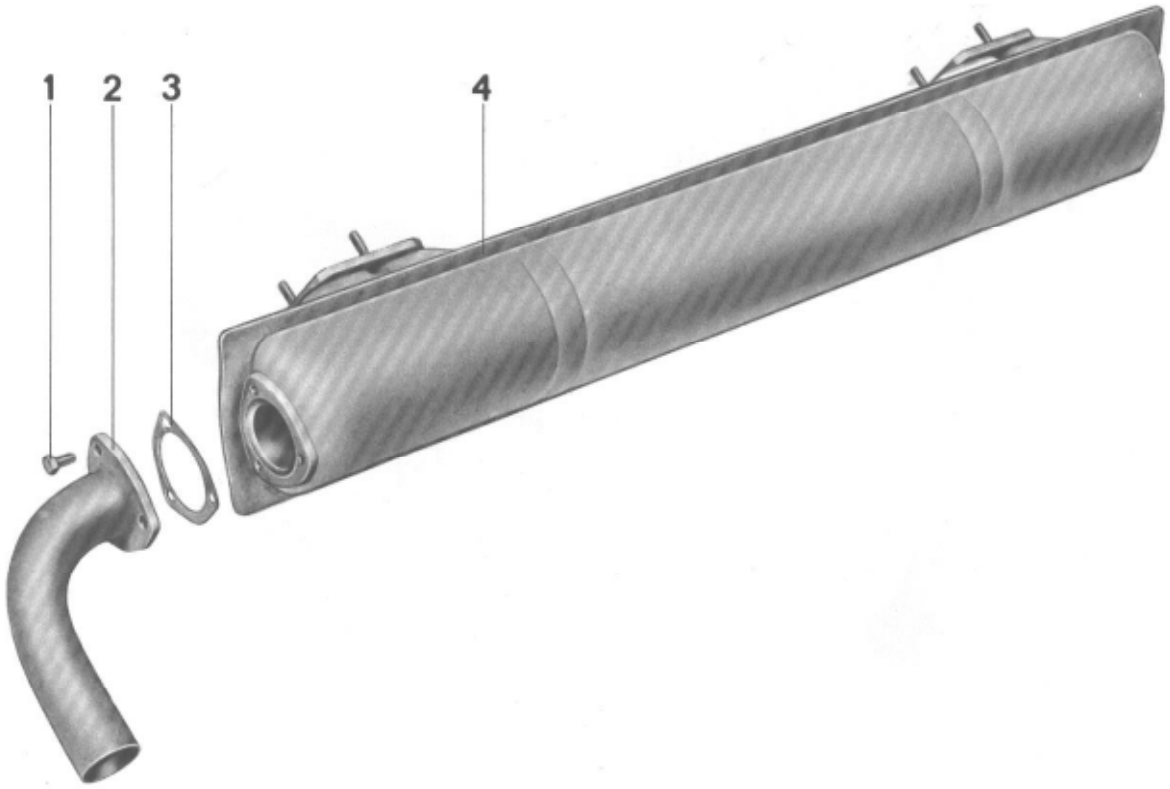
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. nut M 8, self-locking	6			
2	Seal	2		Replace	
3	Exhaust muffler	1	Exchange if heavily rusted		
4	Hex. screw M 6	1			
5	Spring washer	1			
6	Washer	1			
7	Hex. screw M 6	1			
8	Washer	1			

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

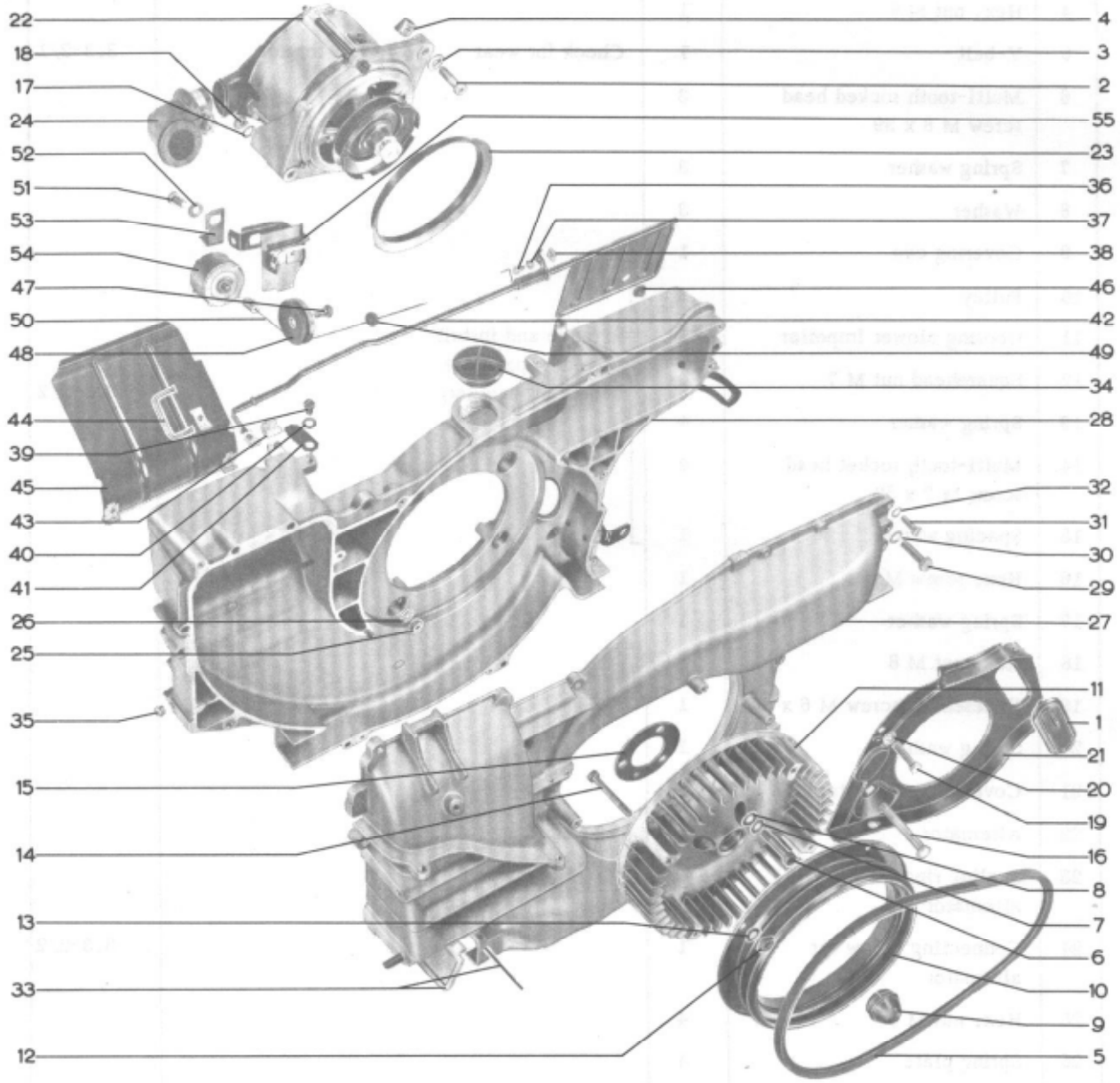


No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Connection pipe	2			
2	Hose clip	5			
3	Heating air hose	2			
4	Hex. nut M 6	4			
5	Spring ring	4			
6	Washer	4			
7	Holding plate	1			
8	Heating air blower	1			

Effective with 1974 Models



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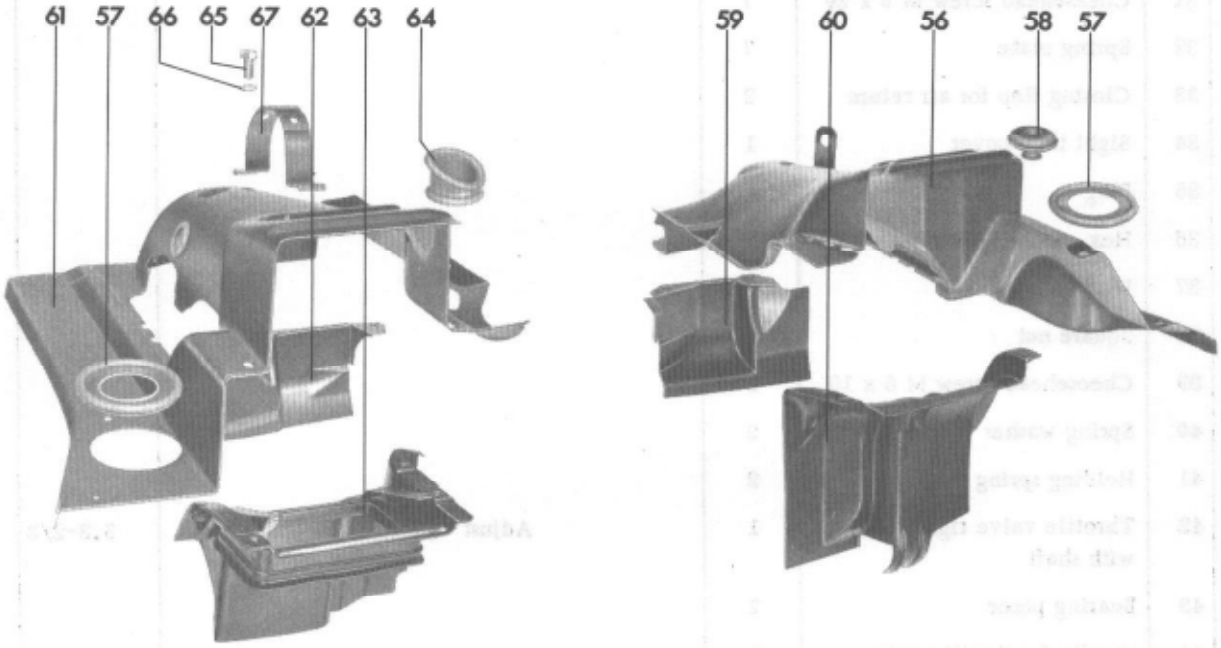
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cover for cover plate	1			
2	Multi-tooth socket head screw M 8	1			
3	Spring washer	1			
4	Hex. nut M 8	1			
5	V-belt	1	Check for wear	Adjust tension	3.3-2/1
6	Multi-tooth socked head screw M 8 x 39	3			
7	Spring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

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



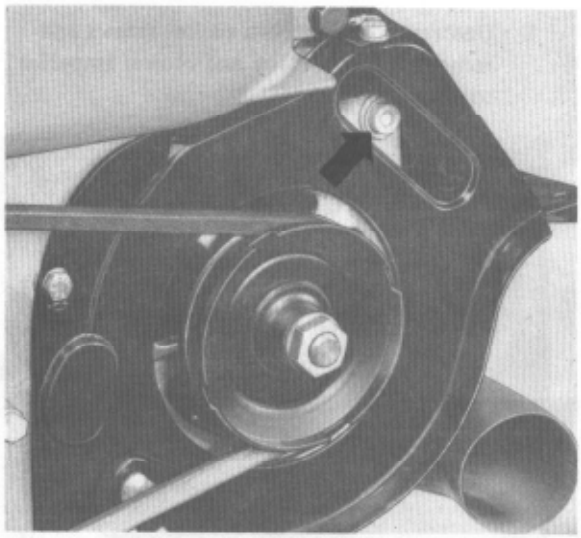
No.	Designation	Each	Observe during: Removal / Installation	Spec. Instr.
56	Cylinder jacket right	1		
57	Bushing for connecting pipe	2		
58	Bushing for cable	1		
59	Warm air guide right front	1		
60	Warm air guide right rear	1		
61	Cylinder jacket left	1		
62	Warm air guide left front	1		
63	Warm air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

CHECKING AND ADJUSTING OF V-BELT TENSION

Checking V-belt Tension

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

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



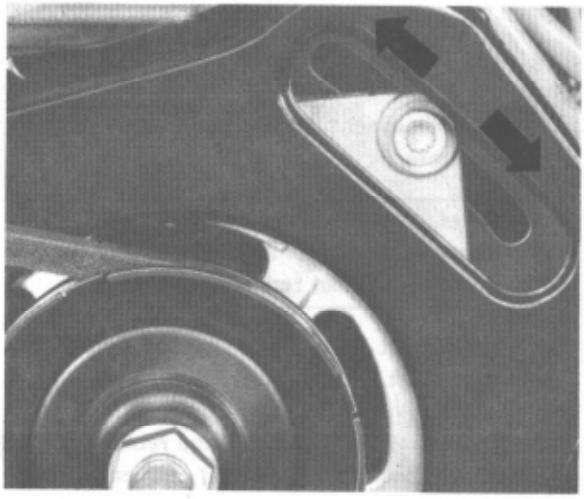
Adjusting V-belt Tension

1 - Remove cover for cover plate.

2 - Loosen multi-tooth socket screw M 8.

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

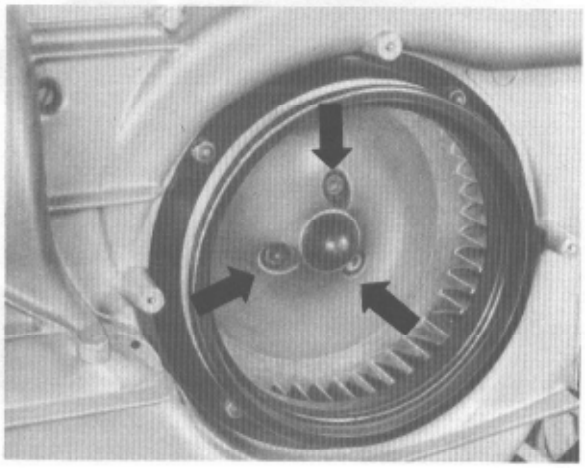
4 - Tighten screw.



REMOVAL AND INSTALLATION OF COOLING BLOWER HOUSING

Removal

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



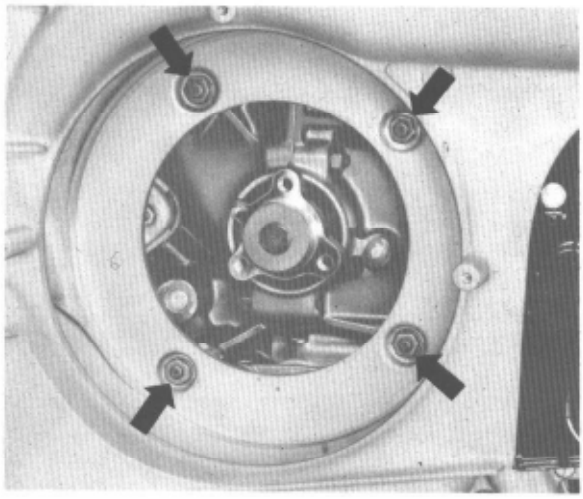
2 - Remove spacing washer.

3 - Remove cover plate for alternator and generator.

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

4 - Disconnect cable for cooling air control from shaft.

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

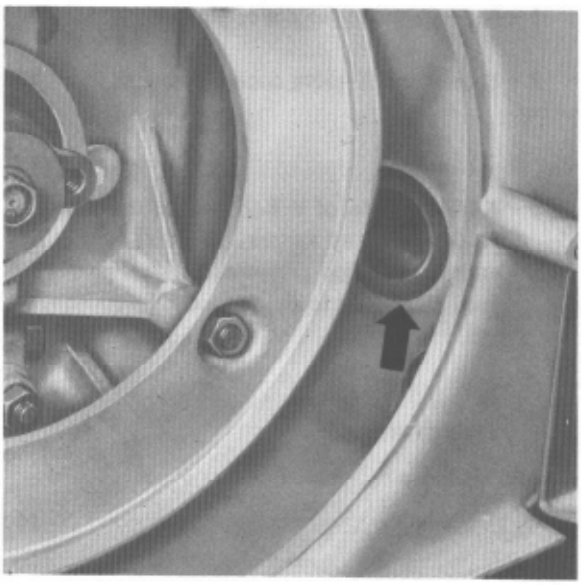


Installation

For installation proceed as follows:

1 - Adjust throttle flap for cooling air control.

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



3 - Adjust V-belt tension.

REPLACING COOLING BLOWER IMPELLERS

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

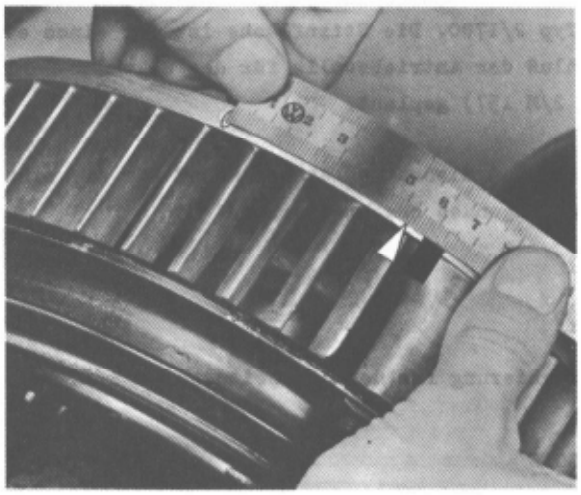
27° timing mark = 52.5 mm along the circumference
7.5° timing mark = 14.6 mm along the circumference

Making Timing Notch

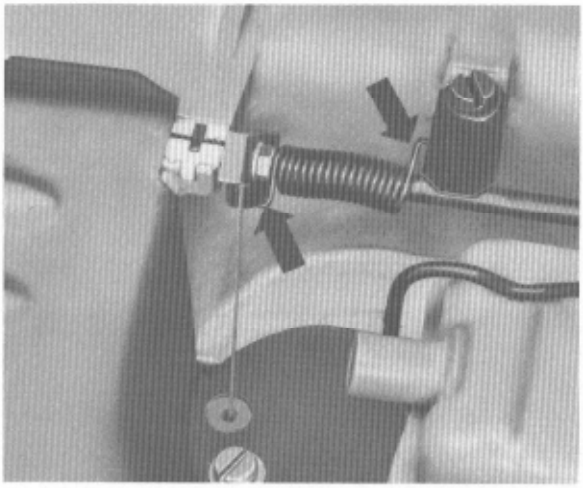
1. Scratch-mark location of timing mark (from TDC) with aid of a vlexible measuring tape.

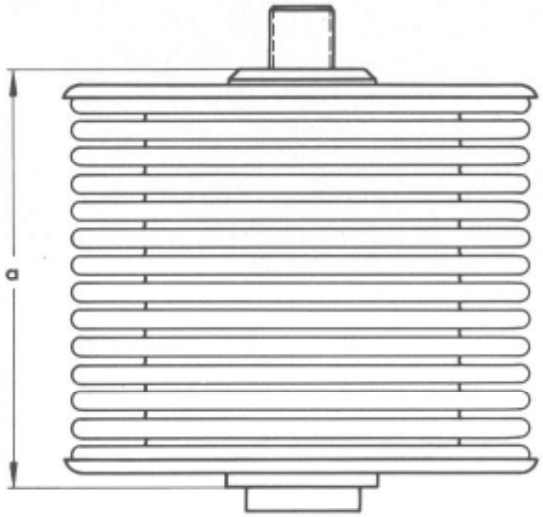
2. Make timing notch with a triangular file.

3. Mark notch with red paint.



AUTOMATIC COOLING AIR CONTROL





Removal

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

Installation

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

Adjustment

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

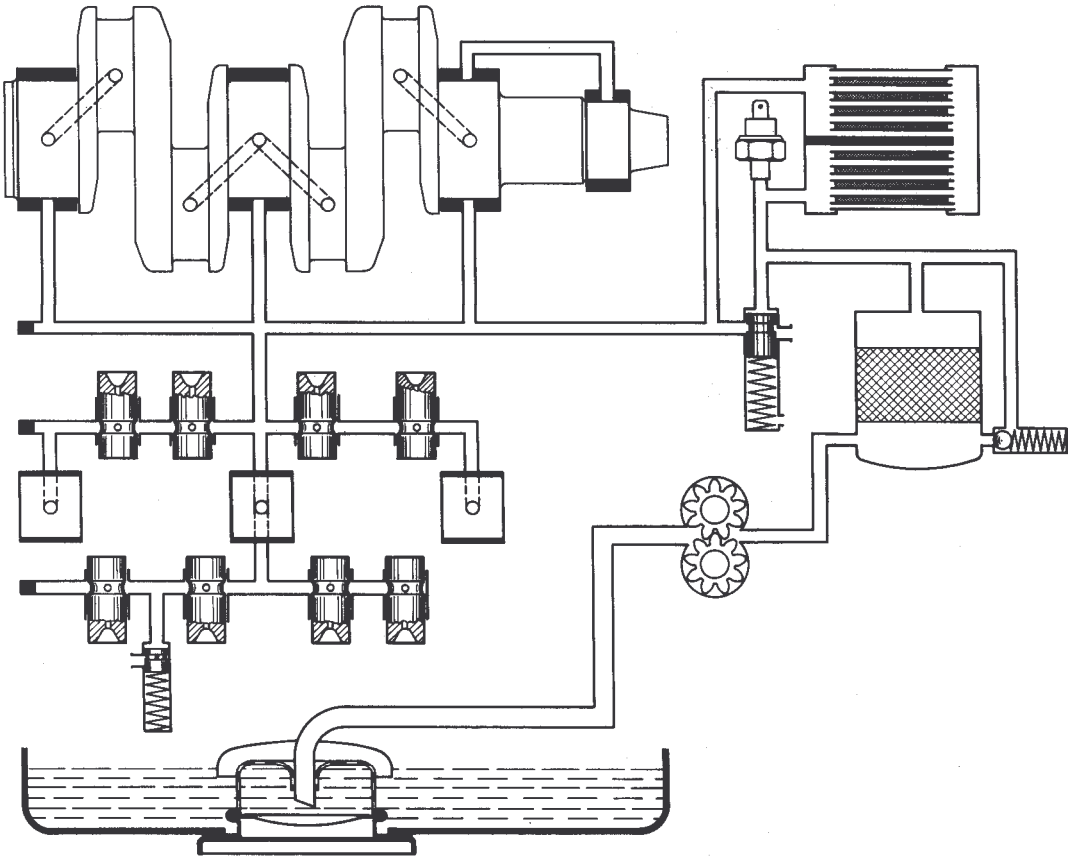
2 - Push throttle flaps into closing position and tighten cable control.

Checking Thermostat

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

DESCRIPTION

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



Oil Capacities:

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

Oil Dipstick:

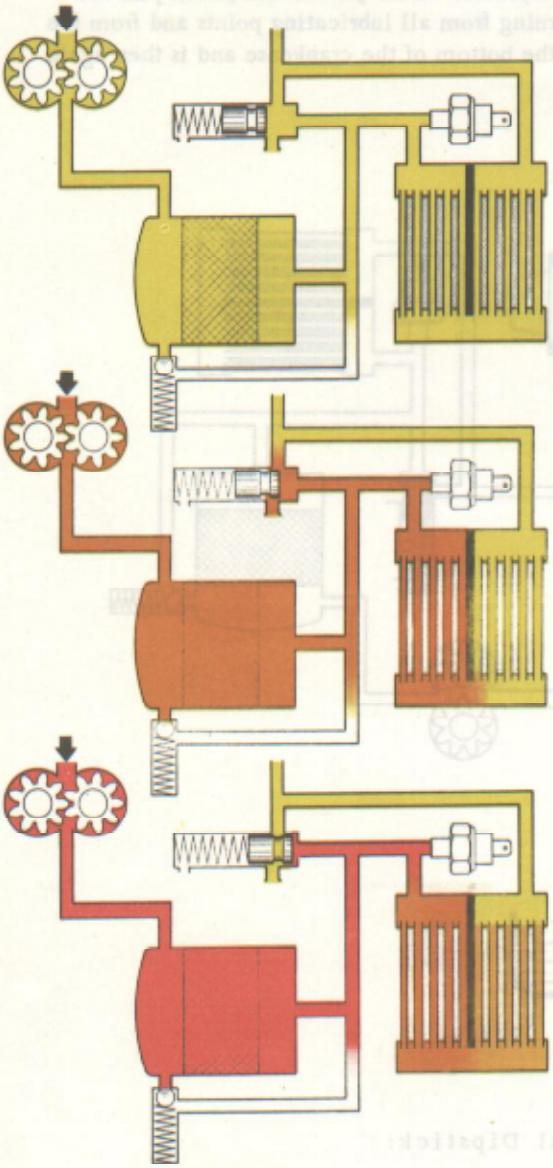
top mark - max. capacity
bottom mark - min. capacity (approx. 2.5 lits.)

Oil Pressure:

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

Oil Pressure Valves:

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



a - The oil is cold and thick:

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

b - The oil is warming up and becomes thinner:

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

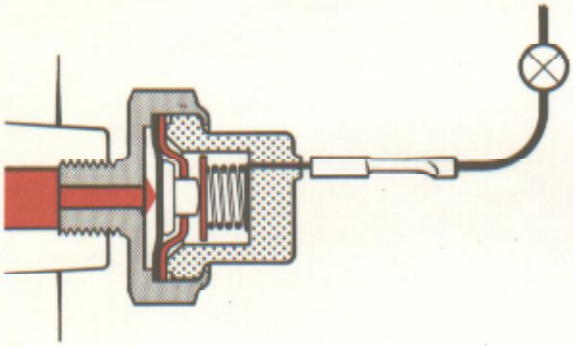
c - Oil is at operating temperature and thin:

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

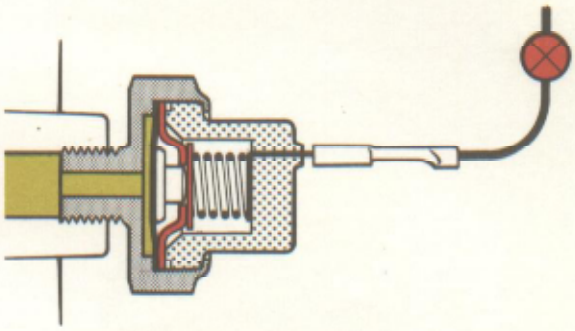
The lateral oil pressure relief valve at end of oil circuit will maintain the oil pressure within range of crankshaft and camshaft bearings to approx. 2 kg/cm^2 (28 psi).

Oil Pressure Switch:

The oil pressure switch serves to control the oil pressure.



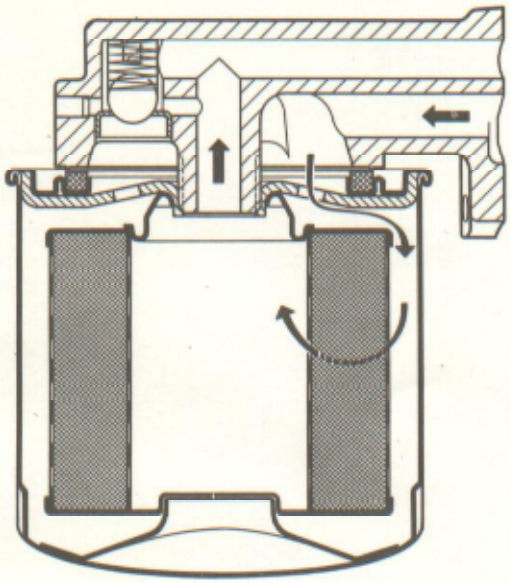
a - Oil pressure increases when engine is started:
Contact opens (0.15-0.45 kg/cm^2 = 2-6.4 psi).
Control lamp extinguishes.



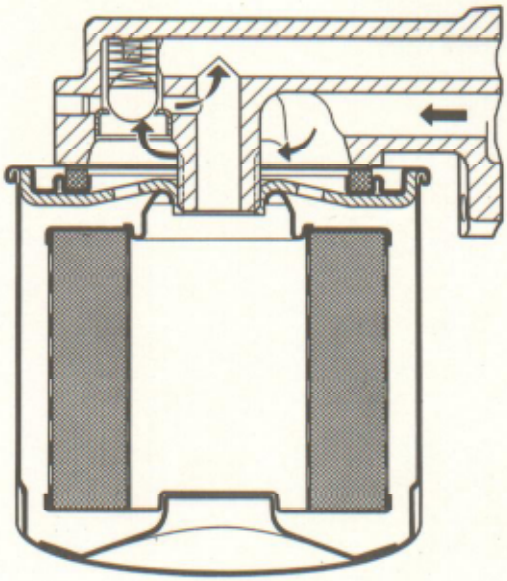
b - Oil pressure too low with the engine running:
Contact closes.
Control lamp lights up.

Oil Filter:

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



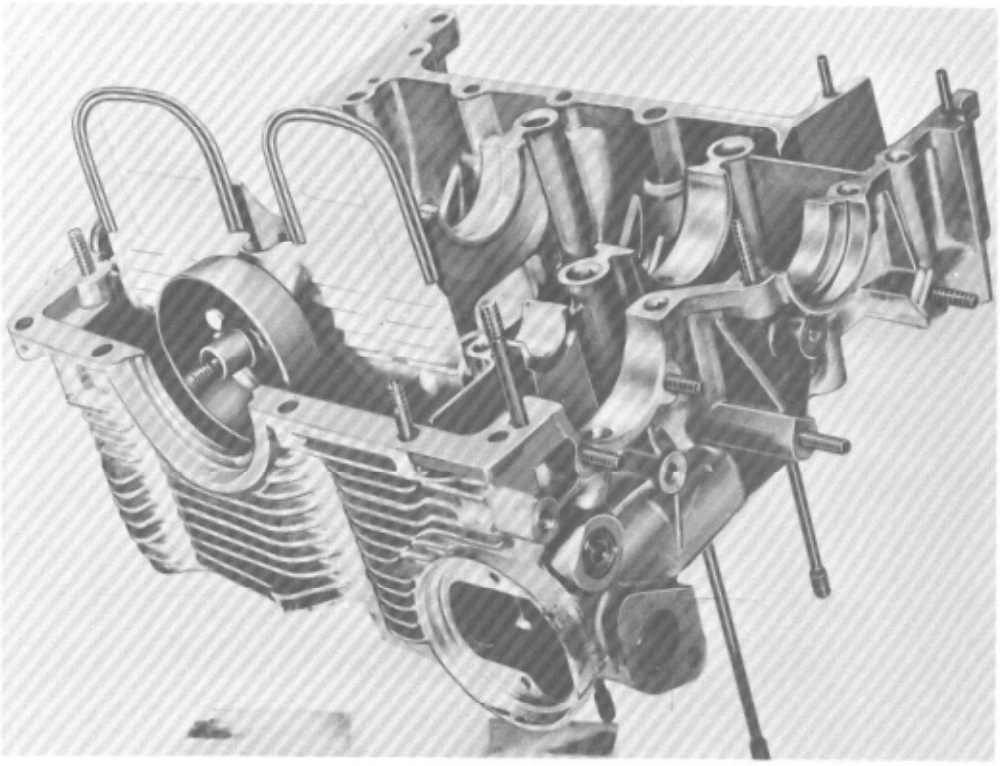
a - Normal oil flow.

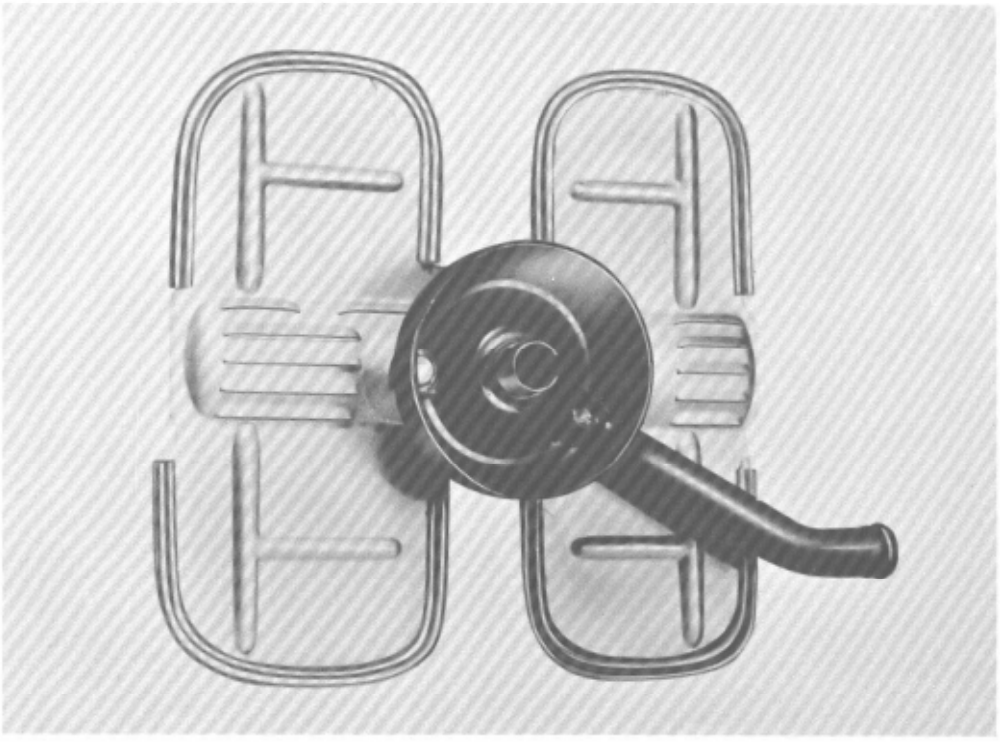


b - Oil flow with oil filter clogged.

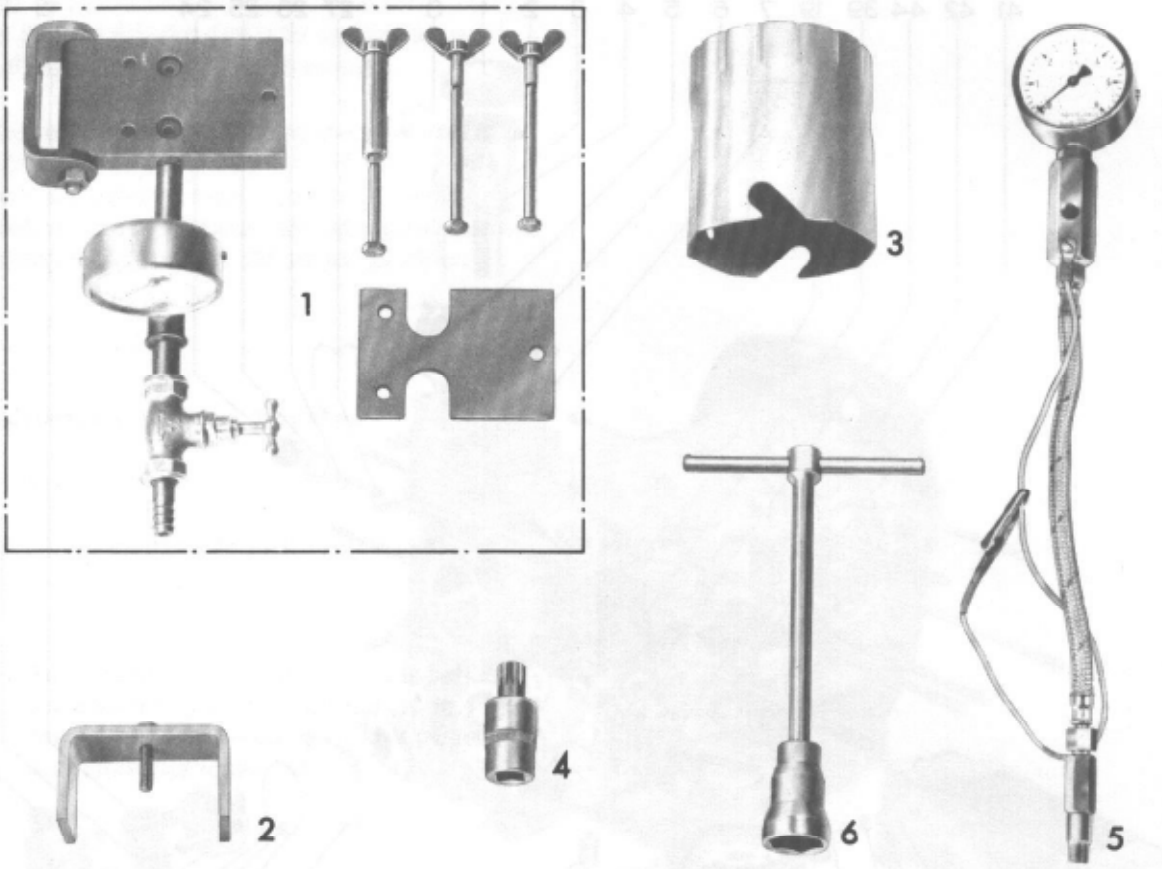
DESCRIPTION

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

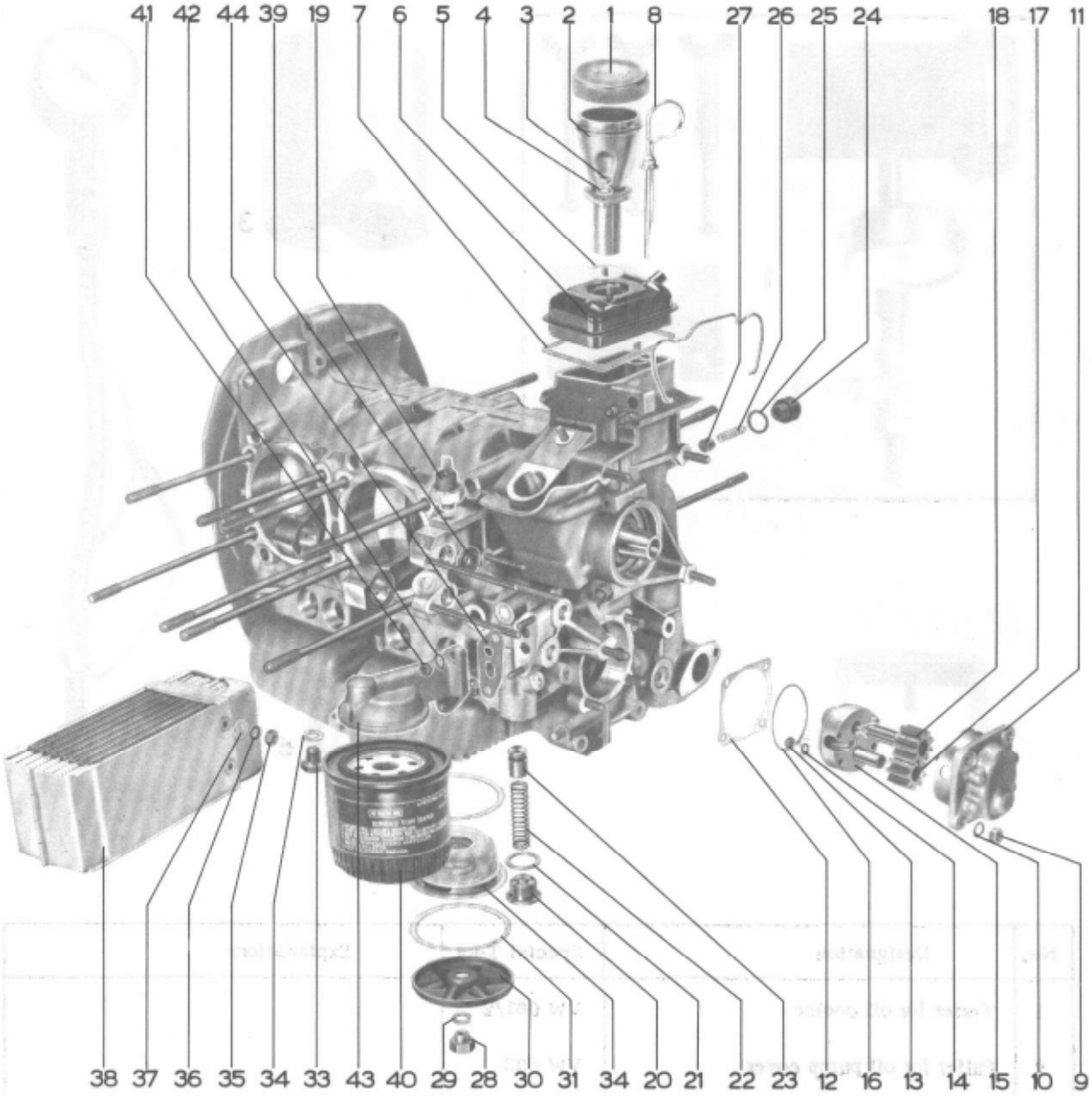




TOOLS



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


41 42 44 39 19 7 6 5 4 3 2 1 8 27 26 25 24 18 17 11
38 37 36 35 34 33 43 40 29 28 30 31 34 20 21 22 23 12 16 13 14 15 10 9

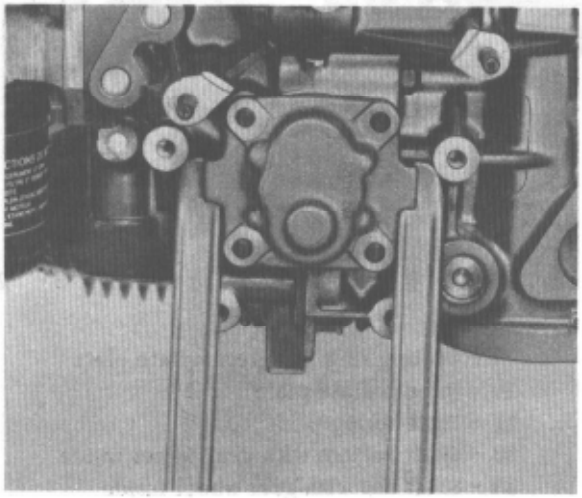
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Cover for oil filler	1			
2	Oil filler	1			
3	Hex. nut M 6	2			
4	Spring washer	2			
5	Seal for oil filler	1		Replace	
6	Oil vent	1			
7	Seal	1		Replace	
8	Oil dipstick	1			
9	Hex. nut M 8	4		Tighten to 2.0 mkg (14.5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

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

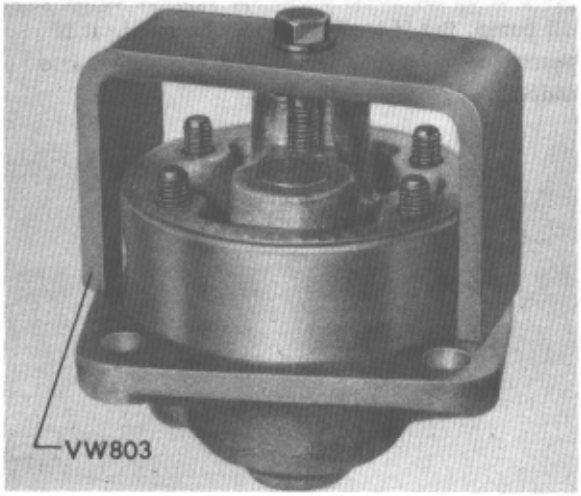
REMOVAL AND INSTALLATION OF OIL PUMP

Removal

1 - Remove oil pump with 2 mounting levers.



2 - Pull oil pump cover with puller VW 803.



Checkup

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

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

Installation

The following points must be observed:

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

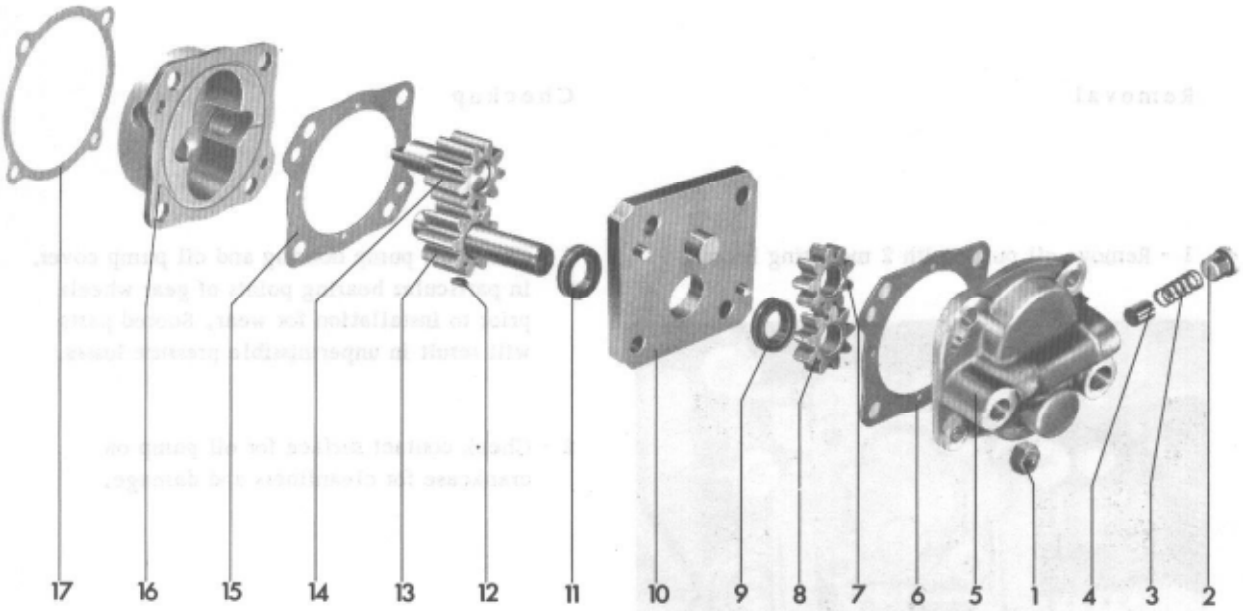
2 - Install oil pump cover with lubricated rubber sealing ring into housing.

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

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

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

REMOVAL AND INSTALLATION OF DOUBLE OIL PUMP SPORTOMATIC



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

Removal

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

Checkup

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

REMOVAL AND INSTALLATION OF OIL PRESSURE VALVES

Removal

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

Installation

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

2 - Checking spring.

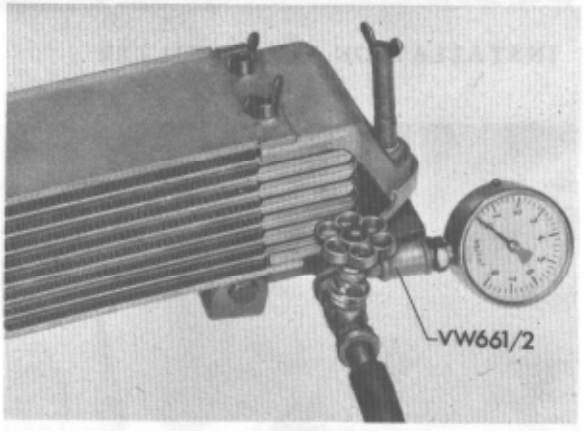
	Oil relief valve, bottom	Oil pressure control valve, lateral
Spring lenght loaded	23.4 mm (0.92 in.)	16.8 mm (0.66 in.)
Load	11.1 kg (24.5 lbs.)	4.35 kg (9.59 lbs.)

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

Remark:

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

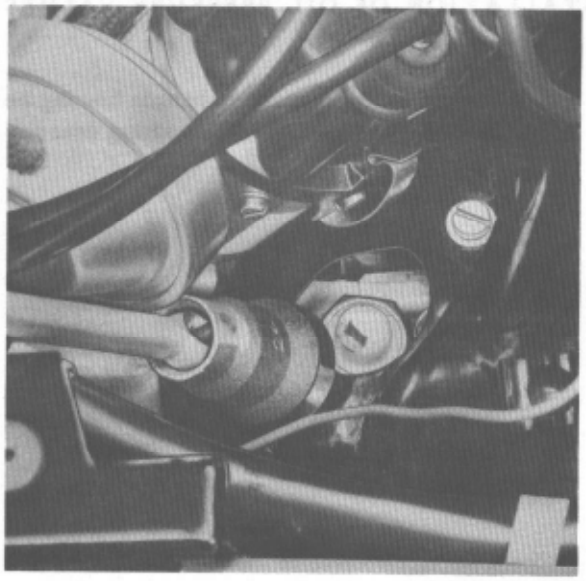
CHECKING THE OIL COOLER

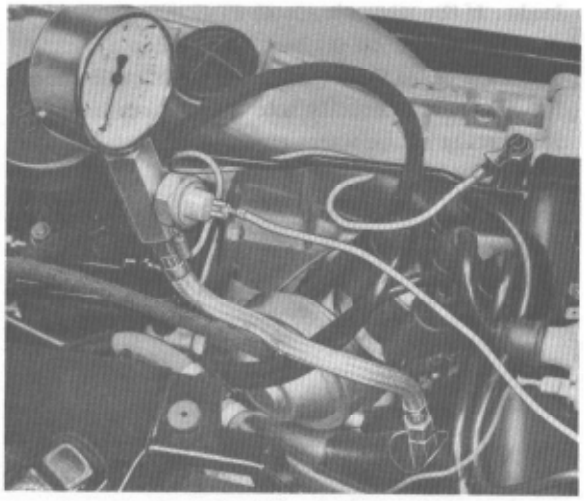


1 - Check oil cooler for leaks and tight seat of all welded plates. Test pressure 6 kg/cm^2 (85 psi). Tester for oil cooler: VW 661/2 (self-made).

2 - Leaking oil cooler: check oil relief valve.

CHECKING THE OIL PRESSURE SWITCH





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

1 - Unscrew oil pressure switch and screw into tester.

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

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

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

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

INSTALLATION OF OIL FILTER

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

2 - Lubricate rubber seal slightly.

3 - Screw filter in manually until seal is seated.

4 - Tighten oil filter with spanner.

5 - Fill up with engine oil.

6 - Start engine and check for leaks.

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

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

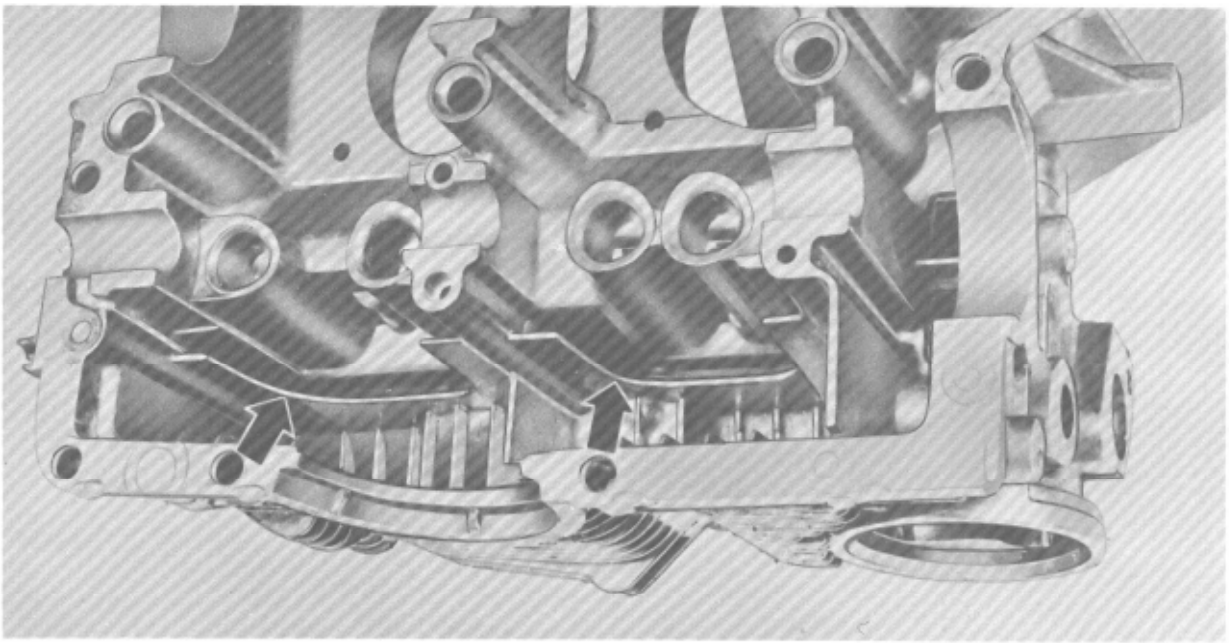
INSTALLING CONTOURED GASKET

Installation

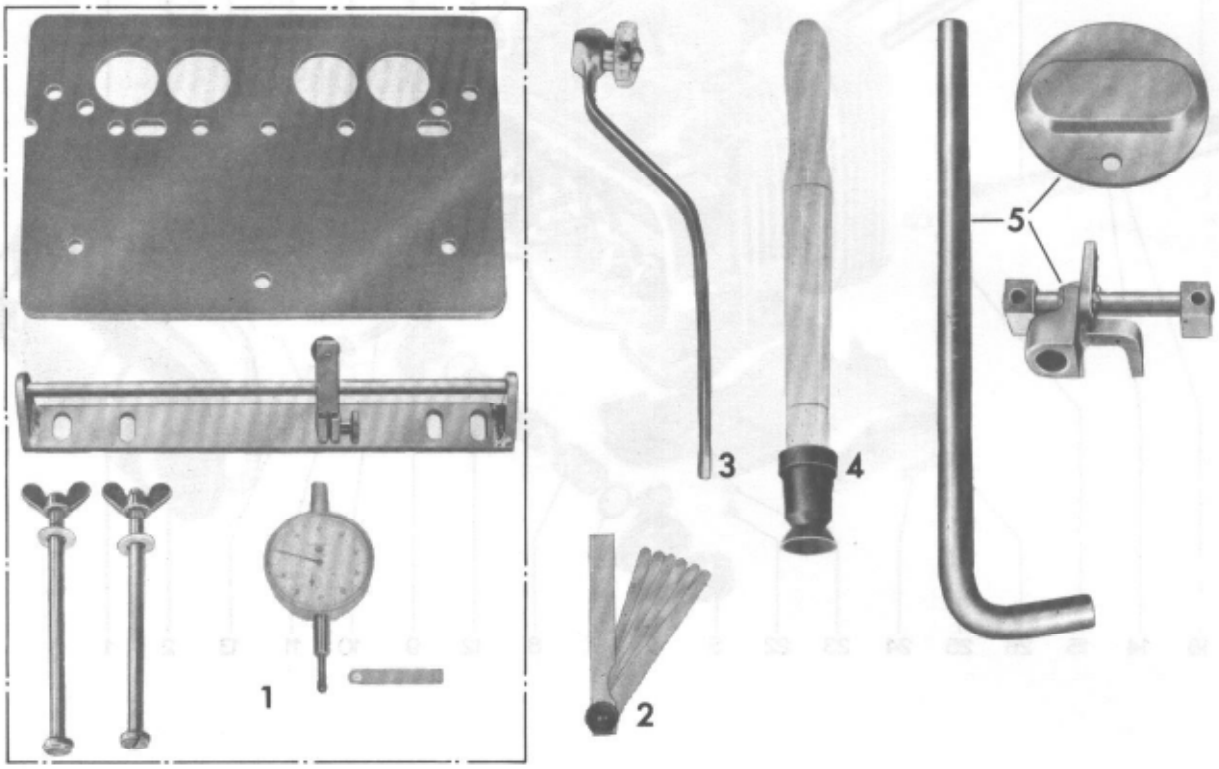
When installing contoured gasket to the oil baffle plate, use a silicone adhesive.

Subsequent Installation

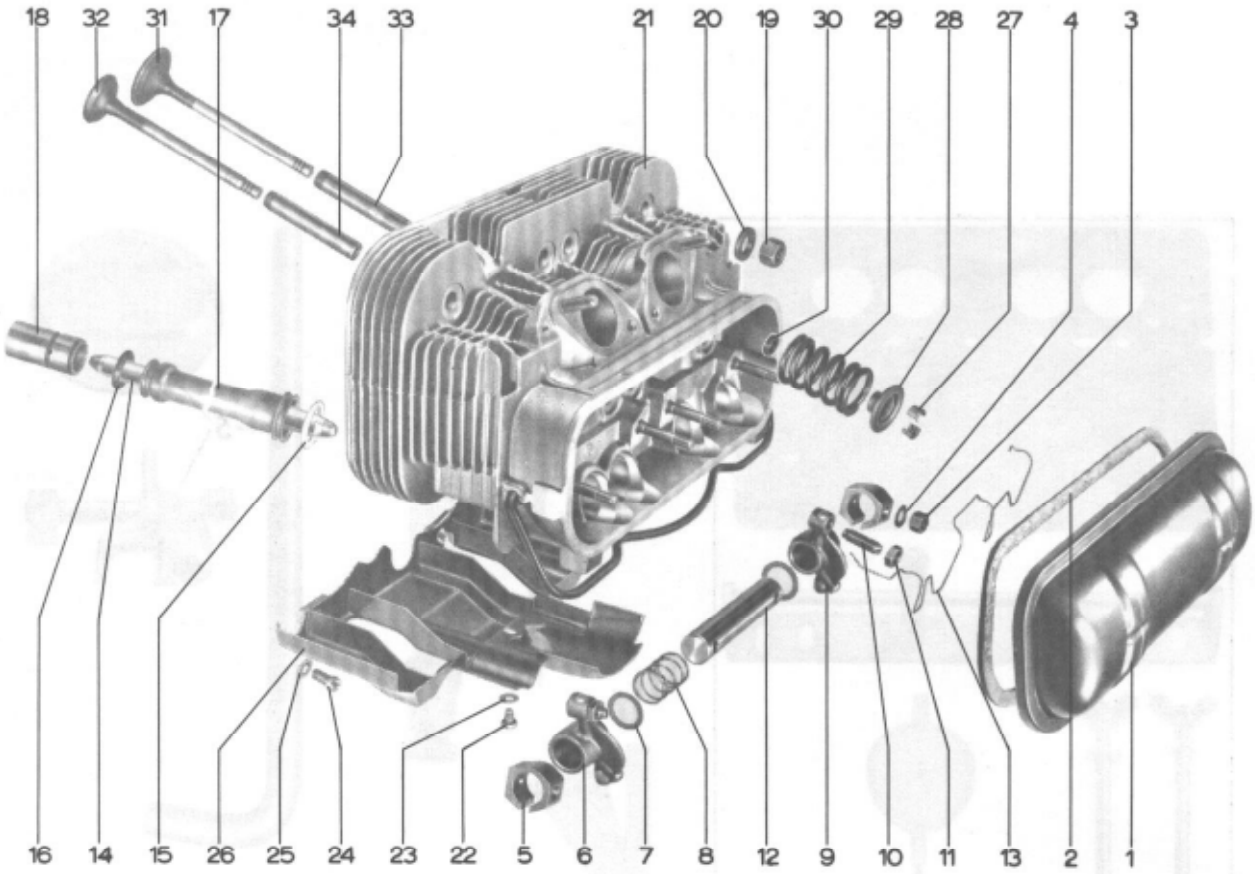
Subsequent installation is possible beginning with engine No. W 0 074 387. Engines manufactured as of this number are equipped with a modified oil pick-up tube and a circumferential retaining rib.



TOOLS



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



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

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

Checkup

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

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

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

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

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

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

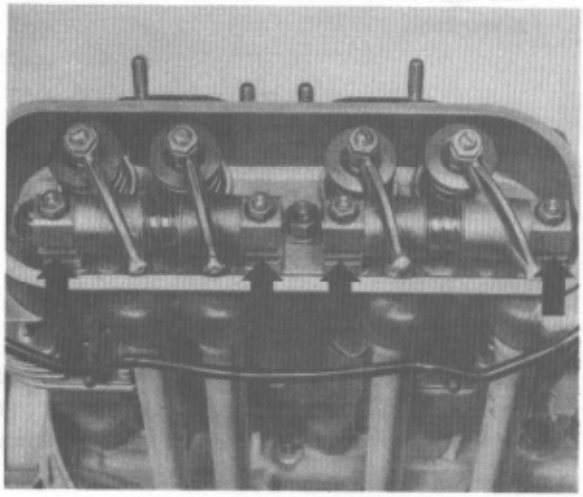
If the axial thrust surface of the rocker arms or bearing pieces are showing score marks, refinishing with fine emery cloth is permitted.

Installation

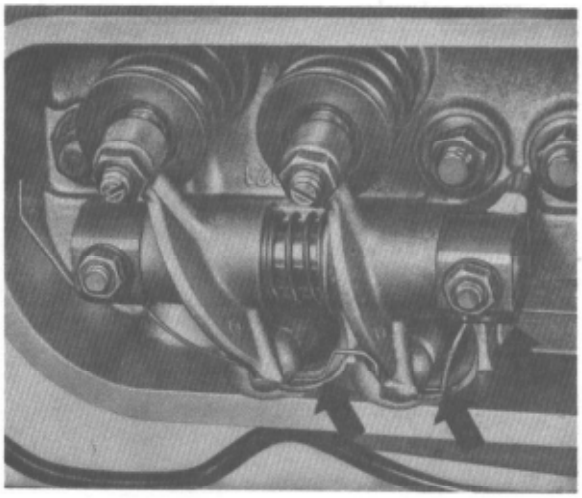
1 - Insert tappet with engine oil.

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

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



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



INSPECTION AND INSTALLATION OF CYLINDER HEAD

Checkup

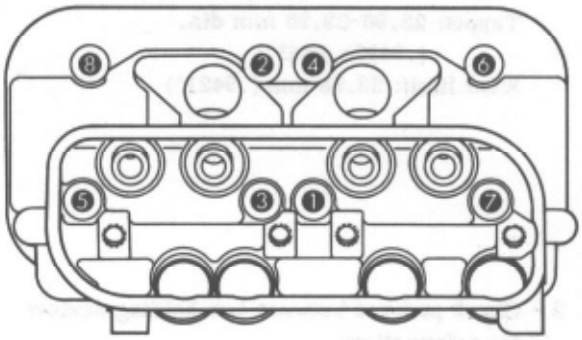
1 - Check cylinder heads for cracks in combustion areas and exhaust ducts as well as for leaks on cylinder support. Replace damaged cylinder heads.

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

Installation

1 - Replace sealing ring for cylinder head.

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



3 - Screw on baffle plate.

CHECKING VALVE GUIDES

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

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

1 - Remove residue with a cleaning tool.

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

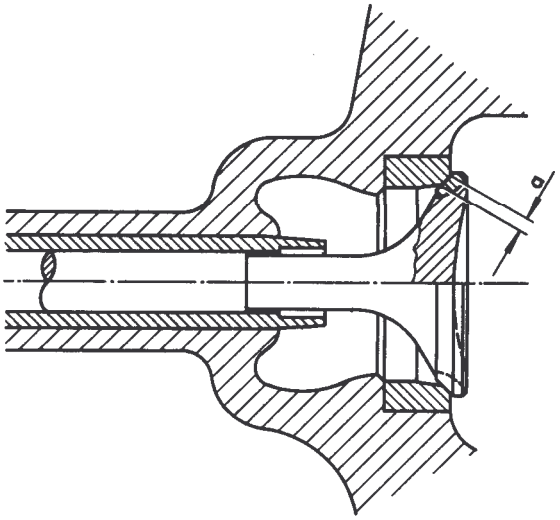
3 - Insert dial gauge into holder and attach dial gauge extension.

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

5 - Adjust dial gauge and determine rocker play.

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

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

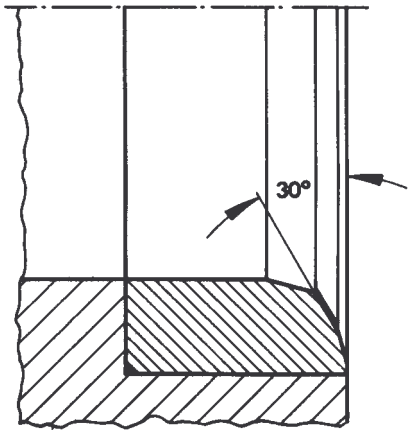


Width of valve seats (a) :

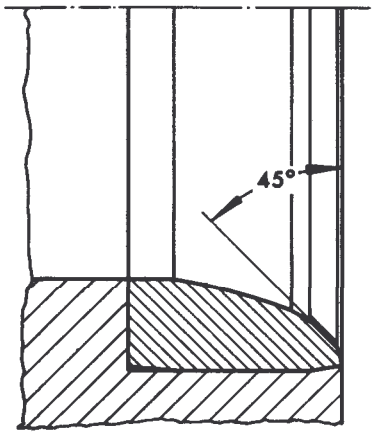
Intake 1.8-2.2 mm
(.0709-.0866 in.)
Exhaust 2.0-2.5 mm
(.0787-.0984 in.)

Sequence

1 - Finish 30° surface for inlet valve.



2 - Finish 45° surface for exhaust valve.



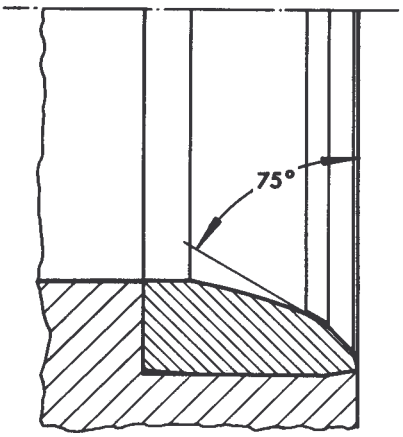
These seats must be finished with particular care to guarantee a perfect concentric seat. The material removal should be restricted to a minimum to prevent early unusability of the rings. The refinishing must be terminated as soon as the entire seat surface has been coverred.

3 - Refinish 75° surface.

Chamfer bottom edge of exhaust valve seat ring slightly.

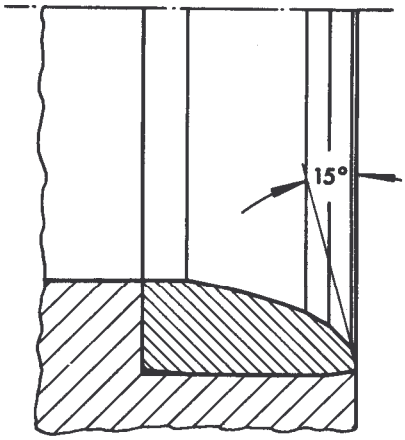
3 - Refinish 75° surface.

Chamfer bottom edge of exhaust valve seat ring slightly.



4 - Refinish 15° surface.

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

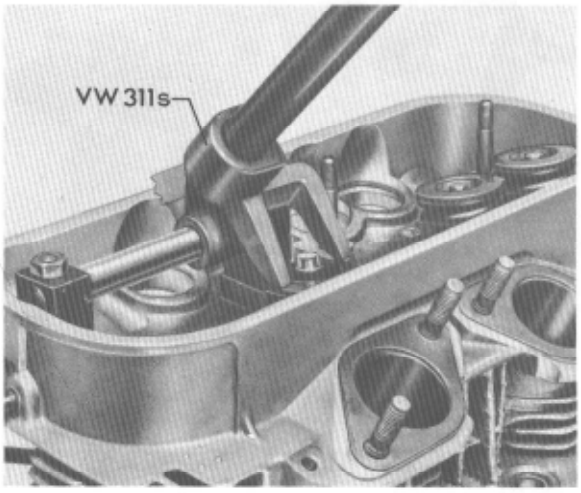


5 - The valve seat can be checked with a new valve.

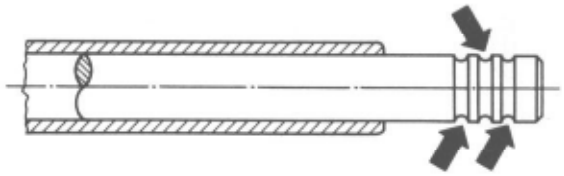
REMOVAL AND INSTALLATION OF VALVES

Removal

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



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

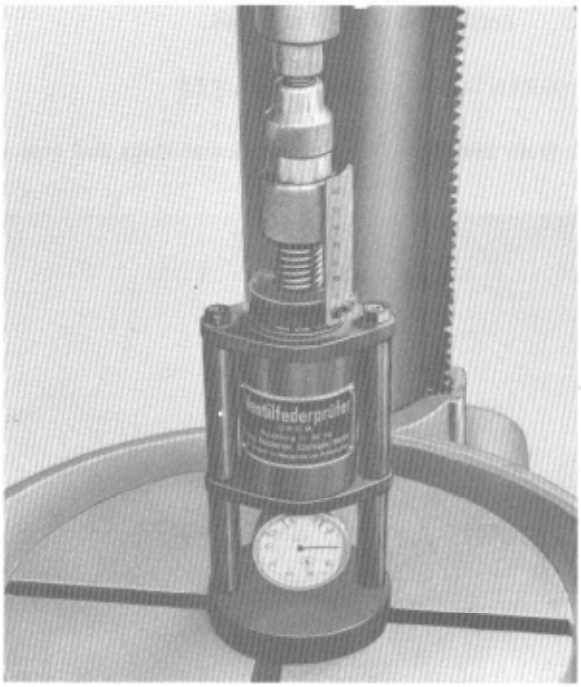


Checkup

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

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

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



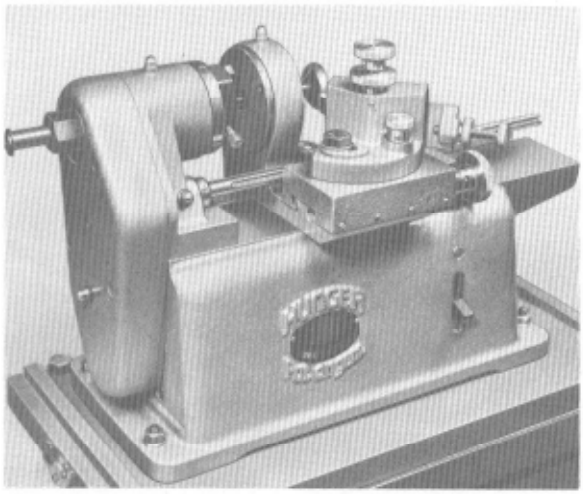
Installation

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

2 - Slide oil scraper ring on valve stem.

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

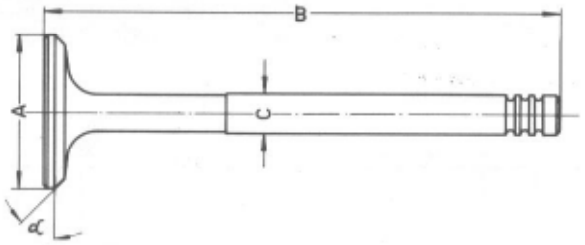
REFINISHING VALVES



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

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

For 1.8 liter engines beginning with 1974 models



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

CHECKING FOR LEAKS

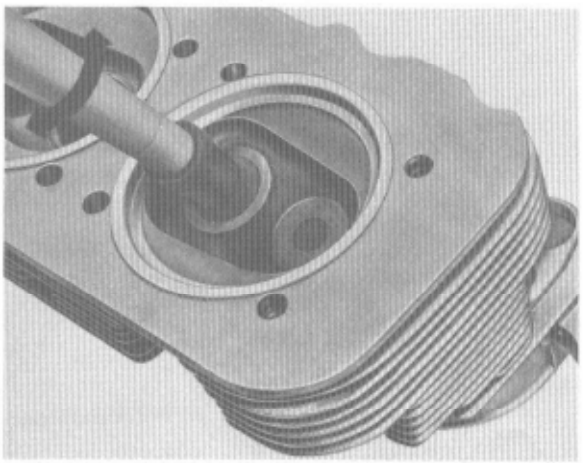
Valves can be checked for leaks by establishing a contact pattern.

Contact Pattern

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

GRINDING-IN OF VALVES

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



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

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

Caution!

Carefully remove grinding paste following grinding operation.

VALVE CLEARANCE

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

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

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

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

Insufficient clearance:

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

Excessive clearance:

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

ADJUSTMENT OF VALVES

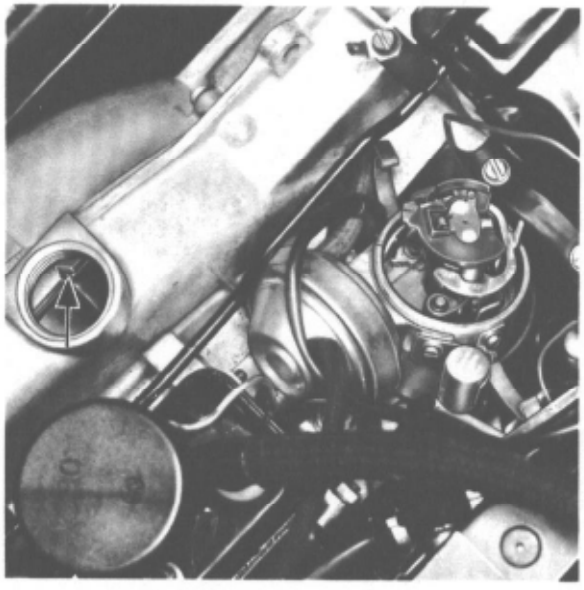
Valve clearance is adjusted in the firing order 1-2-3-4 Cylinder.

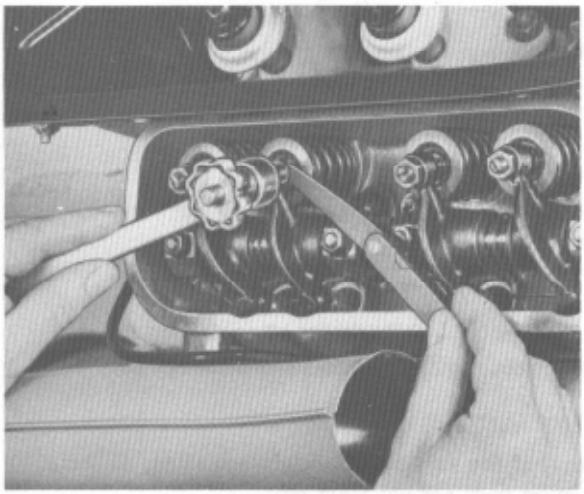
The piston of the cylinder to be adjusted must be at TDC of the compression stroke, because both valves will then be closed.

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

2 - Check valve clearance with feeler gauge.

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



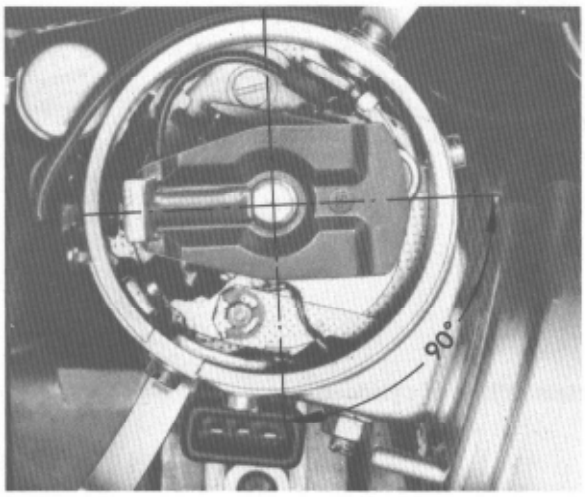


3 - Adjust valve clearance with valve adjusting spanner and feeler gauge.

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

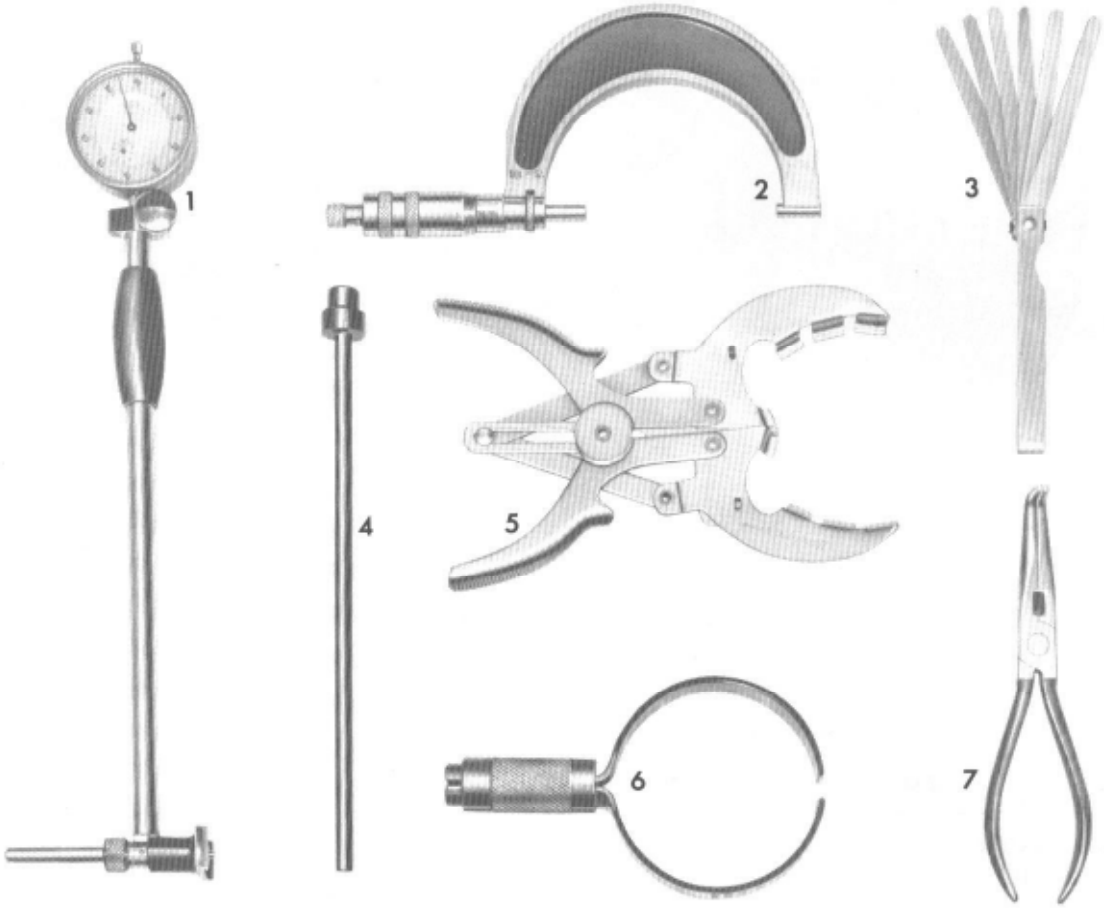
4 - Hold adjusting screws and tighten counter nuts.

5 - Check adjustment.

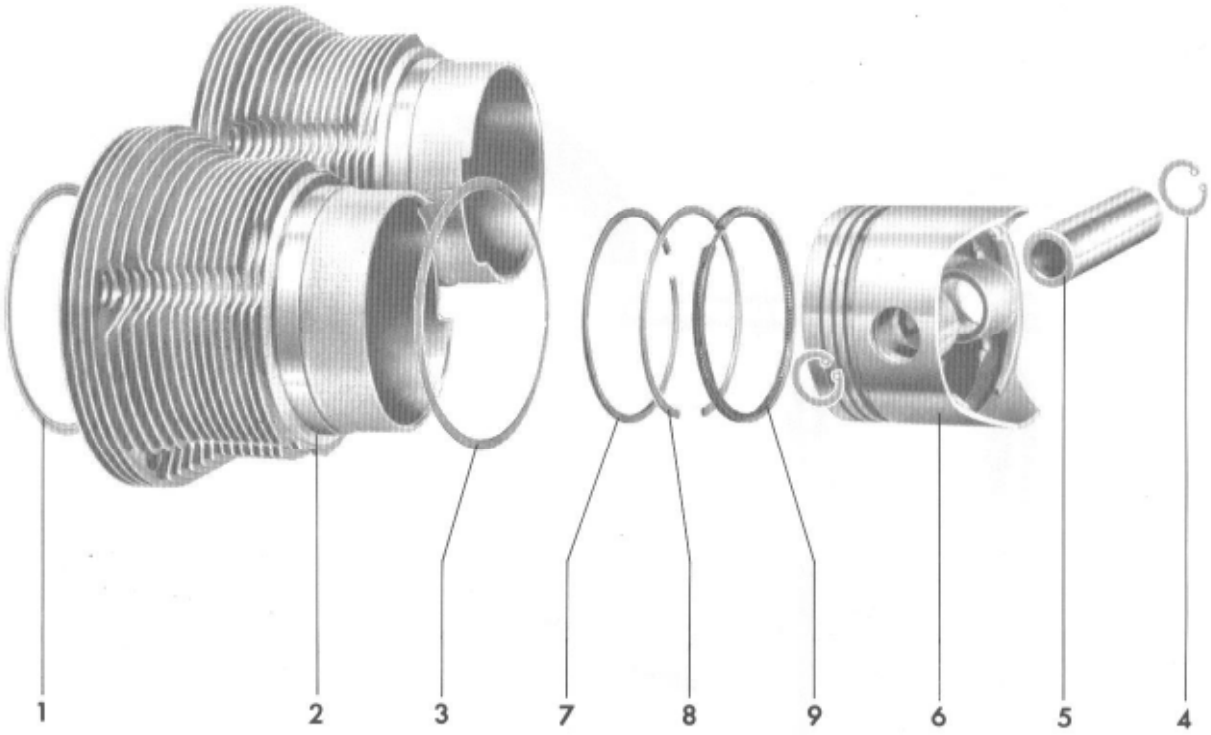


6 - For additional adjustment of valves on cylinder 2, 3 and 4, keep turning crankshaft to the left until the finger of the distributor rotor is offset by 90° in each case.

TOOLS



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



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

REMOVAL AND INSTALLATION OF CYLINDERS

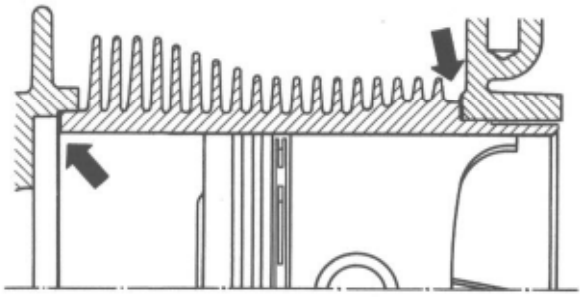
Removal

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

Checkup

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

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



Note:

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

Installation

1 - Lubricate piston and piston pin.

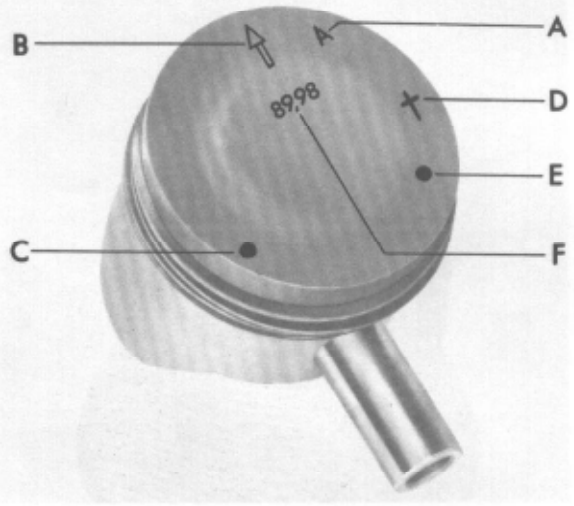
2 - Compress piston rings with piston ring strap VW 123d. Watch out for uniform alignment of gaps on piston ring. The gap of the oil scraper ring should always be on top.

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

REMOVAL AND INSTALLATION OF PISTONS

Removal

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



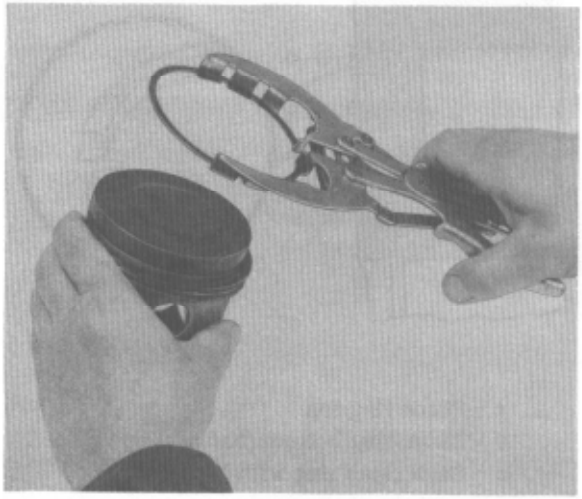
2 - Remove locking rings for piston pin with circlip pliers.

3 - Remove piston pin with mandrel VW 207c.

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

Installation

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



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

Marking of Piston

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

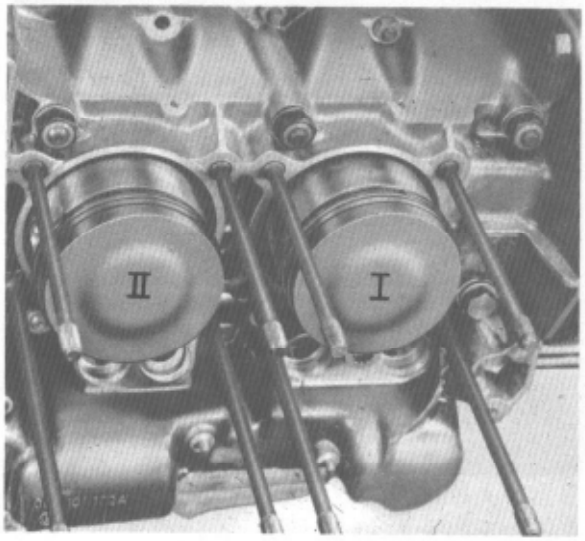
B - Arrow (punched-in) indicates that the piston must be installed in the direction of the arrow toward flywheel.

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

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

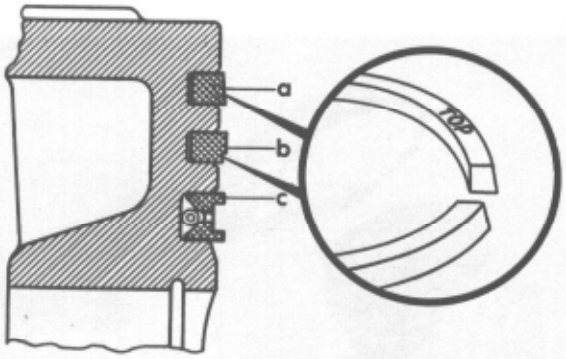
E - Indication of weight class by colour dot (brown = -weight, grey = +weight).

F - Indication of piston size in mm.



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

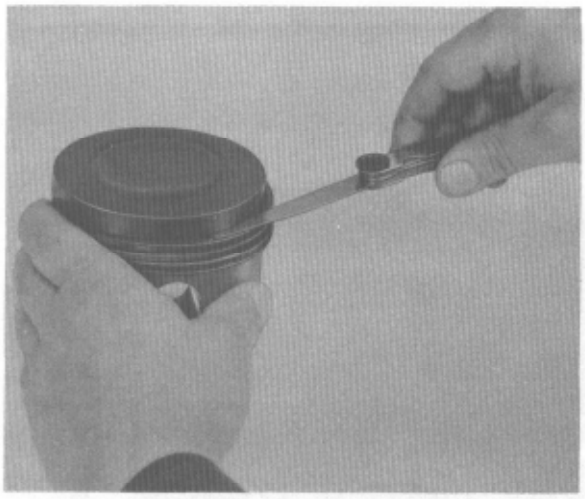
	Width of gap in mm	Wear limit in mm
Piston ring top	0.35-0.55 (.0138-.0217")	0.90 (.0354")
Piston ring bottom	0.30-0.55 (.0118-.0217")	0.90 (.0354")
Oil scraper ring	0.25-0.40 (.0098-.0157")	0.95 (.0374")



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

4 - Position piston rings with piston ring pliers only.

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

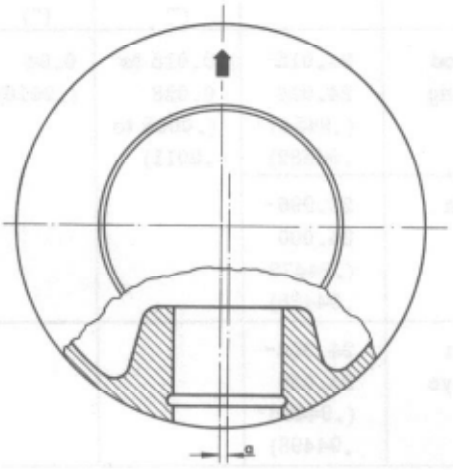


5 - Check vertical clearance of rings in ring grooves with feeler gauge.

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

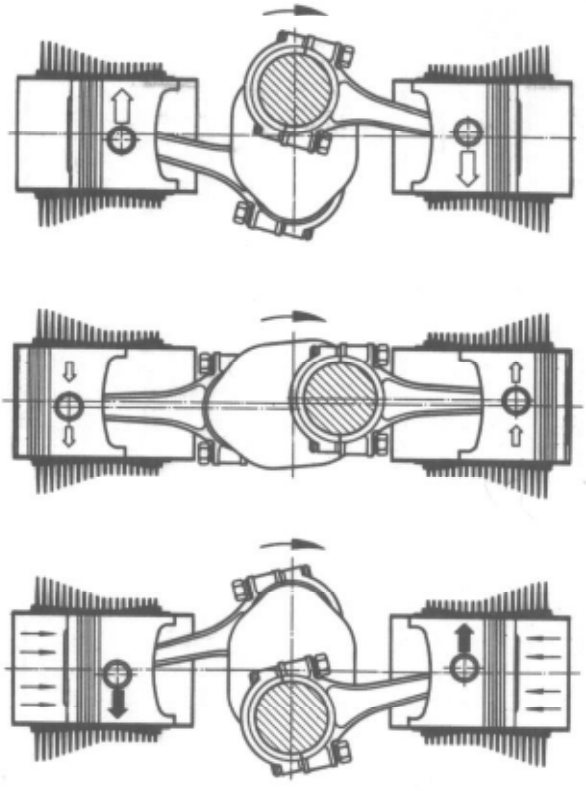
6 - Insert locking rings on pistons of cylinders 1 and 2 on side facing flywheel, on pistons of cylinders 3 and 4 on impeller side.

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



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

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



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

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

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

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

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

CHECKING CLEARANCE BETWEEN CYLINDER AND PISTON

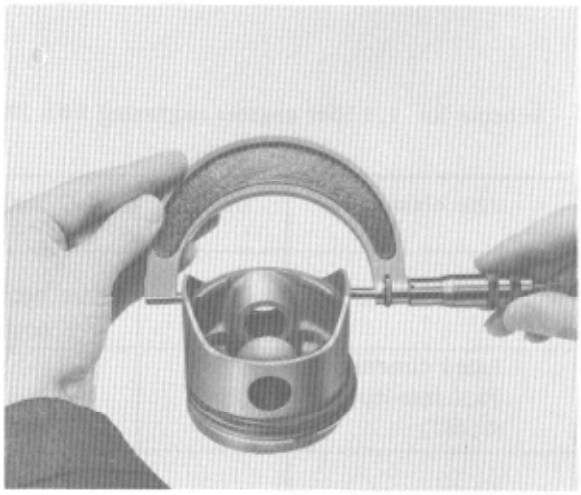
Measure clearance not with a feeler gauge but determine by measuring both, the cylinder and the piston.

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

For 1.8 liter engines beginning with 1974 models

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

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



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

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

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

Scheme for 1.8 liter engines beginning with 1974 model

Size class	Colour	Cylinder mm dia.	Pert. piston mm dia.
Standard size	Blue	92,992 - 93,008 (3.66110-3.66173")	92,97 (3.66023")
Rated dimension 93,0 mm dia. (3.66")	Pink	93,002 - 93,018 (3.66149-3.66212")	92,98 (3.66063")
1st Oversize Rated dimension mm dia.			
2nd Oversize Rated dimension mm dia.			

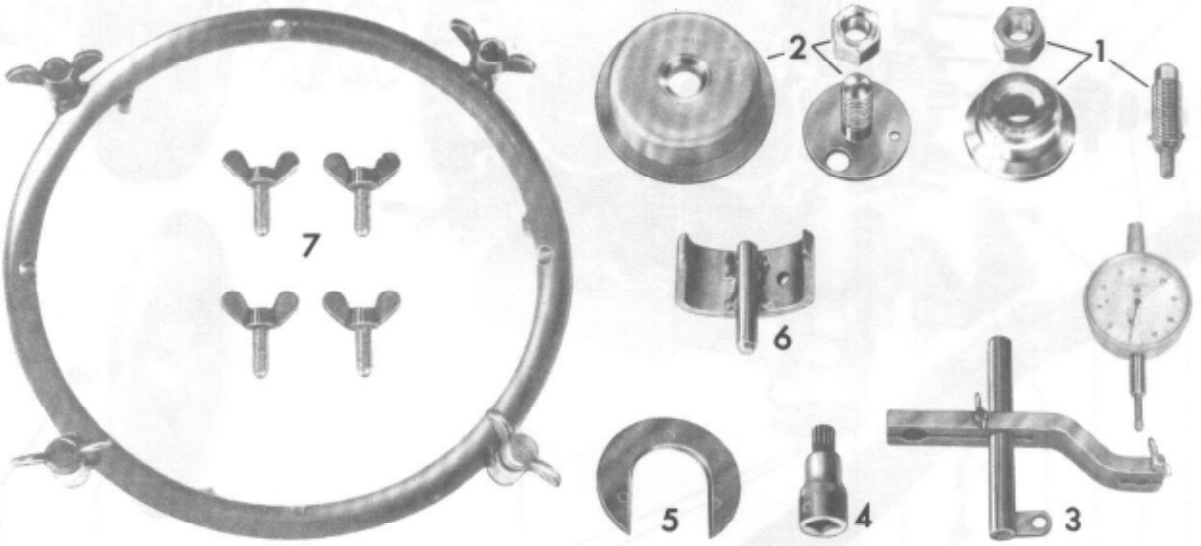
When the measuring of piston and the pertinent cylinder shows that the operational clearance approaches the value of 0.2 mm (.0079), exchange piston and cylinder together against a set of the same size class (standard size or oversize). The difference of weight of the pistons in one engine should not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

Caution!

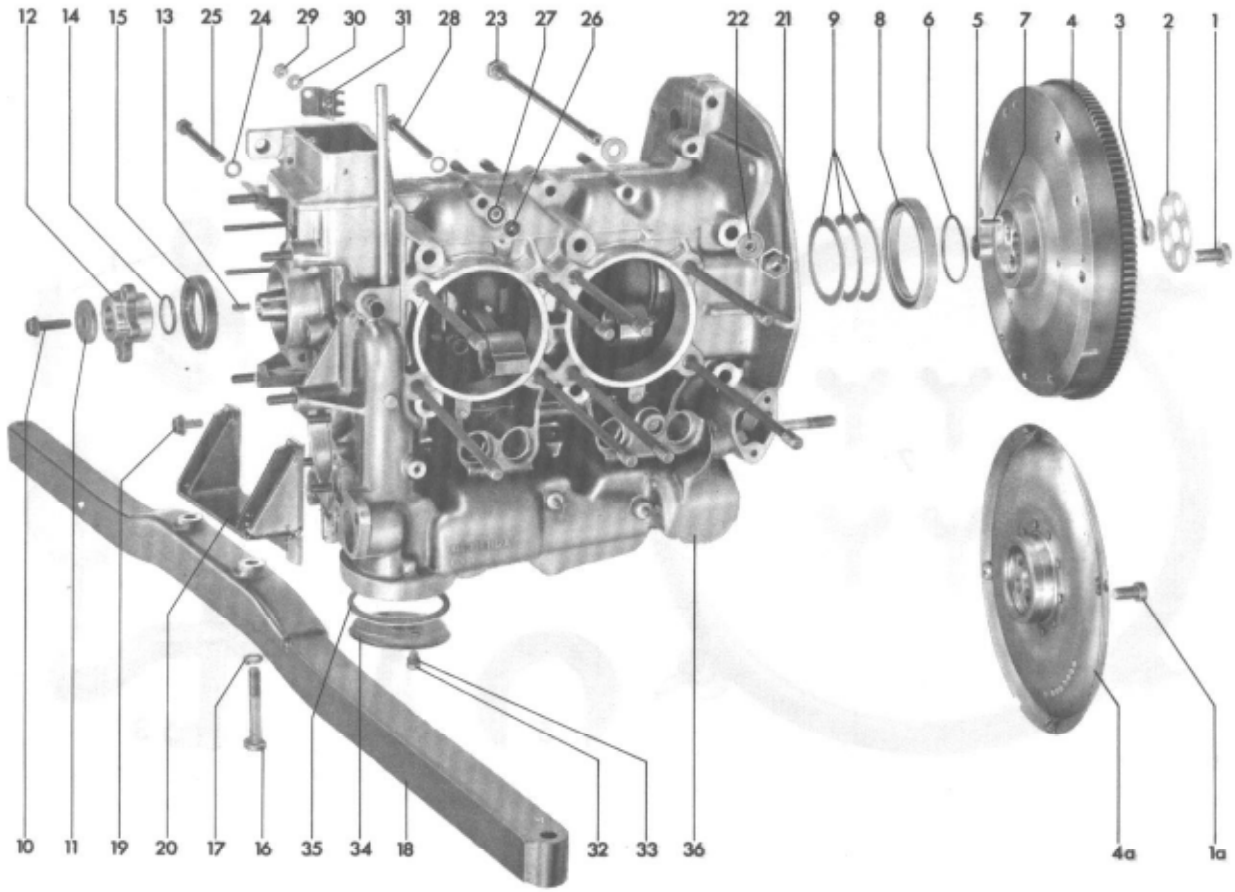
Only cylinders and pistons of the same size class may be installed in one and the same engine.

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

TOOLS



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



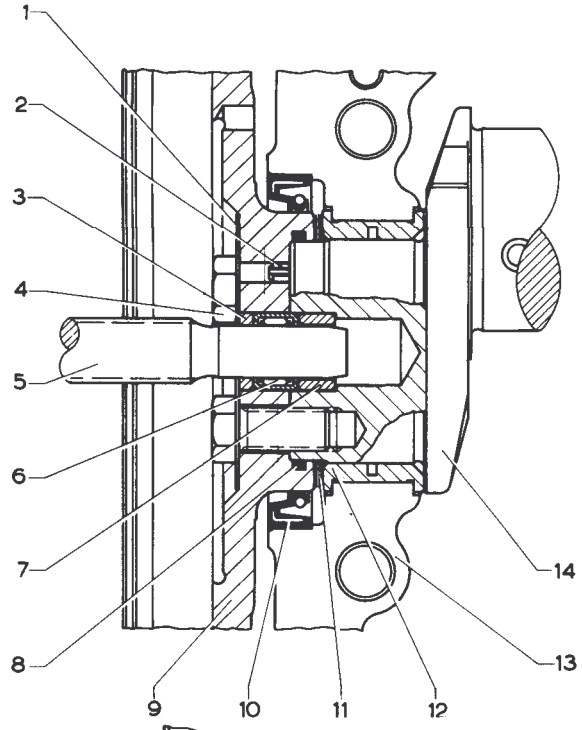
No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Hex. screw M 12 x 1.5, self-securing	5		Tighten to 11.0 mkg (79.5 ft. lbs.)	
1a	Multi-tooth socket screw M 12 x 1.5	5	Sportomatic only	With insert M 12, tighten to 8.5 mkg (61.5 ft. lbs.)	
2	Washer	1		Replace	
3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

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

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

CHECKING AND INSTALLING FLYWHEEL

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



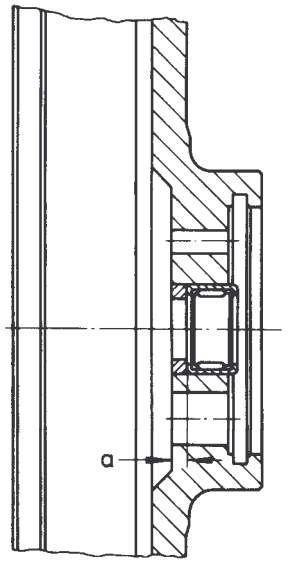
Checkup

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

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

3 - Watch out for correct seat of needle bearing.

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



"a" = 3.2 mm (0.126")

Installation

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

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

3 - Adjust axial play of crankshaft.

4 - Lubricate running surface for sealing ring.

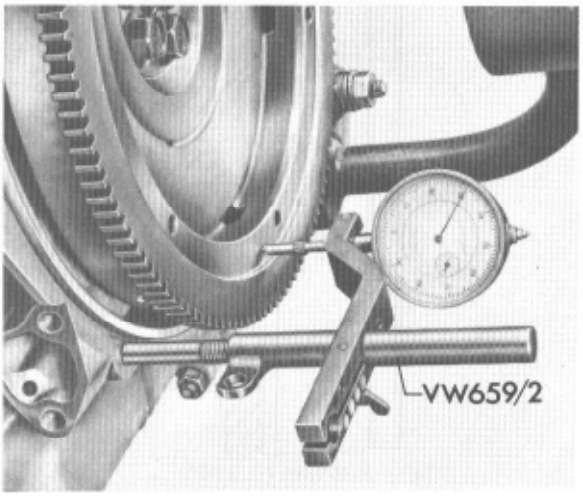
AXIAL PLAY OF CRANKSHAFT

Checking the Axial Play

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

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

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



Adjusting the Axial Play

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

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

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

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

5 - Remove flywheel.

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

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

8 - Check axial play again.

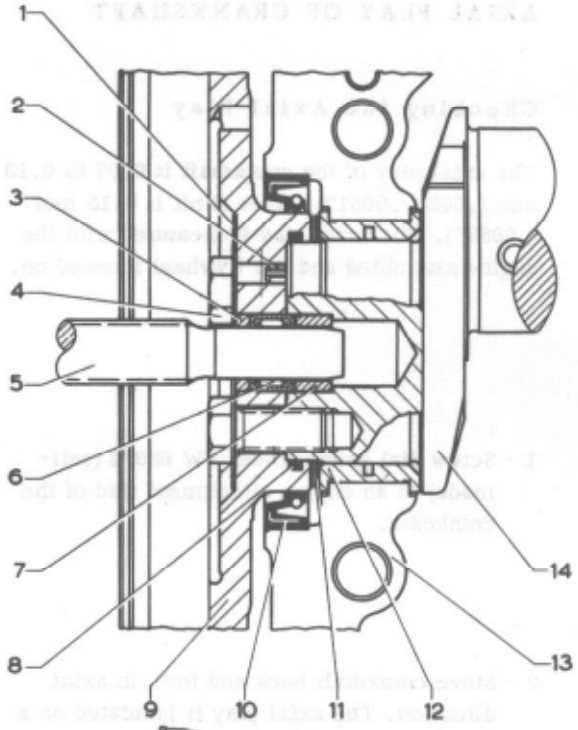
Spacing washers are provited in the following sizes:

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

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

CHECKING AND INSTALLING FLYWHEEL

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



Checkup

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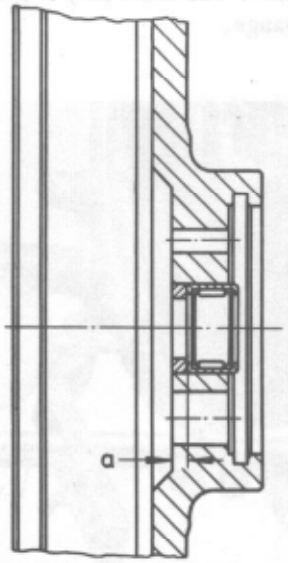
2 - Check bores for hex. screws and clamping sleeve. If bores are worn out, replace flywheel.

3 - Watch out for correct seat of needle bearing.

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



"a" = 3.2 mm (0.126")

Installation

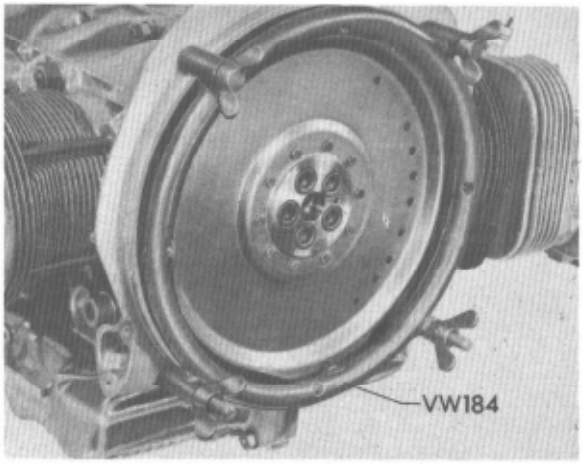
1 - Grease needle bearing in flywheel only with approx. 0.2 cm^3 (0.012 cu.in.) multi-purpose grease, if bearing has been washed. Moisten felt ring with engine oil. Wipe off excess lubricant.

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

3 - Adjust axial play of crankshaft.

4 - Lubricate running surface for sealing ring.

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



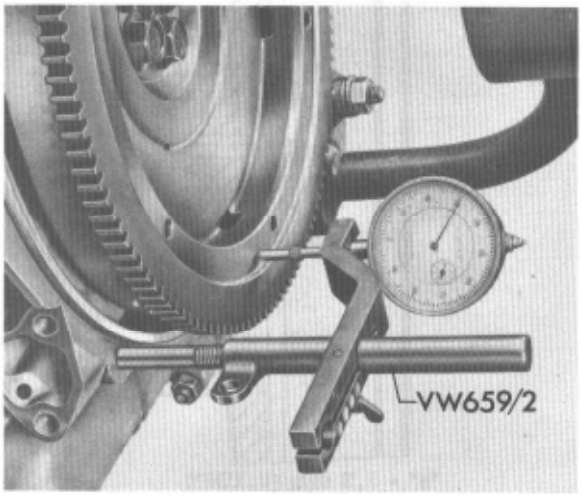
AXIAL PLAY OF CRANKSHAFT

Checking the Axial Play

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

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

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



Adjusting the Axial Play

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

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

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

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

5 - Remove flywheel.

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

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

8 - Check axial play again.

Spacing washers are provited in the following sizes:

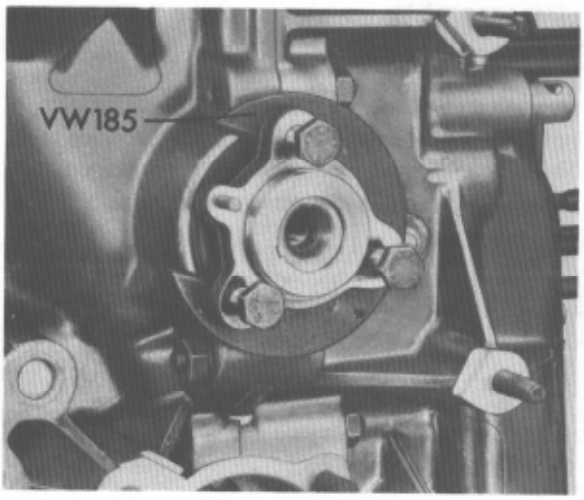
0.24 mm (.0094")	0.34 mm (.0134")
0.30 mm (.0118")	0.36 mm (.0142")
0.32 mm (.0126")	0.38 mm (.0150")

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

REMOVAL AND INSTALLATION OF SEALING RINGS FOR CRANKSHAFT

Removal

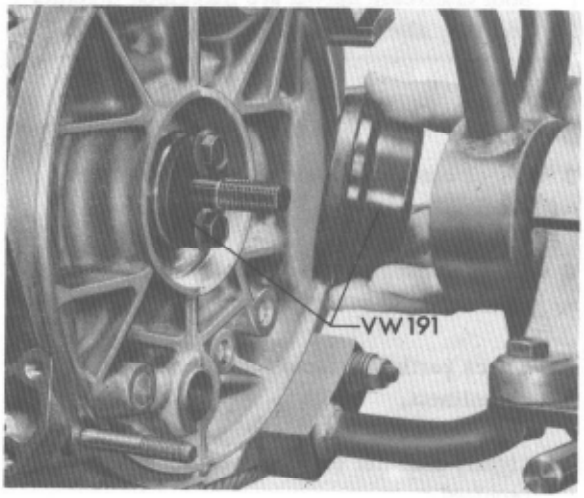
Prior to removing sealing ring on impeller end, force off impeller hub with the assistance of plate VW 185.



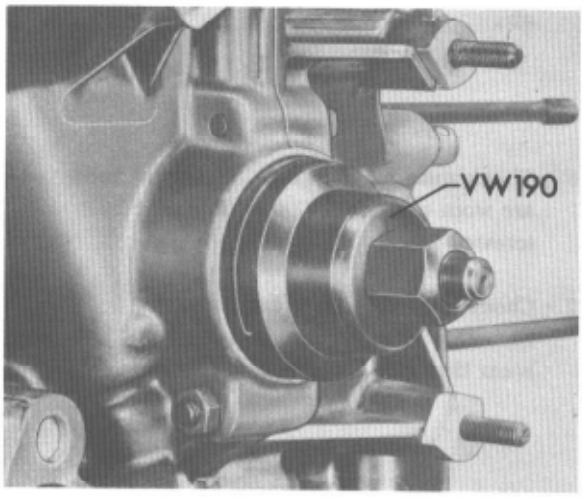
Installation

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

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



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



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

DISASSEMBLY AND ASSEMBLY OF CRANKCASE

Disassembly

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

Checkup

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

1 - Check crankcase for external damage and cracks.

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

3 - Check parting surfaces for planeness and cleanliness.

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

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

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

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

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

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

Assembly

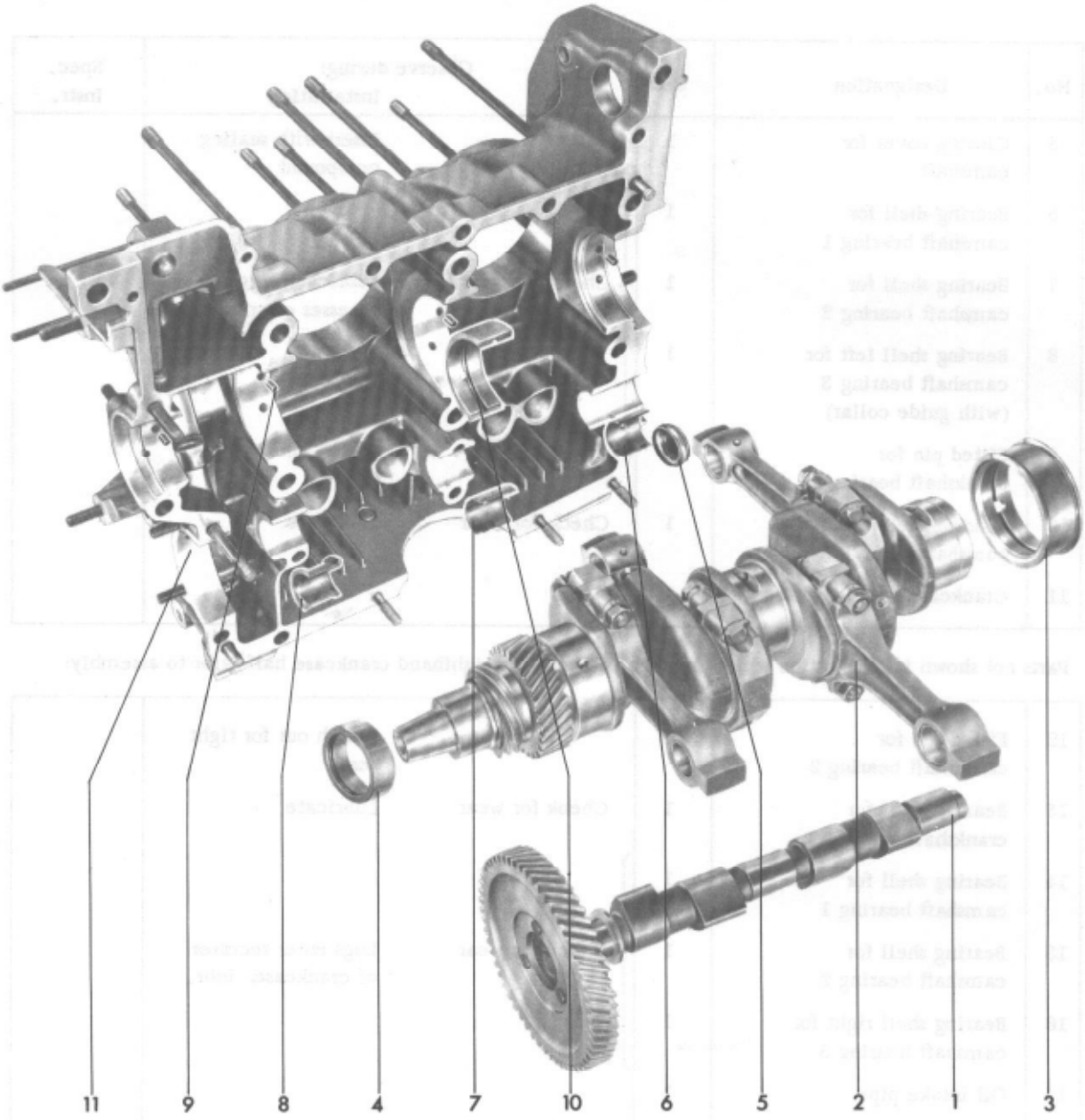
1 - Coat parting surfaces of housing halves uniformly thin with sealing compound. Never permit sealing compound to enter the oil ducts of the crankshaft and camshaft bearings.

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

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

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

5 - Rotate crankshaft to check for easy running.



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

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

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

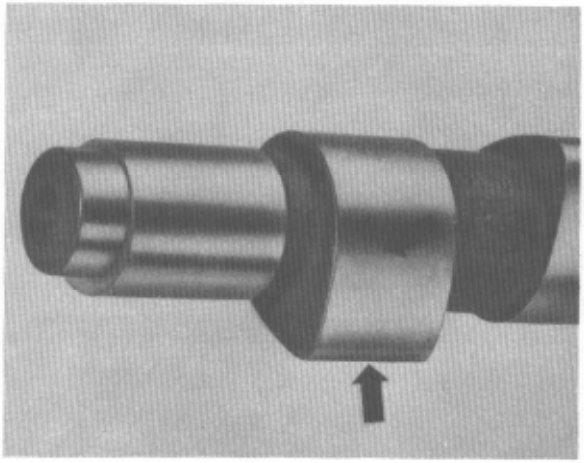
12	Fitted pin for crankshaft bearing 2	1		Watch out for tight seat	
13	Bearing shell for crankshaft bearing 2	1	Check for wear	Lubricate	
14	Bearing shell for camshaft bearing 1	1	Check for wear	Lugs enter recesses of crankcase, lubr.	
15	Bearing shell for camshaft bearing 2	1			
16	Bearing shell right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

INSPECTION AND INSTALLATION OF CAMSHAFT

Checkup

1 - Check riveting of camshaft gear and camshaft.

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

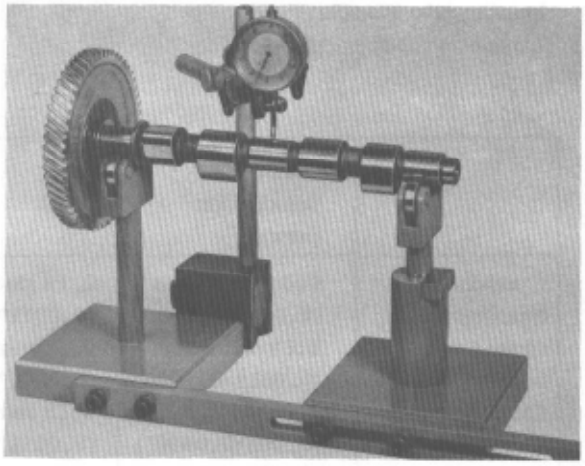


3 - Check camshaft for out-of-true.

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

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

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



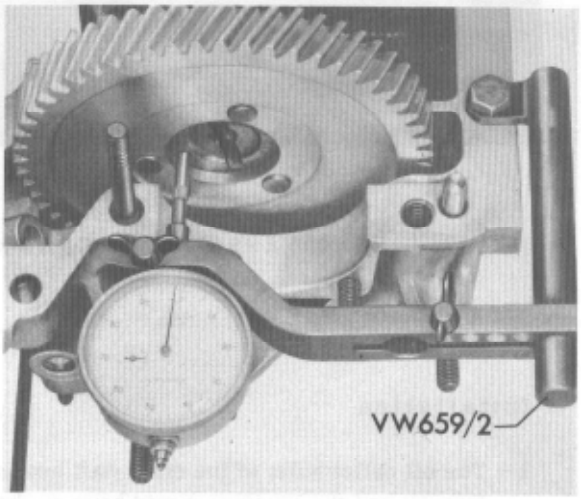
4 - Check camshaft gear for wear and perfect contact pattern.

5 - Check axial play.

The axial play on guide bearing is:

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

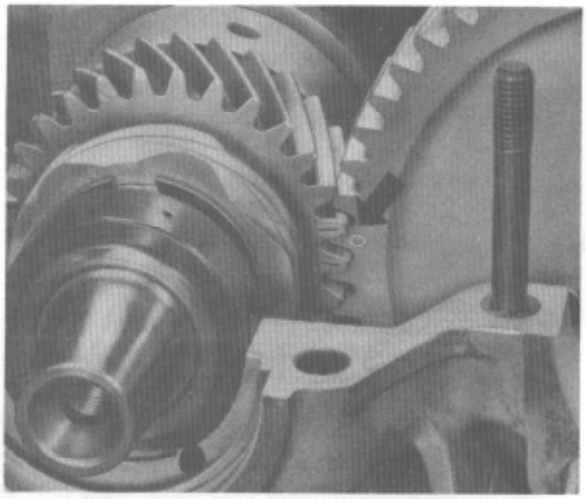
Wear limit: 0.16 mm (.0063")



6 - Check backlash along entire circumference of camshaft gear.

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

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



Installation

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

INSTALLING PREASSEMBLED CRANKSHAFT

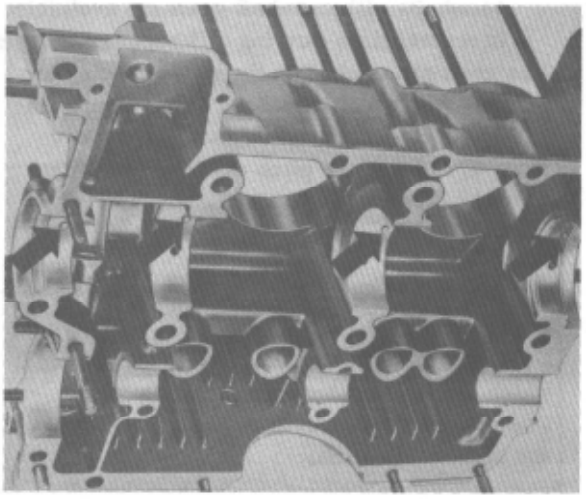
Installation

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

2 - Check set pins for tight seat.

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

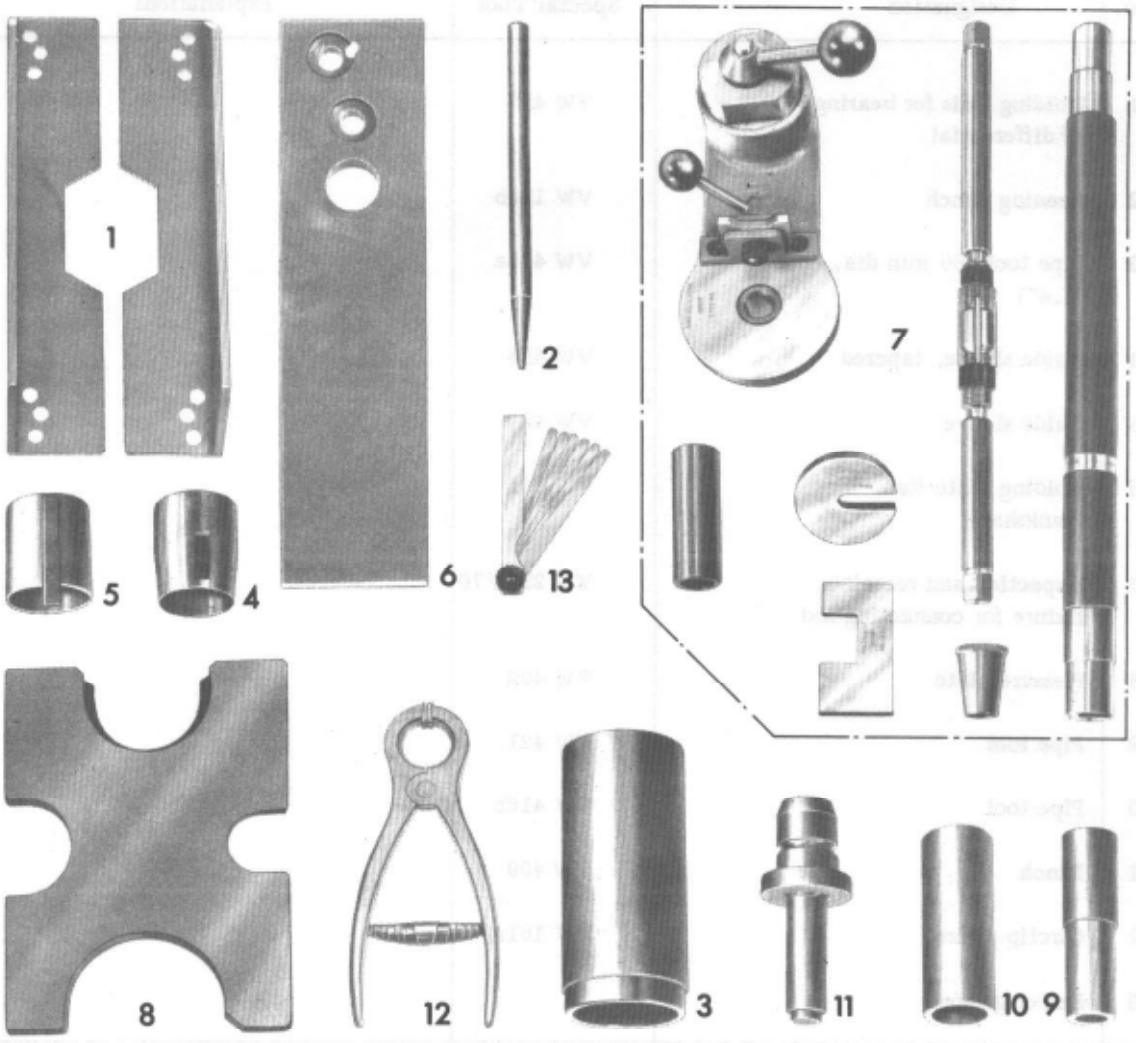
4 - Observe markings of timing gears when installing camshaft.



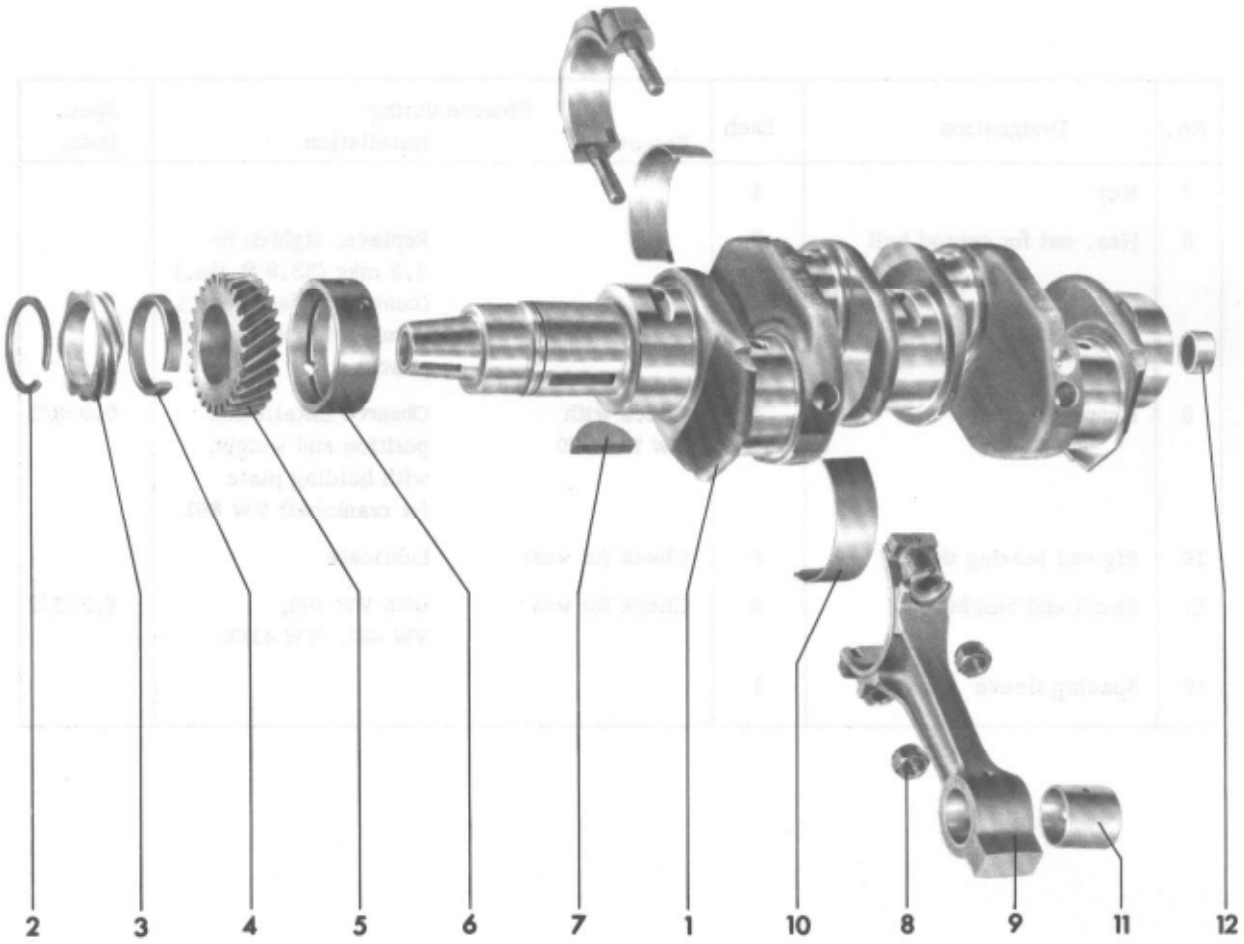
Bearing play, taking bearing pressure through housing into account:

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

TOOLS



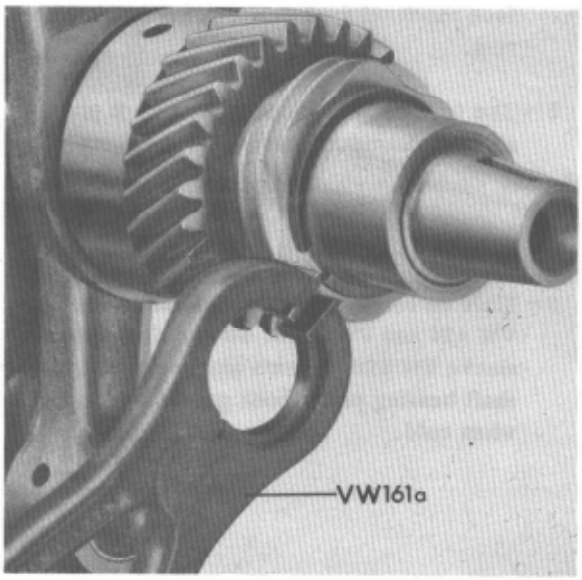
No.	Designation	Special Tool	Explanations
1	Holding rails for bearings of differential	VW 457	
2	Peening punch	VW 124b	
3	Pipe tool, 60 mm dia. (2.4")	VW 415a	
4	Guide sleeve, tapered	VW 428	
5	Guide sleeve	VW 427	
6	Holding plate for crankshaft	VW 801	
7	Inspection and reaming fixture for connecting rod	VW 214f/70	
8	Pressure plate	VW 402	
9	Pipe tool	VW 421	
10	Pipe tool	VW 416b	
11	Punch	VW 409	
12	Circlip pliers	VW 161a	
13	Feeler gauge		



No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Crankshaft	1	Check for wear		6.3-2/1
2	Locking ring	1	with circlip pliers with VW 415a, VW 428, VW 161a		
3	Ignition distributor drive gear	1	Check for wear	Heat to approx. 80 °C (176 °F) with VW 415a, VW 427	6.3-2/1
4	Intermediate ring	1			
5	Crankshaft gear	1	Remove on press with VW 457	Heat to approx. 80 °C (176 °F), chamfer facing bearing 3 with VW 415a, VW 427	6.3-2/1
6	Crankshaft bearing 3	1	Check for wear	Lubricate, hole for set pin facing crank web	

No.	Designation	Each	Observe during: Removal	Installation	Spec. Instr.
7	Key	1			
8	Hex. nut for conrod bolt	8		Replace, tighten to 3.3 mkg (23.9 ft.lbs.) (contact surface lubr.), secure with peening punch	
9	Connecting rod	4	Check with VW 214f/70	Observe installation position and weight, with holding plate for crankshaft VW 801	6.3-3/1
10	Big end bearing shell	8	Check for wear	Lubricate	
11	Small end bushing	4	Check for wear	with VW 402, VW 421, VW 416b	6.3-3/2
12	Spacing sleeve	1			

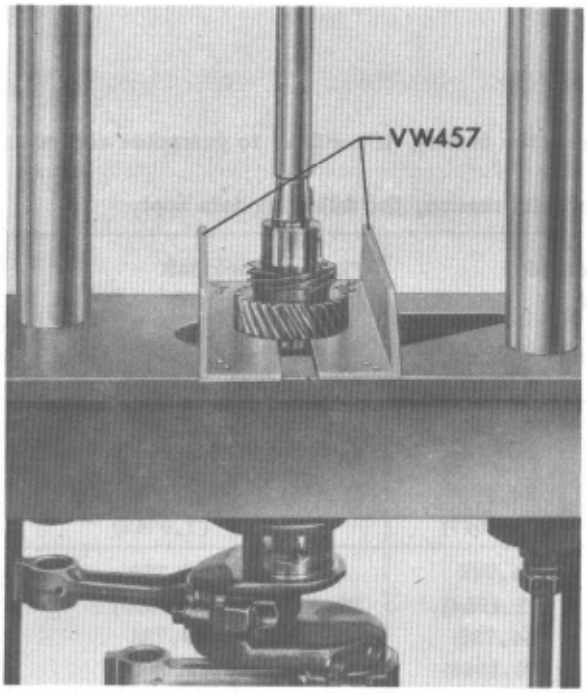
DISASSEMBLY AND PREASSEMBLY OF CRANKSHAFT



Disassembly

1 - Remove locking ring for ignition distributor drive gear with circlip pliers VW 161a.

Caution!
Do not store removed crankshaft without corrosion protection by oil or grease.



2 - Remove ignition distributor drive gear, intermediate ring and crankshaft gear on repair press in combination with holding rails from VW 457.

Slight seizing marks may be carefully removed, but without impairing press seat.

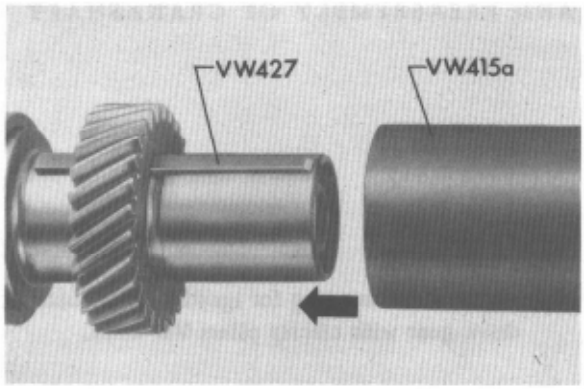
Checkup

Out-of-true on 2nd and 4th bearing (bearings 1 and 3 on V-blocks)	Bearing journals out-of-true	Unbalance
max. 0.02 mm (.0008")	max. 0.03 mm (.0012")	max. 12 cmg

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

2 - Clean crankshaft and blow compressed air through oil ducts.

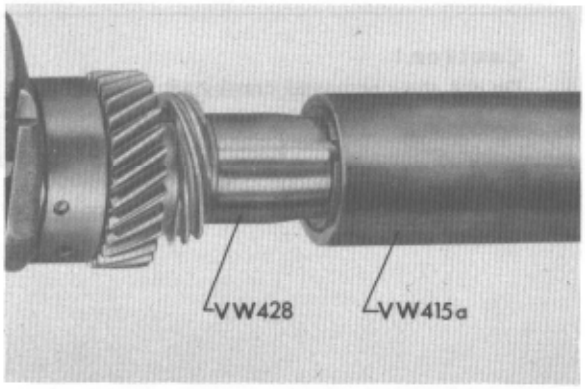
3 - Inspect bore of crankshaft gear and ignition distributor drive gear for seizing marks and check contact pattern of teeth.



Preassembly

1 - Heat crankshaft gear in oil bath to approx. 80°C (176°F) and fit in combination with VW 427 and VW 415a. The chamfer should face the crankshaft bearing. Fit intermediate ring.

2 - The ignition distributor drive gear is pressed on in the same manner.

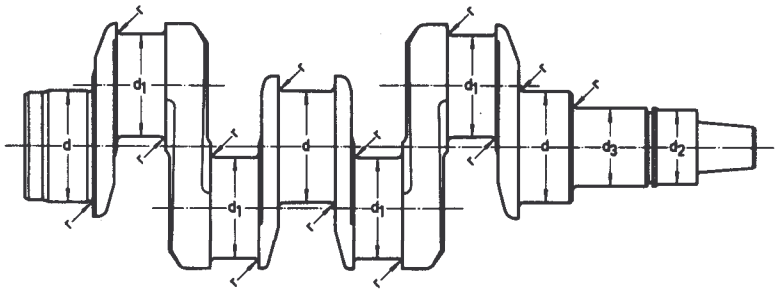


3 - Slide on locking ring in combination with VW 428 and VW 415a. The conical guide sleeve VW 428 prevents any damage to crankshaft bearing pin. Check gears for tight seat when cold.

RECONDITIONING OF CRANKSHAFT

Crankshafts which must be reconditioned should be sent to the factory, if possible, to guarantee accurate and expert regrinding.
In cases where the crankshaft cannot be submitted for special reasons, the following data apply:

	Pins for crankshaft bearings 1, 2 a. 3 (d)		Pins for conrod bearing (d_1)		Pins for crankshaft bearing 4 (d_2)	
	Rated dia. mm (in.)	Lapping dia. mm (in.)	Rated dia. mm (in.)	Lapping dia. mm (in.)	Rated dia. mm (in.)	Lapping dia. mm (in.)
Normal	60.00 (2.362)	59.990 (2.3618) 59.971 (2.3611)	55.00 (2.1654)	54.996 (2.1652) 54.983 (2.1647)	40.00 (1.575)	40.000 (1.5748) 39.984 (1.5742)
Undersize 1	59.75 (2.353)	59.740 (2.3520) 59.721 (2.3512)	54.75 (2.156)	54.746 (2.1554) 54.733 (2.1548)	39.75 (1.565)	39.750 (1.5650) 39.734 (1.5643)
Undersize 2	59.50 (2.342)	59.490 (2.3421) 59.471 (2.3414)	54.50 (2.146)	54.496 (2.1455) 54.483 (2.1450)	39.50 (1.555)	39.500 (1.5551) 39.484 (1.5545)
Undersize 3	59.25 (2.332)	59.240 (2.3323) 59.221 (2.3315)	54.25 (2.136)	54.246 (2.1357) 54.233 (2.1352)	39.25 (1.545)	39.250 (1.5453) 39.234 (1.5446)



$d_3 = \frac{42.006}{41.995}$ mm dia. $= \frac{1.6538}{1.6534}$ in. dia.

$r = \frac{2.5}{2.0}$ mm dia. $= \frac{.098}{.079}$ in. dia.

Careful grinding of radii on crankshaft and camshaft bearing pins is of decisive importance for the life of the crankshaft. Try for a value of 2.5 mm (.098 in.). The radii must be polished.

Regrinding

Never refinish bearing shells.

Following the grinding, be sure that the oil holes have no sharp edges. Chamfer edges lightly, if required.

The crankshaft gear and the ignition distributor drive gear should be pressfit to crankshaft
42.006 mm dia. (1.6538 in.)
41.995 mm dia. (1.6534 in.)
If repeated removal and fitting of these gears will loose the pressfit, chromeplating or the spraying of metal at the pertinent spots may reestablish the required pressfit.

To be sure that the crankshaft is free of cracks, a resonance test is recommended prior to installation. Then check crankshaft for out-of-round.

INSPECTION AND INSTALLATION OF CONNECTING RODS

Checkup

1 - Check connecting rods for external damage. Replace entire connecting rod, even if only the bolts are damaged.

2 - Check connecting rod weight.

The difference in weight of the connecting rods in one engine should not exceed 6 grams.

Conrod weight = conrod complete, but without bearing shells.

2 Weight classes are available for installation,

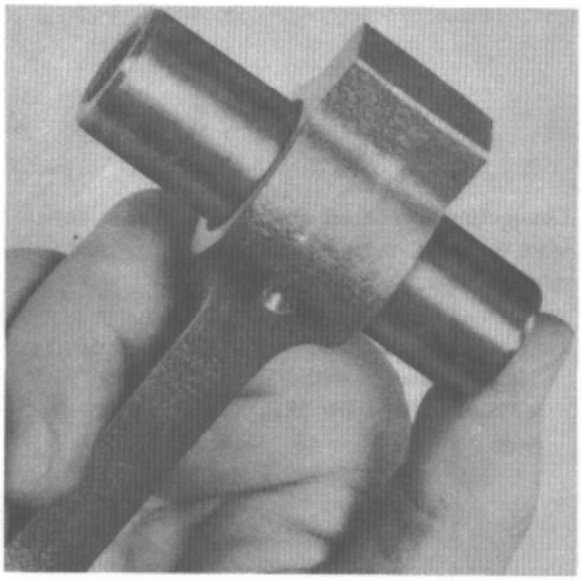
white = 746-752 grams
black = 769-775 grams

which are also available as spare parts.

Refinishing is therefore not required.

The colour coding is on connecting rod cap.

3 - Check conrod bushing. In a new bushing the normally tempered piston pin should slip in easily under light finger pressure.

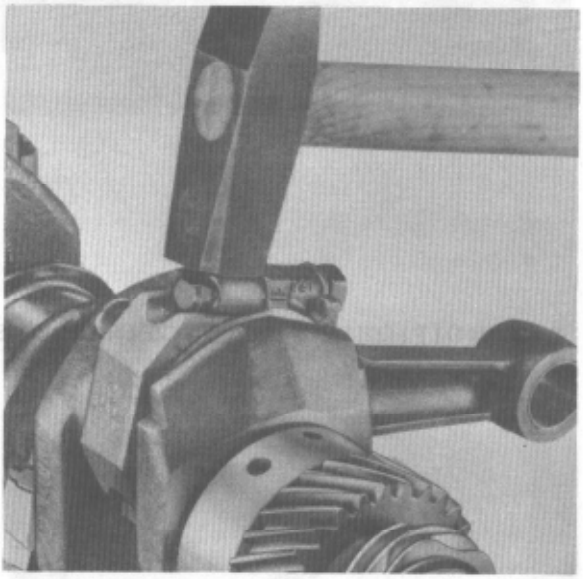


4 - Square connecting rod in conrod testing fixture VW 214f/70; straighten, if required.

Installation

1 - The code numbers on the parting joint of connecting rod top and bottom should be located on one side.

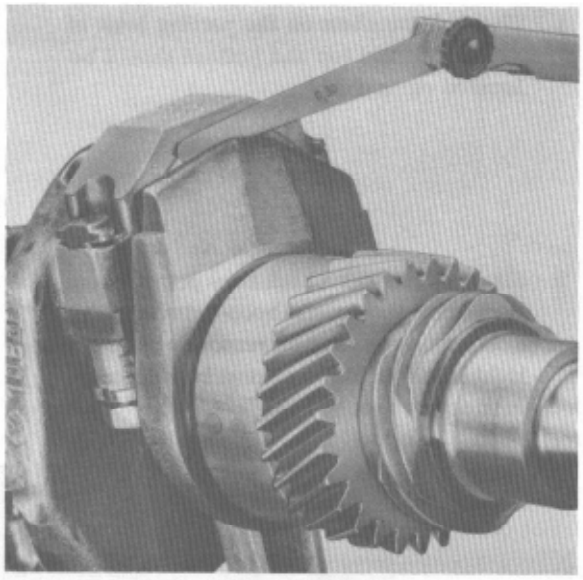
2 - Slight distortions which may occur when tightening the conrod bolts between the bearing halves may be removed by applying light hammer blows against both sides of connecting rod.



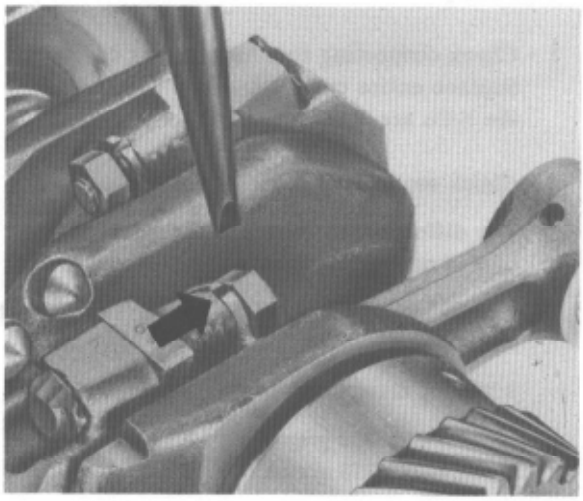
The connecting rod should slide under its own weight. Any refinishing or recessing of bearings is never permitted.

3 - Measuring axial play of connecting rod with feeler gauge.

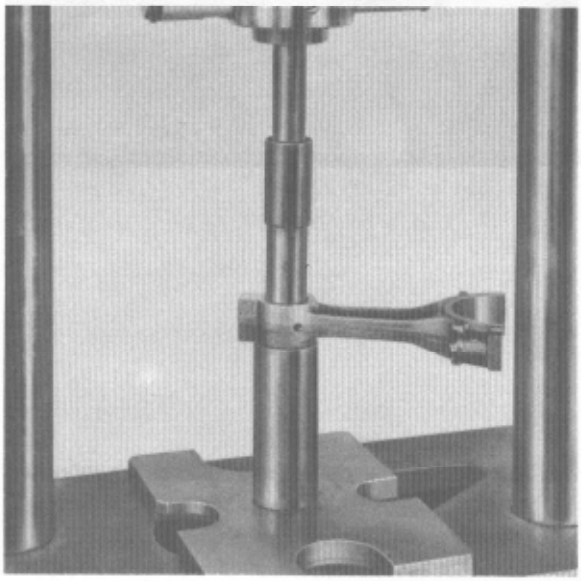
During installation (new): 0.1-0.4 mm (0.004-0.016")
Wear limit: 0.7 mm (0.026")



4 - Secure hex. nuts with peening punch VW 124a.



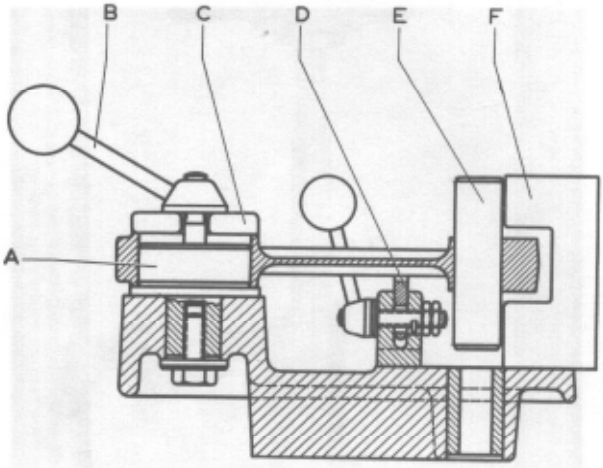
RECONDITIONING CONNECTING RODS



Connecting rods which are slightly bent or have worn bushings, must be squared and provided with new bushings.

1 - Remove small end bushings in VW repair press in combination with VW 402, VW 409, VW 416b, and VW 421.

2 - Insert connecting rod in fixture VW 214f/70.

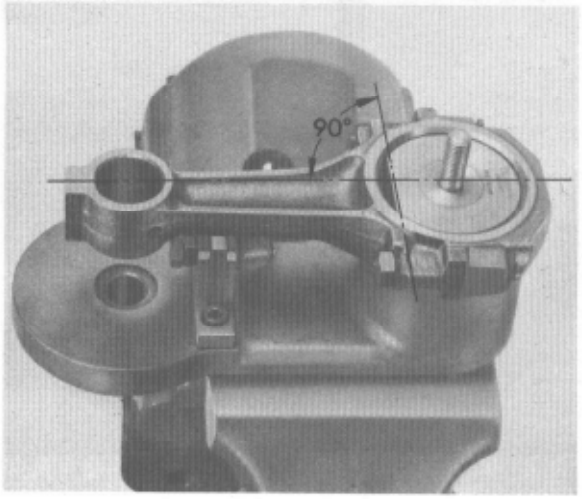


A - Receiving mandrel
B - Locking lever
C - Take-up washer
D - Support
E - Bolt
F - Sight gauge

Turn mandrel A in such a manner that the milled surface is crosswise to center axis of connecting rod.

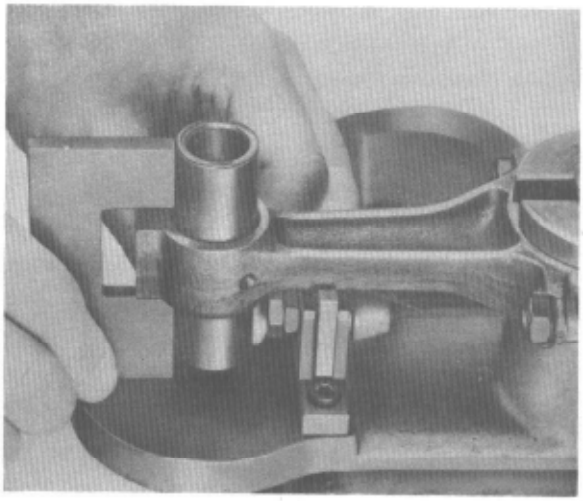
3 - After fitting washer C, tighten locking lever B only to the extent that the connecting rod is still movable in both directions. Support D is loose.

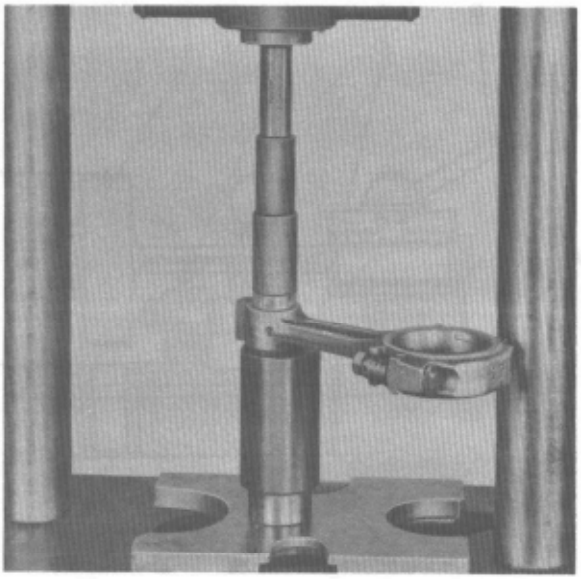
4 - Introduce bolt E into conrod eye and push with two fingers in the direction of mandrel A in such a manner that no canting will occur between the receiving mandrel and the conrod bearing or between the conrod eye and bolt.



5 - Check connecting rod for distortion and parallel alignment. (The illustration shows the inspection for parallel alignment).

If there are deviations, tighten locking lever well and straighten connecting rod with straightening mandrel.





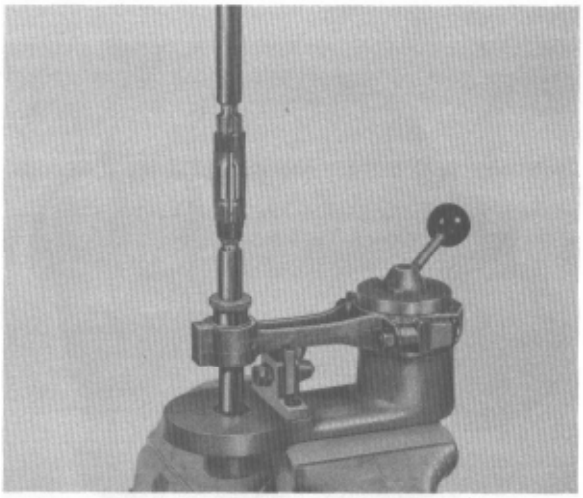
6 - Install small end bushing on VW repair press in combination with VW 402, VW 409 and VW 421.

7 - Drill oil holes (3.5 mm dia. = 0.14").

8 - Place rod of reamer through conrod eye and pertinent bore of fixture, with the conical guide bushing serving for centering the small end bushing.

Tighten locking lever and support for holding connecting rod.

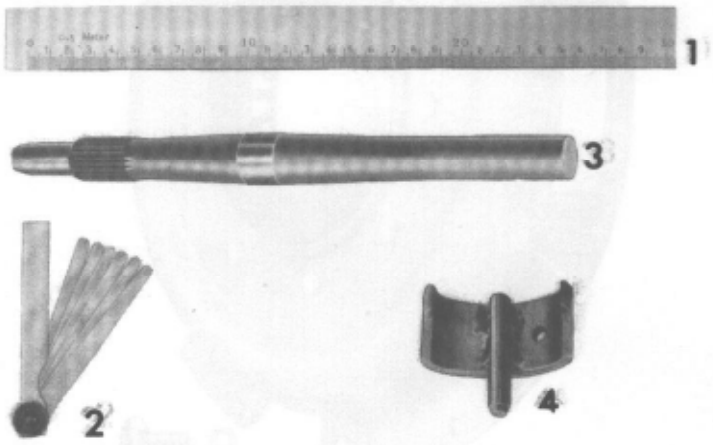
Small end bushing ID	24.015-24.024 mm dia. (0.9455-0.9458")



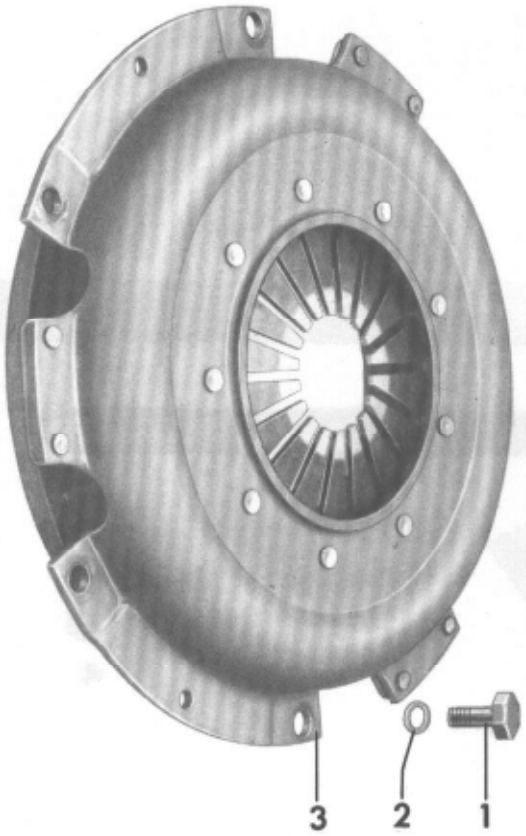
Following the reaming, the inside surface of the bushing should be free of score and chatter marks. The piston pin should slide in easily under finger pressure and without using oil. If bushings have been reamed too much by mistake, the non-permissible play between the piston pin and the bushing should not be compensated by installing an oversize piston pin. Always use a new bushing and ream.

9 - Check parallel alignment and distortion once again, this time with the piston pin inserted as described above. Any slight differences can be straightened out by introducing a mandrel into piston pin.

TOOLS



No.	Designation	Special Tools	Explanations
1	Steel straightedge		at least 200 mm (7.9 in.) long
2	Feeler gauge		commercial
3	Input shaft		
4	Holding clip for flywheel	VW 215c	

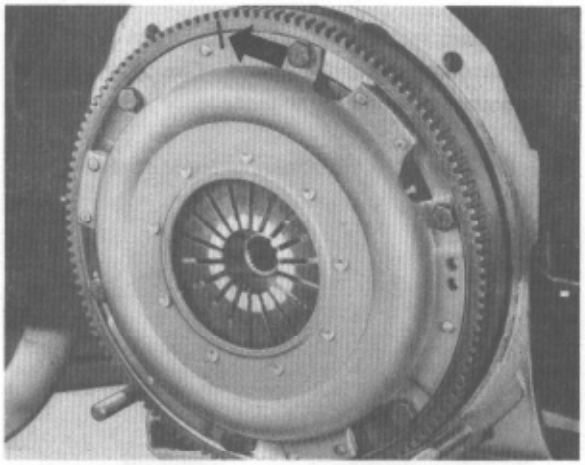


No.	Designation	Each	Observe during: Removal	Observe during: Installation	Spec. Instr.
1	Multi-tooth screw M 7 x 15	6		Tighten crosswise to 2.0 mkg (14.5 ft.lbs.)	
2	Spring plate	6			
3	Diaphragm spring clutch	1	Mark installation position, check for wear		7.1-2/1

REMOVAL AND INSTALLATION OF CLUTCH

Removal

1 - New engines are balanced following assembly, this is why the installation position of the clutch should be marked, to eliminate major unbalance during reinstallation.



2 - Loosen fastening bolts uniformly.

Loosen bolts alternately and crosswise by one or two turns, until the spring action stops, to eliminate any distortion of cover.

Installation

Observe the following instructions for installation:

1 - Clean contact surface of clutch disk in flywheel and check for wear. Surface cracks and score marks can be removed by grinding or machining. If required, replace flywheel.

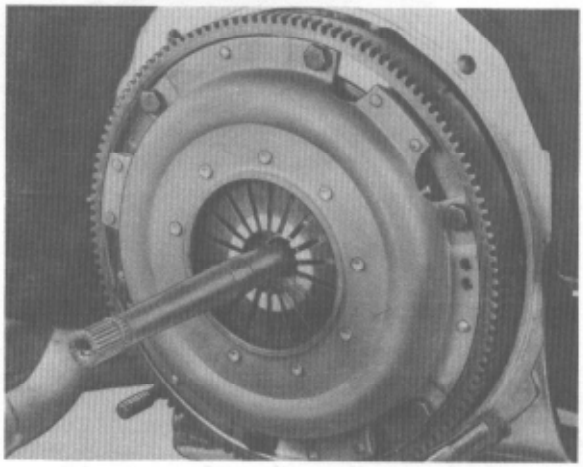
2 - Coat needle bearing in flywheel with approx. 0.2 cm^3 multi-purpose grease only if it has been cleaned. Moisten felt ring with engine oil. Wipe off excess lubricat.

3 - Check clutch and clutch disk. Instructions on how to conduct an inspection are contained in the sections "Inspection of Clutch" and "Clutch Disk".

4 - Check splining of input shaft and coat lightly with molybdenum disulfide powder. Apply powder with a brush or a piece of non-fraying cloth. The clutch disk should slide easily without unpermissible radial play.

5 - Check clutch throwout bearing. The throwout bearing requires no service. Do not wash or flush with cleaning gasoline or other cleaning agents, but with a clean cloth only. Replace bearings which are contaminated inside and loud. Watch out for correct seat of holding springs.
Grease guide bushing lightly with molybdenum disulfide paste.

6 - Insert clutch with clutch disk into flywheel. Accurate centering of clutch disk is performed with the assistance of an input shaft.



7 - Observe balancing marks.
When a new clutch is installed, the balancing marks on clutch and flywheel should be offset by 180°.

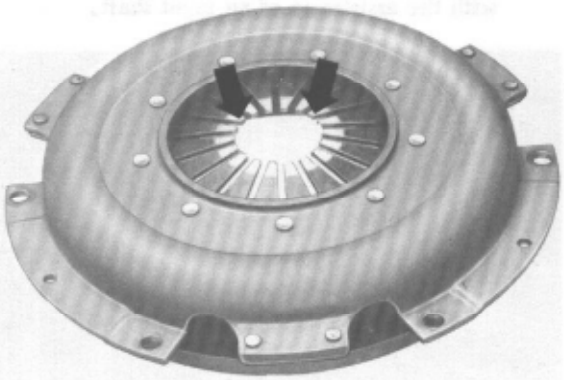
	Designation (heavy end)
Flywheel	White paint stripe on outside edge, if remaining unbalance is between 5 and 20 cmg.
Clutch	White paint stripe on outside edge, if the remaining unbalance is between 5 and 15 cmg.

8 - Tighten fastening bolts uniformly and crosswise to 2.0 mkg. (14.5 ft.lbs.)

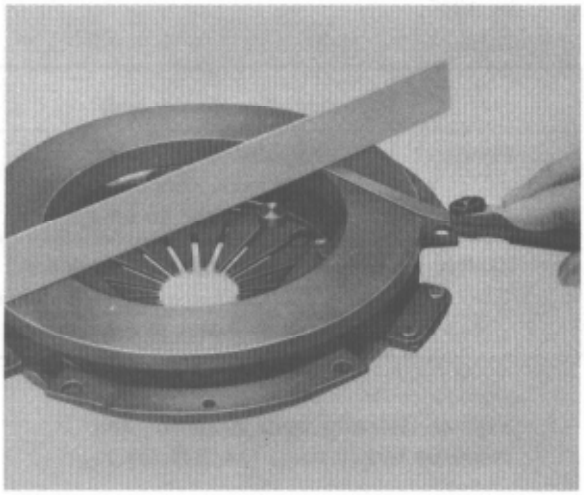
INSPECTING CLUTCH

The inspection of the diaphragm spring clutch is restricted to a thorough sight test. Any reconditioning or repairing of clutch in workshops is not intended.

1 - Check ends of diaphragm spring for wear marks (support of clutch throwout bearing). Wear marks of up to 0.3 mm (0.0012 in.) are of no significance.

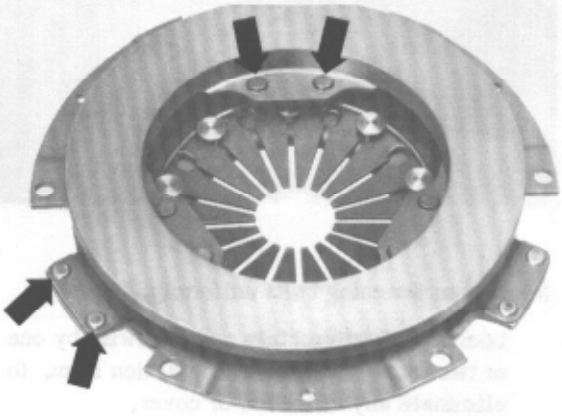


2 - Check supporting surface of pressure plate for cracks, burned spots and wear. Pressure plates which are bent inwards up to 0.3 mm (0.0012 in.) are still fit for installation.



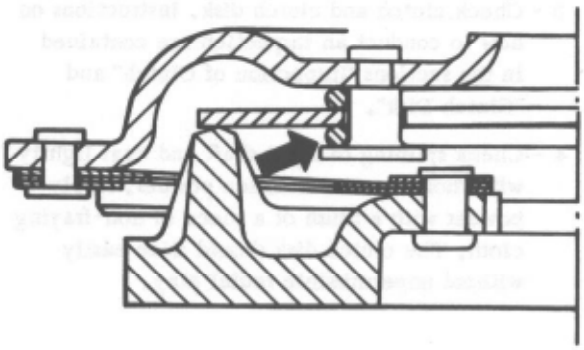
3 - Inspect spring connections between pressure plate and cover for cracks. Check rivet connections for tight seat.

Clutches with damaged or loose riveting

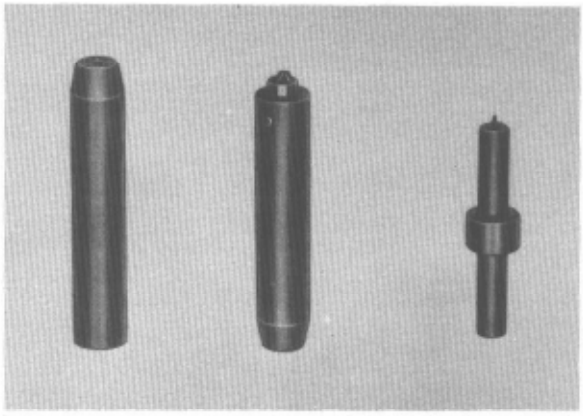


4 - The diaphragm spring is mounted on cover between two wire rings by means of a rivet connection.

Clutches with visible wear on rivet head or wire ring should be replaced.



TOOLS



No.	Designation	Special Tool	Explanations
1	Riveting tool for clutch disk	VW 783	

INSPECTION OF CLUTCH DISK

Toothing:	The clutch disk should slide easily on input shaft without unpermissible radial play. Replace worn parts.
Riveting:	Check riveting; replace clutch disk, if required.
Spring elements:	If the spring elements or the driven plate are cracked, completely replace clutch disk.
Clutch lining:	Replace worn, cracked, oily or burned linings.
Out-of-true:	Check clutch disk for lateral wobble. Max. 0.5 mm (0.02 in.) at 210 mm dia. are permitted, (8.3"). Straighten slightly distorted disks with rubber hammer.

LINING CLUTCH DISK

1 - Unusable linings may not be removed by tearing them off but by drilling the rivets on rivet head end.

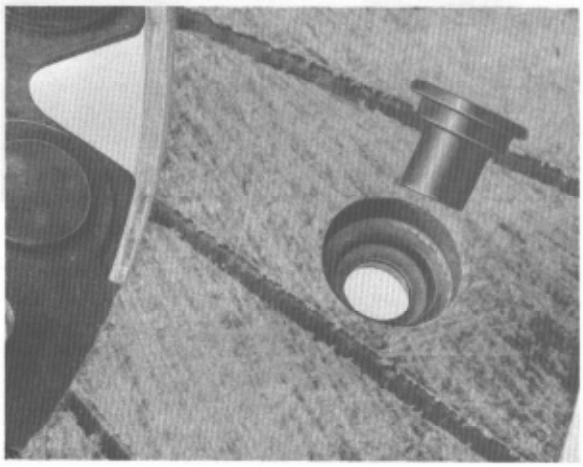
Caution!

Riveting clutch linings on clutch disks with double lining spring is permitted only with riveting tools VW 783. Unsuitable tools may result in the distance between the two lining springs not being maintained.

2 - Use only linings approved by Volkswagen.

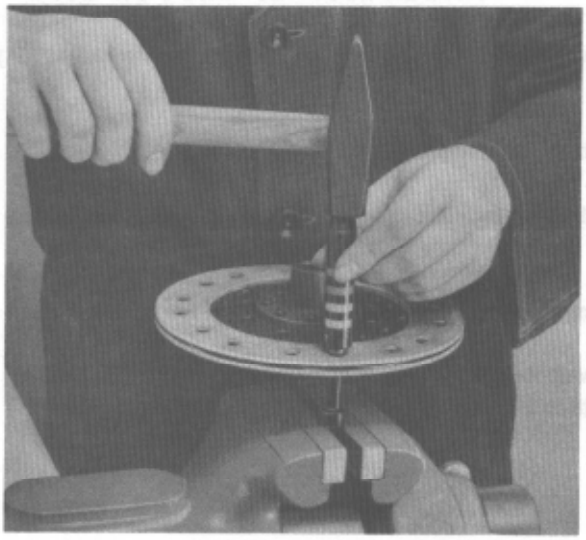
Flywheel end: Jurid or Textar

Clutch end: Textar



3 - For attaching clutch linings on clutch disk use only rivets (spare part No. 311 141 195 A), which have a 2 mm dia. (0.08 in.) bore.

4 - When riveting, be sure that the rivet shoulder is always inserted into the larger bore of the double lining spring. Riveting is done on clutch lining.

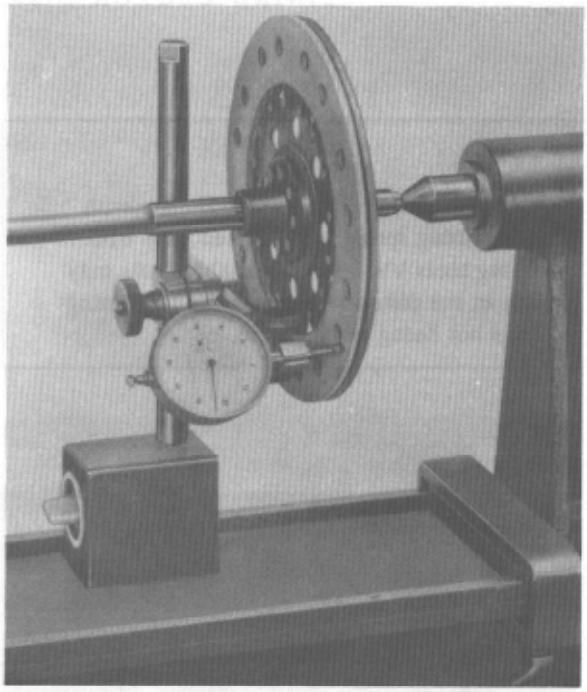


5 - Using riveting tools VW 783:

a - Clamp riveting support into vise.

b - Split rivet with rivet header, but be sure not to turn header.

c - Double-punch individual rivet segments with die.



6 - Upon application of lining, check clutch disk for out-of-true.

Permissible lateral out-of-true (measured at 210 mm dia. = 8.3"): max. 0.5 mm (0.02").

The engine used in Type 914/2.0 vehicles is an air cooled, four cylinder, four cycle unit with valves in head (OHV). The cylinders are arranged in two opposed banks of two cylinders each. The engine is attached to the transaxle by four bolts. The power train, consisting of engine, transmission, and differential, is supported by two mounts, that is, a transverse engine mount, bolted in the center to the crankcase and at both ends to the longitudinal body side members, supporting the forward part of the power train, and the rear transverse mount which rests in rubber cushions.

Ignition System

The ignition system is battery powered. It incorporates an ignition coil and a distributor with automatic spark advance with centrifugal and vacuum control. The ignition system transforms battery voltage from 12 volts to the required ignition voltage, delivering it to each of the four spark plugs in proper sequence and at an exact firing time with the aid of a distributor. The distributor is driven by the crankshaft through a worm gear and shaft.

Cooling

The cooling system utilizes a radial blower. The blower impeller is attached to the crankshaft hub by three bolts. It draws air through an opening in the blower housing and forces it through shrouds and baffles to the finned cylinders and cylinder heads. Part of the fresh cooling air is used for the interior compartment heating by passing through heat exchangers which encase part of the exhaust pipes.

A thermostat located below cylinders 1 and 2 actuates two flaps in the intake ducts of the forward half of the cooling blower housing by means of a control cable. The flaps control the flow of fresh air to permit quicker engine warmup and also maintain a fairly constant operating temperature under all load conditions; this provision does not affect the flow of heating air.

Oil Circulation

The engine is lubricated by a forced feed system with an oil cooler. The gear type oil pump is located on the driven end of the camshaft and is driven by it. The oil is picked up from the lowest point in the crankcase and forced into the oil galleries in the crankshaft to lubricate the connecting rods. Another part of the oil lubricates the camshaft bearings, while still another part flows through the hollow push rods to the rocker arms where it lubricates rocker arm bearings and the valve stems. The cylinder walls, pistons, and piston pins are splash lubricated.

Dirt particles are kept out of the lubrication system by a full flow oil filter as well as a screen located at the lowest point in the crankcase. Should the oil filter become clogged, a ball check valve located in the filter base opens a bypass channel allowing the oil to flow directly to the points of lubrication.

The oil cooler is mounted on the crankcase side and is cooled by air drawn by the cooling blower. It is located in the oil circuit in such way that oil pumped by the pump must pass through the oil cooler before reaching the individual lubrication points. This cooling system ensures that the oil retains all its lubricating qualities even at high outside air temperatures and maximum engine loads.

A bypass valve allows part of the oil to bypass the oil cooler and flow directly to the oil galleries when the oil is cold and thick. A pressure relief valve located at the oil circuit terminal end maintains an oil pressure of about 2.0 atm (25.5 psi) in the main bearing and camshaft bearing area.

An oil pressure switch (sensor) is located in the pressure line between the oil pump and oil cooler. It opens the warning lamp circuit when the oil pressure has reached 0.15 - 0.45 atm (2.2 - 6.5 psi).

The oil pressure warning lamp lights up when the ignition switch is turned on or when the oil pressure is too low.

Cylinder Heads

Each two cylinders have one common, removable, and extensively finned light alloy cylinder head with shrunk-in valve seats and guides. The valves are located overhead. The exhaust valves are armored in high grade chrome-nickel steel. In addition, to provide better heat dissipation, the stems are sodium filled.

Valve Timing

The camshaft is located in the crankcase and rides in three split-sleeve steel inserts which are coated with white metal. It is driven by the crankshaft through helical gears. Bearing number 3 takes up the axial thrust of the camshaft. Camshaft gear is made of light alloy and is riveted to the camshaft. Valve timing is effected by cams through cam followers, pushrods, and rocker arms. Each cam actuates one valve in each of two opposing cylinders.

Cylinders

The four special-cast cylinders are uniform in design and can be individually replaced together with their corresponding pistons. Cooling is by air with heat dissipation through integral cooling fins.

Pistons

The steel reinforced pistons have two compression rings and one oil scraper ring in each. An expander is located between the piston and oil scraper ring. The piston pins float in the small end bushing of the connecting rods and are secured in the pistons by circlips.

Crankcase

The two-piece crankcase is made of pressure cast light alloy. Both halves are machined together as a pair during manufacture and cannot be replaced individually.

Crankshaft

The crankshaft is symmetrically forged with all bearing journals induction hardened. Four main bearings are used. Bearings 1, 3, and 4 are aluminum-sleeve inserts with leaded surface. Bearing ≠ 2, as seen from the clutch side, is a split-sleeve tri-metal insert. Bearing ≠ 1 also takes up the axial thrust of the crankshaft. The flywheel, with integral starter gear, is attached with five bolts and secured against torsional slippage. Camshaft and distributor drive gears are secured with Woodruff keys. The hub of the cooling blower impeller is seated on the conical shaft end and secured with a Woodruff key and nut. *Crankshaft sealing at the flywheel and cooling blower ends is by means of oil seals.*

Connecting Rods

The four connecting rods are steel forgings with I-section shank. The big ends of the connecting rods ride on tri-metal bearing inserts; the small ends have lead-bronze coated steel bushings to accomodate the piston pins.

Clutch

The single plate, dry clutch disc has linings on both sides and is free to move axially on the input shaft splines. The clutch cover, which accomodates the clutch pressure plate and diaphragm spring, is bolted to the flywheel. In engaged condition, the clutch disc is pressed against the flywheel by the clutch pressure plate and diaphragm spring, thus providing for power transfer between engine and transmission.

Distributor - 1975 Models

AFC Fuel Injected Engine

The distributor centrifugal spark advance vacuum retard curves are identical to the 1974 specifications (vacuum spark advance is not used).

Distributor rotor without speed limiter

Distributor rotor with speed limiter

Engine speed is controlled by the distributor rotor with a built-in speed switch (except California). California vehicles have a separate speed switch that limits the fuel supply.

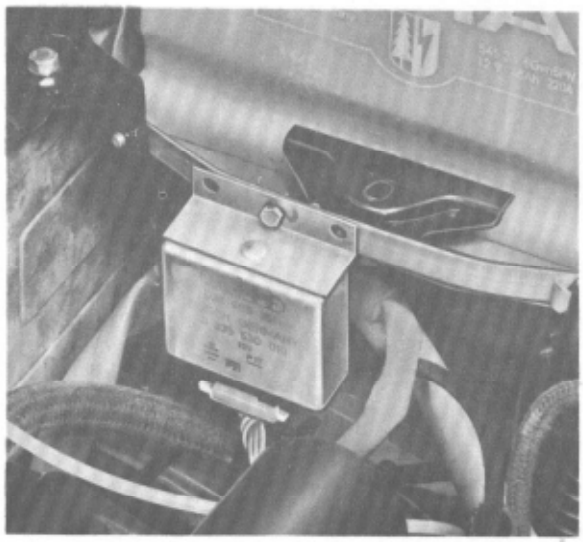


TABLE OF ENGINES

Model Year	Code	Displ. cm^3	Output DIN HP at rpm (SAE net)	Stroke/Bore mm	Compression Ratio	Fuel System	Version
1970	W	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1971	W	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1972	EA	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
1973	EA	1679	80/4900 (76)	66/90	8.2 : 1	MPC	USA
	EB	1679	72/5000 (69)	66/90	7.3 : 1	MPC	California
	GA	1971	95/4900 (91)	71/94	7.6 : 1	MPC	USA
1974	EC	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	USA
	GA	1971	95/4900 (91)	71/94	7.6 : 1	MPC	USA
1975	EC-a	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	USA
	EC-b	1795	76/4800 (72,5)	66/93	7.3 : 1	AFC	California
	GC-a	1971	88/4900 (84)	71/94	7.6 : 1	MPC	USA
	GC-b	1971	88/4900 (84)	71/94	7.6 : 1	MPC	California

TECHNICAL DATA

Power Rating	70 KW (95 DIN HP)
Identification Symbol	GA
Type	aircooled 4-stroke gasoline injection engine integrated with transmission and differential in rear of vehicle
Number of cylinders	4
Cylinder arrangement	opposed four, 2 cylinders each bank
Bore	94 mm
Stroke	71 mm
Piston displacement	1971 cc
Compression ratio	7.6:1
Max. power output (DIN) KW $\frac{1}{min}$ (HP/rpm)	70/4900 (95/4900)
Max. torque (DIN) Nt $\frac{1}{min}$ (mkg rpm)	147/3000 (15.0/3000)
Mean piston speed m/s $\frac{1}{min}$ (m/s rpm)	11.6/4900
Octane	91 RON (research method)
Total weight, dry	approx. 146 kg
Ignition	battery ignition
coil	12 V
distributor	see page 22.2-1/1 for version
engine speed limiter	5850 $\pm$ 100
firing point BTC	27°
firing order	1 - 4 - 3 - 2
spark advance	centrifugal force and vacuum
dwell angle	44-50°
spark plugs	M 14x1.25x19, heat range value 175
electrode gap	0.7
Cooling air	
transfer capacity ltr/sec rpm	800/4600
Lubrication	forced feed, by gear-type pump
oil cooling	oil cooler in air stream of blower
oil filter	full-flow
oil pressure indication	by control lamp
oil capacity	3.5 ltr with filter change 3.0 ltr without filter change
oil consumption, ltr/1000 km	0.5 - 1.0
Cylinder heads	1 per 2 cylinders, with integral cooling fins, aluminum alloy
valve seats	shrunk-in, sintered steel
valve guides	shrunk-in, special brass
spark plug threads	cut into cylinder head
Valve timing	1 camshaft under crankshaft; cam followers, pushrods, and rocker arms guided in housing
Valves	1 intake and 1 exhaust valve per cylinder
exhaust valves	armored seat; sodium filled stem
arrangement	overhead
clearance - intake exhaust	0.15 mm) 0.20 mm) with cold engine
Valve springs	1 spring per valve

TECHNICAL DATA

Power Rating	70 KW (95 DIN HP)
Identification Symbol	GA
Valve timing with 1 mm valve clearance:	
intake opens	12° BTC
intake closes	42° ATC
exhaust opens	43° BTC
exhaust closes	4° ATC
Cylinders	individual cylinders, special grey casting with integral cooling fins
distance between centers	124.5 mm
Pistons	light alloy with steel liner
piston pins	floating, circlip secured
piston rings	2 compression rings 1 oil scraper ring
Crankcase	two-piece, divided vertically through main bearings and camshaft bearings, aluminum alloy
Camshaft	grey cast, with 3 bearings
camshaft bearings	thin-wall steel split inserts with white metal surface
camshaft drive	helical gears
Crankshaft	forged high-grade steel, 4 plain bearings
main bearings ≠ 1, 3 and 4	aluminum sleeves, lead coated
main bearing ≠ 2	split sleeve, tri-metal
main bearings ≠ 1-3	60 mm dia.
main bearing ≠ 4	40 mm dia.
connecting rod bearings	50 mm dia.
flywheel	forged, integral with starter ring gear
Connecting rods	forged, with I-shaped shank cross-section
connecting rod bearings	thin-wall, tri-metal split sleeve inserts
piston pin bushings	pressed-in steel sleeves with lead-bronze surface
Clutch	diaphragm spring clutch
type	single plate, dry
total facing area	375 cm^2

TOLERANCES AND WEAR LIMITS

Parts reaching or coming close to the values shown in the "Wear Limit" column should not be reinstalled during overhaul. Consider the oil consumption of the given engine when determining the wear limits of pistons and cylinders.

NOTE: The values are in mm when unit specifications are not shown.

Power Rating		70 KW (95 HP)	
Code		GA	
		When new	Wear limit
Cooling System			
Thermostat	opening pressure	65-70° C	
Impeller/V-belt pulley	unbalance	max. 5 cmg	
Oil Circuit			
1 - Oil pressure (SAE 30 grade only) at 70° C oil temperature and 2500 rpm	pressure	ca. 4.4 bar (4.5 atm)	2 bar (atm)
2 - Spring for oil pressure reliev valve, compressed length = 39,0 mm	load	66,7-86,3 N (6,8-8,8 kg)	
3 - Spring for oil pressure control valve, compressed length - 16.8 mm	load	42.7 N (4.35 kg)	
4 - Oil pressure switch opens at	pressure	0.15 - 0.45 bar (atm)	
Cylinder Head and Valves			
1 - Seat depth for cylinder in cylinder head		5.4 - 6.6	
2 - Combustion chamber volume		58.7 - 60.2 cm^3	
3 - a) Rocker arm	inside diameter	20.0 - 20.02	20.04
b) Rocker arm shaft	diameter	19.95 - 19.97	19.93
4 - Valve spring, compressed length = 30 mm	load	711.2 - 818.1 N (72.5 - 83.5 kg)	
5 - Valve seat			
a) Intake	width	1.8 - 2.2	
b) Exhaust	width	2.0 - 2.5	
c) Intake	seat angle	45°	
d) Exhaust	seat angle	45°	
e) Outer correction	bevel angle	15°	
f) Inner correction	bevel angle	75°	
6 - Valve guide			
Intake	bore diameter	8.00 - 8.02	8.06
Exhaust	bore diameter	9.00 - 9.02	9.06
7 - Valve stem			
Intake	diameter	7.94 - 7.95	7.90
Exhaust	diameter	8.91 - 8.92	8.87
8 - Valve guide/valve stem			
Intake and exhaust	side clearance	max. 0.30	1.2
9 - Valve head			
Intake	diameter	42.0	
Exhaust	diameter	36.0	
10 - Valve clearance (cold)			
Intake	adjustment	0.15	
Exhaust	adjustment	0.20	

Power Rating		70 KW (95 HP)	
Code		GA	
		When new	Wear limit
11 - Compression pressure (with open throttle and engine at operating temperature, all spark plugs removed, with compression gauge in spark plug seat without blowby, engine cranked by starter motor)	pressure	8.3 - 10.8 bar (8.5 - 11.0 atm)	6.4 bar (6.5 atm)
Pressure difference between cylinders			max. 1.5 bar
Cylinder and Piston			
Two oversizes, each with 0.5 mm greater diameter			
1 - Cylinder	out-of-round	max. 0.01	
2 - Cylinder/piston	clearance	0.02 - 0.05	0.20
3 - a) Upper piston ring	side clearance	0.04 - 0.07	0.12
b) Lower piston ring	side clearance	0.04 - 0.07	0.10
4 - Oil scraper ring	side clearance	0.02 - 0.05	0.10
5 - a) Upper piston ring	ring gap	0.35 - 0.55	0.90
b) Lower piston ring	ring gap	0.35 - 0.55	0.90
6 - Oil scraper ring	ring gap	0.25 - 0.40	0.95
7 - Piston weight			
8 - Weight difference between pistons		max. 4 g	max. 10 g +)
+) In the event of repairs			
Crankcase			
1 - Main bearing seat			
a) Bearings 1-3	diameter	70.00 - 70.02	70.03
b) Bearing 4	diameter	50.00 - 50.04	50.04
2 - Oil seal seat, flywheel side . . .	diameter	95.00 - 95.05	
3 - Oil seal seat, blower side	diameter	62.00 - 62.05	
4 - Camshaft bearing seat	diameter	27.50 - 27.52	
5 - Oil pump housing seat	diameter	70.00 - 70.03	
6 - Valve lifter bore	diameter	24.00 - 24.02	24.05
Camshaft			
1 - Bearings 1-3	diameter	24.99 - 25.00	
2 - Center bearing runout (Bearings 1 and 3 on V-blocks)	runout	max. 0.02	0.04
3 - Camshaft/camshaft bearing clearance (including preload exerted by housing)	side play	0.02 - 0.05	0.12
Thrust bearing	end play	0.04 - 0.13	0.16
4 - Camshaft gear	backlash	0.00 - 0.05	
5 - Valve lifter	side play	23.96 - 23.98	23.93
6 - Housing bore/valve lifter	side play	0.02 - 0.06	0.12
7 - Pushrod	runout	max. 0.3	

Power Rating		70 KW (95 HP)	
Code		GA	
		When new	Wear limit
Crankshaft and Connecting Rods			
Three undersizes, each with 0.25 mm smaller diameter			
1 - a) Bearings 1 - 3	diameter	59.97 - 59.99	
b) Bearing 4	diameter	39.98 - 40.00	
c) Connecting rod bearing	diameter	49.98 - 49.99	
2 - Crankshaft runout at Bearing 2 and 4 (Bearings 1 and 3 on V-blocks)	runout		0.02
3 -	unbalance	max. 12 cmg	
4 - Main bearing journal	out-of-round		0.03
5 - Crankpin	out-of-round		0.03
6 - Crankshaft/main bearing clearance (including preload exerted by housing)			
a) Bearings 1 and 3)	side play	0.05 - 0.10	0.18
b) Steel bearing 2	side play	0.03 - 0.09	0.17
c) Bearing 4	side play	0.05 - 0.10	0.19
7 - Crankshaft/main bearing 1	end play	0.07 - 0.13	0.15
8 - Crankpin/connecting rod	side play	0.02 - 0.07	0.15
	end play	0.10 - 0.40	0.70
9 - Connecting rod weight			
10 - Weight difference between connecting rods		max. 6 g	
11 - Piston pin	diameter	23.99 - 24.00	
12 - Small end bushing	diameter	24.01 - 24.02	
13 - Piston pin/bushing	side play	0.02 - 0.03	0.04
14 - Flywheel runout (measured in center of clutch friction surface)	lateral runout	max. 0.4	
	unbalance	max. 20 cmg	
Oil seal contact flange	outside diameter	74.9 - 75.1	74.4
Machining starter gear teeth			max. 2
Clutch			
1 - Total clutch pressure	pressure	4903 - 5491.8 N (500 - 560 kg)	
2 - Total clutch unbalance	unbalance	max. 15 cmg	
3 - Pressure plate runout	lateral runout		0.10
4 - Clutch disc (measured at 210 mm dia.)	lateral runout	max. 0.5	

TIGHTENING TORQUES

Designation	Thread	Nm (mkg) ft. lbs
1 - Bolts for U-joint shaft	M 8 x 1.25	44.1 (4.5) 32.5
2 - Transmission support nuts	M 8	19.6 (2.0) 14.5
3 - Engine support nuts (body)	M 10	29.4 (3.0) 21.7
4 - Nuts securing engine to transmission	M 10	29.4 (3.0) 21.7
5 - Spark plugs	M 14 x 1.25	34.3 (3.5) 25.3
6 - Nut for small V-belt pulley	M 14 x 1.5	58.8 (6.0) 43.4
7 - Cooling blower impeller bolts	M 8	19.6 (2.0) 14.5
8 - Oil pump nuts	M 8	19.6 (2.0) 14.5
9 - Oil drain plug	M 12 x 1.5	21.6 (2.2) 15.9
10 - Retaining nut for oil screen cover	M 8	12.7 (1.3) 9.4
11 - Nuts for rocker arm shaft	M 7	13.7 (1.4) 10.1
12 - Cylinder head nuts	M 10	31.4 (3.2) 23.1+)
13 - Engine support bolts (crankcase)	M 8	29.4 (3.0) 21.7
14 - Bolt for blower impeller hub	M 8	31.4 (3.2) 23.1
15 - Flywheel bolts	M 12 x 1.5	107.9 (11.0) 79.6
16 - Bolts and nuts for crankcase halves	M 8	19.6 (2.0) 14.5
17 - Nuts for crankcase halves	M 10 x 1.25	32.4 (3.3) 23.9 +++)
18 - Connecting rod nuts	M 9 x 1	32.4 (3.3) 23.9 ++)
19 - Clutch bolts	M 8	23.5 (2.5) 18.1

+) Tightening sequence - see page 25.1-2/5

++) Use new nuts, oil contact surface

+++) Place O-ring outside

SPECIAL TOOLS

1	Engine adapter for garage jack	VW 612/4
2	Bench clamp for engine mount	VW 313
3	Engine bench mount	VW 307a
4	Carburetor actuator	Local manufacture
5	Puller	Local purchase item
6	Oil cooler tester	VW 661/2
7	Oil pump cover puller	VW 803
8	Assembly plate and valve guide tester	US 4400 A
9	Valve spring depresser	VW 311s
10	Piston pin mandrel	VW 207c
11	Oil filter remover	Local purchase item
12	Oil seal installer (blower impeller side)	VW 190
13	Oil seal installer (flywheel side)	VW 191
14	Dial gauge holder	VW 659/2
15	Blower hub remover	VW 185
16	Flywheel lock	VW 215c
17	Internal-head socket adapter, M 14	Local purchase item
18	Press adapter plates (differential side bearing removal)	VW 457
19	Notching punch	VW 124a
20	Press tube, 60 mm dia.	VW 415a
21	Tapered guide sleeve	VW 428a
22	Wrench for oil pressure switch	Local purchase item
23	Crankshaft support plate	VW 801
24	Connecting rod aligning and reaming set	VW 214f/70
25	Press plate	VW 402
26	Press tube	VW 421
27	Press block	VW 409
28	Lock ring pliers	VW 161a
29	Press tube	VW 416b
30	Oil pressure and oil pressure switch test set	Local purchase item

31	Feeler gauge	Local purchase item
32	Valve adjusting wrench	Local purchase item
33	Valve lapper	Local purchase item
34	Inside micrometer	Local purchase item
35	Micrometer, 75-100 mm	Local purchase item
36	Piston ring expander	Local purchase item
37	Piston ring compressor	Local purchase item
38	Internal-head socket adapter, M 12	Local purchase item
39	Lock ring pliers, offset	Local purchase item
40	Metal straight-edge, 200 mm long	Local purchase item
41	Input shaft section	Local purchase item
42	Timing light	Local purchase item
43	Tach-dwell meter	Local purchase item
44	Vacuum gauge, measuring ranges 0-133 and 0-798 mbar (0-100 and 0-600 mmHg)	Local purchase item
45	Fuel shut-off clamp	Local purchase item

ENGINE TEST RUN AND CHECK

General

Test stands for fuel injection engines must have an electric fuel pump, a microfilter, and a fuel line for returning surplus fuel from the pressure regulator to the tank. It is appropriate to mount the necessary components as well as the fuel tank, fuel flow measuring instruments, and a holder for the control unit on a common rack.

The engine test run and checkout procedure includes the following:

1 - Initial check
2 - Running-in
3 - Fuel consumption check
4 - Performance check
5 - Final test

Apply the same procedure for checking engines which have been partly or fully overhauled. The work can best be done on a dynamometer where the engine load can be regulated and adjusted to the requirements for power and fuel consumption tests.

Initial Check

a - Adjust valves
b - Adjust breaker point gap and ignition timing
c - Check V-belt tension
d - Fill engine with 3.5 liters engine oil
e - Check fuel injection system using checklist and tester. (The control unit used with the given engine, and the pressure sensor, must be used during the performance test.)

Running-in

Turn crankshaft by hand several times before starting the engine. Upon starting, the green oil pressure control light must go out with increasing engine speed, otherwise it will be an indication that the oil pump is not picking up oil and the bearings are not properly lubricated.

The red generator control light must also go out with increasing engine speed. The fuel pump and fuel lines should be checked for leaks during the running-in procedure; also checked should be the pressure in fuel ring main.
The running-in of the engine of the test stand can generally be limited to about 30 minutes, as follows:

10 min. 1500 rpm at 3-5 kg load
20 min. 2500 rpm at 6-10 kg load

Fuel Consumption Check

Fuel consumption should be checked at the end of the 30-minute test run.
Fuel consumption can be determined from flow rate at given engine speed and load (see table).

Engine speed RPM	Brake load N (kg)	Flow rate sec/100 cc
3000	78.5 (8.0)	40-46
5000 full throttle	min.	10.0-12.0

Performance Check

Engine performance is checked upon completion of the fuel consumption check.
The respective values are shown in the power performance chart.
A deviation of ± 5 % is permissible to allow for tolerances in manufacture and testing environment.

Final Test

a - Adjust idling when engine is warm.

b - Check for oil leaks.

Engine should be checked for oil leaks after the fuel consumption and performance checks. Particular attention should be given to the push rod cover tubes, oil pump, oil cooler, valve cover, and crankcase joining surface.

c - Check compression.

Compression should be checked with a compression gauge, with open throttle and engine at operating temperature. All spark plugs should be removed and engine turned over by the starter.

d - Final check.

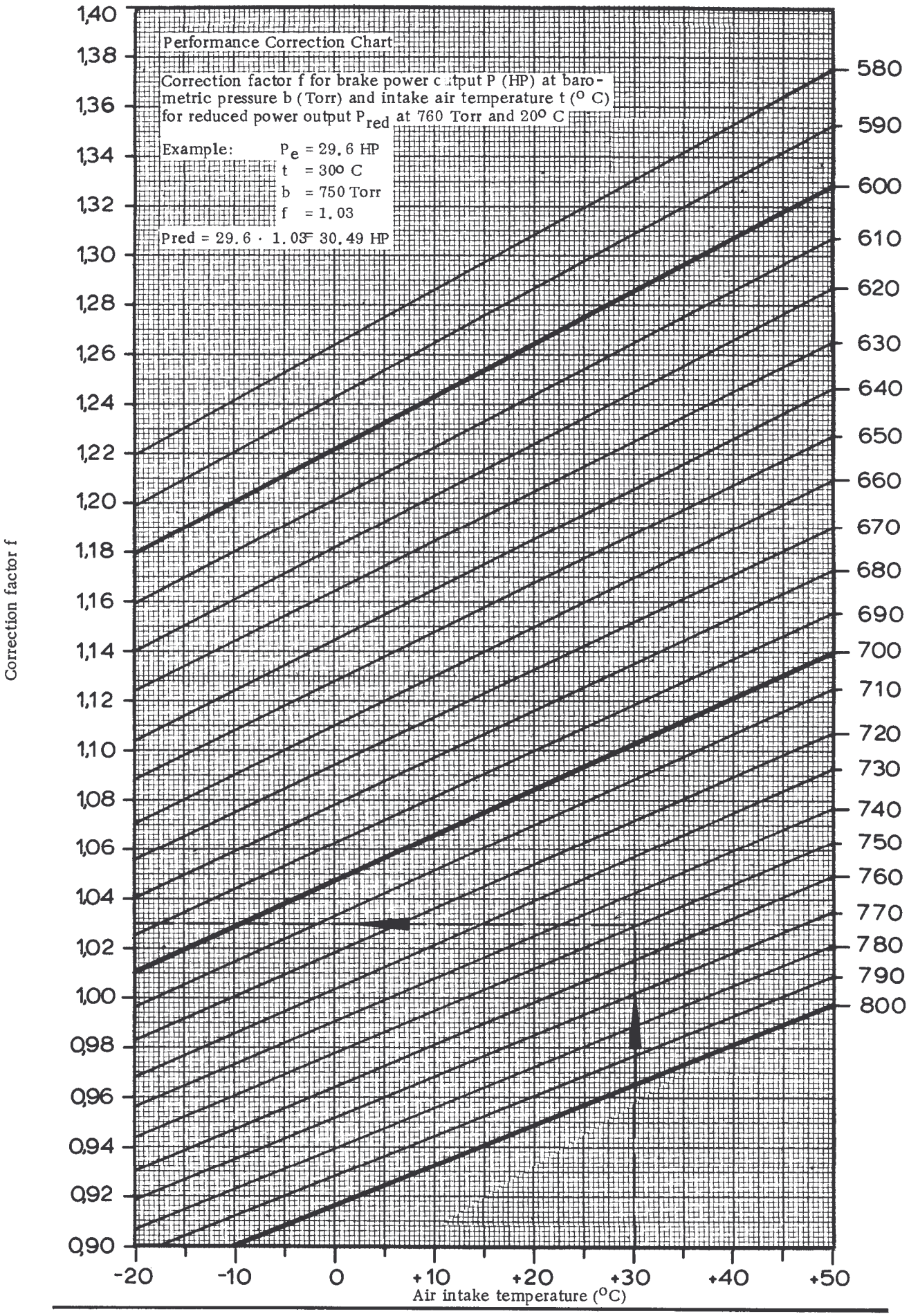
Check valve clearance and V-belt tension prior to mounting engine in vehicle. Make sure that the air cleaner is clean.

e - Engine storage.

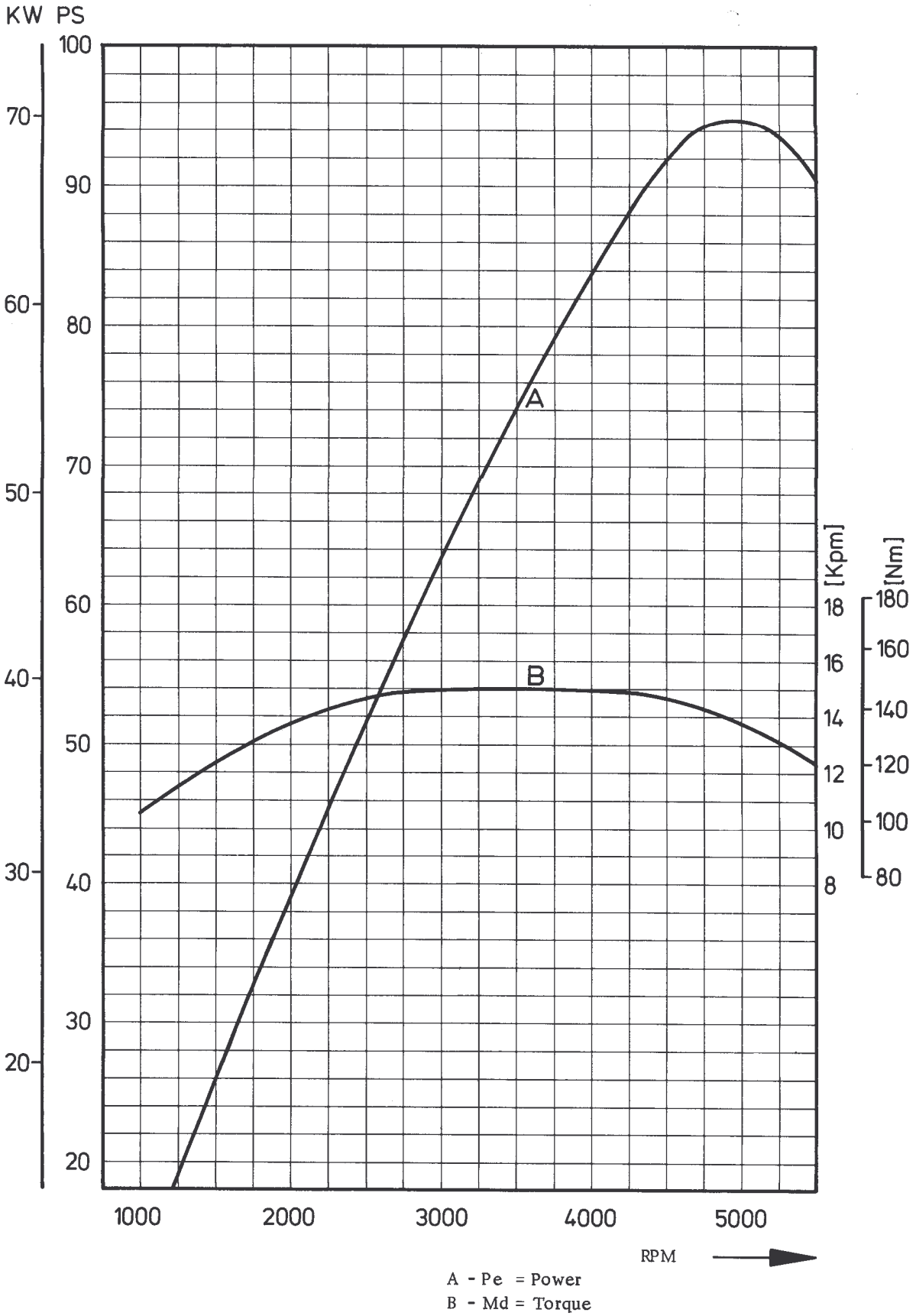
Engines stored for extended periods of time must be corrosion-proofed. Fuel and exhaust gas remnants cause corrosion in cylinders and valve guides, etc, when left in the engine over long periods of time. Such damage can be avoided by pouring some anti-corrosion oil into the intake manifolds during the engine shut-off time or else through the spark plug openings. External engine surfaces should also be sprayed with anti-corrosion oil.

Dynamometer Tests

Power performance and fuel consumption can also be checked on a dynamometer. Test requirements and readout values can be found in the data specification cards.

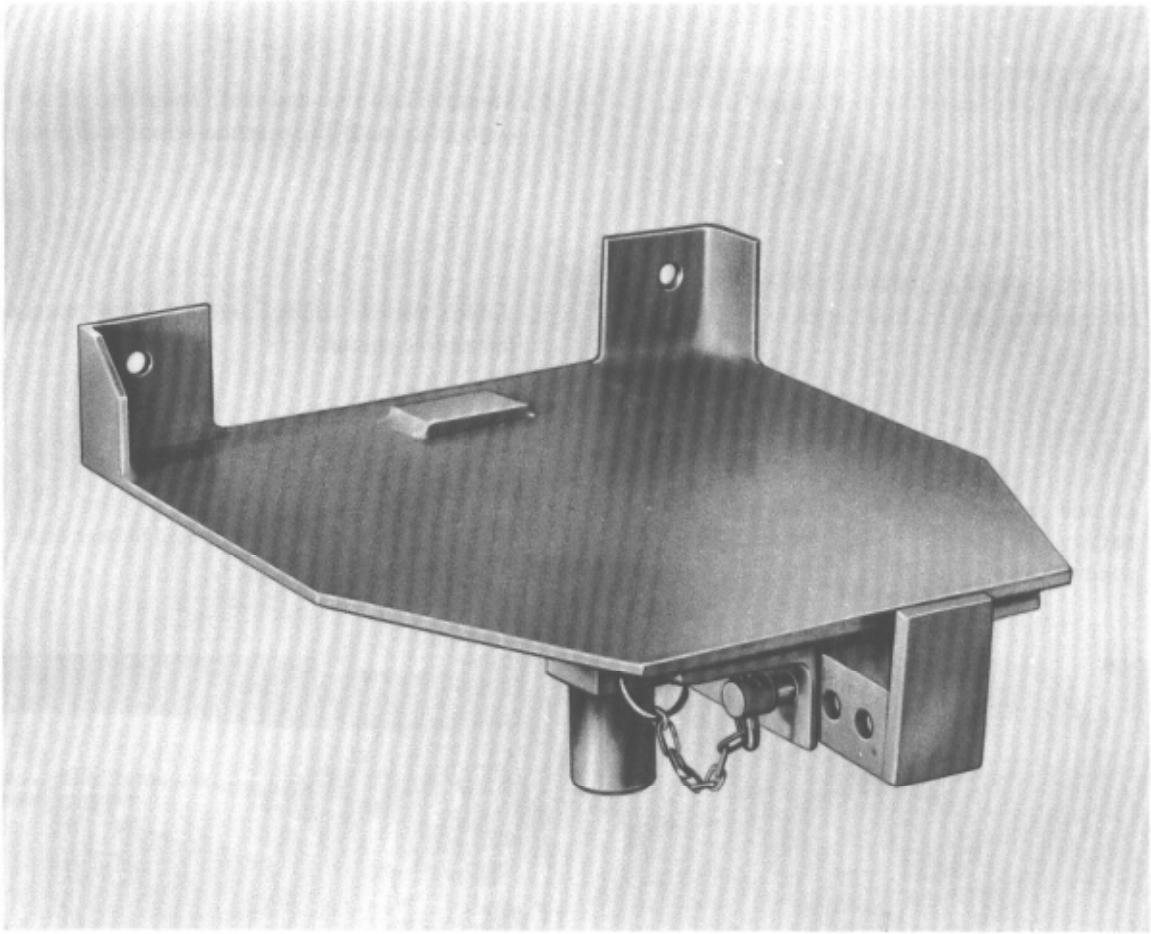

Performance Correction Chart
Correction factor f for brake power output P (HP) at barometric pressure b (Torr) and intake air temperature t (° C) for reduced power output P_{red} at 760 Torr and 20° C
Example: P_e = 29.6 HP
t = 30° C
b = 750 Torr
f = 1.03
Pred = 29.6 · 1.03 = 30.49 HP
Correction factor f
1,40
1,38
1,36
1,34
1,32
1,30
1,28
1,26
1,24
1,22
1,20
1,18
1,16
1,14
1,12
1,10
1,08
1,06
1,04
1,02
1,00
0,98
0,96
0,94
0,92
0,90
Air pressure b (Torr)
580
590
600
610
620
630
640
650
660
670
680
690
700
710
720
730
740
750
760
770
780
790
800
-20
-10
0
+10
+20
+30
+40
+50
Air intake temperature (°C)

POWER PERFORMANCE CURVE



A - Pe = Power
B - Md = Torque

TOOLS



No.	Description	Special Tool	Remarks
1	Engine adapter and support	US 612/4 US 612/3	

Removal

The engine and transmission are removed or installed as one unit.

1. Mark the installed location of the luggage compartment lid on the hinges and remove lid.

2. Detach ground strap and positive lead from the battery, and remove slotted screw from the positive lead.

3. Unscrew control unit from the holder (do not detach electrical control wire) and lay control unit on engine.

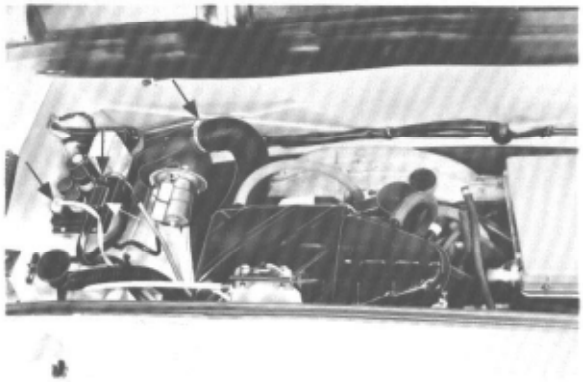
4. Detach electrical connections (3 multiple plugs in the regulator plate, wire connector in pressure sensor, connector for oil templera-ture sensor).

5. Detach vacuum hose from pressure sensor.

6. Separate fuel line and fuel return line at the connection near the pressure sensor and plug it up.

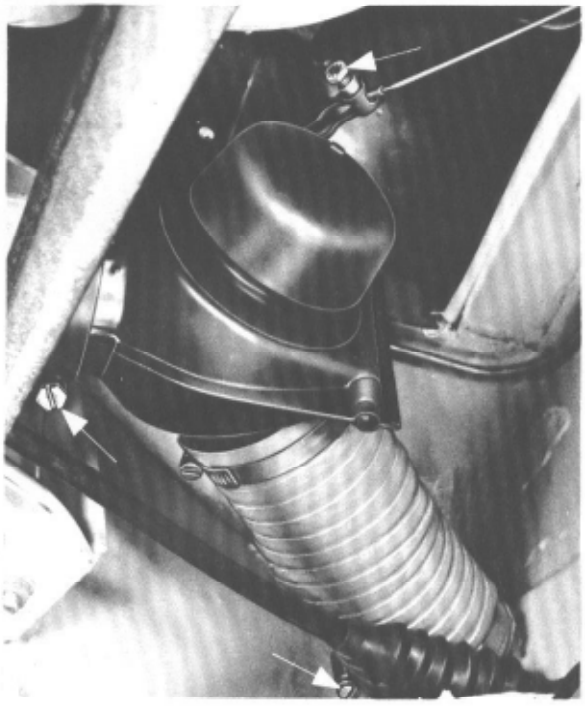
7. Detach throttle control cable and push through the engine shroud.

8. Loosen hose clamp at the heater blower and detach heating duct.



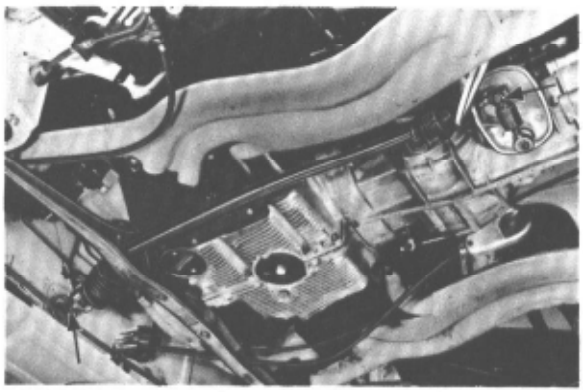
9. Raise the car.

10. Remove heater box with control cables and hoses.



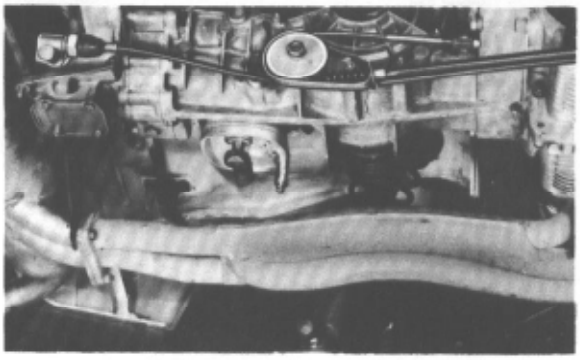
11. Remove cover cap from the rear of the gear shift rod and grommet from the front.

12. Loosen conical screws in the shift rod, remove shift finger from the shift rod, and pull shift rod out rearward.



13. Remove clutch cable adjusting nut and cable pulley retaining nut, bend open the retaining clip and pull clutch cable out forward through the engine support.

14. Unscrew speedometer drive cable and pull forward.



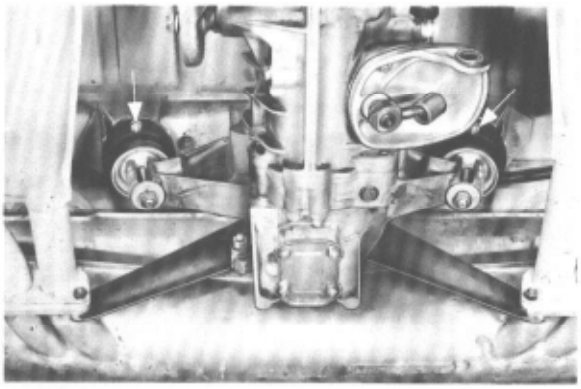
15. Unscrew ground strap from luggage pan.

16. Detach wire connector for backup light.

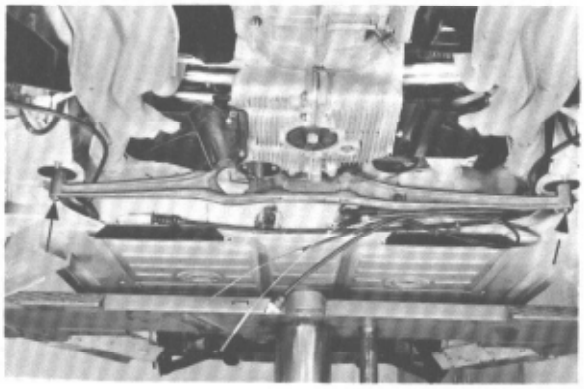
17. Detach axle shaft flanges from differential.

18. Lower the vehicle somewhat. Place garage jack (with US 612/4 engine adapter and US 612/3 support) under the engine-transmission assembly with slight preload.

19. Remove four M8 nuts from transmission support.



20. Remove engine support fasteners.



21. Carefully lower the engine-transmission assembly, being sure not to damage the axle shafts.

Installation

Note the following points during reassembly:

1. Check the clutch throwout bearing for wear before bolting transmission to engine.

2. Lightly coat the throwout bearing guide bushing, splines in the input shaft, and the starter bushing with MoS_2 paste.

3. When installing the engine-transmission assembly be sure that the fuel lines near the injectors are not damaged.

4. Torque engine support retaining bolts, transmission support retaining nuts, and Allen bolts in axle shafts as specified.
Use new locking plates.

5. Adjust clutch play.

6. Adjust throttle control cable.

NOTE: Watch for possibly chaffed electrical wires or fuel lines.

Disassembly and reassembly is accomplished in the following order:

Disassembly:

1 - Drain engine oil

2 - Remove muffler and heat exchanger

3 - Remove rear engine shield

4 - Remove intake manifold with stacks and injectors

5 - Remove oil filler and breather assembly

6 - Remove ignition distributor

7 - Remove front engine shields

8 - Remove blower impeller

9 - Remove cooling blower housing and alternator

10 - Remove engine mount

11 - Remove front and rear cylinder shrouds and hot air ducts

12 - Remove oil cooler

13 - Remove oil filter

14 - Remove oil pump

15 - Remove rocker arm shafts, push rods, push rod cover tubes, and tappets

16 - Remove cylinder heads

17 - Remove cylinders and pistons

18 - Remove clutch and flywheel

19 - Disassemble crankcase

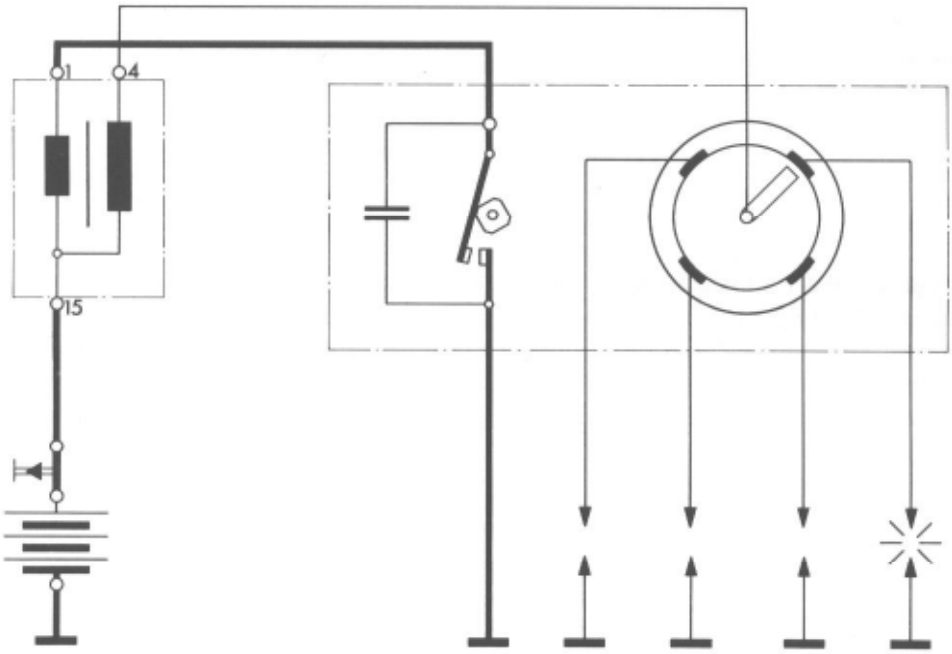
20 - Remove camshaft and crankshaft with connecting rods

Assembly:

Reassembly is accomplished in reverse order of the above. Special instructions are contained in subsequent sections.

DESCRIPTION

The ignition system is battery powered. Ignition voltage is produced by the ignition coil which transforms battery voltage into the required ignition voltage of 15000 to 20000 volts. The process is described below. A breaker cam, located on the camshaft-driven distributor shaft, opens the breaker points just before the piston in the firing cylinder has reached its firing position. This interrupts the flow of current through the primary winding in the ignition coil, causing the magnetic field to collapse and simultaneously induce high voltage in the coil secondary winding. This high ignition voltage passes through an ignition lead to the distributor rotor which, at this instant, alignes with an electrode in the distributor cap; the electrode is connected to the spark plug in the firing cylinder. The ignition voltage crosses the spark plug electrodes in the form of an electric arc and ignites the compressed fuel/air mixture in the cylinder.



Ignition Coil

The ignition coil consists of a laminated iron core with a few turns of large primary winding wire and many turns of small secondary winding wire. The end of the primary winding and secondary winding is connected to the battery through terminal 15. The other end of the primary winding is connected to the ground through terminal 1 and breaker points. The secondary winding leads to the high tension terminal.

Distributor

The distributor directs high voltage to each of the four spark plugs in proper sequence and at the most advantageous time.

A centrifugal and vacuum ignition advance mechanism built into the distributor maintain correct ignition timing at all engine speeds.

a - Centrifugal Advance

The centrifugal advance is actuated by weights mounted on a supporting plate. As the engine speed increases, the weights are forced outward, causing a lever to move the breaker cam in the direction of rotation of the distributor shaft. This movement results in advanced timing. Return springs pull the centrifugal weights back into their original position when the engine speed decreases.

b - Vacuum Advance

Intake manifold vacuum drawn from a point near the throttle valve advances the breaker points, in addition to the centrifugal advance, by moving the points against the direction of rotation of the breaker cam on the distributor shaft; this occurs primarily under part-throttle conditions.

Spark Plugs

Spark plugs operate under constantly severe electrical, mechanical, chemical, and particularly thermal stresses. The use of the right kind of spark plugs is essential if good starting, idling, acceleration, and engine performance are to be expected. In addition to electrical and mechanical considerations, heat range plays a very important role. The higher the heat range, the smaller the possibility of hot spots but so much the greater the possibility of fouling. Spark plugs of low heat range qualities have opposite characteristics.

SPECIFICATIONS

Ignition Coil

Type/Model	Version	Comments
914/2.0	022905115 A	12 volts

Distributor

Type/Model	Spark Advance	Version
914/2.0	Centrifugal advance and double-action vacuum advance	039 905 205 039 905 205 A (from Model 74 on)
914/2.0 from 1975 Models USA except California	Centrifugal and single action vacuum	039 905 205 A
914/2.0 from 1975 Models California	Centrifugal and single action vacuum	039 905 205 B

Spark Plugs

Type/Model	Spark Plug Type +)	Remarks
914/2.0	BERU 175/14/3 BOSCH W 175 T2	Threads M14x1.25x19.0
914/2.0 from 1975 Models USA only	Beru 175/14/3 L Bosch W 175 M 30	M 14x1, 25x19,0 threads

+) Or other name-brand factory-approved spark plugs of proper heat range.

MAINTENANCE

Ignition Coil:

Keep coil cap clean and dry.

Distributor:

1 - Inspect breaker points for pitting, replace if necessary.

2 - Lubricate breaker arm rubbing block with a little multipurpose grease.

3 - Lubricate the breaker arm pivot and the distributor shaft oil felt with a drop of oil.

4 - Inspect distributor cap for dirt deposits, cracks, and signs of arcing, cleaning or replacing the cap if necessary.

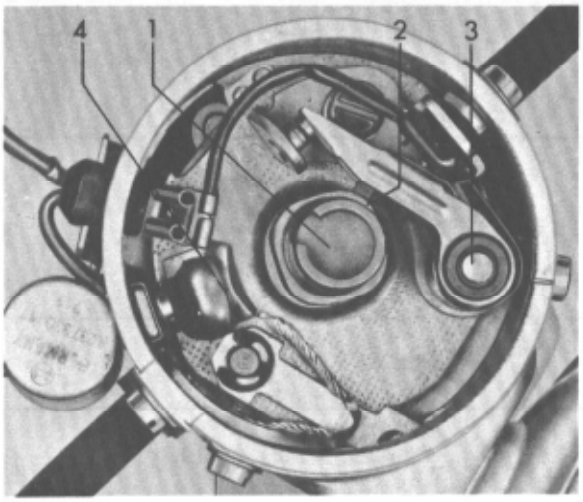
5 - Check and adjust dwell angle.

6 - Check and correct ignition timing adjustment.

Spark Plugs:

Clean spark plugs, check and adjust electrode gap.

Special Instructions:

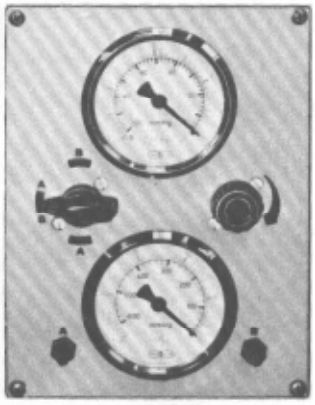


A - Regularly lubricate oil felt (1) and breaker arm pivot (3) with a drop of oil.

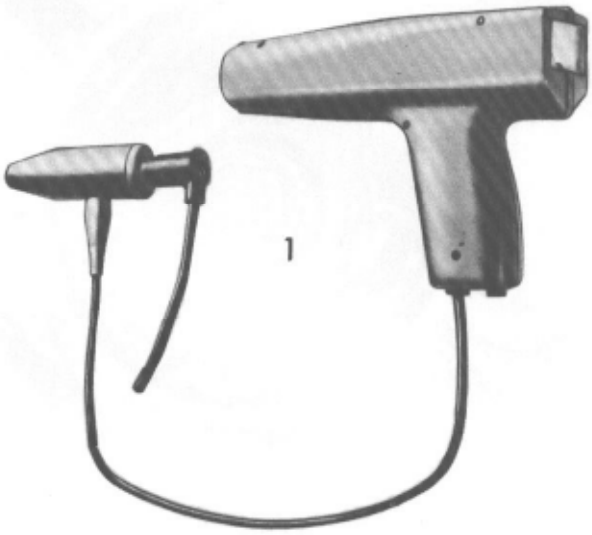
B - Lubricate breaker point rubbing block (2) and ball (4) with multipurpose oil. Keep grease off breaker contact points.

TESTING EQUIPMENT

2



3

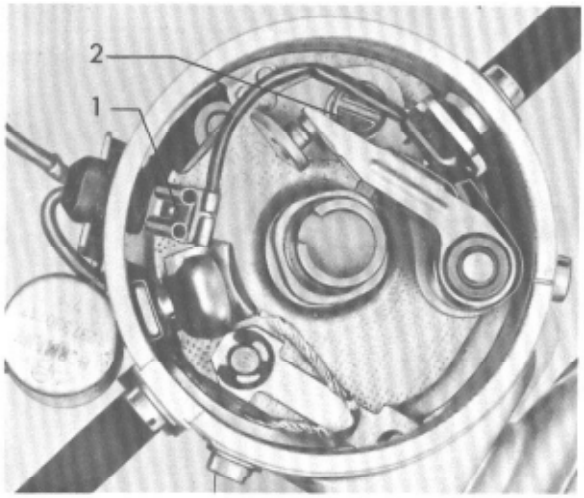


No.	Description	Special Tool	Remarks
1	Timing light		
2	Tach-dwell meter		
3	Vacuum gauge		Scale range 0-100 and 0-600 mm Hg
4	Carburetor actuator		Local manufacture

REPLACING DISTRIBUTOR BREAKER POINTS

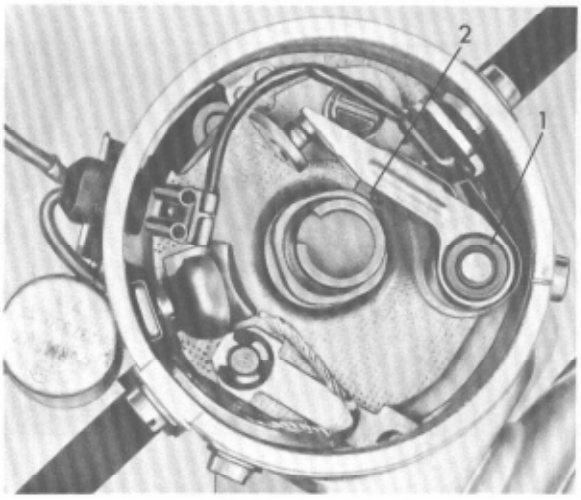
Breaker points pit in the course of use. In addition, the plastic rubbing block wears and reduces breaker point gap. For this reason, the breaker points should be replaced at 12,000-mile intervals.

Removal



Installation

1 - Lubricate breaker arm pivot (1) with a drop of oil.



2 - Lightly lubricate breaker cam and plastic rubbing block (2) with a little multipurpose grease.

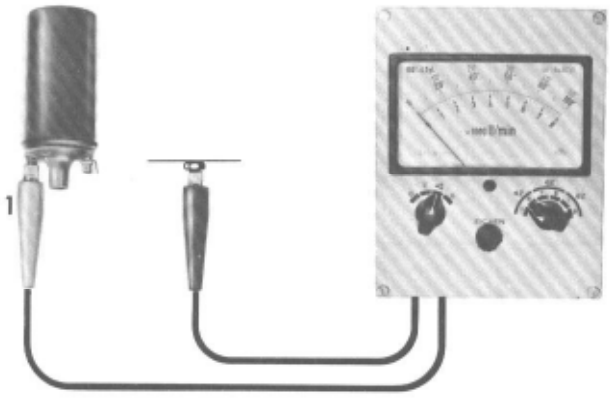
3 - Thoroughly remove any grease or oil from the breaker points if any should have gotten there inadvertently.

4 - Adjust breaker point gap.

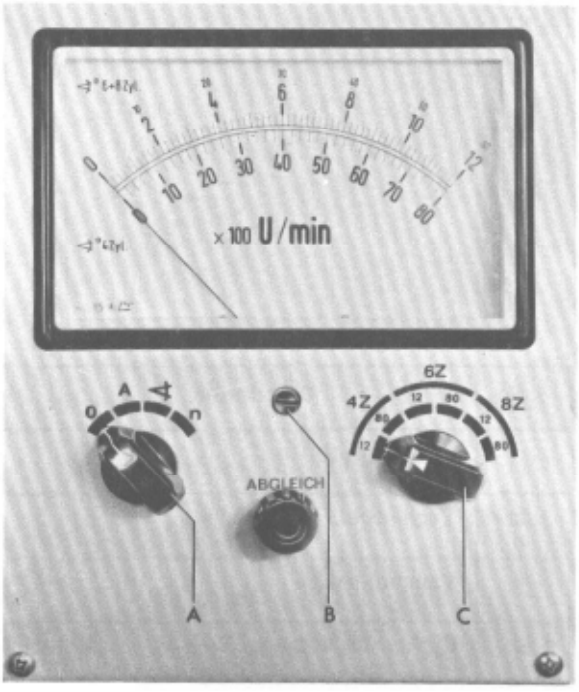
ADJUSTING BREAKER POINTS WITH TACH-DWELL METER

When using a different tach-dwell meter than that shown in the illustration, be sure to follow instructions for its use.

1 - Connecting meter:
Green clip to Terminal 1 on the ignition coil, black clip to metal ground.



2 - Calibrating meter:
Turn test mode selector of meter to "A". Turn calibration knob (marked "Abgleich") until meter needle is exactly on last dial mark (12/80).



A - Test mode selector
B - Zero-adjust
C - Range selector

3 - Checking dwell angle:

Turn test mode selector to " ⊲ " and range selector to "4 Z" (number of cylinders).

Start engine and run at about 1000 rpm while reading dwell angle indication on lower part of meter dial (each mark equals 2^{o}).

4 - Run engine at about 2000 rpm. The dwell meter indication at this speed should not deviate by more than $\pm 1^{o}$ from the previously shown value. A greater deviation indicates worn distributor shaft in which case it will be necessary to remove the distributor and check it on a distributor test bench.

Compare measured values with specifications.

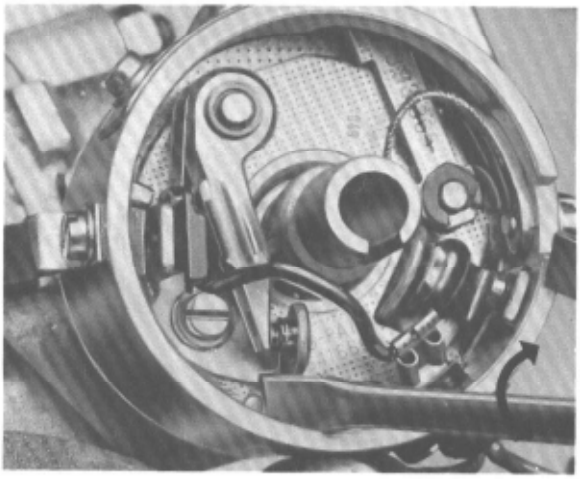
Dwell angle specification:	$44\text{-}50^{o}$
Wear limit:	$42\text{-}58^{o}$

This means that new breaker points should be adjusted to the specified dwell angle value, and that breaker points in use should not be readjusted as long as the dwell angle reading falls within the permissible wear limit.

5 - Adjusting dwell angle.

Remove distributor cap, withdraw rotor, and loosen breaker point base plate.

With ignition switched on and engine cranked with starter, adjust breaker point gap until correct dwell angle value shows on the meter. Tighten the breaker point base plate and check dwell angle again to see that the adjustment has not been altered excessively in the process.



6 - Install rotor and distributor cap, recheck dwell angle again.

NOTE: The ignition timing must be readjusted whenever the dwell angle has been reset.

ADJUSTING IGNITION TIMING WITH TIMING LIGHT

When using different instruments than those shown below, be sure to follow instructions for their use.

1 - Check dwell angle and adjust if necessary.

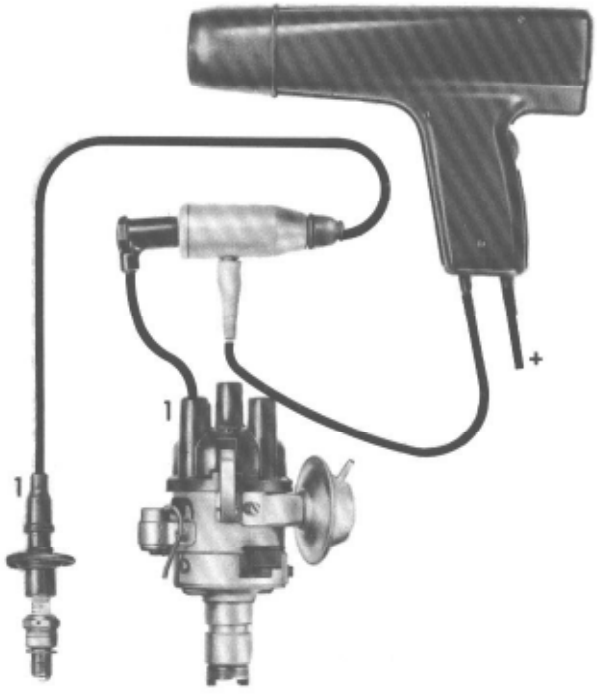
2 - Bring engine oil temperature to 30-70° C.

3 - Connect tach-dwell meter and calibrate. Turn test mode selector to "n". Turn range selector to "4 Z" and adjust to "12" within this range setting.

Engine speed is indicated on the upper scale.

4 - Connect timing light.

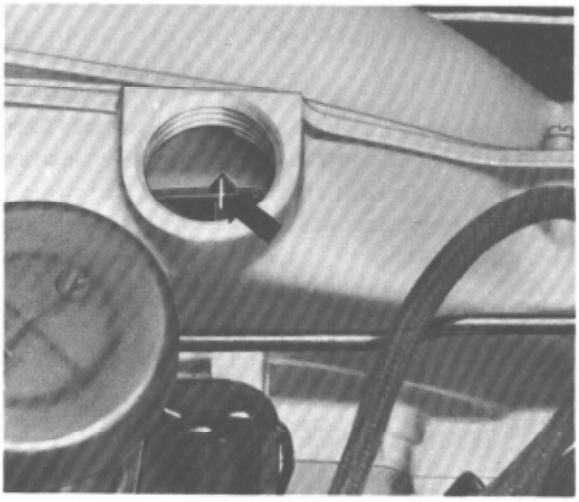
The timing light sensor is connected into the ignition circuit for Cylinder 1. The selector wheel in the timing light grip must be turned to the zero-stop.



5 - Detach both vacuum hoses from the vacuum unit.

6 - Run engine at 3500 rpm and point the timing light at the blower impeller.

7 - The ignition timing notch must align with the reference mark on the cooling blower housing.



NOTE: Two reference marks will be found on the blower impeller:

1 - "0" mark indicating top dead center (TDC).
2 - Ignition timing notch.

CHECKING AUTOMATIC SPARK ADVANCE

When using different instruments than those shwon below, be sure to follow instructions for their use.

Checking Centrifugal Spark Advance

1 - Connect and calibrate tach-dwell meter. Turn test mode selector to "n". Turn range selector to "4 Z" and adjust to "80" within this range setting. Engine speed is indicated on the lower scale.

2 - Connect timing light.

3 - Detach vacuum hoses from the distributor vacuum unit.

4 - Start engine and check basic adjustment of ignition timing, correcting if necessary.

5 - Increase engine speed slowly. Start of the spark advance is shown by the movement of the reference notch. See table on page 22.2-2/4 for specifications.

6 - Set engine rpm to values shown in the table. Bring the reference notch back by turning the the selector wheel in the spark advance tester. The spark advance is shown on the meter in degrees.

7 - Determine end of spark advance by further increasing the engine rpm.

8 - If the test values do not correspond with specifications, repair the spark advance mechanism in the distributor (free the components, replace stretched springs) or replace distributor. (See page 22.2-2/4 for specifications.)

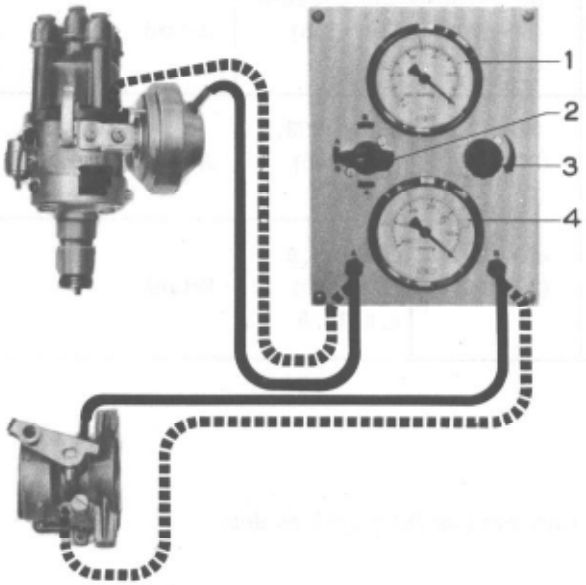
Checking Vaccum Spark Advance

Operation of the vacuum spark advance unit can be checked by reconnecting the previously detached vacuum hoses to the engine while it is running at a fast idle; engine speed should thus increase noticeably.

NOTE:
Spark advance and retard functions must be checked separately in double-action vacuum units, at which time it is necessary to disconnect the vacuum hose from that part of the vacuum unit which is not under test.

Vacuum retard

1 - Connect timing light. Connect vacuum gauge between vacuum retard unit at the distributor and vacuum line at the intake manifold.



1 - Vacuum gauge 0-133 mbar (0-100 mm Hg)
2 - Selector valve
3 - Regulator
4 - Vacuum gauge 0-800 mbar (0-600 mm Hg)

2 - Detach vacuum hoses from the vacuum unit.

3 - Run engine at 3500 rpm.

4 - Direct the timing light on the 0° mark. Read the value on tester and make a mental note.

5 - Connect vacuum hose of the advance unit to the retard unit.

6 - The vacuum retard value is determined from the difference between the now indicated value and that noted mentally in step 4, above.

Vacuum advance

1 - Connect vacuum gauge between vacuum advance unit and vacuum line.

2 - Detach vacuum line from the vacuum retard unit.

3 - Run engine at 3500 rpm and direct the timing light on the 0° mark (vacuum regulator valve must be open).

4 - Read the value on tester and make a mental note.

5 - Close vacuum regulator valve.

6 - The vacuum advance value is determined from the difference between the now indicated value and that noted mentally in step 4, above.

7 - If deviations from the values given in the table are noted during the test, check as follows:

a - Check breaker point plate for free movement. If necessary, disassemble the distributor and free the plate.

b - Check vacuum lines and vacuum unit for leaks, replace if necessary.

IGNITION TIMING DATA FOR INSTALLED DISTRIBUTORS

Distributor Number	Begin at rpm	RPM degrees	End at rpm degrees	Begin at mbar (mm Hg)	End at mbar (mm Hg) degrees	Direction of change
039 905 205	900-1100	1500 6-10	3000 20-24	133.3- 173.3 (100-130)	193.3-211.0 (145-165) 6-8	Advance
				80.0-133.3 (60-100)	197.3-210-6 (148-158) 8-12	Retard
039 905 205 A	950-1050	1500 4-9	3000 22	40-173,3 (30-130)	253,5-273,5 (190-205) 5,5-7	Advance
				40-133,3 (30-100)	200-213,5 (150-160) 8,5-12,5	Retard

x) Advanced ignition vacuum control does not apply to USA Versions from 1975 Models.

TROUBLE DIAGNOSIS

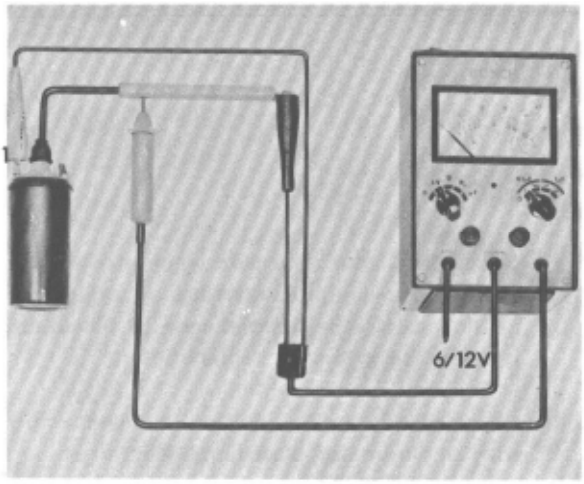
Checking Ignition Coil

1 - Clean coil cap and keep dry to prevent current leakage or arcing.

2 - Check terminal tab connectors for firm seating to ensure absence of voltage leaks.

3 - Check ignition output with ignition coil tester. Connect the tester as shown in the illustration. Follow instructions furnished with the unit.

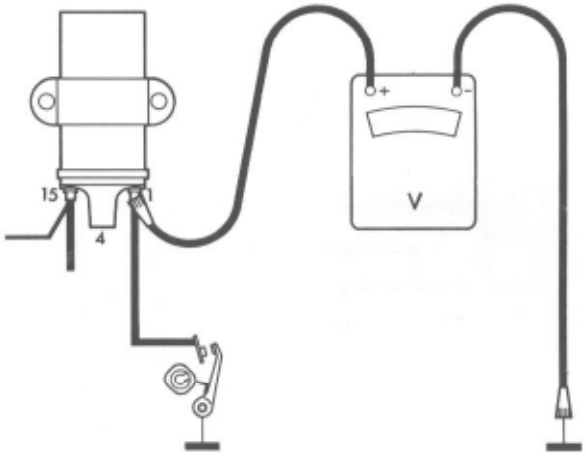
Principle of operation:
The high tension side of the coil (terminal 4) is connected through a load resistor and is activated over terminal 1 by a constant electrical pulse generated by the tester. Ignition voltage occuring under this load is the measured. Nominal voltage is approx. 18,000 volts (18 kV).



4 - If a coil tester is not available, proceed as follows:

Pull ignition lead out of terminal 4 in the distributor cap (in center of cap) and hold the end about 1/2" from ground (use insulated pliers). When engine is cranked with starter, an electric spark should cross between the ground and the lead's end. If there is no spark, first check voltage at terminal 15 in the coil with the aid of a voltmeter. In a 12-volt system, the voltage should be at least 9 volts.

If higher voltage is noted, connect a voltmeter or test lamp to terminal 1 in the ignition coil (distributor connection) to make sure that no current flows when the breaker points are closed, and that current flows when the points are open. If the voltmeter shows no reading with open breaker points as well (distributor has no short circuit), then the ignition coil has an open circuit and should be replaced.



Checking Breaker Points (electrically)

Connect voltmeter between ignition coil terminal 1 and the ground. Crank engine until distributor breaker points have closed; the voltmeter needle should not deflect. Open the breaker points; the voltmeter needle now must have deflected. If the voltmeter needle should deflect with breaker points closed, it is an indication that the points are either dirty or burned.

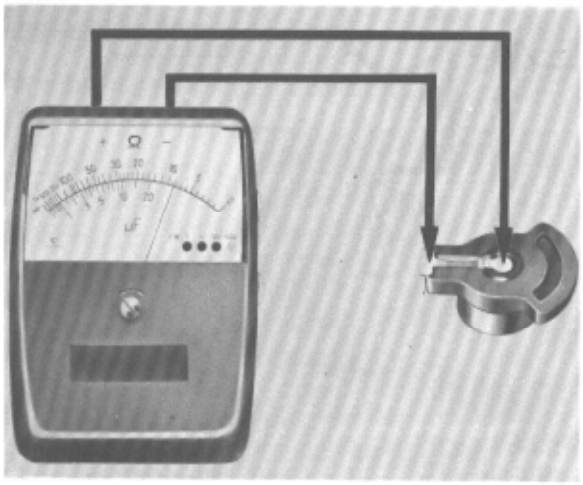
Checking Condenser

The condenser is important in the ignition system as it prevents breaker point arcing and their premature wear.
Burned breaker points, weak spark and starting problems, or a complete absence of spark can be the result of a defective condenser. However, it is seldom that a condenser does fail.
Use a test lamp to check condenser for shorts:
Detach from the coil wire # 1 which connects to the distributor. Connect a test lamp between terminal # 15 in the coil and distributor wire # 1. The lamp should not light when breaker points are open and ignition is switched on; if the lamp does light up, condenser is shorted.
Condenser insulation resistance, capacity, and series resistance can be checked with special instruments. When such instruments are used, follow the manufacturer's instructions.
Replace condensers only with a specified type (see spare parts catalog) because wrong condenser capacity can have a detrimental effect on breaker point life.

Checking Radio Interference Suppressors

Resistance in copper core ignition leads is too low to comply with radio interference regulations in some countries. For this reason, suppressors have been placed in spark plug connectors and distributor rotor. Many radio installations include suppressors in ignition lead connectors.

The interference suppressors with excessive resistance can be responsible for engine misfiring.

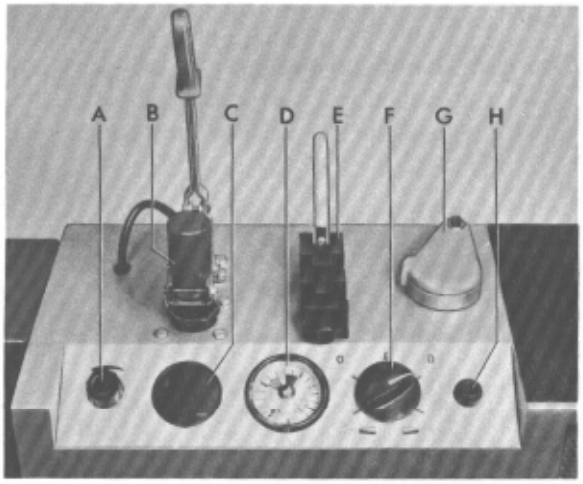


1 - Check distributor rotor with an ohmmeter. A suppressor-equipped rotor has a cast-in resistor which should not exceed 10,000 ohms. If resistance is higher, replace rotor.

2 - Check spark plug and ignition lead connectors with an ohmmeter. Resistance should not exceed 5-10,000 ohms.

CLEANING AND CHECKING SPARK PLUGS

When instruments other than those shown here are used, be sure to follow the manufacturer's instructions.



A - Regulating valve

B - Quick-release clamp (on testing socket)

C - Inspection window with mirror

D - Pressure gauge with calibrated scale

E - Electrode gap adjuster

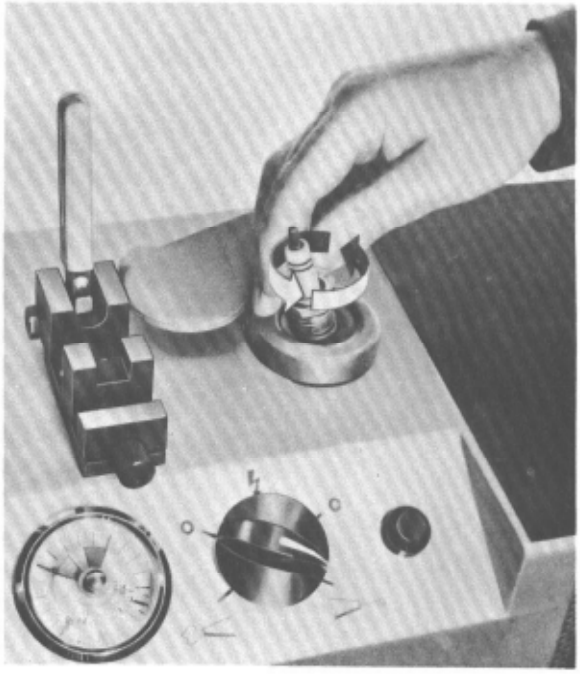
F - Selector valve

G - Sandblast socket with swinging cover

H - Push button

1 - Spark plugs with heavy deposits of carbon or other matter should first be cleaned with a wooden pick to keep the coarse dirt out of the sand blaster; do not scrape with a metal tool. If the insulator is oily, wash spark plug in gasoline and blow clean with compressed air prior to sandblasting.
Swing the socket cover to the side and place spark plug slightly sideways into the rubber socket. Turn selector valve to position and sandblast spark plug for about 10-15 seconds while moving it around in a circular motion.

Turn selector valve to position and clean dust with compressed air. Make sure that all sand and dust is completely removed.
Turn selector valve to position "0" before taking the spark plug out.
Should the electrodes and insulator still not be clean, repeat sand blasting with subsequent air cleaning.



2 - Adjusting Electrode Gap to 0.7 mm

Place spark plug into the electroce gap adjuster so that the feeler gauge is between the electrodes. The connecting point between the negative electrode and spark plug body should be facing up.
Move the adjustable receptable to within 1 mm distance from the spark plug body. Bend negative electrode by pulling actuating lever. The electrode gap is thus correctly set.

3 - Checking Spark Plugs

Adjust calibrated scale in pressure gauge to 0.7 mm gap. Place spark plug in testing socket and secure with quick-release clamp.

NOTE:

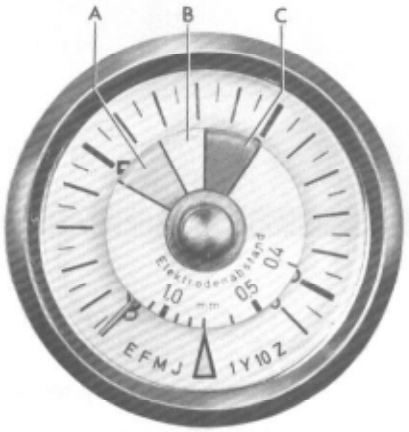
Do not insert Spark plugs wet with fuel in tester since this can lead to an explosion.

Turn selector valve to " ϟ ". Close regulating valve. The pressure chamber is now pressurized. The pressure gauge indicator must be higher than the green field in the scale, that is, so high that all sparks travel across the parallel spark path.

The spark plug insulation can be considered good if no sparks are in evidence anywhere except the parallel spark path.

Lower the pressure by opening the regulating valve until sparks begin to travel across the spark plug gap.

The position of the indicator in the pressure gauge shows the ignition voltage requirements of the spark plug and thus the condition of the electrodes:



Indicator in green area (C) =
Spark plug in good condition

Indicator in yellow area (B) =
Spark plug still usable

Indicator in red area (A) =
Replace spark plug

Further reduce the pressure until the sparks jump evenly across the spark plug electrodes. When in this position, pay close attention to tracking along the insulator.

A spark plug is also defective when no sparks can be seen to cross the electrodes or the parallel spark path or when only individual sparks occur in the spark plug with pressure adjusted to below 5 atmospheres. This can be the result of a cracked insulator in the spark plug body.

CHECKING DISTRIBUTOR ON TEST BENCH

The vacuum advance, centrifugal advance, and dwell angle can be checked on the distributor test bench. Various distributor test benches are in use. The following requirements apply to all:

Variable-speed motor, tachometer, vacuum pump, and vacuum gauge with an additional range of 0-133 mbar (0-100 mm Hg) for servicing distributors used in VW engines.

The following test procedure is necessary:

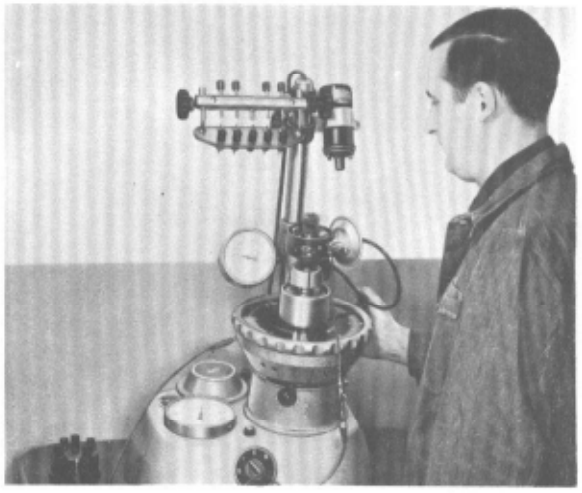
1 - Install distributor and check for quiet operation.

2 - Check dwell angle and correct it if necessary.

3 - Adjust speed to 400 rpm, observing that the centrifugal advance has not operated at this point.

4 - Connect hose between vacuum pump and vacuum advance unit of the distributor. Use pump to create full vacuum condition.

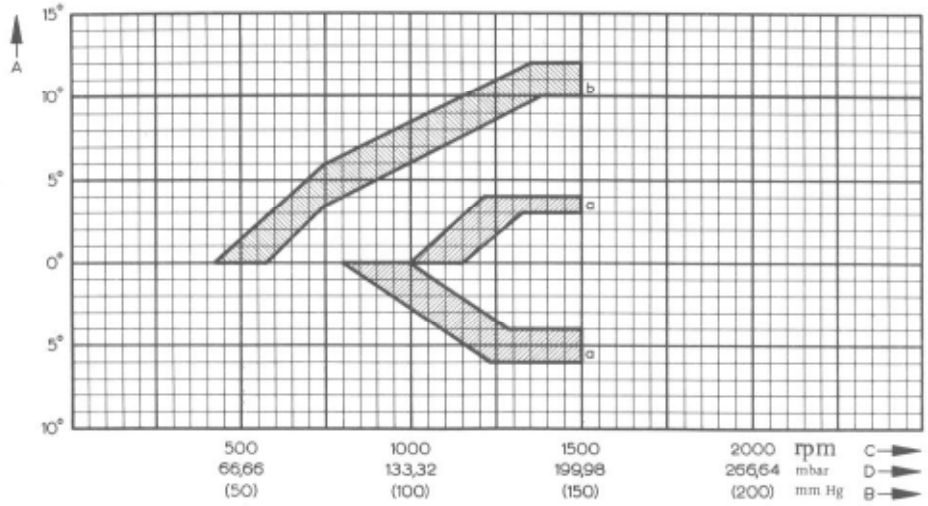
5 - Check vacuum advance unit for leaks. A vacuum of 133 mbar (100 mm Hg) should remain constant for about 1 minute with vacuum line closed.



6 - Check vacuum advance under decreasing vacuum conditions. Repeat the test as many times as possible while selecting different points in the vacuum curve and noting the actual advance values on the test bench scale. These test values must fall within the shaded areas of the advance curves shown on the chart. If this is not the case, repeat the tests with a new vacuum advance unit.

7 - Run test according to the speed-dependent advance curve. Centrifugal advance is checked with decreasing speed from 1500 rpm down.

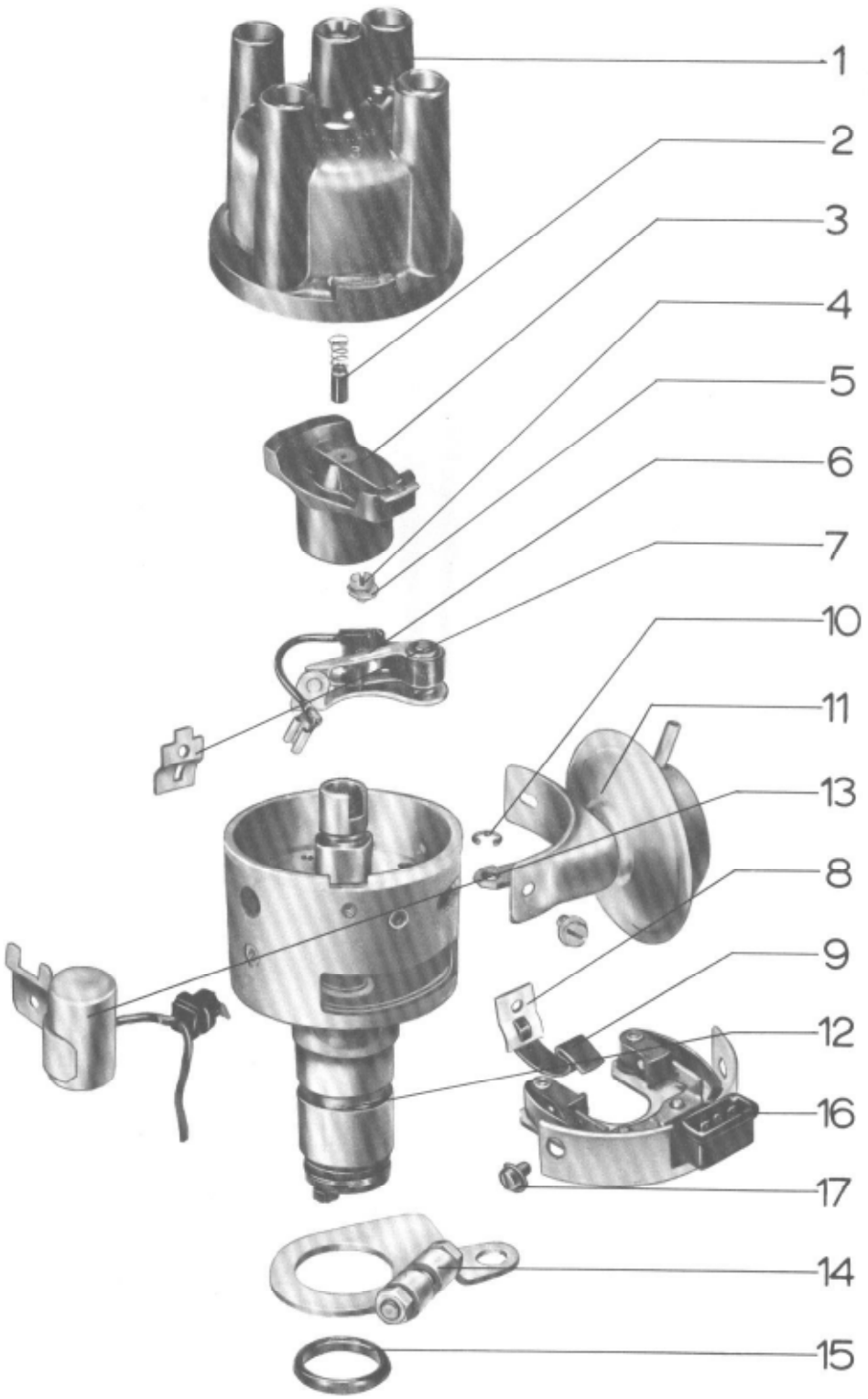
Advance Curve for Removed Distributors



A - Advance in degrees at distributor shaft
B - Vacuum in mm
C - Distributor shaft speed in rpm

a - Vacuum control curve
b - Centrifugal control curve

No.	Description	Special Tool	Remarks
1	Puller	--	Standard type



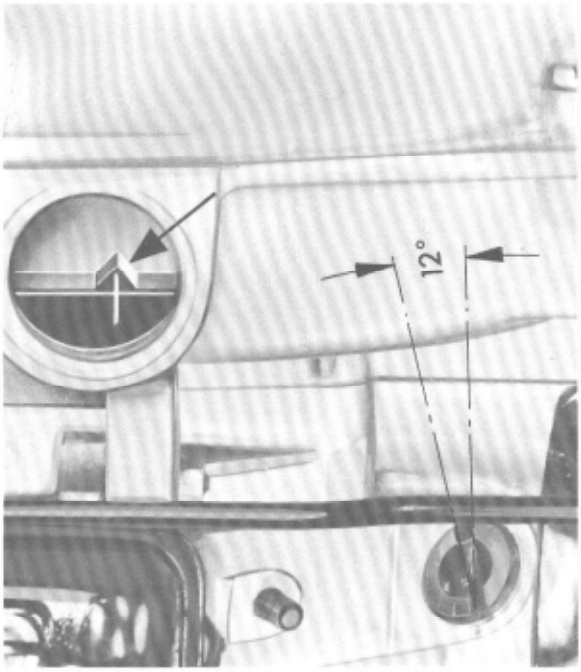
22.4-1/2 Ignition Distributor - Exploded View

Printed in Germany

No.	Description	Qty	Note when removing	Note when installing	Remarks
1	Distributor cap	1		Check for cracks, carbonized current paths and good condition of the carbon contact	
2	Carbon contact with spring	1		Check for good seating	
3	Rotor	1			
4	Screw	1			
5	Washer	1			
6	Breaker points	1	Remove wire and lock screw	Contacts must be free of oil and grease and parallel to each other. Lubricate breaker arm pivot with 1 drop engine oil. Lubricate cam and rubbing block with multipurpose grease.	
7	Retaining clip with lug	1			
8	Shackle	1			
9	Spring clip	2			
10	Snap ring	1			
11	Vacuum unit	1		Check for leaks.	
12	Distributor housing	1	When excessive shaft clearance is noted, replace shaft or housing		
13	Condenser	1			
14	Distributor mounting clamp	1			
15	O-ring	1			
16	Trigger contacts	1		Replace contacts if oily. Lightly lubricate rubbing blocks with multipurpose grease.	
17	Screw	4			

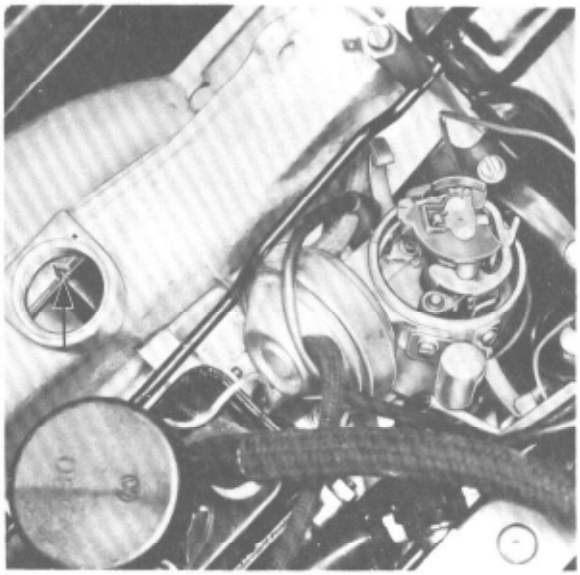
INSTALLING DISTRIBUTOR

1 - Adjust cylinder 1 to firing point. The offset slot in the top end of the distributor shaft should be at an angle of approximately 12° in relation to the longitudinal axis of the engine; the larger segment is on the crankshaft side of engine.

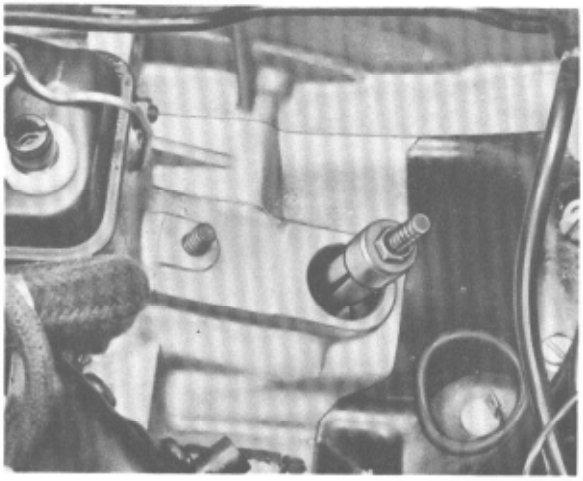


2 - Turn distributor rotor on ignition distributor until it points toward the mark for cylinder 1 on distributor housing.

3 - Adjust ignition timing.



REMOVING AND INSTALLING DISTRIBUTOR DRIVE SHAFT

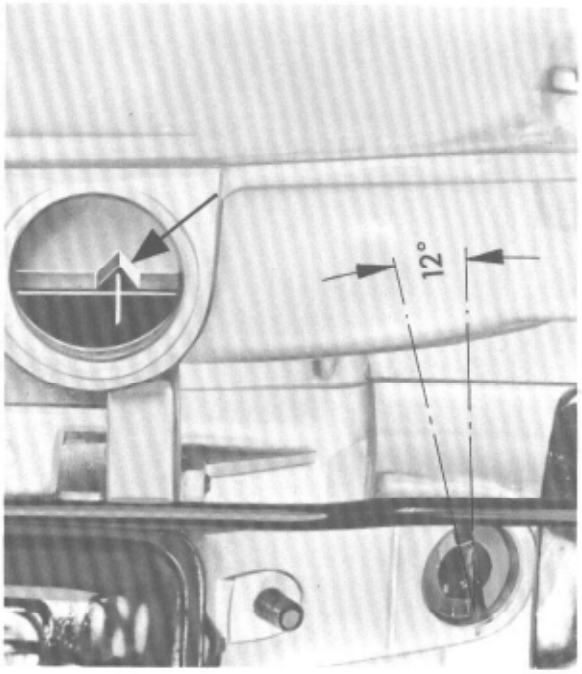


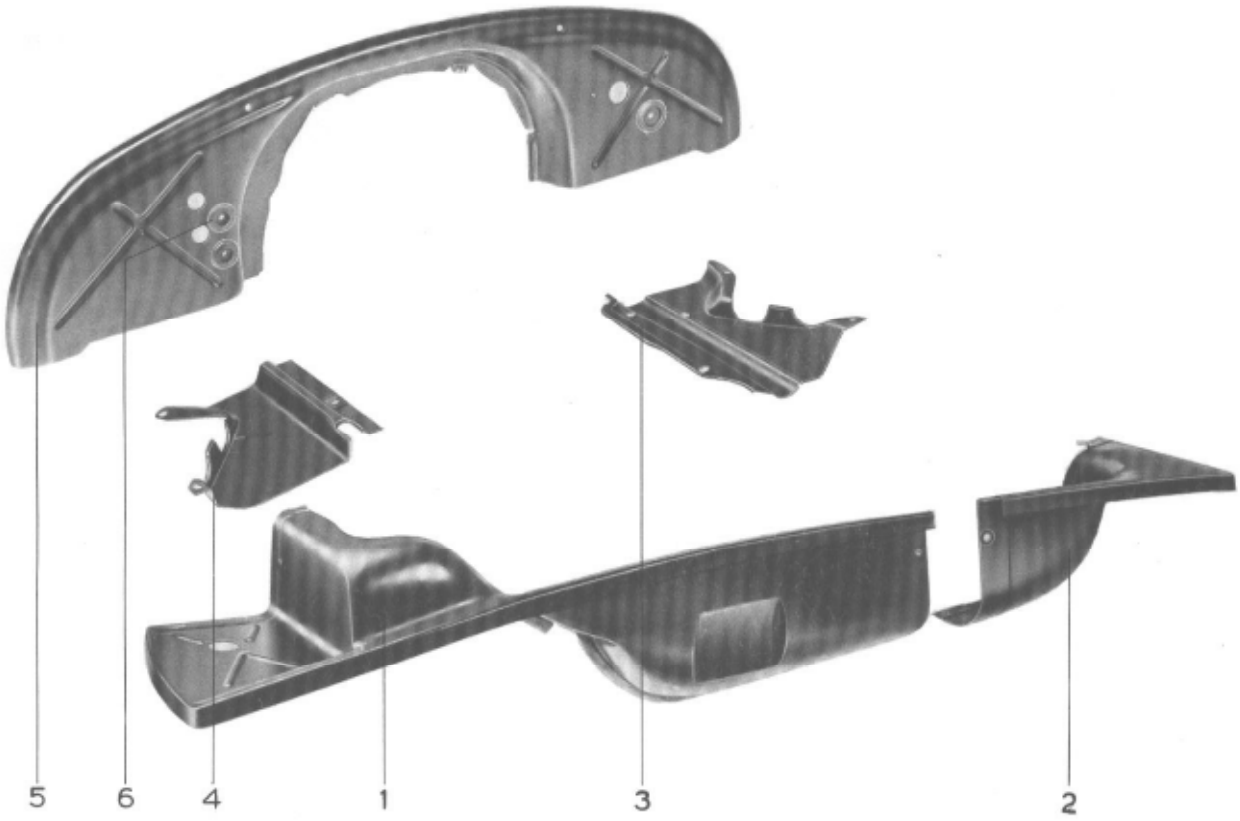
1 - Remove washer located under the distributor drive shaft.

NOTE: Proceed with caution - don't drop washer inside!

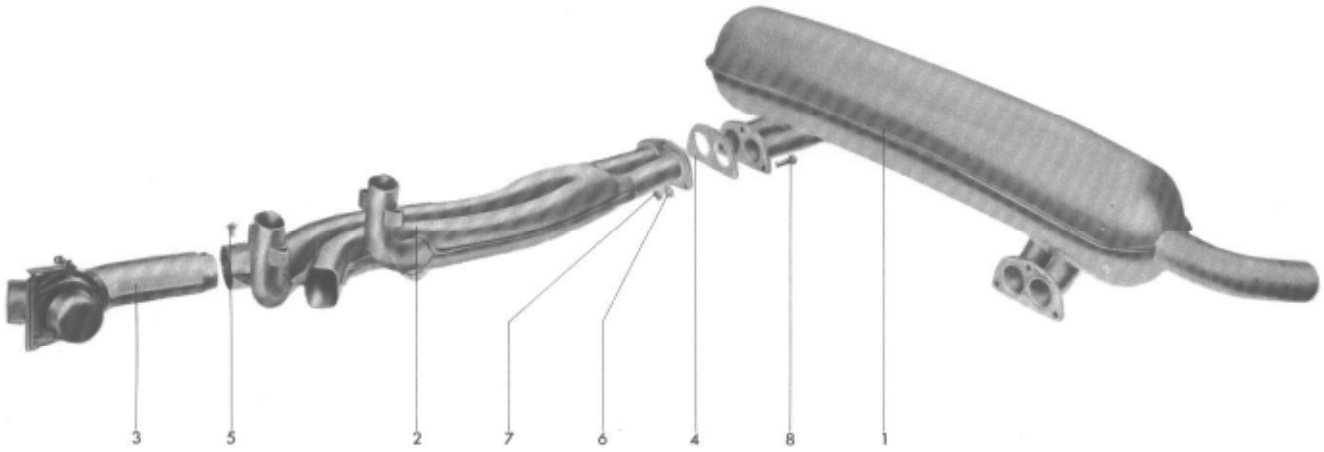
The washer can be removed from the installed engine with the aid of a magnet. Removed engine can be turned 180° around so that the washer can fall out.

2 - The offset slot in the top end of the distributor shaft should be at an angle of approximately 12° in relation to the longitudinal axis of the engine; the larger segment is on the crankshaft side of the engine.



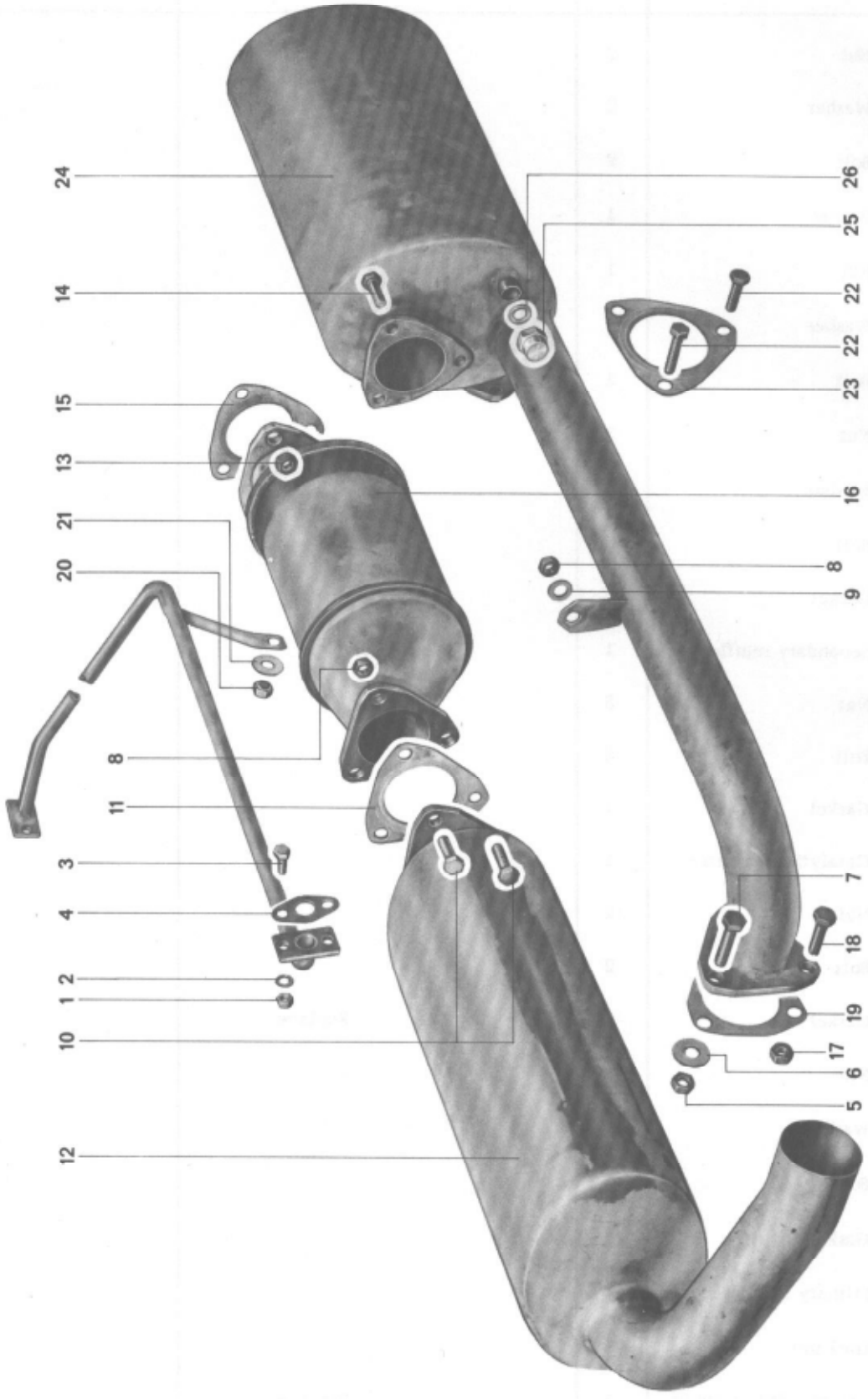


No.	Description	Qty	Note when removing / installing	Remarks
1	Engine cover plate, right front	1		
2	Engine cover plate, left front	1		
3	Warm air guide, bottom left	1		
4	Warm air guide, bottom right	1		
5	Engine cover plate, rear	1		
6	Grommet	3		



No.	Description	Qty	Note when removing	Note when installing	References
1	Muffler	1	Replace when badly rusted		
2	Heat exchanger	2	Left and right side differ from each other. Check for damage. Rework sealing connections if neccessary.		
3	Warm air duct	2			
4	Gasket	2		Replace	
5	Screw	2			
6	Washer	6			
7	Self-locking nut, M8	6			
8	Bolt, M8	6			

DISMANTLING AND ASSEMBLING EXHAUST SYSTEM - 1975 MODELS



No.	Description	Qty.	Note when removing	Note when installing	Remarks
1	Nut	2			
2	Washer	2			
3	Bolt	2			
4	Gasket	1		Replace	
5	Nut	1			
6	Washer	1			
7	Bolt	1			
8	Nut	3			
9	Washer	1			
10	Bolt	3			
11	Gasket	1		Replace	
12	Secondary muffler	1			
13	Nut	3			
14	Bolt	3			
15	Gasket	1			
16	Catalytic converter	1			
17	Nut	2			
18	Bolt	2			
19	Gasket	1		Replace	
20	Nut	3			
21	Washer	1			
22	Bolt	3			
23	Gasket	1			
24	Primary muffler	1			
25	Lock nut	1			
26	Gasket 8x12 Copper	1		Replace	

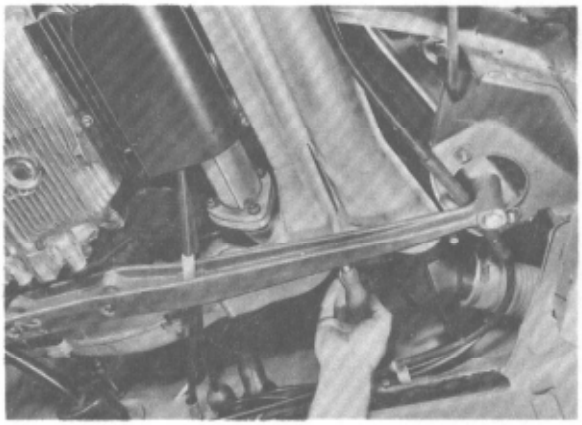
REMOVING AND INSTALLING HEAT EXCHANGER

Removing

1. Detach floor air guide plate.

2. Disconnect heater cable. Remove flap support.

3. Remove heater air support cap screw on heat exchanger.



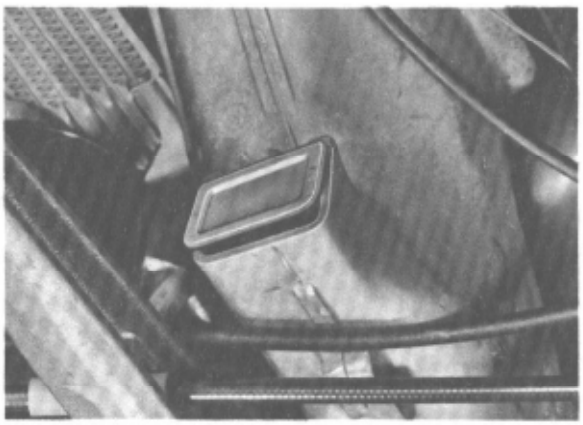
4. Loosen and remove warm air guide cover.

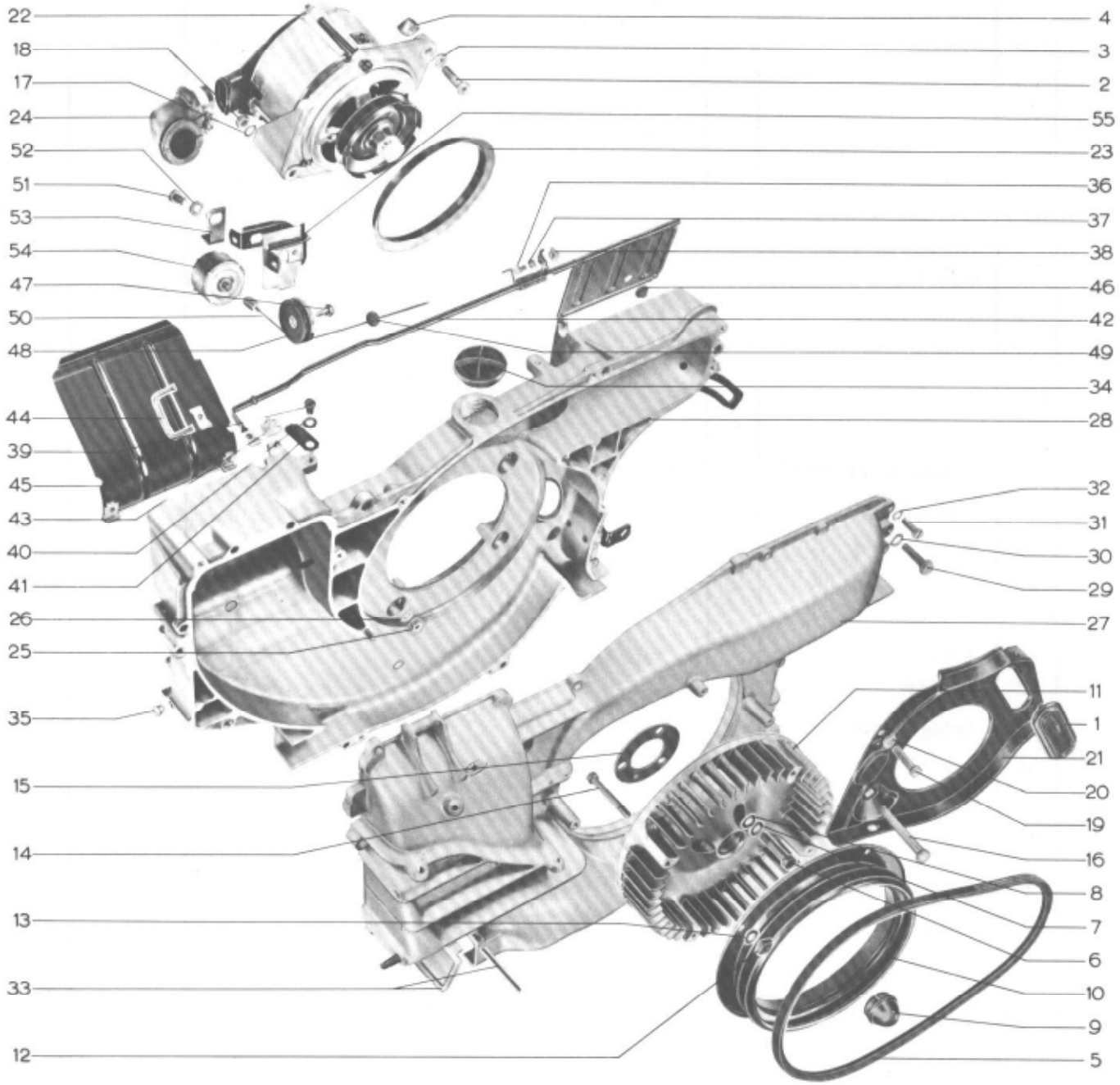
5. Remove bolts at flanges of heat exchanger.

6. Remove heat exchanger with gaskets.

Installing

Check air flap for ease of movement before installing heat exchanger.

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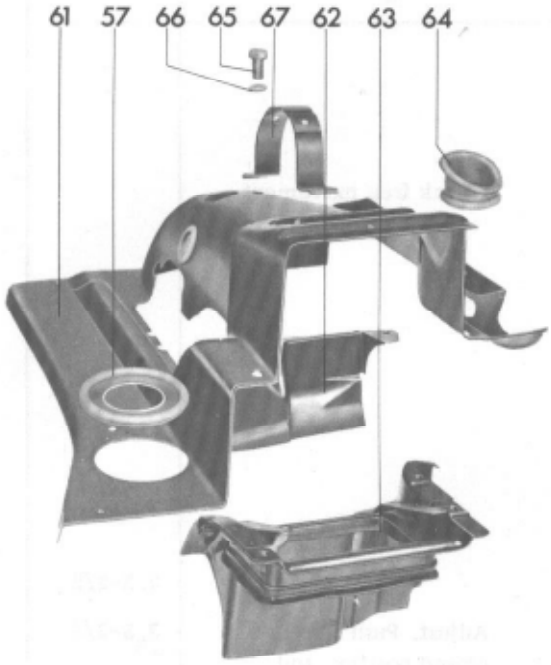
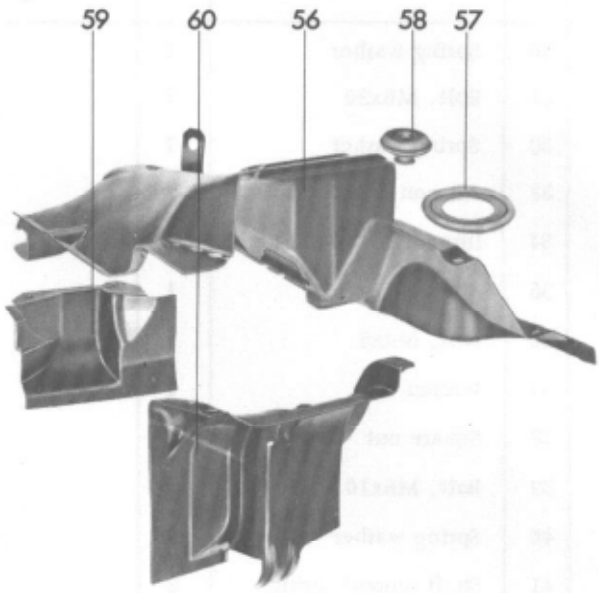
No.	Description	Qty	Note when removing	Note when installing	References
1	Cover plate closure	1			
2	Internal-head bolt, M8	1		Loosen when adjusting V-belt	Fig. 1,2
3	Spring washer	1			
4	Nut, M8	1			
5	V-belt	1	Check for wear. Washer oily V-belts in detergent solution and rinse with water	Adjust tension to deflect 15 mm in length center under vigorous thumb pressure	Fig. 1,2
6	Internal-head bolt, M8x39	3		Torque to 19.6 Nm (2.0 mkg)	
7	Spring washer	3			
8	Washer	3			
9	Cap	1			
10	Pulley	1			
11	Cooling blower impeller	1	Remove and install together since parts are balanced together		
12	Square nut, M7	4			
13	Spring washer	4			
14	Internal head bolt, M7x52	4			
15	Spacer	1			
16	Bolt, M8	1			
17	Spring washer	1			
18	Nut, M8	1			
19	Bolt, M6x30	1			
20	Spring washer	1			
21	Alternator shroud	1			
22	Alternator	1			
23	Alternator seal	1			
24	Connecting elbow for alternator	1		Insert into front cooling blower housing half	Fig. 5
25	Nut, M8	4			
26	Spring washer	4			
27	Cooling blower housing rear half	1	Remove and install together		3.3-2/2
28	Cooling blower housing front half	1			
29	Nut, M8x30	3			

No.	Description	Qty	Note when removing	Note when installing	References
30	Spring washer	3			
31	Bolt, M6x20	7			
32	Spring washer	7			
33	Air non-return flap	2		Check free movement	
34	Inspection hole cover	1			
35	Plug	1			
36	Bolt, M4x8	1			
37	Washer	1			
38	Square nut	1			
39	Bolt, M6x10	2			
40	Spring washer	2			
41	Shaft support spring	2			3.3-2/2
42	Control flap with shaft, right side	1		Adjust. Push flap into closed position and tighten cable	3.3-2/3
43	Support bearing	2			
44	Control flap link	1			
45	Control flap, left side	1			
46	Buffer	1			
47	Bolt, M6	1			
48	Cooling air control cable pulley	1		Check free movement	
49	Sealing grommet	1			
50	Cooling air control cable	1	Detach prior to removal of cooling blower housing		
51	Bolt, M8x15	1			
52	Washer	1			
53	Thermostat washer	1			
54	Thermostat	1		Test through submersion in water	3.3-2/3





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

CHECKING AND ADJUSTING V-BELT TENSION

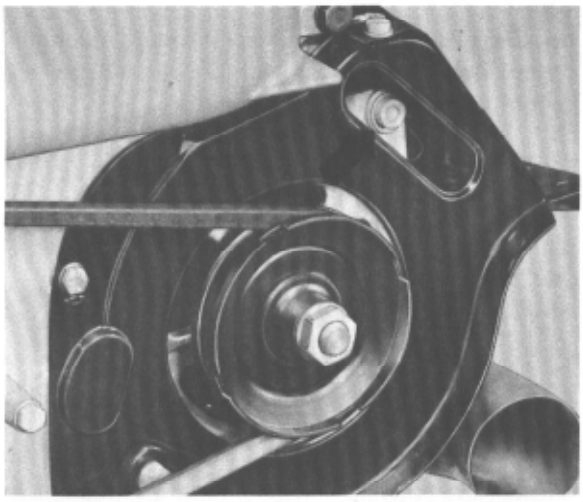


Fig. 1

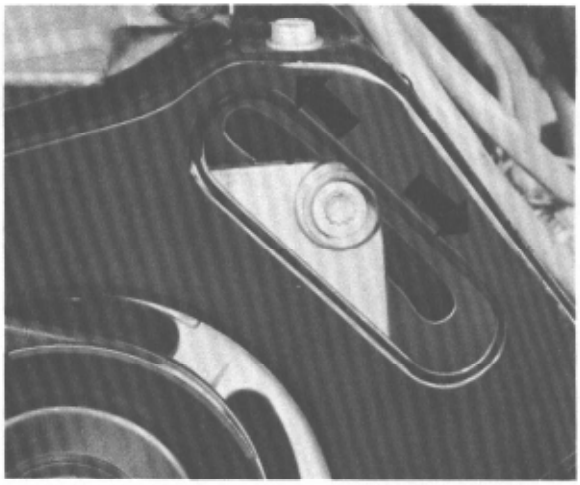


Fig. 2

REMOVING AND INSTALLING COOLING AIR BLOWER HOUSING

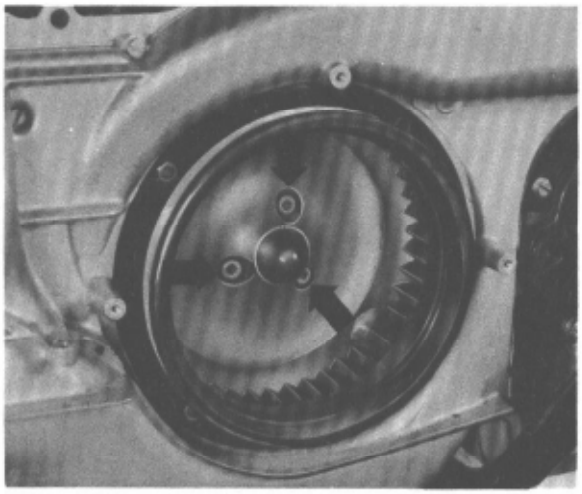


Fig. 3

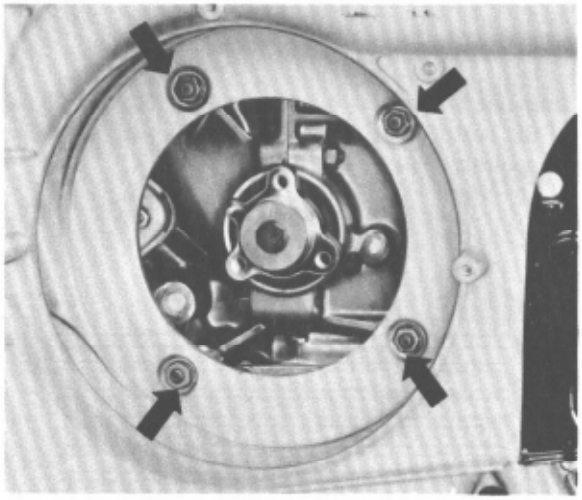
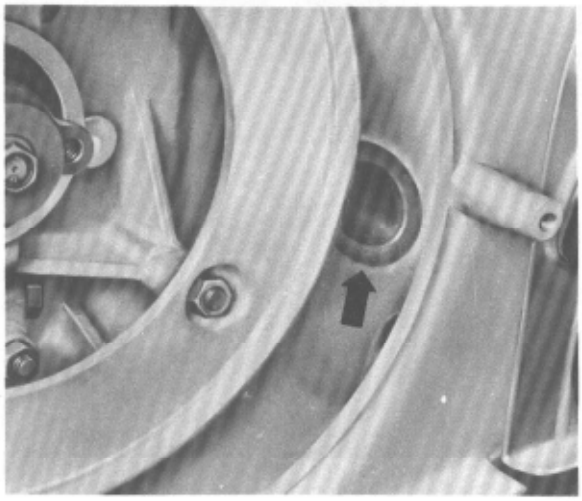


Fig. 4

NOTE
The cooling air blower can be removed with alternator installed.

Removing and Installing Cooling Air Blower Housing

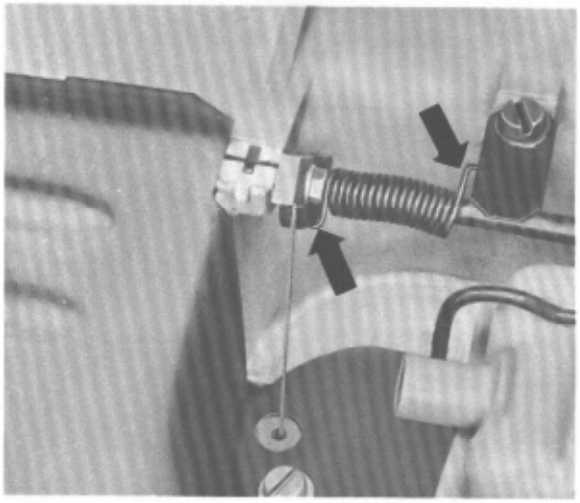


Removal

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

Installation

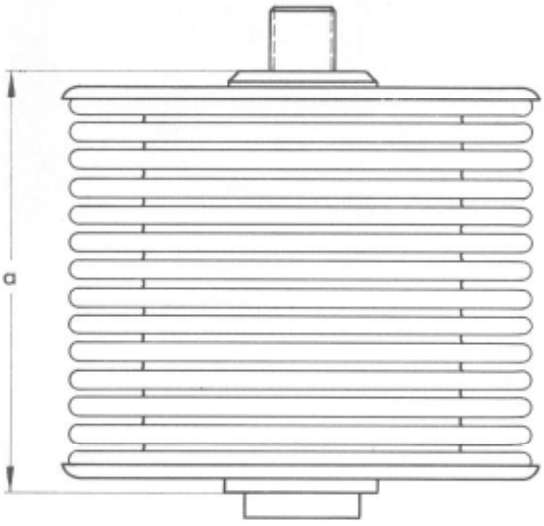
The bent ends of the return spring must rest against the casting lug for the shaft support spring on one side, and behind the control cable guide on the other.



THERMOSTATIC COOLING AIR CONTROL

Checking Thermostat

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



REPLACING COOLING BLOWER IMPELLERS

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

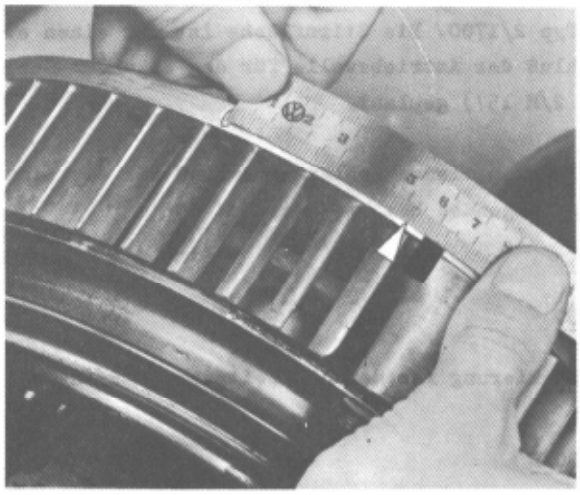
27° timing mark = 52.5 mm along the circumference
7.5° timing mark = 14.6 mm along the circumference

Making Timing Notch

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

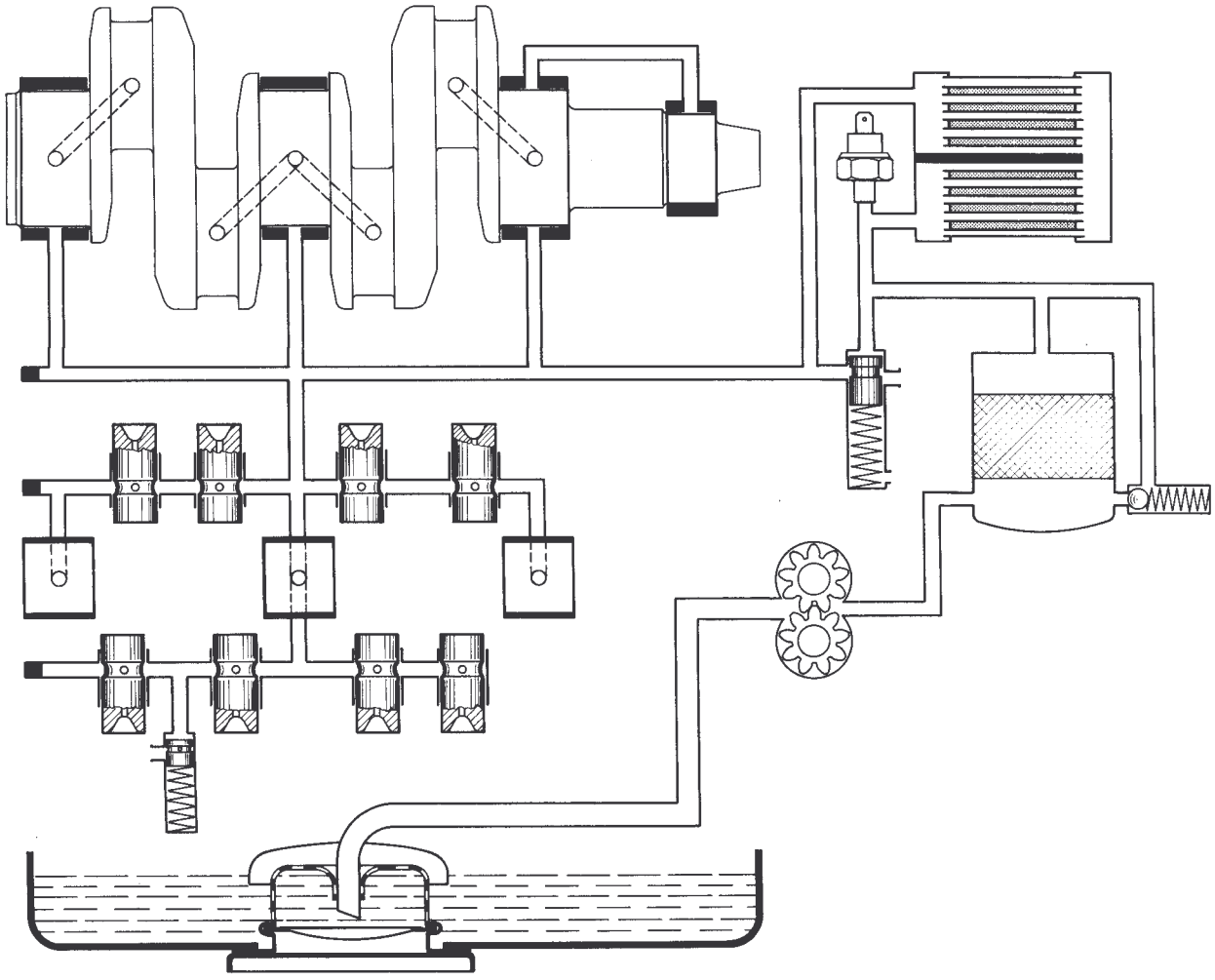
2. Make timing notch with a triangular file.

3. Mark notch with red paint.



DESCRIPTION

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



Oil capacity:

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

Oil dipstick:

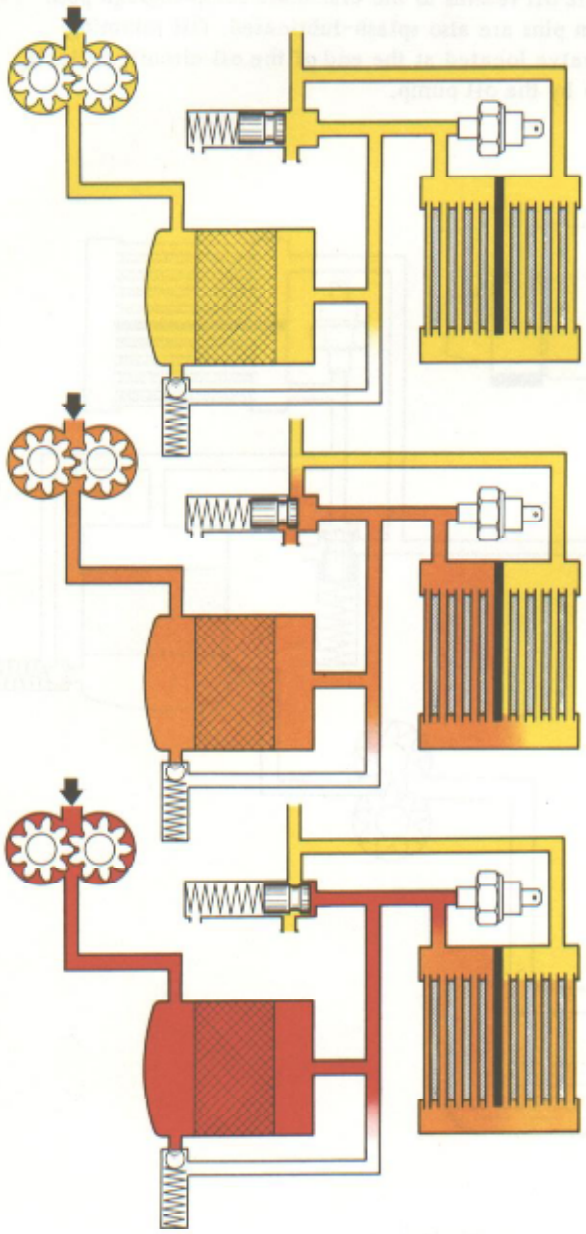
upper mark - max. level
lower mark - min. level (3.0 ltrs)

Oil pressure:

(measured at oil pressure switch; applies only to SAE 30 oils)
oil temperature of 70° C
at 2500 rpm: 4.4 bar (4.5 atm)
min. 2.0 bar (2.0 atm)

Oil Pressure Control Valves

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



a - When the oil is cold and thick,

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

b - As the oil warms up and becomes thinner,

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

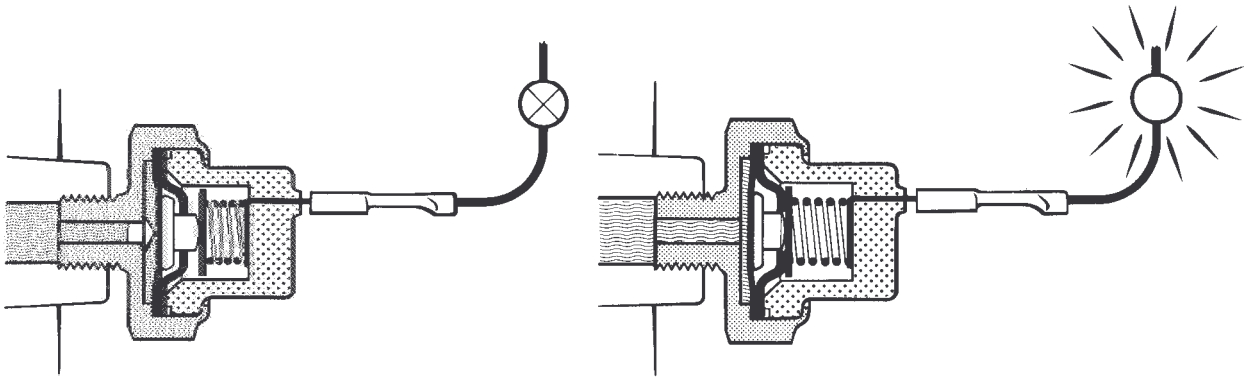
c - As the oil is at operating temperature and thin,

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

An oil pressure control valve, located at the end of the oil circuit, maintains an oil pressure of approx. 2.0 bar (2.0 atm) within the crankshaft and camshaft bearing areas.

Oil Pressure Switch

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



a - Oil pressure rises when engine is started:

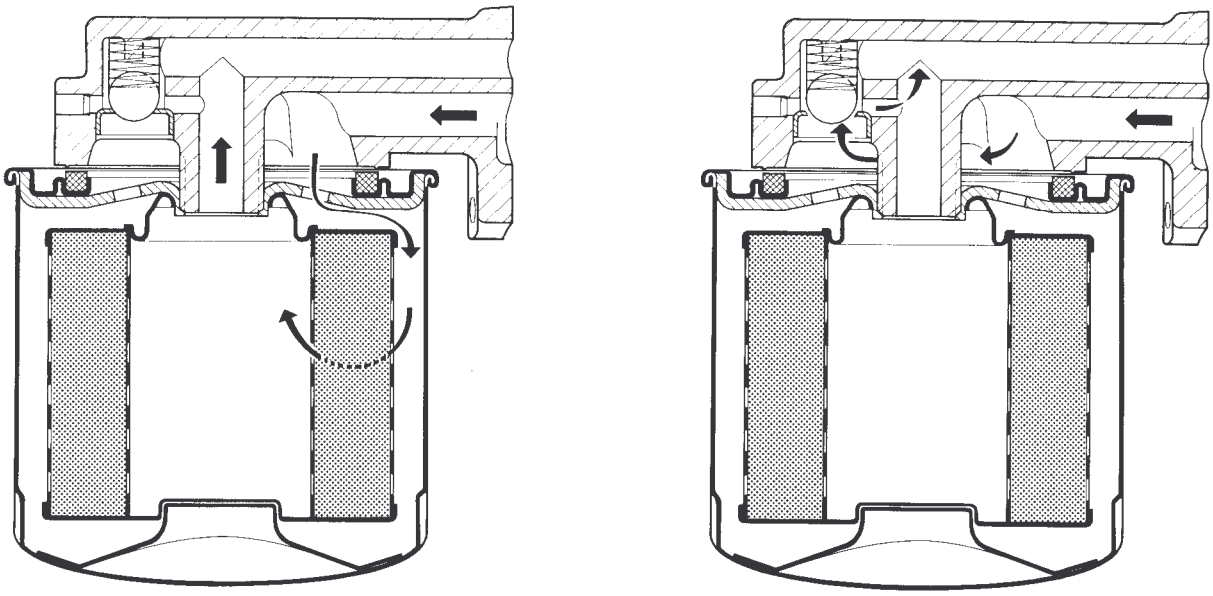
contact opens between 0.15 and 0.44 bar (0.15-0.45 atm),
warning light goes out.

b - If oil pressure is too low with engine running:

contact closes,
warning light goes on.

Oil Filter

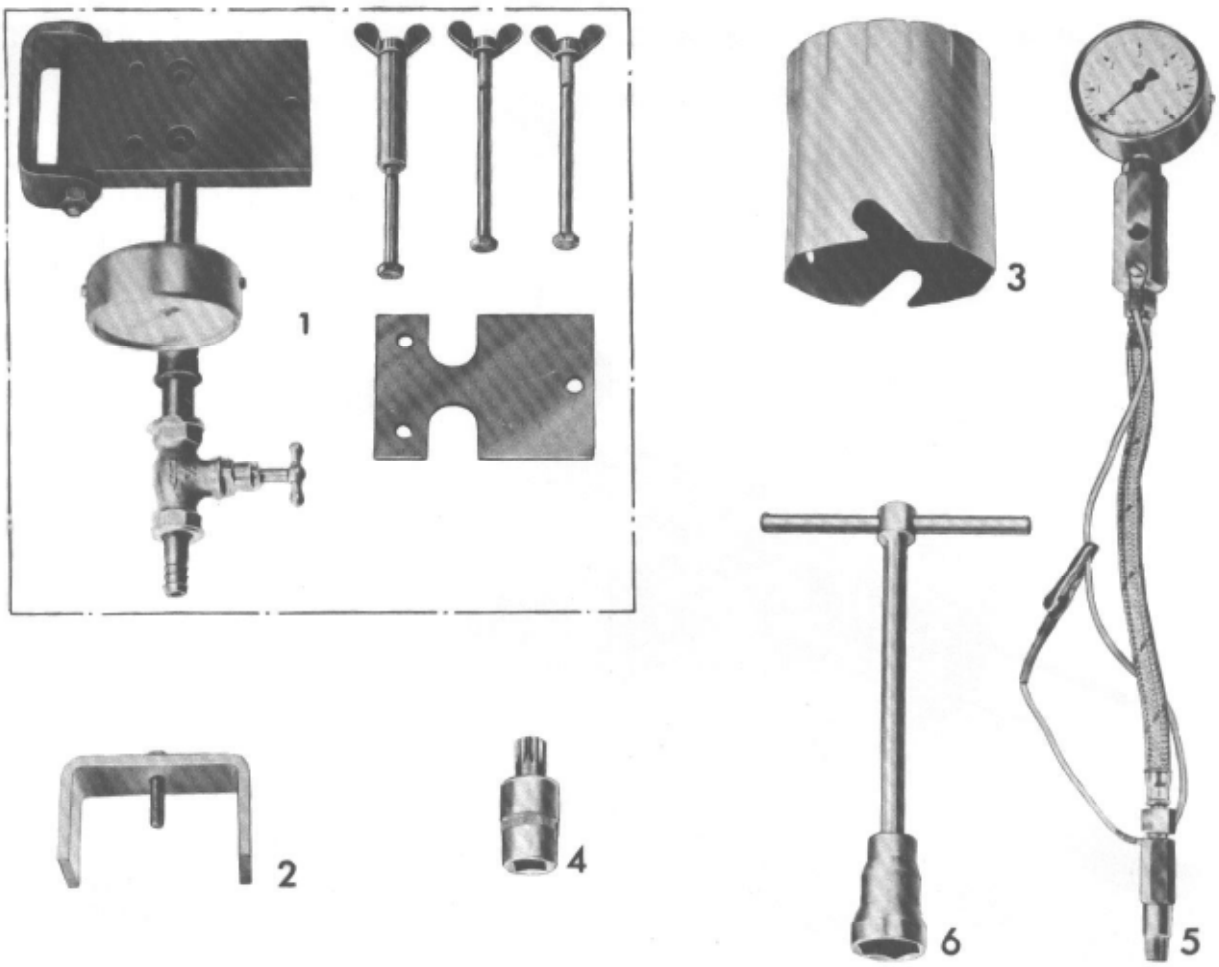
The full-flow oil filter entraps even very small dirt particles. A bypass valve in the oil filter base ensures that the oil will continue to flow even if the filter should become clogged.



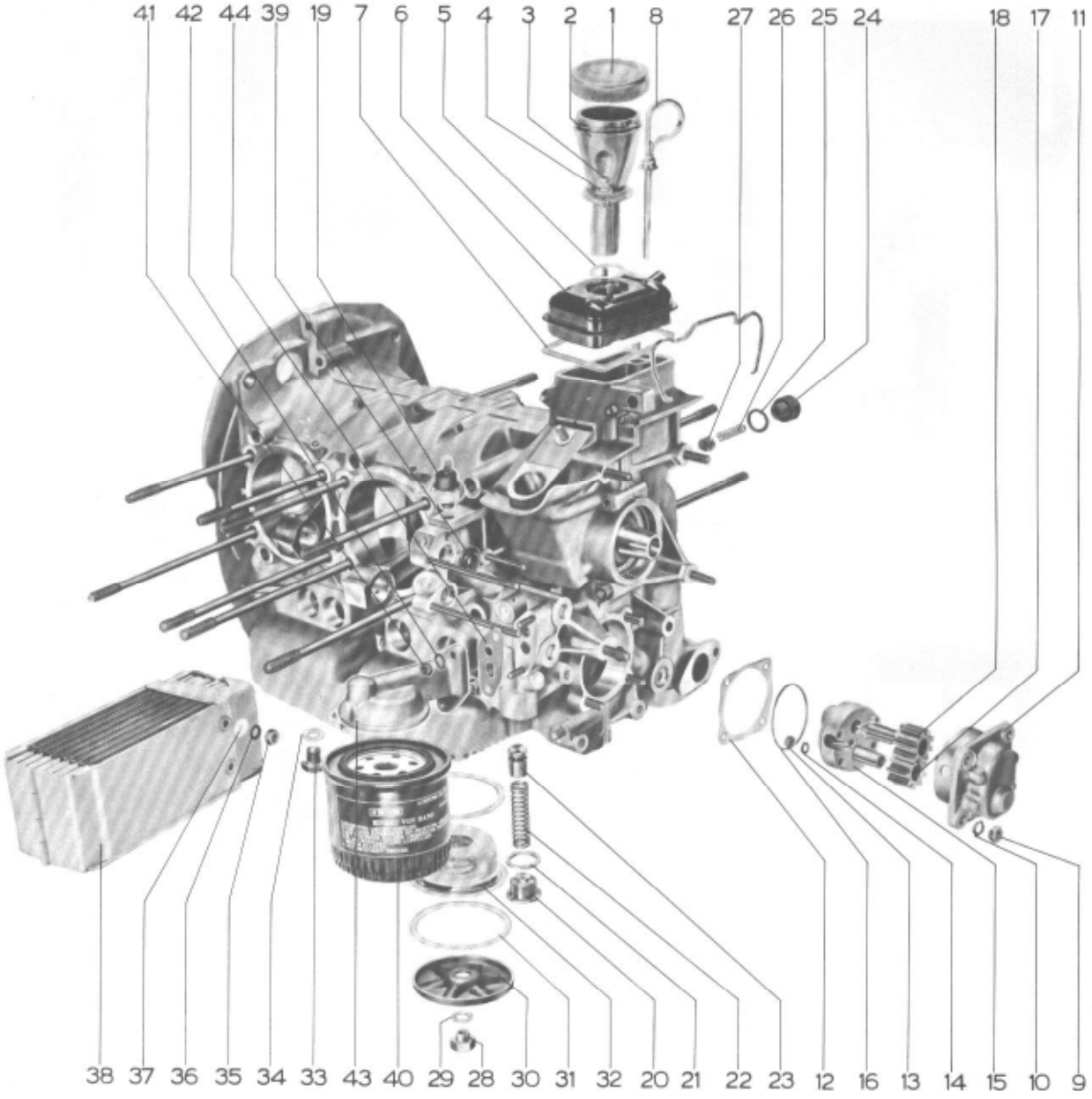
a - Normal oil path.

b - Oil bypassing a clogged filter.

TOOLS



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


41 42 44 39 19 7 6 5 4 3 2 1 8 27 26 25 24 18 17 11
38 37 36 35 34 33 43 40 29 28 30 31 32 20 21 22 23 12 16 13 14 15 10 9

No.	Description	Qty	Note when removing	Note when installing	References
1	Oil filler cap	1			
2	Oil filler neck	1			
3	Nut, M6	2			
4	Spring washer	2			
5	Oil filler gasket	1		Replace	
6	Oil breather	1			
7	Gasket	1		Replace	
8	Dipstick	1			
9	Nut, M8	4		Torque to 19.6 Nm (2.0 mkg)	
10	Spring washer	4			
11	Oil pump housing	1	Use 2 levers. Check for wear (esp. pump gear seats).	Clean gasket area. Turn crankshaft twice to center pump, tighten nuts.	Fig. 1
12	Oil pump housing gasket	1		Replace	
13	Self-locking nut, M6	4			
14	Spring washer	4			
15	Oil pump cover	1	Use VW 803 puller. Check for traces of wear.		Fig. 2
16	Pump cover O-ring	1		Replace. Oil.	
17	Pump gear	1	Check for wear.	Oil. Check for free movement.	
18	Pump drive shaft	1	Check for wear.	Oil. Lug must be flush with slot in camshaft.	
19	Oil pressure switch	1			4.1-3/1
20	Plug, M22x1.5				

No.	Description	Qty	Note when removing	Note when installing	References
21	Gasket	1		Replace	
22	Spring for oil pressure relief valve (bottom)	1		Check: spring length compressed: 39,0 mm load: 66,7-86,3N (6,8-8,8 kg)	
23	Pressure relief plunger	1	Check for wear	Carefully smooth scoring marks. Pull out with thread tap, if necessary	
24	Plug, M16x1.5	1	Use internal head socket M14		
25	Gasket	1		Replace	
26	Spring for oil pressure control valve (side)	1		Check: spring length compressed: 16.8 mm; load: 42.7 N (4.35 kg)	
27	Pressure control plunger	1	Check for wear	Carefully smooth scoring marks. Pull out with thread tap, if necessary	
28	Retaining nut, M8	1		Max. torque 12.7 Nm (1.3 mkg)	
29	Gasket	1		Replace	
30	Oil Strainer cover	1		Gasket surface must be straight. Clean thoroughly	
31	Gasket	2		Replace	
32	Oil strainer	1		Clean. Check for damage	
33	Drain plug	1		Torque to 21.6 Nm (2.2 mkg)	
34	Gasket	1		Replace	
35	Nut, M6	3			
36	Spring washer	3			
37	Washer	3			
38	Oil cooler	1	Check shrouding for firm attachment. Check for leaks with oil cooler tester VW 661/2, test pressure 5.9 bar (6.0 atm). If defective, check oil pressure relief valve.		Fig. 3
39	Oil cooler gasket	2		Replace	

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

Removing Oil Pump

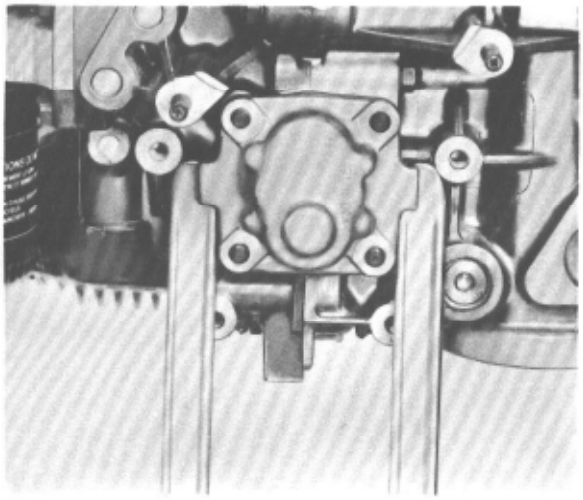


Fig. 1

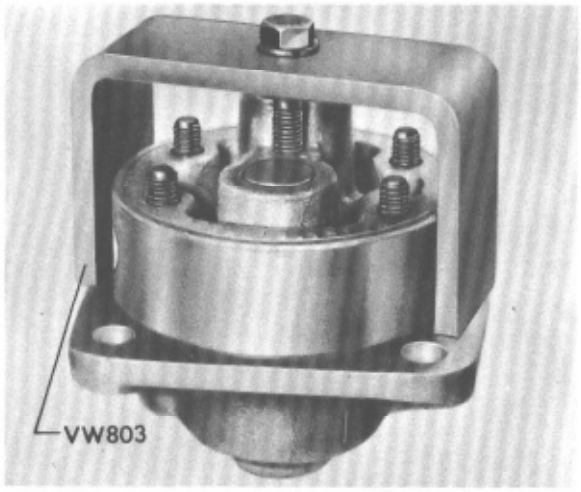


Fig. 2

Checking Oil Cooler

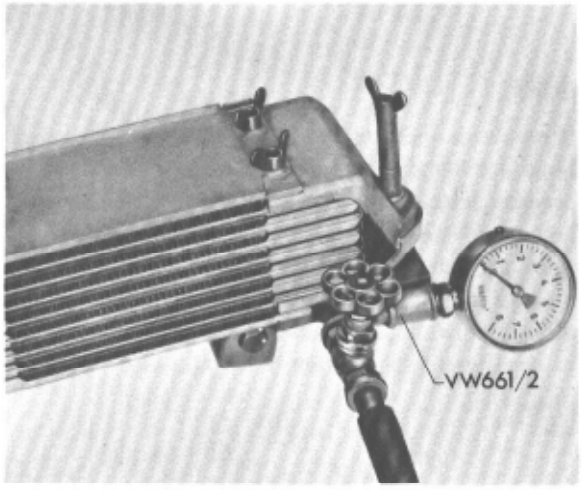
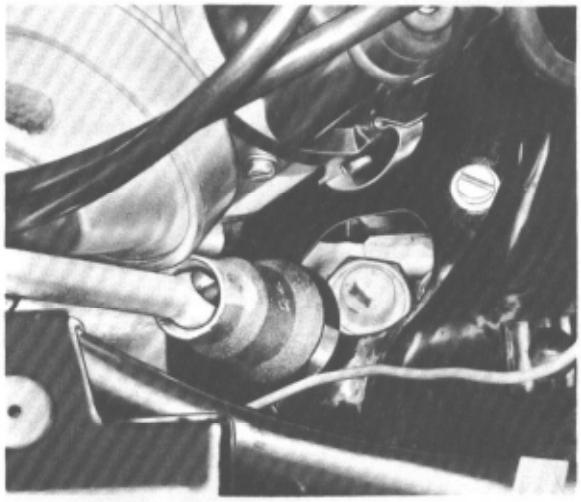


Fig. 3

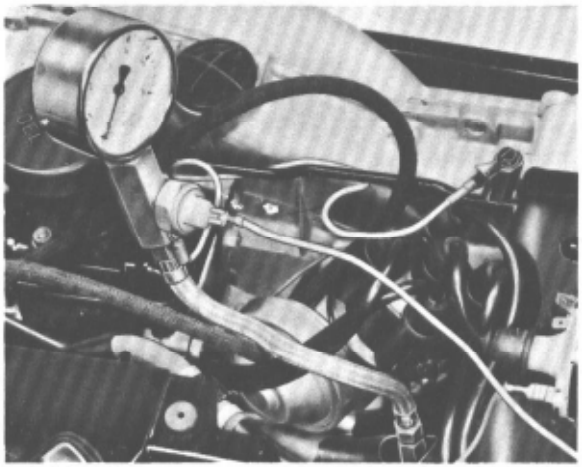
Checking Oil Pressure Switch

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

1 - Remove oil pressure switch and screw into tester.



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



3 - Start engine. Observe that pressure will rise on the pressure gauge and the light will go out as the engine rpm increase. The switch contact should remain closed and the lamp lit as long as the oil pressure is below 0.15-0.44 bar (0.15-0.45 atm).

4 - Stop engine. A slight delay may occur before the lamp lights up as drops slowly.

5 - The tapered threads seal the oil pressure switch. The switch should not be overly tightened to prevent damaging the treads.

Installing Oil Filter

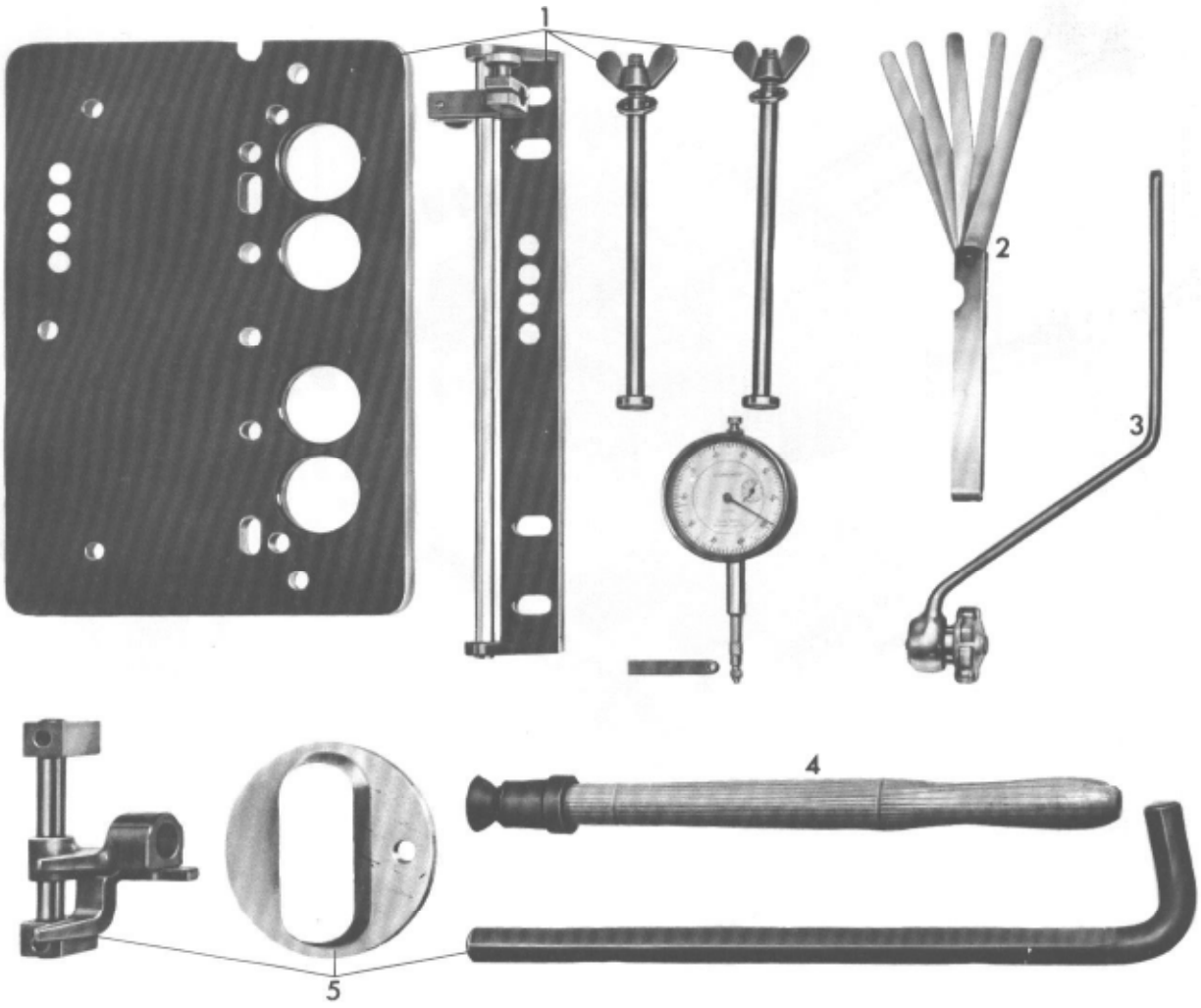
CAUTION

Washing and cleaning of the oil filter is not permissible!

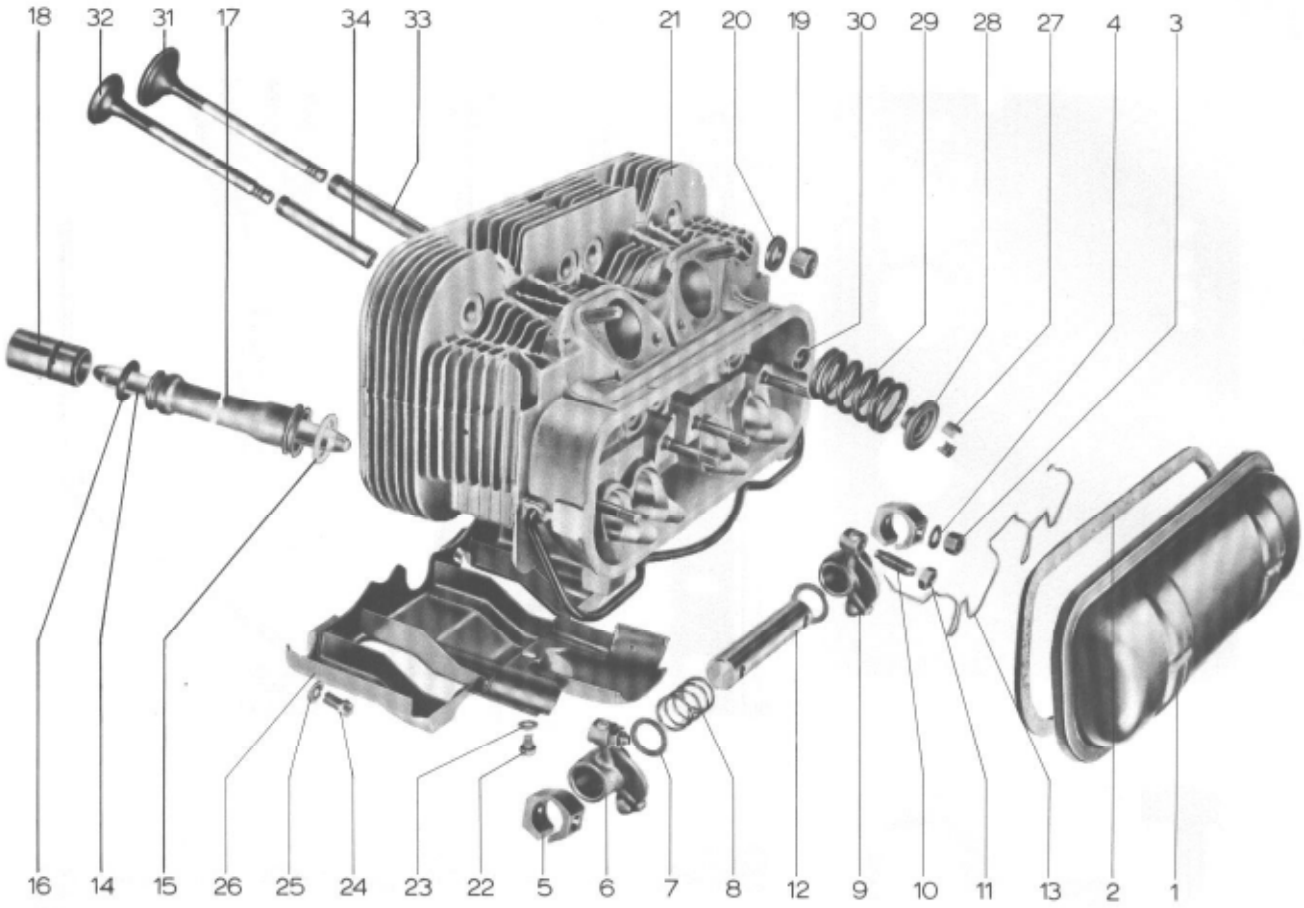
NOTE

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

TOOLS



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



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

No.	Description	Qty	Note when removing	Note when installing	References
6	Exhaust rocker arm	4	Check for wear and scoring marks. New: 20.00-20.02 mm dia. Wear limit: 20.04 mm dia.	Smooth grooves worn into side thrust flanks with fine-grit emery cloth.	
7	Thrust washer	8			
8	Spring	4			
9	Intake rocker arm	4	Check for wear and scoring marks. New: 20.00-20.02 mm dia. Wear limit: 20.04 mm dia.	Smooth grooves worn into side thrust flanks with fine-grit emery cloth.	
10	Valve adjusting screw	8	Replace if binding.		
11	Nut, M8x1	8	Replace if binding.		
12	Rocker arm shaft	4	Check for wear and scoring marks. New: 19.95-19.97 mm dia. Wear limit: 19.93 mm dia.		
13	Push rod cover tube retaining clip	2		Must engage bearing support slots and rest on lower edges of the cover tubes.	Fig. 6
14	Pushrod	8	Mount on centers to check for runout max. 0.3 mm		
15	0-ring, red	8		Replace	
16	0-ring, black	8		Replace	
17	Push rod cover tube	8		Push fully in to stop	
18	Tappet	8	Check for wear and scoring marks	Install lubricated with engine oil	
19	Nut, M10	16		Watch tightening sequence. Tighten lightly at first, then torque to 31.4 Nm (3.2 mkg).	Fig. 5
20	Washer	16			

No.	Description	Qty	Note when removing	Note when installing	References
21	Cylinder head	2		Check for cracks in combustion chambers and exhaust ports, also for leakage along cylinder contact surfaces. Check spark plug threads and studs for damage or tightness. If necessary, install Heli-coil inserts.	
22	Screw, M5x10	2			
23	Washer	2			
24	Screw, M6	4			
25	Washer	4			
26	Baffle	2		Left and right not same	
27	Valve keeper	16		Replace if peened	
28	Valve cap	8			
29	Valve spring	8		Check spring tension: compressed length: 30 mm; test load: 711.2-818.1 N (72.5-83.5 Kp)	
30	Oil deflector	8		Replace. Install oiled	
31	Intake valve	4	Use spring depressor VW 311s. Check seat for burn spots or wear, reface if necessary.	Coat stem with molybdenum disulfide paste	Fig. 1
32	Exhaust valve	4			Fig. 4
			Remove burrs from valve keeper seat.		Fig. 2
33	Intake valve guide	4	Check with wear indicator US 4400 A		5.1-2/2
34	Exhaust valve guide	4			

25.1-1/4 Cylinder Head and Valves - Exploded View (USA only)

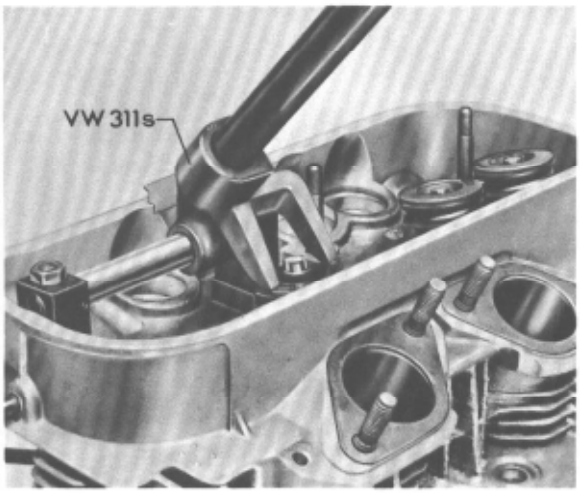


Fig. 1

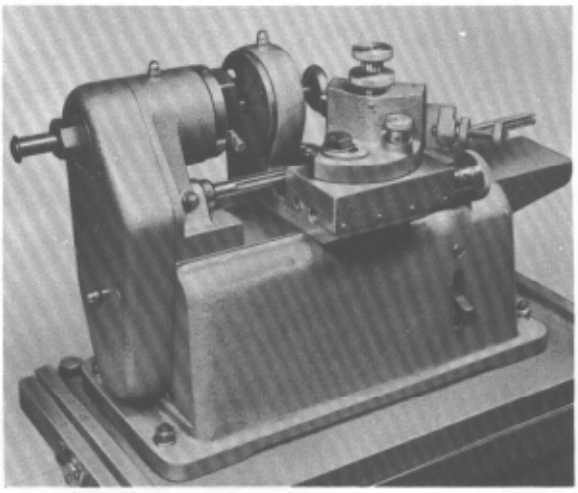


Fig. 4

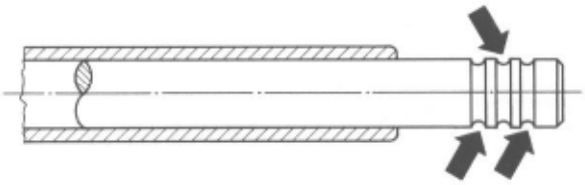
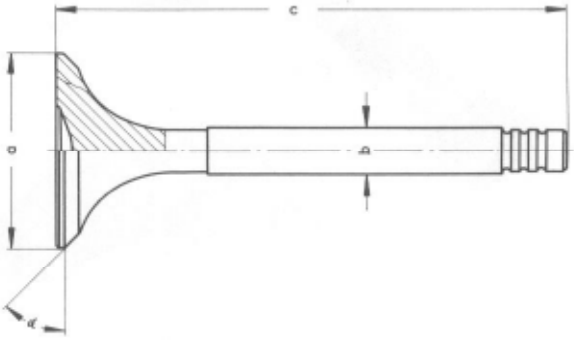


Fig. 2



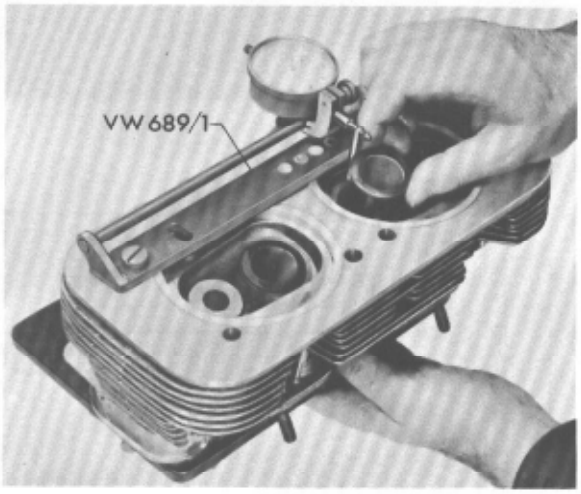
	Intake Valve	Exhaust Valve
a	41.8-42.2 mm dia.	35.8-36.2 mm dia.
b	116.8	117
c	7.94-7.95 mm dia.	8.91-8.92 mm dia.
	45°	45°

Fig. 3

CHECKING VALVE GUIDES

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

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



1 - Remove deposits with cleaning reamer.

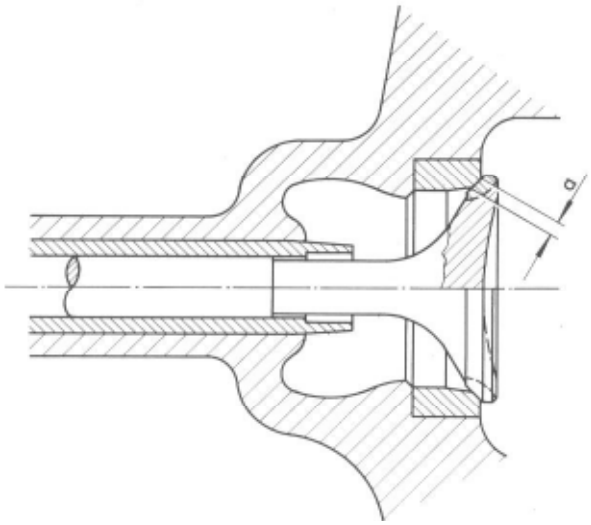
2 - Place cylinder head on clamping plate US 4404 A and fasten with gauge bracket.

3 - Place new valve in guide. The valve stem end must reach to end of guide.

4 - Determine side play.

	Intake valve guide	Exhaust valve guide	Wear limit
Side play	0.30 mm		1.2 mm
Inside diameter	8.00 - 8.02mm dia.	9.00 - 9.02mm dia.	8.06 - 9.06mm dia.

REFACING VALVE SEATS



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

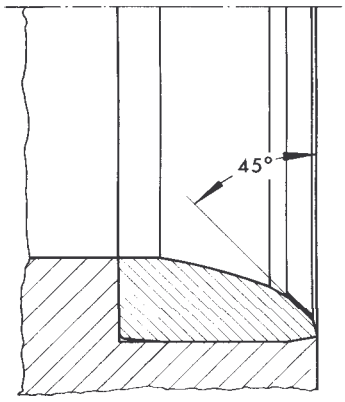
Valve seat width (a):

Intake = 1.8 - 2.2 mm
Exhaust = 2.0 - 2.5 mm

WORK PROCEDURE

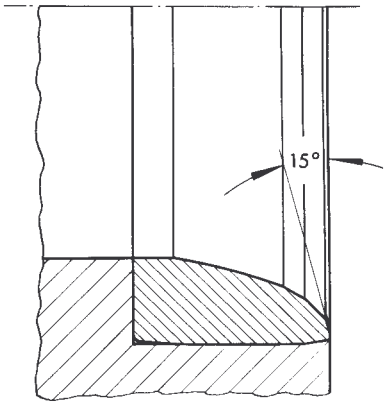
Preparing 45° surface:

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



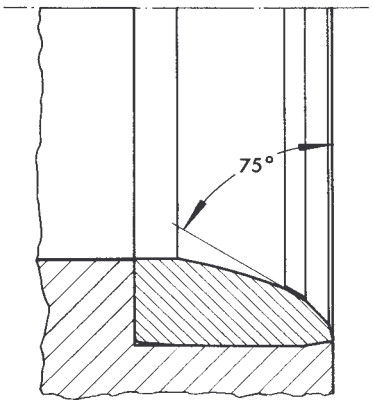
Preparing 15° surface:

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



Preparing 75° surface:

Lightly chamfer bottom edge of exhaust valve seat insert.



CHECKING VALVES FOR LEAKS

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

Contact Print

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

LAPPING VALVES

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

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

CAUTION: Thoroughly remove grinding paste after the lapping operation.

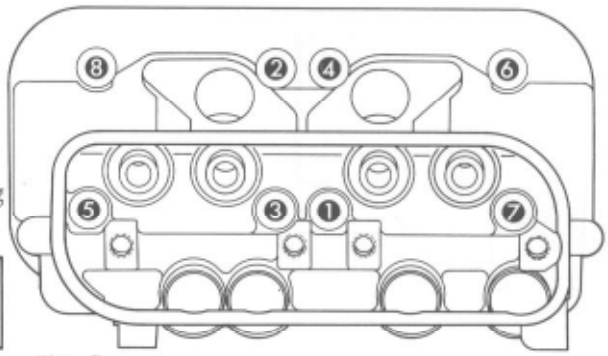
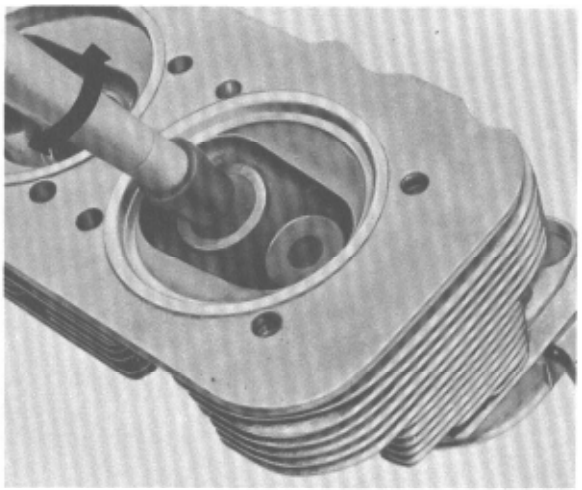


Fig. 5



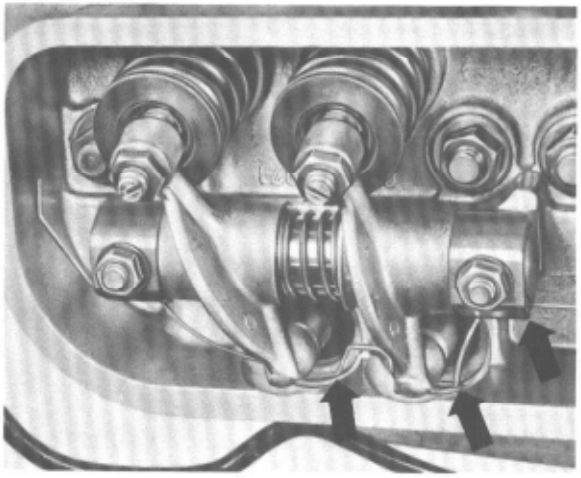


Fig. 6

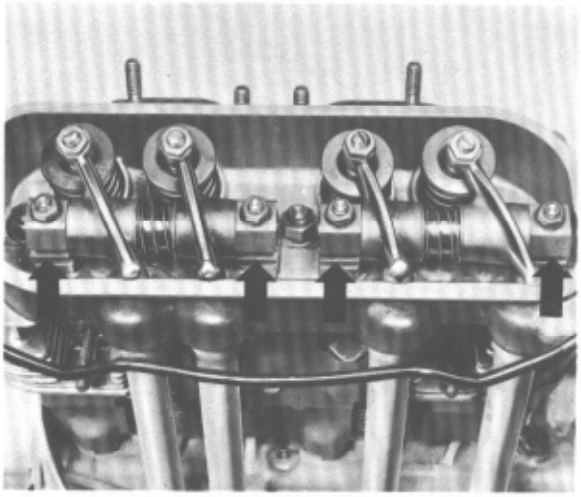


Fig. 7

ADJUSTING VALVES

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

Valve clearance: Intake = 0.15 mm Exhaust = 0.20 mm

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

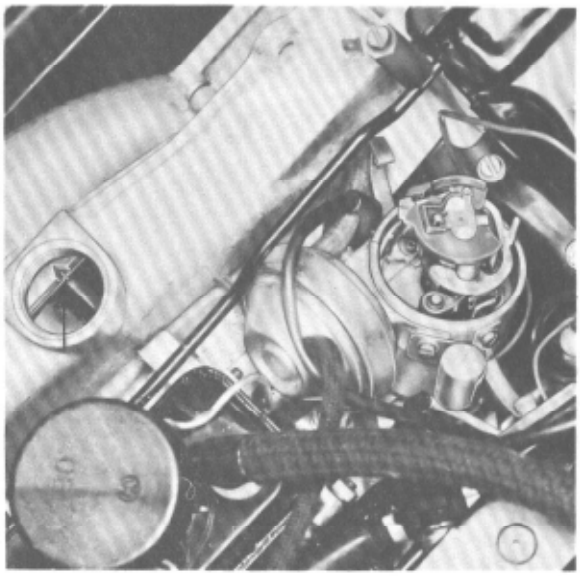
Proper valve clearance adjustment can be achieved only if the valve stems are not excessively loose in their guides and the valve stem ends are not worn unevenly.

Tight valve clearance will result in the following:

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

Loose valve clearance will result in the following:

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



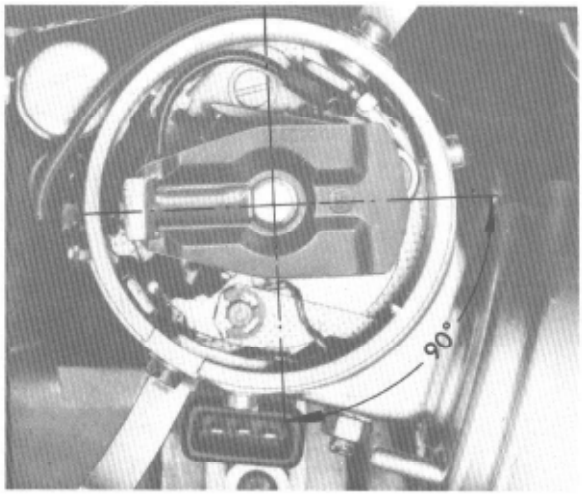
Adjusting Valves

Follow cylinder sequence 1 - 2 - 3 - 4.

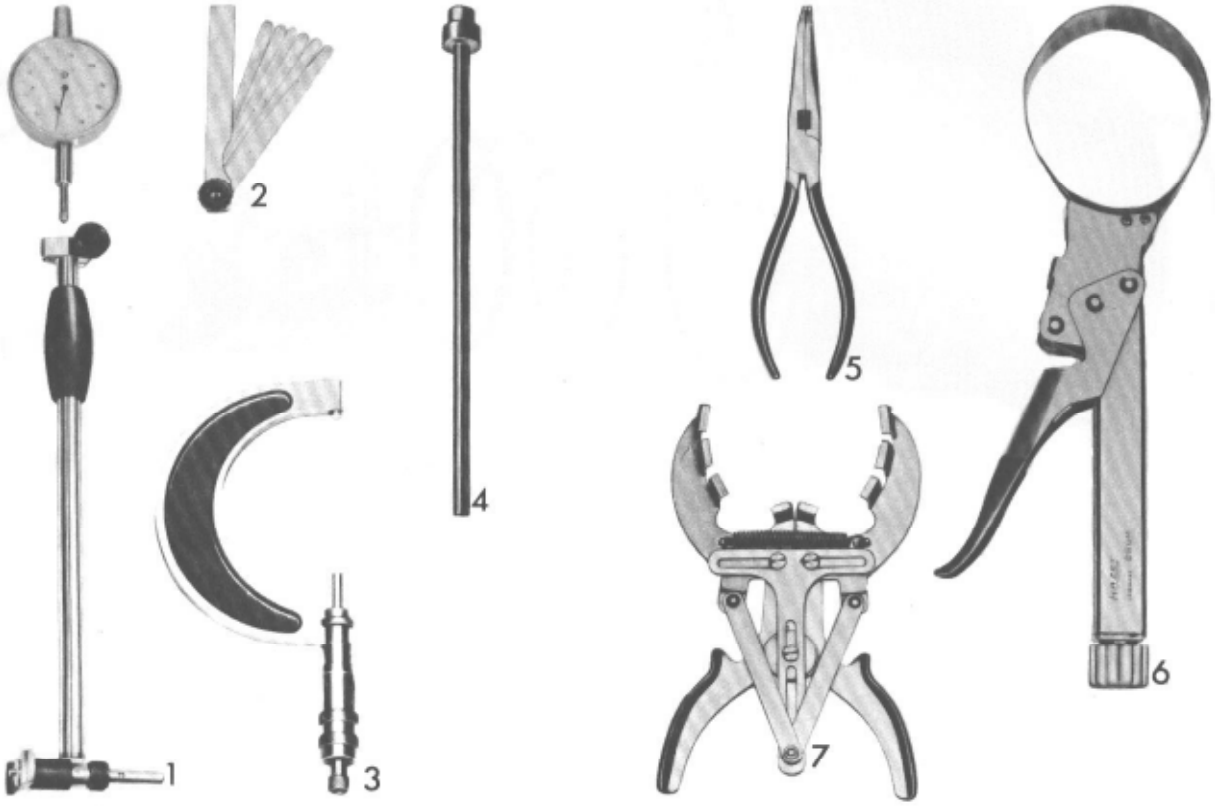
1 - Bring piston in cylinder 1 to firing point.

2 - Check valve clearance with feeler gauge:
Intake = 0.15 mm
Exhaust = 0.20 mm
The feeler gauge should pass snugly between the valve stem and the adjusting screw.

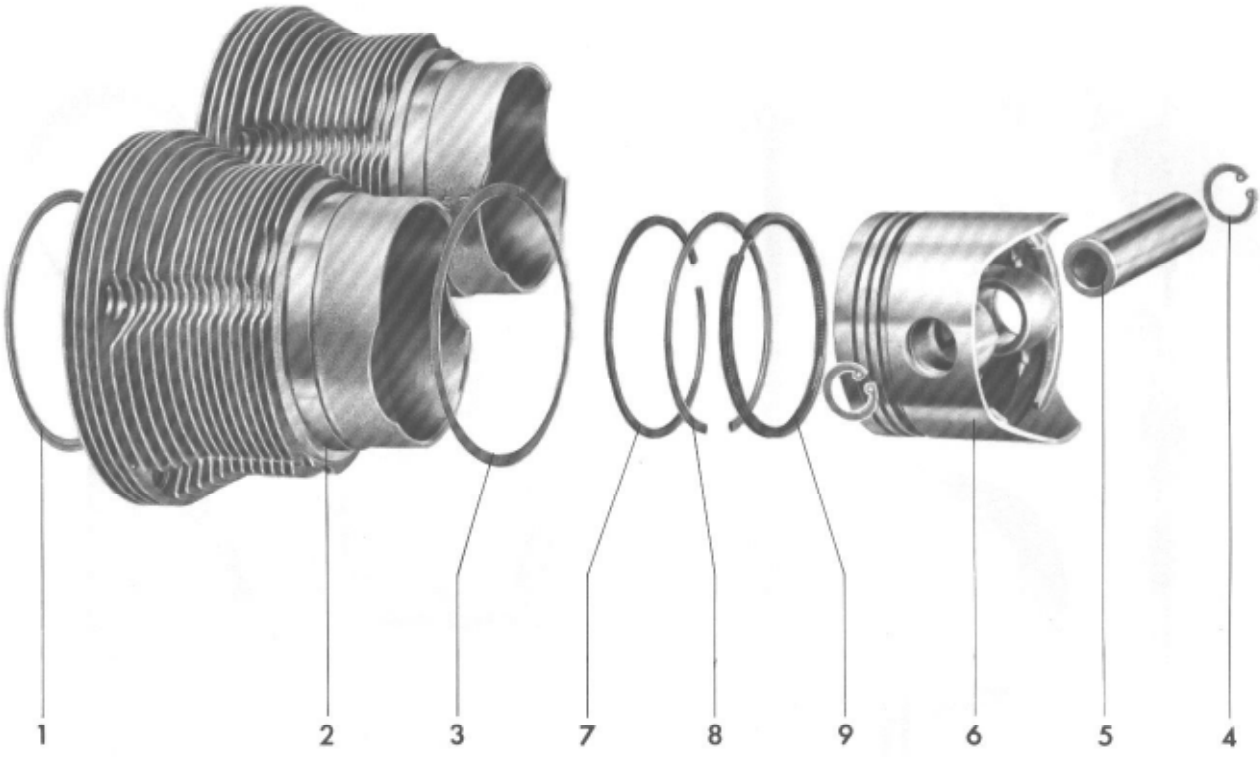
3 - Turn crankshaft to the left 90° at a time to adjust valves in cylinders 2, 3, and 4.



TOOLS



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



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

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

CHECKING CYLINDERS

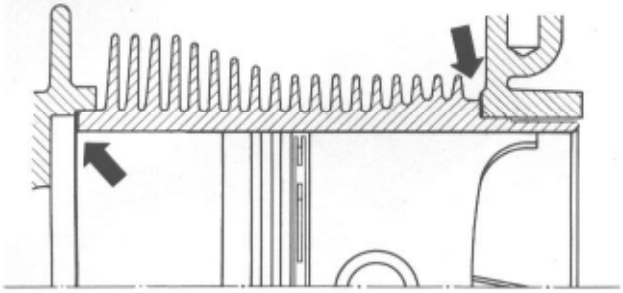


Fig. 1

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

REMOVING PISTONS

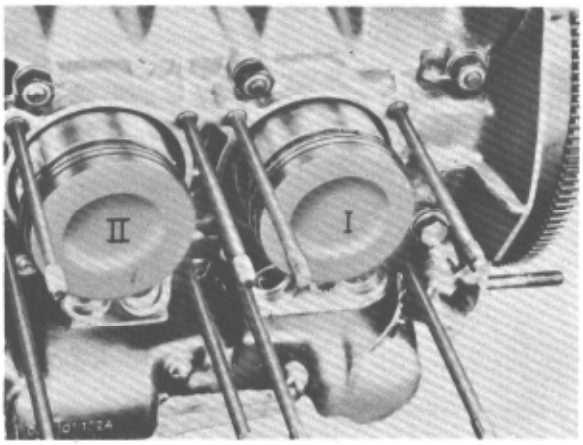


Fig. 2

PISTON MARKINGS

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

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

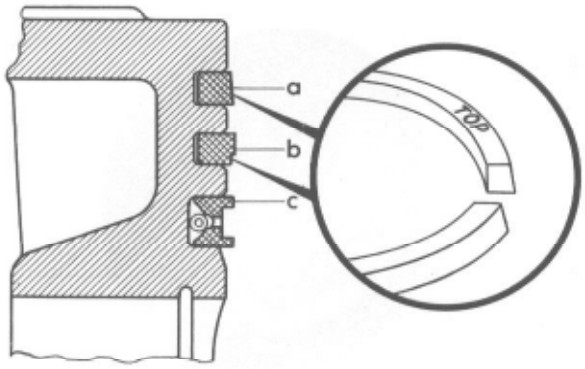
C - Paint mark indicating size group (blue, pink).

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

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

F - Piston size in mm.

CHECKING PISTONS



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

Fig. 3

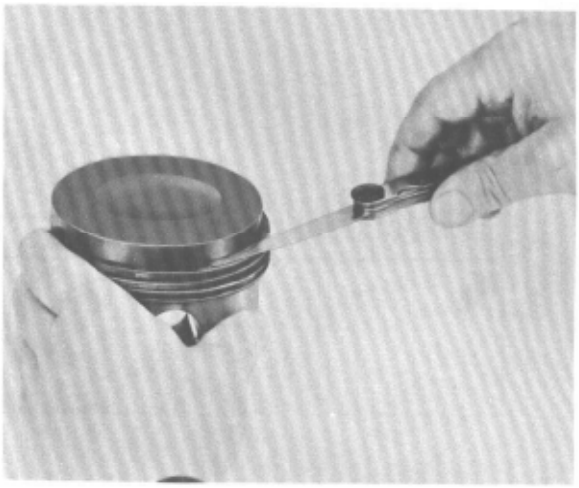


Fig. 5

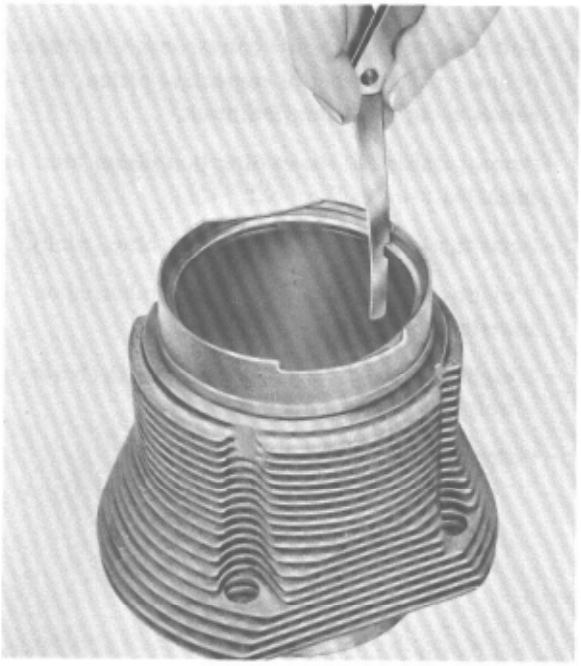


Fig. 4

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

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

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

	Diameter mm	Clearance mm	Wear Limit mm
Piston pin bushing, dia.	24.015-24.024	0.015 to 0.028	0.04
Piston pin, dia.	23.996-24.000		
Piston pin bore in piston	24.000-24.005		

Replace piston pin and bushing when wear limit is reached.

CHECKING CYLINDER TO PISTON CLEARANCE

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

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

Installed Clearance	Wear Limit
0.02 - 0.05 mm	0.2 mm

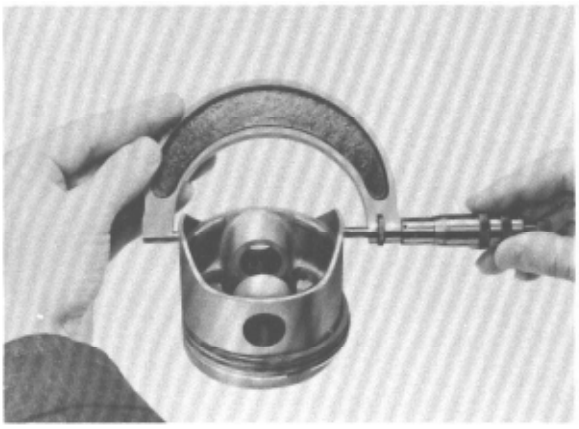


Fig. 7

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

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

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

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

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

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

INSTALLING PISTONS

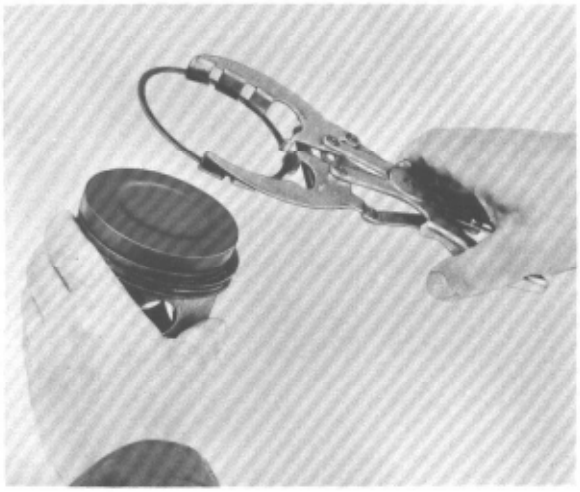


Fig. 8

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

Fig. 9

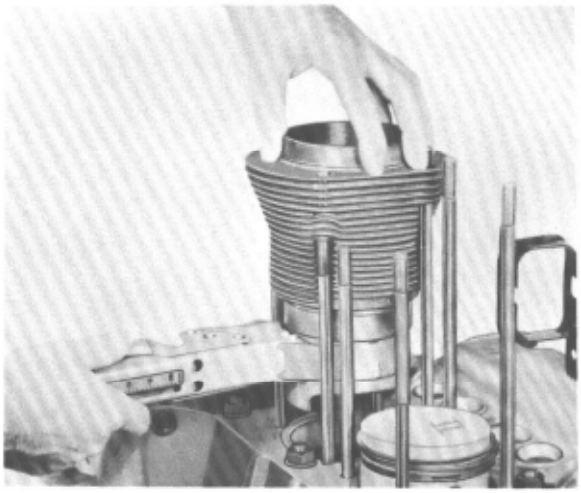


Fig. 10

NOTE
74 KS (100 HP) engine

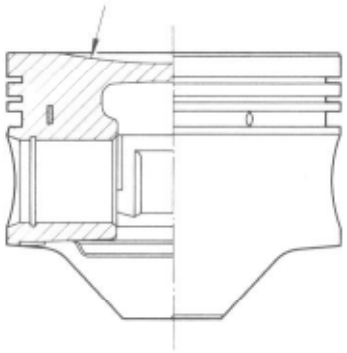


Fig. 11

70 KW (95 HP) engine

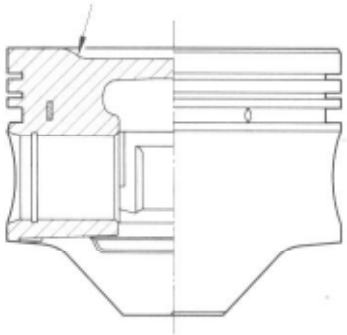
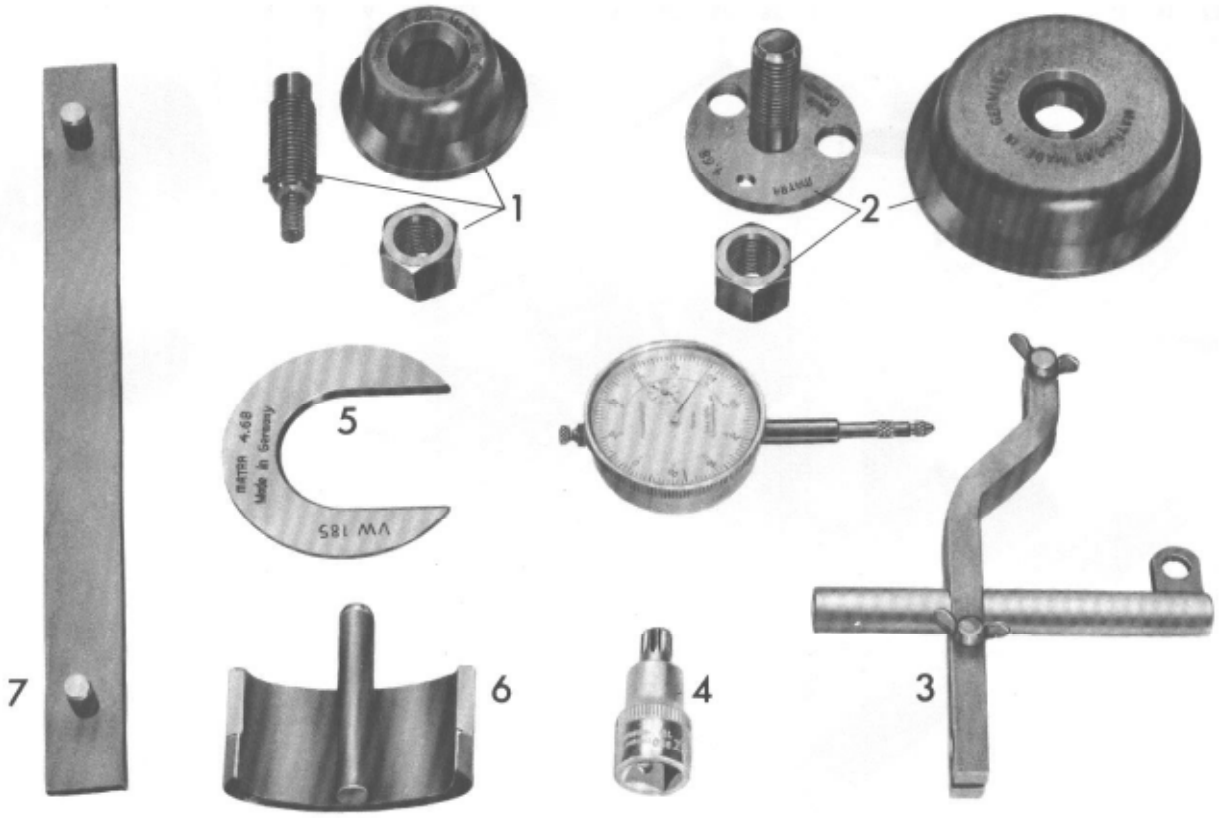
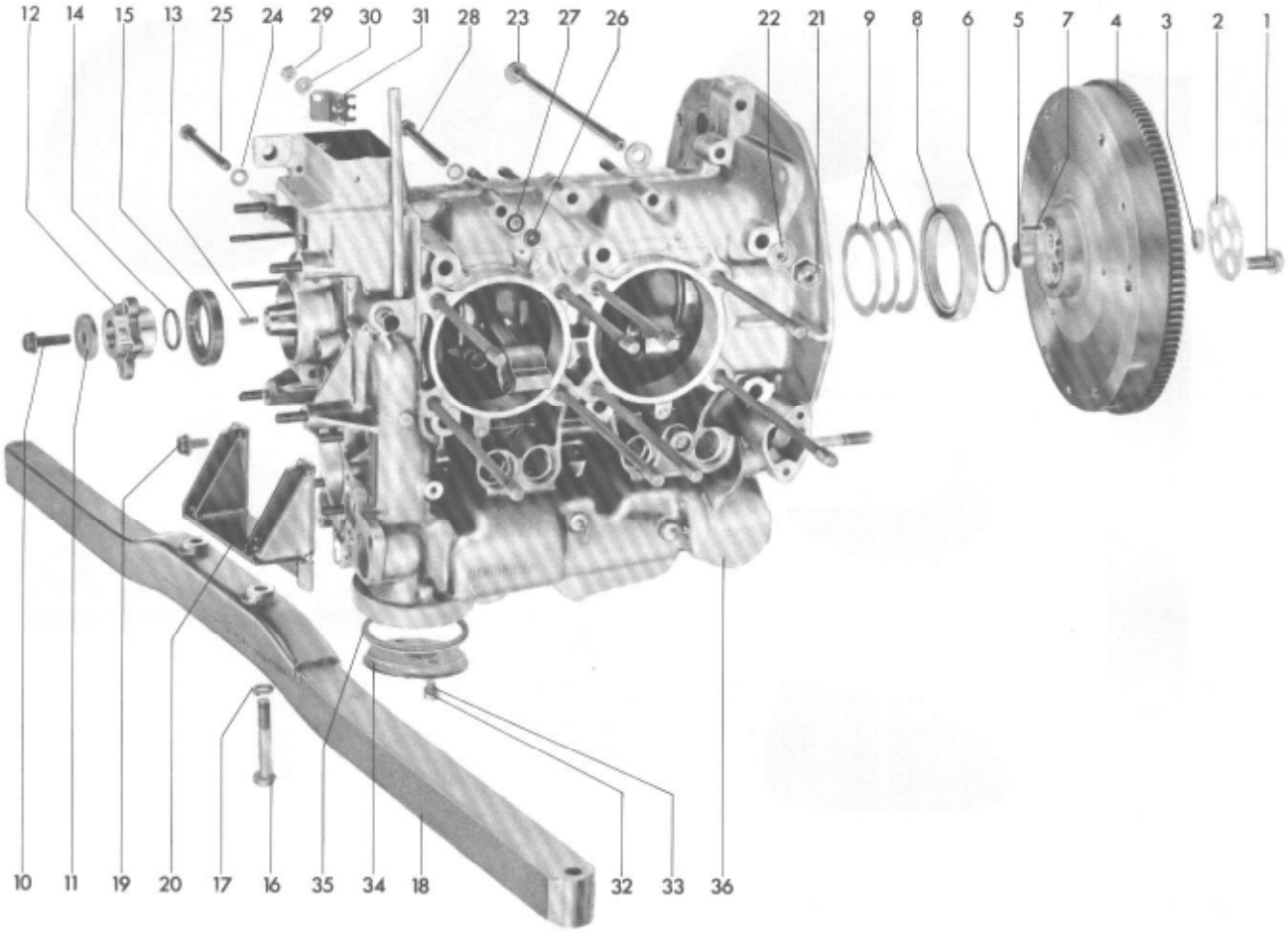


Fig. 12

TOOLS



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



No.	Description	Qty	Note when removing	Note when installing	Remarks
1	Bolt, self locking, M 12x1.5	5		Torque to 107.9 Nm (11.0 mkg)	
2	Washer	1		Replace.	
3	Felt ring, for needle bearing	1		Dip in oil.	
4	Flywheel	1	Damaged teeth can be machined up to max.2 mm on the clutch side. Machine chamfer into teeth. Replace flywheel if bolt holes are enlarged. Check needle bearing for good seating.	Clutch contact surface must be free of grease or oil. Oil running surface of oil seal. Use flywheel lock VW 215c.	6.1-2/1 Fig. 1

No.	Description	Qty	Note when removing	Note when installing	Remarks
5	Needle bearing	1		Lubricate if it was washed. Note entry depth.	
6	Flywheel 0-ring	1		Replace. Lubricate.	
7	Rollpin	1		Replace flywheel if rollpin is loosely seated.	
8	Flywheel oil seal, 95 mm dia.	1		Replace. Lubricate lightly. Install with installer VW 191, all the way in. Do not cant.	Fig. 3
9	Spacers	3		Determine thickness by adjusting end play with dial gauge holder VW 659/2.	6.1-2/2
10	Bolt, self-locking, M 8x30	1		Torque to 31.4 Nm (3.2 mkg).	
11	Washer	1			
12	Blower impeller hub	1	Use 3 M8 bolts and VW 185.		Fig. 2
13	Woodruff key	1			
14	0-ring for hub	1		Replace. Lubricate lightly.	
15	Crankshaft oil seal, 65 mm dia.	1		Replace. Lubricate lightly. Use installer VW 190.	Fig. 4
16	Internal head bolt	2			
17	Lock washer	1			
18	Engine support	1			
19	Bolt, self-locking, M8	4		Torque to 29.4 Nm (3.0 mkg).	
20	Bracket for engine support	1			
21	Self-sealing nut, M10x1.25	6		Sealing ring faces outward. Torque to 19.6 Nm (2.0 mkg). Replace damaged nuts. Coat with sealing compound D3.	
22	Washer	12			

No.	Description	Qty	Note when removing	Note when installing	Remarks
23	Bolt, M10x1.25x213	6		Coat bolt heads with sealer D3.	
24	Gasket	1		Replace.	
25	Bolt, M8x113, oil pipe securing	1			
26	Bolt, M8	10		Torque to 19.6 Nm (2.0 mkg)	
27	Spring washer	20			
28	Bolt, M8	5			
29	Bolt, M6	2			
30	Spring washer	2			
31	Ignition cable support	1			
32	Bolt, M6	2			
33	Gasket	1		Replace.	
34	Oil sump cover	1			
35	Sump cover gasket	1		Replace	
36	Crankcase	1	Use rubber mallet; avoid damaging joint surfaces through use of sharp-edged tools.	Check for external damage and cracks. Clean joining surfaces with cleaning solvents. Check flatness bevel edges of bearing bores if necessary. Flush oil galleries and blow thru with air. Check stud bolts for tightness.	6.1-2/1

CHECKING FLYWHEEL

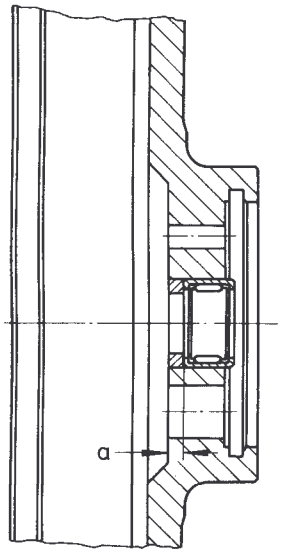


Fig. 1 "a" = 3.2 mm

Bore in Crankcase	Diameter mm	Wear Limit (Dia. mm)
Crankshaft bearings 1 - 3	70.00-70.02	70.03
Crankshaft bearing 4	50.00-50.03	50.04
Camshaft bearings 1 - 3	27.50-27.52	27.54
Oil seal, flywheel end	95.00-95.05	
Oil seal, blower impeller end	62.00-62.05	
Oil pump housing	70.00-70.03	

CHECKING AND ASSEMBLING CRANKCASE

1 - Check cam follower bores in housing.
Diameter: 24.00-24.02 mm
Wear limit: 24.05

2 - Join crankcase halves and torque as specified. Check bearing bores in housing with inside micrometer and micrometer caliper.

Reassembly

1 - Evenly coat crankcase joining surfaces with sealer. Make sure that no sealer enters the oil galleries of crankshaft and camshaft bearings.

2 - Join crankcase halves and first lightly tighten oil suction pipe retaining bolt using a new gasket.

3 - Install M10x1.25 self-sealing nuts with sealing rings facing outward, and tighten.

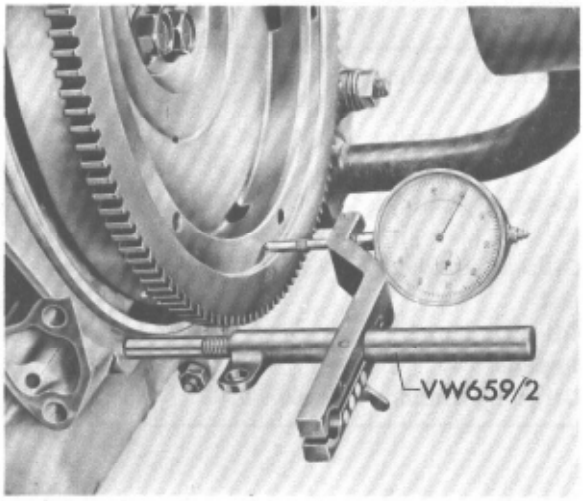
4 - Tighten M8 and M6 nuts.

5 - Turn crankshaft to check for free rotation.

CRANKSHAFT END PLAY

End play: New: 0.07 - 0.13 mm
Wear limit: 0.15 mm

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



Adjusting End Play

1 - Install flywheel with 2 shims but leave oil seal for flywheel and blower impeller off.

2 - Install dial gauge holder VW 659/2 and dial gauge on crankcase.

3 - Move crankshaft back and forth axially and read end play on gauge.

4 - Determine thickness of third shim:

Reading on dial gauge
\- 0.10 mean end play
= third shim thickness

5 - Remove flywheel.

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

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

8 - Recheck end play.

Shims are available in following thicknesses:

0.24 mm	0.34 mm
0.30 mm	0.36 mm
0.32 mm	0.38 mm

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

REMOVING AND INSTALLING CRANKSHAFT OIL SEALS

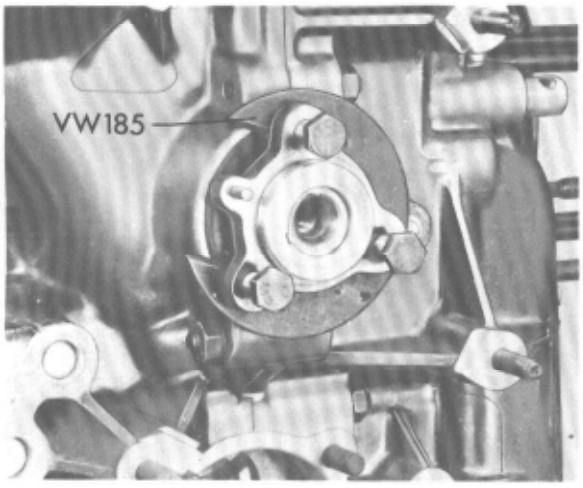


Fig. 2

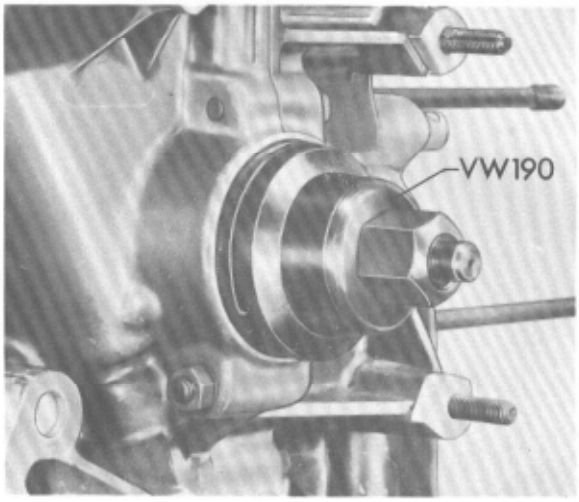


Fig. 4

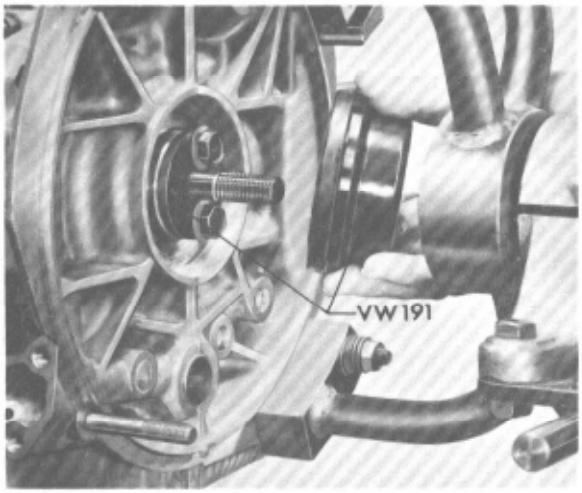
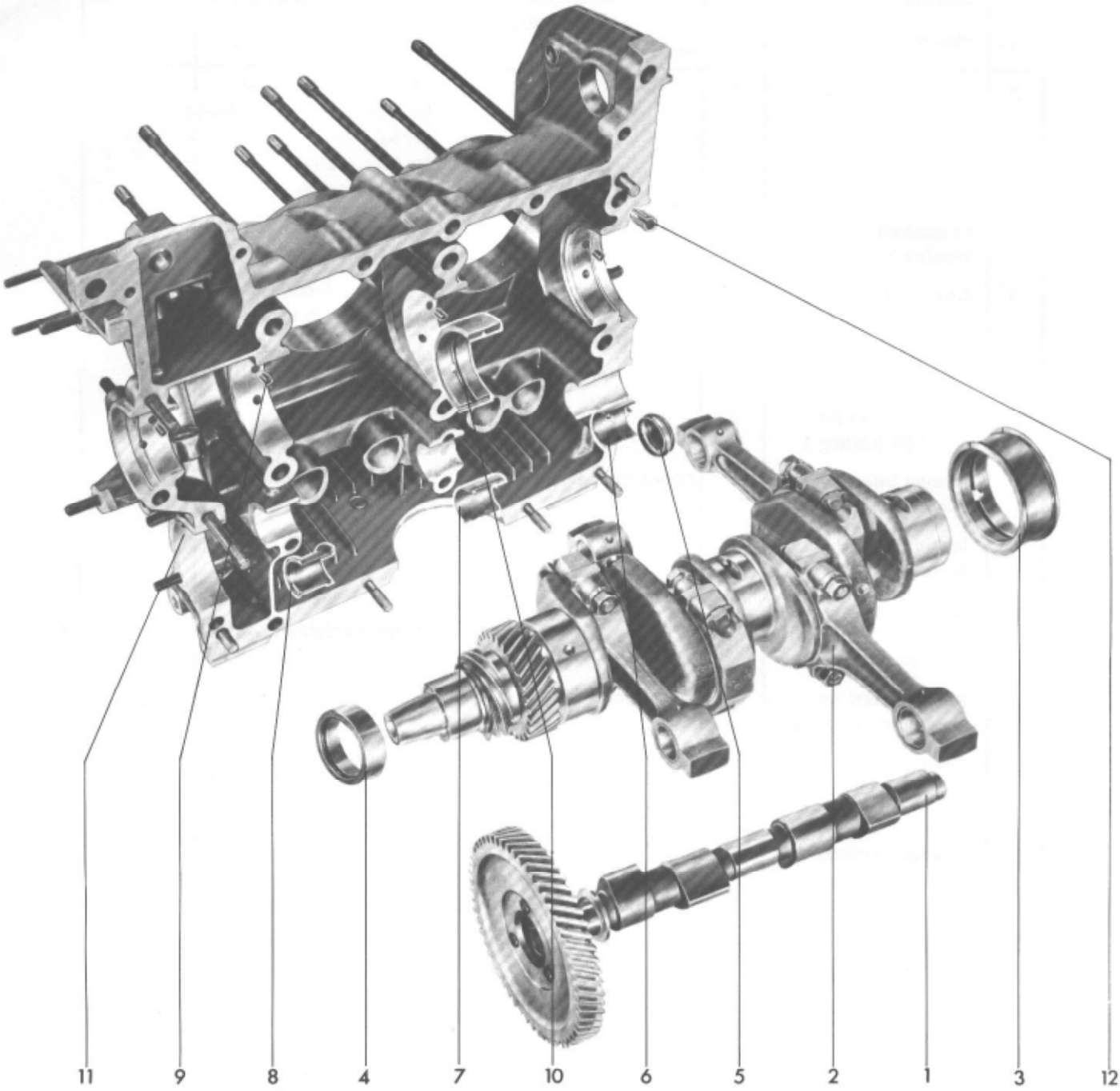


Fig. 3



No.	Description	Qty	Note when removing	Note when installing	Remarks
1	Camshaft	1	Check rivets which secure timing gear to camshaft. Check bearing journals and cam lobes for wear. Check timing gear for contact pattern and wear.	Check runout: new = max. 0.02 mm; wear limit = max. 0.04 mm (measured at center journal). Check end play at thrust bearing: 0.04-0.13 mm; wear limit = 0.16 mm. Check pairing and timing with crankshaft. Check gear backlash over entire timing gear circumference.	Fig. 1 Fig. 2 Fig. 3 Fig. 4 26.2-2/2

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

Checking and Installing Camshaft

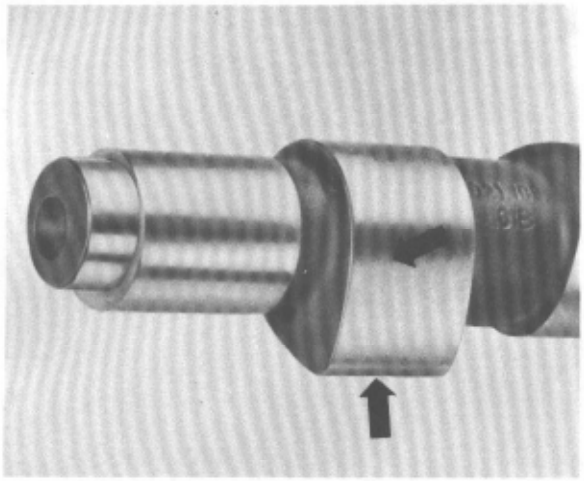


Fig. 1

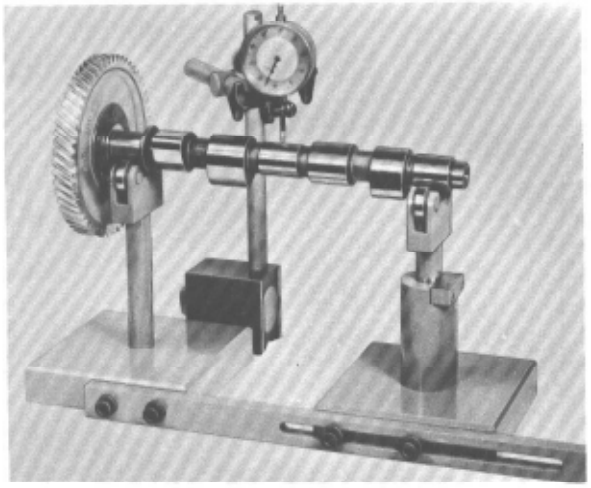


Fig. 2

Checking runout:
When new: max. 0.02 mm
Wear limit: max. 0.04 mm

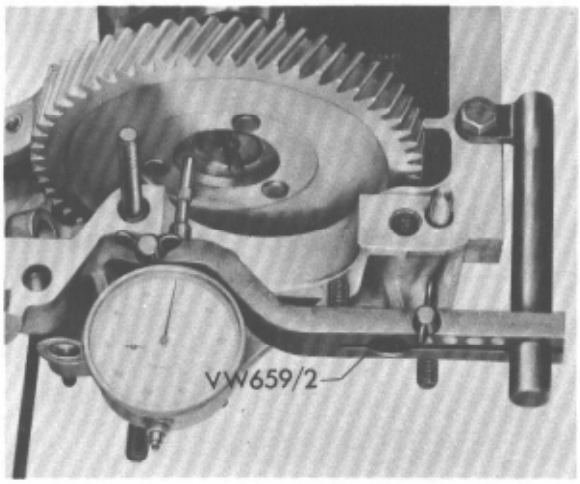


Fig. 3

Checking end play: (at thrust bearing)
When new: 0.04 - 0.13 mm
Wear limit: 0.16 mm

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

Gear backlash between timing and crankshaft gears is 0.00 - 0.05 mm.
The timing gear is of right size when backlash can hardly be felt and the timing gear does not lift when the crankshaft is turned in reverse direction.

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

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

NOTE
Do not confuse the numeral 0 with the symbol 0 which is a timing mark.
Crankshaft gears are furnished in one size and bear no size markings.

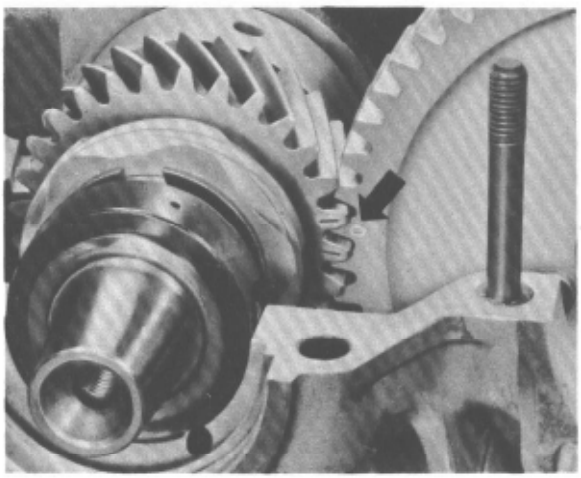


Fig. 4

Installing Preassembled Crankshaft

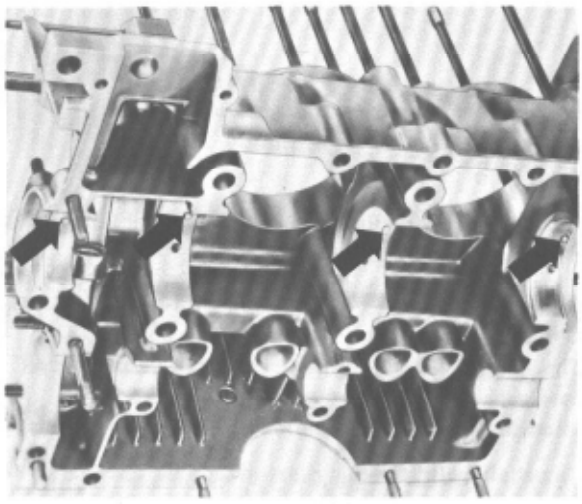


Fig. 5

Bearing clearance with bearings under crankcase pressure:

	When New	Wear Limit
Crankshaft bearings 1 and 3	0.04-0.10 mm	0.18 mm
Crankshaft bearing 2	0.03-0.09 mm	0.17 mm
Crankshaft bearing 4	0.05-0.10 mm	0.19 mm

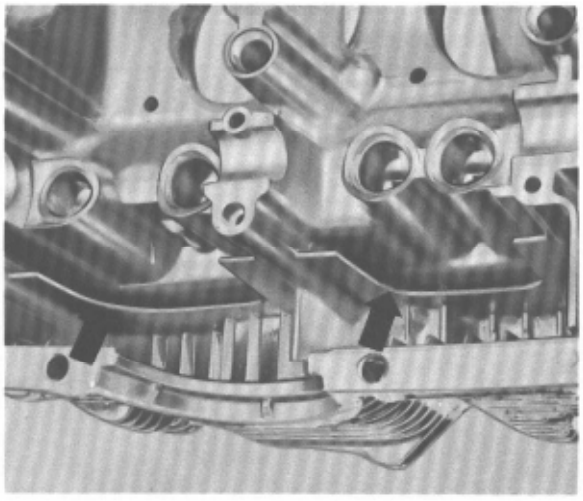
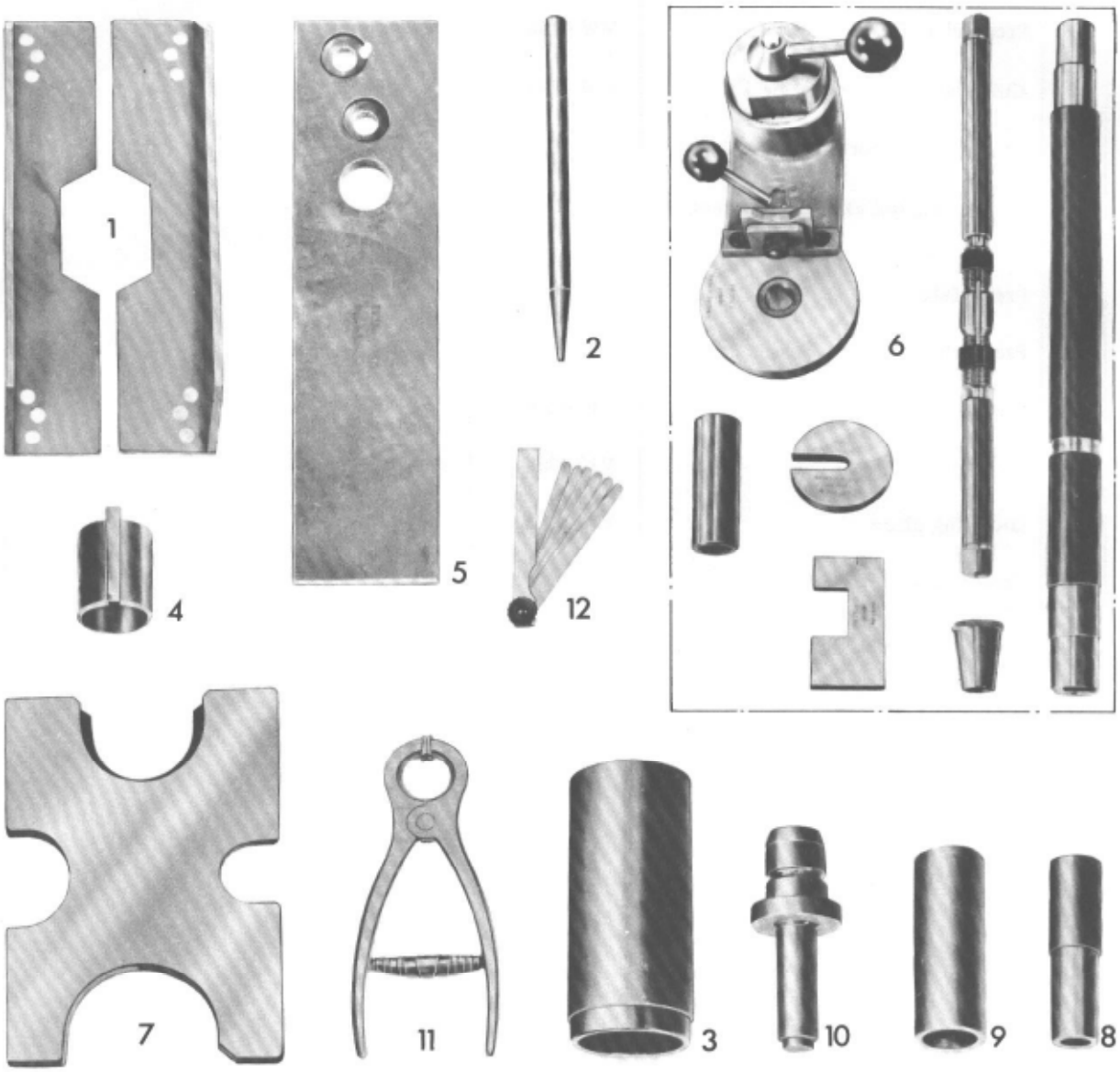
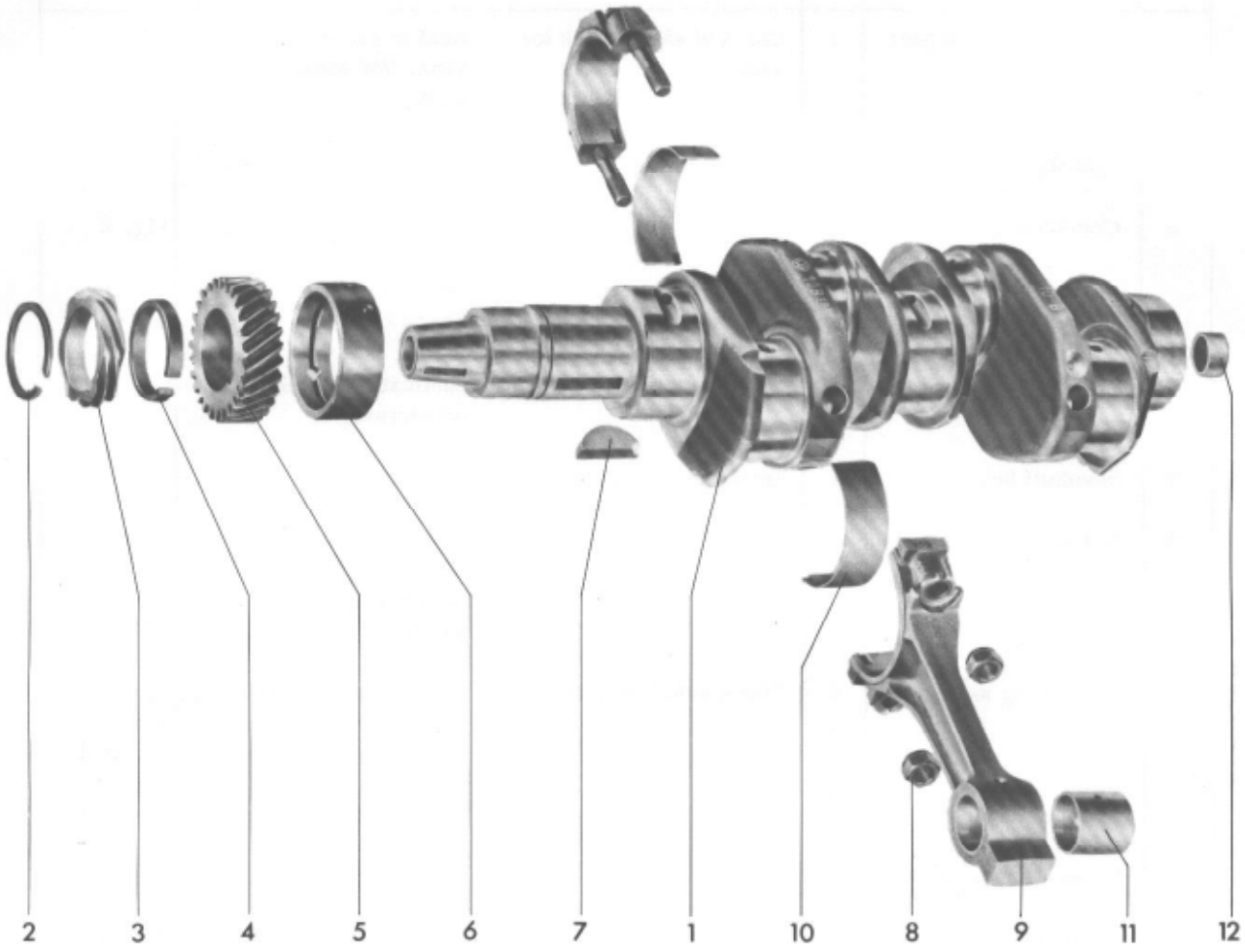


Fig. 6

TOOLS



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



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

No.	Description	Qty	Note when removing	Note when installing	Remarks
3	Distributor drive gear	1	Use VW 457. Check for wear.	Heat to ca. 80° C. Use 415a, VW 428a. Check teeth.	Fig. 2 Fig. 4
4	Spacer	1			
5	Crankshaft gear	1	Use press and VW 457.	Heat to approx. 80° C. Chamfer faces bearing 3. Unse VW 415a, VW 428a. Check teeth.	Fig. 2
6	Crankshaft bearing 3	1	Check for wear.	Lubricate. Dowel hole faces counterweight.	
7	Woodruff key	1	Replace when damaged.		
8	Nut for connecting rod bolt	8		Replace. Torque to 32.4 Nm (3.3 mkg). Contact surface oiled. Lock with punch.	Fig. 8
9	Connecting rod	4	Check with VW 214f.	Max. weight difference 6g. Note installation position and weight. Measure side play with crankshaft in VW 801 support plate.	Fig. 6 6.3-3/2 -3/3 Fig. 7
10	Connecting rod insert	8	Check for wear.	Lubricate.	
11	Piston pin bushing	4	Check for wear. Use VW 402, VW 409, VW 416b, VW 421.	Use VW 402, VW 409, VW 421. Piston pin must enter under light finger pressure.	Fig. 9 Fig. 5
12	Spacer	1			

DISASSEMBLING AND PREASSEMBLING CRANKSHAFT

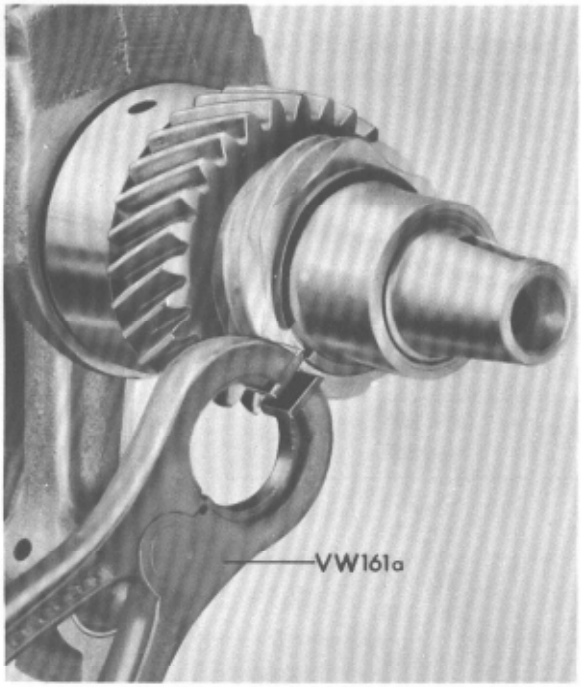


Fig. 1

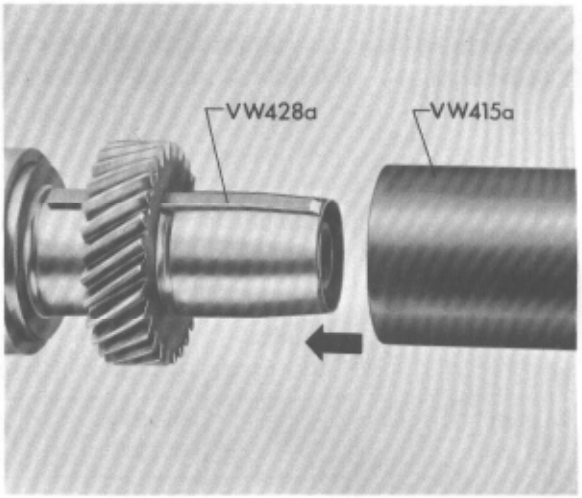


Fig. 3

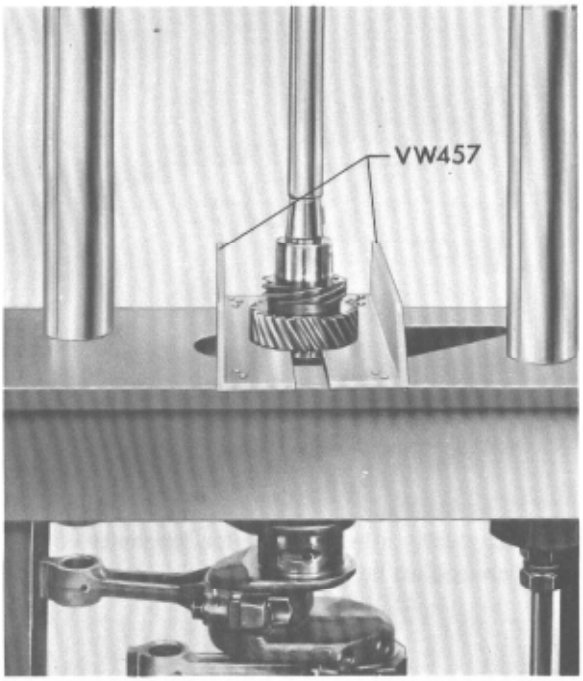


Fig. 2

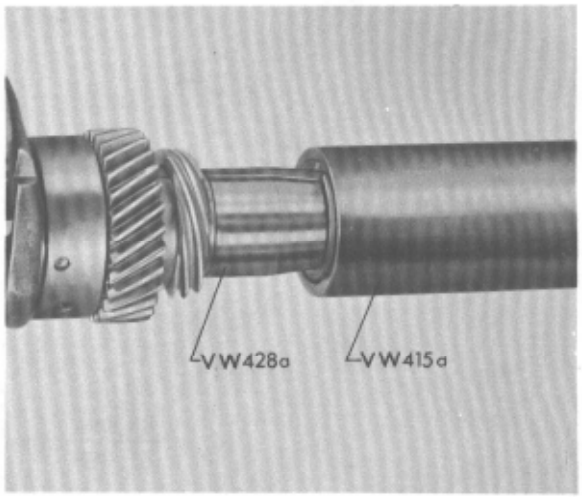


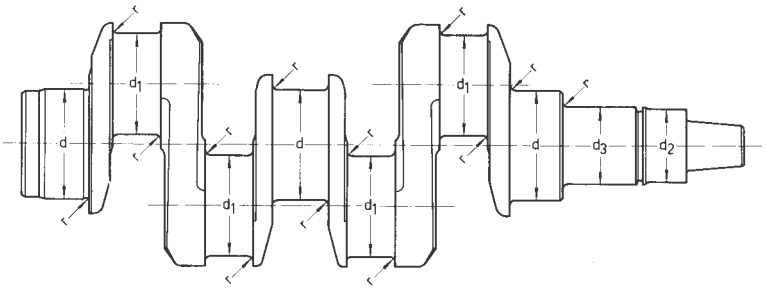
Fig. 4

Runout at bearings 2 and 3 (bearing 1 and 3 on V-block)	Bearing journal out of round	Un-balance
max. 0.02 mm	max. 0.03mm	max. 12 cmg

RECONDITIONING CRANKSHAFT

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

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



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

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

Do not recondition bearing inserts under any circumstances.

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

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

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

CHECKING AND INSTALLING CONNECTING RODS

Check connecting rods weight.

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

NOTE
Connecting rods cannot be reconditioned.

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

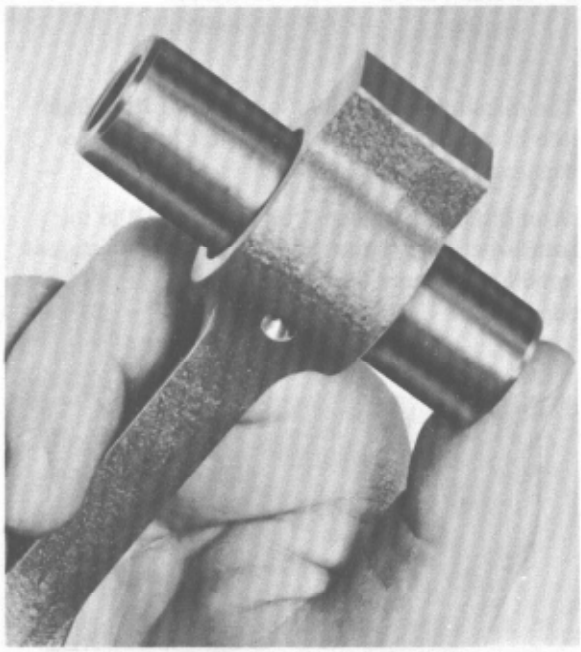


Fig. 5

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

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

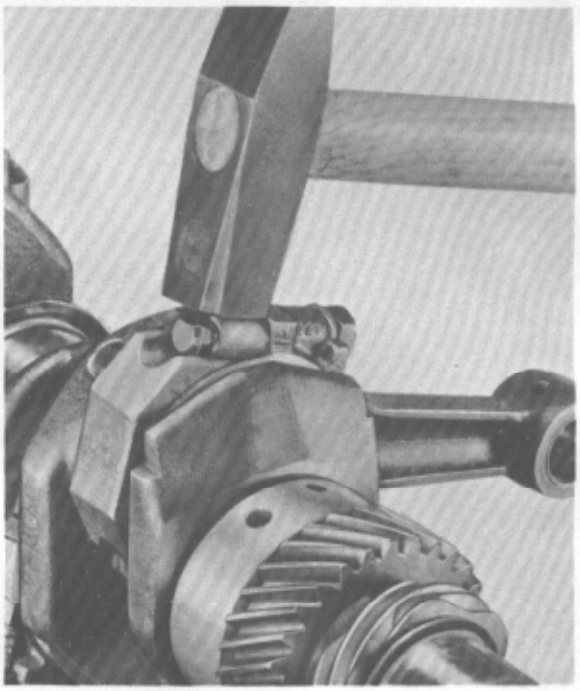


Fig. 6

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

Side Clearance
When new: 0,1-0,4 mm
Wear Limit: 0,7 mm

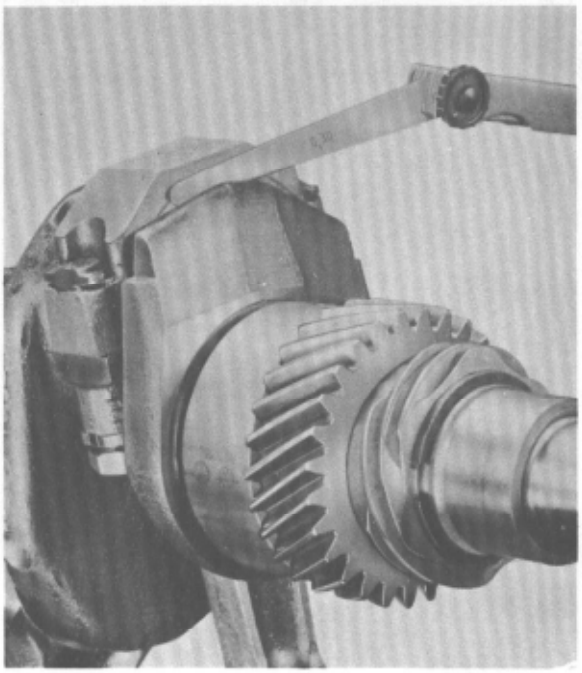


Fig. 7

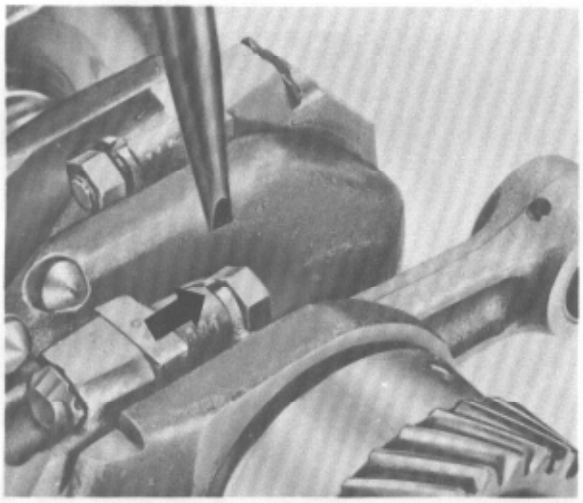
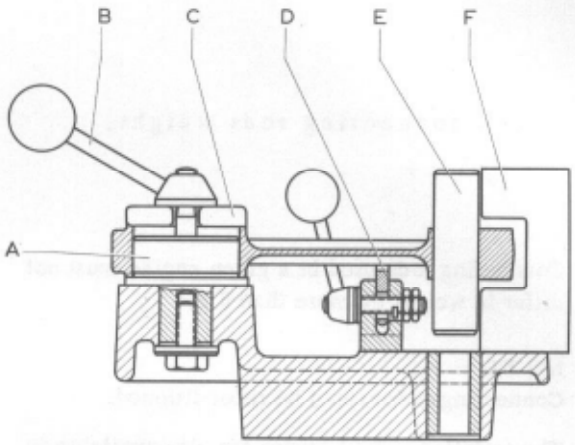


Fig. 8



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

RECONDITIONING CONNECTING RODS

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

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

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

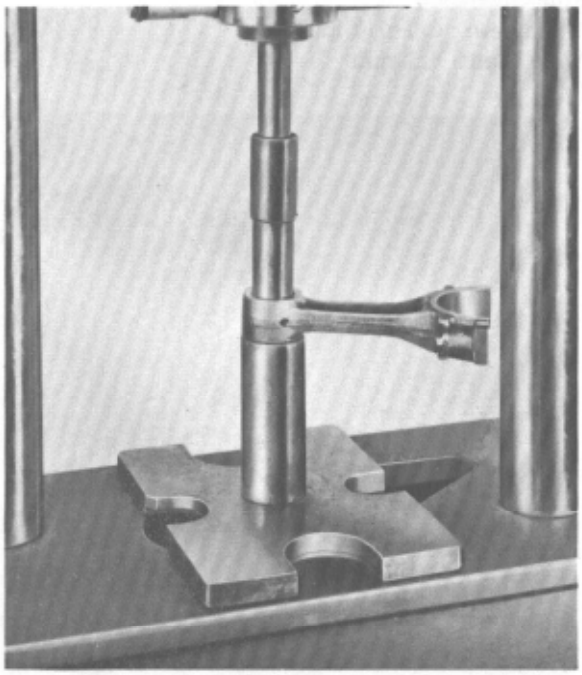
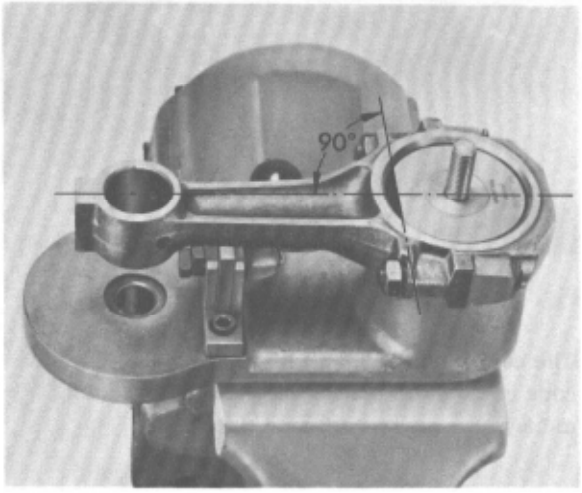
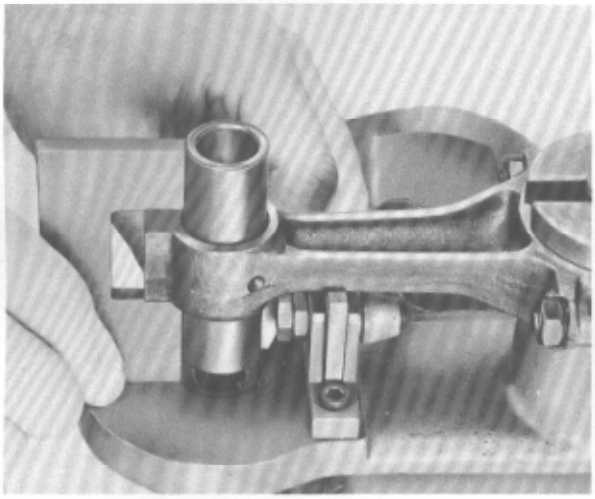
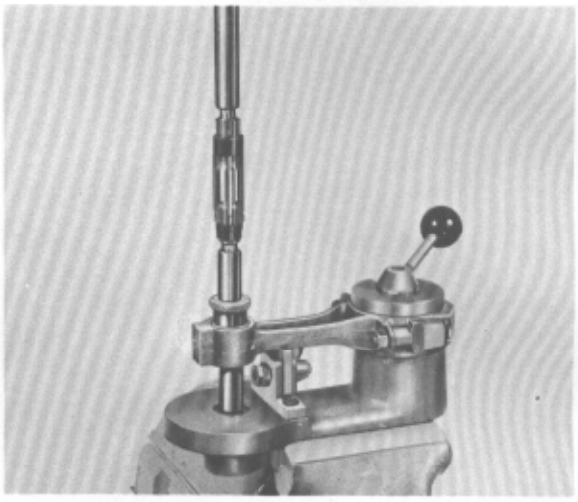


Fig. 9







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

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

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

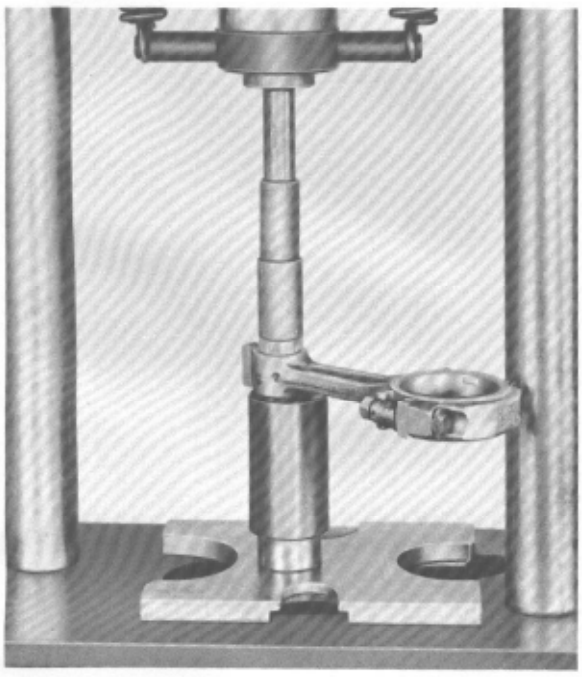


Fig. 10

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

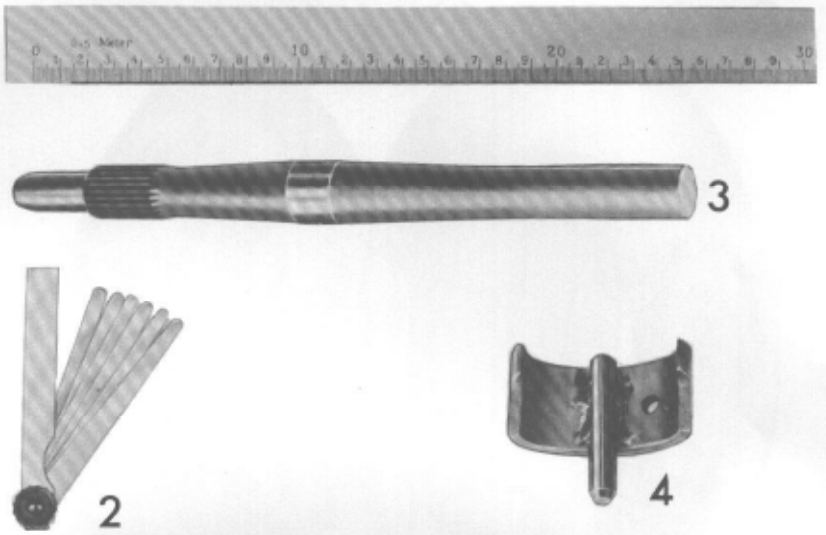
Tighten lever B and support D.

Inside diameter of piston pin bushing:	24.015 - 24.024 mm

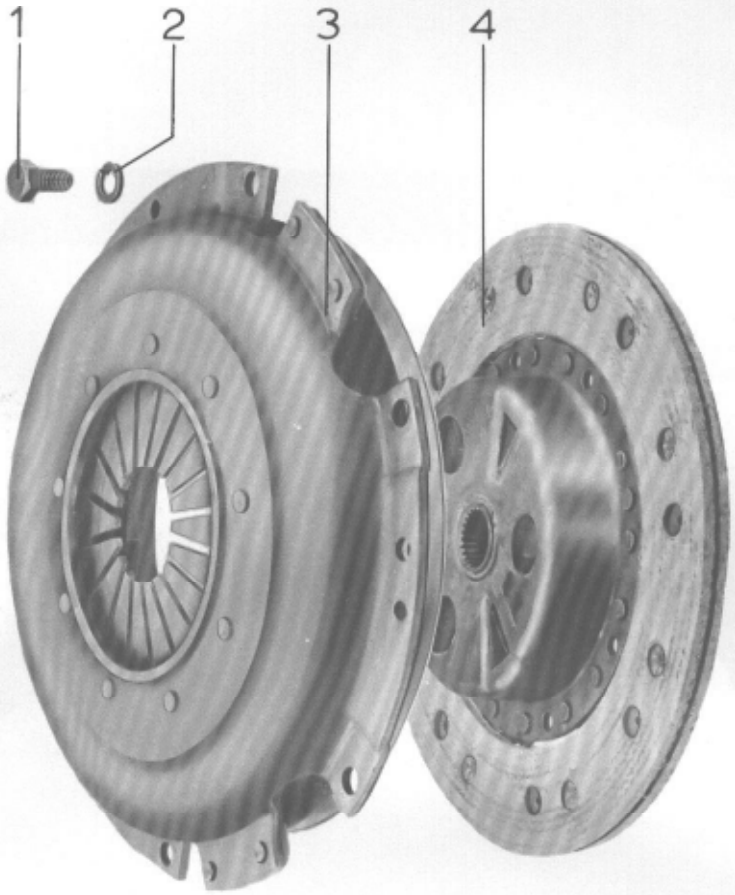
The inner surface of the bushing must be free of scoring or chatter marks. The piston pin must enter under light finger pressure with lubrication. It is improper to install an oversize piston pin in cases where the bushing has been reamed too much; in such cases install new bushing and ream it to correct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

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

TOOLS



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



No.	Description	Qty	Note when removing	Note when installing	Remarks
1	Bolt, M8x15	6	Loosen bolts crosswise one or two threads at a time.	Torque crosswise to 23.5 Nm (2.5 mkg).	
2	Lock washer	6			
3	Clutch assembly	1	Mark installed position.	Check rivets. Clean seating surface in flywheel. Check for wear. Surface cracks or scoring can be corrected by grinding or milling.	Fig. 1 7.1-2/1
4	Clutch plate	1	Check for wear.	Check splines. Clutch plate should slide easily on input shaft without undue play. Check rivets and side runout. Coat input shaft splines with molybdenum disulfide powder. Align with input shaft.	7.1-2/2 Fig. 2

Removing Clutch

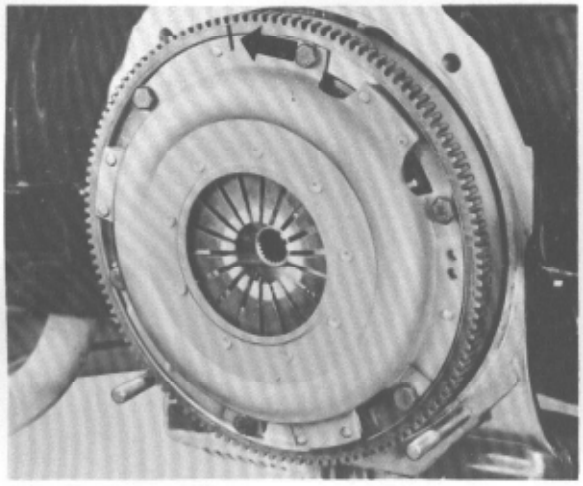
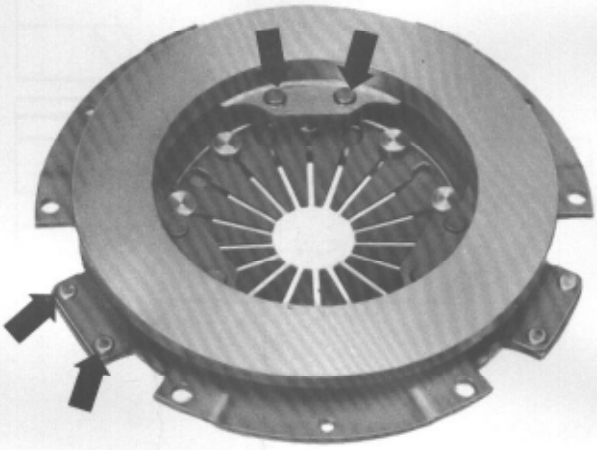


Fig. 1

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

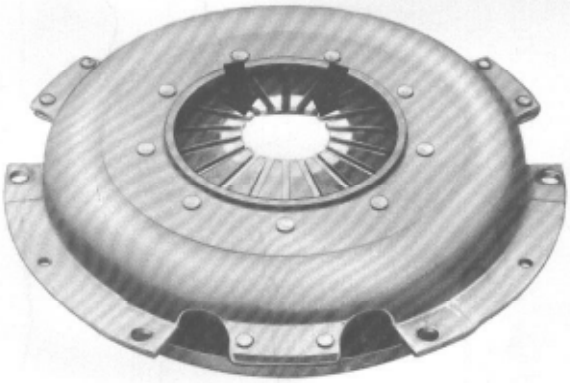
Clutches with damaged or loose rivets must be replaced.

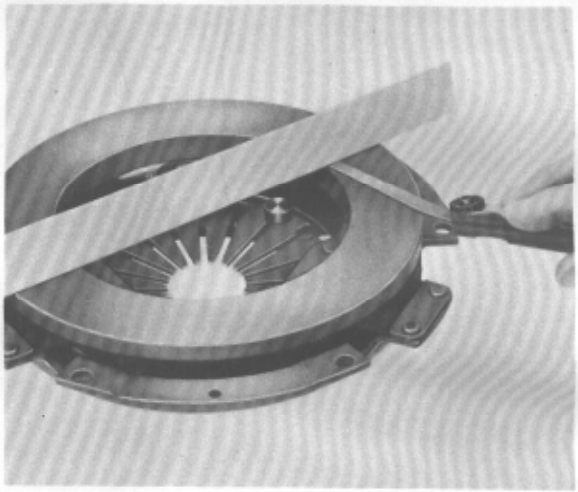


Checking Clutch

Check tips of diaphragm spring fingers for scoring at the throwout bearing contact surface. Score marks up to 0.3 mm depth are harmless.

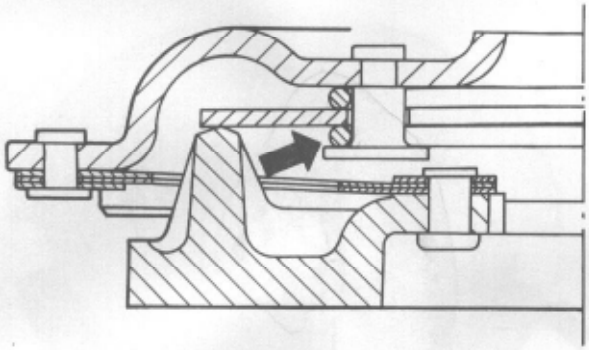
Check pressure plate contact surface for cracks, hot spots, and wear. Pressure plates which are bent inward up to 0.3 mm are still serviceable.





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

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



Installing Clutch

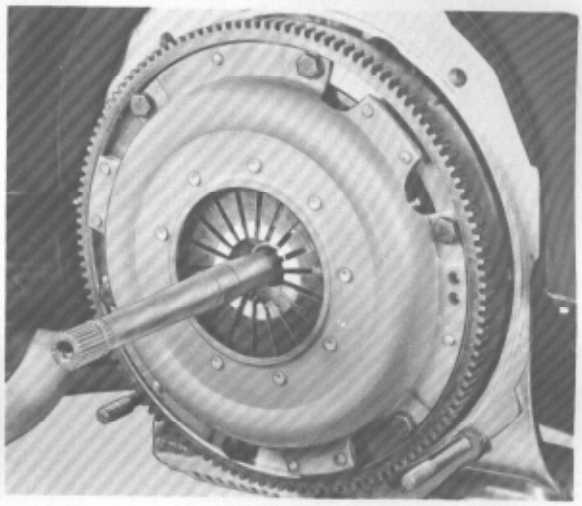


Fig. 3

Checking Clutch Plate

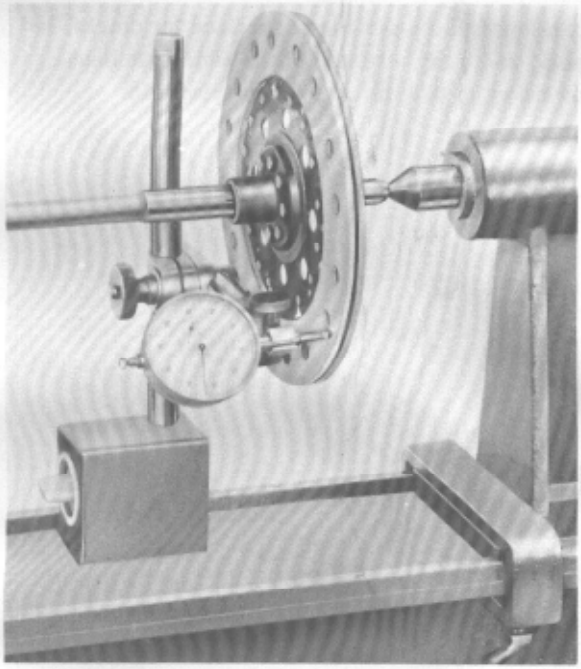


Fig. 2

Permissible side runout: 0.5 mm
(Measured at the 210 mm dia. point).