Section M

Engine, Ignition System

VW engines are air-cooled, four-cylinder, four-stroke carburetor or fuel injection engines with two pairs of horizontally opposed cylinders and overhead valves. They are attached to the transmission case with four bolts. The engine/transmission unit is fitted at the rear of the vehicle.

Ignition system

The ignition system has a coil and a distributor with automatic spark advance. The low tension current from the battery is converted to high tension current by the ignition system and fed to each of the four plugs in the correct sequence and exactly at the proper time by the distributor. The distributor is driven from the crankshaft by a gear and a short shaft.

Cooling

The engine is cooled by a radial fan. The fan draws air in through an opening in the fan housing and forces it past the heavily finned cylinders and cylinder heads. The air flow is directed by deflector plates fitted round the cylinders and cylinder heads. Part of the fresh cooling air is used for the heating system and is warmed by the exhaust pipes in the heat exchangers.

A thermostat controls the quantity of cooling air by means of two flaps fitted in front of the intakes to the cylinder ducts so that the engine warms up quickly and the temperature remains fairly uniform under all operating conditions. The quantity of air for the heating system is not affected by the flaps.

Lubrication system

The engine is lubricated by a pressure feed system with an oil cooler in the circuit.

The gear type oil pump is driven by the camshaft and is situated in the crankcase at the gear end of the camshaft. The oil is drawn from the lowest point in the crankcase and forced through the cooler into oil passages. Part of the oil goes through the crankshaft main bearings into drillings in the crankshaft and lubricates the connecting rod bearings. A second part lubricates the camshaft bearings and a third part passes through the hollow push rods to the rocker arms to lubricate these bearings and the valve stems. Cylinder walls, pistons and piston pins are splash lubricated.

Impurities in the oil are retained by a strainer fitted at the lowest part of the crankcase.

The oil temperature is reduced in the oil cooler by means of air supplied by the fan. The cooler is fitted in the oil circuit so that the oil from the pump must pass through the cooler before reaching the various bearings. The oil is then cooled so that it retains its full lubricating properties even at high outside temperatures and high engine speeds.

When the oil is cold and thick, an oil pressure relief valve opens and permits part of the oil to flow directly into the engine without passing through the cooler.

In the pressure circuit between oil pump and cooler there is a switch for the oil pressure warning lamp. This switch opens at a pressure of between 2.1 and 6.3 psi (0.15—0.45 kg/cm²) and breaks the circuit to the oil pressure warning lamp.

The lamp lights when the ignition is switched on and when the oil pressure is too low.

Cylinder heads

Each pair of cylinders has a detachable, finned cylinder head of cast light alloy with shrunk-in valve seat inserts and valve guides.

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Valve gear

The camshaft runs in three bearings with split steel, white-metal coated shells and is driven from the crankshaft by helically toothed gears. No. 3 bearing takes the camshaft thrust. The camshaft gear is of light metal alloy and is riveted to the camshaft. The valves are operated via cam followers, push rods and rocker arms. Each cam operates the valves of two opposed cylinders in turn.

Cylinders

The four cylinders are all identical and can be replaced separately complete with pistons. The cylinders have fins to improve transfer of heat to the cooling air.

Pistons

The light alloy pistons with steel inserts are fitted with two compression rings and one oil scraper ring. The piston pins are fully floating in the piston bores und are secured laterally by circlips.

Crankcase

The split crankcase is a pressure die casting of light alloy. Both halves are machined together and must, therefore, only be replaced as a pair.

Crankshaft

The crankshaft is forged in one plane and all bearing journals are induction hardened. The crankshaft runs in four bearings in the crankcase. Bearings 1, 3 and 4 are aluminium bushes with lead-coated surfaces. No. 2 bearing — seen from the clutch end — is a split shell three-layer type. No. 1 bearing takes up the crankshaft end thrust. The flywheel is provided with a toothed ring for the starter drive and is held to the crankshaft by four dowels and a gland nut.

Connecting rods

The four I-section connecting rods are forged in steel. At the crankshaft end they have three-layer bearing shells and at the piston pin end they are fitted with steel bushes with a lead-bronze coating.

Clutch

Between engine and manual transmission is a dry, single-plate clutch which is fitted in the flywheel. The driven plate with linings on both sides is free to slide axially on the splined transmission drive shaft. The clutch cover, the pressure plate and the springs are bolted concentrically to the flywheel face. When engaged, the driven plate is pressed against the clutch surface on the flywheel by the pressure of the springs. Power can then be transmitted from engine to transmission.

Type	1/1600	1/1600	1/1600 [1]	1/Model 181
Engine code letter	B	AE	AE, AK, AH [2]	AM
Bore mm (in.)	85.5 (3.96)	85.5 (3.96)	85.5 (3.96)	85.5 (3.36)
Stroke mm (in.)	69.0 (2.72)	69.0 (2.72)	69.0 (2.72)	69.0 (2.72)
Capacity cm^3 (cu. ins.)	1584 (96.6)	1584 (96.6)	1584 (96.6)	1584 (96.6)
Compression ratio	7.5	7.5	7.3	7.3
Output DIN PS at rpm	47/4000	50/4000	48/4000	48/4000
SAE bhp at rpm	57/4400	60/4400	46/4000 [3]	46/4000 [3]
Torque DIN mkg at rpm	10.6/2200	10.8/2800	10.2/2000	10.2/2000
SAE ft lb at rpm	81.7/3000	81.7/3000	72.0/2000 [3]	72.0/2000 [3]
Piston speed				
meter per sec. at rpm	9.2/4000	9.2/4000	9.2/4000	9.2/4000
feet per min. at rpm	1811/4000	1811/4000	1811/4000	1811/4000
Octane requirement RON	90	91	91	91
Dry weight kg (lbs.)	115 (253)	120 (265)	120 (265)	

Ignition	Battery
Coil	12 volt
Distributor	see M 3.2/1-1
Ignition timing	see M 3.2/1-1
Firing order	1—4—3—2
Dwell angle	44—50°
Spark plugs	see M 3.2/1-1
Spark plug thread	M 14×1.25×12.7
Spark plug gap mm (in.)	0.6 (0.024)
Cooling	Air cooling by radial fan on generator shaft
Air quantity liter (cu. ft.)/sec.	575 (21) | 620 (24)
at rpm	/4000 | /4000
Lubrication	Pressure feed by gear type pump
Engine oil cooling	Oil cooler in fan air stream
Engine oil filter	—
Engine oil pressure indicator	By warning lamp
Engine oil, changing quantity	2.5 liter (5.3 US pints)
Engine oil, initial filling	2.0 liter (4.25 US pints)
Oil consumption liter/1000 km	0.5—1.0
US pints/1000 miles	1.7—3.4

[1]) from engine No.: AE 558 001
[2]) M 27 (engines with exhaust recirculation system / Automatic Stick Shift for California only)
[3]) SAE net ratings

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Type	1/1600 1/Model 181
Engine code letter	B, AE, AH, AK, AM
Cylinder heads	One for each pair of cylinders with cooling ribs
Valve seat inserts	Shrunk-in, sintered steel
Valve guides	Shrunk-in, special brass
Spark plug threads	Cut in cylinder head
Valve mechanism	Camshaft below crankshaft, cam followers in crankcase, push rods and rocker arms
Valve timing with 1 mm (0.04 in.) valve clearance	
Intake opens before TDC	7° 30′
Intake closes after BDC	37°
Exhaust opens before BDC	44° 30′
Exhaust closes after TDC	4°
Valves	1 intake, 1 exhaust per cylinder
Valve head exhaust	32.0 mm (1.260 in.) diameter
Valve head intake	35.5 mm (1.397 in.) diameter
Clearance: intake	0.15 mm (0.006 in.)
exhaust	0.15 mm (0.006 in.)
Valve springs	1 spring per valve
Cylinders	Separate cylinders of special gray cast iron with cooling ribs
Distance between centers	112 mm (4.41 in.)
Pistons	Light alloy with steel inserts
Piston pins	Floating, secured by circlips
Piston rings	2 compression 1 oil scraper
Crankcase	Two-part magnesium alloy, divided vertically through crankshaft and camshaft bearings
Camshaft	Gray cast iron, three bearings
Camshaft bearings	Thin-wall steel shells with white metal layer
Camshaft drive	Helical gears
Crankshaft	Forged high quality steel, four main bearing journals
Main bearings, 1, 3 and 4	Aluminum, lead coated
Main bearing, 2 (center bearing)	Split shells, three-layer
Main bearing journal 1–3	55.0 mm (2.165 in.) diameter
Main bearing journal 4	40.0 mm (1.575 in.) diameter
Connecting rod journals	55.0 mm (2.165 in.) diameter
Flywheel	Forged, with integral starter ring
Connecting rods	Forged, with I-section shaft
Connecting rod bearings	Three-layer, thin-wall shells
Piston pin bearings	Pressed-in steel bushings with lead-bronze layer
Clutch	
Type	Single disc, dry
Total lining area	363 cm² (56 sq. in.) [1]
Pressure	357.5–392.5 kg (786–863 lb.) [1]

[1] from August 1972 diaphragm spring clutch total lining area: 339 cm² (53 sq. in.)
pressure: 380—440 kg (838—970 lb.)

Type	1/1600 1/Model 181	
	New part	Wear limit *)
Cooling		
Thermostat ..... opening temperature	65–70° C (149–158° F)	–
Fan pulley / crankshaft pulley out of balance	–	–
Fan ..... out of balance	max. 5 cmg	–
Belt pulley ..... radial runout	–	–
Engine lubrication system		
1 - Oil pressure (only for SAE 30 oil) at an oil temperature of 70° C (158° F) and 2500 rpm ... pressure	3 kg/cm² (42 psi)	2 kg/cm² (28 psi)
2 - Oil pressure relief valve spring (up to July 1969)		
Length loaded	43.2 mm (1.700 in.)	–
Load	2.5–4.2 kg (5–9 lbs.)	–
3 - Oil pressure relief valve spring (from August 1969)		
Length loaded	44.1 mm (1.736 in.)	–
Load	5.6–7.3 kg (12–16 lbs.)	–
4 - Oil pressure regulating valve spring		
Length loaded	20.2 mm (0.795 in.)	–
Load	2.9–3.6 kg (6–8 lbs.)	–
5 - Oil pump: Gears/housing without gasket ..... end play	–	0.1 mm (0.004 in.)
Gears ..... backlash	0.0–0.2 mm (0.0–0.008 in.)	–
6 - Oil pressure switch opens at ..... pressure	0.15–0.45 kg/cm² (2–6 psi)	–
Cylinder head and valves		
1 - Cylinder seating depth in cylinder head	13.45–13.55 mm 0.5295–0.5334 in.	–
2 - Combustion chamber capacity	48–50 cm³ [1]) (2.9–3.0 cu. in.) [1])	–
3 - Rocker arm ..... inside diameter	18.00–18.02 mm (0.7086–0.7094 in.)	18.04 mm (0.7102 in.)
4 - Rocker shaft ..... diameter	17.97–17.98 mm (0.7074–0.7078 in.)	17.95 mm (0.7066 in.)
5 - Rocker shaft / arm ..... radial play	0.02–0.05 mm (0.0008–0.002 in.)	–

*) The term "Wear limit" means that parts which are near, or have reached the dimensions given should not be reinstalled during repairs.

[1]) from August 1970: 50–52 cm³ (3.0–3.2 cu. in.).

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Type		1/1600 1/Model 181	
		New part	Wear limit
6 - Valve seat:			
Intake	width	1.4–2.5 mm (0.055–0.098 in.)	–
Exhaust	width	1.4–2.5 mm (0.055–0.098 in.)	–
Intake	seat angle	45°	–
Exhaust	seat angle	45°	–
Outer correction angle		15°	–
Inner correction angle		75°	–
7 - Valve guides:			
Intake	inside diameter	8.00–8.02 mm (0.315–0.316 in.)	8.06 mm (0.317 in.)
Exhaust	inside diameter	8.00–8.02 mm (0.315–0.316 in.)	8.06 mm (0.317 in.)
8 - Valve stems:			
Intake	diameter	7.94–7.95 mm (0.3126–0.3129 in.)	7.90 mm (0.3110 in.)
Exhaust	diameter	7.91–7.92 mm [1] (0.3114–0.3118 in.) [1]	7.87 mm (0.3098 in.)
	out of round	max. 0.01 mm (0.0004 in.)	–
9 - Valve guide/valve stem:			
Intake	rock	0.21–0.23 mm (0.008–0.009 in.)	0.8 mm (0.032 in.)
Exhaust	rock	0.23–0.27 mm (0.009–0.010 in.)	0.8 mm (0.032 in.)
10 - Valve spring:			
Length loaded		31.0 mm (1.22 in.)	–
Load		53.2–61.2 kg (117–135 lbs.)	–
11 - Compression (with engine warm, throttle open, all plugs out, gauge in plug seat and engine turned by starter)			
with code letter	B, AE [2]	8–10 kg/cm² (114–142 psi)	7 kg/cm² (100 psi)
with code letter	AE, AH, AK, AM	7.5–9.5 kg/cm² (107–135 psi)	6 kg/cm² (85 psi)
Difference between cylinders		–	max. 2 kg/cm² (28 psi)
Cylinders and Pistons			
1 - Cylinder	out of round	max. 0.01 mm (0.0004 in.)	–
2 - Cylinder/piston	clearance	0.04–0.06 mm (0.0016–0.0024 in.)	0.20 mm (0.008 in.)

[1]) from August 1970: 7.92–7.94 mm (0.3118–0.3126 in.)

[2]) up to engine No. AE 558 000

Type	1/1600 1/Model 181	
	New part	Wear limit
3 - Piston weight		
—Weight (brown)		
engine code letter B, AE, AM	402—412 g	
(engine code letter AE from Aug. 1970 up to July 1971)	398—410 g	
+Weight (grey)		
engine code letter B, AE, AM	410—420 g	
(engine code letter AE from Aug. 1970 up to July 1971)	406—418 g	
4 - Weight difference between pistons in one		
engine	max. 5 g	—
during repair	max. 10 g	—
5 - Compression ring		
upper side clearance	0.07—0.10 mm (0.0028—0.004 in.)	0.12 mm (0.0047 in.)
lower side clearance	0.05—0.07 mm (0.002—0.0028 in.)	0.10 mm (0.004 in.)
6 - Oil scraper ring side clearance	0.03—0.05 mm (0.0011—0.0019 in.)	0.10 mm (0.004 in.)
7 - Compression ring		
upper gap	0.30—0.45 mm (0.012—0.018 in.)	0.90 mm (0.035 in.)
lower gap	0.30—0.45 mm (0.012—0.018 in.)	0.90 mm (0.035 in.)
8 - Oil scraper ring gap	0.25—0.40 mm (0.010—0.016 in.)	0.95 mm (0.037 in.)
Connecting rods		
1 - Connecting rod weight, in production	500—610 g	—
supplied as spare part		—
—weight (brown or white)	580—588 g	—
+weight (gray or black)	592—600 g	—
2 - Weight difference between connecting rods in one engine	max. 5 g	max. 10 g
3 - Connecting rod bushing . diameter	22.008—22.017 mm (0.8664—0.8667 in.)	—
4 - Piston pins diameter	21.996—22.000 mm (0.8658—0.8661 in.)	—
5 - Piston pin/bushing radial play	0.01—0.02 mm (0.0004—0.0008 in.)	0.04 mm (0.0016 in.)
Crankcase bores		
1 - Bores for crankshaft bearings	65.00—65.02 mm (2.559—2.5598 in.)	65.3 mm (2.5708 in.)
a) Bearing Nos. 1—3 diameter		
b) Bearing No. 4 diameter	50.00—50.03 mm (1.9685—1.9696 in.)	50.4 mm (1.984 in.)
2 - Bore for seal at flywheel end diameter	90.00—90.05 mm (3.5433—3.5452 in.)	—
3 - Bore for camshaft bearings diameter	27.50—27.52 mm (1.0826—1.0834 in.)	—
4 - Bore for oil pump housing diameter	70.00—70.03 mm (2.7559—2.7570 in.)	—
5 - Bore for cam followers . diameter	19.00—19.02 mm (0.7480—0.7488 in.)	19.05 mm (0.750 in.)

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Type		1/1600 1/Model 181	
		New part	Wear limit
Camshaft			
1 - Bearings	inside diameter	25.02–25.04 mm (0.9850–0.9858 in.)	–
2 - Camshaft journals	diameter	24.99–25.00 mm (0.9838–0.9842 in.)	–
3 - Camshaft/bearings	radial play	0.02–0.05 mm (0.0008–0.002 in.)	0.12 mm (0.0047 in.)
	end play	0.04–0.13 mm (0.0016–0.0051 in.)	0.16 mm (0.0063 in.)
4 - Runout at center bearing (Nos. 1+3 on V-blocks)		max. 0.02 mm (0.0008 in.)	0.04 mm (0.0016 in.)
5 - Camshaft gear	backlash	0.00–0.05 mm (0.0–0.002 in.)	–
6 - Cam follower	diameter	18.96–18.98 mm (0.7464–0.7472 in.)	18.93 mm (0.7452 in.)
7 - Bore/cam follower	radial play	0.02–0.06 mm (0.0008–0.0024 in.)	0.12 mm (0.0047 in.)
8 - Push rod	runout	max. 0.3 mm (0.012 in.)	–
Crankshaft			
1 - Crankshaft at No. 2 and 4 bearings (Nos. 1 and 3 on V-blocks)	runout	–	0.02 mm (0.0008 in.)
2 - Crankshaft	out of balance	max. 12 cmg	–
3 - Main journal	out of round	–	0.03 mm (0.0012 in.)
4 - Connecting rod journal	out of round	–	0.03 mm (0.0012 in.)
5 - Connecting rod bearing	inside diameter	55.02–55.05 mm (2.1661–2.1673 in.)	–
6 - Connecting rod journal	diameter	54.98–55.00 mm (2.1645–2.1653 in.)	–
7 - Connecting rod journal/ Connecting rod bearing	radial play	0.02–0.07 mm (0.0008–0.0028 in.)	0.15 mm (0.006 in.)
	end play	0.1–0.4 mm (0.004–0.016 in.)	0.7 mm (0.028 in.)
8 - Crankshaft bearings			–
Bearings Nos. 1 and 3	diameter	55.03–55.07 mm (2.1665–2.1681 in.)	–
Bearing No. 2	diameter	55.02–55.08 mm (2.1661–2.1685 in.)	–
Bearing No. 4	diameter	40.05–40.10 mm (1.5767–1.5787 in.)	
9 - Crankshaft bearing journals			
Bearings Nos. 1, 2, 3	diameter	54.97–54.99 mm (2.1641–2.1649 in.)	–
Bearing No. 4	diameter	39.98–40.00 mm (1.5740–1.5748 in.)	–

Type	1/1600 1/Model 181	
	New part	Wear limit
10 - Crankshaft bearing/ crankshaft		
Bearings 1 and 3 ..... radial play	0.04–0.10 mm (0.0016–0.004 in.)	0.18 mm (0.0071 in.)
Bearing 2 ..... radial play	0.03–0.09 mm (0.0012–0.0035 in.)	0.17 mm (0.0067 in.)
Bearing 4 ..... radial play	0.05–0.10 mm (0.002–0.004 in.)	0.19 mm (0.0075 in.)
end play	0.07–0.13 mm (0.0028–0.0051 in.)	0.15 mm (0.0059 in.)
11 - Flywheel ..... lateral runout (measured at center of friction surface)	max. 0.30 mm (0.0118 in.)	–
imbalance	max. 20 cmg	–
Shoulder for oil seal .... outside diameter	69.9–70.1 mm (2.7519–2.7598 in.)	69.4 mm (2.7322 in.)
Machining of tooth width	–	max. 2.0 mm (0.08 in.)
12 - Drive plate ..... imbalance	max. 5 cmg	–
Clutch		
1 - Complete clutch ..... out of balance	max. 15 cmg	–
2 - Pressure plate ..... runout	–	0.10 mm (0.004 in.)
3 - Release ring ..... runout	max. 0.3 mm (0.012 in.)	0.4 mm (0.016 in.)
4 - Flywheel/release ring .. distance	26.7–27.3 mm (1.051–1.075 in.)	–
5 - Clutch springs color	white / red	
Length loaded	29.2 mm (1.149 in.) / 29.2 mm (1.149 in.)	–
Load ..... new	44.5–49.5 kg (99–100 lb) / 34–37 kg (75–81 lb)	–
Load ..... settled	39–44 kg (86–97 lb) / 29.5–32.5 kg (66–72 lb)	–
6 - Clutch plate ..... runout [measured at 195 mm (7.677 in.) diameter]	max. 0.5 mm (0.02 in.)	–
7 - Free play at clutch pedal	10–20 mm ($^3/_8$–$^3/_4$ in.)	–

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Engines for vehicles with manual transmission

General

Engine testing should cover the following points:

1 - Preliminary inspection
2 - Warmup
3 - Fuel consumption test
4 - Output test
5 - Final inspection

Completely or partly reconditioned engines should also be tested in this way. A test stand with water brake is most suitable for these tests. On this type of stand the load on the engine can be adjusted to suit the performance and fuel consumption test conditions.

Preliminary check

a - Adjust valve clearance.
b - Adjust contact points and set ignition.
c - Check belt tension.
d - Fill the engine with oil (see M 1.1/1-1).

Warming up

Prior to starting, crank the engine several revolutions by hand. If the engine has not been in operation for a long period, it is advisable to inject a few drops of oil into the air intake opening of the carburetor while starting the engine.

After the engine has been started, the oil pressure warning light must go out immediately as the engine speed increases. Otherwise the oil pump has not picked up any oil to feed bearings and friction surfaces.

The generator warning lamp should also go out at a fast idle speed.

When the engine starts running check for leaks at fuel pump, fuel lines and carburetor. Check fuel pump pressure.

The warmup period on the test bench may generally be limited to 30 minutes. The engine should run:

10 minutes at 1500 rpm with minimum load.
20 minutes at 2500 rpm with increased load.

Fuel consumption test

Check the fuel consumption at the end of the 30 minute warmup period, using a suitable measuring glass and a stop watch. At a fixed speed and load the fuel consumption can be determined from the time taken to consume a given amount of fuel.

	Engine speed rpm	Brake load kg (lb.)	Seconds to consume 100 ccm
up to July 1970	2900	6.5 (14.3)	51—55
	4000 (full throttle)	at least 11.2 (24.5)	21.5—22.5
from Aug. 1970	2500	5.7 (12.3)	55—65
	4000 (full throttle)	at least 11.4 (24.7)	19.0—20.5

Output test

After the fuel consumption test, the engine output is tested and compared with the values given in the output graph. A variation of ±5% is permissible to compensate for manufacturing tolerances and differences in test conditions.

The correction factor "f" is found in the diagram by using the measured intake air temperature and the barometric pressure.

The engine output is dependent on the oil temperature. The output test should, therefore, be carried out at an oil temperature of at least 80° C (176° F) in the crankcase.

Final Inspection

1 - Set idling speed while engine is warm.
2 - Check for oil leaks.
After the full-load and fuel consumption test, the engine should be checked for oil leaks. Special attention should be paid to push rod tubes, oil pump, oil cooler, cylinder head covers and the crankcase joint.
3 - Check the compression.
The compression is checked with the throttle fully open and the engine warm. The spark plugs are removed and the engine turned over with the starting motor.
4 - Re-check.
Before installation in the vehicle, check valve clearance and belt tension. The air cleaner should be clean and filled with the required amount of oil.

Storage of engines

Engines which are to be stored for a long time must be specially treated to prevent corrosion. All remaining traces of fuel and combustion gases will become chemically active and attack the cylinder walls, valve guides, etc.

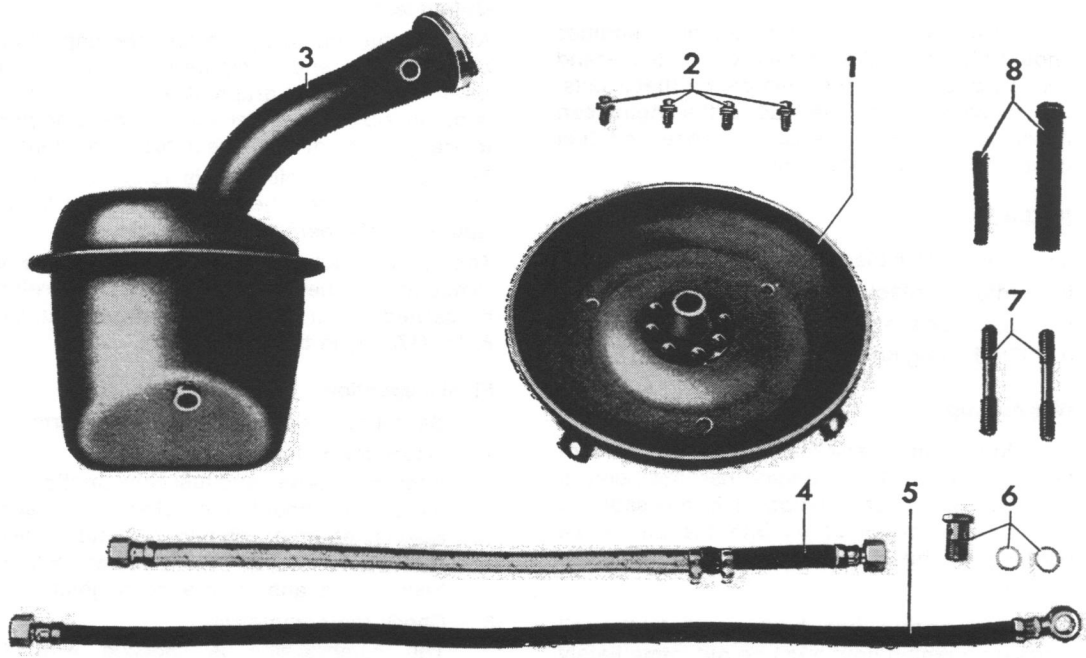
To prevent damage of this kind, it is recommended that anti-corrosion oil be injected through the carburetor air intake during the last engine revolutions.

The spark plugs can also be removed and anti-corrosion oil injected directly into each cylinder. The exterior of the engine should be sprayed with anti-corrosion oil.

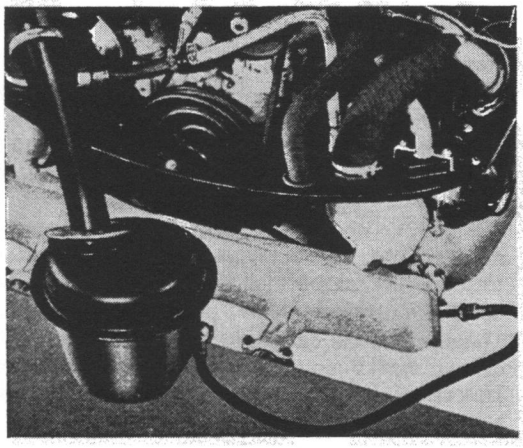
Special instructions for engines for vehicles with Automatic Stick Shift

When testing engines for vehicles with Automatic Stick Shift on a test stand, additional preparations are necessary. These engines have drive plates instead of the flywheel, additional vacuum connections on carburetor, manifold or balance pipe and a second oil pump for the converter ATF feed and bolts instead of the two engine mounting studs.

The following additional parts are required and should be available at every test stand:



1 - Drive flange
2 - 4 twelve points bolts
3 - ATF tank with dipstick (cap)
4 - ATF pressure hose with suction hose and approx. 2 quarts of ATF
5 - ATF return hose
6 - Union bolt with two washers
7 - 2 studs AM 10×82
8 - Plugged hose



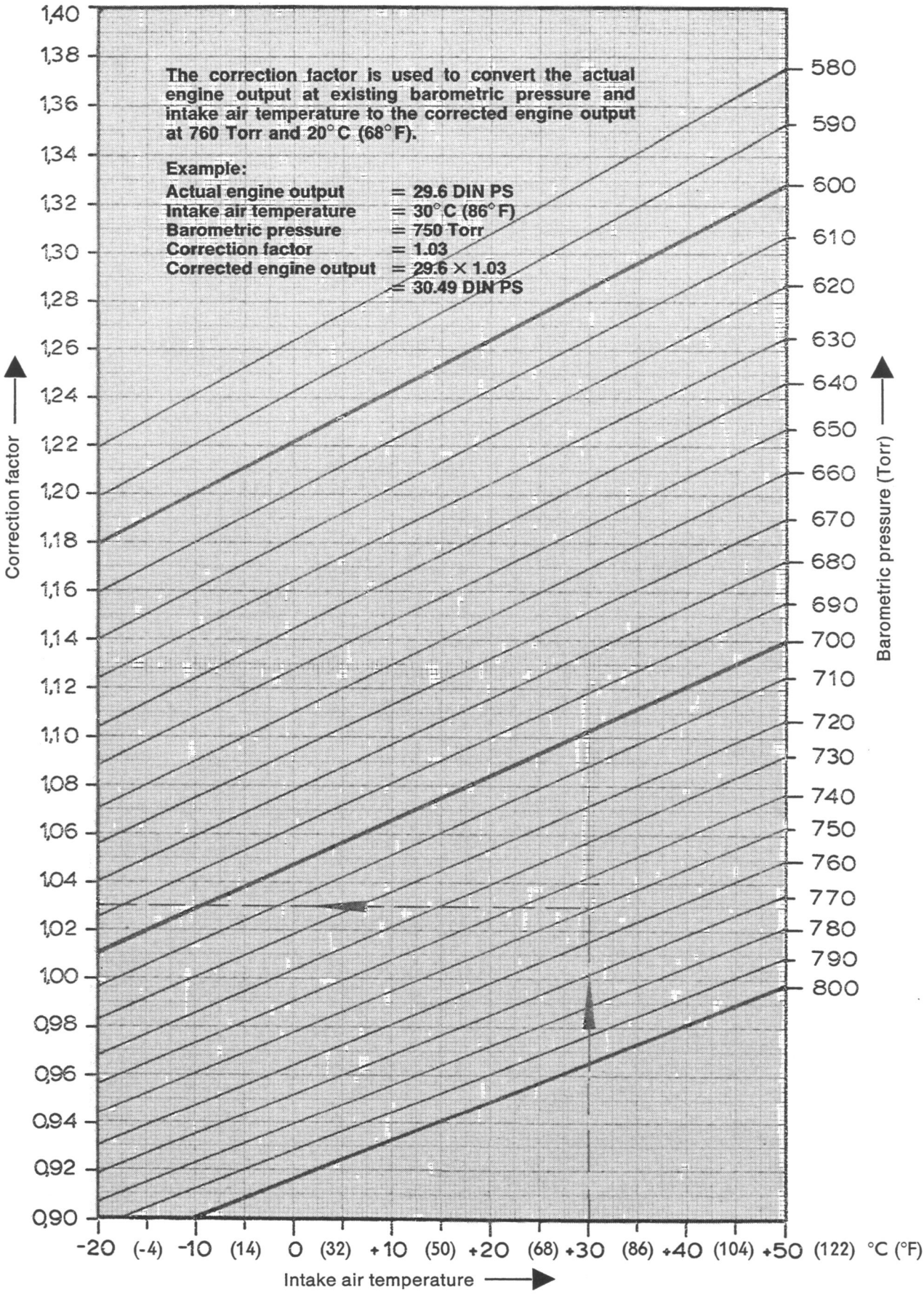
Installation instructions

1 - Attach drive flange to drive plate on engine with the four twelve point bolts.

2 - Install the two lower engine mounting studs into the crankcase.

3 - Connect ATF tank to dual pump.

4 - Seal the vacuum connections on carburetor and intake manifold.



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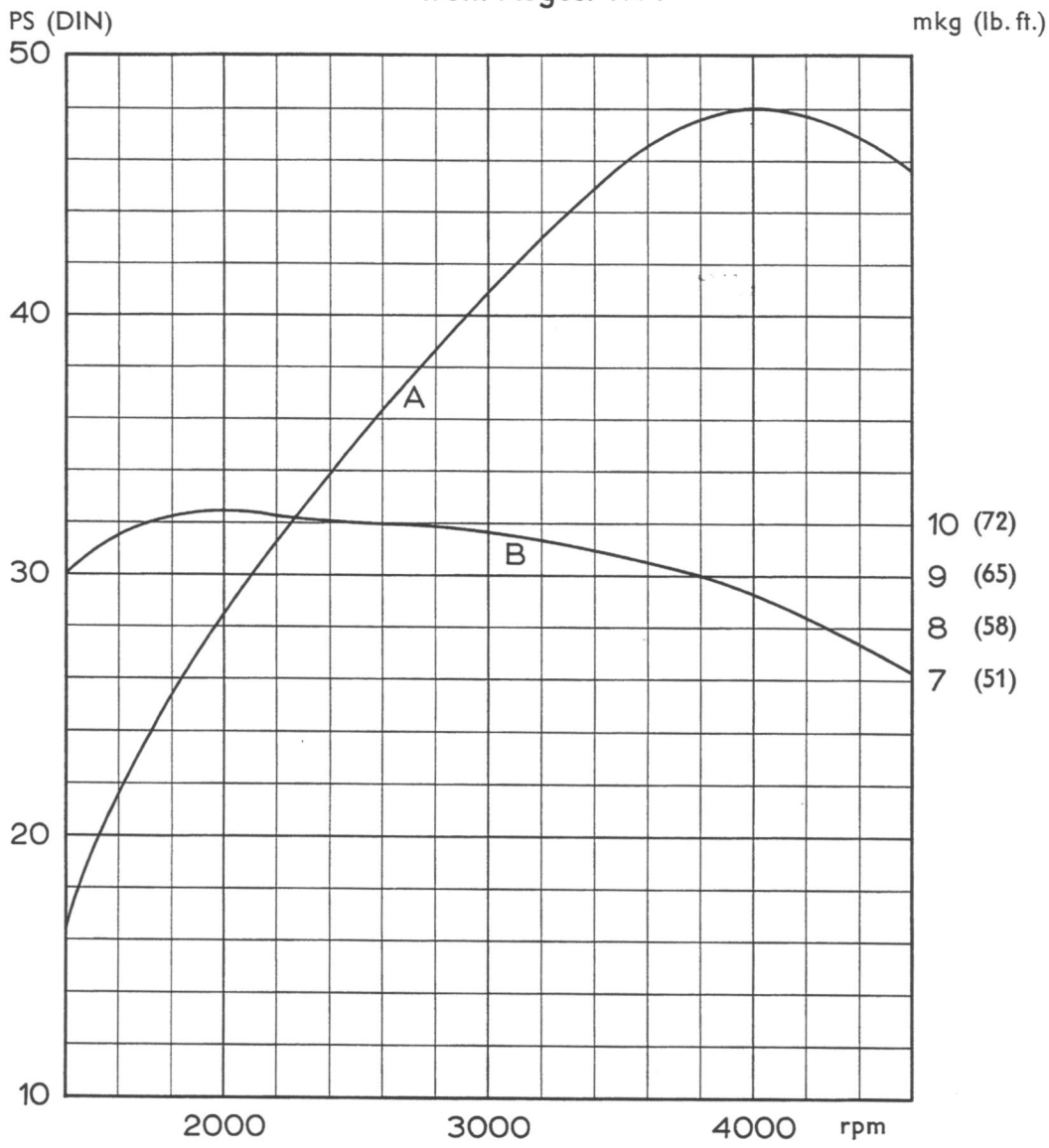

A = Output (PS)

B = Torque

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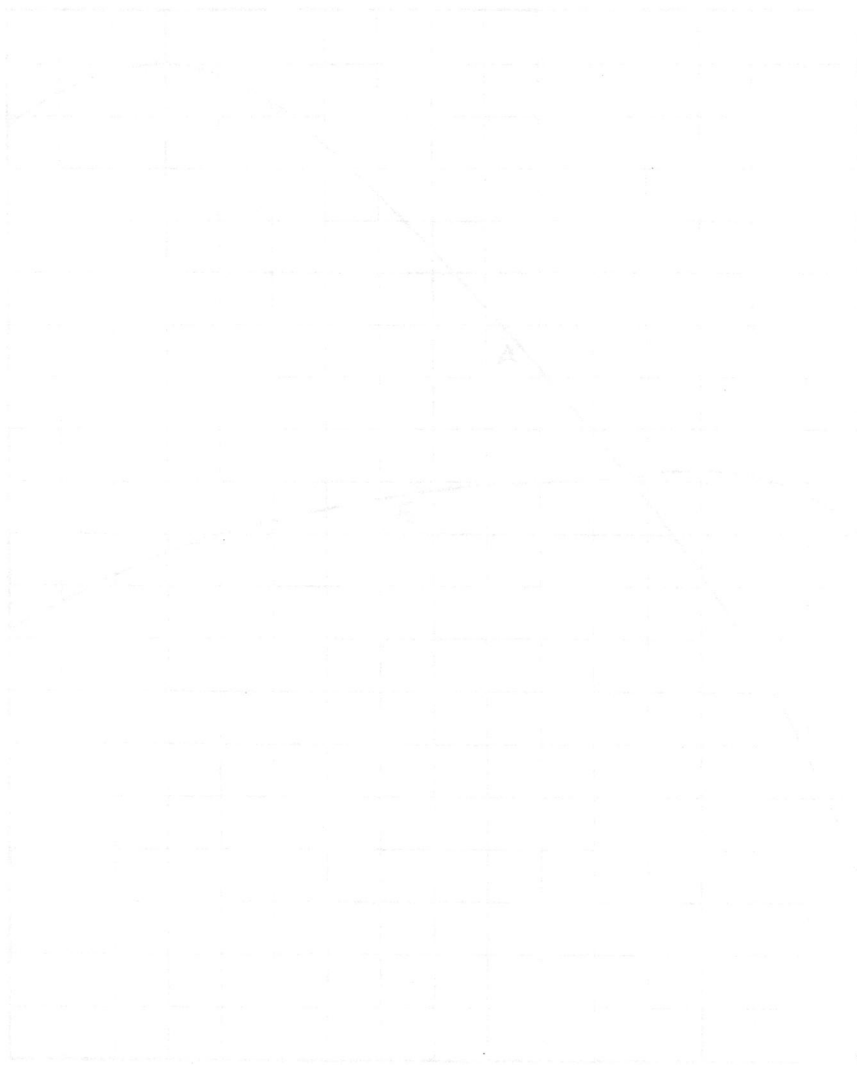

Testing and checking engines

General

Engine testing should cover the following points:

1 - Preliminary inspection

2 - Warming up

3 - Fuel consumption test

4 - Output test

5 - Final inspection

Fully and partly reconditioned engines should also be tested in this way. A test stand with water brake is most suitable for these tests. On this type of stand the load on the engine can be adjusted to suit the performance and fuel consumption test conditions.

Preliminary check

a - Adjust valve clearance.

b - Adjust contact points and set ignition.

c - Check belt tension.

d - Fill the engine with oil (see M 1.3/1-1 for quantity).

Warming up

Prior to starting, crank the engine several revolutions by hand. If the engine has not been in operation for a long period, it is advisable to inject a few drops of oil into the air intake opening of the carburetor while starting the engine.

After the engine has been started, the green oil pressure warning light must go out immediately as the engine picks up speed. Otherwise the oil pump has not picked up any oil to feed bearings and friction surfaces.

The red generator warning lamp should also go out at a fast idle speed.

After the engine has been started check for leaks on fuel pump, fuel lines and carburetor. Check fuel pump pressure.

The warm up period on the test bench may generally be limited to 30 minutes. The engine should run:

10 minutes at 1500 rpm with 3 kg (6.6 lb.) load.

20 minutes at 2500 rpm with 6 kg (13.2 lb.) load.

Fuel consumption test

Check the fuel consumption at the end of the 30 minute warm up period, using a suitable measuring glass and a stop watch. At a fixed speed and load the fuel consumption can be determined from the time taken to consume a given amount of fuel.

	Engine speed rpm	Brake load kg (lb.)	Seconds to consume 100 cc
1/1200	2200	5.0 (11)	84.5—91.5
	3600 (full throttle)	at least 9.1 (20)	30—33
1/1300	2500	5.7 (12.5)	66.5—71.5
	4000 (full throttle)	at least 9.6 (21)	25.5—27.5
1/1600	2900	6.5 (12.5)	51—55
	4000 (full throttle)	at least 10.2 (22.5)	21.5—22.5
2/1600	2400	5.6 (12.3)	65—70
	4000 (full throttle)	at least 11.0 (24)	20.5—23.0
3/1600	2500	5.7 (12.5)	65—70
	4000 (full throttle)	at least 12.8 (28.2)	18.5—20.5
3/1600 M 236	2900	6.5 (12.5)	51—55
	4000 (full throttle)	at least 10.5 (23)	18—20

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Output test

After the fuel consumption test, the engine output is tested and compared with the values given in the output graph. A variation of ± 5 % is permissible to compensate for manufacturing tolerances and differences in test conditions.

Note the following to obtain accurate test results:

1 - Connect generator or regulator to the electrical circuit on the test stand.

2 - Install damper pipe or tail pipes on the muffler.

3 - Open the flaps on the heat exchangers and connect flexible metal hoses.

3/1600:

4 - Close the fresh air pipes.

5 - Check engine oil temperature with the thermometer on the test stand.

6 - Measure intake air temperature.

7 - Find corrected engine output with the aid of the correction factor.

8 - Extract exhaust gas as well as heating and cooling air.

Additional notes to above points:

To point 5:

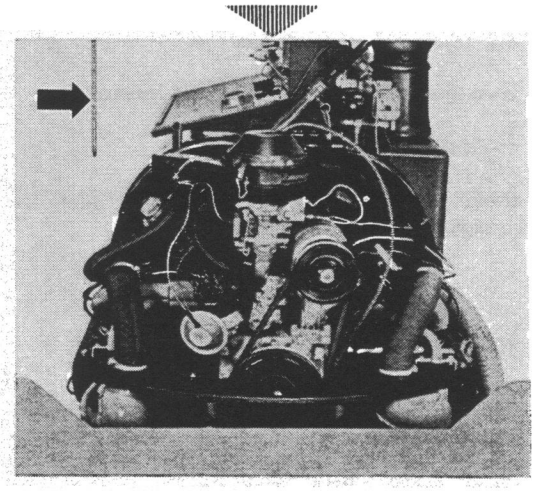
The engine output is dependent on the oil temperature. The output test should, therefore, be carried out at the following oil temperatures:

Type 1, 2 and Industrial Engine:	at least 80° C (176° F) in crankcase
Type 3:	at least 60° C (140° F) in oil filler neck

The temperatures are different because of the location of the temperature sensing unit. (Types 1—2 in the crankcase, type 3 in the oilfiller neck.)

To point 6:

To establish the correction factor, is it necessary to measure **the temperature of the intake air** about 10—15 cm (4—6 in.) away from the air cleaner during the test.



To point 7:

The engine output is influenced by barometric pressure and temperature. Therefore, it is necessary to adjust the actual output of an engine to certain standard operating conditions. According to DIN 70020, these standard conditions are 20° C (68° F) and 760 Torr (= 760 mm Hg or 29.92 in. Hg). The engine output based on these figures is called "Corrected output".

The various factors (and their units of measurement) that must be considered in the calculation of engine output and torque are:

Actual brake load . . . . . = F_e (kg)
Corrected brake load . . . = F_{red} (kg)
Engine speed . . . . . = n (rpm)
Actual engine output . . . = P_e (bhp)
Corrected engine output . . = P_{red} (bhp)
Intake air temperature . . . = t (°C)
Barometric pressure . . . . = b (Torr)
Correction factor . . . . . = f
Torque . . . . . = M_d (mkg)

The values needed to check the performance of the engine are computed on the basis of the following equations:

1 - Actual engine output: $P_e = \frac{F_e \cdot n}{1000}$ (bhp)

2 - Corrected engine output: $P_{red} = P_e \cdot f$ (bhp)

3 - Corrected engine output: $P_{red} = \frac{F_e \cdot n}{1000} \cdot f$ (bhp)

4 - Correction factor: $f = \frac{760}{b} \cdot \sqrt{\frac{273 + t}{293}}$

5 - Torque: $M_d = F_{red} \cdot 0.716$

These equations are represented graphically on pages M 1.6/1-4 to M 1.6/1-6. The diagrams are read in the following manner:

Correction Factor Diagram

The correction factor is found by using the measured intake air temperature and the barometric pressure.

Output Diagram

The actual engine output is found by reading the actual brake load at the given engine speed.

The corrected engine output can now be established by multiplying the actual engine output with the correction factor. This method should be used whenever the engine performance test is conducted under extreme weather conditions.

Consolidated Diagram

In this diagram the corrected engine output can be read directly. In the lower left hand part of the coordinate system, the correction factor is obtained from the intake air temperature and the barometric pressure. The field on the upper left yields the values for corrected brake load and torque on the basis of the actual brake load and the correction factor.

On the right hand side of the coordinate system, the corrected engine output can be determined by reading right from the vertical axis to the engine speed and down to the horizontal axis.

Note: Always read parallel to the coordinates. For further details see examples in each diagram.

To point 8:

Exhaust gases have to be emitted outdoors because they contain poisonous carbon monoxide. Assure good ventilation of the test room.

To avoid overheating the engine (output drop), it is advisable to extract cooling and heating air as well.

Final Inspection

a - Set idling speed while engine is warm.

b - Check for oil leaks.
After the full-load and fuel consumption test, the engine should be checked for oil leaks. Special attention should be paid to push rod tubes, oil pump, oil cooler, cylinder head covers and the crankcase joint.

c - Check the compression.
The compression is checked with the throttle fully open and the engine warm. The spark plugs are removed and the engine turned over with the starting motor.

d - Re-check.
Prior to installation in the vehicle, check valve clearance and belt tension. The air cleaner should be clean and filled with the required amount of oil.

e - Storage of engines.
Engines which are to be stored for a long time must be specially treated to prevent corrosion. All remaining traces of fuel and combustion gases will become chemically active and attack the cylinder walls, valve guides, etc. To prevent damage of this kind, it is recommended that anti-corrosion oil be injected through the carburetor air intake during the last engine revolutions. The spark plugs can also be removed and anti-corrosion oil injected directly into each cylinder. The exterior of the engine should be sprayed with anti-corrosion oil.

Checking on a vehicle test stand

The output and fuel consumption can be measured on a vehicle test stand when the engine is installed. Test conditions and values for this type of test are given in the respective specification charts.

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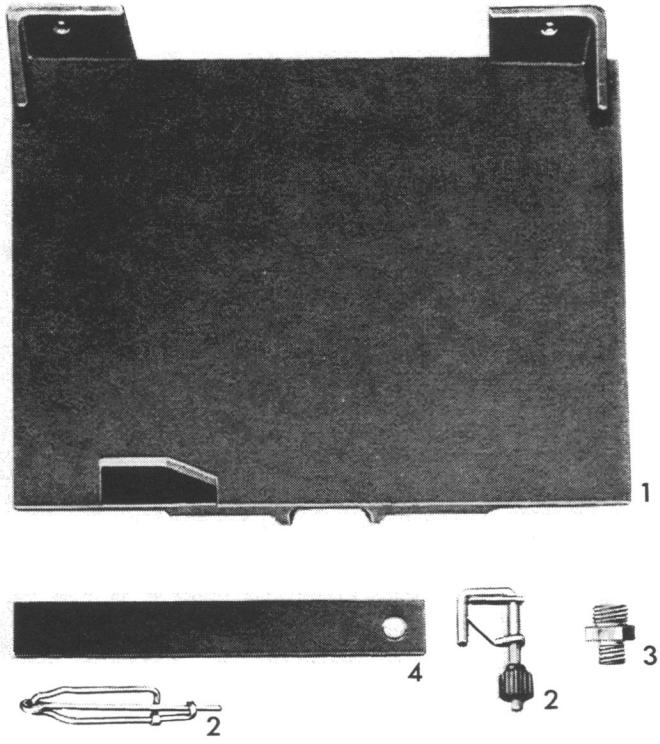

No.	Description	Special tool	Remarks
1	Support for engine jack	VW 612/2	
2	Clip for fuel line	VW 647	
3	Union M 16×1.5		soldered up
4	Retaining plate for converter	VW 802	

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Removing

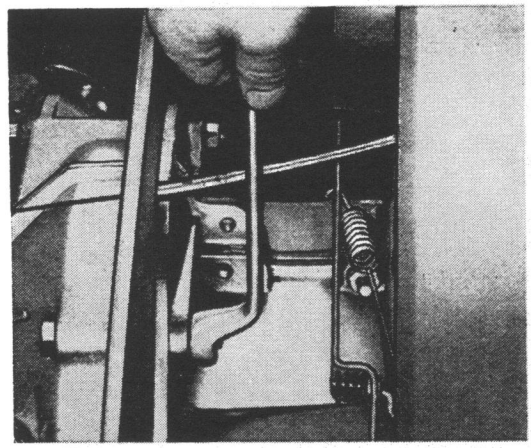
1 - Disconnect ground strap from battery.

2 - Remove air cleaner.

3 - Up to Engine No. H 5924000:

Remove throttle positioner.

4 - Remove nuts from two upper engine mounting bolts.



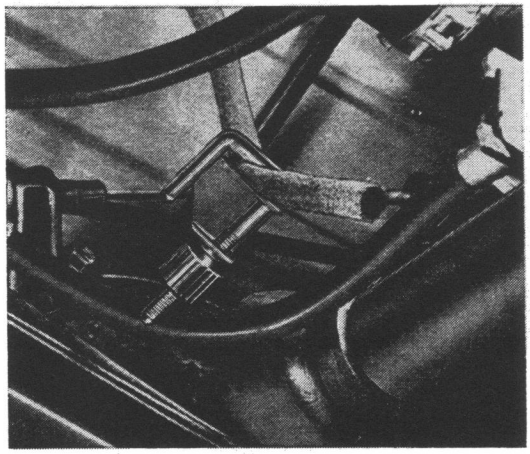
Note

From August 1970, a special nut is pressed into crankcase on upper left side. On these engines the bolt must be inserted from the transmission side.

5 - Disconnect wires from generator, ignition coil, oil pressure switch and carburetor.

6 - Disconnect accelerator cable from carburetor.

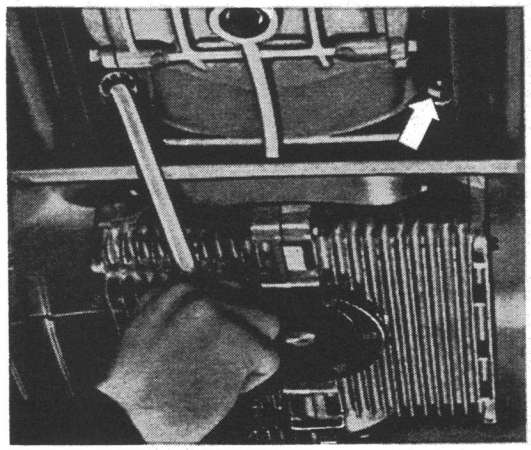
7 - Pull fuel hose off and plug it.



8 - Disconnect both heater flap cables and detach heater pipes from engine.

9 - Pull accelerator cable out of guide tube.

10 - Remove two nuts from lower engine mounting bolts (arrow).



11 - Remove engine downward.

Caution

Take care not to damage the main drive shaft, clutch and clutch plate.

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Installing

1 - Check clutch release bearing for wear and replace if necessary.

Roughen up the plastic ring with coarse emery and lightly rub in molybdenum disulfide paste.

2 - Rub molybdenum disulfide powder lightly into splines of drive shaft with a clean cloth.

3 - Lubricate starter bushing lightly with multi-purpose grease.

4 - Clean transmission case and engine flange.

5 - If the damping material in the engine compartment is loose, secure it properly before installing engine.

6 - When inserting the engine and guiding it over the main drive shaft, take care not to damage the shaft, the clutch plate and the release bearing.

It is advisable to turn the engine back and forth with the belt pulley (engage a gear).

7 - When installing the engine, locate the lower studs in the transmission flange first then insert upper bolts. Tighten nuts uniformly.

8 - Adjust clutch pedal free play.

9 - Install engine seal properly.

10 - Adjust accelerator cable at full throttle.

11 - Adjust ignition.

The following sequence of operations is recommended when disassembling and assembling the engine:

Disassembling

1 - Drain engine oil.

2 - Remove front cover plate.

3 - Remove rear cover plate.

4 - Remove muffler.

5 - Remove heat exchangers (left and right).

6 - Remove fan housing complete with generator.

7 - Remove intake manifold complete with preheating pipe.

8 - Remove generator support.

9 - Remove cylinder cover plates (left and right).

10 - Remove crankshaft pulley.

11 - Remove distributor and fuel pump.

12 - Remove distributor drive shaft.

13 - Remove oil cooler.

14 - Remove rocker arm shafts.

15 - Remove cylinder heads.

16 - Remove cylinders.

17 - Remove pistons.

18 - Remove clutch.

19 - Remove flywheel.

20 - Remove oil pump and strainer.

21 - Split crankcase.

22 - Take out camshaft and crankshaft.

Assembling

Proceed in reverse order. Additional instructions are found on following pages.

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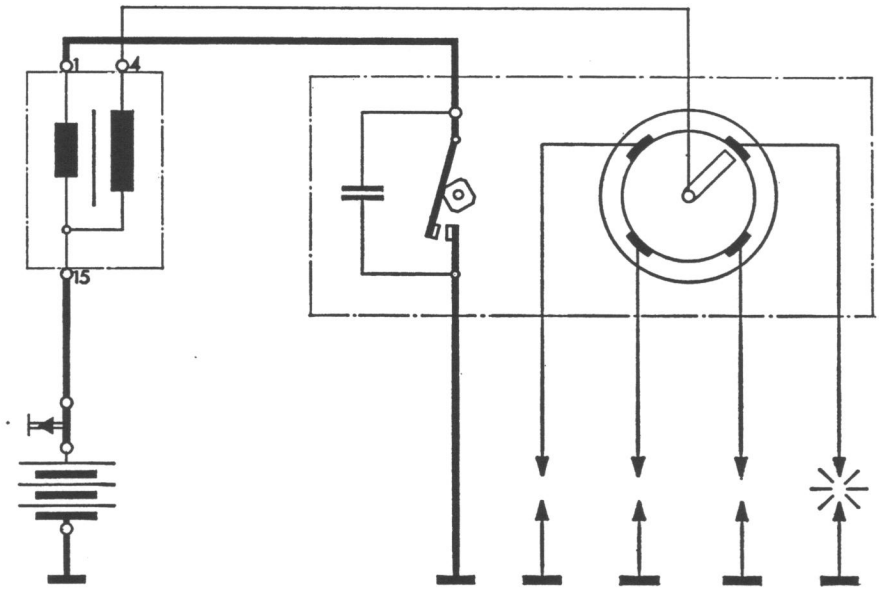
Ignition System

The ignition system is a battery type.

The battery voltage is stepped up in the coil to 15,000—20,000 volts as in a transformer. This takes place as follows:

As the distributor shaft rotates (driven by the crankshaft), the integral contact breaker cam opens the contact points.



This interrupts the flow of current in the primary windings of the coil. The magnetic field built up in the two windings by the flow of current collapses and induces a high voltage surge in the secondary winding.

This high voltage surge passes through an ignition cable to the rotor in the distributor. The tip of the rotor is just opposite the contact in the distributor cap to which the spark plug in the cylinder to be fired is connected.

A spark jumps across the plug electrodes and ignites the compressed fuel/ air mixture in the cylinder.

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Ignition coil

The coil consists of a laminated iron core around which is wrapped a few turns of thick wire to form the primary winding and a large number of turns of thin wire to form the secondary winding. The beginning of the secondary winding is attached to the iron core to which the high voltage cable is connected. The end of the secondary winding is connected to the beginning of the primary winding and both are connected to terminal 1 on the coil.

Distributor

The distributor provides a means of distributing the ignition current to each of the four spark plugs in the correct sequence and exactly at the firing point.

The distributors are fitted with a vacuum or combined centrifugal and vacuum spark control arrangement to ensure that the ignition timing is automatically varied to suit all engine speeds and load conditions.

Vacuum spark control

The vacuum advance mechanism controls the firing point according to engine load and speed. There are **two** vacuum drillings in the carburetor, one in the venturi and one near the throttle valve. The drilling in the venturi gives a speed-sensitive vacuum advance and the drilling near the throttle valves gives a load-sensitive advance.

The depression created in the carburetor is routed to the vacuum unit on the distributor. A diaphragm in the vacuum unit is moved by the vacuum and a pull rod transmits the movement of the diaphragm to the contact breaker plate and turns it against the direction of rotation of the cam on the distributor shaft. When the depression ceases, a return spring moves the breaker plate back to its original position.

Centrifugal and vacuum spark control

1 - Centrifugal control

Two weights on a carrier plate fly outward as the distributor speed increases. The contact breaker cam is connected to the weights by a small link so that cam is turned in the direction of rotation of the distributor shaft and the ignition timing is advanced. Return springs pull the weights back to the initial position as the speed drops.

2 - Single vacuum control

a - The vacuum taken from the carburetor via **one** drilling near the throttle valve acts mainly in the part load range in addition to the centrifugal advance and turns the breaker contact plate against the direction of rotation of the cam on the distributor shaft.

b - Double vacuum control

The vacuum is taken in front of and behind the throttle valve and led in separate lines to the two chambers in the vacuum unit. The diaphragms of these chambers are connected by a rod to the breaker contact plate which is moved either in the direction of distributor shaft rotation to retard the spark timing or against the direction of distributor shaft rotation to advance the spark timing.

To give the retarded timing required at idling speed the vacuum is taken from behind the fully closed throttle valve and acts on the breaker contact plate via the ring-shaped diaphragm.

When the throttle valve is opened, the vacuum in the drilling in front of the throttle valve increases and the breaker contact plate is moved in the direction of advanced timing.

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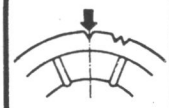
Model		1/Manual Transmission 1/Model 181				
Code letters		B	AE	AE, AH, AK	AK	AM
Used	from	11 Aug. 1969	1 Aug. 1970	1 Aug. 1971	1 April 1973	1 April 1973
Engine No.	from	B 6 000 001	AE 000 001	AE 558 001 AH, AK 000 001	AK 1 200 009	AM 000 001
Distributor Production		113 905 205 T	113 905 205 AJ	113 905 205 AN	043 905 205	113 905 205 AN 043 905 205 C
Distributor Replacement		111 905 205 AA	113 905 205 AJ	113 905 205 AN	043 905 205	043 905 205 C
Ignition timing		0°	5° after TDC		7.5° before TDC	5° after TDC
Timing marks						
Speed	rpm	800—900				
Vacuum hose or hoses		off	on		off	on
Dwell angle	set to	44—50°				
	wear limit	42—58°				
Centrifugal spark control Begin	rpm		1000—1250	1000—1250	1050—1250	1000—1250
	rpm Degrees		1500 6—12	1500 6—12	1500 6—12	1500 6—12
	rpm Degrees					
End	rpm Degrees		3800 22—25	3800 22—25	3800 22—25	3800 22—25
Vacuum spark control advance Begin	mmHg	3—7	110—160	110—160	60—100	110—160
	mmHg Degrees	30 17—19				
End	mmHg Degrees	70—76 32—35	210—240 9—12	180—200 5—8	200 8—12	180—200 5—8
Vacuum spark control retard Begin	mmHg		80—130	80—150		80—150
End	mmHg Degrees		160—230 11— 13	160—230 11—13		160—230 11—13
Spark plugs [1]	below +25° C (77° F)	W 145 T 1				
	above +25° C (77° F)	W 175 T 1				

[1]) Or plugs from other manufacturers with equivalent heat values and approved by VW factory.

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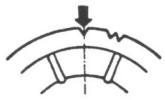
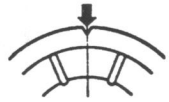
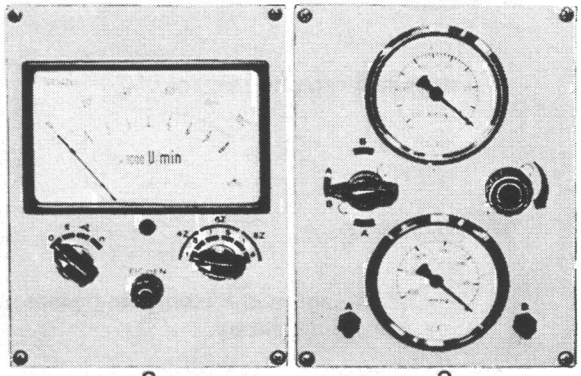
Model		1/Automatic Stick Shift			
Code letters		B	AE, AH	AH	AK
Used	from	11 Aug. 1969	1 Aug. 1970	1 April 1973	1 Aug. 1972
Engine No.	from	B 6 000 002	AE 000 002	AH 090 024	AK 000 001
Distributor Production		113 905 205 AD 113 905 205 AE	113 905 205 AH	043 905 205 A	113 905 205 AH
Distributor Replacement		113 905 205 AE	113 905 205 AH	043 905 205 A	113 905 205 AH
Ignition timing		0°	5° after TDC	7.5° before TDC	5° after TDC
Timing marks					
Speed	rpm	800—900			
Vacuum hose or hoses		on		off	on
Dwell angle	set to	44—50°			
	wear limit	42—58°			
Centrifugal spark control					
Begin	rpm	1050—1200	1000—1200	1000—1200	1000—1200
	rpm Degrees	1700 13—15	1600 12—15	1600 12—15	1600 12—15
	rpm Degrees	2200 13—16	2200 12—16	2200 12—16	2200 12—16
End	rpm Degrees	3900 25—28	3800 22—25	3800 22—25	3800 22—25
Vacuum spark control advance					
Begin	mmHg	70—120	110—160	60—100	110—160
	mmHg Degrees				
End	mmHg Degrees	240 8—12	150—170 2—5	200 8—12	150—170 2—5
Vacuum spark control retard					
Begin	mmHg	60—100	80—130		80—130
End	mmHg Degrees	170 6—8	160—230 11—13		160—230 11—13
Spark plugs [1]	below +25° C (77° F)	W 145 T 1			
	above +25° C (77° F)	W 175 T 1			

[1]) Or plugs from other manufacturers with equivalent heat values and approved by VW factory.



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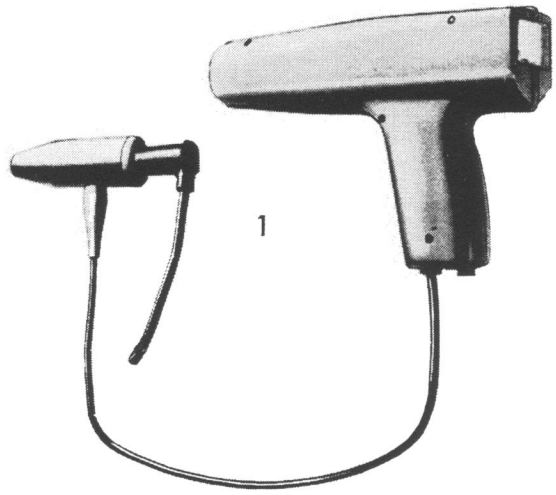

1

No.	Description	Special tool	Remarks
1	Stroboscopic timing light		
2	Dwell angle — tachometer tester		
3	Vacuum measuring gauge		range 0—100 and 0—600 mm Hg

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Coil

Keep coil cap clean and dry.

Distributor

1 - Check points for pitting and build-up, replace if necessary.

2 - Lubricate fiber block on breaker arm with a small amount of multi-purpose grease.

3 - Lubricate breaker arm bushing and felt wick in shaft with a drop of engine oil.

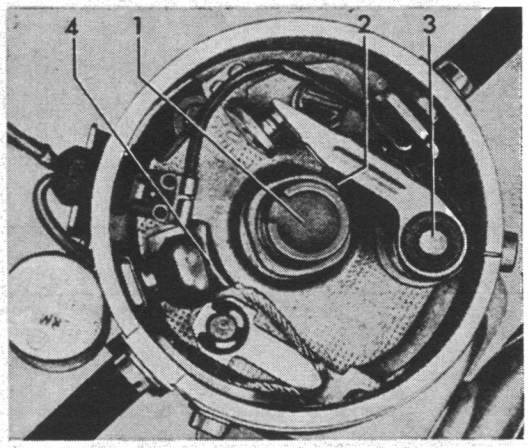
4 - Check that distributor cap is clean. Check for cracks and arcing marks. Clean or replace as necessary.

5 - Check and adjust dwell angle.

6 - Check timing and adjust if necessary.

Spark plugs

Clean, check gaps and adjust.



Special instructions (lubrication)

A - The felt wick in the distributor shaft (1) and the contact arm bushing (3) should be lubricated with a few drops of engine oil regularly.

B - The fiber block on the breaker arm must be lubricated with multi-purpose grease. To avoid the risk of grease getting on to the contact points, use only a very small quantity and press it into the corner between fiber block and breaker arm (2) and on the ball (4).

5 - Run engine at 1000 to 1200 rpm and note dwell meter reading.

Dwell angle: 42°—58°

6 - Run engine at 2000—2500 rpm and check reading again.

Note:

Small breaker gap = large dwell angle
Large breaker gap = small dwell angle

Evaluating meter readings:

The point gap must not be less than .012 in. (0—3 mm). If the dwell angle reading shows that a smaller gap is necessary (measured with feders) there is a **mechanical defect in the distributor.**

When the speed is increased, the dwell angle must not alter noticeably (max. ±1°). Large deviations indicate **defects in distributor,** such as worn bearings or a worn cam.

Unsteady, jerky movements of the needle are usually caused by burned and **unserviceable breaker points.**

Adjusting contact points with feeler gauge

The contact points should only be adjusted with a feeler gauge if a dwell meter is not available. Even when there is only a small build-up on the points, the points can no longer be set accurately by this method.

1 - Remove distributor cap and rotor.

2 - Turn the crankshaft until the breaker arm is fully lifted by the cam.

3 - Loosen the screw holding the fixed contact point.

4 - Insert screwdriver between the two small pins on the contact breaker plate and in the slot at the end of the fixed point. Turn the screwdriver until the clearance is .016 in. (0.4 mm).

5 - Tighten lock screw.

Important

When the contact points have been adjusted, the ignition timing must be reset as an alteration of .004 in. (0.1 mm) in the breaker gap alters the ignition timing about 3°.

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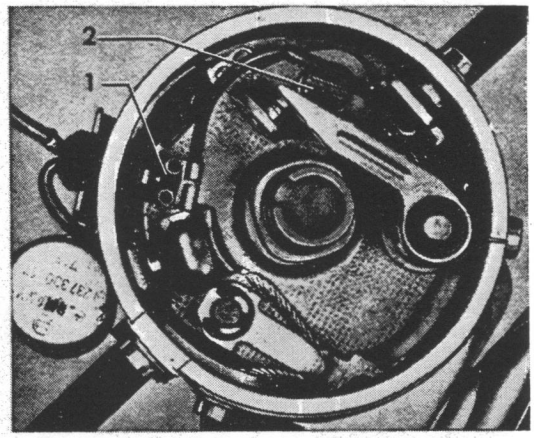
Normal wear of the rubbing block allows the contact point gap to close, causing the points to burn rapidly with subsequent engine misfiring.

Removing

1 - Disconnect wire (1).

2 - Remove screw (2).



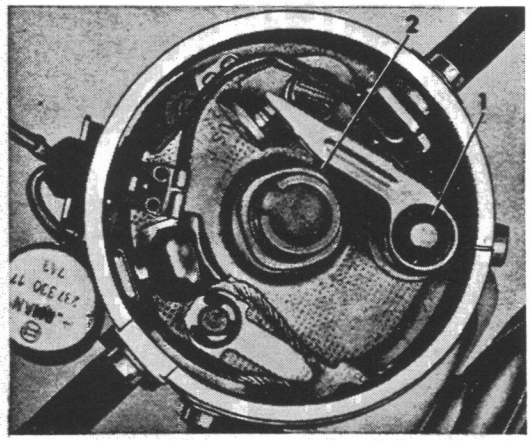
Installing

1 - Lubricate contact pivot (1) with one drop of engine oil.

2 - Lubricate cam and fiber block (2) with the enclosed grease capsule.

3 - Remove any oil or grease which may have gotten on the points accidentally.

4 - Adjust points.

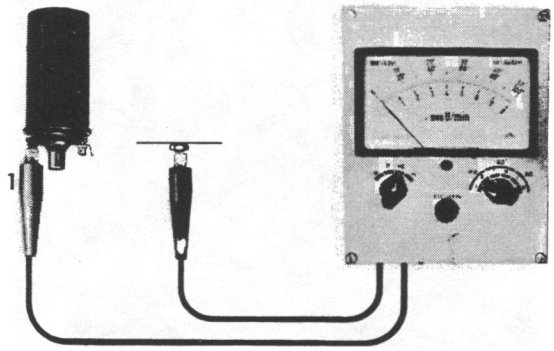


Adjusting dwell angle

If the dwell angle tester used is different from the one shown here, the appropriate instructions for use must be followed.

1 - Connect tester:

Connect green clip to terminal 1 on coil and black clip to a metal part.



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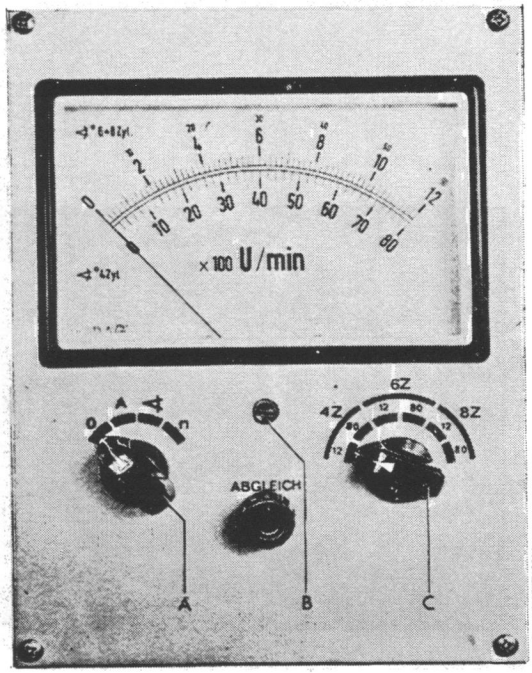


A - Test selection switch

B - Zeroing screw

C - Measuring range selection switch

2 - Calibrate the tester:

Set test selection switch to "A". Turn knob of calibrating switch until the needle is exactly on the end mark (12 or 80) of the scale.

3 - Measure dwell angle.

Set test selection switch to "⊲" and measuring range selection switch to 4 Z (number of cylinders).

Start engine and run it at about 1000 rpm. Read off dwell angle on lower scale (1 graduation = 2°).

Then increase engine speed to about 2000 rpm. The needle must not deviate more than ±1° from the previous reading. If it does, it indicates that the distributor shaft or the breaker plate is worn. In such cases remove distributor and replace breaker plate.

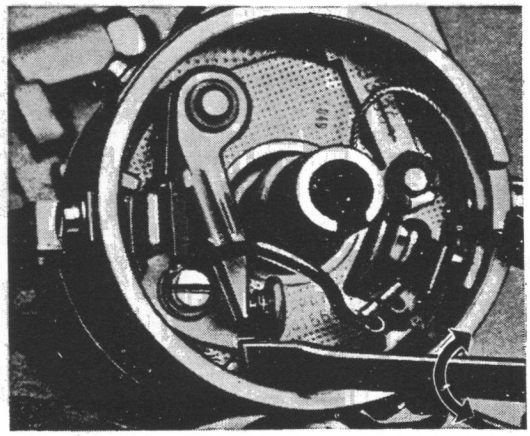
Compare readings with specified figures.

Specified dwell angle	44—50°
Wear limit	42—58°

This means that **new** contacts must be adjusted to the specified figure and that worn contacts should not be adjusted as long as the dwell angle is within the wear limit.

4 - Adjust dwell angle.

Take distributor cap and rotor arm off and loosen screw holding the contacts. With ignition switched on and starter turning the engine over, alter the contact gap until the correct angle can be read on the tester. Tighten contact securing screw and check again to see that the angle has not changed as the screw was being tightened.



5 - Install rotor arm and distributor cap and check dwell angle again.

Note

When the dwell angle has been adjusted, the ignition timing must also be readjusted.

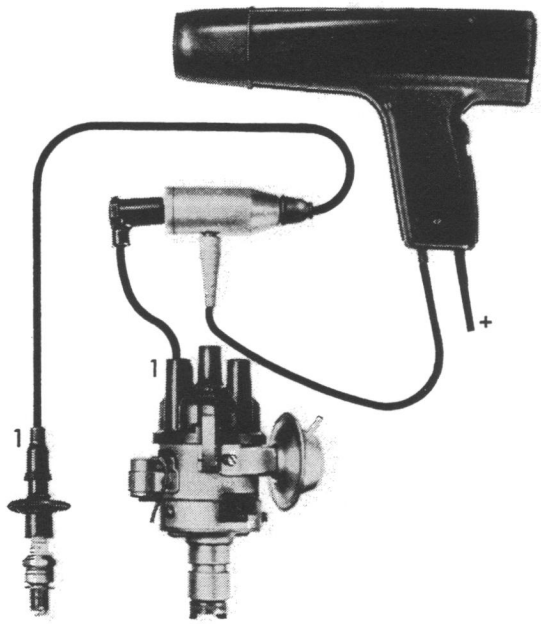
If the instrument used is different from the one shown here, the appropriate instructions for use must be followed.

1 - Check dwell angle, if necessary adjust.

2 - Engine oil temperature 30–70° C (86 to 158° F).

3 - Connect the dwell angle tester and calibrate it. Set test selection switch to "n". Set measuring range selection switch to "4 Z" and to "12" in this group.

The speed is read off on the upper or lower scale.



4 - Connect stroboscopic timing light. The impulse unit is connected in the No. 1 cylinder plug cable as shown. The adjusting disc in the handle must be turned back to the zero stop.

5 - **Only if specified:**

Pull vacuum hose or hoses off the vacuum unit on the distributor (see table M 3.2/1).

6 - Run engine at the given speed 800–900 rpm.

Note

Set engine to specified speed with throttle valve closed by turning the bypass air screw.

7 - Check ignition timing:

The mark on the pulley must be in line with the crankcase joint.

8 - Adjust ignition timing:

Turn distributor until the setting mark aligns with the reference mark (see M 3.2/1).

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If the instruments used are different from those shown in the list of tools the appropriate instructions for use must be followed.

1 - Connect dwell angle tester and trim it. Set test selection switch to "n". Set measuring range selection switch to "4 Z" and to "80" in this group. The speed is read off on the lower scale.

2 - Connect stroboscopic timing light.

3 - Start engine, check basic ignition timing and rectify as necessary.

4 - **Pull hose or hoses off the vacuum unit on distributor.**

5 - Run engine at 900 rpm. and direct flashes onto the timing mark.

The setting may deviate from the basic setting due to the absence of the vacuum connections and this should be "brought back" with the aid of the adjusting disc on the control angle measuring instrument. Note the reading.

6 - Increase speed slowly. The start of the spark advance will be shown by the movement of the timing mark.

7 - Set the speed to the figure given in the table (see M 3.2). "Bring the mark back" with the aid of the disc on the control angle measuring instrument. Read off the advance in degrees on the instrument and subtract the reading at point 5 to obtain the centrifugal spark control.

8 - If the test results do not agree with the specified figures, the control mechanism in the distributor must be repaired (freed up, weak springs replaced) or a new distributor installed.

1 - Pull hose off vacuum unit on carburetor and connect hoses of **vacuum tester** to engine so that connection "A" is connected to the vacuum unit and connection "B" to the carburetor.

2 - Connect stroboscopic timing light (see page 3.3/2).

3 - Set change-over knob to "B" and close control valve. Start engine. If no vacuum is show, the vacuum connection in the carburetor is blocked.

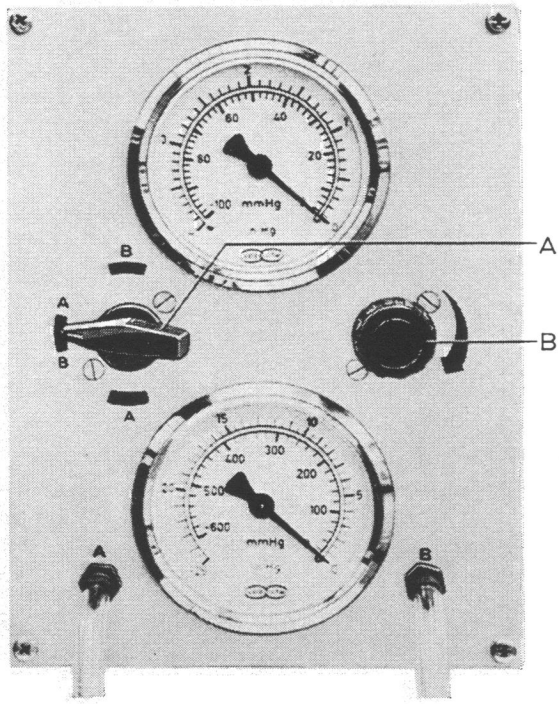
If vacuum is present, move change-over knob to "AB" and increase speed until a reading of at least 100 mmHg is recorded. Then move knob to "A" and switch engine off. The indicated vacuum must remain constant for at least 1 minute, otherwise the vacuum unit or the hose is leaking.

4 - Move knob to "AB" and open control valve. Start engine, check basic ignition timing and rectify if necessary.

5 - Close control valve and increase speed until the vacuum reading is higher than given in the table (see 3.2/1) for the end of advance check. Move knob to "A" and let engine run on at idling speed.

6 - Reduce the vacuum with the control valve to the test pressure given in the table.

Direct flashes from timing light onto the timing mark and "bring the mark back" with the adjusting disc. Read off the advance in degrees on the measuring instrument.



A - Change-over knob

B - Control valve

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Vacuum spark retard

1 - Connect tester between "retard unit" and vacuum line.

2 - Pull vacuum hose off "advance unit".

3 - Run engine at 900 rpm and direct flashes onto timing mark. (Vacuum control valve must be open.)

4 - Bring mark back with adjusting disc.

Read off the total spark retard on the measuring instrument (see specified figures page 3.2/1).

5 - Close vacuum control valve slowly. Read off vacuum figures for beginning and end of spark retard.

Vacuum spark advance

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

2 - Pull vacuum hose off "retard unit".

3 - Run engine at 900 rpm and direct flashes onto timing mark. (Vacuum control valve must be open.)

4 - With the adjusting disc on the measuring instrument, bring back the deviation from the basic ignition timing caused by the absence of the "retard" vacuum connection. Note the reading.

5 - Increase speed until the vacuum reading is higher than given for the end of spark control check in table (see page 3.2/1).

6 - Maintain vacuum and reduce speed to 900 rpm.

7 - Bring mark back with adjusting disc and read off the advance. Subtract the reading noted at point 4 to obtain the vacuum spark advance.

8 - Open vacuum control valve slowly. Read off the vacuum figures for beginning and end of advance.

Checking coil

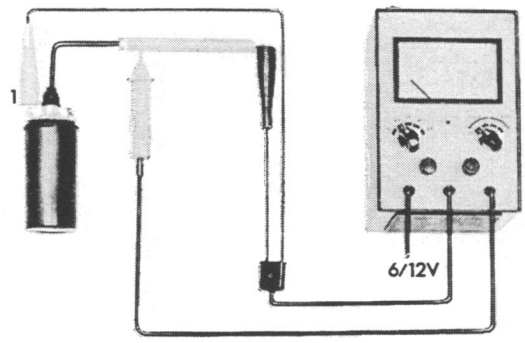
1 - Keep coil cap clean and dry to avoid shorting and tracking.

2 - Check that the flat terminals fit tightly to prevent voltage drop.

3 - Check coil output with coil tester.

The test appliance should be connected as shown in illustration and operated in accordance with manufacturer's instructions.

A resistance is connected to the high tension side of the coil (terminal 4) and a constant impulse flow fed into the coil from the test appliance. The ignition voltage given by the coil under this load is measured and should be in the order of 18,000 V (18 kV).



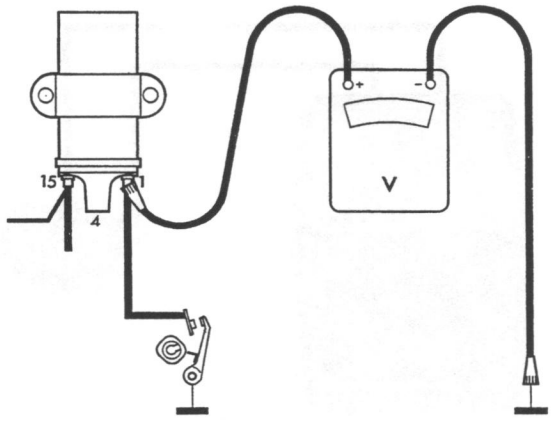
4 - If such a test appliance is not available, the coil can be tested as follows:

Pull the high tension cable out of the center of the distributor cap (terminal 4) and hold it about 10 mm away from a suitable ground. It is advisable to use a pair of insulated pliers for this purpose. Then turn the engine over with the starter and see if a spark jumps from cable end to ground. If there is no spark, check the voltage at terminal 15 on the coil with a voltmeter. There should be at least 9 volts at this point on a 12 volt system.

If the measured voltage is above this figure, check terminal 1 on coil (connection to distributor) with a voltmeter or test light. There should be no voltage reading at this terminal when the contacts are closed and a reading when they are open. Should there be no voltmeter reading even when contacts are open (distributor not being shorted) there is an open circuit in the coil and the coil must be replaced.

Checking contact points (electrical)

Connect voltmeter to terminal 1 on the coil and ground. Turn engine until points in distributor are closed. The meter needle should move. When points are open, meter needle should not move. If the meter needle does not move when points are closed, the points are either dirty or burned.



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Checking condenser

The condenser reduces arcing when the points first open and prevents them from being burned prematurely.

A defective condenser causes badly burned points, a poor spark with starting difficulty or complete loss of ignition spark.

The condenser can be tested for short circuit with a test light:

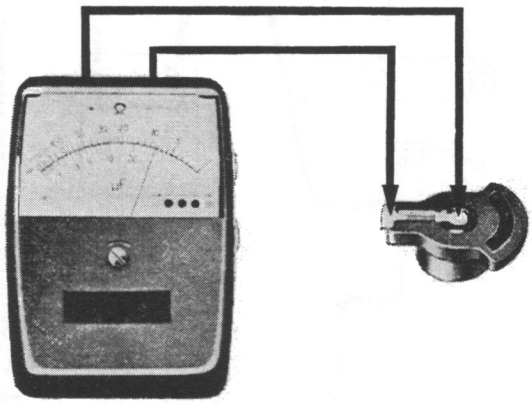
Pull off wiring to distributor at coil (terminal 1). Connect a test light between terminal 15 on the coil and the wiring (1) on the distributor. When the points are open and ignition switched on, the lamp should not light up. If it does light, there is a short in the condenser. There are condenser testers with which it is possible to test the insulation resistance, the capacity and the series resistance of a condenser. These testers should be used in accordance with the manufacturer's instructions.

Only condensers of the prescribed type should be used as replacements as condensers with different capacities will reduce the service life of the points (see Parts List.).

Checking suppression resistances

The resistance of the copper-cored cables is too low to conform to the radio interference suppression regulations in some countries. For this reason, suppression resistances are installed in the plug connectors and in the rotor. Further resistances in the cable connectors are often installed when a radio is being installed in the vehicle.

Failure of any of these resistances can cause misfiring.



1 - Check rotor with an ohmmeter.

The suppressed rotor has a moulded-in resistance which has a resistance value of up to 10 kΩ. If the resistance is higher, the rotor must be replaced.

2 - Check plug and distributor connectors with an ohmmeter.

The resistance of a plug connector or cable connector must not be more than 5—10 kΩ.

Trouble shooting

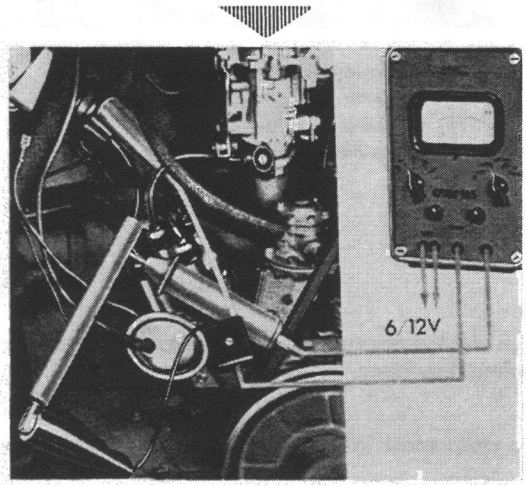
Checking coil

1 - Keep insulating cap clean and dry to avoid shorting and tracking.

2 - Check that the flat terminals fit tightly to prevent voltage drop.

3 - Check coil output with coil tester.

The test appliance should be connected as shown in illustration and operated in accordance with manufacturer's instructions.



Operation:

A resistance (1) is connected to the high tension side of the coil (terminal 4) and a constant impulse flow fed into the coil from the test appliance (2). The ignition voltage given by the coil under this load is measured and should within specifications.

4 - If such a test appliance is not available, the coil can be tested as follows:

Pull the high tension cable out of the center of the distributor cap (terminal 4) and hold it about .4 in. (10 mm) away from a suitable ground. It is advisable to use a pair of insulated pliers for this purpose. Then turn the engine over with the starter and see if a spark jumps from cable end to ground. If there is no spark, chech the voltage at terminal 15 on the coil with a voltmeter. There should be at least 9 volts at this point on a 12 volt system.

If the measured voltage is above this figure, check terminal 1 on coil (connection to distributor) with a voltmeter or test lamp. There should be no voltage reading at this terminal when the points are closed and a reading when they are open. Should there be no voltmeter reading even when points are open (distributor not being shorted) there is an open circuit in the coil and the coil must be replaced.

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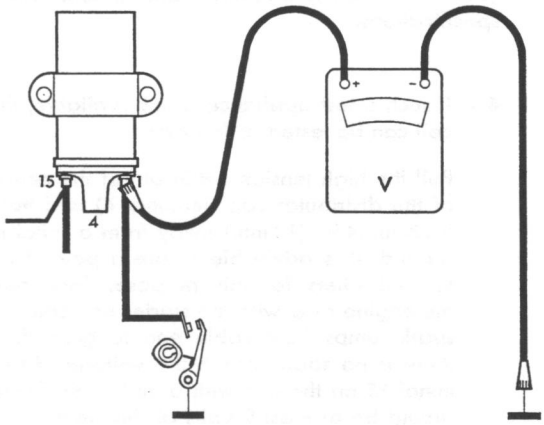
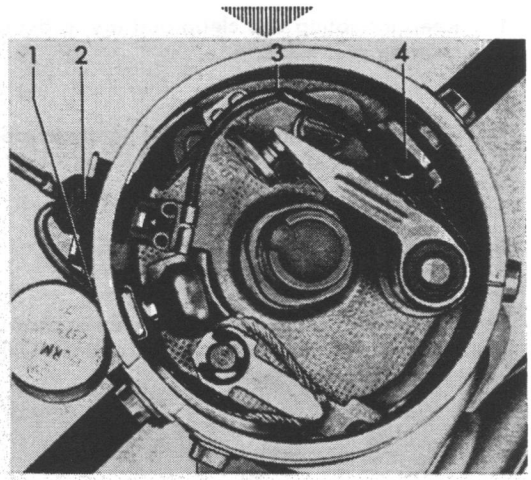
Checking contact breaker points (electrically)

Connect voltmeter to terminal 1 on the coil and ground. Turn engine until points in distributor are closed. The meter needle should move. When the points are open, the meter needle should not move.

If the meter needle does not move when points are closed, the points are either dirty or burned.



If the meter needle moves when the points are open, there is a short circuit in the distributor. Check the following points when this happens:



1 - Condenser
2 - Cable entry
3 - Cable
4 - Insulation on breaker arm spring

Checking condenser

The condenser plays an important part to reach the high voltage necessary for the ignition system. It also reduces arcing and premature burning of the points when they open.

A defective condenser causes badly burned points, a poor spark with starting difficulty or complete loss of ignition spark.

Defective condensers are extremely rare.

The condenser can be tested for short circuit with a test lamp:

Pull cable 1 to distributor off at coil. Connect a test lamp between terminal 15 on the coil and cable 1 on the distributor. When the points are open and the ignition is switched on, the lamp should not light up. If it does light, there is a short in the condenser.

There are condenser testers that test the insulation resistance, the capacity and the series resistance of a condenser. These testers should be used in accordance with the manufacturer's instructions.

Only condensers of the prescribed type should be used as replacements. Condensers with different capacities will reduce the service life of the points (see Parts List.).

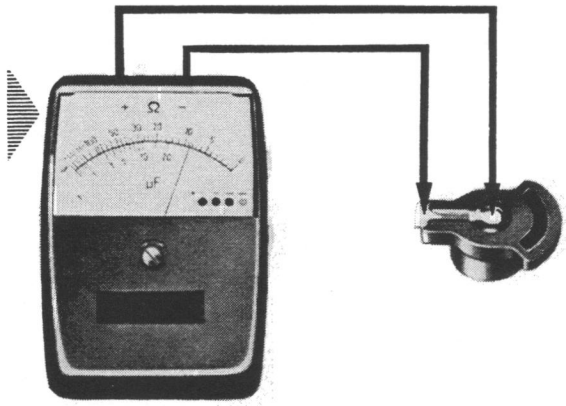
Checking suppression resistances

The resistance of the copper-cored cables is too low to conform to the radio interference suppression regulations in some countries. For this reason, suppression resistors are fitted in the plug connectors and in the rotor. In addition, there are resistors needed when a radio is installed.

Failure of any of these resistors can cause misfiring.

1 - Check rotor with an ohmmeter.

The suppressed rotor has a moulded-in resistor which has a resistance value of up to 10 kΩ. If the resistance is higher, the rotor must be replaced.



2 - Check plug and distributor connectors with an ohmmeter.

The resistance of a plug connector or cable connector must not be more than 5—10 kΩ.

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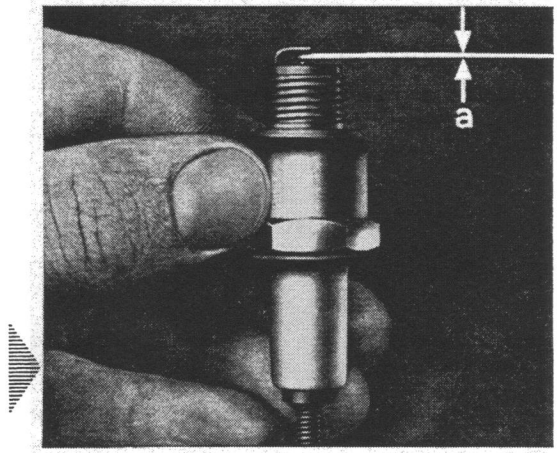
Checking ignition parts

Checking spark plugs

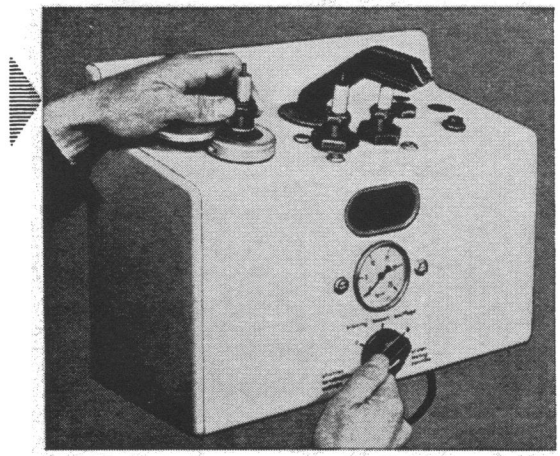
When in operation, the plug electrode gap tends to increase due to natural burning. When the gap becomes too large, the plug will start to misfire. Furthermore, dirty plugs can cause ignition and starting difficulties.



The gap is checked with a spark plug gauge and adjusted to the correct gap "a" by bending the ground electrode.

"a" = .028 in. (0.7 mm)

With a spark plug tester the plugs can be tested under a pressure of 85—114 psi (6—8 kg/cm²). The sparking can be seen through an inspection hole. The same tester can be used to clean the plugs. Older testers work on a sandblast principle while modern appliances use a special cleaning agent.



Plugs should always be cleaned with such an appliance. Steel wire brushes and other tools are unsuitable for this purpose.

Checking distributor on a test stand

On a distributor test stand, the cam offset, the vacuum advance, the centrifugal advance and the dwell angle can be checked. There are various types of test stand on the market, but they all have the following equipment in common:

Variable speed motor, tachometer, vacuum pump and a vacuum measuring gauge which must have a range of 0—100 mm Hg for distributors installed on VW engines.

The recommended test sequence is as follows:

1 - Clamp distributor in position and ensure that it runs smoothly.

2 - Check the dwell angle (see M 3.3/1-2). It may be necessary to adjust the contact gap and thus the dwell angle.

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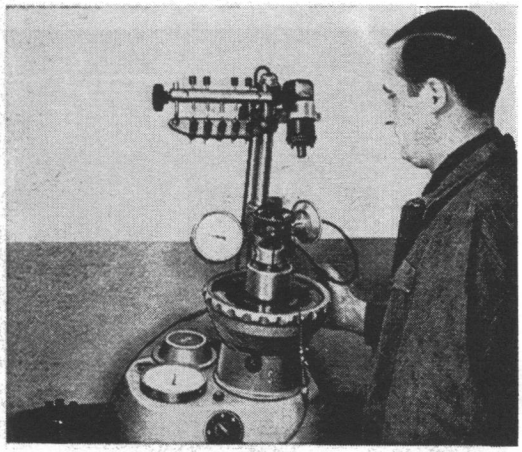
3 - Set speed to 500 rpm and note that at this speed the centrifugal advance mechanism has not started operating.



4 - Connect hose between vacuum pump and vacuum unit on distributor. Generate full vacuum with pump.

5 - Check vacuum unit for leakage. A vacuum of 100 mm Hg should remain constant for about 1 minute with vacuum line sealed.

6 - With a falling vacuum, measure the vacuum advance. Check the vacuum to vacuum unit at as many points as possible and read off the actual advance figures obtained on the test stand scale. The values must be inside the shaded area of the advance curves. If they are outside this area, repeat the test with a new vacuum unit.

7 - Run off the speed sensitive advance curves on the test stand. These values must also be within the shaded area.

No.	Description	Special tool	Remarks
1	Extractor for starter bushing	VW 228 b	

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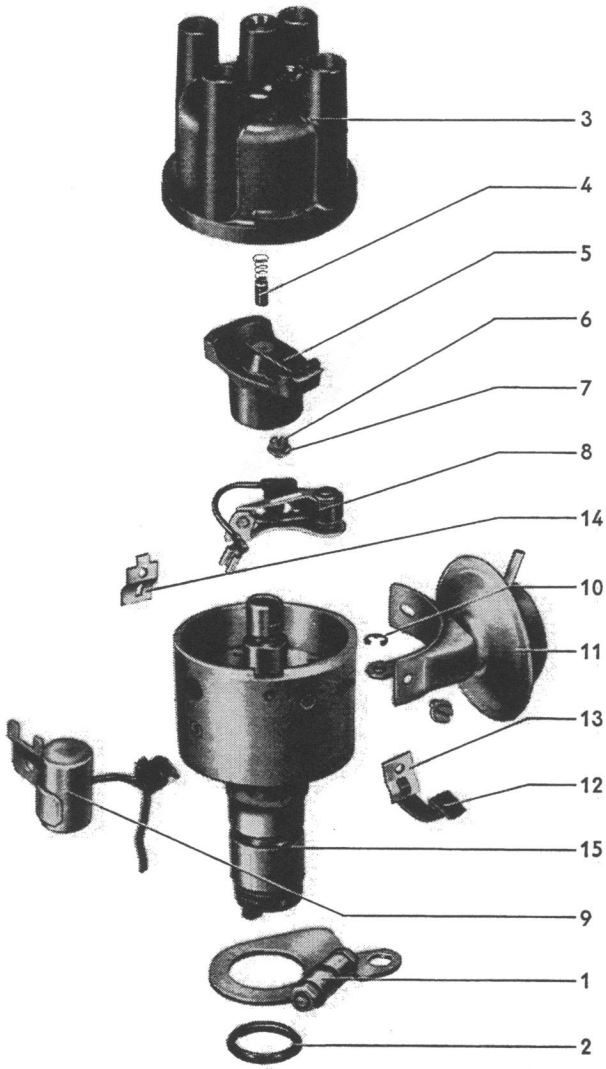

3.4 1-2 **Disassembling and assembling distributor**

No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Clamp	1			
2	Rubber sealing ring	1		replace	
3	Distributor cap	1		check for cracks, tracking and condition of carbon brush	
4	Carbon brush and spring	1		check correct position	
5	Rotor	1			
6	Screw	2			
7	Washer	1			
8	Contact points	1	disconnect wire remove screw	make sure that the contact points are clean and correctly adjusted. Lubricate contact pivot with one drop of oil; Lubricate cam and fiber block with multi-purpose grease.	3.3/2 3.3/1
9	Condenser	1			3.3/3
10	Clip for pull rod	1			
11	Vacuum unit	1		check for leakage	
12	Retaining clip	2			
13	Tab for retaining clip	2			
14	Tab with boss for retaining clip	2		install near cut-out in distributor body	
15	Distributor body	1		if radial play between shaft and housing is excessive, replace shaft or complete distributor.	3.4/1

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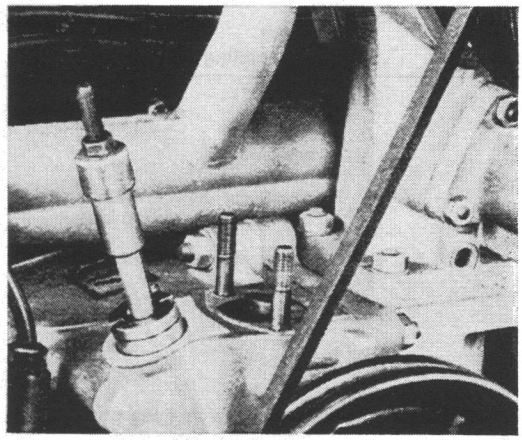
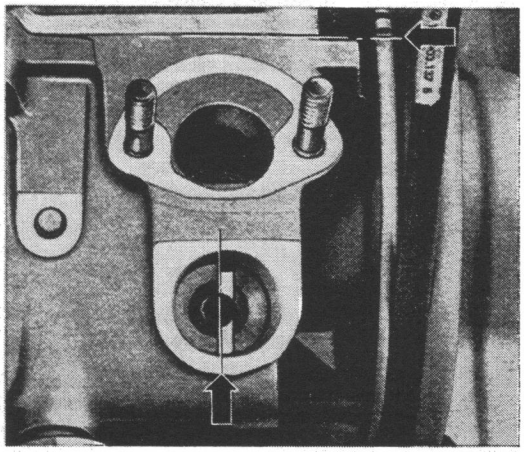




Removing and installing distributor drive shaft

1 - Withdraw drive shaft with removal tool turning shaft to left as it comes out.

2 - Remove washer under drive shaft. **Be careful not to drop it into the engine.** For removal use a magnet. If the engine is on an engine stand, turn the engine to let the washer fall out.

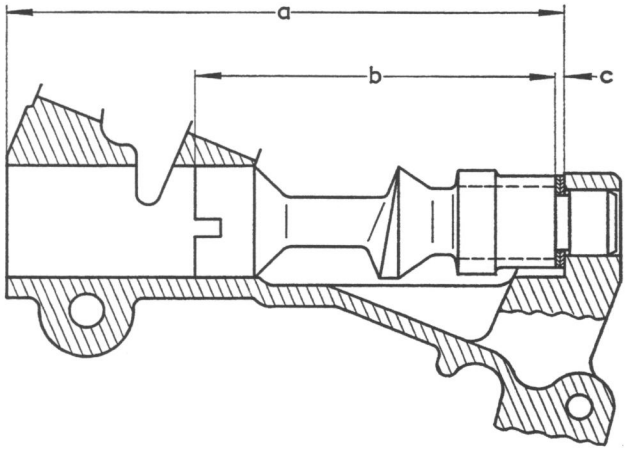
3 - Insert drive shaft.

The smaller segment must face the pulley.

Note

Due to various modifications in production and reworking of the bore for the distributor drive shaft during unit reconditioning, several combinations between crankcases, distributor drive shafts and shims have resulted.

The correct pairing of parts is of importance especially for the assembly of short block engines that are supplied without distributor drive shafts and shims. Details are given in the following table:

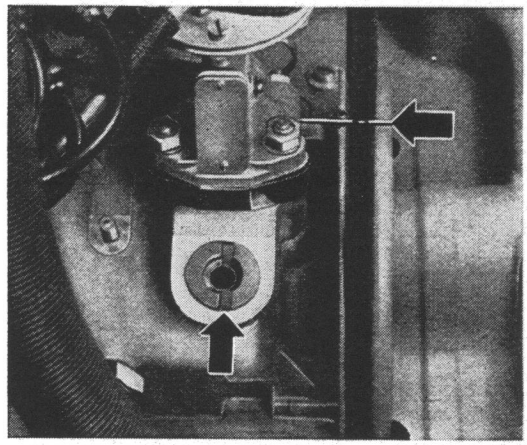


a - Depth of bore for the distributor drive shaft in mm (in.)		126.1 (4.964)	126.8 (4.991)	131.1 (5.157)		133.5 (5.255)
b - Length of distributor drive shaft up to shoulder in mm (in.)		80.3 (3.16)	80.3 (3.16)	80.3 (3.16)	85.3 (3.357)	85.3 (3.357)
c - Thickness of shims in mm (in.)	upper	0.6 (0.023)	0.6 (0.023)	6.3 (0.248)	0.6 (0.023)	0.6 (0.023)
	lower	0.6 (0.023)	1.25 (0.049)	—	0.6 (0.023)	3.0 (0.118)

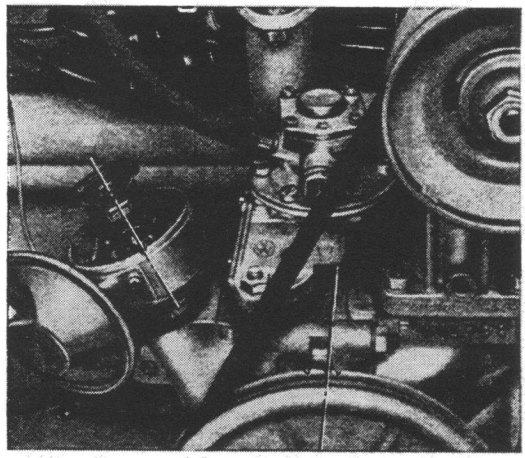
Installing distributor

1 - Set No. 1 cylinder to firing point.

The offset slot in the distributor drive shaft must be **at a right angle** to the crankcase joint. The smaller segment must face the pulley.



2 - Turn rotor in distributor until it is pointing to the No. 1 cylinder mark on distributor housing.



3 - Insert distributor.

4 - Set timing.

Note

From August 1970 rubber sealing caps were installed on the plug connectors, coil and distributor due to the absence of the water drain plate in the engine compartment lid.

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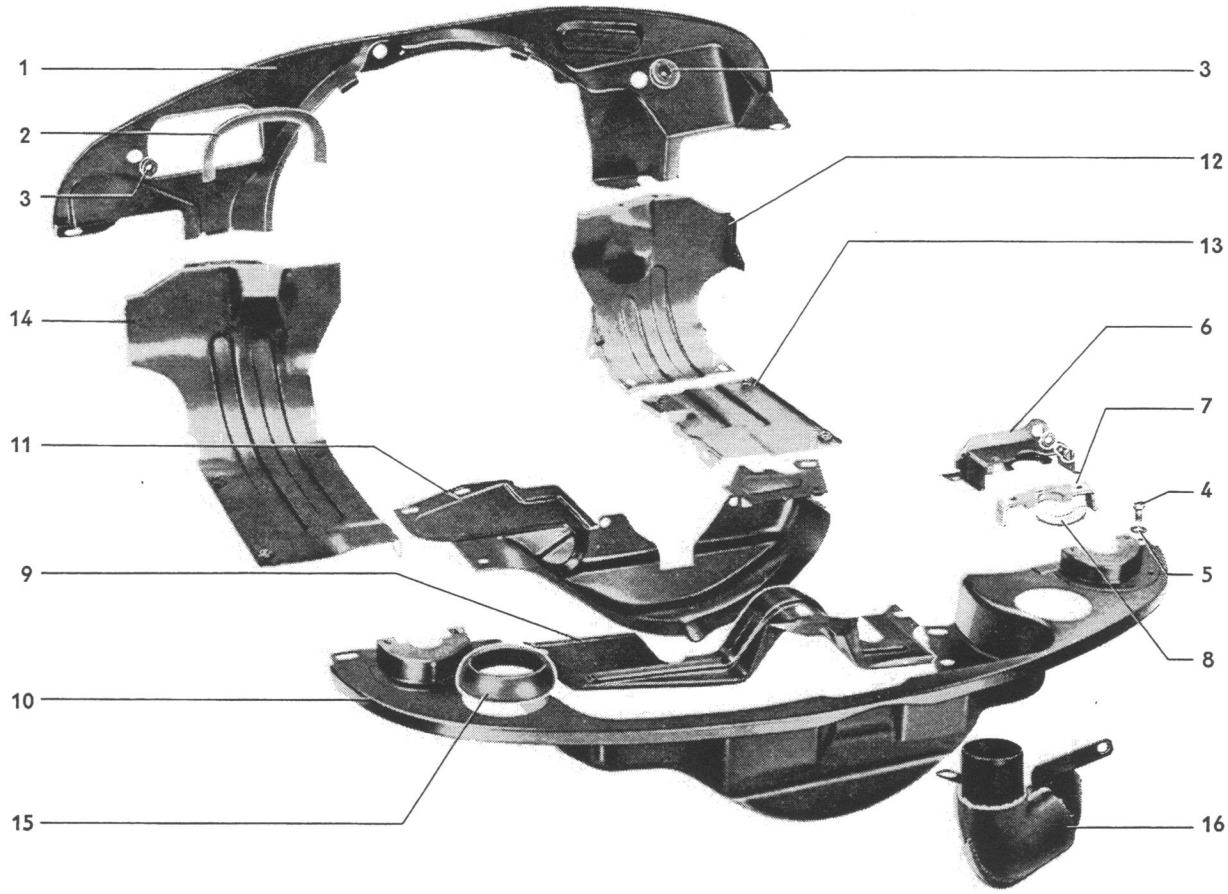

No.	Description	Qty.	Note when removing	Note when installing	Special instructions see
1	Cover plate, front	1			
2	Rubber seal	1			
3	Cable grommet	2			
4	Screw M 6×10	14			
5	Washer	14			
6	Pre-heating pipe protection plate	2	right and left differ		
7	Half-round gasket, front	2		when damaged, replace	
8	Half-round gasket, rear	2		when damaged, replace	
9	Crankshaft pulley cover plate	1			only up to July 1972
10	Cover plate, rear	1			
11	Cover plate below pulley	1			
12	Warm air duct lower part, right	1			
13	Warm air duct lower part rear, right	1			
14	Warm air duct lower part, left	1			
15	Grommet for heater hose	2			
16	Elbow	1			

Carburetor preheating chart

Type	Special characteristics
1/1500, 1600 1/Automatic Stick Shift 2/1600	Warm air taken from below the right cylinder head (thermostatically controlled flap)
3/1600	Warm air taken from right heat exchanger (weight balanced flap)

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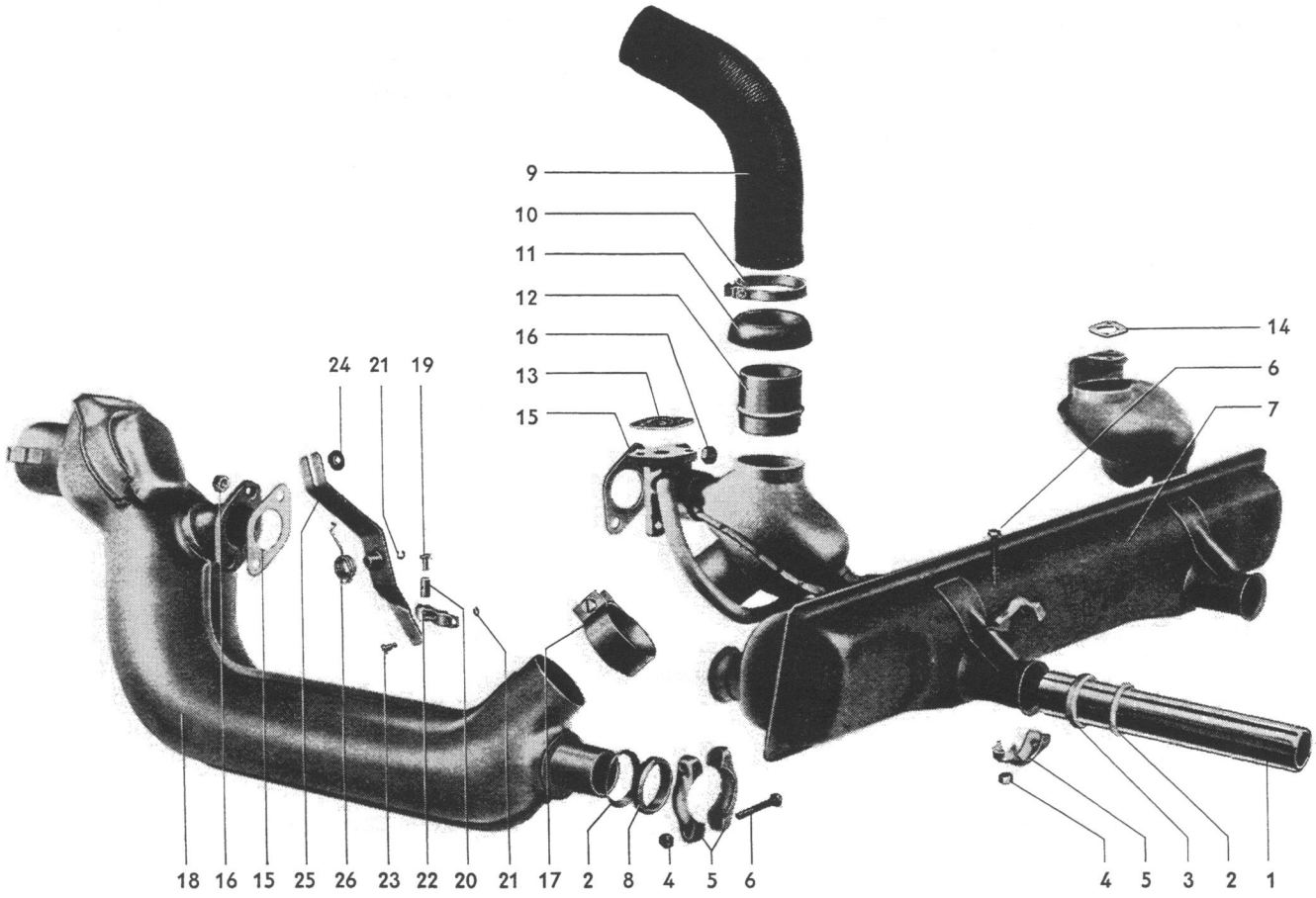

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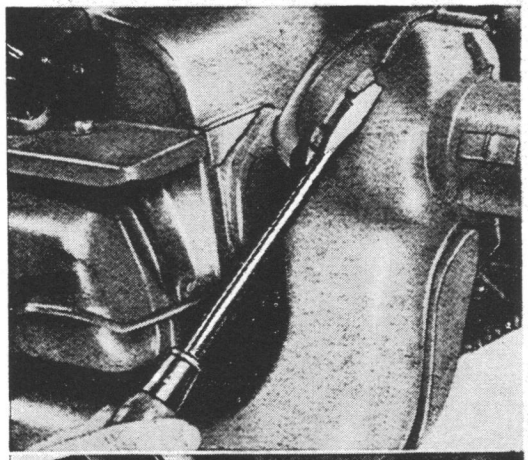
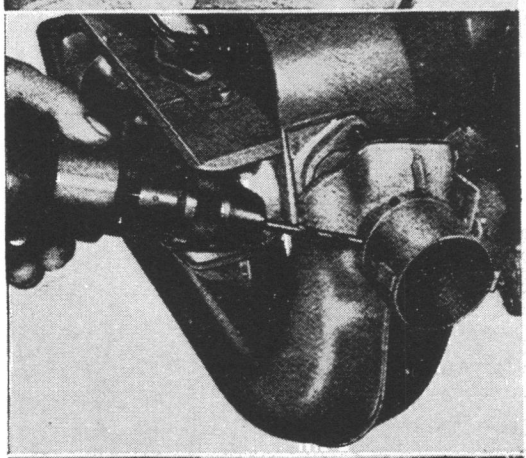
No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Tail pipe	2		note insertion depth	M 4.2/2
2	Retaining ring, 35 mm dia.	4			
3	Seal, 35 mm dia.	2		replace	
4	Nut M 6 self locking	8			
5	Clamp	8			
6	Bolt M 6×43	8			
7	Muffler	1	check for leaks and damage		
8	Seal, 35 mm dia, for heat exchanger	2	marked white	replace	
9	Heater hose	2	left and right differ		
10	Hose clamp, 9 mm wide	4			
11	Heater hose grommet	2			
12	Connecting pipe	2			
13	Preheating pipe gasket (left)	1	interchangeable	replace	
14	Preheating pipe gasket (right)	1	interchangeable	replace	
16	Nut M 8 self blocking gasket	8		replace	
16	M 8 nut, selflocking	8		torque to 2.2 mkg (16 ft. lb.)	
17	Clamp, 25 mm wide	2			
18	Heat exchanger	2	left and right differ; check for damage; check heater flap for freeness		M 4.2/2
19	Bolt M 5×10	2			
20	Pin	2			
21	C-clip	4			
22	Link	2			
23	Pin	2			
24	Clip	2			
25	Heater flap lever	2	left and right differ		
26	Return spring	2	left and right differ		

Removing

1 - Bend up edges of cover plate for warm air opening and take plate off.

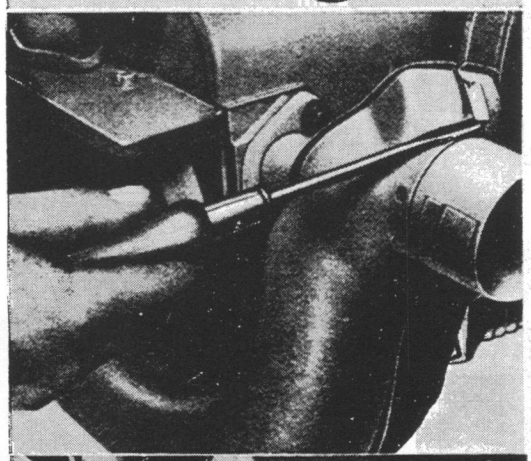


2 - Drill out spot welds that secure outlet pipe to heat exchanger casing with a 6 mm ($^1/_4$ in.) diameter drill.



3 - Bend up lip that holds heat exchanger casing together.

4 - Bend casing apart slightly and remove outlet pipe.



Installing

1 - If necessary, rework heater flap shaft hole in casing and cover plate.

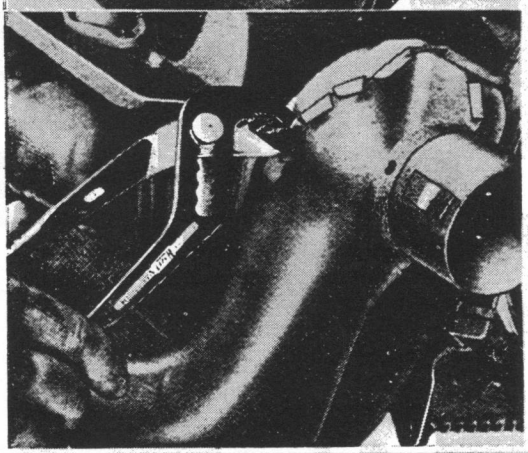
2 - Install new outlet pipe and bend back lip of casing.

3 - Install cover plate and press edges together.

4 - Tack weld outlet pipes to heat exchanger casing. Heater flaps should be opened when doing this.

5 - Check flaps for freeness.

6 - Paint new outlet pipes with cold zinc paint.



Removing and installing flap of heat exchanger **4.2** 2-1

Exhaust muffler with preheating tube in tailpipe mounting (for California only up to July 1973)

Installing

When installing the tailpipes in the muffler, it is essential to make sure that they are inserted to the correct depth.

If the tailpipes are inserted too far into the muffler there is a risk that high back pressure will be set up in the muffler and cause engine damage due to overheating.

The depth of insertion depends on the preheating pipe of the muffler (arrow).

Preheating tube, left:

first adjust the left tailpipe (see table) and than the right one accordingly.

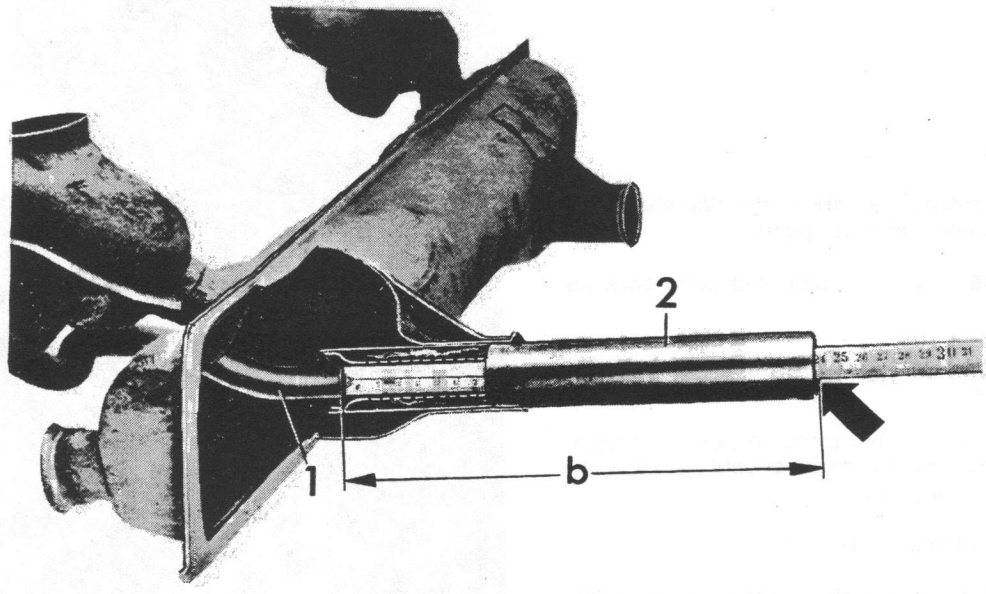
Preheating tube, right:

first adjust the right tailpipe (see table) and than the left one accordingly.

Length of tailpipe in mm (in.)	Dimension "b" in mm (in.)
276 ($10^{7}/_{8}$)	270 ($10^{5}/_{8}$)
249 ($9^{13}/_{16}$)	243 ($9^{9}/_{16}$)
226 ($8^{29}/_{32}$)	220 ($8^{21}/_{32}$)

Adjust dimension "b" as follows:

Insert ruler into the tailpipe (2) so that it rests against the preheating tube (1). Then move tailpipe until the dimension "b" (see table) is obtained.



No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Pulley securing bolt	1		torque to 4.5 mkg (32.5 ft. lb.)	
2	Dished washer	1		concave side faces crankshaft	
3	Crankshaft pulley	1	pull off with VW 203 b/d	check seating and belt surfaces, clean oil return thread and oil, check for run-out	Fig. 1
4	Pulley nut	1		torque to 6 mkg (43 ft. lb.)	
5	Special washer	1			
6	Pulley half, rear	1			
7	Spacer washer	8			
8	V-belt	1	check for wear	adjust tension	M 4.3/2
9	Pulley half, front	1			
10	Woodruff key	2			
11	Generator	1			
12	Nut M 8, galvanized	1			
13	Strap	1			
14	Bolt M 8×25, galvanized	1			
15	Bolt M 6×10	4			
16	Lock washer	4			
17	Fan cover, outer	1			
18	Reinforcement flange	1			
19	Fan cover, inner	1		note installation position	M 4.3/3
20	Lock washer	2			
21	Nut M 6	2			
22	Fan hub	1			
23	Shim	3			
24	Fan	1	check for loose vanes (5 mm wider vanes, from August 1970)	gap between housing approx. 1.8 mm (0.07 in.)	M 4.3/3
25	Lock washer	1			
26	Special nut	1		torque to 6 mkg (43 ft. lb.)	
27	Fan housing	1	check for damage and loose plates		M 4.3/3
28	Washer, galvanized	2			
29	Screw M 6×10	2			
30	Return spring	1			
31	Spring	4			
32	Washer	8			
33	Cooling air regulator, left	1			
34	Cooling air regulator, right	1			
35	Cooling air regulator connecting rod	1			
36	Washer	8			

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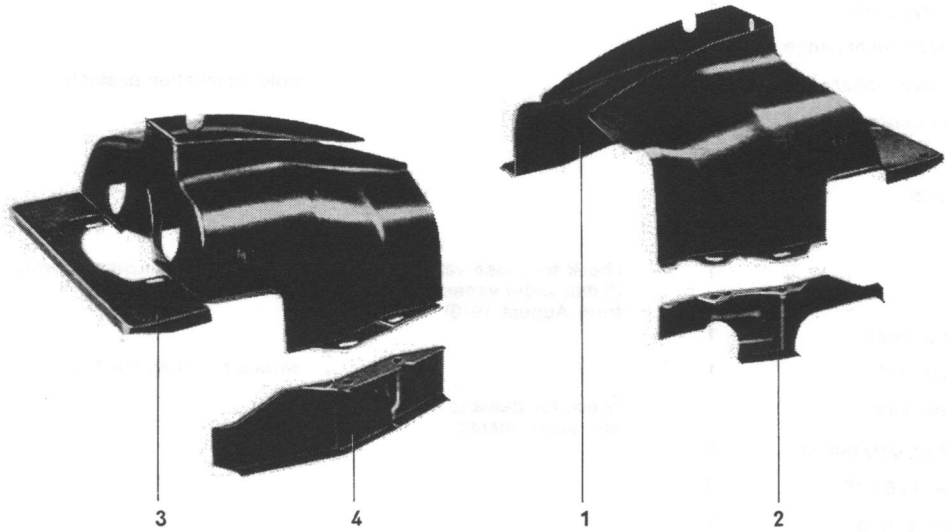
No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
37	Screw M 6×12	8			
38	Lock washer	1			
39	Washer	1			
40	Connecting rod	1			
41	Thermostat bracket	1		adjust	M 4.3/3
42	Thermostat	1		check in water	M 4.3/3
43	Lock washer	1			
44	Bolt M 8×15	1			
45	Lock washer	6	from August 1970		
46	Washer	6			
47	Regulating link	2			
48	Connecting rod for cooling air regulator	1			
49	Air deflector for oil cooler	1			
50	Moulded seal	1			
51	Air duct for oil cooler	1			



No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Cylinder cover plate, right	1			
2	Deflector plate, right	1			
3	Cylinder cover plate, left	1			
4	Deflector plate, left	1			

Checking

1 - Place holding bar on V-belt (see illustration).

2 - Place tension tester on top of the V-belt above the contact tongue of the holding bar.

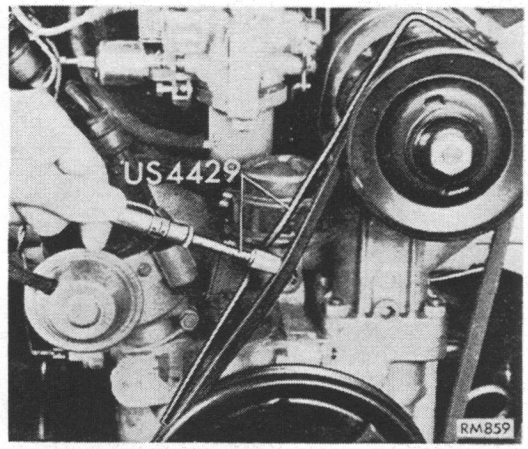
3 - Apply force on tension tester until the inside of the V-belt is flush with the contact tongue.

4 - Read deflection force on tension tester.

The recommended deflection force is:

a) for newly installed belts = 12—14 lbs

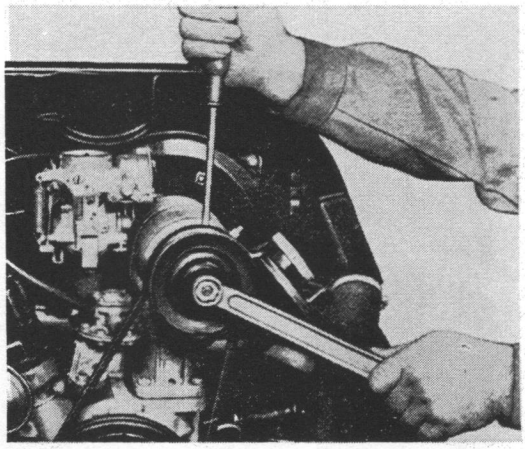
b) for used belts = 8—10 lbs
(after running more than 30 minutes).



Length of belt in mm		Remarks
	900	standard
from August 1970	900 or 905	Designated DA and XDA (low stretch)

Adjusting

1 - Remove nut from generator shaft pulley.

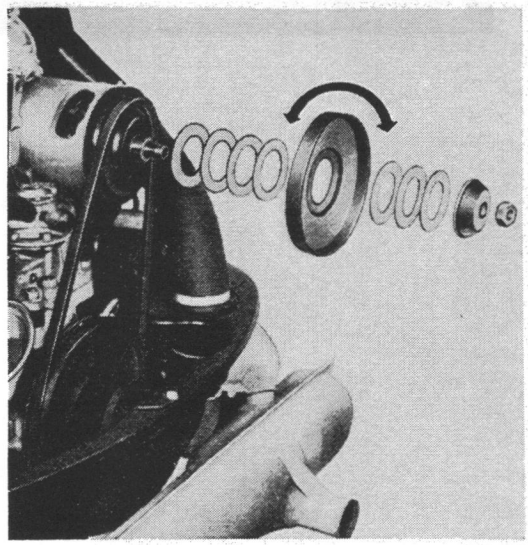


2 - Arrange spacer washers as required to correct belt tension.

The tension of the belt is adjusted by varying the number of washers between the pulley halves.

Adding washers loosens the belt tension and removing them tightens it.

3 - All the spacer washers not installed between the pulley halves should be installed between the rear pulley half and the nut so that all spacer washers are retained on pulley hub.



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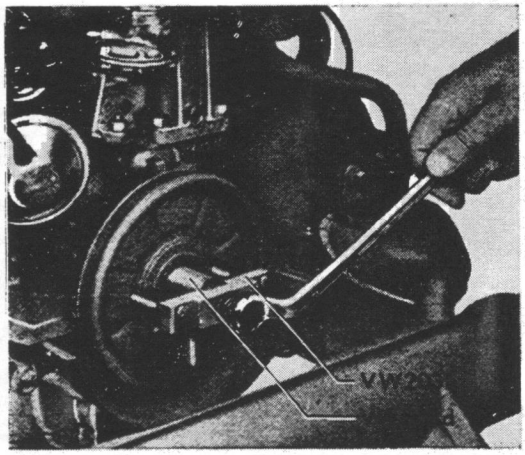
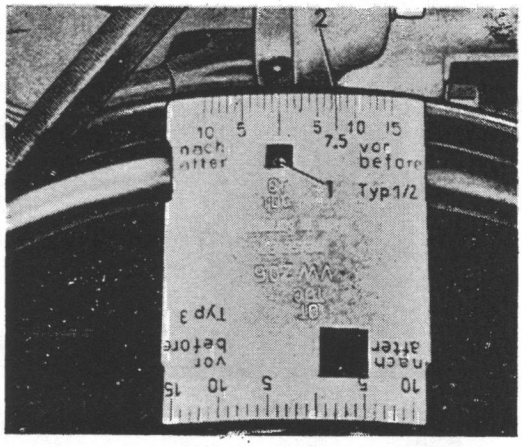


Removing crankshaft pulley

Marking ignition timing notch

From October 1971 the replacement crankshaft pulley has only the TDC mark.

The ignition timing mark must be made when the pulley is installed, using a template and a three-cornered file.



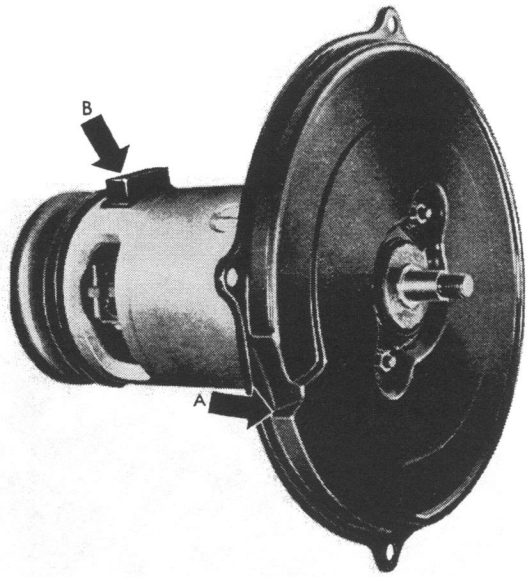
1 - Place template on pulley and align square hole with the TDC mark (1).

2 - Make the timing mark with the aid of the template (2).

3 - Paint notch white.

Installing

1 - Assemble generator (105 mm dia.) and fan covers so that the cooling air slots of the inner cover face downward on installation in fan housing (arrow "A").

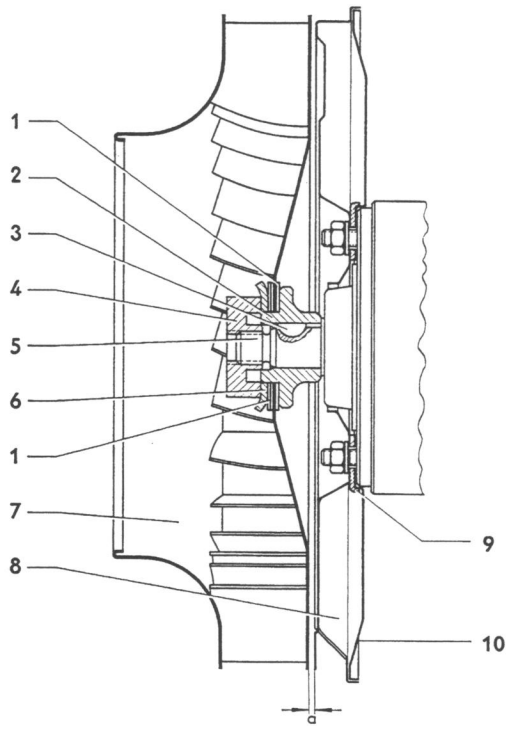


A - Cooling air slots

B - Connections

2 - Check distance of fan to cover (a = 1.8 mm/ 0.07 in.). This distance is achieved by inserting spacer washers between hub and fan. Surplus washers should be installed between dished washer and fan.

a = about 1.8 mm (0.07 in.)



1 - Spacer washers

2 - Hub

3 - Woodruff key

4 - Special nut

5 - Generator shaft

6 - Dished washer

7 - Fan

8 - Fan cover, inner

9 - Reinforcement flange

10 - Fan cover, outer

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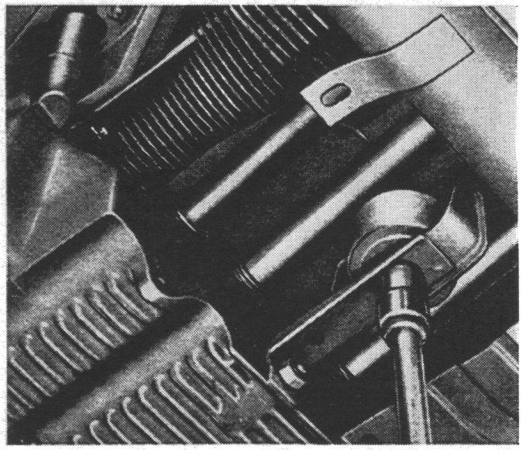


Removing

1 - Remove rear, right warm air duct lower part.

2 - Remove thermostat from bracket and disconnect from connecting rod.

3 - From August 1970.
Take off oil cooler duct and connecting rod for cooling air regulation.

4 - Remove fan housing.

Note

The fan housing can also be removed with the engine installed, after the rear hood has been removed.

Installing

1 - Check fan housing for damage and loose air deflector plates.

2 - Insert thermostat connecting rod into hole in cylinder head and lower fan housing.

3 - Fan housing must fit properly on cylinder cover plates to prevent loss of cooling air. If necessary, cover plates must be bent slightly.

4 - Adjust throttle flaps.

Adjusting

1 - Screw thermostat onto connecting rod.

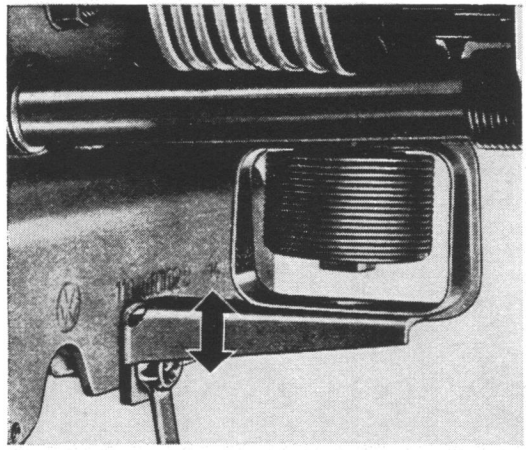
2 - Loosen nut securing thermostat bracket.

3 - Push thermostat upward so that flaps are in open position.

4 - Move thermostat bracket so that thermostat contacts bracket at upper stop (arrow).

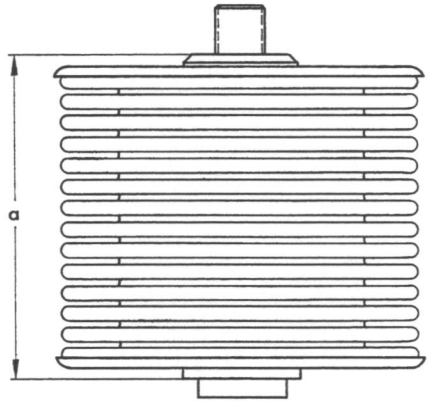
5 - Check operation of flaps by moving thermostat up and down.

6 - Secure thermostat to bracket.



Checking thermostat

At a temperature of 65—70° C (149—158° F) in water, the length of the unit should be at least "a" = 46 mm ($1^{13}/_{16}$ in.).



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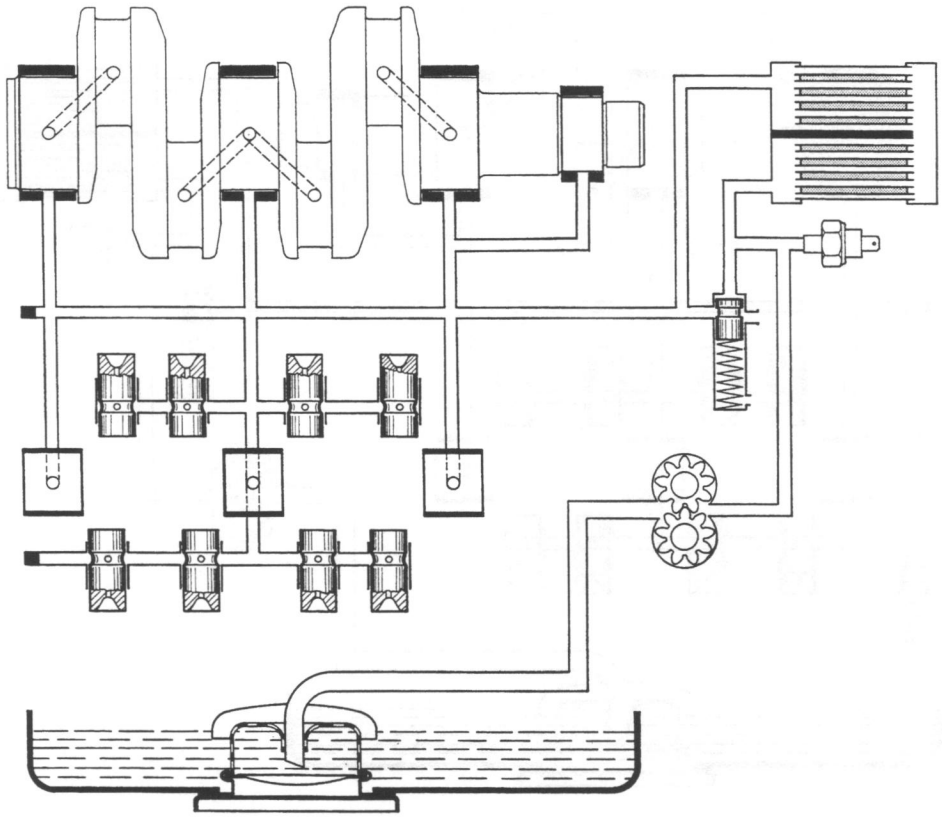
up to July 1969



The oil pump draws oil from the crankcase through the oil strainer and pumps it through the oil cooler into the passages in the crankcase. Part of the oil passes to the main bearings and from there through drillings in the crankshaft to the connecting rod journals. A further part of the oil flows to the camshaft bearings. The remainder of the oil passes through the hollow push rods into the drillings in the rocker arms and lubricates these bearings. Splash oil and oil mist lubricates the valve stems and then flows through the push rod tubes into the crankcase. Cylinder walls, pistons and piston pins are lubricated by splash. The oil drains down to the bottom of the crankcase from all points and is picked up by the pump to be recirculated.

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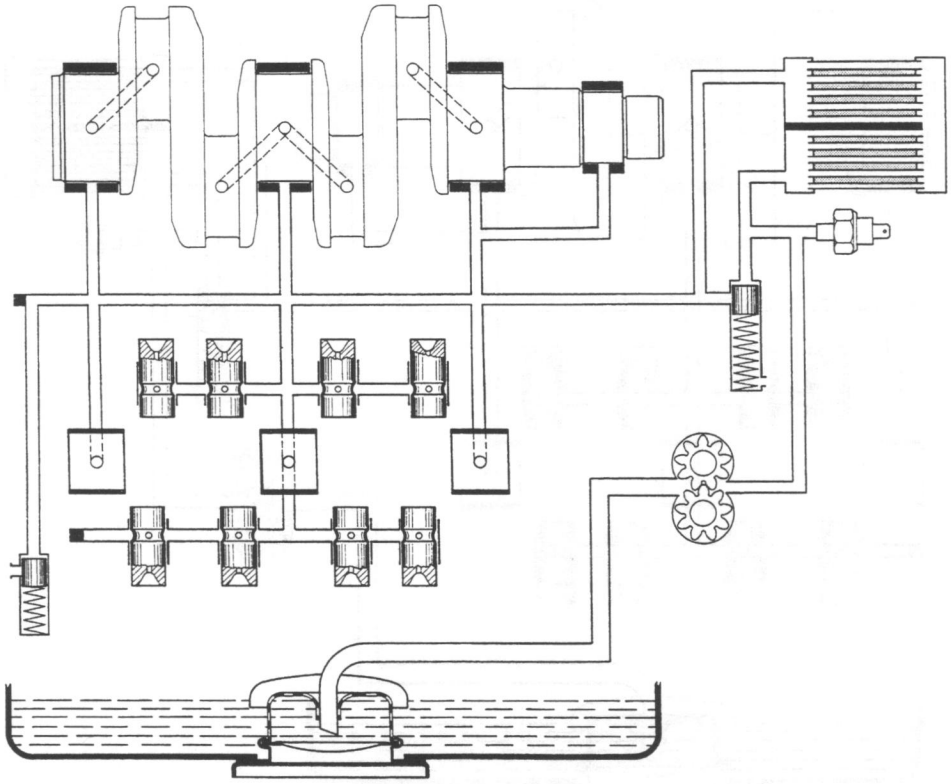
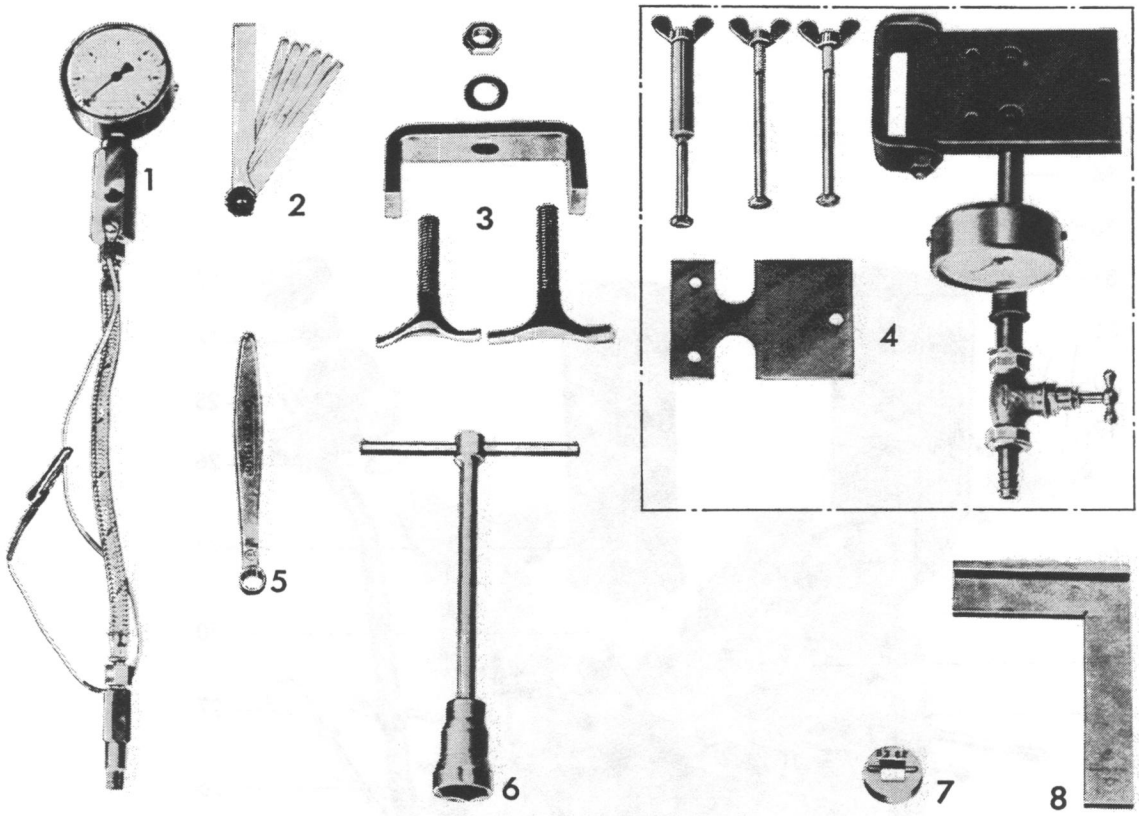
from August 1969



From August 1969, the engine oil system was modified by installing an oil pressure control valve behind the main bearings. This keeps the pressure at the main bearings constant.



No.	Description	Special tool	Special instructions see
1	Oil pressure gauge, or similar	VW 662/2	
2	Feeler gauge		
3	Oil pump extractor	VW 201	
4	Oil cooler testing device	VW 661/2	
5	Box wrench, 10 mm	VW 109	
6	Oil pressure switch wrench	VW 159	
7	Socket, oil filler retaining ring	VW 170	
8	Steel square		

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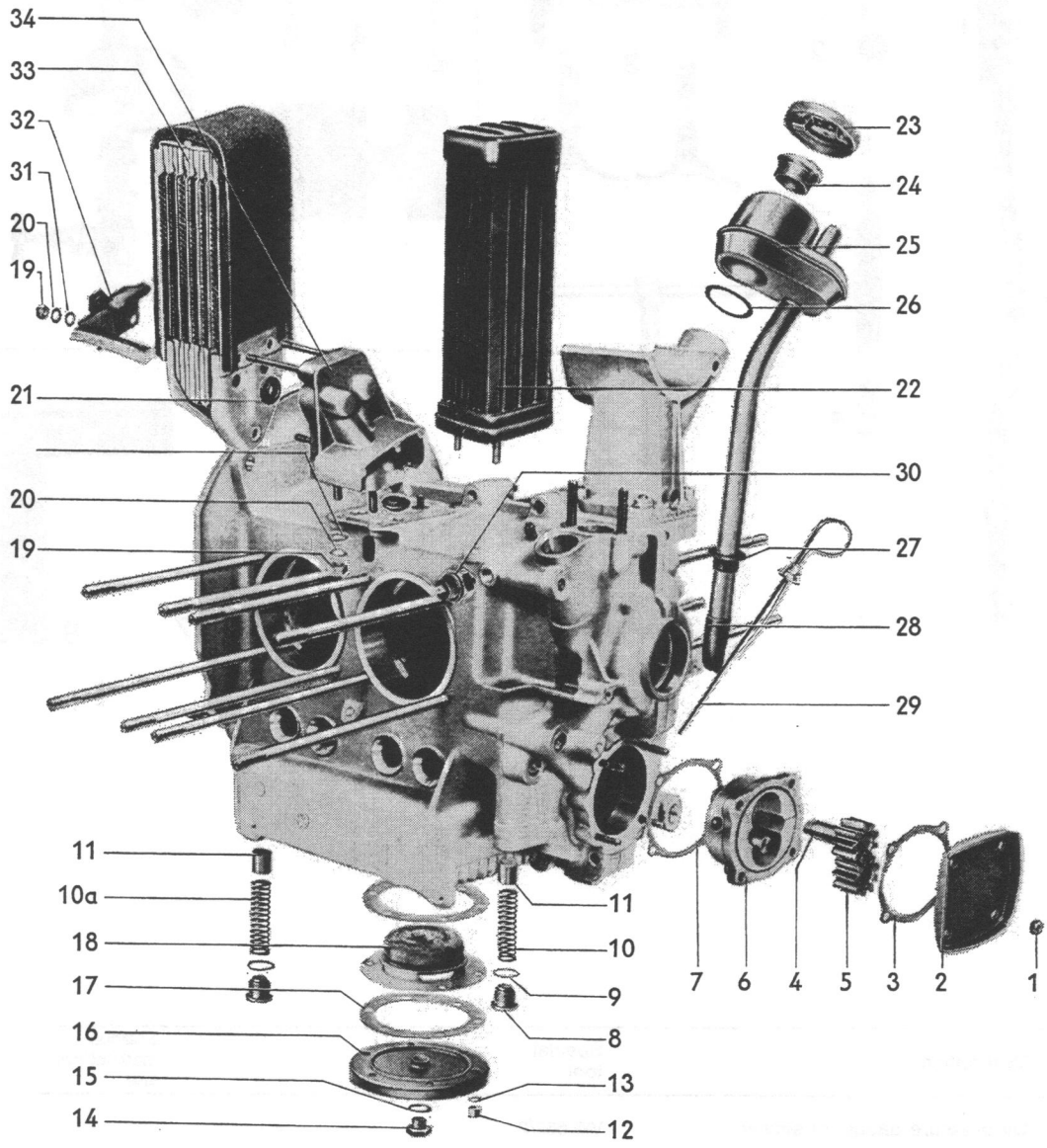
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No.	Description	Qty.	Note when removing	Note when installing	Special instructions see
1	Sealing nut M 8	4		seal foces inward; tighten to 2 mkg (14 lb. ft.)	
2	Oil pump cover	1		If cover surface is scored, replace cover or grind. Note alignment of oil pump housing	
3	Oil pump cover gasket	1		replace	
4	Drive shaft	1		check for wear, axial play: max. 0.1 mm (0.004 in.) without gasket	M 5.1/3-1 Fig. 2
5	Oil pump gear	1		check for wear, backlash 0,0—0,2 mm (0.0—0.008 in.)	M 5.1/3-1
6	Oil pump housing	1	pull out with VW 201	check for wear, align to crankcase by turning the crankcase approx. 2 times	M 5.1/3-1 Fig. 1
7	Oil pump housing gasket	1		replace	
8	Plug M 18×1.5	2			
9	Seal	2		replace	
10	Spring for oil pressure relief valve	1		check for tension, length under load of: 5,6—7,3 kg = 44,1 mm (12.3—16.0 lbs. = 1.73 in.)	
10a	Spring for oil pressure control valve	1		check for tension, length under load of: 3,1—3,8 kg = 20,2 mm (6.8—8.4 lbs. = 0.795 in.)	
11	Piston for oil pressure relief and control valve	2		check for wear	
12	Cap nut M 6	6			
13	Seal	6		replace	
14	Oil drain plug	1	discontinued from August 1972	tighten to 3.5 mkg (25 lb. ft.)	
15	Seal	1	discontinued from August 1972	replace	
16	Oil strainer cover	1	from August 1972 without drain plug	sealing surface must be flat	
17	Gasket	2		replace	
18	Oil strainer	1		clean	
19	Nut M 6	3			
20	Spring washer	3			
21	Oil cooler seal	2		replace	

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No.	Description	Qty.	Note when removing	Note when installing	Special instructions see
22	Oil cooler	1	on installed engines remove and install with box wrench VW 109; check for damage and leaks with VW 661/3 at a pressure of 6 kg/cm² (85 psi)		Fig. 3 Fig. 5
23	Oil filler neck cap	1			
24	Retaining nut for breather	1	use socket VW 170	tighten to 5.5 mkg (40 ft. lbs.)	Fig. 6
25	Oil filler and breather	1	from August 1972 the breather pipe and the breather rubber valve have been discontinued		
26	Seal	1		replace	
27	Grommet	1			
28	Breather rubber valve	1		check for damage, button must engage	
29	Dipstick	1			
30	Oil pressure switch	1		tighten to 1 mkg (7 lb. ft.)	M 5.1/4-1
31	Washer	6			
32	Sealing frame	1			
33	Oil cooler	1	from August 1970 instructions as under No. 22		Fig. 4 Fig. 5
34	Mounting flange	1			

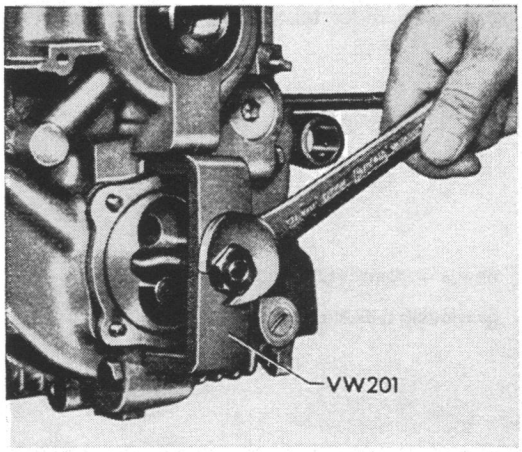

Fig. 1

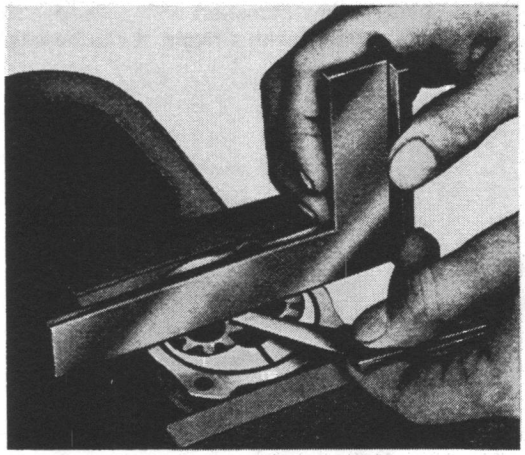

Fig. 2

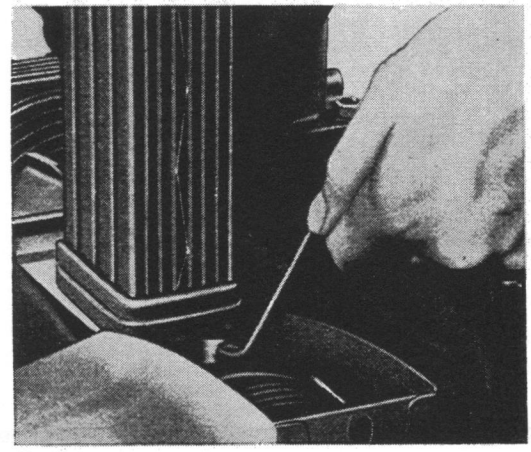

Fig. 3

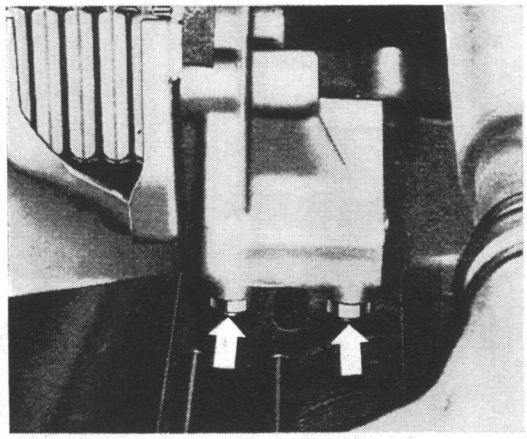

Fig. 4

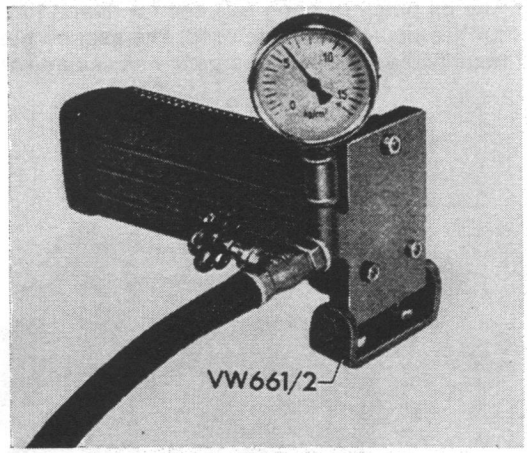

Fig. 5

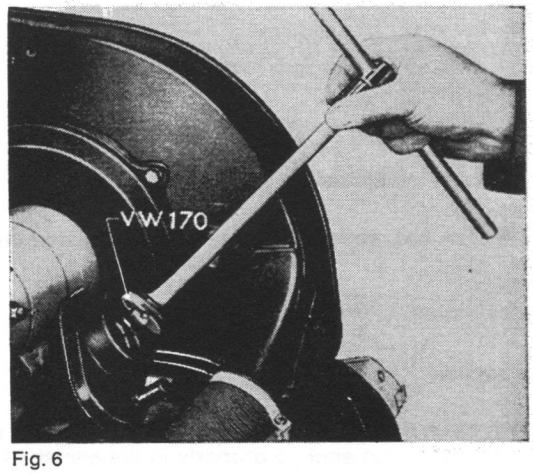

Fig. 6

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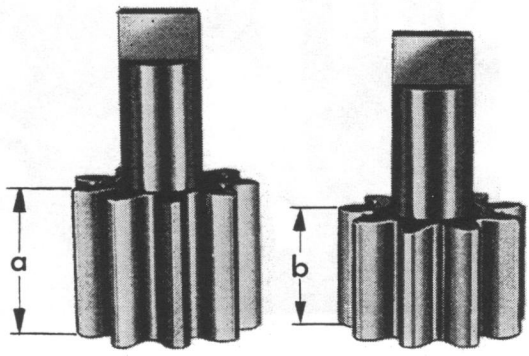
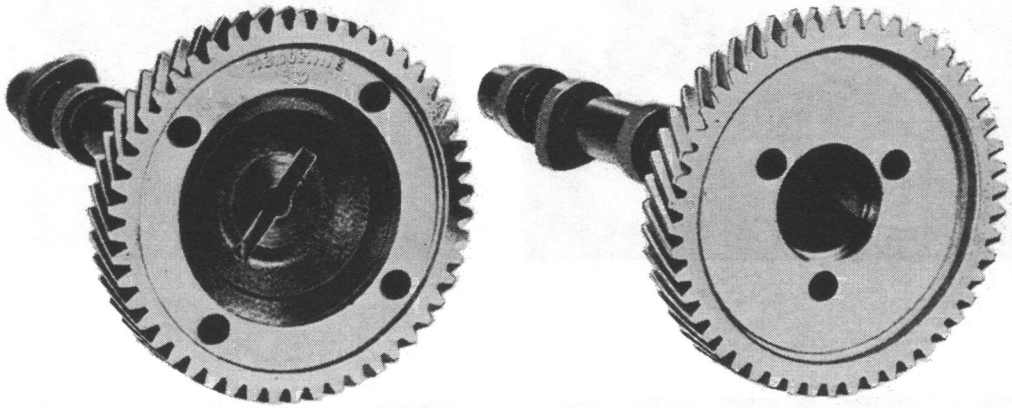
To increase the delivery capacity of the oilpump, gears with wider teeth were installed from April 1971.



new a = 26 mm (1.023 in.)

previously b = 21 mm (0.827 in.)

The oil pump housing has been widened to suit the new gears. A new camshaft with a deeper slot for the oil pump drive is used. The gear on the new camshaft is secured with 4 rivets. It can be easily identified as the previous gear was secured with 3 rivets.



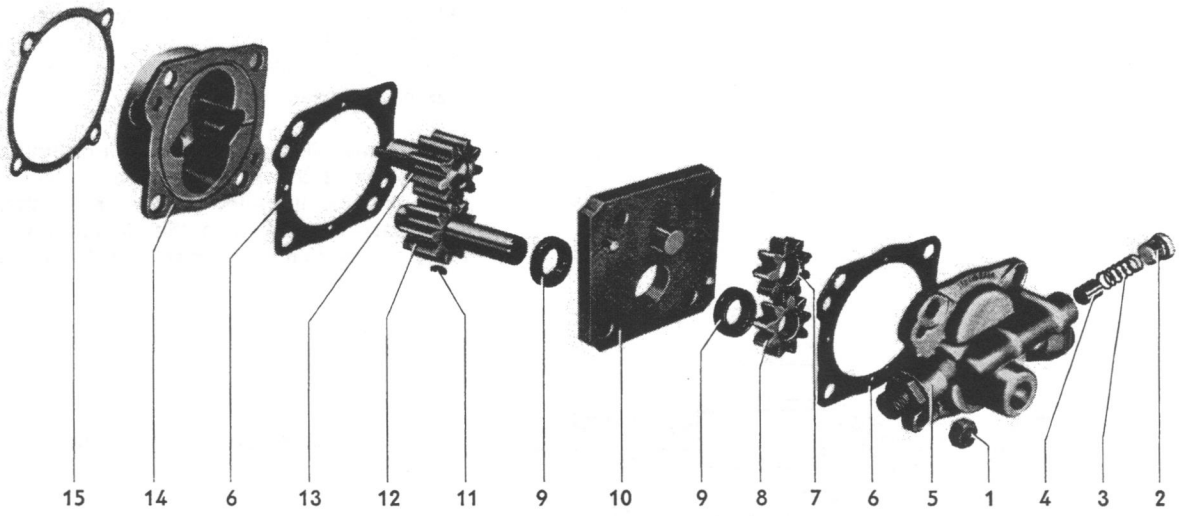
new previously

Service installation

All the new spare parts must be used when installing in earlier engines.

Caution

An old type oil pump cannot be installed in an engine with new camshaft because the oil pump drive shaft does not engage properly in the camshaft slot.



1 - Sealing nut M 8
2 - Plug
3 - Spring
4 - Piston
5 - Cover
6 - Gasket for intermediate plate and cover
7 - Outer, upper gear
8 - Outer, lower gear
9 - Oil seal for plate
10 - Intermediate plate
11 - Woodruff key
12 - Lower shaft with inner gear
13 - Upper shaft with inner gear
14 - Oil pump housing
15 - Gasket for housing

Removing

To avoid damage to the seals in the intermediate plate, remove Woodruff keys before withdrawing plate.

Checking

Replace the complete pump if the oil pump housing, the intermediate plate or the pump cover is damaged. Gaskets and seals can be replaced if the pump is leaking.

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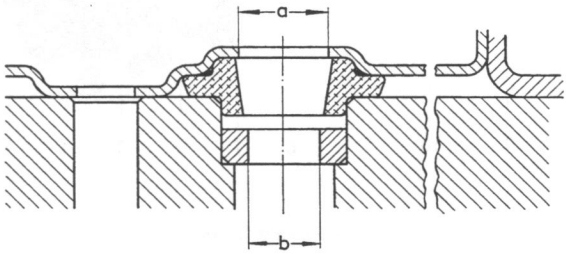
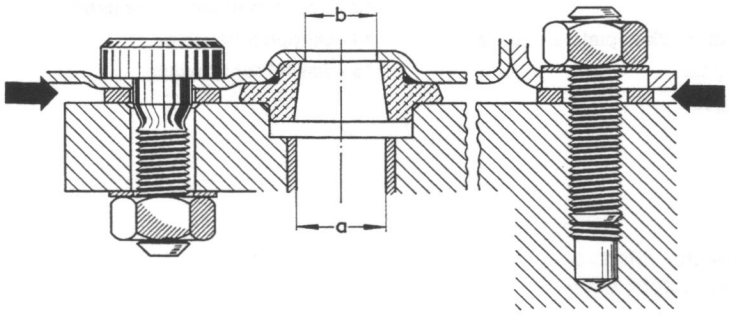
Oil passages in oil cooler and crankcases up to July 1969: b = 8 mm (5/16 in.) diameter from August 1969: a = 10 or 12 mm (3/8 or 15/32 in.) diameter.

When assembling a new oil cooler or crankcase with parts of the previous type, install **green** seals for the oil cooler and spacer washers, if necessary, as shown in the illustrations. The parts are contained in SP set – 111 198 029.



New oil cooler installed on previous type crankcase.



Previous type oil cooler installed on new type crankcase.

Install the 3 washers – N 11 533 2 – supplied in SP set (see arrows).

Note

From August 1970 the oil cooler was moved forward by installing a light alloy mounting flange. The flange is bolted to the crankcase with 8 mm bolts and the oil drillings are sealed with the usual rubber sealing rings.

Only the new crankcase will be supplied as a spare part.

When replacing the crankcase of an older engine (manufactured before August 1970), a stepped M 8/M 6 stud must be used to secure the oil cooler. To centralize the cooler, a bushing – 113 101 145 A – must be installed in one of the holes.

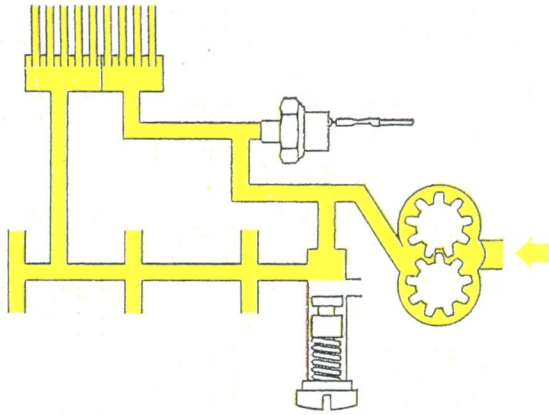
The flow of oil through the oil cooler is regulated by the oil pressure relief valve as follows:

a - Oil is thick and cold:

Oil pressure is high.

Piston is in lowest position.

Oil flows directly to the bearings and part goes back into the crankcase.

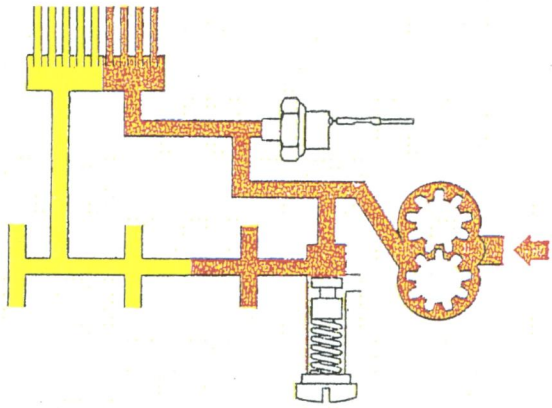


b - The oil warms up and starts to thin out:

Oil pressure drops.

Piston closes the return port.

Oil flows directly to bearings and through the oil cooler to bearings.

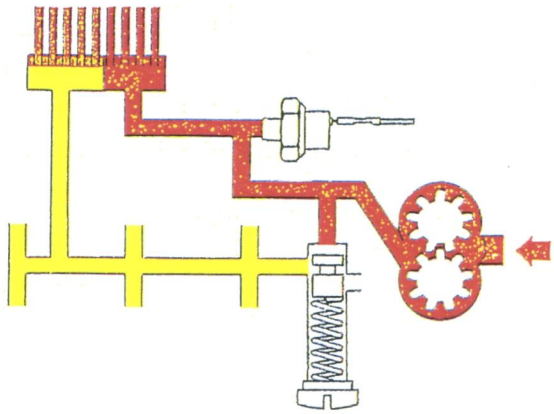


c - Oil is at operating temperature and is thin:

Oil pressure is low.

Piston is in highest position.

All oil has to pass through the oil cooler to the bearings.



Note

From August 1969 the oil pressure is kept constant by the oil pressure control valve located at the end of the system (see M 5.1/1-2).

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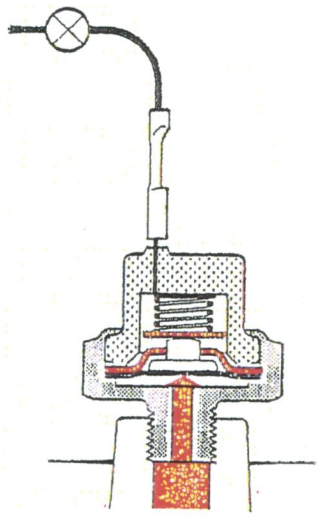
The oil pressure switch indicates the oil pressure in the engine. It is located in the oil pressure line between oil pump and oil cooler. When the engine is not running, the contact on the diaphragm is held closed by spring pressure. When the ignition is switched on, the battery current flows from terminal 15 of the starter switch via the red warning lamp and the oil pressure switch to ground. The red warning lamp lights up.

When the engine is running, the oil pressure actuates the diaphragm, opens the contact and the red warning lamp goes out.

a - Pressure rises when engine is started:

Contact opens 0.15—0.45 kg/cm$_2$ (2—6 psi);

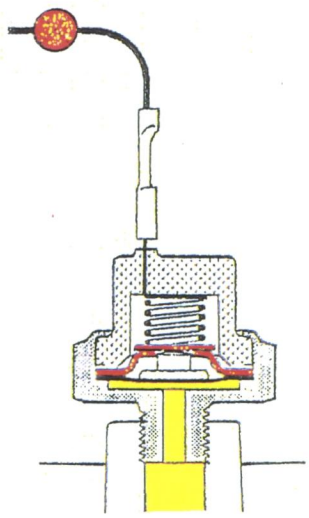
Warning lamp goes out.



b - Pressure is too low when engine is running:

Contact closes;

Warning lamp lights up.



Installing

1 - Sealing is effected by the tapered thread.

To avoid damaging the thread, do not use excessive force when tightening the switch.

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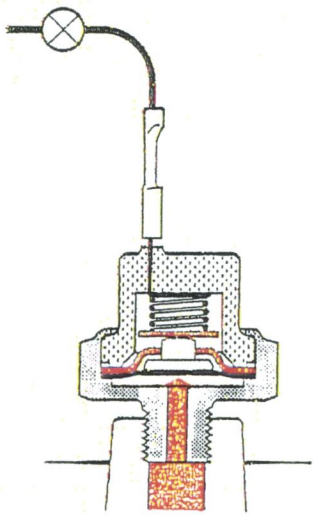
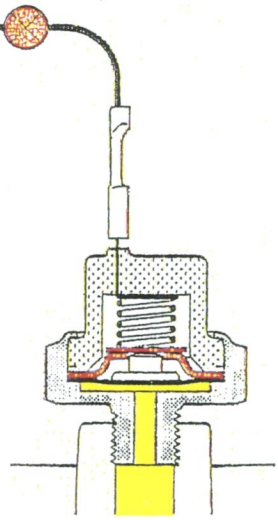
Oil pressure switch

The oil pressure switch indicates the minimum oil pressure in the engine. It is located in the oil pressure line between oil pump and oil cooler. When the engine is not running, the contact on the diaphragm is held closed by spring pressure. When the ignition is switched on, the battery current flows from terminal 15 of the starter switch via the red warning lamp and the oil pressure switch to ground. The red warning lamp lights up.

When the engine is running, the oil pressure actuates the diaphragm, opens the contact and the red warning lamp goes out.



a - Pressure rises when engine is started:
Contact opens (2—6 psi/0.15—0.45 kg/cm²)
Warning lamp goes out.

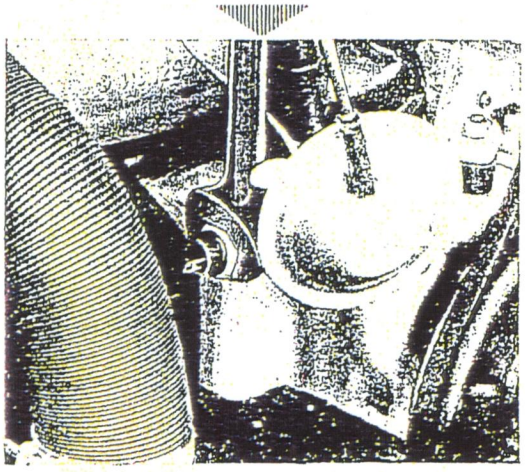


b - Pressure is too low when engine is running:
Contact closes
Warning lamp lights up.

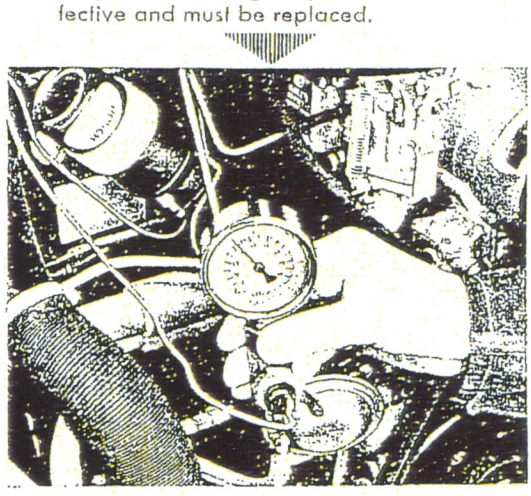
Testing

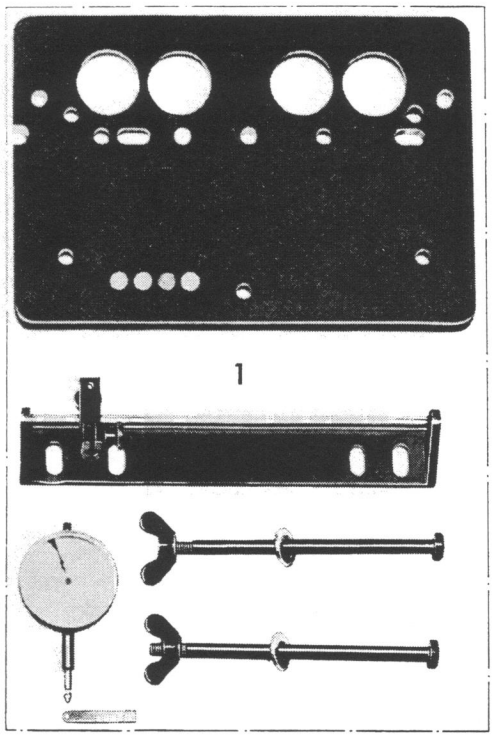
The oil pressure switch can be tested on the engine, using a simple testing device with gauge VW 622/2 and a test lamp, after the engine oil is at operating temperature.

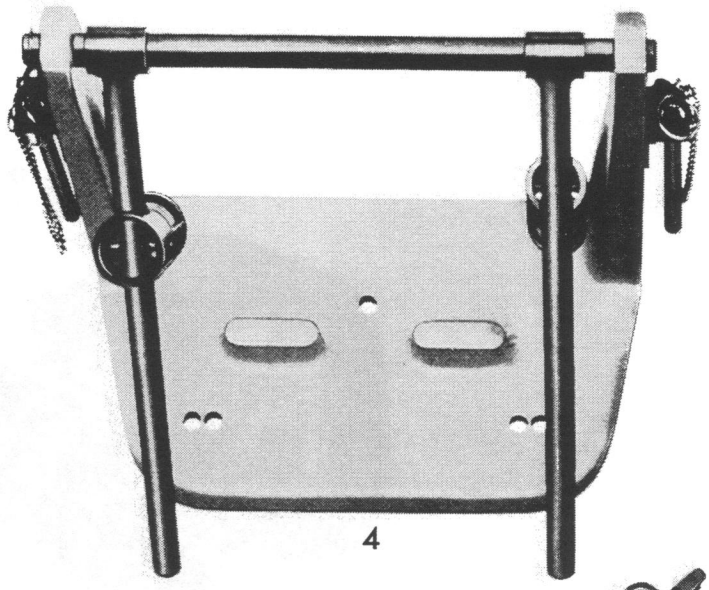
1 - Remove oil pressure switch and screw it into testing device.

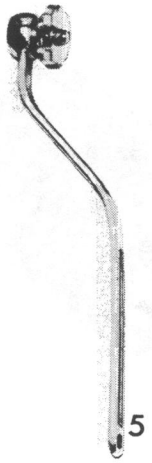


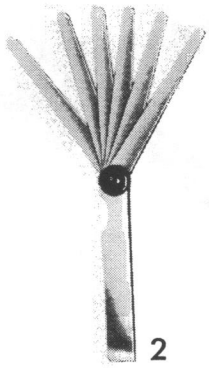
2 - Screw testing device into seat for oil pressure switch on crankcase and connect test lamp to oil pressure switch and to terminal 15 of ignition coil. When the ignition is switched on, the test lamp should light up. If the lamp does not light up, the switch is defective and must be replaced.

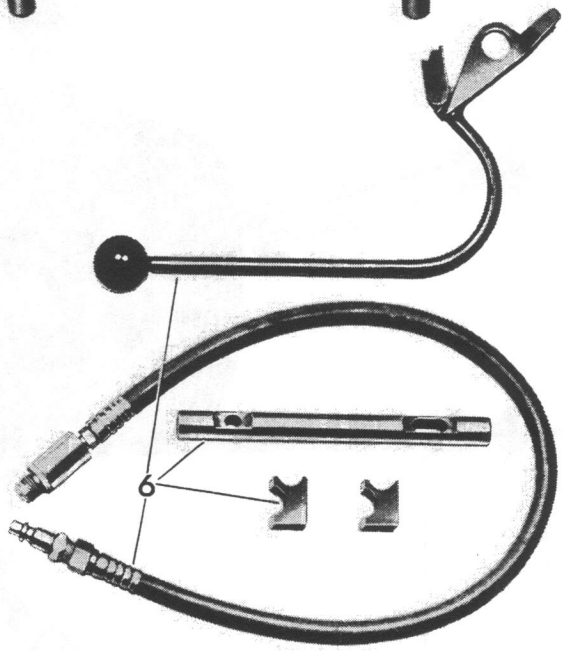












No.	Description	Special tool	Remarks
1	Valve guide wear measuring appliance	US 4420	
2	Feeler gauge		
3	Valve grinding tool		
4	Valve extractor	VW 311 h	
5	Valve clearance adjusting tool		
6	Valve spring compressor	VW 653/2	

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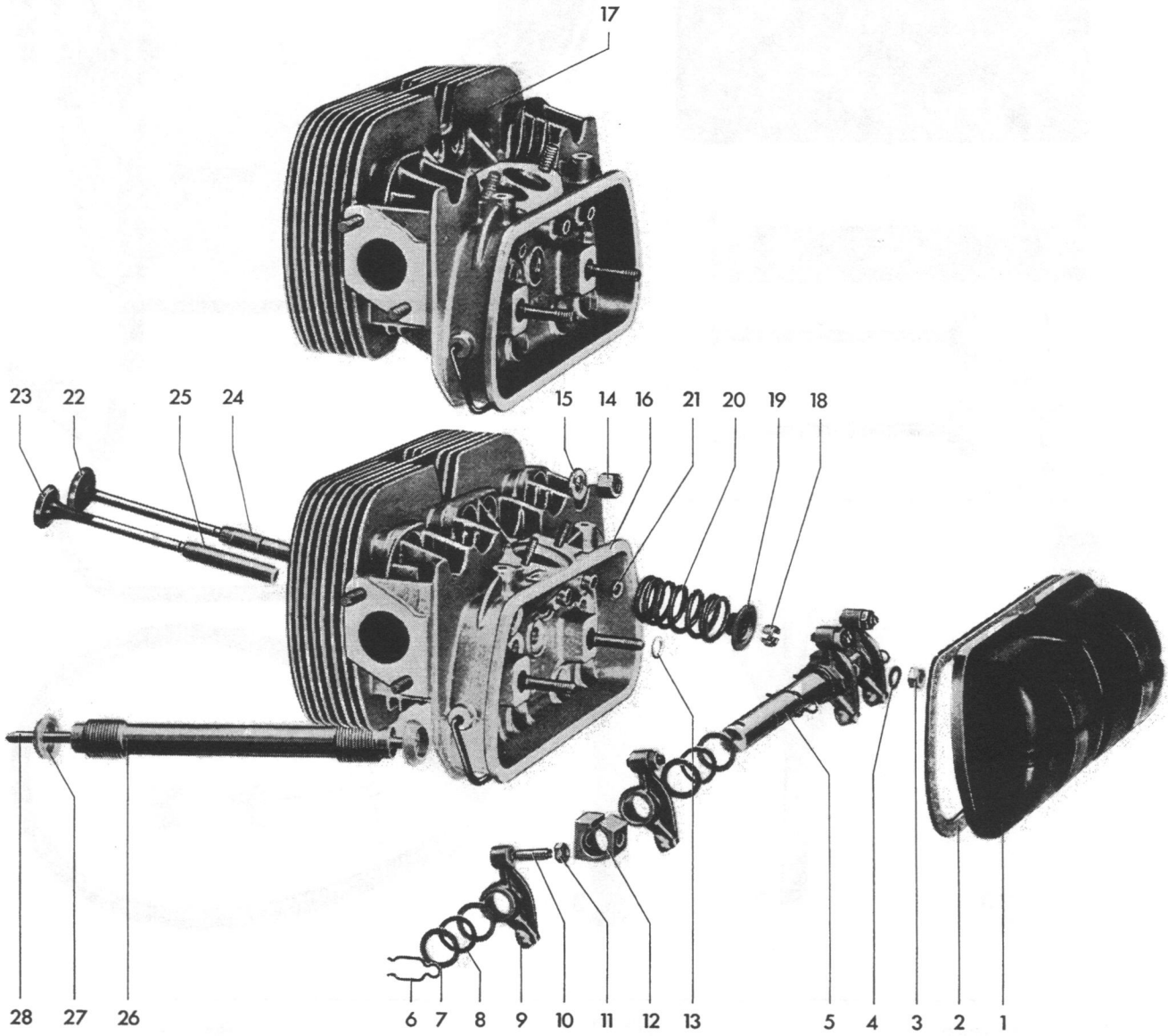
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No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Cylinder head cover	2			
2	Gasket for cylinder head cover	2		replace if damaged or leaking	
3	Nut, M 8×1.25	4		copper plated tighten to 18 lb. ft. 2.5 mkg	
4	Spring washer	4			
5	Rocker shaft	2		check for wear and grooves 17.97—17.99 mm (0.7073—0.7081 in.) diameter wear limit: 17.95 mm (0.7065 in.) diameter	
6	Clip	8			
7	Thrust washer	16			
8	Spring washer	8			
9	Rocker arm	8		check for wear and grooving 18.00—18.02 mm (0.7086—0.7088 in.) diameter wear limit: 18.04 mm (0.7090 in.) diameter	
10	Adjusting screw	8		check for easy turning	
11	Nut, M 8×1	8		check for easy turning	
12	Support	8		check for wear slot must face upward	Fig. 8
13	Seal for stud	4		replace	
14	Nut, M 10	16		note tightening sequence, tighten to 3.2 mkg (23 lb. ft.)	Fig. 6 Fig. 7
15	Washer	16			
16	Cylinder head	2	check cylinder heads for cracks in combustion chambers and exhaust ports and for signs of leakage on cylinder contact surfaces. Check spark plug thread and studs for damage and tightness. If necessary, fit Heli-Coil inserts. when installing cylinder head, make sure that oil seals at ends of push rod tubes are properly seated.		M 6.1/3-4
17	Cylinder head	2	from August 1970 twin intake port		
18	Valve cotter	16		replace if clearance too large	
19	Spring cap	8			
20	Valve spring	8		check valve spring tension Length loaded: 31.0 mm (1.22 in.) Load: 53.2—61.2 kg (117.2—134.8 lb.) Small end of spring faces cylinder head.	Fig. 3
21	Oil deflector ring	8		replace	
22	Intake valve	4	use VW 311 h;	check valve seats for wear. Reface, intake valves only with a valve refacing machine to seat width d = max. 0.5 mm (0.02 in.). Reface exhaust valves by grinding only.	Fig. 1 Fig. 2 Fig. 4
23	Exhaust valve	4	use VW 311 h;	check valve seats for wear. Reface, intake valves only with a valve refacing machine to seat width d = max. 0.5 mm (0.02 in.). Reface exhaust valves by grinding only.	Fig. 1 Fig. 2 Fig. 4
24	Intake valve guide	4	check with measuring device VW 689/1		M 6.1/3-1
25	Exhaust valve guide	4	check with measuring device VW 689/1		M 6.1/3-1
26	Push rod tube	8		pretension, seam faces upward	Fig. 5
27	Sealing ring	8		replace	
28	Push rod	8		check for run-out max. 0.3 mm (0.012 in.)	M 6.1/2-1

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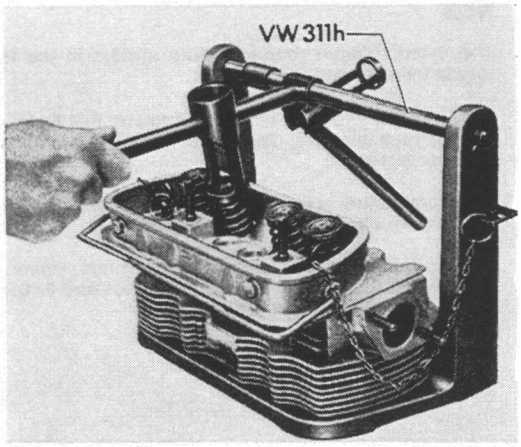


Fig. 1

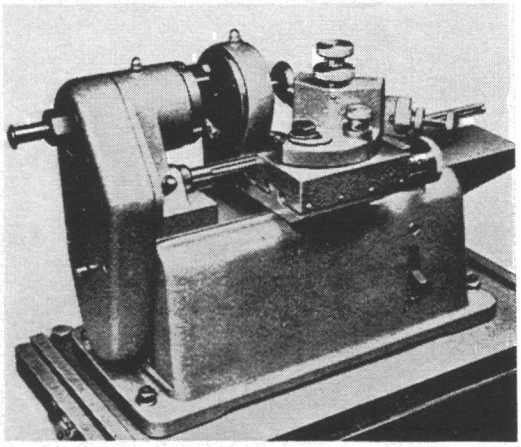


Fig. 2

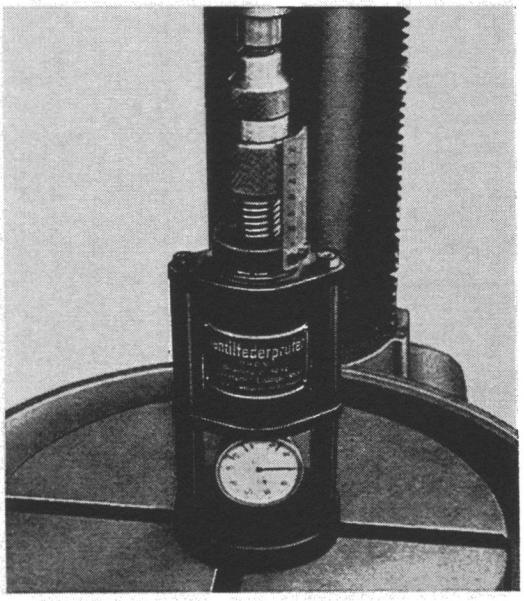


Fig. 3

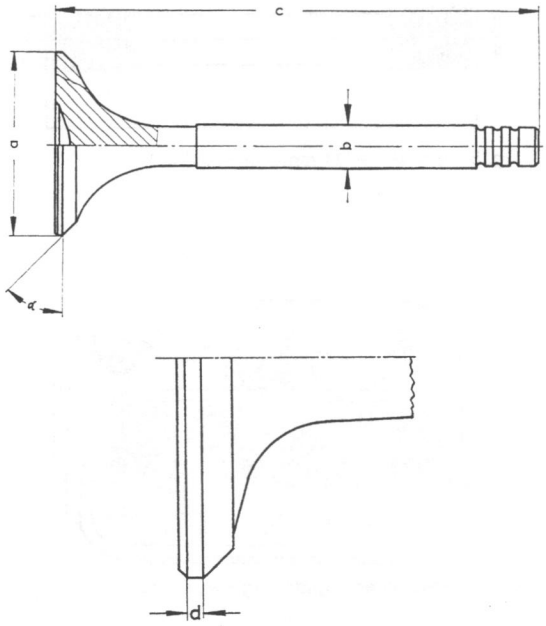
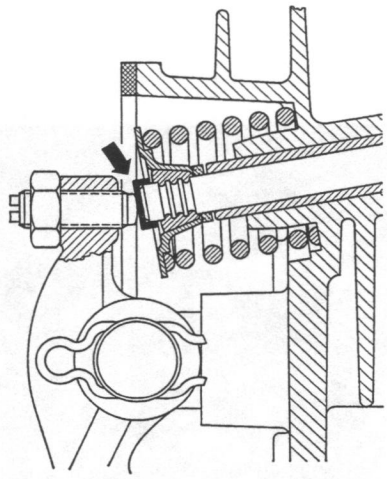


Fig. 4

	Intake valve	Exhaust valve
a	35.6 mm (1.301 in.) diameter	32.1 mm (1.263 in.) diameter
b	7.94–7.95 mm (0.312 —0.313 in.) diameter	7.92–7.94 mm (0.312 —0.313 in.) diameter
c	112 mm (4.4 in.)	112 mm (4.4 in.)
α	44°	45°

Note



Valves with worn stem ends can be used again by installing caps (113 109 621) on the stems (arrow). The caps are placed on the stems before the rocker arms are installed.

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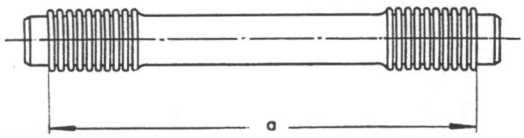


Fig. 5 a = 190—191 mm (7.4—7.52 in.)

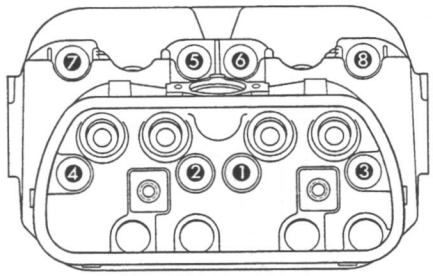


Fig. 6 Preliminary tightening sequence

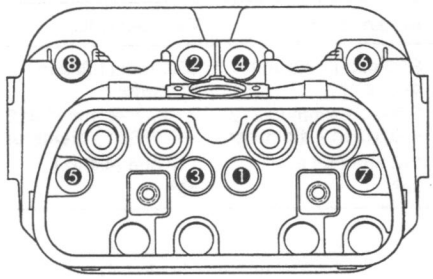


Fig. 7 Final tightening sequence

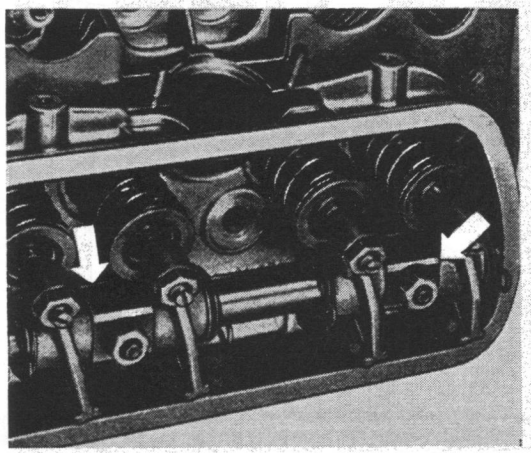


Fig. 8

Note

The cylinder head reconditioning system in the factory is being changed.

Only 1.0 mm (0.04 in.) thick **steel** shims are installed in exchange engines. This shim will not be available as a spare part.

For manufacturing reasons, steel shims are only produced in one thickness — 1 mm (0.04 in.).

For repairs on earlier engines, aluminium shims of thicknesses 0.8, 1.0 and 1.5 mm (0.03, 0.04 and 0.06 in.) will remain available as spare parts.

When repairing or replacing valves, it is necessary to check the valve guides for wear. Worn valve guides should be replaced.

Checking

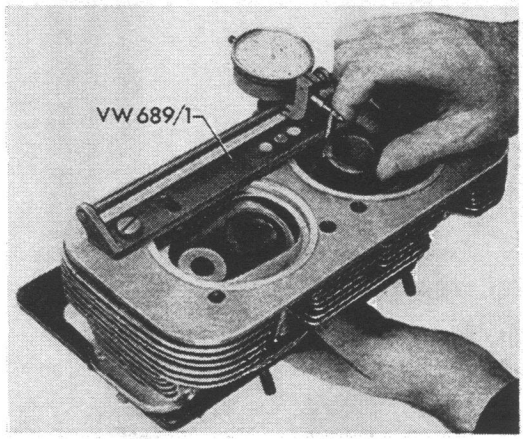
1 - Remove deposits with a reamer.

2 - Place cylinder head on mounting plate VW 689/1 with the combustion chamber upward and fasten it with the guide.

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

4 - Insert new valve into guide to be measured and hold it so that valve stem end is flush with end of valve guide.

5 - Set dial gauge and determine amount of rock.



	Intake valve guide	Exhaust valve guide	Wear limit
Rock	0.21—0.23 mm (0.0082—0.0090 in.)	0.23—0.27 mm (0.0090—0.0106 in.)	0.8 mm (0.031 in.)
Inside diameter	8.00—8.02 mm diameter (0.3149—0.3156 in.)		8.06 mm (0.3172 in.)

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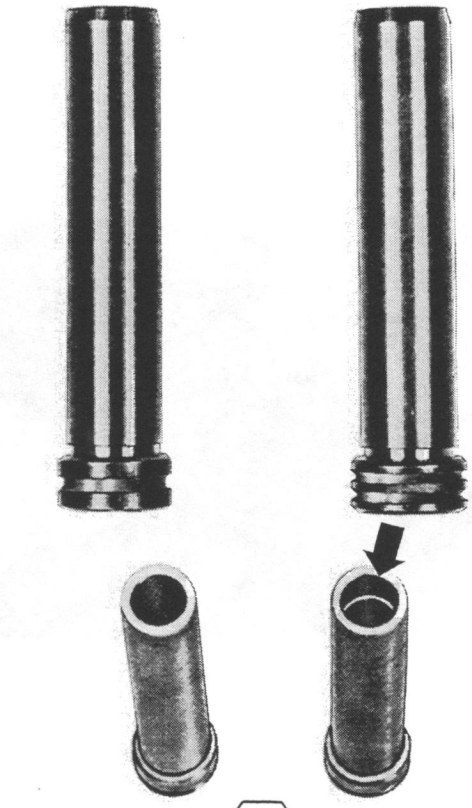


Worn or damaged valve guides can be replaced with the universal cylinder head repair device. Replacement oversize valve guides are available.

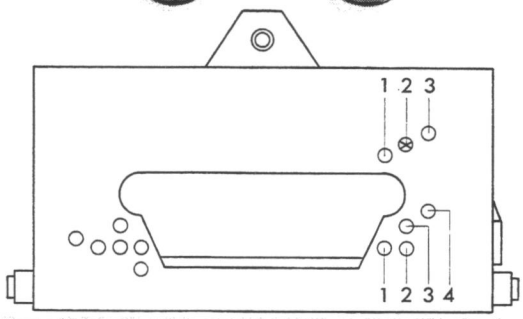
1st oversize: 1 groove

2nd oversize: 2 grooves

Means of identification:

Intake: Inside diameter **not** turned out

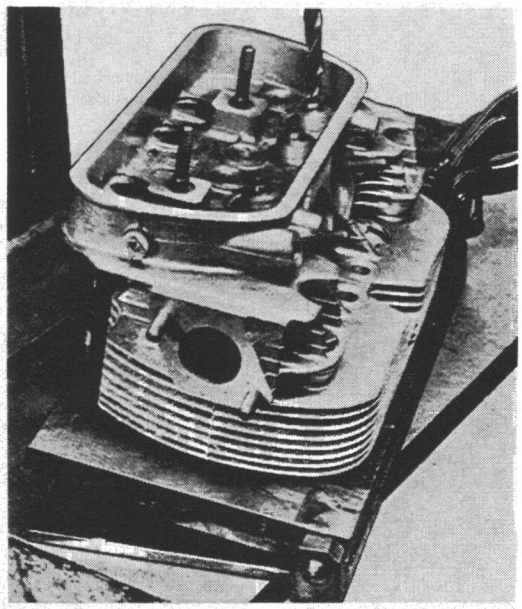
Exhaust: Inside diameter turned out (arrow)



Repair instructions

1 - Place head on device with combustion chambers facing the mouting plate.

2 - Adjust angle of plate to 9° 30′.

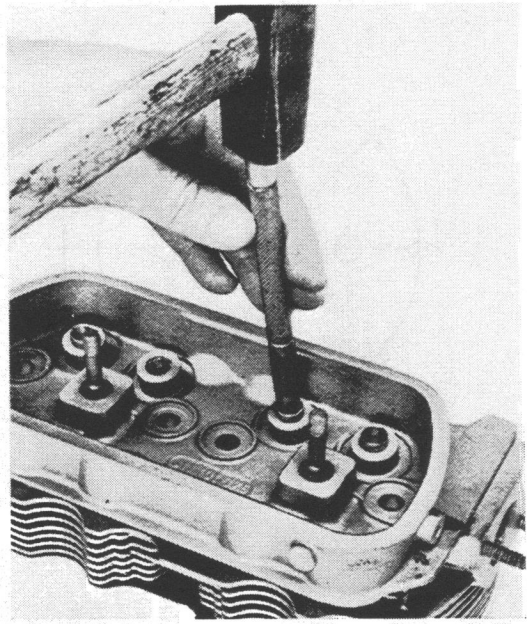


3 - Align plate on drill press table.

4 - Drill guides with shouldered drill to a depth of 40—50 mm (1½—2 in.).

(Drill speed: approximately 100 rpm)

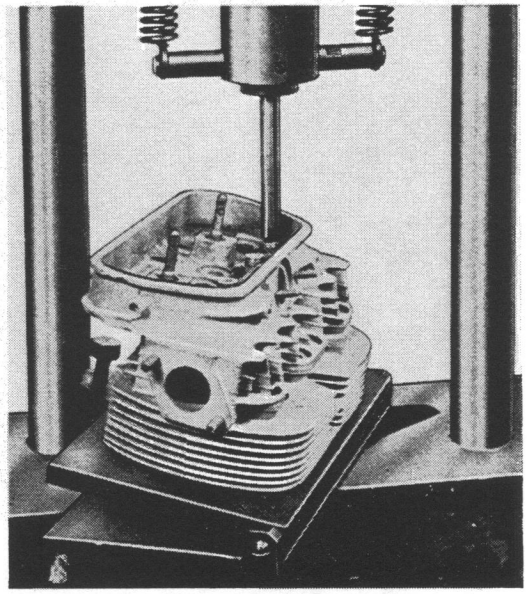
5 - Knock guides out with drift.



6 - Coat 1st oversize guide with engine oil and press it in.

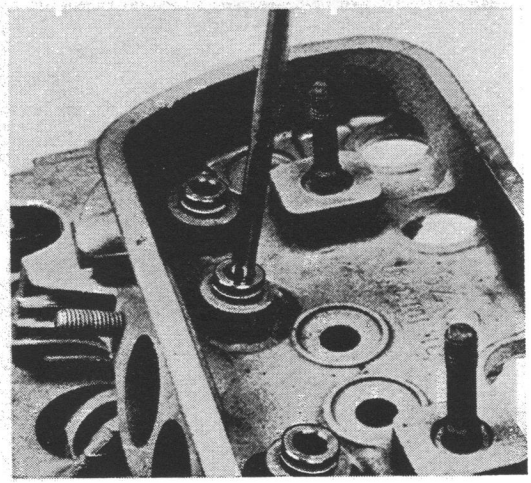
Note

The pressure required should be between 1 and 2 tons. If the pressure is under 1 ton a 2nd oversize guide should be installed.



7 - Ream guides out. Use coolant when reaming.

8 - Check reamed guides for size.



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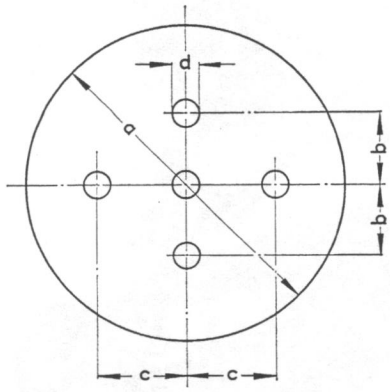


Testing devices needed:

a - A small measuring burette of 100 cc capacity.

b - A transparent plastic plate of 10 mm (0.4 in.) thickness manufactured according to sketch.

a = 93 mm (3.66 in.) diameter
b = 40 mm (1.6 in.)
c = 50 mm (2 in.)
d = 7 mm (0.3 in.)

Testing

When measuring, valves must seal properly and spark plugs must be installed.

1 - Remove carbon deposits from combustion chamber. Especially clean surface on which the plastic plate is to be placed.

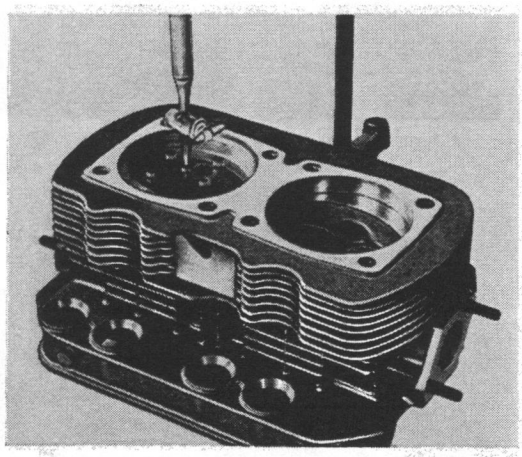
2 - Place the cylinder head in a horizontal position with the combustion chamber facing upward.

3 - Lightly coat contact surface of plastic plate with multipurpose grease.

4 - Place plastic plate in cylinder head and press firmly in position.

5 - Fill burette to zero mark with fuel, naphtha or soapy water.

6 - Fill combustion chamber up to the upper edges of the five holes in the plastic plate with the measuring fluid, ensuring that no air bubbles form. (If necessary, tilt cylinder head slightly.)



Combustion chamber capacity	=	quantity of fluid put in minus 2 cm³ (0.122 cu. in.) *)

*) The capacity of the five holes (7 mm [0.3 in.] diameter × 10 mm [0.4 in.] deep) amounts to 2 cm³ (0.122 cu. in.).

Combustion chamber capacity of one cylinder in the cylinders heads:

Type/Model	Combustion chamber capacity in cm³
up to July 1970	48.0—50.0 cm³ (2.93—3.05 cu. in.)
from August 1970	50.0—52.0 cm³ (3.05—3.17 cu. in.)

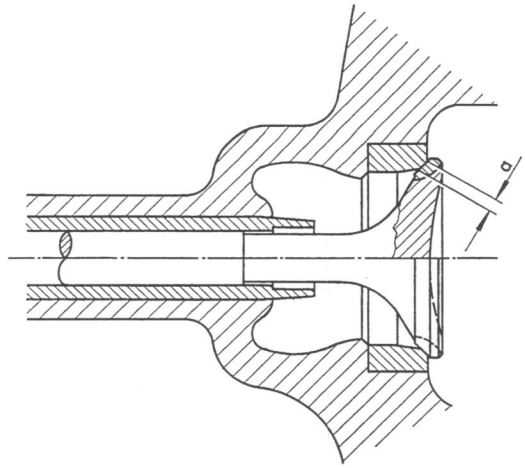
Damaged or burnt seats may be reconditioned as long as the permissible width for the seat is maintained. The outer edge of the 15° chamfer should not exceed the outer diameter of the valve seat insert. If the dimensions are no longer true, the cylinder head has to be replaced. Replacement of valve seats is beyond the scope of a normal workshop, as they are shrunk (chilled) into position.

Seat width (a):

new: Intake = 1.4–2.5 mm (0.055–0.10 in.)
Exhaust = 1.4–2.5 mm (0.055–0.10 in.)

when repairing:

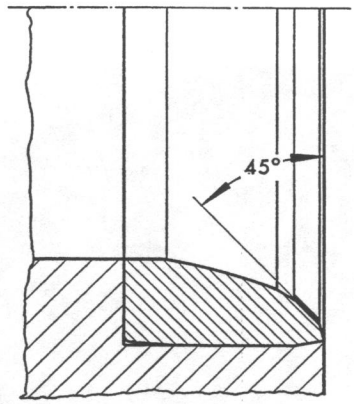
Intake = 1.3–1.6 mm (0.051–0.063 in.)
Exhaust = 1.7–2.0 mm (0.067–0.079 in.)



Sequence of operations

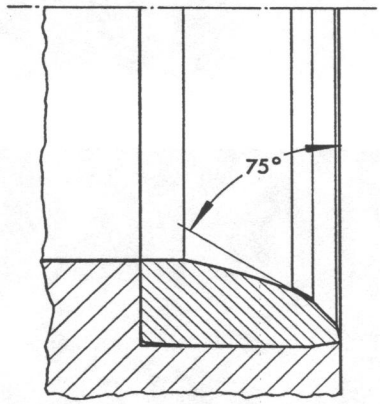
1 - Cut 45° faces.

Cut valve seat inserts carefully to obtain a perfectly concentric seating surface. Remove only the minimum of metal, otherwise the life of the inserts will be adversely affected. Stop grinding as soon as the whole surface is cut.



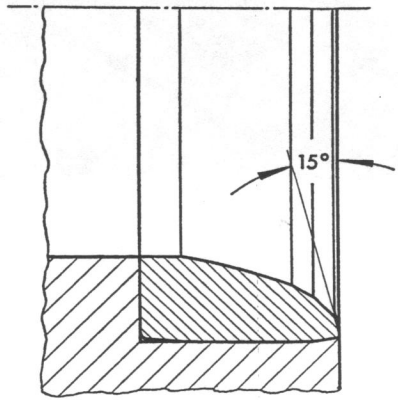
2 - Cut 75° face.

Slightly chamfer lower edge of exhaust valve seat insert.



3 - Cut 15° face.

Chamfer upper edge of valve seat insert until correct seat width is reached.



4 - The valve seats can be checked with a new valve.

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Checking valve seating

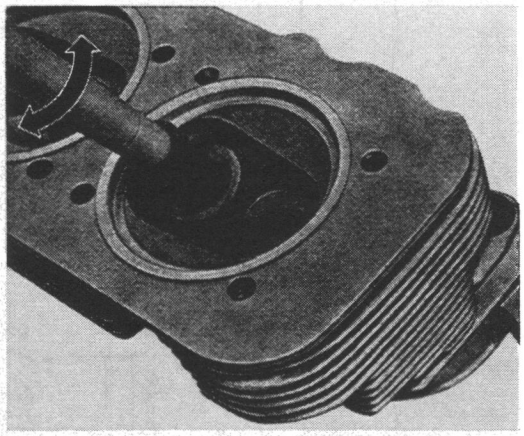
With accurately refaced valve seats and new valves it is usually not necessary to lap the valves.

Preparing contact pattern

1 - Lightly coat the valve with Prussian blue.

2 - Insert valve into valve quide. Apply light pressure and turn the valve approximately 1/4 turn on the valve seat.

3 - Carefully remove valve. The contact pattern will show which parts are not seating properly. If necessary lap valves.



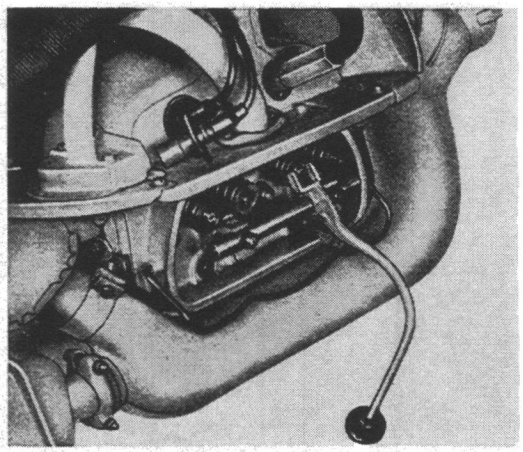
Lapping valves

1 - Coat valve seat with a fine valve grinding compound and insert valve into guide.

2 - Place plunger on valve head and lap valve seat by turning the plunger handle. Lift valve frequently. Turn it evenly to avoid grooves in seating surfaces

Note

After lapping, thoroughly clean off all traces of lapping compound.



Removing and installing a valve spring
(engine installed)

Removing

1 - Remove rocker shaft with rocker arms and sealing rings.

2 - Install tool VW 653/2 in place of rocker shaft.

3 - Install compressed air hose adapter into spark plug hole and apply pressure.

4 - Press spring cap down.

5 - Remove cotters, spring cap and valve spring.

Installing

1 - Check valve spring.

2 - Check cotters.

Valve clearance

The valve clearance must only be checked or adjusted with the engine cold.

Valve clearance:

Intake 0.15 mm (0.006 in.)

Exhaust 0.15 mm (0.006 in.)

The clearance **increases** at first as the engine warms up and then goes back to the proper setting when engine is really warm. It should be carefully checked at the prescribed intervals.

Valve adjustment gives the desired result only if the valves seal tightly, there is no undue clearance in the valve guides, and the stem end is not worn.

Insufficient valve clearance causes:

Burning of valves and valve seats.
Distortion of valves.
Poor performance due to reduced compression.
Uneven engine running.
Altered valve timing.

Excessive valve clearance causes:

Noisy timing mechanism.
Uneven engine running.
Altered valve timing.
Poor performance resulting from insufficient cylinder charge.

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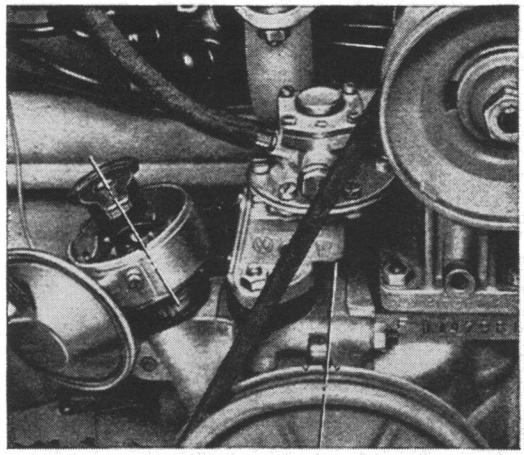
Adjusting valves

The valve clearance is adjusted in cylinder sequence 1–2–3–4.

The piston of the cylinder to be adjusted must be at TDC of the compression stroke, as the two valves are then closed.

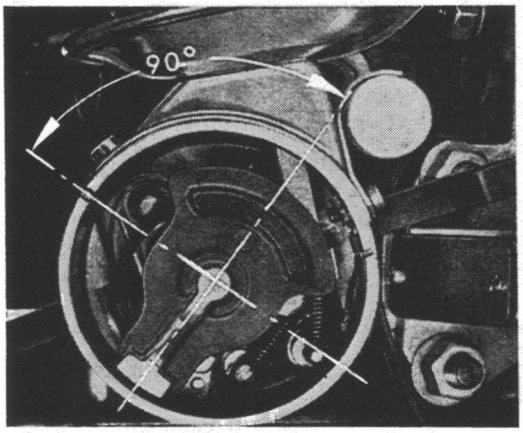


1 - Set No. 1 cylinder to firing position.

2 - Check valve clearance with a feeler gauge.

3 - Adjust clearance with special wrench and a feeler gauge.

The clearance is correct if the feeler blade slides between screw and stem quickly and smoothly.



4 - When adjusting the valves of No. 2, 3 and 4 cylinders, the crankshaft must be turned to the left until rotor arm has moved 90° each time.

No.	Description	Qty.	Note when removing	Note when installing	Special instructions see
1	Cylinder	4	Before removing cylinders, mark them so that they can be installed in the same location. If necessary, replace by another matched cylinder and piston of the same size.	Check cylinders for wear. Cylinder seating surface on crankcase and in cylinder head, cylinder seating shoulders and gaskets must be perfectly clean on installation. Foreign matter at this point could cause cylinder distortion and leaks. Oil the cylinder wall. Compress the rings with the compressing tool. The crankcase studs must not contact the cylinder cooling fins.	M 6.2/4.1 Fig. 3 Fig. 5
2	Sealing ring between cylinder and crankcase	4		replace	
3	Upper piston ring	4	use piston ring pliers	Fit rings by checking gap with a feeler gauge. The mark "Top" on the rings must point toward the piston crown. Make sure that the ring gaps are equally offset.	Fig. 2 M 6.1/3-1 M 6.2/3-2
4	Lower piston ring	4			
5	Oil scraper ring	4			
6	Spring clip	8	remove with VW 122 b		Fig. 4
7	Piston	4	mark before removing	Check for wear, note matching with cylinder; warm to fit piston pin; oil; note weight, max. 10 g.	M 6.2/4-1 Fig. 1
8	Piston pin	4	use VW 207	oil piston, if necessary warm up piston	M 6.2/3-2
9	Deflector plate	2			

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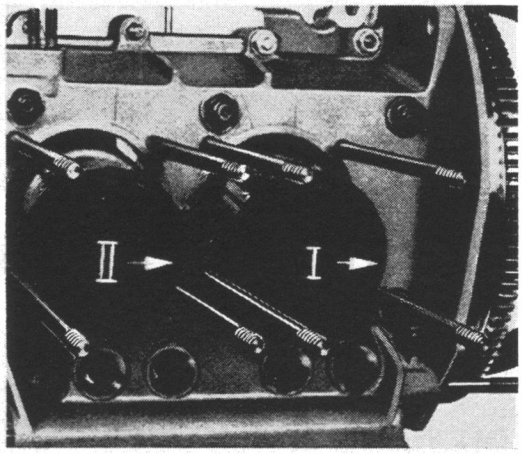

Fig. 1

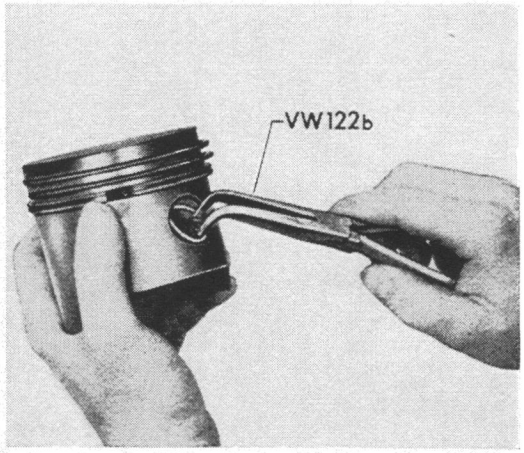

Fig. 4

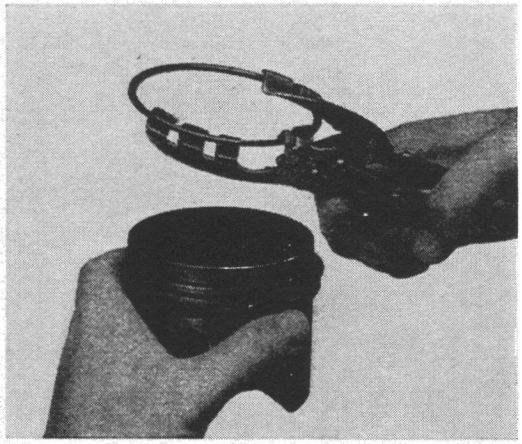

Fig. 2

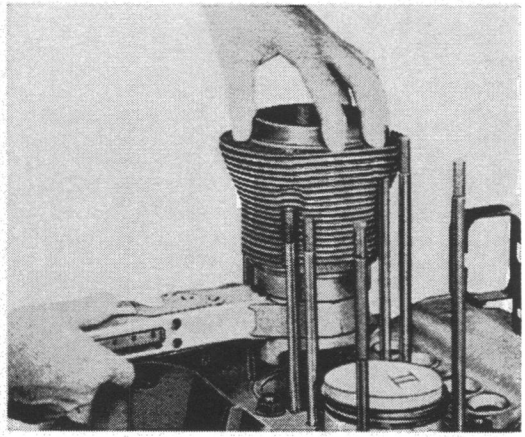

Fig. 5

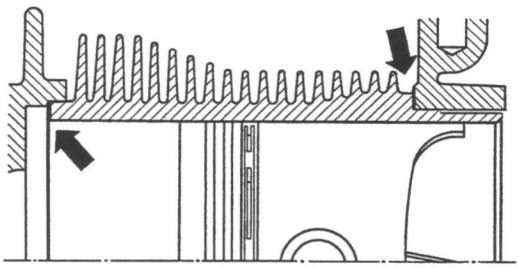

Fig. 3

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Marking of pistons

A - The letter near the arrow corresponds to the index of the part number of the piston concerned. It serves as an identification mark.

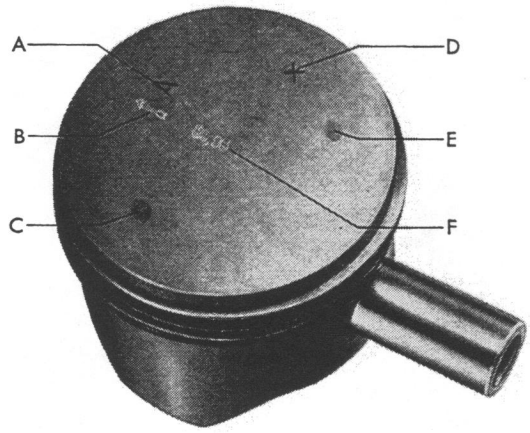
B - Arrow must point towards the flywheel when piston is installed.

C - Paint spot indicating matching size (blue, pink, green).

D - Details of weight grading (+ or −).

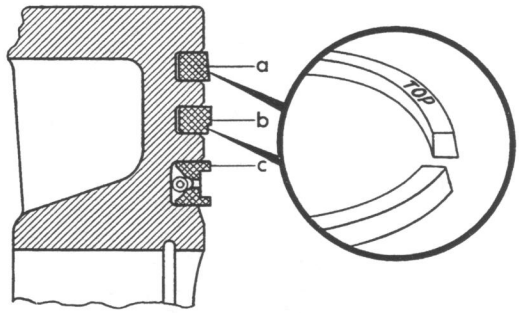
E - Paint spot indicating weight grading (brown = − weight, gray = + weight).

F - Piston size in mm.



Types of piston rings

Upper ring	Ferrox insert, thickness: 2 mm (0.08 in.)
Lower ring	narrow face, thickness: 2 mm (0.08 in.)
Oil scraper ring	with coil spring

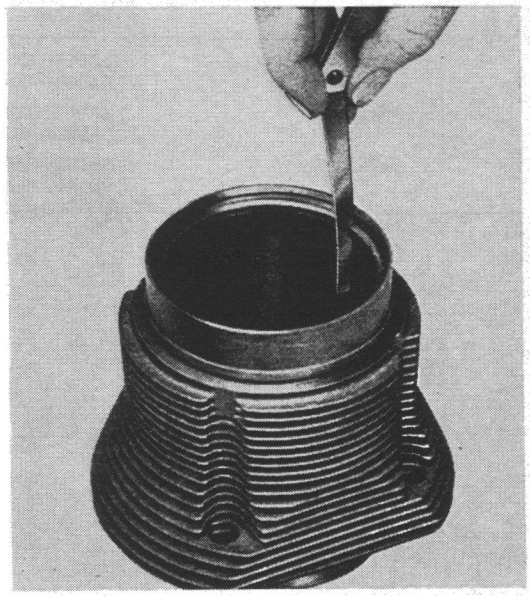


a - Upper ring

b - Lower ring

c - Oil scraper ring

	Gap mm (in.)	Wear limit mm (in.)
Upper ring	0.30–0.45 (0.012–0.018)	0.90 (0.035)
Lower ring	0.30–0.45 (0.012–0.018)	
Oil scraper ring	0.25–0.40 (0.010–0.016)	0.95 (0.037)



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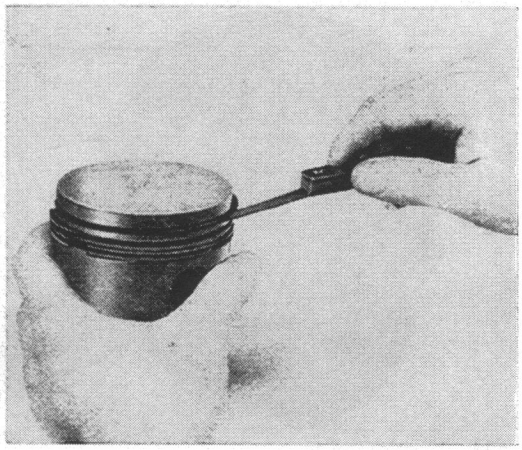
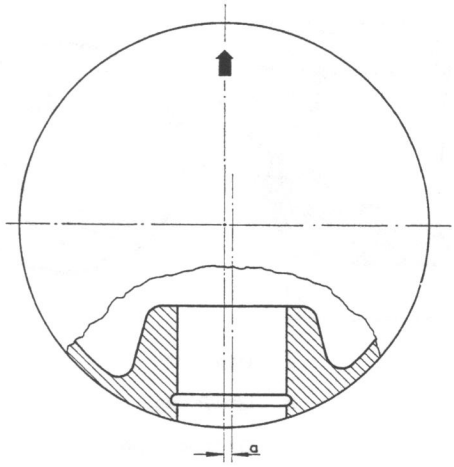


	Clearance mm (in.)	Wear limit mm (in.)
Upper ring	0.07–0.10 (0.0027–0.004)	0.12 (0.005)
Lower ring	0.05–0.07 (0.002–0.0027)	0.10 (0.004)
Oil scraper ring	0.03–0.05 (0.001–0.002)	



Offset of piston pin bore

"a" = 1.5 mm (0.06 in.)

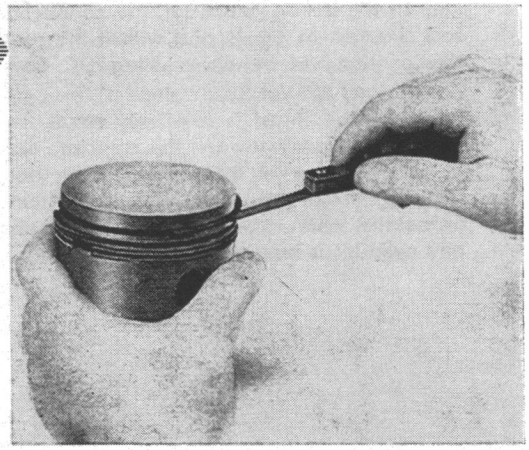
Piston pin and connecting rod bushing

Check and fit piston pin. Depending on the combination of tolerances between piston pin and bearing, the pin may be found to be a light finger-push fit in the piston without heating the piston. This condition is quite normal, even if the piston pin should slide out of the piston under its own weight. There is no reason whatsoever to replace piston pin, piston, or both, in this connection.

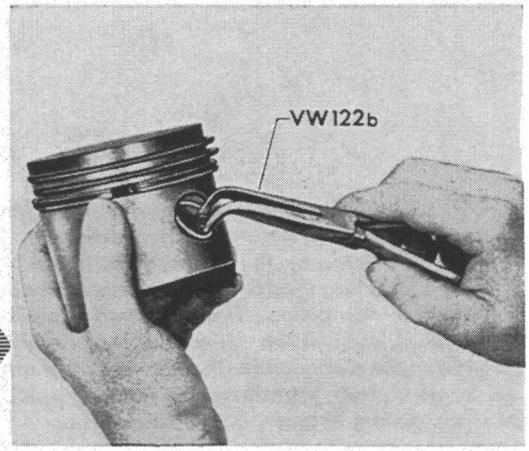
	Diameter mm (in.)	Clearance mm (in.)	Wear limit mm (in.)
Piston pin bushing	22.008–22.017 (0.8664–0.8667)	0.008–0.021 (0.0003–0.0008)	0.04 (0.0016)
Piston pin	21.996–22.000 (0.8658–0.8661)		
Bore in piston	21.997–22.002 (0.8660–0.8668)		

If the clearance between pin and bushing is near the wear limit of 0.04 mm (0.0015 in.), fit a new pin and a new bushing in the connecting rod.

5 - Check the ring clearance in the grooves with a feeler gauge.



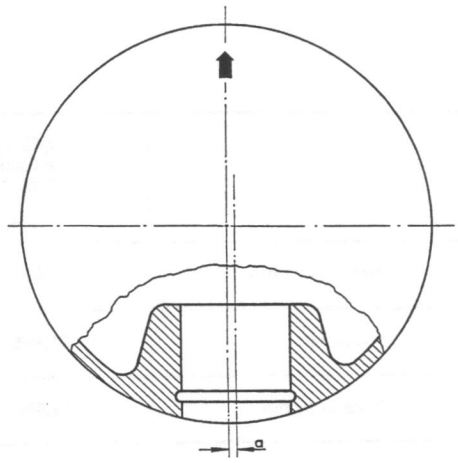
	Clearance mm (in.)	Wear limit mm (in.)
Upper ring 1/1500, 1600 — 2/1600 — 3/1600	0.07—0.10 (.0027—.004)	0.12 (.005)
Lower ring 1/1500, 1600 — 2/1600 — 3/1600	0.05—0.07 (.002—.0027)	0.10 (.004)
Oil scraper ring 1/1500, 1600 — 2/1600 — 3/1600	0.03—0.05 (.0012—.002)	



6 - Install circlips on the flywheel side of pistons for cylinders 1 and 2 and on the opposite side of pistons for cylinders 3 and 4.

Offset of piston pin bore

The piston pin eye in the piston is offset. When installing the pistons ensure that the arrow or the word "vorn" is toward the flywheel.



Type/Model	"a"
1/1500, 1600 — 2/1600 — 3/1600	1.5 mm

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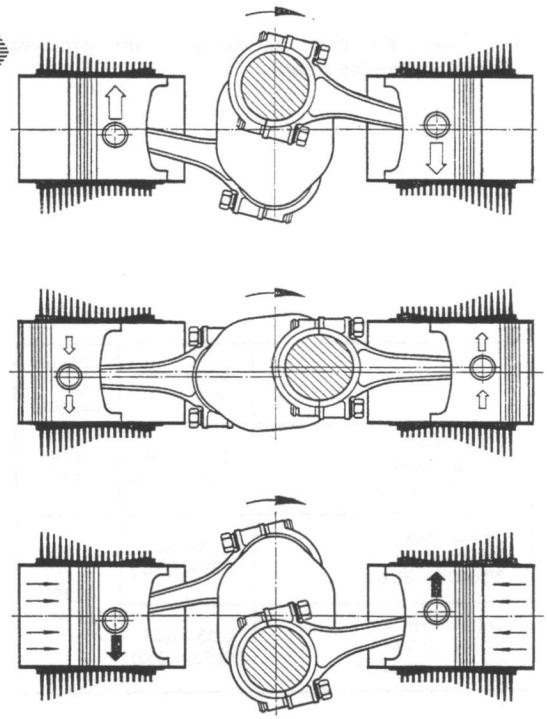
Due to the piston pin offset, the connecting rod changes its angle and with it the pressure contact area before reaching TDC. Combustion has not yet taken place at this point and the side thrust is relatively small. The piston tilts gently toward the opposite side of the cylinder wall, thus avoiding the usual slapping noise caused by the piston, tilting especially when clearance between piston and cylinder is large.



7 - Check and fit piston pin. Depending on the combination of tolerances between piston pin and bearing, the pin may be found to be a light finger-push fit in the piston without heating the piston. This condition is quite normal, even if the piston pin should slide out of the piston under its own weight. There is no reason whatsoever to replace piston pin, piston, or both, in this connection.

If the clearance between pin and bush is near the wear limit of .0015 in. (0.04 mm), fit a new pin and a new bush in the connecting rod.

Pistons should be heated in all cases where the piston pin is not a push fit. The piston is heated to approximately 176° F (80° C). The pin is then pushed fully home as far as the circlip in one movement with the drift VW 207 or VW 207 c.

8 - Insert second circlip. The circlips must seat correctly in their grooves.

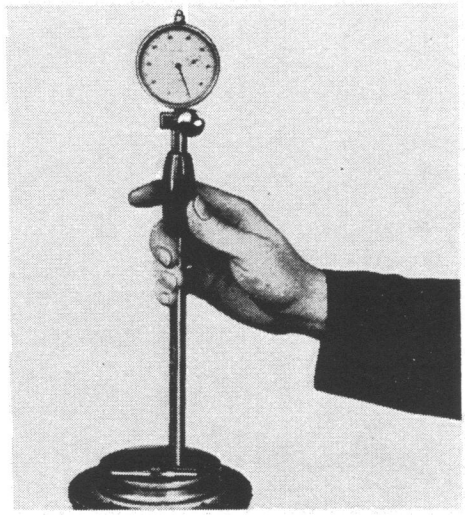
	1/1500, 1600 — 2/1600 — 3/1600 mm dia.	Clearance mm	Wear limit mm
Piston pin bush	20.008—22.017	0.008	0.04
Piston pin	21.996—22.000	0.021	
Bore in piston	21.997—22.002		

The clearance should be determined by measuring cylinder and piston and not with a feeler gauge.

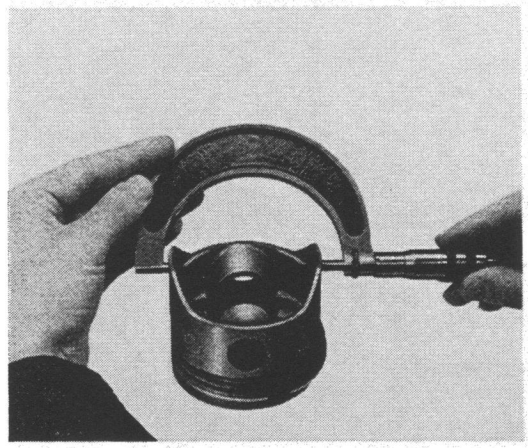
The cylinder is measured with a special dial gauge which is adjusted with micrometer gauge to the size of the cylinder.

The cylinder should be measured 10—15 mm (0.4—0.6 in.) below the upper edge.

New part	Wear limit
0.04—0.05 mm (0.00157—0.00196 in.)	0.2 mm (0.008 in.)



The nominal diameter is stamped on the piston crown. The reading must be taken at the bottom of the skirt at right angles to the piston pin axis.



The size gradings of the cylinders and matching pistons are as follows:

Gradings	Color	Cylinder diameter mm	Matching piston diameter mm
Standard size	Blue	85.492—85.508	85.45
Nominal dimension 85.5 mm diameter	Pink	85.502—85.518	85.46
1st Oversize	Blue	85.992—86.008	85.95
Nominal dimension 86 mm diameter	Pink	86.002—86.018	85.96
2nd Oversize	Blue	86.492—86.508	86.45
Nominal dimension 85.5 mm diameter	Pink	86.502—86.518	86.46

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If measurement of piston and cylinder shows that the clearance is near 0.2 mm (0.008 in.), the piston and cylinder should be replaced by a set of the same size grading (normal or oversize).

The difference in weight between the pistons in **one** engine must not exceed 10 grams. Pistons must not be replaced individually if the cylinders to which they belong show signs of wear.

If the cylinder of a damaged piston shows no signs of wear it is usually sufficient to install a new piston of the appropriate matching size.

Since the compression ratio must not be affected when installing reconditioned cylinders, the distance from the crown to the piston pin eye of the oversize piston is reduced accordingly.

Note

The clinders and pistons in one engine must be of the same size grading.

Besides wear, the oil consumption of the engine is an important factor in deciding whether or not a new cylinder and piston must be installed.

Oil consumption is considered excessive if it is more than 2 pints per 600 miles.

6.2 4-2 **Checking clearance between cylinder and piston**

If measurement of piston and cylinder shows that the clearance is near 0.2 mm (.008 in.), the piston and cylinder should be replaced by a set of the same size grading (normal or oversize). The difference in weight between the pistons in **one** engine must not exceed 10 grams. Pistons must not be replaced individually if the cylinders to which they belong show signs of wear. If the cylinder of a damaged piston shows no signs of wear it is usually sufficient to install a new piston of the appropriate matching size.

Since the compression ratio must not be affected when installing reconditioned cylinders, the distance from the crown to the piston pin eye of the oversize piston is reduced accordingly.

Important

The cylinders and pistons in one engine must be of the same size grading.

Beside the wear, the oil consumption of the engine is an important factor in deciding whether or not a new cylinder and piston must be installed. Oil consumption is considered excessive if it is more than 2 pints per 600 miles (1 liter per 1000 km), on Type 2/1600, 3 pints per 600 miles (1.4 liter per 1000 km).

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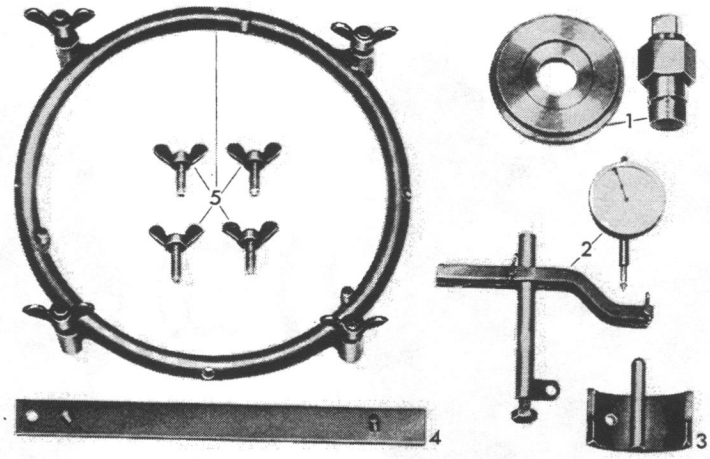

No.	Description	Special tool	Remarks
1	Installing tool for crankshaft oil seal	VW 204 b	
2	Dial indicator bracket	VW 659/2	
3	Retainer for flywheel	VW 215 c	
4	Stop bar, carrier plate	VW 802	
5	Drive plate retainer	VW 184	

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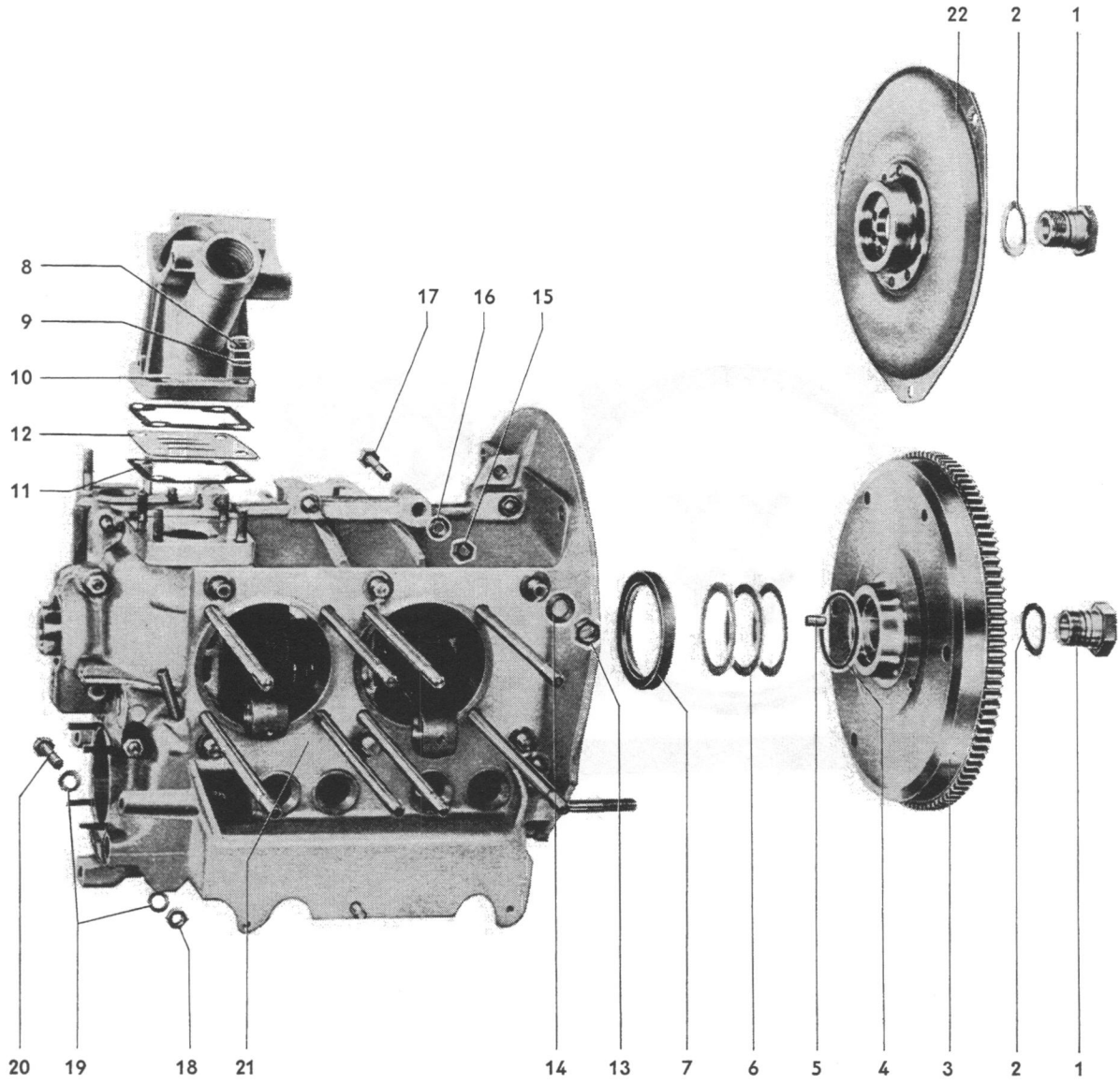
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No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Gland nut *)	1		torque to 35 mkg (253 ft. lb.)	M 7.1/2
2	Lock washer	1			
3	Flywheel	1	mark installation position and note when installing	friction surface must be free of oil and grease	M 7.1/2
4	Rubber seal	1		replace, oil lightly	
5	Flywheel dowel pin	4		check; replace if necessary	
6	Shim	3		use dial gauge bracket VW 659/2 determine thickness by setting axial play 0.07—0.13 mm (0.003—0.005 in.)	M 7.1/2
7	Crankshaft oil seal	1		replace; install with VW 204 b	M 7.1/3-1
8	Nut M 8, galvanized	4			
9	Lock washer, galvanized	4			
10	Generator support	1			
11	Generator support gasket	2		replace, if present	
12	Oil deflector plate	1		replace, if raised edge type; note installation position	M 7.1/2
13	Nut M 12×1.5	6		torque to 3.5 mkg (25 lb. ft.)	
14	Washer, 12.2×22	6			
15	Nut M 8, galvanized	6		torque to 2 mkg (14 lb. ft.) note sequence	
16	Lock washer, galvanized	6			
17	Bolt M 8×50, galvanized	1			
18	Nut M 8	9		torque to 2 mkg (14 lb. ft.) note sequence	
19	Lock washer	11			
20	Bolt M 8×50	2			
21	Crankcase	1		check for wear, clean joints, break edges of bearing bores	M 7.1/2
22	Plate	1			M 7.1/2

*) Type 1/Automatic Stick Shift gland nut without needle bearing and felt ring, 6 mm thinner hex.

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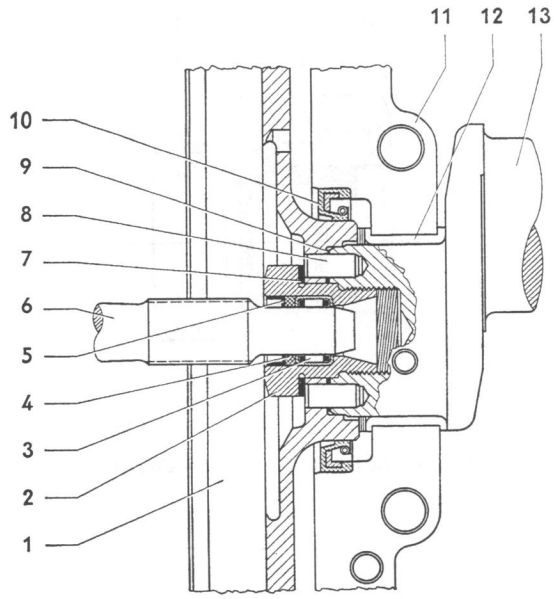
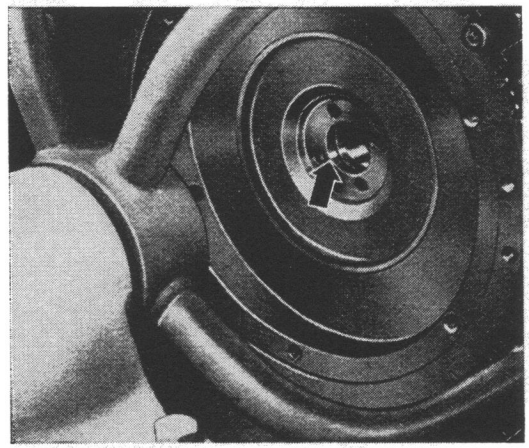
1 - Flywheel
2 - Gland nut
3 - Needle bearing
4 - Felt ring
5 - Retaining ring
6 - Main drive shaft
7 - Lock washer
8 - Dowel pin
9 - Rubber sealing ring
10 - Crankshaft oil seal
11 - Shims
12 - Crankshaft bearing
13 - Crankshaft

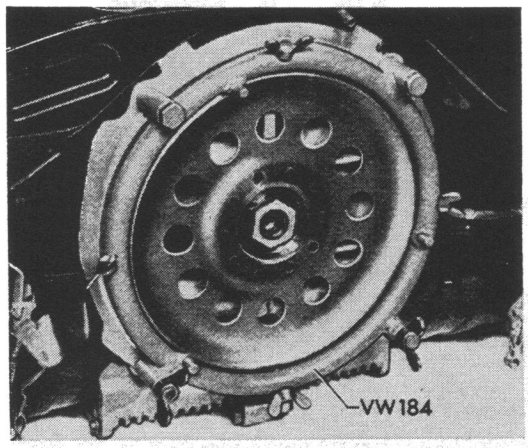


Removing

1 - When new engines have been assembled they are balanced. For this reason, mark position of flywheel (arrow) so that it is not too much out of balance when installed again.



2 - On engines of Automatic Stick Shift vehicles, the drive plate is held with VW 184 when unscrewing the gland nut.



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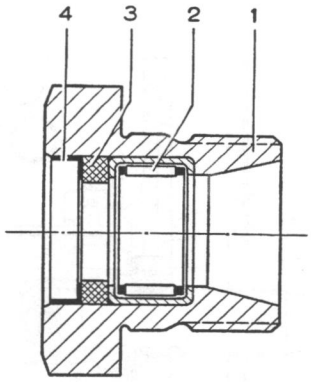


1 - Gland nut
2 - Needle bearing
3 - Felt ring
4 - End ring

Checking flywheel

1 - Check flywheel teeth for wear and damage. A maximum of 2 mm (0.078 in.) can be removed from a damaged gear ring on the clutch side. After deburring, chamfer the teeth.

2 - Check dowel pin holes in the crankshaft for wear.

3 - Check needle bearing for wear.

Installing

1 - Lubricate needle bearing with a small amount of multipurpose grease only if has been washed. Oil felt ring. Wipe excess lubricant off.

2 - Note mark denoting unbalance.

3 - Adjust axial play of crankshaft.

Disassembling crankcase

Use a rubber hammer to loosen the right-hand crankcase half. Do not insert sharp tools, such as screwdrivers etc., between the joining faces.

Checking

Note

Both halves of crankcase are machined together and must be replaced together.

1 - Flush the oil passages and blow them out with compressed air.

2 - Check studs for tightness. If the tapped holes are worn, Heli-Coil inserts can be installed.

Note

When replacing the crankcase of an engine manufactured before August 1970, various other parts will have to be replaced as well (see Parts Bulletin 1–12).

If the old cylinder head studs are to be used again in the new crankcase, the front stud above cylinder No. 3 must be replaced by a longer stud (see Parts Bulletin 1–12).

Assembling

1 - Spread an even film of sealing compound on the jointing faces of the crankcase halves. Be extremely careful not to let any sealing compound enter oil passages of crankshaft and camshaft bearings.

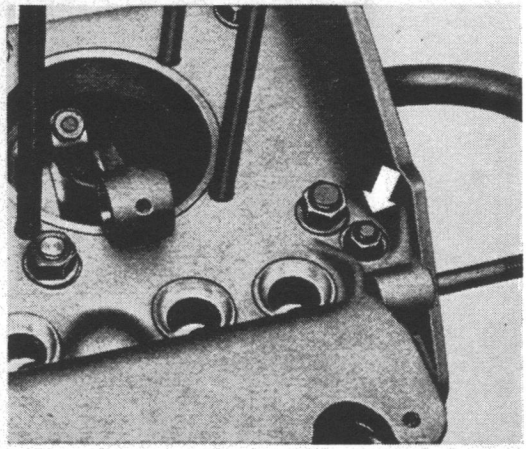
2 - Assemble housing halves.

3 - First tighten M 8 nut next to M 12 stud of main bearing No. 1 (arrow).

Then tighten M 12 nuts. This tightening sequence must be adhered to.

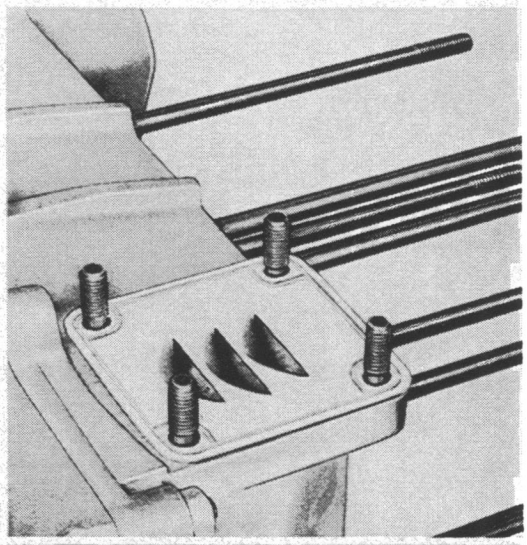
4 - Tighten M 8 and M 6 nuts.

5 - Turn the crankshaft to check for ease of movement.



6 - Install oil deflector plate between crankcase and generator support or breather support.

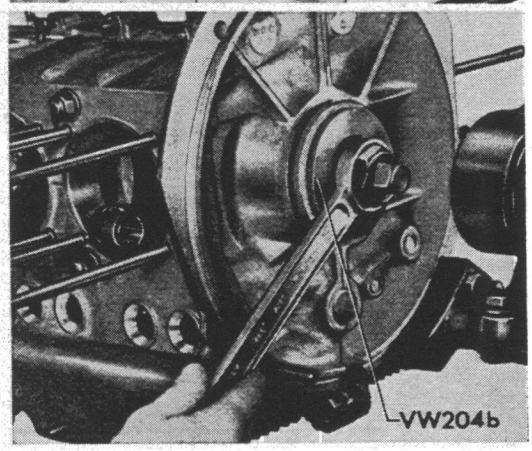
The three louvers in the oil deflector plate face downward and the slightly longer end of the louver faces rearward. The upper face of the plate is marked "top".



Installing crankshaft oil seal

Clean oil seal recess in crankcase and coat it with a thin film of sealing compound. If necessary, slightly chamfer the outer edge with a scraper to prevent the outer surface of the oil seal from being damaged. Remove metal shavings.

The oil seal must bed squarely in the crankcase recess.



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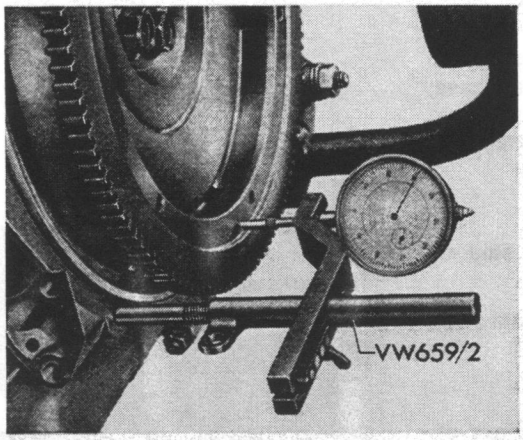

Checking

Crankshaft end play:

New — 0.07 to 0.13 mm (0.0027 to 0.005 in.)
Wear limit — 0.15 mm (0.006 in.)

Move crankshaft in and out and read axial play directly from dial gauge.

Adjusting end play

1 - Install flywheel with two shims but without the seals for crankshaft and flywheel.

2 - Attach dial gauge bracket VW 659/2 and dial gauge to crankcase.

3 - Move crankshaft in and out. Read end play off dial gauge.

4 - Determine thickness of third shim:

Dial gauge reading

— 0.10 (mean end play)

= third shim

5 - Remove flywheel.

6 - Insert seals for crankshaft and flywheel.

7 - Install flywheel and all three shims.

8 - Check end play again.

The thickness is etched on each shim. If necessary, measure the thickness with a micrometer.

Three shims of the required total thickness are to be installed.

Available shims:	Inside diameter in mm	Thickness in mm
	53.6	0.24
		0.30
		0.32
		0.34
		0.36

No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Camshaft	1	Check rivets and wear on bearings, journals and cams. Check gearwheel for wear and contact pattern.	Check run-out, max. when new 0.02 mm (0.0007 in.), wear limit: 0.04 mm (0.0015 in.) (measured at center bearing). Check axial play at thrust bearing: 0.04 to 0.13 mm (0.0015 to 0.0051 in.), wear limit: 0.16 mm (0.0062 in.). Watch matching and fitting position. Check backlash on full circumference of gear-wheel.	M 7.2/2 Fig. 1 Fig. 2 Fig. 3 M 5.1/3
2	Crankshaft and connecting rods	1		edges of oil holes in crank-shaft journals and bearings must be chamfered	M 7.2/2-2
3	Main bearing no. 1	1		check for wear apply oil; hole for dowel pin faces flywheel. Bearing play with housing pre-load: new — 0.04 to 0.10 mm (0.0015 to 0.0039 in.) wear limit: 0.18 mm (0.007 in.)	
4	End cap for camshaft bore	1		install with sealing compound; on engines with Automatic Stick Shift transmissions, base faces camshaft	
5	Camshaft no. 1 bearing shell	1			
6	Camshaft no. 2 bearing shell	1		check for wear apply oil; tabs engage in recesses in crankcase	
7	Left shell for no. 3 camshaft bearing (with thrust shoulder)	1			
8	Cam follower	4		check for wear, oil	
9	Shell for crankhsaft no. 2 bearing	1		check for wear, oil bearing play with housing pre-load: new — 0.03 to 0.09 mm (0.001 to 0.003 in.) wear limit: 0.17 mm (0.006 in.)	
10	Dowel pin for crankshaft bearing	4		check for tightness	Fig. 4
11	Crankcase joint seal	6		replace	
12	Left crankcase half	1			

The following parts are not shown in the illustration but they are installed in right-hand half of crankcase before assembly:

(13)	Dowel pin for crankshaft bearing no. 2	1		check for tightness
(14)	Shell for crankshaft bearing no. 2	1		check for wear, oil
(15)	Shell for camshaft bearing no. 1	1		
(16)	Shell for camshaft bearing no. 2	1		check for wear, tabs engage in recess in crankcase; oil
(17)	Shell for camshaft bearing no. 3	1		
(18)	Cam follower	4		check for wear apply oil; hold with spring clips VW 171

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Note

The backlash between camshaft and crankshaft gears should be: 0.00—0.05 mm (0.00—0.002 in.).

The camshaft gear size is correct if the backlash is hardly noticeable and the camshaft does not lift when crankshaft is turned backward.

To assist in obtaining the specified backlash camshafts are available with various sized timing gears under different part numbers.

The camshaft gears are marked, for example —1, 0, +1, +2 on their inner face. The digits indicate in $^1/_{100}$ mm how much the pitch radius departs from the standard pitch radius which is denoted by "0".

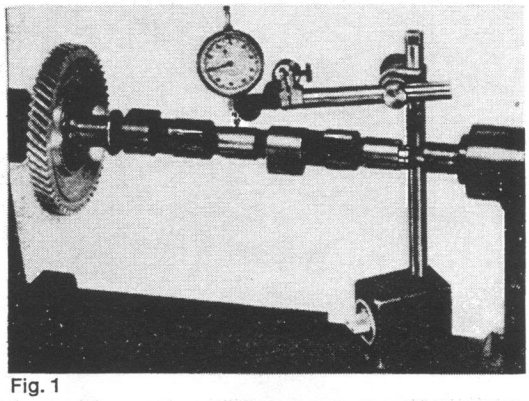


Fig. 1

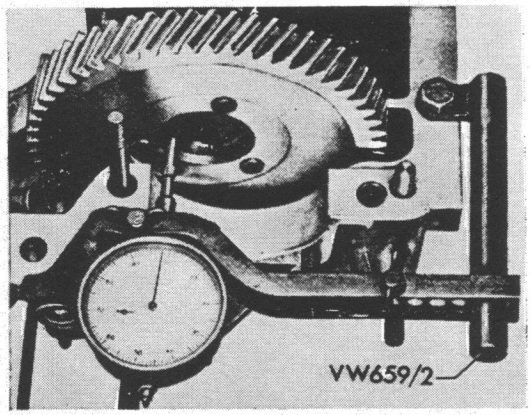


Fig. 2

Caution

The mark "0" (arrow) on the outer face of each camshaft timing gear is to ensure correct timing and must not be confused with the markings on the inner face.
The crankshaft timing gear is obtainable in one size only and has no special marking.

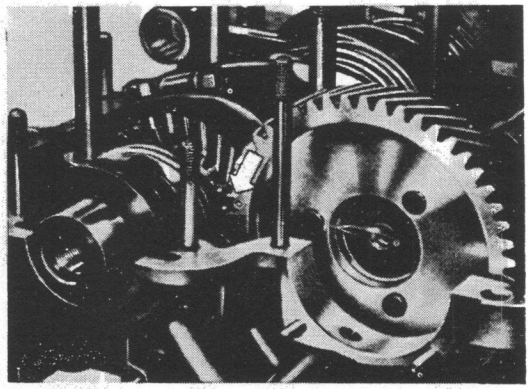


Fig. 3

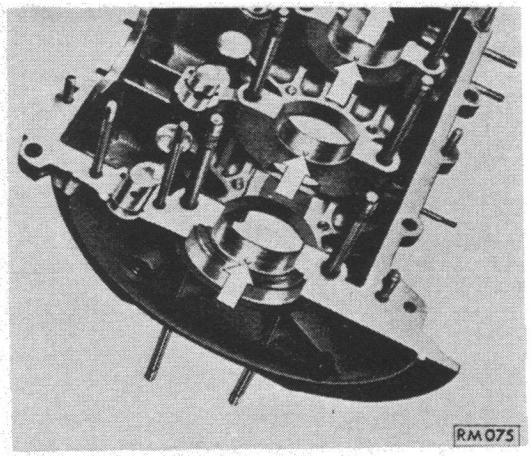


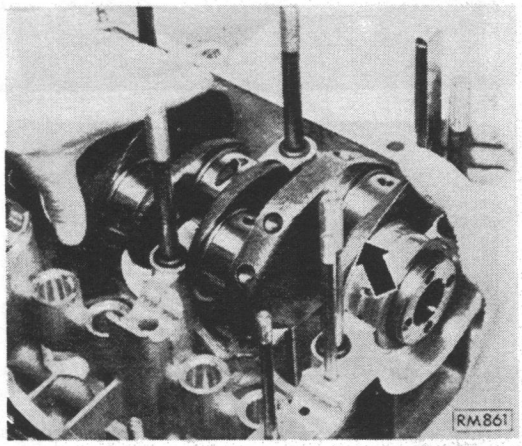
Fig. 4

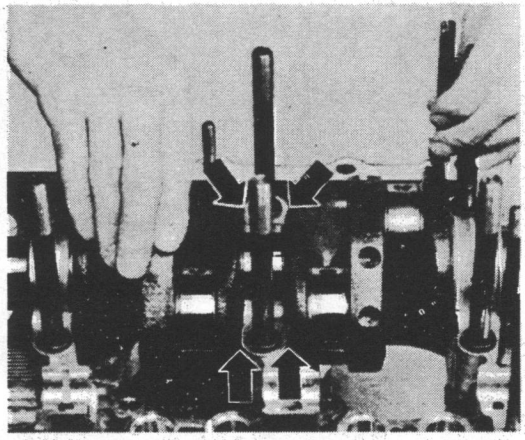
Note

If a new crankcase (with threaded inserts) is to be used as a replacement for an old crankcase (without threaded inserts) and the same crankshaft is to be reused, note the following:

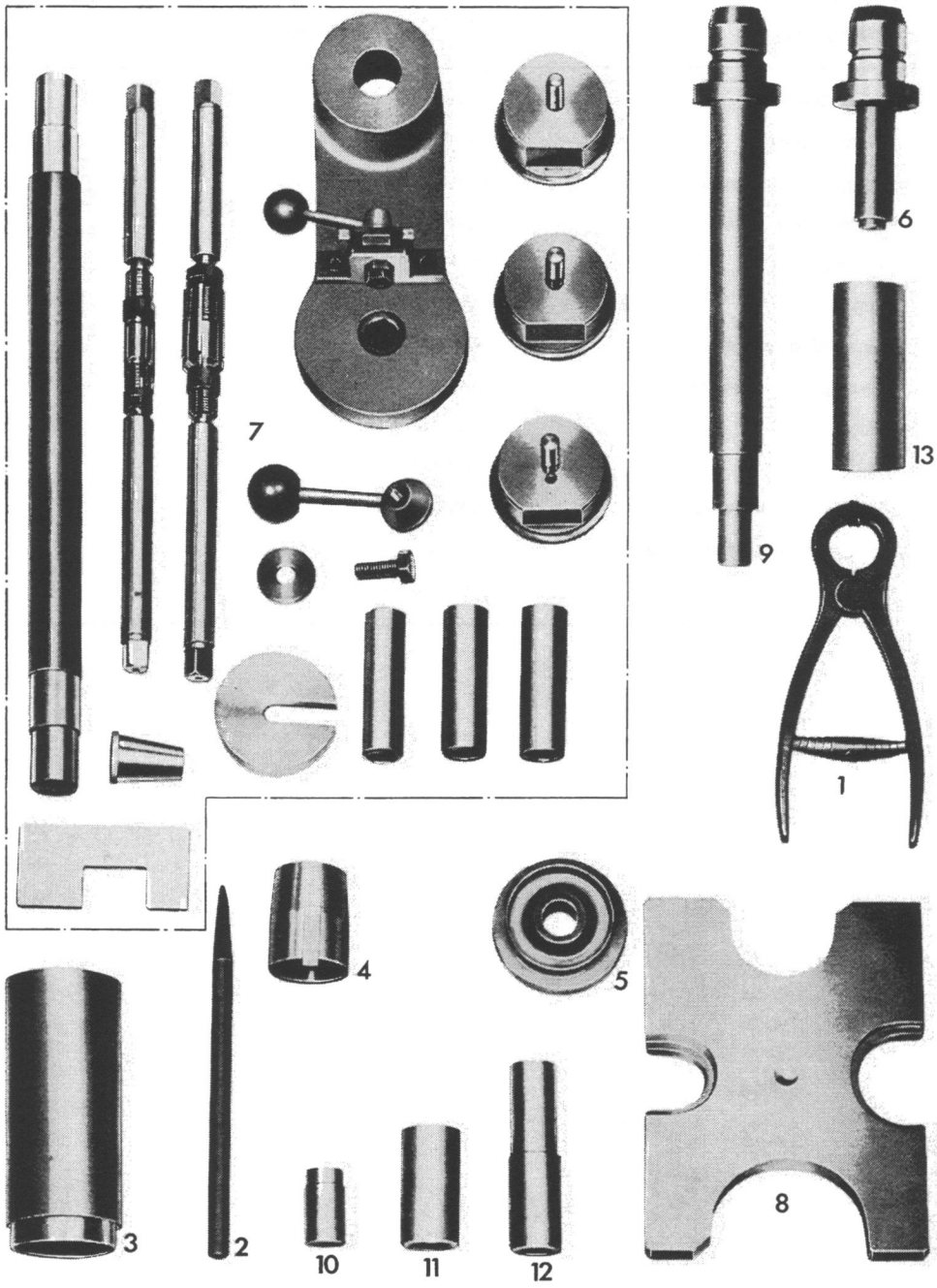
1 - Place the crankshaft with bearings in the left half of the crankcase.

2 - Push a 0.5 mm (0.020 in.) feeler gauge blade between main bearing I and the crankshaft (arrow).





3 - Turn the crankshaft, under light pressure, against the feeler gauge blade and note the clearance at main bearing web II. If the crankshaft contacts the housing (arrow), both crankcase halves must be ground off at the locations concerned.



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No.	Description	Special tool	Remarks
1	Circlip pliers	VW 161 a	
2	Peening chisel	VW 124 a	
3	Tube, 60 mm diameter	VW 415 a	
4	Guide sleeve, tapered	VW 428 a	
5	Thrust pad	VW 442	
6	Punch	VW 409	
7	Connecting rod repair tool	VW 214 f	
8	Thrust plate (converted)	VW 402	
9	Punch	VW 408 a	
10	Arbor	VW 434	
11	Tube, 31,5 mm diameter	VW 418 a	
12	Tube, 28 mm diameter; 100 mm	VW 421	
13	Tube, 37 mm diameter	VW 416 b	

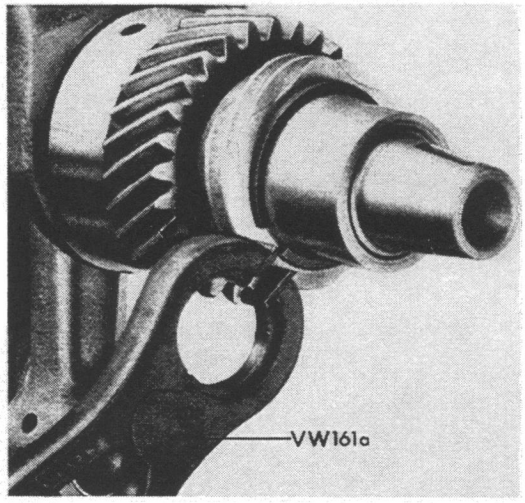

Fig. 1

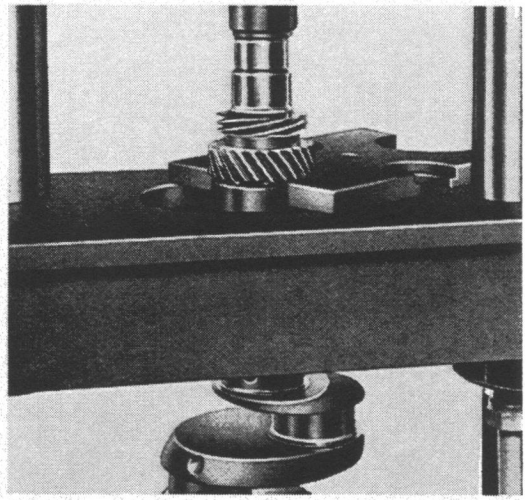

Fig. 2

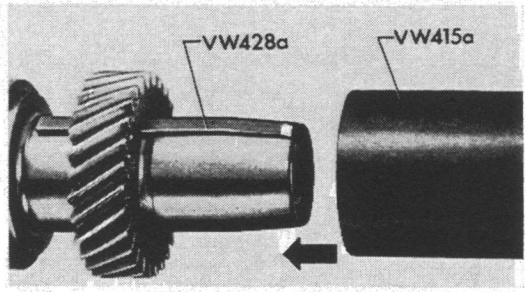

Fig. 3

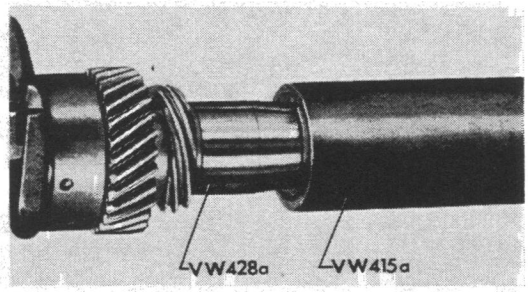

Fig. 4

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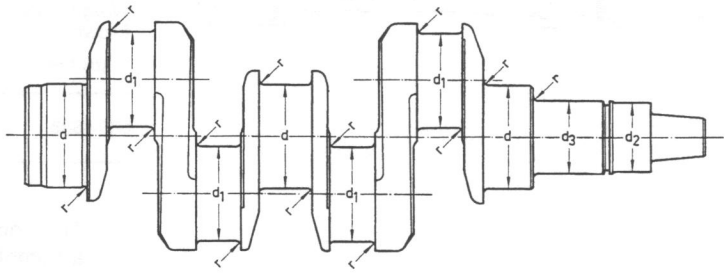
Regrinding crankshaft

For reconditioning the following measurements should be obtained:

	Main journals Nos. 1, 2 and 3 (d)		Connecting rod journals (d_1)		Main journal No. 4 (d_2)	
	Nominal diameter	Lapped diameter	Nominal diameter	Lapped diameter	Nominal diameter	Lapped diameter
Standard	55.00 mm 2.1653 in.	54.990 mm 2.1648 in. 54.971 mm 2.1642 in.	55.00 mm 2.1653 in.	54.996 mm 2.1654 in. 54.983 mm 2.1653 in.	40.00 mm 1.5748 in.	40.00 mm 1.5748 in. 39.984 mm 1.5742 in.
1st Undersize	54.75 mm 2.1555 in.	54.740 mm 2.1551 in. 54.721 mm 2.1544 in.	54.75 mm 2.1555 in.	54.746 mm 2.1555 in. 54.733 mm 2.1550 in.	39.75 mm 1.5650 in.	39.750 mm 1.5650 in. 39.734 mm 1.5643 in.
2nd Undersize	54.50 mm 2.1457 in.	54.490 mm 2.1453 in. 54.471 mm 2.1445 in.	54.50 mm 2.1457 in.	54.496 mm 2.1459 in. 54.483 mm 2.1451 in.	39.50 mm 1.5550 in.	39.50 mm 1.5551 in. 39.484 mm 1.5545 in.
3rd Undersize	54.25 mm 2.1358 in.	54.240 mm 2.1353 in. 54.221 mm 2.1347 in.	54.25 mm 2.1358 in.	54.246 mm 2.1352 in. 54.233 mm 2.1347 in.	39.25 mm 1.5453 in.	39.250 mm 1.5452 in. 39.234 mm 1.5446 in.

Thorough grinding of the radii is of great importance to the life of the crankshaft. Try to get a radius of 2.5 mm. Repolish the radii.



On no account must the bearing shells be re-machined.

After grinding, remove sharp edges on oil passages by slightly chamfering them.

Crankshaft timing gear and distributor drive gear must be a press fit on the crankshaft $\frac{42.006 \text{ mm}}{41.995 \text{ mm}}$ dia. $\frac{1.6538 \text{ in.}}{1.6533 \text{ in.}}$

Where the gears are worn from being removed and installed several times, the press fit can be restored by chromium plating or metal spraying.

To make sure the crankshaft is free from internal cracks, perform a "ringing test" prior to installation. The crankshaft must then be checked for run-out.

$$d_3 = \frac{42.006}{41.995} \text{ mm dia. } \frac{1.6538}{1.6533} \text{ in.}$$

$$r = \frac{2.5}{2.0} \text{ mm } \frac{0.10}{0.08} \text{ in.}$$

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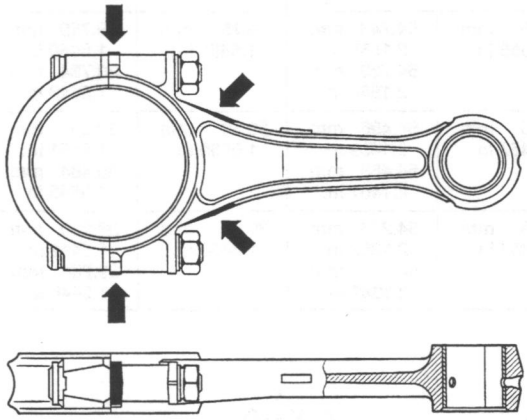


Checking

1 - Check connecting rods for external damage.

Note

Connecting rod bolts must be driven or pressed out. If connecting rod bolts are damaged, the complete connecting rod must be replaced.

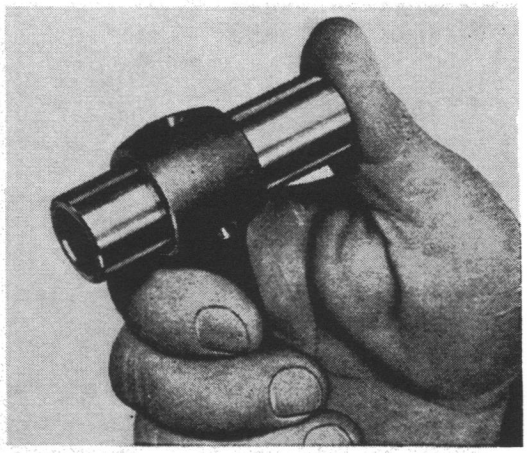
2 - Check weight of connecting rods:

The difference in weight between the connecting rods in an engine must not exceed 10 grams. If one or more connecting rods are replaced, all of them must be re-weighed, as connecting rods in two weight ranges only are supplied as spare parts (see table).

If necessary, metal should be removed from the heavier connecting rods at the points indicated in the drawing. A reduction of approximately 8 grams in weight can thus be obtained.

Weight class brown in grams	Weight class gray in grams
580–588	592–600

The connecting rod weight is the weight of a complete connecting rod without bearing shells.



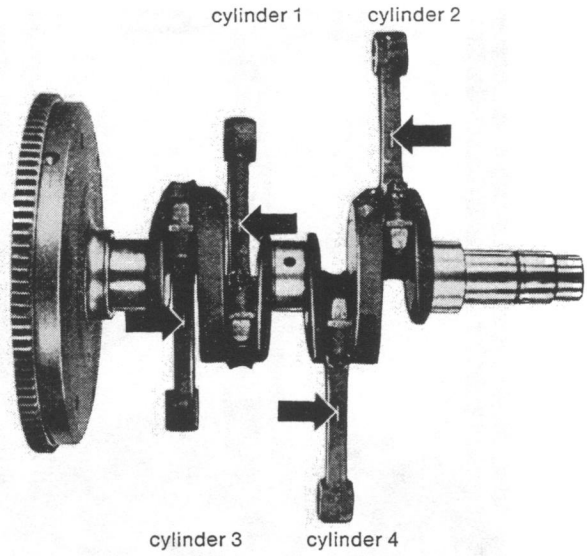
3 - Check piston pin bushing. At room temperature the piston pin should be a push fit in a new bushing.

4 - Check connecting rod in appliance. If necessary, correct alignment.

Installing

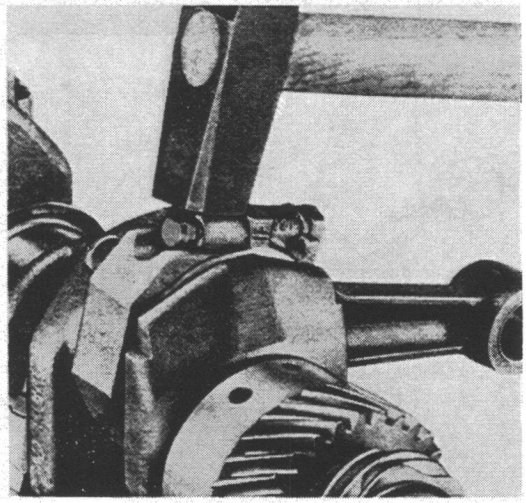
1 - The figures near the joint of the connecting rod and cap must be on the same side.

2 - The forged mark on the connecting rod must be upward on installation (arrows).



3 - Slight pretension between the bearing halves, which can occur when tightening the connecting rod bolts, can be eliminated by light hammer taps on both sides of the connecting rod.

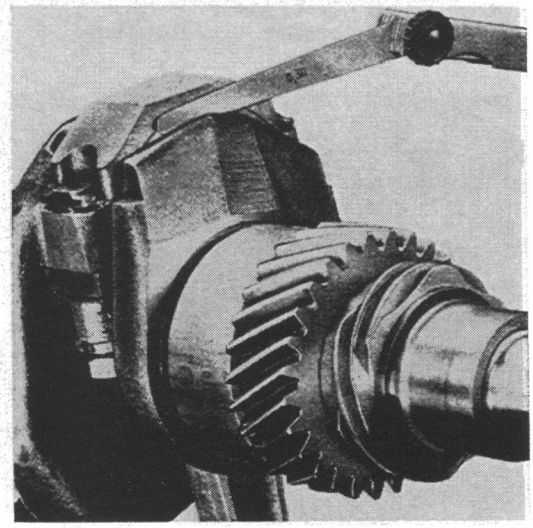
The connecting rod must fall smoothly under its own weight. On no account is it permissible to scrape, ream or file the bearings.



4 - Measure axial play of connecting rods with a feeler gauge.

New: 0.1—0.4 mm (0.004—0.0016 in.)

Wear limit: 0.7 mm (0.028 in.)



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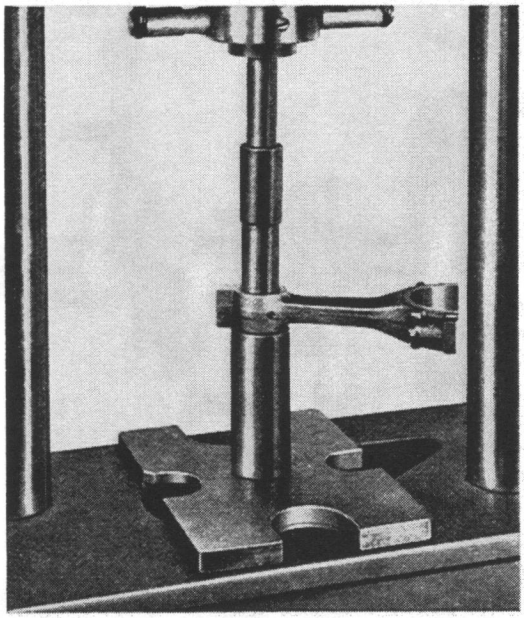
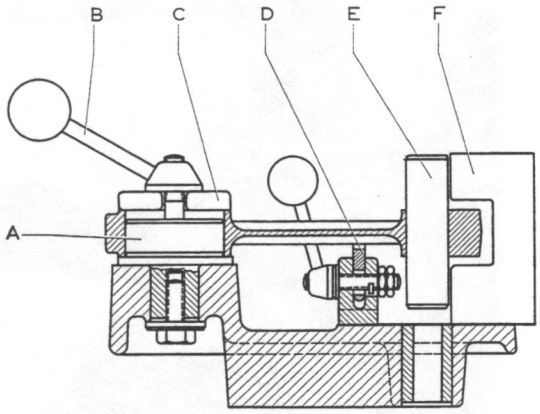


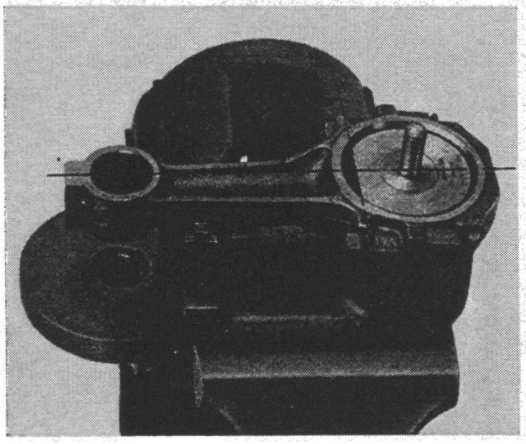
Connecting rods which are slightly bent can be straightened and the bushings can be replaced if worn.

1 - Press bushing out on press, using VW 402, VW 408 a and VW 416 b.



A - Mandrel
B - Locking lever
C - Washer
D - Support
E - Pin
F - Gauge

2 - Place mandrel (7 mm eccentric) in VW 214 f and attach connecting rod.



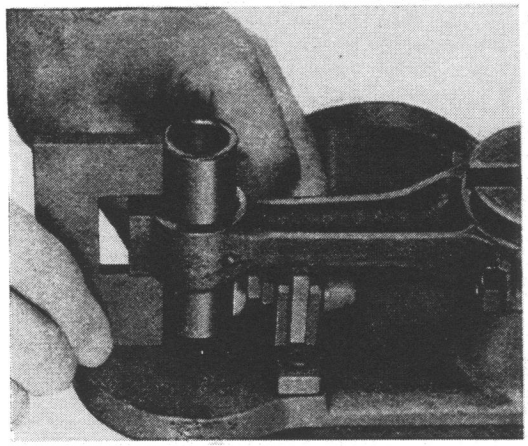
Turn mandrel "A" so that the flat is at right angles to center line of connecting rod.

3 - After inserting washer "C", tighten locking lever B until connecting rod can just be moved in both directions. Support "D" is not tightened.

4 - Insert pin "E" into connecting rod and push it toward mandrel "A" with two fingers so that there is no tilt between mandrel and big end of connecting rod or between connecting rod eye and pin.

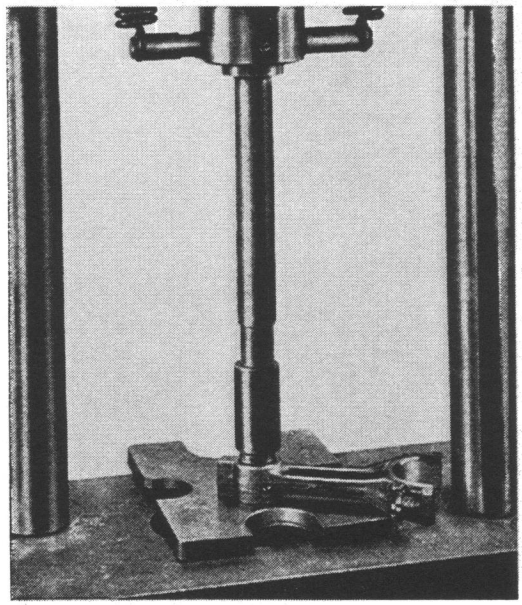
5 - Check connecting rod for twist and parallelism with the gauge "F".

(The picture shows the parallelism check.)



If deviations occur, tighten locking lever and straighten connecting rod with the bar.

6 - Press bushing in, using press tools given in chart.



7 - Drill oil holes (3.5 mm diameter).

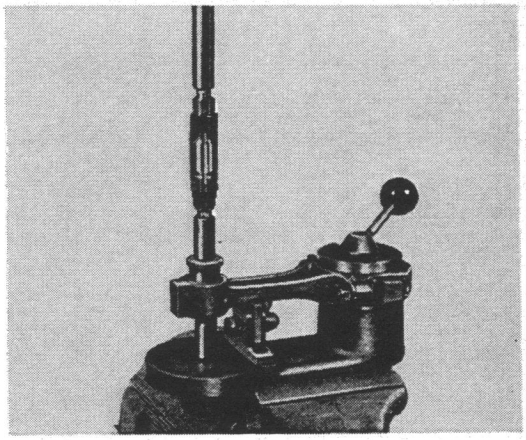
8 - Insert reamer through connecting rod eye and corresponding hole in device. The conical bushing ensures correct centering of piston pin bushing.

Tighten locking lever and support.

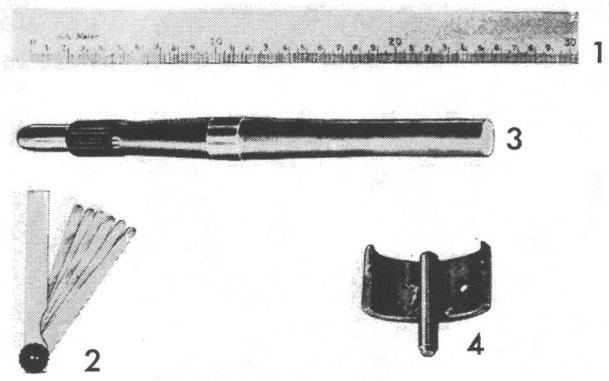
9 - Ream connecting rod bushing. Inside diameter:

22.009 to 22.017 mm (0.8664 to 0.8667 in.).

The bushing bore must be free from scores and chatter marks after reaming. Without applying oil, the piston pin must be a light push fit. It is not permissible to fit an oversize piston pin in order to eliminate excessive clearance between piston pin and bushing. A new bushing must, in all cases, be installed and reamed to size.



10 - Re-check connecting rod for parallelism and twist as mentioned previously, but this time with piston pin installed. Slight deviations can be corrected by inserting a bar into piston pin and straightening.



No.	Description	Special tool	Remarks
1	Straight edge		at least 200 mm long
2	Feeler gauge		
3	Drive shaft (part of)		
4	Flywheel retainer	VW 215 c	

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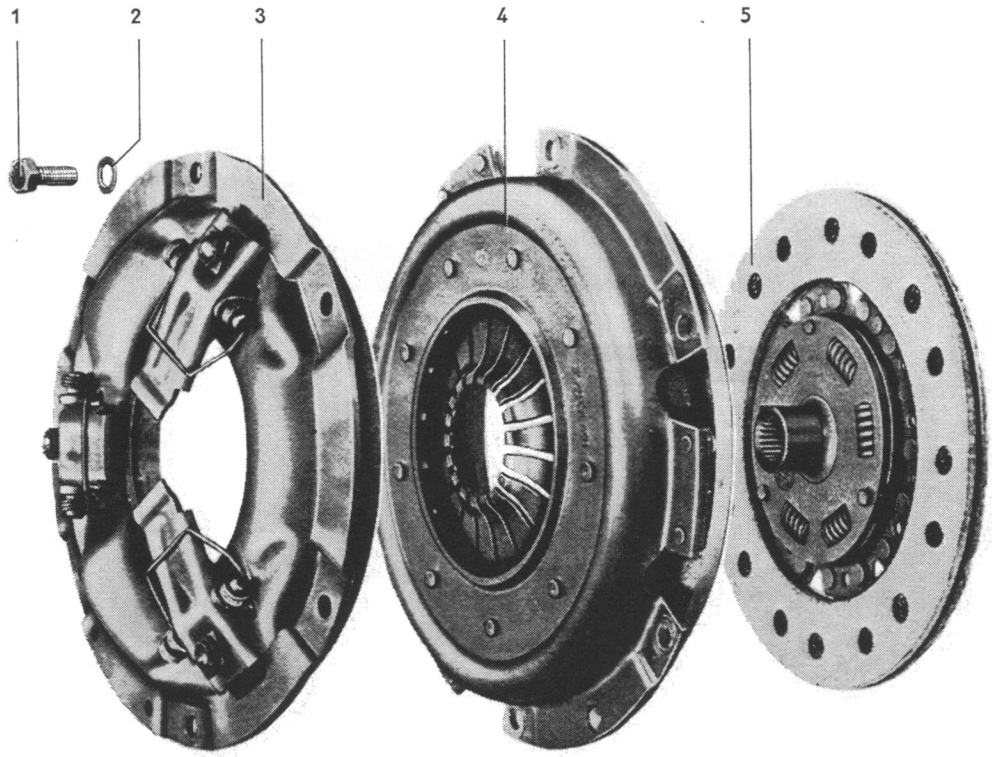

No.	Description	Qty.	Note when removing	Note when installing	Special instructions see
1	Bolt M 8×15	6	loosen diagonally	torque diagonally to 2.5 mkg (18 lb ft)	
2	Lock washer	6			
3	Disc spring clutch (up to July 1972, Chass. No. 112 2961 362)	1	mark position	(up to July 1970 with release ring) clean and check surface for wear	Fig. 1 Fig. 3
4	Diaphragm spring clutch (from Aug. 1972, Chass. No. 113 2000 011)	1	mark position	check tightness of rivets, clean and check surface for wear	Fig. 1 Fig. 3
5	Clutch disc	1		check for wear, check splines, plate must slide freely on the main shaft without excessive play check rivets and disc for run-out lubricate drive shaft splines with molybdenum disulfide powder	Fig. 2 Fig. 3

Removing

1 - New engines are balanced during factory assembly. To avoid imbalance after the engine has been reassembled, mark the position of the clutch on the flywheel (arrow).

2 - Loosen mounting bolts alternately and diagonally.

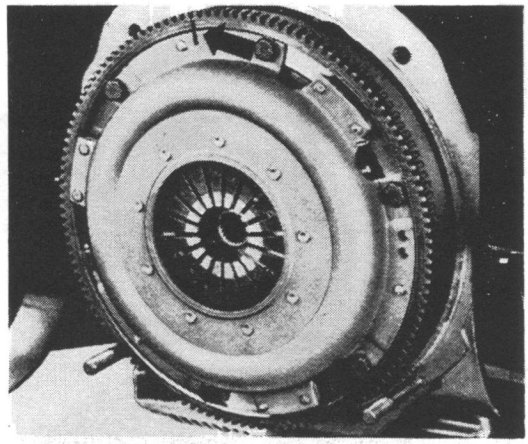

Fig. 1

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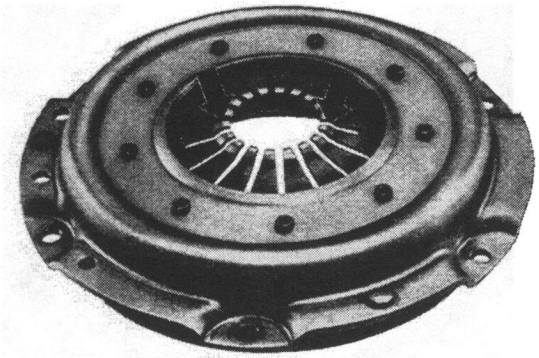
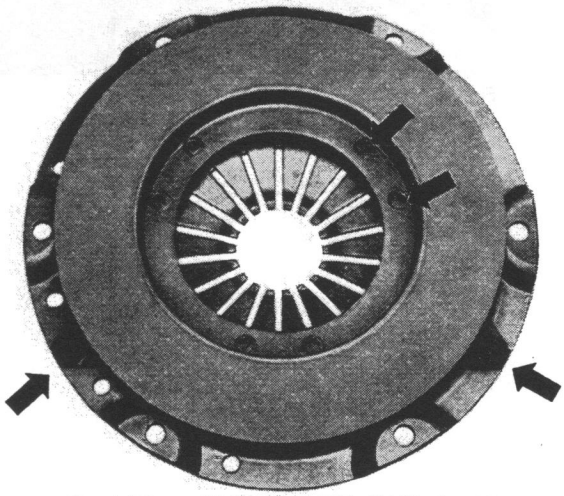


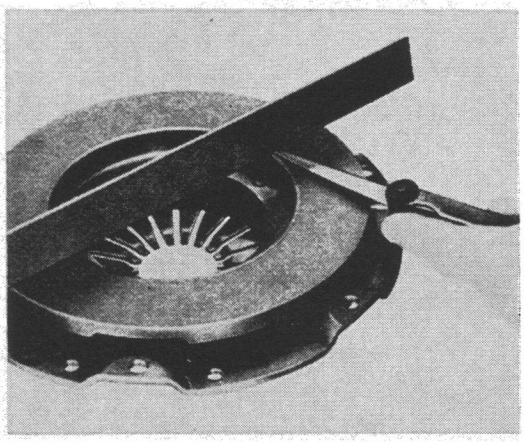


Checking

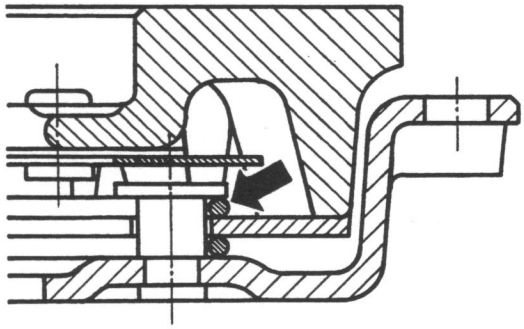
1 - Check ends of diaphragm spring (arrows) for scoring where the release bearing contacts. Scores up to a depth of 0.3 mm (0.012 in.) can be ignored.

2 - Check straps between pressure plate and cover for cracks. Check tightness of rivets (arrows).

Clutch with damaged or loose rivets should be replaced.



3 - Check pressure plate friction surface for cracks, burn marks and wear. Pressure plates on which the friction surfaces have an inward taper of up to 0.3 mm (0.012 in.) can be used again.



4 - The diaphragm spring is riveted to the clutch cover and held between two wire rings.

If the rivet heads or rings show signs of wear, the clutch should be replaced.

Checking clutch disc

Maximum run out: 0.5 mm (0.02 in.) measured at 195 mm (7.677 in.) diameter.

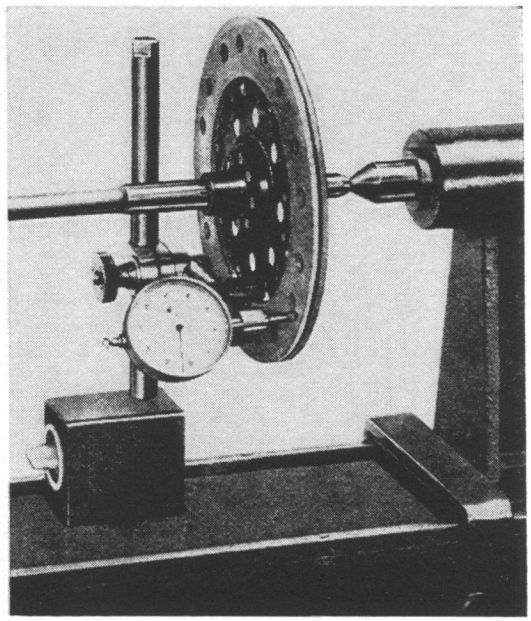


Fig. 2

Installing

1 - The needle bearing in the gland nut should only be lubricated after it has been washed in solvent. Use about 0.2 cm^3 of multi-purpose grease. Apply oil to felt ring. Wipe off excess lubricants.

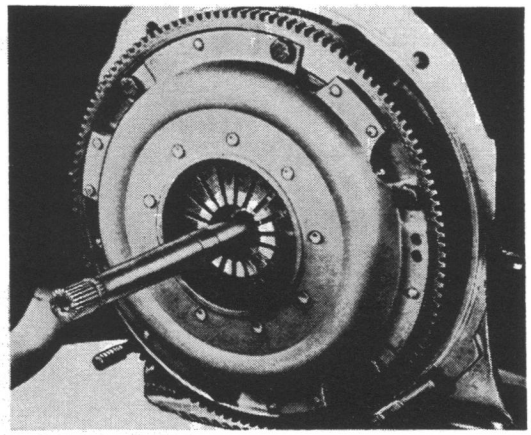
2 - Check clutch and clutch driven plate. Instructions on this are given in the sections "Clutch Checking" and "Clutch Driven Plate".

3 - Check drive shaft splines and lubricate sliding surfaces with molybdenum disulfide powder. The powder should be applied lightly with a brush or cloth.

The driven plate must slide freely on the splines without excessive clearance.

4 - Clean the release bearing by wiping with a clean cloth. Replace noisy and oily bearings. Make sure retaining springs are correctly positioned.

Grease guide bushing lightly with molybdenum disulfide paste (only on centrally located release bearing).



5 - Insert clutch plate into flywheel.

A shortened main drive shaft can be used to center the driven plate.

6 - Install clutch with marks aligned. New parts without marks can be installed in any position.

7 - Tighten bolts uniformly and diagonally to 2.5 mkg (18 lb ft).

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Installing

1 - Check release bearing. The ball bearing is maintenance-free. On no account must the bearing be washed with benzine or other cleaning fluids. Merely use a clean cloth to clean it. Replace internally noisy bearings.

2 - Roughen plastic ring with coarse emery cloth and apply molybdenum disulfide paste sparingly.

3 - Lightly coat the pivoting points between release bearing and operating shaft with multipurpose grease.

4 - Install retaining springs.

5 - Note that retaining springs are positioned correctly.

6 - Check clutch pedal free-play after the engine has been installed. Re-adjust if necessary.

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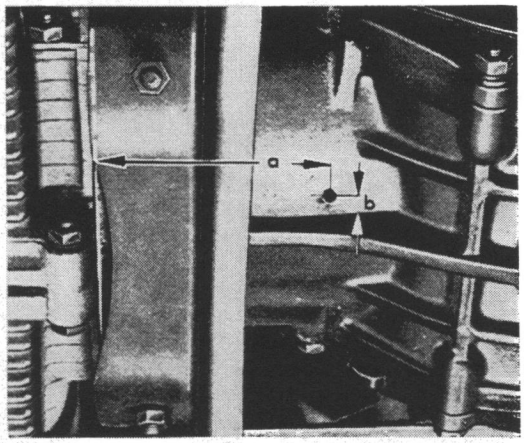
Lubricating plastic ring

Slight oscillation between the plastic ring on the release bearing and the clutch release ring can, under certain conditions, cause a whistling noise. The noise is harmless and does not affect the service life or the operation of the release bearing. Experience has shown that in such cases, lubricating the plastic ring with molybdenum disulfide based paste will stop the noise. Replacement of the bearing because of the noise described above is not justified.

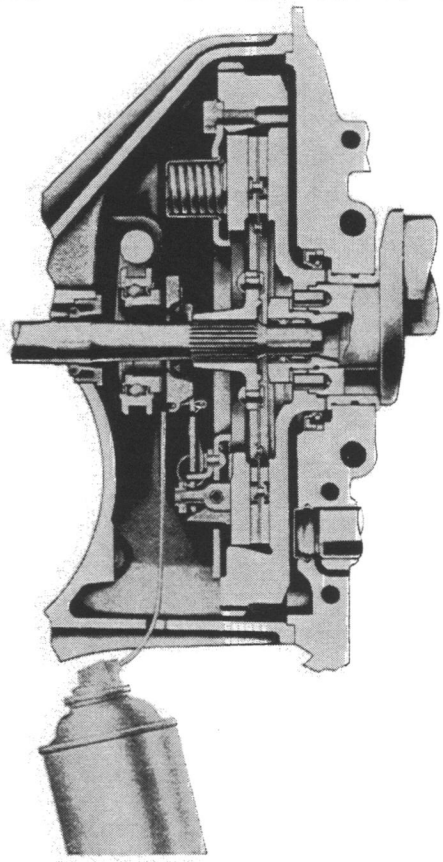


1 - Lift vehicle and drill a 10 mm ($^{23}/_{32}$ in.) hole in the transmission case at the point shown in illustration.

"a" = 67 mm ($2^{5}/_{8}$ in.)

"b" = 10 mm ($^{23}/_{32}$ in.)

2 - Increase the space between release bearing and release ring by unscrewing the adjusting nut on the clutch cable about 5 turns.



3 - Spray plastic ring on release bearing and release ring with a molybdenum disulfide based lubricant.

Spraying time – max. 2 seconds.

Note

Use only a spray compound with a molybdenum disulfide base which contains no oil or grease.

Use an extension for the spray can 140 mm (5.5 in.).

4 - Close the hole with rubber buffer, Part No. 211 843 749.

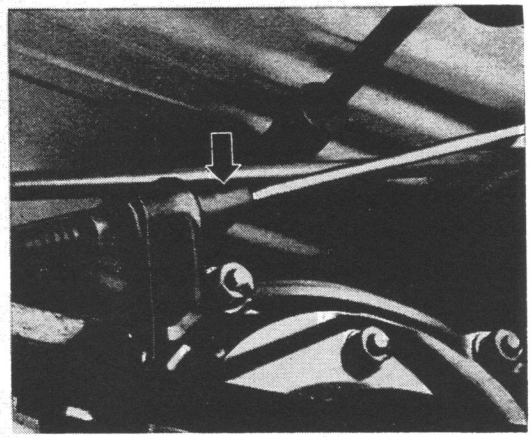
5 - Adjust clutch free play.

Removing

1 - Disconnect clutch cable from clutch operating lever.

2 - Withdraw rubber sleeve from guide tube and cable (arrow).

Remove pedal cluster (see B 2.7/1).



Installing

1 - Check threaded part of clutch cable for freeness and grease clutch cable with multipurpose grease.

2 - Insert clutch cable as shown in illustration.

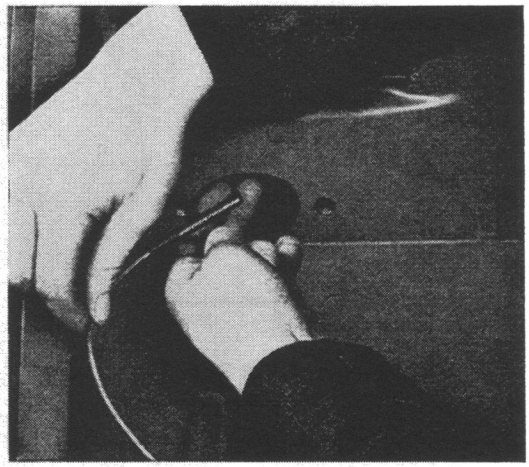
3 - Grease clutch cable eye and clutch pedal shaft with multipurpose grease.

4 - Note correct position of the rubber sleeve at the end of the guide tube.

5 - Adjust clutch play.

6 - Grease wing nut for clutch cable with multipurpose grease.

Install pedal cluster (see B 2.7/1).



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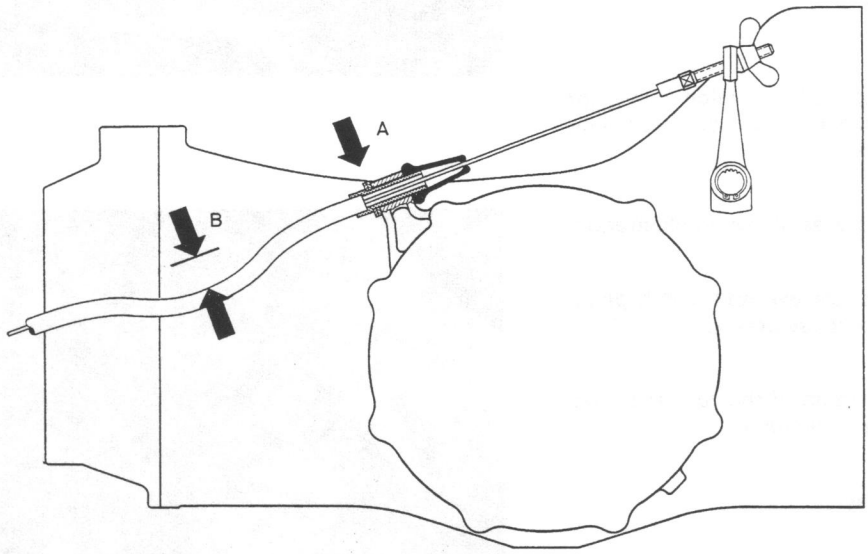
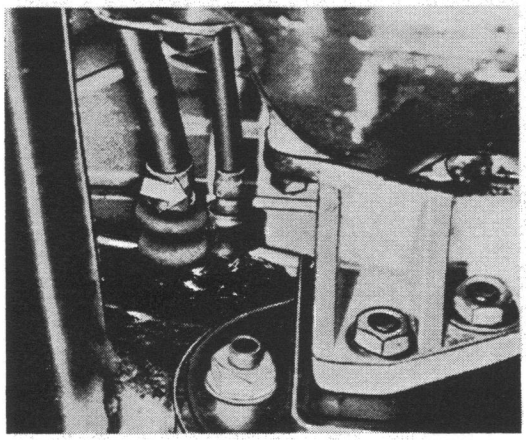
Note

The clutch cable guide tube should sag 25–45 mm (1–1 25/32 in.) (B). This preload is obtained by inserting washers between the bracket on the transmission and the end piece of the guide tube (A).

If the cable guide tube is bent down too much it will make the cable stiff in operation and can create noises or cause breakage of the cable. This trouble can be remedied by shortening the guide tube at the rear end after removing tube and cable.





The guide for the clutch cable has been provided with a hole (arrow) to lubricate the clutch cable.

If the clutch cable creaks, jams or is stiff in operation, it should be lubricated carefully via the lubrication hole.

Use a manual lever-type grease gun with the nozzle as used for the Type 1 door hinges.

After lubricating reinstall the sealing boot for the cable guide.

Clutch cable

From October 1971, Chassis No. 112 2205 116, the clutch linkage has been altered (see Workshop Manual H). In addition, the bow of the clutch cable has been increased to approximately 70 mm ($2^3/_4$ in.).

If the clutch cable is broken on a vehicle produced after this Chassis No. the following parts are to be used for the repair:

Clutch cable – Part No. 113 721 335 A
total length 2260 mm ($89^{31}/_{32}$ in.)

Clutch cable sleeve – Part No. 311 721 361
total length 330 mm (13 in.)

Washer – Part No. N 11 531.4

When installing these parts the bend in the clutch cable sleeve is reduced to 25–45 mm ($1–1^{25}/_{32}$ in.).

Note

The cable must be well greased before it is installed. Push the washer onto the rear end of the cable sleeve. Install the sleeve together with the rubber seal in the bracket on the transmission first. Ensure that it is installed properly on the guide tube.

Turn the lubricating hole downward and make sure that the sealing rubber is sitting correctly. Adjust the clutch pedal free play and coat the threaded end with grease.

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Clutch play:

Between clutch lever and wing nut = 1–2 mm ($^1/_{32}$–$^3/_{32}$ in.). Pedal free-play (a) = 10–20 mm ($^{13}/_{32}$–$^{13}/_{16}$ in.).

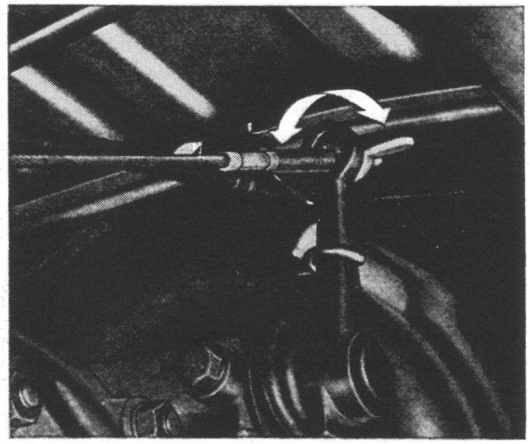
As the clutch linings wear, the clearance between release bearing and release ring is reduced. If there is no play, the clutch pressure is reduced which can lead to clutch slippage and the linings becoming burnt.

Adjusting

1 - Adjust the clutch by turning the wing nut (arrow) until the pedal free-play is

"a" = 10–20 mm ($^{13}/_{32}$–$^{13}/_{16}$ in.)

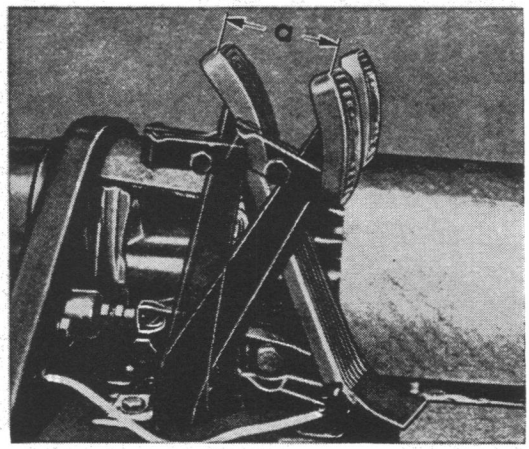
When the free-play is correct, there will be clearance of about 2 mm ($^3/_{32}$ in.) between clutch lever and wing nut.



2 - After adjusting, make sure that the two lugs of the wing nut engage into the cutouts in the clutch lever.

3 - Depress clutch pedal several times and check play again.

4 - Lubricate threads of clutch cable, wing nut and countersunk hole in clutch lever with multipurpose grease.



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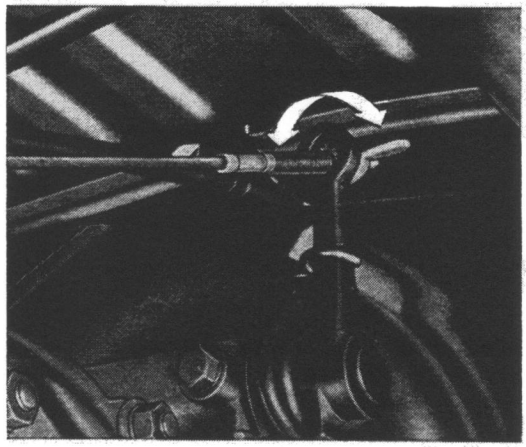
Adjusting clutch play

Types 1, 2, 3

The clutch is to be adjusted so that there is a clearance of .04—.08 in. (1—2 mm) between the release bearing and the release ring with the clutch engaged. Measured at the clutch pedal, the free-play is between .4 and .8 in. (10 and 20 mm). The free-play is adjusted with the wing nut on the clutch operating lever.

As the clutch linings wear, the clearance between release bearing and release ring is reduced. If there is no play at all, the clutch pressure is reduced which can lead to clutch slippage and the linings becoming burnt.

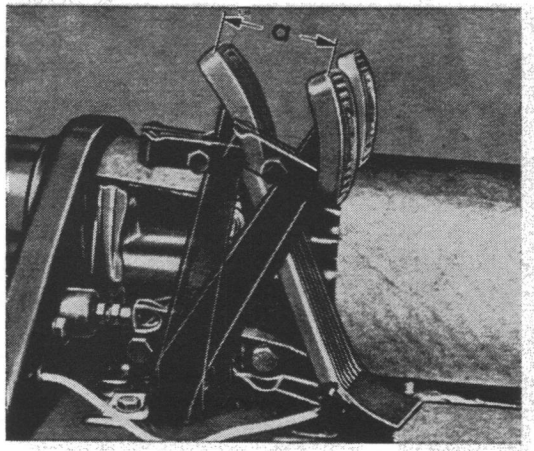


Adjusting

1 - Grip the clutch cable tightly with combination pliers and adjust the clutch by turning the wing nut until the pedal free-play is

a = .4—.8 in. (10—20 mm)

There will be clearance of about .08 in. (2 mm) between clutch lever and wing nut.



2 - After adjusting, ensure that the two lugs of the wing nut engage into the cutouts in the clutch lever.

3 - Depress clutch pedal several times and check play again.

4 - Lubricate threads of clutch cable, wing nut and countersunk hole in clutch lever with multipurpose grease.

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Repairing tapped holes

Damaged or broken threads, on cylinder head for example, can be made reserviceable by installing appropriate HELI-COIL thread inserts.

Sequence of operations

1 - Enlarge damaged tapped hole to nominal diameter.

2 - Cut new thread with appropriate HELI-COIL tap and clean.

HELI-COIL assortment for Volkswagen.

Thread sizes: M 6×1 (VW interference fit)
M 7×1
M 8×1.25 (VW interference fit)
M 10×1.5 (VW interference fit)
M 10×1.5
M 12×1.5
M 14×1.25
M 14×1.5

3 - Place insert into chamber of installing tool.

Caution

The tang of the insert must be at the bottom, as it engages the slot in the installing tool. As soon as the tang engages the slot in the tool, turn tool slowly until the insert is turned by the tensioning sleeve. Then place installing tool over newly tapped hole, screw thread insert in to required depth and withdraw installing tool. The insert should be $^1/_4$ to $1^1/_2$ threads below the surface.

4 - Break tang off thread insert with suitable pliers.

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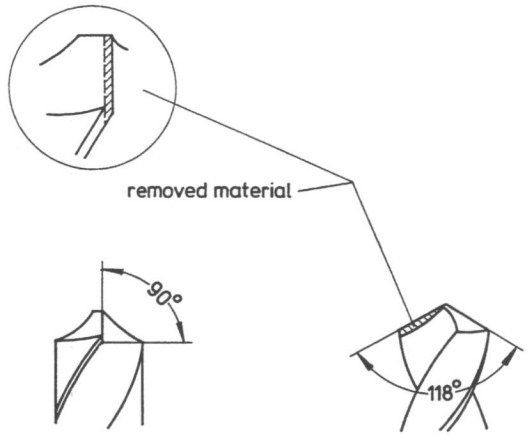
When cylinder head studs are loose or have pulled out of the crankcase it is advisable to install threaded steel inserts (available under Part. No. ZVP 107101).

These inserts have a locking feature on the outside diameter for the crankcase material as well as on the inside diameter for the crankcase stud. Oil leakage is prevented by using closed end inserts for the open stud holes.

A special tool set (US 4415) has been developed to provide the proper interference fit between crankcase and insert.

1 - Place drill and tap jig in cylinder bore. Align the small hole with pilot into the stud hole and lock jig with wingnut.

2 - Drill through ($^{33}/_{64}$" diameter) on open holes, respectively drill blind holes to the depth of former thread. (To assure effective cutting into the magnesium crankcase and to avoid "sudden grabbing", the drill has to be dressed on the cutting lips to 90°, per sketch.)



3 - Repeat the same operation on the 3 remaining holes per cylinder.

4 - Line up drill and tap jig with large diameter of pilot, lock with wingnut for tapping operation.

5 - Cut $^{9}/_{16}$" thread (modified) with special tap by hand or with a $^{3}/_{8}$" reversible impact wrench.

6 - Remove drill jig and install the appropriate insert with insert tool US 4415-6.

The correct installation depth is achieved when the distance between tool and cylinder sealing surface is 1 mm, i.e. when the upper surface of the insert is slightly below the surface of the cylinder seat.

7 - Lock insert with insert tool by driving the 4 "Kee's" into the crankcase material with hammer.

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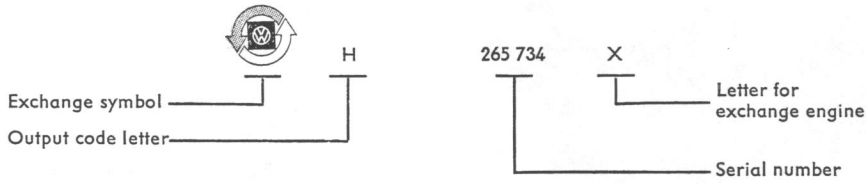
VW exchange engines are stamped with the exchange symbol and an exchange number. The exchange number consists of an output code number, a serial number and the letter X for exchange engine. Before October 1968 the letter X was not stamped on exchange engines.

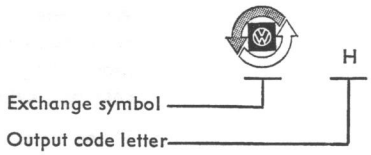
e. g. for VW exchange engines



VW exchange short block engines.

From April 1972 short block engines are only stamped with the exchange symbol and an output code letter. When a short block engine is installed, the number of the old engine must be transferred to the new engine.

e. g. for VW exchange short block engines



Special instructions for short block engines

New and exchange short block engines are protected against corrosion inside and out.

The outside of the engine is sprayed with a wax-based compound. In order to avoid odors and clutch trouble, the engines should be washed with a cold cleaning solution or a depreserving agent before being built up for installation. Seal all openings in crankcase and cylinder heads before washing. All cleaning agent that does not drip off should be blown off with compressed air. Afterward the needle bearing and felt ring in the gland nut must be greased again properly.

The inside treatment is done with anti-corrosion oil that is drained off after use. The residue of about 100 cc that is left in the engine, mixes with the initial filling of engine oil.

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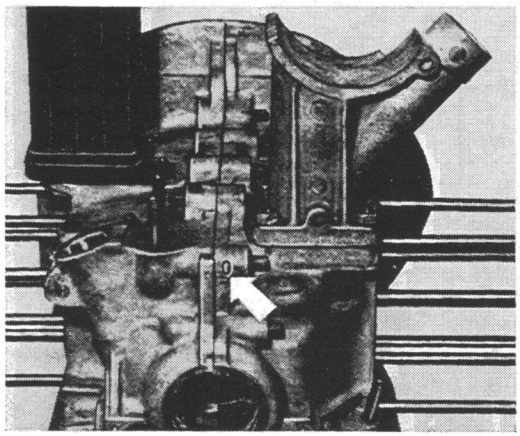

Repair instructions

An exchange engine can differ from a new engine. Because of reworking of various components during reconditioning a number of parts are oversize or undersize.

Note the following when repairing an exchange engine.

1 - **Crankcase**

a - Crankcases on which the joining surfaces have been reworked or the crankshaft bearing seats bored out are marked on the right case half (arrow).

P - Planed (standard dimensions)

O - Crankshaft bores oversize

Caution

Engines marked with an "O" have an oversize crankshaft pulley or fan wheels. Oversize crankshaft pulleys are marked with two circumferential grooves and oversize fan wheels with two 4 mm (0.157 in.) diameter countersink marks on the front.

b - When the cylinder seats on the crankcase have been reworked 0.8 mm (0.031 in.) spacer rings are installed between crankcase and cylinder gaskets.

These rings **must not** be left out because this would alter the compression.

2 - Crankshaft

Crankshafts with worn journals are ground down as follows:

	Main journals 1, 2, 3 and crankpins diameter mm (in.)	Main journal 4 diameter mm (in.)
1st undersize	54.75 (2.1555)	39.75 (1.5650)
2nd undersize	54.50 (2.1457)	39.50 (1.5551)
3rd undersize	54.25 (2.1358)	39.25 (1.5453)
4th undersize	54.00 (2.1259)	39.00 (1.5354)

The following table shows which crankshaft bearings are to be installed with reground shafts and bored out crankcases.

Standard

Crankcase bores	Bearings 1, 2 and 3 = 65 mm (2.5590 in.) Bearing 4 = 50 mm (1.9685 in.)			
Crankshaft	1st undersize mm (in.)	2nd undersize mm (in.)	3rd undersize mm (in.)	4th undersize mm (in.)
Bearings 1, 2 and 3 and crankpins	54.75 (2.1555)	54.50 (2.1457)	54.25 (2.1358)	54.00 (2.1259)
Bearing 4	39.75 (1.5650)	39.50 (1.5551)	39.25 (1.5453)	39.00 (1.5354)
		Spare part No.		
SP Set	111 198 463	111 198 465	111 198 467	111 198 469
consisting of:				
Crankshaft bearings 1	113 105 507 A	113 105 513 A	113 105 519 A	113 105 525 A
2	131 105 537	131 105 543	131 105 549	131 105 555
3	113 105 567	113 105 573	113 105 579	113 105 585
4	021 105 597	021 105 603	021 105 609	113 105 615
Connecting rod bearings	113 105 707	113 105 713	113 105 719	113 105 725

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Oversize

Crankcase bores	Bearings 1, 2 and 3 = 65.50 mm (2.5786 in.) Bearing 4 = 50.50 mm (1.9881 in.)		
Crankshaft	Standard/mm (in.)	1st undersize/mm (in.)	2nd undersize/mm (in.)
Bearings 1, 2, 3 and crankpins	55.00 (2.1653)	54.75 (2.1555)	54.50 (2.1457)
Bearing 4	40.00 (1.5748)	39.75 (1.5650)	39.50 (1.5550)

		Spare part No.	
SP Set	111 198 471	111 198 473	—
consisting of:			
Crankshaft			
bearings 1	113 105 503 D	113 105 509 D	113 105 515 A
2	131 105 533	131 105 539	113 105 545
3	113 105 563	113 105 569	113 105 575
4	113 105 593 A	113 105 599 A	113 105 605
Connecting rod bearings	113 105 701	113 105 707	113 105 713
Crankshaft bearing 1 (with thicker thrust shoulder)	113 105 503 A	113 105 509 A	—

Caution

Up to January 1973 the crankshaft and connecting rod bearings had always been the same undersizes.

From January 1973 the crankshaft and connecting rod bearing undersizes could differ.

e. g. crankshaft bearings = 1st undersize and the connecting rod bearings = 2nd undersize.

3 - **Camshaft**

a - Worn camshaft bearing journals are reground to an undersize of 24.75 mm (0.9744 in.).

b - The camshaft bores in the crankcase are bored out to 28.00 mm (1.1023 in.) if necessary.

The following camshaft bearing shells are used.

	Standard	(oversize)
Crankcase bores	27.5 mm (1.0826 in.)	28.00 mm (1.1023 in.)
	(undersize)	(Standard)
Camshaft journals	24.75 mm (0.9744 in.)	25.00 mm (0.9842 in.)

	Spare part No.	
SP Set	111 198 543	111 198 542
consisting of:		
Camshaft		
bearings 1	113 101 503	113 101 507
2	113 101 513	113 101 517
3 left	113 101 523 A	113 101 527
3 right	113 101 524	113 101 528

4 - Oil pressure valves

The bores in the crankcase for the oil pressure control and pressure relief valves are bored out where necessary and oversize plungers installed.

Standard plunger, diameter = 16.0 mm (0.6299 in.)
Oversize plunger, diameter = 16.5 mm (0.6496 in.)

5 - Cylinder head

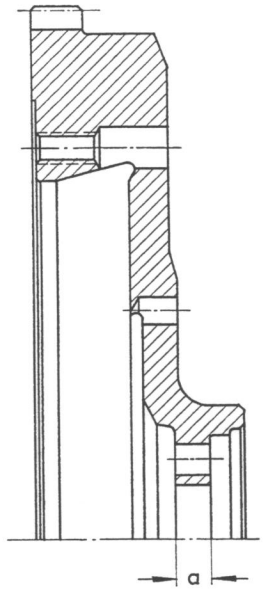
When the cylinder seats in the head have been reworked, a 1 mm (0.0393 in.) thick spacer ring is fitted between cylinder and head with effect from October 1971.

Older engines may have 0.8 mm (0.0314 in.) and 1.5 mm (0.0590 in.) thick spacer rings.

If the rings have to be replaced during a repair, watch the ring thickness as otherwise the compression will be altered.

6 - Gland nut — Flywheel

The various flywheel reworking operations include the machining of the crankshaft seating which reduces the thickness of the flange "a". When installing such flywheels, note the length of the dowels and gland nut.



The following dowels and gland nuts are used with reworked flywheels:

Flywheel flange thickness "a" mm (in.)	Dowel mm (in.)	Shim mm (in.)	Gland nut shaft — length mm (in.)
6.2—6.7 (0.244—0.263)	111 105 277 A 12.5 (0.492)	—	111 105 305 DX*) 24 (0.944)
6.2—6.7 (0.244—0.263)	111 105 277 A 12.5 (0.492)	111 105 297 A 1.4 (0.055)	111 105 305 D 25 (0.984)
6.7—7.2 (0.263—0.283)	113 105 277 14.0 (0.551)	—	111 105 305 D 25 (0.984)
7.2—8.0 (0.283—0.314)	113 105 277 14.0 (0.551)	—	111 105 305 E 27 (1.062)

*) This gland nut is not available as a spare part. Use gland nut with 25 mm (0.984 in.) long threaded portion and shim 111 105 297 A.

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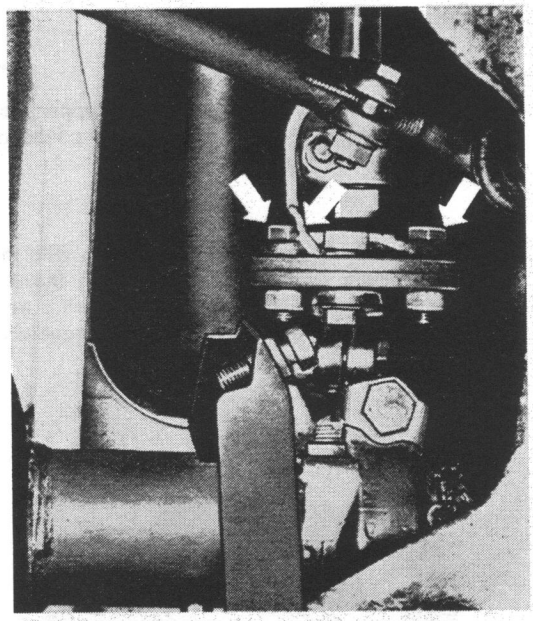
Section V

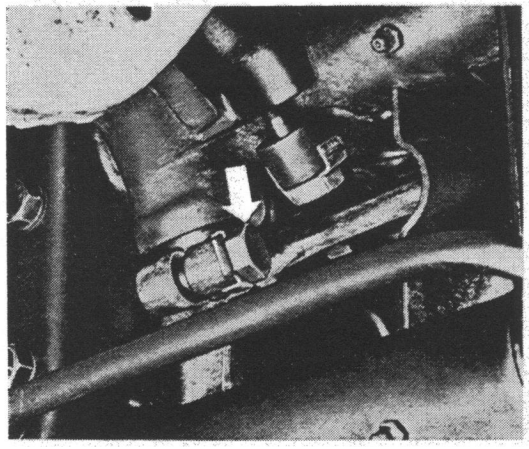
Front Suspension and Steering

Removing

When removing the steering gear, it is advisable to pull the drop arm off the shaft. The tie-rods need not be taken off the drop arm. The arm remains on the vehicle.

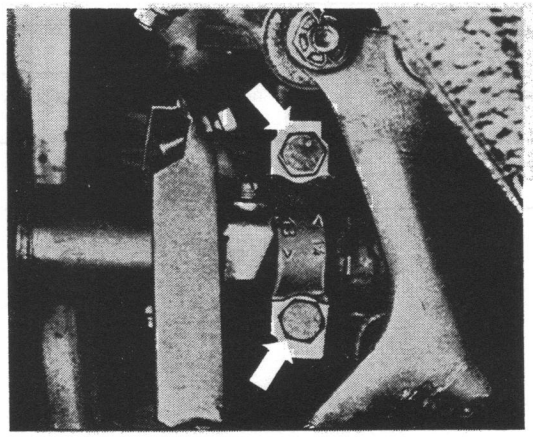


1 - Pull horn ground cable off. Remove bolts from upper flange of column coupling.



2 - Bend lock plate for the drop arm securing bolt and remove bolt.

3 - Pull drop arm off shaft. Turn wheels to a suitable angle.



4 - Bend lock plate for steering gear mounting clamp bolt. Remove bolts.

5 - Remove steering gear.

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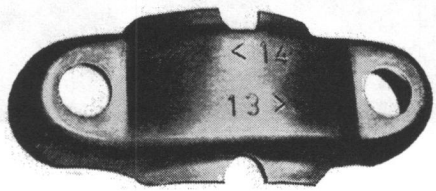
Installing

The position of the steering gear on the upper tube is controlled by two stops welded to the tube as well as cutouts in the mounting clamp.

1 - Install steering gear on the axle tube with the appropriate cutout in the clamp on the left and the arrow pointing forward. Install a new lock plate, tighten bolts to correct torque and lock.



13 = for 113 and 151

14 = for Karmann Ghia

2 - Place drop arm on shaft, install bolt with new lock plate, tighten to correct torque and lock.

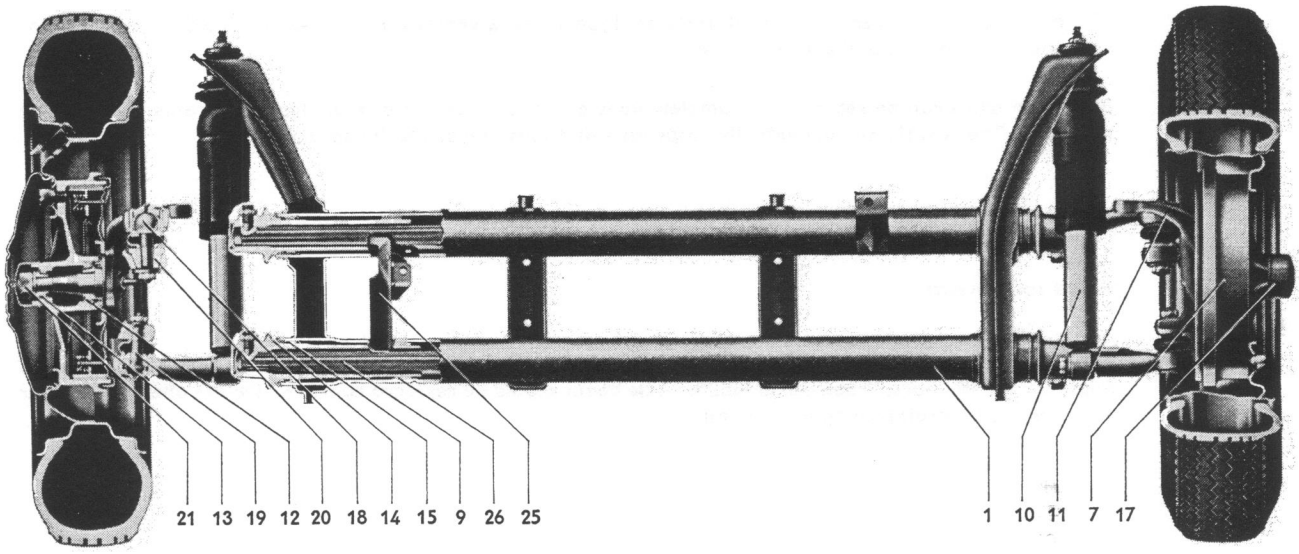
3 - Attach upper flange on column to coupling and tighten nuts to correct torque. **Use new self-locking nuts.**

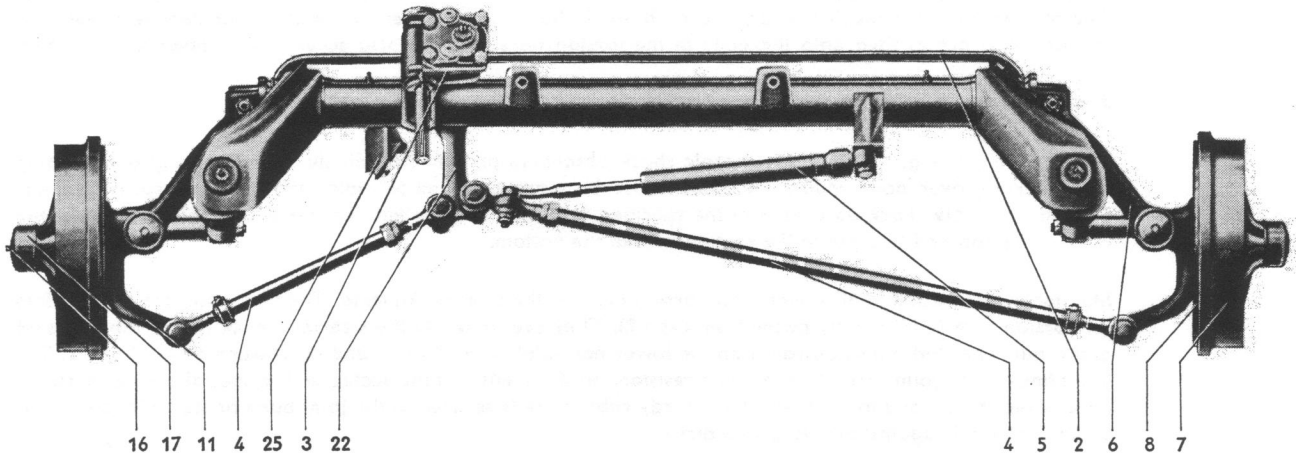
4 - Connect horn ground cable.

5 - Check toe-in and adjust if necessary.

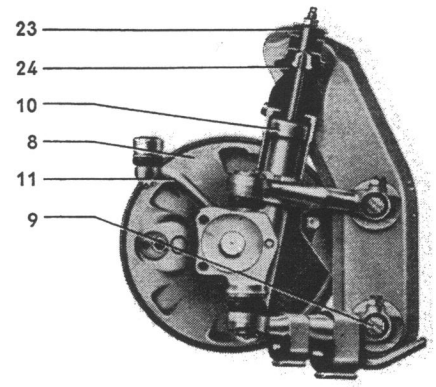
Tightening torques

Location	Description	Thread	Quality grade	Tensile class	mkg	lb. ft.
Steering gear to front axle	bolt	M 10	8 G	8.8	2.5—3	18—22
Drop arm to shaft	nut	M 12×1.5	8 G	8.8	7.0	51
Coupling flange to disc	nut	M 8	6 G	8	1.5	11





1 - Front axle beam
2 - Stabilizer bar
3 - Steering gear
4 - Tie-rods
5 - Steering damper
6 - Torsion arm
7 - Brake drum
8 - Brake backing plate
9 - Torsion bar
10 - Shock absorber
11 - Steering knuckle
12 - Inner wheel bearing
13 - Outer wheel bearing
14 - Torsion arm seal
15 - Torsion arm needle bearing
16 - Speedometer cable
17 - Dust cap
18 - Upper ball joint
19 - Lower ball joint
20 - Eccentric bush for camber adjustment
21 - Clamp nut for wheel bearing adjustment
22 - Steering drop arm
23 - Damper ring
24 - Rubber stop
25 - Wheel lock stop
26 - Plastic seating and metal bushing



Front axle with ball joints, Types 1 and 2 1-1

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The main design features of the front axles on Type 1 and 2 vehicles are the same. The basic construction described therefore, is of the Type 1 axle.

Both front axles can be replaced as complete units and are readily detachable from the frame head or side members. The wheels are individually suspended and thus independently sprung.

Front axle beam

The front axle beam consists of two tubes which are rigidly joined together by welded-on end plates and house the torsion bars. When damaged, the axle beam should be replaced complete. Do not attempt to repair any damage by straightening or welding.

Springing and wheel suspension

In each axle tube is a torsion bar consisting of a pack of separate leaves (Type 1: 10 leaves, Type 2: 9 leaves). The torsion bars are located in an anchor bush in the center and secured with a headless setscrew. The torsion arms are pushed onto the ends of the torsion bars and are also secured with headless setscrews.

A stabilizer bar is attached to the lower torsion arms with rubber blocks and clamps.

Progressively acting, hydraulic, telescopic shock absorbers prevent the vehicle from bouncing and pitching when driving over poor roads. The shock absorbers are designed to match the vehicle suspension characteristics so only shock absorbers of the specified type may be installed. They are attached to the axle end plate at the top and to a pin in the torsion arm at the bottom.

Maintenance-free ball joints connect the torsion arms to the steering knuckle. The ball joints are pressed into the torsion arm (additionally peened on Type 2). They are joined to the steering knuckle by a tapered stud and a nut. The stud points upwards on the lower ball joint of the Type 1 and downward on the Type 2. The ball heads of the joints are fitted in wear-resistant plastic shells and lubricated with a special grease to assure ease of movement and long service life. Sturdy rubber boots secured to the joint body or stud with steel clips protect the joints against moisture and dirt.

The brake drums (Types 1 and 2) or the brake discs/wheel hub (Karmann Ghia only) are cast in one piece and the wheel bearings are of the taper roller type.

Front axle with ball joints, Types 1 and 2

Front axle with ball joints, Types 1 and 2

The main design features of the front axles on Types 1 and 2 vehicles are the same. The basic construction is therefore described for the Type 1 axle.

Both front axles can be replaced as complete units and are readily detachable from the frame head or side members.

Front axle beam

The front axle beam consists of two tubes which are rigidly joined together by welded end plates and house the torsion bars. When damaged, the axle beam should be replaced complete. Do not attempt to repair any damage by straightening or welding.

Springing and wheel suspension

In each axle tube there is a laminated torsion bar consisting of flat steel leaves (Type 1:10 leaves, Type 2: 9 leaves). The torsion bars are located in an anchor bushing in the center and secured with a setscrew. The torsion arms are pushed on to the ends of the torsion bars and also secured with setscrews.

A torsion bar stabilizer is attached to the lower torsion arm with rubber mounting blocks and retaining clips.

Progressive acting, hydraulic, telescopic shock absorbers prevent the vehicle from bouncing and pitching when driving over uneven road surfaces. The shock absorbers are designed to match the vehicle suspension characteristics so only shock absorbers of the specified type may be installed. They are attached to the axle end plate at the top and to a stud in the torsion arm at the bottom.

Maintenance-free ball joints connect the torsion arms to the steering knuckle. The ball joints are pressed into the torsion arm (peened as well on Type 2) and are joined to the steering knuckle by a tapered stud and a nut. The stud points upward on the lower ball joint of the Type 1 and downward on the Type 2. The ball-shaped heads of the joints are located in wear-resistant plastic shells and lubricated with a special grease to give ease of movement and long service life. Sturdy rubber boots secured to the joint body or stud with steel retaining rings protect the joints against moisture and dirt.

The brake drums or the brake discs and wheel hub on Type 1 vehicles are cast in one piece and the wheel bearings are the tapered roller type.

Front axle with ball joints Type 1, Model 181

The front axle of the Type 1, Model 181 is basically the same as the axle of the Type 1/Sedan 111. The Type 1, Model 181 has modified steering knuckles, a greater ground clearance, lower steering ball joints with studs facing downward, stronger torsion arms and end plates. The front axle of the Type 1, Model 181 is also provided with additional supports attached to the frame.

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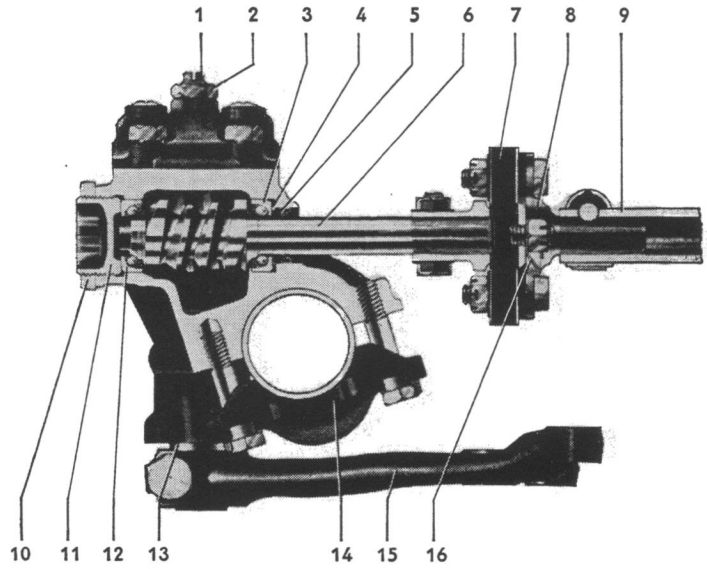
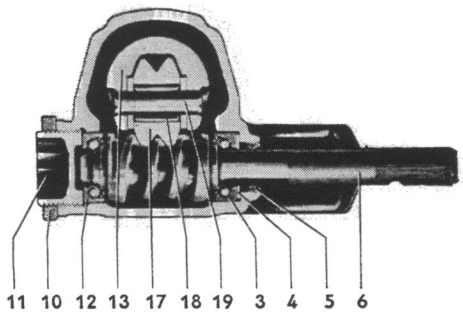
All Type 1 and 3 vehicles are fitted with a roller type steering gear. The steering column is mounted inside a column tube attached to the body. The column is connected to the steering gear by means of coupling with a rubber/fabric disc. The steering case is secured to the axle tube with a mounting clamp. Adjustable, maintenance-free tie-rods located behind the axle beam transmit the steering movements to the road wheels. A hydraulic steering damper helps to reduce road shocks.

The steering housing contains a shaft to which a roller, fitted in a needle bearing, is mounted. This roller engages in an adjustable steering worm spindle. The steering worm spindle is mounted in two thrust ball bearings. The roller is held in bronze bushings in the housing on one side, in the housing cover on the other. The spindle is adjusted axially by a washer fitted under the upper bearing. The steering roller shaft and thus the depth of engagement of the roller in the worm is adjusted with a screw in the housing cover.

Due to a design feature, the roller steering is only free of play in a certain range in the central position. When the steering is moved with the vehicle stationary, the play between spindle and roller increases steadily. The play is not noticed when the vehicle is in motion because of the self-centering action of the wheels.



1 - Roller shaft adjustment screw
2 - Lock nut
3 - Upper worm bearing
4 - Adjusting shim for worm
5 - Oil seal for worm
6 - Steering worm
7 - Coupling disc
8 - Flange for coupling disc
9 - Steering column
10 - Lock nut
11 - Worm adjusting screw
12 - Lower worm bearing
13 - Steering roller shaft
14 - Mounting clamp
15 - Drop arm
16 - Ground connection terminal
17 - Steering roller
18 - Roller needle bearings
19 - Roller support pin



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Steering linkage, Type 1/Sedan 111 and Type 3

Type 1 / Sedan 111 and Type 3 vehicles have two maintenance-free tie rods which are located in a protected area behind the front axle. Both tie rods are adjustable. The movements of the drop arm are transmitted to the wheels by the tie rods. Road shocks are damped by a hydraulic steering damper. The damper is attached to the front axle beam and the tie rod or, on the Type 3, to the drop arm.

Steering linkage, Type 1 / Sedan 113 and Type 4

The Type 1 / Sedan 113 and Type 4 vehicles have three maintenance-free tie rods. The center tie rod is fixed in length and the two outer ones are ajustable.

The movements of the drop arm are transmitted by the center tie rod to the idler arm which is mounted in bonded rubber bushings in the idler arm bracket.

Two adjusting bolts in the bracket limit the movement of the idler arm and thus the wheel lock to left and right. The idler arm bracket is attached to the side member with three bolts.

The hydraulic steering damper is attached to the front axle carrier and the center tie rod.

Steering linkage, Type 2

On the Transporter, the drop arm transmits the movements via an adjustable draglink to the swing lever and two maintenance-free tie rods to the wheels. One tie rod is adjustable and the other is fixed in length. The hydraulic steering damper is attached to the front axle beam and the swing lever.

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Torque specifications for front axle and steering Type 1 / Sedan 111 and Model 181

Location	Description	Thread	Quality grade	Tensile class	mkg	lb ft
Front axle to frame	bolt	M 12×1.5	8 G	8.8	5.0	36
Steering damper to axle	bolt	M 10	8 G	8.8	4.0—4.5	29—32
Steering damper to tie rod	nut	M 10×1	6 G	8	2.5	18
Shock absorber to axle beam side plate	nut	M 10 M 12×1.5	6 G 10 K	6 10.9	2.0 3.0—3.5	14 22—25
Shock absorber to lower torsion arm	nut	M 10	6 G	8	3.0—3.5	22—25
Tie rod to steering knuckle and drop arm	slotted nut	M 12×1.5 M 10×1	8 G	10 8	3.0[1]) 2.5[1])	22[1]) 18[1])
Setscrew for torsion bar	socket hd. screw	M 14×1.5	CK 15 Kv		4.0—5.0	29—36
Locknut for setscrew	nut	M 14×1.5	6 G		4.0—5.0	29—36
Steering ball joint to steering knuckle	self-locking nut	M 12×1.5	6 S	8	5.0—7.0	36—50
Screw for wheel bearing clamp nut	socket hd. screw	M 7	10 K	10.9	1.0—1.3	7—10
Caliper to steering knuckle	bolt	M 10	10 K	10.9	4.0	29
Steering gear to front axle	bolt	M 10	8 G	8.8	2.5—3.0	18—22
Worm shaft to steering coupling	bolt	M 8	10 K	10.9	2.0—2.5	14—18
Steering wheel to column	nut	M 18×1.5	6 G		5.0	36
Drop arm to roller shaft	bolt	M 12×1.5	8 G	8.8	7.0	50
Cancelling ring to steering wheel	fillister hd. screw	AM 3.5	8 G	8.8	0.5	3.5
Lock nut for tapered ring on tie rod	nut	M 14×1.5	6 G		2.5	18
Bolt in clamp for tie rod	bolt	M 8×1	8 G	8.8	1.5	11
Steering column tube mounting plate to instrument panel	bolt with groove	M 8	8 G	8.8	1.5	11
Steering coupling flange to disc	nut	M 8	6 G	8	1.5	11
Cover for steering gear housing	bolt	M 8×1.25	8 G		2.0—2.5	14—18
Locknut for drop arm shaft adjusting screw	nut	M 10×1	5 S		2.5	18
Locknut for worm spindle adjusting screw	nut	M 35×1.5	9 S K 20		5.0—6.0	36—43
Column to coupling flange	bolt	M 8	10 K	10.9	1.5	11
Bracket to front axle (Model 181)	nut	M 12×1.5	10 K	10.9	5.5—6.0	40—43
Front axle bracket to frame (Model 181)	nut	M 10	8 G	8.8	5.5—6.0	40—43

[1]) and turn further to cotter pin hole

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Most front axle repairs can be performed with the axle on the vehicle.

When the axle is taken off, it should be mounted in the repair stand with VW 309 and VW 309c.

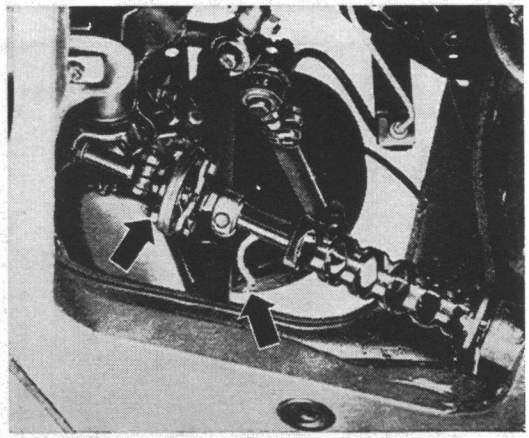
If it is suspected that the axle is bent or distorted due to accident damage, the axle tubes can be checked with a straight edge. Do not attempt to straighten the axle beam.

Removing

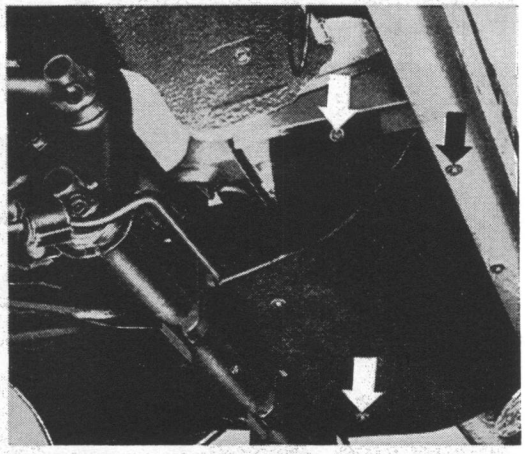
1 - Pull off fuel hose and plug it.

2 - Remove fuel tank.

3 - Disconnect horn ground wire and remove screws holding steering column coupling (arrows).



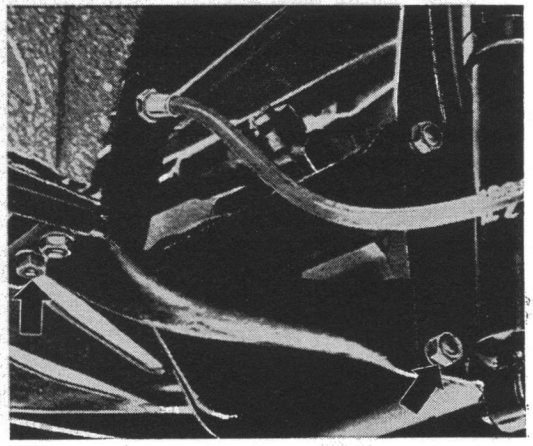
4 - Remove deflector plate if necessary (arrows).



5 - Remove bolts (arrows) attaching reinforcement plates to axle and frame and take reinforcement plates off.

6 - Take cotter pin out of speedometer cable in left wheel and pull cable out of steering knuckle.

7 - Detach brake hoses at brackets and seal lines with dust caps from bleeder valves.



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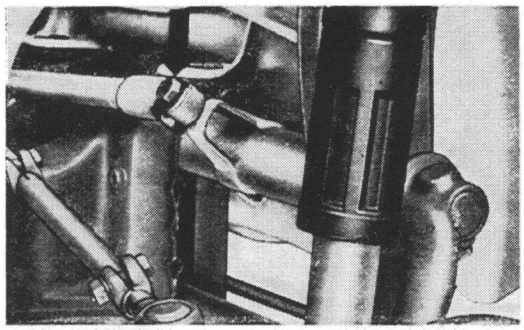
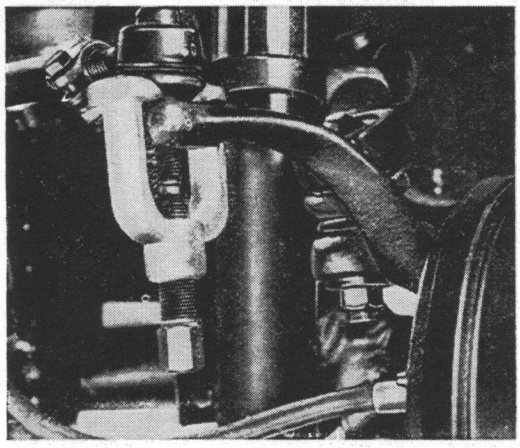
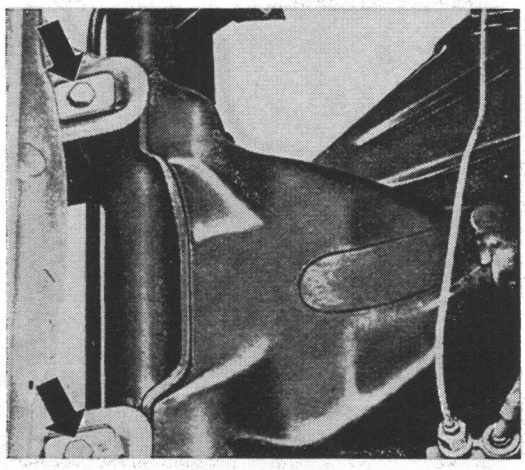


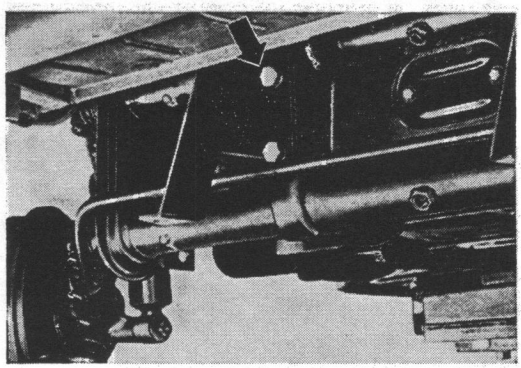
8 - Remove steering damper from bracket on front axle beam (arrow).



9 - Remove cotter pins and nuts holding tierod ends on long tierod and press ends out with VW 266h and remove tierod together with steering damper.



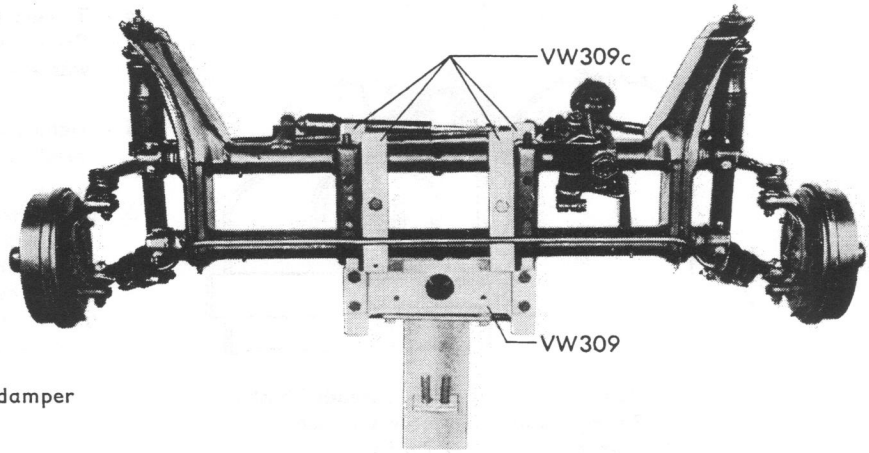
10 - Remove two body mounting bolts (arrows).



11 - Loosen four bolts securing front axle to frame head.

12 - Position floor jack with adaptor, take bolts out and remove axle.

It is advisable to disassemble the axle in the following sequence:



Remove:
1 - tierods and steering damper
2 - steering gear box
3 - brake drums
4 - backing plates
5 - shock absorbers
6 - steering knuckles
7 - stabilizer bar
8 - torsion arms complete with ball joints
9 - torsion bars
10 - needle bearings
11 - metal bushings for torsion arms

Instructions on the assembly of the axle are given in the following sections.

Installing

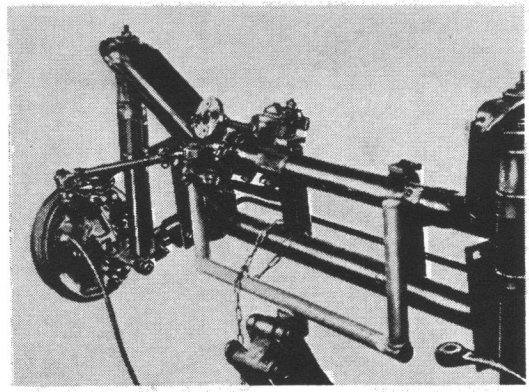
Note the following points:

1 - Place axle in adaptor and position it at the correct angle for installation with the aid of the chain. Place rubber paddings on each of the threaded bushings.

2 - Use new lockwashers on axle bolts.

3 - Tighten axle securing bolts to the correct torque.

Do not forget bracket for deflector plate.



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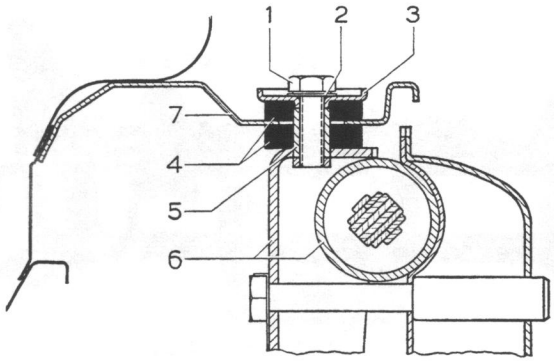
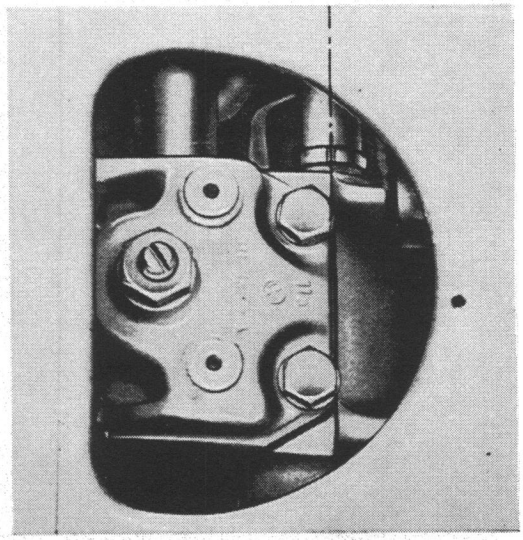


1 - Bolt
2 - Spring washer
3 - Washer
4 - Rubber pad
5 - Threaded bushing
6 - Front axle
7 - Body

4 - Tighten body to axle bolts to correct torque. Do not forget rubber pads, washers and lock-washers.

5 - Tighten tierod end nuts to correct torque and install cotter pins.

6 - Install steering damper bolt in bracket on front axle with a new locking plate, tighten bolt to correct torque and lock it. The locking plate should be fitted so that the open end of the U shaped faces forward and the narrow angled part contacts the bracket.



7 - Set steering to center position with the marking ring and connect column to the steering coupling so that the spokes are horizontal.

8 - Install reinforcement plates and tighten bolts to correct torque.

9 - Install brake hoses. Make sure they hang down and are not twisted.

Check position of hoses over entire steering sweep.

10 - Bleed hydraulic system and adjust brakes.

11 - Check wheel alignment.

12 - Install deflector plate if necessary.

Tools

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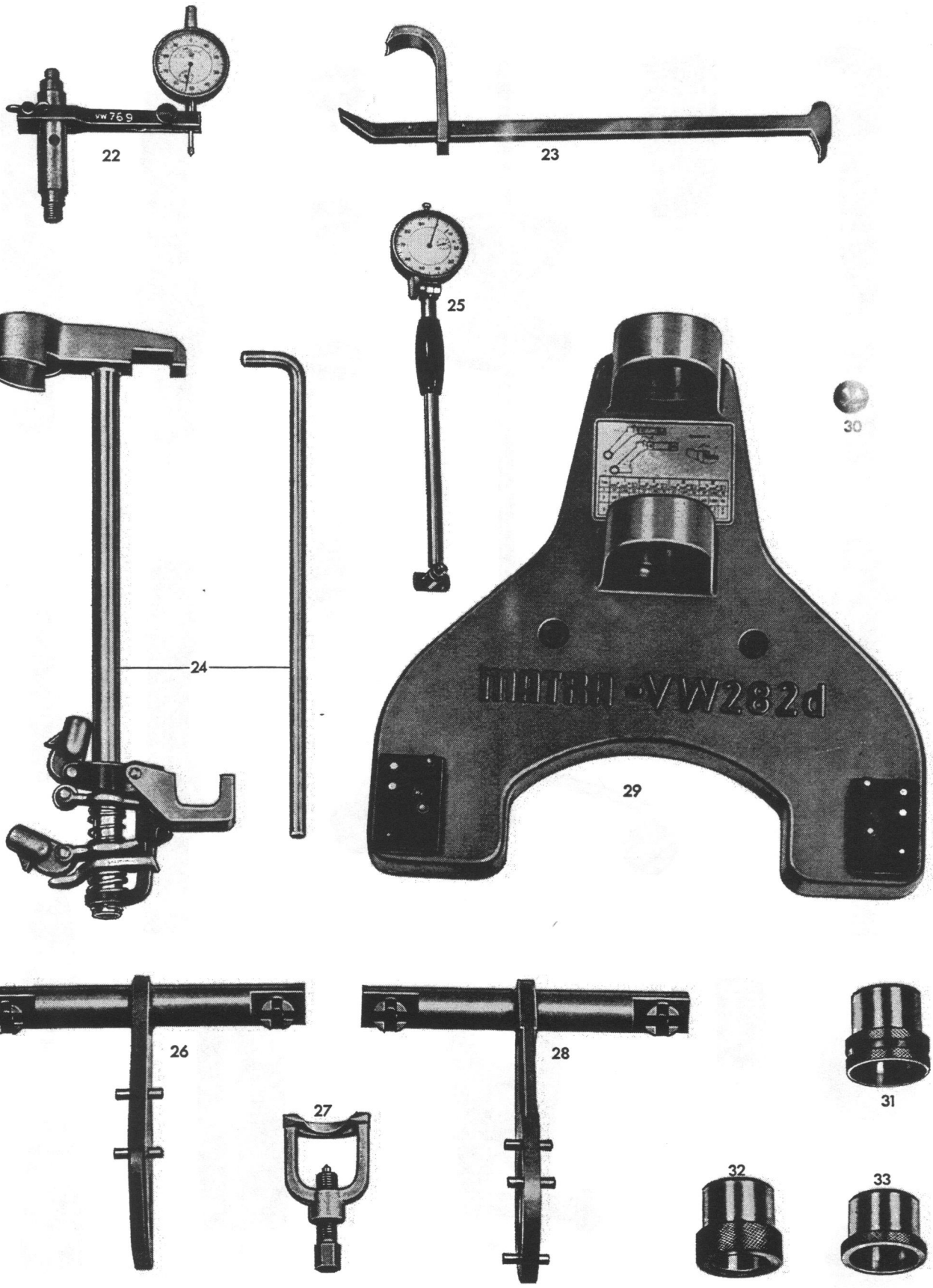
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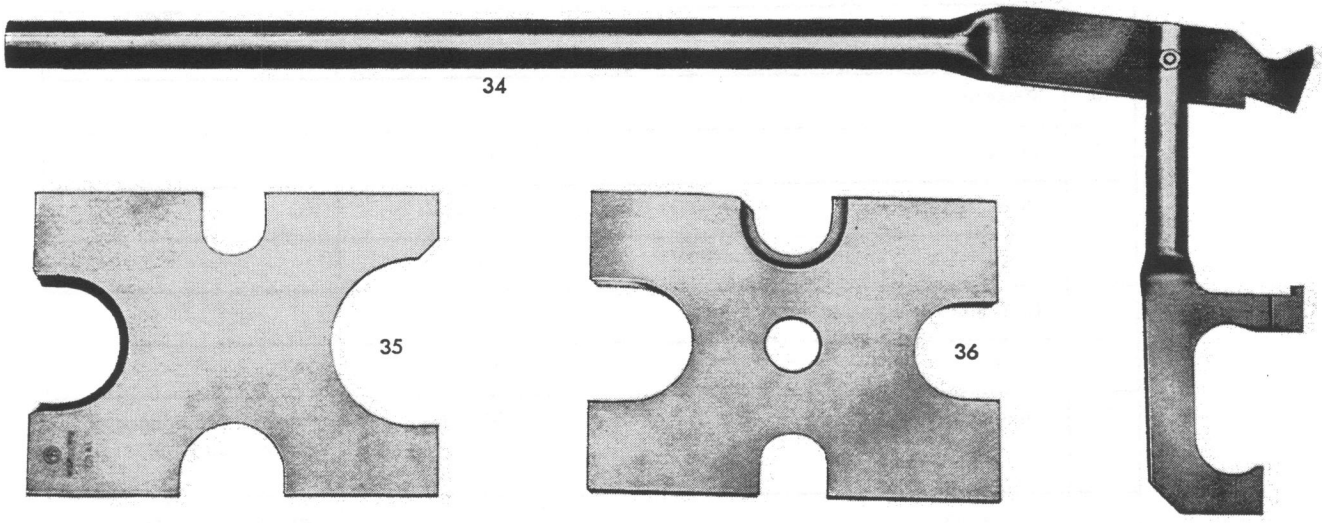

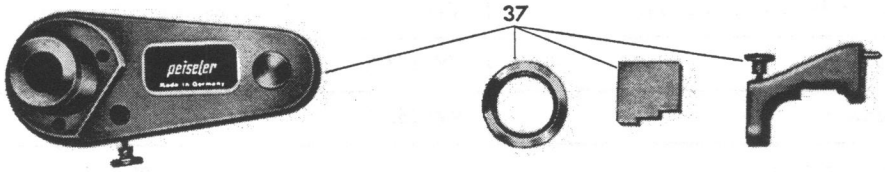

No.	Description	Tool	Explanation
1	Special wrench 36 mm	VW 179	
2	Press tool	VW 432	
3	Ring	VW 440	
4	Ring	VW 429	
5	Multi-purpose tool	VW 771	
6	Washer	VW 771—21/7	for lower needle bearing
7	Washer	VW 771—21/6	for upper and lower metal bushings
8	Washer	VW 771—21/3	for upper needle bearing
9	Press tool	VW 431	
10	Drift	VW 767	
11	Press tool	VW 407	
12	Drift	VW 768	
13	Fitting sleeve	VW 778	

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No.	Description	Tool	Explanation
14	Press tool	VW 408a	
15	Press tool	VW 412	
16	Press tool	VW 433	
17	Tube	VW 418a	
18	Ball joint removing tool	VW 267a	
19	Tube	VW 415a	
20	Fitting sleeve	VW 780-1	for steel retaining ring (lower ball joint)
21	Fitting sleeve	VW 780-2	for steel retaining ring (upper ball joint)
22	Dial gauge bracket and dial gauge	VW 769	for bearing adjustment
23	Hub cap puller	VW 637/2	
24	Clamping device	VW 655/3	
25	Inside measuring gauge		standard type, range 24—60 mm for metal bushings and needle bearing seats
26	Steering knuckle gauge	VW 258 mm	
27	Tie-rod end extractor		commercial type
28	Steering knuckle gauge	VW 258h	
29	Torsion arm test plate	VW 282d	
30	Test point for plate	VW 282d	
31	Bushing	VW 282d/14	
32	Bushing	VW 282d/15	
33	Bushing	VW 282d/13	
34	Lever	VW 281a	for testing ball joint play
35	Plate	VW 402	
36	Plate	VW 401	
37	Measuring bracket	VW 258k or 258p	

No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
72	Metal bushing for torsion arms	4	wear limit 37.38 mm (1.47 in.) knock out with VW 771—21/6	knock new upper bushing in with VW 768 and lower bushing with VW 767	V 4.1/9
73	Grease fitting	4	clean before greasing	turn in, do not knock in	
74	Axle beam	1		replace if bent, do not attempt to straighten	
75	Bolt M 8×25	2		turn in so far that there is a gap of 10±1 mm (0.4±0.004 in.) between upper torsion arm and tire. Steering must be in full lock position and front end fully raised	
76	Nut M 8	2			

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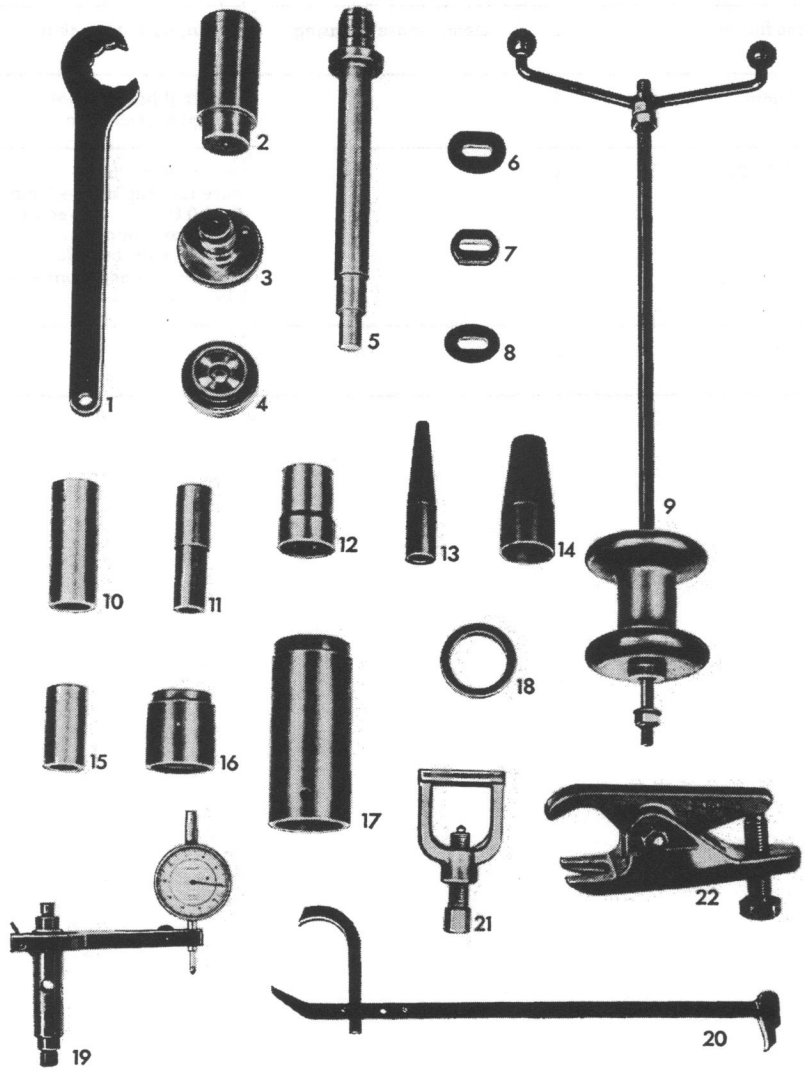
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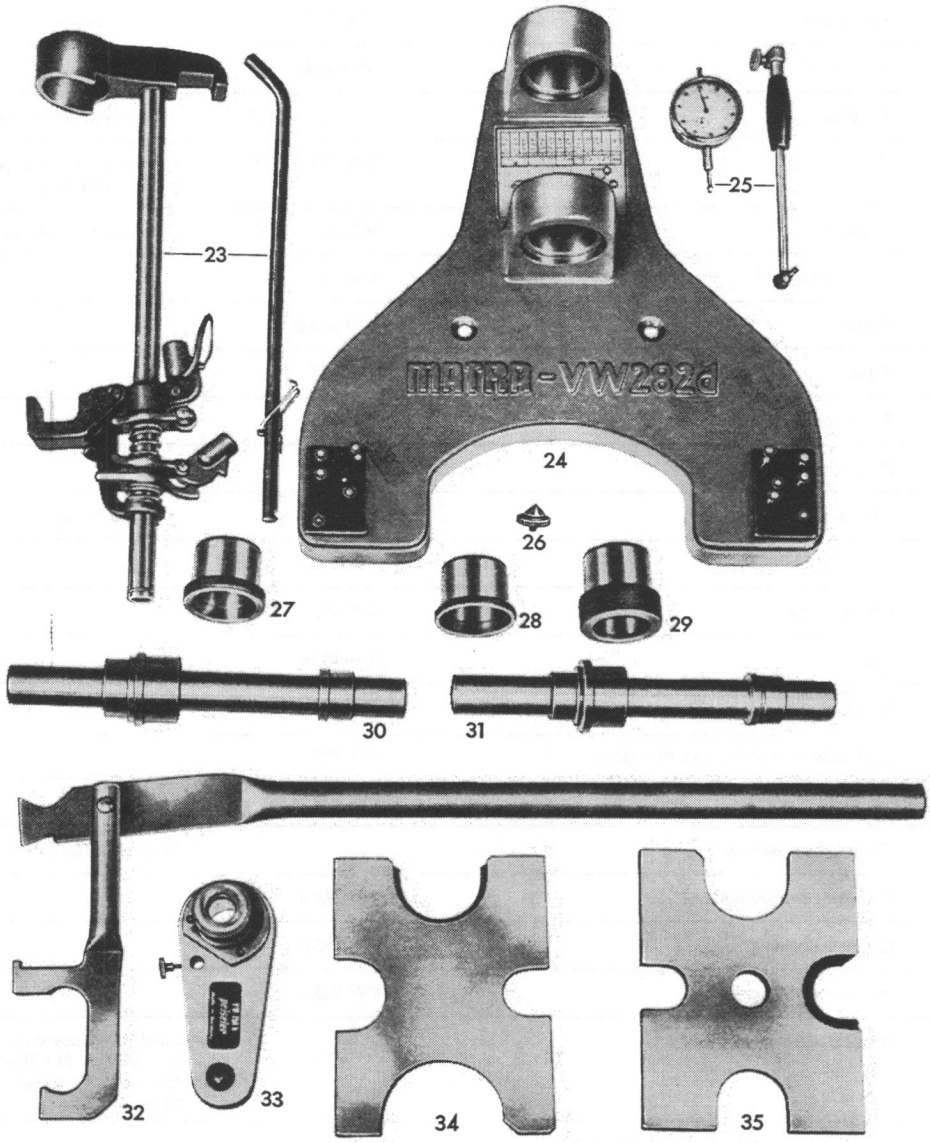

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No.	Description	Tool	Explanation
1	Special wrench 36 mm	VW 179	
2	Press tool	VW 432	
3	Press tool	VW 412	
4	Press tool	VW 433	
5	Press tool	VW 408a	
6	Washer	VW 771—21/7	for lower needle bearing
7	Washer	VW 771—21/6	for upper and lower needle bearings
8	Washer	VW 771—21/3	for upper needle bearing
9	Multi-purpose tool	VW 771	
10	Tube	VW 416b	
11	Tube	VW 421	
12	Press tool	VW 454	
13	Fitting sleeve	VW 778	
14	Fitting sleeve	VW 780	marked "oben"
15	Tube	VW 418a	
16	Fitting sleeve	VW 455	
17	Tube	VW 415a	
18	Ring	VW 429	
19	Dial gauge bracket and dial gauge	VW 769	
20	Dust cap puller	VW 637/2	
21	Tie rod end extractor		local purchase item
22	Ball joint removing tool	VW 267a	
23	Clamping device	VW 655/3	
24	Torsion arm test plate	VW 282d	
25	Inside measuring gauge		local purchase item, range 25—60 mm (0.984—2.362 in.) for metal bushings and needle bearing seats
26	Test point for plate (part of VW 282d)		
27	Bushing	VW 282d/15	
28	Bushing	VW 282d/13	
29	Bushing	VW 282d/12	
30	Drift	VW 767	
31	Drift	VW 768	
32	Lever	VW 281a	for testing ball joint play
33	Measuring bracket	VW 258p	
34	Plate	VW 402	
35	Plate	VW 401	

No.	Description	Qty.	Note when disassembling	assembling	Special instructions see
30	Retainer, large	2	as for point 29	as for point 29	
31	Clip, small	2		hold clip with waterpump pliers to install retainer	V 4.2/5
32	Clip, large	2		as for point 31	V 4.2/5
33	Plate, small	2			
34	Plate, large	2			
35	Rubber mounting, small	2			
36	Rubber mounting, large	2			
37	Stabilizer bar	1			
38	Self-locking nut M 16×1.5	4		always use new nuts tighten to 5—7 mkg (36—50 lb ft)	V 4.1/4
39	Washer, small	2			
40	Washer, large	2			
41	Eccentric bushing for camber adjustment	2	press off upper ball joint with VW 267a	insert in knuckle lightly greased, **no grease in hole for ball joint stud.** In basic position, notch should point forward	V 4.1/4
42	Upper ball joint	2	press out of knuckle with VW 267a, out of torsion arm with VW 412, VW 415a, VW 416b and VW 401	press in with VW 412, VW 432, VW 433, VW 415a, VW 429, VW 402 and VW 401. Notch in joint must be aligned with notch in arm **Note** Check for oversize marking on torsion arm ("B")	V 4.1/4
43	Lower ball joint	2	press out of knuckle with VW 267a, out of torsion arm with VW 412, VW 418a, VW 415a, VW 421 and VW 401	press in with VW 412, VW 454, VW 455, VW 429, VW 415a, VW 402 and VW 401 as for No. 42	V 4.1/6
44	Ring for rubber boot	4		fit with VW 778, do not twist ring	V 4.1/6
45	Boot for lower joint	2		if boot is damaged, clean joint carefully and grease well with multi-purpose grease	V 4.1/6
46	Boot for upper joint	2		as for No. 45	
47	Ring for rubber boot	4		fit with sleeve VW 780 (marked "oben"), ring ends must be offset 60° from ball stud pivot direction	V 4.1/6
48	Plug	4		**always use new plugs,** screw them in, do not knock in	
49	Locknut	4		tighten to 4—5 mkg (28—36 lb ft)	
50	Setscrew for torsion bar	4		tighten to 4—5 mkg (28—36 lb ft)	
51	Torsion arm, upper	2	remove steering knuckle with drum	check for distortion with VW 282d	V 4.1/6
52	Torsion arm, lower	2	remove steering knuckle with drum and stabilizer	as for No. 51	

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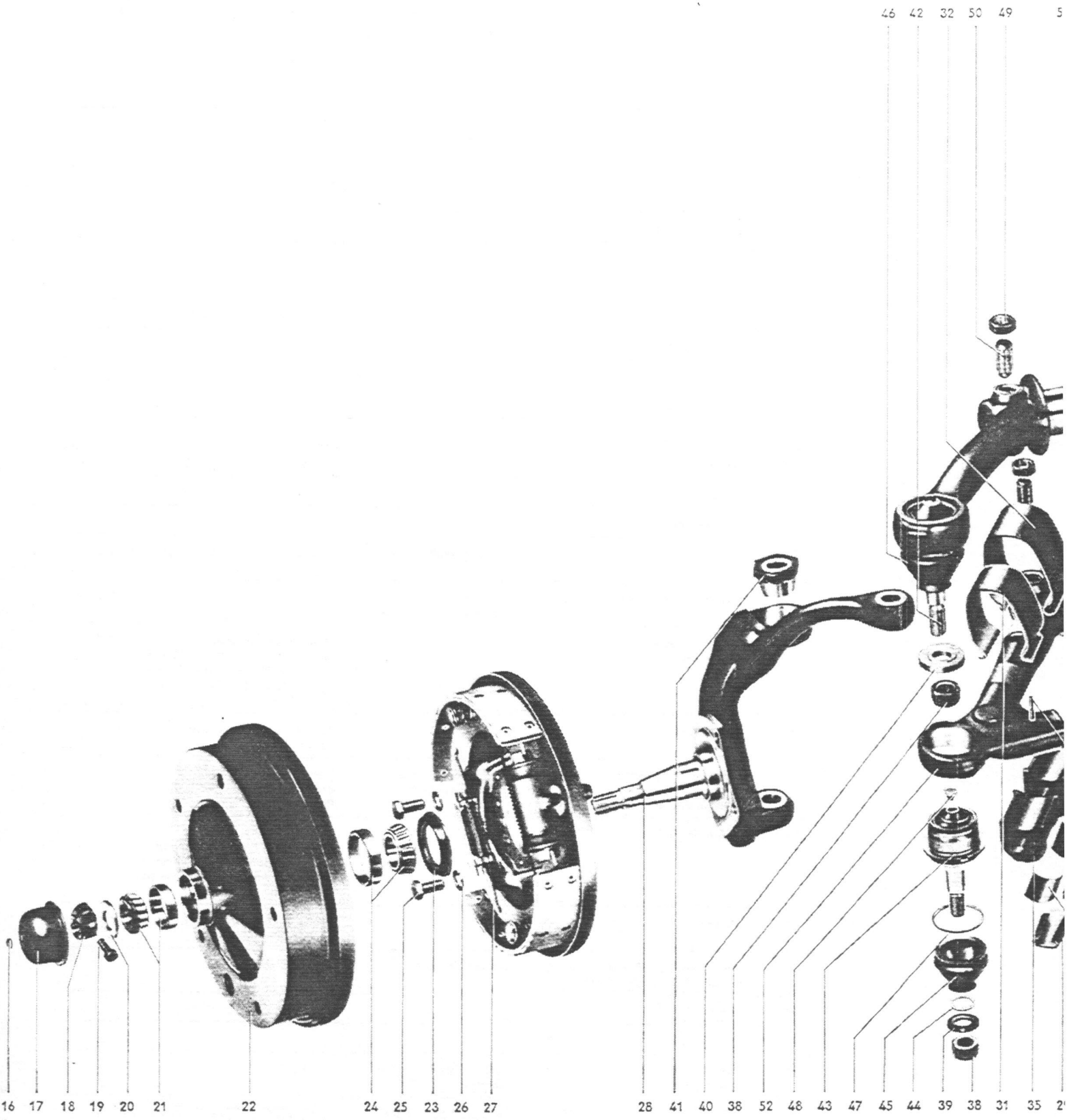
No.	Description	Qty.	Note when disassembling	assembling	Special instructions see
53	Pin	2			
54	Pin for shock absorber	2	drill broken pins out and ream hole	install oversize pin	V 4.2/6
55	Nut M 12×1.5	2		tighten to 4.0 mkg (28 lb ft)	
56	Lock washer 10.5	2			
57	Lock washer 12.5	2			
58	Nut M 10	2	tension upper torsion arm lightly with VW 655/3	tighten as far as possible	V 4.1/10
59	Plate for damper bushing	2			
60	Damper bushing	4			V 4.1/10
61	Pin for buffer	2			
62	Buffer	2			
63	Tube	2			
64	Shock absorber	2	tension upper torsion arm lightly with VW 655/3. Hold lower end of pin (No. 61) with water-pump pliers and remove nut	check shock absorber	V 4.1/10 V 4.2/9
65	Sleeve for rubber bushing	2	press out with VW 408a, VW 402 and VW 401	press in with VW 436a, VW 411, VW 416b, VW 402, VW 401. Coat VW 436a and sleeve lightly with glycerine	V 4.2/9
66	Rubber bushing	2	as for point 65	coat with talcum and press in flush in vise	
67	Torsion bar — 10 leaf	2		check for damage. Note number of leaves and arrangement, bind end with adhesive tape when installing	
68	Seal for upper torsion arm	2		replace if necessary	
69	Seal for lower torsion arm	2		replace if necessary	
70	Needle bearing, upper Standard size: 46.0 mm (1.574 in.) outside diameter Oversize: 46.2 mm (1.819 in.) outside diameter	2	knock out with VW 771 and washer VW 771—21/3	knock in with drift VW 768 until shoulder of drift makes contact. Note bearing dia., oversize is 0.2 mm (0.0078 in.) larger	V 4.1/9
71	Needle bearing, lower Standard size: 50.0 mm (1.968 in.) outside diameter Oversize: 50.2 mm (1.976 in.) outside diameter	2	knock out with VW 771 and washer VW 771—21/7	knock in with drift VW 767 until shoulder of drift makes contact. Note bearing dia., oversize is 0.2 mm (0.0078 in.) larger	V 4.1/9
72	Metal bushing for torsion arms	4	wear limit 37.38 mm (1.47 in.), knock out with VW 771 and washer VW 771—21/6	knock new upper bushing in with VW 768 and lower bushing with VW 767	V 4.1/9
73	Grea e fitting	4	clean before greasing	turn in, do not knock in	
74	Axle beam	1			
75	Bolt M 8×25	2		turn in so far that there is a gap of 10±1 mm (0.393± 0.039 in.) between upper torsion arm and tire when wheel is locked hard over and on full rebound	V 8.1/6
76	Nut M 8	2		tighten so 1.5 mkg (11 lb ft)	



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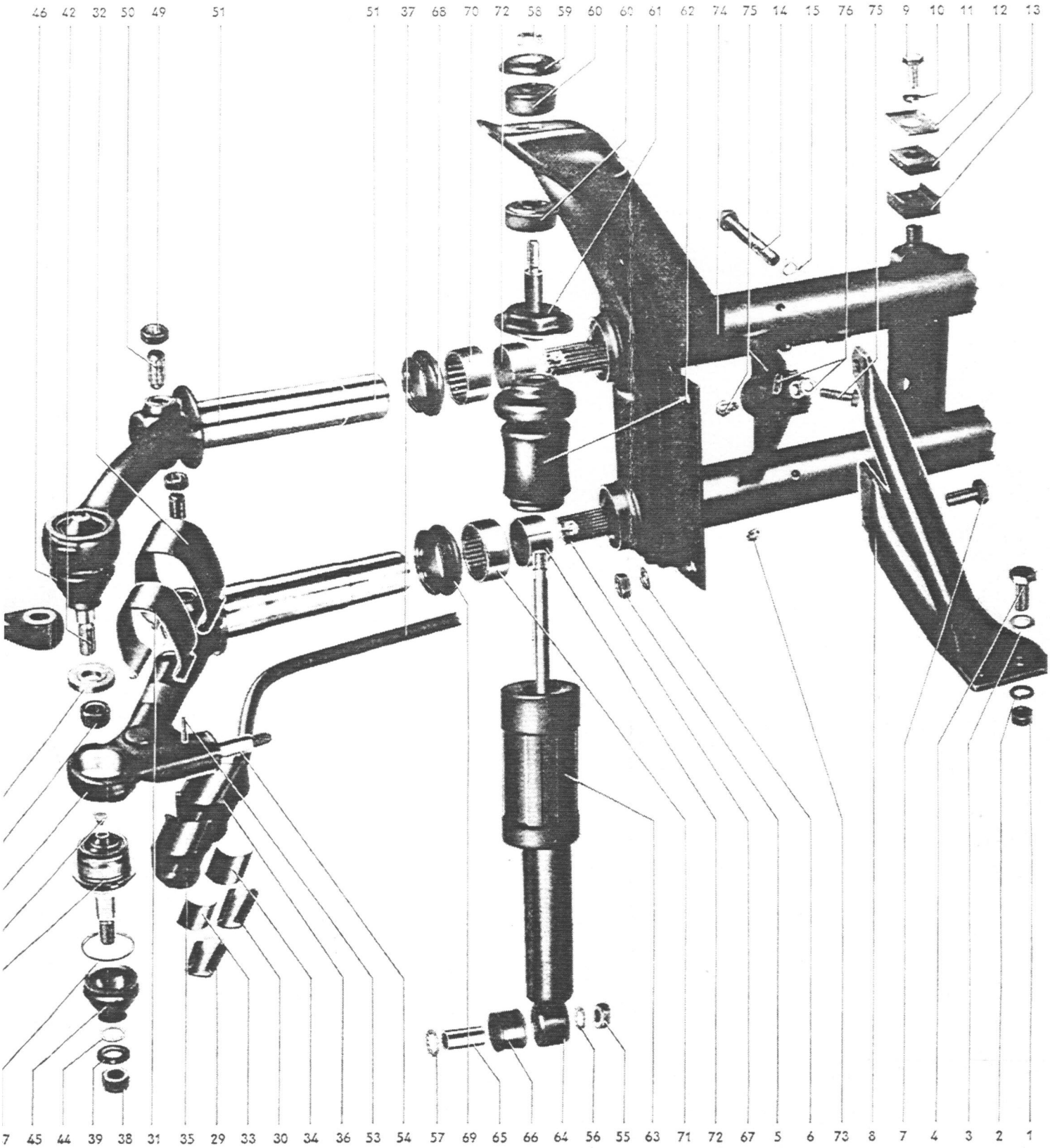
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7 45 44 39 38 31 35 29 33 30 34 36 53 54 57 69 65 66 64 56 55 63 71 72 67 5 6 73 8 7 4 3 2 1

No.	Description	Qty.	Note when disassembling	assembling	Special instructions see
1	Nut M 10	4		tighten to 5.5—6.0 mkg (40—43 lb ft)	
2	Spring washer	4			
3	Washer	4			
4	Bolt M 10×25	4			
5	Nut M 12×1.5	2		tighten to 5.5—6.0 mkg (40—43 lb ft)	
6	Spring washer	2			
7	Bolt M 12×1.5×25	2			
8	Support for axle	2			
9	Bolt M 10×25	2		tighten to 2.0 mkg (14 lb ft)	
10	Spring washer	2			
11	Plate	2			
12	Rubber packing, upper	2			
13	Rubber packing, lower	2			
14	Bolt M 12×1.5×90	2		tighten to 5.0 mkg (36 lb ft)	
15	Spring washer	2			
16	Lock washer	1			
17	Dust cap	2	pull off with VW 637/2	must be free of grease, seal speedo cable hole	V 4.2/3
18	Clamp nut for wheel bearing	2	lefthand thread on left steering knuckle	adjust as specified	V 4.2/3
19	Socket hd. screw for clamp nut M 7×18	2		after adjusting wheel bearing play to 0.03—0.12 mm (0.001—0.004 in.) with VW 769, tighten screw to 1.0—1.3 mkg (7—9 lb ft)	V 4.2/3
20	Thrust washer	2		do not tilt as this will affect adjustment	
21	Outer tapered roller bearing Outside dia. 40 mm (1.574 in.)	2	knock outer race out with brass drift	lubricate with multi-purpose grease of correct specification. Press grease into cage	
22	Brake drum	2		clean carefully, check dimensions, damaged threads for wheel bolts, friction surface condition. Amount of grease per side approx. 50 grams	
23	Oil seal	2		knock in carefully with a rubber hammer	
24	Inner tapered roller bearing Outside dia. 50 mm (1.968 in.)	2	as for point 21	as for point 21	
25	Bolt M 10×18	3		tighten to 5.0 mkg (36 lb ft)	
26	Spring washer	3			
27	Front wheel brake and backing plate	2	detach brake hose at bracket	bleed brakes	
28	Steering knuckle	2	press off ball joints with VW 267a	check bearing seats for wear, check for distortion with VW 258p	V 4.1/4
29	Retainer, small	2	knock off	bend lugs down after installing stabilizer	V 4.2/5

When removing a steering knuckle, the brake parts need only be taken off if the steering knuckle itself has to be replaced.

Removing

1 - Detach brake hose at bracket and seal brake seal with dust cap from bleeder valve.

2 - Press outer tie rod end out.

3 - Remove brake drum and backing plate.

4 - Take self-locking nut off lower ball joint and press ball joint out of steering knuckle with VW 267a. Screw cap nut (M 12×1.5) from VW 267a on to ball joint stud to prevent damage to the thread.

Caution

The upper edges of the fork on the appliance which contact the rubber boot when pressing the joint out must be free of burrs to avoid damaging the boot. Position the appliance carefully.

The nut should be screwed on as far as it will go to ensure that the thrust is taken mainly at the base of the nut as well as on the thread flanks. The nut must not be screwed on too tightly otherwise the stud will turn as well and make the nut difficult to remove after the joint has been pressed out.

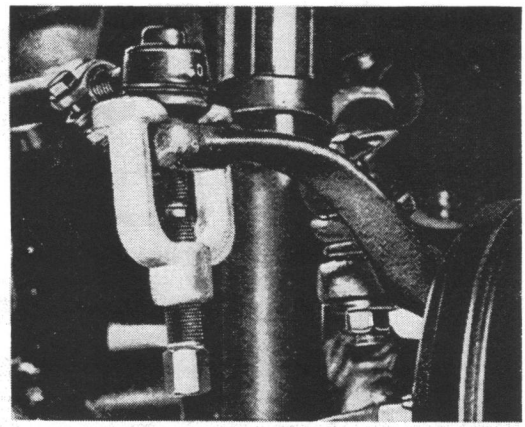
Very tight ball joints can be loosened by tapping the steering knuckle eye with the appliance tensioned.

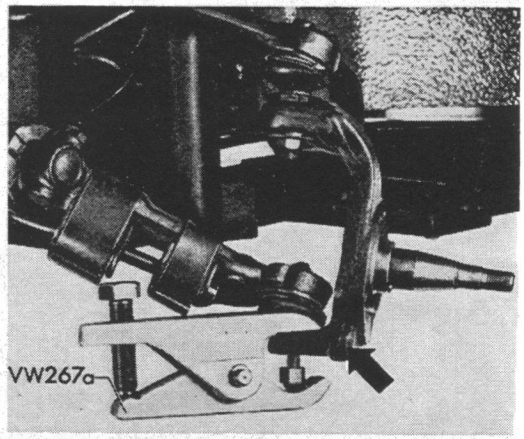
5 - Remove self-locking nut from upper ball joint and loosen eccentric bushing for camber adjustment with VW 179.

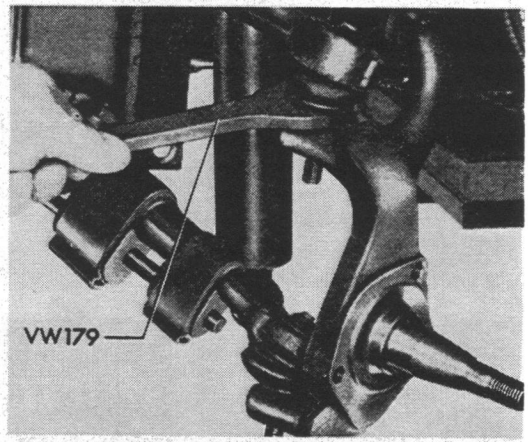
Note

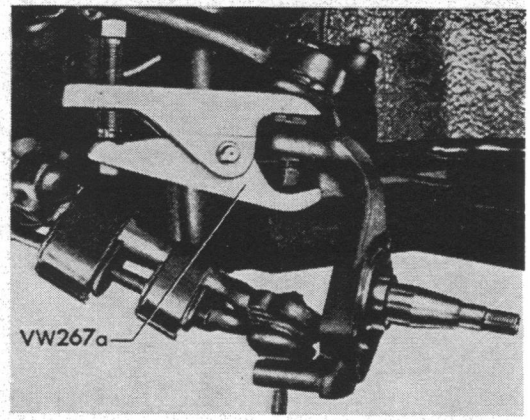
If the upper ball joint is to be repaired or replaced it should be pressed out of eccentric bushing with VW 267a. If the steering knuckle is to be removed, the bushing should be loosened with VW 179 and the bushing left on the ball joint stud.

6 - Take steering knuckle off.









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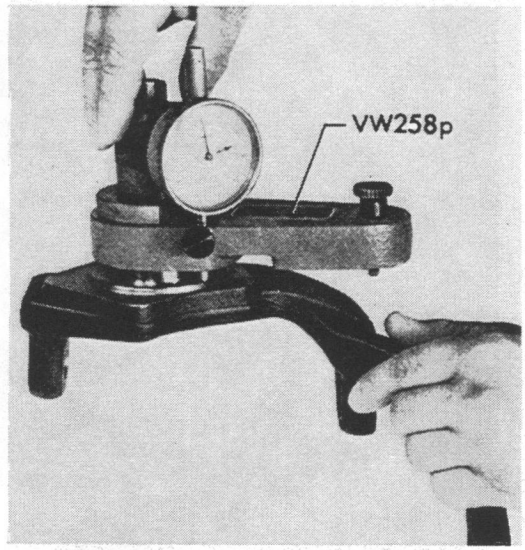
b - Removed

1 - Checking stub axle for bend

Place appliance VW 258p on the stub axle and press it firmly against the shoulder for inner bearing. Set dial gauge to zero and check stub axle by turning appliance one complete turn.

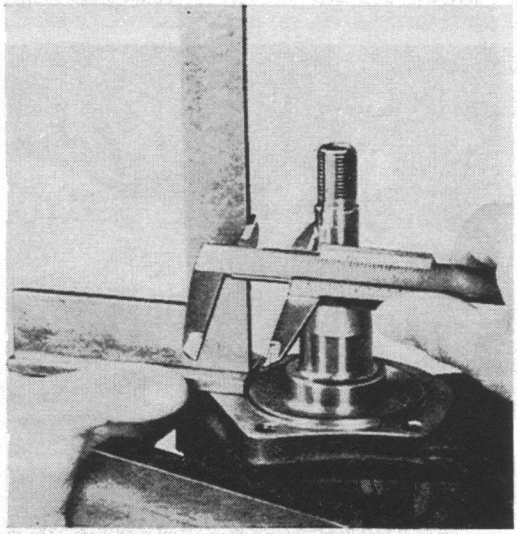
The deflection of the gauge needle must not exceed 0.15 mm (0.0059 in.).



2 - Checking stub axle with square and vernier caliper

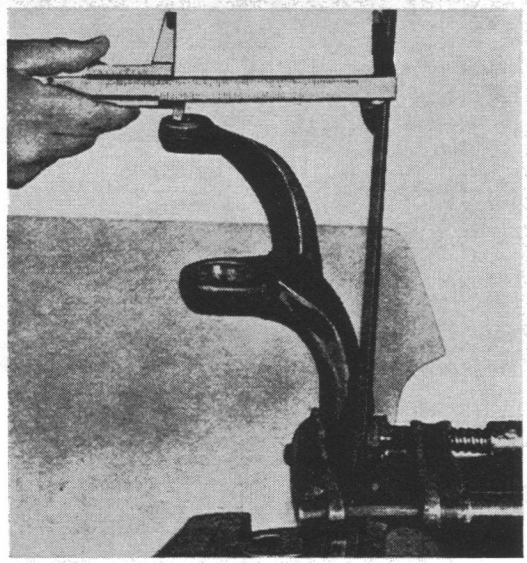
Measure as shown in illustration at least three points around the stub axle.

The difference between the measurements must not exceed 0.25 mm (0.0098 in.).



3 - Checking steering arm for bend

The steering arm on the steering knuckle can be checked with a straight edge and a vernier caliper. The dimension from the backing plate flange to the outer edge of the tie rod hole should be 117.75 to 118.25 mm (4.6357 to 4.6554 in.).



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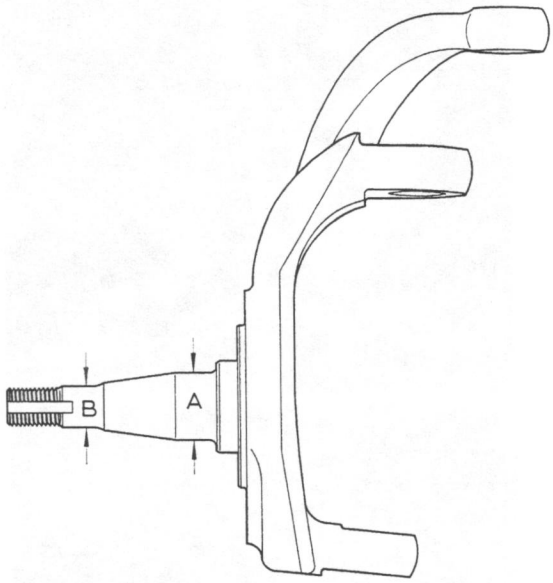


Checking steering knuckle

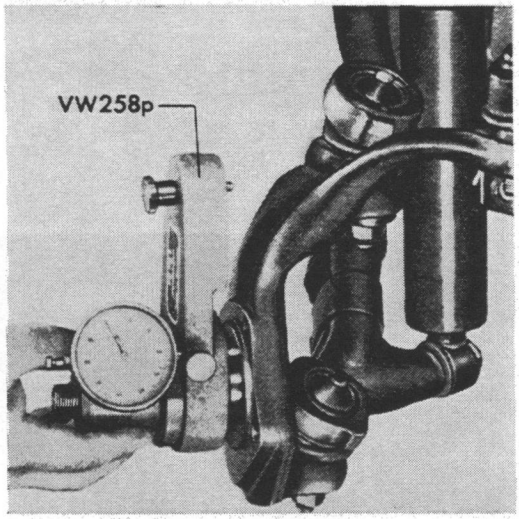
The steering knuckle can be checked on or off the vehicle.

a - On vehicle

1 - Checking bearing seats for wear and size.

Inner bearing seat A =
28.98—29.0 mm dia. (1.1409—1.1417 in.)

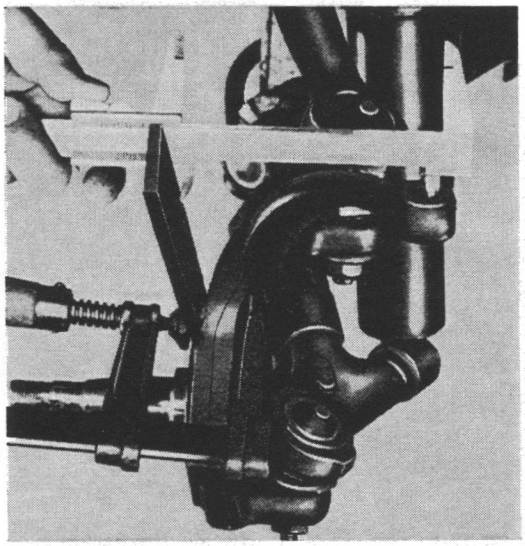
Outer bearing seat B =
17.45—17.46 mm dia. (0.6869—0.6874 in.)



2 - Checking stub axle for bend

Place measuring appliance VW 258p on the stub axle and press it firmly against shoulder for inner bearing. Set dial gauge to zero and check stub axle by turning appliance one complete turn.

The deflection on the dial gauge needle must not exceed 0.15 mm (0.0059 in.).



3 - Checking steering arm for bend

The steering arm on the steering knuckle can be checked for bend with a straight edge and a vernier caliper. The dimension from backing plate flange to the outer edge of the tie rod hole should be 117.75 to 118.25 mm (4.6357 to 4.6554 in.).

Warning

Do not attempt to straighten bent steering knuckles. Install new parts.

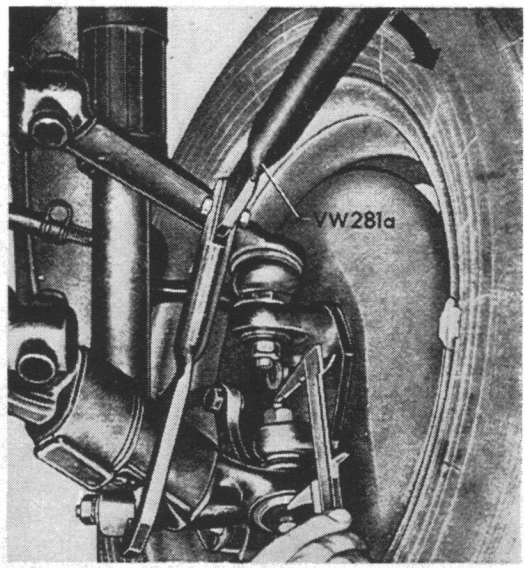
Checking ball joints (installed)

The axial play of the ball joint can be checked with special tool VW 281 a.

1 - Raise vehicle and turn wheels to one side.

2 - Position tool VW 281 a between upper and lower torsion arms as shown in illustration.

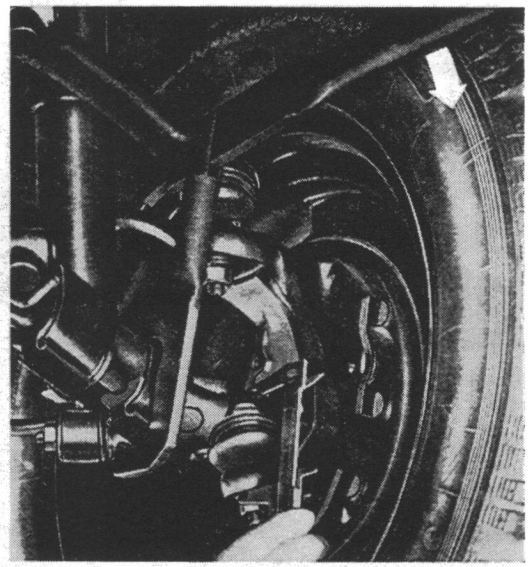
3 - Place vernier caliper on the ball joint with one jaw on the torsion arm and the other jaw on the steering knuckle and read the measurement. Without removing the vernier caliper, pull down checking lever to expand torsion arms and obtain second reading. Subtract first reading from second reading to obtain play of ball joint.



All Type 1 / Sedan 111

	Type 1, except 181	Model 181
Maximum play, new	0.5 mm (0.019 in.)	0.3 mm (0.011 in.)
Wear limit:		
Upper ball joint	2.0 mm (0.08 in.)	2.0 mm (0.08 in.)
Lower ball joint	1.0 mm (0.04 in.)	2.0 mm (0.08 in.)

Worn ball joints must be replaced with new ones.



Model 181

Removing torsion arms

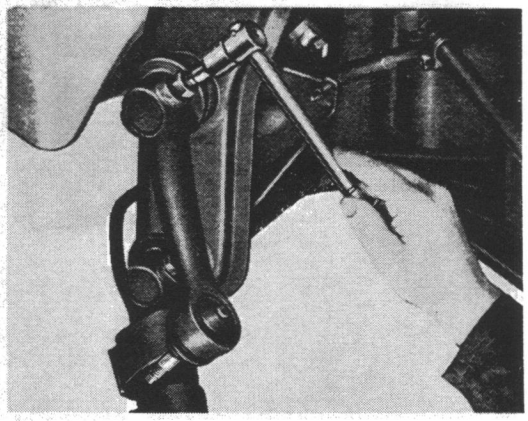
1 - Remove steering knuckle complete with brake drum.

2 - If the lower torsion arm is to be removed, disconnect stabilizer.

3 - Loosen lock nuts on torsion arm securing pins and remove pins.

4 - Remove torsion arms from axle tubes.

5 - If necessary, remove seals from axle tubes.



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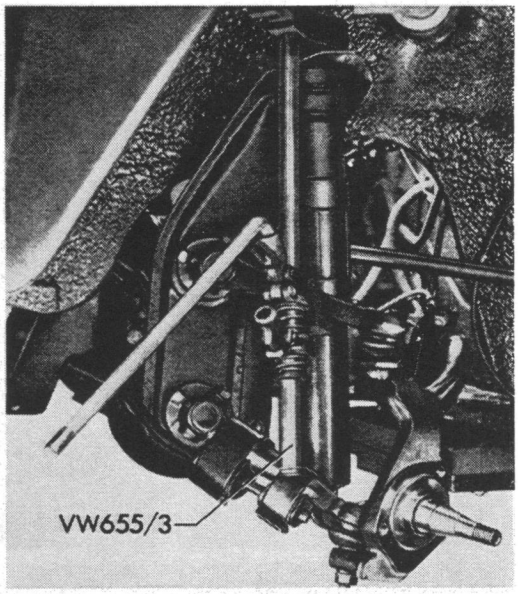

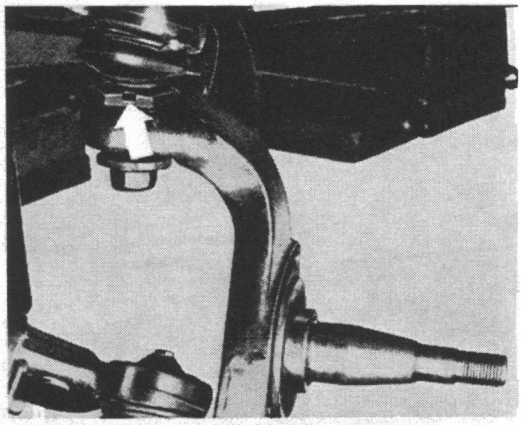

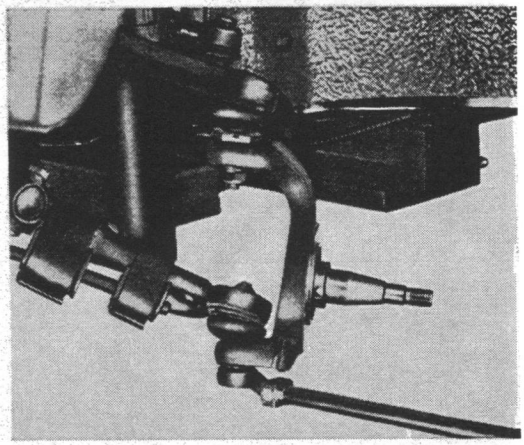

Installing

1 - Install steering knuckle on lower ball joint but do not fully tighten the nut. **Always use new self-locking nuts.**

2 - Lift upper torsion arm with the tensioner VW 655/3 until the steering knuckle can be attached to the upper ball joint.

3 - Set the camber adjusting bushing so that the notch is pointing forward (arrow).

4 - Tighten the self-locking nuts on the ball joints to the correct torque.

Caution

Use only self-locking nuts.

5 - Tighten tie rod end nuts to the correct torque, turn on to align cotter pin holes and fit cotter pins.

6 - Install backing plates and brake drums and tighten backing plate bolts to correct torque.

7 - Adjust wheel bearings correctly. See the instructions on "Checking and adjusting wheel bearings" on page V 4.2/3.

8 - Install brake hoses without twist so that they hang down. Check position of brake hose over full range of steering movement.

9 - Bleed brake system and adjust brakes.

10 - Adjust wheel alignment.

Installing torsion arms

Note the following points:

1 - Check condition of torsion arm sealing rings and install new parts where necessary.

2 - Install torsion arm on torsion bar. Install retaining screws and tighten to correct torque.

3 - Install all other parts. Grease front axle thoroughly with multi-purpose grease.

4 - Check wheel alignment.

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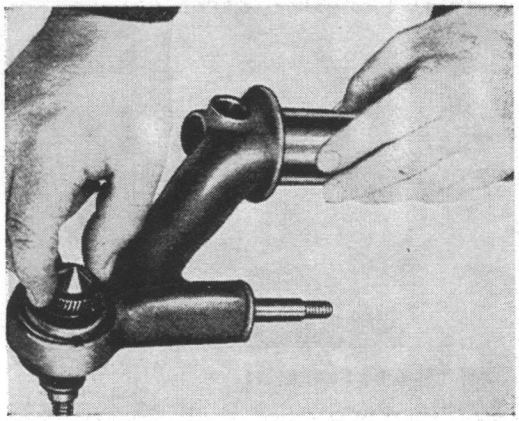
Checking torsion arms

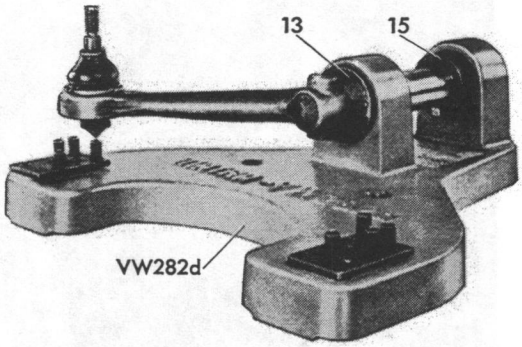
1 - Carefully clean torsion arms and ball joints.

2 - Check bearing seats on torsion arms for wear.

3 - Remove plastic plugs from bottom of ball joint and insert tip of test appliance VW 282d.



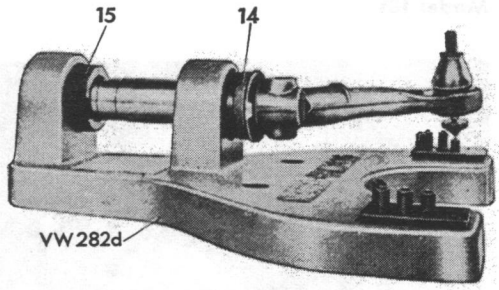
Torsion arm upper



4 - Locate torsion arm bushings in test plate VW 282d.

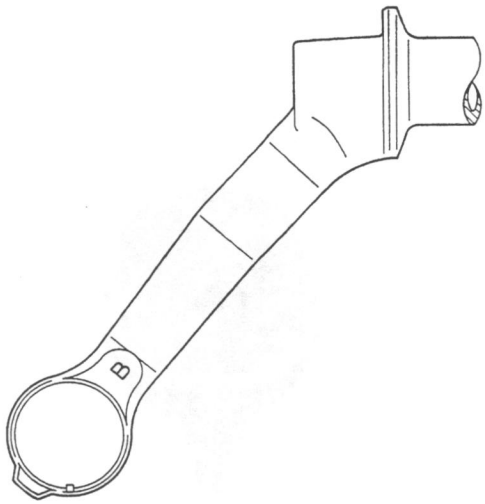
	Sedan 111		Model 181	
	Bushing No.		Bushing No.	
	inner	outer	inner	outer
Upper arm	15	13	15	13
Lower arm	15	14	13	12

Torsion arm lower



5 - Place torsion arm in test plate.

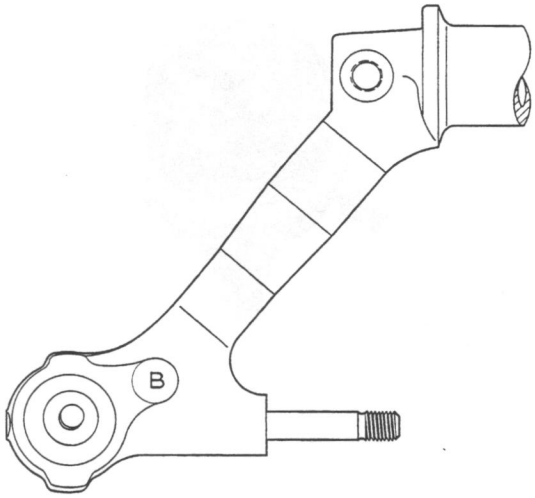
The tip must contact the small boss on the plate. If it does not do so, the torsion arm is bent.



Model 181

The torsion arms with oversize holes for the ball joints (also 0.4 mm = 0.016 in. larger) are marked with a "B" as shown.

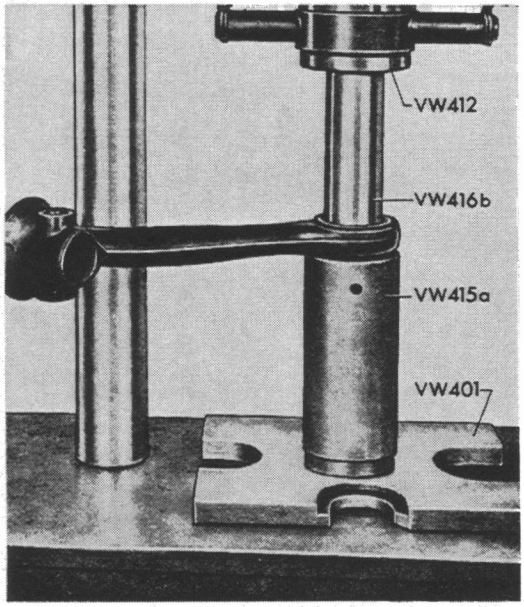
When replacing the ball joints, it is essential to check the marks on the ball joint or torsion arm in order to ensure that the correct joint is pressed in.



Note

The upper ball joint spigot has been increased in diameter from 16 to 18 mm (0.629 to 0.708 in.), and the ball joint spigot thread has been increased in length by 2 mm (0.078 in.). In connection with this, the tapered drilling in the eccentric bushing for camber adjustment has also been increased to 18 mm (0.708 in.) dia., the washer between the steering knuckle and the self-locking nut has been increased in thickness from 5 to 7 mm (0.196 to 0.275 in.), and in diameter from 34 to 38 mm (1.338 to 1.496 in.).

The new ball joints can be service installed without difficulty, but the other new parts, i.e. eccentric bushing and washer, must however also be installed.

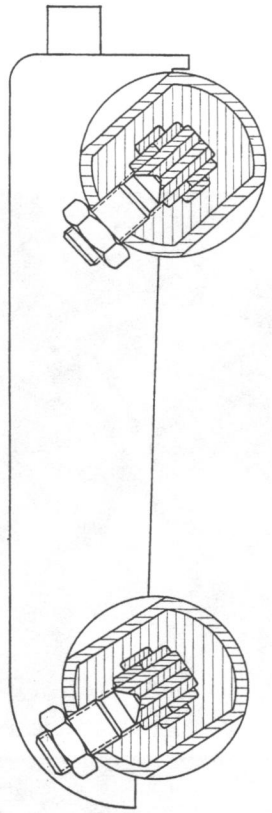


Upper ball joint

1 - Press joint out with press tools VW 412, VW 416b, VW 415a and VW 401.

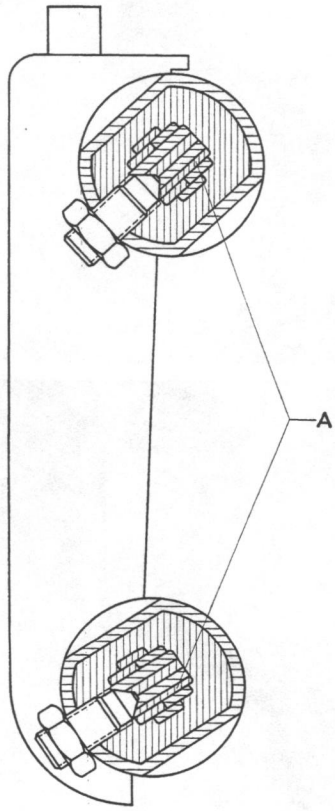
The front axle torsion bars are made up of 10 spring steel leaves. There are two versions which differ as follows:

Type 1 all (except Model 181)



Model 181

A = thinner leaf must be at bottom



Removing and installing torsion bars Type 1 8-1

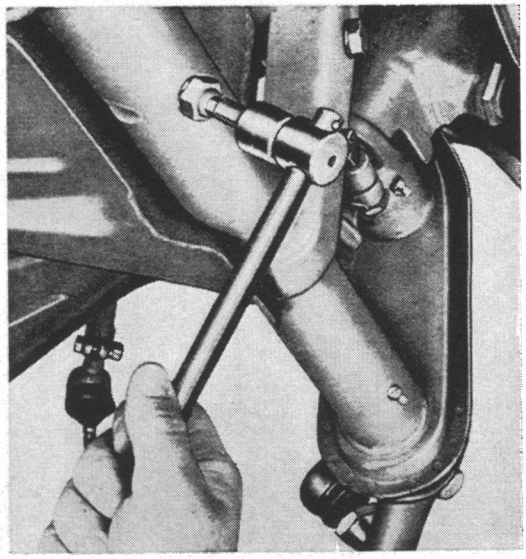
Removing

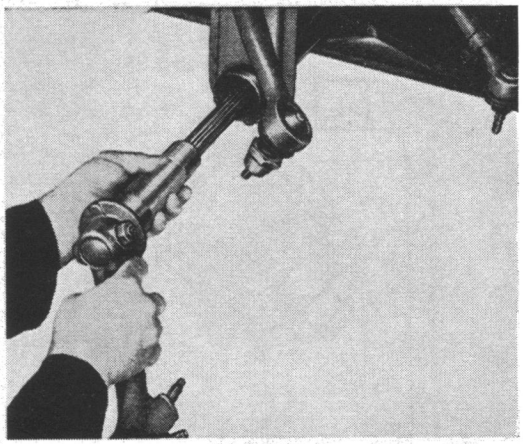
1 - Remove both steering knuckles.

2 - Remove torsion arms on one side.

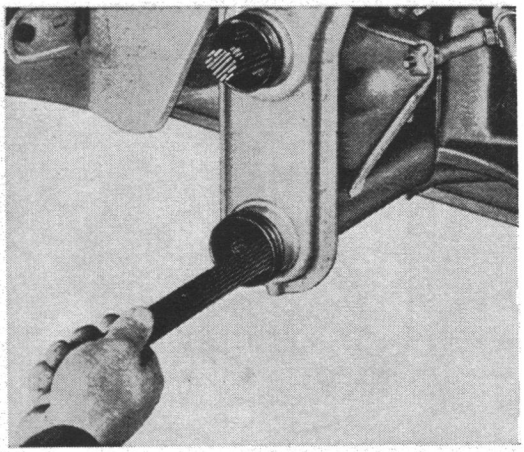
3 - Loosen the locknut on the headless setscrew.

4 - Remove the setscrew.





5 - Pull torsion arm and bar out.



Installing

Note the following points:

1 - Clean the torsion bars and examine them for cracks and breakage. Install new bars if necessary.

2 - Check torsion arms, needle bearing and bushings and replace as necessary.

3 - Coat bars liberally with multi-purpose grease before installing.

4 - When inserting the torsion bars, note the number of leaves and the position of the countersunk marks for the torsion arm attaching pins.

5 - Align the countersunk mark in the center of the bar with the hole for the setscrew. Tighten center setscrew to correct torque and secure with the locknut.

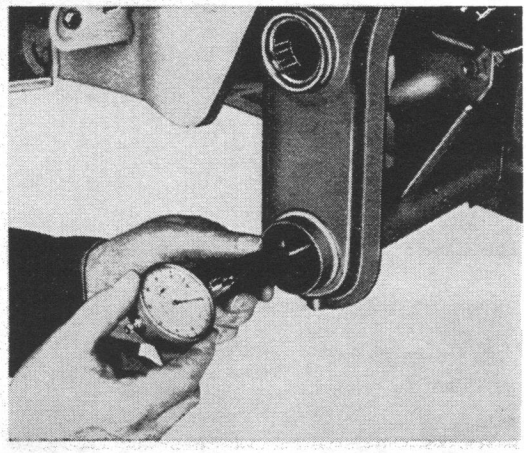
6 - Reinstall all removed parts and lubricate front axle with multi-purpose grease.

The metal bushes are subject to very little wear and do not usually need replacement. However, if wear is noted on the torsion arm bearing surface, the metal bush should be replaced as well as the torsion arm.

Removing

1 - Remove both steering knuckles complete with drums, take out torsion arms and torsion bars.

2 - Measure metal bush wear with an internal measuring gauge. The wear limit for upper and lower bushes is 37.38 mm (1.47 in.).

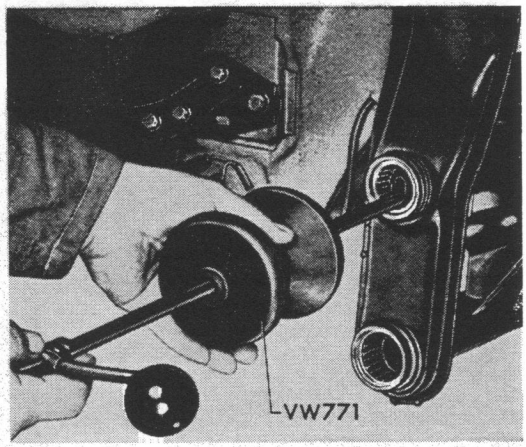


Removing needle bearings and metal bushes

Upper and lower needle bearings

a - Attach washers VW 771—21/3 for **upper needle bearing** or washer VW 771—21/7 for **lower needle bearing** to extractor VW 771. Insert tool into axle tube and locate washer against shoulder of needle bearing.

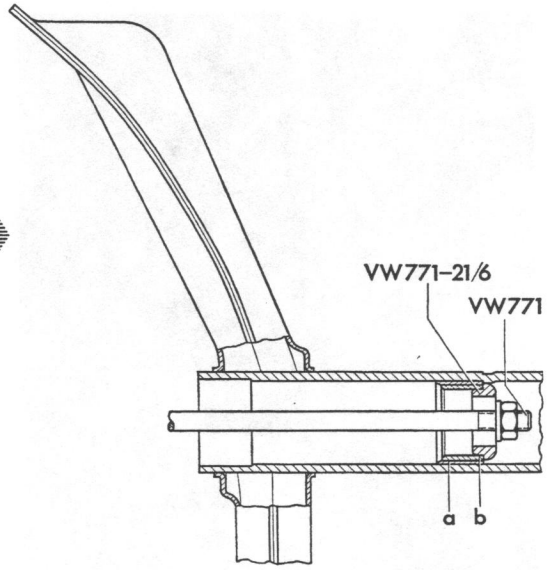
b - Pull bearing out.



Upper and lower metal bushings

a - Insert extractor VW 771 into axle tube with washer VW 771—21/6 attached and locate washer against bushing.

b - Pull metal bushing out.



a - Plastic sleeve
b - Metal bushing

Important

The plastic sleeves for the bushings do not wear and remain in the axle tube. Exercise extreme care when driving out bushings to avoid damaging plastic sleeves.

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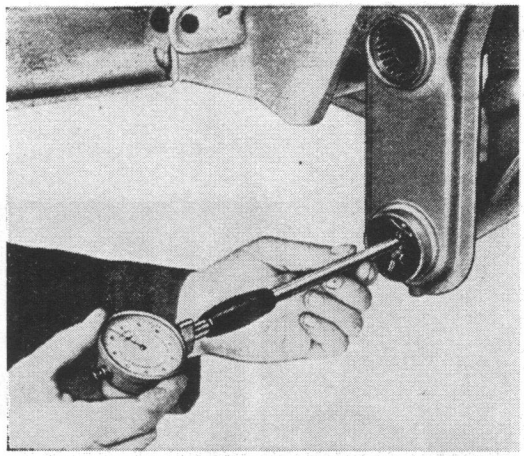
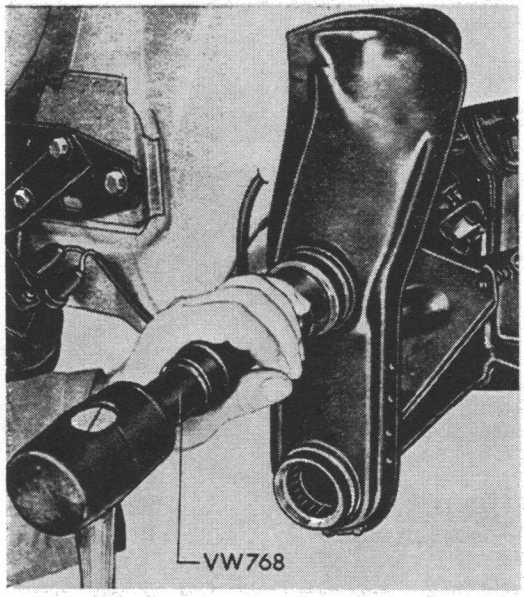
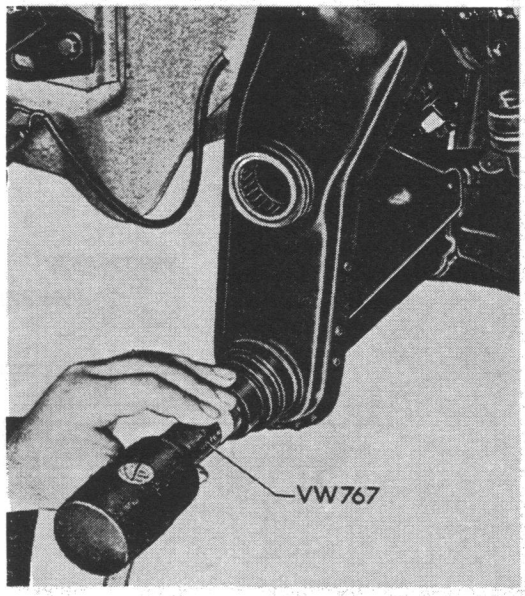






Installing

1 - Clean axle tubes particularly at the needle bearing and bushing seats.

2 - Check condition and dimensions of needle bearing seats in axle tube.

Note:

Since oversize needle bearings are also used, it is essential to check the size of the axle tubes when fitting a new needle bearing. The inside diameters of the bores are:

	Standard	Oversize
Upper:	45.99—45.97 mm 1.81— 1.80 in.	46.19—46.17 mm 1.82— 1.81 in.
Lower:	49.99—49.97 mm 1.97— 1.96 in.	50.19—50.17 mm 1.96— 1.95 in.

The bearings to match are:

	Standard	Oversize
Upper needle bearing:	46 mm 1.811 in.	46.2 mm 1.818 in.
Lower needle bearing:	50 mm 1.969 in.	50.2 mm 1.976 in.

If the seats in the axle tubes are no longer within tolerance, a new axle beam must be fitted as it is not possible to machine the seats.

3 - Drive in new upper metal bushing and upper needle bearing with VW 768. The bushings should be driven in until the shoulder on the drift contacts the axle tube.

Important

When installing the metal bushings be careful not to damage the plastic sleeves. Damaged plastic sleeves cannot be replaced. Clean needle bearings carefully, check for diameter of bearings and bushings.

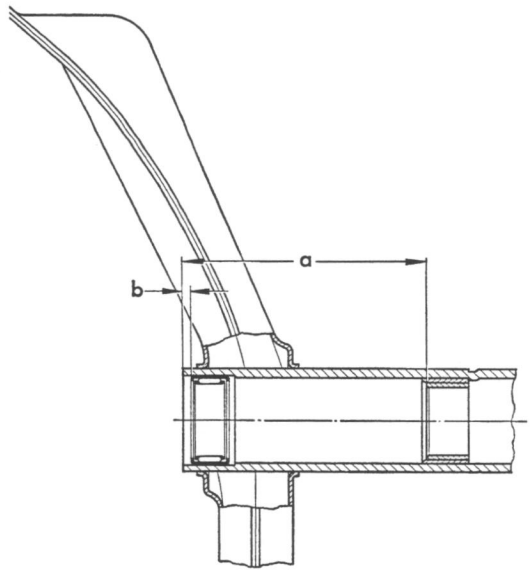
Lubricate needle bearing seats lightly with universal grease. The needle bearings should be installed so that the marking on the shoulder is facing outward.

4 - Drive new lower metal bushing and lower needle bearing in with VW 767 until shoulder on drift contacts the axle tube.

5 - Install all parts removed and lubricate axle thoroughly with multi-purpose grease.

Note:

In cases where the drifts 767 and 768 are not available, drive metal bushings and needle bearings into axle beam to the dimensions given in sketch.



a - metal bushings:

upper 122+2 mm
4.80+.08 in.

lower 132+2 mm
5.20+.08 in.

b - needle bearings:

upper 3.5+0.2 mm
.0137+.008 in.

lower 5.0+0.2 mm
.0197+.008 in.

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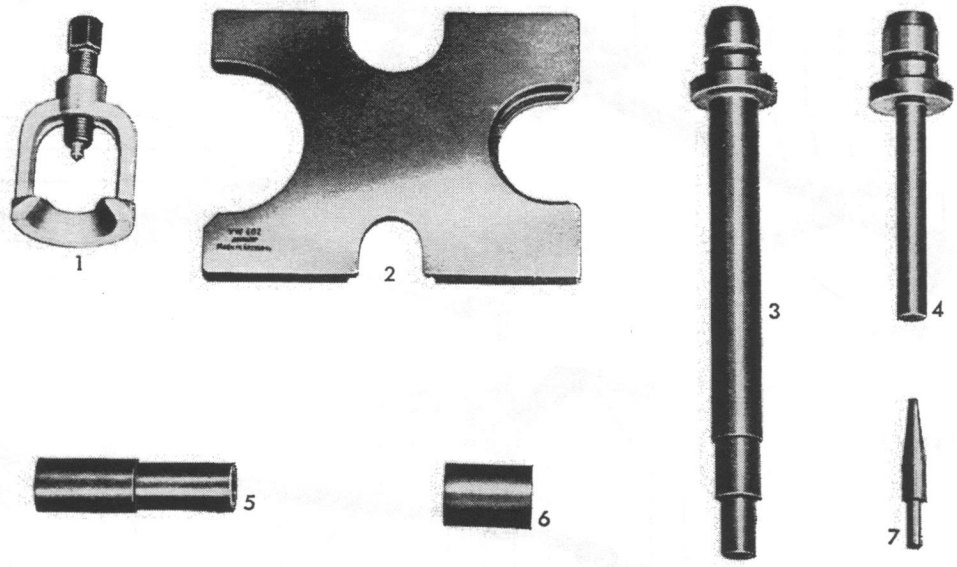
Tools



No.	Description	Special Tool	Remarks
1	Tie-rod end extractor	VW 266 h	
2	Plate	VW 402	
3	Press tool	VW 408	
4	Press tool	VW 411	
5	Tube	VW 421	
6	Tube	VW 426	
7	Tapered pilot	VW 437 a	

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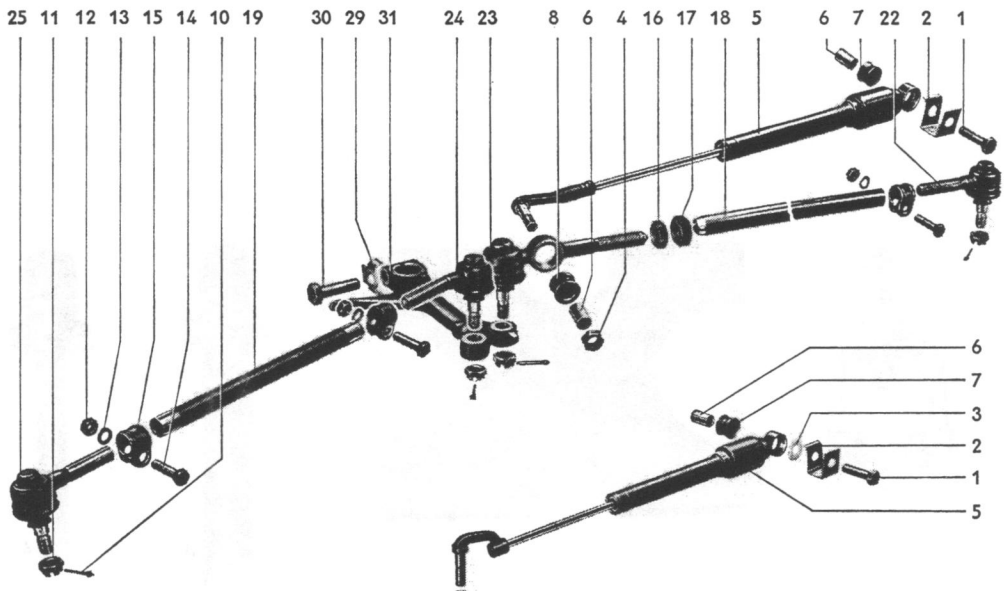
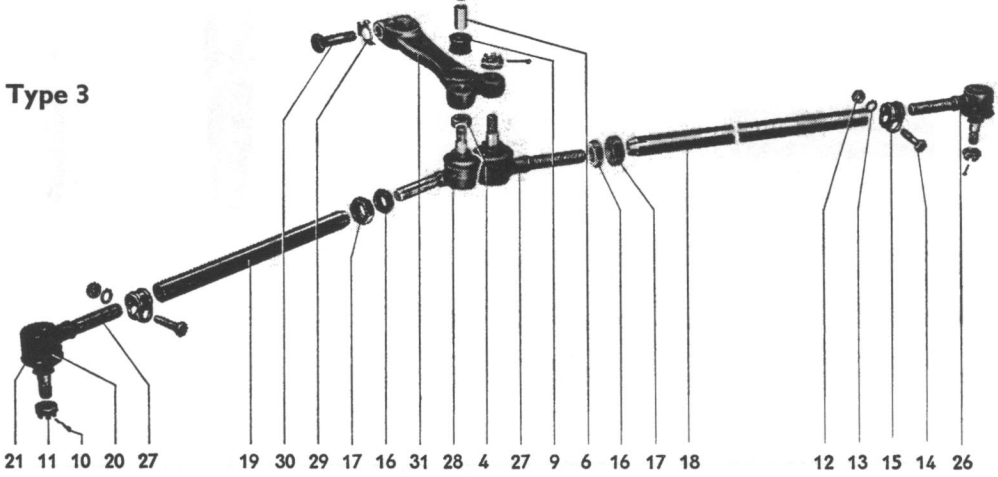
Type 1



Type 3



No.	Description	Qty.	Note when removing	Note when installing	Remarks
1	Bolt M 10×40	1		tighten to 4.0 to 4.5 mkg (29—32 lbs. ft.)	
2	Lockplate	1		use new plate	
3	Washer	1		only on Type 3	
4	Self-locking nut M 10×1	1		always use new nut	
5	Steering damper	1		check by extending and compressing	V 6.1/2-1

No.	Description	Qty.	Note when removing	Note when installing	Remarks
6	Sleeve for rubber bushing	2		coat with glycerine, when pressing into bushing	V 6.1/2
7	Bushing for steering damper	1		coat with talcum and press in flush	V 6.1/2
8	Bushing for tie rod end	1		as No. 7	
9	Bushing for drop arm	1		as No. 7	
10	Cotter pin	4		always use new pins, note size of hole in tie rod end	
11	Slotted nut	4		tighten to 3.0 mkg (22 lb. ft.) then turn on until cotter hole is aligned	
12	Nut M 8 on Type 1 on Type 3	3 2		tighten to 1.5 mkg (11 lb. ft.) after adjusting wheel toe	
13	Spring washer on Type 1 on Type 3	3 2			
14	Bolt M 8×1×30 on Tyep 1 on Type 3	3 2			
15	Clamp on Type 1 on Type 3	3 2			
16	Nut for tapered ring M 14×1.5 on Type 1 on Type 3	1 2		tighten to 2—2.5 mkg (14—18 lb. ft.) after adjusting wheel toe	
17	Tapered ring on Type 1 on Type 3	1 2			
18	Tie rod (long)	1			
19	Tie rod (short)	1			
20	Retaining ring for dust seal	4			
21	Dust seal	4		check for damage	

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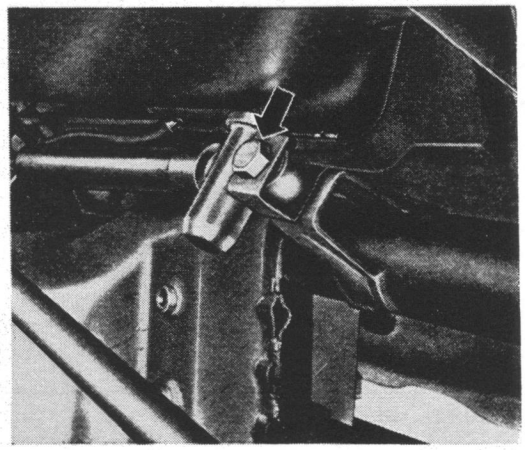
No.	Description	Qty.	Note when removing	Note when installing	Remarks
22	Tie rod end, straight, RH thread	1		**Do not use** the tie rod ends of the Sedan 113	V 6.1/3 V 6.1/6
23	Tie rod end, for steering damper	1			
24	Tie rod end, offset RH thread	1			
25	Tie rod end, straight, LH thread	1		as No. 22	
26	Tie rod end, straight, RH thread	1		as No. 22	
27	Tie rod end, straight, LH thread	2		as No. 22	
28	Tie rod, offset	1		as No. 22	
29	Lockplate	1		use new plate	
30	Bolt M 12×1.5	1		tighten tp 5.0—7.0 mkg (36—50 lb. ft.) and lock with lock plate	
31	Drop arm	1			

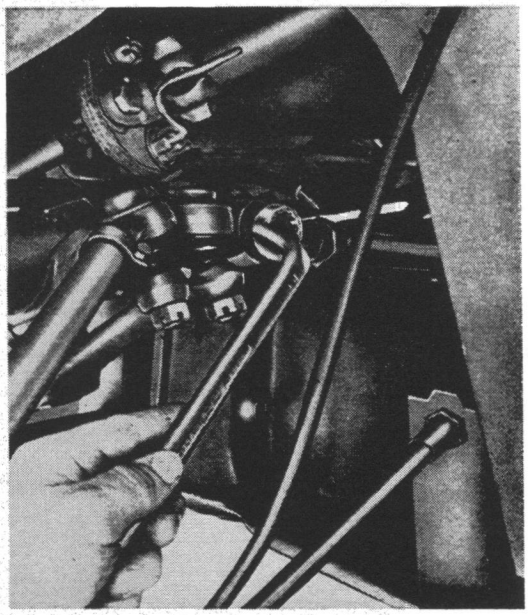
Removing and checking steering damper

Removing

1 - Release lockplate and remove bolt from bracket on axle beam.



2 - Remove nut at tie-rod eye (at drop arm on Type 3) and take damper out.



Checking

Check damper by extending and compressing it. The damper resistance must be uniformly firm and free of jerks over the complete stroke. When in doubt compare with a new damper.

The damping action in both directions must be clearly felt to the end of the stroke.

Two steering dampers which differ in length and stroke are available as replacement parts for type 1 vehicles.

To avoid trouble with the steering due to premature failure of the steering damper ensure, when replacing a damper, that the one installed is the correct type for the vehicle concerned.

Check the rubber bushings and sleeves in damper for wear and damage and replace it necessary.

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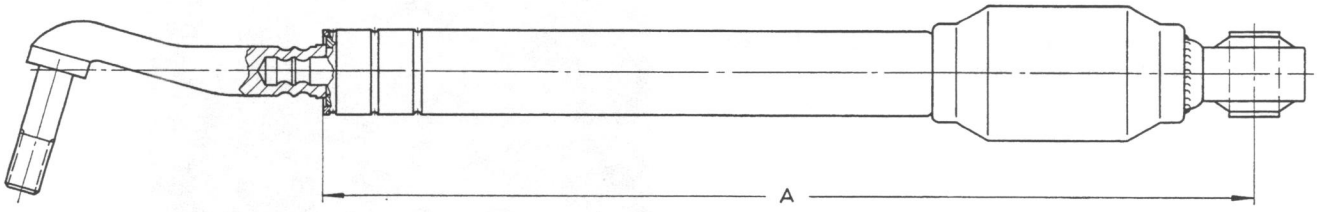
Replacing

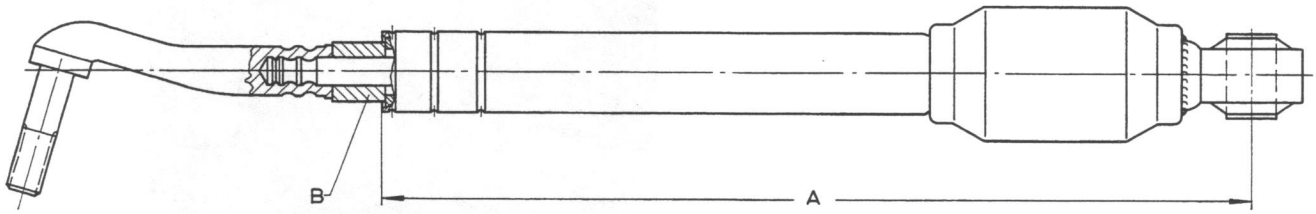
Steering damper without spacer



A = appr. 260 mm (10 1/4")

Model	Chassis No.
113, 117, 141, 143, 151	from 116 000 001
141, 143	from 2 921 252 to 115 999 000

Steering damper with spacer



A = approx. 243 mm (9 9/16")

B = Plastic spacer

Model	Chassis No.
113, 117, 151	from 2 921 252 to 115 999 000

Installing

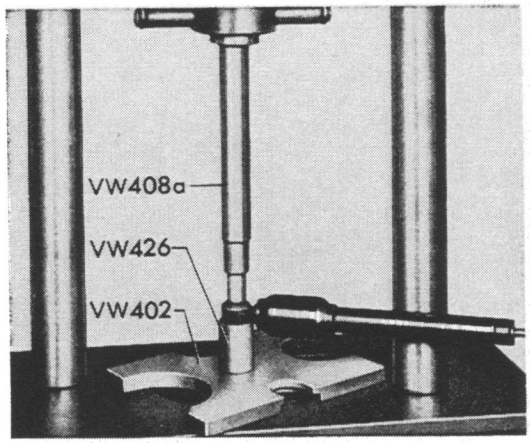
1 - Attach steering damper to tie-rod or the drop arm on Type 3 vehicles. Tighten the **new self-locking nut** to correct torque.

2 - Attach steering damper to bracket on axle tube, using a **new lockplate.** Tighten bolt to correct torque and lock.

Replacing steering damper bushing and sleeve

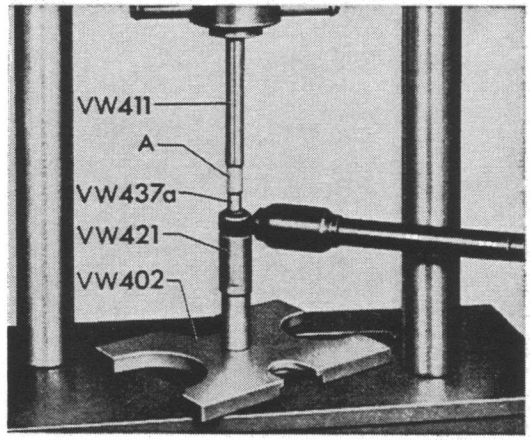
1 - Press bushing and sleeve out with VW 408a, 426 and 402.

2 - Press new bushing into damper eye.



3 - Press sleeve into bushing using VW 411, 437a, 421 and 402.

A = Sleeve for bushing



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Removing

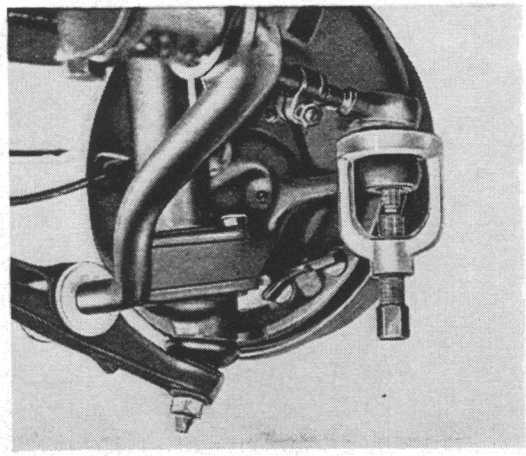
1 - Remove cotter pins and nuts from tie rod ends.

2 - Detach steering damper from tie rod end.

3 - Press tie rod ends out, using VW 266h.

Caution

Do not damage the rubber seals when removing tie rod ends. Take care not to squeeze grease out of the seals when working on the steering linkage. The service life of the joints is satisfactory only when they are packed with the correct amount of grease. Damaged rubber seals must be replaced.



Installing

1 - Check tie rods for damage.

Important

Bent tie rods must be replaced, not straightened.

2 - Check tie rod ends for wear and tighten. If there is any play or if the stud cannot be moved by hand, the tie rod end must be replaced. The thread on the stud must be undamaged.

3 - Check dust seals for damage. The seals may be replaced only if it is known that no dirt has entered the joint. If in doubt, replace the joint.

4 - On Type 1 vehicles, check the steering damper bushing for wear and replace if necessary.

5 - Install both tie rods so that the left-hand thread is on the left.

Caution

Do not confuse the tie rod ends of the link pin or ball joint type axles with those of the suspension strut type axle. Tie rod ends of the suspension strut axle have a greater movement. Under no circumstances are they to be installed on a vehicle with either ball joint or link pin axles. Otherwise the driving and steering characteristics of the vehicle will be seriously impaired.

The tie rod ends of the suspension strut type axle are identified by either a protusion or indentation on the housing as shown at point "A".

6 - Tighten slotted nuts on tie rod ends to correct torque and lock.

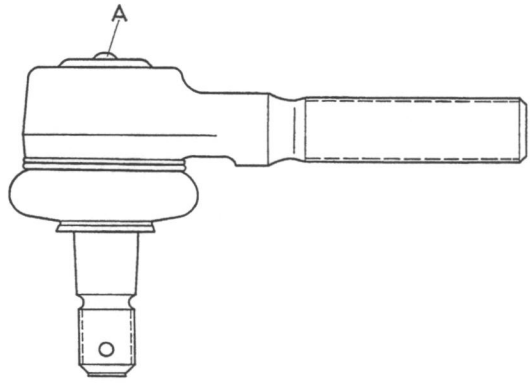
7 - Loosen nuts for tapered rings or clamps.

8 - Turn both ends on each rod in one direction to front or rear as far as possible so that the ends are properly aligned with one another.

9 - In this position tighten nuts for tapered rings or clamps to correct torque.

10 - On Type 1 vehicles, attach steering damper to tie rod.

11 - Adjust wheel toe.



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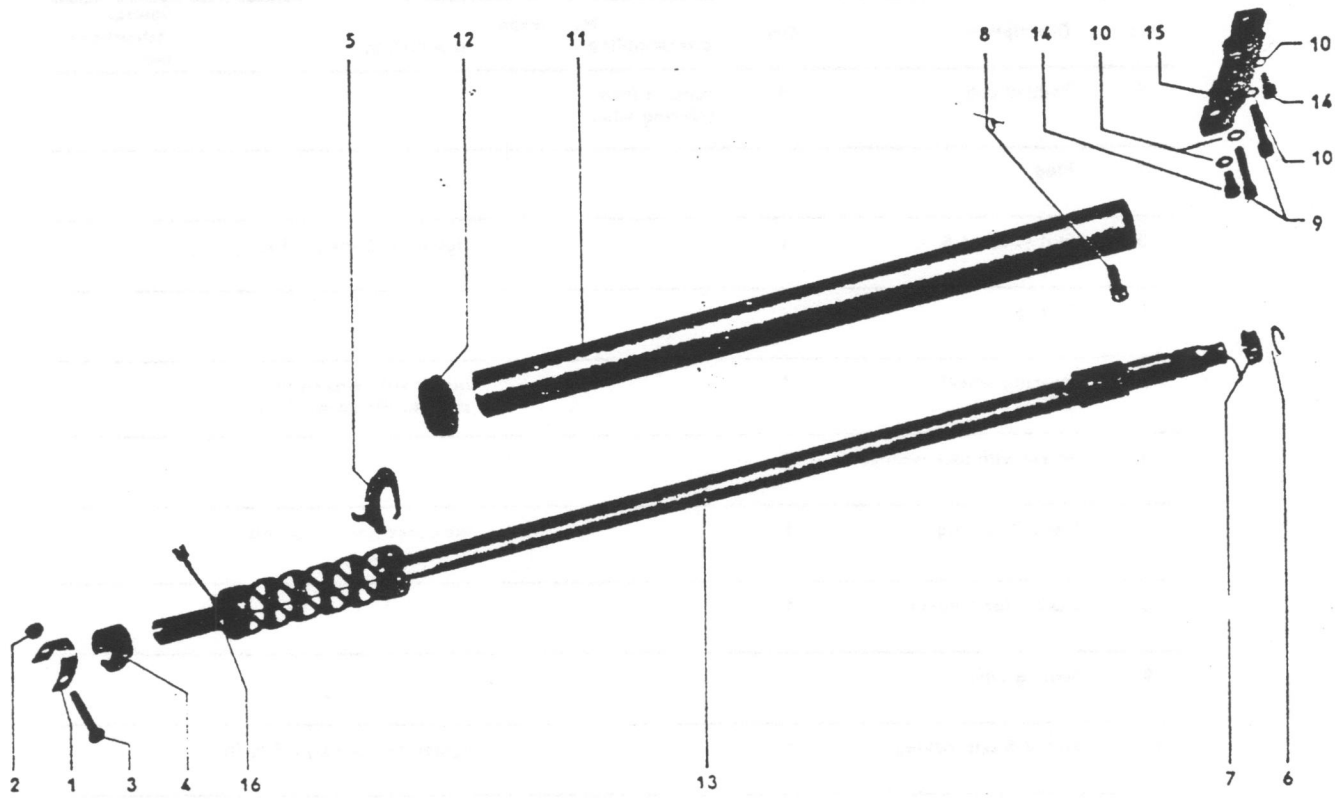

No.	Description	Qty.	Note when removing	Note when installing	Remarks
1	Lockplate	1	bend up	use new plate, lock nut and bolt by bending plate	V 7.1 2-1
2	Hex. nut	1		tighten to 2—2.5 mkg (14—18 lb. ft.) and lock	
3	Bolt	1		lock	
4	Clamp for column	1			
5	Support for column	1	bend tabs up	bend tabs down	V 7.1 2-1
6	Circlip for column	1	pry off with two screwdrivers		
7	Contact ring	1		place in bearing in column switch from underneath	
8	Allen head bolt (M 8 x 22, secures column switch to column tube)	1		tighten to 0.5—1.0 mkg (4—7 lb. ft.)	

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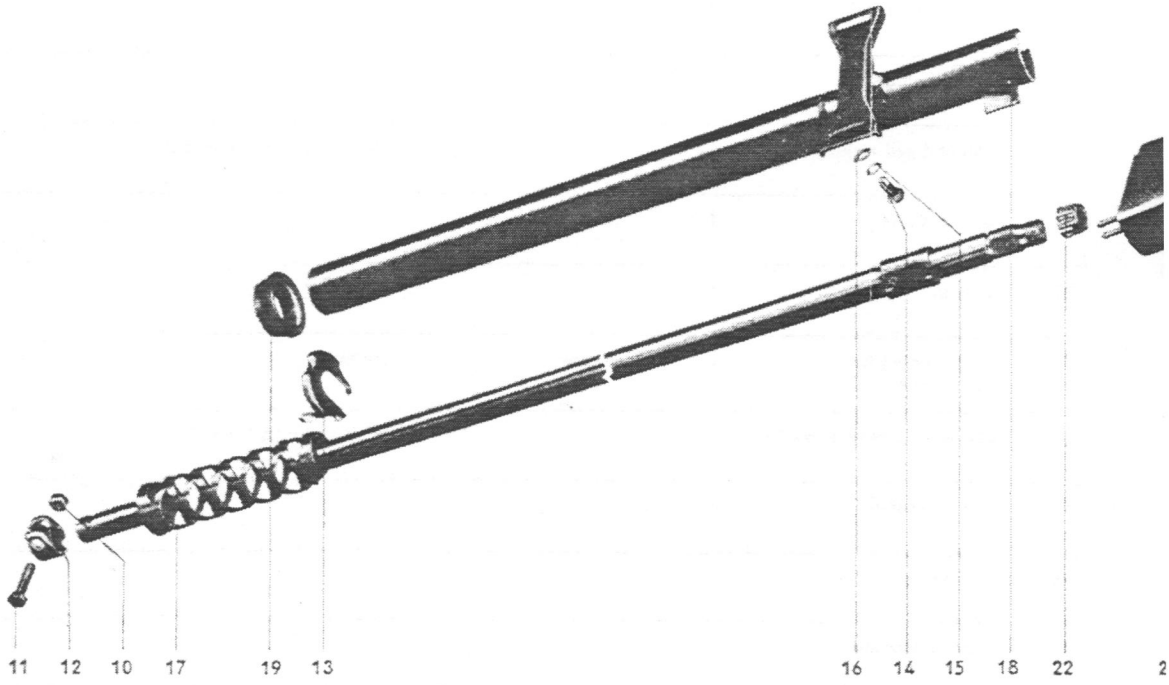
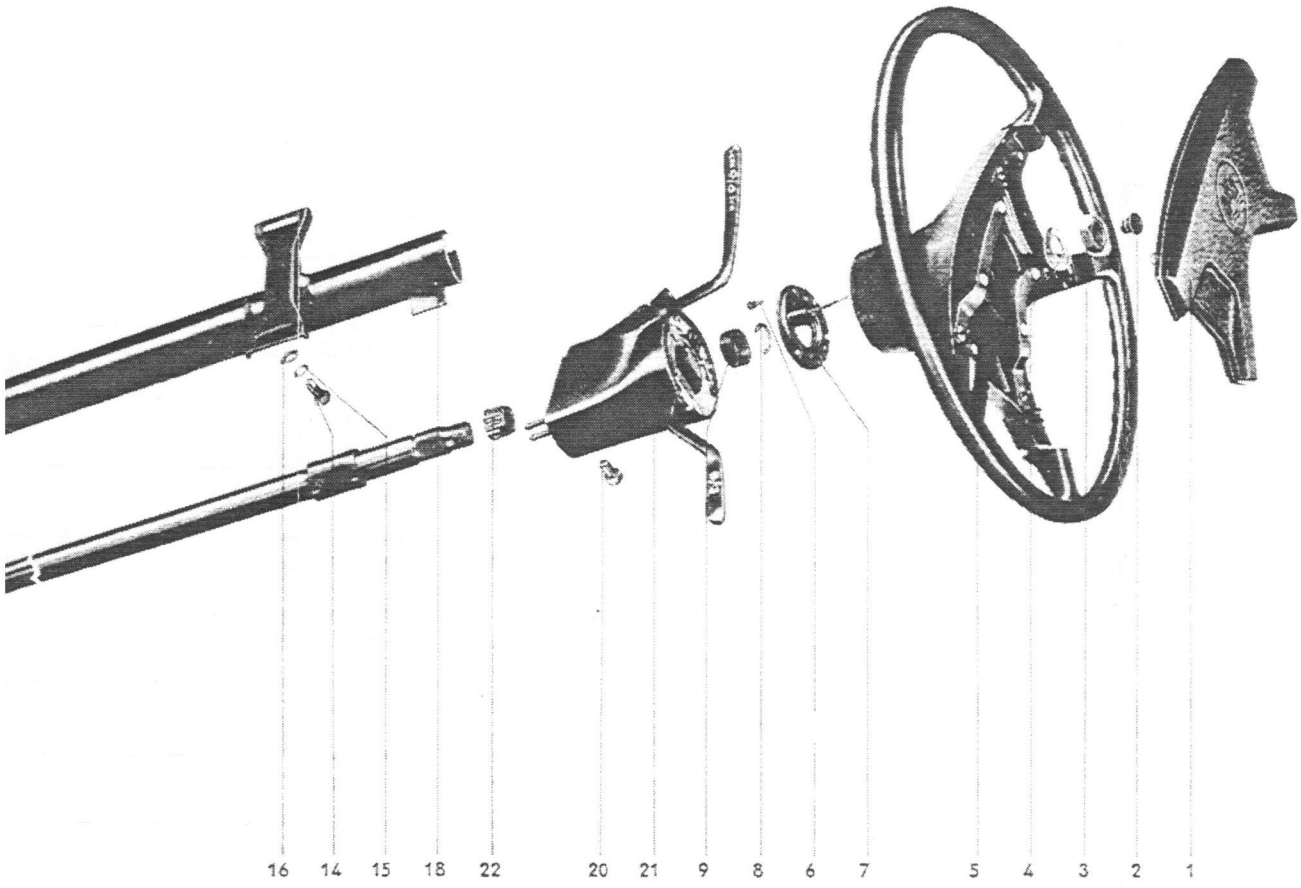
No.	Description	Qty.	Note when disassembling	assembling	Special instructions see
1	Padded cap	1	remove from steering wheel		
2	Plug	1			
3	Nut M 18×1.5	1		tighten to 5 mkg (36 lb ft)	
4	Circlip				
5	Steering wheel	1		install with wheels in straight-ahead position	
6	Screw with lock washer	3			
7	Cancelling ring	1		the cancelling lug points to the right	
8	Circlip for column	1			
9	Sealing ring	1			
10	Nut M 8 self locking	1		tighten to 2.5 mkg (18 lb ft)	
11	Bolt M 8×40	1			
12	Clamp	1			
13	Support ring for column tube	1	open tabs	close tabs	
14	Bolt with groove M 8×18	2		tighten to 2 mkg (14 lb ft)	
15	Spring washer	2			
16	Washer	2			
17	Steering column	1			
18	Column tube	1			
19	Sealing ring	1			
20	Screw M 8×16	1		tighten to 0.5—1 mkg (3.5—7 lb ft)	
21	Steering column switch	1			
22	Contact ring	1			



Disassembling and assembling steering Type 1 / Model 181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No.	Description	Qty.	Note when disassembling	assembling	Special instructions see
1	Padded cap	1	remove from steering wheel		
2	Plug	1			
3	Nut M 18×1.5	1		tighten to 5 mkg (36 lb ft)	
4	Circlip				
5	Steering wheel	1		install with wheels in straight-ahead position	
6	Screw with lock washer	3			
7	Cancelling ring	1		the cancelling lug points to the right	
8	Circlip for column	1			
9	Sealing ring	1			
10	Nut M 8 self locking	1		tighten to 2.5 mkg (18 lb ft)	
11	Bolt M 8×40	1			
12	Clamp	1			
13	Support ring for column tube	1	open tabs	close tabs	
14	Bolt with groove M 8×18	2		tighten to 2 mkg (14 lb ft)	
15	Spring washer	2			
16	Washer	2			
17	Steering column	1			
18	Column tube	1			
19	Sealing ring	1			
20	Screw M 8×16	1		tighten to 0.5—1 mkg (3.5—7 lb ft)	
21	Steering column switch	1			
22	Contact ring	1			

Removing

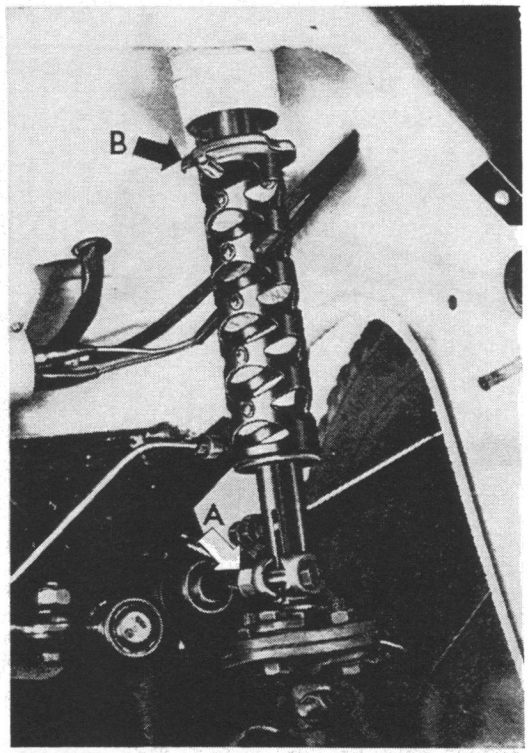
1 - Disconnect battery ground strap.

2 - Remove fuel tank.

3 - Remove nut from bolt in column securing clamp (arrow A). Bend up tab on column support ring and take ring off (arrow B).

4 - Remove steering wheel and column circlip. Turn ignition key to "on" position.

5 - Disconnect all wiring from column switch. Release pressure before disconnecting hoses for windshield washers from the steering column switch.

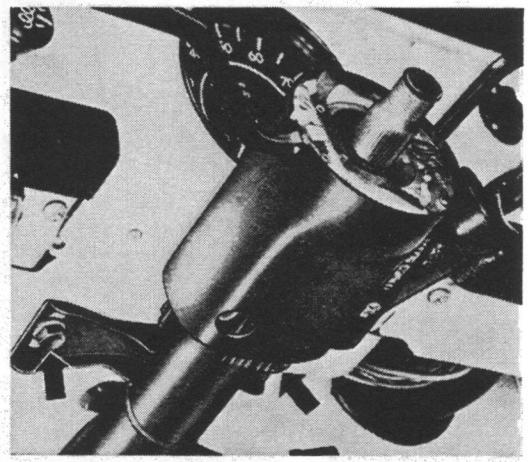


6 - Remove two bolts (arrows) attaching column tube to mounting plate.

7 - Pull column tube back into passenger compartment complete with column and switch.

8 - Remove bolt holding switch to column tube and take switch off.

9 - Pull column tube off column.



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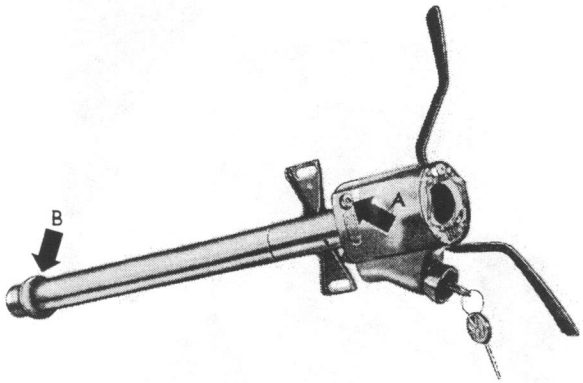
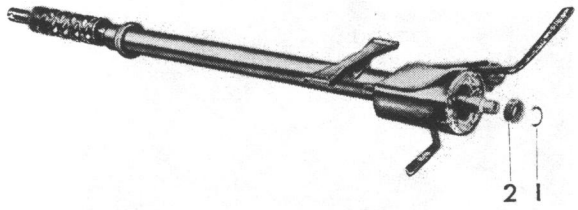
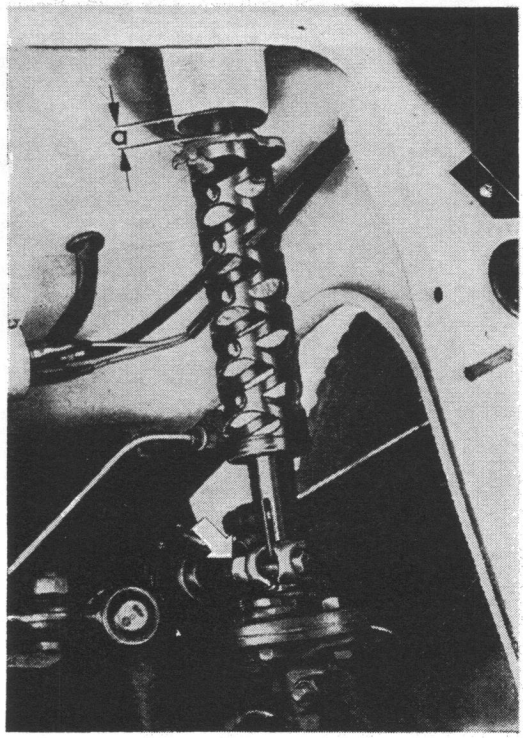




1 = Circlip

2 = Sealing ring



Installing

1 - Install switch on column tube and tighten socket head bolt (arrow A) to correct torque. Fit sealing ring on column tube (arrow B).

2 - Place contact ring and seat on the column, insert column into column tube and secure with circlip.

3 - Install the assembly in the vehicle and push column on to column coupling after installing the clamp. Insert bolt through clamp and tighten new self-locking nut lightly.

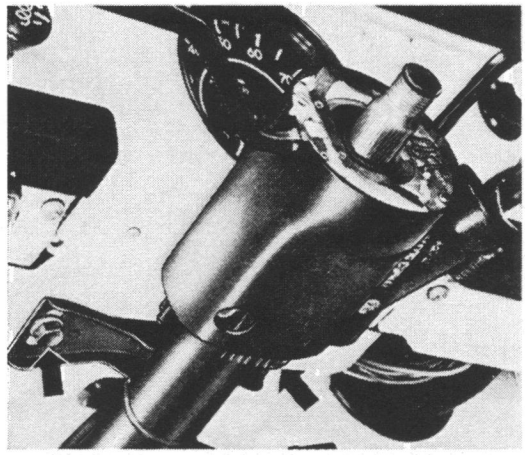
4 - Install column support ring and secure by bending down the tab.

5 - Move steering column far enough that the distance between the support ring and tube in the cross panel is (a) 6—8 mm (0.24—0.31 in.) Then tighten self-locking nut (arrow) to correct torque.

6 - Tighten bolts (arrows) for column tube lightly.

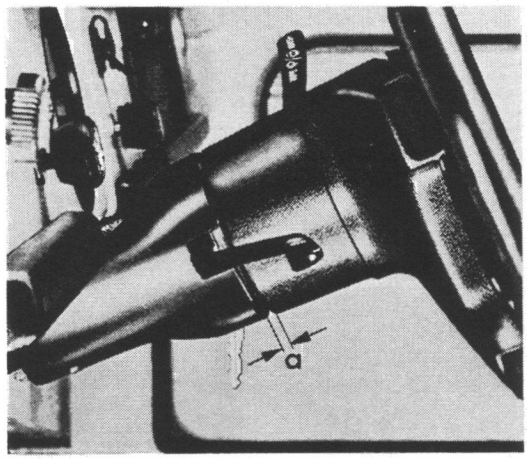
7 - Install steering wheel on column with wheels in straight-ahead position (marking ring on worm spindle in line with casting seam in housing, steering wheel spokes horizontal). Make sure that turn signal lever is in the central position as otherwise the canceling cams will be damaged by the lug on the canceling ring when the steering wheel is installed.

8 - Tighten steering wheel nut to correct torque.



9 - Adjust gap between steering wheel hub and column switch to 2—4 mm (0.08—0.16 in.) (a) by moving the column tube. Tighten bolts to correct torque.

10 - Connect all wires and water hoses for windshield washer to column switch.



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Troubleshooting Chart

Symptom	Cause	Remedy
Hard Steering		
Steering is equally stiff from lock to lock, jams or does not automatically self center	a - Front axle inadequately lubricated	a - Jack up front end af car thoroughly lubricate front axle
	b - Steering gear not properly adjusted	b ; Check steering gear adjustment
Front wheel do not self center although there is no tightness in the steering system	a - Front wheel alignment improperly adjusted	a - Check and adjust front wheel alignment (caster, camber and toe-in)
Play in Steering		
Play in steering gear	a - Steering gear not properly adjusted	a - Sheck steering gear adjustments
	b - Steering gear set worn	b - Install new steering gear set
Excessive play in tie rod ends	Tie rod ends aorn	Install new tie rod ends
Excessive play in front wheel suspension	Worn bearing points (torsion arms stub axle, and front wheel bearings)	Check adjustment of torsion arms and front wheel bearings. Adjust parts with excessive play or replace if necessary
Vehicle pulls to one side	a - Tire pressures uneven. The vehicle pulls to the side with low pressure	a - Check pressures and rectify
	b - Tires unevenly worn. The vehicle pulls to the side on which the tires are most worn	b - Rotate or install new tires
	c - Toe-in out of adjustment	c - Adjust toe-in
	d - Steering damper defective	d - Install new damper
	e - Difference between front wheel camber excessive. The vehicle pulls to one side if the camber differs more than 20′ between sides	e - Check camber
Front wheel wobble	a - Wheels are not balanced	a - Balance wheels (see section B)
	b - Steering out of adjustment	b - Adjust steering
	c - Steering damper defective	c - Install new damper
	d - Shock absorber defective	d - Install new shock absorber
	e - Front axle worn	e - Overhaul axle
	f - Wheel alignment out of adjustment	f - Correct wheel alignment

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Checking the steering gear of accident vehicles

Whenever repairs are performed to the front end of a vehicle that has been involved in an accident the steering must be very carefully checked as follows:

1 - The steering gear and all component parts must be checked for fractures, cracks, distortion and also for security of mountings etc.

2 - In addition the steering must be checked, both with the vehicle standing on its wheels and with the front end jacked up, by turning the steering wheel repeatedly to both full lock positions and checking for excessive play, noises, jamming, sticking, grinding and uneven movement.

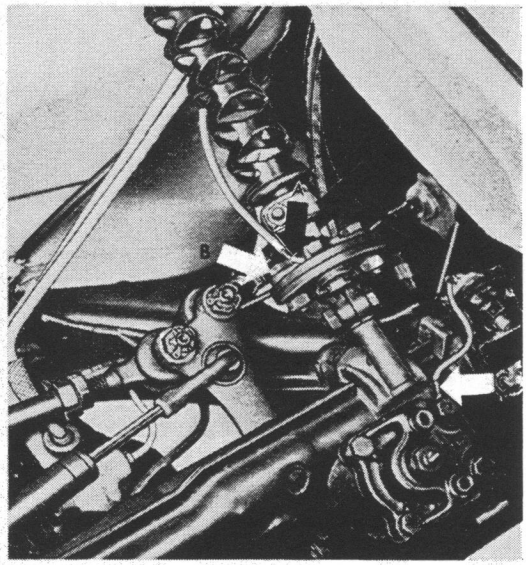
Where such defects are noted, the steering gear must either be repaired or replaced.

Removing

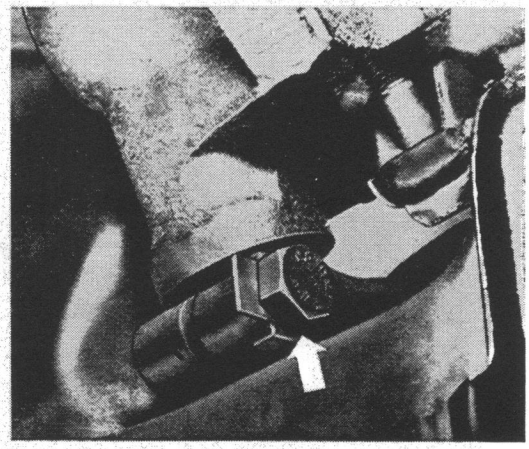
To remove the steering gear, it is necessary to remove the spare wheel well and the fuel tank. The drop arm can now be pulled off the shaft.

1 - Take spare wheel well and fuel tank out.

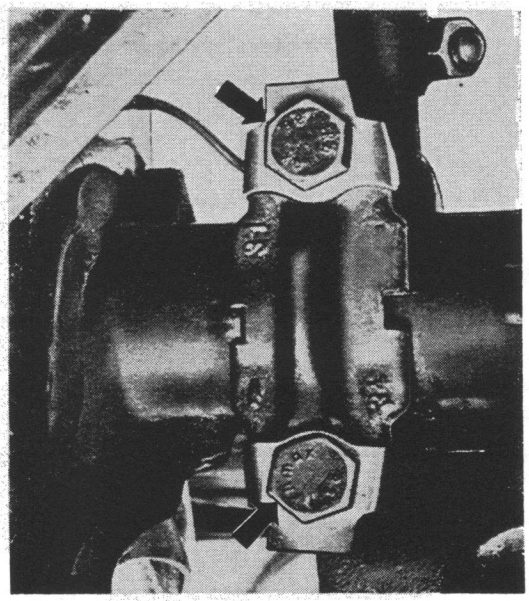
2 - Pull horn ground cable off the connector on the steering column coupling (arrow A), remove bolts holding upper part of flange (arrow B) and bolt holding the ground connection from steering gear to axle retainer (arrow C).



3 - Bend lock plate for drop arm securing bolt and remove bolt.



4 - Bend lock plate for the bolts holding the steering gear clamp. Remove bolts.



5 - Take steering gear.

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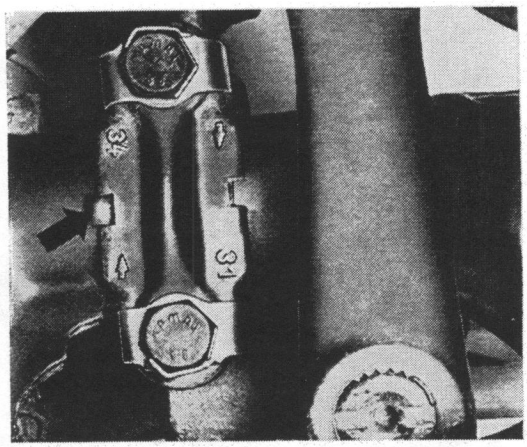


Installing

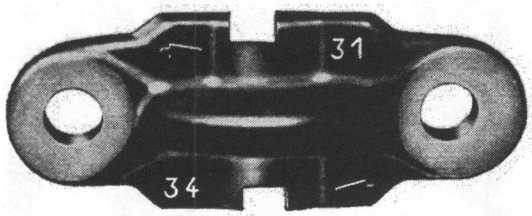
The position of the steering gear on the axle tube is controlled by a stop.

1 - Install steering gear and fit drop arm on shaft.

2 - Install retaining clamp with new lockplates. The clamp should be placed on the axle tube with the appropriate cutout engaged in the stop on the axle.

3 - Tighten clamp securing bolt to correct torque and lock.

4 - Tighten drop arm securing bolt to correct torque and lock. Always use a new locking plate.



5 - Insert bolts for upper column flange, install **new self-locking nuts** and tighten to correct torque.

6 - Connect horn ground cable to the column coupling and attach steering gear ground cable.

7 - Install fuel tank and spare wheel well.

8 - Check toe-in and adjust if necessary.

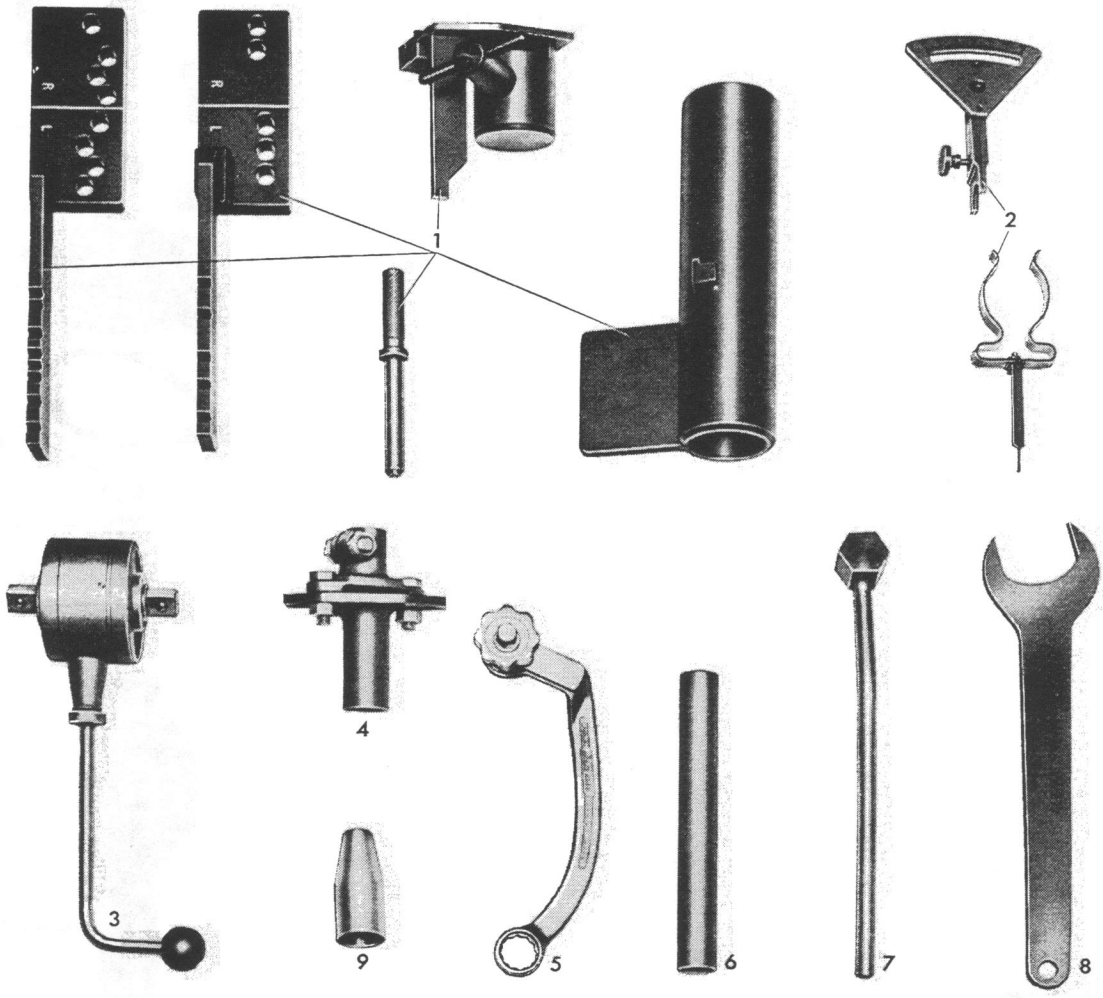
LHD:

Cutout "31" for Sedan and Squareback
Cutout "34" for Karmann Ghia, Type 3

Tightening torques

Location	Description	Thread	Quality grade	Tensile class	mkg	lb. ft.
Steering gear to front axle	Bolt	M 10	8 G	8.8	2.5—3.0	18—22
Drop arm to shaft	Bolt	M 12×1.5	8 G	8.8	7.0	51
Coupling flange to disc	nut	M 8	6 G	8	1.5	11

Tools



No.	Description	Tool No.	Explanation
1	Repair and checking tools	VW 280	
2	Setting devices	VW 279	
3	Torque gauge		standard type, from 0—30 cmkg
4	Adaptor	VW 758/1	
5	Special wrench	2569	17 mm
6	Tube	VW 423	
7	Spindle adjusting wrench	VW 278a	
8	Open-end wrench	VW 277	

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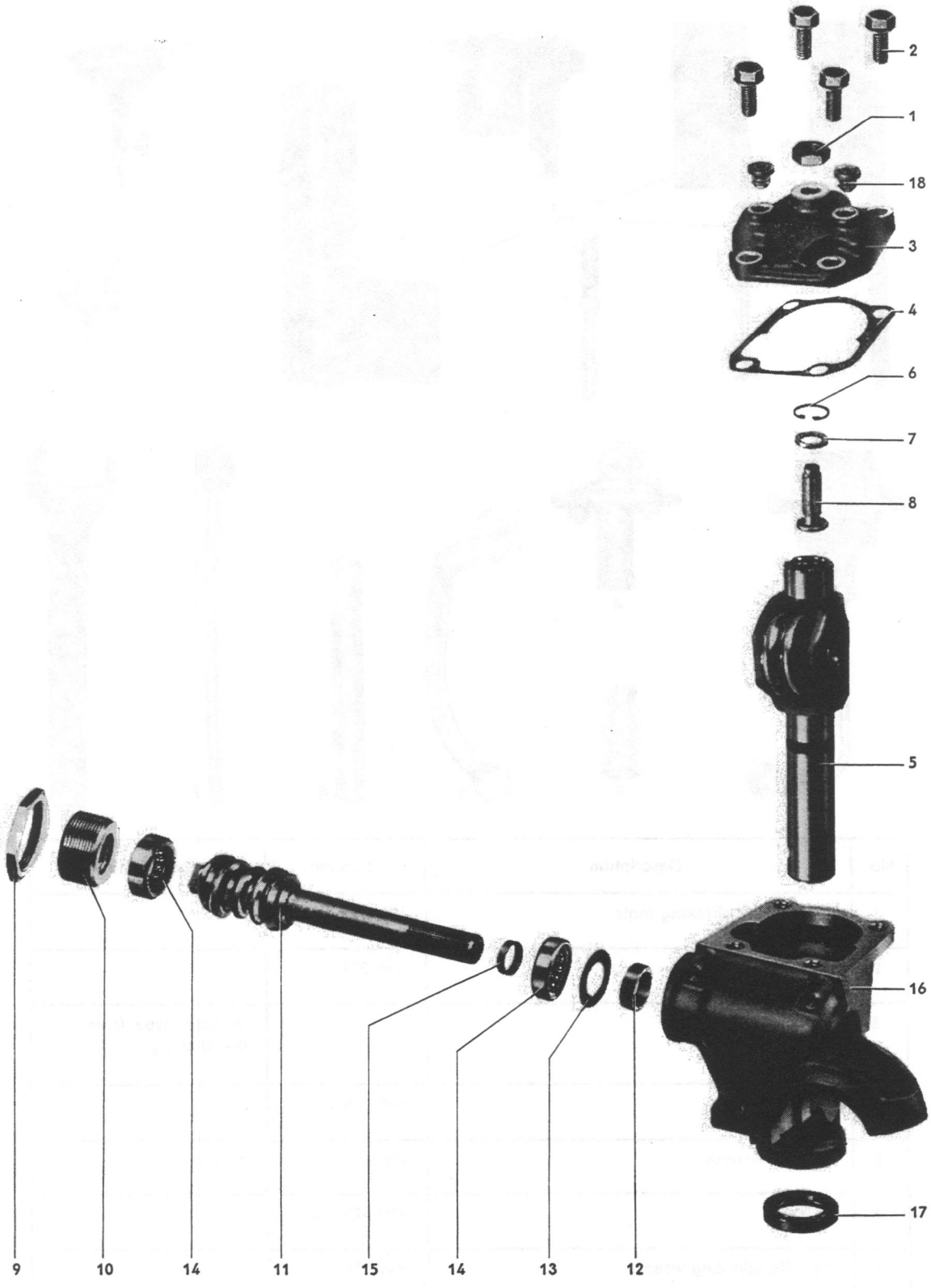
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No.	Description	Qty.	Note when disassembling	Note when assembling	Special instructions see
1	Locknut for adjusting bolt	1			V 8.1/4
2	Bolt M 8×20 and spring washer M 8×15	4 of each		tighten to correct torque	V 8.1/4
3	Housing cover	1	detach by turning adjusting screw (No. 8) and remove	fill housing with liquid transmission grease. Install cover. Before tightening bolts, move cover to side opposite that of spindle if the modified cover marked "KD" is installed use longer bolts.	V 8.1/4
4	Gasket for cover	1		always install new gasket	
5	Drop arm shaft	1	turn spindle to center position, push oil seal protection sleeve VW 649 over splines, press shaft out upward with a punch	check shaft and adjusting screw for damage. Turn screw through the cover	V 8.1/4
6	Circlip 17×1	1		must fit properly in groove in shaft all around	
7	Adjusting washer	x		select as detailed	V 8.1/4
8	Adjusting screw	1		if washer has been selected properly, it should just be possible to turn screw in shaft with thumb and fore-finger, without lateral play	V 8.1/4
9	Lock nut for adjuster	1	loosen with wrench VW 277	tighten to correct torque after adjusting spindle axial play	V 8.1/4
10	Adjuster	1	screw out with VW 278	use sealing compound when installing, tighten, back off and tighten again until spindle turning torque is obtained: 1.5—2.5 cmkg (1.3—2.2 in. lb) 2.0—3.0 cmkg (1.7—2.6 in. lb) with seal installed (No. 12)	V 8.1/4 V 8.1/5
11	Worm spindle	1	knock out with rubber hammer	install with upper bearing and medium thickness washer 0.35 mm (1.378 in.) No 13. Adjust axial play, see turning torque under No. 10	V 8.1/4
12	Seal for spindle	1	knock inward together with washer and upper bearing, using tube VW 423	after adjusting, press seal in with VW 423	V 8.1/4
13	Adjusting washer	x		when installing spindle, use a medium washer 0.35 mm (1.378 in.). If free-of-play movement to left is larger than 11°±2°, use thicker washer; if free-of-play movement to left is less than 11°±2°, use thinner washer	V 8.1/4
14	Ball thrust bearing	2			
15	Marking ring	1		mark center position with ring and secure with paint	
16	Housing	1		fill with 160 cc (5.4 oz.) of transmission grease	
17	Oil seal for shaft	1			
18	Plug for cover	2			

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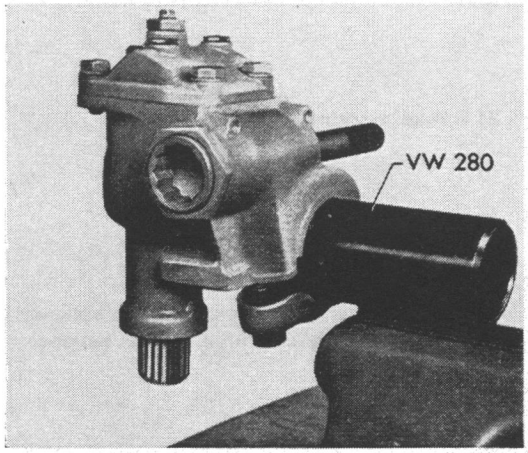
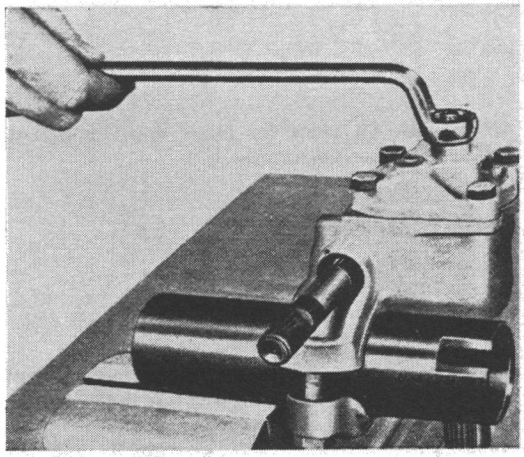
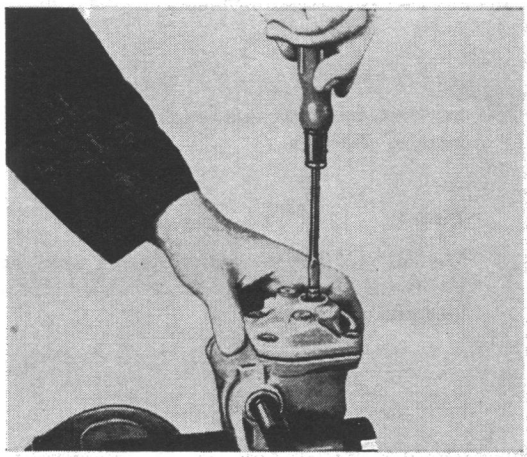
1 - Bolt steering gear onto mounting tube VW 280. The exact position is controlled by a stop on the tube.



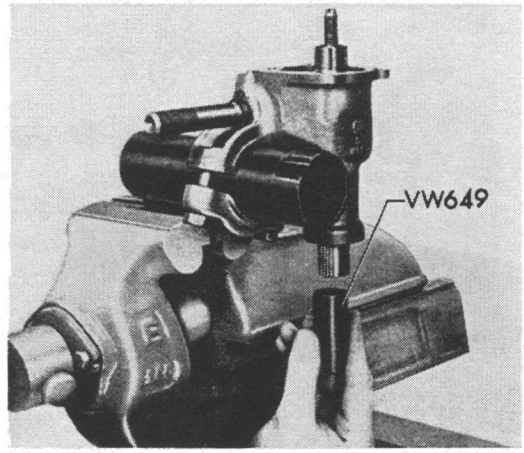
2 - Remove lock nut on drop arm shaft adjusting screw. Remove four cover securing bolts.



3 - Detach cover from shaft by turning the adjusting screw and take cover off.



4 - Slide oil seal protective sleeve VW 649 over splines on drop arm shaft as far as it will go.



5 - Turn steering worm to center position: push drop arm out upwards with a drift.

6 - Remove grease from housing.

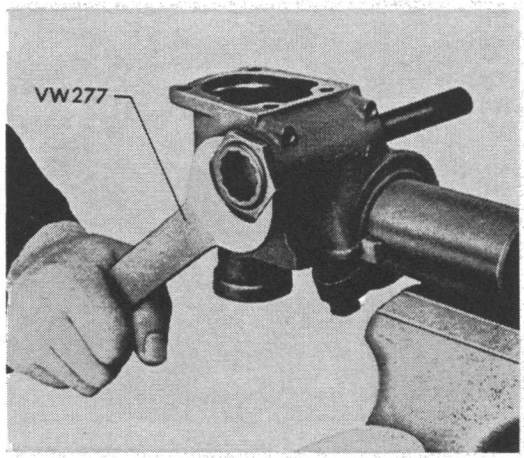
7 - Take circlip for drop arm shaft adjustment out.

8 - Take adjusting screw and shim out of the drop arm shaft.

Note:

The drop arm shaft cannot be dismantled any further.

9 - Loosen the lock nut on the worm spindle adjuster with open-end wrench VW 277.



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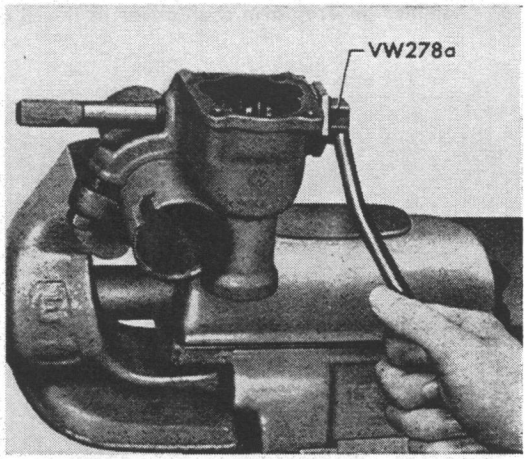
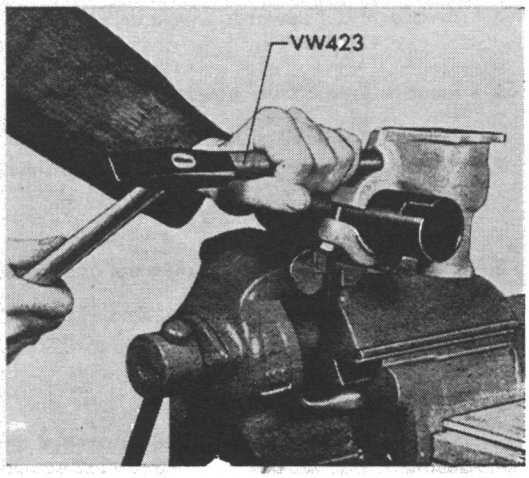


10 - Screw adjuster out with wrench VW 278a.

11 - Take marking ring off.

12 - Remove worm spindle and lower ball bearing by tapping lightly with a rubber hammer.



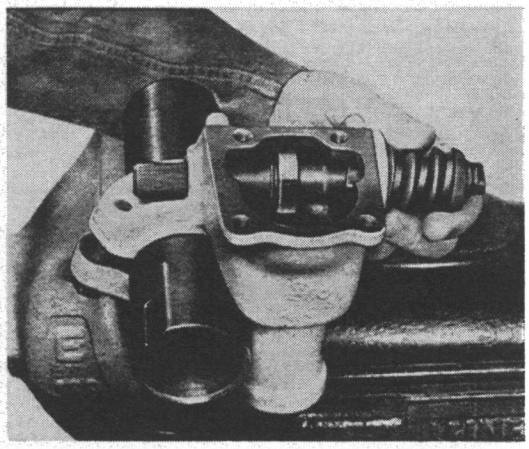
13 - Drive oil seal, shim and upper bearing inwards with tube VW 423.

14 - Check all parts for wear and damage and replace where necessary.

Assembling

When assembling the steering gear, the worm and roller must be adjusted in a way that the free-of-play movement is approximately the same in both directions by selecting a shim of the correct thickness. It is advisable to install a shim of medium thickness (0.35 mm/.0138 in.) first.

The correct shim is then determined with the appliances VW 279 and VW 280.



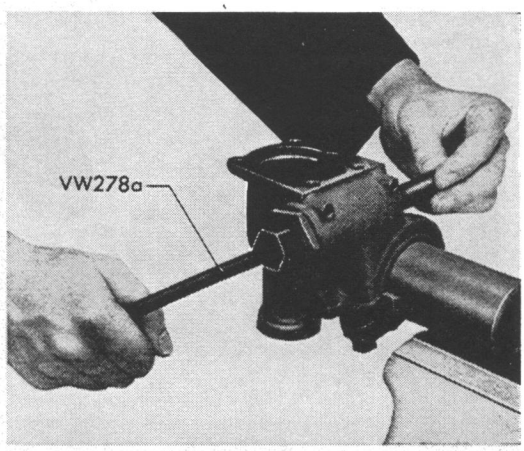
1 - Insert worm spindle into housing with the upper bearing and shim.

Note:

The oil seal for the worm spindle must not be installed until the steering has been assembled and adjusted.

2 - Install lower bearing.

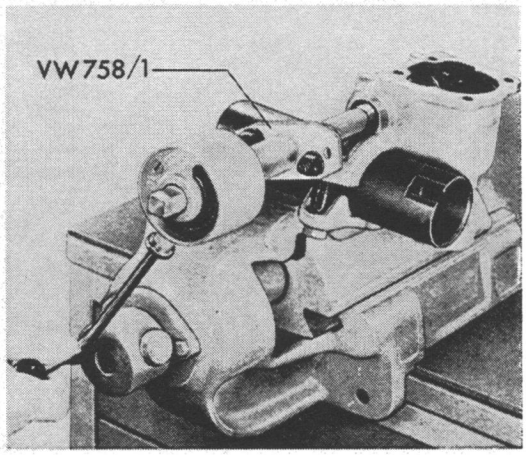
3 - Install worm adjuster with sealing compound and tighten lightly with VW 278a to press the bearings onto their seats.



4 - Loosen adjuster and tighten again until the worm feels rough when turned.

The torque required to turn the worm spindle should be 1.5 to 2.6 cmkg (1.3 to 2.2 in. lb). 2.0 to 3 cmkg (1.7 to 2.5 in. lb) with oil seal installed. A special torque wrench is required for this purpose.

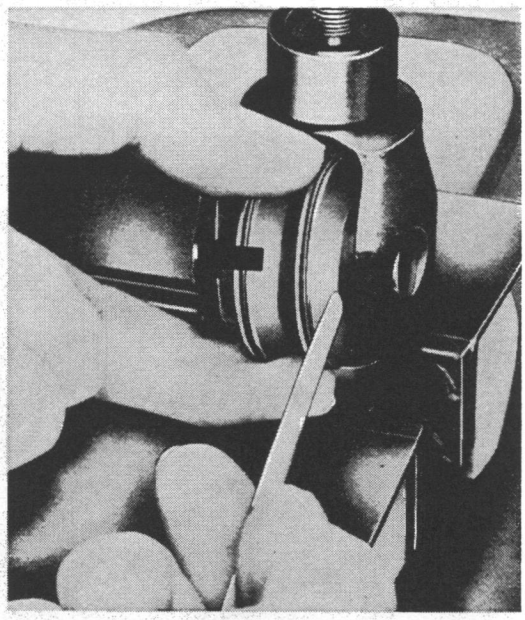
5 - Tighten the adjuster locknut and check the spindle adjustment again.



6 - Assemble drop arm shaft:

a - Check axial play of roller. The play must not exceed 0.04 mm (0.001 in.). It is checked between roller and washer with a 0.05 mm (0.002 in.) feeler blade. If the blade can be pushed between roller and washer, a new shaft must be installed.

b - Check adjusting screw. If the threads or the thrust surface are damaged, a new screw must be used.



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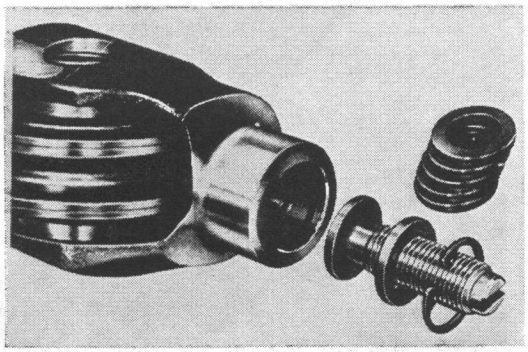
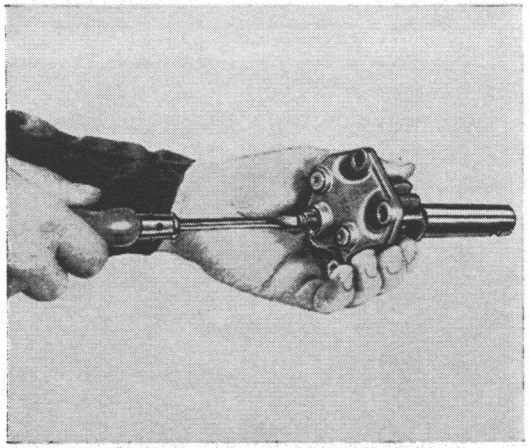


c - Place adjusting screw and shim in the end of the shaft and secure with circlip. The thickness of the shim should be selected so that the screw can just be turned with thumb and forefinger without lateral play. The shims are available in thicknesses from 2.0 mm (0.08 in.) to 2.5 mm (0.098 in.) in 0.05 mm (0.002 in.) steps.

Caution

The circlip must seat properly in the groove all the way around.



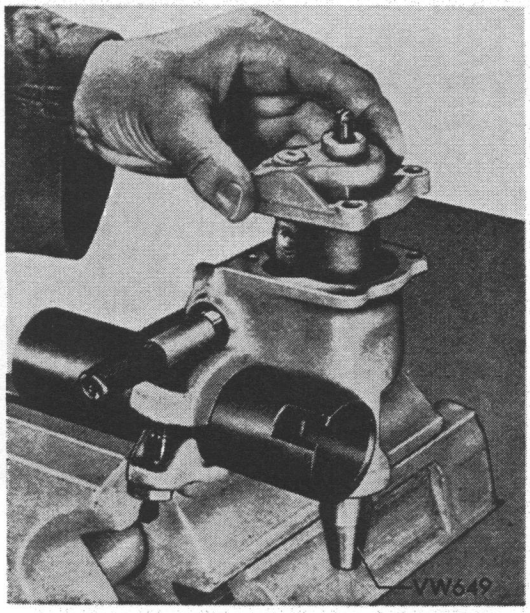
7 - Attach drop arm shaft to housing cover by inserting the adjusting screw through the cover as far as it will go.

Modification
Type 1 from Chassis No. 111 2517 788, Jan. 71
Type 3 from Chassis No. 311 2131 806, Febr. 1971

The material for the steering gear cover has been changed to an aluminium alloy (previously magnesium alloy).

Also a new gasket between the housing and cover as well as longer bolts (M 8 × 25) are installed.

To identify this modified cover the letters "KD" are stamped on it in addition to the Part Number. When this cover is used as a spare part make sure that the longer bolts (M 8 × 25) are also used.



8 - Insert oil seal protection sleeve VW 649 into housing.

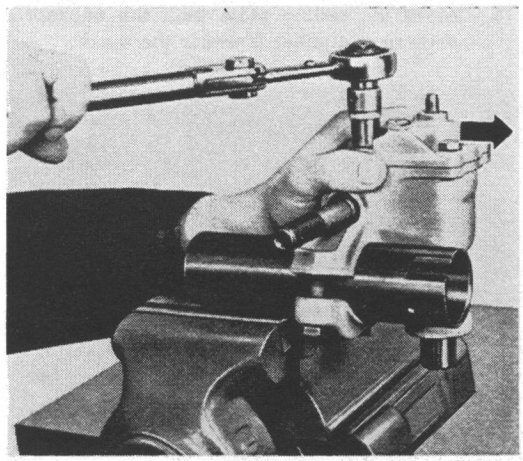
9 - Install drop arm shaft in housing with the roller at right angle to the worm.

Note

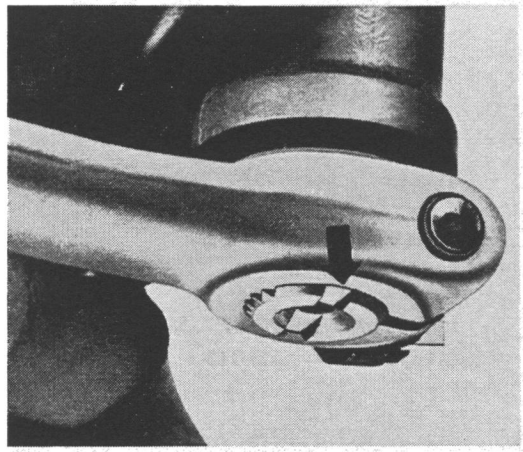
Do not put grease into housing until steering gear has been adjusted.

10 - Tighten cover bolts to 2.0—2.5 mkg (15—18 lb. ft.). While doing this, press the cover against the hou.ing on side opposite to worm as shown by arrow. This will prevent the cover from moving and causing premature play in the steering.

To adjust the steering gear, fit the appropriate drop arm on the shaft.

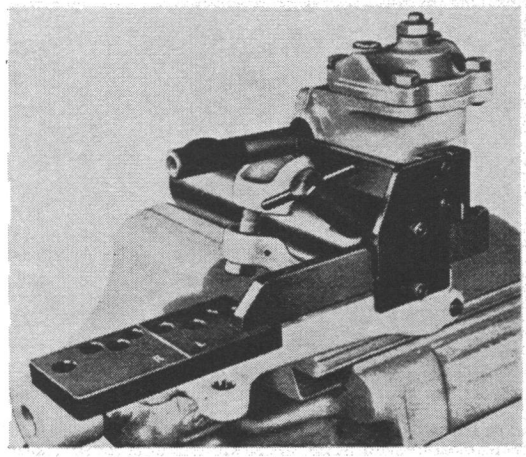


11 - Push drop arm on until upper edge is level with the chamfer on shaft. Tighten securing bolt to 7.0 mkg (51 lb. ft.) and lock.



12 - Check operation of steering by moving drop arm back and forth several times.

Adjusting



1 - Place measuring head of appliance VW 280 in the mounting tube and clamp in position. Ensure that the feeler plate on the head contacts the worm spindle.

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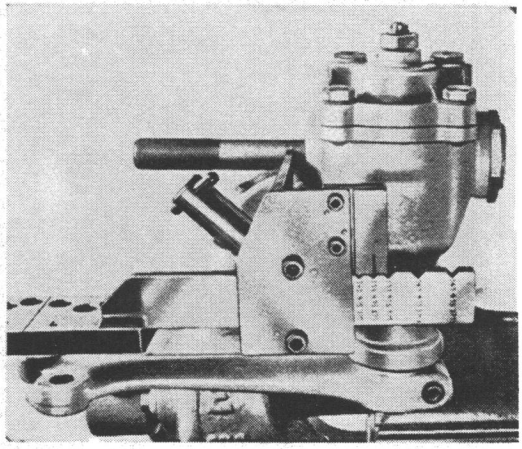
2 - Move the setting plate until the appropriate drop arm number is under the mark:



Typ 1

L = Left hand drive
up to August 1965

113 415 371 — 113 - 117 - 151
141 415 371 a — 141 - 143

from August 1965

131 415 371 — 113 - 117 - 151
141 415 371 B — 141 - 143

Type 3

L = Left hand drive

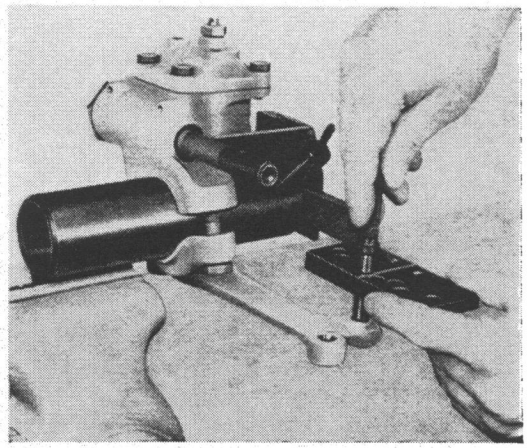
311 415 371 — 311 - 361

3 - Move drop arm to center position:

a - Align right hand hole in drop arm roughly under the appropriate hole in plate.

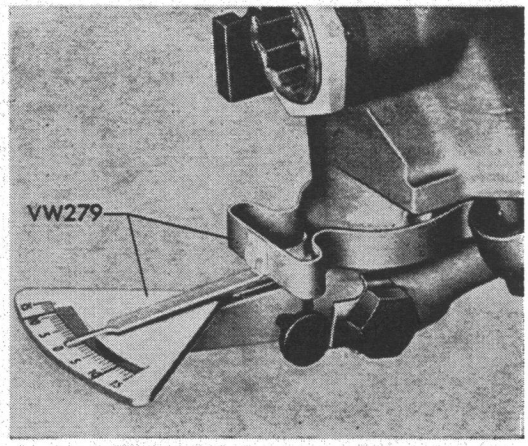
b - Insert pilot into correct hole in plate.

c - Move drop arm and plate slightly until the pilot fits the hole in the drop arm.



4 - Insert scale of setting device VW 279 into slot in drop arm and clamp in position.

5 - Install finger of VW 279 on housing and set to zero.



6 - Pull pilot out.

7 - Turn drop arm 11° to left or right.

Important

The angle of 11°±2° is only applicable when drop arm shaft and worm spindle or one of these parts has been replaced. Otherwise the steering should be set to 5°.

8 - Turn drop arm shaft adjusting screw in until no further play can be felt. While doing this, move the drop arm slightly and hold the worm spindle with other hand. The column coupling flange should be fitted on the worm spindle to enable it to be held properly.

9 - Tighten the lock nut of adjusting screw to correct torque.

10 - Check the no-play range on the other lock. It should be possible to turn the worm through the center position with a torque of 9—12 cmkg.

At 11°±2° there should be no detectable play at the drop arm. If play can be felt at this angle, dismantle the steering gear again and correct the setting of the worm to the roller by installing a different shim:

a - No-play angle to left side of scale is larger than 11°±2°.

Fit a thicker shim.

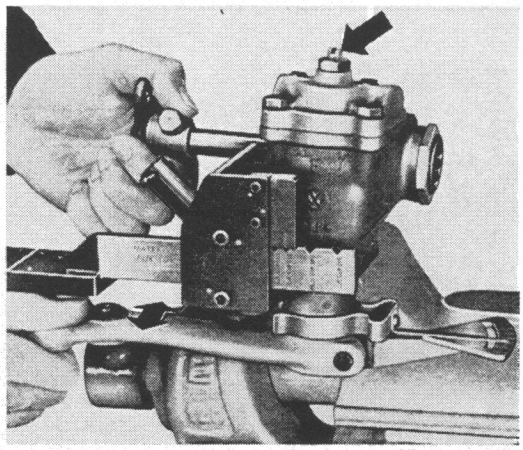
b - No-play angle to left side of scale is smaller than 11°±2°.

Fit a thinner shim.

The adjustment should be repeated until the necessary degree of accuracy is obtained. Shims are available in thickness from 0.20 mm (.008 in.) to 0.50 mm (.02 in.) in 0.05 mm (.002 in.) steps.

11 - When adjustment is completed, press the worm spindle oil seal in with 21.5 mm (.846 in.) diameter tube VW 423.

12 - Take lock nut off drop arm shaft adjusting screw.



13 - Remove four cover securing bolts.

14 - Loosen cover by turning adjusting screw and take cover off.

15 - Fill housing with transmission grease (approx. 160 cc/5.4 oz.). Move the drop arm shaft about slightly while putting the grease in so that all air escapes and the proper quantity can be put in.

16 - Fill the adjusting screw hole in the drop arm shaft with transmission grease.

17 - Install new plastic plugs in housing cover.

18 - Install cover with a new gasket and insert bolts. Press the cover away from the steering worm and tighten the screws to the correct torque (see V 8.1/4-9).

19 - Adjust drop arm shaft again as described at points 7 to 9.

20 - Mark center position with a new marking ring and secure with paint.

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Checking and Adjusting Steering Gear (Installed)

A - **Checking** (steering gear installed)

The vehicle must not be lifted when checking the roller steering.

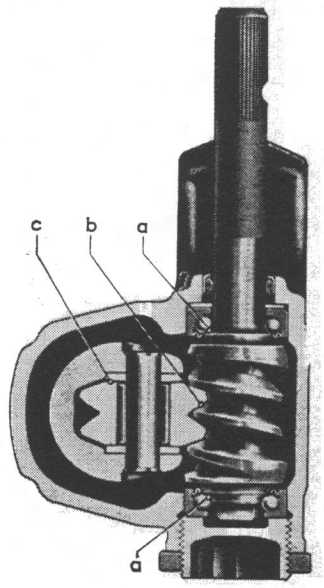
1 - Set the front wheels to straightahead position.

2 - Move the steering wheel lightly, holding outer end of spoke, until resistance is felt in both directions. This movement at the center position is determined by the steering adjustment and by the linkage (tie rods and coupling disc). It must not exceed max. 25 mm (1.0 in.), measured on the circumference of the steering wheel.

B - **Adjusting**

Excessive play at the center position can be caused by three things. These points should be checked in the following order:

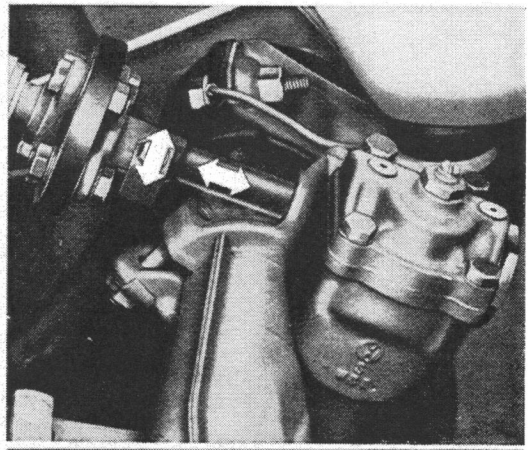
a = Axial play of worm spindle
b = Play between roller and worm
c = Axial play of roller



Note

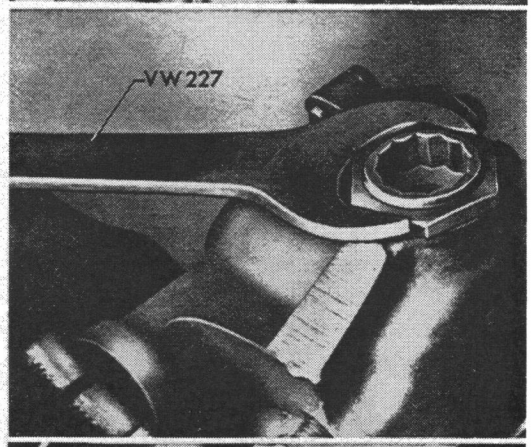
Before adjusting the steering gear, the cesurity of the steering gear housing cover bolts and the steering gear mounting bolts must be checked. Loose bolts must be tightened to the specified torque.

539.307.23 V 7th Supplement Printed in Germany 5.71



a - Axial play of worm spindle

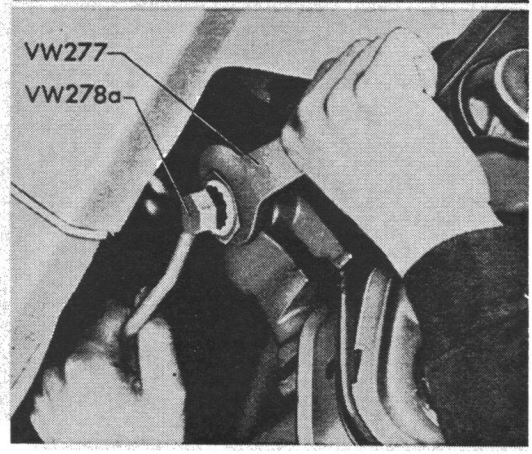
The worm spindle axial play is determined by turning the spindle at the steering coupling with the vehicle lifted. If there is play it can be eliminated as follows:



1 - Turn steering fully to left ro right.

2 - Loosen locknut on worm spindle adjuster with special wrench VW 277.

3 - Turn worm spindle and tighten the adjuster with special wrench VW 278a at the same time until play can no longer be felt.



4 - Hold adjuster and tighten lock nut with special wrench VW 277.

5 - Turn worm spindle from lock to lock. There should be no tight spots. Should there be any, the adjuster has been moved in too far and the adjustment has to be rectified.

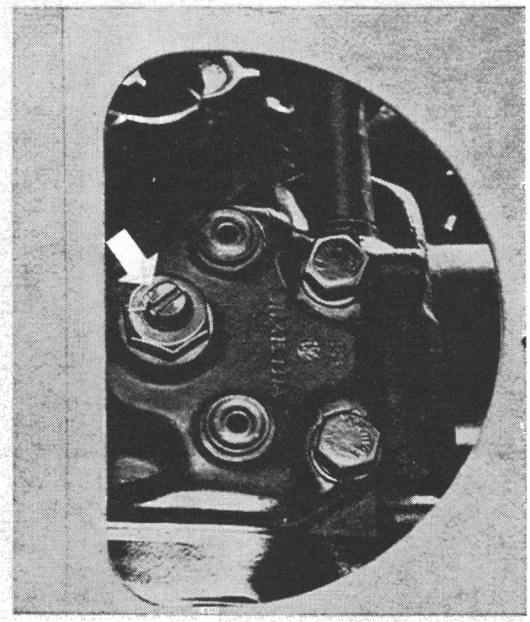
b - Play between roller and worm

If play in the steering gear cannot be eliminated by adjusting the worm spindle, the roller to worm setting must be adjusted. There should be no play between roller and worm with the steering gear in the center position. The roller to worm adjustment can be made with the vehicle lifted. To check the adjustment, however, the vehicle must be standing on the ground.

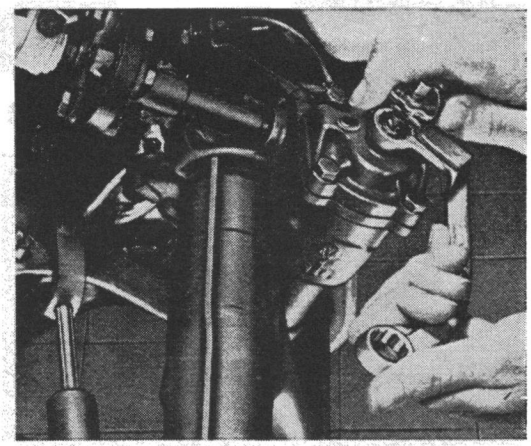
1 - Turn steering wheel 90° to left or right.

2 - Loosen locknut on drop arm shaft adjusting screw and turn adjusting screw out about one turn.

3 - On **Type 1** / Sedan 111 vehicles, the adjusting screw (arrow) is accessible through the hole in the luggage pan.



On **Type 3** vehicles, the spare wheel well must be taken out. The steering gear is then adjusted with the special roller steering wrench.



4 - Turn adjusting screw in until roller can be felt contacting the worm.

5 - Hold screw and tighten lock nut.

6 - With vehicle standing on wheels, turn steering wheel 90° to each side and check adjustment. The play at this point must not exceed 25 mm (1 in.), measured at the circumference of the steering wheel. If there is more play on one side, the adjustment of the roller to worm must be repeated on this side at 90°.

7 - Check toe-in and rectify if necessary.

8 - Road test the vehicle. If the steering does not return to about 45° from the center position after taking a corner at 10—12 mph, the roller setting is too tight. The adjustment should then be repeated, otherwise the worm and roller will be damaged.

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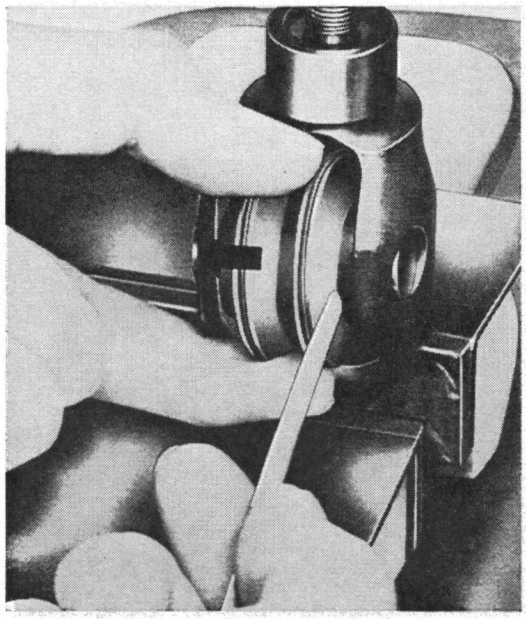


c - Axial play of roller

If the steering cannot be adjusted properly by carrying out the adjustments described so far, the steering gear must be removed, disassembled and the axial play of the roller checked.

1 - Check roller axial play. The play must not exceed 0.04 mm (.0016 in.).

Measure the clearance between roller and washer (arrow) with a 0.05 mm (.002 in.) feeler gauge. If the feeler blade can be pushed between roller and washer, the complete drop arm shaft must be replaced.

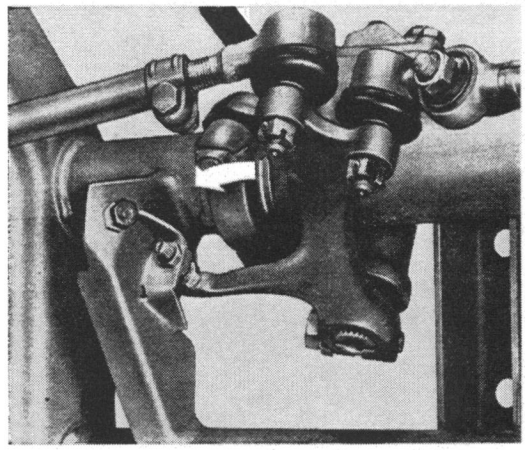
2 - Assemble steering gear, adjust and install

3 - Check toe-in, rectify if necessary.

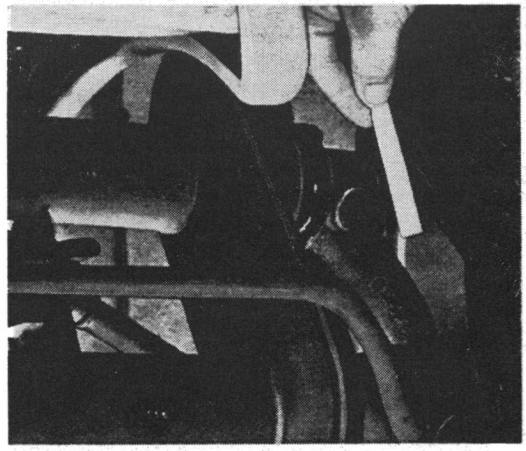
4 - Road test vehicle.

Type 1

The wheel lock to left and right is limited by two adjustable stops on the axle beam which contact the drop arm.



When correcting the wheel lock, the bolts in the steering stops on the axle beam must be set so that there is always a gap of 10 mm ± 1 mm (.4 ± .04 in.) between upper torsion arm and tire. This dimension, which is measured with the vehicle lifted with the wheels fully extended and on full lock, ensures that there is adequate clearance between wheel housing and wheels under all load conditions.



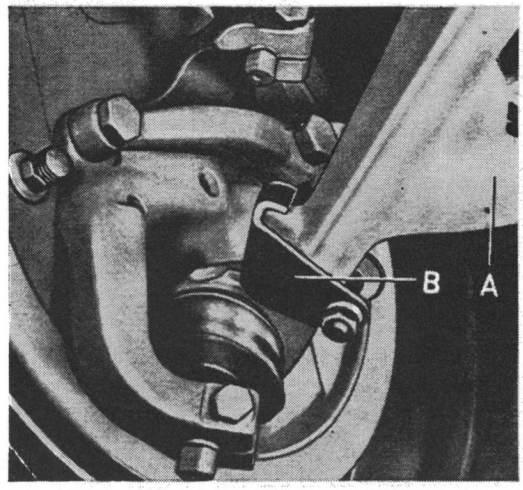
Type 3

If the steering lock on a vehicle is too great the front tires will tend to rub on the wheel housings.

This can be eliminated by installing clips on the torsion arms.

The clip is pushed over the torsion arm and secured with a bolt M 8 × 35, a washer 8.1, a spring washer B 8 and a nut M 8.

If this makes the diameter of the turning circle too large, the clips should be removed again and the lugs on the torsion arms ground down slightly. When grinding the lugs, however, take care not to reduce the clearance between tire and wheel housing to less than 35 mm (1.37 in.) with the clip installed. The vehicle must be empty and should not be lifted or supported when measuring.



a = Lower torsion arm
b = Clip

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SERVICE

Workshop Bulletin

No. F

(Supersedes W. B. F of 15 February 1973) of 4 June 1974

Subject:	Type / Model:
Adjusting overheating switch on BN 4 heater in Type 1/Model 181 and Type 2	1 / Model 181 2

see workshop manual

The overheating switch can be adjusted only when installed. Adjustment is necessary when a new switch is installed or when the setting is not correct. The switch cannot be set to temperature readings but to the upper cut-off value of the temperature regulating switch.

These instructions do not apply to the BN 2 heater.

Printed in Germany 0.00.578.024.21

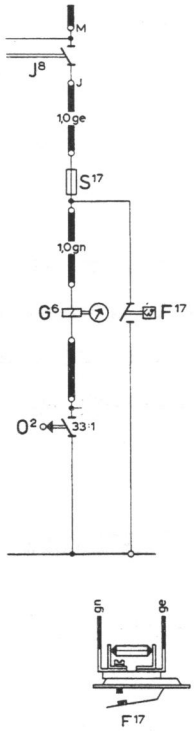
see workshop manual

Adjusting instructions

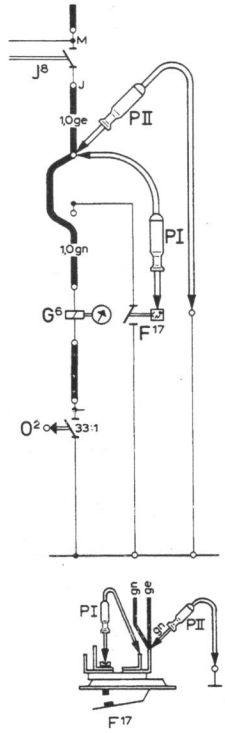
When adjusting the switch on Type 1 Model 181, use a new temperature regulating switch.

1 - Connect wires and test lights to overheating switch as shown in wiring diagram and illustrations. Take overheating fuse out.

Standard wiring layout



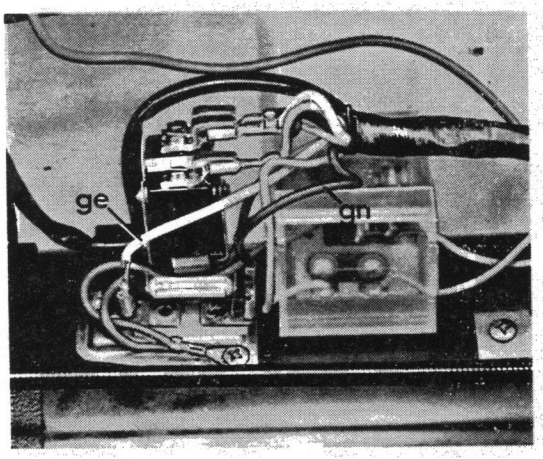
Test wiring layout

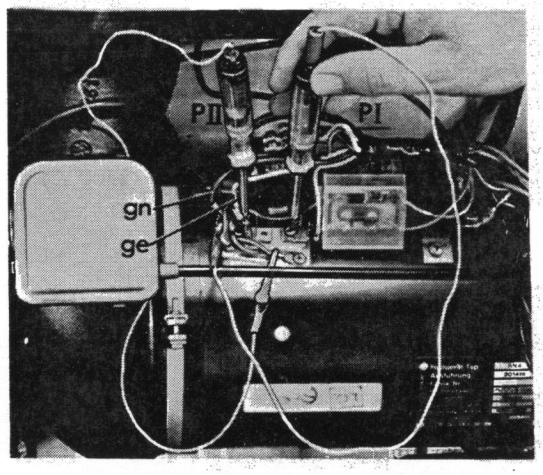


gn = green

ge = yellow

J 8 = Relay (controlled by temperature regulating switch)
S 17 = Overheating fuse
G 6 = Metering pump
F 17 = Overheating switch
P = Test light
O 2 = Breaker contacts in combustion air blower





see workshop manual

2 - Start engine.

3 - Switch heater on.

4 - Set to maximum output: Pull Bowden cable out all the way. Type 1/Model 181: Move lever on warm air outlet up so that warm air is directed to the windshield.

5 - Close vehicle doors.

6 - Wait until heater has regulated four times (Heater goes out, test light II goes out).

7 - Remove green paint from adjusting screw of overheating switch and turn adjusting screw in as far as it will go.

8 - When heater starts again (test light I and II light up) turn adjusting screw out slowly until test light I just goes out.

C a u t i o n

If the test light II goes out, do not turn adjusting screw further. Continue adjustment after test light II has come on again.

9 - Switch heater off.

10 - Take test lights off.

11 - Turn adjusting screw of overheating switch out as follows:

Type 1/Model 181	- 1 turn
Type 2 Delivery Van, Combi, Station wagon	- 3 turns
Type 2 Pick-up	- 2 turns

12 - Seal adjusting screw with a different colored paint.

13 - Connect green wire to the appropriate connector on the overheating switch.

14 - Install overheating fuse (8 amp.).

15 - Type 1/Model 181: Install old temperature regulating switch.

(If the overheating switch fuse blows during the test run, the temperature regulating switch should be replaced. Before doing this, however, check that the air circulation duct is not blocked).

Workshop Bulletin

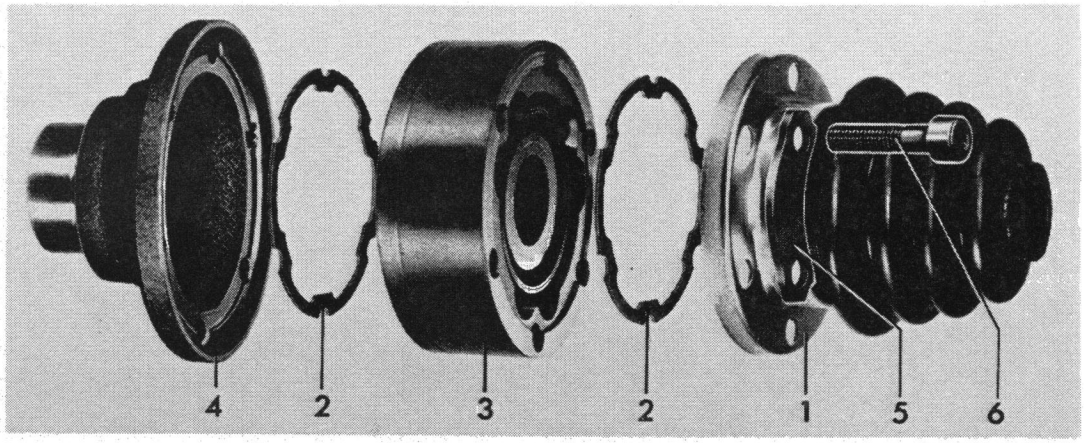
No. H

(Supersedes W.B. H of 15 February 1974) of 5 June 1974

Subject:	Type/Model:
Constant Velocity Joints	1/Model 181 4

see workshop manual

To improve sealing of C.V. joints, a gasket was installed on both sides of the joint. Both drive flange and joint have a recess for the gasket.



1 - Gap and boot
2 - Gasket
3 - Joint
4 - Flange
5 - Plate
6 - Socket head screw

Repair instructions

During repairs, joints and flanges should be checked whether they have a recess for the gaskets.

Parts with recess - Install gasket

Parts without recess - Do not install gasket

When installing shafts, be sure to position gasket in recess. If necessary hold them in place with some grease when assembling joints. Gaskets which are not properly positioned will cause socket head bolts to become loose. The tightening torque for socket head bolts remains unchanged (4.5 mkg / 32 ft lb). If gaskets are not available, drive flanges and joints without recess for gasket (Type 181) should be installed as otherwise grease will leak from joints.

Printed in Germany 0.00.574.126.21

Workshop Bulletin

No. V

(Supersedes Workshop Bulletin V of 16 June 1972) of 29 Sept. 1973

Subject:	Type/Model:
Values for wheel alignment checks	1, 2, 3 and 4

see workshop manual

This bulletin contains the current alignment specifications for front and rear axle of all models. Previous bulletins pertaining to alignment are herewith superseded.

Workshop Bulletin "Torsion bar adjustment" contains all the necessary dimensions and specifications for their adjustment.

Make adjustments as close as possible to values given. Avoid using the tolerances to their fullest extent.

All measurements are made with vehicle unladen, fuel tank full, tires inflated to pressures for maximum vehicle weight, with vehicle properly aligned and suspension bounced.

Printed in Germany 3.48.5 73.064.21

see workshop manual

Type 1

Link pin and ball joint front axles

Total toe, wheels not pressed		+30' ± 15'
Total toe, wheels pressed		+5' ± 15'
Applied pressure		22 ± 4 lbs. (10 ± 2 kg)
Maximum permissible difference between total toe with wheels pressed and not pressed		25'
Camber in straight-ahead position		
from Chassis No. 116 000 001		30' ± 20'
up to Chassis No. 115 979 202		40' ± 30'
Maximum permissible difference between sides		30'
Toe angle difference at 20° lock to left and right (not pressed)		
a - from Chassis No. 116 000 001		
	to left	-1°20' ± 30'
	to right	-2°10' ± 30'
b - up to Chassis No. 115 979 202		-2° ± 30'
c - De Luxe Sedan and Convertible		
up to Chassis No. 1 430 497	to left	-1°40' ± 30'
	to right	-2°30' ± 30'
Maximum permissible difference between sides		1°
d - Karmann Ghia		
up to Chassis No. 1 644 421		-2° ± 1°
Offset between stub-axles in direction of motion		max. 8 mm
Caster angle of a wheel		3°20' ± 1°
Corresponds to camber difference of a wheel on a lock from 20° left 20° right		2°15' ± 40'

Strut front axle

Total toe, wheels not pressed	+30' ± 15'
Total toe, wheels pressed	+10' ± 15'
Applied pressure	22 ± 4 lbs. (10 ± 2 kg)
Maximum permissible difference between total toe with wheels pressed and not pressed	max. 25'
Camber in straight-ahead position	1° + 20' ± 40'
Maximum permissible difference between sides	30'

see workshop manual

Toe angle difference at 20° lock to left and right (not pressed) all models	-30' ± 30'
Offset between stub axles in direction of motion	max. 11 mm
Caster angle of a wheel (measured with the vehicle standing horizontally) Corresponds to camber difference of a wheel on a lock from 20° left to 20° right	2° ± 35' / 1°20' ± 25'

Rear axle

Camber with spring plates correctly set (after at least 300 miles in use)	
a - All models with double joint rear axle *)	-1° ± 40'
Model 181	+20' ± 40'
b - Vehicles with swing axle	
Model 11 from Chassis No. 117 000 001	+1° ± 1°
permissible minimum camber	-1°
Model 14 from Chassis No. 147 000 003	+15' ± 1°
Model 15 up to Chassis No.157 000 002	
permissible minimum camber	-1°30'
all models up to Chassis No.116 1 021 298	+2°30' ± 1°
permissible minimum camber	0°
all models up to Chassis No. 2 528 668	+3° ± 30'
permissible minimum camber	+2°
Maximum permissible difference between sides	
All models with double joint rear axle	45'
All models with swing axle	20'
Total rear wheel toe with camber correctly set	
All models with double joint rear axle	0° ± 15'
All models with swing axle	-5' ± 10'
Maximum permissible deviation in wheel alignment	max. 10'

*)

Note:

When checking the rear wheels with an optical measuring device and the camber values have exceeded the limit in a negative direction, (settling after considerable mileage), the camber can be corrected within specific limits as follows:

1 - With the vehicle standing on its wheels loosen the bolts connecting the spring plate and diagonal arm flange. The diagonal arm will be lifted thereby, and the camber altered in the positive direction (approx. 45').

2 - With the diagonal arm in this position retighten the bolts to the prescribed torque.

Type 2

Front axle

Total toe, wheels not pressed	
from Chassis No. 218 000 001	+15' ± 15'
up to Chassis No. 217 148 459	+ 5' ± 10'
Total toe, wheels pressed	
from Chassis No. 218 000 001	+ 5' ± 15'
up to Chassis No. 217 148 459	- 5' ± 10'
Applied pressure	33 ± 6 lbs. (15 ± 3 kg)
Maximum permissible difference between total toe with wheels pressed and not pressed	25'
Camber in straight-ahead position	
from Chassis No. 218 000 001	+40' ± 20'
up to Chassis No. 217 148 459	+40' ± 30'
Maximum permissible difference between sides	30'
Toe angle difference at 20° lock to left and right(not pressed)	-2°30' ± 30'
Offset between stub axles in direction of motion	max. 8 mm
Caster angle of a wheel	
from Chassis No. 218 000 001	3° ± 40'
up to Chassis No. 217 148 459	max. 1°
Corresponds to camber difference of a wheel on a lock from 20° left to 20° right	
from Chassis No. 218 000 001	2° ± 25'
up to Chassis No. 217 148 459	max. 40'