GROUP E: ENGINE AND CLUTCH

Engine Assembly

Service Operations:

COOLING SYSTEM

Service Operations:

EXHAUST AND HEATING SYSTEM

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ENGINE LUBRICATION SYSTEM

Service Operations:

Second Edition of this page, March 1967

CYLINDER HEADS AND VALVES

Service Operations:

CYLINDERS AND PISTONS

Service Operations

CRANKCASE

Service Operations:

CRANKSHAFT

Service Operations:

LOCATION OF ENGINE SERIAL NUMBER

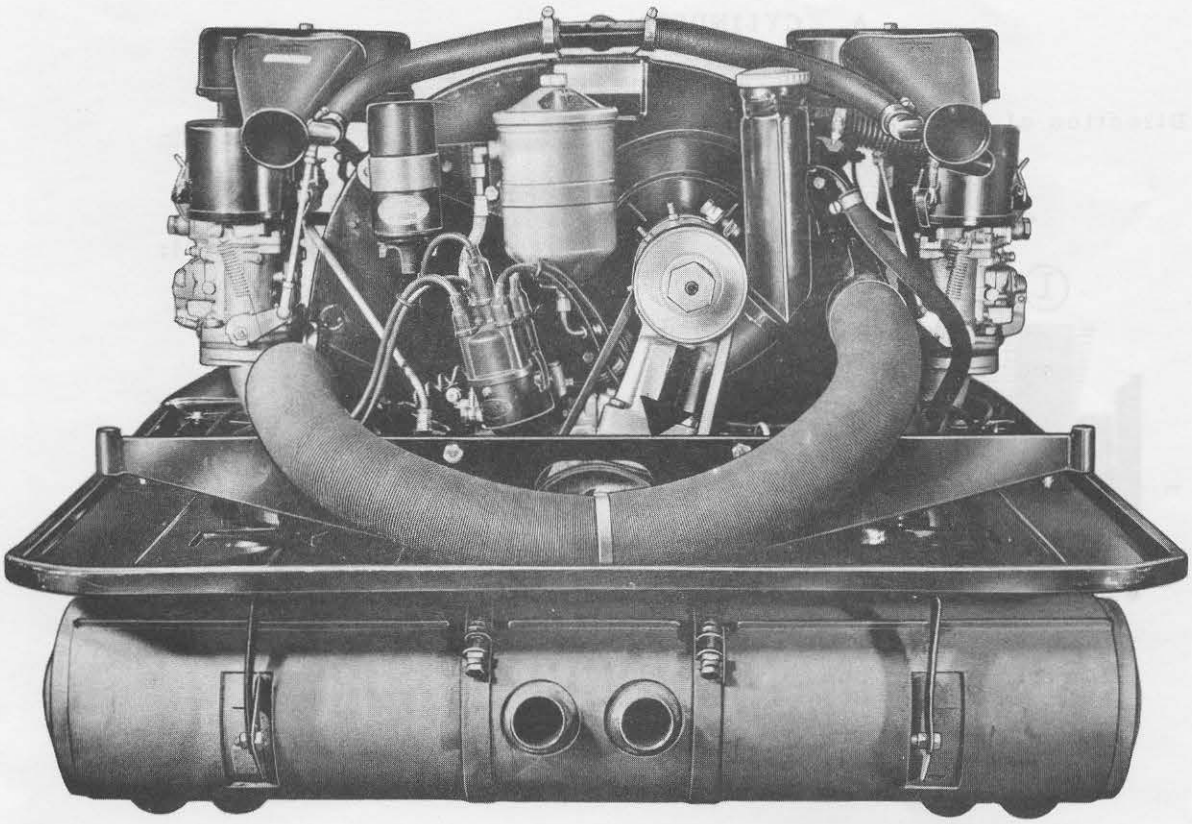

Fig. 1

NUMERICAL DESIGNATION OF CYLINDERS AND MAIN BEARINGS

A. CYLINDERS

Direction of travel

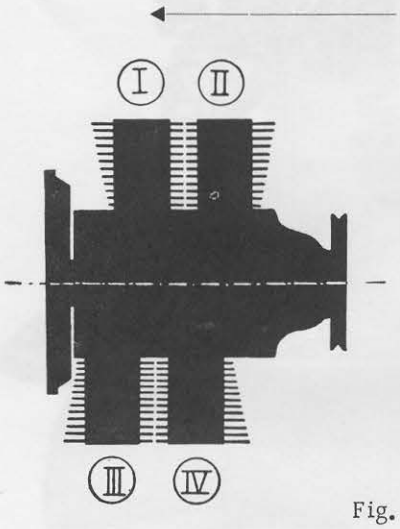

Fig. 2

Viewed in direction of travel:

Cylinder I: Front, right side
Cylinder II: Rear, right side

Cylinder III: Front, left side
Cylinder IV: Rear, left side

B. MAIN BEARINGS

Bearing 1: Inside diameter 50 mm, sleeve insert (flywheel-end)
2: " " 55 mm, split insert
3: " " 55 mm, split insert
4: " " 40 mm, sleeve insert (at crankshaft pulley)

CROSS-SECTIONAL VIEW OF ENGINE

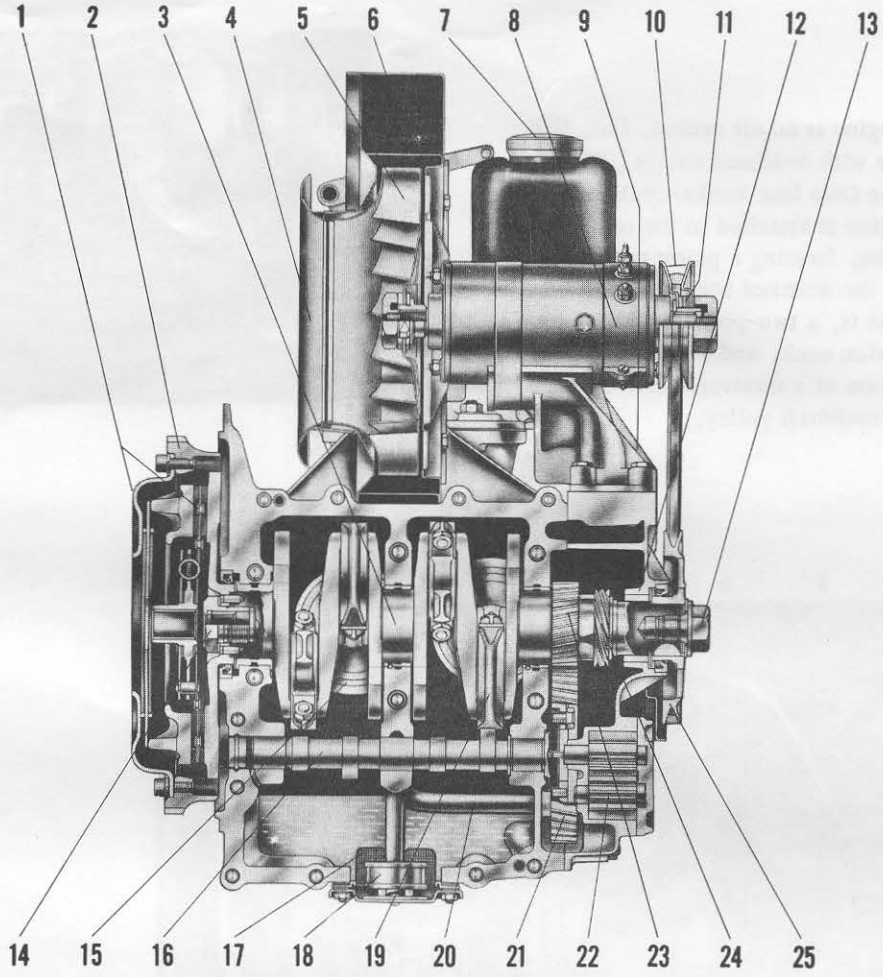

Fig. 3

1 Clutch
2 Flywheel
3 Main bearing journal, Bearing 2
4 Cooling air inlet
5 Cooling blower impeller
6 Air blower housing
7 Oil filler
8 Generator
9Generator carrier
10 V-belt
11 Spacers, adjusting V-belt tension
12 Bearing sleeve, Bearing 4
13 Pulley retaining nut
14 Flywheel gland nut
15 Cylinders and pistons
16 Camshaft
17 Oil strainer
18 Magnetic filtering element
19 Connecting rod bearing cap
20 Oil suction tube
21 Timing gear
22 Oil pump
23 Camshaft drive gear
24 Distributor drive gear
25 Crankshaft pulley

General

The Porsche engine is an air cooled, flat, four cylinder engine with overhead valves (OHV), operating on the Otto four-stroke-cycle principle. The engine is attached to the transmission by four bolts, forming a power train which is suspended in the unitized body in four mounting points, that is, a two-point forward mount at the transmission neck, and a two-point rear mount in the form of a transverse carrier situated near the crankshaft pulley.

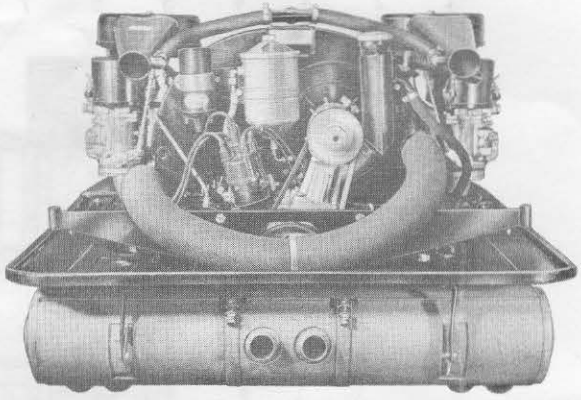

Fig. 4

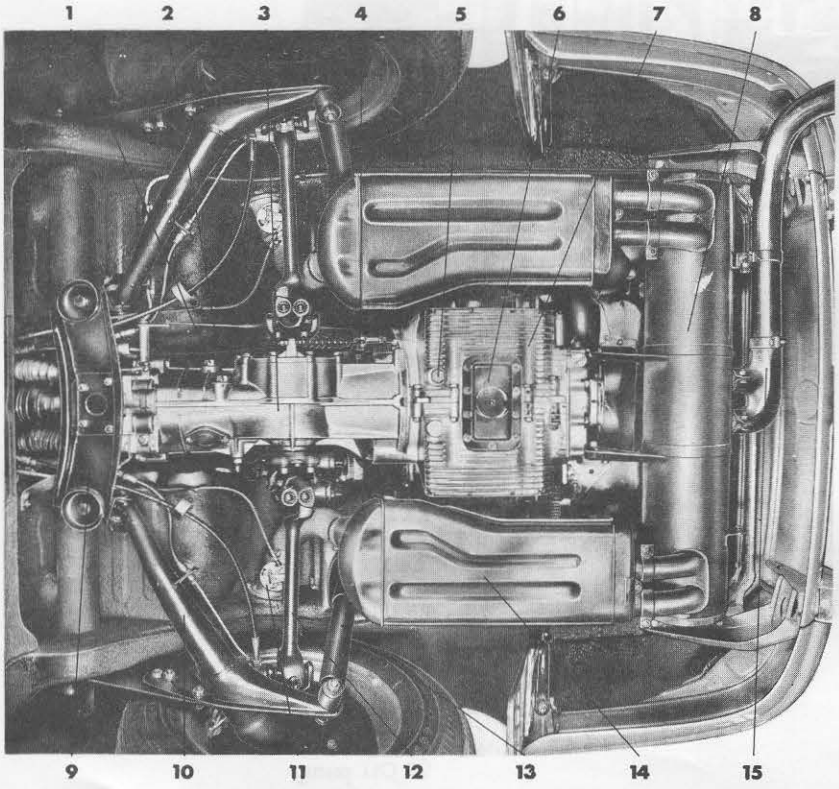

Fig. 5

Bottom View of Vehicle

1 Transmission filler plug
2 Transmission drain plug
3 Transmission
4 Clutch control lever
5 Engine drain plug
6 Oil strainer cover
7 Crankcase
8 Exhaust muffler
9 Forward power train carrier
10 Suspension control arm
11 Heating air control gates
12 Axle shaft
13 Shockabsorber
14 Heat exchanger
15 Tail pipe

Crankcase

The cast - light alloy crankcase consists of two crankcase sections and a timing gear cover.
It is possible to replace the timing gear cover alone, if the dovel pin bores are bored to 8,1 mm diameter. before assembling.
When assembling, first tighten the screw lightly, then while turning the crankshaft tighten to the correct torque.

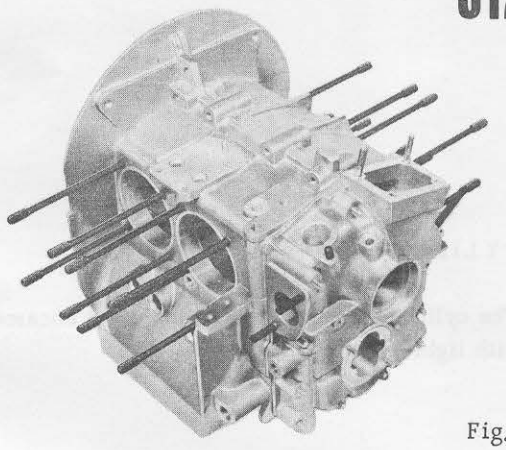

Fig. 6

CRANKSHAFT AND CONNECTING RODS

The four connecting rods ride on the plain-bearing crankshaft in lead-bronze bearing inserts. All connecting rods have bronze piston pin bushings.
All crankshaft journals are soft nitrided.
Bearings 2 and 3 (seen from the clutch-end) are split-sleeve inserts.
Bearing 4 may be replaced without disassembling the crankcase by removing the timing gear cover.

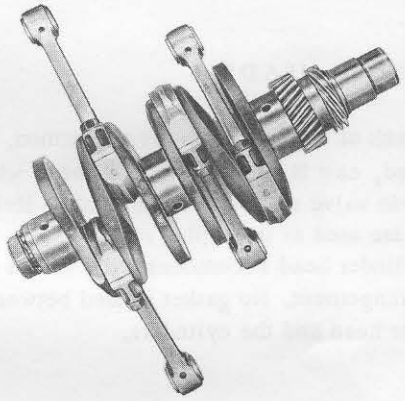

Fig. 7

Bearing 1 also takes up the crankshaft thrust. The flywheel, which also carries the starter gear teeth, is attached to the crankshaft by means of a gland nut and fixed in position by 8 aligning dowel pins. The camshaft gear and the distributor drive gear are locked to the crankshaft through Woodruff keys. The crankshaft pulley is attached to the crankshaft through a hex bolt and locked with a Woodruff key. The crankshaft is sealed in the crankcase through oil seals located at the flywheel and crankshaft pulley ends.

PISTONS

The light-alloy pistons in the Type 912 engine have 3 piston rings each, the lowest ring being the oil scraper.
The piston pins float in the connecting rod bushings; they are contained within the pistons through the use of circlips.

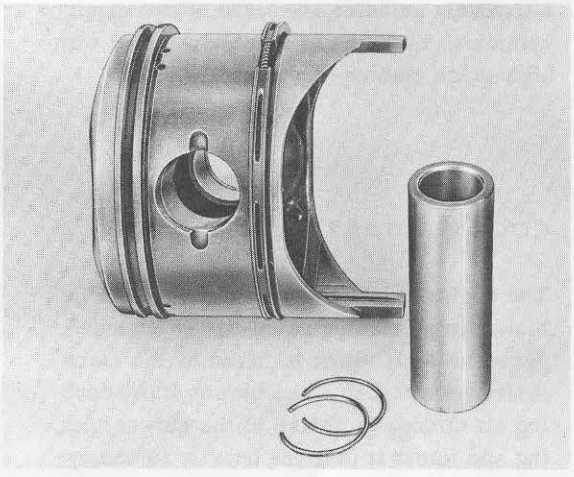

Fig. 8

CYLINDERS

The cylinders are made of carbon steel encased with light-alloy cooling fins.

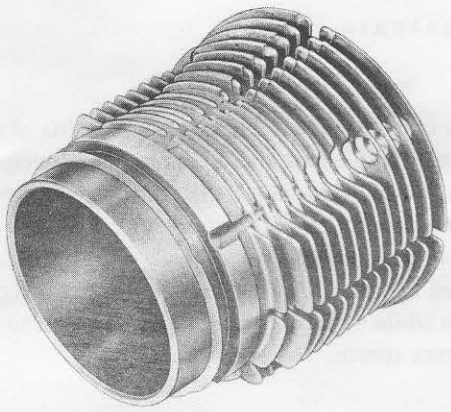

Fig. 9

CYLINDER HEADS

Each bank of two cylinders has a common, heavily finned, cast light alloy cylinder head with shrunk-in valve seats and valve guides. Helicoil inserts are used as spark plug seats.
The cylinder head accomodates the valves in a "V" arrangement. No gasket is used between the cylinder head and the cylinders.

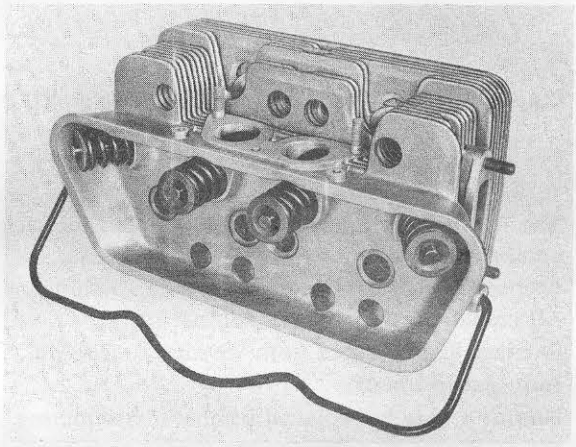

Fig. 10

VALVE TIMING

The 3-journal camshaft rides on the base metal of the crankcase. Camshaft drive is through helical gears; the timing gear is of light alloy. Valve timing is effected through cams, valve lifters, pushrods, and rocker arms. Each cam alternately actuates one valve of two opposing cylinders. The exhaust valves are cased with high-grade chrome-nickel steel.

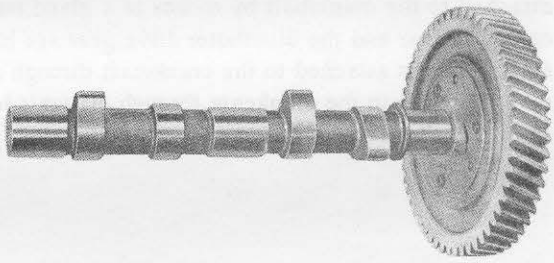

Fig. 11

COOLING SYSTEM

The engine is cooled by an air blower. The blower impeller is situated on the extended generator shaft which is driven by the crankshaft over a V-belt. The blower draws cooling air through an intake in the blower housing and forces it over the heavily finned cylinders and cylinders heads. The cooling air is guided by deflector baffles.

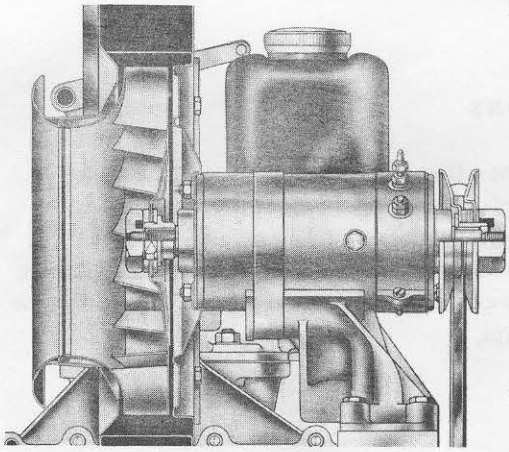

Fig. 12

ENGINE LUBRICATION SYSTEM

Engine lubrication is effected through a forced-feed system and includes an oil cooling provision.
The oil pump is situated in the timing gear cover and is driven by the camshaft. The oil is picked up from the lowest point in the crankcase and forced into the oil cooler and the oil galleries. Part of the oil is forced through the main bearings into the drilled oil galleries in the crankshaft and lubricates the connecting rod bearings. A second part of the oil lubricates the camshaft bearings, and still another part passes through the hollow pushrods to the rocker arm bearings, also lubricating the valve shafts. Cylinder walls, pistons, and piston pins are lubricated through oil splash. Oil draining from the points of lubrication collects in the bottom of the crankcase where it passes through an oil strainer and a magnetic filtering element, both entrapping foreign matter that may be suspended in the oil. A bypass oil filter additionally cleans the circulating oil.

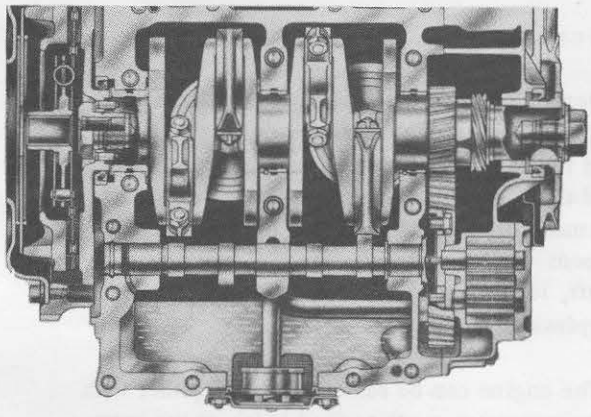

Fig. 13

OIL COOLING

The oil cooler is mounted on the crankcase in the stream of cooling air forced through by the cooling blower. The oil cooler is so inserted into the oil circuit that the oil pumped by the oil pump must pass through the oil cooler before it reaches the points of lubrication. Cooling of the oil ensures that it retains its full lubricating qualities even in very warm weather and under constant operating loads. When the oil is cold and thickflowing, a pressure relief valve permits the oil to bypass the oil cooler and flow directly into the oil galleries.

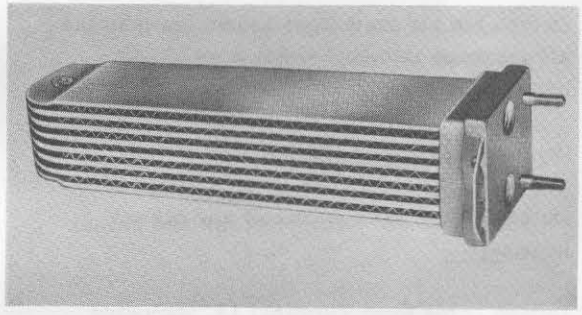

Fig. 14

OIL PRESSURE INDICATOR

A pressure-actuated swich is connected to the pressure gallery between the pump and oil cooler. The swich opens the electric circuit of the oil pressure indicator lamp at a pressure between 0.3 and 0.6 atm (4.5 - 8.8 psi), causing the lamp to go out. The lamp glows when the ignition is turned on and the oil pressure is low.

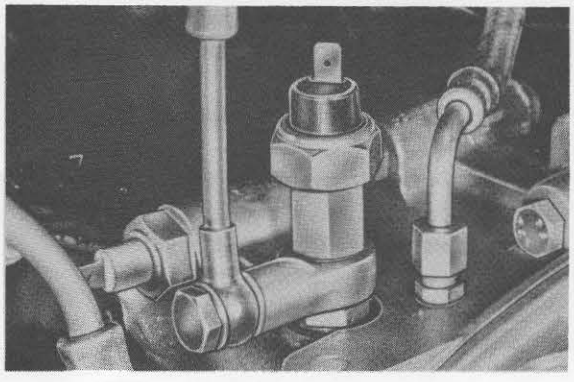

Fig. 15

General:

Depending upon the type of equipment at the shop's disposal, the steps involving the raising of the car, placement on stands, and removal of the engine can be appropriately simplified. Among others, the following devices may be used:
lift, rolling stand, assembly stand or dolly, hydraulic jack, or chain jack.

The engine can be removed only together with the transmission. Described below is the most convenient procedure to follow:

Removal

1. Disconnect battery.
2. Open engine compartment lid.
3. Detach hot air ducts from air gates and heat exchanger.
4. Detach both heat control cables (applicable to Export heater only).
5. Detach hot air ducts from T-join between the air cleaners, detach T-joint from blower housing.
6. Remove air cleaner tops.
7. Detach cables from generator and blower housing.
8. Detach cable from Terminal 15, including tachometer connection, at the ignition coil.
9. Detach cables from oil pressure sensor and oil temperature sensor.
10. Detach fuel intake line from fuel pump, detach fastening clip from engine shield.
11. Detach axle shafts from connecting flanges.
12. Detach cables from engine starter.
13. Detach clutch cable from clutch control lever.
14. Detach ground strap.
15. Disconnect backup light cable.
16. Disconnect throttle linkage from forward cross-shaft (at transmission).
17. Remove rear center-tunnel cover in passenger compartment.
18. Withdraw rubber boot in center tunnel by pulling forward.
19. Remove safety wire from conical bolt and unscrew bolt.
20. Detach shift rod clutch from shift control lever.
21. Place jack, with carrier plate attached, in the center of gravity of engine and transmission with jack under slight pressure.
22. Detach rear engine support from its base in body.
23. Detach transmission support.
24. Lower the jack with care.
25. Pull the jack with engine to the rear.
26. Detach transmission from the engine.

Installation

Install engine in reverse order of the above, noting the following points:

1. Before attaching engine to transmission, check transmission input shaft for runout.

2. Check clutch throwout bearing.

3. Fill flywheel bushing in gland nut with 2-3 cc (.06 - .09 fl. oz.) graphite grease.

4. Check and coat with graphite grease the transmission shaft splines and pilot journal, starter shaft bushing, and gear teeth of starter drive pinion and flywheel gear.

5. Throughly clean the mating surface of engine and transmission joining flanges.

6. Care must be excercised when guiding the transmission for attachment to the engine since damage may occur to the flywheel bushing, throwout bearing, or transmission input shaft. To align the clutch plate splines with those on the input shaft, slightly turn the crankshaft pulley, with transmission in gear, until alignment is achieved.

7. To attach the transmission, guide it to align the lower mounting holes, inserting the lower bolts first, then push transmission firmly against the engine until both flanges meet uniformly on all sides. Tighten all retaining bolts with equal torque.

8. Check clutch free-play, adjust if necessary.

2 EN

Special Tools:

P 1a Electric piston heater
P 2 Piston pin mandrel
P 8a Piston ring compressor
P 42 Torque wrench, 50 mkg (362 lbs/ft), flywheel tightening and loosening
P 44 Hex socket, 36 mm, flywheel tightening and loosening
VW 307 Engine and transmission bench mount

Disassembly

Disassemble the engine in the following order:

1. Drain engine oil.

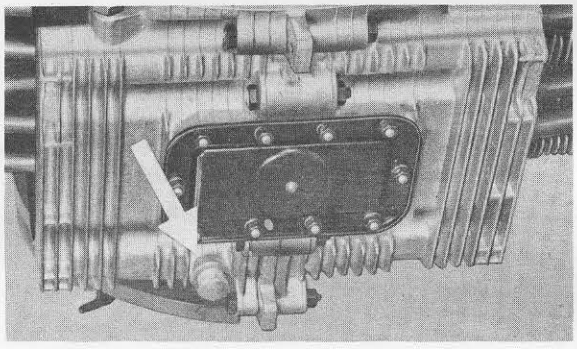

Fig. 16

2. Remove engine front, rear, and side shields.

3. Remove exhaust muffler and exhaust pipes with heat exchangers.

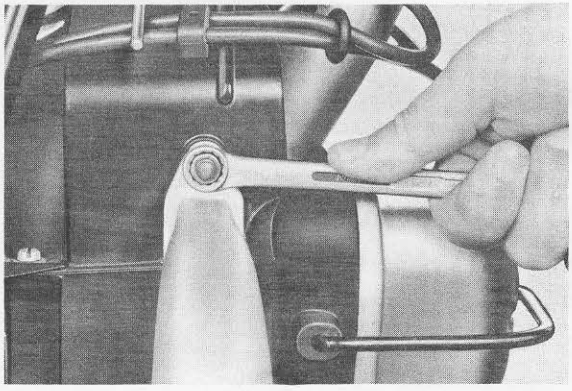

Fig. 17

4. Detach cable connecting coil and distributor, remove distributor cover.

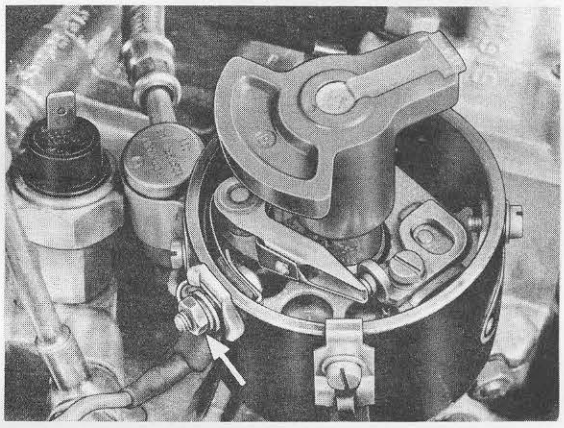

Fig. 18

5. Remove air cleaners.

6. Remove fuel lines and throttle linkage.

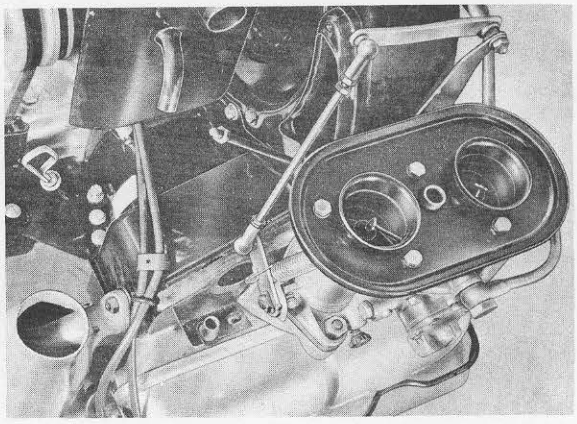

Fig. 19

7. Remove carburetors (2 Fu).

8. Remove V-belt.

9. Detach oil lines from bypass oil filter.

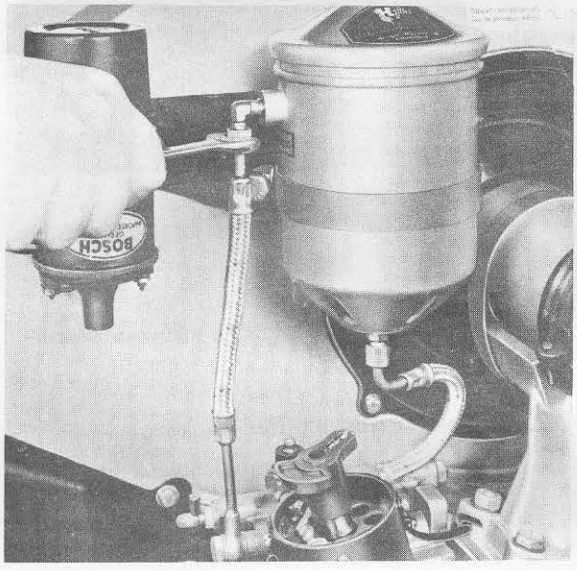

Fig. 20

10. Remove oil filler.

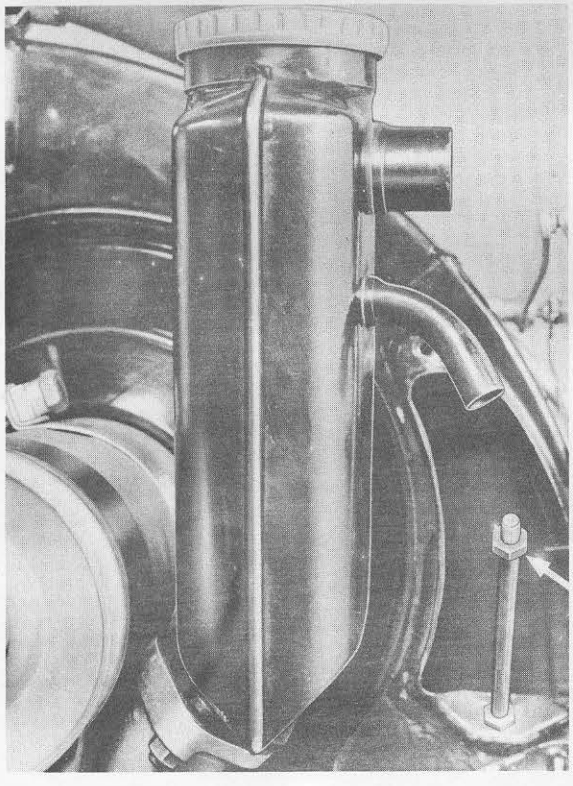

Fig. 21

11. Remove shroud retaining bolts.

12. Unfasten generator.

13. Withdraw blower housing (4 En).

14. Remove cylinder shrouds and, in cases involving the Export heater, lower air ducts (8 En).

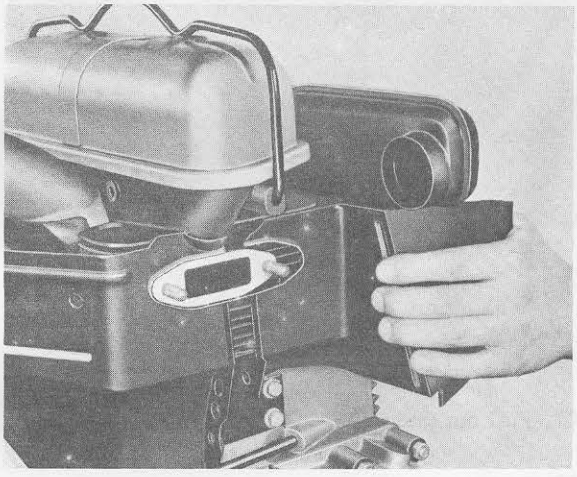

Fig. 22

15. Remove fuel pump (13 Fu).

16. Remove distributor and distributor pinion shaft.

17. Remove generator carrier.

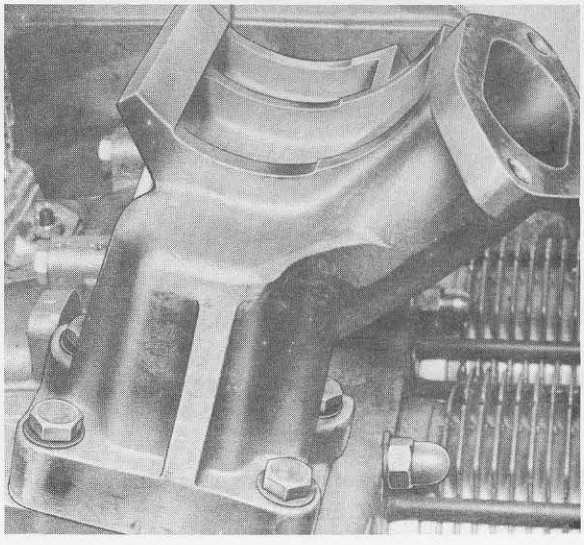

Fig. 23

18. Remove rocker box covers.

19. Remove rocker arms.

20. Remove rocker arm carriers (23 En).

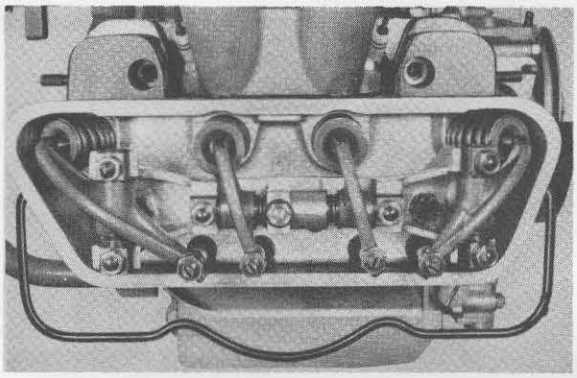

Fig. 24

21. Pull out pushrods.

22. Remove intake ducts.

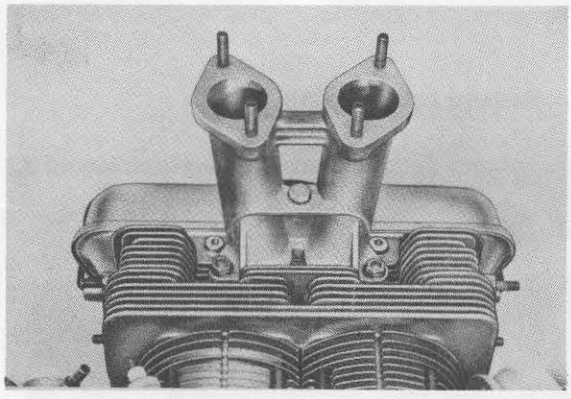

Fig. 25

23. Remove cylinder heads (25 En).

24. Remove pushrod tubes and air deflector baffles.

25. Remove cylinders and pistons, marking each for reassembly (36 En, 38 En).

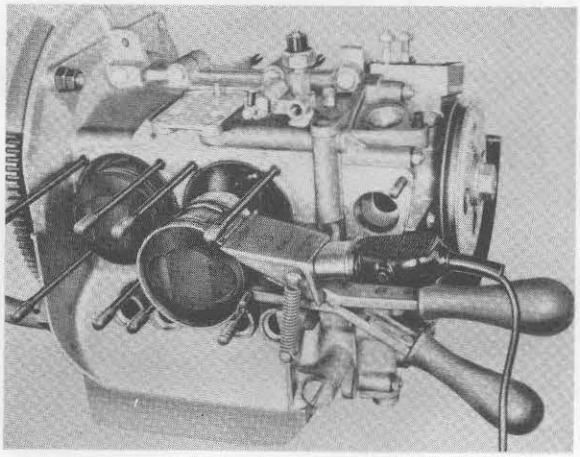

Fig. 26

26. Remove crankshaft pulley, withdraw Woodruff key (47 En).

27. Remove exhaust muffler brackets.

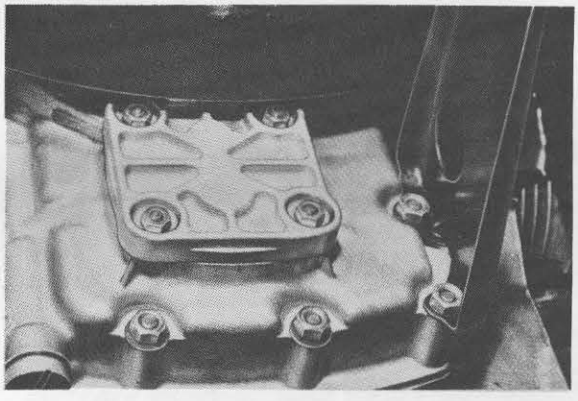

Fig. 27

28. Remove oil pump cover.

29. Withdraw oil pump gears.

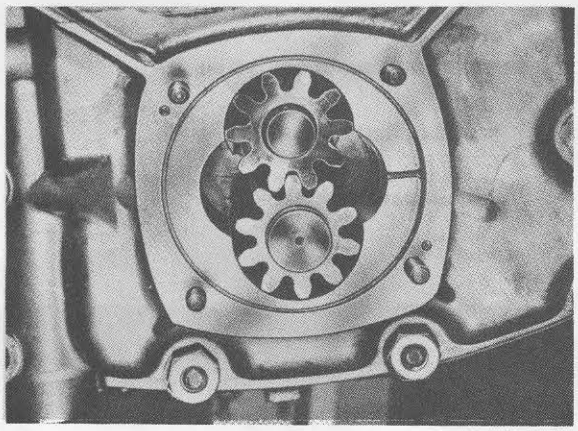

Fig. 28

30. Remove timing gear cover (45 En).

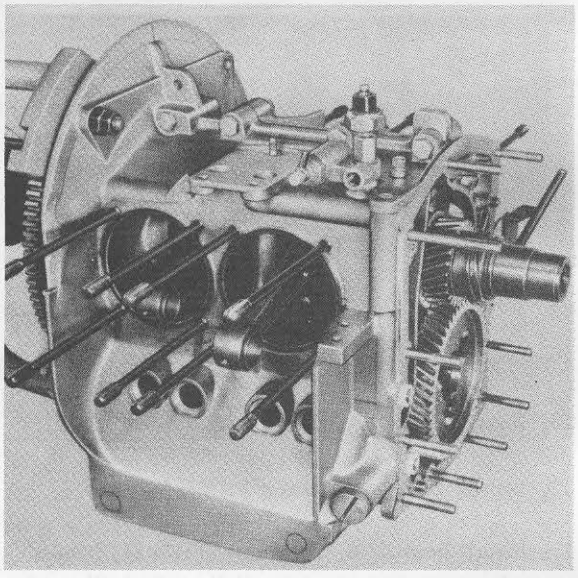

Fig. 29

31. Remove clutch (57 En).

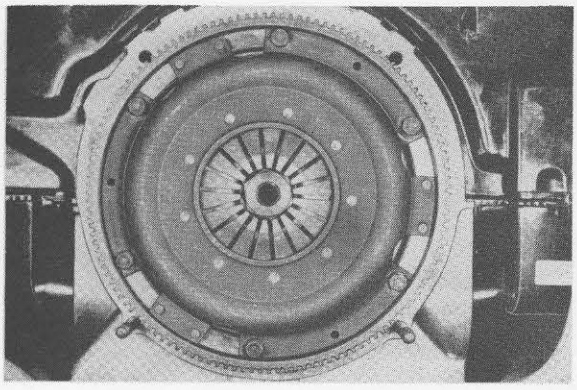

Fig. 30

32. Remove flywheel (46 En).

33. Remove oil strainer cover and oil strainer.

34. Disassemble crankcase (41 En).

35. Withdraw crankshaft and camshaft.

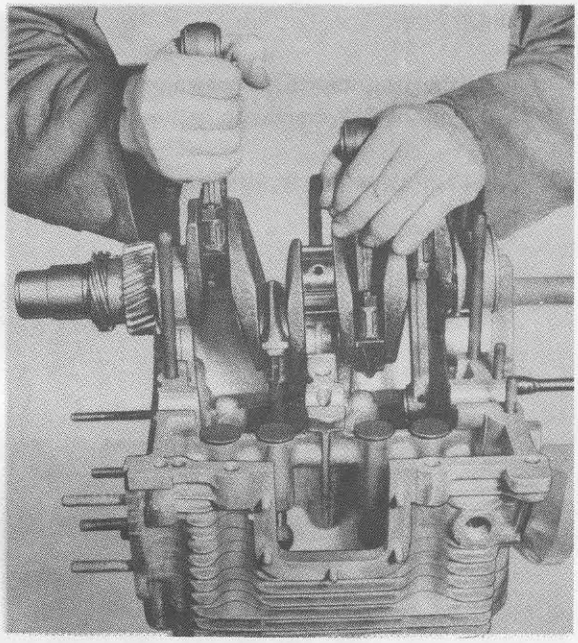

Fig. 31

36. Withdraw valve lifters.

37. Withdraw bearing 2 and 3 inserts.

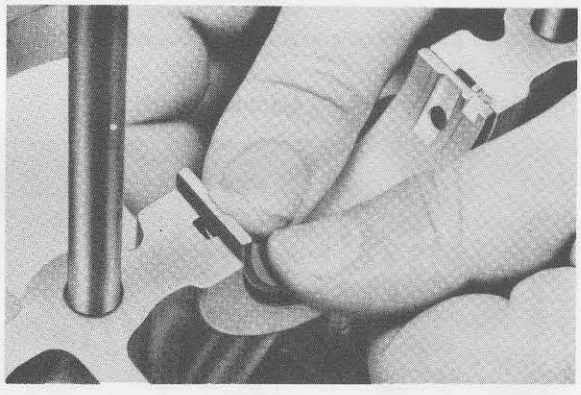

Fig. 32

38. Remove oil seal, deflector, Bearing 4, and bypass valve from the timing gear cover.

Reassembly

Reassemble engine in reversed order of the above, noting the following points:

1. Thoroughly clean crankcase parts, flush oil passages with clean gasoline, install oil drain plug.

2. Install bearing inserts for Bearing 2 and 3 into the right and left crankcase halves.

3. Lubricate valve lifters with graphite oil and install.

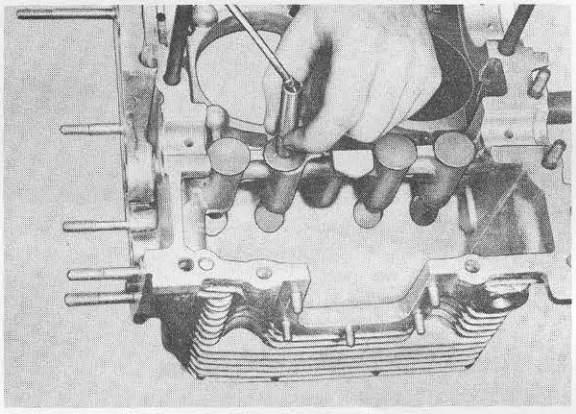

Fig. 33

4. Check dowel pin in Bearing 1 for firm seating.

5. Place assembled crankshaft into crankcase half.

6. Place camshaft into crankcase half.

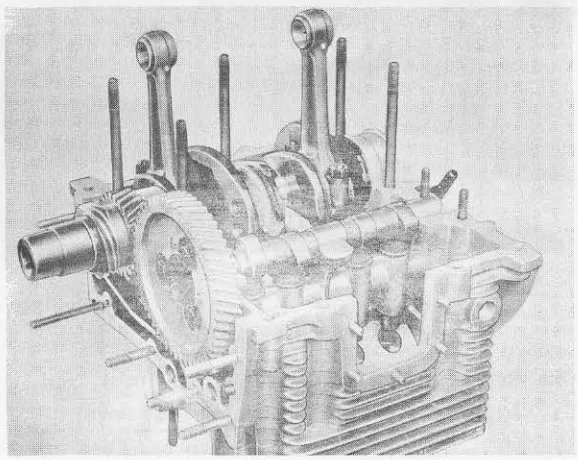

Fig. 34

7. Insert thrust washer and oil seal.

8. Install camshaft end plug.

9. Join both crankcase halves.

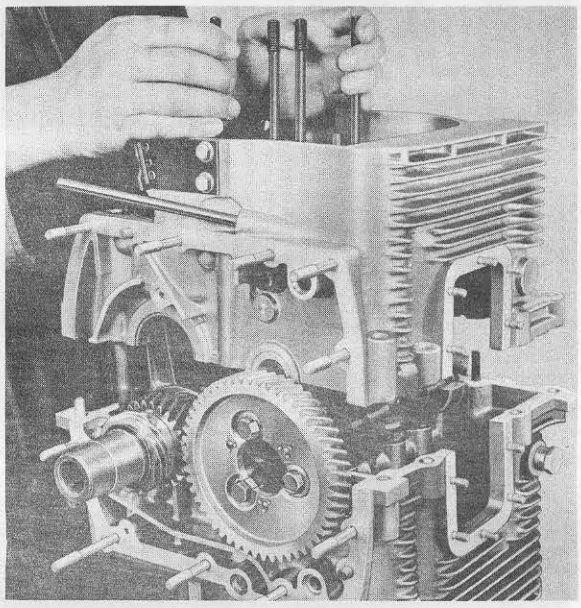

Fig. 35

10. Install flywheel.

11. Install clutch.

12. Install oil strainer and oil strainer cover.

13. Install Bearing 4, deflector, oil seal, bypass valve, counter-pressure oil line, and oil pump, into the timing gear cover. Install timing gear cover, check Bearing 4 set screw for firm seating.

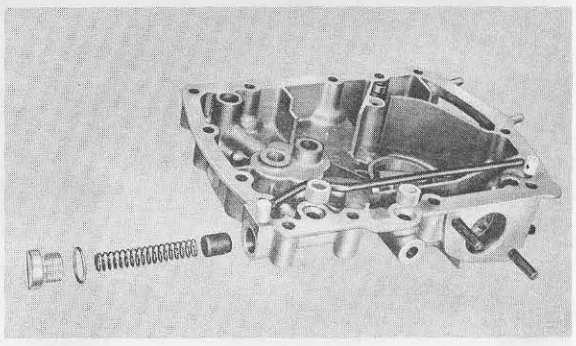

Fig. 36

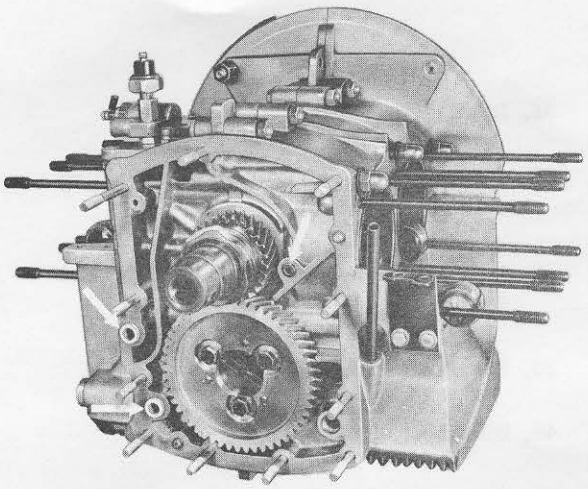

Fig. 37

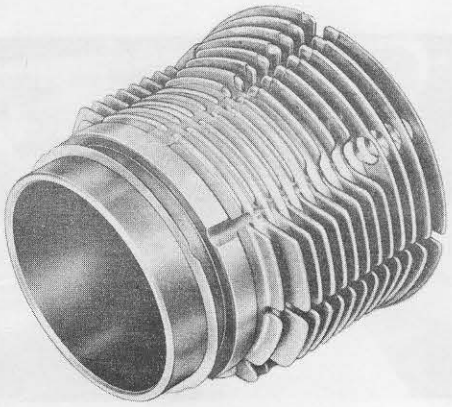

Fig. 39

14. Install crankshaft pulley shield.

15. Install crankshaft pulley.

16. Insert distributor pinion shaft with thrust washer and spring.

17. Install distributor.

18. Install fuel pump.

19. Install oil cooler.

21. Install deflector baffles with supporting springs.

22. Install pushrod covers with gaskets.

23. Insert cylinder head and tighten. Note proper location of cylinder shrouds.

24. Squirt oil into pushrods and insert in place.

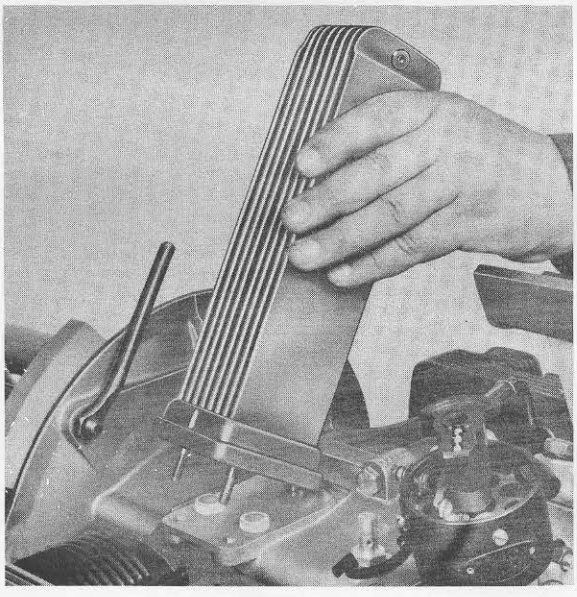

Fig. 38

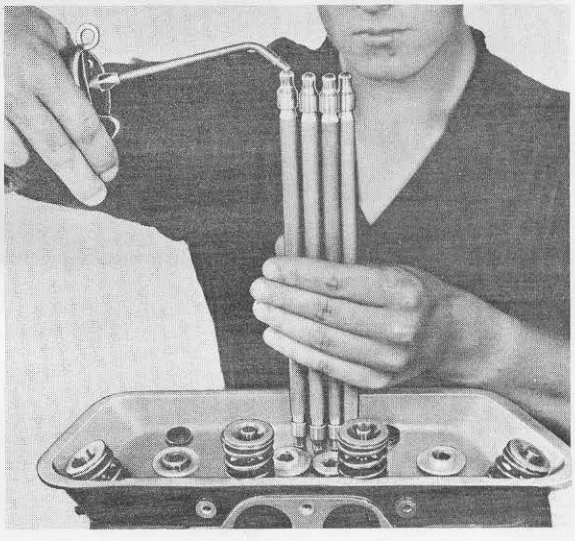

Fig. 40

20. Install pistons and cylinders. Do not fail to install cylinder base gaskets.

25. Install rocker arm carriers.

26. Adjust valve clearance, install rocker box covers.

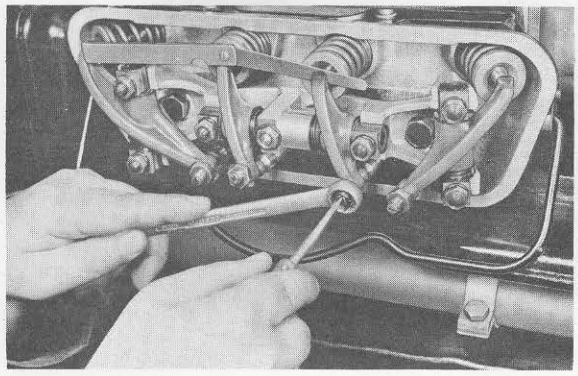

Fig. 41

27. Install spark plugs.

28. Install intake manifolds using new gaskets (clean the gasket surface).

29. Insert blower housing with generator.

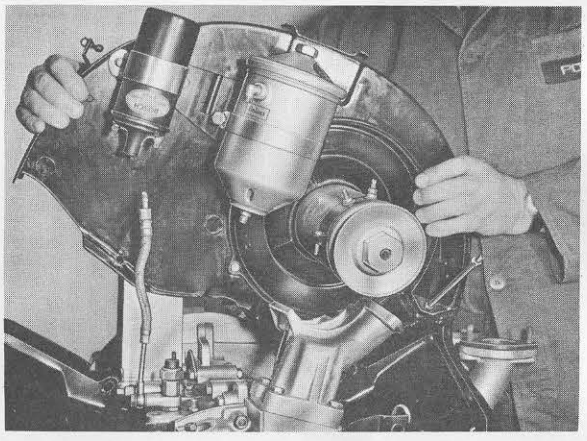

Fig. 42

30. Install cylinder shrouds.

31. Install fuel pump shield.

32. Fasten lower air ducts (Export heater).

33. Install cylinder end shrouds.

34. Attach oil lines to bypass oil filter and oil-pressure switch, check for leakage.

35. Fasten generator strap, spin generator shaft to ensure that blower impeller is not binding.

36. Install V-belt.

37. Connect cable to Terminal 1 connecting coil and distributor.

38. Install carburetors, throttle linkage, and fuel line.

39. Install oil filler.

40. Install air cleaners.

41. Connect ignition leads.

42. Install exhaust muffler, connecting with heat exchangers.

43. Fill engine oil, run engine briefly and re-check oil level, replenish if necessary.

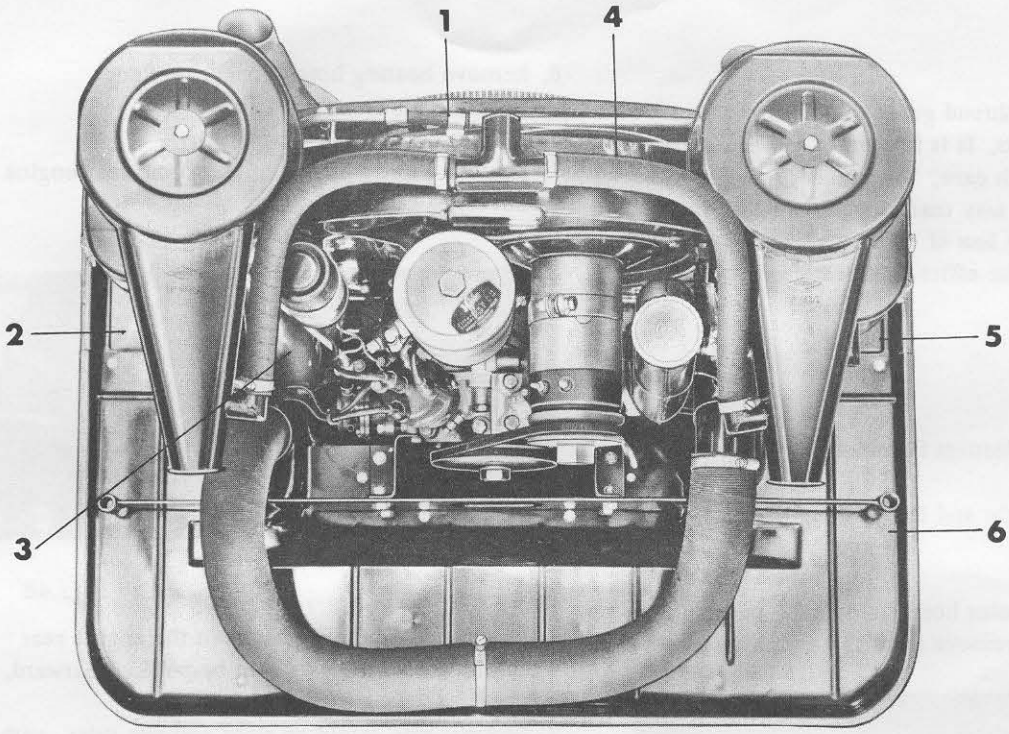

Fig. 43

1. Engine front shield
2. Engine side shield
3. Cylinder shroud
4. Blower housing
5. Engine side shield
6. Engine rear shield

Engine removed

The cooling air shroud guide the cooling air to the cooling points. It is important to accomplish the assembly with care. The shrouds have to be installed in such way that no open areas or slits are created since loss of cooling air would considerably reduce the efficiency of the cooling system.

Removal

1. Remove air cleaners from both carburetors.

2. Loosen the right and left heating hose attaching clamps.

3. Loosen the center hose clamp and, pushing it to the right, remove from the attaching tab.

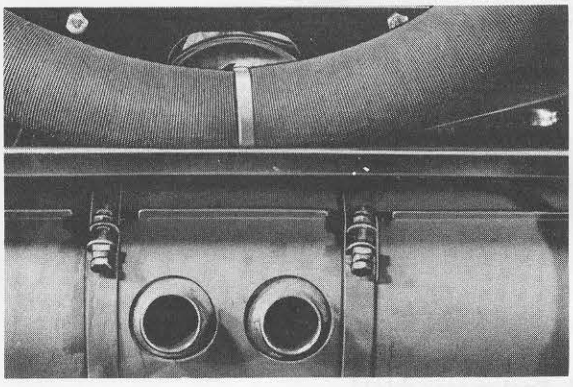

Fig. 44

4. Remove transverse engine carrier (4 bolts); in cars equipped with the newer version of the carrier also remove the carrier plate.

5. Remove crankcase breather hose from breather.

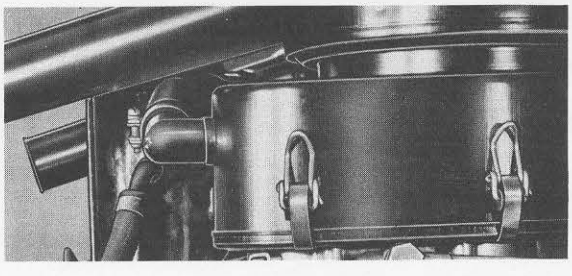

Fig. 45

6. Remove heating hose connecting flange from the air blower housing.

7. Remove short connecting hose from rear engine coverl panel.

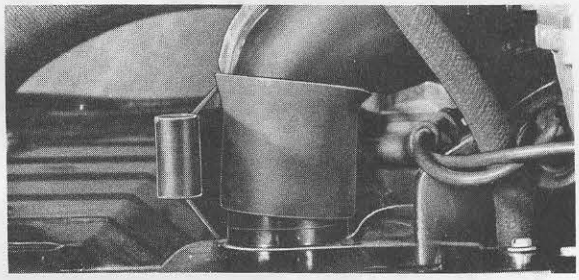

Fig. 46

8. Remove retaining screws from the engine rear shield and withdraw shield by pulling rearward.

9. Remove side shield on right and left sides, withdraw together with breather.

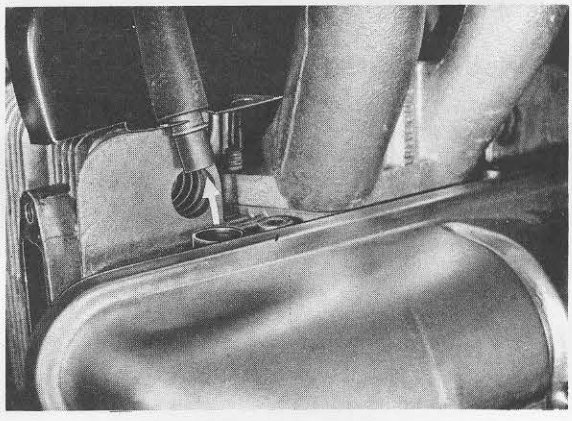

Fig. 47

10. Remove engine front shield.

11. Remove exhaust muffler.

12. Remove heat exchanger (13 En).

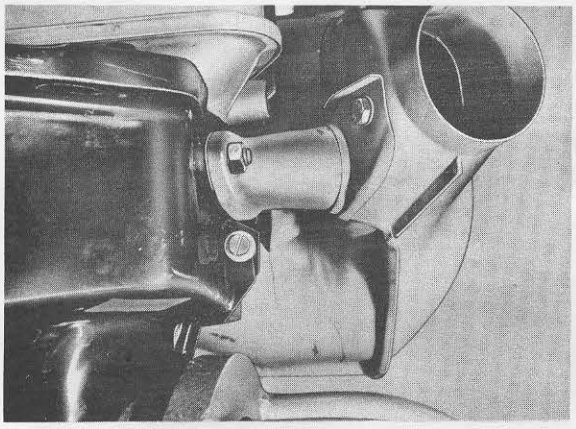

Fig. 48

13. Detach cables connecting the distributor and coil, and remove distributor cover.

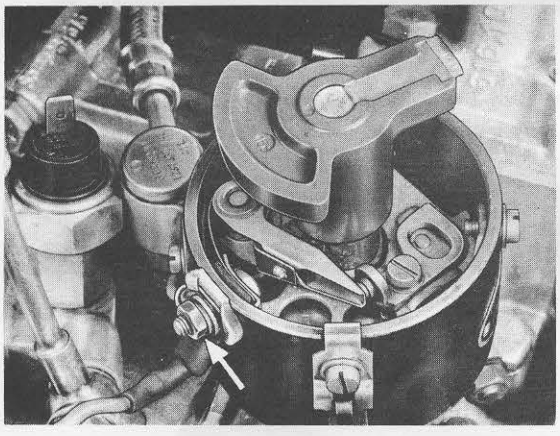

Fig. 49

14. Remove carburetors (2 Fu).

15. Remove V-belt.

16. Remove oil breather.

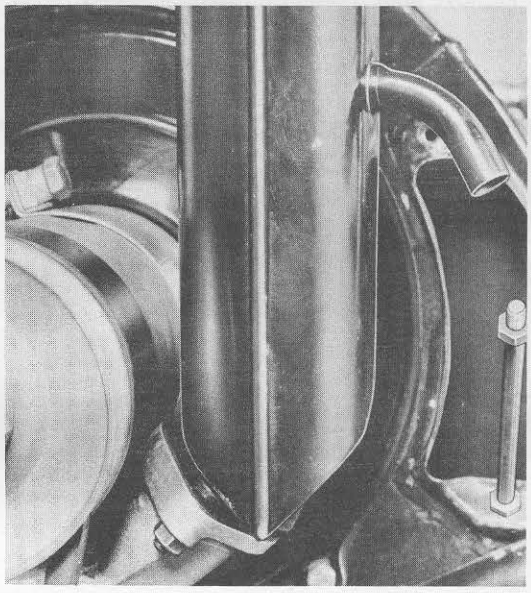

Fig. 50

17. Detach oil lines from bypass oil filter.

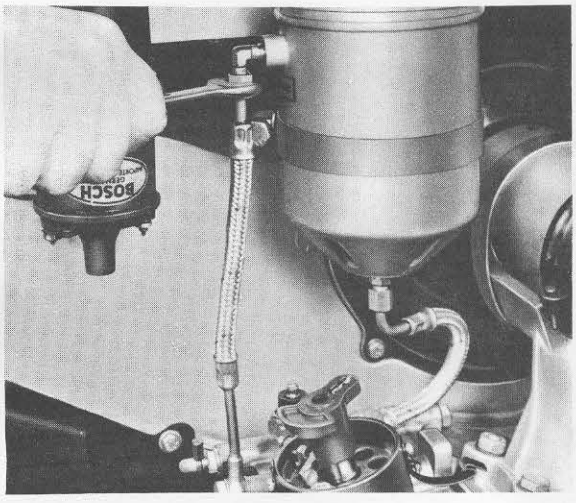

Fig. 51

18. Remove distributor.

19. Remove fuel pump.

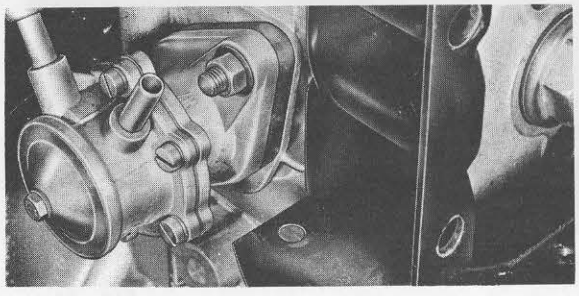

Fig. 52

20. Remove both transverse carrier supports.

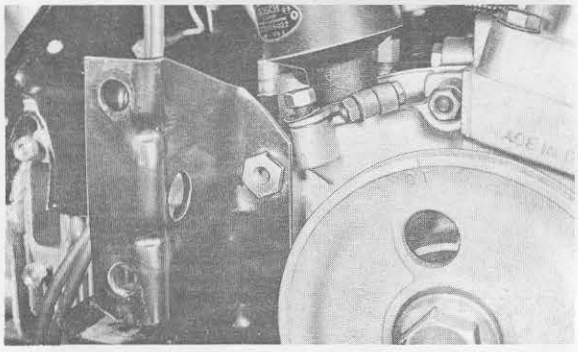

Fig. 53

21. Remove cover shrouds.

22. Unfasten generator retaining strap.

23. Withdraw blower housing.

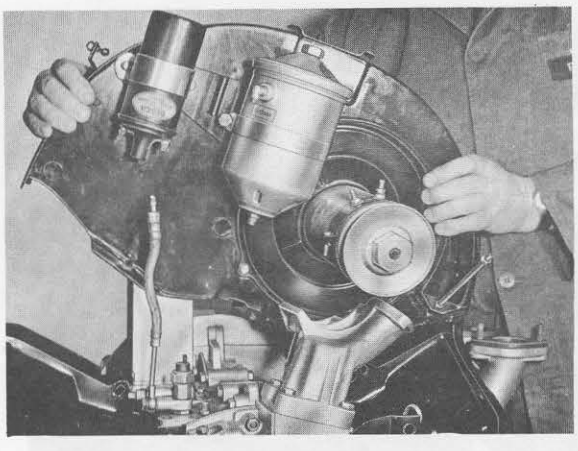

Fig. 54

24. Remove cylinder shrouds and lower air duct.

25. After removing the cylinder heads, withdraw deflector baffles and supporting springs.

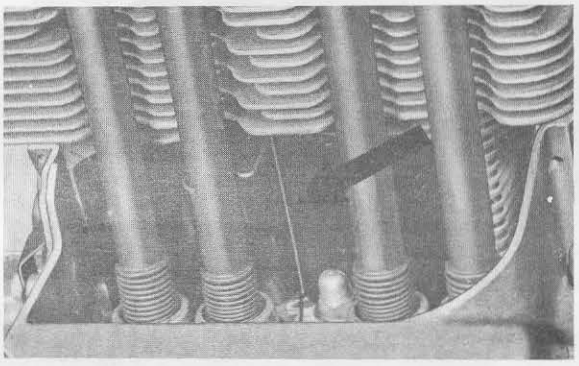

Fig. 55

26. Using a puller, withdraw crankshaft pulley and remove pulley shield.

The cooling air shrould should be reinstalled in reversed order of the above, making certain that the shrouds are well fitted and the spark plug rubber covers properly seated. Torn, porous, or otherwise defective rubber gaskets must be replaced. All rubber parts should be kept free of grease and oil. Particular attention must be given to proper placement of the deflector baffles.

Deflector baffle for Cyl 3 and 4

Deflector baffle for Cyl 1 and 2

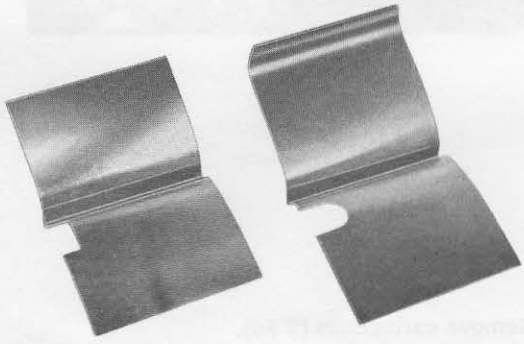

Fig. 56

1. Detach throttle linkage from both throttle control levers.

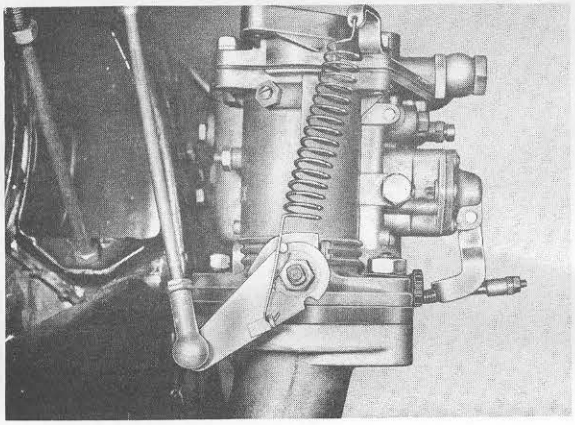

Fig. 57

2. Remove carburetors and fuel supply line.

3. Detach throttle control linkage.

4. Remove generator retaining strap.

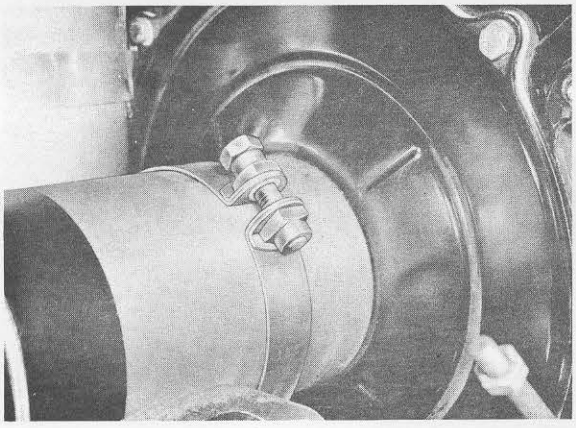

Fig. 58

5. Detach oil lines from bypass oil filter.

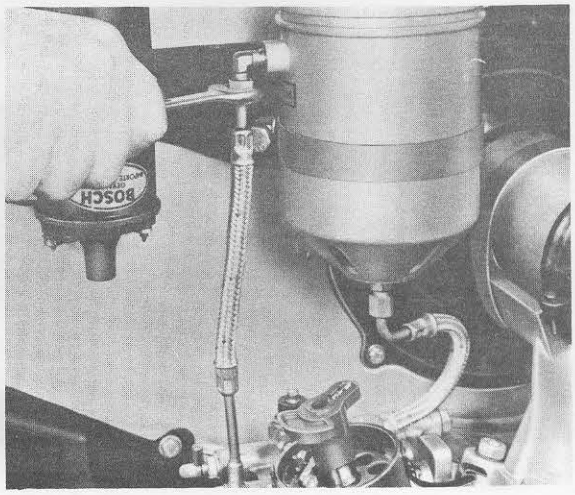

Fig. 59

6. Detach ignition leads from spark plugs, and cable connecting distributor with coil, remove distributor cover.

7. Remove retaining screws from cylinder end and side shrouds.

8. Detach heating air connecting flange from air blower housing.

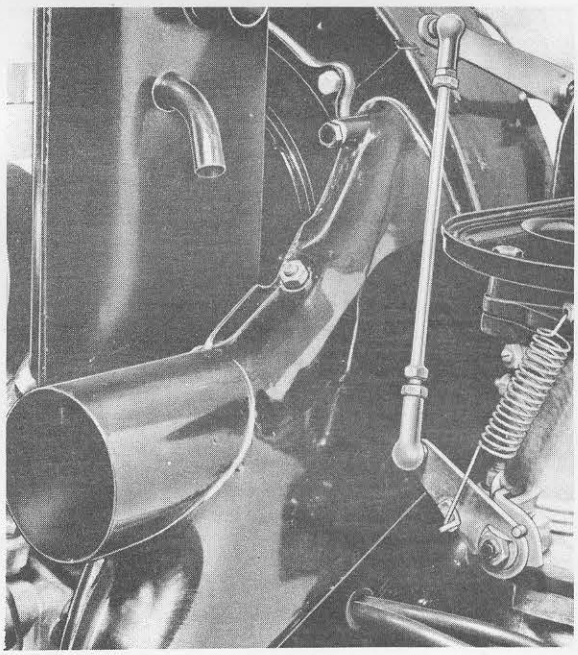

Fig. 60

9. Remove air blower housing by pulling it up.

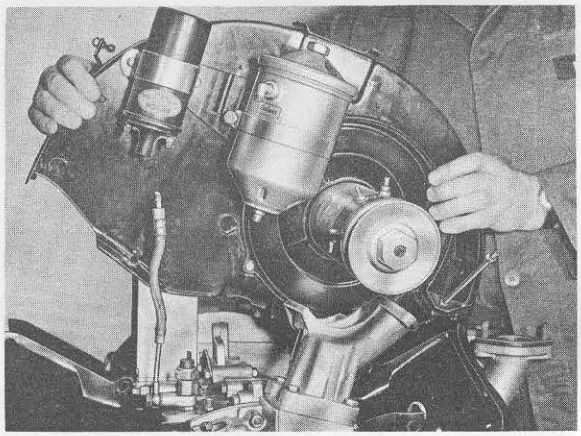

Fig. 61

Installation:

Install the air blower housing in reversed order of the above by noting the following points:

1. The cover shrouds must join their counterparts with good fit to preclude loss of cooling air.

2. With engine installed, properly connect the generator cables.

3. Adjust carburetor linkage.

4. Check gasket at the oil filler stack, replace if necessary.

REMOVING AND INSTALLING COOLING BLOWER

5 EN

General

The detachable generator carrier permits withdrawel of the generator and blower impeller assembly without removal of the entire air blower housing. The work procedure is as follows:

Removal

1. Remove V-belt and detach generator cables.
2. Loosen generator retaining strap.
3. Remove oil filler stack.
4. Remove bypass oil filter assembly.
5. Remove retaining bolts from the blower housing cover.

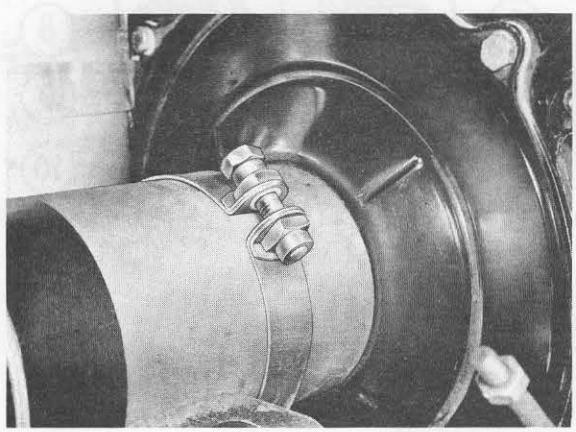

Fig. 62

6. Remove generator carrier, cover the crankcase opening to prevent entry of foreign matter.

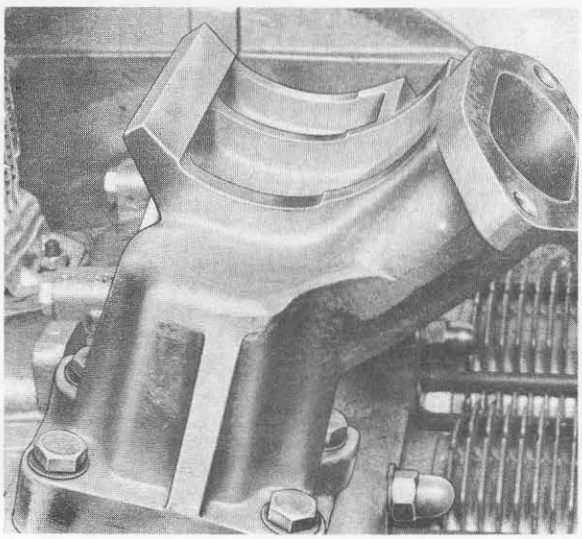

Fig. 63

7. Withdraw the generator and blower impeller assembly.

Installation

The installation is accomplished in reversed order of the above by noting the following points:

1. Properly connect generator cables (brown cable to Terminal D-, black cable to Terminal DF, red cable to Terminal D+).
2. Insert new gasket between the generator carrier and timing gear cover.
3. Check for proper V-belt alignment between the generator and crankshaft pulleys and correct be repositioning the generator in its cradle; however, make certain that no tension is created between the blower housing cover and the blower housing when the retaining screws are tightened.

6 EN

Special Tools :

P 42	Torque wrench, or
VW 118	Torque wrench
P 44	Hex socket, 36 mm, for P 42,

Removal

1. Remove air blower (5 En).
2. Mount generator in a vice by fastening it by the pulley spindle through plastic or aluminium grip protectors.
3. Unscrew the special impeller nut and withdraw impeller together with its back shield.

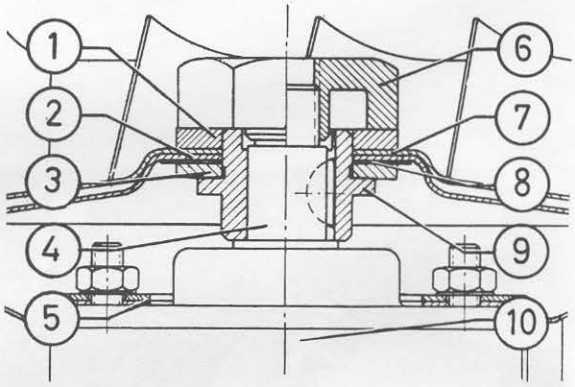

Fig. 64

1 Thick washer
2 Impeller back shield
3 Thick washer
4 Generator shaft
5 Blower housing cover
6 Special impeller nut
7 Impeller
8 Spacers (as needed, 2-5 each)
9 Impeller hub
10 Generator

Installation:

Installation is accomplished in reversed order of the above by noting the following points:

1. Note the proper arrangement of spacers.
2. Position impeller shield.
3. Tighten the special impeller nut to 10 mkp (72.3 lbs/ft).
4. The clearance between the blower housing cover and impeller should be approx 3 mm (1/8").
5. When turning, the impeller should not strike the housing cover.

REMOVING AND INSTALLING AIR HOSE CONNECTING DUCT

Removal

1. Detach heating hose from connecting duct.

2. Detach breather hose from breather.

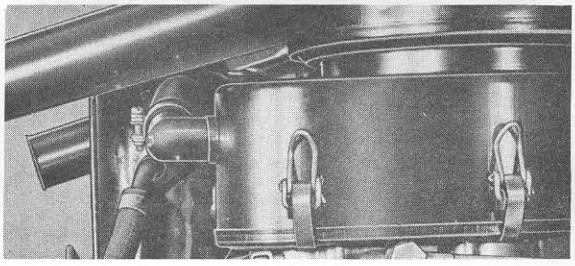

Fig. 65

3. Remove retaining nut and bolt from the connecting duct. Push rubber hose section down and off the duct, pull duct diagonally upward.

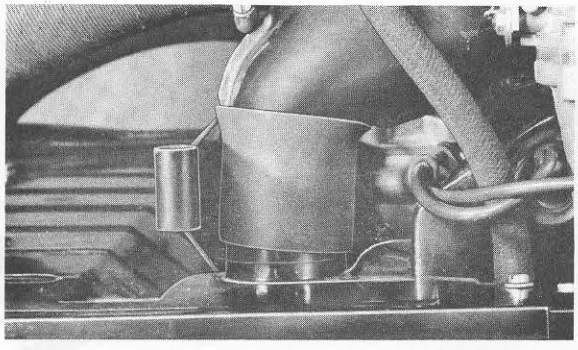

Fig. 66

Installation

Note the following points during installation:

1. Check adjustment of the counter-nut used for fastening the connecting duct. The nut must be screwed in deep enough to permit flush alignment of the connecting duct with the blower housing without deformation of the duct when tightened at the attaching points.

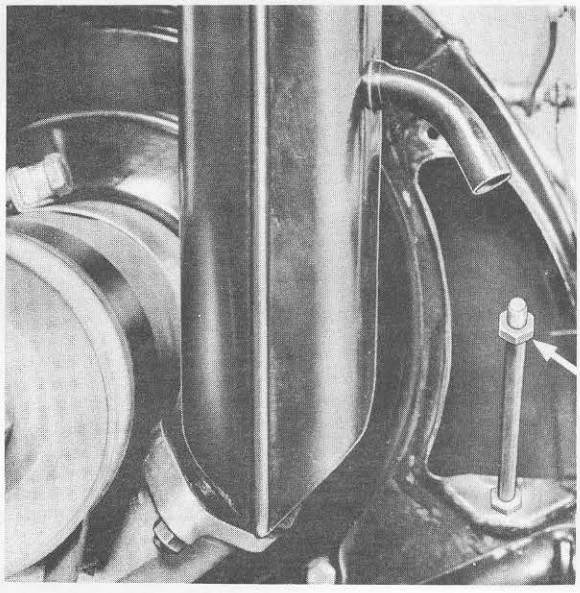

Fig. 67

2. Inspect heating hose and breather hose for air-tightness and possible damage.

8 EN

INSTALLING LOWER DUCT WITH AIR GATES

(Export-type heater)

The following points should be observed when installing the lower air duct:

The air gates located in the lower air duct must be so adjusted that they perform the opening and closing functions in unison. Ensure that the large air gate flaps are positioned approx 10 mm (2/5") from the bottom of the ducts when the small air gate flap is fully closed. Upon mounting the lower ducts at the engine, check for proper functioning of the air gates and readjust if necessary.

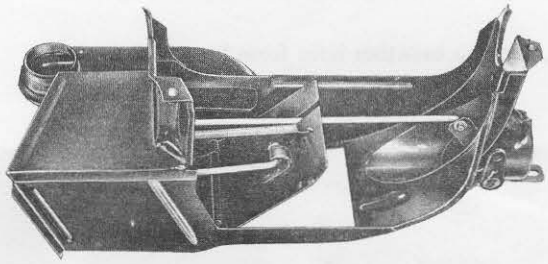

Fig. 68

9 EN

INSTALLING AIR GATE ASSEMBLY

The following points should be observed when installing the air gate assembly:
Check for proper seating of the 2,5 mm-thick cork gasket.
Check heating hose attachment for air-tightness and firm seating with the help of the hose clamp.

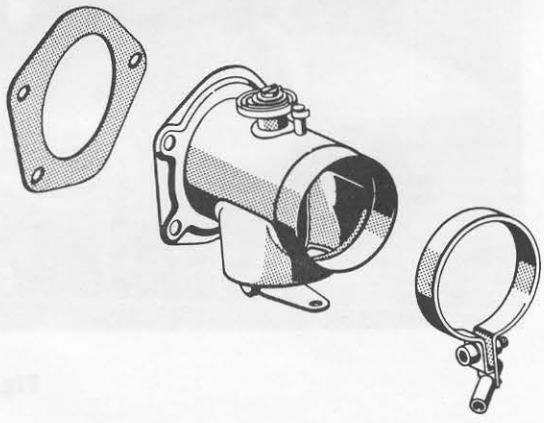

Fig. 69

CHECKING V - BELT TENSION

10 EN

General

The generator and air blower are driven by a V-belt. The loads created by these two accessory units impose considerable stresses upon the belt at high engine speeds and, especially, during downshifts. For this reason, we recommend that the V-belt tension be frequently checked and adjusted when necessary.

Loose V-belt tension results in belt slippage in the pulley causing the engine to run hot; excessively high V-belt tension leads to belt failure and, possibly, premature wear of the generator bearings.

Inspection

When servicing the engine, care should be excercised to keep oil and grease off the V-belt; oily V-belts should be washed in a soap or detergent solution and then thoroughly rinsed in clear water although it is always of advantage in such cases to install a new belt. V-belts contaminated with oil or grease for any length of time are usually no longer serviceable and must be replaced.
When correctly adjusted, the V-belt can be deflected by 15-20 mm (5/8 - 3/4 in.) under slight thumb pressure applied midway between both belt pulleys. The belt should not show any signs of wear such as frayed edges or split flanks.

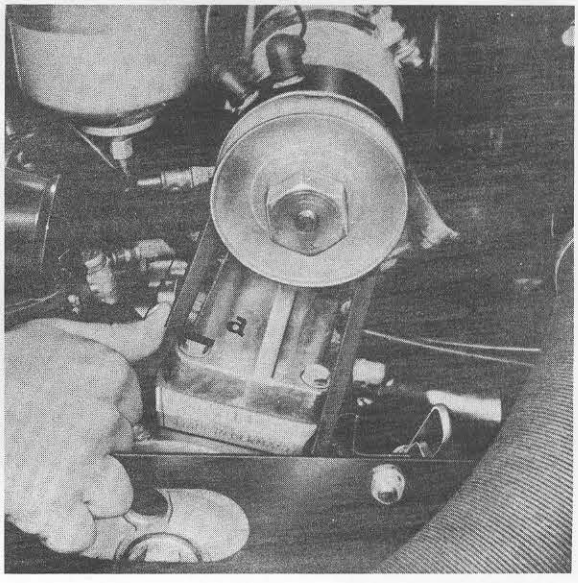

Fig. 70

ADJUSTING V-BELT TENSION

11 EN

1. Remove generator pulley retaining nut (36 mm wrench); to lock the pulley in place during this procedure, insert a square-edged screwdriver into the recess in the inner edged of the pulley and brace it against the top bolt protruding from the generator housing (see Fig. 71).

2. Remove outer pulley half.

3. Arrange spacers between pulley halves as needed. The belt tension should be so adjusted, by adding or removing spacers between the two pulley halves, that the belt will yield by about 15-20 mm (5/8 - 3/4") under light thumb pressure. Removal of spacers increases the belt tension, addition of spacers decreases the tension (see Fig. 72). If the belt has streched or worn to such extent that only one spacer remains between the pulleys at correct belt tension, it should be replaced since the con-

dition will result in insufficient cooling due to decreased impeller speeds. In addition, it should be noted that the belt does not ride at the pulley root, that is, on the pulley spacers.

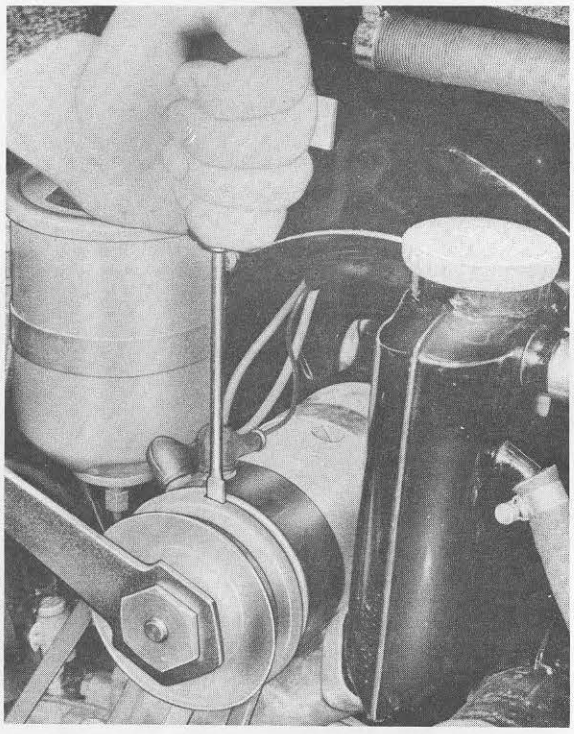

Fig. 71

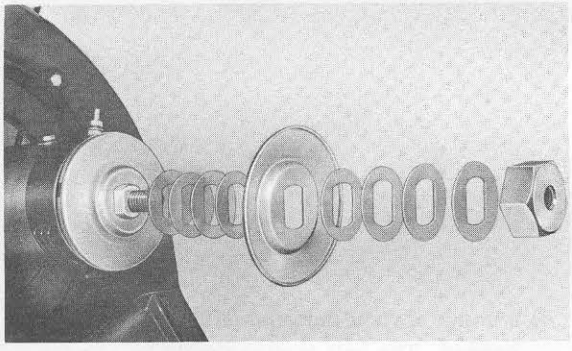

Fig. 72

4. Mount outer pulley half.

5. Spacers not inserted between the two pulley halves should be placed onto the shaft between the outer pulley half and the nut so that all spacers remain on the pulley hub.

6. Tighten pulley retaining nut. Loose pulley halves will quickly become defective in their seats and also cause a rapid V-belt wear. Damaged pulley halves must be replaced.

Note

New V-belt will stretch after a short time of use so that they no longer have the proper tension after 50 - 100 km (30-60 miles). For this reason it is absolutely necessary to recheck the belt tension of new belts within a short period subsequent to the installation.

Attempts to remove the V-belt by means of a screwdriver, without loosening the generator pulley, will result in damaged V-belt and pulley.

Due to varying laws in force, it is necessary to equip The Type 912 cars with two different heating systems. Cars manufactured for sale in Germany and Sweden are equipped with a modified heating system known as 356 B/T6 whereas all other Type 912 export cars continue to be equipped with the well-proven and reliable Export-type heating system. The difference between the two systems is that in the 356 B/T6 system the air required for heating is drawn from the air blower housing and ducted to the passenger compartment through the heat exchangers, without passing through the engine cooling cycle. In the Export-type heating system the cold air performs its engine cooling function and, already preheated, is ducted into the heat exchanger and on to the passenger compartment. The desired effectiveness of both heaters is achieved through the use of appropriately designed heat exchangers.

DESCRIPTION OF THE 356B/T6 HEATING SYSTEM

(Germany and Sweden)

Functional View of the Heating System

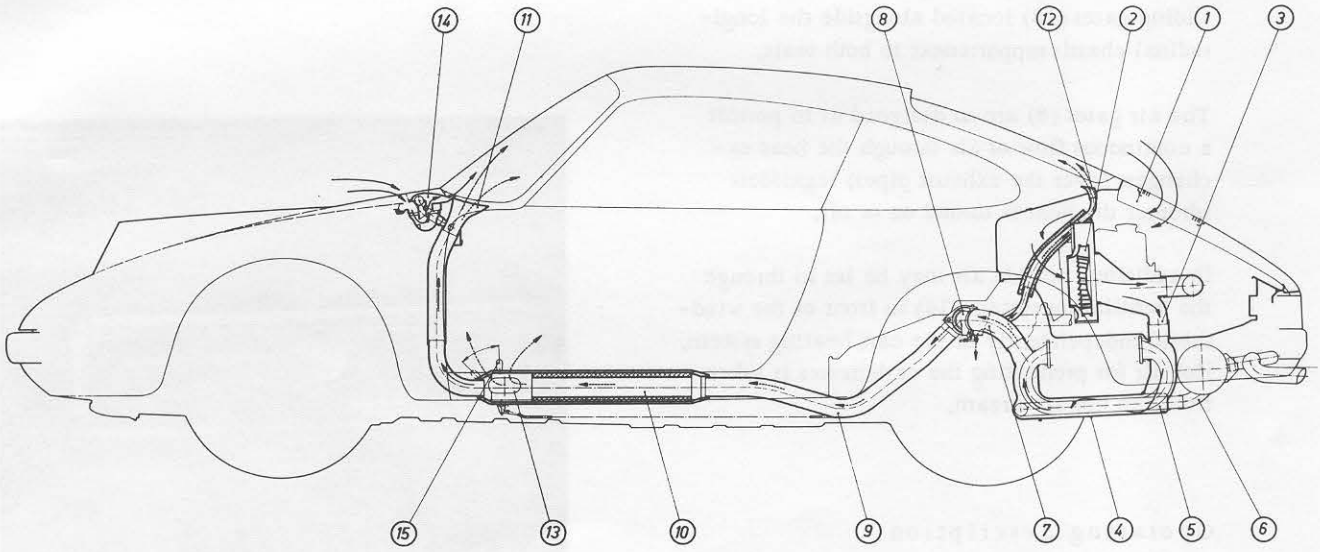

Fig. 73

Functional Description:

The entire fresh air mass enters through slots in the engine compartment lid (1), being drawn in by the cooling air blower. Part of the fresh air mass required for heating the passenger compartment is diverted from the cooling air blower (2) into a separate duct (3).

The fresh air (outside air) flows from the supply duct through the two heat exchangers (4) at the engine. The heat exchangers consist of sheet-metal jackets which enclose the exhaust pipes (5). All detachable and welded joints of the exhaust system (6) are located outside the heat exchangers.

The entire engine exhaust system as well as most part of the engine, such as the crankcase and cylinders, is located in the free-air stream beneath the rear section of the car.

The heating air flows from both heat exchangers through connecting hoses (7), air gates (8), guide ducts (9), and silencers (10) which are situated within the longitudinal chassis support members, to heat outlets arranged in pairs.

Heat outlets are provided as follows:

For defrosting the windshield (11) and the rear window (12) by way of defroster nozzles.
For the forward leg area (pedal area) by way of sliding gates (13) located alongside the longitudinal chassis supports next to both seats.

The air gates (8) are so designed as to permit a continuous flow of air through the heat exchangers (over the exhaust pipes) regardless whether the heat is turned on or off.

In addition, outside air may be let in through the ventilating system (14) in front of the windshield independently of the cars heating system. Hot air for preheating the carburetors is taken from the hot air stream.

Operating description:

The heat is controlled through a control lever (15) located in front of the gearshift lever.

With the lever moved back, the heater is open, and with the lever moved forward, the heater is closed.

Through the lever action, air gate flaps are moved in the air gate assembly (8) by way of a cable connection. Should the cable break, the two flaps shut automatically and the hot air is permitted to flow outside.

Fig. 74

Located in the forward leg area, along the right and left sides adjacent to the front seats, are sliding gates (13) with which it is possible to regulate the flow of hot air to the leg area. When the slider is moved forward, the flow of air stops although in that case the entire warm air supply enters the passenger compartment through the defroster nozzles (11 and 12).

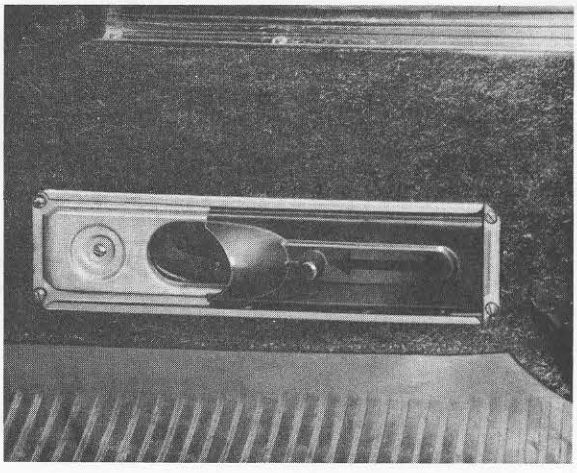

Fig. 75

The flow of ventilating air through the ventilating system (14) can be regulated by means of a lever mounted on the instrument panel.

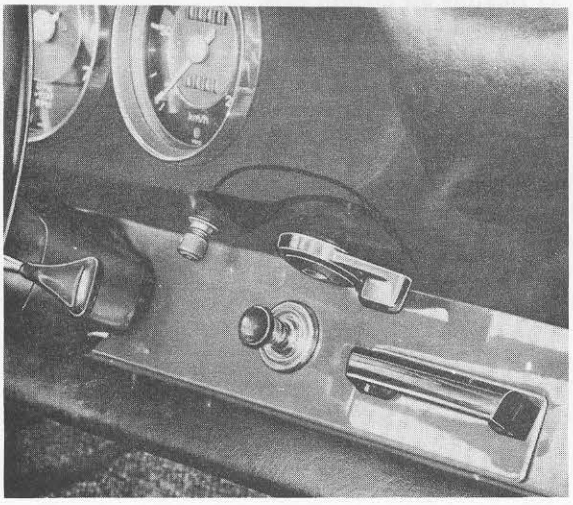

Fig. 76

Lever to the right:
Ventilating air shut off.

Lever to the left:
Ventilating air open.

Bottom View of Vehicle

Heater Type

356b/T6

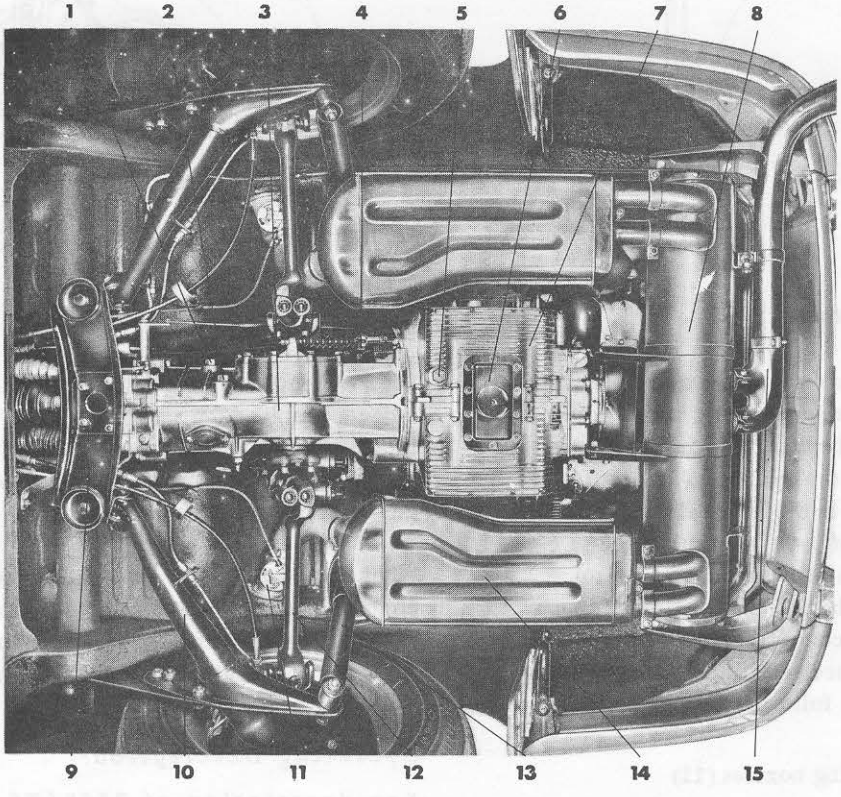

Fig. 77

Bottom View of Vehicle

1 Transmission filler plug
2 Transmission drain plug
3 Transmission
4 Clutch control lever
5 Engine drain plug
6 Oil strainer cover
7 Engine crankcase
8 Exhaust muffler
9 Forward power train carrier
10 Suspension control arm
11 Heating air control gate
12 Axle shaft
13 Shockabsorber
14 Heat exchanger
15 Tail pipe

DESCRIPTION OF THE EXPORT - TYPE HEATING SYSTEM

Functional View of the Heating System

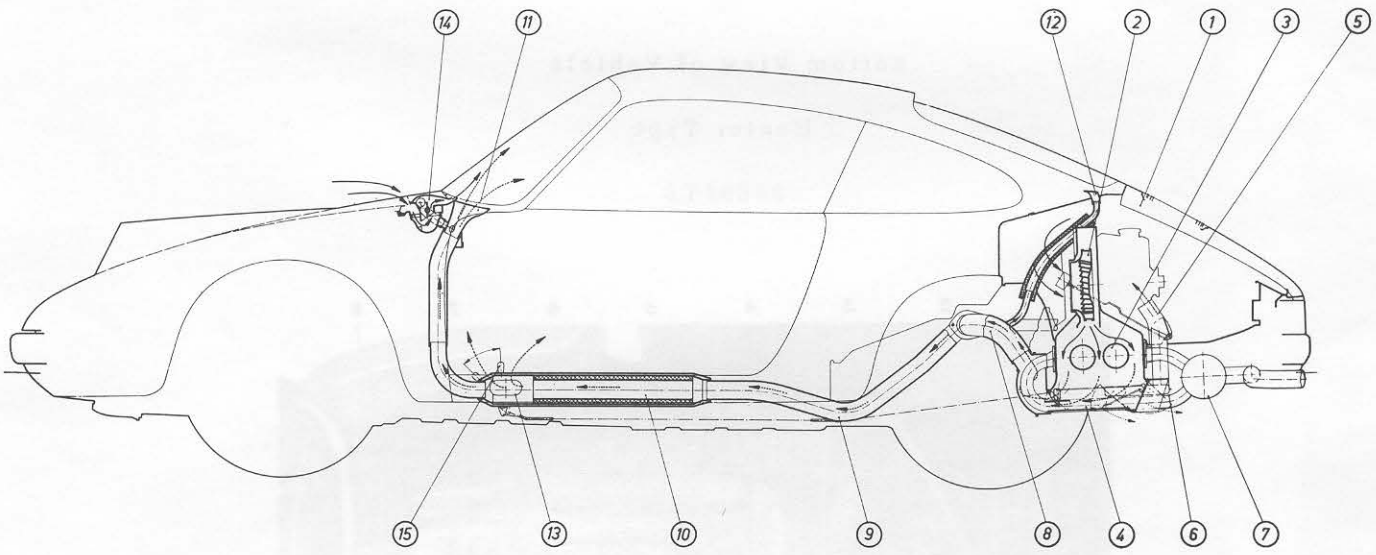

Fig. 78

Functional Description

The entire fresh air mass enters through slots in the engine compartment lid (1), being drawn in by the cooling air blower (2). The air blower forces the air over the cylinders (3) where it is preheated, and on to the lower air ducts. When the heater is shut off, the air flows directly outside. When the heater is turned on (control lever -15- moved back), the air flows through a heat jacket into connecting hoses (8), ducting pipes (9), and silencers (10) into the passenger compartment. The following hot air outlet pairs are provided:

Windshield defrosting nozzles (11)

Rear window defrosting nozzles (12)

Leg area outlets through sliding gates (13) located adjacent to the front seats.
In addition, independently of the car's heating system, ventilating outside air may be let in through the ventilating system (14) in front of the windshield.

When the heater is on, warm air enters the engine compartment through outlets (5). This warm air prevents carburetor icing and undercooling of the engine. The flow of air into the engine compartment is controlled by a thermostat.

Operating Description:

See description of 356B/T6 heater

BOTTOM VIEW OF VEHICLE

Export - type Heater

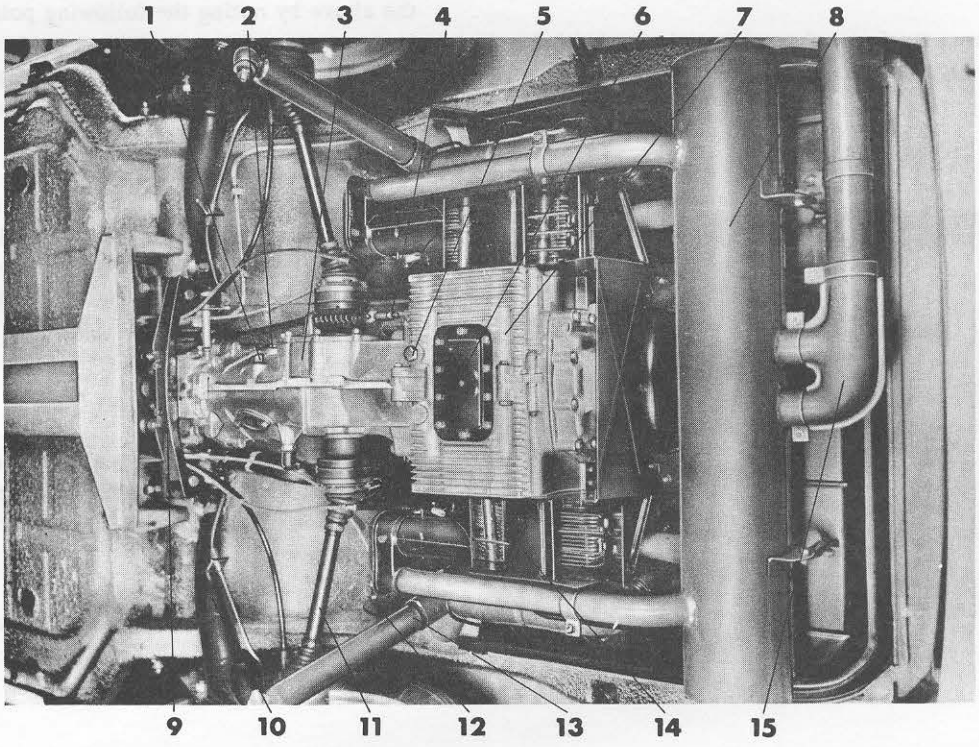

Fig. 79

1 Transmission drain plug
2 Transmission filler plug
3 Transmission
4 Clutch control lever
5 Engine drain plug
6 Oil strainer cover
7 Engine crankcase
8 Exhaust muffler
9 Forward power train carrier
10 Suspension control arm
11 Axle shaft
12 Heating air control gate
13 Shockabsorber
14 Lower air duct for heater
15 Tail pipe

Second Edition of this page, March 1967

REMOVING AND INSTALLING EXHAUST MUFFLER

Removal

1. Remove both supports for engine rear shield.

2. Loosen the four exhaust pipe clamps behind the heat exchangers.

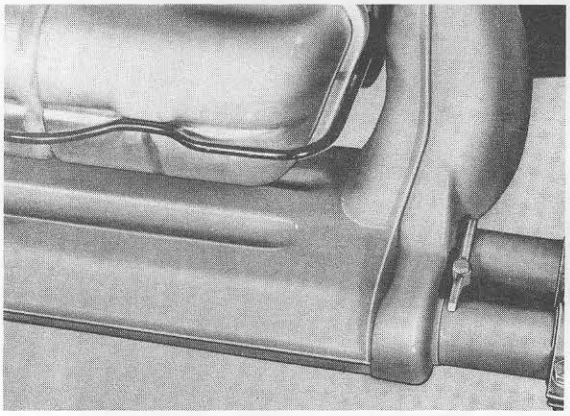

Fig. 80

3. Loosen and remove supporting straps in the center of the muffler.

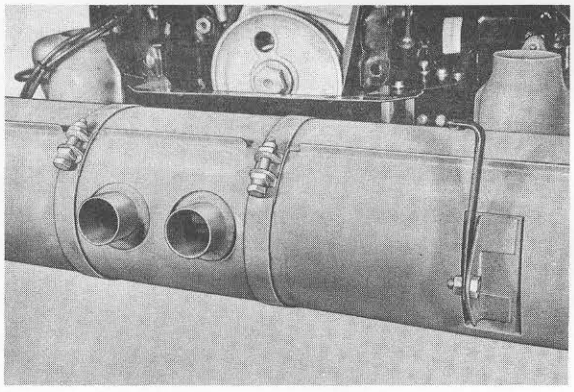

Fig. 81

4. Pull muffler back to remove, loosening stuck pipe connections through light tapping with a rubber mallet.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Inspect muffler and exhaust pipes prior to installation for leaks or possible damage.

2. Straighten flattened or bent pipes. The welded joint between the muffler and the rear exhaust pipe is particularly exposed to collision damage. Exhaust gases escaping through any cracks at this point can enter the engine compartment and with the heater on, the car's interior.

3. Use new gaskets.

4. Ensure that a good gas-seal is achieved at the front pipe connecting points. If the mating flanges are not straight, straighten prior to installation.

5. With the engine installed, the exhaust muffler must not touch the body.

REMOVING AND INSTALLING HEAT EXCHANGER WITH EXHAUST PIPE

(Engine removed, applicable to 356B/T6 heater)

13 EN

Removal

1. Remove engine rear shield.

2. Detach clamps from holders.

3. Remove exhaust muffler (12 En).

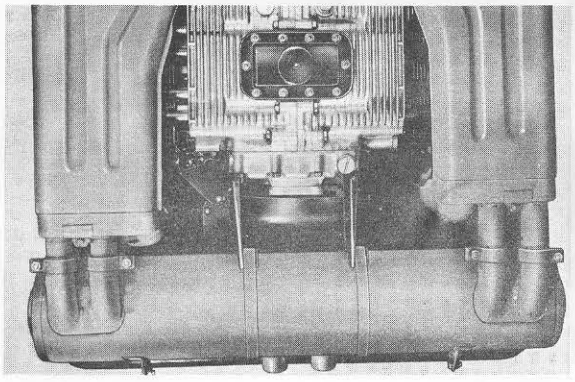

Fig. 82

4. Remove nuts from front and rear flanges.

5. Remove securing claws from both exhaust pipe ends.

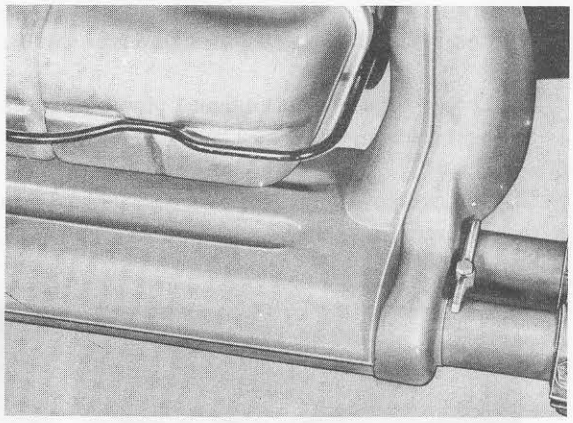

Fig. 83

6. Remove retaining bracket and sheetmetal cover from heat exchanger.

7. Remove lower duct shroud front and rear.

8. The heat exchanger can be withdrawn after removal of the front or rear flange from the cylinder head.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Straighten flattened or bent pipes.

2. Prior to installation, check parts for proper sealing.

3. Use new gaskets.

14 EN REMOVING AND INSTALLING EXHAUST MUFFLER

(Engine removed, apllicable to Export-type heater)

Removal

1. Remove both supports for engine rear shield.
2. Loosen right and left exhaust pipe clamps at heat exchangers.
3. Remove covers located over the exhaust flange at engine rear shield.

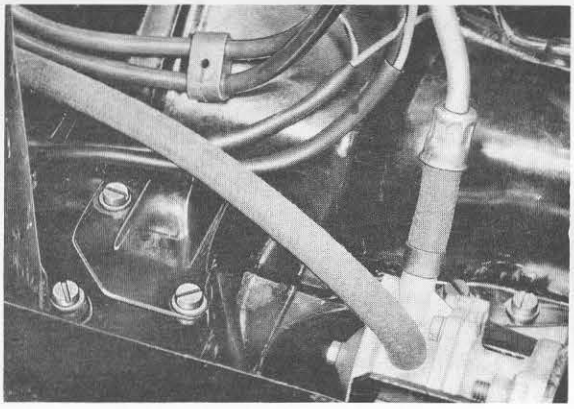

Fig. 84

4. Remove tail pipe from muffler.
5. Remove exhaust flange retaining nuts from cylinder heads and pull muffler back to remove, loosening stuck pipe connections through light tapping with a rubber mallet.

Installation

Note the following points during installation:

1. Inspect muffler and exhaust pipes prior to installation for leaks or possible damage.
2. Straighten flattened or bent pipes.
3. Use new gaskets.
4. With the engine installed, the exhaust muffler must not touch the body.

15 EN REMOVING AND INSTALLING HEAT EXCHANGER WITH EXHAUST PIPE

(Engine removed, applicable to Export-type heater)

Removal

1. Loosen exhaust pipe clamps at muffler.
2. Remove retaining bolts from front exhaust flange.
3. Withdraw heat exchanger with exhaust pipe from lower duct.

Installation

Note the following points during installation:

1. Check heat exchanger and exhaust pipes for tightness and damage.
2. Sealing surfaces and flanges must be clean and straight.
3. Use new gaskets.

Removal

1. Detach cable ends from connecting levers at air gate assemblies.

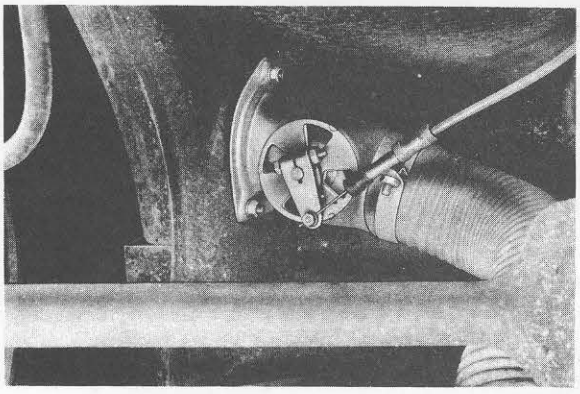

Fig. 85

2. Remove center tunnel cover.

3. Remove the three retaining bolts from shift lever base.

4. Remove the two bolts from shift rod carrier.

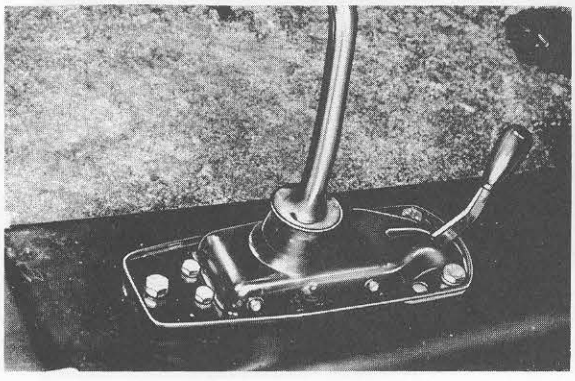

Fig. 86

5. Withdraw shift lever assembly.

6. Move heater control assembly slightly away from the tunnel and pull control cable out.

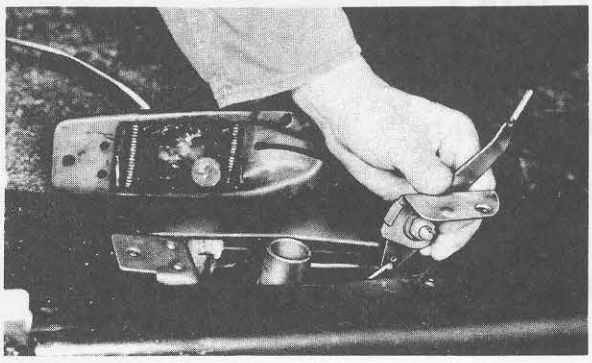

Fig. 87

Installation

It should be noted that the cable in the 356B/T6 heater connects to the smaller upper hole, and the cable in the Export heater connects to the larger hole below.

1. Thread one end of control cable through the respective hole in the control lever and pull through to the bent end.

2. Insert both ends of control cable into conduit tube making certain that cables do not cross.

3. Install shift lever base.

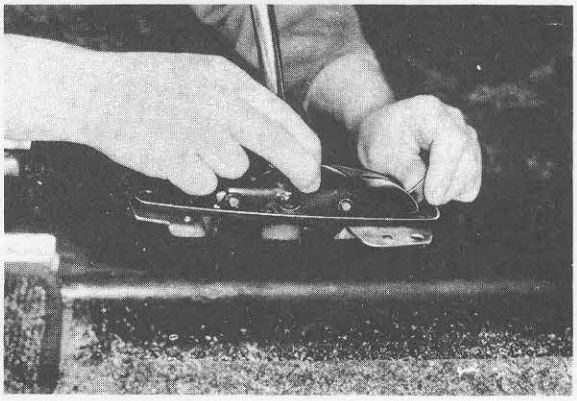

Fig. 88

4. Properly align the base plate of the control lever, insert bolts, and tighten uniformly.

5. Move control lever forward to stop, into OFF position.

6. Attach cable ends to connecting levers at the air gate assemblies. Make sure that the heater flaps work in unison, opening and closing fully.

17 EN

Disassembly

1. Hold head of hex bolt in a vise and remove self-locking nut.

2. Remove component parts one by one.

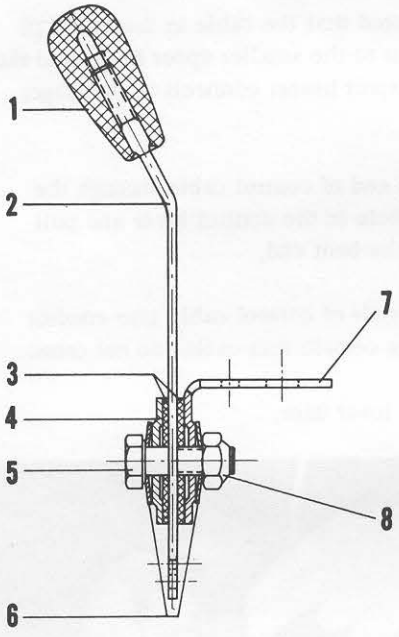

Fig. 89

1 Control lever grip
2 Control lever (left hand drive cars)
3 Friction discs
4 Pressure disc
5 Hex bolt
6 Diaphragm spring
7 Supporting bracket
8 Self-locking nut

Reassemly

1. Hold head of hex bolt in a vise.

2. Install parts in the order shown in illustration.

3. Tighten self-locking nut to 50 cmkp (3.6 lbs/ft) then turn back one complete turn (360^{o}).

4. Adjust by testing friction of lever brake which should be 10 ± 1 mkp (22 ± 2.2 lbs/ft), measured with a spring scale attached to the lever through the upper hole at 90^{o} and pulled to lever pivot center.

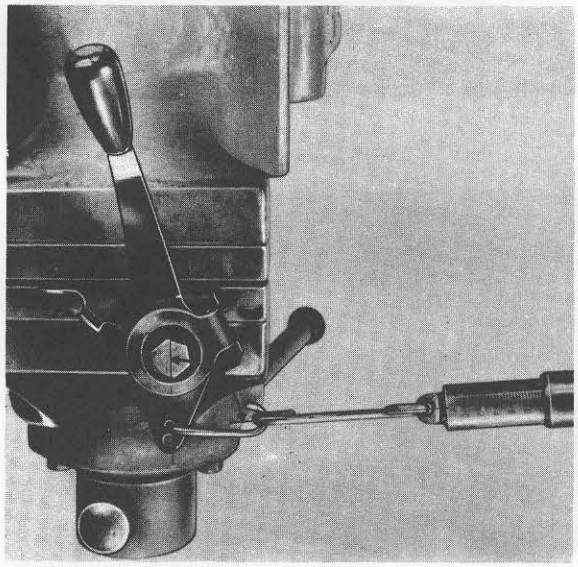

Fig. 90

Tighten nut if setting is too weak, loosen nut if setting is too tight.

ENGINE LUBRICATION SYSTEM

Oil Circuit Diagram

Oil Circuit in Cold Engine

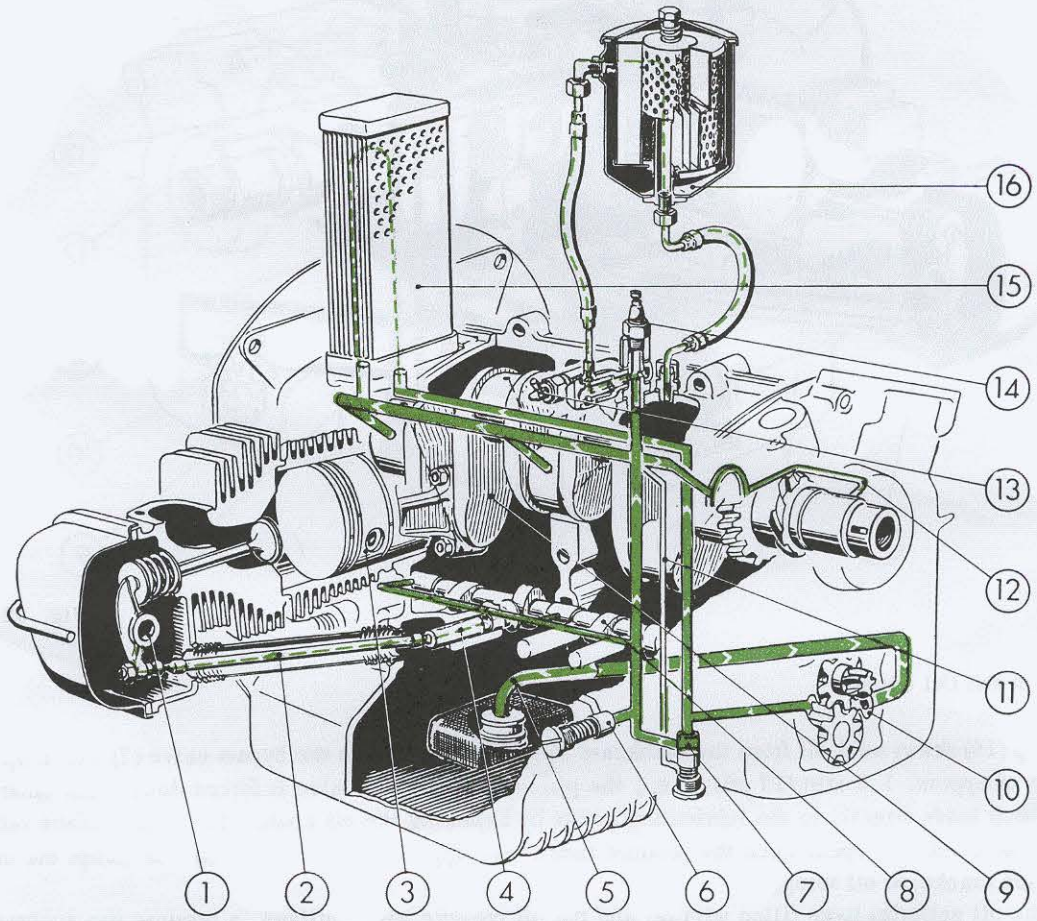

Fig. 91

1 Rocker arm
2 Pushrod
3 Piston
4 Valve lifter
5 Oil suction tube
6 Pressure relief valve
7 Bypass valve
8 Camshaft
9 Crankshaft
10 Oil pump
11 Counter-pressure line
12 Oil line to Bearing 4
13 Oil temperature sensor
14 Oil pressure switch
15 Oil cooler (repositioned back in sketch for better view)
16 Bypass oil filter

Oil Circuit at Operating Temperature

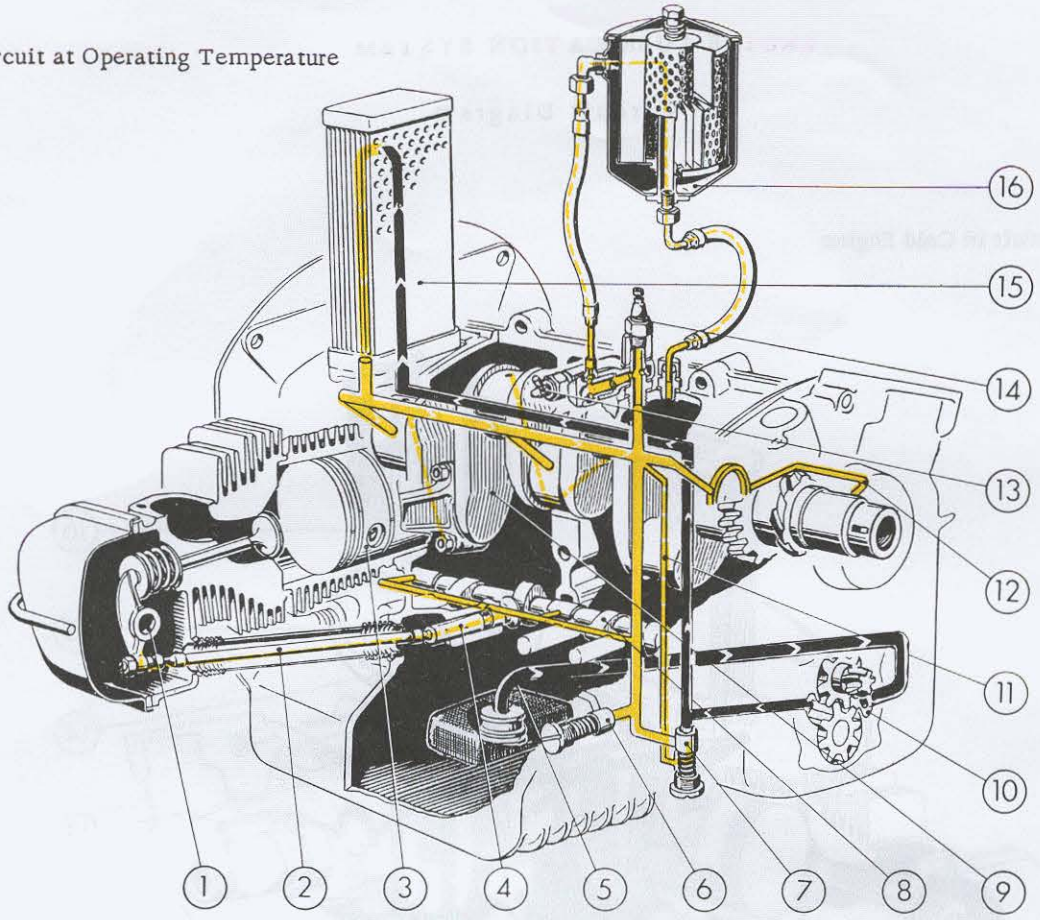

Fig. 92

Description of the Oil Circuit

The oil pump (10) draws cold oil from the crankcase sump and forces it to the bypass valve (7) which opens at a pressure of approx. 1.3 atm (19 psi), i.e., the piston of the bypass valve is forced down, thus clearing a passage which leads directly to the lubricating points by bypassing the oil cooler (15). The pressure relief valve (6) in the crankcase opens when the pressure rises above approx. 2.9 atm (42 psi) and dumps the oil excess into the crankcase oil sump.

As soon as the oil galleries have filled with oil and the oil pressure has stabilized, a pressure rise equivalent to the pressure in the rest of the system also occurs in the counter-pressure line (11) and under the bypass valve (7), thus equalling the pressure exerted upon the bypass valve from the side of the pump (10). The pressure relief valve (6) limits the oil pressure in the system to 3 atm (44 psi).

The mechanical spring in the bypass valve exerts a pressure equivalent to approx. 1.3 atm (19 psi). Since equal oil pressure now prevails at both ends of the bypass valve, the mechanical spring is able to expand and, so, move the bypass valve up.

As the bypass valve (7) moves up, it blocks the direct passage and causes the oil to flow through the oil cooler before reaching the lubricating points

REMOVING AND INSTALLING OIL STRAINER

Removal

1. Remove hex nuts from oil strainer cover.
2. Remove oil strainer cover.
3. Remove oil strainer and gaskets.

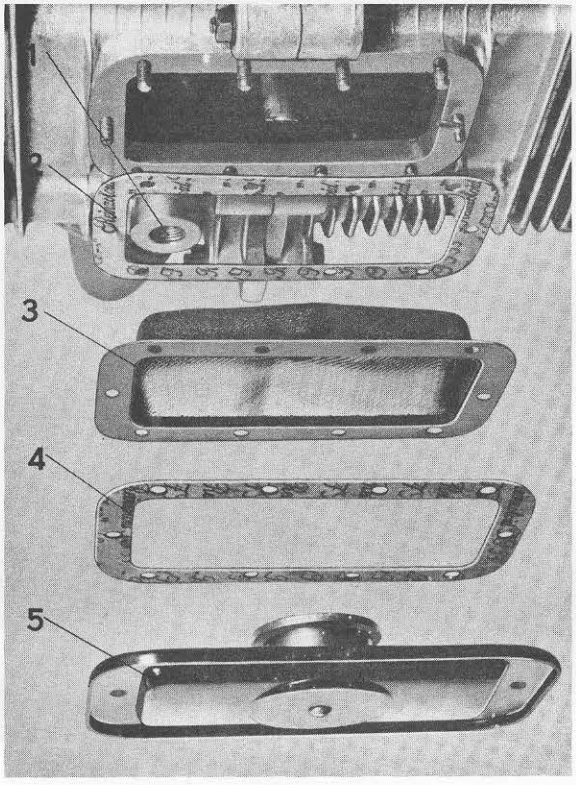

Fig. 93

1 Oil drain plug
2 Gasket
3 Oil strainer
4 Gasket
5 Oil strainer cover with magnetic filtering element

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Check oil suction tube for proper positioning.
2. Clean oil strainer and remove gasket remnants.
3. Use new gaskets on both sides of the oil strainer.
4. Insert oil strainer making sure that the orifice in the strainer has a close fit around the oil suction tube.
5. Remove gasket remnants from the oil strainer cover. Straighten the cover if it is warped or bent, otherwise a good oil seal cannot be expected.
6. Clean magnetific filtering element.
7. Do not overtighten the hex retaining nuts, especially when using thicker gaskets, since this may warp the cover.

Note

A magnetic oil filtering element has been included in the oil strainer cover to provide for a better filtering of the oil. The element is situated in the center of the oil strainer cover with the oil suction tube located within it. The oil first passes through the oil screen and then flows through the magnetic filtering element.

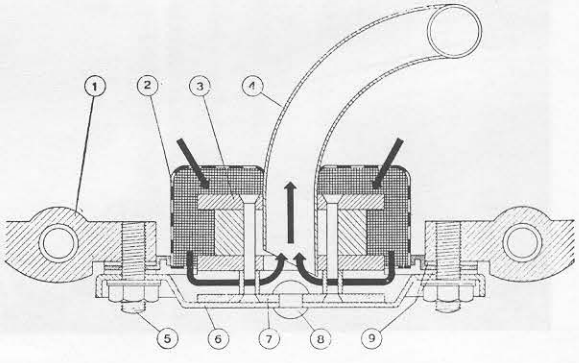

Fig. 94

1 Crankcase
2 Oil strainer
3 Magnetic filter
4 Oil suction tube
5 Stud
6 Oil strainer cover
7 Disc
8 Rivet
9 Gasket

19 EN

Special Tools: P 74 Socket attachment

General

The pressure relief valve is located in the crankcase and governs engine oil pressure.

When encountering malfunctions in the engine lubrication system, and always in cases of leaks in the oil cooler, check the pressure relief valve for proper functioning.

The bypass circuit valve is located in the timing gear cover and ensures immediate lubrication of engine bearings and other points when the engine is started.

Functional Description of the Bypass Valve:

The purpose of the bypass valve in the timing gear cover is to provide instant lubrication for points in the engine, by bypassing the oil cooler, when the engine is started.

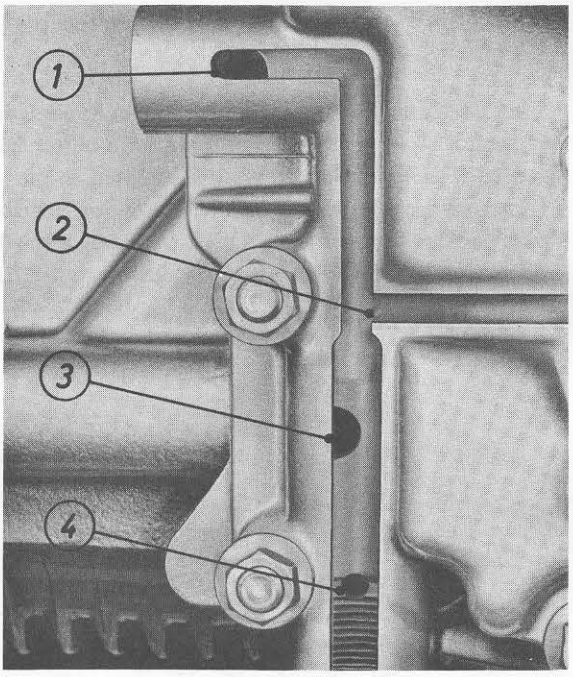

Fig. 95

1 Oil gallery to oil cooler
2 Oil gallery from oil pump
3 Oil gallery to lubricating points by bypassing the oil cooler
4 Opening for counter-pressure oil line

When the engine is not running, the valve (plunger) closes the passage to the lubricating points. As soon as the engine begins to run, the oil pump sucks oil from the oil sump in the crankcase and forces it to the bypass valve. The bypass valve is then forced down, under the pressure of the oil, and opens the oil gallery to the lubricating points by bypassing the oil cooler.

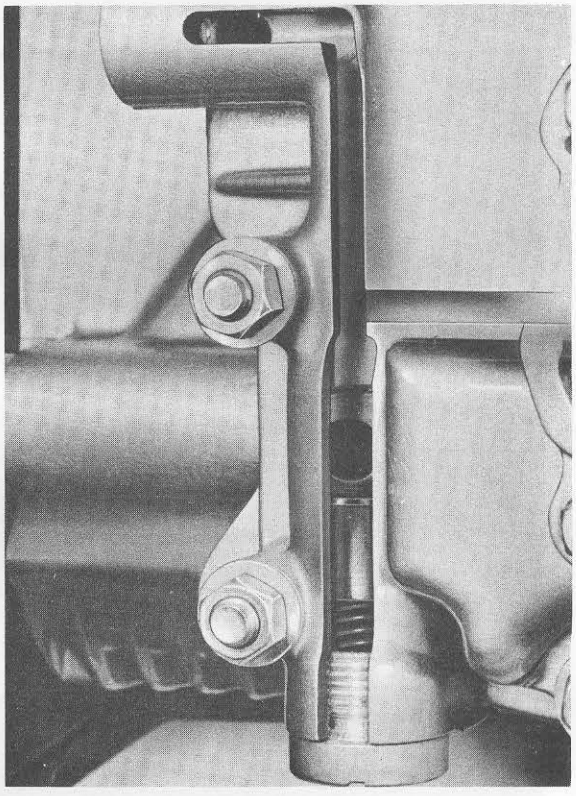

Fig. 96

As soon as the oil pressure has built up, some of the oil flows through the counter-pressure line to the cavity under the valve plunger equally counteracting the pressure exerted by the oil from above, permitting the mechanical spring to expand and, thus, push the valve plunger up and close the oil gallery of the direct lubricating circuit. This forces the oil to flow through the oil cooler before it can reach the lubrication points within the engine.

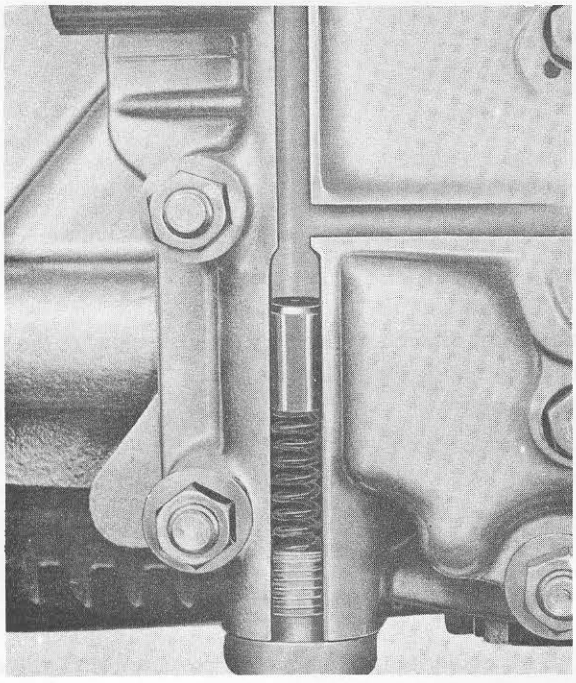

Fig. 97

Removal

1. Remove cap screw with tool P 74.

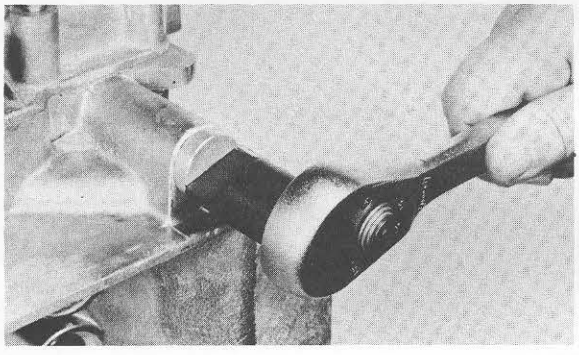

Fig. 98

2. Withdraw spring and valve plunger; if plunger is stuck, it can be removed with an M 10 thread tap.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Inspect valve plunger and plunger bore in housing for traces of seizure (scatches, etc.). Carefully smoothen the surfaces, replace if necessary.

2. Check mechanical spring

Pressure Relief Valve and Bypass Valve Spring	
Free length	66 mm (2,6")
Wire diameter	1,4 mm (.055")
Tension at 49 mm(1,93")	4,7 kp (10,3 lbs) ± 7%

3. Install new gasket washer.

4. Insert the piston so that its hollow end faces towards the cap screw.

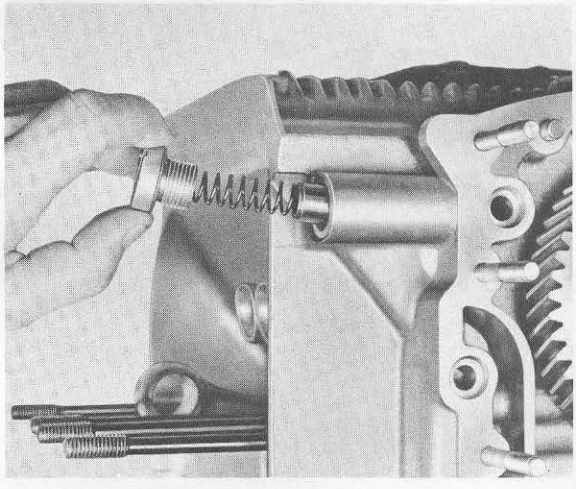

Fig. 99

5. To prevent scratching the bore in the housing, make sure that the spring end does not ride in the plunger bore in housing.

20 EN

REMOVING AND INSTALLING OIL COOLER

Removal

1. Remove air blower housing (4 En).

2. Unscrew oil cooler retaining nuts with a box wrench.

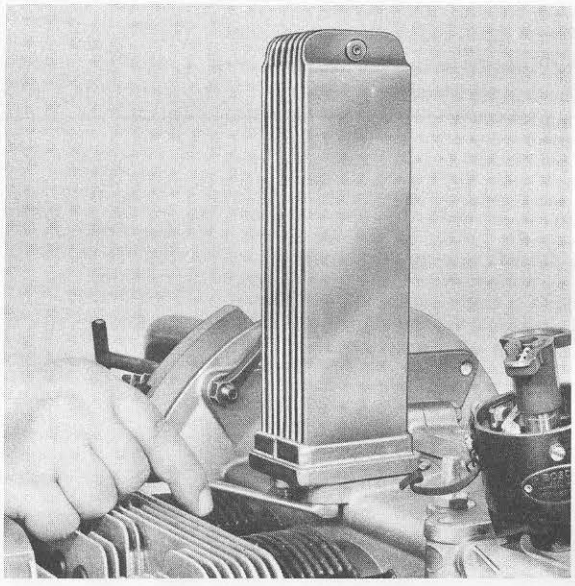

Fig. 100

3. Remove oil cooler and gaskets.

Fig. 101

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Check oil cooler for leaks and proper tightness of retaining nuts (test pressure is 10 atm-147 psi).

2. If oil cooler is leaking, check pressure relief valve.

3. Use new gaskets.

REMOVING AND INSTALLING OIL PUMP

Removal

1. Remove engine rear shield and intermediate shield between the air ducts.
2. Remove crankshaft pulley.
3. Remove crankshaft pulleys shield.
4. Remove oil pump cover.
5. Remove oil pump gears.

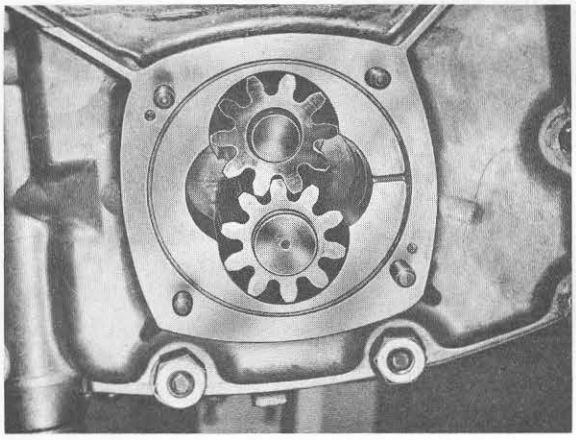

Fig. 102

Installation

(follow reversed order)

1. Inspect oil pump housing, especially gear seating areas, for wear. Wear within the housing will result in decreased oil pressure.
2. Inspect pump gears for wear. Gear flank clearance should be 0.03 - 0.08 mm (.001 - .003").
   Axial play of gears in the housing, with gasket but without preload, is o.o35 - 0.10 mm (.0014" - 0039").
   Wear limit 0.20 mm (.0079").
3. Check shaft of driven gear for firm seating in the housing.
4. Check sealing surface for oil pump cover (at crankcase) for cleanliness.
5. Place a straightedge across the face of the pump gears. Using a feeler gauge, measure clearance between the cover mounting flange in housing and face of gears, which should be 0.06-0.128 0.128 mm (.0024" - .0050").
6. Use a new, genuine gasket (0.20mm = .008") without applying gasket paste.
   Gesket thickness in excess of specification will result in decreased oil pressure.

22 EN

CHANGING BYPASS OIL FILTER CARTRIDGE

Bypass oil filter cartridges used in Porsche cars cannot be cleaned and have to be replaced when contaminated (normal replacement after every 10,000 km or 6,000 miles).

1. Unscrew filter cover retaining bolt.
2. Withdraw filter cover.
3. Withdraw filter cartridge with a slight turn.

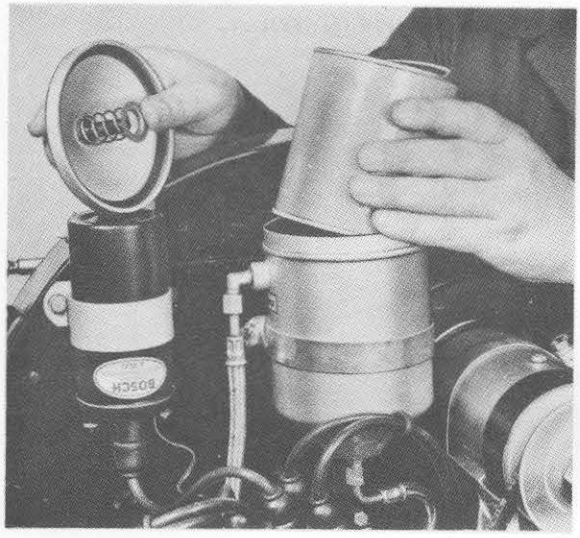

Fig. 103

4. Remove oil from filter housing (use a suction pump).
5. Clean filter housing interior (do not use shredded rags).
6. Insert new cartridge by turning it slightly.
7. Insert new gasket into housing cover, properly position the cover on the housing, depress, and tighten securely.
8. Check engine oil level.
9. Allow engine to idle for a few moments.
10. Check for oil leaks in filter housing body and oil line connections.
11. Recheck engine oil level.
12. Repenish engine oil to the top mark on the oil dipstick (use premium, grade HD oil).

23 EN

REMOVING AND INSTALLING ROCKER ARM CARRIER

Removal

1. Remove rocker box cover.
2. Remove the 7 hex nuts (SW 13) from the rocker arm shafts.

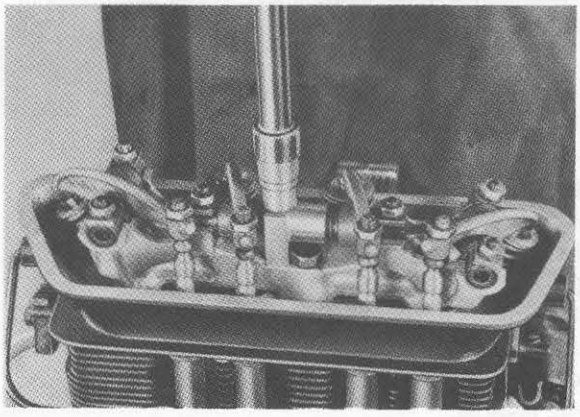

Fig. 104

22 EN

CHANGING BYPASS OIL FILTER CARTRIDGE

Bypass oil filter cartridges used in Porsche cars cannot be cleaned and have to be replaced when contaminated (normal replacement after every 10,000 km or 6,000 miles).

1. Unscrew filter cover retaining bolt.
2. Withdraw filter cover.
3. Withdraw filter cartridge with a slight turn.

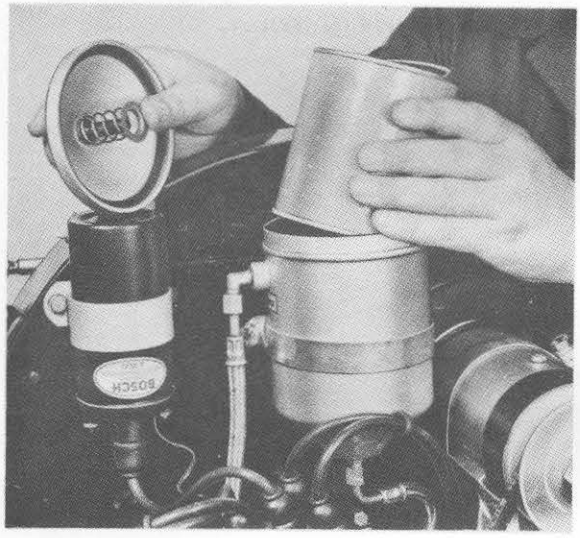

Fig. 103

4. Remove oil from filter housing (use a suction pump).
5. Clean filter housing interior (do not use shredded rags).
6. Insert new cartridge by turning it slightly.
7. Insert new gasket into housing cover, properly position the cover on the housing, depress, and tighten securely.
8. Check engine oil level.
9. Allow engine to idle for a few moments.
10. Check for oil leaks in filter housing body and oil line connections.
11. Recheck engine oil level.
12. Repenish engine oil to the top mark on the oil dipstick (use premium, grade HD oil).

23 EN

REMOVING AND INSTALLING ROCKER ARM CARRIER

Removal

1. Remove rocker box cover.
2. Remove the 7 hex nuts (SW 13) from the rocker arm shafts.

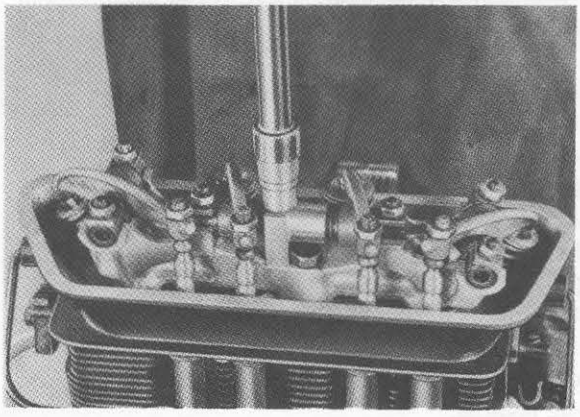

Fig. 104

3. Withdraw rocker arm shafts with rocker arms, springs, washers and spacers.

4. Remove the three rocker arm carrier retaining bolts (SW 15 mm) and withdraw carrier.

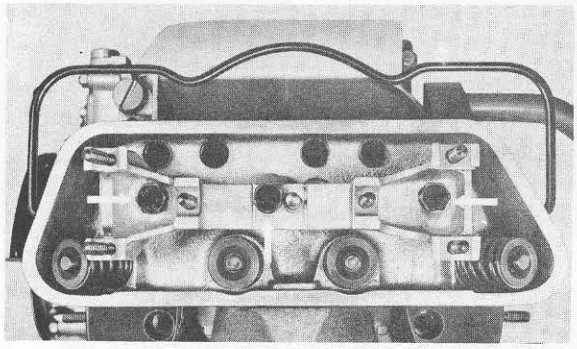

Fig. 105

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Inspect retaining bolts for defects. Coat threads and base of bolt heads with graphite oil. Use new spring washers.

2. Tighten retaining bolts to 5 mkp (36 lbs/ft).

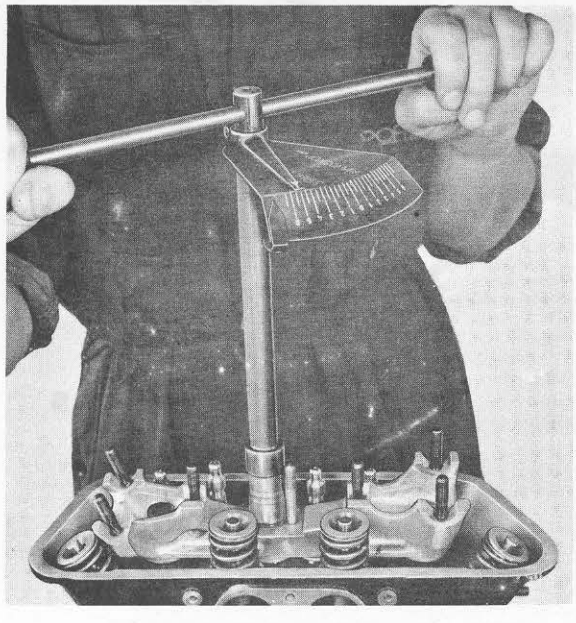

Fig. 106

3. Tighten the 7 rocker arm shaft retaining nuts (SW 13) to 2.5 mkp (18 lbs/ft).

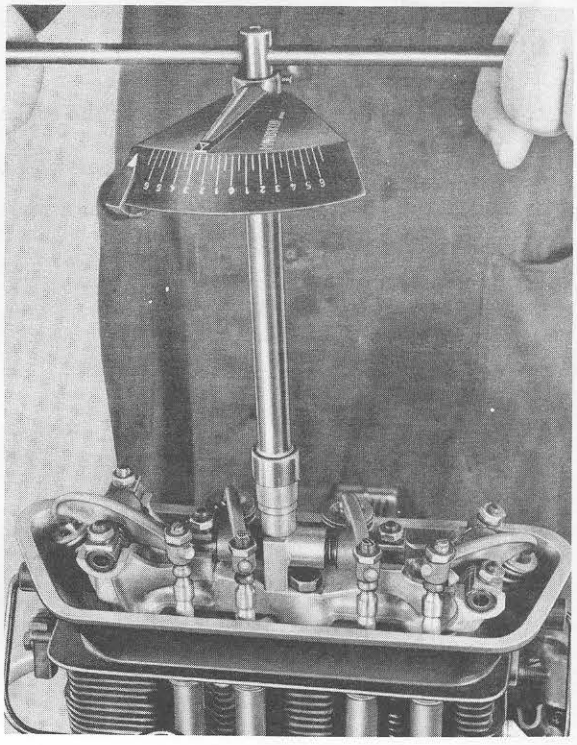

Fig. 107

4. Adjust valve clearance.

5. Reoil shafts and rocker arms, install rocker box cover.

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DISASSEMBLING AND REASSEMBLING ROCKER ARM CARRIER

24 EN

Disassembly

1. Remove the 7 hex nuts (SW 13) from the rocker arm shafts.
2. Withdraw rocker arm shafts with rocker arms, springs, washers, and spacers.
3. Remove valve adjusting screws.

Reassembly

Reassemble the rocker arm carrier in reversed order of the above by noting the following points:

1. Inspect rocker arm shafts and rocker arms for defects. Replace parts showing traces of wear or damage.
2. Inspect valve adjusting screws for defects. Replace screws which have strained threads or damaged ball joint sockets.
3. Check adjusting screws and rocker arms for unobstructed oil flow.
4. Arrange the spacers and / or thrust washers in such way that the rocker arms strike the valve shafts approximately in the center of the shaft butt, and that the pushrods do not come in contact with the pushrod tubes.
5. Make certain that the washers, springs, and spacers are properly arranged.

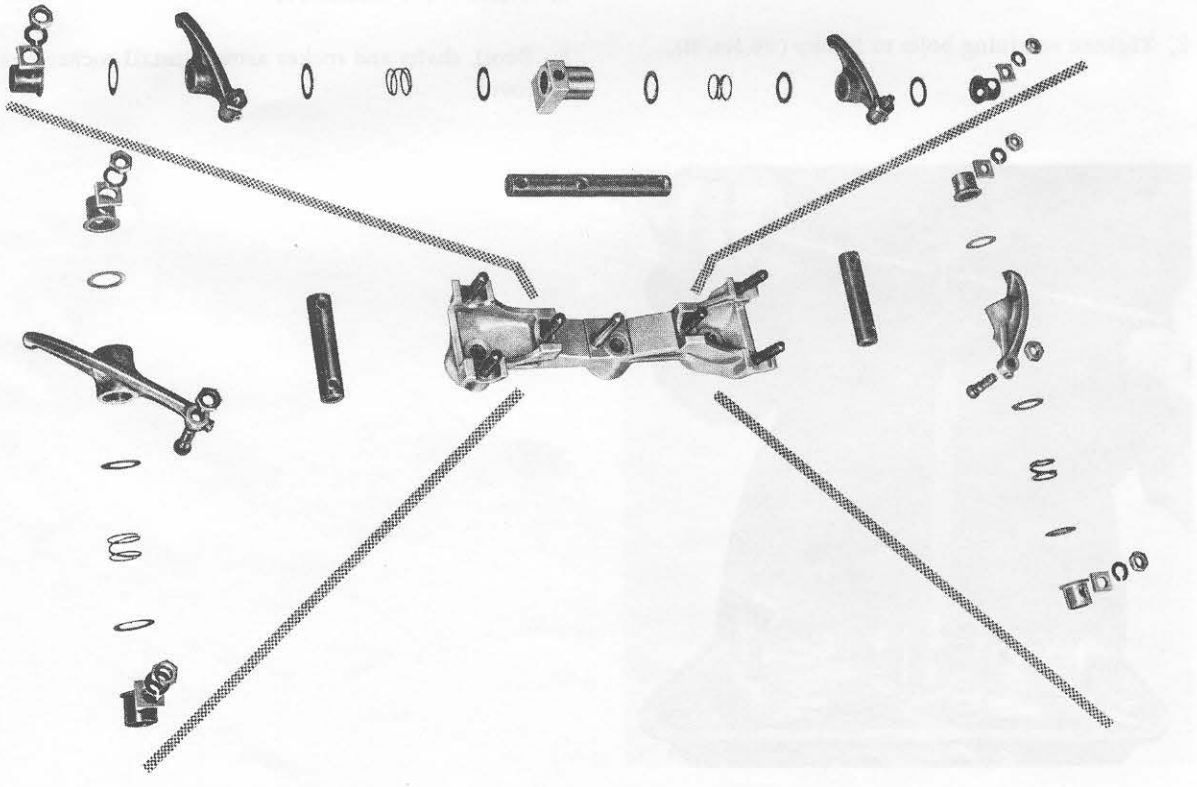

Fig. 108

REMOVING AND INSTALLING CYLINDER HEAD

(Engine removed)

Special Tools: VW 157 Allen wrench adapter
VW 118 Torque wrench

Removal

1. Remove lower air duct, side shield, cylinder shrouds, intake duct and carburetor.

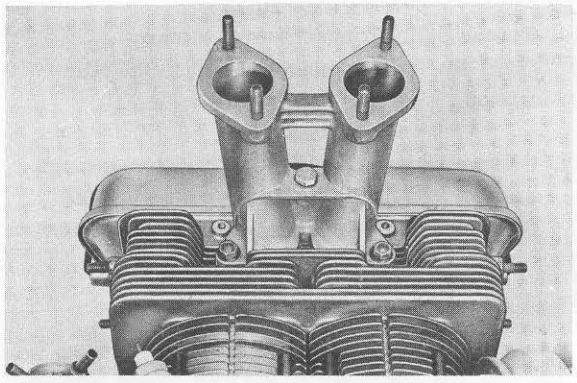

Fig. 109

2. Remove rocker box cover and unbolt rocker arm carrier.

3. Remove cylinder head retaining nuts with Allen wrench adapter (the 8 Allen nuts are shown above and below the valve stems in the illustration below); remove washers located between the nuts and cylinder head.

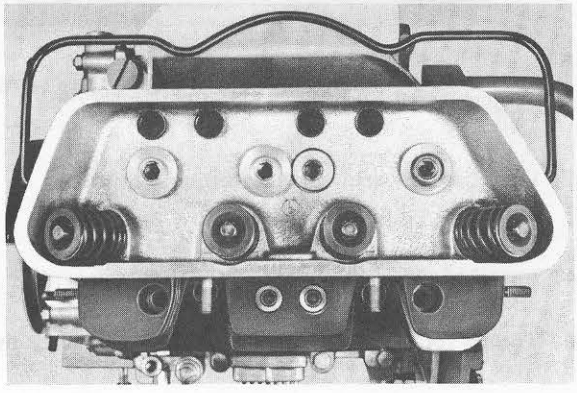

Fig. 110

4. Withdraw cylinder head.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. No gasket is used between the cylinder head and cylinders.

2. Insert pushrod cover tubes. To ensure proper sealing at the tube ends between crankcase and cylinder head, the tubes must have the required length at assembly, that is, used tubes must be stretched at the bellows. The stretching should be accomplished with care so as to prevent possible cracking of the metal.

3. When installing the cylinder head make sure that the new O-rings at the cover tube ends are properly seated; position the tube weld seams up.

a) Sealing points in crankcase.

b) Sealing points in cylinder head.

a) b)

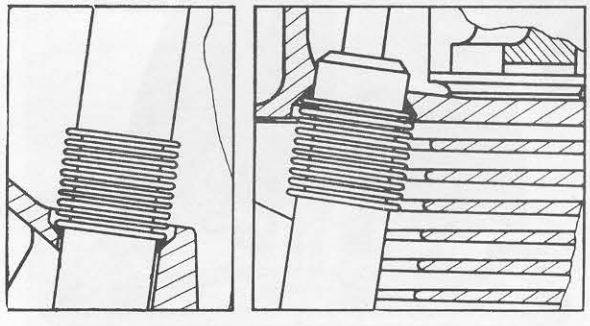

Fig. 111

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4. The cover tube O-rings are trapezoidal in cross-section.

5. Prior to installation, lubricate O-rings used under the cylinder head nuts located within the rocker box.

6. O-rings should not be coated with gasket compound.

7. Ensure proper positioning of cylinder deflector baffles (compare profile of recess for cap nut and one for hex bolt).

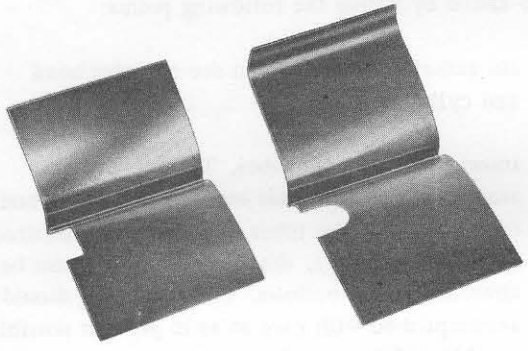


Fig. 112

8. Place 1 washer under each cylinder head nut situated outside the rocker box.

Fig. 113

9. Coat cylinder head nuts with graphite paste tighten lightly, then torque to 1 mkp (7.2 lbs/ft) in sequence shown in the illustration.

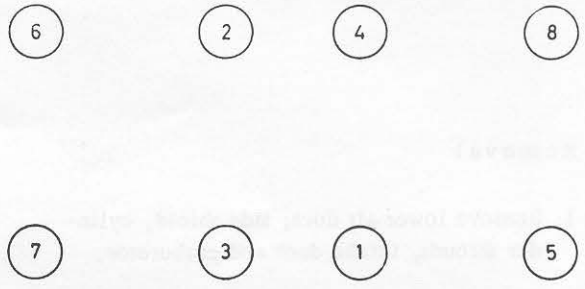


Fig. 114

10. Torque cylinder head nuts to 3 mkp (21.7 lbs/ft) in sequence shown in the illustration.

11. Pump oil into pushrods until it comes through at other end, and insert into pushrod cover tubes so that one end seats in the valve lifter.

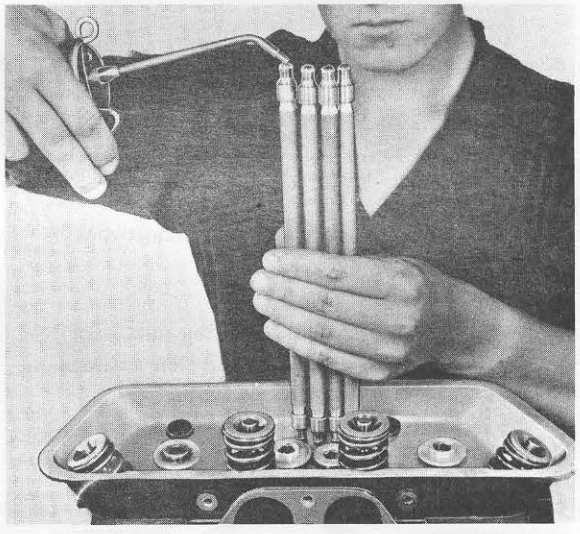


Fig. 115

12. Install rocker arm carrier, torque retaining bolts to 5 mkp (36.2 lbs/ft).

13. Install rocker arms.

14. Torque rocker arm shaft retaining nuts (SW 13 mm) to 2.5 mkp (18.1 lbs/ft).

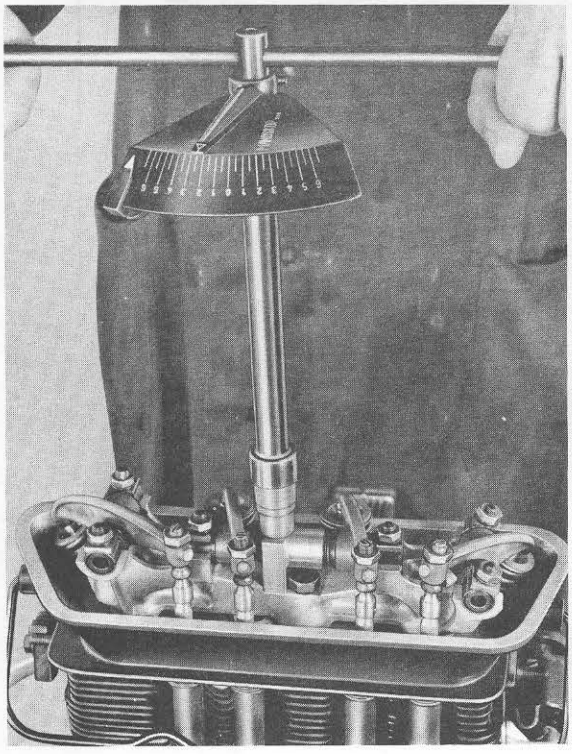


Fig. 116

15. Adjust valve clearance.

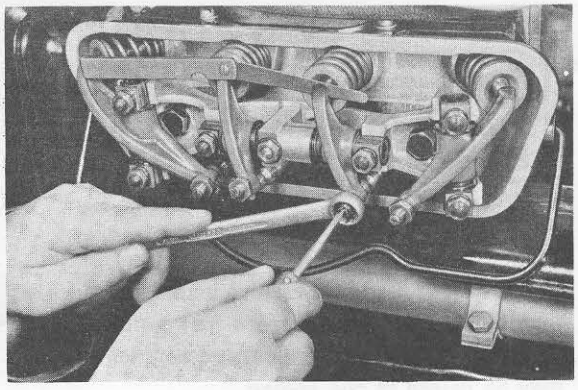


Fig. 117

16. Mount rocker box cover.

Note

When installing the cylinder head make absolutely sure that the cylinders are properly seated in the cylinder head. If a misaligned cylinder head is tightened, it will most likely warp to the extent of being no longer useable.

REMOVING AND INSTALLING VALVE SPRINGS

26 EN

Use special tool P7 for removing and installing valve springs.

Checking valve springs:

Free length Wire diameter	47 mm (1,85") 4.5 mm (.177")
Spring tension with spring compressed to 41 mm (1.61")	36kp(79,3lbs)± 5kp(3,32lbs)
Spring tension with spring compressed to 30.15 mm (1.19")	97kp(213,2lbs)± 2,5kp(5,51lbs)

Spring tension variations up to 5% are permissible in used springs.

All valve springs used in one engine must be of equal free length since the length affects springing characteristics.

Checking Installed Length

Note:

Intake and exhaust valve springs are of the same length. The installed spring length is changed or adjusted through the addition or removal of spacers located under the springs.

Important:

The valve springs must always rest on the steel washer and never on the spacers since the spring could damage the spacers.

1. Install special tool P 10 with the respective spring retainer and both valve keepers.

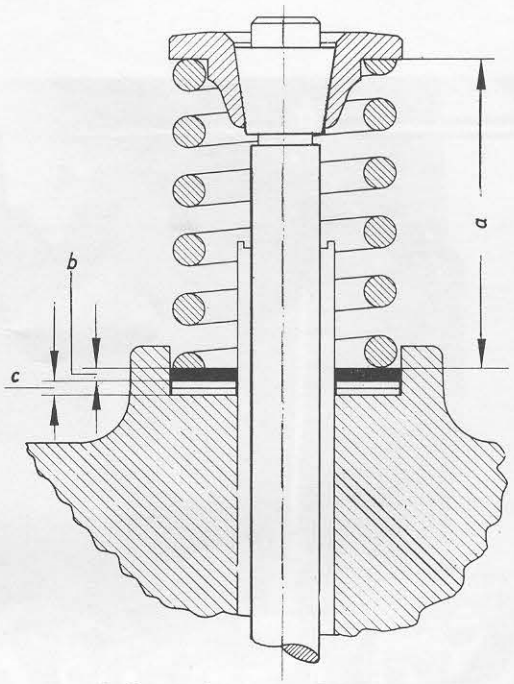
2. Determine the indicated value and correct it, if necessary, by adding or removing spacers.

3. Install valve springs so that the closely wound coils rest on the 1,5 mm thick washer (see note, above).

Installed length of valve springs is:
Intake = 41,0 mm (1.61")
Exhaust = 40,5 mm (1,59")

Note:

Valve springs made by various manufacturers are supplied under the same spare part number. However, all springs (progressive or linear coils) may be paired in one engine.



a = Installed length
b = Steel washer
c = Spacers

Fig. 118

27 EN

CHECKING VALVE GUIDES FOR WEAR

Special Tools: P 21b Valve guide plug gauge

Replacing of valve guides see 35 EN.

When installing the sealing caps, it should be noted that first the valve is pushed into the valve guide and then the sealing cap pulled over the valve guide until the base of the cap comes to rest against the valve guide.

Clearance between valve guide bore and valve stem is:

Intake = 0.035 - 0.060 mm (.0014" to .0024")
Exhaust = 0.055 - 0.080 mm (.0022" to .0031")

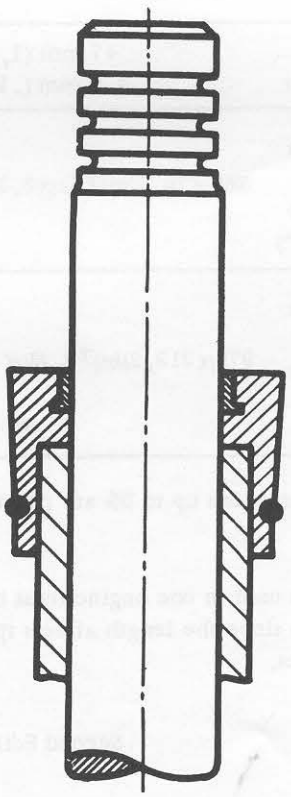


Fig. 118 a

Valve guide bores should be measured with a valve guide plug gauge of 10 mm diameter (.394").

CHECKING AND RECONDITIONING VALVE SEATS

Special Tools: P 11 Valve seat cutter handle with 10 mm dia. cutter guide
P 12 Eight-piece valve seat cutter set.

Checking

1. Check valve guides for firm seating in the cylinder head.
2. Check valve seating using machinists blue.
3. Inspect valve seat surface. If the valve does not seat on the whole seat surface, lightly rework the seat with a cutter.
4. Valve seating may be checked with the valves installed in the cylinder head by pouring some gasoline into the respective port.

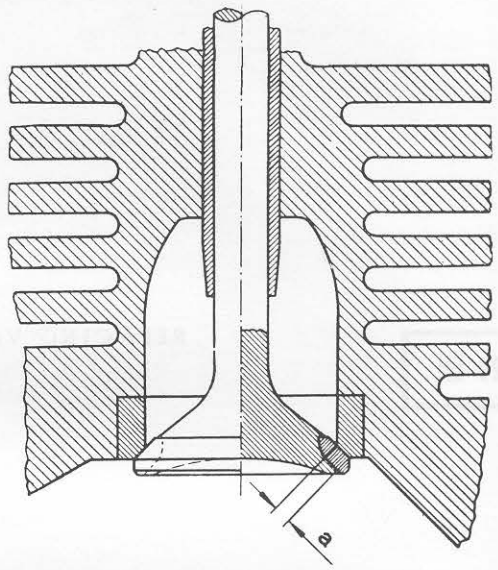


Fig. 119

Reworking Valve Seats

Valve seats showing traces of wear or pitting may be refaced providing that the permissible width of the 45° seat can be maintained, and the 25° bevel in the outer circumference does not exceed the outer diameter of the valve seat insert. If this is not possible, the cylinder head must be replaced. It is not possible to replace the valve seat inserts with the equipment at hand in normal workshops.

Valve seat width Intake 1.25 ± 0.15 mm (.050 ± .006 in.)

Exhaust 1.55 ± 0.15 mm (.061 ± .006 in.).

Work Procedure

1. 45° seat cut:
   The 45° cut must be performed with particular care to produce a smooth surface free of chatter marks. It is very important to apply pressure from directly above. Removal of base metal must be held at a minimum so as not to render the valve seat insert prematurely unusable. The cutting procedure should be discontinued as soon as the cutter has cleaned the entire seat area.

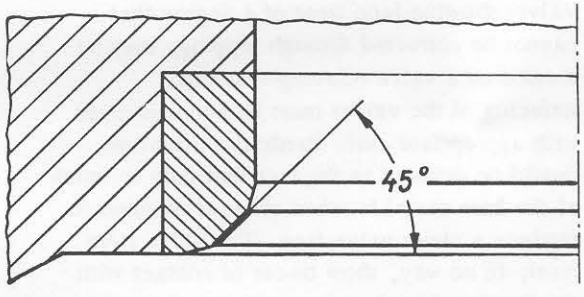


Fig. 120

2. 75° bevel cut:
   Lightly bevel the lower edge of the valve seat using the 75° cutter.

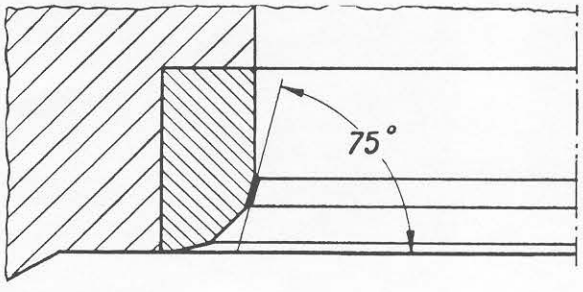


Fig. 121

3. 25^{o} bevel cut:
Using the 25^{o} cutter, bevel the upper edge of the seat until the specified seat width is obtained.

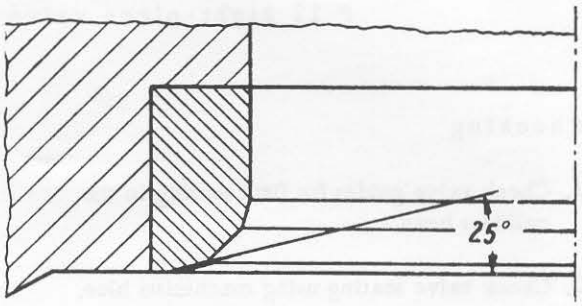


Fig. 122

29 EN

REFACING VALVES

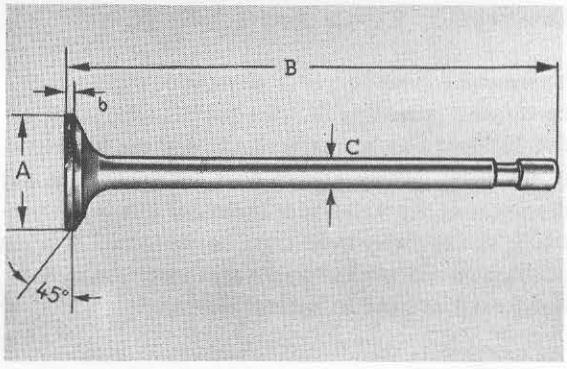


Fig. 123

Valves showing face wear of a degree that cannot be corrected through lapping, may be dressed on a valve refacing machine.
Refacing of the valves must be accompliched with appropriate care. Particular attention should be devoted to the fact that only so much of the base metal is taken off as is required to produce a clean valve face. The valve stem must, in no way, show traces of contact with the dressing wheel; valves with stems touched by the dressing wheel must not be installed.

Valve dimensions

	Intake	Exhaust
A	37.9 - 38.1 mm (1.492 - 1.500 in.)	33.9 - 34.1 mm (1.334 - 1.342 in.)
B	117,9 mm (4.630 in.)	128,5 mm (5.060 in.)
C	9.98 - 9.99 mm (.3929 - .3933 in.)	9.96 - 9.97 mm (.3921 - .3925 in.)
b	1.7 - 2.3 mm (.067 - .091 in.)	2.0 - 2.3 mm (.079 - .091 in.)

SEATING VALVES

30 EN

Special Tools: P 9 Suction cup, for turning valve

The following points should be observed when seating (lapping) valves:

1. Seat valve with the P 9 suction cup.
2. Use fine-grain grinding compound to prevent roughness or "grooving".
3. Upon completion of lapping, fully remove all grinding compound remnants.

N o t e :

The grinding compound is water-soluble and should not be exposed to oil or grease. A special effort should be made to thoroughly clean and flush with water all involved component parts of the engine, including the valve guide bores, and then to dry and oil these prior to reassembly.

INSPECTING VALVES

31 EN

1. Clean valves from carbon deposits.
2. Inspect valve face for wear or pitting. If necessary, reface on dressing machine. When refacing the valves, make certain that --especially in the case of the thermally higher stressed exhaust valves-- the dimension b (see Fig. 123) is not exceeded.
3. Valve stems showing excessive wear (ridge formation) must be replaced.
4. Valves with warped stems, traces of seizure, or damaged valve keeper seats must be replaced. Valve stems cannot be reground or straightened for any reason.

TESTING INSTALLED VALVES FOR LEAKAGE

32 EN

Installed valves may be tested for leakage by pouring some gasoline into the respective port.

Properly seated valves will not permit gasoline to pass through.

ADJUSTING VALVE CLEARANCE

Valve clearance (cold) is:	
Intake	0.10 mm (.004")
Exhaust	0.15 mm (.006")

General:

Excessive clearance causes valve noise and decreased power.

Insufficient clearance results in decreased power, valve overheating or burning, and carburetor flashback which may cause a carburetor fire.

We therefore recommend that the valves be adjusted in a reputable shop.

The valves should be adjusted when the engine is cold.

The best sequence to follow is Cyl. 1, 2, 3, and 4 while rotating the crankshaft counterclockwise.

Prior to adjusting, position the piston on top dead center (TDC) on compression stroke since both valves are closed at that point. If adjustment begins with Cyl. 1, turn crankshaft counterclockwise until both valves are closed and the "OT" (TDC") mark on the crankshaft pulley is lined up with the mark on the crankcase.

Adjusting:

1. Remove both rocker box covers (engine cold).

2. Remove distributor cap.

3. Turn crankshaft counterclockwise--using a box wrench on the crankshaft pulley, if necessary-- until the "OT" mark on the pulley has lined up with the mark on the crankcase. At this point, the distributor rotor will be pointing towards a notch machined into the distributor housing.

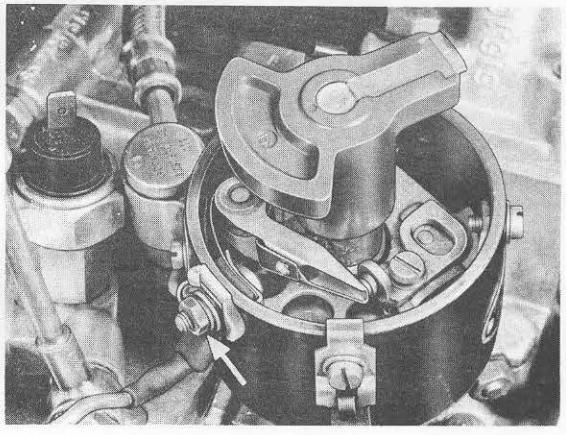


Fig. 124

4. Check valve clearance at Cyl. 1.

5. Loosen lock nut on adjusting screw.

6. Adjusting clearance by turning the screw while simultaneously checking the clearance with a feeler gauge.

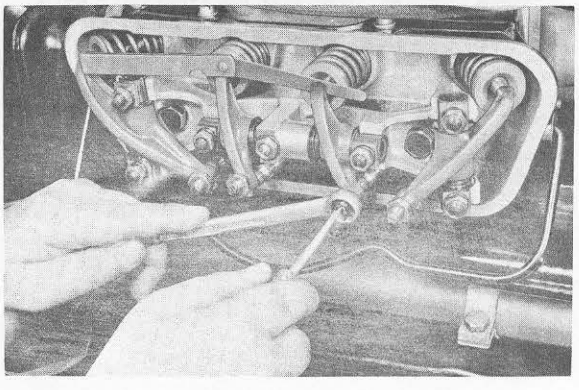


Fig. 125

7. Hold adjusting screw in position when tightening the lock nut.

8. Recheck clearance.

CHECKING VALVE TIMING AND CLEARANCE

34 EN

Normally the valve clearance should be checked or adjusted when the engine is cold at an outside air temperature of approx. 20°C (68°F). The valve clearance is as follows:

Intake valves 0.10 mm (.004")
Exhaust valves 0.15 mm (.006")

Valve clearance should be checked at regular intervals and appropriate care. The following malfunctions can be caused by wrong valve adjustment:

Insufficient clearance:

Burnt or pitted valves and seats.
Warped valves.
Unevenly running engine.
Valve timing off

Excessive clearance:

Valve noise
Increased wear in valve components
Unevenly running engine
Valve timing off

Proper valve adjustment results in a well running engine only when the valves are seating well, the valve guides are not worn, and the valve stem ends are not pounded in or otherwise worn.

Valve timing points:

Intake opens before	TDC	17°
Intake closes after	BDC	53°
Exhaust opens before	BDC	50°
Exhaust closes after	TDC	14°

Note:

The above timing points are established with 1.00 mm valve clearance in cold engine. When valve timing has been checked, reset valve clearance to normal specifications.

Lapped or refaced valves and seats seat faster than normal. For this reason, set valves with an additional 0.15 mm (.006") clearance over the specified value for a test run of at least one-half hour.

When the test run has been completed, or before testing engine performance, readjust valve clearance to normal values.

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Cylinder heads with worn valve guides, valve seats, or spark plug inserts may be sent to the factory for reconditioning.

When the cylinder heads are being reconditioned, the combustion chamber displacement is measured and so indicated in cubic centimeters.

Make sure that cylinder heads used in one engine have the same combustion chamber displacement (permissible deviation is $\pm$ 1 cc).

Reworked cylinder heads must be checked for combustion chamber displacement and the appropriate value stamped into the head.

Should it be not possible to send the cylinder heads back to the factory for overhaul, the job may be performed locally providing that the required equipment is at hand.

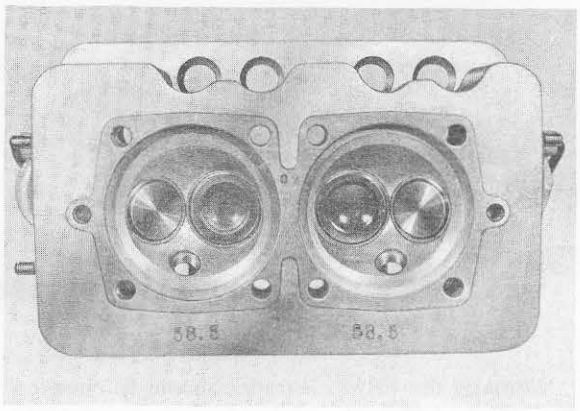
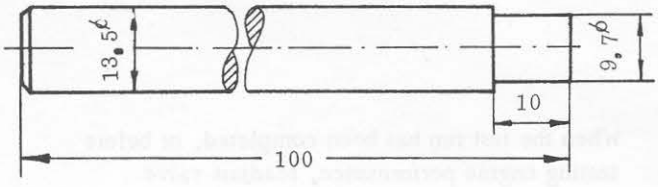


Fig. 126

Removing and installing Valve Guides

Removal

1. Drill valve guides with a 12 mm (.427 in.) drill to loosen in their seats.
2. If a heating oven is available, the guides need not be drilled but, instead, the head heated to approx. 180 °C (356 °F).
3. Using a punch of proper size (see illustration), drive the valve guides out towards the combustion chamber.



Installation

The valve guide receiving bores in the cylinder head will have widened somewhat during the removal. Consequently, oversized valve guides will have to be used and properly fitted into the head.

1. Precisely measure the valve guide receiving bores in the head.
2. Machine the oversize valve guides on a lathe to bring to outside diameter matching that of the bore in the head.
   The required preload for the intake and exhaust-valve guides is 0,041-0,06 mm (.0016-.0024 in.).
3. Press the valve guides into the zylinder head from the rocker arm side. Use tallow for lubrication.
4. Ream the guides with a broach reamer or a precision drill to a diameter of 10 mm E7.
   If necessary, the valve guides may be reamed with a conventional reamer.

Removing and installing Valve Seat Inserts :

Removal

1. Using a portable electric grinder, grind through a valve seat insert so that it loosens in its seat.
2. Drive the old seat insert out.
3. Precisely measure the seat receiving bore in the head.
4. Machine the oversize valve seat inserts on a lathe to bring to outside diameter matching that of the bore in the head.

The required preload is as follows :

Intake valve insert : 0,15-0,19 mm (.006" to .0075")

Exhaust valve insert: 0,10-0,15 mm(.004" to .006")

5. Heat zylinder head to approx. 200° C (392° F).
6. Using an appropiate driver, drive the valve seat insert into place.
7. Allow the zylinder head to slowly cool to room temperature.

Table of Dimensions for Valve Guide Installation (1mm = .03937 ")

Valve Guide Size	Valve Guide Outside Dia.	Diameter of Receiving Bore in Cylinder Head
Standard	14,048 - 14,059 mm	14,000 - 14, 008 mm
1st oversize	14, 248 - 14,259 mm	14,200 - 14,208 mm
2nd oversize	14,448 - 14,459 mm	14,400 - 14,408 mm

Table of Dimensions for Valve Seat Insert Installation

Insert Size	Insert Outside Diameter	Diameter of Receiving Bore in Cylinder Head
Standard (intake)	41,182 - 41,198 mm	41,000 - 41, 025 mm
1st oversize (intake)	41,502 - 41,518 mm	41,328 - 41,352 mm
Standard (exhaust)	37,120 - 37,140 mm	36,990 - 37,020 mm
1st oversize (exhaust)	37,680 - 37,7oo mm	37,550 - 37,580 mm

REMOVING AND INSTALLING CYLINDERS

36 EN

Special Tools: P 8a Piston ring compressor, 82,5 mm dia

Removal

1. Remove rocker arms and rocker arm carrier. Remove valve pushrods and mark for reassembly.
2. Remove cylinder head and pushrod cover tubes (25 En).
3. Withdraw cylinders, mark 1 through 4 as appropriate.

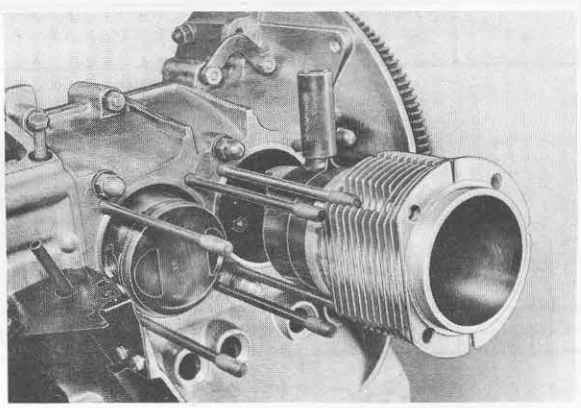


Fig. 127

Installation:

Installation is accomplished in reversed order of the above by noting the following points:

1. Check cylinders for wear, if necessary replace together with pistons of same size group.
2. The cylinder seat in crankcase and cylinder head must be clean at time of installation since dirt particles lead to cylinder distortion. Using a straight edge, check cylinder seats in crankcase for linear alignment of seating surfaces in relation to each other and, upon insertion of cylinders into crankcase, check aligment across the top of cylinders.
3. Use new gasket rings at base of cylinders.
4. Check and oil pistons and piston rings. Ensure that piston rings are installed in appropriate locations (check "TOP" markings).
5. Stagger piston ring gaps 120° apart with oil control ring gap facing up, compress rings with piston ring compressor.
6. Lightly oil cylinder bores and push onto pistons. Visually check the required clearance between the cylinder stud bores and studs. The studs must not touch the cooling fins. Clearance can be determined by turning the cylinders in their bases. If necessary, straighten studs.
7. Install pushrod cover tubes. Do not fail to install deflector baffles and supporting springs.
8. Tighten cylinder head nuts to 3 mkp (21.7 lbs/ft) by following proper sequence.

INSPECTING CYLINDERS

Special Tools: P 13c Cylinder gauge setting ring

(Note: 1 mm = 0.03937 in.)

Standard Size

Group	Cylinder Diameter	Piston Diameter
-1	82.485 - 82.494	82.47
0	82.495 - 82.504	82.48
+1	82.505 - 82.514	82.49

Wear limit is a clearance of 0.2 mm (.008") between piston and cylinder. Exact piston to cylinder clearance can be determined only by measuring each component separately.

Measure cylinders at a point approx. 15 mm (3/4") below the cylinder top using a bore micrometer with setting ring P 13c.

1st Oversize

Group	Cylinder Diameter	Piston Diameter
-1 KD 1	82.985 - 82.994	82.97
0 KD 1	82.995 - 83.004	82.98
+1 KD 1	83.005 - 83.014	82.99

Replace cylinders which are worn close to the permissible wear limit.

All cylinders are marked at the base to indicate the bore diameter group, such as "O", or reconditioned units by "+1 KD 1" etc.

The piston tops bear appropriate size values (+1 KD 1, etc).

The above tables show which piston and cylinder size groups can be paired.

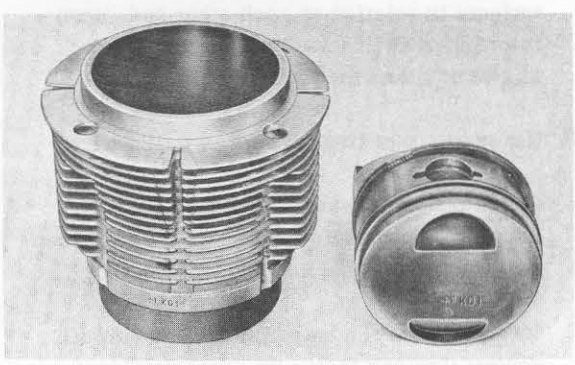


Fig. 128

The piston to cylinder clearance when new is 0.02 mm (.0008"), the wear limit is 0.2 mm (.008").

Cylinders worn close to the wear limit should be replaced together with pistons; use cylinder / piston replacement sets falling into the appropriate size group.
Piston/cylinder sets installed in one engine may not differ by more than four size groups.

Note:

The Biral cylinders are available in four height groups; cylinder height is the distance between the cylinder seating flanges at the crankcase and the cylinder head.

Cylinders installed under one cylinder head must be of same height and bear same identifying symbols at the cylinder base. The identifying symbol is a triangle inside which the number 5, 6, 7, or 8 is stamped, depending on the particular size group.

REMOVING AND INSTALLING PISTONS

38 EN

Special Tools: P 1a Electric piston heater
P 2 Piston pin mandrel

General:

The piston pins are arranged in the pistons off the center and it is, therefore, important to correctly install the pistons in the engine. The piston top bears an arrow mark. When installed, the piston must be so oriented that the arrow points in the direction of vehicle travel, i. e., towards the flywheel.

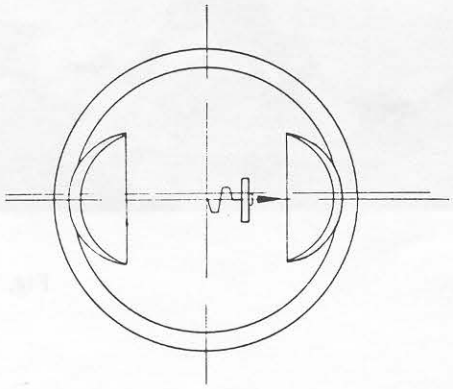


Fig. 129

Owing to the off-centered piston pin, the connecting rod shifts its direction of attack, and so does the piston its tangential angle in relation to the cylinder wall prior to reaching the top dead center (TDC). Since in this position the combustion has not yet begun, the prevailing side forces are still small, which permits the piston to shift onto the opposite cylinder wall softly rather than with a slamming impact. As a result, piston slap noise occuring at time of the pressure point shift is kept at a minimum, especially when the piston to cylinder wall clearance is greater than normal.

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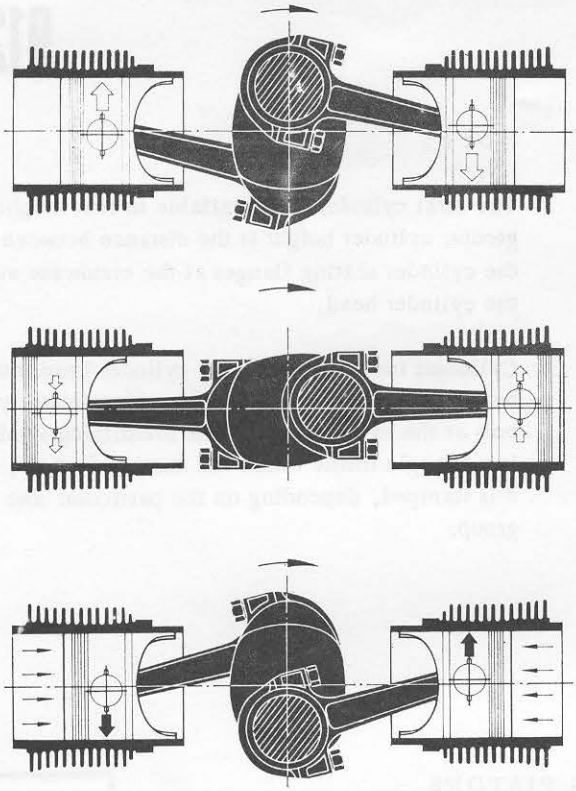

Fig. 130

Removal

1. Remove cylinders (36 En).

2. Mark pistons to ensure reassembly in original position and location.

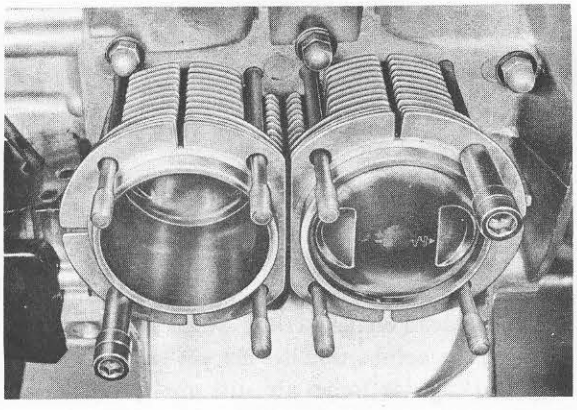

Fig. 131

3. Remove piston pin retainers making sure they don't fall into crankcase.

4. Heat pistons to approx 80° C (175° F) using electric piston heater.

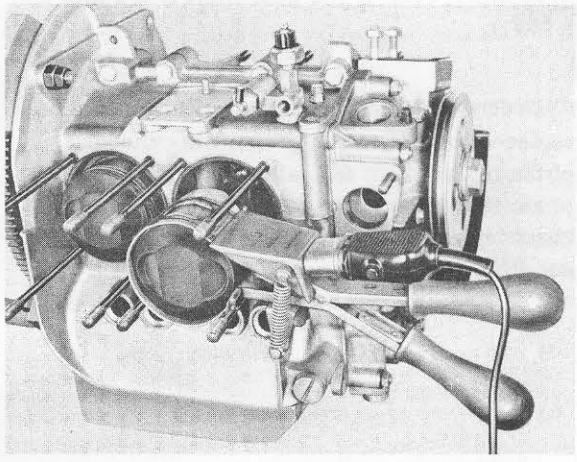

Fig. 132

5. Using the piston pin mandrel, drive piston pins out and remove pistons.

6. Remove piston rings (if necessary) using a piston ring expander. To avoid breaking or bending the piston rings, expand these as little as possible, keeping rings close to the piston body.

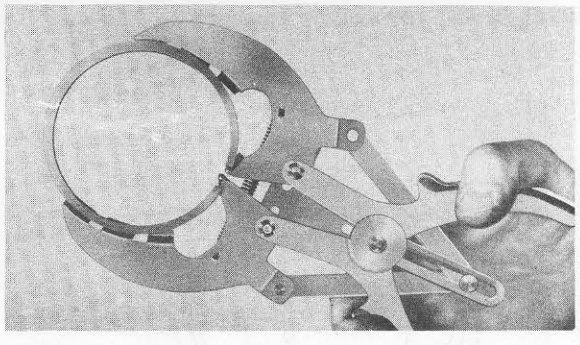

Fig. 133

Installation

Install pistons in reversed order of the above by noting the following points:

1. Connecting rods must be in proper alignment.

2. Clean pistons. Remove carbon deposits from piston top and piston ring grooves without scratching the base metal. Signs of uneven contact or carbon deposits on one side of the piston may indicate poor connecting rod alignment.

3. Check piston rings for proper condition, ring gap, and ring groove clearance. If not as specified, replace piston rings or pistons, as required.

4. Measure pistons. Size designation is stamped into each piston top. Measurements are accomplished as shown in the illustration (perpendicular to piston pin axis).

   Piston size groups are shown in tables under 40 En. Piston clearance at installation is 0.02 mm (.0008"). If the measurement of the piston and cylinder reveals a clearance approaching the wear limit, the piston and cylinder should be replaced with a set falling into the same size group. If the mating cylinder of a damaged piston does not show traces of wear or damage, it may be possible to replace the piston alone with one falling into the appropriate size (letter) group.

5. Fit compression rings and oil scraper.

6. Check piston ring gap. This is done by inserting the ring into the cylinder and pushing it down, somewhat, with a piston, then measuring gap with a feeler gauge.

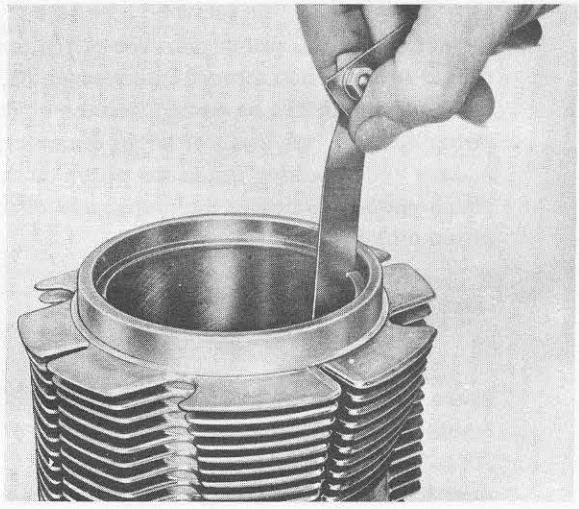

Fig. 134

Applicable to all rings:

Ring gap 0.3 - 0.45 mm (.012" - .018").
Stagger piston ring gaps so that they are approx. 120° apart.

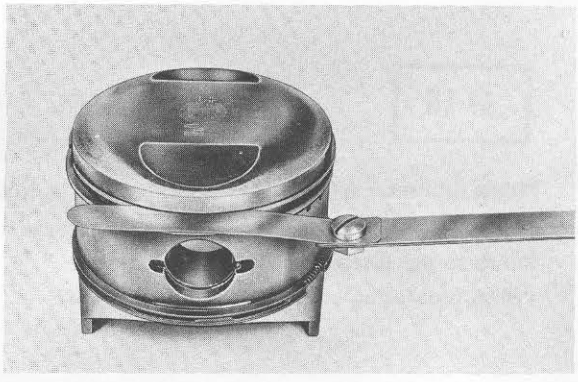

Fig. 135

Piston ring side clearance is specified in the Table of Tolerances and Wear Limits (page E 95).
Piston rings must be installed with a ring expander to prevent piston damage or ring breakage.

Piston rings must be installed in the piston so that the "TOP" marking on the ring faces up, i.e., towards the piston top.

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7. Insert piston pin retainer on the flywheel side first.

8. Inspect and install piston pin. The piston pin is held in the piston through interference fit. If the piston pin can be pushed into the cold piston by hand, use a pin of larger diameter. A color code marking inside the piston on the piston pin boss indicates the proper size of the piston pin, as follows:

white - 21.997-22.000 mm
blue - 22.000-22.003 mm

Piston pin clearance in the connecting rod bushing is 0.020 - 0.036 mm (.0008" to .0014"). If the clearance approaches the wear limit of 0.050 mm (.002"), fit a new piston pin into a new connecting rod bushing.

Install the cold, oiled piston pin in the piston which has been heated to 80°C (175°F) through immersion in hot oil or application of the electric piston heater, in which condition the pin should slide into the piston under light pressure; the pin should be pushed through, to the pin retainer, in one continued move.

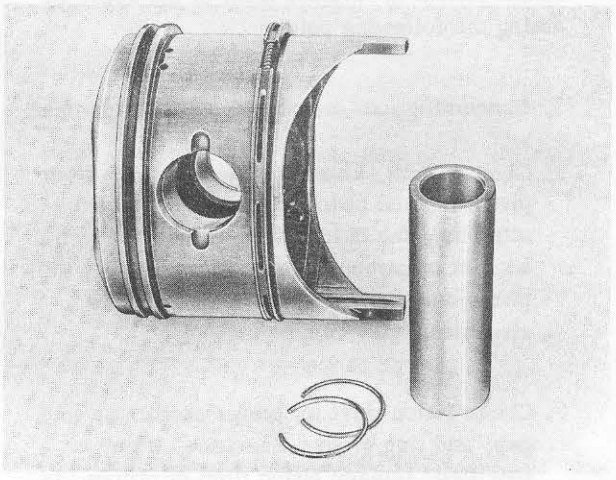

Fig. 136

9. Install second pin retainer. The pin retainers must fit well in their groove within the piston pin boss.

39 EN

INSPECTING PISTONS

Piston diameter is indicated by size group stamped into the piston top. The individual size groups are shown in the piston size table (page E 65). Piston measuring point is shown in Fig. 137.

In order to obtain precise measurement values, we recommend the use of a fixed dial gauge which has been preset with gauge blocks. Pistons showing evidence of seizure or wear are no longer serviceable; however, if the mating cylinder is in good condition, the fault can be rectified by installing only a new piston of the appropriate size group or letter designation.

PISTON MEASURING POINTS AND IDENTIFICATION

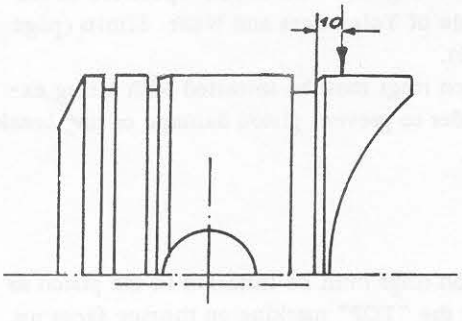

Fig. 137

Characteristic features:

Conspiculously broad bevel around the piston top perimeter.

Two compression rings above the piston pin, one oil scraper below the piston pin.

Nominal diameter measuring point shown by arrow (Fig. 137).

DISASSEMBLING AND REASSEMBLING CRANKCASE

Special Tools: P 44 Hex socket (36 mm)
P 49 Retaining Springs

41 EN

Disassembly

1. Remove oil drain plug.
2. Remove oil cooler.

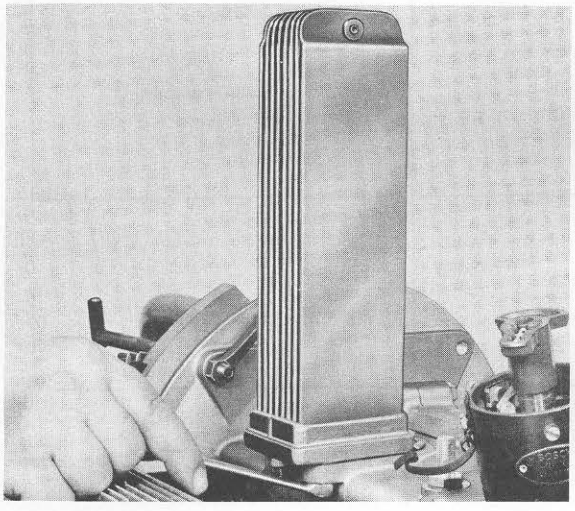

Fig. 138

3. Remove flywheel (46 En).
4. Remove oil pressure switch.
5. Remove oil pressure relief valve.
6. Remove oil strainer and magnetic filtering element.
7. Remove fuel pump insulating flange.
8. Remove distributor and distributor pinion shaft.
9. Remove crankshaft pulley and Woodruff key.
10. Remove pulley shield.
11. Remove oil pump (21 En).

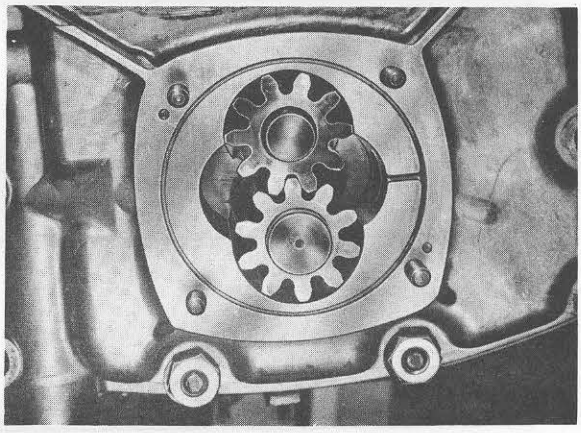

Fig. 139

12. Remove generator carrier.
13. Remove timing gear cover.

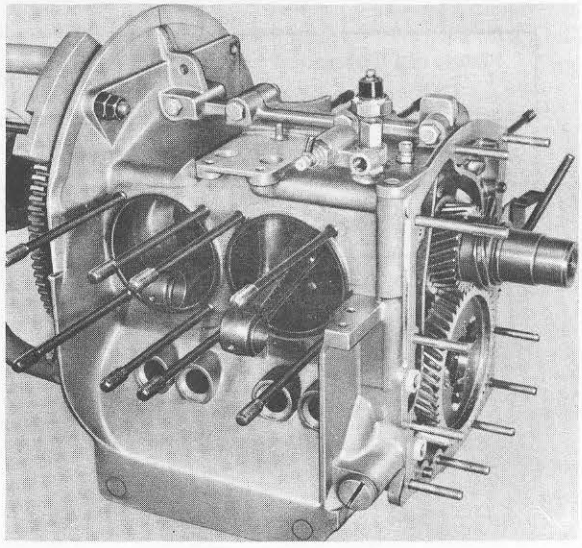

Fig. 140

14. Remove crankcase retaining nuts.

15. Remove crankcase retaining nuts at camshaft end (flywheel side).

16. Withdraw right crankcase half using a rubber mallet if necessary. Do not pry with sharp tools, such as a screwdriver, as this could damage the mating surface.

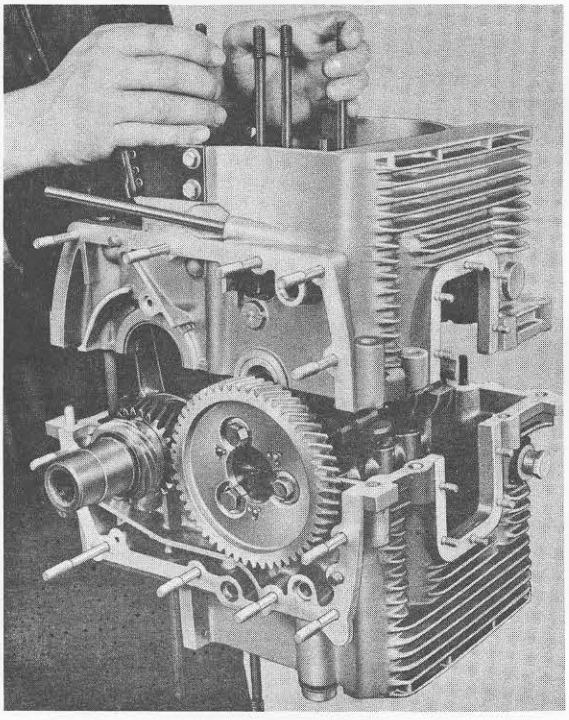

Fig. 141

17. Remove valve lifters.

18. Withdraw camshaft and crankshaft.

19. Remove camshaft end cap.

20. Remove crankshaft oil seal at Bearing 1.

21. Withdraw Bearing 2 and 3.

Reassembly

Reassembly is accomplished in reversed order of the above by noting the following points:

1. Inspect crankcase and timing gear cover for cracks or damage.

2. Using an appropriate solvent, remove sealing compound remnants from crankcase mating surfaces.

3. Check mating surfaces for linear alignment and cleanliness.

4. Assemble empty crankcase and tighten retaining nuts. Using an inside micrometer, measure main bearing bores.

5. If necessary, lightly break the sharp edges from main bearings bores.

6. Flush oil passages with solvent and blow trough with compressed air.

7. Check oil suction tube for firm seating and tightness; if necessary, refasten with P 50a ball end punch.

8. Check valve lifters and lifter guide bores.

9. Check firm seating of dowel pins aligning timing gear cover.

10. Insert main bearing dowel pins. Install main bearing inserts for Bearing 2 and 3· place the insert half which has the oil passage into the left crankcase half making sure that the passage in the insert lines up with the passage in the crankcase bearing seat; install the other insert halves in the right crankcase half.

11. Install crankshaft and camshaft, check for free rotation.

12. Install thrust washer, crankshaft oil seal and Bearing 1.

13. Note correct positioning of timing gears. (See Fig. 142).

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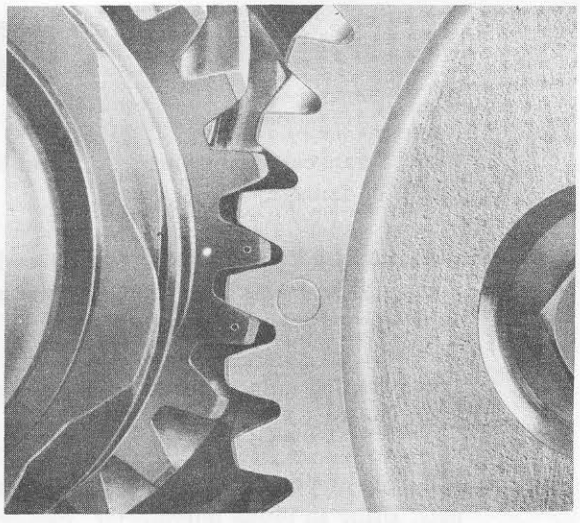

Fig. 142

14. Install camshaft end plug, seal with gasket compound.

15. Secure valve lifters with P 49 retaining springs.

16. Apply a thin, uniform coat of gasket compound to crankcase mating surfaces. Make absolutely certain that no gasket compound enters oil galleries of crankshaft and camshaft bearings.

17. Join crankcase halves.

18. Install O-rings and beveled washers fitted under cap nuts; position the washers so that the inside bevel faces the crankcase to accomodate the O-rings. Tighten cap nuts to 4 mkp (29 lbs/ft).

19. Tighten crankcase retaining nuts at camshaft end (flywheel side).

20. Install timing gear cover.

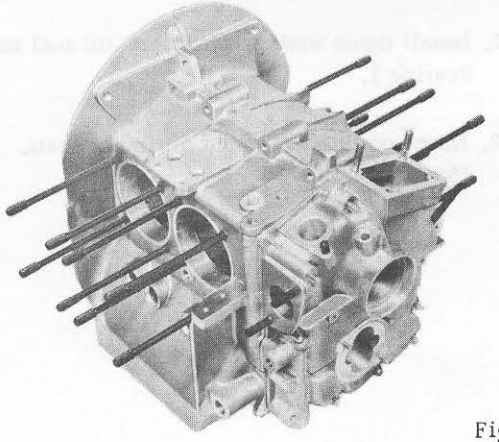

Fig. 143

21. Tighten remaining crankcase retaining bolts to 3 mkp (21.7 lbs/ft).

22. Tighten timing gear cover retaining nuts to 2 mkp (14.5 lbs/ft).

23. Install new oil seal at Bearing 4 in timing gear cover.

24. Turn crankshaft to check for free rotation.

25. Install fuel pump insulating flange and fuel pump.

REMOVING AND INSTALLING DISTRIBUTOR PINION SHAFT

Removal

1. Remove distributor cap.

2. Detach connecting wire from distributor.

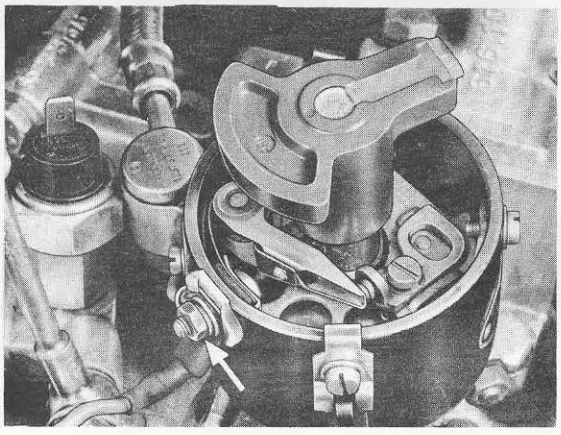

Fig. 144

3. Remove hex nut which holds distributor base plate.

4. Withdraw distributor.

5. Remove fuel pump, insulating flange, gaskets, and actuating plunger (13 Fu).

6. Withdraw distributor. pinion shaft by pushing up and turning to the left through orifice of fuel pump receiving flange.

7. Withdraw thrust washer from pinion shaft base in crankcase (Caution - do not drop washer into crankcase interior).

8. Withdraw spring from pinion shaft.

Installation

Installation is accomlished in reversed order of the above by noting the following points:

1. Inspect fuel pump cam and shaft pinion for wear. If pinion shows traces of wear, install new pinion shaft as well as distributor drive gear (bronze) on crankshaft.

2. Inspect thrust washer at base of pinion shaft for wear, replace if necessary (Caution- do not drop washer into crankcase interior).

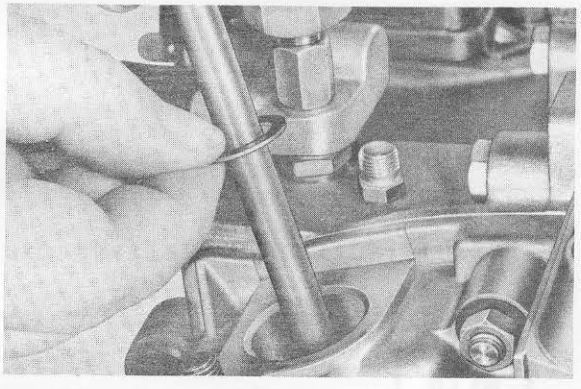

Fig. 145

3. Position piston in Cylinder 1 on firing point TDC and insert pinion shaft.
The coupling slot in the pinion shaft is off center. When installed, the pinion shaft must be so positioned that the slot is directly perpendicular to the longitudinal engine axis with the smaller section of the pinion shaft top facing towards the crankshaft pulley.

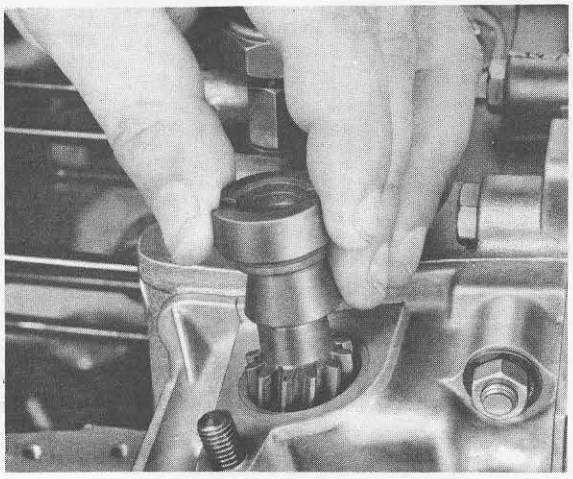

Fig. 146

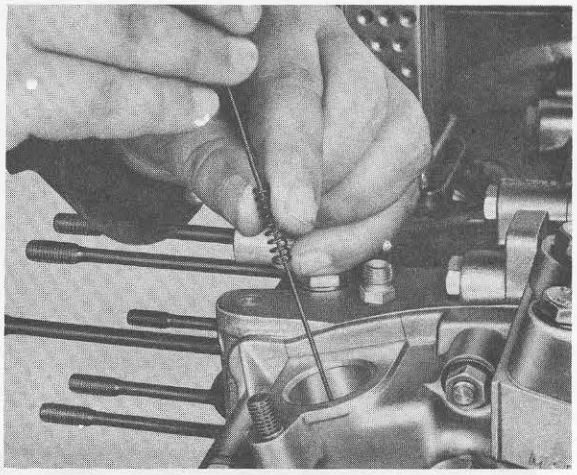

Fig. 147

4. Insert spring into pinion shaft with the help of a welding rod or a thin screwdriver (see Fig. 147).

5. Install distributor.

6. Connect wire to distributor.

7. Adjust ignition timing.

8. Mount distributor cap.

REMOVING AND INSTALLING OIL SEAL AT BEARING 4

Special Tools: P 73 Installer for oil seal at Bearing 4

43 EN

Removal

1. Remove crankshaft pulley (47 En).

2. Withdraw Woodruff key.

3. Deform old oil seal by striking it with hammer and punch through the recess slot in the seal seat, withdraw oil seal.

4. Withdraw oil deflector.

5. Remove burr, if any, from oil seal seat.

Installation

1. Insert oil deflector.

2. Install oil seal with P 73 installer.

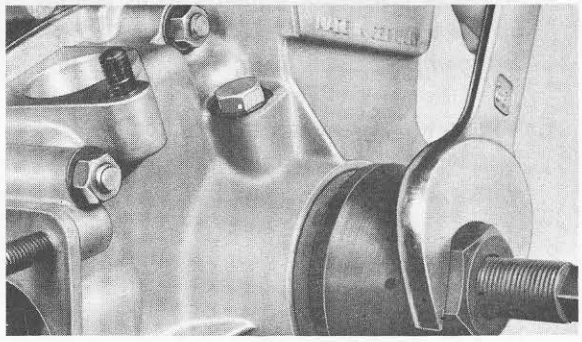

Fig. 148

3. Lubricate oil sealing surface on crankshaft pulley (smoothen if necessary).

4. Insert Woodruff key.

5. Install crankshaft pulley.

REMOVING AND INSTALLING BEARING 4

Special Tools: P 27a Assembly plate for removing and installing Bearing 4
P 73 Installer for oil seal at Bearing 4

Removal

1. Remove timing gear cover (45 En).
2. Deform old oil seal by striking it with hammer and punch through recess slot in seal seat.

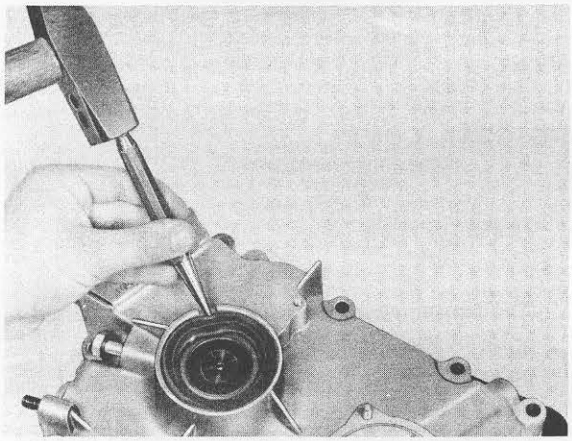

Fig. 149

3. Pry old oil seal out with a screwdriver or similar tool.

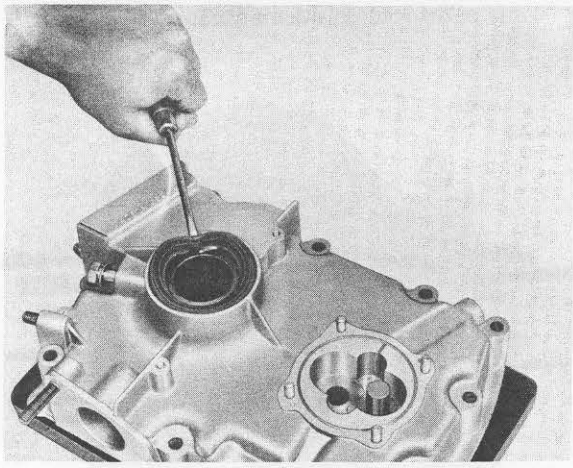

Fig. 150

4. Withdraw oil deflector.
5. Remove bearing set screw.
6. Remove burr, if any, from recess in oil seal seat.

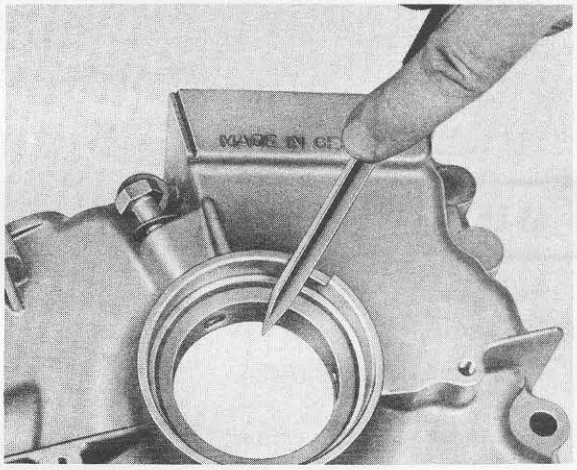

Fig. 151

7. Heat timing gear cover to approx. 60°C (140° F) and remove Bearing 4 using punch P 27a of the assembly plate set.

Installation

1. Inspect timing gear cover for absence of damage.
2. Inspect Bearing 4 seating bore in timing gear cover.
3. Turn set screw of Bearing 4 until the tip of the screw projects approx. 1 mm into the bearing seating bore in timing gear cover.
4. Heat timing gear cover to approx. 160°C (320° F) and install Bearing 4 using special tool P 27a.
5. Tighten the bearing set screw; make sure that the screw is not too long, such as to exert pressure upon the bearing.
6. Insert oil deflector.

7. Install oil seal using P 73 installer.

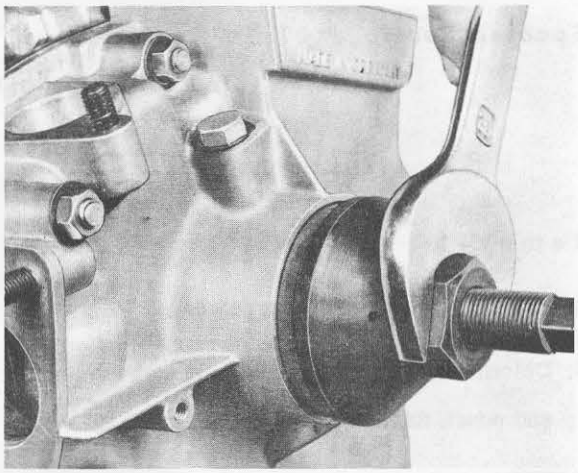

Fig. 152

Note:

When installing Bearing 4, proceed quickly since the bearing insert will begin to expand immediately upon contact with the hot timing gear cover and may, possibly, bind in the process.

45 EN REMOVING AND INSTALLING TIMING GEAR COVER

Removal:

1. Remove generator (5 En).
2. Remove generator carrier.
3. Remove distributor and distributor pinion shaft.
4. Remove fuel pump (13 Fu).
5. Remove crankshaft pulley (47 En). (See Note, below).
6. Remove crankshaft pulley shield.
7. Remove oil pump (21 En).
8. Remove retaining nuts from timing gear cover.
9. Remove timing gear cover.
10. Remove counter-pressure oil line and rubber plugs.

Note:

To prevent damaging the oil seal in timing gear cover, remove Woodruff key from crankshaft before withdrawing the cover.

Installation

The timing gear cover is installed in reversed order of the above by noting the following points:

1. Use new gaskets. It should be noted that the three O-rings provided for sealing the oil galleries between the timing gear cover and crankcase (see Fig. 153 - - two O-rings to the left of the timing gear) are not omitted nor that they fall out when the timing gear cover is positioned on the crankcase.

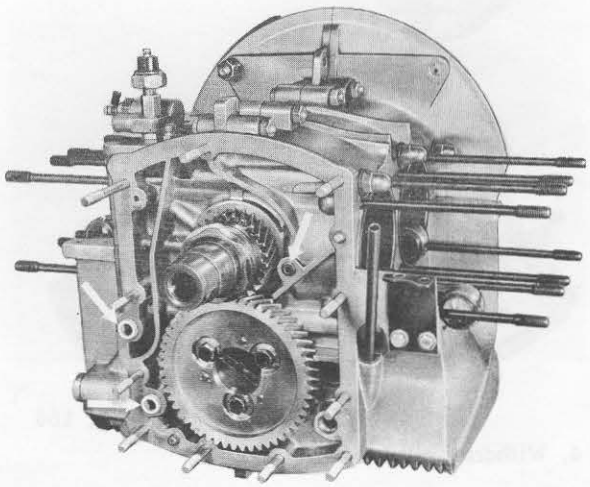

Fig. 153

2. Ensure that the dowel pins are firmly seated.

3. Place one rubber plug on each end of the counter pressure oil line and install in the timing gear cover so that the open end of the upper plug faces the crankcase while the open end of the lower plug is inside the timing gear cover (see Fig. 154).

4. Inspect oil seal at crankshaft pulley and replace if worn or damaged.

5. Use new gasket under generator carrier.

6. Torque retaining nuts of timing gear cover to 2 mkp (14.5 lbs/ft).

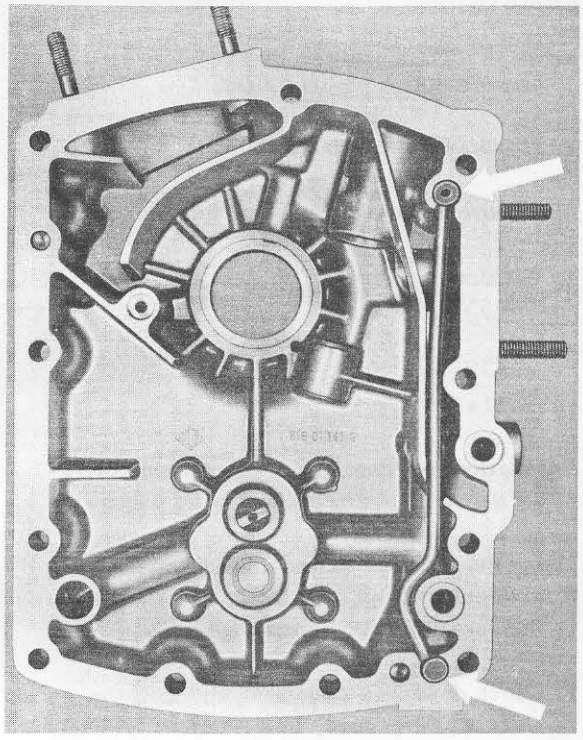

Fig. 154

REMOVING AND INSTALLING FLYWHEEL

46 EN

Special Tools: P 44 Hex socket (36 mm)

General:

The flywheel is attached to the crankshaft by way of a gland nut; eight dowel pins transmit the torque forces. A soft iron gasket is installed between the flywheel and the crankshaft. Oil sealing is accomplished by an oil seal installed in the crankcase at Bearing 1; the seal rides on the flywheel hub. The gland nut contains a pilot bushing which supports one end of the transmission input shaft.

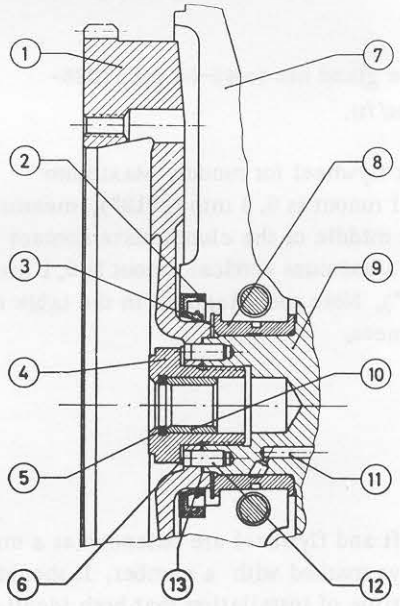

Fig. 155

1 Flywheel
2 Oil seal
3 Spacer
4 Gland nut
5 Gasket
6 Spring washer
7 Crankcase
8 Bearing 1
9 Crankshaft
10 Pilot bushing
11 Oil gallery
12 Dowel pin
13 Soft iron gasket

Removal

1. Remove clutch pressure plate.
2. Withdraw clutch plate.
3. Remove gland nut using P 44 hex socket.
4. Withdraw flywheel.

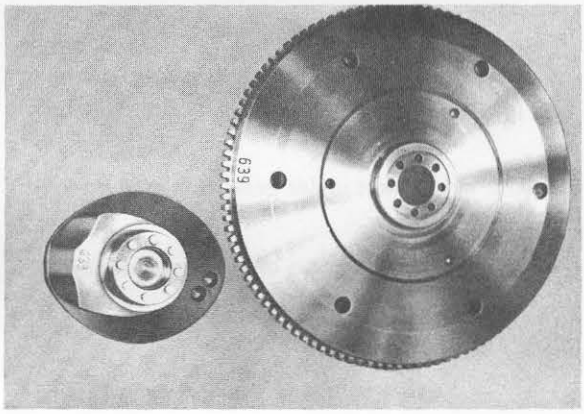

Fig. 156

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Inspect flywheel starter ring for serviceable condition of gear teeth; slightly pounded teeth may be dressed with a file.
2. Check dowel pin seats in flywheel; if the seats appear peened, install a new flywheel.
3. Check dowel pins in the crankshaft, replace if necessary.
4. Use new soft iron gasket.
5. Check and adjust crankshaft end play.
6. Check pilot bushing in gland nut for wear.
7. If the pilot bushing requires replacement, install new needle bearing with gland nut.
8. Torque gland nut to 45-50 mkp (326-362 lbs/ft).
9. Check flywheel for runout. Maximum lateral runout is 0,3 mm (.012"), measured in the middle of the clutch plate contact area. Maximum vertical runout is 0,1 mm (.004"). Note specifications in the table of tolerances.

To ensure proper installation of the flywheel in relation to the crankshaft, two dowel pins have been positioned closer together; this point is identified on the crankshaft and flywheel by the number 1 stamped into both parts.

Fig. 157

Note:

Crankshaft and flywheel are balanced as a unit and always marked with a number. It should be noted at time of installation that both identifying numbers are same.
Replacement flywheels or crankshafts are balanced to 0 so that they are individually relaceable.

Second Edition of this page, October 1968

RECONDITIONING FLYWHEEL

If necessary recondition the flywheel gradually on a lathe (according to table below). Please pay attention to the fact that the bearing surface of the clutch must be reconditioned by the same proportion as the thrust surface of the flywheel.

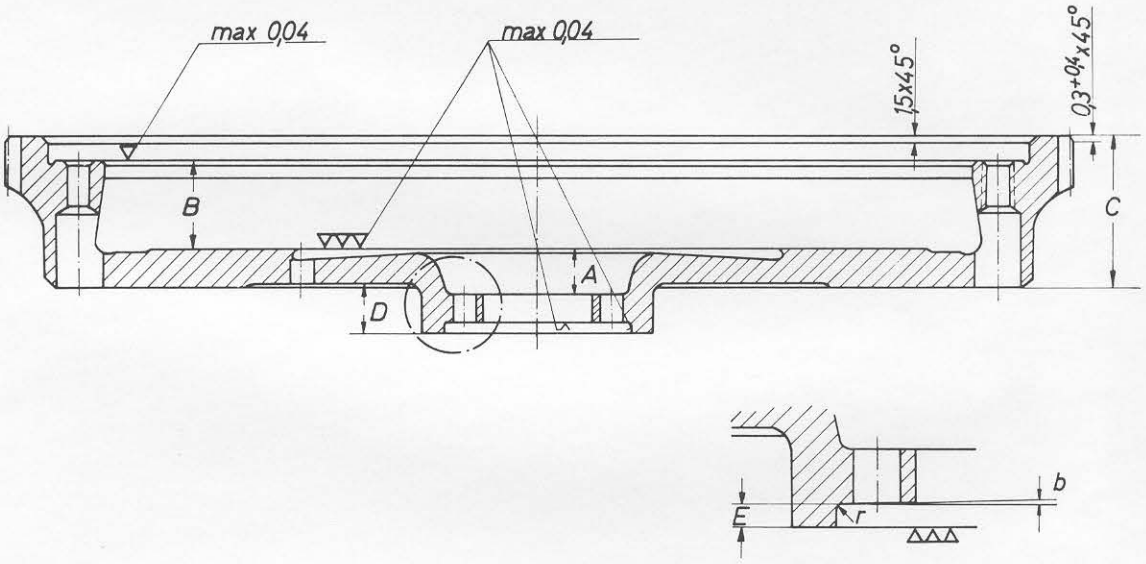

Fig. 157a

Measuring point	Original measure	Reconditioning grade			Tolerance
	mm	1	2	3	
A	12,3	11,8	11,5	11,2	± 0,1
B	22,5	-	-	-	+ 0,2
C	39,5	38,8	38,4	38,0	± 0,2
D	13,25	12,95	12,75	12,55	± 0,1
E	3,15	3,1	-	-	± 0,05
r	0,5	0,5	-	-	- 0,2
b	1°30'	-	-	-	-

REMOVING AND INSTALLING CRANKSHAFT PULLEY

47 EN

Removal

1. Remove V-belt.
2. Remove engine rear shield.
3. Remove crankshaft pulley retaining bolt.
4. Withdraw crankshaft pulley.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Inspect crankshaft pulley, prior to installation, for good condition of its seat and belt running surfaces.
2. Check for possible pulley runout.
3. Check oil sealing surface of pulley.
4. Check oil seal for absence of damage or wear, replace if necessary.

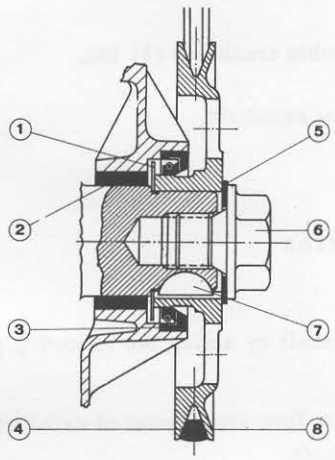

Fig. 158

1. Oil deflector
2. Bearing 4
3. Oil seal
4. V-belt
5. Spring washer
6. Retaining bolt
7. Woodruff key
8. Crankshaft pulley

REMOVING AND INSTALLING OIL SEAL AT FLYWHEEL

48 EN

Special Tools: VW 204b Crankshaft oil seal installer

Removal

1. Remove flywheel. Inspect oil sealing surface on flywheel hub.
2. Remove old oil seal.
3. Clean the oil seal seat and apply a thin coat of gasket compound. If necessary, remove sharp edges from outer surface perimeter, making sure to remove any remaining filings.

Installation

1. Install new oil seal using VW 204b/ oil seal installer; to install, screw installer into crankshaft end and tighten guide piece which carries the oil seal. The oil seal must rest at the bottom of its seat and must not be slanted in the installation process.
2. Remove installer.
3. Use new soft iron gasket.
4. Instal flywheel; lightly oil the oil sealing surface (hub).

Second Edition of this page, March 1967

REMOVING AND INSTALLING CAMSHAFT

Removal

1. Disassemble crankcase (41 En).

2. Withdraw camshaft.

Installation

Install camshaft by noting the following points:

1. Check for firm attachment of camshaft gear to camshaft.

2. Check camshaft for wear at bearing journals and camshaft lobes, i.e., rippled wear in lift ramps or slanted wear, in relation to camshaft axis, of cam lobe races.
   End play specifications are shown in the table of tolerances, page E 95.

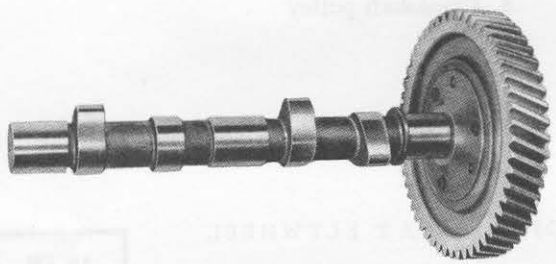

Fig. 159

3. Check camshaft for whip.

4. Check camshaft gear for good condition and proper tooth contact.

5. When installed, the camshaft gear tooth marked "o" lies between two crankshaft gear teeth bearing a punch mark each.

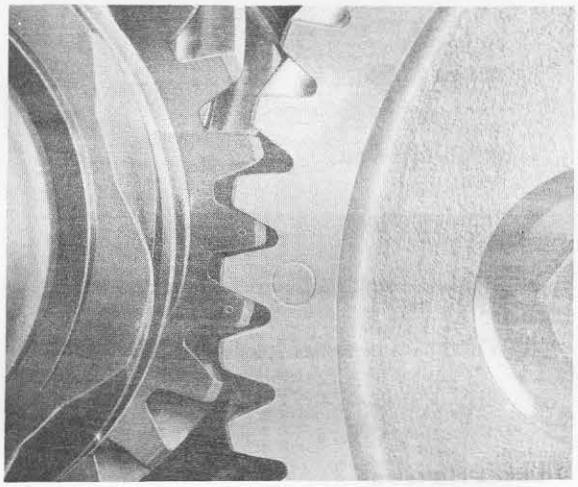

Fig. 160

6. Check gear backlash over the entire circumference of the camshaft gear. Correct backlash, in assembled crankcase, between the camshaft gear and crankshaft gear is 0.015 - 0.04 mm (.0006 - .0016"). To measure, move gears back and forth while taking readings with a dial gauge and measuring the entire circumference of the camshaft gear.

   The facilitate proper backlash adjustment, camshafts are furnished with camshaft gears in five sizes.

   The camshaft gears are marked on the camshaft side with electrically inscribed or mechanically stamped identification numbers such as 0, +1, +2, -1, and -2. The numbers show, in hundreds of one millimeter, by how much the pitch circle radius differs from standard size (0); it identifies a standard gear 0, oversize of +1 or +2 (+ 1/100 or +2/100 mm), or undersize gears.

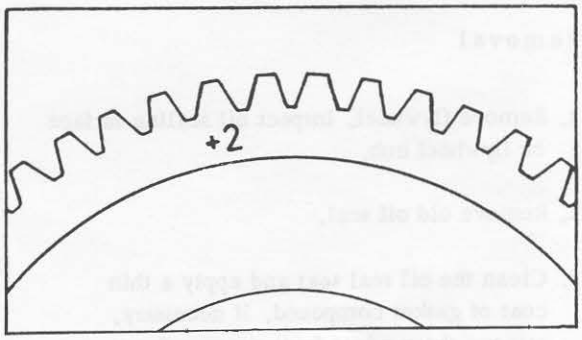

Fig. 161

Note:

Do not confuse the number "0" with the timing mark "o" on the other side of the gear. The crankshaft gear is supplied in one size only and no identification is necessary.

7. Lubricate camshaft with graphite oil and install.

8. Do not fail to install camshaft end plug.

9. When assembling a new crankcase, check camshaft for snug but easy rotation; if necessary check camshaft bearings with machinist's blue and smoothen bearing seats in crankcase with a scraper.

Note:

When installing a new camshaft gear ensure that the timing mark on the camshaft gear, its nearest mounting bolt bore, and the oil pump drive slot on the camshaft end align in an almost straight line.
Before drilling the 5,8 mm (.228") dowel pin holes, and tapering these from the camshaft side, check the gear for runout. The three dowel pins must be firmly seated in the camshaft gear and additionally secured by three punch strikes each. If necessary, install larger dowel pins which may be locally manufactured from high-grade steel. Torque retaining bolts to 2,5 mkp (18 lbs/ft).

REMOVING AND INSTALLING CRANKSHAFT WITH CONNECTING RODS

50 EN

Removal

1. Disassemble crankcase (41 En).

2. Withdraw camshaft.

3. Remove crankshaft with connecting rods.

4. Mark insert of Bearing 2 and 3.

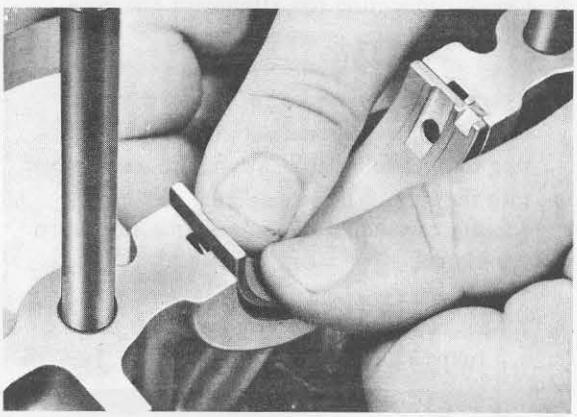

Fig. 162

Installation

Installation is accomplished by noting the following points:

1. Lightly bevel bearing seat edges at the crankcase joint to prevent gouging as a result of bearing preload upon reassembly of crankcase.

2. Check dowel pin in Bearing 1 for firm seating.

3. Oil passages in crankshaft journals and bearings must not have sharp edges in evidence.

4. Install in crankcase insert halves of Bearing 2 and 3.

5. Place insert of Bearing 1 on crankshaft journal so that the off-centered dowel pin bore is closest to the flywheel side.

6. Insert crankshaft.

7. Note timing marks when installing camshaft.

Second Edition of this page, March 1967

REMOVING AND INSTALLING CONNECTING RODS

Special Tools: VW 310a Crankshaft bench mount

51 EN

Removal

1. Remove crankshaft and place into VW 310a bench mount (50 En).

2. Remove connecting rod retaining nuts, remove connecting rods and caps.

Installation

Installation is accomplished in reversed order of the above by noting the following points:

1. Check connecting rod weight: Maximum permissible weight difference between connecting rods of one engine is 6 g (.211 oz.) .

2. Check piston pin bushing. The piston pin should enter a new bushing under light finger pressure.

3. Check connecting rod alignment and correct if necessary.

4. Upon thorough cleaning of all parts install connecting rod inserts and assemble connecting rods. The identification number stamped into the side of the connecting rod and its bearing cap should be on the same side when assembled.

5. Torque connecting rod retaining nuts to 4.5 mkp (32.5 lbs/ft).

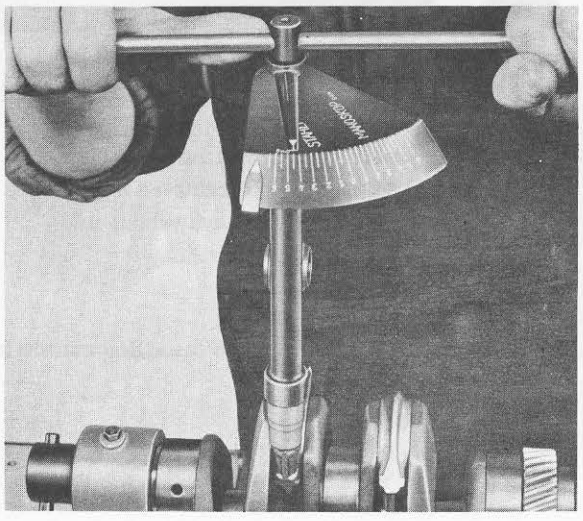

Fig. 163

6. Visually check if connecting rod and its bearing cap have actually joined, that is, if no obstruction is in the joint.

7. Minor stresses which may result from tightening the connecting rod retaining nuts can be relieved through light hammer blows. The connecting rods, oiled prior to installation, should tip freely under their own weight. Under no circumstances may bearings be dressed or reworked to fit.

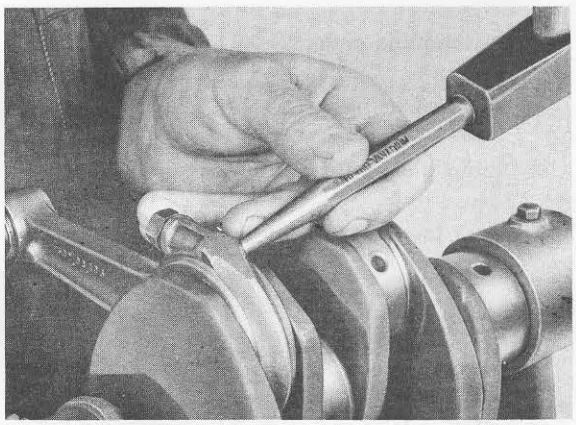

Fig. 164

8. Check lateral clearance between connecting rods and crankshaft (0.15-0.20 mm) (.006 to .008").

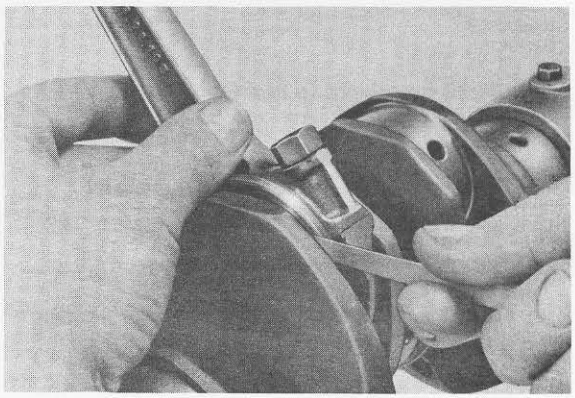

Fig. 165

INSTALLING CONNECTING ROD BUSHINGS

52 EN

(Connecting rods removed from engine)

If clearance between piston pin and bushing is excessive, install new bushings in the connecting rods by noting the following points:

1. Install new bushings on a press using a round block.

2. Bring bushing bore to correct size by means of precision drilling.

3. It is in no case permissible to rebore worn bushings and fit these with oversize piston pins.
   State weight when ordering connecting rods.

Note

If at all possible, connecting rod bushings should be brought to correct bore size only by means of precision drilling.

Only in cases of emergency, when precision drilling equipment is not at hand, or if economic reasons prevent the removal of crankshaft from the engine, is it permissable to ream the connecting rod bushings, and in such cases only with a well guided reamer and with the greatest of care.

MEASURING AND REALIGNING CONNECTING RODS

53 EN

Special Tools: P 14b Connecting rod measuring fixture

Measuring

1. Remove crankshaft and take off connecting rods. Mark connecting rods and caps to ensure reassembly in original locations and positions.

2. Remove bearing inserts.

3. Install connecting rod in P 14b measuring fixture.

4. Insert measuring pin into connecting rod and check for twists or bends.

Checking for twists.

Fig. 166

Aligning

Connecting rods may be realigned in the measuring fixture with the use of a MATRA aligning tool, or with other commercial aligning tools.

54 EN DISASSEMBLING AND REASSEMBLING CRANKSHAFT

Special Tools :

VW 161a Lock ring pliers, for removing and installing gear lock ring on crankshaft.

VW 202 Puller with
VW 202a Puller jaws, and
VW 202f Block -- for removing gears from crankshaft

VW 310a Crankshaft bench mount

VW 427 Guide tube, for installing camshaft drive gear, spacer, and distributor drive gear on crankshaft.

VW 428 Tapered guide tube, for installing gear lock ring on crankshaft

SPECIFICATIONS FOR PLAIN BEARING CRANKSHAFT

Stroke	mm	74 (2.913")	
Connecting rod journal diameter	mm	53 (2.0866")	
Main bearing journal diameter:	mm	Bearing 1: 50 mm (1.9685") Bearing 2: 55 mm (2.1654")	Bearing 3: 55 mm (2.1654") Bearing 4: 40 mm (1.5748")

Disassembly

1. Install crankshaft in VW 310a bench mount (mount has 8 seating holes).

2. Remove connecting rods (51 En).

3. Using VW 161a lock ring pliers, remove gear lock ring from crankshaft.

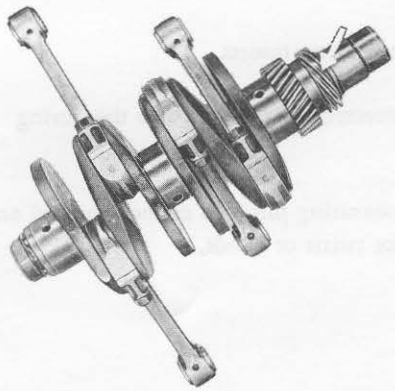

Fig. 167

4. Remove distributor drive gear, spacer, and camshaft drive gear from crankshaft using VW 202 puller with VW 202a puller jaws and VW 202f block. Minor scoring in the seating surface should be removed with care although the dressing must not impair the press fit of the gears.

Reassembly

Reassembly is accomplished in reversed order of the above by noting the following points:

1. Check crankshaft for whip, cracks (accoustical sound test), or wear. Replace crankshaft if necessary. The crankshaft may be reground.

The crankshaft can only be regrinded at the factory.

2. To simplify reassembly, mark insert of Bearing 1 at the crankcase joint (this aids in locating the dowel pin seat).

3. Insert Woodruff key for camshaft and distributor drive gears.

4. Inspect camshaft drive gear for wear and tooth contact, heat to 80°C (176°F), and press onto crankshaft, with chamfered side facing flywheel, using VW 427 guide tube.

5. Check distributor drive gear for wear, replace if necessary. Heat gear to 80°F (176°F) and press onto crankshaft using VW 427 guide tube.

6. Install gear lock ring on crankshaft, use VW 428 tapered guide tube to prevent damaging the bearing journal. Check gears for firm seating when cool.

7. Clear oil galleries with compressed air, flush with oil.

8. Install connecting rods.

CHECKING AND ADJUSTING CRANKSHAFT END PLAY

55 EN

Special Tools:
P 17 Dial gauge holder, for measuring end play in assembled engine.

Checking End Play

End play should be 0,14 - 0,17 mm (.0055 to .0067"), wear limit 0.22 mm (.0087"). End play should be adjusted before installing the crankshaft. The use of more than one soft iron gaskets is not permissible.

1. Properly position Bearing 1 on Journal 1

2. Install spacer of calculated thickness. The spacers are available in thicknesses from 0.8 to 1.05 mm (.0315 to .0413") and are marked alphabetically from A through F.

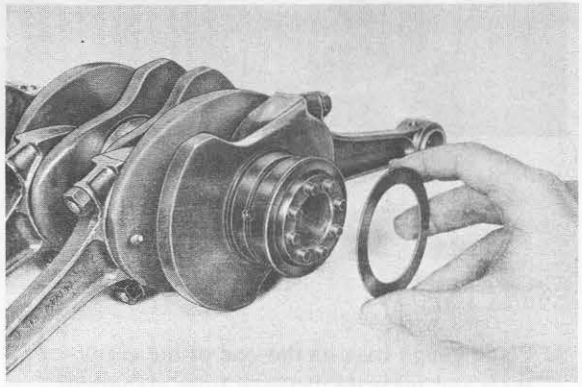

Fig. 168

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3. Attach flywheel to crankshaft and torque gland nut to 45-50 mkp (326-362 lbs/ft).

4. Measure end play with feeler gauge.

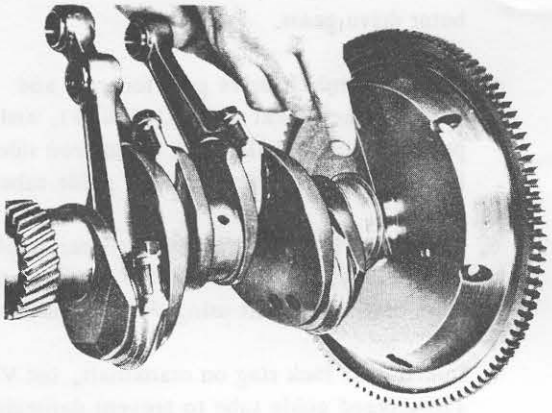

Fig. 169

End play is measured at the crankshaft pulley when the engine is installed in vehicle, and at the flywheel when the engine is removed. In both cases use a dial gauge mounted in P 17 holder. When measuring end play at the crankshaft pulley, attach gauge holder to a stud in the timing gear cover; when measuring at the flywheel, attach the holder to the engine mounting flange by means of a bolt.

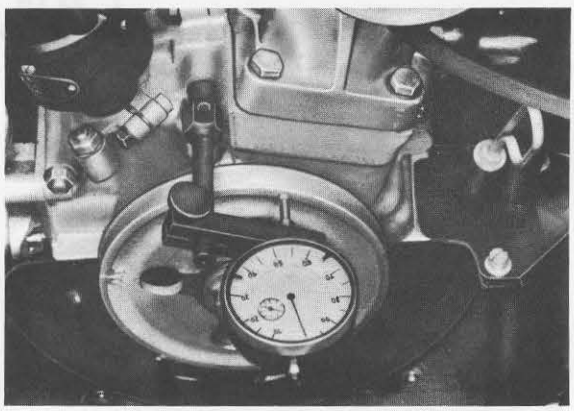

Fig. 170

Calculating End Play

1. Place gauge base on the end of the crankshaft and measure distance from crankshaft end to the thrust flank of Bearing 1 (crankshaft pushed to flywheel).

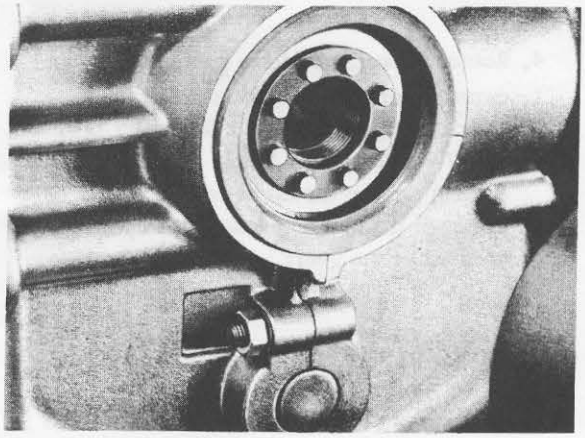

Fig. 171

2. Place gauge base on the flywheel hub and measure depth of seat (flywheel hub takes up the thrust, hub seat rests on crankshaft end).

3. From the difference between both readings, and considering the thickness of the soft iron gasket, the thickness of the required spacer may be determined.

The soft iron gasket thickness is 0.10 - 0.14 mm (.004 - .006") The use of more than one soft iron gaskets is not permissible.

Example:

(1 mm = .03937 in.)

Crankshaft-end to Bearing 1 thrust flank	4.015 mm
Crankshaft seat depth in flywheel hub	- 3.025 mm
	0.990 mm
Soft iron gasket thickness	+ 0.100 mm
	1.090 mm
Required end play	- 0.140 mm
Spacer Thickness =	0.950 mm

RECONDITIONING CRANKSHAFT

56 EN

Crankshafts can only be regrinded at the factory and/or obtained through the exchange service, as these crankshafts demand a special treatment of material.
Appropriate undersize bearings are available within the spare part programm; it must be determined however, if the main bearing bores in the crankcase are standard or oversize.

MAIN BEARING AND CRANKSHAFT JOURNAL DIMENSIONS

(1 mm = .03937")

MAIN BEARINGS

Nomenclature	Version		Bearing 2 and 3 mm	Bearing 1 mm
Crankshaft Journal	Standard	Diameter	54.990-54.971	49.991-49.975
Bearing Insert	Inside standard	Wall thickness	2.615- 2.603	5.096- 5.108
	Outside standard	Outside diameter	-	60.29 + 0.02
Crankcase Bore	Standard	Diameter	60.24 ± 0.005	60.24 ± 0.005
Crankshaft Journal	Standard	Diameter	54.990-54.971	49.991-49.975
Bearing Insert	Inside standard	Wall thickness	2.740- 2.728	5.221- 5.233
	Outside oversize	Outside diameter	-	60.54 + 0.02
Crankcase Bore	Oversize	Diameter	60.49 ± 0.005	60.49 ± 0.005
Crankshaft Journal	1st undersize	Diameter	54.740-54.721	49.741-49.725
Bearing Insert	Inside undersize	Wall thickness	2.740- 2.728	5.221 - 5.233
	Outside standard	Outside diameter	-	60.29 + 0.02
Crankcase Bore	Standard	Diameter	60.24 ± 0.005	60.24 ± 0.005
Crankshaft Journal	1st undersize	Diameter	54.740-54.721	49.741-49.725
Bearing Insert	Inside undersize	Wall thickness	2.865- 2.853	5.346- 5.358
	Outside oversize	Outside diameter	-	60.54 ± 0.02
Crankcase Bore	Oversize	Diameter	60.49 ± 0.005	60.49 ± 0.005

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Nomenclature	Version		Bearing 2 and 3 mm	Bearing 1 mm
Crankshaft Journal	2nd undersize	Diameter	54.490-54.471	49.491-49.475
Bearing Insert	Inside undersize	Wall thickness	2.865- 2.853	5.346- 5.358
	Outside standard	Outside diameter	-	60.29 + 0.02
Crankcase Bore	Standard	Diameter	60.24 $\pm$ 0.005	60.24 $\pm$ 0.005
Crankshaft journal	2nd undersize	Diameter	54.490-54.471	49.491-49.475
Bearing Insert	Indise undersize	Wall thickness	2.990- 2.978	5.471- 5.483
	Outside oversize	Outside diameter	-	60.54 + 0.02
Crankcase Bore	Oversize	Diameter	60.49 $\pm$ 0.005	60.49 $\pm$ 0.005
Crankshaft Journal	3rd undersize	Diameter	54.240-54.221	49.241-49.225
Bearing Insert	Inside undersize	Wall thickness	2.990- 2.978	5.471- 5.483
	Outside standard	Outside diameter	-	60.29 + 0.02
Crankcase Bore	Standard	Diameter	60.24 $\pm$ 0.005	60.24 $\pm$ 0.005
Crankshaft Journal	3rd undersize	Diameter	54.240-54.221	49.241-49.225
Bearing Insert	Inside undersize	Wall thickness	3.115- 3.103	
	Outside oversize	Outside diameter		60.54 + 0.02
Crankcase Bore	Oversize	Diameter	60.49 $\pm$ 0.005	60.49 $\pm$ 0.005

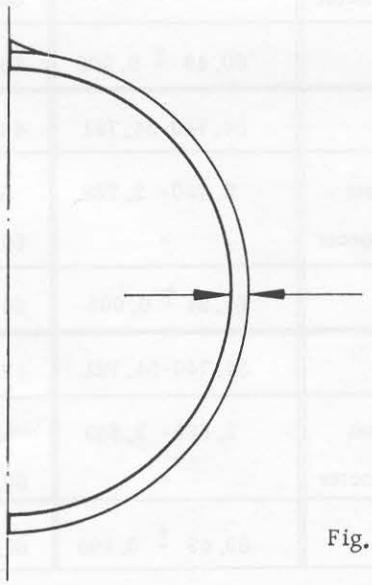

Fig. 172 Measuring point for establishing thickness of bearing inserts.

DIMENSIONS FOR BEARING 4

Nomenclature	Version		Bearing 4 mm
Crankshaft Journal	Standard	Diameter	39.982-39.971
Bearing Insert	Inside standard Outside standard	Wall thickness Outside diameter	4.975- 4.985 50.050-50.034
Crankcase Bore	Standard	Diameter	50.000-50.024
Crankshaft Journal	Standard	Diameter	39.982-39.971
Bearing Insert	Inside standard Outside oversize	Wall thickness Outside diameter	4.975- 4.985 50.050-50.034
Crankcase Bore	Oversize	Diameter	No oversize provided
Crankshaft Journal	1st undersize	Diameter	39.732-39.721
Bearing Insert	Inside undersize Outside standard	Wall thickness Outside diameter	5.100- 5.114 50.050-50.034
Crankcase Bore	Standard	Diameter	50.000-50.024
Crankshaft Journal	1st undersize	Diameter	39.732-39.721
Bearing Insert	Inside undersize Outside oversize	Wall thickness Outside diameter	No oversize provided
Crankcase Bore	Oversize	Diameter	No oversize provided

Two additional undersizes are available for the crankshaft journal and insert for Bearing 4:

2nd Undersize:	Crankshaft journal diameter	=	39.50 mm
	Wall thickness	=	5.239 mm
3rd Undersize:	Crankshaft journal diameter	=	39.25 mm
	Wall thickness	=	5.364 mm

CONNECTING ROD BEARINGS

Nomenclature	Version		All Journals (mm)
Journal	Standard	Diameter	53.000-52.987
Insert	Standard	Wall thickness	1.96 - 1.97
Connecting Rod Bore	Standard	Diameter	56.980-56.999
Journal	1st undersize	Diameter	52.750-52.737
Insert	Inside undersize Outside standard	Wall thickness	2.085- 2.095
Connecting Rod Bore	Standard	Diameter	56.980-56.999

Two additional undersizes are available for the connecting rod journals and bearing inserts:

2nd Undersize:	Journal diameter	52.50 mm h5
	Wall thickness	2.215 +0.01 mm
3rd Undersize:	Journal diameter	52.25 mm h5
	Wall thickness	2.339 +0.01 mm

The crankshaft can be reconditioned, or procured in exchange, only at the factory since they are subject to an exclusive metal treatment. The respective undersize bearings can be procured as spare parts but it must be determined if the main bearing bores in the crankcase are standard or oversize.