Disassembling and Assembling Crankcase

36 EN

Special Tools:

P 5	Socket 15 mm
P 42	Torque wrench
P 43	Puller for V-belt pulley
P 44	Socket 36 mm
P 51	Sleeve for protecting crankcase
VW 102	T-handled wrench 14 mm
VW 106	T-handled wrench 10 mm
VW 118	Torque wrench
VW 247	Ring gauge for main bearing bores

Disassembling Crankcase

1. Fasten left half of crankcase to engine stand. Remove oil drain plug.
2. Remove oil cooler (16 EN).

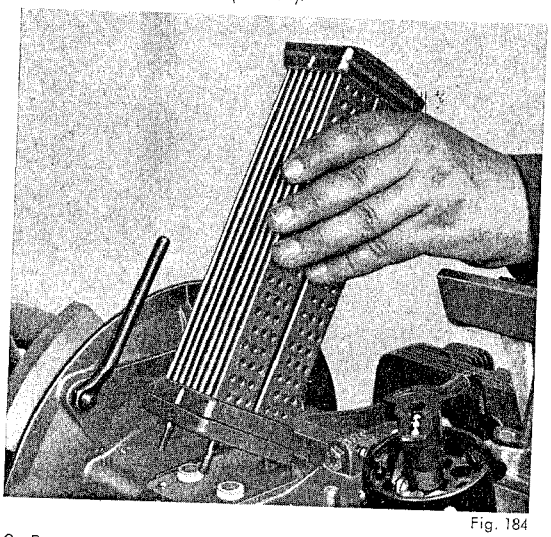


Fig. 184

3. Remove flywheel (41 EN).
4. Remove oil pressure switch.
5. Remove pressure relief valve (15 EN).
6. Remove oil strainer and magnetic filter (14 EN).
7. Remove fuel pump mount.

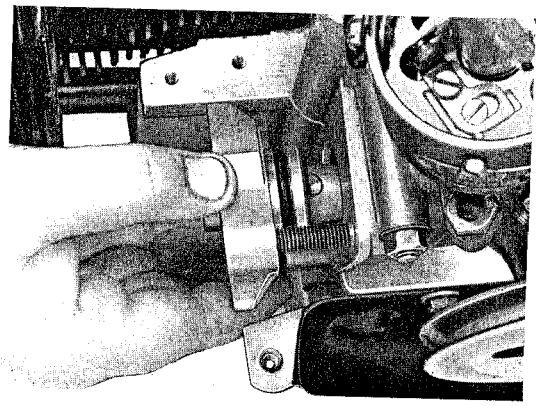


Fig. 185

8. Remove distributor and distributor drive.
9. Remove V-belt pulley and lock washer.

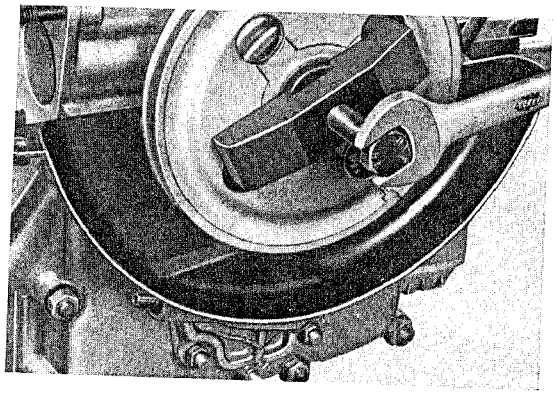


Fig. 186

10. Remove tachometer drive.
11. Remove oil pump (17 EN).

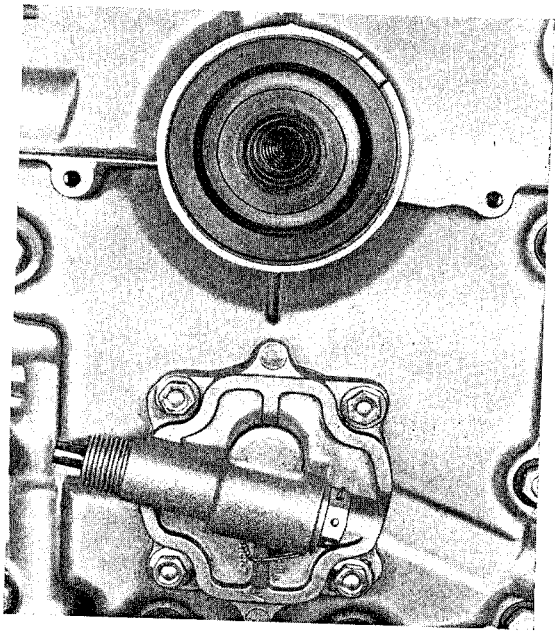


Fig. 187

12. Remove generator bracket.

13. Remove timing case cover.

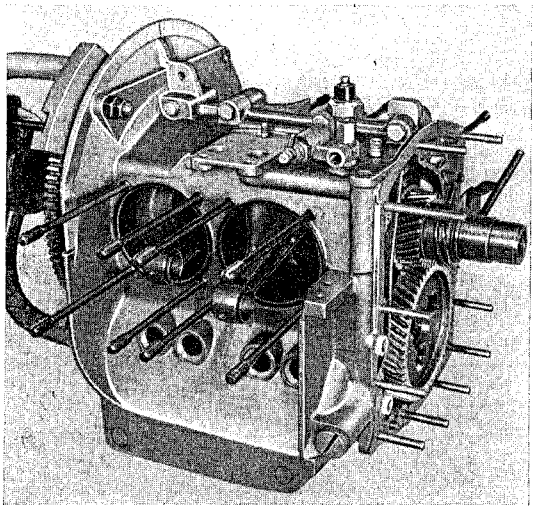


Fig. 188

14. Remove crankcase nuts.

15. Remove camshaft bearing bolts.

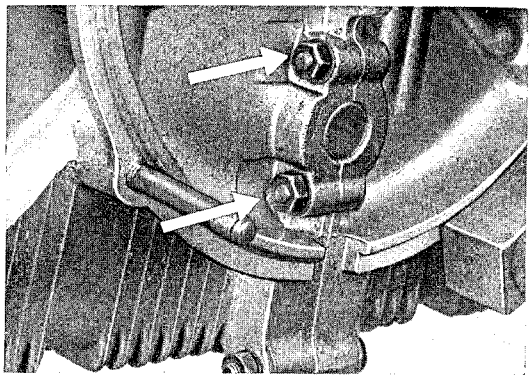


Fig. 189

16. Remove right half of crankcase using a rubber mallet if necessary. Do not pry with sharp instruments.

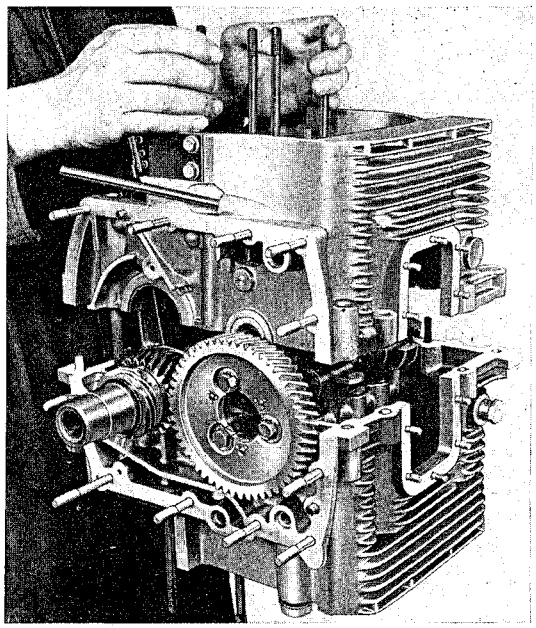


Fig. 190

17. Remove tappets.

18. Remove camshaft and crankshaft.

19. Remove camshaft end cap.

20. Remove crankshaft oil seal at flywheel.

21. Remove bearing No. 2.

Assembly

The assembly is accomplished in the reverse order of disassembly observing the following points:

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

2. Remove all traces of old sealing compound from mating surfaces of the crankcase with solvent. (Do not scrape.)

3. Inspect mating surfaces with straight edge for trueness and cleanliness.

4. Assemble empty crankcase and tighten nuts. Using gauge ring VW 247 and inside micrometer, check main bearing bores (dimensions page E 81).

5. Remove sharp edges from main bearing bores if necessary.

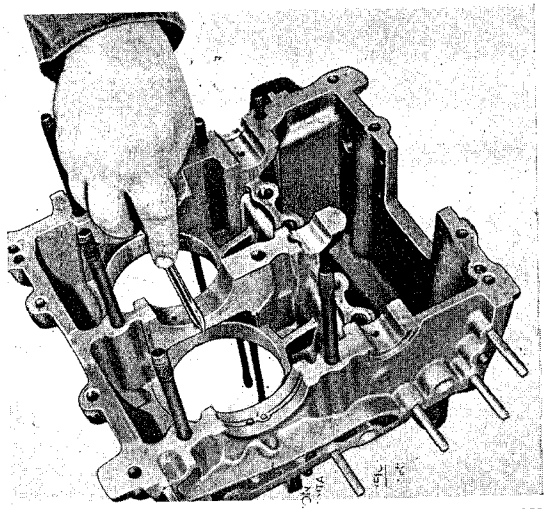


Fig. 191

6. Flush oil passages with solvent and compressed air.

7. Check oil suction pipe for firm leak free seat. If necessary tighten pipe using punch P 50.

8. Check tappets and tappet bores.

9. Check tightness of the dowel pins of the timing case cover.

10. Install main bearing dowel pins.

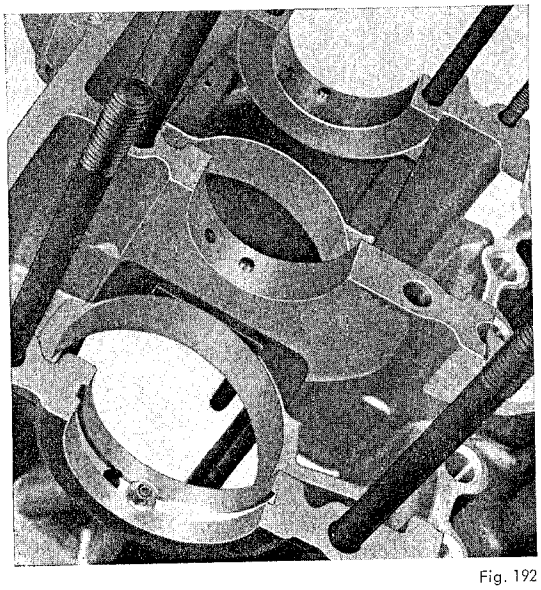


Fig. 192

11. Main bearing No. 2 inserts: Place one half in the left crankcase section so that the oil hole is in line with the oil passage. Place the other half in the right crankcase section so that when assembled their two oil pockets meet.

12. Install crankshaft and camshaft and check free rotation.

13. Install main bearing No. 1 oil seal and thrust washer.

14. Note correct position of timing gears.

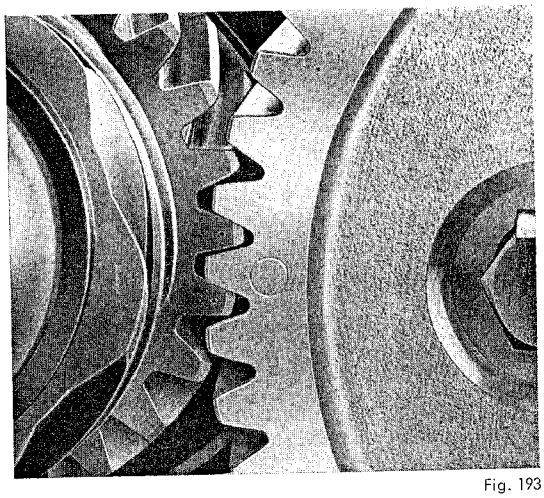


Fig. 193

15. Install camshaft end plug.

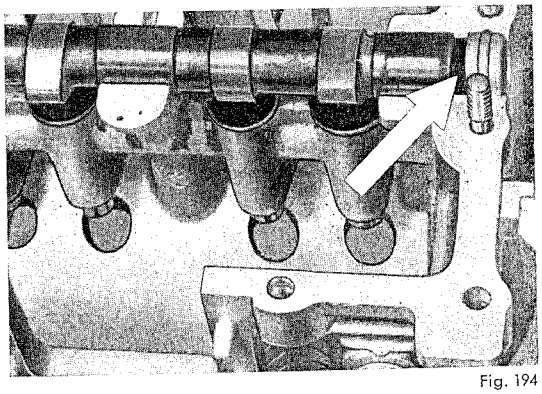


Fig. 194

16. Secure tappets in right crankcase section using springs P 49.

17. Apply a uniform thin coat of sealing compound to joining surfaces.

18. Under no circumstances may sealing compound enter oil passages of the crankshaft and camshaft bearings.

19. Assemble crankcase sections.

20. Install oil seals and washers for cap nuts. The inside bevel of the washers receives the oil rings and should face the crankcase. Tighten cap nuts to 4 mkg (29 ft. lb.) torque.

21. Tighten camshaft end bearing bolts on flywheel side.

22. Install timing case cover (40 EN).

23. Tighten timing case cover nuts to 2 mkg (14.5 ft. lb.) torque.

24. Tighten remaining M 8 nuts to 3 mkg (21 ft. lb.) torque.

25. Install new oil seal at main bearing No. 4 (38 EN).

26. Turn flywheel and check for free rotation of crankshaft. (Protect crankcase with sleeves P 51.)

27. Install fuel pump flange and fuel pump.

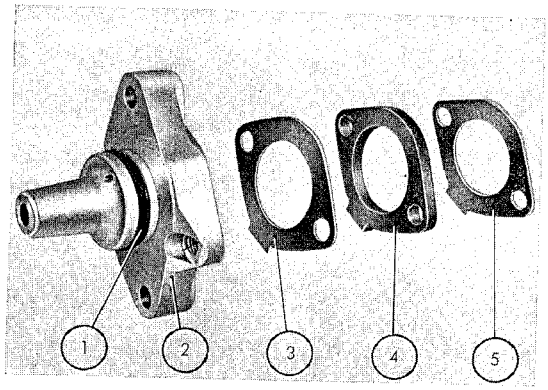


Fig. 196

① Oil ring
② Fuel pump flange
③ Gasket
④ Insulating spacer
⑤ Gasket

37 EN

Removing and Installing Distributor Drive Shaft

Special Tools: VW 126a Fuel pump wrench

Removal

1. Remove distributor cap.
2. Disconnect cable 1 from distributor.

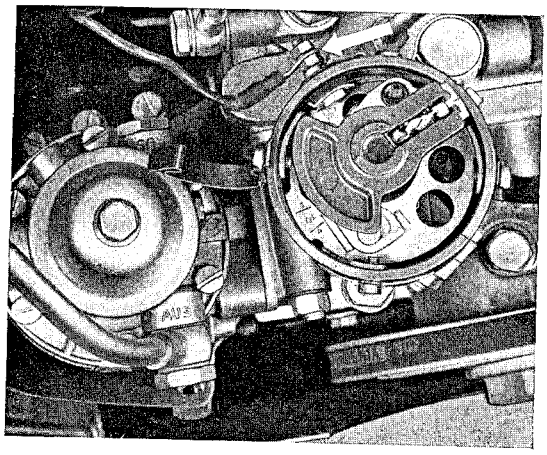


Fig. 195

3. Remove nut holding distributor base plate.
4. Remove distributor.
5. Remove fuel pump, pump flange, and push rod.
6. Grasp distributor drive shaft through fuel pump mount and lift rotating to left.
7. Remove thrust washer from distributor drive shaft housing. Caution: Do not drop washer into timing gears.
8. Remove distributor drive spring from housing.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Inspect fuel pump cam and gear for wear. If gear shows wear, a new distributor drive shaft and bronze pinion must be installed.

2. Inspect thrust washer for wear and replace if necessary. Caution: install the thrust washer using a screwdriver to prevent the washer from falling into the timing gears.

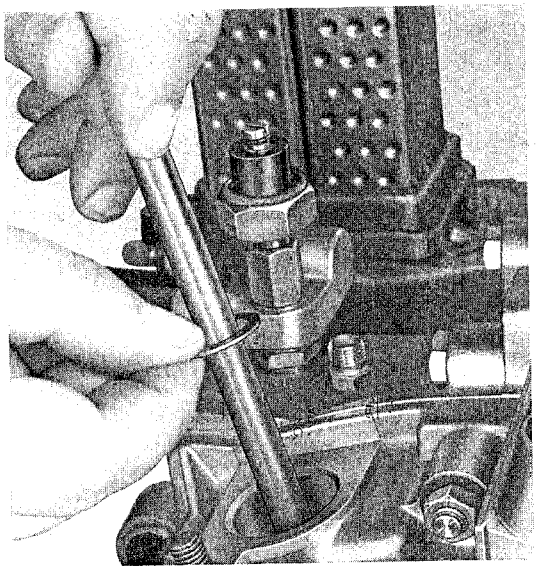


Fig. 197

3. Bring cylinder I to TDC (both valves closed) and install distributor drive shaft.

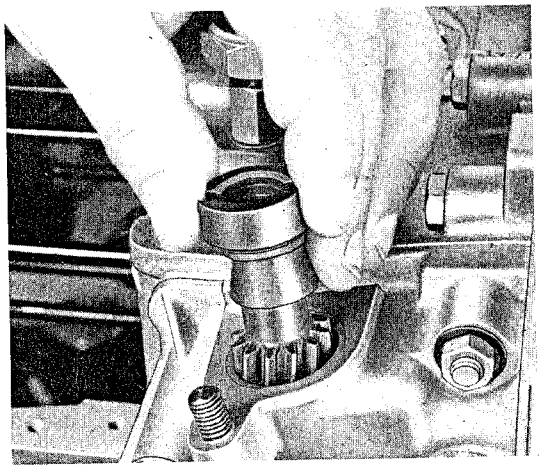


Fig. 198

The slot in the drive shaft must be parallel to the timing case cover joint and offset toward the V-belt pulley.

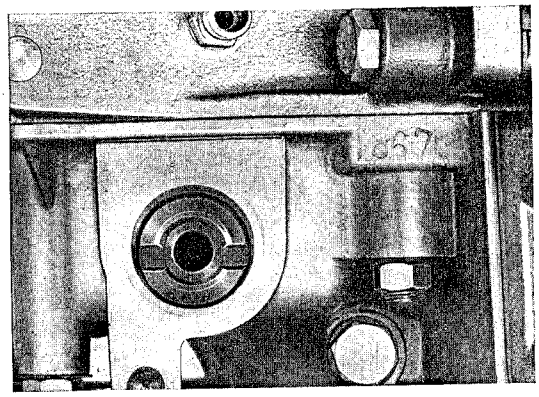


Fig. 199

4. Install the drive shaft spring using a welding rod.

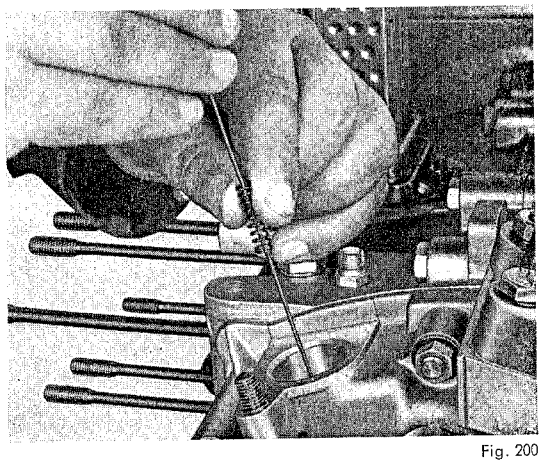


Fig. 200

5. Install distributor.

6. Connect cable I.

7. Adjust ignition timing.

8. Install distributor cap.

38 EN

Removing and Installing No. 4 Bearing Oil Seal

Special Tools: P 73 Press for installing oil seal

Removal

1. Remove V-belt pulley.
2. Remove woodruff key.
3. Distort old oil seal using a punch at the recess in the seal housing. Remove oil seal.
4. Remove oil seal washer.
5. Remove burr which may appear on housing recess.

Installation

1. Install oil seal washer.
2. Install oil seal using press P 73.

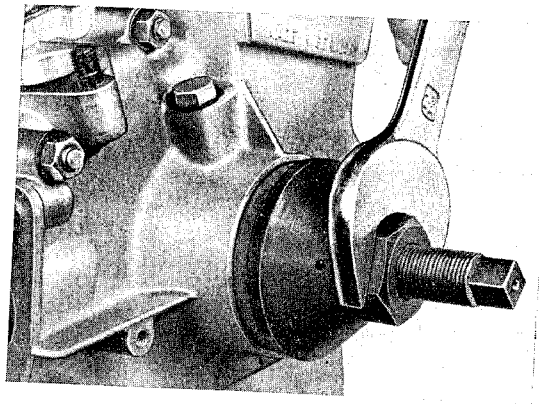


Fig. 201

3. Lubricate seal contact surface on V-belt pulley.
4. Install lock washer.
5. Install V-belt pulley.

39 EN

Removing and Installing No. 4 Bearing

Special Tools: P 27a Assembly plate for removing and installing No. 4 bearing
P 73 Press for installing oil seal

Removal

1. Remove timing case cover (40 EN).
2. Remove oil seal (38 EN).
3. Use screwdriver to pry out deformed oil seal.

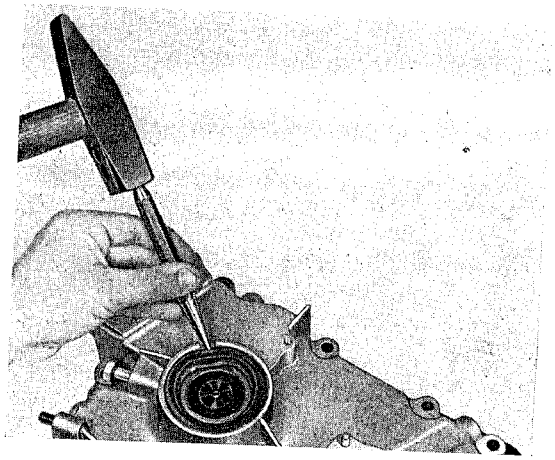


Fig. 202

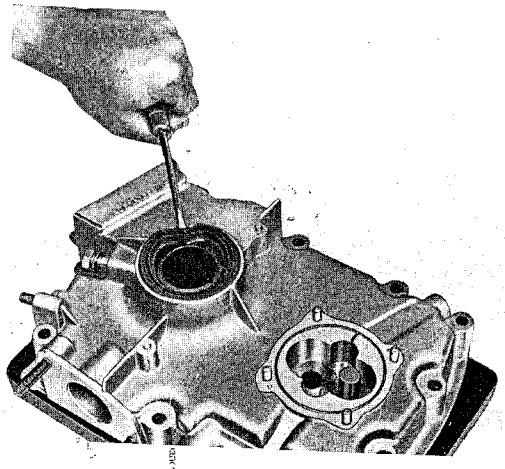


Fig. 203

4. Remove oil seal washer.
5. Loosen set screw.

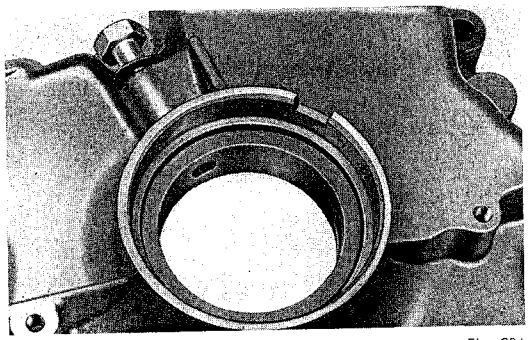


Fig. 204

6. If necessary remove burrs from oil seal housing.

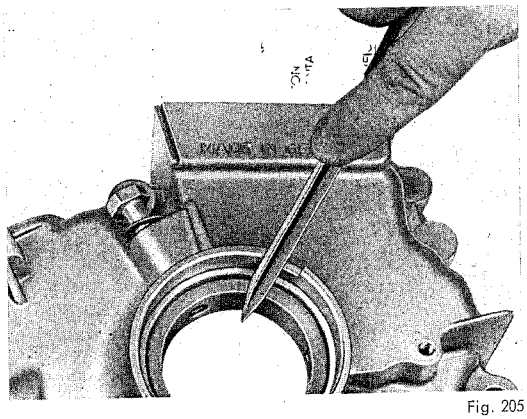


Fig. 205

7. Heat timing case cover to approx 60° C (140° F) and press out bearing No. 4 using tool P 27.

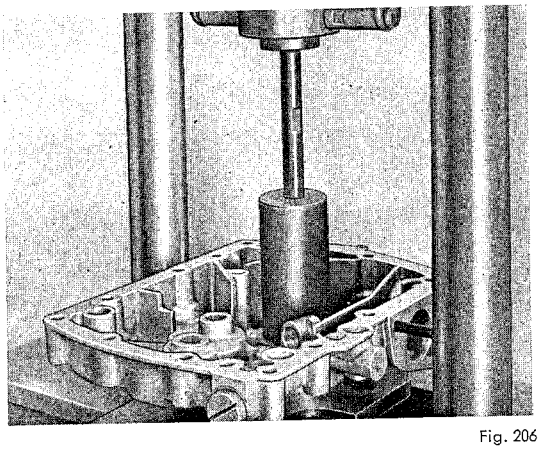


Fig. 206

Installation

1. Inspect timing case cover for damage.
2. Inspect main bearing bore.
3. Advance the set screw until it protrudes approx. 1 mm ($^1/_{32}$ in.) into the bearing bore.
4. Heat timing case cover to approx. 160° C (320° F) and set on assembly plate P 27 so that the dowels fit the recesses in the timing case cover.
5. Place bearing insert on the bearing guide of tool P 27 so that the oil hole and set screw groove are in line with the set screw.
6. Press in bearing using drift P 27.

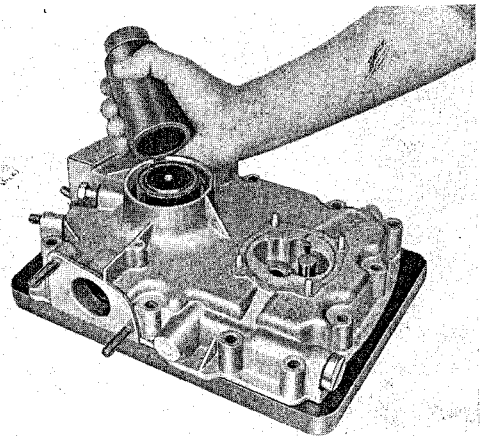


Fig. 207

7. Tighten set screw being sure that it does not press against or deform the bearing.
8. Remove sleeve from bearing guide and install oil seal washer.

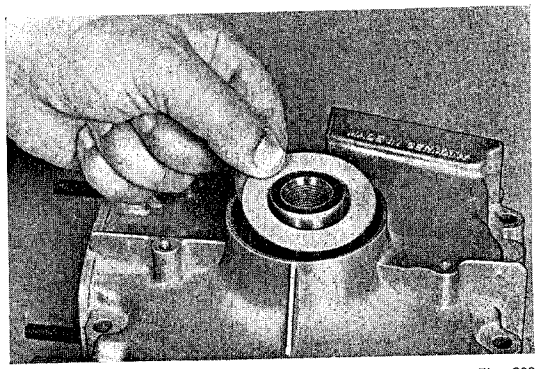


Fig. 208

9. Install oil seal using P 73 and P 27.

Note:

When pressing the bearing insert in, it is important to work quickly to prevent the insert from becoming warm, expanding, and possibly binding in the housing.

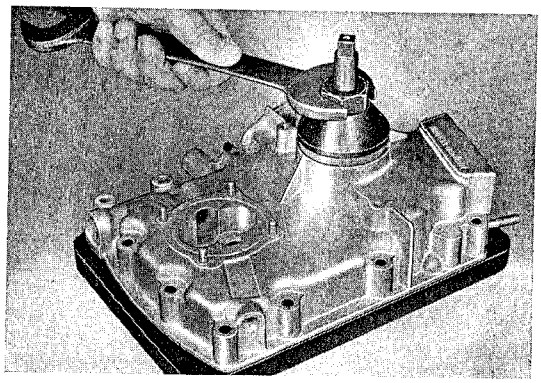


Fig. 209

40 EN

Removing and Installing Timing Case Cover

Removal

1. Remove generator (5 EN).
2. Remove generator bracket.
3. Remove distributor and distributor drive shaft (37 EN).
4. Remove fuel pump.
5. Remove V-belt pulley (42 EN).
6. Remove V-belt pulley cover.
7. Remove oil pump and tachometer drive (17 EN).
8. Remove nuts securing timing case cover.
9. Remove timing case cover.
10. Remove back pressure oil line and rubber plugs.

Note:

To prevent damaging the main bearing seal, the woodruff key for the V-belt pulley must be removed from the crankshaft before taking off the timing case cover.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Install new oil seals at the three oil line connections from the timing case cover to the crankcase. Two at the left of the camshaft gear and one to the right of the crankshaft pinion (Fig. 210). Care must be taken that these rubber rings do not become dislodged when installing the timing case cover.

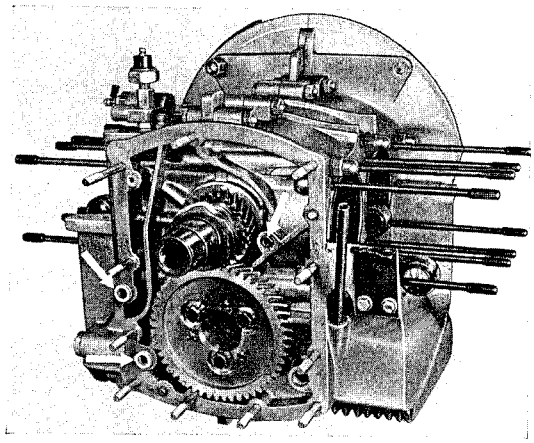


Fig. 210

2. Check whether dowel pins are secure.

3. Place one rubber plug on each end of the back-pressure oil line and install it in the timing case cover so that the upper plug has the open end, and the lower one the closed end toward the crankcase (Fig. 211).

4. Inspect main bearing oil seal for wear and replace if necessary.

5. Clean sealing compound from all joining surfaces and install a new generator bracket gasket.

6. Apply a uniform thin coat of sealing compound and install the cover. Tighten the nuts on the timing case cover to 2 mkg (14.5 ft. lb.) torque.

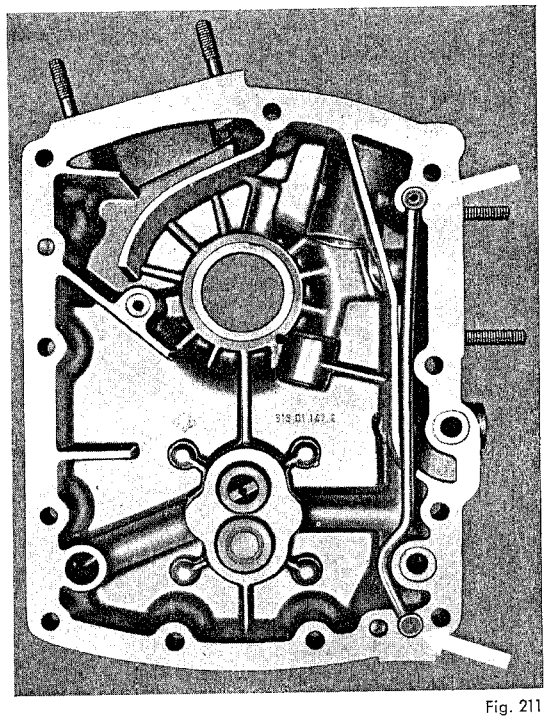


Fig. 211

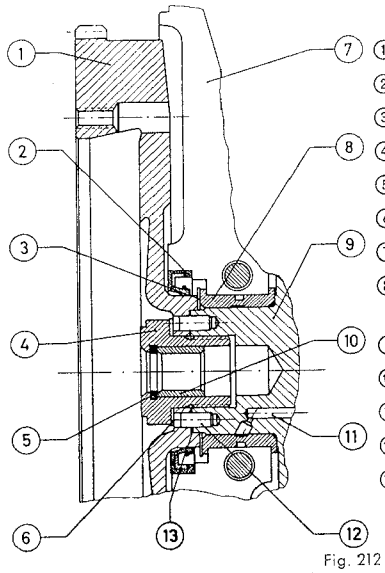
Removing and Installing Flywheel

41 EN

Special Tools: P 42 Torque wrench
P 44 Socket (36 mm)
VW 218 Gland nut bushing drift
VW 246 Limit gauge for gland nut bushing

General

The flywheel is secured to the crankshaft by a gland nut and eight dowel pins which transmit torque. A soft iron gasket is installed between the crankshaft and flywheel. An oil seal mounted in the end of the crankcase rides on the flywheel hub. The gland nut contains the pilot bushings for the gearbox main shaft.



① Flywheel
② Oil seal
③ Spacer washer
④ Gland nut
⑤ Oil seal
⑥ Lock washer
⑦ Crankcase
⑧ Main bearing No. 1
⑨ Crankshaft
⑩ Pilot bushing
⑪ Oil passage
⑫ Dowel pin
⑬ Soft iron gasket

Fig. 212

Removal

1. Remove clutch pressure plate (57 EN).

2. Remove clutch plate (57 EN).

3. Remove gland nut using P 42 and P 44.

4. Remove flywheel.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Inspect the flywheel starter ring for damage. Dress damaged teeth with a file.
2. Inspect dowel pin holes in the flywheel. If holes have become enlarged install a new flywheel.
3. Inspect dowel pins in the crankshaft, replace worn pins.
4. Install a new soft iron gasket.

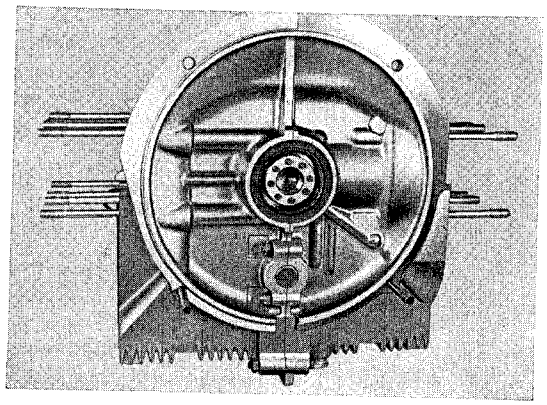


Fig. 213

5. Check and adjust crankshaft end play (50 EN).
6. Check pilot bushing in gland nut using gauge VW 246.
7. If the bushing requires replacement, the oil seal must also be replaced. Install new bushing using drift VW 218.
8. Tighten gland nut 35 to 37 mkg (254 to 268 ft. lb.).
9. Check flywheel for trueness. Max. permissible wobble 0.3 mm (.012 in.) measured at center of the clutch plate pressure surface. Max. permissible eccentricity 0.1 mm (.004 in.) measured on the surface indicated by the arrow in Fig. 214.

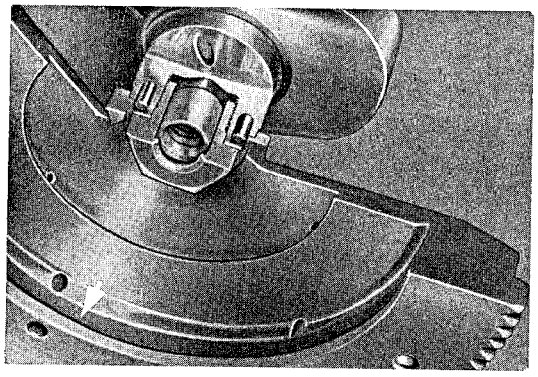


Fig. 214

Note:

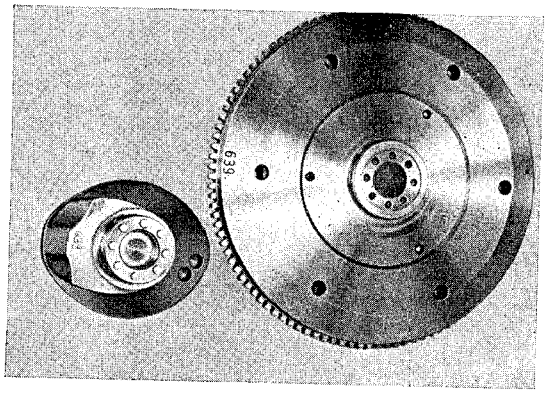


Fig. 215

The crankshaft and flywheel are balanced as a unit and are marked with the same number. When installing the flywheel the number must be same as the crankshaft. When a new flywheel or crankshaft is to be used, the two components must be removed and balanced together and the new part should then be stamped with a matching number.

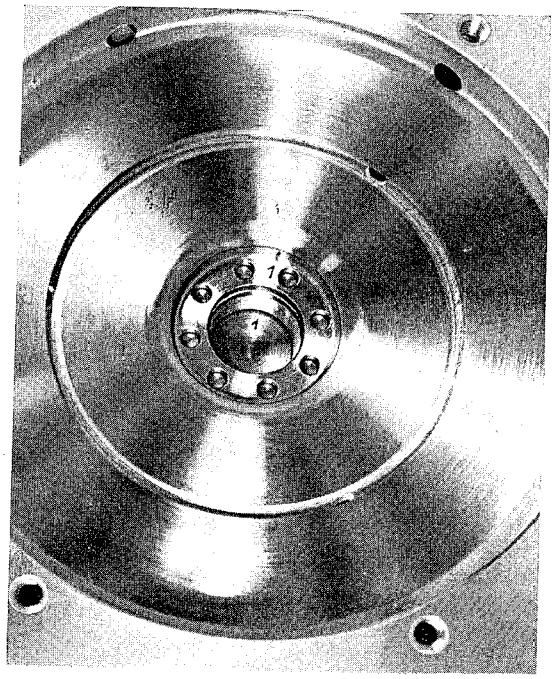


Fig. 216

In order to simplify installing the flywheel in the correct position on the crankshaft, one pair of dowel pins is closer together than the other pins. This pair is marked with the number 1 on the crankshaft and flywheel.

Removing and Installing V-belt Pulley

Special Tools: P 43 Puller for V-belt pulley

42 EN

Removal

1. Remove V-belt.
2. Remove rear cover plate.
3. Remove pulley bolt.
4. Remove pulley using puller P 43.

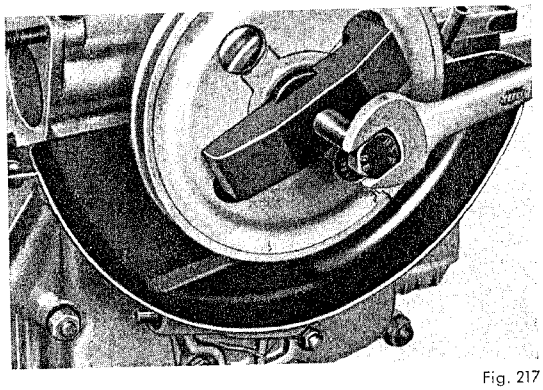


Fig. 217

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Inspect the pulley hub and oil seal surface for damage or defects.
2. Insure that the pulley runs true.
3. Check surface of oil seal.
4. Insure that the oil seal is in good condition; replace if necessary.

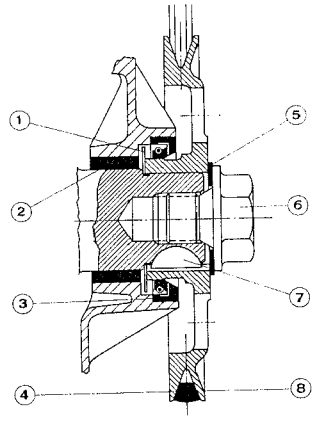


Fig. 218

① Oil seal washer
② Main bearing No. 4
③ Oil seal
④ V-belt
⑤ Lock washer
⑥ Pulley bolt
⑦ Woodruff key
⑧ V-belt pulley

Removing and Installing Crankshaft Oil Seal at Flywheel

Special Tools: VW 204 Press for installing oil seal

43 EN

Removal

1. Remove the flywheel (41 EN), and inspect the oil seal surface on the flywheel hub.
2. Remove oil seal.
3. Clean the oil seal seat and apply a thin coat of sealing compound. If necessary remove sharp edges from the housing with a scraper.

Installation

1. Install a new oil seal using press VW 204 by mounting the oil seal on the collar and threading the tool into crankshaft.
   The oil seal must seat flush on the bottom of the oil seal recess.
2. Remove the press.
3. Install a new soft iron gasket.
4. Install the flywheel. Apply a light coat of oil on the seal surface.

44 EN

Removing and Installing Camshaft

General

The 1600 and 1600 S engines are equipped with different camshafts. The cam rise for 1600 engines is 33.2 mm (1.307 in.) and for 1600 S engines 35 mm (1.379 in.). Camshaft gears for both engines are cast light alloy.

Removal

1. Disassemble crankcase (36 EN).
2. Remove camshaft.

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Check whether the camshaft gear is secure on the camshaft.
2. Inspect the camshaft bearings and cams for wear (worn lift ramps or uneven contact).
   See Tolerances and Wear Limits pages E 110 and E 111.

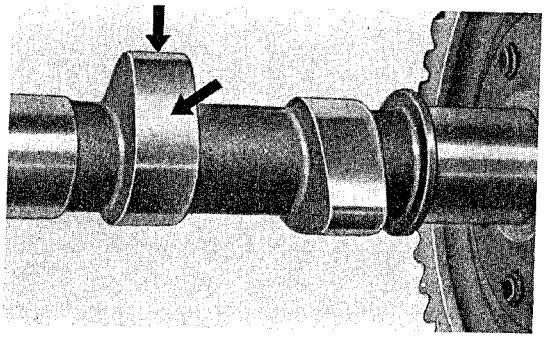


Fig. 219

3. Check the camshaft for trueness.
4. Inspect the camshaft gear for wear and correct gear contact.
5. Install the camshaft so that the gear tooth marked "O" lies between the gear teeth with punch marks.

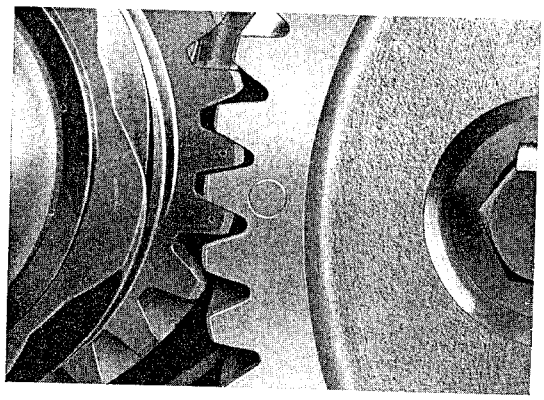


Fig. 220

6. Check the gear tooth clearance around entire circumference of the camshaft gear. The correct clearance between the timing gears is 0.015 to 0.040 mm (.0006 to .0016 in.). This measurement is made using a dial gauge while rotating the camshaft gear back and forth with the crankshaft held stationary.

In order to meet the tolerance requirements, camshaft gears are supplied in five sizes.

Camshaft gears are marked on the cam side −2, −1, 0, +1, +2. This figure indicates how many $^{1}/_{100}$ mm the pitch diameter is greater or smaller than standard size.

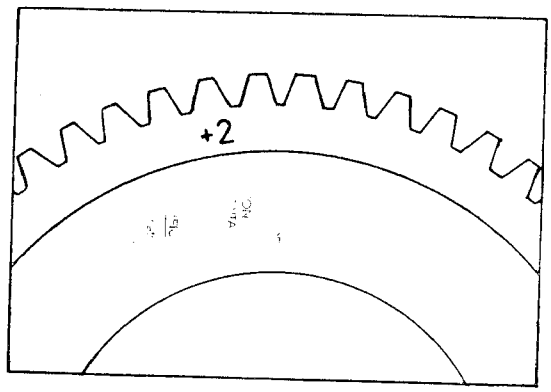


Fig. 221

Size marking on a light alloy camshaft gear. △

Note:

Do not confuse the number "0" with the timing mark "O" on the other side of the gear. The crankshaft gears are available in one size only and have no size marking.

7. Lubricate with graphite oil and install camshaft.

8. Install camshaft end plug.

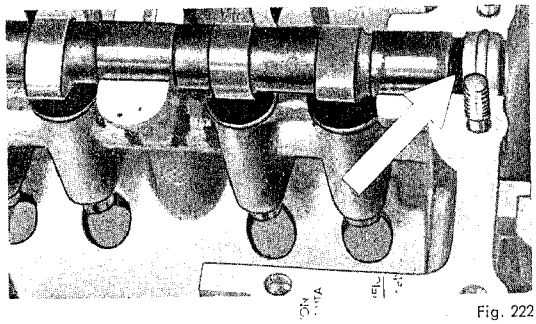


Fig. 222

9. When using a new crankcase, test camshaft rotation and bearing contact using engineer's blue. Remove sharp edges with a scraper.

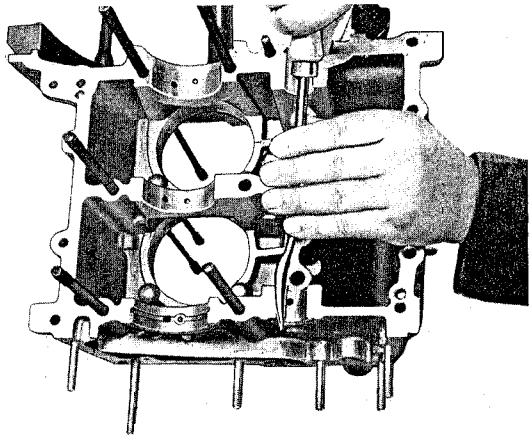


Fig. 223

Note:

If a new camshaft gear is installed, the timing mark, the nearest mounting bolt, and the oil pump drive slot on the camshaft must be in line.
Before drilling and tapering the 5.8 mm (.228 in.) dowel pin holes toward the camshaft, mount the gear and check for eccentricity. The three dowel pins are driven into the gear from the outside so that they fit snugly in the tapered holes and are secured by three punch marks. If necessary, oversize dowel pins can be locally fabricated from high quality steel. Tighten camshaft gear screws to 2.5 mkg (18 ft. lb.) torque.

Removing and Installing Crankshaft and Connecting Rods

45 EN

Removal

1. Disassemble crankcase (36 EN).

2. Remove camshaft.

3. Remove the crankshaft with connecting rods. Do not store a crankshaft without protecting it with preservative grease.

4. Mark both halves of No. 2 bearing insert.

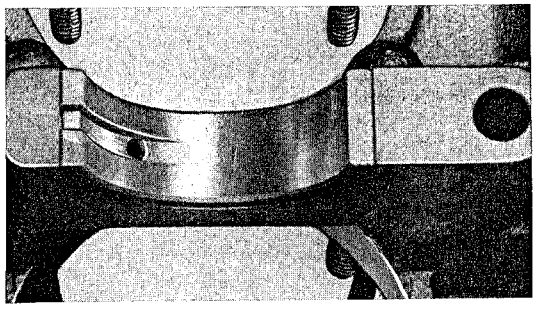


Fig. 224

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Remove sharp edges from the main bearing seats at

the crankcase joint, so that bearings No. 1 and No. 3 will not be gouged when assembling the crankcase.

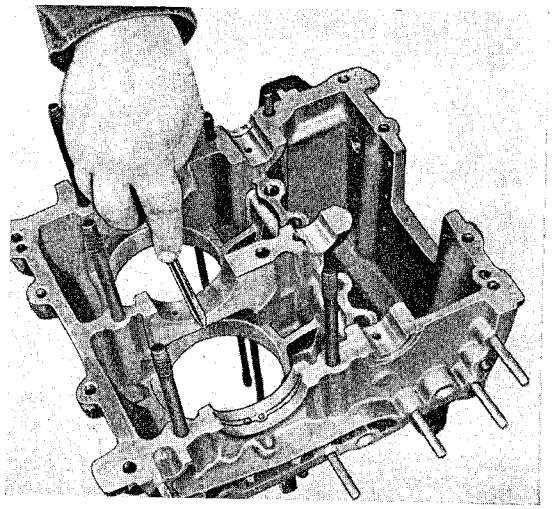


Fig. 225

2. Check whether dowel pins are secure.

3. Remove all sharp edges from the oil holes in the crankshaft journals and bearing inserts.

4. Insert one half of bearing No. 2 in the crankcase.

5. Place bearing insert No. 1 on the crankshaft with the dowel pin hole nearest the flywheel end.

6. Install bearing inserts so that the dowel pins fit and oil holes are in line with the oil passages in the crankcase.

7. Install the crankshaft and check each bearing to insure that the dowel pins fit properly.

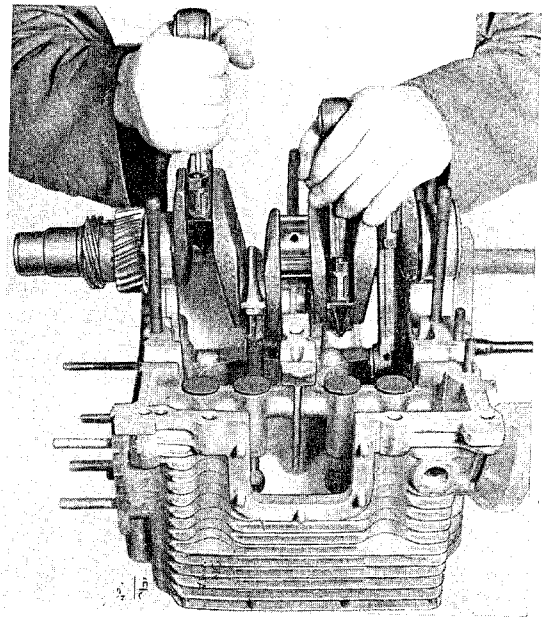


Fig. 226

8. Install camshaft noting timing marks.

46 EN

Removing and Installing Connecting Rods

Special Tools: VW 310 Crankshaft stand

Removal

1. Remove crankshaft (45 EN) and mount in crankshaft stand VW 310 (49 EN).

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

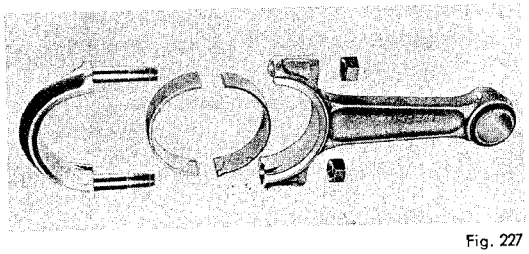


Fig. 227

Connecting rod and bearing inserts (Exploded view).

Installation

The installation is accomplished in the reverse order of removal observing the following points:

1. Weigh connecting rods. Maximum permissible weight difference between connecting rods of one engine is 15 grams (0.53 oz.).
2. Check piston pin bushings. A new bushing should allow the piston pin to be installed by a light push fit.
3. Check connecting rod alignment and straighten if necessary (48 EN).
4. After carefully cleaning all parts, assemble connecting rods on the crankshaft. The identification number on the rod and rod cap must be on the same side.
5. Tighten connecting rod nuts to 4.5 mkg (32.6 ft. lb.) torque.

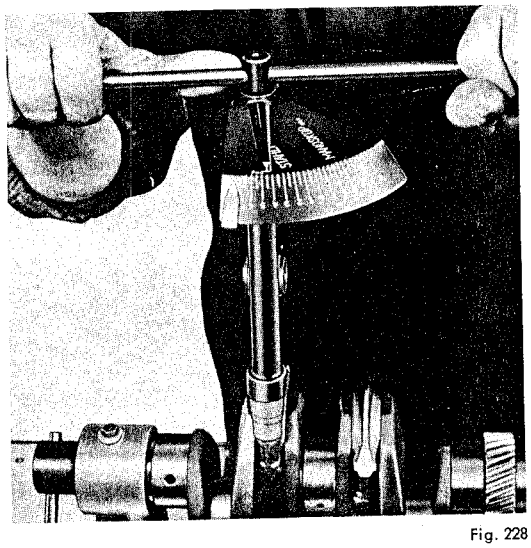


Fig. 228

6. Check whether connecting rod caps fit flush against the rods and have no obstructions in the joint.

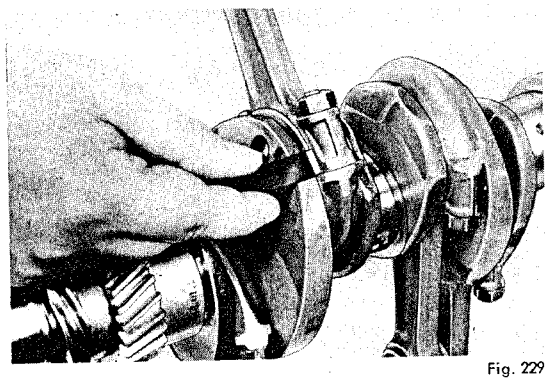


Fig. 229

7. Stresses which may arise from tightening the nuts should be relieved by light tapping with a hammer. Lightly oiled connecting rods should turn freely under their own weight. Under no circumstances should bearings be altered to fit.

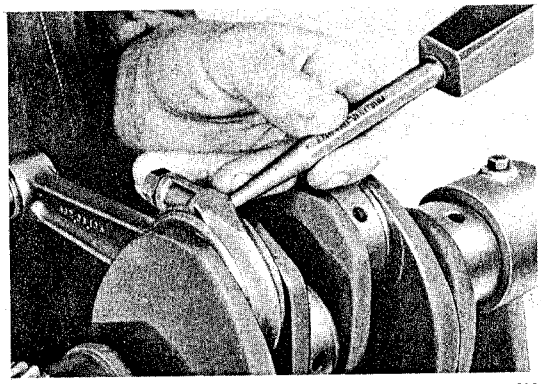


Fig. 230

8. Lateral clearance between connecting rods and crankshaft should be from 0.10 to 0.30 mm

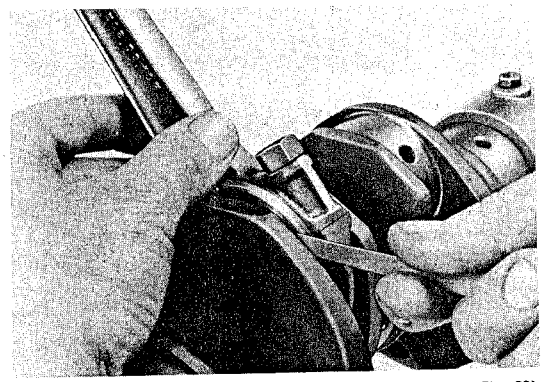


Fig. 231

Second Edition of this Page, March 1962

47 EN

Replacing Piston Pin Bushings

Special Tools: P 15 Press for extracting and installing piston pin bushings

Replacing piston pin bushings with connecting rods removed from engine.

If piston pin clearance is excessive in the connecting rod, a new bushing must be installed observing the following points:

1. Remove old bushing using a standard press or press P 15.

2. Install new bushing and ream to correct size.

3. In no case should worn out bushings be bored out and oversize piston pins be used.
   When ordering new or exchange connecting rods, it is important to indicate the weight of the old connecting rods.

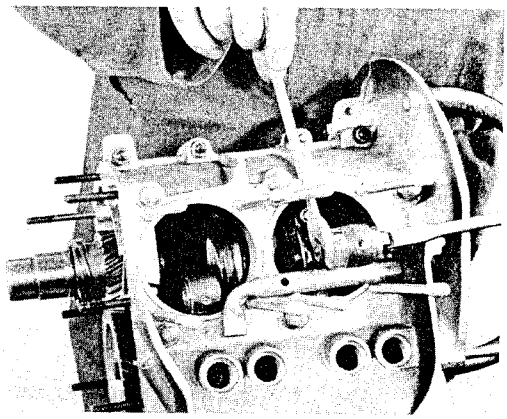


Fig. 232

Replacing piston pin bushings with connecting rods in engine.

Note:

The piston pin bushings should be precision reamed. However, if it becomes necessary to replace the bushing while the connecting rod is installed, a hand reamer may be used with extreme care.
Remove old bushing as shown in Fig. 232 and install new bushing as in Fig. 233.

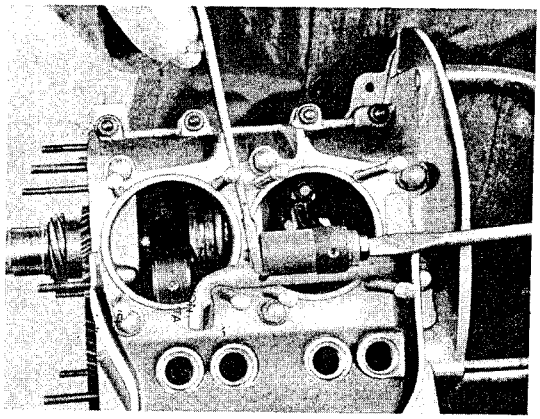


Fig. 233

48 EN

Measuring and Aligning Connecting Rods

Special Tools: P 14 Connecting rod gauge

Measuring

1. Disassemble the engine and remove connecting rods from the crankshaft. Mark connecting rods and caps with their respective locations for proper installation.

2. Remove bearing inserts.

3. Mount connecting rods on gauge P 14.

4. Insert measuring pin in the connecting rod and check angular and lateral alignment.

Aligning

Use standard aligning tools to straighten connecting rods.

Checking lateral alignment.

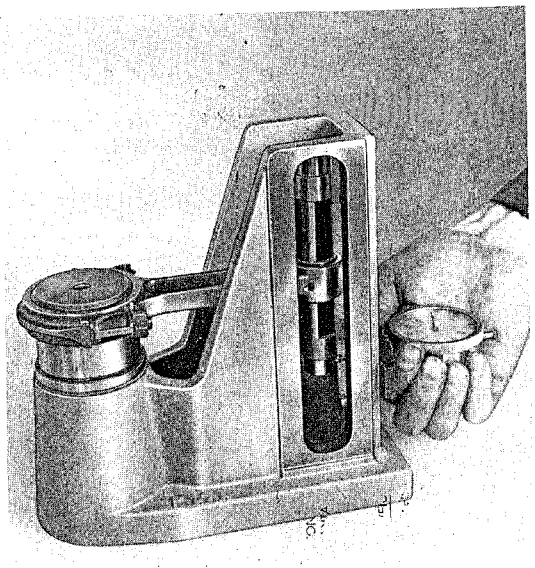


Fig. 234

Checking angular alignment.

Fig. 235