

3. Basic engine equipment

M 01.00 Crankcase

M 01.10 Removing and installing balancing weights - 2L / 3L



Preparatory work:

- Remove the crankshaft, see M 02.00.

Dismantling:

- Unscrew and remove machine screws (1/1) at driver (1/2).

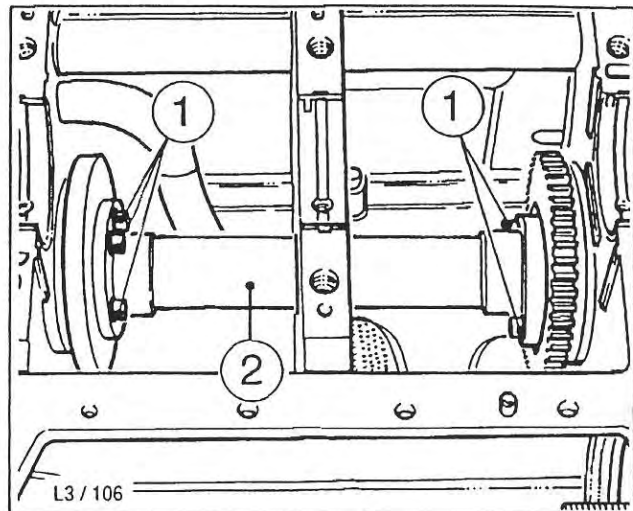
Note:

On the 3 L, also unscrew and remove the machine screws at the divided driver.

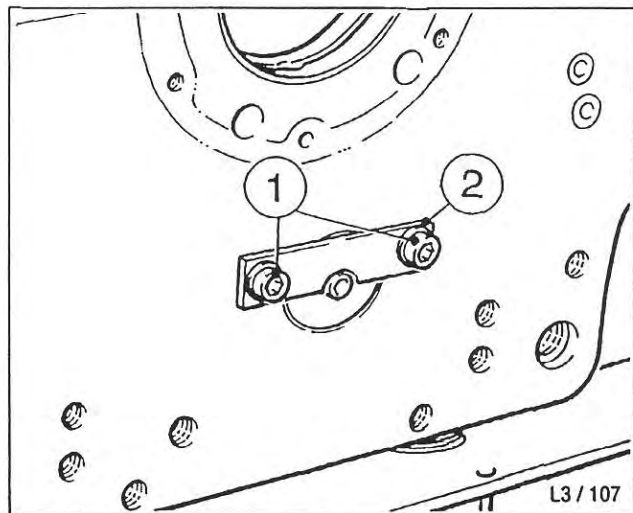
- Unscrew and remove the machine screws (2/1) at the plate (2/2) and take off the plate.
(On more recent version: secured with stud bolts and nuts)
- Unscrew the plug from the thrust bushing at the timing end of the engine and drive the shaft out towards the flywheel end; see Fig. 3.
- Drive out the thrust bushing (timing end).
- Take the balancing weights and driver out of the lower part of the crankcase.

Checking / repairs:

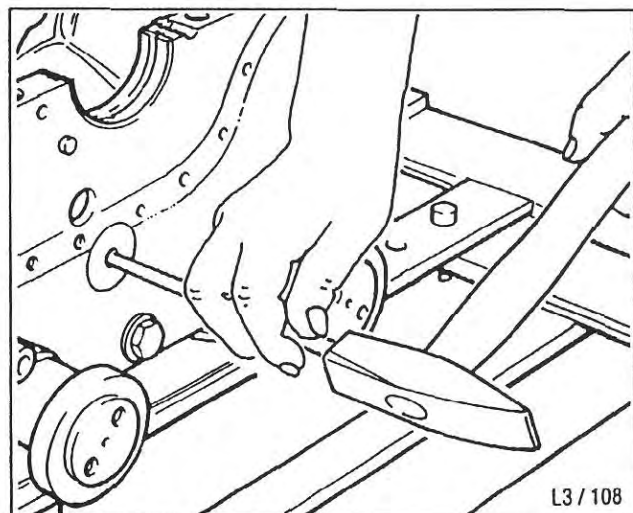
- Check the shaft at its bearing points for score-marks and correct dimensions; for values, see Section 4.
- Check the needle roller bearings of the balancing weights for score-marks.
- Check the gearwheel with balancing weight and the crankshaft-end gearwheel for the balancing weights for signs of damage.
- Renew the O-ring seals at the thrust bushings.



1



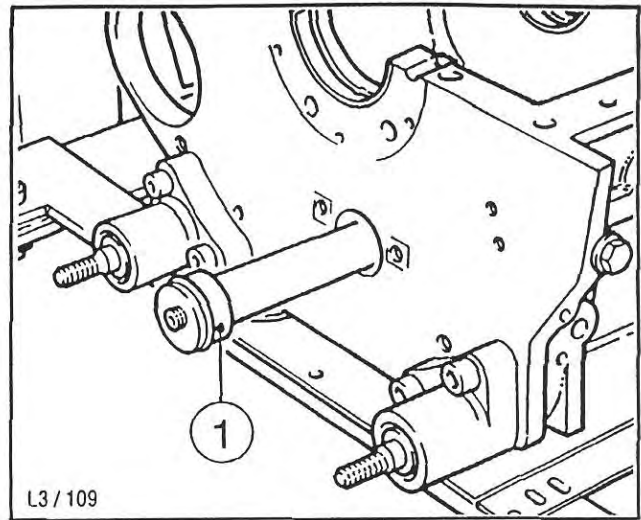
2



3

Assembling:

- Insert the thrust bushing (timing end) until flush with the housing.
- Place the gearwheel with balancing weight (flywheel end) and the balancing weight (timing end) in the lower part of the crankcase, insert the driver and screw hand-tight to the balancing weights. Insert the shaft with thrust bushing (4/1) from the flywheel end, see Fig. 4, and drive it fully into the timing-end thrust bushing.



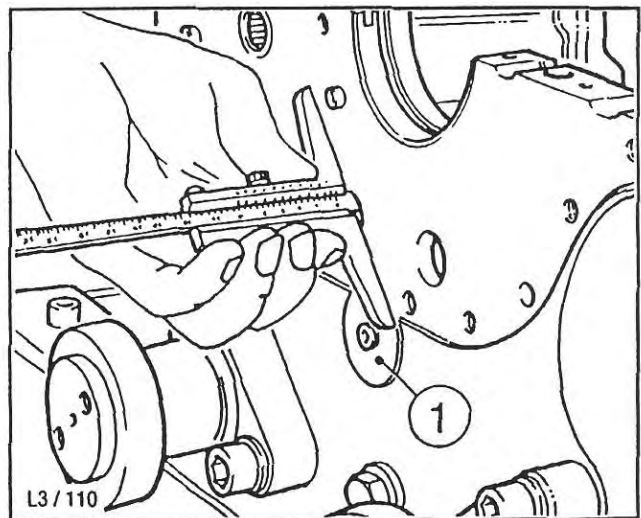
4

- Tighten the machine screws for the driver and use a depth gauge to measure endplay at the balancing weights; see Fig. 5.

Note:

The timing-end thrust bushing (5/1) forms part of the sealing face at the timing case cover, and must therefore be flush with the endface of the crankcase after driving in the shaft.

Endplay can be adjusted by moving the flywheel-end thrust bushing axially until the value stated in Section 4 is obtained.

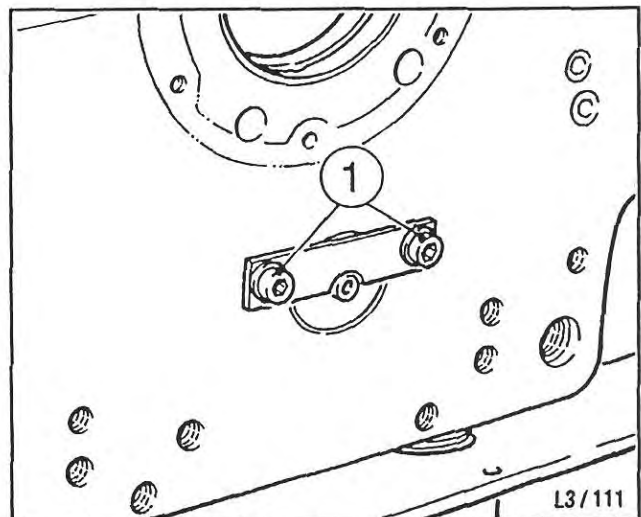


5

- Apply sealant **D** to the machine screws (6/1) and attach the plate; also coat the screw plug for the timing-end thrust bushing with sealant **D** and screw it in. Turn the balancing weights to ensure free rotation.

Note:

When installing the oil sump and the crankcase cover, apply sealant **D** to two M8 hex bolts in each case at the timing and flywheel ends, where a through-hole has been drilled.



6

M 01.00 Crankcase

M 01.20 Removing and installing balancing weights - 4 L

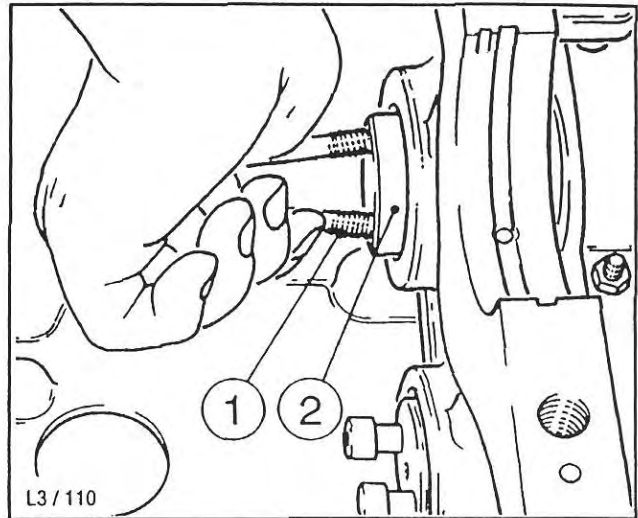


Preparatory work:

- Remove the crankshaft; see M 02.00.
- Take off the oil sump.

Dismantling:

- Unscrew the machine screws (7/1) at the bearing journals (7/2) and pull them out. Using two machine screws, loosen the bearing journals and pull them out. Mark the installed positions of the bearing journals.

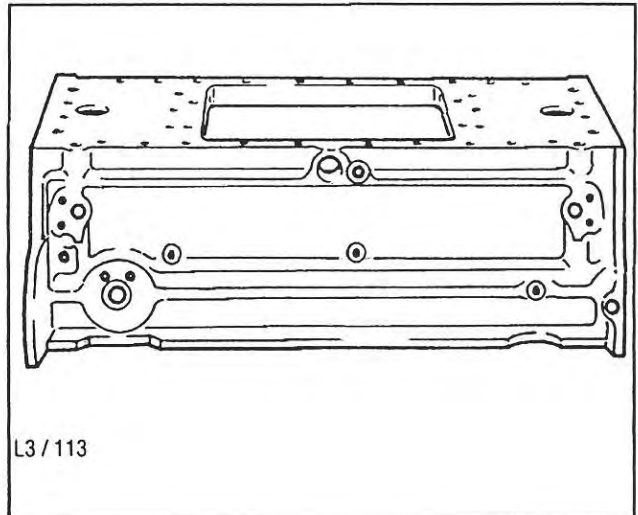


7

- Invert the lower part of the crankcase.

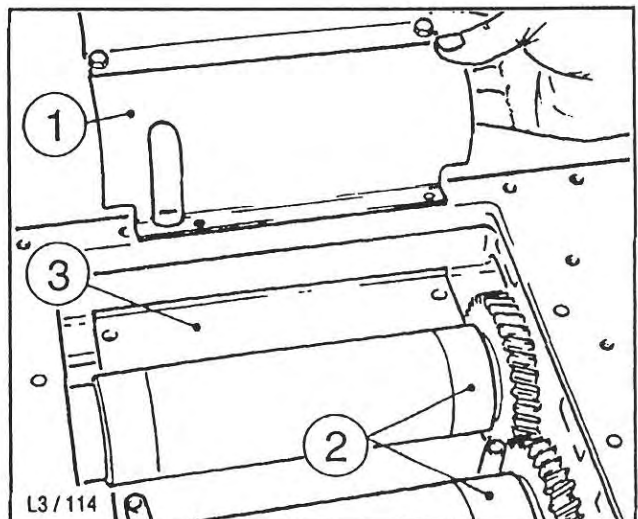
Note:

The joint line is a sealing face, and must not be damaged. Place the crankcase on a wooden grid or frame; see Fig. 8.



8

- Unscrew splash plate (9/1) and take out balancing weights (9/2), then remove splash plate (9/3).

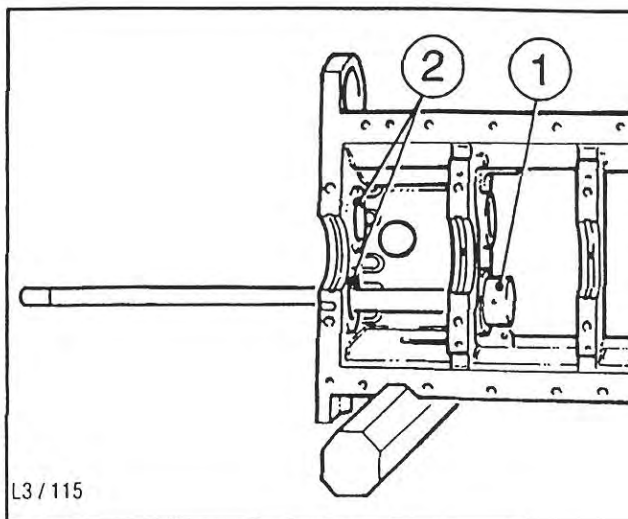


9

- Check dimensions of bearing bushings (10/1) and, if necessary, drive them out with a suitable drift. First drive the end caps out of the crankcase bores (10/2).

Checking / repairs:

- Check the bearing journals and bushings for score-marks and incorrect dimensions; for values, see Section 4.
- Check the balancing weight gearwheels and the crankshaft-end gearwheel for the balancing weights for damage.



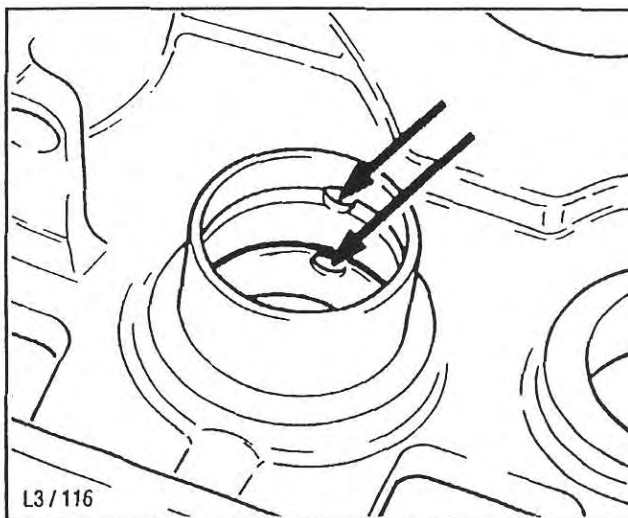
10

Assembling:

- Blow through the oilways thoroughly with compressed air.

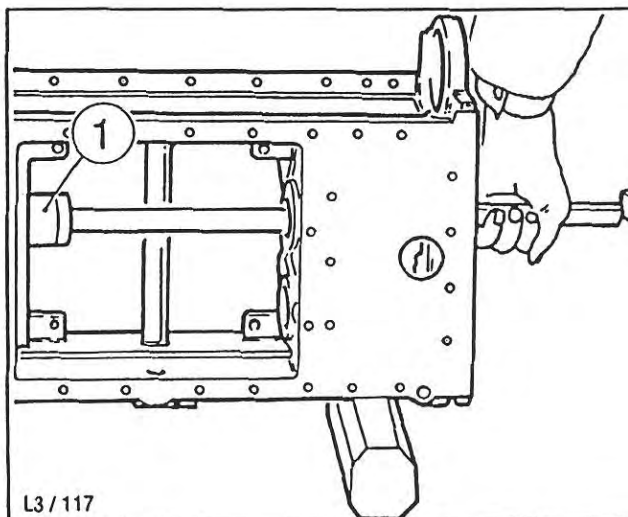
Note:

Before installing the bearing bushings, make sure that the oil hole is in the correct position; see Fig. 11.



11

- Coat the bearing bushings (12/1) with sealant D and drive them into the housing until flush, using a suitable drift; see Fig. 12.
- Coat the sealing faces of the end caps (10/2) with sealant C and insert them again.
- Renew the end caps.

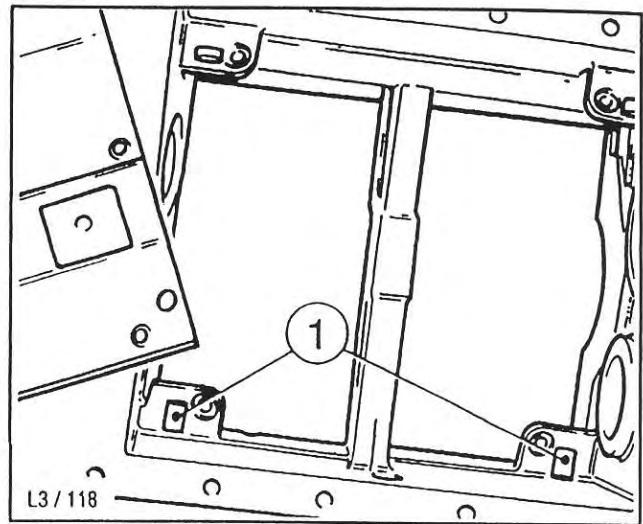


12

- Insert spacing rollers for the M8 screws in the correct positions as shown in Fig. 13.

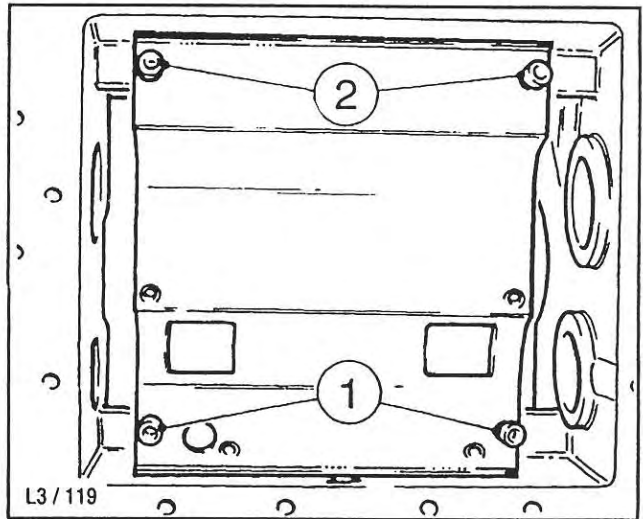
Note:

Insert the longer spacing rollers (13/1) at the oil filter flange side.



13

- Insert splash plate as shown in Fig. 14, insert the lower machine screws (14/1) and tighten them. Screw the upper machine screws (14/2) in only hand-tight.

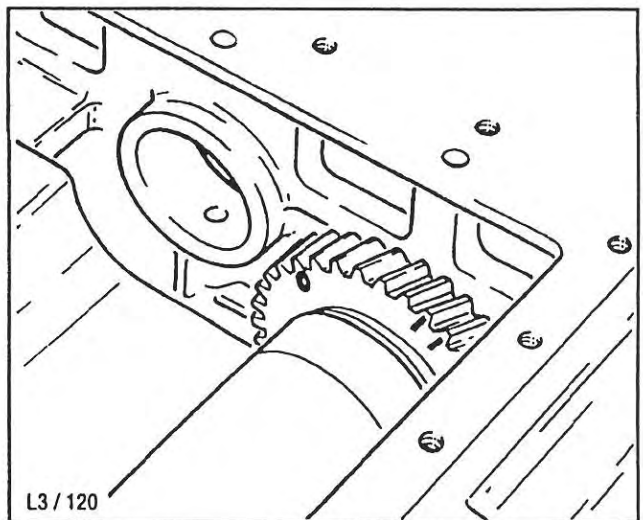


14

- Insert the balancing weight with circle and line markings as shown in Fig. 15, and push in the bearing journal.

Note:

This balancing weight is driven directly from the crankshaft.



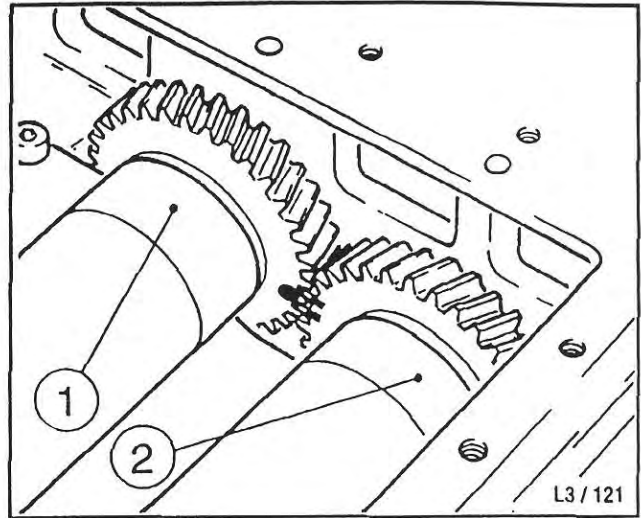
15

- Insert the balancing weight with circle mark (16/1) and push in the bearing journal.

Note:

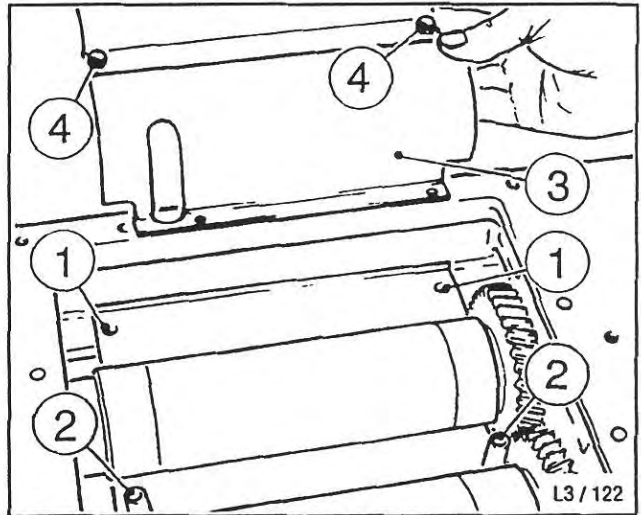
When installing this balancing weight (16/1), make sure that the circle mark on it is between the two line marks on balance weight (16/2).

In this position, the circle mark on balancing weight (16/2) must face the crankshaft.



16

- Take out the two machine screws at holes (17/1) again.
Place spacing rollers (17/2) on the splash plate.
Insert splash plate (17/3) and screw in hex bolts (17/4) hand-tight.
- Insert machine screws (17/1) and tighten.; also tighten hex bolts (17/4).



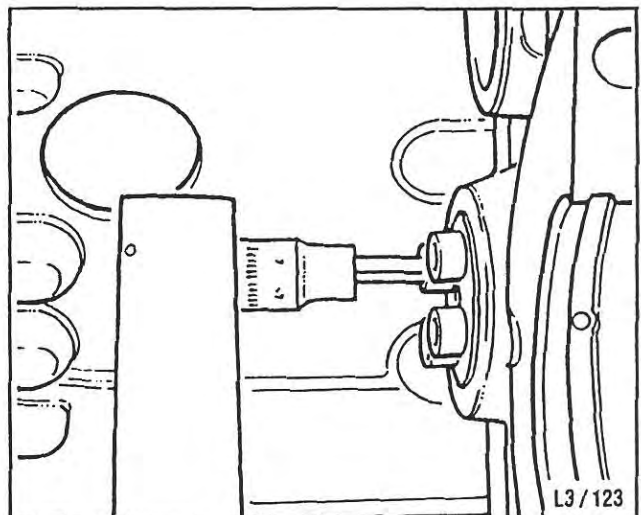
17

- Turn the lower part of the crankcase back upright again (joint line at the top).
- Insert the machine screws at the bearing journals and tighten them to the specified torque with a torque wrench; Fig. 18.
- Rotate the balancing weights and check for free movement.

Note:


When attaching the oil sump, apply sealant D to two M8 hex bolts in each case at the timing and flywheel ends, since these are inserted in through-holes.

Engines with an oil sump attached must not have a Ø 40 mm end cap installed in the lower part of the crankcase.



18

M 01.30. Cleaning the crankcase, installing the oil spray jets

 - 41 -

Cleaning the crankcase

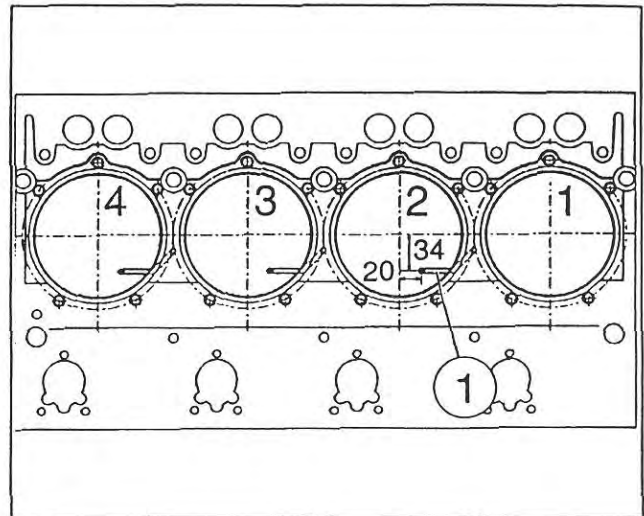
- Remove all screw plugs from the oilways and, after cleaning the crankcase by immersion in a cleaning bath or with high-pressure cleaning equipment, blow it dry with compressed air; flush out all oilways particularly thoroughly and blow through them, so that no particles of dirt or swarf remain.
- After this, insert all screw plugs again and check that the aluminium or sheet-metal plugs for the oilways are firmly seated. In case of doubt, renew them; apply sealant **E** to all plugs before inserting. To ensure firm location, secure the aluminium plugs with light punch-marks at the edge of the hole in the housing.

Oil spray jets

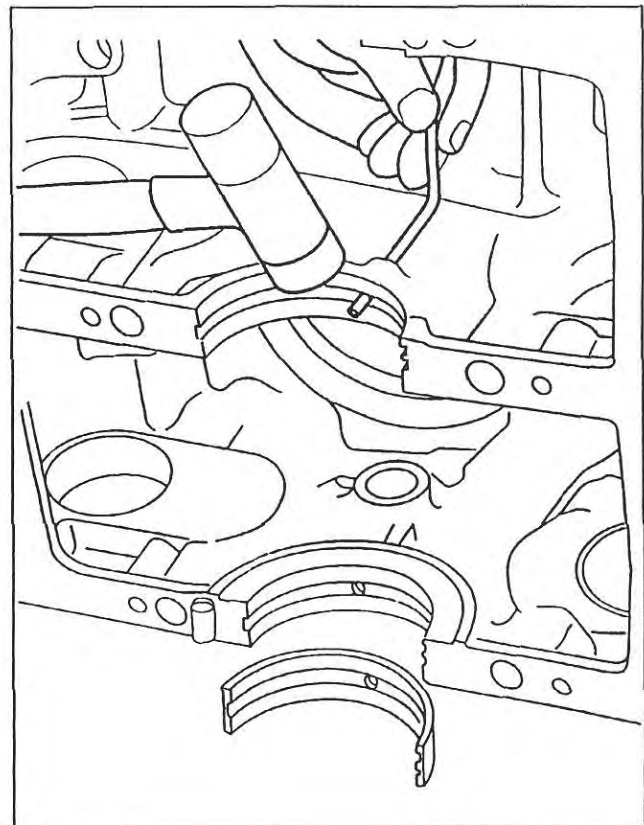
- First check for firm location and accurate spray direction; if necessary, re-align the spray jet with light hammer-blows or bend it carefully by hand until the correct position is reached. Check this with the gauge - 41 - or work from the drawing shown here (Fig. 171).

If oil spray jets have broken off or are loose, new ones must be inserted. Proceed as follows:

- Remove pieces of the old jet from the drill-way (with a suitable drift or similar tool); degrease the entire area thoroughly; insert the new spray jet and drive it in initially app. 6 - 8 mm farther than its final position. Strike the projecting end lightly with a hammer to bend it slightly and ensure a firm seating in the bore (Fig. 172).



171

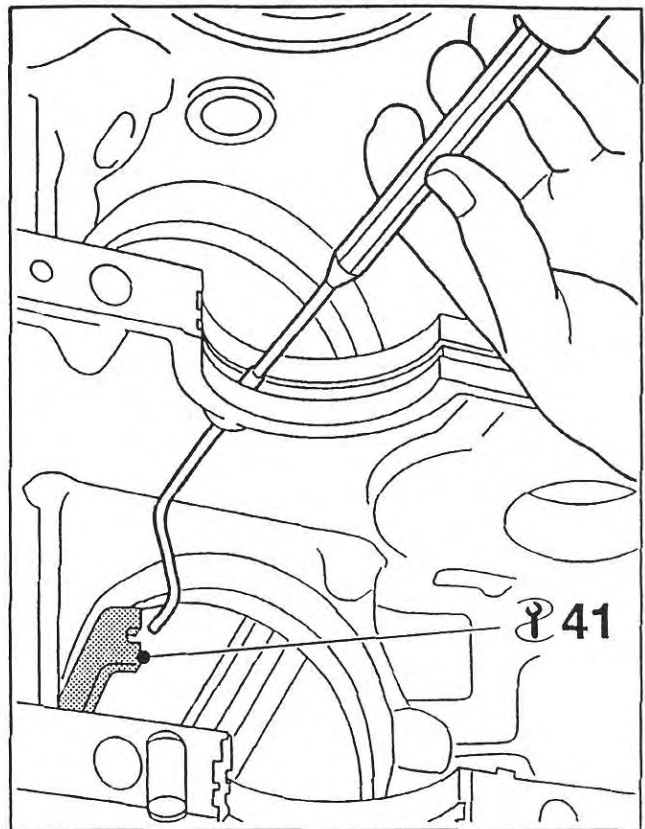


172

- Apply sealant **E** to the projecting end and move the spray jet to its final position. Do not dent the jet inlet bore; drive it in until the end of the tube is flush with the oil groove in the bearing seat (Fig. 173).
- Check the position of the jet outlet again, and adjust if necessary.
- Apply sealant **E** again where the spray jet passes through opposite the bearing seat; the capillary action of the sealant will ensure that the tube is fully coated and cannot shake loose in its seat.

Note:

On Series L 41 and M 41 engines, an oil spray jet is also installed for cylinder 1.



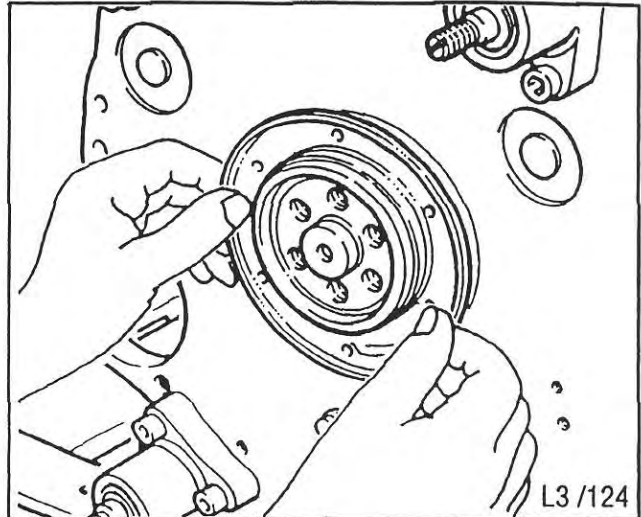
173

M 02.00 Crankshaft

⌘ - 8 -

Preparatory work:

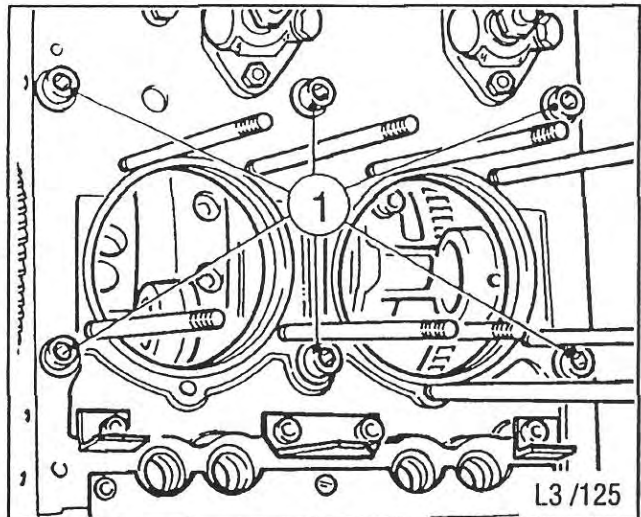
- Take off enclosure parts and air guide plates; see M 35.00.
- Take off cylinder heads; see M 07.00.
- Detach fan and V-belt pulley from crankshaft; see M 13.00.
- Remove piston, conrod and cylinder; see M 05.00 / M 06.00.
- Take off flywheel and connecting housing.
- Detach the timing case cover; see M 11.00.
- Take off the starter motor.



19

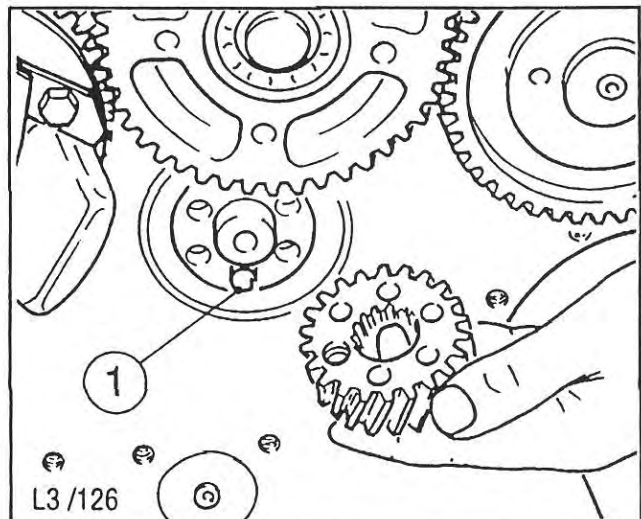
Dismantling:

- Remove machine screws and spring washers for end cover and pull off the end cover; see Fig. 19.
- Unscrew the machine screws(20/1) and pull them out.



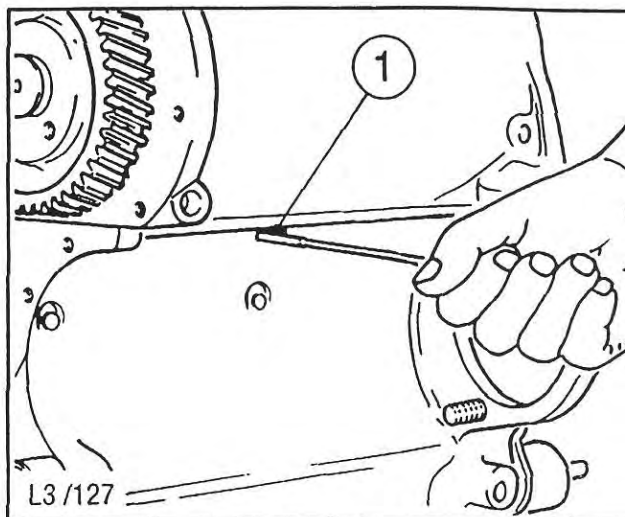
20

- Remove machine screws from crankshaft gearwheel, loosen the gearwheel on the crankshaft with a plastic-faced hammer and pull it off.
- Pull out the locking collet (21/1).



21

- Unscrew and remove the hex bolts (22/1) at both sides.

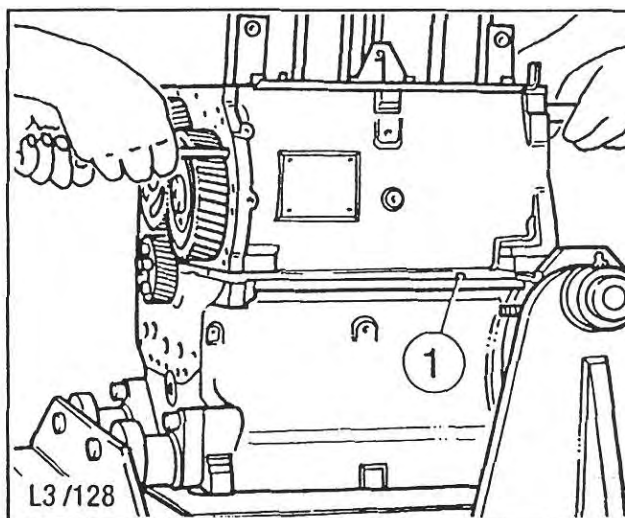


22

- The two halves of the crankcase are secured together with straight pins (23/1). Drive these back with a hammer and a suitable drift until they are flush with the sealing face. Lift the upper part of the crankcase up vertically: Fig. 23.

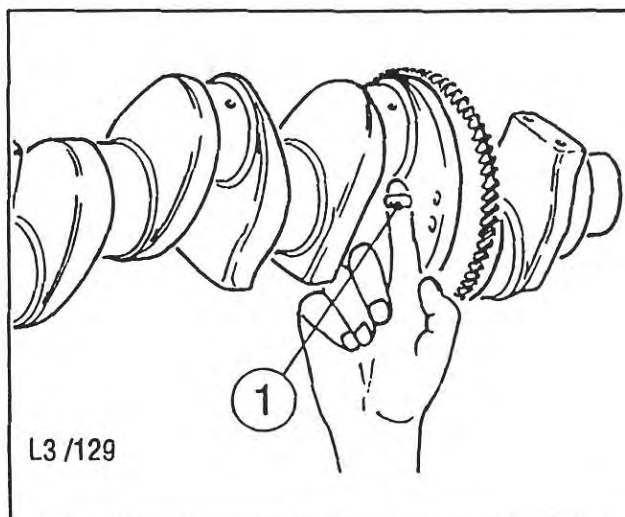
Note:

To simplify the loosening and lifting off of the upper part of the crankcase, insert two M 8 x 65 machine screws (retaining screws of setting-down device) at the timing end and two M 14 x 50 hex bolts (used to secure connecting housing) at the flywheel end in the holes provided.



23

- Lift the crankshaft out of the lower part of the crankcase.
 - Carefully warm the balancing weight gearwheel on the 2 and 3 L ... with a welding torch and knock it off with an aluminium drift.
- For the 4 L ... crankshaft, unscrew and remove the flywheel-end counterweight, remove the machine screws for the gearwheel and drive out the straight pin (24/1).



24

Checking / repairs:

- Check all crankshaft bearing journals for score-marks and incorrect dimensions; for measured values, see Section 4. Measure in two planes offset through 90 degrees.
- Check the shaft sealing ring contact face for score-marks. If the contact face is worn, a „wear sleeve“ can be pushed over it. When doing so, use sealant **E**. Assembly instructions are included with the spare part.
- Renew the shaft sealing ring in the end cover.
- Check the bearing shells for damage and visible signs of wear.

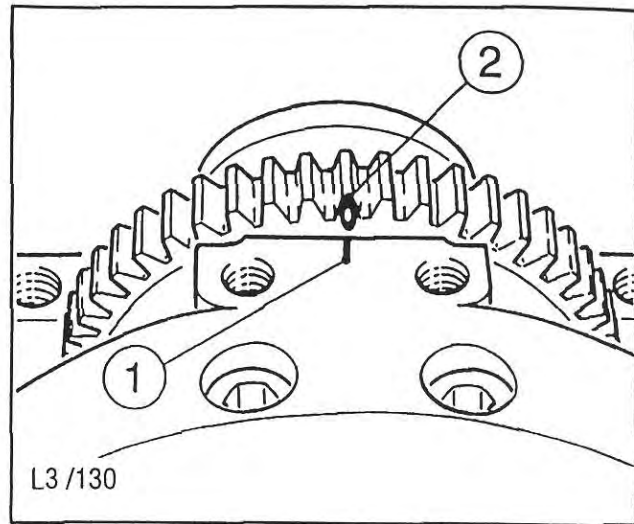
Installing:

- Pull the balancing-weight gearwheel on to the crankshaft.
On the 2 and 3 L .. crankshafts, unscrew and remove the flywheel-end counterweight; this will expose the line marking (25/1) on the crankshaft.
Heat the gearwheel to app. 125° C and pull it on so that the line marking (25/1) on the crankshaft is aligned with the „O“ marking (25/2) on the gearwheel; see Fig. 25.
- On the 4 L ... crankshaft, unscrew and remove the flywheel-end counterweight and manoeuvre the balancing-weight gearwheel into position as shown in Fig. 26.
- Apply sealant **C** to the straight pin (24/1) and drive it in.
- Apply sealant **D** to the machine screws and tighten them to the specified torque.

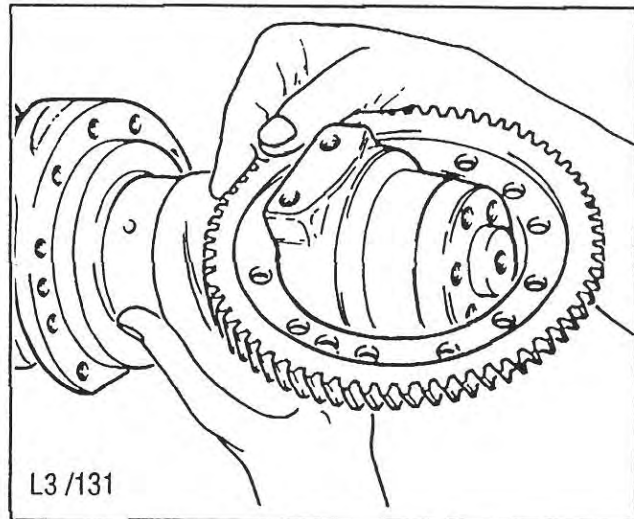
Note:

From mid-1994 on, a modified gearwheel and different retaining screws were introduced. The new screws are not to be used with the old gearwheel (Fig. 27).

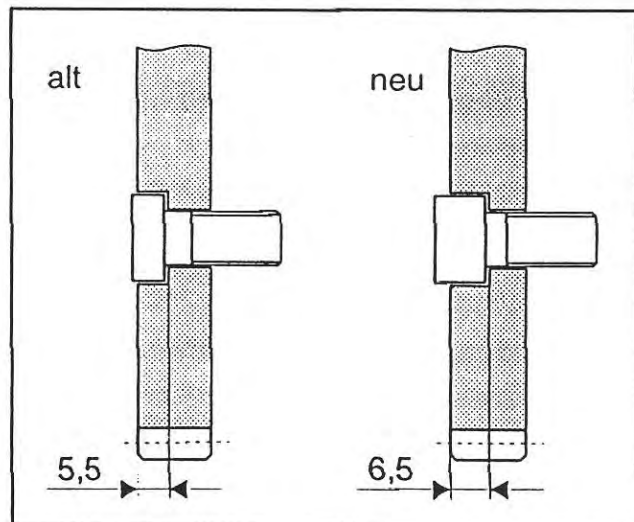
On the 2 and 3 L .. engines, do not install the counterweights again until the crankshaft has been placed back in the lower part of the crankcase.



25

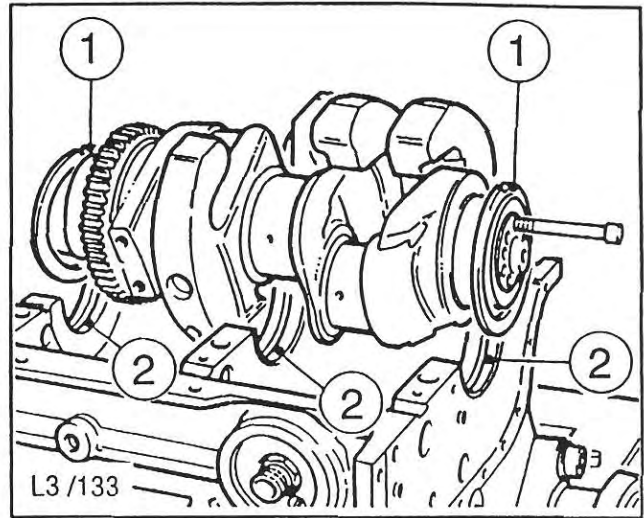


26



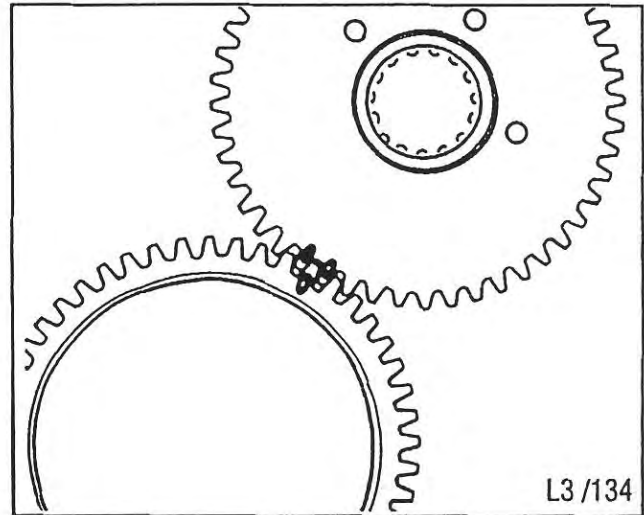
27

- Place the thrust washers (28/1) on the crankshaft so that the lubricating grooves face the thrust face on the crankshaft. Insert the bearing half-shells (28/2) into the lower part of the crankcase, and apply oil to them.



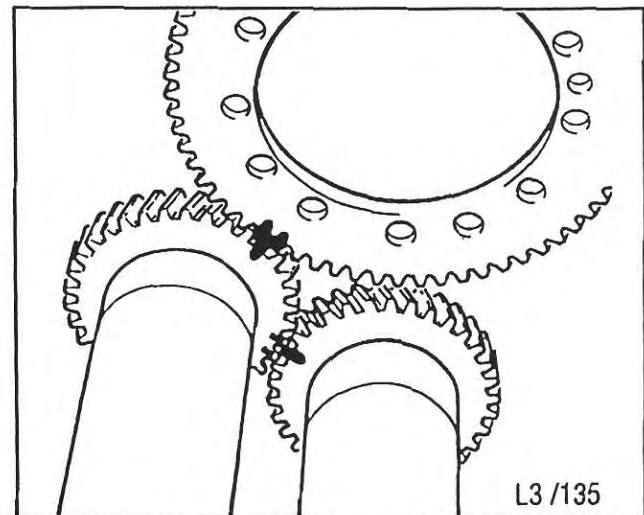
28

- Place the crankshaft in the lower part of the crankcase and make sure that the gearwheels mesh together as indicated by the marks.
- For 2 / 3 L ... see Fig. 29.



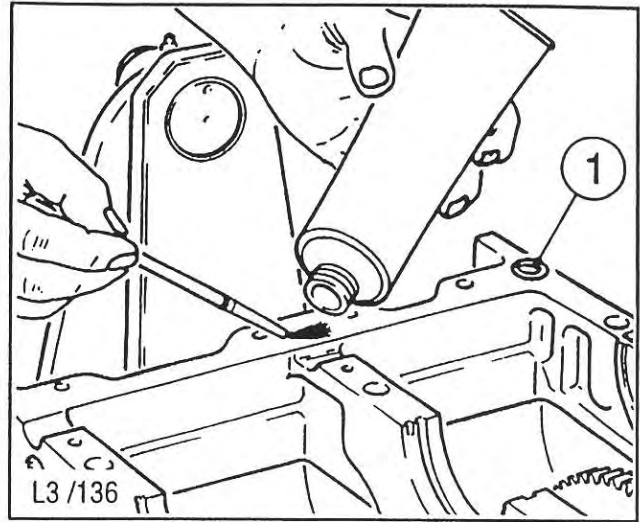
29

- For 4 L ... see Fig. 30.



30

- Insert the O-ring seal (31/1) for the main oilway into the lower part of the crankcase. Apply a thin, uniform coat of sealant **B** to all areas of the joint line on the lower part of the crankcase, and also on the intermediate webs of the crankcase; see Fig. 31.
- Insert the bearing shells into the upper part of the crankcase and coat them with oil.



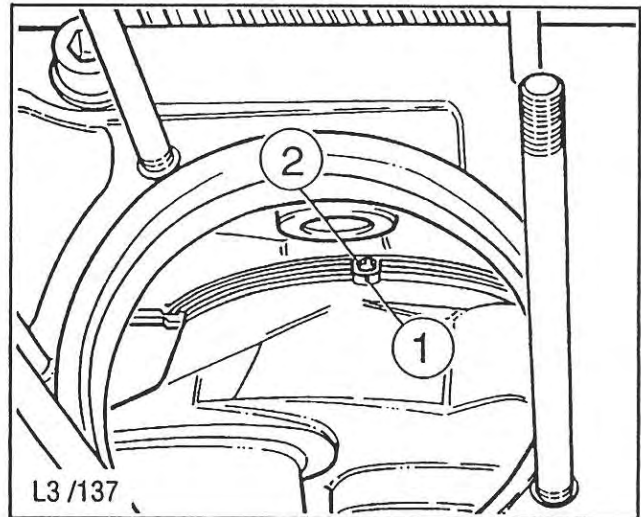
31

- Position the thrust washers so that the groove (32/1) faces upwards in each case. Lift upper part of crankcase and place it very carefully.

Note:

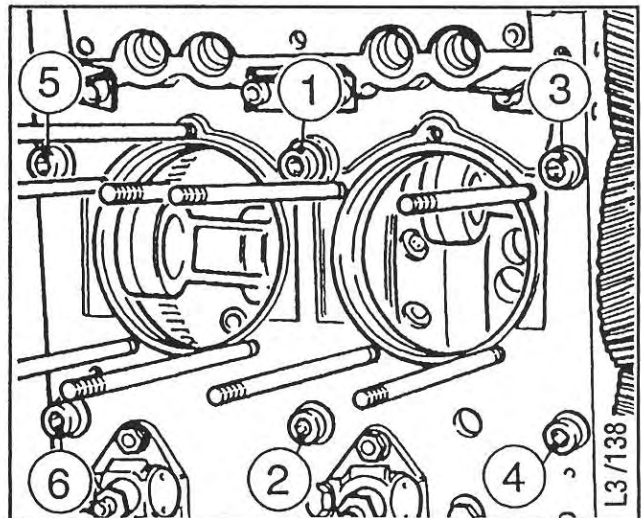
When installing, make sure that the two centering pins (32/2) in the upper part of the crankcase are inserted into the grooves (32/1) of the thrust washers; see Fig. 32.

- Drive in the straight pins (23/1) again to locate the two halves of the crankcase.



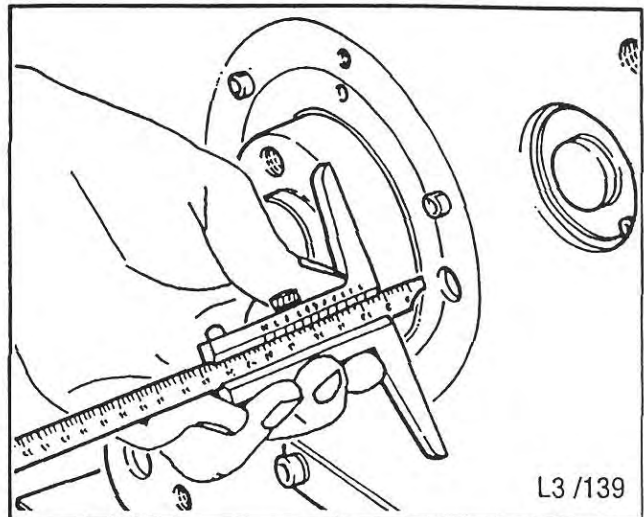
32

- Insert the machine screws and tighten them to the specified torque in the order shown in Fig. 33.



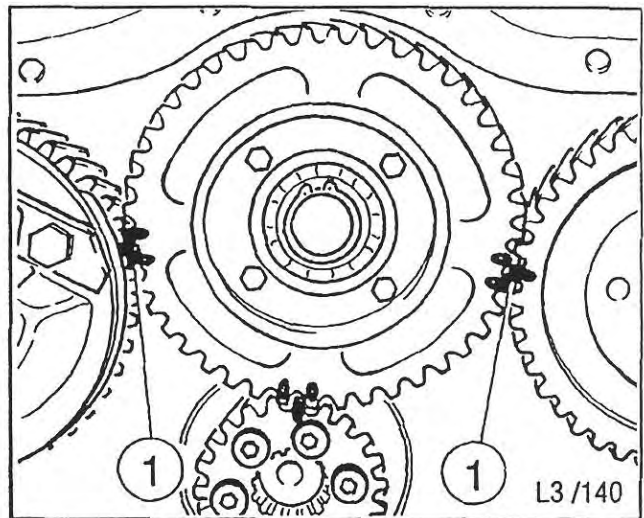
33

- Check crankshaft endplay with a depth gauge, Fig. 34, and compare it with the desired value stated in Section 4.



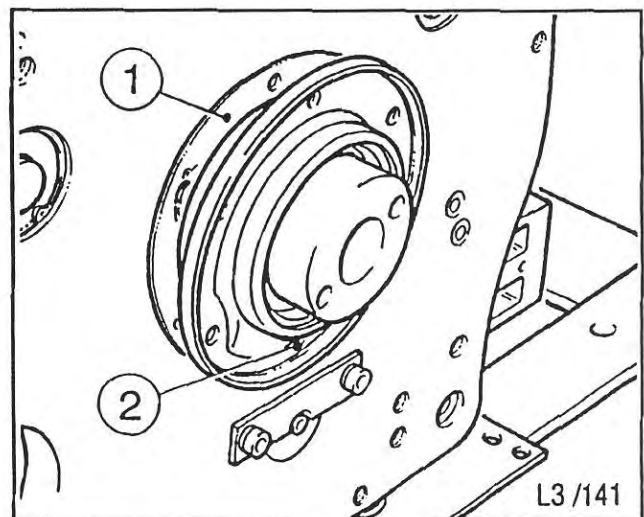
34

- Drive the locking collet to secure the gearwheel (21/1) into the end of the crankshaft.
- Turn the camshafts until the two marks (35/1) are aligned and the mark for the crankshaft gearwheel faces downwards.
- Engage the crankshaft gearwheel, noting the position of the mark, and tighten it to the specified torque.



35


- Place the gasket (36/1) on the locking collets.
- Insert a new shaft sealing ring and grease its sealing lip. Install the end cover, coat the machine screws with sealant **D** and tighten them to the specified torque.



36

M 04.00 Camshaft

M 04.10 Camshaft, valve gear

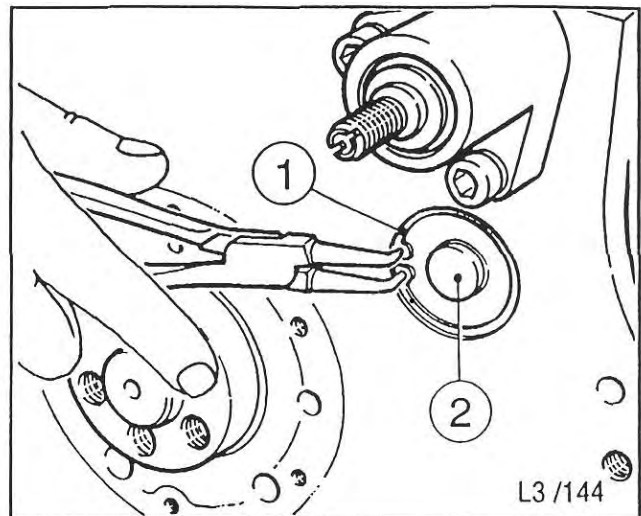
 - 9 - 30 - 31 -

Preparatory work:

- Take off the upper part of the crankcase; see M 02.00.

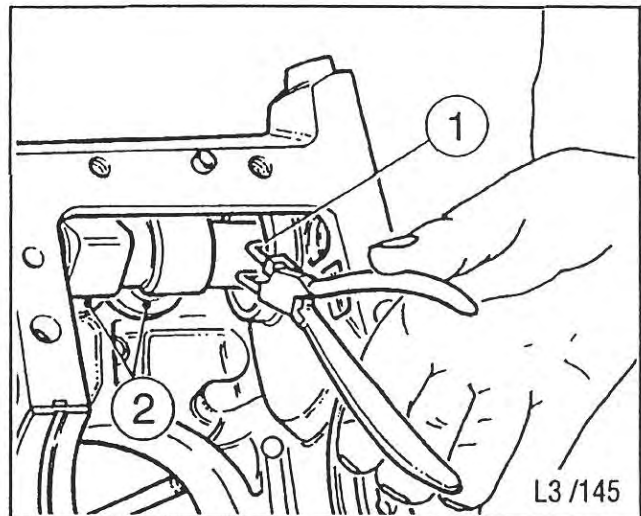
Dismantling:

- Remove the circlip (37/1) at the cover, pull the cover (37/2) out with water-pump pliers and remove the shim washers.



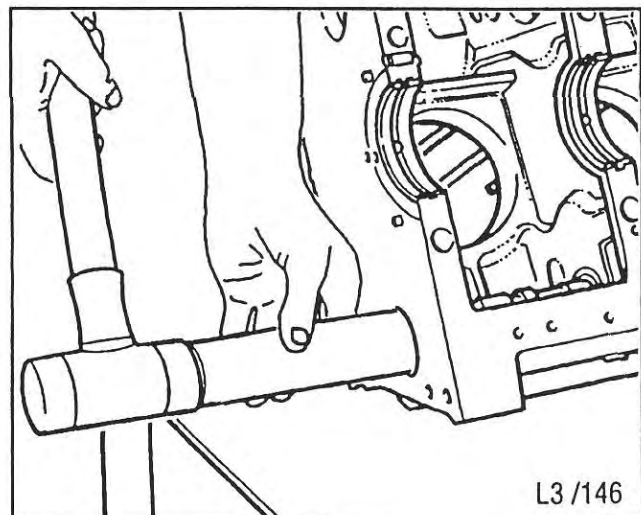
37

- Stand the upper part of the crankcase up, take the circlip (38/1) out of the safety groove and press the valve tappet (38/2) off the camshaft.



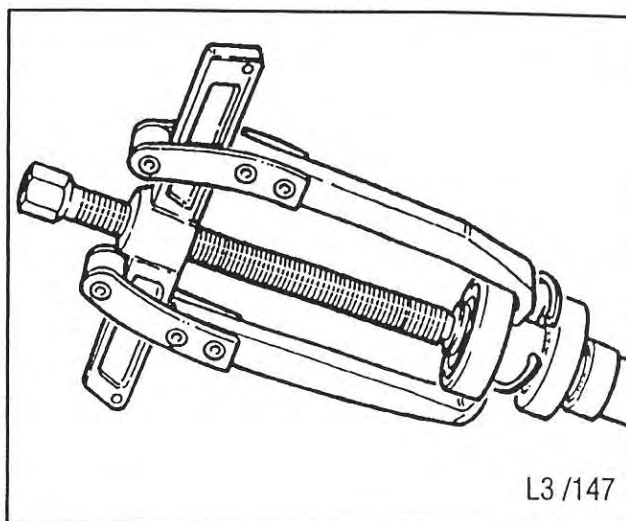
38

- Using a \varnothing 47 mm driving-out sleeve, drive the camshaft out towards the timing end (see Fig. 39) and pull out the valve tappets.



39

- Remove the circlip and shim washers and pull off the ball bearing with a two-arm puller; see Fig. 40.

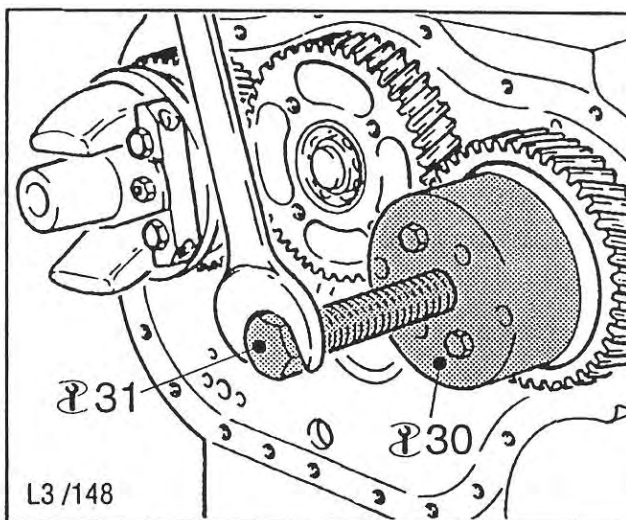


40

- If the gearwheel or camshaft is renewed, use puller - 30 - with forcing-off screw - 31 - to pull the gearwheel off the camshaft; see Fig. 41.

Checking / repairs:

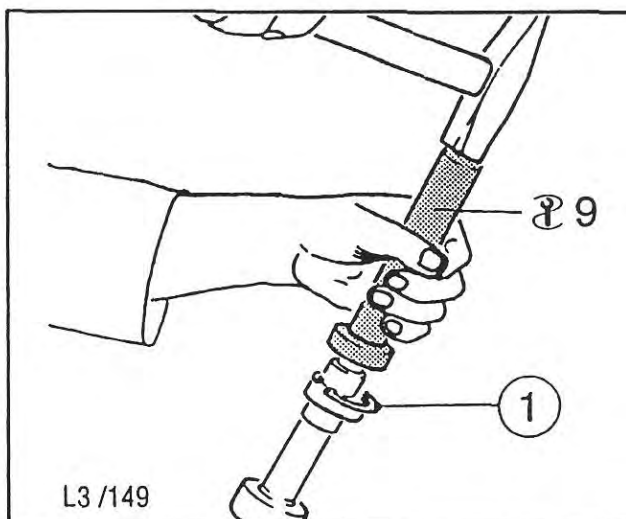
- Inspect the camshaft bearing points and the bearing bores in the crankcase for score-marks and incorrect dimensions; for values, see Section 4.
- Check the camshaft gearwheel for score-marks.
- Check the camshaft ball bearings for wear.
- Check the tappets for score-marks.
- Check the bores in the crankcase for the tappets for score-marks and incorrect dimensions; for values, see Section 4.



41

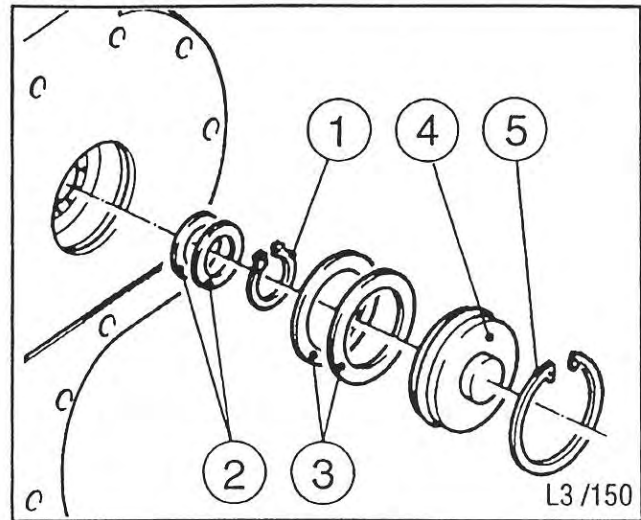
Assembly:

- Heat the camshaft gearwheel to app. 150 - 200°C on a hotplate, and press it on.
- Place the circlip (42/1) in position and pull on the ball bearing with impact sleeve - 9 -; see Fig. 42.



42

- When installing a new camshaft, make sure that there is no endplay between the ball bearing and the circlip (43/1). If necessary, insert shim washers (43/2).



43

- Install the camshaft, noting the correct positions of the marks, and insert circlip (44/1).
- Drive the camshaft towards the timing end of the engine until the ball bearing is in contact with the circlip (44/1).
- Insert shim washers (43/3), push in cover with O-ring seal (43/4) and attach circlip (43/5).

Note:

- Check camshaft endplay; for values, see Section 4.
- If necessary, insert shim washers (43/3).
- A special camshaft has been introduced to operate the valves on the following engines.

It can be identified by an "H" cast into the camshaft.

2 M 31 H from No. 841087 000008

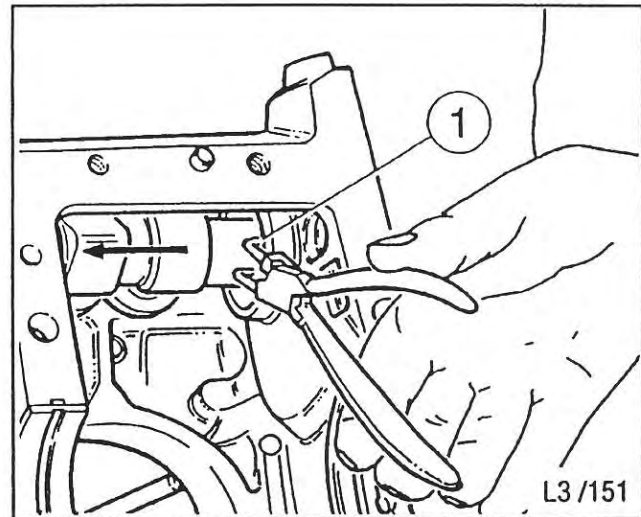
3 M 31 H from No. 851087 000004

4 M 31 H from No. 861087 000004

2 M 40 H from No. 781487 001631

3 M 40 H from No. 791487 000952

4 M 40 H from No. 801487 000873



44

M 04.00 Camshaft

M 04.20 Camshaft for injection pump

⌘ - 9 - 30 - 31 -

Preparatory work:

- Remove the injection pump; see M 14.00.
- Remove the engine speed control; see M 32.00.
- Remove the starting-mixture charging device; see M 12.00.
- Remove the fuel delivery pump.

Dismantling:

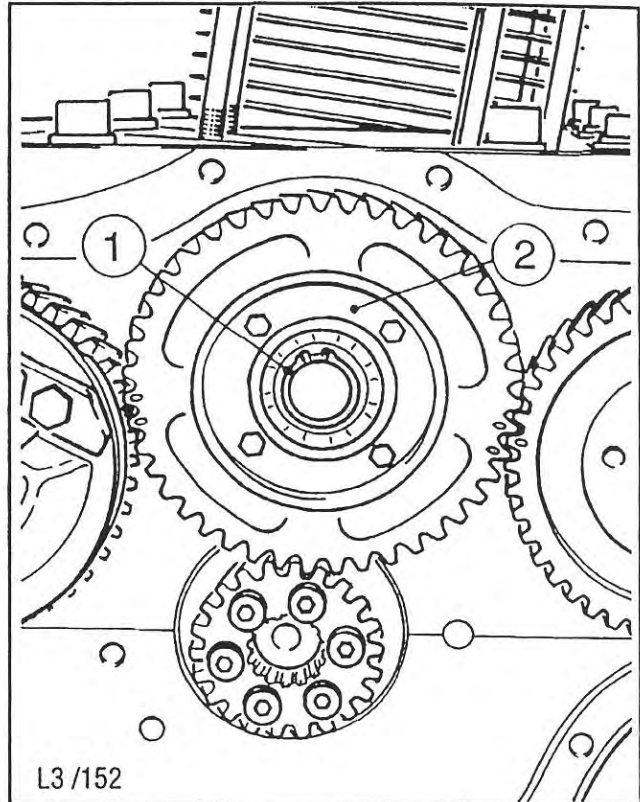
- See M 04.10.

Detaching the intermediate gearwheel:

Note:

The intermediate gearwheel can only be pulled off after removing the injection pump camshaft.

- Take off the circlip (45/1) and unscrew the splash plate (45/2).



45

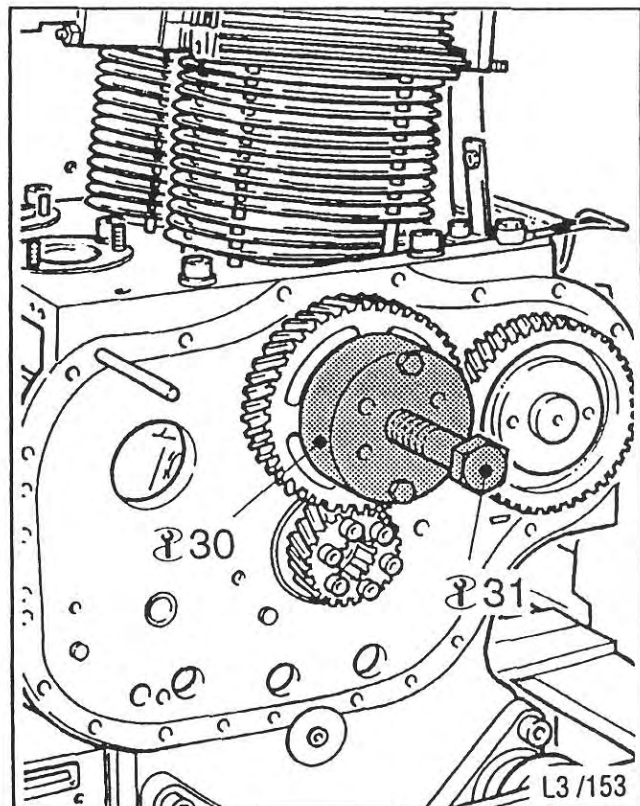
- Pull off the gearwheel with the puller - 30 - and the forcing-off screw - 31 - : see Fig. 46.

Note:

The two ball bearings in the intermediate gearwheel are separated by a circlip.

Checking / repairs:

- Check the camshaft bearing points and the bearing points in the crankcase for scoremarks and incorrect dimensions; for values, see Section 4.
- Check the ball bearings for the camshaft and the intermediate gearwheel for wear.



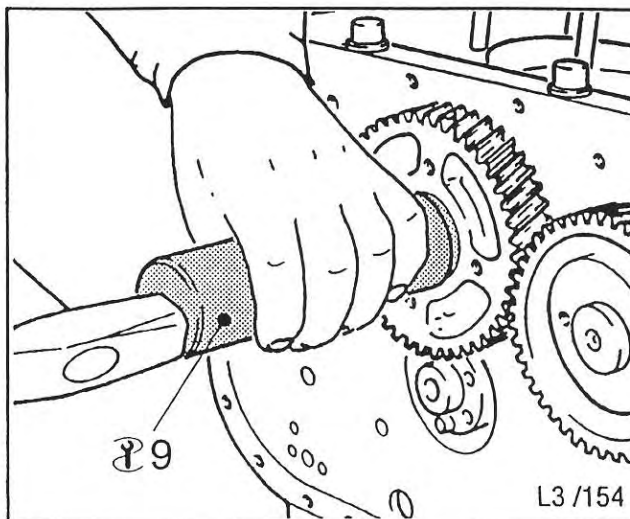
46

Attaching the intermediate gearwheel:

Note:

The intermediate gear wheel must be installed **before** the camshaft for the injection pump is installed.

- Press the ball bearing into the intermediate gearwheel and pull the gearwheel on using impact sleeve - 9 - , noting the positions of the markings; see Fig. 47.
- Place the circlip on the shaft.



47

Note:

Before pulling on, place the intermediate gearwheel uniformly on the shaft, to prevent the shaft from being pushed into the crankcase.

Installing the camshaft:

- See „Installing camshaft for valve gear“ (M 04.10).

Note:

The camshaft for L 40/M 40 is marked „L 40“ next to the delivery pump drive cam.

M 04.00 Camshaft

M 04.30 Governor and injection timer

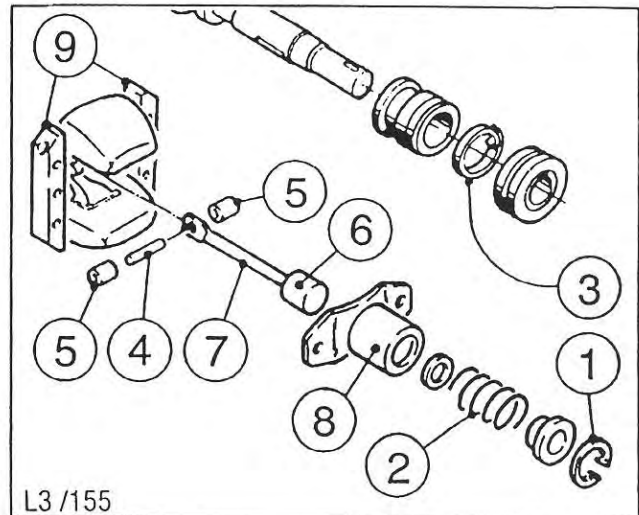
⌘ - 30 - 31 - 40 -

Preparatory work:

- Removing camshaft for injection pump;
see M 04.20.

Dismantling the governor: (up to engine serial number: 2 L 40.16, 3-4 L 40.15, .M 40.12 and .L 30 and H.L 30)

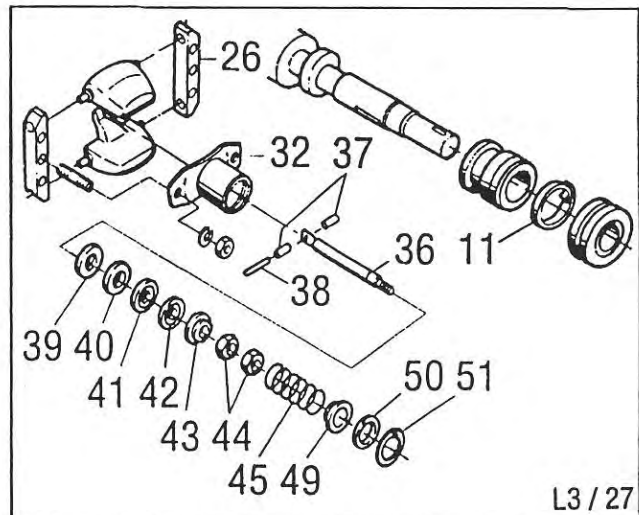
- Remove circlip (48/1) and pull out governor spring (48/2).
- Detach spring from governor (48/3) and push out pin (48/4) with roller sleeves (48/5).
- Pull out spring sleeve (48/6) with pull rod (48/7).
- Unscrew spring bridge (48/8) and take off holder for governor weights (48/9).



48

Dismantling governor: (from engine serial number: 2 L 40.17, 3-4 L 40.16, .M 40.13, and all L 31 and M 31 engines)

- Remove circlip (48a/51) and pull out spacing ring (48a/50), spring plate (48a/49) and governor spring (48a/45).
- Remove the spring at the governor collar (48a/11) and push out pin (48a/38) with roller sleeves (48a/37).
- Pull out the pull rod (48a/36), unscrew the nuts (48a/44) and take off the spring plate at the governor (48a/43), the locating washer (48a/42) and needle roller race (48a/41), the shim washer (48a/40) and the thrust washer (48a/39).
- Unscrew the spring bridge (48a/32) and take off the holder for the governor weights (48a/26).



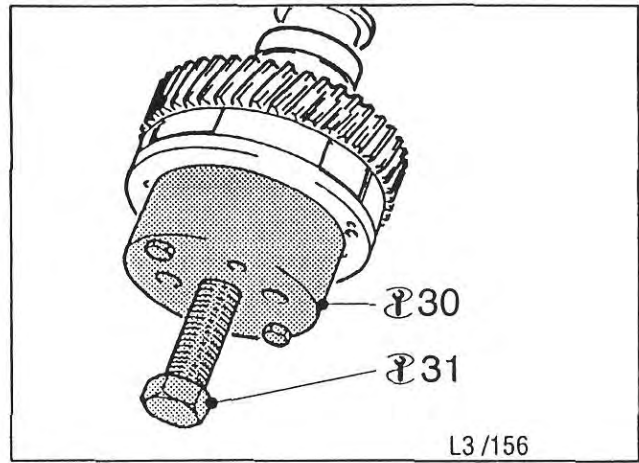
48a

Checking / repairs:

- Check all parts for damage and signs of wear.

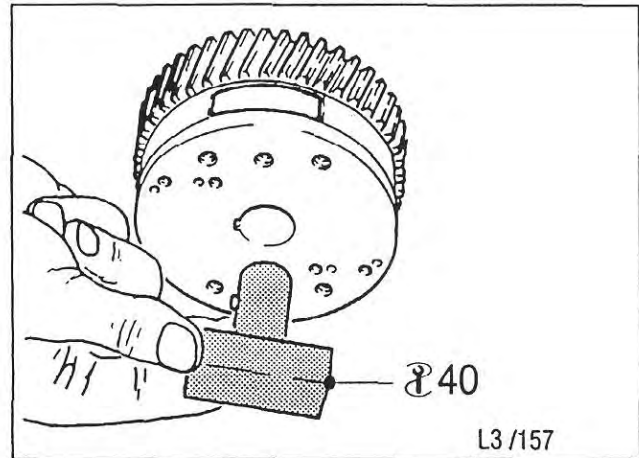
Pull off and dismantle the injection timer:

- Using puller - 30 - with pressing-off screw - 31 -, pull the injection timer off the cam-shaft; see Fig. 49.



49

- Clamp the holder for injection timer assembly - 40 - into the vise and place the hole in the injection timer's support disc on the special tool; see Fig. 50.

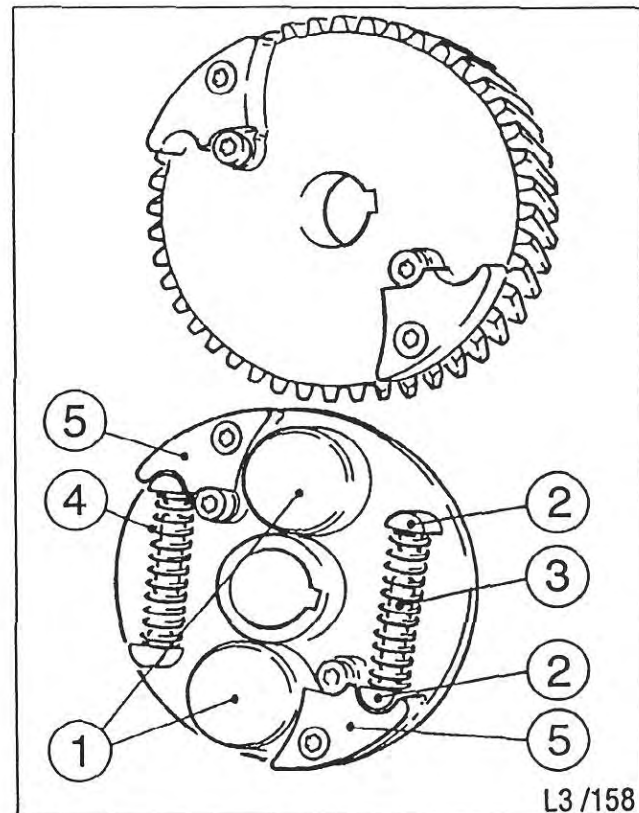


50

- Turn the gearwheel counter-clockwise by hand against the spring loading, and lift it carefully off the support disc.
- Take off the centrifugal weights (51/1), retaining blocks (51/2) and pins (51/3) with coil springs (51/4).
- Unscrew and remove the cam tracks (51/5).

Checking / repairs:

- Examine the support disc and gearwheel in the centrifugal weight area for score-marks.
- Inspect the coil springs and their retaining blocks for damage.
- Check the centrifugal weights for score-marks.



51

Assembling the injection timer:

- Assemble the injection timer by following the dismantling instructions in the reverse order.

Note:

The gearwheel and support disc were modified at the beginning of 1992.

Parts from the old and new versions cannot be combined.

If necessary, renew the complete injection timer.

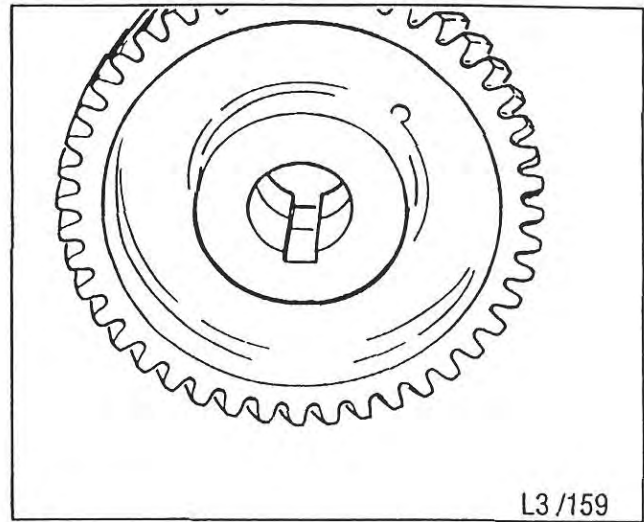
After placing the gearwheel on the support disc, check that the slots in the gearwheel and support disc are aligned as shown in Fig. 52.

- Turn the injection timer clockwise and allow it to move back to check its freedom of movement; see Fig. 53.

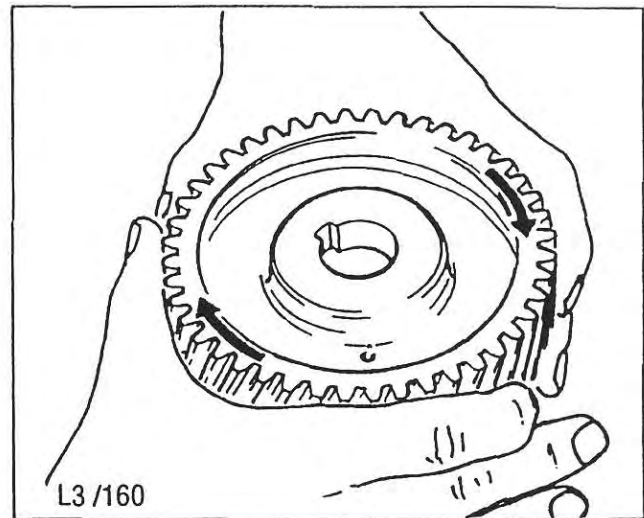
- Coat the hole in the support disc with sealant **C** and press the camshaft (with shaft key) into the injection timer until the gearwheel has 0.05 mm of endplay.

Note:

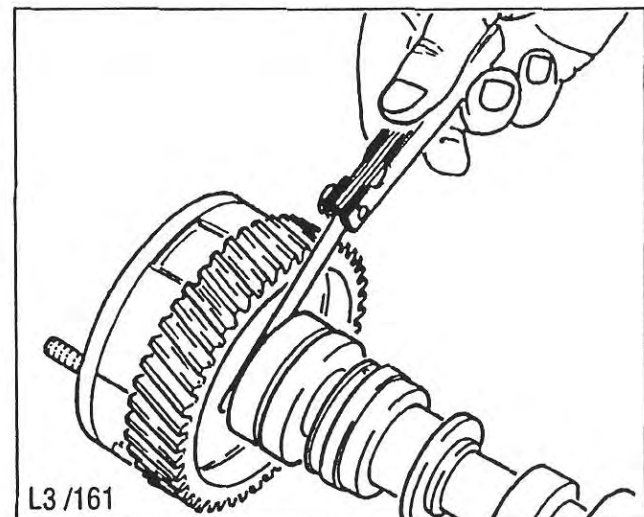
Check endplay with a feeler gauge as shown in Fig. 54.



52



53



54

Assembling the governor:

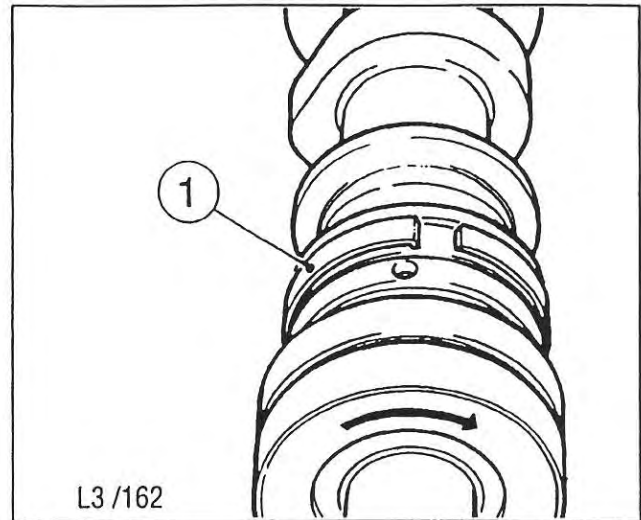
- Assemble the governor by working the opposite order to that described for dismantling; refer to Figs. 48 and 48a.

Note:

When assembling the governor, make quite sure that all moving parts are able to move freely.

On L/M 31/40 engines there must be a clearance of 0.5 mm between spring plate (48a/43) and nut (48a/44).

On L/M 41 engines the spring plate (48a/43) must be held firmly when nut (48a/44) is tightened.



55

- Install the spring for the governor (55/1) so that the endface of the tapered section points in the direction of rotation.

Renewing governor spring:

(without detaching the timing case cover)

Preparatory work:

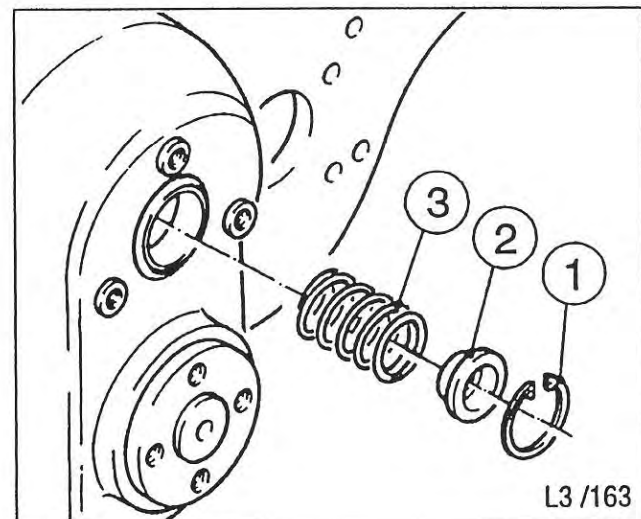
- Remove the engine shutdown device; see M 20.00.
- On the H.L30 take off the cover; see M 11.00.

Dismantling:

- Remove circlip (56/1) and spring plate (56/2).
- Take out governor spring (56/3) and check it for cracks or breakage.

Assembling:

- Choose the correct new governor spring as stated in Section 4, according to the engine's intended use and speed range.
- Install the governor spring or engine shutdown device by working in the opposite order to that described for removal.



56

M 05.00 Conrod

 - 35 - 36 -

Preparatory work:

- Take off the cylinder head; see M 07.00.
- Remove the cylinder and piston; see M 06.00.

Dismantling:

- Unscrew and remove the big-end bolts (62/1) and lift out the conrod and big end cap with the aid of guide pin - 35 - or - 36 -.

Checking / repairs:

- Check the conrod bushing, big end bearing and crankpin for score-marks and incorrect dimensions; for values, see Section 4.

Assembly:

- Press the bushing into the conrod.

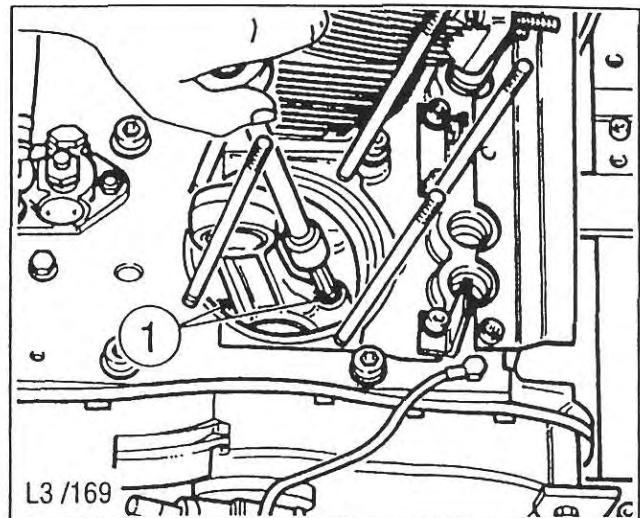
Note:

When pressing in the conrod bushing, make sure that the oil holes are aligned and that the bushing projects by an equal amount on each side.

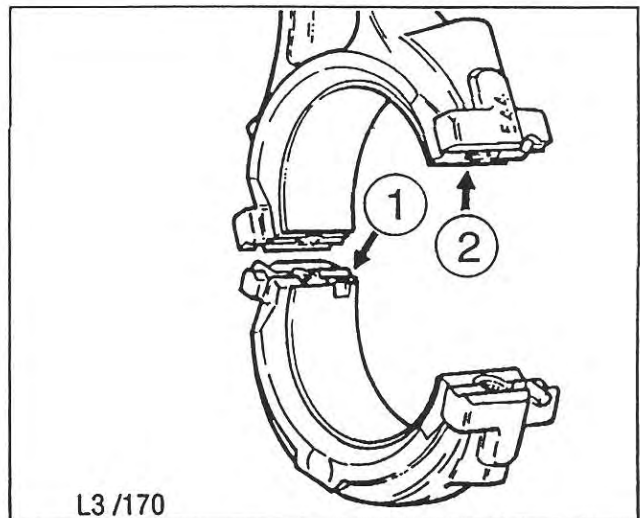
- Insert the big end bearing half-shells into the conrod, making sure that the locating nuts are in the grooves provided; see Fig. 63.
- Install the big end cap, using guide pin - 35 - or - 36 -; see Fig. 64.
- Attach the upper part of the conrod, insert the big end bolts and tighten them to the specified torque.

Note:

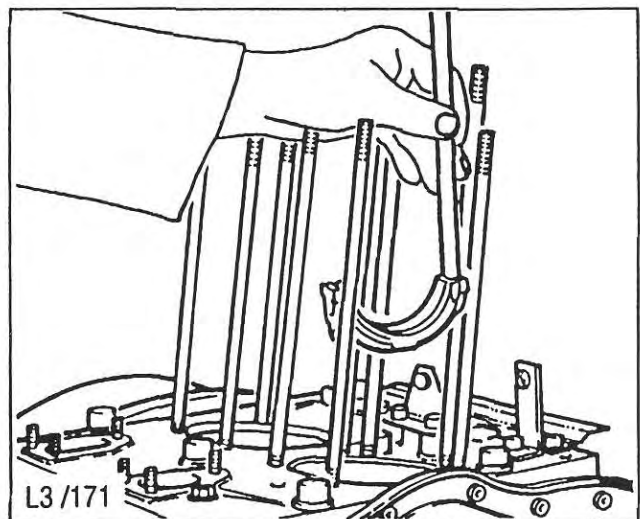
The groove (63/1) in the big end cap must be on the side nearest the injection pump. The groove (63/2) in the main conrod must be on the valve tappet side.



62



63



64

M 06.00 Piston and cylinder

M 06.10 Air-cooled engines

Ⓟ - 12 - 16 - 17 -

Preparatory work:

- Detach the cylinder head; see M 07.00.

Dismantling:

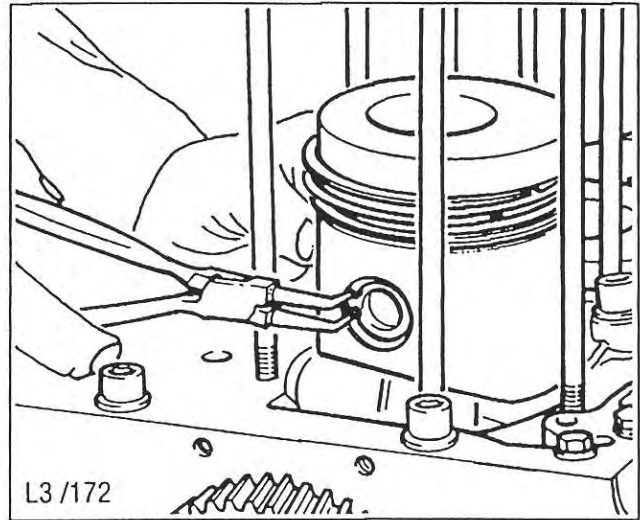
- Mark the relative position of the cylinder and piston and pull off the cylinder.
- Take out the piston pin circlip; see Fig. 65.
- Press the piston pin out by hand and lift off the piston.

Checking / repairs:

- Check the cylinder wall for seizure marks or score-marks.
- Check that the dimensions of the cylinder are correct; for values, see Section 4.
- Check the piston for seizure marks or ring web fractures.
- Check piston ring end gaps; for values, see Section 4.

Checking piston ring end gaps:

- Pull the piston rings off the piston.
- Place each piston ring in its cylinder bore and move it to the TDC position of the piston.
- Clean the piston crown and use it to position the piston ring at a right-angle to the cylinder axis.
- Use feeler gauges to measure the piston ring end gap (where the ends of the piston ring come together).
- For limit values, see Section 4.



65

Checking cylinder wear and suitability for further use:

- Repeat the piston ring measuring procedure with a new piston ring.
- Compare the measurements obtained in this way with the maximum wear limits; if these are exceeded, the cylinder should not be re-used but an oversize cylinder should be installed instead.
- If the measured values are within the limits, the cylinder can be used again, with new piston rings.

In this case, the cylinder wall must be roughened very slightly with a honing tool, since the honed finish will have been largely worn away after a lengthy period of operation. If the cylinder were to be used again without re-honing (whether the existing piston rings or new ones were fitted), excessive oil consumption would occur and would not drop to the normal level after a time, since the piston rings would not be able to match themselves to the cylinder wall.

Procedure:

- While turning the honing tool in the cylinder, it must also be moved to and fro axially.
Recommended speed of rotation approx. 350 rpm.
- Depending on the speed, the tool should perform about 20 - 30 strokes a minute. This stroke rate will produce a cross-cut pattern at approximately 45°.
- Continue honing only until this crosscut pattern can be clearly seen. It is normally obtained after a honing time of approx. 20 - 45 seconds per cylinder.
- After honing, clean the cylinder with warm or hot water and a cold cleanser, using a brush, then oil the cylinder wall.

Warning!

Do not hone for too long a period, and do not dry-hone.

Use honing oil or a mixture of oil and fuel (1:1).

If possible, keep below the speed stated above.

Wear protective goggles!

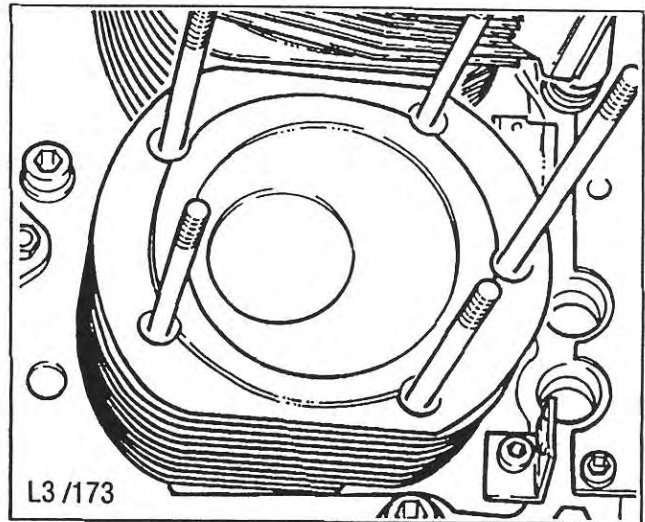
Assembling:

To install the piston, follow the dismantling instructions in the reverse order.

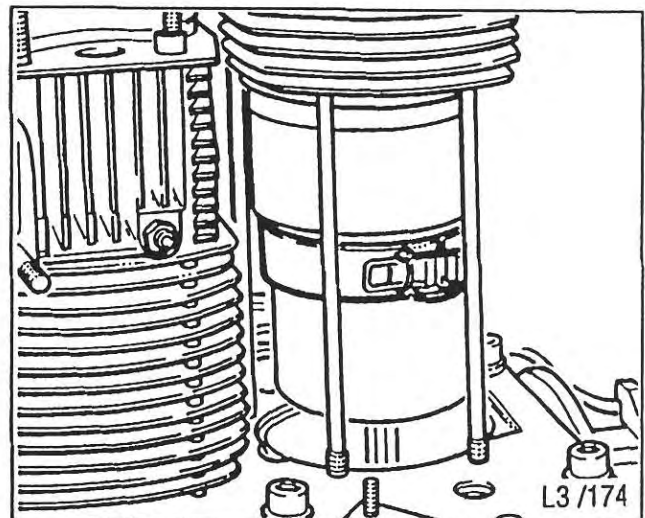
Note:

The recess in the piston crown must be located towards the injection pump; see Fig. 66.

- The piston ring gaps must be offset by 120° in each case; oil the piston rings in their grooves.
- Attach clamping tool - 17 - and carefully install the cylinder; see Fig. 67.



66



67

M 06.00 Piston and cylinder

M 06.20 Water-cooled engines (H.L 30)

 - 16 - 17 -

Preparatory work:

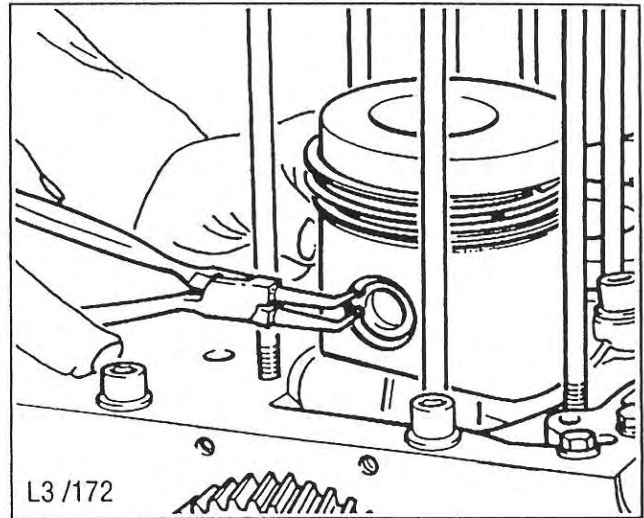
- Take off the cylinder head; see M 07.00.
- Take off the alternator and water pump.

Dismantling:

- Carefully pull the cylinder off.
- Take out the piston pin circlip; see Fig. 68.
- Press the piston pin out by hand and lift off the piston.

Checking / repairs:

- Examine the cylinder for seizure marks or score-marks on the cylinder wall.
- Check cylinder dimensions and state of wear; see Section 4.
- Inspect piston for seizure marks and ring web breakage.
- Check piston ring end gap; see Section 4.
- Check piston ring end gap, cylinder wear and suitability for further use; see Section 4.



68

Installing:

Install the piston by following the removal procedure in the reverse order as appropriate.

Note:

The recess in the piston crown must be located towards the injection pump; see Fig. 69.

- The piston ring gaps must be offset by 120° in each case; oil the rings well in their grooves.

For each cylinder bore a figure is stamped on the crankcase and another figure on the cylinder. The two figures, if added together, represent the thickness of the shim plates to be inserted at the base of that cylinder; see Fig. 70.

Example:

Figure on crankcase	15
Figure on cylinder	20
Shim plate thickness needed	35 = 0.35 mm

These shim plates compensate for cylinder and crankcase manufacturing tolerances; in addition the gap is reduced to within a tolerance range of 1.0 - 1.5 mm.

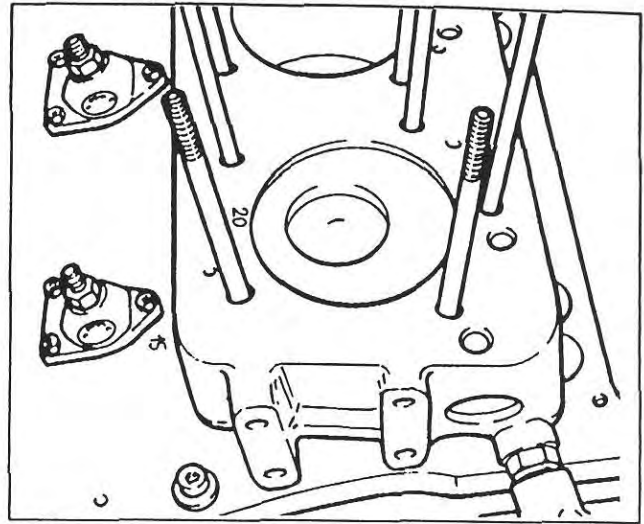
- Attach shim plates 70/1 to the cylinder with a small amount of grease.
- Oil the cylinder bore well.

Note:

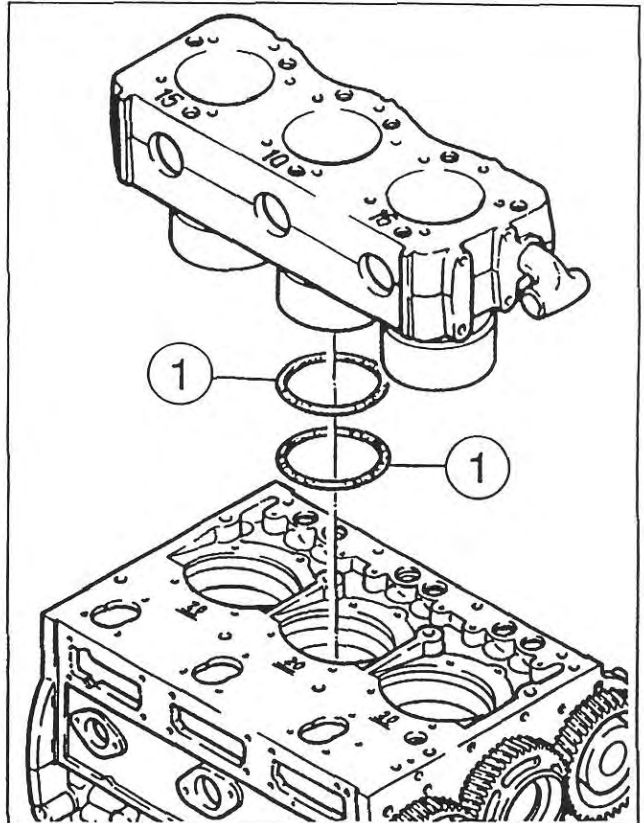
If spare parts are obtained, the manufacturer attaches the shim plates to the crankcase or cylinder. They are not included in the set of gaskets.

To order them separately, please quote the following part numbers:

036 330 00	0.10 mm
036 388 00	0.15 mm
036 329 00	0.20 mm



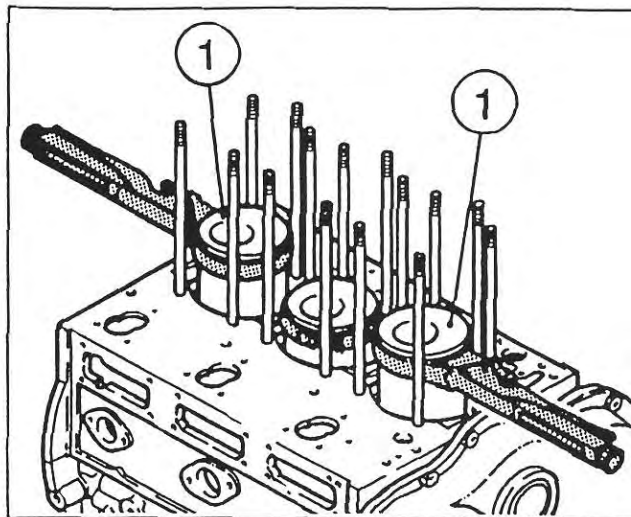
69



70

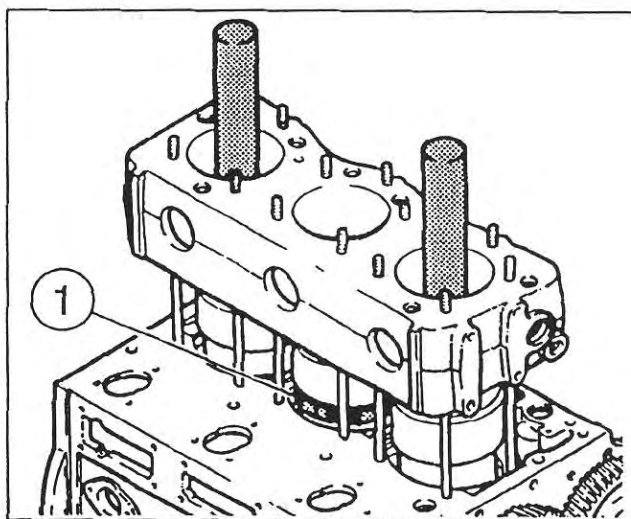
Installing cylinder assembly on H 3 L 30:

- Set pistons „1“ and „3“ to approximately the same height and attach piston ring clamping tools - 17 -; attach piston ring clamping strap 622 469 00 to the centre piston; see Fig. 71.



71

- With the help of a second person, carefully place the cylinder assembly in position and insert auxiliary pins 621 646 00 into the recesses on pistons „1“ and „3“; see Fig. 72.
- Lower the cylinder assembly and at the same time move the auxiliary pins to and fro until the pistons enter the cylinders.
- Take off the piston ring clamping tools and move the centre piston to and fro during the lowering movement until it enters its cylinder.
- The ring clamping strap is pushed into the cylinder, and can then be pulled out of the rectangular side opening in the crankcase with the aid of a strong piece of wire.



72

Installing the cylinder assembly on the H 2 L 30:

- Set both pistons to approximately the same height and attach the piston ring clamping tools.
- Further installation work is as described for the H 3 L 30, but without the work relating to the centre cylinder.

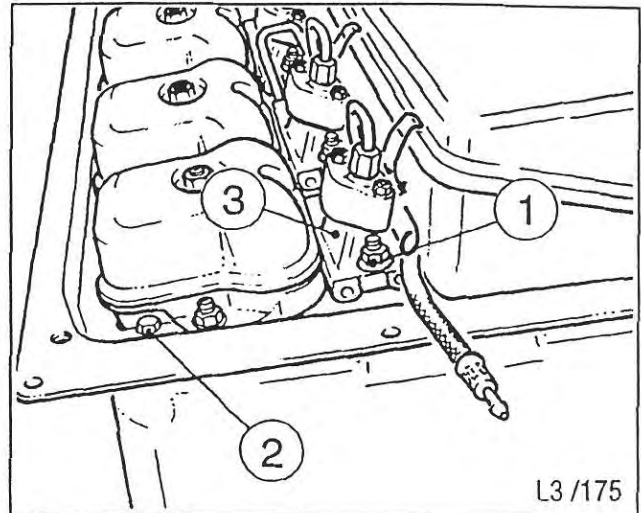
M 07.00 Cylinder head

M 07.10 Air-cooled engines



Preparatory work:

- Take off the enclosure hood.
- Take off the exhaust-side enclosure and the muffler (silencer); see A 03.00.
- Unscrew and remove the air outlet shaft, side panel and cross-member; see M 35.00.
- Unscrew and remove the cover plate and take out the screws for the base plate; see M 35.00.
- Take off the air cleaner.
- Remove the injector; see M 14.00.



73

Dismantling:

- Take off the cylinder-head (rocker) cover.
- Unscrew the shouldered nuts (73/1) and bolts (73/2).
- Pull off the centering flanges (73/3).
- Detach the support plate mounts.
- Press the air guide housing and suction shaft apart.
- Lift off the support plate; see Fig. 74.
- Detach the exhaust manifold and air intake pipe.

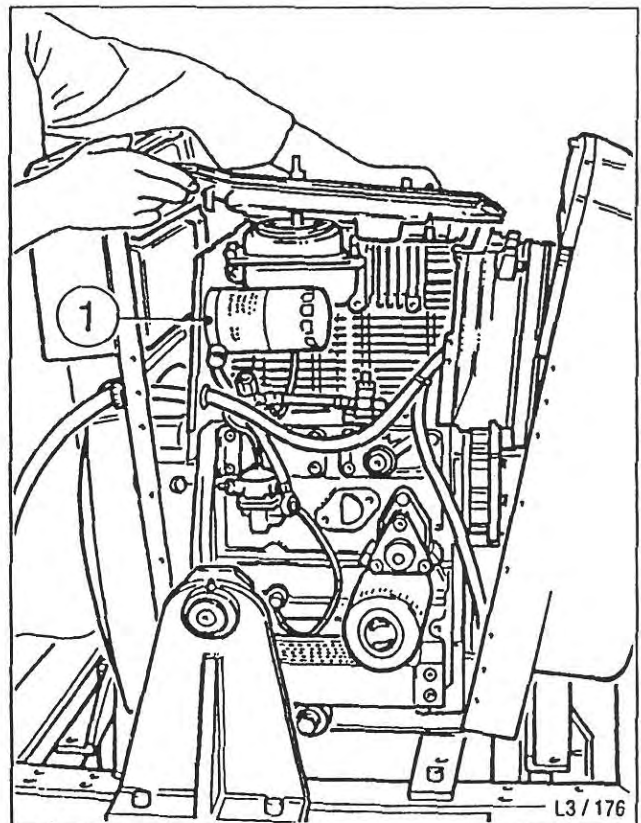
Note:

To simplify dismantling of the air intake pipe, it is best to unscrew and remove the air cleaner (74/1).

- Lift off the cylinder head and remove the pushrod protective tubes.

Checking the cylinder head:

- Inspect for cracked webs or worn valve tappets.
- Check the radius of the rocker pads for wear.



74

Installing:

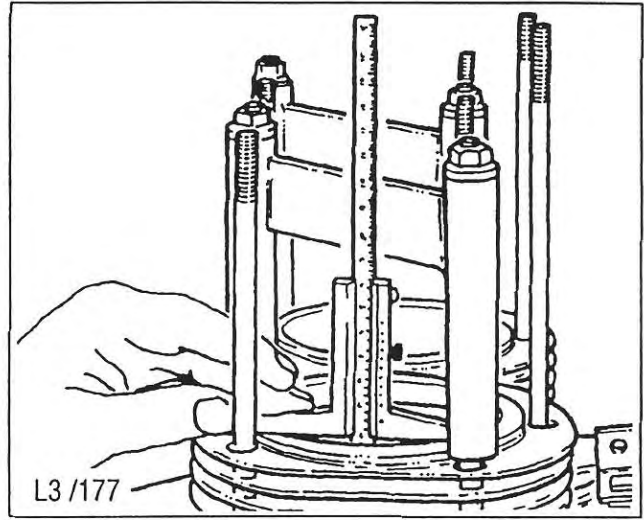
- Determine the gap between the cylinder head and the piston at TDC.

Note:

This gap should be re-measured whenever a cylinder, piston, conrod, crankshaft or crankcase is renewed.

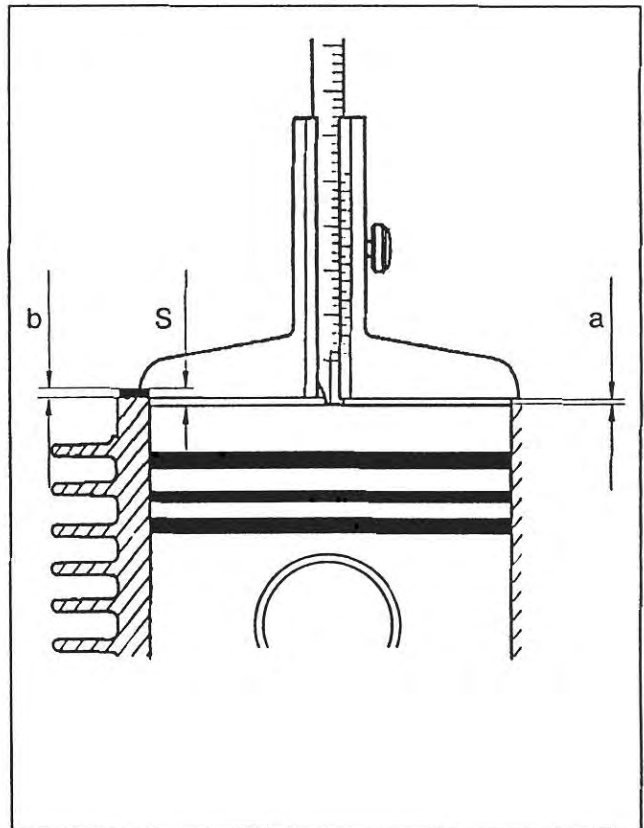
Measure at all cylinders, with the engine cold.

- Clamp the cylinder down with a suitable tensioning strap, and use a depth gauge; see Fig. 75.



75

- Turn the engine over until the piston reaches and passes through top dead centre (TDC).
- Measurement „a“ plus the thickness of gasket „b“ yields the gap dimension „S“ stated in Section 4; see Fig. 76.

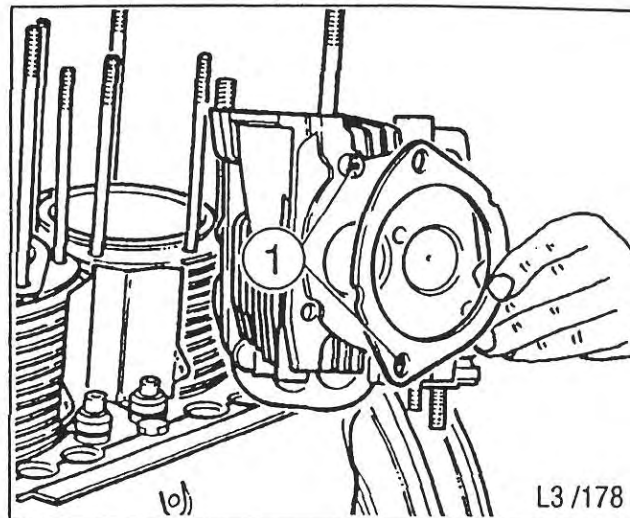


76

- Having established the correct gasket thickness, coat it with a little grease on the cylinder head side, and place it in the centering collar on the cylinder head.

Note:

Centering on the L 30 is not by means of a centering collar but with centering sleeves; the gasket has two centering holes; see Fig. 77.



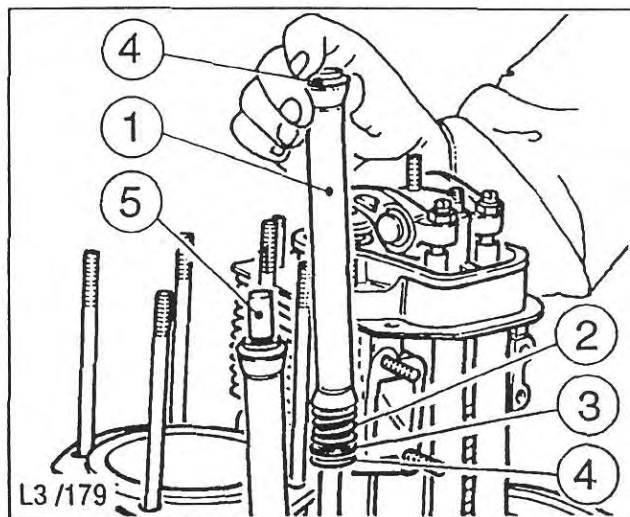
77

- Insert the protective tubes (78/1) with spring (78/2), thrust rings (78/3) and O-ring seals (78/4) into the bore in the crankcase.

Note:

Always renew the O-ring seals (78/4) during cylinder or cylinder head repairs.

- Insert the pushrods (78/5).

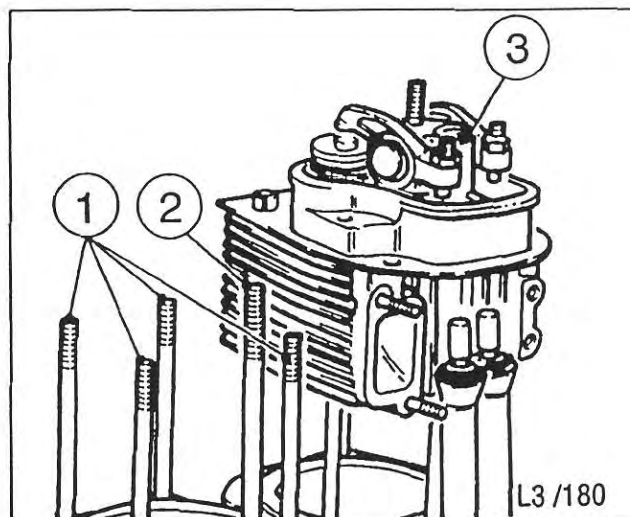


78

- Attach the cylinder head, making sure that the protective tubes with O-ring seals enter the corresponding holes in the cylinder head correctly; see Fig. 79.
- Oil the stud bolt threads (79/1) and screw on the shouldered nuts.

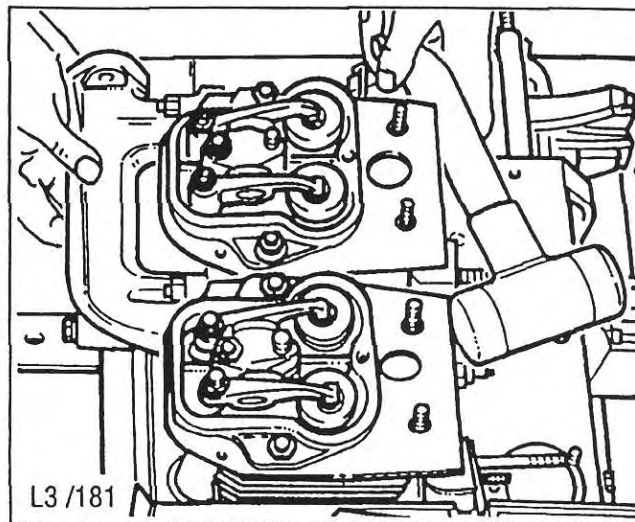
Note:

Apply sealant D or a permanently elastic sealant to the thread of stud bolt (79/2) and the shouldered nut contact face (79/3).



79

- Screw the cylinder head on until it is resting evenly on the cylinder, but without final tightening.
- Align the cylinder head by attaching the exhaust manifold; see Fig. 80.
- Install the support plate and the injector centering flanges.
- Tighten the cylinder head uniformly, in a cross-wise pattern, to the specified torque.
- Take off the exhaust manifold, attach the gaskets and install it again.
- Adjust valve clearances to the specified values.
- Further installation work is as described for removal, but in the reverse order.



80

M 07.00 Cylinder head

M 07.20 Overhauling cylinder head (air-cooled engines)

🔧 - 1 - 2 - 6 - 7 -

Preparatory work:

- Removing cylinder head - see M 07.10.

Dismantling cylinder head:

- Place the cylinder head on the centering collar.

Note:

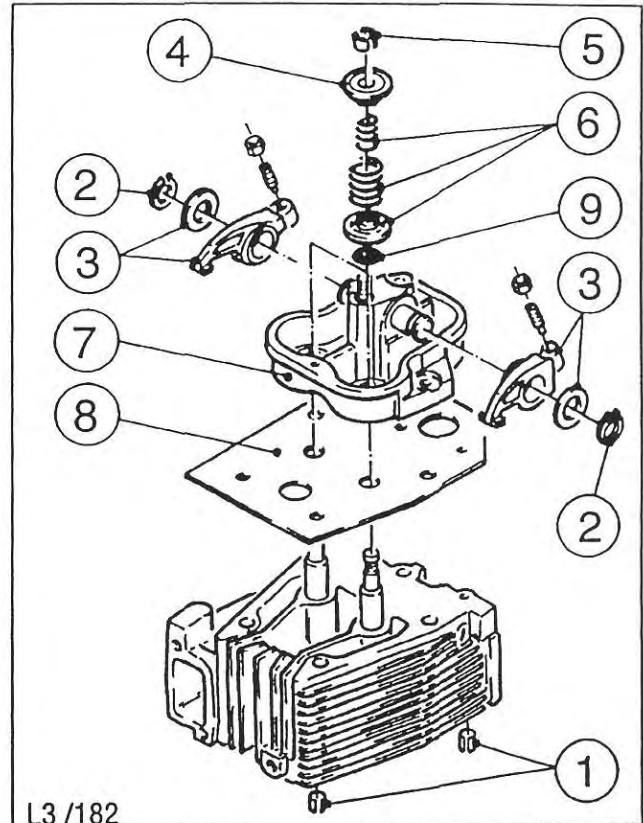
On the L 30, pull out the centering sleeves (81/1).

The cylinder head sealing face must not be scratched or otherwise damaged; always use a soft cloth or similar underlay.

- Remove circlip (81/2) and pull off rockers with shims (81/3).
- Press spring plate (81/4) down with tool - 6 - and remove the valve spring collets (81/5).
- Take out the valve springs with underlay washers (81/6) and lift off the rocker housing (81/7).
- Lift off the intermediate plate (81/8) and take out the valve cone.

Checking parts:

- Check the valve guides and valve stems for score marks and correct dimensions; for values, see Section 4.
- Inspect the cylinder head for cracks (in the metal webs) or an uneven sealing surface.
- Renew the O-ring seals (81/9); on the L 30, seal them with silicone.
- Check the valve seat rings and valve cones for wear; for valve recess into cylinder head, see Section 4.
- Check correct dimensions of rocker bushing, rocker shaft and rocker pad radius; for values, see Section 4.



L3 /182

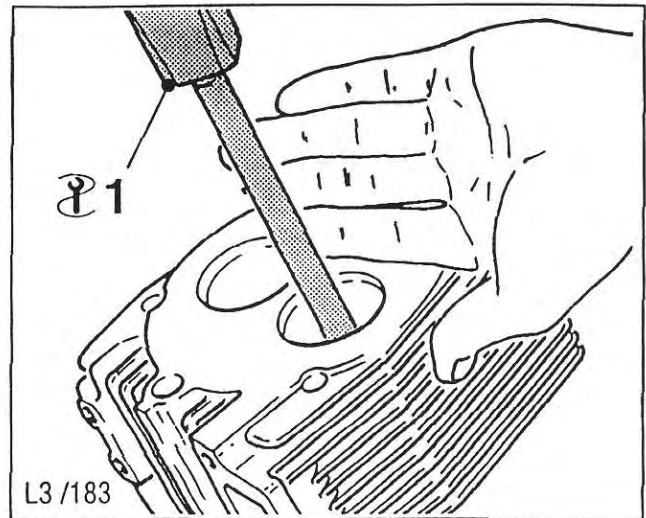
81

Assembling cylinder head:

- If necessary, use a pressing-in tool - 1 - to force out the valve guides; see Fig. 82.
- Use the pressing-in tool again to insert the new valve guides - 1 -.

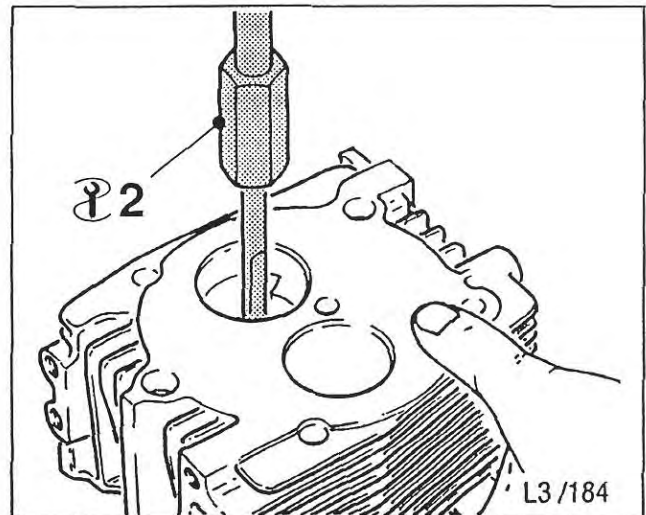
Note:

The correct pressing-in depth must be complied with; for projection, see Section 4.



82

- Using a hand-held reamer - 2 -, ream out the valve guides to their nominal diameter; see Fig. 83.

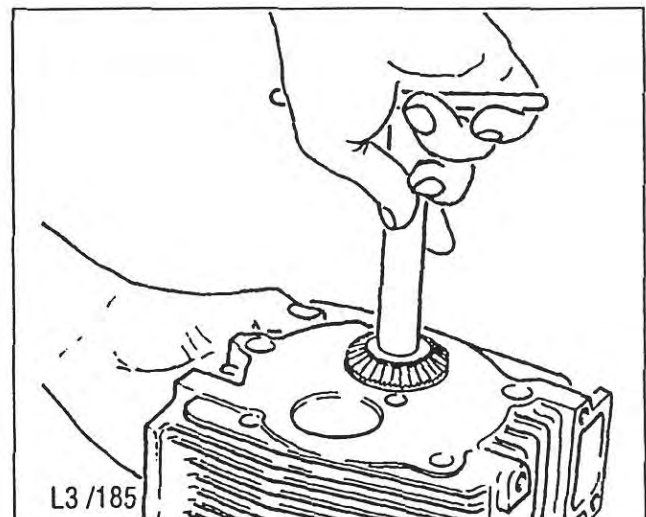


83

- Re-machine the valve seats with a valve seat milling cutter; see Fig. 84.

Note:

The valve seat must always be re-machined after installing new valve guides or before installing new valves, but no more metal than absolutely necessary (no patches anywhere on circumference of valve seat).



84

- Insert valves into valve guide.
Lap the valve cones with grinding paste (grade: 180-250).

Note:

To check the lapped valve seats, clean the valves, insert them and pour a small amount of diesel oil into the inlet and exhaust ports. No fuel should seep through past the valve seats.

Assembling the cylinder head:

- To assemble the cylinder head, follow the dismantling instructions in reverse as appropriate.

Note:

- Engines built in 1979 - 1983 have one spring per valve; from 1984 onwards, two springs per valve were installed. If repair work is carried out in this area, the second valve spring should be retrofitted.
- On M 31/M 40 engines up to 2300 min⁻¹, cylinder heads with the code letter „H“ (high swirl) are used; above 2300 rpm the cylinder head code letter is „L“ (low swirl). These code letters are stamped in the inlet port.
- On engines built from mid-1986 on with a running speed below 2300 rpm the longitudinally slotted rocker and valve stem seal adjusting screws are used; these screws were installed on all engines from mid-1989 onwards. Retrofit these screws if repairs are carried out.
- Before pressing on the valve stem seals, insert the valves into the valve guides. Press the seals on with assembly tool - 7 -.

M 07.00 Cylinder head

M 07.30 Water-cooled engines (H.L 30)



Preparatory work:

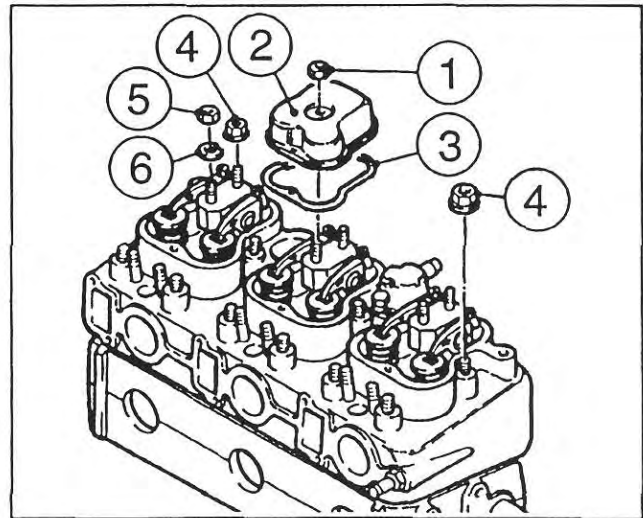
- Drain the coolant and unscrew the coolant lines from the cylinder head.
- Take off the exhaust system and exhaust manifold.
- Take off the air cleaner and detach the air intake flange.
- Remove the injectors.

Dismantling:

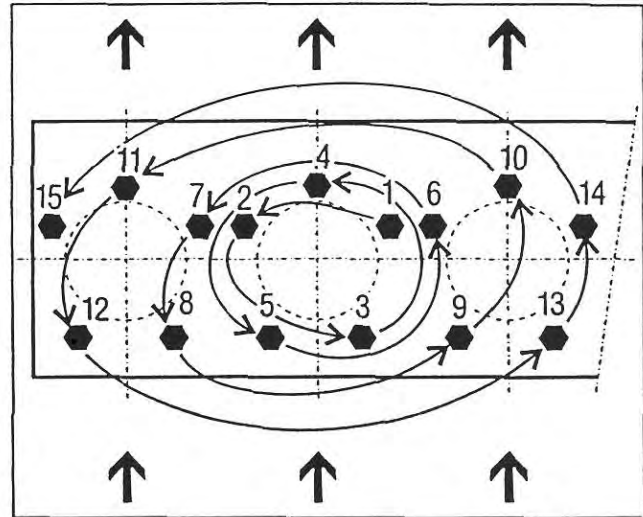
- Take off the cylinder head cover; Fig. 85.
- Slacken off the shouldered nuts by half a turn (85/4) in the reverse of the order shown in Fig. 86 or 87.
- Unscrew and remove the nuts in the same order.
- Unscrew the hex nuts (85/5) with spring washers (85/6) and take off the rocker pedestals.
- Lift off the cylinder head.
- Take off the pushrods and protective tubes.
- Take off the cylinder head gasket and sealing rings.

Checking the cylinder head:

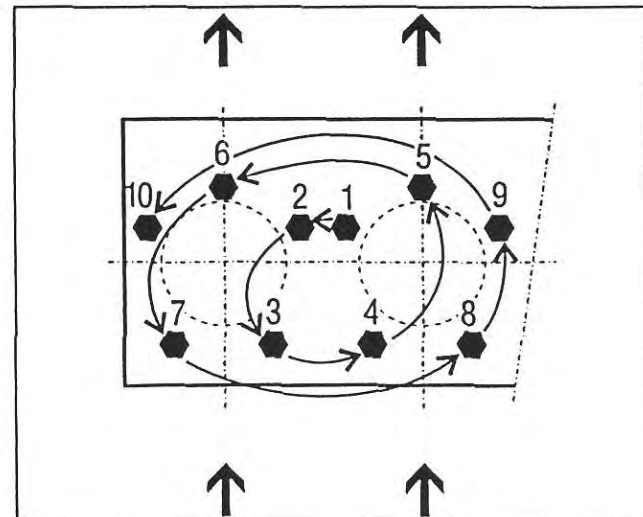
- Visual inspection for cracks in webs.
- Visual inspection of cylinder head sealing face for unevenness.
- Check pad radius on rockers for wear.



85



86



87

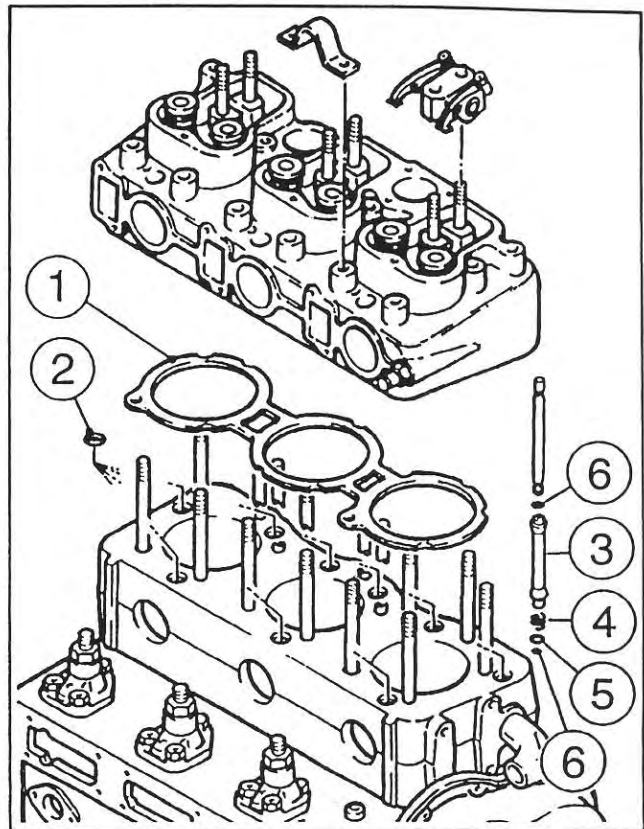
Assembly:

- Clean the sealing faces on the cylinder head and cylinder.
Clean the cylinder.
- Install a new cylinder head gasket (88/1) and sealing rings (88/2).
- Insert the protective tubes (88/3) with springs (88/4), thrust rings (88/5) and new sealing rings (88/6) into the bore in the crankcase. Grease the sealing rings slightly.
- With the aid of a second person, place the cylinder head in position, making sure that the protective tubes with O-ring seals enter the holes in the cylinder head correctly.
- Insert the pushrods.
- Install the rocker pedestals. Make sure that the adjusting screws are inserted correctly into the pushrods; if necessary, unscrew them.
- Coat the thread of the tierod in the oil cavity with sealant **D**.
- Screw on the shouldered nuts and tighten them by hand in the order 1 - 15 (Fig. 86 or 87) until they are firmly against the cylinder head.
- Tighten nuts 1 - 15 to half the specified torque.
- Tighten nuts 1 - 15 to the full specified torque..
- Adjust valve clearances.

Note:

The valve clearance for engines with aluminium pushrods is 0.40 mm, for engines with steel pushrods 0.20 mm.

- Further installation is by following the removal instructions in the opposite order.



88

M 07.00 Cylinder head

M 07.40 Reconditioning the cylinder head (water-cooled engines)

⌚ - 1 - 2 - 6 - 7 -

Preparatory work:

- Remove the cylinder head; see M 07.30.

Dismantling the cylinder head:

- Remove the circlips (89/10) from the rocker pedestal and pull off the rocker (89/11) with shim washers (89/12).
- Pull out the centering sleeves (89/1) and place the cylinder head on its sealing surface.

Note:

Do not scratch or otherwise damage the cylinder head sealing face; always place a soft cloth or similar underlay beneath it.

- Press the spring plate (89/2) down with tool - 6 - and remove the valve spring collets (89/3).
- Take out the valve springs (89/4) with underlay washers (89/6).

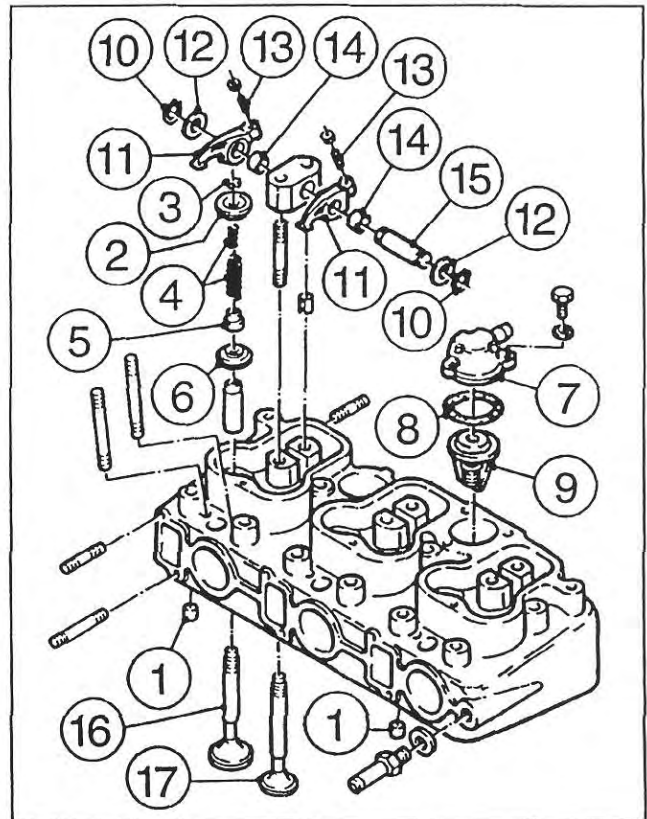
Note:

Engines with a running speed of less than 2300 rpm. are equipped with adjusting screws with longitudinal slots for the rockers (89/13) and valve stem seals (89/5).

You are recommended to retrofit these screws during subsequent repair work.

Engines built up to and including 1983 (all running speeds) have single valve springs. During repairs you are recommended to install double valve springs on engines which run at **more than** 2300 rpm.

- Place the cylinder head on the exhaust side and pull out valve cones (89/16 and 17).
- Take off cover (89/7) with sealing ring (89/8) and take out thermostat (89/9).



89