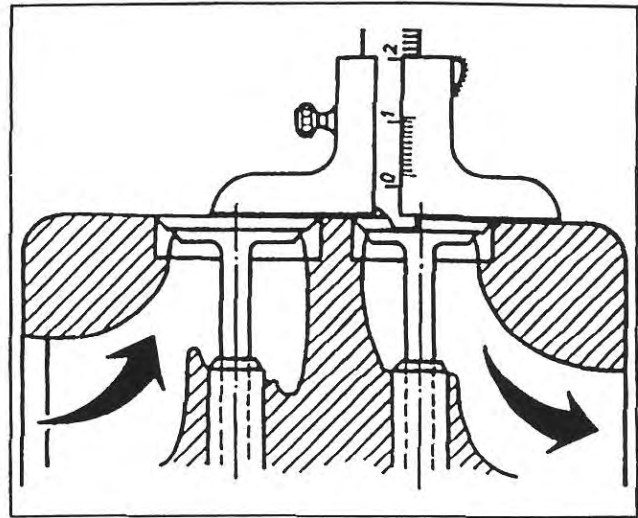


Checking parts:

- Check correct dimensions of bushing for rocker (89/14), rocker shaft (89/15) and rocker pad radius.
For values, see Section 4.
- Check valve guides and valve stems for wear; see Section 4.
- Inspect the cylinder head for cracks (in webs) and unevenness of the sealing surface.
- Examine the valve seat rings and valve collets for wear. Note valve recess in head; see Fig. 90 and Section 4.



90

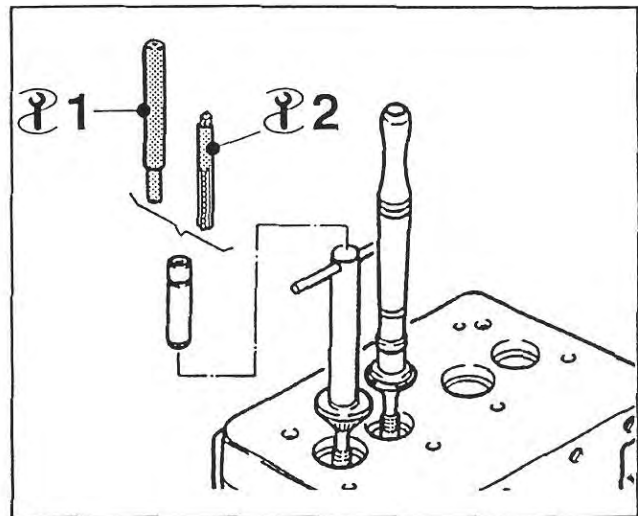
Reconditioning cylinder head:

- If necessary, press the valve guides out with pressing-in tool - 1 -, Fig. 91.
- Press in new valve guides with the same tool - 1 -.

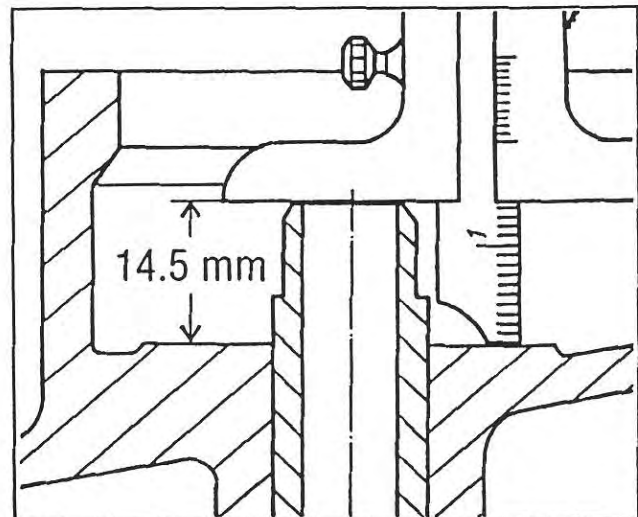
Note:

The pressing-in depth must be correct; for projection, see Fig. 92.

- Ream out the valve guides to nominal diameter with hand-held reamer - 2 -, Fig. 91.
- If the valve seats are leaking or have been damaged locally, or after installing new valve guides, they must be remachined. This is carried out with special milling cutters which are available commercially.
- Only mill away sufficient metal to eliminate patches on the surface of the valve seat.
- After this, lap in the valves with grinding paste, grain size 180 - 250; see Fig. 91.



91



92

Note:


- To check the lapped valve seats, clean and install the valves, then pour a small quantity of diesel oil into the inlet and exhaust ports.
No diesel oil should seep through past the valve seats.
- Note correct valve recess measurement; see Fig. 90 and Section 4.

Assembling cylinder head:

The cylinder head is assembled by following the removal procedure in the reverse order.

Before pressing on the valve stem seals, insert the valves into the valve guides. Press the seals on with assembly tool - 7 -.

M 10.00 Oil pump

 - 13 -

Preparatory work:

- Take off the timing case cover; see M 11.00.

Dismantling:

- Take out the machine screws (97/1) and lift off the oil pump.
- If necessary, pull out needle roller bearing (98/1) with an internal puller.

Checking / repairs:

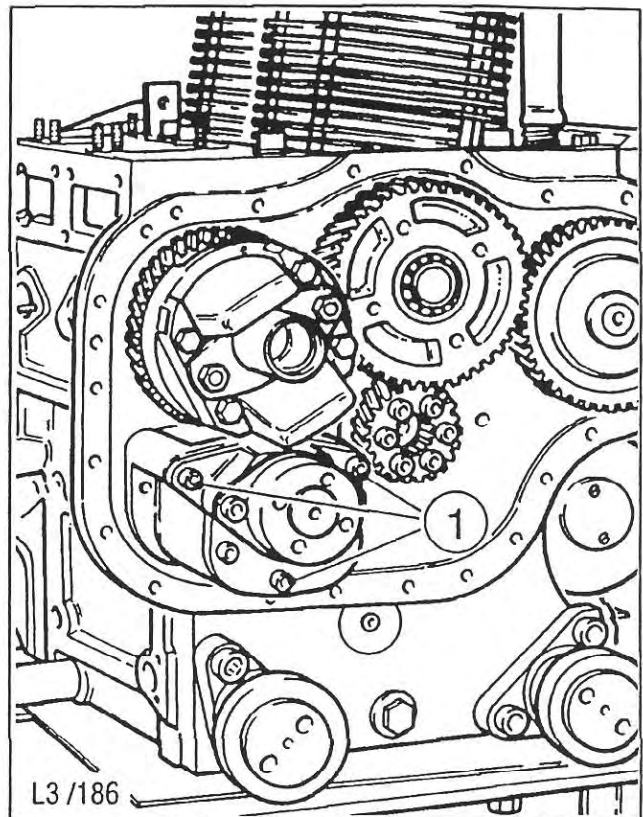
- Examine the contact face for the shaft sealing ring for score-marks.
If the contact face is worn, a „wear sleeve“ can be pushed over it. Use sealant **E** for this purpose.
Installation instructions are included with the spare part.

Assembly:

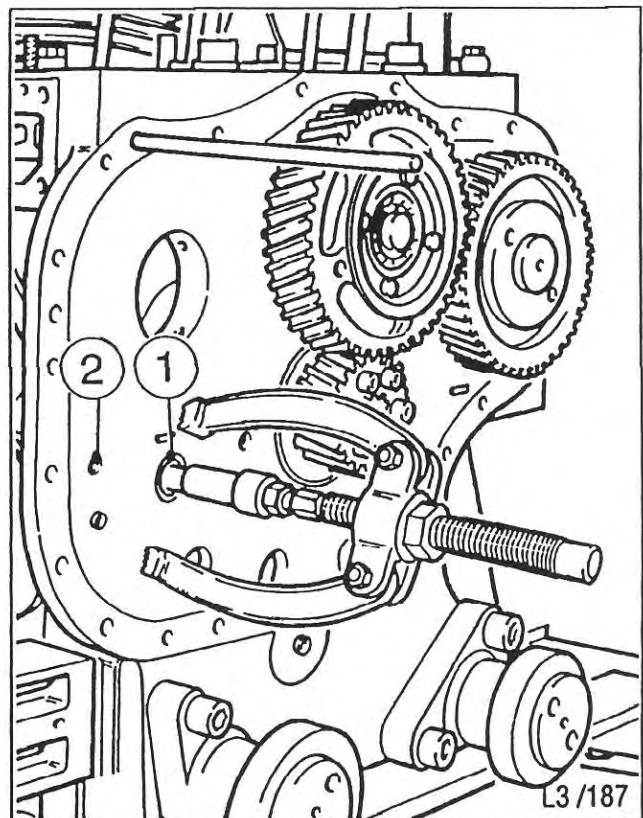
- Using a plastic-faced hammer, drive the needle roller bearing flush into the crankcase.
- Insert the oil pump with bearing journal into the needle roller bearing and place it over the centering sleeves.
- Insert and tighten the machine screws.

Note:

- Apply sealant **D** to the machine screw for hole (98/2).
- Coat the endface of the oil pump which is in contact with the crankcase with sealant **B**.
- Re-assemble the engine in the opposite order to that described for dismantling.
- When renewing the oil pump, make sure that the correct type is installed (2- / 3- or 4-cylinder engine).



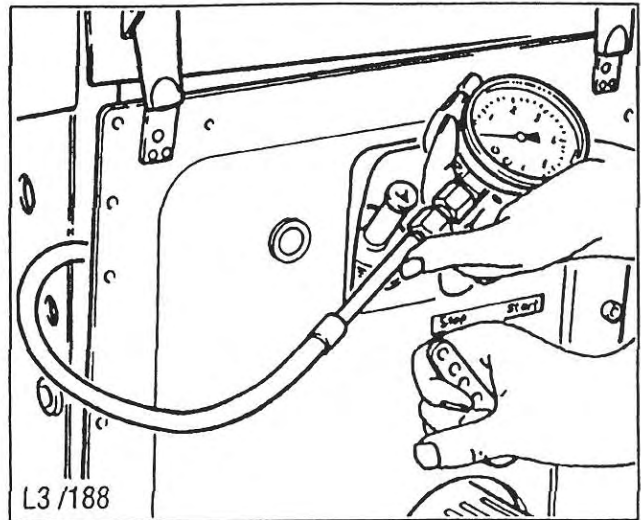
97



98

Checking oil pressure:

- Unscrew the oil pressure sensing switch and connect an oil pressure gauge with flexible hose - 13 - .
- Install the side panel and enclosure hood.
- Start the engine and compare the oil pressure when it is at regular operating temperature with the values in Section 4; see Fig. 99.
- Before assembly, coat the thread of the oil pressure sensing switch with sealant **D**.



99

M 11.00 Timing case cover



Preparatory work:

- Take off the exhaust silencer (muffler); see A 03.00.
- Take off the air guide housing; see M 35.00 (engines with enclosure only)
- Take off the fan; see M 13.00.
- Take off the engine shutdown device; see M 20.00.

Dismantling

Timing case cover without hydraulic pump drive:

- Pull the hose off the crankcase breather valve (100/1).

Note:

From 2 L 40.14, 3/4 L 40.13, M 41 and on the M 31, M 40 and M 41 the hose connection (101/2) for the crankcase breather has been moved to the top of the crankcase. The valve (101/1) was bonded into the air intake pipe until early 1987. Since then it has been secured in the air intake pipe by two O-rings.

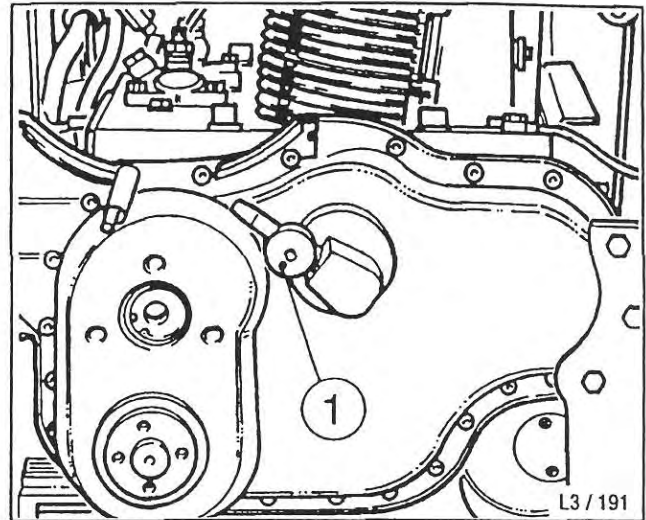
- Remove the circlip (102/1) and coil spring (102/2) from the pull rod of the engine shutdown device.

From early 1996 an additional cup spring and an O-ring have been installed to seal the pull rod.

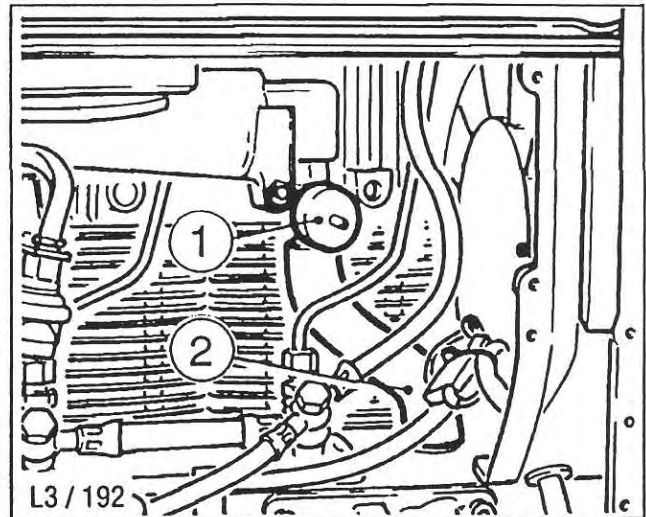
- Unscrew and remove the belt pulley (102/3) and the machine screws holding the timing case cover all round.
- Pull off the timing case cover and remove the gasket.

Checking parts:

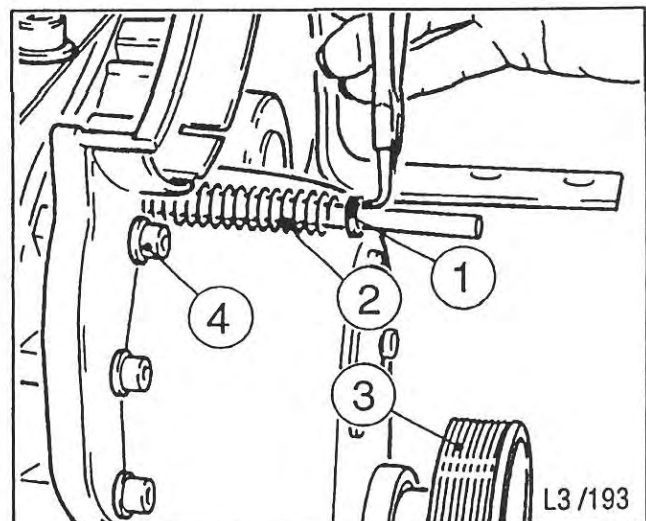
- Check the timing case cover for cracks or unevenness of the sealing surface.
- Examine the shaft sealing ring for damage and renew if necessary.
- Press off the breather valve cap and examine the diaphragm for damage.



100



101



102

Dismantling

Timing case cover for hydraulic pump drive:

Additional work:

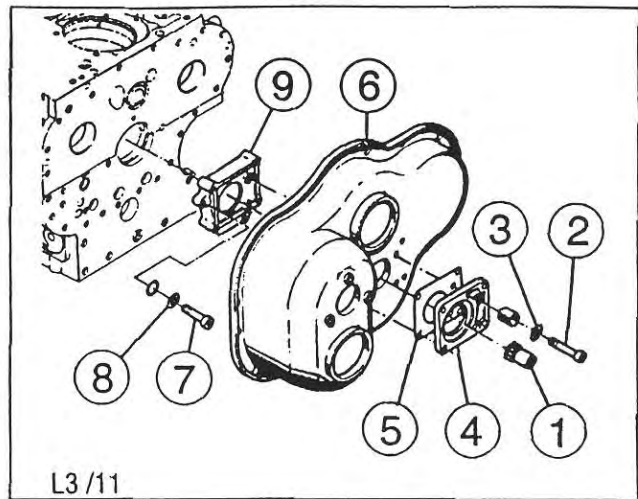
- Take off the hydraulic lines and hydraulic pump.
- Pull out the driver (103/1).
- Remove both machine screws (103/2) including spring washer (103/3), plate (103/4) and gasket (103/5).
- After removing the timing case cover retaining screws (103/4) and taking off the timing case cover (103/6) the support mount (103/9) is exposed and can be taken off after removing the two screws (103/7) with spring washer (103/8).

Note:

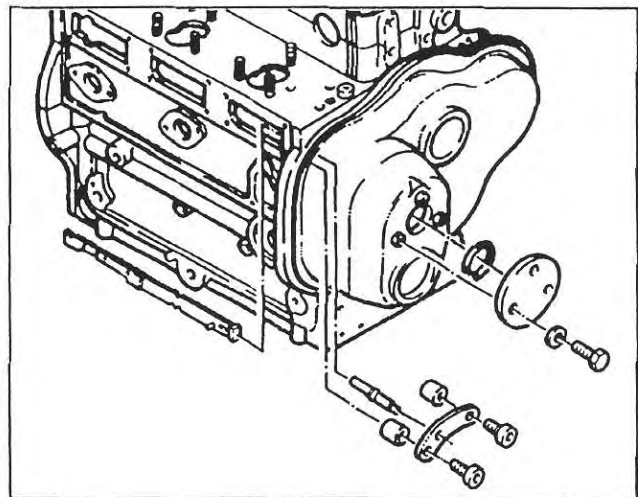
- On older L 30/L 40 / H.L 30 engines there is no support mount for the hydraulic pump drive.
- H2L30 and H3L30 engines do not have a hydraulic belt tensioner. For this reason the pull rod is locked out of action by a hoop. A blank cover is fitted in place of the shutdown device; see Fig. 104.

Assembling:

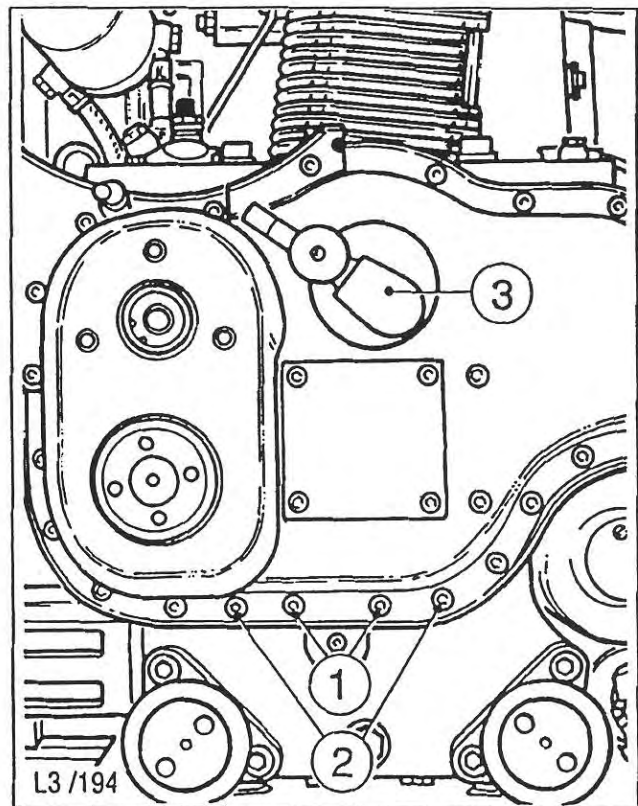
- Apply grease to the contact edge of the shaft sealing ring.
- Before fitting, coat new seals on both sides with sealant H.
- Install the timing case cover.
- On the 2 and 3 L ... insert M 8 x 12 machine screws into holes (105/1) and (105/2) with sealant D.



103



104



105

- Further timing case cover attachment and engine assembly procedures are as described for removal, but working in the reverse order.

Note:

When renewing the breather valve, secure the new valve housing in the insert (105/3) with sealant **E** and then seal all round with sealant **H**.

If the insert is renewed, use sealant **C** for bonding in.

The hose spigot opening in the air intake pipe must face toward the intake port of cylinder 1.

The position of the opening can be varied by inserting or removing spacing washers (only on engines with crankcase breather in timing case cover).

M 12.00 Extra-fuel device

M 12.10 with injection pump PFR 1K 80



Preparatory work:

- Detach the enclosure hood and side panel; see M 35.00.
- On twin-cylinder engines, detach the oil filler pipe.

Dismantling:

- Remove the screws for the extra-fuel device and take it off; see Fig. 106.

Dismantling the hydraulic extra-fuel device::

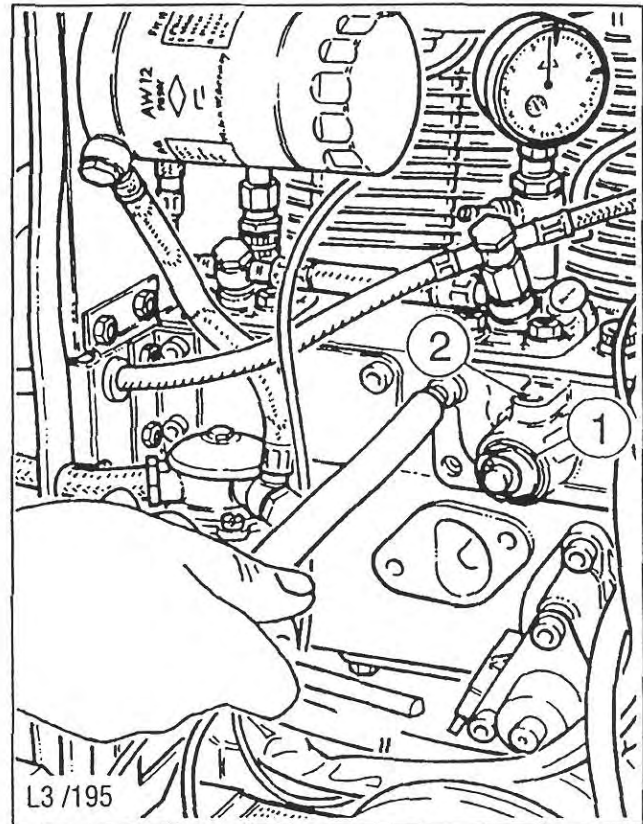
- Take off the circlip (106/1), unscrew the threaded pin (106/2) and push out cylinder (107/1).
- Take off the circlip (107/2) and pull out the end cover (107/3) and the piston (107/4) with spring (107/5).
- Take out circlip (107/6) with spring plate (107/7), spring (107/8) and ball (107/9).

Checking / repairs:

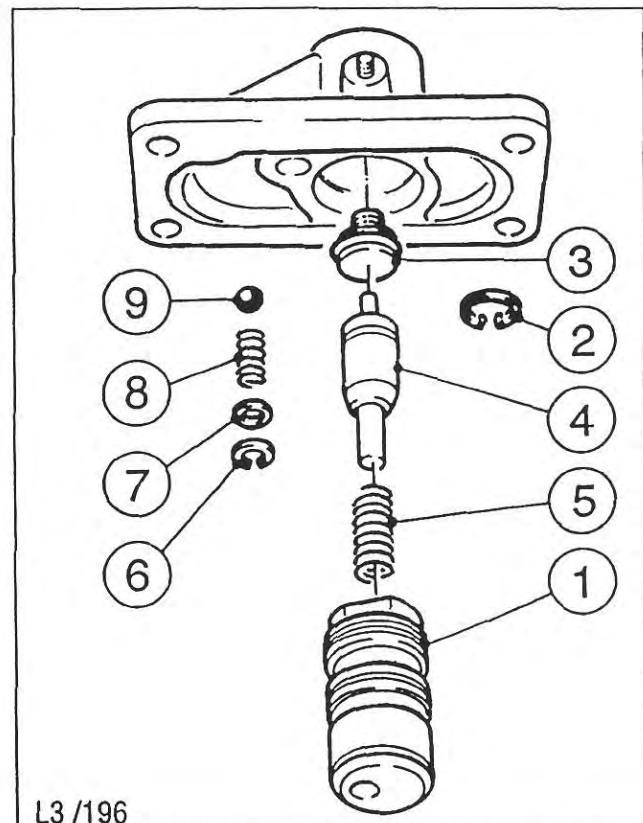
- Inspect the piston and cylinder of the extra-fuel device for score-marks or worn areas.
- Check the ball seat of the pressure relief valve for wear marks.
- Renew the O-ring seals.

Assembling the hydraulic extra-fuel device:

- Assembly is as shown in Fig. 107, working in the opposite order from dismantling.



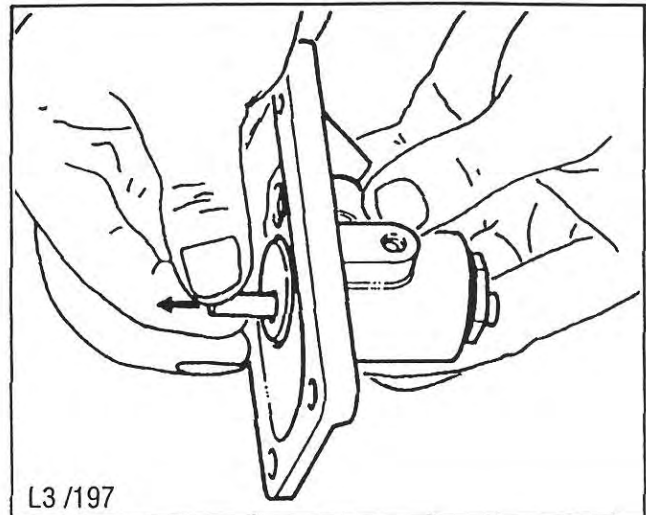
106



107

Checking the extra-fuel device:

- After assembly, check free movement of the extra-fuel device's piston by pulling it out and letting it slide back; see Fig. 108.



L3 /197

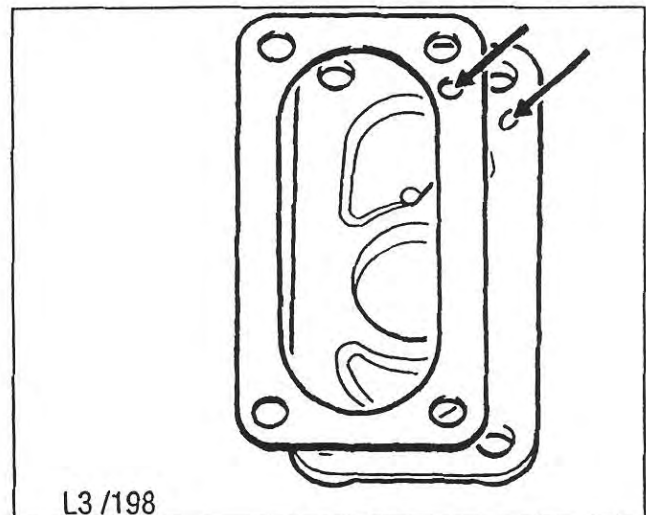
108

Attaching:

- The extra-fuel device is installed by following the removal instructions in the opposite order, taking particular care that the gasket is correctly installed as shown in Fig. 109 and the scribed mark is noted. Apply sealant **H** to both sides of the gasket. Only a thin coat should be applied, so that the oil in the extra-fuel device is not blocked. Install the machine screws with sealant **D**.

Adjusting the extra-fuel device:

- Piston (107/4) also acts as the full-load stop for the governor lever and is eccentrically located in the cylinder (107/1).



L3 /198

109


The effective stroke and therefore the maximum injected fuel volume are adjusted by turning this cylinder.

For effective stroke requirements and adjusting procedure, see M 14.00.

If the **same** extra-fuel device is detached and re-attached, the effective stroke does not have to be adjusted, provided that the setting of the volume limiting eccentric was not altered.

M 12.00 Extra-fuel device

M 12.20 with injection pump PFR 1K 90

 - 34 -

Preparatory work:

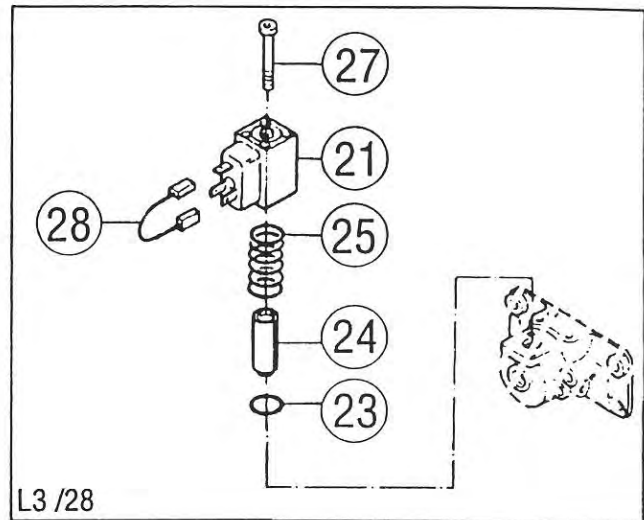
- see M 12.10.

Dismantling:

- Pull terminal 7 off the solenoid valve (only version with electric engine shutdown).
- Remove the screw (111/28) with sealing rings (111/36).
- Make a scribed mark on the crankcase and the monitoring block, so that the monitoring block can later be re-attached in the same position as before, and the original power setting is therefore retained.
- Take out the retaining screws (111/5) and take off the engine monitoring block.

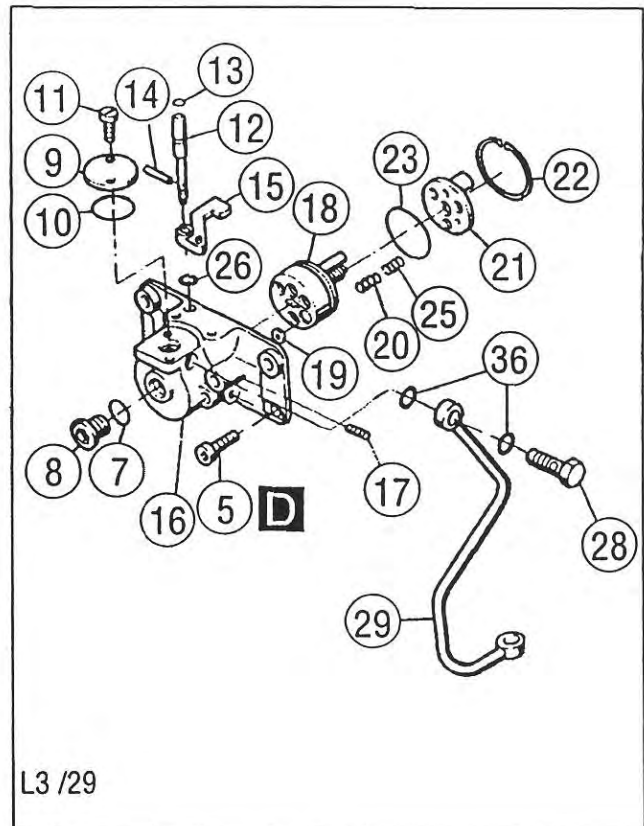
Dismantling the engine monitoring block:

- Unscrew and remove the cover (111/9) with sealing ring (111/10); on version with electric engine shutdown, unscrew the solenoid valve (110/21) and take it off complete with sealing ring (110/23), armature (110/24) and spring (110/25).
- Remove the screw plug (111/8).
- Take off the lock washer (111/26), pull up shaft (111/12) take out lever (111/15), drive out locking collet (111/14) and remove shaft (111/12) from the housing.
- Remove circlip (111/22); hold eccentric (111/21), slacken off grub screw (111/17) and pull out the eccentric with springs (111/20,25) and piston (111/18).



L3 /28

110



L3 /29

111

Checking parts:

- Examine the piston for score marks or wear.
- Check the valve seat (111/19) for wear.
- Renew the O-rings.

Assembling the engine monitoring block:

- Proceed in the opposite order of work to that described for removal.

Note:

To install the piston, use auxiliary bushing
- 34 -.

Assembly:

- Move the speed control lever to the „Stop“ position.
- To attach, follow the instructions for detaching the device in the reverse order.
- Make sure that the gasket is correctly seated and note the scribed mark which indicates the correct position; install the machine screws with sealant **D**.

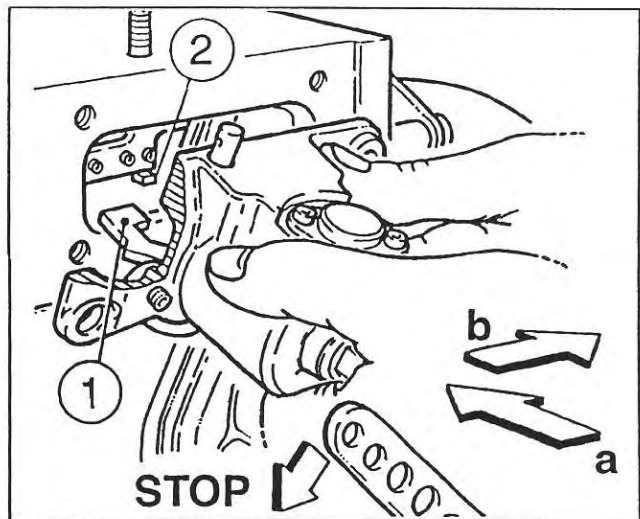
Note:

When attaching, make sure that lever (112/1) engages to the left of plate (112/2). To do this on engines with the lower idle speed governed to ≥ 1700 rpm the shaft (111/12) must be turned counter-clockwise when assembling. Check when the monitoring block is installed by turning shaft (111/12) counter-clockwise; it must then move back by itself to its initial position.

Adjusting the engine monitoring block:

- The maximum fuel injection volume is adjusted by turning the piston (111/18). For the need to adjust the fuel injection volume, and the correct procedure, see Section M 14.00. If the **same** monitoring block is detached and re-attached, the fuel injection volume need not be adjusted, provided that the setting of piston (111/18) was **not** altered.


If the monitoring block is renewed or after it has been repaired, the fuel injection volume (power setting) must **always be adjusted**.



112

M 12.00 Extra-fuel device

M 12.30 with PFR 1K 90 injection pump (from L / M 31.12, M 40.16, 2 L 40.19 3-4 L 40.18 and L / M 41)

 - 34 -

Preparatory work:

- see M 12.10.

Dismantling:

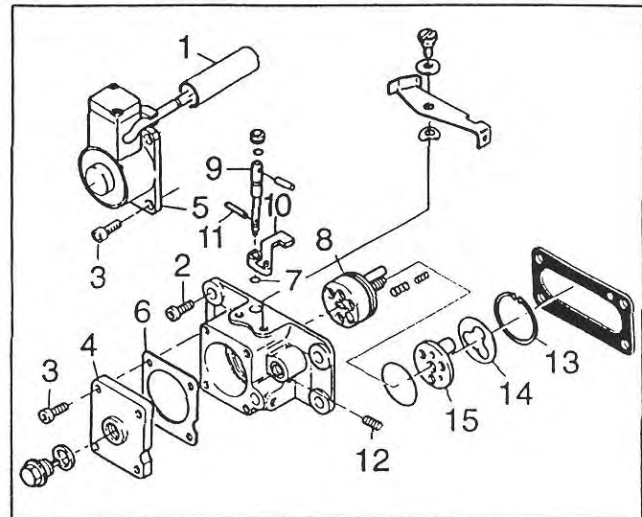
- Detach plug connector (164/1) from engine wiring harness (electric version only).
- Take out machine screws (164/3) and detach cover (164/4) and solenoid valve (164/5) with gasket (164/6).
- Make a scribe mark on the crankcase and the servo block to ensure that they are installed again in the same relative positions and the power setting therefore remains unchanged.
- Remove machine screws (164/2) and take off the servo block.

Checking / repairs:

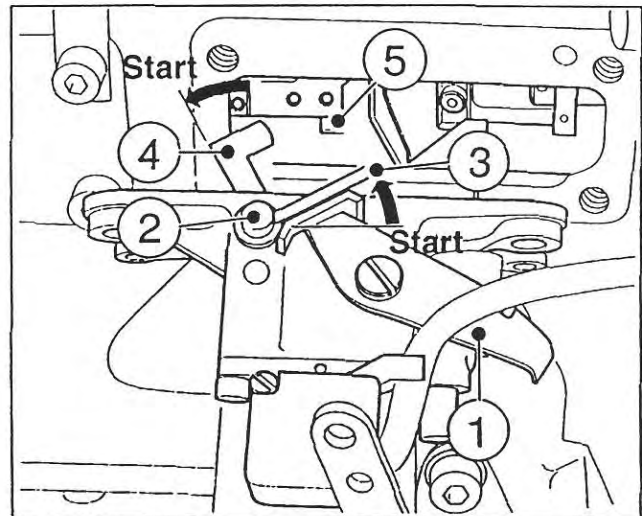
- Turn lever (165/1) in the „Start“ direction. Shaft (165/2) is then turned by locking pin (165/3) and the sickle-pattern lever (165/4) moved to the starting position. When the lever is released, all elements must return to the „Stop“ position (Fig. 166).

Ensure free movement if necessary by greasing or oiling lightly.

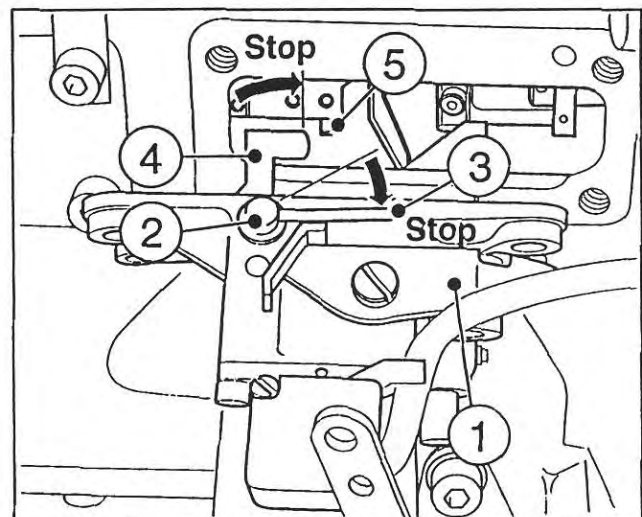
- Press piston (167/8) by hand in the „Start“ direction:
The sickle-shaped lever must move to the starting position, but return to the „Stop“ position when the piston is released.



164



165



166

Dismantling the servo block:

- Take off lock washer (164/7).
- Hold piston (164/8), raise shaft (164/9) and take out sickle-shaped lever (164/10).
- Release piston (164/8) carefully and take it out of the housing.
- Drive out locking collet (164/11) and pull shaft (164/9) out of the housing.
- Take out grub screw (164/12).
- Remove circlip (164/13) and take out washer (164/14) and eccentric disc (164/15).

Checking / repairs:

- Examine piston for wear or score marks.
- Renew gaskets.

Assembling the servo block:

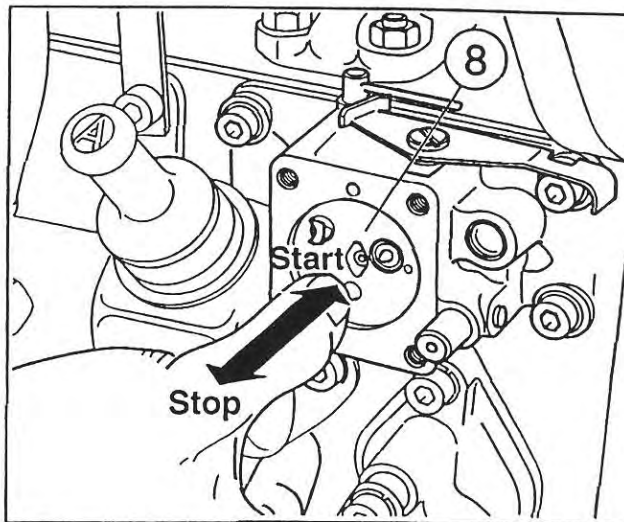
- Assemble in the opposite order of work to that described for removal.
When installing the piston, use bushing - 34 -
Note correct position of gasket (164/6) (oil hole).
Apply sealant **D** to machine screws (164/3) and tighten them to a torque of 9.5 Nm.

Caution:

If the tightening torque is too high, the servo piston may seize (distortion).

Installing:

- Set the speed control lever to „Stop“.
Make sure that the gasket is installed in the correct position (oil hole) and that the scriber markings are aligned.
Insert machine screws (164/2) using sealant **D** and noting their correct positions; attach a lead seal.
When attaching the monitoring block, make sure that sickle-shaped lever (166/4) is located at the left of stop (166/5).



167

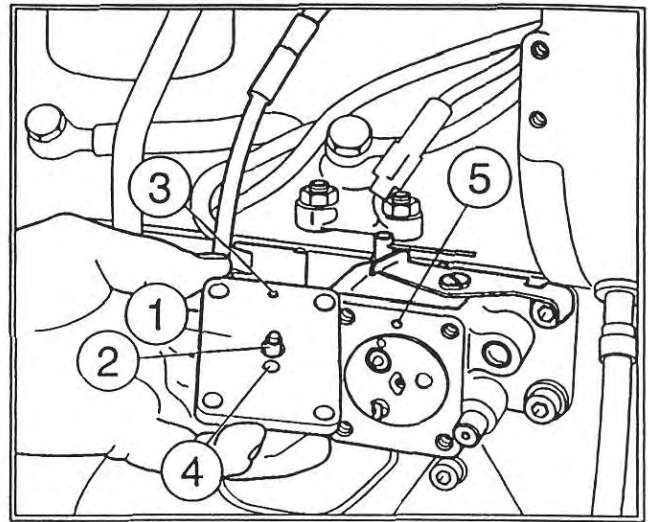
Warning:

The sickle-shaped lever must never be under or to the right of the stop.

- Screw the block on tightly.
- Set the speed control to the „Start“ position and move piston (167/8) to and fro between the start and stop positions.
With the injection pump removed or the side cover taken off, the governor lever can be seen to perform the same movement.

**Checking valve solenoid:
(Fig. 168)**

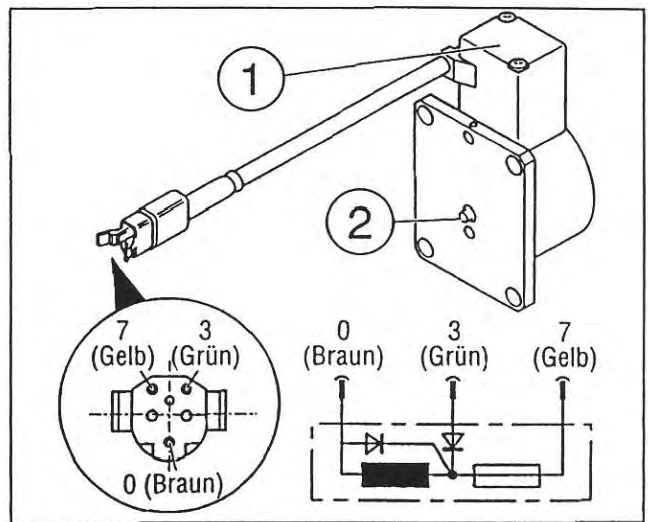
- without electric control:
Valve pin 2 is in the rest position;
the connection between bores 3 and 4 is closed.
- Apply the electric current to connection „7“
(yellow wire):
the valve pin must extend by app. 6 mm.
 $F \approx 15 - 20 \text{ N}$ (loading can easily be overcome with the finger), free passage between bores 3 and 4.
- Apply the electric current to connection „3“
(green wire):
the valve pin must extend fully.
 $F \approx 30 - 50 \text{ N}$ (very difficult to overcome loading with finger pressure), free passage between bores 3 and 4.
- If any repairs are made to the wiring, make sure that the plugs are wired up correctly (Fig. 169).



168

Note:

When installing the valve solenoid or cover (164/4), note the correct installed position (this also applies to the gasket); holes 168/3 and 5 must be aligned.



169

M 13.00 Fan



Preparatory work:

- Take off the exhaust-system capsule (encapsulated engines only) and the silencer (muffler); see A 03.00.

Encapsulated engines:

- Take off the capsule side panel, air outlet duct, air guide housing and fan impeller; see M 35.00.

Non-encapsulated engines:

- Take off the cooling air guide.
- Take off the hydraulic shutdown device; see M 20.00.
- Disconnect the battery.

Removing:

- Mark and disconnect the wiring at the alternator.
- Take out screws (117/1).
- Pull out the fan housing.

Checking parts:

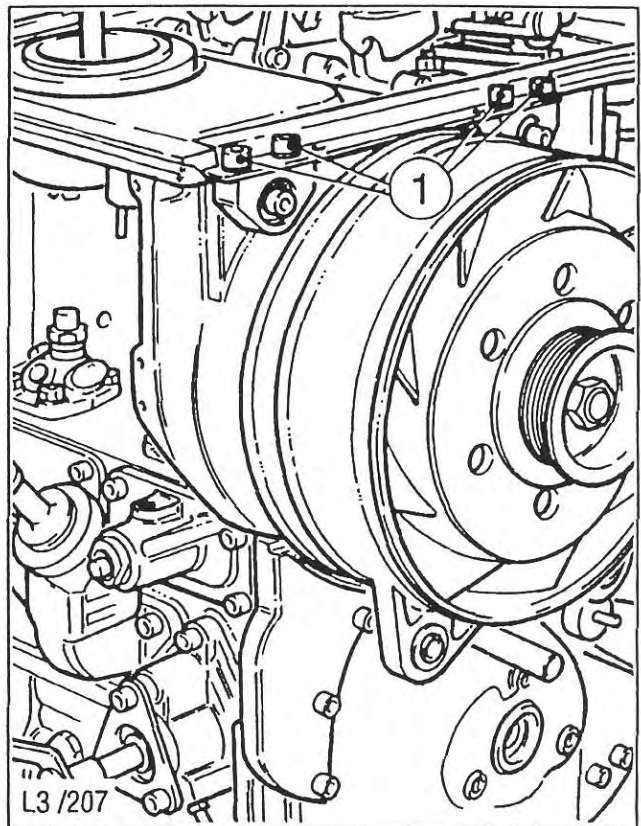
- Check the fan housing sealing strips for signs of damage; if necessary, attach new sealing strips with adhesive **G**.

Installing:

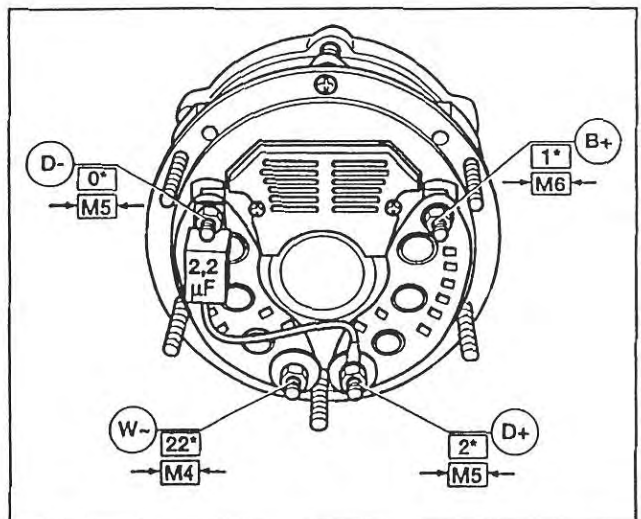
- Apply a slip agent, e.g. Vaseline, to the contact faces of the fan housing sealing strips.
- Install the fan housing and check that the sealing strips are correctly positioned.
- Re-assemble the items removed from the engine in the opposite order of work to that described for their removal.
- Make sure that the Poly-V belt is installed accurately.

Note:

When connecting cables to the alternator, do not accidentally interchange them; see Fig. 118.



117



118

M 14.00 Fuel injection equipment

M 14.00 Injection pump, functional check

⌘ - 5 -

Preparatory work:

- Take off the capsule hood and side panel.
- Detach the fuel delivery pipes from all injector pumps, holding the pipe union to prevent it from turning.

Check injection pumps: (Fig. 182)

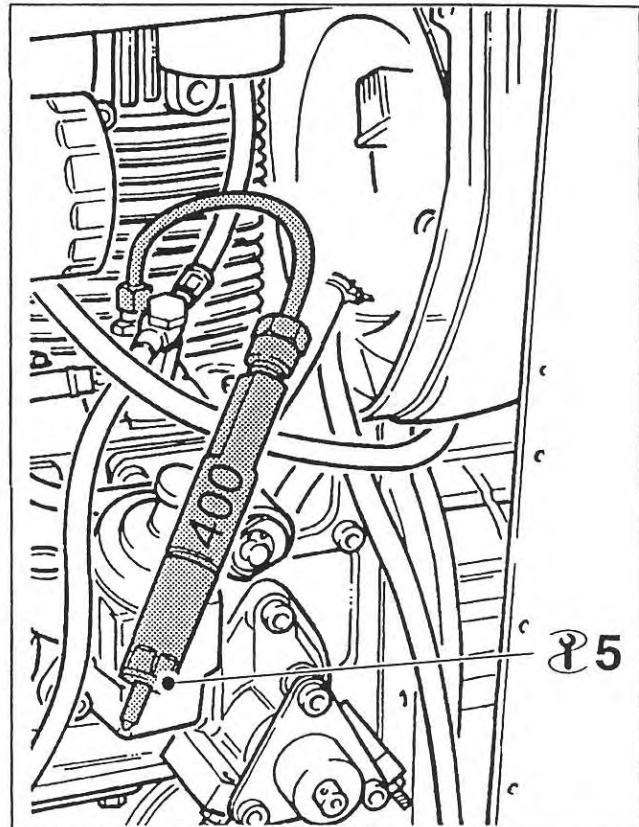
- Attach test nozzle - 5 - with delivery pipe to the injection pump you wish to check.
- Cover the pressure valve holders on the other injection pumps with absorbent cleaning cloths.
- Move the speed control lever to the start position and run the starter.

If the spray pattern is correct, the pump you have checked is in good mechanical working order (no pump element wear, no leakage at pressure valve).

WARNING!

Keep hands away from the injected fuel spray.

The fuel spray from the injector nozzle can cause blood poisoning if it contacts the skin.



182

M 14.00 Fuel injection equipment

M 14.10 with injection pump PFR 1K 80



Preparatory work:

- Take off enclosure hood, side panel and cover for air guide housing; see M 35.00.
- Take off fuel filter and fuel delivery pump.
- Take off guide plate for oil cooler on S/Z.
- On engines with shutdown solenoid, to remove pump for cylinder 1 take off the starting charge device including the solenoid (see A 11.00); on the two-cylinder engine, also take off the oil filler pipe.

Removing the injection pump:

- Set the speed control lever to a central position.
- Remove the hex nuts for the injection pump mounting, and pull out the injection pump.
- Take off the shim washers.

Note:

- Do not install the shim washers at the wrong points.
- On four-cylinder engines, the hollow restrictor screw for the injection pump at the timing end has a return-flow restrictor. During repairs, make sure that the correct hollow screw is used, or else the volume of fuel in the injection pump will be altered.

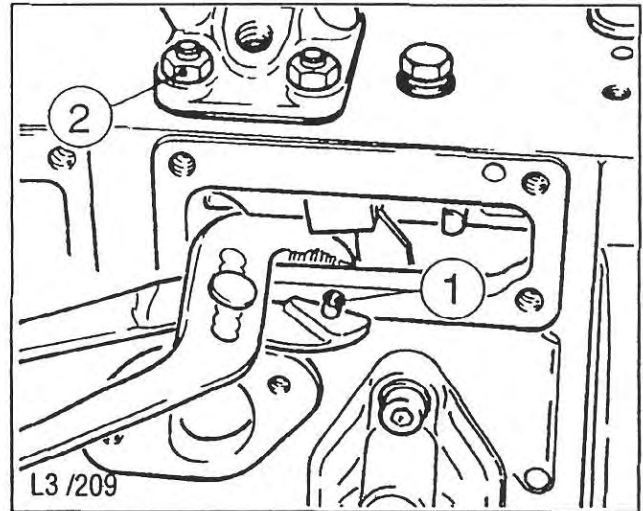
Removing the governor rod:

- Take off the oil filler pipe, the starting charge control device and all side covers.
- Using water pump pliers, press out locking pin (119/1) until the governor lever can be moved to the flywheel end; see Fig. 119.

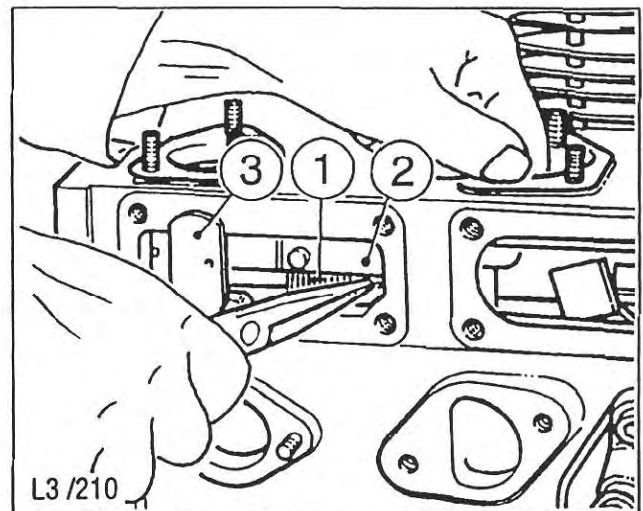
- Unscrew and remove the extended stub bolt or machine screw (119/2) at the injection pump for cylinder 1. This also acts as a travel limiter for the governor rod.

Note:

- This device is not fitted to older engines.
- Disconnect tension spring (120/1) at the governor rod (120/2) and pull out the governor rod guide (120/3) with packing seals.

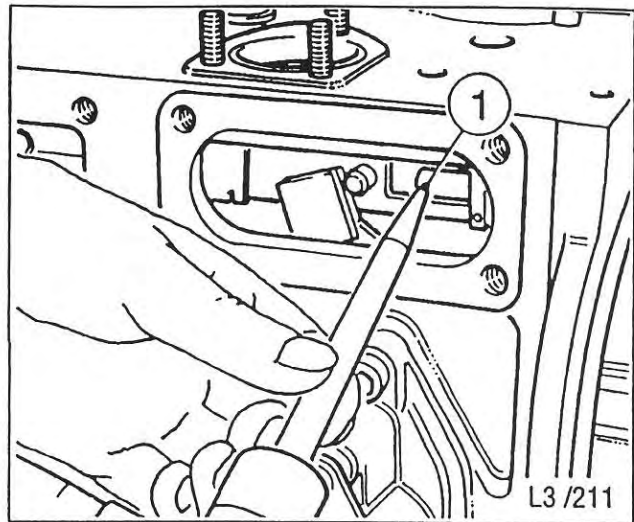


119



120

- Drive locking collet (121/1) halfway into the pull rod with a suitable split pin driver.
- Turn the pull rod through 180° and pull out the locking collet with water pump pliers.
- Take off the Poly-V-belt; see M 20.00.
(The pull rod will be pulled out.)



121

- Pull the governor rod out towards the fly-wheel end; see Fig. 122.

Note:

To remove the governor rod on Types „C“ and „K“, the rear enclosure panel must be taken off.

Checking parts:

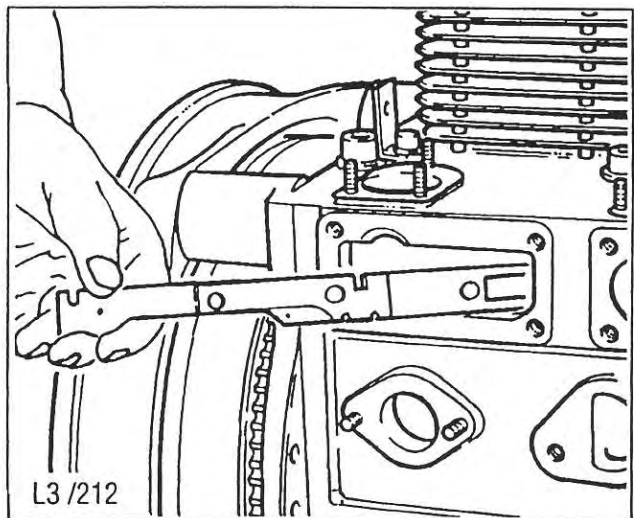
- Check the governor rod for score-marks in the governor rod guide area.

Installing the governor rod:

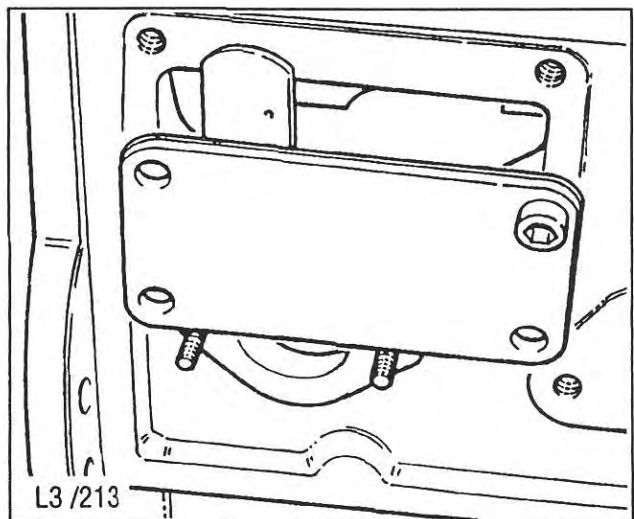
- Install the governor rod by following the instructions for its removal in the reverse order.
- After installing the governor rod, secure its guide in position with the side cover: see Fig. 123.

Note:

Play at the governor rod guide between crankcase and cover must not exceed 0.1 mm.
If play is greater than this, insert packing seals between the crankcase and the governor rod guide.

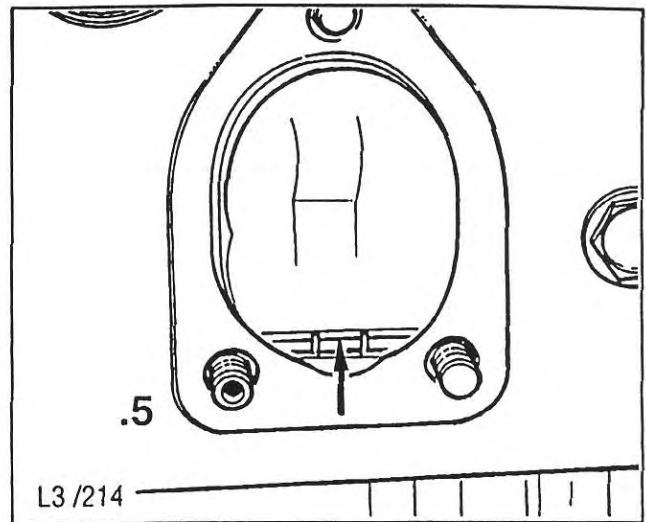


122



123

- Using the speed control lever, locate the governor rod so that the groove for the toothed rack pin on the flywheel-end injection pump is precisely in the centre of the mounting hole for the injection pump in the crankcase; see Fig. 124.
- Check the position of the other grooves and if necessary reposition the sliding elements on the governor rod.
- Insert the injection pumps and tighten them in position.
- For adjusting work, see M 14.50.




124

Note:

When installing the injection pumps, use the shim washers at the points from which they were previously removed. The figure stamped next to the injection pump indicates the thickness of the shims, e.g. 75 = 0.75 mm.

M 14.00 Fuel injection equipment

M 14.20 with injection pump PFR 1K 90

 - 27 -

Preparatory work:

- see M 14.10.

Removing the injection pump:

- Insert locating pin - 27 - into the hollow-drilled stud bolt of pump 1 to lock the governor rod in the „X“-Position (141/1).
- Remove the hex nuts and spring washers securing the injection pump.
- Pull out the injection pump.
- Take off the paper gaskets and shim washer.

Note:

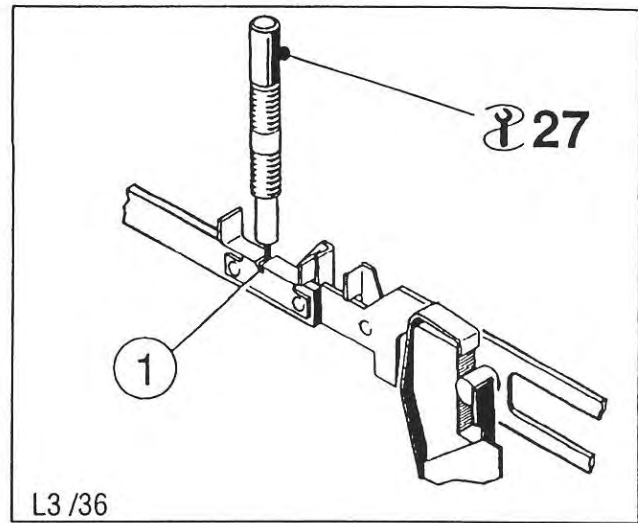
The installed positions of the gaskets, shim washers and injection pumps must **not be changed**, or else the start of fuel injection will be altered.

Removing and installing governor rod:

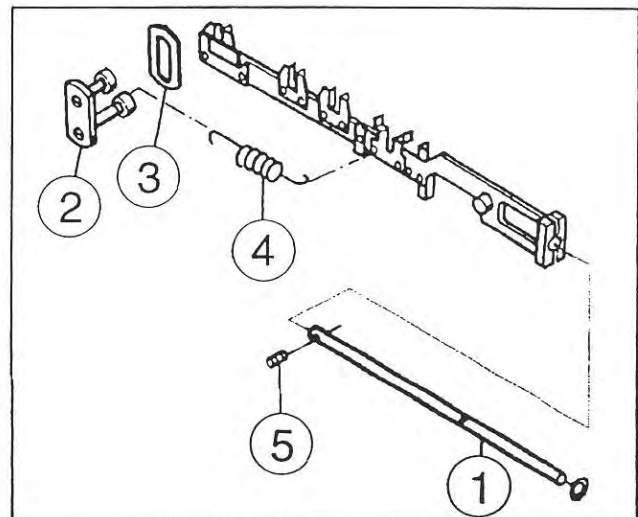
- Pull out locking collet (170/5).
- Remove the roller guide at the flywheel end (paper washers 170/3 are used to compensate for play); note the presence of spring (170/4).
- Pull the governor rod out towards the flywheel.
- Install in the reverse order of work.

Note:

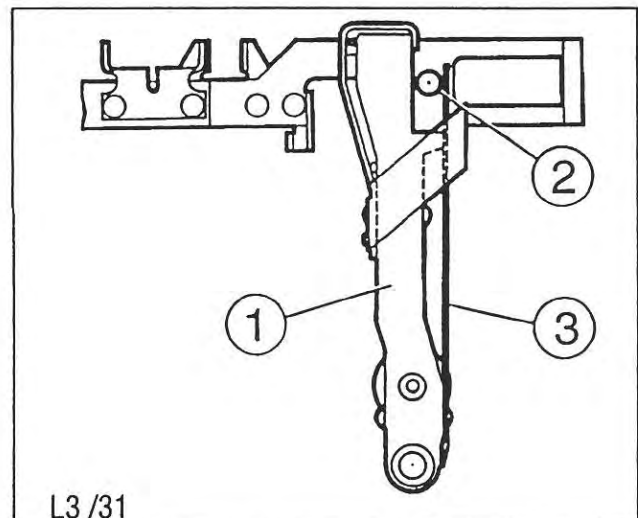
When installing the governor rod, the stop pin for the governor rod (126/2) must engage between the governor lever (126/1) and the leaf spring (126/3).



141



170



126

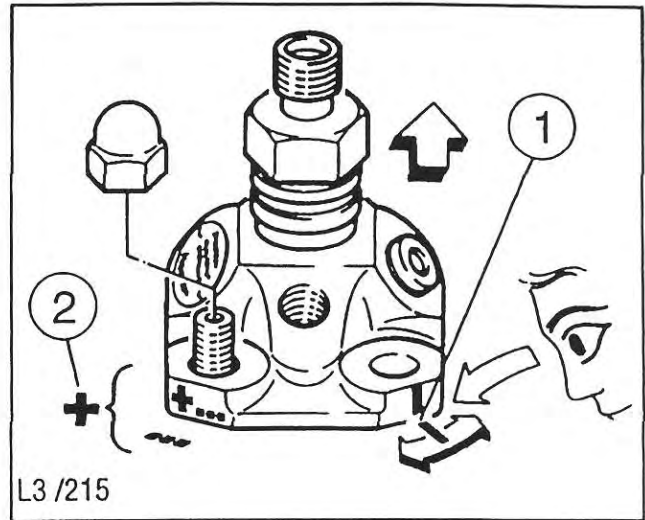
Installing the injection pump:

- Connect the governor rod in the „X“-position.
- When installing the injection pumps, use the same shim washers and gaskets as before.
- Insert the injection pumps and, before tightening, press them towards the cylinder and position them so that the scribed mark on the pump flange is precisely aligned with the corresponding notch on the crankcase (127/1).

Note:

When installing a **new** injection pump, add up the figures on the pump flange and the crankcase. The total of the two figures is the thickness of the shim washers with gaskets to be inserted, in tenths of a millimetre. Never use more than one steel shim washer. How to make up the seal pack:

Total thickness (mm)	Paper gasket (mm)	Steel washer (mm)
0.2	0.2	—
0.3	0.3	—
0.4	0.2 + 0.2	—
0.5	0.3 + 0.2	—
0.6	0.3 + 0.3	—
0.7	0.2 + 0.2	0.3
0.8	0.3 + 0.2	0.3
0.9	0.3 + 0.3	0.3
1.0	0.2 + 0.2	0.6
1.1	0.3 + 0.2	0.6
1.2	0.3 + 0.3	0.6
1.3	0.2 + 0.2	0.9
1.4	0.3 + 0.2	0.9
1.5	0.3 + 0.3	0.9
1.6	0.2 + 0.2	1.2
1.7	0.3 + 0.2	1.2
1.8	0.3 + 0.3	1.2



127

M 14.00 Fuel injection equipment

M 14.30 Injector

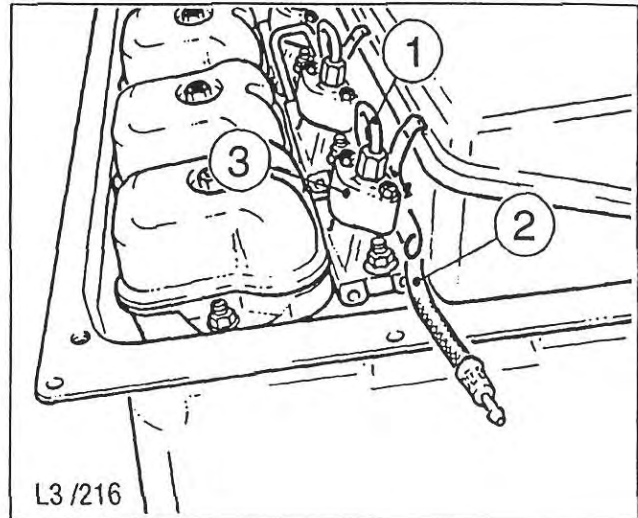
⌘ - 4 - 37 -

Preparatory work:

- Take off the enclosure hood and side panel; see M 35.00.

Removing:

- Unscrew and remove fuel pressure pipe (128/1) and oil leak-off line (128/2).



128

- Unscrew and remove loop for injector (128/3). Take out the injector and sealing ring (129/1) using impact extractor tool - 4 -.

Functional check:

- Connect extension tube with test pressure gauge for fuel injection system - 37 - to the pressure tube connection for the injection pump; see Fig. 129.
- Connect the injector to the tester, cover the remaining injection pumps over with clean cloths and start the engine.

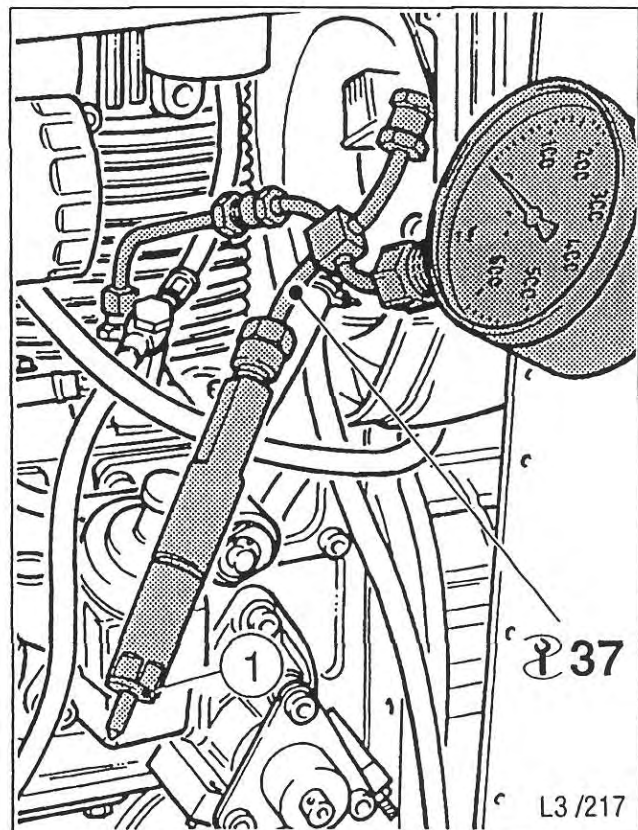
Note:

All injectors should be removed for this test.

WARNING:

Keep the hands away from the fuel spray emerging from the injectors.

The fuel spray from the injectors can cause blood poisoning.



129

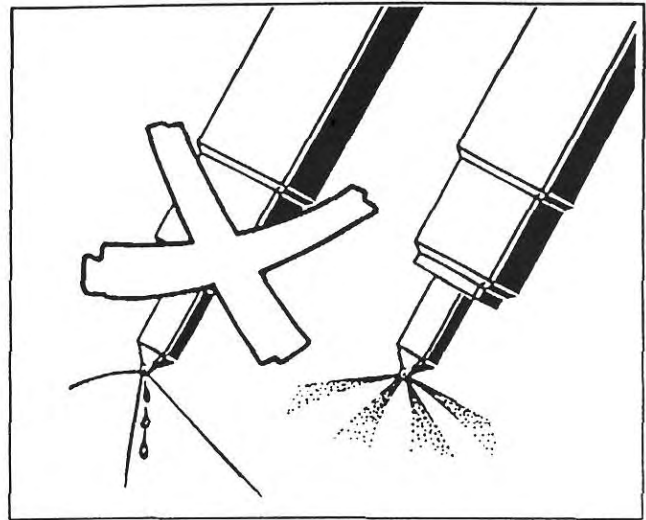
- Check the spray pattern from the injector as shown in Fig. 130.

Assembling:

- Install the injectors using new sealing rings and working in the opposite order to that described for their removal.

Note:

- Place the seal on the injector so that the soft, graphited side is at the top, towards the injector.
- Tighten the hex nuts to retain the injector and the collar nuts on the pressure pipe to the specified torques (see Section 4), holding the pressure pipe connection on the injection pump to prevent it from turning.
- The fuel pressure pipes from 2 L 40.17, 3/4 L 40.16, M 40 L.13 and M 31 L have a smaller internal diameter and are identified by the section of hose pushed on to them.



130

M 14.00 Fuel injection equipment

M 14.40 Injector nozzle



Preparatory work:

- Remove the injector; see M 14.30.

Dismantling:

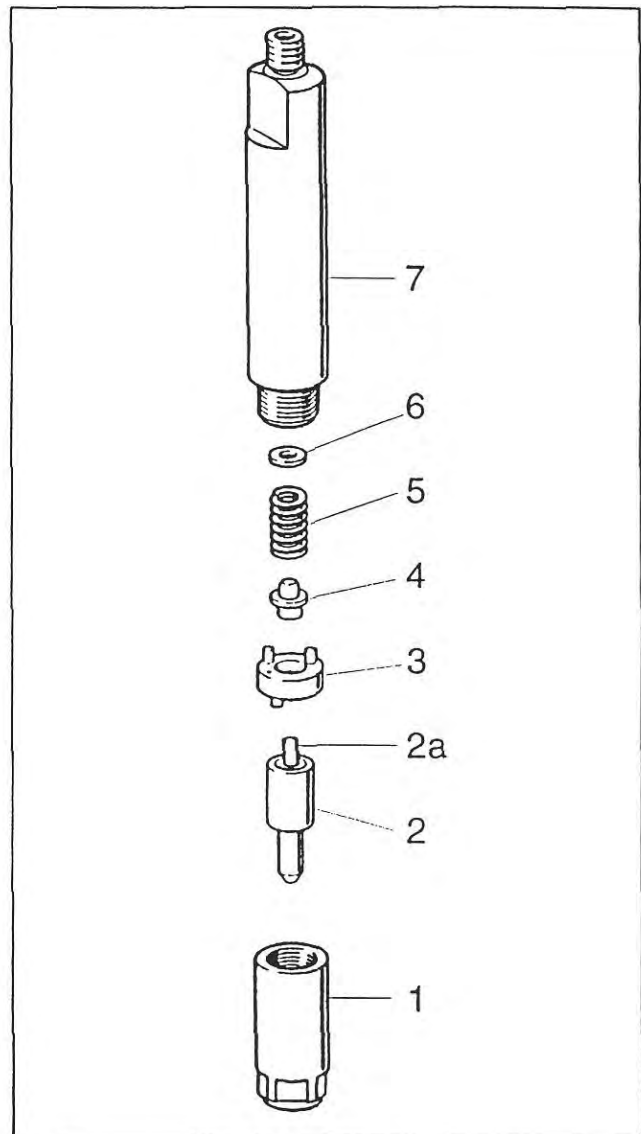
- Take off the collar nut (132/1) and remove the nozzle with needle (132/2).
- Take out spacer (132/3), pressure pin (132/4), spring (132/5) and shim washers (132/6).

Checking parts:

- Inspect the needle of the nozzle for score marks or signs of overheating.
- The nozzle needle (132/2a) must, when the nozzle is held vertical, slide down slowly and smoothly under its own weight on to its seat.
- Renew the nozzle if necessary.
- Check the sealing faces on the nozzle holder for damage.

Assembling:

- Install the shim washers, spring, pressure pin and spacer in the nozzle holder again as shown in Fig. 132, in the opposite order from their removal.
- Attach the injector nozzle so that the pins on the spacer locate in the holes on the nozzle.
- Screw on the collar nut and tighten it.
- Mount the injector on the tester and determine its fuel delivery pressure; for values, see Section 4.
- Correct the fuel delivery pressure by inserting shim washers:
Thicker washers = higher delivery pressure
Thinner washers = lower delivery pressure
0.15 mm \approx 15 bar.



132

M 14.00 Fuel injection equipment

M 14.50 Adjustment work with PFR 1K 80 injection pump (up to 2 L 40.16, 3-4 L 40.15, M 40.12, also L 30 and H.L 30)

 - 10 - 11 - 29 -

Nature of repair	Adjustments needed	Notes
Removing and installing or exchanging complete injection pump	Synchronising	Install shims again at the point where they were removed
Repairing injection pump		Injection pump must only be repaired by authorised workshop
Renewing camshaft for injection pump	Start of injection	Measure effective stroke before removal and restore when installing
Renewing crankcase	Synchronising	
	Effective stroke	
Removing and installing governor rod	Synchronising	Measure effective stroke before removal and restore when installing
Renewing governor rod	Effective stroke	
Renewing starting charge control	Effective stroke	Measure effective stroke before removal and restore when installing
Conversion from injection-pump with control lip at top (start of series production) to pump with control lip at bottom (current series production status)	Start of injection	All pumps on the engine must be converted
	Synchronising	
	Effective stroke	For adjustment data see Section 4
Modifying the power setting	Effective stroke	Measure the original effective stroke. Alter effective stroke only by difference value

1. Adjusting start of fuel delivery:

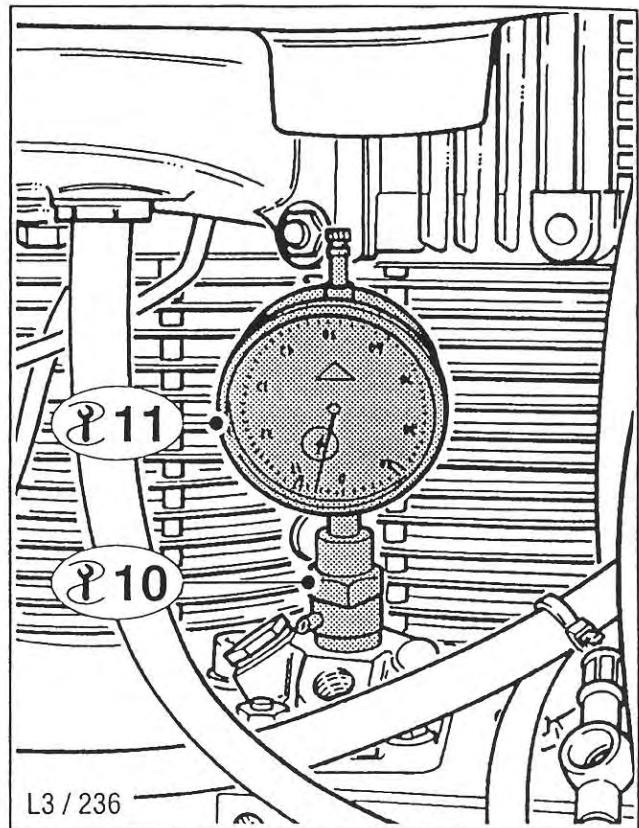
Note:

Start the adjustment at the timing-end injection pump.

- Move the speed control lever to the full-load position and secure it there.
- Remove the pressure tube connection and pressure valve at the injection pump.
- Screw the overflow device - 10 - into the injection pump.
- Screw the extension pin of the overflow device into the dial gauge - 11 - and insert it in the overflow device; see Fig. 133.
- Connect the fuel feed line from the test tank.

Note:

The test tank must be attached at least 200 mm (8 in) above the injection pump.



133

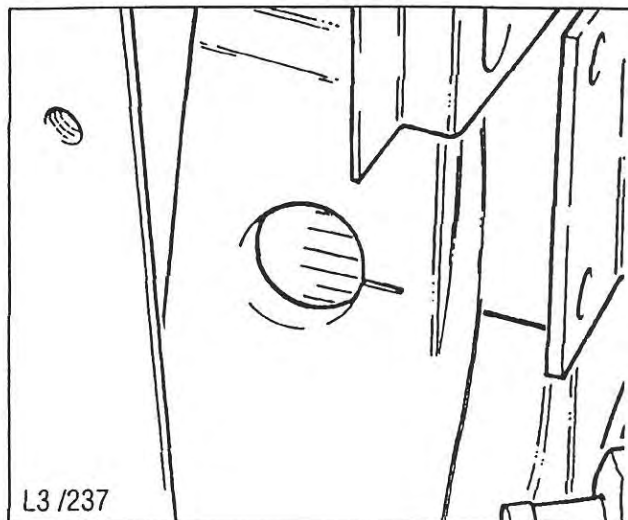
- Turn the crankshaft in the normal direction of rotation (counter-clockwise when looking at the flywheel), until the dial gauge needle starts to move.
- Open the fuel feed; fuel will emerge from the overflow device.
- To turn the engine over, attach a ratchet with 1/2-inch square end to the square recess in the belt pulley.
- Continue to turn the engine over slowly until the fuel emerges from the overflow pipe slowly as separate droplets (about. 1 droplet every 5 - 6 seconds).
- This point is the start of fuel delivery.

- Read the angle in degrees at the inspection hole in the connecting housing, and compare it with the desired value in Section 4. To take the reading, remove the plastic plug: see Fig. 134. On engines without a connecting housing, the fixed mark is stamped on the crankcase.

Note:

On engines built before or in 1980, the angle in degrees is only stamped on the engine for the first (timing-end) cylinder; only two marks are provided for the other cylinders.

The short mark (half diameter of inspection hole) shows the angle for the start of delivery, the long mark (full diameter of inspection hole) shows the piston top dead centre point.



134

- If necessary, correct the start of fuel delivery as follows:

If the reading is **smaller** than the desired value:

= fuel delivery starts too late.

Remove shims.

If the reading is **larger** than the desired value:

= fuel delivery starts too soon.

Add more shims.

Note:

Use a dial gauge as follows to determine the thickness of the shims needed to correct the value:

- Set the dial gauge to "0" at the actual start of fuel delivery, and turn the flywheel to the desired start of fuel delivery. The dial gauge will now show the thickness of the shims to be inserted or removed.
- Repeat the measurement procedure; the fuel drip from the overflow pipe on the adjusting device must start precisely when the desired value is reached.
- Carry out the measuring procedure at all injection pumps.

2. Adjusting end of fuel delivery:

Note:

Engines equipped with Type PFR 1K 80A 439/2 injection pumps must be adjusted to the correct end of the delivery stroke.

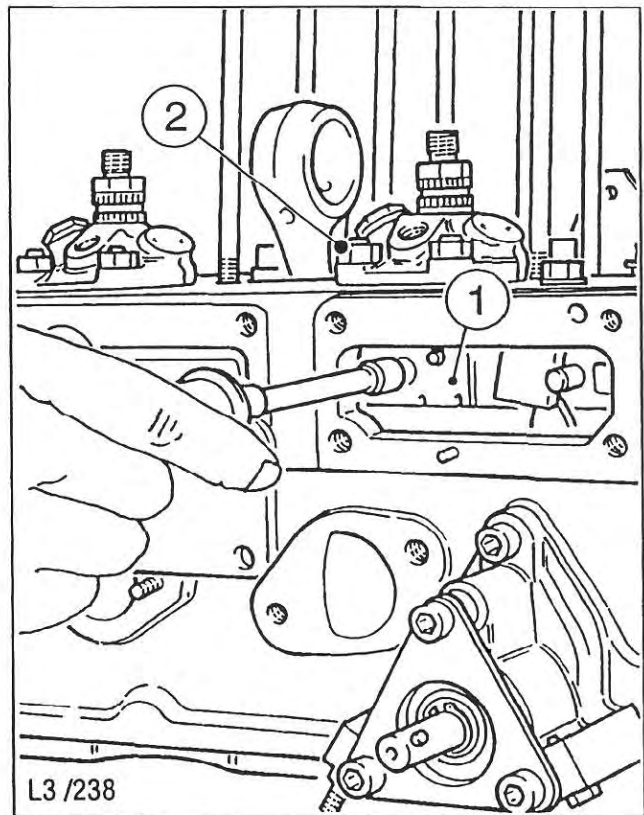
- Prepare for the measuring procedure in the same way as if the start of fuel delivery is to be measured.
- Turn the crankshaft in the normal direction of engine rotation until the gauge needle begins to move and the fuel emerging from the overflow pipe starts to drip slowly or ceases to drip.
- Continue to turn the crankshaft slowly until the fuel just begins to drip from the overflow pipe again (about 1 droplet every 5 - 6 seconds).
- This point is the end of fuel delivery.
- The value obtained in this way must agree with the desired value stated in Section 4.
- If necessary, correct it as described above.

3. Synchronising injection pump delivery volume:

- Move the governor rod by hand fully to the right, to the „Stop“ position, and hold it there.
- Loosen all sliding elements (135/1) on the governor rod; the toothed rack on the fly-wheel-side injection pump must be in the „Stop“ position.
- Move the sliding elements for the other injection pumps to the right („Stop“ position) until the pump toothed rack is against its stop, and tighten there; see Fig. 135.
- Release the governor rod.
- Before installing, coat the gaskets for the cover and the starting charge device on both sides with sealant H. Apply the sealant only as a very thin coating to the starting charge device, to ensure that its oilway is not blocked when assembling.
- Coat all bolt threads for the cover and starting charge device with sealant D.

Note for engines from serial number L 30.17, 2 L 40.15, 3 / 4 L 40.14, M 40.11 on:

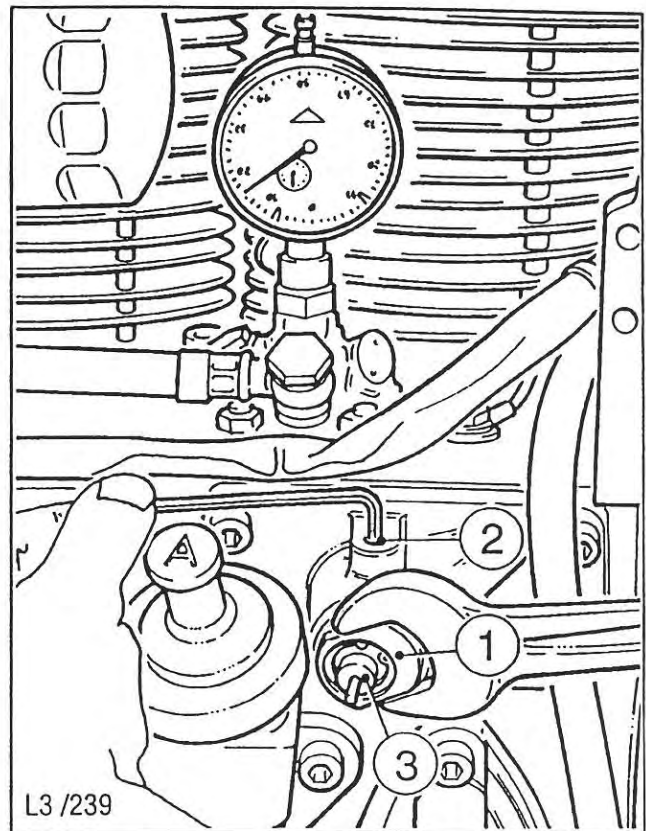
The governor rod travel limit screw (135/2) must be unscrewed during this work, or else the „Stop“ point for the pump governor rods will not be reached.



135

4. Adjusting effective stroke: (on engines with start of delivery adjustment)

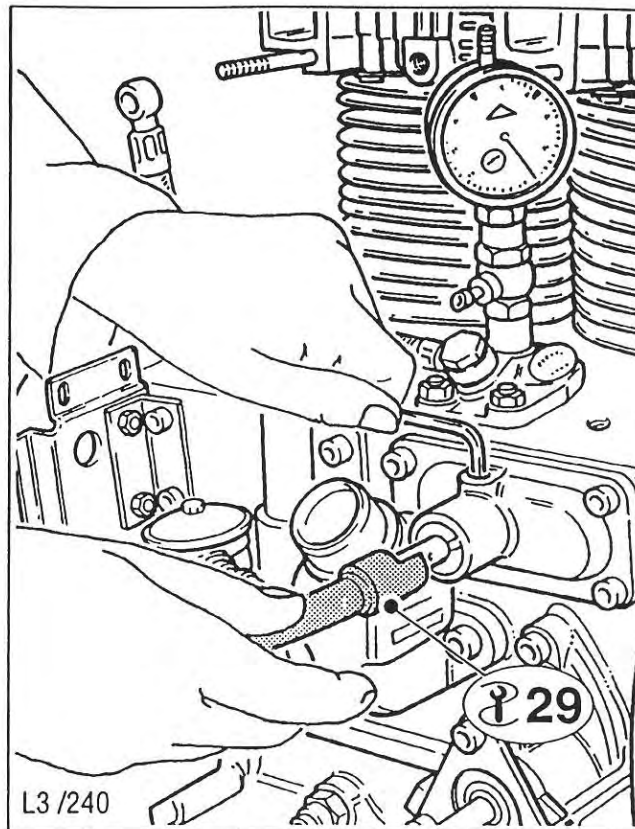
- Install the start charging device and replace the cover by hydraulic starting charge adjuster 619 845 00; see Fig. 136/3.
- Set the speed control lever to full load and secure it there.
- Insert the overflow device with dial gauge, as described in the section „Adjusting start of fuel delivery“.
- Connect the fuel feed line from the test tank and open the shutoff tap; fuel will emerge from overflow device.
- Turn the crankshaft until the injection pump has just reached the start of fuel delivery (about 1 droplet of fuel emerges every 5 - 6 seconds).
- Set the dial gauge to zero and continue to turn the crankshaft in the normal direction of engine rotation until the dial gauge moves from “0” to precisely the nominal effective stroke value stated on the type plate.
- In this position, fuel should start to drip out of the overflow device again.
- If this is not the case, loosen grub screw (136/2) and turn the eccentric flow limiter (136/1) until the fuel begins to drip out slowly.
- When the setting is correct, retighten grub screw (136/2), seal it with lacquer and install the cover again in place of the adjuster (136/3).



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5. Adjusting the effective stroke (on engines with end-of-delivery adjustment):

- Prepare for the adjustment in the same way as described for start-of-delivery adjustment.
- Set the injection pump to the end of fuel delivery.
- Turn the crankshaft in the opposite direction to normal rotation until the dial gauge shows the nominal effective stroke stated on the type plate.
- Correct if necessary as described above. To do this, use the starting charge wrench - 29 - (see Fig. 137).
- After adjusting correctly, tighten the grub screw and seal it with lacquer.
- Remove the overflow device, install the pressure valve with pressure tube connection and tighten to the specified torque.



137

6. Note on changing the power setting:

- Measure and make a note of the original power setting. Remember that as a result of tolerances the actual effective stroke setting may not coincide exactly with the effective stroke value on the type plate.
- The effective stroke setting for the desired power is obtained from the original effective stroke setting plus (for an increase in power) or minus (for a decrease in power) the difference between the two effective stroke values according to the adjustment data.

Example:

To change an L 30 engine from power output B to power output F:

Effective stroke for power output F from table:	1.14 mm	
– Effective stroke for power output B from table:	<u>1.07 mm</u>	
Difference between effective stroke values:	0.07 mm	
Effective stroke measured at engine:		1.05 mm
+ difference value		<u>0.07 mm</u>
New effective stroke setting:		1.12 mm

M 14.00 Fuel injection equipment

M 14.60 Adjustment work with PFR 1K 90 injection pumps
 (from engine serial numbers 2 L 40.17, 3-4 L 40.16, M 40.13
 on L 31 / 41 and M 31 / 41: all engines)

 - 23 - 24 - 25 - 26 - 27 - 28 -

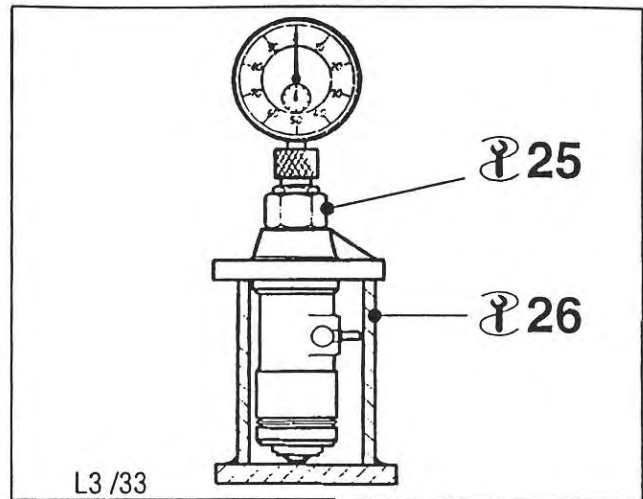
Inst. work	Work needed on fuel injection system
Renew injection pump	Start of injection (with shims); precise radial position of pump
Renewing governor rod	Marking crankcase with radial position of injection pumps Adjusting injected volume for nominal power output
Renewing start charge control	Adjusting injected volume for nominal power output Adjusting damper spring (generator operation only)
Renewing governor lever	Adjusting injected volume for nominal power output
Renewing injection pump camshaft	Marking crankcase for adjustment of start of fuel injection Adjusting start of fuel injection
Renewing crankcase	Marking crankcase for adjustment of start of fuel injection and radial position of injection pumps Adjusting start of fuel injection Adjusting injected volume for nominal power output
Altering nominal engine speed	Adjusting max. idle speed Varying injected volume for nominal power output Adjusting damper spring (generator operation only)

Important note:

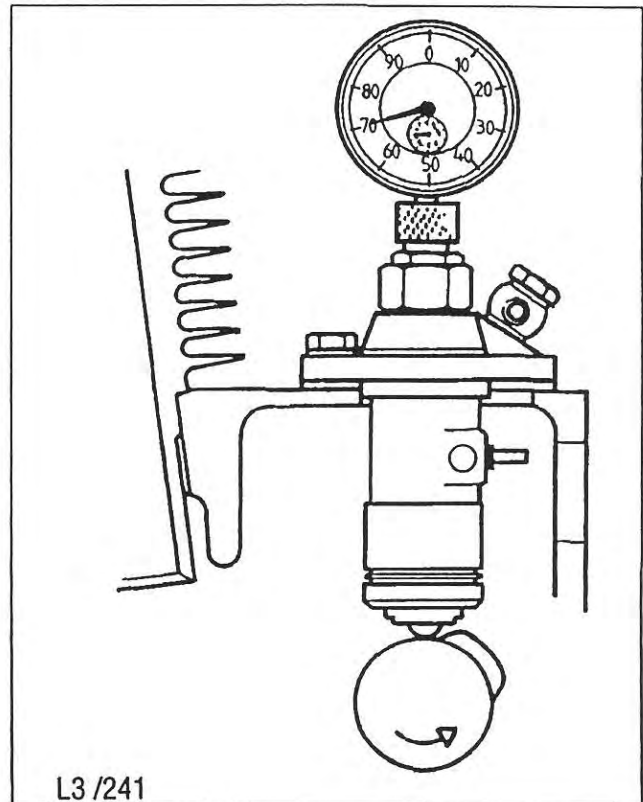
The threaded connections for the injection pump pressure valves must **not** be opened, or else pump pre-calibration will be changed.

1. Crankcase mark for adjusting start of fuel delivery:

- Insert measuring device - 25 - into the calibrating device - 26 - and adjust it so that both needles of the dial gauge are at „0“; see Fig. 138.
- Insert the measuring device into the mounting hole on the injection pump and screw it down firmly. The correct cam must be on its base circle.
- Turn the flywheel in the normal direction of engine rotation until the start-of-delivery mark on the flywheel (15° before TDC) for the cylinder in question is aligned with the fixed mark on the crankcase or in the inspection hole of the connecting housing; see Fig. 134.
- In this position, take the total dial gauge reading; see Fig. 139.

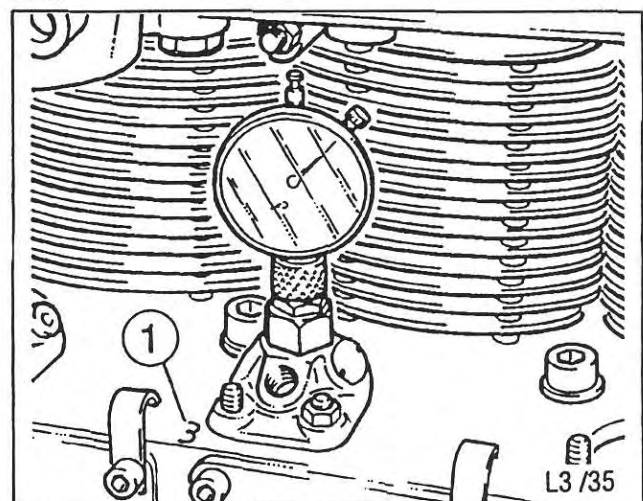


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139

- From this total dial gauge reading, deduct 2.15 ± 0.05 mm and stamp the remaining value (without +/- sign or decimal point) into the crankshaft as a tenths of millimetre value (140/1). Repeat this procedure for each pump mounting hole.

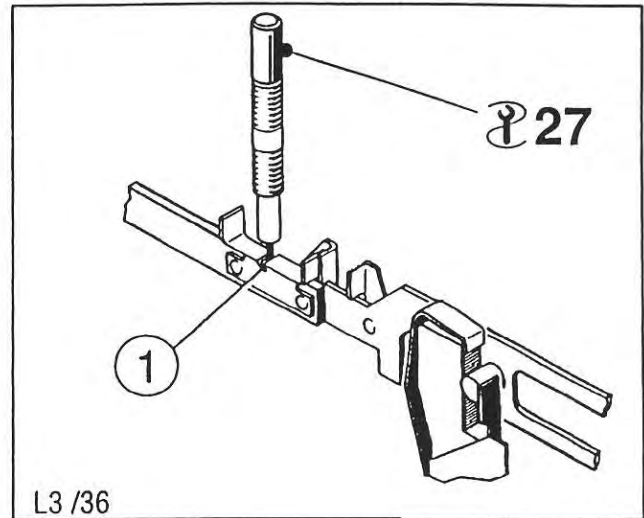


140

2. Marking the crankcase for the radial position of the injection pumps:

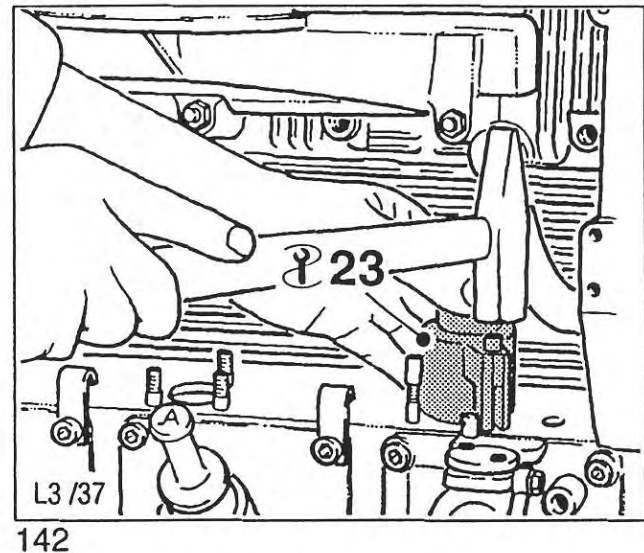
- Insert the locating pin - 27 - into the hollow-drilled stud bolt of pump 1 to lock the governor rod in position „X“ (141/1).

- Insert the marking device - 23 - into the injection pump mounting hole, turn clockwise to make proper contact and stamp the mark on the crankcase; see Fig. 142. Make this mark for each injection pump mounting hole.



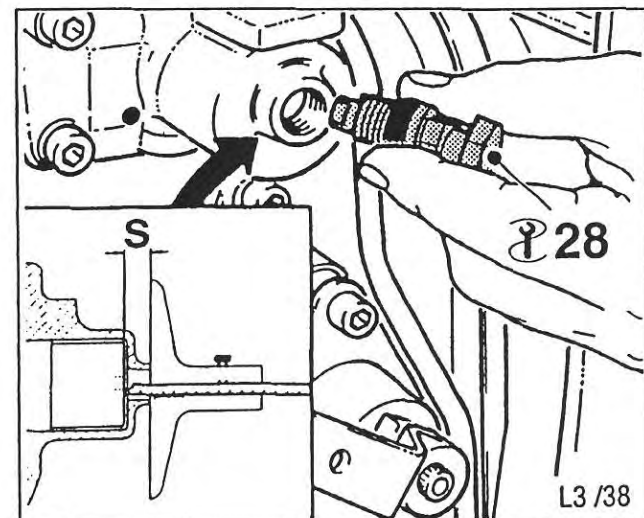
3. Adjusting injection volume for nominal power output (engine stopped)

- Move the speed control lever to the „Stop“ position.
- Remove the screw plug from the monitoring block housing or replace the valve solenoid by the plate of the adjusting tool -28-, then use a depth gauge to measure the distance „S“ from the outer edge to the flat face on the piston inside; see Fig. 143.
- Screw in the injection volume adjusting tool - 28 -, using a number of copper sealing rings according to the following table:



S(mm)	Number of sealing rings
≤ 11.3	2
>11.3	1

see also Fig. 143.



- Remove the second injection pump (looking from the timing end) and install measuring device - 24 - in its place (the ball end on the vertical lever must engage in the driving slot of the governor rod); see Fig. 144.

- Loosen the grub screw (146/1).
- Turn the adjusting screw (19 mm across flats) by 1/8 of a turn counter-clockwise.
- Move the speed control lever to the starting position.

- Insert locating pin - 27 - into the hollow-drilled stud bolt, then turn the adjusting screw slowly clockwise until the locating pin engages under light pressure in the corresponding slot of the governor rod; Figs. 141 and 145.

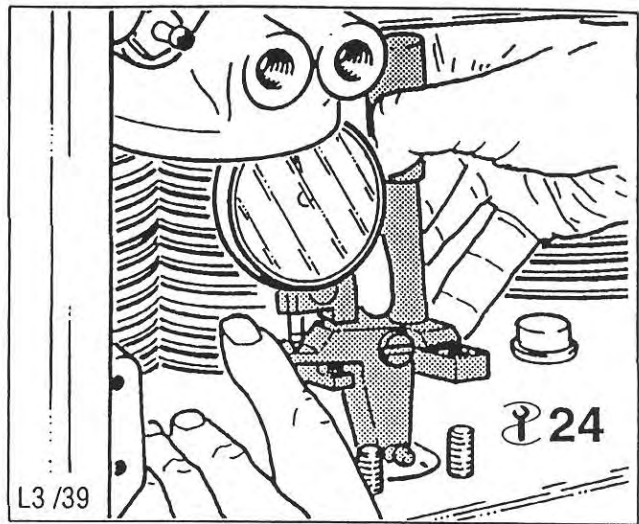
This determines the „X“ position of the governor rod.

- In this position, set the dial gauge scale on the adjusting device precisely to „0“.
- Pull out the locating pin; the needle of the dial gauge should then move by 0.01 - 0.02 mm.
- Determine the governor rod travel stated on the type plate (the figure is in hundredths of a millimetre).
- Turn the injection volume adjusting tool until the dial gauge shows the control distance needed. Do not forget to allow for the 0.01 - 0.02 mm already indicated by the dial gauge.

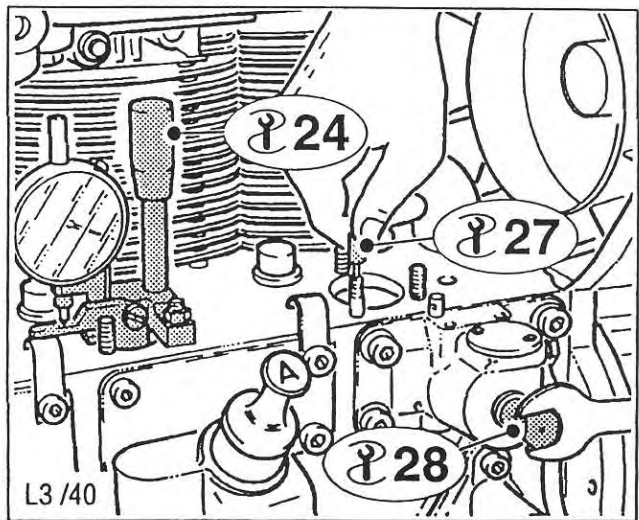
Note:

A minus value (= lower power range) is obtained by turning the adjusting tool clockwise, a plus value (higher power) by turning counter-clockwise.

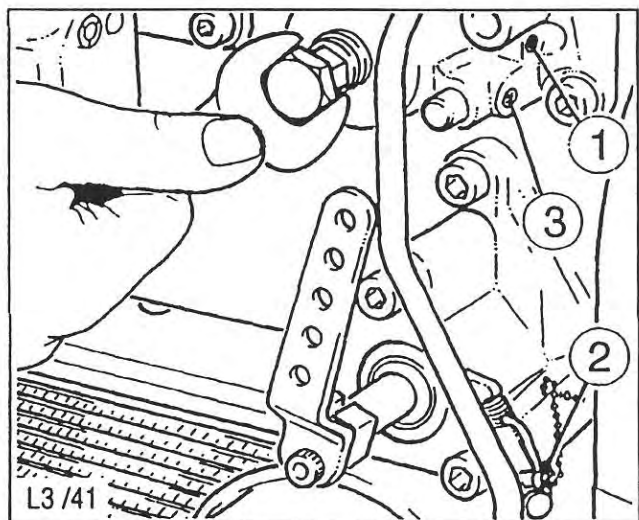
- Tighten the grub screw (146/1) carefully to prevent this setting from being lost, and secure it with lacquer.



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145



146

- Replace the adjusting tool - **28** - by the screw plug again, using a suitable tool (e.g. screwdriver) to check that the engine monitoring piston slides smoothly. If it tends to stick, slightly reduce the preload at the grub screw (146/1) and repeat the check.
- Remove the adjusting device - **24** - and install the injection pump (M 14.20).

Note on changing the power setting

Adjustment data for a change in engine power can be obtained from your HATZ service point. Proceed as follows to change the power setting:

- Move the speed control lever to the stop position.
- Screw in the injection volume adjusting tool - **28** -.
- Move the speed control lever to the start position.
- Install measuring device - **24** - and set the dial gauge to precisely „0“.
- The governor rod travel for the desired power output is obtained from the original governor rod travel setting plus (for increased power) or minus (for decreased power) the difference from the adjustment data.

Example:

To change a 3 M 40 engine (n=3000 rpm) from power output B to power output F.

Governor rod travel for output F acc. to adjustment data: +0.13 mm

Governor rod travel for output B acc. to adjustment data: -0.26 mm

Difference from adjustment values: 0.39 mm

The adjusting tool - **28** - must therefore be turned counter-clockwise until the dial gauge of the measuring device - **24** - reads 0.39 mm.

If the engine's **running speed** is to be altered (with or without a change in power output), the following work is needed:

- Set the engine speed to the new value.
- Move the governor rod to position „X“ and set the dial gauge to „0“.
- Turn the adjusting tool - **28** - until the dial gauge shows the governor rod travel called for according to the type plate or adjustment data.

4. Adjusting the damping spring (generator operation, PV 187)

This adjustment can only take place with the engine running at the upper idle speed limit and off-load. In addition, the engine must have reached its regular operating temperature, or else the speed setting will not be accurate.

- Turn the stop screw for the upper idle speed limit (146/2) until this speed is about 0.3 % lower than the desired value according to the type plate.

Example:

Type plate data $3000/60 = 3060 - 0.3 \% = 3050$ rpm. Make sure that the damping spring is not yet touching the governor lever. Unscrew the grub screw (146/3) at the monitoring block until no change in engine speed is detected. After this, retighten the grub screw (146/3) until the upper idle speed rises again by the same value of app. 0.3 %.

M 17.00 Flywheel

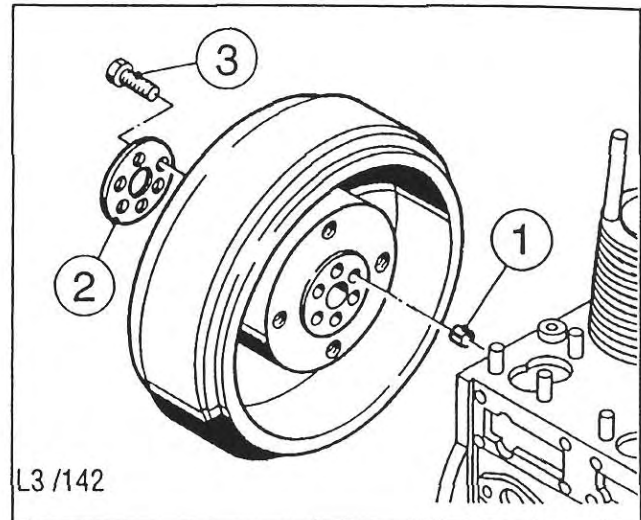


Dismantling:

- Remove bolts (148/3) and disc (148/2).
- Screw in two suitable stud bolts to act as guides.
- Take off the flywheel.

Assembling:

- Drive locking collet (148/1) into the end of the crankshaft at the flywheel end to provide the necessary centering action.
- Attach the flywheel so that the locking collet enters the centering hole.
- Place the disc (148/2) in position, insert the bolts (148/3) and tighten them to the specified torque.



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M 20.00 Engine shutdown device / belt tensioner

⌘ - 20 - 21 - 39 -

Preparatory work:

Engines with enclosure

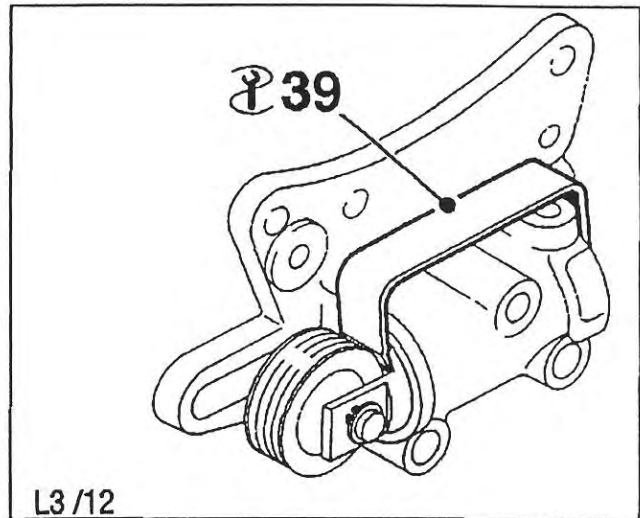
- Take off the cover for the air guide housing and front impeller.

Engines without enclosure

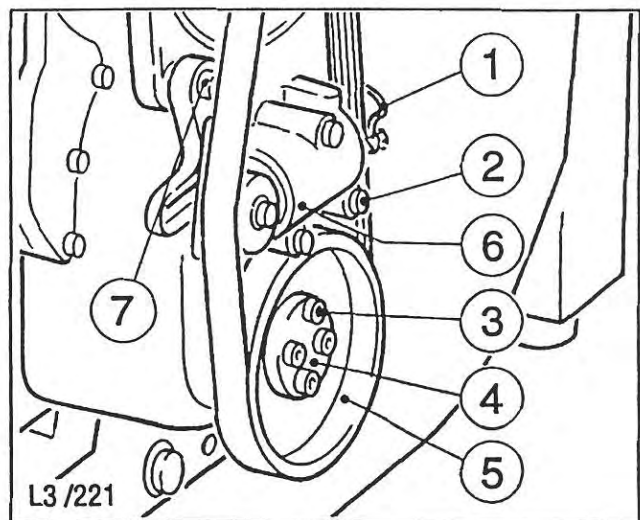
- Take off belt guard, if fitted.

Removing:

- Press back the tensioning roller and attach the locking device - 39 - (Fig. 149).
- Take out screws (150/3) with spring washers and remove the drive pulley (150/4) (the drive pulley is not fitted from year of manufacture 1985 onwards).
- Pull the belt pulley (150/5) out of its centering mount and take it off together with the Poly-V belt.
- Detach the oil line (150/1) and remove the 3 machine screws (150/2) with spring washers.
- Detach the mount (150/7) at the cooling fan, noting the installed shims.
- Take off the engine shutdown device (150/6).



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150

Dismantling the engine shutdown device:

(from engine serial numbers L 30.15, 2 L 40.12, 3/4 L 40.11).

- Remove the locking device.

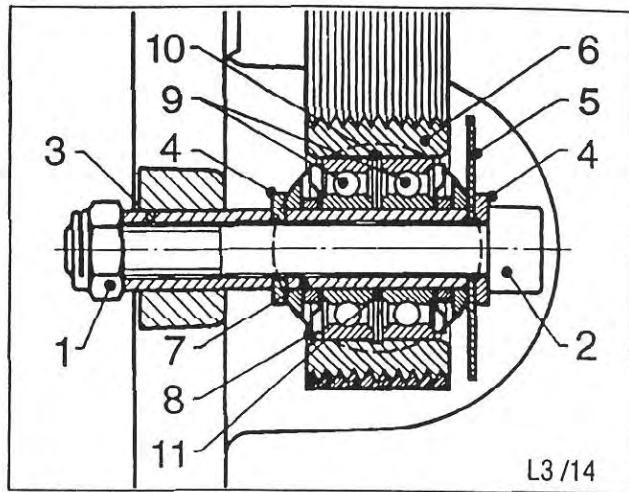
Warning:

The piston with tensioning roller are spring-loaded; release the spring loading gradually.

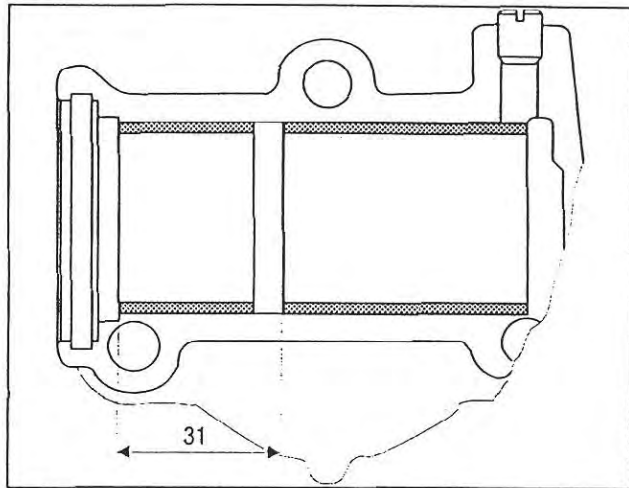
- Take out circlip (152/1).
- Unscrew the nut (151/1) and take out the machine screw (151/2) with sleeve (151/3) and washers (151/4) and (151/5), at the same time forcing the tensioning roller (151/6) back slightly against its spring loading.
- Carefully release the spring loading completely and pull out the piston (152/3) with spring (152/6) and filler (152/7).
- Remove the support disc (152/2) and quad ring (152/4) from the housing.
- Take the restrictor screw (153/1) out of the back of the housing.
- Press the shaft out of the piston and remove the tensioning roller.
- Take off the Nilos rings (151/8). Drive the ball bearings (151/9) out towards the outside in each case, since a circlip (151/10) is installed between them.
- Take out the support disc (151/11).

Checking the parts:

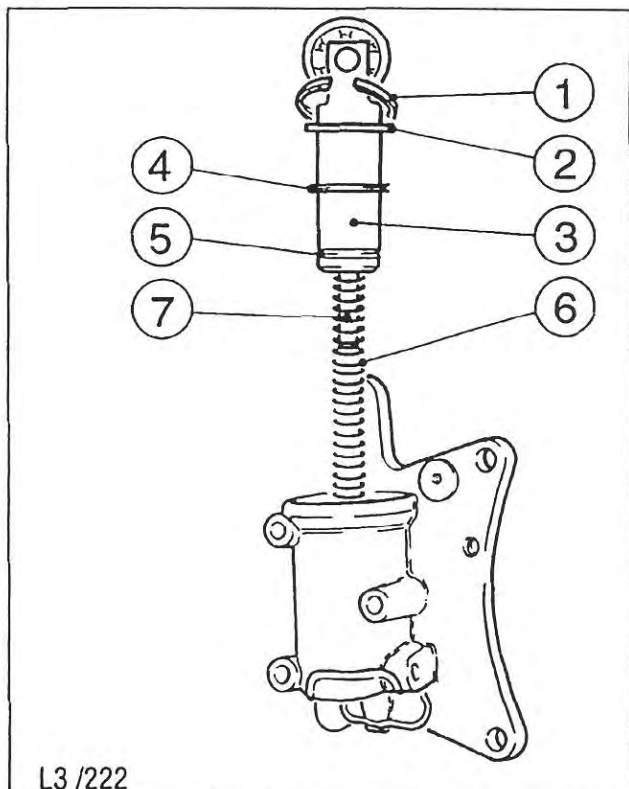
- Check the piston for the tensioning roller and the bushings in the housing for score- or wear-marks. If damaged, renew the bushings or the piston.
To renew the bushings, use special tools - 20 - 21 - and press the bushings in as shown in Fig. 174.
- Check the tensioning roller ball bearing and renew if necessary.
- Renew quad rings (152/4) and (152/5).
- Renew the tensioning roller or belt pulley if any grooves are damaged or ribs broken off.
- Check that the bore in the restrictor screw is not blocked.



151



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152

Assembling:

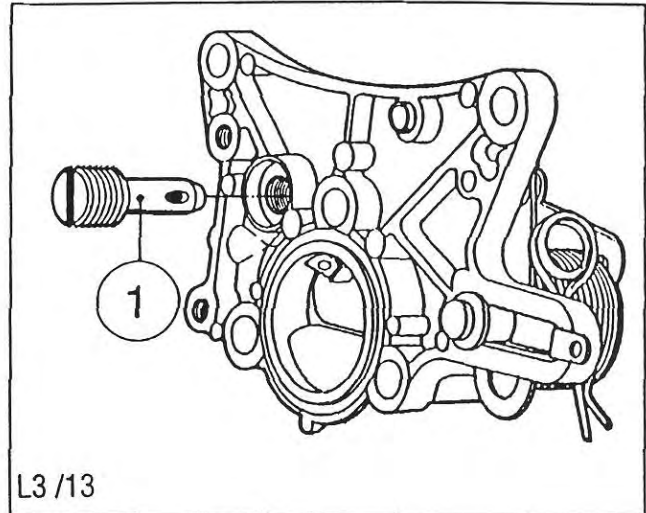
- Assemble by following the dismantling procedure in the opposite order.
- Make sure that the Poly-V belt is fitted correctly.

Assembly instructions:

- Insert restrictor screw (153/1) with sealant **D**.
- Pack the Nilos rings (151/8) with anti-friction bearing grease when assembling.

Note for older versions of L 30 / L 40 engines:

- The circlip (152/1), support washer (152/2) and quad rings (152/4) and (152/5) have been installed since 1980.
- A ball pressure-relief valve was installed instead of the restrictor screw (153/1) until about early 1982.
- A modified tensioning roller mount is used from the L 30.15 / 2 L 40.12, 3/4 L 40.11 onwards.



153

M 22.00 Air cleaner



Dismantling:

L-engines

- Take off the enclosure hood.
- Remove dirt adhering in the air cleaner housing area.
- Loosen screws (175/1) only sufficiently to permit the complete air cleaner housing to be raised.
- Cover the opening in the intake pipe to prevent dirt or other foreign bodies from entering.
- Open the air cleaner housing and take out the filter element (176/3).
On three-cylinder engines, the cover (176/2) is also held with a clip (176/7).

M-engines

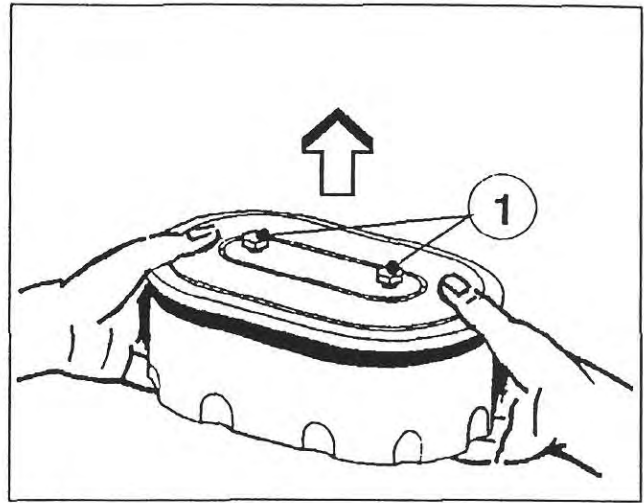
- Release the clips (177/1) and take off the air cleaner housing cover (177/2)
- Remove dirt adhering in the region of the air cleaner housing.
- Slacken off screws (177/3) only enough to permit the cover (177/4) with filter element (177/7) to be raised.
- Cover the opening in the suction pipe to prevent dirt and other foreign bodies from entering.

Checking / repairs:

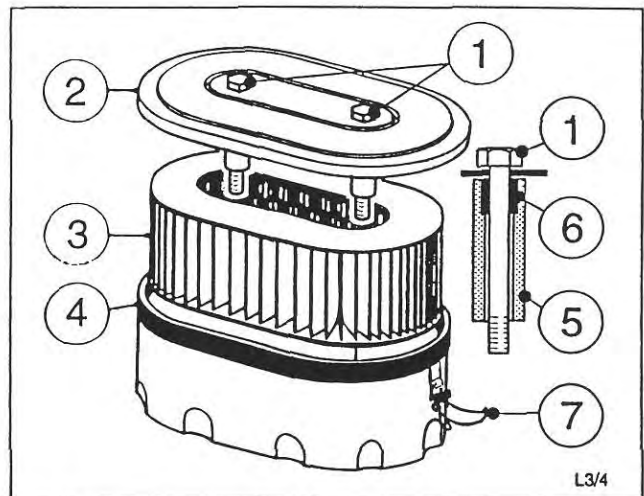
- Check the sealing faces for signs of damage.
- Clean the filter housing and the cover.
Spacer „5“ is connected by an elastic sleeve „6“ with the retaining screw, so that it cannot fall into the intake pipe during maintenance work.
- If the spacer is loose, renew bushing „6“.

Assembling:

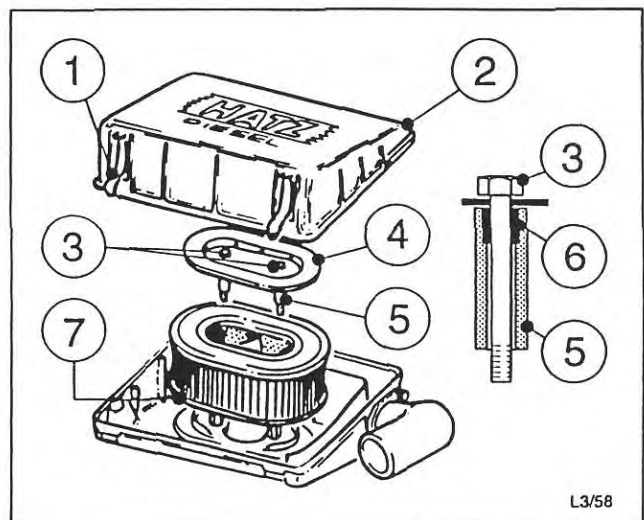
- Follow the instructions in the reverse order.



175



176



177

M 31.00 Crankcase breather



General:

The crankcase breather operates by way of a diaphragm valve in the intake pipe. During maintenance or repair work, in particular if the engine's oil consumption is high or it is producing too much blue exhaust smoke, you are recommended to check the condition of the diaphragm.

Dismantling:

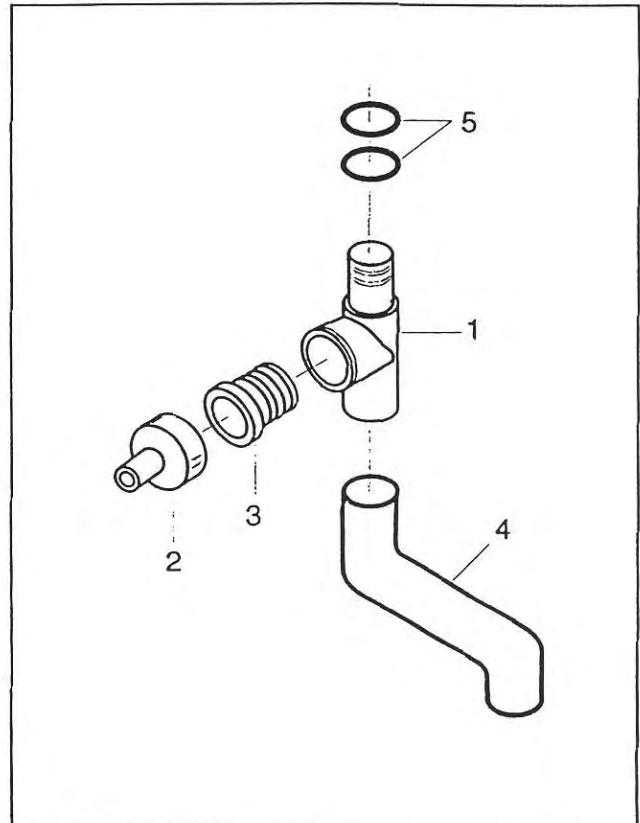
- Pull housing 1 with cap 2 and diaphragm 3 out of the intake manifold and hose 4 (Fig. 178).
- Pull cap 2 out of housing 1 and remove diaphragm 3.

Checking / repairs

- Examine the diaphragm for cracks and renew if necessary.
- Renew O-rings 5.

Assembling:

- Proceed in the opposite order to that described above.



178

M 32.00 Speed control

M 32.10 Engines with PFR 1K 80 injection pump



Preparatory work:

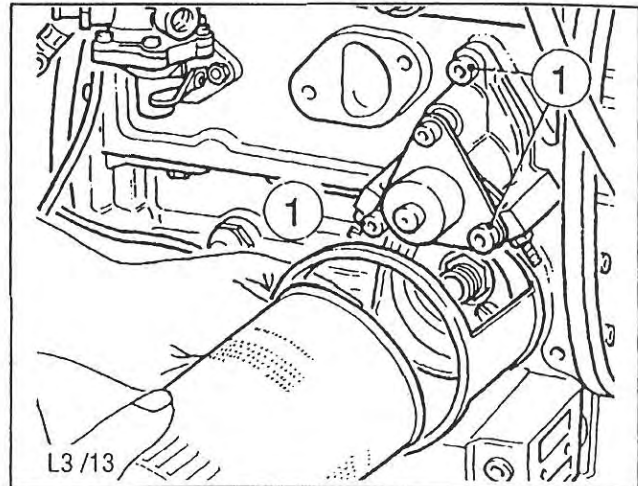
- Detach the enclosure hood.
- Take off the speed control lever and the side panel; see M 35.00.
- Renew the oil cleaner.
- On two-cylinder engines, unscrew and remove the oil filler pipe; see M 12.00.

Dismantling:

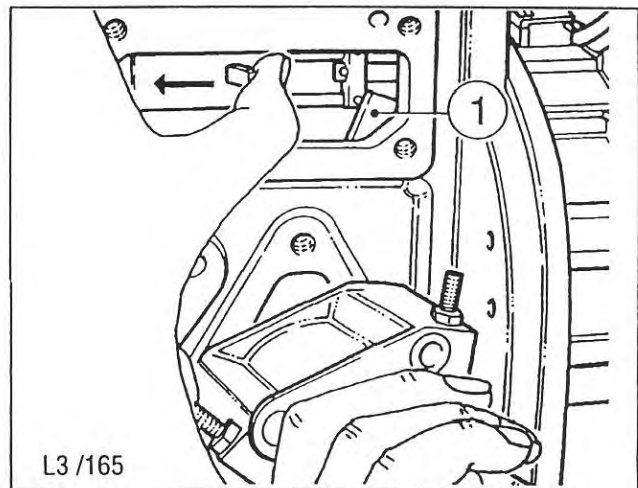
- Remove machine screws (154/1).
- Turn the speed control shaft counter-clockwise to the „Stop“ position and pull the governor rod towards the flywheel end;
- see Fig. 155.
- As shown in Fig. (155/1), move the governor lever over to the timing side and pull it out downwards.

Dismantling the speed control:

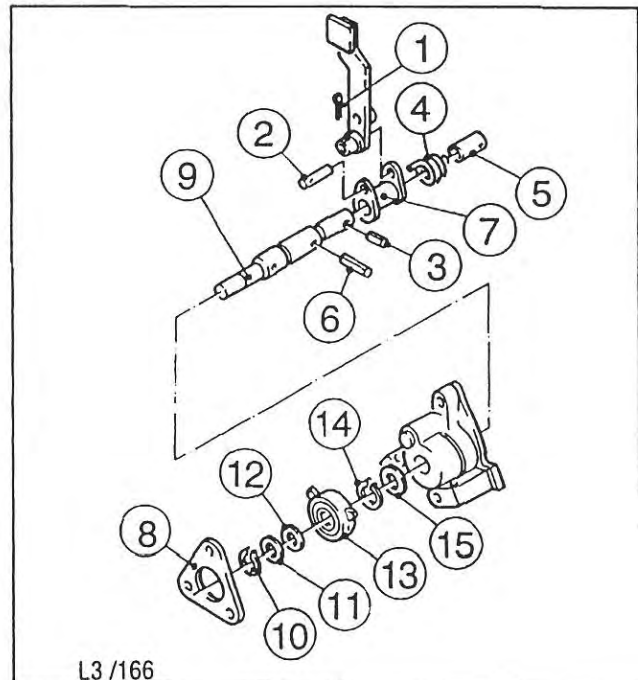
- Pull out the cotter pin or locking collet (156/1) and push out the bolt (156/2).
- Drive out the locking collet (156/3), pull off the torsion spring (156/4) and sleeve (156/5), drive out locking collet (156/6) and pull off the speed control fork (156/7).
- Unscrew the tensioning plate (156/8) and remove circlip (156/10), support washer (156/11) and shim(s) (156/12).
- Pull off governor shaft stop (156/13), remove circlip (156/14) with spacing washer (156/15) and pull out shaft (156/9).



154



155



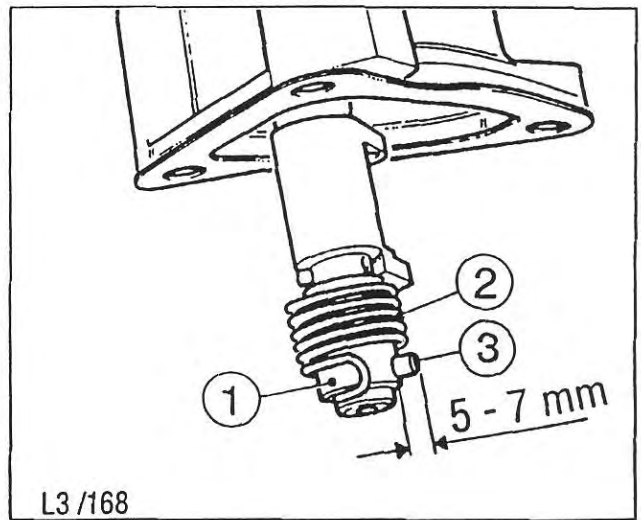
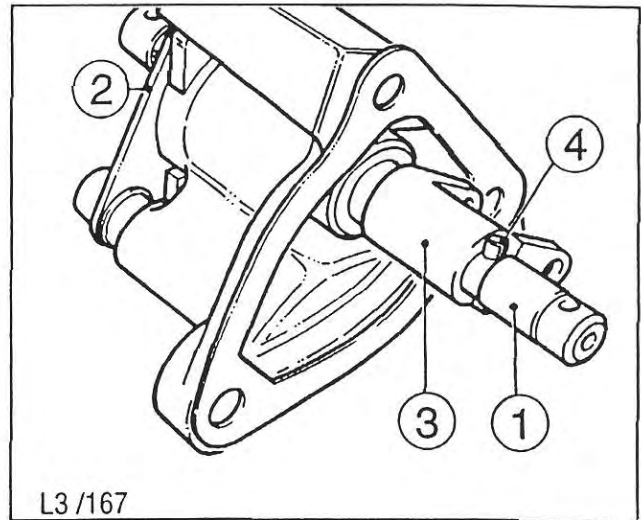
156

Checking / repairs:

- Check ball bearing at governor lever for wear.
- Check governor lever, pin for speed control, fork, adjusting shaft and housing for score-marks; renew parts if damaged.

Assembling:

- Push in the shaft and install the spacing washer, circlip, governor shaft stop, shim(s), support disc, circlip and tensioning plate.
Push on the fork (157/3) and drive the locking collet (157/4) in flush with the fork; see Fig. 157.
- Push on the sleeve (158/1) and torsion spring (158/2), then drive in the locking collet (157/4) flush with the fork; see Fig. 158. Preload torsion spring (158/2) by a quarter-turn clockwise, then connect to the locking collet.
- Further assembly is in the reverse order to that described for dismantling; use a new gasket.
- Apply sealant **D** to screws (154/1) when inserting.



M 32.00 Speed control

M 32.20 Engines with PFR 1K 90 injection pump



Dismantling:

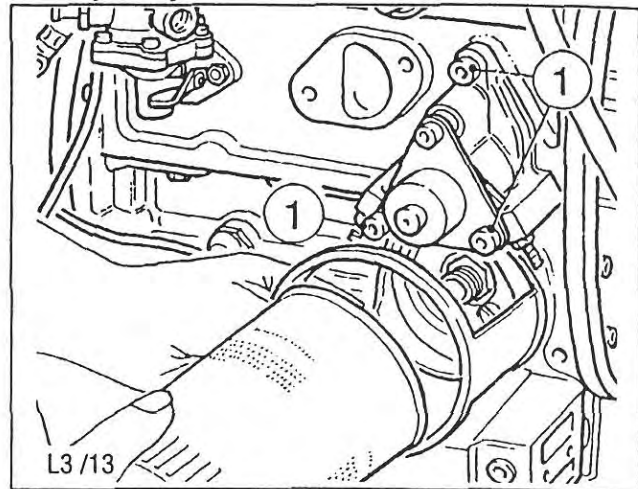
- Remove machine screws (154/1).
- Turn the speed control shaft anti-clockwise to the „Stop“ position and pull the governor rod towards the flywheel end of the engine; see Fig. 179.
- Turn speed control mount (179/1) to the right and pass governor lever (179/2) under governor rod (179/3).
- Carefully pull the speed control mount out downwards.

Dismantling the speed control: (Bild 180)

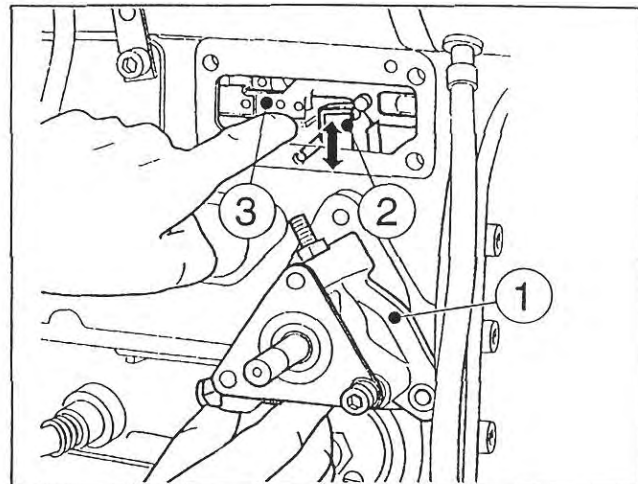
- Drive out locking collet 1.
- Slide out pin 2 and take off governor lever 3.
- Take out locking collet 4 for stop 5 and pull out control shaft 6.
- Disconnect spring 7.
- Drive out locking pin 8 and pull off fork 9.

Checking / repairs:

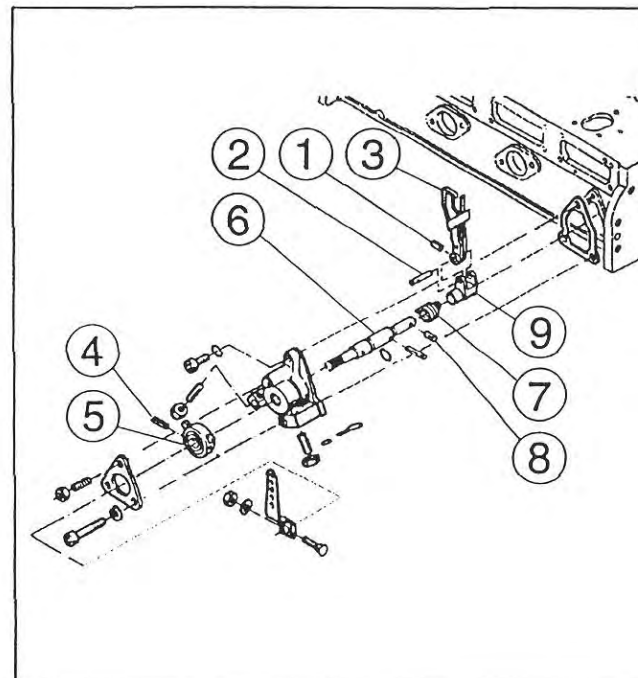
- Check ball bearing at governor lever for wear.
- Check governor lever, speed control pin, fork, control shaft and housing for score marks and renew all damaged parts.



154



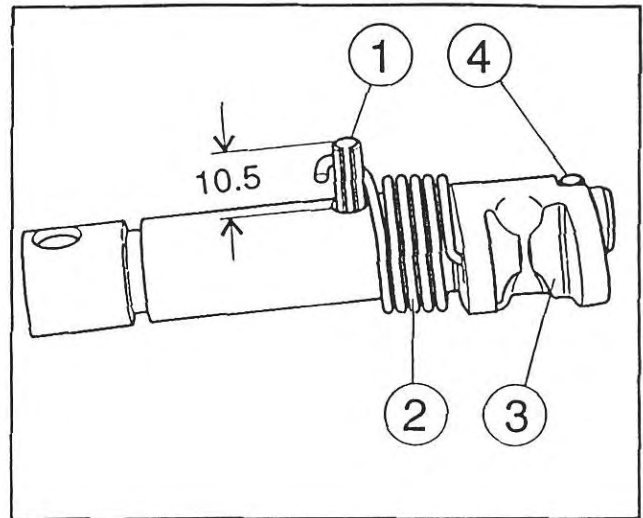
179



180

Assembling:

- Drive in locking collet (181/1) until it projects by 10.5 mm.
- Insert spring (181/2) into fork (181/3) and push on to control shaft.
- Drive locking collet (181/4) in flush with the fork and connect the spring to it, using a suitable tool.
- Continue installation by following the removal instructions in the reverse order.



181

Note:

Since there are various patterns of governor lever, make sure when repairing the speed control that the original governor lever is installed again.

If the governor lever or the complete speed control is renewed, note that torque equalisation may have been activated at the original governor lever.

In case of doubt, contact your nearest HATZ service point.

M 35.00 Capsule



Preparatory work:

- Remove the engine.

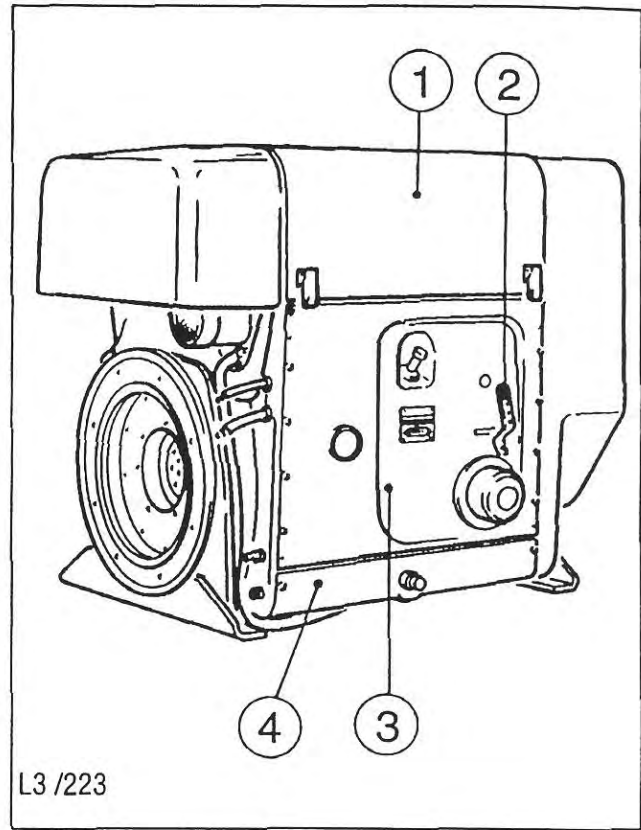
Note:

It is normally only necessary to remove the engine from the equipment in which it is being used in order to dismantle the capsule if the air guide housing or rear panel have to be taken off.

- Remove exhaust capsule; see A 03.00.

Dismantling:

- Take off the hood (159/1), speed control lever (159/2), side panel (159/3) and cover plate (159/4).



L3 /223

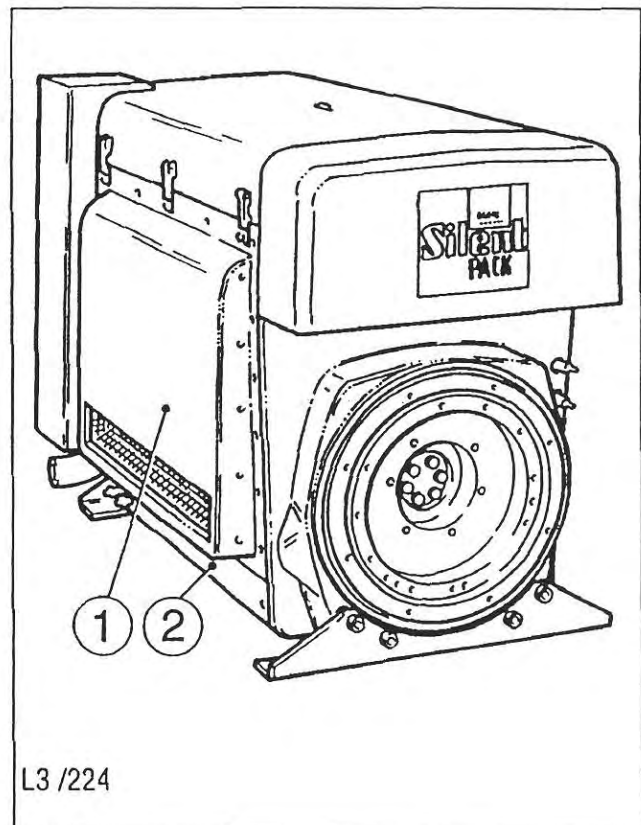
159

- Detach the air outlet shaft (160/1) and cover plate (160/2).

Note for 4 L 40 C:

Take out the cooling air guide lining elements.

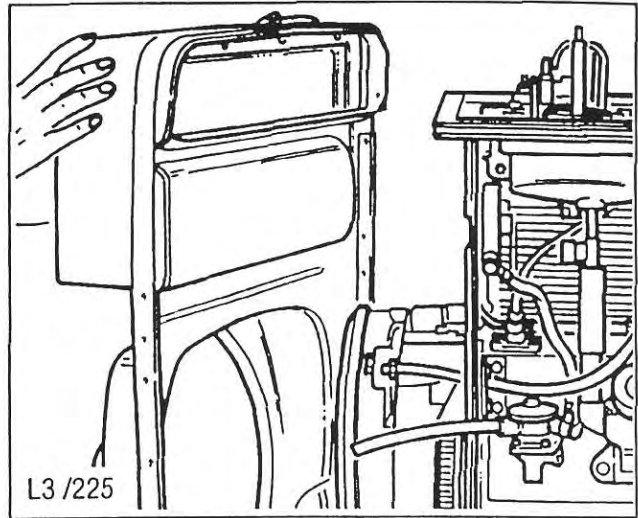
- Take off the cross-member above the injectors and raise the engine slightly at its suspension lug until the baseplate of the enclosure can be unscrewed and removed.
- Detach the feet from the engine.
- When the feet have been removed, the four 22 mm hex bolts used to attach the baseplate should be used to support the engine.



L3 /224

160

- Unscrew the earth (ground) strap and the + line from the rear panel of the enclosure.
- Take off the rear panel with intake duct; see Fig. 161.

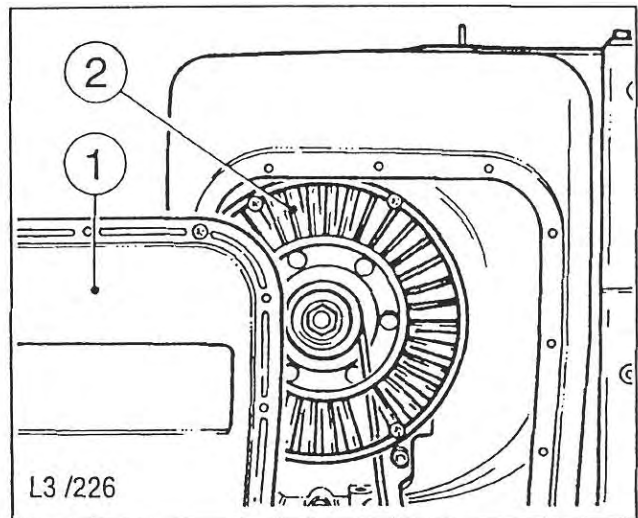


161

- Unscrew the cover from the air guide housing (162/1).
- Take out the screws holding the fan impeller (162/2) and remove the impeller.
- Take off the air guide housing; see Fig. 163.

Checking the parts:

- Examine the various sections of the enclosure for damage.
- Renew damaged or incomplete sealing strips.



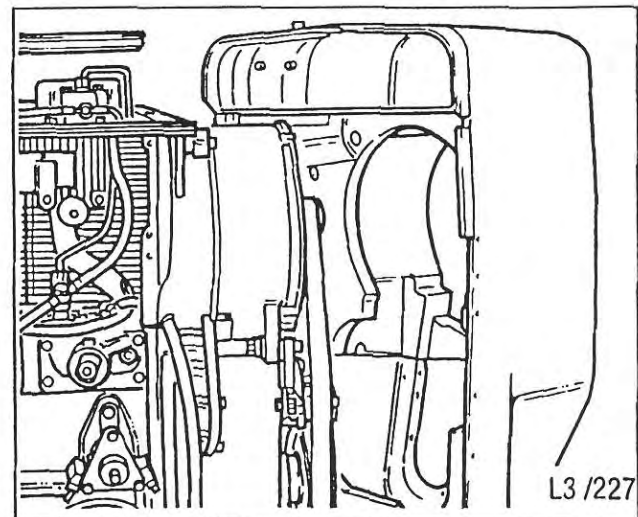
162

Assembling:

- Assemble the enclosure by following the dismantling instructions in the reverse order as appropriate.

Note:

Make sure that all enclosure sections are carefully installed and that all sealing strips are seated correctly. Unless the enclosure is completely sealed, neither the potential level of noise reduction nor adequate cooling can be ensured.



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