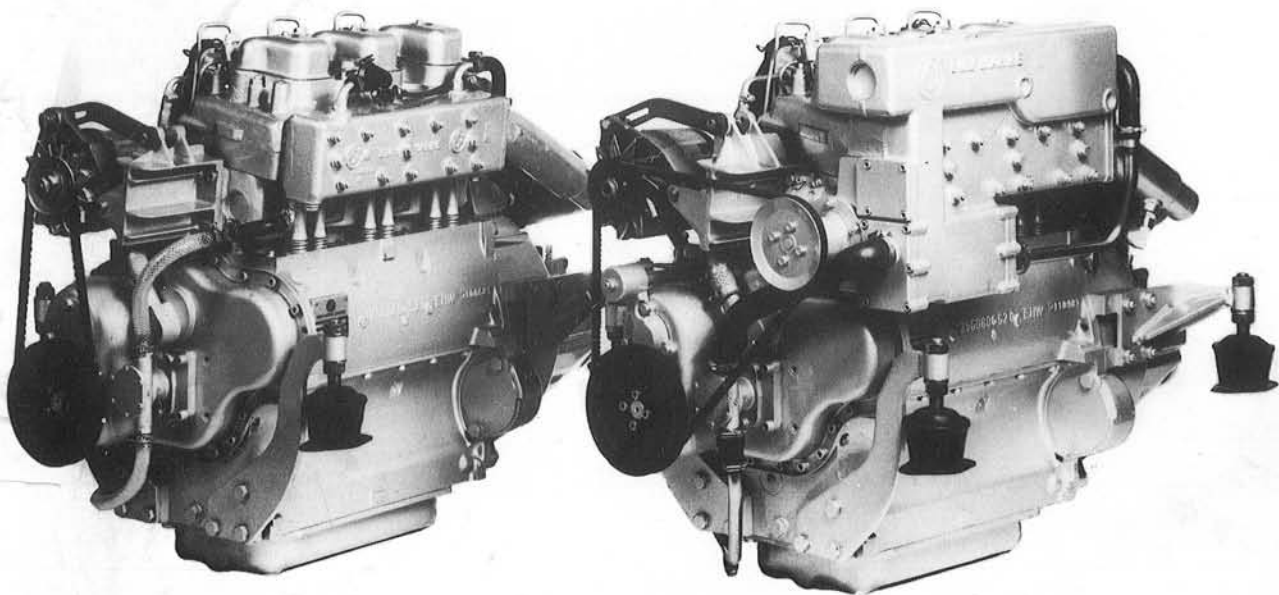
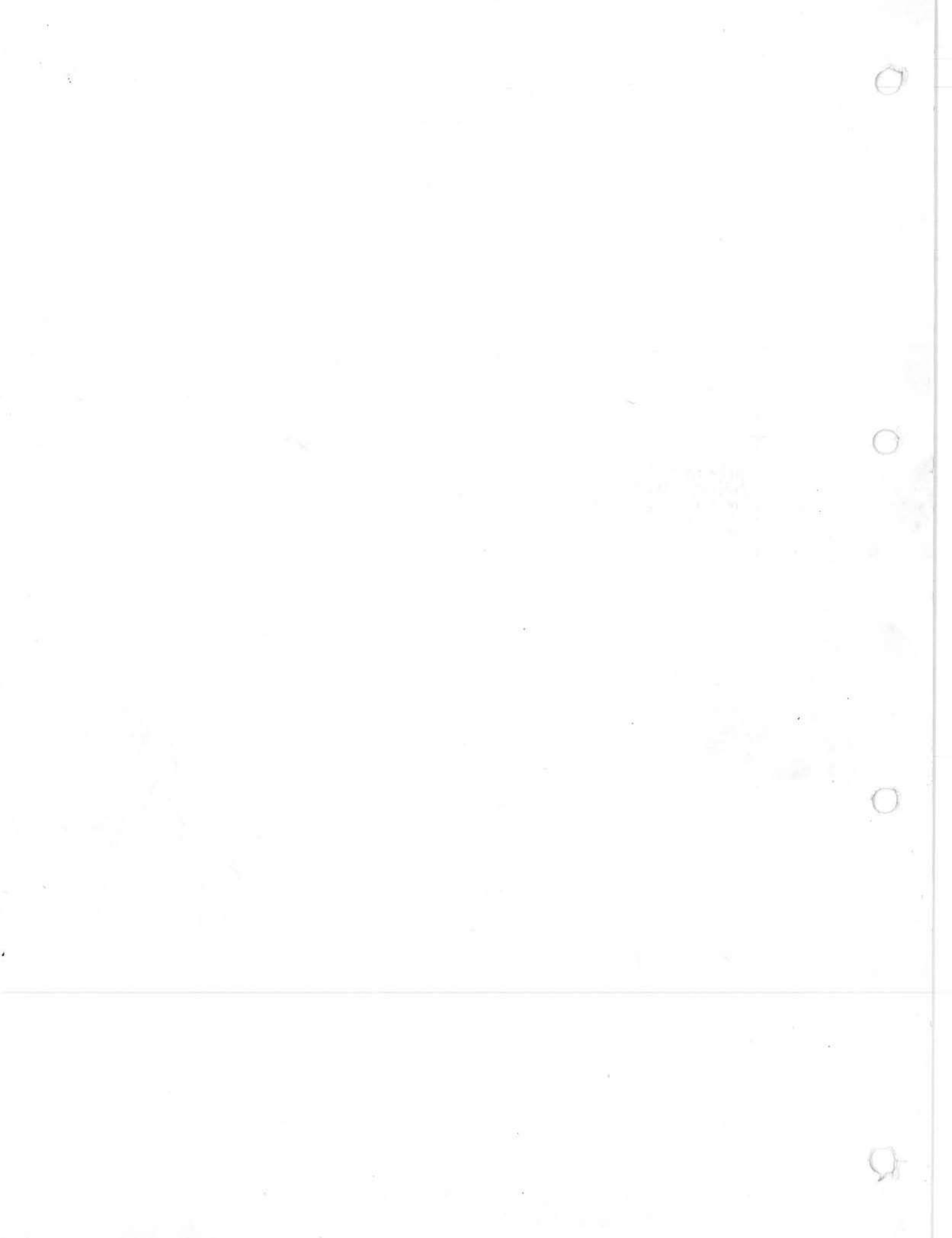


Workshop Manual

BMW D 35/D 50

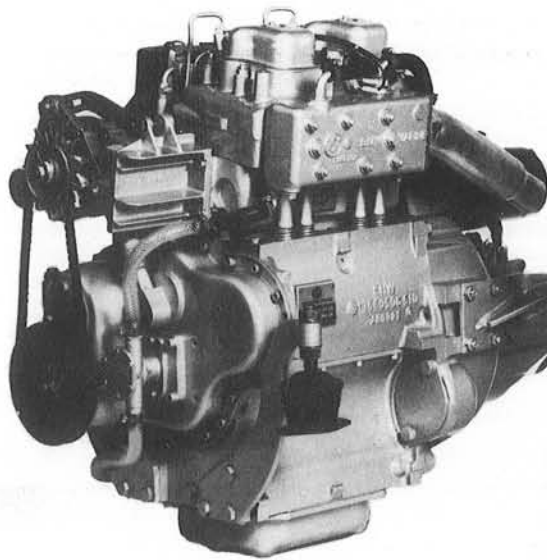


BMW Marine Engines

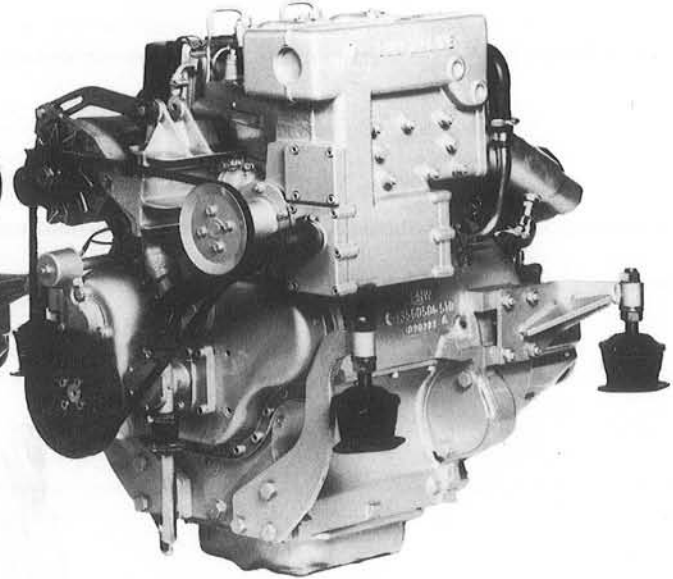


BMW D 35-2/D 50-2 Marine engine

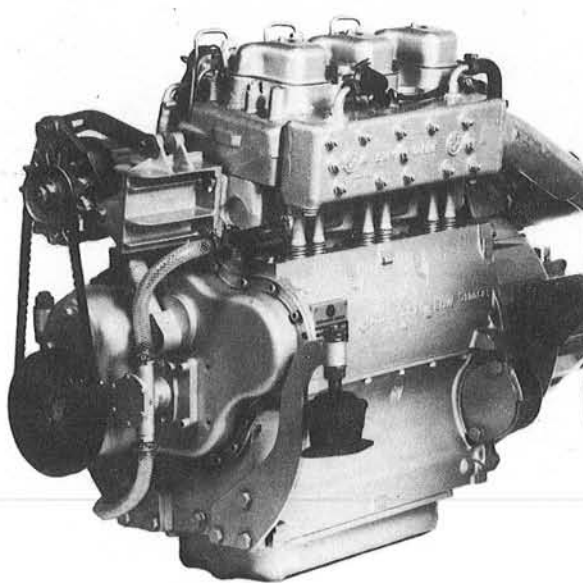
The engine is a four-stroke diesel engine with direct injection. It has a dual-circuit cooling system. The raw-water pump is driven directly from the crankshaft, the fresh-water pump via V-belt. Electric starter and alternator are standard equipment. The fuel system is equipped with automatic bleeding.



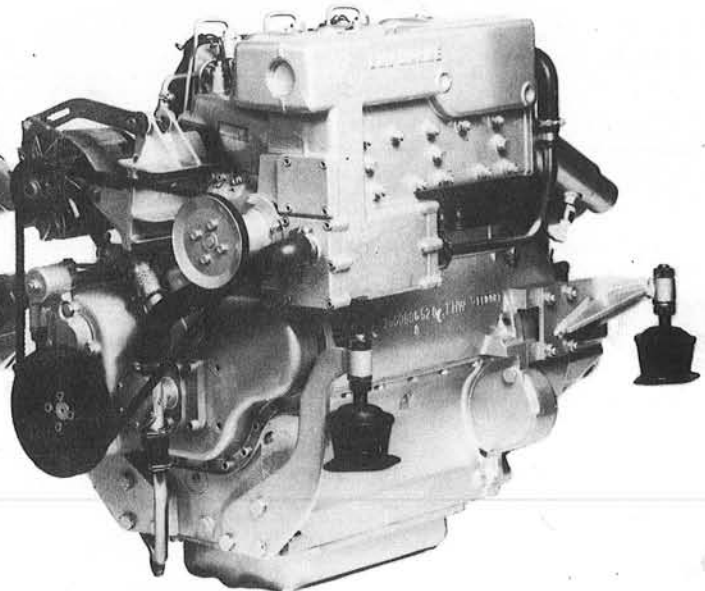
D 35-1



D 35-2



D 50-1



D 50-2

NOTES ON USE OF THE WORKSHOP MANUAL

This workshop manual describes complete procedures for stripping, overhauling and assembling the engine.

The description serves also to illustrate repairs of limited scope, such as the replacement of bearings or gaskets.

The relevant technical data are provided in each section.

General technical data are to be found on page 5.

If assembly is not described, it takes place logically in the reverse order to the described stripping. For this purpose, careful attention has to be paid to the notes for assembly and installation.

Required setting and adjusting procedures are described at the end of the respective section.

Dimensions in brackets (e. g., 13 mm) refer to width across flats of respective bolts and nuts.

BMW Marine Service Bulletins should always be read, before a repair job is started.

We reserve the right to make changes.

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TECHNICAL DATA

	D 35-2	D 50-2
Number of cylinders	2	3
Bore x stroke, mm	95 x 100	95 x 100
Displacement, c. c.	1416	2124
Max. power, kW/rpm	22/3000	33/3000
Max. torque, Nm/rpm	75/2250	110/2500
Compression ratio	19 : 1	19 : 1
Dry weight with gearbox, kg	258	313
Gearbox	Optionally Hurth or ZF	
Max. installation angle	15°	15°

Specifications

Fuel	Diesel oil, DIN 51601/USA No. 2	
Lubricating oil, engine	HD-APICC/CD	
Oil capacity, engine, litres	7.4	10.6
Injector	Bosch	Bosch
Injection pressure, bar	250 ⁺⁸	250 ⁺⁸
Injection pump	Bosch	Bosch
Injector nozzle	Bosch DLLA 160 S 908 dto.	
Starter	Bosch 12 V / 1,9 kW	
Alternator	Motorola 14 V / 55 A 770 W	
Battery	recommended capacity 90 Ah	
Cooler capacity (fresh water)	approx. 7 l	approx. 10

Adjustment data

Injection starts	17° — 18° BTDC	
Valve clearance, engine cold		
Aluminium tappet, mm	0.40	0.40
Steel tappet, mm	0.20	0.20
Idling speed, rpm	900 ± 50	900 ± 50
Speed limit, rpm	3160	3160
Firing sequence	1 2	1 3 2

D 35-2/D 50-2 tightening torques

	Thread	Nm
Injector holder	M 8	15
Injection pump pressure valve		35
Injector nozzle union nut		85
Cylinder head nuts	M 10 x 1	55
Connecting rod bolts		60
Cheese-head screws for counterweight		65
Cheese-head screws for end cover*		9
Hexagon-head screws on flywheel		135
Cheese-head screws on crankcase halves	M 12	90
Gearwheel on crankshaft		30
Cheese-head screws for fastening cam plates (injection timing mechanism)	M 6	10
Hexagon-head screws for governor-weight support		25
Hexagon nuts for governor spring bridge		25
Clutch housing to crankcase**		80

** Apply Loctite 221 to the threads

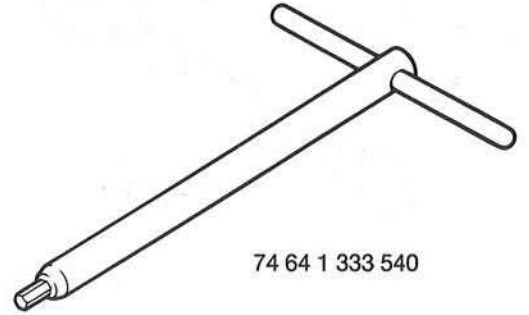
** Secure staybolts with Loctite 221 in the crankcase

SPECIAL TOOLS

74 64 1 333 540	Allen screw wrench 6 mm
74 64 1 333 535	Spill tool for injection pump
74 64 1 333 564	Piston ring compressor
74 64 1 333 546	Dial indicator
74 64 1 333 594	Piston ring pliers
74 64 1 333 541	Allen screw socket 6 mm
74 64 1 333 550	Allen screw socket 8 mm
74 64 1 333 562	Allen screw socket 10 mm
74 64 1 333 542	Fuel line wrench
74 64 1 333 552	Gudgeon pin remover
74 64 1 333 536	Puller (to be used together with 74 64 1 333 568)
74 64 1 333 568	Puller screw for 74 64 1 333 536
74 64 1 333 565	Blocking tool for automatic cold start
74 64 1 333 566	Oil pressure gauge with flexible line
74 64 1 333 548	Holder for valve seat cutter
74 64 1 333 544	Bridge for measuring piston ring gap
74 64 1 333 545	Pressure gauge for injection system



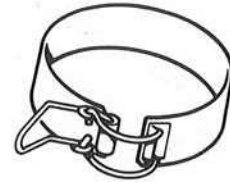
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74 64 1 333 540

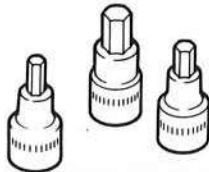


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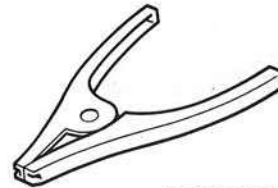


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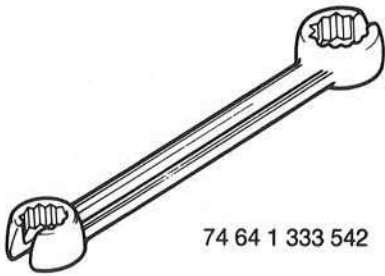
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74 64 1 333 562



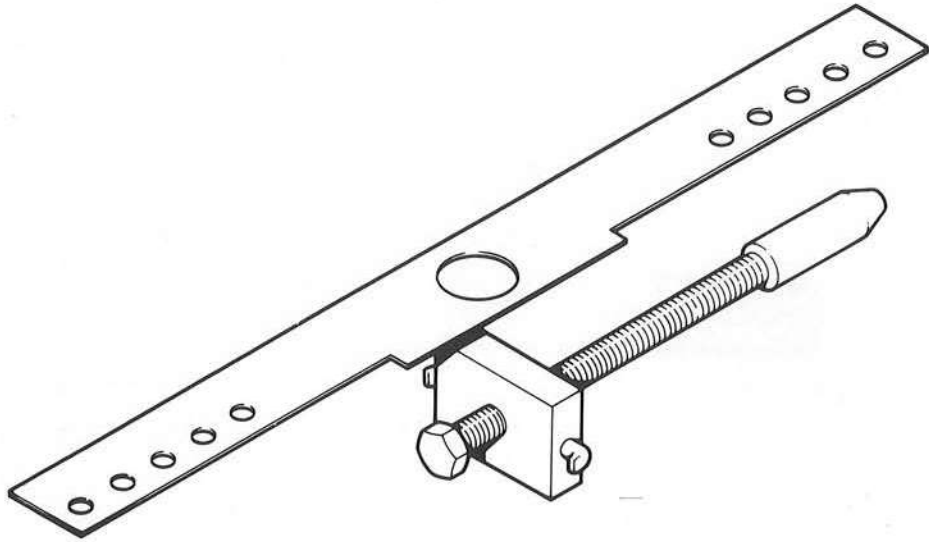
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74 64 1 333 594



74 64 1 333 542



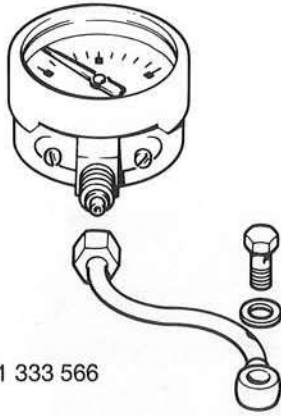
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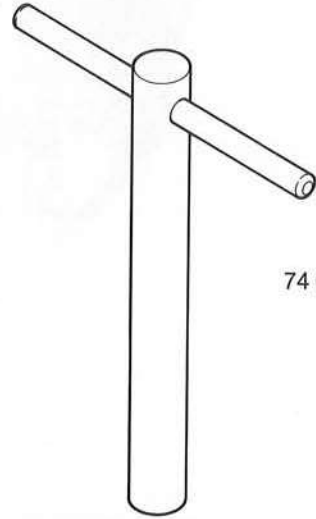
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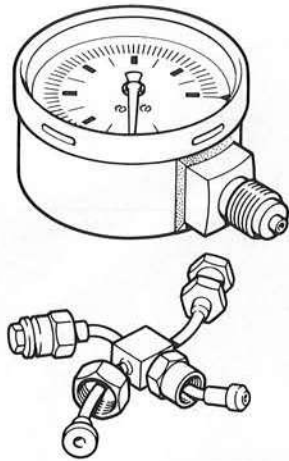
74 64 1 333 566



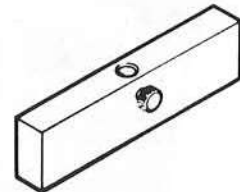
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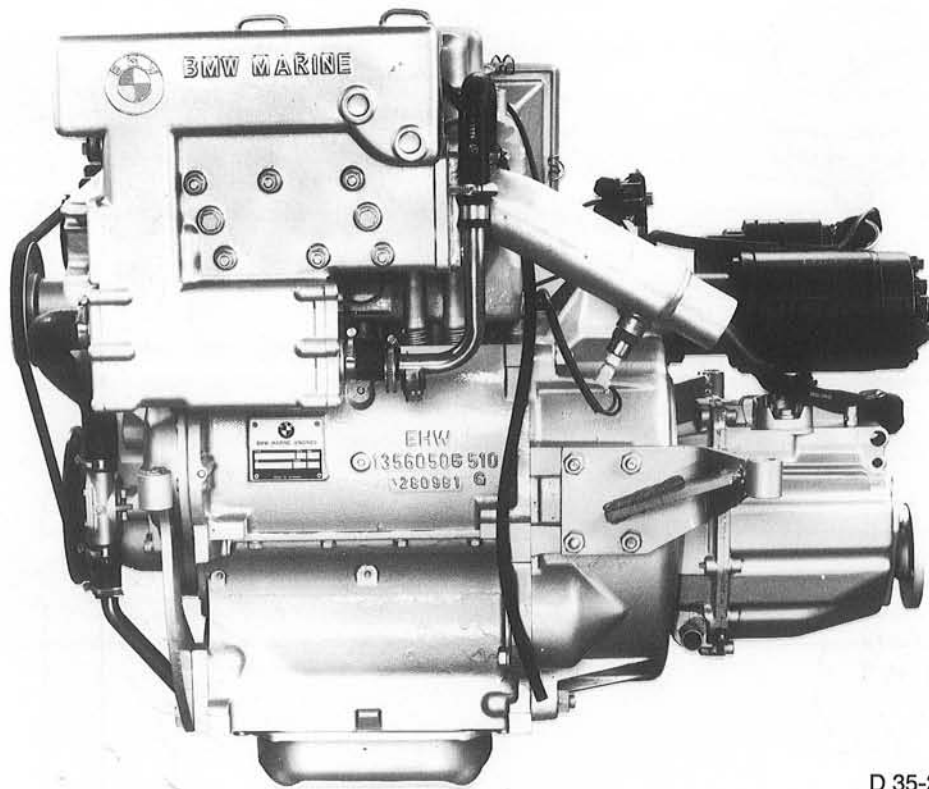


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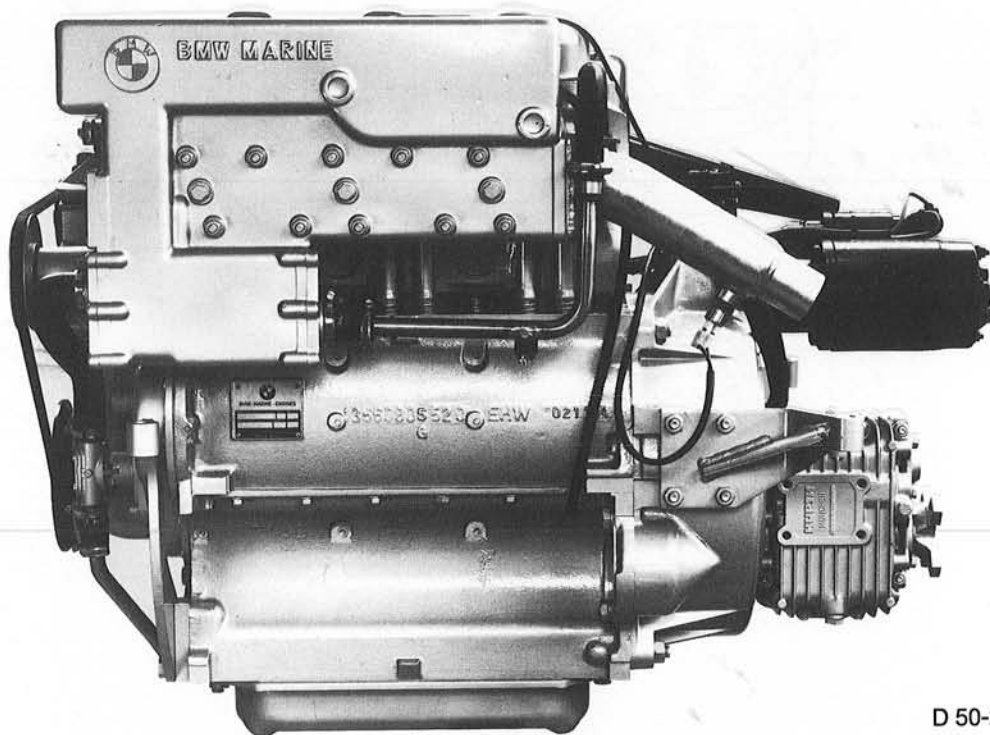


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VIEW OF ENGINE

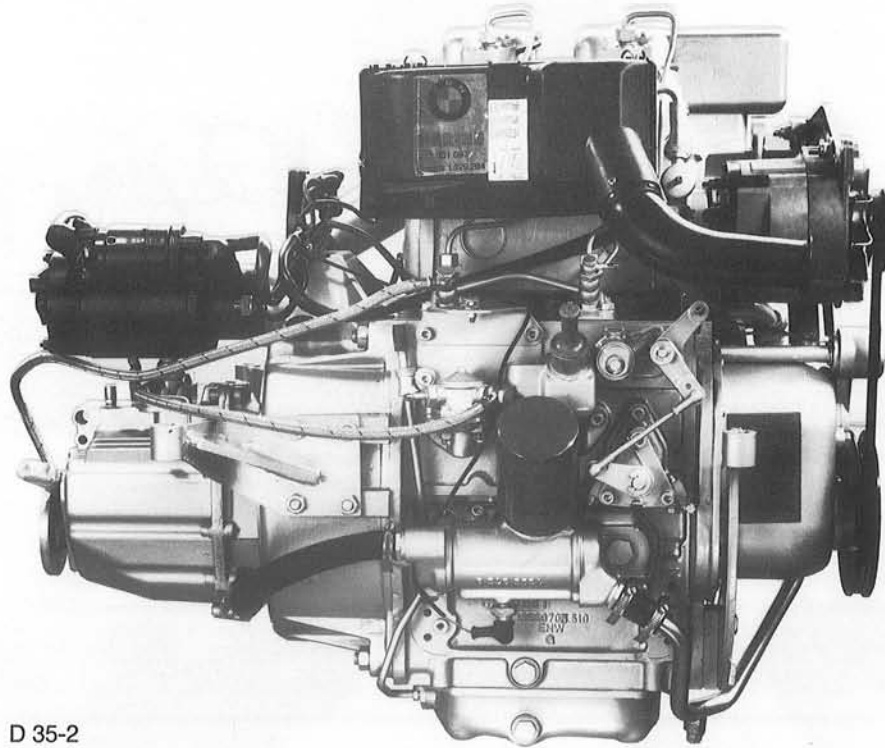


D 35-2

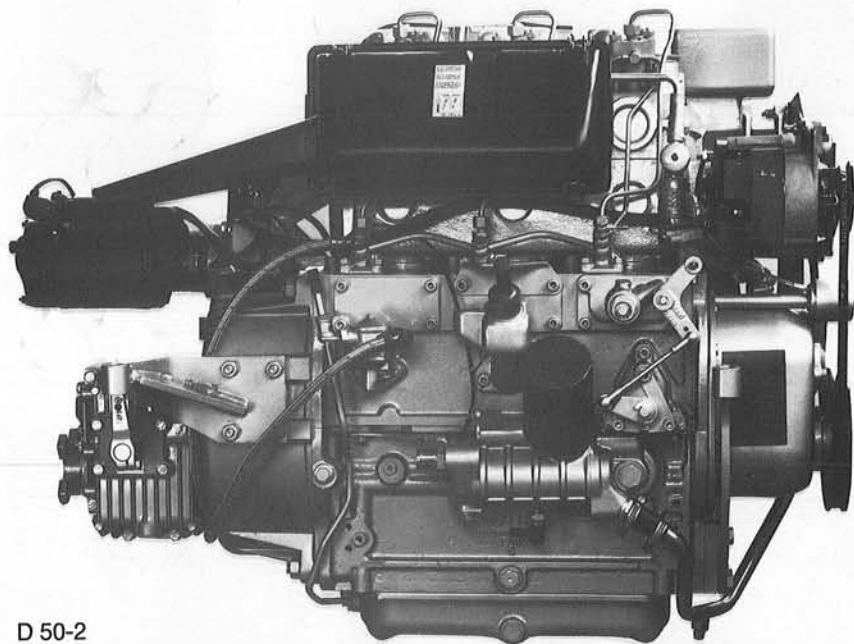


D 50-2

VIEW OF ENGINE

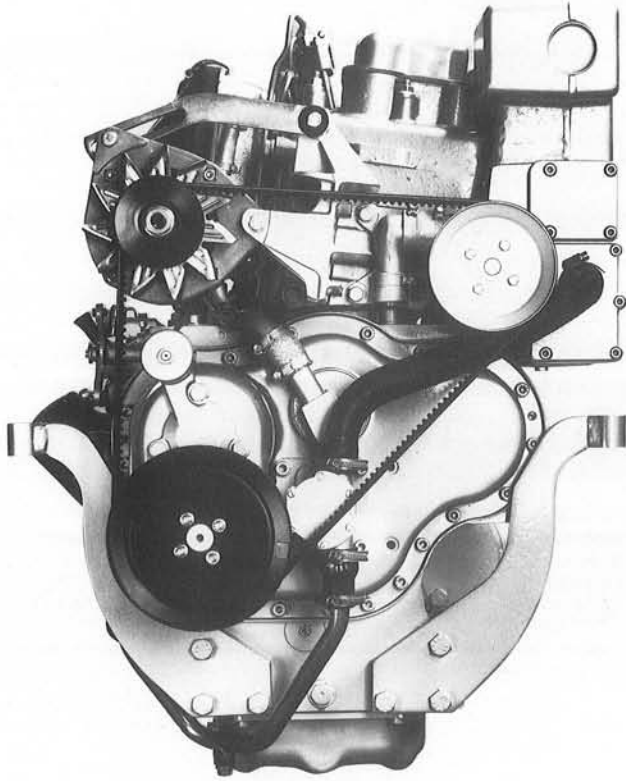


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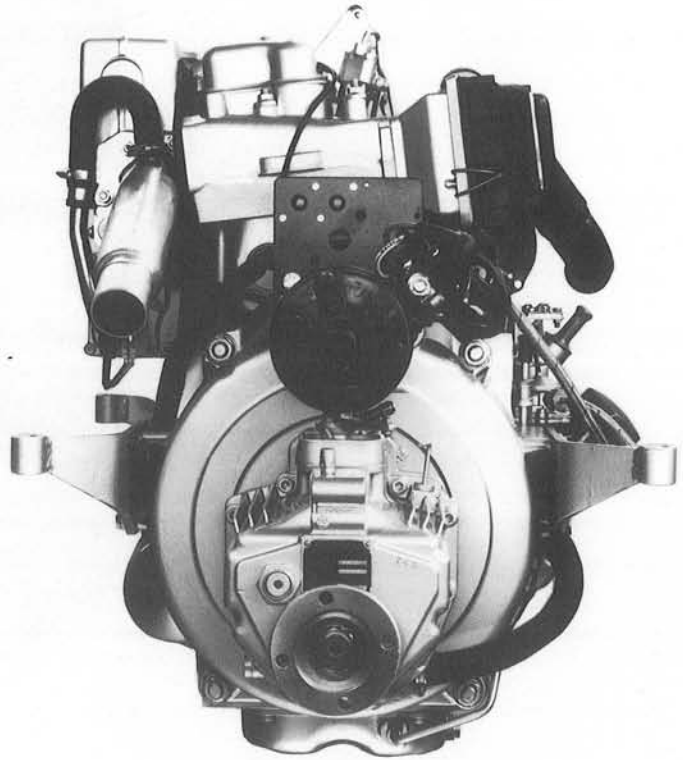


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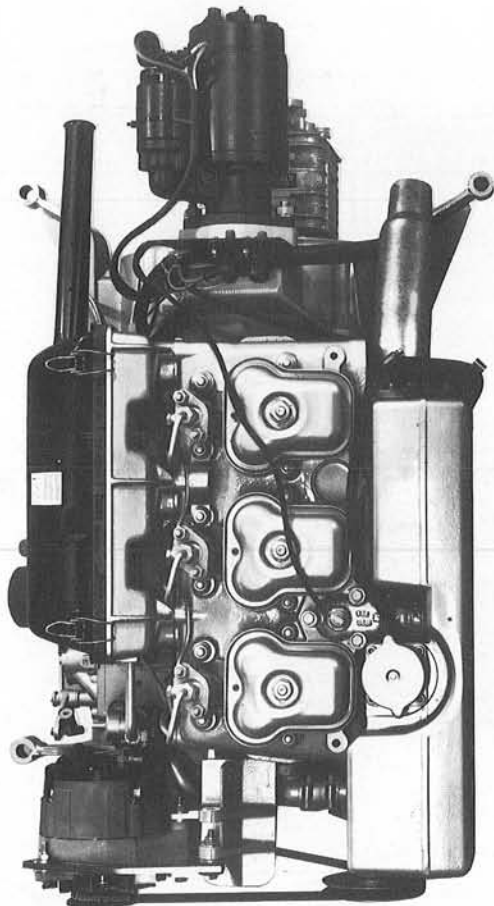
VIEW OF ENGINE



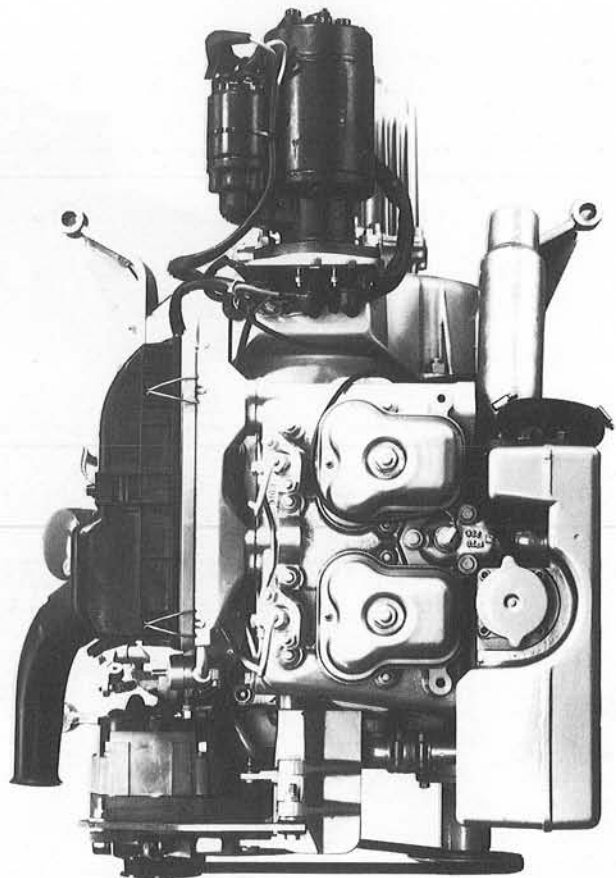
D 50-2



D 35-2




D 50-2



D 35-2

Service and Maintenance

Required service and maintenance work is listed below.
 This sign  indicates that special tools and particular knowledge are required to carry out the job in question. Your authorized BMW Marine service dealer is recommended for such purposes.

Job	Intervals								See Page for Description of Job
	Daily Before Starting	Every 14 Days	Every 50 Hours or Annually	Every 100 Hours or Annually	Every 200 Hours	Every 500 Hours	Every 1000 Hours	As Req.	
Clean fuel tank					X				
Clean raw water filter			X					X	
Clean oil/water heat exchanger								X	
Clean water/water heat exchanger								X	
Tighten cylinder head bolts			X						19
Clean fuel pump screen filter				X					
Clean fuel filter		X							13
Check engine oil level	X								17
Check battery fluid		X							
Check valve clearance					X				19
Clean injectors				X					14
Check V-belt tension		X							21
Check fresh water level	X								
Check gearbox oil level	X								18
Tighten fuel lines					X				
Change engine oil*			X						
Change gearbox oil			X						
Renew fuel filter				X					
Renew air filter				X					14
Renew oil filter cartridge*				X		X or annually			
Renew V-belt							X		
Tighten hose clamps				X					
* only for the first time on new engine after 10 hours									



ALTERNATOR

12.31

Removal of alternator

Fig. 12

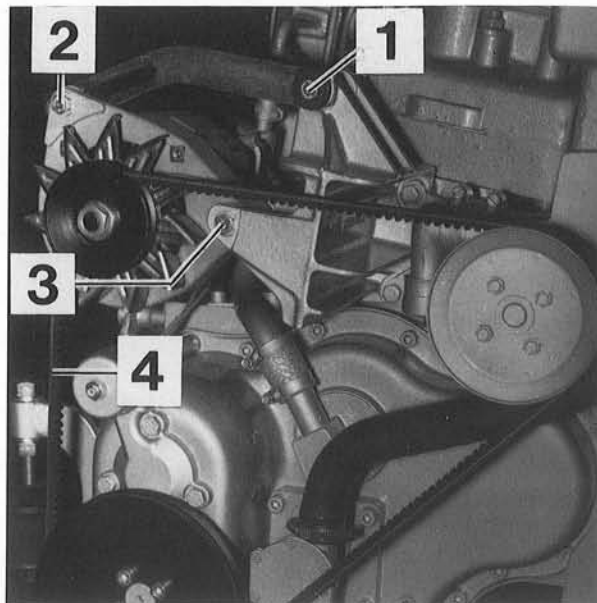
Disconnect electrical leads and earthing lead, except for brown lead at connection D+, from the alternator.

Slacken off the alternator fastening bolts (13 mm) (12/1, 2, 3) and lower the alternator.

Remove the V-belt (12/4).

Unscrew the bolts (12/2, 3) completely and take alternator out of the holder.

Disconnect the electrical lead still on the alternator from connection D+.

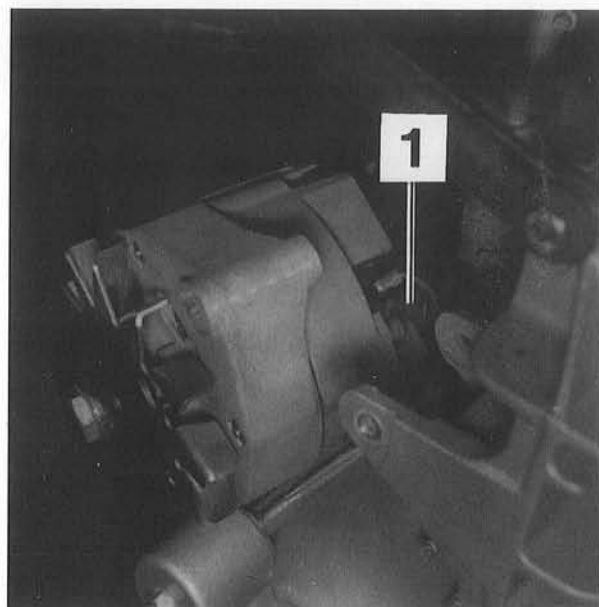


12

Installation of alternator

Fig. 13

Before the alternator is placed in the holder, fasten electrical lead to connection D+ (13/1) and cover with rubber protective cap.



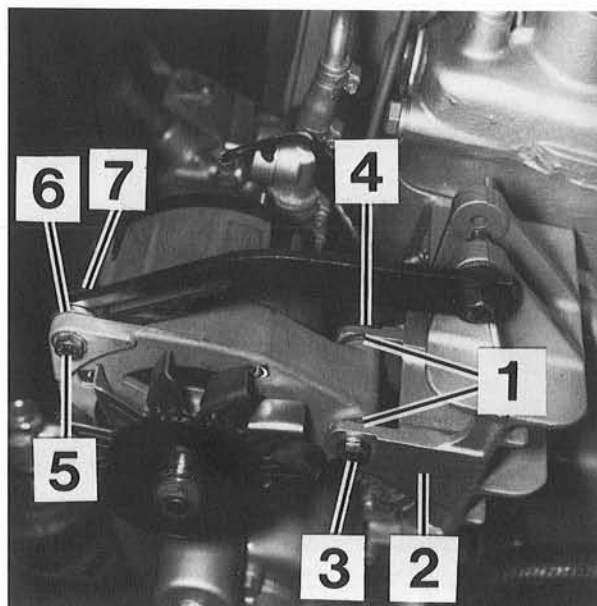
13

Fig. 14

Place alternator with spacers (14/1) in the holder (14/2), push bolt (14/3) through and screw together loosely with retaining nut (14/4).

Place top holding bolt (14/5) in alternator, push on spacers (14/6) and screw together loosely with nut (14/7) on the holding bracket.

Fasten electrical leads and earthing lead to the alternator and cover with rubber protective caps.



14

Note

The leads are identified by their colours.

Install V-belt, tension it (press alternator upwards) and tighten all fastening bolts and nuts.

(The tension is correct if the V-belt can be pressed down about 5 mm with light thumb pressure applied half-way between alternator and water pump pulley).

STARTER

12.41

Removal of starter

Fig. 15

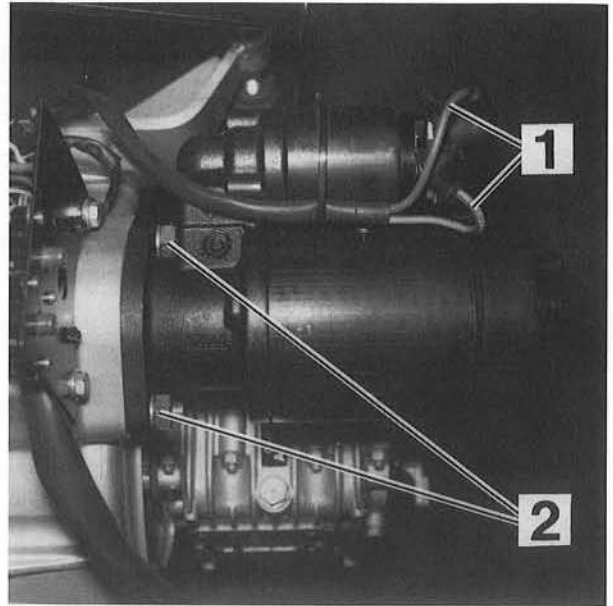
Disconnect the two electrical leads (15/1) from the starter. Unscrew the two fastening nuts (15/2) and lift starter out of its support.

Note:

In the event of a defect, always replace the complete starter.

Installation of starter

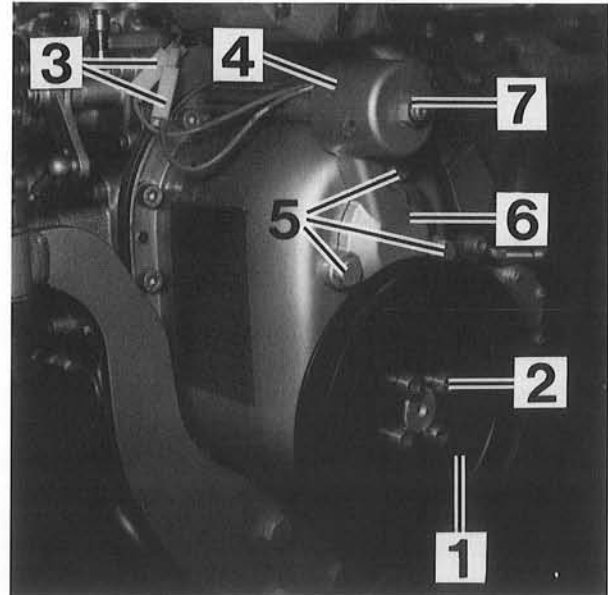
Place starter in its support and tighten the two fastening nuts with a torque of 43—48 Nm. Connect up electrical leads and cover over with rubber protective caps.



AUTOMATIC ENGINE STOP**Removal of lifting magnet**

Fig. 16

Take off V-belt, see „Removal of alternator“.
 Remove V-belt pulley (16/1) by unscrewing the four Allen screws (16/2). Disconnect plug connections of both electrical leads (16/3) which originate from the lifting magnet (16/4).
 Unscrew the three hexagon-head screws (16/5) on the cover (16/6) and the hexagon nut (16/7) on the lifting magnet and remove the cover. Pull out the lifting magnet.

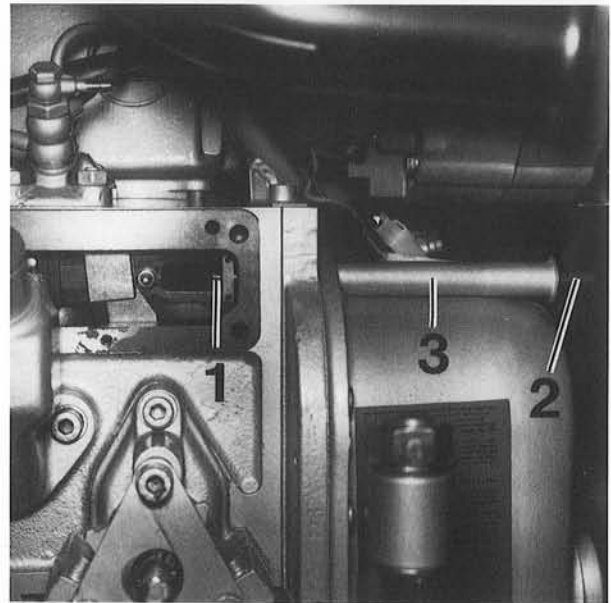


16

Remove traction rod

Fig. 17

Remove crank lever, see „Removal of control linkage“.
 Remove automatic cold start, see „Removal of automatic cold start“.
 Disengage retaining ring and pull out traction rod (17/2) with protective tube (17/3) to the front.

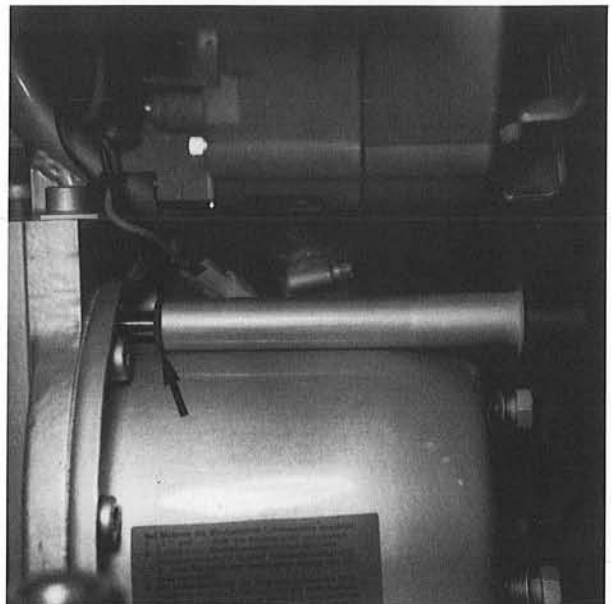


17

Install traction rod

Fig. 18

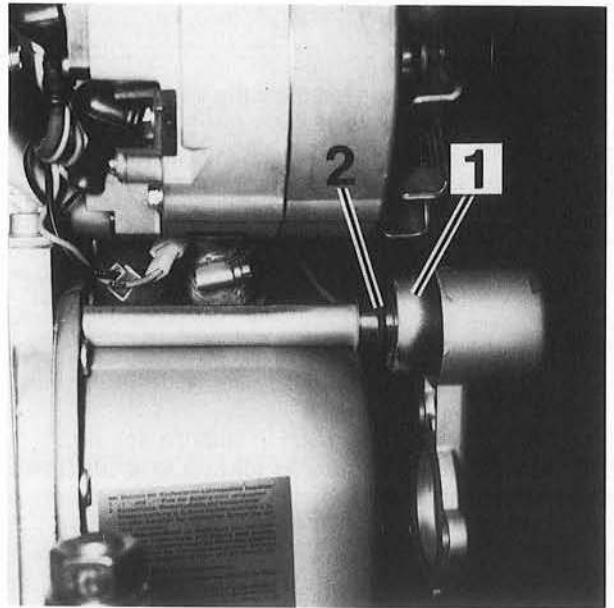
Renew O-ring, insert traction rod in governor linkage and compress the retaining ring into annular groove.



Installation of lifting magnet

Fig. 19

Insert new lifting magnet (19/1) with O-ring (19/2). Replace cover with a new O-ring. Screw tight the three hexagon-head screws on the cover and the hexagon nut with spring washer on the lifting magnet. Connect up the two electrical leads to the lifting magnet. Fasten V-belt pulley with four Allen screws. Fasten V-belt and tension it, see „Installation of alternator“.



INSTRUMENT PANEL

61.11

The instrument panel features the following functions:

Coolant temperature gauge — it gives a reading of 80—85° C (176—185° F) under normal operating conditions.

Fuses — 15 ampere delayed-action for starter control circuit.

— 8 ampere delayed-action for indicator lamps and gauges.

Voltmeter — the needle should always be in the green field when the ignition is on and the engine is running.

Engine stop button — is used to stop the engine.

Rheostat — to switch on and off and to adjust the instrument illumination.

Ignition lock.

Oil pressure warning lamp — comes on when the oil pressure is less than 0.8 bar.

Battery charge indicator lamp.

Engine temperature indicator lamp — comes on, if the temperature in the exhaust flange pipe rises above 70° C.

Tachometer with operating hour counter (IDEA).

If the tachometer is out of order, it can be repaired at the nearest Moto-Meter or IDEA service station.

TACHOMETER WITH OPERATING HOUR COUNTER (IDEA)

The measuring mechanism, which is operated on the basis of the pulses from alternator terminal W, is tuned to the engine model involved in each case. Wear of the existing V-belt, or the use of other V-belts and belt pulleys, disarranges this tuning. However, it can be re-adjusted by means of a potentiometer at the back of the instrument and a simultaneous check of engine speed (e. g., with stroboscope, chronotachometer or inductive tachometer), the low and high idling speeds being used as datum points. Afterwards, the potentiometer has to be sealed with varnish.

The operating hour counter functions only when the alternator is running.

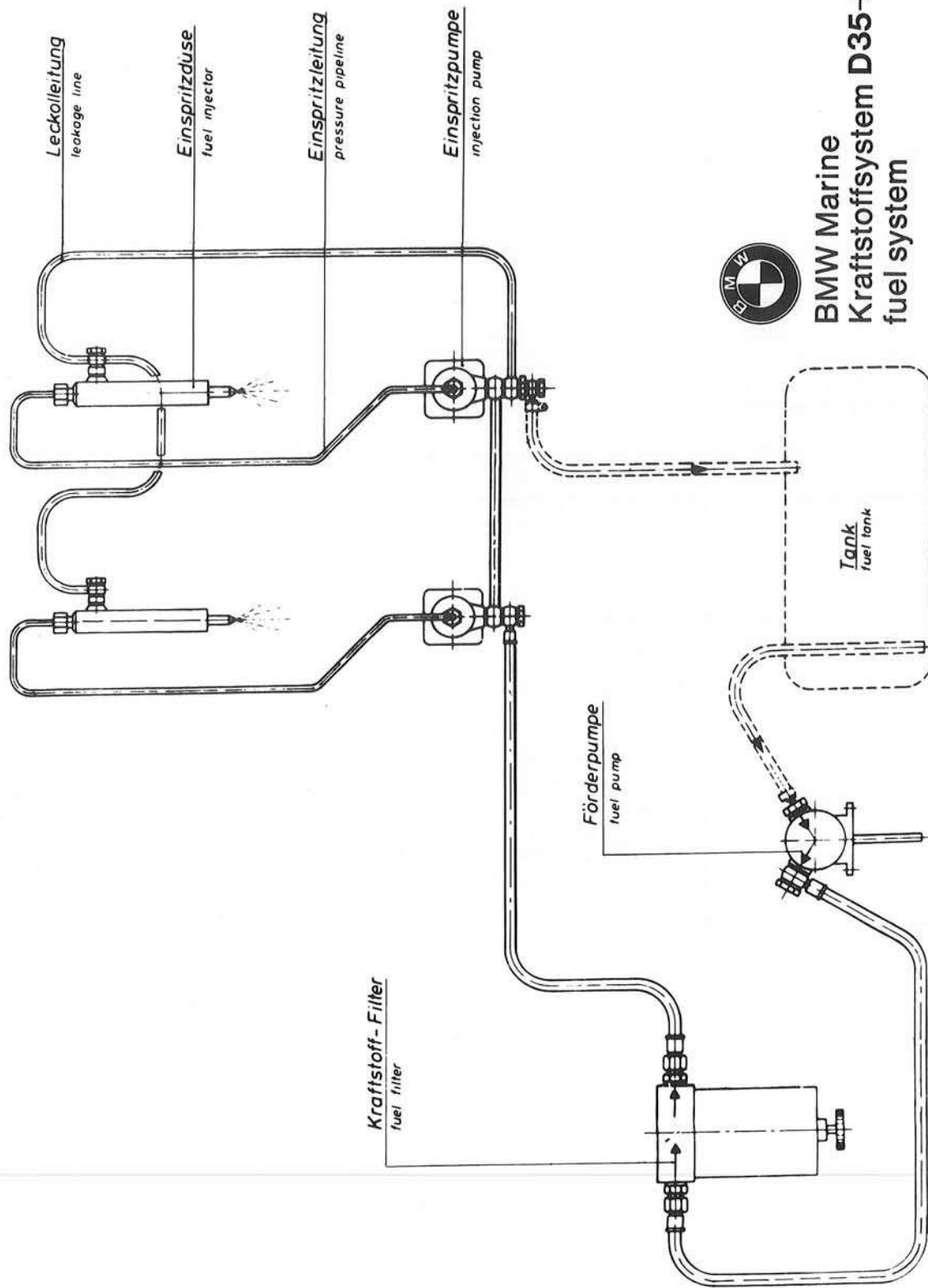
Defect	Remedy
Operating hour counter does not function, although the tachometer is in order.	Fastening clamp is too tight. Ease and tap lightly.
Tachometer vibrates at specific speeds.	Vibration of the boat hull is being transferred to the instrument panel. Fasten panel pliantly with rubber or foam-plastic underlay.
Tachometer and operating hour counter are not functioning.	Check: Instrument fuse alternator, charging voltage (14.0—14.4 V is in order), plug connections on alternator, between engine, connecting and instrument wiring harnesses (colour of the pick-up lead is grey). If necessary, exchange instrument.

Fuel flow circuit

1. **Fuel tank** — Follow the manufacturer's or boat builder's recommendations for draining, cleaning and other maintenance work.

Note

To prevent rust, sludge or wax tailings forming, do not leave diesel fuel in the tank during winter lay-up.

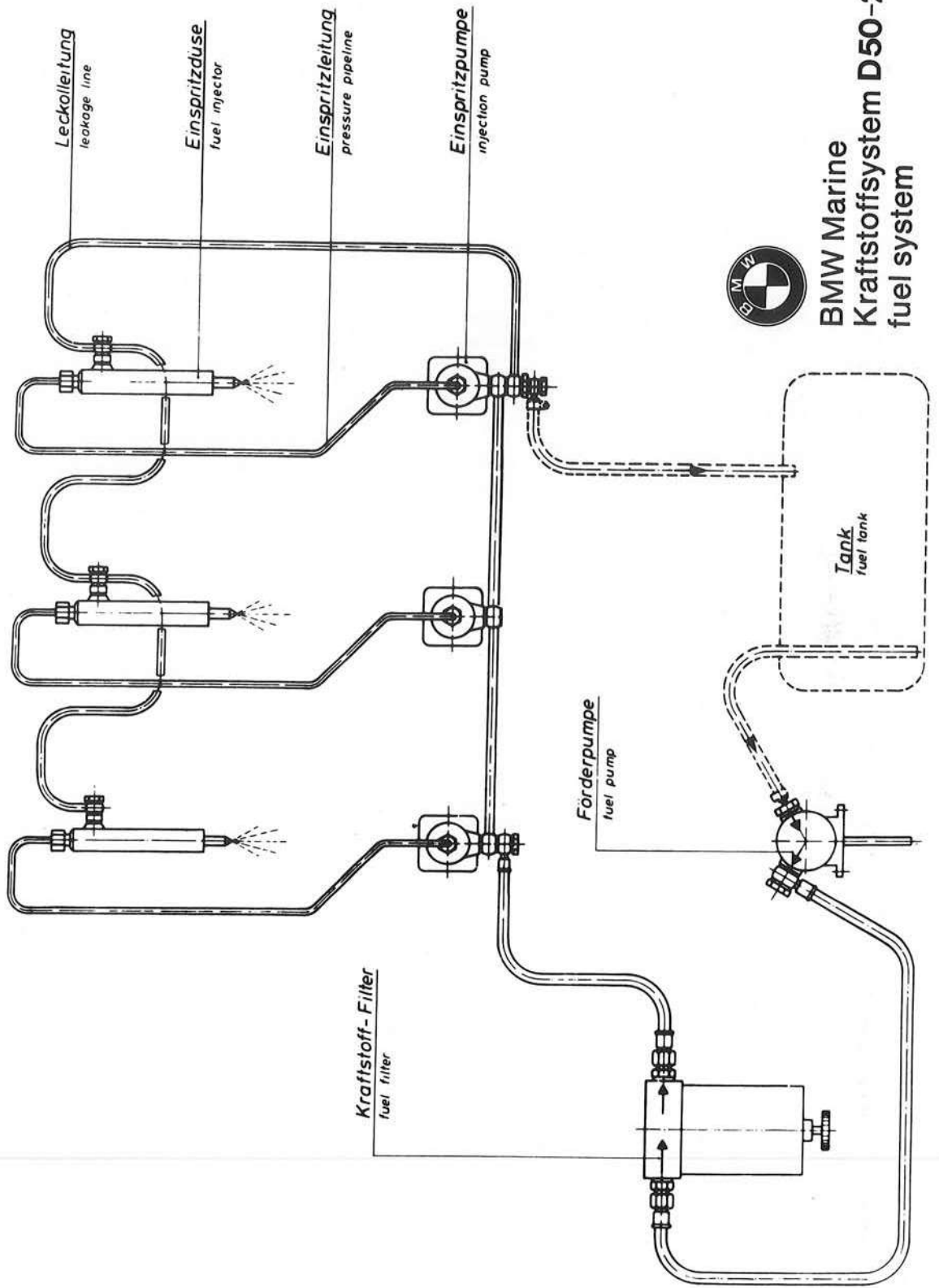


Fuel flow circuit

1. Fuel tank — Follow the manufacturer's or boat builder's recommendations for draining, cleaning and other maintenance work.

Note

To prevent rust, sludge or wax tailings forming, do not leave diesel fuel in the tank during winter lay-up.



AIR FILTER

13.75

Removal

Fig. 22 Air filter D 35-2

Release clips (22/1) and remove filter element (22/2).

INTAKE COVER

Preparation

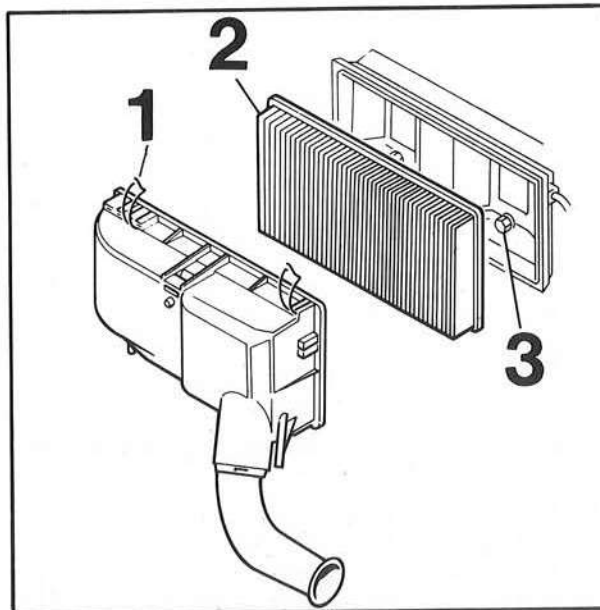
— Remove filter element

Removal

Undo the four (D 35-2) or six (D 50-2) self-locking nuts (13 mm) (22/3). Properly close up the intake openings.

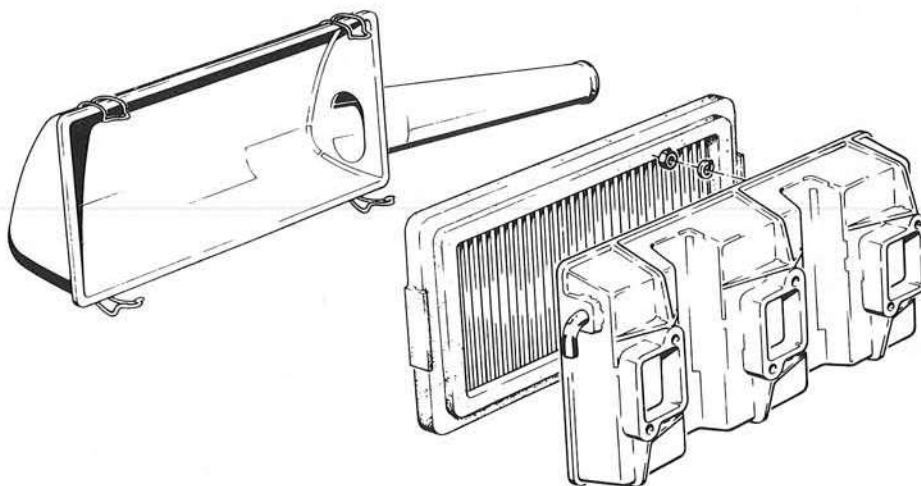
Note for assembly

Renew gaskets.



22

Fig. 23 Air filter D 50-2



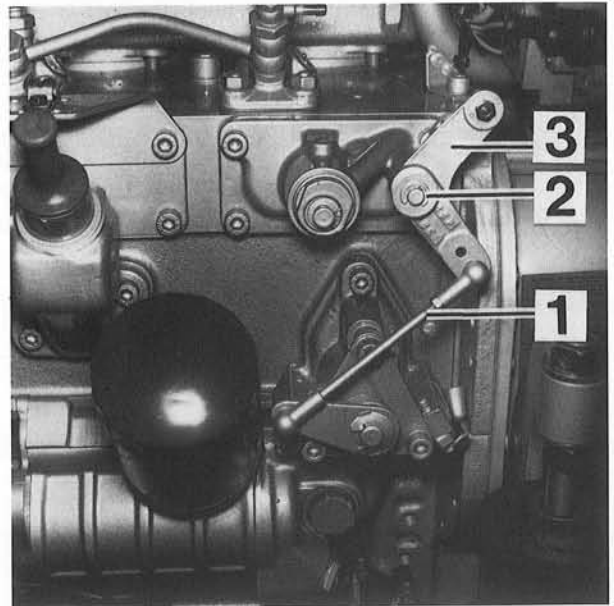
FUEL CONTROL LINKAGE

13.21

Removal of control linkage.

Fig. 24

Detach traction rod (24/1).
Disengage circlip (24/2) and pull off crank lever (24/3).

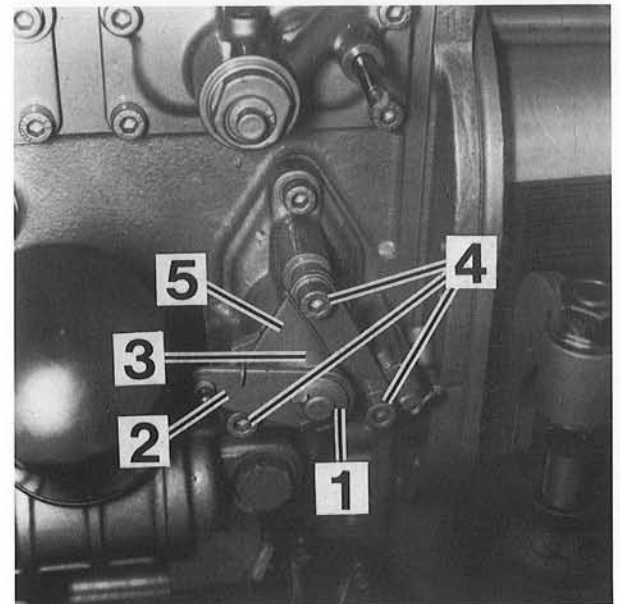


24

Fig. 25

Disengage circlip (25/1) and pull accelerator lever (25/2) and torsion spring (25/3) off shaft. Undo three Allen screws (25/4) and take off clamping sheet (25/5).

Caution:
There is a spacer behind the clamping sheet at each hole.



25

Installation of fuel control linkage

Fig. 26

Place the clamping sheet (26/1) with spacers (26/2) in position at the governor and fasten with three Allen screws (26/3) and spring washers (short screw at top). Install torsion spring (26/4) with accelerator lever (26/5) on the shaft at the stop and fit new circlip (26/6). Tension the torsion spring.

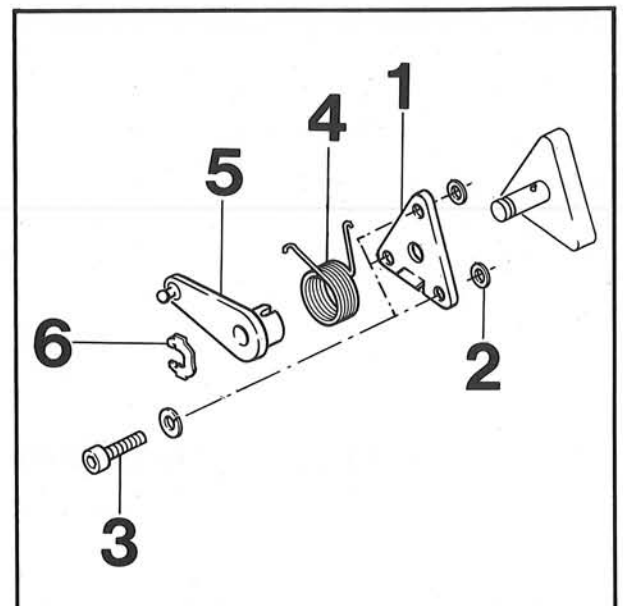
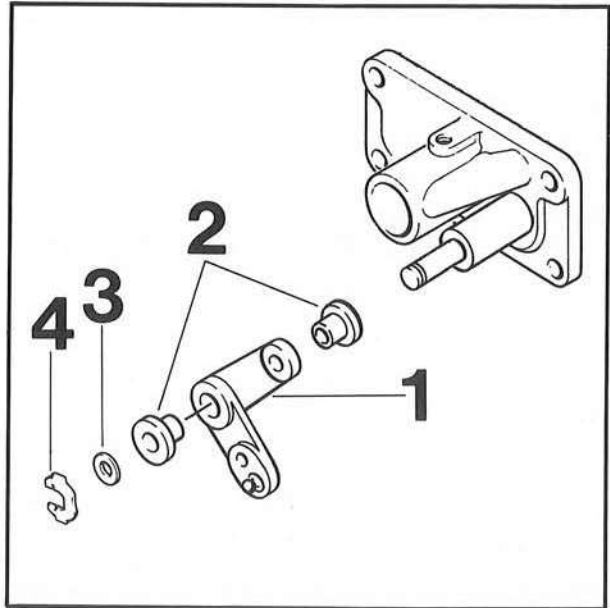


Fig. 27

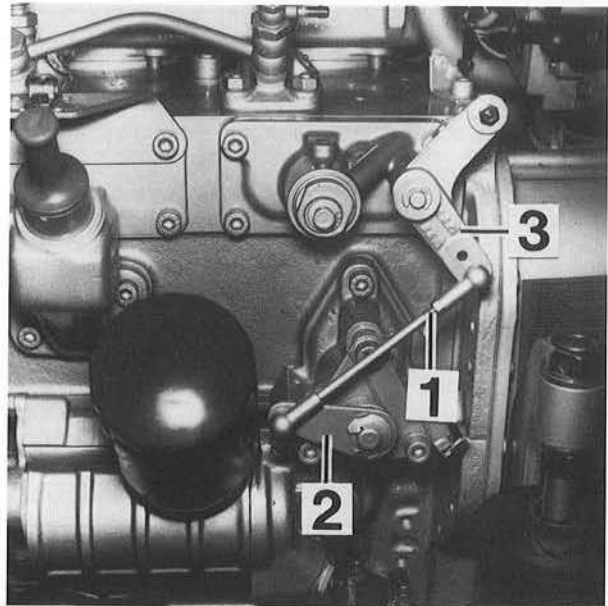
Place crank lever (27/1) with two bushings (27/2) and washer (27/3) on the cold start shaft and fasten with new circlip (27/4).



27

Fig. 28

Fix traction rod (28/1) on ball pin of accelerator lever (28/2) and of crank lever (28/3).



28

FUEL PUMP

13.31

Removal

Fig. 29

Detach fuel lines at the fuel pump.
Remove nuts (29/1) (10 mm) and washers (29/2) and separate pump and O-ring (29/3) from the engine (O-ring should always be renewed).

Repair

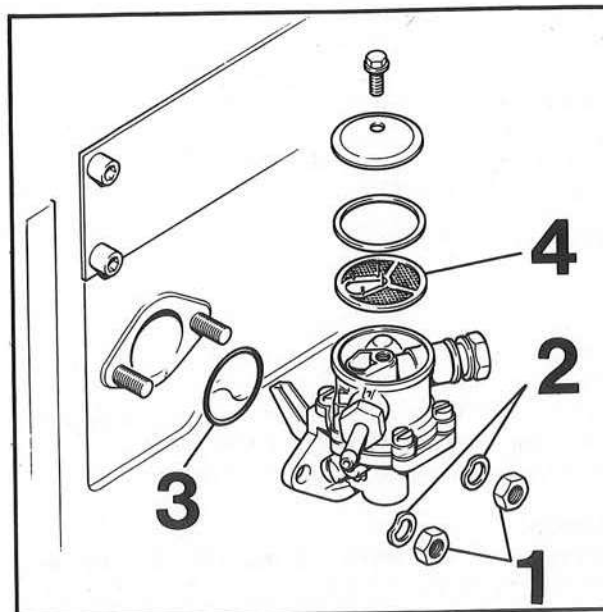
Apart from cleaning of the filter (29/4), no other repair can be carried out. It is expedient to replace the complete pump always.

Note for installation

After the pump has been installed, the fuel system has to be bled, see 13.00.

Specifications

Max. suction head 1.0 m
Max. line length 3.0 m



29

INJECTION PUMP

13.51

Preparation

- Remove intake cover of air filter, 13.75.
- Remove fuel lines.

Removal

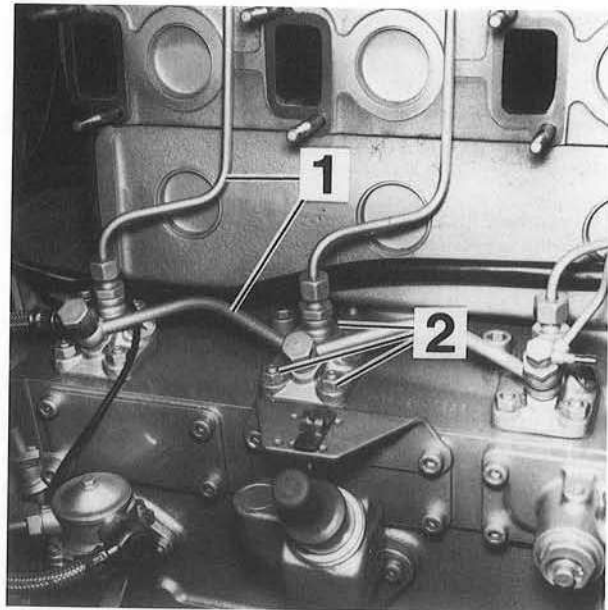
Fig. 30

Move accelerator lever to the middle position (Fig. 31).

Remove the nuts (30/2) securing the injection pump and then pull out the injection pump. Remove the shims (32/1) and seals (32/2).

Caution!

Always mark the shims, so that they can be re-installed at the correct site.

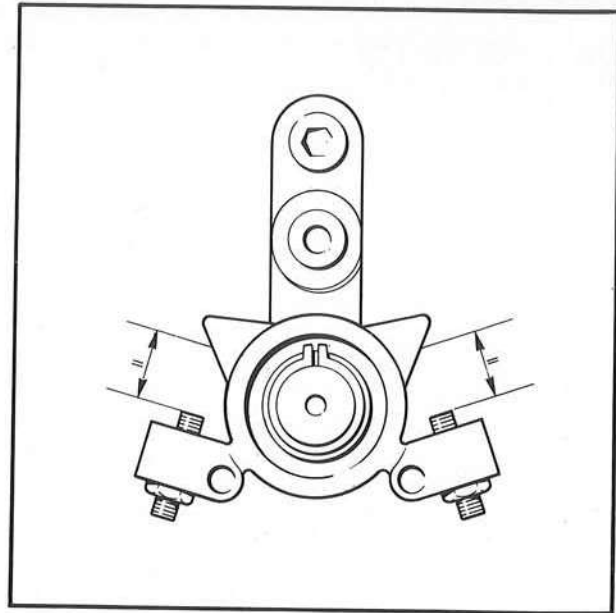


30

Fig. 31 Accelerator lever

Checks

Checks and repairs on the injection pumps should be carried out only at Bosch workshops.

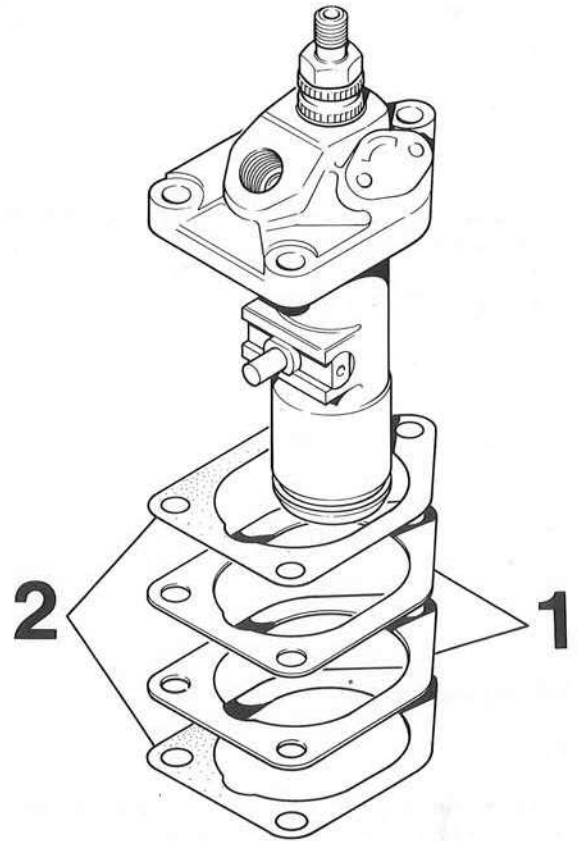


31

Fig. 32

Injection pump

- 1. Shims
- 2. Seals



32

Notes for installation

Fig. 33

Block the governor rod with the accelerator lever so that the rear (flywheel side) governor rod groove is exactly centered in the rear injection pump hole.

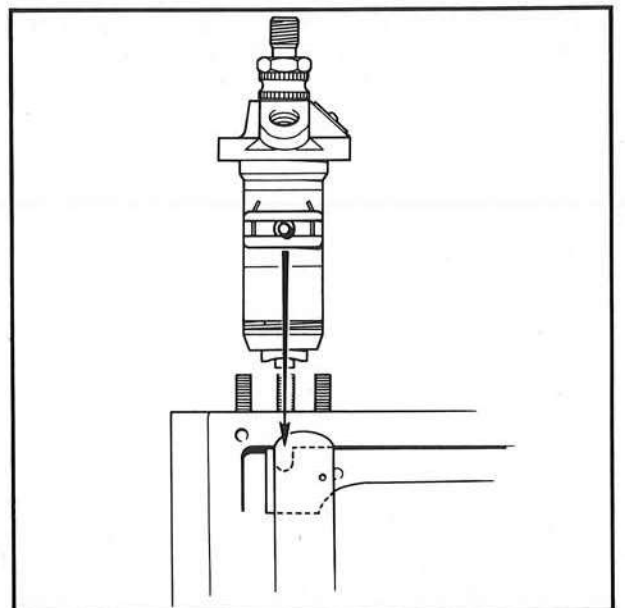
Check the position of the other governor rod grooves and adjust, if necessary (13.41).

The shims removed earlier should always be re-used.

Attention!

To enable a provisional setting, for instance if the crankcase has been exchanged, there is a number punched on every injection pump, e. g., „8“. This number denotes the required thickness of the shims.

The various adjustment jobs on injection pumps will be covered in detail later in sections 10.41 and



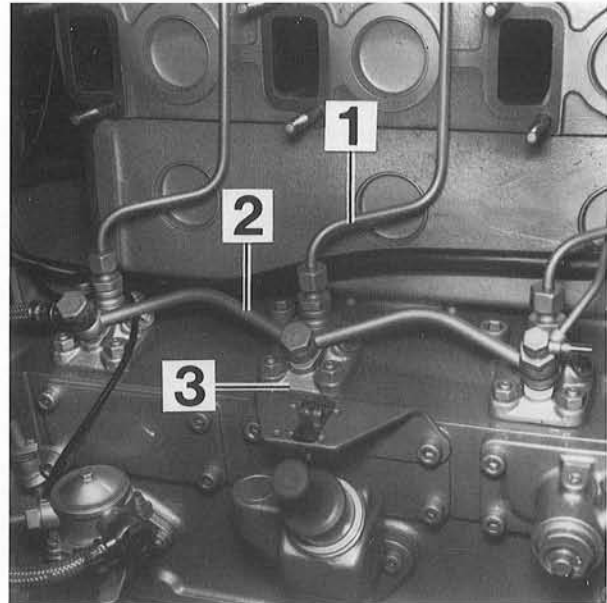
INJECTOR

13.53

Removal

Fig. 34

Unfasten the fuel pressure pipe (34/1) and the fuel leakage line (34/2) at the injector. Remove the clamp (34/3) and then pull out the injector and sealing washer.



34

Check (visual check)

Fig. 35

Clean the injector with a brass brush until all traces of dirt and oil carbon have been removed.

Strip the injector by unfastening the sleeve nut (35/1).

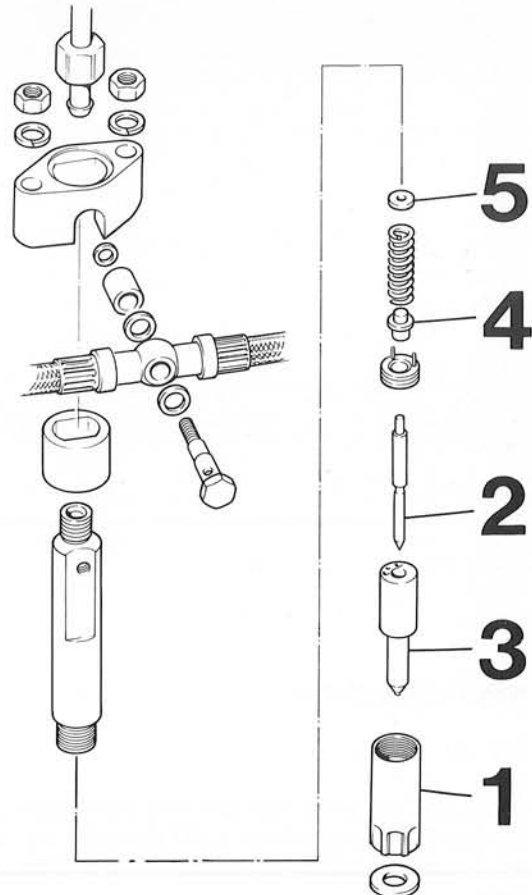
Check all parts for wear and damage, in particular

- nozzle needle (35/2) for rough needle seating
 - nozzle needle (35/2) for overheating (blueing)
 - nozzle body (35/3) for blocked spray holes
 - plunger (35/4) for wear at needle end
- Exchange damaged parts.

Caution!

Nozzle body and nozzle needle are lapped together and can only be exchanged as a unit. For the same reason, they must not be inadvertently interchanged with similar parts from other injectors.

After being checked, all parts should be dipped in clean diesel fuel to prevent corrosion and rusting. Subsequently carry out a sliding test. In the vertically held nozzle body, the nozzle needle must slide down on to its seat under its own weight.



35

Check (with injector tester)

Shut off the pressure gauge and pump hand lever vigorously several times to check whether the nozzle is opening.

Open the pressure line to reduce the feed pressure and cut in the pressure gauge.

Press the hand lever down slowly and read off the opening pressure from the pressure gauge.

Correct opening pressure to 250⁺⁸ bar by adding or removing shims (35/5).

Fig. 36

Press hand lever down slowly again and check nozzle spray pattern (see illustration). In this test procedure, the nozzle must produce a high-pitched whistle (chatter). Fast pumping of the lever (4—6 times/sec.) must intensify the chatter.

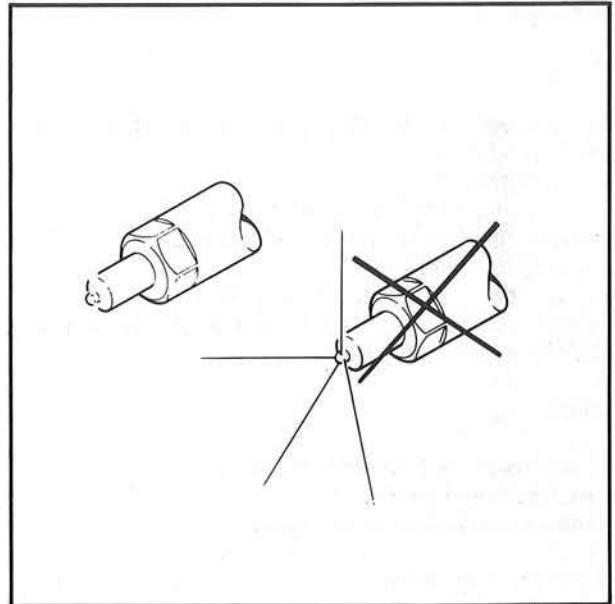
Finally, a check should be made for leaks. For this purpose, the injector should be subjected to a pressure of 230 bar. The nozzle is leakproof, if it is still dry after 10 seconds.

Caution!

The spray from a discharging nozzle is powerful enough to penetrate the skin, causing death of tissue and blood poisoning. Utmost caution is therefore needed in this work. Keep hands away from the spray.

Tightening torque:

Sleeve nut 85 Nm



AUTOMATIC COLD START

13.51

Preparation

D 35-2 only

— Remove oil filler, 11.43.

Removal

Fig. 37

Detach the four Allen screws which fasten the cover (6 mm).

Note!

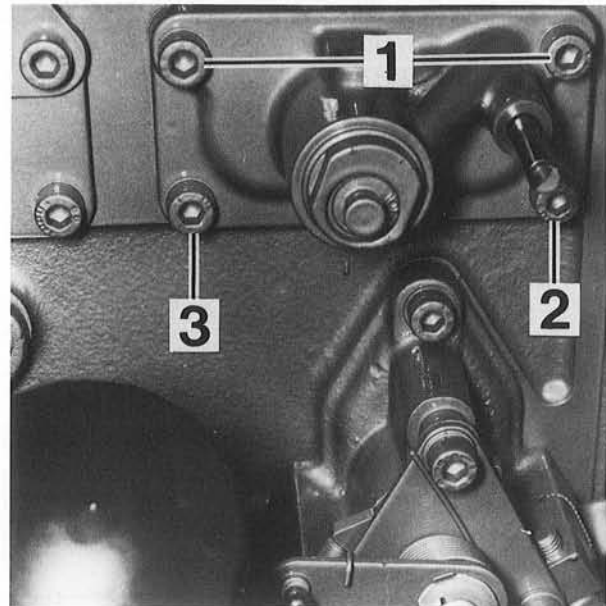
D 35-2 has three (D 50-2 two) different screws which must not be mixed up.

1 = 2 x M8 x 20

2 = 1 x M8 x 16

3 = 1 x M8 x 16 with low head

(D 35-2 only; same as 2 in the case of D 50-2).



37

Stripping

Fig. 38

Remove spring ring (38/1) and wipe off surplus paint on cylinder.

Unscrew stud (38/2).

Push out the complete cylinder (38/3).

Remove circlip (38/4) and pull out the plug (38/5) with a pair of pliers.

Pull out piston (38/6) and spring (38/7).

Take out circlip (38/8), spring collar (38/9), spring (38/10) and ball (38/11).

Check

Check piston and cylinder for wear.

Check ball seat for wear.

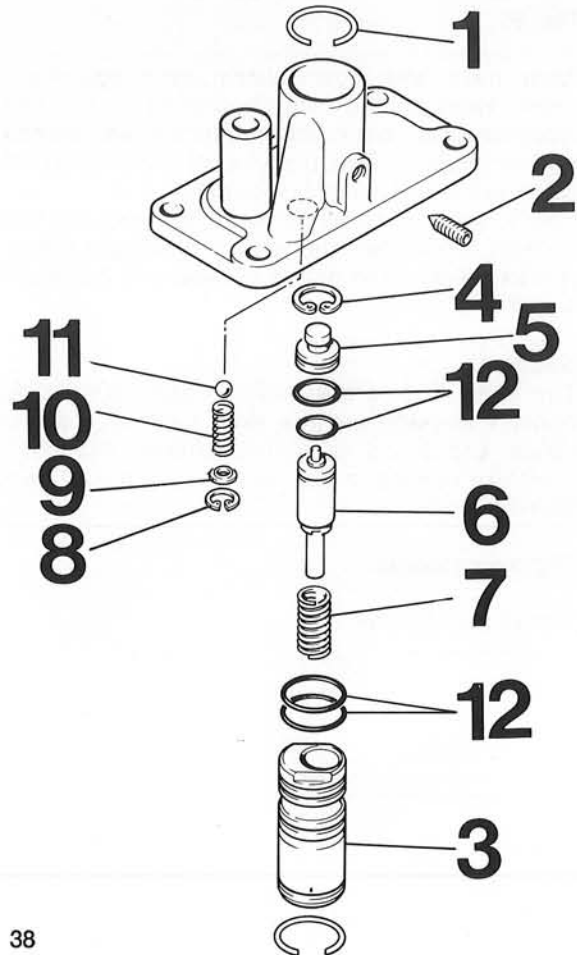
Renew O-rings (38/12) and seal.

Notes for installation

Lubricate piston and cylinder with engine oil.

Apply Loctite 221 to threads of the four fastening screws and install them in the correct position, see Fig. 37.

Tighten stud only when the adjustments described in Section 13.01 have been completed.



38

GOVERNOR ROD

13.41

Preparation

- Remove injection pumps, 13.51
- Remove fuel control linkage, 13.21
- Remove fuel pump, 13.31
- Remove automatic cold start 13.51, oil filler 11.43 and the side cover plates.

Removal

Fig. 39

Remove governor rod guide (39/1) and spring (39/2).

Caution!

The spring can easily fall into the crankcase.

Press the clamping sleeve (39/3) out with a pair of pliers and then press the governor lever (39/4) fully to the rear.

Turn governor rod (39/7) through 90° and pull out clamping sleeve (39/5) with a pair of pliers.

Slide the governor rod off the guide pin (39/6) and take out the governor rod through the rear crankcase opening.

Check

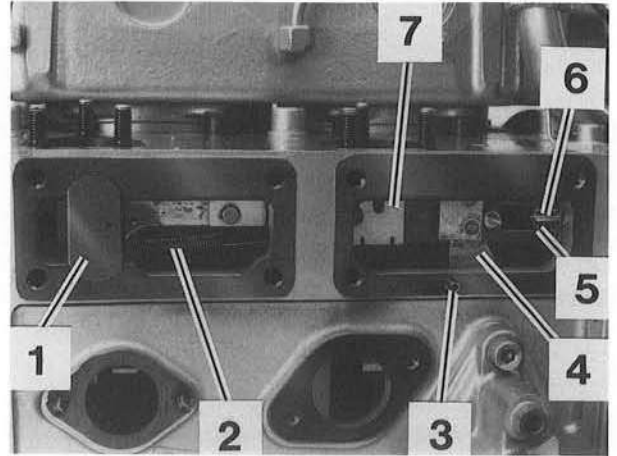
The governor rod should be checked for wear in the area of the governor rod guide. Replace if worn.

Note for installation

Hold the governor rod guide in place with the cover to prevent it falling out.

Caution!

The clearance between crankcase and governor rod guide must not exceed 0.1 mm. If greater, it should be correctly set by means of shims between crankcase and governor rod guide.



39

Adjustment

Fig. 40

The delivery rate of the injection pumps is adjusted at „zero delivery“ for equal delivery. The adjustment work involves adjusting the setting plates of the governor rod to obtain equal delivery. This is performed as follows:

Install governor rod.

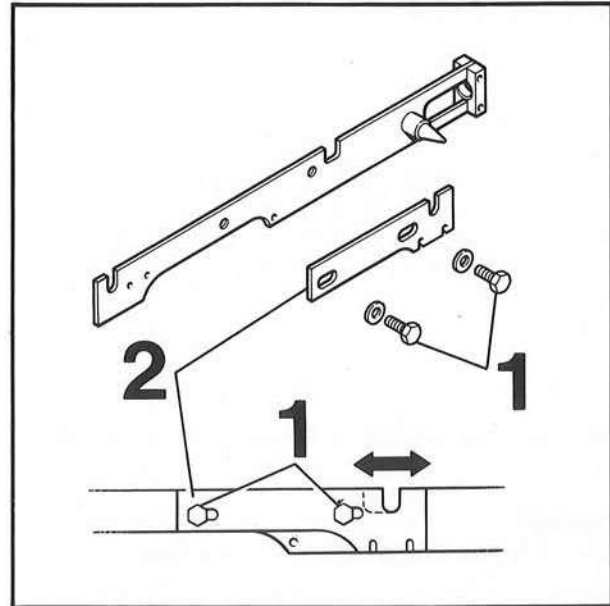
Clamp the governor rod guide laterally with the cover. The other openings in the side of the crankcase remain open.

Install the injection pumps.

Block accelerator lever in „Stop“ position (for this purpose, shift automatic engine stop manually to the „Stop“ position).

Push the governor rod fully forwards and loosen the screws (40/1) securing the setting plates (40/2) of the governor rod.

Push the now loose setting plates forwards and tighten the screws.



40

Attention!

This adjustment should be made as accurately as possible, as it affects the amount of fuel injected over the whole speed range.

GOVERNOR

Fig. 13.41

Removal of governor

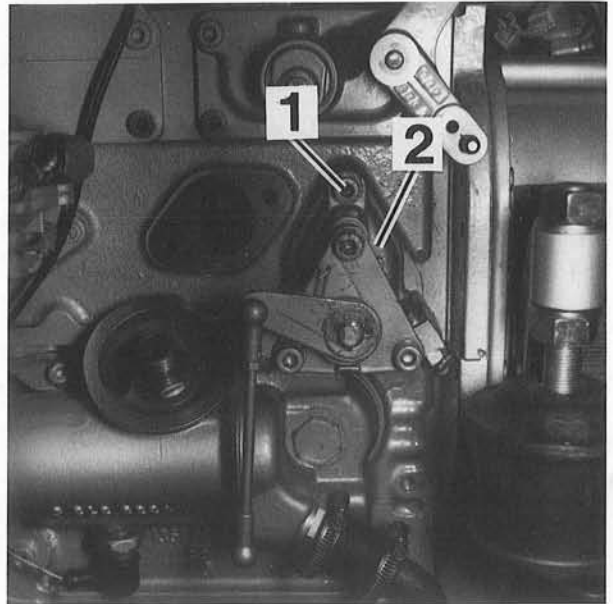
Preparation

- Remove oil filter
- Disconnect fuel control linkage, 13.21
- Remove oil dipstick and oil filler, 11.43 (applies only to D 35-2)
- Remove automatic cold start, 13.51
- Take off air filter cover with filter element

Removal

Fig. 41

Unscrew Allen screws (41/1). Turn support (41/2) through 90° anti-clockwise. Press governor lever fully to the right into the crankcase and under the governor rod towards the centre of the engine. Keep the governor lever and the support at an angle of 90°.



41

Fig. 42

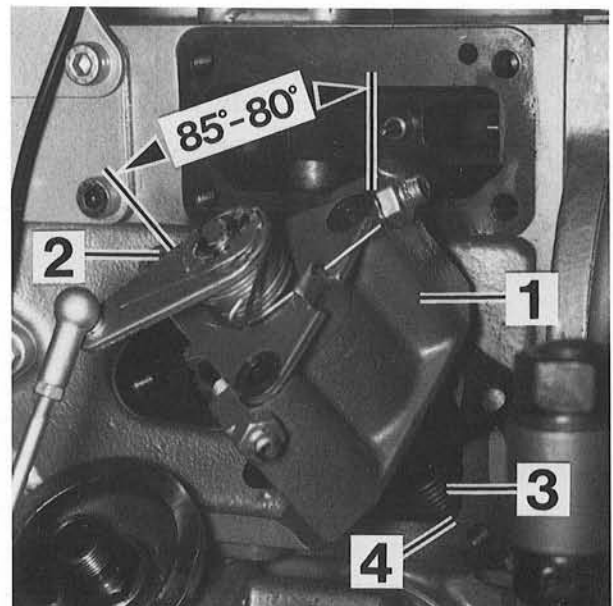
Tilt the entire governor (42/1), withdraw it from the crankcase and remove from the engine. Take away any bits of seal left on the flange.

Attention:

When the governor is tilted, the angle between the apex (42/2) of the support and the governor lever must be made about 5 to 10° smaller. As shown in the illustration, the shaft (42/3) must point to the right-hand corner (42/4) of the installation hole.

Note:

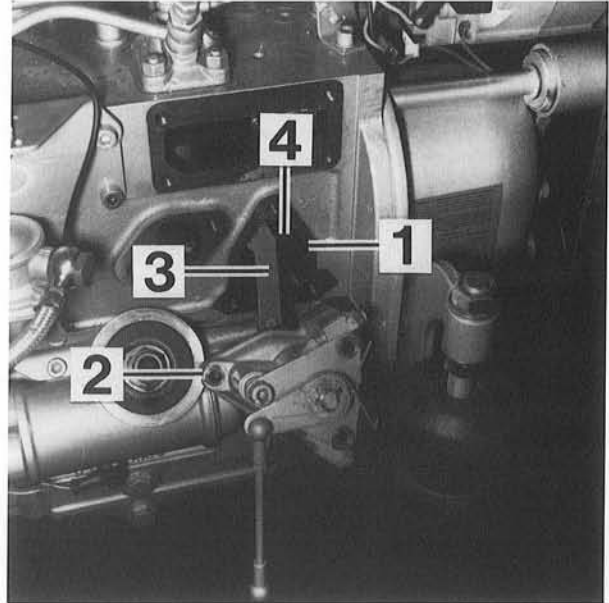
Do not use force to withdraw the governor. Should the governor become jammed when being withdrawn, move the support slightly to and fro. In doing so, do not alter the position of the shaft and of the governor lever, if possible.



Installation

Fig. 43

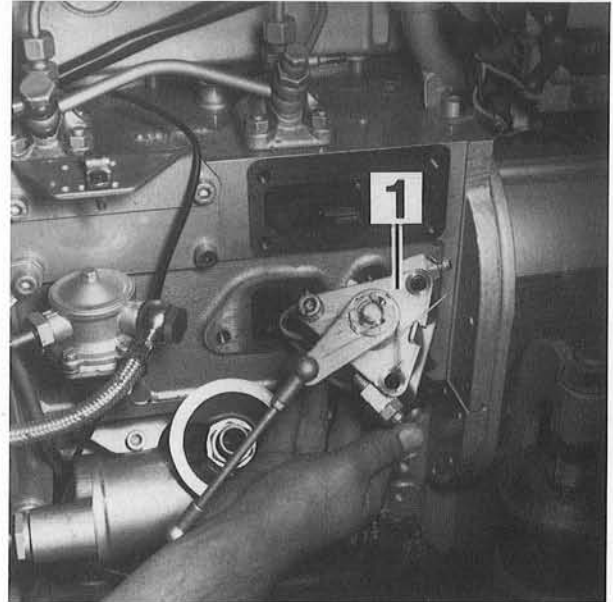
Place a new seal on the flange of the support (43/1). Bring the support apex (43/2) and the governor lever (43/3) to an angle of 90° . Insert the governor lever into the installation hole (43/4) for the governor.



43

Fig. 44

Push the governor (44/1) into the crankcase while maintaining the 90° angle between the support apex and the governor lever.



44

Fig. 45

Apply the shaft (45/1) at the right-hand corner (45/2) of the installation hole and slew into the crankcase by tilting the governor. In doing so, keep the governor lever vertical, whenever possible, and turn the support (45/3) slowly through 5 to 10° clockwise.

Attention:

Do not use force to install the governor in the crankcase. In the event that the governor shaft (45/1) becomes jammed, hold the governor in the described position and swing the support to and fro at a somewhat larger radius until the shaft slews into the crankcase without perceptible resistance.

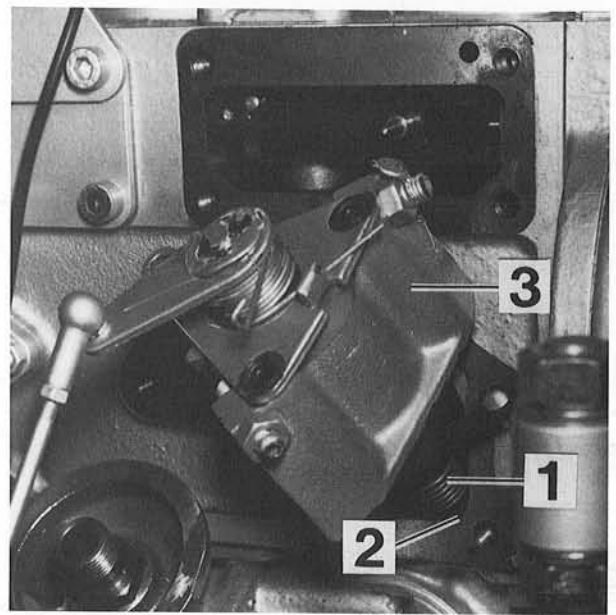
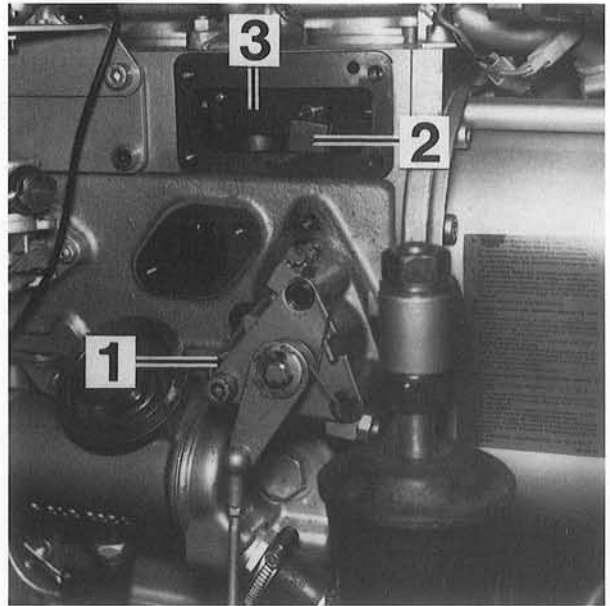


Fig. 46

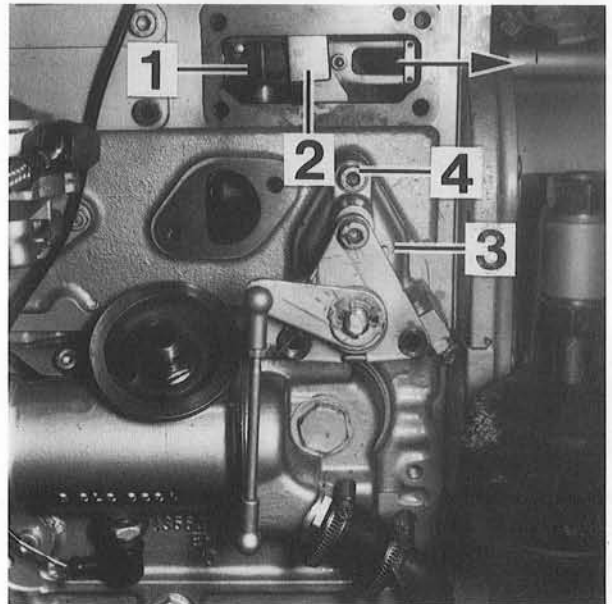
Place the support apex (46/1) and the governor lever (46/2) again at right angles to one another. Press the governor lever forwards and slew into the crankcase by turning the support clockwise, pass beneath the governor rod (46/3) and swing rearwards until it appears in the automatic cold start opening.



46

Fig. 47

Press the governor rod (47/1) fully forwards (arrow) and bring the governor lever (47/2) against stop. Align support (47/3) and seal with the holes and screw in upper Allen screw (47/4) loosely.

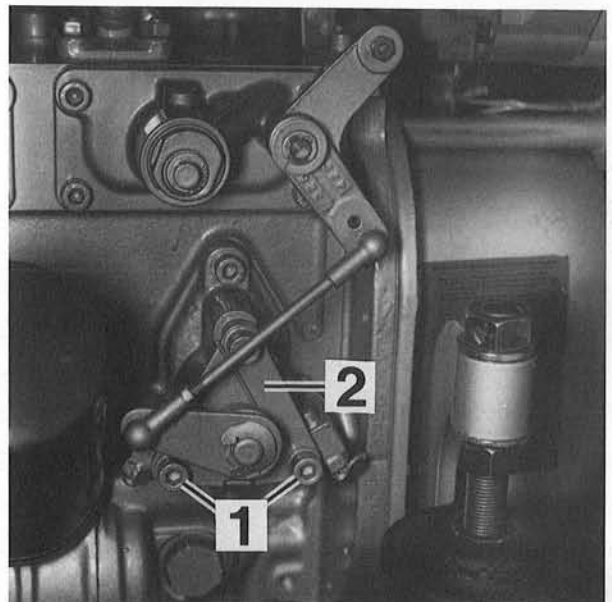


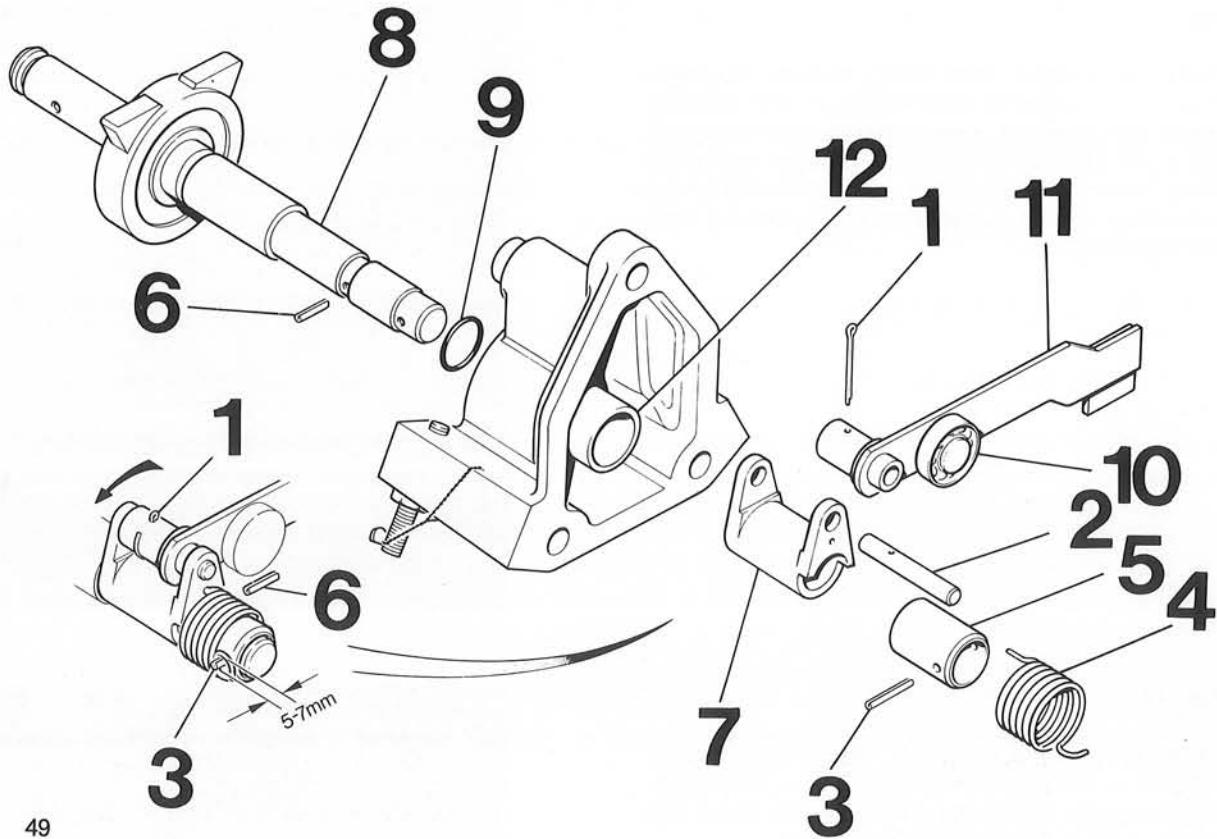
47

Fig. 48

For each hole of the lower Allen screws (48/1), insert a spacer between the support and the clamping sheet (48/2), see „Fuel control linkage“, place spring washer on the Allen screws and screw in the Allen screws. Tighten all three Allen screws.

Install automatic cold start.
 Install oil filler and oil dipstick.
 Install oil filter.
 Attach air filter cover with filter element.
 Connect fuel control linkage.





49

Stripping

Fig. 49

Remove fuel control linkage.
 Remove cotter pin (49/1) and pull out the pin (49/2).
 Knock out the clamping sleeve (49/3).
 Remove the spring (49/4) and pull out the sleeve (49/5).
 Knock out the clamping sleeve (49/6) and pull out the fork (49/7).
 Pull out the shaft (49/8) and replace the O-ring (49/9).

Check

The following parts should be checked for wear:

- Ball bearing (49/10) on the governor lever
- Governor lever (49/11)
- Pin (49/2)
- Fork (49/7)
- Shaft (49/8)
- Hole for shaft in support (49/12).

Replace worn and damaged parts.

Caution!

The ball bearing can only be exchanged complete with the governor lever.

Notes for assembly

Use new O-ring when shaft (49/8) is pushed into the support.
 Push the fork (49/7) on to the shaft with the hole to retain the spring facing outwards.
 Push sleeve (49/5) on to the shaft and install the spring (49/4) with its straight end inserted into the hole in the fork.
 Knock in the long clamping sleeve (49/3) until it protrudes 5—7 mm to securely hold the spring.
 Turn the fork and thus preload the spring. Then knock the short clamping sleeve into the shaft flush with the fork.
 Push the pin (49/2) into place and secure it with the cotter pin (49/1).
 Install the complete governor together with a new seal.
 Attach the fuel control linkage.

INJECTION PUMP ADJUSTMENTS

13.01

After jobs have been performed on the injection pumps, certain adjustments have to be made. What has to be done after a specific job, can be seen from the table.

Job performed	Adjustments required	Remarks
Removal, installation, exchange or repair of injection pump	Equal delivery	Injection pumps may be repaired only at an authorized Bosch service station
Replacement of crankcase or injection pump camshaft	Start of injection Equal delivery Effective stroke	
Removal and installation of governor rod	Equal delivery	
Replacement of governor rod	Equal delivery Effective stroke	
Replacement of automatic cold start	Effective stroke	

Adjusting start of injection

Preparation

- Remove intake cover, 13.75.
- Disconnect fuel pressure pipes from the injection pumps.
- Set accelerator lever to full speed.

Adjustment

Fig. 50

Note!

Always commence adjustments at No. 1 cylinder (timing gear end).

Remove the pump delivery valve (50/1) for No. 1 cylinder and fit special spill tool 74 64 1 333 535 (51/1) in its place.

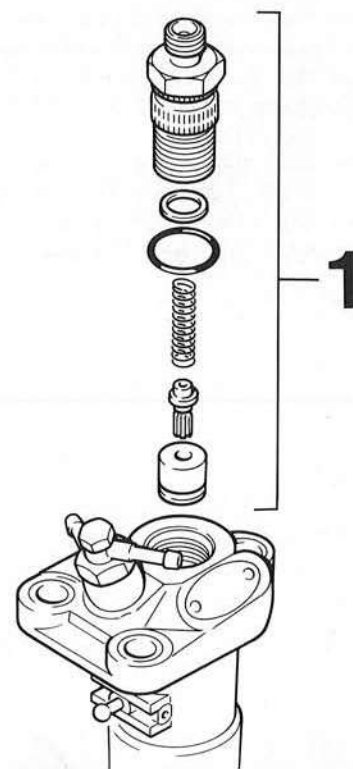
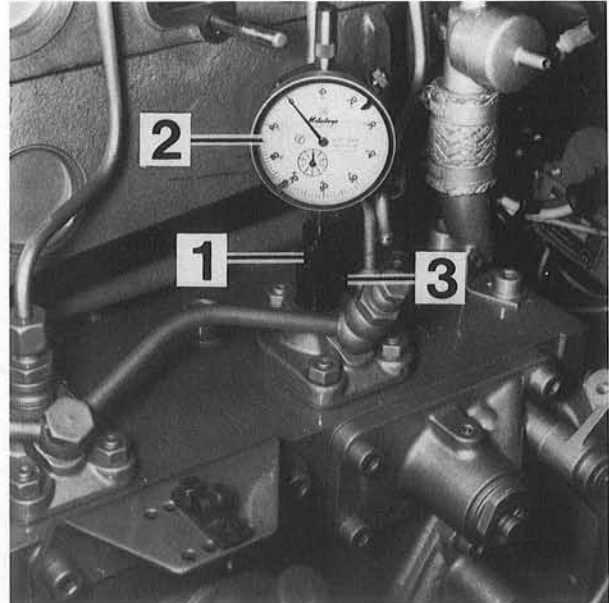


Fig. 51

Fit the extension pin of the spill tool into dial indicator 74 64 1 333 546 (51/2) and then place the indicator in position in the spill tool. Connect a reservoir with diesel fuel to the feed line for the injection pumps and fix the reservoir at least 200 mm above the injection pumps. Turn the crankshaft until the piston of No. 1 cylinder is 20° BTDC on the compression stroke. Open the cock of the fuel reservoir. Fuel should now flow out of the spill tool (51/3). Now turn the engine slowly counter-clockwise (viewed from the flywheel end) until the fuel drips slowly (1 drip in 5 seconds). This is the point when injection starts.



51

Fig. 52

At this point, compare the flywheel markings with the marking in the clutch housing (52/1). (The complete flywheel markings can be seen from Fig. 53).

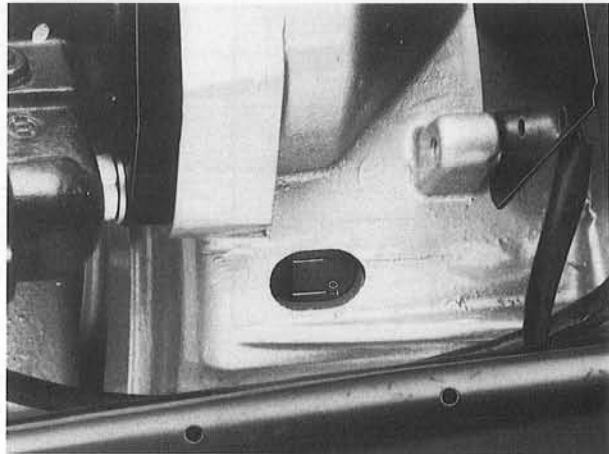
If required, the start of injection is adjusted as follows:

Start of injection too late: remove shims at the injection pump.

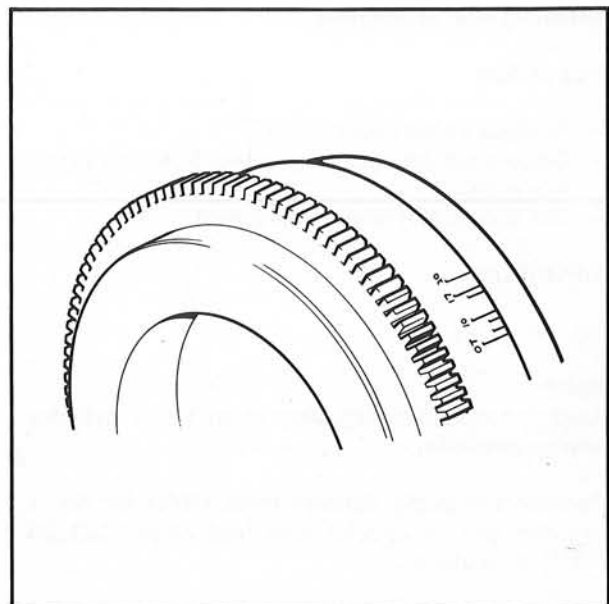
Start of injection too early: add shims at the injection pump.

The following procedure is adopted to establish the change which is required:

- Set the dial indicator to „0“ where injection actually starts.
- Turn the flywheel until the 17° marking is opposite the clutch housing marking.
- The required change in the thickness of the shims can now be read off directly from the dial indicator.
- After the shims have been changed, the start of injection should be checked once again.
- The other injection pumps are checked and adjusted in the same way.



52



Adjusting effective stroke

Preparation

- Remove intake cover, 13.75.
- Remove fuel pressure pipe of No. 1 injection pump (timing gear end).
- Remove the delivery valve of this injection pump (50/1).

Adjustment

Fig. 54

Screw in spill tool 74 64 1 333 535 (54/1) and fit extension pin into the dial indicator (54/2).

Remove the plug of the automatic cold start and replace it by blocking tool 74 64 1 333 565 (54/3).

Note!

Manually actuate the automatic engine stop (55/1) to bring the governor rod to the engine stop position.

Set the accelerator lever to full speed.

Turn flywheel to the point where fuel injection starts (fuel drips slowly from the spill tool (54/4) at a rate of 1 drip every 5 seconds). (This should happen at 17° BTDC).

Set the dial indicator to "0".

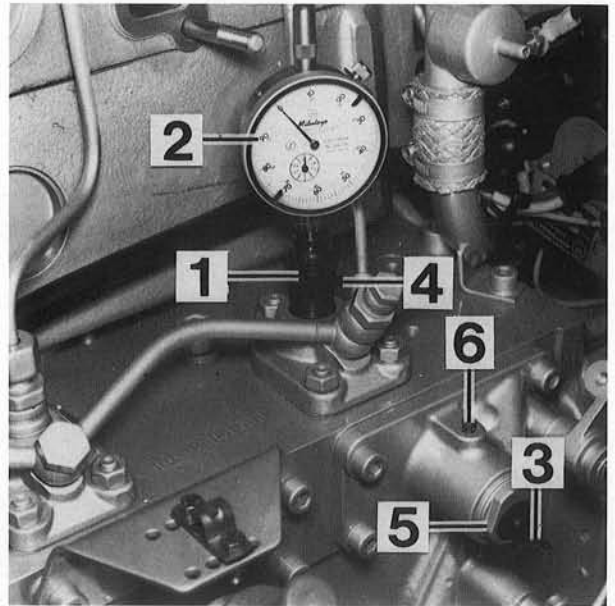
Turn the flywheel counter-clockwise (viewed from the flywheel end), until the dial indicator shows 1.14 mm.

In this position, the fuel must start dripping again (1 drip every 5 seconds).

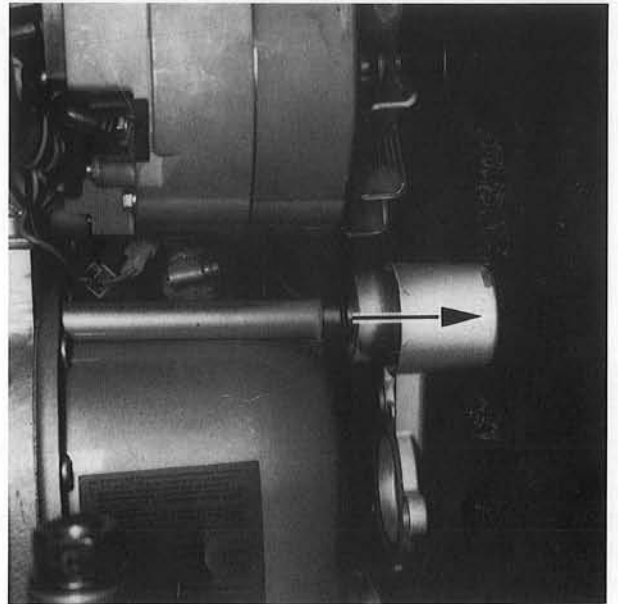
If it does not, the eccentric (54/5) should be turned until the fuel starts dripping.

Lock the eccentric in this position with the grub screw (54/6) and secure the grub screw with a drop of Loctite 221.

Remove the tools and refit the previously removed parts.



54



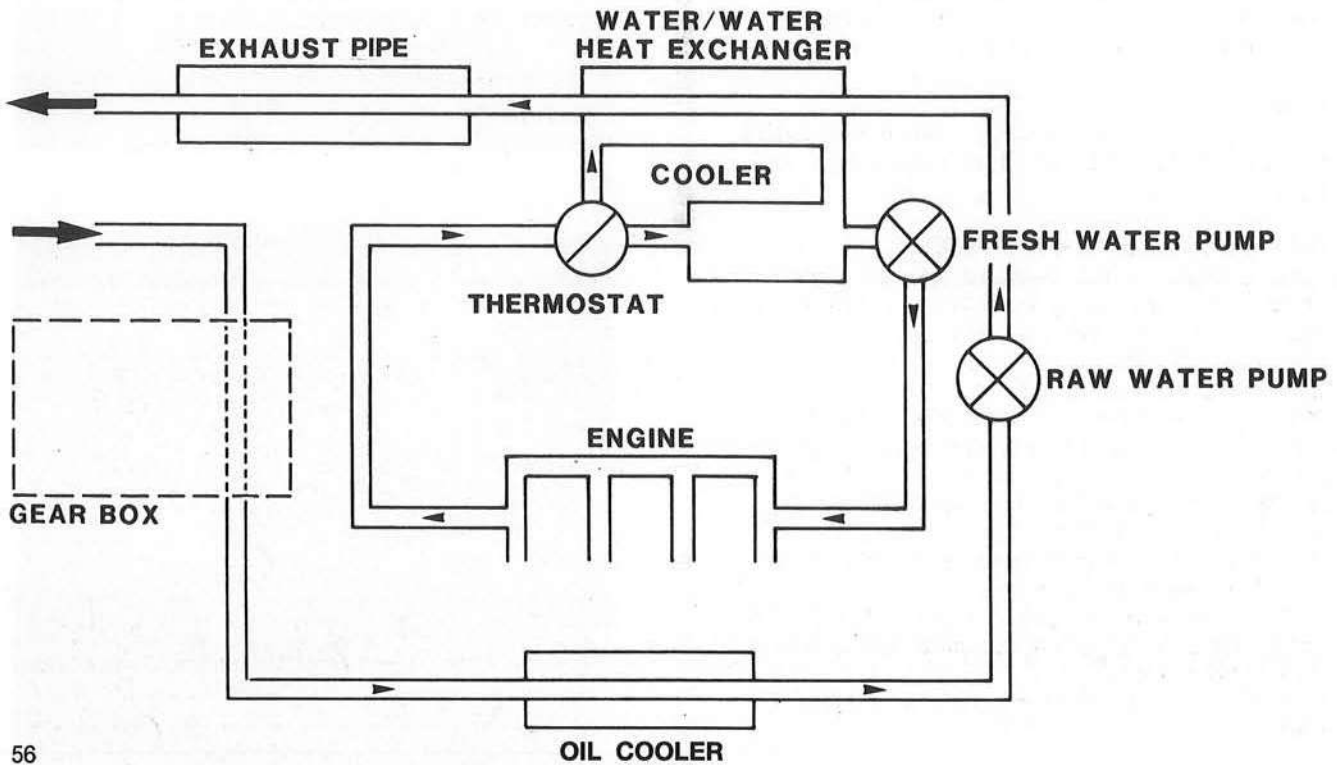
55

DUAL-CIRCUIT COOLING SYSTEM

17.00

The engine has a dual-circuit cooling system of compact design, in which the cooler, the fresh-water circulating pump, the thermostat and the exhaust gas collector are integrated in one housing.

The fresh-water circulating pump is driven by the V-belt. It can be replaced only as a complete unit. The raw water pump is an impeller pump with a neoprene impeller and is driven off the camshaft. The pick-up for the coolant temperature gauge is sited at the junction between cylinder head and cooling-water tank.



56

Cooling circuit

Fresh water flows from the water pump, through the engine block and, via the cylinder head, into the cooling water tank. From there it flows either, when water temperature is above 80° C, via the water heat exchanger and the opened thermostat or, when water temperature is below 80° C, directly via the thermostat to the water pump and circulates from there back into the inner cooling circuit.

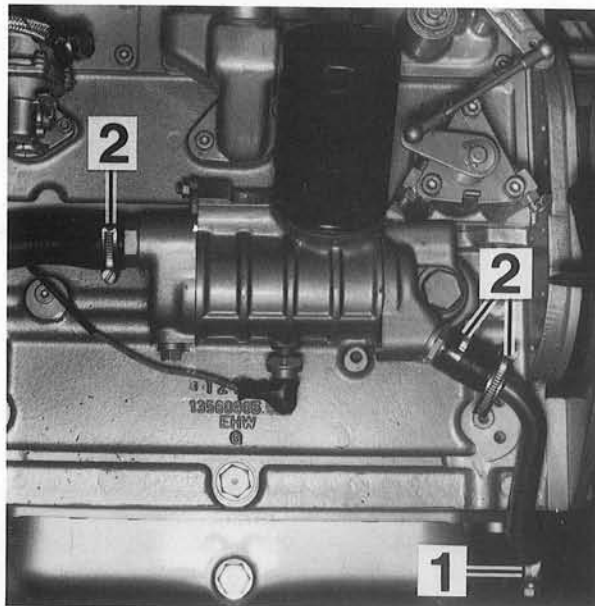
The raw water circuit begins with the raw water inlet, passes on — depending on the gearbox — via the gearbox oil cooling system and through the engine oil cooler to the raw water pump, flows through the water/water heat exchanger and ends up in the collector pipe, from where the water goes overboard with the exhaust gas.

REMOVAL AND INSTALLATION OF DUAL-CIRCUIT COOLING SYSTEM

Removal of dual-circuit cooling system

Fig. 58

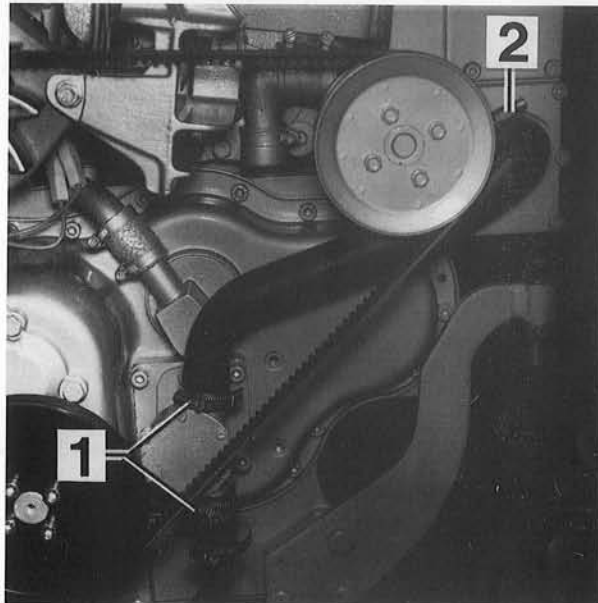
Unfasten drain plug (58/1) and drain raw water. Undo hose clamps (58/2) at oil cooler and gear-box (only in the case of ZF gearbox) and pull off hoses.



58

Fig. 59

Undo hose clamps at the raw water pump (59/1) and at the cooler (59/2) and pull off hoses. Slacken off the alternator fastening bolts. Lower the alternator and remove the V-belt, see „Removal of alternator“.



59

Fig. 60

Open cooler cap. Unscrew drain plug (60/1) in heat-exchanger cover and collect fresh water in a container made ready for this purpose. Pull plugs (60/2) out of engine temperature pick-up. Undo hose clamp (60/3) on heat exchanger and self-locking nut on exhaust flange and remove elbow pipe (60/5) from heat-exchanger cover.

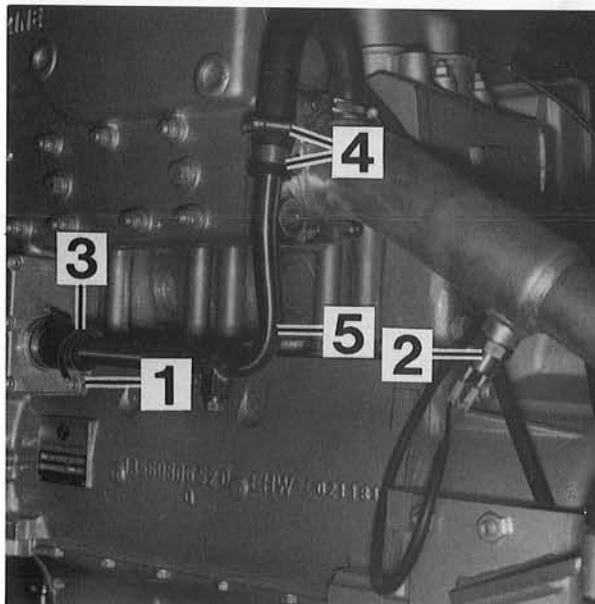
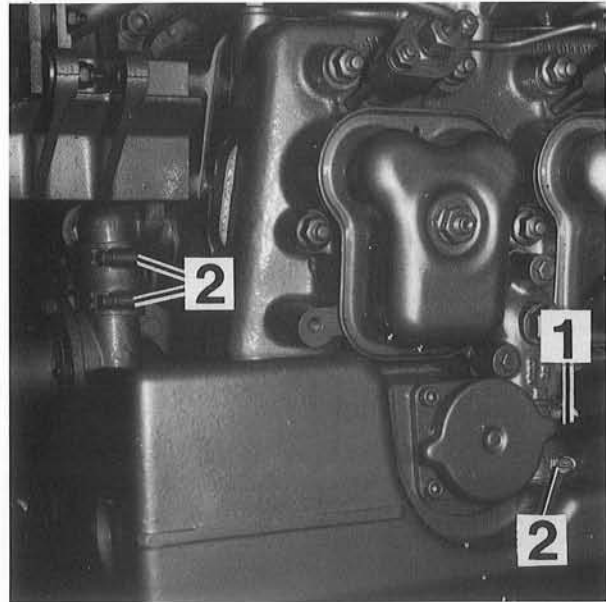


Fig. 61

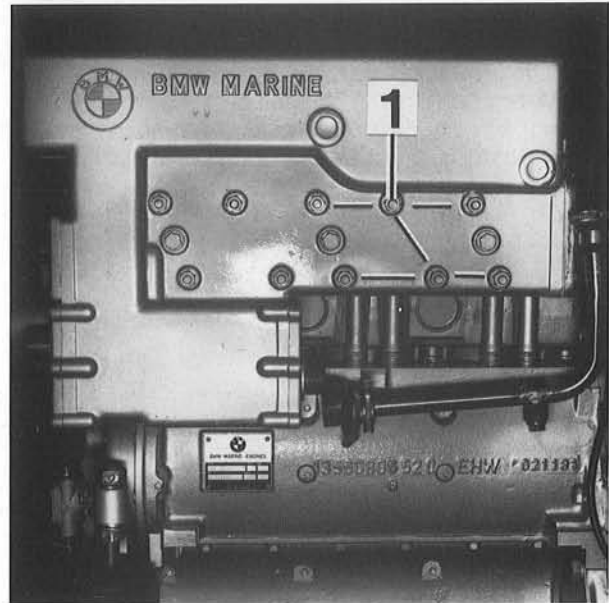
Remove exhaust steam hose (61/1) and unfasten hose clamps of the two connecting hoses (61/2).



61

Fig. 62

Unscrew the six or ten self-locking nuts (62/1) and carefully take the cooler with seal off the engine. Close up the exhaust gas openings at the cylinder head.



62

Installation of dual-circuit cooling system

Fig. 63

Clean sealing faces on the cooler and on the cylinder head. Place new gasket (63/1) on stay bolts of cylinder block.

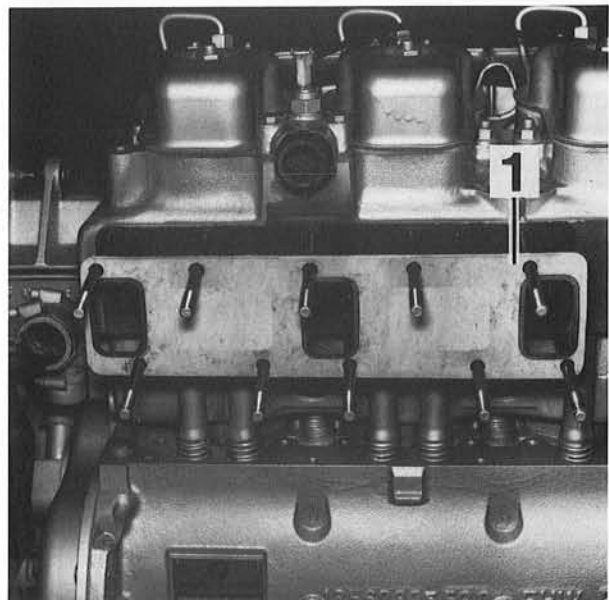


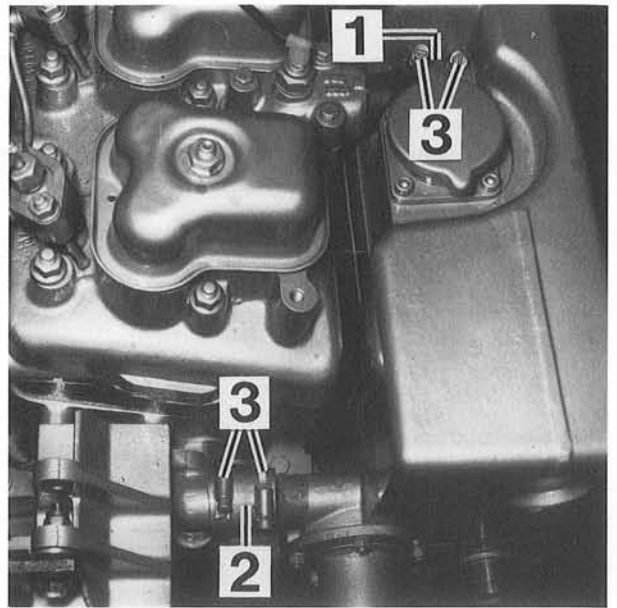
Fig. 64

Place cooler on the stay bolts and push so far in the direction of the cylinder head until the two connecting hoses (64/1, 2) can be pushed on to the stub pipes.

Press the cooler against the cylinder block and fasten uniformly tight by means of the six or ten self-locking nuts.

Tighten the hose clamps (64/3) of the two connecting hoses.

Attach the exhaust steam hose.



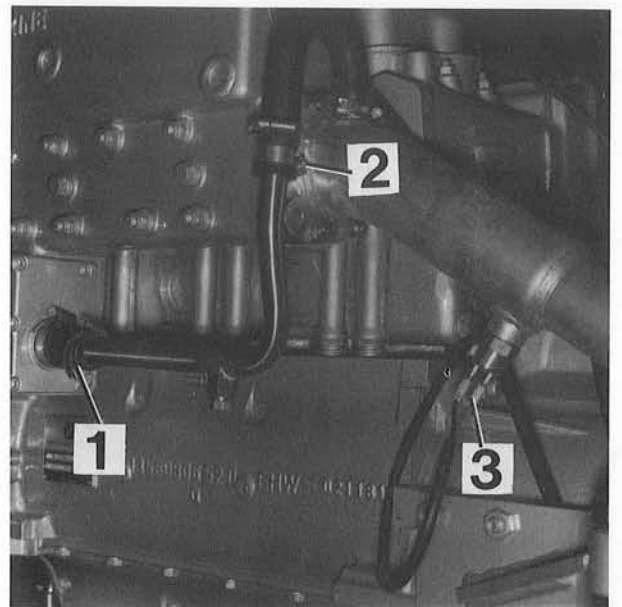
64

Fig. 65

Push hose on the heat-exchanger stub pipe and tighten the hose clamp (65/1).

Fasten elbow pipe to exhaust flange with self-locking nut (65/2).

Plug in the two plugs (65/3) into the engine temperature pick-up.



65

Fig. 66

Push hose clamps on to raw water hose (66/1) and fix hose between raw water pump and heat exchanger. Push elbow pipe (66/2) on to the lower hose stub pipe. Tighten hose clamps (66/3).

Place V-belt in position and tension it, see „Installation of alternator“.

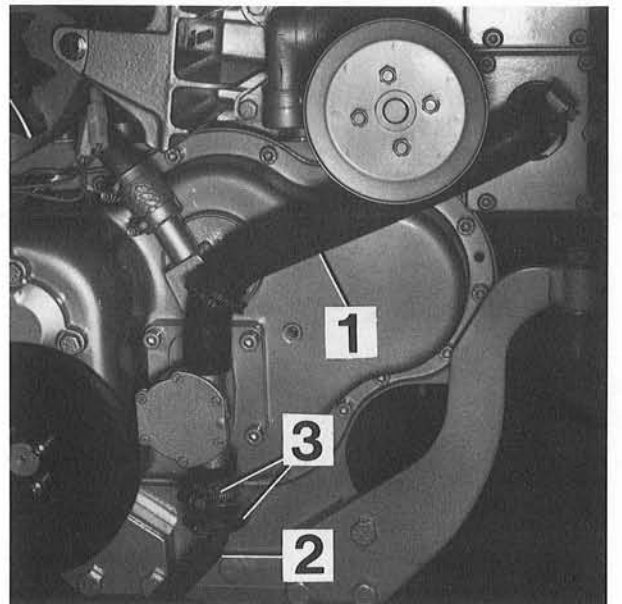
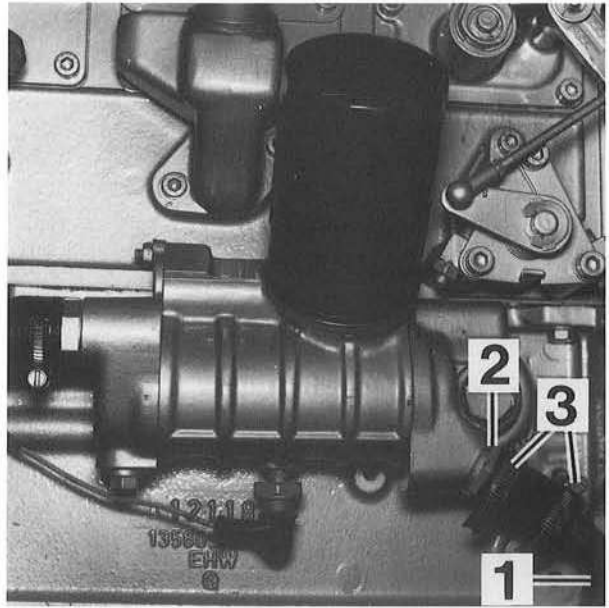


Fig. 67

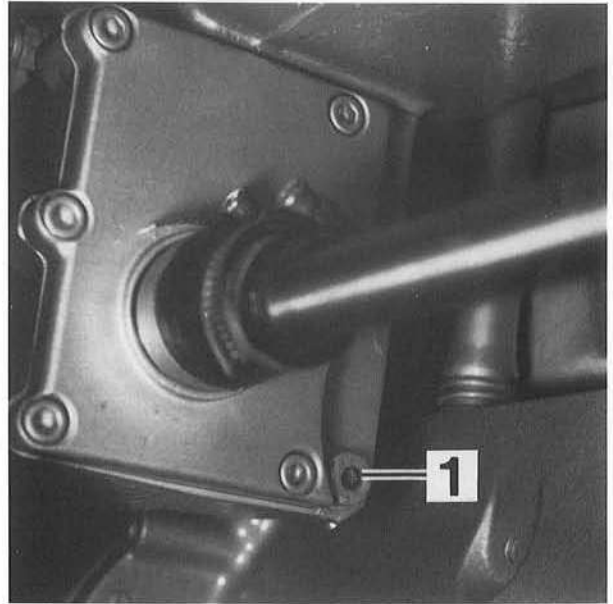
Push the lower end of the elbow pipe (67/1) on to the stub pipe of the oil cooler (67/2) and tighten the hose clamp (67/3).
Fit the raw water hose (67/4) between gearbox (only ZF gearbox) and oil heat exchanger and tighten hose clamps (67/5).
Screw drain plug with copper ring (67/6) into the elbow pipe.



67

Fig. 68

Screw water drain plug (68/1) into the cooler.
Fill in coolant.
For capacity, see „Technical data“.



68

STRIPPING AND ASSEMBLY OF DUAL-CIRCUIT COOLING SYSTEM

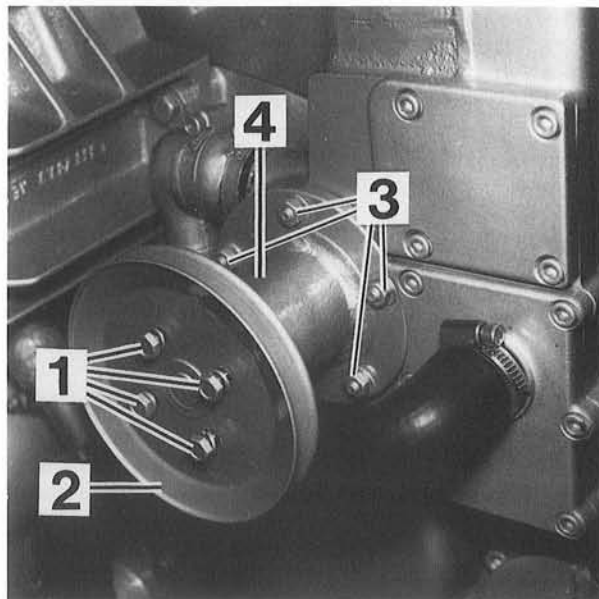
Removal of water pump

Fig. 69

Take off V-belt, see „Removal of dual-circuit cooling system“.

Drain fresh water, see „Removal of dual-circuit cooling system“, unscrew the four fastening bolts (69/1) and take off the belt pulley (69/2).

Undo the five retaining nuts (69/3) and take the pump (69/4) out of the housing. The water pump can be exchanged only as a complete unit.



69

Installation of water pump

Fig. 70

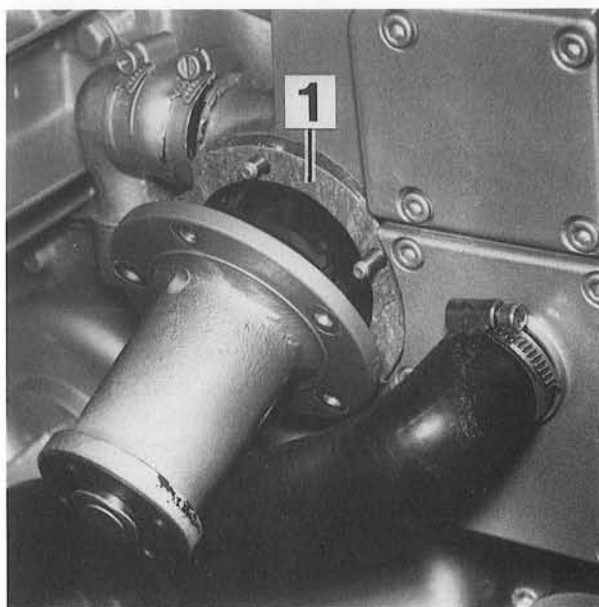
Clean water pump seat and flange of old bits of seal left on them.

Put on a new seal (70/1).

Place the water pump on its seat and fasten tight with the five hexagon nuts (see top photo).

Attach belt pulley and fasten with the four bolts (see top photo). Place V-belt in position and tension it.

Fill in fresh water, see „Installation of dual-circuit cooling system“.



70

Exchange thermostat

Fig. 71

Drain fresh water, see „Removal of dual-circuit cooling system“.

Unscrew the four Allen screws (71/1) and take off cover (71/2) together with the seal. Remove bits of seal left on the cover and housing.

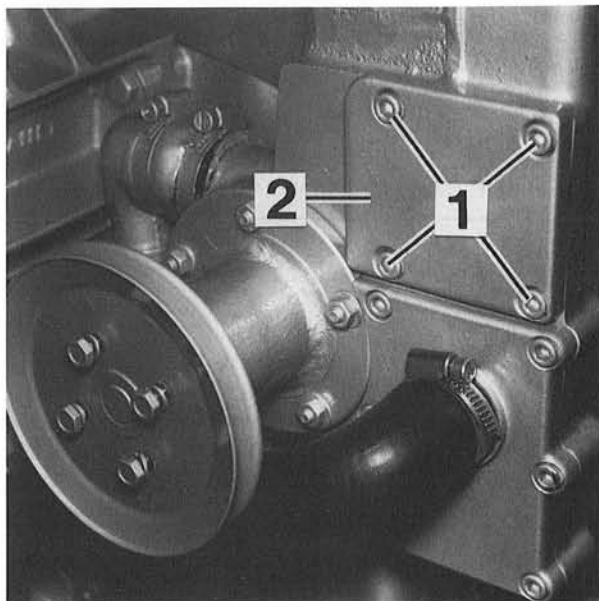


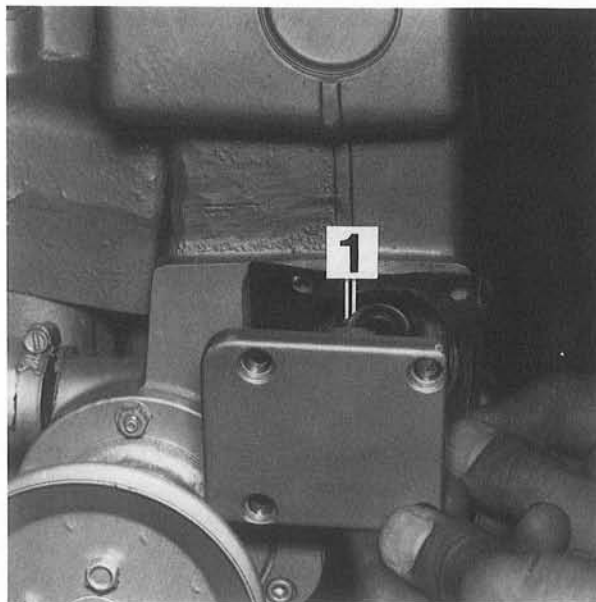
Fig. 72

Take out thermostat (72/1) and install new thermostat together with a new O-ring. Pay attention that they are properly seated.

Place new seal on thermostat housing.

Place cover in position and screw it tight with the four Allen screws.

Fill in fresh water, see „Installation of dual-circuit cooling system“.



72

Removal of heat exchanger.

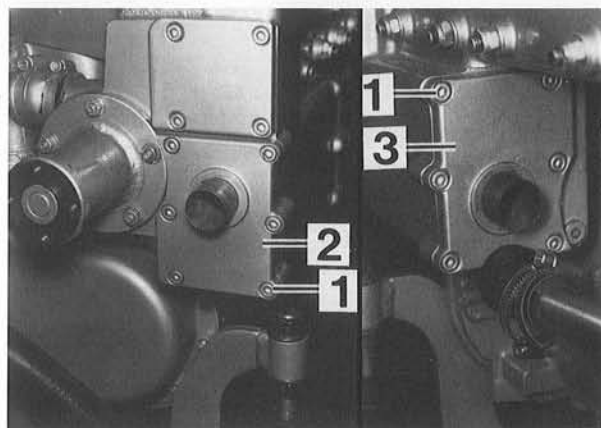
Fig. 73

Take off V-belt, see „Removal of dual-circuit cooling system“, unscrew the four fastening bolts and remove the pulley of the water pump.

Drain the fresh water.

Remove the raw water hoses on both sides of the heat-exchanger housing, see „Removal of dual-circuit cooling system“.

Unscrew the Allen screws (73/1), six in each case, from the front and rear cover (73/2, 3) of the heat-exchanger housing and remove the covers from the housing. Take out the heat exchanger. Remove bits of seal left on the covers and on the housing.



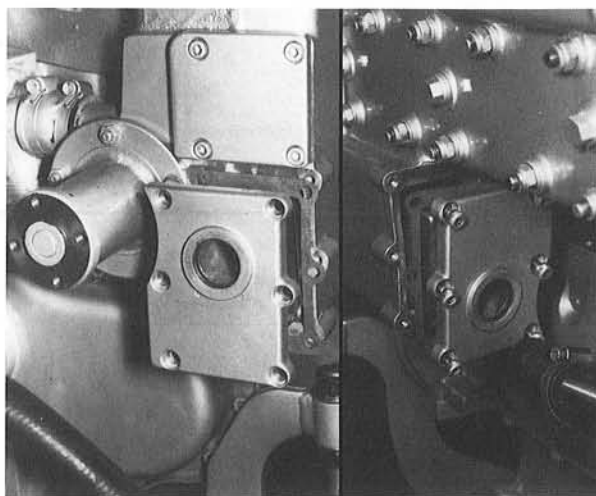
73

Installation of heat exchanger

Fig. 74

Prior to installation, clean the heat exchanger and the heat-exchanger housing. Install the heat exchanger. Place new O-ring in each of the covers. Mount new seals on both sides of the housing. Place covers in position and screw tight with six Allen screws in each case. Fasten the raw water hoses on both sides of the heat exchanger housing. Fill in fresh water, see „Installation of dual-circuit cooling system“.

Install the belt pulley and fasten with four bolts. Place the V-belt in position and tension it, see „Installation of alternator“.



74

RAW WATER PUMP

17.11

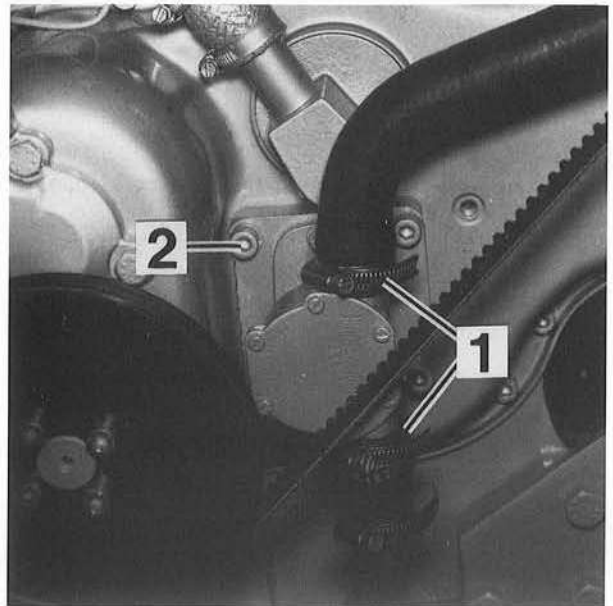
Removal

Fig. 75

Unfasten hose clamps (75/1) and detach hoses from the pump.

Remove the screws (75/2) together with their spring washers.

Pull out the raw water pump. Exchange O-ring.



75

Stripping

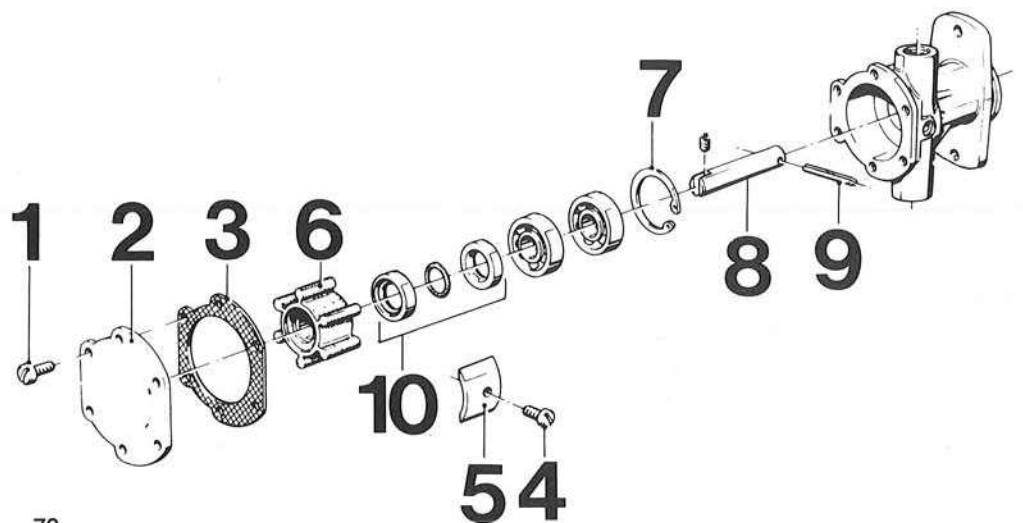
Fig. 76

Unscrew the screws (76/1) and remove cover (76/2) and seal (76/3).

Unscrew the screw (76/4) and withdraw the impeller (76/6) and comb (76/5).

Extract circlip (76/7) and tap shaft (76/8), complete with bearings and clamping sleeve (76/9), out of pump housing.

Push out seals and O-ring (76/16).

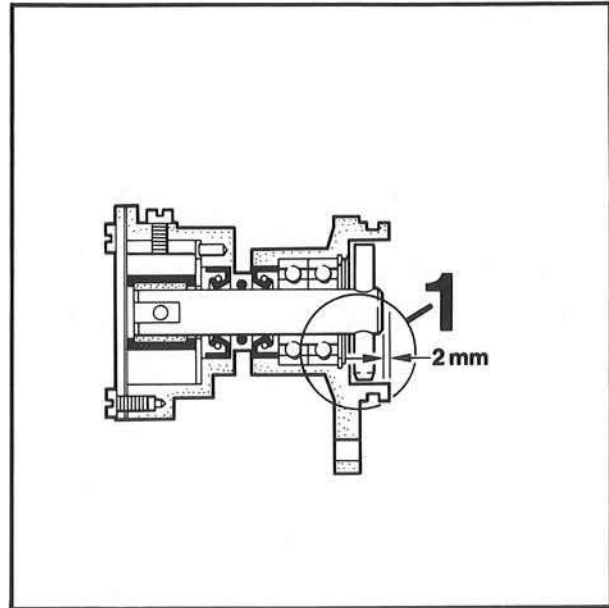


76

Notes for assembly

Fig. 77

Pack bearings with grease.
Exchange seals and O-ring.
Press bearings on to shaft. Note distance of bearings from end of shaft (approx. 12 mm).
Note distance of rear end of shaft to pump housing (see 77/1).



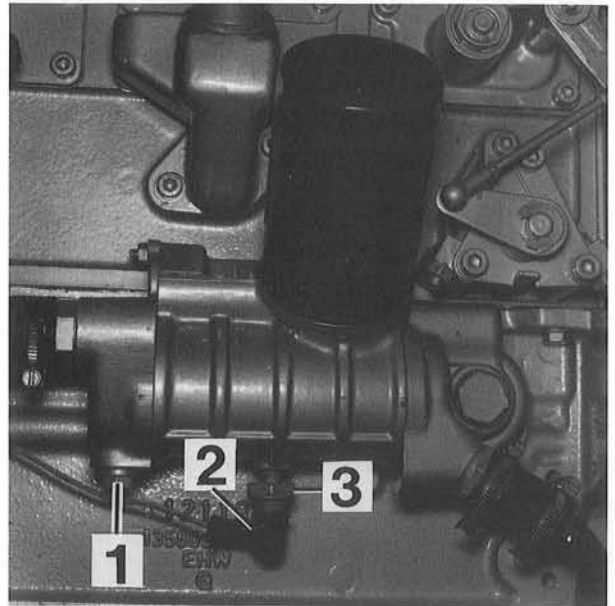
OIL COOLER**Removal**

Fig. 78

Remove raw water hoses on both sides of the oil cooler, see „Removal of dual-circuit cooling system“.

Unscrew drain plug (78/1) and drain remaining water from heat exchanger.

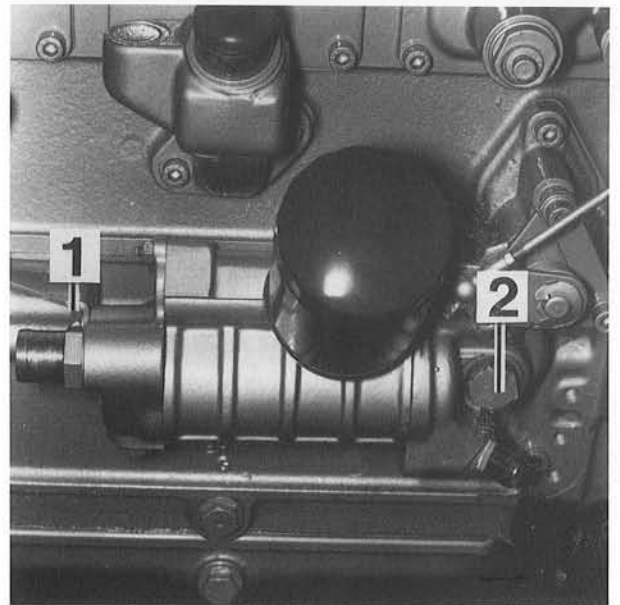
Detach electrical lead (78/2) from the oil pressure pick-up (78/3). Screw out the oil pressure pick-up and drain the oil from the oil cooler and oil filter.



78

Fig. 79

First unscrew the holding bolt (79/1), then the banjo bolt (79/2), and remove the oil cooler from the engine block.



79

Installation

Fig. 80

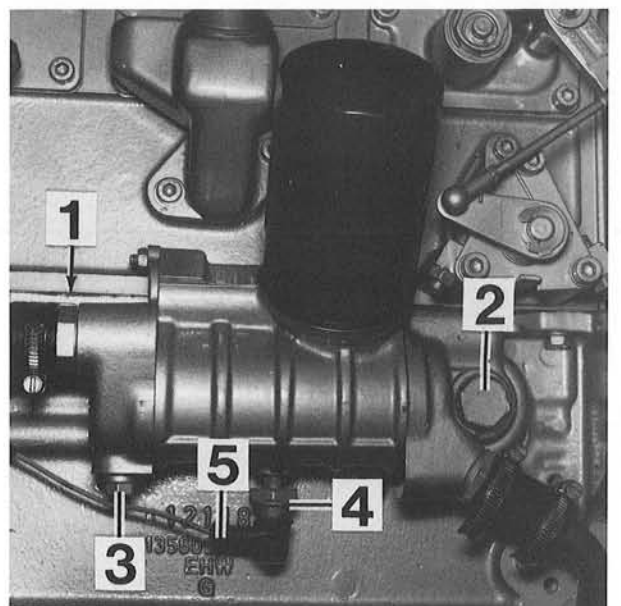
Place new O-ring in angle flange (on engine side). Apply the oil cooler to the engine block and bolt on to the angle bracket finger-tight by means of the holding bolt and spring washer (80/1). Provide the banjo bolt with a copper seal and screw in place. Tighten the holding bolt.

Screw in the drain plug (80/3) and the oil pressure pick-up (80/4).

Refill with oil.

Connect up the electrical lead to the oil pressure pick-up (80/5).

Install the raw water hoses on both sides of the oil cooler, see „Installation of dual-circuit cooling system“.

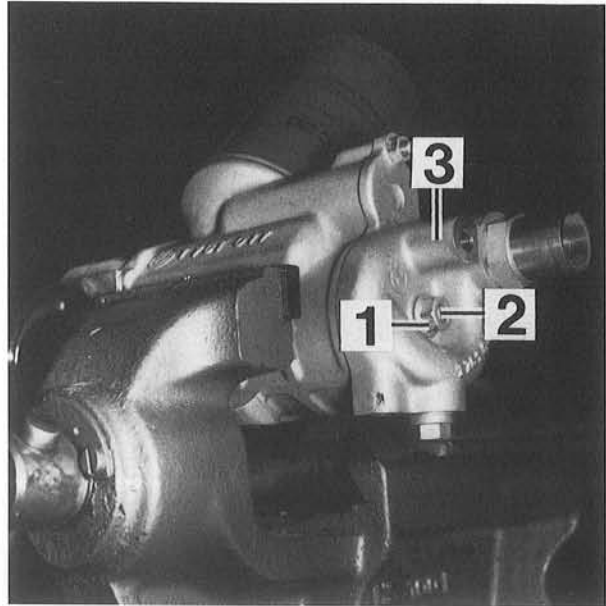


80

Stripping

Fig. 81

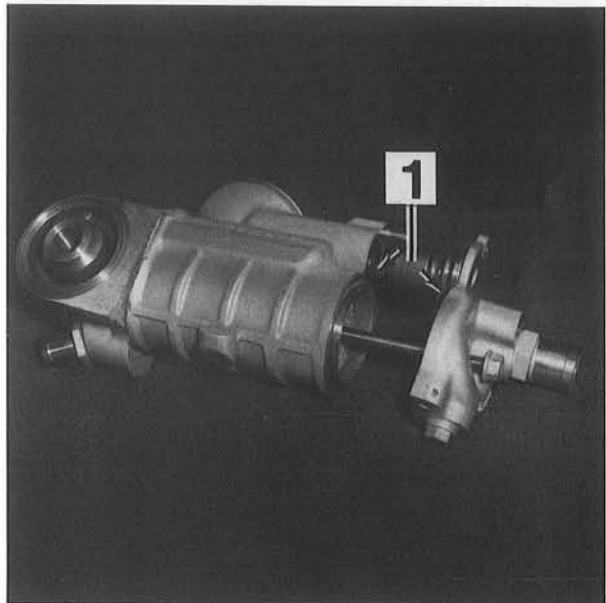
Clamp the oil cooler in a vise, using aluminium grips.
Unscrew the hexagon nut (81/1) and stud (81/2)
and remove the cover (81/3).



81

Fig. 82

Remove the thermostat cover, thermostat and
spring (82/1) from the thermostat housing.
Remove the O-ring.



82

Fig. 83

Loosen the angle flange with a plastic hammer
and pull it off.

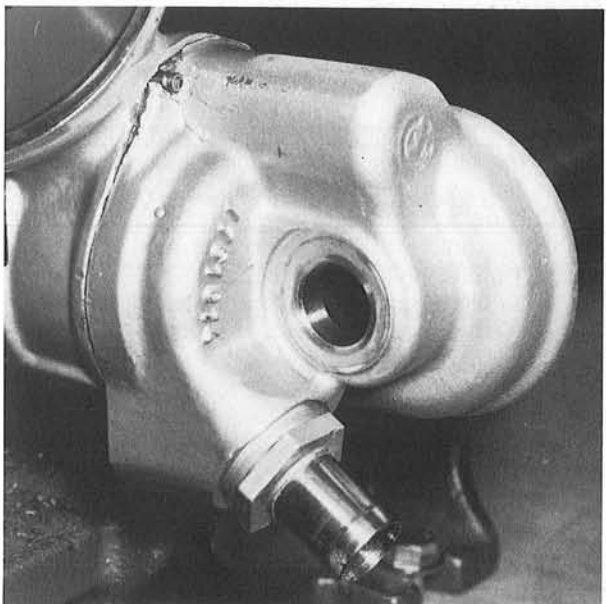


Fig. 84

Extract the heat exchanger and clean it thoroughly.

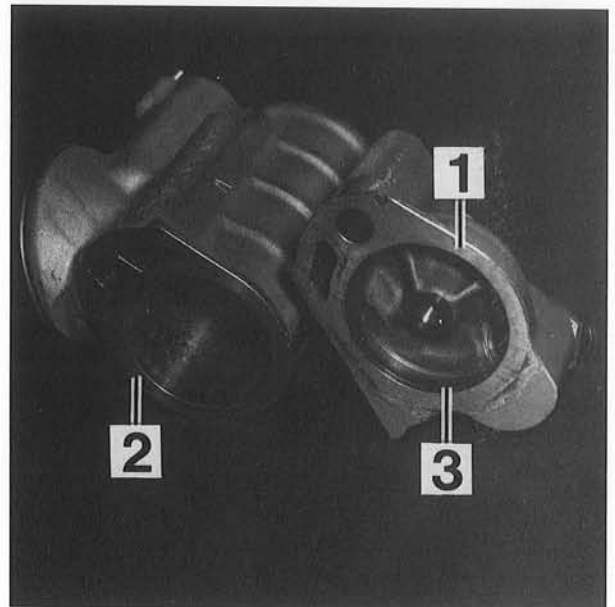


84

Assembly

Fig. 85

Install the heat exchanger in the housing.
Apply a liquid seal to the sealing faces of the angle flange (85/1) and of the housing (85/2).
Install a new O-ring (85/3).



85

Fig. 86

Align groove in angle flange on spring dowel and place angle flange on the housing.

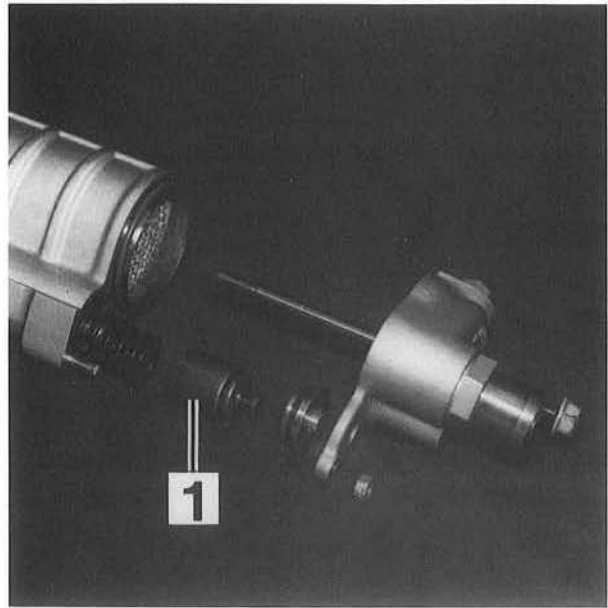


86

85

Fig. 87

Install new thermostat in housing (87/1). Fit new O-ring and fasten cover with stud and hexagon nut.



87

REVERSING GEAR

27.63

Removal

Fig. 88

Remove the starter, 12.41.

Remove the holder for attached electricals (88/1) by undoing the two nuts (13 mm).

Remove the rear starboard engine bracket (88/2) (17 mm).

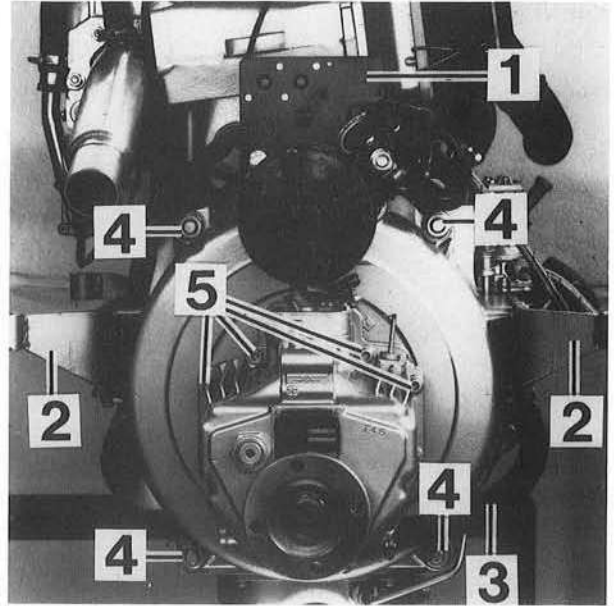
Detach the cooling water hose from the reversing gear (88/3).

Remove the four nuts (22 mm) (88/4) securing the clutch housing and pull it out complete with the reversing gear.

Separate the reversing gear from the clutch housing by unscrewing the six screws (17 mm) (88/5).

Repair

Repair of the reversing gear is described in a separate manual. Authorized dealers can also be entrusted with repair work.

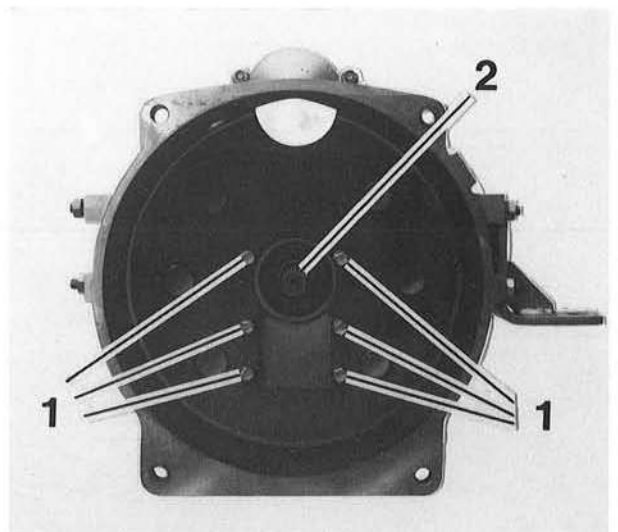


88

Notes on assembly

Fig. 89

Grease the shaft splines with water-resistant grease (89/1).



89

VIBRATION DAMPER

21.21

Preparation

- Remove starter, 12.41.
- Remove reversing gear/clutch housing, 27.63.

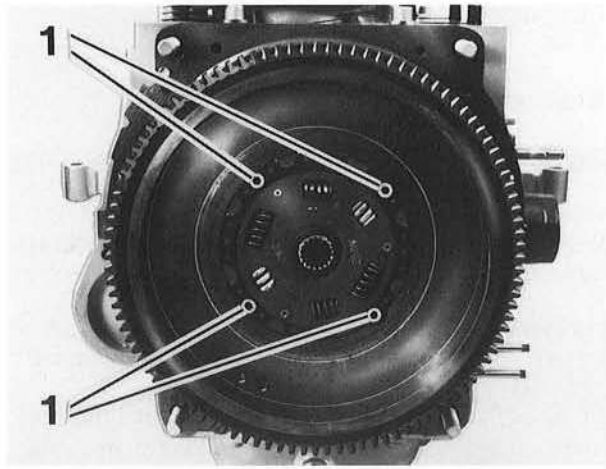
Removal

Fig. 90

Unscrew the six Allen screws (90/1) (6 mm) and take out the vibration damper.

Check

Check the springs for cracks. Check also the absorption plate between the springs for cracks.



90

CYLINDER HEAD, VALVES, ROCKER ARMS AND PUSH RODS

11.12

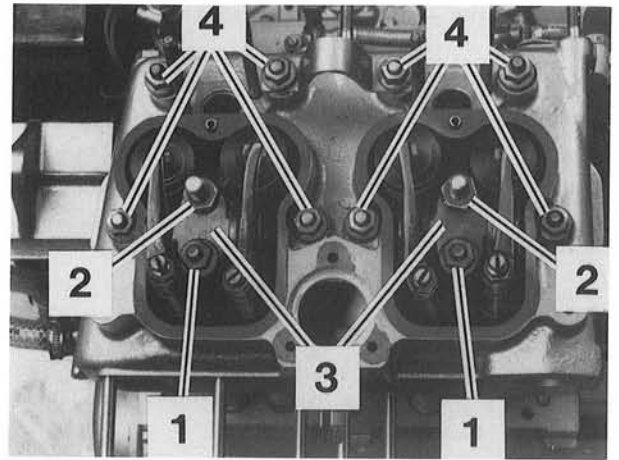
Preparation

- Remove thermostat, 17.11.
- Remove the rocker covers.
- Remove the injectors, 13.53.
- Remove the cooler, 11.62.
- Remove the water temperature pick-up.
- Remove the air filter, 13.75.

Removal

Fig. 91

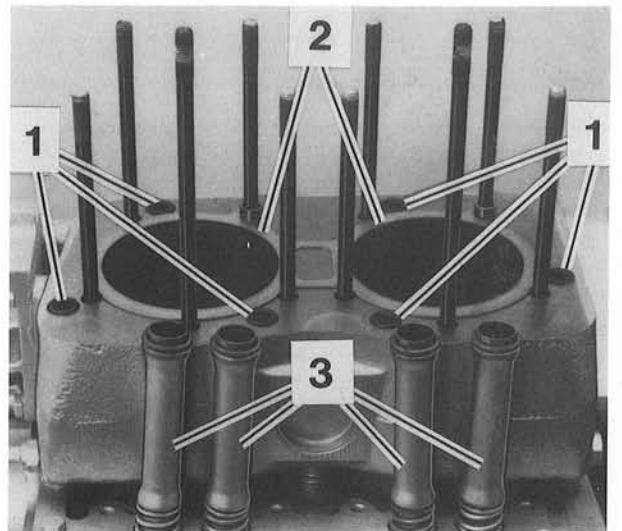
Undo the nuts (91/1) (14 mm).
 Remove the nuts (91/2) (17 mm) securing the rocker arm supports (91/3) and lift out the latter.
 Pull out the push rods and mark them so that they can be re-installed in their original position.
 Remove the nuts (91/4) and lift off the cylinder head.



91

Fig. 92

Remove O-rings (92/1) at the water ports, the cylinder-head gasket (92/2) and the push rod tubes (92/3).



92

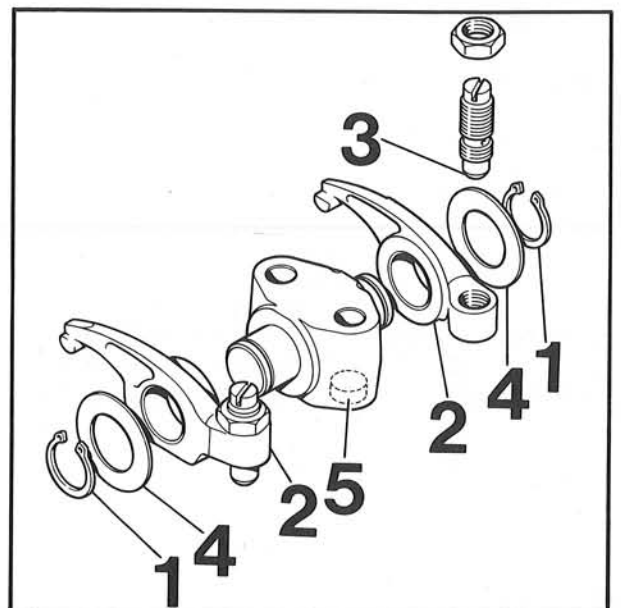
ROCKER ARM AND ROCKER ARM SUPPORT

Fig. 93

Remove circlip (93/1) and pull off the rocker arm (93/2).
 Check rocker arm shaft and bush for wear.
 Check the push-rod end of the adjusting screw (93/3) for wear. (Exchange if wear is present).
 On assembly, use shims (93/4) to set end float of rocker arm at 0.1 mm.

Attention!

The recess (93/5) on the underside of the rocker arm support must be on the push rod side.



93

Specifications — rocker arm and rocker arm support

	Specified dimension	Max. wear
Rocker arm shaft, mm	18.980—18.967	
Rocker arm bush (inside diameter, mm)	18.988—19.046	19.2
Radius at rocker arm, mm	8	Flat areas are not permissible

Push rods

Check push rods for wear at the ends and for straightness.

Clean push rods, in particular the oil duct.

Tappets

See Section „Camshaft“.

Valves

Fig. 94

Compress springs with suitable press and withdraw collets (94/1).

Remove upper spring plate (94/2), valve spring (94/3) and the lower spring plate (94/4).

Withdraw valves from cylinder head and mark sites for correct installation.

Check the valves for burned heads, cracks in heads and damaged valve stem.

Valves can be reground, providing the maximum permissible limit for sinking the valves is observed, see Fig. 95.

Note!

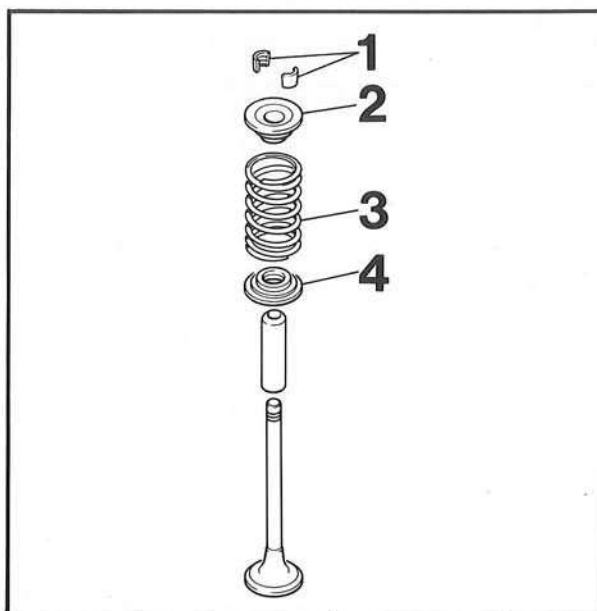
If the measured figure exceeds the specified one, valve or cylinder head, and both if necessary, must be exchanged.

If the figure read off is less than specified, the valve seat should be cut deeper into the cylinder head to guarantee enough clearance between piston and valve.

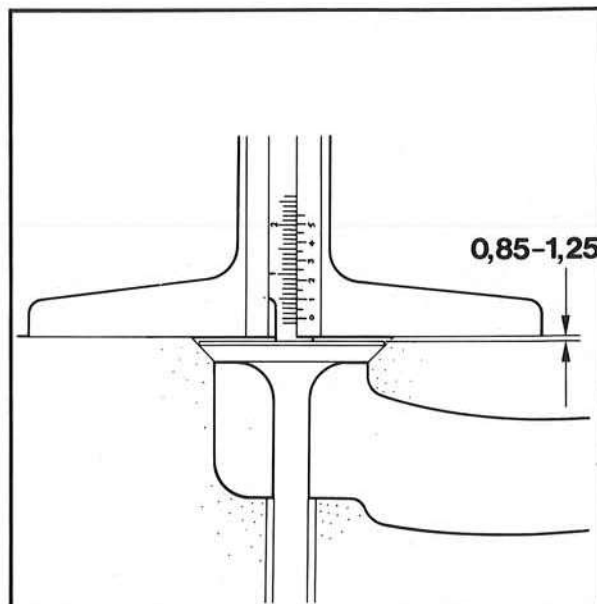
Specifications — valves

Valve clearance (cold engine; inlet and exhaust), see „Technical data“.

Valve stem diameter	inlet mm	8.94— 8.96
	exhaust mm	8.95— 8.97
Wear limit		
Min. diameter		
inlet and exhaust mm	8.90	
Valve head diameter	inlet mm	39.8 —40.1
	exhaust mm	34.8 —35.1
Valve sinkage	mm	0.85— 1.25



94



95

Valve guide

Fig. 96

Check valve guides for wear and replace, if necessary. The valve guides are pressed out and pressed in with the same tool.

Note!

When the valve guides are being pressed in, it must be watched that the force pressed in, must be more than 1000 N. If less force is required to install them, there is a risk of them becoming loose in operation.

Press in the valve guide, as shown in the illustration, until it protrudes 17 mm on the rocker arm side of the cylinder head.

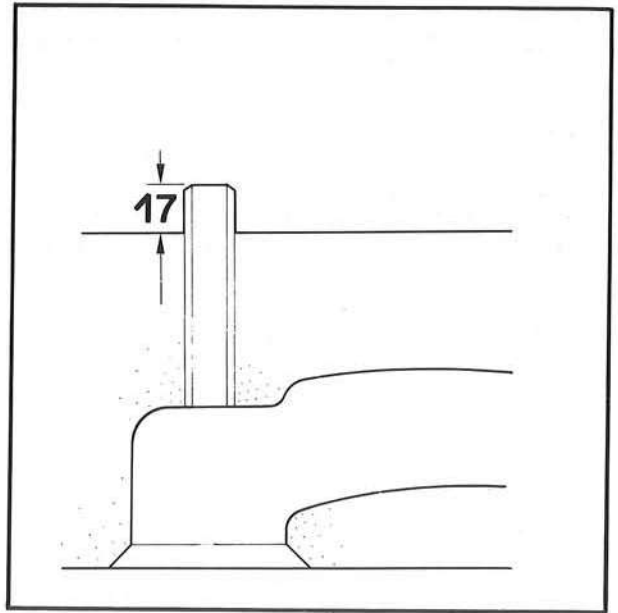
Then use a hand reamer to ream the valve guide to nominal diameter.

Specifications

Valve guide,	
OD mm	15.038—15.046
ID mm	9.000—9.009
Max. permissible ID (wear limit) mm	9.05
Minimum pressing-in force N	1000
Projecting length of valve guide (rocker arm side) mm	17.0

Note!

When a valve is exchanged, the valve seat must always be re-cut and ground in with the new valve. See also Section „Cylinder head“.



96

Cylinder head and valve seats

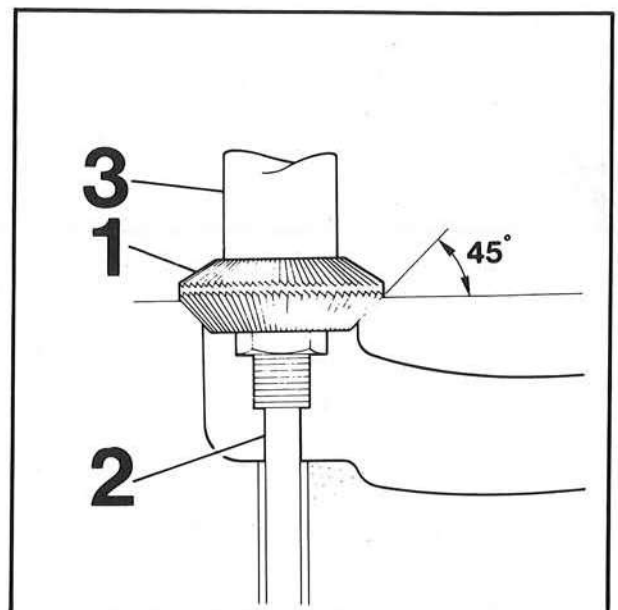
Fig. 97

Check the valve seats and cylinder head for cracks. If cracks are present, the cylinder head must be exchanged (valve seats are part of the cylinder head).

If valve seats are only slightly damaged, they can be re-cut with a valve cutter (97/1) in conjunction with guide pin (97/2) and holder (97/3).

After it has been re-cut, the valve seat should be lapped in together with the valve. For this purpose, a valve grinding tool and emery paste (grain size 180—250) are used.

The lapped-in valves must always be checked for leaks. For this purpose, install the cleaned valves and pour some diesel fuel into the inlet and exhaust port. The fuel must not seep through.



97

98

Important!

Always check the valve sinkage after grinding in (see Fig. 95).

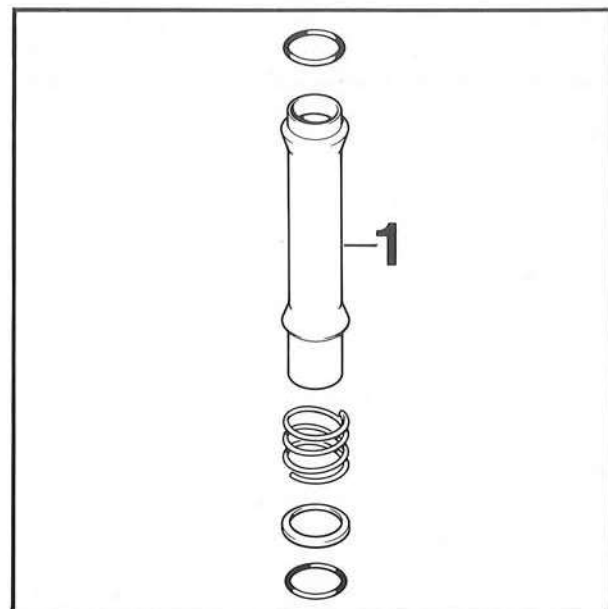
Specifications

Valve guide in cylinder head	dia. mm 15.000—15.018
Valve sinkage	mm 0.85 — 1.25

Notes for assembly

Fig. 98

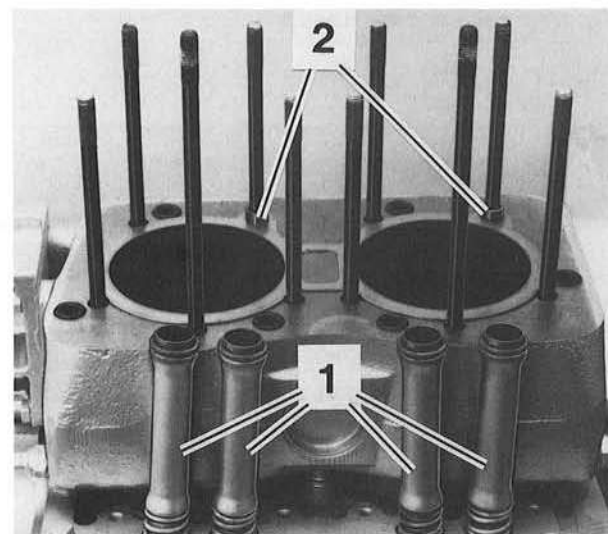
Pay attention that the rings at the bottom of the push rod tubes are in the correct position (98/1 and 99/1).



98

Fig. 99

Place the cylinder-head gasket in position so that it is around the cylinder clamping sleeves. (99/2).



99

Fig. 100

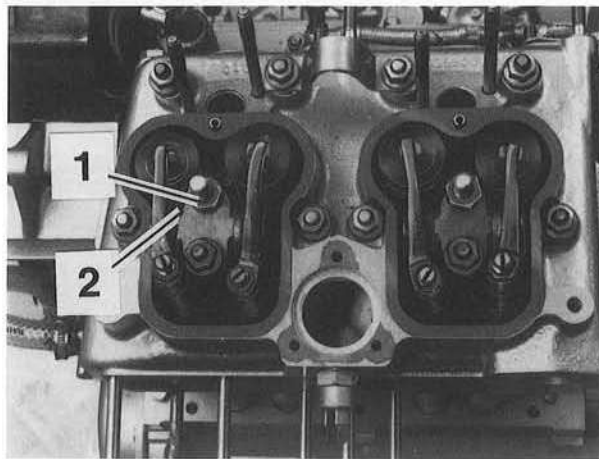
Before the rocker arm supports (100/2) are installed, apply a thin coat of Atmosit or similar sealing compound to their undersides.

Apply Loctite 221 to threads of the straight-through stay bolts and to the underside of the nuts (100/1).

Tighten the cylinder-head nuts to the correct tightening torque (55 Nm). *40 ft lbs*

Note:

The nuts for securing the rocker-arm covers are self-sealing with a nylon insert. Check the insert for cracks or damage and exchange the nuts, if necessary.



100

Tightening the cylinder-head nuts

Fig. 101

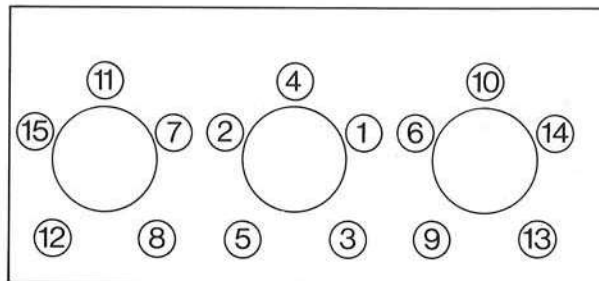
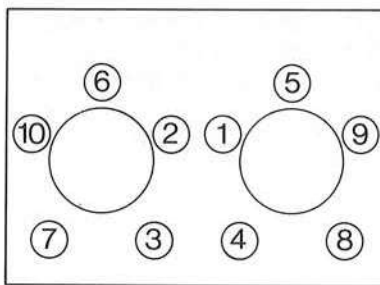
Tighten the nuts with a torque wrench by stages as shown in the sketches, as follows:

1st stage: tighten nuts by hand until they are fully up against the cylinder head (thread not lubricated).

2nd stage: tighten nuts with 1/2 x tightening torque.

3rd stage: tighten nuts with specified tightening torque.

The nuts are unfastened in the reverse sequence, i. e., from the two outer edges towards the centre.



101

CHECKING AND ADJUSTING VALVE CLEARANCE

Fig. 102

Attention:

Check and adjust valve clearance while the engine is cold.

- Unscrew hexagon nuts and remove rocker-arm covers.
- Bring No. 1 cylinder to TDC — compression stroke.
- The rocker arms of No. 2 cylinder are at overlap.
- Check valve clearance of the No. 1 cylinder with a feeler gauge.

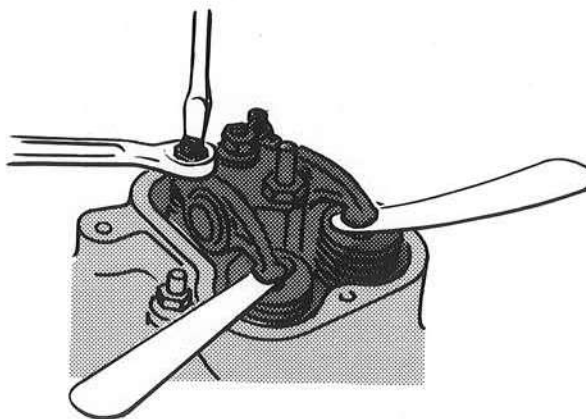
If the clearance is incorrect, adjust as follows:

- Slacken hexagon nut, introduce feeler gauge and set valve clearance by means of the adjusting screw. Tighten hexagon nut.

The valve clearance is correctly adjusted, if the feeler gauge can be pulled through with just perceptible resistance. The valves of the other cylinders are to be adjusted in the same way.

- Install rocker-arm covers with new gaskets and screw tight.
- After brief trial run, check whether the covers are leakproof against the cylinder.

See „Technical data“ for valve clearance and firing sequence.



102

D 35-2 cylinder at	TDC	1	2	
	overlap	2	1	
D 50-2 cylinder at	TDC	1	3	2
	overlap	2	1	3

103

CYLINDERS

11.11

Preparation

- Remove the cylinder head, 11.12.
- Remove the alternator holder.

Removal

Lift out the cylinders carefully without damaging the piston rings.

Remove the shims from the cylinder base.

Check

Check the cylinder wall for wear, i. e., for scores, ovality and conicity.

If there is wear, the cylinders can be rebored to oversize (see „Technical data“).

Notes for assembly

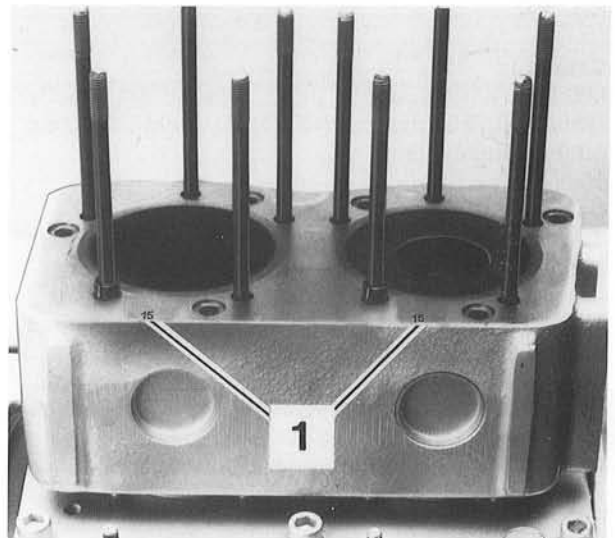
Fig. 104

As the cylinders are a separate unit from the crankcase, it is very important that shims of the correct thickness be fitted between cylinders and crankcase. The shims compensate for machining tolerances, i. e., provide for a correct distribution of the load and for the specified gap between cylinder head and piston.

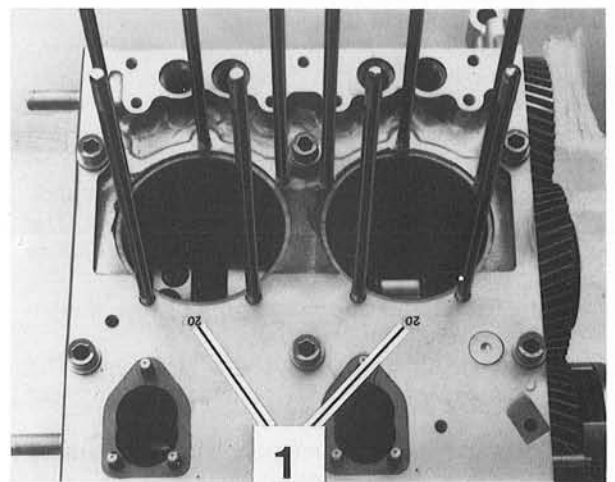
To make assembly easier, a number (dimension) is punched at the top of each cylinder (104/1) and on the crankcase (105/1). These two dimensions are added together to obtain the required thickness of shims in hundredths of a millimetre at the base of each cylinder.

Specifications

Bore	Standard mm	95.01
	Oversize mm	96.01
	Wear limit mm	95.15
Roughness	microns	1.0—1.2



104



105

PISTONS AND CONNECTING RODS

11.25 and 11.24

Preparation

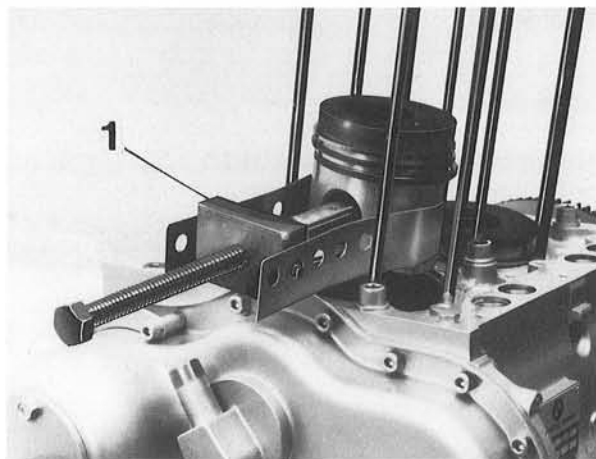
— Remove the cylinders (11.11).

Removal

Fig. 106

Remove the inner circlip securing the gudgeon pin.

Press out the gudgeon pin by thumb or, if it is difficult to move, use the gudgeon pin remover 74 64 1 333 552 (106/1).



106

Fig. 107

Caution!

Make sure the gudgeon pin is pressed out exactly in the centre of the tool (107/1), to avoid scratches on the gudgeon pin.

Caution!

Turn crankshaft carefully, so that the piston rings are not damaged (107/2).

Mark the pistons, so that they can be re-installed in their original position.

Bring the connecting rods to TDC prior to removal. Remove one of the connecting rod bolts and replace it by a tool.

Remove the second bolt and withdraw connecting rod followed by its bottom part.

Caution!

Care must be taken not to drop bearing shells and pins (108/1) into the crankcase.

Keep removed parts together in sets, so that they can be re-installed at the same site.

Check

Check piston rings for wear. Measure piston ring gap and renew piston rings, if necessary.

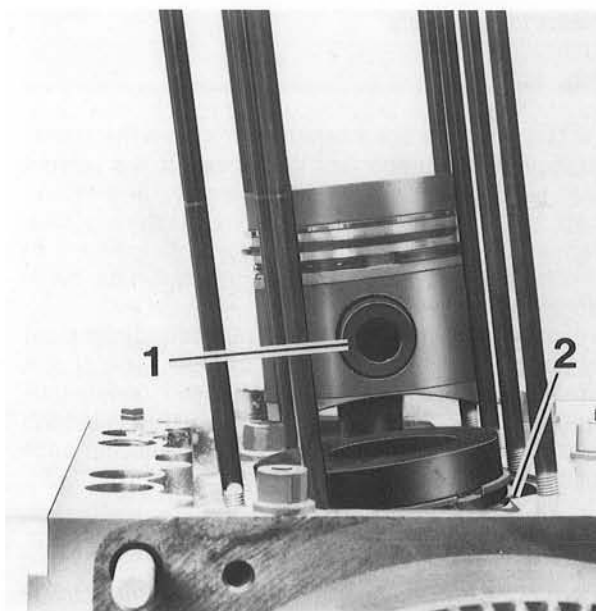
Check pistons for wear, scores and seizing marks. Check also the gudgeon-pin boss for wear. The gudgeon pin is a fully floating one and therefore it must have no radial clearance.

Measure small end and compare with the dimensions in the specifications.

Exchange small-end bush, if wear is found. The small-end eye should also be measured without bush.

Check that big-end and small-end eyes are parallel.

Check the big-end bearings for wear.



107

Notes for installation

Fig. 108

Check position of small-end bush. Its lubrication holes must be aligned with the connecting rod bores (108/2).

The notch in the bottom part of the connecting rod must face towards the injection pump side. The notch in the top part of the connecting rod (108/3) must face towards the valve tappet side.

Do not forget the two pins (108/1)!

Tighten the connecting rod bolts with a tightening torque of 60 Nm.

Install the pistons with the combustion chamber towards the injection pump camshaft.

Specifications

Connecting rod

Small end ID (without bush)	mm	35.000—35.016
Big end ID (without bearing)	mm	63.000—63.019
Small end bush OD	mm	35.045—35.085
Small end bush ID	mm	32.025—32.041

Piston

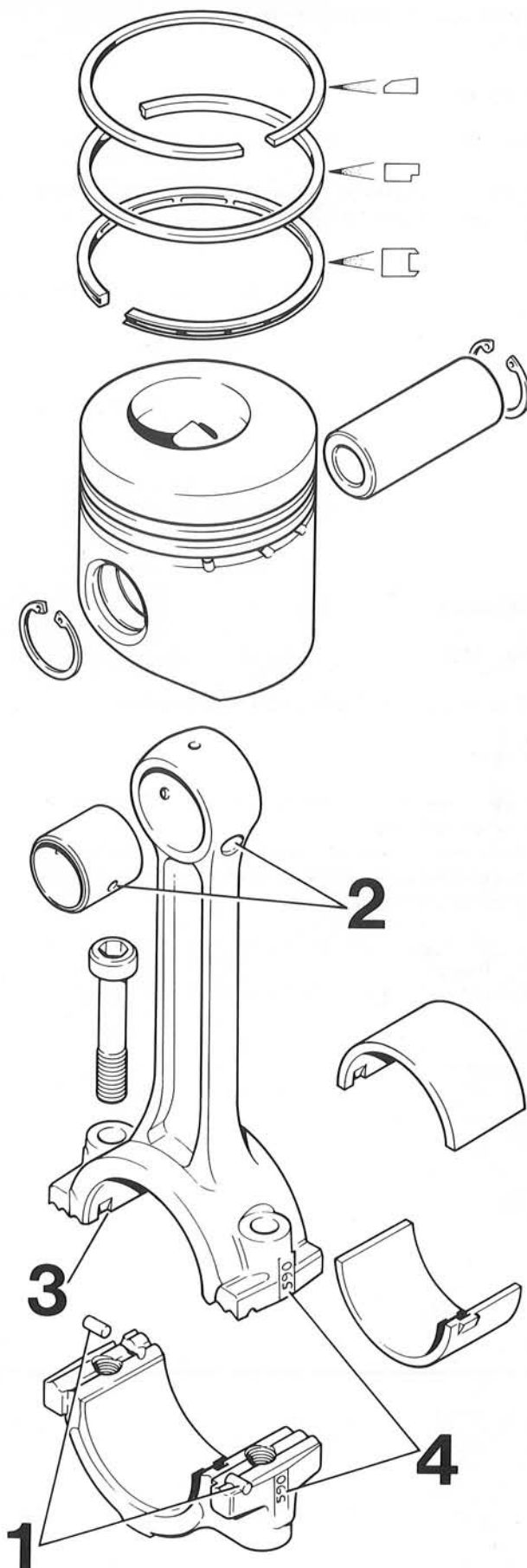
Piston diameter	Standard mm	94.94
	Oversize mm	95.94
Piston clearance	mm	0.06—0.07

Piston rings

Piston ring gap, normal, mm		
1st compression ring	0.40—0.65	
2nd compression ring	0.40—0.65	
Oil control ring	0.30—0.60	
Wear limit, mm		
1st and 2nd compression rings	1.0	

Big-end bearing

Inside diameter		
Standard (installed) mm	60.040—60.083	
Undersize (installed) mm	59.540—59.583	
Bearing thickness,		
Standard mm	1.468—1.480	
Undersize mm	1.718—1.730	
Bearing clearance,	normal mm	0.05 — 0.10
Wear limit	mm	0.2



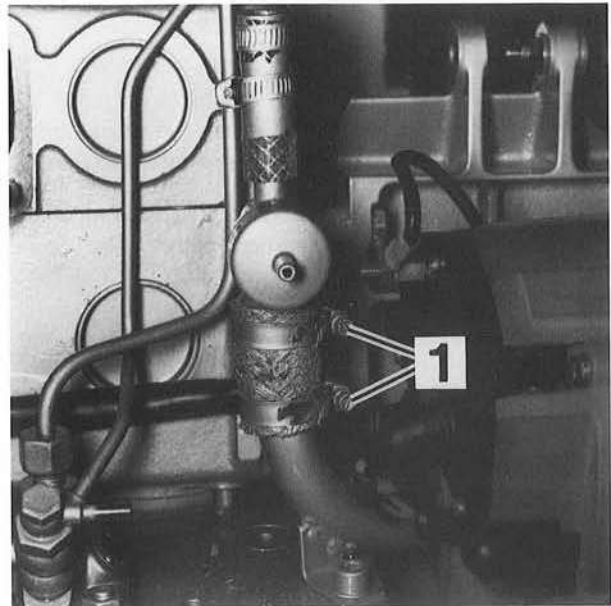
CRANKCASE VENTILATION

11.15

Removal

Fig. 109

Loosen hose clamps at the ends of the pipe (109/1) and pull out breather valve.



109

Stripping

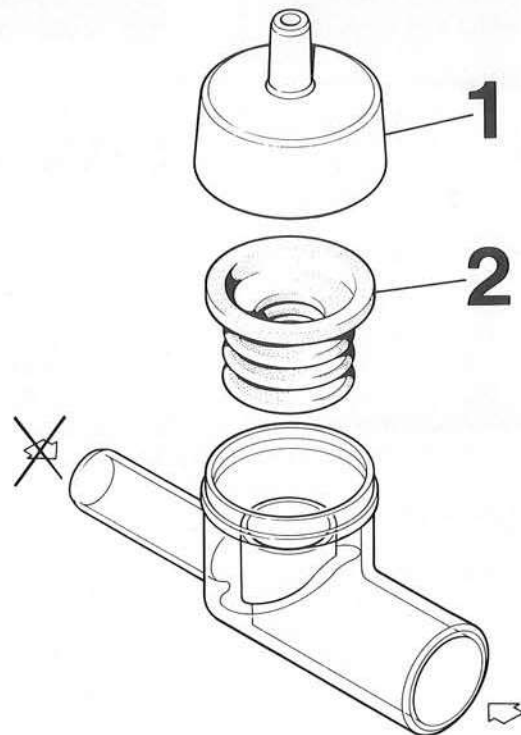
Fig. 110

Remove the cap (110/1) with a screwdriver.

Check

Clean the rubber bellows (110/2) and check for cracks and holes.

The non-return valve closes when air flows towards the crankcase and opens to airflow in the opposite direction (arrows).



110

TIMING CASE COVER

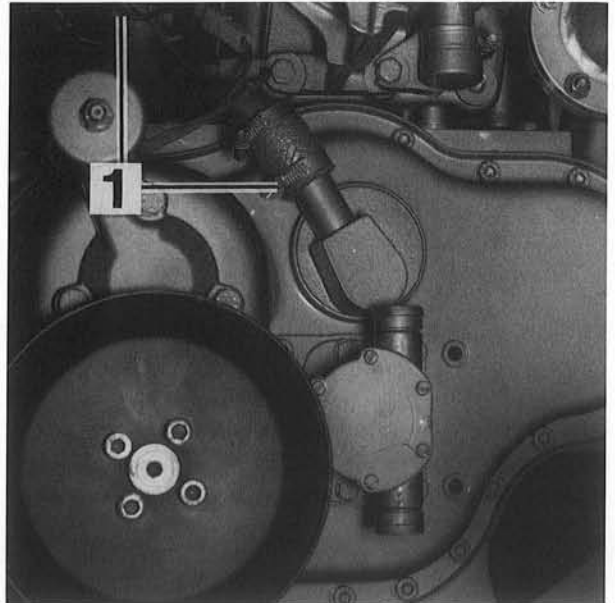
11.14

Preparation

- Remove raw water pump and hoses, 17.11.
- Remove V-belt.

Fig. 111

Remove crankcase ventilation (111/1).

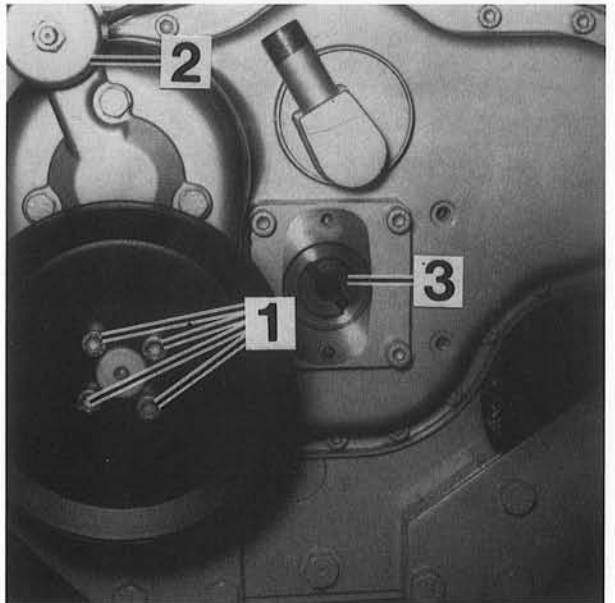


111

Removal

Fig. 112

Remove V-belt pulley by unscrewing the four Allen screws (6 mm) (112/1).
Remove the engine stop switch (112/2).
Pull out the driver (112/3) for the raw water pump.



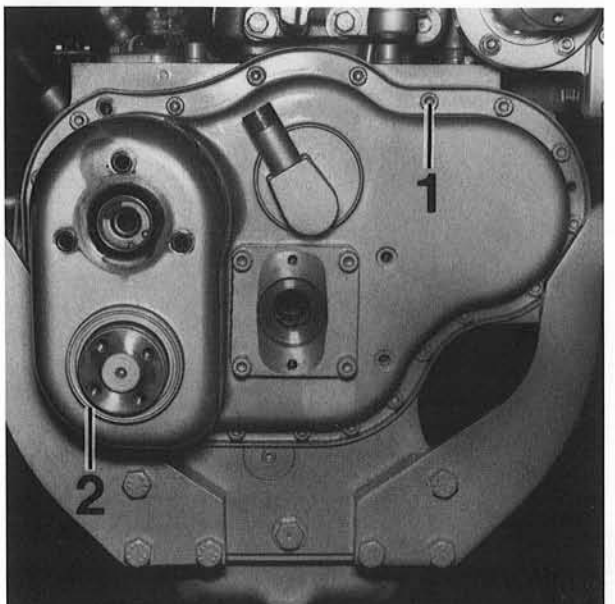
112

Fig. 113

Detach the timing case cover by unscrewing the Allen screws (6 mm) (113/1).
Remove the gasket between timing case cover and crankcase and clean the sealing faces.

Check

Check the sealing faces for damage.
Check the oil pump sealing ring (113/2) and renew, if necessary.

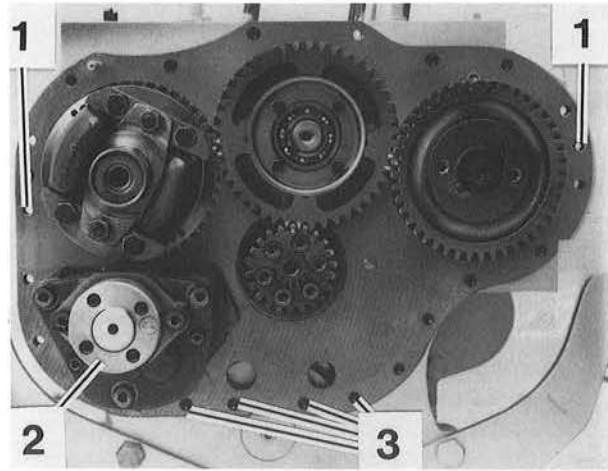


113

Notes for assembly

Fig. 114

The two clamping sleeves (114/1) should protrude approx. 2 mm from the front of the crankcase.
Grease the oil pump hub (114/2) to prevent damage to the shaft sealing ring.
Carefully clean the threads and apply Loctite 221 to the four short Allen screws (114/3) before inserting them.



114

OIL PUMP

11.41

Preparation

— Remove the timing case cover (11.14).

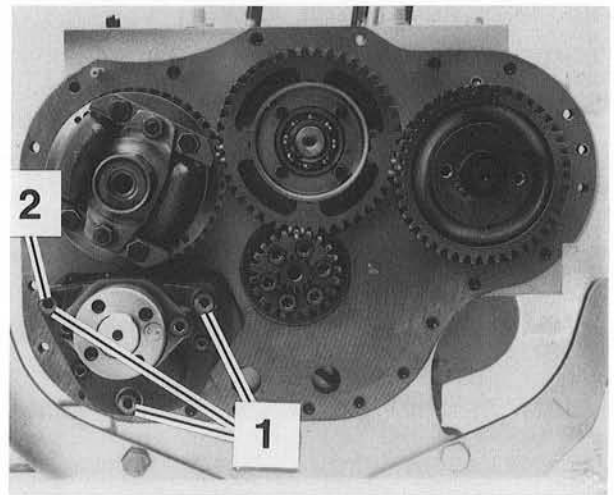
Removal

Fig. 115

Unscrew the three Allen screws (115/1) securing the oil pump to the crankcase.
If necessary, use special tool to withdraw the needle bearing.

Check

A faulty oil pump can only be replaced as a complete unit.



115

Notes for assembly

Fig. 116

Install the needle bearing flush with the crankcase. Apply a thin layer of Loctite 573 around the oil ducts (116/1) of the oil pump. Install the oil pump and tighten the screws.

Caution!

The screw (115/2, 116/2) must be secured with Loctite 221 to avoid leaks.

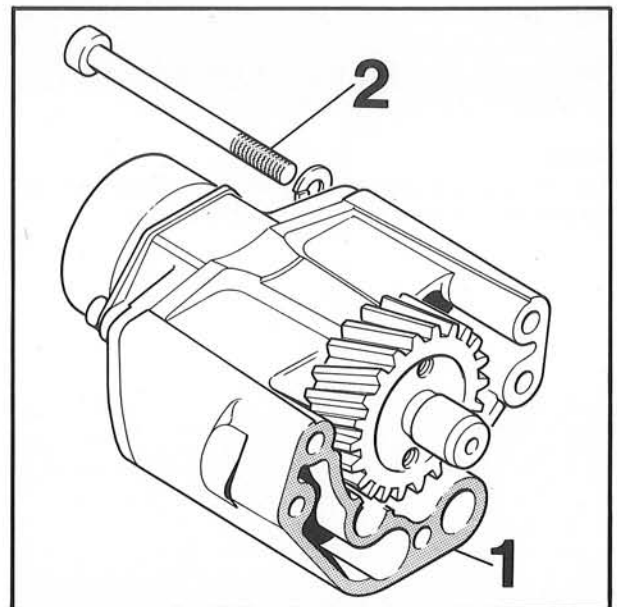
Oil pressure check

Fig. 117

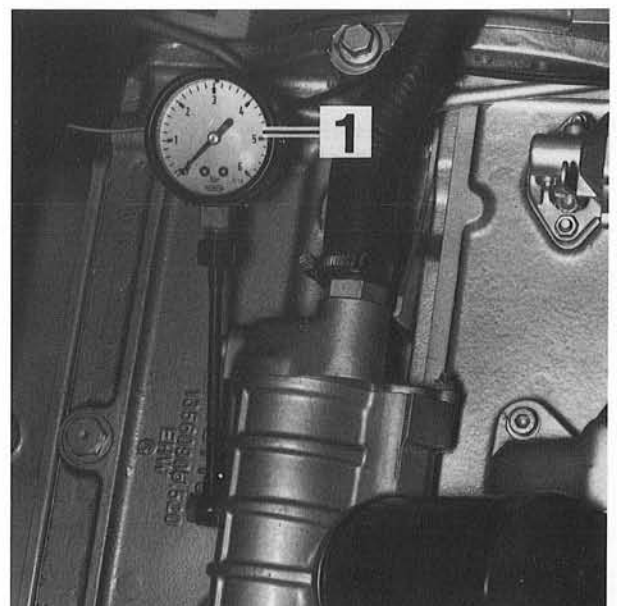
Detach electrical lead, unscrew the pick-up and connect up pressure gauge 74 64 1 333 566 (117/1) in place of the pick-up. Start the engine and ascertain oil pressure when operating temperature has been reached.

Specification

Oil pressure	
at 700 rpm	minimum 0.9 bar
at 3000 rpm	minimum 4.0 bar



116



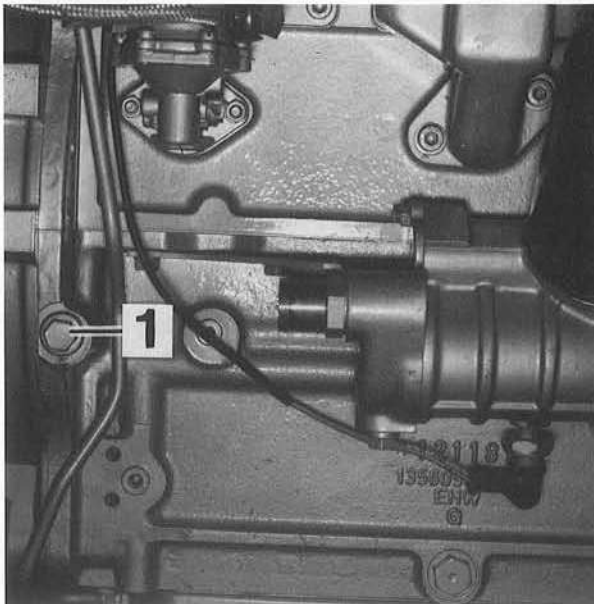
117

OIL PRESSURE CONTROL VALVE

11.42

Fig. 118

An oil pressure control valve is located behind the plug (118/1).



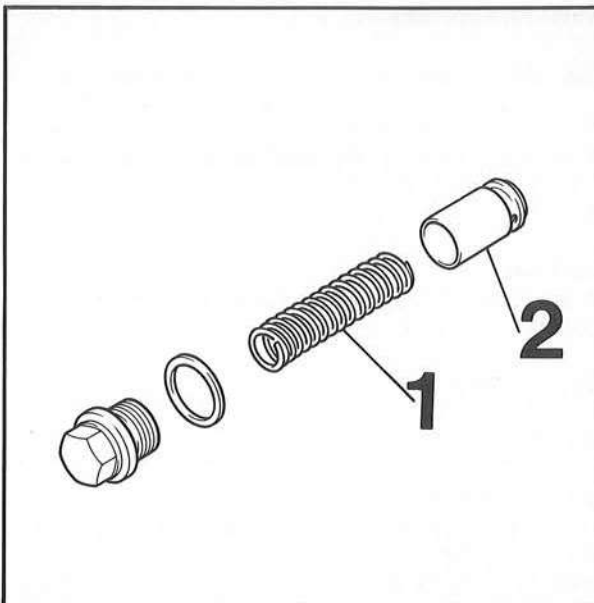
118

Fig. 119

Remove the plug and pull out the spring (119/1) and poppet (119/2) for inspection.

Note!

To unscrew the plug (118/1), the oil cooler has to be removed in the case of the D 35-2 engine.

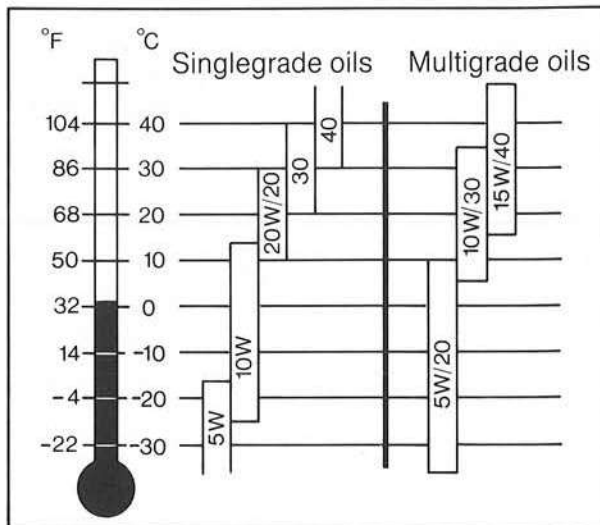


119

Oil specification

Fig. 120

Always use a high-quality oil to API specification CC or CD. If a CC oil has been used for a longish period of time, a switchover to a CD oil should not be made. However, if a switchover is unavoidable, the first oil change after the switchover must be made after only ten hours of operation. It can be seen from the table which oil viscosity is correct for the prevailing ambient temperature.



120

OIL FILLER

11.43

Preparation

— Pull out oil dipstick.

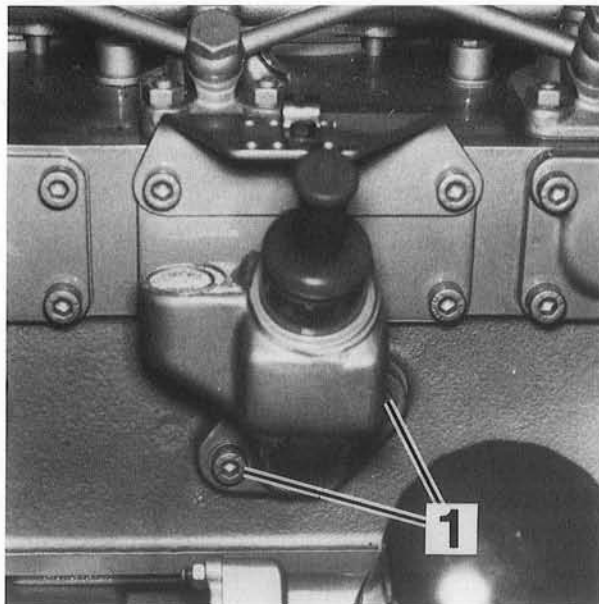
Removal

Fig. 121

Unfasten the two Allen screws (6 mm) (121/1) and pull out the oil filler.

Notes for assembly

Renew the gasket.



121

OIL PAN, OIL SCAVENGE LINE AND OIL SUCTION LINE

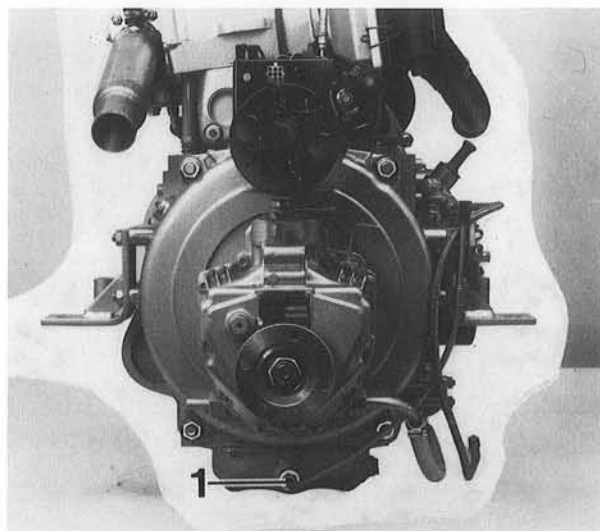
11.13

Oil pan removal

Fig. 122

Drain the engine oil.

Remove the oil scavenge line. For this purpose, always first unfasten the small outer coupling nut (122/1).



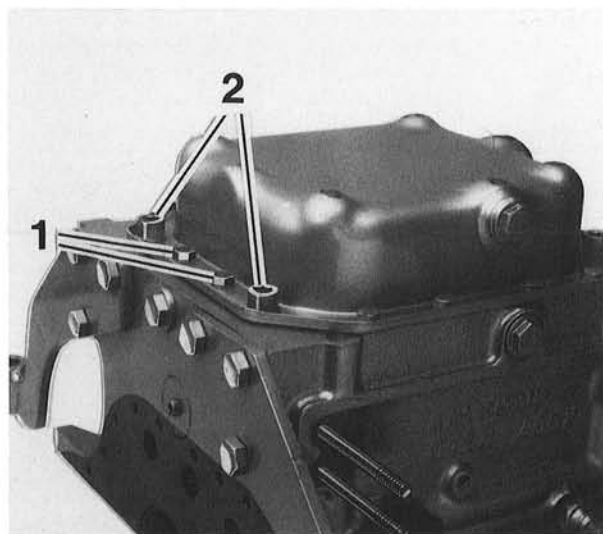
122

Fig. 123

Unfasten the screws securing the oil pan (123/1) (13 mm), (123/2) (10 mm Allen screws). Use a new gasket when re-assembling.

Notes for assembly

Apply Loctite 221 when installing the two screws at the front and the rear of the oil pan (123/1).



123

OIL SUCTION LINE

Preparation

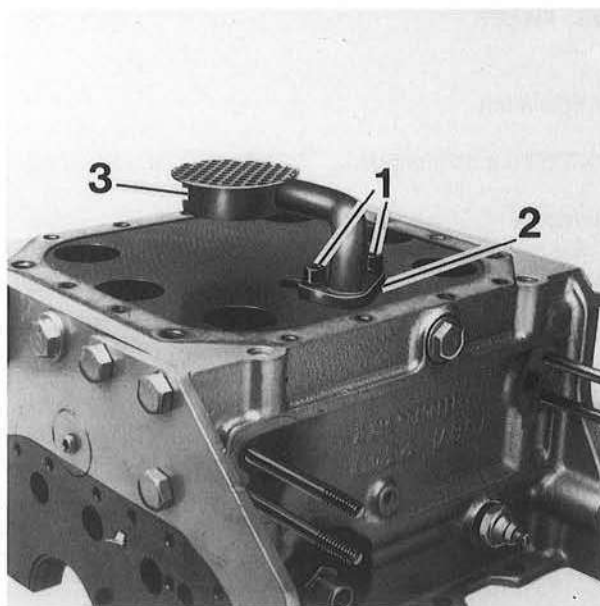
— Remove the oil pan.

Removal

Unfasten the two Allen screws (6 mm) (124/1), and lift out the oil suction line (124/3) and the O-ring (124/2).

Notes on assembly

Always renew the O-ring.



124

FLYWHEEL

11.22

Preparation

— Remove the vibration damper, 21.21.

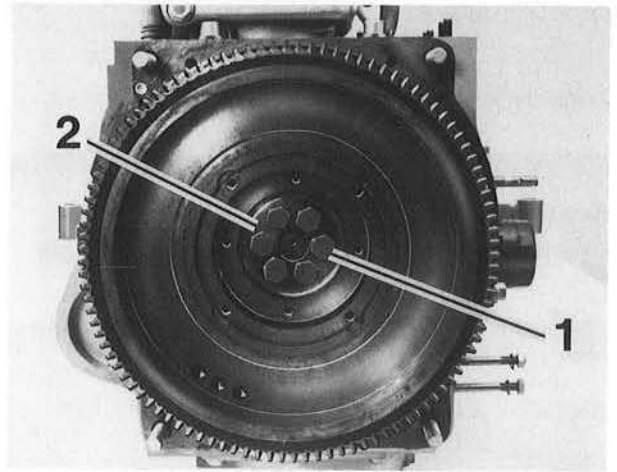
Removal

Fig. 125

Unscrew the six screws (125/1) securing the flywheel and lift out the flywheel.

Check

Check the steel washer (125/2) for cracks.
Check the starter ring gear for wear and broken teeth.



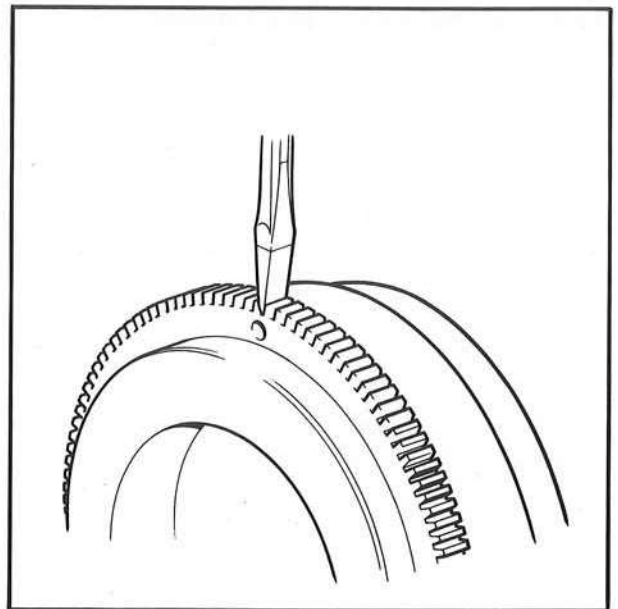
125

Fig. 126

If the ring gear has to be replaced, drill two holes in the ring gear and break it away with a chisel.

Notes for assembly

Heat the new ring gear to 200° C and fit it to the cold flywheel.
Fit the mating sleeve to the crankshaft and install the flywheel.
Screw in the screws, with the hardened steel washer between screw heads and flywheel, and tighten with a tightening torque of 135 Nm.



126

CRANKSHAFT REAR SEAL

11.14

Preparation

— Remove flywheel, 11.22.

Removal

Fig. 127

Screw out the six Allen screws (5 mm) (127/1) and remove end cover together with shaft seal.

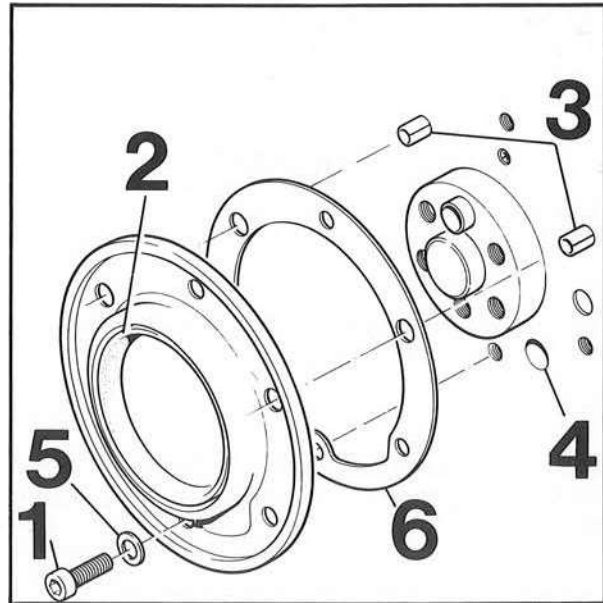
Check

Check the end cover for flatness.
Check the shaft seal (127/2) for wear and cracks.

Notes for assembly

Pay attention that the seal (127/6) is in the correct position. It must fit over the two mating sleeves (127/3) and leave the return oil ducts (127/4) free.

Grease the shaft seal prior to installation.



127

Fig. 128

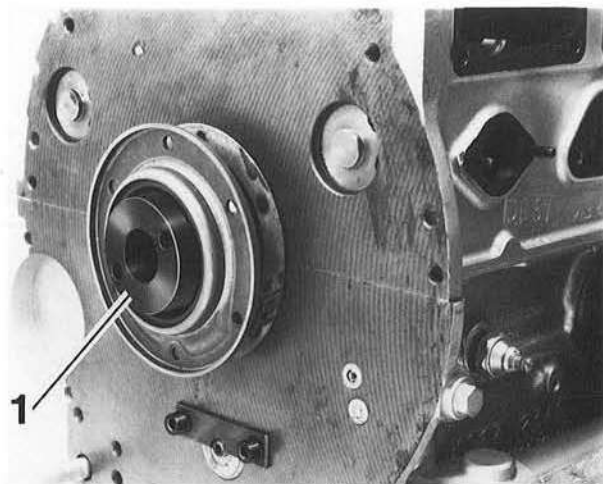
Use fitting tool (128/1) to push the end cover on to the crankshaft.

Apply Loctite 221 to the threads of the Allen screws prior to installing them.

Tighten the screws with a tightening torque of 9 Nm.

Caution!

The lowest screw (127/1) must be installed with a copper washer (127/5) under its head.



128

CRANKSHAFT

11.21

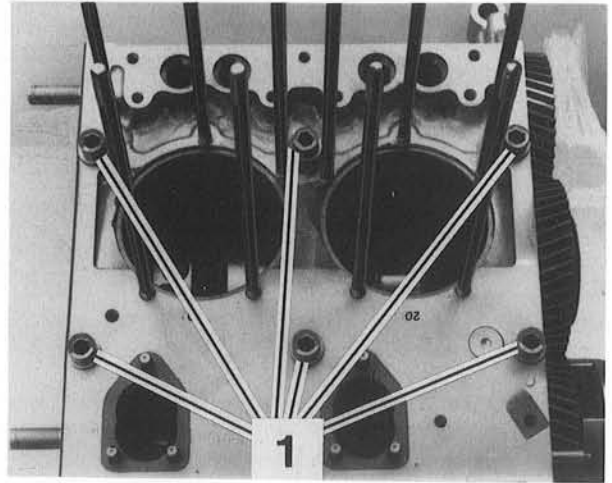
Preparation

- Remove pistons and connecting rods, 11.25.
- Remove timing case cover, 11.14.
- Remove crankshaft rear seal end cover, 11.14.

Removal

Fig. 129

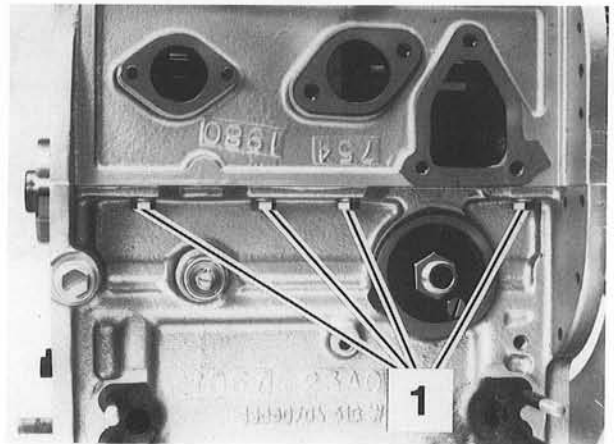
Remove the Allen screws (10 mm) (129/1).



129

Fig. 130

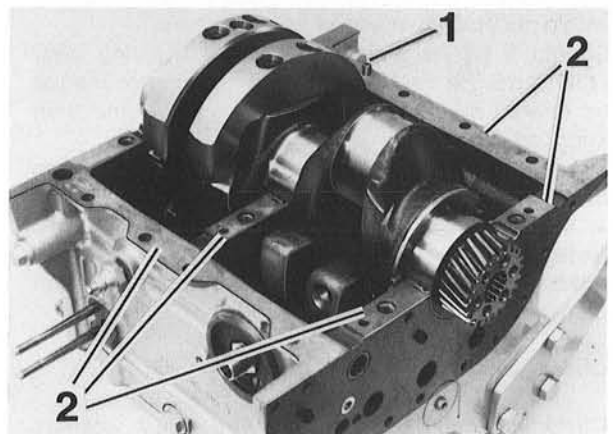
Remove the screws (13 mm) (130/1) on both sides of the crankcase.



130

Fig. 131

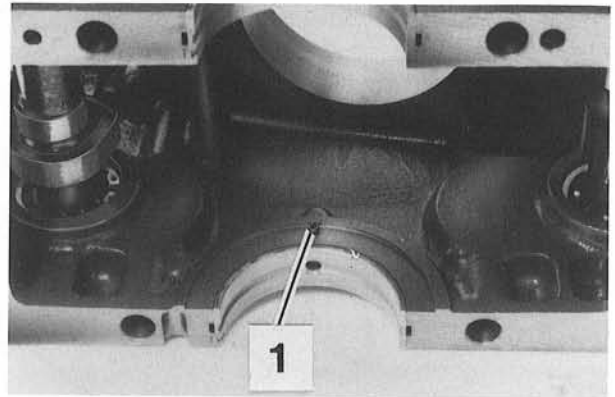
Separate carefully the two halves of the crankcase. Light tapping with a plastic hammer may be necessary, as they are centered together with a dowel (131/1).



131

Fig. 133

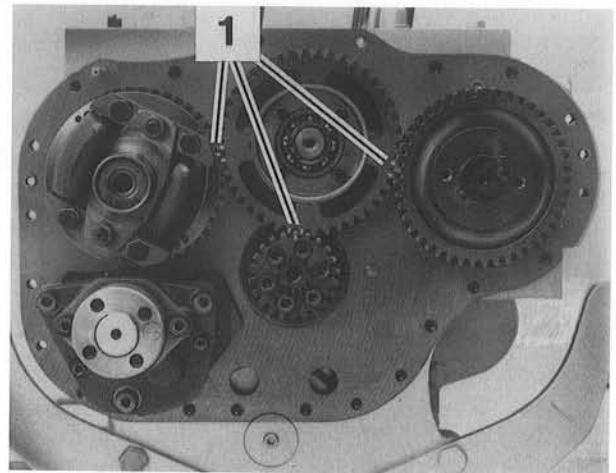
Set the top half of the crankcase down on the bottom half, paying attention to the dowels (131/1) and (133/1).
Tighten the screws.



133

Fig. 134

Fit the gear to the crankshaft, paying attention to the timing marks (134/1).



134

Specifications

Main bearing journals

Diameter	Standard mm	71.981—72.000
	Undersize mm	71.481—71.500
Width	front end mm	26.0 —26.5
	rear end mm	26.5 —27.5
	intermediate mm	32.0 —32.3
Radius	mm	3.5

Crank pin

Diameter	Standard mm	59.981—60.000
	Undersize mm	59.481—59.500
Width	mm	32.000—32.062
Radius	mm	3.5

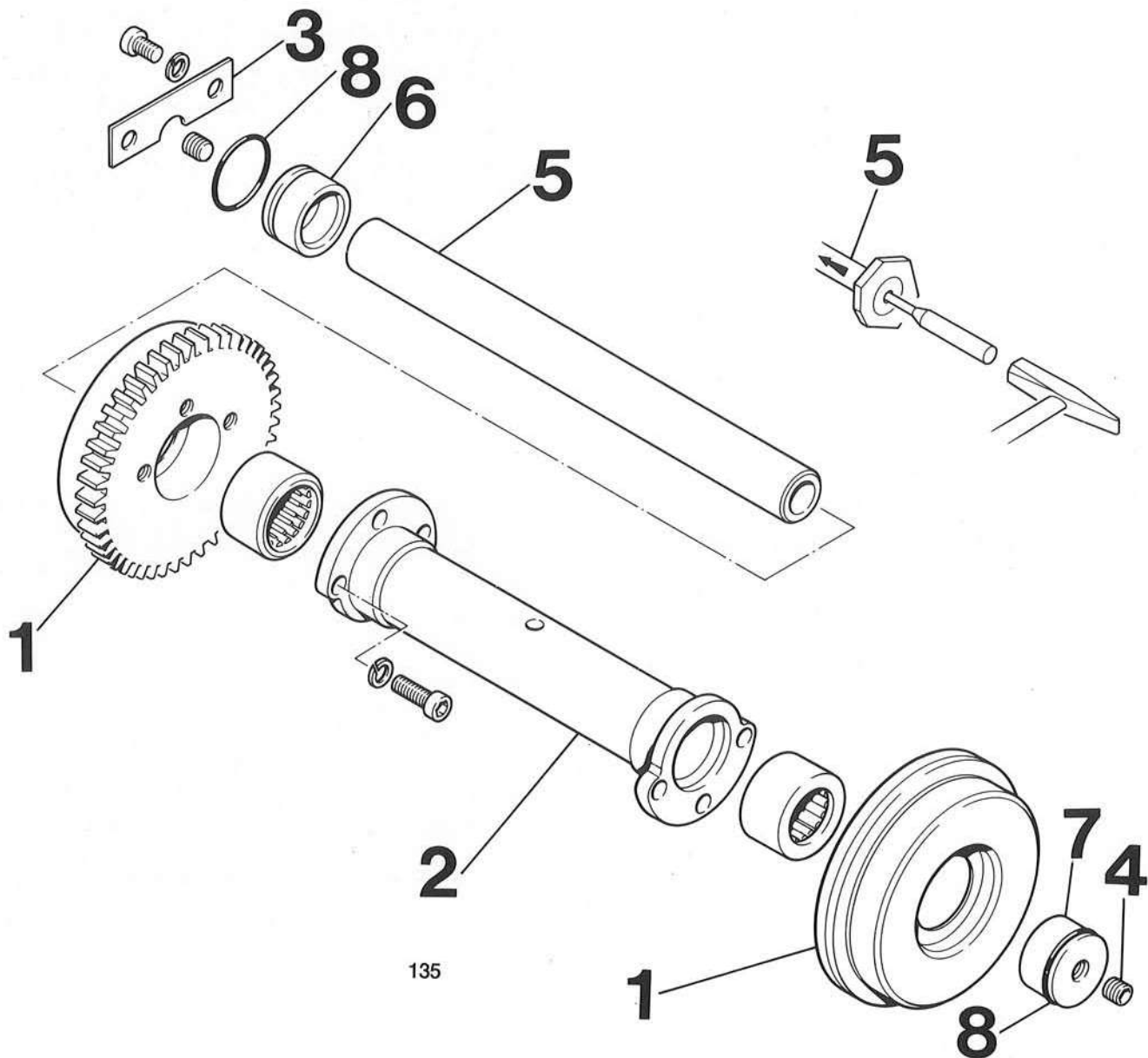
Clearance

Main bearing	mm	0.056— 0.118
Connecting rod bearing	mm	0.040— 0.102
Degree of hardness R _c		50—55

Depth of hardness	mm	2.5
Crankshaft end clearance	mm	0.16 — 0.44
Maximum permissible bearing clearance after wear	mm	0.2
Main bearing, inside diameter	Standard, installed mm	72.056—72.099
	Undersize, installed mm	71.556—71.599
Main bearing, shell thickness	Standard mm	2.960— 2.972
	Undersize mm	3.210— 3.222
Connecting rod bearing, inside diameter	Standard, installed mm	60.040—60.083
	Undersize, installed mm	59.540—59.583
Connecting rod bearing, shell thickness	Standard mm	1.468— 1.480
	Undersize mm	1.718— 1.730

MASS BALANCING MECHANISM

11.27



Preparation

— Remove crankshaft, 11.21.

Removal

Fig. 135

Separate the balance weights (135/1) from the connecting shaft (135/2) (6 mm Allen screws). Always detach the balance weight at the front end first (136/1).

Note!

The D 50-2 has a two-part connecting shaft, which thus has to be separated on removal.

Take off the plate (135/4) securing the rear check bush.

Unscrew the screw plug (135/4) of the front-end check bush.

Knock out the balance shaft (135/5) to the rear, using a suitable mandrel and hammer.

Remove the rear check bush (135/6) from the shaft and insert the shaft again.

Knock out the front-end check bush (135/7) approx. 5mm and afterwards take out the balance shaft, connecting shaft and balance weights.

Check

Check the needle bearing for wear.

Check the gear teeth for wear and damaged teeth. Check the balance shaft for wear and scores. Measure its diameter and compare with the specifications below.

Renew the O-rings (135/8) of the check bushes.

Notes for assembly

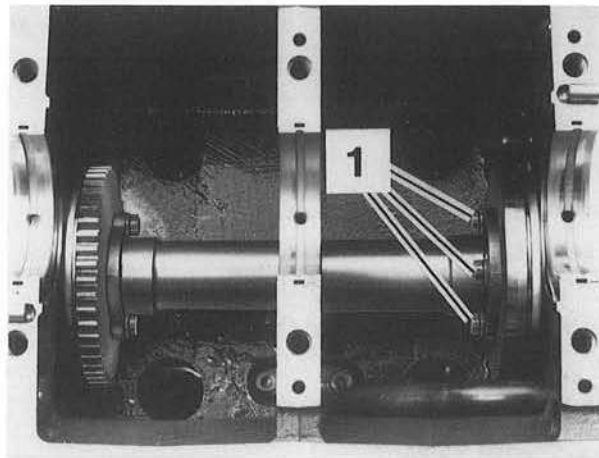
Fig. 136

Install the balance weights and connecting shaft and screw in the screws finger-tight. Insert the shaft from the flywheel side and drive it into the front check bush. Knock in the front check bush flush with the crankcase.

Note!

The front check bush forms part of the sealing face to the timing case cover and must therefore be exactly flush with the crankcase in order to avoid leakages.

Drive in the flywheel-side check bush and then tighten up the screws on the connecting shaft. Adjust the position of the rear check bush until the specified axial clearance of the balance shaft is obtained. The axial clearance is measured with a depth gauge against the front-end balance weight. Check that the mass balancing mechanism moves freely. Install the plugs of the check bushes with a little Loctite 221 applied to their threads.



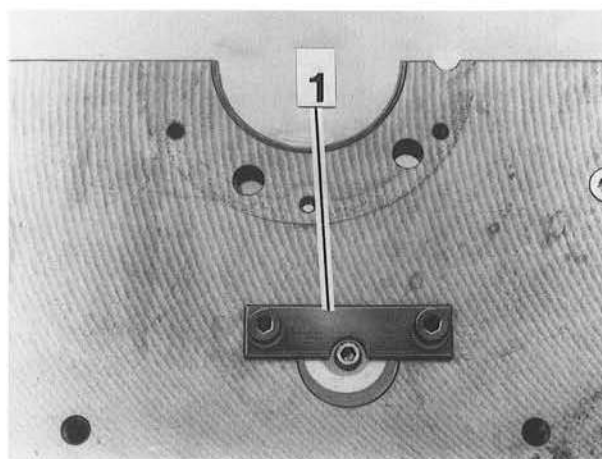
136

Fig. 137

Install the plate and secure its screws with Loctite 221 (137/1).

Specifications

Balance shaft dia.	mm	27.991—28.000
Wear limit	mm	27.970
Axial clearance of shaft		
	D 35-2 mm	0.15 — 0.60
	D 50-2 mm	0.15 — 0.70



137

CAMSHAFT FOR INJECTION PUMP

13.41

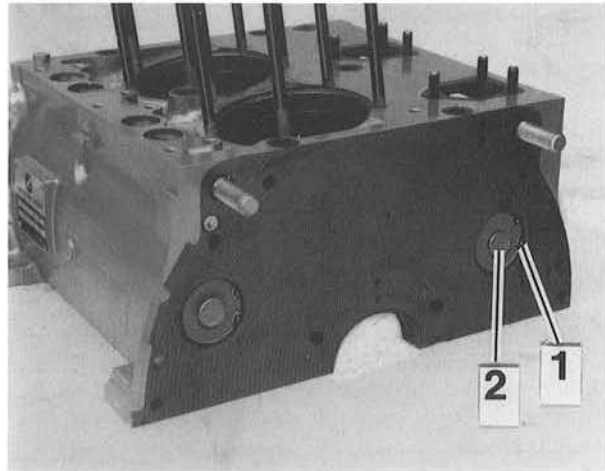
Fig. 138

Preparation

- Separate the top part of the crankcase from the bottom part, see Crankshaft 11.21.
- Remove injection pumps, 13.51.
- Remove automatic cold start, 13.51.
- Remove governor, 13.41.
- Remove oil pump, 11.41.
- Remove governor rod, 13.41.
- Remove fuel pump, 13.31.

Removal

Remove circlip (138/1) and pull out the cover (138/2) with a pair of pliers. Also take out the shims behind the cover.

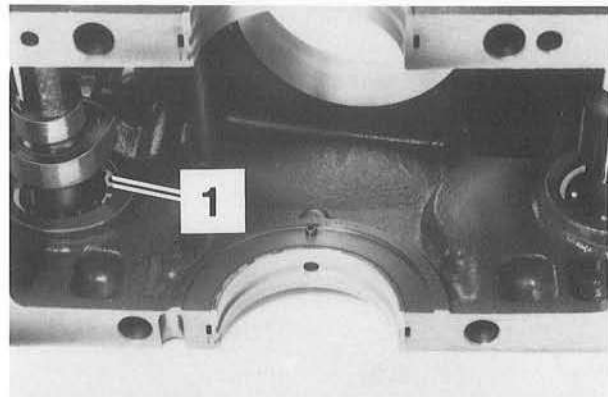


138

Fig. 139

Remove the circlip on the inside of the crankcase (139/1, 140/2).

Knock the camshaft out with a piece of 47 mm dia. tube and a hammer towards the front end of the engine.



139

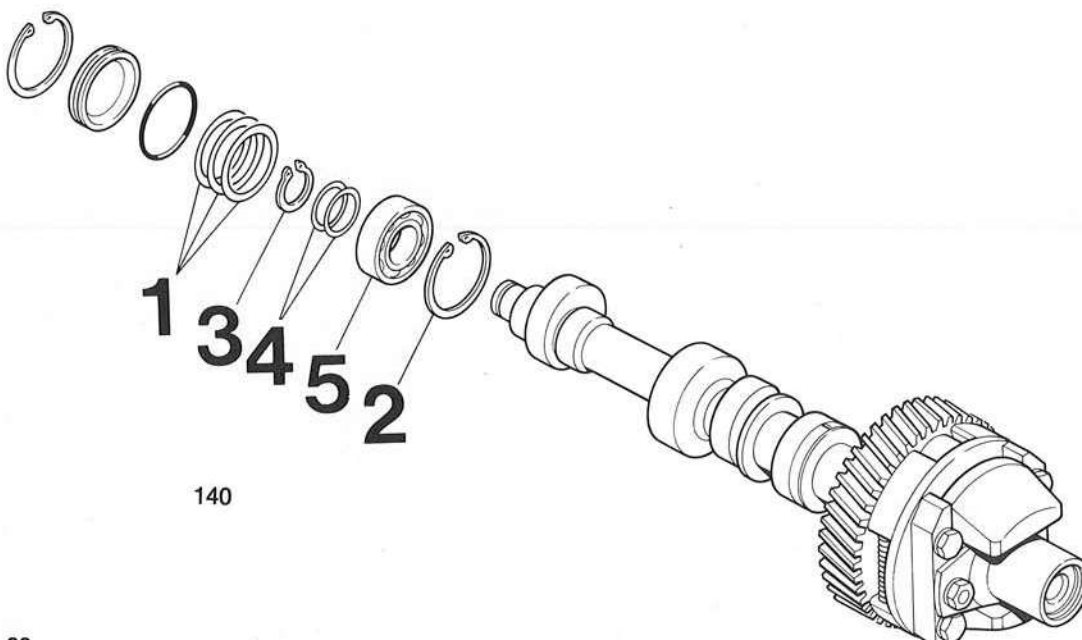
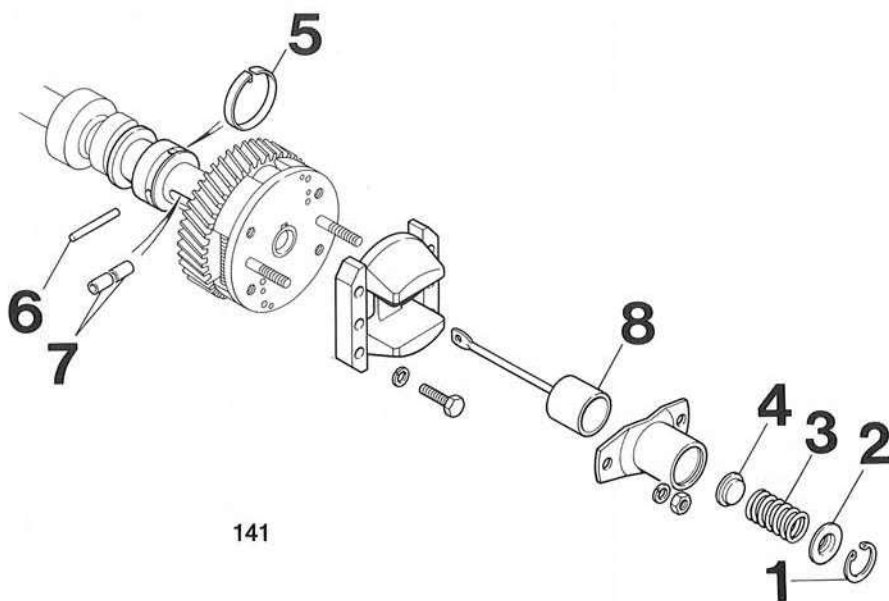


Fig. 140

Remove circlip (122/3) and shims (122/2) at the rear end of the camshaft.
Remove the ball bearing (122/5) with a puller.



141

GOVERNOR

Stripping

Fig. 141

Remove the circlip (141/1), spring plate (141/2), governor spring (141/3) and centering disc (141/4). Hook out the spring (141/5) and push out the pin (141/6) and the two roller sleeves (141/7). Pull out the spring sleeve complete with draw rod (141/8).

Fig. 142

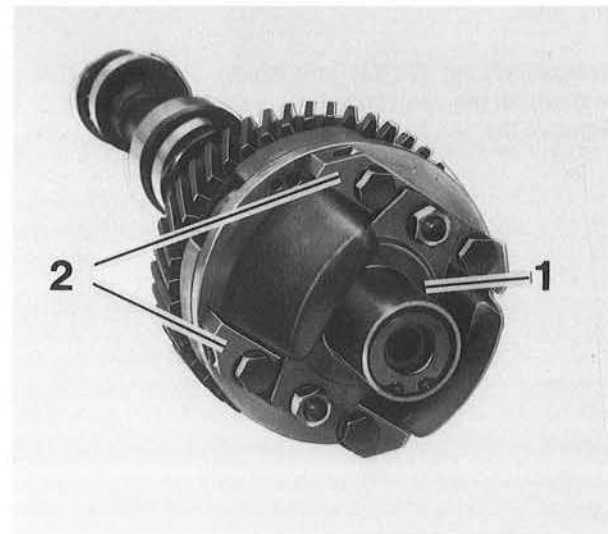
Remove the spring bridge (142/1).
Remove the governor weight supports (142/2).

Notes for assembly

Assembly is carried out fundamentally in the reverse order.

Check the governor weights for ease of movement after installation.

Ensure that the spring (141/5) is installed as in Fig. 141.



142

INJECTION TIMING MECHANISM**Preparation**

— Remove governor.

Stripping

Fig. 143

Remove the two studs (143/1) from the support disc (143/2).

Pull the injection timing mechanism off the camshaft with puller 74 64 1 333 536 in conjunction with puller screw 74 64 1 333 568.

Fasten the holder for injection timing mechanism assembly in a vice and fix the injection timing mechanism on the holder with the support disc facing downwards.

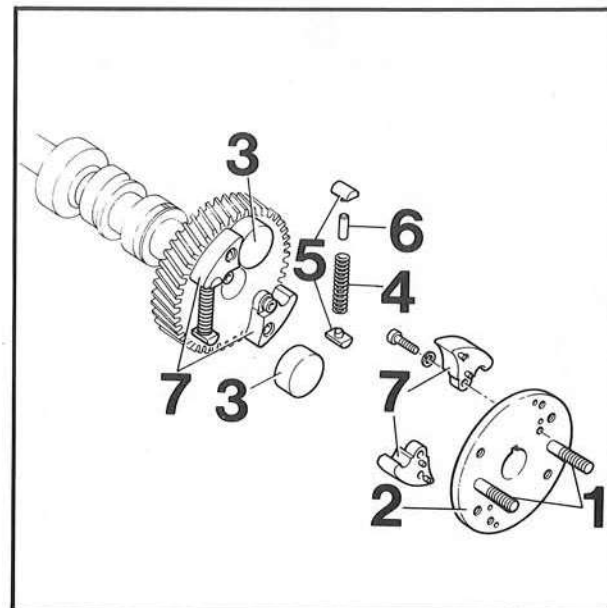
Note!

Do not press the injection timing mechanism too far downwards. The pin of the holder must not project out of the hub.

Turn the gear clockwise against the force of the spring and carefully lift off upwards.

Take off flyweights (143/3), springs (143/4), thrust pieces (143/5) and pins (143/6).

Remove the cam plates (143/7).



143

Check

Check the cam plates and flyweights for wear.

Check the springs and thrust pieces for wear and damage.

Notes for assembly

Assembly is carried out fundamentally in the reverse order.

Fix the thrust pieces in the cam plates of the gear. Turn the gear carefully and press it down on to the support disc.

Check whether the keyway of the support disc and of the gear are aligned. Turn the gear clockwise a small amount and check for ease of movement.

Apply Loctite 601 to the hub of the support disc and press the injection timing mechanism on to the camshaft until the gear has an end float of 0.05 mm.

Specifications

Camshaft

Bearing diameter,

front bearing mm 53.921—53.940

intermediate bearing mm 53.921—53.940

rear bearing

(ball bearing seat) mm 20.008—20.021

Bore for bearing in crankcase

Diameter front bearing mm 54.000—54.030

intermediate bearing mm 54.000—54.030

rear bearing mm 46.982—46.993

Camshaft end play mm 0.1

IDLER GEAR

11.27

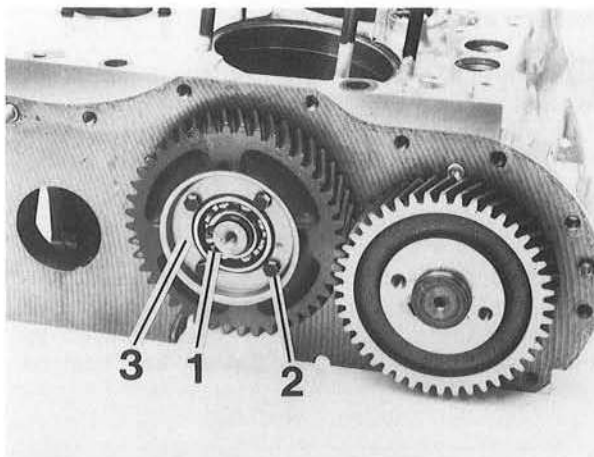
Preparation

— Remove camshaft for injection pumps, 13.41.

Removal

Fig. 144

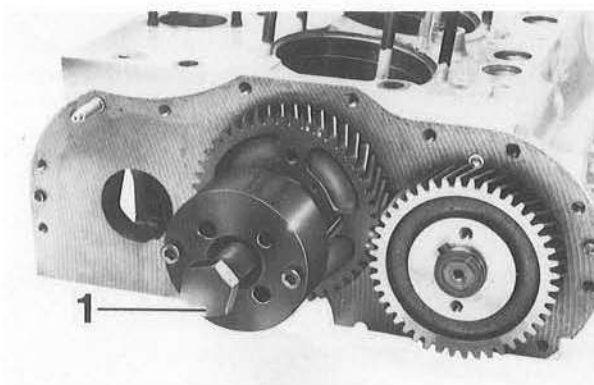
Remove the circlip (144/1) and the screws securing the splash plate (144/3).



144

Fig. 145

Pull off the idler gear with puller 74 64 1 333 536 in conjunction with puller screw 74 64 1 333 568 (145/1).



145

Check

Fig. 146

Check the ball bearings for wear.
Check the idler gear for wear and cracks.

Note!

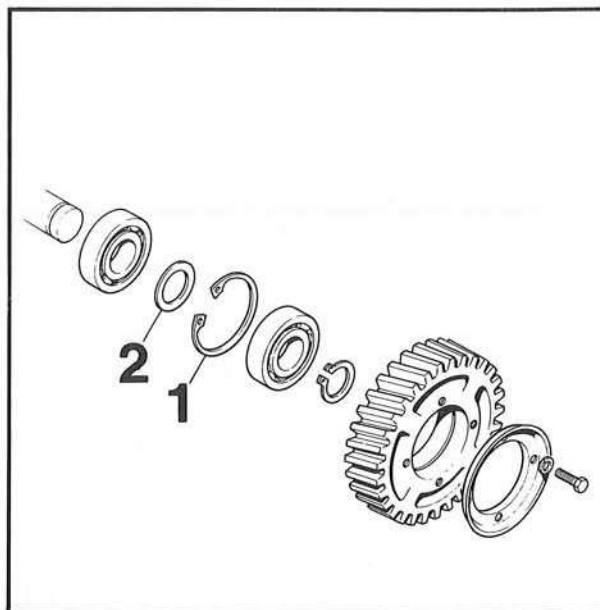
The two ball bearings are separated by a circlip (146/1) and a spacer (146/2).

Notes for assembly

Fit the ball bearings into the gear and then install the gear on the shaft, paying attention to the markings.

Note!

Place the idler gear symmetrically on to the shaft, to avoid the shaft being pushed into the crankcase.



CAMSHAFT (VALVE TRAIN) AND TAPPETS
11.31 and 11.32

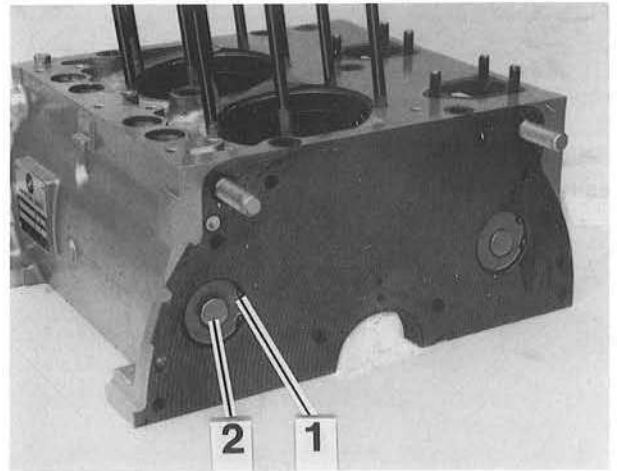
Preparation

— Separate the top part of the crankcase from the bottom part, see Crankshaft 11.21.

Removal

Fig. 147

Remove circlip (147/1, 149/1) and pull out the cover (147/2, 149/2) with a pair of pliers. Also take out the shims behind the cover.



147

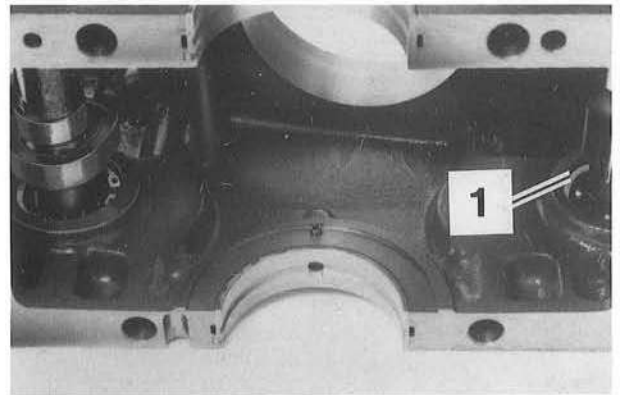
Fig. 148

Remove the circlip (148/1, 149/6) on the inside of the crankcase.

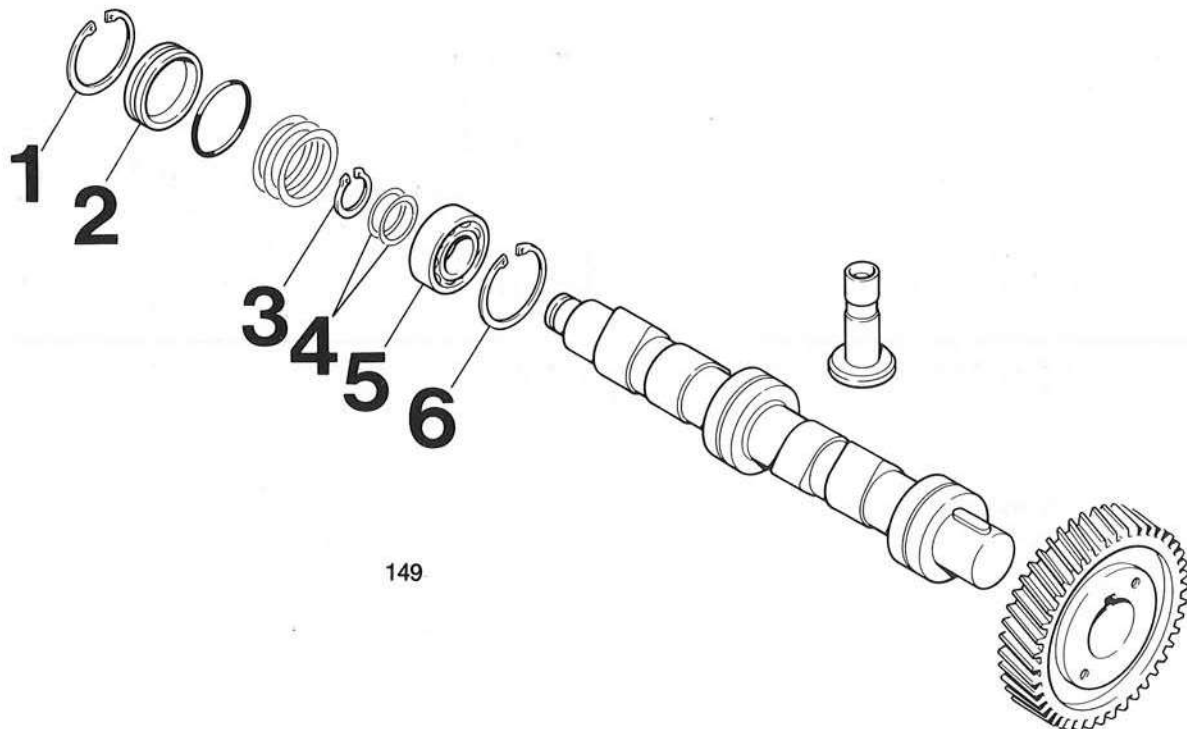
Ensure that the tappets are in their top position and will not obstruct the camshaft when it is driven out.

Drive the camshaft out with a piece of 47 mm dia. tube and a hammer.

Lift out the camshaft carefully.



148



149

Fig. 149

Remove circlip (149/3) and shims (149/4) at the rear end of the camshaft.

Remove the ball bearing (149/5) with a bearing puller.

Fig. 150

If replacement of the camshaft or of the camshaft gear is necessary, the gear is removed with puller 74 64 1 333 536 in conjunction with puller screw 74 64 1 333 568 (150/1).

Note!

The gear can be pulled off with the camshaft either installed or removed.

Pull out the tappets.

Check

Check the tappets for wear at the base and in the push rod area.

Check the ball bearing for wear.

Check the camshaft for wear (journals and cams).

Check the camshaft gear for wear and cracks.

Notes for assembly

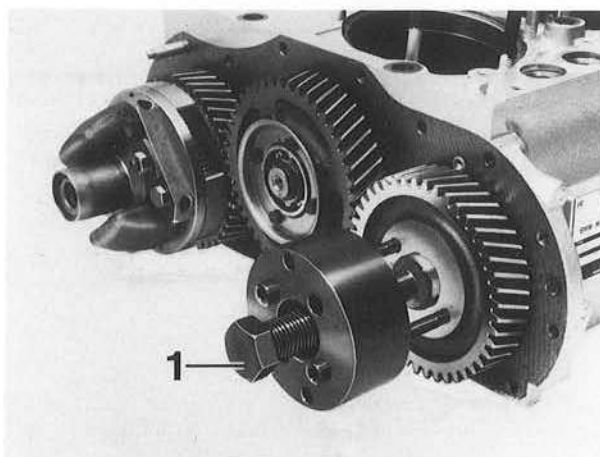
Heat the camshaft gear to 150° to 200° C and press it on to the camshaft.

Install the inner circlip and mount the ball bearing. There must be no play between the ball bearing and its circlip. Adjust with shims, if required.

Install crankshaft, paying attention to the marks, and secure with circlip (148/1).

Install cover and secure with circlip.

Measure end play of camshaft and adjust to specified value by means of shims between the cover and the ball bearing, see Specifications.



150

Specifications**Camshaft****Bearing diameter,**

front bearing mm 53.921—53.940

intermediate bearing mm 53.921—53.940

rear bearing seat mm 20.008—20.021

Bore for bearing in crankcase

Diameter front bearing mm 54.000—54.030

intermediate bearing mm 54.000—54.030

rear bearing mm 46.982—46.993

End play

mm 0.1

WINTER LAY-UP AND LENGTHY OPERATING BREAKS

The engine must be given preservation treatment for lengthy lay-ups, to prevent its components being destroyed by corrosion.

Before the boat is taken out of the water

Run engine warm and drain oil with the engine at a standstill.

Pour in corrosion inhibiting oil UNTIL LEVEL REACHES BOTTOM mark on oil dipstick.

Drain gearbox oil and fill up with specified oil.

Caution!

Before the engine is recommissioned, the corrosion inhibiting oil must be replaced by the recommended engine oil. It is expedient to hang an appropriate tag on the engine.

Mix 2 litres of diesel fuel with 1 litre of corrosion inhibiting oil in a suitable container. Route a hose from the fuel line, or direct from the fuel filter, into this container.

Start engine and let it run for about 15 minutes.

Subsequently, on land

Drain water from the raw water cooling system. Do not remove the water pump impeller.

Close the raw water cock and detach water pipe at pump.

Mix approx. 12 litres of clean water with approx. 1.2 litres of emulsified corrosion inhibiting oil in a container. Continually mix oil with water and stir as thoroughly as possible.

Connect a hose to the raw water pump and hang the other end in the container.

Start the engine and let it run at idle until the oil-water mixture comes to an end. Then stop the engine.

Completely empty the raw water cooling system. Remove the impeller of the raw water pump (17.11). Check fresh water, antifreeze.

Unscrew fuel injectors (13/53) and pour about 1 teaspoonful of corrosion inhibiting oil in cylinder.

Crank engine several times. Install fuel injectors.

Clean engine and gearbox and treat with corrosion inhibiting oil for protection from corrosion damage.

Lubricate all cables and linkages.

Disconnect battery.

Preparations for recommissioning

Drain corrosion inhibiting oil and fill up with recommended oil (see page 5).

Install impeller in raw water pump.

Unscrew fuel injectors and crank engine several times to remove surplus oil from the cylinder.

Renew fuel filter.

Refuel with fresh diesel oil. Old fuel should not be used. Check lines and connections.

Connect up battery.

Start engine, as soon as boat is in the water.

Do not forget to open the raw water cock! — Check fuel and cooling systems for teakages.

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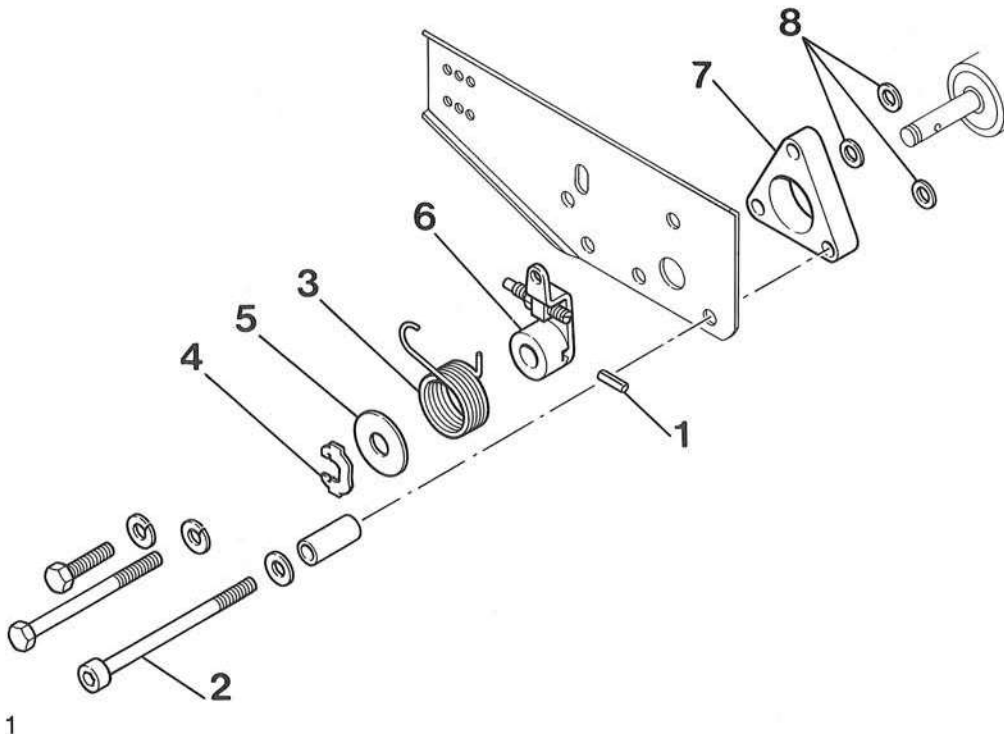
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ANNEX

Description of jobs specific to the D 35/50-1 engine
Fuel control system
Cooling System
Cooling circuit, flow diagram
Removing and installing the thermostat
Renewing the zinc anodes

THROTTLE CABLE ADAPTER PLATE

13.21



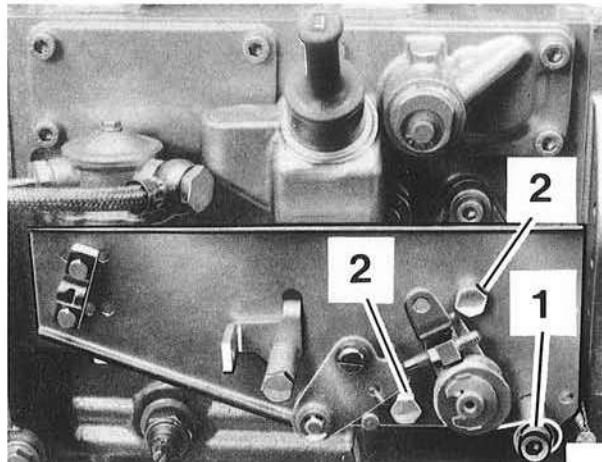
Removal

Fig. 1 and 2

- Remove the Allen screw (6 mm) (2/1) and (1/2) and release the spring (1/3).
- Remove the circlip (1/4) and pull out washer (1/5) and spring (1/3).
- Knock out the spring pin (1/1) securing the throttle lever.
- Pull out the throttle lever (1/6).
- Remove the two remaining screws (2/2) securing the adapter plate and lift out the spacer (1/7) and the three washers (1/8).

ASSEMBLY HINTS

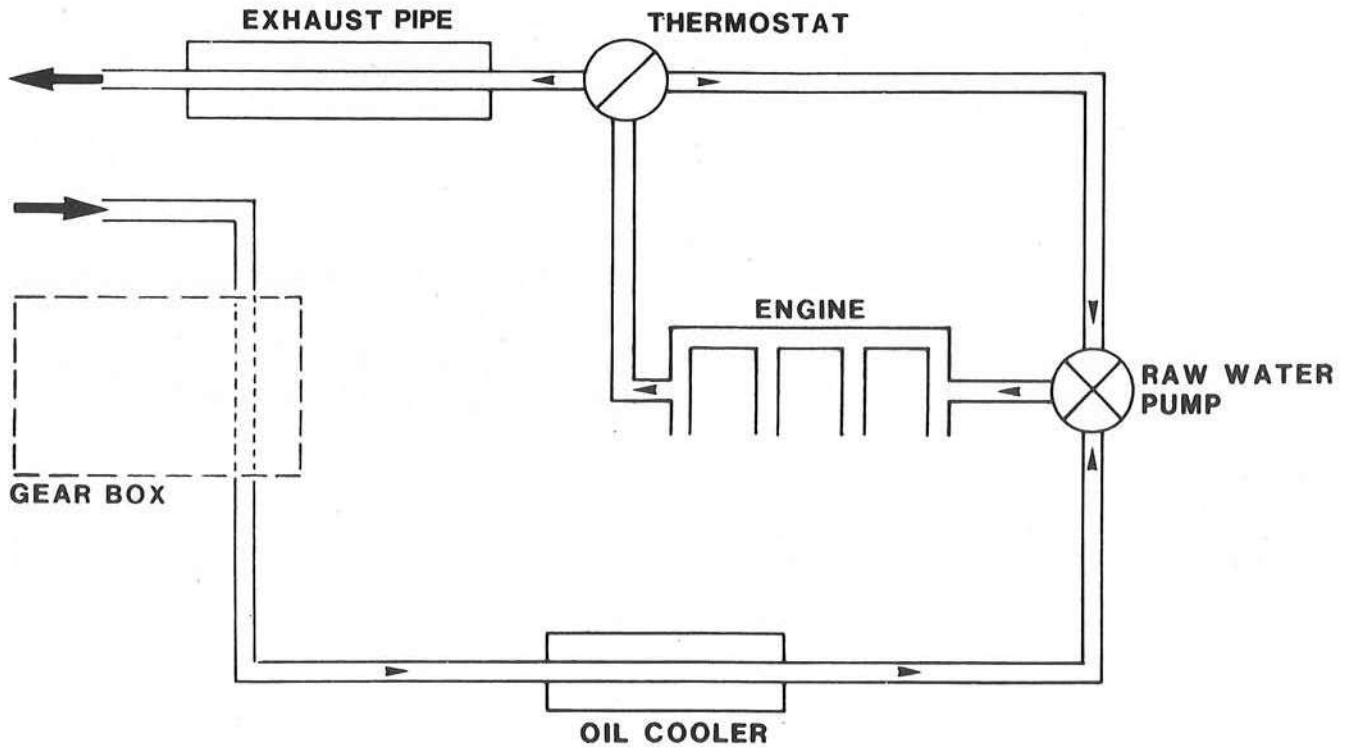
- Hook the throttle lever return spring around the idling adjusting screw.
- Install washer and circlip.
- Hook the spring around the Allen screw and its sleeve and turn the screw in.



2

COOLING SYSTEM

17.00



3

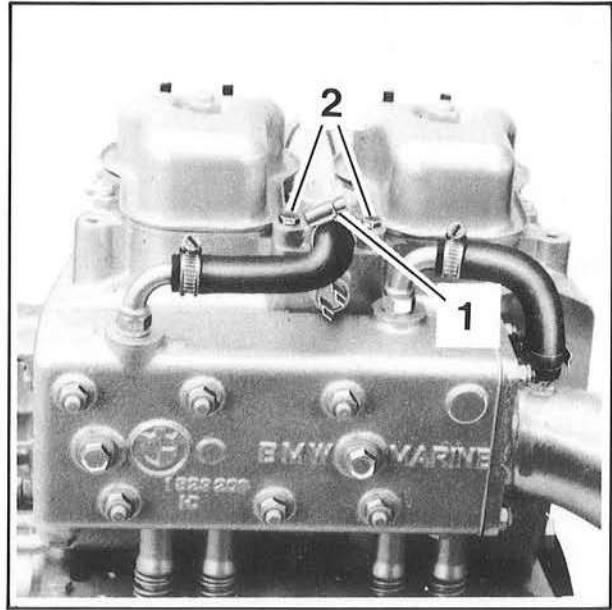
The engine is equipped with thermostat-controlled raw water cooling. The water is drawn to the raw water pump through the reverse gear oil cooler and engine oil cooler. The raw water pump is of impeller-type and is equipped with a neoprene impeller. From the water pump, the water is directed into the cylinder block and cylinder head, with a thermostat-controlled outlet into the exhaust manifold. As long as the thermostat is closed, the water is by-passed direct into the exhaust manifold. The water is then mixed with the exhaust gases in the water-jacketted exhaust pipe and is then lead overboard through the exhaust pipe.

THERMOSTAT

17.11

Removal

- Loosen hose clamp (4/1) and water hose from thermostat cover.
- Remove the thermostat cover by loosening the three screws (10 mm) (4/2).
- Lift out O-ring (5/1) and thermostat (5/2).



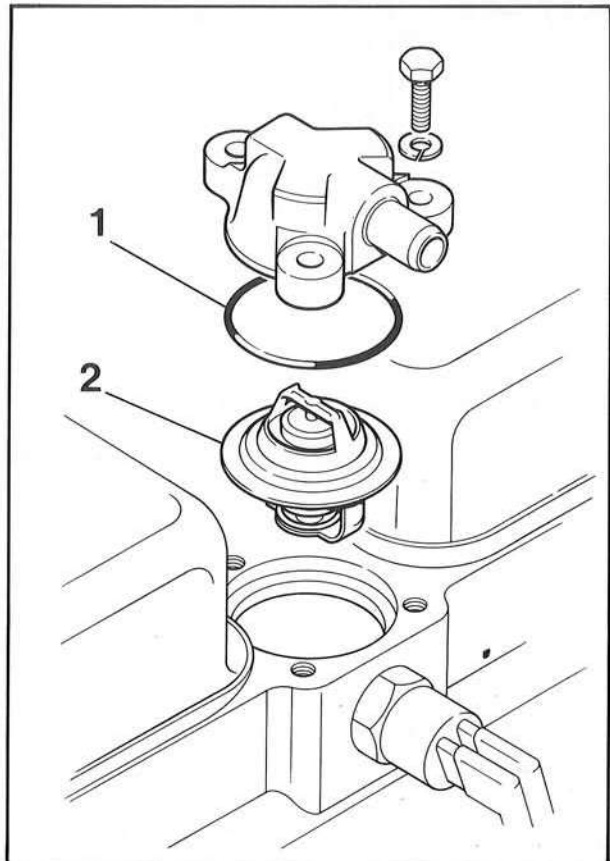
4

Inspection

- The function of the thermostat can be checked in warm water. The opening temperature should be 55° C. If otherwise, or the thermostat is sticking, replace.

Assembly hints

- Always renew the O-ring (5/1).
- Check for leakage.



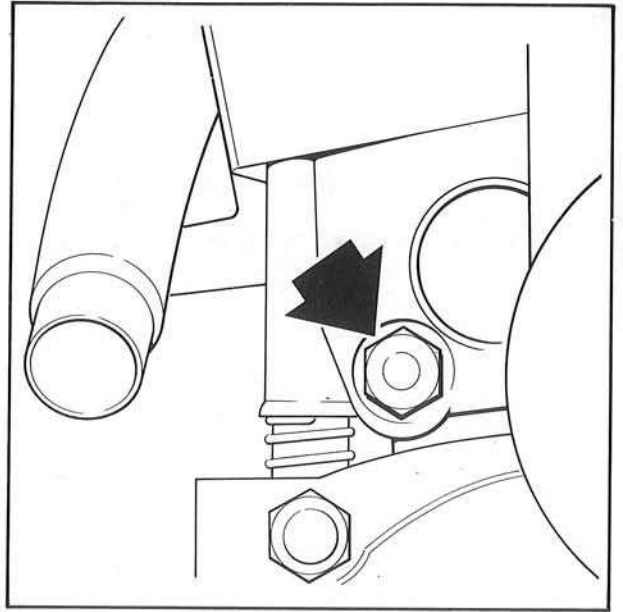
5

ZINC ANODES

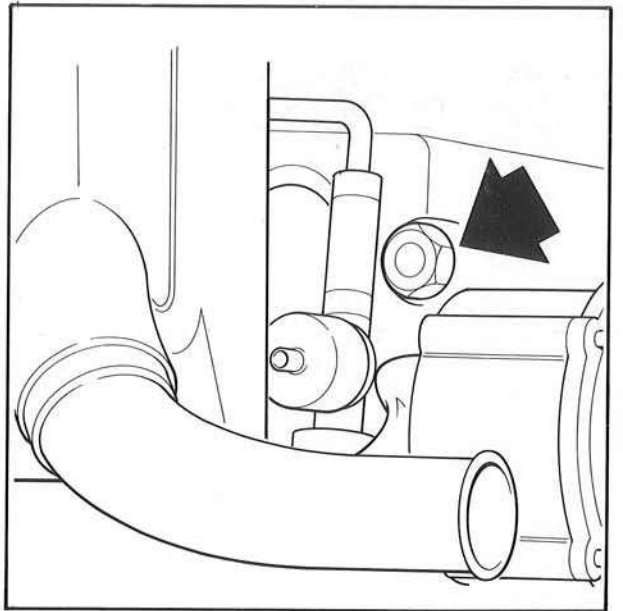
17.11

Fig. 6 and 7

The zinc (sacrificial) anodes are located in cylinder head and cylinder block. For ease of identification they are marked with a blue dot. Renew if necessary.



6



7



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1. From engine block
 1.1 cold — to the fresh water pump
 1.2 warm — via the heat exchanger
 to the fresh water pump
 2. Thermostat
 3. Fresh water pump
 4. into engine block

Fresh water circuit

A. From engine block
 A.a. cold — through oil filter
 A.b. Warm via the heat exchanger through the oil filter
 B. Oil thermostat
 C. Oil filter
 D. to engine block

Oil circuit

I. From raw water valve — gearbox
 II. through oil/water heat exchanger
 III. to the raw water pump
 IV. Through water/water heat exchanger
 V. to exhaust pipe jacket.

Raw water circuit

FLUID CIRCUIT IN COOLING SYSTEM



BMW D 50-2

