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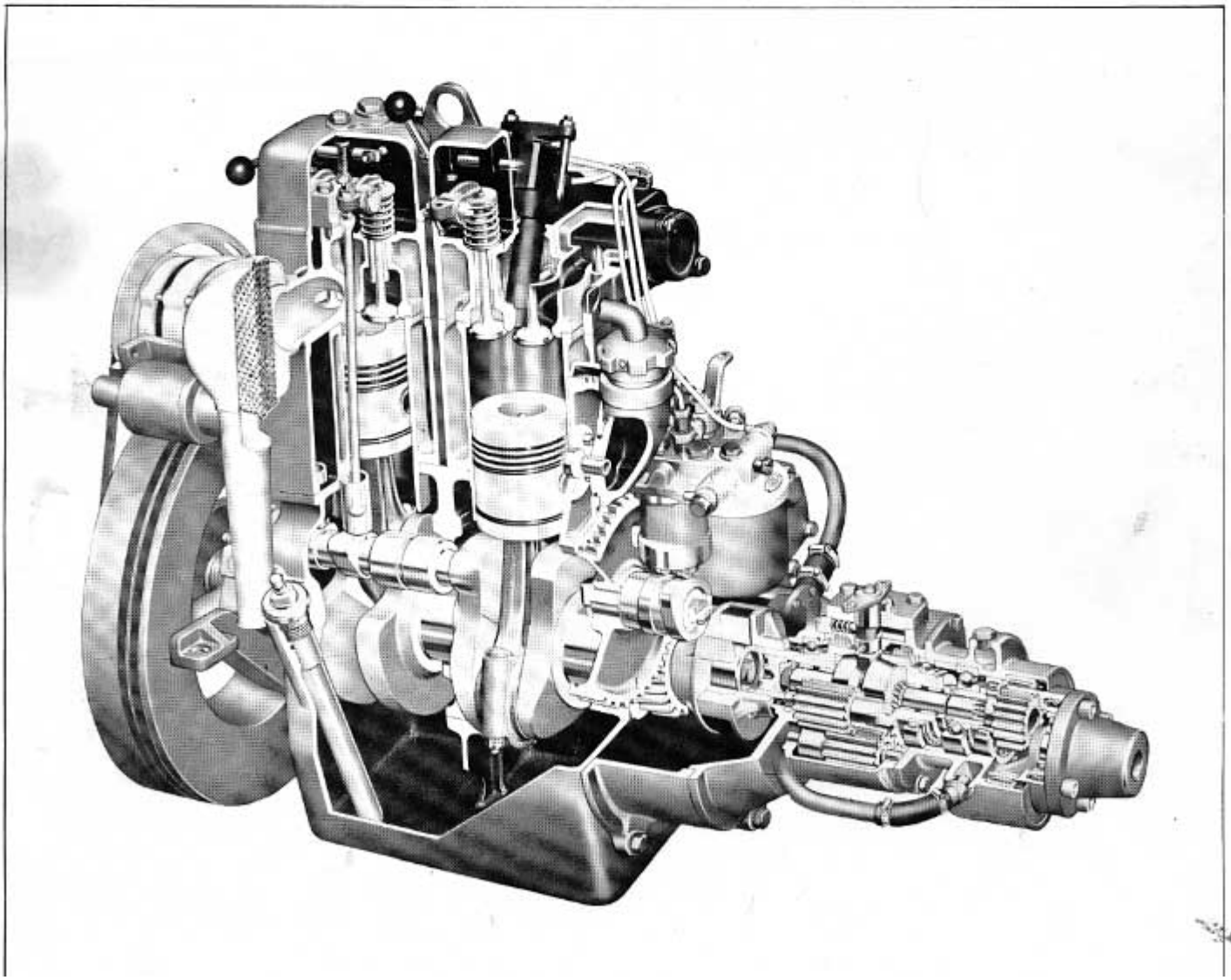
VOLVO PENTA

WORKSHOP MANUAL
MD1B-MD2B-MD3B
marine diesel engines



INTRODUCTION

This workshop manual contains descriptions of repair works on the marine diesel engines MD 1B, MD 2B and MD 3B.

Since there are differences between the different models, as far as extra equipment is concerned, it is important that you state engine type and serial number when orderering spare parts or in correspondence.

The instructions in this manual describe the most suitable repair methods assuming the use of certain special tools, listed under the headline "Special Tools".

We retain the right to carry out design modifications and for this reason the contents of this book are not to be considered binding.

AB VOLVO PENTA
Technical Information Dept.

NEW MEASUREMENT UNITS

The technicians have long fought for an international standardized measurement system. In 1960 such a system, called SI (Systéme International d'Unites), was established. This system is mainly built on previous system with the exception that the units are equalized i.e. no conversions are needed. The european industry is now starting to use this SI-system. In this manual the new SI-units are introduced. Units used earlier are given within brackets.

The new units are:

Power is given in kW (kilowatt)
previous unit HP (Horsepower)

Torque is given in Nm (Newton meter)
previous unit Kpm (kilopond meter)

Engine revolutions are given in r/s (revolution per second)
previous unit rpm (revolution per minute)

Volume is given in dm^3 (cubic decimeter)
previous unit l (litre)

REGISTER

PRESENTATION

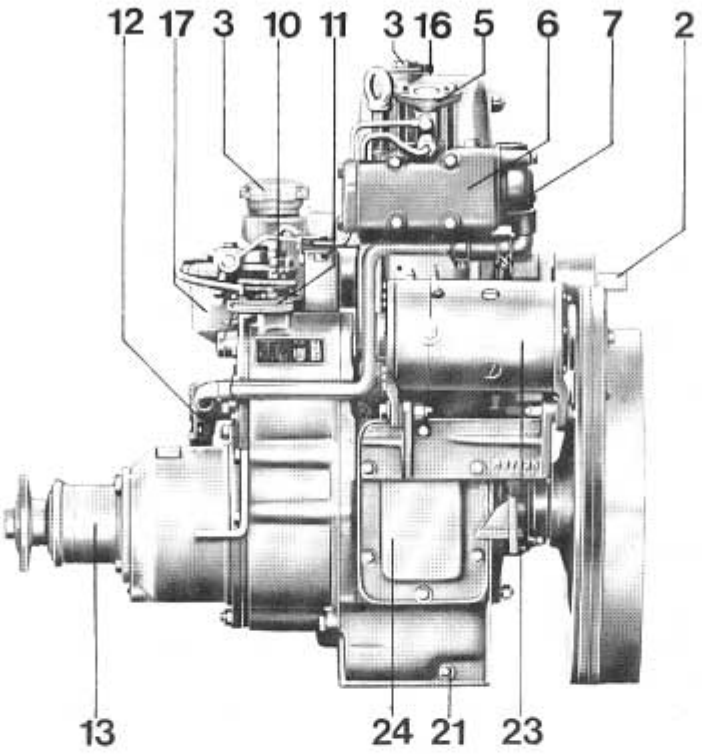


Fig. 1. MD 1B with reverse gear type RB, ratio 1,87:1

1. Control lever
2. Connection shaft for handstart
3. Oil filler cap, engine
4. Oil pressure gauge
5. Injector
6. Water-cooled exhaust manifold
7. Thermostat-housing
8. Starter
9. Oil dip-stick
10. Fuel injection pump
11. Control lever
12. Sea-water pump
13. Reverse gear type RB
14. Airfilter with silencer
15. Decompression lever
16. Valve cover
17. Fuel filter
18. Feed pump
19. Oil pressure sending unit
20. Oil filter
21. Oil drainage, engine
22. Alternator
23. Starter-generator
24. Inspection cover
25. Oil drainage, reverse gear
26. Oil filler plug, reverse gear
27. Water drainage, reduction gear
28. Reduction gear type MS

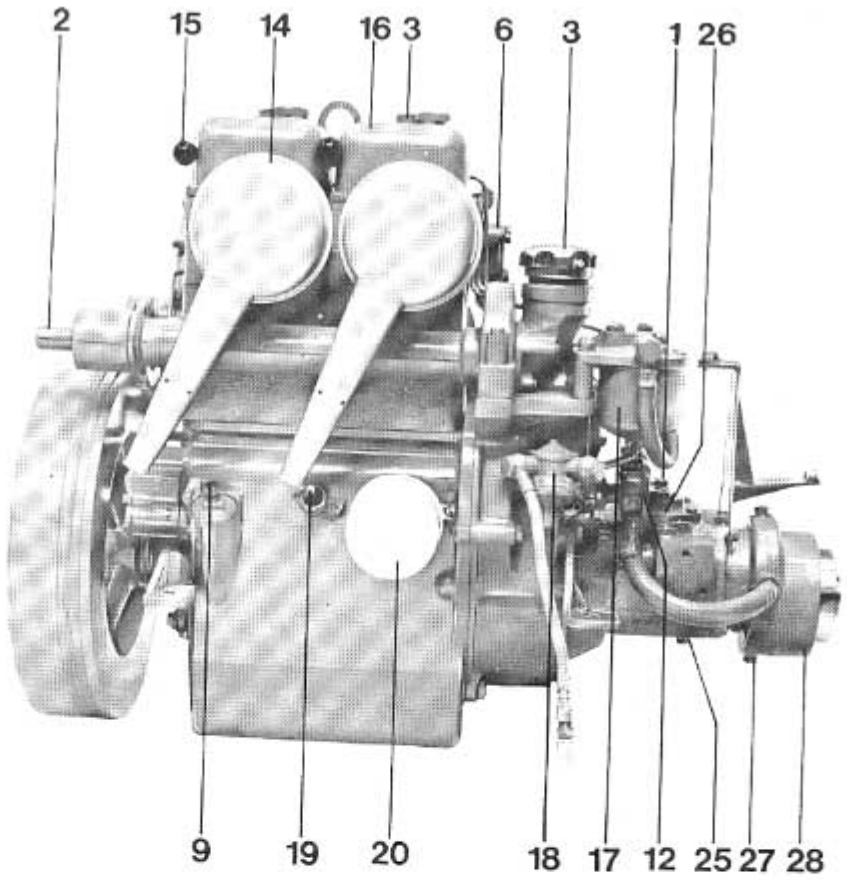


Fig. 2. MD 2B with reverse gear type MS, ratio 1,91:1 (Reference numbers, see page 2)

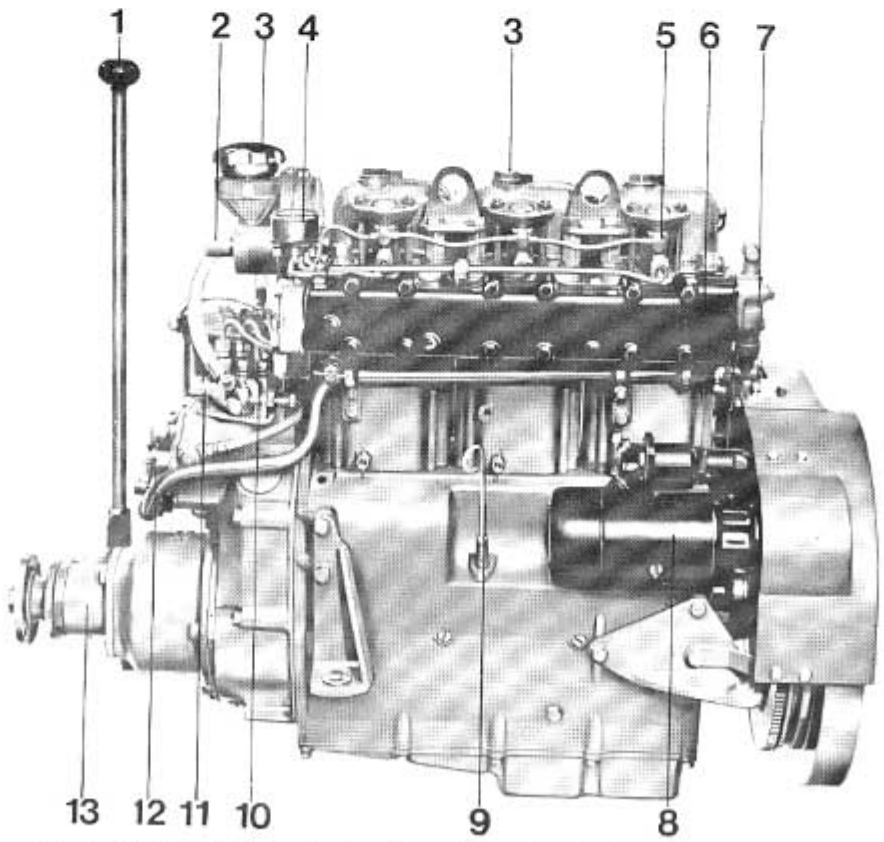


Fig. 3. MD 3B with reverse gear type RB, ratio 1,97:1 (Reference numbers, see page 2)

ENGINE BLOCK

DESCRIPTION

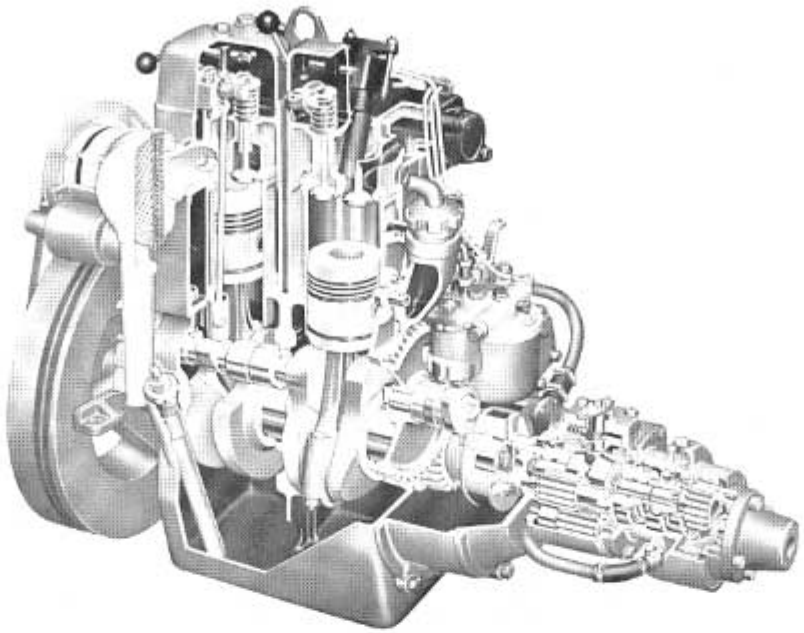


Fig. 4. View of MD 2B with reverse gear type MS, ratio 1,91:1

Cylinder block and crank case

The cylinder blocks, being identical and interchangable, are manufactured of cast iron. The cylinders are surrounded by a cooling water jacket. The crankcase is manufactured of cast iron and provided with an inspection cover. MD 3B has no inspection cover but is instead provided with a removable oil sump.

The cylinder block of the engine is kept in place by the cylinder head which in turn is bolted to the crank case by means of long bolts.

Cylinder head and valves

The cylinder head, one for each cylinder, is manufactured of a special alloy cast iron with high heat resistance.

The injectors are mounted in thinn copper sleaves, which are cooled directly by the cooling water. An effective cooling of the injectors is hereby secured.

The valves are mounted hanging in the cylinder head and are actuated by the camshaft via valve lifters, lifting rods and rocker arms.

The valves operate in replaceable valve guides. The clearance between the valve and the rocker arm is set by means of adjusting screws in the rocker arms.

The rocker arms are lubricated by an oil pipe which is connected to the lubricating oil pump.

The inlet valve is provided with a sealing ring against oil. Both inlet and outlet valves are provided with wear hats.

Piston, piston rings and piston rod

The piston rods are drop forged and tempered. The main bearing shells have a wear surface of lead bronze. The pistons are manufactured of light alloy and are provided with three compression rings and one oil scrape ring. The top compression ring is chromium plated in order to decrease cylinder wear. The piston top has a circular hollowness which is combustion chamber.

Gudgeon pin

The gudgeon pin is manufactured of steal and case hardened. The case hardening gives the gudgeon pin a very hard and wear resistant surface. At the same time the core still has left its toughness resulting in great tensile strength.

Crank shaft and main bearings

The crankshaft is made of drop forged steel and has surface hardened shaft journals. MD3B has four main bearings, MD2B has three and MD1B has two main bearings. The main bearing shells are exchangable and carry a wear-surface of lead-bronze.

REPAIR INSTRUCTIONS

COMPRESSION TESTING

To check the condition of the engine in a simple way it is possible to perform a compression test.

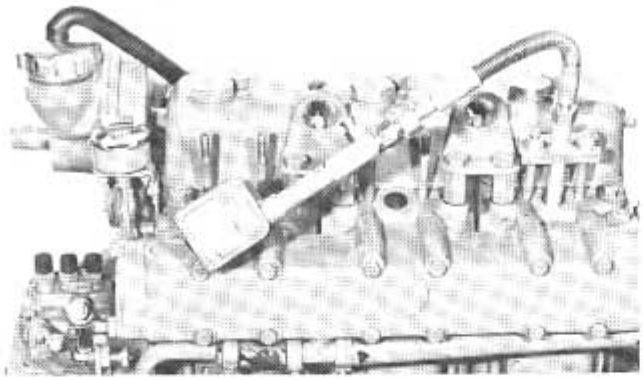


Fig. 5.

Engines with electrical starting:

1. Run the engine warm.
2. Remove the injectors and fit the compression gauge by turns in each cylinder, where the injectors have been mounted.
3. Move the speed control to zero position and turn the engine by using the starter, until the highest value has been measured on the compression gauge. NB Take care that the battery is in good condition. The pressure should be between 20–24 kp/cm^2 (285–340 p.s.i.). Most important is however that the difference in pressure between the cylinders is not exceeding 10%.
4. Low pressure in all cylinders might depend on big wear of piston rings and liners. Low pressure in one cylinder indicates untight valves or damaged piston rings.

Engines without electrical starting:

Fit the compression gauge as above. Move the decompression levers in upright position. Turn the engine as fast as possible by using the crank handle while pushing down the decompression lever for one cylinder at the time.

CYLINDER HEAD AND VALVE SYSTEM

Removing of cylinder head

1. Empty the cooling system.
4. Unscrew pressure-pipes and leak-off oil pipe. Fit protective caps.
5. Unscrew hose- and pipeconnections to exhaust manifold. Remove exhaust manifold.
6. Disconnect the oil-pipe-line from the rocker arm shafts and then remove the attaching screws holding the rocker arm brackets. Remove the rocker arm mechanism and the push rods. NB Mark the rocker arm brackets to make sure they are re-fitted correctly.

   Add for MD3B:
   Remove handstart device and, if exsisting, the bracket for the oil pressure gauge on the cylinder block.
7. Unscrew and remove the bolts and nuts holding the cylinder heads. Lift the cylinder heads straight upwards. Be careful not to damage the tip of the injectors.
8. Remove the cylinder head gasket.

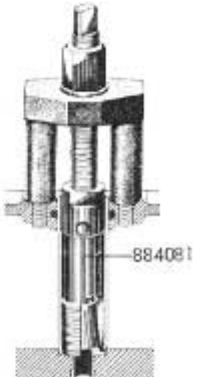
Disassembling the cylinder head

1. Unscrew and remove nuts holding the injectors. Pull out the injectors.
2. Remove the valve, valve springs and sealing rings for the inlet valves. Place the valves in the correct order in a valve stand.
3. Clean all parts. Be particularly careful with the cooling water channels. Examine tightness by test-pressurizing with a water-pressure of 3 kp/cm^2 (43 p.s.i.).

Replacement of copper sleeve and injector seal ring

Removing

1. Insert puller no. 884081 in the injector sleeve until it bottoms, with the yoke tubes over the stud bolts.



2. Turn the expanding tool spindle anti-clockwise thereby tensioning the spindle in the sleeve. Do not pull too hard but just enough to give the spindle a firm grip. (Fig. 6)
3. Tighten down the nut whereby the spindle and the sleeve are pulled up. Remove the sleeve and then take off the tool from the sleeve.
4. Remove the seal ring in the upper part of the cylinder head and clean the hole thoroughly, particularly the lower, thinner part. Make sure that the hole is smooth and free from rusting which could cause leakage on the new injector sleeve.

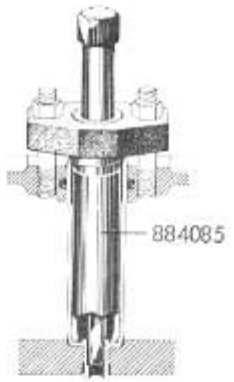


Fig. 8 Spreading of injector sleeve.

Fitting

1. Smear the new seal ring with grease and fit the seal ring in the slot in the cylinder head. Make sure the ring is correctly located and undamaged.
2. Fit the injector sleeve on tool no. 884077 and oil in the sleeve externally. Push down the tool with the sleeve in the cylinder head hole while the tool and sleeve are turned clockwise or anti-clockwise.

   As soon as the thin part of the sleeve is correctly located, drive it into position with a hammer and a drift. (Fig. 7)

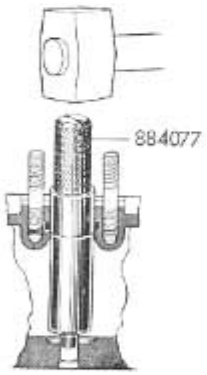


Fig. 7. Pressing in the injector sleeve

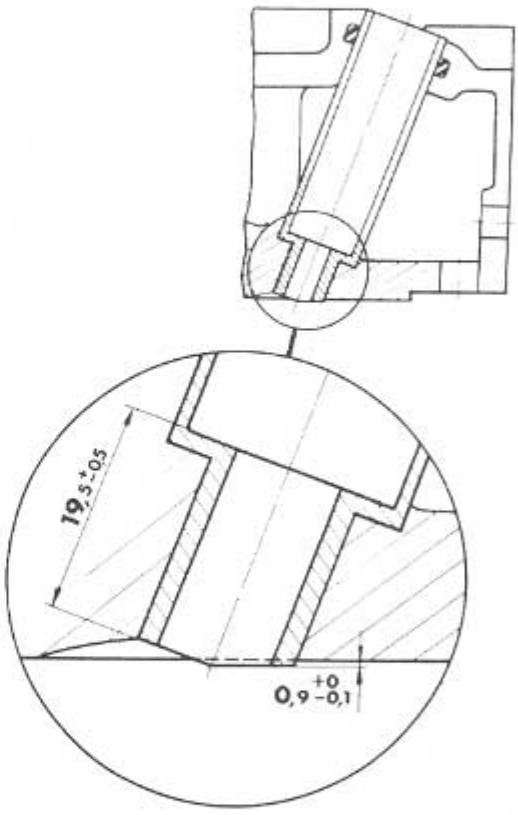


Fig. 9 Adjusting the injector sleeve.

3. Oil in the spreader tool no. 884085 (see Fig. 8) and push the tool down into the sleeve. (NB Check that the stud is enough unscrewed). Put some nuts or washers on the long attaching bolts allowing the yoke to be tightened with the attaching nuts.
4. Screw the tool as fas as the shoulder in the injector sleeve permits thereby spreading the injector sleeve. Remove the tool.
5. Then adjust the length of the sleeve as shown in Fig. no. 9.

Valve Guides

To measure the valve guide wear, fit a new valve in the guide and then measure the clearance with an indicator as shown on fig. no. 10.

See the specifications for wear tolerances under "Technical

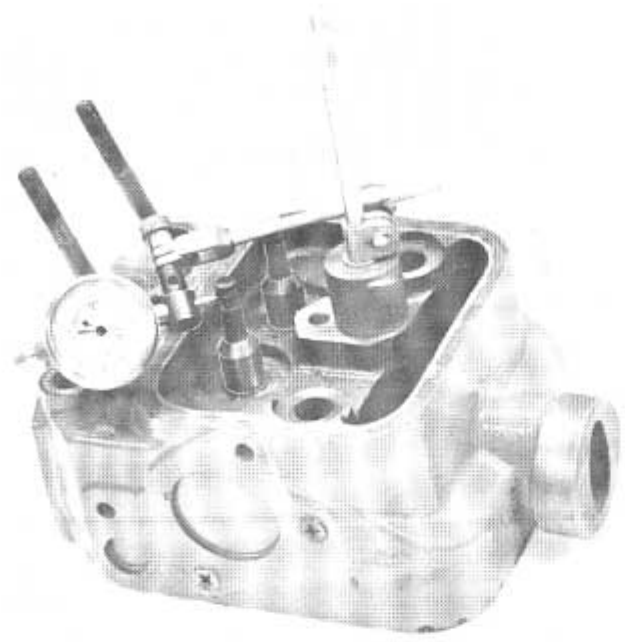


Fig. 10 Checking the valve guide wear.

Grinding valve seats and valves.

1. Before starting grinding, replace and ream the va guides if the wear tolerances have been exceeded.
2. Work the valve seats with a reamer or a grinding sto Do not grind off too much, just give the seat the ri shape and a good mating surface. The seat angle sho be 45° and the width 1,5 mm (.06") (see fig. 12). T width is adjusted by using a 30° resp. 60° rear or grinding stone.
3. Clean the valves and grind them in a machine. The s angle of the valves: 44,5°. The sealing surface is gri ed just enough to become clean. If less than 1 r (.04") edge is left on the valve disc, the valve should scrapped. Also if the stem is bent or if the meas "A", fig. 12, is exceeding 2,5 mm (.10"), the va should be scrapped. If this measure is exceeded a when using a new valve, the cylinder head must be placed.
4. Grind the valves, using grinding compound, and che the mating with marking-ink.

Replacing valve guides

1. Press out the valve guides using tool no. 9991459 as per fig. no. 11.
2. Oil in the guides externally and press them in using tool no. 884499 which gives the guide the correct height above the cylinder head spring plane. After the guides being pressed in the distance "A" should be 18 mm (.71"). (See fig. 11)
3. Ream the valve guides using tool no. 9994128.

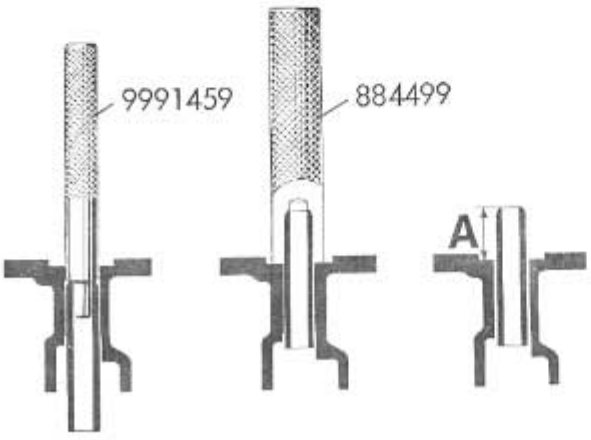


Fig. 12. Data for grinding of valves and valve seats

A = max 2,5 mm (.10")	C = 45°
B = 1,5 mm (.06")	D = 44,5°

Checking the valve springs

The valve springs are checked for straightness, length a tension. This is carried out in a spring tester. The spri must have the values shown in "Technical Data".

Push rods

The push rods should be straight throughout their en length. This can be checked by using a face-plate. If the viations are not too large, the push rods can be rectified

Valve lifters

Check the valve lifters for wear. The bearing surface against the cylinder block must not be scratched or porous. The contact surface against the camshaft must not be rugged or unevenly worn. Change valve lifters if necessary.

Rocker arm mechanism

1. Remove the lock rings on the rocker arm shaft and remove rocker arms from the shaft.

   NB The rocker arms are different form each other. Mark them to make sure they are correctly fitted.

2. Clean the various parts. Make sure to clean the oil channels of the rocker arm shaft and the oil holes and the rocker arms.

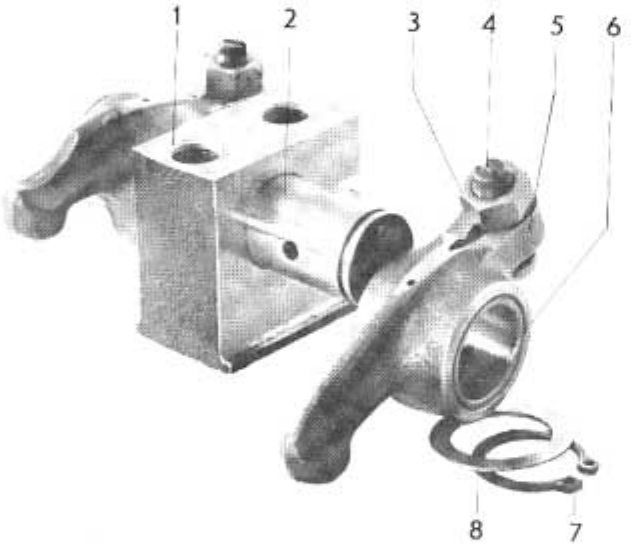


Fig. 13 Rocker arm mechanism

1. Bearing bracket
2. Rocker arm shaft
3. Locknut
4. Adjusting screw
5. Rocker arm
6. Bushing
7. Lockring
8. Washer

3. Check for rocker arm shaft wear. Check also the spherical part of the adjusting screw for deformation or wear. The threads must be undamaged on the screw and locknut. The spherical surface of the rocker arm contact surface against the valve stem must not be worn or pitted. Adjustment can be carried out in the grinding machine in case of slight wear.

4. Oval-worn rocker arm bushings must be replaced. Use a drift to press them out and in. When the bushing is pressed in, the oil hole must be located as shown on fig. no. 14. After pressing in, ream the bushing to a close running fit on the shaft. Remove all metallic fragments.

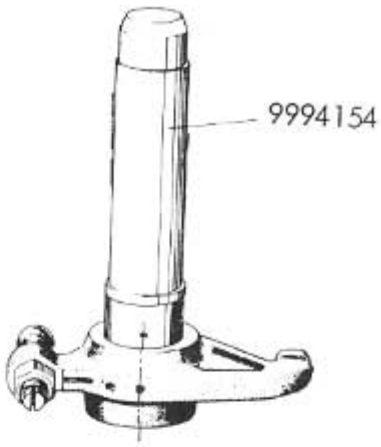


Fig. 14 Replacing a rocker arm bushing

Assembling the cylinder head

1. Oil in the new seal rings for the inlet valves. Place the pin of tool no. 884497 in the valve guide hole. Push the seal ring over the pin and knock carefully down the sealring, using the sleeve (see fig. no. 15). When the pin bottoms in the sleeve the sealring is in its right position.

2. Oil in the valve stems and put some grease in the slots for the valve keys on the inlet valves. Place the valves in respective guides. NB Push in very carefully the inlet valves in order not to damage the sealrings.

3. Fit valve springs and washers. The valve springs are fitted with the tightly wound end against the cylinder head. Fit the wear hats.

4. Fit the injectors but do not tighten them.

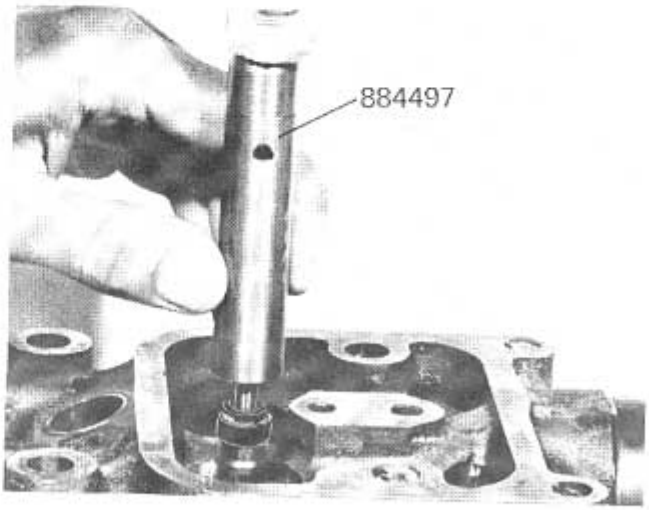


Fig. 15. Fitting of sealring for inlet valve

Fitting the cylinder head

If the cylinderhead has been replaced or if the cylinder block has been disassembled, the fitting must be done according to separate instructions (See "Adjusting the compression ratio")

2. Fit the cylinder heads without tightening them. If the handstarting device has been disassembled, that is on MD1B and MD2B, this should first be fitted properly.
3. Fit the exhaust manifold and tighten it just so much that it is lining up the cylinder heads. NB Turn the gaskets in the right direction, otherwise the cannels are sealed off, (completely or partly). The "ears" of the gasket should be turned upwards and the high, narrow hole should be turned facing the flywheel.
4. Tighten the cylinderbolts in steps and in the order shown in fig. no. 16. Use a torque wrench and tighten with the torque stated below.

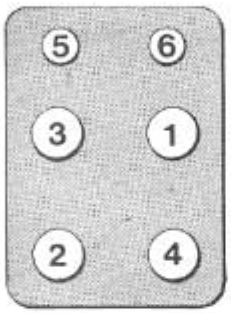


Fig. 16. Tightening diagram for cylinder head

Tightening torque:
No. 1, 2, 3 and 4 – 110 Nm (11 kpm) (80 lb.ft.)
No. 5 and 6 – 45 Nm (4,5 kpm) (33 lb.ft.)

5. Tighten the bolts for the exhaust manifold.
6. Fit the push rods and the rocker arm mechanism.
7. Connect the lubricating oil pipes to the rocker arm mechanism.
8. Adjust the valves and fit the valve cover and adjust the decompression mechanism, (see below).
9. Connect the fuel lines. Tighten the injectors.
10. Air-vent the fuel system (see separate head line).
11. Start the engine and run it warm. Retighten the cylinder bolts.
12. Remove the valve cover and fine-adjust the valves (see "Valve Adjustment" below). The clearance, with warm engine, should be 0,30 mm (.012") for inlet valves and 0,35 mm (.014") for exhaust valve.
13. Fit the valve cover and air cleaner and readjust the decompression device.

Adjusting the valves

After the cylinder head and cylinder block have been assembled, the valves are adjusted before the engine is started.

Watch the valves while turning the crankshaft with the crank handle. Turn until the inlet valve starts to open and the exhaust valve starts to close (the valves are "rocking"). Then turn the crankshaft one more turn and adjust the

With a warm engine, the clearance should be 0,30 (.012 for the inlet valves and 0,35 mm (.014") for the exhau valve.

Since the pistons are designed with the combustion cha ber in the piston crown, the pistons travel so high agair the valves that valve adjustment must never be carried o while the engine is running because of the risk of the valv coming in contact with the pistons, resulting in serio damage.

Adjusting the decompression device

The degree to which the decompression device press down the exhaust valve must always be checked when val clearance is checked. If the downward movement excee 0,5 mm (.02") there is a risk for piston damage.

The adjustment is carried out with the exhaust valve o loaded. Remove the oil filler plug on the valve cove Loosen the locknut and unscrew the adjusting screw. Th retighten the adjusting screw until it just reaches the rock arm. Tighten the adjusting screw one half turn further cc responding a downward movement of 0,5 mm (.02"). Th tighten the locknut.

CYLINDER BLOCK AND PISTON

Removing the cylinder block

1. Remove the cylinder heads according to previous i structions.
2. Remove the hand starting device.
3. Lift the cylinder blocks straight upwards.

Inspection of the cylinder block

After the block has been thoroughly cleaned and all c posits removed, examine tightness by test-pressurizing wi a water-pressure of 3 kp/cm^2 (43 p.s.i.).

Measuring the cylinder bore

The cylinder bore is subject to most wear at the upper pa and it therefore becomes tapered. The cylinders further b come oval. To obtain a complete picture of the conditi of the cylinders, measurements must therefore be carri out at several different points, both laterally and longitu

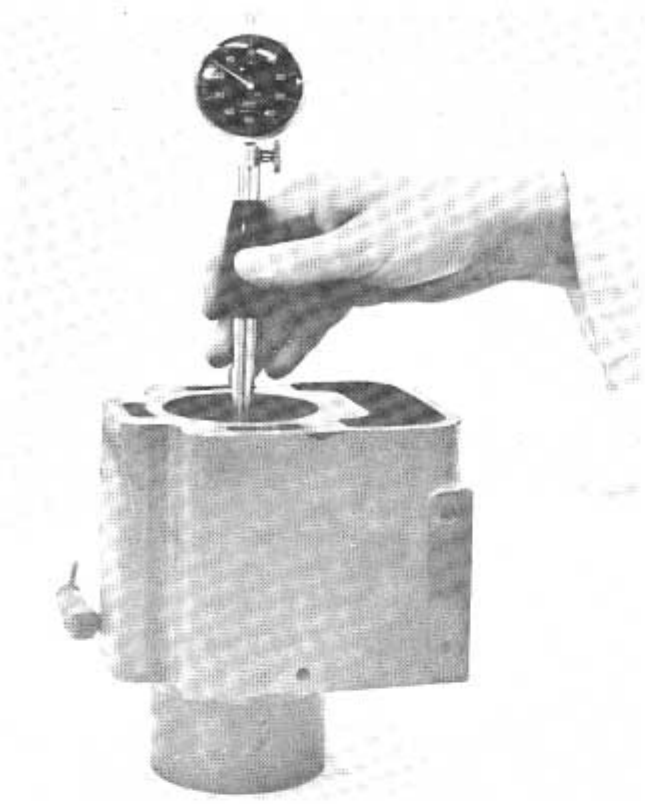


Fig. 17. Measuring cylinder bore wear

The degree of wear decides the steps to be taken. If there are scratches or scoring or if the wear exceeds 0,25 mm (.010") the cylinder block should be replaced.

Removing of pistons

1. Remove the cylinder head and cylinder block. See instructions under separat head-line.
2. **MD1B and MD2B:** Remove the inspection covers on the crankcase.

   MD3B: Remove the oil sump and the oil strainer.

   NB Do not forget to remove the rubber seals at the ends of the suction line of the oil pump.
3. Mark the connecting rods and bearing caps and remove the pistons.

Checking the pistons and fitting-in of piston rings

1. Check the pistons for scratches or other damages. Remove the piston rings with a piston ring plier.
2. Clean the pistons. NB Be particularly careful with the piston ring grooves.
3. Measure the pistons with a micrometer gauge. The
4. Check the clearence of the new piston rings in the piston ring grooves (see fig. no. 18).
5. Check the piston ring gap by pushing down a piston ring in the cylinder using a piston to push with, (see fig. no. 19). The measurement shall be taken below the lower turning point of the piston.
6. Fit the piston rings using a piston ring plier. Fit the oilring first. The oilring can be turned either way. The compression rings are fitted according to fig. no. 20. Be careful to distribute the ring openings evenly around the piston.

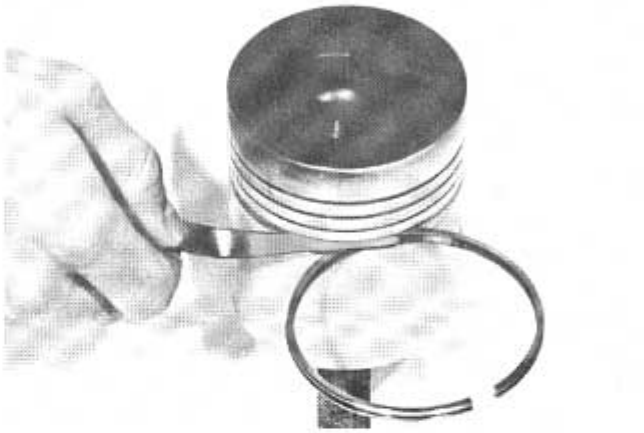


Fig. 18. Piston ring clearance in groove

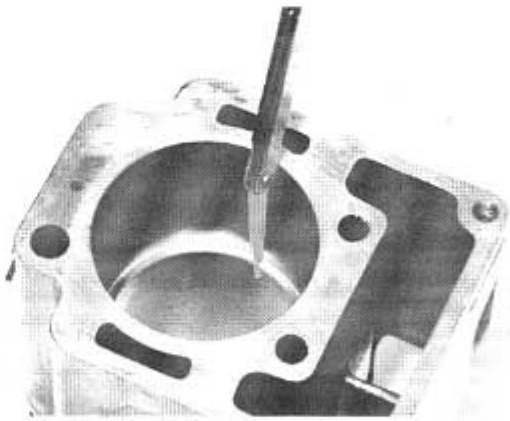
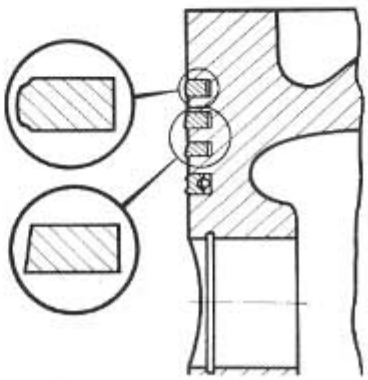


Fig. 19. Measuring the ring gap



Checking connecting rods

After careful cleaning check the connecting rods for straightness and distortion. Rectify if necessary.

The connecting rod bolts are always replaced when overhauling is done, because of the stresses working on them. Check the connecting rod bushings, preferably using the gudgeon pin as gauge. There must be noticeable clearance.

Replacing gudgeon pin and bushing

1. Mark the piston and connecting rod.
2. Remove the lockrings.
3. Press out the gudgeon pin using a drift.
4. Press out the old bushing.
5. Press in a new bushing. Make sure that the lubricating hole in the bushing indexes with the hole in the connecting rod.
6. Ream or diamond-drill the bushing to an accurate running fit. When clearance is correct the gudgeon pin should slide through the bushing under its own weight without noticeable clearance.
7. Oil in the gudgeon pin and connecting rod bushing.
8. Fit one of the circlips.
9. Warm up the piston to about 70°C (160°F). Fit together the piston and connecting rod.

   NB It should be possible to press in the gudgeon pin, never hammer it into place.
10. Fit the other circlip.
11. Check that the connecting rod runs easily in the connecting rod bearing.

Fitting the piston and cylinder block

Check the compression ratio after the fitting and adjust if necessary (See "Adjusting the compression ratio").

1. Clean the bearing races and crankshaft bearing journals.
2. Oil in the bearing surfaces with motor oil.
3. Fit piston and connecting rod in respective cylinder block using a piston ring compressor.

   NB Be sure to remove possible wear edges in the cylinder block.
4. Place an adjusting pad, thickness 0,2 mm (.008") on the lower connecting surface of the cylinder block.
5. Fit the cylinder block including the piston on the engine. Note. Turn the piston to the correct position. The recess in the piston top must be directly under the injector.
6. Fit and tighten the bearing caps. Tightening torque 65
7. **MD1B, MD2B:** Fit the inspection covers together wit new gaskets and "Fermatex".

   MD3B: Fit the oil strainer and the oil sump. Nl Replace the sealrings at the ends of the oil line of th oilpump. Oil them in and put them at the ends of th oil line (see fig. no. 36) before the oil line is fittec Replace also the gasket for the oil sump.
8. Adjust the compression ratio as per below.

Fitting the cylinder block (piston fitted)

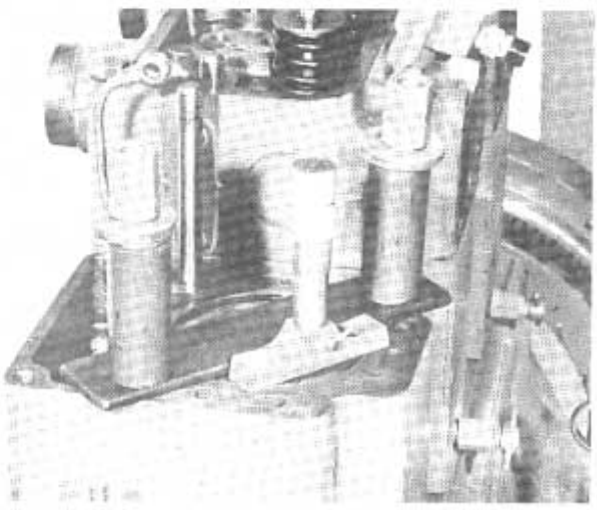
1. Oil in the cylinder bore. NB Possible wear edge must b removed.
2. Place the adjusting pad, thickness 0,2 mm (.008"), o the lower part of the contact surface of the cylinde block.
3. Press together the piston rings while the cylinder bloc is pushed down over the piston.
4. Adjust the compression ratio as per below.

Adjusting the compression ratio.

When replacing pistons, cylinder head and cylinder block the clearance between the piston and the cylinder hea must be measured. If this is not done, there is a risk th engine will run roughly or not provide the right output.

1. Clean carefully all contact surfaces.
2. Fit the piston (See "Fitting the piston")
3. Fit the cylinder block. Make sure that there is always an 0,2 mm (0.008") shim or adjusting pad between the cylinder block and the crankcase.

   The adjusting pads are available in thicknesses 0,2 and 0,3 mm (.008" and .012").
4. Tighten the cylinder block against the crankcase (See fig. no. 21).



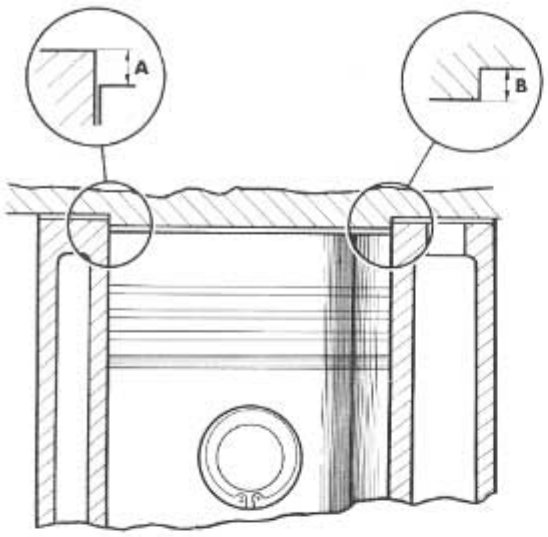


Fig. 22.

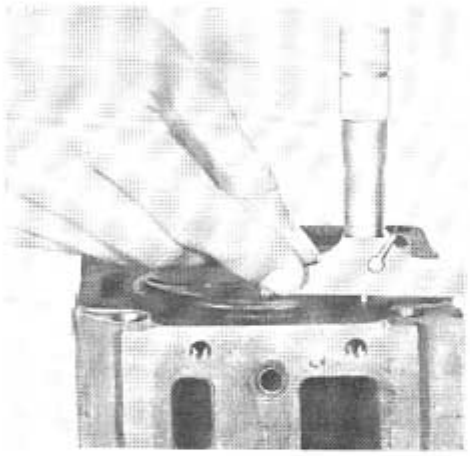


Fig. 23. Measuring the measurement "B" according to fig. no. 22

5. Move the piston to its top position.
6. Measure the distance from the upper part of the cylinder block to the piston using an indicator gauge or a depth micrometer, (see fig's nos. 21 and 22).

   To this measurement "A", according to fig. no. 22, add 1,2 mm (.047"), which is the thickness of a compressed cylinder head gasket.

7. Then measure the height difference between the downward projecting part of the cylinder head and the mating surface (see fig. no. 23). This measurement corresponds "B" according to fig. no. 22. From the value "A" +1,2 (.047") mm subtract "B". The resulting value should be 0,8 – 0,9 mm (.031–.035"). Try to be as near 0.8 mm (.031") as possible.

   Example: "A" = 2,9 mm and "B" = 3,5 mm
   2,9 + 1,2 = 4,1

   This means that a further 0,2 mm (.008") shim must be fitted.

   If it is found that measurement "A" is so large that the clearance 0,8–0,9 mm (.031"–.035) cannot be obtained with an 0,2 mm (.008") shim, the upper surface of the cylinder block must be ground. This work requires great precision and should be carried out by a specialized workshop.

8. After having decided the shim thickness, remove the cylinder block and fit the required number of shims.
9. Before placing the cylinder block in position, inspect it. If cylinder wear is slight, the wear edge at the top of the bore does not need removing.
10. Compress the piston rings while pushing down the cylinder block over the piston.
11. Put the new cylinder head gasket on the cylinder and fit the cylinder head (See "Fitting the cylinder head").

Checking the compression ratio

(Engine not disassembled)

1. Remove the injectors.
2. Put down a lead wire, diameter approx. 2 mm (.08"), 50–60 mm (2,0"–2,4") into the cylinder (the piston must not be in T.D.C.)
3. Keep the lead wire in this position and turn the engine and let the piston pass T.D.C. Pull out carefully the lead wire.
4. Measure with a micrometer the part of the lead wire flatted by the piston. The measurement should be 0.8–0,9 mm (.031"–.035"). If this measurement is not correct, the compression ratio must be adjusted (See "Adjusting the compression ratio").

CAMSHAFT

Removing the camshaft

1. Remove the cylinder heads (see instructions on page 5).
2. Remove the timing gear casing (see instructions on page 16).
3. Lift up the valve lifters and place them in order in a stand.
4. Remove the carrier-bolt on the rear end of the camshaft. NB This bolt is left-hand threaded.
5. Pull off the cam disc and the gear at the same time from the shaft.
6. Loosen and remove the thrust flange which is located behind the gear.
7. Then pull the camshaft straight out to avoid damaging

Replacing camshaft bearings

The bearings are pressed into their recesses and are line-bored after being pressed in, so that camshaft bearing replacement can only be carried out when the engine is completely disassembled.

When pressing in the bearings make sure that they are pressed in in a way that the oil holes index with the corresponding oil drillings in the block.

Fitting of camshaft

1. Oil in the bearing races and slide in the camshaft. Be careful not to damage the bearings. NB If the oil pump is fitted, the camshaft must be turned so that it engages in the oil pump cog clutch.
2. Fit the thrust flange and secure the bolts. NB There is a cut on the inside of the thrust-plate which must be located facing the small oil hole in the crankcase.
3. Check the woodruff-key for damages and fit it on the shaft. (NB MD3B has two woodruff-keys).
4. Fit the camshaft gear and cam disc. NB The punch marks on the camshaft gear must register with the punch mark on the crankshaft, see fig. no. 24.
5. Tighten the carrier bolt. Tightening torque MD1B, MD2B: 80 Nm (8 kpm) (58 lb.ft.) MD3B: 320 Nm (32 kpm) (231 lb.ft.).
6. Fit the timing gear casing. Use a new gasket and smear it with "Permatex" or similar compound.
7. Fit the feed pump, manual starter, valve lifters, pus rods, cylinder head, etc. For special instructions se under respective head line.

CRANKSHAFT

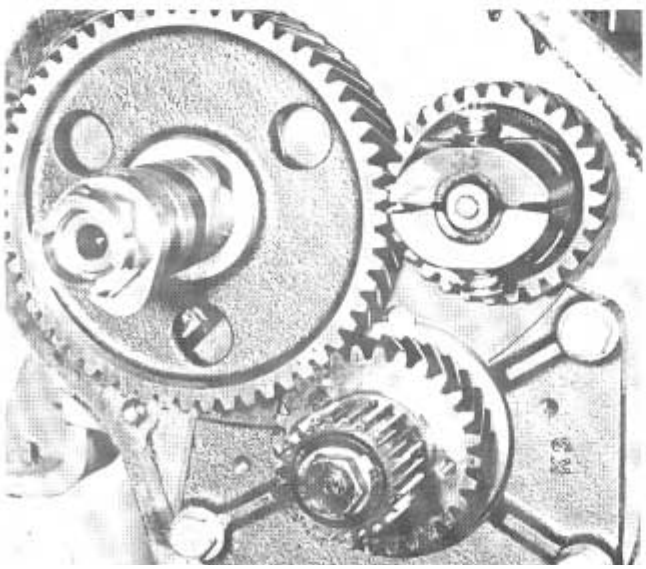
Removing of crankshaft

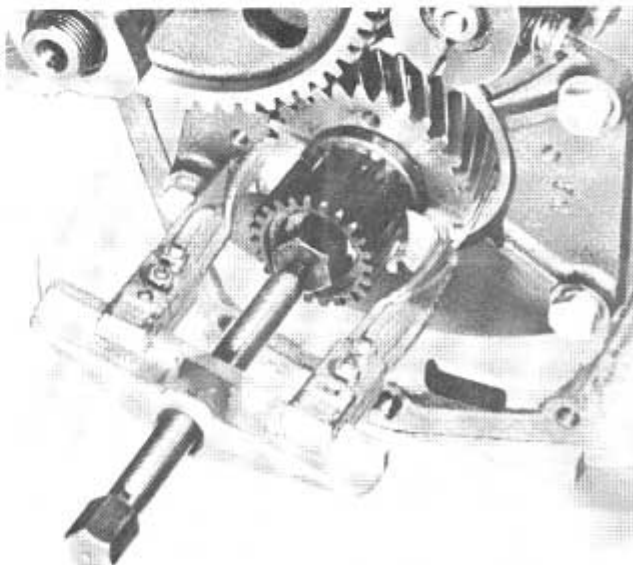
As regards the cylinder head, cylinder block and piston please see under respective head line.

1. Untighten and remove the reverse gear.
2. Remove the flywheel (see "Replacing the crankshaf sealring") and the woodruff-key. Remove the fron bearing housing on MD1B and MD2B.
3. Untighten and remove the bolt in the rear end of th crankshaft.
4. Then pull off the outer gear using a puller according t fig. no. 25.

   On engines provided with a MS-reverse gear instead pu off the coupling-half.
5. Pull off the inner crankshaft gear. Use tool no. 884078
6. Unscrew the left-hand threaded carrier on the camshaf and pull off the cam disc and the camshaft gear using puller.

MD3B: Pull off the bearing shield using a puller as per fig no. 26.





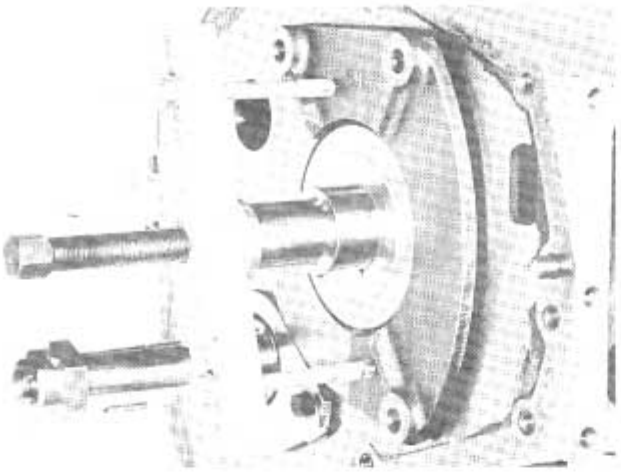


Fig. 26.

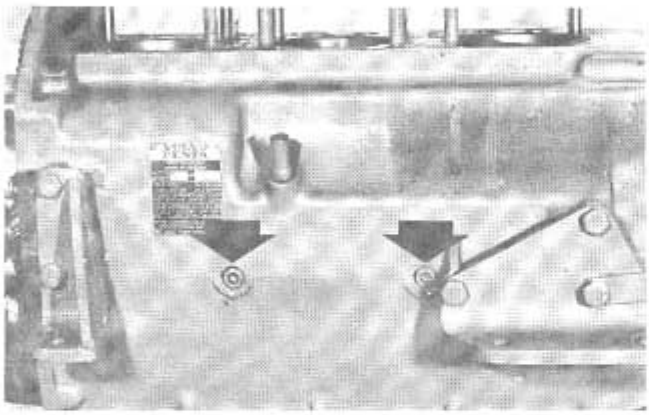


Fig. 27. Locking screws for intermediate bearings, MD3B

MD2B, MD3B: Untighten and remove stopscrew, which is located facing the intermediate bearing in the engine block, see fig. no. 27.

MD1B, MD2B: Pull out the crankshaft through the hole in the front of the crankcase.

MD3B: Pull out the crankshaft through the hole in the rear of the crankcase.

Checking the crankshaft

Remove the intermediate bearings (MD2B, MD3B) and clean the crankshaft. Then check and measure the end journals of the crankshaft. Regarding measurements see "Technical Data". If too big ovality or taper is found when measuring, it is possible to grind the crankshaft to under-dimension.

Replacing main bearings

1. Hammer out or press out the old bearing using the drift (1) as per fig. no. 28, or tool no. 884489.

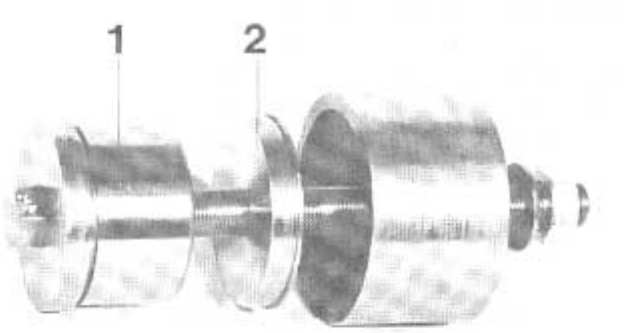


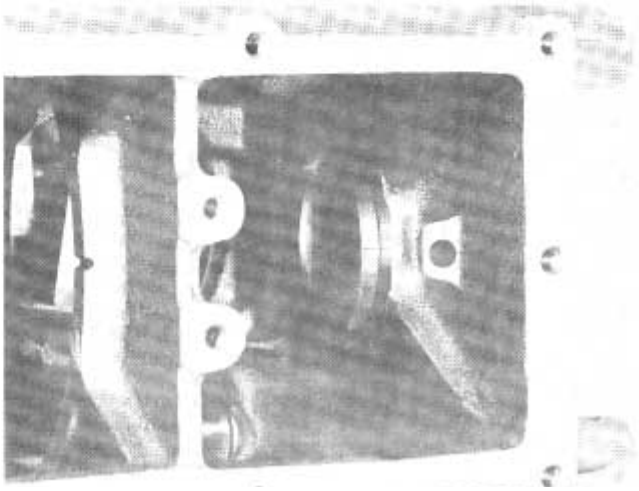
Fig. 28. Tool (884489) for removal and fitting of main bearings

1 = Drift (Fits also to standard handle no. 9991801.
2 = Guide (used for MD3B)

2. Put together the bearing halves using a rubber-cord and line the bearing for a correct position (the locking-tounges must fit into the corresponding recess in the bearing socket). Press in the bearing using tool no. 884489 or a hydraulic press.

When fitting the forward main bearing on MD3B perform as follows:

3. Push in one bearing half into its location, in a way that the locking-tounge on the bearing half is located facing the recess in the block.
4. Pull the bearing half straight backwards approx. 10 mm (.4") and make a mark on its outside and a corresponding mark in the block (see fig. no. 29).
5. Take out the bearing half again and put both halves together using a rubber cord. Press in the bearing, using the tool no. 884489, so that the marks fit.



Fitting the crankshaft

1. Check the cleaning of the crankshaft drillings and the contact surfaces for the bearing shells. Oil in the end journals.

   MD2B, MD3B: Fit the intermediate bearings on the crankshaft. Tightening torque 80 Nm (8,0 kpm) (58 lb.ft.).

2. Put some grease on the 2 axial washers and then put one of them onto the shaft. Turn the flat faced side against the rear main bearing.

3. Fit the crankshaft into the crankcase. Make sure that the "ear" of the axial washer fits into the corresponding recess in the crankcase. On MD3B this recess is to be found in the bearing shield.

   MD2B, MD3B: Make sure that the hole for the locking screw of the intermediate bearing is indexing the corresponding hole in the crankcase. Replace the O-ring on the locking-screw for the intermediate bearing. Wind thread-tape on the threads and then "Permatex" outside on the thread-tape. Fit the locking-screw until it bottoms. Then unscrew it half a turn.

   MD3B: Fit the bearing shield in the corresponding holes in the rear of the crankcase. Make sure that the "ear" of the axial washer fits into the recess in the shield.

4. Fit the outer axial washer (the flat faced side turned against the rear main bearing). Make sure the "ear" of the washer fits into the corresponding recess in the crankcase and bearing shield respectively).

5. Fit the spacer (turn the flat faced side against the rear main bearing).

6. Fit the timing gear on the crankshaft. Fit also the outer gear and coupling half respectively and then lock it with the screw. Tightening torque – see "Technical Data".

   On some engines the gear and coupling half must be warmed up to approx. 150°C (300°F) to make it possible to fit them.

7. Check the axial clearance using a dial test indicator. If no axial clearance: Check the location of the axial washers.

8. Fit the camshaft timing gear and the cam disc on the camshaft. Make sure they are correctly located according to the marking (see fig. no. 24). Tighten the left-hand threaded carrier screw. Tightening torque – see "Technical Data".

   MD1B, MD2B: Clean the front bearing housing and fit new sealing rings in the grooves of the bearing housing (see fig. no. 30). Oil in the sealing rings to avoid damaging them. Fit the bearing housing.

9. Fit the forward crankshaft sealing ring, flywheel,

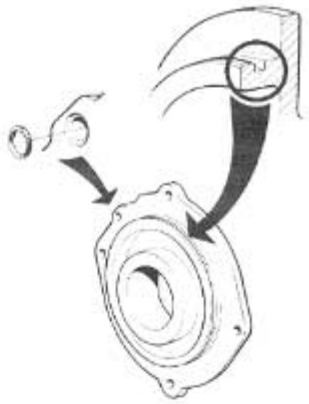


Fig. 30. Sealing crankcase – bearing housing, MD1B, MD2B

Replacing the crankshaft sealring

MD3B: Remove the V-belt guard.

1. Remove the generator stretcher and remove the V-belts.
2. Untighten and remove the nut holding the flywheel.
3. Pull off the flywheel using puller no. 884078.
4. Remove the woodruff-key.

   MD1B, MD2B: Untighten and remove the sealing cover.

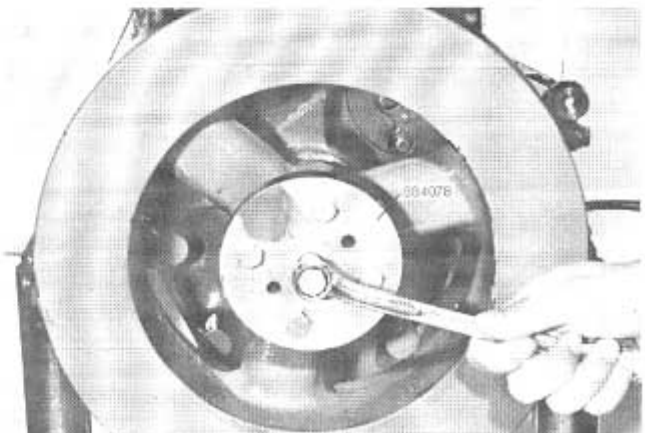
5. Tape over the key-way in the crankshaft and put grease on the crankshaft to avoid damaging the selaing ring when fitted.

   MD1B, MD2B: Fit the new sealing ring in the sealing cover. Fit the cover together with a new gasket.

   MD3B: Fit a new sealing ring for the crankshaft.

6. Remove the tape, fit the woodruff-key and then fit the flywheel. Tightening torque – 700 Nm (70 kpm) (506 lb.ft.). Use a new lock washer.
7. Fit the V-belts and adjust the V-belt tension.

   MD3B: Fit the V-belt guard.



Removing the timing gear casing

1. Loosen and remove the manual starter. Loosen and remove the inspection cover on the timing gear casing.
2. Loosen and remove coupling or gearbox if mounted.
3. Remove the feed-pump and injection pump.
4. Loosen and remove tubes and hoses which have connection with the time gear casing.
5. Remove the timing gear casing.

   The fitting is done in the reversed order. As regards fitting of the injection pump, see "Fuel System".

   Use a new gasket and smear it with "Permatex" or corresponding compound.

HAND STARTER

MD1B and MD2B

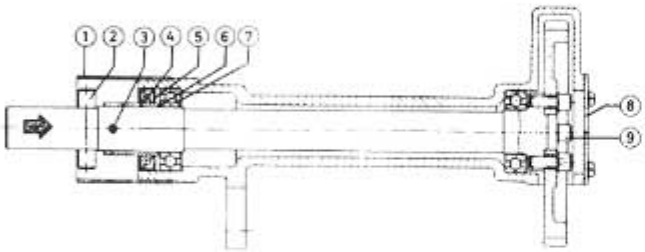


Fig. 32. Hand starter, MD1B, MD2B.

If only the sealing ring (5) and the O-ring (6) must be replaced, follow points 4, 5, 6 and 8. Removal of the ball bearing (7) is not necessary. Refit in the reversed order.

1. Loosen and remove the hand starter.
2. Remove the cover (8, fig. no. 32).
3. Loosen the screws (9) and remove the gear.
4. Knock loose the sleeve (1) pressed on the housing.
5. Drive out the pin (2), use support under the shaft.
6. Drive out the spring pin (3) and pull off the sleeve (4).
7. Press the shaft out of the housing. Press as shown by the arrow, see fig. no. 32.
8. Remove the sealing ring (5), the O-ring (6) and the ball bearing (7).

Refitting in reverse order. Replace the sealing ring. Before pressing the shaft into the housing, fill the space between the sealing ring and ball bearing and the large space behind the ball bearing with heat resistant grease.

When the manual start has been refitted, check if there is a play between the gear of the hand starter and the gear of the camshaft. If there is no clearance, increase the number

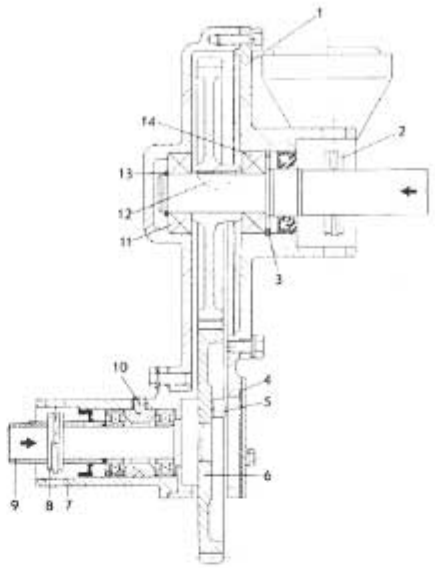


Fig. 33. Hand starter, MD3B (later execution)

MD3B

Removing

1. Unscrew the oil pipe for the cold starting device.
2. On engines with oilpressure gauge: Remove the oilpipe and the bracket for the oilpressure gauge.
3. Remove the hand starter.

Disassembling

1. Loosen and remove the cover (1, fig. no. 33) together with the gear and the shaft.
2. Remove the pin (2) and press out the shaft in the direction indicated by the arrow.
3. If the bearings (11 and 14) are to be removed, loosen first the lockring (3). NB The key (12) must be removed before the bearing (14) is taken out.
4. Remove the cover (4).
5. Remove the screws (5) and the gear (6).
6. Remove the sleeve (7).
7. Remove the pin (8) and pull out the sleeve (9).
8. Press out the shaft in the direction indicated by the arrow.
9. Remove the lock-screw (10) and press out the bearings, spacer and the sealing ring.

Refit in the reversed order. Replace the sealing rings.

Grease the bearings and fill the spaces close to the bearings with heat-resistant grease.

Before fitting check the clearance between the two gears. The cover (4) is not to be tightened until the hand starter has been fitted on the engine. Check through the opening if there is a clearance between the lower gear of the hand starter and the camshaft gear. If there is no clearance increase the number of gaskets between the hand starter and

LUBRICATING SYSTEM

DESCRIPTION

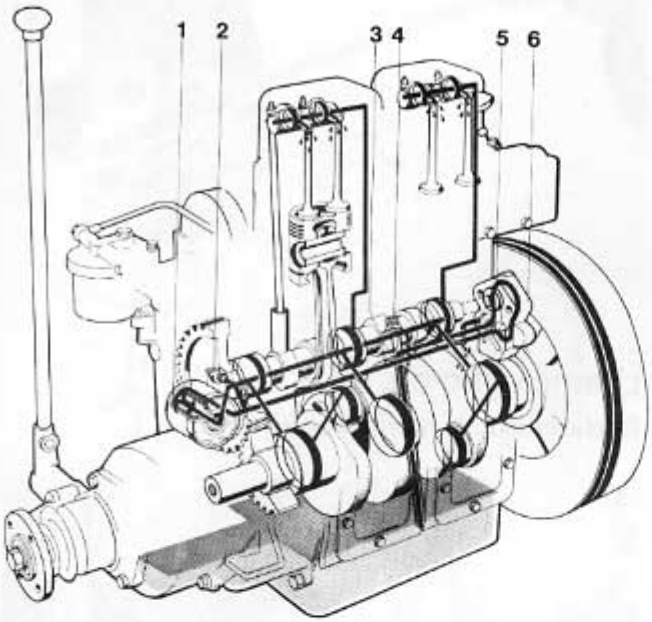


Fig. 34. Lubricating system, MD2B with reverse gear type RB

1. Oil filter
2. Oil pressure sending unit
3. Oil strainer
4. Oil dip stick
5. Reduction valve
6. Oil sump

The engine is provided with a complete pressure lubricating system, figurized in fig. 34. The pressure is produced by a gearpump. The pump suctions oil from the oil sump through a strainer and a suction pipe. Inside the oilpump there is a reduction valve, restraining the pressure from getting too high. From the pump the oil is forced through an oilfilter and further out into the oil-channels of the lubricating system. An oil pressure contact with a warning lamp or a pressure gauge is also included in the system, allowing the oil pressure to be checked.

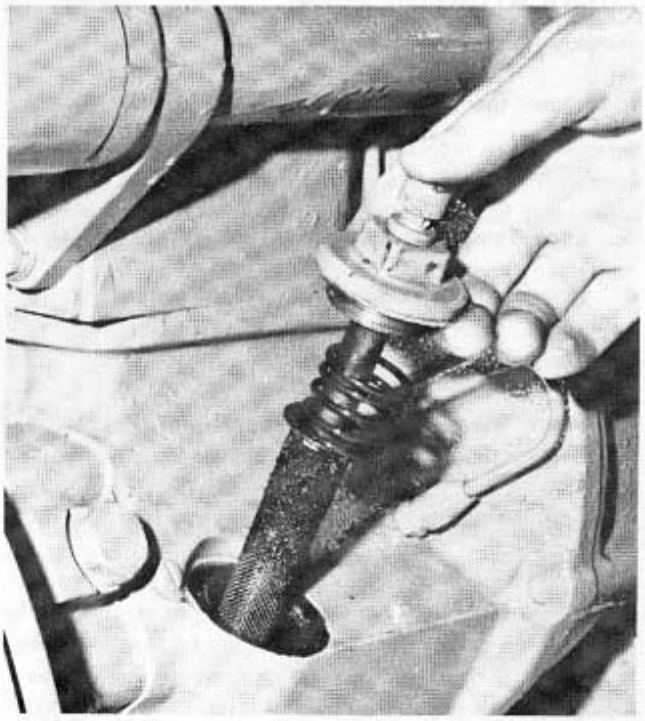


Fig. 35. Removing the oil strainer, MD1B

REPAIR INSTRUCTIONS

OIL STRAINER

MD1B and MD2B

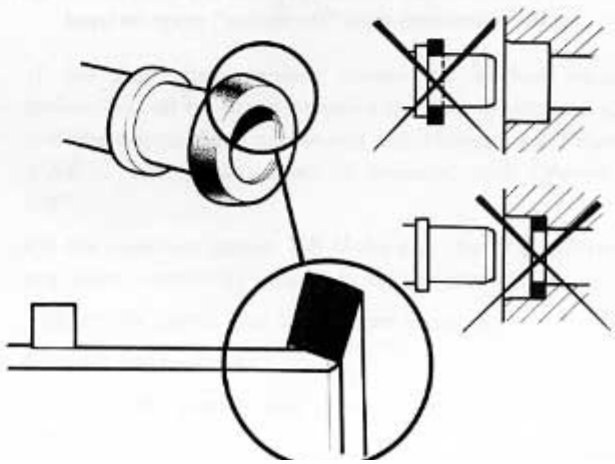
The oil strainer should be removed and cleaned after every 100 hours of operation.

1. Loosen the square nut on the strainer. Lift up the strainer as shown in fig. no. 35.
2. Clean the strainer in fuel oil or white spirit and refit it.

MD3B

The oil strainer needs only to be removed and cleaned when the engine is disassembled for overhaul. The oil strainer can be removed when the oil sump is taken away.

1. Disassemble the strainer and pull off the suction pipe.
2. Clean the parts and refit the strainer.
3. Remove the old sealing rings for the suction pipe. Oil in the new sealing rings and put them on the suction pipe as shown in fig. no. 36.
4. Push in the suction pipe in the strainer housing and then into the engine block.
5. Tighten the strainer in the block.



LUBRICATING OIL PUMP

Removing and disassembling

1. Loosen the three screws holding the pump.
2. Remove the oil pump.
3. Loosen and remove the cover (save the old gasket).
4. Remove the gears, the spring and the piston.
5. Clean all parts carefully.
6. Check the levelness of the cover and possible wear. Replace or surface-grind it if necessary.
7. Test the spring of the reduction valve (see "Technical Data").
8. Check the axial clearance according to fig. no. 37. NB The old gasket shall be used when taking the measurement. If necessary increase or decrease the number of gaskets to get at clearance of 0,02–0,11 mm (.001"–.004"). The thickness of a new gasket is 0,10 mm (.0039").

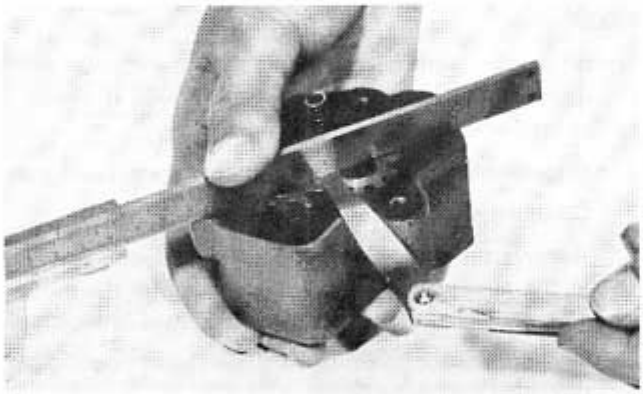


Fig. 37. Measuring the axial clearance

9. When assembling and fitting the pump, which is done in reverse order compared with the disassembling, new gaskets smeared with "Permatex" must be used.

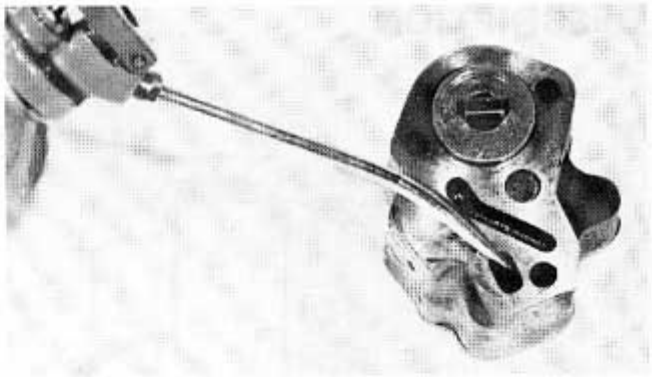


Fig. 38.

LUBRICATING OIL FILTER

Replacement of lubricating oil filter

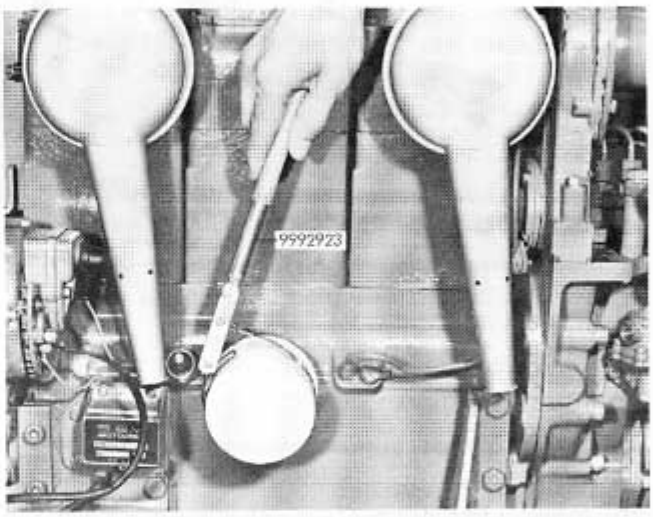


Fig. 39. Replacing the lubricating oil filter.

1. Remove the old oil filter using tool 9992923.
2. Smear oil on the rubber gasket of the new filter and check that the contact surface on the engine is free from dirt. Screw on the oil filter by hand until it just touches the crankcase.
3. Screw then on the filter a further half turn, not more. Start the engine and check for leakage.

FUEL SYSTEM

DESCRIPTION

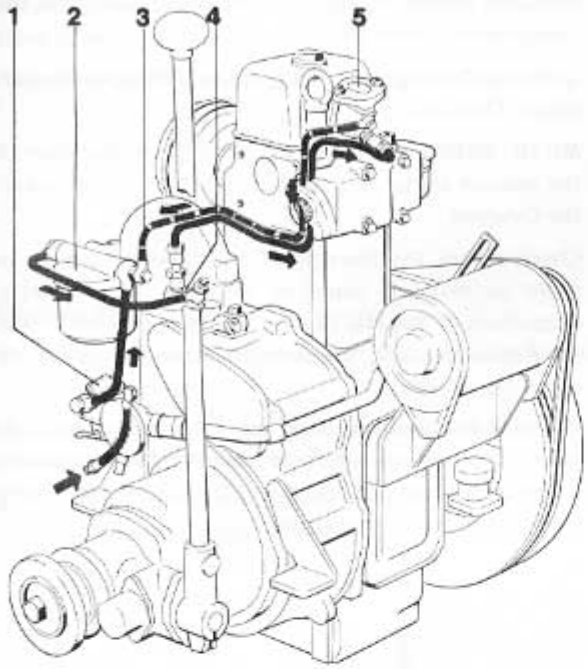


Fig. 40. Fuel system, MD1B

1. Feed pump with pre-filter
2. Fuel filter
3. Leak-off fuel pipe
4. Injection pump
5. Injector

The fuel system consists of feed pump with pre-filter, injection pump with governor, fuel filter, pipes and injector.

Fuel is sucked by the feed pump from the fuel tank through the pre-filter and forced through the fuel filter to the injection pump. Feed pump and injection pump are driven by the camshaft.

REPAIR INSTRUCTIONS

The greatest cleanliness must be observed when working on the fuel system and its equipment.

INJECTION PUMP

Removing

1. Loosen all pipe connections and fit protective caps.
2. Remove the inspection cover from the timing gear casing.
4. Lift the pump straight up. If this would not work it might depend upon the control arm is sticking in the timing gear casing. If so push the speed control in either direction.

NB Repair works including adjustment to the internal pump components which can alter their settings may only be carried out by authorized Diesel Workshops using the required tools and test devices.

Fitting

1. Clean around the pump attachment.
2. Measure the distance from the attaching surface on the timing gear casing to the pump cam basic circle, see fig. no. 41, (the cam shall be turned facing the crankshaft). Use a depth micrometer or sliding calliper to take the measurement. The measurement should be 82,8±0,2 mm (3,260±.008"). This measurement includes compressed gasket between pump flange and the timing gear casing. This measurement must agree if the injection angle is to be correct.

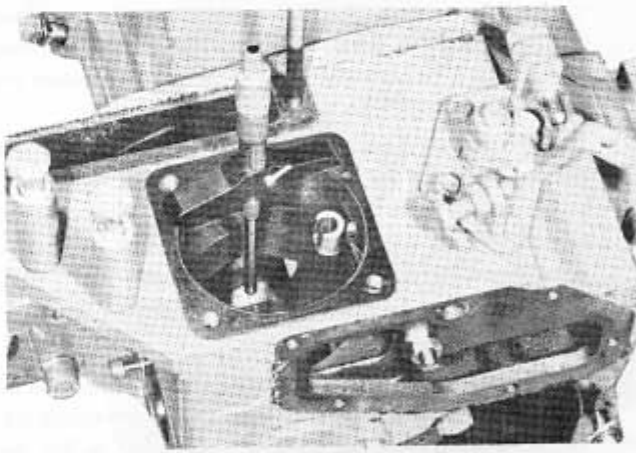


Fig. 41.

3. If the given measurement cannot be reached more gaskets has to be fitted between the timing gear casing and the pump. Each gasket has a thickness of 0,2 mm (.008"). The gaskets shall be smeared with "Permatex".
4. Fit the injection pump. NB Make sure that the control arm cube is correctly located in the governor lever.
5. Tighten the pump. Use new copper washers.
6. Connect the fuel lines.
7. Air-vent the system (see "Air-venting the fuel system").

Adjusting the control rod travel

The exact injection quantity can only be produced by running the pump in a test bench. A rough adjustment can, however, be done by measuring and adjusting the length of the travel of the control rod from zero-position to maximum position. **NB The cold starting device must not be connected while measuring.**

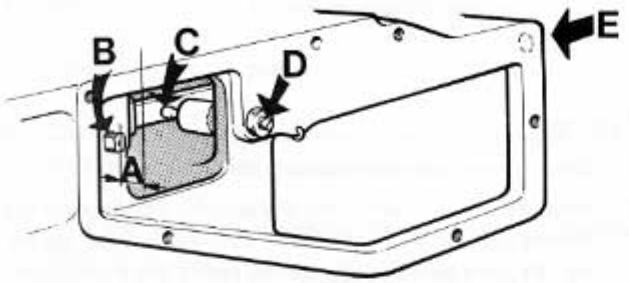


Fig. 42. Measuring the control rod travel: MD3B.

A = Measurement between the maximum position of the control rod and the contact surface of the inspection cover.
B = Control rod
C = Cold starting device
D = Adjusting screw
E = Connection for oil pipe

1. Remove the inspection cover from the timing gear casing. Measure the distance from the contact surface of the inspection cover to the end of the control rod when this is completely pressed in (as far forward on the engine as possible).
2. Measure the distance between the contact surface and the control rod when this stands in its maximum position. NB The cold starting device must not be engaged while taking the measurement. To get a correct measurement on MD3B connect first compressed air of 1 kp/cm^2 (14 p.s.i.) to connection point E, see fig. no. 42.
3. The difference between the two measurements shall be 8,2±0.1 mm (.323"±.004"). Adjust the control rod travel if necessary by adjusting the screw (D on fig. no. 42) inwards and outwards respectively.

Checking the injection angle

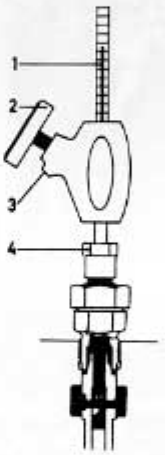
When checking the injection angle use a "Wilbaer-tube". The test is done on the cylinder closest to the timing gear casing.

1. Fit the "Wilbaer tube" on the delivery pipe nipple.

   MD1B, MD2B: Adjust the pump for highest feeding. The cold starting device must no be engaged.

   MD3B: Remove the inspection cover on the timing gear casing and adjust the control rod of the pump so that its rear end is even with the rear edge of the pump housing.
2. Turn the engine in the right direction of rotation until
3. Open up the level valve on the testing device so that the level is 25–30 mm high, counted from below.
4. Turn the engine in the direction of rotation until the compression stroke starts.
5. Continue turning until the fuel starts rising in the glass gauge. Then stop.

   MD1B, MD2B: Place tool no. 884057 on the shaft of the manual starter so that the marked part is resting on the flywheel.
6. Check where the marking of the flywheel stands. In order to make it easier to perform this on earlier executions of the MD3B, not having inspection hole in the flywheel guard, make a hole in the flywheel guard as per fig. no. 44.
7. If the injection angle does not agree with prescribed value, increase or decrease the number of gaskets between the pump housing and the timing gear casing until correct value is received.



1. Glass gauge (fuel level)
2. Level valve control
3. Testing device housing
4. Connection nipple

Fig. 43. Level control (Wilbaer tube)

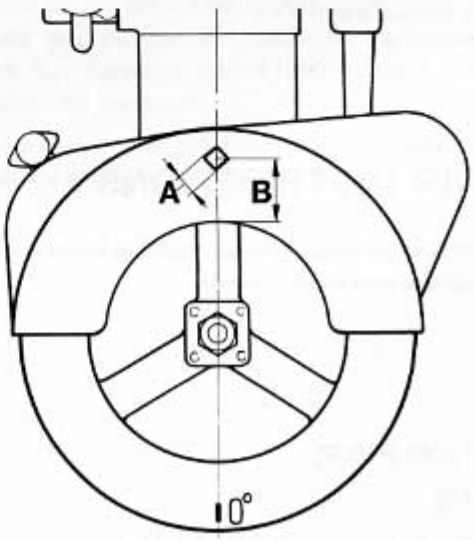


Fig. 44. Hole in the flywheel guard on earlier executions of MD3B.

INJECTORS

Checking and adjusting the injectors must be done in a nozzle testing device in accordance with the recommendations of the manufacturer.

Regarding opening pressure, see "Technical Data".

Removing

1. Clean the injector, delivery pipe and cylinder head round the injector.
2. Unscrew the delivery pipe and leak off line from the injectors. Fit protective caps.
3. Loosen both nuts retaining the injector to the cylinder head and lift up the injector.

Fitting

1. Turn the engine over a few revolutions to blow the copper sleeves clean before fitting the injectors. Check that the contact surface for the injector in the bottom of the copper sleeve is clean.
2. Slide down the injectors into position and then fit the washers and nuts without tightening them.
3. Connect the leak-off line and delivery pipes. Replace damaged gaskets.
4. Then tighten the injectors. Tighten the nuts alternatingly to avoid tension being created, which might influence the function of the needle in the nozzle. Tightening torque should be 20 Nm (2 kpm) (14,5 lb.ft.).

FUEL FILTER

Replacing the fuel filter

1. Clean round the filter, particularly under the projecting edges of the cover.
2. Remove the container with the filter insert.
3. Clean the container internally.
4. Remove the gasket in the cover and clean the gasket groove.
5. Fit a new gasket in the cover. Fit a new insert. NB Never try to clean an old insert. Fit the container into

Air-venting the fuel system

1. Open the air-venting screw on the fuel filter. See fig: no. 45.
2. Feed fuel using the feed-pump. When air bubbles no longer come out, close the air-venting screw.
3. Open the air-venting screw on the injection pump and repeat operations as per point 2 above.

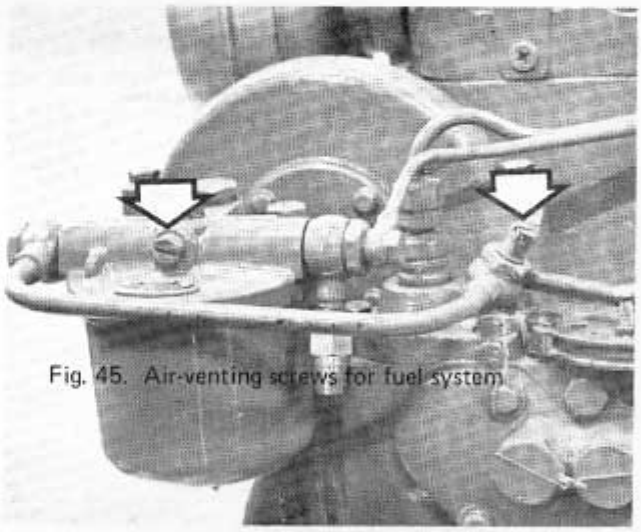


Fig. 45. Air-venting screws for fuel system

Checking the feed pump pressure

1. Remove one of the air-venting screws, see fig. no. 45, and connect instead a pressure gauge.
2. Start the engine and warm it up.
3. Increas the revolutions to 42 r/s (2500 rpm) (without load on the engine). Register the pressure gauge.

FEED PUMP

The feed pump is provided with a manual feeding device. After having performed adjustment works use this device i.e. to feed fuel to the fuel filter and injection pump. A pre-filter is built into the housing of the feed pump.

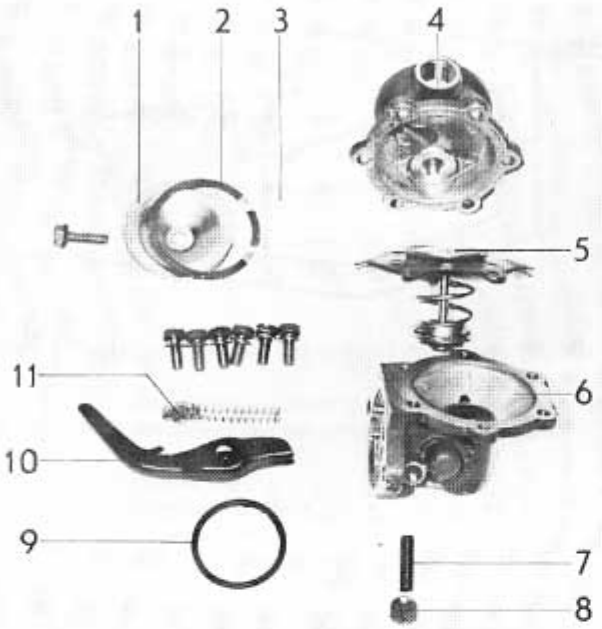


Fig. 46. Feed pump

1. Cover
2. Gasket
3. Strainer
4. Upper part
5. Diaphragm
6. Lower part
7. Lever-shaft
8. Locking screw
9. O-ring
10. Lever
11. Return spring

Removing

1. Clean the pump and its surroundings.
2. Remove the pipe connections.
3. Loosen and remove the pump.

Disassembling

1. Mark the upper and lower parts. Remove the upper part from the lower part.
2. Remove the return spring (11, fig. no. 46) and the screw (8). Push out the lever shaft using a pointed plier, see fig. no. 47. Pull out the lever and the diaphragm.
3. Loosen the screw on the underside of the upper part, remove the stop lever and the plate spring (inlet valve). Notice the location of the plate spring. The outlet valve

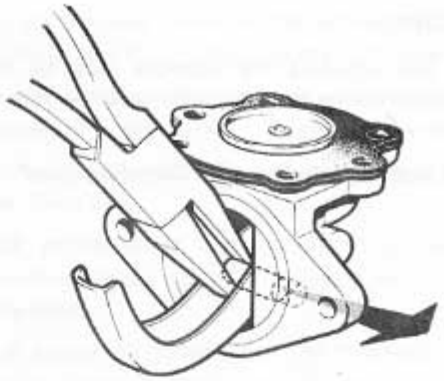


Fig. 47. Removing the lever

Inspection

Check the diaphragm and gasket for leakage and moving parts for wear.

Assembling

1. Wash the upper part and the strainer using gasoline and clean with compressed air.
2. Fit the inlet valve and its stop lever. Tighten the screw, but only so hard as to ensure good contact between the plate spring and the pump housing.
3. Push down the diaphragm, slide in the lever and check that the lever is correctly located relative to the diaphragm rod. Fit the shaft, stop screw and the return spring.
4. Fit the upper part according to marking and tighten it.
5. Fit the strainer, the gasket and the cover.

Fitting

1. Fit and tighten the feed pump. Do not forget the O-ring, sealing against the block.
2. Connect the fuel lines.
3. Air-vent the fuel system (see separate head line).

Cleaning the strainer

Loosen and remove the cover (1, fig. no. 46). Remove the

CENTRIFUGAL GOVERNOR

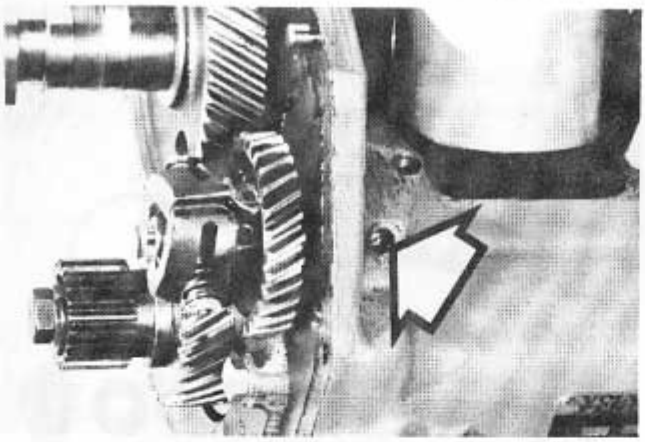


Fig. 48.

Removing

1. Loosen and remove the timing gear casing, see "Removing the timing gear casing".
2. Remove the stop screw, located on the right hand side of the engine seen from the governor (see fig. no. 48).
3. Remove the governor, using two screwdrivers.
4. Clean all parts.

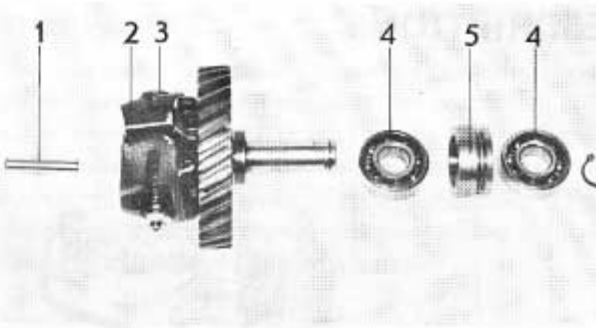


Fig. 49. Centrifugal governor

1. Sliding pin
2. Governor weight
3. Governor spring
4. Ball bearings
5. Spacer

Inspection

1. Check if the weights (2, fig. no. 49) are seizing or if clearance between shaft and governor weight is too l
2. Check if the pin (1) is sliding easily in the shaft.
3. Check both ball bearings.

Fitting

Fitting is done in the reversed order to removing. Ch that all moving parts move easily and oil them in bef fitting. NB Make sure that the groove in the spacer is fac the stop screw.

COOLING SYSTEM

DESCRIPTION

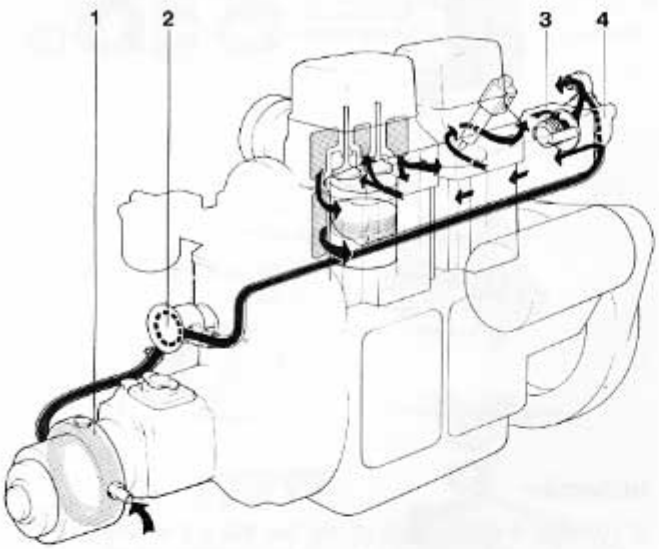


Fig. 50. Cooling System, MD2B with reverse gear type MS

1. Reduction gear
2. Sea-water pump
3. Thermostat
4. Thermostat housing

To provide effective cooling water circulation, the engine is fitted with a sea-water pump. This pump is fitted on the timing gear casing and driven by the camshaft through a carrier flange. The impeller in the sea-water pump is made of neoprene rubber and operates against a cam.

The pump (2, fig. no. 50) sucks cooling water from outside the boat through the externally located sea-cock strainer and forces the water to the distribution housing (thermostat housing).

The cooling water has the possibility of following two ways from the distribution housing. The thermostat (3) in the thermostat housing keeps the passage from the engine closed at the same time as it opens the passage from the distribution housing above the thermostat. The water in the engine is therefore warmed up rapidly while the water supplied by the sea-water pump passes the engine through the bypass without cooling it. When the engine has obtained its normal operating temperature the thermostat opens the outlet from the engine and the warm water is supplied out in the bypass line. The engine and the exhaust manifold is then filled with cold water and when this is reaching the thermostat this cloces again the outlet from the cooling channels.

In this way the thermostat balances cooling water circula-

REPAIR INSTRUCTIONS

SEA-WATER PUMP

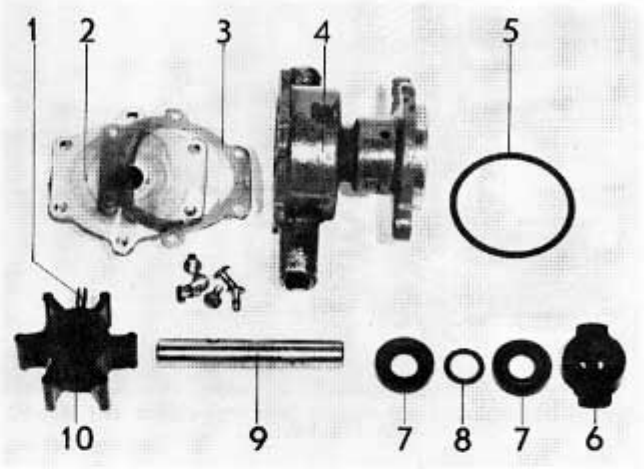


Fig. 51. Sea-water pump

1. Locking screw
2. Cover
3. Gasket
4. Pump housing
5. O-ring
6. Carrier
7. Sealing rings
8. O-ring
9. Shaft
10. Impeller

Replacing impeller

The impeller is made of neoprene rubber. The impeller can be damaged if lacking water i.e. when the water intake has been blocked. When replacing impeller, do it as follows:

1. Remove the cover. Watch out for water pouring in through the pump. Pull out the shaft with the impeller, using two screwdrivers, out of the housing just as much as needed for removing the screw (1, fig. no. 51), holding the impeller. Put a piece of rubber or similar under the screw-drivers to prevent damaging the pump housing.
2. Pull the impeller off the shaft. Clean the pump housing internally and fit the new impeller. Fit the cover with the original gasket, having the right thickness.

Replacing the sealing rings

1. Remove the sea-water pump. Watch out for water pouring into the boat. Remove the carrier (6, fig. no. 51).
2. Loosen and remove the cover.
3. Push out the shaft together with the impeller.
4. Remove the sealing rings.

7. Knock one of the sealing rings in place using the drift part no. 884499. One side of the sealing ring is provided with a spring – turn this side against the impeller.

8. Fit the impeller on the shaft. Grease the shaft and the shaft lodging in the cover with water resistant grease.

9. Push in the shaft with the impeller into the pump housing. NB Be careful not to damage the sealing ring.

10. Fit the O-ring and the second sealing ring carefully. (The spring loaded side of the sealing ring to be turned against the timing gear casing).

11. Fit the cover using a new, genuine gasket. Check the carrier and the big O-ring. Replace them if necessary.

12. Put the carrier onto the shaft and fit the pump.

THERMOSTAT

The thermostat is accessible when the thermostat hou on the exhaust manifold has been removed. Watch out water pouring into the boat. Test the thermostat u water heating up. The thermostat shall open and c according to values given in "Technical Data". Fa thermostat must be rejected. Use new sealing rings w fitting (MB3B has only one sealing ring).

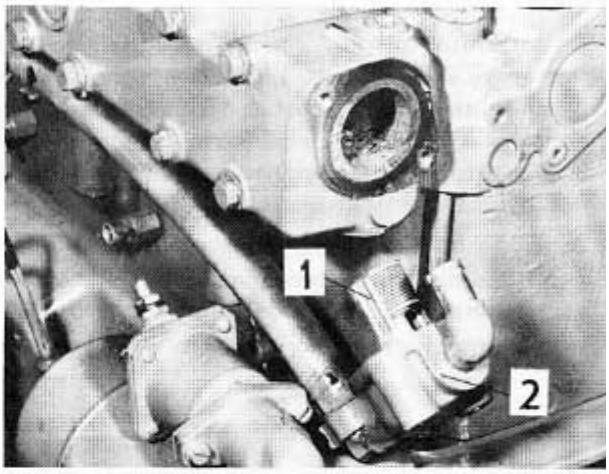


Fig. 52.

1. Thermostat
2. Thermostat housing

ELECTRICAL SYSTEM

MD3B and MD2B with MS reverse gear are equipped with 12 volt starter motor and alternator as standard.

MD2B with RB reverse gear and MD1B are alternatively equipped with dynastarter meaning a combined generator and starter motor, operated by the flywheel by means of V-belts.

IMPORTANT

For engines equipped with alternator:

1. Do not cut off the current between the alternator and the battery while the engine is running. Thus if a main switch is fitted, this must not be disconnected until the engine is at standstill. Furthermore no cable must be disconnected while the engine is running to avoid the risk fo destroying the regulator.
2. Battery, battery cables and terminals must be checked regularly. The battery poles must be well cleaned and the terminals well tightened and greased to avoid interruption. Furthermore all cables must be well tightened, no loose connections are allowed. NB Be careful not to mix the plus- and minus poles of the battery with each other, when fitting the battery.
3. When using auxiliary battery for starting check first that the rated voltage of the auxiliary battery is the same as that of the main battery. Connect the auxiliary battery to the main battery – plus pole to plus pole and minus pole to minus pole. Disconnect the auxiliary battery when the engine has started. NB Never disconnect the cables to the main battery.
4. When welding (electrically) on the engine or on engine equipment disconnect the cables of the regulator and insulate them. Furthermore disconnect the battery cables.
5. When repairing the alternator equipment always first remove the battery cables (disconnect the battery). Same instruction is valid when recharging the battery onboard.
6. Never test a connection using a screw driver or similar tool in order to see if it sparkles.

Cable marking:

Descr.	Colour	mm^2	AWG
A**	Bone-white	2,5	13
B	Black	1,5	15
C^a	Red	25	3
C^b	Red	2,5	13
D	Green	1,5	15
D**	Green	2,5	13
G	Brown	1,5	15
H	Blue	1,5	15
H^a	Blue	25	3

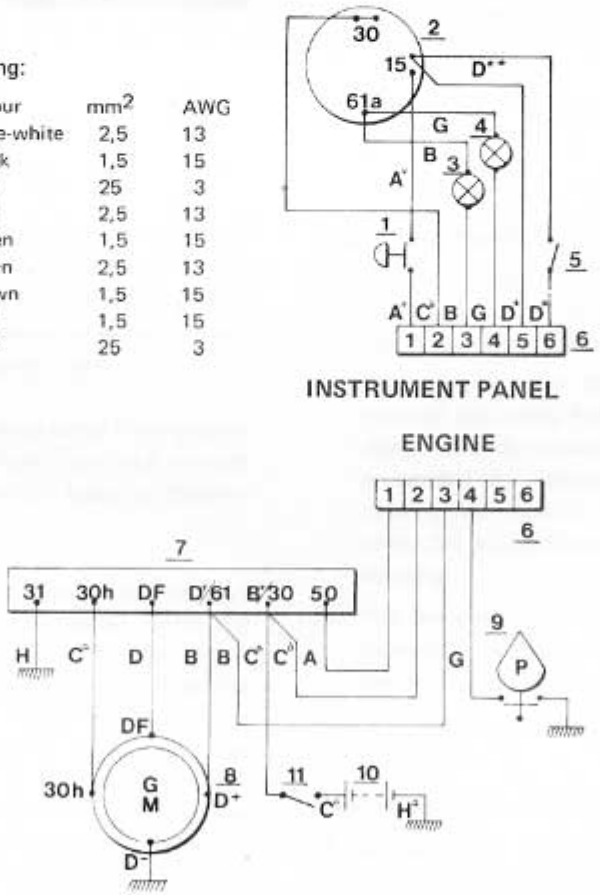
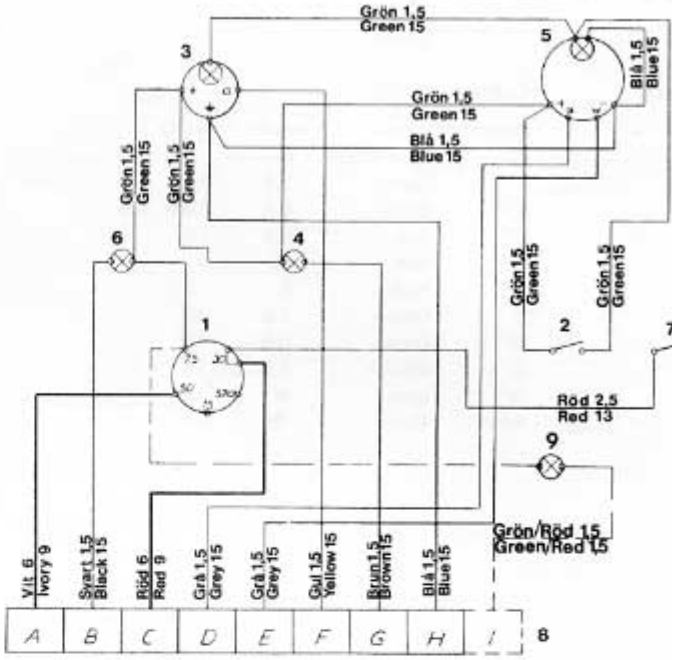


Fig. 53. Wiring diagram for MD1B and earlier execution of MD2B (with dynastarter)

1. Starter button
2. Key switch
3. Charging control lamp
4. Oil pressure control lamp
5. Switch
7. Charging regulator
8. Dynastarter
9. Oil pressure relay
10. Battery, 12 Volt, max. 60 Ah.
11. Main switch

Fig. 54. Wiring diagram for later execution of MD2B with dynastarter.

1. Key switch
2. Switch, instr. light
3. Temperature gauge
4. Oil pressure warning lamp
5. Revolution counter
6. Charging control lamp – dynastarter
7. Switch, optional lights
8. Connection block
9. Charging control lamp – alternator
10. Battery
11. Main switch
12. Dynastarter
13. Alternator (optional)
14. Charging regulator
15. Fuse
16. Temperature sending unit
17. Sending unit – rev. counter
18. Sending unit – oil pressure
19. Remain. electrical equipm.



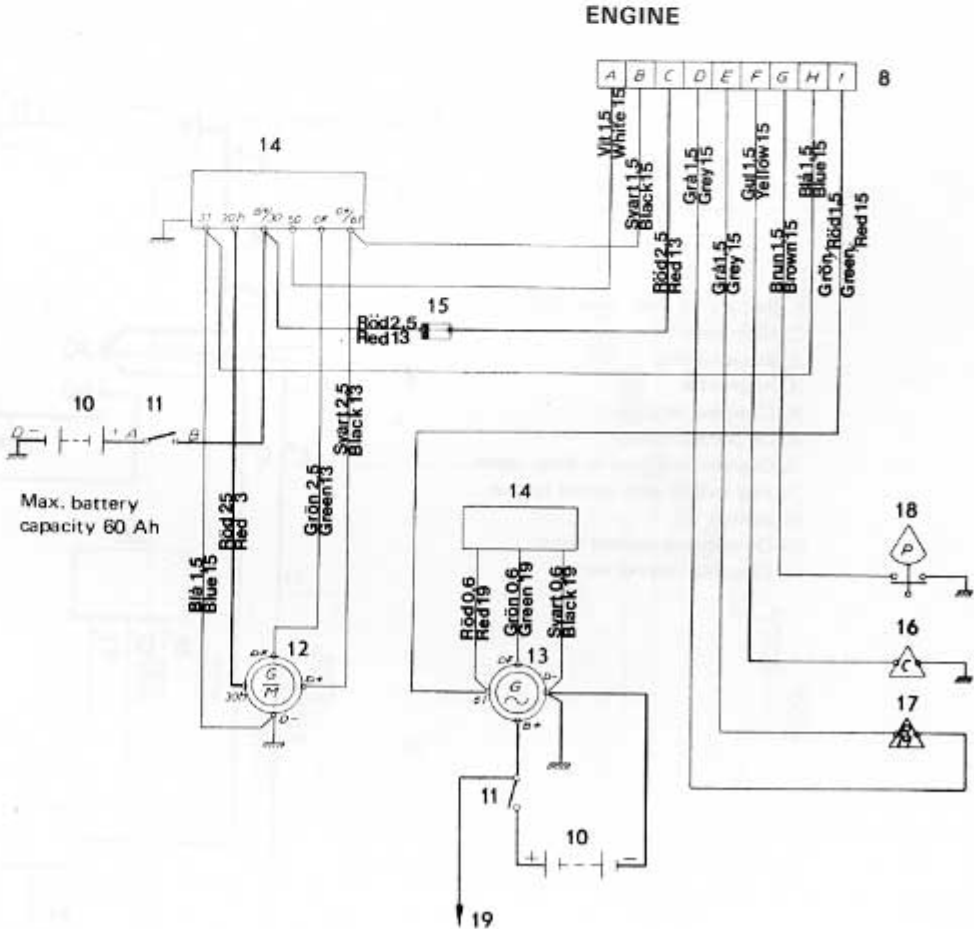
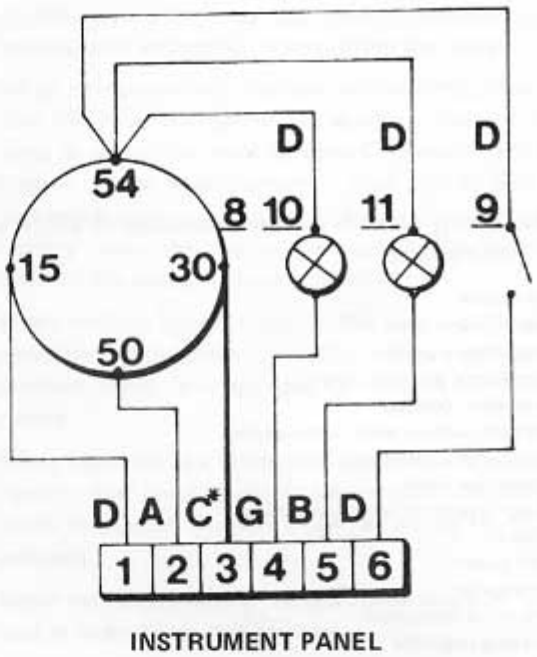
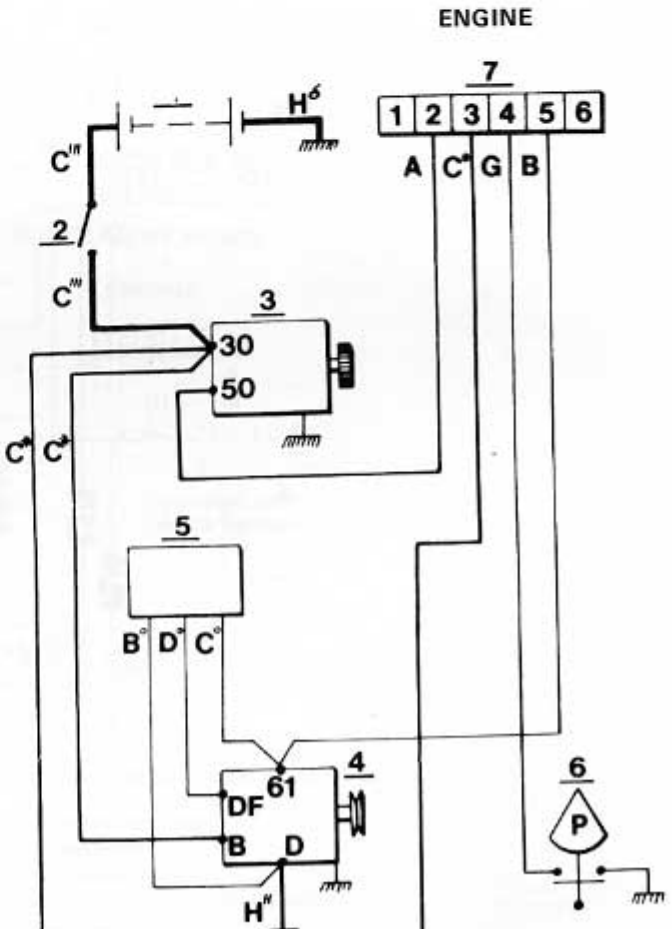


Fig. 55. Wiring diagram, earlier execution of MD3B

Cable marking:

Descr.	Colour	mm^2	AWG
A	Bone-white	6	9
B	Black	1,5	15
B^o	Black	0,6	19
C^o	Red	0,6	19
C'''	Red	35	1
C^*	Red	6	9
D	Green	1,5	15
D^o	Green	0,6	19
G	Brown	1,5	15
H''	Blue	4	11
H^d	Blue	35	1

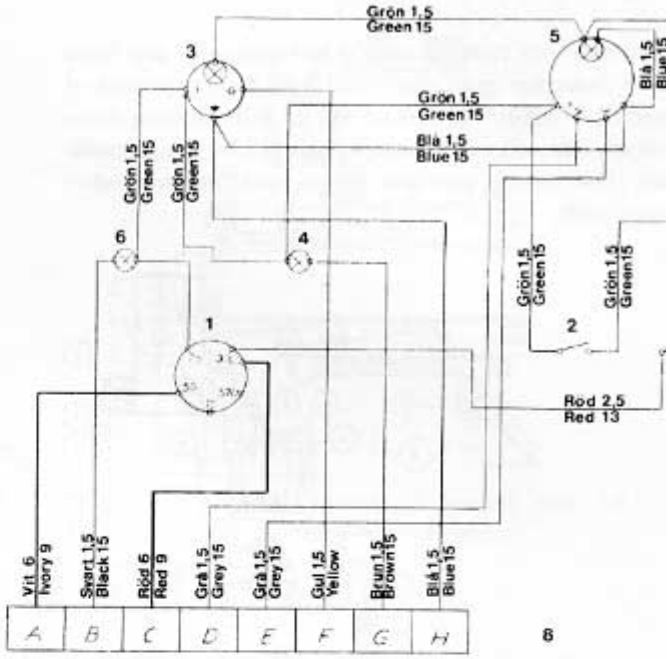




1. Battery 12 Volt, max. 150 Ah.
2. Main switch
3. Starter motor
4. Alternator
5. Charging regulator
6. Oil pressure relay
7. Connection block to instr. panel
8. Key switch with starter button
9. Switch
10. Oil pressure control lamp
11. Charging control lamp

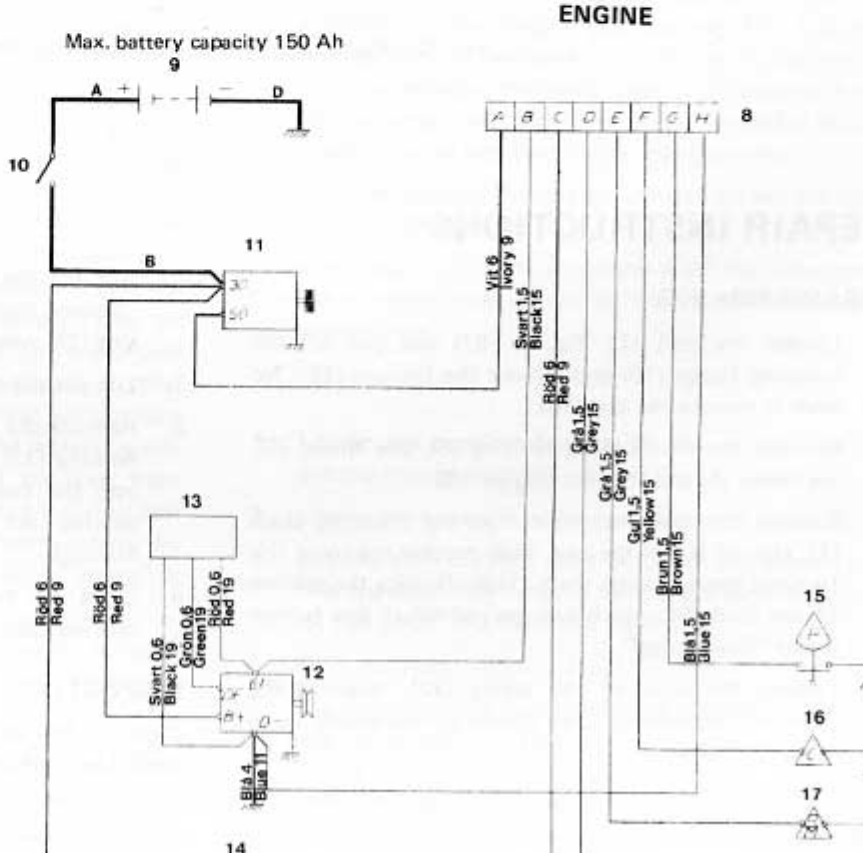
Fig. 56. Wiring diagram, MD2B (with starter motor) and MD3B (later execution)

1. Key swith
2. Switch, instr. light
3. Temperature gauge
4. Oil pressure warninglamp
5. Revolution counter
6. Charging control lamp
7. Switch, optional equipm.
8. Connection block
9. Battery
10. Main switch
11. Starter motor
12. Alternator
13. Charging regulator
14. Fuse
15. Sending unit, oil pressure
16. Sending unit, temperature
17. Sending unit, rev. counter



INSTRUMENT PANEL

ENGINE



REVERSE GEAR—TYPE RB

DESCRIPTION

The Volvo Penta type RB reverse and reduction- gear has a built-in reduction gear with ratio 1,87:1. Engagement of "ahead" or "astern" is carried out by self-adjusting cones which are retained in the engaged position by the propeller thrust. The reverse gear and engine have the same lubricating system.

When "ahead" is engaged, the outgoing shaft with its cone is moved forward and engagement occurs against the front cone. Engine driving power is transmitted from the crankshaft gear to the internally toothed ring on the front cone.

When "astern" is engaged, the outgoing shaft is moved backwards and engagement occurs against the inner cone. This functions through an idler gear and this means that the direction of rotation of the outgoing shaft is therefore reversed.

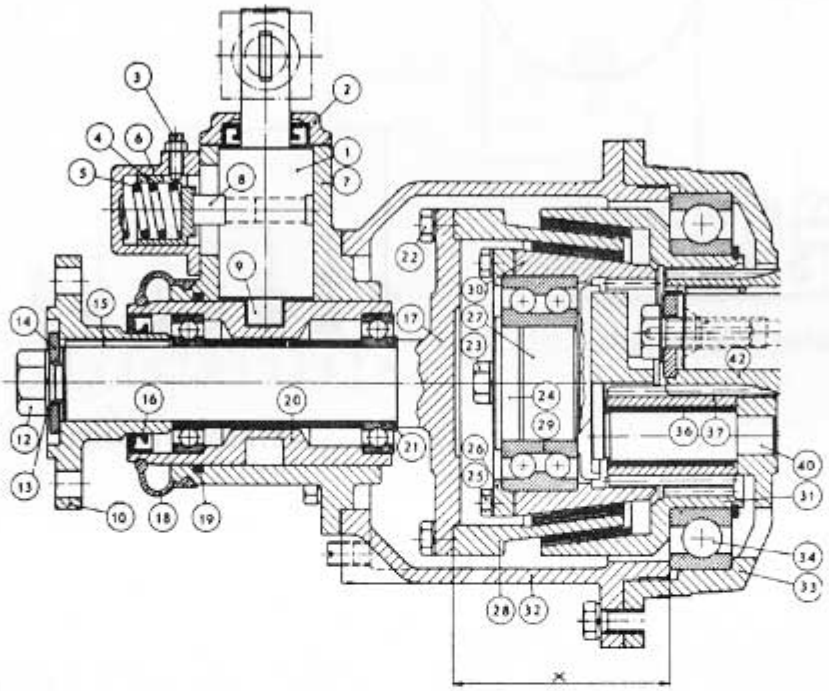


Fig. 57. Reduction- reverse gear, type RB, Ratio 1,87:1

REPAIR INSTRUCTIONS

DISASSEMBLING

1. Loosen the bolt (12, fig. no. 57) and pull off the coupling flange (10) and remove the bellows (18). No need to remove the key (15).
2. Remove the interlocking housing (6), the spring (5), the sleeve (4) and the blocking pin (8).
3. Remove the actuating lever from the actuating shaft (1). Do not forget the key. Then remove the cover (2). Remove the actuating shaft (1+9). (Notice the postion of the stud (9), which has marked sides). See further under "Assembling".
4. Loosen the bolts on the casing (32), retaining the casing to the housing (33). Knock off the casing, using a rubber mallet.
5. Loosen the bolts (22) and remove the shaft (17) and the sleeve (20).

pull off the gear (30). If the bearing (29) shall be removed from the gear, loosen the bolts (25) and the ring (26) where upon the ball bearing is pressed out.

7. Lift out the cone (28).
8. Remove the gear (31) and the bearing (34) from the housing (33). Removal is facilitated by inserting a drift into the two holes on the housing, knocking on the bearing race and thus striking the bearing out of the housing.
9. Drive out the shaft (40) with the gear (37) and the bearing (36).

INSPECTING

Clean all the parts carefully. At the same time inspect the parts and replace all worn parts. Fit new gaskets and O-rings. Check carefully sealing rings for damage.

Wear on the friction facing on the gear (31), which is most

Place the cone (28) in the gear (31) and measure "X" as per fig. no. 57. The difference between "X" and 85 mm (3.35 in.) decides the thickness of the shims (21). If the measurement, for example, is 83 mm (3.27 in.), fit a washer with a thickness of 2 mm (.079"). If wear is so big that "X" is less than 81 mm (3.19 in.), the worn parts must be replaced. The friction facing in the gear and the cone are not replacable.

ASSEMBLING

1. Fit the bearing (36) and gear (37) and press the shaft into the housing (33).
2. Fit the gear (31) with the bearing (34) in the housing (33).
3. Put the cone (28) into the gear (31).
4. Fit together the bearing support (27), the bearing (29), the cover (24) and the gear (30) to one unit and tighten the cover (24). Fit the bearing so that the recess on one side of the bearing is facing the cogs on the gear (30). The bearing support (27) and the washer (24) are fitted in a way that the middle through hole is turned upwards.
5. Put in the unit in the cone (28).
6. Fit the shaft (17) and the sleeve (20) onto the cone (28).
7. Fit the reverse gear casing (32) over the assembled parts and tighten it to the housing (33).
8. Fit the bellows (18) and the coupling flange (10). Check before fitting that the bolt (12) is well tightened and that the key (15) is well located in its kew-way in the shaft (17).
9. Fit the carrier (9), the shaft (1), the cover (2), the blocking pin (8), the sleeve (4), the spring (5) and the interlock housing (6). Oil in the parts before fitting. The carrier (9) is fitted so that the O-marked sides are in the longitudinal axis of the engine. Fit the actuating lever and check the lever movements from neutral to "ahead" and "astern", these movements should be equal. If movement one way considerably exceeds the other, adjust be turning the carrier (9). This is designed so that the centre for the rectangular section is offset relative to the centre of the cylindrical section (the guide). If the carrier is fitted so that the projecting side is turned forward, the movement of the lever from "ahead" to neutral is reduced. If the stud is turned half a turn so that the projecting parts is facing astern, the movements of the lever from neutral to "astern" is reduced.

   Then check that the reverse gear engages in both "ahead" and "astern" positions.

CHANGING THE POSITION OF THE ACTUATING SHAFT

The clutch mechanism can be placed in different positions

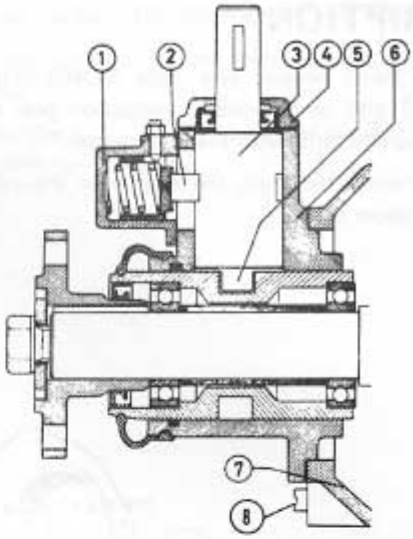


Fig. 58. Rear section of reverse gear RB (manoevering mechanism)

1. Interlock housing
2. Interlock pin
3. Actuating shaft
4. Cover
5. Carrier
6. Bearing housing
7. Reverse gear housing
8. Plug — oil drainage

1. Drain the reverse gear from oil by removing the drain plug (8, fig. no. 58).
2. Move the actuating lever to neutral.
3. Loosen the bolts retaining the bearing housing attached to the reverse gear housing (7). Pull bearing housing rearwards very slightly (facilitated carefully engaging the lever), insert a knife between sealing surfaces and carefully loosen the gasket so t it only remains attached to one sealing surface.
4. Turn the bearing housing to the desired position a tighten it there.

If the key-way is in such a position after the adjustme that the actuating lever cannot be fitted, turn the shaft a carrier as follows:

1. Loosen the interlock housing (1, fig. no. 58) and out the interlock pin (2).
2. Loosen the cover (4) without pulling it off the shaft.
3. Lift the shaft (3) with cover (4) out of the housing a turn the shaft 180° (half a turn). Also turn the carr (5) half a turn and then refit the shaft.
4. Refit the parts.
5. If a remote control is connected to a RB-reverse gear, must be so designed that there is no constant pressu on the control components of the reverse gear. Wh the reverse gear is engaged for "ahead" or "astern", t remote control should be completely off-loaded so th

REVERSE GEAR—TYPE MONO SHIFT (MS)

DESCRIPTION

The Volvo Penta reverse gear type MONO SHIFT has a ratio of 1:1 and as optional a reduction gear with ratio 1,91:1, integrally built with the reverse gear.

Power is transmitted from the engine to the reverse gear through a rubber carrier.

For manoevering "ahead" or "astern", the Volvo Penta patented cone clutch is used. With this type of clutch, engagement is both smooth and quiet.

The engaging power of the cone clutch is influenced by the size of the transmission torque. The greater the torque, the stiffer will be the clutch engagement with increased throttling.

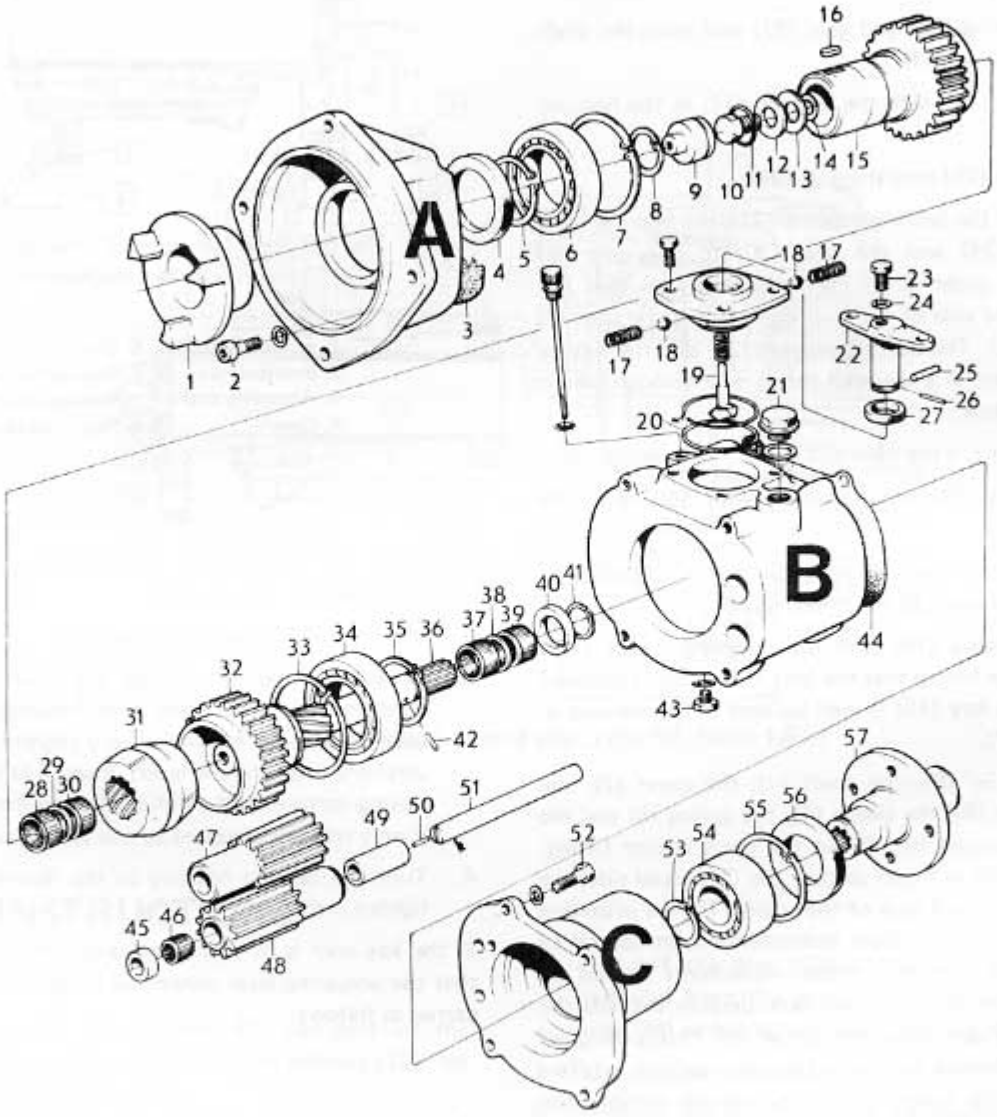


Fig. 59. Reverse gear type MS, without reduction gear

A = Front housing
B = Intermediate housing
C = Rear housing

REPAIR INSTRUCTIONS

DISASSEMBLING

(Regarding special tools, see page 37)

1. Clean the reverse gear externally.
2. Drain the reverse gear from oil by removing the oil
3. Remove the four bolts retaining the manoevering mechanism and lift the cover with one hand using the

4. Put the reverse gear straight up, turning the connection side against the engine downwards. Remove the four bolts (52) and lift off the rear housing. If the reduction gear is mounted, remove this instead. Remove the gasket (44). In the partition plane between the rear housing (reduction gear respectively) and the intermediate housing, two shaft ends can be seen. Put a piece of tape over these shaft ends, preventing them from falling out, when the reverse gear is turned.
5. Turn the reverse gear and put it in a screw vise. Use tool 884152.
6. Remove the lock ring (8) and pull out the sleeve (9) using tool no. 884490. Pull of the carrier (1) using a puller.
7. Loosen the four bolts (2) holding the intermediate housing and the front housing together.
8. Loosen the bolt (10) and unscrew it two to three turns.
9. Turn the reverse gear and put it on the flange of the front housing. Loosen the lockring (41) and lift off the washer (40). Remove the guide-pin (42) from the shaft (36), using a plier.
10. Use a rubber mallet and knock carefully the intermediate housing from the front housing. Then lift the intermediate housing carefully straight upwards. Prevent the shafts (51) from falling out of the intermediate housing. Keep them in place by putting a piece of tape over them. Collect the neddle-bearings (37 and 39) and the spacer (38).
11. Remove the coupling socket (31) from the shaft.

Inspect the four disassembled main units: front housing, intermediate housing, reduction gear and rear housing respectively and the shifting mechanism. By break-down in the reverse gear, disassemble it and inspect it carefully. When minor faults appear and when these can be located to either of the four main units, disassemble only the unit concerned (see under respective head line).

Front housing

1. Remove the bolt (10). NB Do not forget the washers (12 and 13) and the shims (14).
2. Pull out the shaft (36). NB Do not forget the neddle-bearings (28 and 30) and the spacer (29).
3. Remove the sealing ring (4).
4. Inspect the bearing (6) and the gear (15). If these parts must be replaced, operations 5 incl. 8 must be carried
5. Remove the key (16) and the lock ring (5).
6. Press the gear out of the front housing. Use drift 884263.
7. Loosen the lock ring (7) and press out the bearing using drift no. 884265.

Intermediate housing

1. Remove the tape and press out the shafts (51), ou the planet gears (47 and 48). Remove the bearings and the sleeves (49).
2. Inspect all bearings, bushings and gears of the in mediate housing. If the gears (32, 47 and 48) or bearing (34) must be replaced, operations 3–8 be are carrid out. As the bearing (34) by disassemb always is subject to unfavourable stresses, it shoul rejected and replaced by a new one.
3. Refit the shafts of the planet gears (51), spacers bearing (46) and bushings (45).
4. Loosen the lock ring (35).
5. Press out the gear (32) using the drift no. 884 Check that the cogs of the gear fit into those of planet gears.
6. Loosen the lock ring (33).
7. Drift out the bearing (34) using drift no. 884168.
8. Remove the bearings of the two planet gears (47 48), the spacers and shafts. Then lift out the two g of the intermediate housing.

Rear housing

1. Carefully clean the unit. Inspect the bearing (54) the sealing ring (56). If any of them must be repla operations below must be carried out.
2. Loosen the lock ring (53).
3. Press the flange (57) out of the rear housing, sleeve no. 884152.
4. Remove the sealing ring (56).

Reduction gear (disassembling)

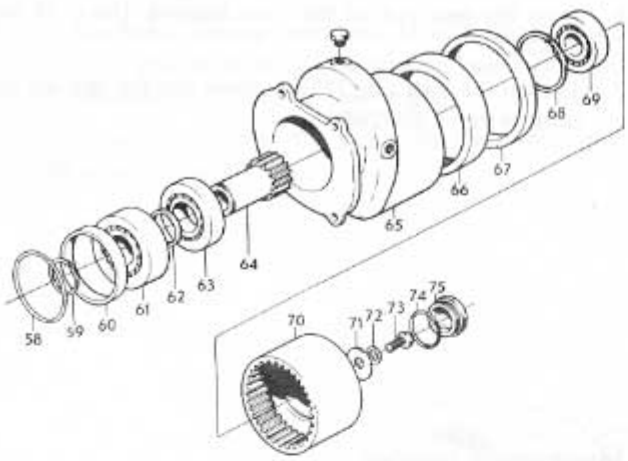
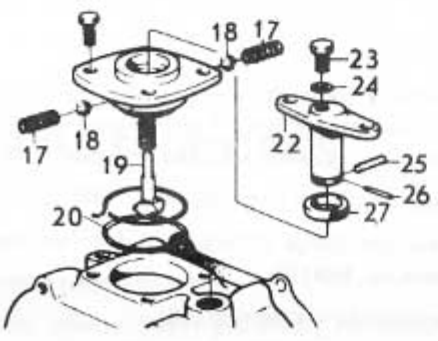


Fig. 60. Reduction gear

1. Remove the plug (75) and the bolt (73).
2. Pull out the gear (70) using the puller no. 884078 (put a spacer between the centre bolt of the puller and the threaded stud).
3. Carefully knock out the gear (64) together with the bearings (61 and 63). Use a brass drift.
4. Remove the sealing ring (67).
5. Carefully clean the parts and inspect the bearings and gears. If any of them must be replaced, see respective paragraphs below. NB the bearing (69) in the big gear (70) and the big bearing (66) must be replaced after having been disassembled. To avoid damaging the bearing (61), when pressing out the gear (64), hold against the inner race of the bearing.
6. Knock out the bearing (66) using a drift.
7. Remove the lock ring (59) and press out the gear (64) using drift no. 884266. Remove the spacer and the inner bearing. Carefully remove the inner race of the bearing (63) using a thinn brass drift.
8. Press out the bearing (69) using a suitable sleeve or a drift.

Manoevering mechanism (disassembling)



1. Knock out the clamp pin (26, fig. no. 61) and pull out the pin (25). Remove the lock wire, the springs (17) and the balls (18) (earlier execution of the reverse gear has only one spring and one ball). Pull out the off-centre piston (22). Remove the sealing ring (27).
2. Clean and inspect the parts carefully. Replace worn parts.

ASSEMBLING

Manoevering mechanism (fig. no. 61)

1. Fit the sealing ring (27) in the cover whereby the spring loaded side of the sealing ring is turned inwards. Always use a new sealing ring.
2. Fit the off-centre piston (22). Fit the pin (25) and the lock pin with the clamp pin (26). Take care to fit the clamp pin in the middle of the off-centre piston.
3. Fit the balls (18) and the springs (17). Apply a lock wire in the groove of the cover and use it to compress the springs. Cut off the lock wire and push down the end of it into the recess of the cover. The only task the lock wire has to perform, is to hold the springs during the fitting of the manoevering mechansim.
4. Fit the slide lever (19), the spring and the O-ring (20).

Reduction gear (fig. no. 60)

1. Press in the big bearing (66) into the gear housing, using the drift no. 884488.
2. Grease the sealing ring (67) and press it in, using drift no. 884488.
3. Press the bearing (69) into the gear (70) using drift no. 884488. Carefully push the gear through the sealing ring (67). Use a rubber mallet and knock down the gear, just so much as to allow the fitting of the bolt (73) with washer and new lock washer. Tighten with a torque of 55 Nm (5,5 kpm) (40 lb.ft.). Fit the plug (75) after having replaced the O-ring.
4. Press the bearings (61 and 63) and the spacer (62) onto the gear (64) using the drift no. 884263. (Do not fit the lock ring until the whole unit has been fitted into the housing). Turn the housing and press down the gear together with the bearings, using drift no. 884500. Turn the gear, while pressing it in, allowing it to cog-in. Fit the lock ring (59).

Rear Housing

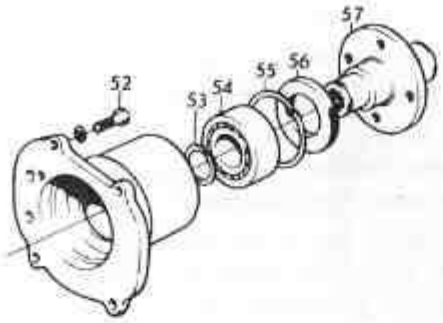


Fig. 62. Rear housing

1. Press in the bearing (54) into the rear housing, using drift no. 884488.
2. Lock the bearing with the lock ring (55).
3. Fit the sealing ring (56).
4. Grease the sealing ring and press in the flange (57). NB Hold against the inner race of the bearing, using drift no. 884263.
5. Lock the flange with lock ring (53).

Intermediate housing

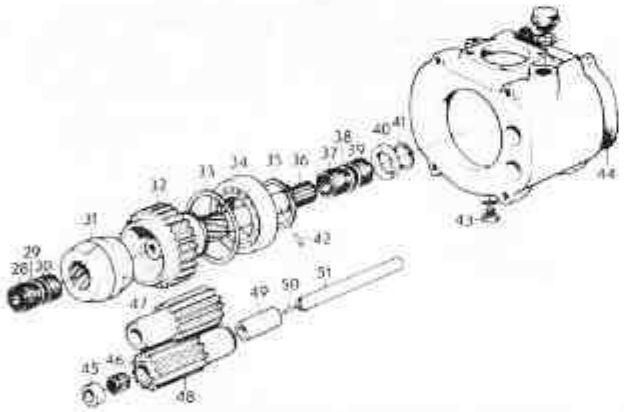


Fig. 63. Intermediate housing

1. Fit the lock ring (33) into the housing.
2. Press in the bearing (34) into the housing, using drift no. 884500.
3. Place the planet gears (47 and 48) on their respective locations in the intermediate housing. Then fit the bushings, the bearings, the sleeves and shafts of the planet gears. Put a piece of tape over the shaft ends to prevent them from falling out.
4. Press in the gear (32) into the bearing (34) using drift 884263. NB Hold against the inner race of the bearing, using drift no. 884488. Check that the cogs of

Front housing

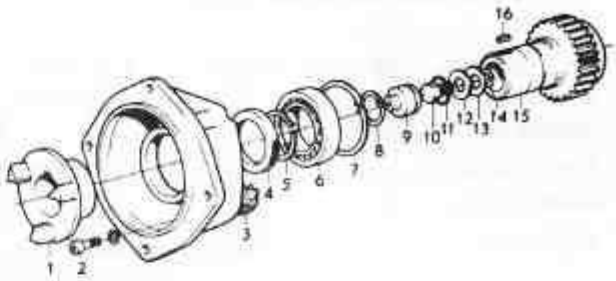


Fig. 64. Front housing

1. Fit the guiding pins (50, fig. no. 63) in the fro housing so far that they project approx. 2 mm (.08 above the partition plane.
2. Press in the bearing (6, fig. no. 64) into the fro housing, using the drift no. 884500.
3. Lock the bearing with the lock ring (7).
4. Press the gear (15) into the bearing, using drift n 884263. (Use the tool no. 884488 to hold against t inner race of the bearing).
5. Lock the gear with the lock ring (5).
6. To protect the sealing ring (6) when fitting, put fi sleeve no. 884487 over the shaft end of the ge Grease the sealing ring and fit it. Turn the spri loaded side of the sealing ring against the bearing. **not press in the sealing ring further than it is even wi the edge of the housing.** Remove the sleeve and fit t key (16).

Assembling the front housing with the interm diate housing (fig. no. 63 and 64)

1. Fit the needle bearings (28 and 30) and the spacer (2 onto the shaft (36).
2. The shaft is being fitted in the gear of the fr housing. Fit the bolt (10) with the steel washer (1 brass washer (13) and the shims (14). Do not scr down the bolt completely, two or three turns shou remain until it bottoms.
3. Turn the gear an let it rest on the connection flan Then put the coupling socket (32) onto the shaft (3 NB The drilling in the coupling socket shall be turn against the front housing.
4. Place the neddle bearings (37 and 39) and the spa (38) on the shaft (36).
5. Put a new gasket (3) on the sealing plane of the fr housing. NB The holes in the gasket for the guid pins (50) must be located correctly.
6. Remove the tape, locating the shafts of the planet ge in the intermediate housing.
7. Connect the intermediate housing with front housi Turn the shafts of the planet gears, using a scr driver, so that the locking pins (50) will be located

9. Put the brass washer (40) onto the shaft. The grooves of the washer must be located correctly relative to the pin (42).
10. Lock the brass washer with the lock ring (41). NB Use a new lock ring. The operation is facilitated if the shaft is lifted upwards.
11. Turn around the reverse gear. Use tool no. 884152, fixed in a screw vice.
12. Tighten the four bolts (2) an belonging washers.
13. Tighten the bolt (10). Tightening torque: 100 Nm (10 kpm) (72 lb.ft.). Measure the axial clearance in the shaft unit (see fig. no. 65). The clearance should be 0,2–0,3 mm (.008"–.012"). Increase or decrease the number of shims until the correct clearance is reached. The shims are available in two thicknesses, 0,1 mm and 0,5 mm (.004" and .020").
14. Fit the O-ring (11) on the sleeve (9). Grease the O-ring and push the sleeve into the gear. Be careful not to damage the O-ring.
15. Lock the sleeve with the lock ring (8).

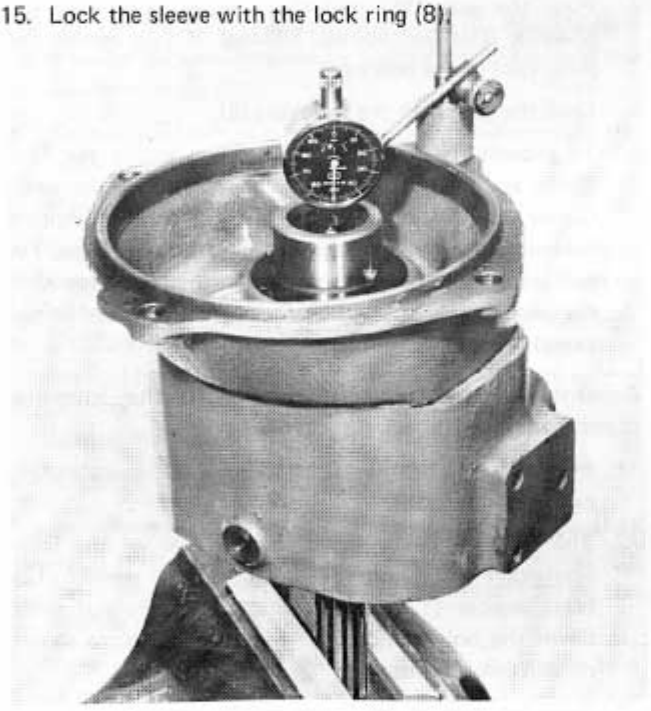


Fig. 65.

FINAL ASSEMBLY

1. Fit the manoevering mechanism into the gear housing so that the bolt (23, fig. no. 61) in the off-centre piston is moved towards starboard.
2. Remove the bolt (23) and all shims (24). Tighten the bolt and put the mechanism in neutral position. Try to turn the shaft (36). NB To be sure that the coupling socket is turning with the shaft, the outgoing shaft end must be turned. Add one shim at the time until the shaft can be turned without resistance. After the
3. Fit the key (16, fig. no. 64) on the gear (15). Warm up the carrier (1) to approx. 150° C (300° F) and fit it.

Reverse gear without reduction gear

4a. Turn the gear and let it rest on the flange of the front housing. Remove the tape holding the shafts of the planet gears in the intermediate housing.

4b. Turn the shafts of the planet gears, using a screw driver, so that the locking pins (50) will be located in the grooves at the shaft ends.

Reverse gear with reduction gear

4a. Measure on the intermediate housing the distance from the outer bearing race to the rear plane of the housing (A, fig. no. 66).

4b. Measure the depth of the corresponding recess in the reduction gear (B, fig. no. 66). NB The old gasket should be included when measuring.

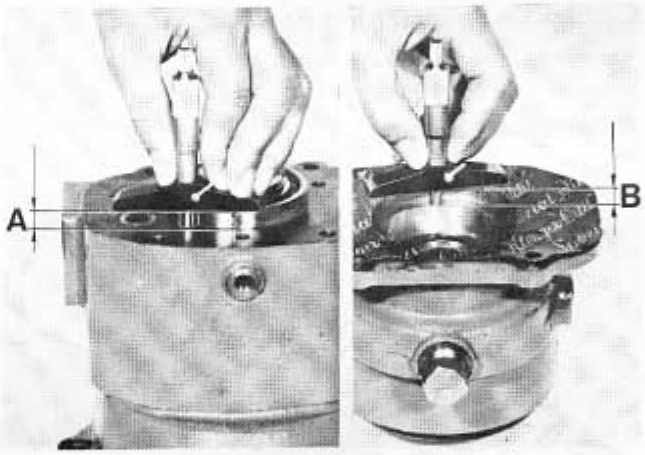


Fig. 66.

4c. Increase or decrease the number of shims until a clearance of about 0,1–0,2 mm (.004"–.008") is reached. The shims are available in two thicknesses, 0,1 mm and 0,35 mm (.004" and .014").

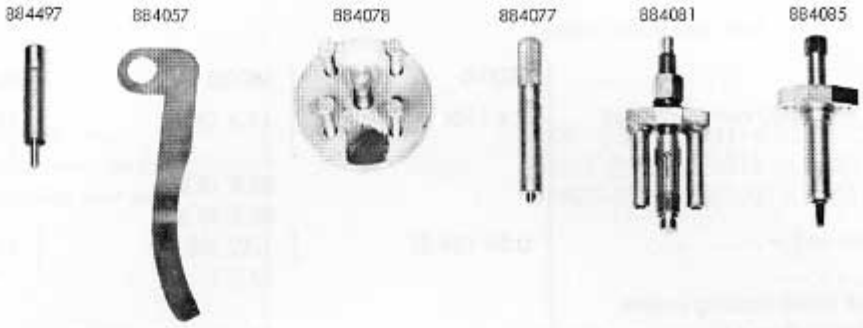
4d. Turn the shafts of the planet gears, using a screw driver, so that the locking pins (50) will be located in the grooves at the shaftends. Put a new gasket on the rear plane of the intermediate housing and connect the reduction gear.

All reverse gears

5. Fit the oil drain plug, (43, fig. no. 63).
6. Fill oil. Check with the oil dip stick that correct amount has been filled.

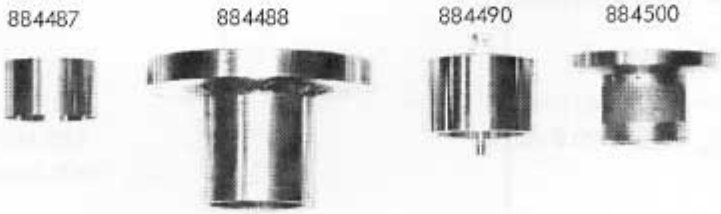
SPECIAL TOOLS

ENGINE



Part. no.	Description
884057	Control device for injection angle
884077	Drift for fitting copper sleeve
884078	Puller for crankshaft and crankshaft gear
884081	Puller for copper sleeve
884085	Spreader tool for copper sleeve
884489	Tool for removing and fitting of main bearing
884497	Tool for fitting of sealing ring for inlet valve
884499	Drift for fitting of valve guide
9991459	Drift for removing of valve guide
9994128	Reamer for valve guide
9994154	Drift for removing and fitting of rocker arm bushing

REVERSE GEAR, TYPE MS



Part. no.	Description
884487	Sleeve for fitting of front sealing ring
884488	Drift for fitting of gear
884490	Puller for sealing sleeve
884500	Drift for fitting of bearings

TECHNICAL DATA

ENGINE

General

	MD1B	MD2B	MD3B
Type designation			
Output (DIN) at 42 r/s (2500 rpm), kW(Hp)	7.4 (10)	18.4 (25)	26.5 (36)
Number of cylinders	1	2	3
Bore, mm (in.)		88.9 (3.5)	
Stroke, mm (in.)		90.0 (3.54)	
Displacement dm^3 (cu.in.)	0.56 (34.2)	1.12 (68.4)	1.68 (102.5)
Compression ratio		17.2:1	
Compression pressure while turning engine with starter motor, kp/cm^2 (p.s.i.)		20–24 (284–341)	
Direction of rotation, seen from flywheel		Clockwise	
High idling speed, r/s (r.p.m.)		45 (2700)	
Low idling speed, r/s (r.p.m.)		9.2–10.8 (550–650)	

Cylinder block

Material	Cast iron
Bore, standard, mm (in.)	88.90 (3.500)
0.762 mm oversize, mm (in.)	89.66 (3.491)

Piston

Material	Light-alloy
Height, total, mm (in.)	103 (4.055)
Height from gudgeon pin centre to piston top, mm (in.)	65 (2.559)
Piston clearance in cylinder, mm (in.)	0.10–0.14 (0.004–0.006)
Pistons available as:	
Standard, mm (in.)	88.78 (3.495)
0.762 mm (.030") oversize, mm (in.)	89.54 (3.525)

Gudgeon pin

Diametre	28.000–28.004 (1.1024–1.1025)
Gudgeon pin bushing diametre, mm (in.)	28.014–28.025 (1.1029–1.1033)
Clearance gudgeon pin – bushing, mm (in)	Close running fit

Piston rings

Compression rings	3
Oil scraper ring	1
Top compression ring is chromium-plated	
Piston rings available as:	
Standard, and	
0.762 mm (0.030") oversize	
Piston ring clearance in groove, axially:	
1st compression ring, mm (in.)	0.060–0.092 (0.0024–0.0036)
2nd compression ring, mm (in.)	0.060–0.092 (0.0024–0.0036)
3rd compression ring, mm (in.)	0.040–0.077 (0.0016–0.0030)
Oil scraper ring, mm (in.)	0.030–0.062 (0.0012–0.0024)
Piston ring gap in cylinder:	
1st compression ring, mm (in.)	0.40–0.55 (0.0157–0.0217)
2nd compression ring, mm (in.)	0.30–0.45 (0.0118–0.0177)

	MD1B	MD2B	MD3B
Cylinder head			
Material		Special-alloy cast-iron	
Crankshaft			
Crankshaft axial clearance, mm (in.)		0.08–0.35 (0.0031–0.0138)	
Main bearing radial clearance, mm (in.)		0.038–0.100 (0.0015–0.0039)	
Big-end bearing radial clearance, mm (in.)		0.054–0.099 (0.0021–0.0039)	
Main bearing journals			
Diametre			
Standard, mm (in.)		66.646–66.665 (2.6239–2.6246)	
0.254 mm (.010") undersize, mm (in.)		66.392–66.411 (2.6139–2.6146)	
0.508 mm (.020") undersize, mm (in.)		66.138–66.157 (2.6039–2.6046)	
0.762 mm (.030") undersize, mm (in.)		65.884–65.903 (2.5939–2.5946)	
Main bearing shells			
Thickness			
Standard, mm (in.)		2.136–2.145 (0.0841–0.0844)	
0.254 mm (.010") oversize, mm (in.)		2.263–2.272 (0.0891–0.0894)	
0.508 mm (.020") oversize, mm (in.)		2.390–2.399 (0.0941–0.0944)	
0.762 mm (.030") oversize, mm (in.)		2.517–2.526 (0.0991–0.0994)	
Big-end bearing journals			
Diameter			
Standard, mm (in.)		53.966–53.985 (2.1246–2.1254)	
0.254 mm (.010") undersize, mm (in.)		53.712–53.731 (2.1146–2.1154)	
0.508 mm (.020") undersize, mm (in.)		53.458–53.477 (2.1046–2.1054)	
0.762 mm (.030") undersize, mm (in.)		53.204–53.223 (2.0946–2.0954)	
Big-end bearing shells			
Thickness			
Standard, mm (in.)		1.384–1.391 (0.0545–0.0548)	
0.254 mm (.010") oversize, mm (in.)		1.511–1.518 (0.0595–0.0598)	
0.508 mm (.020") oversize, mm (in.)		1.638–1.645 (0.0645–0.0648)	
0.762 mm (.030") oversize, mm (in.)		1.765–1.772 (0.0695–0.0698)	
Piston rod			
Axial clearance at crankshaft, mm (in.)		0.05–0.25 (0.0020–0.0098)	
Camshaft			
Axial clearance, mm (in.)		0.05–0.15 (0.0020–0.0059)	
Radial clearance in bearings, mm (in.)		0.03–0.09 (0.0012–0.0035)	
The bearings are bored or reamed after being pressed in			
Lifting height of cams, mm (in.)		5.75–5.85 (0.2264–0.2303)	
Valve system			
Inlet:			
Disc diameter, mm (in.)		38 (1.496)	
Stem diameter, mm (in.)		7.955–7.970 (0.3132–0.3138)	
Valve seat angle		44.5°	
Seat angle in cylinder head		45.0°	
Seat width in cylinder head, mm (in.)		1.5 (0.06)	

	MD1B	MD2B	MD3B
Exhaust valve:			
Disc diameter, mm (in.)		34 (1.338)	
Stem diameter, mm (in.)		7.925–7.940 (0.3120–0.3126)	
Valve seat angle		44.5°	
Seat angle in cylinder head		45.0°	
Seat width in cylinder head, mm (in.)		approx. 1.5 (0.06)	
Clearance, warm engine, mm (in.)		0.35 (0.014)	
Decompression device			
Max. depression of exhaust valve, mm (in.)		0.5 (0.020)	
Valve guide			
Length, mm (in.)		59 (2.323)	
Inner diameter after fitting and reaming, mm (in.)		8.0–8.015 (0.3150–0.3156)	
Height above cylinder head spring surface, mm (in.)		18 (0.709)	
Clearance valve stem – guide:			
Inlet valve, mm (in.)		0.03–0.06 (0.0012–0.0024)	
Exhaust valve, mm (in.)		0.06–0.09 (0.0024–0.0035)	
Valve spring			
Length, unloaded, mm (in.)		50 (1.969)	
loaded with 300±20 N (30±2 kp) (66.14±4.41 lb), mm (in.)		39 (1.535)	
loaded with 560± 30 N (56±3 kp) (123.46±6.61 lb), mm (in.)		32 (1.260)	
Lubricating system			
Oil capacity, engine, dm^3 (Imp. qts. = US qts.)			
incl RB-gear, excl filter	1.7 (1.5=1.8)	3.0 (2.6=3.2)	5.5 (4.8=5.8)
incl filter	1.95 (1.7=2.1)	3.25 (2.9=3.4)	5.75 (5.0=6.0)
excl MS-gear, excl filter	1.7 (1.5=1.8)	3.0 (2.6=3.2)	5.5 (4.8=5.8)
incl filter	1.95 (1.7=2.1)	3.25 (2.9=3.2)	5.75 (5.0=6.0)
Oil-grade, according to API-system		For service CD[1]	
Viscosity			
above +20° C (68° F)		SAE 20	
below +20° C (68° F)		SAE 10 W	
Oil-pressure, warm engine, idling, kp/cm^2 (p.s.i.)		0.8–1.5 (11.4–21.3)	
Oil-pressure, warm engine, max r/s, kp/cm^2 (p.s.i.)		2.0–3.0 (28.4–42.7)	
MS-gear			
Oil capacity with reduction gear, dm^3 (Imp. qts. = US qts.)		0.60 (0.53=0.63)	
Oil-grade/viscosity		Same as in engine	
Lubricating oil pump			
Type		Gear	
Spring for reduction valve:			
Length, unloaded, mm (in.)		40 (1.57)	
loaded with 25±2 N (2.5±0,2 kp) (5.51±0.44 p.s.i.), mm (in.)		34 (1.34)	
loaded with 35±2 N (3,5±0,2 kp) (7.72±0.44 p.s.i.), mm (in.)		31.5 (1.24)	

	MD1B	MD2B	MD3B
Fuel system			
Injection pump, make Bosch	PFR1K75A380/11	PFR2K75A381/11	PFR3K75A382/11
Injectors, make Bosch,			
Nozzle holder		KBL87S78/4	
Nozzle		DLLA150S720	
Hole diameter, mm (in.)		Four, 0.27 (0.011)	
Opening pressure kp/cm^2 (p.s.i.)		170–178 (2417–2531)	
Pre-injection angle		23–26^o before T.D.C.	
Fuel filter			
Type		Bosch FJ/DW 2/3	
Filter insert		Bosch FJSJ 32 U7	
Feed pump			
Type		Pierburg PE 15672	
Feed pressure at 42 r/s (2500 rpm), kp/cm^2 (p.s.i.)		0.65–0.85 (9.2–12.1)	
Electrical system			
Battery voltage, V		12	
Battery capacity			
MD2B and MD3B with starter (not dynastarter), Ah			Max. 150
MD2B and MD1B with dynastarter, Ah	Max. 60		
Dynastarter			
Make Bosch	LA/EJ90/12/2900 + 1,0 R 2		
Generator output, max.	135		
Generator output, continous, W.	90		
Starter motor			
Make Bosch			0.001.315.002
Output kW (Hp)			1.344 (1.8)
Alternator			
Make SEV Motorola			827302
Output, W (A)			450 (38)
Specific gravity of battery electrolyte:			
Fully charged battery, g/cm^3		1.275–1.285	
Start re-charging at g/cm^3		1.230	
Cooling system			
Thermostat, type		Bellows thermostat	
Starts opening at ^{o}C (^{o}F)	73–77 (164–170)	60 (140)	57–60 (134–140
Fully open at ^{o}C (^{o}F)	90 (194)	74 (164)	72 (162)
Reverse gear			
Type RB			
Ratio without additional gear		1.87:1	
with additional gear		3.42:1	
Lubricating system		Common with engine	
Type MS			
Ratio with reduction gear		1,91:1	
Lubricating system		Separate (not common with engine)	
Oil capacity incl reduction gear, dm^3			

	MD1B	MD2B	MD3B
WEAR TOLERANCES			
Cylinder block			
To be re-bored when wear attains (or if engine has abnormally high oil consumption), mm (in.)		0.25 (0.010)	
Crankshaft			
Main- and big-end bearing journals allowed ovality, mm (in.)		0.06 (0.002)	
allowed taper, mm (in.)		0.05 (0.002)	
Max. axial clearance on crankshaft, mm (in.)		0.40 (0.016)	
Valves			
Valve stem, allowed max wear, mm (in.)		0.02 (0.001)	
Max clearance between stem – valve guide inlet valve, mm (in.)		0.15 (0.006)	
exhaust valve, mm (in.)		0.17 (0.007)	
Edge of valve disc should be minimum, mm (in.)		1.0 (0.039)	
Distance from valve disc to contact surface of cylinder head, new valve, maximum, mm (in.)		2.5 (0.098)	
Camshaft			
Bearing journals, allowed ovality, mm (in.)		0.03 (0.001)	
Bushings, allowed max wear, mm (in.)		0.05 (0.002)	
TIGHTENING TORQUE		**Nm (kpm) (lb.ft.)**	
Cylinder head nuts		110 (11) (80)	
Cylinder head bolts		45 (4,5) (33)	
Intermediate bearings		80 (8) (58)	
Bolt for crankshaft gear	80 (8) (58)		120 (12) (87)
Bolt for coupling half (engine with MS-reverse gear)		140 (14) (101)	
Flywheel-nut		700 (70) (506)	
Piston rod bolts		65 (6,5) (47)	
Injectors		20 (2,0) (14,5)	
Carrier for water pump	80 (8) (58)		320 (32) (231)
Main bearing cover		45 (4,5) (33)	

VOLVO PENTA

CORRECTIONS AND ADDITIONS TO WORKSHOP MANUAL, PUBL NO 2668

On page 12 of the above-mentioned manual, the thickness of the compressed cylinder head gasket has been given as 1.2 mm (0.047"). Please alter this measurement to 1.4 mm (0.055"). You are also requested to alter the measurement "A" in the example on the same page, from 2.9 mm (0.114") to 2.7 mm (0.106").

Also, the control rod travel on page 20 has been indicated at 8.2 ± 0.1 mm (0.323 ± 0.004"). This measurement applies only to the MD3B. Please insert the following measurements for the MD2B: 8.6 ± 0.1 mm (0.339 ± 0.004"), and for the MD1B: 9.1 ± 0.1 mm (0.358 ± 0.004").

New delivery valves

The fuel injection pumps have been provided with a new type of delivery valve with effect from the following engine serial numbers:
MD1B: No 20471, MD2B: No 17507 and MD3B: No 2276. The earlier type (part No 243419) has been replaced by the so-called "cross" valves with part No 833743. Only the new type of valve will be stocked. Different kinds of valves may not be fitted on the same pump.

On engines with the new type of delivery valves, the control rod travel is shortened by 1.5 mm (0.06")[x]. On these engines the control rod travel should be 7.6 ± 0.1 mm (0.3 ± 0.004") for the MD1B, 7.1 ± 0.1 mm (0.28 ± 0.004") for the MD2B and 6.7 ± 0.1 mm (0.26 ± 0.004") for the MD3B.

NOTE. If the control rod travel is alterd, the high idle, 45 r/s (2700 r/m), should be checked and if necessary adjusted.

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x) This measurement corresponds to 1.5 turns on the adjuster screw for the MD1B and MD2B and two turns for the MD3B.

Adjusting the pre-injection angle

In a number of cases when adjusting the pre-injection angle, there has been some difficulty in obtaining a sufficiently large angle ($23 - 26^{\circ}$ B.T.D.C.) in spite of the fact that only one seal has been fitted between the fuel injection pump and the timing gear casing. Where such cases arise, larger rollers must be fitted on the lifters of the pump elements. When larger rollers are required, first measure the old ones. Then select a size corresponding to the measured pre-injection angle. Rollers are available with a difference of 0.12 mm (0.0047") between each size class. A larger diameter of 0.12 mm (0.0047") on rollers corresponds to an increase in the pre-injection angle of about 1.2°.

NOTE. If a pump has rollers of different sizes, the diameter must be increased equally as much on all rollers. Check the pre-injection angle with the help of a Wilbaer tube each time the injection pump is removed.

Shims for cylinder block

A later type of shims fitted between the cylinder block and crankcase has been prepared with a special kind of sealing agent and has been provided on both sides witha protective coating of plastic.

Important: Thoroughly clean the sealing surfaces on the engine with a degreasing agent and remove the plastic coating on the shims before fitting it. Otherwise leakage can occur.

Oil filler pipe on MD1B, MD2B

In order to avoid oil leakage between the oil filler pipe and the manual starting housing, the O-ring must be greased and must be fitted in the right position during the installation.