TIGHTENING TORQUE (FOR 4 AND 6 CYL.)

COMPONENT		TORQUE	
		Nm	kgm
Cooling Nozzles (M8x1.25x10)		15 ± 3	1.5 ± 0.3
Main bearing cap	1st stage	50 ± 6	5.0 ± 0.6
	2nd stage	80 ± 6	8.0 ± 0.6
	3rd stage	90° ± 5°	
Rear gear housing assembly			
(M8x1.25x40)		24 ± 4	2.4 ± 0.4
(M8x1.25x25)		24 ± 4	2.4 ± 0.4
(M10x1.5)		49 ± 5	4.9 ± 0.5
Oil pump (M8x1.25x30)		8 ± 1	0.8 ± 0.1
Front cover assembly			
(M8x1.25x45)		24 ± 4	2.4 ± 0.4
(M8x1.25x30)		24 ± 4	2.4 ± 0.4
Connecting rod bolts(M11x1.25)	1st stage	30 ± 3	3.0 ± 0.3
	2nd stage	60 ± 5	6.0 ± 0.5
	3rd stage	60° ± 5°	
Ladder frame assembly (M10x1.25x25)		43 ± 5	4.3 ± 0.5
Oil rifle plugs			
(M10x1)		6 ± 1	0.6 ± 0.1
(M14x1.5)		11 ± 2	1.1 ± 0.2
Assemble oil suction tube (M8x1.25x20)		24 ± 4	2.4 ± 0.4
Oil pan assembly			
(M8x1.25x25)		24 ± 4	2.4 ± 0.4
(M18x1.50)		60 ± 9	6.0 ± 0.9
Set timing pin		5 ± 1	0.5 ± 0.1
Fuel pump assembly			
M8 screw		24 ± 4	2.4 ± 0.4
M6 screw		10 ± 1	1.0 ± 0.1
M6 nut		10 ± 1	1.0 ± 0.1
M10x1.5 flange head nuts	pre–torque	10 – 15	1.0 – 1.5
		50 – 55	5.0 – 5.5
Fuel pump gear (drive gear nut)	Snug torque	15 – 20	1.5 – 2.0
	Final torque	85 – 90	8.5 – 9.0
Timing pin cap of fuel pump		30 – 35	3.0 – 3.5
Rocker assys (M8)		24 ± 4	2.4 ± 0.4
Cylinder head bolts			
(M12x70)		50 + 90°	5.0 + 90°
(M12x140)		40 + 180°	4.0 + 180°
(M12x180)		70 + 180°	7.0 + 180°
Assy rocker covers (M8x1.25x25)		24 ± 4	2.4 ± 0.4
Intake manifold (M8x1.25)		24 ± 4	2.4 ± 0.4
Assy air intake connection (M8x1.25)		24 ± 4	2.4 ± 0.4
Oil bypass valve into lube filter head (M22x1.5x10)		80 ± 8	8.0 ± 0.8
Plug (M12x1.5x12)		10 ± 1	1.0 ± 0.1
Exhaust manifold (M10x1.5x65)		43 ± 6	4.3 ± 0.6
Water pump (M8x1.25x25)		24 ± 4	2.4 ± 0.4
Water outlet connection			
(M8x1.25x35)		24 ± 4	2.4 ± 0.4
(M8x1.25x70)		24 ± 4	2.4 ± 0.4
Fan support (M10x1.5x20)		33 ± 5	3.3 ± 0.5
Fan pulley			
(M6)		10 ± 2	1.0 ± 0.2
(M10)		43 ± 6	4.3 ± 0.6

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ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine does not start	Battery flat or faulty.	Check and recharge battery. Replace battery if necessary.	
	Connections to battery terminals corroded or loose.	Clean, examine and tighten the nuts on the battery terminals. Replace the cable terminals and the nuts if excessively corroded.	
	Incorrect timing of injection pump.	Check and correctly time the injection pump.	See your dealer.
	Deposits or water in the fuel tank.	Disconnect the hoses and clean them using a jet of compressed air. Dismantle and clean the injection pump. Remove water from tank and refuel.	Drain feed system.
	No fuel in tank.	Refuel.	
	No power supply.	Overhaul or replace the fuel or transfer pump.	
	Air bubbles in the fuel lines or injection pump.	Check the hoses to ensure that air is in fact present and also check the fuel pump. Eliminate the air from the injection pump by unscrewing the cap and working the fuel pump by hand.	
	Faulty starter motor.	Repair or replace the starter motor.	

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OVERHAUL OF ENGINE PROVIDED WITH MECHANICAL ROTARY PUMP

Preface

Part of the operations illustrated within this section can be partially executed while the engine is assembled on the vehicle, depending on the room available for access to the engine and on the equipment application as well.

With regard to the engine disassembly operations, please apply for information consulting the specific manual. All operations of engine disassembly operations as well as overhaul operations must be executed by qualified engineers provided with the specific tooling and equipment required.

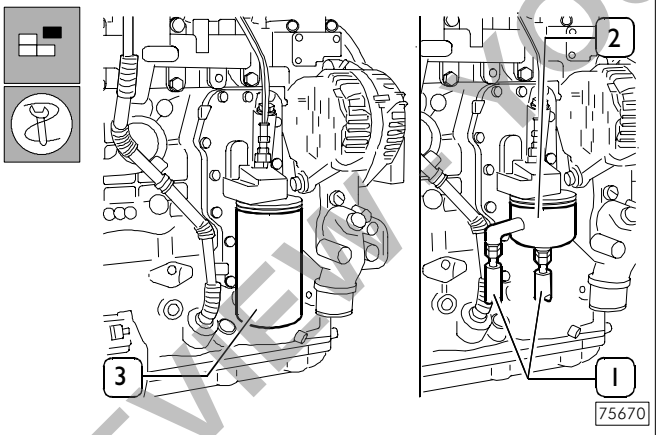
The following information relate to the engine overhaul operations only for what concerns the different components customising the engine, according to its specific duties.

For specific application exigencies, some units can be assembled to the engine in different positions.

Within "General overhaul" section, all the operations of engine block overhaul have been contemplated. Therefore the above mentioned section is to be considered as following the part hereby described.

Engine setting operations for the assembly on turning stand

Figure 2



In order to apply the brackets to the engine block to fix it on to the stand for the overhaul, it is necessary to perform the following operations:

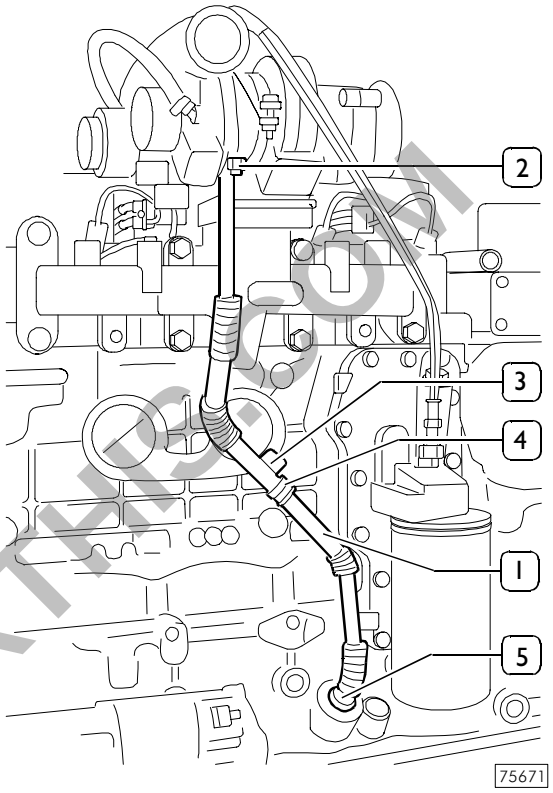
On the right hand side:

❑ disassemble pipes (1) from the union (2) fitting the lubrication oil filter (assembled on the opposite side): unlock the nuts fixing the pipes (1) and remove them from the union (2); drain the oil eventually still inside the pipes and plug them properly in order to avoid impurity inlet.

For some versions, the oil filter (3) is directly assembled on to the heat exchanger: in such case it shall be disassembled using acceptable tools.

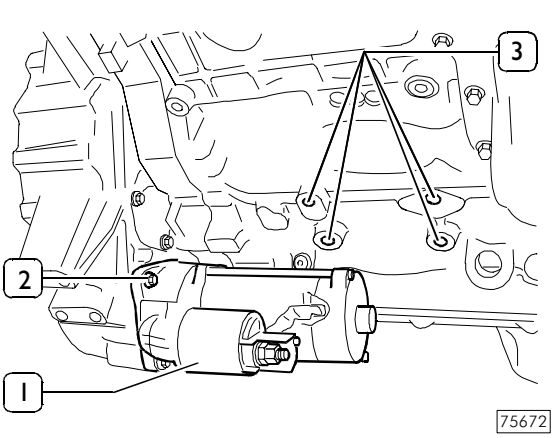
Warning: the oil filter contains inside aprx. 1 kg. of engine oil. Provide for oil recovery and disposal in compliance with the law and regulations in force.

Figure 3



❑ disassemble lubrication oil exhaust pipe from the turbo - blower:
Underneath the turbo - Blower loosen the two screws (2), loosen the screw (3) fixing the pipe throughout the stop collar (4) fixing the block; finally loosen and remove the union (5) from the block; plug the pipe ends and the exhaust of the turbo - blower.

Figure 4



❑ Disassemble the starter;
Properly hold the starter (1) and loosen the two fixing screws (2); assemble the bracket bearing using the four screw threaded ports (3).

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COMPONENT		TORQUE	
		Nm	kgm
Rear lifting bracket (M12x1.75x30)		77 ± 12	7.7 ± 1.2
Crankshaft pulley (M12x1.75x10.9)		110 ± 5	11.0 ± 0.5
Flywheel housing			
(M12x120)		85 ± 10	8.5 ± 1.0
(M12x80)		85 ± 10	8.5 ± 1.0
(M10x80)		49 ± 5	4.9 ± 0.5
(M10x40)		49 ± 5	4.9 ± 0.5
Flywheel housing (M12x1.25)	1st stage	30 ± 4	3.0 ± 0.4
	2nd stage	60° ± 5°	
Assy rear cover plate to flywheel housing (M8x1.25x16)		24 ± 4	2.4 ± 0.4
Fuel injectors		60 ± 5	6.0 ± 0.5
Fuel lift pump		24 ± 4	2.4 ± 0.4
Turbocharger to exhaust manifold (M10)		43 ± 6	4.3 ± 0.6
Oil feed to oil filter head		24 ± 4	2.4 ± 0.4
Oil feed to turbocharger (M12x1.5)		35 ± 5	3.5 ± 0.5
Oil drain (M8x1.25x16)		24 ± 4	2.4 ± 0.4
Alternator to alternator support (M8x1.25x30)		24 ± 4	2.4 ± 0.4
Alternator to water inlet conn. assy (M8x1.25x30)		24 ± 4	2.4 ± 0.4
Lower alternator mounting (M10x1.25x25)		24 ± 4	2.4 ± 0.4
Alternator upper pivot to support (M10)		49 ± 5	4.9 ± 0.5
Alternator mounting hardware (M12x1.75x120)		43 ± 6	4.3 ± 0.6
Alternator wiring (M6x1.0 nut)		10 ± 2	1.0 ± 0,2
Starter motor to gear case (M10)		49 ± 5	4.9 ± 0.5

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ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine does not start at low temperatures	Fuel system clogged with paraffin crystals forming due to the use of unsuitable fuel.	Replace the fuel with fuel suitable for use at low temperatures. Replace the fuel filters.	
	K.K.S.B. device for cold spark advance control operating incorrectly.	Check or replace the injection pump.	See your dealer.
The engine cuts out.	Idle rpm too low.	Adjust with adjustment screw.	
	Irregular flow of injection pump.	Adjust flow.	See your dealer.
	Impurities or water in the fuel lines.	Disconnect the hoses and clean them using a jet of compressed air. Dismantle and clean the injection pump. Remove water from fuel tank and refuel.	Drain feed system.
	Clogged fuel filter.	Dismantle and replace if necessary.	
	Presence of air in the fuel and injection system.	Check that the hoses are not cracked or the unions loose. Replace worn parts, remove the air from the hoses and deaerate the injection pump and fuel filter by unscrewing the caps and working the primer pump by hand.	
	Broken injection pump controls.	Replace the faulty parts.	
	Abnormal clearance between camshaft cams and tappets.	Adjust clearance by replacing shims.	
	Burnt, corroded or chalky valves.	Replace the valves, rectify or replace the cylinder head seatings.	

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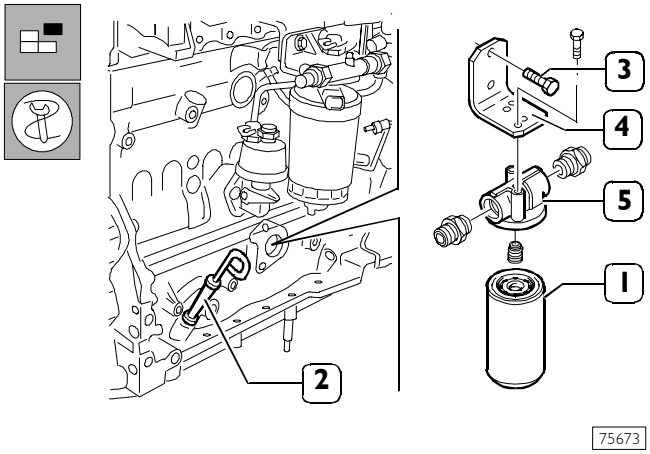
Figure 5



On the left hand side:

❑ Disassemble oil filter (1) and bracket as well (for versions with engine oil filter not directly assembled on to the exchanger);
Use acceptable tool to install oil filter;
Loosen the screws (3) removing the bracket together with the filter bearing (4 and 5).

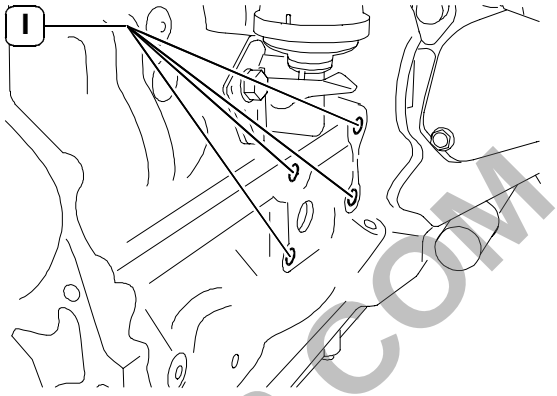
Warning: the oil filter contains inside aprx. 1 kg. of engine oil.
Provide tank with sufficient capacity to contain the liquid.

Warning: avoid contact of engine oil with the skin: in case of skin contamination rinse in running water.

Engine oil is highly pollutant: provide for disposal in compliance with the law and regulations in force.

❑ Remove the oil level rod together with guide pipe (2); (loosen the guide pipe disassembling from the block); properly pipe the screw–threaded port to avoid inlet of foreign matters.

Figure 6



❑ Assemble the second bracket throughout the screw–threaded ports (1).

❑ Lift the engine using the rocker arm and put it on the turning stand.

❑ Drain the oil through the cap underneath the plug.

Warning: avoid contact of engine oil with the skin: in case of skin contamination, rinse in running water.

Engine oil is highly pollutant: provide for disposal in compliance with the law and regulations in force.

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ANOMALY	POSSIBLE CAUSE	REMEDY	NOTE
The engine overheats	Faulty water pump.	Check the unit and replace if necessary. Replace the gasket.	
	Malfunctioning thermostat.	Replace the thermostat.	
	Fouling in coolant openings in the cylinder head and cylinder groups.	Wash following the standards specified for the type of descaling product used.	
	Water pump drive belt slack.	Check and adjust the tightness of the belt.	On applications provided with automatic tensioner, check corret worching of such device.
	Coolant level too low.	Top–up radiator with coolant.	
	Incorrect engine timing.	Check timing and tune correctly.	
	Incorrect calibration of injection pump.	Correct the delivery rate of the pump on a bench so that the injection is at the specified rate.	See your dealer.
	Dry air cleaner blocked.	Clean the air filter or replace if necessary.	
Engine operation is irregular and lacks power	Incorrect timing of injection pump.	Check timing and correctly set pump.	
	K.K.S.B. automatic cold advance device malfunctioning.	Check or replace injection pump.	
	Excessive piston wear.	Check or replace injection pump.	
	Incorrect calibration of speed regulator.	Check and correctly calibrate the regulator.	See your dealer.

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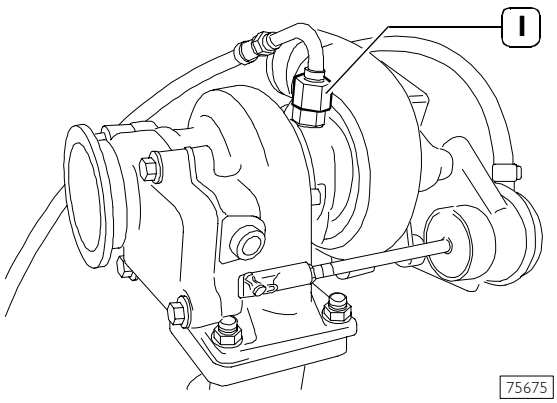
Disassembly of application components

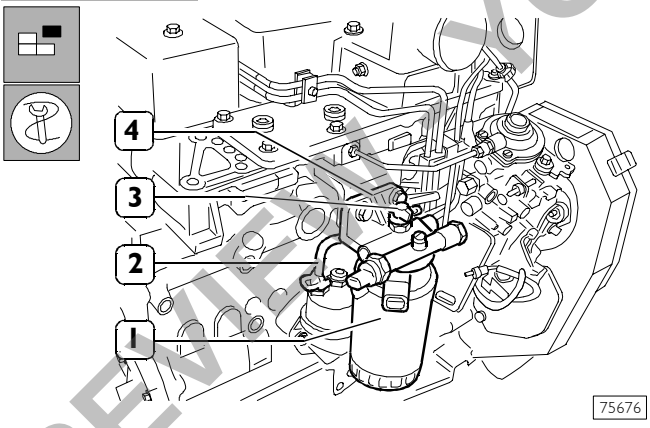
Figure 7



Proceed disassembling the supercharger:

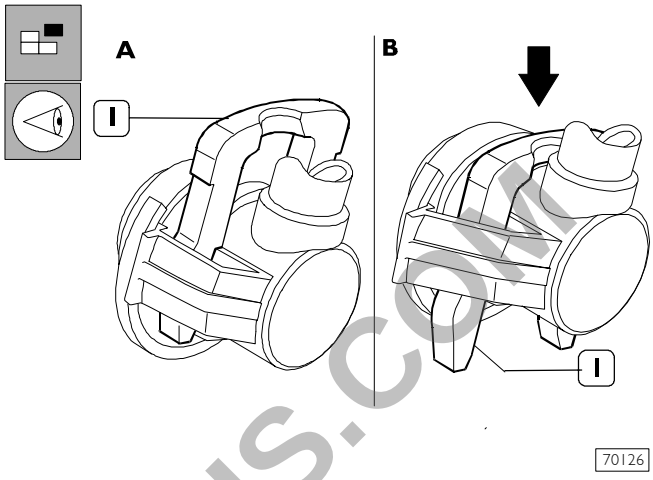
- ❑ loosen the fixing nut (1) and remove the lubrication pipe from the supercharger. Analogously carry out the same operation on the other end of the pipe and remove it from the upper part of the heat exchanger.
- ❑ Loosen the screw nuts fixing the supercharger on the exhaust manifold.
- ❑ Hold up the supercharger and after lifting it remove the gasket.

Figure 8



- ❑ Place a container under the fuel filter and screw out the condense drain faucet underneath said filter. Carry out complete drainage of the fuel contained therein.
- ❑ Screw out completely the faucet and, using acceptable tools, remove the oil filter (1).
- ❑ Disconnect fuel pipelines (2 and 3) respectively from priming pump to filter bearing and from this last one to the feed pump.
- ❑ Remove the fuel filter bearing (4) from the bracket fixed to the engine head.

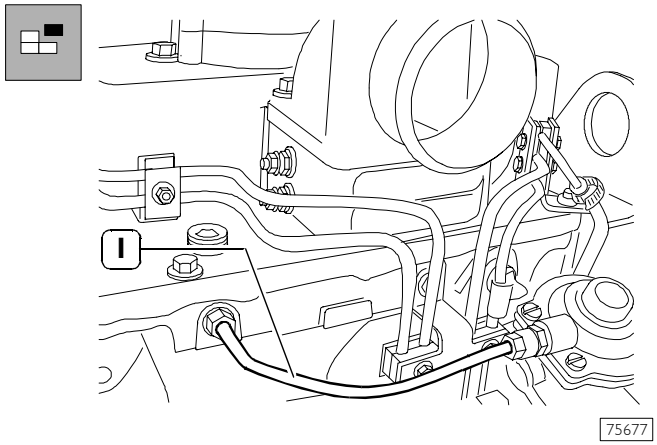
Figure 9



To disconnect fuel pipelines (2 and 3, picture 8), in low pressure from the relating pipe fittings, it is **Necessary to press the locking fastener (1) as shown in picture B.**

After having disconnected the pipeline, reset the locking fastener (1) in lock position as shown in. Picture A, to avoid any possible deformation of the fastener itself.

Figure 10



- ❑ Disconnect the LDA pipe (1) from the head and from the feed pump. Pipe the ends of the pipelines as well as the feed pump and the engine head.

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CONTENT OF SECTIONS

	Section
General information	**I**
Feed	**2**
Duty – Industrial applications Mechanical injection Engines	**3**
Overhaul and technical specifications	**4**
Equipment	**5**
Installation guidelines Safety instructions	**Appendix**

PREFACE TO USER'S GUIDELINE MANUAL

Section 1 describes the engine illustrating its features and working in general.

Section 2 describes the type of fuel feed.

Section 3 relates to the specific duty and is divided in four separate parts:

1. Mechanical part, related to the engine overhaul, limited to those components with different characteristics based on the relating specific duty.
2. Electrical part, concerning wiring harness, electrical and electronic equipment with different characteristics based on the relating specific duty.
3. Maintenance planning and specific overhaul.
4. Troubleshooting part dedicated to the operators who, being entitled to provide technical assistance, shall have simple and direct instructions to identify the cause of the major inconveniences.

Sections 4 and 5 illustrate the overhaul operations of the engine overhaul on stand and the necessary equipment to execute such operations.

Installation general prescriptions are reported within the appendix.

Such prescriptions shall be strictly followed by the operators in–charge of installation to avoid incorrect working as well as serious failures which may reduce performance and life of the engine.

Furthermore, the appendix reports general safety prescriptions to be followed by all operators whether being in–charge of installation or maintenance, in order to avoid serious injury.

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SAFETY PRESCRIPTIONS

Standard safety prescriptions

Particular attention shall be drawn on some precautions that must be followed absolutely in a standard working area and whose non fulfillment will make any other measure useless or not sufficient to ensure safety to the personnel in–charge of maintenance.

Be informed and inform personnel as well of the laws in force regulating safety, providing information documentation available for consultation.

- ❑ Keep working areas as clean as possible, ensuring adequate aeration.
- ❑ Ensure that working areas are provided with emergency boxes, that must be clearly visible and always provided with adequate sanitary equipment.
- ❑ Provide for adequate fire extinguishing means, properly indicated and always having free access. Their efficiency must be checked on regular basis and the personnel must be trained on intervention methods and priorities.
- ❑ Organize and displace specific exit points to evacuate the areas in case of emergency, providing for adequate indications of the emergency exit lines.
- ❑ Smoking in working areas subject to fire danger must be strictly prohibited.
- ❑ Provide Warnings throughout adequate boards signaling danger, prohibitions and indications to ensure easy comprehension of the instructions even in case of emergency.

Prevention of injury

- ❑ Do not wear unsuitable cloths for work, with fluttering ends, nor jewels such as rings and chains when working close to engines and equipment in motion.
- ❑ Wear safety gloves and goggles when performing the following operations:
  – filling inhibitors or anti–frost
  – lubrication oil topping or replacement
  – utilization of compressed air or liquids under pressure (pressure allowed: ≤ 2 bar)
- ❑ Wear safety helmet when working close to hanging loads or equipment working at head height level.
- ❑ Always wear safety shoes when and cloths adhering to the body, better if provided with elastics at the ends.
- ❑ Use protection cream for hands.
- ❑ Change wet cloths as soon as possible
- ❑ In presence of current tension exceeding 48–60 V verify efficiency of earth and mass electrical connections. Ensure that hands and feet are dry and execute working operations utilizing isolating foot–boards. Do not carry out working operations if not trained for.
- ❑ Do not smoke nor light up flames close to batteries and to any fuel material.
- ❑ Put the dirty rags with oil, diesel fuel or solvents in anti–fire specially provided containers.
- ❑ Do not execute any intervention if not provided with necessary instructions.
- ❑ Do not use any tool or equipment for any different operation from the ones they've been designed and provided for: serious injury may occur.
- ❑ In case of test or calibration operations requiring engine running, ensure that the area is sufficiently aerated or utilize specific vacuum equipment to eliminate exhaust gas. Danger: poisoning and death.

During maintenance

- ❑ Never open filler cap of cooling circuit when the engine is hot. Operating pressure would provoke high temperature with serious danger and risk of burn. Wait unit the temperature decreases under 50°C.
- ❑ Never top up an overheated engine with cooler and utilize only appropriate liquids.
- ❑ Always operate when the engine is turned off: whether particular circumstances require maintenance intervention on running engine, be aware of all risks involved with such operation.
- ❑ Be equipped with adequate and safe containers for drainage operation of engine liquids and exhaust oil.
- ❑ Keep the engine clean from oil tangles, diesel fuel and or chemical solvents.
- ❑ Use of solvents or detergents during maintenance may originate toxic vapors. Always keep working areas aerated. Whenever necessary wear safety mask.
- ❑ Do not leave rags impregnated with flammable substances close to the engine.
- ❑ Upon engine start after maintenance, undertake proper preventing actions to stop air suction in case of runaway speed rate.
- ❑ Do not utilize fast screw–tightening tools.
- ❑ Never disconnect batteries when the engine is running.
- ❑ Disconnect batteries before any intervention on the electrical system.
- ❑ Disconnect batteries from system aboard to load them with the battery loader.
- ❑ After every intervention, verify that battery clamp polarity is correct and that the clamps are tight and safe from accidental short circuit and oxidation.
- ❑ Do not disconnect and connect electrical connections in presence of electrical feed.
- ❑ Before proceeding with pipelines disassembly (pneumatic, hydraulic, fuel pipes) verify presence of liquid or air under pressure. Take all necessary precautions bleeding and draining residual pressure or closing dump valves. Always wear adequate safety mask or goggles. Non fulfillment of these prescriptions may cause serious injury and poisoning.

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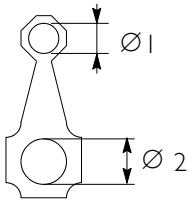
SPECIAL REMARKS

Where possible, the same sequence of procedures has been followed for easy reference.
Diagrams and symbols have been widely used to give a clearer and more immediate illustration of the subject being dealt with, (see next page) instead of giving descriptions of some operations or procedures.

Example



Ø 1 = housing for connecting rod small end bush

Ø 2 = housing for connecting rod bearings

Tighten to torque
Tighten to torque + angular value

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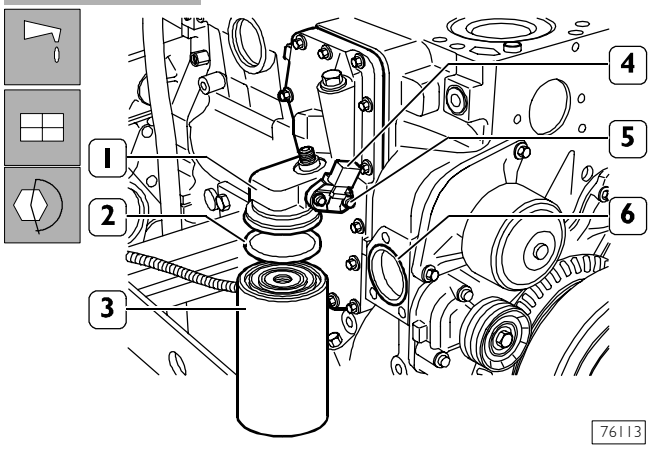
Figure 168

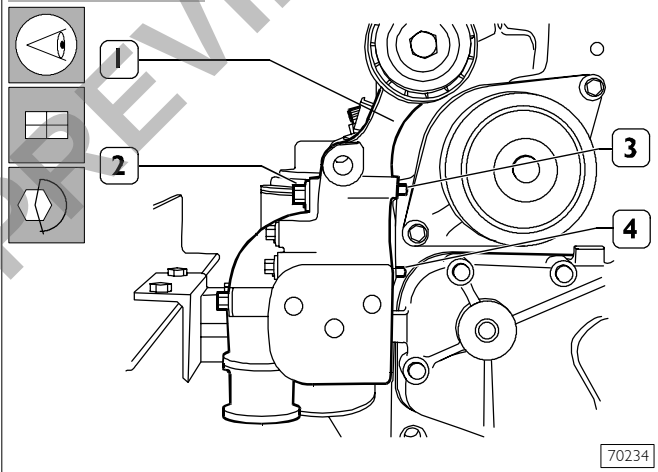


- ❑ Lubricate the fixing ring (2) using engine oil and place it on the oil filter (3).
- ❑ Manually start the oil filter (3) on the bearing union (1) until counter–boring, further screw up the oil filter (3) by 3/4 turn.
- ❑ Apply, (if needed) new fixing ring on the oil temperature/pressure sensor (4) and assemble it to the bearing (1) tightening the fixing screws to the prescribed couple.
- ❑ Tighten the screw (5) and lock it to the prescribed couple.

In some applications, the bearing of the exchanger shall be assembled to a screw threaded union connected to the filter on the opposite side of the engine, throughout two pipelines (see Figure 105).

- ❑ Place a new fixing ring on the block housing (6).

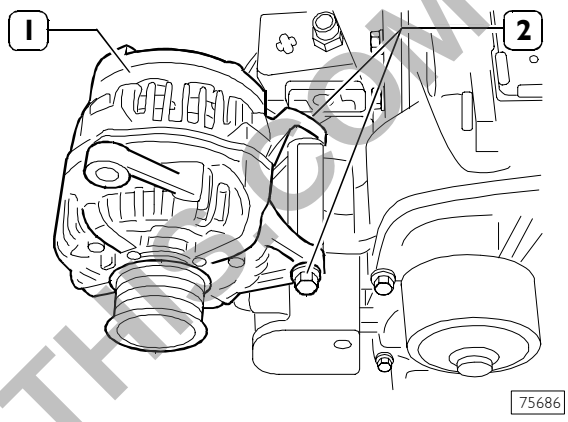
Figure 169



- ❑ Assemble the alternator bearing (1) ensuring that the pins (3 and 4) are against the engine block.
- ❑ Tighten the screws (2) and lock them to the prescribed couple.

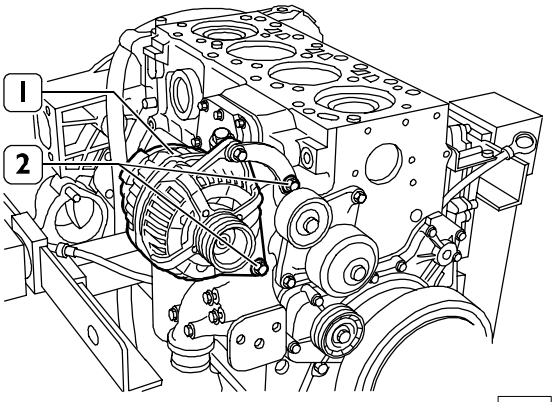
Before assembly, always check that the threads of the ports and of the screws have no evidence of tear and wear nor dirt.

Figure 170



- ❑ Reassemble the alternator (1).
- ❑ Tighten the screw (2) and lock it to the prescribed couple.

Figure 171



- ❑ Refit the alternator (1).
- ❑ Tighten the screw (2) to the specified torque.

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