LDW FOCS 502 - Automotive

SERVICE MANUAL





REGISTRATION OF MODIFICATIONS TO THE DOCUMENT

Any modifications to this document must be registered by the drafting body, by completing the following table.

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Manual's purpose

This manual contains the instructions needed to carry out a proper maintenance of the engine, therefore it must always be available, for future reference when required.

Safety pictograms can be found on the engine and it is the operator's responsibility to keep them in a perfectly visible place and replace them when they are no longer legible.

Information, description and pictures in this manual reflect the state of the art at the time of the marketing ofengine.

However, development on the engines is continuous. Therefore, the information within this manual is subject to change without notice and without obligation.

Lombardini Srl reserves the right to make, at any time, changes in the engines for technical or commercial reasons.

These changes do not require **Lombardini Srl** to intervene on the marketed production up to that time and not to consider this manual as inappropriate.

Any additional section that **Lombardini Srl** will deem necessary to supply some time after the main text shall be kept together with the manual and considered as an integral part of it.

The information contained within this manual is the sole property of **Lombardini Srl** As such, no reproduction or replication in whole or part is allowed without the express written permission of **Lombardini Srl**

Original instructions translated from the Italian language

Data reported in this issue can be modified at any time by Kohler Engines .

PREFACE

Every attempt has been made to present within this use and maintenance, accurate and up to date technical information. However, development on the *Lombardini* series is continuos.

Therefore, the information within this manual is subject to change without notice and without obligation.

Carefully read and follow all instructions in this booklet as well as all those provided with the equipment on which this engine is used. The information contained within this service manual is the sole property of *Lombardini*.

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Information presented within this manual assumes the following the person or persons performing service work on *Lombardini* series engines:

- 1 is properly trained and equipped to safely and professionally perform the subject operation;
- 2 possesses adequate hand and Lombardini special tools to safely and professionally perform the subject service operation;
- 3 has read the pertinent information regarding the subject service operations and fully understands the operation at hand.
- For spare parts and after sale assistance contact authorized service centers.
- For any spare parts order please specify following details: ENGINE TYPE AND SERIAL NUMBER Version (K) on the engine name plate
- The complete and updated list of authorized *Kohler* service centers can be found on our web site: *www.kohlerengines.com* & *www.lombardinigroup.it/dealer-locator*
- Pls contact Service Centers for special applications.

GENERAL SERVICE MANUAL NOTES

1. Use only genuine repair parts. Failure to use genuine parts could result in sub-standard performance and low longevity.

- 2. All data presented are in metric format:
- . dimensions are presented in millimeters (mm),
- . torque is presented in Newton-meters (Nm),
- . weight is presented in kilograms (kg),
- . volume is presented in liters or cubic centimeters (cc)
- . pressure is presented in barometric units (bar).
- **3.** To ensure safe operation please read the following statements and understand their meaning. Also refer to your equipment manufacturer's manual for other important safety information.

This manual contains safety precautions which are explained below.



GLOSSARY AND TERMINOLOGY

For clarity, here are the definitions of a number of terms used recurrently in the manual.

- Cylinder number one: is the timing belt side piston .
- Rotation direction: anticlockwise «viewed from the flywheel side of the engine».

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Safety regulation **GENERAL NOTES**

- Lombardini engines are built to provide safe and longlasting performances, but in order to obtain these results it is essential that the maintenance requirements described in • Fuel is flammable, so the tank must be filled only when the the manual are observed along with the following safety recommendations.
- The engine has been built to the specifications of a machine manufacturer, and it is his responsibility to ensure that all necessary action is taken to meet the essential and legally prescribed health and safety requirements. Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by Lombardini, which therefore declines all responsibility for accidents caused by such operations.
- The following instructions are intended for the user of the machine in order to reduce or eliminate risks, especially those concerning the operation and standard maintenance of the engine.
- The user should read these instructions carefully and get to know the operations described. By not doing so he may place at risk his own health and safety and that of anyone else in the vicinity of the machine.
- The engine may be used or mounted on a machine only by personnel suitably trained in its operation and aware of the dangers involved. This is particularly true for standard and, above all, special maintenance work. For special maintenance contact personnel trained specifically by Lombardini. This work should be carried out in accordance with existing literature.
- Lombardini declines all responsibility for accidents or for failure to comply with the requirements of law if changes are made to the engine's functional parameters or to the fuel flow rate adjustments and speed of rotation, if seals are removed, or if parts not described in the operating and maintenance manual are removed and reassembled by unauthorized personnel.

Danger

- In addition to all other machine specifications, ensure that During operations which involve access to moving parts of the engine is in a near horizontal position when starting. If starting manually, ensure that the necessary operations can be performed without any risk of striking against walls or dangerous objects. Rope starting (except for recoil rope • Check the belt tension only when the engine is turned off. starting) is not permitted even in emergencies.
- Check that the machine is stable so that there is no risk of it overturning.
- Get to know the engine speed adjustment and machine To start the engine follow the specific instructions provided stop operations.
- Do not start the machine in closed or poorly ventilated environments. The internal combustion process generates carbon monoxide, an odourless and highly toxic gas, so spending too long a time in an environment where the engine discharges its exhaust products freely can lead to loss of consciousness and even death.
- The engine may not be used in environments containing flammable materials, explosive atmospheres or easily combustible powders, unless adequate and specific • Close the fuel tank filler cap carefully after each filling precautions have been taken and are clearly stated and certified for the machine.
- To prevent the risk of fire, keep the machine at a distance of Do not smoke or use naked flames while filling. at least one metre from buildings or other machines.
- Children and animals must be kept at a sufficient distance The operations of checking, filling up and replacing the cooling

from the machine to prevent any danger resulting from its operation.

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- engine is turned off. Dry carefully any fuel that may have spilled, remove the fuel container and any cloths soaked in fuel or oil, check that any sound-absorbing panels made of porous material are not soaked with fuel or oil, and make sure that the ground on which the machine is located has not absorbed fuel or oil.
- Before starting, remove any tools that have been used for carrying out maintenance work to the engine and/or the machine and check that any guards removed have been replaced. In cold climates it is possible to mix kerosene with the diesel fuel to make the engine easier to start. The liquids must be mixed in the tank by pouring in first the kerosene and then the diesel fuel. Consult Lombardini technical office for mixture proportions. Petrol may not be used because of the risk of it forming flammable vapours.
- During operation the surface of the engine reaches temperatures that may be dangerous. Avoid in particular all contact with the exhaust system.
- The liquid cooling circuit is under pressure. Do not carry out any checks before the engine has cooled down, and even then open the radiator cap or the expansion tank cautiously. Wear protective clothing and glasses. If there is an electric fan, do not approach the engine while it is still hot as the fan may come on even when the engine is not running. Clean the cooling system with the engine turned off.
- While cleaning the oil bath air filter, check that the oil is disposed of in such a way as not to harm the environment. Any filtering sponges in the oil bath air filter should not be soaked with oil. The cyclone pre-filter cup must not be filled with oil.
- Since the oil must be emptied out while the engine is still hot (approx. 80°C), particular care should be taken in order to avoid burns. In any case make sure that oil does not come into contact with your skin because of the health hazards involved.
- Fuel vapours are highly toxic, so fill up only in the open air or in well ventilated environments.
- the engine and/or removal of the rotary guards, disconnect and insulate the positive cable of the battery so as to prevent accidental short circuits and activation of the starter motor.

1 Important

- in the engine and/or machine operating manual. Do not use auxiliary starting devices not originally installed on the machine (e.g. Startpilot systems which utilise ether etc.)
- Before carrying out any work on the engine, turn it off and allow it to cool down. Do not perform any operation while the engine is running.
- Check that the discharged oil, the oil filter and the oil contained in the oil filter are disposed of in such a way as not to harm the environment.
- operation. Do not fill the tank right up to the top, but leave sufficient space to allow for any expansion of the fuel.
- Take care when removing the oil filter as it may be hot.

liquid must be carried out with the engine turned off and cold. Take particular care if liquids containing nitrites are mixed with others not containing these compounds as this may give rise to the formation of nitrosamines which are a health hazard. The cooling liquid is polluting, so dispose of in a manner that does not damage the environment.

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 In order to move the engine simultaneously use the eyebolts fitted for this purpose by Lombardini. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.

California Proposition 65 WARNING

Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

Regulations for lifting the engine



Before removing the engine from the vehicle on which it is installed, disconnect the power supply, detach the fuel and coolant supply, and all connections including the mechanical ones.

Attach the engine to a suitable lifting device (lifting beam).

To move the engine simultaneously use the eyebolts installed, these lifting points are not suitable for the entire machine, then use the eyebolts installed by the manufacturer. Before lifting, make sure the weight is correctly balanced by checking its barycentre.

Close all engine openings accurately (exhaust, intake, etc.), then wash the outside and dry with a jet of compressed air.

The bracket of the lifting points have been designed to lift the engine only. They are not intended nor approved to lift additional weights.

Do not use different methods to lift the engine than those described herein. In case different methods are used, no warranty shall be granted for any consequential damage. Use protective gloves when handling the engine





GENERAL SAFETY DURING OPERATING PHASES

- The procedures contained in this manual have been tested and selected by the manufacturer's technical experts, and hence are to be recognised as authorised operating methods.
- A number of procedures must be carried out with the aid of equipment and tools that simplify and improve the timing of operations.
- All tools must be in good working condition so that engine components are not damaged and that operations are carried out properly and safely.
- It is important to wear the personal safety devices prescribed by work safety laws and also by the standards of this manual.
- Holes must be lined up methodically and with the aid of suitable equipment. Do not use your fingers to carry out this operation to avoid the risk of amputation.
- Some phases may require the assistance of more than one operator. If so, it is important to inform and train them regarding the type of activity they will be performing in order to prevent risks to the health and safety of all persons involved.
- Do not use flammable liquids (petrol, diesel, etc.) to degrease or wash components. Use special products.
- Use the oils and greases recommended by the manufacturer.
- Do not mix different brands or combine oils with different characteristics.
- Discontinue use of the engine if any irregularities arise, particularly in the case of unusual vibrations.
- Do not tamper with any devices to alter the level of performance guaranteed by the manufacturer.

SAFETY AND ENVIRONMENTAL IMPACT

Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment.

Procedures for identifying the extent of the impact on the environment must consider the following factors:

- Liquid waste
- Atmospheric emissions
- Waste management
- Use of raw materials and natural resources
- Soil contamination
- Regulations and directives regarding environmental impact

In order to minimise the impact on the environment, the manufacturer now provides a number of indications to be followed by all persons handling the engine, for any reason, during its expected lifetime.

- All packaging components must be disposed of in accordance with the laws of the country in which disposal is taking place.
- Keep the fuel and engine control systems and the exhaust pipes in efficient working order to limit environmental and noise pollution.

- When discontinuing use of the engine, select all components according to their chemical characteristics and dispose of them separately.

Information and safety signals



Disabling engine. Accidental starting can cause severe injury or death. Before working on the engine or equipment, disable the engine as follows: 1) Disconnect negative (-) battery cable from battery.

Rotating Parts!
Rotating Parts can cause severe injury. Stay away while engine is in operation.

Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the engine with covers, shrouds, or guards removed.

Lethal Exhaust Gases!
Carbon Monoxide can cause severe nausea, fainting or death. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area
building or confined area.

Engine exhaust gases contain poisonous carbon monoxide. Carbon monoxide is odorless, colorless, and can cause death if inhaled. Avoid inhaling exhaust fumes, and never run the engine in a closed building or confined area.

Hot Parts!
Hot Parts can cause severe burns. Do not touch engine while operating or just after stopping.

Engine components can get extremely hot from operation. To prevent severe burns, do not touch these areas while the engine is running, or immediately after it is turned off. Never operate the engine with heat shields or guards removed.



Explosive Fuel!

Fuel can cause fires and severe burns.

Do not fill the fuel tank while the engine is hot or running.

Fuel is flammable and its vapors can ignite. Store fuel only in approved containers, in well ventilated, unoccupied buildings. Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition. Do not start the engine near spilled fuel. Never use fuel as a cleaning agent.

Explosive Gas!
Explosive Gas can cause fires and severe acid burns. Charge battery only in a well ventilated area. Keep sources of ignition away.

Batteries produce explosive hydrogen gas while being charged. To prevent a fire or explosion, charge batteries only in well ventilated areas. Keep sparks, open flames, and other sources of ignition away from the battery at all times. Keep batteries out of the reach of children. Remove all jewelry when servicing batteries. Before disconnecting the negative (-) ground cable, make sure all switches are OFF. If ON, a spark will occur at the ground cable terminal which could cause an explosion if hydrogen gas or fuel vapors are present.

	High Pressure Fluid Puncture!			
	High Pressure Fluids can punctureskin and cause severe injury or death. Do not work on fuel system without proper training or safety equipment.			
Fuel system is to be serviced only by properly trained personnel wearing protective safety equipment. Fluid puncture injuries are highly toxic and hazardous. If an injury occurs, seek immediate medical attention.				
	Electrical Shock!			
	Electrical Shock can cause injury. Do not touch wires while engine			

Do not touch wires while engine is running.

Never touch electrical wires or components while the engine is running. They can be sources of electrical shock.



Explanation of the safety pictograms that can be found on the engine or in the Workshop manual

	- Read the Operation and Workshop manual before performing any operation on the engine
<u>^</u>	- High temperature components - Danger of scalding
<u>∧</u> ¥ີ2	 Presence of rotating parts Danger of entangling and cutting
<u>^</u>	 Presence of explosive fuel Danger of fire or explosion
	 Presence of steam and pressurized coolant Danger of scalding

- Use protective gloves before carrying out the operation
- Use protective glasses before carrying out the operation
- Use sound absorbing protections before carrying out the operation
 Electric shock Danger of severe scalding or death
 Fluids under high pressure Danger of fluids penetration
- Lethal exhaust gas - Danger of poisoning or death

Indications regarding the points on the engine where the safety pictograms are placed

- Ensure the good condition of safety signs.

- If the safety signs are damaged and / or illegible, you must replace them with other originals and place them in the positions shown below.
- For cleaning use a cloth, water and soap.





2.1 GENERAL DESCRIPTION OF THE ENGINE

Main components



- A) Cylinder head
- B) Engine block
- C) Crankcase
- D) Timing belt assembly
- E) Flywheel and crankshaft assembly
- F) Air intake assembly
- G) Cooling fan
- H) Negative-pressure vent valve

- L) Alternator
- M)Oil filter
- N) Exhaust manifold
- P) Starter motor
- Q) Camshaft
- R) Coolant pump
- S) Fuel supply pump
- T) Oil pump



2.2 TECHNICAL SPECIFICATIONS



						DIM	ENSIONS (m	ım)					
Α	451	С	353	E	181	G	36	1	340	М	51 (¹)	0	182
B	491	D	238	F	213	Η	280	L	151	Ν	52 (²)	Ρ	160

(1) with suction fan

(2) with blower fan

GENERAL DE	TAILS			
		502 Euro 2	502 Euro 4	
Operating cycle	4-stroke c	diesel		
Number of cylinders	n°	2		
Bore x stroke	mm	72x62	71,5x62	
Displacements	cm ³	505	498	
Compression rate	22,5:1			
Intake	Air filter	(dry)		
Filter capacity	μm	13÷	-14	
Filtering surface	cm ²	44	70	
Cooling	Wate	r		
Driving shaft rotation	Clockwise (from distribution side)			
Combustion sequence	1:2			
Timing system	Synchronous toothed belt			
Dry weight of engine	Kg	60	54	
Maximum tilt while operating	no more than 1 minute	35	5°	
Maximum tilt while operating	no more than 30 minutes 25°			
Volume of air flow (at 3600 RPM)	NI/min 910			
Volume of cooling air (at 3600 RPM)	m³/min	30	6	
POWER AND T	ORQUE			
Maximum operating speed	RPM	36	00	
Max. power (N 80/1269/EEC - ISO 1585 - DIN 7020)	kW (CV)	4	6	
Maximum torque (at 2400 RPM)	Nm	23.0	21.0	
Axial load allowed on driving shaft	Kg 300			

CONSUMPTION AT MA	XIMUM POWER	
Specific fuel onsumption	g/kWh	326
Specific oil consumption	Kg/h	0,007
SUPPLY CIF	RCUIT	
Supply type	Indirect in	jection
Fuel type	Car die	esel
Fuel supply	Electric or mem	brane pump
Fuel filter	Screw-on or in-	line "fispino"
Filter paper	m	PF905
Filtering surface	cm ²	2400
Filter capacity (Electrical and / or diaphragm pumps)	u	2÷3
Maximum operating pressure	bar	4
Type of lubrication	Completely	/ forced
	Trochoid	nump
Maximum oil quantity	including filter (I)	14
Maximum oil quantity	excluding filter (I)	13
Oil pressure at minimum speed (with oil temperature of 120°C)	no lower th	i,o an 1 har
Oil filter contridge	no lower th	
Maximum aparating processor	bor	7
Maximum operating pressure	bar	7
	bar	20
Filter capacity	μ	15
By-pass valve setting	bar	1,5÷1,7
Filtering surface	Cm ²	730
COOLING CI	RCUII	
	50% water - 50%	antifreeze fiuld
	20	000.070
Opening temperature	Ĵ	83°÷87°
Max stroke (at 94°C)	mm	/
Liquid return	l/h	30÷80
	UIPMENT	10
Nominal voltage	V	12
Alternator (nominal voltage)	V	14
Internal/external alternator (nominal current) (see "Alternator load curve diagrams")	A	40
Starter motor power	Kw	1,1
Preheating glow plugs		
Nominal voltage	V	12,5
Absorption (after 5 seconds)	A	12÷14
Surface temperature of the sheath	C°	850°
Control unit temperature sensor		
Working field	O°	-30°÷80°
Voltage	V	6+24
Max. temperature	°C	150°
Oil pressure switch		
Operating pressure	bar	0,15÷0,45
Coolant temperature monitoring sensor		
Electric circuit	Unipolar	system
Supply voltage	V	6÷24
Absorbed power	W	3
Closed circuit temperature	°C	107°÷113°

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TECHNICAL INFORMATION



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2.4 ALTERNATOR LOAD CURVE DIAGRAMS

Reading taken after heat stabilisation at 25°C and constant voltage 13,5V.



* To determine engine r.p.m.s, check the gear ratio adapted to pulleys.

voltage 12,5V.

Reading taken after heat stabilisation at 20°C and constant

External load curve diagram



** The alternator turns at the same rate as the engines.



LUBRICANT

SAE Classification

In the SAE classification, oils differ on the basis of their viscosity, and no other qualitative characteristic is taken into account.

The first number refers to the viscosity when the engine is cold (symbol W = winter), while the second considers viscosity with the engine at régime.

The criteria for choosing must consider, during winter, the lowest outside temperature to which the engine will be subject and the highest functioning temperature during summer.

Single-degree oils are normally used when the running temperature varies scarcely.

Multi-degree oil is less sensitive to temperature changes.



International specifications

They define testing performances and procedures that the lubricants need to successfully respond to in several engine testing and laboratory analysis so as to be considered qualified and in conformity to the regulations set for each lubrication kind. A.P.I

: (American Petroleum Institute)

MIL : Engine oil U.S. military specifications released for logistic reasons

ACEA : European Automobile Manufacturers Association

Tables shown on this page are of useful reference when buying a kind of oil.

Codes are usually printed-out on the oil container and the understanding of their meaning is useful for comparing different brands and choosing the kind with the right characteristics.

Usually a specification showing a following letter or number is preferable to one with a preceding letter or number.

ACEA Regulations - ACEA Sequences

LIGHT DUTY DIESEL ENGINES			HEAVY DUTY DIESEL ENGINES			
B1	Low-viscosity, for frictions reduction	E 2	Standard			
B2	Standard	E3	Heavy conditions (Euro 1 - Euro 2 engines)			
B 3	High performances (indirect injection)	E 4	Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)			
B 4	High quality (direct injection)	E 5	High performances in heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)			

API.	MIL Seque	ences

API	CH-4	CG-4	CF-4	CF-2	CF	CE	CD	СС
MIL				L- 4	6152	D/E		

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2.6 OPERATING PRINCIPLE FOR LUBRIFICATION

Rif.	Description
1	Pressure switch
2	Rocker-arm pin
3	Connecting rod big end pin
4	Oil filter cartridge
5	Main jurnal
6	Oil drain plug
7	Oil dipstick
8	Air vent
9	Oil refilling pump
10	Camshaft
11	Oil pressure regulating valve
12	Oil pump
13	Crankshaft
14	Oil suction filter



2.7 OPERATING PRINCIPLE FOR COOLING

Rif.	Description
1	Coolant refilling plug
2	Compensation tank
3	Thermostatic valve
4	Cylinder block
5	Liquid temperature monitoring thermostat
6	Circulating pump
7	Fan
8	Radiator





2.8. OPERATING PRINCIPLE FOR FUEL INJECTION

With mechanical supply pump

Rif.	Description
1	Tank
2	Fuel filter
3	Supply pipe
4	Supply pump
5	Injection pump
6	Injector
7	Fuel rail
8	Exhaust pipe
9	Plug
10	Solenoid valve

Note: the tank is supplied complete with filter on request.



With electrical supply pump

Rif.	Description
1	Tank
2	Fuel filter
3	Supply pipe
4	Electrical supply pump
5	Pump
6	Injector
7	Fuel rail
8	Exhaust pipe
9	Plug





2.9 WIRING DIAGRAM



Rif.	Description
1	40A alternator
2	Starter motor
3	Battery (recommended 44Ah-210A-DIN)
4	Preheating glow plugs
5	Coolant temperature monitoring sensor
6	Glow plug pre-heating control box
7	Ignition switch
8	50A fuses
9	5A fuses
10	Electrostop device or electrical fuel lift pump
11	Glow plugs indicator
12	Coolant temperature indicator

Rif.	Description
13	Coolant thermostat indicator light
14	Engine oil preassure lamp
15	Oil preassure gauge
16	Battery load indicator
17	Coolant thermometer
18	Coolant thermomenter sensor
19	Fuel level light
20	Fuel level indicator
21	Relay (normally closed with a 3 second delay) 40÷50 A
22	Electrical fuel lift pump

TECHNICAL INFORMATION



With internal alternator



Rif.	Description
1	40A alternator
2	Starter motor
3	Battery (recommended 44Ah-210A-DIN)
4	Preheating glow plugs
5	Coolant temperature monitoring sensor
6	Glow plug pre-heating control box
7	Ignition switch
8	50A fuses
9	5A fuses
10	Electrostop device or electrical fuel lift pump
11	Glow plugs indicator
12	Coolant temperature indicator

Rif.	Description
13	Coolant thermostat indicator light
14	Engine oil preassure lamp
15	Oil preassure gauge
16	Battery load indicator
17	Voltage regulator
18	Coolant thermometer
19	Coolant thermomenter sensor
20	Fuel level light
21	Fuel level indicator
22	25 V - 10000 µF condensator
23	Electrical fuel lift pump



2.10 SPECIAL TOOLS AND EQUIPMENT FOR MAINTANANCE

Serial number	Description	Serial number	Description
7107-1460-127	Instrument for balancing injection pump delivery	7107-1460-048	Tool for lowering injection advance control valve
7107-1460-030	Precombustion chamber extractor	7107-1460-074	Equipment for injection advance control and injector calibration
7107-1460-029	Pin wrench for ring nut on pump/injector pumping element	7107-1460-051	Driving shaft clamping tool
7107-1460-027	Precombustion chamber pin wrench	7107-1460-031 Pive	ot pin precombustion chamber
7107-1460-047	Tool for mounting intake/exhaust valve guide gasket	7271-1460-049	Tool for adjusting timing belt tension



2.11 TABLE FOR TIGHTENING TORQUES

Table of tightening torques for standard screws (coarse thread)

Resistance class (R)								
Quality/ Dimensions	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
Diameter	R>400	N/mm²	R>500	N/mm²	R>600N/mm ²	R>800N/ mm ²	R>1000N/ mm ²	R>1200N/ mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M3	0,5	0,7	0,6	0,9	1	1,4	1,9	2,3
M4	1,1	1,5	1,4	1,8	2,2	2,9	4,1	4,9
M5	2,3	3	2,8	3,8	4,5	6	8,5	10
M6	3,8	5	4,7	6,3	7,5	10	14	17
M8	9,4	13	12	16	19	25	35	41
M10	18	25	23	31	37	49	69	83
M12	32	43	40	54	65	86	120	145
M14	51	68	63	84	101	135	190	230
M16	79	105	98	131	158	210	295	355
M18	109	145	135	181	218	290	405	485
M20	154	205	193	256	308	410	580	690
M22	206	275	260	344	413	550	780	930
M24	266	355	333	444	533	710	1000	1200
M27	394	525	500	656	788	1050	1500	1800
M30	544	725	680	906	1088	1450	2000	2400

Tightening torques for standard screws (fine threads)

Resistance class (R)								
Quality/ Dimensions	4.6	4.8	5.6	5.8	6.8	8.8	10.9	12.9
Diameter	R>400N/mm ²		R>500N/mm ²		R>600N/mm ²	R>800N/ mm ²	R>1000N/ mm²	R>1200N/ mm²
	Nm	Nm	Nm	Nm	Nm	Nm	Nm	Nm
M 8x1	10	14	13	17	20	27	38	45
M 10x1	21	28	26	35	42	56	79	95
M 10x1,25	20	26	24	33	39	52	73	88
M 12x1,25	36	48	45	59	71	95	135	160
M 12x1,5	38	45	42	56	68	90	125	150
M 14x1,5	56	75	70	94	113	150	210	250
M 16x1,5	84	113	105	141	169	225	315	380
M 18x1,5	122	163	153	203	244	325	460	550
M 18x2	117	157	147	196	235	313	440	530
M 20x1,5	173	230	213	288	345	460	640	770
M 20x2	164	218	204	273	327	436	615	740
M 22x1,5	229	305	287	381	458	610	860	1050
M 24x2	293	390	367	488	585	780	1100	1300
M 27x2	431	575	533	719	863	1150	1600	1950
M 30x2	600	800	750	1000	1200	1600	2250	2700



TECHNICAL INFORMATION

Tightening torques for main components

POSITION	Diam. & pitch (mm)	Torque (Nm)
Injector pump connecting rod	M 3 spec.	1,2
Aluminium connecting rod	8x1	30
Steel connecting rod	8x1	50
Preheating glow plugs	12x1,25	25
Rocker-arm cover	6x1	9
Crankcase (screws for fixing crankshaft)	M 10	30
Crankcase (screws for fixing engine block)	M 6	10
Screw for speed governor bearing support cover	M 6	10
Preheating glow plugs cable nuts	5x0,8	5
Fuel supply pump nuts	8x1,5	24
Nut for synchronous timing belt pulley	M 10	40
Injector pump nut	8x1,25	20
Rocker arm support nuts	10x1,5	40
Fuel pump control eccentric	10x1,25	80
Oil sealing ring flange screws (flywheel side)	M 6	12
Precombustion chamber ring nut	30x1,5	180
Governor tinkage adjustment pin	6x1	7
Crankshaft pulley screw (timing belt side)	16x1,5 sin.	180
Camshaft pulley screw	10x1,25	80
Oil pressure switch	12x1,5	25
Oil plug	12x1,5	40
Cylinder head screws		(1)
Injector pump head screws	TCEI 4x1,5	4
Flywheel screws	10x1,5	80
Coolant thermostat / Control unit sensor		30
Control unit temperature sensor		30

 $^{\mbox{\tiny (1)}}$ For more detailed information see "Assembling the cylinder head"



2.12 TABLE OF SEALANTS

Area of application	Sealant
Fuel rail attachment	Loctite 638
Oil filter cartridge union (M 20X1,5)	Loctite 601
Camshaft bearing screw (M 6)	Loctite 270
Stud bolt for tightening pulley (M 10)	Loctite 601
Cylinder head plug (ø 18)	Loctite 510
Engine and engine block cylinder head plug (ø 30)	Loctite 510

2.13 ROUTINE ENGINE MAINTENANCE

After the fil 500 k			irst Km REGULARITY KM (x 1000 Km)																			
PROSEDURE	DETAU		5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
PROCEDURE	DETAIL																					
CLEANING	Pump injectors																					
	Radiator fan																					
	valve and rocker arm clearance																					
	Engine oil	EVERY 2.500 Km																				
	Solenoid valve operation																					
ECK	Oil vapor recovery																					
СН	Fuel pipe and connections																					
	Coolant																					
	Alternator belt																					
	Timing belt	EVERY 25.000 Km																				
	Alternator																					
	Air filter element																					
	Engine oil											-DV			~							
щ	Oil filter	EVERY 5.000 Km																				
DN G	Fuel filter																					
СНА	Coolant																					
	Alternator belt																					
	Timing belt						EVE	RY	50.0	000	Km ((or a	at ev	/ery	disa	isser	mbly)				
	Fuel pipes									E	EVER	RY 4	l yea	ars								

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MALFUNCTIONS

1	3.1 LOOKING FOR MALFUNCTIONS															
					PROBLEM											
		PROBABLE CAUSE	Engine does not start	Engine starts and then stops	Does not accelerate	Inconsistent rpm	Black smoke	White smoke	Low oil preassure	Oil consumption too high	Consommation huile en excès	Oil and condensation dripping from the exhaust	Coolant overheats			
		Clogged pipes														
		Clogged fuel filter														
		Air in the fuel circuit														
	E	Clogged tank breather														
	CUI	Faulty fuel pump														
	CIR	Blocked injector														
	Щ	Blocked injection pump valve														
	ЦЦ	Injector not adjusted														
		Excess leaking in the plunger														
		Jammed injection pump delivery control														
		Wrong injection pump delivery setting														
	7	High oil level														
	0 E	Blocked pressure relief valve														
	CA	Worn oil pump														
	BIFI	Air in the oil intake pipe														
	UB	Faulty pressure gauge or switch														
		Clogged oil suction hose														
		Burnt fuse on pre-heating glow plugs														
	ELECTRICAL SYSTEM	Failure in glow plugs control unit														
		Discharged battery														
		Inefficient or wrong cable connection														
		Faulty ignition switch														
		Faulty starter motor														
	щ	Air filter clogged														
	O Z	Excessive idle operation														
	EN ≜	Incomplete running-in														
	F	Overloaded engine														
	MΑ	Clogged cooling circuit														
		Slack or broken fan control belt														
		Incorrect injection timing														
		Delayed injection														
		Incorrect governor linkage adjustment														
	RS	Broken or loose governor spring														
	PAI	Low lale setting														
	BE	Worn or stuck piston rings														
	LS/	Worn or scored cylinders														
	L L L	Worn valve guides														
	MT	Valves sluck														
	AD	Driving sheft not turning fresh														
		Damaged head gasket														
		Slack pump/injector control rod														
		Incorrect pump/injector delivery balancing														

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STORING THE ENGINE

4.1 HANDLING AND LIFTING

- Secure the engine using a lifting device (lifting beam) of suitable capacity.
- Hook the lifting device to the points indicated in the drawing.
- Before lifting, check the load's centre of gravity.

i Important

• The dimensions of the brackets on the fastening points have been specially conceived to lift the engine and have not been tested for lifting additional weights. Do not lift the engine using different methods from those described. Non-observance of this requirement will invalidate the insurance warranty from any damages caused in this way.



4.2 STORING THE ENGINE (UNINSTALLED)

- If the engine is not to be used for extensive periods, check the surroundings and the type of packaging and make sure that they are suitable for correct storage.
- If necessary, cover the engine with a protective sheet.
- Avoid storing the engine directly on the ground or in an environment that is humid, exposed to bad weather or close to sources of danger, including less visible ones, such as high-voltage power lines etc.
- If the engine is not to be used for more than 1 month, it is necessary to apply the protective measures that are valid for 6 months (see "Protective treatment (first 6 months of inactivity)")
- If, after the first 6 months, the engine is still not to be used, it is necessary to carry out a further measure to extend the protection period (see "Protective treatment (after 6 months of inactivity)").

4.3 STORING THE ENGINE (INSTALLED)

If the engine has been installed on a machine and is not due to be used for extensive periods, it is necessary to carry out a few maintenance measures in order to ensure it remains efficient and to protect its components. If the engine is installed on the machine and is not to be used for short periods of time, the following measures must be carried out:

- Check the condition of the electrical contacts and protect them, if necessary, using an anti-rust spray.
- Disconnect the battery.
- Empty the fuel tank to prevent the risk of fire.
- Remove the key from the dashboard and put it in a safe place to avoid acts of vandalism.
- Lock the cabin and the cowls to prevent strangers getting access.

If the engine is not to be used for more than 1 month, it is necessary to apply protective measures that are valid for 6 months (see "Protective treatment").

If, after the first 6 months, the engine is still not to be used, it is necessary to carry out a further measure to extend the protection period (see "Protective treatment").



4.4 PROTECTIVE TREATMENT

- 1. Check that the engine oil and coolant are up to level.
- 2. Start the engine and keep idle at minimum speed for 15 minutes.
- 3. Switch off the engine and leave to cool.
- 4. Take out the lubricant
- 5. Fill the casing with AGIP RUSTIA C protective oil
- 6. Empty the fuel tank completely.
- 7. Replace fuel filter.
- 8. Fill the fuel tank with a mixture made up of 10% AGIP RUSTIA NT protective oil and 90% fuel.
- 9. Release the air from the fuel supply circuit.
- 10. Start the engine and check for fuel leaks.
- 11. Start the engine and bring to ³/₄ of the maximum speed for 5-10 minutes.
- 12. Switch off the engine.

- 13. Spray SAE 10W oil on the exhaust and intake manifolds.
- 14. Close all openings to prevent foreign bodies from entering.
- 15. Thoroughly clean all external parts of the engine using suitable products.
- Treat non-painted parts with protective products (AGIP RUSTIA 100/F).
- 17. Loosen the alternator-fan belt.
- 18. If necessary, cover the engine with a protective sheet.



• After a year of engine inactivity, the coolant loses its properties and must be replaced

4.5 PREPARING THE ENGINE FOR OPERATION (UNINSTALLED)

After a period of inactivity and before installing and running the engine, it is necessary to carry out a few measures in order to ensure that it runs at maximum efficiency.

- 1. Remove the protective treatment.
- 2. Remove any blockages from the exhaust and intake ducts.
- 3. Use a cloth soaked in degreasing product to remove the external protective treatment.
- 4. Remove the intake manifold.
- 5. Injectlubricationoil(nomorethan2cm³)intothevalvesand replace the intake manifold.
- 6. Adjust the alternator-fan belt tension.
- 7. Turn the flywheel manually to check the movement of the mechanical parts.
- 8. Start the engine and run at ¾ of the maximum speed for 5-10 minutes.
- 9. Switch off the engine.
- 10. Remove the protective oil to replace with engine oil.
- 11. Introducenewoil(see "Tableoflubricants")uptothecorrect level marked on the dipstick.
- 12. Check the filters for aging (air, oil, fuel) and, if necessary, replace them with original spares.



- Over time, a number of engine components and lubricants lose their properties, even when the engine is not in use, and so it is important to consider whether they need replacing, based not only on the number of hours of use, but also on age and wear.
- 13. Installtheengineontothemachineandmakethenecessary connections and unions.
- 14. Make sure that electrical contacts are intact and efficient.
- 15. Check that the engine oil and coolant are up to level.
- 16. Start the engine and keep at minimum speed for a few minutes.
- 17. Check for leaks and, if necessary, find and eliminate the cause.
- 18. Switch off the engine.

Δ

4.6 PREPARING THE ENGINE FOR OPERATION (INSTALLED)

After a period of inactivity and before installing and running the engine, it is necessary to carry out a few measures in order to ensure that it runs at maximum efficiency.

- 1. Use a cloth soaked in degreasing product to remove the external protective treatment.
- 2. Adjust the alternator-fan belt tension.
- $3. \ \ Make sure that electrical contacts are intact and efficient.$
- 4. Check the filters for aging (air, oil, fuel) and, if necessary, replace them with original spares.

Important

- Over time, a number of engine components and lubricants lose their properties, even when the engine is not in use, and so it is important to consider whether they need replacing, based not only on the number of hours of use, but also on age and wear.
- 5. Check that the engine oil and coolant are up to level.
- 6. Starttheengineandkeepatminimumspeedforafewminutes.
- 7. Checkforleaksand, if necessary, find and eliminate the cause.
- 8. Switch off the engine.



5.1 RACCOMENDATIONS FOR REMOVING THE ASSEMBLIES

- Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.
- This chapter describes procedures for removing assemblies and/or individual components, in order to carry out work on specific parts of the engine.
- See the chapter entitled "Overhauls and tuning" for operations involving checks, overhauls and tuning of assemblies and/or components.
- See the chapter entitled "Installation of assemblies" for operations involving the installation of assemblies and/ or components.

1 Important

- To locate specific topics, the reader should refer to the index.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.

5.2 REMOVING THE EXHAUST AND INTAKE MANIFLODS

5.2.1 Disassembling the intake manifold

Air filter (square type)

- 1. Remove the cover (A).
- 2. Remove the intake manifold (B)
- 3. Unhook the minimum-maximum device (C) or the spring (C1).
- 4. Remove the gasket (D).
- 5. Closetheopeningsandductstopreventforeignbodies from entering.



Air filter (cylindrical type)

- 1. Remove the cover (E).
- 2. Disconnect the intake and air vent pipes.
- 3. Remove the intake manifold (**F**).
- 4. Unhook the minimum-maximum device or the spring.
- 5. Remove the gasket (G).
- 6. Closetheopeningsandductstopreventforeignbodies from entering.





5.2.2 Disassembling the exhaust manifold

- 1. Remove the dipstick tube (H).
- 2. Remove the exhaust manifold (L).
- 3. Remove the gaskets (**M**).

5

4. Close the openings and ducts to prevent foreign bodies from entering.



5.3 REMOVING THE COOLING FAN BELT DRIVE

1. 1 - Remove the cooling fan (A).





• The cooling fan belt drive comes in more than one version: with external or internal alternator.





- 5.3.1 Disassembling the cooling fan belt (with external alternator)
- 1. Loosen the nuts (**B B1**).
- 2. Loosen the belt (**D**) by adjusting the alternator (**C**) manually.
- 3. Remove the belt (D).



- 4. Remove the hub (E) and flange.
- 5. Remove the pulley (**F**), washers and spacer.

5.3.2 Disassembling the cooling fan belt (with internal alternator)

- 1. Remove the hub (E) and flange.
- 2. Remove the belt (**D**).
- 3. Remove the pulley (F), washers and spacer.



5.4 REMOVING THE TIMING BELT

5.4.1 Disassembling the timing belt casing

- 1. Disassemble the starter motor.
- 2. Install tool "7107-1460-051" to inhibit rotation of the crankshaft.
- 3. Loosen the screw (G).



• The screw is left-handed. Turn clockwise to unscrew.





- 4. Loosen the screws and remove the pulley (H).
- 5. Remove the casing (L).

5



5.4.2 Disassembling the timing belt

- 1. Twist the pulley nut (**M**) to fully loosen the belt (**N**).
- 2. Remove the belt (N), working it away in sequence first from the pulley and (P) and then from the others.



• The timing belt must always be replaced with an original spare part whenever it is removed.



5.4.3 Disassembling the pulleys (camshaft and crankshaft)

- 1. Remove the pulley (P).
- 2. Remove the pulley (Q).





5.5 REMOVING THE CYLINDER HEAD

5.5.1 Disassebling the rocker arm cover

- 1. Remove the negative-pressure vent valve (A).
- 2. Remove the rocker arm cover (**B**).
- 3. Remove the gasket (C).



5.5.2 Disassebling the rocker arms

- 1. Press the rocker arm to fully push the drive rod down (E).
- 2. Introduce a pin to interrupt the injector stroke in order to be able to extract the drive rod.
- 3. Let go of the rocker arm and remove the drive rod.
- 4. Repeat the same operation on the other injector.
- 5. Remove the rocker arm pin and support (**D**).



5.5.3 Disassebling the fuel pump

- 1. Disconnect the supply pipe (G1) from the union.
- 2. Remove the supply pump (**G**).
- 3. Remove the O-ring (G2).
- 4. Extract the drive rod (H).







5.5.4 Disassembling the injection-pumps

1. Remove the fuel rail (**F**).



- Make sura that the injector gaskets remain in position.
- 2. Unhook the spring (L).

i Important

- If injector pumps are to be used during installation, do not loosen the screws (L1) in order to not balance injector pump deliveries during tuning.
- 3. Unscrew the screws (M).
- 4. Remove the connecting rod (**M1**).
- 5. Dismount the injection-pumps (N).



5.5.5 Disassembling precombustion chamber

- 1. Disconnect the electric cable (P).
- 2. Remove the preheating glow plugs (Q).
- 3. Unscrew the ring nut (**R**) using the special pin wrench "7107-1460-027".




4. Screw the extractor "7107-1460-030" onto the precombustion chamber (S) and remove it.



5.5.6 Disassembling the speed governor and flow limiter

- 1. Remover the cover (T).
- 2. Extract the weights assembly (\mathbf{U}) from the camshaft.



- 3. Remove the fuel flow limiter (V).
- 4. Unscrew the pin and extract the governor tinkage adjustment pin (**W**).





5.5.7 Disassembling the camshaft

- 1. Remove the cover (X).
- 2. Extract the camshaft (Y) from the cylinder head.

Important

• Make sure the drive rod has been removed and rotate the camshaft gently to remove it easily.



5.5.8 Disassembling the cylinder head

- 1. Remove the cylinder head (A).
- 2. Take off the gasket (B).



5.6 REMOVING THE CRANK GEAR AND CRANKCASE

5.6.1 Disassembling the flywheel

- 1. Disassemble the starter motor (A).
- 2. Install tool "7107-1460-051" to inhibit rotation of the crankshaft.
- 3. Remove the flywheel (\mathbf{B}) .





4. Remove the support (**C**).



5.6.2 Disassembling the oil pump

- 1. Remove the flange (D).
- 2. Extract the key (E) from the crankshaft.
- 3. Bring piston number one (flywheel side) to the top dead centre, with the oil pump activation key in line with break in the flange, in order to be able to remove it.





- You should in no way try to force removal of the pump, if its activation key is not lined up with the break in the flange.
- 4. Remove the oil pump (**F**).
- 5. Take off the gasket (G).





5.6.3 Disassembling the crankcase and crankshaft

1. Remove the flange (**H**).

5

2. Tske off the gasket (L).



3. Remove the crankcase ($\boldsymbol{M}).$



4. Remove the connecting rod cap (**N**).



- Before removing the cap, mark the area of contact with the connecting rod, in order to recognise the right position during reassembly.
- 5. Remove the crankshaft (**P**) and place it in a container for washing.



5.6.4 Disassembling connecting rod and piston

- 1. Extract the connecting rod/piston assembly (Q).
- 2. Remove the crankshaft half bearings.

Warning

• Before removing the crankshaft half bearings, mark the seat position, in order to recognise and match it up during reassembly.

Important

• Be careful not to damage the half bearing during removal.



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5.7 DISASSEMBLING THE VALVES

- 1. Place the cylinder head on the workbench.
- $2. \ \ {\rm Pressdownhard} on the {\rm cup}({\bf A}), using the {\rm special tool}.$
- 3. Remove the half collets (**B**) blocking the cup (**A**), the spring (**C**), the collar (**D**) and the gasket (**E**).



4. Remove the valves (F).

🚺 Important

• Keep components together during the disassembly phase, in order to be able to reassemble correctly.





5.8 DISASSEMBLING THE PISTON

- 1. Remove the stop ring (**B**).
- Extract the wrist pin (C) to separate the piston (D) from the connecting rod (E).

Important

• Keep each connecting rod together with its piston and wrist pin.



3. Remove the stop rings (\mathbf{F}).



Notes :	

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OVERHAULS AND TUNING

6.1 RECOMMENDATIONS FOR OVERHAULS AND TUNING

- Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.
- This chapter describes procedures for controlling, overhauling and tuning assemblies and/or individual components.

🚺 Important

- To locate specific topics, the reader should refer to the index.
- -
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- The operator must comply with the specific measures described in order to avoid errors that might cause damage to the engine.
- Before carrying out any operation, clean the assemblies and/or components thoroughly and eliminate any deposits or residual material.

6.1.1 Shaft seals

- Clean the shaft thoroughly and make sure that it is not damaged or scored or has become oval-shaped in the areas of contact with the seals.
- Lubricate the seal lips, and pointing them in the right direction, place them in their seat using a special pad.

6.1.2 O-Rings

- Lubricate the seal before introducing it to its seat.
- Avoid "rolling" the gasket during the attachment phase.

6.1.3 Bearings

- Use special extractors or plugs to remove bearings.
- Clean the bearings thoroughly. Check their condition and, if they are fully intact, lubricate all over, otherwise replace with original spares.

- Wash the components with special detergent and do not use steam or hot water.
- Do not use flammable products (petrol, diesel, etc.) to degrease or wash components. Use special products.
- Dry all washed surfaces and components thoroughly with a jet of air or special cloths before reassembling them.
- Apply a layer of lubricant over all surfaces to protect them against oxidation.
- Check all components for intactness, wear and tear, seizure, cracks and/or faults to be sure that the engine is in good working condition.
- Some mechanical parts must be replaced en bloc, together with their coupled parts (e.g. valve guide/valve etc.) as specified in the spare parts catalogue.

- Do not use a hammer directly on the gaskets during assembly, to avoid damaging them.
- Be careful not to damage the gaskets while joining them to the shaft.

- Do not use a hammer directly on the bearings during assembly, to avoid damaging them.

6.2 OVERHAULING THE CRANK GEARS AND CRANK CASE

6.2.1 Overhauling cylinders and pistons

Before deciding what kind of overhaul needs to be done, it is important to carry out a dimensional check and verify the correspondence of cylinders, pistons, sealing rings, crankshaft and connecting rods.



6.2.2 Dimensional check and overhaul of cylinders

- 1. Place the engine block on the workbench.
- 2. Using a micrometer, measure the diameter at points 1-2-3 (see diagram).
- 3. Rotatethemicrometer90° and remeasure. I fovalization or wear is greater than 0.05mm, the cylinder must be ground.

🛋 Important

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- The increases recommended by the manufacturer for the cylinder head 0.5 and 1 mm.
- When grinding make sure that the working angle is $45-55^{\circ}$ and that the average roughness is Ra=0.5-1.
- Do not sand the internal surfaces of the cylinders using emery cloth.
- Protect the contact surfaces with lubricant oil, to prevent them from rusting

The table shows the reference values and their class applies to new engines).

Important

- Pistons with nominal diameter are supplied only in class (A) spares. Those uprated by 0.5 and 1 mm have the uprating referance (ø72.5 e ø73) engraved on the upper part of the piston (see "Table of cylinder - piston classes and dimensions").



Table of cylinder - piston classes and dimensions - (Euro 2)			
Dimension class	Ø Cylinders (mm)	Ø pistons (mm)	clearance (mm)
А	71.990÷72,000	71,930÷71,940	
В	72,000÷72,010	71,940÷71,950	0,05÷0,07
С	72,010÷72,020	71,950÷71,960	

Table of cylinder - piston classes and dimensions - (Euro 4)			
Dimension class	Ø Cylinders (mm)	Ø pistons (mm)	clearance (mm)
А	71.490÷71,500	71,450÷71,440	
В	71,500÷71,510	71,450÷71,460	0,04÷0,06
С	71,510÷71,520	71,460÷71,470	

6.2.3 Dimensional check and overhaul of pistons

- 1. Clean the piston thoroughly (D).
- 2. Usingamicrometer, measure the piston 9 mm from the base of the skirt.
- 3. Check the table to identify the class from the values detected. The class letter is engraved on the piston, If clearance between cylinder and piston is greater than 0.05mm, the piston and sealing rings must be replaced, and rematched according to the diameter of the ground cylinders "see Table of cylinder-piston classes and dimensions").

Important

- Before replacing the pistons, check that the weight difference does not exceed 4g to prevent weight imbalances.
- Protect the contact surfaces with lubricant oil, to prevent them from rusting.



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6.2.4 Dimensional check of sealing rings

- 1. Place a sealing ring in the cylinder and measure the distance between the two tips using a thickness gauge (**H**).
- 2. Repeat for all the sealing rings. If the distance between the tips does not correspond to the indicated values, replace the sealing ring with an original spare (see "Dimensional table of sealing rings").



6

Dimensional table of sealing rings		
Sealing rings	distance between tips (mm)	Wear & tear limit (mm)
1 °	0,10÷0,25	
2 °	0,25÷0,40	1,0
3 °	0,20÷0,40	

3 -Put the sealing rings on the piston in the order shown in the figure.

Important

• Place the sealing rings with the markings facing up towards the upper part of the piston (crown).

4. Using a thickness gauge, measure the clearance of each sealing ring. If clearance does not correspond to the values shown, replace the sealing rings with original spares.



Table of sealing rings clearance		
Sealing rings	Clearance (mm)	
1 °	L1 = 0,065÷0,105	
2 °	L2 = 0,045÷0,090	
3°	$L3 = 0,040 \div 0,080$	

Important

- Sealing rings cannot be replaced separately.
- Protect the contact surfaces with lubricant oil, to prevent them from rusting.





6.2.5 Dimensional check and overhaul of crankshaft

- 1. Wash the crankshaft thoroughly using suitable detergent.
- 2. Introduce a pipe cleaner into the lubrication ducts to remove any residual dirt.
- 3. Blow compressed air into the points indicated to free the ducts from oil.
- 4. Check the surfaces of the main journals and crank pins for wear and tear to see whether grinding is necessary.
- 5. Usingamicrometer, measure the diameter of the main journals (A1) and crank pins (B1).
- Using a dial indicator, measure the inside diameters of the crankshaft (A2) and connecting rod (B2) half bearings

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🚺 Important

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- Crankshaft half bearings cannot be replaced separately.
- If the crankshaft needs to be ground, establish the diameters of the connecting rod and crank pins, in order to choose the matching measurements available of connecting rod and half bearing spare parts (see "Table of diameters of connecting rods and half bearings").
- When grinding the crankshaft it is possible to downrate the crankshaft and connecting rod pins by 0,25 mm and 0,50 mm.
- When grinding the crankshaft it is also necessary to consider grinding the sides (shoulder) to be able to choose uprated ring replacements (see "Table of uprated shoulder half-rings").
- Protect the contact surfaces with lubricant oil, to prevent them from rusting.

Table of diameters of connecting rods and half bearings

Réf.	Dimensions (mm)	Wear and tear limit (mm)	Clearance (mm)	Max clear. (mm)
A1	47,984÷48,000	47,900	A 2 - A 1 =	0.200
A 2	48,022÷48,058	48,055	0,032÷0,016	0,200
B 1	39,894÷40,000	39,900	B2-B1=	0.120
B 2	40,020÷40,035	40,100	0,021÷0,066	0,130

Ta	Table of diameters of connecting rods and half bearings PROGRESS			
Réf.	Dimensions (mm)	Wear and tear limit (mm)	Clearance (mm)	Max clear. (mm)
A1	47,984÷48,000	47,95	A 2 - A 1 =	0.12
A 2	48,025÷48,071	48,1	0,025÷0,087	0,12
B 1	39,984÷40,000	39,95	B2-B1=	0.10
B 2	40,021÷40,050	40,08	0,021÷0,066	0,10

Table of uprated shoulder half-rings			
Holf ringo	Di	mensions (mm)	
nall-rings	А	В	Clearance
Standard	22,787÷22,920	23,050÷23,100	
1° increase	22,987÷23,120	23,250÷23,300	C = A-B
2° increase	23,087÷23,220	23,350÷23,400	0,130÷0,313
3° increase	23,187÷23,320	23,450÷23,500	



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6.2.6 Dimensional check and overhaul of connecting rods

- 1. Check that the contact surfaces are perfectly clean and intact.
- Assemble the cap (D) onto the connecting rod big end and tighten the screws to a torque of 38 Nm (40 Nm x PROGRESS).
- 3. Using a micrometer, measure diameters ø a-b.

1 Important

- If the diameter of the conncting rod small end does not match the diameter of the wrist pin, the connecting rods must be replaced to achieve the right match (see "Table of connecting rod dimensions").
- The half-bearings are supplied smaller than the nominal dimensions, by 0,25 mm and 0,50 mm.
- Before replacing the connecting rods, check that the weight difference does not exceed 10g to prevent weight imbalances (see "Table of connecting rod dimensions").
- Protect the contact surfaces with lubricant oil, to prevent them from rusting.



		Table of connecting rod dimensions			
↓ → øb	₽ ₽ ₽ ₽ ₽ ₽	Dimensions (mm)	Clearance (mm)	Wear and tear limit (mm)	
d	d	109,975÷110,025			
	Øb	20,010÷20,020	~ . ~		
	Øc	19,995÷20,000	Ø b - Ø c 0 010±0 025	0,40	
\bigcirc	Ø a	40,020÷40,035	0,010.0,020		
55	е	55,000÷55,020			



6.2.7 Checking parallelism of the connecting rod axes

- 1. Insert the wrist pin (V) in the connecting rod small end.
- 2. Use a dial indicator to check that there is parallelism between the small end and big end axes. Parallel deviation, measured at the very tip of the wrist pin, must not exceed 0.015-0.030mm. If parallel values do not correspond to those indicated, replace the connecting rod with an original spare.
- 3. After carrying out all checks and overhauls, remount the connecting rods, pistons and sealing rings (see "Pre-assembly of sealing rings - pistons" and "Preassembly of connecting rods - pistons").

🚺 Important

• Protect the contact surfaces with lubricant oil, to prevent them from rusting.



6.2.8 Check and overhaul of the fuel pump

Disassemble the oil pump before checking or overhauling. See "Disassembling the oil pump" for the correct procedure.

- 1. Remove the plate (A).
- 2. Remove the O-ring (B).
- 3. Remove the sealing ring (C) from the flange and clean the seat.
- 4. Unscrew the oil (**D**) and extract the gasket (**E**), the spring (**F**) and the valve (**G**).
- 5. Disassemble the rotors (H).
- 6. Blow compressed air into the valve seat to clean it.
- 7. Thoroughly clean all the components.
- 8. Measure the length of the spring (**F**). If the length of the spring is not between 27.50 and 27.75mm, replace it with an original spare.
- 9. Replace the valve (G), the spring (F), the gasket (E) and the plug (D).
- 10. Fill the sealing ring (**C**) with grease and lubricate the rim with oil.
- 11. Mount the new sealing ring (\mathbf{C}) using a special tool.







- Given the particular function played by this sealing ring, it is important to use only original spares.
- 12. Mount the rotors (**H**) with the referance notches facing upwards so that they are visible.
- 13. Using a thickness gauge, measure the clearance between the rotor teeth.

If clearance is above the 0.25mm limit for wear, replace the rotors with original spares.

- 14. Check that the contact surfaces are perfectly clean, intact and not deformed.
- 15. Mount the new O-ring.



- The O-ring must always be replaced with an original spare part whenever the pump is disassembled.
- 16. Replace the plate (A) and put in the screws (L).
- 17. Tighten the screws (L) to a torque of 10 Nm.





6.2.9 Overhauling the decanting device

In order to overhaul the decanting device, it is necessary to disassemble the starter motor.

See "Replacing the starter motor" for the correct procedure.

- 1. Loosen the clamp and extract the pipe (A).
- 2. Remove the cover (B).
- 3. Thoroughly clean the inside of the cover and blow compressed air on the decanting device (**C**) to eliminate residues.
- 4. Check that the decanting device is intact and, if necessary, replace it with an original spare.
- 5. Slip ona new gasket (D).
- 6. Replace the cover (**B**) and fix it using the screws.
- 7. Replace the pipe (A) and fasten it using the clamp.
- 8. Mount the starter motor and tighten the screws to a torque 45 Nm.

6.3 OVERHAUL OF CYLINDER HEAD AND RELATED COMPONENTS

6.3.1 Checking and overhauling the cylinder head

- 1. Placethecylinderheadonasurfaceplateandposition it with the corners on the stud bolts.
- 2. Using a dial indicator make sure the cylinder head is level.



- If the level deviation is above 0.1mm, the cylinder head must be ground, removing not more than 0.2mm.
- Beforegrinding, remove the valves (see "Disassembling the valves") and the precombustion chambers (see "Disassembling the precombustion chamber").





6.3.2 Checking and overhauling the rocker arm pin

- 1. In order to carry out a control of the rocker arm assembly, it is necessary to disassemble the cylinder head.
- 2. See "Disassembling the rocker arms" for the correct procedure.
- 3. Bore a hole in the blocking pin (A), using a 4mm bit to remove it.
- 4. Extract the supports and the rocker arm from the pivot pin (**B**).
- 5. Thoroughly clean the components.

6



5. Using a micrometer measure, the diameters of the pivot pin and the rocker arms (see "Table of dimensions pin-rocker arm").

	Table of dimensio	ns pin-rocker	' arm
Réf.	Dimensions (mm)	Clearance (mm)	Wear and tear limit (mm)
Øa	17,989÷18,000	Ø a - Ø b =	0.090
Øb	18,015÷18,030	0,015÷0,041	0,090

If the diameters do not correspond to the values shown, replace the pin and, if necessary, the rocker arms with original spares.

If the pin can be re-used, remove the plugs and clean the inside carefully, to eliminate residual dirt.

- 6. Place the new plugs in the pin.
- 7. Carefully clean and lubricate the supports and rocker arms and remount on the pin.



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- 8. Insert a new pin (**E**) and drive it in 0÷1 mm from the flat part of the support.
- 9. Reassemble the rocker arm assembly in the cylinder head (see "Assembling the rocker arms").



6.3.3 Checking and replacing the camshaft

In order to carry out a control of the camshaft, it is necessary to disassemble it from the cylinder head. See "Disassembling the camshaft" for the correct procedure.

 Using a dial indicator, measure the diameters of the seats (ØX) and, with a micrometer, find out the diameters of the camshaft (ØY) (see "Table of camshaft dimensions").

	Table of camshaft dimensions			
Réf.	Dimensions (mm)	Clearance (mm)	Wear and tear limit (mm)	
Øa	37,035÷37,060	Ø a - Ø b =	0 170	
Øb	36,975÷37,000	0,035÷0,085	0,170	

If the diameters do not correspond to the values shown, replace the camshaft with an original spare.





2. Use a micrometer to measure the maximum dimensions of the involutes of the intake, exhaust and injection cams (see "Table of cam dimensions").

Table of cam dimensions	
Réf.	Dimensions (mm)
Н	29,598÷29,650
H 1	28,948÷29,000

If the dimensions of cam involutes are lower than the values shown by 0.1mm (maximum dimension), replace the camshaft with an original spare.

i Important

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- Protect the contact surfaces with lubricant oil, to prevent them from rusting.
- 3. Replace the camshaft (see "Assembling tha camshaft").



6.3.4 Checking and replacing the fuel pump drive rod

To check the drive rod it is necessary to disassemble the fuel pump.

See "Disassembling the fuel pump" for the correct procedure.

- 1. Rotate the camshaft until the drive rod is at the most indented point.
- 2. Check that the distance between the driverod (**A**) and the cylinder head is between 1.66 and 2.18mm. If the distance does not correspond to this value, replace the drive rod with an original spare.
- 3. Assemble the fuel pump (see "Assembling the fuel pump").



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6.3.5 Checking and overhaulimg the valves

In order to carry out a control of the valves, it is necessary to remove them from the cylinder head. See "Disassembling the valves" for the correct procedure.

 Use a gauge to measure the length of the springs (see "Table of dimensions for springs – valve stems – valve guides").

Table of dimensions for springs - valve stems - valve guides					
Réf.	Dimensions (mm)	Clearance (mm)	Wear and tear limit (mm)		
Øx	7,005÷7,020				
Øy	6,960÷6,990	Øb-Øc=	0,10		
Ζ	43,5÷46,0				
W	0,5÷0,8	0,050÷0,005	1,10		
J	1,6÷1,7		2,00		

If the length does not correspond to the value shown, replace the springs with original spares.

2. Use a micrometer to measure the diameters of the valve stems and guides (see "Table of dimensions for springs – valve stems – valve guides"). If the diameters do not correspond to the values show, replace the valves and guides with original spares.

🛕 Important

- Take measurements in several places in order to discover possible ovalization and/or wear.
- 3. Thoroughly clean the valves and their seats.
- 4. Measure the width of the seal for each valve (J) and the indentation (W) from the flat part of the cylinder head (see "Table of dimensions for springs – valve stems – valve guides"). If the dimensions do not correspond to the values shown, replace the valve seat ring with an original spare.
- 5. Use a pointed tool to take out the valve seats.
- 6. Remove any debris, clean the valve seat holder carefully and scrape the mouth.
- 7. Lubricate the new valve seats and put them into the holder manually.
- 8. Use the special tool to put the valve seats in the holder.
- 9. Slide the valves into their seats.
- Measure the degree of indentation of each valve from the flat part of the cylinder head (see "Table of dimensions for springs-valve stems-valve guides"). Se le dimensioni rilevate corrispondono ai valori indicati, smerigliare ogni valvola nella propria sede.



Protect the contact surfaces with lubricant oil, to prevent them from rusting.

11. Assemble the valves (see "Assembling the flywheel").







6.3.6 Adjusting valve-rocker arm clearance

In order to make the adjustment, it is necessary to remove the rocker arm cover.

See "Disassembling the rocker arm cover" for the correct procedure.



- Adjustment of valve clearance must be done when the engine is cold.
- 1. Placethepistonsatthecompressiontopdeadcentre.
- 2. Turn the screw and the lock nut to adjust clearance. Adjustment can be made in two different points: the contact area between the rocker arm and the camshaft (0.15mm) and/or the contact area between the rocker arm and the valve (0.2mm).
- 3. Repeat the same operation on the other valves.



6.3.7 Checking clearance volume

- 1. Position the pistons at the top dead centre.
- 2. Measure the distance in four diametrically opposite points on the piston crown.
- Repeat the operation on all pistons. The maximum value determines the measurement (A).

Choose the gasket corresponding to the measured value. This match determines the value of the clearance volume (see "Table of head gasket and clearance volume values").

Table of head gasket and clearance volume values						
A (mm)	Number of holes		Clearance volume (mm)			
0,97÷1,06	0		0.00.0.40			
1,07÷1,16	1,16 1		0,39÷0,46			
1,17÷1,25	2	D C	0,40÷0,48			



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6.3.8 Calibrating the injector

To carry out setting, the injector pump must be disassembled from the engine.

Per conoscere la procedura corretta, vedi "Smontaggio pompe-iniettori".

- 1. Remove the non-return valve (**A**) and replace it with the plug supplied with the "7107-1460-074" tool.
- 2. Mount the tool head (**B**) and fasten with the screws.
- 3. Connectthepumpforcalibratingthedieselinjectorsto the head union.
- Press the pump and bring to a pressure of 130 bars for 10 sec, in order to check the needle seal. Replace the nozzle (see "Nozzle-injector replacement") if there is any dripping.
- 5. Press the pump again and check to see whether the fuel comes out at a pressure of 140-155 bars (optimal operating calibration).
- 6. If calibration is not optimal, it is possible to modify the action of spring, using the adjustment shims. The adjustment shims are available in 11 sizes between 1mm and 2mm, uprated at 0.1mm gaps. If after inserting the largest adjustment shim (2mm) optimal calibration is still not achieved, the spring (see "Nozzle-injector replacement") must be replaced.

6.3.9 Checking and overhauling the speed governor

Disassemble the speed governor before checking or overhauling.

See "Disassembling the speed governor and flow limiter" for the correct procedure.

Exploded diagram of the speed governor





Pump

Union

- Remove the tool "7107-1460-074".
 Replace the non-return valve.
- Assemble the injection-pump on the engine (see "Assemble injection –pumps").
- 1. Use a gauge to make sure that the distance (A) is between 45 and 46 mm.
- 2. Make sure that the contact surfaces (**B**) are perfectly level with a deviation of no more than 0.05 mm. If the deviation is greater than this, replace the speed governor with an original spare.



6.4 CHECKING TIMING BELT RATING

6.4.1 Valve adjustments

- 1. Bring the piston to the compression top dead centre.
- 2. Adjust the screw (A) and the lock nut in order to adjust the rocker arm valve clearance to 2 mm.
- 3. Rotatethecrankshaftclockwisethrough360°inorder to make the piston reaching the balancing top dead centre.
- 4. Applyamagneticgoniometeronthecrankshaftpulley and set it to zero.



- 5. Place two dial indicators on the collars of the intake and exhaust valves, then set them to zero.
- 6. Rotate the crankshaft clockwise until the dial indicator moves away from zero.
- 7. Measure the rotation angle of the crankshaft by using the magnetic goniometer. The value registered indicates when the intake valve

starts opening.

- 8. Go on rotating the crankshaft clockwise until the dial indicator stops at point "0".
- 9. Measure the rotation angle of the crankshaft by using the magnetic goniometer.

The value registered indicates when the intake valve starts closing.

The values registered must coincide with those indicated on the timing angle diagrams (see "Distribution timing angle diagram").

10. Repeat these procedures on the other valves.





6.5 DIAGRAM OF TIMING BELT RATES

Rotate the crankshaft clockwise to find out the timing rates of the entire cycle in each cylinder (operation and control).

Timing belt operating angles (valve clearance 0.25 mm)

 $\alpha = 14^{\circ}$ before **S** (top dead center)

- $\beta = 38^{\circ}$ after I (bottom dead center)
- $\gamma=\textbf{34}^\circ$ before ~I (bottom dead center)
- $\boldsymbol{\delta}$ = 18° after S (top dead center)

Timing belt control angles (valve clearance 2 mm)

- $\alpha = 25^{\circ}$ after **S** (top dead center)
- $\beta = closes 2^{\circ} after I (bottom dead center)$
- $\gamma=\mathbf{5}^{\circ}$ after I (bottom dead center)
- δ = 18° before S (top dead center)



6.6 ADJUSTING STATIC INJECTION TIMING

In order to adjust injection timing, it is necessary to remove the rocker arm cover.

See "Disassembling rocker arm cover" for the correct procedure.

- 1. Disassemble the injector pump fuel rail (A).
- 2. Select the cylinder on which the injection static advance adjustment will be carried out.
- 3. Unscrewtherockerarmsupportnut(**B**)corresponding to the cylinder on which the procedure will be carried out.





- 4. Assemble the dial indicator on stud bolt (C).
- 5. Place the dial indicator tracer on the exhaust valve collar.
- 6. Remove the O-ring (**D**) from the little non-return valve and replace it with the suitable rubber cap (**E**) (part of tool "7107-1460-048").
- 7. Install the tool metal base plate ($\ensuremath{\textbf{F}}\xspace).$

- 8. Remove the rocker arm cover gasket.
- 9. Fix the tool lever base (G) on cylinder head.
- 10. Rotate the crankshaft clockwise until the injection cam acts on the rocker arm that controls the injector pump. In these conditions, the piston is near the compression top dead centre.
- 11. Place the auxiliary tank at a height higher than that of the injectors (~30-40) cm.
- 12. Connect the tank to union (H).





- Rotate slowly the crankshaft clockwise keeping the lever (L) lowered and the valve set on the piston crown, until the dial indicator shows the maximum measurement.
- 14 . Set the dial indicator to zero. In these conditions, the compression top dead centre can be identified.



16. Rotate the crankshaft anticlockwise until liquid leaks from the pipe (**M**), and then stop turning when the flow is constant and without air bubbles.

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- 17. Then turn slowly the crankshaft clockwise in order to identify the exact point at which liquid stops leaking. In these conditions, the point which coincides with the static injection timing can be identified.
- 18. Act again on lever (L) to lower the valve and bring it again on the piston.
- 19. Measure the piston lowering value by using the dial indicator.
- 20. Convert the value registered from millimetres to degrees (see "Conversion table for establishing injection timing").

Important

- When converting, refer to the table value that is nearest to the registered one (see "Conversion table for establishing injection timing").
- For a good engine operation, the injection static advance must be as follows:
- Engine with maximum speed up to 3000 rpm: 13° (± 1°)
- Engine with maximum speed above 3000 rpm: 15° (± 1°)



Conversion table for establishing injection timing

mm	injection advance angle	mm	injection advance angle
1,947	18°	0,733	11 °
1,739	17°	0,606	10°
1,543	16°	0,491	9°
1,358	15°	0,388	8°
1,184	14°	0,297	7°
1,022	13°	0,218	6°
0,871	12°		

If the static advance does not correspond to the ideal values, change the adjustment by means of the screw (N).

To increase the angular value (higher static advance), turn the screw clockwise.

To decrease the angular value (lower static advance), turn the screw anticlockwise.

Important

- Half turn of the screw equals approximately 5° of static angular advance.
- 21. Disassemble all equipment when the injection static advance is reached.
- 22. Fasten and tighten the nut (**B**) to a final torque of 40 Nm.



Important

• Repeat on the other cylinder.

D

23. Once adjustment is finished, assemble the new O-rings (**D**) on the injector pumps.

🚺 Important

- The O-rings must always be replaced with original spare parts whenever the fuel rail is disassembled.
- 24. Apply some silicone sealant on the fuel rail seat.
- 25. Assemble the fuel rail and fasten the screws without tightening them.
- 26. Tighten the screws to a final torque of 4 Nm.
- 27. Slip on a new gasket (P).
- 28. Reassemble the rocker arm cover (see "Assembling the rocker arm cover").



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6.7 BALANCING THE INJECTION-PUMP DELIVERY



• It is necessary to balance delivery whenever the injection-pump is replaced.

In order to work on the injector, it is necessary to remove the rocker arm cover.

See "Disassembling the rocker arm cover" for the correct procedure.

- 1. Remove the fuel rail (A).
- 2. Mount the "7107-1460-127" tool heads (**B**).





Ρ

4 Nm



OVERHAULS AND TUNING

- 3. Position the assembly "7107-1460-127" above the height of the injectors.
- 4. Connect the outlet and intake pipes of the assembly to the test heads.

Important

- Be careful not to reverse the intake and outlet pipes when connecting.
- 5. Open the cocks (C).
- 6. Start the engine and keep it at minimum idle speed (~ 1150÷1250 Rpm).
- 7. Turn the equipment switching valve by means of the lever (D).

(The engine is supplied by tubes and no more by tool tank).

- 8. Check the level of the test heads after 1 minute.
- 9. Make sure the difference in volume is no greater than 1 cm³.





- If the difference is greater, increase delivery of the injector pump with the highest level, or reduce the one with the lowest level.
- 10. Loosen the screw (E) to adjust delivery at the injector.
- 11. Shift the plate (**F**) gently in one of the two directions. Shift the plate towards the flywheel to increase delivery. Shift the plate towards the timing belt to reduce delivery.
- 12. Tighten the screw (E) to a torque of 1.1 Nm.
- 13. Close the cocks and disconnect the assembly.
- 14. Put the new O-rings on the injector pumps.
- 15. Apply sealant to the seat of the fuel rail.



- The O-rings must always be replaced with original spares whenever the fuel rail is disassembled.
- 16. Assemble the fuel rail and fasten the screws without tightening them completely.
- 17. Tighten the screws to a torque of 4Nm.





6.8 ADJUSTING MINIMUM AND MAXIMUM IDLE SPEED RPMS - (only for Euro 2 engines)

- 1. Connect a revolution counter to the engine.
- 2. Run the engine and bring it to the operating temperature.
- 3. Turn the idle adjusting screw (A) and set the engine to the minimum speed required.
- 4. Tighten the lock nut (**B**) when finished.

🚺 Important

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- To decrease the rpm number, loosen the screw. To increase it, tighten the screw.
- 5. Turn the peak-rpm adjusting screw (**D**) and set the engine to the maximum speed required.
- 6. Tighten the lock nut (C) when finished.

Important

• To decrease the rpm number, tighten the screw whereas to increase it loosen the screw.



6.9 ADJUSTING INJECTION DELIVERY

The adjustment may be performed with the dynamometric brake (accurate adjustment) or without it (approximate adjustment).

6.9.1 Adjusting injection delivery (without dyno break) (only for Euro 2 engines)

- 1. Loosen locknut (A).
- Firmly tighten the screw (B) of the flow limiter.
 Start the engine and bring it to the operating
- temperature.
- 4. Bring the engine to maximim rpm allowed.
- 5. Loosen the screw (**B**) of the flow limiter until the engine speed starts to decrease.
- 6. Retighten the screw rotating it 2.5 revolutions, then fasten with the lock nut (A).

Т lmportant

• If the engine gives off too many fumes at maximum load, loosen the flow limiter screw. If it gives off no fumes or does not achieve maximum power, tighten the flow limiter screw.



OVERHAULS AND TUNING

6.9.2 Adjusting injection delivery (with dyno break)

- 1. Start the engine and bring it to the operating temperature.
- 2. Bring the engine to maximim rpm allowed.
- 3. Loosen the locknut (A).
- 4. Firmly tighten the screw (\mathbf{B}) of the flow limiter.
- 5. Activate the dyno brake to bring the engine to maximum power and speed.
- After a few minutes of running the engine and when it has "stabilised", slowly unscrew the limiter screw (B) until the speed starts to decrease.
- 7. Fasten the screw (B) with the locknut (A).
- 8. Deactivate the dyno brake and take note of the "stabilized" engine speed.
- 9. Switch off the engine and leave to cool.
- 10. Check the valve-rocker arm clearance (see "Adjusting valve/rocker arm clearance").



6.10 CHECKING OIL PREASSURE

- 1. Remove the preassure switch (A).
- 2. Mount a union in the hole (**B**) and connect to a 10-bar pressure gauge (**C**).
- 3. Start the engine and bring it to the operating temperature.
- 4. Start the engine and bring it to a speed of 900 RPM, while at the same time making sure that the pressure gauge shows a pressure of 1 bar (oil temperature 80÷120 °C).
- 5. Switch off the engine.
- 6. Remove the pressure gauge (C) and the union (B).
- 7. Replace the pressure switch (A) and tighten it to a torque of 25Nm.





Note :

- Information is given in a logical order in terms of timing and sequence of operations. The methods have been selected, tested and approved by the manufacturer's technical experts.
- This chapter describes procedures for installing assemblies and/or individual components that have been checked, overhauled or replaced with original spare parts.

🚺 Important

- To locate specific topics, the reader should refer to the index.
- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- In order to fix assemblies and/or components securely, the operator must tighten the fastening parts in a criss-cross or alternating pattern.
- Assemblies and/or components with a specific tightening torque must initially be fastened at a level lower than the assigned value, and then subsequently tightened to the final torque.

7.2 PRE-ASSEMBLY OF SEALING RINGS-PISTONS

- Thoroughly clean the pistons and lubricate the coupling areas.
- Put the sealing rings on the piston in the order shown in the figure.



- Place the sealing rings with the markings facing up towards the upper part of the piston (crown).
- Keep the pistons together with their own connecting rods and wrist pins.



7.3 PRE-ASSEMBLY OF CONNECTING RODS - PISTONS



Important

- Before pre-assembly, check that the weight difference between the two connecting rod-piston-wrist pin assemblies does not exceed 10 g to prevent weight imbalances.
- 1. Lubrificate the wrist pin (**A**) and the seat of the small end of the connecting rod (**B**).
- 2. Place the lock ring (**C**) on the piston complete with sealing rings (**D**).

Important

- Insert the lock rings with the tips pointing towards the base of the piston with a tolerance of 15°.
- 3. Insert the wrist pin (**A**) into the piston (**D**) and install the connecting rod (**B**) (complete with cap).
- 4. Insertthewristpincompletelyandfastenwiththelock ring.

i Important

- Make sure the lock rings are positioned correctly in their seats.
- Lubricate the coupling parts and those that are prone to oxidation.



7.4 INSTALLING VALVES

7.4.1 Assembling the valves



- Make sure that the cylinder head is perfectly clean and dry.
- Check that all components are intact and, if necessary, replace them with original spares.
- 1. Lubrificate the valve stem sealing ring (**A**), insert it into tool "717-1460-047", and mount it right into the seat of the valve guide.
- 2. Lubrificate the vale stem (B).
- 3. Slip the valve into the seats.



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- 4. Mount the collar (**C**), the spring (**D**), the cup (**E**) and the half collets (**F**).
- 5. Press down hard on the cup (**E**), using the special tool "7107-1460-047" to insert the half collets (**F**) into the valve stem groove.
- Release the tool and check that the half collets are positioned correctly.
 If the half collets are not correctly positioned, repeat
- the operation.
- 7. Repeat the same operation on the other valves.



7.5 INSTALLATION OF CRANK GEAR AND CRANKCASE

7.5.1 Installing piston/connecting rod -engine block

(Important

- Make sure that the engine block and the crankcase are perfectly clean and dry.
- 1. Assemble the pipe (A) with the oil suction filter.
- 2. Mount the new O-rings (A1).
- 3. Carefully clean and lubricate the cylinders and the connecting rod-piston assembly (**B**).
- Rotate the sealing rings so that the cuts have a displacement of about 120° between them.

Important

- In order not to damage the sealing rings and the contact areas while inserting the piston into the cylinder, use the special containment device.
- 5. Mount the connecting rod-piston assembly (**B**) onto the engine block and position the connecting rod big ends along the axis of the crankshaft.

Important

• The piston combustion chamber must be assembled on the precombustion chamber.







7.5.2 Assembling the crankshaft

1. Mountthehalf-bearings(**C**)andthestandardshoulder half-rings (**E**) (flywheel side).



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- Follow the marks made during the removal phase.
- The shoulder half-rings must be placed with the lubrication grooves facing outwards.
- 2. Lubrificate the half-bearings (**C**), the connecting rod big ends (**D**) and caps (**F**).
- 3. Carefully lubricate the crankshaft main journals and crank pins.



- 4. Assemble the crankshaft (G).
- 5. Replace the connecting rod caps (**F**) and put in the screws.
- 6. Tighten the connecting rod cap screws to a temporary torque of 25Nm.
- 7. Tighten the connecting rod cap screws to a final torque of 30 Nm (50 Nm x PROGRESS).
- 8. Assemble the crankcase (see "Assembling the crankcase").
- 9. Measure the axial clearance of the crankshaft (see "Measuring crankshaft axial clearance").



7.5.3 Assembling the crankcase



- Make sure that the contact surfaces and related pins are perfectly intact and clean.
- Make sure there are no foreign bodies or residual material in the engine block and crankcase.
- 1. Mount the new gaskets (**H1-H2**) for the engine block contact surface with the crankcase.
- 2. Replace the crank case (\mathbf{H}) and put in the screws ($\mathbf{L-M}$).
- 3. Tighten the screws (L) temporarily in a crisscross pattern.



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- 4. Tighten the screws (M) temporarily in alternating pattern.
- 5. Tighten the screws (L) in a crisscross pattern to a final torque of 50Nm.
- 6. Tighten the screws (**M**) in an alternating pattern to a final torque of 10Nm.



7.5.4 Measuring crankshaft axial clearance

To measure the axial clearance of the crankshaft, it is necessary to assemble the shaft complete with crankcase.

See "Assembling the crankcase" for the correct procedure.

1. Using dial indicator, measure the а axial shift of the crankshaft. Axial shift must be between 0.130 and 0.313mm. If axial shift is above these values, it is necessary to insert uprated shoulder half-rings and once again disassemble the crankcase (see "Dimensional check and overhaul of crankshaft").



7.5.5 Assembling the crankshaft flange (flywheel side)

- 1. Clean the flange and the sealing ring seat (N).
- 2. Using the special pad, insert a new sealing ring (**N**) into the flange (**Q**).



- Given the particular function played by this sealing ring, it is important to use only original spares.
- 3. Check that the contact surfaces are perfectly clean and intact.





- 4. Slip on a new gasket (P).
- 5. Replace the falnge (Q) and put in the screws (R).

Important

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- Be careful not to damage the sealing rings during this operation.
- 6. Tighten the screws (**R**), in a crisscross pattern to a final torque of 12Nm.



7.5.6 Installing the oil pump

Before installing the oil pump, make sure there are no malfunctions (see "Check and overhaul the oil pump").



- Check that the contact surfaces are perfectly clean and intact.
- 1. Slip on a new gasket (A).



- 2. Insert the oil pump activation key into the crankshaft.
- 3. Bring piston number one (flywheel side) to the top dead centre, with the oil pump activation key in line with break in the flange, in order to be able to assemble the pump.
- 4. Install the pump (B) and put in the screws (C).



• Be careful not to damage the sealing rings during this operation.



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- 5. Tighten the screws in a crisscross pattern, and tighten each of them to their respective final torques (see image).
- 6. Insert the key (D) into the crankshaft.
- 7. Install the alternator support (**E**) and tighten the screws to a torque of 2.2Nm.



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7.5.7 Assembling the flywheel

1. Install the support (**F**) and tighten the screws to a torque of 25 Nm.



- 2. Install the flywheel (G) and put in the screws (H).
- 3. Tighten the screws temporarily in a crisscross pattern.
- 4. Tighten the screws in a crisscross pattern to a final torque of 80Nm.

Important

• Turn the flywheel manually to check the movement of the mechanical parts.





7.6 INSTALLATION OF CYLINDER HEAD AND COMPONENTS

7.6.1 Assembling the precombustion chamber

i Important

- Check that the contact surfaces are perfectly clean and intact.
- Installtheprecombustionchamber(A), so that it shole (H) coincides with the one on the pre-heating glow plug.
- Insert tool "7107-1460-031" into the seat of the preheating glow plug in order to lock the chamber while the ring nut (B) is being tightened.



- 3. Apply some anti-seize product to the ring nut thread (**B**) and to the surface that is in contact with the precombustion chamber.
- 4. Mount the ring nut (**B**).
- 5. Tighten the ring nut to a temporary torque of 100Nm.
- 6. Make sure that the precombustion chamber protrusion (C) is between 3.56÷4,04 mm. If the protrusion (C) exceeds the recommended value, insert a shim (D) (provied ad spare part) beneath the precombustion chamber (A).
- 7. Tighten the ring nut to a final torque of 180Nm.





- 9. Tighten the glow plug to a torque of 20 Nm.
- 10. Repeat the same operations on the other chamber.
- 11. Connect the glow plug power supply cable (**F**).


INSTALLATION OF ASSEMBLIES

7.6.2 Assembling cylinder head

i Important

- Make sure there are no foreign bodies or residual material in the cylinder head cavity.
- Check that the contact surfaces are perfectly clean and intact.
- 1. Slip on a new gasket (G).
- 2. Choose the gasket shim to be installed (see "Check clearance volume")
- 3. Make sure that the length of the screws (H) does not exceed 92mm, otherwise replace.
- 4. Lubricate the screws copiously (H).
- 5. Mount the cylinder head (L) and put in the screws (H).
- 6. Tighten the screws in sequence (see diagram) to a temporary torque of 40 Nm.

Important

- Use a torque wrench with an angle torque tool to tighten the screws.
- 7. Tighten the screws further clockwise, rotating 90°.
- 8. Tighten the screws to their final torque, rotating 90.

🚺 Important

• If the screws (**H**) belong to 10.9 class, the tightening torque is 60Nm and it is not necessary to tighten them further.



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7.6.3 Assembling the camshaft



- Make sure that the camshaft and it's housing are perfectly intact and clean.
- 1. Lubricate the camshaft (A) and its housing.
- 2. Insert the camshaft into its housing.
- 3. Mount a new O-ring onto the cover (B).
- 4. Mount the cover (**B**) and tighten the screws to a torque of 10 Nm.





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7.6.4 Assembling the speed governor and flow limiter

🛕 Important

- Make sure that all components are perfectly clean and dry.
- Check that all components are intact and, if necessary, replace them with original spares.
- 1. Mount the levers (C) and pivot them with the screw (D) to a torque of 0.70 Nm.
- 2. Install the flow limiter.



3. Mount the rotation components onto the camshaft.

Important

- The rotation components are produced in several versions. Consult the diagram when mounting.
- 1. Mount the weights assembly (H) onto the camshaft.
- $2. \quad Carry out this operation with the weights open so that$
- they close on the flat part of the spacing collar.Check that all the components of the cover (L) are intact and, if necessary, replace them with original spares.



i Important

- Make sure that the contact surfaces are perfectly intact and clean.
- 3. Mount the new O-ring on the cover (L).
- 4. Mount the cover (L) and fasten the screws without tightening them.
- 5. Tighten the screws in an alternating pattern to a final torque of 10 Nm.

Important

• Check that the camshaft has no axial clearance.



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7.6.5 Assembling injection-pumps

Important

- Check that all components are intact and, if necessary, replace them with original spares.
- Before replacing the injectors it is always necessary to replace the flameproof bulkhead, the copper gasket and the oil and diesel O-ring seals.
- Always make sure that the injectors are calibrated correctly (see "Calibrating and replacing the injector").
- 1. Inserttheflameproofbulkhead(**M**)intheinjectorseat, with the flat part directed as in the drawing.
- 2. Grease the copper gasket (N) and the oil O-ring seals (N1) copiously.
- 3. Install the injector pumps (**Q**) and fasten the nuts without tightening them.
- 4. Tighten the nuts to a temporary torque of 10 Nm.
- 5. Tighten the nuts to a final torque of 20 Nm.
- 6. Hook the connecting rod (**R**) to the adjustment levers and, fasten the injector pumps without fully tightening the screws.
- 7. Tighten the screws to a final torque of 1,1 Nm.
- 8. Hook the spring (S).







• The following procedures must be performed only if pumps have been replaced. Otherwise, go directly to point 13.

Prepare the injector pumps for running the engine, as explained below.

9. Loosen the screws (T) of every injection pump.

10. Move the plates (**U**) fully towards the flywheel side in order to maximise the injector delivery.



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11. Tighten the screws (T) to a torque of 1,1 Nm.

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12. Balance the injector deliveries (see "Balancing injector pump deliveries").



- 13. Put the new O-rings on the injector pumps.
- 14. Apply sealant to the seat of the fuel rail.
- 15. Assemble the fuel rail and fasten the screws without tightening them.
- 16. Tighten the screws to a final torque of 4Nm.
- 17. Mount the rocker arm cover (see "Assembling the rocker arm cover").



7.6.6 Assembling the mechanical fuel pump



- Check that the contact surfaces are perfectly clean and intact.
- Make sure that the length of the drive rod is between 153,15÷153,25 mm, otherwise replace it.
- 1. Insert the drive rod (V).
- 2. Mount a new O-ring (W).
- 3. Install the fuel pump (**Z**) and fasten the nuts without tightening them.
- 4. Tighten the nuts to a final torque of 22Nm.
- 5. Connect the pipes to the pump.



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7.6.7 Assembling the rocker arms

i Important

- Check that the contact surfaces are perfectly clean and intact.
- 1. Press down hard on the pump stroke to insert the pin, which facilitates assembly of the drive rods (**B**).
- 2. Mount the rocker arm assembly (A).
- 3. Insert the pump injector activation drive rods (**B**).
- 4. Tighten the nuts by hand.
- 5. Tighten the nuts to a temporary torque of 20 Nm.
- 6. Tighten the screws in an alternating pattern to a final torque of 40 Nm.
- 7. Remove the pins and check that the rocker arms (**B**) have been inserted correctly.



7.6.8 Assembling the rocker arm cover

Important

- Make sure that the rocker arm cover is perfectly clean and dry.
- Check that the contact surfaces are perfectly clean and intact.
- 1. Slip on a new gasket (C).
- 2. Apply some silicone sealant on the fuel rail seat (**D**).
- 3. Mount the cover (\mathbf{E}) and fasten the screws without
- tightening them.Tighten the screws in a crisscross pattern to a final torque of 9 Nm.
- 5. Assemble the negative-pressure vent valve (F).





7.7 INSTALLING THE TIMING BELT DRIVE

7.7.1 Assembling the timing belt pulley

- 1. Insert the key (B) into the crankshaft.
- 2. Mount the pulley (A).
- 3. Mount the pulley (C) and tighten the screw to a torque 80 Nm.

Important

• To ensure the correct timing, line up the reference notches on the pulley (A-C) with the respective gear timing notches (X-Y).



7.7.2 Assembling the timing belt

1. Insert the belt into the pulley (C). Keeping it taut, insert into pulley (A).

🚺 Important

- Keep the reference arrows (G) directed as shown in the diagram.
- The timing belt must always be replaced with an original spare part whenever it is removed.
- 2. Keep the belt inserted into the two pulleys and then mount it onto pulley (E) and the pulley nut (F).
- 3. Tighten the belt using the pulley nut (**F**) and fasten temporarily.

Important

• To maintain engine timing while the timing belt is being installed, keep it slotted onto the two pulleys (A-C), which must remain lined up with their notches.



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INSTALLATION OF ASSEMBLIES

- 4. Insert tool "7107-1460-049" in the tensioner holder lever.
- 5. Calibrate the torque wrench to 20 Nm and insert it into the tool, with the lever perpendicular to the belt.
- 6. Loosen the nut slightly (\mathbf{D}).
- 7. Turn the torque wrench clockwise to tighten the belt to 20 Nm. Once the specified torque is reached (20 Nm), tighten the nut (**D**) temporarily without allowing the belt tension to loose.



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- 8. Mount the pulley (G1).
- 9. Tighten the nut (**D**) to a final torque of 40Nm.
- 10. Rotate the crankshaft a few times to settle and position the belt correctly.
- 11. Before doing so, make sure that the pulley notches (crankshaft and camshaft) are lined up with their respective timing notches.
- 12. Insert the tool again into the lever on the pulley nut support and repeat all the steps to check belt tension.
- 13. Disassemble the pulley (G1).



7.7.3 Assembling the belt drive cover

- 1. Mount the guard (G), without tightening the screws completely.
- 2. Tighten the screws in an alternating pattern to a final torque of 10 Nm.



If replacement of the optional dust guard rings (H-H1) and the peripheral sleeve becomes necessary for technical or construction reasons, please request the pre-assembled guard (G) complete with rings and gaskets.





7.8 INSTALLATION OF THE COOLING FAN BELT DRIVE

7.8.1 Assembling the fan belt drive pulleys

- 1. Checkthatallcomponentsareintactand, if necessary, replace them with original spares.
- 2. Mount the pulley (G1) and fasten the screws without tightening them.
- 3. Tighten the screws in a crisscross pattern to a final torque of 10 Nm.



4. Mount tool "7107-1460-051" to inhibit rotation of the crankshaft.

5. Apply some anti-seize product to the screw thread (L).



- The screw is left-handed. Turn anticlockwise to screw.
- 6. Tighten the screw (L) to a torque of 180 Nm.



7. Remove the tool (**M**).

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8. Install the starter motor (N) and tighten the screws to a torque of 45 Nm.



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- 9. Mount the pulley (P), washers and spacer.
- 10. Tighten the screw (Q) to a torque of 25 Nm.



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7.8.2 Assembling the fan belt drive

The engine may have an external or internal alternator.

With internal alternator

- 1. Install the belt, flange and the pulley hub (R).
- 2. Tighten the screws (S) to a torque of 10 Nm.
- 3. Carry out belt tension (see "Replacing alternator/fan belt").

With external alternator

- 1. Install the flange and the pulley hub (R).
- 2. Tighten the screws (S) to a torque of 10 Nm.
- 3. Install the belt (T).
- 4. Tighten the belt (T) (see "Replacing the alternator fan belt").





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7.8.3 Assembling the cooling fan

- 1. Check that the fan is intact and, if necessary, replace it with an original spare.
- 2. Install the cooling fan (U).
- 3. Tighten the screws to a torque of 10 Nm.



7.9 INSTALLING INTAKE AND EXHAUST MANIFOLDS

7.9.1 Assembling exhaust manifold

- 1. Makesurethatthemanifoldductsarecleanandintact.
- Check that the contact surfaces are perfectly clean and intact.
- 3. Eliminate any blockages in the ducts.
- 4. Put on the new gaskets (A).
- 5. Mount the manifold (**B**) without tightening the nuts completely.
- 6. Tighten the screws in an alternating pattern to a final torque of 25 Nm.



7.9.2 Assembling the intake manifold

Air filter (square type)

- 1. Check that the contact surfaces are perfectly clean and intact.
- 2. Eliminate any blockages in the ducts.
- 3. Slip on a new gasket (D).
- Bringthemanifold(C)uptothecylinderheadandhook on the minimum-maximum device or the governor spring.
- 5. Install the manifold (C) without tightening the screws (F) completely.
- 6. Tighten the screws in an alternating pattern to a final torque of 25 Nm.



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- 7. Clean the cover $(\ensuremath{\textbf{H}})$ with a a jet of air.
- 8. Check the state of the filter cartridge (G). If necessary, remove the cartridge, knock it repeatedly against a flat surface to eliminate dirt and clean with a jet of air.
- 9. Return the cleaned filter cartridge or replace it with an original spare.
- 🕐 Warning
- Do not use liquids to clean the filter cartridge.
- 10. Replace the cover (H) and re-hook it carefully into place.



Air filter (cylindrical type)

- 1. Check that the contact surfaces are perfectly clean and intact.
- 2. Eliminate any blockages in the ducts.
- 3. Slip on a new gasket (L).
- 4. Bring the manifold (**M**) up to the cylinder head and hook on the minimum-maximum device.
- 5. Install the manifold (M) without tightening the screws (N) completely.
- 6. Tighten the screws in an alternating pattern to a final torque of 25Nm.
- 7. Check the state of the filter cartridge. If necessary, remove the cartridge and clean with a jet of air.
- 8. Return the cleaned filter cartridge or replace it with an original spare.



- Do not use liquids to clean the filter cartridge.
- 9. Replace the filter housing.
- 10. Mount the cover (P).



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Notes :

8.1 RACCOMMENDATIONS FOR REPLACING PARTS

- This chapter describes the procedures for replacing a number of components and/or assemblies which are not recommended for repairs.

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- Some of these operations are also contained in the user's operation and maintenance manual.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- All operations, except where expressly stated otherwise, must be carried out when the engine is not running and has cooled sufficiently to avoid the risk of burns.



• To locate specific topics, the reader should refer to the index.

8.2 REPLACING THE ALTERNATOR - FAN BELT



• Replacement may be carried out with the engine installed on the machine.

The engine may have an external or internal alternator.

With external alternator

- 1. Switch off the engine and leave to cool.
- 2. Loosen the nuts (B B1).
- 3. Loosen the belt by adjusting the alternator manually and tighten the nut (**B1**).



4. Slip off the belt (**D**) and replace it with an original spare.





5. Adjust the alternator manually while at the same time tightening the screw to regulate belt tension.

Important

- Use the method shown in the diagram to check belt tension. The resultant (**R**) must be 10÷15 mm.
- 6. Tighten the nuts (**B** -**B1**) to a final torque of 40 Nm and 25 Nm respectively.

With internal alternator

- 1. Switch off the engine and leave to cool.
- 2. Remove the cooling fan.
- 3. Remove the hub and flange.
- 4. Slip off the belt and replace it with an original spare.



- 6. Manually rotate the fan to make sure the belt is fitted correctly.
- 7. Tighten the screws to a torque of 10 Nm.
- 8. Regolare la tensione della cinghia.

Important

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- To check the belt tension, follow the procedure explained in the figure. The resultant (**R**) must be 10÷15 mm.
- If the belt is too tense, insert a spacer between the flange and the pulley, or remove a spacer if it is too slack.











- 9. Install the cooling fan.
- 10. Tighten the screws to a torque of 10 Nm.



8.3 REPLACING THE TIMING BELT

Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Disassemble the cooling fan belt drive (see "Removing the cooling fan belt drive").
- 3. Disassemble the timing belt drive (see "Removing the timing belt drive").
- Replace the timing belt with an original spare (see "Assembling the timing belt drive").

- 5. Check the timing belt rating (see "Checking timing belt rating").
- 6. Mount the belt drive cover (see "Assembling the belt drive cover").
- 7. Replace the cooling fan belt drive (see "Installation of the cooling fan belt drive").

8.4 REPLACING THE OIL FILTER

i Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Prepare a receptacle to catch leaks.
- 3. Remove the filter (A) using the special tool.
- 4. Lubricate the new filter seal with engine oil.
- 5. Install and tighten the filter manually.



• Polluting substances should be disposed of properly, in full compliance with the law.



8.5 REPLACING THE AIR FILTER



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- Polluting substances should be disposed of properly, in full compliance with the law.
- Replacement may be carried out with the engine installed on the machine.

Air filter (square type)

- 1. Switch off the engine and leave to cool.
- 2. Remove the cover (A).
- 3. Extract the cover that is to be replaced (\mathbf{B}) .
- 4. Clean the cover with a jet of air.
- 5. Replace the cartridge with an original spare.
- 6. Mount the cover and hook it carefully into place.



Air filter (cylindrical type)

- 1. Switch off the engine and leave to cool.
- 2. Remove the cover (C).
- 3. Extract the cover that is to be replaced (D).
- 4. Clean the cover with a jet of air.
- 5. Replace the cartridge with an original spare.
- 6. Mount the cover and hook it carefully into place.





8.6 REPLACING THE ALTERNATOR



- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Disconnect the battery.
- 3. Disconnect the electrical connectors.
- 4. Loosen the nut (A).
- 5. Loosen the belt (C) by adjusting the alternator (B) manually.
- 6. Slip the belt (C) off the alternator pulley.
- 7. Remove the alternator and replace it with a new one.
- 8. Insert the belt into the alternator pulley.
- 9. Regulate belt (**C**) tension (see "Replacing alternator fan belt").
- 10. Reconnect the electrical connectors.



8.7 REPLACING THE STARTER MOTOR

Warning

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Disconnect the electrical connectors.
- 3. Remove the starter motor.

Important

- If in order to take care of the problem it is necessary to remove the motor, please refer to an authorised BOSCH service centre.
- 4. Install the starter motor (A) and tighten the screws.
- 5. Tighten the screws to a final torque of 40 Nm.
- 6. Make sure that the distance (**B**) is between 17,5÷19,5 mm.
- 7. Reconnect the electrical connectors.



REPLACING PARTS

8.8 REPLACING THE FLYWHEEL RING GEAR

In order to replace the ring gear, it is necessary to disassemble the flywheel.

See "Disassembling the flywheel" for the correct procedure.

1. Cut the ring gear (A) in several places using a chisel and remove it.

Important

- Remove any debris and carefully clean the ring gear.
- 2. Heat the new ring gear uniformly and keep it at a temperature of 300°C for15÷20 minuti.

Warning

- Risk of burning: be careful of hot surfaces.
- 3. Insert the ring gear into its seat and place it carefully on the rim of the flywheel (B).
- 4. Leave to the ring gear to cool gently before reassembling the flywheel.

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8.9 REPLACING THE COOLANT THERMOSTAT

Important

- Replacement may be carried out with the engine installed on the machine.
- Switch off the engine and leave to cool. 1.
- Disconnect the electrical connectors. 2.
- 3. Remove the thermostat.

Important

- The screw is left-handed, turn clockwise to unscrew.
- Install the new thermostat. 4.
- Tighten the thermostat to a torque of 30 Nm. 5.

Important

- The screw is left-handed, turn anti-clockwise to tighten.
- 6. Reconnect the electrical connectors.







REPLACING PARTS

8.10 REPLACING THE COOLANT PUMP

1 Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Disassemble the cooling fan (see "Removing the cooling fan belt drive").
- 3. Disassemble the timing belt drive (see "Removing the timing belt drive").
- 4. Disassemble the coolant pump.
- 5. Install a new pump and tighten the screws to a torque of 20 Nm.

Important

• Following a failure, the coolant pump cannot be repaired and must be replaced with an original spare.



8.11 REPLACING THE THERMOSTATIC VALVE

Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Remove the cover.
- 3. Remove the valve and make sure it is working properly.

Important

- The valve must be heated in order to check weather it is functioning correctly.
- Dip the thermostatic valve in a metal container of water.
- Use a thermometer with a full scale of 150°C to monitor
- the temperature of the water in the container.Heat the water and, using the thermometer, make
- sure that the temperature at which the valve begins to open is between 78 and 82°C.
- If the thermostatic valve opens at a different temperature, it must be replaced.
- Maintaining the conditions described above, heat the water to 94°C and check whether or not the valve is completely open at this temperature, i.e. that it has lifted to 7mm.
- Check whether the valve is completely shut once it has cooled down.



If the length does not correspond to the value shown, replace the valve spring with an original spare.

4. Mount the cover and fasten the screws.

REPLACING PARTS

8.12 REPLACING THE NEGATIVE-PRESSURE VENT VALVE

Important

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- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Loosen nut (A).
- 3. Loosen the clamps and disconnect the pipes.
- 4. Take off the negative-pressure vent valve (**B**).
- 5. Install the negative-pressure vent valve.
- 6. Tighten the nut to a final torque of 22Nm.
- 7. Connect the pipe to the coupling.

Caption 1) Nut

- 2) Bushing
- 3) Valve body
- 4) Diaphram
- 5) Bottom plate
- 6) Quicklock ring
- 7) O-ring
- 8) Collar
- 9) O-ring
- 10) Seal collar
- **11)** Spring**12)** Gas vent pipe
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8.13 REPLACING THE PREHEATING GLOW PLUGS

Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Remove the intake manifold (see "Disassembling the intake manifold").
- 3. Disconnect the electric cable.
- 4. Disconnect the preheating glow plugs.
- Install the new preheating glow plugs and tighten the screws to a torque of 20 Nm.
- 6. Reconnect the electric cable.
- 7. Mount the intake manifold (see "Assembling the intake manifold").

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pre-heating glow plugs

8.14 REPLACING INJECTOR PUMP PARTS

Exploded diagram of the injector pump The figure shows the injector pump parts.



8.14.1 Pumping element replacement

- Press down hard on the pump collar to fit the pin (A).
- 2. Disassemble the lock ring (1).
- 3. Press down hard on the pump collar to remove the pin (**A**).
- 4. Remove the parts (2-3-4-5).
- 5. Loosen the screws (6).
- 6. Disassemble the support (7) and the lever (8).
- 7. Insert tool "7107-1460-029" and disassemble the ring nut (9).

Important

- Rotate in an alternating way the ring nut during disassembling to avoid damaging the O-ring (**10**).
- 8. Extract the barrel (11), the valve (12) as well as the parts (13-14-15).





- 9. Check the good seal of the delivery valve (12) as well as of the pumping element (parts 4-11). If necessary, replace them with original spare parts.
- 10. Assemble all parts (15-14-13).
- 11. Assemble the delivery valve (12).

(Important

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- The needle (B) and the valve seat (C) must be assembled as shown in the figure.
- 12. Assemble the barrel (11) and tighten the ring nut (9) provided with a new O-ring (10).

Important

- Rotate in an alternating way the ring nut during assembling to avoid damaging the O-ring (10).
- 13. Assemble in sequence all parts (5-4-3-2) on the support (7).
- 14. Press down part (2) to fit the pin (A).
- 15. Reassemble the stop ring (1).





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- 16. Rotate the plunger (4) by means of the control blade (29) as shown in the figure.
- 17. Insert the lever (8) and engage it in the plunger (4).

Warning

- Check that the position of both lever (8) and plunger control blade (29) is the same as that shown in the figure.
- If the control blade is positioned in a different way, the engine may not run.
- 18. Tighten the screws (6) to join the support to the injector pump case .
- 19. Press down hard on the pump collar to remove the pin (A).



REPLACING PARTS

8.14.2 Replacing nozzle-injector

Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Disassemble the injection pump (see "Disassembling injection pumps").
- 2. Loosen the ring-nut (21).
- 3. Extract the nozzle (23) and the parts (24-25-26-27).
- 4. Check that all components are intact and, if necessary, replace them with original spare parts.
- 5. Reassemble the parts (**27-26-25-24**).
- Assemble a new nozzle (23).
- 7. Tighten the ring nut (**21**) to a final torque of 70 Nm.

Important

- Check the setting (see "Injector pump setting") since it could be necessary to replace the adjusting shim (27) and the spring (26).
- 8. Repeat the same operation on the other injector.
- 9. Assemble the injector pump (see "Injector pump assembly").



8.15 REPLACING THE COOLING FAN SUPPORT

i Important

- Replacement may be carried out with the engine installed on the machine.
- 1. Switch off the engine and leave to cool.
- 2. Disassemble the cooling fan belt drive (see "Removing the cooling fan belt drive").
- 3. Remove the belt drive cover (see "Disassembling timing belt casing").
- 4. Remove the support (A).
- 5. Install the new support.
- 6. Tighten the screws (B) to a torque of 20 Nm.
- 7. Mount the belt drive cover (see "Assembling the belt drive cover").
- 8. Replace the cooling fan belt drive (see "Installation of the cooling fan belt drive")





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