

KD  
425-2



**KOHLER** Engines

**REGISTRATION OF MODIFICATIONS TO THE DOCUMENT**

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

Drafting body	Document code	Model N°	Edition	Revision	Issue date	Review date	Endorsed
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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 of engine.
- However, development on the engines is continuous. Therefore, the information within this manual is subject to change without notice and without obligation.
- **KOHLER co.** reserves the right to make, at any time, changes in the engines for technical or commercial reasons.
- These changes do not require **KOHLER co.** to intervene on the marketed production up to that time and not to consider this manual as inappropriate.
- Any additional section that **KOHLER co.** 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 **KOHLER co.** As such, no reproduction or replication in whole or part is allowed without the express written permission of **KOHLER co.**

**Original instructions translated from the Italian language**

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



## PREFACE

Every attempt has been made to present within this use and maintenance, accurate and up to date technical information. However, development on the **Kohler** series is continuous. 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 **Kohler**. As such, no reproduction or replication in whole or part is allowed without the express written permission of **Kohler**.

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

- 1 - is properly trained and equipped to safely and professionally perform the subject operation;
- 2 - possesses adequate hand and **Kohler** 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](http://www.kohlerengines.com) & [www.lombardinigroup.it/dealer-locator](http://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.



**Danger** Warning is used to indicate the presence of a hazard that can cause severe personal injury, death, or substantial property damage if the warning is ignored.



**Important** This indicates particularly important technical information that should not be ignored.



**Warning** Caution is used to indicate the presence of a hazard that will or can cause minor personal injury or property damage if the caution is ignored.

## 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».

This manual contains pertinent information regarding the repair of KOHLER air-cooled, indirect injection Diesel engines type **KD425-2**.

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This manual contains safety precautions which are explained below.



### Danger

Warning is used to indicate the presence of a hazard that can cause severe personal injury, death, or substantial property damage if the warning is ignored.



### Warning

Caution is used to indicate the presence of a hazard that will or can cause minor personal injury or property damage if the caution is ignored.



### Important

This indicates particularly important technical information that should not be ignored.

## Safety regulation

### GENERAL NOTES

- **Kohler** 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 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 **Kohler**, 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 **Kohler**. This work should be carried out in accordance with existing literature.
- **Kohler** 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 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 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 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 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 at least one metre from buildings or other machines.
- Children and animals must be kept at a sufficient distance from the machine to prevent any danger resulting from its operation.
- Fuel is flammable, so the tank must be filled only when the 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 KOHLER 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.
  - During operations which involve access to moving parts of 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.
  - Check the belt tension only when the engine is turned off.
- 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.
- In order to move the engine simultaneously use the eyebolts fitted for this purpose by **Kohler**. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.



### Important

- To start the engine follow the specific instructions provided 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.
- Close the fuel tank filler cap carefully after each filling operation. Do not fill the tank right up to the top, but leave sufficient space to allow for any expansion of the fuel.
- Do not smoke or use naked flames while filling.
- Take care when removing the oil filter as it may be hot.
- The operations of checking, filling up and replacing the cooling 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

### 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



### Important

- 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

 <b>DANGER</b>	<b>Accidental Starts!</b>
	<b>Accidental Starts can cause severe injury or death.</b> Disable engine by disconnecting negative (-) battery cable.
<i>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.</i>	

 <b>DANGER</b>	<b>Explosive Fuel!</b>
	<b>Fuel can cause fires and severe burns.</b> Do not fill the fuel tank while the engine is hot or running.
<i>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.</i>	

 <b>DANGER</b>	<b>Rotating Parts!</b>
	<b>Rotating Parts can cause severe injury.</b> Stay away while engine is in operation.
<i>Keep hands, feet, hair, and clothing away from all moving parts to prevent injury. Never operate the engine with covers, shrouds, or guards removed.</i>	

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

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

 <b>DANGER</b>	<b>High Pressure Fluid Puncture!</b>
	<b>High Pressure Fluids can puncture skin and cause severe injury or death.</b> Do not work on fuel system without proper training or safety equipment.
<i>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.</i>	

 <b>DANGER</b>	<b>Hot Parts!</b>
	<b>Hot Parts can cause severe burns.</b> Do not touch engine while operating or just after stopping.
<i>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.</i>	

 <b>CAUTION</b>	<b>Electrical Shock!</b>
	<b>Electrical Shock can cause injury.</b> Do not touch wires while engine is running.
<i>Never touch electrical wires or components while the engine is running. They can be sources of electrical shock.</i>	

## 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		- Use protective gloves before carrying out the operation
 	- High temperature components - Danger of scalding	 	- Use protective glasses before carrying out the operation - Use sound absorbing protections before carrying out the operation
 	- Presence of rotating parts - Danger of entangling and cutting	 	- Electric shock - Danger of severe scalding or death - Fluids under high pressure - Danger of fluids penetration
 	- Presence of explosive fuel - Danger of fire or explosion		- Lethal exhaust gas - Danger of poisoning or death
 	- Presence of steam and pressurized coolant - Danger of scalding		

## 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.

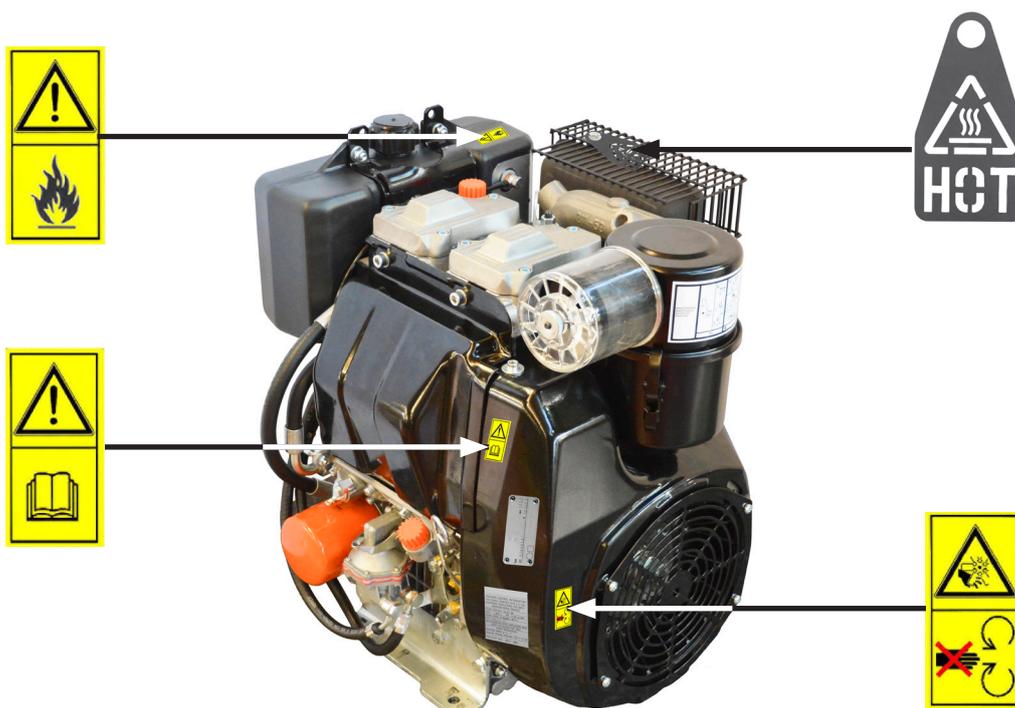


Plate for EPA regulations

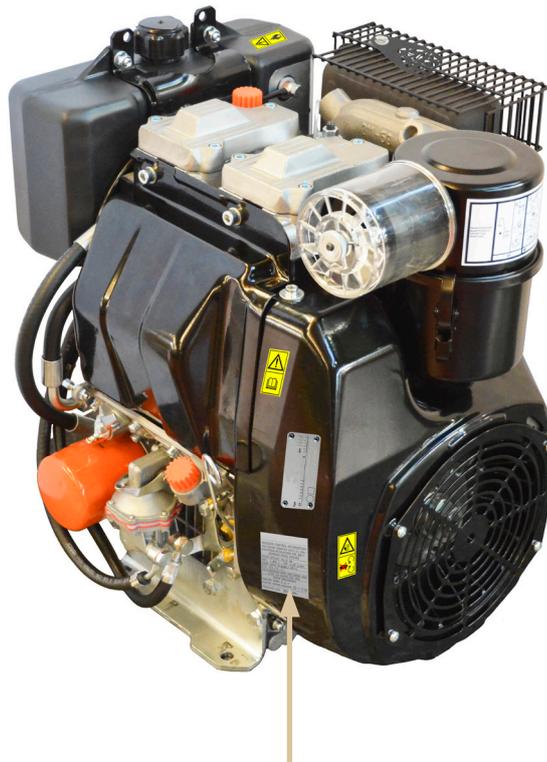


Plate for EPA regulations placed on the air-shroud

Compilation example

<b>KOHLER®</b>	
EMISSION CONTROL INFORMATION THIS ENGINE COMPLIES WITH U.S. EPA/ CALIFORNIA REGULATIONS FOR 2011 NONROAD DIESEL ENGINES	
3	POWER CATEGORY: 19-37 KW
2	DISPL.: 1.870 l   PM: 0,30 g/kWh
5	ENGINE FAMILY ID: BLBDL1.8711L
9	ECS: ECM, DDI, IDI
USE IN CONSTANT-SPEED APPLICATION ONLY ULTRA LOW SULFUR FUEL ONLY	
TUNEUP SPECIFICATION:	
6	INJECTION TIMING: 2° +/- 1°
7	INJECTOR OPENING PRESSURE: 230 +/- 10 bar
8	PRODUCTION DATE: 2011 Jan.

- 1) Model year
- 2) Engine displacement
- 3) Power category, kW
- 4) Particulate emission limit (g/kWh)
- 5) Engine family ID
- 6) Injection timing (BTDC)
- 7) Injector opening pressure (bar)
- 8) Production date (example 2013\_Jan)
- 9) Emission Control System = ECS

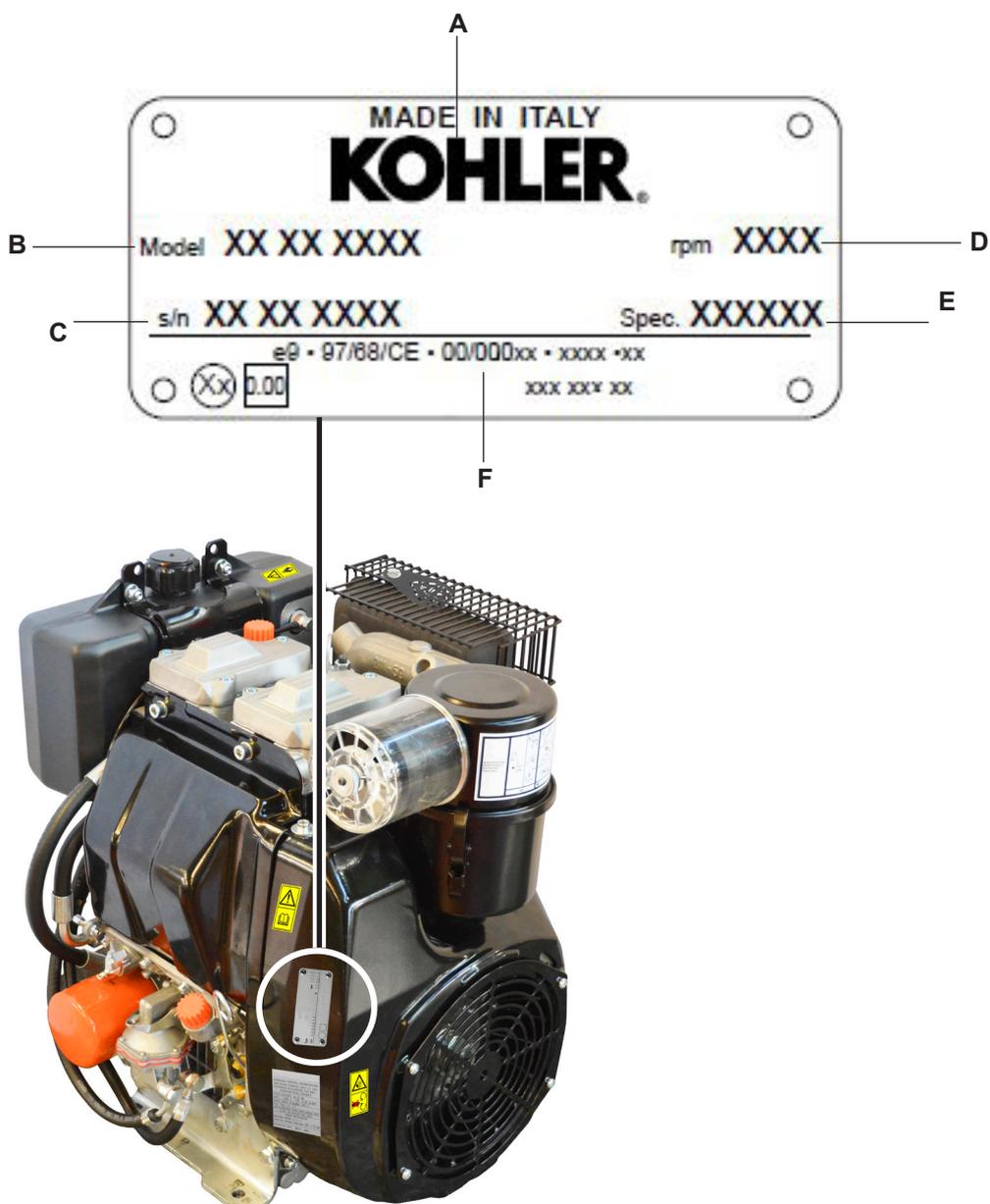
The identification plate shown in the figure can be found directly on the engine.

It contains the following information:

- A) Manufacturer's identity
- B) Engine type
- C) Engine serial number
- D) Maximum operating speed
- E) Number of the customer version (form K)
- F) Approval data

#### Approval data

The approval reference directives EC are on the engine plate (F).



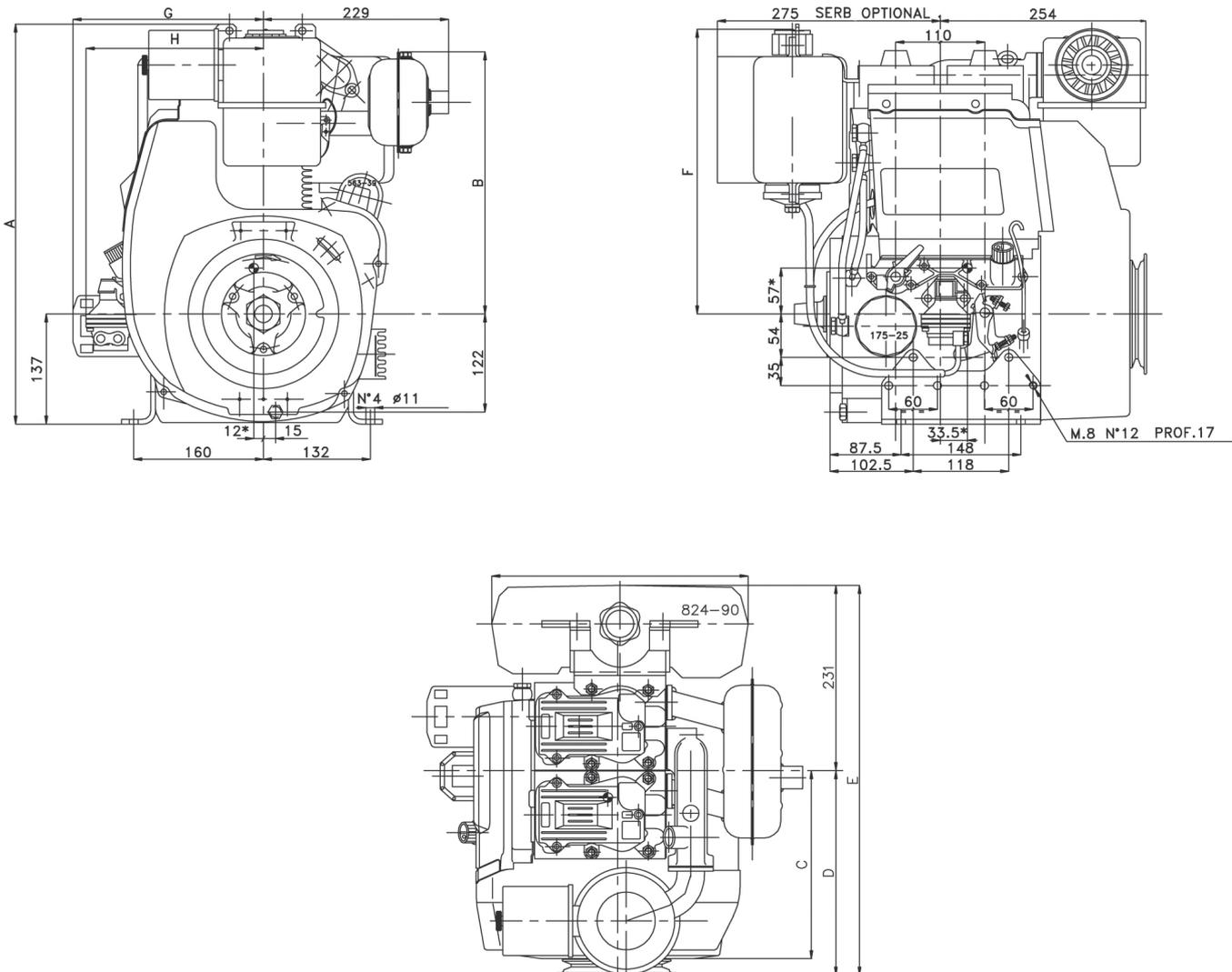
**TECHNICAL SPECIFICATIONS**

ENGINE TYPE			KD425-2
Number of cylinders		N.	2
Bore		mm	85
Stroke		mm	75
Swept volume		cm <sup>3</sup>	851
Compression ratio			19:1
Power kW (HP)	N 80/1269/CEE-ISO 1585	@ 3000 RPM	12,5(17)
		@ 3600 RPM	14(19)
	NB ISO 3046 - 1 IFN	@ 3000 RPM	11,4(15,5)
		@ 3600 RPM	13(17,7)
	NA ISO 3046 - 1 ICXN	@ 3000 RPM	10,5(14,3)
		@ 3600 RPM	12(16,5)
Max. torque *		Nm	40,5@2400
Fuel consumption **		g/kW.h	246
Oil consumption		g/kW.h	0,8
Capacity of standard oil sump		lt	1,8
Recommended battery 12V		Ah -A	66-300
Dry weight		kg	53
Combustion air volume		m <sup>3</sup> /h	75
Cooling air volume		m <sup>3</sup> /h	750
Max. permissible driving shaft axial: continuous (instantaneous)		kg.	100(300)
Max. inclination	Flywheel site: continuous (instantaneous)		25°(30°)
	Power take off site: continuous (instantaneous)		25°(35°)
	Lateral: continuous (instantaneous)		25°(40°)

\* Referred to **N** power

\*\* Consumption at max torque

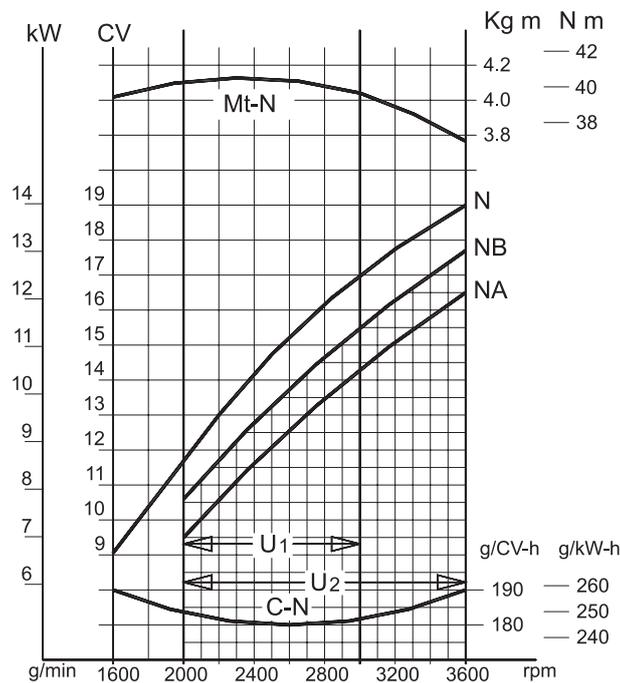
## OVERALL DIMENSIONS



Note: Dimensions in mm

PERFORMANCE DIAGRAMS

**KD 425-2**



**N (80/1269/EEC - ISO 1585)**  
**NB (ISO 3046 - 1 IFN)**

**AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load.  
**RATING WITH NO OVERLOAD CAPABILITY**: continuous light duty operation with constant speed and variable load.

**NA (ISO 3046 - 1 ICXN)**

**CONTINUOUS RATING WITH OVERLOAD CAPABILITY**: continuous heavy duty with constant speed and constant load.

**Mt-N Torque at N power.**

**C** Specific fuel consumption at **N** power.

**U1**: Standard utilization range of engines rated at 3000 rpm

**U2**: Standard utilization range of engines rated at 3600 rpm

The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar.

Max. power tolerance is 5%.

Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

**Note**: Consult **KOHLER** for power, torque curves and specific consumptions at rates differing from those given above.

## POSSIBLE CAUSES AND TROUBLE SHOOTING

**THE ENGINE MUST BE STOPPED IMMEDIATELY WHEN:**

- 1) - The engine rpms suddenly increase and decrease
- 2) - A sudden and unusual noise is heard
- 3) - The colour of the exhaust fumes suddenly darkens
- 4) - The oil pressure indicator light turns on while running.

**TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS**

The following table contains the possible causes of some failures which may occur during operation. Always perform these simple checks before removing or replacing any part.

POSSIBLE CAUSE		TROUBLE									
		Engine does not start	Engine starts but stops	No acceleration	Non-uniform speed	Black smoke	White smoke	Too low oil pressure	Increase oil level	Excessive oil consumption	Oil and fuel dripping from exhaust
FUEL CIRCUIT	Clogged pipes										
	Clogged fuel filter										
	Air inside fuel circuit										
	Clogged tank breather hole										
	Faulty fuel pump										
	Injector jammed										
	Jammed injection pump delivery valve										
	Wrong injector setting										
	Excessive plunger blow-by										
	Jammed injection pump delivery control										
	Wrong injection pump setting										
LUBRICATION	Oil level too high										
	Jammed pressure relief valve										
	Worn oil pump										
	Air inside oil suction pipe										
	Faulty pressure gauge or switch										
	Clogged oil suction pipe										
ELECTRIC SYSTEM	Battery discharged										
	Wrong or inefficient cable connection										
	Defective ignition switch										
	Defective starter motor										
MAINTENANCE	Clogged air filter										
	Excessive idle operation										
	Incomplete running-in										
	Engine overloaded										
SETTINGS/REPAIRS	Advanced injection										
	Delayed injection										
	Incorrect governor linkage adjustment										
	Broken or loose governor spring										
	Idle speed too low										
	Worn or jammed piston rings										
	Worn or scored cylinders										
	Worn valve guides										
	Jammed valves										
	Worn bearings										
	Governor linkage not free to slide										
	Drive shaft not free to slide										
	Damaged cylinder head gasket										

ROUTINE ENGINE MAINTENANCE



**Important**

- Failure to carry out the operations described in the table may lead to technical damage to the machine and/or system

OPERATION	OPERATION DESCRIPTION	Frequency x hours							
			8	50	200	300	400	2500	5000
Cleaning	Oil-bath air cleaner	(*)							
	Head and cylinder fins	(*)							
	Internal oil filter								
	Fuel tank								
	Injector								
Check	Level air cleaner oil								
	Level oil sump								
	Battery fluid								
	Valve/rocker arm clearance								
	Injector setting								
Replacement	Oil air cleaner	(**)							
	Oil sump	(**)(***)		□					
	Internal oil filter cartridge								
	External oil filter cartridge								
	Fuel filter cartridge								
	Dry air cleaner cartridge								
Overall inspection	Partial	(x)							
	Complete	(xx)							

□ First replacement

(\*) Under severe working conditions, clean daily.

(\*\*) Under extremely dusty conditions, change every 4-5 hours.

(\*\*\*) See recommended oil type.

(x) The partial overhaul includes the following operations: valve and seat lapping, injector and injection pump overhaul, injector projection check, fuel injection spark advance check, check of the harmful area between head and piston, camshaft and crankshaft end float check, tightening of bolts.

(xx) The general overhaul includes - in addition to all partial overhaul - the following procedures: cylinder and piston replacement, seat, guide and valve refacing, crankshaft replacement or grinding, bench bearing and connecting rod replacement.

The maintenance operations listed above refer to an engine operating in normal conditions (temperature, degree of humidity, dust in the working environment). They may vary significantly according to the type of use.



**Danger**

- To avoid explosions or fire outbreaks, do not smoke or use naked flames during the operations.
- Fuel vapours are highly toxic. Only carry out the operations outdoors or in a well ventilated place.
- Keep your face well away from the plug to prevent harmful vapours from being inhaled. Dispose of fuel in the correct way and do not litter as it is highly polluting.

**FUEL**

When refuelling, it is advisable to use a funnel to prevent fuel from spilling out. The fuel should also be filtered to prevent dust or dirt from entering the tank.

Use the same type of diesel fuel as used in cars. Use of other types of fuel could damage the engine. The cetane rating of the fuel must be higher than 45 to prevent difficult starting. Do not use dirty diesel fuel or mixtures of diesel fuel and water since this would cause serious engine faults.

The capacity of the standard tank is: lt. 4,0

## PRESCRIBED LUBRICANT

	<b>SAE 15W-40</b>	specifications	<b>API CF-4/SG ACEA B2-B4 MIL-L-2104 C / MIL-L 46152 D</b>
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For a temperature of -10°C an oil with a **5W40** viscosity is recommended. For a temperature of -15°C an oil with a **0W30** viscosity is recommended.

**Danger**

- The engine may be damaged if operated with insufficient lube oil. It is also dangerous to supply too much lube oil to the engine because a sudden increase in engine rpm could be caused by its combustion.
- Use proper lube oil preserve your engine. Good quality or poor quality of the lubricating oil has an affect on engine performance and life.
- If inferior oil is used, or if your engine oil is not changed regularly, the risk of piston seizure, piston ring sticking, and accelerated wear of the cylinder liner, bearing and other moving components increases significantly.
- Always use oil with the right viscosity for the ambient temperature in which your engine is being operated.
- The used engine oil can cause skin-cancer if kept frequently in contact for prolonged periods.
- If contact with oil cannot be avoided, wash carefully your hands with water and soap as soon as possible.
- Do not disperse the oil in the ambient, as it has a high pollution power.

**LUBRICANT**

**SAE Classification**

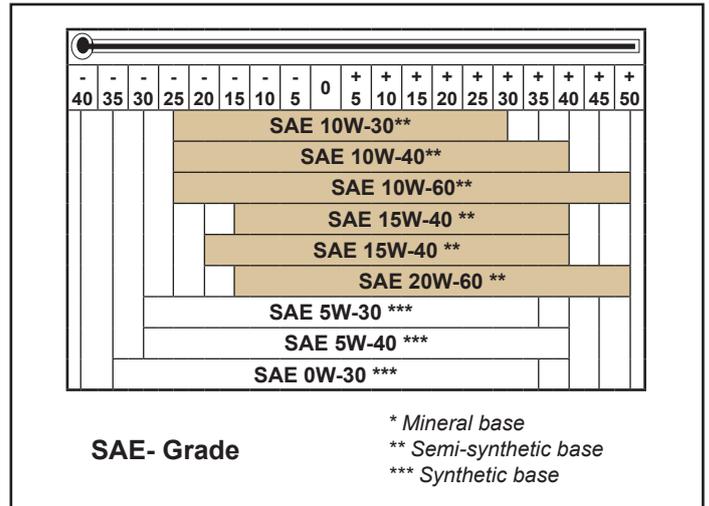
In the SAE classification, oils differ on the basis of their viscosity, and no other qualitative characteristic is taken into account.

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.

An SF oil, for instance, is more performing than a SE oil but less performing than a SG one.

**ACEA REGULATIONS - SEQUENCES**

LIGHT DUTY DIESEL ENGINES	
<b>B1 =</b>	Low-viscosity, for frictions reduction
<b>B2 =</b>	Standard
<b>B3 =</b>	High performances (indirect injection)
<b>B4 =</b>	High quality (direct injection)

HEAVY DUTY DIESEL ENGINES	
<b>E2 =</b>	Standard
<b>E3 =</b>	Heavy conditions (Euro 1 - Euro 2 engines )
<b>E4 =</b>	Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines )
<b>E5 =</b>	High performances in heavy conditions (Euro 1 - Euro 2 - Euro 3 engines )

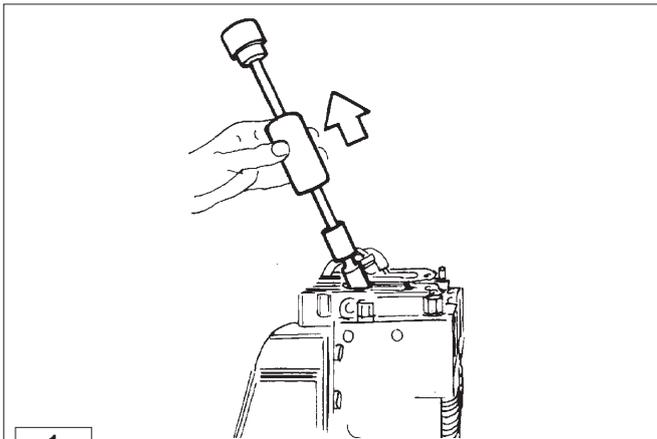
**API / MIL SEQUENCES**

API	CH-4	CG-4	CF-4	CF-2	CF	CE	CD	CC
MIL			L- 46152 D / E					

## RECOMMENDATIONS FOR DISASSEMBLING

**Important**

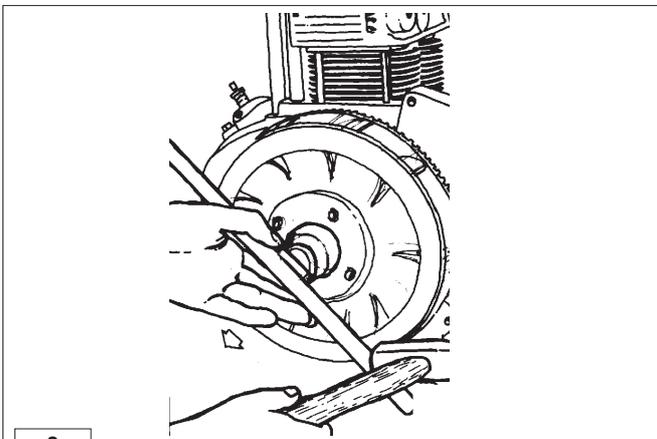
- To locate specific topics, the reader should refer to the index.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way 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.



1

**Extracting fuel injectors**

Unscrew the fuel feeding pipes.  
Remove the injectors using a commercial extractor tool as shown in fig. 1.



2

**Removing the flywheel**

Use the extractor number 00365R0020 as shown in figure 2.

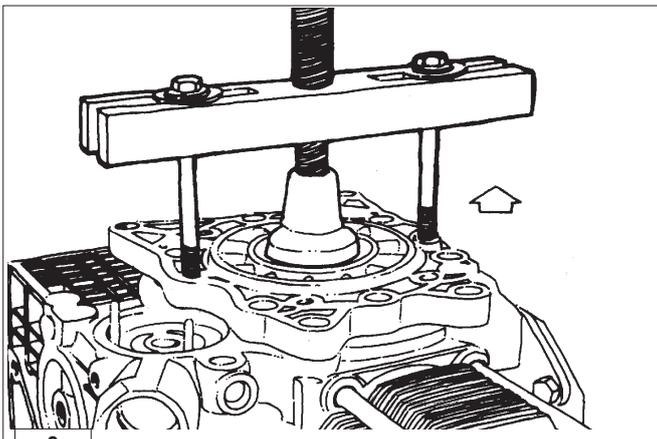
**Danger**

During the demounting phases, pay particular attention to prevent the flywheel from dropping as this could seriously injure the operator.

Wear protective goggles when removing the flywheel ring.

**Warning**

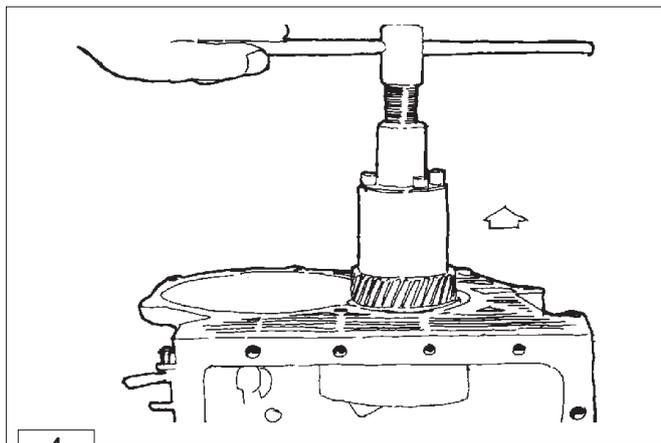
Do not tap the end of the extractor when removing the flywheel.



3

**Extraction of flywheel side main bearing**

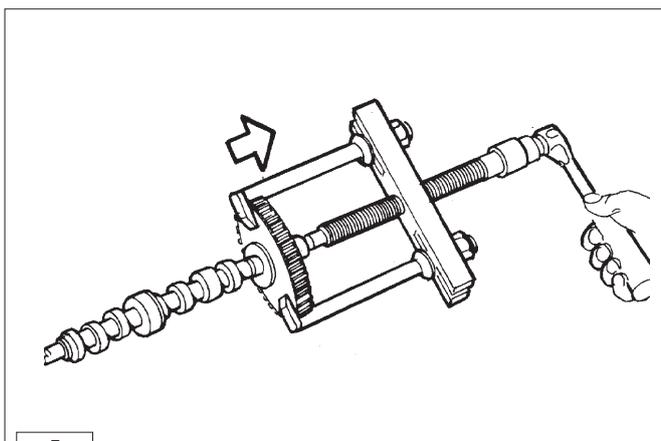
Withdraw the bearing using two M8 screws taking care to tighten them evenly; alternatively use a commercial extractor, as shown in figure 3.



4

**Extraction of crankshaft gear**

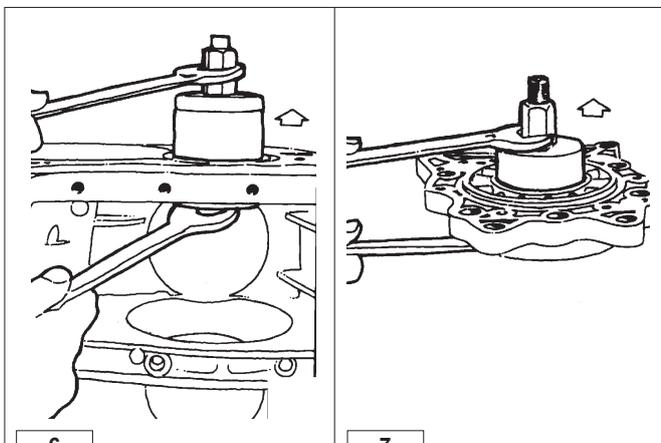
Use extractor tool number 00365R0890 (fig.4).



5

**Extraction of the camshaft gear**

Use the extractor number 00365R0010 (fig.5).

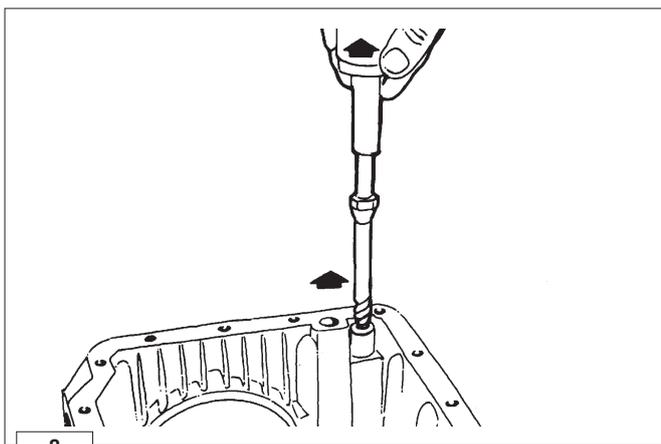


6

7

**Extracting crankcase bushes**

From crankcase (fig.6)  
From main bearing (fig.7)  
Use extractor number 00365R0900.



8

**Extracting the oil pressure indicator plug**

Loosen the plug securing screw, and remove circlip, spring and ball.  
Cut a thread on the inside of the plug body and then withdraw it using a commercial extractor tool (fig. 8).

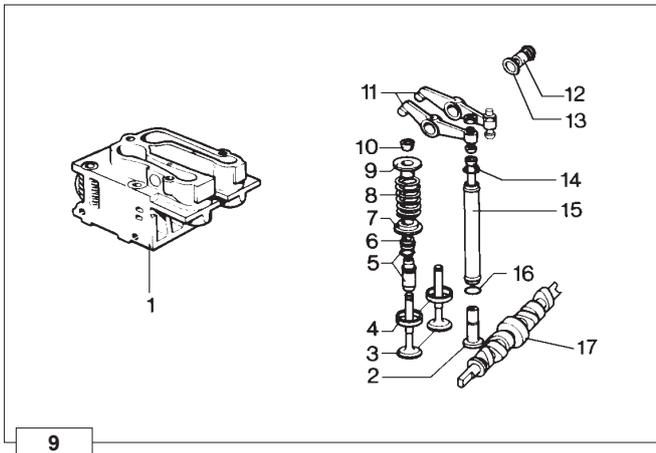
## RECOMMENDATIONS FOR OVERHAULS AND TUNING

**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.
- 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.

**Danger**

- During repair operations, when using compressed air, wear eye protection.



**Cylinders heads**

Parts shown in figure 9.

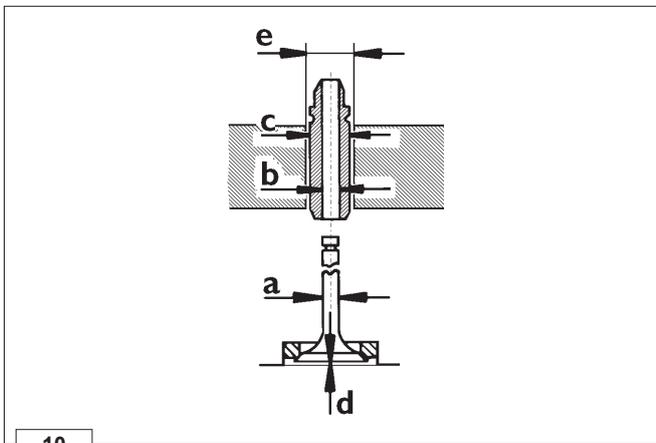
- 1.Head
- 2.Tappets
- 3.Valves
- 4.Seats
- 5.Guides
- 6.Seals
- 7.Lower washers
- 8.Springs
- 9.Top washers
- 10.Valve locking split cones
- 11.Rocker arms
- 12.Rocker pins
- 13.Gaskets
- 14.Push rods
- 15.Cover tube
- 16.O-ring
- 17.Camshaft

The heads are made off aluminium with valve guides and seats are made of cast iron.

**Warning**

- Do not disassemble the head when the engine is hot to avoid deformation.

Clean heads of carbon deposits and check the cylinder mating surfaces; if they are deformed they must be ground to a maximum of 0.3 mm. Check that there are no cracks or other imperfections in the heads. If defects are encountered the heads must be renewed. In this case consult the spare parts catalogue.

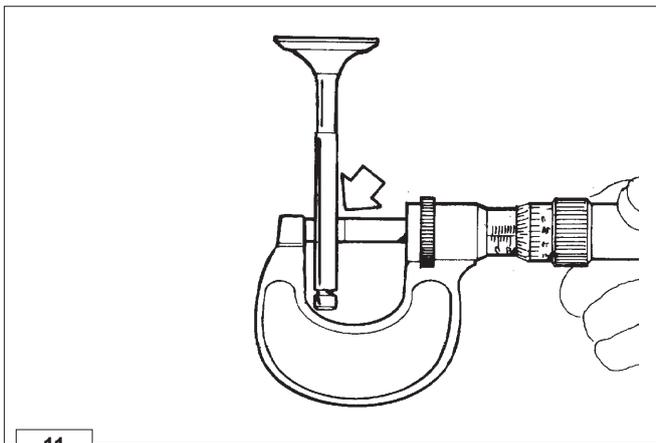


**Valves - Guides - Seats**

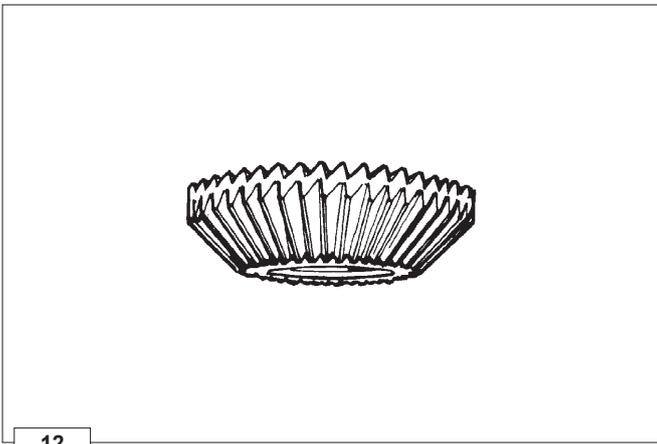
Clean the valves with a wire brush and renew them if the valve heads are deformed, cracked or worn.

Guide	a mm	b mm	c mm	d mm	e mm
Inlet	6,960+6,970	7,00+7,01	13,025+13,037	0,8+1,0	13+13,01
Exhaust	6,945+6,955	assembly			

Check the dimensional conformity of the valve stems (fig. 11) and the clearance between valve and guide, bore out the guides to the dimensions indicated in the table (fig. 10). Renew both guide and valve if the clearance is greater than 0.1mm.

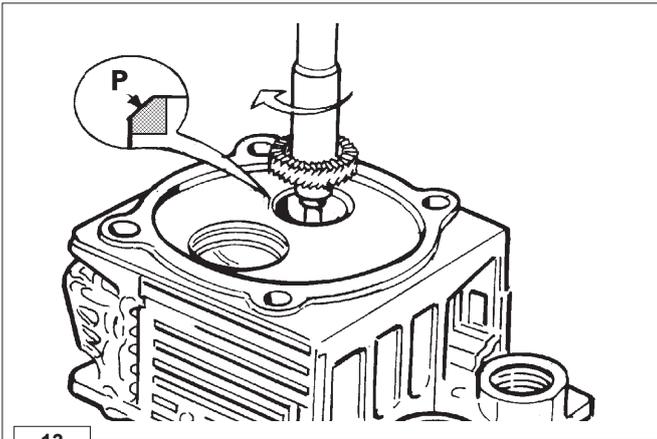


It is always necessary to grind the valve seats when new guides are fitted. Oversize valve guides with external diameter increased by 0.10 are available.



12

After prolonged running of the engine the hammering of the valves on their seats at high temperature tends to harden the faces of the seats and makes manual grinding difficult. It is necessary to remove the hardened surface with a 45° cutter (fig. 12).



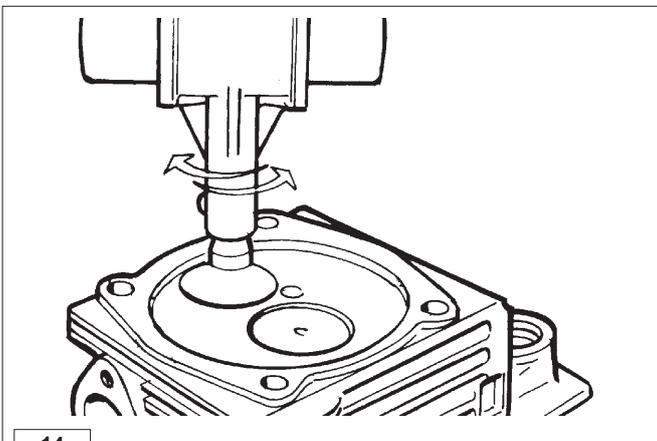
13

Grinding of valve seats causes a widening of the valve seat face **P** (fig.13).

Final lapping of the valve on the seat must be carried out by coating the seat with a fine lapping compound and rotating the valve in a clockwise and counterclockwise direction with slight pressure until a perfect surface finish is obtained (fig.14).

Observe the valve seating clearances indicated in the following table (fig.10).

Fitting mm	Max. wear mm
$d = 0,8 \div 1,0$	$d = 1,3$



14

#### Important

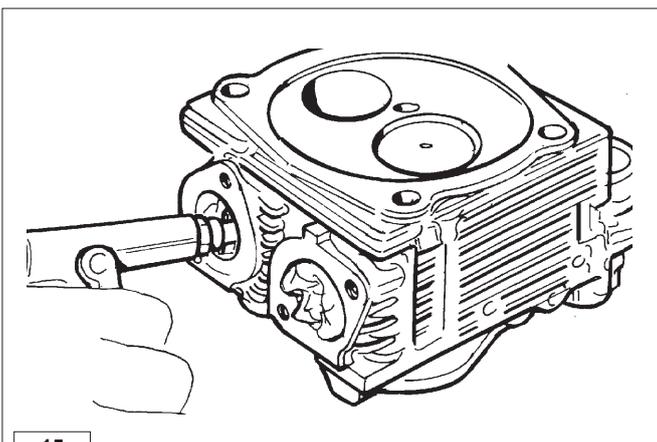
- In the case of lower values the valve may strike the piston. In the case of values in excess of 1.3 mm the valve seat rings must be replaced.

Fitting of new seats or valves always requires preparatory grinding. Valves are available with the external diameter increased by 0.5 mm.

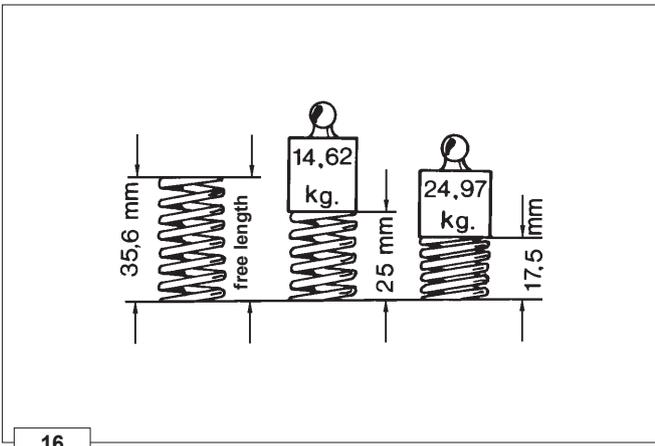
After grinding wash the valve and seat carefully with petrol or paraffin in order to remove residual grinding paste and chips. Once you have finished grinding check the efficiency of the seal between the valve and seat as outlined below:

1. Fit the valve on the head with spring, washers and split cones (fig.9).
2. Invert the head and pour in a few drops of diesel fuel or oil around the edges of the valve head.
3. Blow compressed air into the inlet of the cylinder head taking care to seal the edges so that the air does not escape (fig.15).

Should air bubbles form between the seat and the valve remove the valve and regrind the seat.



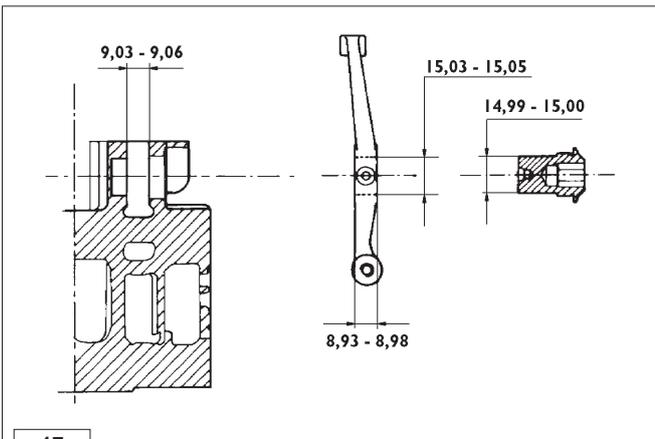
15



16

**Valves and springs**

In order to check the springs for possible failure measure the lengths under load as shown in figure 16. The permissible tolerance for loads and lengths is  $\pm 10\%$ . If the figures measured do not fall within these values, the springs must be renewed.



17

**Rocker arms**

Make sure that the facing surfaces between rocker and pin are not scored and show no signs of seizure. If such marks are encountered, renew rocker and pin.

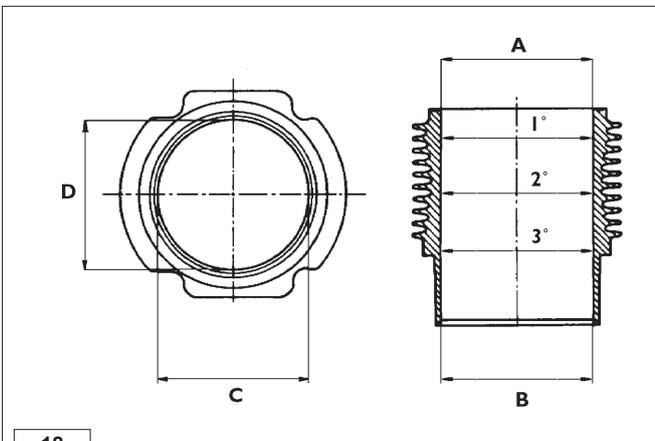
Rocker / pin clearance (fig.17):

Fitting mm	Max. wear mm
0,03 $\div$ 0,06	0,15

Rocker axial play (fig.17):

Fitting mm	Max. wear mm
0,05 $\div$ 0,130	0,5

Make sure that the rocker arm adjusting screw is not worn and that the lubrication hole is free of dirt.



18

**Cylinders**

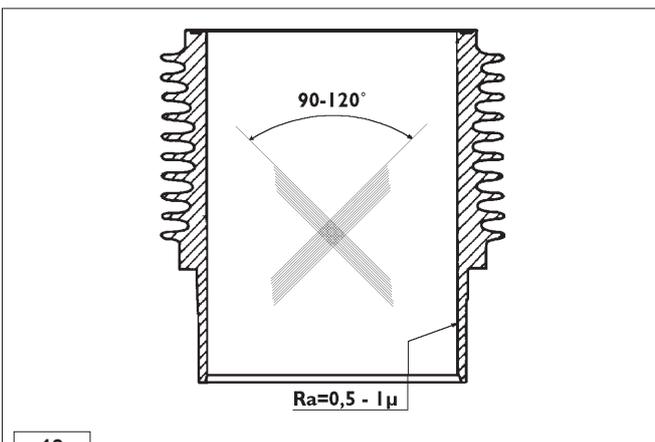
Air cooled with cylinder barrels in special cast iron with integral liners.

Use a dial gauge to check internal diameters (C-D) at three different heights (fig.18). Maximum permitted taper (A-B) and ovality (C-D) is 0.06mm.

Diameter of cylinders (fig.18):

KD 425-2	$\varnothing 85 \div 85,015$
----------	------------------------------

If the diameter of the cylinder does not exceed said values or if there are slight surface scores on the cylinder, it will be sufficient to change the piston rings.



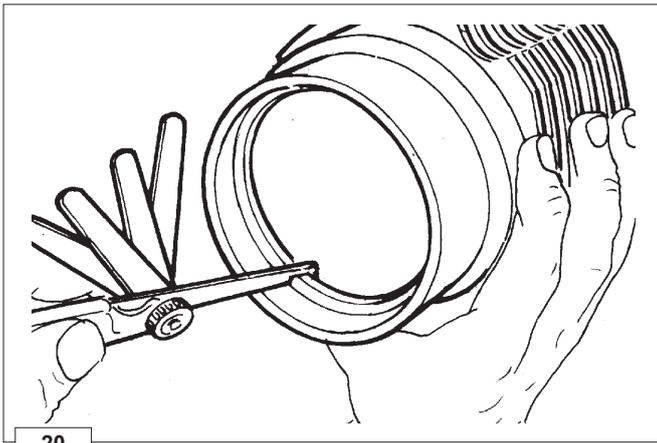
19

**Important**

- Do not manually hone the cylinder bore surfaces with emery cloth or other means.

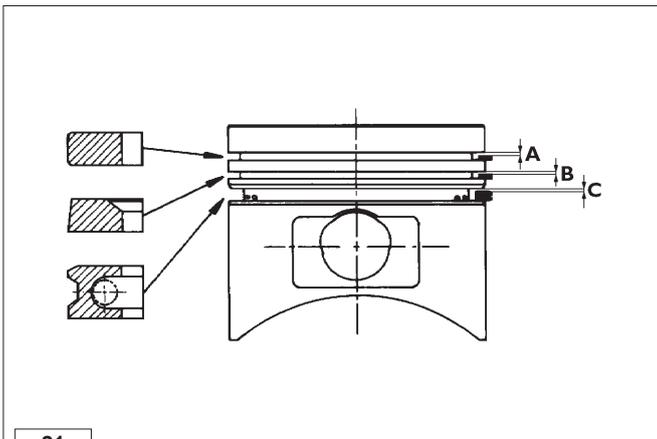
The cross-hatch pattern should be at an angle of  $90^\circ \div 120^\circ$ ; lines should be uniform and clear in both directions. Average roughness must range between 0.5 mm 1  $\mu\text{m}$ . The cylinder surface which comes into contact with piston rings should be machined with the plateau method.

If the taper and ovality of the cylinder exceed the values indicated, then the cylinder and piston must be renewed.

**Piston rings - Pistons - Piston pins**

Check the wear of piston rings by fitting them into the cylinder through the lower end and measuring the end gap (fig.20). The values should be:

Piston ring	Fitting mm	Max. wear mm
Compression	0,30 ÷ 0,50	0,80
Oil scrapper	0,25 ÷ 0,50	



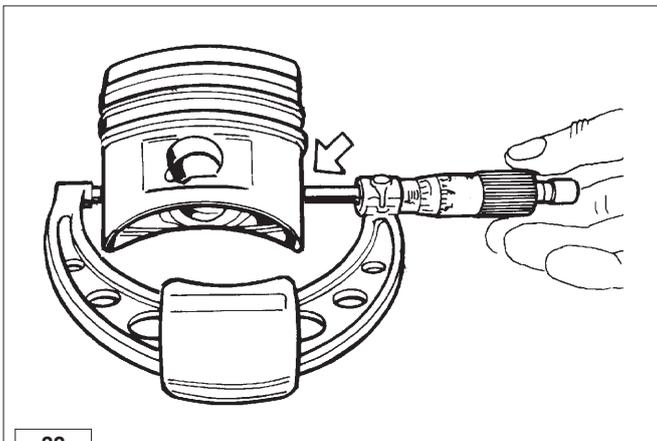
Check that the rings move freely in the grooves and check the ring/groove clearance using a feeler gauge (fig.21).

If the clearance exceeds the values shown in the table, renew the piston and the piston rings.

Piston ring	Max. wear mm
1st Compression	<b>A</b> = 0,22
2nd Compression	<b>B</b> = 0,18
3rd Oil scrapper	<b>C</b> = 0,16

**Important**

- Piston rings must always be renewed after dismantling the piston.



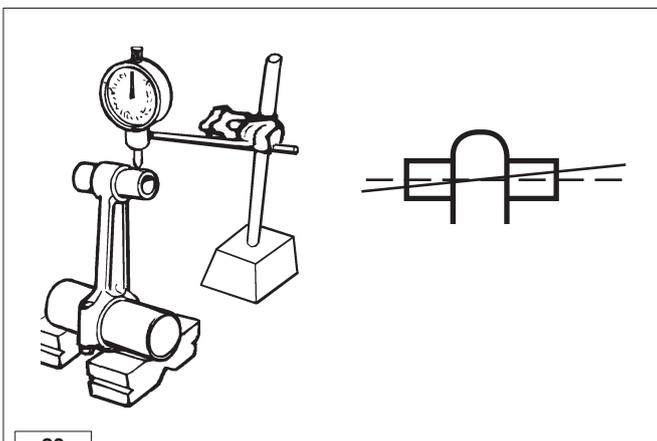
Piston diameter check: The diameter of the piston must be measured at approximately 18 mm from the base (fig.22).

Engine	Diameter mm
KD 425-2	84,910 ÷ 84,940

Check the clearance between cylinder and piston, if it is greater than 0.120 mm both cylinder and piston must be replaced.

Assembly clearance between piston pin and piston in millimetres:

Fitting mm	Max. wear mm
0,003 ÷ 0,013	0,050

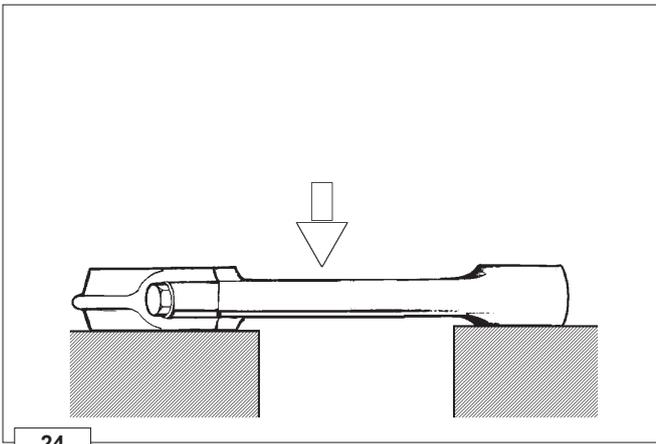
**Connecting rods**

The connection between the connecting rod small end and the wrist pin is without a bushing. Assembly clearance between connecting rod small end and piston pin in millimetres:

Engine	Ø Piston pin mm	Assy. clearance mm	Max wear mm
KD 425-2	21,997 ÷ 22,002	0,023 ÷ 0,038	0,070

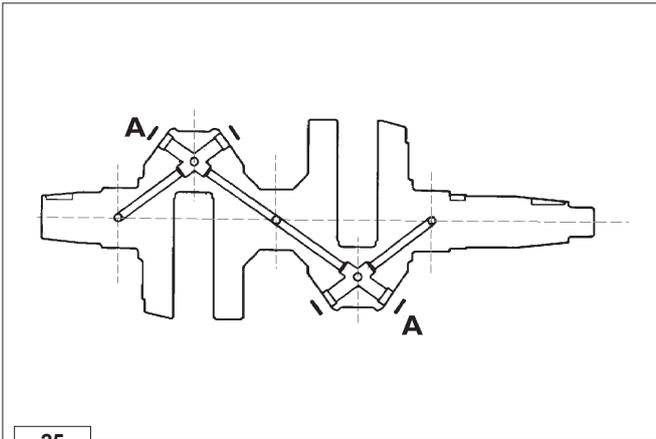
Checking parallelism between the two axes of the connecting rod (fig.23):

1. Fit the wrist pin in the hole in the small end of the connecting rod and fit a calibrated pin into the big end (with bush fitted).



24

2. Position the calibrated pin on two prisms arranged on a check surface.
3. Use a dial gauge to check that the discrepancy between readings at the ends of the calibrated pin is no more than 0.05 mm; should deformation exceed this value (max. 0.10mm) the connecting rod must be straightened. This operation is performed by placing the connecting rod on a parallel surface and applying slight pressure mid-way along the convex side of the stem (fig.24).

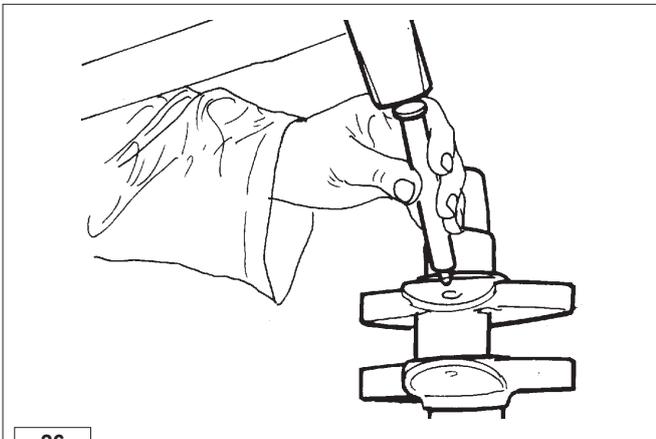


25

**Crankshaft**

Whenever the engine is dismantled, particularly for the replacement of cylinders and pistons due to wear caused by the aspiration of dust, it is good practice to check the condition of the crankshaft.

1. Remove the plugs "A" from the oil passages (fig.25).
2. Use an appropriately shaped steel punch to clean the inside of the oil passages and the collection traps. If the deposits are particularly resistant, immerse the whole crankshaft in petrol or paraffin before proceeding with the operations.
3. When the oil passages and traps have been thoroughly cleaned, close the openings with new plugs (fig.26).

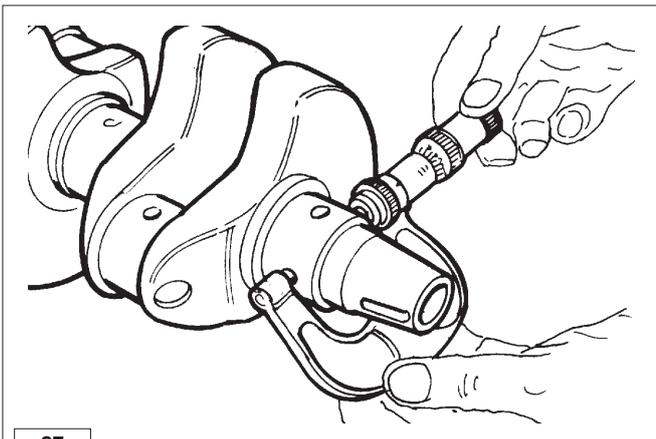


26

**Checking crankshaft dimensions**

Once the crankshaft has been thoroughly cleaned, use a micrometer to check the wear and ovality of the main journals and crank journals across two sections at right angles to each other (fig.27).

If wear exceeds 0.08 mm (fig.28) grind the crankshaft to the dimensions shown in the table:



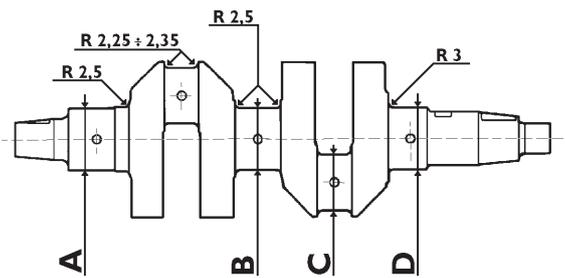
27

Dimensions	STD mm	- 0,25 mm	- 0,50 mm	-0,75 mm
A - B - D	45,005	44,755	44,505	44,255
	45,015	44,765	44,515	44,265
C	39,994	39,744	39,494	39,244
	40,010	39,760	39,510	39,260

Undersize bearing bushes are already available at the necessary sizes without requiring any adjustment by boring.

**Warning**

- During grinding take care not to remove the shim adjustment material from the main journal thrust face to avoid changing the crankshaft end float; also ensure that the grinding wheel radii are as specified in figure 28 so as not to create crack initiation sections on the crankshaft.

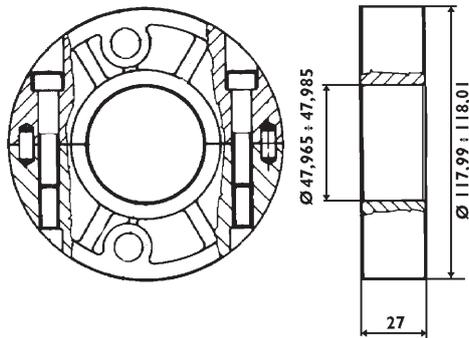


28

**Central main bearings**

In order to facilitate assembly the central main bearings are of different external diameters (fig.29) and are machined with a bevelled edge to assist their insertion into the crankcase. Check the dimensions of the shells and renew them if they are worn or deformed.

Also check the condition of the oil passages, if necessary, clean them with paraffin or petrol and dry with compressed air.



29

**Oil seal rings**

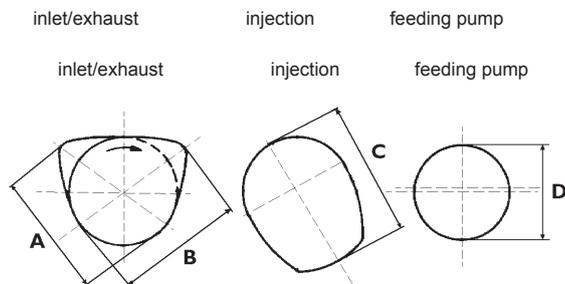
Check that the rings have not hardened around the internal contact edge and that they show no signs of cracks or wear.

**Camshaft**

Check the cams and bearing journals for scoring and wear. Measure the dimensions and compare them to the values in the table below and shown in figures 30-31.

Camshaft dimensions fig.30.

Cam	Measurement	Dimensions mm
Timing	<b>A - B</b>	34,69 ÷ 34,74
Injection	<b>C</b>	34,98 ÷ 35,02
Fuel pump	<b>D</b>	25,50 ÷ 25,70



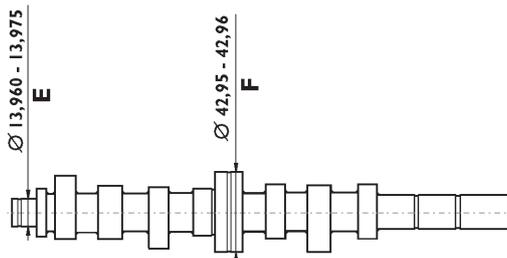
30

Assembly clearance between the journals and their housings should be (fig.31):

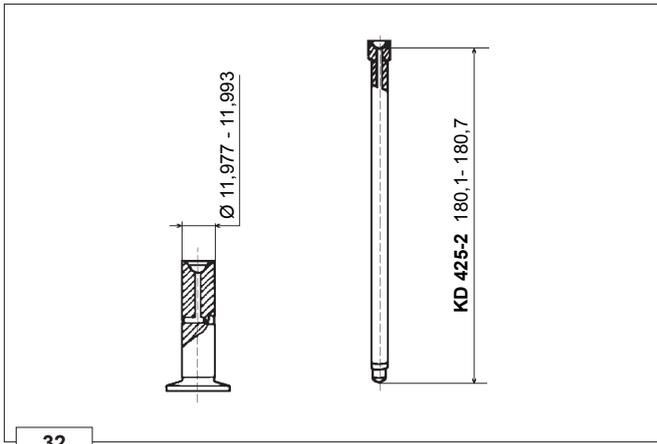
Measurement	
<b>E</b>	0,025 ÷ 0,065
<b>F aluminium crankcase</b>	0,07 ÷ 0,105
<b>F cast iron crankcase</b>	0,04 ÷ 0,075

**Warning**

- Renew the camshaft if the cams or journals show wear in excess of 0.1mm.



31



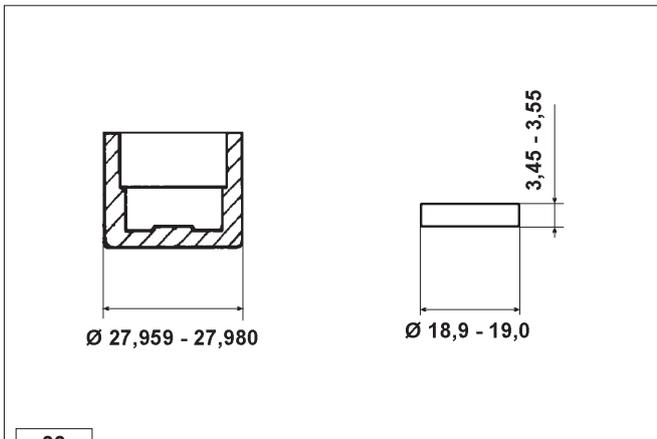
32

**Tappets and push rods**

Make sure that the tappet surfaces (fig.32) are free from wear and present no signs of scoring or seizure, otherwise, renew. Assembly clearance between tappets and their housings should be:

Fitting mm	Max. wear mm
0,07 ÷ 0,041	0,10

The push rods must be straight and with the spherical surfaces at either end in good condition (fig.32). Make sure that the lubrication holes inside the tappets and push rods are free of dirt.



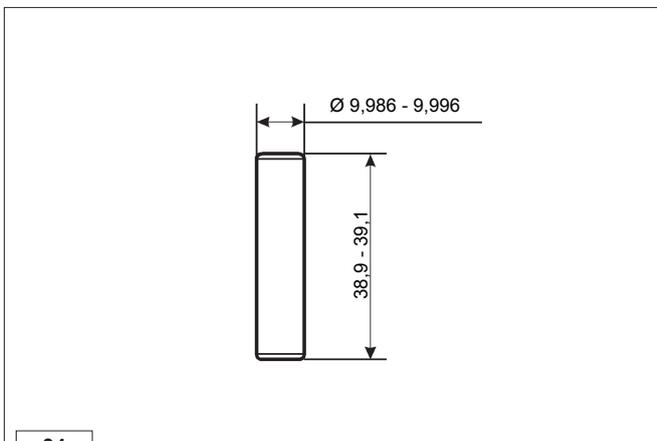
33

**Injection pump plug nuts and control rods**

Renew the parts if the surface wear is greater than 0.10mm (fig.33).

Assembly clearance between control rods and their housings in the crankcase:

Fitting mm	Max. wear mm
0,02 ÷ 0,059	0,10

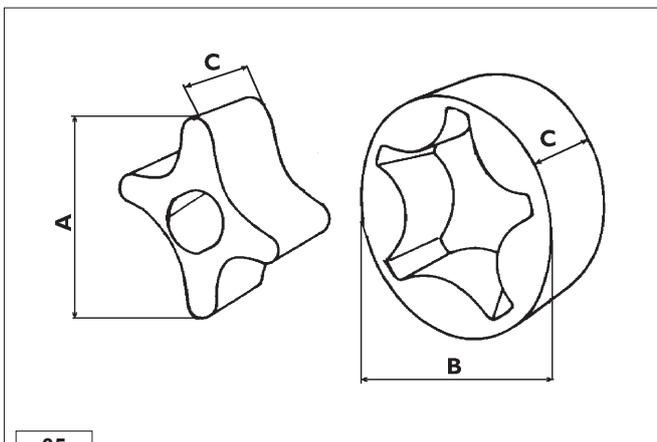


34

**Fuel pump push-rod**

Check that the surfaces of the fuel pump push-rod, fig. 34, are free of wear, scoring, or signs of seizure, otherwise, renew. Assembly clearance between fuel pump push-rod and its housing in the crankcase:

Fitting mm	Max. wear mm
0,05 ÷ 0,098	0,120

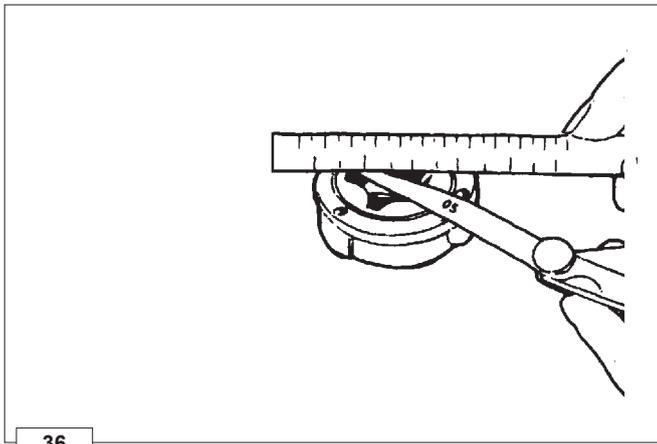


35

**Oil pump**

Check the rotors and renew them if they have worn lobes or centres. Check the extent of pump wear by taking the measurements indicated in figure 35.

Measurement	Dimensions mm	Max. wear mm
A	29,72 ÷ 29,77	29,65
B	40,551 ÷ 40,576	40,45
C	17,92 ÷ 17,94	17,89



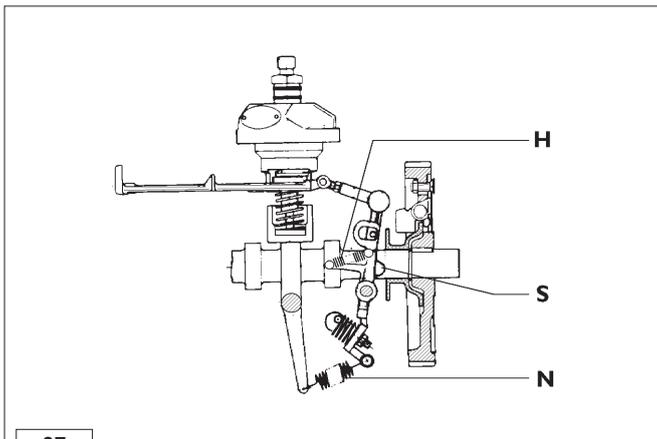
36

The clearance between the external rotor of the oil pump and the cover facing surface must be:

Fitting mm	Max. wear mm
0,27 ÷ 0,47	0,60

End float of rotors (fig.36):

Fitting mm	Max. wear mm
0,01 ÷ 0,06	0,10



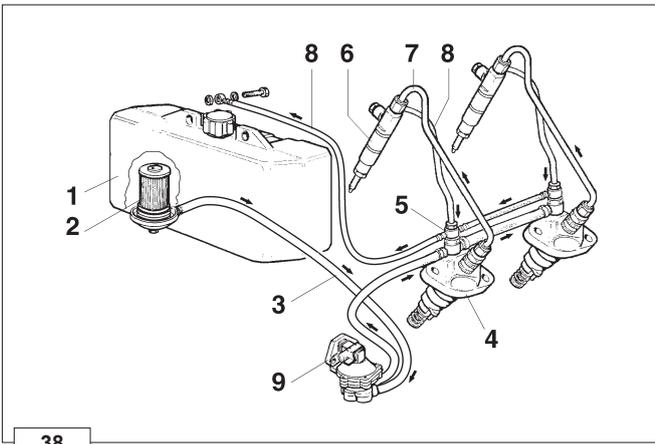
37

#### Governor lever and spring

Check that the shoes (**S**, fig.37) are level and that the springs have not lost their elasticity. Renew any excessively worn parts after consulting the spare parts catalogue.

Supplement and governor spring dimensions (fig.37):

Spring	Lenght mm	Lenght under load mm	Load kg	Nr of windings
Governor ( <b>N</b> )	32 ÷ 34	53	1,9	14,75
Supplement ( <b>H</b> )	25,75 ÷ 26,25	38,7	0,6	25,5



38

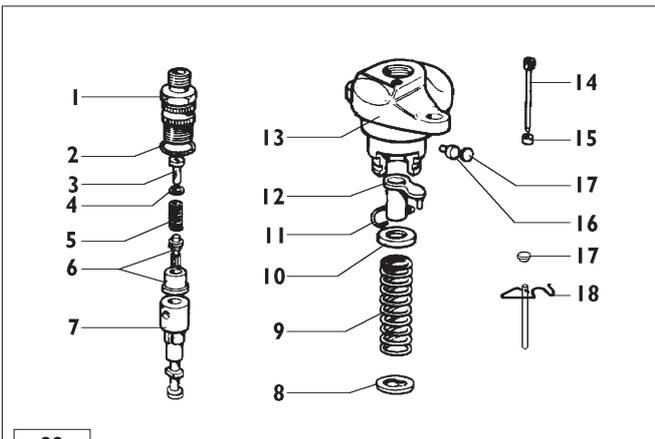
**Fuel circuit**

Fuel feeding can be either gravity type or forced, with a mechanical double diaphragm pump operated a cam located on the camshaft. Fuel is filtered by a filter in the fuel tank or through an external filter cartridge.

The fuel circuit is bled of air automatically.

Components of figure 38:

- 1. Fuel tank
- 2. Fuel filter
- 3. Fuel supply lines
- 4. Fuel injection pumps
- 5. Bleed off connection
- 6. Fuel injectors
- 7. Injection lines
- 8. Fuel return lines
- 9. Fuel sully pump.

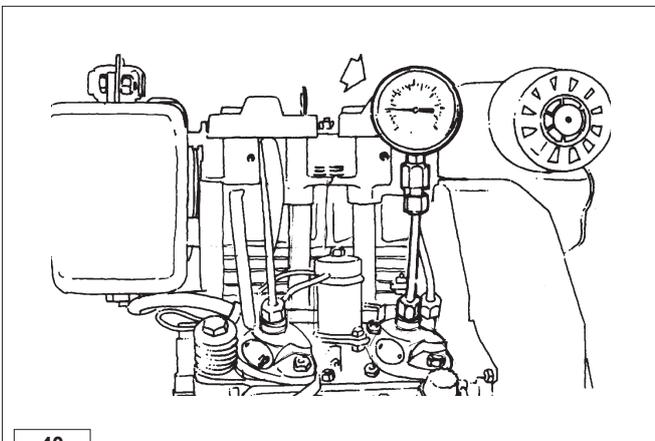


39

**Injection pumps**

Components of figure 39:

- 1. Delivery connection
- 2. O-ring
- 3. Filler
- 4. Washer
- 5. Valve spring
- 6. Delivery valve
- 7. Injection plunger
- 8. Lower plate
- 9. Spring
- 10. Top plate
- 11. Retaining ring
- 12. Adjustment sleeve
- 13. Pump body
- 14. Sleeve securing pin
- 15. Distance ring
- 16. Eccentric pin
- 17. Cap
- 18. Clip for BOSCH pump type PF30.



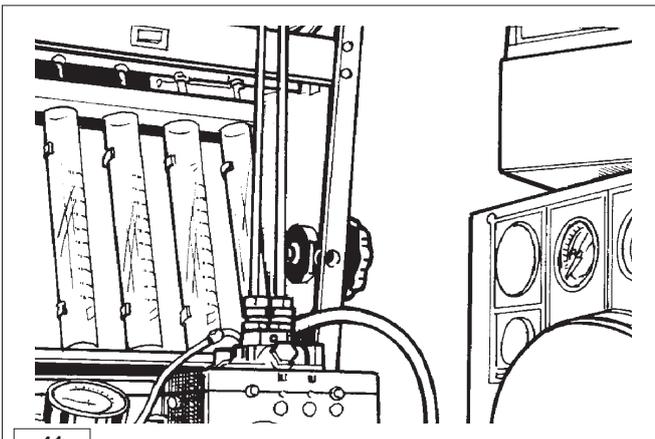
40

**Checking injection pumps**

Before dismantling the injection pumps check for pressure leak of the pumping unit, plunger and valve, as follows:

1. Connect a pressure gauge with 600 Kg/cm<sup>2</sup> full scale to the diesel delivery line (fig.40).
2. Set the control sleeve (nr. 12, fig.39) to a mid-point delivery position.
3. Turn the flywheel slowly until the plunger has completed a full compression stroke.
4. Take the pressure gauge reading. If it is below 300 Kg/cm<sup>2</sup> the complete plunger unit must be changed.

During the test the reading on the gauge will show a progressive pressure increase to a maximum value and then will fall suddenly and stop at a lower pressure. Replace the valve if the fall in pressure exceeds 50 Kg/cm<sup>2</sup> and continues to fall slowly. The pressure drop from 200 Kg/cm<sup>2</sup> to 150 Kg/cm<sup>2</sup> must occur in a time interval of no less than 7 seconds.



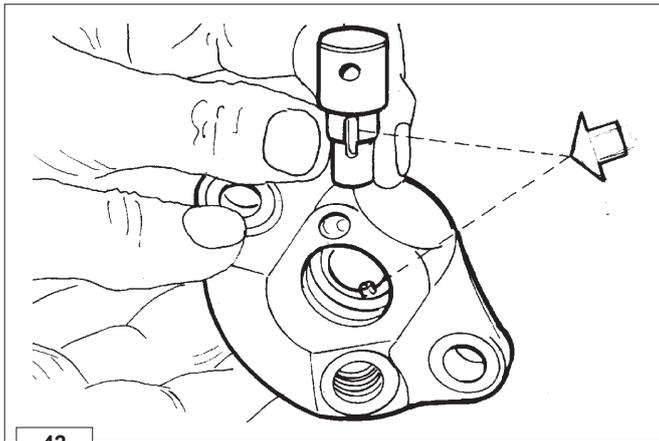
41

**Injection pump setting (fig.41)**

Set the maximum quantity delivered by the pump by turning the eccentric pin using a screwdriver (nr. 16, fig.39).

With the control sleeve at 10mm from the stop position and the pump running at 1,500 rpm, the quantity of fuel for 1,000 shots must be between:

**23 ÷ 25 cc                      20 ÷ 22 cc (BOSCH)**



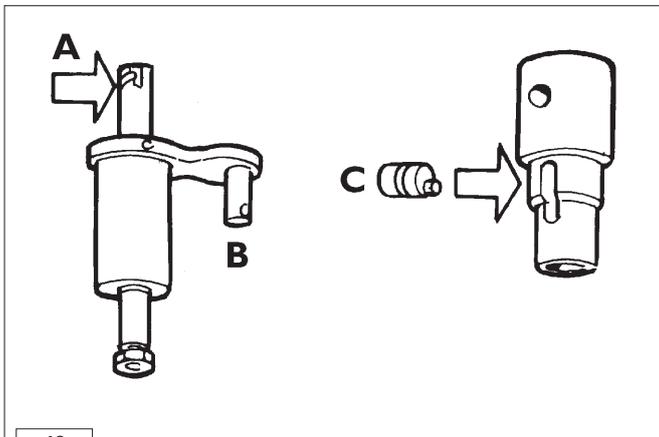
42

**Warning**

- The difference between the deliveries of the two pumps when locked must not exceed 0.5 cc.

Also check:

1. That the distance between the injection cams in the rest position (bottom dead centre) and the pump supporting face is between  $52.8 \div 54.4$  mm as shown on the data plate;
2. That the stroke of the piston with injection cams in the rest position (bottom dead centre), to the start of delivery is between  $2 \div 2.1$  mm.

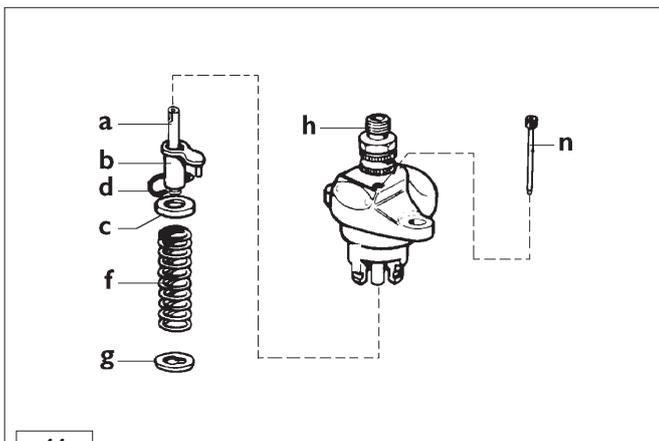


43

### Assembly of injection pumps

If it proves necessary to disassemble the injection pumps they must be reassembled following the instructions listed below:

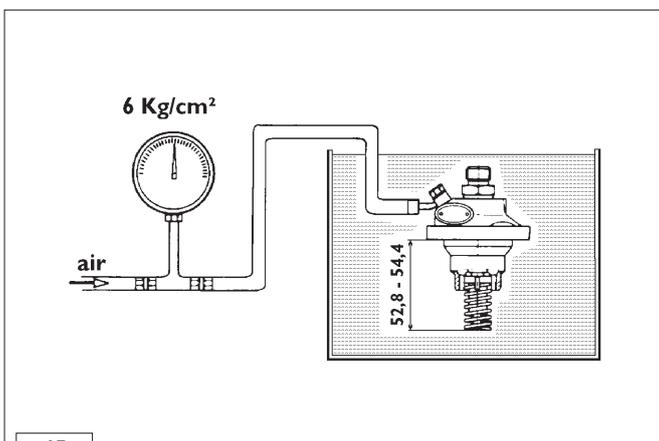
1. Insert barrel into pump casing with the fuel inlet hole aligned with the feeding connection (fig.42). This is the only possible position because of the stud on the pump body. Make sure that the seating face between the barrel and the pump are free of dirt.
2. Insert delivery valve, copper gasket, spring, washer, filler, O-ring, and temporarily tighten the delivery connection.
3. Insert plunger, with helical profile (A, fig.43) on the opposite side of the sleeve pin (B, fig.43), into the internal groove of the control sleeve (make sure the helical profile is turned towards the fuel inlet and eccentric pin (C, fig.43).
4. Complete pump assembly with plunger (a, fig.44), control sleeve (b), upper washer (c), retaining ring (d), spring (f) and secure all with the spring holder washer (g)
5. Tighten delivery valve holder (h, fig.44) to  $4.5 \div 5$  kgm torque.
6. Check, by compressing the spring through its various work positions, that the control sleeve (b, fig.44) turns freely and does not stick or encounter resistance throughout its full stroke; any irregular movement will give rise to hunting of engine speeds.
7. Secure the control sleeve using the pin (n, fig.44) screwed into pump housing.



44

**Warning**

- Always check the injection pump calibration after the delivery connection (h, fig.44) has been dismantled.

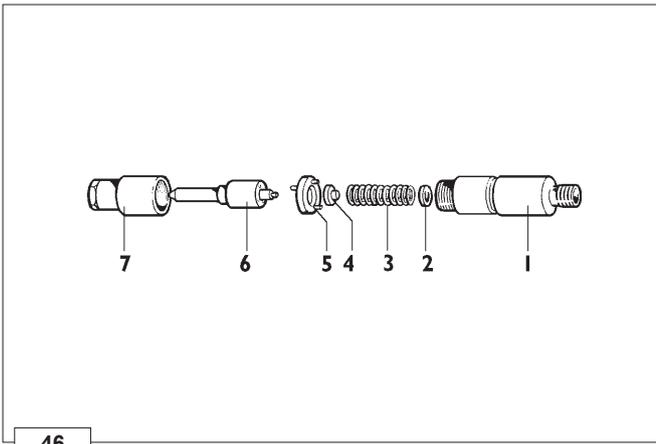


45

### Testing air tightness

Feed pressurized air at 6 Kg/cm<sup>2</sup> into the fuel supply union and completely immerse the pump in oil or diesel fuel for about 20 ÷ 30 seconds (fig.45); check that no air bubbles are released.

**N.B.:** Tightness can be checked by compressing the springs to  $52.8 \div 54.4$  mm, which corresponds to the bottom dead centre working position of the pump.



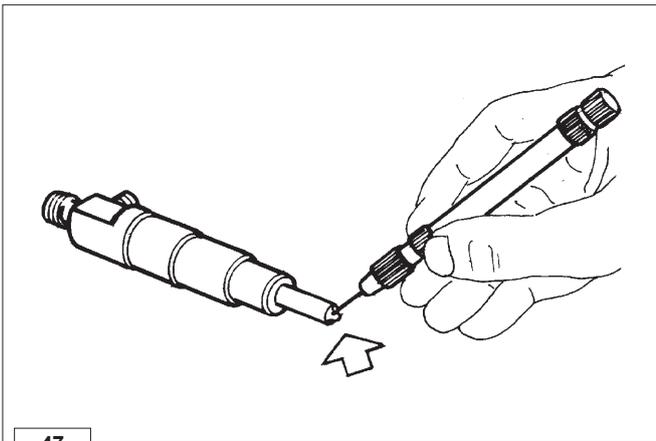
**Injectors**

Details of fig.46:

- 1.Injector casing
- 2.Adjusting shim
- 3.Spring
- 4.Rod
- 5.Distance ring with locating pin
- 6.Nozzle
- 7.Ring nut

**Checking and setting the injectors**

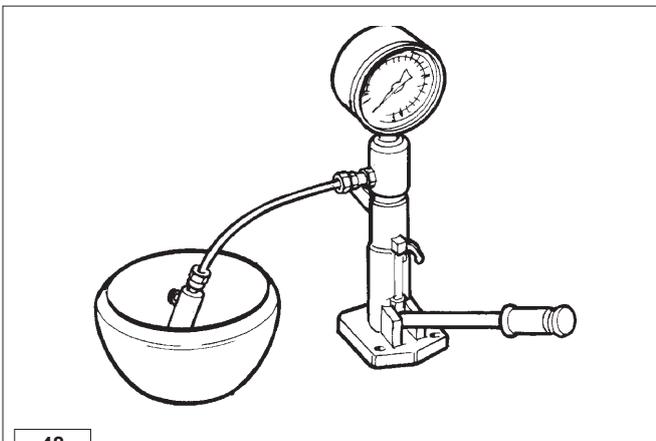
1. Clean the nozzle holes with 0.25 mm gauge steel wire (fig.47).
2. Place the injector on the test bench (p.n. 00365R0430, fig.48) bypass the pressure gauge and operate the lever rapidly. The nozzle should chatter audibly and spray correctly.
3. Connect the pressure gauge while pressing the lever slowly and steadily until injection occurs. The opening pressure registered on the gauge should be 230 Kg/cm<sup>2</sup> (200 Kg/cm<sup>2</sup> on silenced versions). Change the adjusting shims (nr. 2, fig. 46) in order to achieve correct adjustment.
4. Testing fortightness: Operate test bench hand lever until the pressure gauge reads 20 Kg/cm<sup>2</sup> below the opening pressure of the needle valve. The nozzle can be considered well sealed if there no Diesel fuel accumulates at the nozzle tip after 10 seconds.



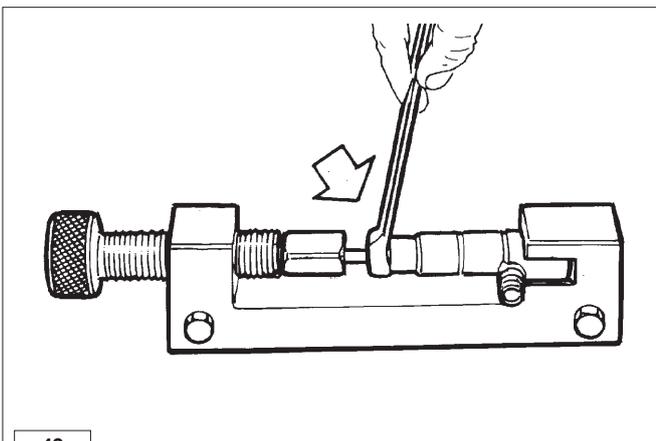
**Disassembly and re-assembly of injectors**

Unscrew the ring nut on the injector nozzle using a ring wrench and a special tool as illustrated in figure 49 serving to release the pressure exerted by the spring on the ring nut.

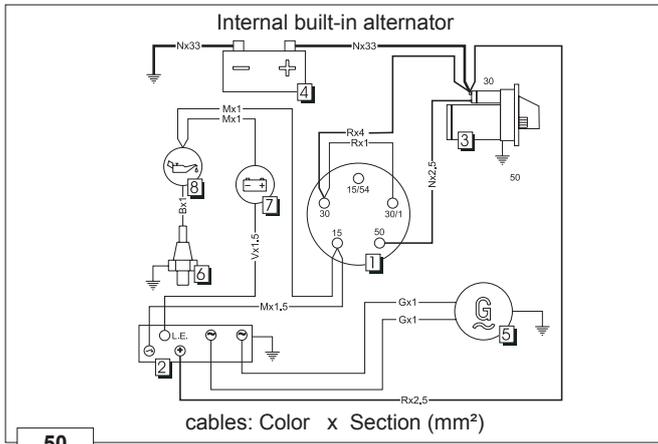
1. Visual check: make sure that the seat of the needle shows no signs of hammering or excess roughness, that the needle is not worn or damaged, and that the holes are free of carbon deposits.
2. Smoothness test: the needle, previously immersed in diesel and inserted into the nozzle casing, must be pulled out to a third of the length of the guide while holding the nozzle in a vertical position. When the needle is released it should return freely to its seat by the effect of its own weight.



Reassemble the injector following the assembly order shown in figure 46; during reassembly make sure that the locating elements on distance ring 5 (fig.46) are correctly inserted to the corresponding holes. Torque the nozzle securing ring nut to:



**kgm 3,5 (Nm 34,3)**



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**Plant specifications****Starter motor:**

Left rotation, 12V, power from 1.25 to 1.4 kW

**Built-in alternator:**

280W

**Voltage regulator:**

Electronic with controlled diodes and connection for battery charge indicator light

**External alternator:**

12V - 400W

**Recommended battery:**

Refer to tables p.15

**Flywheel ring gear:**

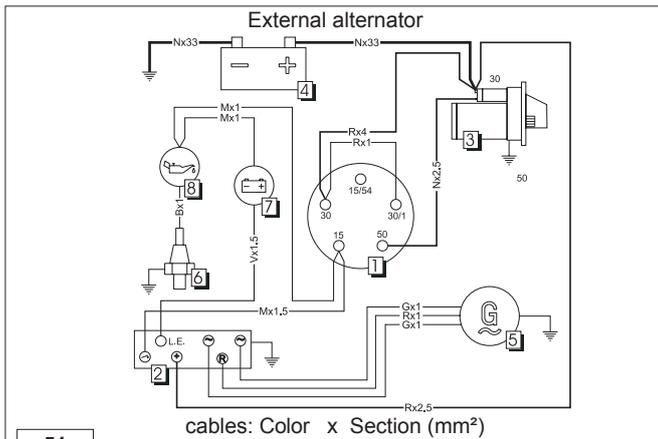
Check teeth for wear or damage. Fit crown wheel to flywheel by pre-heating to 200-250°C.

## Description (fig. 50-51)

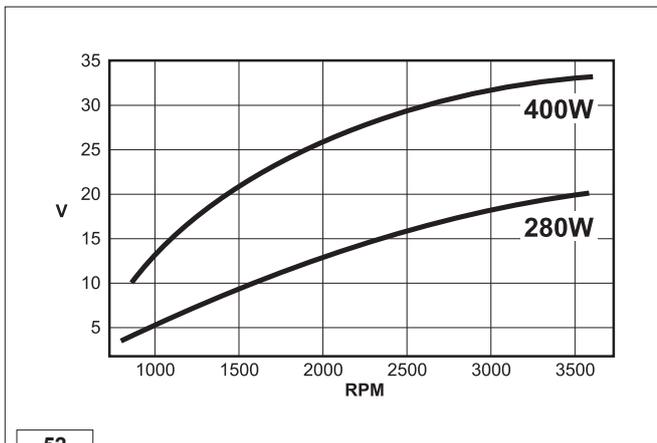
1. Ignition key (optional)
2. Voltage regulator
3. Engine starter
4. Battery (not included)
5. Alternator
6. Pressure switch
7. Battery recharge warning light (optional)
8. Oil pressure warning light (optional)

Cables color (fig. 50-51)

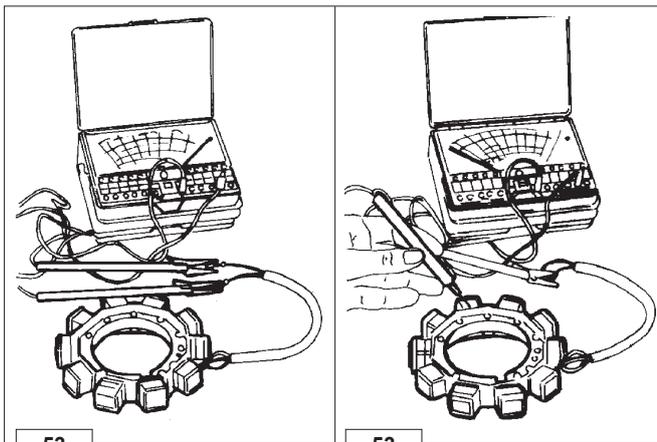
- M** Brown  
**N** Black  
**A** White  
**V** Green  
**R** Red



51



52



53

53

**Checking electrical equipment**

1. Make sure that the connections between the voltage regulator and alternator are correctly made and in good condition.
2. Disconnect the starter motor wire from the battery terminal and connect a dc ammeter (fig.50 and 51).
3. Connect a dc voltmeter to the battery terminals (fig.50 and 51).
4. Turn over the engine a few times without load or connect an 80÷100W lamp load across the battery to restrict voltage to lower than 13V.
5. Accelerate the engine to 3000 rpm. The current shown by the ammeter must be in line with the values indicated in figure 52.
6. Disconnect the load from the battery (if it was previously connected) and keep the engine running at the above indicated speed for a few minutes, the battery voltage should slowly increase until it reaches approximately 14.2V. At the same time the charge current should drop to around 2A in a period of time that depends on whether the battery is fully charged or not.
7. If the charging current is absent or is lower than the value indicated above, proceed by checking the alternator and if necessary, renewing the voltage regulator.

**Checking the alternator**

Check:

1. with motor stopped: the continuity of the windings (fig.53) by connecting an ohmmeter and ensuring that resistance is zero, and the insulation between the windings and ground (fig. 54) by ensuring that the ohmmeter gives a reading of infinite resistance. If these readings are not obtained the stator must be renewed.
2. with motor running: use a multimeter to check the charge current between the two yellow wires. Bring the engine up to 3000 rpm - the multimeter should give a reading of 35V. If the values are more than 10V below this value, the rotor is de-magnetized and the alternator must be renewed.



**Important**

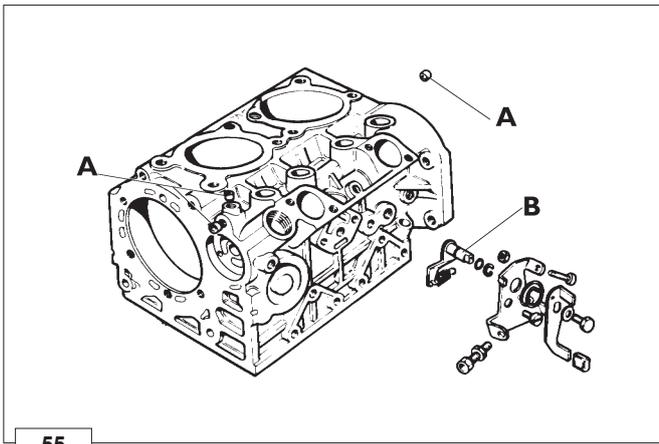
1. The alternator will not deliver current when the yellow wires are disconnected.
2. The alternator will burn out if the yellow wires are connected to ground.
3. The voltage regulator may be damaged if the ground connection or other circuit connections are not made properly.
4. The alternator and the voltage regulator will burn out instantly if the battery connections are inverted.

## RECOMMENDATIONS FOR ASSEMBLING

- The instructions are provided in a sequential way, following a practical and chronological order. The working methods have been selected, tested and approved by the Manufacturer's technicians.
- This chapter describes all the installation procedures for assemblies and /or single components after overhauling, testing and, if necessary, replacement using original spare parts.

**Important**

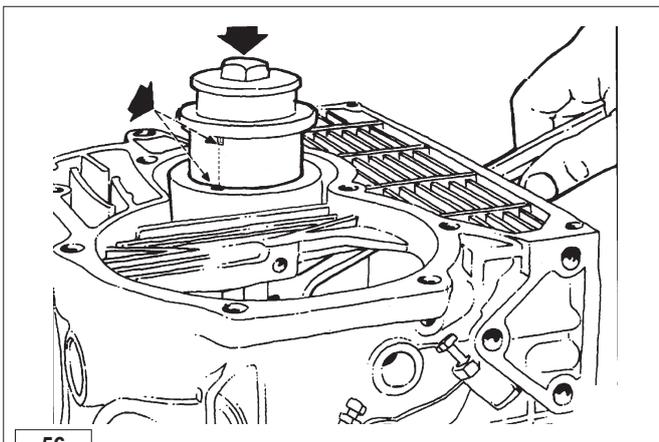
- To locate specific topics, the reader should refer to the index.
- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- 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.
- In order to operate safely and easily, we recommend positioning the engine on a rotating stand for engine overhauling.
- 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 correctly, the operator must tighten the fastening elements in a criss-cross or alternating pattern.
- For assemblies and/or components having a prescribed tightening torque, first tighten to a lower torque, then carry out the final torque to the prescribed value.



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**⚠ Important**

- Notice: These instructions are valid for engines up-dated prior to the publication of this manual. Any modifications must be checked on the technical circulars.
- Before assembling the engine carefully clean all parts and dry them with compressed air. Lubricate moving parts to prevent seizing when starting up. Replace the gaskets with new ones each time the engine is assembled.
- Use torque wrenches to ensure that the correct tightening torques are applied.

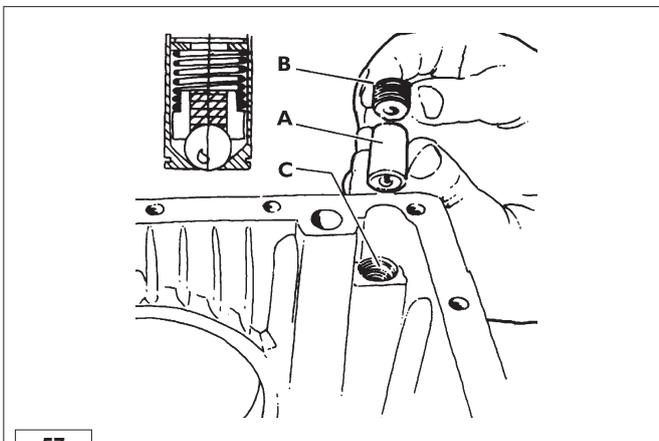


56

**Preparing the crankcase**

Clean the mating surfaces of sealing compound residues or other foreign material using a copper scraper or fine emery stone. Make sure that the oil passages are open and free of built-up deposits.

1. Fit the plugs (A, fig.55) in their holes.
2. Insert the internal accelerator lever (B, fig.55) into the crankcase with its spring taking care to protect the oil seal O-ring from damage. Complete the external assembly with plate, spring, lever, etc. as shown in figure 55.
3. Mount the bearing bush (gear train side) using either a standard press or a made-to-measure punch as shown in figure 56. Fit the bush by matching the hole with the passage on the crankcase. Bushes with standard or smaller internal diameters can be ordered as required.
4. Insert the complete oil pressure relief valve (A, fig. 57) into its housing (C, fig.57). Make sure that the valve ball seat is free of dirt that could reduce the effectiveness of the pressure seal. Secure the oil pressure valve with the relative screw (B, fig. 57).
5. Insert the cylinder studs and the centring pins.



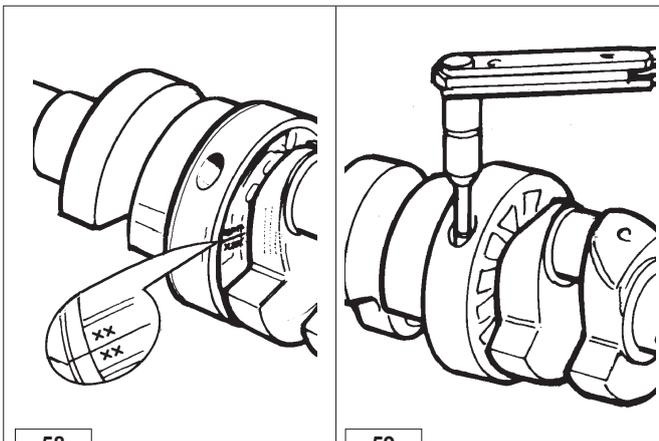
57

**⚠ Important**

- A warped oil retainer may allow the introduction of air into the engine thus causing crankcase ventilation problems.
- Use genuine oil retainers

**Central main bearings**

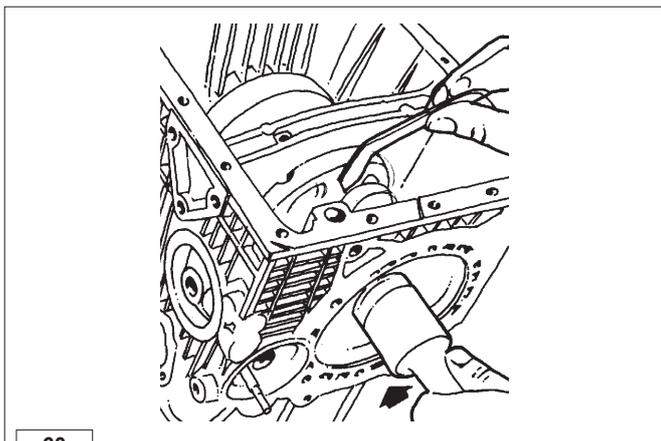
Fit the shells into their seats and coat with a thin film of oil. The reference numbers (fig.58) must be aligned on each half-shell, making sure that the oil passages match the corresponding openings in the crankcase. Torque the bearing assembly bolts (fig. 59) to:



58

59

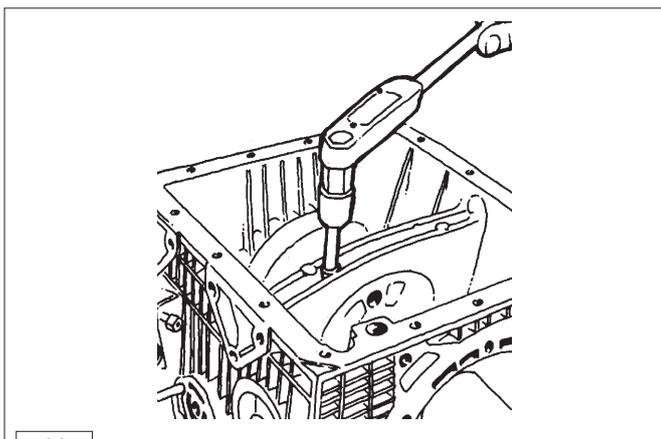
kgm 2,2 (Nm 21,6)



60

**Crankshaft**

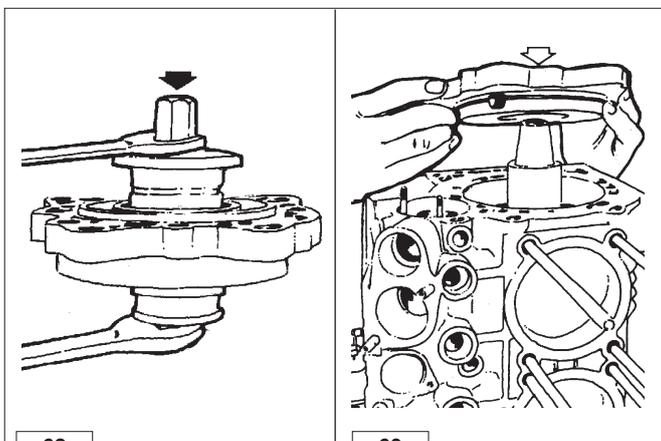
Fit the crankshaft into the crankcase using tool p.n. 00365R0910 as shown in figure 60; make sure that the bearing oil passages are matched to the crankcase oil passages.



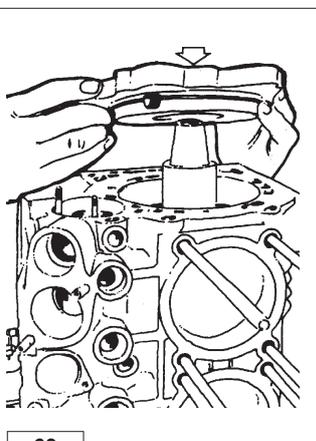
61

Torque the bearing screws (fig. 61) to :

**kgm 2,2 (Nm 21,6)**



62



63

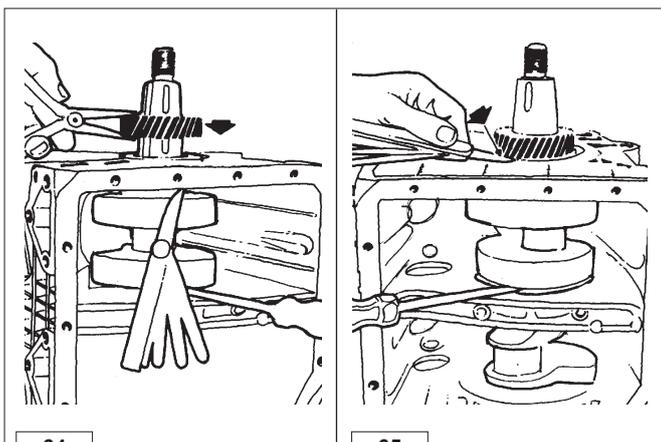
**Main bearings - flywheel side**

Fit the bush to the bearing carrier using a special tool of appropriate diameter as shown in figure 62. Insert the bush arranging the groove so that it is facing the internal side of the bearing and positioned vertically.

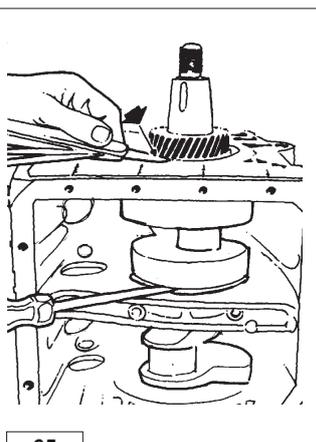
Fit the oil seal ring to the bearing using a suitable diameter tubular punch.

Fit the bearing into the crankcase after having first interposed an O-ring between the contact surfaces (fig. 63). Torque the screws to:

**kgm 2,2 ÷ 2,4 (Nm 21,6 ÷ 23,5)**



64



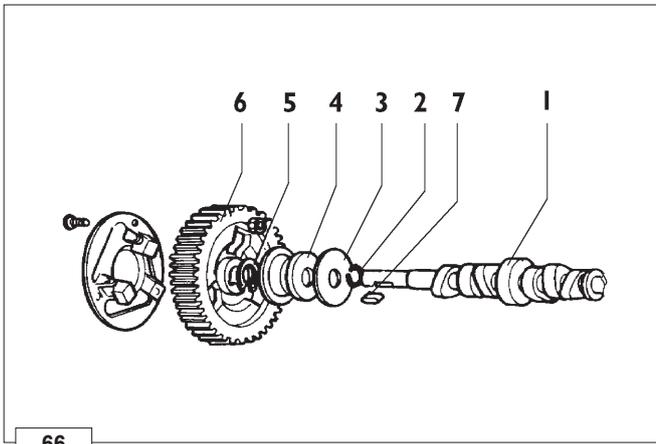
65

**Crankshaft end float**

Install an 0.15 mm feeler gauge between the crankshaft shoulder and the crankcase (flywheel side).

Use a screwdriver to force the crankshaft against its shoulder as shown in figure 64. Pre-heat the timing gear to a temperature of 180 ÷ 200 °C and fit it onto the crankshaft pressing it down until it comes into contact with the crankcase. Wait until the timing gear has cooled down and then withdraw the feeler gauge and the screwdriver and check end float (fig. 65), which must be within the range:

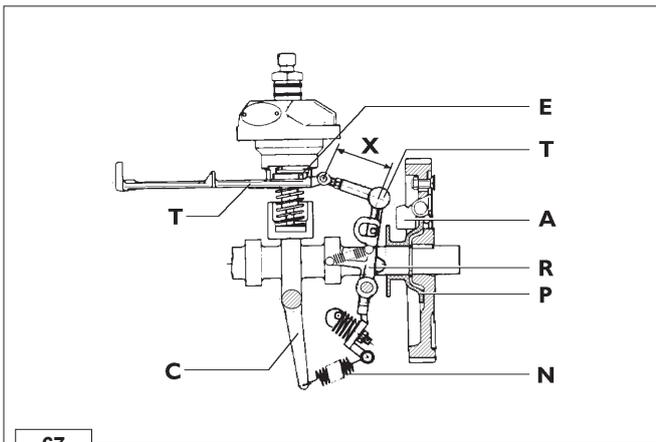
**0,10 ÷ 0,20 mm**  
**0,20 ÷ 0,30 mm (cast iron crankcase)**



**Camshaft**

Prepare the camshaft assembly (fig.66) as described below:

1. Fit adjustment shim (nr. 3) and governor washer (nr. 4) onto the camshaft.
2. Fit snap ring (nr. 5) and key (nr. 7) into their respective seats.
3. Preheat (180 ÷ 200 °C) gear (nr. 6) complete with flyweights and mount it to the camshaft, making sure that it is snugly fitted against the retaining ring.
4. Insert the governor driving plate retaining ring (nr. 2).

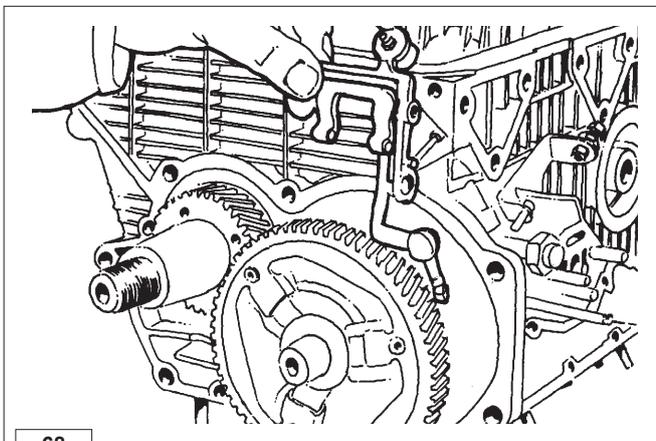


The speed governor is of the centrifugal type with flyweights keyed directly onto the end of the camshaft gear (fig.67).

Flyweights (A) impelled outward by centrifugal force, cause a moving plate (P) to shift axially. The plate operates a lever (R) which is connected, through tie rods (T) to the control sleeves (E) of the injection pumps.

Spring (N) placed under tension by speed control lever (C), contrasts the action of the centrifugal force of the governor.

The balance between the two forces keeps the engine speed virtually constant with respect to load variations.



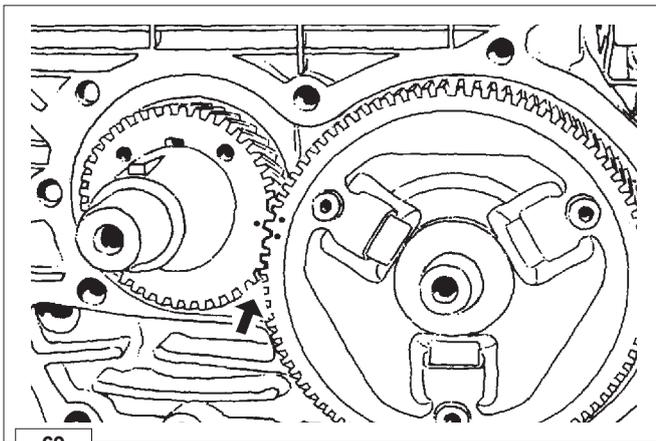
**Governor tie rod adjustment**

The length of the tie rod, measured between the centredistance of holes (X, fig. 67), must be:

mm 36,5 ± 1 turn

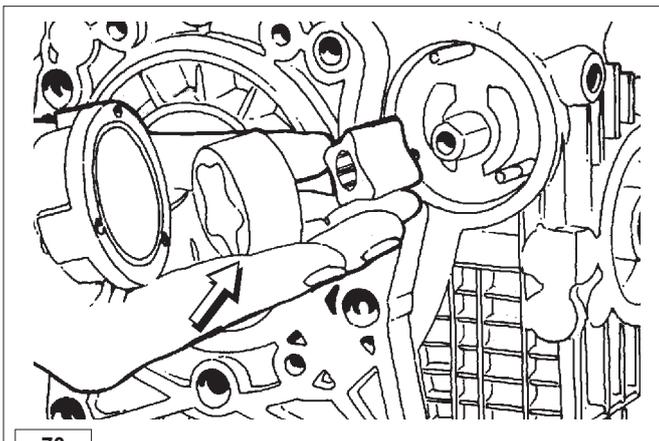
**⚠ Important**

- The accuracy of this setting will serve to eliminate hunting of engine speed, difficulty in starting, and power fall-off.



**Assembly**

1. Fit the tappets into their housings in the crankcase
2. Fit the governor lever and tie rod, simultaneously with the camshaft, into the crankcase (fig.68)
3. Insert the governor lever fulcrum pin from the outside of the crankcase and secure it with the relative screw (fig.68). The lever must be free to effect its full stroke without sticking.
4. Insert the spring between the governor lever and the accelerator, making sure that it is correctly installed.
5. Check that the timing marks on the camshaft and crankshaft gears are correctly aligned with respect to each other (fig. 69).



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### Oil pump

See pag. 25 if you wish to check the rotors.

Fit the external oil pump rotor with the bevel toward the inside of the cover (fig.70).

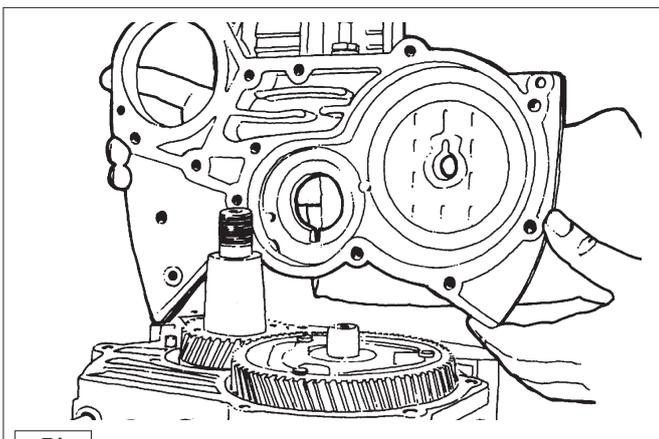
Torque the bolts to:

**kgm 0,5 ÷ 0,6 (Nm 4,9 ÷ 5,9)**



### Important

- It is good practice to fill the oil suction pipe in order to aid pump priming when the engine is started up for the first time.



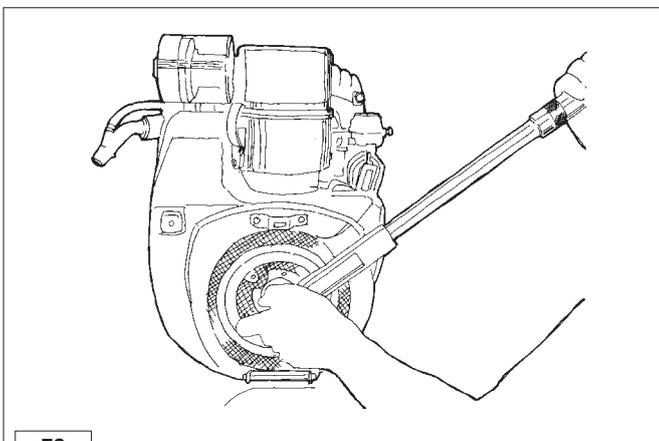
71

### Timing cover

Check that the timing markeson the camshaft and crankshaft gears are aligned (fig.69).

Fit the oil seal onto the cover using a normal tubular punch of appropriate diameter. Mount the cover to the crankcase (fig.71) after first inserting a gasket between the mating surfaces; tighten the screws to:

**kgm 2,2 ÷ 2,4 (Nm 21,6 ÷ 23,8)**

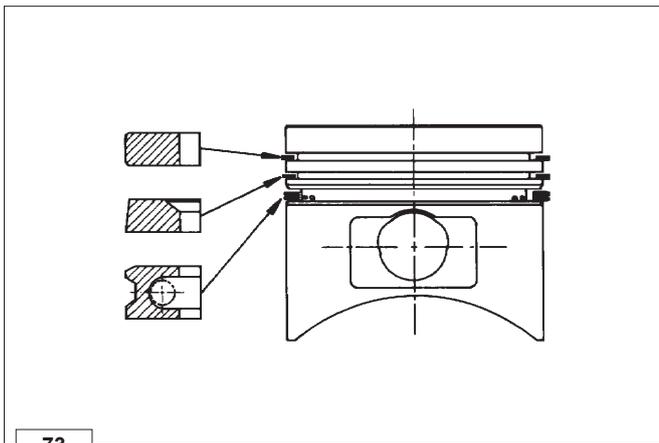


72

### Pulley and flywheel

Tighten the pulley and flywheel nut (fig.72) to:

**kgm 18 ÷ 22 (Nm 176,5 ÷ 215,7)**



73

**Pistons**

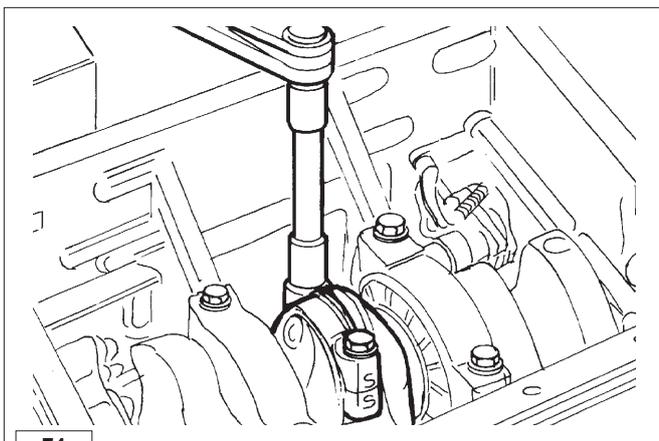
**⚠ Important**

- Lubricate the following parts with oil before mounting: the piston pin, the piston, the cylinder and the big-end bearing

Fit the piston rings onto the pistons (fig.73) in the following order:

1. Chromed compression ring
2. Torsional compression ring (with internal bevel facing upward)
3. Expander oil scraper ring (external bevel facing upward).

Install the piston to the connecting rod, by pushing the wrist pin in, without heading the piston.



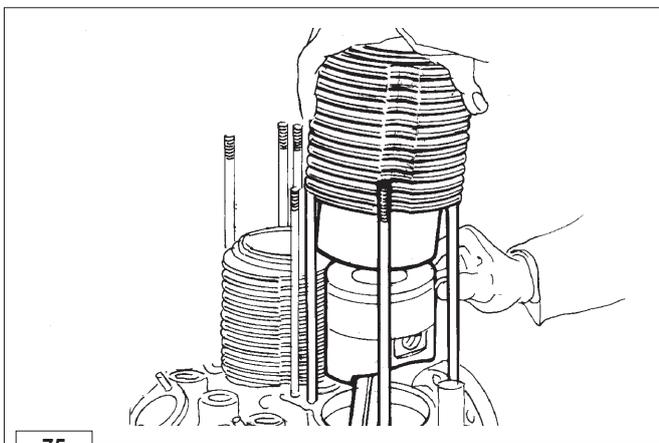
74

**Connecting rods**

After having fitted the bearings into the big ends mount the connecting rods to the crank journals pins; note that the pistons are marked with an arrow showing the direction of rotation of the engine. The combustion chamber, which is offset with respect to the central axis of the piston, must be turned to face the injector nozzle side. Mount the connecting rod big end cap ensuring that the reference numbers are aligned with those punched on the connecting rod itself (fig.74). Torque the bolts to:

**kgm 3,6 ÷ 3,8 (Nm 35,3 ÷ 37,3)**

Now fit the oil pan after first inserting the appropriate gasket between the facing surfaces.



75

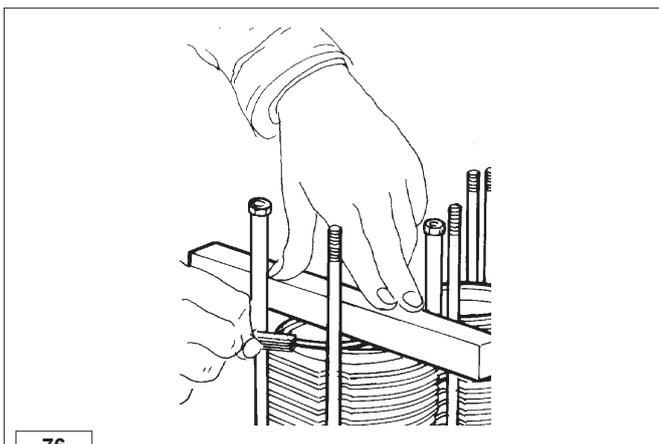
**Cylinders**

Before fitting the cylinders turn the piston rings so that the end gaps are arranged at intervals of 120° with the end gap of the first compression ring aligned with the axis of the wrist pin. The lower face of the cylinders are chamfered to permit the easy insertion of the piston rings. The operation can be simplified, however, using a normal piston ring compressor (p.n. 00365R0770) as shown in figure 75.

Mount the cylinders to the crankcase as shown in figure 76 and then bring the pistons up to their respective TDC (top dead centre) positions. The following must now be checked:

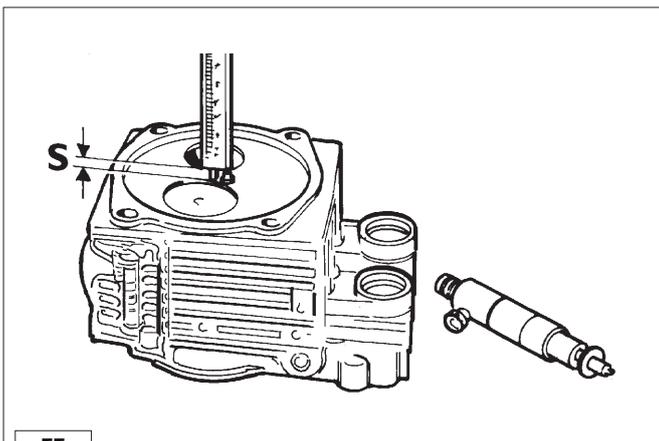
1. that the dots punched on the flywheel (TDC) correspond to the reference mark on the flywheel-housing
2. that the pistons protrude over the top surface of the cylinders (fig.76) by a distance of:

**0,10 ÷ 0,20 mm**



76

This distance is adjusted with special shims that are inserted between the bottom surface of the cylinder and the crankcase 0.1 - 0.2 - 0.3 mm.



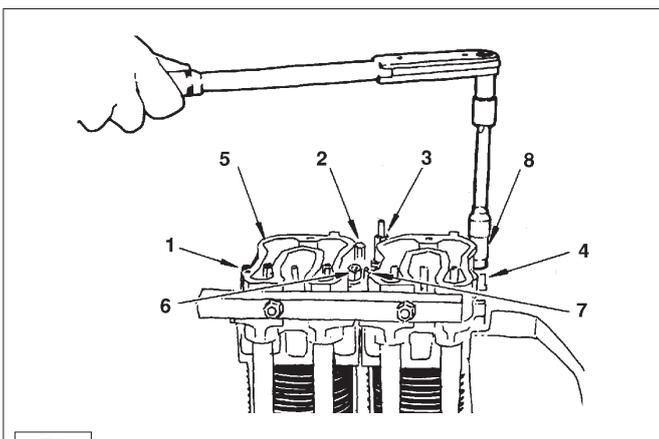
77

### Checking injector protrusion

Before mounting the heads to the cylinders fit the injectors into their housings and, after having secured them temporarily, check the protrusion of the nozzles from the head faces (fig.77). Protrusion **S** should be:

**1,75 ÷ 2,25 mm**

This value is adjusted by inserting copper washers between the injectors and the injector supporting faces on the heads (fig. 77).



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### Cylinder heads

For checking and overhaul of the cylinder heads refer to page 19.

Fit the push rods and oil sealing O-rings on the cover pipes and proceed to install the cylinder heads with the relative gaskets on the facing surfaces.



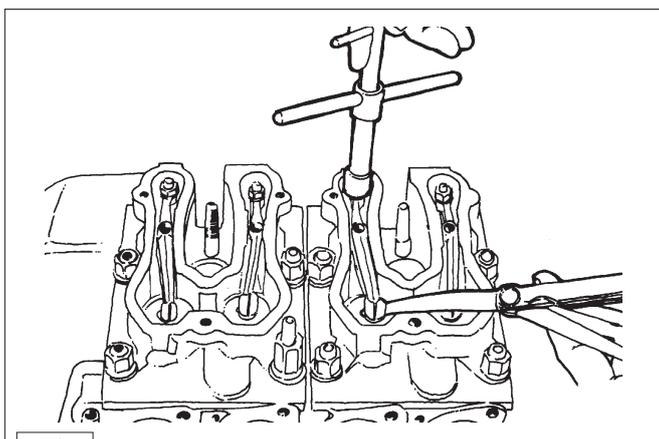
#### Important

- Make sure that the oil seal rings are correctly seated in the heads to avoid the risk of oil leaks.

Align the heads using a metal bar or the exhaust manifold (fig.78).

Following a cross pattern tighten the head nuts (fig.78) in increments of 1 kgm until you reach the value:

**4 kgm (Nm 39,2)**



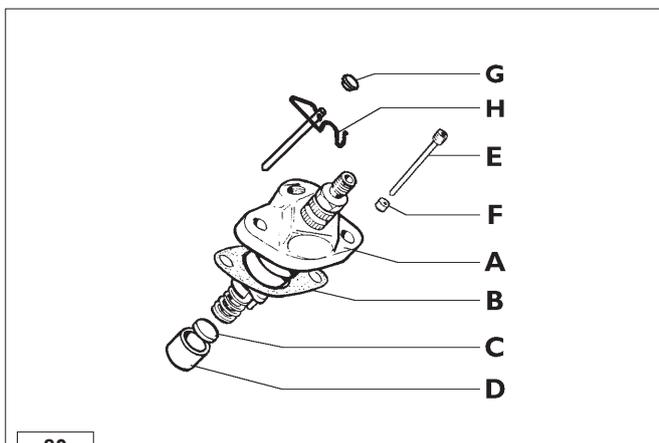
79

### Valve clearance

The clearance between valves and rockers with the engine cold (fig.79) is:

**0,15 mm  
intake/exhaust**

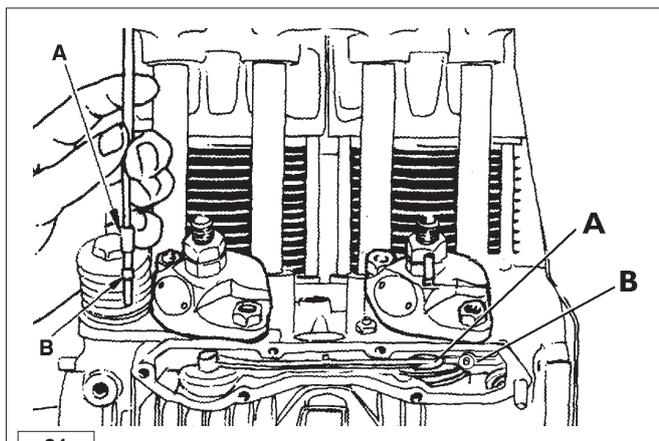
This clearance is to be adjusted with the pistons at their respective TDC compression positions.



80

**Injection pumps**

1. Insert the injection pump tappet (D) and spacer (C) into the housings in the crankcase (fig.80).
2. Assemble the injection pumps (A fig. 80) on the crankcase and secure them on the adjustment sleeve by means of the appropriate pins (E or H fig. 80) on PF30 BOSCH pumps. Then, place the advance adjustment shims (B, fig. 80) between the crankcase and the pump.
3. Fix the injection pump connection rod (A, fig.81) to the speed governor lever tie rod (B, fig.81)
4. Secure the injection pumps to the crankcase, taking care to turn the first injection pump around through approximately 3/4 of a turn in a clockwise direction.



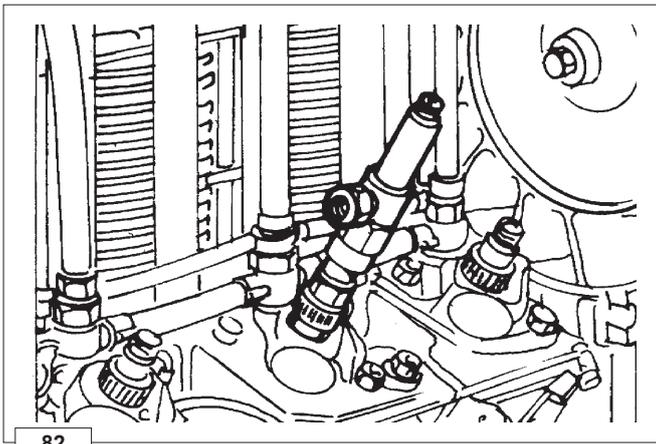
81

5. Release the control sleeves:
  - on the traditional pumps by loosening the pins (E, fig.80) and inserting the appropriate distance collars (F, fig.80).
  - on the BOSCH type PF30 pumps by removing the pins (H, fig.80) and closing the hole on the pump body using plug G.



**Important**

- injection pumps should be released only after they have been connected to the governor tie rod and secured to the crankcase. If one or both pumps must be changed, in order to guarantee the same fuel delivery for each pump the pump remaining on the crankcase must be locked using the pins (E or H, fig.80). Alternatively the above steps must be performed in their entirety.



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## Injection check

1. Connect the fuel tank to the injection pumps.
2. Set the speed control lever to Max. (fig.83) and the piston to the start of compression (cylinder nr. 1 on timing gear side).
3. To eliminate the injection delay caused by the milling on the pumping elements, bring the injection pump connection rod (A, fig.81) to a position mid-way between minimum and maximum.
4. Fit the special tool, p.n. 00365R0940, to the delivery valve holder (timing case side) as shown in figure 82.
5. Turn the flywheel slowly until the column of diesel fuel inside the special tool starts to move. This indicates the start of static injection.

For variable advance pumps, the reference mark on the flange bell (fig.85) must match the intermediate point (\*) between TDC and "IP" (start of dynamic injection) punched onto the flywheel. On traditional pumps the static start of injection (\*) is the same as the start of dynamic injection (IP).

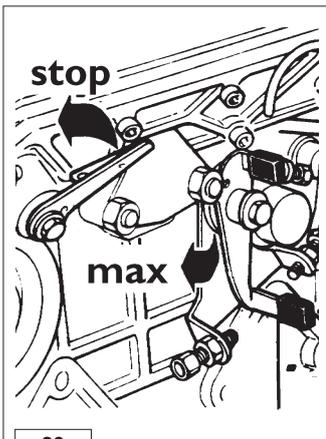
Should the reference mark (\* or IP) fall short of the notch on the flange bell, this indicates that injection is too advanced so that the injection pump must be removed and then reassembled with shims (gaskets) between the pump and the crankcase (fig.84).

Should the reference mark (\* or IP) fall after the TDC reference mark, this indicates that injection is too retarded. In this case proceed as above but this time removing shims.

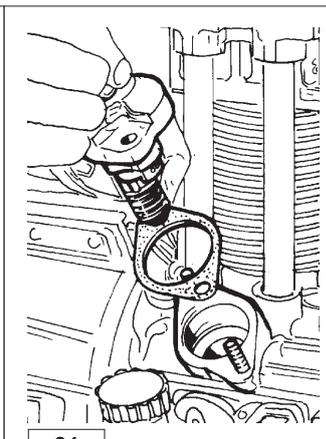
Now repeat the injection timing check for all injection pumps. Note that every 0.1mm shim inserted beneath the pump corresponds to 2.75mm rotation of the flywheel.

Should the flywheel need changing, determine TDC and mark the start of static and dynamic injection as shown in the table:

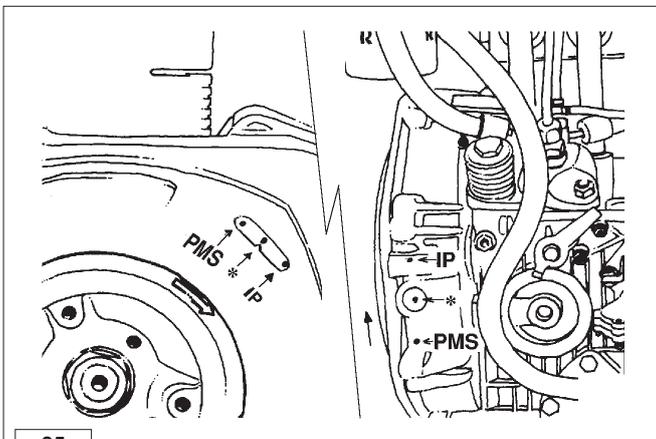
Version	I.P.	(*)
standard	22° = 44 mm	17° = 34 mm
whisper quiet	20° = 40 mm	12° = 24 mm



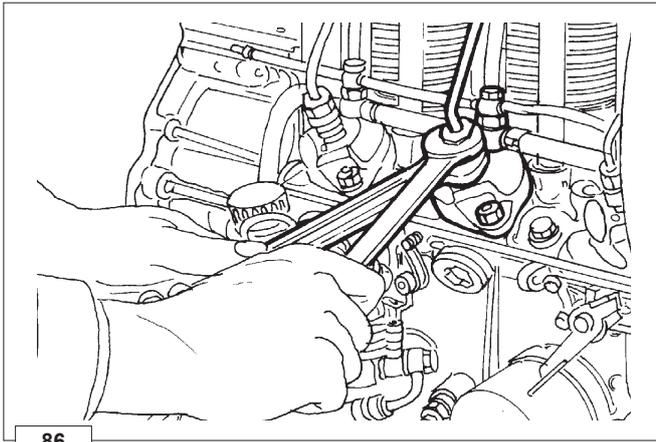
83



84



85



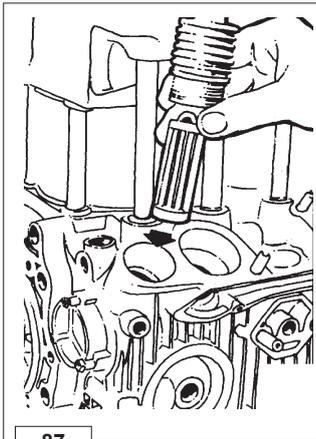
86

**Injectors and injector pipes**

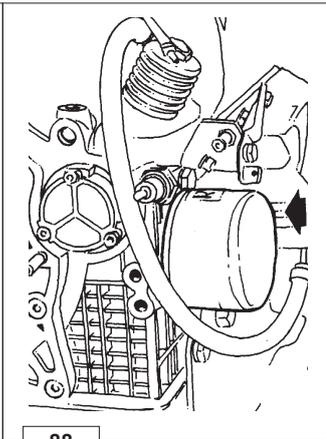
Mount injectors to heads placing copper gaskets in between (see pag. 36).  
Connect the injectors to the pumps by way of the injection lines.

**⚠ Important**

- Important: always use two wrenches to loosen or tighten the unions on the injector pipes (fig.86) thereby ensuring that the position of the delivery valve holder on the pumps is not changed (see pag.33).



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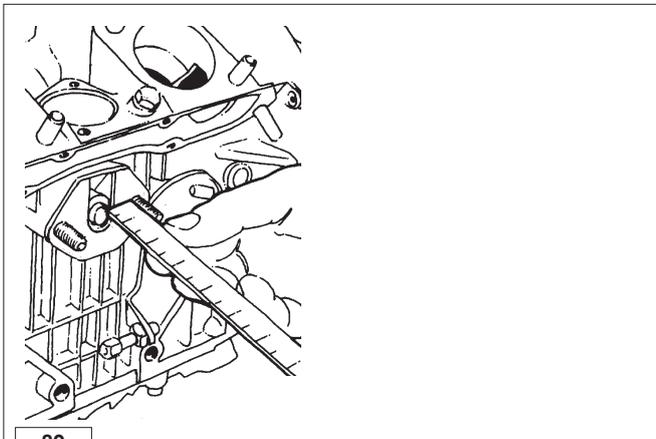


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**Oil filter**

Fit the mesh type oil filter cartridge into the crankcase (fig.87) and check that the rubber seals and the O-ring on the cover are in good condition.

On request, engines can mount an external filter cartridge that can be screwed onto the crankcase (fig.88). Oil the seal before assembly.



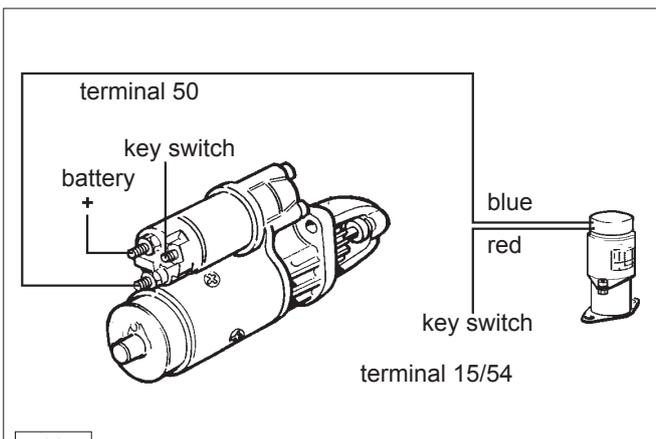
89

**Feed pump**

1. Insert the fuel feed pump tappet into its housing and make sure that it moves freely.
2. Fit the 0.2 and 1mm adjustment gaskets.
3. With the fuel pump excenter in rest position the tappet should protrude from the gasket surface (fig. 89) by:

1,3 ÷ 1,7 mm

4. With the fuel feed pump cam in the rest position mount the pump and actuate it manually .



90

**Electric shut off**

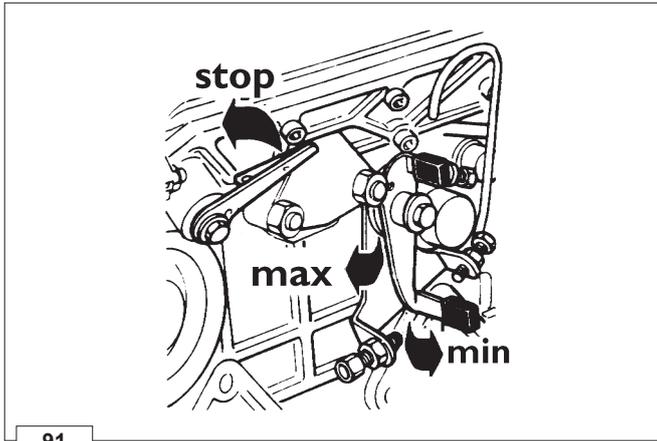
If the engine is equipped with an electric shut off, insert the electro-magnet into the crankcase taking care to position the engine shut-off lever in the STOP position; make sure that the injection pump connection lever moves freely along its entire stroke.

Make the electrical connections as shown in diagram 90.

**Speed adjustment (fig.91)**

When the engine is hot set idle speed at 1000 rpm and maximum no-load speed at:

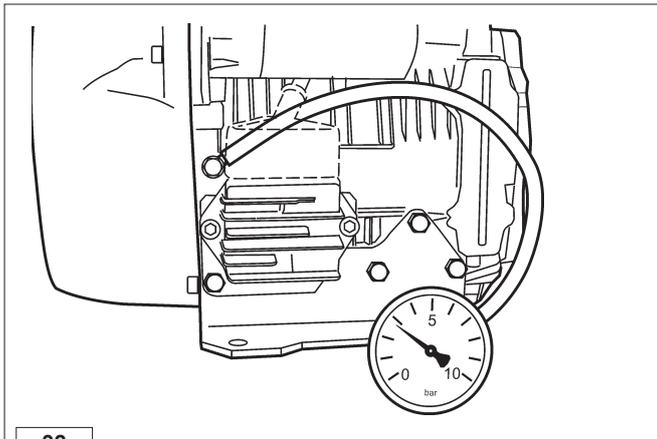
3750 rpm      for engines at 3600 rpm



91

**Checking oil pressure**

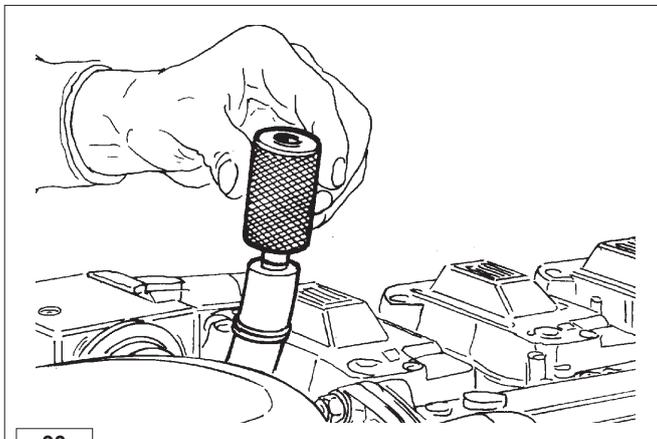
1. Remove the bolt from the hole in the crankcase and fit a pressure gauge with 0 to 10 kg/cm<sup>2</sup> full scale (fig.92)
2. Start the engine, accelerate to 3000 rpm and wait for the oil to reach a temperature of 70 to 80°C.
3. The pressure reading must be between 2.5 and 4 kg/cm<sup>2</sup>.
4. Reduce engine speed to minimum; the pressure should not fall below 1 ÷ 1.5 Kg/cm<sup>2</sup> with oil temperature of 80°C.



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**Checking for oil leaks**

1. Remove the exhaust gas collection pipe from the inlet manifold and close the connection with a plug (fig.93).
2. Start the engine and let it run for a few minutes. The high pressure generated in the crankcase will show up any oil leaks.
3. Reconnect the exhaust gas collection pipe to the inlet manifold.

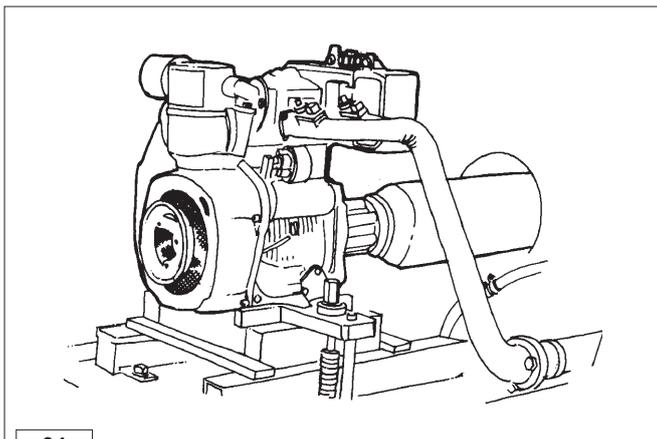


93

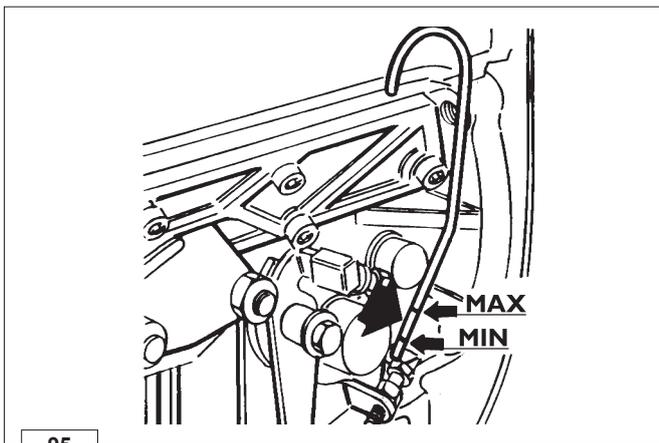
**Dyno testing of engine**

After you have placed the engine on the brake (fig.94) perform the following:

1. Check the oil level (fig.95).
2. Start the engine and let it idle.
3. Check the oil pressure on the pressure gauge (fig.92)
4. Run in engine before testing it at full power.



94

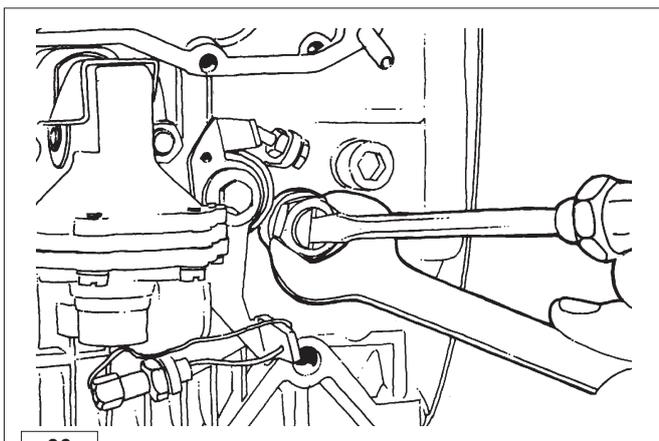


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Running-in table

Time (min)	RPM	Load
5	2000	0
15	3000/3600	0
30	"	30 %
30	"	50 %
30	"	70 %
5	"	100 %

Engine power curves are reported at page 17.



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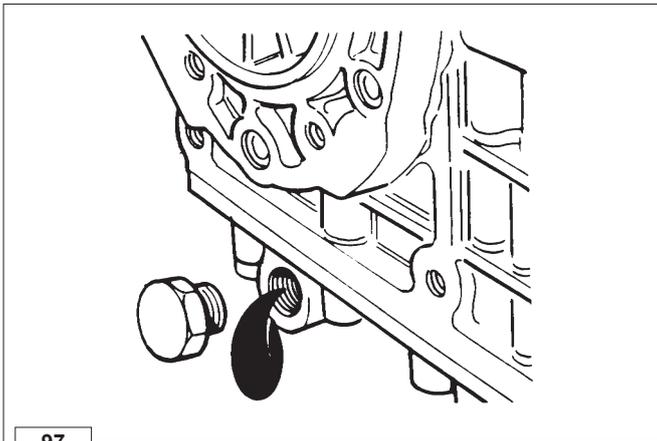
**i** Important

- In order to check that the setting is correct, without tools, accelerate the engine a few times with no load and check the exhaust fumes.
- Delivery of diesel fuel is correctly calibrated when the exhaust gas is slightly coloured by smoke; change the adjustment if necessary by turning the adjustment screw (fig.96).

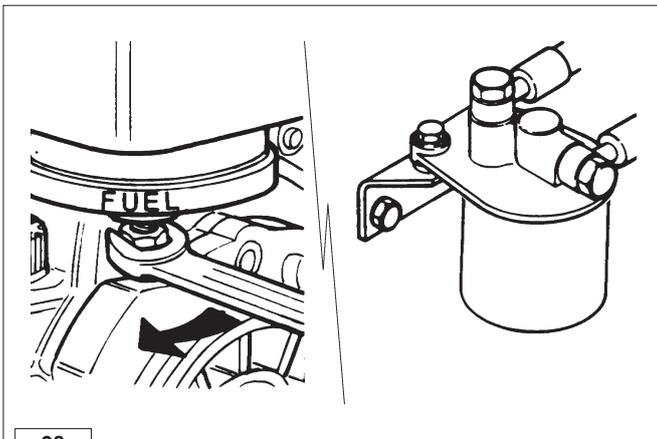
Prepare engines as follows for storage over 3 months:

#### Storage

- Let engine run at idling speed in no-load conditions for 15 minutes.
- Fill crankcase with protection oil MIL-1-644-P9 and let engine run at 3/4 full speed for 5/10 minutes.
- When engine is warm empty oil pan and fill with standard new oil (fig. 97)
- Remove fuel tube and empty the tank
- Remove fuel filter, replace cartridge if dirty and refit (fig. 98).
- Carefully clean cylinder fins, heads and fan.
- Seal all openings with tape.
- Remove injectors, pour a spoonful of oil type SAE 30 into the cylinders and rotate manually to distribute the oil. Refit injectors.
- Spray oil type SAE 10W into exhaust and intake manifolds, rocker arms, valves, tappet etc. Grease all unpainted parts.
- Loosen belt
- Wrap the engine in a plastic film.
- Store in a dry place, if possible not directly on the soil and far from high voltage electric lines.
- For the lubrication and injection system as well as for moving parts use rustproof oil type MIL-L-21260 P10 grade 2, SAE 30 (Ex. ESSO RUST - BAN 623 - AGIP, RUSTIA C. SAE 30) Let the engine run with rustproof oil and drain any excess.
- Coat external unpainted surfaces with antirust type MIL-C-16173D - grade 3 /Ex. ESSO RUST BAN 398 - AGIP, RUSTIA 100/F).



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#### How to prepare the engine for operation

- Clean engine outside
- Remove protections and covers
- Remove antirust with an appropriate solvent or degreaser.
- Remove injector, fill with standard oil, turn crankshaft by a few revolutions, remove oil pan and drain the protective oil.

For reference check the specific tools manual, cod. ED0053030770-S, to be found at:

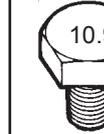
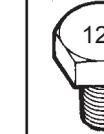
<http://iservice.lombardini.it>

Couplings	Spiel (mm)	Grezen (mm)
Camshaft and central bearings (aluminum crankcase)	0,070 ÷ 0,105	0,2
Camshaft and central bearings (cast iron crankcase)	0,040 ÷ 0,075	0,2
Camshaft and flywheel side bearing	0,025 ÷ 0,075	0,2
End gap of compression rings	0,30 ÷ 0,50	0,8
End gap of oil scraper rings	0,25 ÷ 0,50	0,8
Connecting rod and wrist pin	0,023 ÷ 0,038	0,07
Rocker arm and pin	0,03 ÷ 0,06	0,15
Fuel pump push rod and housing	0,05 ÷ 0,098	0,12
Injection pump tappets and housing	0,020 ÷ 0,059	0,1
Tappets and housings	0,07 ÷ 0,041	0,1
Oil pump rotor and housing	0,27 ÷ 0,47	0,6
Pistons and wrist pin	0,003 ÷ 0,013	0,05
Inlet valve guide to stem	0,030 ÷ 0,050	0,1
Exhaust valve guide to stem	0,045 ÷ 0,065	0,1

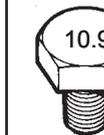
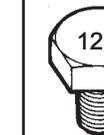
Adjustments	MIN (mm)	MAX (mm)
Crankshaft end float	0,10 ÷ 0,20	0,2
Rocker arm end float	0,05 ÷ 0,130	0,5
Valve clearance	0,15	0,15
Valve depth from cylinder head	0,8 ÷ 1,0	1,3
Injector protrusion	1,75 ÷ 2,25	2,25
Piston protrusion	0,10 ÷ 0,20	0,2

Tightening torques	kgm	(Nm)
Big ends	3,6 ÷ 3,8	(35,3 ÷ 37,3)
Timing cover	2,2 ÷ 2,4	(21,6 ÷ 23,5)
Injector ring nut	3,5	(34,3)
Injectors	2 ÷ 2,3	(19,6 ÷ 22,6)
Injection pump	2 ÷ 2,3	(19,6 ÷ 22,6)
Oil pump	0,5 ÷ 0,6	(4,9 ÷ 5,9)
Injection pump connection	4,5 ÷ 5	(44,1 ÷ 49)
Central bearing halfshells	2,2	(21,6)
Central main bearings	2,2	(21,6)
Main engine bearings - flywheel side	2,2 ÷ 2,4	(21,6 ÷ 23,5)
Cylinder heads	4	(39,2)
Injection pipe	1,5 ÷ 2,5	(14,7 ÷ 24,5)
Flywheel	18 ÷ 22	(176,5 ÷ 215,7)

**Table of tightening torques for standard screws (coarse thread)**

Resistance class (R)								
Quality/ Dimensions								
Diameter	R>400N/mm <sup>2</sup>		R>500N/mm <sup>2</sup>		R>600N/mm <sup>2</sup>	R>800N/mm <sup>2</sup>	R>1000N/mm <sup>2</sup>	R>1200N/mm <sup>2</sup>
	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

**Table of tightening torques for standard screws (fine thread)**

Resistance class (R)								
Quality/ Dimensions								
Diameter	R>400N/mm <sup>2</sup>		R>500N/mm <sup>2</sup>		R>600N/mm <sup>2</sup>	R>800N/mm <sup>2</sup>	R>1000N/mm <sup>2</sup>	R>1200N/mm <sup>2</sup>
	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





## **KOHLER** Engines

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