# WORK SHOP MANUAL

**15LD series engines, p.no. 1-5302-467**

# 15 LD 225
# 15 LD 315
# 15 LD 350
# 15 LD 400
# 15 LD 440

**6th Edition**

SERVICE

LOMBARDINI

## FOREWORD

We have done all in our power to give up to date and accurate technical information in this manual. Lombardini engines are, however, constantly developing thus the data in this publication may be liable to modification without prior notice.



The information in this manual is given on the assumption that:

1- the persons who service Lombardini engines have been adequately trained and outfitted to safely and professionally carry out the necessary tasks;

2- the persons who service Lombardini engines possess the necessary skills and special Lombardini tools to safely and professionally carry out the necessary tasks;

3- the persons who service Lombardini engines have read the specific information concerning the above mentioned Service operations and that they have clearly understood the operations required.

## GENERAL SERVICE NOTES

1 - Only use genuine Lombardini spare parts. Use of spurious spares may lead to incorrect performance and shorten the life of the engines.
2 - The metric system is used to express all data, i.e. the dimensions are given in millimeters (mm), torque is expressed in Newton-meters (Nm), weight in kilograms (Kg), volume in liters or cubic centimeters (cc) and pressure in barometric units (bar).

LOMBARDINI
SERVICE

# WARRANTY CERTIFICATE

The products manufactured by Lombardini Srl are warranted to be free from conformity defects for a period of 24 months from the date of delivery to the first end user.
For engines fitted to stationary equipment, working at constant load and at constant and/or slightly variable speed within the setting limits, the warranty covers a period up to a limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
If no hour-meter is fitted , 12 working hours per calendar day will be considered.
For what concerns the parts subject to wear and deterioration (injection/feeding system, electrical system, cooling system, sealing parts, non-metallic pipes, belts) warranty covers a maximum limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
For correct maintenance and replacement of these parts, it is necessary to follow the instructions reported in the documentation supplied with each engine.
To ensure the engine warranty is valid, the engine installation, considering the product technical features, must be carried out by qualified personnel only.
The list of the Lombardini authorized dealers is reported in the "Service" booklet, supplied with each engine.
Special applications involving considerable modifications to the cooling/lubricating system (for ex.: dry oil sump), filtering system, turbo-charged models, will require special written warranty agreements.
Within the above stated periods Lombardini Srl directly or through its authorized network will repair and/or replace free of charge any own part or component that, upon examination by Lombardini or by an authorized Lombardini agent, is found to be defective in conformity, workmanship or materials.
Any other responsibility/obligation for different expenses, damages and direct/indirect losses deriving from the engine use or from both the total or partial impossibility of use, is excluded.
The repair or replacement of any component will not extend or renew the warranty period.

Lombardini warranty obligations here above described will be cancelled if:

- Lombardini engines are not correctly installed and as a consequence the correct functional parameters are not respected and altered.
- Lombardini engines are not used according to the instructions reported in the "Use and Maintenance" booklet supplied with each engine.
- Any seal affixed to the engine by Lombardini has been tampered with or removed.
- Spare parts used are not original Lombardini.
- Feeding and injection systems are damaged by unauthorized or poor quality fuel types.
- Electrical system failure is due to components, connected to this system, which are not supplied or installed by Lombardini.
- Engines have been disassembled, repaired or altered by any part other than an authorized Lombardini agent.

Following expiration of the above stated warranty periods and working hours, Lombardini will have no further responsibility for warranty and will consider its here above mentioned obligations for warranty complete.
Any warranty request related to a non-conformity of the product must be addressed to the Lombardini Srl service agents.

# INDEX

This manual contains pertinent information regarding the repair of LOMBARDINI water-cooled, indirect injection Diesel engines type **15LD225, 15LD315, 15LD350, 15LD400, 15LD440:** updated November 15, 2003.

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## POSSIBLE CAUSES AND TROUBLE SHOOTING

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 | ● | | | | | | | | | |
| MAINTE-NANCE | 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 | ● | | | | | | | | | |

# SAFETY AND WARNING DECALS

| DANGER | CAUTION |
|---|---|
| **Failure to comply with the instructions could result in damage to persons and property** | **Failure to comply with the instructions could lead to technical damage to the machine and/or system** |

## SAFETY INSTRUCTIONS

- Lombardini Engines are built to supply their performances in a safe and long-lasting way. To obtain these results, it is essential for users to comply with the servicing instructions given in the relative manual along with the safety recommendations listed below.
- The engine has been made according to a machine manufacturer's specifications and all actions required to meet the essential safety and health safeguarding requisites have been taken, as prescribed by the current laws in merit. All uses of the engine beyond those specifically established cannot therefore be considered as conforming to the use defined by Lombardini which thus declines all liability for any accidents deriving from such operations.
- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation in particular, along with the relative routine maintenance work.
- The user must read these instructions carefully and become familiar with the operations described. Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- The engine may only be used or assembled on a machine by technicians who are adequately trained about its operation and the deriving dangers. This condition is also essential when it comes to routine and, above all, extraordinary maintenance operations which, in the latter case, must only be carried out by persons specifically trained by Lombardini and who work in compliance with the existing documentation.
- Variations to the functional parameters of the engine, adjustments to the fuel flow rate and rotation speed, removal of seals, demounting and refitting of parts not described in the operation and maintenance manual by unauthorized personnel shall relieve Lombardini from all and every liability for deriving accidents or for failure to comply with the laws in merit.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ. In the case of manual start-ups, make sure that the relative actions can take place without the risk of hitting walls or dangerous objects, also considering the movements made by the operator. Pull-starting with a free cord (thus excluding self-winding starting only), is not permitted even in an emergency.
- Make sure that the machine is stable to prevent the risk of overturning.
- Become familiar with how to adjust the rotation speed and stop the engine.
- Never start the engine in a closed place or where there is insufficient ventilation. Combustion creates carbon monoxide, an odourless and highly poisonous gas. Lengthy stays in places where the engine freely exhausts this gas can lead to unconsciousness and death.

- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unles specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Fuel is inflammable. The tank must only be filled when the engine is off. Thoroughly dry any spilt fuel and move the fuel container away along with any rags soaked in fuel or oil. Make sure that no soundproofing panels made of porous material are soaked in fuel or oil. Make sure that the ground or floor on which the machine is standing has not soaked up any fuel or oil.
- Fully tighten the tank plug each time after refuelling. Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- Fuel vapour is highly toxic. Only refuel outdoors or in a well ventilated place.
- Do not smoke or use naked flames when refuelling.
- The engine must be started in compliance with the specific instructions in the operation manual of the engine and/or machine itself. Do not use auxiliary starting aids that were not installed on the original machine (e.g. Startpilot').
- Before starting, remove any tools that were used to service the engine and/or machine. Make sure that all guards have been refitted.
- During operation, the surface of the engine can become dangerously hot. Avoid touching the exhaust system in particular.
- Before proceeding with any operation on the engine, stop it and allow it to cool. Never carry out any operation whilst the engine is running.
- The coolant fluid circuit is under pressure. Never carry out any inspections until the engine has cooled and even in this case, only open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. If there is an electric fan, do not approach the engine whilst it is still hot as the fan could also start operating when the engine is at a standstill. Only clean the coolant system when the engine is at a standstill.
- When cleaning the oil-cooled air filter, make sure that the old oil is disposed of in the correct way in order to safeguard the environment. The spongy filtering material in oil-cooled air filters must not be soaked in oil. The reservoir of the separator pre-filter must not be filled with oil.
- The oil must be drained whilst the engine is hot (oil T ~ 80°C). Particular care is required to prevent burns. Do not allow the oil to come into contact with the skin.
- Make sure that the drained oil, the oil filter and the oil it contains are disposed of in the correct way in order to safeguard the environment.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and cold. Take care to prevent fluids containing nitrites from being mixed with others that do not contain these substances since "Nitrosamine", dangerous for the health, can form. The coolant fluid is polluting and must therefore be disposed of in the correct way to safeguard the environment.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the positive wire of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Only check belt tension when the engine is off.
- Only use the eyebolts installed by Lombardini to move the engine. These lifting points are not suitable for the entire machine; in this case, the eyebolts installed by the manufacturer should be used.

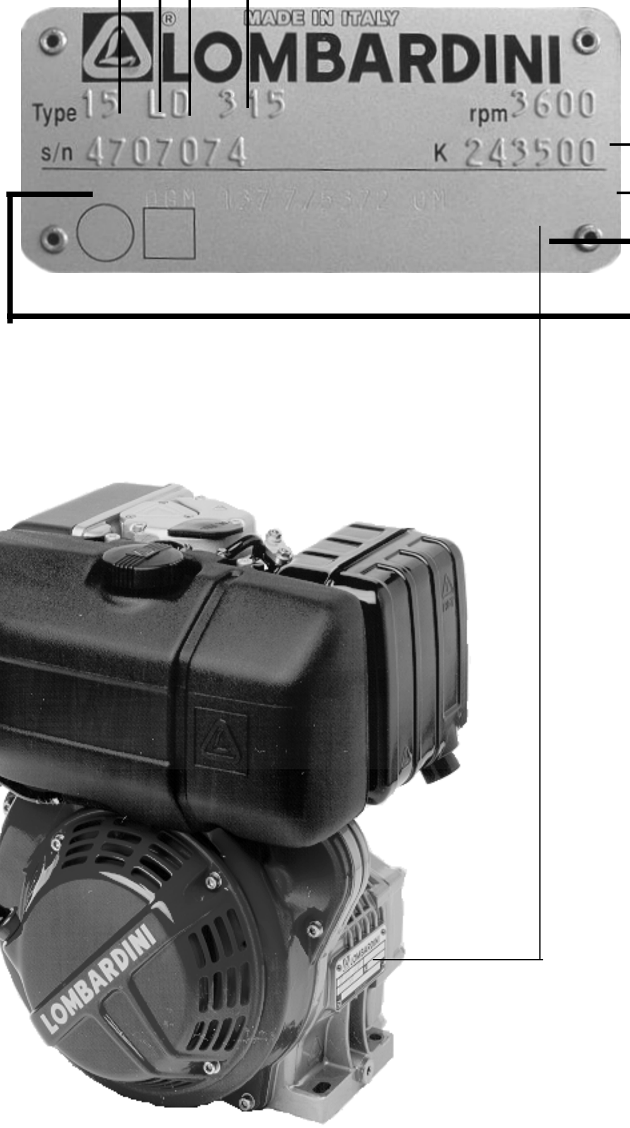
# NOTE

## MODEL NUMBER

Displacement (cc)
Diesel
LOMBARDINI
Engine group number

## ENGINE IDENTIFICATION

R.P.M.
Customer's code
Approval code
Engine Serial Number



## CHARACTERISTICS 15 LD 225, 15 LD 315, 15 LD 350

| TIPO MOTORE | | | 15LD 225 | 15LD 315 | 15LD 350 |
|---|---|---|---|---|---|
| Number of cylinders | | N. | 1 | 1 | 1 |
| Bore | | mm | 69 | 78 | 82 |
| Stroke | | mm | 60 | 66 | 66 |
| Swept volume | | $Cm^3$ | 224 | 315 | 349 |
| Compression ratio | | | 21:1 | 20,3:1 | 20,3:1 |
| R.P.M. | | | 3600 | 3600 | 3600 |
| Power kW (HP) | N 80/1269/EEC-ISO 1585 | | 3,5(4,8) | 5,0(6,8) | 5,5(7,5) |
| | NB ISO 3046 - 1 IFN | | 3,3(4,5) | 4,6(6,2) | 5,1(7,0) |
| | NA ISO 3046 - 1 ICXN | | 3,1(4,2) | 4,1(5,6) | 4,7(6,4) |
| Max. torque * | | Nm | 10,4@2400 | 15@2400 | 16,6@2400 |
| Fuel consumption ** | | g/kW.h | 267 | 262 | 260 |
| Oil consumption | | l/h | 0,0021 | 0,0035 | 0,0038 |
| Capacity of standard oil sump | | lt | 0,9 | 1,2 | 1,2 |
| Recommended battery | | V/Ah | 12/36 | 12/44 | 12/44 |
| Dry weight | | kg | 28 | 33 | 33 |
| Combustion air volume at 3600 r.p.m. | | l./min | 350 | 480 | 540 |
| Cooling air volume at 3600 r.p.m. | | l./min | 3800 | 5000 | 5000 |
| Max.permissible driving shaft axial load in both directions | | kg. | 150 | 200 | 200 |
| Max. inclination | continuous service for up to 30 min. | | 25° | 25° | 25° |
| | discontinuous service for about 1 min. | | 35° | 35° | 35° |
| | permanent service | | *** | *** | *** |

* Referred to N power
** Referred to NB power
*** Depending on the application


15 LD 225


15 LD 315

15 LD 350

## CHARACTERISTICS 15 LD 400, 15 LD 440

| TIPO MOTORE | | | 15LD 400 | 15LD 440 |
|---|---|---|---|---|
| Number of cylinders | | N. | 1 | 1 |
| Bore | | mm | 82 | 86 |
| Stroke | | mm | 76 | 76 |
| Swept volume | | $Cm^3$ | 401 | 442 |
| Compression ratio | | | 20,3:1 | 20,3:1 |
| R.P.M. | | | 3600 | 3600 |
| Power kW (HP) | N 80/1269/EEC-ISO 1585 | | 7,0(9,5) | 7,7(10,5) |
| | NB ISO 3046 - 1 IFN | | 6,4(8,7) | 7,0(9,6) |
| | NA ISO 3046 - 1 ICXN | | 5,8(7,9) | 6,4(8,7) |
| Max. torque * | | Nm | 21,3@2400 | 23,5@2400 |
| Fuel consumption ** | | g/kW.h | 262 | 260 |
| Oil consumption | | l/h | 0,005 | 0,0055 |
| Capacity of standard oil sump | | lt | 1,5 | 1,5 |
| Recommended battery | | V/Ah | 12/44 | 12/44 |
| Dry weight | | kg | 45 | 45 |
| Combustion air volume at 3600 r.p.m. | | l./min | 580 | 635 |
| Cooling air volume at 3600 r.p.m. | | l./min | 5500 | 5500 |
| Max.permissible driving shaft axial load in both directions | | kg. | 200 | 200 |
| Max. inclination | continuous service for up to 30 min. | | 25° | 25° |
| | discontinuous service for about 1 min. | | 35° | 35° |
| | permanent service | | *** | *** |

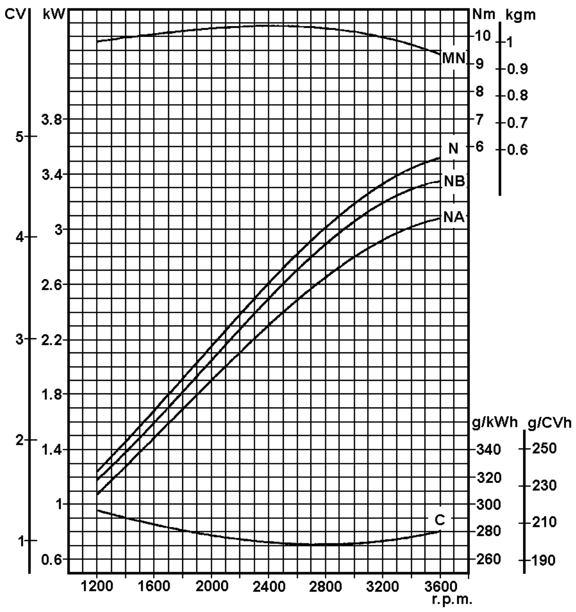
* Referred to N power
** Referred to NB power
*** Depending on the application


15 LD 400

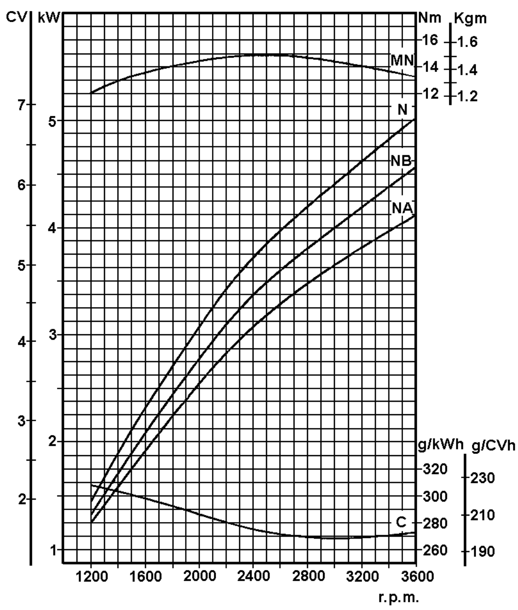

15 LD 440

## CHARACTERISTICS POWER, TORQUE AND SPECIFIC FUEL CONSUMPTION CURVES

### 15 LD 225




### 15 LD 315

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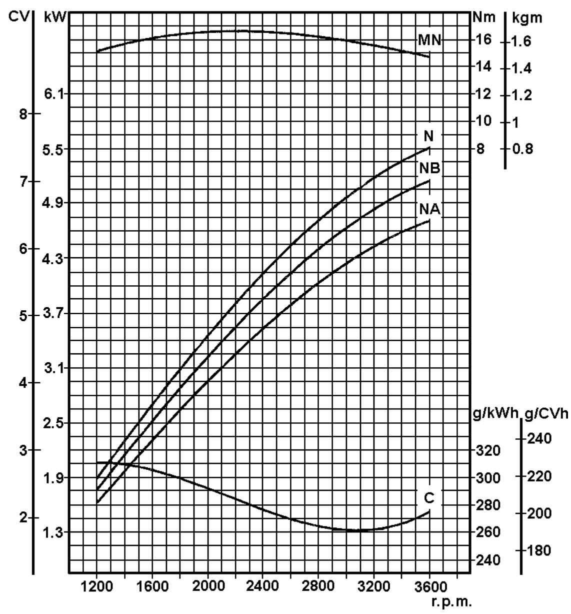


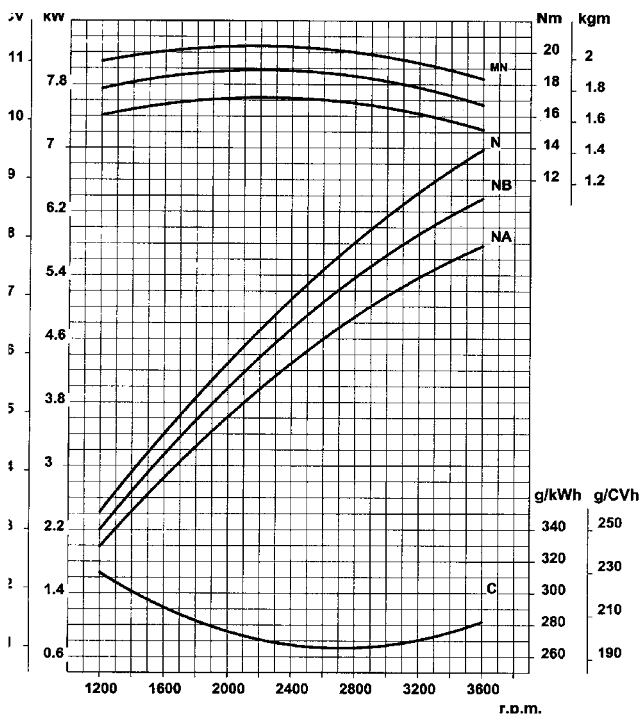

**N (80/1269/EEC - ISO 1585) AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load.
**NB (ISO 3046 - 1 IFN) RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load.
**NA (ISO 3046 - 1 ICXN) CONTINUOS RATING WITH OVERLOAD CAPABILITY:** continuos heavy duty with constant speed and constant load.
**MN** Torque at **N** power.
**C** Specific fuel consumption at **NB** power.

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 LOMBARDINI for power, torque curves and specific consumptions at rates differing from those given above.

## CHARACTERISTICS POWER, TORQUE AND SPECIFIC FUEL CONSUMPTION CURVES

### 15 LD 400

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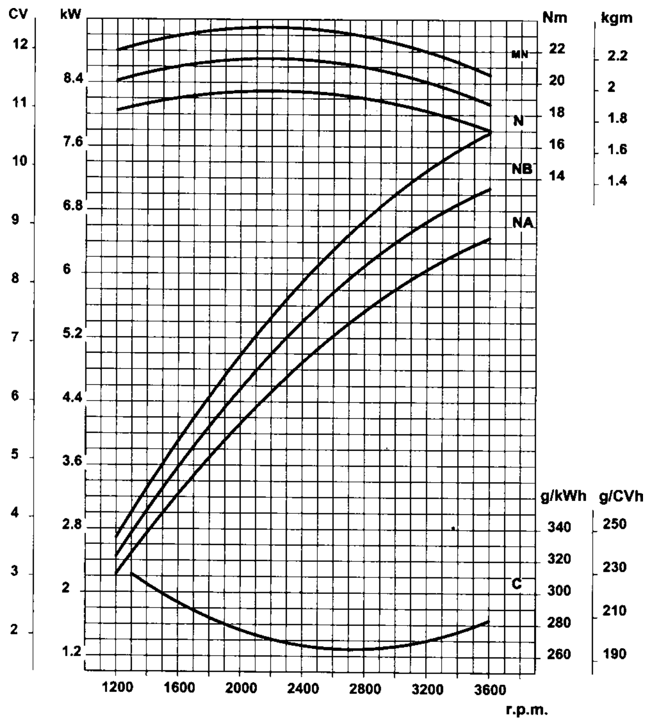
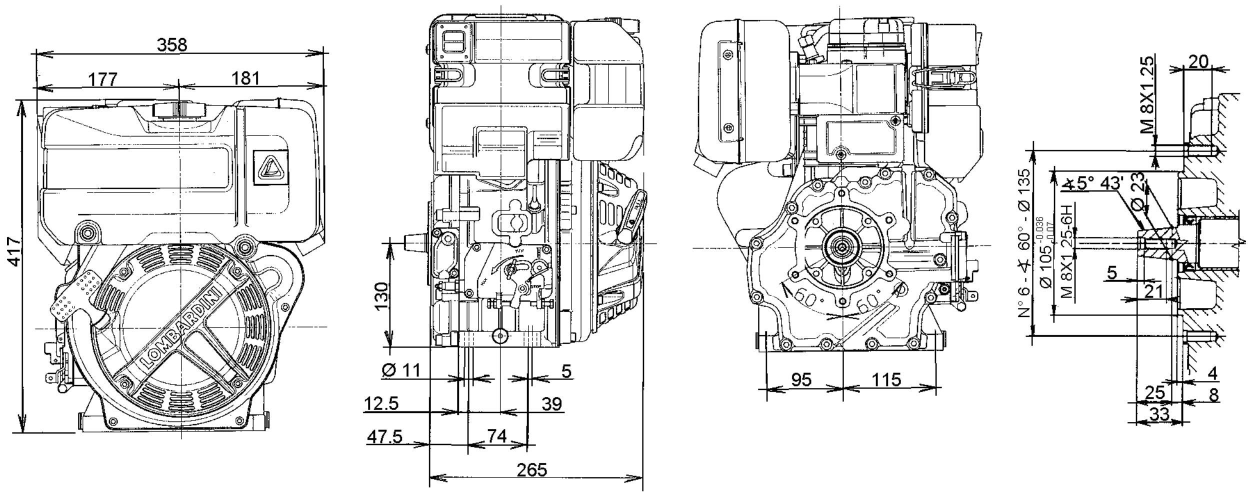



**N (80/1269/EEC - ISO 1585) AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load.
**NB (ISO 3046 - 1 IFN) RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load.
**NA (ISO 3046 - 1 ICXN) CONTINUOS RATING WITH OVERLOAD CAPABILITY:** continuos heavy duty with constant speed and constant load.
**MN** Torque at **N** power.
**C** Specific fuel consumption at **NB** power.

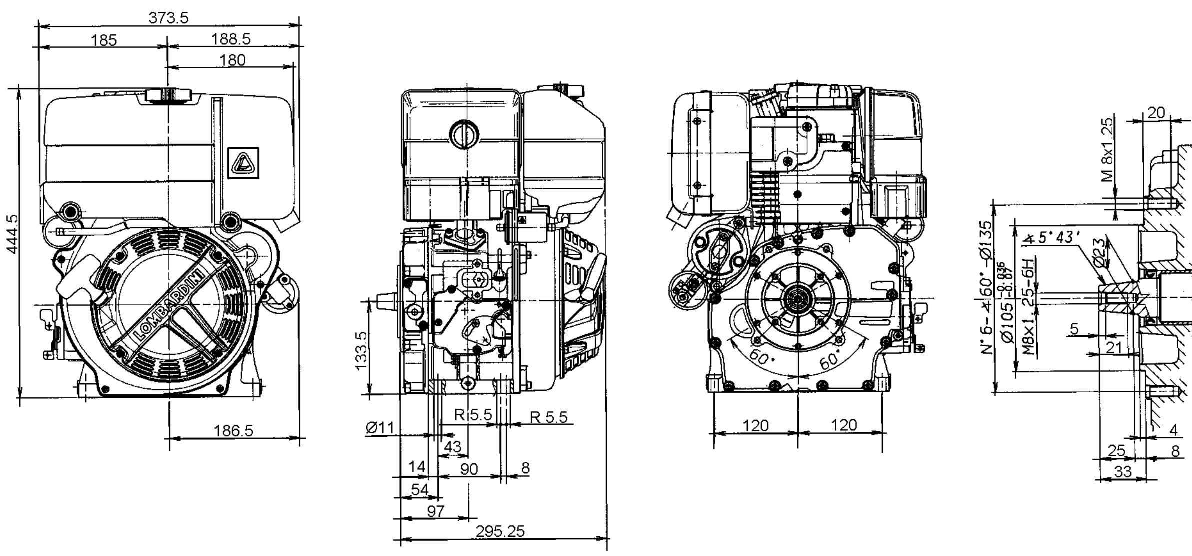
The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar.
Max. power tolerance is 5%.
Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

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

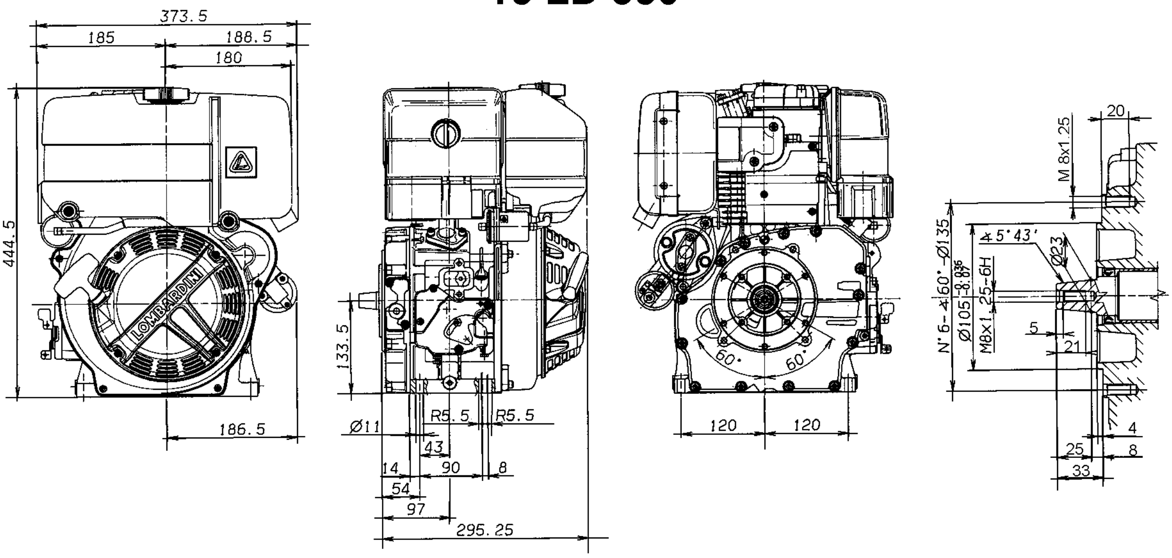
## 15 LD 225



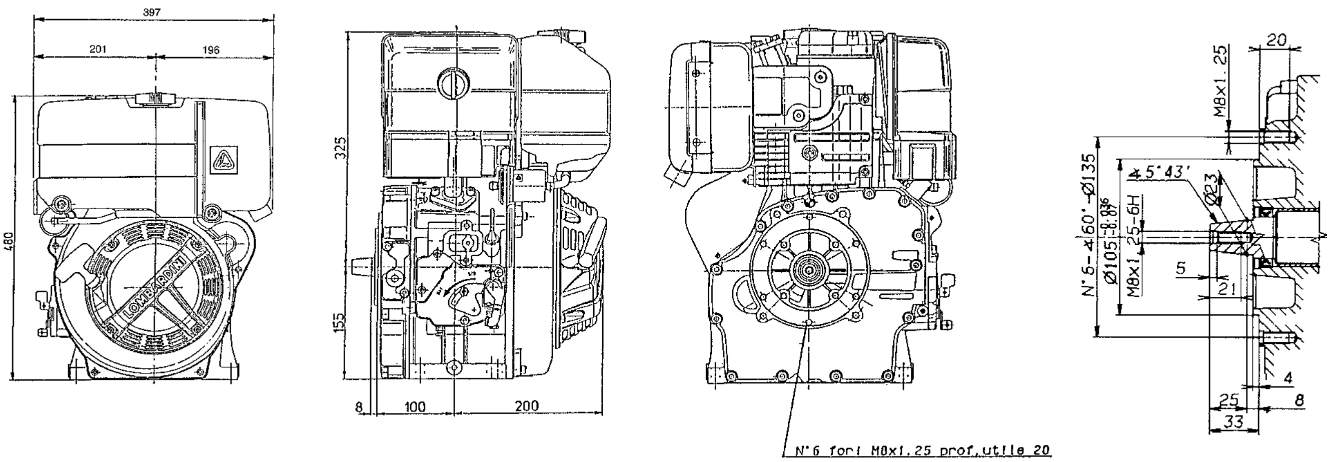

## 15 LD 315



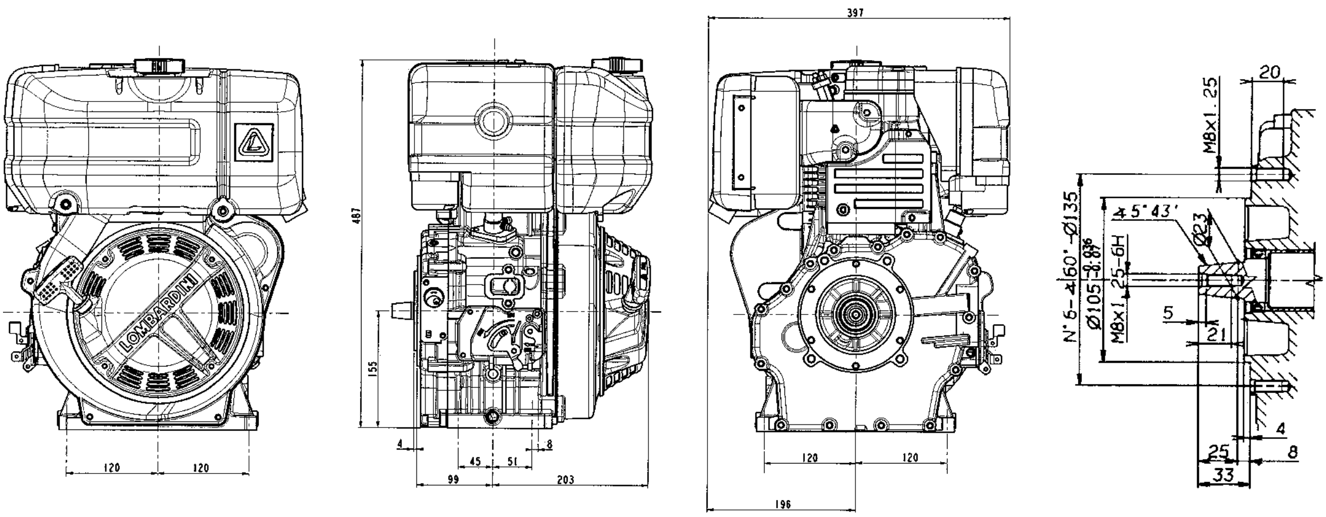

## 15 LD 350



## 15 LD 400




## 15 LD 440



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

## MAINTENANCE

| OPERATION | COMPONENT | | INTERVAL (HOURS) | | | | |
|---|---|---|---|---|---|---|---|
| | | | | 10 | 50 | 250 | 500 |
| CLEANING | OIL-BATH AIR CLEANER | | (*) | ● | | | |
| | HEAD AND CYLINDER FINS | | (*) | | | | ● |
| | INJECTOR | | | | | | ● |
| | | | | | | | |
| | | | | | | | |
| CHECK | LEVEL | AIR CLEANER OIL | (**) | | ● | | |
| | | OIL SUMP | | ● | | | |
| | | | | | | | |
| | VALVE/ROCKER ARM CLEARANCE | | | | | | ● |
| | INJECTOR SETTING | | | | | | ● |
| REPLACEMENT | | AIR CLEANER | (**) | | | | |
| | | SUMP | (***) | | | ● | |
| | OIL FILTER CARTRIDGE | | | | | | ● |
| | FUEL FILTER CARTRIDGE | | | | | | ● |
| | DRY AIR CLEANER CARTRIDGE | | (°) | | | | |

(*) Under severe working conditions, clean daily.
(**) Under extremely dusty conditions, change every 4-5 hours.
(***) See recommended oil type.
(°) After the polyurethane prefilter has been serviced 6-10 times (see fig. 2 for 315-350 engines), when the clogging indicator (if installed) signals that the part must be replaced, or if it is irreparably clogged.

---

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:

| | | |
|---|---|---|
| 15 LD 225 | = | l. 3.0 |
| 15 LD 315 | = | l. 4.3 |
| 15 LD 350 | = | l. 4.3 |
| 15 LD 400 | = | l. 5.0 |
| 15 LD 440 | = | l. 5.0 |

The engine could be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil as its combustion could sharply increase the rotation speed.
Use a suitable oil in order to protect the engine.
The lubrication oil influences the performances and life of the engine in an incredible way.
The risk of piston seizure, jammed piston rings and rapid wear of the cylinder liner, the bearings and all moving parts increases if oil whose characteristics differ from the recommended type is used, or if the oil is not regularly changed. All this notably reduces engine life.
Oil viscosity must suit the ambient temperature in which the engine operates.

Old oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time. If contact with the oil is inevitable, you are advised to thoroughly wash your hands with soap and water as soon as possible.
Appropriate protective gloves etc should be wore during this operation.
Old oil is highly polluting and must be disposed of in the correct way. Do not litter.

**RECOMMENDED OIL**

AGIP SUPERDIESEL MULTIGRADE 15W40 specifications API CF-4/ SG ACEA E2,B2 MIL-L-46152 D/E. ESSO SPECIAL PKW-UNIFLO DIESEL 15W40 specifications API CF-4/SG ACEA E2,B2 MIL-L-46152 D/E. In the countries where AGIP and ESSO products are not available, use oil API SJ/CF for Diesel engines or oil corresponding to the military specification MIL-L-46152 D/E.

**OIL SUPPLY ( liters ) 15 LD 225**
**Standard oil sump**

**filter included** 0.9

**OIL SUPPLY ( liters ) 15 LD 315**
**Standard oil sump**

**filter included** 1.2

**OIL SUPPLY ( liters ) 15 LD 350**
**Standard oil sump**

**filter included** 1.2

**OIL SUPPLY ( liters ) 15 LD 400 - 440**
**Standard oil sump**

**filter included** 1.5

**ACEA SEQUENCES**

A = Gasoline (Petrol)
B = Light Diesel fuels
E = Heavy Diesel fuels

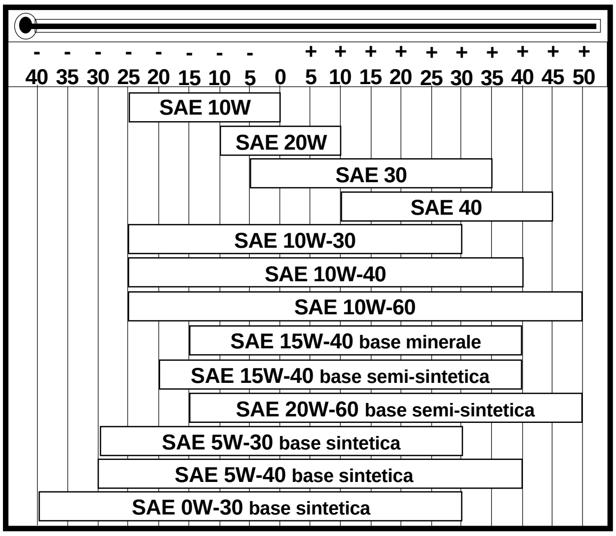
Required levels :

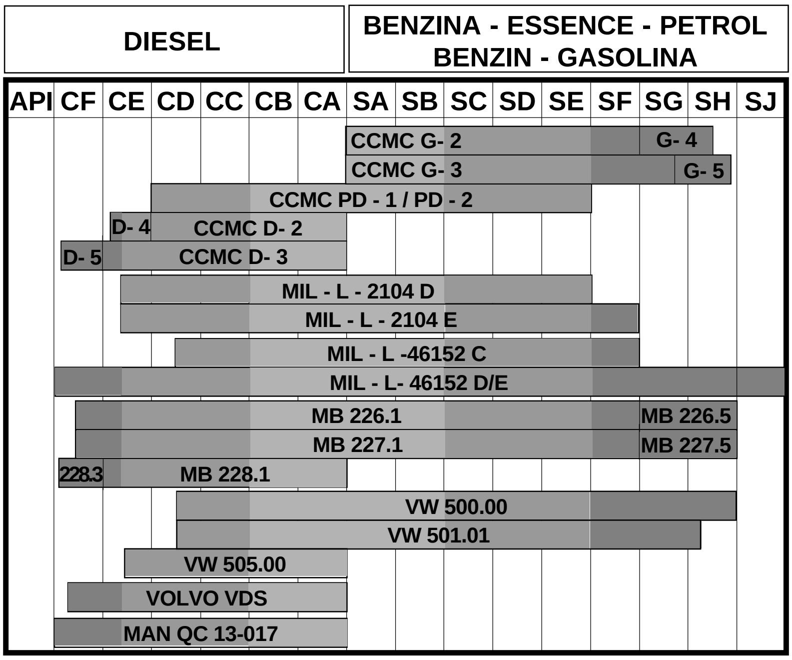
A1-96
A2-96
A3-96

B1-96
B2-96
B3-96

E1-96
E2-96
E3-96

**GRADE**



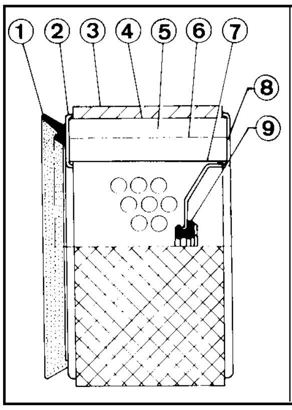



**WARNINGS!**

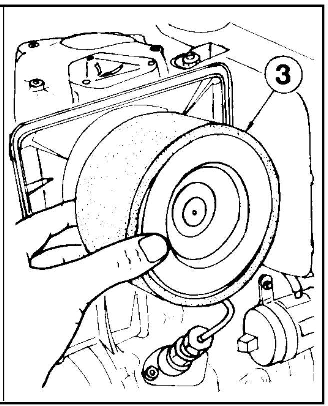
**! During repair operations, when using compressed air, wear eye protection**.

**DISASSEMBLY AND REASSEMBLY**

Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions. Always use original LOMBARDINI spare parts for repair operations.




1




2

**!** Clean the filtering element with air blast. Air must be blown from inside to outside the cartridge at a distance of at least 15 cm from the paper.
Lightly and repeatedly tap the element on a hard surface to eliminate all excess dirt.

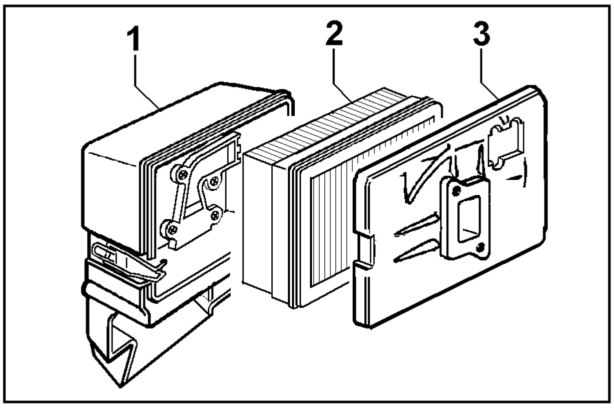
**Dry air cleaner for 15LD 315 and 15 LD 350**

Cartridge components:

**1** Seal
**2** Metallic body
**3** Polyurethane prefilter
**4** outer mesh
**5** Filter media
**6** Blade
**7** Inside envelope
**8** Metallic body
**9** Inner seal

**Cartridge characteristics:**
media porosity 7 µm, useful filtering area 1960 $cm^2$.
**Polyurethane pre-filter characteristic**:
porosity 60 p.p.i., front area 207 $cm^2$.

**Note:** Pre-filter **3** can undergo maintenance operations; if dirty, wash with soap and water and dry ( maximum 10 cleanings ). See page 18 for cartridge replacement.




3

**!** Clean the filtering element with air blast. Air must be blown from inside to outside the cartridge at a distance of at least 15 cm from the paper.
Lightly and repeatedly tap the element on a hard surface to eliminate all excess dirt. Replace if irreparably clogged.

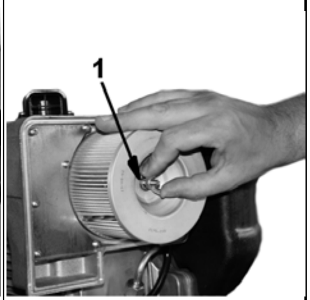
**Dry air cleaner for 15LD 225**

Cartridge components:

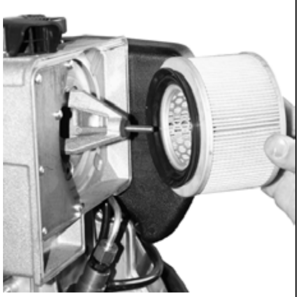
**1** Complete cover
**2** Filtering material
**3** Support

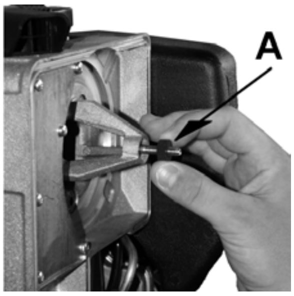
Characteristics of the filtering material:
paper porosity : 3 µm
filtering area : 4400 $cm^2$
outer ring in open-cell polyurethane

See page 18 for the frequency with which the filtering material must be changed.



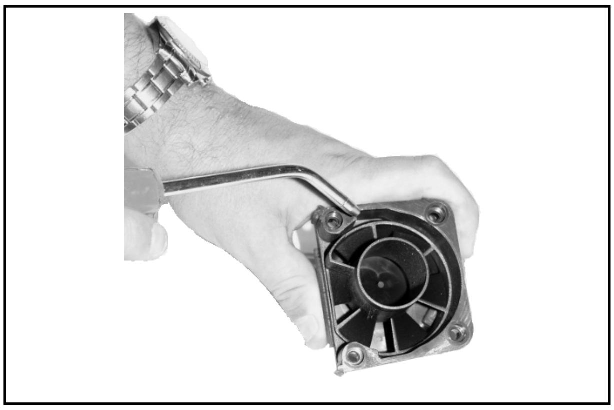

4 4a






5 5a

6



7

! Clean the filtering element with air blast. Air must be blown from inside to outside the cartridge at a distance of at least 15 cm from the paper.
Lightly and repeatedly tap the element on a hard surface to eliminate all excess dirt.

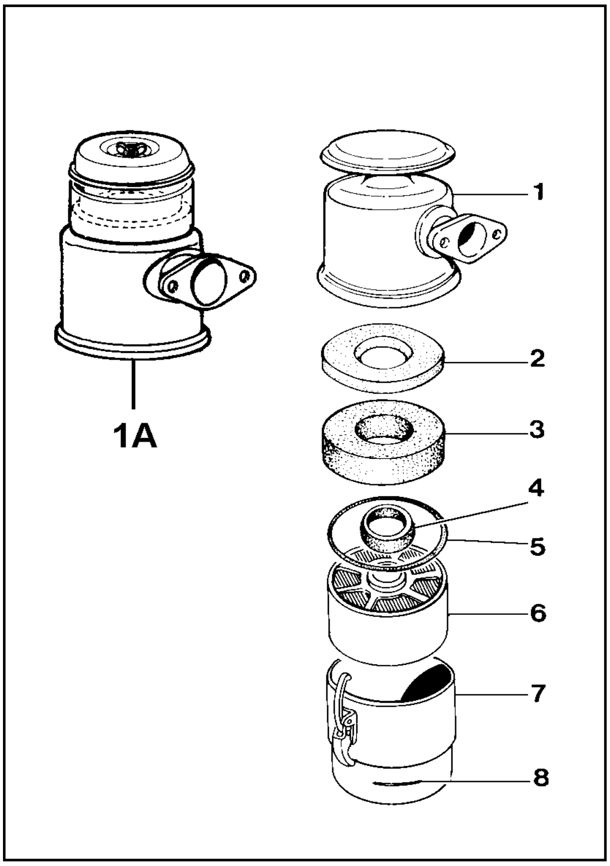
**Dry air cleaner for 15LD 400-440**

Open air cleaner (fig. 4).
Unscrew the wing nut **1** (fig. 4a) and remove the filter element (fig. 5).
Check the rubber seal is undamaged **A** (fig. 5a)
Clean the filtering element with air blast.
If the filtering element has been already cleaned other times, or if it is irreparably clogged, throw it away and replace .
Refit the air filter and make sure the seal **A** is properly inserted, then tighten the wing nut **1**.

! Make sure that the filter is mounted in the correct way otherwise dust and other impurities could ilfiltrate into the intake ducts.

**Prefilter for dry air filter**

Remove and clean the pre-filter if clogged.




8

Never clean the filtering element **6** using solvents with a low flash point. This could cause an explosion !

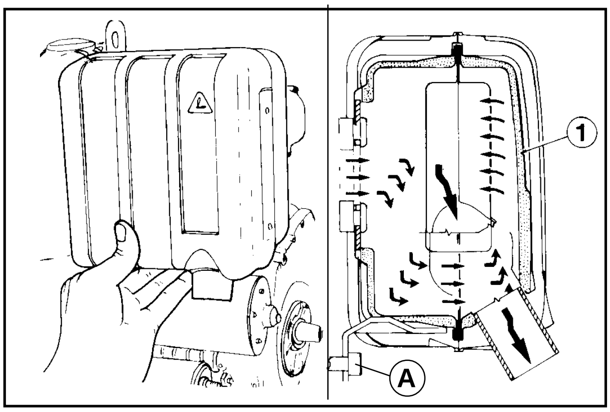
Make sure that the retention rings **4 - 5** are in a good condition and replace them if they are damaged.

**Oil-bath air cleaner (optional)**

Components:
**1** Upper shell
**1A** Upper unit with separator pre-filter
**2** Secondary filter element
**3** Primary polyurethane
**4** Internal seal ring
**5** External rubber gasket
**6** Lower metal filter element
**7** Lower cup
**8** Oil level gauge

**Characteristics of filter element 2**:
made of Viledon synthetic fabric, porosity 120 gr/m$^2$, resin-covered.

**Characteristics of filter element 3**:
open-celled polyurethane foam; porosity 45 P.P.I..
Both filter elements can be washed with soap and water for a maximum of 10 times.
Wash the metal filter **6** with Diesel fuel Blow out excess fuel with compressed air. See pages 14 and 15 for periodic maintenance details and oil replacement.

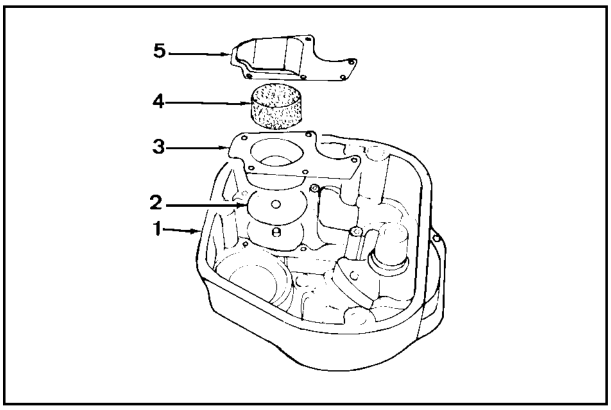



9 10

Allow the exhaust manifold to cool before demounting it in order to prevent scorching and burns.

**Muffler**

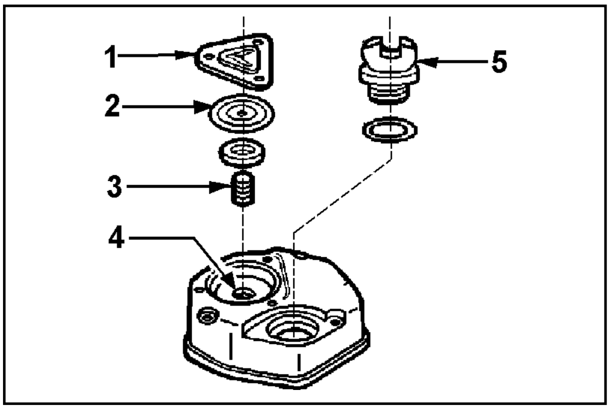
When reassembling replace the exhaust manifold gaskets.
Tighten nuts to 25 Nm.
The muffler design includes internal sound absorbing panels.
Tighten the bearing nuts and screw **A** to a 25 Nm torque value.




11

**Rocker arm cover breather system**

The crankcase breather system is located inside the rocker arm cover. Check that diaphragm **2** is intact ; wash with Diesel oil and blow through the small mesh element **4** with compressed air.
When reassembling fix box **3** with Loctite " Form-a- gasket No. 6" and screw plate **5**. Also see below.

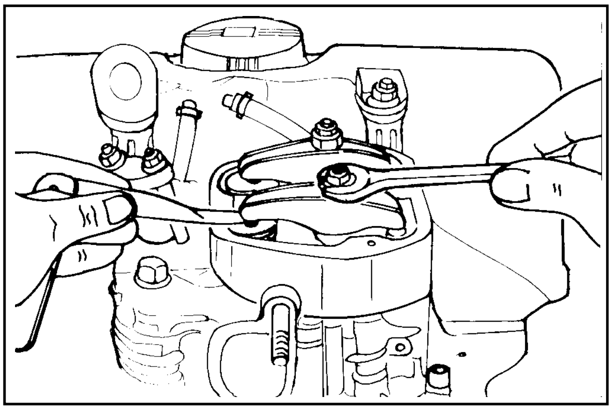



12

! Always check the the spring and valve to make sure they are in a good conditions.

**Rocker arm cover - Breather ricirculation**

Crankcase vapor recirculation occurs through duct **4.**
If the air filter clogs, the increased intake vacuum could suck oil through duct 4 into the combustion chamber, causing the engine to operate at a runaway rate. This is prevented by valcuum valve **2** which, when the vacuum increases, overcomes the resistance of spring **3** and shuts the duct **4**.
Make sure that oil plug **5** is correctly closed.
Refit cover **1** and tighten rocker arm cover to 10 Nm.

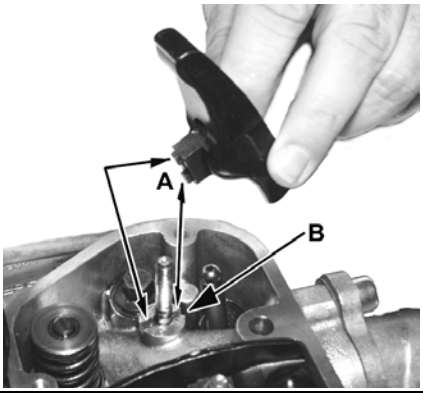


13

**Valve/rocker arm clearance ( 15 LD 225-315-350 )**

Set valve/rocker arm clearance when the engine is cold: bring piston to top dead center on the compression stroke and set clearance at 0.10-0.15 mm using a thickness gauge. Tighten lock nut.

**N.B.:** Since an automatic decompression device is available on the exhaust lobe, manualy rotate the engine until the tappets are at lowest point.




13a

!

**The engines 15 LD 400 and 440 have hydraulic tappets, therefore no adjustment is required.**

When replacing the rocket arms, position the piston at the bottom dead centre and tighten the fixing screw gradually to adjust the hydraulic tappets.
While tightening, make sure that **A** fits correctly into **B** (fig. 13a).
The adjusting screw pin should be tightened to 20 Nm.

13b

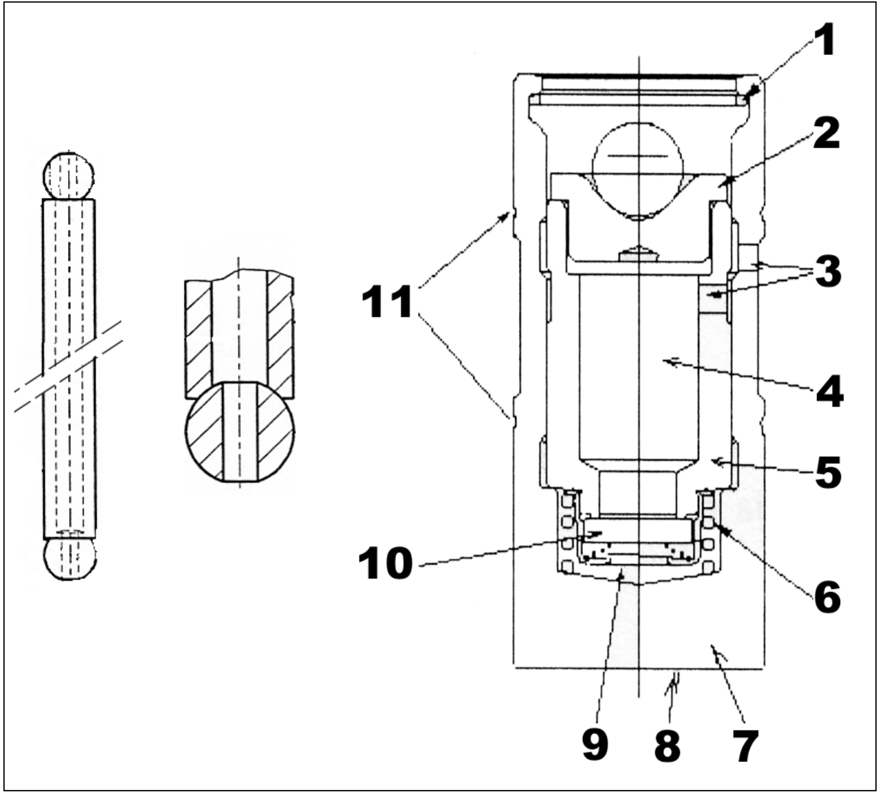
!

**Do not start the engine for approximately 4 hours to allow the hydraulic tappets to settle completely.**

Once the tappets have settled, tighten the bolt to 10Nm.

**Hydraulic tappets 15 LD 400-440**

Distribution uses hydraulic tappets for automatic adjustment of valve clearance.
The figure shows the tappet used in 15 LD 400 engines.



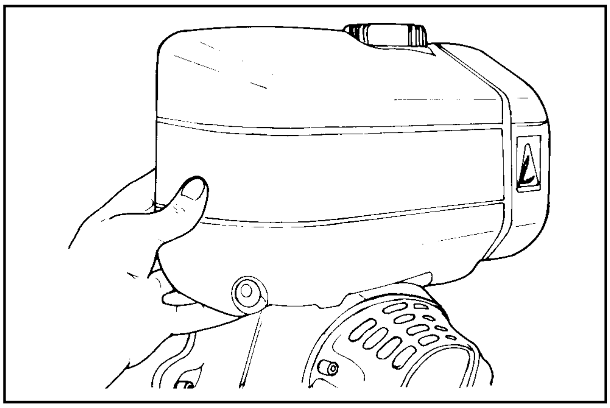

**Caption**

**1**- Lock ring
**2**- Upper collar
**3**- Oil inlet holes
**4**- Low-pressure chamber
**5**- Piston
**6**- Play-recovery spring
**7**- Case
**8**- Area to be lubricated
**9**- High-pressure chamber
**10**- Check valve
**11**- Identification marks

Fill the low-pressure chamber through the oil inlet holes.
If clearance occurs while running, as the tappet returns to the base of the camshaft, the play-recovery spring stretches out, keeping all timing system parts close together.
While the play-recovery spring is stretching, the check valve lets oil into the high-pressure chamber from the low-pressure chamber, to recover the increase in volume in the high-pressure chamber, caused by the stretching spring. In this way, since oil is practically uncontrollable, when the valve is next opened, play will be completely recovered.
During each cycle a small amount of oil is drawn from the high-pressure chamber into the piston coupling wall with the case and then, passing through the internal inlet hole, flows into the low-pressure chamber.
The tappet is shortened by less than 0.1mm each cycle. This allows the tappet to make up the reduction in play while the engine is running.
It is not necessary for the oil to reach the tappet on the downward stroke: light pressure is enough to ensure that air bubbles do not form.
The tappet may be supplied with the high-pressure chamber full or empty. The low-pressure chamber is always empty.
The tappet should always be handled in an upright position to prevent the high-pressure chamber from emptying.
The surface that comes into contact with the cam should be lubricated generously during assembly using AS COMPUND 40 type MOLYSLIP (see figure). This operation is important to ensure correct lubrication right from the start.
The distribution system is assembled as follows:

a) Make sure that the piston is between the Bottom Dead Centre and the halfway point
b) Insert the rods into position on the tappets
c) Mount the rocker arm and the joint block, then tighten the fixing nut to the specified torque
d) DO NOT START THE ENGINE FOR AT LEAST 4 HOURS AFTER TIGHTENING THE ROCKER ARMS because the valve-piston contact may be put at risk.

The tappet is unloaded when it is possible to shift the internal part by 3.5÷4 mm using a force of 30 Nm.
If the tappets are loaded (for example if they have been left in a horizontal position) the engine will be noisy during the first few minutes after switching on, until the air has been completely drained out of the inside of the tappets themselves.

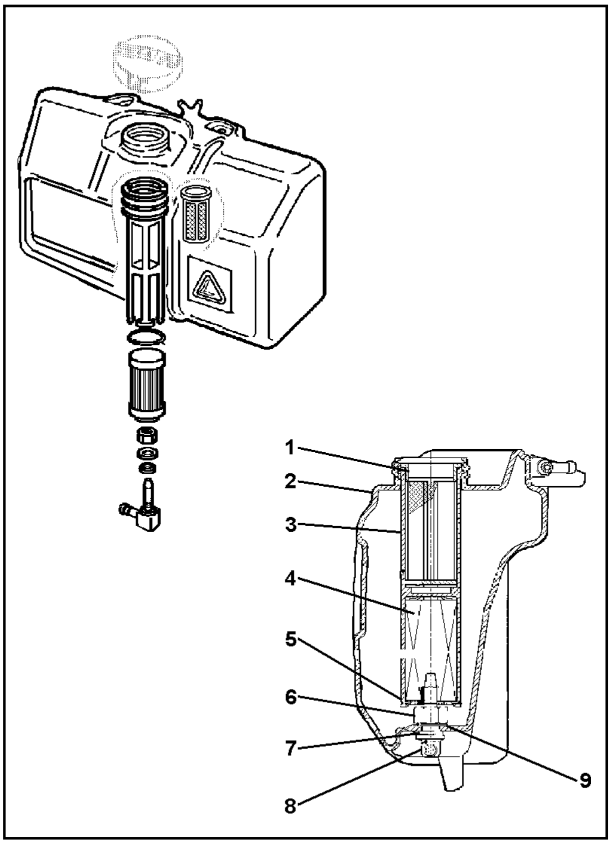


14

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.

**Tank**

Unscrew the upper and lower studs and remove the washers, which otherwise might make removal of the tank difficult. Next disconnect the fuel and air bleeding tubes.
Completely empty the tank to make sure that no impurities remain.
When reassembling tighten the upper nuts to 15 Nm.

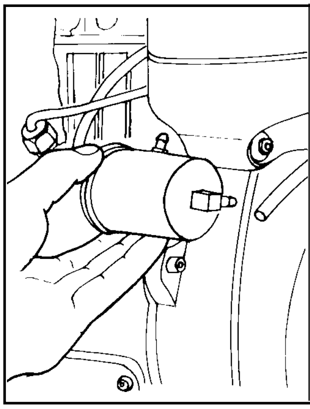



15

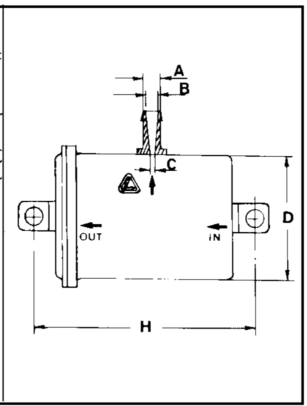
**Fuel filter 15 LD 225-400-440 (version with internal filter)**

**1** Fuel filter
**2** Fuel tank
**3** Filter sleeve
**4** Filter cartridge
**5** Flush ring
**6** Nut
**7** Union seal
**8** Diesel fuel outlet union
**9** Flat washer

See page 18 for the frequency with which the fuel filter must be replaced.
See fig. 99 for the dimensions.



16



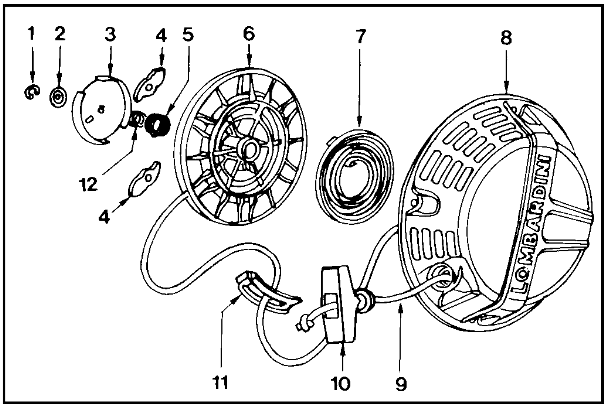

17

**Fuel filter for 15 LD 225 - 315 - 350 - 400 - 440 (version with external filter)**

Loosen the clamps and disconnect the hoses.

**Characteristics**

Filtering area ≥ 390 $cm^2$
Paper porosity ≤ 7 μ m.
See page 18 for replacement
See fig. 98 for dimensions.




18

### Re-coil starting

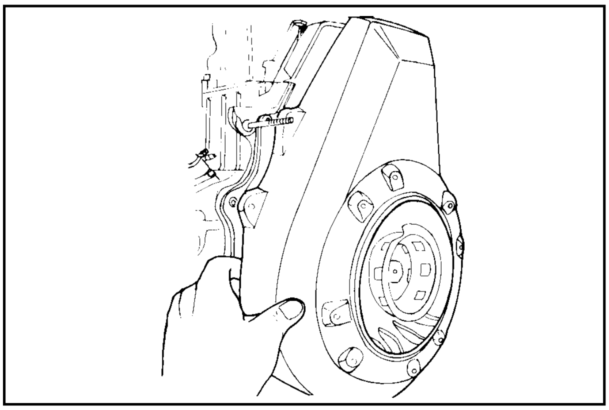
Operation:
When pulling handle **10,** thanks to the action of friction spring **12,** teeth **4** protrude from cap **3.** After starting these teeth go back to the initial position because the cap rotates. Rope **9** is re-wound around pulley **6** by means of spring **7**.

Components:

| | |
|---|---|
| **1** Retainer | **7** Spring |
| **2** Washer | **8** Guard |
| **3** Cap | **9** Rope |
| **4** Flyweights | **10** Handle |
| **5** Spring | **11** Rope guide |
| **6** Pulley | **12** Spring |

**Note:** there are two kinds of guards **8**, one for engines with an rpm above 2000 and one with fewer cooling channels for engines with a lower rpm

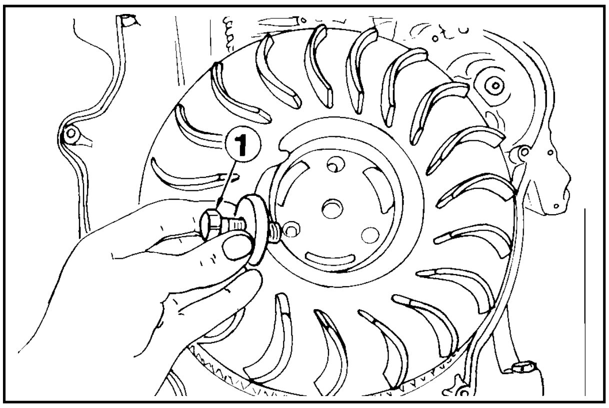
On reassembly, tighten the screws to 10Nm.



19

### Shroud

The shroud and the metal sheeting outside the cylinder are made of special material (ANTIPHON) which absorbs noise, thus reducing total engine sound pressure levels.
When refitting tighten shroud screws to 10 Nm.

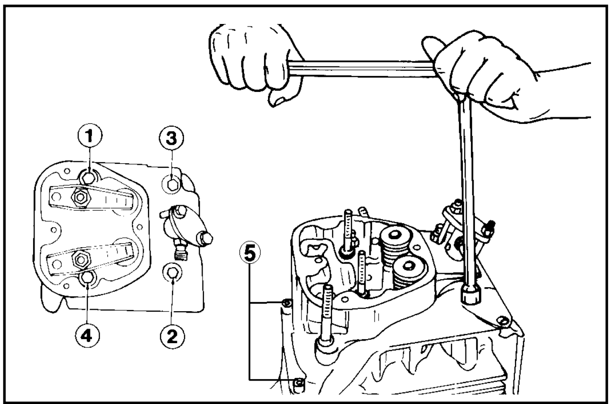



20

⚠ 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.

### Flywheel

Unscrew bolt **1** in a clockwise direction.
Remove the flywheel with a puller.
Make sure that the tapered surface that couples to the drive shaft is not damaged.
To remove the starter rim, it is advisable to cut it into several parts with a hacksaw and to then use a chisel. To replace, slowly heat for 15-20 minutes to a temperature of 300°C max.
Fit the rim into the flywheel housing. make sure that it rests evenly against the support of the housing itself.
Allow it to slowly cool.
When refitting tighten bolt **1** to 150 Nm.
See pages 34 and 35 for injection timing reference marks.



21

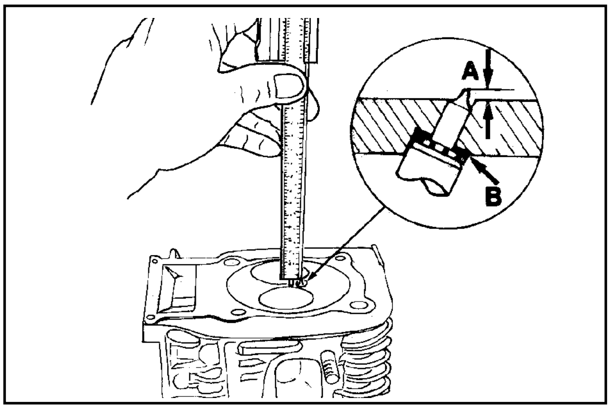
Do not demount when hot or the part could become deformed.

**Cylinder head**

If the surface of the cylinder head is deformed, flatten it by removing 0.2 mm of material at most.
Always replace the seal. See figs 46-47-48-49-50 when selecting the thickness. The bolts must be tightened in different phases for the various engines, in compliance with the order shown in the figure:

First tighten the 4 screws M10, then the 2 side screws M6.
Lubricate the shanks of the bolts, under their heads and the washers with engine oil. Do not use too much oil. Oil that deposits in the threaded hole on the cylinder block could become pressurized during the tightening phase, sensibly diminishing the driving force. Always make sure that the holes on the cylinder block are dry and clean.

| | |
|---|---|
| **Engine 15 LD 225**<br><br>1st phase: tighten all the bolts to a 30 Nm torque value in a crossed fashion.<br>2nd phase: unscrew all the bolts by 180°.<br>3rd phase: tighten all the bolts to a 20 Nm torque value in a crossed fashion.<br>4th phase: make a 52° turn in the same order as the 3rd phase.<br>5th phase: tighten the 2 side bolts (5) to a 10 Nm torque value. | **Engine 15 LD 350**<br><br>1st phase: tighten all the bolts to a 30 Nm torque value in a crossed fashion.<br>2nd phase: unscrew all the bolts by 180°.<br>3rd phase: tighten all the bolts to a 20 Nm torque value in a crossed fashion.<br>4th phase: make a 60° turn in the same order as the 3rd phase.<br>5th phase: tighten the 2 side bolts (5) to a 10 Nm torque value |
| **Engine 15 LD 315**<br><br>1st phase: tighten all the bolts to a 30 Nm torque value in a crossed fashion.<br>2nd phase: unscrew all the bolts by 180°.<br>3rd phase: tighten all the bolts to a 20 Nm torque value in a crossed fashion.<br>4th phase: make a 72° turn in the same order as the 3rd phase.<br>5th phase: tighten the 2 side bolts (5) to a 10 Nm torque value. | **For 15 LD 400 and 400 engines**<br><br>1st phase: tighten all screws crosswise to 20Nm.<br>2nd phase: tighten the screws in the same order to 40Nm.<br>3rd phase: tighten all screws in the same order to 50Nm.<br>4th phase: following the same order as in phase 3, rotate 60°.<br>5th phase: following the same order as in phase 4, rotate 60°.<br>6th phase: tighten the 2 side screws (5) to 10 Nm |



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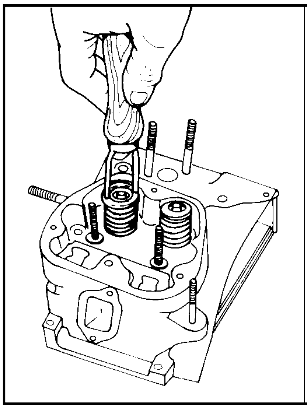
**Injector projection**

The end of nozzle **A** should project 2,5 mm for 15 LD 225-315-350 and 3,0÷3,5 mm for 15 LD 400-440 from the cylinder head plane.
Adjust with copper gaskets **B** with thickness of 0.5, 1 and 1.5 mm



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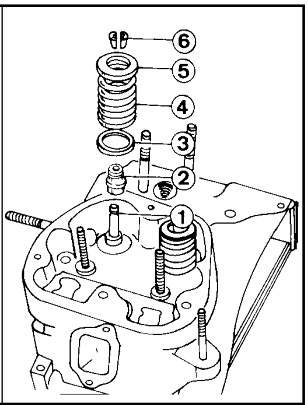


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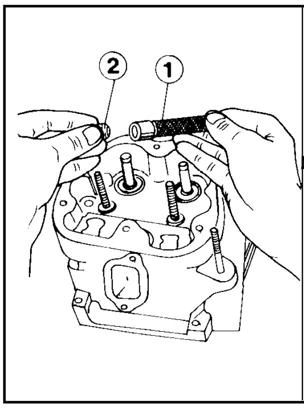
### Valves - Disassembly

Components:
**1** Valve stem
**2** Oil seal
**3** Spring washer/set
**4** Spring
**5** Cap
**6** Half collets

**Note:** To remove half collets place a suitable plate under the valve head and press down firmly as indicated in the figure.

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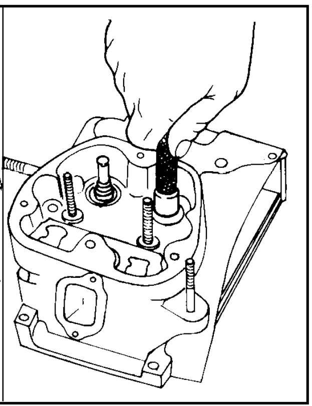

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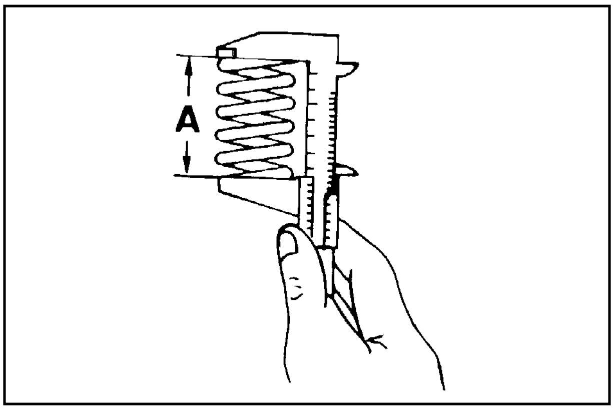
### Valves - Oil seal in valve guide

To prevent seal **2** from being deformed when the valve guide is mounted, fit it into tool **1** serial N° 7107-1460-047 after having thoroughly lubricated it, then proceed as indicated in the figure.

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### Valve, springs

Measure the free length with a caliper.

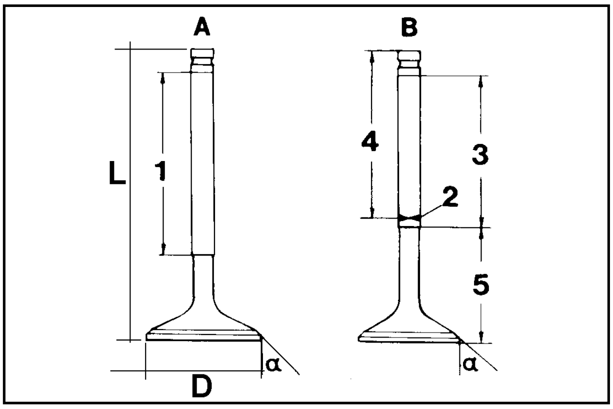
**Engine 15 LD 225-315-350**

Free length **A** = 33.72

**Engine 15 LD 400-440**

Free length **A** = 34,88

**Note**: Replace the spring if the free length **A** is 1 mm less than specified.

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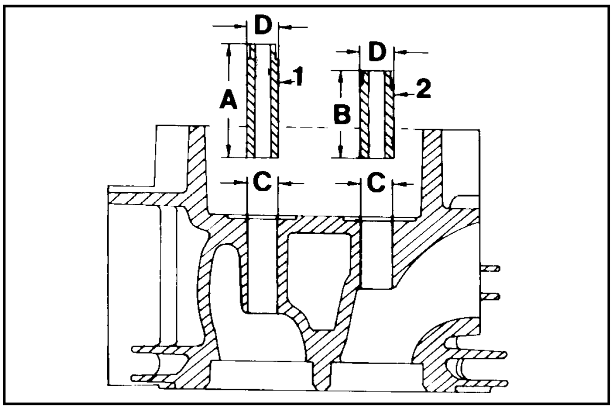
## Valves, characteristics

**Intake valve A**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| **Portion made of** | X 45 Cr Si 8 uni 3992 | | |
| **1** | Chromium-plated portion | | |
| **D** | 31,6 -0-0,2 | 36 -0-0,2 | 37,8 -0-0,2 |
| **L** | 81,8 | 91 | 92,2 -0,2+0,2 |
| **α** | 45° 35' ÷ 45 65' | | |

**Exhaust valve B -** Stem and head are of two different materials

| | 15 LD 225 | 15 LD 315 | 15 LD 350 | 15 LD 400 | 15 LD 440 |
|---|---|---|---|---|---|
| **2** | Tronçon soudé | | | | |
| **3** | Chromium-plated portion | | | | |
| **4** | Portion made of --> X 45 Cr Si 8 UNI 3992 | | | | |
| **5** | Portion made of --> X 70 Cr Mn Ni N21.6 UNI 3992 | | | | |
| **α** | 45° 35' ÷ 45 65' | | | | |

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## Valves, guides and housings

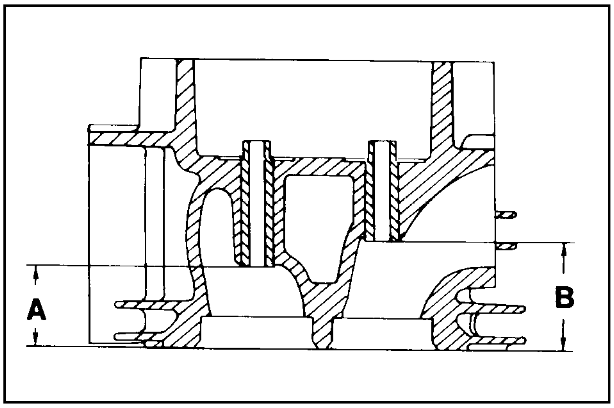
**1** Intake guide
**2** Exhaust guide

**Dimensions (mm) for 15 LD 315-350-400-440**
**A** = 40
**B** = 31
**C** = 11.000-11.018
**D** = 11.040-11.055

**Dimensions (mm) for 15 LD 225**

**A** = 35
**B** = 30
**C** = 10.000-10.020
**D** = 10.040-10.055

**Note**: Valve guides with outer diameters increased by 0.5 mm are also available as spares. In this case, housing **C** must be increased by 0.5 mm for assembly purposes.

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## Valves, guide insertion

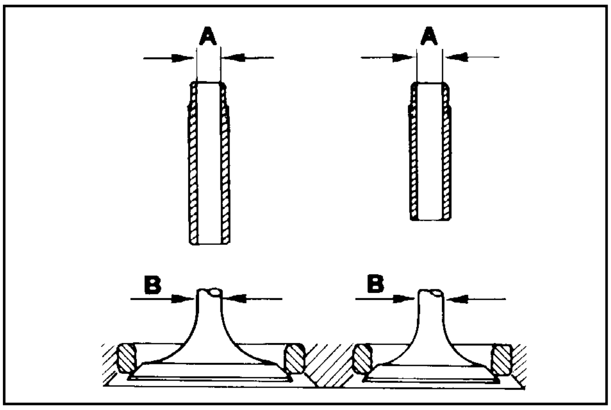
Heat the block to a temperature of 160°-180°
Force the guides, considering distance **A** and **B** in relation to the block surface.

**Dimensions (mm) for 15 LD 315-350-400-440**

**A** = 25.8-26.2
**B** = 34.8-35.2

**Dimensions (mm) for 15 LD 225**

**A** = 23.8-24.2
**B** = 28.8-29.2

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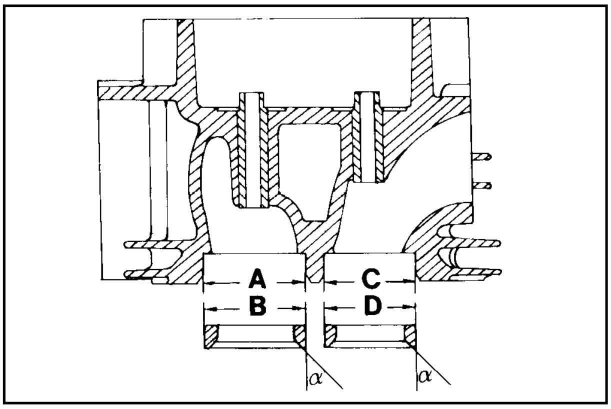
**Dimensions and clearance between guides and valve stems (mm)**

| | 15 LD 225 | 15 LD315-350 | 15 LD 400-440 |
|---|---|---|---|
| A | 6,020÷6,035 | 7,025÷7,040 | |
| B | 5,985÷6,000 | 6,985÷7,000 | 6,985÷7,000 |
| (A-B) | 0,020÷0,050 | 0,025÷0,055 | |
| (A-B) limite | 0,14 | | |

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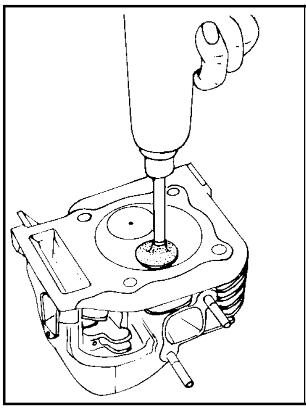
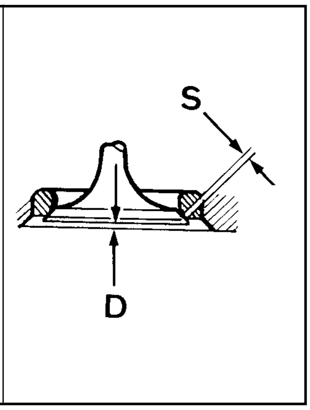
**Valves seats and valve seat bores**

**Dimensions (mm)**

| | 15 LD 225 | 15 LD315-350 | 15 LD 400-440 |
|---|---|---|---|
| **A** | 32,50÷32,51 | 37,00÷37,01 | 39,00÷39,01 |
| **B** | 32,60÷32,62 | 37,10÷37,12 | 39,10÷39,12 |
| **C** | 28,50÷28,51 | 33,00÷33,01 | 35,00÷35,01 |
| **D** | 28,60÷28,62 | 33,10÷33,12 | 35,10÷35,12 |

**Note :** Since the seats are supplied pre-finished, they must not be machined after having been inserted.

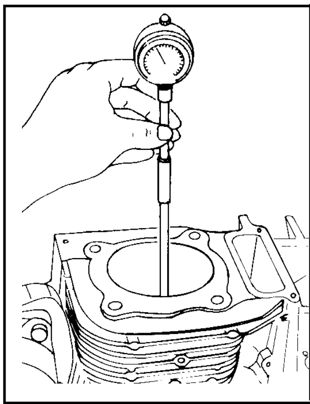


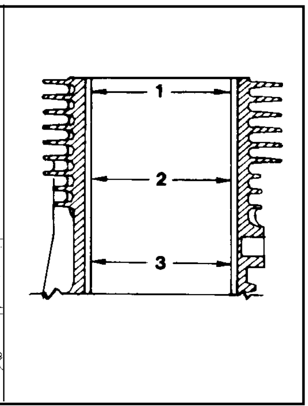



33 34

**Valve seat lapping**

After cutting valve seats, lap valve seats with fine lapping compound.
The sealing surface **S** should not exceed 2 mm.
Lowering valve for 15 LD 225-315-350 (D = 0.55÷0.85 mm).
Lowering valve for 15 LD 400-440 (D = 0.35÷0.65 mm).
Wear limit 1.5 mm.

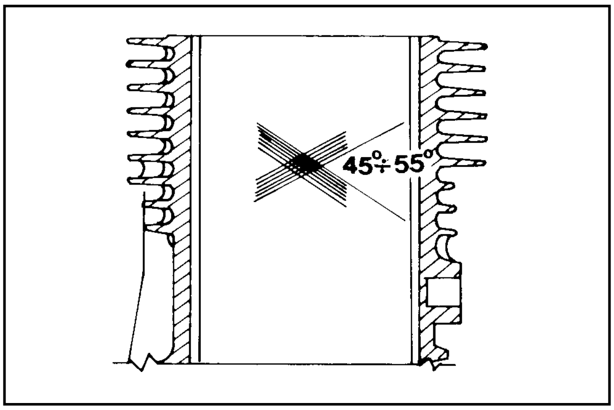




35 36

### Cylinder

Set a bore gauge to zero with a calibrated ring.
Check diameter at **1, 2** and **3**; repeat the operation at the same points after turning the bore gauge 90°.
If wear exceeds the max. given value by 0.05, bore the cylinder and fit oversize piston and rings.
See fig. 40 and 41 for cylinder diameter values.

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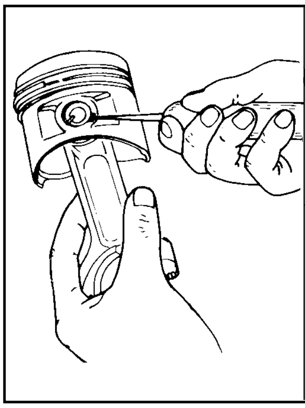
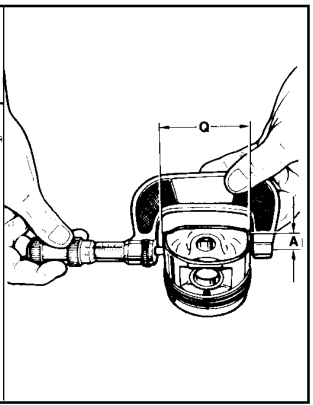
**!** <u>Do not manually hone the cylinder bore surfaces with emery cloth or other means.</u>

### Cylinder roughness

The cross-hatch pattern should be at an angle of 45°-55°; lines should be uniform and clear in both directions.
Average roughness must range between 0.5 mm 1 µm.
The cylinder surface which comes into contact with piston rings should be machined with the plateau method.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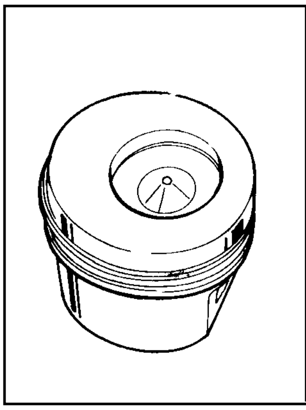
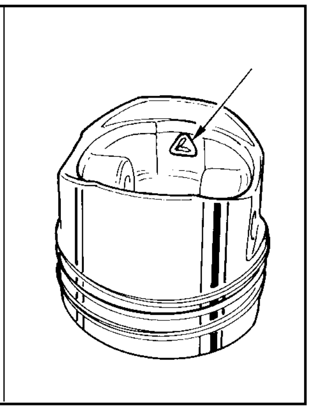
### Piston

Being of low expansion type, the piston allows small clearances between piston and cylinder and, thus, oil consumption is reduced.
Remove circlips and piston pin.
Remove piston rings and clean grooves.
Measure diameter **Q** at the **A** distance from the skirt bottom (**A** = 12 mm).
Replace the piston and piston rings if wear on the diameter is 0.05 mm more than the minimum value given (see table in fig. 40-41).

**Note**: Oversize pistons of 0.50 and 1.00 mm are available.

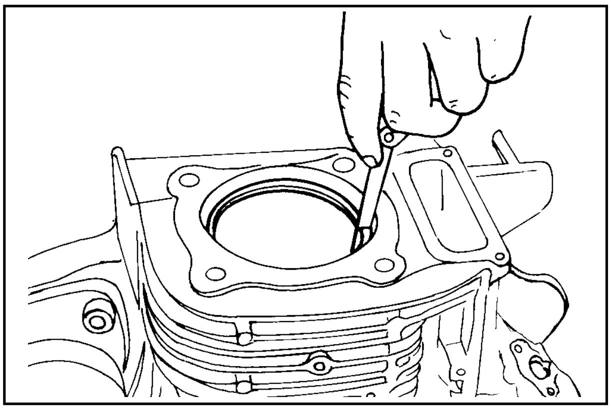



40 41

### Dimensions of pistons and cylinders, Logo

**Logo can be found inside the piston**

| Pistons and cylinder dimensions (mm) | | | |
|---|---|---|---|
| | Ø Cilinders | Ø Piston | Clearance |
| **15 LD 225** | 69.00÷69,015 | 68,955÷68,970 | 0.03÷0.06 |
| **15 LD 315** | 78.00÷78.15 | 77.955÷77.970 | 0.03÷0.06 |
| **15 LD 350** | 82.00÷82.015 | 81.955÷81.970 | 0.03÷0.06 |
| **15 LD 400** | 82,00÷82,015 | 81,955÷81,970 | 0.03÷0.06 |
| **15 LD 440** | 86,00÷86,015 | 85,955÷85,970 | 0.03÷0.06 |



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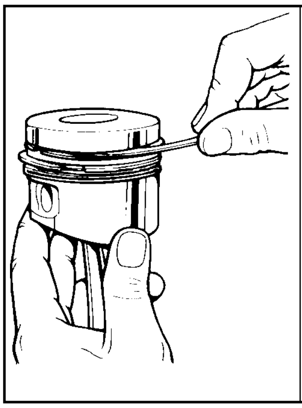
**Piston rings, distance between the tips (mm)**

Fit the piston ring into the top part of the cylinder and measure the distance between the tips.

| Engine | Piston rings | Value | | |
|---|---|---|---|---|
| | | GOETZE (stamped GOE) | BUZULUK (stamped KO) | NR (stamped N) |
| **15 LD 225** | 1st piston ring (nitrided) | 0.20÷0.40 | | |
| | 2nd piston ring | 1.00÷1.50 | 0,30÷0,50 | |
| | 3rd piston ring, oil scraper (nitred) | 0.25÷0.50 | | |
| **15 LD 315** | 1st piston ring (chromated) | 0.30÷0.50 | | |
| | 2nd piston ring (torsional) | 0.30÷0.50 | | |
| | 3rd piston ring, oil scraper | 0.25÷0.50 | | |
| **15 LD 350** | 1st piston ring (nitrided) | 0.20÷0.35 | | |
| | 2nd piston ring | 1.00÷1.50 | 0,30÷0,50 | |
| | 3rd piston ring, oil scraper (nitred) | 0.25÷0.50 | | |
| **15 LD 400** | 1st piston ring (nitrided) | 0.20÷0.35 | | |
| | 2nd piston ring | 1.00÷1.50 | 0,30÷0,50 | |
| | 3rd piston ring, oil scraper (nitred) | 0.25÷0.50 | | |
| **15 LD 440** | 1st piston ring (chromated) | | 0.20÷0.35 | |
| | 2nd piston ring (torsional) | | 0.30÷0.50 | |
| | 3rd piston ring, oil scraper | | 0.20÷0.40 | |

Wear limit 1 mm - for the 2nd piston ring of 15 LD 225 and 15 LD 350 engines, the wear limit is 2.0 mm.



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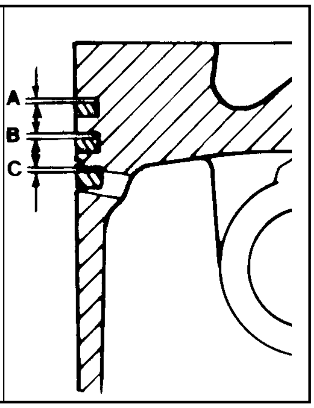


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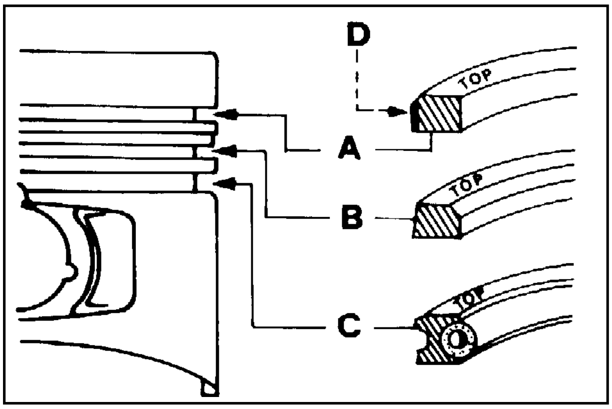
**Piston rings, play between the slots (mm)**

| | 15 LD 225 | 15 LD 315 | 15 LD 350 - 400 | 15 LD 440 |
|---|---|---|---|---|
| A | 0.07÷0.115 | 0.07÷0.10 | 0.035÷0.11 | 0,07÷0,11 |
| B | 0.04÷0.08 | 0.05÷0.08 | 0.050÷0.09 | 0,05÷0,09 |
| C | 0.03÷0.07 | 0.04÷0.075 | 0.030÷0.087 | 0,03÷0,07 |

Replace the piston or piston rings if the value exceeds the maximum limit.

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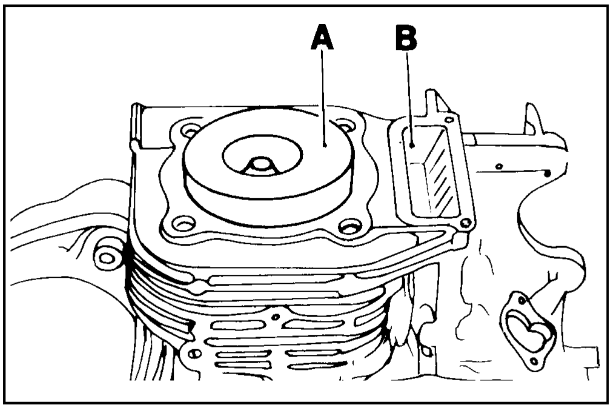
**Piston rings, assembly order**

**A** = 1st Chromium plated piston ring (nitrided for 225-350-400)
**B** = 2nd piston ring (torsional)
**C** = 3rd piston ring (oil scraper) (nitrided for 225-350-400)
**D** = Chromium plated zone

**Note:** If a word (top, or some other word) is written on the surface of a piston ring, mount that surface upwards.
Before inserting the piston into the cylinder, oil and turn the piston rings so that the cuts are staggered 120° to each other.
In 15 LD 350 and 15 LD 225 engines, the second piston ring is not torsional, while the first and third piston rings do not have chromium plated zones but are nitrided.

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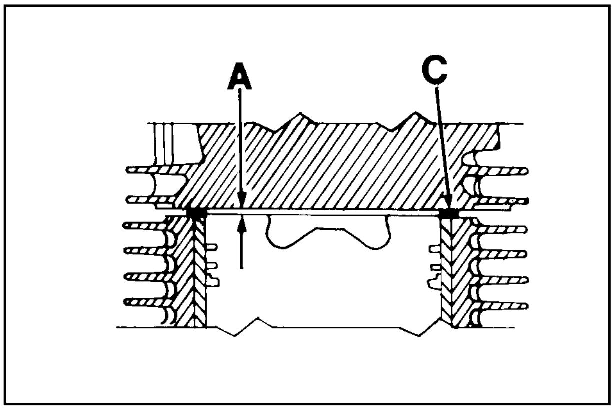
**!** Lubricate the following parts with oil before mounting: the piston pin, the piston, the cylinder and the big-end bearing

**Piston - Refitting**

Connect piston to connecting rod, lubricate piston pin and introduce it into the piston/connecting rod assembly by exerting pressure with your thumb.
Fit both piston pin circlips and check that they are well seated.
When introducing both the connecting rod and the piston into the cylinder make sure that the larger crown surface **A** (if compared to the combustion chamber) is on the same side as the pushrod opening **B**.

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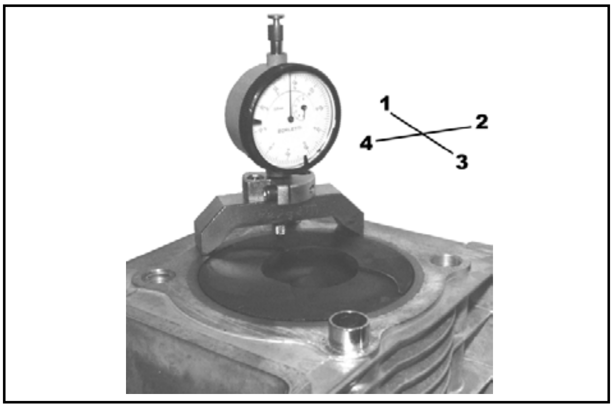
**Clearance**

**A** = Clearance
**C** = Head gasket
The thickness of gasket **C** determines the clearance **A**, which must be 0.45-0.55 mm for 15 LD 315 with injection pump serial N° 6590-259; it is 0.50-0.60 mm with injection pump serial N° 6590-281.
The clearance is 0.45-0.55 mm for 15 LD 225 in all cases.
The clearance is 0.50-0.60 mm for 15 LD 350-400-440 in all cases.
For the correct thickness of gasket **C** see table in fig. 49÷50.
There are gaskets with inner diameters oversized by 1 mm for 15 LD 315 and 15 LD 350, required if the cylinders are ground.

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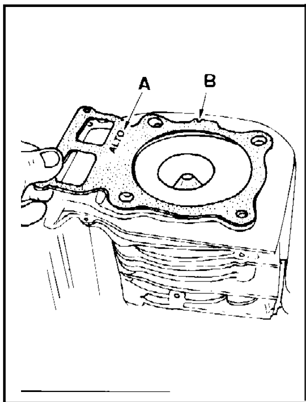
### Piston protrusion check

To calculate the right thickness for the gasket, the protrusion between the piston and the cylinder head surface must be measured.
Use a dial indicator with base plate. Reset to zero while resting on a surface plate, then position against the cylinder head base plane as shown in the diagram, so that the dial indicator rod rests against the piston. Now take the reading.
Repeat the operation in the other three points (going crosswise) and take the readings.
Calculate the average of these four readings to get the precise measurement of the protrusion between the piston and the cylinder head base plane.
Choose the appropriate gasket according to the following table.

**!** Only remove the head gasket from its protective wrapping just before assembly.

**See page 26 when tightening the cylinder head**

Having chosen the required thickness, mount the gasket as shown in the figure (see letter **A**).
Find the number of notches in zone **B** to find the thickness of the gasket when the cylinder head is mounted.
The gasket thickness given in the table is the one obtained with the gasket mounted and the head torqued.

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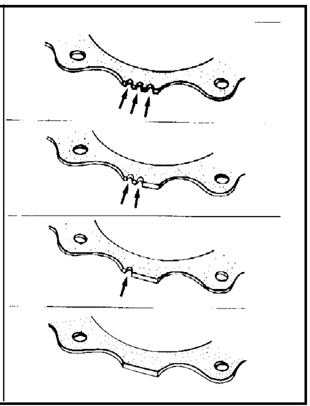

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**Head gasket (mm)**

| For 15 LD 225 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,351÷0,450 | 0,9 | 0 |
| 0,450÷0,550 | 1 | 1 notch |
| 0,550÷0,650 | 1,1 | 2 notches |
| 0,650÷0,750 | 1,2 | 3 notches |

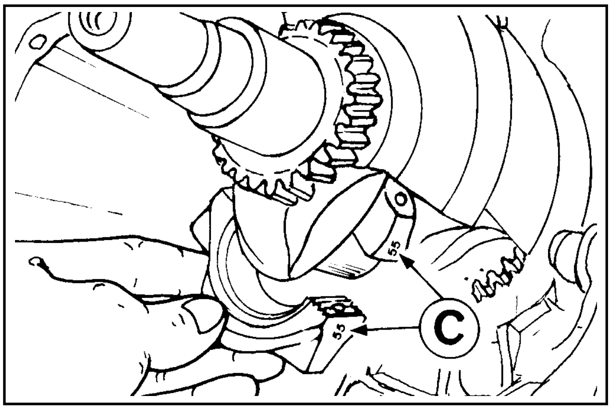
| For 15 LD 315 with injection pump P.no. 6590.259 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,365÷0,450 | 0,9 | 0 |
| 0,450÷0,550 | 1 | 1 notch |
| 0,550÷0,650 | 1,1 | 2 notches |
| 0,650÷0,750 | 1,2 | 3 notches |

| For 15 LD 315 with injection pump P.no. 6590.281 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,365÷0,400 | 0,9 | 0 |
| 0,400÷0,500 | 1 | 1 notch |
| 0,500÷0,600 | 1,1 | 2 notches |
| 0,600÷0,700 | 1,2 | 3 notches |

| For 15 LD 350 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,365÷0,500 | 1 | 0 |
| 0,500÷0,600 | 1,1 | 1 notch |
| 0,600÷0,700 | 1,2 | 2 notches |
| | | |

| For 15 LD 400 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,410÷0,500 | 1 | 0 |
| 0,510÷0,600 | 1,1 | 1 notch |
| 0,610÷0,700 | 1,2 | 2 notches |
| | | |

| For 15 LD 440 | | |
|---|---|---|
| Piston protusion | Gasket Thickness | Number of notches |
| 0,410÷0,500 | 1 | 0 |
| 0,510÷0,600 | 1,1 | 1 notch |
| 0,610÷0,700 | 1,2 | 2 notches |
| | | |



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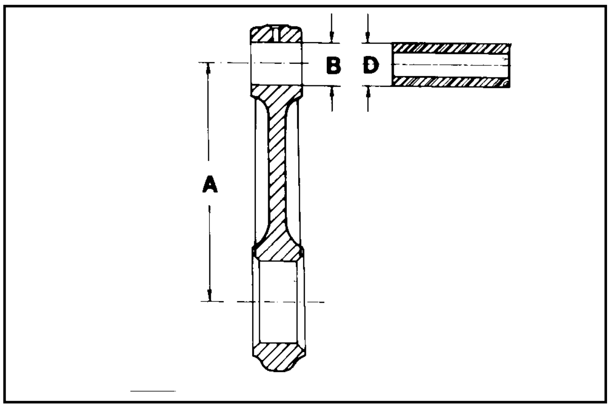
! When remounting the big-end bearings, remember to thoroughly clean the parts and generously lubricate them to prevent seizure when the engine is started up for the first time

**Connecting rod**

Demount the connecting rod and proceed with the following inspections.
The big-end cap and big-end bear the same numbers.
When remounting, mount the cap from the same side as in **C** of the figure.
Tighten the 15 LD 225 bolts to a 23 Nm torque value.
Tighten the bolts to a 30 Nm torque value for 15 LD 315-350-400-440.



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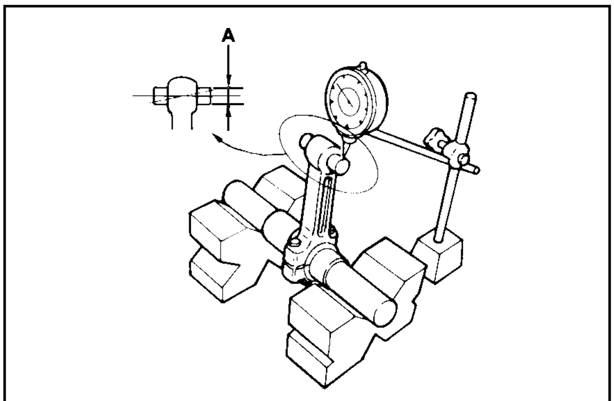
**Connecting rod, piston pin**

| | 15 LD 225 | 15 LD 315 | 15 LD 350 | 15 LD 400-440 |
|---|---|---|---|---|
| A | 99,970÷100,03 | 109,970÷110,03 | 109,97÷110,03 | 124,97÷125,03 |
| B | 20,010÷20,020 | 20,010÷20,020 | 22,010÷22,020 | 23,010÷23,020 |
| D | 19,995÷20,000 | 19,995÷20,000 | 21,995÷22,000 | 22,995÷23,000 |
| (B-D) | 0,010÷0,025 | 0,010÷0,025 | 0,010÷0,025 | 0,010÷0,025 |
| (B-D) limite | 0,05 | 0,05 | 0,05 | 0,05 |

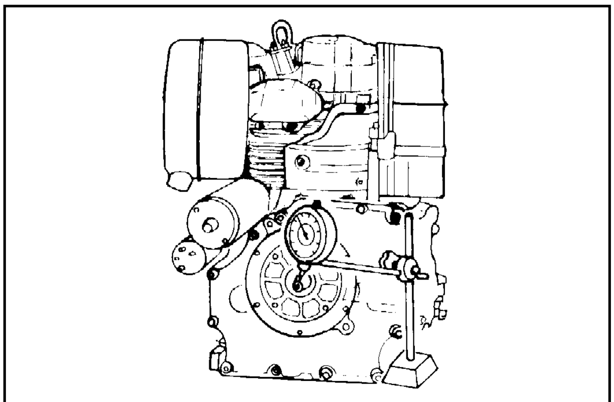
**Note:** The connecting rod has no insert bearings. See fig. 62 for connecting rod big end diameter.



53

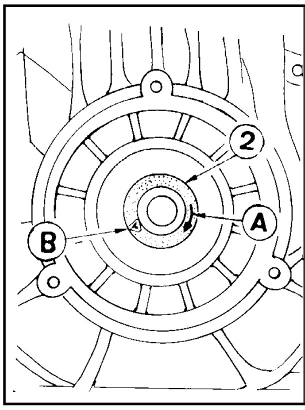
**Connecting rod alignement**

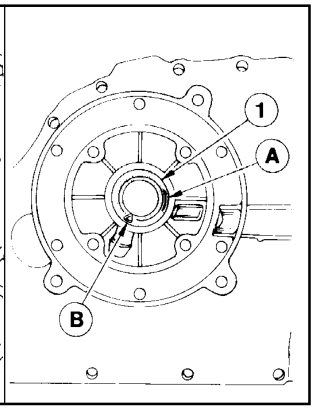
Use a dial gauge as shown in the figure.
Check that axes are aligned using the piston pin; axial misalignment **A** = 0.015; limit 0.03 mm.


54

**Crankshaft end play**

Secure the engine to a metal base or table. Use a dial indicator with column and magnetic base plate. Place the stylus on the crankshaft.
Move the driving shaft back and forth on the flywheel side.
End play should be 0.05 - 0.25 mm; it is not adjustable.



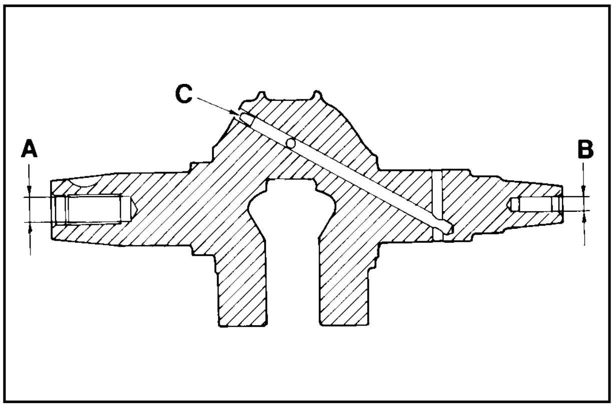




55 56

! A warped oil retainer may allow the introduction of air into the engine thus causing crankcase ventilation problems.
Use genuine oil retainers with the LOMBARDINI logo (see **B**).

**Drive shaft oil seals**

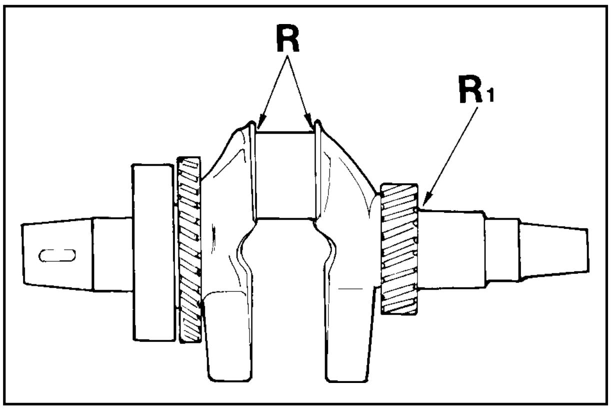
Oil retainer **1** is located in the gear cover on the timing side while retainer **2** is located in the crankcase on the flywheel side.
Arrows a point to the crankshaft direction of rotation.
Press them into their seats by exerting uniform pressure throughout their front surface.




57

**Drive shaft, lubrication ducts, bore thread on flywheel side and p.t.o.**

Remove plug **C** and check that the lubrication duct is perfectly clean.
Close with a new plug checking for proper sealing.
**A** = M14x1.5 (turn counterclockwise)
**B** = M8x1.25 (with standard shaft)

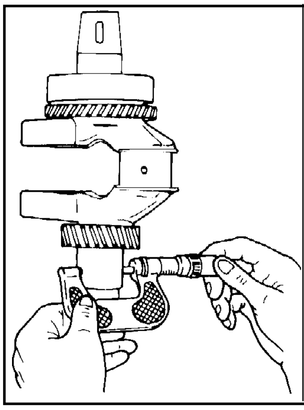


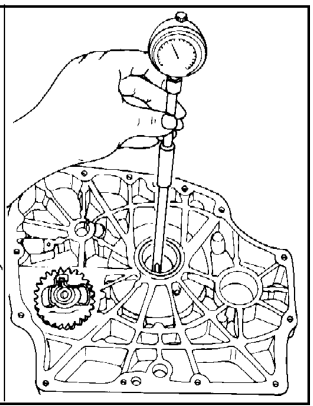

58

! When the crankpin and main journal are ground, values **R** and **$R_1$** must be obtained again to prevent the drive shaft from breaking.

**Drive shaft, connection radius**

Radius **R** that joins the crankpin to the supports is 2.8-3.2 mm.
Radius **$R_1$** that joins the main journal to the timing gear is 0.5 mm.

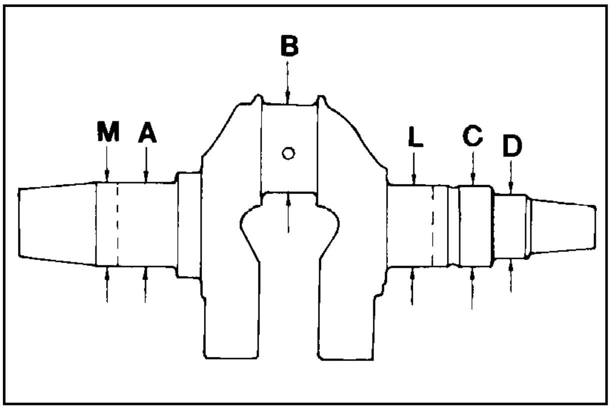




59 60

**Drive shaft, main journal/crankpin diameter, gear cover bearing inside diameter on timing side**

Use an outside micrometer for the main journal and an inside bore gauge for the gear cover bearing on the timing side.

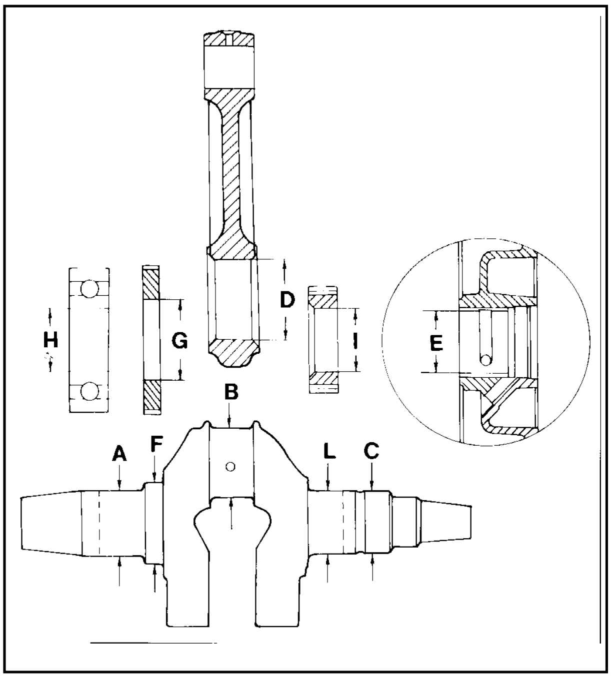



61

**Crankshaft - journal diameter (mm)**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| M<br>oil seal<br>working area | 34,959÷34,975 | 34,959÷34,975 | 39,959÷39,975 |
| A | 35,002÷35,013 | 35,002÷35,013 | 40,002÷40,013 |
| B | 33,984÷34,000 | 37,984÷38,000 | 39,984÷40,000 |
| L | 35,240÷35,256 | 35,240÷35,256 | 40,240÷40,256 |
| C | 34,984÷35,000 | 34,984÷35,000 | 39,984÷40,000 |
| D<br>oil seal<br>working area | 27,967÷28,000 | 27,967÷28,000 | 29,967÷30,000 |

The undersizes for the crankpin and main journal are 0.25, 0.50 and 1 mm.




62

! The gears must be mounted with the right tools so that they can be correctly timed.
The gears should not therefore be demounted.
Only the complete shaft is available as a spare.

**Drive shaft - Main bearing inside diameter, connecting rod big end, crankshaft bearing and timing control gear and balancer - Clearance and interference between the corresponding journals**

**Dimensions (mm) (see also fig. 61)**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| D | 34,030÷34,046 | 38,030÷38,046 | 40,030÷40,046 |
| E | 35,030÷35,050 | 35,030÷35,050 | 40,030÷40,050 |
| G | 45,000÷45,016 | 45,000÷45,016 | 53,000÷53,019 |
| H | 34,988÷35,000 | 34,988÷35,000<br>35,184÷35,200 | 39,988÷40,000 |
| I | 35,200÷35,216 | 35,200÷35,216 | 40,200÷40,216 |

**Clearance (mm)**

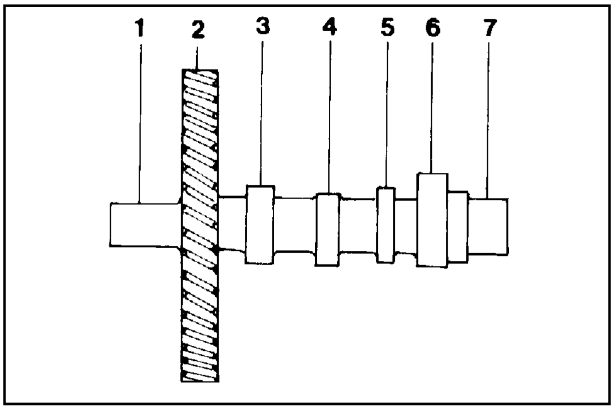
| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| **(D-B)** | 0,03÷0,062 | 0,030÷0,062 | 0,0300,062 |
| **(D-B)** limite | 0,120 | 0,120 | 0,120 |
| **(E-C)** | 0,03÷0,066 | 0,030÷0,066 | 0,0300,066 |

**Interference (mm)**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| **(A-H)** | 0,002÷0,025 | 0,002÷0,024 | 0,002÷0,024 |
| **(F-G)** | 0,015÷0,056 | 0,015÷0,056 | 0,015÷0,056 |
| **(L-I)** | 0,024÷0,056 | 0,024÷0,056 | 0,024÷0,056 |

**Availability of bearings**

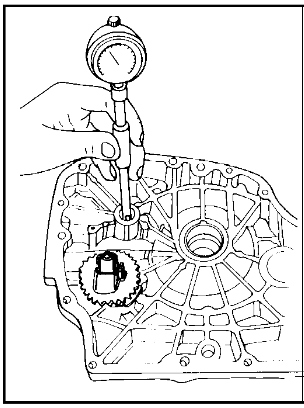
Main bearings are available at their nominal value or undersized 0.25 , 0.50 and 1.0 mm.
Connecting rods are available with big end at nominal value or undersized 0.25 and 0.50 mm.




63

## Camshaft

Components:
**1** Journal, gear cover on timing side
**2** Gear
**3** Exhaust lobe
**4** Injection lobe
**5** Fuel pump eccentric
**6** Intake lobe
**7** Journal, crankcase side



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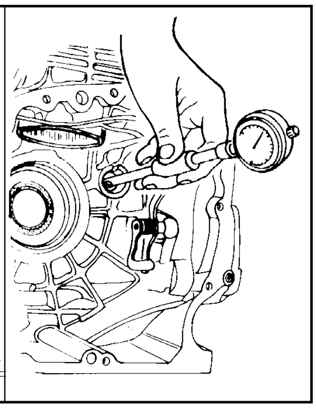

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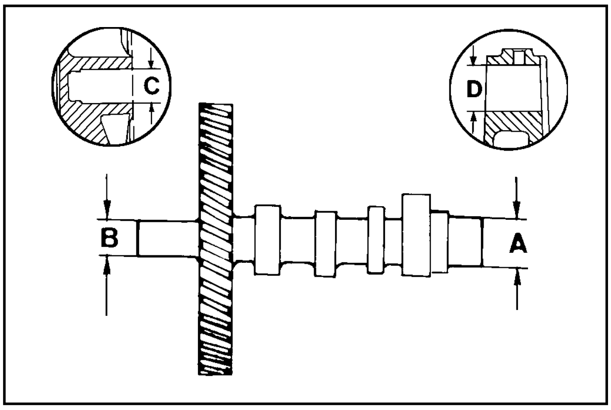
## Camshaft journals and bore

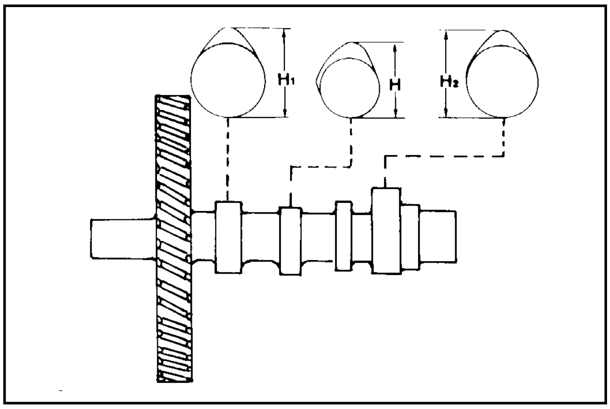
Use a comparator for interiors




66

**Dimensions of camshaft journals and bore (mm)**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| **A** | 19,459÷19,474 | 21,959÷21,980 | 17,966÷17,984 |
| **B** | 15,957÷15,984 | 15,957÷15,984 | |
| **C** | 16,000÷16,018 | 16,000÷16,018 | |
| **D** | 19,500÷19,521 | 22,000÷22,021 | 18,00÷18,018 |
| **(D-A)** | 0,026÷0,062 | 0,020÷0,062 | 0,016÷0,052 |
| **(D-A)** limite | 0,120 | 0,120 | 0,100 |
| **(C-B)** | 0,016÷0,061 | 0,016÷0,061 | |
| **(C-B)** limite | 0,120 | 0,120 | |

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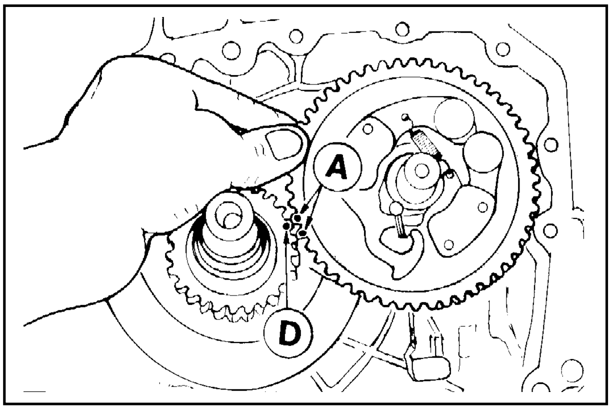
**Cam height (mm)**

| | 15 LD 225 | 15 LD 315-350 | 15 LD 400-440 |
|---|---|---|---|
| **H** | 30,25÷30,30 | 30,25÷30,30 | 32,00÷32,05 |
| **$H_1$** | 35,75÷35,80 | 35,75÷35,80 | 36,10÷36,15 |
| **$H_2$** | 33,65÷33,70 | 35,05÷35,10 | 35,10÷35,15 |

**Note:** Replace camshaft if cam wear exceeds the minimum given value of H, H1 and H2 by 0.1 mm.

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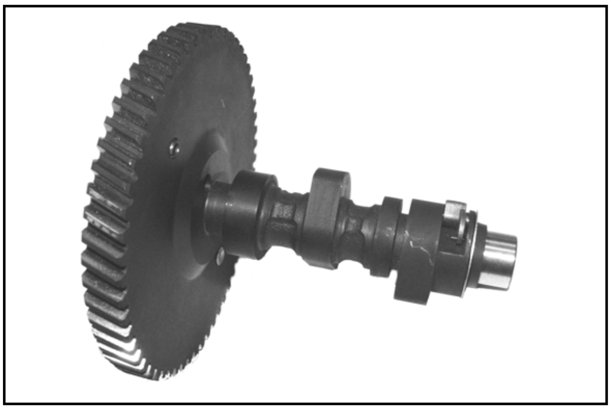
### Camshaft timing

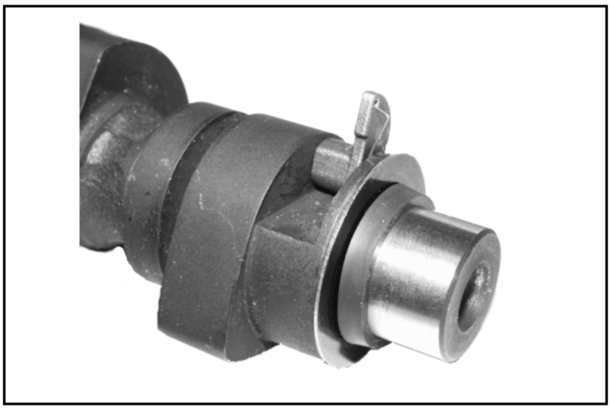
Fit camshaft by aligning marks' **A** with mark **D** on the crankshaft.



68a

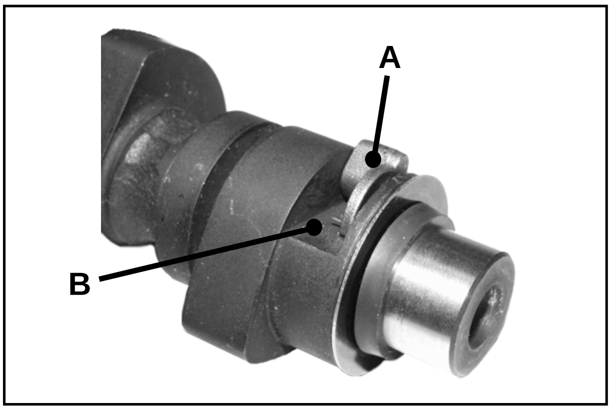
### Camshaft – Antireverse system 15 LD 400-440

it consists of a device on the camshaft which lifts the intake valve in case of a startup in reverse direction with respect to normal rotation.



68b

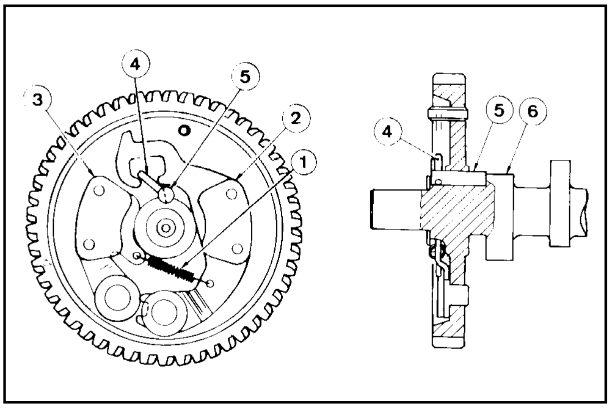
During normal operation, the tappet overcomes the spring resistance while passing on the system and decompression does not operate.




68c

In case of a startup in reverse direction, the antireverse system lifts the valve as the tappet passes by. Startup is thus inhibited.

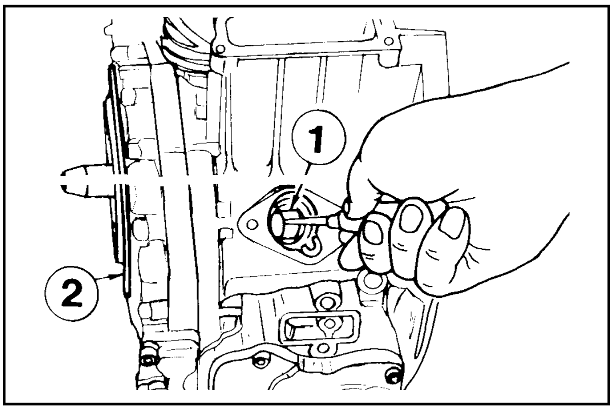
Note: Check the antireverse system for wear, and make sure it is kept in the rest position by the return spring, as shown in picture 68c. Verify that in this condition the clearance between weight A and surface B is 1 mm.




69 70

### Automatic decompression

With the engine at a standstill and up to a rate of about 300 RPM, spring **1**, acting on weights **2** and **3** via lever **4** and pin **5**, keeps the exhaust valve open during the compression phase also.
Once the engine exceeds the 300 RPM rate, weights **1** and **2** keep pin **5** in the hold position owing to the action of the centrifugal force. In this position, cam **6** can regularly control the exhaust valve thanks to a ridge on the pin itself.
Since there is then no compression in the cylinder, the engine will easily start when the self-winder is used.

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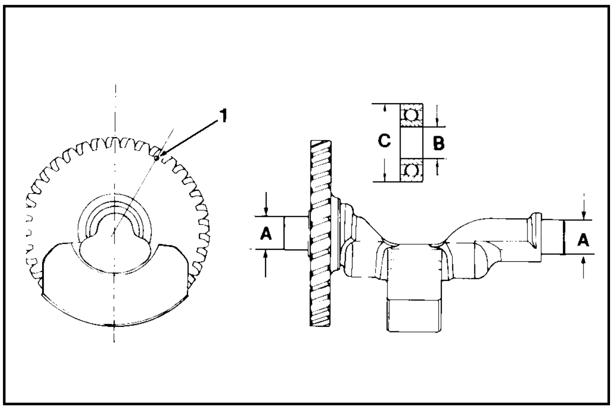
### Camshaft end play

Perform this check before fitting cylinder head and tappets including the injection tappets.
Temporarily fit camshaft **1** complete with washer; tighten gear cover **2** to 25 Nm.
Check end play by moving the camshaft back and forth using a suitable tool; the end play value is 0.10÷0.25 mm and is not adjustable.

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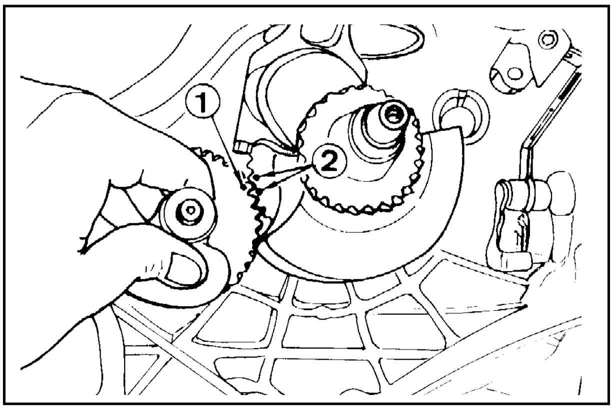
### Dynamic balancer (on request)

The dynamic balancer is supported by two identical ball bearings housed in the crankcase and in the gear cover on the timing side respectively.
**1** is the reference point for timing with the cranksaft gear (see below).

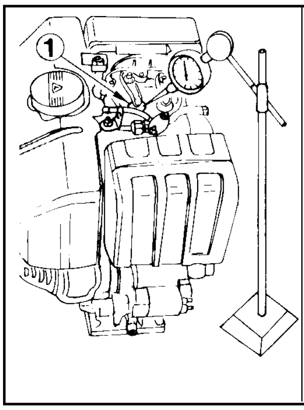
Dimensions (mm):
**A** = 14.983-14.994
**B** = 14.99-15.00
**C** = 34.89-35.00
**D** = 34.958-34.983 (bearing housing diameter on crankcase and gear cover on timing side).




73

**Dinamic balancer timing**

Position crankshaft as shown in the figure.
Introduce the dynamic balancer so that timing mark **1** engages between teeth **2** of the crankshaft gear.

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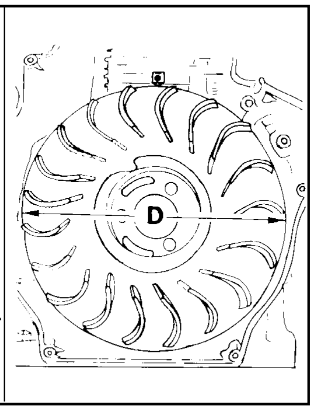


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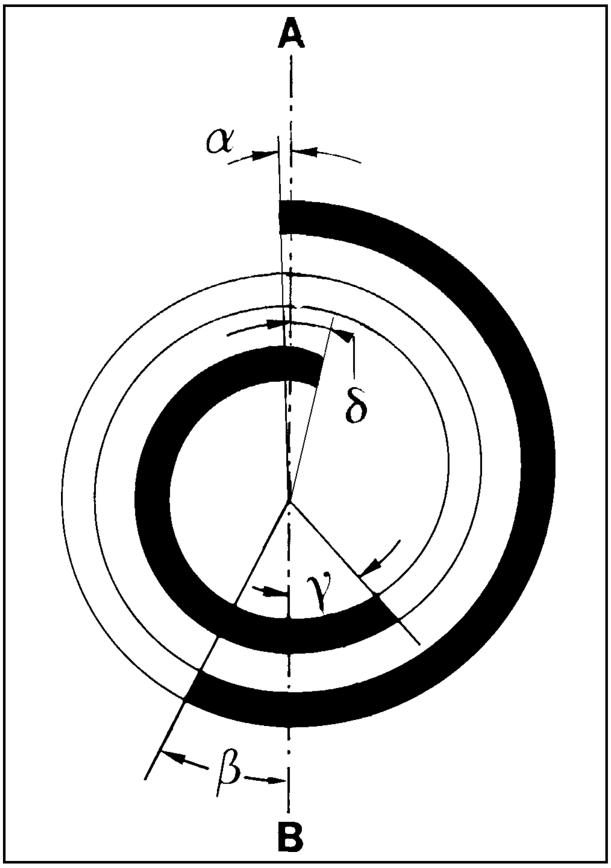
**Valve timing check**

Remove the tank and conveyor to access the flywheel.
Carry out the inspections on the drive shaft. The values given are measured on the circumference of the flywheel.
Adjust the valve play as indicated on the next page.
Reset the comparator on the cap of intake valve **1**. Turn the drive shaft in the spinning direction and find $\alpha$ (point at which the intake valve starts to open in relation to top dead center **A**) and $\beta$ (point at which the intake valve shuts after bottom dead center **B**) see fig. 77-78.
Proceed in a similar way with the exhaust valve, checking $\gamma$ (point at which the exhaust valve opens) and $\delta$ (point at which the exhaust valve shuts).

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**Timing angles for operation (0.15 valve play).**

**For 15 LD 225**

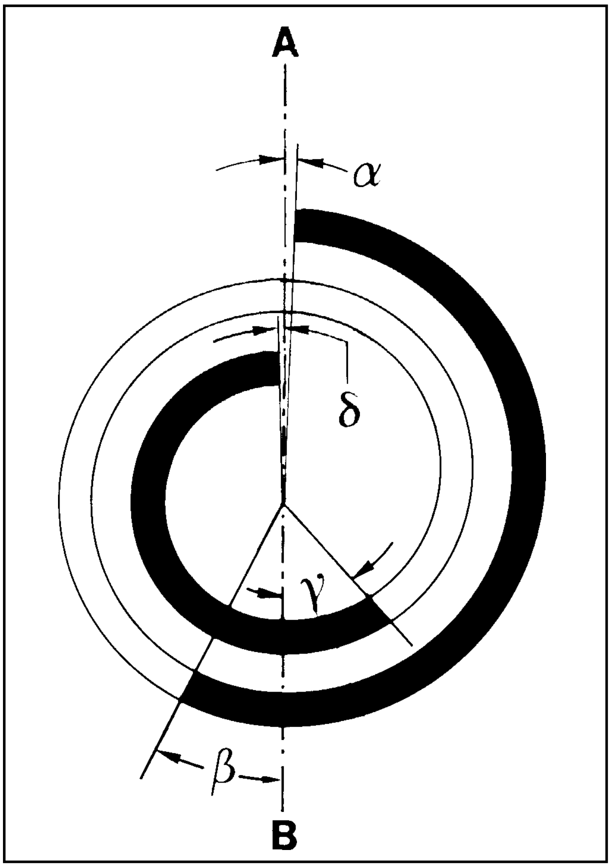
α = 6° before **A** corresponding to 12 mm
β = 22° after **B** corresponding to 44 mm
γ = 58° before **B** corresponding to 116 mm
δ = 10° after **A** corresponding to 20 mm.

Values measured on the circumference of the flywheel D = 230 (one degree corresponds to 2 mm).

**For 15 LD 315 - 350**

α = 10° before **A** corresponding to 20.09 mm
β = 42° after **B** corresponding to 87.78 mm
γ = 58° before **B** corresponding to 121.22 mm
δ = 10° after **A** corresponding to 20.9 mm.

Values measured on the circumference of the flywheel D = 240 (one degree corresponds to 2.09 mm).




78

**Timing angles for inspection (0.65-0.70 valve play).**

**For 15 LD 225**

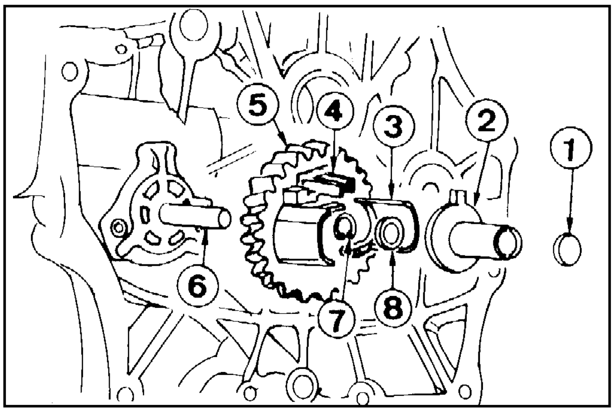
α = 7° after **A** corresponding to 14 mm
β = 9° after **B** corresponding to 18 mm
γ = 45° before **B** corresponding to 90 mm
δ = 3° before **A** corresponding to 6 mm.

Values measured on the circumference of the flywheel D = 230 (one degree corresponds to 2 mm).

**For 15 LD 315 - 350**

α = 1° after **A** corresponding to 2.09 mm
β = 31° after **B** corresponding to 64.79 mm
γ = 45° before **B** corresponding to 94.05 mm
δ = 3° before **A** corresponding to 6.27 mm.

Values measured on the circumference of the flywheel D = 240 (one degree corresponds to 2.09 mm).

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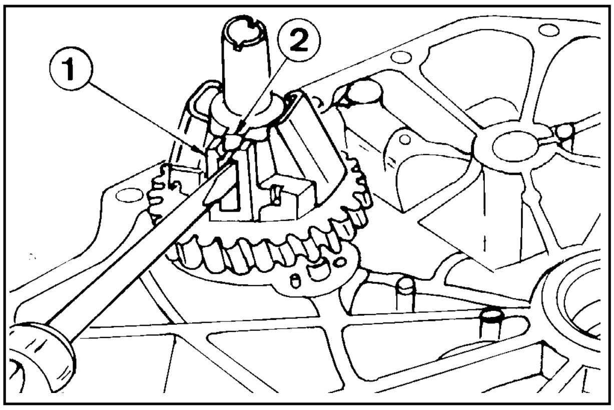
**Speed governor**

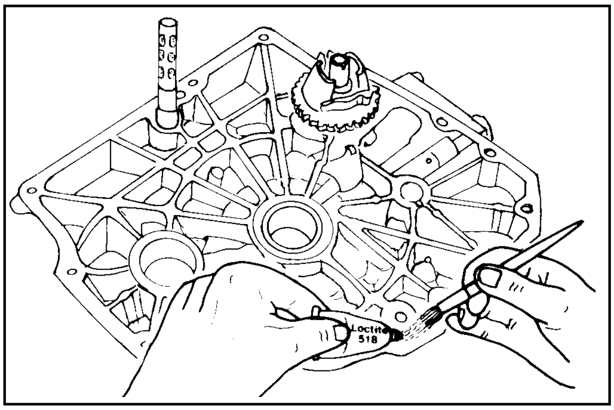
Components:
**1** Spool spacer
**2** Spool
**3** Weights
**4** Spool guide
**5** Gear
**6** Oil pump driving shaft
**7** Circlip
**8** Thrust ring




80

**Speed governor removal**

Spool guide **1** has retainers one end which prevent spool **2** from slipping out.
To remove the speed governor use a suitable tool to slightly widen the two teeth.

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**Refitting gear cover on timing side**

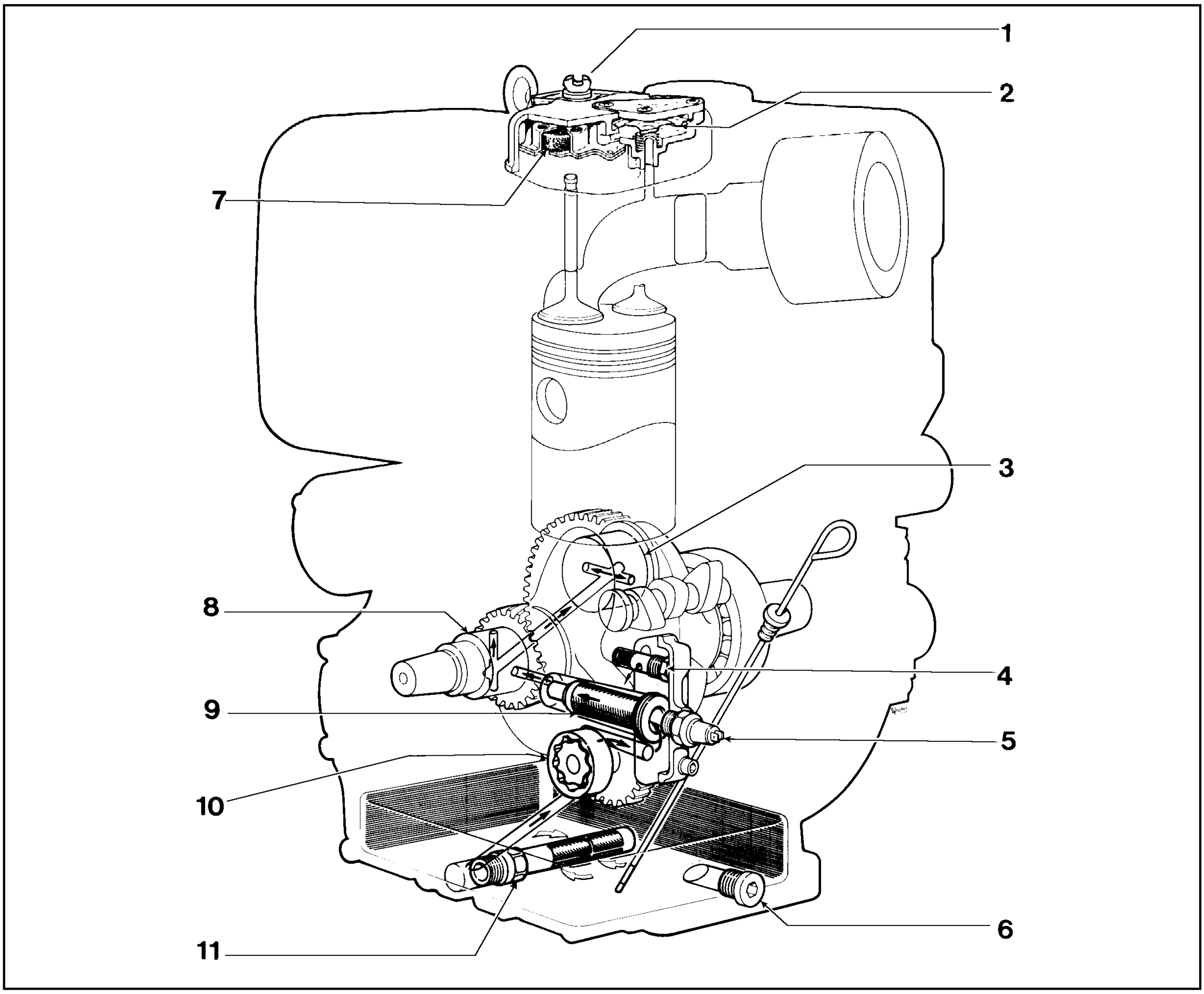
Proper sealing between gear cover and crankcase is ensured by the liquid sealant "Loctite 5205". Carefully clean the two sealing surfaces and spread the sealant uniformly.
Tighten screws to 23 Nm.

! Wait **3** hours before starting the engine.

The engine can be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil because its combustion may lead to a sharp increase in the rotation speed.
Use suitable oil in order to protect the engine.
Nothing more than lubrication oil can influence the performances and life of an engine.
Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts. Engine life will also be notably reduced.
The oil viscosity must suit the ambient temperature in which the engine operates.

Old engine oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time. Wear protective gloves to avoid touching used oil. If contact with the oil is unavoidable, you are advised to wash your hands with soap and water as soon as possible. Dispose of old oil in the correct way as it is highly polluting.

## 15 LD 225 - 315 - 350 LUBRICATION SYSTEM AND BREATHER RECIRCULATION SYSTEM

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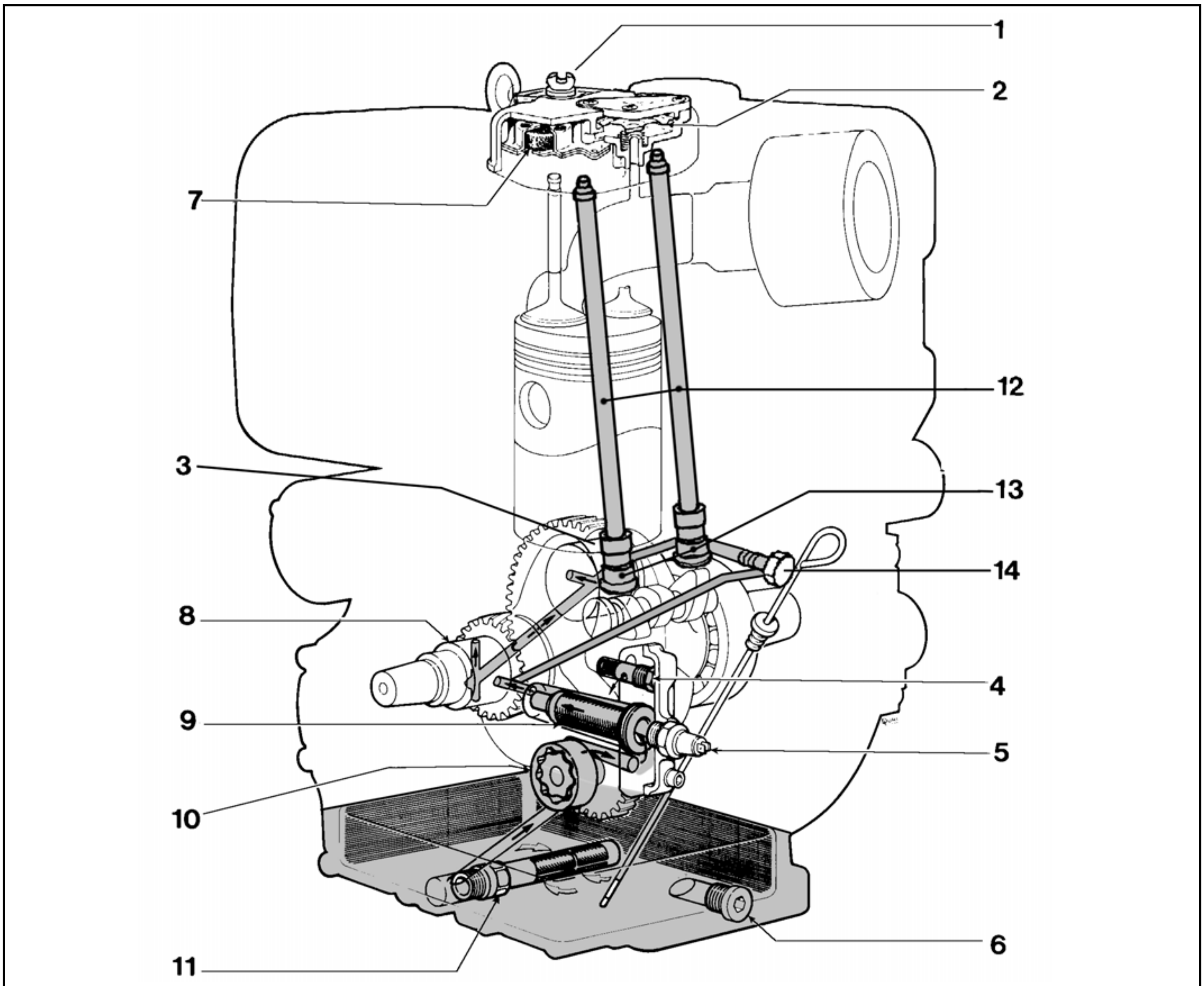
Components:

**1)** Oil fill cap
**2)** Safety valve
**3)** Rod journal
**4)** Pressure control valve
**5)** Pressure switch
**6)** Oil drain plug
**7)** Metal filter element
**8)** Main journal
**9)** Oil filter
**10)** Oil pump
**11)** Oil intake filter

## 15 LD 400-440 LUBRICATION SYSTEM AND BREATHER RECIRCULATION SYSTEM

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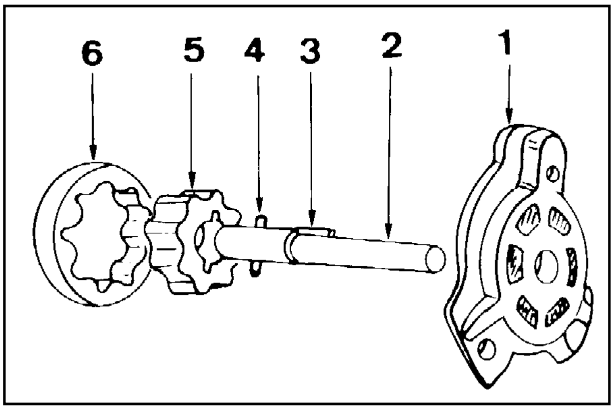
Components:

**1)** Oil fill cap
**2)** Safety valve
**3)** Rod journal
**4)** Pressure control valve
**5)** Pressure switch
**6)** Oil drain plug
**7)** Metal filter element
**8)** Main journal
**9)** Oil filter
**10)** Oil pump
**11)** Oil intake filter
**12)** Pushrods
**13)** Hydraulic tappets
**14)** Calibrated union

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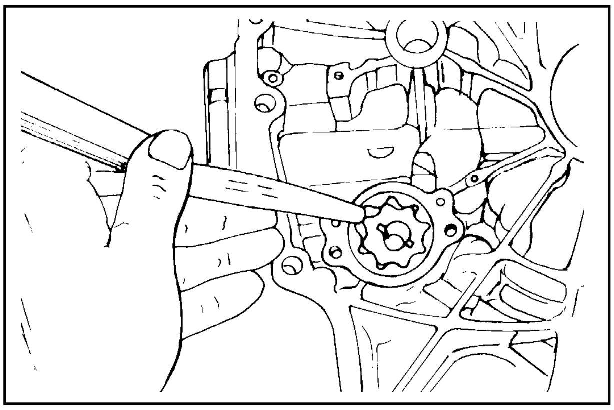
**Oil pump**

Components:

**1** Cover
**2** Shaft
**3** Key
**4** Pin
**5** Internal rotor
**6** External rotor

Oil pump delivery at 3000 rpm is 5.8 l/min.



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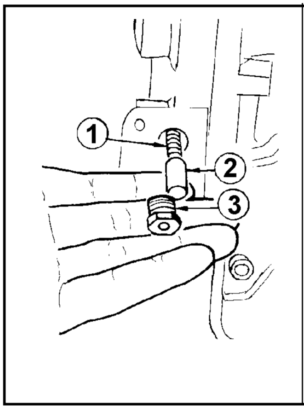
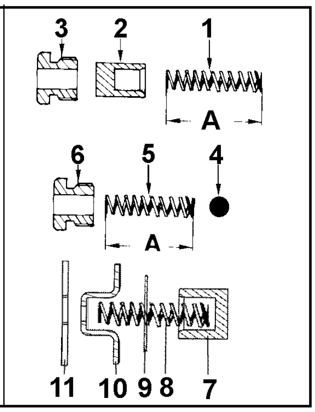
**Oil pump - Clearance between rotors**

Measure clearance as shown in the figure; the max. value is 0.13 mm; wear limit 0.25 mm.

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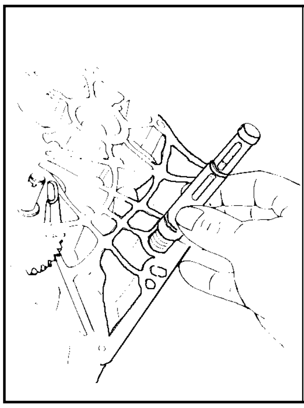
**Oil pressure regulation valve**

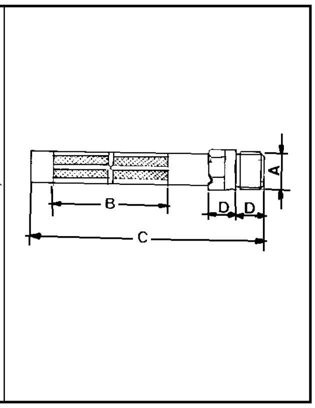
**Components for 15 LD 315 and 15 LD 350:**
**1** Spring **2** Valve **3** Plug
Free length **A** of the spring is 27.50-27.75 mm.

**Components for 15 LD 225:**
**4** Ball **5** Spring **6** Plug
Free length **A** of the spring is 23.50-24.50 mm.

**Components for 15 LD 400-440:**
**7** Plunger **8** Spring **9** Washer
**10** Cup **11** Snap ring
Free length **A** of the spring is 25,50÷25,75 mm.

Note: If **A** is 1 mm less than the given value, replace the valve.
Valve setting is not adjustable.



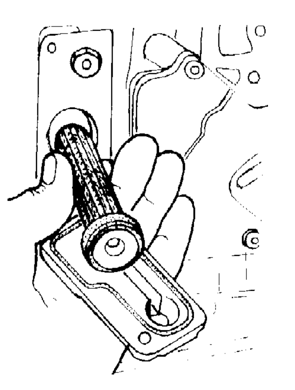


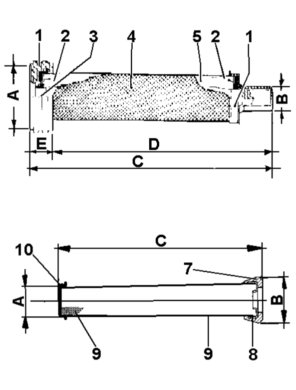

88 89

**Internal strainer**

The oil pick-up strainer is made of nylon 66. Its degree of filtration is 500 µm.

Dimensions (mm):
**A** = M16x1.5
**B** = 64
**C** = 102
**D** = 12






90 91

**Oil filter**

Filter components: **15 LD 315/350**

**1** Seal
**2** Adhesive
**3** End cap
**4** Filtering material
**5** Plate

Dimension mm: **A** = 26.5 **B** = 18 **C** = 88.5 **D** = 67.5 **E** = 8.5

Characteristics:
Useful filtering area = 75 $cm^2$
Degree of filtration = 50 µm.
The by-pass valve is set at 0.6-0.8 bar.

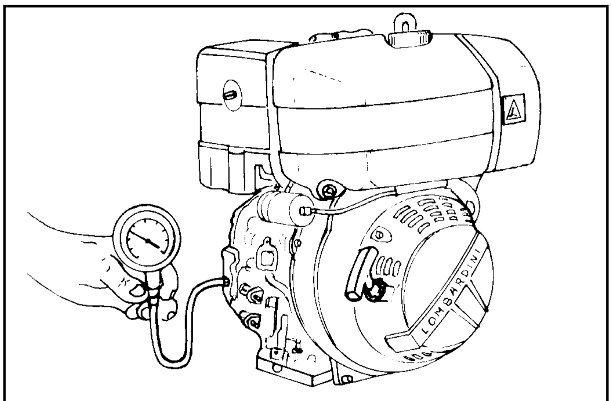
Filter components: **15 LD 225**

**7** Rubber pad
**8** Upper cover
**9** Filter element
**10** Lower cover

Dimension mm: **A** = 19.0-19.3 **B** = 12.5 **C** = 83.0-83.5

Characteristics:
Useful filtering area ≥ 75 $cm^2$
Degree of filtration = 40-60 µm.

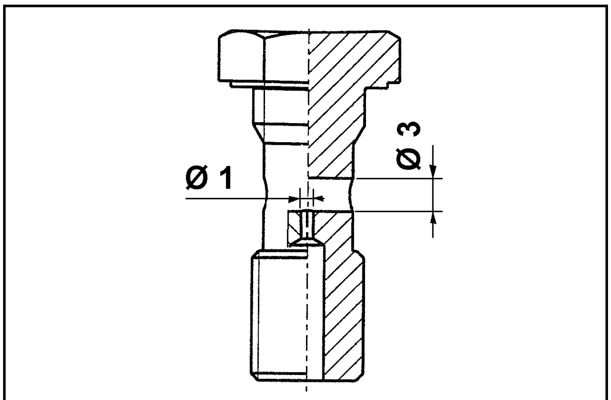
See page 18 for the replacement frequencies.



92

**Oil pressure check**

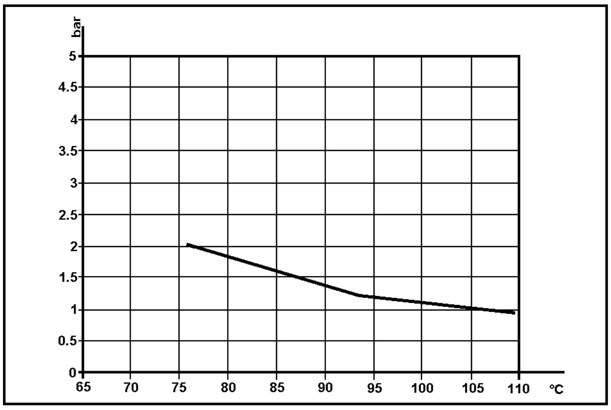
When assembly operations are completed fill engine with oil and fuel; connect a 10 bar pressure gauge to the oil filter fitting.
Start the engine and check pressure as a function of the oil temperature (see below).




93

**Calibrated pipe for lubrication of hydraulic tappets**

The pipe is fitted to the hydraulic tappets oil line (see fig. 83, detail 11).
If the calibrated hole is clogged, the tappets are not sufficiently lubricated, valve clearance is therefore increased and the engine may be noisier.
If the diameter of the calibrated pipe is larger than the ones given in picture 93, the pressure exerted by the hydraulic tappets may cause the valves to remain open even during the compression phase.

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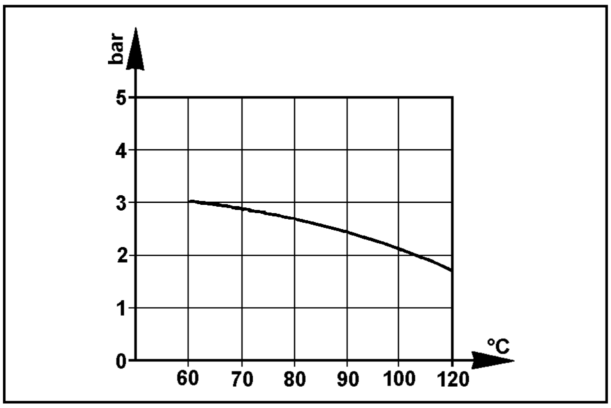
**Oil pressure curve at idle speed**

The curve is obtained at the oil filter port with engine running at a constant speed of 1200 r.p.m. in no-load conditions; pressure is given in bar and temperature in centigrades.
The curve represents the minimum pressure value while the maximum value is 5 bar.

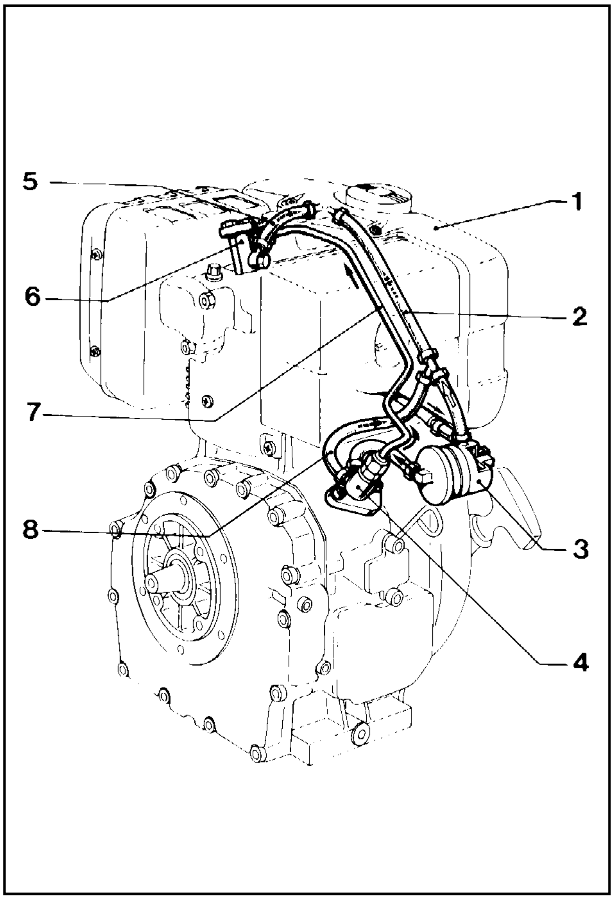



95

**Oil pressure curve at full speed**

The curve is obtained at the oil filter port with engine running at 3000 r.p.m. at the **N** power; pressure is given in bar and temperature in centigrades.
The curve represents the minimum pressure value while the maximum value is 5 bar.

**Note**: After the running-in period the lube max. temperature should be less than the room temperature +95°C.

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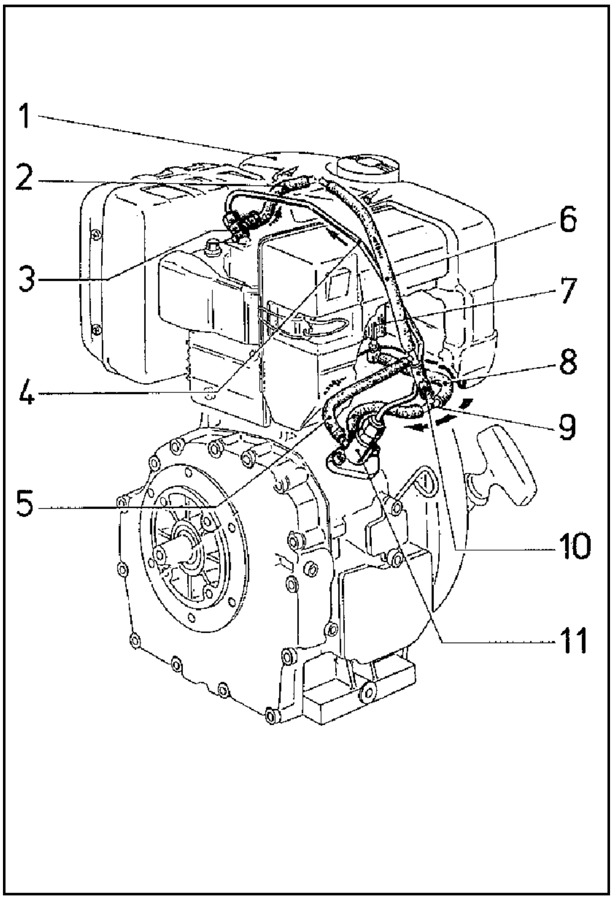
**Fuelling/injection circuit for 15 LD 315-350-400-440**

Components:

**1** Tank
**2** Return tube
**3** Fuel filter
**4** Injection pump
**5** Injector leak-off line
**6** Injector
**7** High pressure line
**8** Return tube

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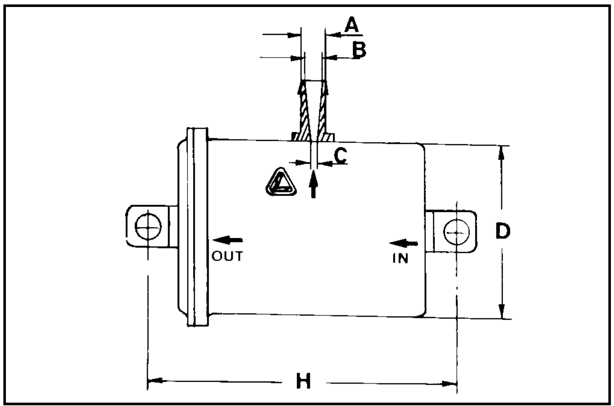
**Fuelling/injection circuit for 15LD 225**

**1** Tank
**2** Injector leak-off line
**3** Injector
**4** High pressure line
**5** Return tube
**6** Return tube
**7** Diesel fuel filter
**8** Fuel pipe
**9** T-connector
**10** Reduction
**11** Injection pump

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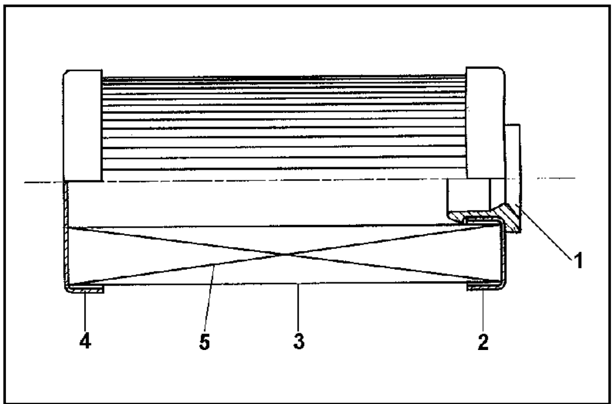
**Fuel filter 15 LD 225-315-350-400-440**

**A** = 7.3
**B** = 3.8
**C** = 1.5
**D** = 42
**H** = 75

Characteristics:
Filtering area ≥ 390 cm²
Filtration level ≤ 7 µm
See page 18 for fuel filter replacement

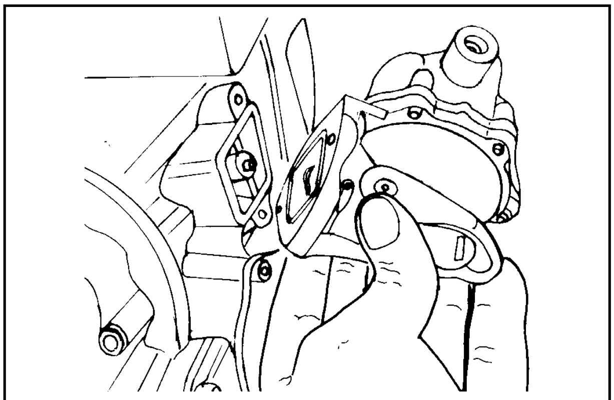



99

**Fuel filter 15LD 225 (version with internal filter in tank)**

**1** Rubber retention ring
**2** PRV cover
**3** SCP radial unit
**4** PRV cover
**5** Segment

Characteristics:
Filtering area 215 $cm^2$
Filtration level 7 µm
See page 18 for fuel filter replacement

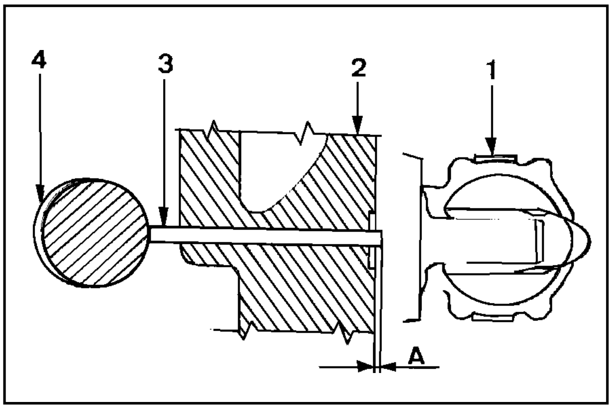


100

**Feed pump (optional)**

A feed pump is usually requested when the tank is not supplied in conjunction with the engine.
The pump is the diaphragm type and is operated by a camshaft eccentric through a drive rod.
Tighten screws to 15 Nm.

Characteristics: At 2000 rpm of the camshaft, the minimum delivery is 40 l/h, while the automatic adjustment pressure is 0.5 ÷ 0.7 bars.

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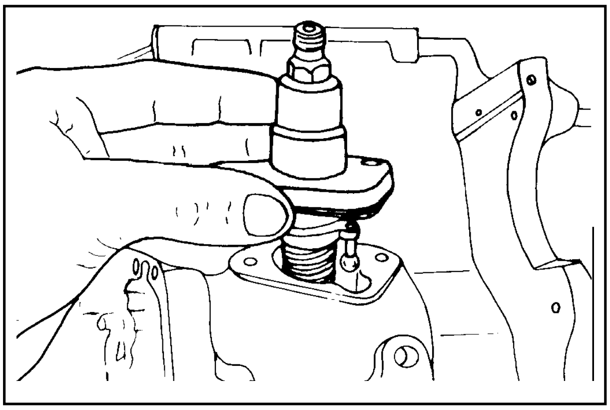
### Fuel pump, drive rod protrusion

Components:

**1** Fuel pump
**2** Crankcase
**3** Drive rod
**4** Eccentric

Check while eccentric **4** is at rest (lowest point of travel).
Protrusion **A** of drive rod 3 is 1.5-1.9 mm; it is not adjustable.

Drive rod length = 58-58.2 mm for 15 LD 225
Drive rod length = 65.8-66.0 mm for 15 LD 315/350
Drive rod length = 61,4÷61,6 mm for 15 LD 400/440



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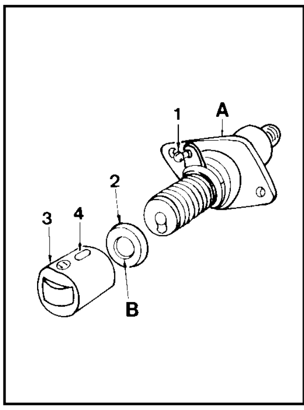
### Injection pump

This is of the simplified QLC type; it is housed in the crankcase and is controlled by the camshaft via tappets.

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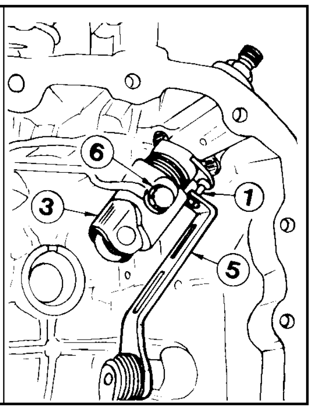


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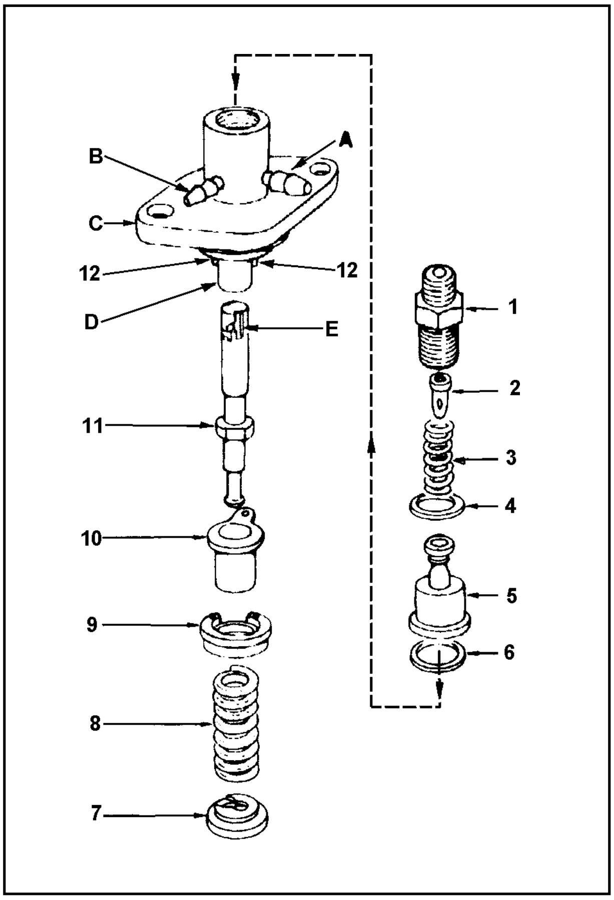
### Injection pump fitting in the crankcase

Fit tappets **3** so that screw **6** is introduced into guide **4**.
Tighten screw **6** to 9 Nm and check that the tappet is free to move downwards.
Fit pad **2** into the tappet so that recess **B** points downwards as shown in the figure.
Fit the injection pump into the crankcase complete with gasket (**C**) position8ing flow control **1** in the fork of lever **5** which should be in the maximum flow position.

**!** When removing the injection pump from its housing make sure that spacer **2** is not dropped into the oil sump; injection pump operation will be impaired uf the spacer is not installed.



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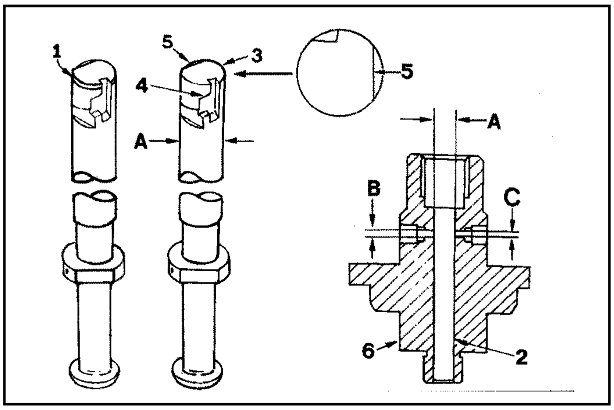
### Injection pump components and disassembly

**1** Delivery union
**2** Filler
**3** Spring
**4** Gasket
**5** Valve
**6** Gasket
**7** Spring retainer
**8** Spring
**9** Spring plate
**10** Rack
**11** Plunger
**12** Pin

**A** = Fuel outlet union
**B** = Fuel intake union
**C** = Fastening
**D** = Barrel
**E** = RH helix

Demount in compliance with the numeric order.
Plate **9** is held firm by pins **12**. Lever up by inserting a tool between the plate and the body of the pump.
The volume shifted by delivery valve **5** is 15 $mm^3$ in the pump of 15 LD 315-350 and 25 $mm^3$ in the pump of 15 LD 225 is 21 $mm^3$ in the pump of 15 LD 400/440



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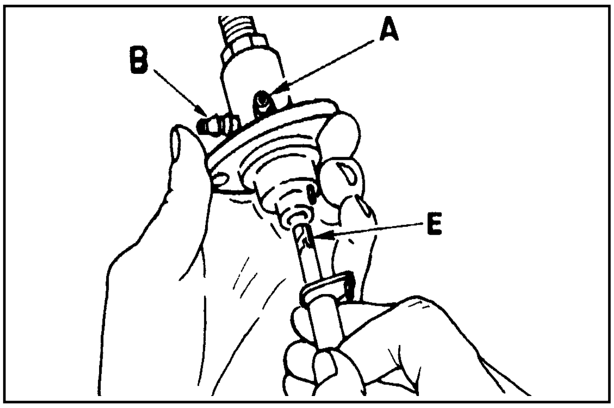
### Injection pump, body, plunger and delivery valve

| Components: | Dimensions mm: |
|---|---|
| **1** Delivery valve | **A** = 5.50 (nominal diam.) 225-315-350 |
| **2** Barrel | **A** = 7,00 (nominal diam.) 400-440 |
| **3** Plunger | **A** = 6,00 (nominal diam.) 315-350 EPA |
| **4** Right helix | **B** = 2.00 / 2.03 |
| **5** Delay notch | **C** = 1.50 /1.53 |
| **6** Pump body | |
| **7** Collar | |

**Note:** The injection pump installed in engines for small vehicles, soundproof generating sets, EPA and 15 LD 400-440 engines, are characterised by the inclusion of a collar **1** which contributes to noise-reduction.



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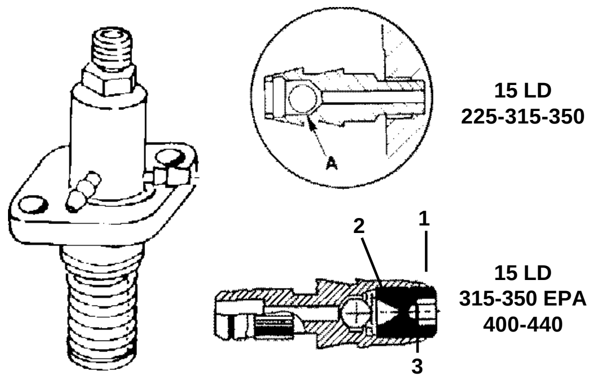
### Injection pump refitting

The plunger is fitted with helix **E** facing towards the outlet union **A**; if it is mistakenly fitted with the helix facing the intake coupling **B** the injection pump no longer operates (there is no danger of engine runaway); complete refitting following fig. 107.

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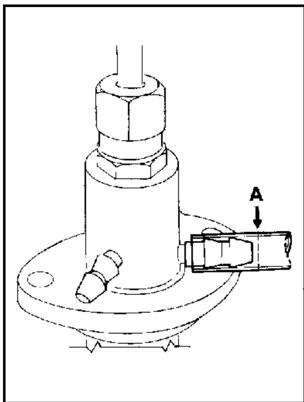
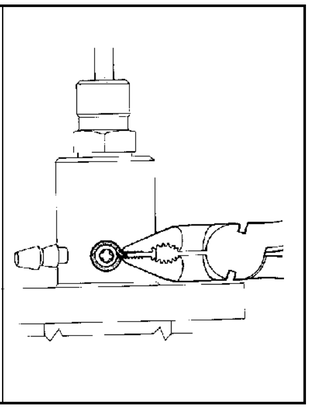
### Injection pump non-return valve

The exhaust union has a non-return valve **A**. The purpose of this valve is to improve the injection phase by expelling the air in the fuel and preventing it from being sucked in by the pump during the intake phase. This also ensures that the engine stops promptly as soon as the stopping device is activated by means of the solenoid valve.

### Outlet fitting components for 315-350 EPA E 400-440 engines

**1)** Outlet fitting
**2)** Ball Ø1/8"
**3)** Threaded dowel



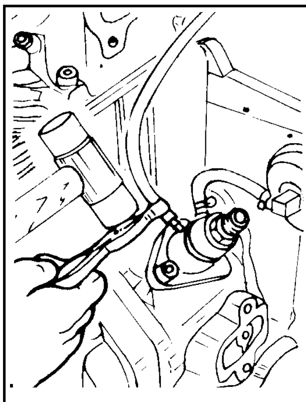



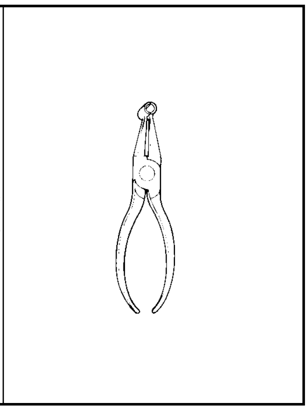
109 110

**!** Do not cut the tube longitudinally because you might damage the union.

### Injection pump, Rilsan tube removal

Cut nylon tube at **A.**
Remove the portion of the tube which is still connected to the union using common pliers. Pinch the nylon tube without impairing the sealing properties of union (see figure).
Re-cycle the same feeding tube if the remaining length allows it; replace if not.

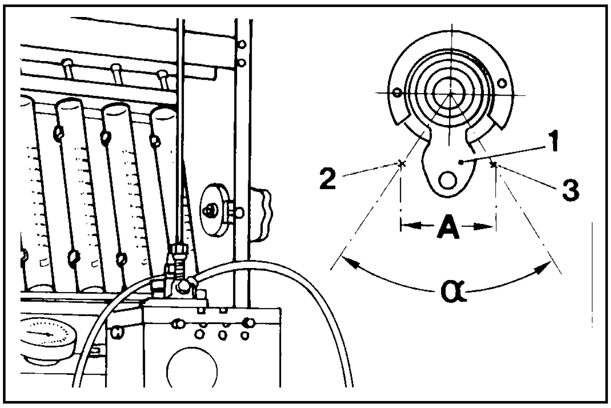




111 112

### Injection pump, Rilsan tube refitting

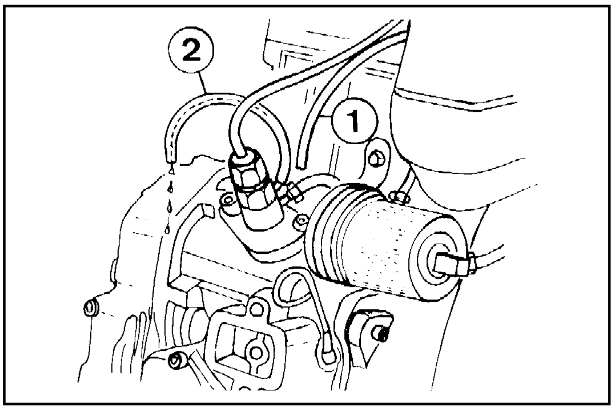
The outlet tube is made of nylon type Rilsan; it is connected to the suitable injection pump union by means of special pliers (Ser.No. 7104-1460-023) and a plastic-head hammer (see figure).




113

**Injection pump delivery check on test bench**

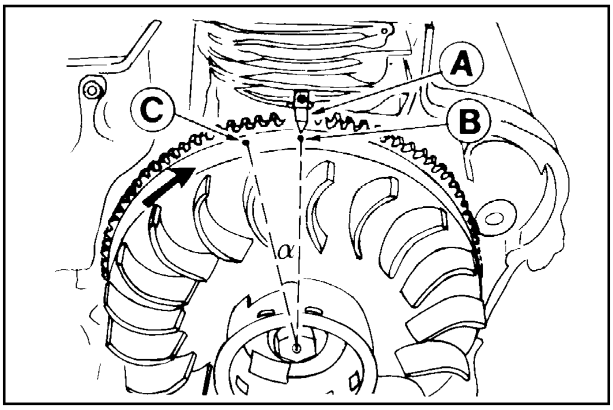
**1** Delivery control rack rod
**2** Rack rod **1** in stop position
**3** Rack rod 1 in max. delivery position
**A** = 18-19 mm (max.rack rod stroke)
**α** = 66°




114

**Static injection timing**

Disconnect pipe **1** from injection pump and close it, to avoid fuel leakages.
Mount in its place a nylon pipe **2** as shown in the picture. Insert in this pipe an iron wire and let it project by approximately 10 mm: in this way any drop in fuel can easily be checked.

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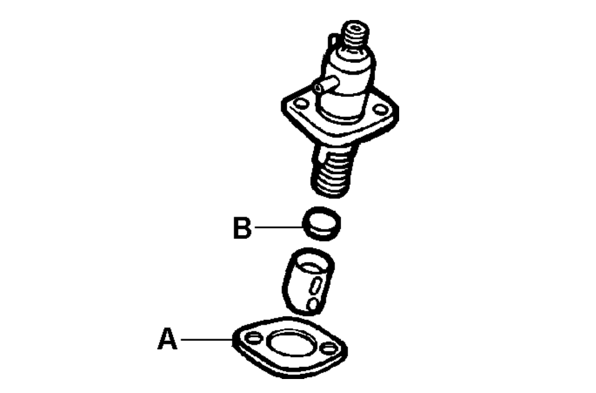
**Static injection lead test on flywheel**

Fill the tank and make sure that the fuel is not more than 10-15 cm above the tester. Set the flow governor lever of the injection pump in the stop position and lock it there.
Turn the flywheel in the engine rotation direction. proceed slowly during the compression phase. The fuel that flows from tube **2** will tend to diminish. Stop as soon as it creases to drip (one drop of fuel every 30-40 seconds is tolerated): this is the static injection lead. Make sure that **B** coincides with **A**.
See fig. 117-118 if **B** does not coincide with **A**.

**!** Use a temporary tank if the engine is not fitted with one. Here again, it is essential to make sure that the fuel level is no more than 10-15 cm above the injectionm pump.

**References on the flywheel**
**A** = Reference of fixed TDC on crankcase
**B** = Injection lead reference on the flywheel
**C** = TDC reference on flywheel
**α** = Reference in degrees between **B** and **C**.
When **B** coincides with **A**, the piston is in the static injection lead position. When **C** coincides with **A,** the piston is at top dead center.

| Motor type | B/C mm | | | | α |
|---|---|---|---|---|---|
| | with external Ø flywheel 220 | with external Ø flywheel 230 | with external Ø flywheel 240 | with external Ø flywheel 260 | |
| 15 LD 225 standard | 40÷44 | 42÷46 | | | 21÷23 |
| 15 LD 225 recorded up to 1500 [rpm] | 29÷32,5 | 30÷34 | | | 15÷17 |
| 15 LD 225 recorded from 1500 to 2200 [rpm] | 34,5÷38 | 36÷40 | | | 18÷20 |
| 15 LD 315/350 standard and minivecture | | 46÷50 | 48÷52 | | 23÷25 |
| 15 LD 315/350 Soundproof generating sets | | 40÷44 | 42÷46 | | 20÷22 |
| 15 LD 315/350 recorded to 1500 [rpm] | | 36÷40 | 38÷42 | | 18÷20 |
| 15 LD 400 recorded to 3600 [rpm] | | | | 29,48 | 13 |
| 15 LD 400 recorded to 3000 [rpm] | | | | 24,95 | 11 |
| 15 LD 400 EPA recorded to 3600 [rpm] | | | | 28,35 | 12,5 |
| 15 LD 400 EPA recorded to 3000 [rpm] | | | | 24,95 | 11 |
| 15 LD 440 recorded to 3600 [rpm] | | | | 31,75 | 14 |
| 15 LD 440 recorded to 3000 [rpm] | | | | 27,21 | 12 |

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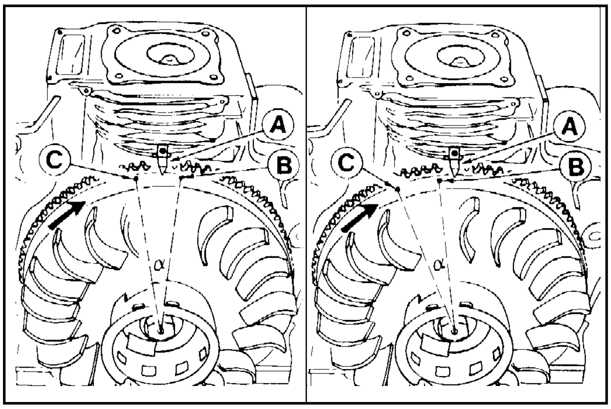
## Injection advance adjustment

Injection advance beyond the thickness of gasket **A** is determined by the thickness of the pad inside the injection tappet.
To alter the value of injection advance the pad must be replaced with another of a suitable thickness (see fig. 117-118).
To extract pad **B**, use a rod with a suction cap or magnet at one end.
The replacement pads supplied have 10 different thicknesses (between 4.0 and 4.9mm).
To alter the value of injection advance the pad must be replaced with another of a suitable thickness (see fig. 117-118).



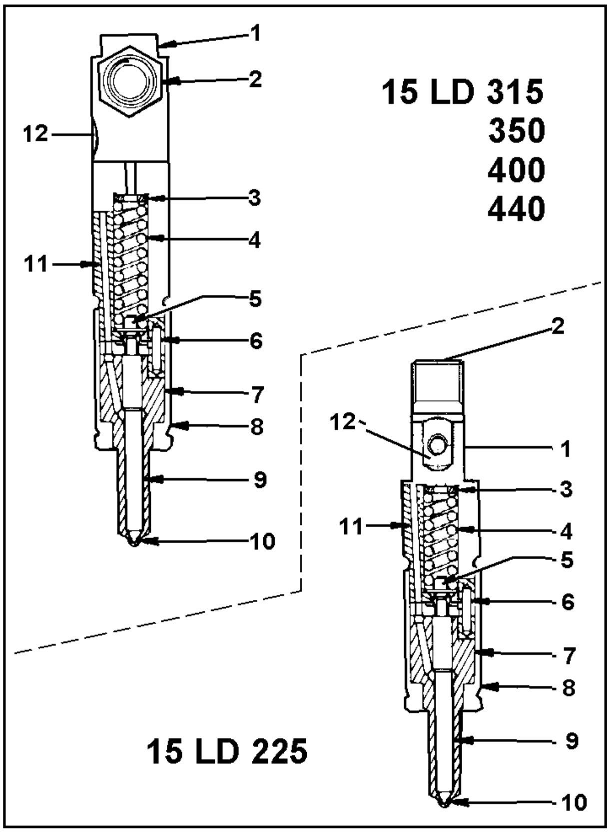

117 118

If reference point **B** does not coincide with **A** follow the examples in fig. 117-118.

**1)** Example of delayed injection advance (fig. 117): to make **B** match up with **A**, replace the pad with a thicker one (fig. 116).

**2)** Example of early injection advance (fig. 118): to make **B** match up with **A**, replace the pad with a thinner one (fig. 116).

**Note:** When the thickness of the pad varies by 0.1mm under the pump, **B** is delayed or brought forward by 1° on the flywheel.

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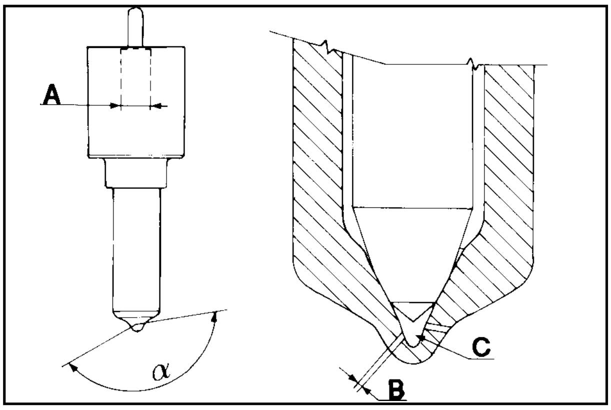
## Injector

Components:

**1** Body
**2** Union
**3** Adjusting shim
**4** Spring
**5** Pressure rod
**6** Pin
**7** Nozzle
**8** Nozzle cup
**9** Needle valve
**10** Tip
**11** Duct
**12** Return hole

After re-assembly, tighten ring nut **8** to a 50 Nm torque value.

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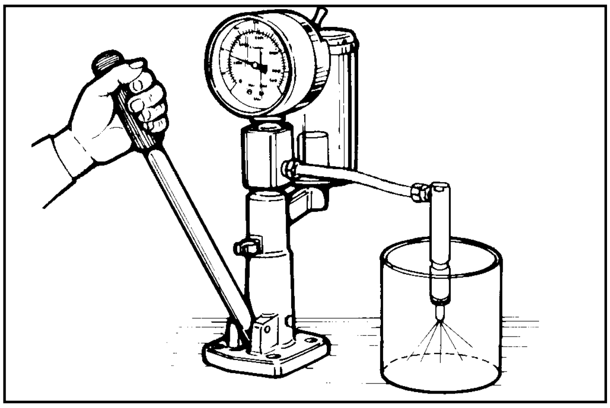
## Nozzles

The set-up between the needle and the guide must leave the needle free to fall and merely as a result of its own weight, when lifted 7mm from its seat and rotated in different directions, with the nozzle kept at a 45° angle.
Rotation of the needle must be completely smooth and uninhibited by obstacles and malformations.
Moreover, on being squeezed against its seat, it must fall freely, when the nozzle is inverted.
The test must be carried out after rinsing both the needle and nozzle with trichloroethane and wetting with filtered SHELL CALIBRATION FLUID “C” oil.

| | 15 LD 225 | 15 LD 315 | 15 LD 315 EPA | 15 LD 350 | 15 LD 350 EPA | 15 LD 400 | 15 LD 400 EPA | 15 LD 440 |
|---|---|---|---|---|---|---|---|---|
| **A** | 4,5 | 4,5 | 4,5 | 4,5 | 4,5 | 4,5 | 4,5 | 4,5 |
| **B** (N° and diam. of holes | 4 x 0,17 | 4 x 0,20 | 5 x 0,141 | 4 x 0,22 | 5 x 0,150 | 5 x 0,159 | 5 x 0,150 | 5 x 0,166 |
| hole length | 0,5 | 0,6 | 0,8 | 0,6 | 0,8 | 0,5 | 0,8 | 0,5 |
| **α** | 160° | 160° | 155° | 160° | 155° | 160° | 160° | 160° |
| pin height | 0,10÷0,15 | 0,10÷0,15 | 0,175÷0,225 | 0,125÷0,175 | 0,175÷0,225 | 0,375÷0,425 | 0,375÷0,425 | 0,375÷0,425 |
| **C** sump volume | 0,36 mm³ | 0,36 mm³ | 0 mm³ | 0,36 mm³ | 0 mm³ | 0,19 mm³ | 0 mm³ | 0,19 mm³ |
| Pressure (bar) * | 214 ± 4 | 214 ± 4 | 240 ± 6 | 214 ± 4 | 240 ± 6 | 200 ± 4 | 259 ± 4 | 200 ± 4 |

***** These values apply to new injector and allow for loosening of up to10% after breaking-in period



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## Injector calibration

Connect the injector to a hand pump and adjust if necessary, modifying the thickness above the spring.
When the spring is replaced, calibration must be carried out at a pressure higher than 10 bars to counterbalance adjustments while running.

Spraying and opening pressure

With the pressure gauge closed, press hard on the hand pump at least 10 times.
Open the pressure gauge and press down on the pump once every second, while keeping a check on the spraying process and pressure.
The opening pressure must lie between the two values given in the table. Jets must be uniform and well distributed.

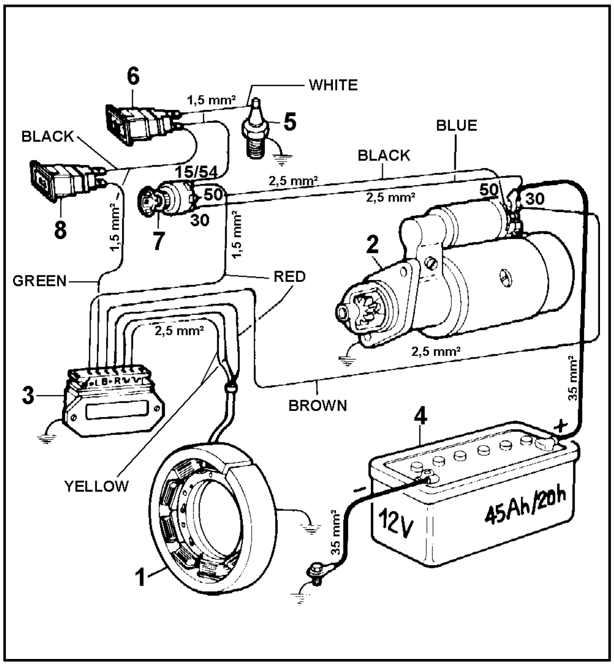
Leakage time (waste)

Pressure must drop from 150 to 100 bars in a span of not less than 8 seconds and not more than 30.

Seat seal

Nozzle tip wet.
Pressure must be kept 20 bars below the opening pressure for 10 seconds.
After this time, dampness on the nozzle tip is acceptable, and may be identified by touching with a dry finger. Only a drop of dampness is acceptable and not a large thick patch which would indicate a leak.

# NOTE

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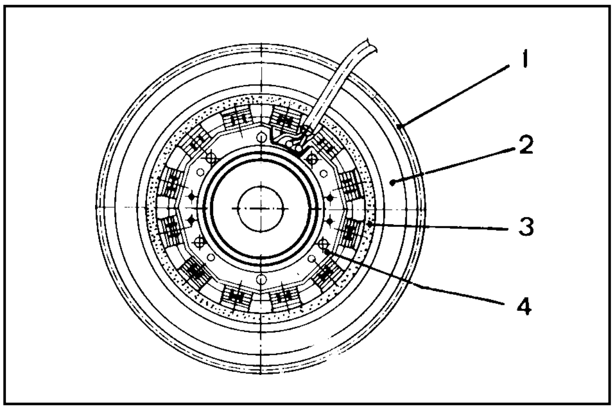
### 12V, 12A electric ignition diagram

Components:
**1** Alternator
**2** Starter motor
**3** Voltage regulator
**4** Battery
**5** Pressure switch
**6** Oil pressure light
**7** Key switch
**8** Battery charging light

**Note**: The battery, which is not supplied by LOMBARDINI, should have 12V nominal voltage rating and a capacity of not less than 44 Ah / 210 Amp. of fast discharge intensity.

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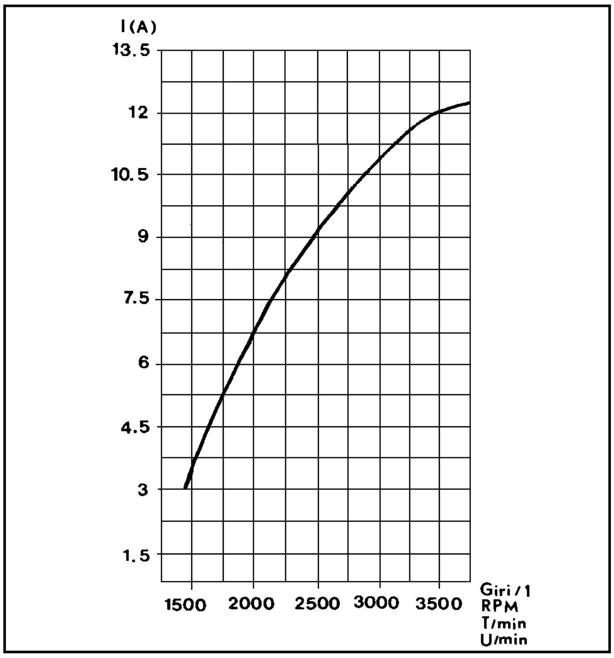
### Alternator

Components:
**1** Ring gear
**2** Flywheel
**3** Rotor
**4** Stator

Fixing screws must be tightened to 1.2 Nm.

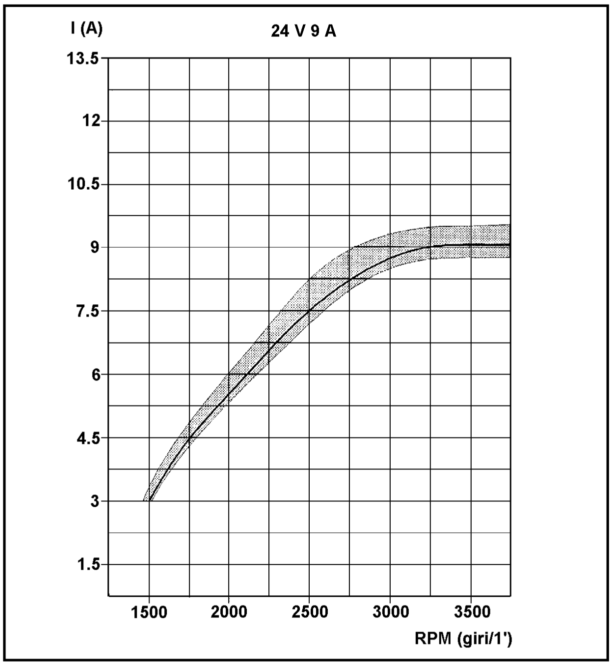
**Note:** The rotor is made up by a plastoferrite ring which is fixed to flywheel while the stator is mounted on the crankcase.




124

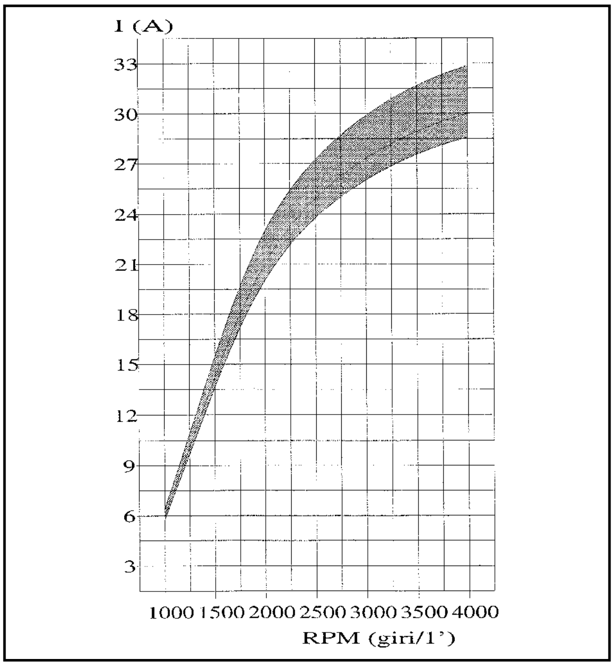
### Alternator battery charger graph (12V, 12A)

This test has been carried out after thermal stabilization at 20°C for 2 minutes at 3000 r.p.m. with constant battery voltage of 12.5V.
The value of the power supplied with reference to the curve may change in a range between +10% and -5%.




125

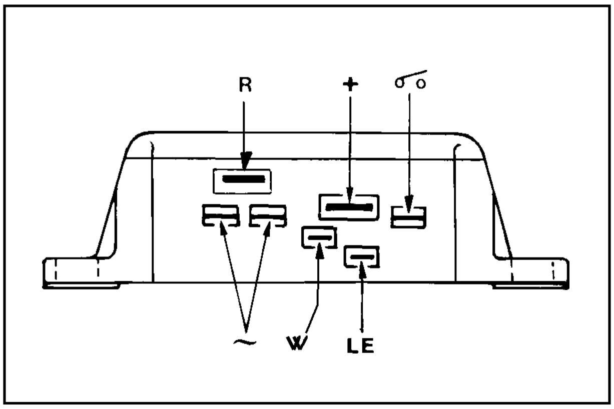
## 24V, 9A alternator battery recharging curve




126

## 12V, 30A alternator battery recharging curve

The test was conducted after heat stabilizing at 20°C.
The value of the current delivered in relation to the curve may be subjected to a variation of between +10 % and -5%.



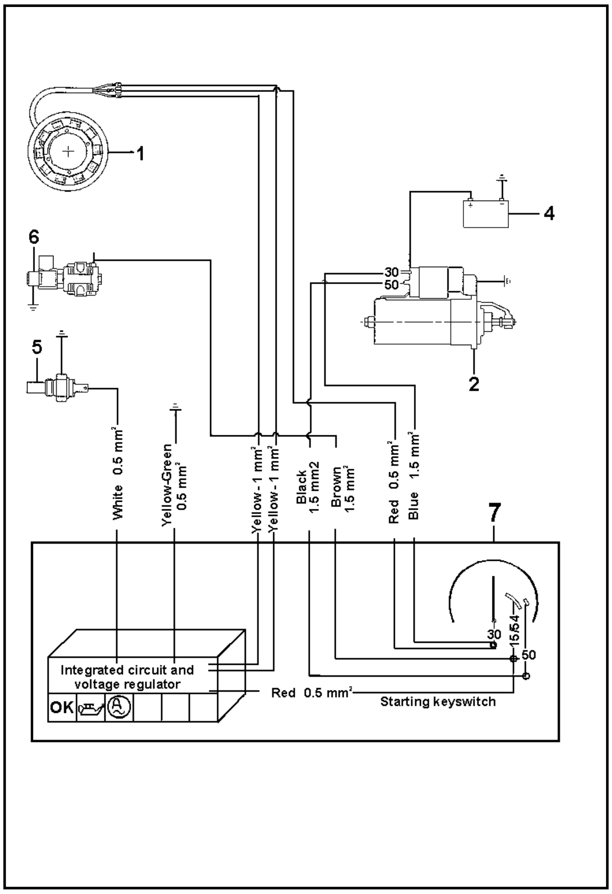

127

## Voltage regulator

12V, 12A: for standard alternators with 3 output wires
12V, 30A: for 12V, 20A alternators with 2 output wires
24V, 9A: for 24V, 9A alternators with two output wires

The tabs are in different sizes to prevent incorrect connections.

| Tab dimensions mm | | |
|---|---|---|
| | Width | Thickness |
| ~ | 6.35 | 0.80 |
| R | 9.50 | 1.12 |
| + | 9.50 | 1.12 |
| LE | 4.75 | 0.50 |
| 0/0 | 6.35 | 0.80 |
| W | 4.75 | 0.50 |



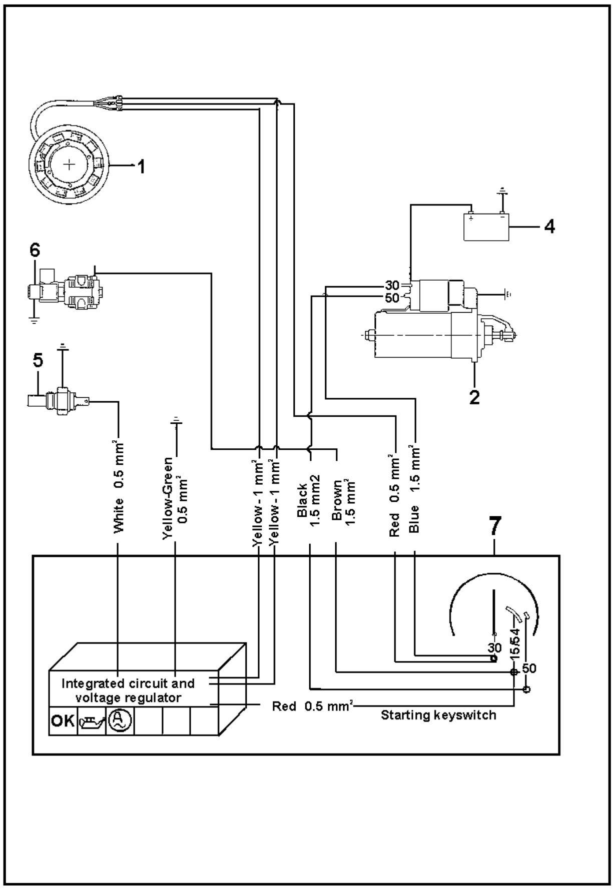

128

### 12V electric starter diagram with voltage regulator built into the ignition panel

Components:

**1** Alternator
**2** Starter motor
**4** Battery
**5** Pressure switch
**6** Solenoid valve
**7** Ignition switch

**Note**: The battery, which is not supplied by LOMBARDINI, should have 12V nominal voltage rating and a capacity of not less than 44 Ah / 210 Amp. of fast discharge intensity.



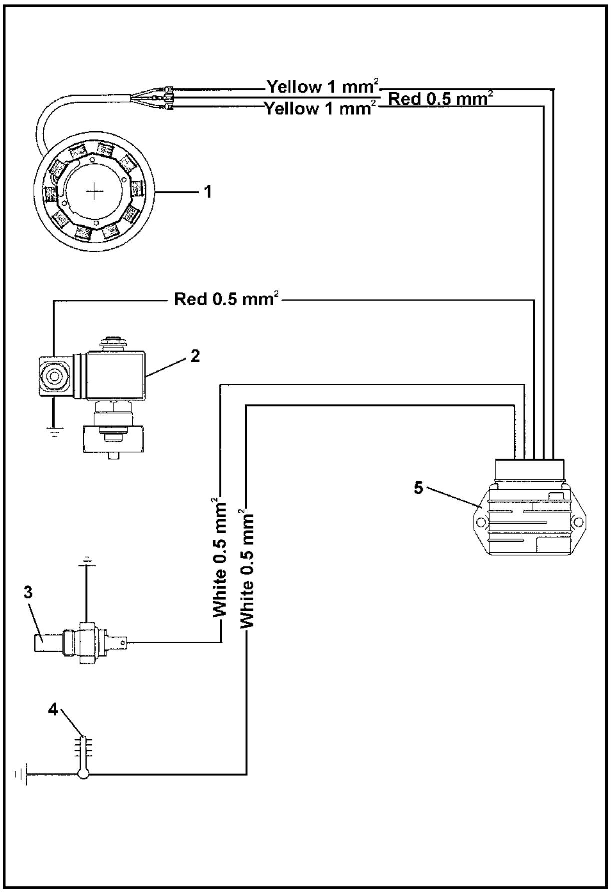

129

### 12V electric ignition layout with motor protection (optional)

Components:

**1** Alternator
**2** Starter motor
**4** Battery
**5** Pressure switch
**6** Solenoid valve
**7** Ignition switch
**8** Panel

**Note**: The battery, which is not supplied by LOMBARDINI, should have 12V nominal voltage rating and a capacity of not less than 44 Ah / 210 Amp. of fast discharge intensity.

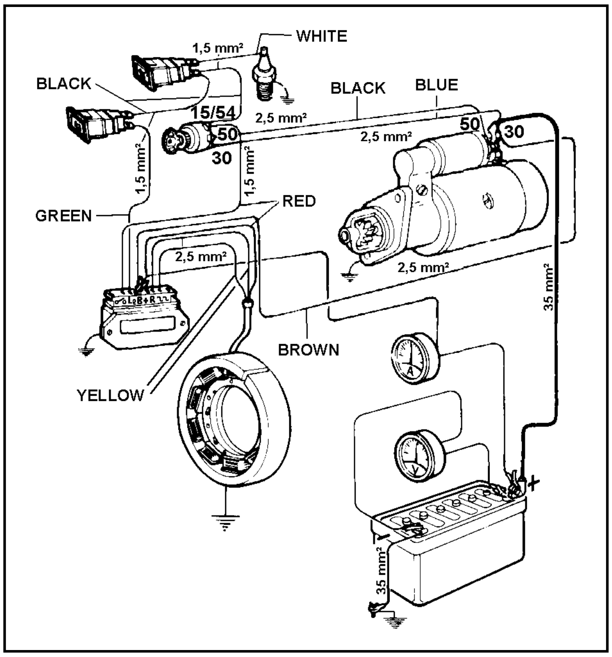



130

**Diagram of electric starter motor protection with sole self-winding starter - without battery - (optional)**

Components:

**1** Alternator
**2** Solenoid valve
**3** Pressure switch
**4** Thermostat
**5** A.c. motor stop device

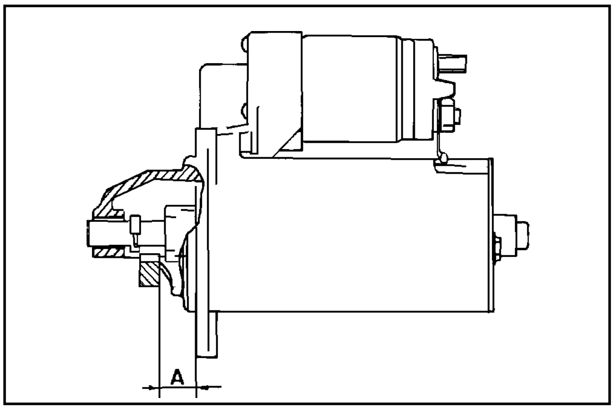



131

### Testing voltage regulator for proper operation

Check that connections correspond to the schematic.
Disconnect the terminal from the battery positive pole.
Connect a d.c. voltmeter between the battery poles.
Fit an ammeter between the positive pole and the **B+** on voltage regulator.
Start and stop the engine a several times until battery voltage drops below 13V.
When battery voltage reaches 14.5V the ammeter current should suddenly drop down to almost zero.
Replace regulator if recharge current is zero with voltage below 12,5V.

**!** When the engine is running do not disconnect battery cables or switch key to "off" position.
Keep regulator away from heat sources above 75°C.
Do no electric welding on engine or application.



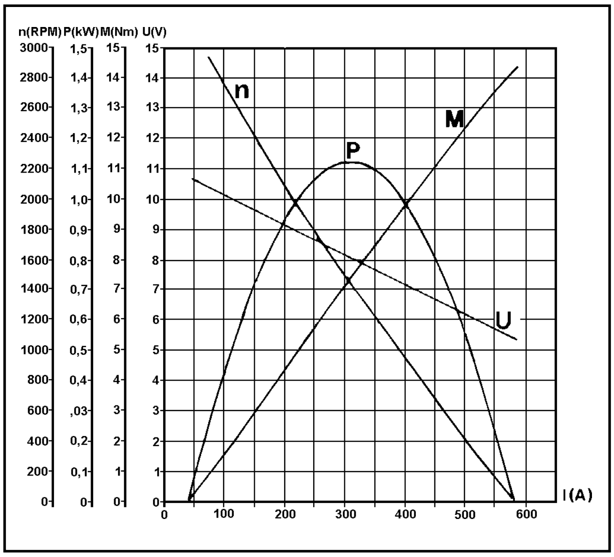

132

### Starting motor

**Bosch type DW (L) 12V, 1.1 KW for 15 LD 315-350-400-440**
**Bosch type DW (L) 12V, 0.9 KW for 15 LD 225**

Anti-clockwise rotation direction (viewed from pinion side)
**A** = 17.5-19.5 mm (distance from flywheel rim surface to starter motor flange surface)

**Note:** Contact Bosch service centers for repair operations.

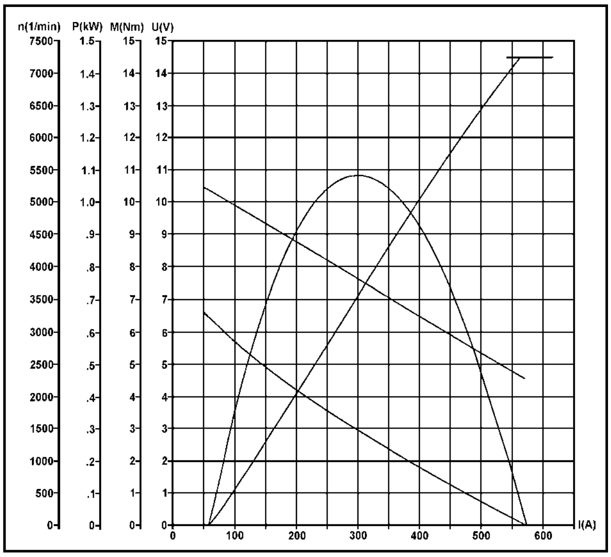



133

### Characteristic curves for starting motor type DW (L) 12V, 1.1 KW

The curves were obtained at a temperature of -20°C with 66 Ah battery.

**U** = Motor terminal voltage in Volts
**n** = Motor speed in r.p.m.
**M** = Torque in Nm
**J(A)** = Absorbed current in Ampere.

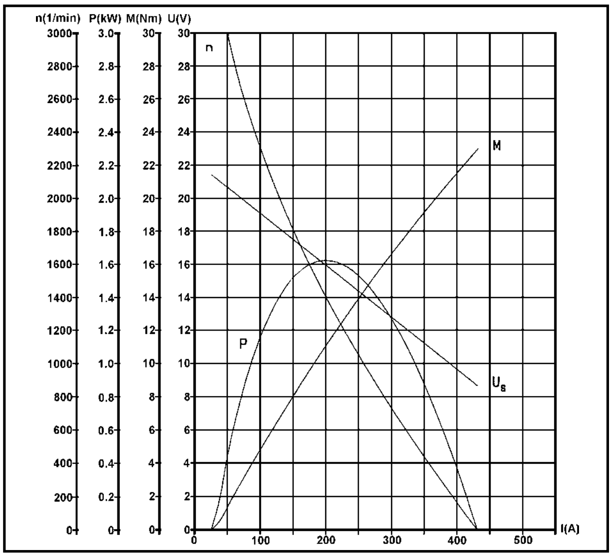



134

**Characteristic curves of Bosch starter motor type DW (L) 12V, 0.9 kW**

The curves were measured at a temperature of -20°C with a 55 Ah battery.

**U** = Voltage on motor terminals in Volts.
**n** = Motor speed in rpm
**M** = Torque in Nm
**I (A)** = Power draw in Amperes.

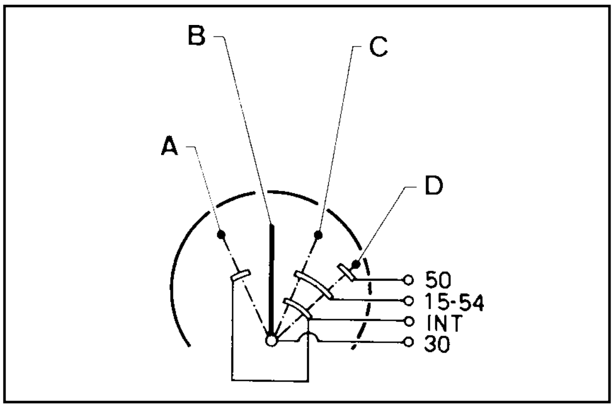



135

**Characteristic curves of Bosch starter motor type DW (L) 24V, 1.6 kW**

The curves were measured at a temperature of -20°C with a 36 Ah battery.

**U** = Voltage on motor terminals in Volts.
**n** = Motor speed in rpm
**M** = Torque in Nm
**I (A)** = Power draw in Amperes..

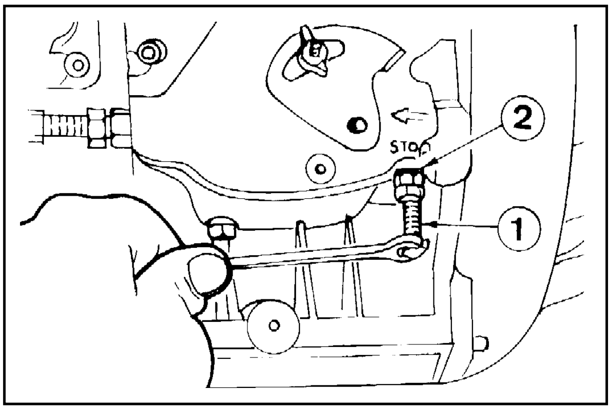



136

**Ignition switch positions**

**A** = Accessory
**B** = Off
**C** = On
**D** = Start

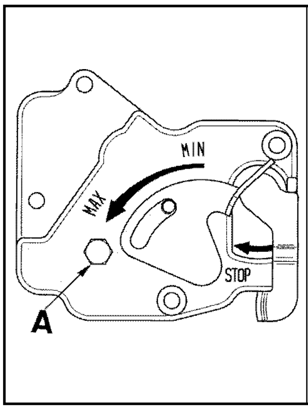
## ADJUSTMENTS - 15 LD 315-350



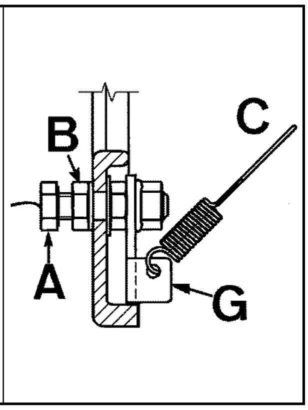
137

**Idling speed setting in no-load conditions (standard**)

After filling with oil and fuel, start the engine and let it warm up for 10 minutes.
Adjust idling speed to 1000-1250 rpm by turning set screw **1**; then tighten lock nut.
Washer **2** assures sealing and prevents possible oil leaks.



138



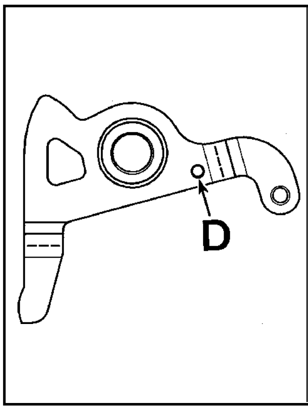
139

**Idle speed adjustment, for small car versions**

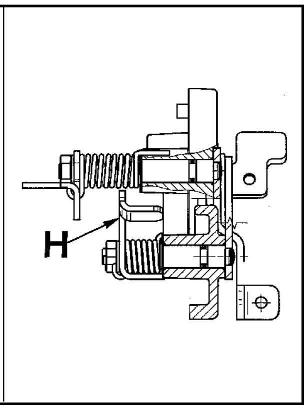
The idle speed adjusting spring (**C**) for small cars must be hooked in the speed governor lever hole **D** ( fig.140).
Completely unscrew the std idle speed adjusting screw **1** (fig.137).
Loosen nut **B** by one half of a turn.
Turn the screw **A** anticlockwise until lever **G** touches cover.
Start the engine: turning clockwise screw **A ,** set idle speed at 1050 rpm ; tighten the lock nut **B** tighten the screw **1** (fig. 137) until touching lever **H** (fig. 141); when the screw touches the lever, the speed increases; at this point unloose screw 1/4 of a turn and lock the lock nut of screw **1.**

The controls cover screws must be tightened to 10Nm.

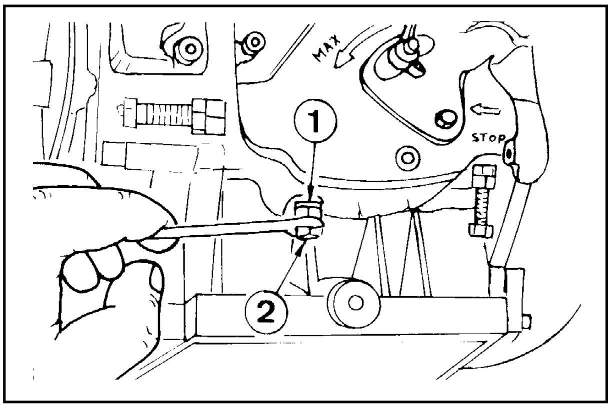
**Note**: By this way idle speed on hot engine could diminish of 80 rpm max.



140



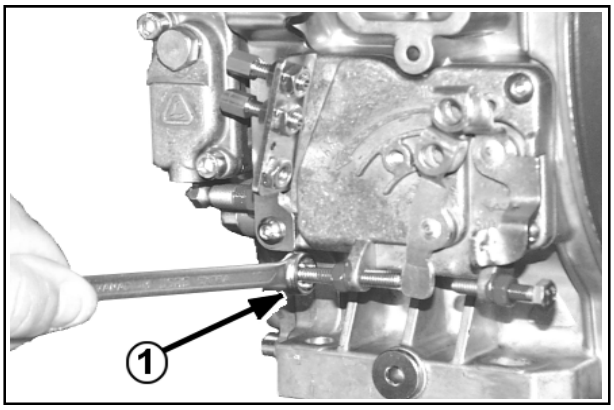
141



142

**Full speed setting in no-load conditions (standard)**

After setting idle speed turn screw **2** and set full speed in no-load conditions at 3800 rpm; then tighten lock nut.
Washer **1** assures sealing and prevents possible oil leaks.

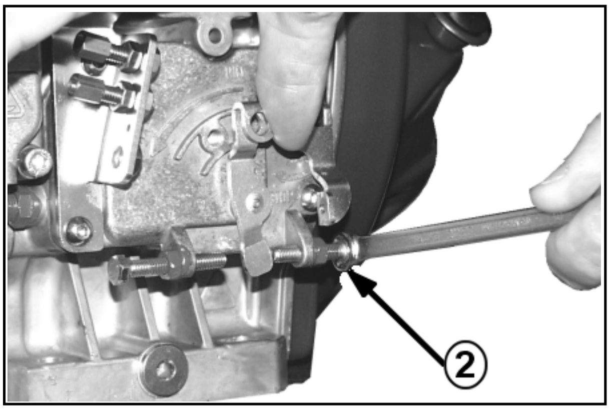



143

## ADJUSTMENTS - 15 LD 225-400-440

**No-load idling adjustment (standard**)

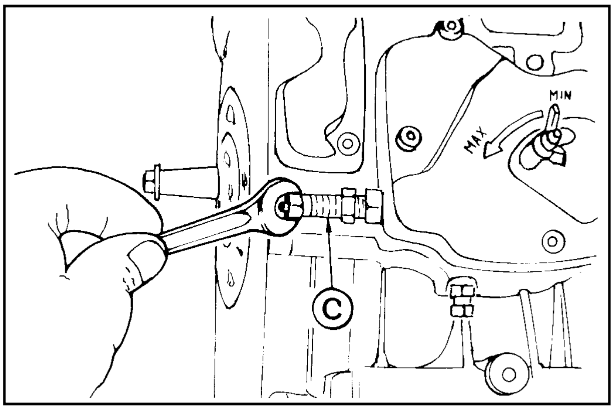
After having filled the engine with oil and fuel, start it and allow it to warm up for 10 minutes.
Using adjuster screw **1**, regulate the idling rate at 1000-1250 rpm.
Tighten the check nut.




144

**No-load top rate adjustment (standard**)

After having adjusted the idling rate, use screw **2** and regulate the top rate at 3800 rpm (for engines set at 3600 rpm on load).
Tighten the check nut.

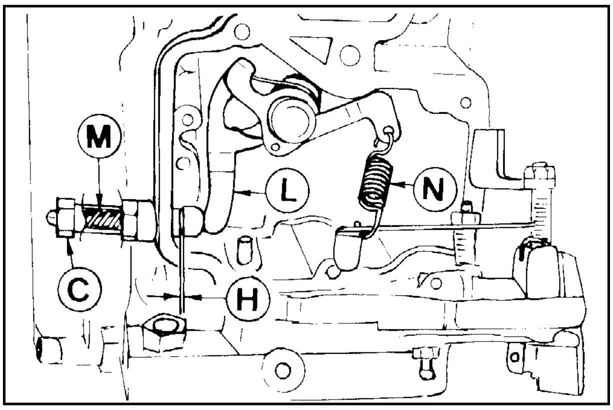



145

**Injection pump flow rate adjustment for 15LD 225-315-350-400-440**

This regulation must be carried out by means of a water brake, otherwise the adjustment will be approximate. proceed in the following way.
Loosen flow rate limiter **C** by 5 turns.
Accelerate the engine to no-load top rate, i.e. to 3800 rpm.
Re-tighten limiter **C** until the engine tends to decelerate.
Loosen limiter **C** by one and a half turns.
Tighten the check nut.

**Note:** Tighten **C** if the engine produces an excessive amount of exhaust in the maximum load condition; loosen **C** if no smoke is exhausted and if the engine is unable to develop its maximum power.



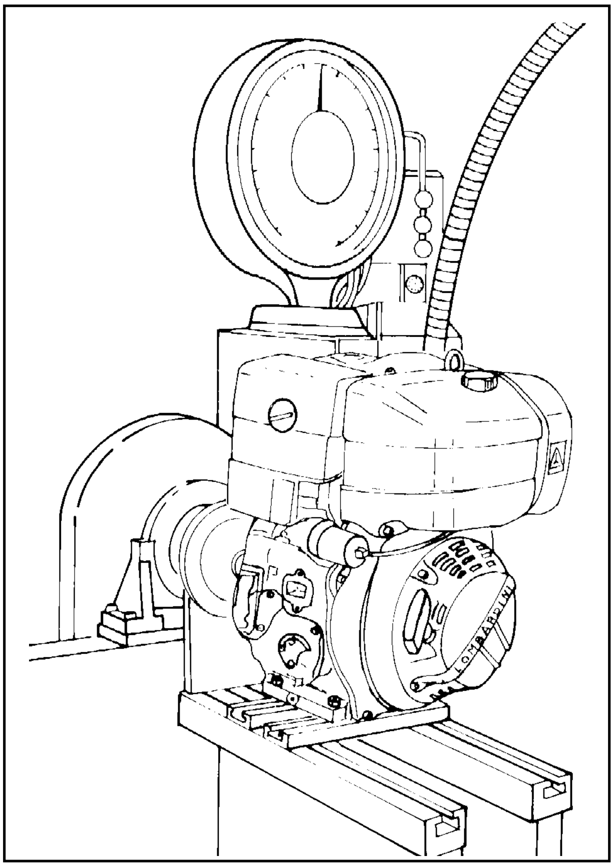

146

**Injection pump delivery limiting and torque adapter (standard)**

Delivery limiting device **C** has the function of limiting the injection pump max. delivery.
The same device also acts as torque adapter. The speed governor spring acts on lever **L** with standing the resistance opposed by spring **M** inside the cylinder.
The stroke **H** allowed by the torque device to lever **L** is 0.20 / 0.25 mm.
As a result of this pump delivery increases and torque reaces its peak value.

**Note:** In generator sets and power welders, the torque setting device acts as a delivery limiter only.

147



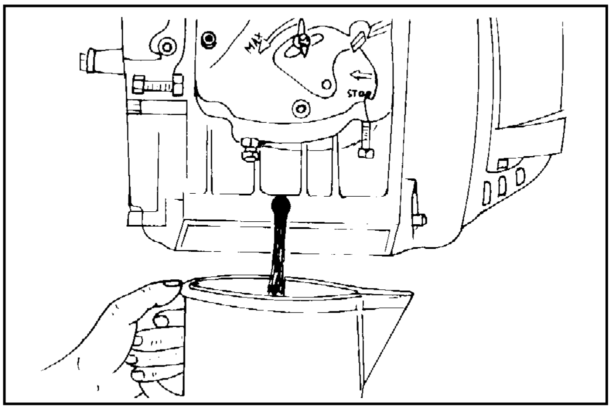
148

**Injection pump delivery setting**

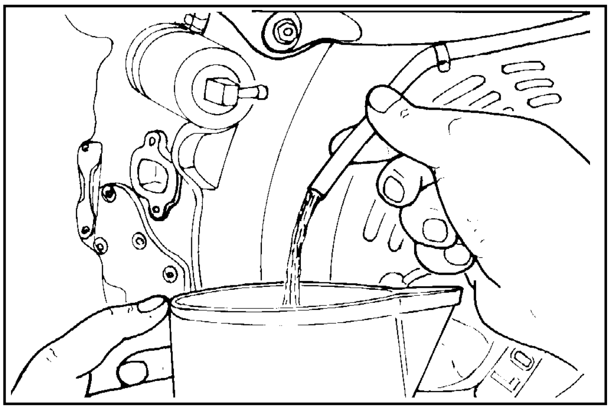
1) Bring engine to idling speed
2) Unscrew delivery limiting device **C** ( see fig. 145)
3) Bring the engine to the power and rpm required by the manufacturer of the device.
4) Check that fuel consumption falls within the table specifications (see below).
   If consumption is not as indicated change balance conditions at the torque dynamometer by varying the load and adjusting the governor.Under stable engine conditions check consumption again.
5) Tighten limiting device **C** until the engine rpm decreases.
   Lock the limiting device by means of lock nut.
6) Release brake completely and check at what speed the engine becomes stable
   Speed governor should comply with the requirements of the class indicated by the manufacturer of the device.
7) Stop the engine.
8) Check valve clearance when engine has cooled down.

**Required settings (the most common ones)**

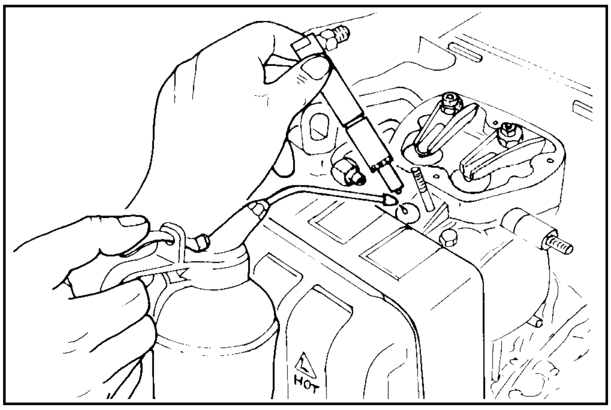
| Engine | R.P.M. | Power kW | Specific fuel consumption | |
|---|---|---|---|---|
| | | | Time (sec) per 100 cc | g/kW.h |
| 15 LD 225 | 3600 | 3,50 | 298 | 287 |
| | 3000 | 3,0 | 357 | 280 |
| 15 LD 315 | 3600 | 5,0 | 242 | 275 |
| | 3000 | 4,5 | 283 | 265 |
| 15 LD 350 | 3600 | 5,5 | 198 | 275 |
| | 3000 | 4,9 | 235 | 260 |
| 15 LD 400 | 3600 | 7,3 | 151 | 275 |
| | 3000 | 6,3 | 184 | 260 |
| 15 LD 440 | 3600 | 8,0 | 137 | 275 |
| | 3000 | 7,2 | 160 | 260 |




149



150

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**Storage**

Prepare engines as follows for storage over 30 days

**Temporary protection (1/6 months)**

- 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.
- Remove fuel tube and empty the tank
- Remove fuel filter, replace cartridge if dirty and refit.
- 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 manualy 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.

**Permanent protection (over 6 months)**

The following is recommended apart from the above instructions:

- 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).

**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.

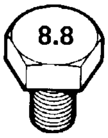
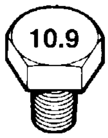
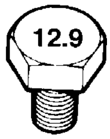
## MAIN TORQUE SPECIFICATIONS

| POSITION | Reference ( fig. N° and page) | Diam. and pitch ( mm ) | Torque ( Nm ) 225 | Torque ( Nm ) 315-350 | Torque ( Nm ) 400-440 |
|---|---|---|---|---|---|
| Re-coil starting | fig. 18 - p. 25 | 6x1 | 10 | 10 | 10 |
| Connecting rod | fig. 51 - p. 36 | 8x1 (315-350)<br>7x1 (225) | 23<br>- | 30<br>- | 30<br>- |
| Rocker arm adjusting screw lock nut | fig. 13 - p. 23 | 6x0,5 | 7 | 10 | 10 |
| Rocker arm adjusting screw pin | fig. 13 - p. 23 | 8x1,25 | 20 | 20 | 20 |
| Shroud | fig. 19 - p. 25 | 6x1 | 10 | 10 | 10 |
| Rocker arm cover | fig. 12 - p. 23 | 6x1 | 10 | 10 | 10 |
| Control arm cover | - | 6x1 | 10 | 10 | 10 |
| Enhanced engine oil sump | - | 10x1,5 | - | - | 40 |
| Exhaust manifold | - | 8x1,25 | - | - | 25 |
| Air cleaner support | fig. 3 - p. 20 | 8x1,25 | 25 | 25 | 25 |
| Oil filter head | fig. 90 - p. 49 | 6x1 | 10 | 10 | 10 |
| Injection tappet guide screw | fig. 103-104 - p 53 | 6x1 | 9 | 9 | 9 |
| Injector fixing onto the head | - | 6x1 | 12 | 9 | 9 |
| Muffler on manifold | fig. 9-10 - p. 22 | 8x1,25 | 25 | 25 | 25 |
| Fuel pump | fig. 100 - p. 52 | 8x1,25 | 15 | 15 | 15 |
| Injection pump union | - | 14x1,5 | 40 | 40 | 40 |
| Injection pump fastening screws | fig. 102 - p. 53 | 6x1 | 15 | 10 | 10 |
| Oil pump support | fig. 84 - p. 48 | 6x1 | 10 | 10 | 10 |
| Gear cover, timing side | fig. 81 - p. 45 | 8x1,25 | 23 | 23 | 23 |
| Calibrated fitting for hydraulic tappet lubrication | - | 10x1,5 | - | - | 15 |
| Injection pump delivery union | fig. 105 - p. 54 | 14x1,5 | - | - | 40 |
| Fuel tank bottom lower fixing | fig. 14 - p. 24 | 8x1,25 | 15 | 15 | 15 |
| Enhanced sump half-shells | - | 8x1,25 | - | - | 15 |
| Fuel tank top fixing | - | 14x1,5 | 20 | 20 | 20 |
| Oil drain plug | fig. 21 - p. 26 | - | - | - | - |
| Cylinder head (*) | fig. 21 - p. 26 | 6x1 | 10 | 10 | 10 |
| Flywheel pulley fixing screws | - | 8x1,25 | - | - | 25 |
| Flywheel | fig. 20 - p. 25 | 14x1,5 sinistra | 150 | 150 | 150 |

## USE OF SEALANT

| POSITION | TYPE OF SEALANT |
|---|---|
| Locking of adjustment lever box | Loctite 648 BV |
| Air valve case | Loctite “Form-a-gasket N.6” |
| M6 fixing screw for fuel filter | Loctite 222 |
| M8 fixing screw for muffler bracket | Loctite 222 |
| M8 fixing screws for fuel supply pump | Loctite 222 |
| M16 fixing screw for oil intake filter and cover | Loctite 222 |
| M6 finxing screws for air shroud | Loctite 222 |
| M6 stud bolt for dry air filter cover | Loctite 222 |
| M6 fixing screws for side oil refilling union | Loctite 270 |
| M6 screw for injection tappet guide | Loctite 270 |
| M8 STEI screw for closing oil intake hole cover | Loctite 270 |
| M8 STEI screw for closing crankcase lubrication hole | Loctite 270 |
| M8 fixing screws for air filter support and intake manifold | Loctite 270 |
| Rocker arm fulcrum screws | Loctite 270 |
| Stator screws | Loctite 270 |
| M8 stud bolts for tank | Loctite 270 |
| Plastoferrite on flywheel | Loctite 480 |
| Base coupling surface - cover | Loctite 5205 |
| Coupling surface for enhanced engine oil sump | Loctite 5205 |
| Coupling surface for enhanced oil sump half-shells | Loctite 5205 |
| Hydraulic tappet contact - cam | MOLYSLIP AS COMPOUND 40 |

# STANDARD BOLT TORQUE SPECIFICATIONS

| STANDARD BOLT TORQUE SPECIFICATIONS | | | | | | |
|---|---|---|---|---|---|---|
| **DESCRIPTION** |  | |  | |  | |
| **Diameter per pitch (mm)** | **R ≥ 800 N/mm²** | | **R ≥ 1000 N/mm²** | | **R ≥ 1200 N/mm²** | |
| | **Nm** | **Kgm** | **Nm** | **Kgm** | **Nm** | **Kgm** |
| 4x0,70 | 3,6 | 0,37 | 5,1 | 0,52 | 6 | 0,62 |
| 5x0,80 | 7 | 0,72 | 9,9 | 1,01 | 11,9 | 1,22 |
| 6x1,00 | 12 | 1,23 | 17 | 1,73 | 20,4 | 2,08 |
| 7x1,00 | 19,8 | 2,02 | 27,8 | 2,84 | 33 | 3,40 |
| 8x1,25 | 29,6 | 3,02 | 41,6 | 4,25 | 50 | 5,10 |
| 9x1,25 | 38 | 3,88 | 53,4 | 5,45 | 64.2 | 6,55 |
| 10x1,50 | 52,5 | 5,36 | 73,8 | 7,54 | 88.7 | 9,05 |
| 13x1,75 | 89 | 9,09 | 125 | 12,80 | 150 | 15,30 |
| 14x2,00 | 135 | 13,80 | 190 | 19,40 | 228 | 23,30 |
| 16x2,00 | 205 | 21,00 | 289 | 29,50 | 347 | 35,40 |
| 18x2,50 | 257 | 26,30 | 362 | 37,00 | 435 | 44,40 |
| 20x2,50 | 358 | 36,60 | 504 | 51,50 | 605 | 61,80 |
| 22x2,50 | 435 | 44,40 | 611 | 62,40 | 734 | 74,90 |
| 24x3,00 | 557 | 56,90 | 784 | 80,00 | 940 | 96,00 |

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Internet: http://www.lombardini.it

WORKSHOP MANUAL

# 25 LD

## 330-2 - 425-2

LOMBARDINI
A KOHLER COMPANY

**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 |
|---|---|---|---|---|---|---|---|
| Tech-Pubs | ED0053031690 | 51494 | **1°** | **0** | 24/02/2017 | 24/02/2017 | Vittorio Cardini |

## Manual's purpose

- This manual contains the instructions needed to carry out a proper maintenance of the engine, therefore it must always be available, for future reference when required.
- Safety pictograms can be found on the engine and it is the operator's responsibility to keep them in a perfectly visible place and replace them when they are no longer legible.
- Information, description and pictures in this manual reflect the state of the art at the time of the marketing ofengine.
- However, development on the engines is continuous.Therefore, the information within this manual is subject to change without notice and without obligation.
- **LOMBARDINI srl** reserves the right to make, at any time, changes in the engines for technical or commercial reasons.
- These changes do not require **LOMBARDINI srl** to intervene on the marketed production up to that time and not to consider this manual as inappropriate.
- Any additional section that **LOMBARDINI srl** will deem necessary to supply some time after the main text shall be kept together with the manual and considered as an integral part of it.
- The information contained within this manual is the sole property of **LOMBARDINI srl**. As such, no reproduction or replication in whole or part is allowed without the express written permission of **LOMBARDINI srl**.

**Original instructions translated from the Italian language**

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

## PREFACE

Every attempt has been made to present within this use and maintenance, accurate and up to date technical information.
However, development on the **Lombardini** series is continuos.
Therefore, the information within this manual is subject to change without notice and without obligation.
Carefully read and follow all instructions in this booklet as well as all those provided with the equipment on which this engine is used.


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

1 - is properly trained and equipped to safely and professionally perform the subject operation;
2 - possesses adequate hand and **Lombardini** special tools to safely and professionally perform the subject service operation;
3 - has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- For spare parts and after sale assistance contact authorized service centers.
- For any spare parts order please specify following details: ENGINE TYPE AND SERIAL NUMBER - Version (K) - on the engine name plate
- The complete and updated list of authorized **Kohler** service centers can be found on our web site: **www.kohlerengines.com** & **www.lombardinigroup.it/dealer-locator**
- Pls contact Service Centers for special applications.

## GENERAL SERVICE MANUAL NOTES

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

**2 -** All data presented are in metric format:
. dimensions are presented in millimeters (mm),
. torque is presented in Newton-meters (Nm),
. weight is presented in kilograms (kg),
. volume is presented in liters or cubic centimeters (cc)
. pressure is presented in barometric units (bar).

**3 -** To ensure safe operation please read the following statements and understand their meaning.
Also refer to your equipment manufacturer's manual for other important safety information.

This manual contains safety precautions which are explained below.

**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 LOMBARDINI air-cooled, indirect injection Diesel engines type **25LD330-2 and 25LD425-2**.


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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

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

**Danger**

- In addition to all other machine specifications, ensure that 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 Lombardini technical office for mixture proportions. Petrol may not be used because of the risk of it forming flammable vapours.
- During operation the surface of the engine reaches temperatures that may be dangerous. Avoid in particular all contact with the exhaust system.
- The liquid cooling circuit is under pressure. Do not carry out any checks before the engine has cooled down, and even then open the radiator cap or the expansion tank cautiously. Wear protective clothing and glasses. If there is an electric fan, do not approach the engine while it is still hot as the fan may come on even when the engine is not running. Clean the cooling system with the engine turned off.
- While cleaning the oil bath air filter, check that the oil is disposed of in such a way as not to harm the environment. Any filtering sponges in the oil bath air filter should not be soaked with oil. The cyclone pre-filter cup must not be filled with oil.
- Since the oil must be emptied out while the engine is still hot (approx. 80°C), particular care should be taken in order to avoid burns. In any case make sure that oil does not come into contact

with your skin because of the health hazards involved.

- Fuel vapours are highly toxic, so fill up only in the open air or in well ventilated environments.
- 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.

**Important**

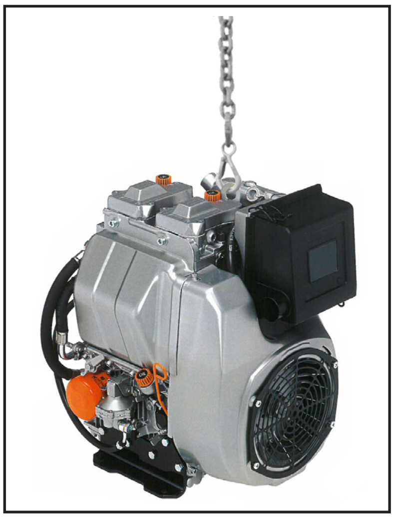
- To start the engine follow the specific instructions provided in the engine and/or machine operating manual. Do not use auxiliary starting devices not originally installed on the machine (e.g. Startpilot systems which utilise ether etc.)
- Before carrying out any work on the engine, turn it off and 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 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 **Lombardini**. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.

| California Proposition 65<br>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
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- 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

| DANGER | Accidental Starts! |
|---|---|
|  | **Accidental Starts can cause severe injury or death.** Disable engine by disconnecting negative (-) battery cable. |

*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.*

| DANGER | Rotating Parts! |
|---|---|
|  | **Rotating Parts can cause severe injury.** Stay away while engine is in operation. |

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

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

*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.*

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

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

| DANGER | Explosive Fuel! |
|---|---|
|  | **Fuel can cause fires and severe burns.** Do not fill the fuel tank while the engine is hot or running. |

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

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

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

| DANGER | High Pressure Fluid Puncture! |
|---|---|
|  | **High Pressure Fluids can puncture skin and cause severe injury or death.** Do not work on fuel system without proper training or safety equipment. |

*Fuel system is to be serviced only by properly trained personnel wearing protective safety equipment. Fluid puncture injuries are highly toxic and hazardous. If an injury occurs, seek immediate medical attention.*

| CAUTION | Electrical Shock! |
|---|---|
|  | **Electrical Shock can cause injury.** Do not touch wires while engine is running. |

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

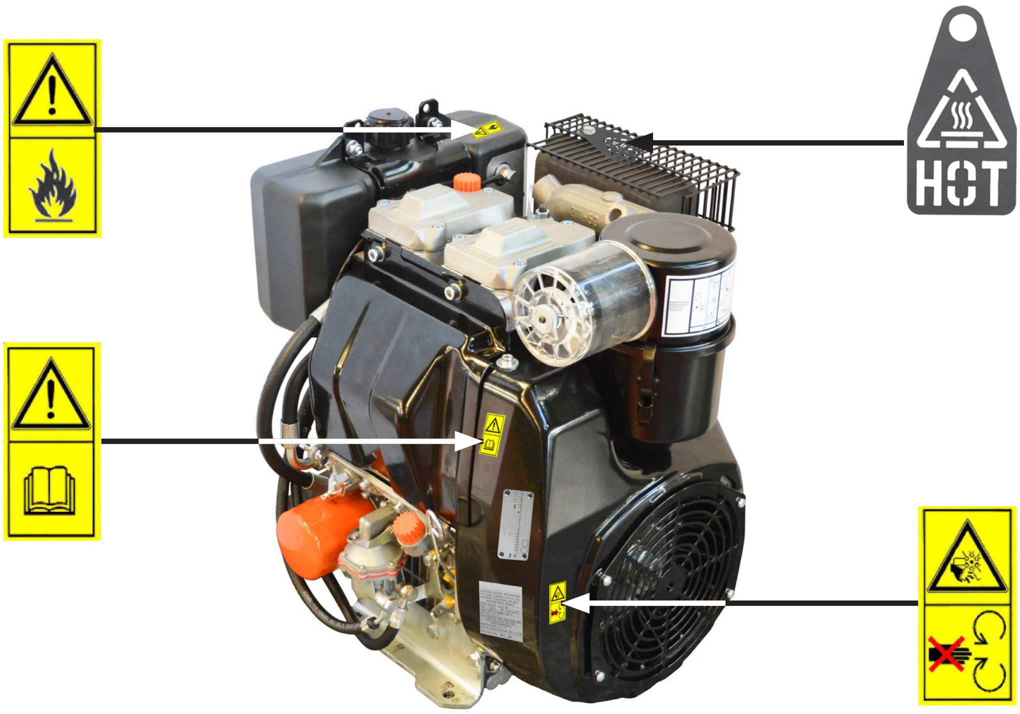
## Explanation of the safety pictograms that can be found on the engine or in the Workshop manual

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

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

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

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



## Plate for EPA regulations

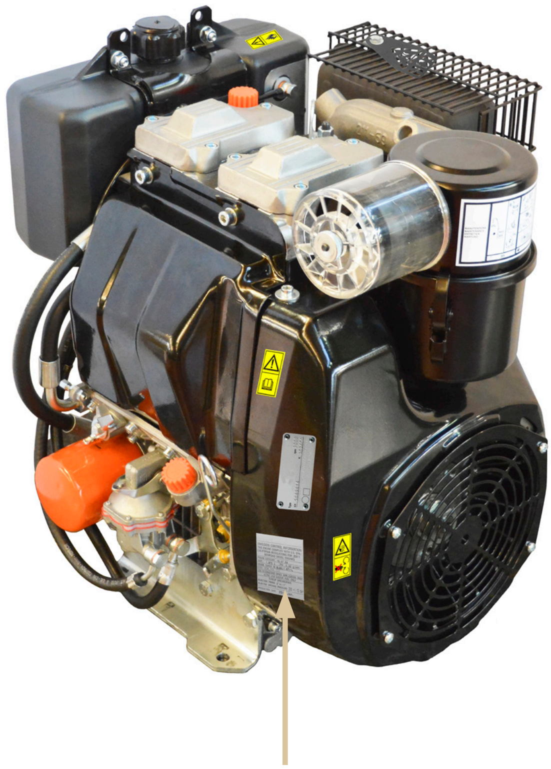
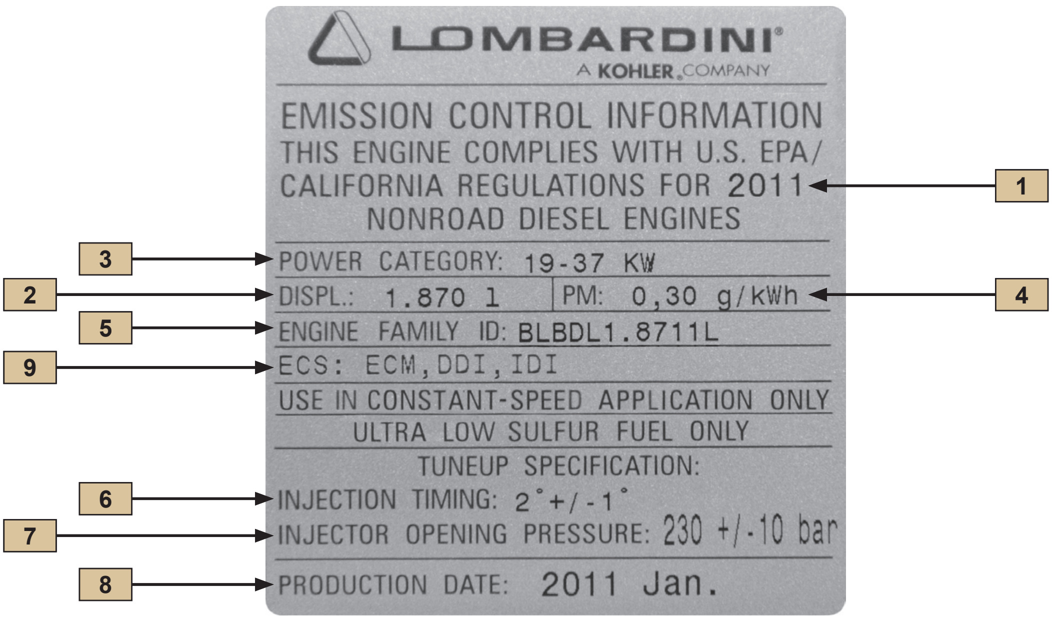


**Plate for EPA regulations placed on the air-shroud**

## Compilation example



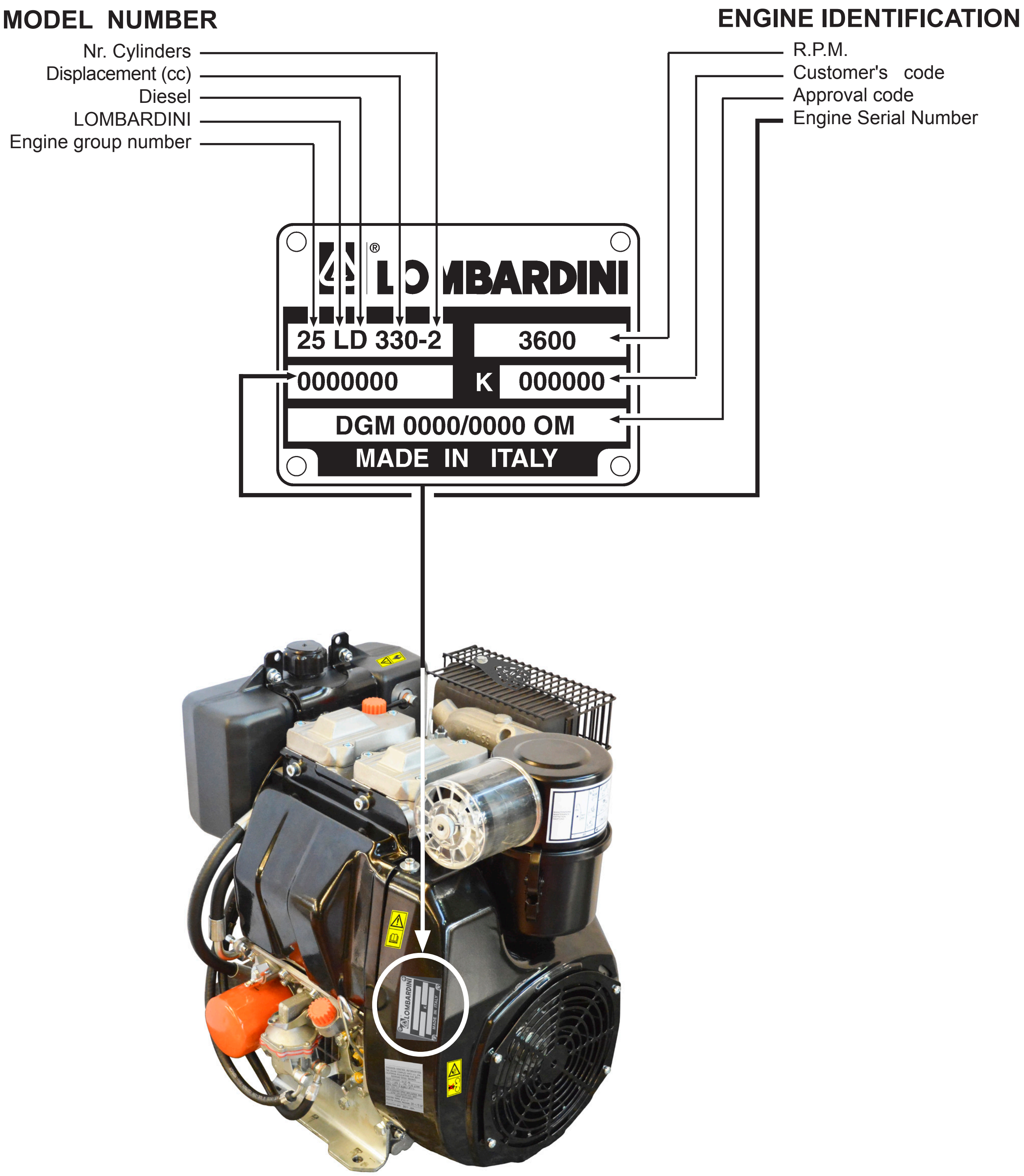

**1)** Model year
**2)** Engine displacement
**3)** Power category, kW
**4)** Particulate emission limit (g/kWh)
**5)** Engine family ID
**6)** Injection timing (BTDC)
**7)** Injector opening pressure (bar)
**8)** Production date (example 2013_Jan)
**9)** Emission Control System = ECS

## MANUFACTURER AND MOTOR IDENTIFICATION DATA

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

**Approval data**

The approval reference directives EC are on the engine plate.

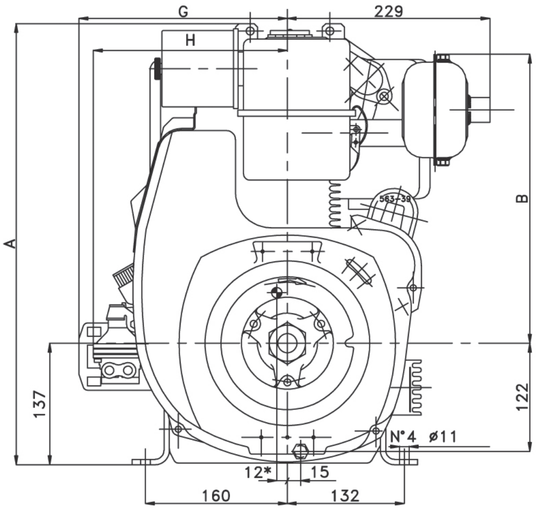


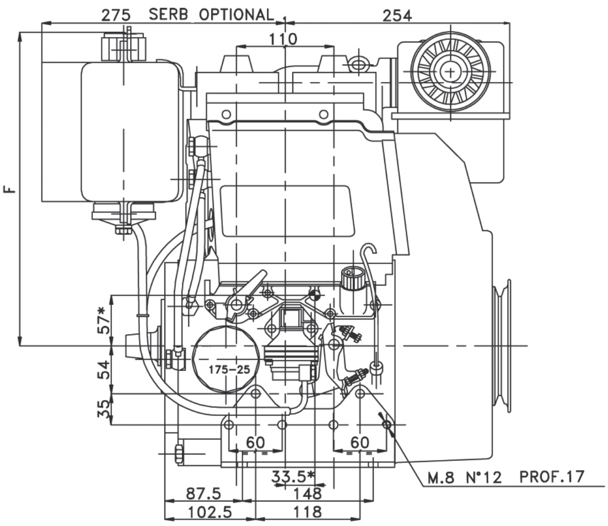
## TECHINICAL SPECIFICATIONS

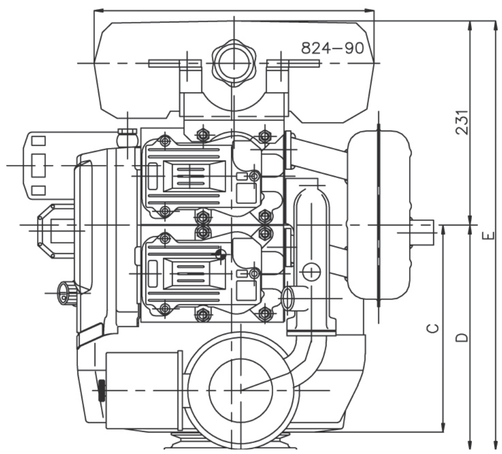
| ENGINE TYPE | | | | 25LD330-2 | 25LD425-2 |
|---|---|---|---|---|---|
| Number of cylinders | | | N. | 2 | 2 |
| Bore | | | mm | 80 | 85 |
| Stroke | | | mm | 65 | 75 |
| Swept volume | | | cm³ | 654 | 851 |
| Compression ratio | | | | 19:1 | 19:1 |
| Power kW (HP) | N 80/1269/CEE-ISO 1585 | @ 3000 RPM | | 10(13,6) | 12,5(17) |
| | | @ 3600 RPM | | 12(16,3) | 14(19) |
| | NB ISO 3046 - 1 IFN | @ 3000 RPM | | 9,3(12,6) | 11,4(15,5) |
| | | @ 3600 RPM | | 11,2(15,2) | 13(17,7) |
| | NA ISO 3046 - 1 ICXN | @ 3000 RPM | | 8,6(11,7) | 10,5(14,3) |
| | | @ 3600 RPM | | 10,3(14) | 12(16,5) |
| Max. torque * | | | Nm | 32@2400 | 40,5@2400 |
| Fuel consumption ** | | | g/kW.h | 246 | 246 |
| Oil consumption | | | g/kW.h | 0,8 | 0,8 |
| Capacity of standard oil sump | | | lt | 1,8 | 1,8 |
| Recommended battery 12V | | | Ah -A | 66-300 | 66-300 |
| Dry weight | | | kg | 50 | 53 |
| Combustion air volume | | | m³/h | 50 | 75 |
| Cooling air volume | | | m³/h | 600 | 750 |
| Max.permissible driving shaft axial: continuous (instantaneous) | | | kg. | 100(300) | 100(300) |
| Max. inclination | Flywheel site: continuous (instantaneous) | | | 25°(30°) | 25°(30°) |
| | Power take off site: continuous (instantaneous) | | | 25°(35°) | 25°(35°) |
| | Lateral: continuous (instantaneous) | | | 25°(40°) | 25°(40°) |

* Referred to **N** power
** Consumption at max torque

## OVERALL DIMENSIONS



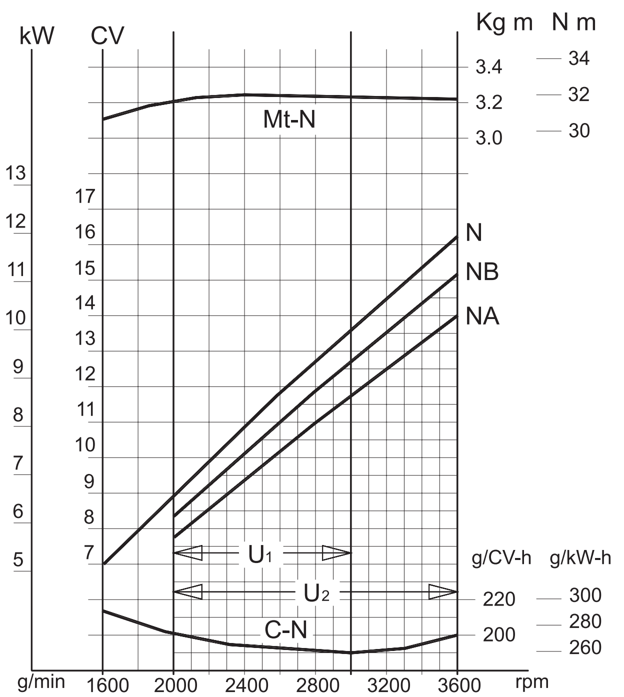



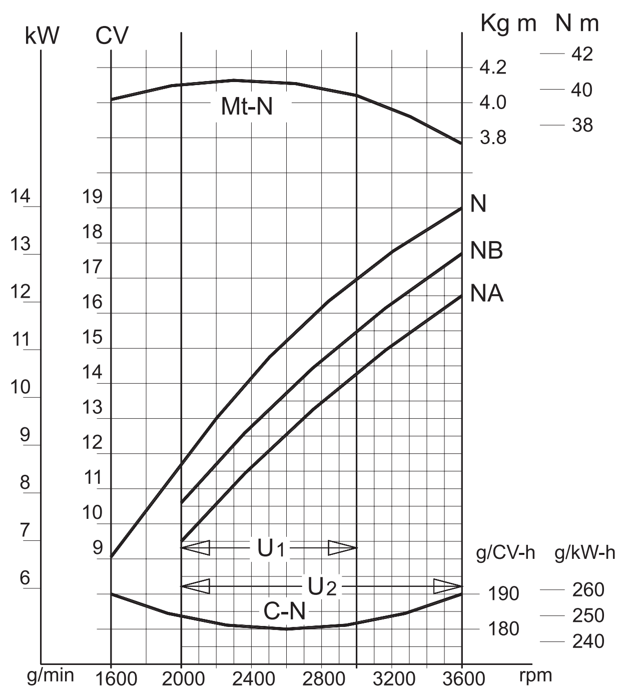

Note: Dimensions in mm

## PERFORMANCE DIAGRAMS

### 25LD330-2




### 25LD425-2




| | |
|---|---|
| **N (80/1269/EEC - ISO 1585)** | **AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load. |
| **NB (ISO 3046 - 1 IFN)** | **RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load. |
| **NA (ISO 3046 - 1 ICXN)** | **CONTINUOS RATING WITH OVERLOAD CAPABILITY:** continuos 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 **LOMBARDINI** 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 | ■ | | | | | | | | | |
| MAINTE-NANCE | 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 | | | | | | | | |
| | Injectror | | | | | | | | |
| 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 | | | |
|---|---|---|---|
| | **SAE 15W-40** | specifications | **API CF-4/SG**<br>**ACEA B2-B4**<br>**MIL-L-2104 C / MIL-L 46152 D** |

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.

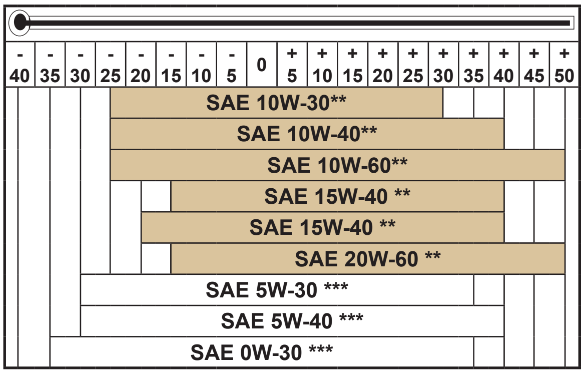
**Danger**

- 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.




SAE- Grade

* Mineral base
** Semi-synthetic base
*** Synthetic base

### *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 | |
|---|---|
| ***B1 =*** | Low-viscosity, for frictions reduction |
| ***B2 =*** | Standard |
| ***B3 =*** | High performances (indirect injection) |
| ***B4 =*** | High quality (direct injection) |

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

## API / MIL SEQUENCES

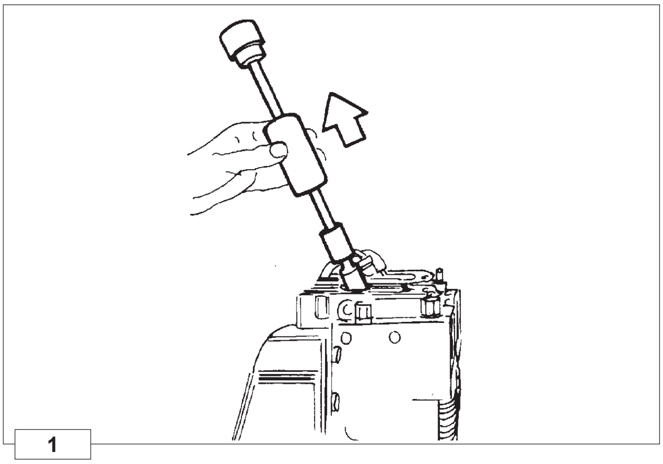
| API | CH-4 | CG-4 | CF-4 | CF-2 | CF | CE | CD | CC |
|---|---|---|---|---|---|---|---|---|
| MIL | | | L- 46152 D / E | | | | | |

## RECOMMENDATIONS FOR DISASSEMBLING

**Important**

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

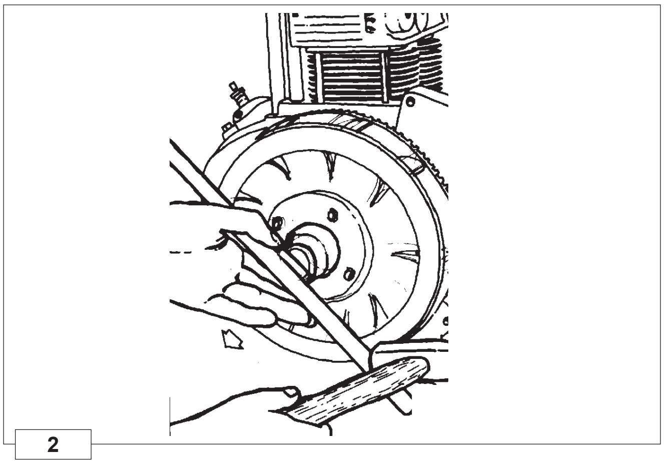
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- 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.



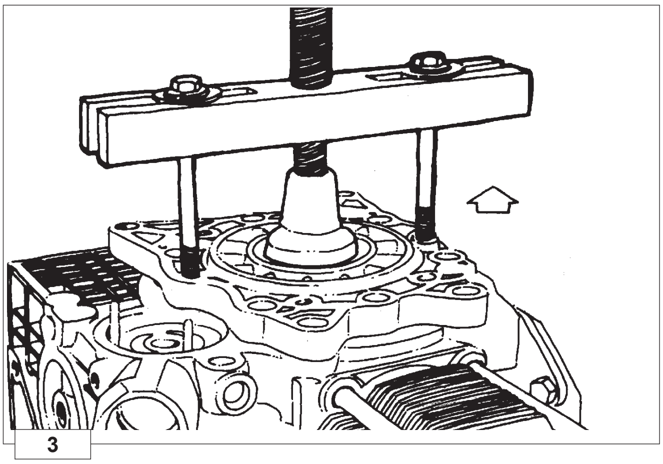
2

**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.

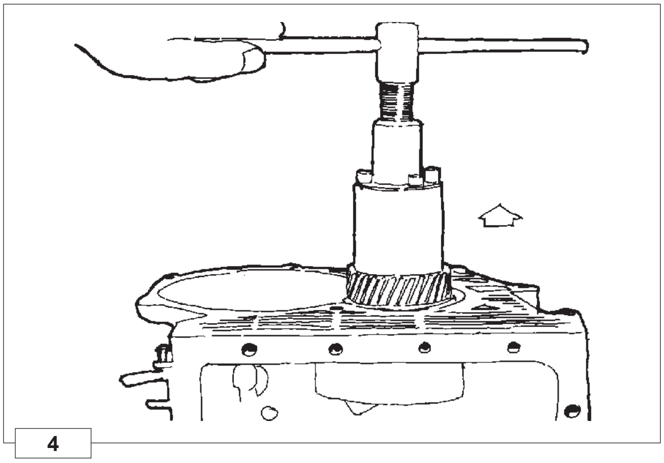
**Warning**
Do not tap the end of the extractor when removing the flywheel.



3

**Extraction of flywheel side main bearing**

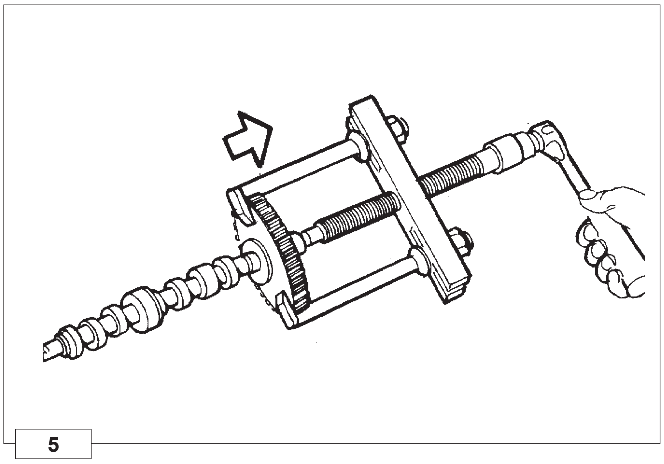
Withdraw the bearing using two M8 screws taking care to tighten them evenly; alternatively use a commercial extractor, as shown in figure 3.



4

**Extraction of crankshaft gear**

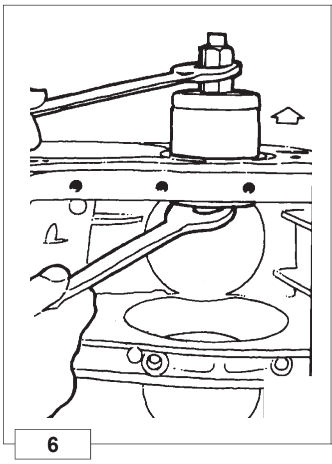
Use extractor tool number 00365R0890 (fig.4).



5

**Extraction of the camshaft gear**

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



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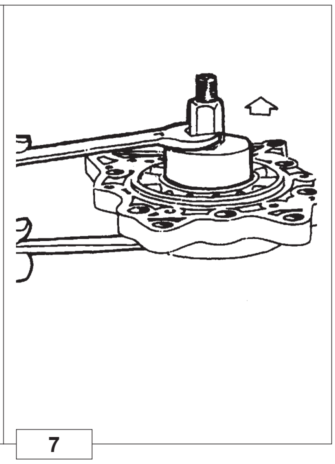
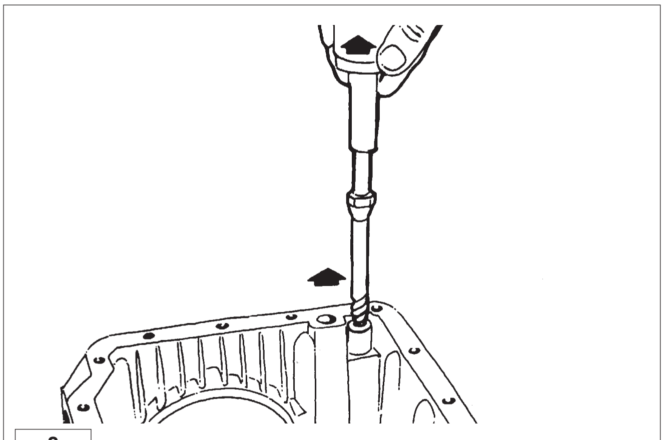


7

**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.

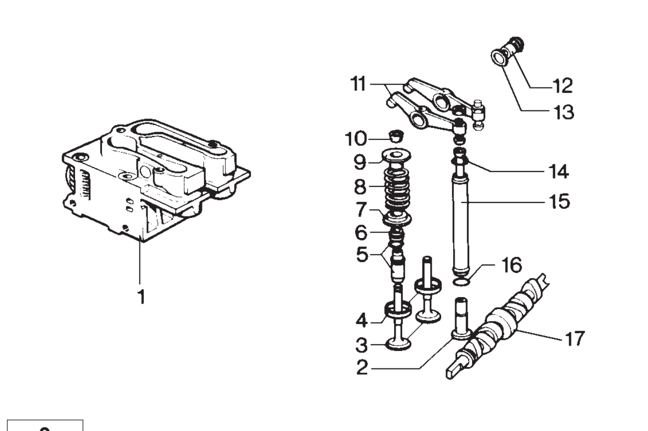
**Danger**

- 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



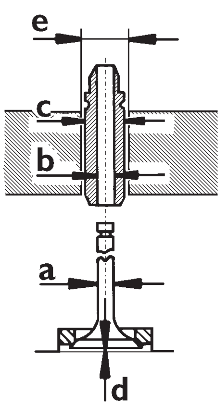
9

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



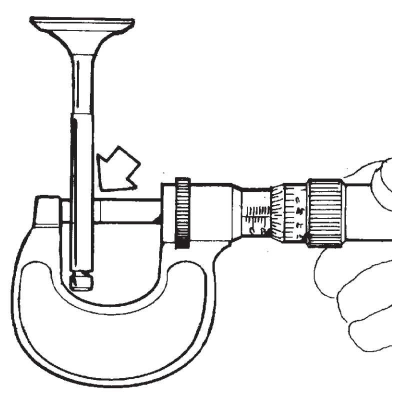
10

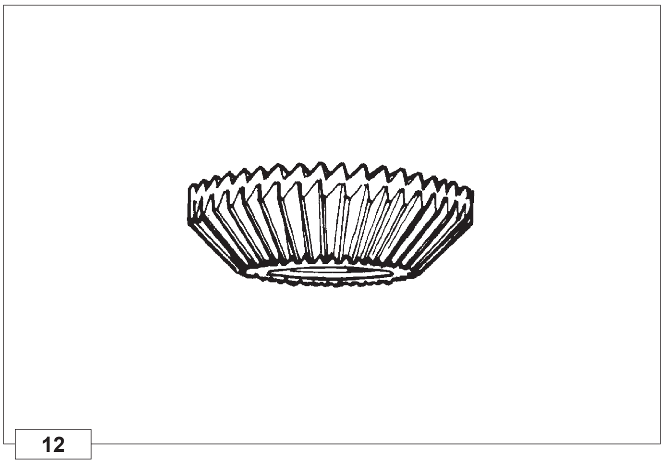
Clean the valves with a wire brush and renew them if the valve heads are deformed, cracked or worn.

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

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.

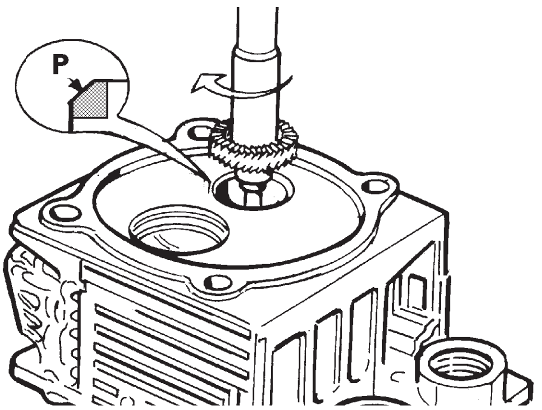
It is always necessary to grind the valve seats when new guides are fitted.
Oversize valve guides with external diameter increased by 0.10 are available.


11



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).

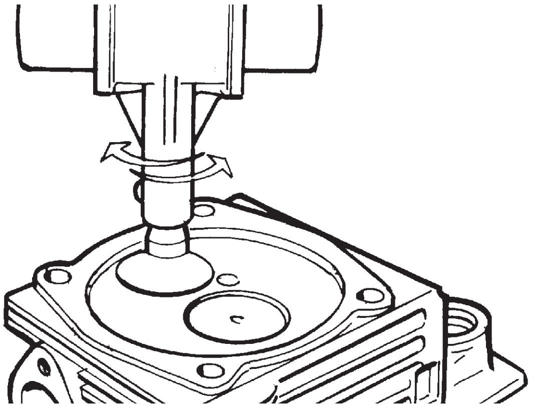



13

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 ÷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.

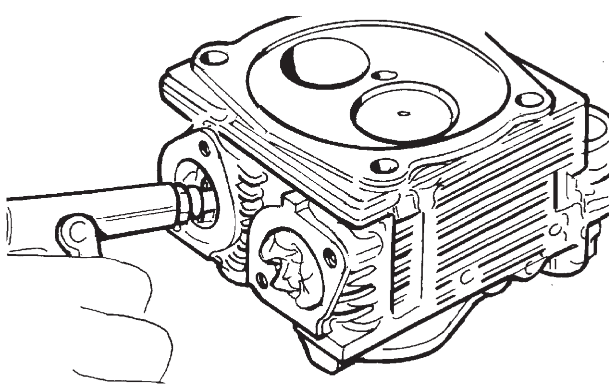
After grinding wash the valve and seat carefully with petrol or paraffin in order to remove residual grinding paste and chips. Once you have finished grinding check the efficiency of the seal between the valve and seat as outlined below:

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.



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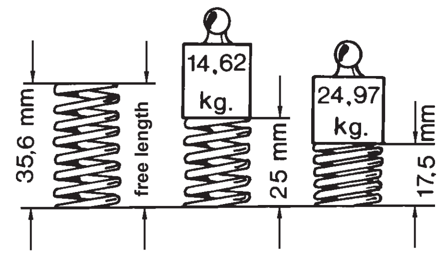
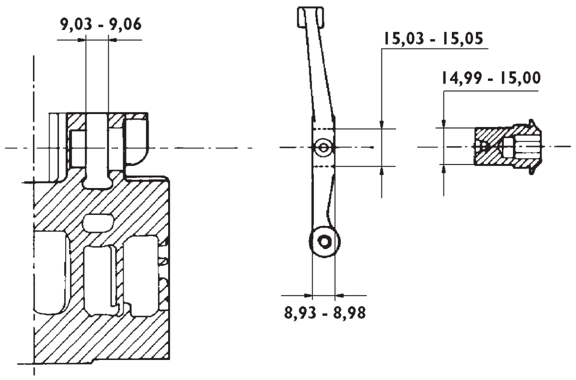



16

## 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 ± 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.

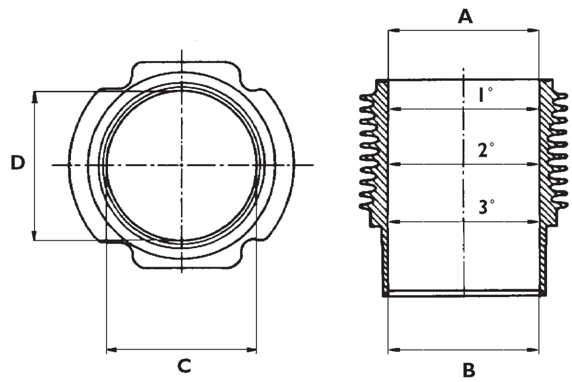
Rocker / pin clearance (fig.17):

| Fitting mm | Max. wear mm |
|---|---|
| 0,03 ÷ 0,06 | 0,15 |

Rocker axial play (fig.17):

| Fitting mm | Max. wear mm |
|---|---|
| 0,05 ÷ 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

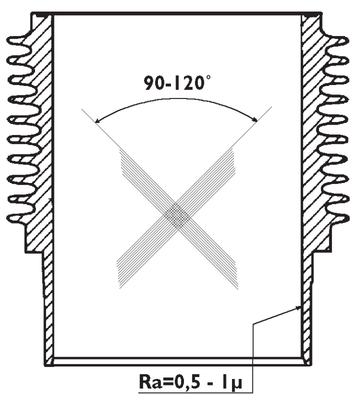
Air cooled with cylinder barrels in special cast iron with integral liners.

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):

| | |
|---|---|
| 25LD330-2 | Ø 80 ÷ 80,020 |
| 25LD425-2 | Ø 85 ÷ 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.



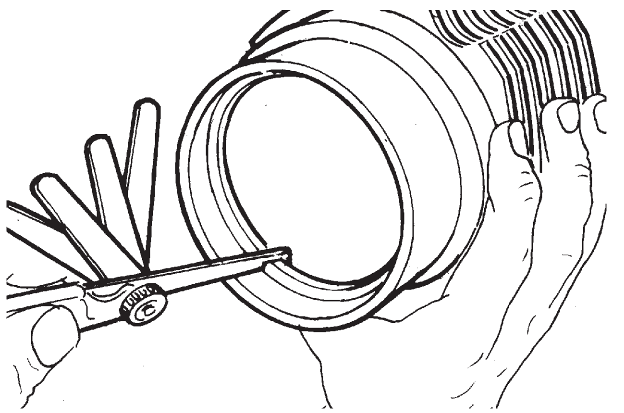

19

**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°÷120°; lines should be uniform and clear in both directions.
Average roughness must range between 0.5 mm 1 μm.
The cylinder surface which comes into contact with piston rings should be machined with the plateau method.

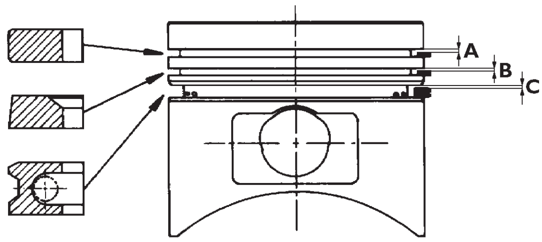
If the taper and ovality of the cylinder exceed the values indicated, then the cylinder and piston must be renewed.


20

## 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 | |



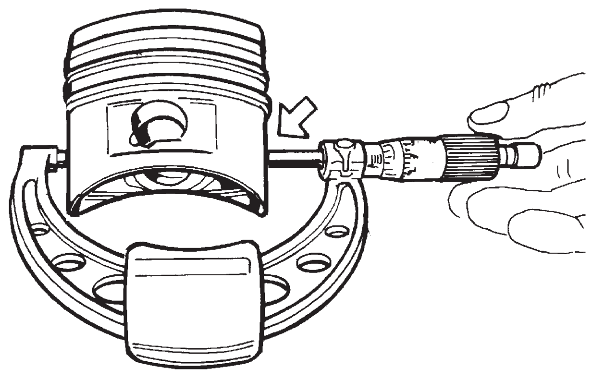
21

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 | **A** = 0,22 |
| 2nd Compression | **B** = 0,18 |
| 3rd Oil scrapper | **C** = 0,16 |

**Important**

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

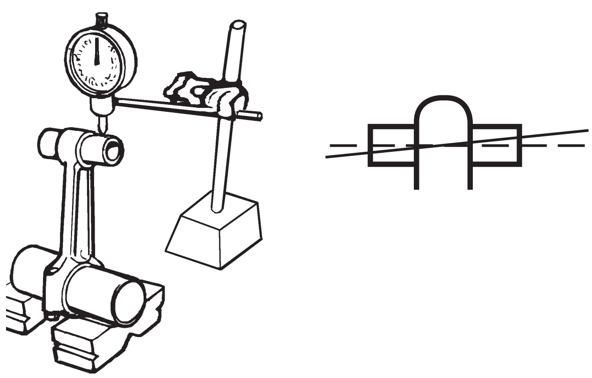

22

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

| Engine | Diameter mm |
|---|---|
| 25LD330-2 | 79,93 ÷ 79,958 |
| 25LD425-2 | 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 |


23

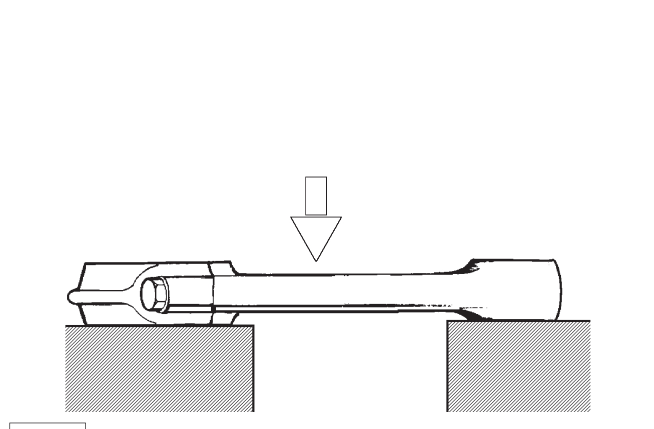
## Connecting rods

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 |
|---|---|---|---|
| 25LD330-2 | 19,997 ÷ 20,002 | 0,023 ÷ 0,038 | 0,070 |
| 25LD425-2 | 21,997 ÷ 22,002 | 0,023 ÷ 0,038 | |

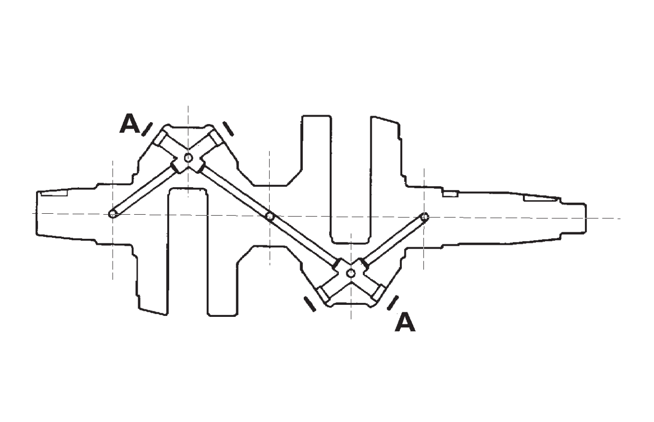
Checking parallelism between the two axes of the connecting rod (fig.23):

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

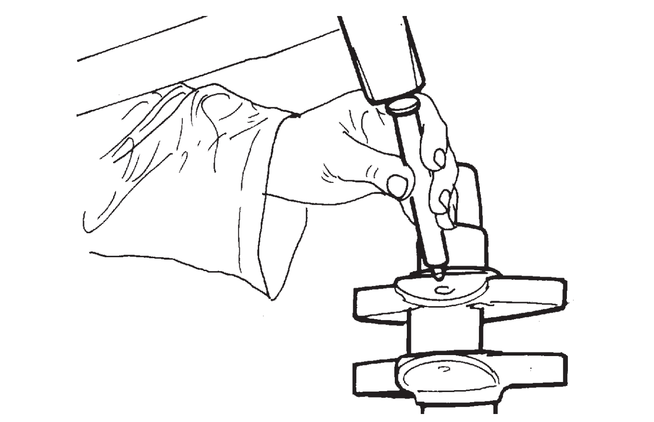
**Crankshaft**

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.

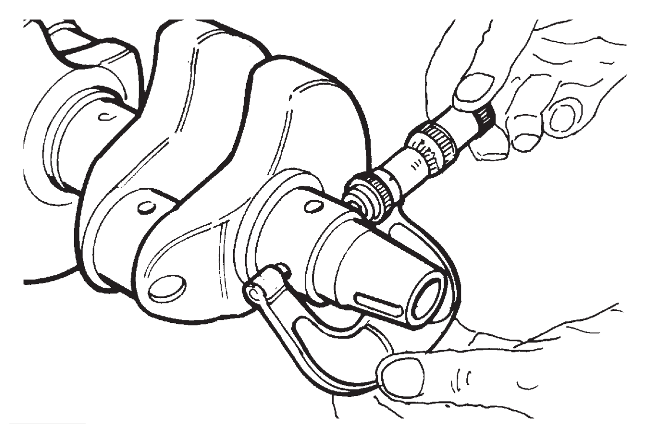
3. When the oil passages and traps have been throughly cleaned, close the openings with new plugs (fig.26).


26

Checking crankshaft dimensions

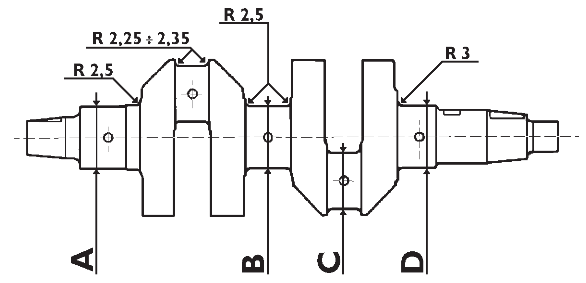
Once the crankshaft has been thoroughly cleaned, use a micrometer to check the wear and ovality of the main journals and crank journals across two sections at right angles to each other (fig.27).

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 ÷ 45,015 | 44,755 ÷ 44,765 | 44,505 ÷ 44,515 | 44,255 ÷ 44,265 |
| **C** | 39,994 ÷ 40,010 | 39,744 ÷ 39,760 | 39,494 ÷ 39,510 | 39,244 ÷ 39,260 |

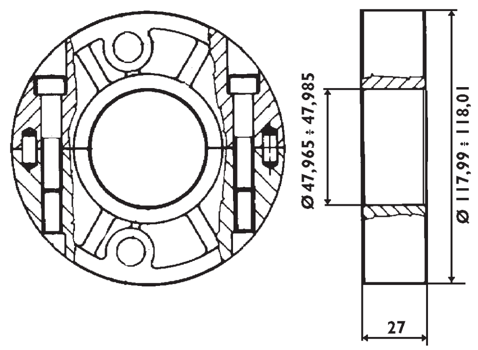
Undersize bearing bushes are already available at the necessary sizes without requiring any adjustment by boring.




28

## 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.



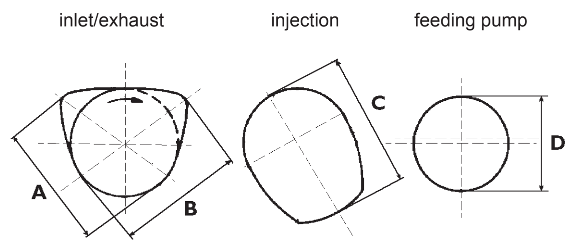

29

## 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 (25LD425-2) and, if necessary, clean them with paraffin or petrol and dry with compressed air.

## 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.



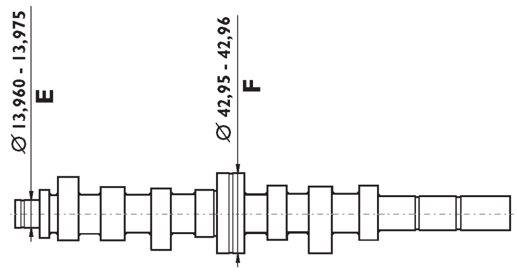

30

## 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 if figures 30-31.

Camshaft dimensions fig.30.

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



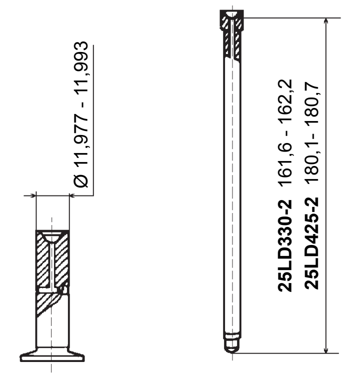

31

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

| Measurement | Clearance mm |
|---|---|
| **E** | 0,025 ÷ 0,065 |
| **F** aluminium crankcase | 0,07 ÷ 0,105 |
| **F** cast iron crankcase | 0,04 ÷ 0,075 |

## Warning

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



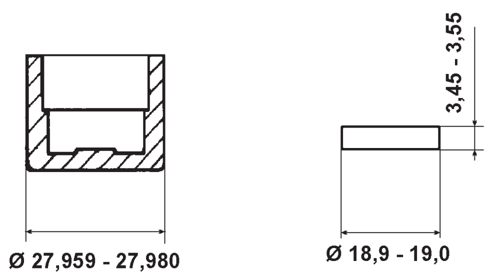
32

### 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.



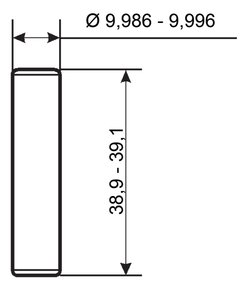
33

### 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 |

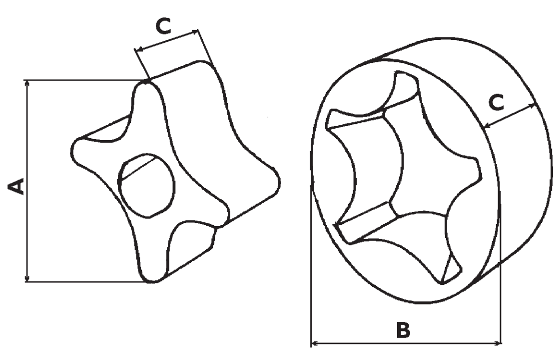


34

### 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 |

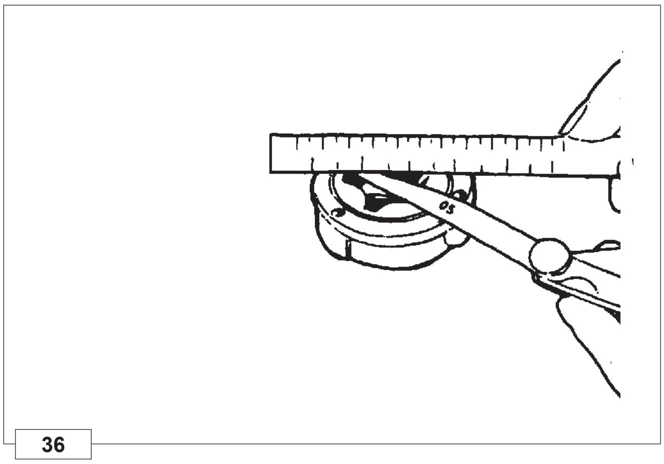


35

### 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 |



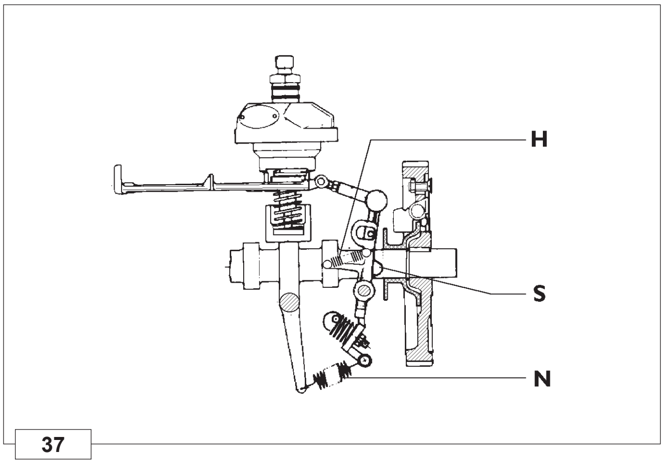
36

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 |



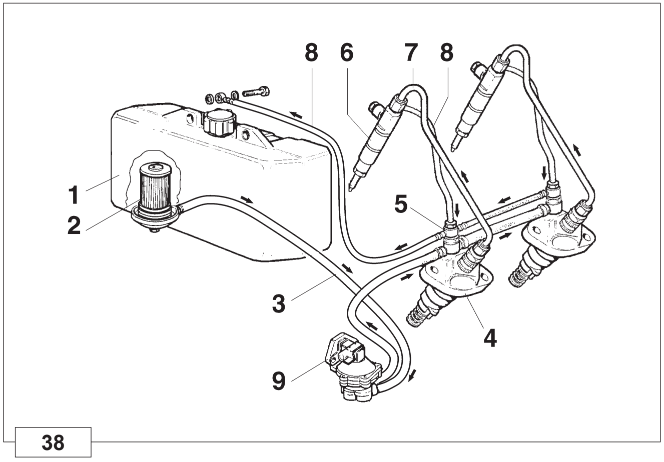

37

**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 (**N**) | 32 ÷ 34 | 53 | 1,9 | 14,75 |
| Supplement (**H**) | 25,75 ÷ 26,25 | 38,7 | 0,6 | 25,5 |



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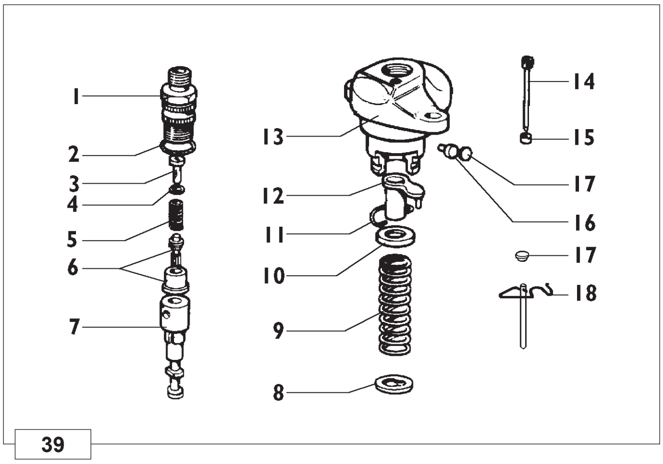
## Fuel circuit

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.



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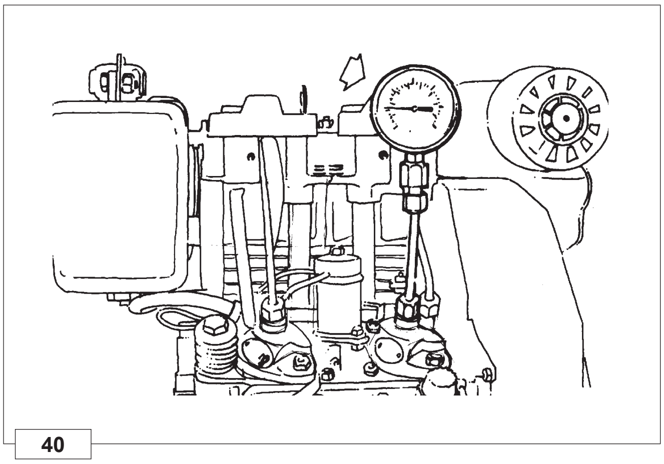
## Injection pumps

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.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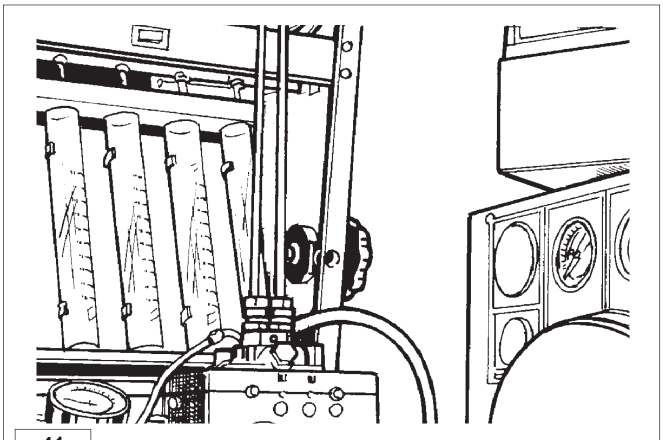
## Checking injection pumps

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/cm² 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/cm² 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/cm² and continues to fall slowly.
The pressure drop from 200 Kg/cm² to 150 Kg/cm² must occur in a time interval of no less than 7 seconds.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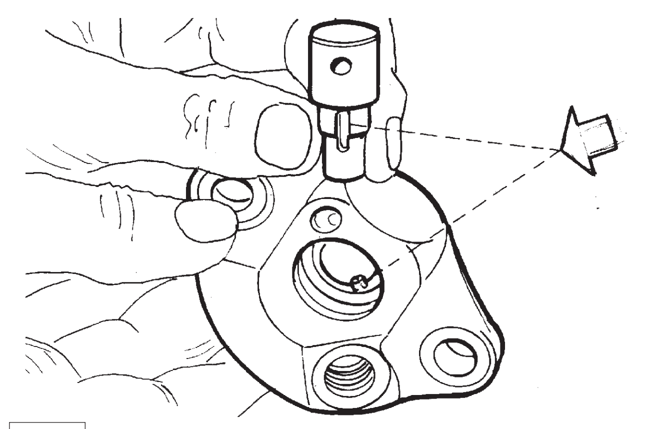
## Injection pump setting (fig.41)

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)** |



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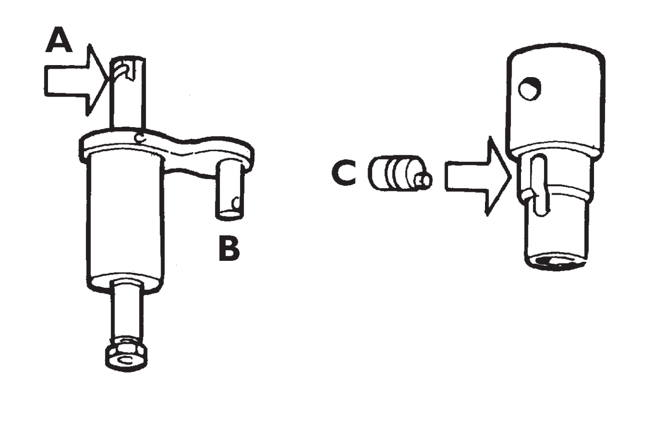
**Warning**

- 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 ÷ 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 ÷ 2.1 mm.**

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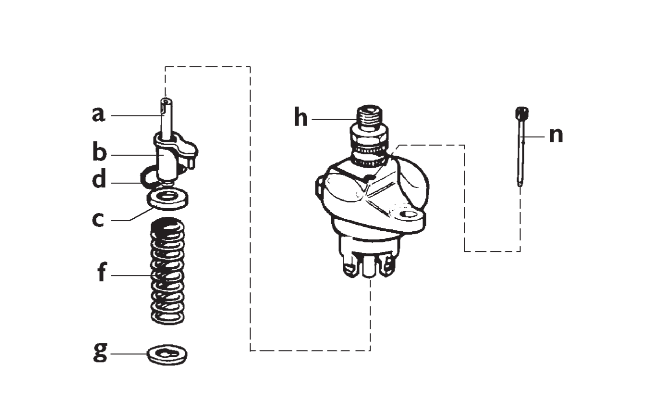


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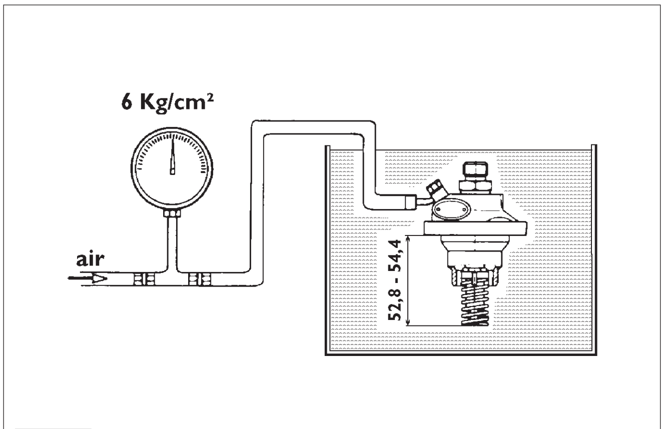
### Assembly of injection pumps

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 ÷ 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.

**Warning**

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

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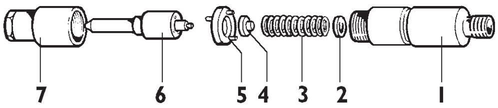
### Testing air tightness

Feed pressurized air at 6 Kg/cm² into the fuel sullpy 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 ÷ 54.4 mm, which corresponds to the bottom dead centre working position of the pump.



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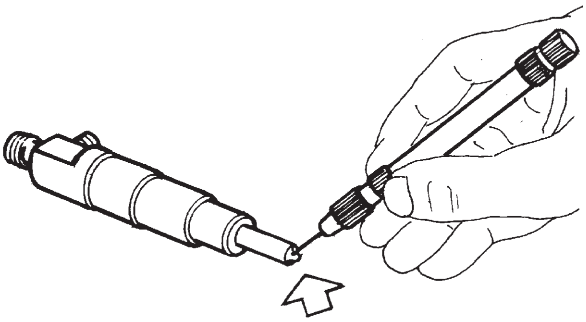
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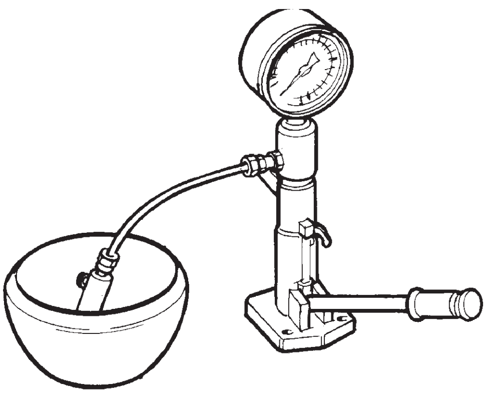
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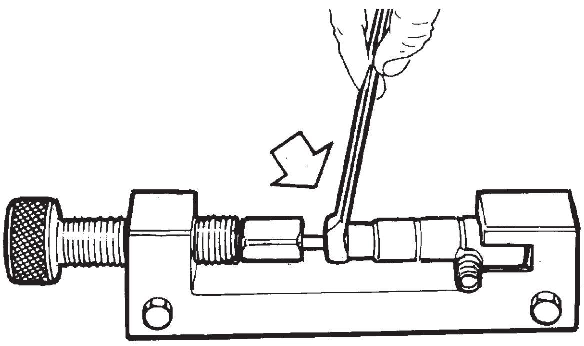
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### Injectors

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/cm² (200 Kg/cm² 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/cm² 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

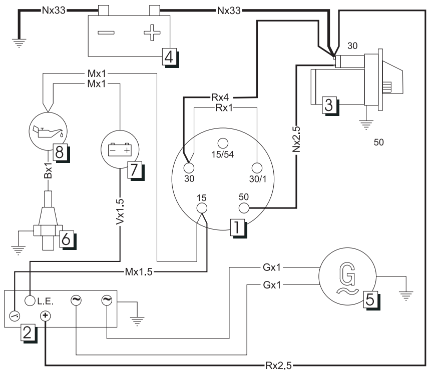
Unscrew the ring nut on the injector nozzle using a ring wrench and a special tool as illustrated in figure 49 serving to release the pressure exerted by the spring on the ring nut.

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) |
|---|

Internal built-in alternator




cables: Color x Section (mm²)

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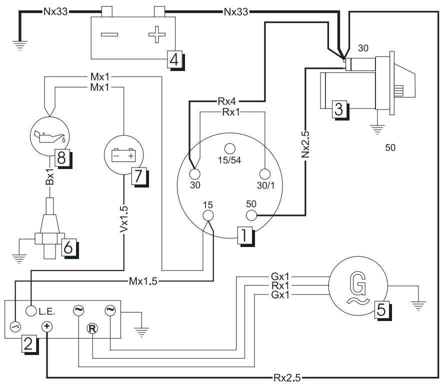
External alternator




cables: Color x Section (mm²)

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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

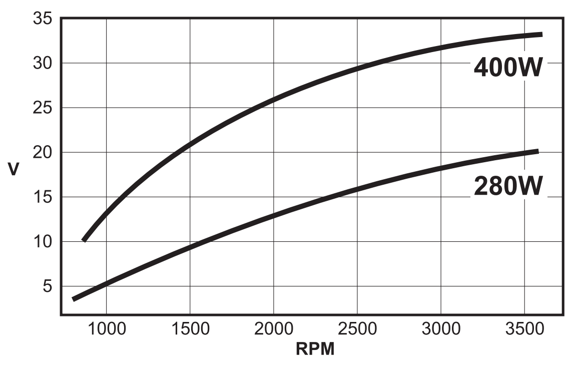
**Flywheel ring gear:**
Check teeth for wear or damage. Fit crown wheel to flywheel by pre-heating to 200-250°C.

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

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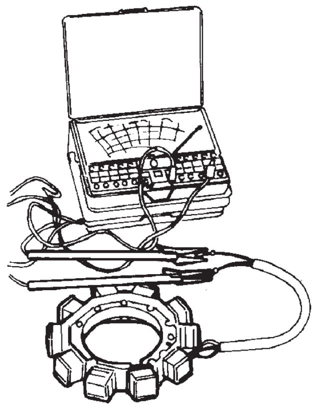

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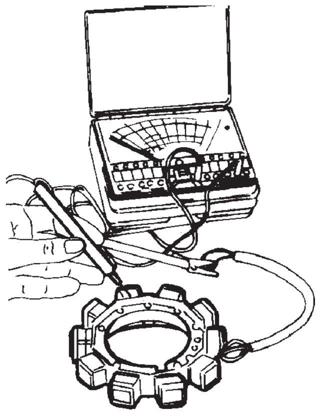

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## Checking electrical equipment

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 the 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 multitester to check the charge current between the two yellow wires. Bring the engine up to 3000 rpm - the multitester 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.

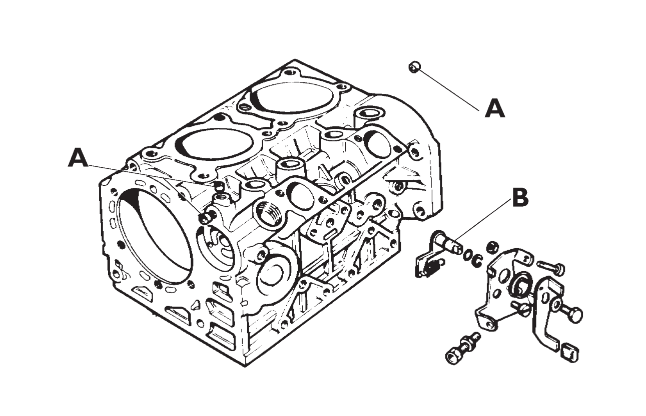
## RECOMMENDATIONS FOR ASSEMBLING

- 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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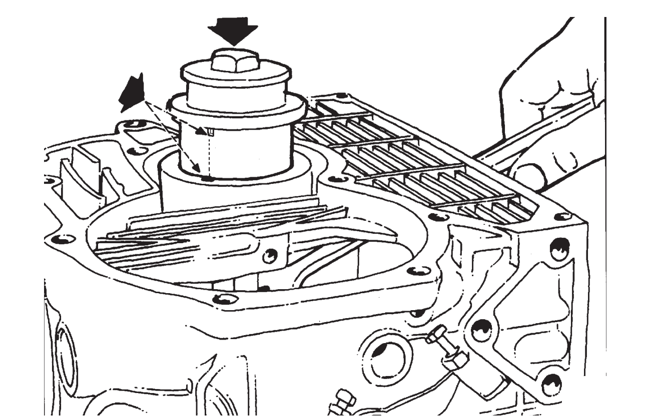
**Important**

- 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.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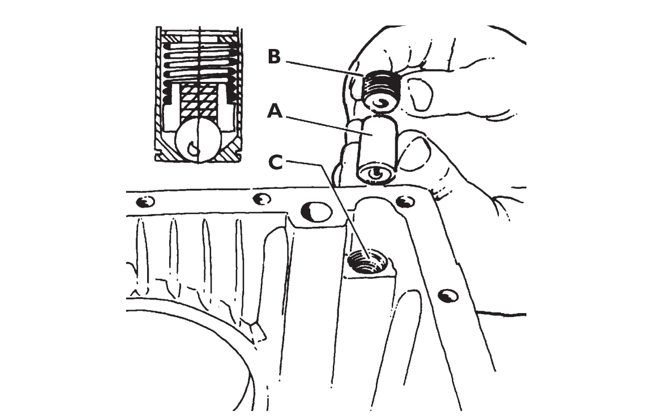
### Preparing the crankcase

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.

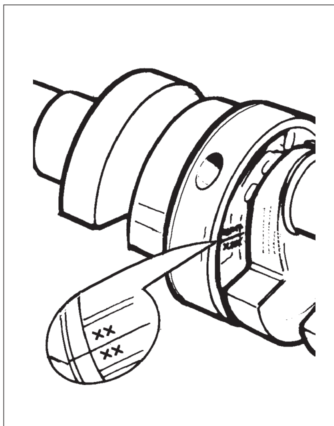
1. Fit the plugs (**A**, fig.55) in their holes.
2. Insert the internal accelerator lever (**B**, fig.55) into the crankcase with its spring taking care to protect the oil seal O-ring from damage.
   Complete the external assembly with plate, spring, lever, etc. as shown in figure 55.
3. Mount the bearing 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.



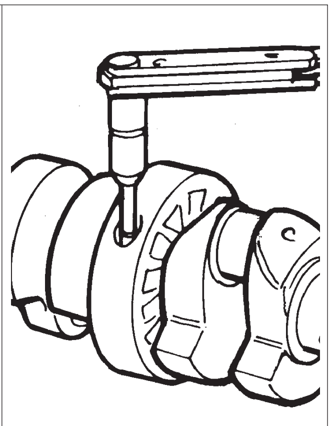
57

**Important**

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



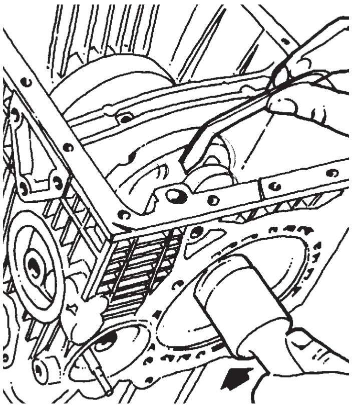
58


59

### Central main bearings

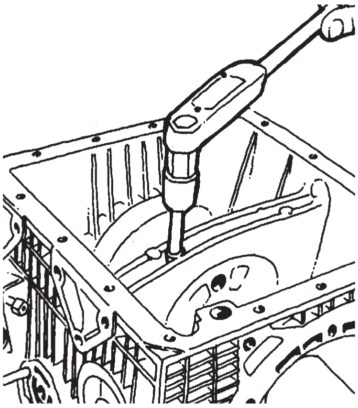
Fit the shells into their seats and coat with a thin film of oil.
The reference numbers (fig.58) must be aligned on each half-shell, making sure that the oil passages match the corresponding openings in the crankcase. Torque the bearing assembly bolts (fig. 59) to:

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


60

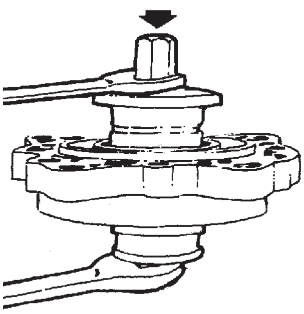
**Crankshaft**

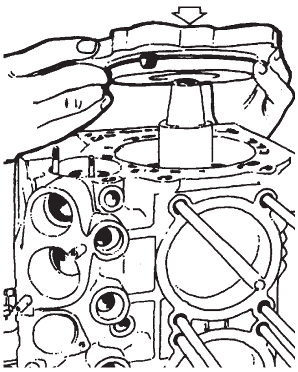
Fit the crankshaft into the crankcase using tool p.n. 00365R0910 as shown in figure 60; make sure that the bearing oil passages are matched to the crankcase oil passages.


61

Torque the bearing screws (fig. 61) to :

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

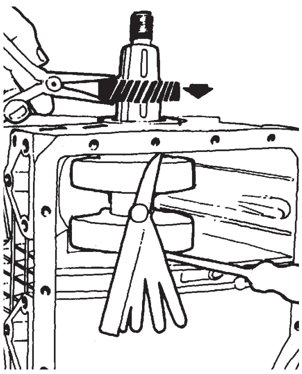

62

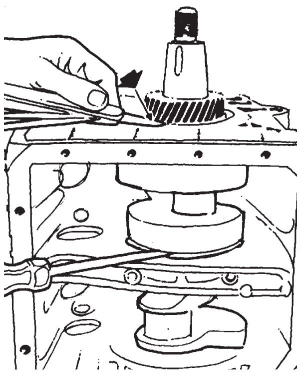

63

**Main bearings - flywheel side**

Fit the bush to the bearing carriern 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)** |

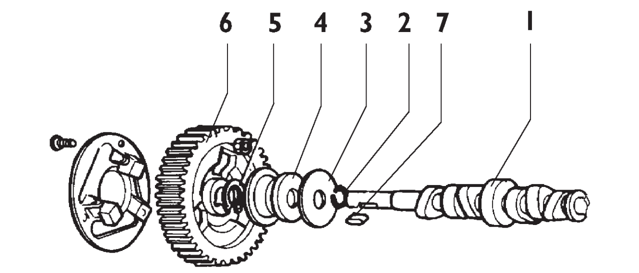

64


65

**Crankshaft end float**

Install an 0.15 mm feeler gauge betwen 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) |

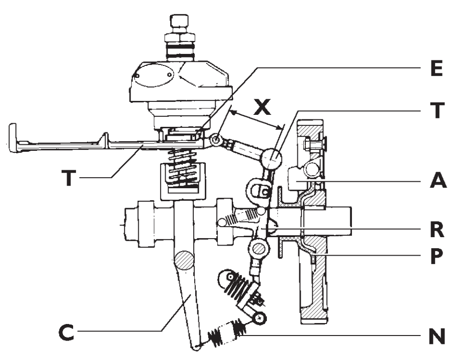


66

## Camshaft

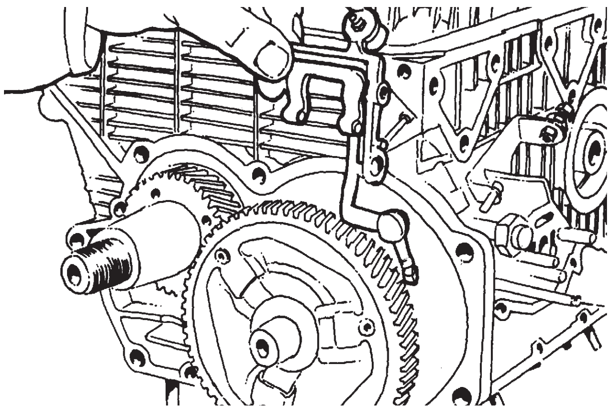
Prepare the camshaft assembly (fig.66) as described below:

**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).



67

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.


68

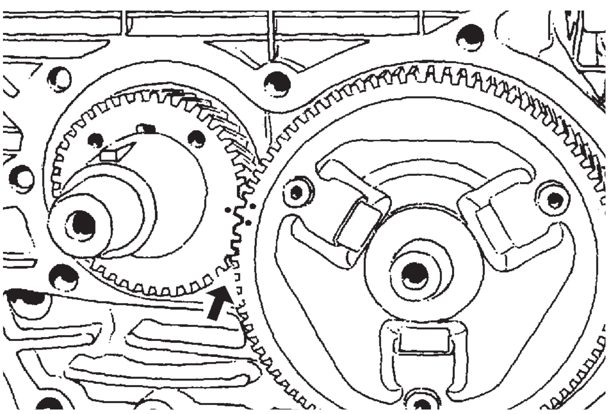
## Governor tie rod adjustment

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

| |
|---|
| **mm 36,5 ± 1 turn** |

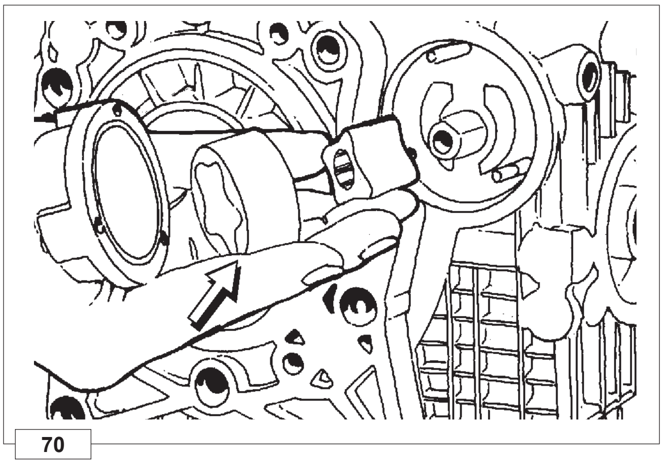
**Important**

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


69

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).



70

## Oil pump

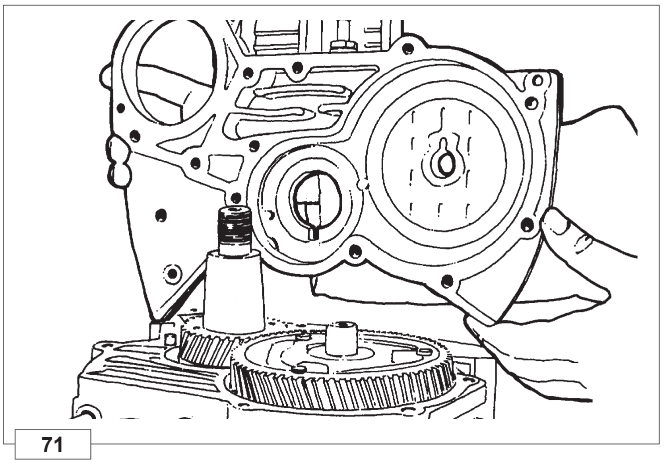
See pag. 25 if you wish to check the rotors.

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

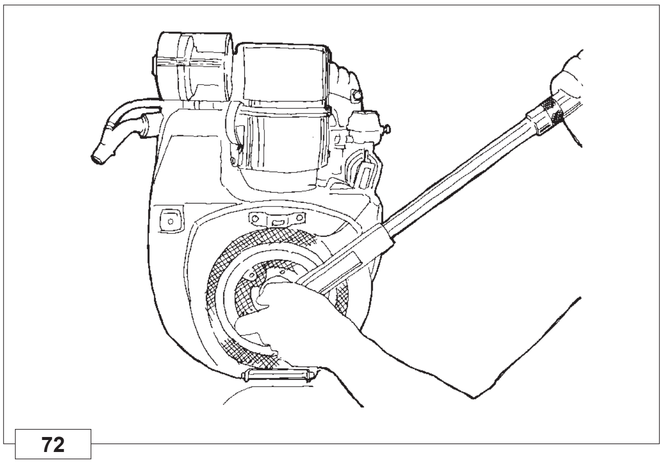


71

## 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)**

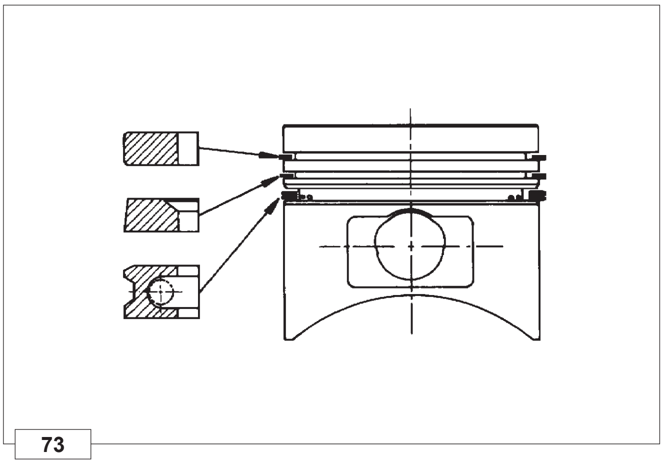


72

## Pulley and flywheel

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

**kgm 18 ÷ 22 (Nm 176,5 ÷ 215,7)**



73

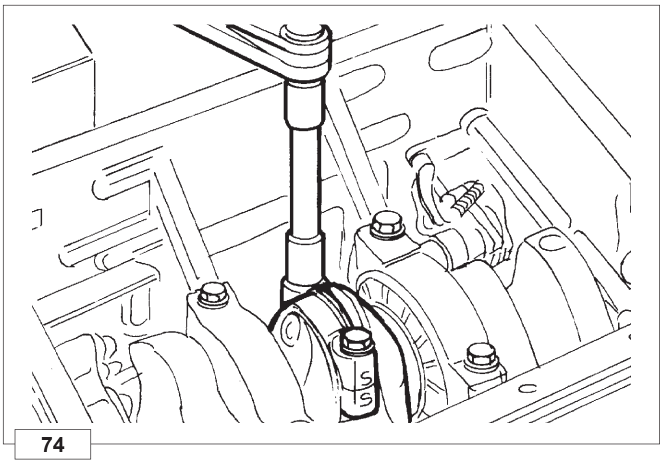
## Pistons

**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 pushind the wrist pin in, without heading the piston.



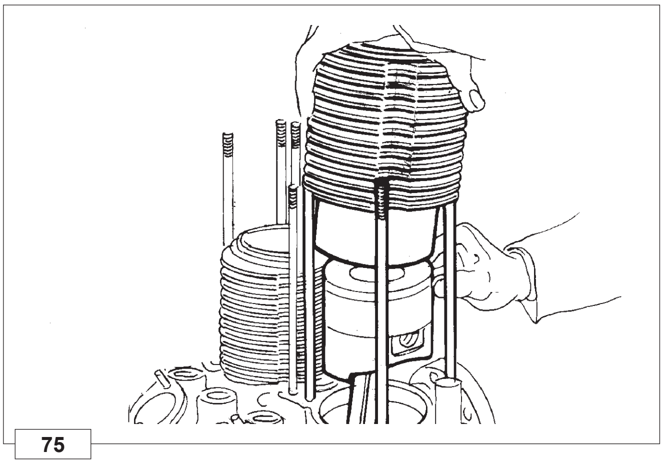
74

## 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)**

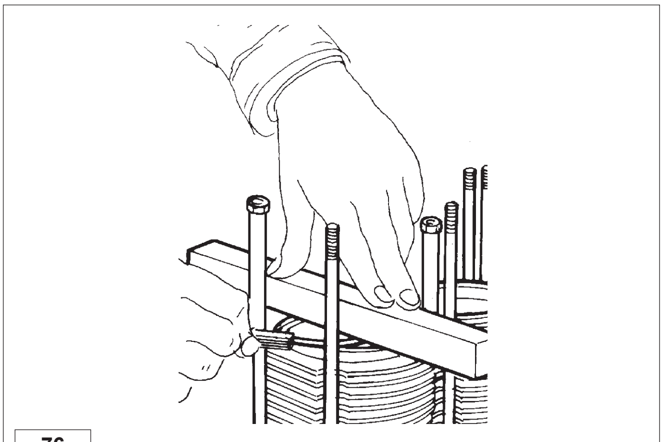
Now fit the oil pan after first inserting the appropriate gasket between the facing surfaces.



75

## Cylinders

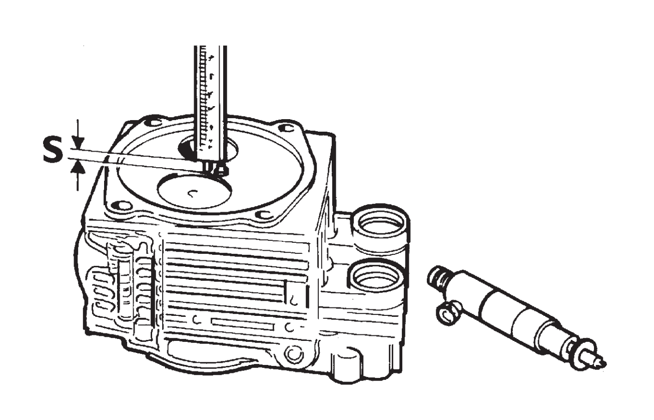
Before fitting the cylinders turn the piston rings so that the end gaps are arranged at intervals of 120° with the end gap of the first compression ring aligned with the axis of the wrist pin. The lower face of the cylinders are chamfered to permit the easy insertion of the piston rings. The operation 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:



76

**0,10 ÷ 0,20 mm**

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.



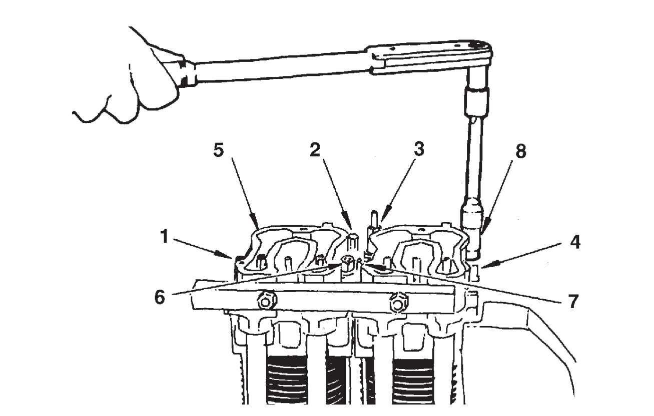

77

### 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).




78

### Cylinder heads

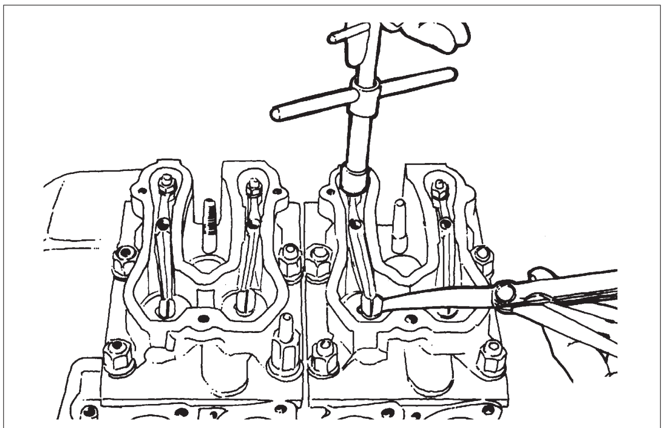
For checking and overhaul of the cylinder heads refer to page 19.
Fit the push rods and oil sealing O-rings on the cover pipes and proceed to install the cylinder heads with the relative gaskets on the facing surfaces.

**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)** |



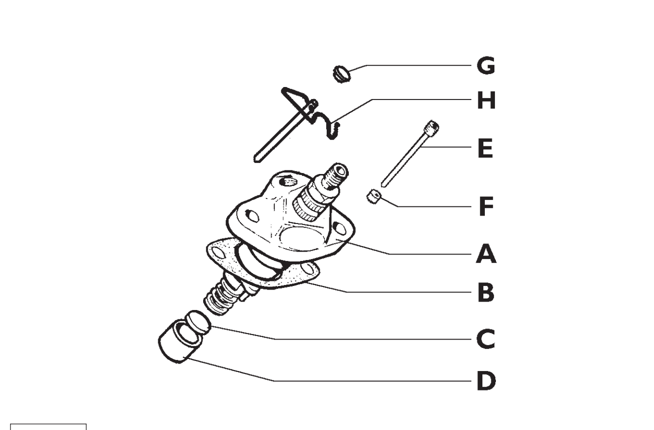
79

### Valve clearance

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

| |
|---|
| **0,15 mm intake/exhaust** |

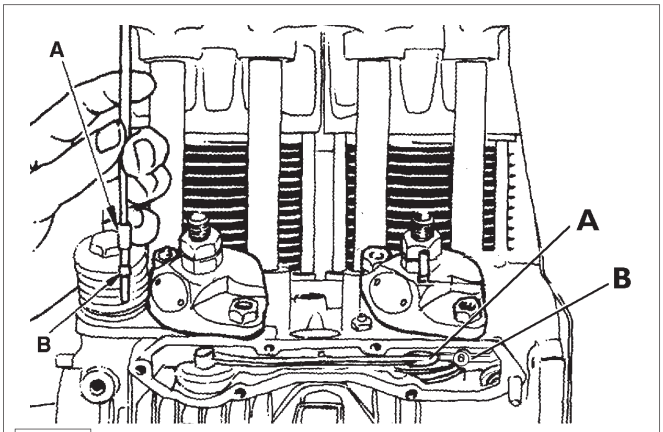
This clearance is to be adjusted with the pistons at their respective TDC compression positions.



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.

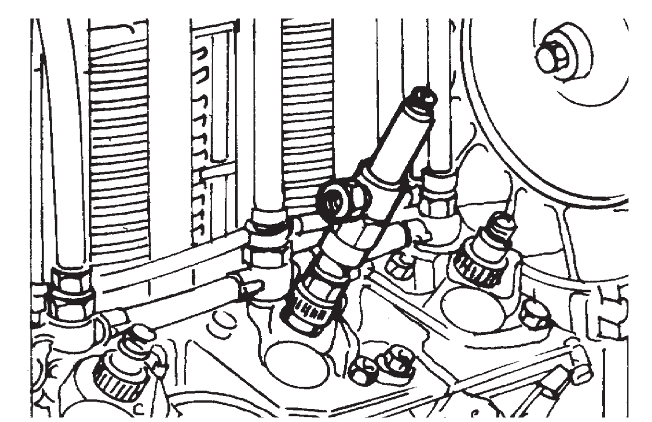


81

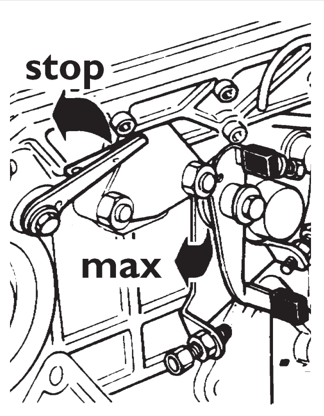
5. Release the control sleeves:
- on the traditional pumps by loosening the pins (**E**, fig.80) and inserting the appropriate distance collars (**F**, fig.80).
- on the BOSCH type PF30 pumps by removing the pins (**H**, fig.80) and closing the hole on the pump body using plug **G**.

**Important**

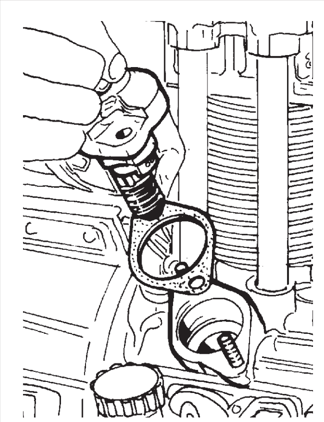
• injection pumps should be released only after they have been connected to the governor tie rod and secured to the crankcase. If one or both pumps must be changed, in order to guarantee the same fuel delivery for each pump the pump remaining on the crankcase must be locked using the pins (**E** or **H**,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



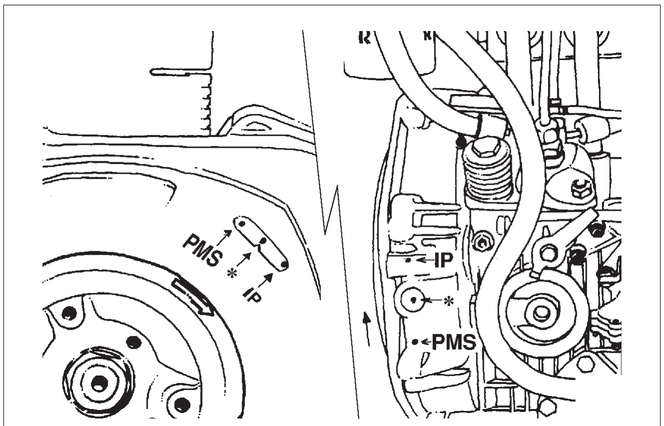
82




83



84




85

**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.

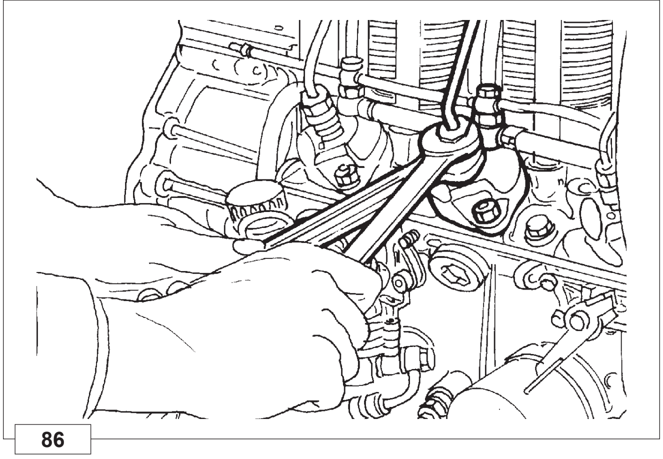
For variable advance pumps, the reference mark on the flange bell (fig.85) must match the intermediate point (*) between TDC and "IP" (start of dynamic injection) punched onto the flywheel.
On traditional pumps the static start of injection (*) is the same as the start of dynamic injection (IP).

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 |



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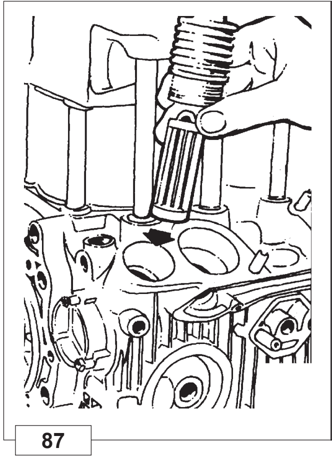
## Injectors and injector pipes

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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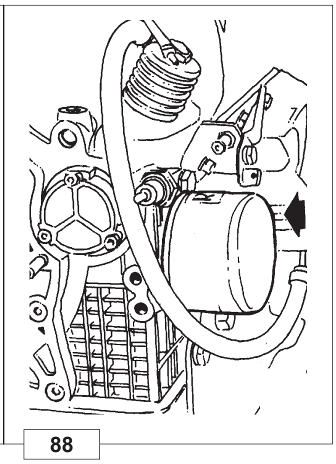
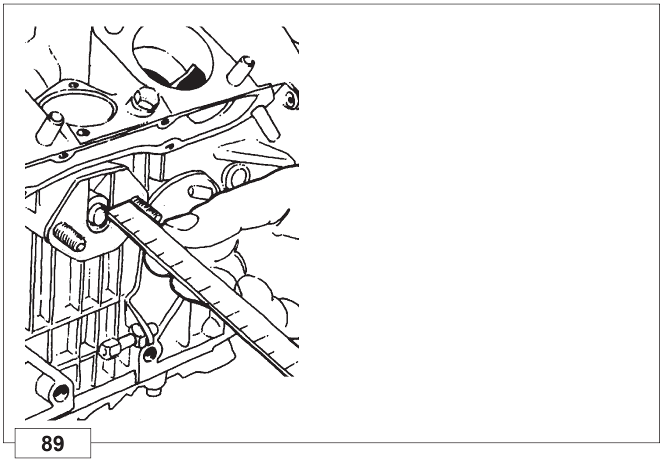


88

## 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 25LD425-2 engines can mount an external filter cartridge that can be screwed onto the crankcase (fig.88). Oil the seal before assembly.



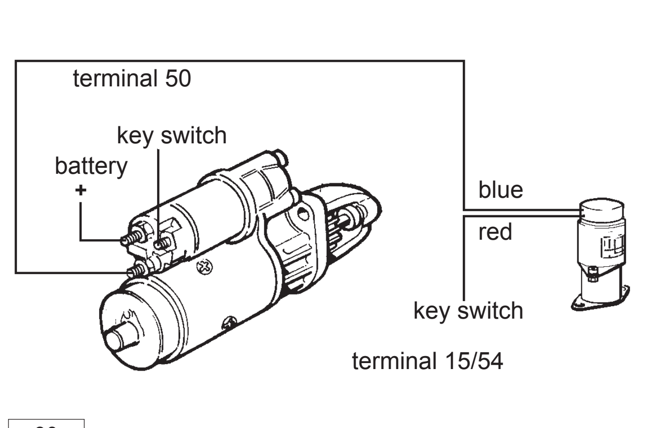
89

## 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** |

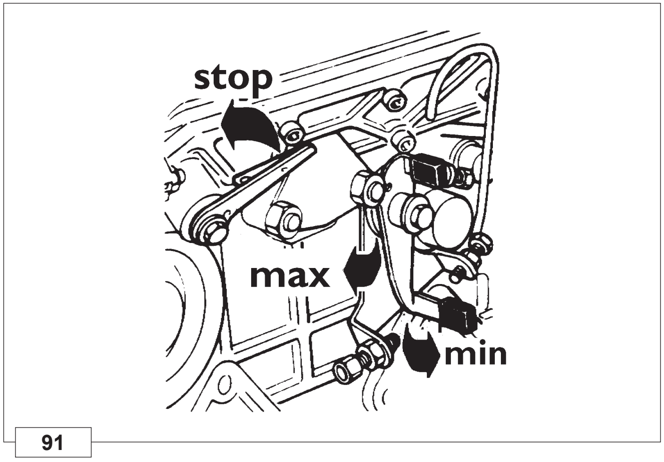
4. With the fuel feed pump cam in the rest position mount the pump and actuate it manually .




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 the injection pump connection lever moves freely along its entire stroke.
Make the electrical connections as shown in diagram 90.

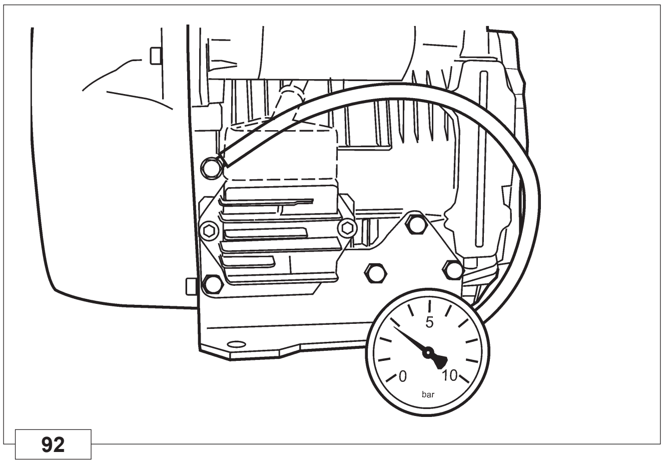



91

### Speed adjustment (fig.91)

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

| | |
|---|---|
| 3150 rpm | for engines at 3000 rpm |
| 3750 rpm | for engines at 3600 rpm |

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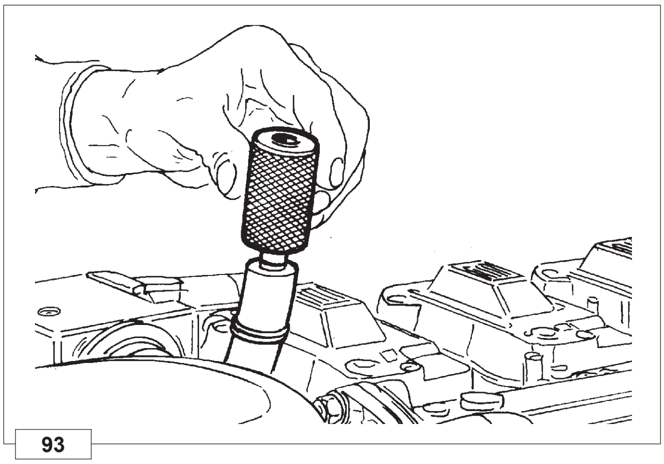
### Checking oil pressure

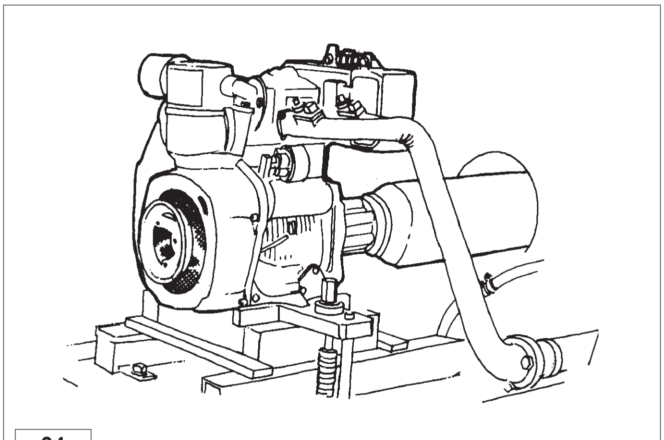
1. Remove the bolt from the hole in the crankcase and fit a pressure gauge with 0 to 10 kg/cm² full scale (fig.92)
2. Start the engine, accelerate to 3000 rpm and wait for the oil to reach a temperature of 70 to 80°C.
3. The pressure reading must be between 2.5 and 4 kg/cm².
4. Reduce engine speed to minimum; the pressure should not fall below 1 ÷ 1.5 Kg/cm² with oil temperature of 80°C.



93

### 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.



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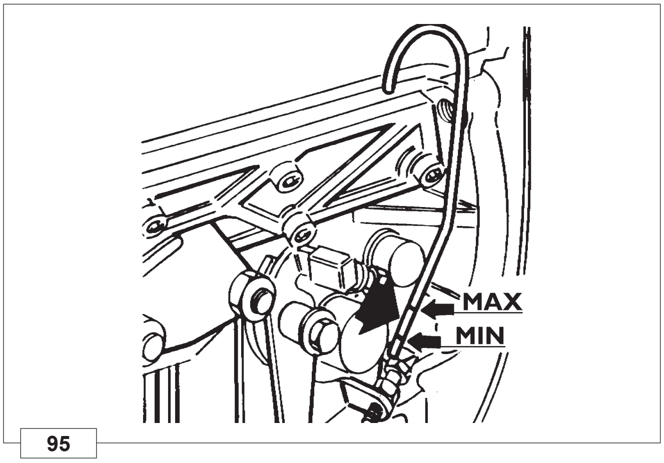
### Dyno testing of engine

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.



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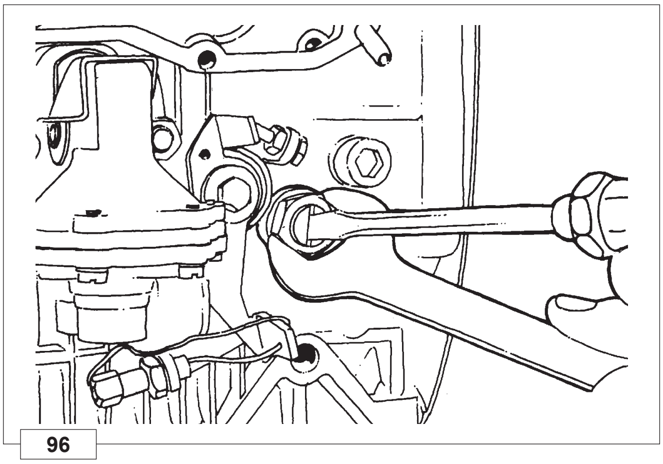
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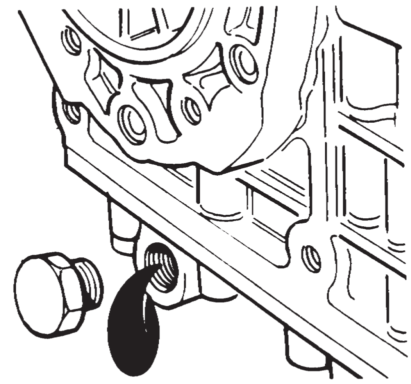
Running-in table

| 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.

**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).



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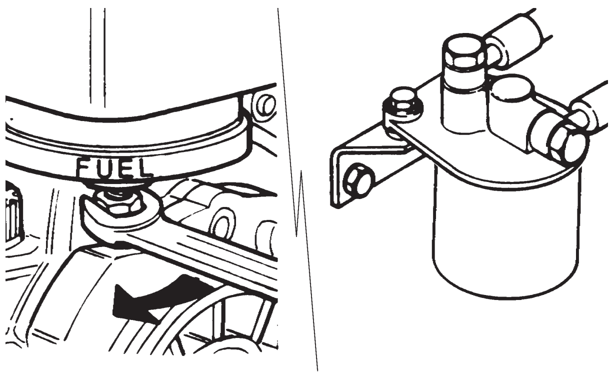


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Prepare engines as follows for storage over 3 months:

**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 manualy 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).

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

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

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

UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

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# WORKSHOP MANUAL

## Engine Series 3 - 4 LD

LOMBARDINI
A KOHLER. COMPANY
SERVICE

**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 |
|---|---|---|---|---|---|---|---|
| DICOM/ATLO | ED0053025560 | 50839 | **4°** | **3** | 01-94 | 15.06.2014 | |

Manual's purpose

- This manual contains the instructions needed to carry out a proper maintenance of the engine, therefore it must always be available, for future reference when required.
- Safety pictograms can be found on the engine and it is the operator's responsibility to keep them in a perfectly visible place and replace them when they are no longer legible.
- Information, description and pictures in this manual reflect the state of the art at the time of the marketing ofengine.
- However, development on the engines is continuous.Therefore, the information within this manual is subject to change without notice and without obligation.
- **LOMBARDINI srl** reserves the right to make, at any time, changes in the engines for technical or commercial reasons.
- These changes do not require **LOMBARDINI srl** to intervene on the marketed production up to that time and not to consider this manual as inappropriate.
- Any additional section that **LOMBARDINI srl** will deem necessary to supply some time after the main text shall be kept together with the manual and considered as an integral part of it.
- The information contained within this manual is the sole property of **LOMBARDINI srl**. As such, no reproduction or replication in whole or part is allowed without the express written permission of **LOMBARDINI srl**.

## PREFACE

Every attempt has been made to present within this use and maintenance, accurate and up to date technical information. However, development on the Lombardini series is continuos.
Therefore, the information within this manual is subject to change without notice and without obligation.
Carefully read and follow all instructions in this booklet as well as all those provided with the equipment on which this engine is used.
The information contained within this service manual is the sole property of Lombardini.
As such, no reproduction or replication in whole or part is allowed without the express written permission of Lombardini.

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

1 - is properly trained and equipped to safely and professionally perform the subject operation;
2 - possesses adequate hand and Lombardini special tools to safely and professionally perform the subject service operation;
3 - has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- For spare parts and after sale assistance contact authorized service centers.
- For any spare parts order please specify following details: ENGINE TYPE AND SERIAL NUMBER - Version (K) - on the engine name plate
- Tel. No. appears on service booklet or on the website: **www.lombardinigroup.it**
- 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.

**WARNING** 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.

**CAUTION** 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 handbook provides the main information concerning the repair of the following LOMBARDINI Diesel engines **3LD 450, 3LD 510, 3LD 451/S, 3LD 510/S, 4LD 640, 4LD 705, 4LD 820,** which are air-cooled, provided with direct injection and revised on the 15-06-2014.

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**IMPORTANT**

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

## SAFETY INFORMATION

### GENERAL NOTES

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

**WARNING**

- 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 **Lombardini** technical office for mixture proportions. Petrol may not be used because of the risk of it forming flammable vapours.
- During operation the surface of the engine reaches temperatures that may be dangerous. Avoid in particular all contact with the exhaust system.
- The liquid cooling circuit is under pressure. Do not carry out any checks before the engine has cooled down, and even then open the radiator cap or the expansion tank cautiously. Wear protective clothing and glasses. If there is an electric fan, do not approach the engine while it is still hot as the fan may come on even when the engine is not running. Clean the cooling system with the engine turned off.
- While cleaning the oil bath air filter, check that the oil is disposed of in such a way as not to harm the environment. Any filtering sponges in the oil bath air filter should not be soaked with oil. The cyclone pre-filter cup must not be filled with oil.
- Since the oil must be emptied out while the engine is still hot (approx. 80°C), particular care should be taken in order to avoid burns. In any case make sure that oil does not come into contact with your skin because of the health hazards involved.
- Fuel vapours are highly toxic, so fill up only in the open air or in well ventilated environments.

- 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.

**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 fílling 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 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 **Lombardini**. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.

**Regulations for lifting the engine**

- Before removing the engine from the vehicle on which it is installed, disconnect the power supply, detach the fuel and coolant supply, and all connections including the mechanical ones.
- Attach the engine to a suitable lifting device (lifting beam).
- To move the engine simultaneously use the eyebolts installed, these lifting points are not suitable for the entire machine, then use the eyebolts installed by the manufacturer.
- Before lifting, make sure the weight is correctly balanced by checking its barycentre.
- Close all engine openings accurately (exhaust, intake, etc.), then wash the outside and dry with a jet of compressed air.

**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.*

## 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

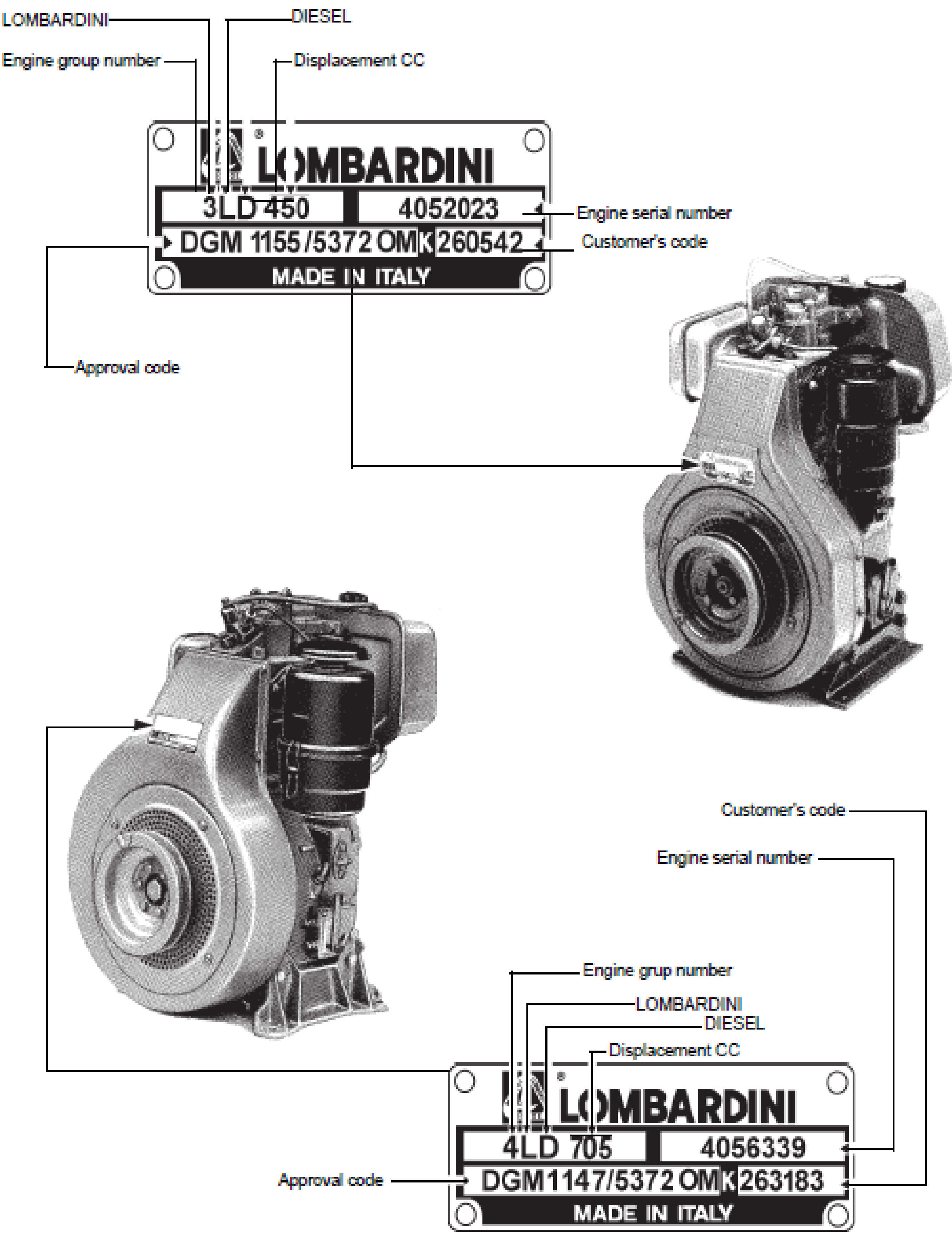
Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment.
Procedures for identifying the extent of the impact on the environment must consider the following factors:

- Liquid waste
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- 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.

## MANUFACTURER AND MOTOR IDENTIFICATION DATA



| ENGINE TYPE | | | 3LD450 | 3LD510 |
|---|---|---|---|---|
| Cylinders | | N. | 1 | 1 |
| Bore | | mm | 85 | 85 |
| Stroke | | mm | 80 | 90 |
| Displacement | | Cm³ | 454 | 510 |
| Compression ratio | | | 18,1:1 | 18,1:1 |
| rpm | | | 3000 | 3000 |
| KW Power | N DIN 70020 - 80/1269/CEE - iso 1585 | | 7,5 | 9,0 |
| | NB DIN 6271 - ISO 3046 - 1 IFN | | 6,6 | 7,3 |
| | NA DIN 6271 - ISO 3046 - 1 ICXN | | 6,0 | 6,6 |
| Peak torque * | | Nm<br>RPM | 28,5<br>@ 1700 | 32,8<br>@ 1800 |
| Fuel specific consumption | | l/h | 1,7 | 1,9 |
| Oil consumption | | Kg/h | 0.007 | 0.008 |
| Dry weight | | Kg. | 57 | 60 |
| Combustion air volume at 3000 rpm | | l./1' | 560 | 630 |
| Cooling air volume at 3000 rpm | | l./1' | 9000 | 9000 |
| Max. axial load permissible for drive shaft in two directions | | Kg. | 250 | 250 |
| Max. inclination | instantaneous | a | 35° | 35° |
| | extended to 1 h. | α | 30° | 30° |
| | permanent | α | **** | **** |

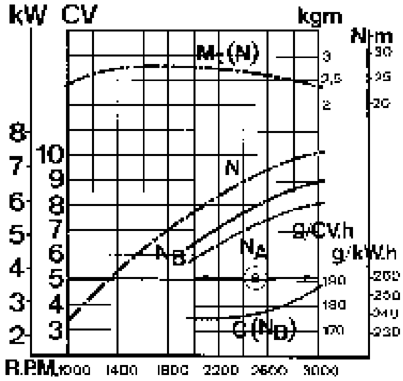
| ENGINE TYPE | | | 4LD640 | 4LD705 | 4LD820 |
|---|---|---|---|---|---|
| Cylinders | | N. | 1 | 1 | 1 |
| Bore | | mm | 95 | 100 | 102 |
| Stroke | | mm | 90 | 90 | 100 |
| Displacement | | Cm³ | 638 | 707 | 817 |
| Compression ratio | | | 17,0:1 | 17,0:1 | 17,0:1 |
| rpm | | | 3000 | 3000 | 3000 |
| KW Power | N DIN 70020 - 80/1269/CEE - iso 1585 | | 10,5 | 12,0 | 13 |
| | NB DIN 6271 - ISO 3046 - 1 IFN | | 8,8 | 9,9 D | 11,4 D |
| | NA DIN 6271 - ISO 3046 - 1 ICXN | | 7,9 | 8,8 D | 10,3 D |
| Peak torque * | | Nm<br>RPM | 38,7<br>@ 1700 | 43,1<br>@ 2000 | 48<br>@ 1600 |
| Fuel specific consumption | | l/h | 2,4 | 2,6*** | 3,0*** |
| Oil consumption | | Kg/h | 0.024 | 0,030*** | 0,035*** |
| Dry weight | | Kg. | 100 | 100 | 105 |
| Combustion air volume at 3000 rpm | | l./1' | 780 | 770 D | 890 D |
| Cooling air volume at 3000 rpm | | l./1' | 12000 | 10400 D | 10400 D |
| Max. axial load permissible for drive shaft in two directions | | Kg. | 300 | 300 | 300 |
| Max. inclination | instantaneous | a | 35° | 35° | 35° |
| | extended to 1 h. | α | 25° | 25° | 25° |
| | permanent | α | **** | **** | **** |

* It stands for power
** It stands for NB power
*** It stands to NB power at 2600 rpm
**** According to the application D at 2600 rpm

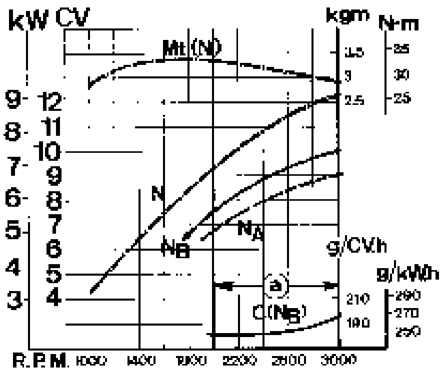
**Note:** For LDA 450, LDA 510, LDA 96, LDA 97, LDA 820 out-of-production engines, the repair specifications are equal to those of the engines specified in the table. 3 LD 451/S, 3LD 510/S engines, which are currently produced, not specified in the table, turn anticlockwise ( seen from the flywheel side), and are provided with the same feature as 3LD450 and 3LD510engines.

## PERFORMANCE DIAGRAMS

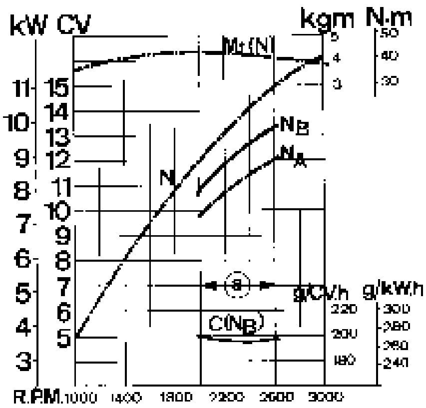
3LD 450



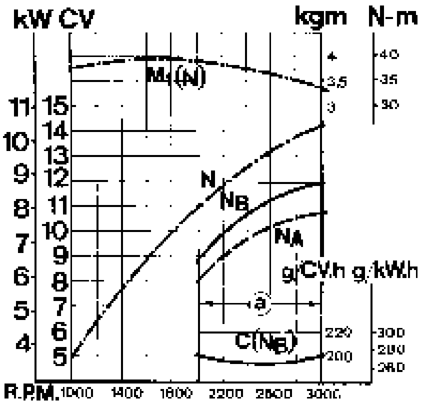

3LD 510



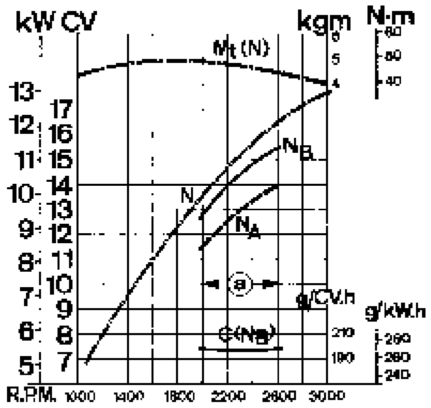

4LD 705




4LD 640




4LD 820




**N (80/1269/EU - ISO 1585)** **AUTOMOTIVES POWER** : Discontinuous services at variable rpm and load.
**NB (ISO 3046 - 1 IFN)** **NON-OVERLOADABLE POWER:**Continuous light services at constant rpm and variable load.
**NA (ISO 3046 - 1 ICXN)** **CONTINUOUS OVERLOADABLE POWER:** Continuous heavy-duty services at constant rpm and load.

The above mentioned power levels refer to the engine equipped with air filter, standard silencer, suction fan - which previously underwent a breaking-in period - at 20°C ambient conditions, at 1 bar.
The maximum power is guaranteed with a 5% tolerance.
These powers are reduced of abt. 1% every 100 m height and of 2% for every 5°C exceeding 25°C.

**C (NB):** Specific fuel consumption at NB power
**MT** : Torque at N power
a : Continuous service field of use. For any purpose out of this field of use, please contact company LOMBARDINI.

## 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.

| PROBABLE CAUSES | | TROUBLE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | It does not start | It starts but does not stop | It does not accelerate | Inconsistent rpm | Black smoke | White smoke | Low oil pressure | Oil level increase | Excessive oil consumption | Oil and fuel leakage from the exhaust |
| FUEL CIRCUIT | Clogged pipings | ● | | | | | | | | | |
| | Clogged fuel filter | ● | ● | ● | | | | | | | |
| | Presence of air in the fuel circuit | ● | ● | ● | | | | | | | |
| | Clogged tank breather | ● | ● | ● | | | | | | | |
| | Faulty fuel pump | ● | ● | | | | | | | | |
| | Blocked injector | ● | | | | | | | | | |
| | Blocked injection pump valve | ● | | | | | | | | | |
| | Wrong injector setting | | | | | ● | | | | | |
| | Plunger excessive leakage | | | | | | | | ● | | |
| | Stuck injection pump delivery control | ● | | ● | ● | | | | | | |
| | Wrong injection pump delivery setting | | | ● | | ● | | | | | |
| LUBRICATION | High oil level | | | | ● | | ● | | | ● | |
| | Blocked pressure relief valve | | | | | | | ● | | | |
| | Worn oil pump | | | | | | | ● | | | |
| | Presence of air inside the oil intake pipe | | | | | | | ● | | | |
| | Faulty pressure gauge or switch | | | | | | | ● | | | |
| | Clogged oil intake duct | | | | | | | ● | | | |
| ELECTRICAL EQUIPMENT | Discharged battery | ● | | | | | | | | | |
| | Inefficient or wrong cable connection | ● | | | | | | | | | |
| | Faulty starting switch | ● | | | | | | | | | |
| | Faulty starting motor | ● | | | | | | | | | |
| MAINTENANCE | Clogged air filter | ● | | ● | | ● | | | | | |
| | Excessive idle operation | | | | | | ● | | | | ● |
| | Incomplete running-in | | | | | | ● | | | | |
| | Overloaded engine | | | ● | | ● | | | | | |
| SETTINGS AND REPAIRINGS | Advanced injection | ● | | | | | | | | | |
| | Delayed injection | | | | | ● | | | | | |
| | Incorrect governor tinkage adjustment | ● | | | ● | | | | | | |
| | Broken or loose govener spring | | | ● | | | | | | | |
| | Low idling setting | | ● | | ● | | | | | | |
| | Worn or stuck piston rings | | | | | | ● | | | ● | ● |
| | Worn or scored cylinders | | | | | | ● | | | ● | ● |
| | Worn valve guides | | | | | | ● | | | ● | ● |
| | Sticking valves | ● | | | | | | | | | |
| | Worn crankshaft-connecting rod bearings | | | | | | | ● | | | |
| | Non-sliding speed governor leverage | ● | ● | | ● | | | | | | |
| | Crank shaft not turning freely | | | | | ● | | | | | |
| | Cylinder head gasket | ● | | | | | | | | | |

## ROUTINE ENGINE MAINTENANCE

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

# MAINTENANCE ENGINES 3LD 450 - 510 - 450/S - 510/S
# 4LD 640 - 705 - 820

| OPERATION | DETAIL | | INTERVALS (HOURS) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 10 | 50 | 125 | 250 | 500 | 1000 | 2500 | 5000 |
| CLEANING | AIR FILTER (OIL-BATH) (*) | | | ● | | | | | | | |
| | HEAD AND CYLINDER FINS (*) | | | | | | ● | | | | |
| | FUEL TANK | | | | | | | | ● | | |
| | INJECTORS | | | | | | | ● | | | |
| CHECK | LEVEL | AIR FILTER OIL | | ● | | | | | | | |
| | | SUMP OIL | | ● | | | | | | | |
| | | BATTERY LIQUID | | | ● | | | | | | |
| | FUEL HOSE COUPLING FASTENING | | | | | | | ● | | | |
| | VALVE AND ROCKER ARM CLEARANCE | | | | | | | ● | | | |
| | INJECTOR SETTING | | | | | | | ● | | | |
| CHANGE | | AIR FILTER(**) (***) | | ● | | | | | | | |
| | | SUMP (***) | | | □ | | ● | | | | |
| | OIL FILTER CARTRIDGE | | | | □ | | ● | | | | |
| | FUEL FILTER CARTRIDGE | | | | | | ● | | | | |
| OVERHAUL | PARTIAL (****) | | | | | | | | | ● | |
| | GENERAL | | | | | | | | | | ● |

□ First replacement.
(*) In particular running conditions even every day.
(**) In particularly dusty environments every 4-5 hours.
(***) See prescribed oil.
(****) It includes the check of cylinders, segments, guides, valve seat springs and grindings, head and cylinder descaling, injection pump and injector checks.

**CAPACITIES IN LITERS**

**Standard fuel tank**
3LD450, 3LD510, 3LD450/S, 3LD510/S = 5.3
4LD 640, 4LD705, 4 LD 820 = 7.2

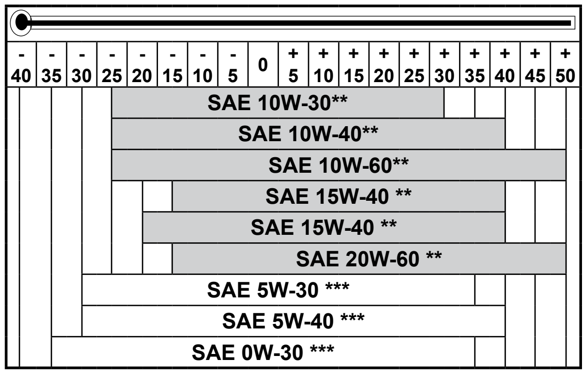
**Standard oil sump**:
3LD450, 3LD510, 3LD450/S, 3LD510/S =1.75
4LD640, 4LD705, 4LD 820 = 2.60

**Air filter oil bowl** = 0.3
For special filters, tanks and oil sumps, please follow LOMBARDINI instructions.

## 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.




**SAE- Grade**

** Mineral base*
*** Semi-synthetic base*
**** Synthetic base*

***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 | |
|---|---|
| ***B1 =*** | Low-viscosity, for frictions reduction |
| ***B2 =*** | Standard |
| ***B3 =*** | High performances (indirect injection) |
| ***B4 =*** | High quality (direct injection) |

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

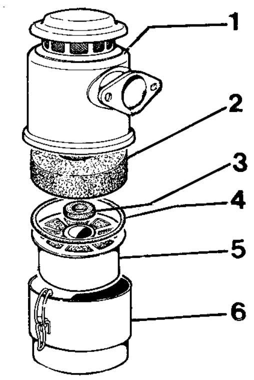
**API / MIL SEQUENCES**

| 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

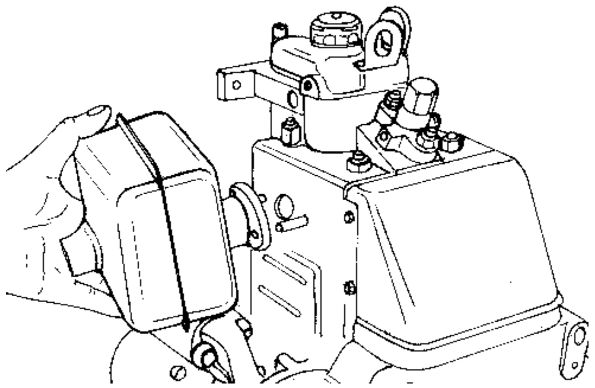
**Oil-bath air filter (standard)**

**Danger – Attention**
Always wear protective goggles if compressed air is used.

**Caution – Warning**
Never use solvents with a low flash point to clean the filter element. Such action could cause an explosion.

Oil-bath type with double filtering mass.
The lower mass is made of metal, while the upper is made of polyurethan.
Check the gasket conditions and replace them in case they are damaged.
Make sure that the weldings are not damaged.
Carefully clean the lower body and the filtering masses using some gas oil, blow the lower mass with compressed air and dry the upper mass by means of a cloth. Fill with engine oil filter to the indicated level.
While reassembling, tighten the nuts at 25 Nm (3LD450, 3LD510, 3LD450/S, 3LD 510/S), at 30 Nm (4LD 640, 4LD 705, 4LD 820)
Details:

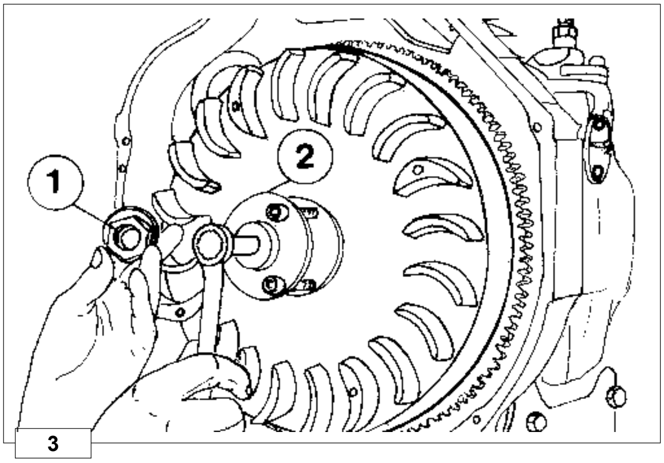
**1** Upper body
**2** Filtering mass made of polyurethan
**3** Internal sealing ring
**4**External sealing ring
**5** Filterning mass
**6** Bowl


2

**Silencer (standard)**

**Danger – Attention**
Allow the exaust manifold to cool before demounting it in order to preventscorchingand burns

Make sure that it is free from any carbon and oily residues, if contaminated, replace it. While reassembling it, replace the gaskets and tighten the brass nuts at 25 Nm.

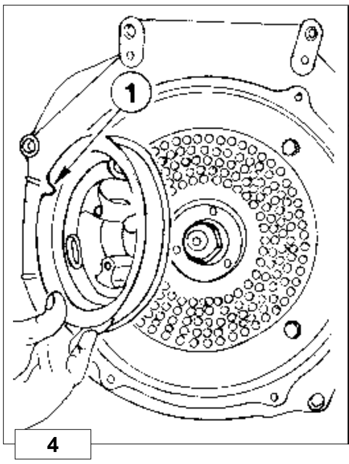


3

### Flywheel

Clockwise unscrew nut **1** and remove the flywheel using the puller **2** Part. no. 7271-3595-050 for 3LD 450, 3LD 451/S, 3LD510, 3LD510/S, while for 4LD 640, 4 LD 705, 4LD 820 use puller with Part. no. 7271-3595-048.
Check that the starter ring gear, when it is present, and the conic surface of the driving shaft coupling hole are intact.
While reassembling, tighten the screws 1 at 170 Nm for 3LD 450, 3LD 450/S, 3LD510, 3LD 510/s and at 350 Nm for 4LD 640, 4LD 705, 4LD 820.

**Note:** The flywheels of the left-hand engines (3LD 451/S, 3LD 510/S) have a blading turned in the opposite direction and the nut **1** shall be anticlockwise unscrewed.



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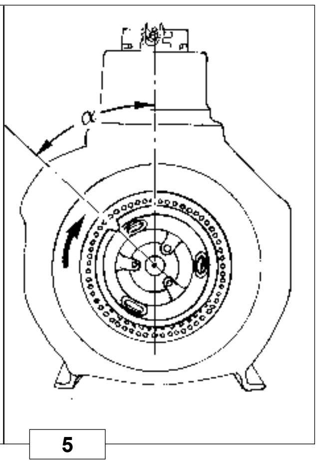
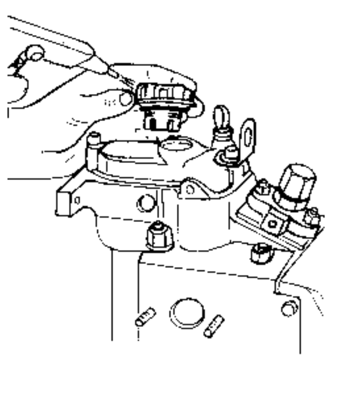


5

### Starting pulley

In order to carry out any easier staring, it is necessary to place the driving shaft at the TDC (Top dead center) and to assemble the pulley with notch 1 moved back at ( 45°) according to the rotation direction of the engine, as per picture 4 and 5 .
Tighten the screws at 35 Nm for 3LD 450, 3LD 450/S, 3LD510, 3LD 510/S, at 40 Nm for 4LD 640, 4LD 705, 4LD 820.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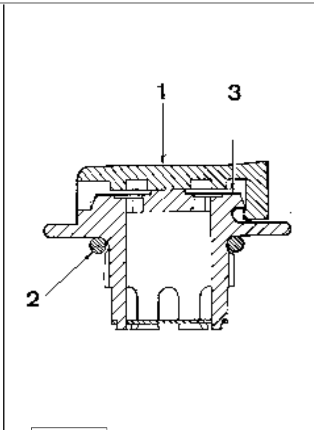
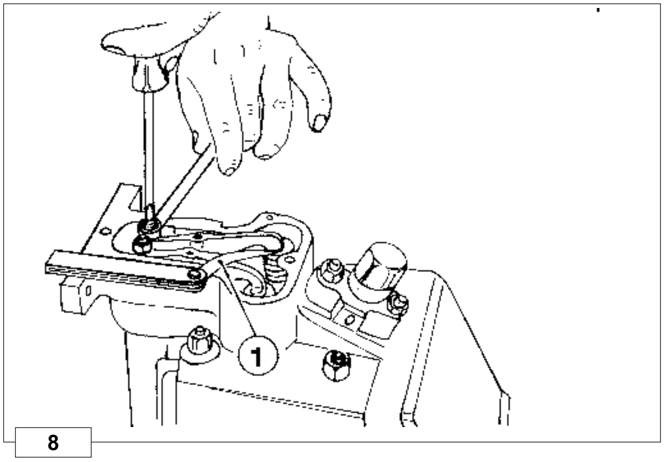


7

### Vent plug

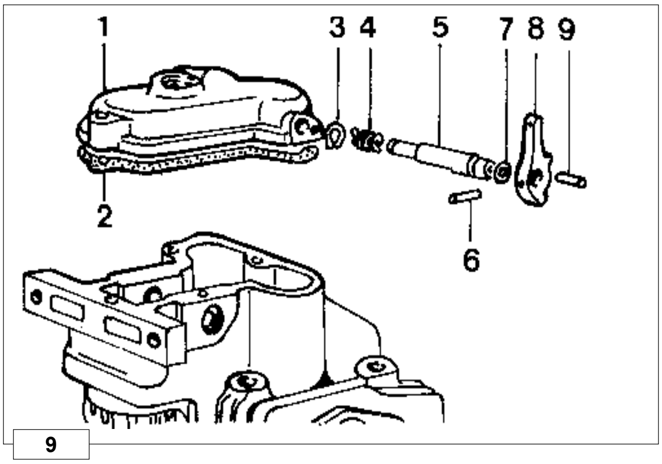
Components:
**1** Vent plug and oil refiling
**2** O-ring
**3** Diaphragm




8

## Valve/rocker arm clearance

Place the piston at the compression top dead centre.
Place thickness gauge **1** between the valve stem and the rocker arm; cold-adjust the clearance at 0.15 ÷0.20 mm for both valves.
Tighten the rocker arm box cap at 20 Nm.



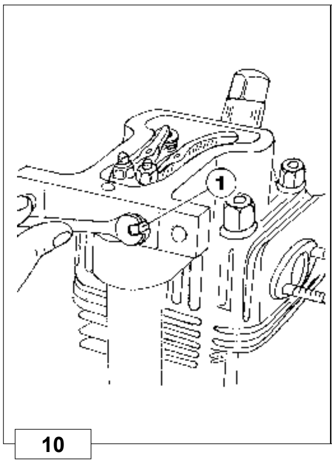

9

## Decompression (by request)

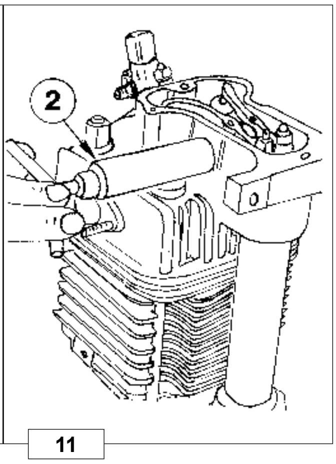
Components:

| | |
|---|---|
| **1** Cover | **6** Pin |
| **2** Gasket | **7** Ring |
| **3** Lock ring | **8** Lever |
| **4** Spring | **9** Pin |
| **5** Shaft | |

The engine rocker arm cover can be equipped with a decompression device which compresses the exhaust valve at the TDC (top dead centre), lowering it of abt. 1mm. during the starting phase. The lowering is adjusted by the gaskest thickness 2. Make sure that the lever turns for abt. half a stroke before it actuates the valve.
Warning!
The use of decompression to stop the engine may cause serious damages.



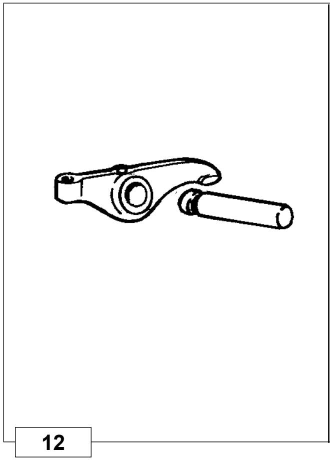

10




11

## Rocker arm pin, extraction

Before extracting the rocker arm pin in 3LD 450, 3LD 451/S, 3LD 510, 3LD510S engines, unscrew screw **1**, as per picture 10.
Extract the pin using tool **2** Part. no. 7276-3595-040, picture 11 also for 4LD 640, 4LD 705, 4LD 820 engines.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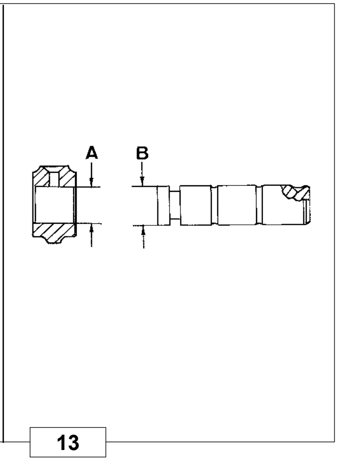


13

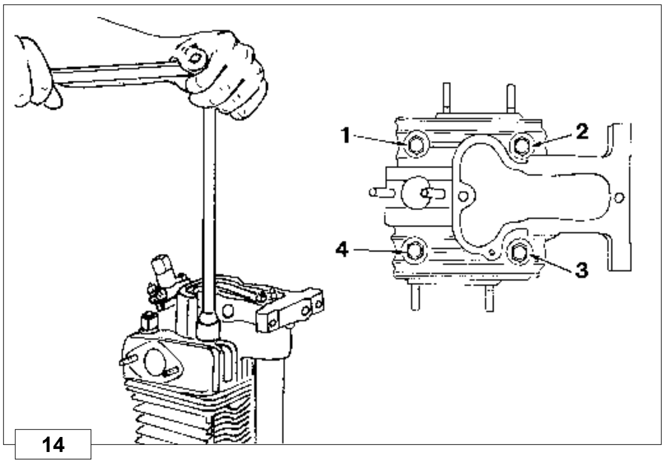
**Rocker arm pin and hole**

Dimensions (mm)

**A** = 15.032 ÷ 15.050
**B** = 14.989 ÷ 15.000

Clearances

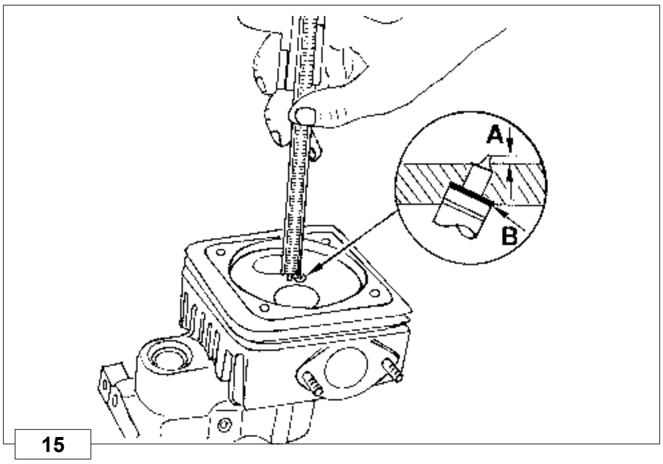
**(A-B)** = 0.032 ÷ 0.061
**(A-B)** = worn limit = 0.120



14

**Head**

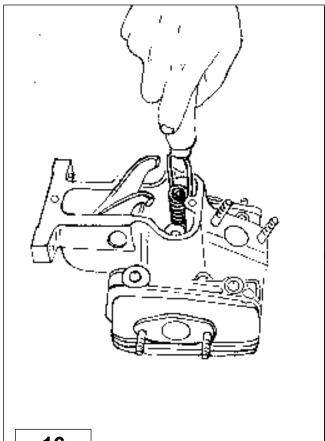
Do not disassemble while it is hot as to avoid any possible distortion.
If the head surface is distorted, smooth it by removing up to 0.3 mm thickness.
Always replace the copper gasket, see picture 34 for the choice of thickness.
Gradually tighten the nuts according to the following order **1**, **3**, **2**, **4**, at 50 Nm for 3LD 450, 3LD 451/S, 3LD 510, 3LD510/S, and at 80 Nm for 4LD 640, 4LD 705, 4LD 820.

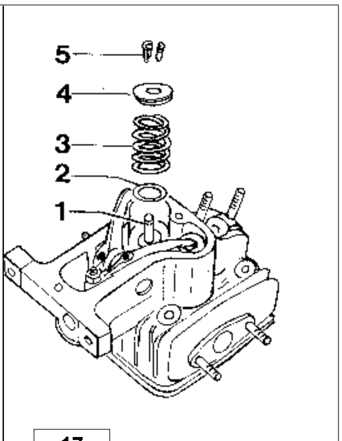


15

**Injector, projection**

The projection of the nozzle ends **A** with respect to the head surface shall be:
2.5÷3 mm for 3LD 450, 3LD 451/S
3÷3.5 mm for 3LD 510, 3LD 510/S
3.5÷4 mm for 4LD 640, 4LD 705, 4LD 820
Adjust by means of a copper gasket **B** having a thickness of 0.5 mm, 1 mm, 1.5mm .


16

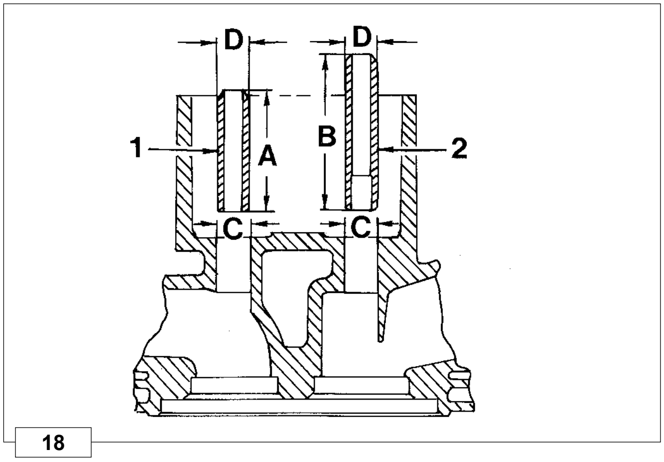


17

**Valves**

**1** Valve stem
**2** Spring holding disk
**3** Spring
**4** Cap
**5** Cotters

**Note:** In order to remove the cotters, put a shim under the valve head and strongly press, as shown in picture 16.




18

### Valves guides and housings

**1** Exhaust valve guide
**2** Intake valve guide

Dimensions (mm):

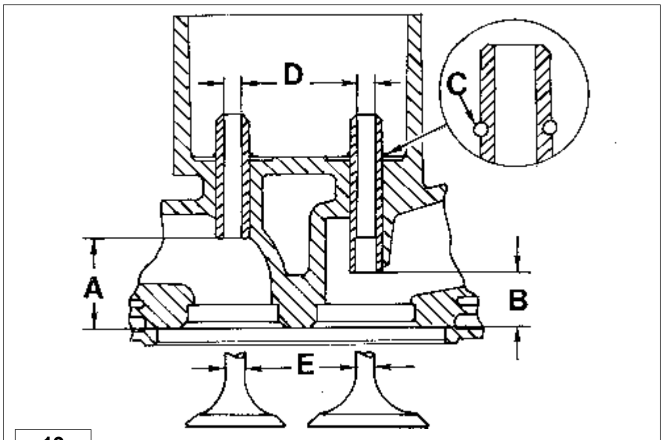
3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S

**A** = 43.80 ÷ 44.20 **B** = 55.80 ÷ 56.20
**C** = 11.00 ÷ 11.018 **D** = 11.05 ÷ 11.06

4LD 640, 4LD 705, 4LD 820

**A** = 47.80 ÷ 48.20 **B** = 65.80 ÷ 66.20
**C** = 12.000 ÷ 12.018 **D** = 12.05 ÷ 12.06

**Note**: Valve guides with an external dia. increased of 0.5 mm can be used as spare parts; in this case it is necessary to increase the housing **C** of 0.5 mm for the assembly.




19

### Valve guides insertion

Heat the head at 160° ÷ 180°. Force the guides according to **A** and **B** distance with respect to the head surface.

3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S

**A** = 30.80 ÷ 31.2 **B** = 18.8 ÷ 19.2

4LD 640, 4LD 705, 4LD 820

**A** = 35.8 ÷ 36.2 **B** = 17.8 ÷ 18.2

**Note**: if the guides are supplied with the housing for the lock ring **C**, insert the ring, then drive the guides without worrying about **A** and **B**.

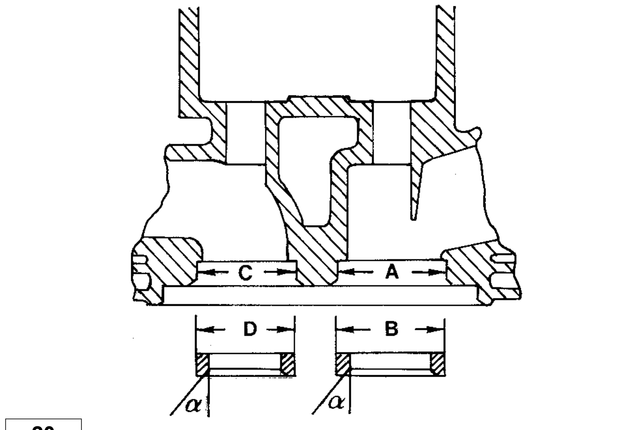
### Valve guide dimensions and clearances

3LD 450, 3LD 451/s, 3LD 510, 3LD 510/S (mm):

**D** = 7.030 ÷ 7.050 **E** = 6.985 ÷ 7.000
**(D-E)** = 0.030 ÷ 0.065 **(D-E)** limit= 0.13

4LD640, 4LD 705, 4LD 820

**D** = 8.030 ÷ 8.050 **E** = 7.985 ÷ 8.000
**(D-E)** = 0.030 ÷ 0.065 **(D-E)** limit =0.13

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## Valve housings and seats

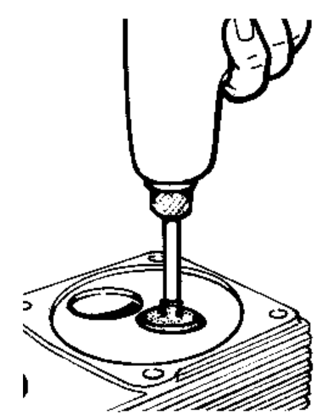
3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S (mm);

**A** = 34.99 ÷ 35.01 **C** = 30.99 ÷ 31.01
**B** = 35.10 ÷ 35.12 **D** = 31.10 ÷ 31.12

4LD 640, 4LD 705, 4LD 820 (mm):

**A** = 42.99 ÷ 43.01 **C** = 36.99 ÷ 37.01
**B** = 43.12 ÷ 43.14 **D** = 37.10 ÷ 37.12

Drive the seats in the housings and mill at 45°.



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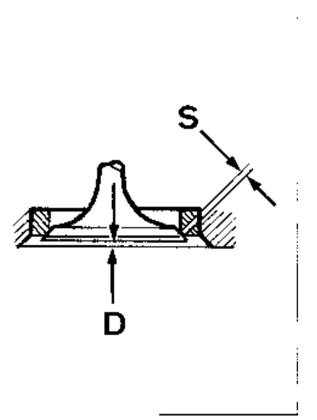
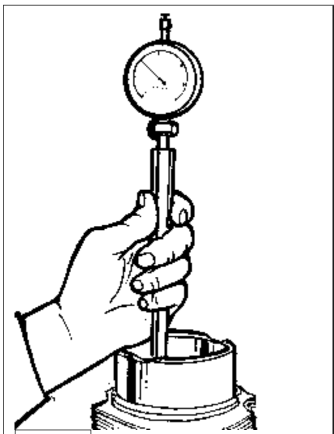



22

## Valve seat grinding

After milling, grind with fine emery paste in engine oil bath.
The S sealing surface shall not exceed 2 mm.
Embed valves D after grinding for 3LD 450, 3LD 451/S, 3LD 510,
3LD 510/S = 0.55 ÷ 1.05 mm; for 4LD 640, 4LD 705, 4LD 820 = 0.45 ÷ 0.95 mm.



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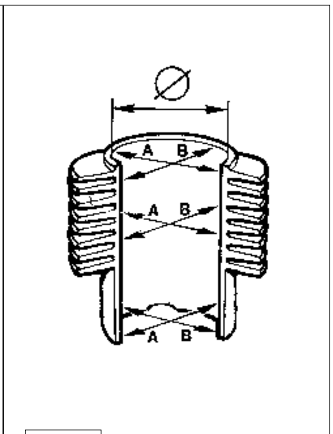


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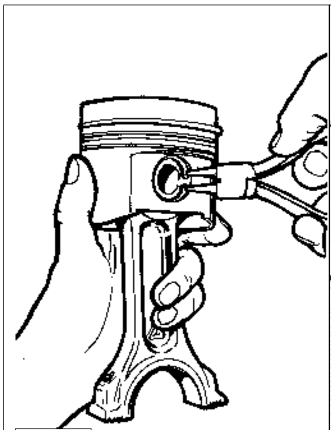

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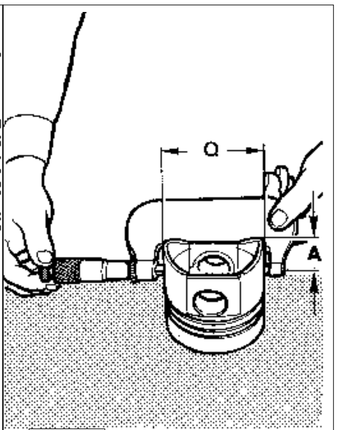


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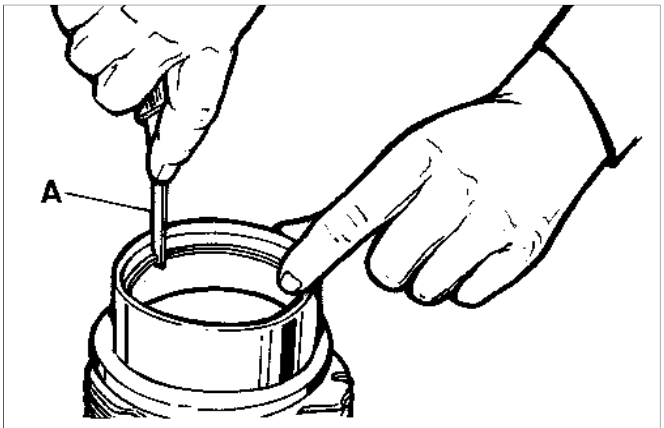


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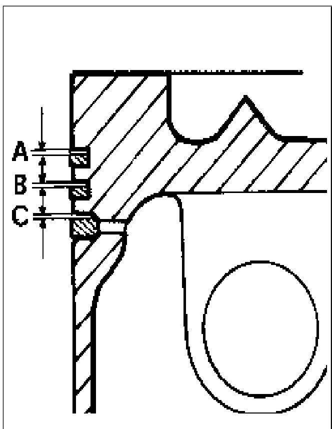


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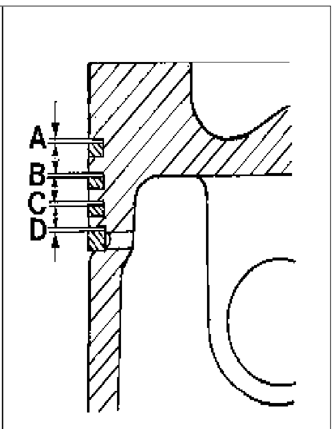



29

**Cylinder and piston**

Set a bore gauge to zero with a calibrated ring. Check the dia. **Ø** at points **A** and **B** at three different heights, see pictures 23 and 24.
In case of wear exceeding 0.06 mm to the maximum value prescribed, grind the cylinder at the subsequent increased value.
The increases suggested are 0.50 and 1.00 mm.
Measure the piston **Q** dia. (picture 26) at **A** height from the skirt base:

**A** = 17 mm (3LD 450, 3LD 451/S, 4LD 820)
**A** = 12 mm (3LD 510, 3LD 510/S)
**A** = 22 mm (4LD 640, 4LD 705)

Remove the stop rings and extract the piston pin, picture 25.
Remove the piston rings and clean the slots.
Replace the piston as well as the segments in case the dia. wear exceeds 0.05 mm as regards to the minimum value prescribed.

Dimensions (mm)

| ENGINES | Ø | Q | (Ø-Q) |
|---|---|---|---|
| 3LD 450, 3LD 451/S<br>3LD 510, 3LD 510/S | 85,00 ÷ 85,02 | 84,925 ÷ 84,945 | 0,05 ÷ 0,09 |
| 4LD 640 | 95.00 ÷ 95,02 | 94.88 ÷ 94.90 | 0.10 ÷ 0.14 |
| 4LD 705 | 100.00 ÷ 100.02 | 99.83 ÷ 99.85 | 0.15 ÷ 0.19 |
| 4LD 820 | 102.00 ÷ 102.02 | 101.85 ÷ 101.89 | 0.11 ÷ 0.17 |

**Note:** Even if 3LD 450, 3LD 450/S and 3LD510, 3LD510/S pistons have the same bore, they differ in other dimensions, thus they are not interchangeable.

**Distance among segment ends (mm)**

Insert the piston ring in the lower part of the cylinder, then measure the distance among the points.

3LD 450, 3LD 451/S, 3LD510, 3LD 510/S
1st piston ring (chromium plated) **A** = 0.30 ÷ 0.50
2nd piston ring (torsional) **A** = 0.30 ÷ 0.50
3rd piston ring (scraper ring) **A** = 0.25 ÷ 0.50

4LD 640, 4LD 705, 4LD 820
1st piston ring (chromium plated) **A** = 0.40 ÷ 0.65
2nd piston ring (torsional) **A** = 0.40 ÷ 0.65
3rd piston ring (torsional) **A** = 0.40 ÷ 0.65
4th piston ring (oil scraper ring) **A** = 0.30 ÷ 0.60

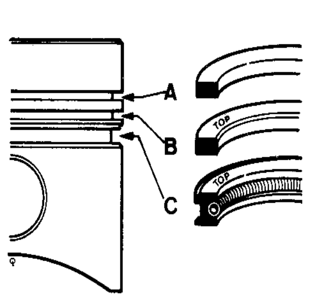
**Piston ring - Clearances among slots (mm)**

3LD 450, 3LD 451/S, 3LD 510, 3LD 510S, picture28

**A** = 0.08 ÷ 0.09
**B** = 0.06 ÷ 0.07
**C** = 0.05 ÷ 0.06

4LD 640, 4LD 705, 4LD 820, picture 29

**A** = 0.12 ÷ 0.14
**B** = 0.07 ÷ 0.09
**C** = 0.07 ÷ 0.09
**D** = 0.06 ÷ 0.08



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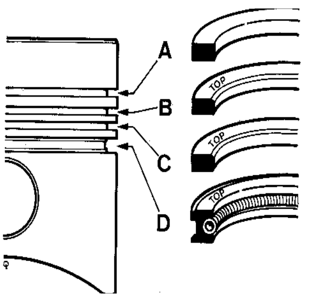


31

**Piston ring assembly order**

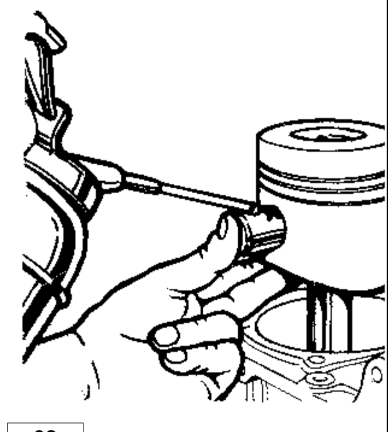
3LD 450, 3LD 450/S, 3LD 510, 3LD 510/S, picture 30

**A** = slot for first piston ring (chromium plated)
**B** = slot for piston ring segment (torsional)
**C** = slot for third piston ring (oil scraper ring)

4LD 640, 4LD 705, 4LD 820, picture 31

**A** = slot for first piston ring (chromium plated)
**B** = slot for second piston ring (torsional)
**C** = slot for third piston ring(torsional)
**D** = slot for fourth piston ring(oil scrarper ring)

**Note:** before inserting the piston in the cylinder, oil the piston ringwith engine oil and turn them, thus the cuts are misaligned.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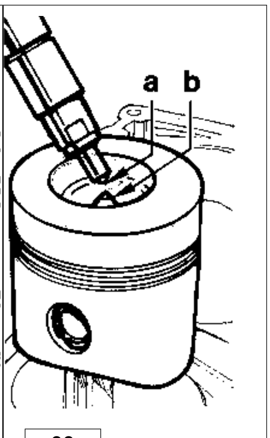

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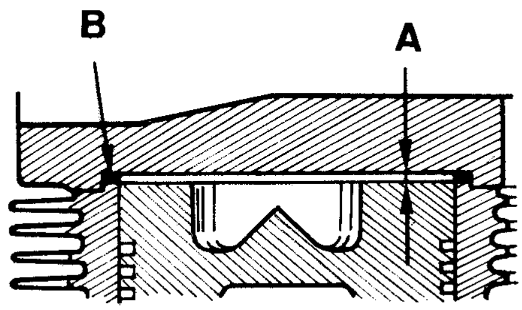
**Piston reassembly**

**Important**

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

Couple the piston with the connecting rod, thus the combustion chamber centre **B** is perpendicularly under end **A** of the nozzle housed inside the head.
Lubricate the piston pin and insert it in the piston, lightly pressing with your thumb.
Make sure that the two stop rings are well housed inside their seats.



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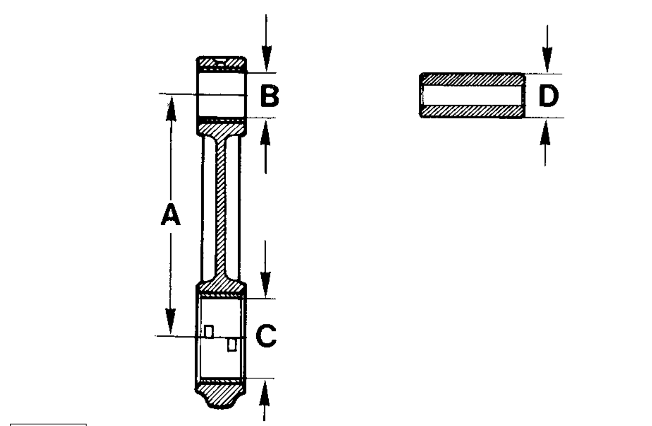
**Clearance volume**

**A** = Clearance volume
**B** = Head gasket

The thickness **B** head gasket determines the clearance volume **A** which shall be 0.75 ÷ 0.90 mm for 3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S and 0.80 ÷ 1.00 mm for 4LD 640, 4LD 705, 4LD 820.
Measure the piston crown position as to the cylinder surface and chose a gasket having a suitable thickness.
Always consider that the piston at the top dead centre could be at the same level, either under or over the cylinder.

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**Connecting rod equipped with bearings and piston pin**

For 3LD 450, 3LD 450/S, 3LD 510, 3LD 510/S

Dimensions (mm)

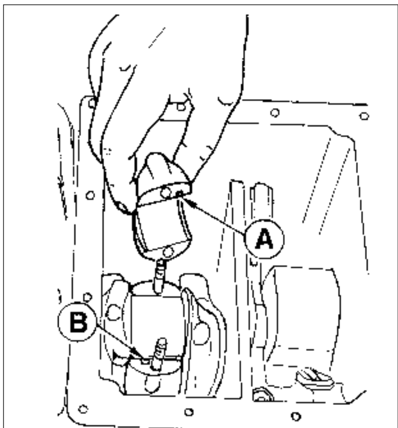
**A** = 144.05 ÷ 145.05
**B** = 23.02 ÷ 23.03 (with driven and machined bearing)
**C** = 42.028 ÷ 42.052 (with bearing tightening at 3 Nm)
**D** = 22.995 ÷ 23.000

For 4LD 640, 4LD 705, 4LD 820

Dimensions (mm)

**A** = 162.95 ÷ 163.05
**B** = 28.02 ÷ 28.03
**C** = 55.40 ÷ 55.43
**D** = 27.995 ÷ 28.000

The connecting rod big end bearings are supplied either at nominal value and diminished to 0.25 and 0.50 mm.

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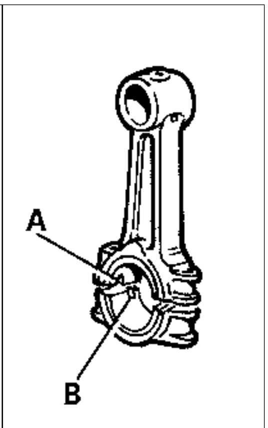


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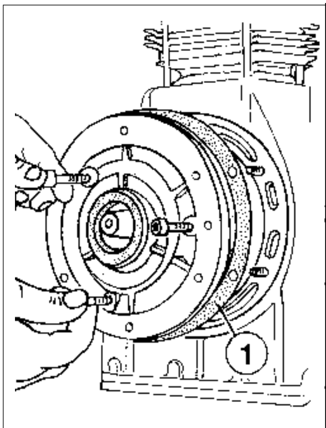
**Connecting rod, big end bearings**

While reassembling, the A and B centering marks should not be on the same side.
Tighten the screws at 30 Nm for 3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S and at 45 Nm for 4LD 640, 4LD 705, 4LD 820.

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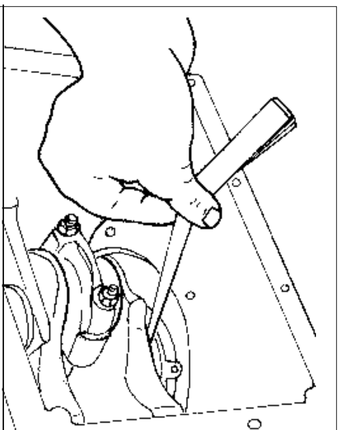

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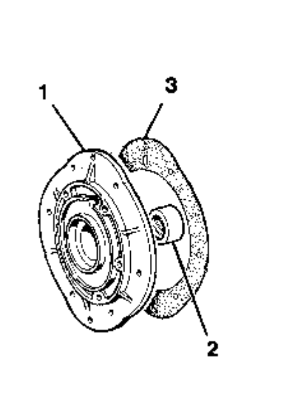
**Main bearing on flywheel side**

Extract the bearing using three screws, as per picture 38.
While reassembling, replace gasket **1**. Check that the oil seal ring is intact. Tighten the screws at 25 Nm.

**Drive shaft axial clearance**

After having screwed the main bearing on the flywheel, check drive shaft axial clearance. Its value is 0.10 ÷ 0.40 mm for 3LD 450, 3LD 450/S, 3LD 510, 3LD 510/S and 0.10 ÷ 0.30 mm for 4LD 640, 4LD 705, 4Ld 820.
The adjustment is carried out by changing the gasket **1** thickness.



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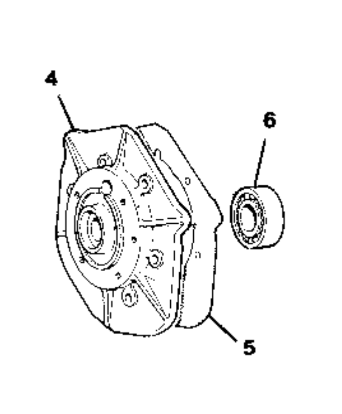

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**Side distributor port**

It can be found in engines equipped with industrial type drive shaft.
The gaskets **3** and **5**, thanks to their thickness, assure the oil seal and affect the camshaft axial clearance, as well.
For the check, see information hereunder.

Components

For 3LD 450, 3LD 510 picture 40

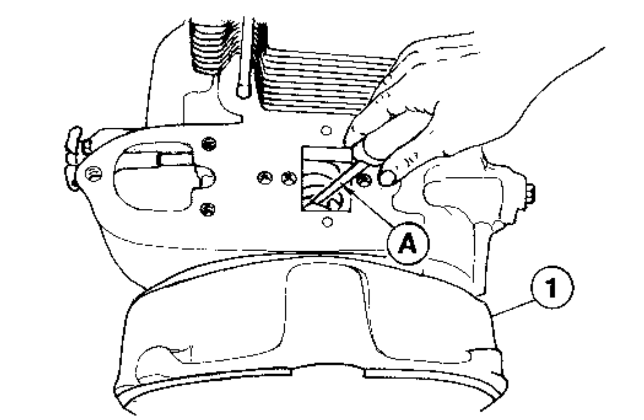
**1** Port **2** Bush **3** Gasket

Fix the door at its base at 25 Nm.

For 4LD 640, 4LD 705, 4LD 820 picture 41

**4** Port **5** Gasket **6** Ball bearing

Fix the port at its base at 40 Nm.



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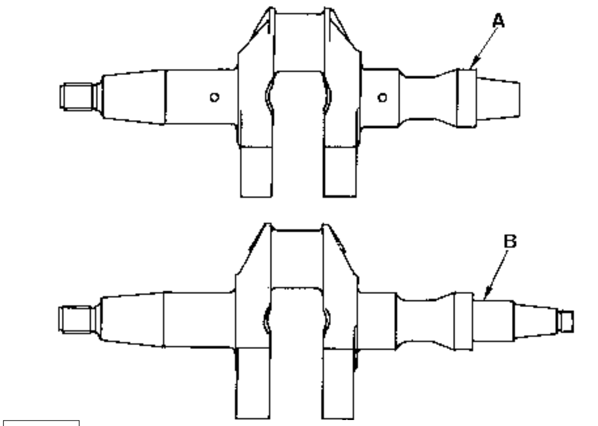
**Camshaft axial clearance**

Carry out this check before assembling the head. Fix the side distributor port or bell **1** at 25 Nm. Remove the intake and exhaust tappets and with an implement operate on the camshaft forward and backward in an axial direction.

The axial clearance **A** shall be:

**A** = 0.20 ÷ 0.60 mm 3LD 450, 3LD 450/S, 3LD 510, 3LD 510/S.
**A** = 0.15 ÷ 0.65 mm for 4LD 640, 4LD 705, 4LD 820.

Adjust the clearance by changing the gasket thickness between the distributor port (if it is assembled) or bell 1 and the base; it is forbidden to assemble more than one gasket.

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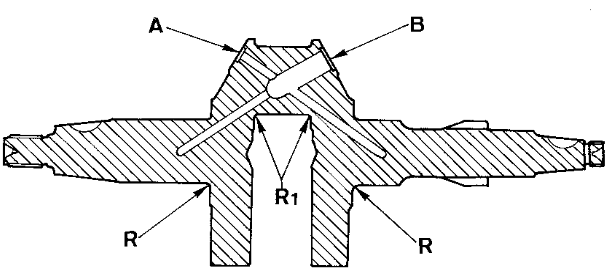
### Drive shaft

There are two types of standard drive shafts:

**A** Automotive type (agricultural machines)
**B** industrial type (motor pumps generating set, etc.)

**Note:** For left-handed engines, i.e 3LD 510/S, the drive shaft turns anticlockwise (seen from the flywheel position) and their thread is clockwise on the power takeoff side as well as on the flywheel side.

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### Drive shaft lubrication ducts

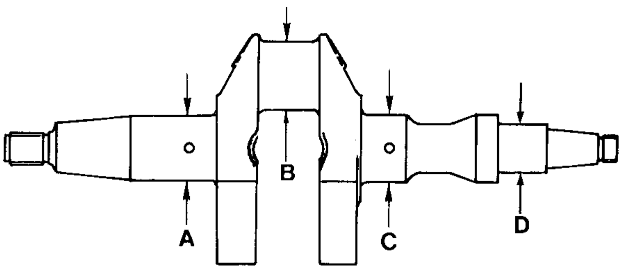
**Caution – Warning**
Always wear protective goggles if compressed air is used.

Remove the caps, clean the ducts **A** and **B** with a point and blow them with compressed air.
Replace the caps by caulking them on their seat, then check their seal.

### Drive shaft connecting radius

**R** = 3 mm
**$R_1$** = 3.5 mm

**Note:** When the main journal and the crank are ground, it is essential to reset **R** and **$R_1$** values in order to avoid any possible breaking of the drive shaft.

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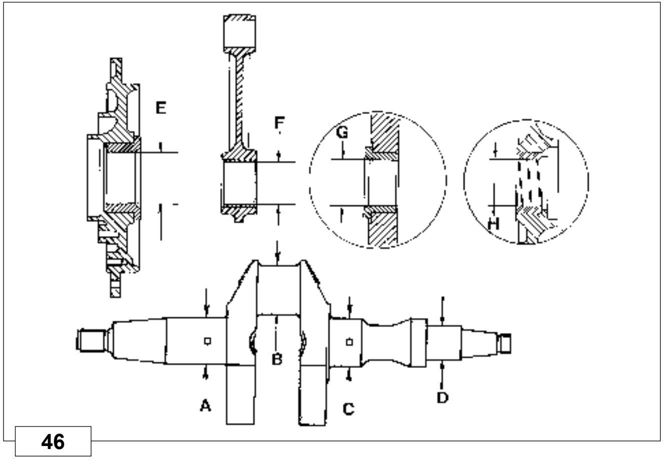
### Drive shaft main journal and crank diametres (mm)

3LD 450, 3LD 510, 3LD 451/S, 3LD 510/S

**A** = 39.990 ÷ 40.000
**B** = 41.987 ÷ 42.000
**C** = 41.990 ÷ 42.000
**D** = 29.990 ÷ 30.000

4LD 640, 4LD 705, 4LD 820

**A** = 44.900 ÷ 45.000
**B** = 55.340 ÷ 55.353
**C** = 44.900 ÷ 45.000
**D** = 29.990 ÷ 30.000



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**Drive shaft internal diam. crankshaft bearing / connecting rod head and clearances regarding their respective pins (mm)**

3LD 450, 3LD 510, 3LD 451/S, 3LD 510/S

**E** = 40.040 ÷ 40.050 **F** = 42.028 ÷ 42.052
**G** = 42.04 ÷ 42.05 **H** = 30.07 ÷ 30.09

A, B, C, D, see picture 45

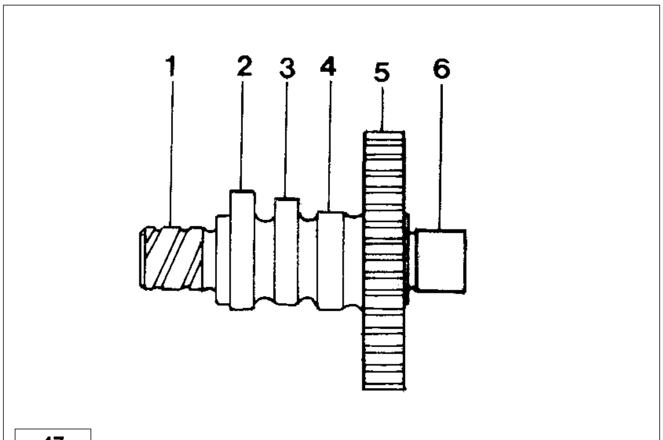
**E - A** = 0.040 ÷ 0.060 worn limit 0.12
**F - B** = 0.028 ÷ 0.065 worn limit 0.13
**G - C** = 0.040 ÷ 0.060 worn limit 0.12
**H - D** = 0.070 ÷ 0.10 worn limit 0.18

4LD 640, 4LD 705, 4LD 820

**E** = 45.045 ÷ 45.070 **F** = 55.40 ÷ 55.43 **G** = 45.045 ÷ 45.070

A, B, C, D, see picture 45

**E - A** = 0.065 ÷ 0.080 worn limit 0.16
**F - B** = 0.051 ÷ 0.10 worn limit 0.18
**G - C** = 0.45 ÷ 0.080 worn limit 0.16



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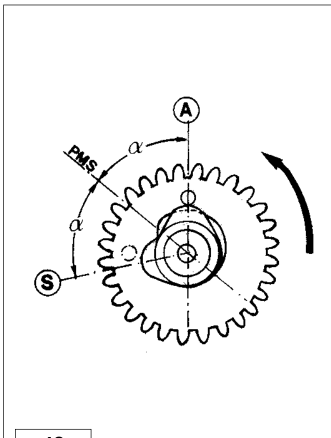
**CAMSHAFT**

Components:

**1** Base side pin
**2** Intake cam
**3** Injection cam
**4** Exhaust cam
**5** Gear
**6** Side distributor port pin

**Note:** The two engine series 3LD 450, 3LD 510 and 4LD 640, 4LD 820 have the same camshaft; it differs in 3LD 451/S and 3LD 510/S left-handed engines.



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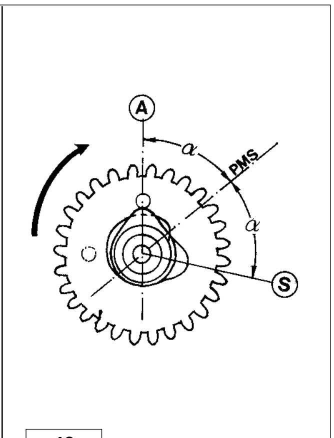

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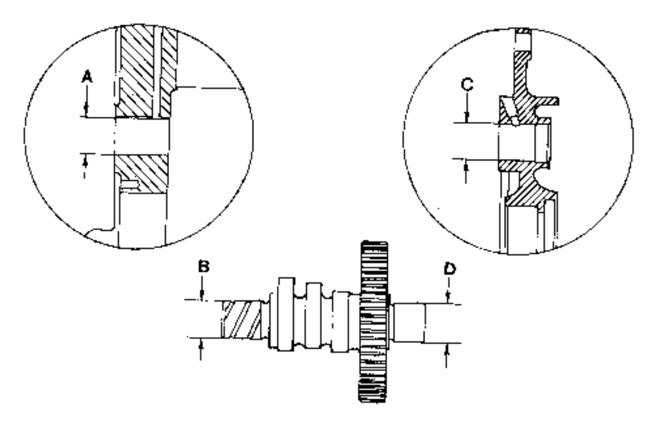
**Camshaft intake and exhaust cam timing**

For 3LD 450, 3LD 510, 4LD 640, 4LD 705, 4LD 820, see picture 48.
Clockwise rotation.
**TDC** = Top dead centre of the piston
**A** = Intake cam axis
**S** = Exhaust cam axis
**α** = 50° 30' ÷ 51° 30'

For 3ld 451/S, 3LD 510/S, see picture 49
Clockwise rotation
**TDC**= Top dead centre of the piston
**A** = Intake cam axis
**S** = Exhaust cam axis
**α** = 50° 30' ÷ 51° 30'



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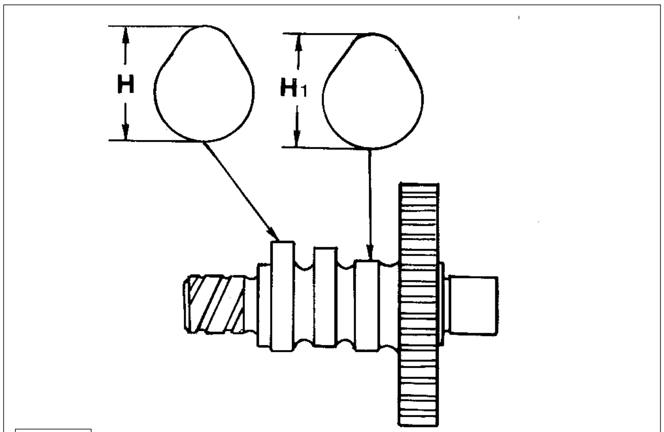
**Camshaft pin and housing dimensions (mm)**

**A** = 18.000 ÷ 18.018 (housing on the base)
**B** = 17.945 ÷ 17.975
**C** = 18.000 ÷ 18.018 (housing on the port)
**D** = 17.945 ÷ 17.975

**A-B** and **C-D** = 0.025 ÷ 0.073 Worn limit = 0.13



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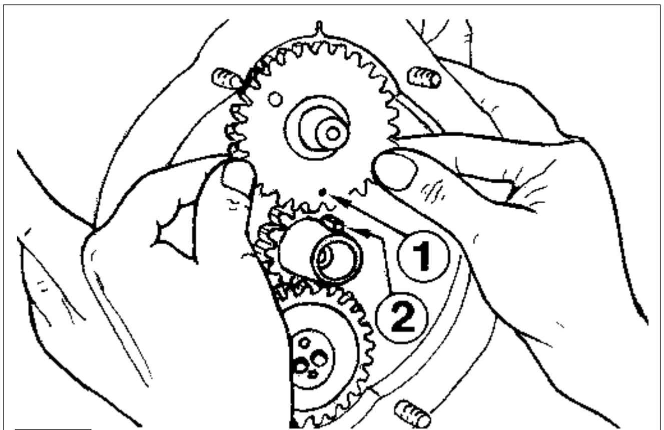
**Camshaft intake and exhaust cam height.**
The two cam heights are different.

Dimensions (mm) :
**H** = 33.92 ÷ 34.02 (intake cam)
**$H_1$** = 33.42 ÷ 33.52 (exhaust cam)

If the cam wear exceeds the agreed minimum value of 0.1 mm for **H** and **$H_1$** , replace the camshaft.



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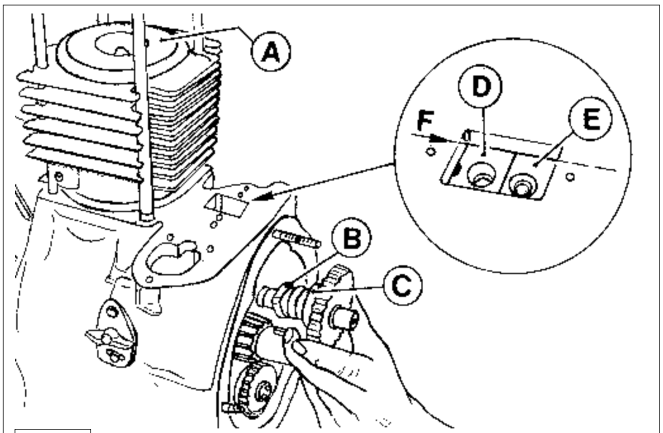
**Distribution timing**

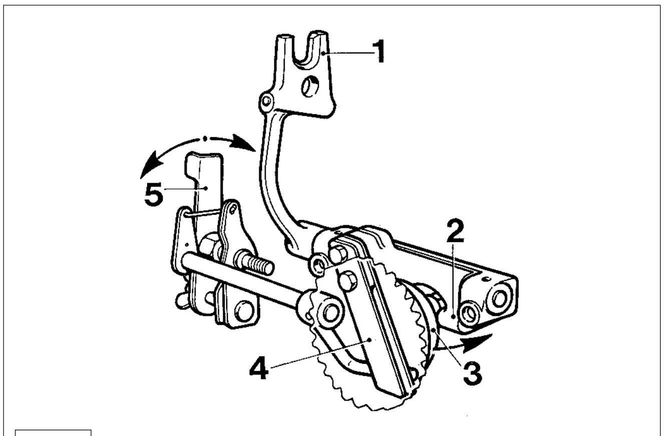
assemble the camshaft gear by coinciding reference **1** with reference **2** of the gear (camshaft key).



53

**Distribution timing without following the references**

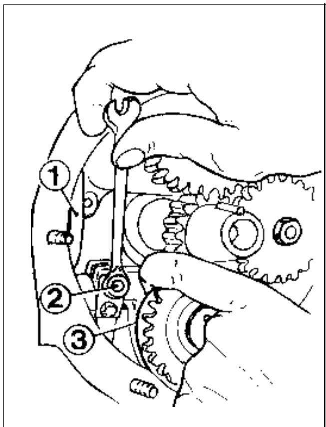
Place piston **A** at the top dead centre.
Insert the camshaft, thus the intake cam **B** and the exhaust cam **C** are well balanced (while the intake opens, the exhaust closes).
Insert the respective tappets **D** and **E**.
Carry out the check: the intake **D** and exhaust **E** tappets laid on their cams shall be at the same level **F**.



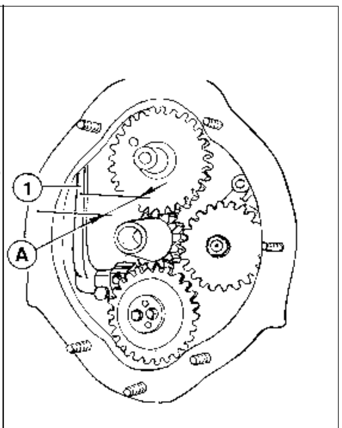

54

**Speed governor**

It has a centrifugal system with 6 balls housed in the gear, which is directly operated by the drive shaft.
The balls, moved at the gear periphery by a centrifugal force, axially shift the bell **3**, which actuates the fork **2** connected to lever **1** in order to determine the injection pump rack rod position. A spring with two plates **4**, energized by the accelerator control **5**, opposes the action of the governor cetrifugal force. The balance between the two forces keeps the rpm rate constant with the change of load.




55




56

**Timing of the speed governor**

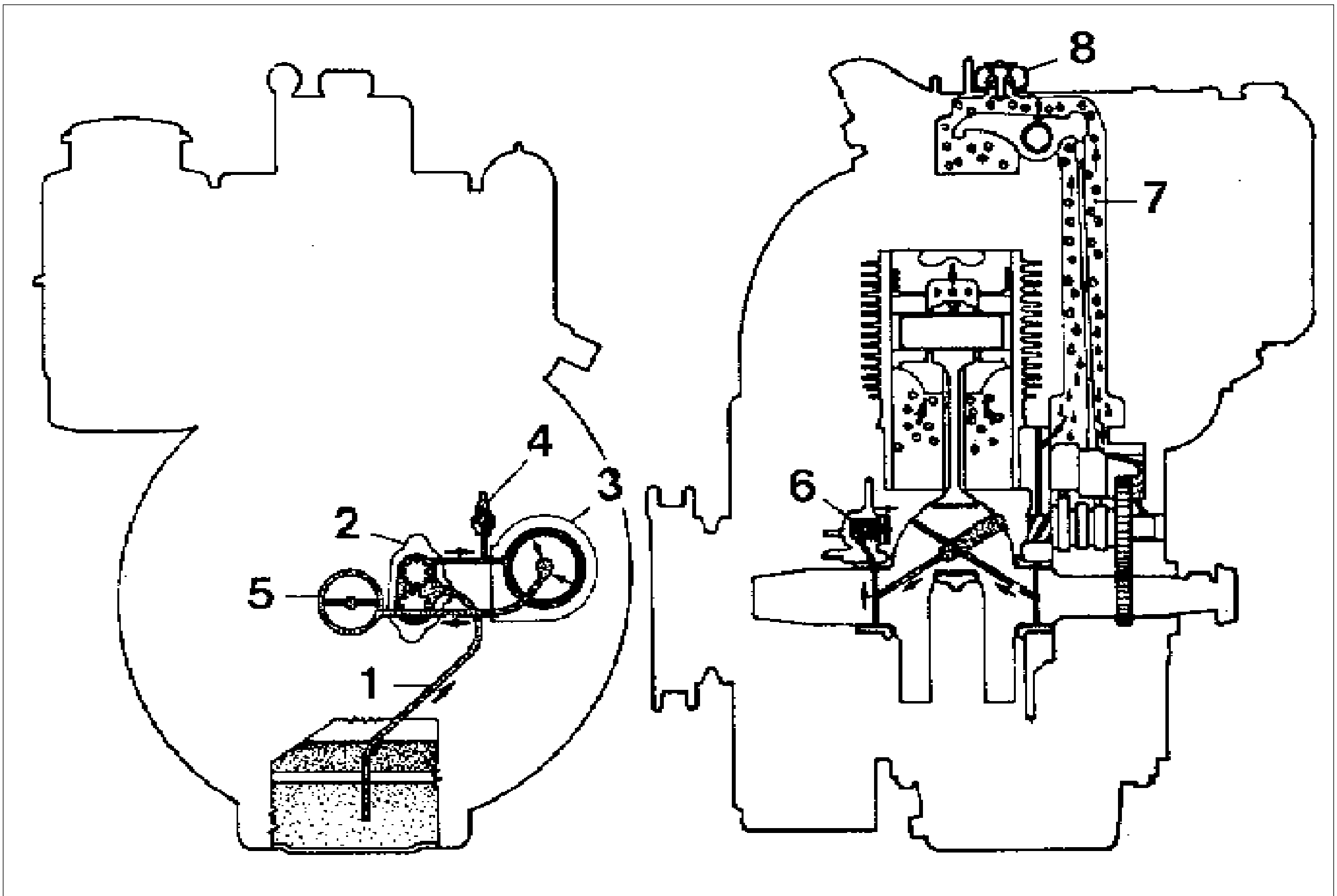
Adjust the injection pump control lever **1** thus, when the governor is closed, it is placed at distance **A** as to the external surface of the base.
- Loosen the screw **2**.
- Close the governor (move the mobile bell **3** towards the operator, picture 55).
- Place lever **1** at **A** distance, picture 56 (22 mm for 3LD 450, 3LD 510, 3LD 451/S, 3LD 510/S and 28 mm for 4LD 640, 4LD 705, 4LD 820).
- Tighten the screw **2**.

**Danger – Attention**

The engine can be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil because its combustion may lead to a sharp increase in the rotation speed.
Use suitable oil in order to protect the engine.
Nothing more than lubrication oil can influence the performances and life of an engine.
Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts. Engine life will also be notably reduced.
The oil viscosity must suit the ambient temperature in which the engine operates.

Old engine oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time. If contact with the oil is unavoidable, you are advised to wash your hands with soap and water as soon as possible.
Dispose of old oil in the correct way as it is highly polluting.

## LUBRICATION CIRCUIT

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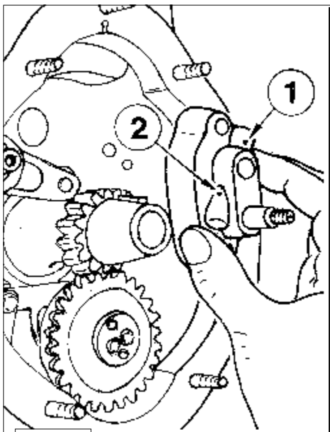
**Lubrication circuit**

Details:

**1** Intake pipe
**2** Oil pump
**3** Oil filter
**4** Pressure switch
**5** Crankshaft bearing
**6** Pressure adjusting valve
**7** Tappet rod protection pipe
**8** Vent and oil filler plug.

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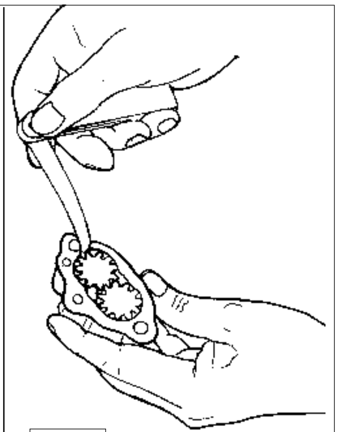
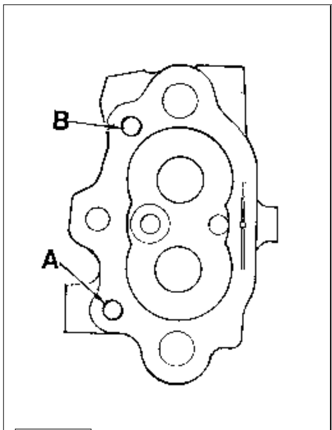


59

**Oil pump**

Make sure that the gear teeth are intact and check that the clearance between the gear periphery and the pump case does not exceed 0.15 mm and that the drive shaft can easily turn with an axial clearance not exceeding 0.15 mm.
Check that the gear lubrication holes **1** and **2** are not clogged.
Tighten the pump case at 30 Nm.
Tighten the pump control gear at 20 Nm.
The oil pumps for 3LD 451/S and 3LD 510/S engines, which turn anticlockwise (from flywheel position), are different, see information below.

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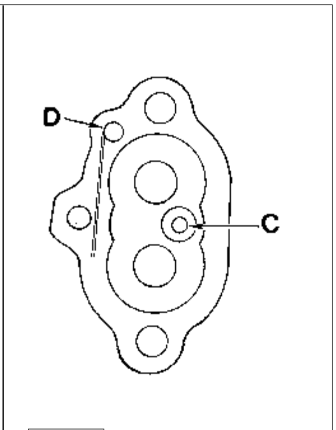


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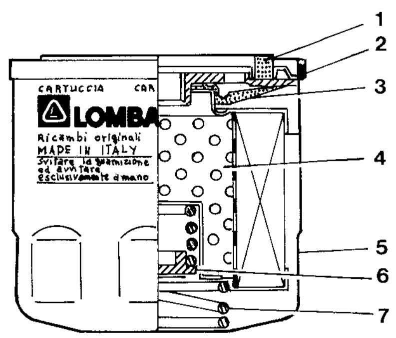
**Oil pump, difference between clockwise rotation pump and anticlockwise pump**

The difference between the oil pump on clockwise rotation engines and the anticlockwise one is the suction duct provided either with the pump case and with the base.
See picture 60 for anticlockwise rotation engines from flywheel position (3LD 451/S, 3LD 510/S).
**A** =Intake
**B** = Delivery
Picture 61, for clockwise rotation engines, seen from the flywheel side (3LD 450, 3LD 510, 4LD 640, 4LD 705, 4LD 820)
**C** = Intake
**D** = Delivery

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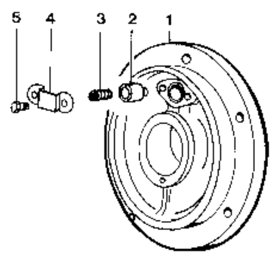
**Oil filter cartridge**
Componens:

| | |
|---|---|
| **1** Gasket | **5** Bowl |
| **2** Assembly | **6** By-pass valve |
| **3** Antidrainage rubber cap | **7** Spring |
| **4** Filter element | |

**Features:**
Maximum operating pressure: 7 bars
Maximum operating temperature: -25° + 150°C
Filtering degree: 20 µm
By-pass valve setting: 1÷ 1.4
Total filtering surface: 750 $cm^2$

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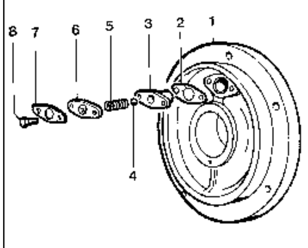


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**Oil pressure regulating valve**
It is housed in the flywheel side main bearing

For 3LD 450, 3LD 451/S, 3LD 510, 3LD 510/S, see picture 63

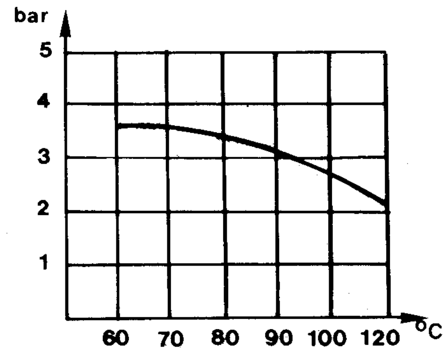
| | |
|---|---|
| **1** Support | **4**Sheet metal |
| **2** Valve | **5** Screw |
| **3** Spring | |

Tighten the support at 25 Nm.

For 4LD 640, 4LD 705, 4LD 820,see picture 64

| | |
|---|---|
| **1** Support | **5** Spring |
| *2* Gasket | **6** Flange |
| **3** Valve support | **7** Plate |
| **4** Ball | **8** Screw |

Tighten the support at 40 Nm.

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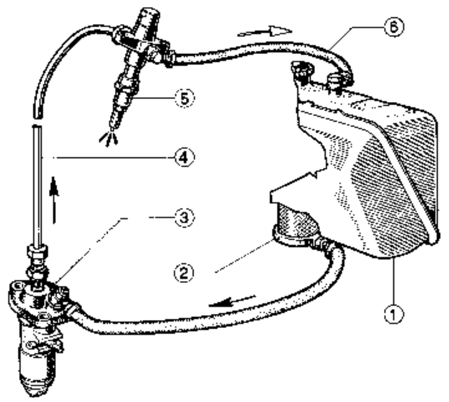
**Oil pressure check**

After the assembly operation, fill the engine with oil and fuel; connect a 10 bars pressure gauge to the fitting on the oil filter.
Start the engine and check the pressure reaction according to oil temperature.

**Oil pressure curve with the engine at its maximum speed**

It is shown on the filter and obtained with the engine at 3000 rpm at **N** power; the pressure is expressed in bars and the temperature in degrees Celsius. The curve represents the pressure minimum value, while its maximum value is 5 bars. The minimum oil pressure (1200 rpm) with the oil temperature at 100° C shall not be lower than 0.8 bars.

**Note**: When the engine has been run in, the oil lubrication maximum temperature shall be lower than the following addition: ambient temperature + 95° C.

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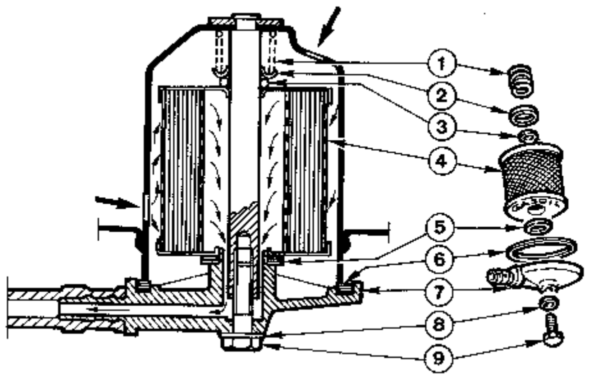
**Standard feeding/injection circuit**

Components:

**1** Tank
**2** Filter
**3** Pump
**4** Pipe
**5** Injector
**6** Injector waste pipe

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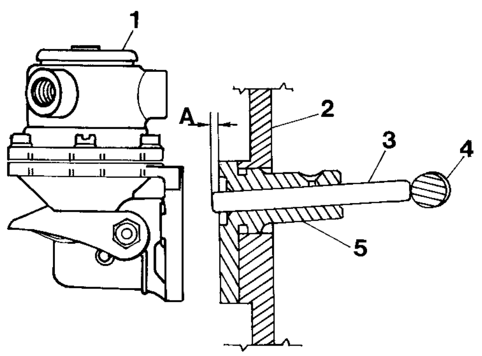
**Fuel filter inside the tank (standard)**

**Details:**

| | |
|---|---|
| **1** Spring | **6** Gasket |
| **2** Disk | **7** Cover |
| **3** Ring | **8** Ring |
| **4** Cartridge | **9** Bolt |
| **5** Gasket | |

Cartridge features:
Filtering degree = 7 μm
Filtering surface = 390 cm$^2$

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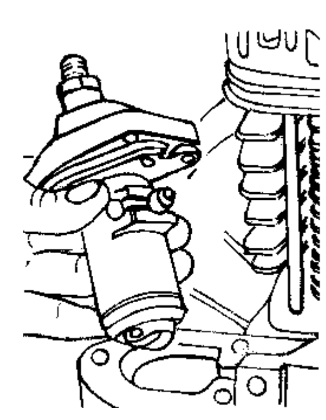
**Feeding pump (by request)**

**Features**:
at 1500 rpm of the control eccentric, the minimum delivery is 60 l/h, while the automatic adjustment pressure is 4 ÷ 5 m column of water.

**Feeding pump rod projection**

Details:
**1** Feeding pump
**2** Base
**3** Rod
**4** Oil pump drive shaft eccentric

The check shall be carried out with the eccentric **4** at rest.
The projection A of rod 3 is 0.8 ÷ 1.2 mm; it shall be adjusted with the following supplied gaskets having a thickness of 0.50; 0.80 and 1.0 mm.
Rod length = 65.4 mm for 3LD 450, 3LD 450/S, 3LD 510, 3LD 510/S and 75.2 mm for 4LD 640, 4LD 705, 4LD 820.



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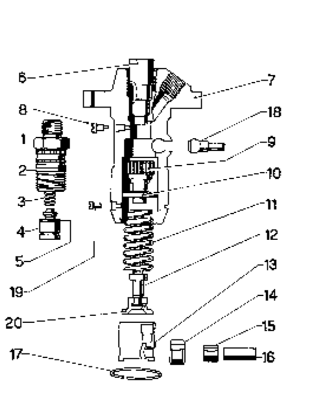


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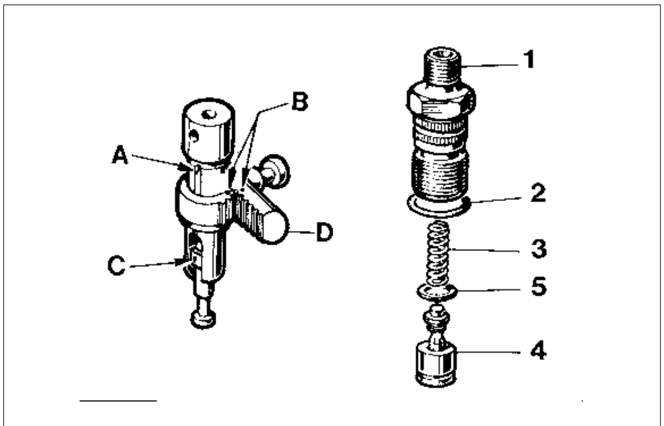
### Injection pump

Components:

**1** Delivery fitting
**2** O-ring
**3** Spring
**4** Delivery valve
**5** Gasket
**6** Barrel
**7** Pump case
**8** Eccentric
**9** Sector gear
**10** Spring bearing cap
**11** Spring
**12** Pumping piston
**13** Tappet case
**14** External roller
**15** Internal roller
**16** Pin
**17** Lock ring
**18** Rack rod
**19** Lock pin
**20** Collar

Tighten the pump at its base at 30 Nm.

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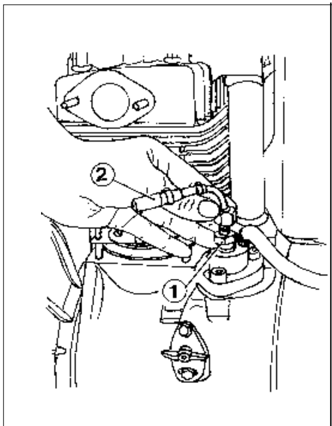
### Injection pump assembly

Insert the cylinder **6** in the pump case **7**, engaging the slot **A** in the eccentric **8**.
Insert the delivery valve **4**, copper gasket **5**, spring **3** O ring **2**, then tighten the fitting at 3.5 ÷ 40 Nm.
Assemble the rack rod **18** and sector gear **9** coinciding points **B**.
Insert the upper collar **10**, spring **11** and piston **12** <u>with reference **C** on the same side of the slot **A**</u> (if it is assembled on the opposite side, the engine revs out).
Assemble the collar **20**, the tappet **13** with rollers **14**, **15** and pin **16**.
While pressing on the tappet, insert the pin **19** and the ring **17**.

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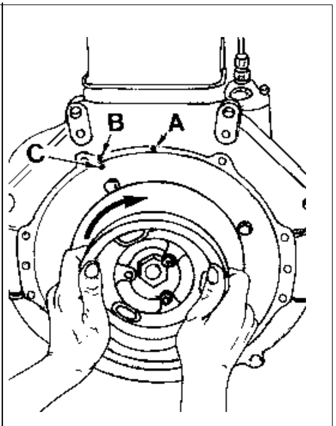


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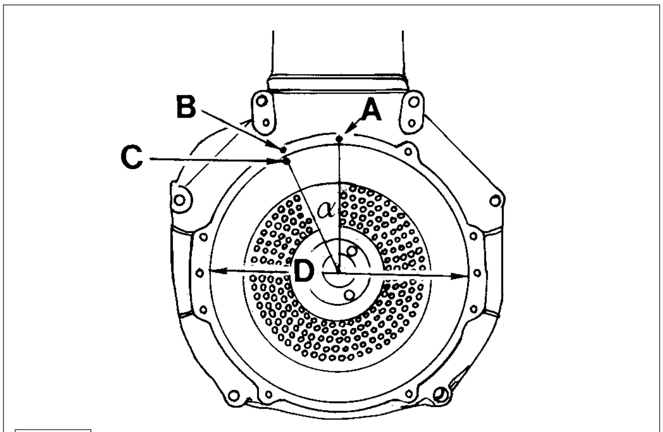
### Advanced injection (static)

Disconnect the diesel oil thrust pipe fitting, being careful not to loosen also the pump delivery fitting **1**, then screw the tester for the advanced injection check **2**.
Fill the tank, checking that the fuel level is at least 10 cm above the tester. Place the accelerator lever halfway.
Turn the flywheel towards the engine rotation direction and make sure that the fuel arrives at the tester assembled on the injection pump delivery fitting.
Repeat this operation; during the compression phase, operate slowly and immediately stop when the fuel moves into the tester hole; move the flywheel 3 mm back; this is the static advanced injection.
If **C** does not coincide with **B** but comes before, add some shims under the pump, otherwise, remove the shims if **C** is beyond **B**.

**Note**: By removing or adding a 0.1 mm shim under the pump, it is possible to delay or advance **C**, which is after **B**.



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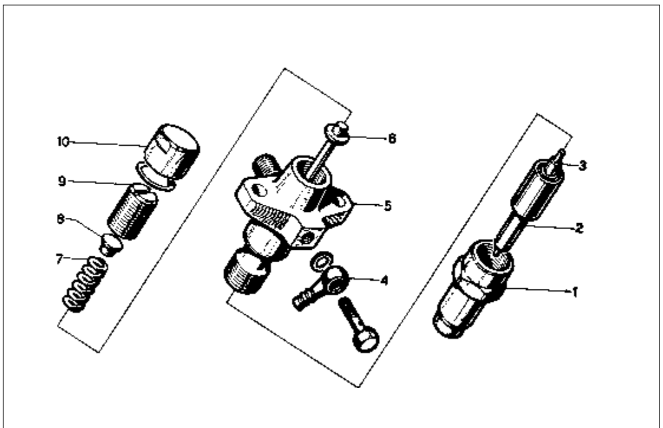
**Advanced Injection references on the conveyor and flywheel protection disk**

**A** Piston reference at top dead centre
**B** Injection advance reference as to A
**A ÷ B** Distance in mm
**C** Reference of piston in injection advance position
α Reference in degrees
**D** Flywheel protection disk diameter

| ENGINES | (A-B) mm | α mm | D (3LD) mm | D (4LD) mm |
|---|---|---|---|---|
| 3LD 450, 451/S, 510, 510/S | 58 ÷ 63 | 24° ÷ 26° | 276 | 310 |
| 4LD 640, 705, 820 | 65 ÷ 70 | | | |
| 4LD 820 a 2600 giri/1' | 60 ÷ 65 | 22° ÷ 24° | | |

**Note**: 1° stands for 2.7 mm on dia. D= 310 mm; on dia. D = 276 mm, 1° stands for 2.4 mm.



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**Injector**

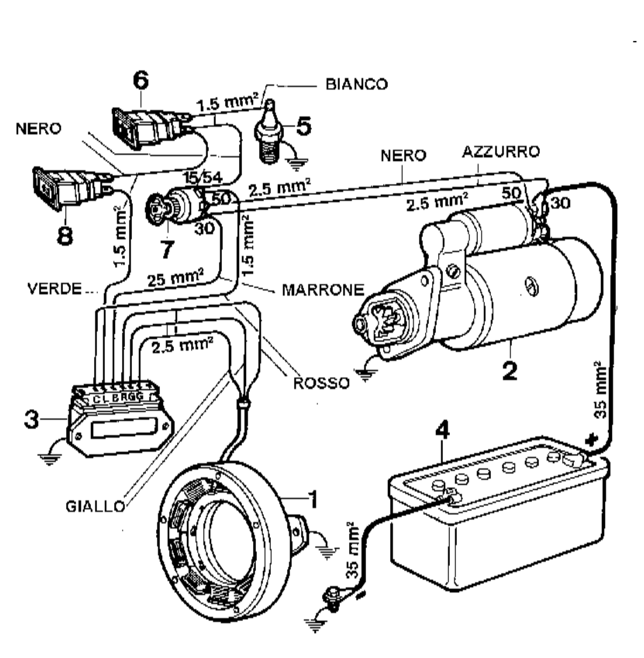
Components:

**1** Ring nut
**2** Nozzle
**3** Needle
**4** Fitting
**5** Nozzle bearing
**6** Pressure rod
**7** Spring
**8** Spring seat
**9** Union
**10** Ring nut

**Setting**

Connect the injector to a manual pump and check that the setting pressure is 190 ÷ 200 bars.
If necessary adjust, actuating the union **9**.
While replacing the spring, the setting shall be carried out at a pressure higher than 10 bars (200 ÷210 bars) in order to counterbalance the running adjustments.
Check the needle valve seal by slowly activating the manual pump up to abt. 170 bars.
In case of dripping, replace the nozzle.
Tighten the injector to the head at 15 Nm for 3LD 450, 3LD 451/S, 3 LD 510, 3 LD 510/S and at 20 Nm for 4LD 640, 4LD705, 4LD 820.

**Note**: A new injector is currently assembled, its components are different, though the setting remains the same.

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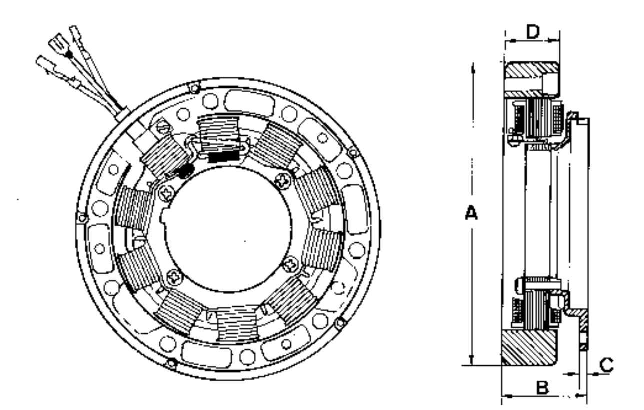
**12 V 14 A electrical ignition, diagram with voltage regulator , battery recharge lamp and manostat**

Components:
**1** Alternator
**2** Starting motor
**3** Voltage regulator
**4** Battery
**5** Oil pressure switch
**6** Oil pressure lamp
**7** Ignition switch
**8** Battery recharge lamp

**Note**: The batteries, which are not supplied by Lombardini, shall have a 12 V voltage and the following capacity:

3LD 450, 3lD 451/S, 3LD 510, 3LD 510/S = 45 Ah
4LD 640 = 55 Ah
4LD 705 = 66 Ah
4LD 820 = 70 Ah

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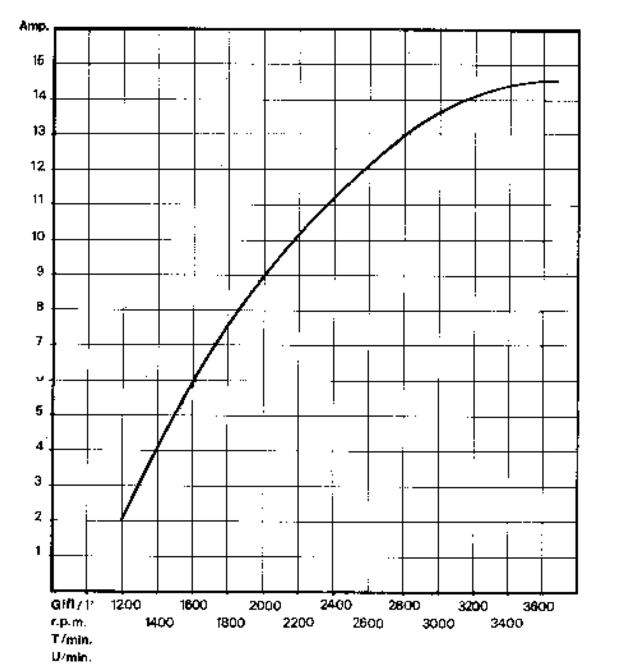
**12.5 V 14 A alternator**

It is equipped with a fixed rotor assembled on the main journal, while the pivoting rotor is housed inside the flywheel.

Dimensions (mm):
**A** = 159
**B** = 44.5
**C** = 4
**D** = 28.5

**Note**: The clearance between inductor and rotor (air gap) shall be 0.5 ÷ 0.6 mm.

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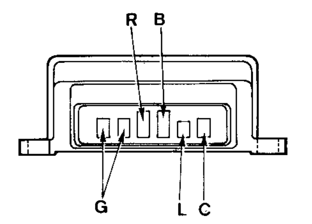
**12,5 V, 14 A alternator battery recharge curve**

It is carried out at + 25° C ambient temperature, 12.5 V battery voltage.

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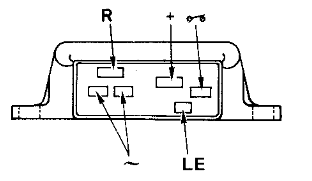


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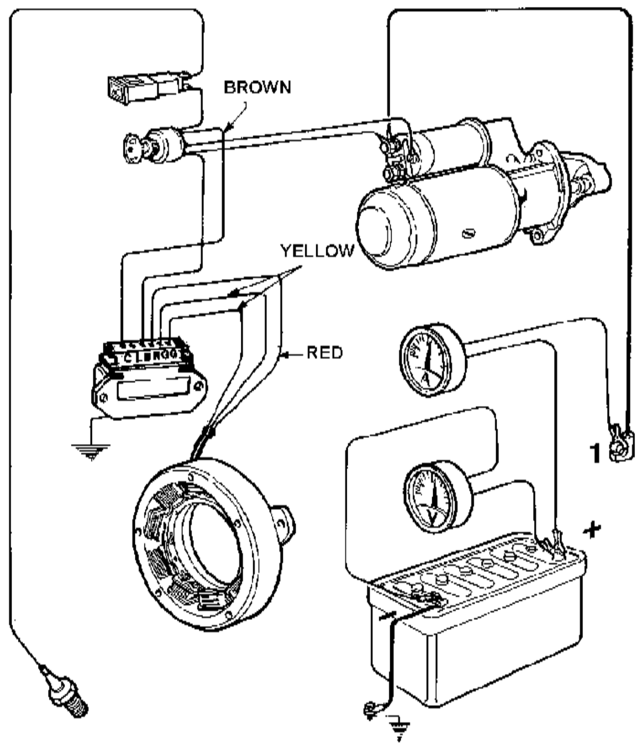
**Voltage regulator**

There are two different types of regulators: one with make SAPRISA, ALTECNA, NICSA and the other with make DUCATI.

| ALTECNA SAPRISA NICSA | Cable Colours | DUCATI | Tab dimensions | |
|---|---|---|---|---|
| | | | Width | Thickness |
| ~ | giallo | G | 6,25 | 0,8 |
| R | rosso | R | 9,50 | 1,2 |
| + | rosso | B | 9,50 | 1,2 |
| LE | verde | L | 4,75 | 0,8 |
| | marrone | C | 6,25 | 0,8 |

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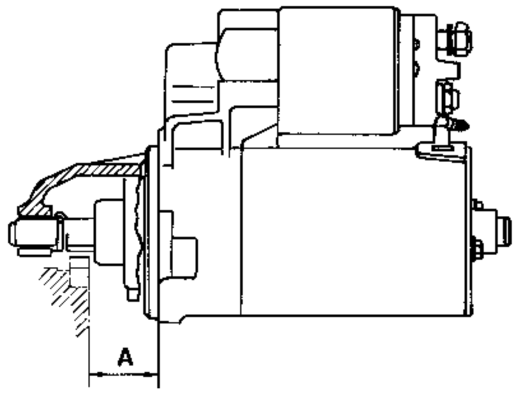
**Voltage regulator, running check**

Make sure that the connections are in compliance with the diagram.
Remove the respective clamp from the battery positive pole.
Insert a voltmeter with direct current between the two poles of the battery.

Connect a 20A ammeter at direct current between the positive pole and cable **1** respective clamp.
Start a few times until the battery voltage goes down to 13 V.
When the battery voltage reaches 14.5 V, the ammeter current will drop to a value near zero.
If the voltage is lower than 14 V and the recharge current is zero, replace the regulator.

**Note**: The voltage regulator does not work when not earthed and the battery is completely discharged.

**Warning**: when the engine runs, do not remove the battery cables and do not take the key off the control board.
Do not place the regulator near heat sources, a temperature exceeding 75° C could cause damages.
Avoid any electric welding either on the engine and on the equipment.

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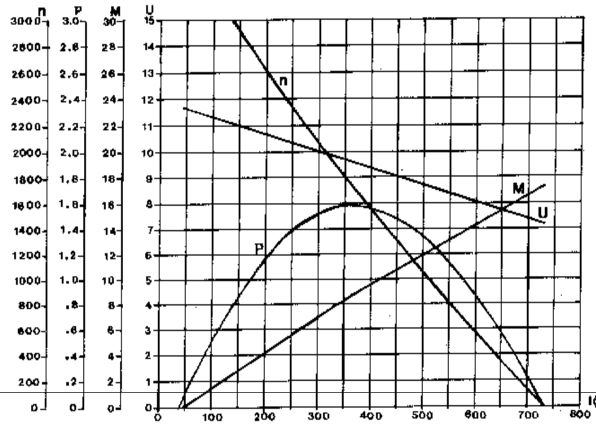
**Bosch DW (L) 12 V 1, 1 KW type, starting motor**

For 3LD 450, 3LD 510
Anticlockwise rotation direction (seen from the flywheel side)
**A** = 29.5 ÷ 31.5 mm (rim surface and motor flange distance)

**Note**: For any possible repairs, please contact bosch service centres.

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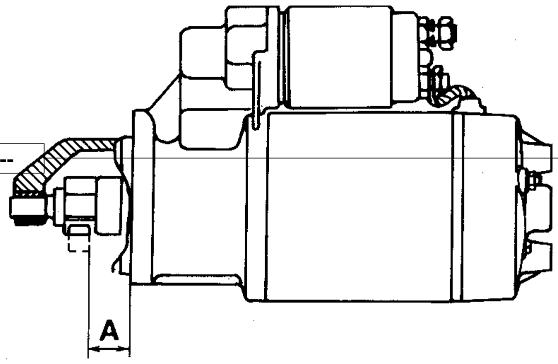
**Characteristic curves for Bosch DW(L) 12V 1.1 kW type, starting motor**

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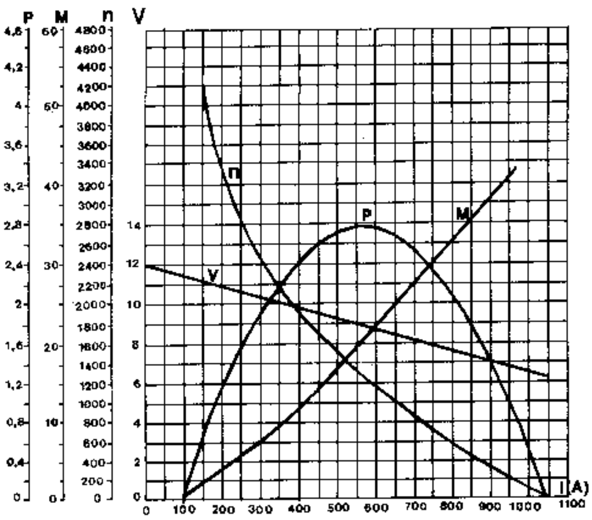
**Bosch JF(L) 12V 2.5 kW type, starting motor**

For 4LD 640, 4LD 705, 4LD 820
Anticlockwise rotation (seen from the pinion side)
**A =** 23 ÷ 25 mm

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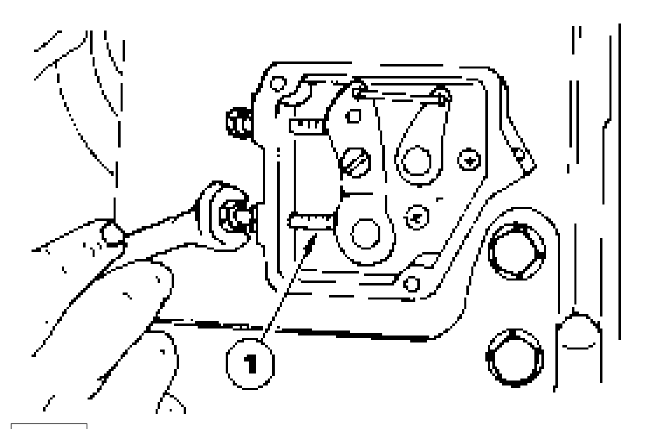
**Characteristic curves for Bosch JF(L) 12V 2,5 kW type starting motor**

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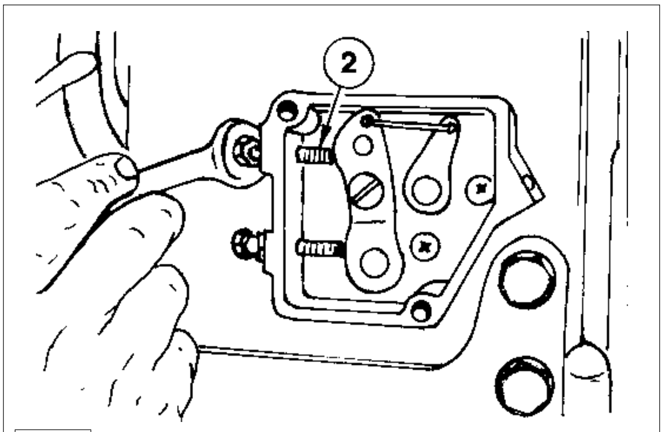
**Minimum rpm adjustment at idle running (standard)**

After filling the engine with oil and fuel, start and warm up the engine for 10 minutes.
Actuating the adjusting screw **1**, set the idling at 1150 rpm; then fasten the lock nut.

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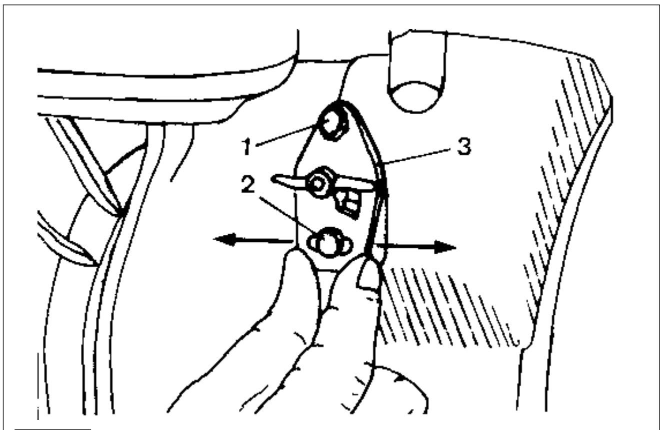
**Peak rpm adjustment at idle (standard)**

After adjusting the minimum rpm, set the screw 2 and adjust the peak rpm at 3200 rpm at idle; then fasten the lock nut.

**Note**: The peak rpm standard idle adjustment of 4LD 820 shall be carried out at 2800 rpm.

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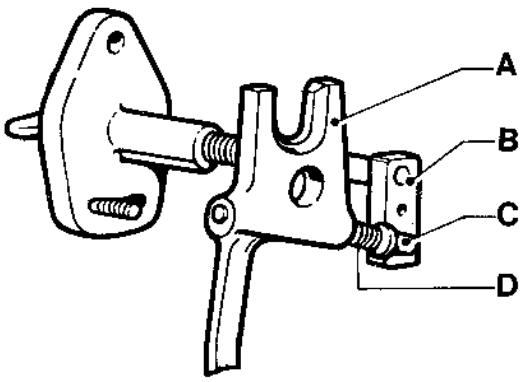
**Injection pump delivery adjustment (standard)**

This adjustment shall be carried out with the engine at dynamometric brake, otherwise the resulting adjustment could be approximate; in this case operate as it follows.

· Unloose the screws **1** and **2** by 1/4 of a turn
· Move the limiting device **3**, thus the screw **2** stays in the centre of the slot. Tighten the screws **1** and **2**.

**Carry out the exhaust smoke check as it follows:**

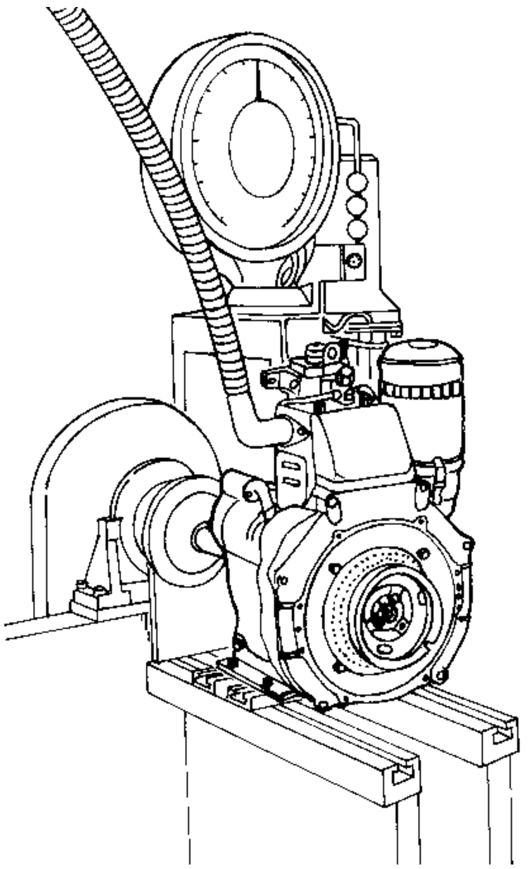
· Abruptly start the accelerator at idle.
In case of a quick pickup with light exhaust smoke to the Bosch scale index **3**, this means that the limiting device is correctly adjusted.
· In case of a slow pickup without smoke, move the limiting device towards the left (pumping duration increase).
· In case of a rapid pickup with thick smoke (exceeding index **3** of Bosch scale), move the limiting device towards the right (pump duration decrease).




89

**Limiting device for injection pump delivery and torque gearing device**

It is housed in the pump control lever **A** and it is constituted of a spring on cam **B**, limiting the stroke of the same lever **A**.
At the torque rate, the spring flexure, subject to the accelerator control action, allows a further stroke of lever **A,** thus an increased delivery of the injection pump.



90

**Adjustment of injection pump delivery with braked engine**

1) Bring the engine to its idling point .
2) Move the delivery limiting device 3 towards the left, see picture 88
3) Operate the engine until it reaches the power and rpm required by the manufacturer of the equipment.
4) Make sure that the consumption is in compliance with the values specified in the table of the adjustments (see information below).
   If the consumption is in compliance with the fixed values, it is essential to change the balance conditions measured on the brake, operating either on the load and on the regulator.
   When the engine is steady, carry out the consumption check again.
5) Move the limiting device 3 towards the right, as per picture 88, until the engine rpm number descreases. Lock the limiting device by means of the two screws.
6) Completely release the brake and check the rpm at which the engine settles. The speed governor performances shall be in compliance with the class required by the manufacturer of the equipment.
7) Stop the engine.
8) When the engine is cold, check the valve clearance again.

**Required adjustments (the most demanded)**

| Engine | Rpm | Kw power | Specific fuel consumption * | |
|---|---|---|---|---|
| | | | Time secs for 100 cc. | r/kW.h |
| 3LD 450 | 3000 | N 7,5 | 140-146 | 272-283 |
| 3LD 450 | 3600 | NB 7 | 143-149 | 285-299 |
| 3LD 510 | 3000 | N 9 | 117-122 | 272-283 |
| 4LD 640 | 3000 | N 10,5 | 96-100 | 284-295 |
| 4LD 705 | 3000 | N 10,8 | 96-100 | 276-287 |
| 4LD 705 | 2600 | N 10 | 108-113 | 263-277 |
| 4LD 820 | 2600 | N 12,1 | 87-92 | 258-273 |

* The specific consumption values indicated are valid after abt. 100 working hours.

- If the engine is not to be used for extensive periods, check the storage area conditions and the type of packaging and make sure that these are suitable for correct storage.
  If necessary, cover the engine with a proper protective sheet.
- Avoid storing the engine in direct contact with the ground, in environments that are humid and exposed to bad weather, near high voltage electric lines, etc.

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

## PROTECTIVE TREATMENT

**1 -** Pour in the engine housing AGIP RUSTIA C protective oil up to the maximum level.
**2 -** Fill up with fuel containing 10% AGIP RUSTIA NT.
**3 -** Start the engine and keep it idle at minimum speed for some minutes.
**4 -** Bring the engine to ¾ of the maximum speed for 5÷10 minutes.
**5 -** Turn off the engine.
**6 -** Empty out completely the fuel tank.
**7 -** Spray SAE 10W on the exhaust and intake manifolds.
**8 -** Seal the exhaust and intake ducts to prevent foreign bodies from entering.
**9 -** Thoroughly clean all external parts of the engine using suitable products.
**10 -** Treat non-painted parts with protective products (AGIP RUSTIA NT).
**11 -** Loosen the alternator/fan belt (if present).
**12 -** Cover the engine with a proper protective sheet.

**In countries in which AGIP products are not available, find an equivalent product (with specifications: MIL-L-21260C).**

**Maximum every 24 months of inactivity, the engine must be started up by repeating all “Engine Storage” operations.**

## PREPARING THE ENGINE FOR OPERATION AFTER PROTECTIVE TREATMENT

After the storage period and before starting up the engine and preparing it for operation, you need to perform certain operations to ensure maximal efficiency conditions.

**1 -** Remove the protective sheet.
**2 -** Remove any sealing devices from the exhaust and intake ducts.
**3 -** Use a cloth soaked in degreasing product to remove the protective treatment from the external parts
**4 -** Inject lubricating oil (no more than 2 cm3) into the intake ducts.
**5 -** Adjust the alternator/fan belt tension (if present).
**6 -** Turn the engine manually to check the correct movement and smoothness of the mechanical parts.
**7 -** Refill the tank with fresh fuel.
**8 -** Make sure that the oil is up to the maximum level.
**9 -** Start the engine and after some minutes bring it to ¾ of the maximum speed for 5-10 minutes.
**10 -** Turn off the engine.
**11 -** Remove the oil drain plug (see “Oil replacement”) and discharge the AGIP RUSTIA NT protective oil while the engine is hot.
**12 -** Pour new oil (see “Table of lubricants”) up to the maximum level.
**13 -** Replace the filters (air, oil, fuel) with original spare parts.

**Over time, a number of engine components and lubricants lose their properties, so it is important considering whether they need replacing, also based on age (see Replacement table).**

**Maximum every 24 months of inactivity, the engine must be started up by repeating all “Engine Storage” operations.**

## 3LD 450 - 3LD 510 - 3LD 450/S - 3LD 510/S MAIN DRIVING TORQUES

| POSITION | REFERENCE ( Picture NO. ) | Dia. /Pitch ( mm ) | Torque ( Nm ) |
|---|---|---|---|
| Injection pump union | 71 | 18x1.5 | 40 |
| Connecting rod | 36 | 8x1.25 | 30 |
| Clutch bearing bell bolt | - | 14x1.5 | 250 |
| Flanging bell | - | 8x1.25 | 25 |
| Clutch bell (industrial engine) | - | 16x1.5 | 80 |
| Rocker arm box cap | 8 | 8x1.25 | 20 |
| Oil sump | - | 6x1 | 10 |
| Oil pump case | 58 | 8x1.25 | 30 |
| Air filter | 1 | 8x1.25 | 25 |
| Oil filter | - | 8x1.25 | 25 |
| Oil pump gear | 58 | 8x1.25 | 20 |
| Injector towards the head | 75 | 8x1.25 | 15 |
| Rocker arm fulcrum pin for injection pump | - | 14x1.5 | 60 |
| Gear pin for speed governor | - | 10x1.5 | 40 |
| Engine foot | - | 8x1.25 | 40 |
| Injection pump | 69 | 8x1.25 | 25 |
| Distributor side port | 40 | 8x1.25 | 25 |
| Oil pressure switch | - | 12x1.5 | 35 |
| Starting pulley | 4 | 8x1.25 | 35 |
| Main bearing on flywheel side | 63 | 8x1.25 | 25 |
| Sump oil drain bolt | - | 10x1.5 | 35 |
| Cylinder | 14 | 10x1.5 | 50 |
| Flywheel | 3 | 20x1.5 | 170 |

## MAIN DRIVING TORQUES 4LD 640 - 4LD 705 - 4LD 820

| POSITION | Reference ( picture no.) | Dia. / Pitch ( mm ) | Torque ( Nm ) |
|---|---|---|---|
| Injection pump unit | 71 | 18x1.5 | 40 |
| Connecting rod | 36 | 10x1.5 | 45 |
| 4LD 820 clutch bearing bell bolt | - | 14x1.5 | 280 |
| 4LD 640, 4LD clutch bearing bell bolt | - | 14x1.5 | 250 |
| Bolt for hub | - | 14x1.5 | 280 |
| Flanging bell | - | 10x1.5 | 40 |
| Rocker arm box cap | 8 | 8x1.25 | 20 |
| Oil sump | - | 8x1.25 | 25 |
| Oil pump case | 58 | 8x1.25 | 40 |
| Air filter | 1 | 10x1.5 | 50 |
| Oil filter | - | 8x1.25 | 25 |
| Oil pump gear | 58 | 8x1.25 | 20 |
| Injetor towards the head | 75 | 8x1.25 | 20 |
| Rocker arm pin for injection pump control | - | 8x1.25 | 30 |
| Gear pin for speed governor | - | 10x1.5 | 40 |
| Engine foot | - | 10x1.5 | 40 |
| Injection pump | 69 | 8x1.25 | 30 |
| Distributor side port | 41 | 10x1.5 | 40 |
| Oil pressure switch | - | 12x1.5 | 35 |
| Starting pulley | 4 | 10x1.5 | 40 |
| Main bearing on flywheel side | 64 | 10x1.5 | 40 |
| Sump oil drain bolt | - | 14x1.5 | 70 |
| Cylinder head | 14 | 12x1.5 | 80 |
| Flywheel | 3 | 20x1.5 | 350 |

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

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

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

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

## USE OF DOPE FOR 3LD 450 - 3LD 510 - 3LD 451/S - 3LD 510/S

| POSITION | TYPE OF SEALANT |
|---|---|
| Clutch bearing bell and embedded hexagonal-head screws | LOCTITE 270 |
| Control pin threading | LOCTITE 270 |
| Coupling nipple for oil filter cartridge | LOCTITE 270 |
| Stud bolt for clamping on engine head | LOCTITE 270 |
| Stud bolt for clamping on main bearing flywheel side | LOCTITE 270 |
| Stud bolt for clamping on distributor port side | LOCTITE 270 |
| Stud bolt on engine bell | LOCTITE 270 |
| Clamping screw for pin regulator | LOCTITE 270 |
| Clamping screw for baffle on air conveyor | LOCTITE 270 |
| Stud bolt for clamping on engine flange bell | LOCTITE 270 |
| Rocker arm fulcrum pin for injection pump control | LOCTITE 270 |
| Bracket clamping screw on side plates | LOCTITE 270 |
| Stud bolt for clamping at feeding pump | LOCTITE 270 |

## USE OF DOPE FOR 4LD 640 - 4LD705 - 4LD 820

| POSITION | TYPE OF SEALANT |
|---|---|
| Bearing on port or bell | LOCTITE 270 |
| Regulating pin threading | LOCTITE 270 |
| Stud bolt for clamping on engine head | LOCTITE 270 |
| Stud bolt for clamping on main bearing on flywheel side | LOCTITE 270 |
| Stud bolt for clamping on distribution side | LOCTITE 270 |
| Lock screw for rocker arm pin | LOCTITE 270 |
| Clamping screw for regulating pin | LOCTITE 270 |
| Industrial port | DOW CORNING Q3 - 7091SILICONE |
| Stud bolt for clamping on feeding pump | LOCTITE 270 |

# WORKSHOP MANUAL

**cod. __ ED0053025560**



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# WORK SHOP MANUAL

**12LD477-2, series engines, p.no. 1-5302-625**

# 12 LD 477/2

**1st Edition**

SERVICE

# FOREWORD

We have done all in our power to give up to date and accurate technical information in this manual. Lombardini engines are, however, constantly developing thus the data in this publication may be liable to modification without prior notice.



The information in this manual is given on the assumption that:

1 - the persons who service Lombardini engines have been adequately trained and outfitted to safely and professionally carry out the necessary tasks;

2 - the persons who service Lombardini engines possess the necessary skills and special Lombardini tools to safely and professionally carry out the necessary tasks;

3 - the persons who service Lombardini engines have read the specific information concerning the above mentioned Service operations and that they have clearly understood the operations required.

# GENERAL SERVICE NOTES

1 - Only use genuine Lombardini spare parts. Use of spurious spares may lead to incorrect performance and shorten the life of the engines.
2 - The metric system is used to express all data, i.e. the dimensions are given in millimeters (mm), torque is expressed in Newton-meters (Nm), weight in kilograms (kg), volume in liters or cubic centimeters (cc) and pressure in barometric units (bar).

SERVICE

# WARRANTY CERTIFICATE

The products manufactured by Lombardini Srl are warranted to be free from conformity defects for a period of 24 months from the date of delivery to the first end user.
For engines fitted to stationary equipment, working at constant load and at constant and/or slightly variable speed within the setting limits, the warranty covers a period up to a limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
If no hour-meter is fitted , 12 working hours per calendar day will be considered.
For what concerns the parts subject to wear and deterioration (injection/feeding system, electrical system, cooling system, sealing parts, non-metallic pipes, belts) warranty covers a maximum limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
For correct maintenance and replacement of these parts, it is necessary to follow the instructions reported in the documentation supplied with each engine.
To ensure the engine warranty is valid, the engine installation, considering the product technical features, must be carried out by qualified personnel only.
The list of the Lombardini authorized dealers is reported in the “Service” booklet, supplied with each engine.
Special applications involving considerable modifications to the cooling/lubricating system (for ex.: dry oil sump), filtering system, turbo-charged models, will require special written warranty agreements.
Within the above stated periods Lombardini Srl directly or through its authorized network will repair and/or replace free of charge any own part or component that, upon examination by Lombardini or by an authorized Lombardini agent, is found to be defective in conformity, workmanship or materials.
Any other responsibility/obligation for different expenses, damages and direct/indirect losses deriving from the engine use or from both the total or partial impossibility of use, is excluded.
The repair or replacement of any component will not extend or renew the warranty period.

Lombardini warranty obligations here above described will be cancelled if:

- Lombardini engines are not correctly installed and as a consequence the correct functional parameters are not respected and altered.
- Lombardini engines are not used according to the instructions reported in the “Use and Maintenance” booklet supplied with each engine.
- Any seal affixed to the engine by Lombardini has been tampered with or removed.
- Spare parts used are not original Lombardini.
- Feeding and injection systems are damaged by unauthorized or poor quality fuel types.
- Electrical system failure is due to components, connected to this system, which are not supplied or installed by Lombardini.
- Engines have been disassembled, repaired or altered by any part other than an authorized Lombardini agent.

Following expiration of the above stated warranty periods and working hours, Lombardini will have no further responsibility for warranty and will consider its here above mentioned obligations for warranty complete.
Any warranty request related to a non-conformity of the product must be addressed to the Lombardini Srl service agents.

# INDEX

This manual contains pertinent information regarding the repair of LOMBARDINI air-cooled, indirect injection Diesel engines type **12LD477-2:** updated August 01, 2003.


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## POSSIBLE CAUSES AND TROUBLE SHOOTING

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 | ● | | | | | | | | | |
| MAINTE-NANCE | 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 | ● | | | | | | | | | |

# SAFETY AND WARNING DECALS

| DANGER | CAUTION |
| --- | --- |
| **Failure to comply with the instructions could result in damage to persons and property** | **Failure to comply with the instructions could lead to technical damage to the machine and/or system** |

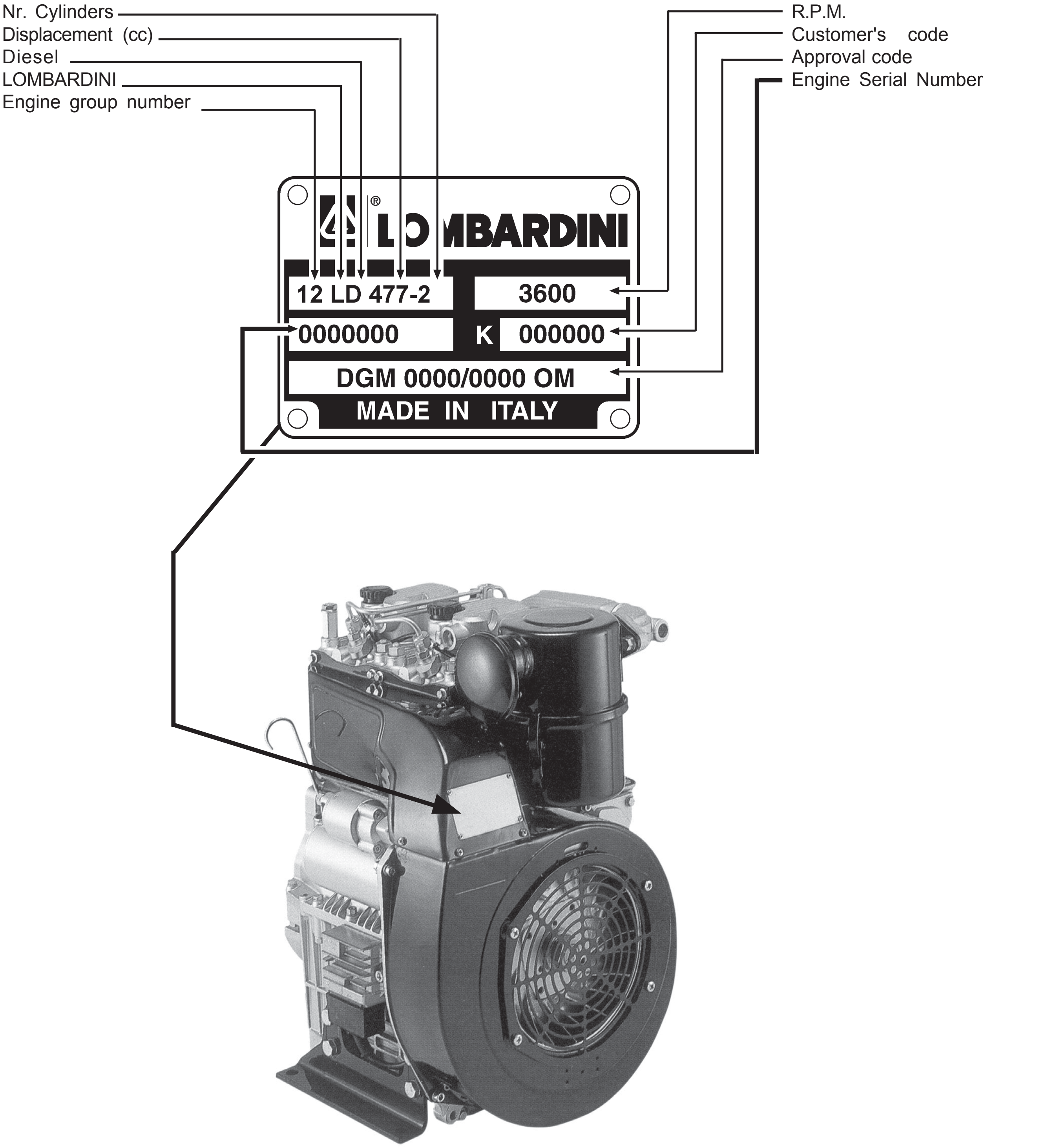
# SAFETY INSTRUCTIONS

- Lombardini Engines are built to supply their performances in a safe and long-lasting way. To obtain these results, it is essential for users to comply with the servicing instructions given in the relative manual along with the safety recommendations listed below.
- The engine has been made according to a machine manufacturer's specifications and all actions required to meet the essential safety and health safeguarding requisites have been taken, as prescribed by the current laws in merit. All uses of the engine beyond those specifically established cannot therefore be considered as conforming to the use defined by Lombardini which thus declines all liability for any accidents deriving from such operations.
- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation in particular, along with the relative routine maintenance work.
- The user must read these instructions carefully and become familiar with the operations described. Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- The engine may only be used or assembled on a machine by technicians who are adequately trained about its operation and the deriving dangers. This condition is also essential when it comes to routine and, above all, extraordinary maintenance operations which, in the latter case, must only be carried out by persons specifically trained by Lombardini and who work in compliance with the existing documentation.
- Variations to the functional parameters of the engine, adjustments to the fuel flow rate and rotation speed, removal of seals, demounting and refitting of parts not described in the operation and maintenance manual by unauthorized personnel shall relieve Lombardini from all and every liability for deriving accidents or for failure to comply with the laws in merit.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ. In the case of manual start-ups, make sure that the relative actions can take place without the risk of hitting walls or dangerous objects, also considering the movements made by the operator. Pull-starting with a free cord (thus excluding self-winding starting only), is not permitted even in an emergency.
- Make sure that the machine is stable to prevent the risk of overturning.
- Become familiar with how to adjust the rotation speed and stop the engine.
- Never start the engine in a closed place or where there is insufficient ventilation. Combustion creates carbon monoxide, an odourless and highly poisonous gas. Lengthy stays in places where the engine freely exhausts this gas can lead to unconsciousness and death.

- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unles specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Fuel is inflammable. The tank must only be filled when the engine is off. Thoroughly dry any spilt fuel and move the fuel container away along with any rags soaked in fuel or oil. Make sure that no soundproofing panels made of porous material are soaked in fuel or oil. Make sure that the ground or floor on which the machine is standing has not soaked up any fuel or oil.
- Fully tighten the tank plug each time after refuelling. Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- Fuel vapour is highly toxic. Only refuel outdoors or in a well ventilated place.
- Do not smoke or use naked flames when refuelling.
- The engine must be started in compliance with the specific instructions in the operation manual of the engine and/or machine itself. Do not use auxiliary starting aids that were not installed on the original machine (e.g. Startpilot’).
- Before starting, remove any tools that were used to service the engine and/or machine. Make sure that all guards have been refitted.
- During operation, the surface of the engine can become dangerously hot. Avoid touching the exhaust system in particular.
- Before proceeding with any operation on the engine, stop it and allow it to cool. Never carry out any operation whilst the engine is running.
- The coolant fluid circuit is under pressure. Never carry out any inspections until the engine has cooled and even in this case, only open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. If there is an electric fan, do not approach the engine whilst it is still hot as the fan could also start operating when the engine is at a standstill. Only clean the coolant system when the engine is at a standstill.
- When cleaning the oil-cooled air filter, make sure that the old oil is disposed of in the correct way in order to safeguard the environment. The spongy filtering material in oil-cooled air filters must not be soaked in oil. The reservoir of the separator pre-filter must not be filled with oil.
- The oil must be drained whilst the engine is hot (oil T ~ 80°C). Particular care is required to prevent burns. Do not allow the oil to come into contact with the skin.
- Make sure that the drained oil, the oil filter and the oil it contains are disposed of in the correct way in order to safeguard the environment.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and cold. Take care to prevent fluids containing nitrites from being mixed with others that do not contain these substances since "Nitrosamine", dangerous for the health, can form. The coolant fluid is polluting and must therefore be disposed of in the correct way to safeguard the environment.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the positive wire of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Only check belt tension when the engine is off.
- Only use the eyebolts installed by Lombardini to move the engine. These lifting points are not suitable for the entire machine; in this case, the eyebolts installed by the manufacturer should be used.

## MODEL NUMBER

## ENGINE IDENTIFICATION



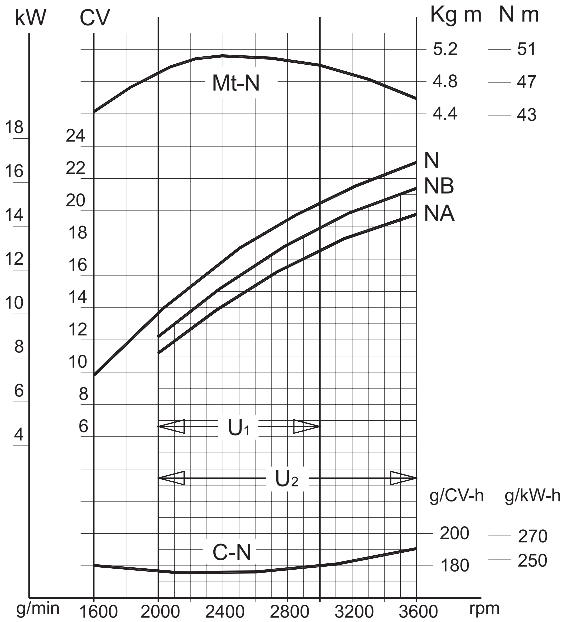
## CHARACTERISTICS

| ENGINE TYPE | | | | 12 LD 477-2 |
|---|---|---|---|---|
| Number of cylinders | | | N. | 2 |
| Bore | | | mm | 90 |
| Stroke | | | mm | 75 |
| Swept volume | | | cm³ | 954 |
| Compression ratio | | | | 19:1 |
| Power kW (HP) | N 80/1269/CEE-ISO 1585 | @ 3000 RPM | | 15(20,5) |
| | | @ 3600 RPM | | 17(23) |
| | NB ISO 3046 - 1 IFN | @ 3000 RPM | | 14(19) |
| | | @ 3600 RPM | | 15,7(21,4) |
| | NA ISO 3046 - 1 ICXN | @ 3000 RPM | | 12,9(17,6) |
| | | @ 3600 RPM | | 14,5(19,8) |
| Max. torque * | | | Nm | 50@2400 |
| Fuel consumption ** | | | g/kW.h | 236 |
| Oil consumption | | | g/kW.h | 0,8 |
| Capacity of standard oil sump | | | lt | 3 |
| Recommended battery 12V | | | Ah -A | 66-300 |
| Dry weight | | | kg | 78 |
| Combustion air volume | | | m³/h | 90 |
| Cooling air volume | | | m³/h | 950 |
| Max.permissible driving shaft axial: continuous (instantaneous) | | | kg. | 100(350) |
| Max. inclination | Flywheel site: continuous (instantaneous) | | | 25°(35°) |
| | Power take off site: continuous (instantaneous) | | | 25°(40°) |
| | Lateral: continuous (instantaneous) | | | 25°(40°) |

* Referred to N power
** Consumption at max torque

## CHARACTERISTICS POWER, TORQUE AND SPECIFIC FUEL CONSUMPTION CURVES

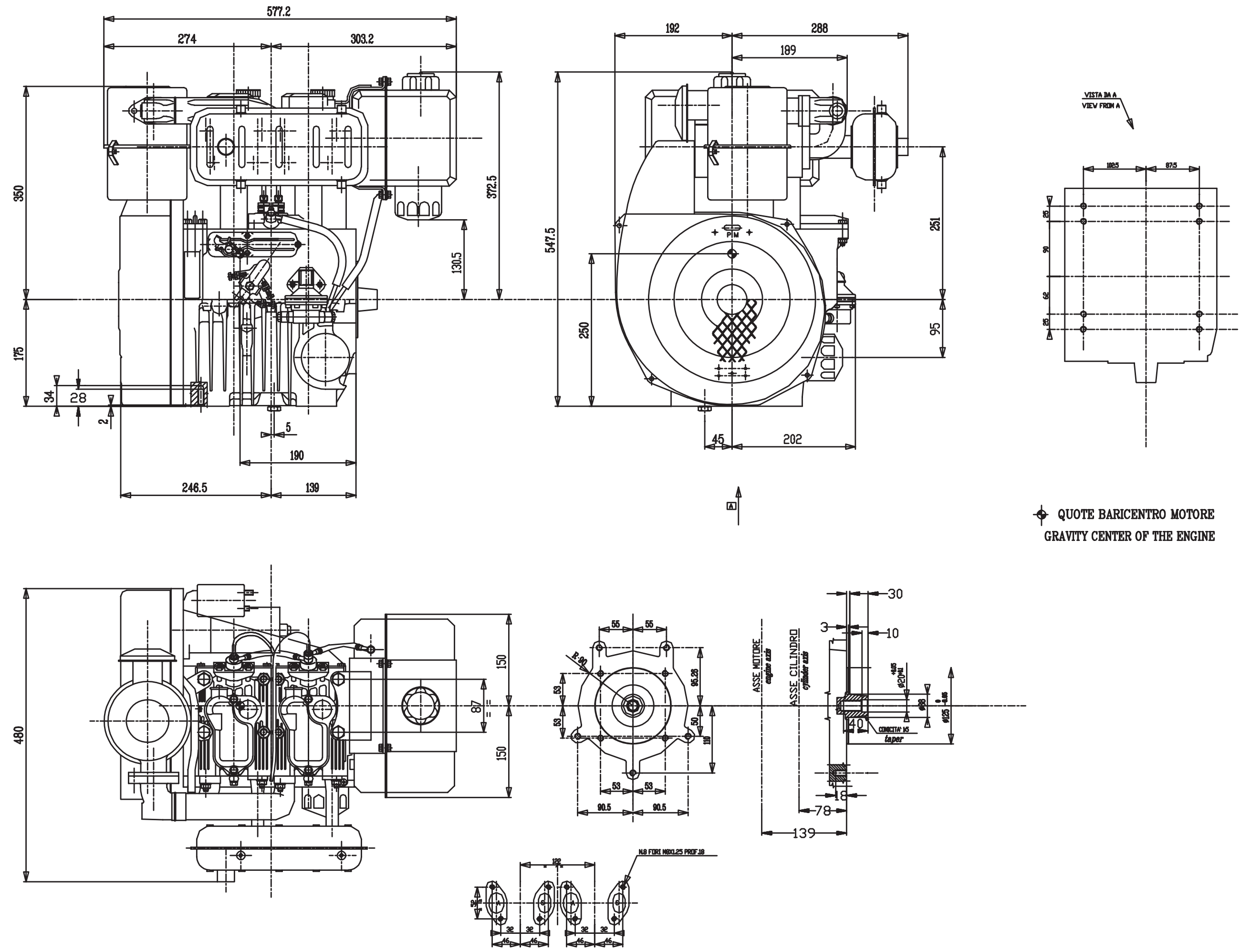
### 12 LD 477-2




**N (80/1269/EEC - ISO 1585)** **AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load.
**NB (ISO 3046 - 1 IFN)** **RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load.
**NA (ISO 3046 - 1 ICXN)** **CONTINUOS RATING WITH OVERLOAD CAPABILITY:** continuos 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

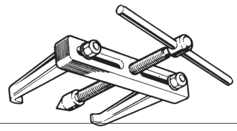
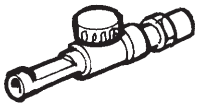
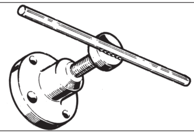
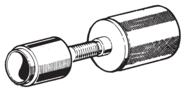
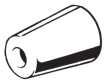
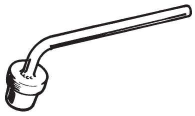
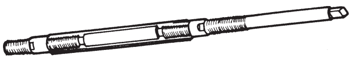
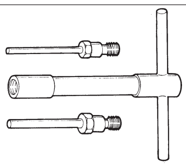
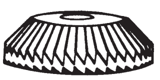
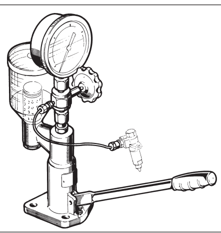
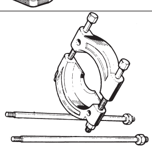
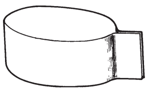
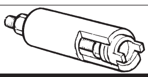
The above power values refer to an engine fitted with air cleaner and standard muffler, after testing and at the environmental conditions of 20°C and 1 bar.
Max. power tolerance is 5%.
Power decreases by approximately 1% every 100 m di altitude and by 2% every 5°C above 25°C.

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




Note: Dimensions in mm

# VII SPECIAL TOOLS

| TOOL | CODE | DESCRIPTION |
|---|---|---|
|  | **00365R0010** | Extractor |
|  | **00365R0940** | Injection advance control tool |
|  | **00365R0020** | Flywheel extractor |
|  | **00365R0040** | Oil seal insertion tool |
|  | **00365R0260** | Oil seal protection cone |
|  | **00365R0210** | Injection pump spanner |
|  | **00365R0450** | Valve guide gauge Ø 7 mm (0.27 inch.) |
|  | **00365R0850** | Valve guide grinder Ø 7 mm (0.27 inch.) |
|  | **00365R0540** | Tool for valve seat |
|  | **00365R0500**<br>**00365R0510** | Cutter Ø 38 mm (1.50 inch.)<br>Cutter Ø 40 mm (1.57 inch.) |
|  | **00365R0430** | Injector test bench |
|  | **00365R0100** | Bearing extractor |
|  | **00365R0770** | Cylinder collar Ø 80=85 mm (3.15=3.35 inch.) |
|  | **00365R0880** | Valve extractor |

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

## MANUTENANCE

| OPERATION | COMPONENT | | INTERVAL (HOURS) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 8 | 50 | 200 | 300 | 500 | 2500 | 5000 |
| CLEANING | OIL-BATH AIR CLEANER | | (*) | ● | | | | | | |
| | HEAD AND CYLINDER FINS | | (*) | ● | | | | | | |
| | FUEL TANK | | | | | | ● | | | |
| | INJECTOR | | | | | | ● | | | |
| CHECK | LEVEL | AIR CLEANER OIL | | ● | | | | | | |
| | | OIL SUMP | | ● | | | | | | |
| | | BATTERY FLUID | | | ● | | | | | |
| | VALVE/ROCKER ARM CLEARANCE | | | | | | ● | | | |
| | INJECTOR SETTING | | | | | | ● | | | |
| | | | | | | | | | | |
| REPLACEMENT | OIL | AIR CLEANER | (**)(***) | | □ | ● | | | | |
| | | SUMP | | | | ● | | | | |
| | 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.

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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. 7.0

The engine could be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil as its combustion could sharply increase the rotation speed.
Use a suitable oil in order to protect the engine.
The lubrication oil influences the performances and life of the engine in an incredible way.
The risk of piston seizure, jammed piston rings and rapid wear of the cylinder liner, the bearings and all moving parts increases if oil whose characteristics differ from the recommended type is used, or if the oil is not regularly changed. All this notably reduces engine life.
Oil viscosity must suit the ambient temperature in which the engine operates.

Old oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time. If contact with the oil is inevitable, you are advised to thoroughly wash your hands with soap and water as soon as possible.
Appropriate protective gloves etc should be wore during this operation.
Old oil is highly polluting and must be disposed of in the correct way. Do not litter.

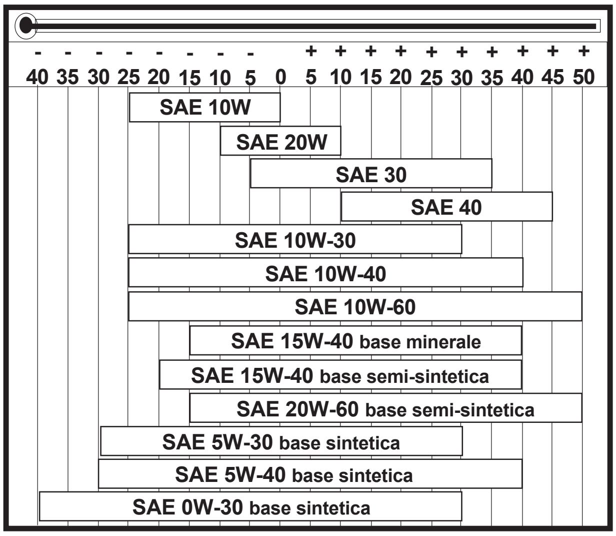
**RECOMMENDED OIL**

AGIP SINT 2000 5W40 specification API SJ/CF ACEA A3-96 B3-96 MIL-L-46152 D/E.
ESSO ULTRA 10W40 specification API SJ/CF ACEA A3-96 MIL-L-46152 D/E.
In countries where AGIP and ESSO products are not available, use API SJ/CF oil for gasoline-fuelled engines or oil that complies with military specification MIL-L-46152 D/E.

**OIL SUPPLY ( liters )**
**Standard oil sump**

**filter included** **3.0 l.**

GRADE




**ACEA SEQUENCES**

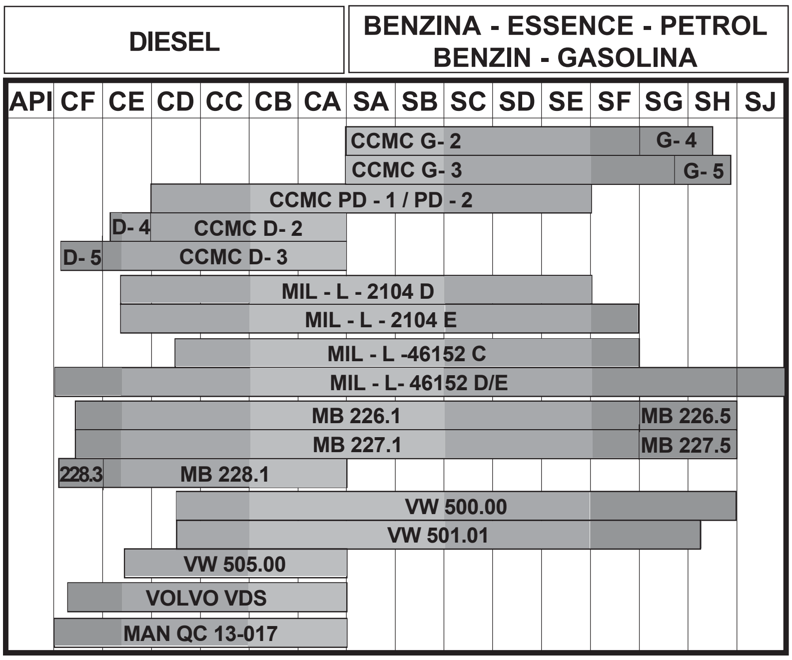
A = Gasoline (Petrol)
B = Light Diesel fuels
E = Heavy Diesel fuels

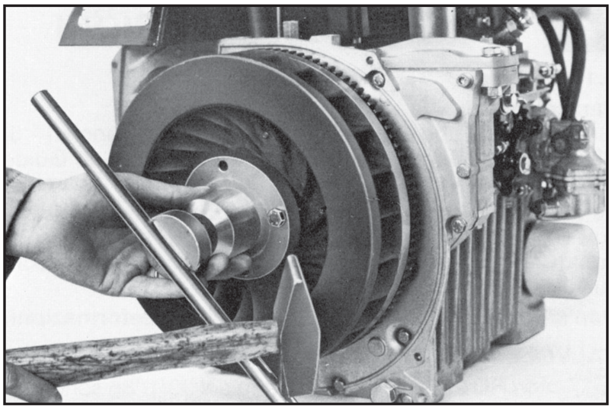
Required levels :

A1-96
A2-96
A3-96

B1-96
B2-96
B3-96

E1-96
E2-96
E3-96

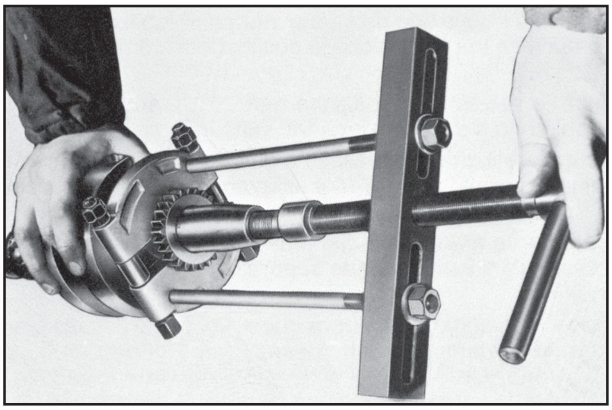




1

> **!** During repair operations, when using compressed air, wear eye protection.

**DISASSEMBLY AND REASSEMBLY**
Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions. Always use original LOMBARDINI spare parts for repair operations.

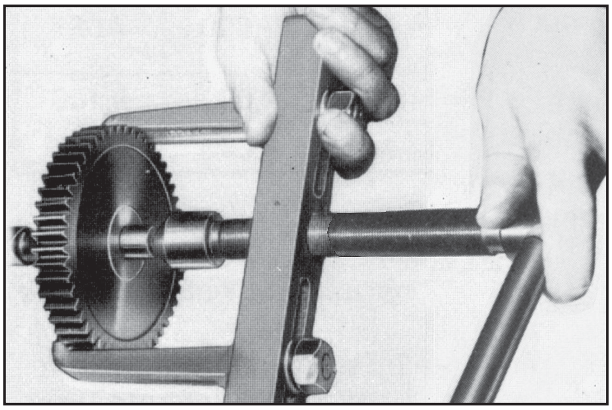


2

**Flywheel extraction**
Use extractor cod. **00365R0020**, as shown in figure 1.

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.

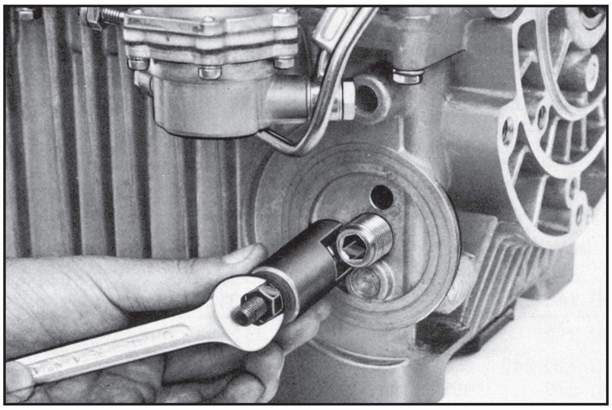
**!** IMPORTANT: Do not tap the end of the extractor when removing the flywheel.



3

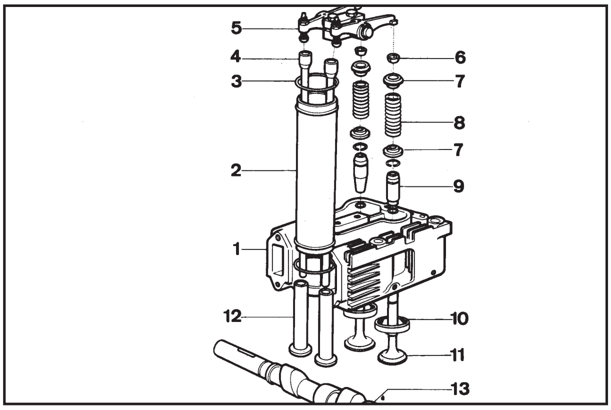
**Crankshaft gear extraction**
Use extractor cod. **00365R0010** and cod. **00365R0100** (fig. 2).

**Camshaft gear extraction**
Use extractor cod. **00365R0010** (fig. 3).



4

**Oil pressure register valve extraction**
Use extractor cod. **00365R0880** (fig. 4).



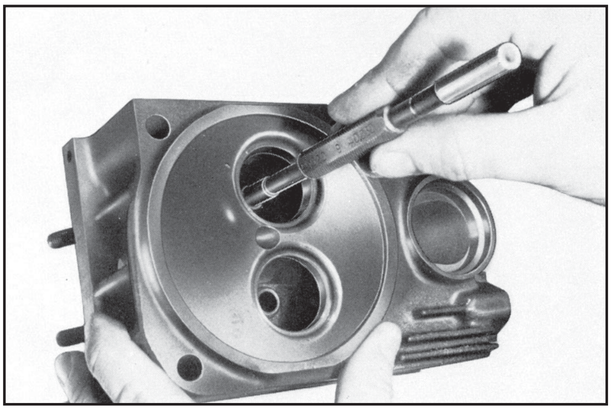

5

## Cylinder heads

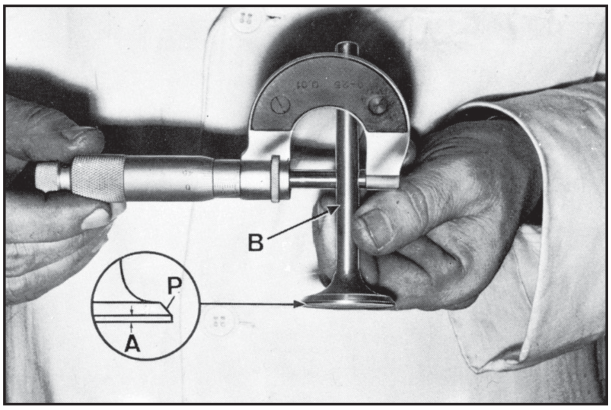
Details of fig. 5:
1. Cylinder head - 2. Pipe - 3. O-Ring - 4. Rockerarms - 5. Rockers - 6. Cotters - 7. Plates - 8. Springs - 9. Guides - 10. Seats - 11. Valves - 12. Tappets - 13. Camshaft.

The heads are of aluminium with inserted guides and valve seats in cast iron. Make sure there are no cracks or imperfections. Should it be so, replace according to the instructions given in the spare parts catalogue.

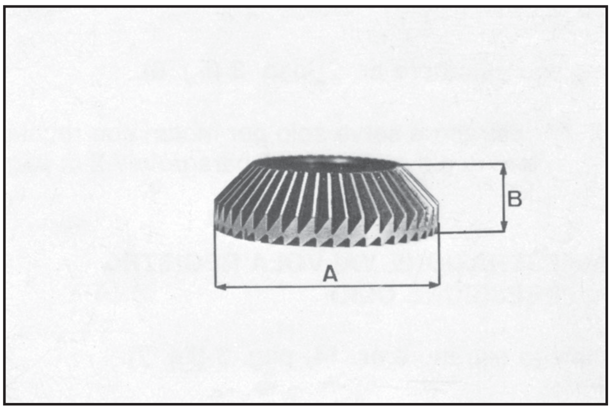
! Never remove head while still hot in order to avoid deformation.



6




7




8

## Valves - Guides - Seats

Clean the valves with a wire brush and renew them if the valve heads are deformed, cracked or worn.
Check clearance between valve and guide with a micrometer on stem B (fig. 7) and with a go/no go gauge as shown in fig. 6 (tool cod. **00365R0450**).
Change the guide if the maximum gauge diameter passes through it, as it has passed the maximum permissible wear.

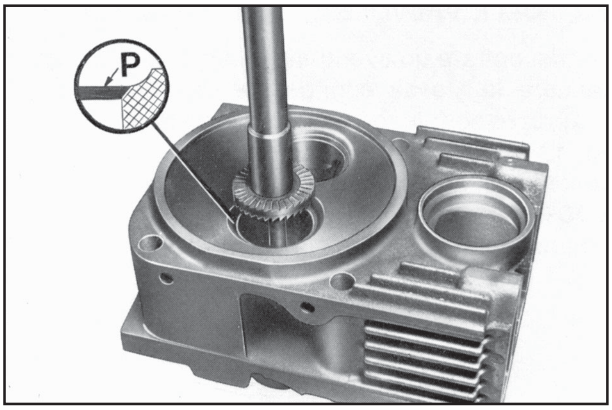
After having fitted the new guide, check exact diameter using the “go” end of the gauge and if necessary grind it to the dimensions indicated in the table using the adjustable grinder (tool cod. **00365R0850**).

| Engine | Guide | Ø Guide mm | Ø Gauge mm | |
|---|---|---|---|---|
| | | | go | no go |
| 12LD477-2 | Inlet<br>Outlet | 7,000 ÷ 7,010 | 7,000 | 7,079 |

Fitting of new guides always requires grinding of the valve seats (see page 19).
Valve guides with an external diameter increased by **0.10 mm** are available.
If the inlet clearance between valve and guide is lower than **0.08 mm** and the outlet clearance is lower than, **0.10 mm**, the wear on **B** is less than **0.03 mm** and **A** is more than **0.05 mm**, recondition the valve by grinding face **P** to **45°** (fig. 7).
As a result of prolonged engine operation, the hammering of the valves on their seats at high temperature causes the face of the seats to harden and hand grinding is made difficult. It is thus necessary to remove the hardened surface with a **45°** cutter mounted on a valve seat grinding tool (fig. 8). Final fitting can then be carried out manually with the cutters listed below.

Cut dimensions for valve seats

| Engine | Inlet | | Outlet | |
|---|---|---|---|---|
| | A x B | Ø guide | A x B | Ø guide |
| 12LD477-2 | 40 x 12 mm | 7 mm | 38 x 12 mm | 7 mm |




9

Cutting of the valve seats involves the widening of the valve seat face **P** with a consequent reduction of seal of the valve itself, fig. 9

If face **P** is more than **2 mm** wide, invert cutter and lower level **Q** of the seat, fig. 10, so as to restore the **P** level to the value of:

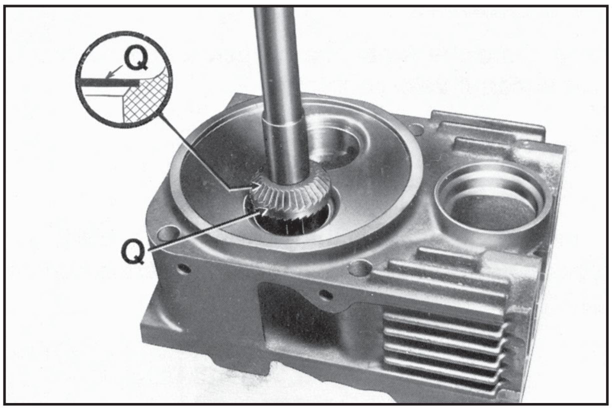
| Fitting mm | Max. wear mm |
|---|---|
| 0,7 ÷ 1,2 | 2 |

Final lapping of the valve on the seat must be carried out by coating the seat with a fire grinding paste and rotating the valve backwards and forwards with a slight pressure until a perfect finish to the surface is obtained (fig. 11).
Make sure the face of the valve head in relation to the face of the cylinder head is:

| Fitting mm | Max. wear mm |
|---|---|
| 0,9 ÷ 1,1 | 1,8 |

**!** If the distance is less, the valve will strike the piston.
If the distance is more than **1.8 mm** the valve seat rings need to be changed. Fitting of new valves or seats always requires grinding.

Valve seats with an external diameter increased by **0.2 mm**, are available.




10

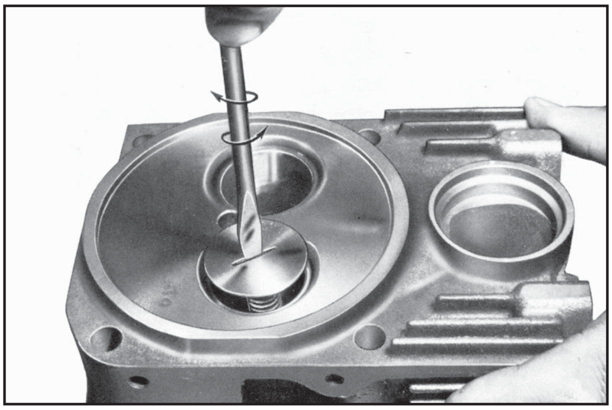
After grinding, wash valve and seat carefully with petrol or paraffin to eliminate any residual grinding paste or cuttings.
To check the worthiness of the seal between valve and seat, after grinding has taken place, proceed as follows:

1. Fit valve on head with spring, plates and cotters (see fig. 5).

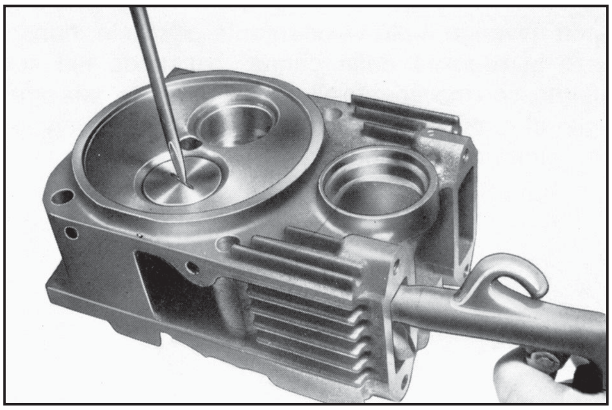
2. Invert head and pour a few drops of diesel or oil round the outside of the valve head.

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. 12).

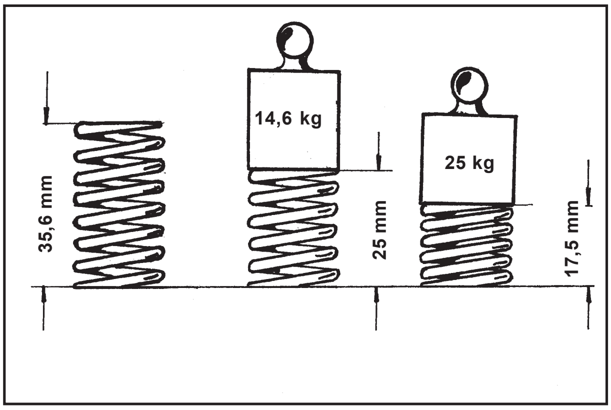
Should air bubbles form between the seat and the valve, remove the valve and regrind the seat.
The fit can also be checked by pushing the valve upwards and letting it fall freely down onto its seat. If the resulting bounce is considerable and uniform, also when the valve is rotated, it means that the fit is good. If not, continue grinding until the conditions described above are achieved.



11

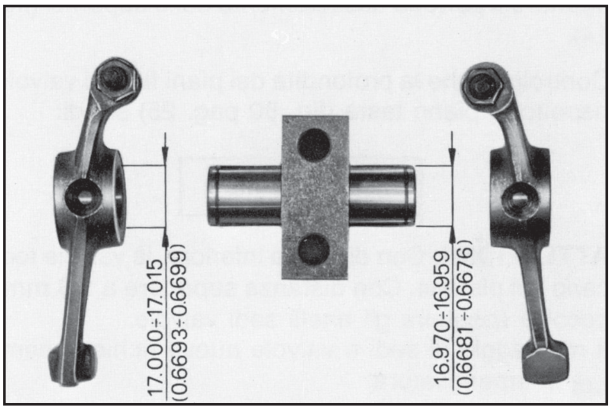


12



13

**Valves and springs**
In order to check the springs for possible failure measure the lengths under load as shown in figure 13.
The permissible tolerance for loads and lengths is ± 10%. If the figures measured do not fall within these values, the springs must be renewed.



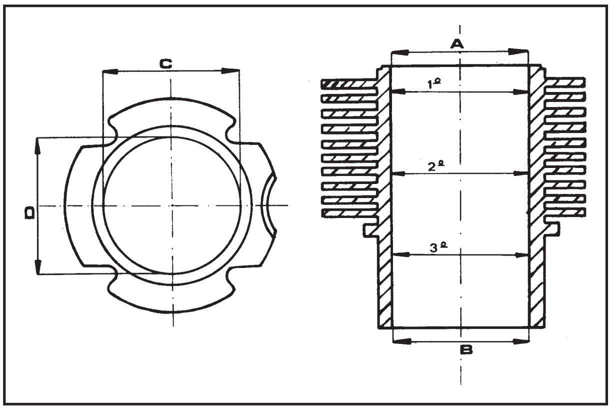
14

**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.14):

| Fitting mm | Max. wear mm |
|---|---|
| 0,030 ÷ 0,056 | 0,15 |

Rocker axial play (fig.14):

| |
|---|
| 0,10 ÷ 0,50 |



15

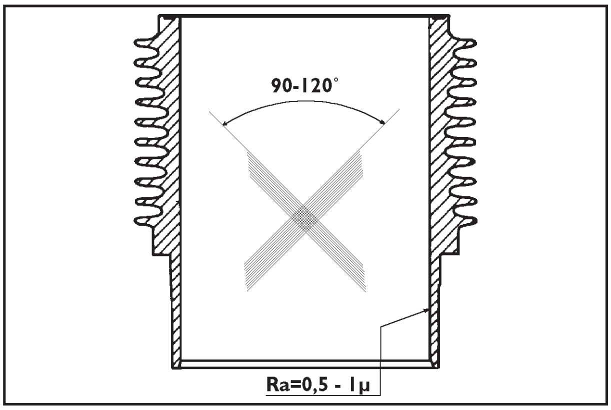
**Cylinders**
Air cooled with cylinder barrels in special cast iron with integral liners.

Use a dial gauge to check internal diameters (C-D) at three different heights (fig.15).
Maximum permitted taper (A-B) and ovality (C-D) is 0.06mm.

Diameter of cylinders (fig.15):

| | |
|---|---|
| **12LD477-2** | Ø 90 ÷ 90,015 |

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.

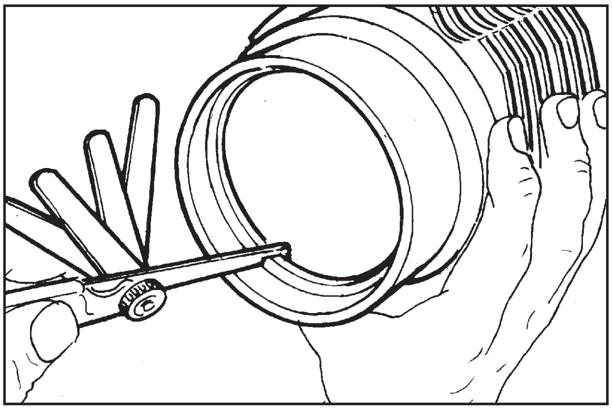


16

**!** 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°÷120°; lines should be uniform and clear in both directions (fig. 16).
Average roughness must range between 0.5 mm 1 μm.
The cylinder surface which comes into contact with piston rings should be machined with the plateau method.

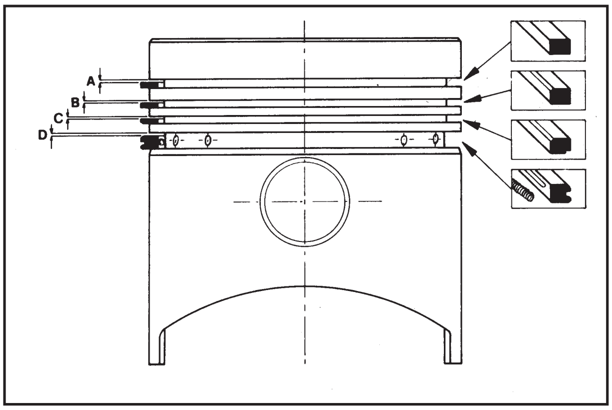
If the taper and ovality of the cylinder exceed the values indicated, then the cylinder and piston must be renewed.



17

**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.17). The values should be:

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

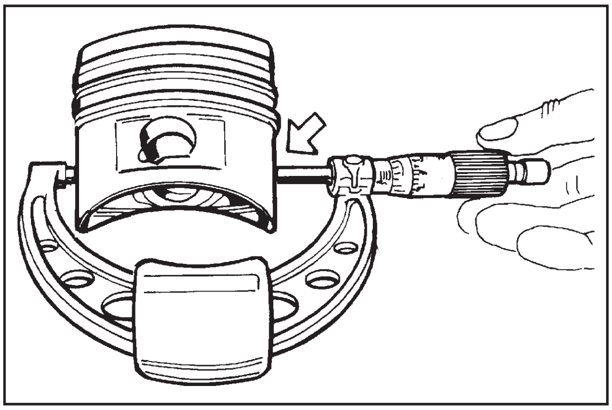



18

Check that the rings move freely in the grooves and check the ring/ groove clearance using a feeler gauge (fig.18).
If the clearance exceeds the values shown in the table, renew the piston and the piston rings.

| Piston ring | Max. wear mm |
|---|---|
| 1st Compression | A = 0,22 |
| 2nd- 3rd Compression | B -C= 0,18 |
| 4th Oil scrapper | D = 0,16 |

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



19

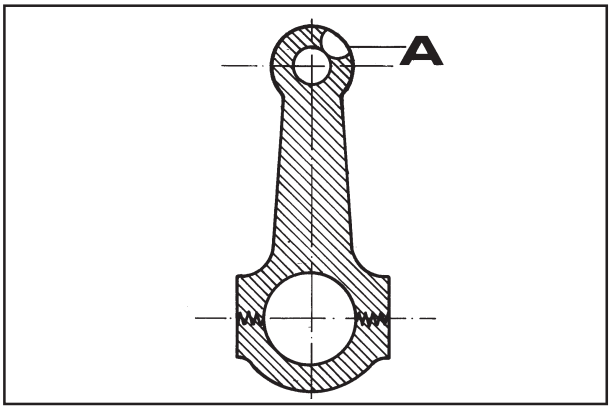
Piston diameter check: The diameter of the piston must be measured at approximately 18 mm from the base (fig.19).

| Engine | Diameter mm |
|---|---|
| **12LD477-2** | 89,919 ÷ 89,930 |

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 |
|---|---|
| 0,001 ÷ 0,010 | 0,060 |



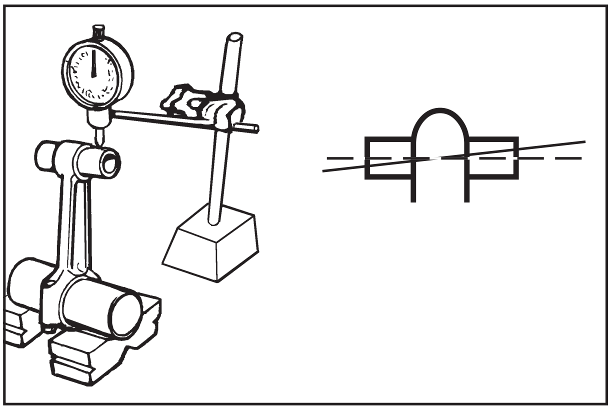
20

**Connecting rods**

On the small end there is a groove (A, fig. 20) for the lubrication of the gudgeon pin. The small end and the gudgeon pin are coupled without a bush in between.

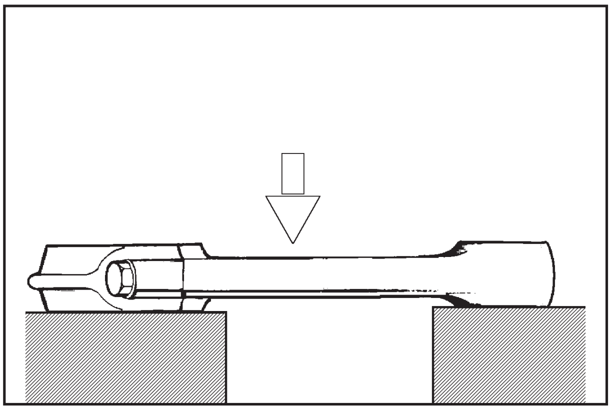
Assembly clearance between connecting rod small end and piston pin in millimetres:

| Engine | Ø Piston pin mm | Assy.clearance mm | Max wear mm |
|---|---|---|---|
| **12LD477-2** | 21,997 ÷ 22,002 | 0,023 ÷ 0,038 | 0,070 |


21

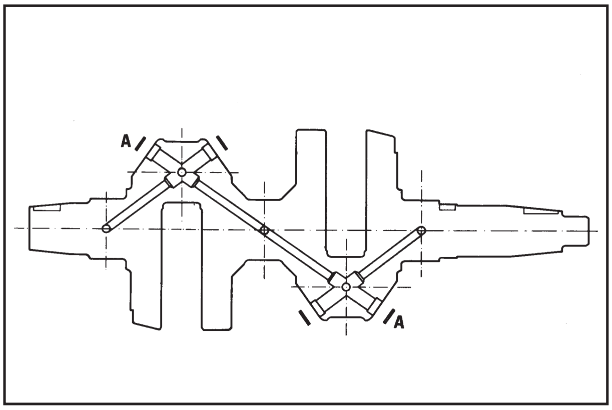
If it is necessary to replace a complete connecting rod with bushes and bolts, make sure its weight is:

| Engine | Weight |
|---|---|
| **12LD477-2** | gr. 570 ± 10 |


22

Check parallelism between connecting rod axies (fig. 21) as follows:

1. Insert the gudgeon pin into the small end bush and a calibrated pin into the big end (with bearing fitted).
2. Place the ends of the pin on 2 prisms set out on a checking bench.
3. Check with a comparator gauge that the discrepancy in the readings at the two ends of the gudgeon pin is not more than **0.05 mm**. Should the distortion exceed this value (max **0.10 mm**), reset connecting rod as follows:
   Place connecting rod stem on checking bench and apply a calibrated pressure to the convex side of the stem (fig. 22).



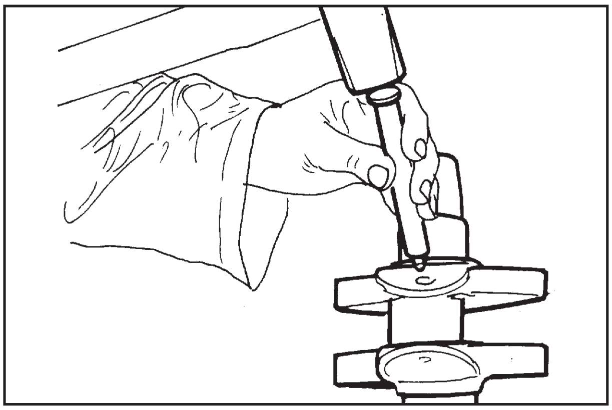
23

**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.23).

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 throughly cleaned, close the openings with new plugs (fig.24).


24

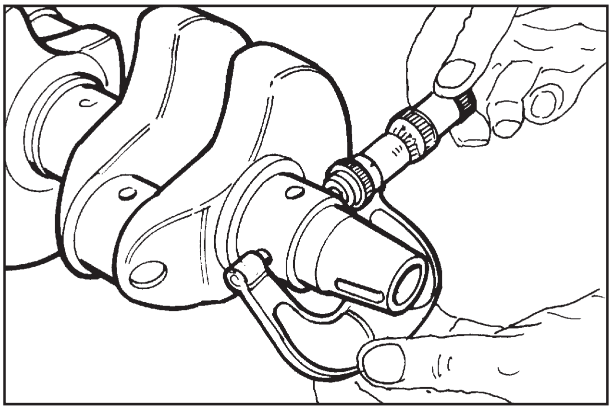
Checking crankshaft dimensions

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.25).

If wear exceeds 0.08 mm (fig.26) grind the crankshaft to the dimensions shown in the table:

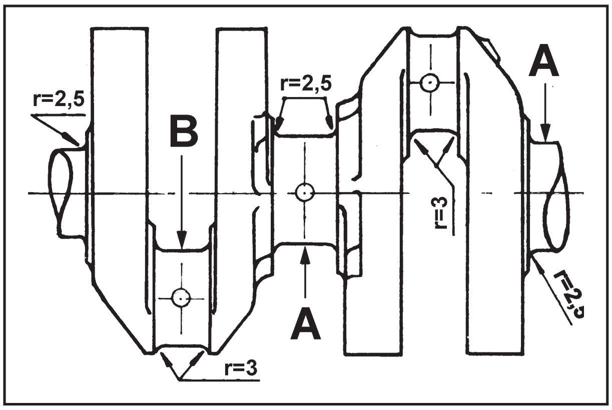
| Dimensions | STD mm | -0,25 mm | -0,50 mm |
|---|---|---|---|
| A | 45,005 ÷ 45,015 | 44,755 ÷ 44,765 | 44,505 ÷ 44,515 |
| B | 44,994 ÷ 45,010 | 44,744 ÷ 44,760 | 44,494 ÷ 44,510 |

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


25

Main bearing bushes with increased external diameters are also available. Table indicates the crankcase boring values.

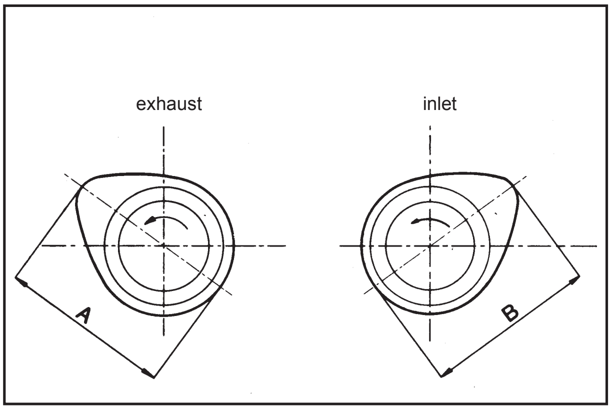
| Bearing | Ø of brush housingmm |
|---|---|
| Standard | 47,965 ÷ 47,985 |
| + 1 mm | 48,965 ÷ 48,985 |



26

!

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 26 so as not to create crack initiation sections on the crankshaft.

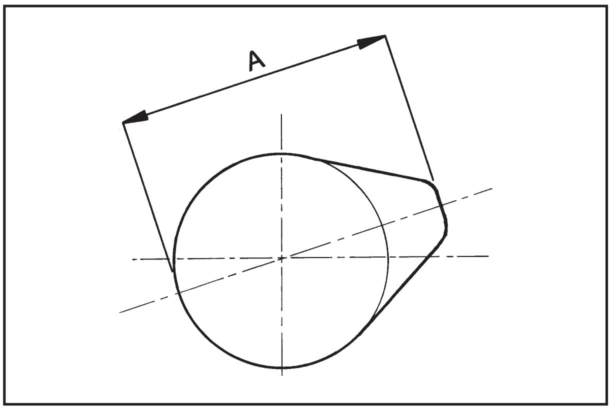


27

### Camshaft
Check cams and support pins for wear or scores.
Check amount of wear by measuring points **A** and **B** shown in fig. 27 and 28 and comparing to the figures of the tables hereunder:

Distribution cam dimensions (fig. 27).

| Engine | Measurement | Fitting mm | Max. wear mm |
|---|---|---|---|
| 12LD477-2 | A-B | 29,95 ÷ 30,00 | 29,70 |



28

Injection cam dimensions (fig. 28)

| Engine | Measurement | Fitting mm | Max. wear mm |
|---|---|---|---|
| 12LD477-2 | A | 28,39 ÷ 28,43 | 28,30 |

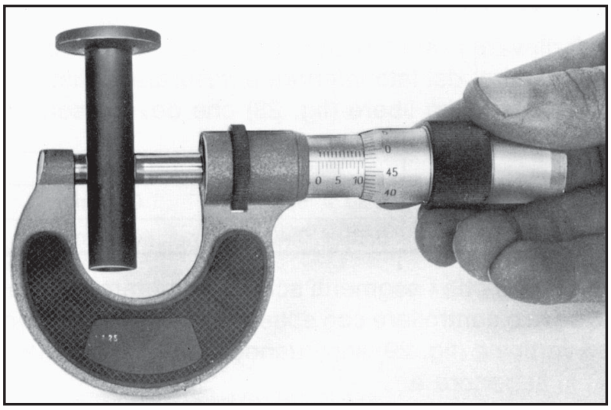
The coupling clearance between pins and respective housings should be:

| Fitting mm | Max. wear mm |
|---|---|
| 0,015 ÷ 0,048 | 0,100 |

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

### Oil seal rings
Make sure the oil seals have not hardened round the internal contact edge with the crankshaft and that they do not show signs of cracks or wear. If they do, replace them with new ones of the same size.

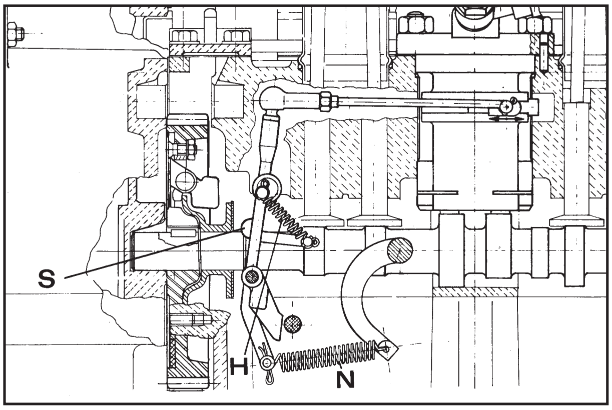
! Then re-fitting the oil seal, use protective cone cod. **00365R0260.** Fit said cone over the ends of the crankshaft to avoid damage to the ring itself.


29

### Tappet checking
Make sure the tappet surfaces are not worn, lined or present signs of seizure. If so, replace.

Tappet and seat check in mm (fig. 29).

| Measurement | Fitting mm | Max .assy.clearance mm |
|---|---|---|
| Tappet | 11,98 ÷ 11,99 | 0,10 |
| Tappet seat | 12,00 ÷ 12,018 | |



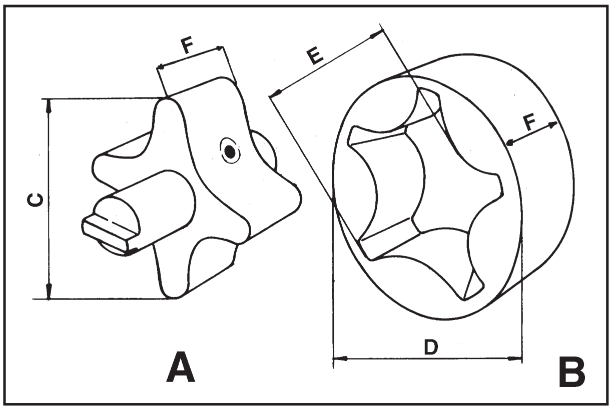
30

### Governor lever and spring

Check that the shoes (**S**, fig. 30) 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. 30):

| Spring | Lenght mm | Lenght under load mm | Load kg | Nr of windings |
|---|---|---|---|---|
| Supplement (H) | 16,9 ÷ 17,4 | 35 | 0,3 | 18,5 |
| Governor (N) | 53 | 69,2 | 2,5 | 13 |



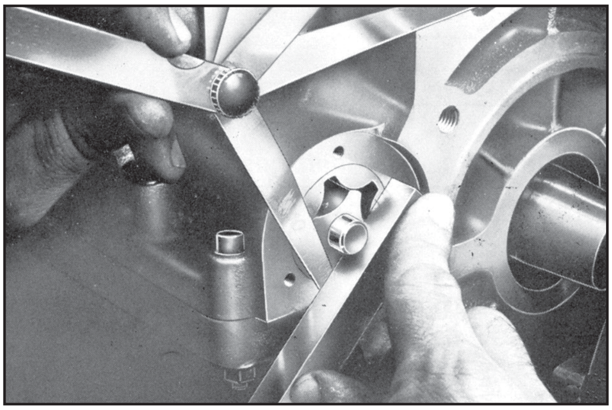
31

### Oil pump checking

The pump is of the lobed rotor type driven by the camshaft.
Dismantle pump and check rotors.
Check lobes and centers and if they are worn, replace rotors.
Check the amount of pump wear, measure rotor **A** and rotor **B** (see fig. 31), and compare to the following table:

| Measurement | Dimensions mm | Max. wear mm |
|---|---|---|
| C | 29,745 ÷ 29,770 | 29,700 |
| D | 40,551 ÷ 40,576 | 40,45 |
| E | 30,030 ÷ 30,60 | 30,10 |
| F | 17,920 ÷ 17,940 | 17,89 |

If wear exceed these figures, replace complete pump.

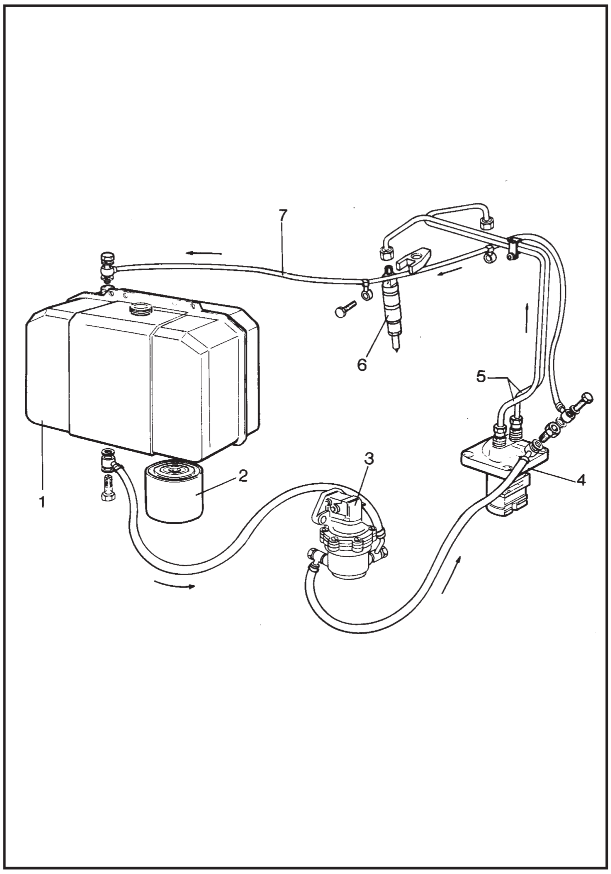

32

The coupling clearance between oil pump external rotor and basement housing is:

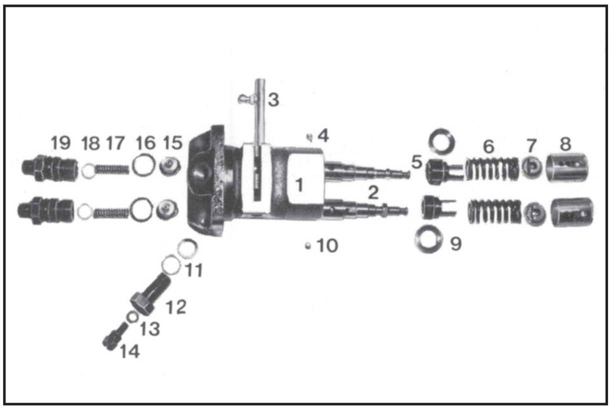
| Fitting mm | Max. wear mm |
|---|---|
| 0,094 ÷ 0,144 | 0,294 |

The axial clearance of the rotors (fig. 32) should be between:

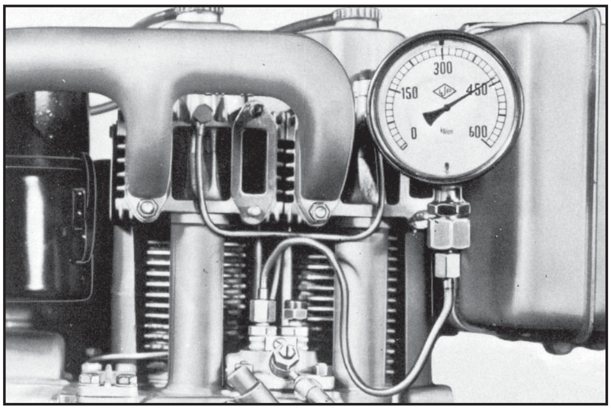
| Fitting mm | Max. wear mm |
|---|---|
| 0,010 ÷ 0,050 | 0,100 |




33




34




35

**Fuel circuit**
Feeding is carried out by a diaphram pump actuated by a camshaft eccentric coupled to a cap.
See assembly on page 36 and consult spare parts catalogue for replacement.

Details of fig. 33:
1.Tank - 2.Diesel filter - 3.Feeding pump - 4.Injection pump - 5.Injection pipes - 6.Injectors - 7.Diesel discharge pipe.

**Injection pump**
The injection pump is of the single casing type with two, constant stroke, separate pumping elements. Details of fig. 34.
1.Pump casing - 2.Pumping element - 3.Rack bar - 4.Eccentric dowel - 5.Adjusting bushing - 6.Spring - 7.Lower plate - 8.Tappet - 9.Upper plate - 10.Locking pin - 11.13.18.Gaskets - 12.Diesel intake connection - 14.Diesel exhaust screw - 15.Delivery valve -16.O-ring - 17.Valve spring - 19.Delivery connection.

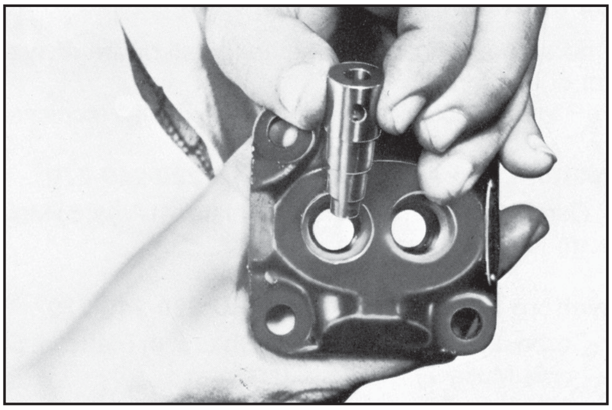
**Checking injection pump**
Before dismantling injection pump check pressure seal of the pumping unit, cylinder and valve as follows:

1. Connect a pressure gauge graded up to **600 kg/cm²** (fig. 35) to the diesel delivery pipe.
2. Set the rack bar in a half way position.
3. Rotate flywheel showly until the pumping element has completed a compression stroke.

**!** If the test is carried out on the bench, take care that the pumping element does not strike the delivery valve while pumping.

4. Take the pressure gauge reading. If the reading is less than **300 kg/cm²** , the complete pumping unit must be replaced.
   During the test, the reading on the gauge will show a progressive pressure increase to a maximum value and will then fall suddenly and stop at a lower pressure.
   Replace valve if the fall in pressure exceeds **50 kg/cm²** and continues to fall slowly.

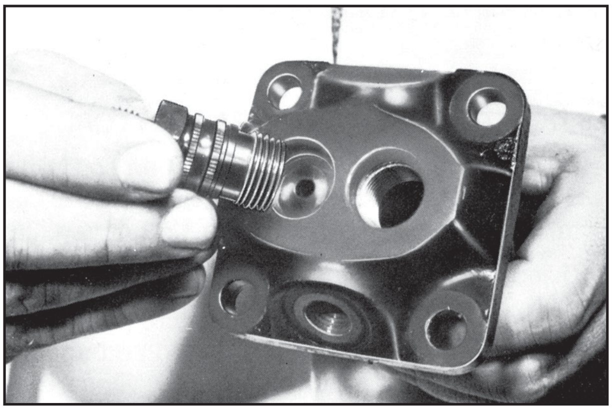
**Injection pump setting**
Register eccentric dowel to the maximum capacity of the pumping elements (**q**, fig. 39).



36

The quantity of diesel is in relation to 1000 deliveries with the rack bar at **8 mm** from the stop position.

| Engine | Ø Pumping element mm | cc valve | Valve Ø mm | Capacity cc | Pump RPM |
|---|---|---|---|---|---|
| 12LD477-2 | 6 | 15 | 4 | 24 ÷ 26 | 1500 |



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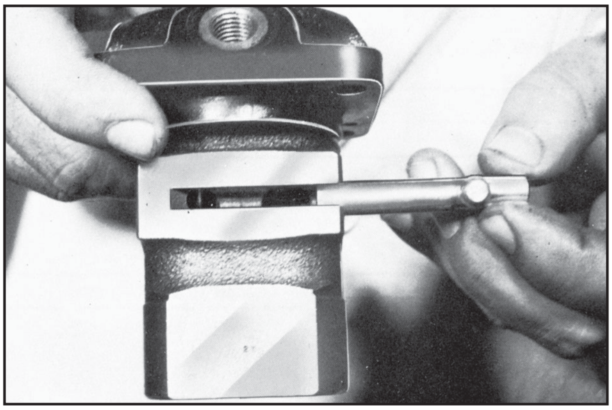

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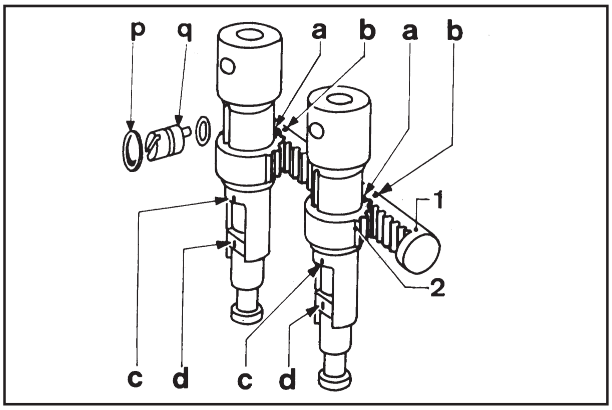



39

**Injection pump assembly**
After having dismantled the injection pump it should be reassembled in the following manner:

1. Insert cylinders into pump casing with diesel inlet opposite to feeding inlet connection (fig. 36). This position is necessary due to two eccentric dowels on the pump casing.
   Make sure the supporting faces of the cylinders and pumps are free of dirt.
2. Fix cylinders by inserting valves and temporarily tightening the delivery connections to stop the pumping elements from coming out. (fig. 37).
3. Insert rack bar and lock in a half way position (fig. 38). Make sure the bar moves freely on the guides. Resistance and drag will cause the engine to run unevenly.
4. Marks **b** cut on the bar must coincide with marks **a** of the toothed quadrants. Marks **c** on toothed quadrants must coincide with marks **d** on the flanges of the piston (fig. 39).
5. Insert piston into cylinder with groove turned towards the eccentric dowel on the pump casing.
6. Complete assembly of pump.

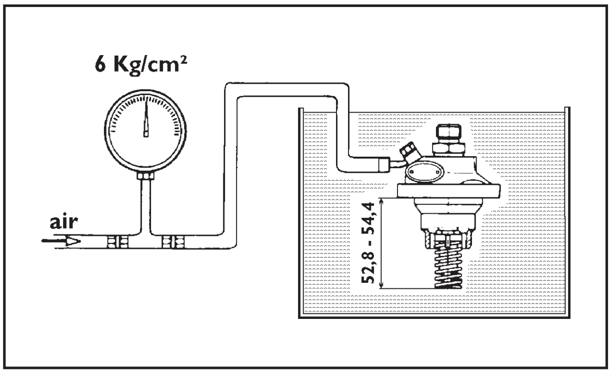
! **IMPORTANT:** The roller tappets (No 8 fig. 34) and the lower plates are not interchangeable as they determine the timing of the pumping elements.

When replacing parts make sure that:

a. the distance between the injection cam in bottom dead centre position (PMI) and the pump supporting surface is **82.6** to **83 mm** as stated on the plate.

b. the piston stroke from the bottom dead centre position (PMI) of the injection cam to delivery commencement is **2.0** to **2.1 mm**.

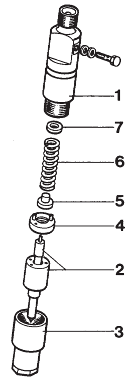
7. Check pressure seal again, as described in paragraph "Checking injection pump" page 26, to make sure the replaced parts are working properly.




40

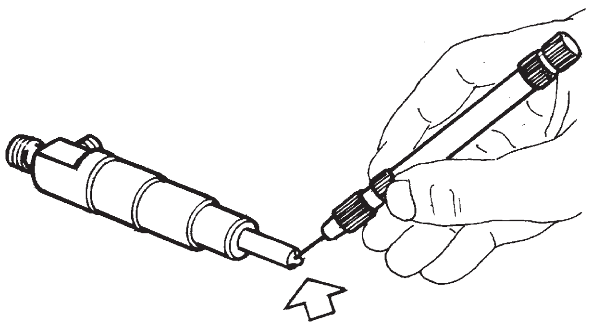
**Testing air tightness**
Feed pressurized air at 6 kg/cm² into the fuel sullpy union and completely immerse the pump in oil or diesel fuel for about 20 ÷ 30 seconds (fig.40); check that no air bubbles are released.

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




41

**Injectors (fig. 41)**
1.Body - 2.Nozzle - 3.Ring nut - 4.Plate - 5.Rod - 6.Spring - 7.Adjustment shim.



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**Injector checking and setting**

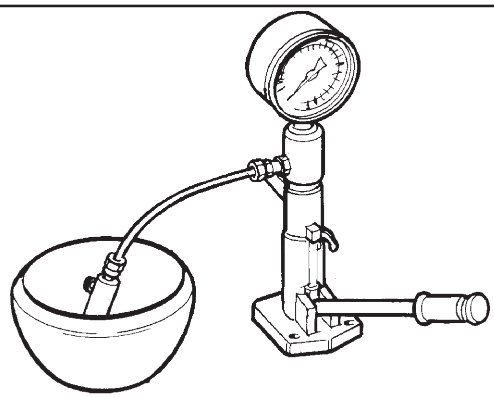
1. Clean out nozzle holes with a thin piece of wire (fig. 42) of the same size as that of the nozzle holes indicated on the table:

| Engine | Ø holes mm |
|---|---|
| 12LD477-2 | 0,25 |

2. Set up injector on a test bench (tool cod. **00365R0430**).

3. Unscrew injector lock coupling (No 3 fig. 41) or nozzle ring nut and insert adjustment shim (7, fig. 41) until the pressure indicated in the table hereunder is reached on the pressure gauge while pumping.

| Engine | Setting kg/cm² |
|---|---|
| 12LD477-2 | 225 ÷ 235 |



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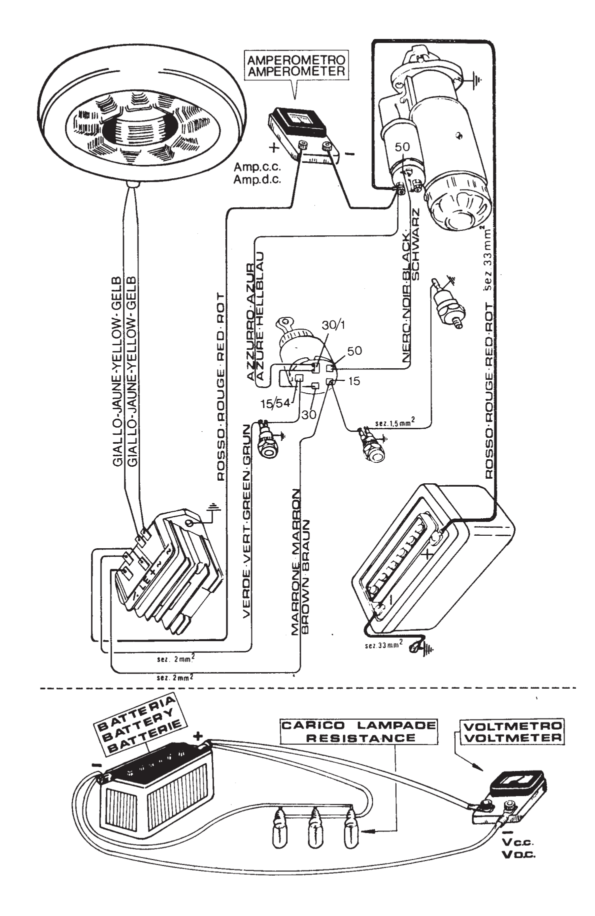
4. Tighten the nozzle ring nut (No 3 fig. 41) at:

**5 kgm (49 Nm)**

5. When setting is complete, while still at the test bench, run pumping elements a few times and check the amount of diesel that passes through the upper leak-off of the injector (fig. 43).




44

**Electric starting with motor and alternator for battery re-charging**

***Characteristics***
**Starter motor:** anticlockwise rotation.
**12V - 1.5 HP (1.1 kW)**

***Flywheel alternator:***
For re-charging **12V/280W** batteries giving 17A charge at **3000 RPM**.

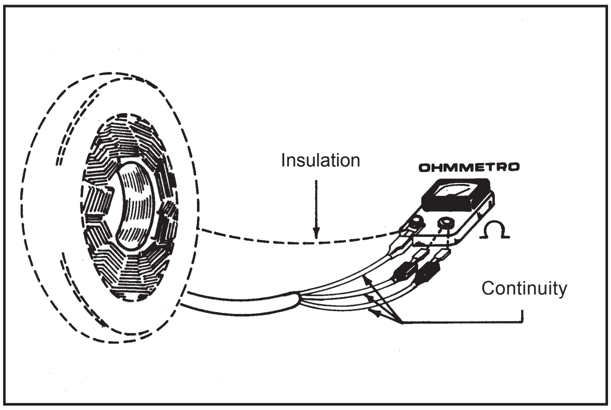
***Regulator:***
Electronic with controlled diodes and preset for battery re-charging pilot light connection.
**12V-24A**

***Optional external alternator with belt control:***
**F**or re-charging **12V/200W** batteries giving **15.5A** charge at **6000 RPM** with **12V/26A** voltage adjustor.

***Battery:***
12V; 80 to 90 Ah
To check starting system circuit see figures 47.

**Circuit checking**

1. Make sure the connections between regulator and alternator are correct and in good condition.
2. Detach from the terminal on the starter motor, the red wire coming from the alternator, and insert a direct current ammeter with a **20 Amp** range between said free terminal and the detached wire.
3. Connect a direct current voltmeter with a minimum range of **15 Volts** (fig. 44), to the battery terminals.
4. Insert starter key and start up a few times at no load or insert a lamp load of **80** to **100 W** at the ends of the battery to keep the battery voltage under **13 Volts.**
5. Run the engine up to the maximum of **3000 RPM**. The charging current reading on the ammeter should be about:
   **17A** with **12V/280W** alternator
   For intermediate values see fig. 46.
6. Disconnect lamp load and keep engine running at A/m revs. for some time.
   The battery voltage will increase progressively until it reaches the setting limit of the regulator which is about **14.5 V.**
   Simultaneously, the charging current will drop to about **2A**. This will occur very quickly if the battery is charged and slowly if it is discharged.
7. If the charging current cuts out or is lower than the values given above, replace governor. If the performance does not improve after this replacement, the trouble must be locked for in the alternator.

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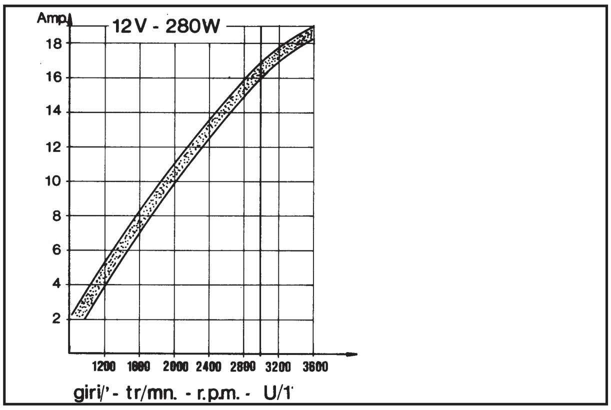
### Alternator checking (stator)

Disconnect alternator cables from the regulator and check continuity between the windings with an Ohmmeter.
Also check that there is good insulation between cables and earth (fig. 45). In the event of an open circuit, replace the stator. If the stator is in good working order but the values of the alternator charge are lower than those stated, the rotor is demagnetised and the entire alternator must be replaced.

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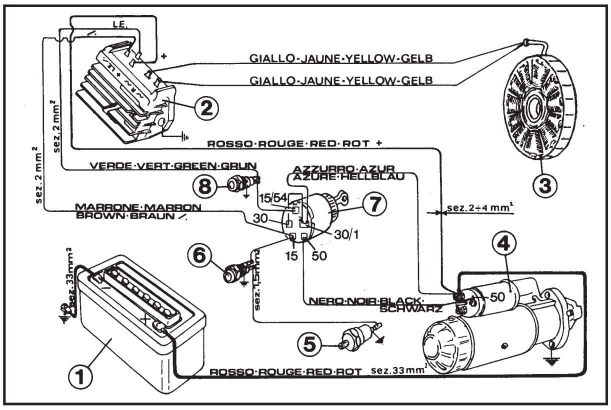
### Wire checking

! Examine condition of wires bearing the following in mind:

1. With one of the yellow wires open circuited, the alternator will not supply current.
2. With both yellow wires open circuited, the alternator will not supply current at all.
3. With one or both wires earthed, the rotor will demagnitize very quickly and the coils of the stator will burn out.
4. With red wire open circuited, the alternator will not supply current.
5. With red wire earthed the alternator will not supply current, the connection wires and warning circuit will burn out and the battery will discharge completely.
6. Avoid sparks between cables, as the alternator could burn out.
7. With an imperfect earth between the negative battery terminal and regulator casing, the charging current is irregular and the regulator could be damaged.
8. If the battery connections are inverted, the alternator and regulator will burn immediately.



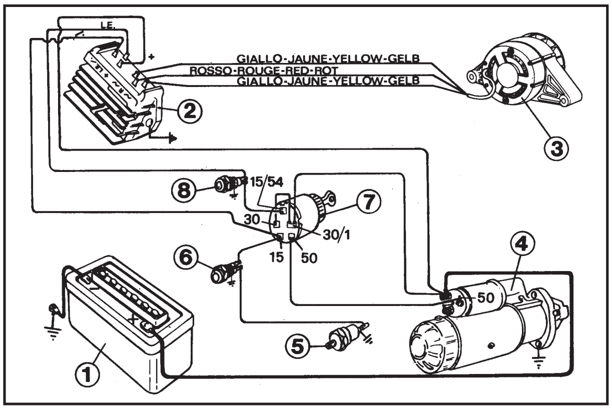

47

### Method of use

By turning the starter key to the first position, the battery charging circuit is started off, and thus:

1. With engine stationary the key must be kept on the off position. If it is left on the first position, the oil warning light could burn out, the battery could discharge and the regulator could be damaged.
2. With engine running turn key to first position. If it is left in the off position, the oil warning light and battery charging functions are excluded.

! The voltage regulator will be damaged beyond repair, if it is run with the battery cables disconnected or with unactivated batteries.



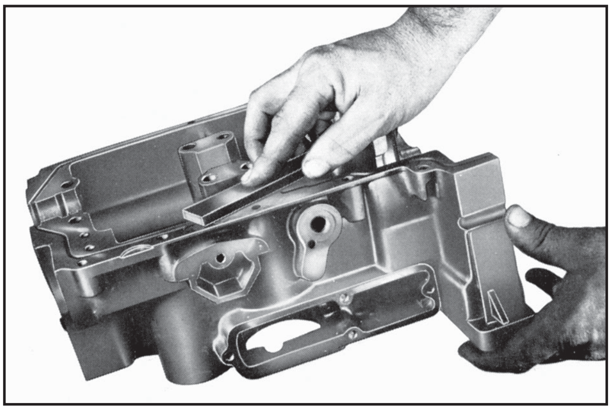
48

**Diagram of electric starting wiring system** with flywheel alternator (fig. 47).

1.Battery - 2.Regulator - 3.Alternator - 4.Starter motor - 5.Pressure gauge - 6.Oil pressure warning light - 7.Starter key - 8.Battery charging light.

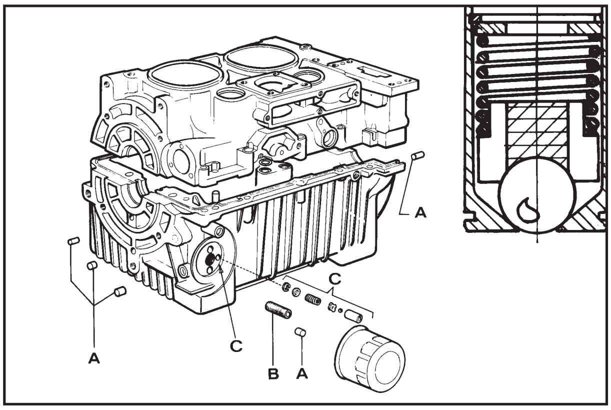
**Diagram of electric starting wiring system** with external alternator (fig. 48).

1.Battery - 2.Regulator - 3.Alternator - 4.Starter motor - 5.Pressure gauge - 6.Oil pressure warning light - 7.Starter key - 8.Battery charging light.



49

! 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.

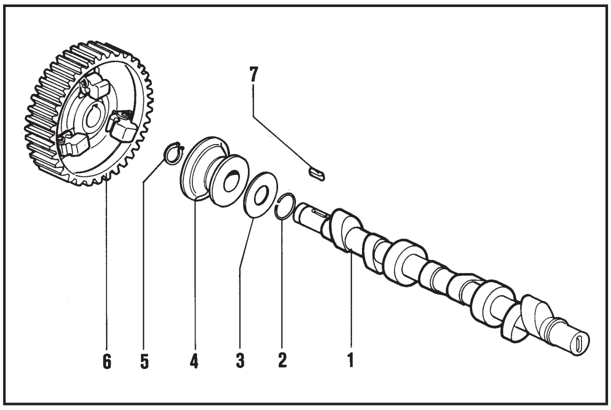



50

**Preparation of crankcase**
Clean support faces and remove seal residue and dirt with a copper plate or a fine emery stone to avoid damage to the contact surfaces (fig. 49).

Lower crankcase (fig. 50)

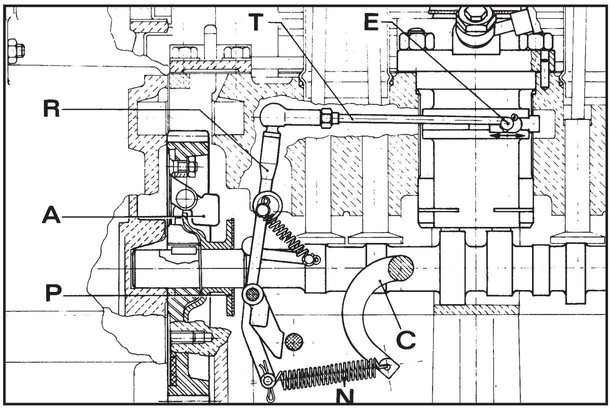
1. Insert plugs (A) into relative seats.
2. Screw in oil filter cartridge connection (B). The connection should protude 11 to 13 mm. from the crankcase.
3. Insert complete oil pressure register valve into its seat (C). Make sure the seat of the valve ball in the casing is free of dirt or scores which could jeopardize the pressure seal.
4. Insert cylinder studs and centering pins.




51

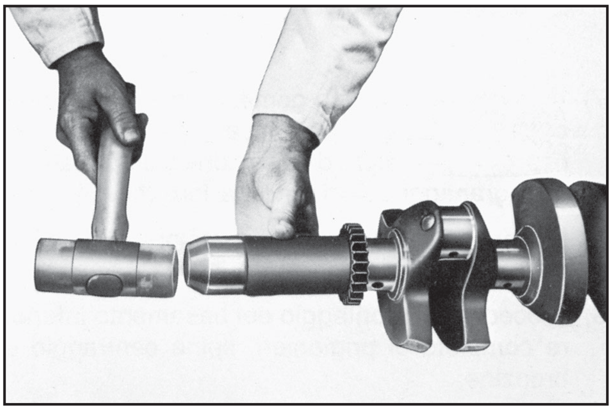
**Camshaft preparation**
To prepare the camshaft unit (fig. 51) proceed as follows:

1. Insert shim adjustment washer (No 3) and governor plate (No 4) on camshaft.
2. Fit snap ring (No 5) and tab (No 7) into respective housings.
3. Heat gear (No 6) complete with masses and insert onto camshaft making sure it rests against the locking snap ring.
4. Insert governor plate locking ring (No 2).




52

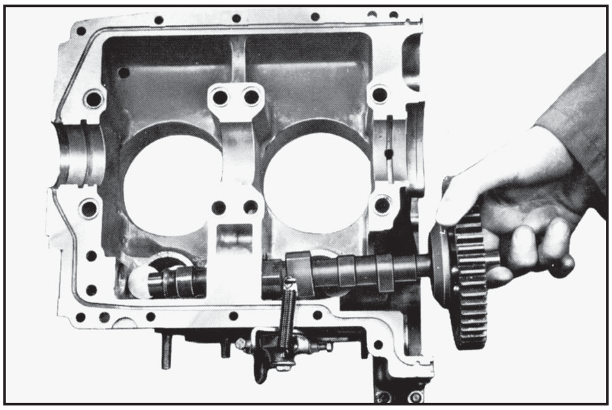
The speed governor is of the centrifugal mass type splined directly onto the ends of the camshaft gear (fig. 52).
Masses (**A**), pushed outwards by the centrifugal force, shift mobile plate (**P**) axially. Said plate actions lever (**R**) connected to injection pump rack bar (**E**) by means of tie rod (**T**).
A spring (**N**) placed under tension by the accelerator (**C**), contrasts the action of the centrifugal force of the governor.
The balance between the two forces keeps the revolutions practically constant when load is changed.
For pre-load adjustment of the speed governor see paragraph on page 40 "Injection pump tie rod connection".



53

**Crankshaft preparation**

The insertion of the main distribution gear onto the crankshaft must be carried out while hot. Heat by means of dry heating or an oil bath at 70/80 °C (fig. 53).



54

**Upper crankcase preparation**

1. Insert accelerator internal lever onto crankcase taking care not to damage the oil seal O-Ring.

2. Fit interchangeable tappets into housings on crankcase.

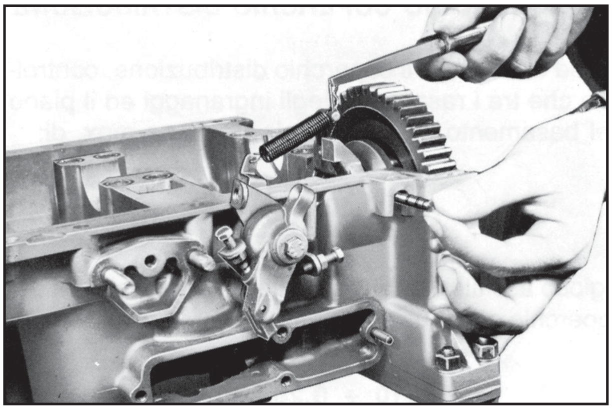
3. Camshaft assembly (fig. 54): in order to assemble the shaft correctly, the cams must be introduced, without applying force, along the grooves inside the crankcase.

4. Mount governor lever and insert lever fulcrum pin taking care not to damage the oil seal rings (fig. 55). The lever should be able to effect the complete stroke without strain.
   Insert spring between governor lever and accelerator.

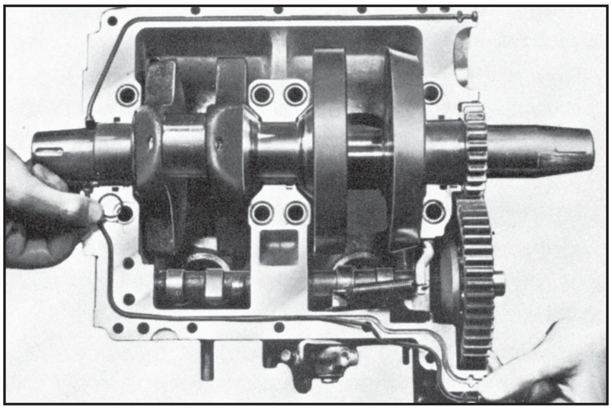
5. Insert main bearings into respective housings and spread with oil slightly.
   The three main bearings are identical and interchangeable.

6. Fit rubber gaskets and O-Rings between crankcases taking care to insert same properly into respective grooves so as to prevent oil leaks between the contact surfaces (fig. 56).

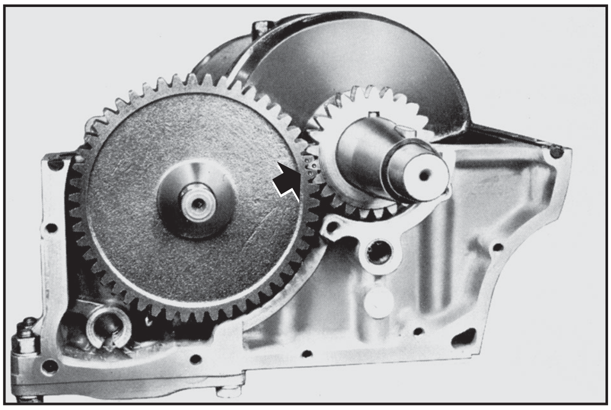
**!** It is advisable to spread a bit of rubber adhesive round the edges of the rubber gasket for better seal.



55



56



57

7. Place crankshaft on previously housed shells making sure the timing references found on the gears coincide (fig. 57).

8. Insert oil seal rings on the drive side of the crankshaft (fig. 58).

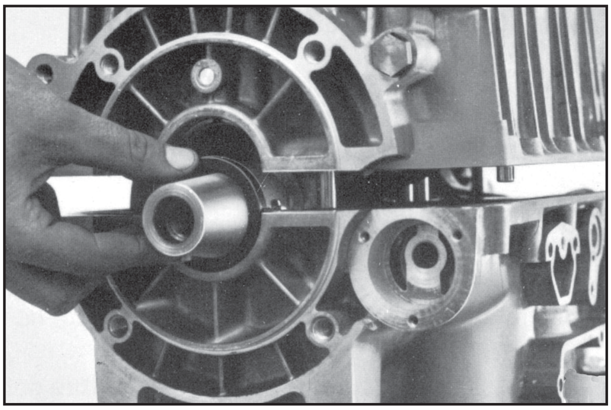
**!** A warped oil retainer may allow the introduction of air into the engine thus causing crankcase ventilation problems. Use genuine oil retainers with the LOMBARDINI.

9. Mount lower crankcase complete with studs, centering pins and bearings.

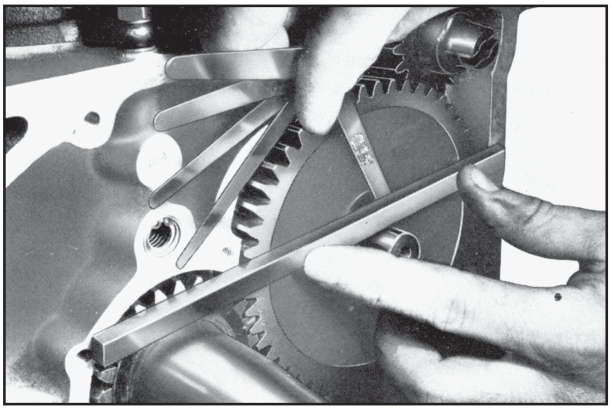
10. Take care to insert the centering pins between crankcases into their respective housings without using force.

11. Tighten crankcase screws, to starting from the centre and alternating towards the outside at:

| |
|---|
| **kgm 1,3 (Nm 12,8)** |



58



59

**Timing cover assembly**
Before mounting the timing cover check that between the gear shims and the crankcase surface (fig. 59) there is a maxi clearance of:

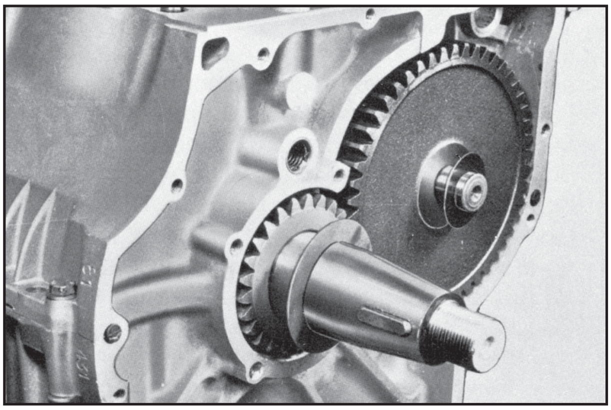
| |
|---|
| **0,10 mm** |

The axial clearance is measured at the timing cover gaskets and must be between:

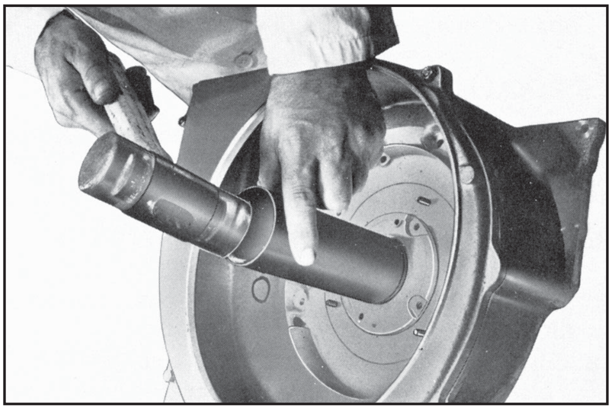
| |
|---|
| **0,10 ÷ 0,20 mm** |

If the axial clearance of the crankshaft becomes excessive after a long working period, add adjustment shims to the engine shaft and camshaft gear until the clearance returns to normal values (fig. 60).

0.2 and 0.3 mm shims are available.



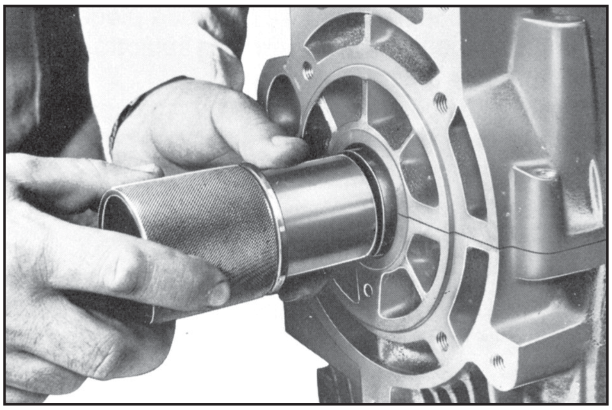
60



61

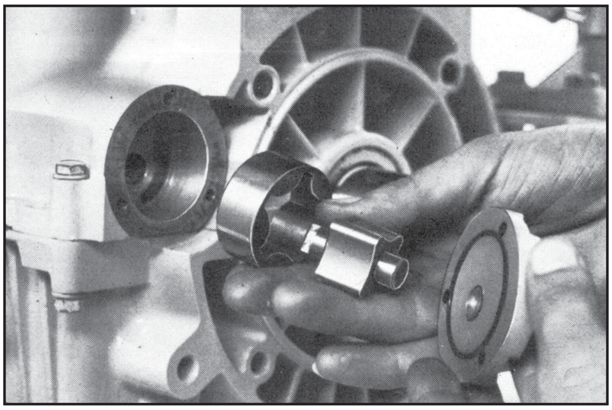
**Fitting of oil seal rings**
To introduce oil seal ring, flywheel side, use an ordinary cylindrical plug of appropriate size as shown in fig. 61.

**!** A warped oil retainer may allow the introduction of air into the engine thus causing crankcase ventilation problems. Use genuine oil retainers with the LOMBARDINI. The oil seal rings are to be fitted with the arrow pointing in the same direction of the crankshaft rotation.



62

Final insertion of the oil seal ring, drive side, requires the use of special tool code **00365R0040** (fig. 62).

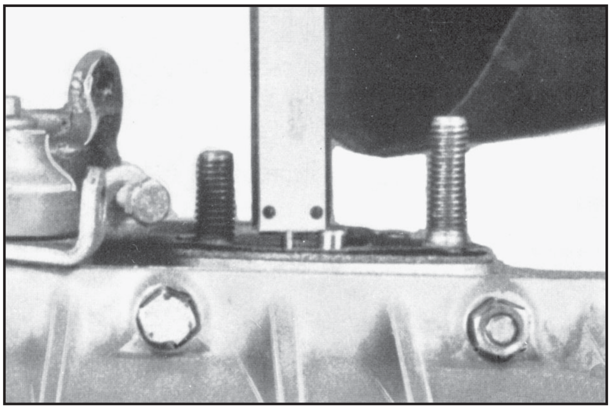


63

**Oil pump assembly**
For rotor checks see page 25.
After tightening crankcase, mount oil pump external rotor with the notch facing inwards (fig. 63).

Make sure the O-Ring on the oil pump cover is in perfect condition.
Tighten screws gradually to a pressure of:

| kgm 1 (Nm 9,8) |
|---|



64

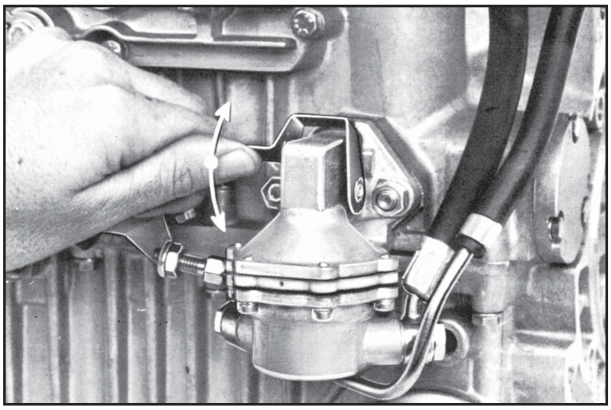
### Feeding pump assembly

1. Insert fuel feeding pump cap into its housing and make sure it moves freely. The length of the cap is :

**34 ÷ 34,2 mm**

2. Fit gasket (0.5 mm and 0.2 mm thick).
3. With fuel pump control cams in a rest position the cap should protude from the gasket surface (fig. 64) for:

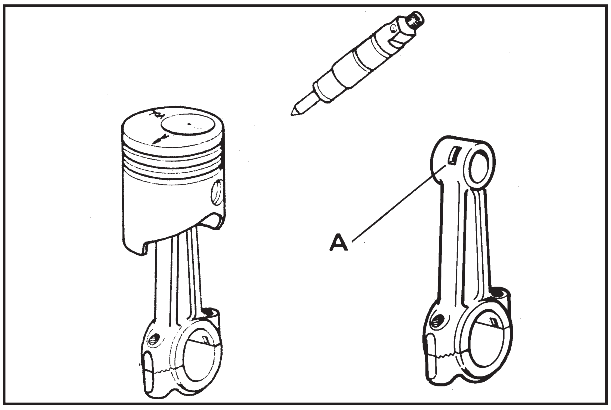
**1,7 ÷ 2,1 mm**



65

4. With fuel feeding pump control cams at bottom dead centre position mount feeding pump and action manually. There should still be a small suction stroke (fig. 65).

**!** If said checks are not carried out, the fuel feeding pump diaphram could be damaged due to the excessive stroke to which it will be subjected.

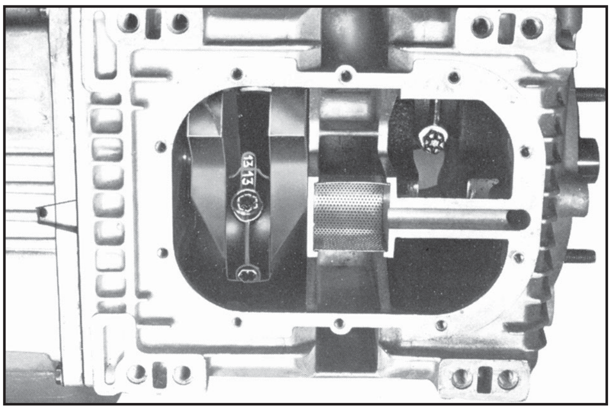



66

### Piston-connection rod couplings

The piston is coupled to the connecting rod by means of slight hand pressure on the gudgeon pin without heating the piston.

The clearance between the small end and the gudgeon pin is: **0.023** to **0.038 mm** and between gudgeon pin and piston: **0.002** to **0.008 mm.**
The lubrication groove (A, fig. 66) on the small end must be turned towards the engine rotation direction (injection pump side).



67

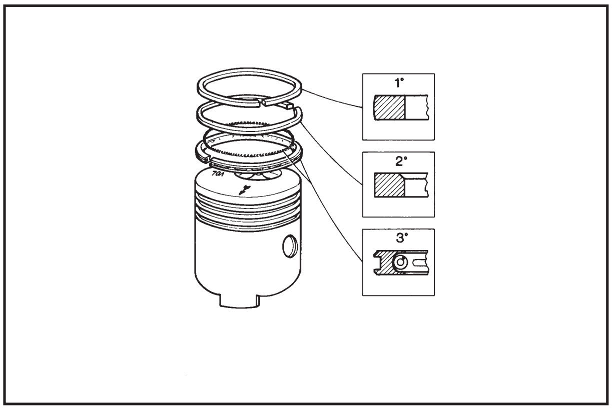
### Connecting rod-crankshaft coupling

After insertion of the bearings into the big end, attach connecting rods to crank pins, bearing in mind that an arrow, on the pistons, indicates the rotation direction of the engine (fig. 66).

The combustion chamber, which is eccentric with respect to the axis, should be turned to the nozzle side.

Mount connecting rod caps with reference numbers corresponding to those on the rod (fig. 67). The coupling clearance between big end bearing and pins is: **0.020 to 0.072 mm**. Tighten up connecting rod bolts to:

**kgm 3,8 ÷ 4 (37,3 ÷ 39,3 Nm)**

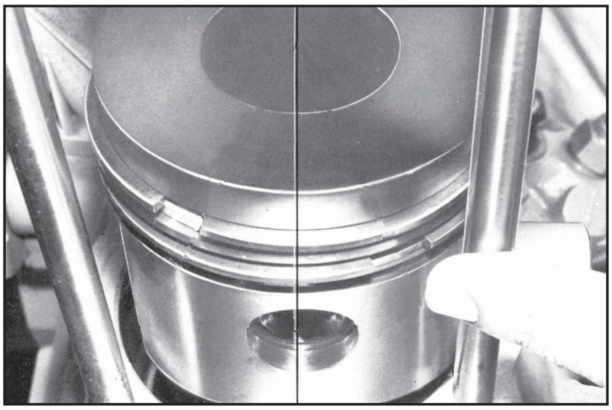



68

### Piston ring fitting

Fit rings onto pistons in the following order (fig. 68):

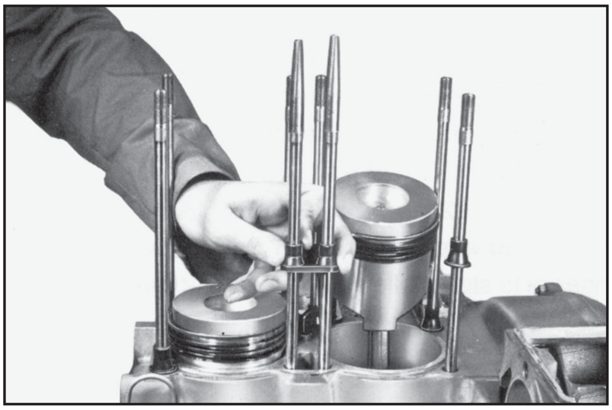
1. Chromed compression seal ring.
2. Torsional compression seal ring (with internal notch turned upwards).
3. Expander oil scraper ring.



69

### Piston ring working position

Before mounting cylinders, rotate rings 120° opposite to each (fig. 69) other with the ends of the 1st compression ring in line with the gudgeon pin axis.



70

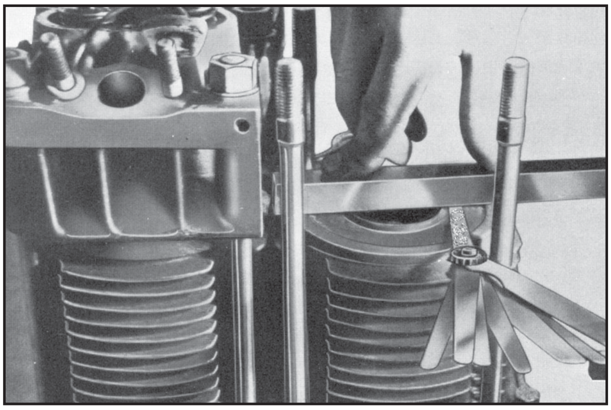
### Protective cap fitting

To prevent the entrance of dust and water which could block the cylinder studs to the upper crankcase, insert protective caps on the studs themselves (fig. 70).
To facilitate cap mounting, oil stud roots.
Insert on crankcase, under the rocker shaft pipes, plates for the lubrication of the camshaft.

71

### Cylinder mounting

The lower end of the cylinder is chamfered for piston ring insertion (fig. 71).
The operation can be carried out easily by using a standard piston ring compression tool (tool **00365R0770**).



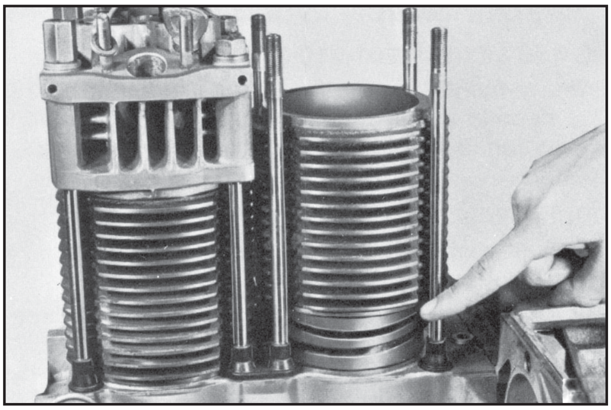
72

**Cylinder height adjustement**

Between the top face of the cylinder and the piston at top dead center, there must be a clearance of:

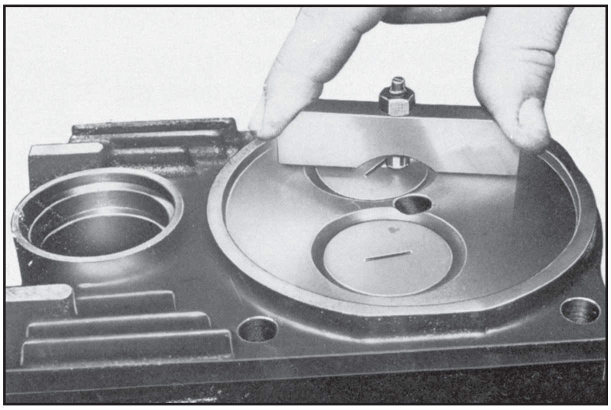
**0,25 ÷ 0,35 mm**

! In order to carry out this operation correctly, make the check with the cylinder pressed well down on its crankcase (fig. 72).



73

The clearance is adjusted by means of shims inserted between the lower face of the cylinder and crankcase (fig. 73).
Shim dimensions: **0.1** to **0.2 mm**



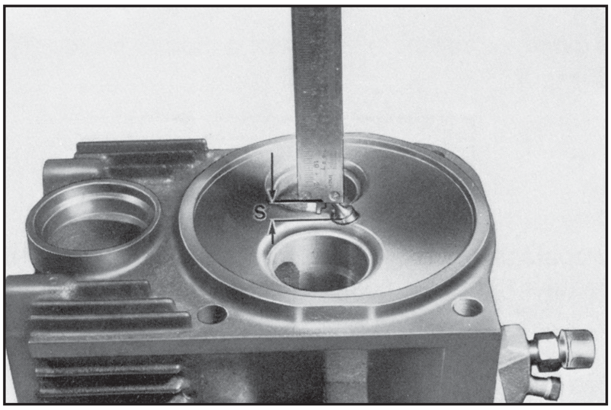
74

**Checking valve head face depth**

When replacing valves check that the clearance from the top of the head to the face (fig. 74) is of:

| Fitting mm | Max. wear mm |
|---|---|
| 0,9 ÷ 1,1 | 1,8 |

For different values see on pages 18-19.



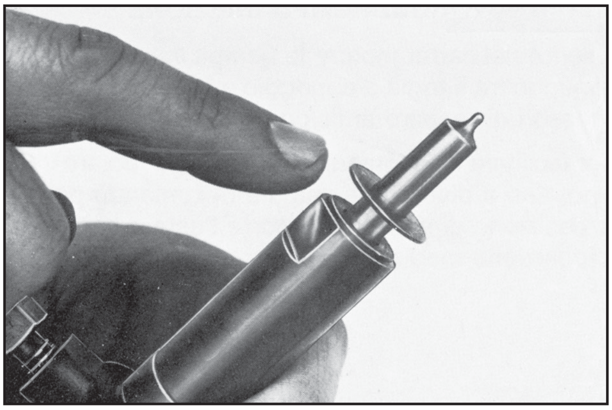

75

**Checking injector protrusion**

Before mounting the heads on the cylinders, insert injectors in their housings and after having secured them temporarily, check protusion of nozzles from head surface (fig. 75).

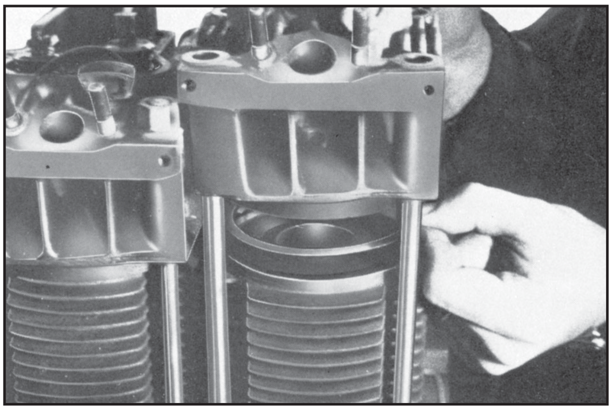
Protusion **S** should be:

**2,25 ÷ 2,75 mm**



76

Adjustment is effected by inserting copper washers between the injector and injector supporting faces on the heads (fig. 76). Washer thickness **1 mm**.

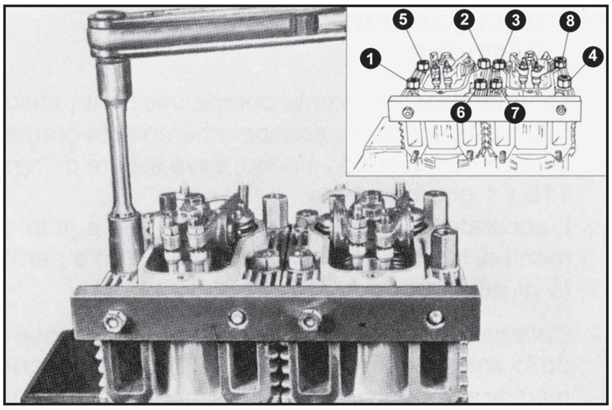


77

**Fitting cylinder heads**

Insert oil seal O-rings on rocker arm housing and fit the cylinder head in place. Insert 0.5 mm copper gaskets between the surfaces. (fig. 77).

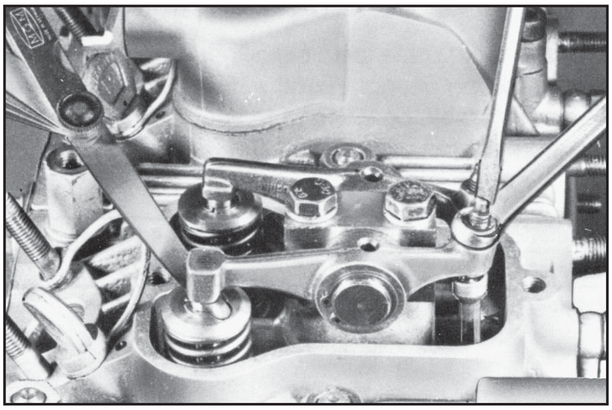
> **!** Make sure the oil seal rings are housed properly in the heads to avoid oil leaks.




78

Align heads using a manifold or a metallic bar as shown in fig. 78.
Tighten down cylinder head nuts uniformly (fig. 78) increasing 1 kgm at every turn until a pressure is reached of:

**5 kgm (49 Nm)**



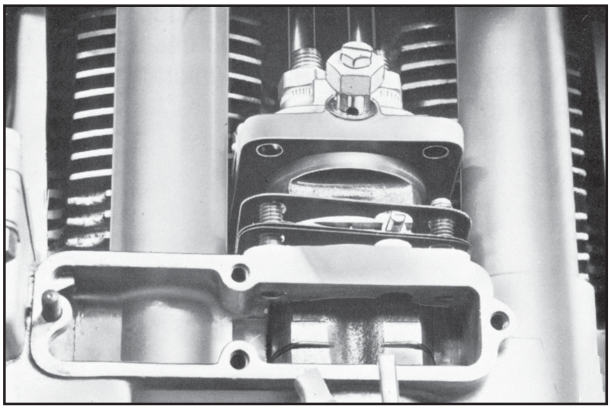
79

**Valve clearance**

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

**0,15 mm intake/exhaust**

The operation must be carried out with the pistons at their top dead center compression position.

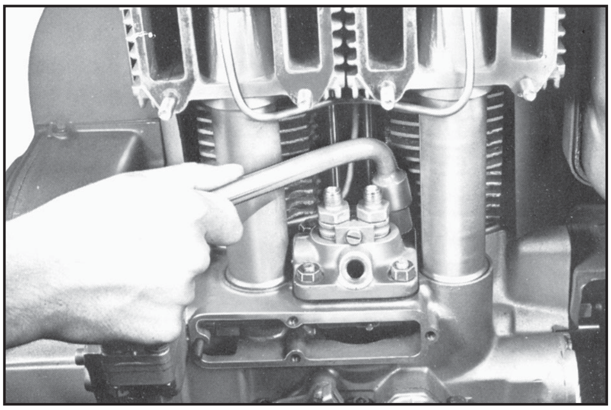


80

### Injection pump fitting

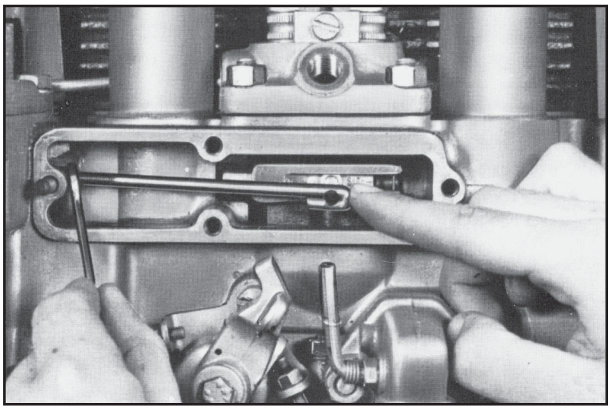
Fit injection pump into timing case inserting adjusting shim between supporting flange and crankcase (fig. 80).

To facilitate the insertion of the pump, rotate the flywheel so as to bring the actuating cam to rest position and set the rack bar in a half way position.



81

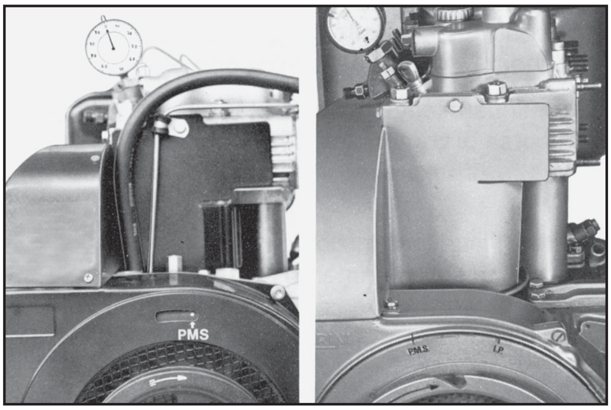
To facilitate tightening of pump nuts on the cylinder side, use the special key (tool od. **00365R0210**) illustrated in fig. 81.



82

### Injection pump tie rod connection

- The injection pump tie rod length, measured from the connecting centre of the rack bar to the centre of the ball joint must be **mm 118 ±1** complete turn.
  Careful operation will avoid uneven running, starting difficulties and power losses.
- Connect tie rod to governor lever, engaging the ball joint to 90° (fig. 82), and to the injection pump rack bar and then insert split pin.

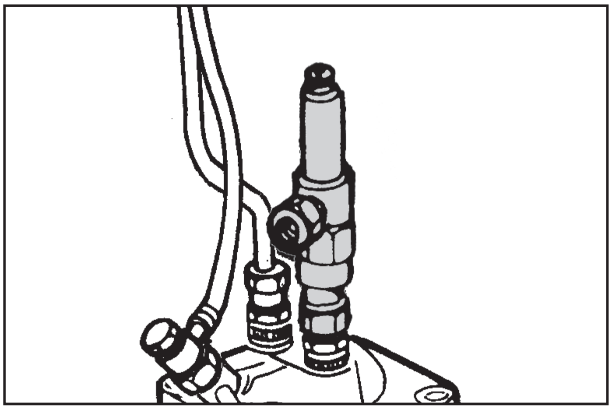



83

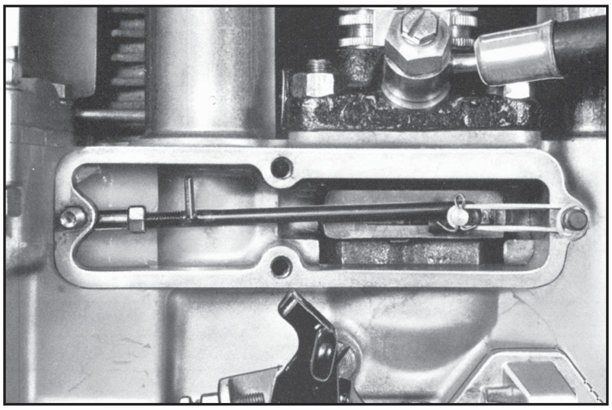
### Checking T.D.C.

With pistons in respective top dead center compression position check that the arrows on the air conveyor coincide with top dead center position indications on the flywheel (fig. 83).

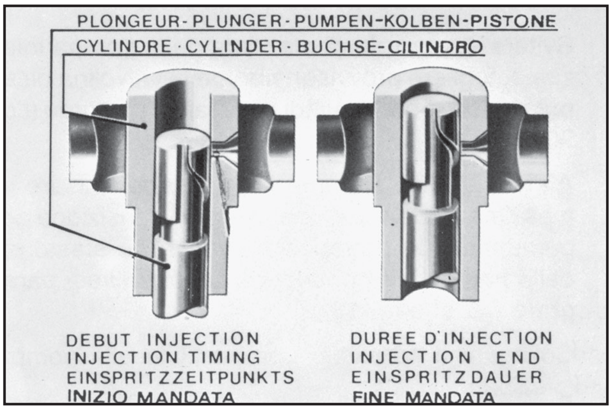
If the flywheel has to be replaced, transfer and punch the above mentioned indications on the new one.



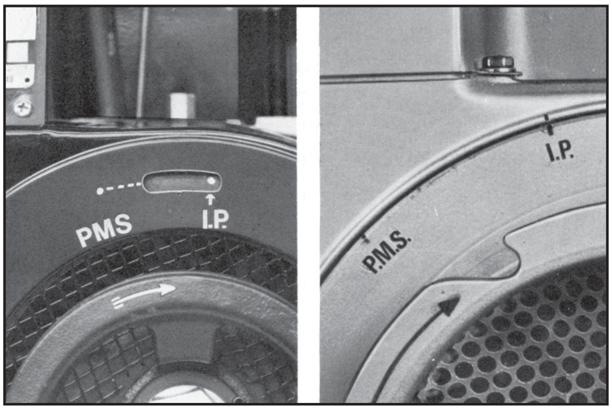
84



85




86




87

**Checking start of injection**

1. Connect fuel tank to injection pump.

2. Bring accelerator lever to max. position and piston, flywheel side, at compression beginning (cylinder No 1)

! All operations are to be carried out with the rack bar in working position to annul the delay caused by the notch on the pumping element of the injection pump.

3. Fit the special tool, p.n. **00365R0940**, to the delivery valve holder (flywheel side) as shown in figure 84.

4. Insert a band (fig. 85) to ease the tension of the spring.

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.

At this moment injection pimp delivery starts (fig. 86) and the top dead centre reference on the air conveyor must coincide with the **IP** mark punched cm the flywheel (fig. 87).

If the **IP** mark falls short of the notch on the air conveyor, injection is too fast. The injection pimp must be disassembled and shims must be added between the pump flange and the crank-case.

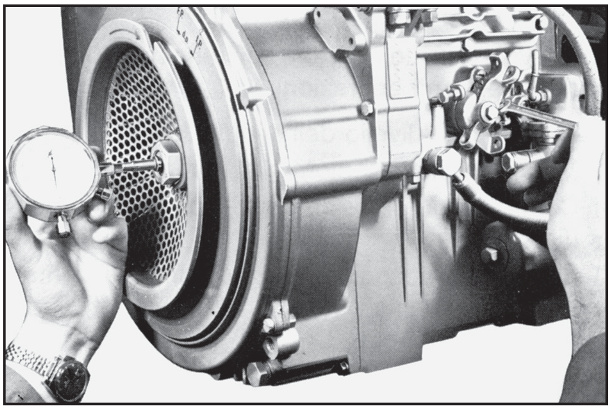
If the **IP** mark falls after the T.D.C. reference notch, injection is too slaw and the above operation is to be inverted.

Bear in mind that every **0.1 mm** shim under the pimp corresponds to a **2.5 mm** rotation of the flywheel.

Repeat operation on second pumping element.

Should the flywheel need to be replaced, the top dead center compression position of the pistons is to be determined as per page 40 and the start of injection according to the following table:

| I.P. | Ø flywheel |
|---|---|
| 26° = 53,5 mm | 236 mm |



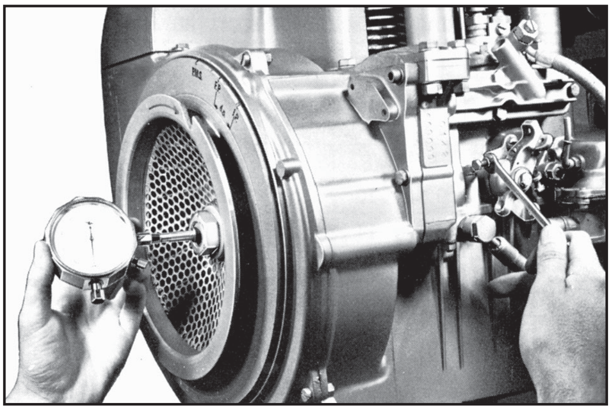
88

## Speed adjustment

1. With engine hot set minimum speed at **1000 RPM** (fig. 88) and maximum to idle (fig. 89) at:
   **3150 RPM** for engines at 3000 rpm
   **3750 RPM** for engines at 3600 rpm
2. Then stop the engine.
3. Remove injectors, clean nozzle holes carefully, check setting and re-fit.
4. Adjust clearance between valves and rockers, while engine is hot, to:

**0,15 mm**
**intake/exhaust**

5. Re-fit rocker covers and sealing gaskets.



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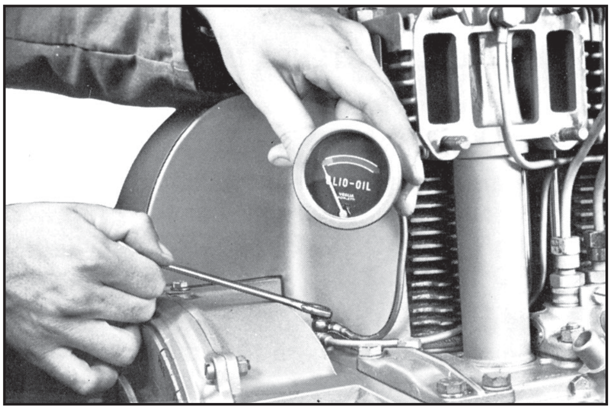

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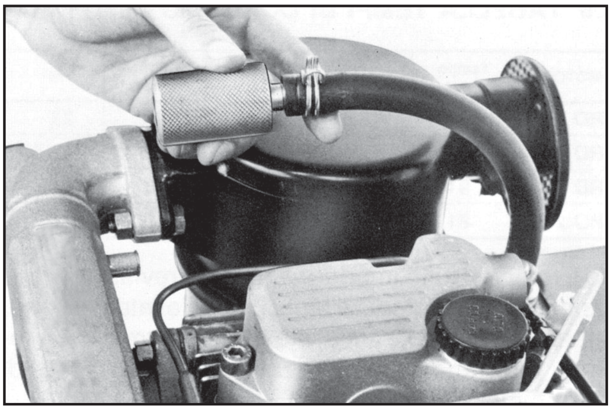
## Checking oil pressure

1. Remove union from rocker oil hole and fit a pressure gauge graded from **0** to **8 kg/cm²** (fig. 90).
2. Start engine and run up to **3000 RPM.** Wait for the oil temperature to reach 70 to 80°C.
3. With engine idling at **3000 RPM** the pressure gauge needle should be slightly over half way corresponding to a pressure of **3** to **4 kg/cm².**
   Said pressure will stabilize at **2** to **3 kg/cm²** when engine runs at full load and the oil temperature exceeds 70 to 80°C.
4. Reduce revs to minimum. The pressure should not fall to under **1 kg/cm²** with the oil temperature exceeding **80°C.**



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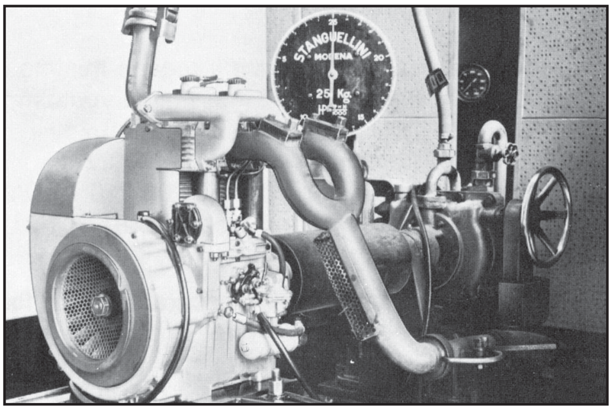
## Checking for oil leaks

1. Remove exhaust gas collection pipe from suction manifold and close with a plug (fig. 91).
2. Start engine and run for a few minutes. The pressure which forms inside the crankcase bring out any oil leaks.
3. Re-fit gas collection pipe to suction manifold.

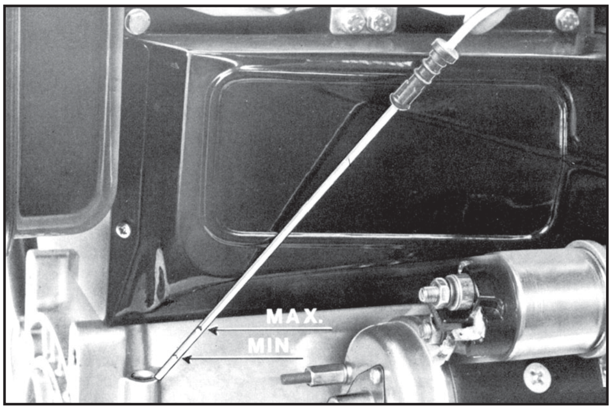


92

### Testing engine on brake

After having placed the engine on the brake (fig. 92), proceed with the following operations:

1. Check oil level (fig. 93).
2. Start engine and run at minimum speed.
3. Check oil pressure on pressure gauge (fig. 90).
4. Run engine in before testing it at full power.



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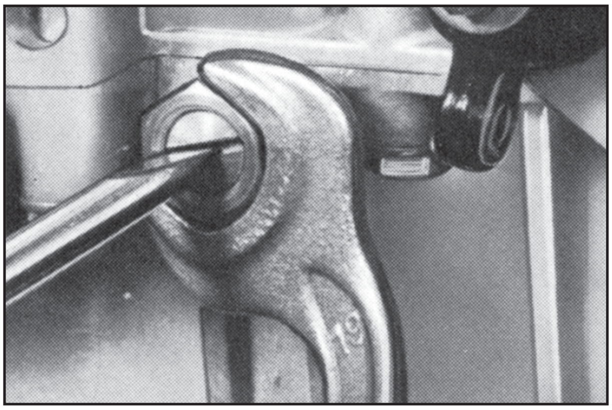
Running-in table

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

Engine power curves are reported at page 12.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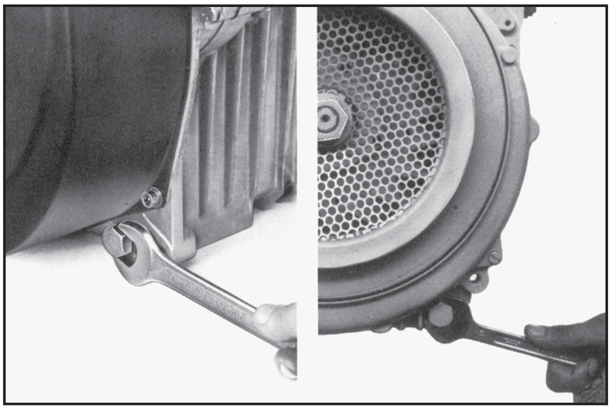
**!** In order to check that the setting is correct, without tools, accelerate the engine a few times with no load and check the exhaust fumes.
Delivery of diesel fuel is correctly calibrated when the exhaust gas is slightly coloured by smoke; change the adjustment if necessary by turning the adjustment screw (fig. 94).



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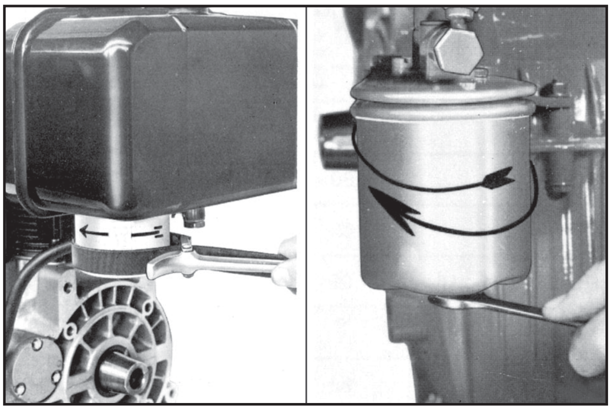

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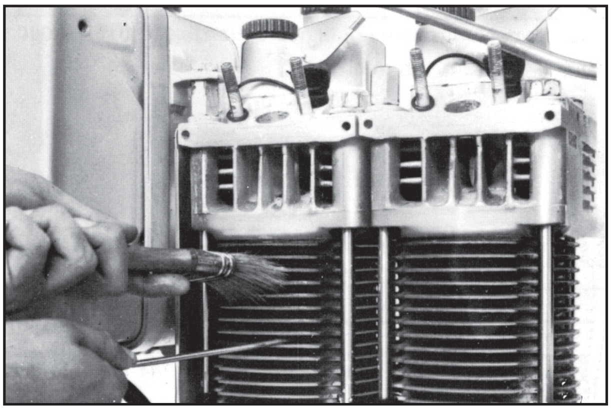

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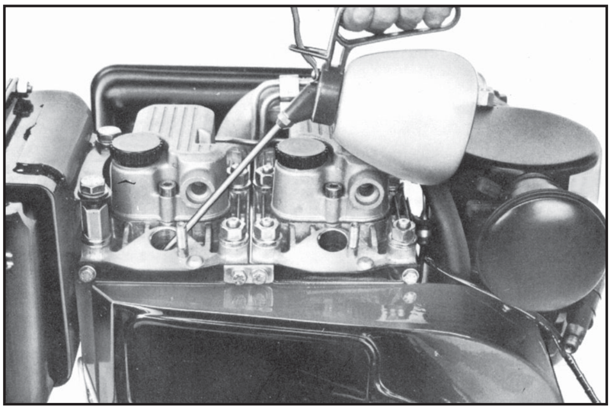

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**Storage**

Prepare engines as follows for storage over 30 days

**Temporary protection (1/6 months)**

- 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. 95)
- Remove fuel tube and empty the tank
- Remove fuel filter, replace cartridge if dirty and refit (fig. 96).
- Carefully clean cylinder fins, heads and fan (fig. 97).
- Seal all openings with tape.
- Remove injectors, pour a spoonful of oil type SAE 30 into the cylinders (fig. 98) and rotate manualy 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.

**Permanent protection (over 6 months)**

- The following is recommended apart from the above instructions:
- 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).

**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.

| Couplings | Spiel (mm) | Grezen (mm) |
|---|---|---|
| Camshaft journal and housing in timing cover | 0,017÷ 0,047 | 0,1 |
| Camshaft journal and housing in crankcase | 0,015÷ 0,048 | 0,1 |
| End gap of compression rings | 0,30 ÷ 0,50 | 0,8 |
| End gap of oil scraper rings | 0,25 ÷ 0,40 | 0,7 |
| Connecting rod and wrist pin | 0,023 ÷ 0,038 | 0,07 |
| Rockers and shaft | 0,030 ÷ 0,056 | 0,15 |
| Main journals and bearings bushes | 0,010 ÷ 0,060 | 0,15 |
| Oil pump drive gear spindle and housing in crankcase | 0,030 ÷ 0,065 | 0,115 |
| External oil pump rotor and housing in engine crankcase | 0,094 ÷ 0,144 | 0,294 |
| Pistons and wrist pin | 0,002 ÷ 0,008 | 0,05 |
| Big end bearing and crankpin | 0,020 ÷ 0,072 | 0,17 |
| Valve guide and stem: inlet | 0,030 ÷ 0,050 | 0,1 |
| Valve guide and stem: exhaust | 0,045 ÷ 0,065 | 0,1 |

| Adjustments | MIN (mm) | MAX (mm) |
|---|---|---|
| Valves | 0,15 | 0,15 |
| Valve depth from cylinder head | 0,9 ÷ 1,1 | 1,8 |
| Dead space between cylinder face and piston | 0,25 | 0,35 |
| Protrusion of injector | 2,25 | 2,75 |

| | MIN (mm) | MAX (mm) |
|---|---|---|
| | 0,10 | 0,20 |
| | 0,10 | 0,20 |
| | 0,01 | 0,05 |

# XVI QUICK REFERENCE CHARTS

| Tightening torques | kgm | (Nm) |
|---|---|---|
| Crankcase | 1,3 | (12,8) |
| Connecting rod | 3,8 ÷ 4,0 | (37,3 ÷ 39,3) |
| Bolt on power take off end | 25 | (245,5) |
| Timing cover | 1 | (9,8) |
| Oil sump | 1,3 | (12,8) |
| Injectors | 2,3 | (22,6) |
| Injection pump | 2,3 | (22,6) |
| Oil pump cover | 0,6 | (5,9) |
| Cylinder head | 5 | (49) |
| Flywheel | 28 | (274,9) |

**Standard screw tightening torques**

| **Denomination** | 8.8 **= 8.8** $R \geq 800$ N/mm² | | R10 **= R10 = 10.9** $R \geq 1000$ N/mm² | | R12 **= R12 = 12.9** $R \geq 1200$ N/mm² | |
|---|---|---|---|---|---|---|
| Diameter x pitch **mm** | **Nm** | **kgm** | **Nm** | **kgm** | **Nm** | **kgm** |
| 4 x 0,70 | 3,6 | 0,37 | 5,1 | 0,52 | 6 | 0,62 |
| 5 x 0,80 | 7 | 0,72 | 9,9 | 1,01 | 11,9 | 1,22 |
| 6 x 1,00 | 12 | 1,23 | 17 | 1,73 | 20,4 | 2,08 |
| 7 x 1,00 | 19,8 | 2,02 | 27,8 | 2,84 | 33 | 3,40 |
| 8 x 1,25 | 29,6 | 3,02 | 41,6 | 4,25 | 50 | 5,10 |
| 9 x 1,25 | 38 | 3,88 | 53,4 | 5,45 | 64.2 | 6,55 |
| 10 x 1,50 | 52,5 | 5,36 | 73,8 | 7,54 | 88.7 | 9,05 |
| 13 x 1,75 | 89 | 9,09 | 125 | 12,80 | 150 | 15,30 |
| 14 x 2,00 | 135 | 13,80 | 190 | 19,40 | 228 | 23,30 |
| 16 x 2,00 | 205 | 21,00 | 289 | 29,50 | 347 | 35,40 |
| 18 x 2,50 | 257 | 26,30 | 362 | 37,00 | 435 | 44,40 |
| 20 x 2,50 | 358 | 36,60 | 504 | 51,50 | 605 | 61,80 |
| 22 x 2,50 | 435 | 44,40 | 611 | 62,40 | 734 | 74,90 |
| 24 x 3,00 | 557 | 56,90 | 784 | 80,00 | 940 | 96,00 |

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# WORKSHOP MANUAL

## 9 LD Engine Series

**cod. ED0053022860**


UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

LOMBARDINI SERVICE
A KOHLER COMPANY

# 9 LD Engine Series

**PREFACE**

- Every attempt has been made to present within this service manual, accurate and up to date technical information.
  However, development on the **LOMBARDINI** series is continuous.
  Therefore, the information within this manual is subject to change without notice and without obligation.

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

Information presented within this manual assumes the following:

1 - The person or people performing service work on **LOMBARDINI** series engines is properly trained and equipped to safely and professionally perform the subject operation;

2 - The person or people performing service work on **LOMBARDINI** series engines possesses adequate hand and **LOMBARDINI** special tools to safely and professionally perform the subject service operation;

3 - The person or people performing service work on **LOMBARDINI** series engines has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- This manual was written by the manufacturer to provide technical and operating information to authorised **LOMBARDINI** after-sales service centres to carry out assembly, disassembly, overhauling, replacement and tuning operations.

- As well as employing good operating techniques and observing the right timing for operations, operators must read the information very carefully and comply with it scrupulously.

- Time spent reading this information will help to prevent health and safety risks and financial damage.
  Written information is accompanied by illustrations in order to facilitate your understanding of every step of the operating phases.

LOMBARDINI SERVICE
A KOHLER COMPANY

**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 |
|---|---|---|---|---|---|---|---|
| CUSE/ATLO | ED0053022860 | 50494 | **4°** | **3** | 06-88 | 01.09.2014 | |

This manual contains pertinent information regarding the repair of LOMBARDINI air-cooled, direct injection Diesel engines type **9 LD 625-2 - 625-2 EPA - 626-2 - 626-2 NR**.

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## WARRANTY CERTIFICATE

- The products manufactured by Lombardini Srl are warranted to be free from conformity defects for a period of 24 months from the date of delivery to the first end user.
- For engines fitted to stationary equipment, working at constant load and at constant and/or slightly variable speed within the setting limits, the warranty covers a period up to a limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- If no hour-meter is fitted , 12 working hours per calendar day will be considered.
- For what concerns the parts subject to wear and deterioration (injection/feeding system, electrical system, cooling system, sealing parts, non-metallic pipes, belts) warranty covers a maximum limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- For correct maintenance and replacement of these parts, it is necessary to follow the instructions reported in the documentation supplied with each engine.
- To ensure the engine warranty is valid, the engine installation, considering the product technical features, must be carried out by qualified personnel only.
- The list of the Lombardini authorized dealers is reported in the “Service” booklet, supplied with each engine.
- Special applications involving considerable modifications to the cooling/lubricating system (for ex.: dry oil sump), filtering system, turbo-charged models, will require special written warranty agreements.
- Within the above stated periods Lombardini Srl directly or through its authorized network will repair and/or replace free of charge any own part or component that, upon examination by Lombardini or by an authorized Lombardini agent, is found to be defective in conformity, workmanship or materials.
- Any other responsibility/obligation for different expenses, damages and direct/indirect losses deriving from the engine use or from both the total or partial impossibility of use, is excluded.
- The repair or replacement of any component will not extend or renew the warranty period.

Lombardini warranty obligations here above described will be cancelled if:

- Lombardini engines are not correctly installed and as a consequence the correct functional parameters are not respected and altered.
- Lombardini engines are not used according to the instructions reported in the “Use and Maintenance” booklet supplied with each engine.
- Any seal affixed to the engine by Lombardini has been tampered with or removed.
- Spare parts used are not original Lombardini.
- Feeding and injection systems are damaged by unauthorized or poor quality fuel types.
- Electrical system failure is due to components, connected to this system, which are not supplied or installed by Lombardini.
- Engines have been disassembled, repaired or altered by any part other than an authorized Lombardini agent.

- Following expiration of the above stated warranty periods and working hours, Lombardini will have no further responsibility for warranty and will consider its here above mentioned obligations for warranty complete.

- Any warranty request related to a non-conformity of the product must be addressed to the Lombardini Srl service agents.

## GENERAL SERVICE MANUAL NOTES

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

2 - All data presented are in metric format. That is, 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) and pressure is presented in barometric units (bar).

## 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».

| Regulations for lifting the engine | |
|---|---|
| ⚠ | - Before removing the engine from the vehicle on which it is installed, disconnect the power supply, detach the fuel and coolant supply, and all connections including the mechanical ones.<br>- Attach the engine to a suitable lifting device (lifting beam).<br>- 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.<br>- Before lifting, make sure the weight is correctly balanced by checking its barycentre.<br>- Close all engine openings accurately (exhaust, intake, etc.), then wash the outside and dry with a jet of compressed air. |

This manual contains safety precautions which are explained below.

**WARNING**
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.

**CAUTION**
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**

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

**WARNING**

- 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 **Lombardini** technical office for mixture proportions. Petrol may not be used because of the risk of it forming flammable vapours.
- During operation the surface of the engine reaches temperatures that may be dangerous. Avoid in particular all contact with the exhaust system.
- The liquid cooling circuit is under pressure. Do not carry out any checks before the engine has cooled down, and even then open the radiator cap or the expansion tank cautiously. Wear protective clothing and glasses. If there is an electric fan, do not approach the engine while it is still hot as the fan may come on even when the engine is not running. Clean the cooling system with the engine turned off.
- While cleaning the oil bath air filter, check that the oil is disposed of in such a way as not to harm the environment. Any filtering sponges in the oil bath air filter should not be soaked with oil. The cyclone pre-filter cup must not be filled with oil.
- Since the oil must be emptied out while the engine is still hot (approx. 80°C), particular care should be taken in order to avoid burns. In any case make sure that oil does not come into contact with your skin because of the health hazards involved.
- Fuel vapours are highly toxic, so fill up only in the open air or in well ventilated environments.

- 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.

**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 fílling 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 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 **Lombardini**. These lifting points are however not suitable for the entire machine, so in this case use the eyebolts fitted by the manufacturer.

| **California Proposition 65 WARNING** |
|---|
| *Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.* |

## 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
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- 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.

## 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.

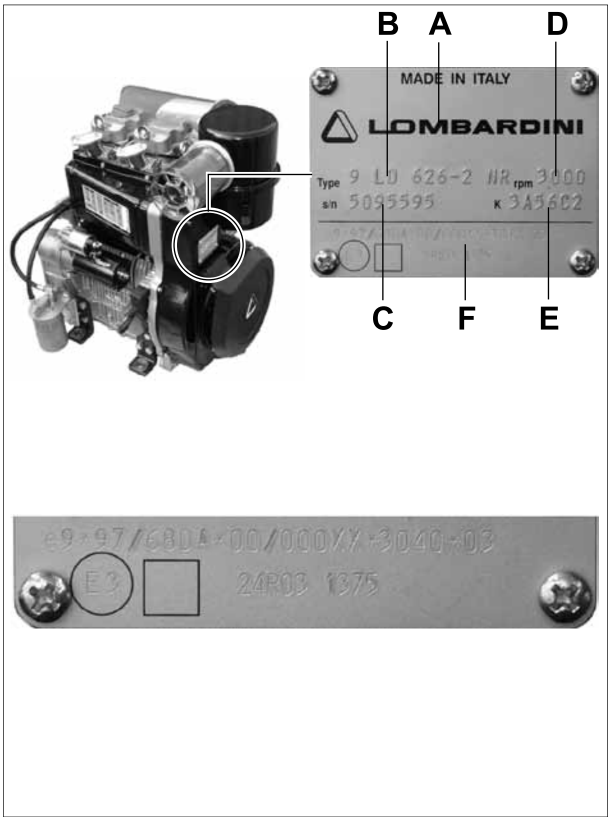
***TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS***

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 | | PROBLEM | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine does not start | Engine starts but stops | No acceleration | Non-uniform speed | Black smoke | White smoke | Oil preassure too low | Overheats | Inadequate per-formance | Excessive oil consumption | High noise level |
| FUEL CIRCUIT | Obstructed fuel line | ■ | ■ | | ■ | | | | | ■ | | |
| | Fuel filter clogged | ■ | ■ | ■ | ■ | | | | | ■ | | |
| | Air or water leaks in fuel system | ■ | ■ | ■ | ■ | | | | | ■ | | |
| | The tank cap vent hole is clogged | ■ | ■ | ■ | | | | | | | | |
| | No fuel | ■ | ■ | | | | | | | | | |
| | Faulty fuel feeding pump | ■ | ■ | ■ | ■ | | | | | ■ | | |
| | Extra fuel control level sticking | | | | | ■ | | | ■ | | | |
| COOLING CIRCUIT | Clogged air filter | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | | |
| | Cooling circuit clogged | | | | | ■ | | | ■ | ■ | | |
| SETTINGS REPAIRS | Incorrect governor linkage adjustment | ■ | | | ■ | | | | | | | |
| | Governor spring broken or unhooked | | ■ | ■ | | | | | | | | |
| | Low idle speed | | ■ | | | | | | | | | |
| | Rings worn or sticking | ■ | | | | | ■ | | ■ | ■ | ■ | |
| | Worn cylinder | ■ | | | | | ■ | | ■ | ■ | ■ | |
| | Worn main con rod-rocker arm bearings | | | | | | | ■ | ■ | ■ | ■ | ■ |
| | Badly sealed intake valve | ■ | | | | | | | ■ | ■ | ■ | |
| | Head tightening nuts loose | ■ | | | | | | | | | | ■ |
| | Damaged cylinder head gasket | ■ | | | | | | | ■ | ■ | | ■ |
| | Excessive valve-rocker arm clearance | | | | | | | | | ■ | | ■ |
| | No clearance between valves and rocker arms | ■ | | | | | | | | | | |
| | Valves sticking or damaged | ■ | | | | | | | | | | ■ |
| | Defective timing system | | | | | | | | | | | ■ |
| | Bent rods | | | ■ | | ■ | | | ■ | ■ | | ■ |
| | Crankshaft not turning freely | ■ | | | | ■ | | | ■ | ■ | | |

| POSSIBLE CAUSE | | Engine does not start | Engine starts but stops | No acceleration | Non-uniform speed | Black smoke | White smoke | Too low oil pressure | Overheats | Inadequate performance | Excessive oil consumption | High noise level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INJECTION | Damaged, blocked or dirty injector | X | | | | X | X | | | X | | X |
| INJECTION | Injection pump valve damaged | X | | | | | X | | | | | |
| INJECTION | Injector not adjusted | X | | | | X | | | | | | |
| INJECTION | Hardened pump control rod | X | | X | X | | | | | X | | |
| INJECTION | Broken or loose supplementary start-up spring | X | | | | | | | | | | |
| INJECTION | Worn or damaged pumping element | X | | | X | X | | | | X | | |
| INJECTION | Incorrect tuning of injection components (delivery balancing advance) | X | | X | X | X | | | X | X | | X |
| INJECTION | Extra fuel control level sticking | | | | | X | | | X | | | |
| LUBRICATION CIRCUIT | Oil level too high | | | | X | | X | | X | | X | |
| LUBRICATION CIRCUIT | Oil level low | | | | | | | X | X | | | X |
| LUBRICATION CIRCUIT | Oil pressure valve blocked or dirty | | | | | | | X | | | | |
| LUBRICATION CIRCUIT | Oil pressure regulator not adjusted | | | | | | | X | | | | |
| LUBRICATION CIRCUIT | Worm oil pump | | | | | | | X | X | | | |
| LUBRICATION CIRCUIT | Oil sump suction line clogged | | | | | | | X | X | | | |
| LUBRICATION CIRCUIT | Faulty pressure gauge or pressure switch | | | | | | | X | | | | |
| LUBRICATION CIRCUIT | Blocked draining pipe | | | | | | | X | | | | |
| ELECTRIC SYSTEM | Discharged battery | X | | | | | | | | | | |
| ELECTRIC SYSTEM | Cable connection uncertain or incorrect | X | | | | | | | | | | |
| ELECTRIC SYSTEM | Faulty starting switch | X | | | | | | | | | | |
| ELECTRIC SYSTEM | Faulty starting motor | X | | | | | | | | | | |
| MAINTENANCE | Excessive idle operation | | | | | | X | | | | X | |
| MAINTENANCE | Incomplete run-in | | | | | | X | | | X | X | |
| MAINTENANCE | Overloaded engine | | X | X | X | X | | | X | X | X | X |
| MAINTENANCE | Non-conforming engine oil | | | | | | | | X | | X | |

## MANUFACTURER AND ENGINE IDENTIFICATION

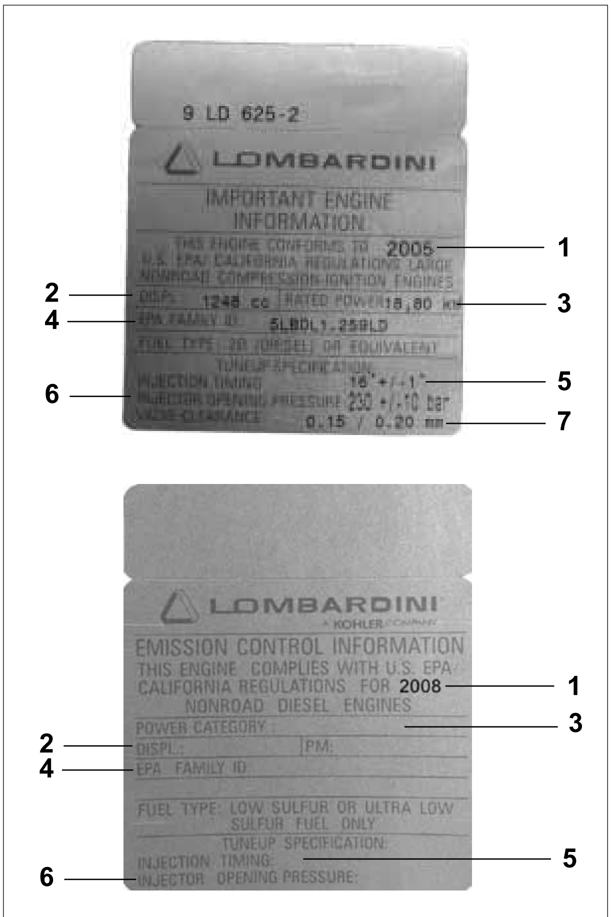



The identification plate shown in the figure can be found directly on the engine.
It contains the following information:

**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**

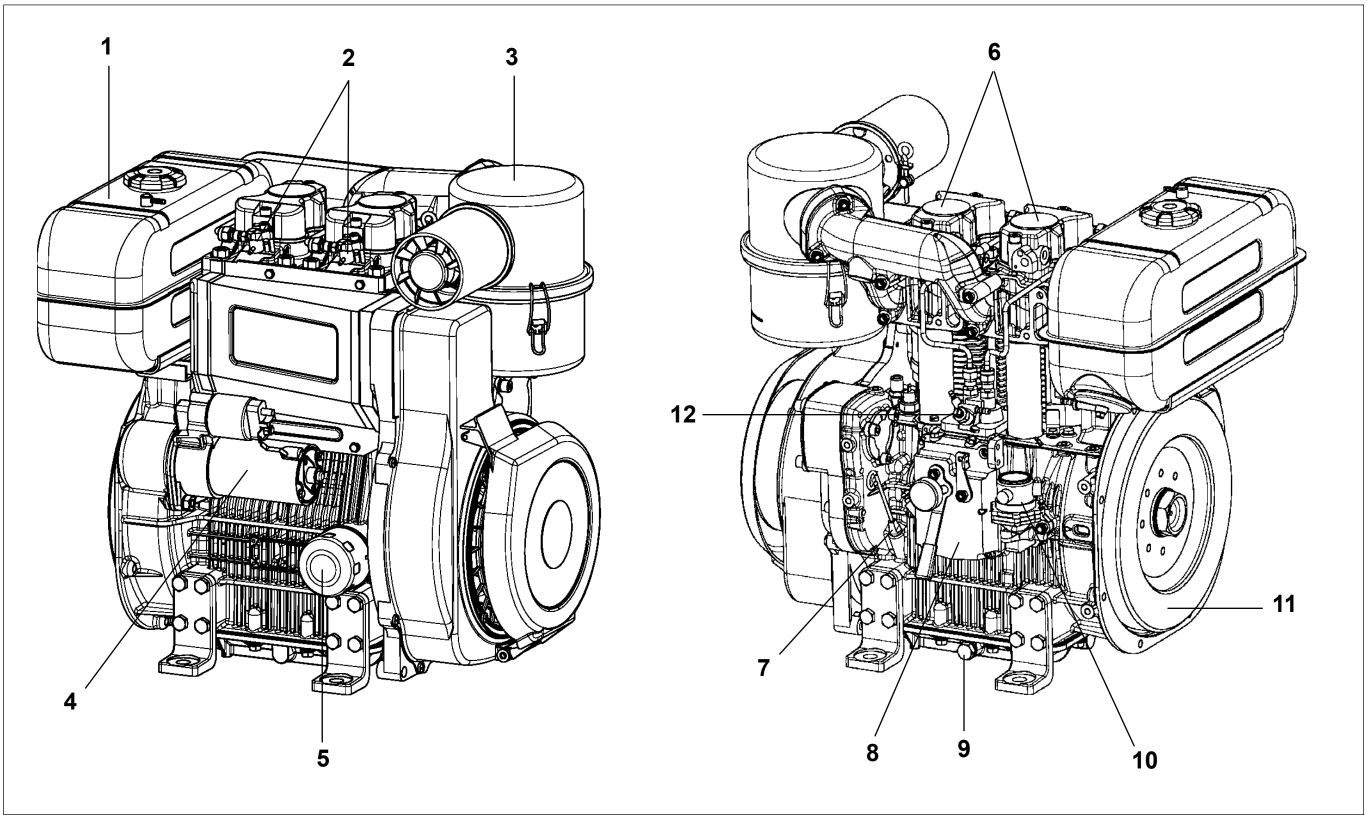
The approval reference directives EC are on the engine identification plate.




The data plate for EPA Standards is applied on the air intake cowling.
It contains the following information:

**1)** Current year
**2)** Engine displacement
**3)** Rated power, measured in kW
**4)** EPA family ID
**5)** Injection timing
**6)** Injection opening preassure
**7)** Valve clearance

## MAIN COMPONENTS




*Components:*

**1)** Fuel tank
**2)** Injectors
**3)** Air cleaner
**4)** Starting motor
**5)** Oil filter
**6)** Rocker arm cover
**7)** Oil dipstick
**8)** Throttle and stop controls
**9)** Oil drain plug
**10)** Fuel feeding pump
**11)** Flywheel
**12)** Injection pump

## TECHINICAL SPECIFICATIONS

| | | | 9 LD engine type | | |
|---|---|---|---|---|---|
| | | | 625-2 | 625/626-2 NR CE | 625-2 EPA |
| **GENERAL DETAILS** | | | | | |
| Operating cycle | | | Four-stroke diesel | | |
| Cylinders | | n° | 2 in line | | |
| Bore x stroke | | mm | 95x88 | 95x88 | 95x88 |
| Displacements | | $cm^3$ | 1248 | 1248 | 1248 |
| Compression rate | | | 17.5:1 | 20.0:1 | 21.0:1 |
| Intake | | | Oil bath air cleaner with cyclonic prefilter or dry air cleaner | | |
| Cooling | | | Air (fan integral to the flywheel) | | |
| Crankshaft rotation | | | Counter-clockwise (from flywheel side) | | |
| Combustion sequence | | Driving shaft degrees | 180° | | |
| **Timing system** | | | Rods and rocker arms | | |
| *Valves* | | n° | 2 per cylinder | | |
| *Shaft* | | | Side camshaft in the crankcase | | |
| *Tappets* | | | Mechanic | | |
| Fuel injection | | | Direct | | |
| Dry weight of engine | | Kg | 110 | 110 | 110 |
| Maximum tilt while operating | | Momentary | 35° | 35° | 35° |
| Maximum tilt while operating | | Up to 1 hour | 25° | 25° | 25° |
| Combustion air volume at 3000 r.p.m. | | l/min | 1600 | 1600 | 1600 |
| Cooling air volume at 3000 r.p.m. | | l/min | 26300 | 26300 | 26300 |
| **POWER AND TORQUE** | | | | | |
| Maximum operating speed | | r.p.m. | 3000 | 3000 | 3000 |
| Maximum power | N (80/1269/CEE) ISO 1585 | kW/CV | 20.7/28 | - | - |
| | NB ISO 3046 IFN | | 18.8/25.5 | 18.8/25.5 | 18.8/25.5 |
| | NA ISO 3046 ICXN | | 16.9/23 | 16.9/23 | 16.9/23 |
| Maximum torque* | | Nm/Kgm | 73./7.4 | 67/6.8 | 68/6.9 |
| Axial load allowed on crankshaft | | Kg | 300 | 300 | 300 |
| **CONSUMPTION AT MAXIMUM POWER** | | | | | |
| Specific fuel onsumption | | g/kWh - g/CV1h | 253-186 | 258-190 | 258-190 |
| Oil consumption | | Kg/h | 0.013 | 0.013 | 0.013 |

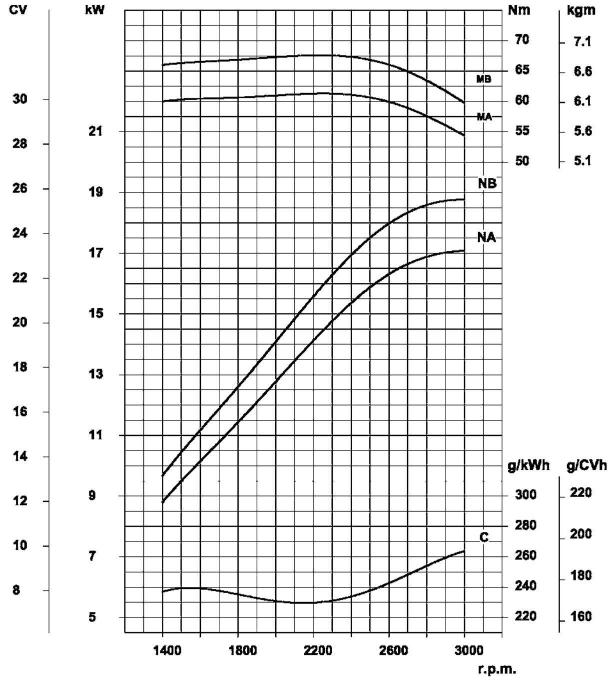
* 2200 rpm x 9LD 625-2; 2000rpm x 9LD625/626 -2 NR/CE and 1700rpm x 9LD 625-2 EPA

| | | 9 LD engine type | | |
|---|---|---|---|---|
| | | 625-2 | 625/626-2 NR CE | 625-2 EPA |
| **FUEL SUPPLY CIRCUIT** | | | | |
| Fuel type | Automotive diesel fuel (minimum cetane: 51) | | | |
| Fuel supply | Mechanical fuel lift pump (diaphragm or pistons) | | | |
| **Fuel filter, internal** | | | | |
| *Filtering surface* | $cm^2$ | 460 | 460 | 460 |
| *Filter capacity* | μm | 7 | 7 | 7 |
| **Fuel filter, external** | | | | |
| *Filtering cartridge* | | PF 904 | PF 904 | PF 904 |
| *Filtering surface* | $cm^2$ | 5000 | 5000 | 5000 |
| *Filter capacity* | μm | 2÷3 | 2÷3 | 2÷3 |
| *Maximum operating pressure* | bar | 4 | 4 | 4 |
| **LUBRICATION CIRCUIT** | | | | |
| Type of lubrication | Completely forced | | | |
| Circuit supply | Gear pump | | | |
| Maximum oil quantity | including filter (l) | 3.1 | 3.1 | 3.1 |
| Maximum oil quantity | excluding filter (l) | 2.8 | 2.8 | 2.8 |
| Oil pressure at min. speed (oil temperature: 120°C) | bar | 0.6 | 0.6 | 0.6 |
| **Oil pressure switch** | Unipolar system | | | |
| *Operating pressure (min. value)* | bar | 0.3 | 0.3 | 0.3 |
| **Oil filter cartridge, external** | | | | |
| *Maximum operating pressure* | bar | 13 | 13 | 13 |
| *Maximum combustion pressure* | bar | 20 | 20 | 20 |
| *Filter capacity* | μm | 15 | 15 | 15 |
| *By-pass valve setting* | bar | 1.5÷1.7 | 1.5÷1.7 | 1.5÷1.7 |
| *Filtering surface* | $cm^2$ | 745 | 745 | 745 |
| **ELECTRICAL SYSTEM** | | | | |
| Alternator, Internal Standard (nominal voltage) | V | 12 | 12 | 12 |
| Alternator, Internal Optional (nominal voltage) | V | 24 | 24 | 24 |
| Alternator, External Optional (nominal voltage) | V | 12 | 12 | 12 |
| Alternator, Internal Standard (nominal current) * | A | 14 | 14 | 14 |
| Alternator, Internal Optional (nominal current) * | A | 6 | 6 | 6 |
| Alternator, External Optional (nominal current) * | A | 33 | 33 | 33 |
| Starter motor power (Bosh GF) | kW | 1.7 | 1.7 | 1.7 |
| Starter motor power ( Bosh DW (R) ) | kW | 1.6 | 1.6 | 1.6 |

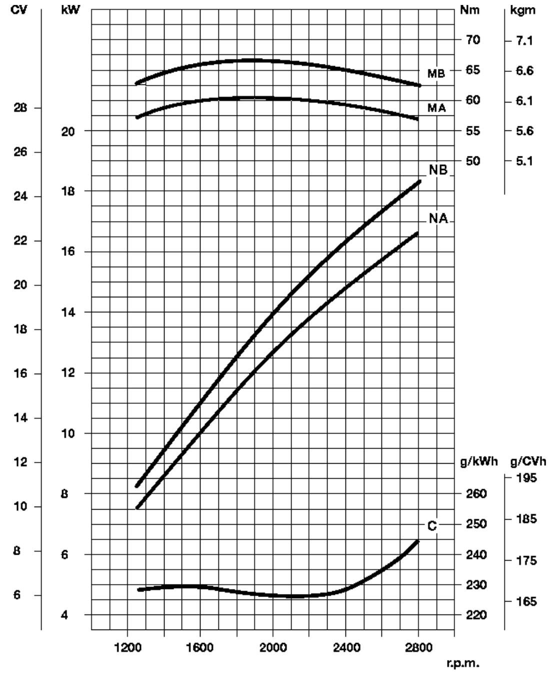
* (see “Alternator battery charger curve” page 66 ÷ 69)

## PERFORMANCE DIAGRAM

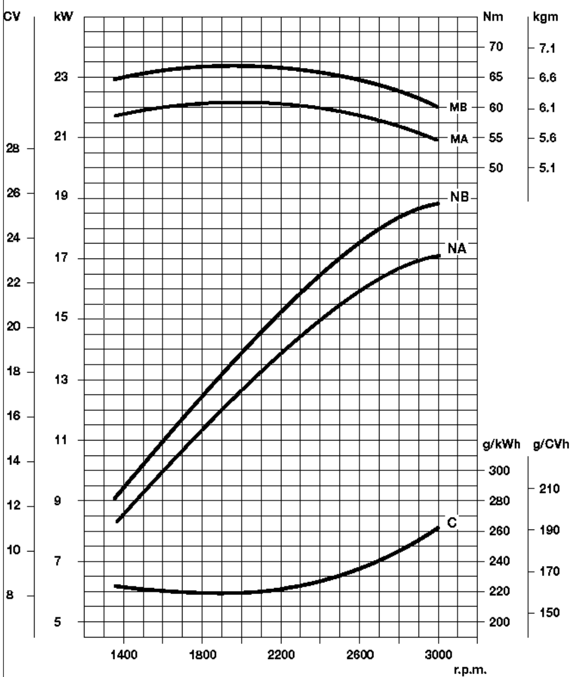
### 9 LD 625-2 EPA @ 3000 r.p.m.



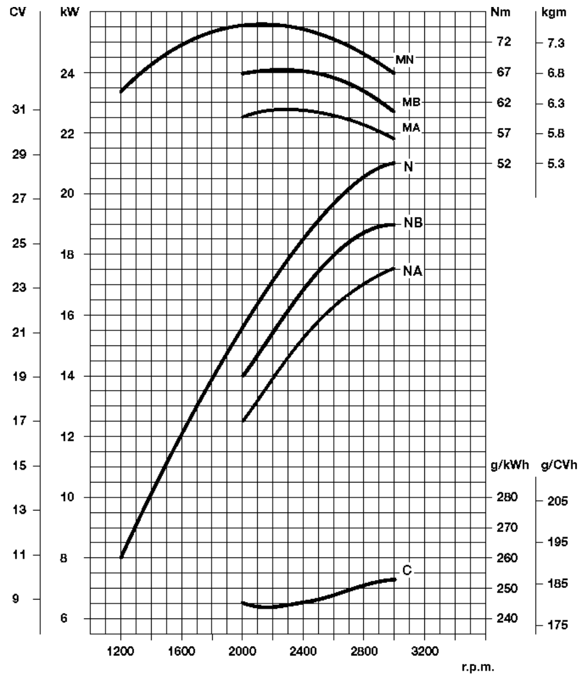

### 9 LD 625 NR @ 2800 r.p.m.



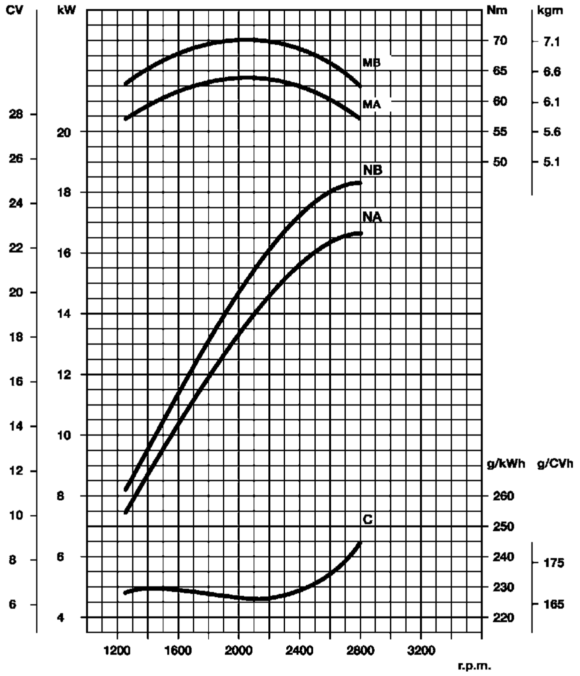

### 9 LD 625 @ 3000 r.p.m.



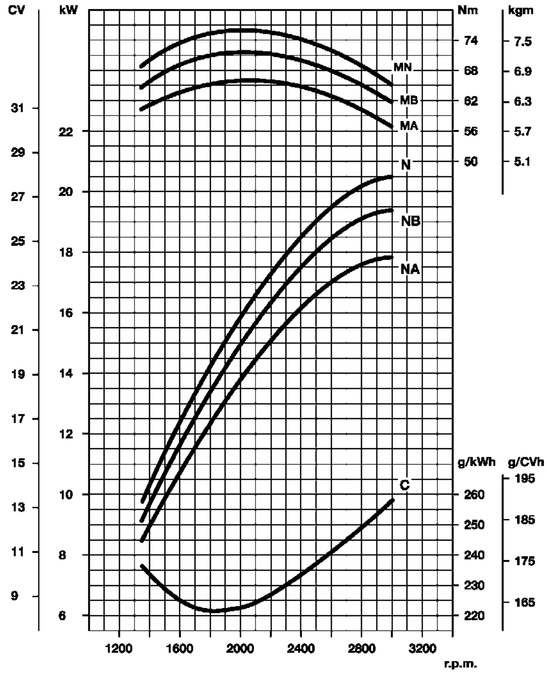

### 9 LD 626-2 @ 3000 r.p.m.



**9 LD 626-2 B2 NR @ 2800 r.p.m.**




**9 LD 626 NR @ 3000 r.p.m.**




**N (80/1269/CEE - ISO 1585):** Automotive rating, intermittent operation with variable speed and variable load.
**NB (ISO 3046/1 - IFN):** 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.

**C (NB) :** Specific fuel consumption at NB power
**Mn :** Torque at N.

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 LOMBARDINI for power, torque curves and specific consumptions at rates differing from those given above.

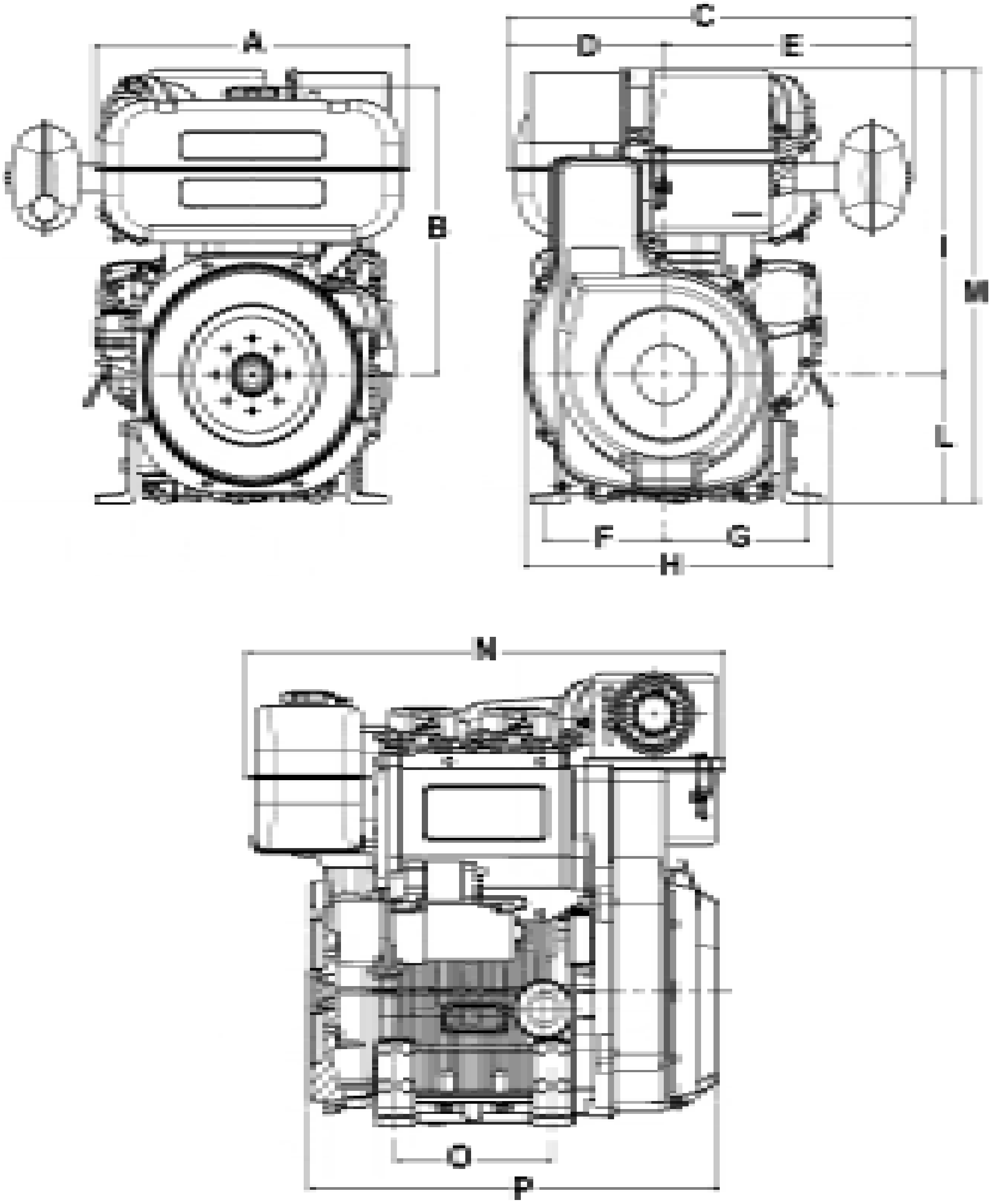
**Important**

**Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.**

## OVERALL DIMENSION

**9 LD 561-2**
**9 LD561-2/L**
**9 LD 625-2**

**9 LD 626-2**
**9 LD 626-2 NR**




| DIMENSIONI mm - MESURES mm - DIMENSION mm - EINBAUMAßE mm - DIMENSIONE mm - DIMEN0ÇÕES (mm) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | 434 | **C** | 557 | **E** | 340 | **G** | 198 | **I** | 421 | **M** | 599 | **O** | 207 |
| **B** | 397 | **D** | 217 | **F** | 168 | **H** | 425 | **L** | 178 | **N** | 633 | **P** | 542 |

## 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**

## EXTRAORDINARY MAINTENANCE

| | | |
|---|---|---|
| **AFTER THE FIRST 50 WORKING HOURS** | **Engine oil replacement.** | **Oil filter replacement.** |

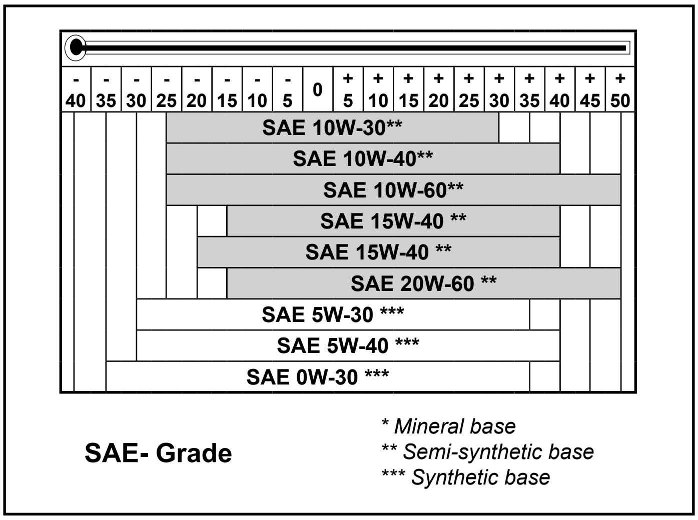
| ORDINARY MAINTENANCE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **OPERATION DESCRIPTION** | | | **FREQUENCY x HOURS** | | | | | | |
| | | | 10 | 125 | 250 | 500 | 1000 | 2500 | 5000 |
| **CHECK** | ENGINE OIL LEVEL | | | | | | | | |
| | OIL BATH AIR CLEANER | (***) | | | | | | | |
| | DRY AIR CLEANER | (***) | | | | | | | |
| | FUEL PIPES | | | | | | | | |
| | EXTERNAL ALTERNATOR BELT TENSION | (**) | | | | | | | |
| | COOLING SYSTEM CLEANING | (***) | | | | | | | |
| | VALVE-ROCKER ARMS CLEARANCE ADJUSTMENT | | | | | | | | |
| | SETTING AND INJECTORS CLEANING | | | | | | | | |
| | RUBBER INTAKE HOSE (DRY AIR CLEANER - INTAKE MANIFOLD) | | | | | | | | |
| | FUEL TANK CLEANING | | | | | | | | |
| | ALTERNATOR AND STARTING MOTOR | | | | | | | | |
| **REPLACEMENT** | ENGINE OIL | (*) | | | | | | | |
| | EXTERNAL OIL FILTER | (*) | | | | | | | |
| | FUEL FILTER | (*) | | | | | | | |
| | EXTERNAL ALTERNATOR BELT | | | | | | | | |
| | RUBBER INTAKE HOSE (DRY AIR CLEANER - INTAKE MANIFOLD) | (**) | | | | | | | |
| | FUEL PIPES | (**) | | | | | | | |
| | DRY AIR CLEANER EXTERNAL CARTRIDGE | (***) | **AFTER 6 CHECKS WITH CLEANING** | | | | | | |
| | DRY AIR INTERNAL EXTERNAL CARTRIDGE | (***) | **AFTER 3 CHECKS WITH CLEANING** | | | | | | |
| **OVERHAUL** | PARTIAL | | | | | | | | |
| | TOTAL | | | | | | | | |

**(*)** - **In case of low use: every year.**
**(**)** - **In case of low use: every 2 years.**
**(***)** - **The period of time that must elapse before cleaning or replacing the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently In very dusty conditions.**

## 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 | |
|---|---|
| ***B1 =*** | Low-viscosity, for frictions reduction |
| ***B2 =*** | Standard |
| ***B3 =*** | High performances (indirect injection) |
| ***B4 =*** | High quality (direct injection) |

| HEAVY DUTY DIESEL ENGINES | |
|---|---|
| ***E2 =*** | Standard |
| ***E3 =*** | Heavy conditions (Euro 1 - Euro 2 engines ) |
| ***E4 =*** | Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines ) |
| ***E5 =*** | 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 | | | | | |

## PRESCRIBED LUBRICANT

| | | |
|---|---|---|
| **AGIP SUPERDIESEL MULTIGRADE 10W40** | specifications | **API CF4 / SG**<br>**ACEA B2 - E2**<br>**MIL - L-4165 D/E** |

In the countries where AGIP products are not available, use oil API SJ/CF for Diesel engines or oil corresponding to the military specification MIL-L-4165 D/E.
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.

| 9 LD ENGINES OIL CAPACITY | | |
|---|---|---|
| **OIL VOLUME AT MAX LEVEL (OIL FILTER INCLUDED)** | Litres | **3.1** |
| **OIL VOLUME AT MAX LEVEL (WITHOUT OIL FILTER)** | Litres | **2.8** |

**Danger - Attention**

- **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.**

**Danger - Attention**

- **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.**

## FUEL RECOMMENDATIONS

Purchase diesel fuel in small quantities and store in clean, approved containers. Clean fuel prevents the diesel fuel injectors and pumps from clogging. Do not overfill the fuel tank.
Leave room for the fuel to expand. Immediately clean up any spillage during refueling.

Never store diesel fuel in galvanized containers; diesel fuel and the galvanized coating react chemically to each other, producing flaking that quickly clogs filters or causes fuel pump or injector failure.

High sulfur content in fuel may cause engine wear. In those countries where diesel has a high sufur content, its is advisable to lubricate the engine with a high alkaline oil or alternatively to replace the lubricating oil recommended by the manufacturer more frequently. The regions in which diesel normally has a low sulfur content are Europe, North America, and Australia.

| PRESCRIBED LUBRICANT | |
|---|---|
| Fuel with low sulphur content | **API CF4 - CG4** |
| Fuel with high sulphur content | **API CF** |

### FUEL TYPE
For best results, use only clean, fresh, commercial-grade diesel fuel. Diesel fuels that satisfy the following specifications are suitable for use in this engine: ASTM D-975 - 1D or 2D, EN590, or equivalent.

### FUELS FOR LOW TEMPERATURES

It is possible to run the engine at temperatures below 0°C using special winter fuels. These fuels reduce the formation of paraffin in diesel at low temperatures. If paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

| | | | |
|---|---|---|---|
| Fuel can be: | - Summer | up to | 0°C |
| | - Winter | up to | -10°C |
| | - Alpine | up to | -20°C |
| | - Arctic | up to | -30°C |

### BIODIESEL FUEL
Fuels containing less than 20% methyl ester or B20, are suitable for use in this engine. Biodiesel fuels meeting the specification of BQ-9000, EN 14214 or equivalent are recommended. DO NOT use vegetable oil as a biofuel for this engine.
Any failures resulting from the use of fuels other than recommended will not be warranted.

### AVIATION FUEL
Aviation fuels suitable for use in this engine include JP5, JP4, JP8 and, JET-A (if 5 percent oil is added).

**EMISSION CONTROL INFORMATION**

**LOW SULFUR FUEL OR**
**ULTRA LOW SULFUR FUEL ONLY**

**EPA /CARB emission label must be attached near the fuel inlet.**

| Capacities standard fuel tank | Litres | 10 |
|---|---|---|
| As for filters, tanks and special crankcases please refer to LOMBARDINI instructions. | | |

## RECOMMENDATIONS FOR DISASSEMBLING AND ASSEMBLING

**Important**

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

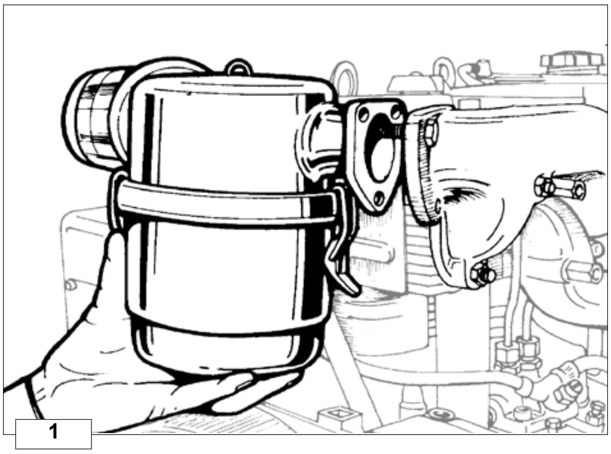
- Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions.
- Always use original LOMBARDINI spare parts for proper repair operations.
- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- In order to fix assemblies and/or components securely, the operator must tighten the fastening parts in a criss-cross or alternating pattern.
- Assemblies and/or components with a specific tightening torque must initially be fastened at a level lower than the assigned value, and then subsequently tightened to the final torque.

## 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.



1

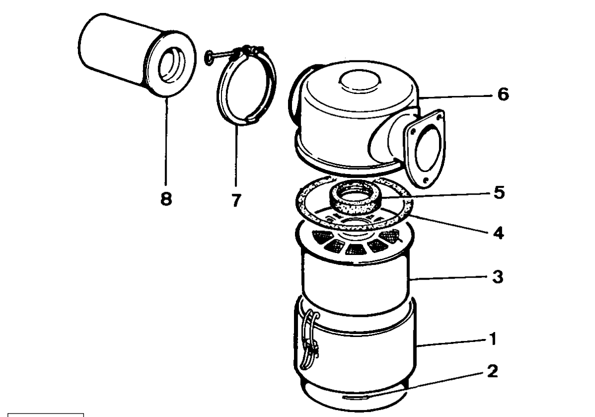
## AIR CLEANER

### Oil-bath air cleaner

Check gaskets and replace if necessary.
Check that flange weld is free of porosity or defective spots.
Carefully clean bowl and filtering element with Diesel oil and blow through with compressed air.
Top up with engine oil to the mark.

❍ When refitting tighten nuts at 25 Nm.

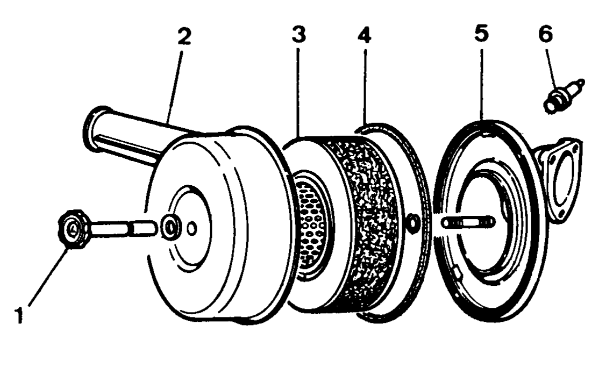
➲ See page 22 for periodic maintenance details.



2

*Components:*

**1** Bowl
**2** Oil level mark
**3** Filtering element
**4** Seal ring
**5** Internal seal ring
**6** Cover
**7** Clamp
**8** Prefilter

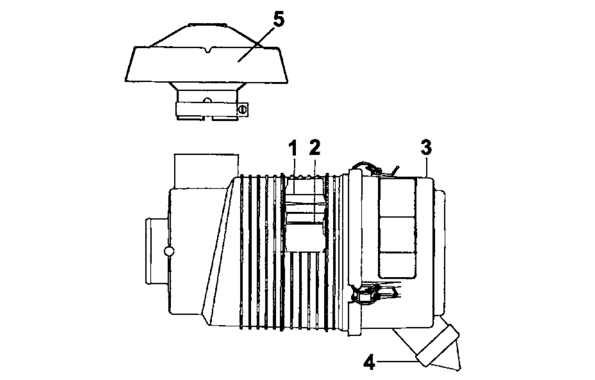


3

**Dry air cleaner**

*Components:*
**1** Hand wheel
**2** Cover
**3** Cartridge
**4** Seal ring
**5** Bracket
**6** Clogging indicator

**Important**
**Replace cartridge immediately when indicator shows that is clogged.**



4

**Dry air cleaner, Donaldson type**

**Danger - Attention**
**Never clean the filter element using highly flammable solvents. It could cause an explosion!**

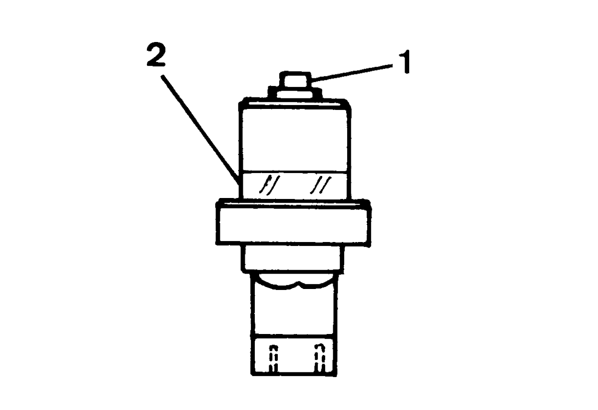
➲ In order to know how often you should check and replace the air filter cartridge and the rubber hose (air filter – intake manifold) see page 22.

**1** Main cartridge
**2** Safety cartridge
**3** Axial cover
**4** Scavenging valve
**5** Cap complete with clamp

Scavenging valve **4** must be positioned as in figure 4.

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

The cartridge can be cleaned by blowing compressed air breadthways outside and inside the cartridge, at a pressure not greater than 5 atmospheres, or in necessity case by knocking the front of the cartridge several times against a flat surface.
Use a lamp to check that the filter element is not damaged or inspect it against the light while slanted.
In case of doubt, install a new cartridge.

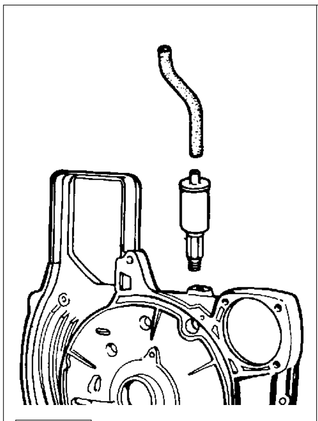



5

**Clogging indicator**

*Components*:
**1** Reset button
**2** Transparent indicator

***Note:*** Indicator is calibrated at 600÷650 mm column of water.



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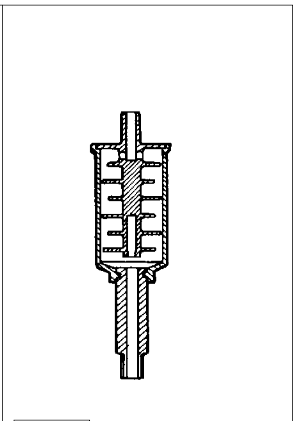
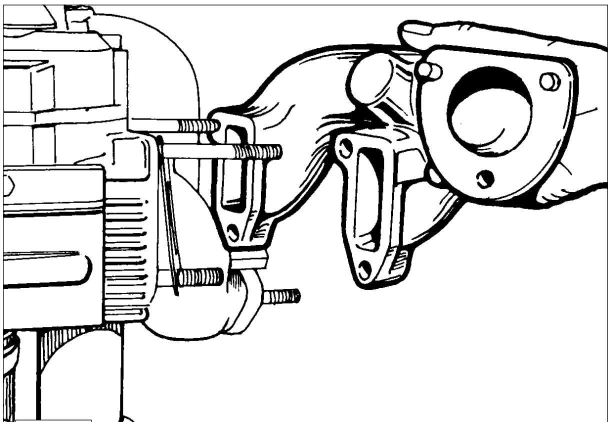


7

**Oil vapour separator**

Fitted on engines with dry air cleaner.
Screw it out of the air conveyor support, carefully wash with gasoline inside and blow out with compressed air.
When refitting replace the copper gasket and connect the oil vapour separator with intake manifold by means of the special rubber hose.



8

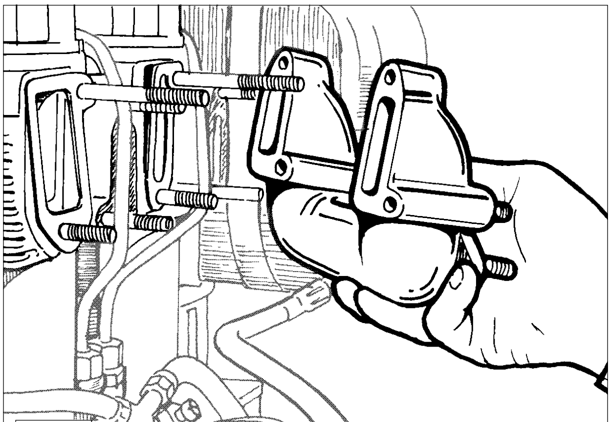
## MANIFOLDS, INTAKE/EXHAUST

**Intake manifold**

To avoid flange breakage check that heads are in line before tightening nuts.
Check flange surface for warpage and correct if necessary.
Replace gaskets.

❍ Tighten nuts at 25 Nm.

***Note:*** In case of low temperature starting we can supply a manifold with possibility of fitting a glow plug with air preheating.

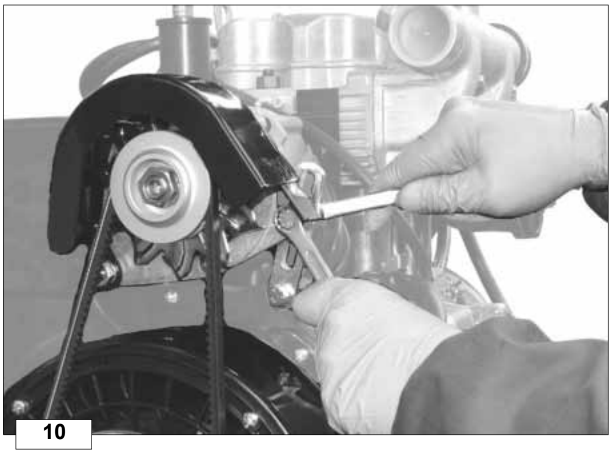


9

**Exhaust manifold**

Check that the inside is clean.
To avoid flange breakage check that heads are in line before tightening nuts.
Replace gaskets.

❍ Tighten nuts at 20 Nm.



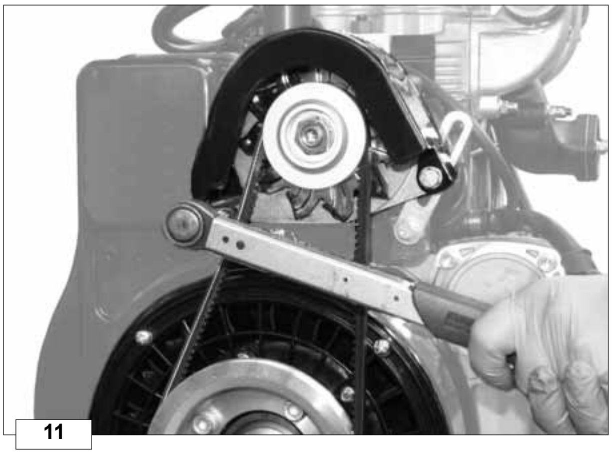
10

## EXTERNAL ALTERNATOR CONTROL BELT
**(only for engines with external alternator)**

**External alternator blower control belt - Disassembly**

Release the two alternator fastening bolts.
Unscrew the fastening nuts of the belt guard and remove it.
Remove the **V** belt.

➲ See page 22 for periodic maintenance details.



11

**External alternator blower control belt – Tension check**

**Important**
**Carry out checks only after isolating the positive battery cable to prevent accidental short-circuiting and, consequently, the activation of the starter motor.**

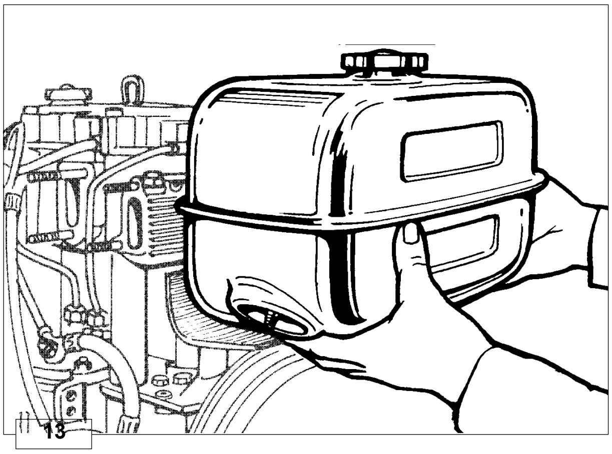
Tension the belt if it flexes more than 1 cm exerting a pressure of 10 kg.

12

**External alternator blower control belt - Reassembly**

Install the belt and the belt guard.
Force the alternator outwards and temporarily tighten the fastening bolts.
Make sure that the belt tension is within the required parameters (see “External alternator blower control belt – Tension check”, Fig. 11).

❍ Tighten the fastening bolts to a final torque of 30 Nm (8x1.25) and 50 Nm (10x1.50).



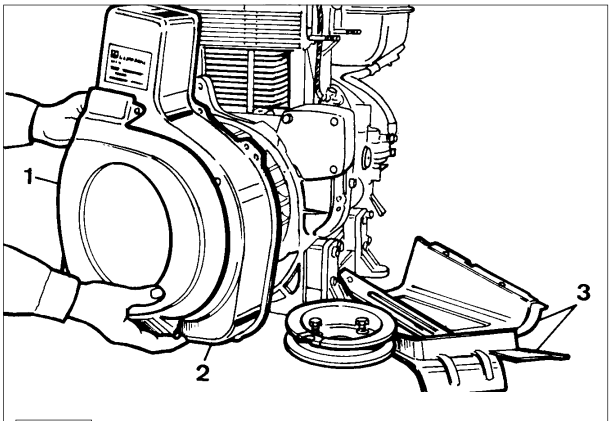
13

## FUEL TANK

After disconnecting the fuel pipes unscrew the anchoring brackets' screws and remove the fuel tank.
Completely empty the tank and check that no impurities are found inside.
If the fuel tank is fitted wth an internal fuel filter remove and replace the cartridge.
Check that cap breather hole is not clogged.
Remove the tank support.

❍ When refitting tighten the support screws at 40 Nm and the bracket screws at 8 Nm.

➲ See page 57 for refitting internal fuel filter.

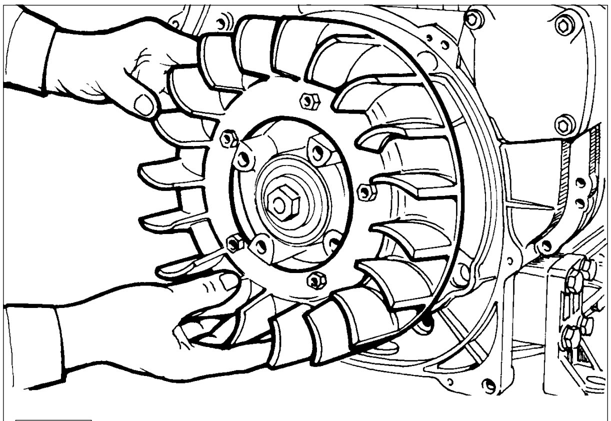



14

## Pulley guard - Shroud - Side plates

*Components*:
**1** Pulley guard
**2** Shroud
**3** Side plates

The pulley guard is made of sound deadening material: it reduces the noise that both the pulley and the fan tend to amplify.
Shroud and side plates are made of ANTIFON, an elastic layer which absorbs the noise caused by the plate vibrations.



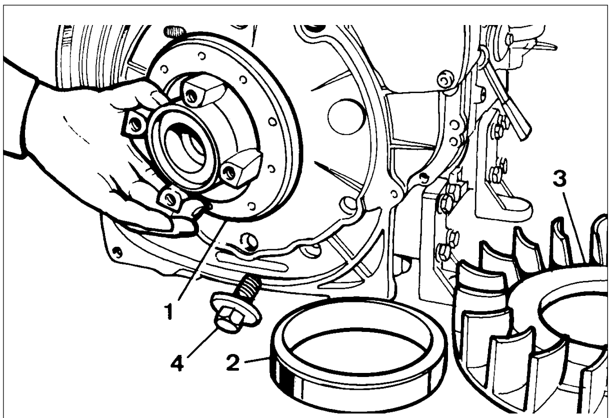
15

## Cooling fan

Carefully clean and check all blades and inserts. Replace the fan even if there is only a single damaged blade or only a single released insert.

➲ See page 16 for cooling air flow.

❍ Tighten the fan's fixing screws at a torque of 10 Nm.



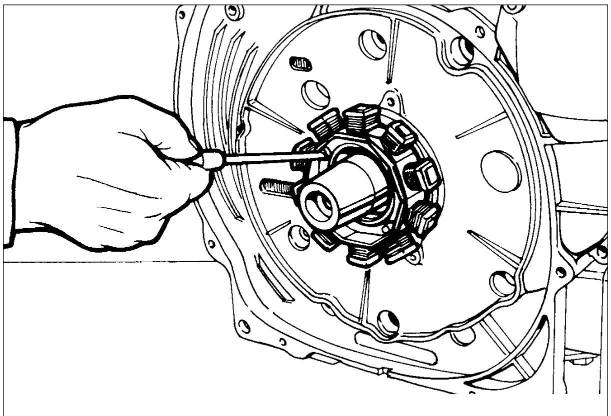

16

## Hub

*Components*:
**1** Hub
**2** Alternator rotor
**3** Fan
**4** Bolt

The hub holds the alternator rotor and the cooling fan.

❍ Unscrew the bolt clockwise and tighten at 160 Nm when refitting.



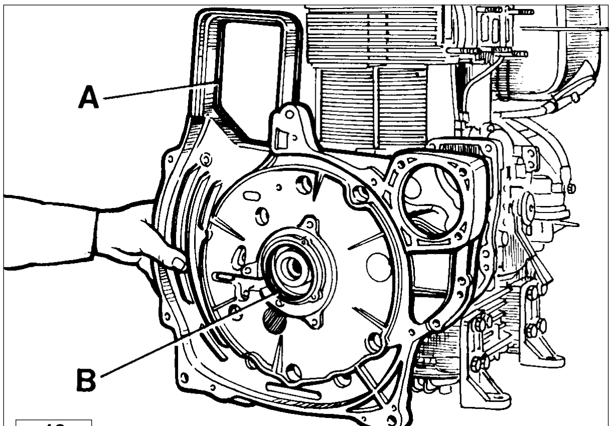
17

## Internal alternator

Remove stator and place it inside the rotor to prevent metal particles from being attracted by the magnets.

❍ When refitting tighten rotor screws and stator bolts at 10 Nm.

➲ See page 67 ÷ 69 for alternator characteristics.

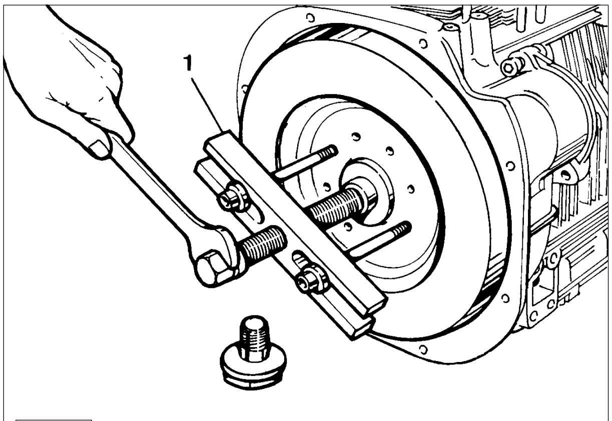


18

**Shroud support (Gear cover plate)**

Loosen screws and remove shroud support very carefully to avoid damage to the oil seal ring.
When refitting check that gaskets **A** and oil seal ring **B** are well inside their housings.

❍ Tighten screws at 25 Nm.



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**FLYWHEEL**

Remove flywheel with puller **1** (part N°. 7271-1460-119).
Check starter ring gear and tapered crankshaft mating surfaces.

❍ When refitting tighten bolt al 300 Nm.

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

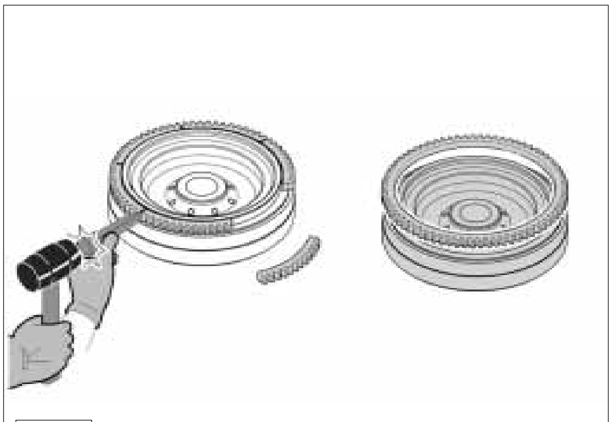
Cut the ring gear in several places using a chisel and remove it.

**Important**
**Remove any debris and carefully clean the ring gear.**

Heat the new ring gear uniformly and keep it at a temperature of 300°C for15÷20 minuti.

**Danger – Attention**
**Risk of burning: be careful of hot surfaces.**

Insert the ring gear into its seat and place it carefully on the rim of the flywheel.
Leave to the ring gear to cool gently before reassembling the flywheel.


20

**ROCKER ARMS**

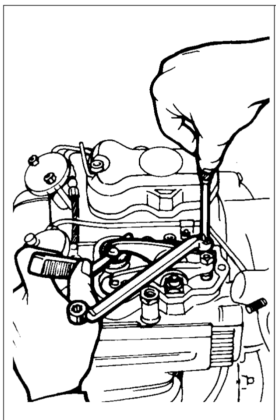
**Valve / Rocker arm clearance**

**Important**
**Setting should be performed when the engine is cold.**

Remove rocker arm cover and check gaskets for breakage.

Bring each cylinder piston to top dead center on the compression stroke and set clearance **A** al 0.15÷0.20 mm for intake and 0.30÷0.35 mm for exhaust.

❍ When refitting tighten cover screws by 20 Nm.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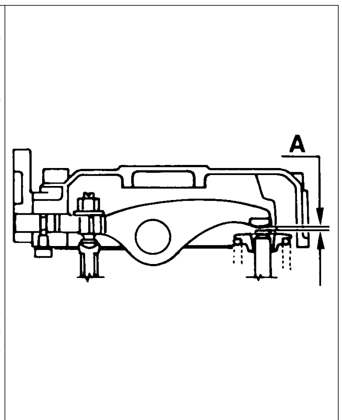

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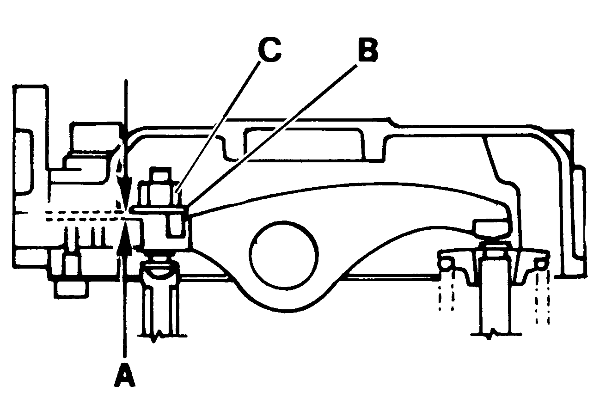

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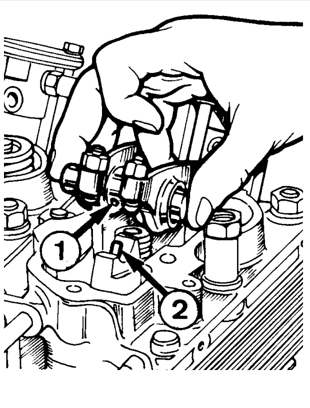
### Compression release (optional)

Bring piston to top dead center on the compression stroke.
Unscrew rocker arm cover side plug and measure clearance **A** between lever and rocker arm, which must be 0.30÷0.40 mm.
For setting purposes remove the rocker arm cover, unscrew the lock nut **C** and set clearance **A** by changing the height of the shims under the plate **B**.
Set the valve/rocker arm clearance, see "Valve / Rocker arm clearance" on page 31.
Reassemble the rocker arm cover and check the decompression lever clearance again.



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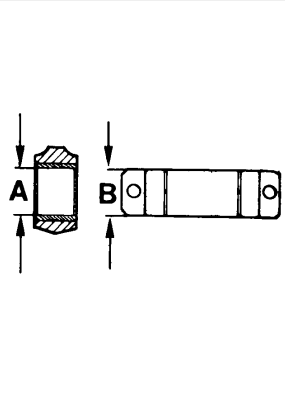

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### Rocker arm assembly

*Components*:
**1** Bore
**2** Lubrication tube

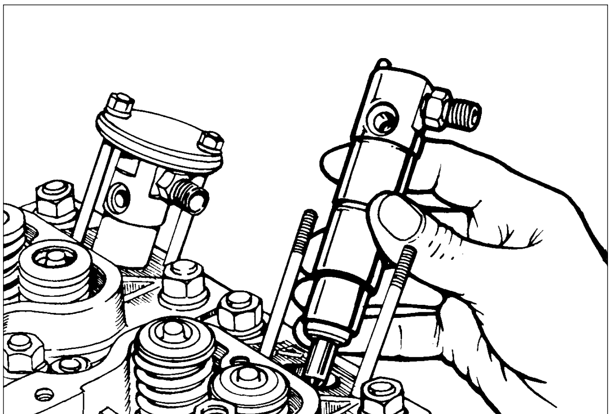
*Dimensions* (mm):
**A** = 18.032÷18.050
**B** = 17.989÷18.000

If clearance (**A** - **B**) exceeds 0.135 mm replace shaft and rocker arms.

**Caution – Warning**
**When retitting check that lubrication tube perfectly matches with the journal bore.**

On slow engines, which are set to 1,500 – 1,800 rpm, the rocker arms differ from the standard version in the upper part of the lubrication channel.

❍ Tighten the rocker arm shaft fastening screws to the head at a torque of 25 Nm.

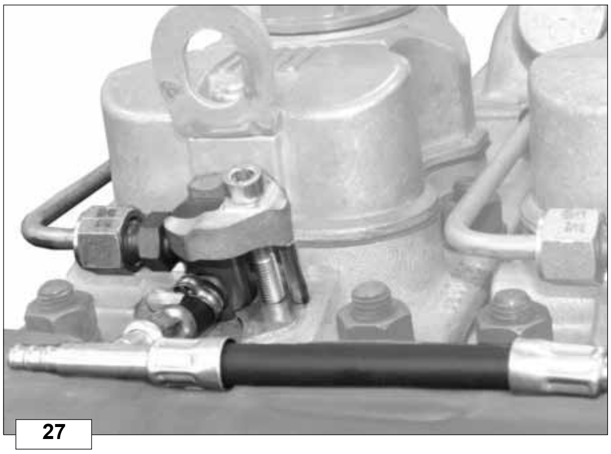

26

### INJECTOR

Clean injector and check calibrated pressure as indicated on page 65.
When refitting check that it correctly protrudes from the cylinder head plane.

❍ Tighten the fixing nuts at 10 Nm.

❍ Tighten the high-pressure pipe union at 25 Nm.



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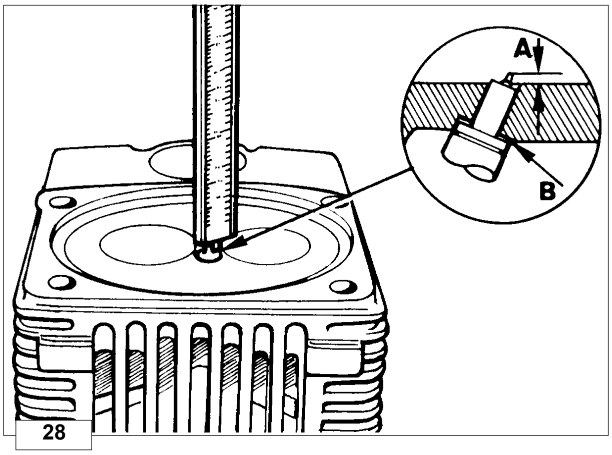
**Injector for EPA and 97/68 CE engines**

The injector is attached to the cylinder head via a forked bracket.

❍ Tighten the fixing bracket screw at 10 Nm.

❍ Fix the high-pressure hose union to the injector union at 25 Nm.

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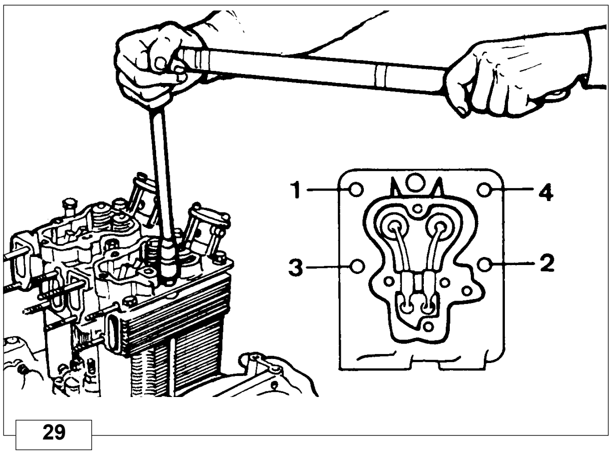
**Injector projection**

The end of nozzle **A** should project 3.0÷3.5 mm. from the cylinder head plane.
Adjust injector projection by means of copper shims **B** measuring 0.5, 1.00 and 1.50 mm in thickness.

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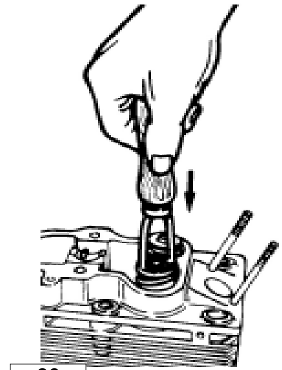
## CYLINDER HEAD

**Important**

**Do not remove it when hot to avoid deformation.**
**The cylinder heads must be tightened with the exhaust or intake manifold mounted to keep them lined up.**

If cylinder head is deformed level it off by removing a maximum of 0.3 mm.
When refitting tighten only if sure that rocker arm lubrication tube is well inside its holes, and that the rubber seals of the tappet hose are assembled and inserted correctly into their seats.
Always replace copper head gasket: see page 39 for choosing the right thickness.

❍ Progressively tighten nuts in the **1**, **2**, **3**, **4** sequence at 55 Nm.



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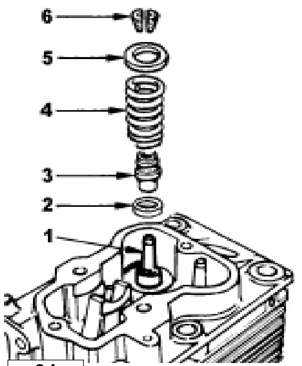


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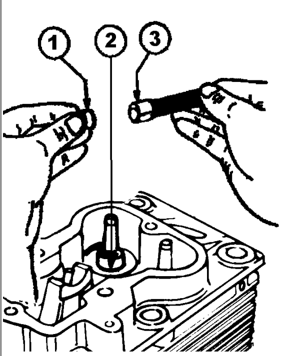
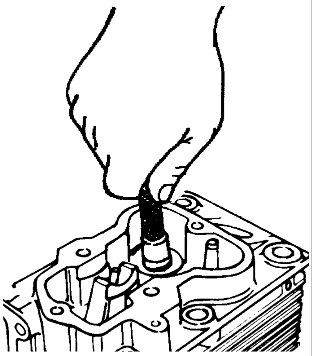
## Valves

*Components:*
**1** Intake valve
**2** Spring seat
**3** Valve stem seal ring
**4** Spring
**5** Retainer
**6** Half collets

To remove half collets firmly press down as shown in the figure.




32



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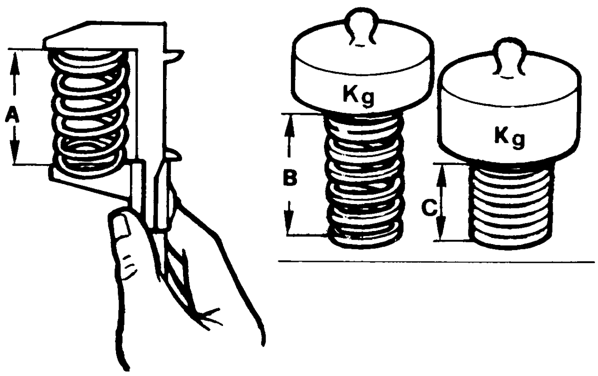
## Valve stem sealing rings - Reassembly

Lubricate the inside of the sealing ring with Molikote BR2 Plus and insert them all the way onto the guides using tool 1460-108.
To prevent deformation of the sealing ring **1** as it is inserted onto the valve guide **2** insert it onto tool **3**.
Lubricate valve stem with the same type of grease; insert the valves into the guides rotating them particularly as they enter the sealing ring.



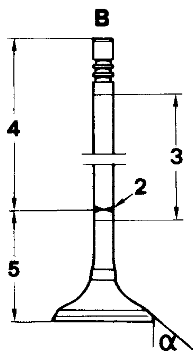

34

## Valve springs

Measure free length with a gauge.
Using a dynamometer check that the spring length under two dìfferent loads corresponds to the values below:

Free length **A** = 52 mm
Length **B** compressed by a 210.6 N = 35.8 mm
Length **C** compressed by a 340.6 N = 25.8 mm

Replace spring if length is 1 mm or more below the stated values.

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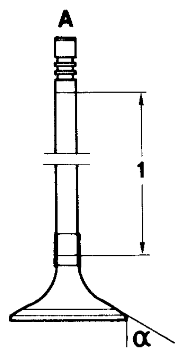


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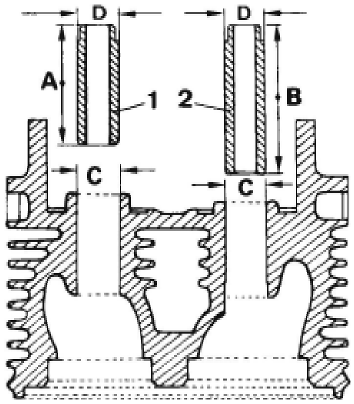
## Valve material

**Intake valves A**
Material: X 45 Cr Si 9-3 UNI En 10090
**1** Chromium-plated portion
**a** 45.5° ÷ 45.75°

**Exhaust valve B**
Shaft and head are made of 2 different materials.
**2** Welded portion
**3** Chromium-plated portion
**4** Portion made of X 45 Cr Si 9 - 3 UNI EN 10090
**5** Portion made of X 55 Cr Mn Ni N 20 - 8 UNI EN 10090
**a** 45.5° ÷ 45.75°



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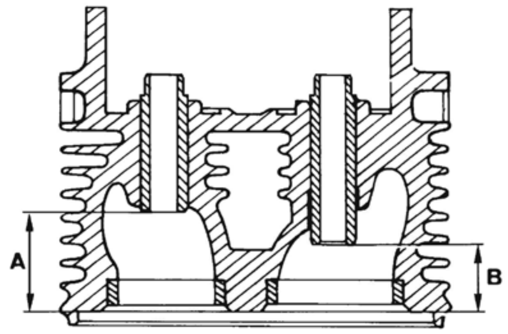
**Valve guides and valve guide housings**

Starting from engine No. 2883619 intake and exhaust valve guides are both made of phosphoric cast iron.

*Components:*
**1** = Exhaust valve guide
**2** = Intake valve guide

| ***Ref.*** | ***Dimensions*** **(mm)** |
|---|---|
| A | 42.0 |
| B | 48 |
| C | 14.000 ÷ 14.018 |
| D | 14.045 ÷ 14.056 |

Valve guides with outside diameter increased by 0.5 mm. are also available;in such cases valve guide bore **C** shouid also be increased by 0.5 mm.



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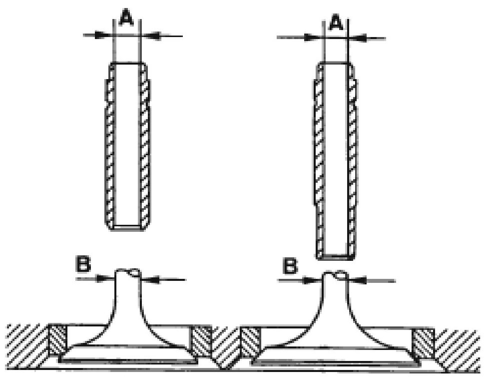
**Valve guide insertion**

Heat cylinder head up to 160÷180°C
Press guides considering the **A** and **B** distances from the head plane.

| ***Ref.*** | ***Dimensions*** **(mm)** |
|---|---|
| A | 30,80÷31,20 |
| B | 24,80÷25,20 |



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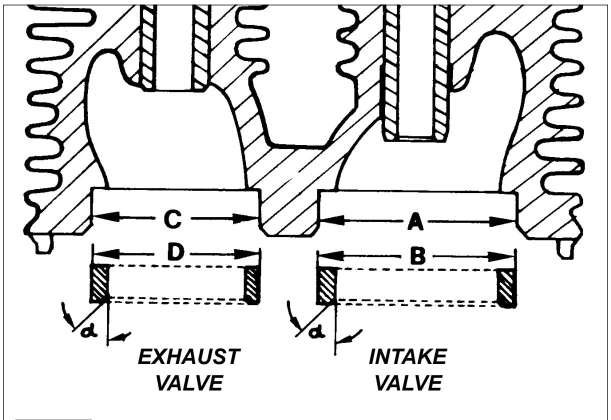
**Dimensions and clearance between guides and valves**

| ***Ref.*** | ***Dimensions (mm)*** | ***Clearance (mm)*** | ***Limit value (mm)*** |
|---|---|---|---|
| A | 8,025÷8,040* | 0,025÷0,055 | 0,15 |
| B | 7,985÷8,000 | | |

* with driven guide.

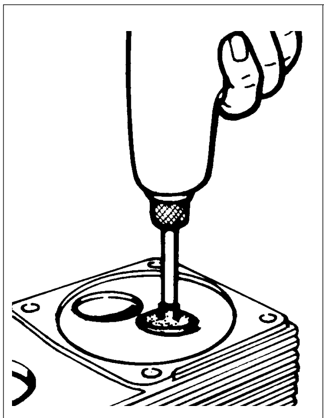



40

### Valve seats and housings

| *Ref.* | ***Dimensions*** **(mm)** |
|---|---|
| A | 40.000 ÷ 40.016 |
| B | 40.081 ÷ 40.095 |
| C | 34.000 ÷ 34.016 |
| D | 34.081 ÷ 34.095 |

Press valve seats into the housings and cut at 45°.



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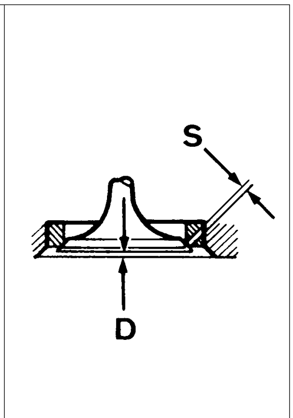


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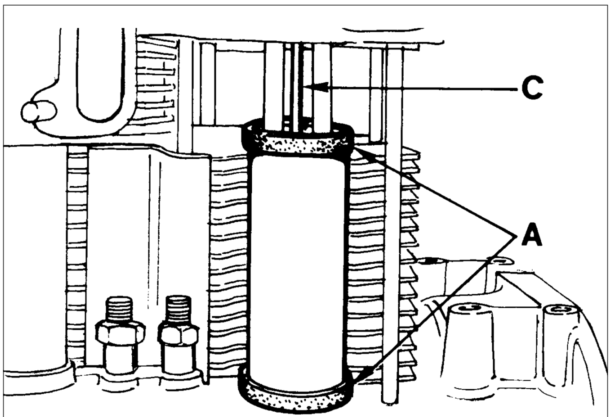
### Valve seat grinding

After cutting grind valve seats with fine emery paste in oil suspension.
The sealing surface **S** should not exceed 2 mm.
Valve recess after grinding **D** = 0.75÷1.25 mm; maximum worn limit 1.65 mm.

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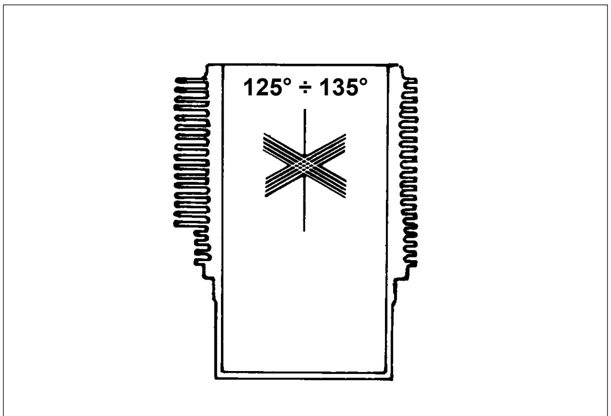
### Pushrod tube

When refitting cheek that gaskets **A** and rocker arm lubricatíon tube **C** are well inside their seats.

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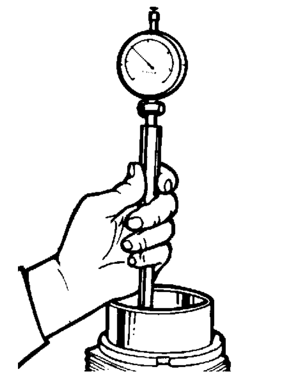
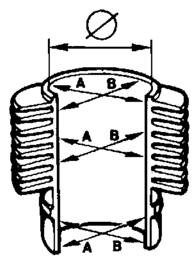
## CYLINDER

*Checks and cylinder roughness*

Fins must be intact.
Cross hatch pattern must range between 125°÷135°: they must be uniform and clear in both directions.
Average roughness should range between 0.35 and 0.60 µm.


45



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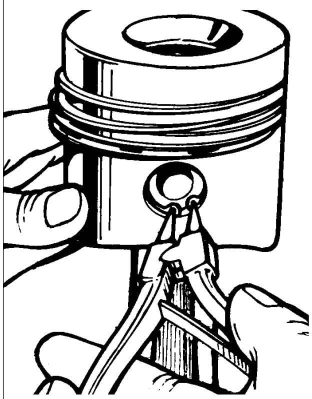
Measure diameter size between two diametrically opposed points at three different heights.

➲ As per the cylinder sizes, see Table “Piston and cylinder types and sizes".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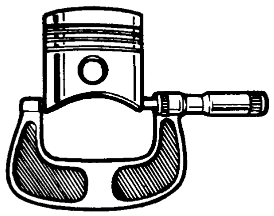
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## PISTON

Remove circlips and remove piston pin.
Remove piston rings and clean grooves.
Measure diameter at 17 mm from the bottom of skirt.

***Table “Piston and cylinder types and sizes"***

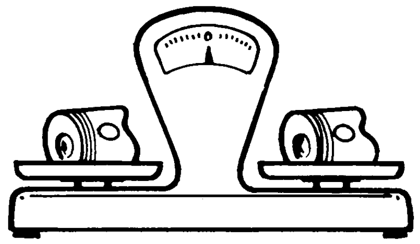
| Class | Ø Piston (mm) | Ø Cylinder (mm) | Clearance (mm) |
|---|---|---|---|
| A | 94.92 ÷ 94.93 * | 95.00 ÷ 95.01 * | 0.07 ÷ 0.09 |
| B | 94.93 ÷ 94.94 * | 95.01 ÷ 95.02 * | |
| C | 94.94 ÷ 94.95 * | 95.02 ÷ 95.03 ** | |

* In case of diameter wear above 0.05 mm replace piston and piston rings.

** In case wear exceeds 0.10 mm, bore the cylinder and fit oversize piston and rings.
In case of less wear replace piston rings only.

***Note:*** Oversize pistons of 0.5 and 1 .0 mm are available (only for standard and 97/68 CE engines).

**Important**
**The cylinder heads must be tightened with the exhaust or intake manifold mounted to keep them lined up.**
**The cylinder and piston must be replaced with a new cylinder and piston of the same class.**



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**Piston weight**

Weigh pistons when replacing them in order to avoid unbalance.

**Important**
**The difference in weight should not exceed 6 g.**


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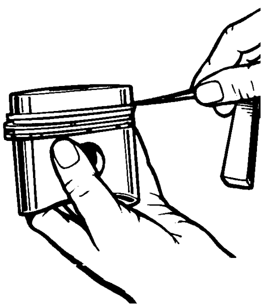
**Piston rings - End gaps (mm)**

Place piston rings squarely into the unworn part of the lower cylinder and measure the end gap.

| | | A |
|---|---|---|
| 1° | Chromium-plated ring | 0.40mm÷0.65mm |
| 2° | Torsional internal tapered ring | 0.40mm÷0.65mm |
| 3° | Oil control ring | 0.30mm÷0.60mm |



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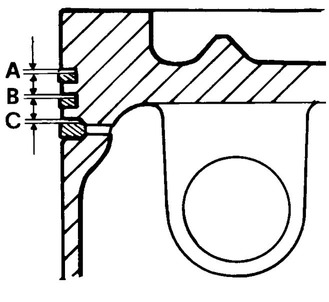


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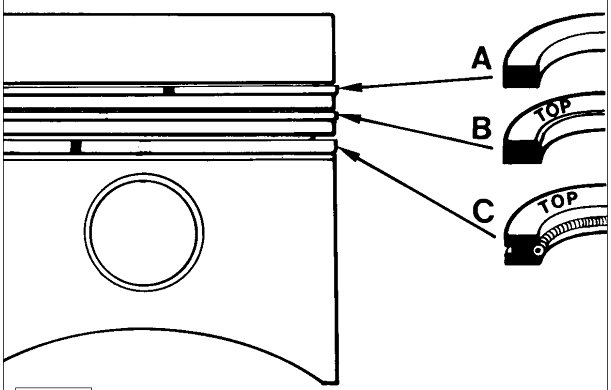
**Pistons rings - Clearance between grooves (mm)**

| ***Ref.*** | ***Dimensions* (mm)** | ***Limit value* (mm)** |
|---|---|---|
| A | 0,07÷0,11 | 0,20 |
| B | 0,05÷0,09 | 0,16 |
| C | 0,04÷0,08 | 0,15 |

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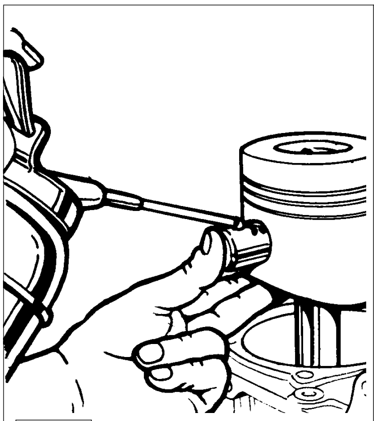
**Piston rings - Fitting sequence**

**A** = 1° Chromium-plated ring
**B** = 2° Torsional (internal tapered) ring
**C** = 3° Oil control ring

**Important**
**Before fitting the piston into the cylinder stagger the ring gaps at 120°.**



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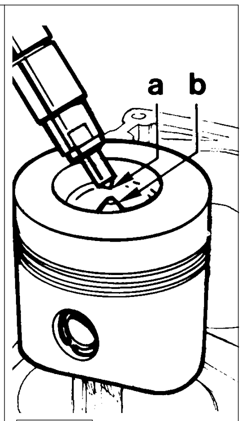


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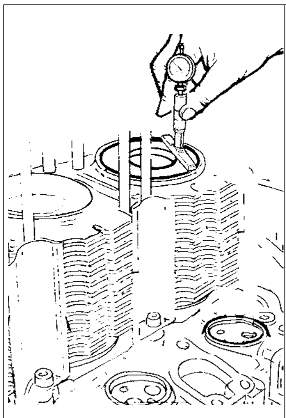
**Piston - Refitting**

Connect piston to connecting rod in a way that the combustion chamber centre **b** is at right angle under nozzle tip **a**.
Lubricate piston pin and introduce it into the piston by exerting pressure with your thumb.
Check that both circlips are well inside their seats.



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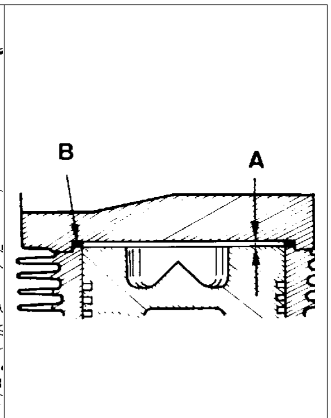


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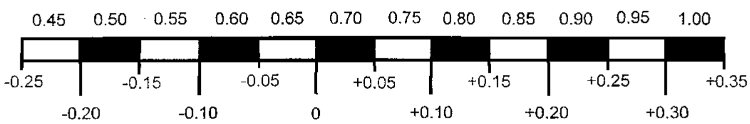
**Piston clearance**

Piston clearance = 0.65 ÷ 0.70 mm, for standard engines
= 0.55 ÷ 0.60 mm, for 97/68 CE and EPA engines

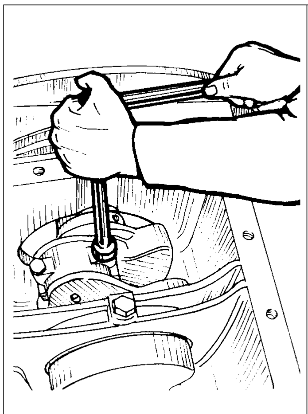
The piston in the **TDC** (top dead centre) position may extend or be short of the upper surface of the cylinder.
Use a dial indicator to measure the difference between the two surfaces (piston crown and upper cylinder surface) and use a suitable thickness copper gasket **B** for the cylinder head to adjust the clearance volume **A**.

(See image below)

**Head seal thickness**




**Distance between the piston at the top dead centre and the cylinder surface**



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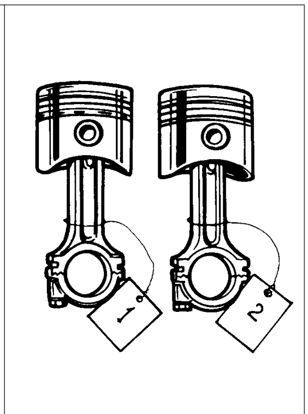


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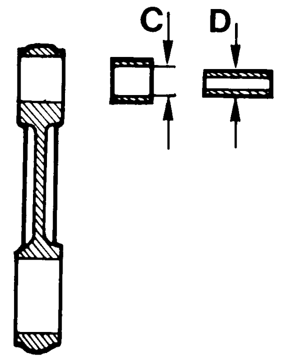
## CONNECTING ROD

Remove the oil sump.
Remove the connecting rod cap.

**Important**
**Both connecting rod/piston units should be fitted back into the corresponding cylinders; mark them so as to identify the correct combination during reassembly.**

➲ See page 40 for specifications as to the tightening of the connecting rod big end bearing.

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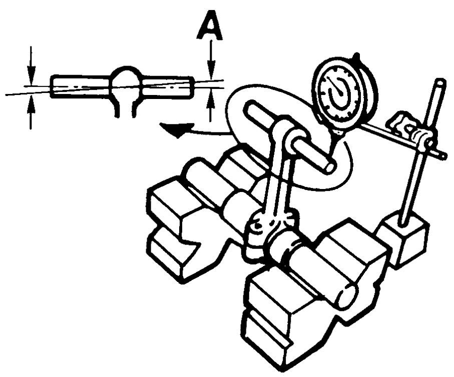
### Connecting rod small end bushing

*Dimensions and clearance (mm):*
**C** = 25.020÷25.030 (with machined bushing in place)
**D** = 24.995÷25.000
**(C-D)** = 0.020÷0.035
**(C-D)** maximum worn limit = 0.070

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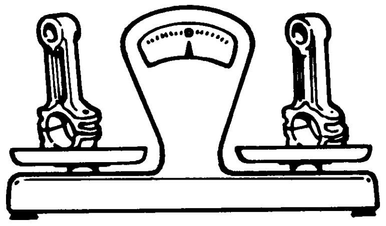
### Connecting rod alignment

Check alignment of small end and big end bearing bores using fitted mandrels; axial mis-alignment **A** = 0.02 mm; maximum limit = 0.05 mm.



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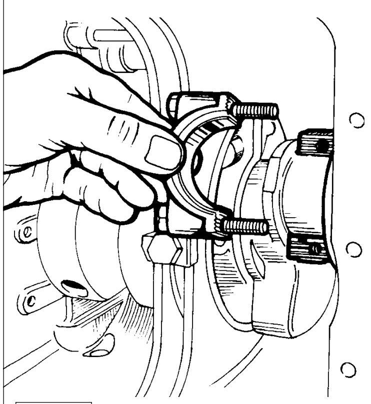
### Connecting rod weight

Weigh connecting rods when replacing them in order to avoid unbalance.

**Important**
**The difference in weight should not exceed 10 g.**



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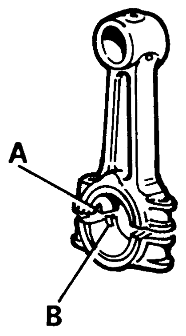


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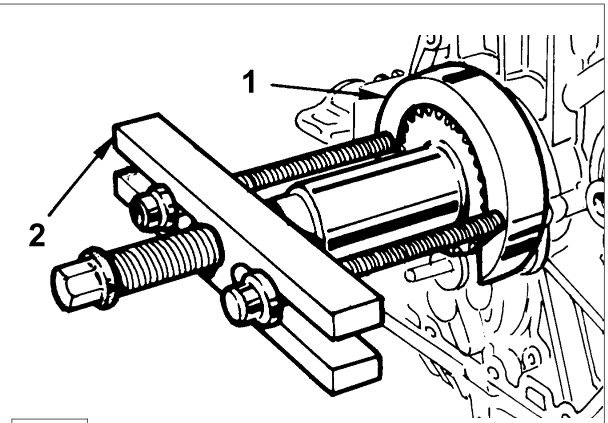
### Connecting rod big end bearing

Both centering notches of the bearings **A** and **B** must be on the same side when refitting.

❍ Tighten bolts at 40 Nm.

➲ See page 44 for dimensions.

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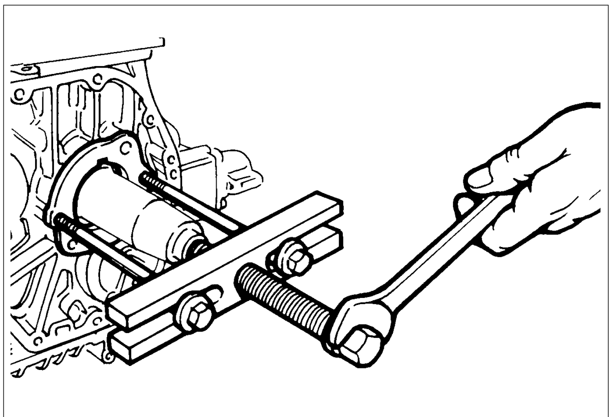
## CRANKSHAFT TIMING GEAR

*Disassembly:*
Use tool **1** (Part N°. 7560-4000-052) and puller **2** (Part N°. 7271-1460-119) to remove the gear.

*Reassembly:*
Heat the gear uniformly and keep it at a temperature of 300 °C for 15 – 20 minutes.

**Caution – Warning**
**Danger of burning: pay attention to the hot surfaces.**

Insert the gear into its seat by inserting the activation key into the gear opening and push until it comes into contact with the driving shaft.
Let it slowly cool down.



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## MAIN BEARING SUPPORTS

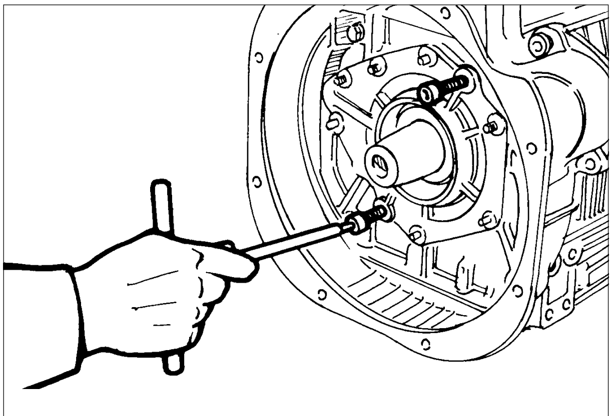
**Main bearing support, gear side**

Remove main bearing by means of two M8x1.25 screws with fully threaded length of 40 mm or a puller (Part N°. 7271-1460-119).

***Note:*** To avoid deformation it is not recomended to replace the bearing bushing, complete assembly's of bushing and support are available in standard, 0.25 mm and 0.50 mm undersize configurations as spare parts.

❍ When refitting tighten the screws at 30 Nm.

➲ See page 44 ÷ 45 for dimensions.



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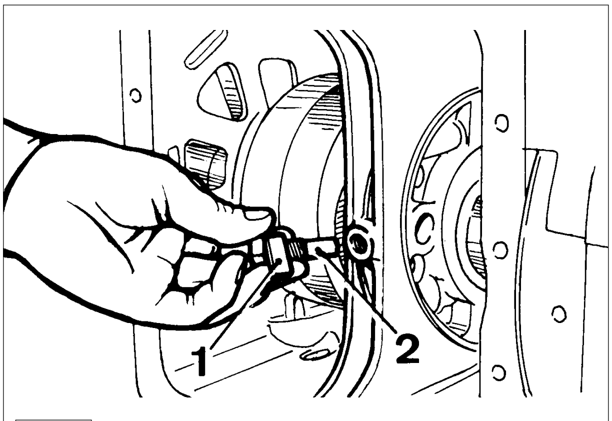
**Main bearing support, flywheel side**

Remove it by means of two M8x1.25 screws with fully threaded length of 40 mm.
Check oil seal ring and replace if warped, hardened or worn-out.

❍ When refitting, tighten nuts at 30 Nm.

➲ See end float on page 45 for gasket replacement detaiis.

➲ See page 44 ÷ 45 for dimensions.

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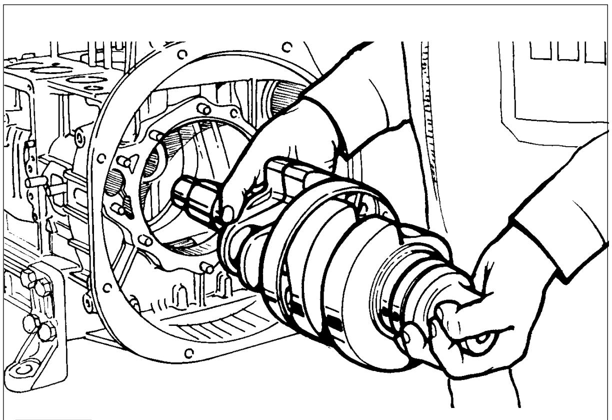
## CRANKSHAFT

**Center main bearing support, locating screw.**

Straighten plate **1** and unscrew screw **2** before removing crankshaft.

❍ When assembling tighten the screw at a torque of 30 Nm.



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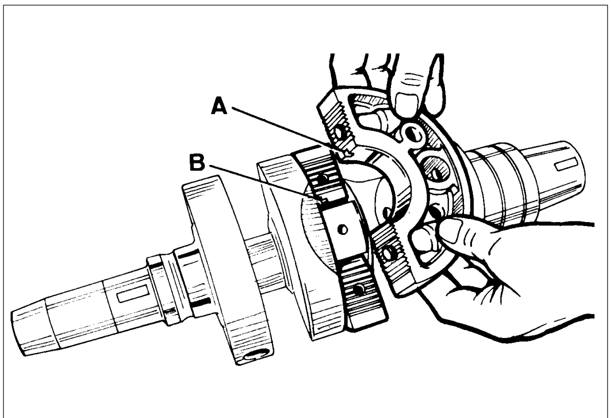
**Crankshaft removal**

To pull out the crankshaft tap lightfy on the timing side end using a copper-headed hammer.
When refitting align center main bearing support so that the locating screw hole coincides with the crankcase hole.

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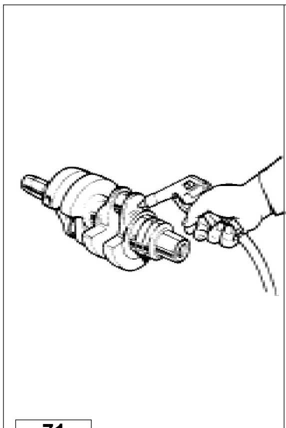
**Crankshaft center main bearing support**

When refitting, both centering notches **A** and **B** must be located on the same side.

❍ Tighten screws at 25 Nm.

➲ See page 44 ÷ 45 for dimensions.



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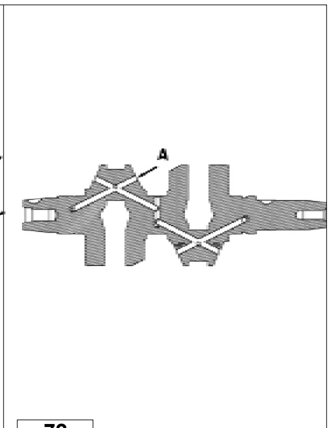


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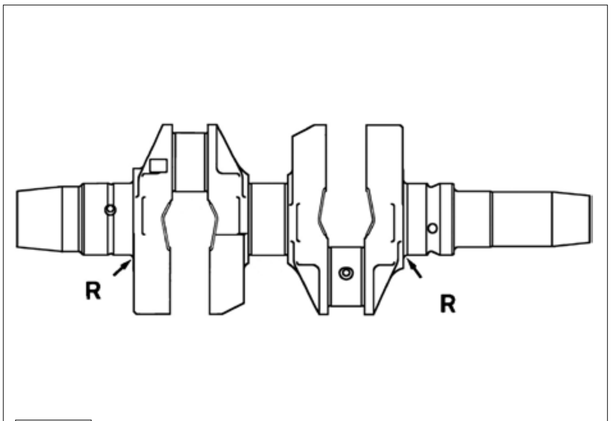
**Crankshaft lubrication ducts**

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

Remove plugs, clean duct **A** with a pointed tool and blow in compressed air. Screw plugs again and check for sealing.

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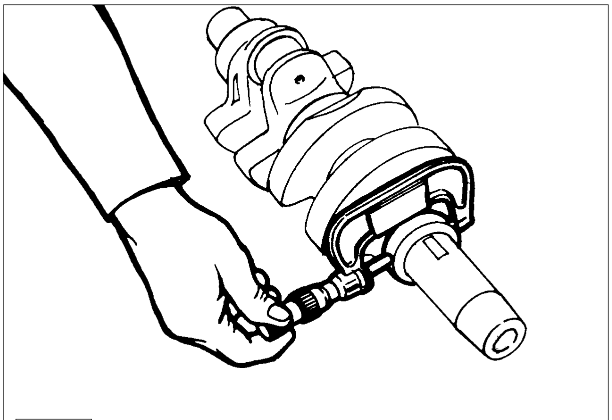
### Crankshaft journal radius

The radius **R** connecting journals to shoulders is 2.8÷3.2 mm.

**Important**
**When grinding external main journals restore the R value to original specification.**



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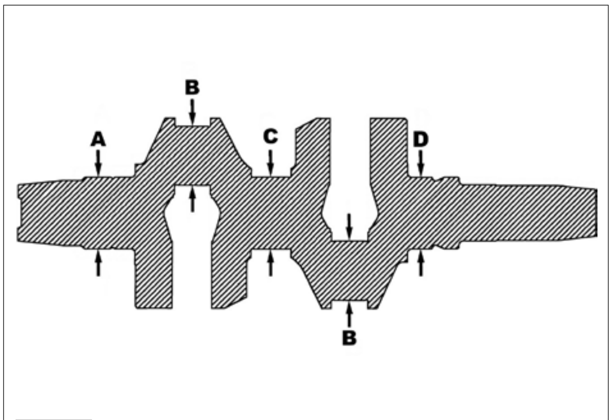
### Checking main journals and crank pins

Use an outside micrometer gauge.

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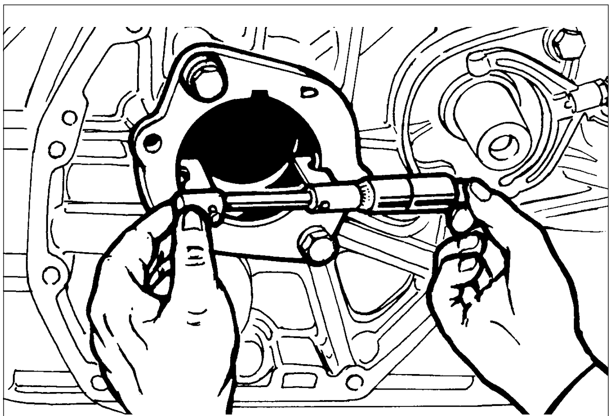
### Main journal and crank pin diameter

| *Ref.* | ***Dimensions*** **(mm)** |
|---|---|
| A | 54.931÷54.950 |
| B | 45.500÷45.516 |
| C | 55.331÷55.350 |
| D | 54.931÷54.950 |



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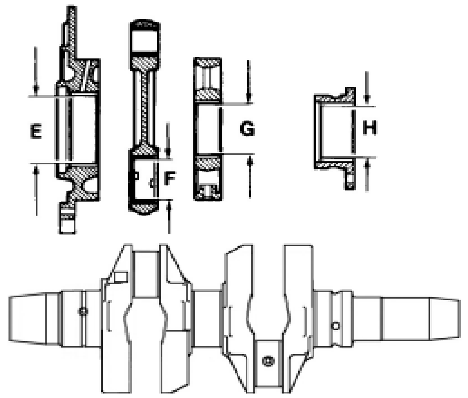
### How to measure main bearing inside diameter

Use an inside micrometer gauge.



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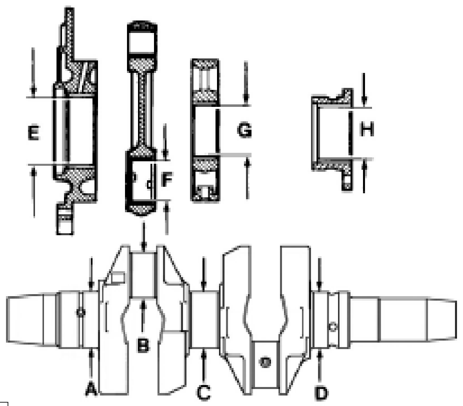
**Main bearing and connecting rod big end bearing inside diameter**

| *Ref.* | *Dimensions* (mm) |
|---|---|
| E | 55.000÷55.020 |
| F | 45.548÷45.578 |
| G | 55.404÷55.435 |
| H | 55.000÷55.020 |

The above dimensions refer to driven in or tightened bearings.

***Note:*** Both main bearings and connecting rod big end bearings are available with inside diameter size measuring 0.25 and 0.50 mm less than the standard version.



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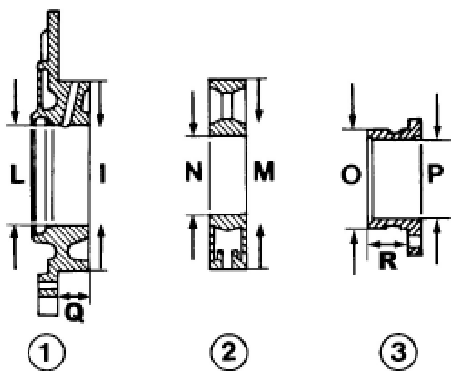
**Clearance between main journals/crank pins and connecting rod bearings**

| *Ref.* | *Clearance* (mm) | *Limit value* (mm) |
|---|---|---|
| E-A | 0.050÷0.089 | 0.180 |
| F-B | 0.032÷0.078 | 0.150 |
| G-C | 0.054÷0.104 | 0.190 |
| H-D | 0.050÷0.089 | 0.180 |



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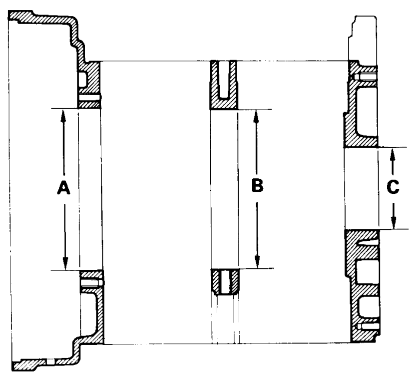
**Main bearíng supports - Dimensions**

**1** Flywheel side
**2** Central
**3** Gear side

| *Ref.* | *Dimensions* (mm) |
|---|---|
| I | 149.000 ÷ 149.020 |
| L | 60.000 ÷ 60.020 |
| M | 147.000 ÷ 147.018 |
| N | 59.074 ÷ 59.093 |
| O | 75.990 ÷ 76.010 |
| P | 60.000 ÷ 60.020 |
| Q | 23.95 ÷ 24.05 |
| R | 31.10 ÷ 31.20 |



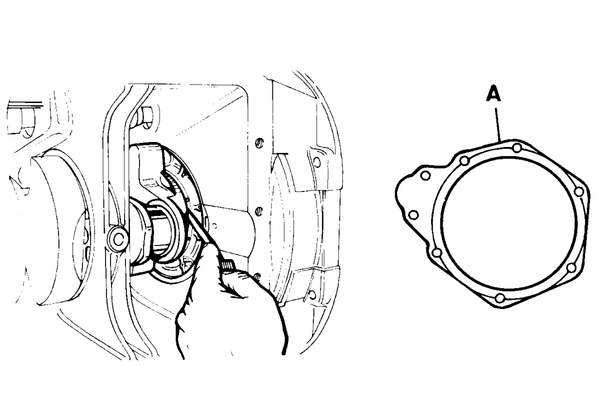
80

**Main bearing housings**

| *Ref.* | *Dimensions* (mm) |
|---|---|
| A | 149,000÷149,020 |
| B | 147,000÷147,020 |
| C | 76,000÷76,020 |

***Table "Clearance between main bearings and main bearing housings"***

| *Ref.* | *Clearance* (mm) | *Limit value* (mm) |
|---|---|---|
| A-I | -0,020÷0,020 | 0,03 |
| B-M | -0,018÷0,020 | 0,03 |
| C-O | -0,010÷0,030 | 0,04 |



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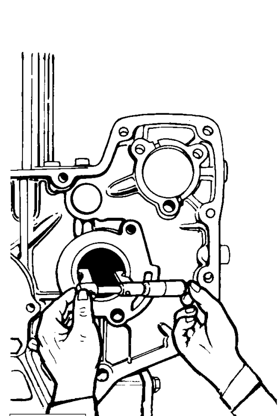
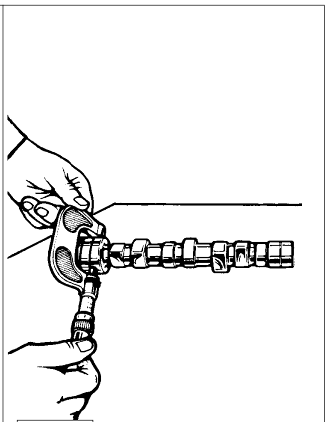
**Crankshaft end play**

When refitting crankshaft check end play by means of a thickness gauge; this value should be 0.08 ÷ 0.38 mm and can be set by changing the thickness of gasket **A** which is located on the flywheel-side main bearings.
Gaskets with thickness of 0.30 and 0.50 mm can be supplied.

**Important**
**Replace the main bearings 1 and 3 (Fig. 79) if the axial clearance value still turns out to be too high even with a seal having a smaller thickness (fig. 79).**

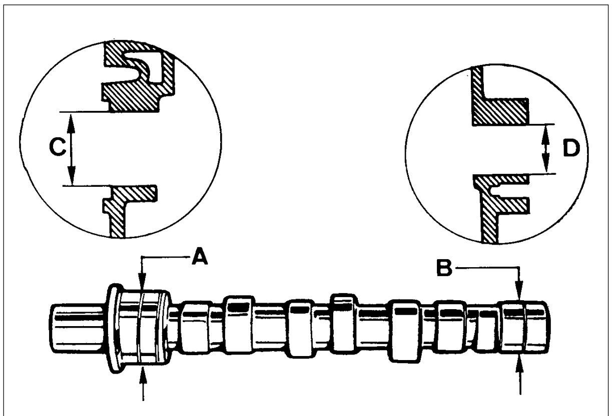

82


83

## CAMSHAFT

**How to measure camshaft journals and housings**

Use an inside micrometer gauge for housings and an outside micrometer gauge for journals.



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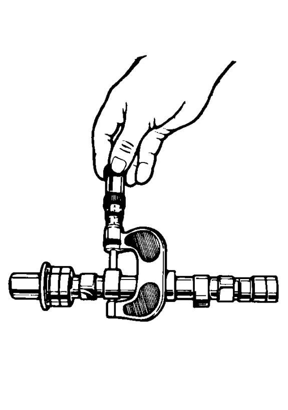
**Dimensions of camshaft journals and housings**

| *Ref.* | *Dimensions* (mm) | *Clearance* (mm) | *Limit value* (mm) |
|---|---|---|---|
| A | 41,940÷41,960 | 0,040÷0,085 | 0,160 |
| C | 42,000÷42,025 | | |
| B | 27,940÷27,960 | 0,040÷0,085 | 0,150 |
| D | 28,000÷28,025 | | |



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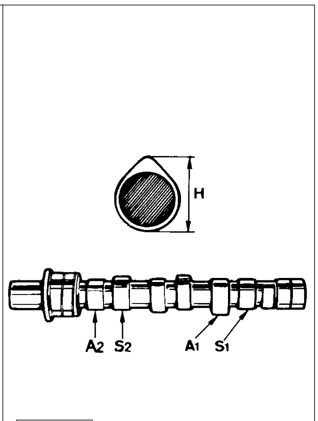


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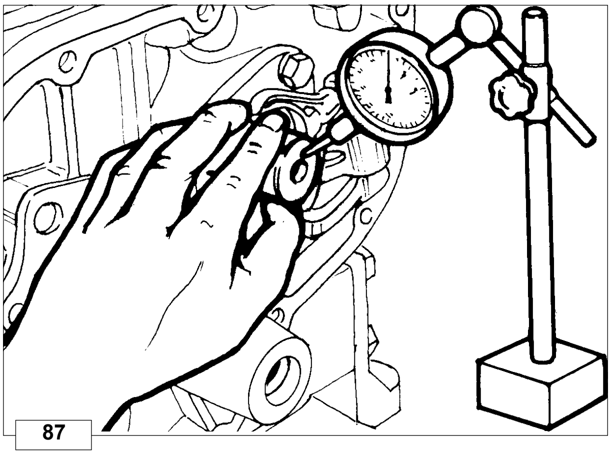
### How to measure intake/exhaust cam height

**A1** = 1 st cylinder intake cam
**S1** = 1 st cylinder exhaust cam
**A2** = 2nd cylinder intake cam
**S2** = 2nd cylinder exhaust cam

Exhaust and intake cams feature the same height **H**.

**H** = 33.625 ÷ 33.650 mm

Replace camshaft if **H** is 0.1 mm below the given value.



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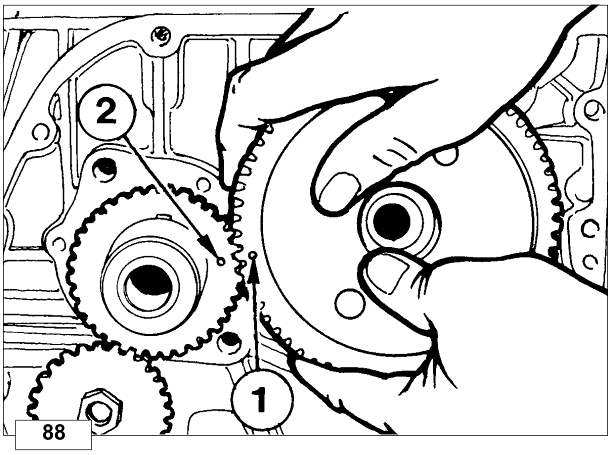
### Camshaft end play

End play should be 0.10÷0.25 mm; check by means of a dial gauge pushing or pulling camshaft as required.

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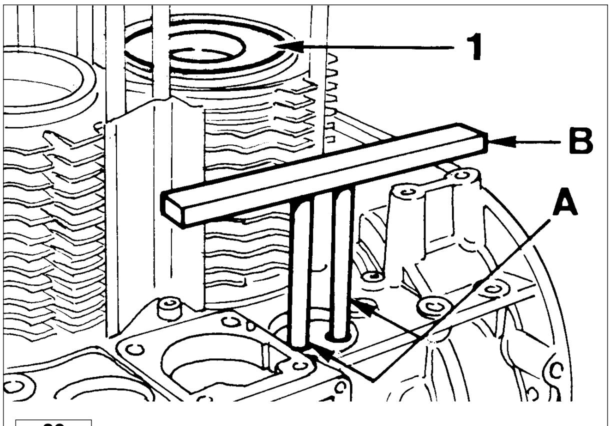
## CAMSHAFT TIMING

Fit camshaft gear by making timing mark **1** coincide with timing -mark **2** on the crankshaft timing gear.

❍ Tighten camshaft boll at 60 Nm.

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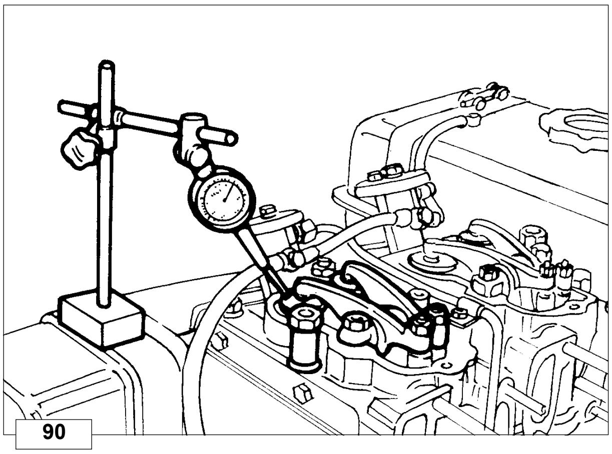
### Valve timing without considering timing marks

Locate piston **1** (on flywheel side) at the top dead centre.
Position two small cylinders **A** of the same height onto the tappets.
Rotate camshaft stopping when cylinder **1** tappets are in overlap position (intake open, exhaust closed).
By means of ruler **B** check that tappets are at the same height.
Engage camshaft gear with crankshaft gear.



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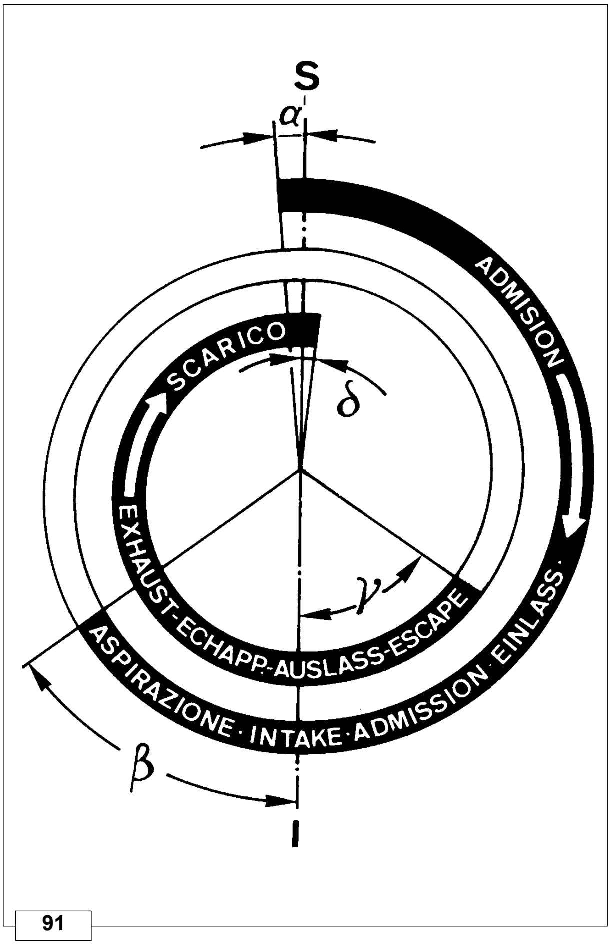
**Valve timing check**

Check valve timing at the crankshaft.
The values shown are checked at the flywheel circumference (with flywheel of 291 mm. diameter each degree corresponds to 2.5 mm).
Set valve clearance at 0.65÷0.70 mm (after checking restore the value at 0.15÷0.20 mm).
Set dial gauge on intake valve to a zero value; by rotating the driving shaft according to its direction of rotation you can measure $\alpha$ (intake valve opening advance referred to top dead centre **S**) and **ß** (intake valve closing delay referred to bottom (**I**) dead centre).
Follow the same procedure for exhaust valves checking $\gamma$ (exhaust valve opening advance) and $\delta$ (exhaust valve closing delay).

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**Valve timing - Angles**

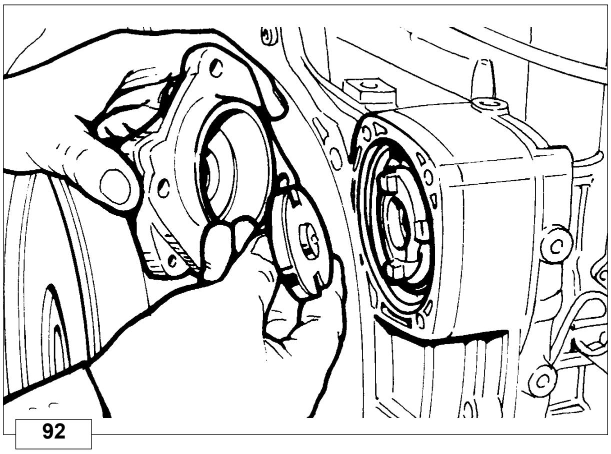
The angle values are determined by turning the driving shaft clockwise

**S** = Piston at top dead centre
**I** = Piston at bottom dead centre

$\alpha$ = Intake valve open
$\beta$ = Intake valve closed
$\gamma$ = Exhaust valve open
$\delta$ = Exhaust valve closed

***Timing angles for checking puposes (valve clearance = 0,65÷0,70 mm)***

$\alpha$ = 1° before **S**
$\beta$ = 21° after **I**
$\gamma$ = 23° before **I**
$\delta$ = 1° after **S**



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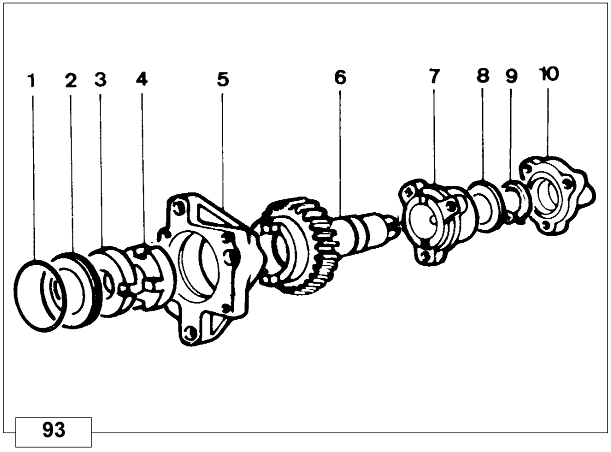
## HYDRAULIC PUMP

**Hydraulic pump p.t.o**

A hydraulic pump of group 1 (**1P**) or 2 (**2P**) can be installed on the gear side, 3rd p.t.o.

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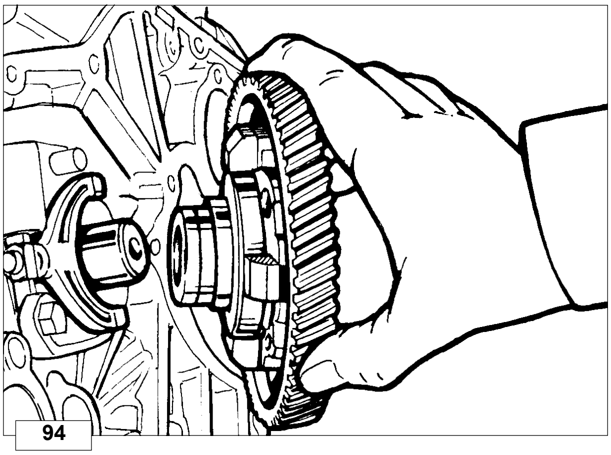
**Hydraulic pump components (1 P)**

**1** Seal ring
**2** Centering ring
**3** Coupling
**4** Half coupling
**5** Flange
**6** Gear
**7** Bracket
**8** Thrust washer
**9** Stop ring
**10** Cover

The maximum total torque is thus 30 Nm corresponding to 12.5 HP at 3000 r.p.m. Reduction ratio 1:1.



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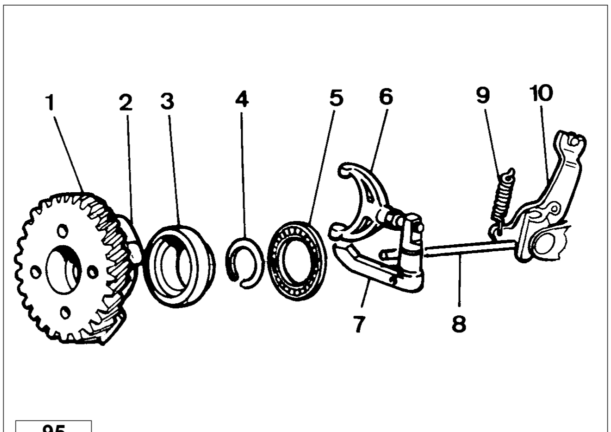
## MECHANICAL SPEED GOVERNOR

Weight-type governor housed inside the camshaft drive gear.

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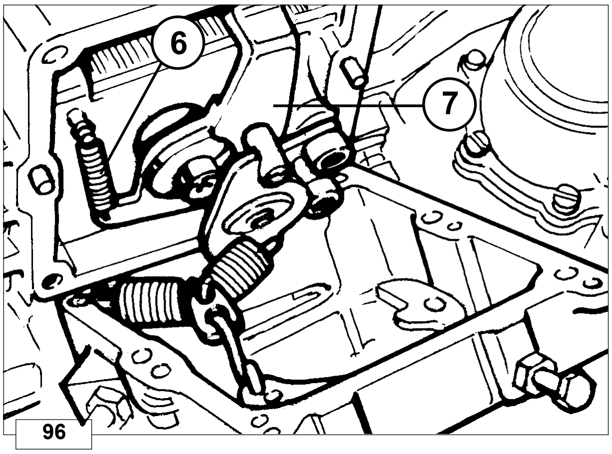
**Mechanical speed governor components**

**1** Gear
**2** Weight
**3** Mobile bell
**4** Stop ring
**5** Thrust washer
**6** Yoke
**7** Lever
**8** Drive rod
**9** Governor spring
**10** Rack control lever

Weights are moved to the periphery by the centrifugal force and thus axially shift a mobile bell connected to the injection pump rack control lever by a linkage.
A spring placed under tension by the accelerator control offset the weight centrifugal force.
Balance between the two forces keeps speed at an almost constant level in spite of load variations.

➲ See page 62 for timing.



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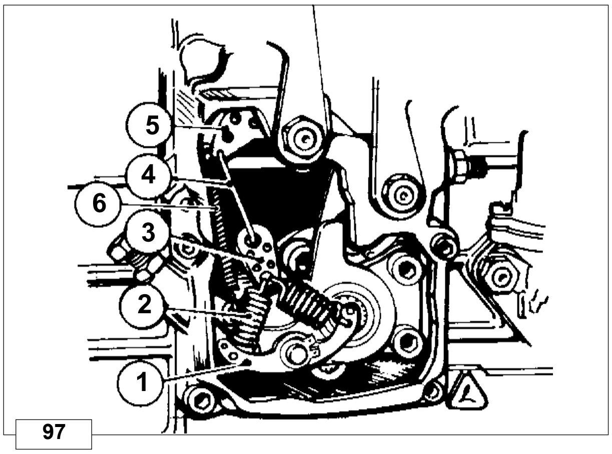
**Governor springs with rocker arm system**

The system features two springs anchored to a rocker arm and allows for minimal r.p.m. changes at low speed levels.

The device is operated automatically: when the engine is stopped spring **6** acts on injection pump control yoke **7** providing maximum fuel delivery, until the engine starts and the governor controls the iniection pump rack.



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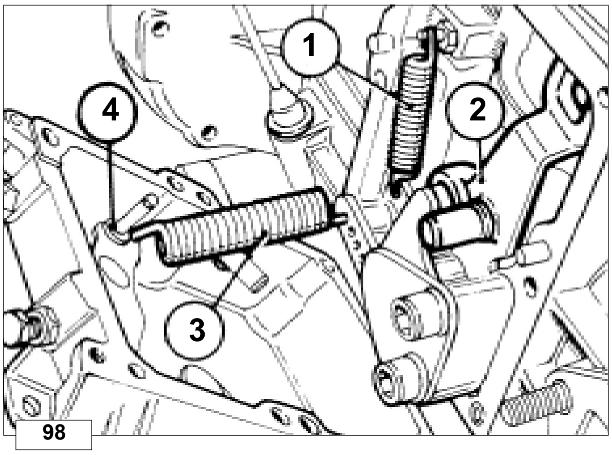
*Components:*

**1** Rocker arm for spring anchoring
**2** Governor springs
**3** Plate
**4** Link
**5** Throttle lever
**6** Supplementary start-up fuel spring



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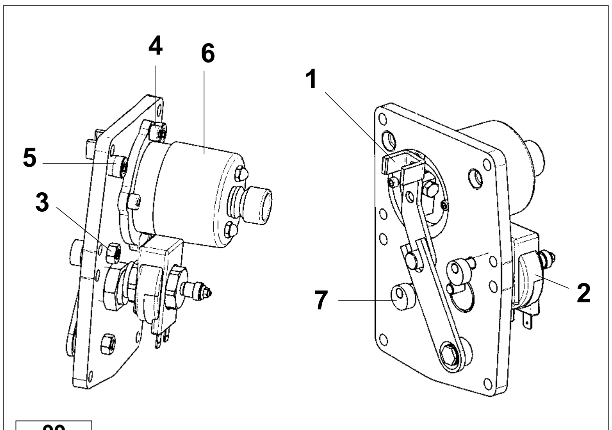
**Governor springs with single-spring system**

**1** Extra fuel spring
**2** Injection pump control lever
**3** Governor spring
**4** Throttle lever



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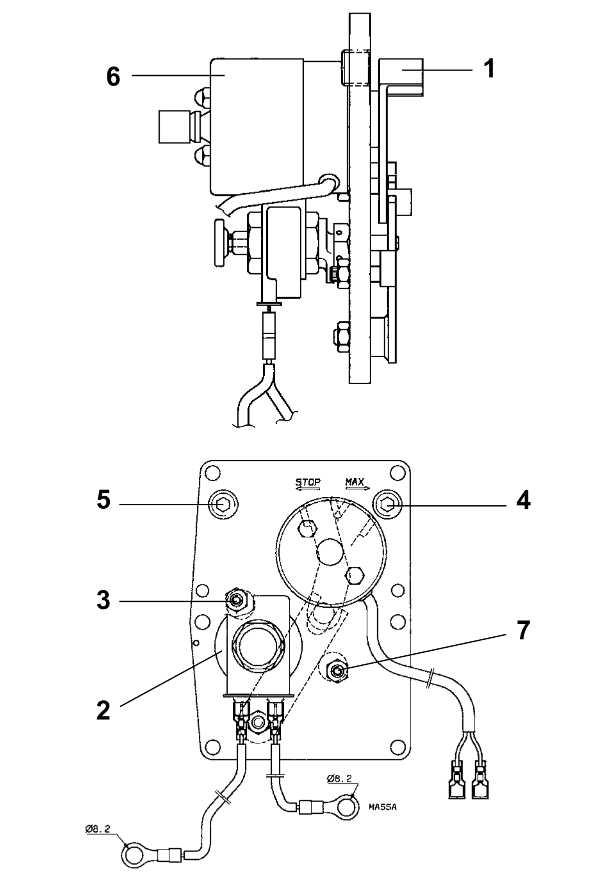
## ELECTRONIC SPEED GOVERNOR
(optional)

**1** Injection pump control lever
**2** Electromagnet
**3** Eccentric screw
**4** Conical plug
**5** Conical plug
**6** Actuator
**7** Eccentric screw

Assemble the entire plate by centring it on the reference pins and make sure that the injection pump rack rod pin is inside lever "**1**". Fix the plate by using the specific screws for its model.

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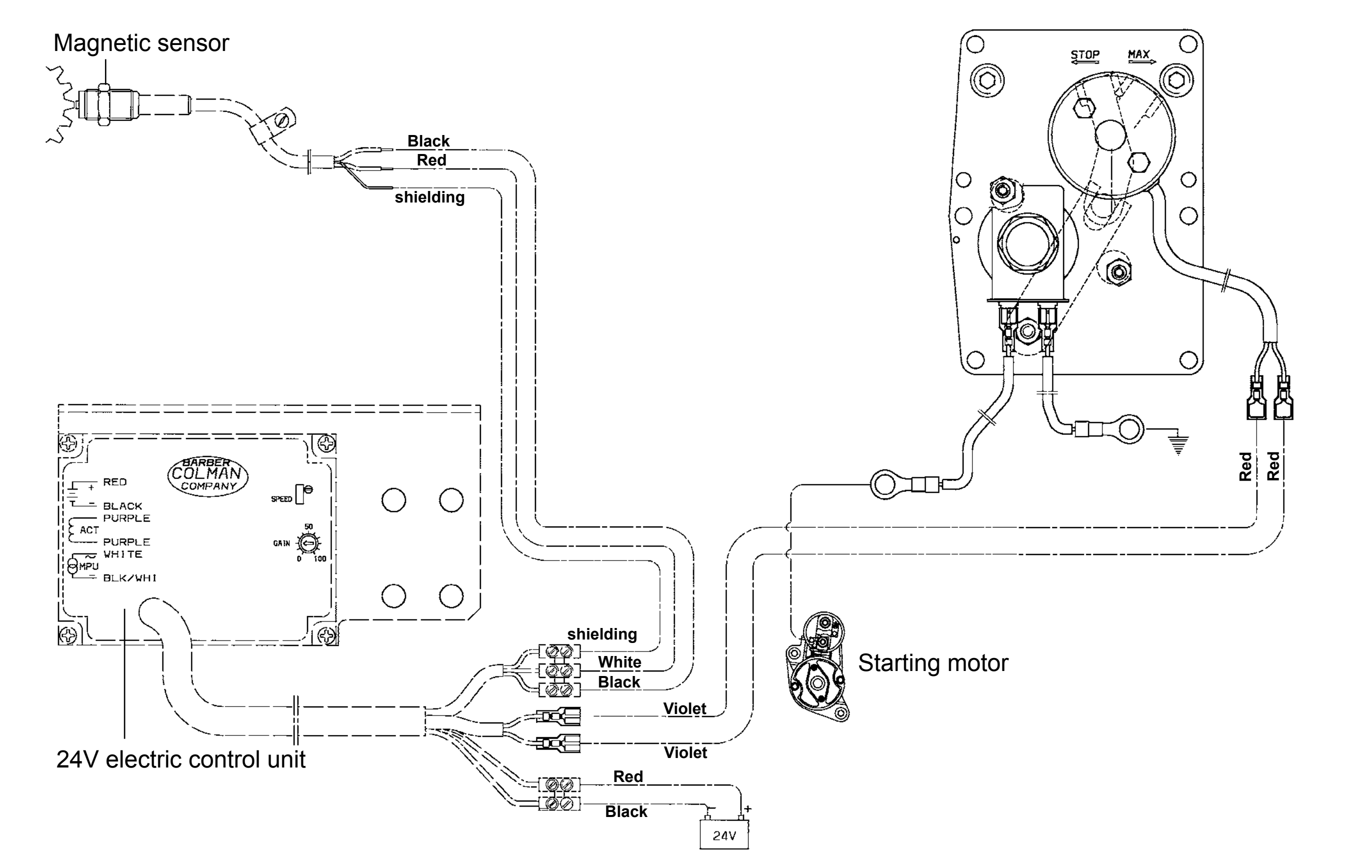
*Adjustment of the stroke end (STOP):*

1 - Remove the conical plug "**5**".
2 - Through the eccentric "**7**" position and check by sight that the lever in stop position is at the extreme left.
3 - From this position, always acting on the eccentric screw "**7**", move the control lever 1,0 ÷ 1,5 mm to right.
4 - Lock the lock nut of the screw "**7**".
5 - Reassamble the conical plug "**5**".

*Adjustment of extra fuel delivery:*

1 - Remove the conical plug "**4**".
2 - Power the electromagnet "**2**" with a 12V voltage and make sure that the plunger has moved. In this case you will hear the typical activated magnet sound.
3 - Feed actuator "**6**" with a tension of 12V (put between the actuator and the 12V a 10 Amp. fuse): the actuator tension will cause the pump delivery control lever to move to the right.
4 - By the eccentric screw "**3**" place and check by sight that the lever in Max position is at the extreme right; from this position, always acting on the screw "**3**", move the delivery control lever by 1,0 ÷ 1,5 mm to the left .
5 - Lock the lock nut of screw "**3**".
6 - Remove feeding from actuator "**6**" e electromagnet "**2**".
7 - Reassamble the conical plug "**4**".

***Speed governor wiring diagram***

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## LUBRICATION SYSTEM AND BREATHER RECIRCULATION SYSTEM

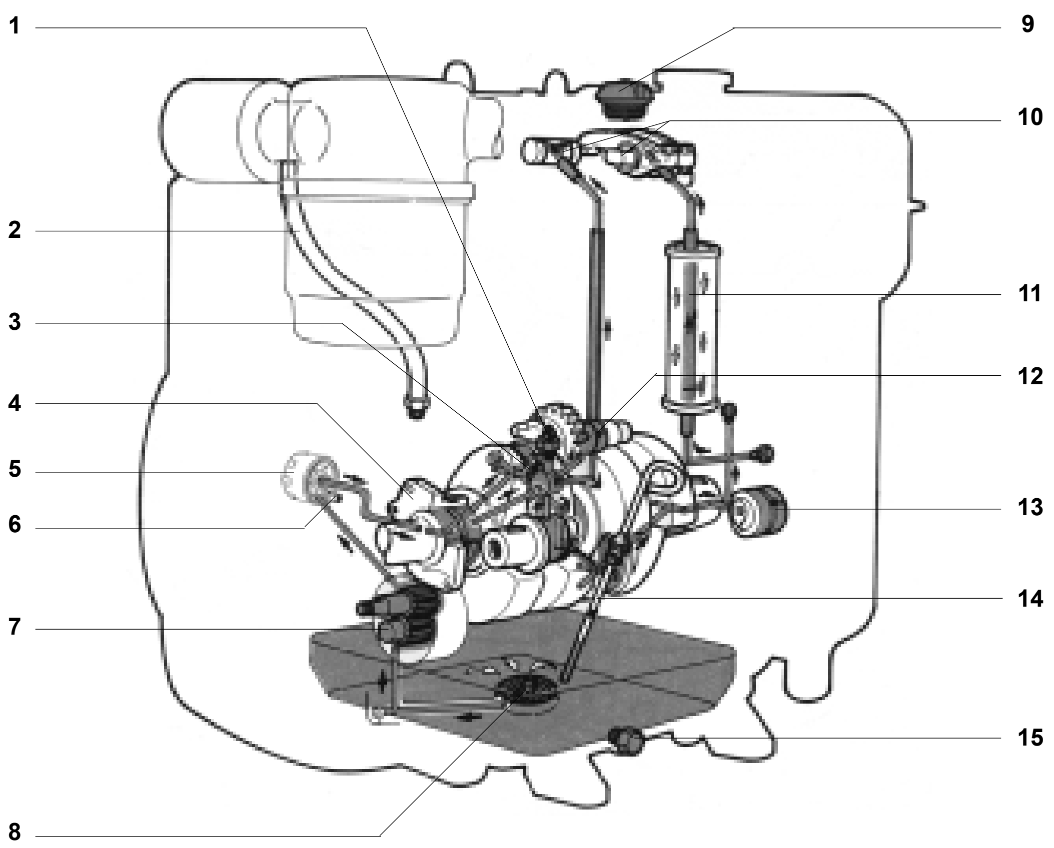
**Danger – Attention**

- **The engine can be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil because its combustion may lead to a sharp increase in the rotation speed.**
- **Use suitable oil in order to protect the engine. Nothing more than lubrication oil can influence the performances and life of an engine.**
- **Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts. Engine life will also be notably reduced.**
- **The oil viscosity must suit the ambient temperature in which the engine operates.**

**Danger – Attention**

- **Old engine oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time. Wear protective gloves to avoid touching used oil.**
- **If contact with the oil is unavoidable, you are advised to wash your hands with soap and water as soon as possible. Dispose of old oil in the correct way as it is highly polluting.**

***Standard lubrication system circuit***

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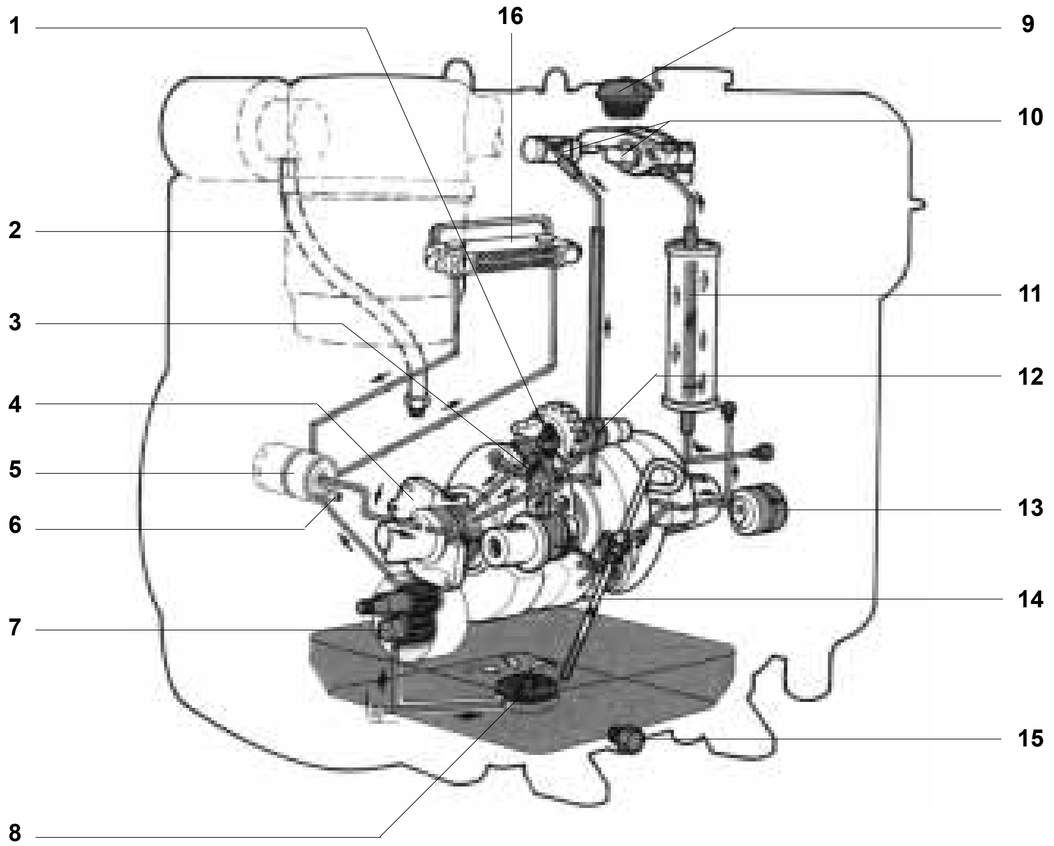
*Components:*

**1)** Oil preassure gauge
**2)** Breather
**3)** Connecting rod big end bearing
**4)** Crankshaft main bearing on gear side
**5)** Cartridge filter
**6)** Oíl pressure relief valve
**7)** Oil pump
**8)** Internal filter
**9)** Oil fill plug
**10)** Rocker arm shafts
**11)** Pushrod protection tube
**12)** Hydraulic pump gear
**13)** Camshaft joumal on fiywheel side
**14)** Oìl dipstick
**15)** Oil drain plug

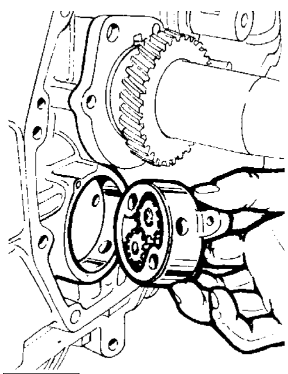
### Lubrication system with oil radiator circuit




103

*Components:*

**1)** Oil pressure gauge
**2)** Breather
**3)** Connecting rod big end bearing
**4)** Crankshaft main bearing on gear side
**5)** Cartridge filter
**6)** Oíl pressure relief valve
**7)** Oil pump
**8)** Internal filter
**9)** Oil fill plug
**10)** Rocker arm shafts
**11)** Pushrod protection tube
**12)** Hydraulic pump gear
**13)** Camshaft joumal on fiywheel side
**14)** Oìl dipstick
**15)** Oil drain plug
**16)** Oil radiator



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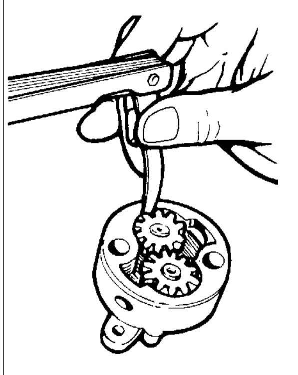

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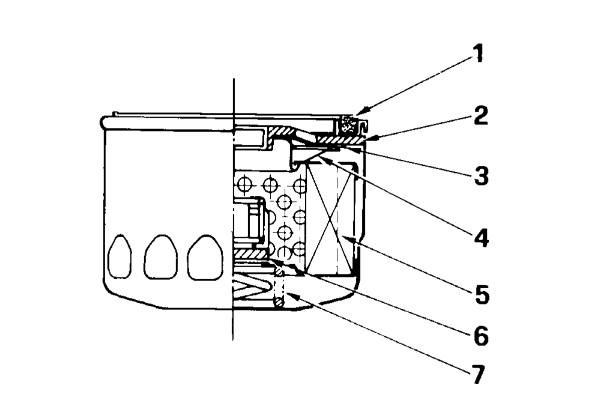
## OIL PUMP

Check that the gear teeth are intact and that clearance between gear edge and pump body does not exceed 0.15 mm.
Furthermore check that the control shaft is free to rotate with end float not exceeding 0.15 mm.
Oil pump delivery at 3000 r.p.m. is 9 liters/min.

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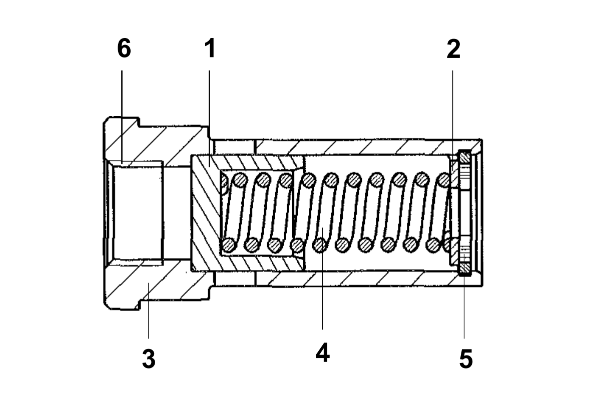
## OIL FILTER CARTRIDGE (EXTERNAL)

*Components*:
**1** Gasket
**2** Plate
**3** Gommino
**4** Spring
**5** Filter element
**6** Bypass valve
**7** Spring

➲ For characteristics see page 17.

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## OIL PRESSURE RELIEF VALVE

*Details*:

**1** Plunger
**2** Washer
**3** Valve body
**4** Spring
**5** Ring snap
**6** M9x1 threading for puller

Operation start pressure.............................5 bar.

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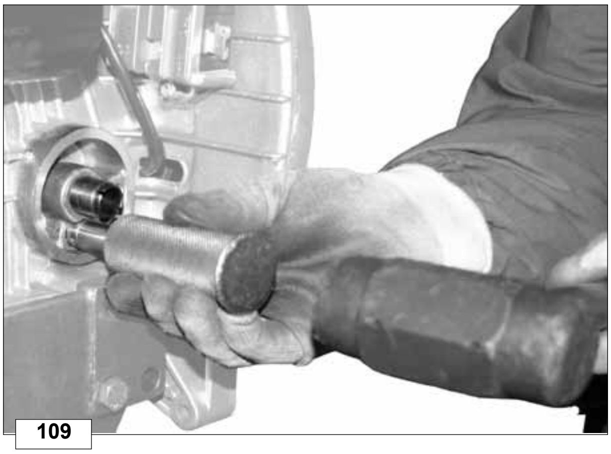
*Disassembly*:

Before removing the oil pressure regulating valve, remove the oil filter by using an appropriate wrench.

Remove the regulating valve using a hammer puller equipped with a M9x1 threaded terminal.



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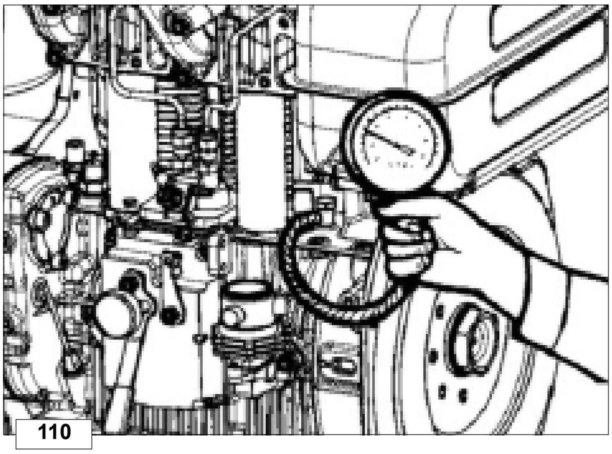
*Reassembly:*

Make sure that the valve seat is free of scratches and scores which could reduce the pressure seal.

Insert the entire oil pressure valve into its housing by keeping it in line.
Make sure that the valve is completely assembled to the engine guard by means of a pad.



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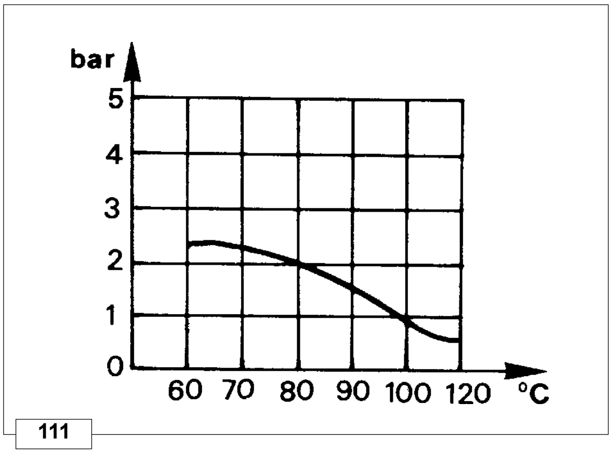
## OIL PRESSURE CHECK

Once the engine is fitted fill with oil and fuel; connect a 10 bar pressure gauge to the fitting.
Start the engine and check pressure as a function of the oil temperature .

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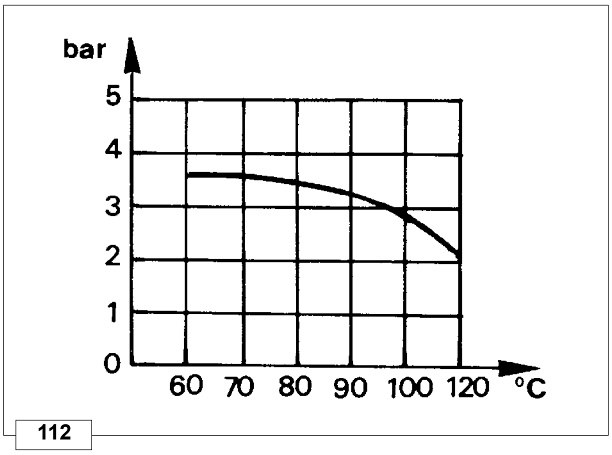
**Oil pressure curve with engine at idle speed**

The curve is obtained at the oil filter lever with constant engine speed of 1200 r.p.m. in no-load conditions and at a room temperature of + 25°C. Pressure is given in bar and temperature in centigrades.

If the oil pressure value is below the indicated one, please check all components indicated on page 52 ÷ 53.

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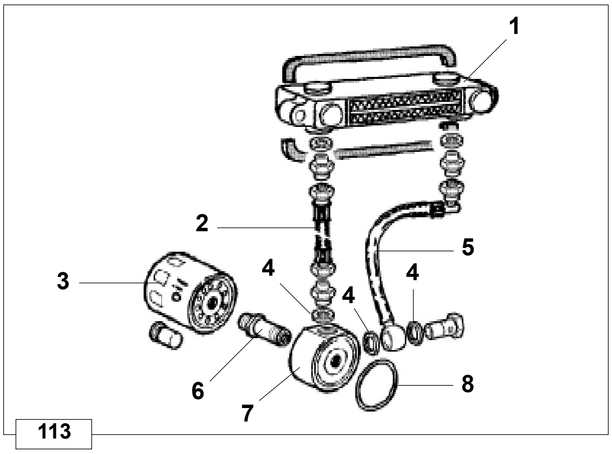
**Oil pressure curve with engine at full speed**

The curve is obtained at the oil filter level with engine working at 3000 r.p.m. and max. power at + 25°C room temperature.
Pressure is given in bar and temperature in centigrades.

If the oil pressure value is below the indicated one, please check all components indicated on page 52 ÷ 53.

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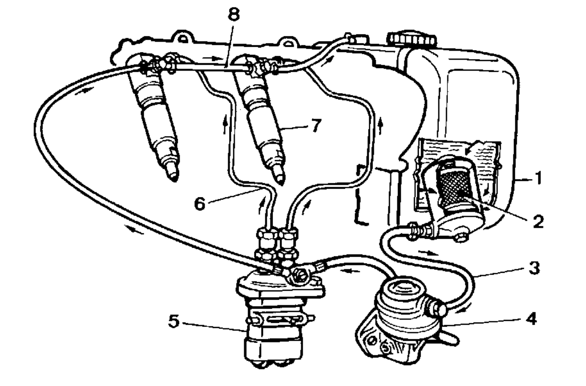
## OIL RADIATOR
**(on request)**

*Components*:

**1** Radiator
**2** Return pipe
**3** Oil filter
**4** Copper gasket
**5** Delivery hose
**6** Union
**7** Oil detection flange
**8** O-ring

## FUEL FEEDING / INJECTION CIRCUIT

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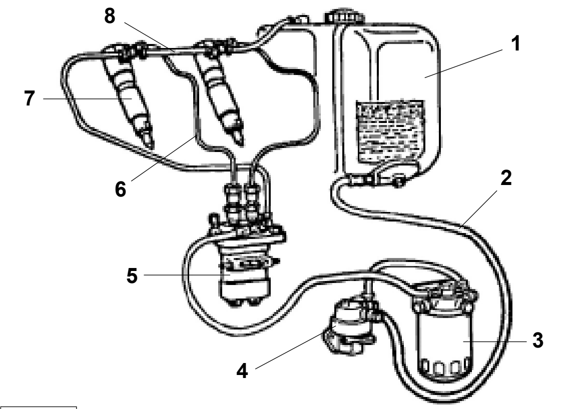
### Fuel feeding / injection circuit with fuel filter inside the fuel tank

*Components*:

**1** Fuel tank
**2** Fuel filter
**3** Fuel feeding tube
**4** Fuel lift pump
**5** Injection pump
**6** High-pressure pipe
**7** Injector
**8** Injector exhaust pipe

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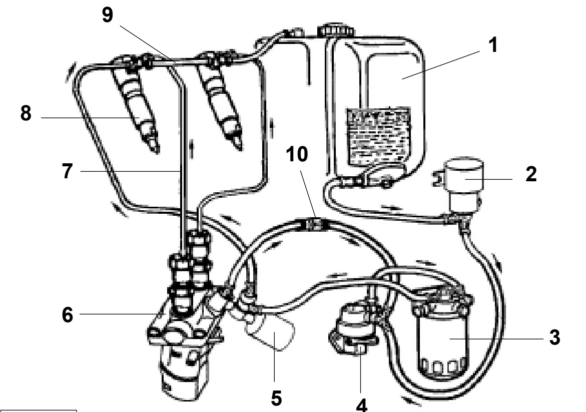
### Fuel feeding / injection circuit with external fuel filter

*Components*:

**1** Fuel tank
**2** Fuel feeding tube
**3** Fuel filter
**4** Fuel lift pump
**5** Injection pump
**6** High-pressure pipe
**7** Injector
**8** Injector exhaust pipe

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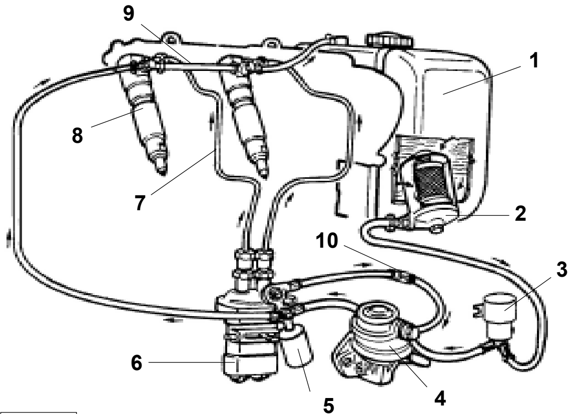
### Fuel feeding / injection circuit with external fuel filter and double solenoid valve

*Components*:

**1** Fuel tank
**2** Solenoid valve
**3** Fuel filter
**4** Fuel lift pump
**5** Solenoid valve
**6** Injection pump
**7** High-pressure pipe
**8** Injector
**9** Injector exhaust pipe
**10** Non-return valve

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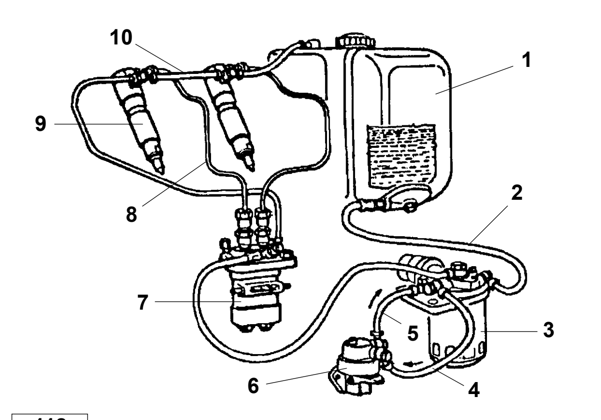
### Fuel feeding / injection circuit with fuel filter inside the fuel tank and double solenoid valve

*Components*:

**1** Fuel tank
**2** Fuel filter
**3** Solenoid valve
**4** Fuel lift pump
**5** Solenoid valve
**6** Injection pump
**7** High-pressure pipe
**8** Injector
**9** Injector exhaust pipe
**10** Non-return valve



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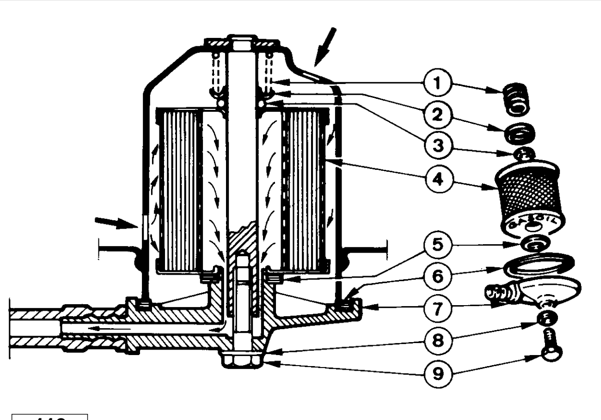
**Fuel feeding / injection circuit with external fuel filter and QSD (Quick Stop System)**

*Components*:

**1** Fuel tank
**2** Fuel feeding tube
**3** Fuel filter
**4** Fuel lift pump intake tube
**5** Fuel lift pump delivery tube
**6** Fuel lift pump
**7** Injection pump
**8** High-pressure pipe
**9** Injector
**10** Injector exhaust pipe



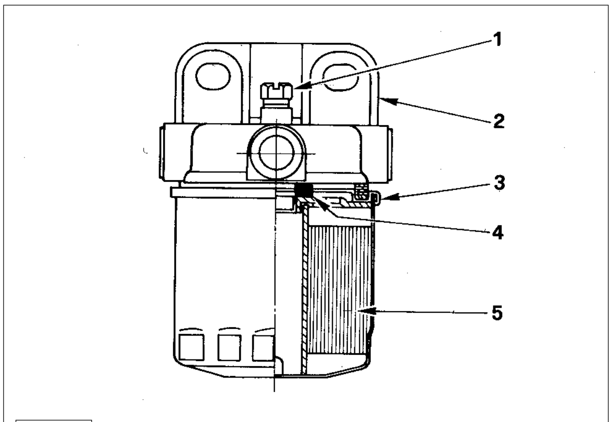
119

## FUEL FILTER

**Fuel filter (inside fuel tank)**

*Components*:
**1** Spring
**2** Disc
**3** Ring
**4** Cartridge
**5** Gasket
**6** Gasket
**7** Cap
**8** Ring
**9** Screw

➲ For characteristics see page 17.



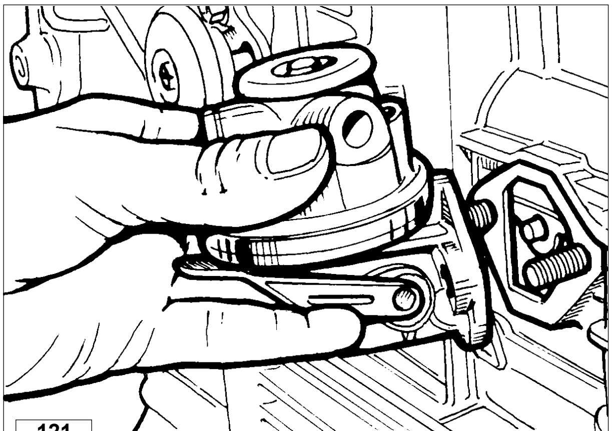
120

**Fuel filter, external**

**1** Air relief valve
**2** Support
**3** Cartridge
**4** Gasket
**5** Filtering element

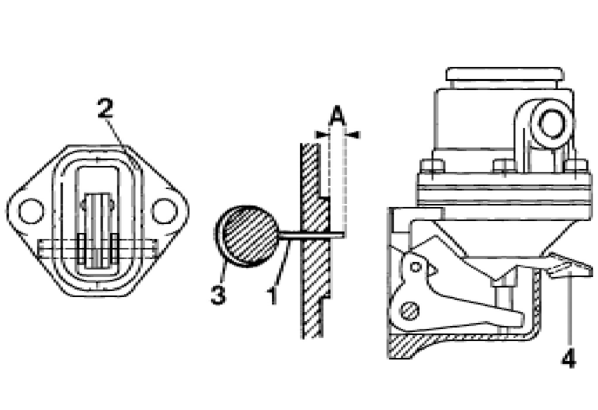
➲ For characteristics see page 17.

➲ For maintenance see page 22.


121

## FUEL LIFT PUMP

The fuel lift pump is of the diaphgragm type operated by a camshaft eccentric through a drive rod.
It features an external lever for manual operation.



122

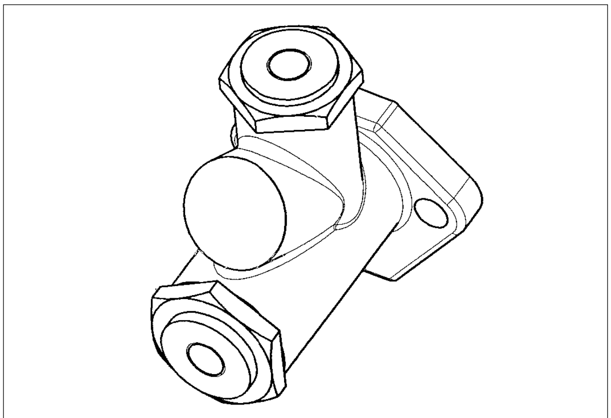
### Fuel feeding pump components

*Components*:

**1** Drive rod: - length: 32,55 ÷ 32,65 mm
- measured protrusion **A**: 1,47 ÷ 2,07 mm

**2** Gasket
**3** Camshaft eccentric
**4** Manual priming lever

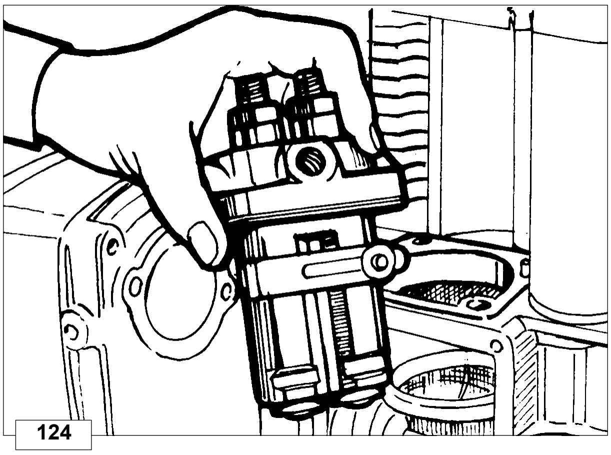
*Characteristics*:
when the control eccentric rotates at 1000 r.p.m. minimum delivery is 73 l/h while self-regulation pressure is 0.5 ÷ 0.7 bar.


123

### Piston fuel lift pump (on request)

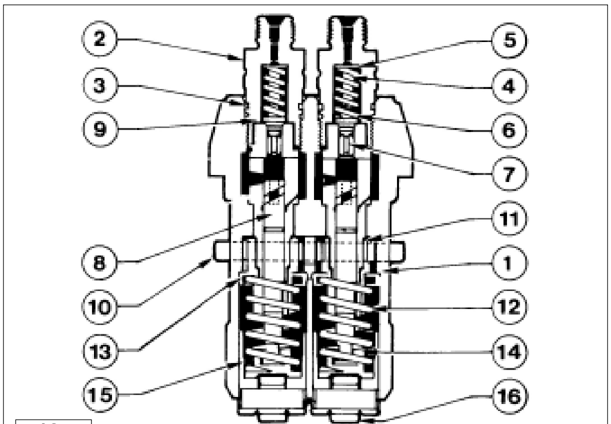
*Characteristics*:
when the control eccentric rotates at 1000 r.p.m. minimum delivery is 65 l/h while self-regulation pressure is 1.5 ÷ 2.5 bar.

**Important**
**The drive rod and its protrusion do not change in relation to the diaphragm pump.**


124

## INJECTION PUMP

The injection system consists of a single-body pump with plungers featuring constant stroke and feeding one cylinder each.
The pump, mounted on the crankcase is directly operated by the camshaft.
Speed governor, extra fuel and stop device are separate from the pump (see pages 48, 49, 50 and 78).



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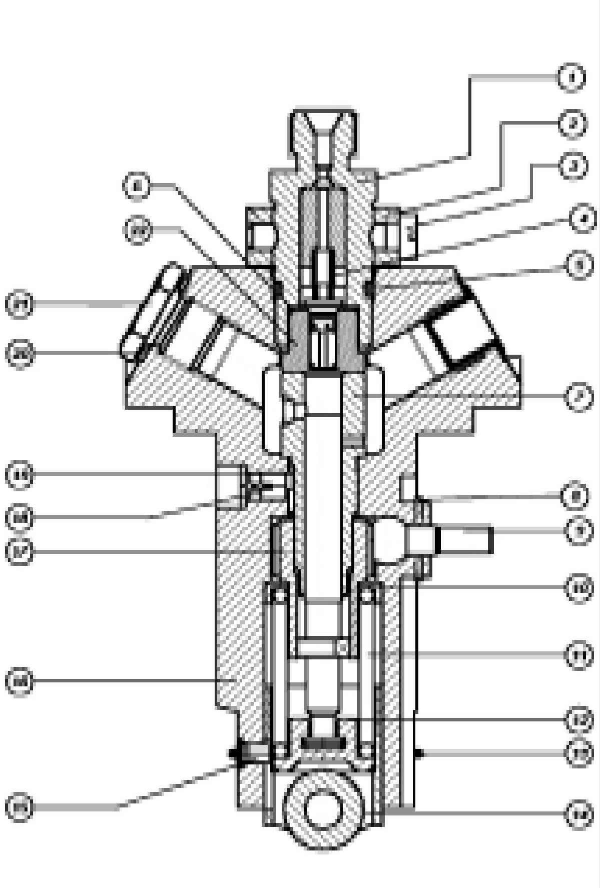
### Injection pump for Standard and 97/68 CE engines

*Components*:

**1** Pump body
**2** Holder-delivery valve
**3** O-ring
**4** Filter
**5** Shim
**6** Valve spring
**7** Delivery valve
**8** Plunger and barrel assembly
**9** Gasket
**10** Rack
**11** Metering sleeve
**12** Tappet spring
**13** Upper retainer
**14** Lower retainer
**15** Tappet
**16** Tappet roller



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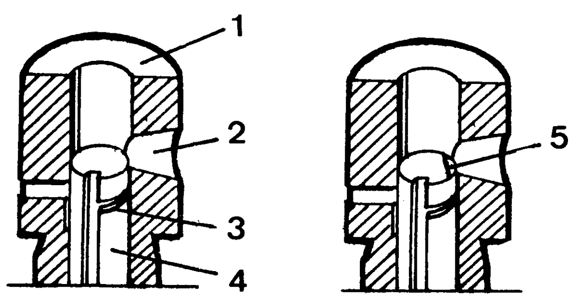
**Injection pump for EPA engines**

*Components*:

**1** Holder-delivery valve
**2** Locking nut clamp
**3** Screw
**4** Valve-Spring
**5** O Ring
**6** Copper gasket
**7** Plunger and barrel assembly
**8** Pin spring
**9** Rack
**10** Seat spring
**11** Spring tappet
**12** Seat phasing
**13** Ring snap
**14** Tappet assembly roller
**15** Pin tappet driver
**16** Pump housing
**17** Metering sleeve
**18** Pin barrel locating
**19** Copper gasket
**20** Gasket fibre seal
**21** Threaded cap
**22** Delivery valve assembly

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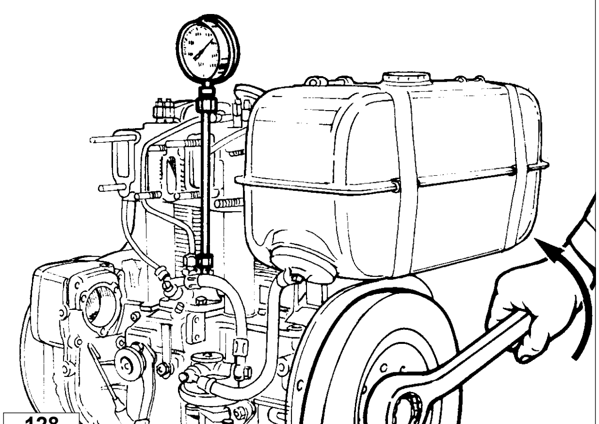
**Plunger and Barrel Assembly**

**1** Barrel
**2** Fuel feeding port
**3** Control helix
**4** Plunger
**5** Retardation notch

Plunger diameter is 7.5 mm.

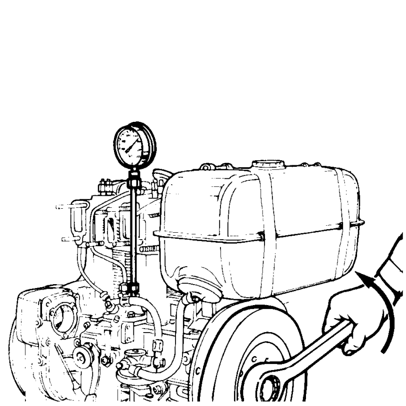
**Important**
Every plunger matches with its own barrel. For this reason they are not interchangeable.



128

**How to check plunger and barrel for internal leakage**

This operation is only indicative since pressure changes depending on the pumping speed.
Connect the delivery union with a 600 bar pressure gauge with safety valve.
Adjust rack rod at half-stroke.
Turn flywheel according to its direction of rotation so that the plunger puts the circuit under pressure.
Replace plunger if the displayed pressure is below 300 bar.
Repeat the same operation for the other plunger.



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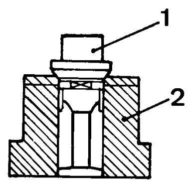
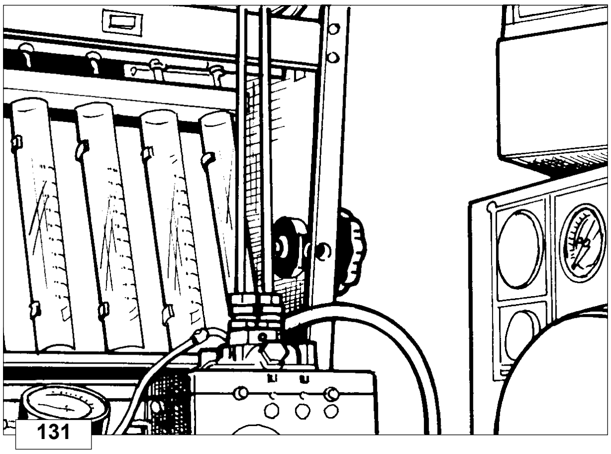



130

## How to check injection pump delivery valve sealing

*Components:*
**1** Valves
**2** Seat

Adjust pump rack at half-stroke.
Turn flywheel according to its direction of rotation so that the plunger puts the circuit under pressure.
During this operation the displayed pressure will gradually reach a peak followed by a sudden drop which corresponds to valve closing.
Pressure drop should be 30÷50 bar.
Replace the valve if pressure drop is below this value.
Repeat the same operation for the other plunger.



131

## Test data for injection pump delivery

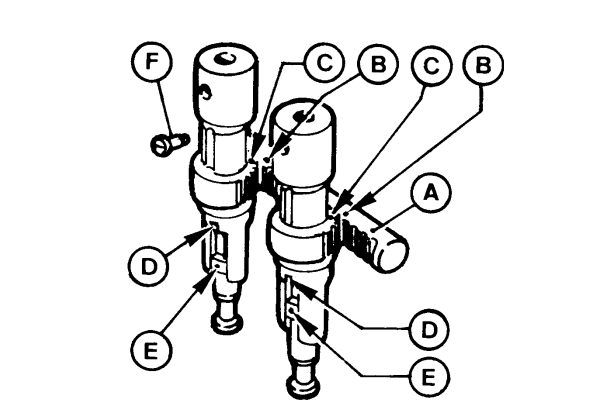
Check only maximum plunger difference by positioning rack rod according to the indicated delivery value.

***9 LD 625-2 - 626-2 - 625/626 CE***

| Control rod max. force | Rod stroke from max deliv. point | R.P.M. | Delivery | Max. plunger difference |
|---|---|---|---|---|
| Newton | mm | | mm³/stroke | mm³/stroke |
| 0,50 | 10 | 1500 | 34÷37 | 3 |
| | 13 | 500 | 7÷11 | 3 |
| | 0 | 150 | 70÷78 | -------- |
| | 10 | 500 | 22÷26 | 3 |

***9 LD 625-2 EPA***

| Control rod max. force | Rod stroke from max deliv. point | R.P.M. | Delivery | Max. plunger difference |
|---|---|---|---|---|
| Newton | mm | | mm³/stroke | mm³/stroke |
| 0,50 | 9.5 | 1500 | 34÷37 | 3 |
| | 11.5 | 500 | 3÷7 | 3 |
| | 0 | 150 | 60÷68 | -------- |
| | 9.5 | 500 | 13÷18 | 3 |

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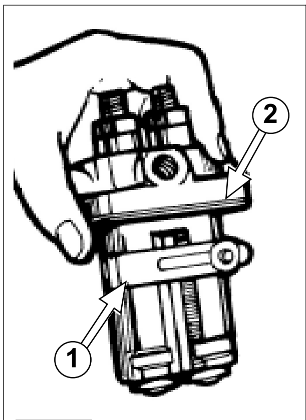
### How to reassemble injection pump components

After replacing the worn-out components, reassemble the pump as follows:

- Introduce sector gears into the pump body by making reference points **C** match with the **B** points on the rack.
- Fix barrels with the eccentric screws **F** on the pump body.
- Fit valves with seats, springs, fillers and delivery unions tightening them at 35 ÷ 40 Nm.
- Fit plungers by making reference points **E** match with the sector gear **D** points.
- Fix retainers and springs; lock tappet with special stop.
- Check that both plungers have the same delivery by performing the necessary measurements at the test bed; if delivery is not the same set screw **F**.

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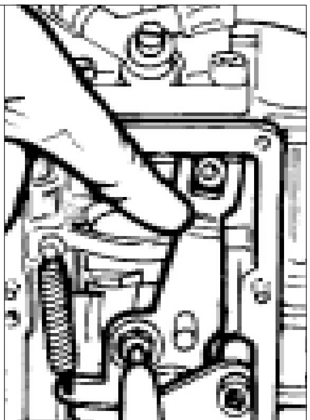

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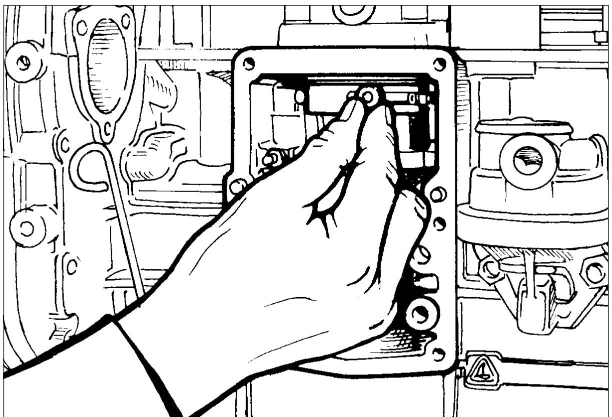
### How to mount injection pump on the engine

During reassembly, make sure the adjustment rod pin **1** is correctly inserted into the opposite seat in the adjustment lever.

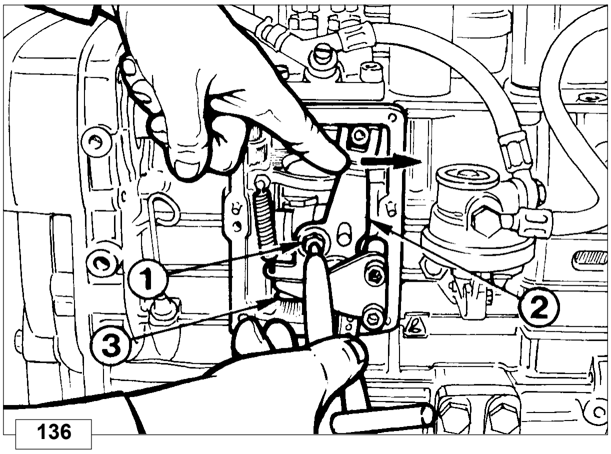
➲ See "Injection advance adjustment" on page 63 for the choice of the seals **2**.



135

❍ Tighten screws at 25 Nm.

Check that rack rod slides smoothly: if not, the engine may fail to start or hunt.



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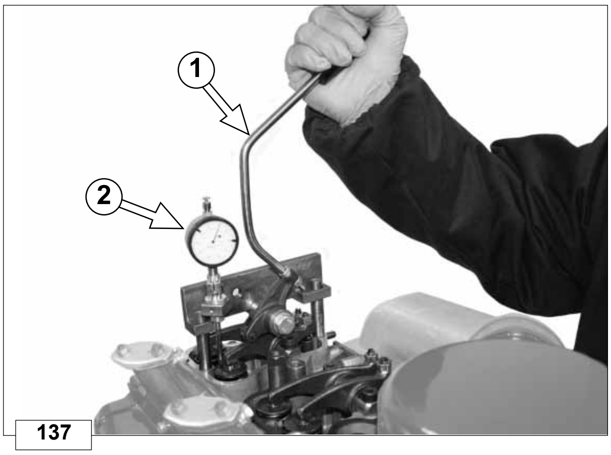
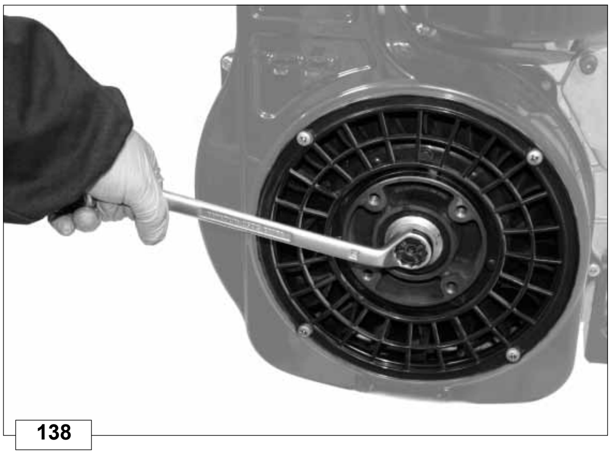
### Injection pump/mechanical speed governor timing

Loosen screw **1**
Move injection pump lever **2** to maximum delivery (to the right).
Check that drive rod **3** closes the speed governor; keeping lever **2** pressed to the right the drive rod should have no clearance.
Tighten screw **1**.



137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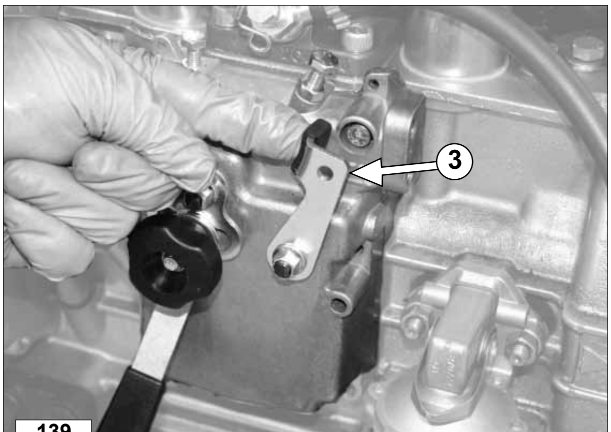

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## (STATIC) INJECTION TIMING

### Injection static advance adjustment

**1** Remove rocker arm covers and high-pressure pipes.

**2** Select the cylinder on which the injection static advance check will be carried out.

**3** Assemble the valve lowering tool (1460.285) by fastening it to the fixing holes of the rocker arm cover screws.

**4** Before tightening the tool fixing screws, make sure that the dial indicator tracer is correctly placed on the intake valve collar.

**5** Place the auxiliary tank at a higher height than the one of the injection pump (~30-40 cm).

**6** Connect the tank to the injection pump fuel supply hole.

**7** Slowly rotate the crankshaft clockwise keeping lever **1** lowered and the valve positioned on the piston crown, until the dial indicator **2** shows the maximum measurement.

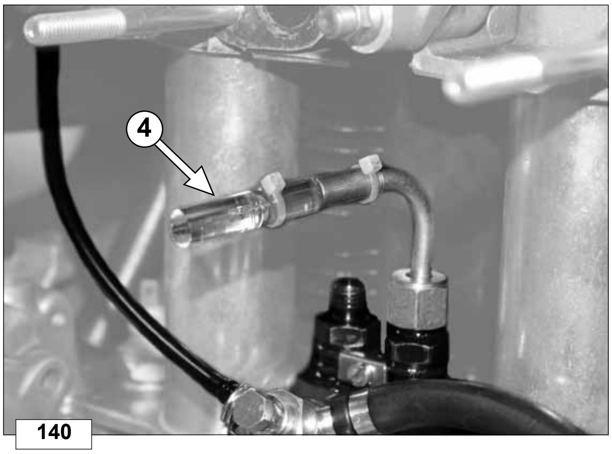
**8** Set the maximum measurement dial indicator to zero which is equivalent to the compression top dead centre.

**9** Assemble the advance tester **4** (serial number 1460.024) on the injection pump delivery union of the cylinder corresponding to the one on which the valve lowering tool has been previously installed.

**10** Rotate the crankshaft clockwise by approximately 45°.

**11** Rotate the crankshaft alternately until the fuel leaks out from tester **4** with a certain pressure.

**12** Position the stop lever **3** half a stroke so that the plunger delay mark is excluded and keep the lever in this position.



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13 Turn the flywheel slowly and clockwise. Stop turning as soon as you notice that the fuel is moving inside tester **4**.

14 Move lever **1** again so as to lower the valve and bring it again in contact with the piston.

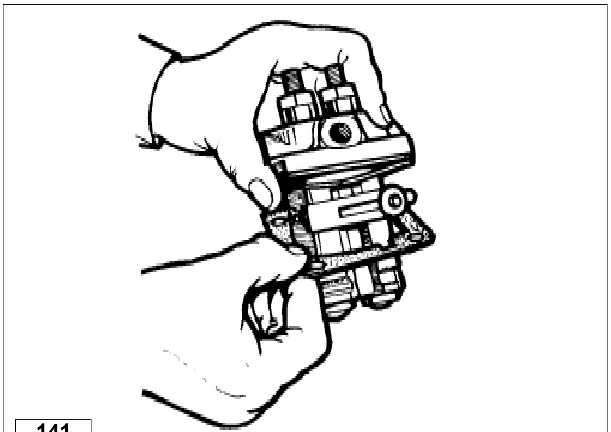
15 Measure the piston lowering value and bring it again in contact with the piston.

16 Convert the registered value from millimetres to degrees (see Table "Conversion for establishing advance").

***Table "Conversion for establishing advance"***

| Engine type | R.p.m. | Advance degrees | Piston lowering value (mm) |
|---|---|---|---|
| 9LD 625/2<br>9LD 626/2 | 3000 | 26° ± 1° * | 24° 4.94<br>25° 5.34<br>26° 5.76<br>27° 6.21 |
| 9LD 625/2 EPA | 3000 | 17° ± 1° * | 15° 1.96<br>16° 2.22<br>17° 2.51<br>18° 2.81 |
| 9LD 625/2 CE NR | 3000 | 18° ± 1° * | 17° 2.51<br>18° 2.81<br>19° 3.12 |
| 9LD 626/2 CE NR | 2800 | 17° ± 1° * | 16° 2.22<br>17° 2.51<br>18° 2.81 |

* Check values.


141

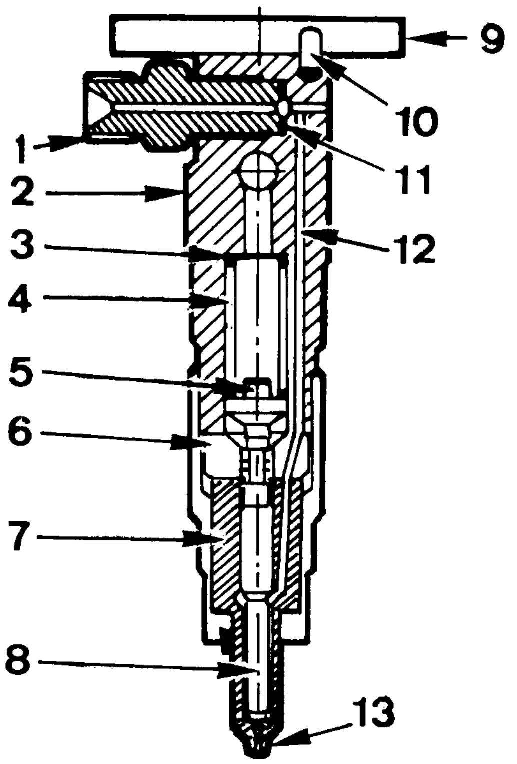
**Injection advance adjustment**

If the values indicated in the table do not correspond to the detected ones, follow the operations as written below:

**1)** Delayed Injection Advance: remove the shims under the pump until the detected value corresponds to the one indicated in the Table "Conversion for establishing advance"

**2)** Advanced Injection Advance: add shims under the pump until the detected value corresponds to the one indicated in the Table "Conversion for establishing advance".

***Note:*** By removing or adding a 0.1 mm shim under the pump, it is possible to advance or delay the injection by about 1°.

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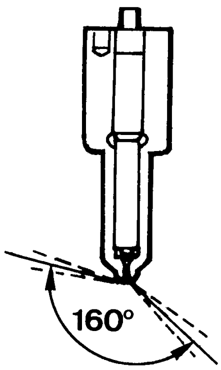
## INJECTOR

**Size S Injector, only for standard engines**

*Components*:
**1** Intake fitting
**2** Nozzle holder
**3** Shim
**4** Spring
**5** Pressure rod
**6** Intermediate flange
**7** Nozzle
**8** Needle valve
**9** Fixing flange
**10** Taper pin
**11** Gasket
**12** System duct
**13** Sump

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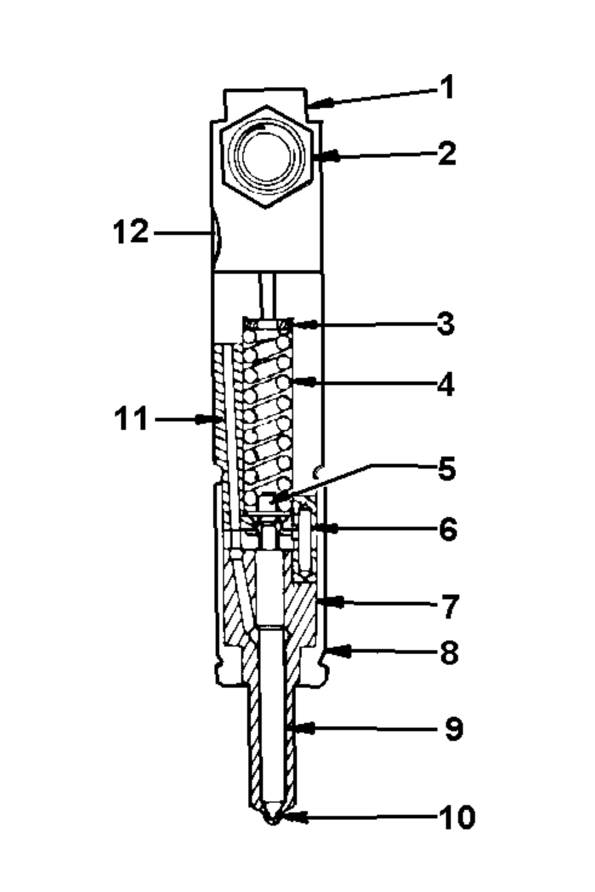
**Size S Nozzle, only for standard engines**

*Features*:
Hole number and diameter....................4x0.28 mm.
Jet angles.............................................160°.
Needle valve elevation .........................0.20 ÷ 0.22 mm

Clean nozzle tip with a brass brush.
Check that holes are not obstructed using a mandrel with steel wìre with 0.28 mm diam.

❍ When refitting tighten ring nut at 60 Nm.

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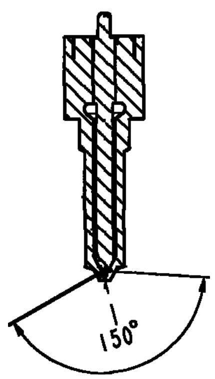
## Size P injector, for 97/68 CE and EPA engines

*Components*:

**1** Injector housing
**2** Intake fitting
**3** Shim
**4** Spring
**5** Pressure rod
**6** Taper pin
**7** Nozzle
**8** Cup
**9** Needle valve
**10** Sump
**11** System duct
**12** Overflow pipe

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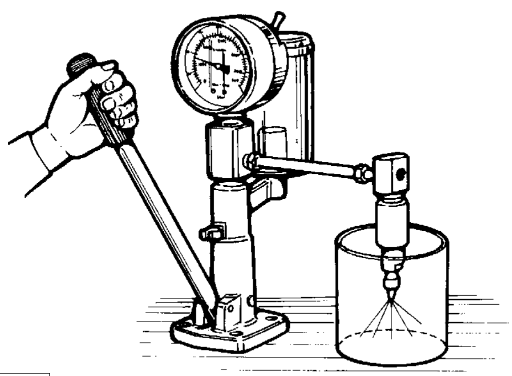
## Size P nozzle, for 97/68 CE and EPA engines

*Features*:
Hole number and diameter............. 5 x 0.23 mm.
Jet angles ....................................... 150°.
Needle valve elevation ................... 0.200 ÷ 0.205 mm

Clean nozzle tip with a brass brush.
Check that holes are not obstructed using a mandrel with steel wìre with 0.23 mm diam.

❍ When refitting tighten ring nut at 42 ÷ 48 Nm.



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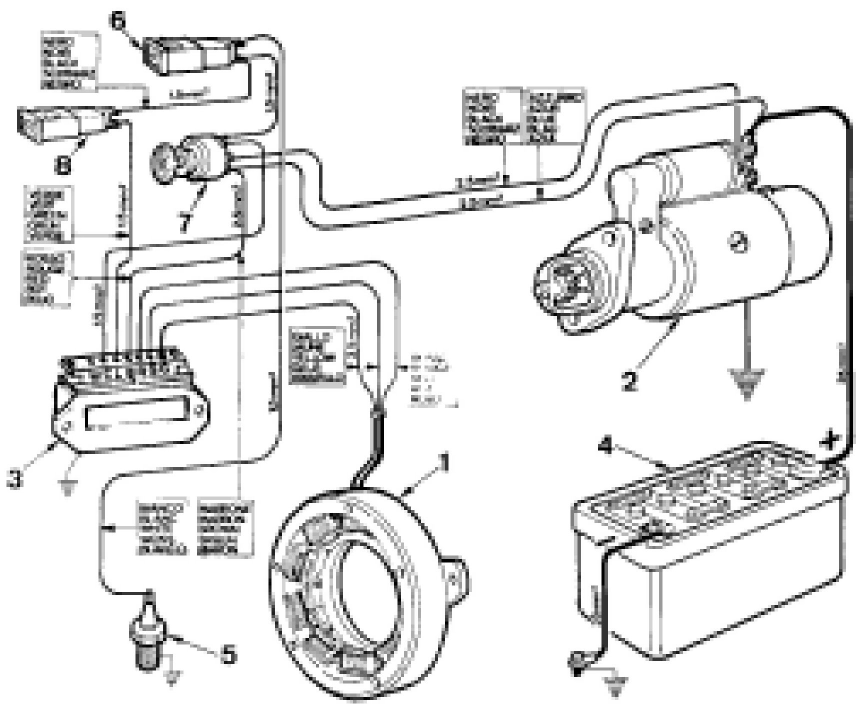
## Injector setting

Connect the injector to a diesel injector calibration pump.
Check needle valve sealing by slowly moving hand pump until approximately 180 bar and maintain this pressure for 10 seconds.
Chek that setting pressure is 210 ÷220 bar for standard engines (245 ÷ 230 bar for EPA e CE engines); make the required adjustments, if any, by modifying the adjusting shim height.

When replacing the spring, setting should be performed at a 10 bar greater pressure (255÷265 bar) to allow for bedding during operation.
Replace nozzle in case of dripping.

### *Electric starting layout with internal alternator*




*Components*:

**1** Alternator
**2** Starting motor
**3** Voltage regulator
**4** Battery
**5** Pressure switch
**6** Oil pressure warning light
**7** Key switch
**8** Battery charging light

**Note:** Battery, which is not supplied by Lombardini, should feature 12 V voltage and capacity not below 70 Ah.

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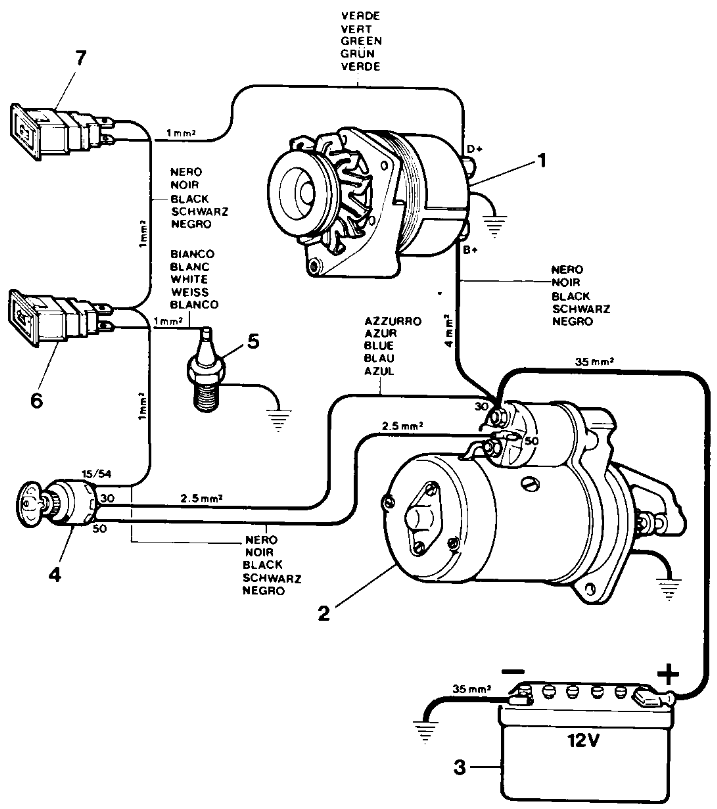
### *Electrical starting layout with external alternator*




*Components:*
**1** Alternator
**2** Starting motor
**3** Battery
**4** Key switch
**5** Pressure switch
**6** Oil pressure warning light
**7** Battery charging light

**Note:** Battery, which is not supplied by Lombardini, should feature 12 V voltage and capacity not below 70 Ah.

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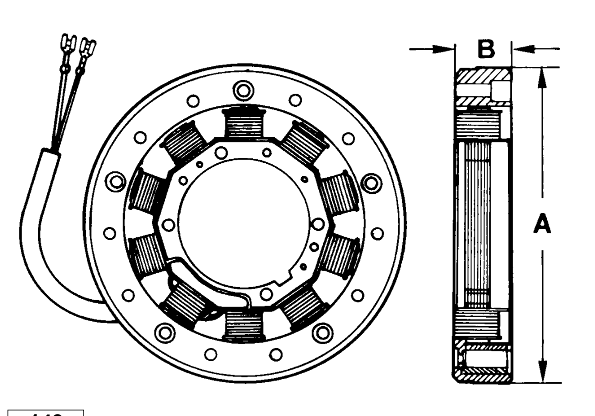


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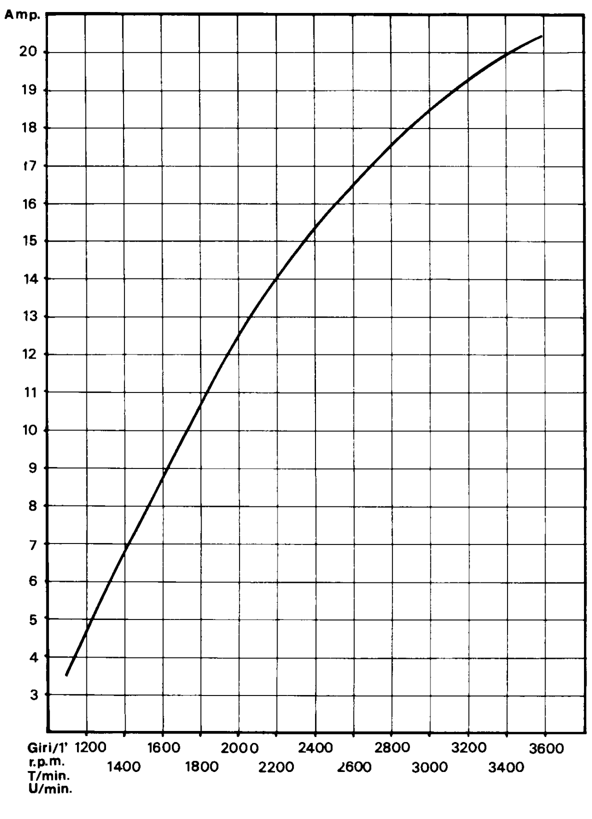
## ALTERNATOR

### Alternator - 12 V, 18A

Features a fixed armature winding mounted on the air shroud bracket. The rotating permanent magnet inductor is located in the fan spindle. Only the two yellow cables are at output.

*Dimensions (mm):*
**A** = 158.80÷159.20
**B** = 27.50÷27.90

***Note:*** Clearance between armature winding and inductor (air gap) must b 0.48÷0.60 mm.

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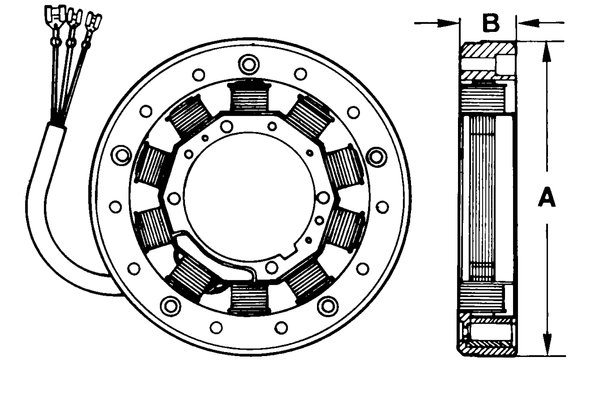
### Alternator battery charger curve (12 V, 18 A)

This curve is obtained at +25°C with 12.5 V battery voltage.

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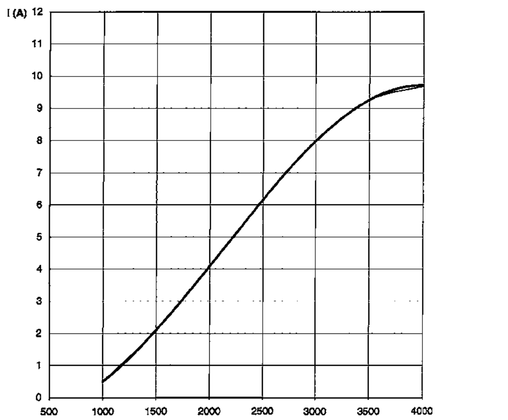
### Alternator - 24 V, 6 A

Features a fixed armature winding mounted on the air shroud bracket. The rotating permanent magnet inductor is located in the fan spindle. There are the two yellow cables and one red cable at output.

*Dimensions (mm):*
**A** = 158.80÷159.20
**B** = 27.50÷27.90

***Note:*** Clearance between armature winding and inductor (air gap) should be 0.48÷0.60 mm.

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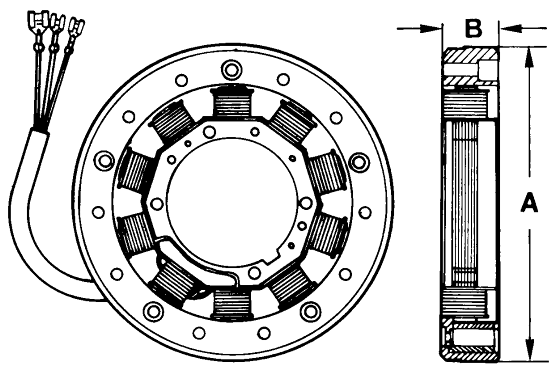
**Alternator battery charger curve - 24 V, 6 A**

The curve was obtained at room temperature of +20°C with 25 V battery voltage.

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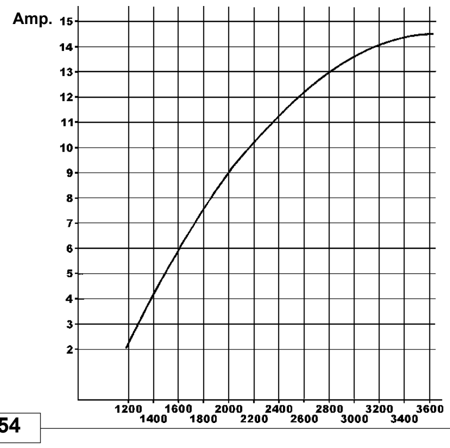
**Alternator - 12 V, 14 A**

Features a fixed armature winding mounted on the air shroud bracket. The rotating permanent magnet inductor is located in the fan spindle. There are the two yellow cables and one red cable at output.

*Dimensions (mm):*
**A** = 158.80÷159.20
**B** = 27.50÷27.90

***Note:*** Clearance between armature winding and inductor (air gap) should be 0.48÷0.60 mm.

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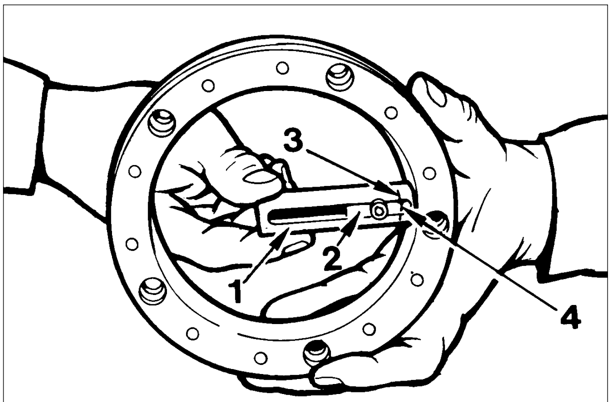
**Alternator battery charger curve standard - 12 V, 14 A**

The curve was obtained at room temperature of +25°C with 12,5 V battery voltage.

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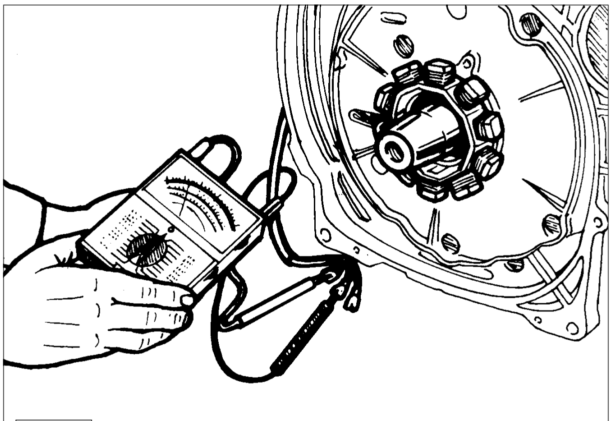
**Magnetization checking tool (Part No. 7000-9727-001)**

*Components:*
**1** Casing
**2** Slider
**3** Casing reference line
**4** Slider reference line

Rest the tool end horizontally onto the magnetic poles.
Hold slider so that its reference line coincides with the casing reference line.
Release slider: if no attraction occurs the rotor is demagnetized, in this case replace alternator.



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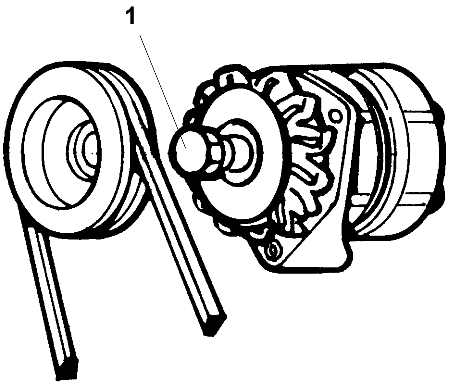
### Checking for cable continuity

Check that stator windings have no unsoldered connections, burnt areas or grounded wìres.
Using an ohmmeter check for continuity between the red cable and the two yellow ones.
Furthermore, check that they are insulated from the ground.

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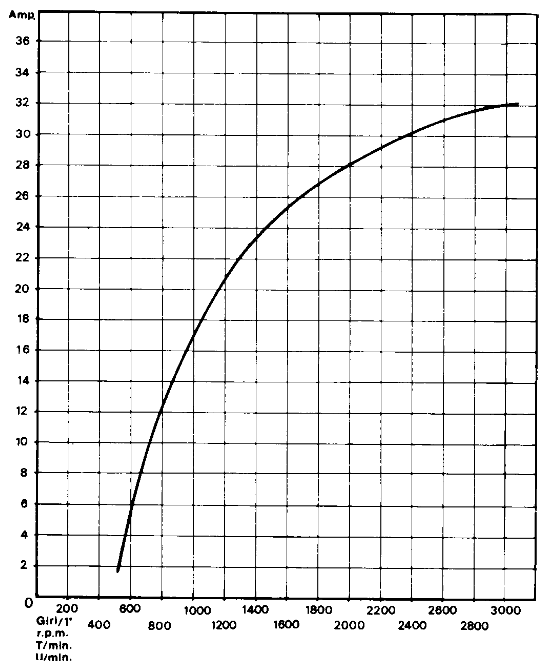
### Alternator, external - 12 V, 33 A

The alternator is of the claw-pole rotor type with built-in voltage regulator. The rotating motion is conveyed by the engine through a "V" belt and sheave.

*Features:*
Rated voltage ...................... 12V
Max. current......................... 33 A (at 7000 alternator r.p.m./min.).
RH direction of rotation.

❍ Tighten the nut **1** at a torque of 70 Nm.

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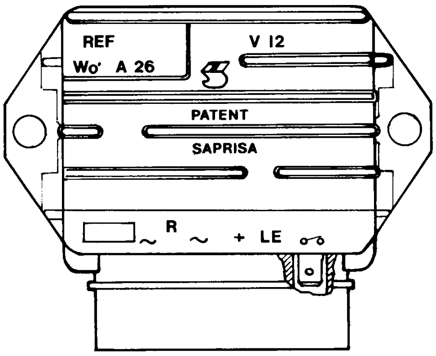
### Alternator battery charger curve - external, 12 V, 33 A

The curve was obtained at room temperature of + 25°C.
Battery terminal voltage is 12.5 V.
The r.p.m. shown on the table refers to the engine.

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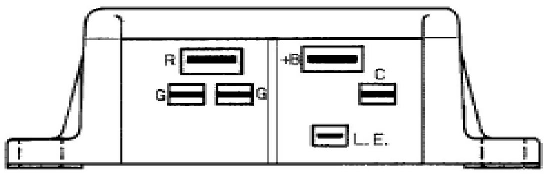
## VOLTAGE REGULATOR

Type LOMBARDINI, supplied by SAPRISA and DUCATI: Voltage 12 V, max. current 26A.

| Connections | Dimensions (mm) | |
|---|---|---|
| | Width | Thickness |
| ~ | 6.35 | 0.80 |
| R | 9.50 | 1.12 |
| + | 9.50 | 1.12 |
| LE | 4.75 | 0.50 |
| o o | 6.35 | 0.80 |

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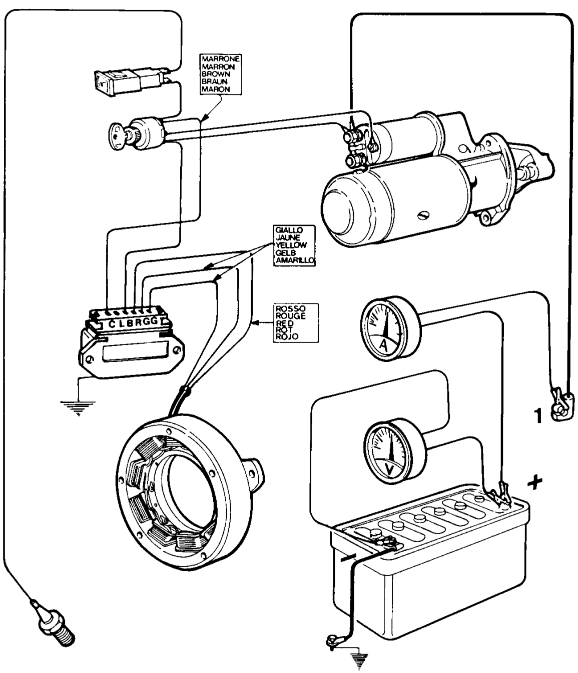
To avoid wrong connections 3 different sizes are supplied.

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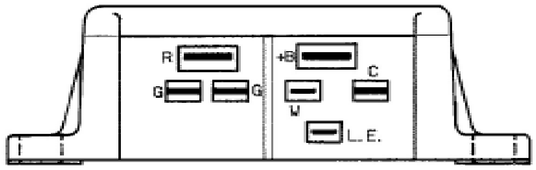
**How to check voltage regulator for proper operation**

- Check that connections correspond to the layout.
- Disconnect the terminal  from the battery positive pole.
- Connect a d.c. voltmeter between the two battery poles.
- Fit an ammeter between the positive pole and the **B+** of the voltage regulator (corresponding to ref. **1** in the picture).
- Start a couple of times until battery voltage drops below 13 V.
- When battery voltage reaches 14.5 V the ammeter current suddenly drops down to almost zero.
- Replace regulator if recharge current is zero with voltage below 14V.

**Caution - Warning**

- **When the engine is running do not disconnect battery cables or remove the key from the control panel.**
- **Keep regulator away from heat sources since temperatures above 75°C might damage it.**
- **No electric welding on engine or application.**

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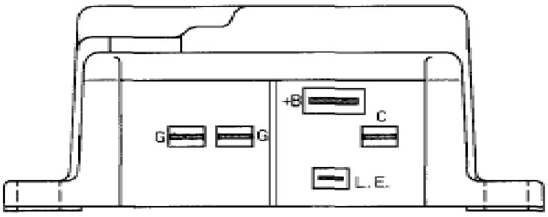
**Voltage regulator - 12V, 26A, with “W” terminal**

“W” pole tab:
Width = 4,75 mm;
Thickness= 0,5 mm.

➲ See page 70 for tag dimensions.

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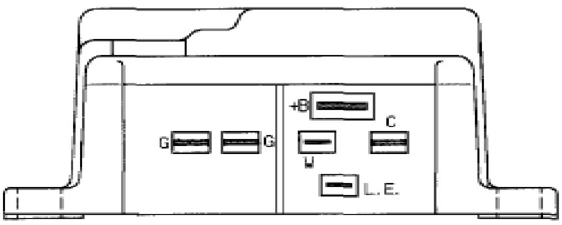
**Voltage regulator - 12 V, 30 A**

The voltage regulator is of the bridge type.

➲ See page 70 for tag dimensions.

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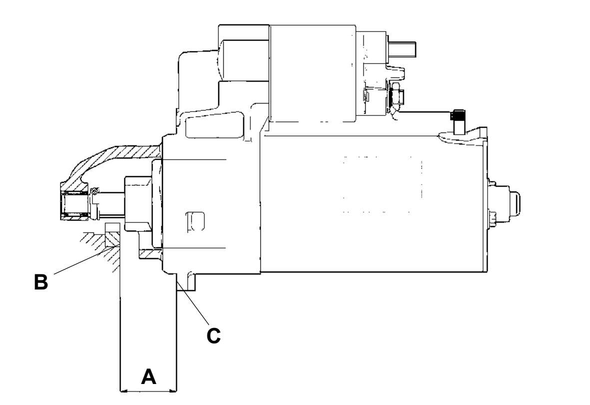
**Voltage regulator - 12V, 30A, with “W” terminal**

“W” pole tab:
Width = 4,75 mm;
Thickness= 0,5 mm.

➲ See page 70 for tag dimensions.

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## STARTING MOTOR

**Important**
- **Made by MARELLI and BOSCH.**
- **Apply to their distributors for any type of repair.**

**Bosch starting motor type GIF - 12 V, 1.7 kW**

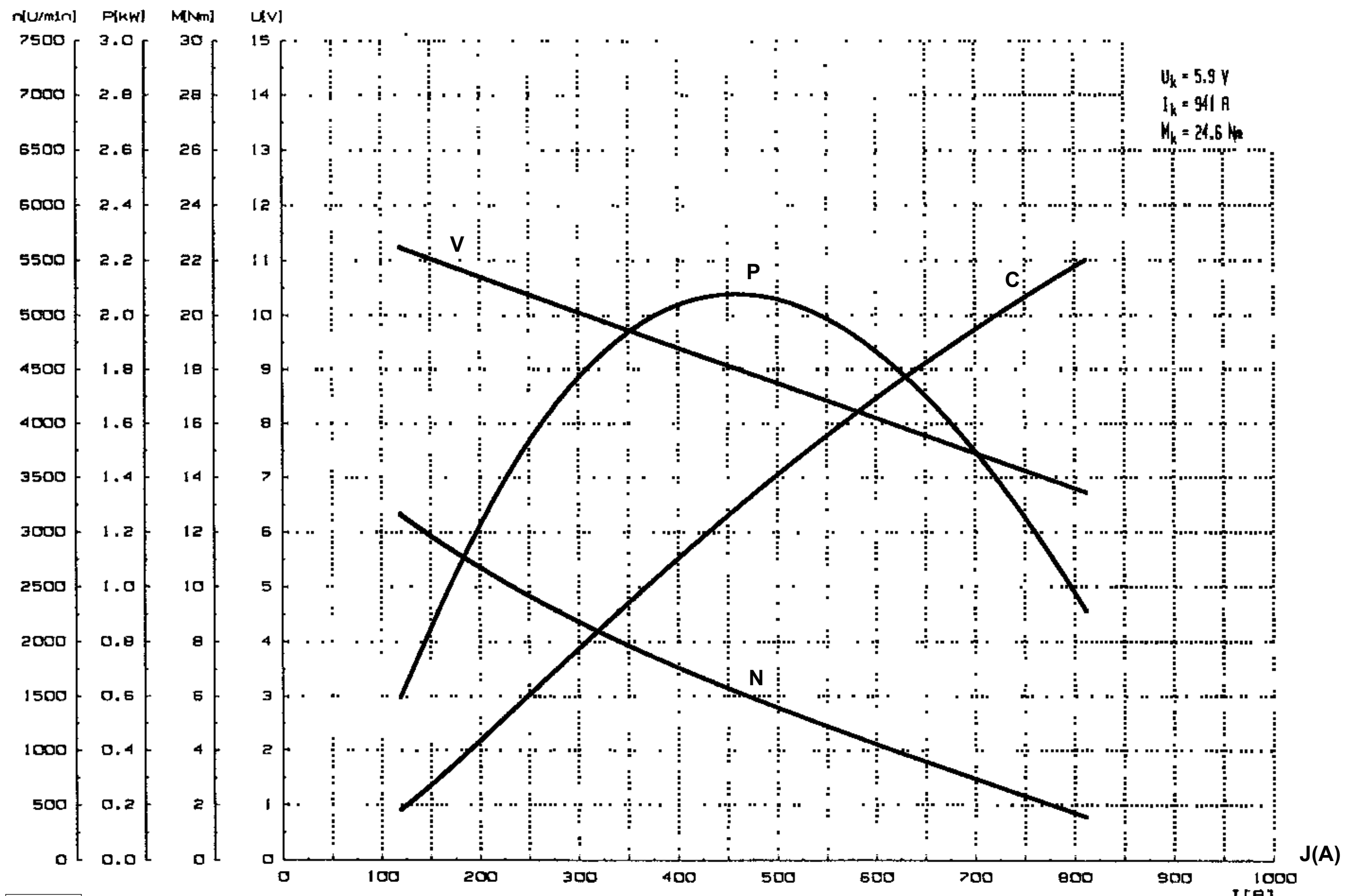
RH direction of rotation.
**A** = 29.5÷31.5 mm
**B** = Ring gear plane
**C** = Flange plane

**Caution – Warning**
**Flywheel should not project from ring gear plane B.**

**Characteristic curves for starting motor type Bosch - 12 V, 1.7 kW**

Curves are obtained at room temperature of + 20°C with 66 Ah battery.

**V** = Motor terminal voltage in Volt
**P** = Power in kW
**C** = Torque in N/m
**N** = Motor speed in r.p.m6.
**J (A)** = Absorbed current in Ampere.

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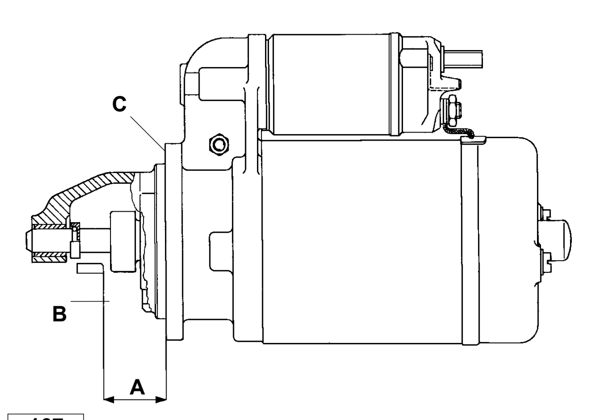

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**Starting motor type Bosch DW (R) 12 V, 1.7 kW**

RH direction of rotation.

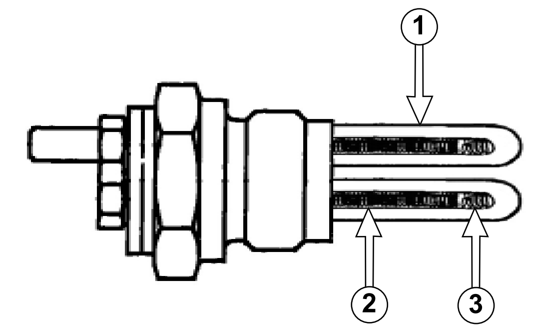
**A** = 29.5÷31.5 mm
**B** = Ring gear plane
**C** = Flange plane

**Caution – Warning**
**Flywheel should not project from ring gear plane B.**

**Characteristic curves of the 24 V 1.6 kW starting motor**

The curves have been measured at a 20°C temperature with an 88 Ah battery.

**V =** Voltage to the motor terminals in Volt
**P =** Power in kW
**C =** Torque in N/m
**N =** Motor speed in rpm
**J (A) =** Absorbed current in Amperes.

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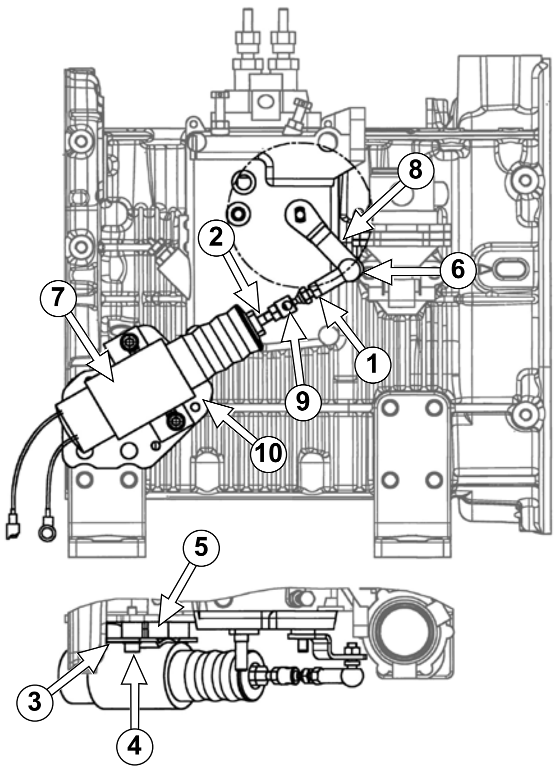
### Pre-heating glow plug

*Components:*
**1** Sheath
**2** Regulation filament
**3** Heating filament

❍ When remounting tighten at a torque of 20 Nm.

| Glow plug Type | 12 V | 24 V |
|---|---|---|
| Nominal voltage | 12 V | 28 V |
| Current | 41 A | 13 A |

***Note:*** The glow plug is not damaged in any way due to the prolonged activation time.

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## DIRECT STOP ELECTROMAGNETS

### Reverse electromagnet – FIRE version

*Features*:

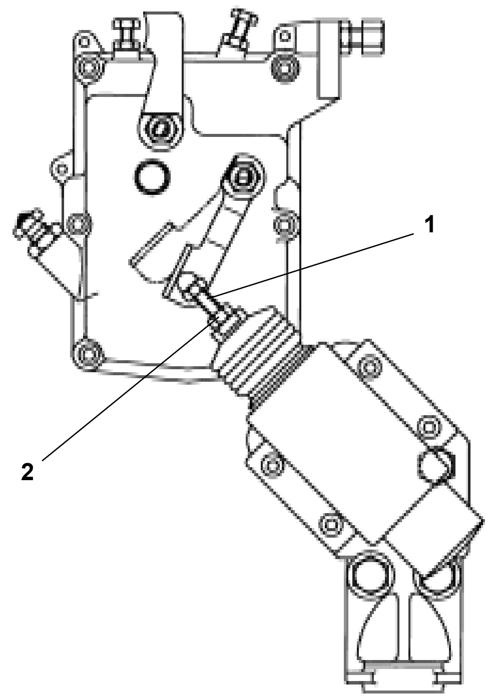
| Electromagnet type | 12 V | 24 V |
|---|---|---|
| Operating tension | 12 V | 24 V |
| Power coil absorption | 40 A | 20 A |
| Hold coil absorption | 0.63 A | 0.30 A |

*Components*:
**1** Nut
**2** Stud bolt
**3** Flat washer
**4** Screw
**5** Spacer
**6** Spherical joint
**7** Electromagnet
**8** Stop control lever
**9** Axial joint
**10** Stop control electromagnet support

*Adjustment*:
- Carry out the adjustments by screwing and unscrewing the joints.
- Adjust the device so as to make the electromagnet get to the end of the stroke before the STOP lever reaches its limit stop after performing the operation stroke.
- When the electromagnet is excited, put the stop lever at about 1.0 – 1.5 mm from its limit stop.
- Once adjustment phase is completed, tighten nut **1**.

**Important**

**The control cover should not present the return spring of the stop lever.**
**Remove the stop lever return spring without replacing the control cover if the device is applied to engines that were originally not equipped with it.**

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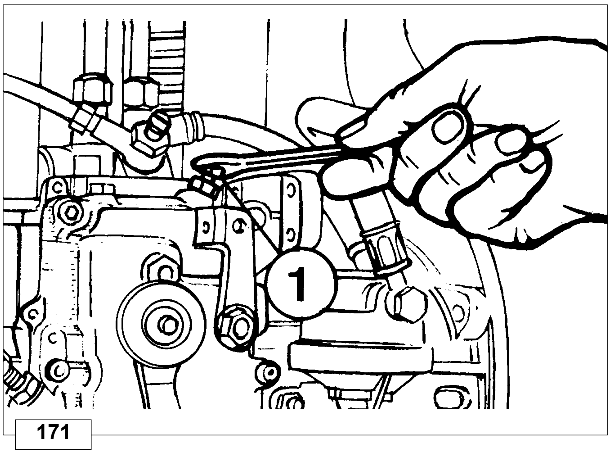
**Direct stop electromagnet**

*Features*:
Operating tension ............................................ 12V.
Power coil absorption ...................................... 41 A.
Hold coil absorption ......................................... 0.5 A.

*Setting*:
- Screw drive rod **1** to the end of the thread on the electromagnet piston.
- Excite the electromagnet and leave the stop lever in normal operation position.
- Bring drive rod 1 in contact with the stop lever and tighten lock nut **2**.

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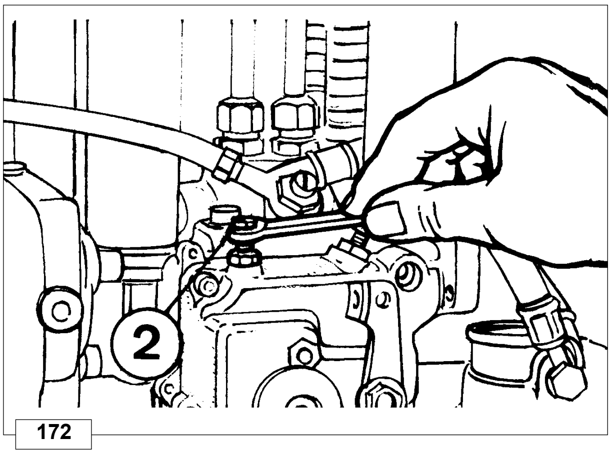


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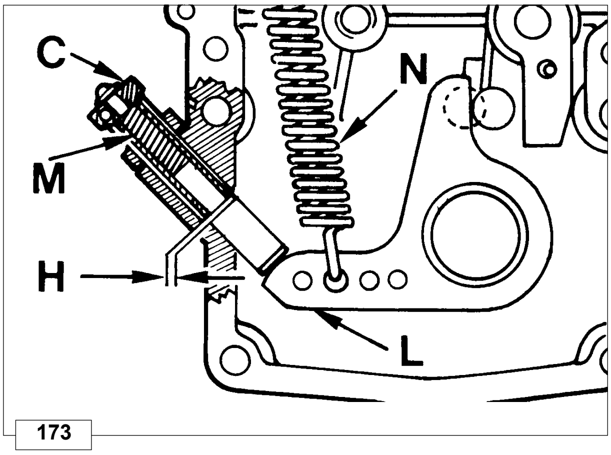


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## SPEED ADJUSTMENTS

**WARNING**

- **Adjustments should be carried out by Lombardini authorised personnel only.**
- **Any tampering with the adjustment immediately makes the warranty null and void.**

**Idling speed setting in no-load conditions**

After filling with oil and fuel, start the engine and let it warm up for 10 minutes.
Adjust idling speed at 1000÷1100 r.p.m. by turning setscrew **1**; then tighten lock nut.

**Full speed setting in no-load conditions (standard)**

After setting idle speed turn screw **2** and set full speed in no-load conditions at 3200 r.p.m.; then tighten lock nut.

***Note:*** When the engine reaches the pre-set power full speed stabilizes at 3000 r. p. m.

Not valid on EPA engines, on which it is not possible to modify the adjustment of the maximum.

## INJECTION PUMP DELIVERY SETTING

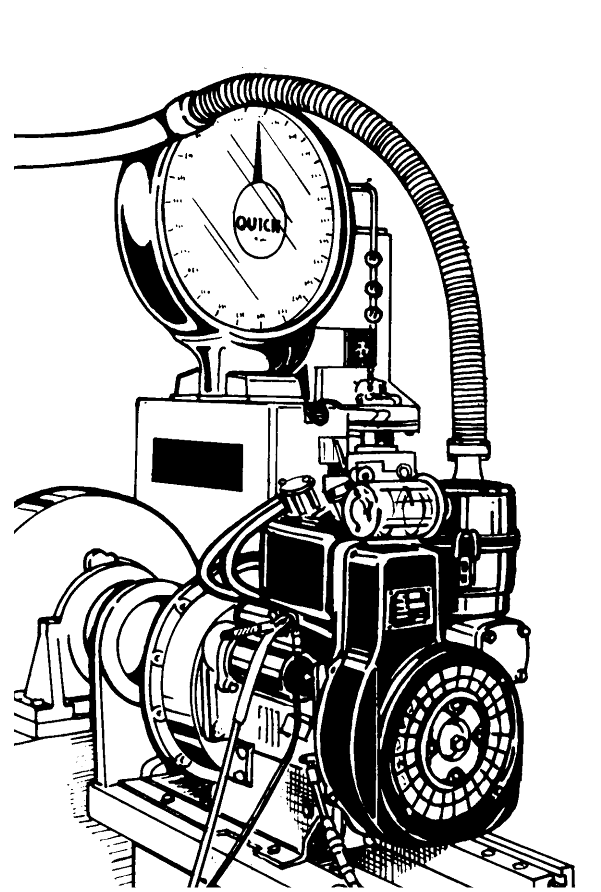
**Important**

**This adjustment must be performed with the engine connected to the dynamometric brake. Without this the regulation is approximate.**

**Injection pump delivery limiting and extra fuel device**

Limiting device **C** limits the injection pump maximum delivery.
It also acts as a torque setting device since spring **N** opposes the resistence of spring **M** inside the cylinder through lever **L**.
The torque setting device allows lever **L** to move over stroke **H** corresponding to 0.15÷0.25 mm.
This consequently increases injection pump delivery with torque reaching its peak value.

***Note:*** In generator sets and power welders, the torque setting device acts as a delivery limiter only.
It therefore does not feature spring **M** or stroke **H**.

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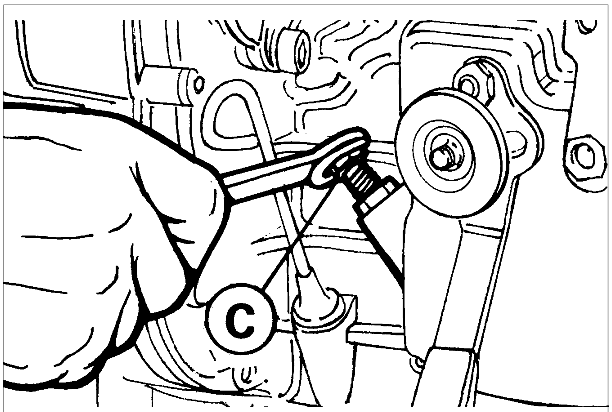
## Injection pump delivery setting with dynamometric brake

**1)** Run the engine and bring it to the operating temperature.
**2)** Release the flow limiter screw **C** completely (see page 175).
**3)** Bring the engine to maximum rotation speed.
**4)** Activate the dynamometric brake to bring the engine to the maximum speed.
**5)** Check that fuel consumption is in line with the values given in the table “Specific fuel consumption”.
If it is not in line with the indicated values, reduce the dynamometric brake load.
**6)** After a few operation minutes and when the engine has stabilized, slowly fasten screw **C** until the rotation speed starts decreasing.
**7)** Lock screw **C** using a lock nut.
**8)** Carry out the fuel consumption check again.
**9)** Release the dynamometric brake and detect the rotation speed of the “stabilized” engine (maximum idle speed).
**10)** Bring the engine to minimum idle speed. Carry out engine setting when the engine is "stabilized".
**11)** Switch off the engine and let it cool down.
**12)** Check the valve/rocker arm clearance (see "Setting valve/rocker arm clearance").

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## Injection pump delivery setting without dynamometric brake

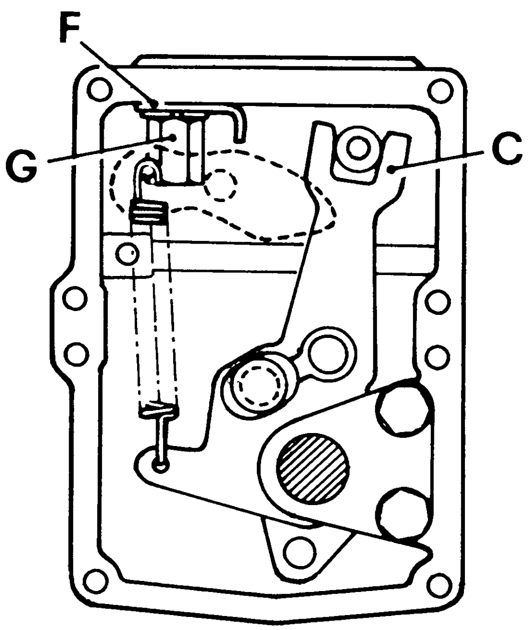
Loosen delivery limiting device **C** by 5 turns.
Bring engine to full speed in no-load conditions i.e. 3200 r.p.m.. Tighten limiting device until the engine shows a drop in r.p.m..
Unscrew limiting device **C** by 1 and ½ turns.
Tighten lock nut.

***Note:*** If the engine, under full load, generates too much smoke tighten **C**; if no smoke is observed at the exhaust and the engine cannot reach its full power unscrew **C**.

### *Required settings (as most commonly applies)*

| Engine | R.p.m. | Power HP (kW) | Specific fuel consumption * | |
|---|---|---|---|---|
| | | | Time (sec) per 100 $cm^3$ | g/HP h (g/kW h) |
| **9LD 625-2** | 3000 | NB 25.50 (18,80) | 60÷63 | 190÷200 (258÷272) |
| **9LD 625-2** | 1800 | NB 18.50 (13.6) | 90÷95 | 171÷181 (233÷246) |
| **9LD 625-2** | 1800 | NA 16.50 (12.13) | 104÷110 | 163÷173 (223÷235) |
| **9LD 625-2** | 1500 | NB 14.80 (10.88) | 110÷116 | 175÷185 (239÷252) |
| **9LD 625-2** | 1500 | NA 13.30 (9.78) | 125÷132 | 169÷178 (230÷243) |
| **9LD 625-2 EPA** | 3000 | NB 25.57 (18.80) | 60.5÷61.5 | 190÷194 259÷264 |
| **9LD 625-2 CE** | 3000 | NB 25.50 (18.80) | 59÷60 | 190 (258) |

The indicated specific fuel consumption refers to the period following approximately 30 working hours.



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**Setting the stop limit stop**

**1)** Remove the throttle lever cover.
**1)** Completely turn lever **C** counter-clockwise and keep it in this position. Retainer **F** should not be in contact with lever **C**.
**2)** Unscrew nut **G** and bring retainer **F** in contact with lever **C**
**3)** Push retainer **F** so that lever **C** is moved backwards clockwise by 1.0 mm.
**4)** Lock retainer **F** by screwing nut **G**

***Note:*** In this condition, the limit stops of the injection pump adjustment rod will not be damaged by the violent impacts caused by the possible assembly of electrostop.

## ENGINE STORAGE

- **When the engines are not for more than 6 months, they have to be protected performing the operations described in the following pages.**

- If the engine is not to be used for extensive periods, check the storage area conditions and the type of packaging and make sure that these are suitable for correct storage.
  If necessary, cover the engine with a proper protective sheet.
- Avoid storing the engine in direct contact with the ground, in environments that are humid and exposed to bad weather, near high voltage electric lines, etc.

**Important**

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

## PROTECTIVE TREATMENT

**1 -** Pour in the engine housing AGIP RUSTIA C protective oil up to the maximum level.
**2 -** Fill up with fuel containing 10% AGIP RUSTIA NT.
**3 -** Start the engine and keep it idle at minimum speed for some minutes.
**4 -** Bring the engine to ¾ of the maximum speed for 5÷10 minutes.
**5 -** Turn off the engine.
**6 -** Empty out completely the fuel tank.
**7 -** Spray SAE 10W on the exhaust and intake manifolds.
**8 -** Seal the exhaust and intake ducts to prevent foreign bodies from entering.
**9 -** Thoroughly clean all external parts of the engine using suitable products.
**10 -** Treat non-painted parts with protective products (AGIP RUSTIA NT).
**11 -** Loosen the alternator/fan belt (if present).
**12 -** Cover the engine with a proper protective sheet.

**Caution - Warning**

**In countries in which AGIP products are not available, find an equivalent product (with specifications: MIL-L-21260C).**

**Important**

**Maximum every 24 months of inactivity, the engine must be started up by repeating all "Engine Storage" operations.**

## PREPARING THE ENGINE FOR OPERATION AFTER PROTECTIVE TREATMENT

After the storage period and before starting up the engine and preparing it for operation, you need to perform certain operations to ensure maximal efficiency conditions.

1 - Remove the protective sheet.
2 - Remove any sealing devices from the exhaust and intake ducts.
3 - Use a cloth soaked in degreasing product to remove the protective treatment from the external parts.
5 - Inject lubricating oil (no more than 2 cm3) into the intake ducts.
6 - Adjust the alternator/fan belt tension (if present).
7 - Turn the engine manually to check the correct movement and smoothness of the mechanical parts.
8 - Refill the tank with fresh fuel.
9 - Make sure that the oil is up to the maximum level.
10 - Start the engine and after some minutes bring it to ¾ of the maximum speed for 5-10 minutes.
11 - Turn off the engine.
12 - Remove the oil drain plug (see “Oil replacement”) and discharge the AGIP RUSTIA NT protective oil while the engine is hot.
13 - Pour new oil (see "Table of lubricants") up to the maximum level.
14 - Replace the filters (air, oil, fuel) with original spare parts.

**Caution - Warning**

**Over time, a number of engine components and lubricants lose their properties, so it is important considering whether they need replacing, also based on age (see Replacement table).**

**Important**

**Maximum every 24 months of inactivity, the engine must be started up by repeating all "Engine Storage" operations.**

*Table of tightening torques for the main components*

| POSITION | Diam. and pitch ( mm ) | Torque ( Nm ) | Sealant |
|---|---|---|---|
| Vibration-damping tank support | - | - | Loctite 270 |
| Connecting rod | 8x1.0 | 40 | |
| Injection pump delivery valve union | 18x1.5 | 40 | |
| Rocker arm cover | 8x1.25 | 20 | |
| Center main bearing support | 8x1.25 | 25 | |
| Intake manifold | 8x1.25 | 25 | |
| Exhaust manifold | 8x1.25 | 25 | |
| Air shroud | 6x1.0 | 6 | |
| Accelerator cover | 6x1.0 | 10 | |
| Governor control cover | 6x1.0 | 10 | |
| Air conveyor shroud | 8x1.25 | 20 | |
| Alternator cable clamp | 6x1.0 | 10 | |
| High pressure fuel line clamp | 5x0.8 | 5 | |
| Air cleaner | 8x1.25 | 25 | |
| | | | |
| | | | |
| Hydraulic pump flange | 8x1.25 | 25 | |
| Air conveyor shroud gasket | - | | Loctite 495 |
| Head injector | 6x1.0 | 10 | Loctite 270 |
| Camshaft gear | 10x1.5 | 60 | |
| Oil pump gear | 10x1.5 | 35 | Loctite 270 |
| Air conveyor sheet | 6x1.0 | 10 | Loctite 242 |
| Internal oil filter pierced plate | 6x1.0 | 10 | |
| Breather sheet | 6x1.0 | 10 | |
| Starting motor | 10x1.5 | 45 | |
| Blower hub | 14x1.5 | 160 | |
| Nippl radiator | 14x1.5 | 40 | |
| Rocker arm shaft | 8x1.25 | 25 | |
| Injection pump control lever pivot | 8x1.25 | 15 | |
| Speed governor external control lever pivot | 8x1.25 | 10 | |
| External stop control lever pivot | 8x1.25 | 10 | |
| Governor spring lower lever pivot | 8x1.25 | 10 | |
| Gear cover plate | 8x1.25 | 25 | |
| Engine mounting foot | 10x1.5 | 40 | |
| Fuel feeding pump | 8x1.25 | 25 | |
| Injection pump | 8x1.25 | 25 | |
| Oil pump | 8x1.25 | 20 | |
| Nozzle holder | 6x1.0 | 10 | |
| Oil pan | 8x1.25 | 30 | |
| Oil pressure switch | 12x1.5 | 25 | |
| Starter motor fixing stud | 10x1.5 | 12 | Loctite 270 |
| Fuel lift pump fixing stud | 8x1.25 | 8÷10 | Loctite 270 |
| Cylinder head fixing stud | 10x1.5 | 15 | Loctite 270 |
| Cooling fan guard | 6x1.0 | 10 | |
| Starting pulley | 10x1.5 | 45 | |
| Fuel filter union | 14x1.5 | 40 | |
| Fuel lift pump union | 10x1.0 | 12 | |
| High pressure fuel line union | 12x1.5 | 25 | |
| Fuel bleeding line union | 8x1.0 | 10 | |
| Voltage regulator | 8x1.25 | 20 | |
| R.p.m. counter driving gear | 5x0.8 | 5 | |
| Main bearing support, gear case side | 8x1.25 | 30 | |
| Main bearing support, flywheel side | 8x1.25 | 30 | |
| Center main bearing support | 10x1.5 | 30 | |
| Air conveyor support | 8x1.25 | 25 | |
| Hydraulic pump gear support | 8x1.25 | 20 | |
| Injection pump control lever support | 8x1.25 | 25 | |
| Governor lever support (camshaft seal) | 8x1.25 | 25 | |
| Governor fork support | 8x1.25 | 25 | |

| POSITION | Diam. and pitch ( mm ) | Torque ( Nm ) | Sealant |
|---|---|---|---|
| Fuel tank bracket | 8x1.25 | 30 | |
| Alternator stator | 5x0.8 | 7 | Loctite 242 |
| Crankase lubrification plug | 8x1.25 | 15 | |
| | | | |
| | | | |
| Oil drain plug | 14x1.5 | 40 | |
| Cylinder head | 10x1.5 | 55 | |
| Blower | 6x1.0 | 10 | Loctite 270 |
| Cooling fan hub fixing screw | 16x1.5 | 160 | Loctite 270 |
| Flywheel | 20x1.5 | 300 | |

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

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

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

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

### *Special tools and equipment for maintenance*

| *SPECIAL TOOLS* | *DESCIPTION* | *Part N°.* |
|---|---|---|
|   | Valve lowering tool for static injection timing check<br>**1** Spacers, h=40mm<br>**2** Dial gauge indicator<br>**3** Dial gauge extension | 1460 - 285 |
|  | Static timing tool | 1460 - 024 |
|  | Tool for valve stem O-ring assembly | 1460 - 047 |
|  | Flywheel puller | 1460 - 119 |
|  | Timing control gear extractor fork | 7560-4000- 052 |

# 9 LD Engine Series

cod. ED0053022860



LOMBARDINI SERVICE
A KOHLER COMPANY

UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

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**WORKSHOP MANUAL**

**11 LD series engines**

**cod. 1-5302-296_ 5° ed.**

# 11 LD 625-3
# 11 LD 626-3

**SERVICE**

**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 |
|---|---|---|---|---|---|---|---|
| CUSE/ATLO | 1-5302-296 | 50510 | **5°** | **4** | 1-89 | 30.07.2007 | |

## PREFACE

- Every attempt has been made to present within this service manual, accurate and up to date technical information.
  However, development on the **LOMBARDINI** series is continuous.
  Therefore, the information within this manual is subject to change without notice and without obligation.

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

Information presented within this manual assumes the following:

1 - The person or people performing service work on **LOMBARDINI** series engines is properly trained and equipped to safely and professionally perform the subject operation;

2 - The person or people performing service work on **LOMBARDINI** series engines possesses adequate hand and **LOMBARDINI** special tools to safely and professionally perform the subject service operation;

3 - The person or people performing service work on **LOMBARDINI** series engines has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- This manual was written by the manufacturer to provide technical and operating information to authorised **LOMBARDINI** after-sales service centres to carry out assembly, disassembly, overhauling, replacement and tuning operations.

- As well as employing good operating techniques and observing the right timing for operations, operators must read the information very carefully and comply with it scrupulously.

- Time spent reading this information will help to prevent health and safety risks and financial damage.
  Written information is accompanied by illustrations in order to facilitate your understanding of every step of the operating phases.

This manual contains the most important information for the repair of LOMBARDINI air cooled, direct injection Diesel engines type **1LD625-3 e 11LD626-3.** This information is current upto 07.30.2007.

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# 11 LD 525-3 / 526-3
# ENGINE
## with advance variator

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## WARRANTY CERTIFICATE

- The products manufactured by **LOMBARDINI** Srl are warranted to be free from conformity defects for a period of 24 months from the date of delivery to the first end user.
- For engines fitted to stationary equipment, working at constant load and at constant and/or slightly variable speed within the setting limits, the warranty covers a period up to a limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- If no hour-meter is fitted , 12 working hours per calendar day will be considered.
- For what concerns the parts subject to wear and deterioration (injection/feeding system, electrical system, cooling system, sealing parts, non-metallic pipes, belts) warranty covers a maximum limit of 2000 working hours, if the above mentioned period (24 months) is not expired.
- For correct maintenance and replacement of these parts, it is necessary to follow the instructions reported in the documentation supplied with each engine.
- To ensure the engine warranty is valid, the engine installation, considering the product technical features, must be carried out by qualified personnel only.
- The list of the **LOMBARDINI** authorized dealers is reported in the “Service” booklet, supplied with each engine.
- Special applications involving considerable modifications to the cooling/lubricating system (for ex.: dry oil sump), filtering system, turbo-charged models, will require special written warranty agreements.
- Within the above stated periods **LOMBARDINI** Srl directly or through its authorized network will repair and/or replace free of charge any own part or component that, upon examination by **LOMBARDINI** or by an authorized **LOMBARDINI** agent, is found to be defective in conformity, workmanship or materials.
- Any other responsibility/obligation for different expenses, damages and direct/indirect losses deriving from the engine use or from both the total or partial impossibility of use, is excluded.
- The repair or replacement of any component will not extend or renew the warranty period.

**LOMBARDINI** warranty obligations here above described will be cancelled if:

- **LOMBARDINI** engines are not correctly installed and as a consequence the correct functional parameters are not respected and altered.
- **LOMBARDINI** engines are not used according to the instructions reported in the “Use and Maintenance” booklet supplied with each engine.
- Any seal affixed to the engine by **LOMBARDINI** has been tampered with or removed.
- Spare parts used are not original **LOMBARDINI**.
- Feeding and injection systems are damaged by unauthorized or poor quality fuel types.
- Electrical system failure is due to components, connected to this system, which are not supplied or installed by **LOMBARDINI**.
- Engines have been disassembled, repaired or altered by any part other than an authorized **LOMBARDINI** agent.

- Following expiration of the above stated warranty periods and working hours, **LOMBARDINI** will have no further responsibility for warranty and will consider its here above mentioned obligations for warranty complete.

- Any warranty request related to a non-conformity of the product must be addressed to the **LOMBARDINI** Srl service agents.

## GENERAL SERVICE MANUAL NOTES

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

2 - All data presented are in metric format. That is, 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) and pressure is presented in barometric units (bar).

## 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».

## SAFETY AND WARNING DECALS

- Important remarks and features of the text are highlighted using symbols, which are explained below:

**Danger – Attention**
**This indicates situations of grave danger which, if ignored, may seriously threaten the health and safety of individuals.**

**Caution – Warning**
**This indicates that it is necessary to take proper precautions to prevent any risk to the health and safety of individuals and avoid financial damage.**

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

## SAFETY REGULATIONS

- **LOMBARDINI** Engines are built to supply their performances in a safe and long-lasting way.
  To obtain these results, it is essential for users to comply with the servicing instructions given in the relative manual along with the safety recommendations listed below.
- The engine has been made according to a machine manufacturer's specifications and all actions required to meet the essential safety and health safeguarding requisites have been taken, as prescribed by the current laws in merit.
  All uses of the engine beyond those specifically established cannot therefore be considered as conforming to the use defined by **LOMBARDINI** which thus declines all liability for any accidents deriving from such operations.
- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation in particular, along with the relative routine maintenance work.
- The user must read these instructions carefully and become familiar with the operations described.
  Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- The engine may only be used or assembled on a machine by technicians who are adequately trained about its operation and the deriving dangers.
  This condition is also essential when it comes to routine and, above all, extraordinary maintenance operations which, in the latter case, must only be carried out by persons specifically trained by **LOMBARDINI** and who work in compliance with the existing documentation.
- Variations to the functional parameters of the engine, adjustments to the fuel flow rate and rotation speed, removal of seals, demounting and refitting of parts not described in the operation and maintenance manual by unauthorized personnel shall relieve **LOMBARDINI** from all and every liability for deriving accidents or for failure to comply with the laws in merit.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ.
  In the case of manual start-ups, make sure that the relative actions can take place without the risk of hitting walls or dangerous objects, also considering the movements made by the operator.
  Pull-starting with a free cord (thus excluding self-winding starting only), is not permitted even in an emergency.
- Make sure that the machine is stable to prevent the risk of overturning.
- Become familiar with how to adjust the rotation speed and stop the engine.
- Never start the engine in a closed place or where there is insufficient ventilation.
  Combustion creates carbon monoxide, an odourless and highly poisonous gas.
  Lengthy stays in places where the engine freely exhausts this gas can lead to unconsciousness and death.
- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unles specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Fuel is inflammable.
  The tank must only be filled when the engine is off.
  Thoroughly dry any spilt fuel and move the fuel container away along with any rags soaked in fuel or oil.
  Make sure that no soundproofing panels made of porous material are soaked in fuel or oil.
  Make sure that the ground or floor on which the machine is standing has not soaked up any fuel or oil.
- Fully tighten the tank plug each time after refuelling.
  Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- Fuel vapour is highly toxic.
  Only refuel outdoors or in a well ventilated place.
- Do not smoke or use naked flames when refuelling.
- The engine must be started in compliance with the specific instructions in the operation manual of the engine and/or machine itself.
  Do not use auxiliary starting aids that were not installed on the original machine (e.g. Startpilot').
- Before starting, remove any tools that were used to service the engine and/or machine.
  Make sure that all guards have been refitted.

- During operation, the surface of the engine can become dangerously hot.
  Avoid touching the exhaust system in particular.
- Before proceeding with any operation on the engine, stop it and allow it to cool.
  Never carry out any operation whilst the engine is running.
- The coolant fluid circuit is under pressure.
  Never carry out any inspections until the engine has cooled and even in this case, only open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. If there is an electric fan, do not approach the engine whilst it is still hot as the fan could also start operating when the engine is at a standstill.
  Only clean the coolant system when the engine is at a standstill.
- When cleaning the oil-cooled air filter, make sure that the old oil is disposed of in the correct way in order to safeguard the environment.
  The spongy filtering material in oil-cooled air filters must not be soaked in oil.
  The reservoir of the separator pre-filter must not be filled with oil.
- The oil must be drained whilst the engine is hot (oil T ~ 80°C).
  Particular care is required to prevent burns.
  Do not allow the oil to come into contact with the skin.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and cold.
  Take care to prevent fluids containing nitrites from being mixed with others that do not contain these substances since "Nitrosamine", dangerous for the health, can form.
  The coolant fluid is polluting and must therefore be disposed of in the correct way to safeguard the environment.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the positive wire of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Only check belt tension when the engine is off.
- Only use the eyebolts installed by **LOMBARDINI** to move the engine.
  These lifting points are not suitable for the entire machine; in this case, the eyebolts installed by the manufacturer should be used.

## 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
- Waste management
- Soil contamination
- Atmospheric emissions
- Use of raw materials and natural resources
- 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.

## 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.

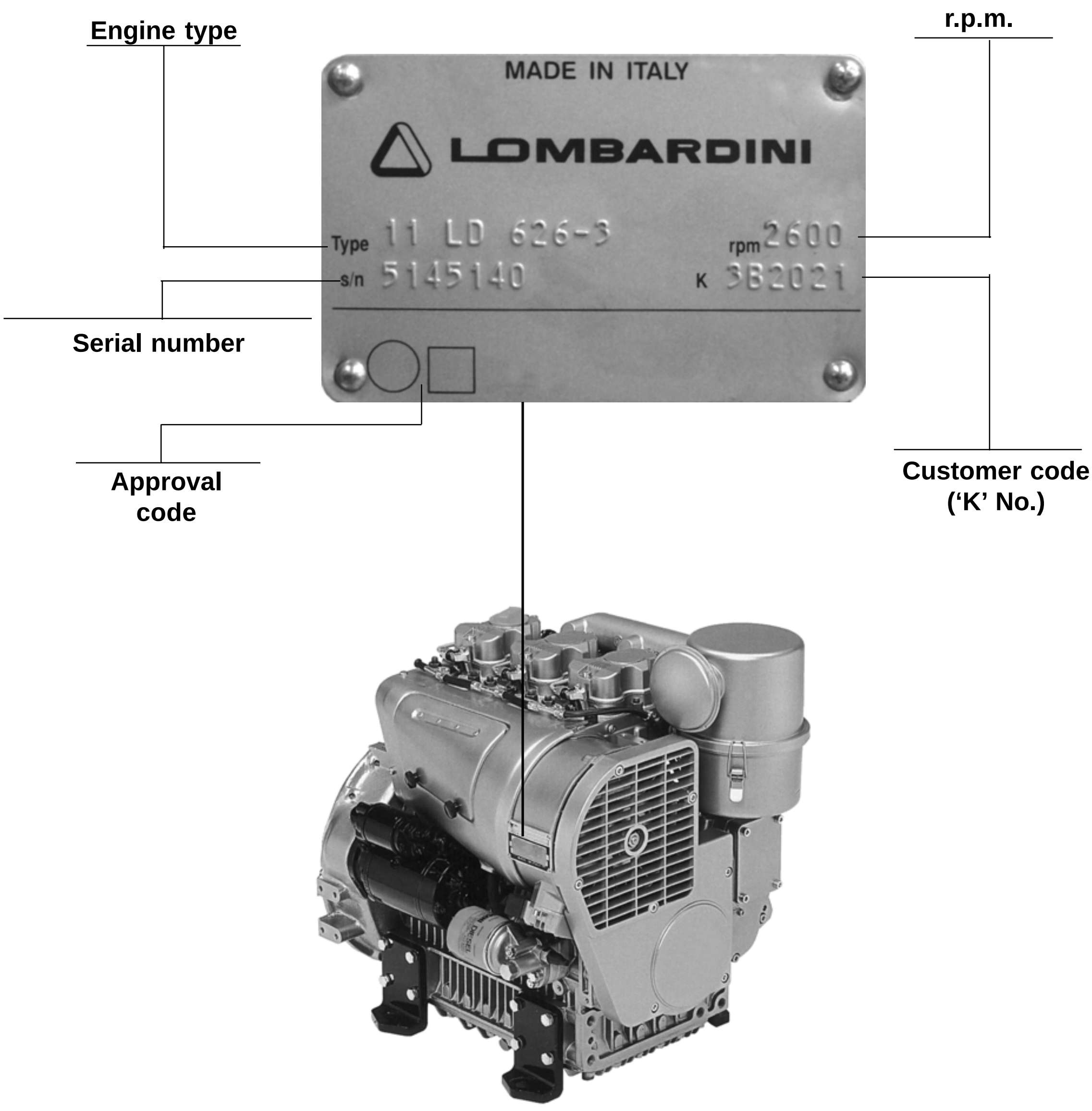
***TABLE OF LIKELY ANOMALIES AND THEIR SYMPTOMS***

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.

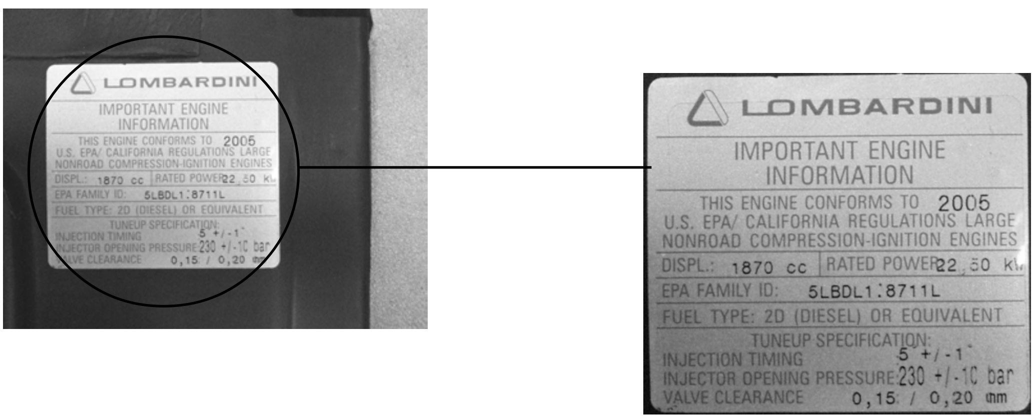
| POSSIBLE CAUSE | | TROUBLE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Engine does not start | Engine starts but stops | No acceleration | Non-uniform speed | Black smoke | White smoke | Too low oil pressure | Overheats | Inadequate performance | Excessive oil consumption | High noise level |
| FUEL CIRCUIT | Obstructed fuel line | ■ | ■ | | ■ | | | | | ■ | | |
| | Fuel filter clogged | ■ | ■ | ■ | ■ | | | | | ■ | | |
| | Air or water leaks in fuel system | ■ | ■ | ■ | ■ | | | | | ■ | | |
| | The tank cap vent hole is clogged | ■ | ■ | | | | | | | | | |
| | No fuel | ■ | ■ | | ■ | | | | | | | |
| ELECTRIC SYSTEM | Discharged battery | ■ | | | | | | | | | | |
| | Cable connection uncertain or incorrect | ■ | | | | | | | | | | |
| | Faulty starting switch | ■ | | | | | | | | | | |
| | Faulty starting motor | ■ | | | | | | | | | | |
| MAINTENANCE | Clogged air filter | | | ■ | ■ | ■ | | | | ■ | | |
| | Excessive idle operation | | | | | | ■ | | | | ■ | |
| | Incomplete run-in | | | | | | ■ | | | | ■ | |
| | Overloaded engine | | | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ |
| | Non-conforming engine oil | | | | | | | | | | ■ | |
| SETTINGS REPAIRS | Incorrect governor linkage adjustment | | | | ■ | | | | | | | |
| | Governor spring broken or unhooked | | ■ | ■ | ■ | | | | | | | |
| | Low idle speed | | ■ | | | | | | | | | |
| | Rings worn or sticking | ■ | | | ■ | | ■ | | ■ | ■ | ■ | |
| | Worn cylinder | ■ | | | ■ | | ■ | | ■ | ■ | ■ | |
| | Worn main con rod-rocker arm bearings | | | | ■ | | | ■ | ■ | ■ | ■ | |
| | Badly sealed intake valve | ■ | | | | | | | ■ | ■ | ■ | |
| | Head tightening nuts loose | ■ | | | | | | | | | | ■ |
| | Damaged cylinder head gasket | | | | | | | | ■ | ■ | ■ | ■ |
| | Excessive valve-rocker arm clearance | | | | | | | | | ■ | | ■ |
| | No clearance between valves and rocker arms | ■ | | | | | | | | | | |
| | Valves sticking | | | | | | | | | | | ■ |
| | Defective timing system | | | | | | | | | | | ■ |
| | Bent rods | | | ■ | ■ | ■ | | | ■ | ■ | | ■ |

| | POSSIBLE CAUSE | TROUBLE: Engine does not start | Engine starts but stops | No acceleration | Non-uniform speed | Black smoke | White smoke | Too low oil pressure | Overheats | Inadequate performance | Excessive oil consumption | High noise level |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INJECTION | Damaged injector | ■ | | | | ■ | ■ | | | ■ | | ■ |
| INJECTION | Injection pump valve damaged | ■ | | | | | | | | | | |
| INJECTION | Injector not adjusted | ■ | | | | | | | | | | |
| INJECTION | Faulty fuel feeding pump | ■ | ■ | ■ | ■ | | | | | ■ | | |
| INJECTION | Hardened pump control rod | | | ■ | ■ | | | | | | | |
| INJECTION | Broken or loose supplementary start-up spring | ■ | | | | | | | | | | |
| INJECTION | Worn or damaged pumping element | | | | ■ | ■ | | | | ■ | | |
| INJECTION | Incorrect tuning of injection components (delivery balancing advance) | ■ | ■ | | ■ | ■ | | | ■ | ■ | | |
| INJECTION | Extra fuel control level sticking | | | | | ■ | | | | | | |
| LUBRICATION CIRCUIT | Oil level too high | | | | ■ | | ■ | | ■ | | ■ | |
| LUBRICATION CIRCUIT | Oil level low | | | | | | | | ■ | | | |
| LUBRICATION CIRCUIT | Oil pressure valve blocked or dirty | | | | | | | ■ | | | | |
| LUBRICATION CIRCUIT | Oil pressure regulator not adjusted | | | | | | | ■ | | | | |
| LUBRICATION CIRCUIT | Worm oil pump | | | | | | | | ■ | | | |
| LUBRICATION CIRCUIT | Oil sump suction line clogged | | | | | | | | ■ | | | |
| LUBRICATION CIRCUIT | Faulty pressure gauge or pressure switch | | | | | | | ■ | | | | |
| LUBRICATION CIRCUIT | Blocked draining pipe | | | | | | | ■ | | | | |
| COOLING CIRCUIT | Worn or broken blower belt | | | | | | | | ■ | | | |
| COOLING CIRCUIT | Cooling circuit clogged | | | | | | | | ■ | | | |

## MANUFACTURER AND MOTOR IDENTIFICATION DATA




**Name plate for EPA rules applied on rocker- arm cap**



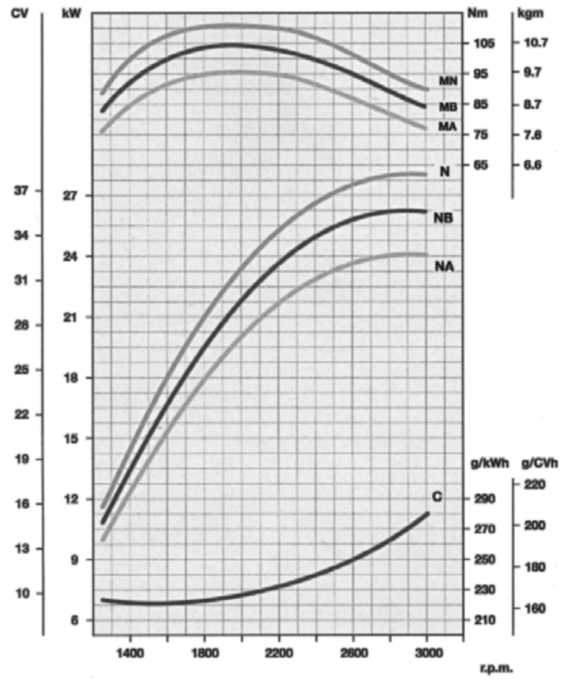
## TECHINICAL SPECIFICATIONS

| ENGINE TYPE | | | 11LD 625-3 | 11LD 626-3 |
|---|---|---|---|---|
| Number of cylinders | | N. | 3 | 3 |
| Bore | | mm | 95 | 95 |
| Stroke | | mm | 88 | 88 |
| Displacement | | Cm³ | 1870 | 1870 |
| Compression ratio | | | 17:1 | 17:1 - 20:1❐ |
| R.P.M. | | | 3000 | 3000 |
| Power kW/HP | N (80/1269/CEE) ISO 1585 | kW/CV | 28/38 | 30,8/42 |
| | NB ISO 3046 IFN | kW/CV | 26/35,4 | 28,6/39 |
| | NA ISO 3046 ICXN | kW/CV | 24/32,7 | 26,3/35,8 |
| Max. torque | | Nm/kgm | 104/10,6 @2000 | 114,5/11,7 @2000 |
| Max. torque at 3rd p.t.o. at 3200 r.p.m. | | kW/CV | 13/17,7 | 13/17,7 |
| Max. torque at 4th p.t.o. at 3200 r.p.m. | | kW/CV | 7,98/10,8 | 7,98/10,8 |
| Specific fuel consumption * | | g/CV.h - g/kW.h | 190/258.5 | 184/250 |
| Tank capacity | | l. | 15 | 15 |
| Oil consumption ** | | kg/h | 0,017 | 0,017 |
| Oil sump capacity | | l. | 5 | 5 |
| Dry weight | | kg | 170 | 170 |
| Combustion air volume at 3000 r.p.m. | | l./min' | 2400 | 2400 |
| Cooling air volume at 3000 r.p.m. | | l./min' | 38000 | 38000 |
| Max. permissible driving shaft axial load in both directions | | kg | 300 | 300 |
| Max. inclination | momentary | α | 35° | 35° |
| | lasting up to 1 h. | α | 25° | 25° |
| | permanent | α | **** | **** |
| Firing Order | | | 1 - 3 - 2 | 1 - 3 - 2 |

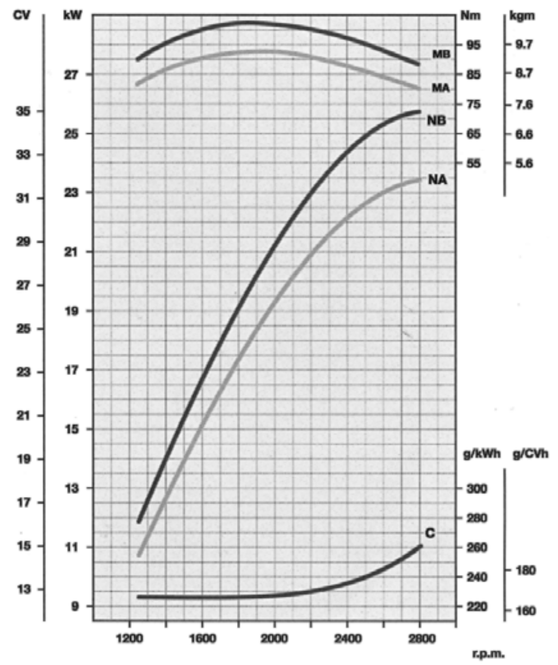
❐ Only for 97/68 CE and EPA approved engines
* Referred to max. NB power
** At NA power
*** Depending on the application

## PERFORMANCE DIAGRAMS

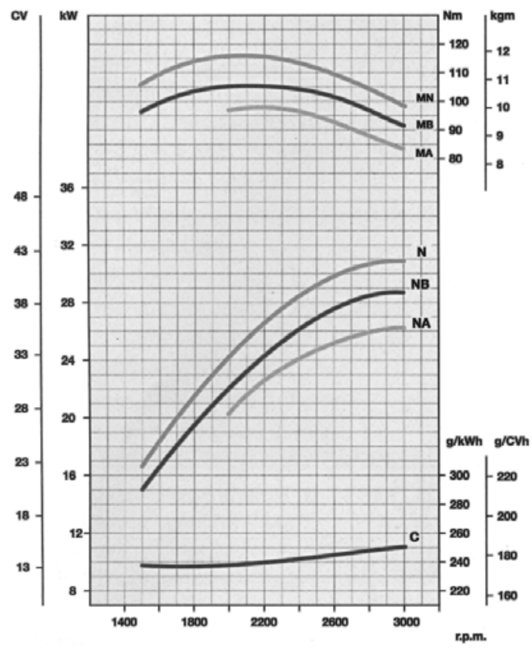
**11 LD 626-3 NR @ 3000 r.p.m.**



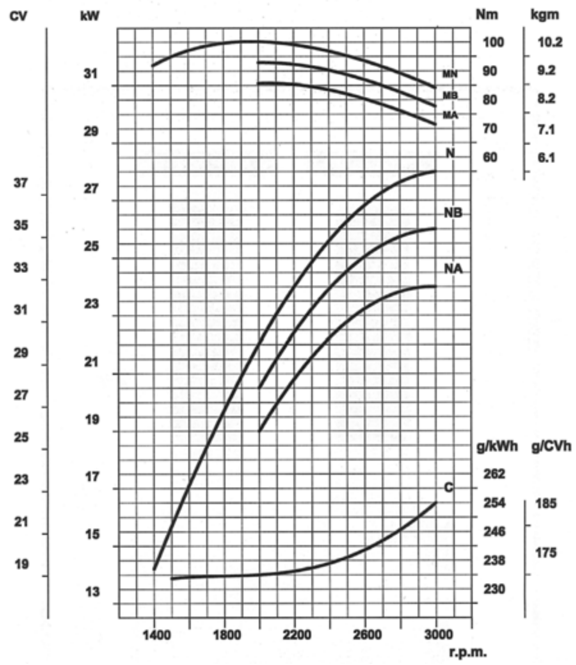

**11 LD 626-3 B2 NR @ 2800 r.p.m.**




**11 LD 626-3 @ 3000 r.p.m.**

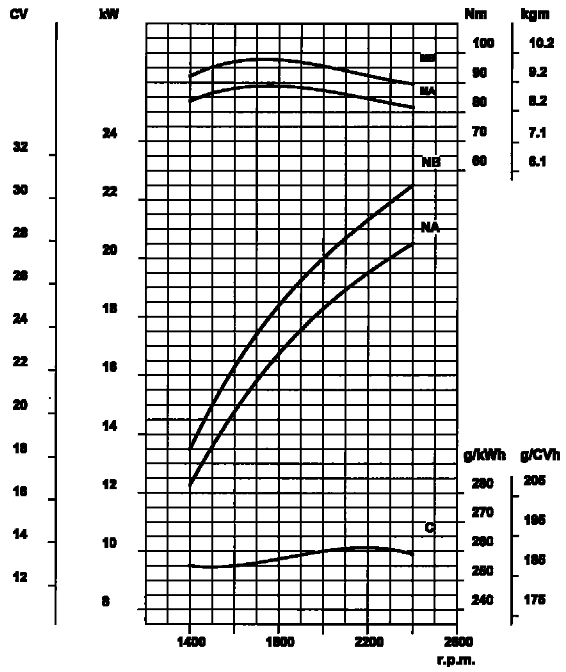



**11 LD 625-3 @ 3000 r.p.m.**

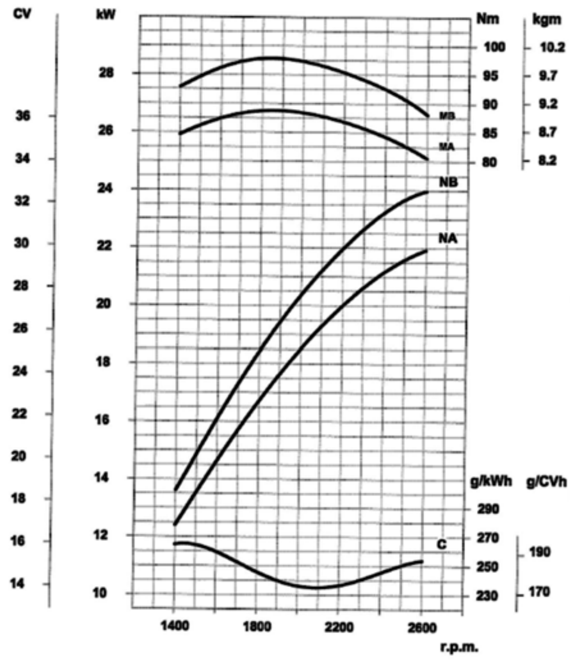


**11 LD 625 - 3 / 626 - 3 EPA**

**@ 2400 r.p.m.**




**@ 2600 r.p.m.**




**N (80/1269/EEC - ISO 1585) - AUTOMOTIVE RATING:** Intermittent operation with variable speed and variable load.
**NB (ISO 3046 - 1 IFN) - RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load.
**NA (ISO 3046 - 1 ICXN) - CONTINUOS RATING WITH OVERLOAD CAPABILITY:** continuos heavy duty with constant speed and constant load.

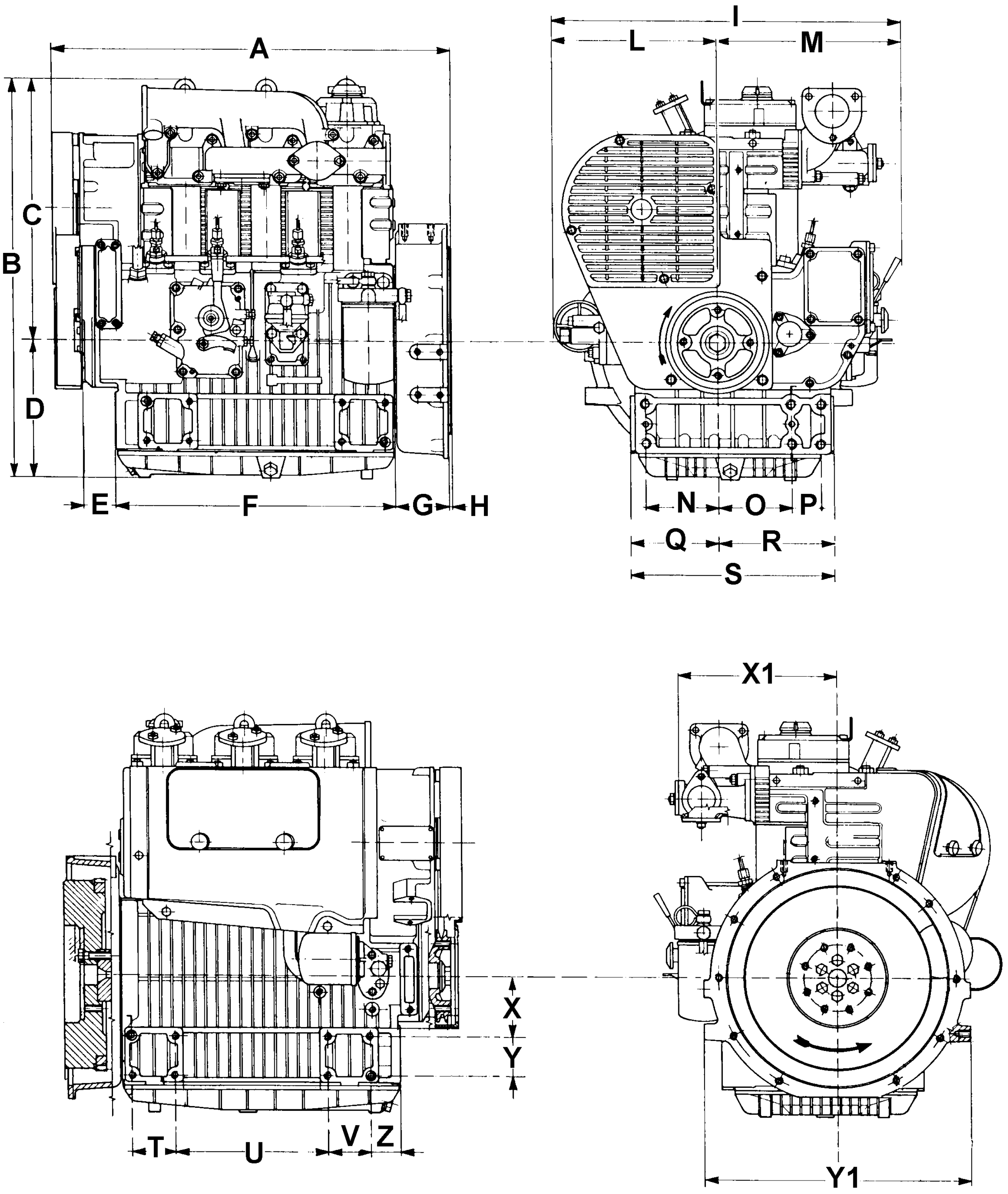
**MN** Torque at **N** power.
**MB (NB curve)**
**MA (NA curve).**
**C** Specific fuel consumption at **NB** power.

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.

**Important**
**Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.**

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

## OVERALL DIMENSIONS




| DIMENSIONI mm - MESURES mm - DIMENSION mm - EINBAUMAßE mm - DIMENSIONE mm - DIMEN0ÇÕES (mm) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | 601 | **D** | 212 | **G** | 82 | **L** | 247 | **O** | 110 | **R** | 173 | **U** | 230 | **X** | 94 | **X1** | 237 |
| **B** | 612 | **E** | 47 | **H** | 4 | **M** | 278 | **P** | 45 | **S** | 305 | **V** | 65 | **Y** | 60 | **Y1** | 400 |
| **C** | 400 | **F** | 421 | **I** | 525 | **N** | 110 | **Q** | 132 | **T** | 65 | **Z** | 46 | | | | |

**Note :** Dimensions shown in mm

## 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**

---

### *EXTRAORDINARY MAINTENANCE*

| | | |
|---|---|---|
| **AFTER THE FIRST 50 WORKING HOURS** | **Engine oilreplacement.** | **Oil filter replacement.** |

---

### *ORDINARY MAINTENANCE*

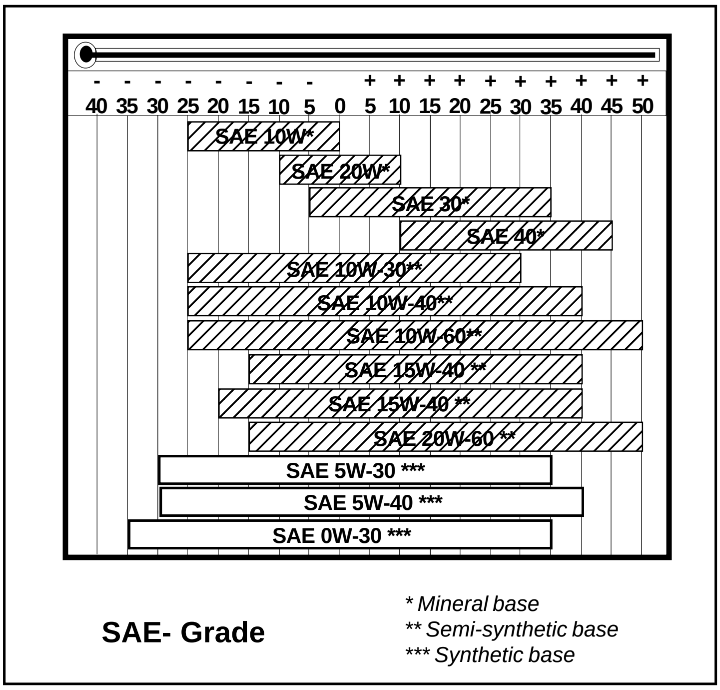
| OPERATION DESCRIPTION | | | FREQUENCY x HOURS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 10 | 125 | 250 | 500 | 1000 | 2500 | 5000 |
| CHECK | LEVEL ENGINE LUBRICANT | | | | | | | | |
| | DRY AIR CLEANER | (***) | | | | | | | |
| | OIL BATH AIR CLEANER | | | | | | | | |
| | BLOWER BELT TENSION | | | | | | | | |
| | VALVE/ROCKER ARMS CLEARANCE ADJUSTMENT | | | | | | | | |
| | SETTING AND INJECTORS CLEANING | | | | | | | | |
| | FUEL PIPES | | | | | | | | |
| | RUBBER INTAKE HOSE (AIR FILTER – INTAKE MANIFOLD) | | | | | | | | |
| | ENGINE OIL RADIATOR CLEANING (IN THE APPLICATIONS WHERE IT IS PRESENT) | | | | | | | | |
| | FUEL TANK CLEANING | | | | | | | | |
| | COOLING SYSTEM CLEANING | | | | | | | | |
| REPLACEMENT | ENGINE LUBRICANT | (*) | | | | | | | |
| | OIL FILTER | (*) | | | | | | | |
| | FUEL FILTER | (*) | | | | | | | |
| | BLOWER BELT | (**) | | | | | | | |
| | FUEL PIPES | | | | | | | | |
| | RUBBER INTAKE HOSE (AIR FILTER – INTAKE MANIFOLD) | (**) | | | | | | | |
| | DRY AIR CLEANER EXTERNAL CARTRIDGE | (***) | AFTER 6 CHECKS WITH CLEANING | | | | | | |
| | DRY AIR CLEANER INTERNAL CARTRIDGE | (***) | AFTER 3 CHECKS WITH CLEANING | | | | | | |
| OVERHAUL INSPECTION | PARTIAL OVERHAUL | | | | | | | | |
| | TOTAL OVERHAUL | | | | | | | | |

**(*) - In case of low use: every year.**
**(**) - In case of low use: every 2 years.**
**(***) - The period of time that must elapse before cleaning or replacing the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently in very dusty conditions.**

## 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 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 Regualtions - ACEA Sequences*

**PETROL**

A1 =Low-viscosity, for frictions reduction
A2 =Standard
A3 =High performances

**LIGHT DUTY DIESEL ENGINES**

B1 =Low-viscosity, for frictions reduction
B2 =Standard
B3 =High performances (indirect injection)
B4 =High quality (direct injection)

**HEAVY DUTY DIESEL ENGINES**

*E1 =OBSOLETE*

E2 = Standard
E3 = Heavy conditions (Euro 1 - Euro 2 engines )
E4 = Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines )
E5 = High performances in heavy conditions (Euro 1 - Euro 2 - Euro 3 engines )

*API / MIL Sequences*

| | DIESEL | | | | | | | | | | PETROL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| API | CH-4 | CG-4 | CF-4 | CF-2 | CF | CE | CD | CC | CB | CA | SA | SB | SC | SD | SE | SF | SG | SH | SJ | SL |
| MIL | | | | | | L - 2104 D / E | | | | | L - 46152 B / C / D / E | | | | | | | | | |

CURRENT OBSOLETE

## PRESCRIBED LUBRICANT

| | | |
|---|---|---|
| **AGIP SUPERDIESEL MULTIGRADE 15W40** | specifications | **API CF 4**<br>**ACEA B2 - E2**<br>**MIL - L-2104 D/E** |

In the countries where AGIP products are not available, use oil API SJ/CF for Diesel engines or oil corresponding to the military specification MIL-L-2104 D/E.
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.

| 11 LD 625/3 - 626/3 ENGINES OIL CAPACITY | | |
|---|---|---|
| **OIL VOLUME AT MAX LEVEL (OIL FILTER INCLUDED)** | Litres | **5,5** |
| **OIL VOLUME AT MAX LEVEL (WITHOUT OIL FILTER)** | Litres | **5** |

**Danger – Attention**

- **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.**

**Danger – Attention**

- **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.**

## FUEL SPECIFICATIONS

**Danger – Attention**

- **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.**

To achieve optimum performance of the engine, use good quality fuel with certain characteristics:

Cetane number (minimum 51): indicates the ignition quality.
A fuel with a low cetane number may cause problems when starting from cold and have a negative effect on combustion.
Viscosity (2.0/4.5 centistokes at 40°C): this is the resistance to flow and performance may decline if not within the limits.
Density (0.835/0.855 Kg/litre): a low density reduces the power of the engine, and density that is too high increases performance and opacity of the exhaust
Distillation (85% at 350°): this is an indication of the mixture of different hydrocarbons in the fuel.
A high ratio of light hydrocarbons may have a negative effect on combustion.
Sulphur (maximum 0.05% of the weight): high sulphur content may cause engine wear.
In those countries where diesel has a high sulphur content, it is advisable to lubricate the engine with a high alkaline oil or alternatively to replace the lubricating oil recommended by the manufacturer more frequently.

| PRESCRIBED LUBRICANT | |
|---|---|
| Fuel with low sulphur content | **API CF4 - CG4** |
| Fuel with high sulphur content | **API CF - CD - CE** |

The countries in which diesel normally has a low sulphur content are: Europe, North America and Australia.

**Fuels for low temperatures**

It is possible to run the engine at temperatures below 0°C using special winter fuels.
These fuels reduce the formation of paraffin in diesel at low temperatures.
If paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

| | | | | |
|---|---|---|---|---|
| **Fuel can be:** | - | **Summer** | **up to** | **0°C** |
| | - | **Winter** | **up to** | **-10°C** |
| | - | **Alpine** | **up to** | **-20°C** |
| | - | **Arctic** | **up to** | **-30°C** |

**For all fuel types, the cetane number cannot be lower than 51.**

**Aviation kerosene and RME fuels (biofuels)**

The only Aviation fuels that may be used in this engine are: JP5, JP4, JP8 and JET-A if 5% oil is added.
For more information on Aviation fuels and Biofuels (RME, RSME) please contact the Lombardini applications department.

| **Capacities standard fuel tank** | Litres | **15** |
|---|---|---|
| As for filters, tanks and special crankcases please refer to LOMBARDINI instructions. | | |

## RECOMMENDATIONS FOR DISASSEMBLING AND ASSEMBLING

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

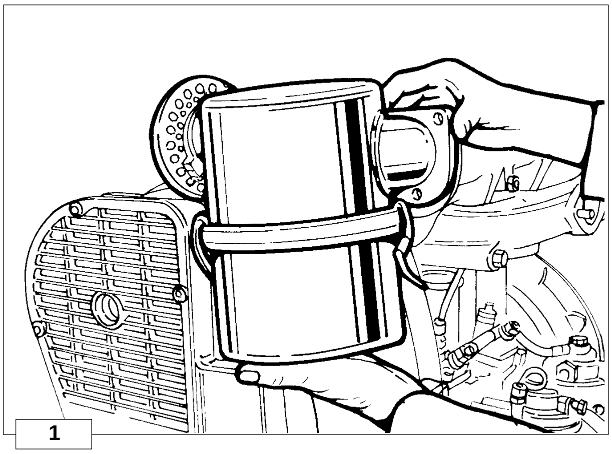
- Besides disassembly and reassembly operations this chapter also includes checking and setting specifications, dimensions, repair and operating instructions.
- Always use original LOMBARDINI spare parts for proper repair operations.
- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- For safety and convenience, you are advised to place the engine on a special rotating stand for engine overhauls.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- In order to fix assemblies and/or components securely, the operator must tighten the fastening parts in a criss-cross or alternating pattern.
- Assemblies and/or components with a specific tightening torque must initially be fastened at a level lower than the assigned value, and then subsequently tightened to the final torque.

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



1

## Oil-bath air cleaner

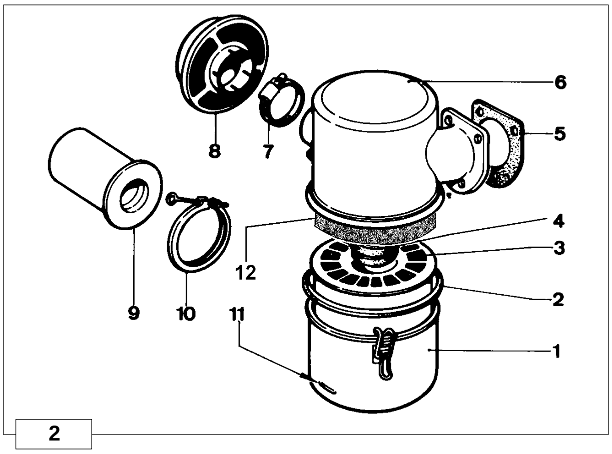
**Danger – Attention**

**Do not blow the paper filter element with compressed air to clean.**

**Caution – Warning**

**Check gaskets and replace as necessary.**
**Check that flange welds are free of defective spots.**

❍ When reassembling, tighten the fastening nuts of the air filter to the intake manifold to 25 Nm.




2

## Oil-bath air cleaner components

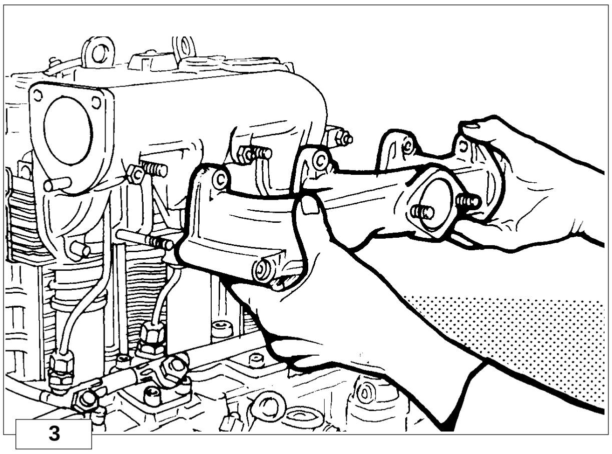
**Caution – Warning**

**Replace if irreparably clogged.**

| | |
|---|---|
| **1** Bowl | **7** Cover clamp |
| **2** External seal ring | **8** Cap |
| **3** Lower filtering element | **9** Centrifugal pre-filter |
| **4** Internal seal ring | **10** Centrifugal pre-filter clamp |
| **5** Gasket | **11** Oil level mark |
| **6** Cover | **12** Upper filtering element (polyurethan sponge) |

***Note:*** Thoroughly clean the lower tank and the metal filter element using diesel fuel then blow compressed air into them.
The upper filter element in polyurethane foam is cleaned by washing it in soapy water; after washing, dry completely using compressed air.

➲ After cleaning refill the engine oil tank up to the indicated level.
See page 17 for the maintenance or replacement instructions.



3

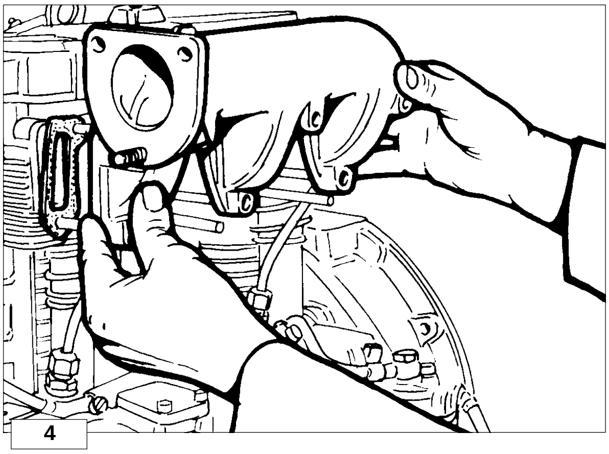
## Exhaust manifold

**Danger – Attention**

**Allow the exhaust manifold to cool before demounting it in order to prevent scorching and burns.**

Make sure that the inside is properly clean and is free from cracks or breakage.
Always replace the seals between the manifold and the exhaust pipes.

❍ When assembling, tighten the nuts in sequence and gradually before the final torque to 20 Nm.



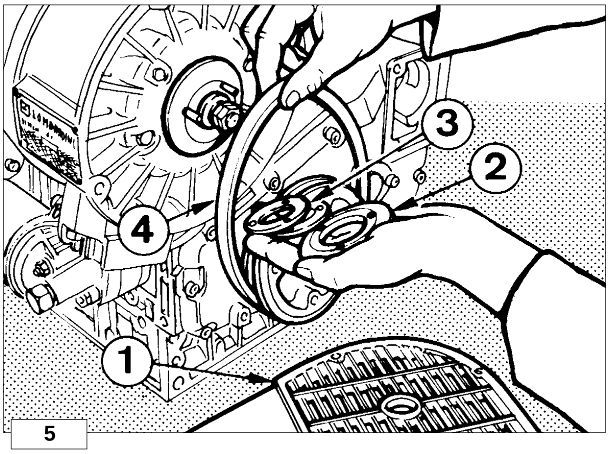
4

## Intake manifold

Before reassembling the manifold check the levelness of the flanges.
Always replace the seals between the manifold and the intake pipes.

❍ Tighten the nuts gradually to 25 Nm.

***Note:*** In case of low temperature starting we can supply a manifold with provision for a glow plug for air preheating.




5

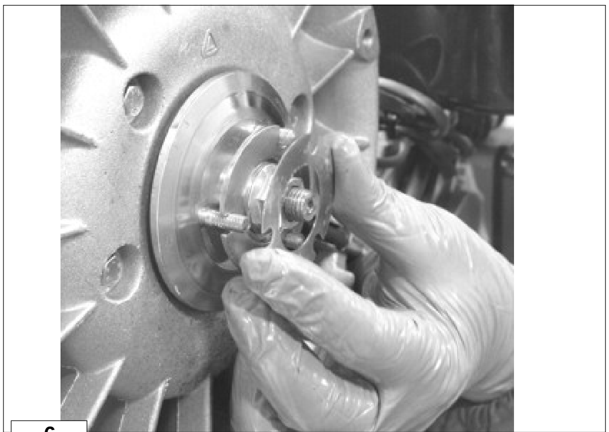
## Blower belt alternator

*Components:*

**1** Guard
**2** Pulley
**3** Spacers
**4** 'V'-belt

Unscrew the fastening screws of the belt guard and remove it, then take out the nuts on the three stud bolts on the half-pulley.
Remove the V belt and check for wear.

➲ See page 17 for periodic maintenance details.

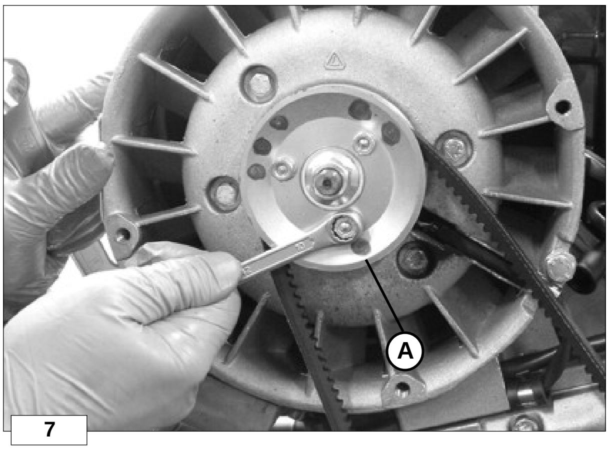


6

## Belt tension adjustment

**Danger – Attention**
**Check the belt tension only when the engine is not running**

The belt tension is adjusted by adding (to reduce tension) or removing (to increase tension) spacers between the half-pulleys.
Spacers are available in thicknesses of 0.5, 1 and 2 mm.

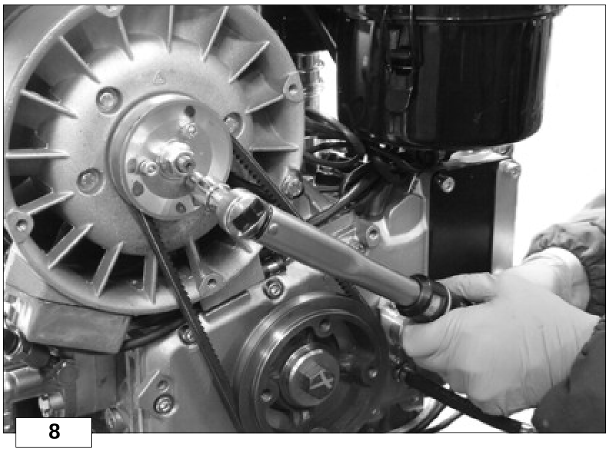



7

## Half-pulley - Reassembly

**Important**
**The three stop nuts of the half-pulley should never be tightened simultaneously.**

Turn the pulley so that, whenever you tighten a nut, this is in the position indicated **A** in the figure 7.
Tightening should be carried out gradually.

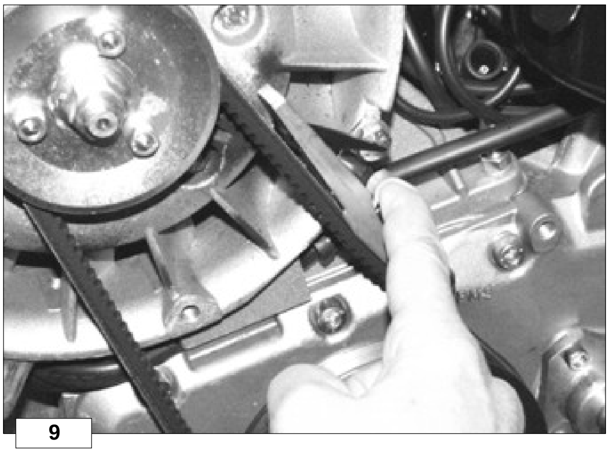


8

### Blower belt alternator - Reassembly

❍ The half-pulley fastening nuts must be tightened using the torque wrench to a final torque of 10 Nm.

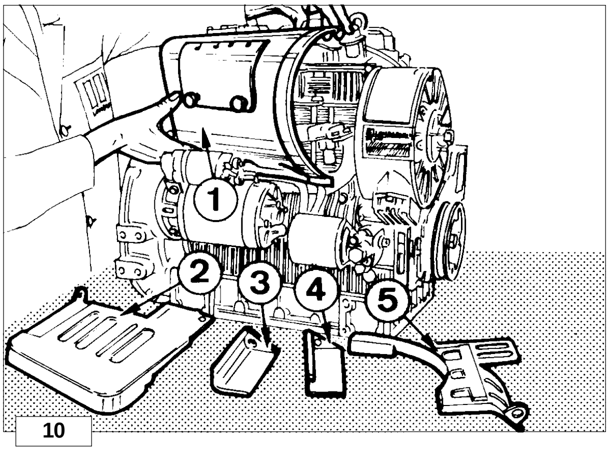
Again during this phase the nut must be in position **A** when tightened as in fig. 7 – page 22.



9

### Tension check

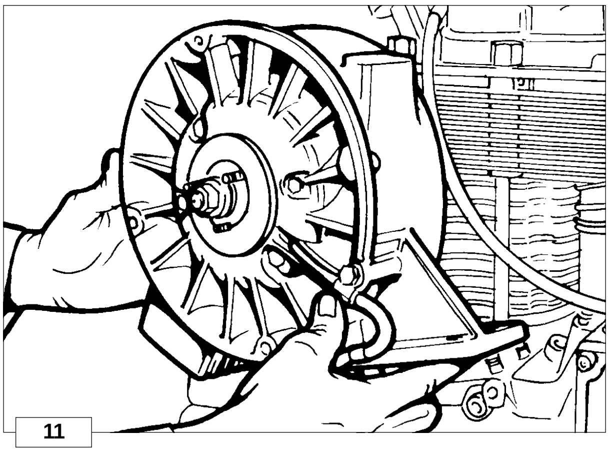
A 4 Kg load located halfway between the pulleys should cause the belt to bend 5 ÷ 15 mm.
The correct belt tension can also be checked with special tools that are available on sale.




10

### Air shroud and baffles - Disassembly

The air shroud **1** and the baffles **2**, **3**, **4**, **5** are shaped in such a way as to direct the flow of air onto the cylinders in order to cool them.
As the shroud is completely covered in noise-absorbent material, it also has the function of reducing the amount of noise generated by the blower fan and vibrations.



11

### Blower assembly

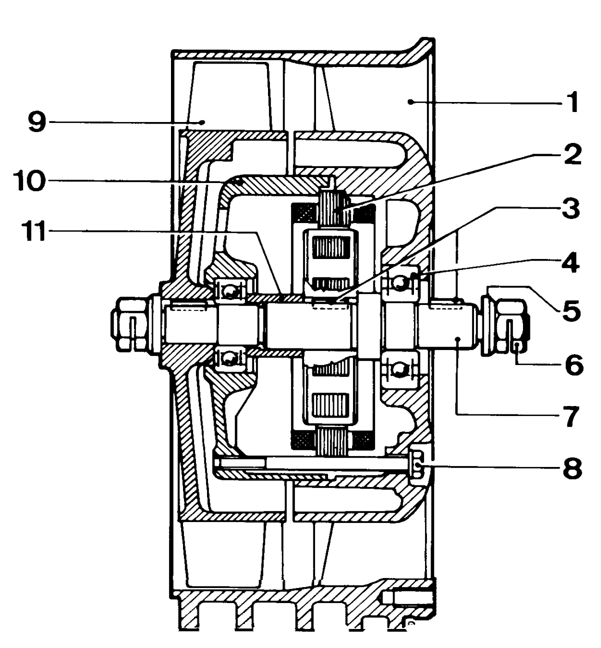
**Danger – Attention**

**Before demounting the cooling fan, disconnect the positive battery cable to prevent accidental short-circuits which could consequently energize the starter motor.**

The plate and tension regulator are fixed to the outside of the blower fan stator.
A 14 A or 21 A alternator is housed inside the stator.

➲ See page 60 - 61 for the alternator technical data.

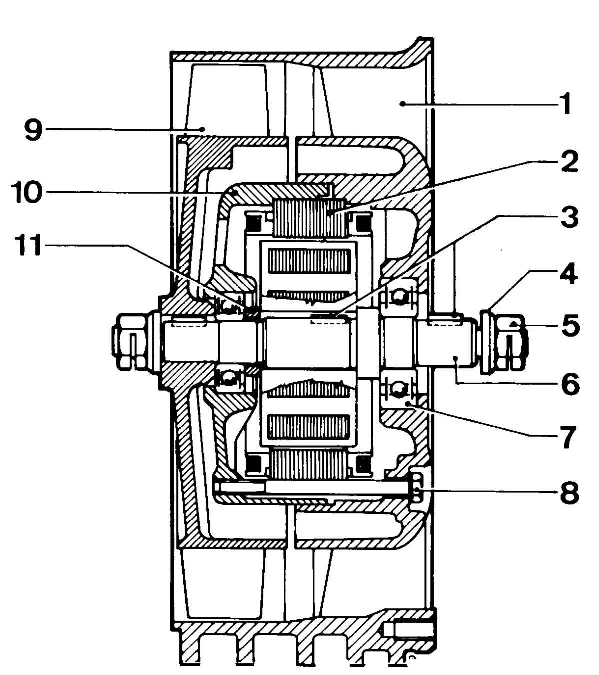
➲ See page 13 for the cooling air volume.



12

### Blower assembly components with 14 A alternator

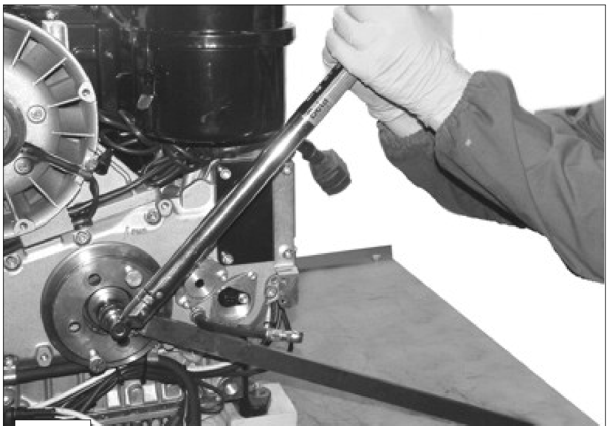
**1** Housing
**2** 14 A alternator
**3** Key
**4** Ball bearing
**5** Washer
**6** Nut
**7** Shaft
**8** Bolt
**9** Fan
**10** 14 A alternator bell
**11** Spacer



13

### Blower assembly components with 21 A alternator

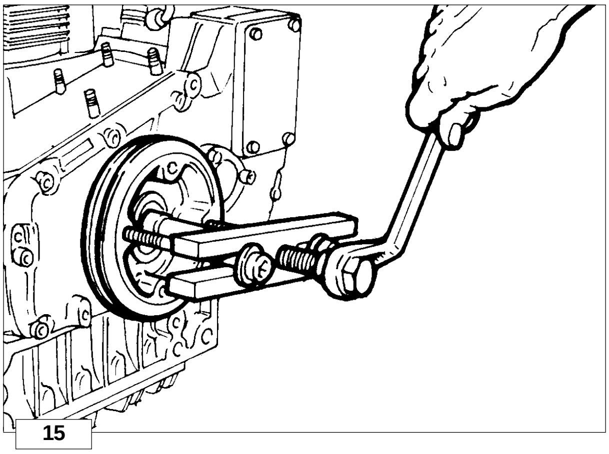
**1** Housing
**2** 21 A alternator
**3** Key
**4** Washer
**5** Nut
**6** Shaft
**7** Bearing
**8** Bolt
**9** Fan
**10** 21 A alternator bell
**11** Spacer


14

### Blower control pulley - Disassembly

The blower control pulley is installed on and is driven by the crankshaft.
To disassemble the pulley unscrew the left-handed bolt (clockwise) after blocking the crankshaft.

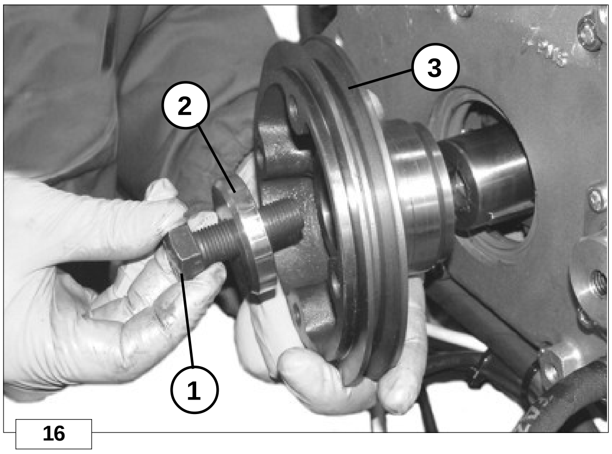
❍ When reassembling, tighten the bolt using a torque wrench to a torque of 300 Nm.



15

### Crankshaft pulley

Remove the pulley using extractor serial no. 1460.200.

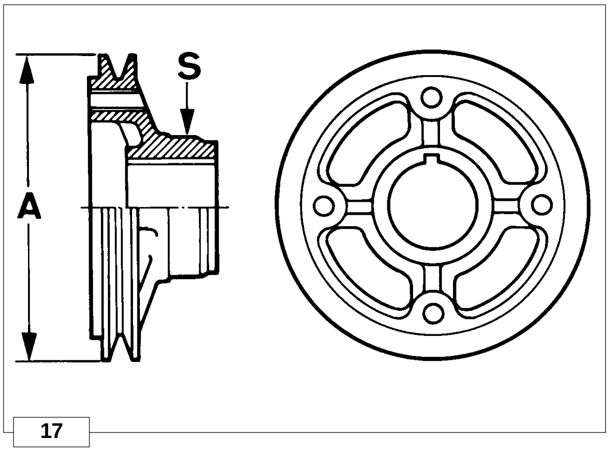



16

*Components:*

**1** Left-handed bolt
**2** Washer
**3** Blower control pulley

***Note:*** It is only possible to check crankshaft axial clearance after tightening the pulley.

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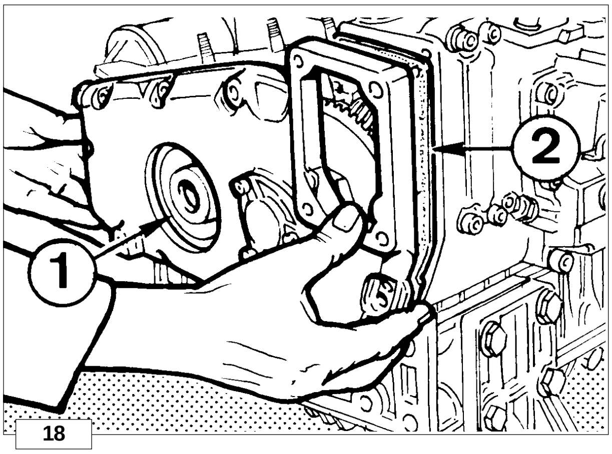
### Blower control pulley diameter

There are three pulleys with different diameters **A** which take account of engine settings:

| | |
|---|---|
| **A** = 142 mm | ( from 2401 to 3000 r.p.m. ) |
| **$A_1$** = 147 mm | ( from 2001 to 2400 r.p.m. ) |
| **$A_2$** = 163 mm | ( from 1500 to 1800 r.p.m. ) |

Check **S** surface in contact with oil seal ring and, if necessary, rub with a fine grain emery cloth.



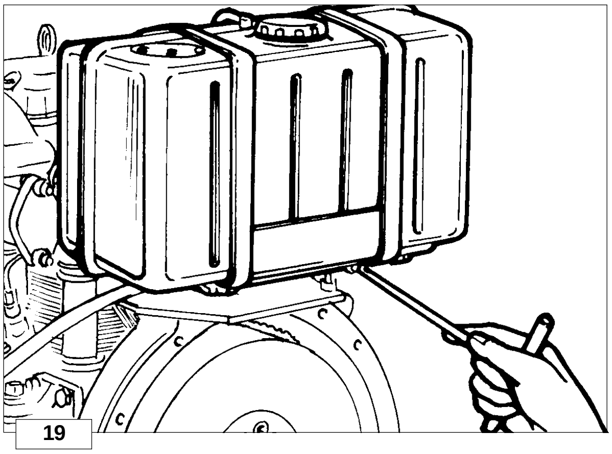

18

### Timing cover

Loosen the screws and remove the cover.

❍ When refitting tighten screws at 25 Nm.

Check oil seal ring **1** and replace if warped, hardened or worn-out.
Replace gasket **2**.



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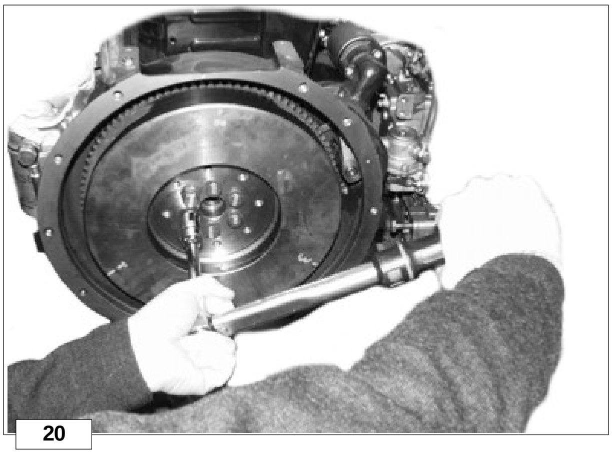
**Tank**

**Danger – Attention**

**Do not smoke or use naked flames during the demounting operations as these could cause explosions or fire outbreaks.**
**Fuel fumes are highly toxic. Only carry out the operations outdoors or in a well ventilated place.**
**Keep your face well away from the filler cap or you could inhale harmful fumes. Dispose of fuel in the correct way as it is highly polluting. Do not litter.**

Remove fuel filter and loosen clamp screws.
Completely empty the tank and check that no impurities are found inside.
Check that cap breather is not clogged.



20

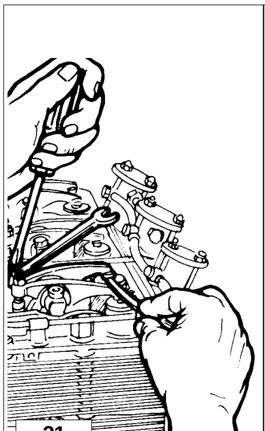
**Flywheel**

**Danger – Attention**

**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.**

Remove the bolts which attach the flywheel to the crankshaft.
To replace starter ring gear heat it up to 300°C for 15 ÷ 20 minutes.
Drive it onto the flywheei caretully checking that it perfectly fits into its seat.
Let it cool down slowly.

❍ When reassembling gradually tighten the fastening screws to 140 Nm on the crankshaft using a torque wrench.



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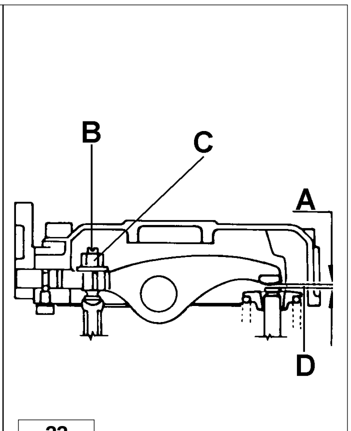


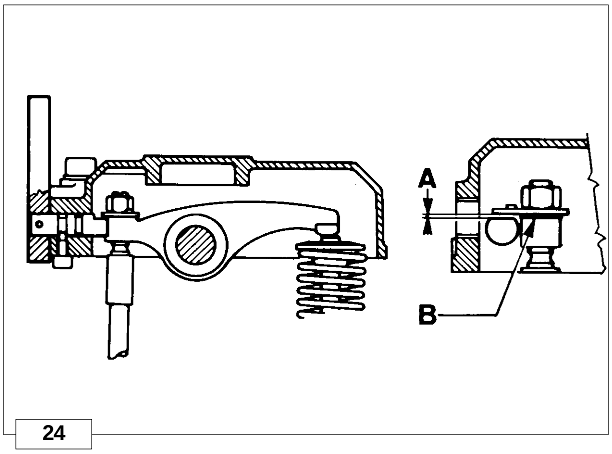

22

**Valve / rocker arm clearance**

**Caution – Warning**

**Make settings when the engine is cold.**

Remove the rocker arm covers and make sure the seals are intact, otherwise replace them. Bring the cylinder piston that is to be adjusted to the compression top dead centre.
Loosen the fastening nut **C**, insert the thickness gauge **D** between the rocker arm and the top of the valve stem, then, using a cross-head screwdriver turn the adjusting screw **B** to set clearance.
Tighten the fastening screw **C** and check valve clearance **A** again to ensure that it is between 0,15 and 0,2 mm for intake and 0,3 ÷ 0,35 mm for exhaust.
❍ When refitting tighten cover screws to 20 Nm.
If necessary place a 0,30 or 0,40 mm shim at **B**.

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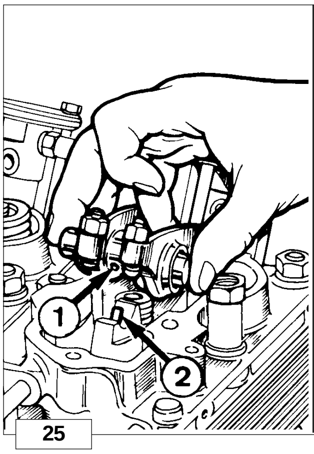
## Compression release (optional)

Bring piston to top dead center on the compressiòn stroke.
Unscrew rocker arm cover side plug and measure clearance **A** should be 0,30 ÷ 0,40 mm.

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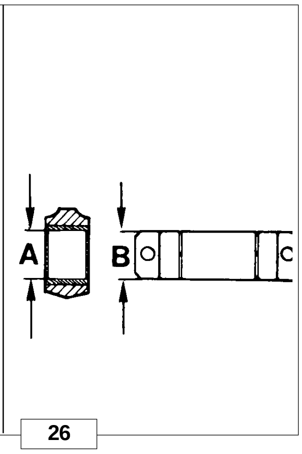


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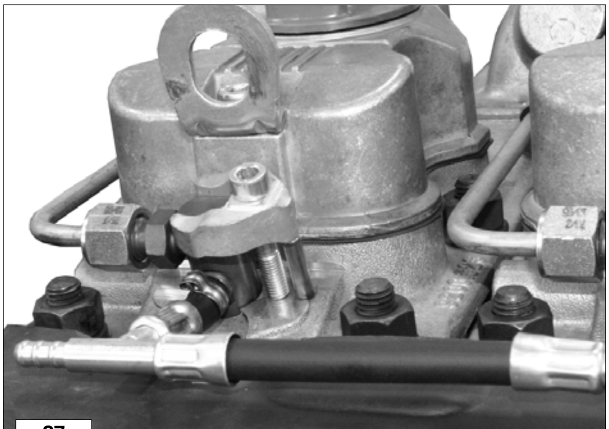
## Rocker arm assembly

Components: **1** Rocker arm axle lubrication hole
**2** Lubrication tube

| Ref. | Dimensions |
|---|---|
| A | 18.032 ÷ 18.050 mm |
| B | 17.989 ÷ 18.000 mm |

Replace the axle and the rocker arm if clearance (**A-B**) is greater than 0,135 mm.
When refitting check that lubrication tube **2** perfectly fits into centering bore **1**.

❍ Tighten screws at 25 Nm.



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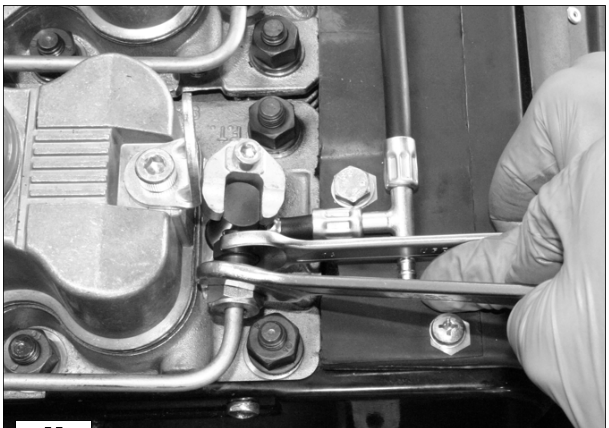
## Disassembling size P injector

The injector is attached to the cylinder head via a forked bracket.



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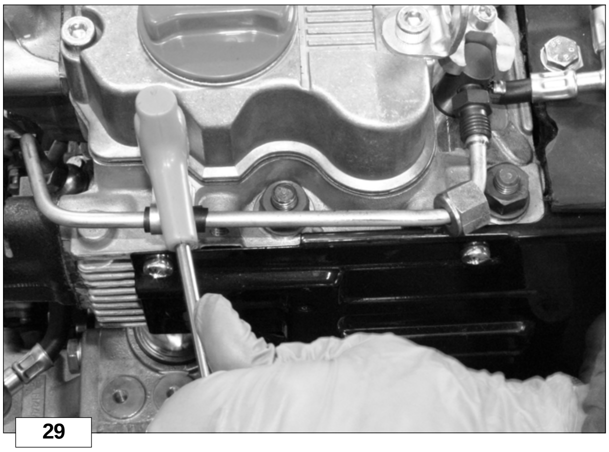
To release the injector union from the high-pressure pipe, use two box wrenches (14 and 17 mm).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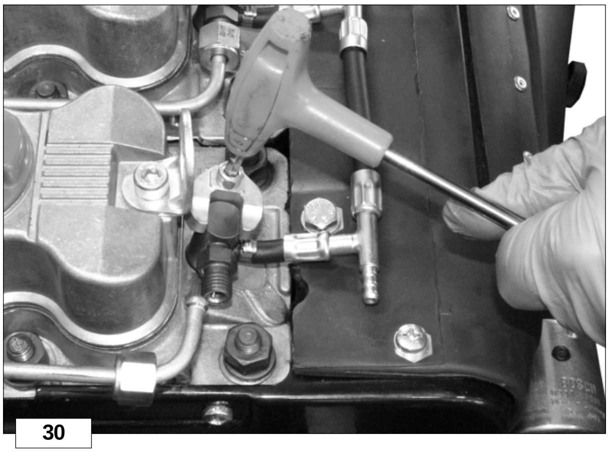
Unscrew the screw fastening the clamp of the high-pressure pipe using a 4 mm hexagon screwdriver.


30

Remove the forked bracket fixing the injector to the cylinder head using a 5 mm hexagon screwdriver (see photo 29 - 30).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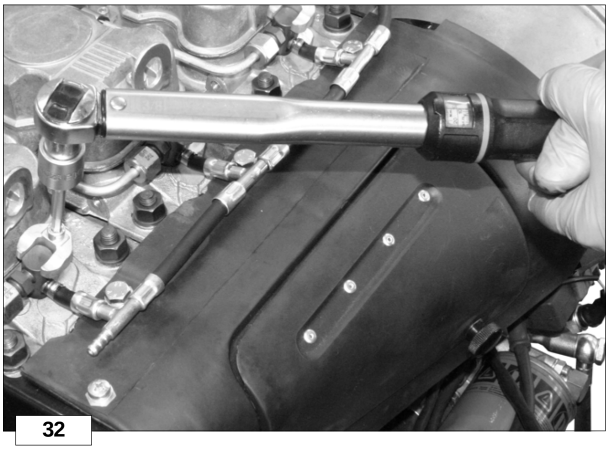
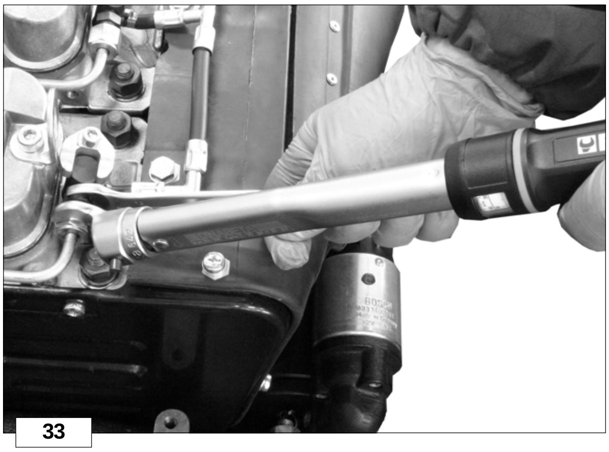
These operations are necessary when checking injector calibration or when replacing it.

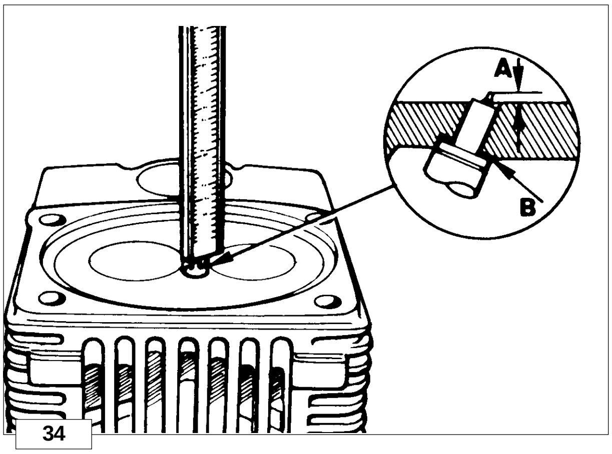

32

❍ The fixing bracket screws must be tightened to 10 Nm using a torque wrench.



33

❍ The high-pressure pipe union must be tightened to the injector union to 20 ÷ 25 Nm using a torque wrench.

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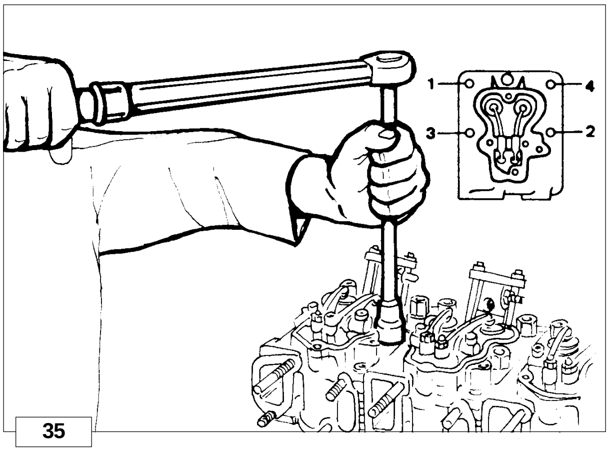
**Injector protrusion**

It is only possible to check injector protrusion with the cylinder head disassembled.
The end of the nozzle must be 3 ÷ 3,5 mm with respect to the head surface **A**.
Protrusion is adjusted by adding or removing copper seals **B** which are supplied at a thickness of 0,5 and 1 mm.

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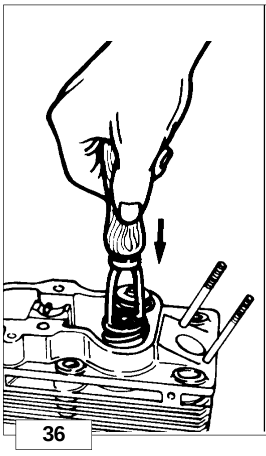
**Cylinder Head**

**Caution – Warning**
**Do not demount or remount while hot as this could lead to deformations.**

If the head surface is distorted, grind it by removing up to 0.3 mm thickness. When reassembling, before tightening, make sure that the rocker arm lubrication hose is firmly lodged into holes. The cylinder heads must be tightened with the exhaust or intake manifold mounted to keep them lined up. Always replace the copper seal between the cylinder head and the cylinder that determines clearance volume; see page 34 for the choice of thickness. See page 32 for how to mount the spring on the tappet rod protection pipe.
❍ The cylinder head fastening nuts must be tightened gradually to 55 Nm and in the sequence **1**, **2**, **3**, **4**; see fig. 35.



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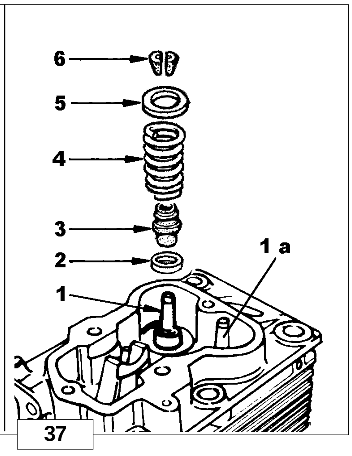


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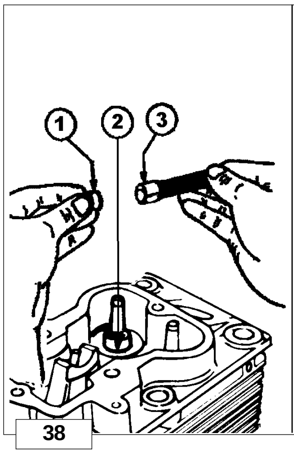
**Valves**

*Components:*

**1** Intake valve
**1a** Exhaust valve
**2** Lower spring collar
**3** Valve stem sealing ring
**4** Spring
**5** Upper spring collar
**6** Three-groove half collets

Te remove half collets firmly press down the special tool 1460 - 113 as shown in the figure 36.



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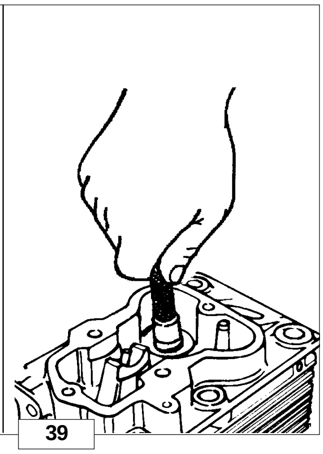
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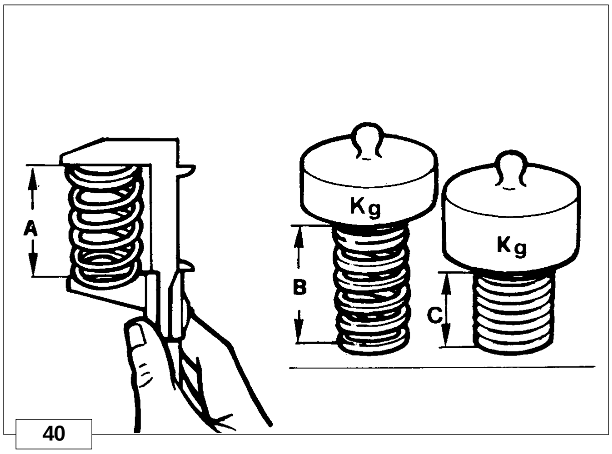
### Valve stem sealing rings - Reassembly

Lubricate the inside of the sealing ring with Molikote BR2 Plus and insert them all the way onto the guides using tool 1460 – 108.
To prevent deformation of the sealing ring **1** as it is inserted onto the valve guide **2** insert it onto tool **3**.
Lubricate valve stem with the same type of grease; insert the valves into the guides rotating them particularly as they enter the sealing ring.



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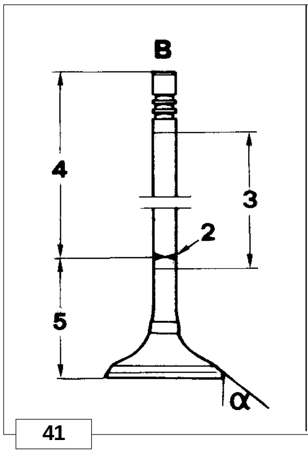
### Valve springs

Measure free length with a gauge.
Using a spring tester check that the spring length under two different loads corresponds to the values below:

Free length **A** = 52 mm
Length **B** compressed by a 21 Kg weight = 34.8 mm
Length **C** compressed by a 32 Kg weight = 25.8 mm.



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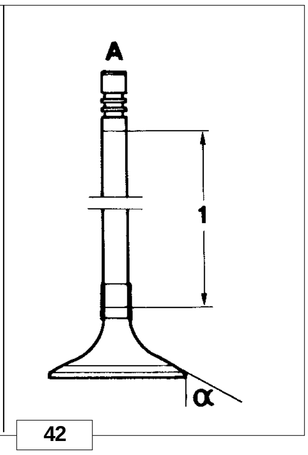

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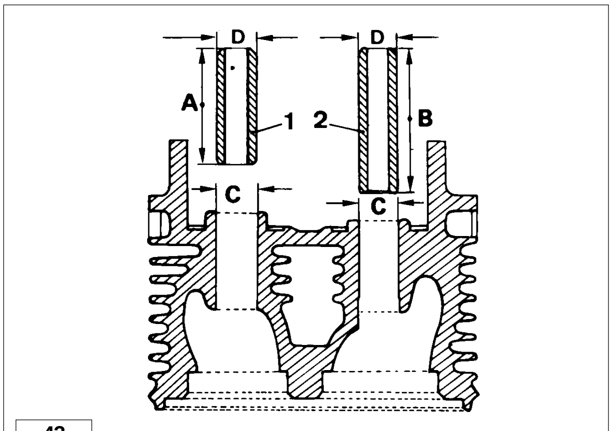
### Valve material

**Intake valves A**
- Material: X 45 Cr Si 9 - 3 UNI EN 10090
**1** = Chromium-plated portion
**α** = 45°15' ÷ 45°25'

**Exhaust valve B**
Shaft and head are made of 2 different materials.
**2** = Welded portion
**3** = Chromium-plated portion
**4** = Portion made of X 45 Cr Si 9 - 3 UNI EN 10090
**5** = Portion made of X 53 Cr Mn Ni N 21 - 9 UNI EN 10090
**α** = 45°15' ÷ 45°25'



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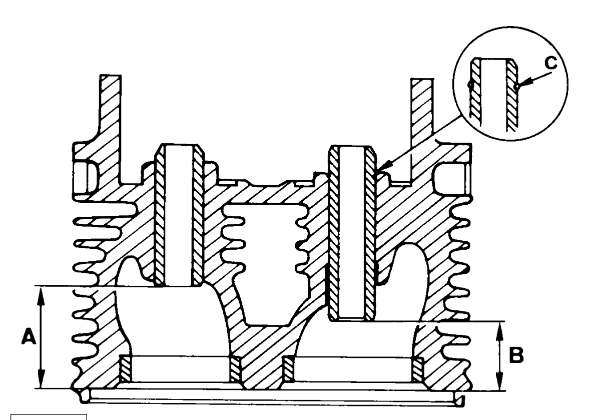
### Valve guides and cylinder head housings

Intake and exhaust valve guides are both made of phosphoric cast iron.
*Components:* **1** = Exhaust valve guide
**2** = Intake valve guide

| Ref. | Dimensions (mm) |
|---|---|
| A | 42,00 |
| B | 48,00 |
| C | 14,000 ÷ 14,018 |
| D | 14,045 ÷ 14,056 |

Valve guides with outside diameter increased by 0,5 mm are also available; in such cases valve guide bore **C** should also be increased by 0,5 mm.

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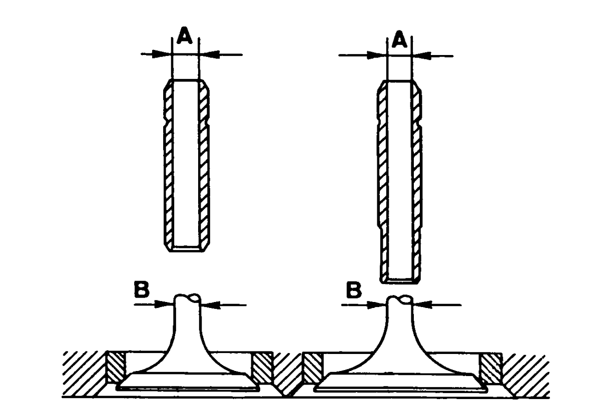
## Valve guide insertion

Heat cylinder head up to 160 ÷ 180°C.
Thread guides considering the **A** e **B** distances from the head plane.

| Ref. | Dimensions (mm) |
|---|---|
| A | 30,80 ÷ 31,20 |
| B | 24,80 ÷ 25,20 |

***Note:*** If the guides are supplied with the housing for the lock ring **C**, insert the ring, then drive the guides until the lock ring is stopped without worrying about **A** and **B**.

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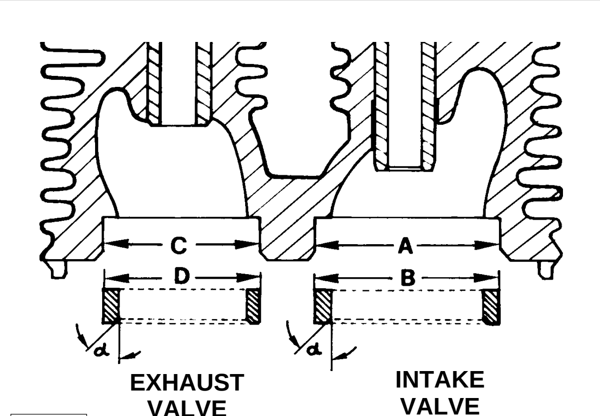
## Dimensions and clearance between guides and valves

| Ref. | Dimensions (mm) | Clearance (mm) | Limit value (mm) |
|---|---|---|---|
| A | 8,025÷8,040 | 0,025÷0,055 | 1,15 |
| B | 7,985÷8,000 | | |

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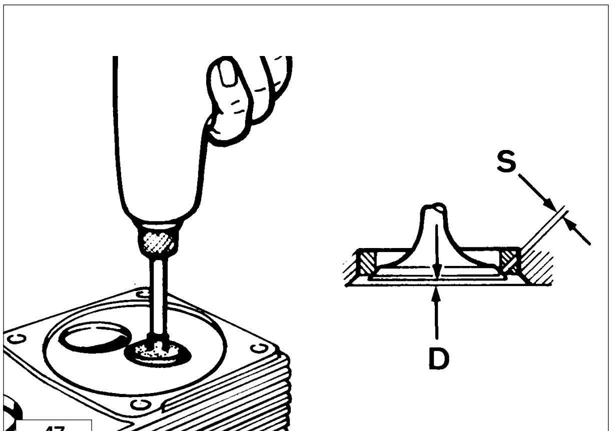
## Valve seats and housings

| Ref. | Dimensions (mm) |
|---|---|
| A | 40,000÷40,016 |
| B | 40,120÷40,140 |
| C | 34,000÷34,016 |
| D | 34,120÷34,140 |

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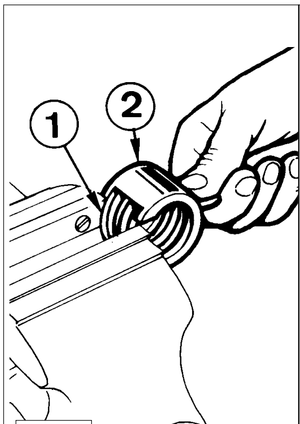
## Valve seat lapping

After cutting, lap valve seats with fine emery paste in oil suspension.
The sealing surface **S** should not exceed 2 mm.

**Valve recess after grinding**

| Ref. | Dimensions (mm) | Limit value (mm) |
|---|---|---|
| D | 0,75÷1,25 | 1,65 |

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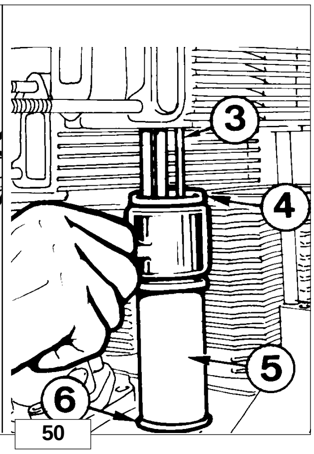


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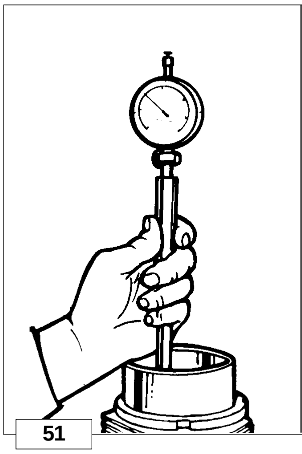
### Pushrod tube spring fitting

*Components:*

**1** Spring
**2** Tool Part No 1460-009
**3** Rocker arm lubrication tube
**4** Gasket
**5** Pushrod tube
**6** Gasket

To mount the spring **1** on the tappet rod protection pipe **5** insert it into the tool **2** with the help of a vice.
Make sure that the rocker arm lubrication hose **3** and the seals **4** and **6** are fully in place.



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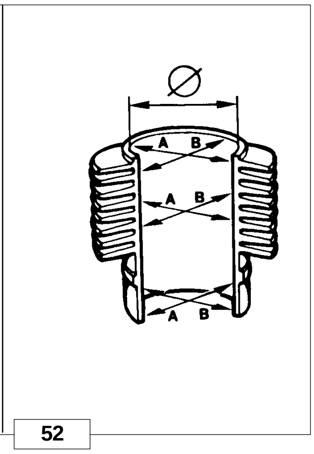


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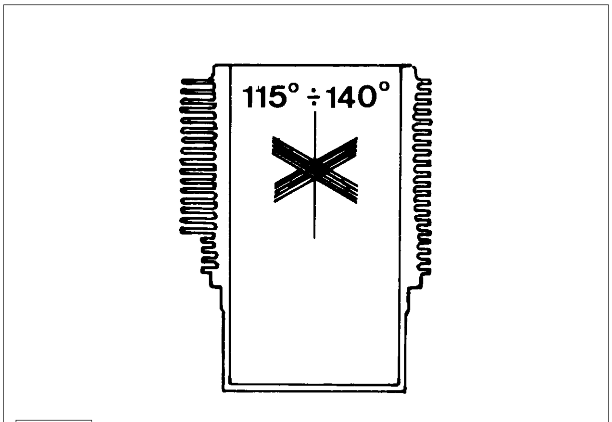
### Cylinder

Measure diameter sìze between two diametrically opposed points at three different heights.

| Ø Cylinder |
|---|
| 95,00 ÷ 95.03 mm |

In case wear exceeds 0,10 mm, bore the cylinder and fit oversize piston and rings.
In case of less wear replace piston rings only.

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### Checks and cyiinder roughness

The cylinder should show no blowholes or porosities.
Seal both ends of cylinder and pressurize with compressed air at 4 bar for 30 sec.
Fins must be intact.
Cross hatch pattern must range between 115° ÷ 140°: they must be uniform and clear in both directions.
Average roughness should range between 0,5 and 1 µm.

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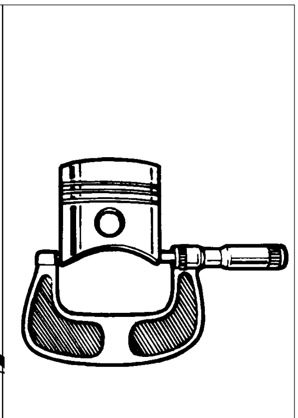

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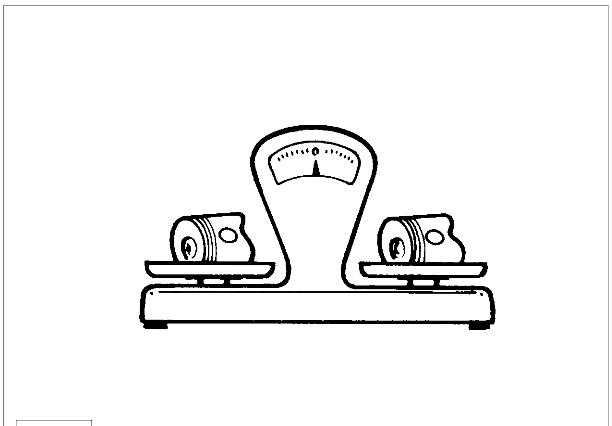
### Piston

Remove the Sieger stop rings and extract the pin.
After removing the snap rings from the piston, clean the grooves if necessary.
Measure the diameter at 2 mm from the base using an external micrometer.

| Ø Piston |
|---|
| 94,92 ÷ 94,95 mm |

Replace the piston and the snap rings if the diameter of the wear is greater than 0,05 mm of the minimum value prescribed.

***Note:*** Oversize pistons of 0,5 and 1,0 mm are available.



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**Piston weight**

Weigh pistons when replacing them in order to avoid unbalance.
The difference in weight should not exceed 6 g.


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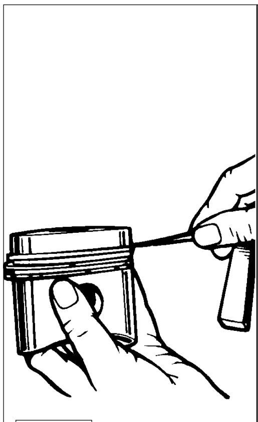
**Metal snap rings - End gaps**

Insert the snap rings in the lower part of the cylinder, then measure the distance between the tips.

| | | | Limit value |
|---|---|---|---|
| 1° | Compression snap ring (chrome-plated) | 0,40 ÷ 0,65 mm | 1 mm |
| 2° | Snap ring (conical internal torsional) | 0,40 ÷ 0,65 mm | 1 mm |
| 3° | Ring (oil scraper) | 0,25 ÷ 0,50 mm | 1 mm |



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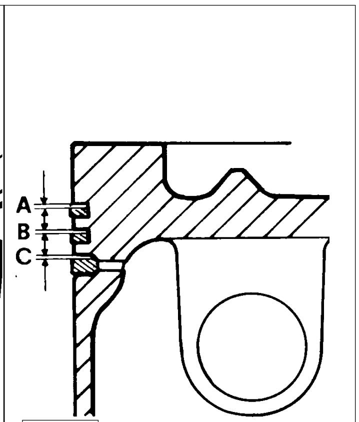


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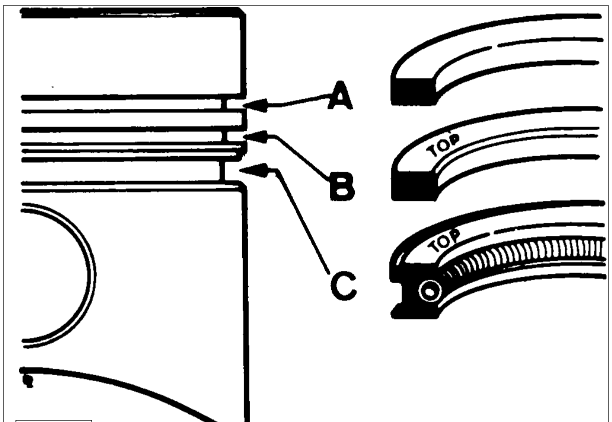
**Metal snap rings - Piston grooves**

| Ref. | Dimensions (mm) | Limit value (mm) |
|---|---|---|
| A | 0,07 ÷ 0,11 | 0,20 |
| B | 0,05 ÷ 0,09 | 0,16 |
| C | 0,04 ÷ 0,08 | 0,15 |

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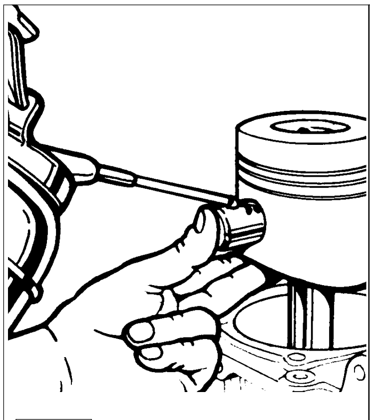
**Metal snap rings - Fitting sequence**

**A** = Compression snap ring (chrome-plated)
**B** = Snap ring (conical internal torsional)
**C** = Ring (oil scraper)

***Note:*** before inserting the piston in the cylinder, rotate snap rings so that cuts are misaligned by 120° from one to the next.

**Important**
**Assemble the segments with TOP facing the piston crown.**



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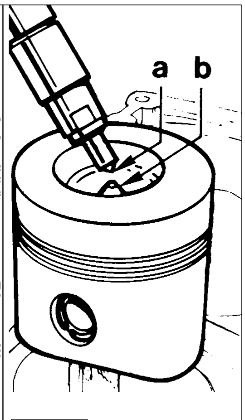


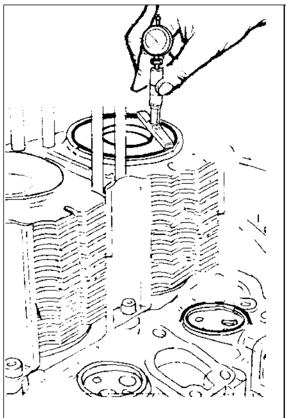

62

## Piston - Refitting

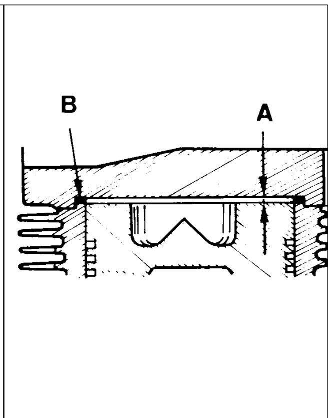
**Caution – Warning**

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

Connect piston to connecting rod in a way that the combustion chamber center **b** is under nozzle tip **a**.
Lubricate piston pin and introduce it into the piston by exerting pressure with your thumb.
Check that both circlips are well inside their seats.



63



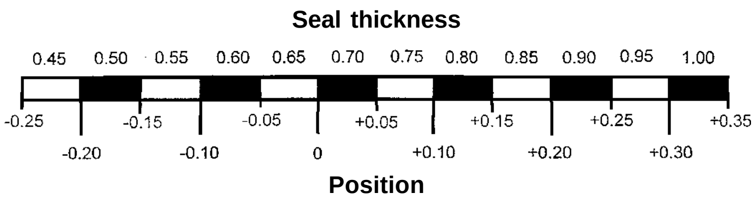

64

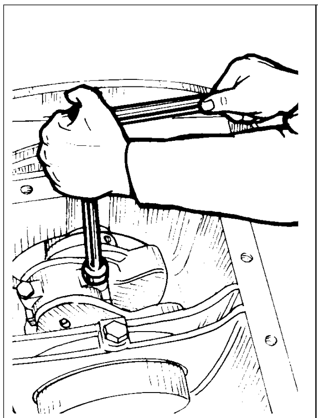
## Piston clearance

**A** = Clearance volume is 0,65 ÷ 0,7 mm for size **S** injectors and 0,55 ÷ 0,6 mm for size **P** injectors
**B** = Copper seal with various thicknesses

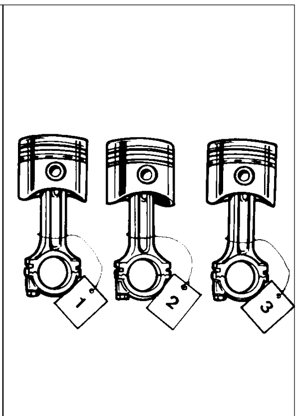
The piston crown in the **TDC** (top dead centre) position may vary, and extend or be short of the upper surface of the cylinder.
Use a dial indicator to measure the positive or negative difference between the two surfaces (piston crown and upper cylinder surface) and use a suitable thickness copper gasket **B** for the cylinder head to adjust the clearance volume **A** between the cylinder head and the piston crown, and which must be between 0,65 and 0,7 mm for size S injectors and 0,55 ÷ 0,6 mm for size **P** injectors.

The table below shows how to choose the most suitable cylinder head copper seal according to the position of the piston in relation to the upper surface of the cylinder.



65




66

## Connecting rod

**Caution – Warning**

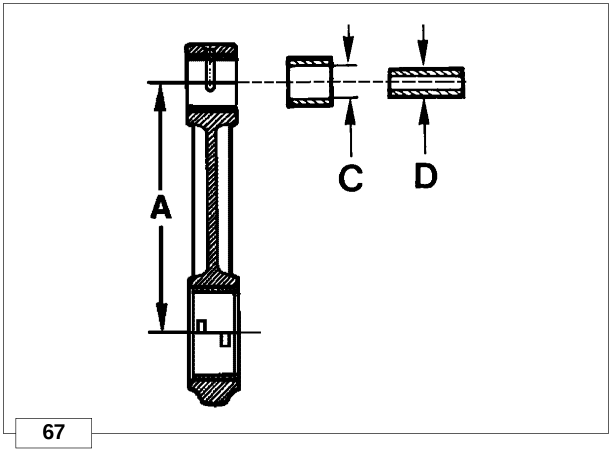
**When remounting the big-end bearings, remember to thoroughly clean the parts and generously lubricate them to prevent seizure when the engine is started up for the first time**

Remove the oil sump and internal oil filter.
Remove connecting rocis and check as follows.

**Important**

**All connecting rod/piston units should be fitted back into the corresponding cylinders; mark them to avoid mistakes.**

➲ See page 35 fig. 71 for specifications as to the tightening of the connecting rod big end bearing.

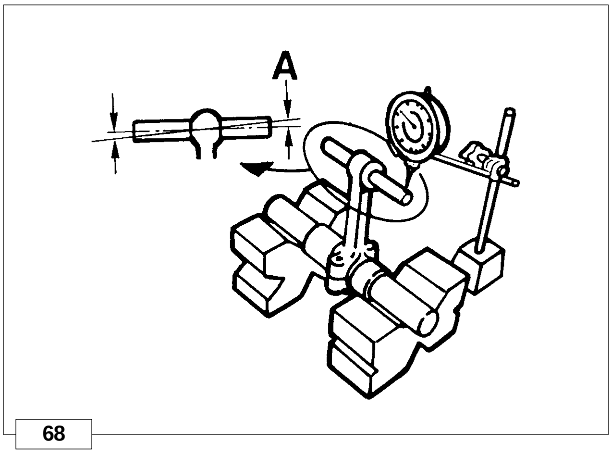



67

**Connecting rod small end bearing and pin**

| Ref. | Dimensions (mm) | Clearance (C - D) (mm) | Limit value (C - D) (mm) |
|---|---|---|---|
| A | 141,95÷142,05 | | |
| C | 25,020÷25,030 | 0,020÷0,035 | 0,070 |
| D | 24,995÷25,000 | | |

* with driven and machined bearing.
When refitting the bearing of the connecting rod small end, as you drive in, make sure that the lubrication hole on the connecting rod coincides with the hole on the bearing.

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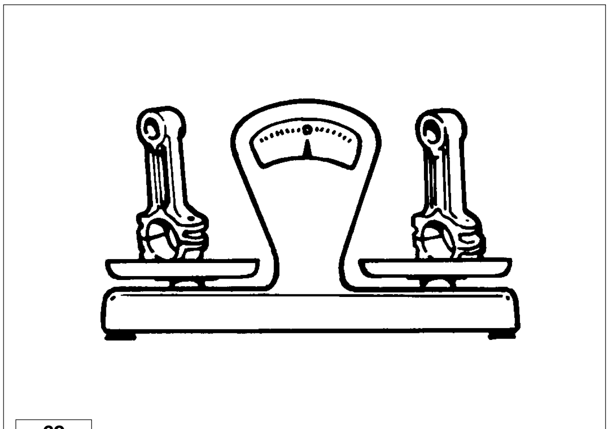
**Connecting rod alignment**

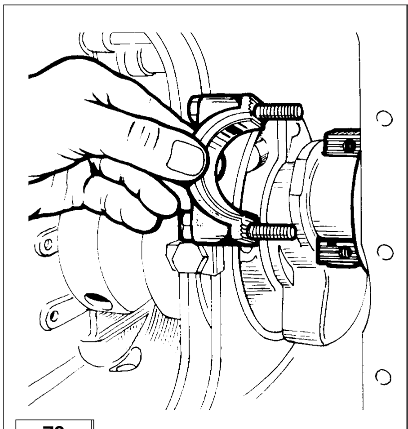
Check alignment of small end and big end bearing bores using fitted mandrels; axial mis-alignment **A** = 0,02 mm; maximum limit 0,05 mm.
Moderale warpage may be corrected by gradually working with a press.



69

**Connecting rod weight**

Weight connecting rods when replacing them in order to avoid unbalance.
The difference in weight should not exceed 10 g.



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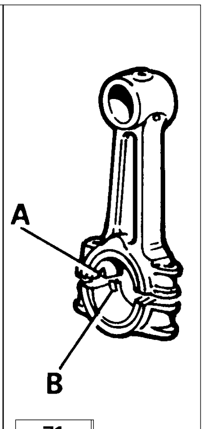


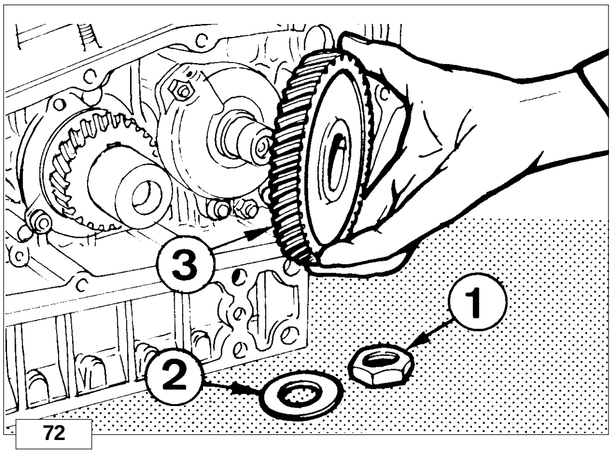

71

**Connecting rod big end bearing**

Both centering notches **A** and **B** must be on the same side when refitting.

❍ Tighten bolts at 40 Nm.

➲ See page 39 for dimensions.



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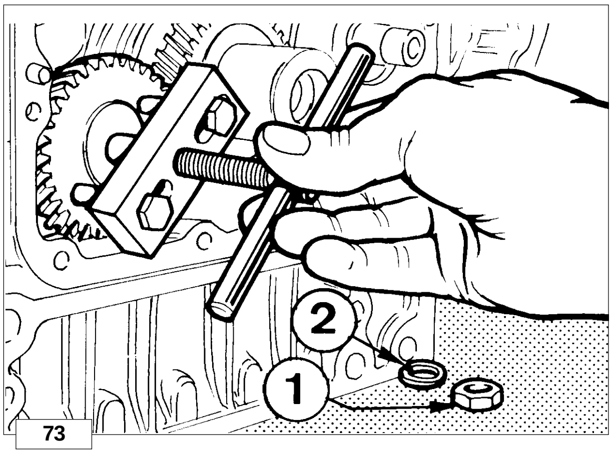
## Camshaft gear

Remove nut **1** and washer **2**. Then remove camshaft gear **3**.
The cylindrical type of coupling makes gear removal easier since no puller is required.

❍ Tighten nut **1** at 25 Nm.

➲ See Page 42 for timing.

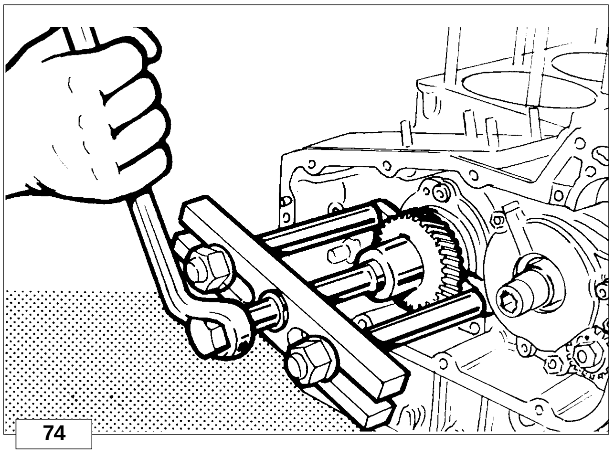


73

## Oil pump gear

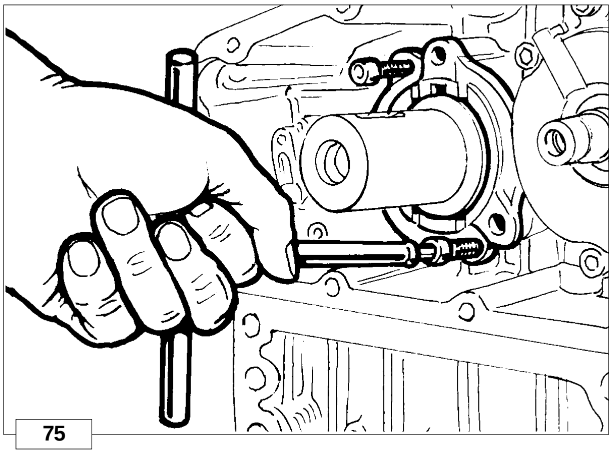
Remove nut **1** and washer **2**. Then remove oil pump gear using a puller with two M 8x1,25 bolts (length: 60 mm).

❍ Tighten the nut at 35 Nm.


74

## Timing gear

The timing gear can be easily pulled out thanks to the cylindrical type of coupling.
However, if resistance is felt use a bearing puller.

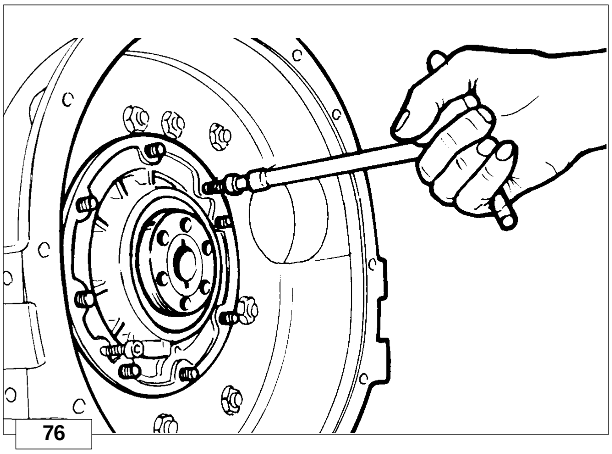

75

## Main bearing support, gear side

Remove crankshaft key and thrust bearing.
Loosen the three fixing bolts and remove the main bearing support on gear side using two M 8x1,25 screws with fully threaded length of 60 mm.

***Note**:* To avoid distortion it is not recommended to repiace the bearing bushing.
Complete assemblies of bushing and support are available in standard, 0,25 and 0,50 mm undersíze configurations as spare parts.

❍ When refitting tighten screws at 25 Nm.

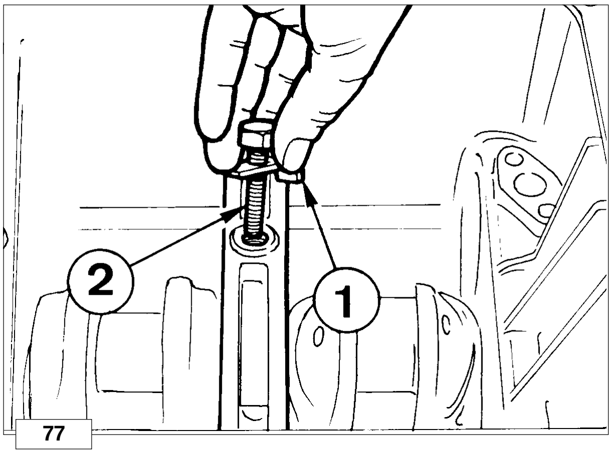

76

**Main bearing support, flywheel side**

Loosen nuts and extract main bearing support using two M 8x1.25 screws with fully threaded length of 40 mm.
Check oil seal ring and replace if warped, hardened or worn-out.

❍ When refitting tighten nuts at 25 Nm.

➲ See Page 40 for dimensions.



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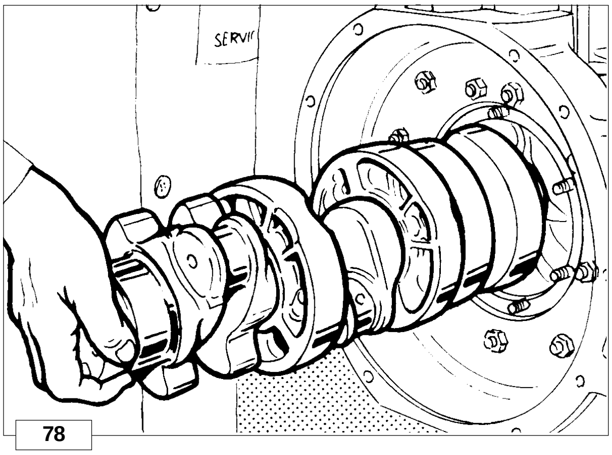
**CRANKSHAFT**

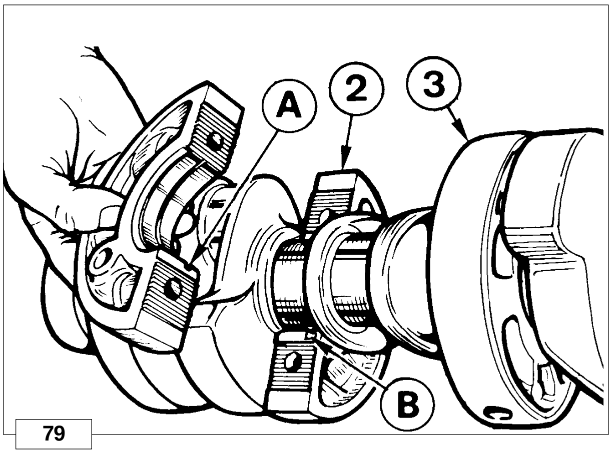
**Center main bearing support, locating bolts**

Before removing the crankshaft, straighten the safety stop **1** and unscrew the bolts **2** of the central main bearings.


78

**Crankshaft removal**

To pull out the crankshaft tap lightly on the gear side end using a copperheaded hammer.
When refitting align center main bearing supports so that the locating bolt holes coincide with the crankcase holes.



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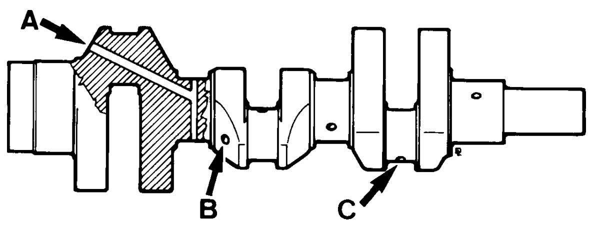
**Crankshaft center main bearing supports**

Main bearing supports **2** and **3** have a different diameter size (see page 40 for dimensions).
When refitting, both centering notches **A** and **B** must be located on the same side.

❍ Tighten screws at 30 Nm.

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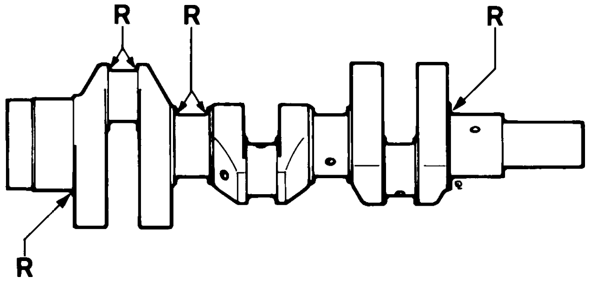
### Crankshaft lubrication ducts

**Important**

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

Remove the caps, clean ducts **A**, **B** and **C** using a drill bit with the same diameter and blow with compressed air.
After cleaning, replace the new caps in their seats and make sure they are sealed.

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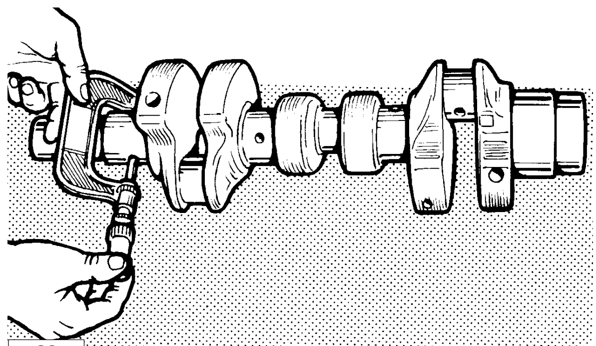
### Crankshaft journal radius

The radius **R** connecting journal to shoulders is 2,8 ÷ 3,2 mm.

***Note:*** When grinding main journals or crank pins restore the **R** value to original specification.



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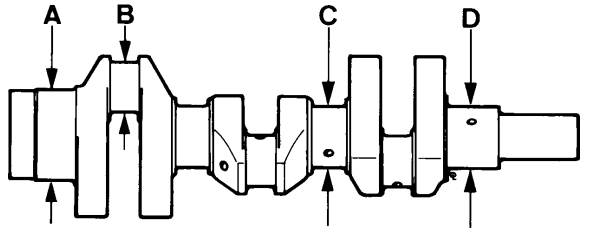
### Checking main journals and crank pins

Use an outside micrometer gauge.

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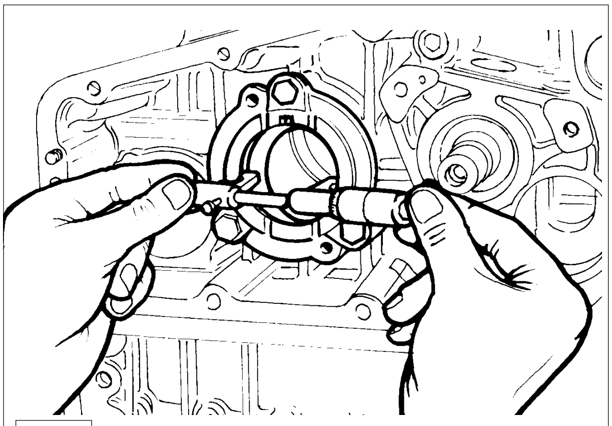
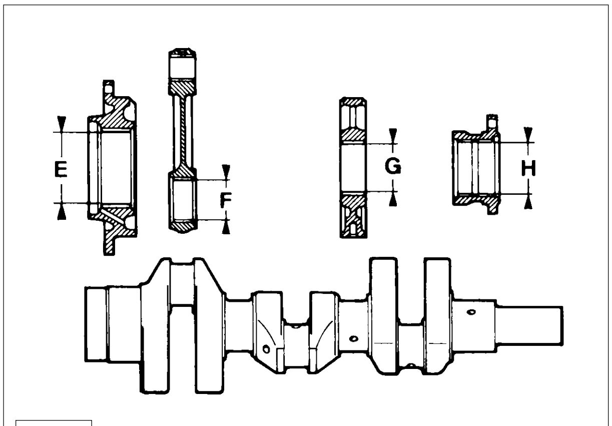
### Main journal and crank pin diameter

| Ref. | Dimensions (mm) |
|---|---|
| A | 80,781÷80,800 |
| B | 45,500÷45,516 |
| C | 55,350÷55,370 |
| D | 54,931÷54,950 |


84

**Diameter of main bearings**

Use an inside micrometer to measure the inside.



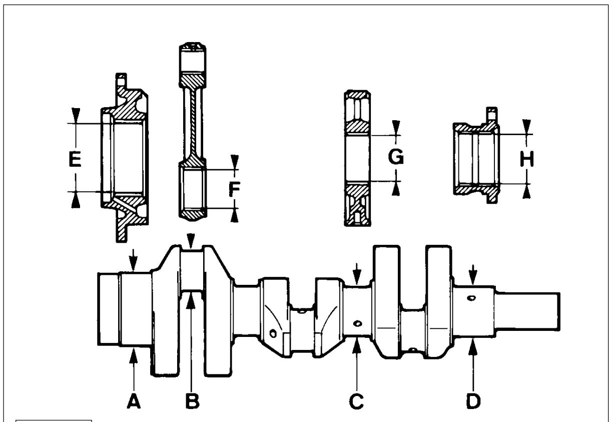
85

**Main bearing and connecting rod big end bearing inside diameter**

| Ref. | Dimensions (mm) |
|---|---|
| E | 80,870 ÷ 80,890 |
| F | 45,548 ÷ 45,578 |
| G | 55,430 ÷ 55,460 |
| H | 55,000 ÷ 55,020 |

The above dimensions refer to driven in or tightened bearings.

***Note:*** Both main bearings and connecting rod big end bearings are available with inside diameter size measuring 0,25 and 0,50 less than the standard version.



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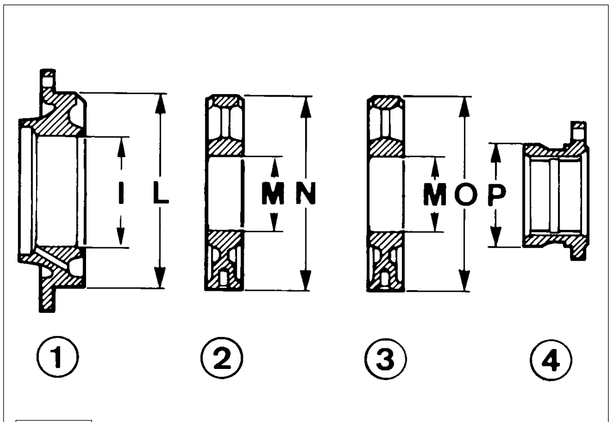
**Clearance between main journals/crank pins and connecting rod bearings**

| Ref. | Dimensions (mm) | Limit value (mm) |
|---|---|---|
| E-A | 0,070÷0,109 | 0,195 |
| F-B | 0,032÷0,078 | 0,150 |
| G-C | 0,060÷0,110 | 0,195 |
| H-D | 0,050÷0,089 | 0,180 |



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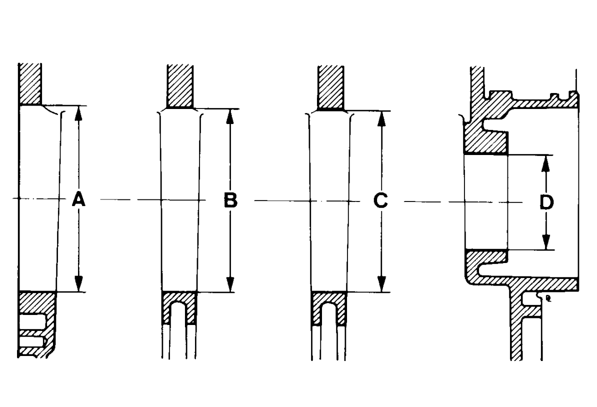
**Main bearing supports**

**1** Flywheei side
**2** 1st central
**3** 2nd central
**4** Gear side

| Ref. | Dimensions (mm) |
|---|---|
| I | 85,785 ÷ 85,815 |
| L | 152,000 ÷ 152,020 |
| M | 60,000 ÷ 60,020 |
| N | 150,000 ÷ 150,020 * |
| O | 148,000 ÷ 148,020 * |
| P | 77,990 ÷ 78,010 |

* with tightened bearing



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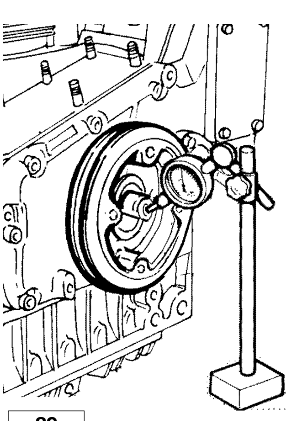
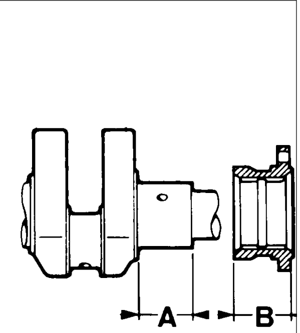
**Main bearing housings**

| Ref. | Dimensions (mm) |
|---|---|
| A | 150,000÷150,020 |
| B | 152,000÷152,020 |
| C | 148,000÷148,020 |
| D | 78,000÷78,020 |


89



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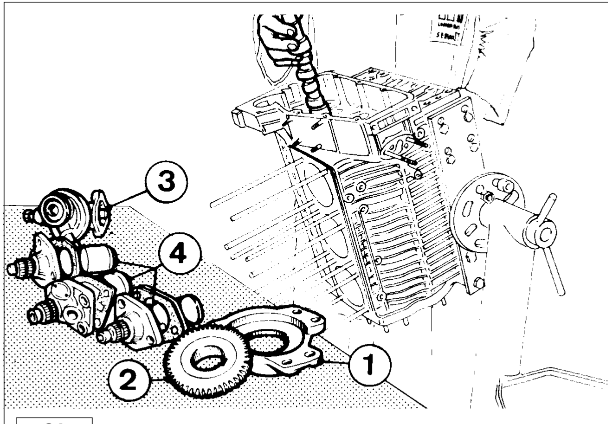
**Crankshaft end play**

| Ref. | Dimensions (mm) |
|---|---|
| A | 48,200 ÷ 48,250 |
| B | 47,950 ÷ 48,000 |

Check crankshaft end play after refitting the crankshaft pulley and tightening its nut at 300 Nm; the crankshaft end play is equal to 0,20 ÷ 0,30 mm and is not adjustable. If this value cannot be obtained check **A** and **B**, and possibly replace the parts whose size is inadequate.



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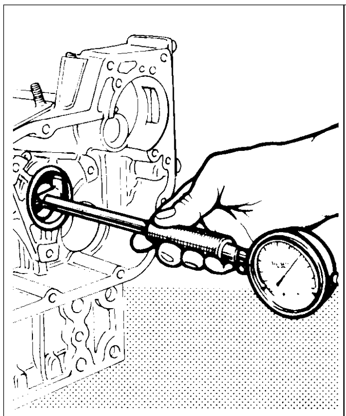
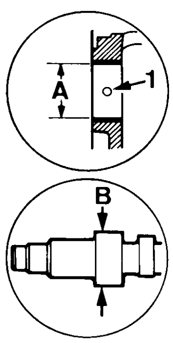
**CAMSHAFT**

**Camshaft removal**

To pull out the camshaft simply remove bell **1**, gear **2**, fuel feeding pump **3**, injection pumps **4** and tilt the engine; in this position the cam followers is not in contact with the camshaft thus making its removal possible.


92



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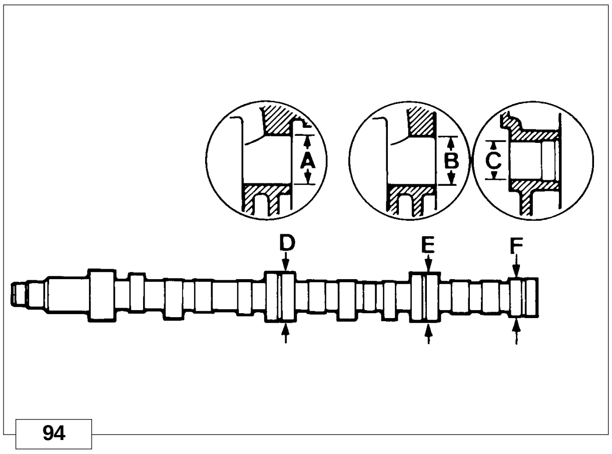
**How to measure camshaft bearing and journal inside diameter**

| Ref. | Dimensions (mm) | Clearance (mm) | Limit value (mm) |
|---|---|---|---|
| A | 44,000÷44,025 | 0,040÷0,085 | 0,170 |
| B | 43,940÷43,960 | | |

Measure **A** using an internal dial indicator and **B** with an external micrometer.
When repiacing the bearing make the lubrication hole **1** match with the corresponding crankcase bore.

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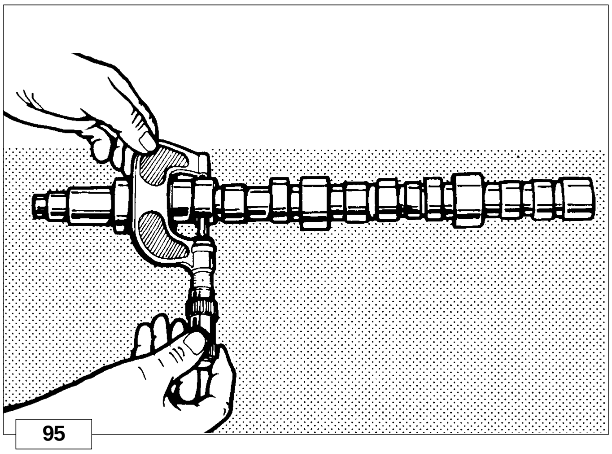
**Dimensions of camshaft journals and housings**

| Ref. | Dimensions (mm) |
|---|---|
| A | 42,000÷42,025 |
| B | 41,000÷41,025 |
| C | 33,200÷33,220 |
| D | 41,940÷41,960 |
| E | 40,940÷40,960 |
| F | 33,140÷33,160 |

| Ref. | Clearance (mm) | Limit value (mm) |
|---|---|---|
| A-D | 0,040÷0,085 | 0,170 |
| B-E | | |
| C-F | 0,040÷0,080 | 0,160 |



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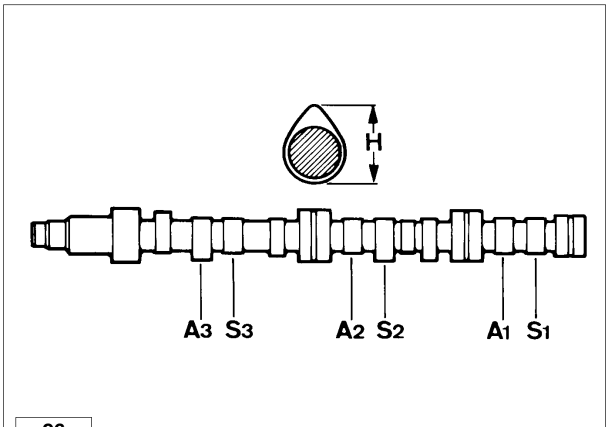
**Checking intake/exhaust cam height**

Use an outside micrometer gauge to measure camshaft lobe height.

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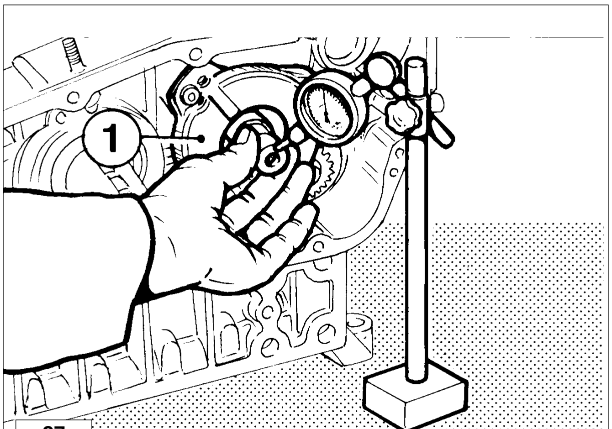
**Intake/exhaust cam height**

**A1**= 1st cylinder intake cam
**S1** = 1st cylinder exhaust cam
**A2** = 2nd cylinder intake cam
**S2** = 2nd cylinder exhaust cam
**A3** = 3rd cylinder intake cam
**S3** = 3rd cylinder exhaust cam
**H** = 33,65 ÷ 33,55 for engines EPA 97/68 CE

Exhaust and intake cams feature the same height **H**.
Replace camshaft if **H** is 0.1 mm below the given value.

**Note**: Engines 11LD 625/3 - 626/3, in the slow speed version (1500 ÷ 2000 r.p.m.) features a camshaft with **H** = 33,765 ÷ 33,865 mm.

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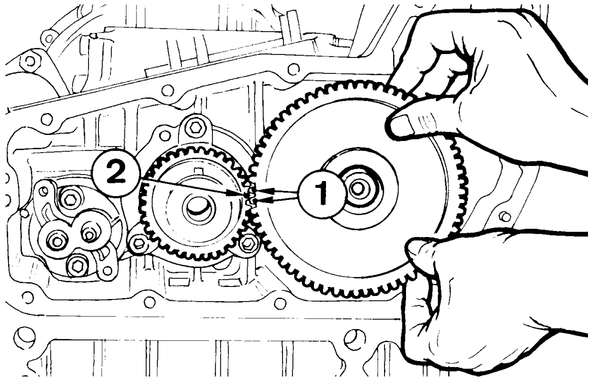
**Camshaft end play**

Check camshaft end play after removing cylinder head, injection pump and fuel feed pump from the engine.

❍ Check that the three cover **1** screws are tightened at 25 Nm.

Place the dial gauge on the camshaft gear outer part; push and pull same gear as required.
Camshaft end play should be 0,15 ÷ 0,30 mm.

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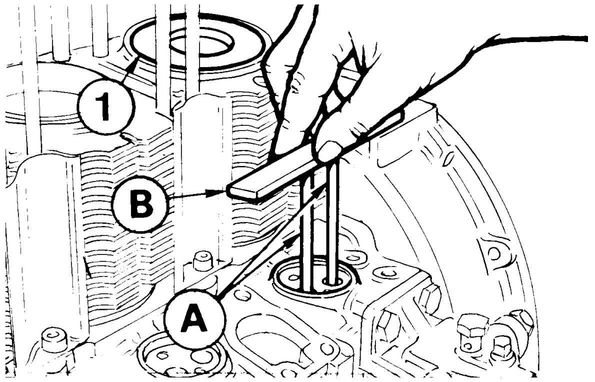
## Camshaft timing

Fit camshaft gear by making timing mark **2** coincide with timing marks **1**.

❍ Tighten camshaft bolt at 250 Nm.

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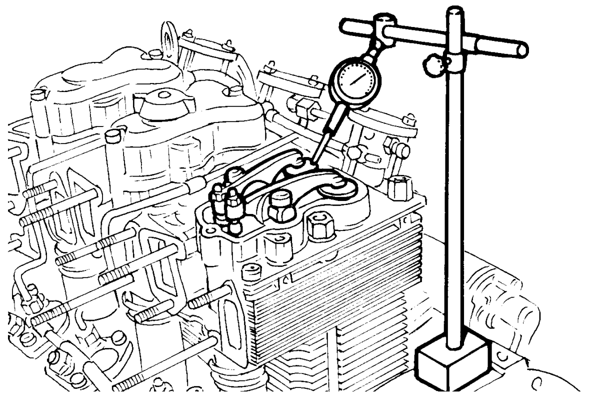
## Valve timing without considering timing marks

Locate piston **1** (on flywheel side) at the top dead center. Position two small cylinders **A** of the same height onto the tappets.
Rotate camshaft stopping when cylinder **1** tappets are in overlap position (intake open, exhaust closed).
By means of ruler **B** check that tappets are at the same height.



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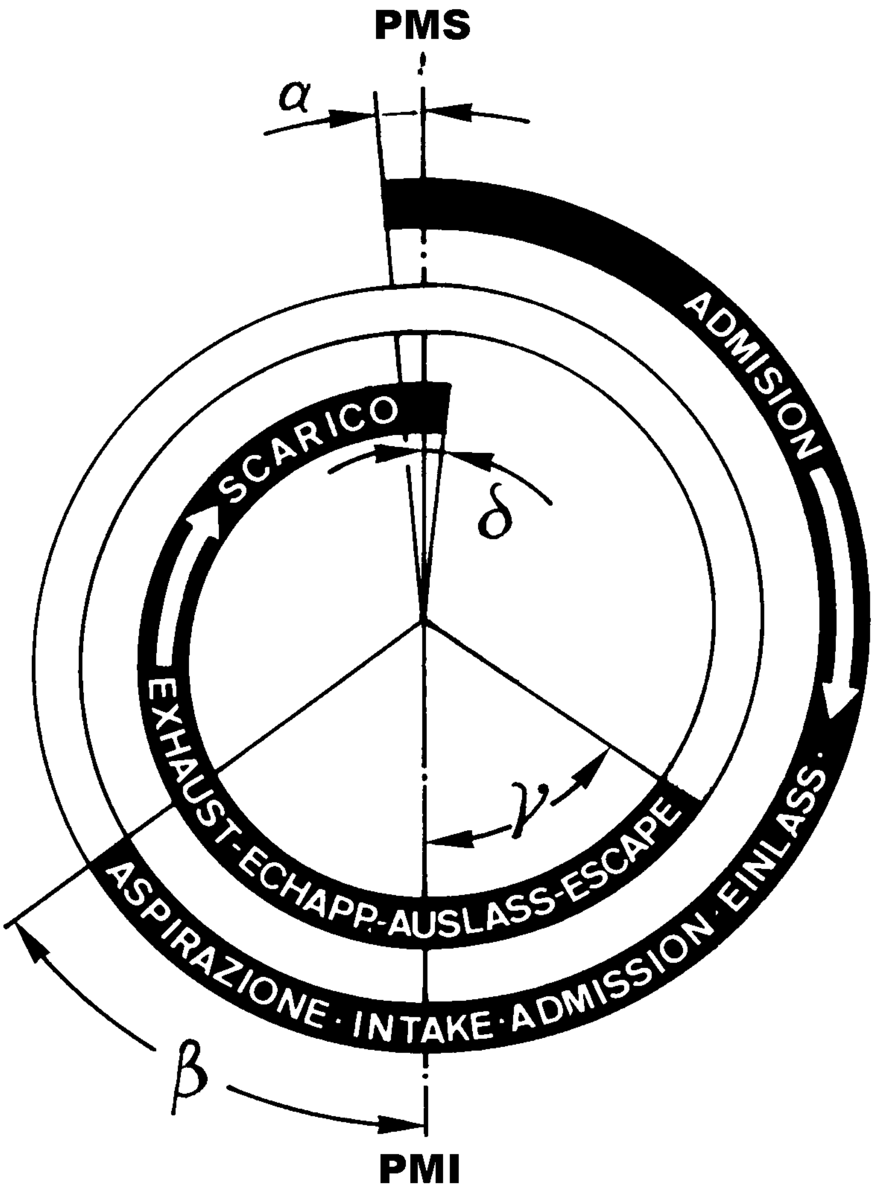
## Valve timing check

Check using an index plate suitable for reading angles, integral with the crankshaft. Readings are taken in degrees.
Set valve clearance at 0,65 ÷ 0,70 mm (after checking restore the value al 0,15 ÷ 0,20 mm). Set dial gauge on intake valve to a zero value; by rotating the driving shaft according to its direction of rotation you can measure **α** (intake valve opening advance referred to top dead centre **PMS**) and **ß** (intake valve closing delay referred to bottom **1** dead centre).

Follow the same procedure for exhaust valves checking **γ** (exhaust valve opening advance) and **δ** (exhaust valve closing delay).




**Legend**

**S =** piston at top dead center
**I =** piston at bottom dead center
**α =** intake valve open
**β =** intake valve closed
**γ =** exhaust valve open
**δ =** exhaust valve closed

**Value expressed in degrees of the timing angles. (valves clearance = 0.65 ÷ 0.70 mm)**

| | | | | | |
|---|---|---|---|---|---|
| α | = | open | 2° | before | P.M.S. |
| β | = | close | 34° | after | P.M.I. |
| γ | = | open | 34° | before | P.M.I. |
| δ | = | close | 2° | after | P.M.S. |

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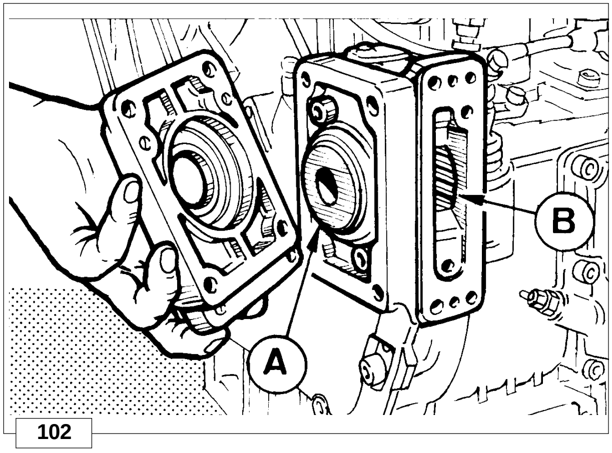

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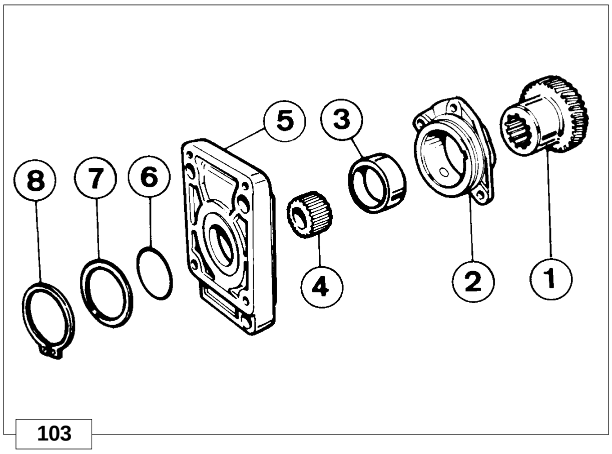
**Hydraulic pump p.t.o. group 1**

A hydraulic pump of group 1 or 2 can be installed on the gear side **A**, 3rd p.t.o.
A group 1 hydraulic pump can be installed at the 4th p.t.o. **B**.



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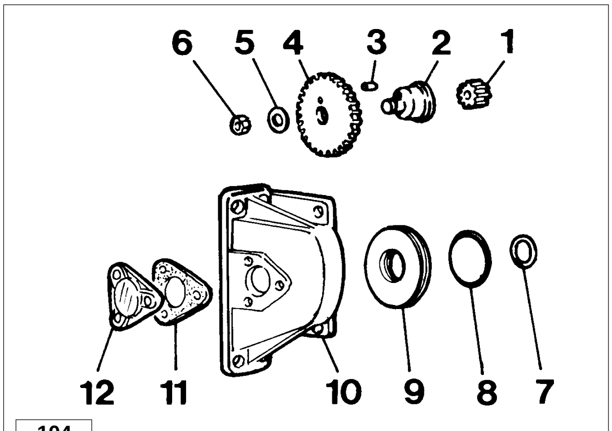
**Hydraulic pump 3rd p.t.o., group 2**

*Components:*

**1** Gear
**2** Gear support
**3** Bearing
**4** Drive
**5** Flange
**6** Washer
**7** Seal ring
**8** Circlip

A max torque of 39,6 Nm can be obtained from this p.t.o.



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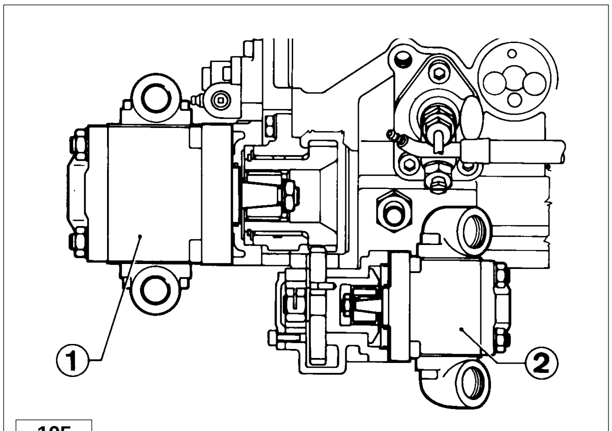
**Hydraulic pump 4th p.t.o., group 1**

*Components:*

| | |
|---|---|
| **1** Drive | **7** Seal ring |
| **2** Control shaft | **8** Seal ring |
| **3** Pin | **9** Centering ring |
| **4** Gear | **10** Bracket |
| **5** Washer | **11** Gasket |
| **6** Nut | **12** Cover |

A max. torque of 243 Nm can be obtained from this p.t.o.



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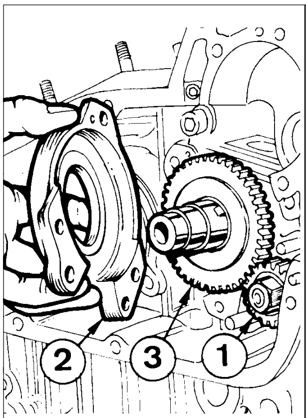
**Use of 3rd and 4th p.t.o.**

**1** Hydraulic pump, group 2, mounted at 3rd p.t.o.
**2** Hydraulic pump, group 1, mounted at 4th p.t.o.

Total power obtainable from 3rd and 4th plo. is 13 kW ( 17.7 HP).
Ratio for both p.t.o. compared to the engine r.p.m. is 1:1 for 4th PTO is 1 : 1,067 for 3th PTO.

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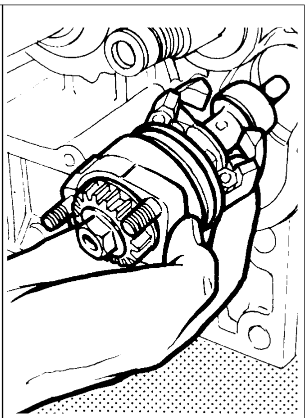

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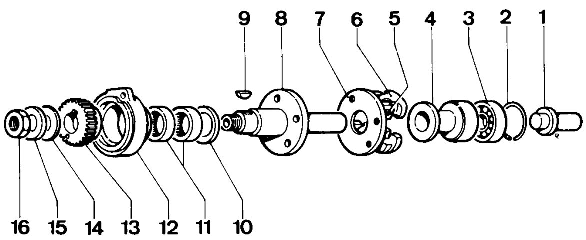
## Mechanical speed governor

The governor (with centrifugal weights) is housed inside the crankcase and is controlled by a camshaft gear.
To remove speed governor **1** remove camshaft bell **2** and speed governor control gear **3**.

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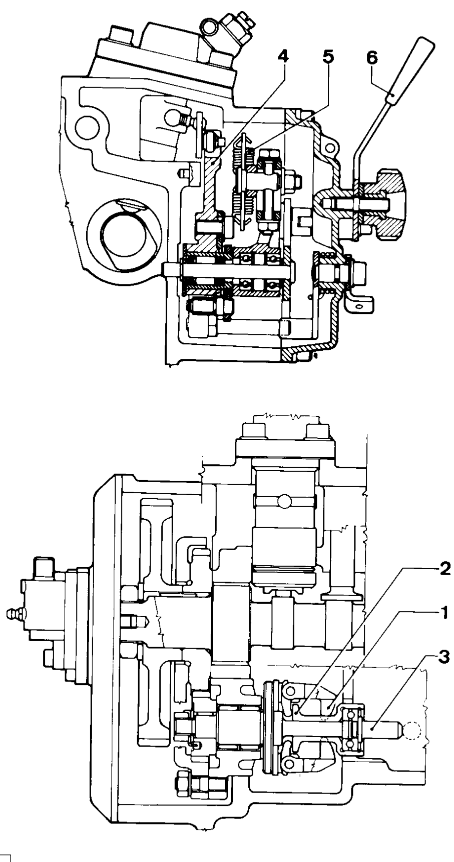
## Mechanical speed governor components (standard)

**1** Drive rod
**2** Stop ring
**3** Bearing
**4** Washer
**5** Pin
**6** Weights
**7** Weight support
**8** Shaft
**9** Key
**10** Thrust washer
**11** Bearings
**12** Shaft support
**13** Gear
**14** Spring washer
**15** Flat washer
**16** Nut

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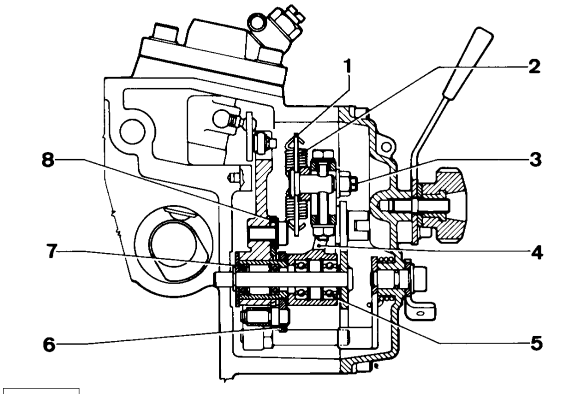
## Mechanical speed governor operation (standard)

Weights **1** are moved to the periphery by the centrifugal force and thus axially shift the washer **2** and the drive rod **3** which, by means of a linkage, move injection pump control lever **4**.
The governor springs **5** placed under tension by the accelerator control lever **6** offset the weights **1** centrifugal force.
Balance between the two forces keeps speed at an almost constant level in spite of load variations.



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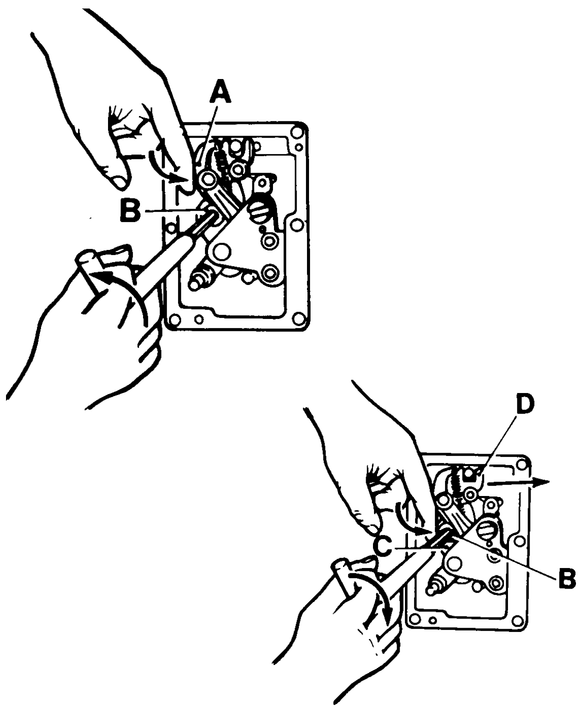
### Mechanical speed governor components for special generating sets

**1** Spring anchoring rocker arm
**2** Governor springs
**3** Journal
**4** Governor control lever
**5** Governor control lever ball bearing
**6** Lever
**7** Bearing
**8** Plate

***Note:*** Two types of governor springs **2** are available: one for full speed regulation at 1500 r.p.m. and the other for full speed regulation at 1800 r.p.m.; in this case governor weights are heavier.



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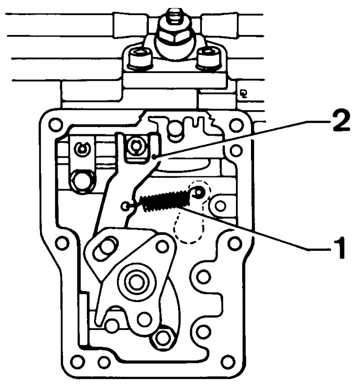
### Mechanical speed governor setting

Lift finkage **A**.
Loosen screw **B**.
Push lever **C** to the right and check that speed governor weights are closed.
Shift injection pump delivery control yoke **D** to the right (for maximum delivery).
Tighten screw **B**.



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### Spring for extra fuel supply at starting

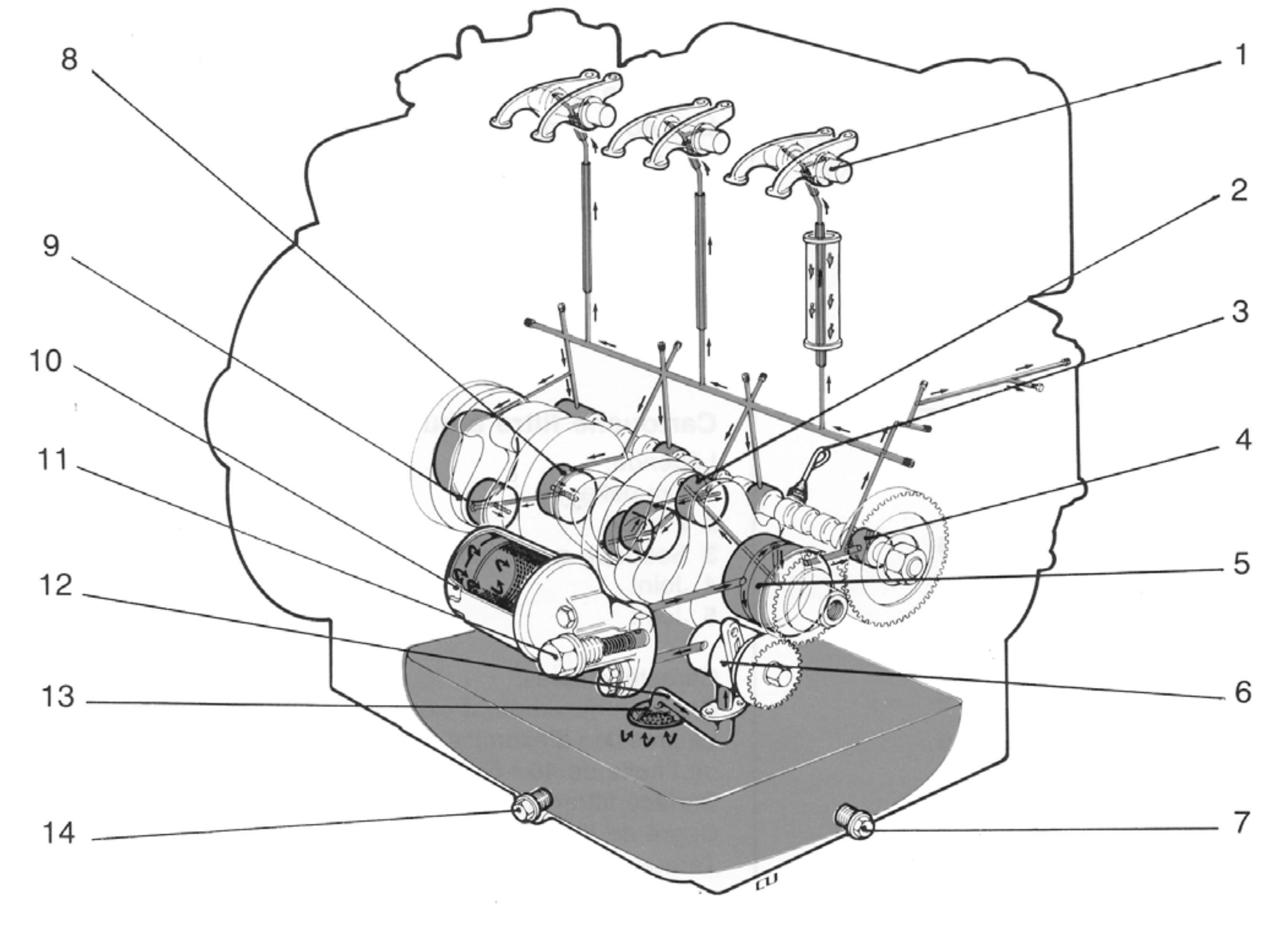
The device is operated automatically: when the engine is stopped spring **1** acts on injection pump control yoke **2** providing maximum fuel delivery, until the speed governor starts operating.

**Danger – Attention**

**The engine can be damaged if allowed to operate with insufficient oil. It is also dangerous to add too much oil because its combustion may lead to a sharp increase in the rotation speed.**
**Use suitable oil in order to protect the engine.**
**Nothing more than lubrication oil can influence the performances and life of an engine.**
**Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts.**
**Engine life will also be notably reduced.**
**The oil viscosity must suit the ambient temperature in which the engine operates.**

**Danger – Attention**

**Old engine oil can cause skin cancer if repeatedly left in contact with the skin and for long periods of time.**
**If contact with the oil is unavoidable, you are advised to wash your hands with soap and water as soon as possible.**
**Dispose of old oil in the correct way as it is highly polluting.**

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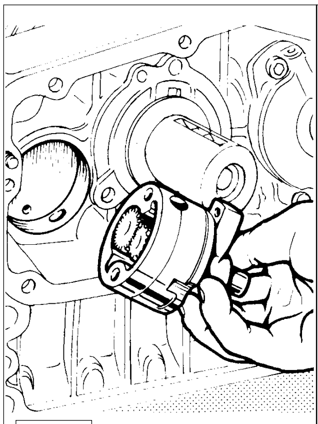
*Components:*

**1)** Rocker arm shaft
**2)** Connecting rod big end bearìng
**3)** Oil dipstick
**4)** Camshaft
**5)** Crankshaft journal
**6)** Oil pump
**7)** Drain plug
**8)** Crankshaft main journal
**9)** Crankshaft
**10)** Cartridge filter
**11)** Oil pressure relief valves
**12)** Pump intake pipe
**13)** Internal strainer
**14)** Drain plug



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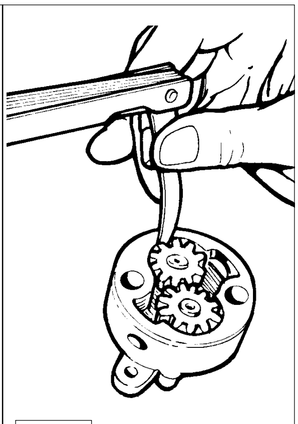

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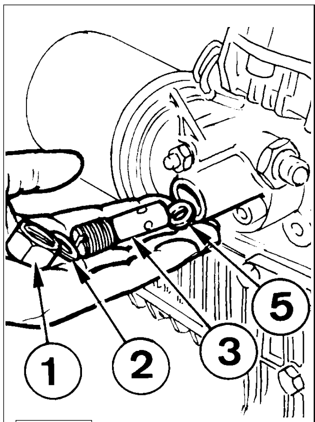
## Oil pump

Check that gear teeth are intact and that clearance between gear edge and pump body is 0,041 ÷ 0,053 mm with limit value 0,10 mm. Furthermore check that control shaft is tree to rotate with end float of 0,040 ÷ 0,090 mm with limit value of 0,170 mm.
Oil pump delivery at 3000 r.p.m. is 18 liters/min.

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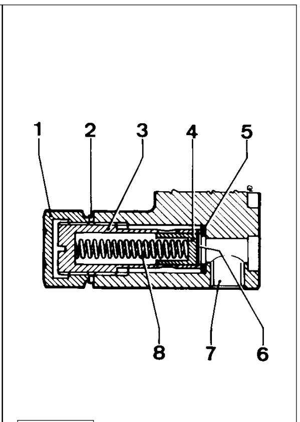


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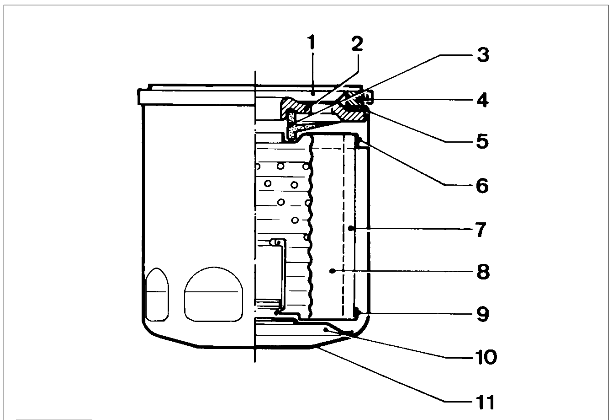
## Oil pressure relief valve

Components:

| | |
|---|---|
| **1** Plug | **5** Rubber gasket |
| **2** Copper gasket | **6** Ring |
| **3** Bushing | **7** Hole for pressure switch connection |
| **4** Piston | **8** Spring |

**Note**: Blow-by at an oil temperature of 40 ÷ 50°C and pressure of 3 bar should be less than 1 l/min.
When refitting screw bushing **3** so that it touches gasket **5**.
Do not tighten excessively since gasket **5** might break causing an oil pressure drop in the system.

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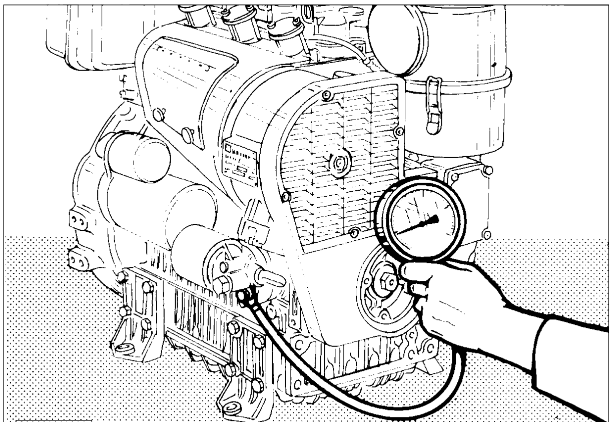
## Oil filter cartridge

| Components: | | |
|---|---|---|
| | **1** Retainer | **6** Upper cover |
| | **2** Plate | **7** Blade |
| | **3** Valve | **8** Filtering element |
| | **4** Gasket | **9** Assembly |
| | **5** Gasket | **10** Belleville washer |
| | | **11** Tank |

**Characteristics**:

Max. working pressure .................................. 13 bar
Filtering area .................................................. 955 $cm^2$
Type of filtration ............................................ 20 µm
By-pass valve opening pressure .................. 1,4 ÷ 1,8 bar.



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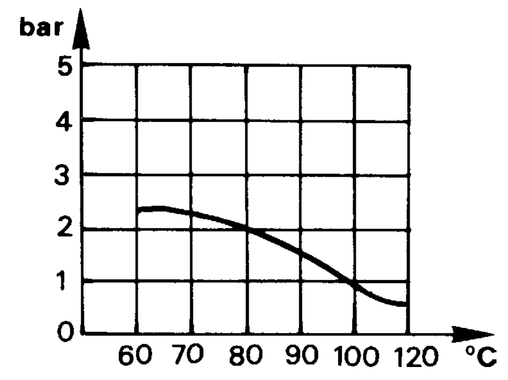
## Oil pressure check

Once the engine is fitted fill with oil and fuel, connect a 10 bar pressure gauge to the oil filter fitting.
Start the engine and check pressure as a function of the oil temperature (see page. 49).



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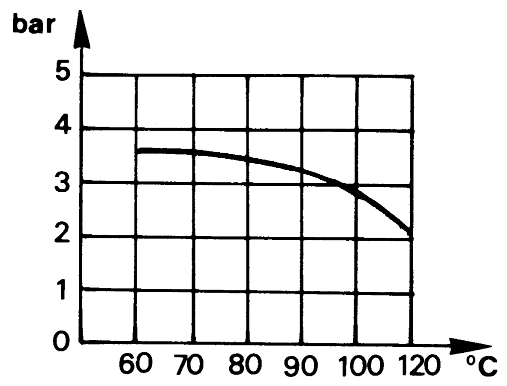
### Oil pressure curve at idling speed

The curve is obtained at the oil filter level with constant engine speed of 1200 r.p.m. in no-load conditions and at a room temperature of + 25°C.
Pressure is given in bar and temperature in centigrades.



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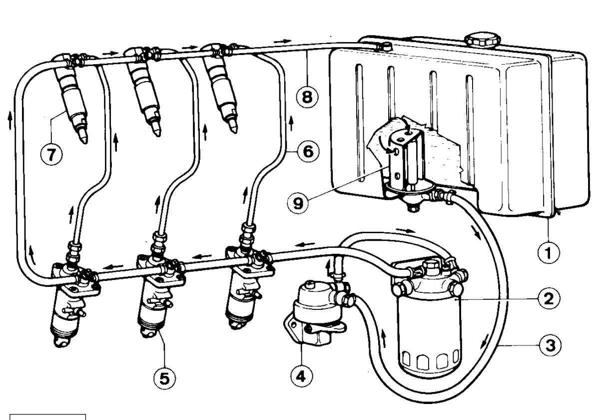
### Oil pressure curve at full speed

The curve is obtained at the oil filter level with engine working al 3000 r.p.m. al the N power. Room temperature is +25°C.
Lube oil peak temperature should be below 120°C for engines without oil cooler and below 110°C for engines with oil cooler. Pressure is given in bar and temperature in centigrades.

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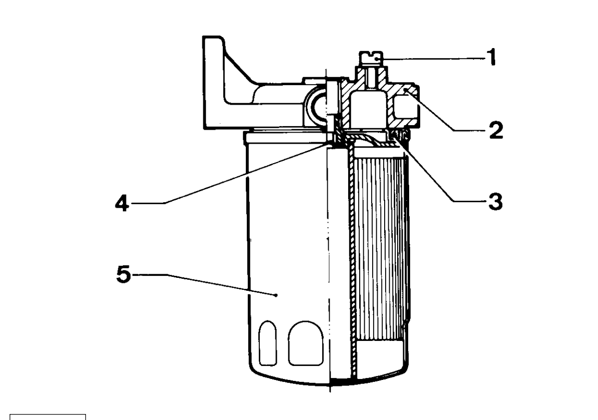
### Fuel feeding/injection circuit

*Components:*

**1** Tank
**2** Filter
**3** Fuel feeding tube
**4** Fuel feeding pump
**5** Injection pump
**6** Injection line
**7** Injector
**8** Injector leak off line and self bleeding system
**9** Bowl

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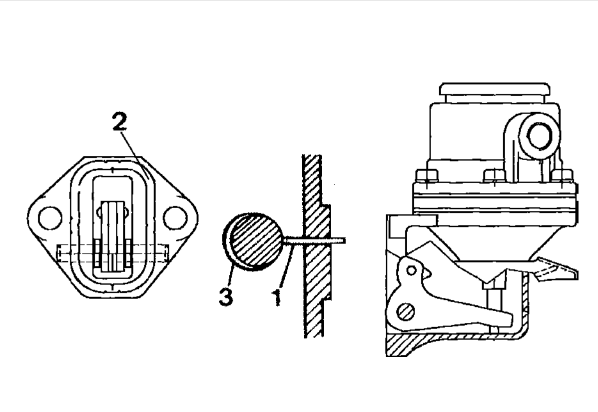
### Fuel filter

*Components:*
**1** Bleeder
**2** Cap
**3** Seal element
**4** Union
**5** Cartridge

*Cartridge characteristics:*
Filtering paper .................... PF 904
Filtering area ...................... 5000 cm2
Degree of filtrafion ............. 2 ÷ 3 µm
Max.,working pressure:...... 4 bar

➲ See page 17 for periodical maintenance details.

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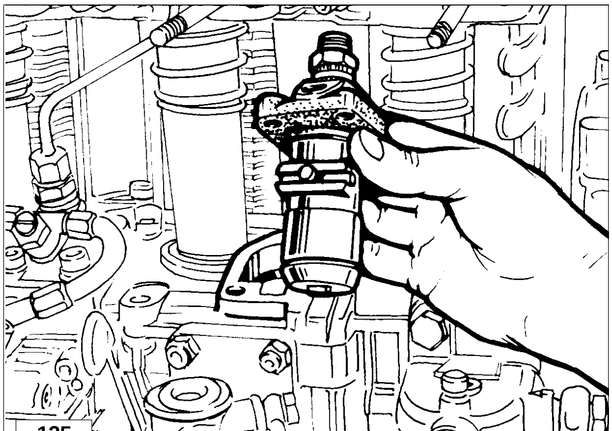
### Fuel feeding pump

The fuel feeding pump is of the diaphgragm type operated by a camshaft eccentric through a drive rod.
It features an external lever for manual operation.

*Components:*

**1** Drive rod : shelf 1,470 ÷ 2,070 mm
**2** Gasket
**3** Camshaft eccentric

*Characteristics:* when the control eccentric rotates at 1500 r.p.m. minimum delivery is 64 l/h while self-regulation pressure is 4 ÷ 5 m water column.



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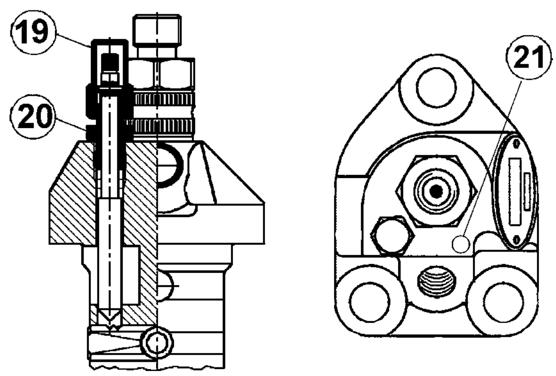
### Injection pump

The Bosch injection system consists of three pumps each feeding one cylinder.
The pumps mounted on the crankcase, corresponding to their proper cylinder, are directly operated by the camshaft.

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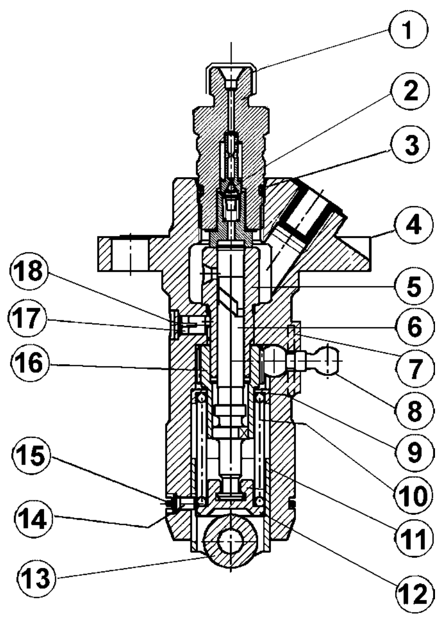
**19** Threaded plug
**20** Adjustment rod locking device
**21** Area in which the pump delivery class is stamped

In this engine the injection pumps are preset by the manufacturer who supplies them stamped with alphabetical classes (A, Ax, B, Bx, C, Cx or D) for standard and 97/68 EC engines, while for EPA2 engines the classes are numerical (5, 6, 7, 8, 9, 10, 11, 12, 13 and 14).
The adjustment rod is locked via the bayonet device.

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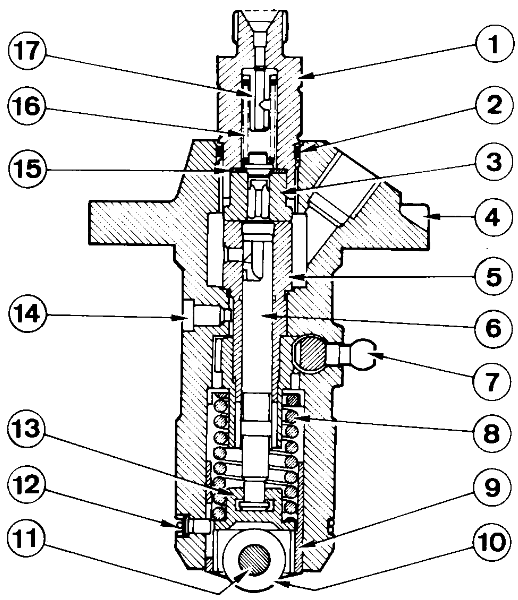
**Injection pump only for EPA engines**

**1** Delivery union
**2** PRV valve
**3** O-Ring
**4** Pump housing
**5** Pumping piston
**6** Pumpung plunger
**7** Elastic pin
**8** Rack rod
**9** Superior retainer
**10** Spring tappet
**11** Tappet body
**12** Inferior retainer
**13** Roller
**14** Journal guide tappet
**15** Elastic pin
**16** Adjustment hose
**17** Plunger stop pin
**18** Cap

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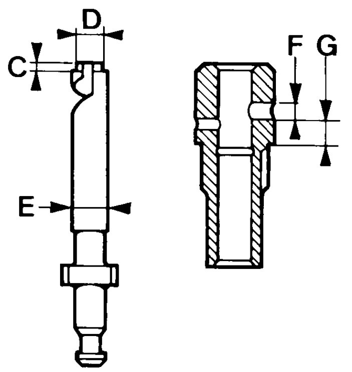
**Injection pump only for standard and 97/68 Ce engines**

**1** Delivery union
**2** Rubber ring
**3** Delivery valve
**4** Pump housing
**5** Piston
**6** Plunger
**7** Rack rod
**8** Spring
**9** Tappet body
**10** Roller
**11** Journal
**12** Pin
**13** Spring retainer
**14** Eccentric
**15** Copper gasket
**16** Spring
**17** Filler

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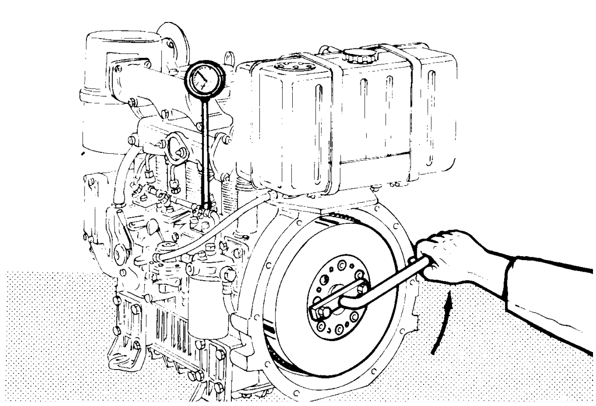
**Plunger**

| Ref. | Dimensions (mm) |
|---|---|
| C | 1,000 ÷ 1,100 mm |
| D | 7,445 ÷ 7,455 mm |
| E | 7,500 mm |
| F | 3,000 ÷ 3,025 mm |
| G | 7,225 ÷ 7,275 mm |



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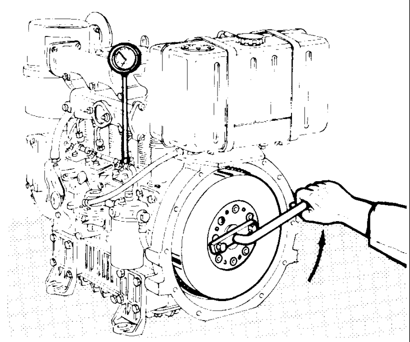
**How to check plunger and barrel for internal leakage**

This operation is only diagnostic since pressure changes depend on the pumping speed.
Connect the delivery union with a 600 bar pressure gauge with safety valve.
Adjust rack rod at half-stroke.
Turn flywheel according to its direction so that the plunger puts the circuit under pressure.
Replace plunger if the displayed pressure is below 300 bar.
Repeat the same operation for the other plungers.



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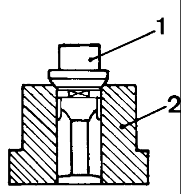


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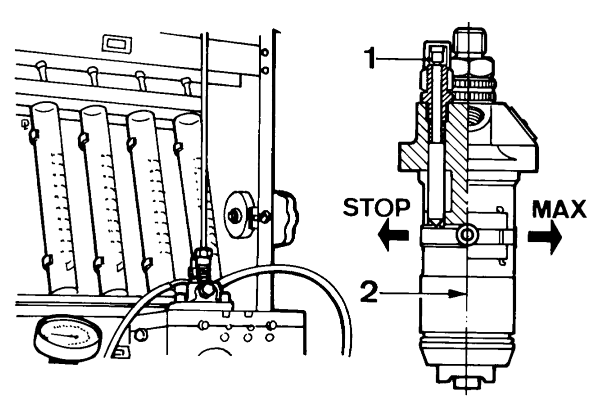
**How to check injection pump delivery valve sealing**

*Components:*

**1** Valve
**2** Seat

Adjust pump rack at half-stroke.
Turn flywheel according to its direction of rotation so that the plunger puts the circuit under pressure.
During this operation the displayed pressure will gradually reach a peak followed by a sudden drop which corresponds to valve closing. Pressure drop should be 30 ÷ 50 bar.
Replace the valve if pressure drop is below this value.
Repeat the same operation for the other two pumps.



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**Test data for injection pump delivery at the test bench for standard and 97 / 68 CE engines**

**1** Rack rod lock to be removed after pump fitting to the engine
**2** Injection pump axis

***Test data:***

| Control rod max. force (N) | Rod stroke from pump axis (mm) + towards max - towards stop | Camshaft r.p.m. | Delivery mm³/stroke |
|---|---|---|---|
| 0,45 | - 2 | 500 | 3 ÷ 4 stamped A<br>4 ÷ 5 stamped Ax<br>5 ÷ 6 stamped B<br>6 ÷ 7 stamped Bx<br>7 ÷ 8 stamped C<br>8 ÷ 9 stamped Cx<br>9 ÷ 10 stamped D |
| | - 2 | 1500 | 27,5 ÷ 30,5 |
| | max | 150 | 90 ÷ 100 |

The above test data refer to pump with plunger dia. of 7,500 mm.

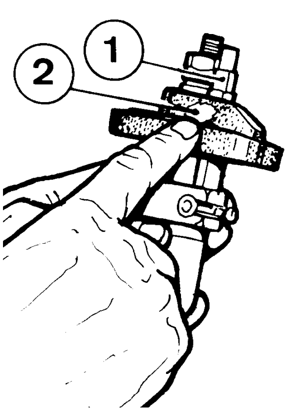
**Test data for injection pump delivery at the test bench only for EPA engines**

***Test data:***

| Control rod max. force (N) | Rod stroke from pump axis (mm) + towards max - towards stop | Camshaft r.p.m. | Delivery mm³/stroke |
|---|---|---|---|
| 0,45 | 0 | 500 | 3 ÷ 4 stamped A<br>4 ÷ 5 stamped Ax<br>5 ÷ 6 stamped B<br>6 ÷ 7 stamped Bx<br>7 ÷ 8 stamped C<br>8 ÷ 9 stamped Cx<br>9 ÷ 10 stamped D |
| | 0 | 1500 | 38 ÷ 40 |
| | max | 150 | 90 ÷ 100 |

The pump class is indicated by the full delivery value * at 1 mm³/ stroke from 5 to 14.
Plunger diameter size: 7,500 mm.

***Note:*** All pumps are tested and set in order to obtain the same delivery at full speed.
After the tests carried out at idle speed pumps are subdivided into classes marked with references in letters or numbers.
These reference marks are very clearly stamped on the upper pump body.
If replacing, make sure that the new pumps have the same references (letters or numbers) as the previous ones.

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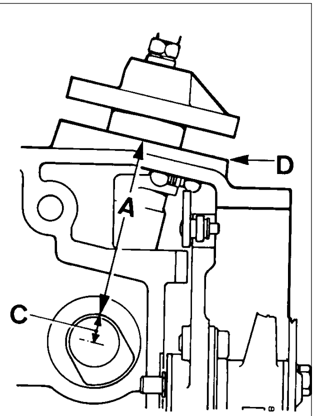


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## Injection pump replacement

**1** Rack rod lock
**2** Reference mark pump class

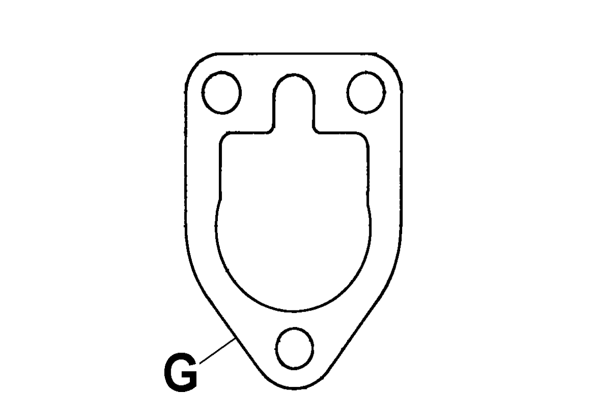
**A** = 82.80 mm
**C** = Injection cam radius
**D** = Injection pump support

**Important**
**Whe replacing this type of injection pump check that the new one has a same reference mark as the old one.**
**The reference marks of injection pumps must be the same.**

Replace as follows:

❍ Fit pump into the crankcase and tighten screws at 25 Nm.

Remove lock **1** and check that rack rod is free to move.
If pump removal is required fit lock **1** to its original position: the rack rod centre should coincide with the pump axis (see fig. 126).
When replacing the crankcase or the camshaft preserve the same distance **A** between **D**, injection pump support, and **C**, injection cam radius; add shims **G** on **D** to obtain the right **A** value if required.
Seals **G** are supplied with different thicknesses: 0,05 – 0,1 – 0,3 and 0,5 mm.

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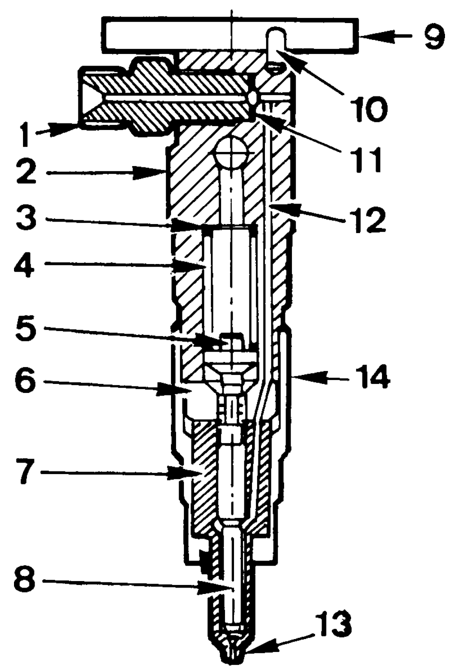
## Size S injector

*Components:*

**1** Intake fitting
**2** Nozzle holder
**3** Shim
**4** Spring
**5** Pressure rod
**6** Intermediate flange
**7** Nozzle
**8** Needle valve
**9** Fixing flange
**10** Taper pin
**11** Gasket
**12** System duct
**13** Sump
**14** Cup

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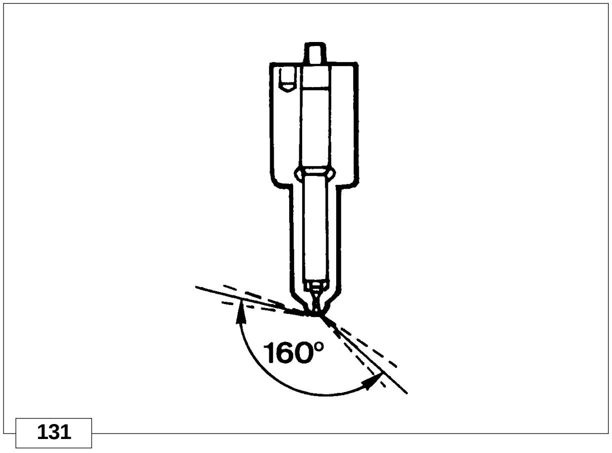

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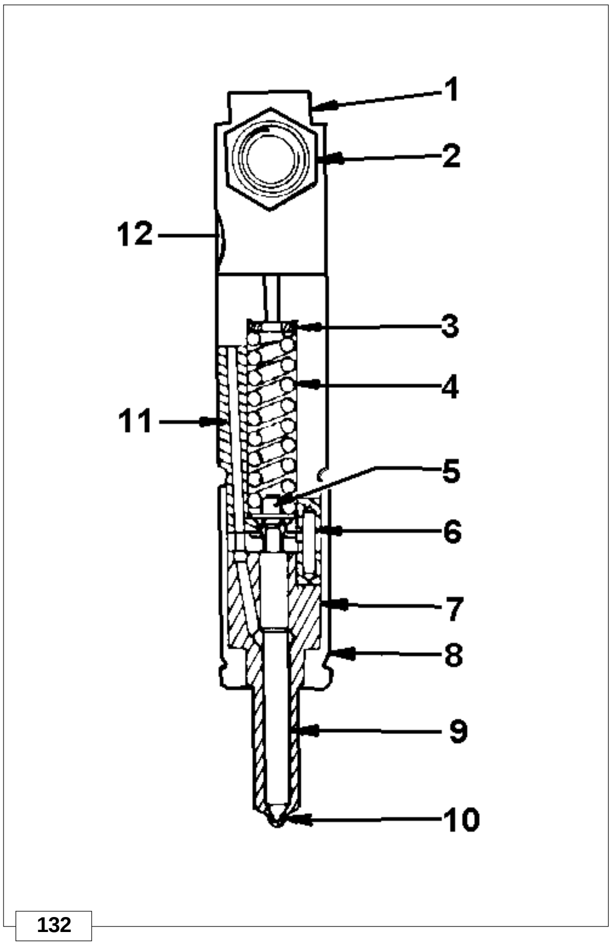
**Size S nozzle**

*Features:*

Hole number and diameter ...... 4x0,28 mm
Jet angles ................................ 160°
Needle valve elevation ............ 0,20 ÷ 0,22 mm
Hole length .............................. 0,7 mm
Sump diameter and length ...... 1x1,5 mm

Clean nozzle tip with a brass brush.
Check that holes are not obstructed using a mandrel with steel wìre with 0,28 mm diam.

❍ When refitting tighten ring nut at 70 Nm.



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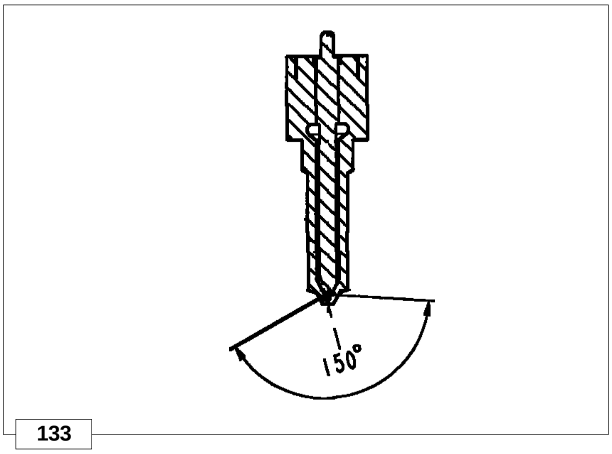
**Size P injector**

*Components:*

**1** Injector housing
**2** Intake fitting
**3** Shim
**4** Spring
**5** Pressure rod
**6** Taper pin
**7** Nozzle
**8** Cup
**9** Needle valve
**10** Sump
**11** System duct
**12** Overflow pipe

❍ When refitting tighten ring **8** nut at 50 Nm.



133

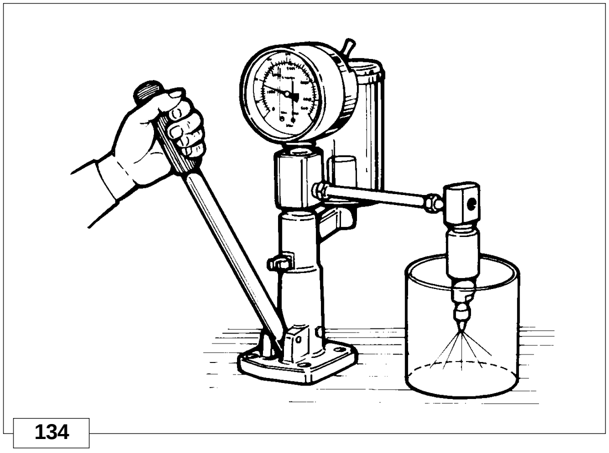
**Size P nozzle**

*Features:*

Hole number and diameter ............ 5 x 0,23 mm.
Jet angles ...................................... 150°.
Needle valve elevation .................. 0,200 ÷ 0,205 mm
Hole length .................................... 1 mm
Sump diameter and length ............ 2 x 2,5 mm

Clean nozzle tip with a brass brush.
Check that holes are not obstructed using a mandrel with steel wìre with 0,23 mm diam.

❍ When refitting tighten ring nut at 55 ÷ 65 Nm.


134

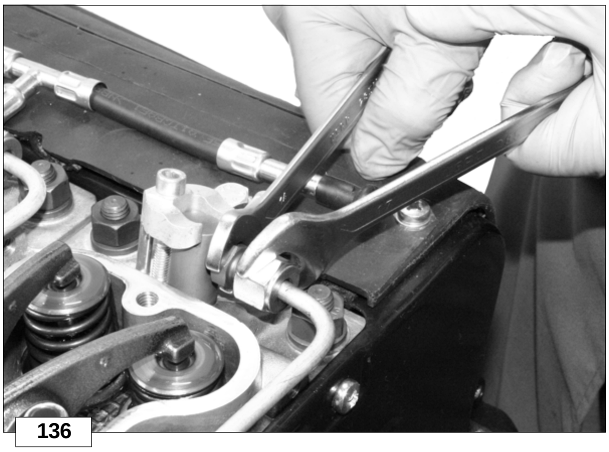
## Injector setting

Connect injector to high pression pump and check that setting pressure is 210 ÷ 220 bar for size S injector and 245 ÷ 255 bar for size P injector.
To change injector setting replace the shim over the spring.
When replacing the spring, setting should be performed at a 10 bar greater pressure to allow for bedding during operation.
Check needle valve sealing by slowly moving hand pump until approximately 180 bar.
Replace nozzle in case of dripping (only for size S injectors).

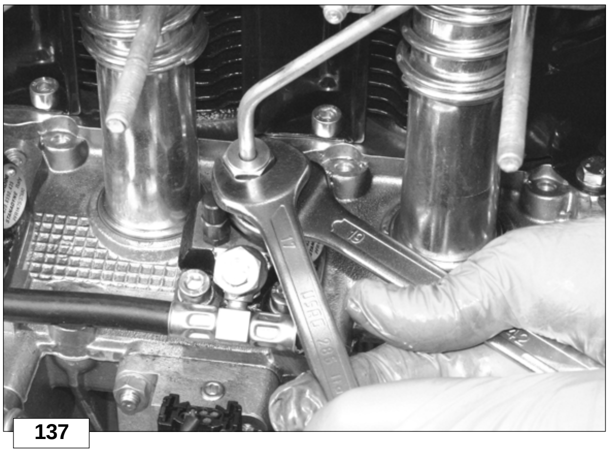

135

## (Static) Injection timing

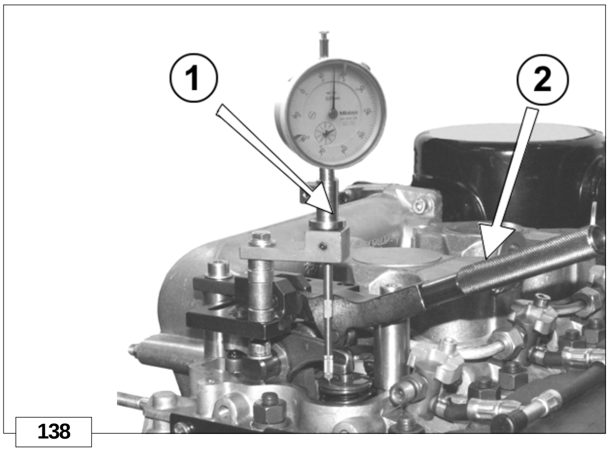
Remove the rocker arm cover.


136

Use a 14 mm box wrench to lock the injector union and a 17 mm box wrench to loosen the union of the injector pump high-pressure pipe.


137

Use a 19 mm box wrench to lock the injection pump union and a 17 mm box wrench to loosen the union of the injector pump high-pressure pipe.

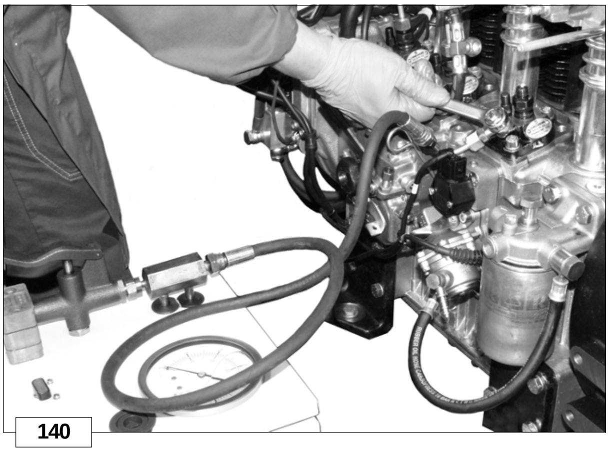



138

Assemble tool serial no. 1460 - 266 made up of lever **2** serial no. 1460 - 275, of a dial indicator **1** serial no. 1460 - 274 inserted in a dial indicator holder serial no. 1460 - 270.
The function of lever **2** is to reduce the effort required against the resistance of the spring when the valve lowers and comes into contact with the piston crown near the top dead centre.
The dial indicator tracer **1** rests against the upper spring bearing ring of the valve.
To sum up, as pressure is placed on lever **2** the valve goes into contact with the piston since the dial indicator **1** is applied to the valve, allowing to know precisely every movement of the piston from and towards the **TDC**, which is very important for the following operation.

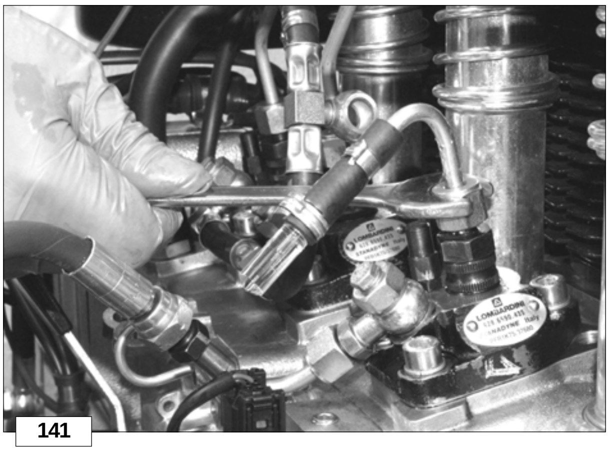
139

Unscrew the fuel supply union for the injection pump of the cylinder which is to be worked on.



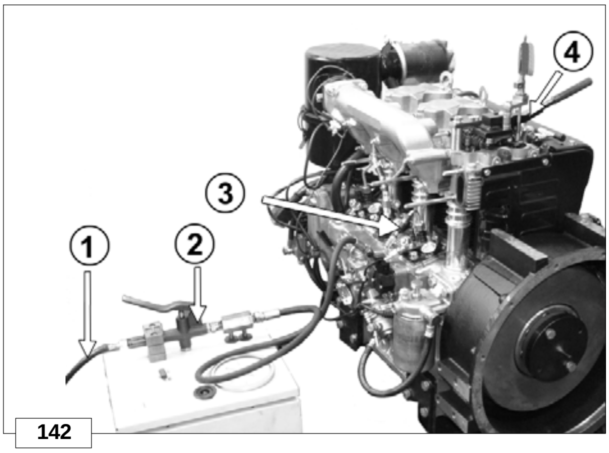
140

To the injection pump connect the high-pressure pump serial no. 1460 - 273 supplied by a tank whose fuel level is at least 100 mm above the injection pump.



141

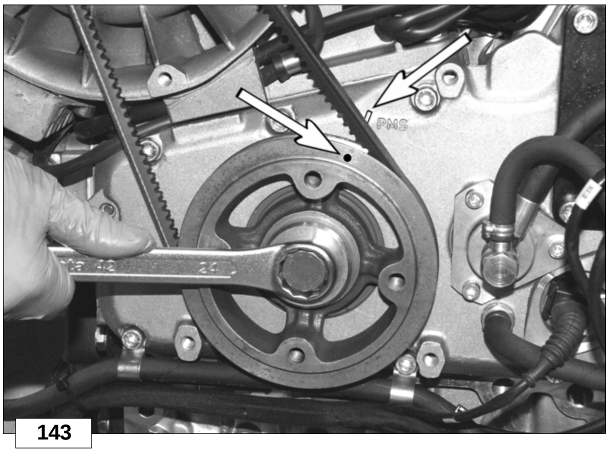
Insert the capillary tester serial no. 1460 - 024 onto the injection pump union where the high-pressure pipe is usually connected from the pump to the injector.




142

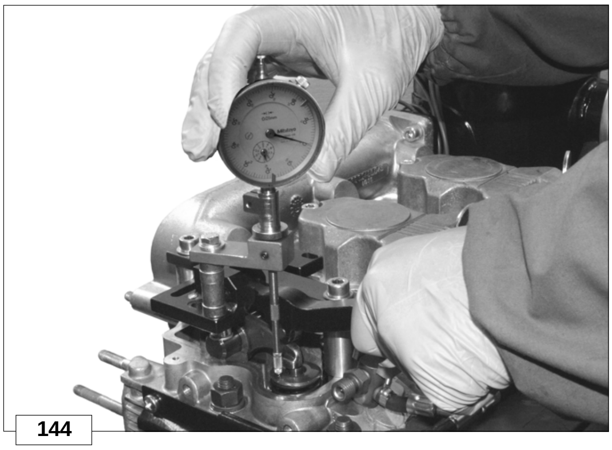
*Components:*

**1** Fuel supply pipe from the tank
**2** High-pressure pipe
**3** Capillary tester
**4** Valve-lowering lever with dial indicator showing piston movement



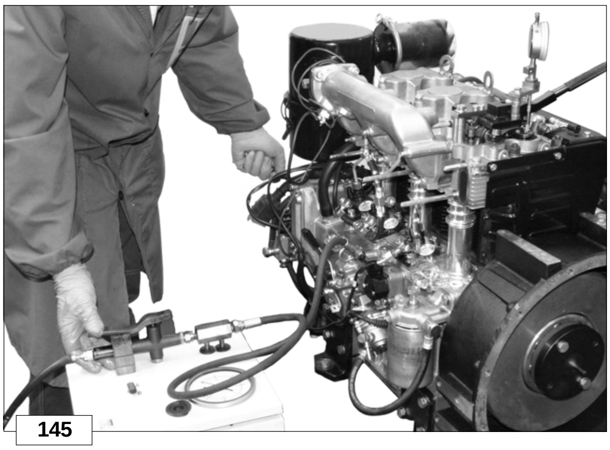

143

Rotate the crankshaft clockwise on the timing belt side and position the relevant cylinder piston at top dead centre.



144

Press the lever to bring the valve into contact with the piston crown.
By joggling back and forth clockwise and anticlockwise, find the dead centre via the dial indicator and then reset to zero.

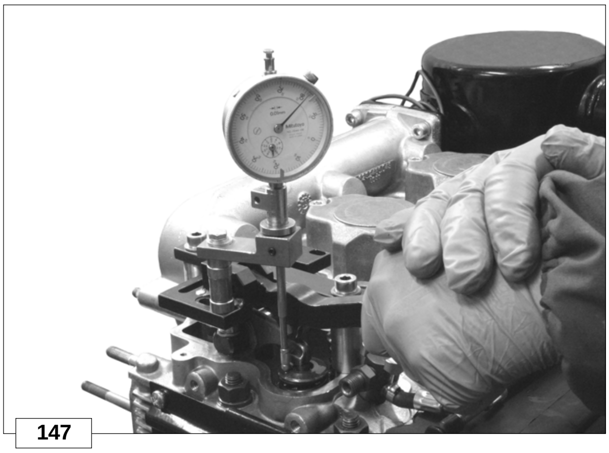


145

Rotate the crankshaft anticlockwise until diesel starts to flow out from the capillary when the high-pressure lever is pressed.
Change direction of rotation of the crankshaft to clockwise from the timing belt side.
Press the high-pressure lever and rotate the crankshaft until fuel stops flowing from the capillary.

146

The capillary tube shows when the fuel is flowing out, thanks to its small transparent slot.



147

After finding the delivery start point (when fuel stops flowing from the capillary), press the lever and use the dial indicator to check how many millimetres the piston has moved from the top dead centre.
Check static injection advance using the conversion table from millimetres to degrees.
If it is necessary to change static advance add the seals **G** in figure 129 (to delay) or remove the seals **G** in figure 129 (to advance) from between the injection pump surface and the crankcase surface.
The same operation must be performed for each cylinder.

**Table static advance values for engines with P size injectors**

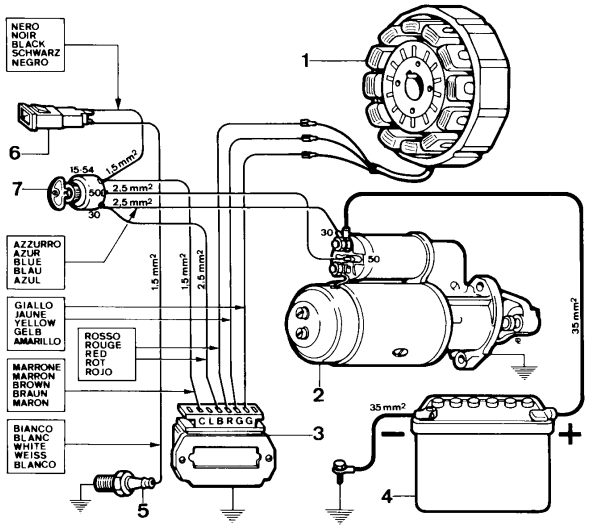
| | R.p.m. | α | Piston lowering (mm) |
|---|---|---|---|
| 97-68 CE | 2400 | 9° ± 1° | 8° --> 0,56<br>9° --> 0,71<br>10° --> 0,87 |
| | 2500÷2800 | 8° ± 1° | 7° --> 0,43<br>8° --> 0,56<br>9° --> 0,71 |
| | 3000 | 9° ± 1° | 8° --> 0,56<br>9° --> 0,71<br>10° --> 0,87 |
| EPA | 2400÷2800 | 5° ± 1° | 4° --> 0,14<br>5° --> 0,22<br>6° --> 0,32 |

**Table static advance values for engines with S size injectors**

| R.p.m. | α | Piston lowering (mm) |
|---|---|---|
| 1500÷2200 | 14° ±1° | 13° --> 1,47<br>14° --> 1,71<br>15° --> 1,96 |
| 2201÷3000 | 16° ±1° | 15° --> 1,47<br>16° --> 1,71<br>17° --> 1,96 |

**Conversion table from degrees into millimetres**

| α | mm |
|---|---|
| 0° | 0,00 |
| 1° | 0,01 |
| 2° | 0,04 |
| 3° | 0,08 |
| 4° | 0,14 |
| 5° | 0,22 |
| 6° | 0,32 |
| 7° | 0,43 |
| 8° | 0,56 |
| 9° | 0,71 |
| 10° | 0,87 |
| 11° | 1,06 |
| 12° | 1,26 |
| 13° | 1,47 |
| 14° | 1,71 |
| 15° | 1,96 |
| 16° | 2,22 |
| 17° | 2,51 |
| 18° | 2,81 |
| 19° | 3,12 |
| 20° | 3,45 |



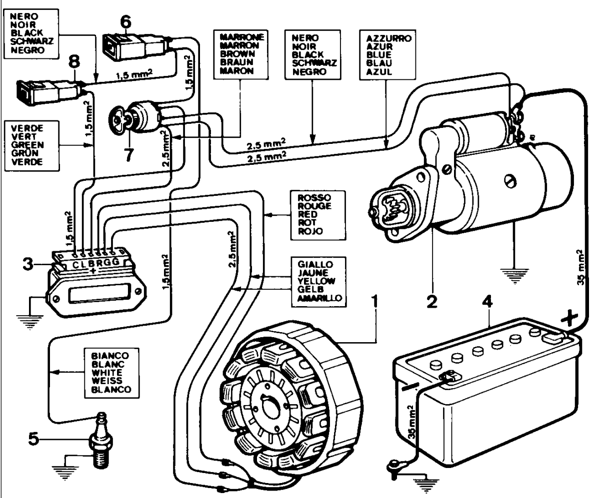

148

## Standard electric equipment

### Electric starting layout without battery charging light

*Components:*

**1** Alternator
**2** Starting motor
**3** Voltage regulator
**4** Battery
**5** Pressure switch
**6** Oil pressure warning light
**7** Key switch



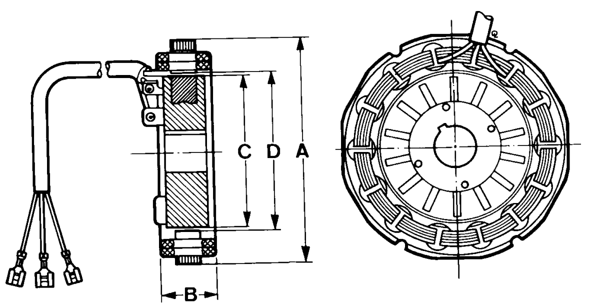

149

### Electrical starting layout with battery charging light

*Components:*

**1** Alternator
**2** Starting motor
**3** Voltage regulator
**4** Battery
**5** Pressure switch
**6** Oil pressure warning light
**7** Key switch
**8** Battery charging light

***Note:*** Battery, which is not supplied by Lombardini, should feature a 12V voltage.
When choosing battery capacity please consider environmental conditions: 66 Ah are recommended down to -10°C and 88 Ah are recommended below -15°C; in any case do not use a battery with greater capacity than 110 Ah.



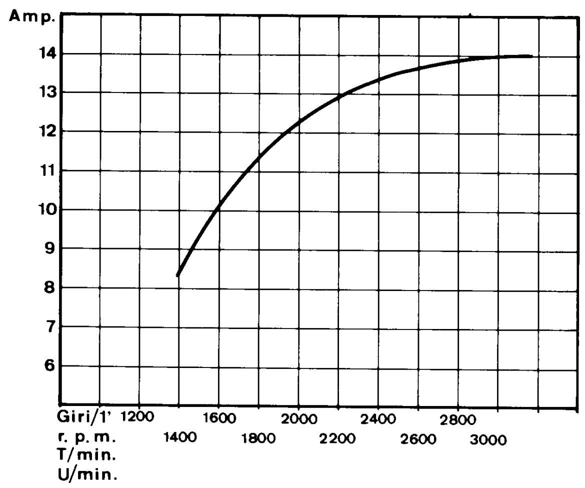

150

### 12,5 V, 14 A Alternator

Features a fixed armature winding, housed in the bell inside the blower stator. The rotating permanent magnet inductor is located in the fan spindle. See page 24.

| Ref. | Dimensions (mm) |
|---|---|
| A | 111,701 ÷ 111,788 |
| B | 31,000 ÷ 33,500 |
| C | 76,226 ÷ 76,300 |
| D | 77,400 ÷ 77,474 |

***Note:*** Clearance between armature winding and inductor (air gap) should be 0,55 ÷ 0,63 mm.

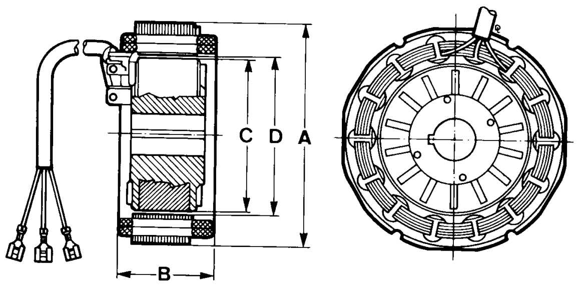



151

**Alternator battery charger curve (12.5 V, 14A)**

The curve was obtained at room temperature of + 25°C with 12.5V battery voltage.

***Note:*** The r.p.m. shown in the table refers to the engine.



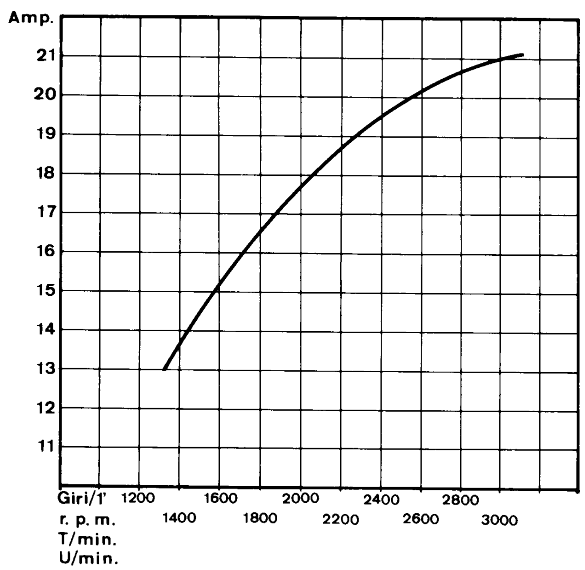

152

**12 V, 21 A Alternator**

Features a fixed armature winding housed in the bell inside the blower stator.The rotating permanent magnet inductor is located in the fan spindle. See page 24.

| Ref. | Dimensions (mm) |
|---|---|
| A | 111,701 ÷ 111,788 |
| B | 49,500 ÷ 52,000 |
| C | 76,226 ÷ 76,300 |
| D | 77,400 ÷ 77,474 |

***Note:*** Clearance between armature winding and inductor (air gap) should be 0,47 ÷ 0,63 mm.

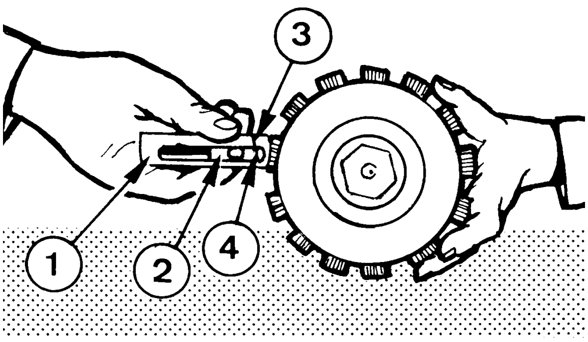



153

**Alternator battery charger curve (12 V, 21 A)**

The curve was obtained at room temperature of + 25°C with 12.5V battery voltage.

***Note:*** The r.p.m. shown in the table refers to the engine.



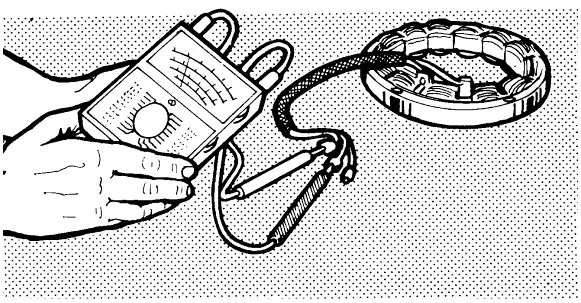

154

## Magnetization checking tool (Part No. 7000-9727-001)

*Components:*

**1** Casing
**2** Slider
**3** Casing reference line
**4** Slider reference line

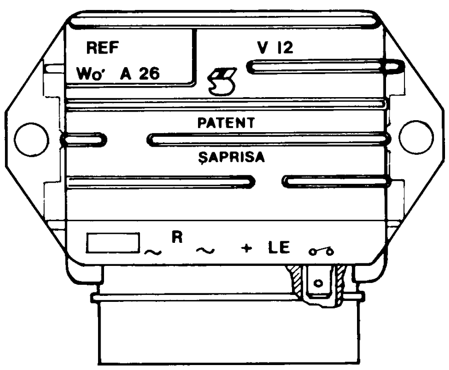
Rest the tool end horizontally onto the magnetic poles.
Hold sfider so that its reference line coincides with the casing reference line.
Release slider: if no attraction occurs the rotor is demagnetized; therefore replace alternator.



155

## Checking for cable continuity

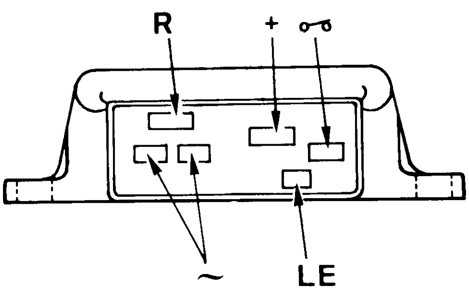
Check that stator windings have no unsoldered connections, burnt areas or grounded wires.
Using an ohmmeter check for continuity between the red cable and the two yellow ones.
Furthermore, check that they are insulated from the ground.




156

## Voltage regulator

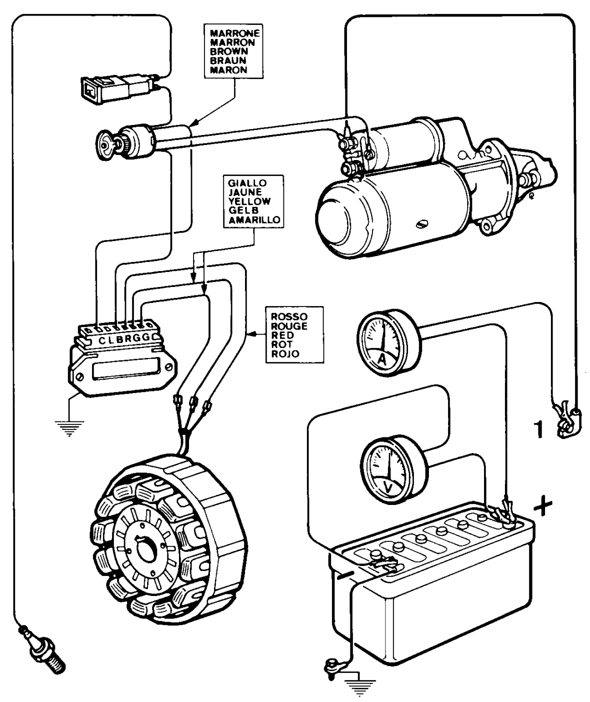
Supplied by SAPRISA : Voltage 12 V, max. current 26A.




157

To avoid wrong connections 3 different sizes are supplied.

| Ref. | Connection size (mm) | |
|---|---|---|
| | Width | Thickness |
| ~ | 6.25 | 0.8 |
| R | 9.50 | 1.12 |
| + | 9.50 | 1.12 |
| LE | 4.75 | 0.5 |
| σ O | 6.25 | 0.8 |



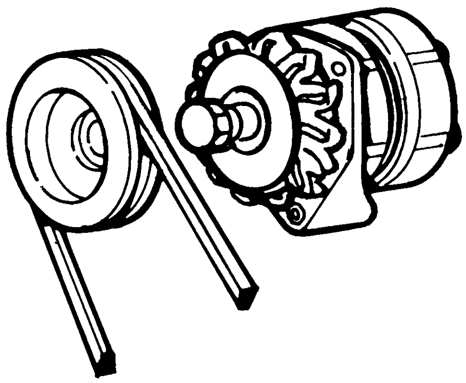

158

**How to check voltage regulator for proper operation**

Check that connections correspond to the layout.
Disconnect the terminal from the battery positive poie.
Connect a d.c. voltmeter between the two battery poles.
Fit an ammeter between the positive pole and the corresponding cable **1** terminal.
The ammeter should be suitabie for reading the required value (14 or 21 A) and for withstanding the starting motor peak absorption (400 ÷ 450 A).
Start a couple of times until battery voltage drops below 13 V.
When battery voltage reaches 14,5 V the ammeter current suddeniy drops down to almost zero.
Replace regulator if recharge current is zero with voltage below 14 V.

**Important**

**When the engine is running do not disconnect battery cables or remove the key from the control panel.**
**Keep regulator away from heat sources since temperatures above 75°C mmght damage it.**
**No electric welding on engíne or application.**

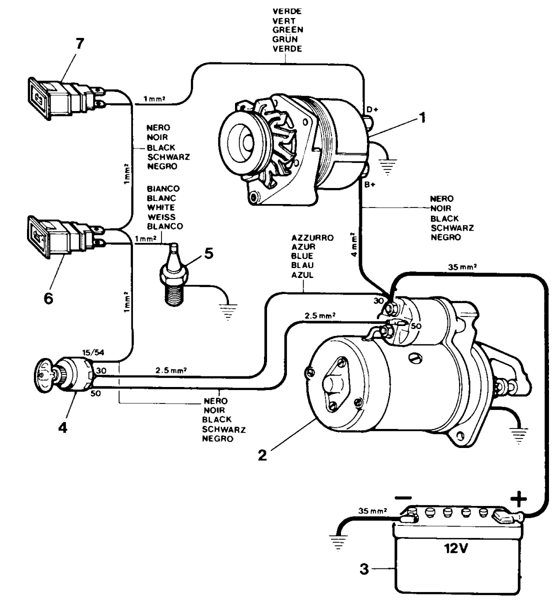


159

## Alternator type Bosch G1 14 V, 33 A

The alternator is ot the claw-pole rotor type with built-in voltage reguiator.
The rotating motion is conveyed by the engine through a 'V' belt and sheave.

*Features:* 12V rated voltage. Max. current 33A at 7000 alternator r.p.m.
RH direction of rotation.

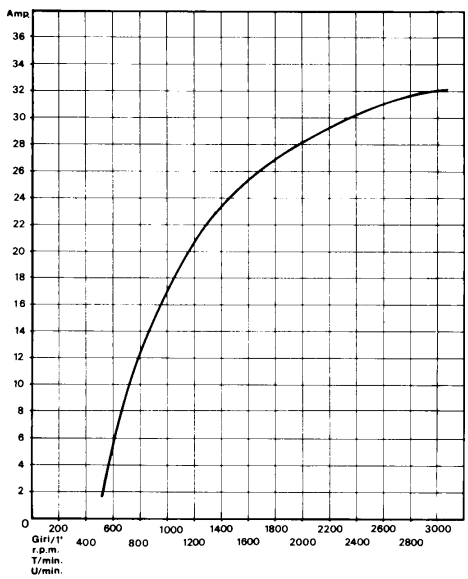



160

## Alternator type Bosch Gil 14 V, 33 A layout

*Components:*

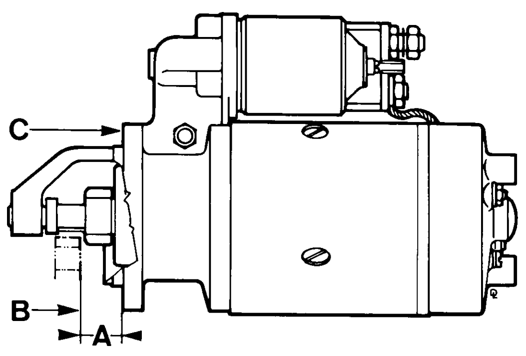
**1** Alternator
**2** Starting motor
**3** Battery
**4** Key switch
**5** Pressure switch
**6** Oil pressure warning light
**7** Battery charging light




161

## 14 V, 33 A Bosch G1 alternator battery charger curve

The curve was obtained at room temperature of +25°C.
Battery terminal voltage is 12.5 V.
The r.p.m. shown on the table refers to the engine.




162

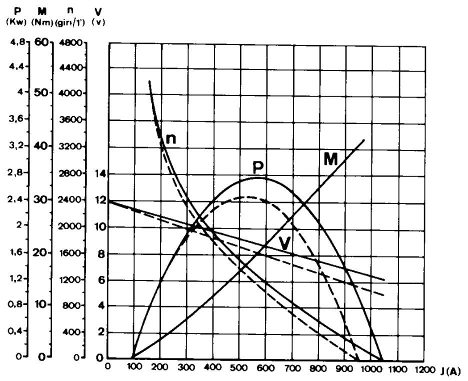
**Starting motor type Bosch JF (R) 12 V, class 2.5**

RH direction of rotation

**A** = 23 ÷ 24 mm
**B** = Ring gear plane
**C** = Flange plane

**Vorsicht - Warnung**
**The flywheel should not project from ring gear plane B.**

***Note:*** Apply to Bosch Service Centers for any type of repair.

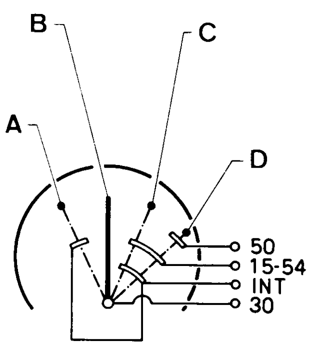



163

**Characteristic curves for starting motor type Bosch JF (R) 12 V**

Curves were obtained at room temperature of + 20°C with 88 Ah bat-
teries.

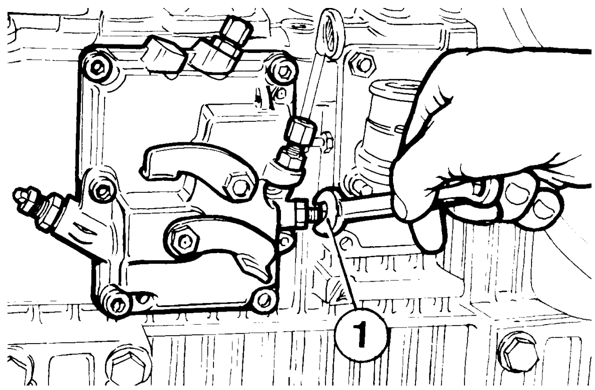
**V** = Motor terminal voltage in Volt
**P** = Power in kW
**C** = Torque in N/m
**N** = Motor speed in r.p.m.
**J (A)** = Absorbed current in Ampere




164

**Starting motor layout**

**A** = Parking lights
**B** = Stop
**C** = Run
**D** = Start

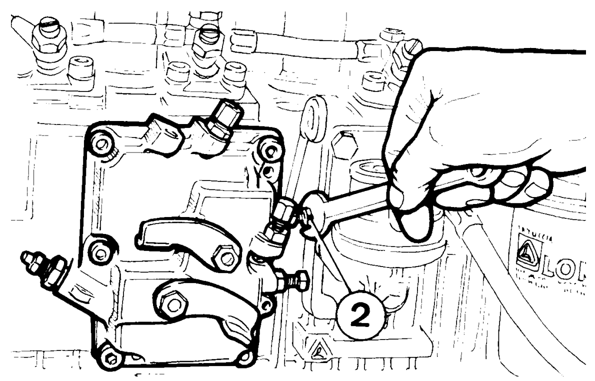



165

## Settings

### 1 - Idling speed setting in no-load conditions (standard)

After filling with oil and fuel, start the engine and let it warm up for 10 minutes. Adjust idling speed at 800 ÷ 900 r.p.m. by turning setscrew **1**; then tighten lock nut.

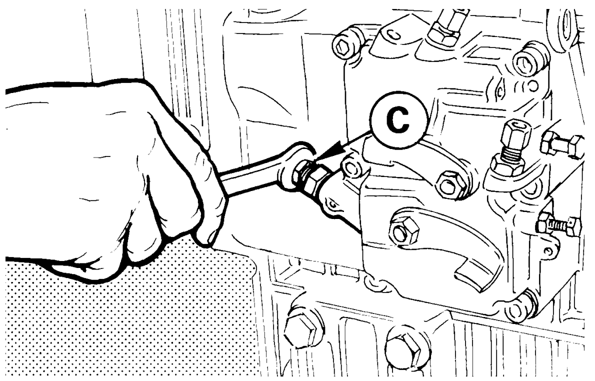



166

### 2 - Full speed setting in no-load conditions (standard)

After setting idle speed turn screw **2** and set full speed in no-load conditions at 3200 r.p.m.; then tighten lock nut.

**Note**: When the engine reaches the pre-set power full speed stabilizes at 3000 r.p.m.

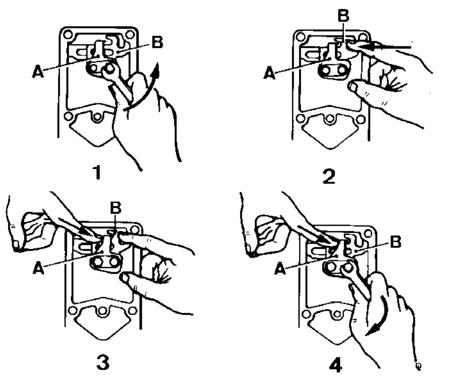



167

### Injection pump delivery setting

This setting should be performed at the torque dynamometer.
If not, setting is only approximate.
The following steps are required:
Loosen delivery limiting device **C** by 5 turns.
Bring engine to full speed in no-load conditions i.e. 3200 r.p.m..
Tighten limiting device until the engine shows a drop in r.p.m..
Unscrew limiting device **C** by 1½ turn. Tighten lock nut.

**Note**: If the engine, under full load, generates too much smoke tighten **C**; if no smoke is observed at the exhaust and the engine cannot reach its full power unscrew **C**.




168

### Stop setting

Remove fuel feeding pump and cover.

**1)** Loosen both bolts fixing plate **A**.
**2)** Push injection pump **B** control rod to the right and keep it in this position.
**3)** Push plate **A** to the right until it touches rod **B** and stop.
**4)** Release rod **B** and push plate **A** to the right so that rod **B** has a stroke of 1 mm.
Tighten both bolts.

**Note**: Under these conditions no damage can be caused to the injection pump rack rod stops by sudden impacts due to the available control solenoids.

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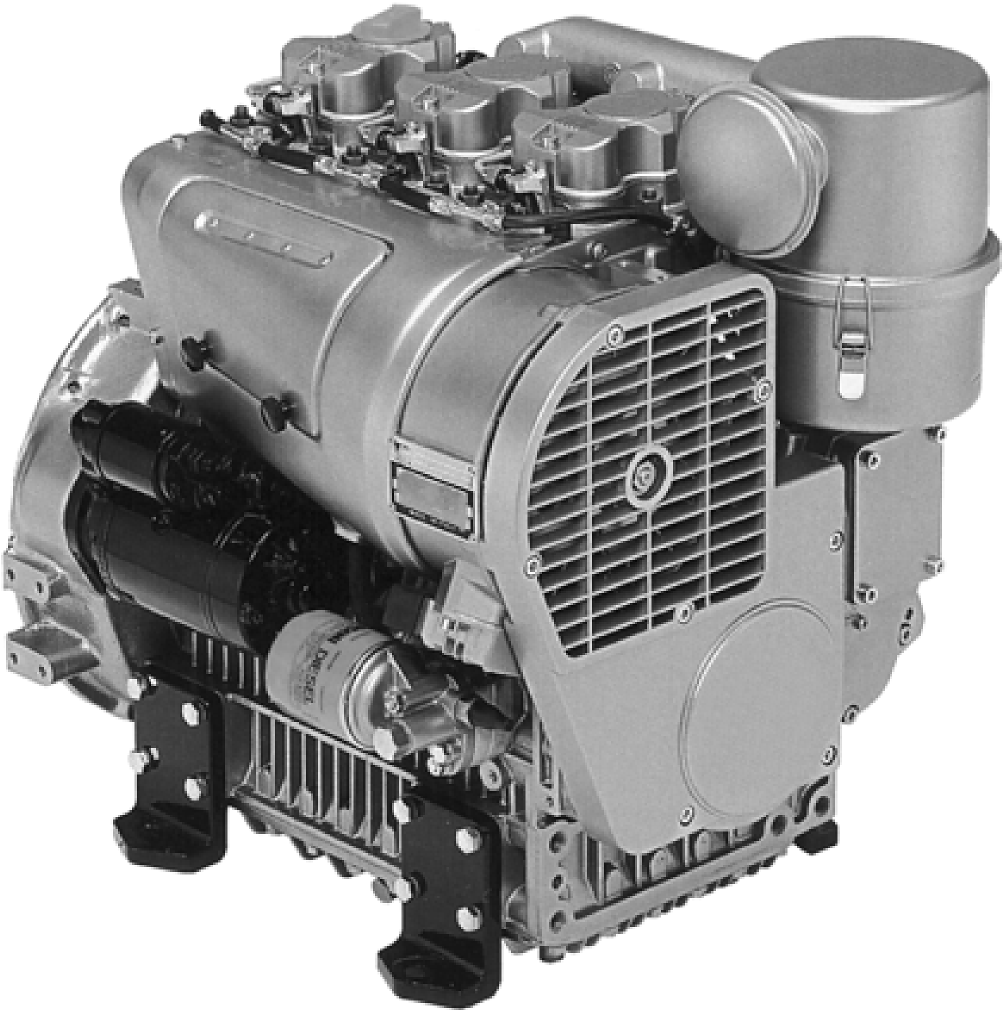
# 11 LD

# 625-3 / 626-3

# ENGINE

# with advance variator



## INJECTION TIMING DEVICE OPERATION

In order to meet EPA tier 2 limits, the engine 11LD 625-3 / 626-3 has been equipped with a variable injection timing device.
The system consists of an electro–hydraulic actuated mechanical device, that allows changing the injection timing by rotating the camshaft against its driving gear.
The change takes place using the oil whose pressure is regulated by a pair of electric valves, which allow a rotation between 0 and 4.5°. The maximum variation of the injection timing is 4.5° (camshaft degrees).
Oil is taken from the engine oil circuit and its pressure acts on a sort of hydraulic piston that moves from one side to the other.
The hydraulic plunger is attached on the inside by means of a straight groove and on the outside via a spiral-shaped groove.
Thus movement from left to right (or vice versa) causes rotation from the driving gear and the camshaft.
In other words, the plunger translates and, at the same time, rotates and thus varying the angular position of camshaft that is connected to it.
The gear timing variation is managed by an ECU which receives electric signals from two speed sensors, the temperature sensor and the load sensor, which reads the position of the injection pump control.
The ECU memory contains the maps of the injection timing variation strategies.

Fig. A_1. Injection timing device: in "Resting position"

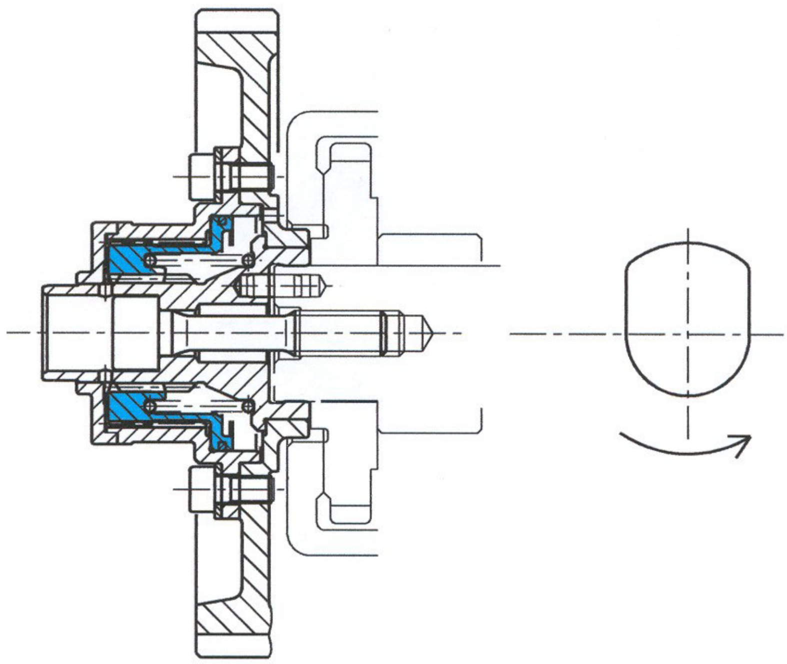


Fig. A_2. Injection timing device: during actuation of an advance (max value 4.5°).
The oil (yellow) goes into the system and moves the plunger (blue) that activates the camshaft anticlockwise.

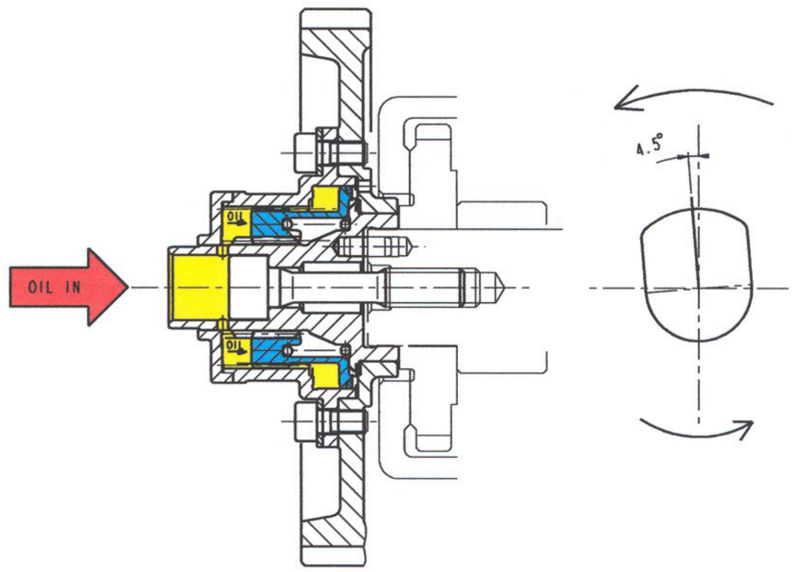
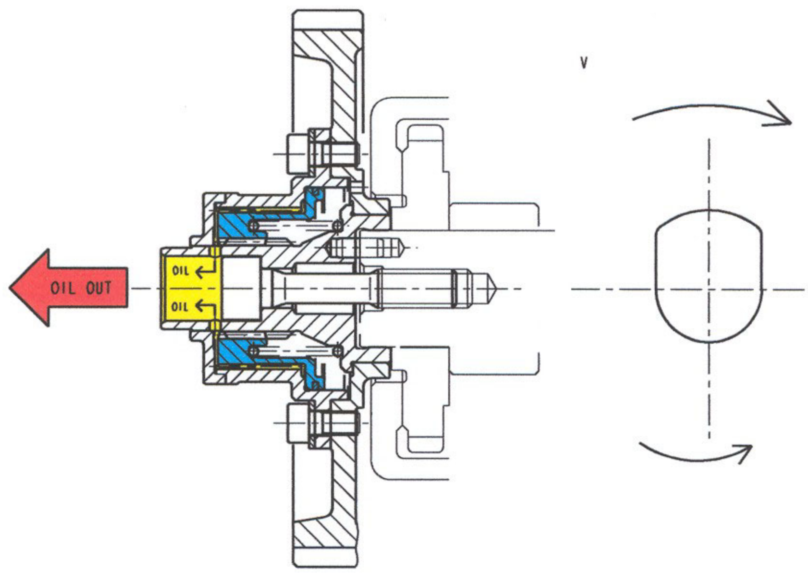
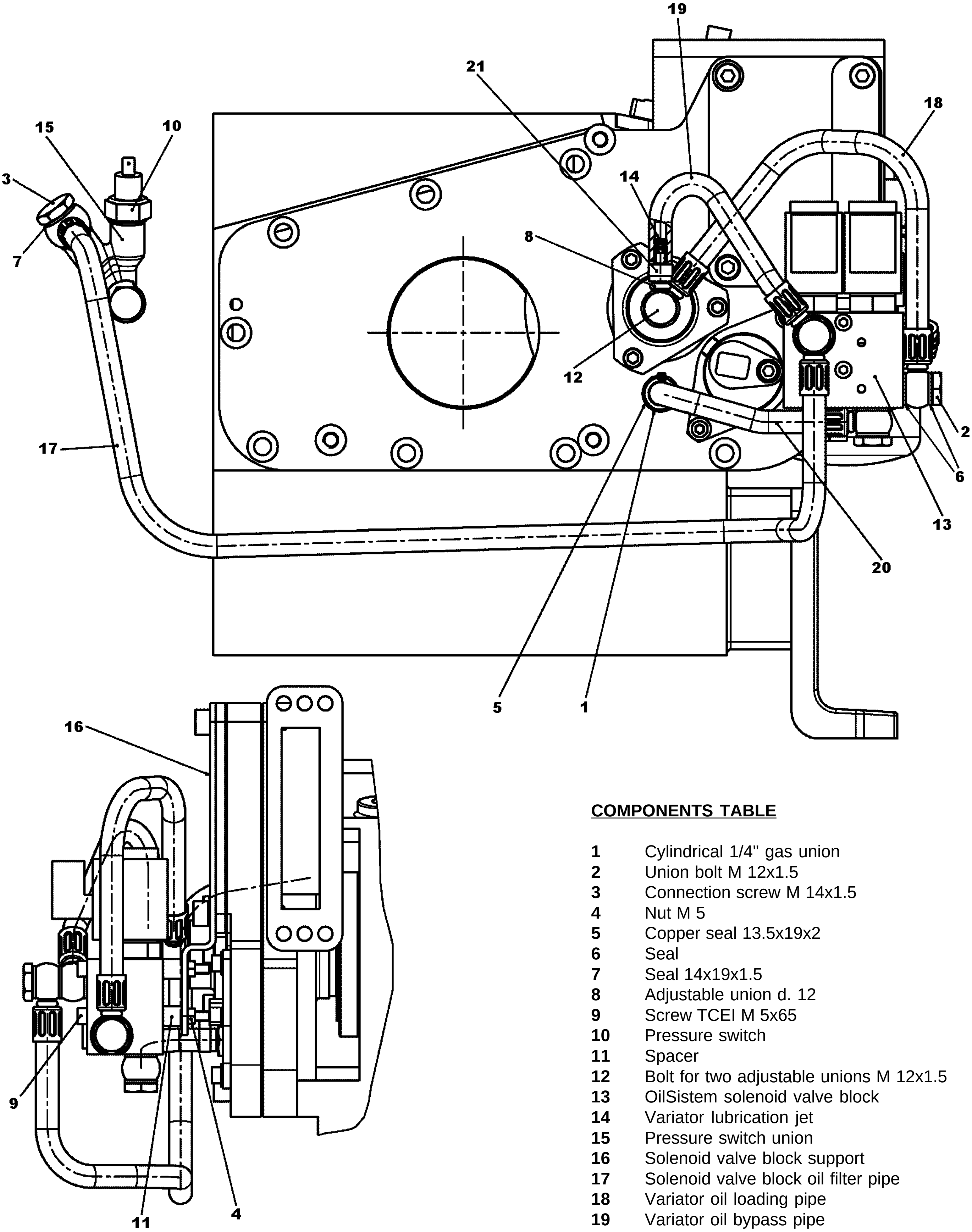



Fig. A_3. Injection timing device: moving from actuation of an advance to resting position.
The oil (yellow) goes out and releases the spring to move the plunger (blue), which in turn activates the camshaft clockwise.




Our system is able to actuate any intermediate advance, regulating the oil pressure. When the set level is reached, the oil exerts the right force to compress the spring at the right height to move the plunger appropriately, thus achieving the required rotation (angular advance).

## Solenoid valve assembly diagram

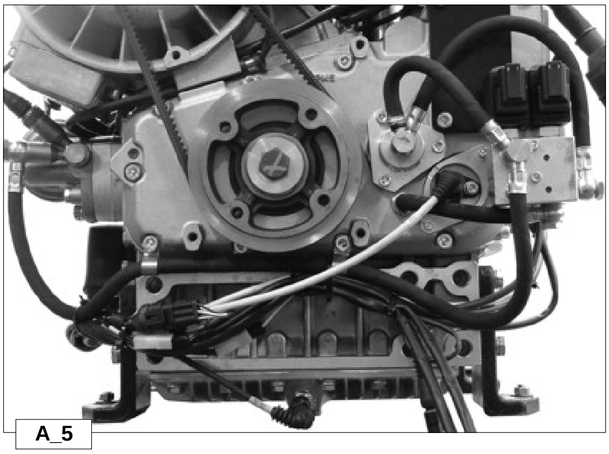



### COMPONENTS TABLE

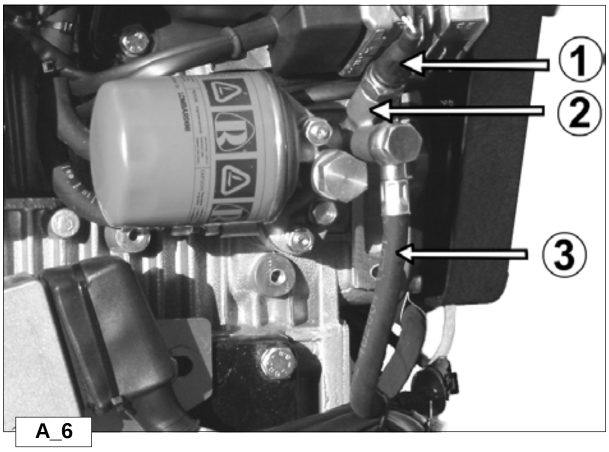
| | |
|---|---|
| **1** | Cylindrical 1/4" gas union |
| **2** | Union bolt M 12x1.5 |
| **3** | Connection screw M 14x1.5 |
| **4** | Nut M 5 |
| **5** | Copper seal 13.5x19x2 |
| **6** | Seal |
| **7** | Seal 14x19x1.5 |
| **8** | Adjustable union d. 12 |
| **9** | Screw TCEI M 5x65 |
| **10** | Pressure switch |
| **11** | Spacer |
| **12** | Bolt for two adjustable unions M 12x1.5 |
| **13** | OilSistem solenoid valve block |
| **14** | Variator lubrication jet |
| **15** | Pressure switch union |
| **16** | Solenoid valve block support |
| **17** | Solenoid valve block oil filter pipe |
| **18** | Variator oil loading pipe |
| **19** | Variator oil bypass pipe |
| **20** | Variator oil draining pipe |
| **21** | "OTECO clic 66" clamp |


A_4

After loosening the screws, remove the alternator belt guard.


A_5

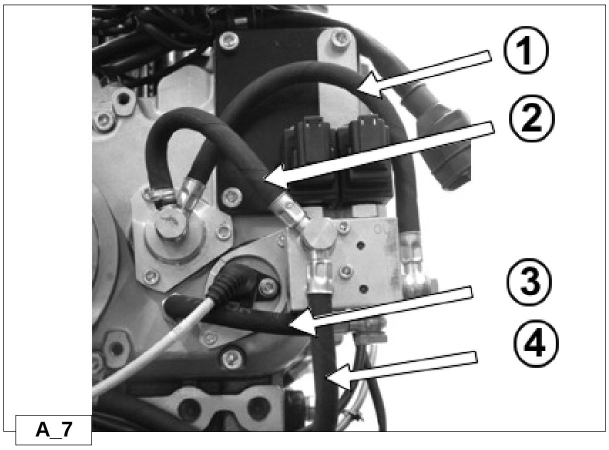
Overall view of variator speed sensor and hydraulic circuit.



A_6

**Components:**

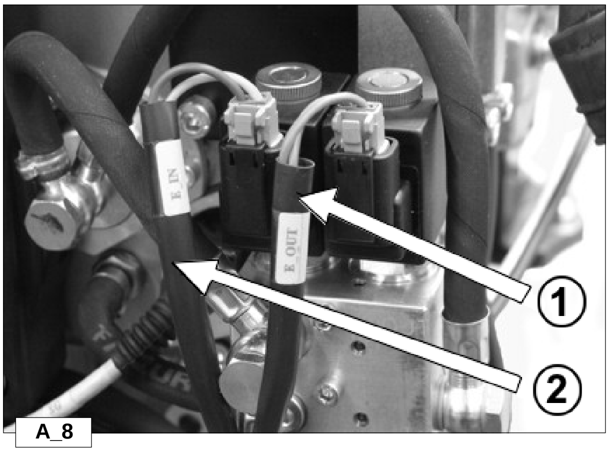
**1** Pressure switch
**2** Pressure switch union
**3** Solenoid valve block oil filter pipe



A_7

**Components:**

**1** Variator oil loading pipe
**2** Variator oil bypass pipe
**3** Variator oil draining pipe
**4** Solenoid valve block oil filter pipe



A_8

Components:

**1** Variator load solenoid valve
**2** Variator unload solenoid valve

**Important**
**Do not invert cables during reassembly.**


A_9

To remove connectors, press the stop tabs and draw upwards.


A_10

➲ Refer to page 78 to identify the pipes.

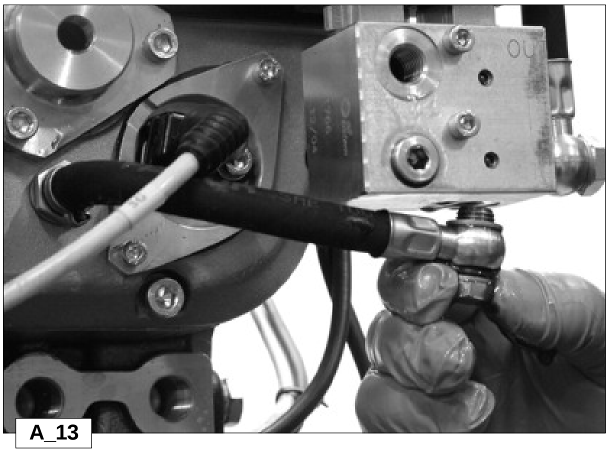
Loosen the union screw of pipes **17** and **19**.


A_11

On the opposite end of the block of pipe **19** is the variator lubrication jet attached to the pipe by a click clamp.

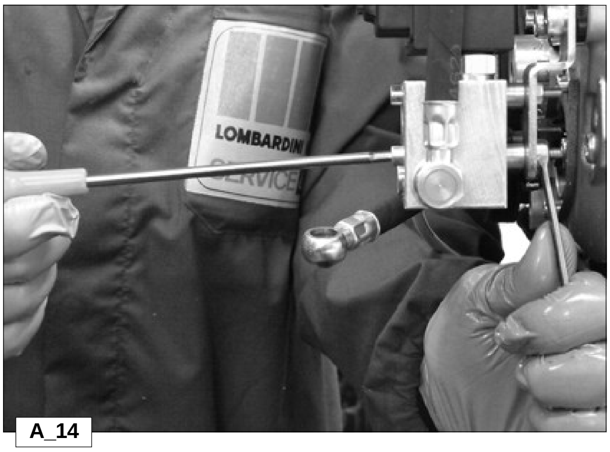
A_12

Variator lubrication jet complete with banjo union.



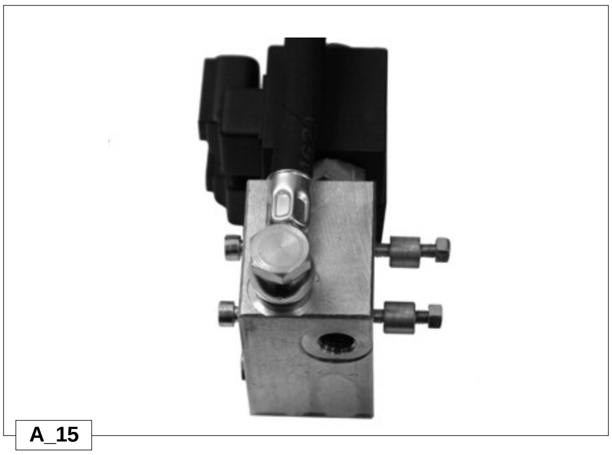
A_13

Unscrew the union of variator oil discharge pipe **20**.




A_14

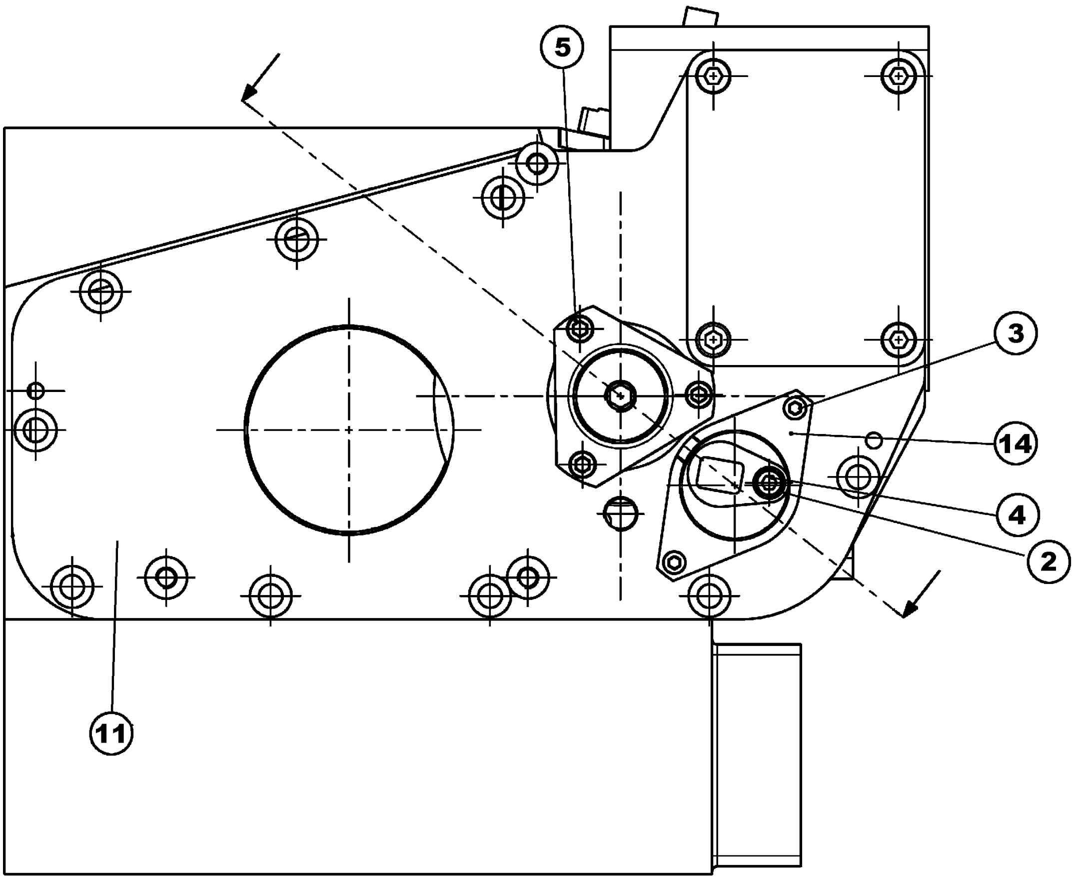
To remove the solenoid valve block from the support bracket, unscrew the two screws M 5.

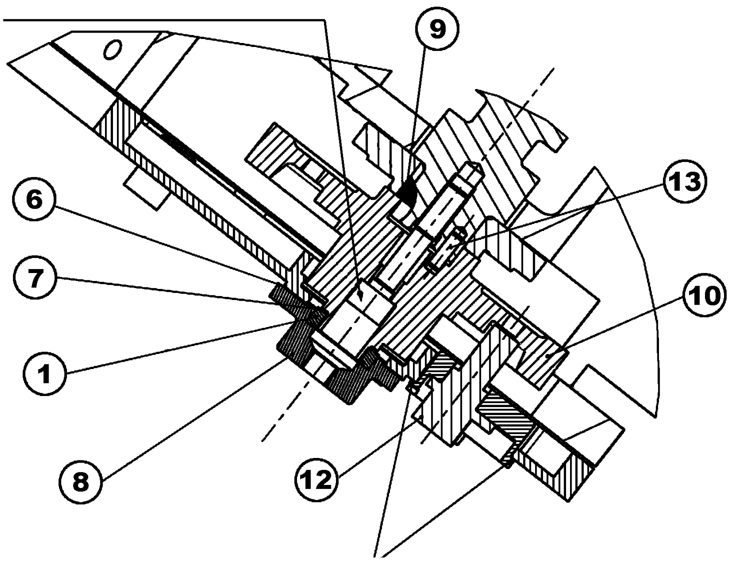


A_15

View of the unassembled solenoid valve block with two spacers between the block and the bracket.

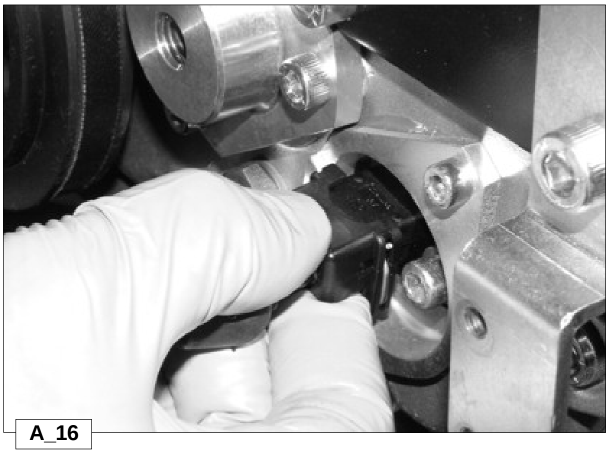
<u>**Speed sensor and variator assembly diagram**</u>



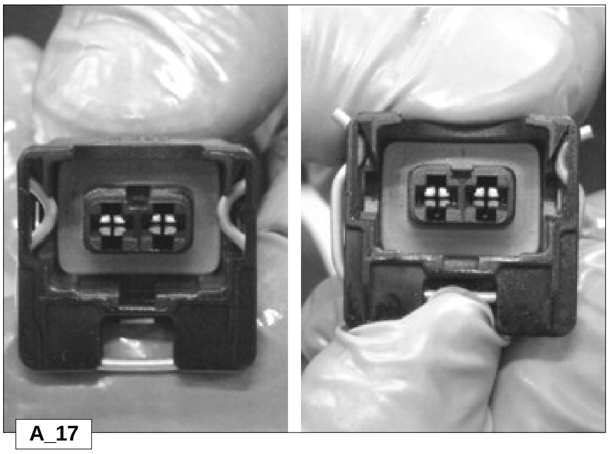

<u>**COMPONENTS TABLE**</u>

| | |
|---|---|
| **1** | Oil seal ring 20x30x7 |
| **2** | Washer 6x12xSp1 |
| **3** | Screw TCEI M 5x10 |
| **4** | Screw TCEI UNI 5931 M 6x10 |
| **5** | Screw TCEI UNI 5931 M 6x14 |
| **6** | Lid seal (rev. counter) |
| **7** | Oil seal support ring |
| **8** | Variator oil bush |
| **9** | Special tab for variator |
| **10** | Advance variator device |
| **11** | Timing cover side cover for variator |
| **12** | Speed and phase sensors |
| **13** | Cylindrical pin 5x16 |
| **14** | Speed sensor support |

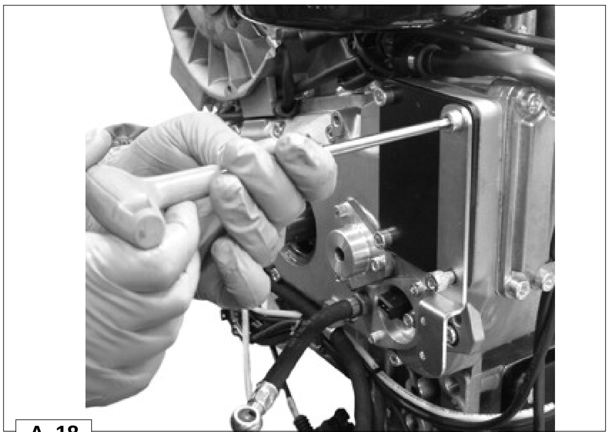


A_16

To remove the speed sensor cable connector press the spring as shown in figures **A_16** and **A_17** and draw upwards.

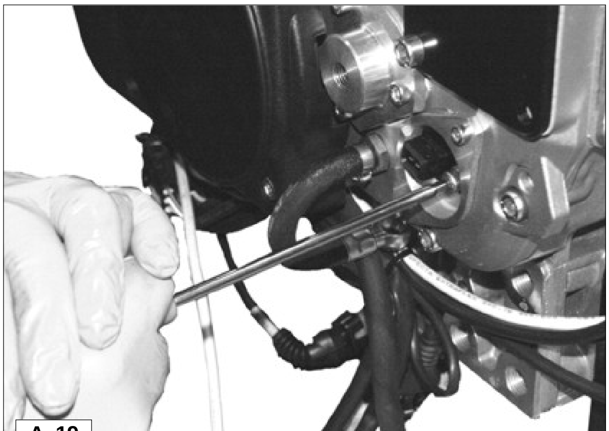


A_17



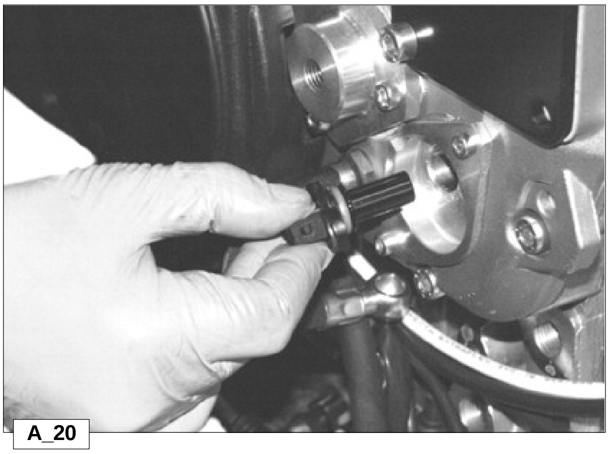
A_18

Loosen the two screws M8 to disassemble the solenoid valve support bracket.

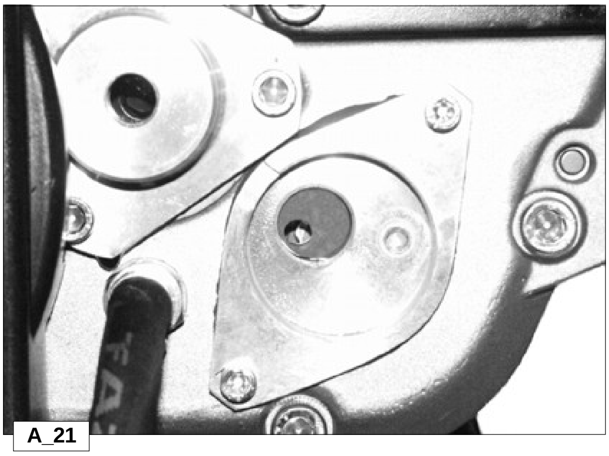


A_19

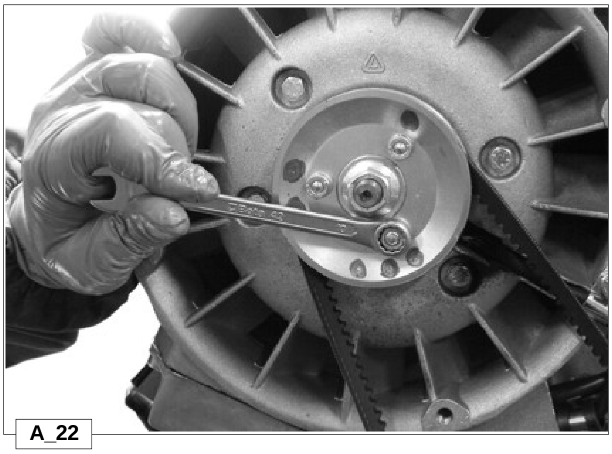
Loosen screw M6 to remove the speed sensor from its support.


A_20

Draw he speed sensor outwards, being careful not to damage the rubber seal ring.


A_21

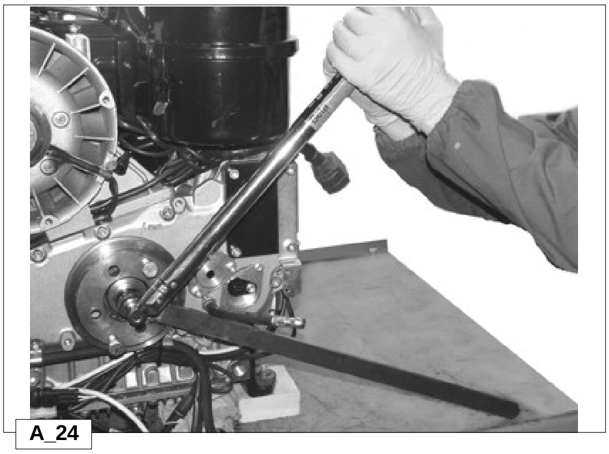
View of speed sensor housing.


A_22

**Blower belt alternator - Disassembly**

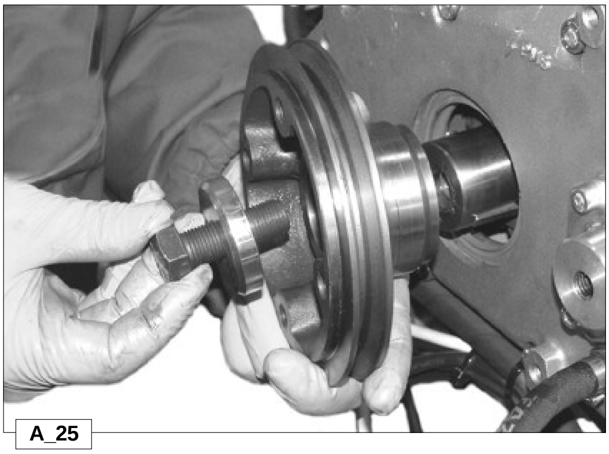
➲ See page 22 - 23.

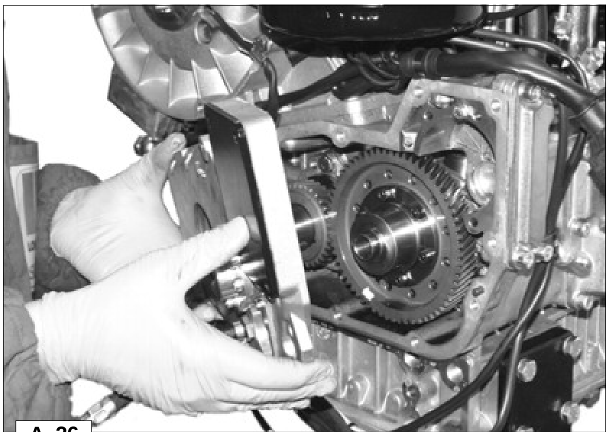

A_23


A_24

**Blower control pulley - Disassembly**

➲ See page 24 - 25.

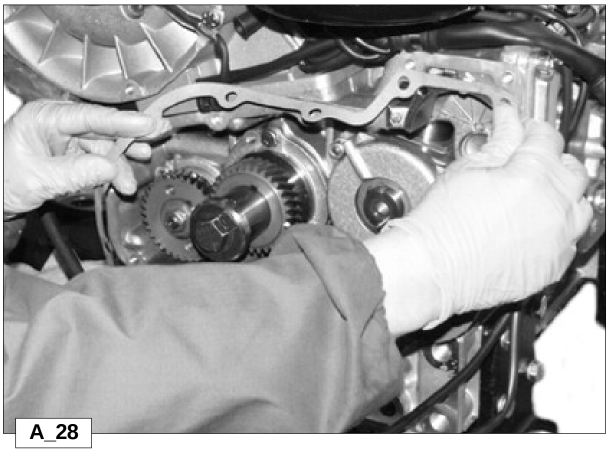

A_25


A_26

After loosening the screws, remove the timing cover.


A_27

Pay attention to the oil seal support ring when disassembling the timing cover.



A_28

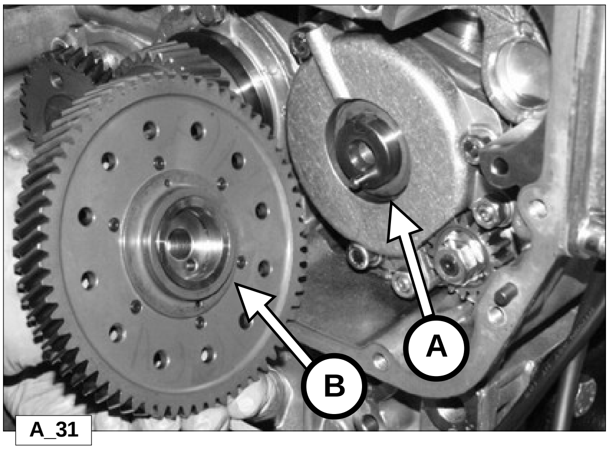
Remove the timing cover seal.

A_29

Unscrew screws M10 on the variator to the camshaft.

A_30

Remove screw M10.



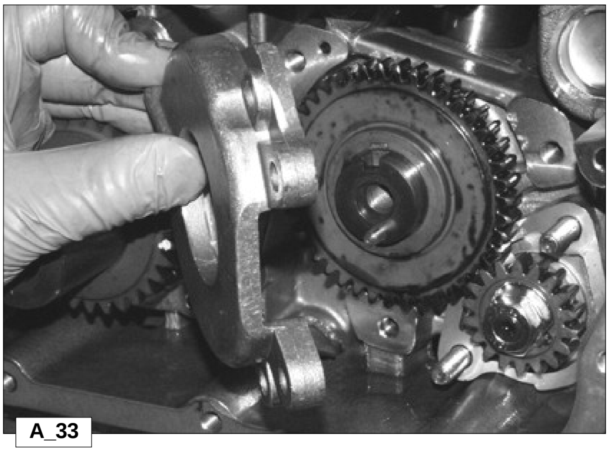

A_31

Remove the variator.
The figure shows the camshaft pin for correct variator timing.

**A** Cylindrical pin Ø 5x16
**B** Pin housing

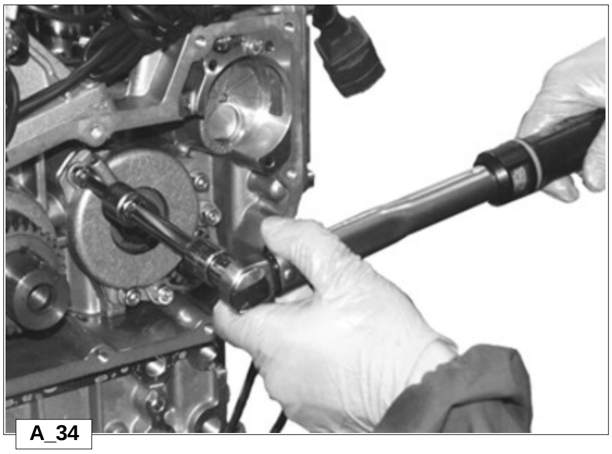
A_32

View of the camshaft ends with pin inserted.



A_33

Remove the shoulder housing of the idle gear that drives the speed governor.

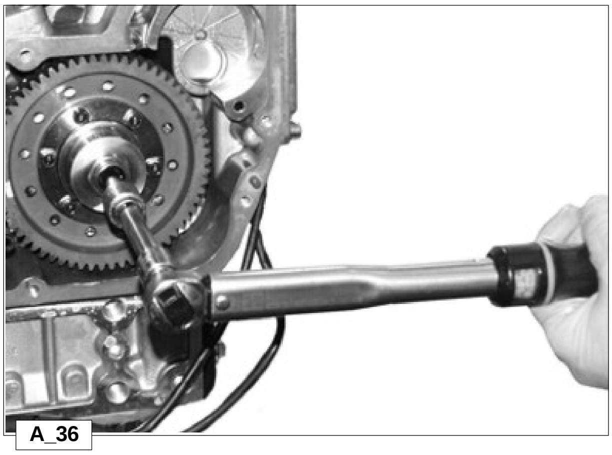


A_34

❍ After refitting the housing tighten the screws to 20 Nm using a torque wrench.

A_35

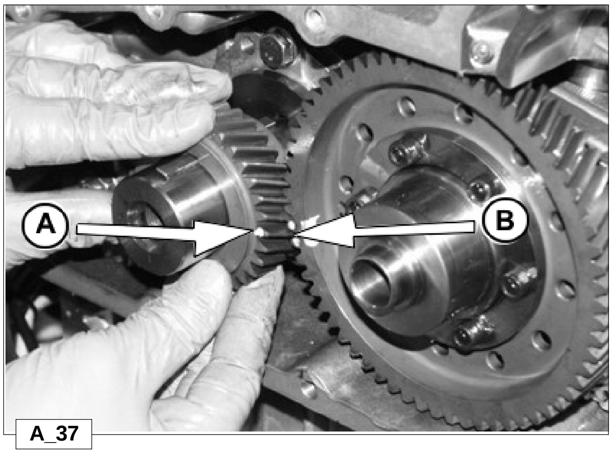
Remove the distribution control gear from the crankshaft.



A_36

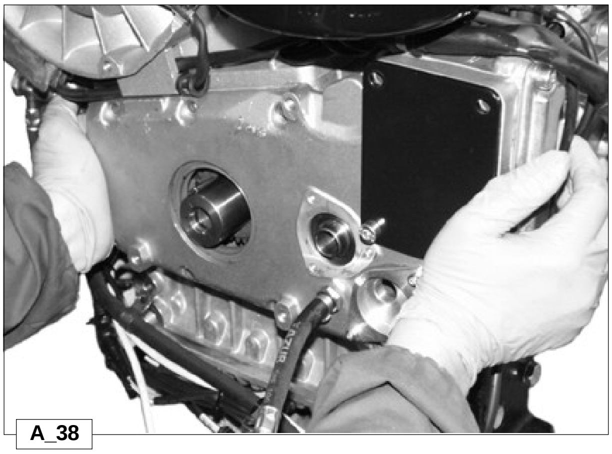
Assemble the variator onto the end of the camshaft taking care to properly insert the timing pin into place and ensuring that the variator comes into contact with the surface of the speed governor idle gear.

❍ Tighten screw M10 to 65 Nm using a torque wrench.

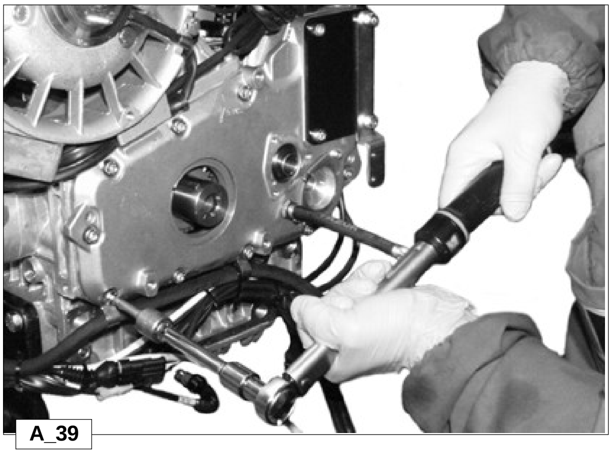



A_37

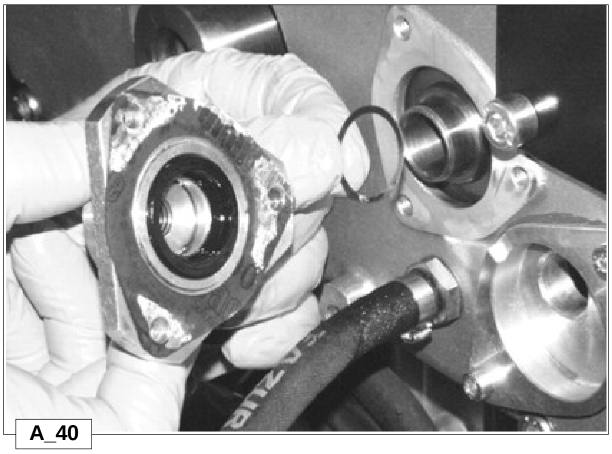
Assemble the timing control gear onto the crankshaft so that reference mark **A** is lined up with the two reference marks **B** on the idle gear installed on the camshaft.


A_38

Replace the timing cover, placing a new seal and lining up with the two centring pins.

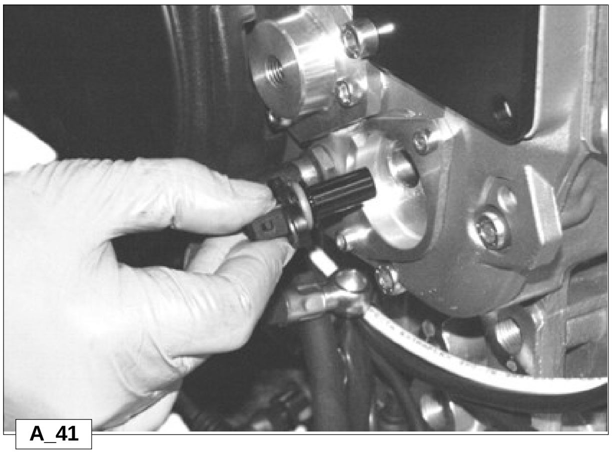

A_39

❍ Tighten the screws to a 25 Nm torque.

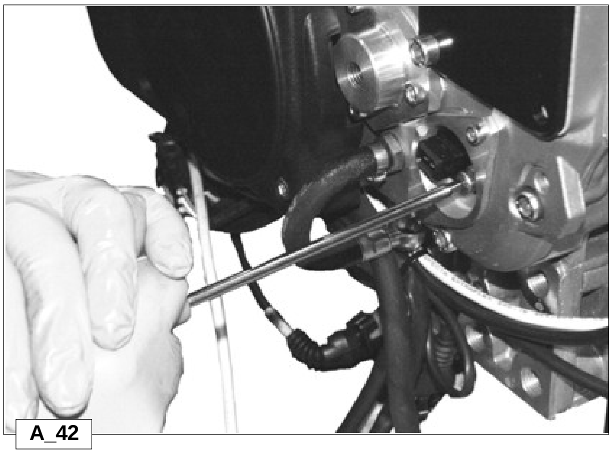

A_40

Refit the oil feed bushing to the variator, placing the oil seal support ring in between.
Replace the seal.

❍ Tighten the three screws M6 to an 8 Nm torque.

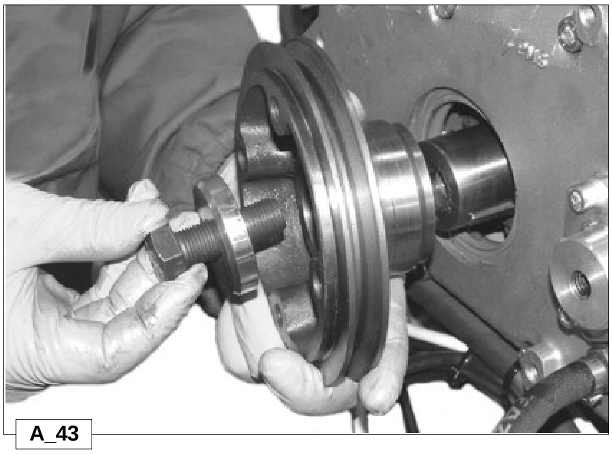

A_41

Replace the speed sensor taking care not to damage the O-ring.



A_42

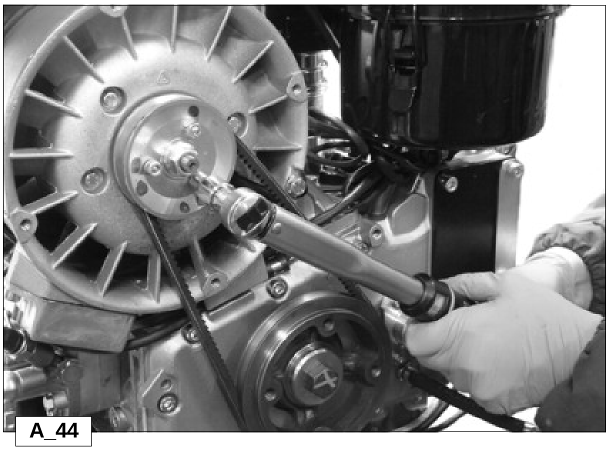
❍ Attach the sensor using screw M6 to a torque of 8 Nm.



A_43

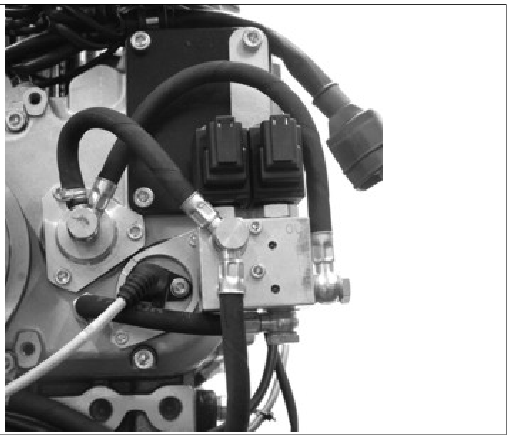
Reassemble the blower control pulley onto the crankshaft.

❍ Tighten the left-handed fastening bolts to torque of 300 Nm.



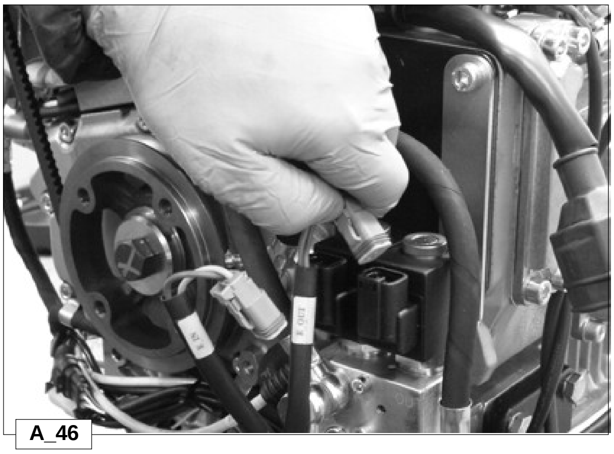
A_44

➲ Replace and check the belt tension (see page 22-23).



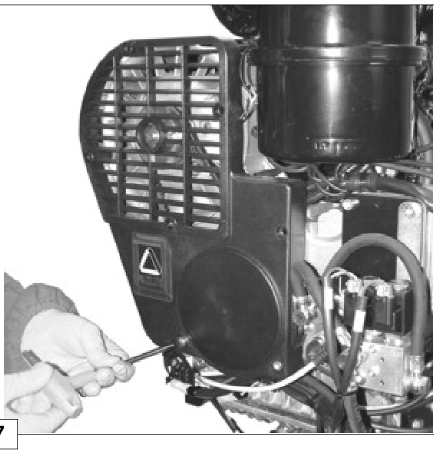
A_45

Replace the variator circuit oil pipes. If in doubt consult the diagram on page 78.



A_46

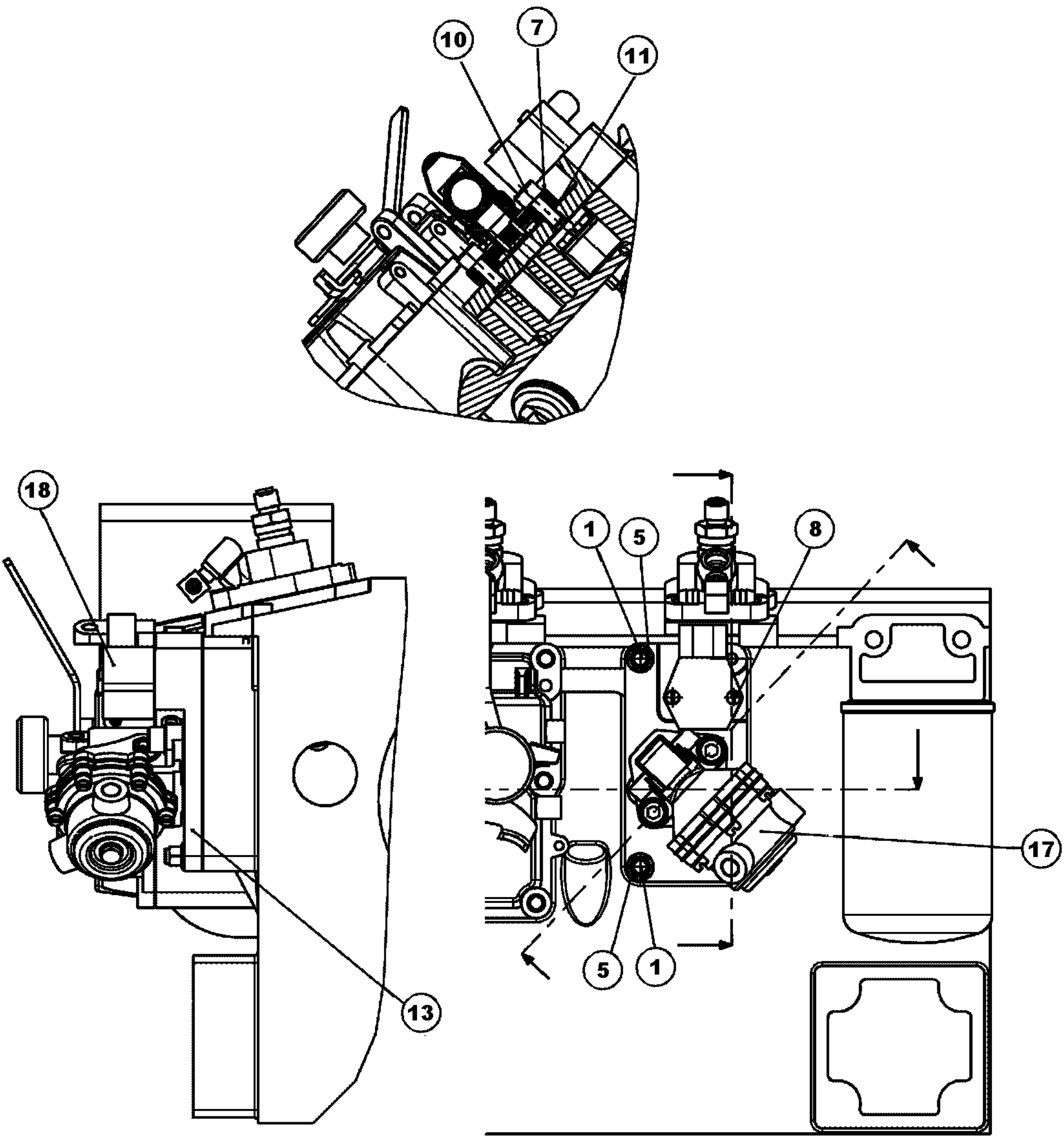
Insert the solenoid valve connectors following the references (**IN** and **OUT**) shown on the cables and on the solenoid valve block.

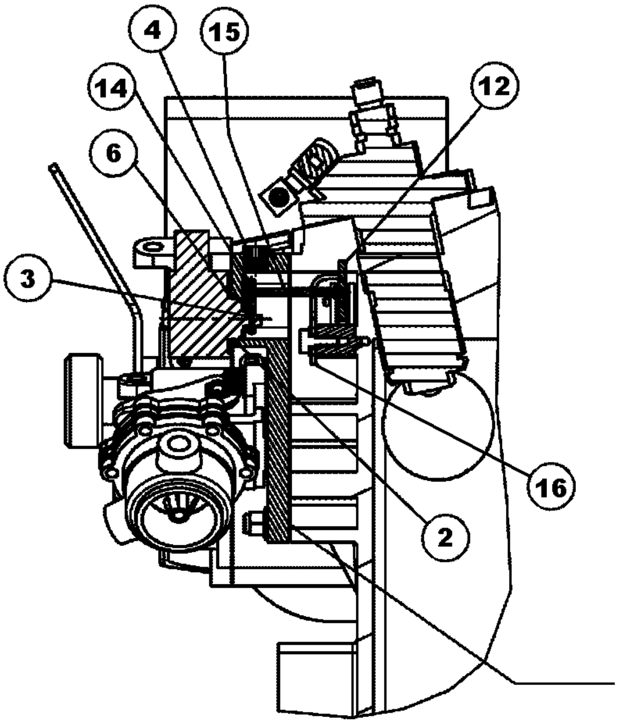


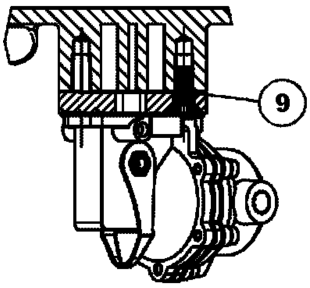
A_47

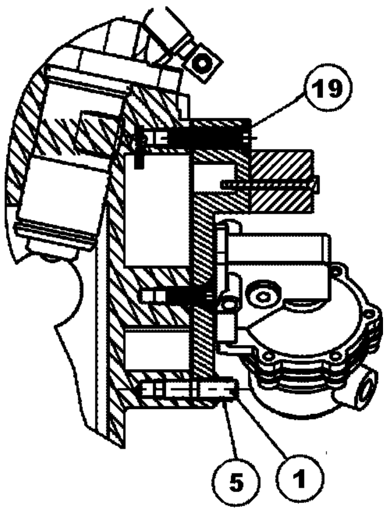
❍ Replace the built guard and tighten to 15 Nm.

## Angular position sensor and AC pump assembly diagram





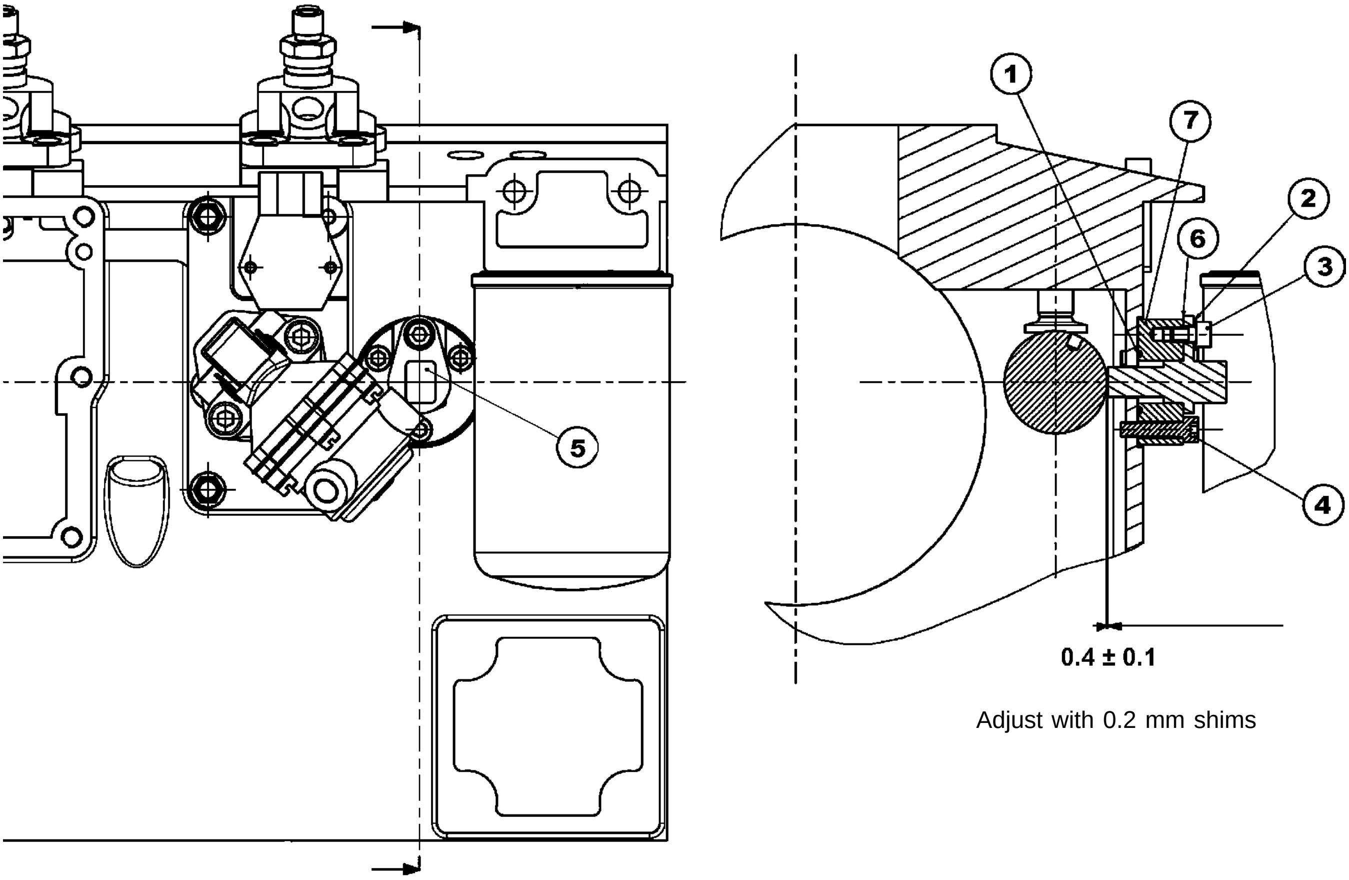




**COMPONENTS TABLE**

**1** Stud bolt M8x20
**2** Silicone O-ring
**3** Snap pin 2x10
**4** Conical screw STEI M 10x1.5
**5** Self-locking flanged hex nut
**6** Copper washer
**7** Crinkled spring washer
**8** Screw TCEI UNI 5931 M 4x35
**9** Screw STEI M 8x20
**10** Fuel supply pump
**11** Screw TCEI M 8x18
**12** Fuel supply pump seal
**13** Sensor pump connection rod
**14** AC pump and angular position sensor cover
**15** Sensor control lever
**16** Connecting pin between rod and sensor
**17** Discharge stop plate
**18** Angular position sensor
**19** Flathead screw

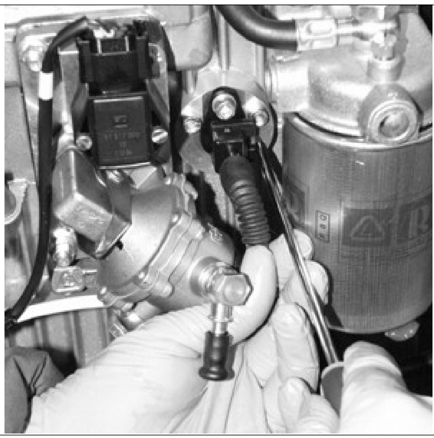
## Phase sensor assembly diagram



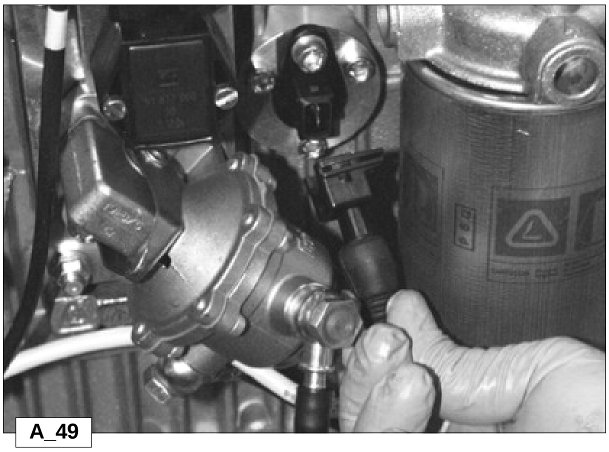

Adjust with 0.2 mm shims

**COMPONENTS TABLE**

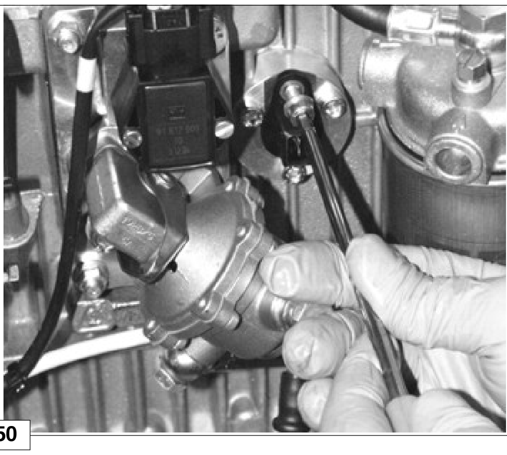
**1** Silicone O-ring
**2** Washer 6x12xSp1
**3** Screw TCEI UNI 5931 M 6x10
**4** Screw TCEI UNI 5931 M 6x25
**5** Speed and phase sensors
**6** Phase sensor air gap adjustment shim
**7** Phase sensor support


A_48

To assemble the phase sensor connector press the locking spring.


A_49

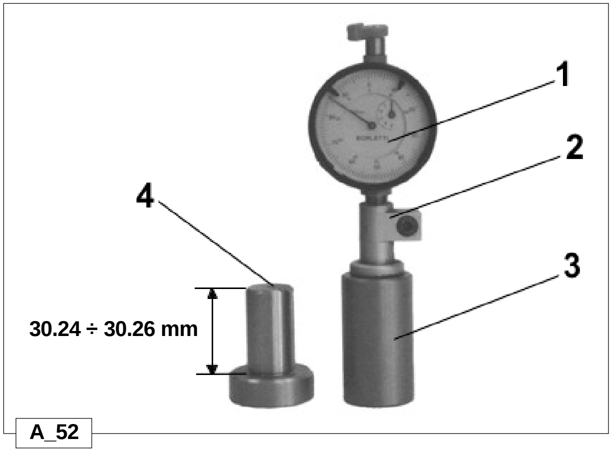
Remove the connector from the sensor.


A_50

❍ Loosen screw M6. When refitting, tighten to 8 Nm.


A_51

Remove the sensor from the support taking care not to damage the O-ring.



A_52

**Components:**

**1** Dial indicator
**2** Support for dial indicator
**3** Sensor control gauge measurement: 30,24 ÷ 30,26 mm
**4** Control master measurement: 30,24 ÷ 30,26 mm for sensor gauge

If replacing the phase sensor, check the length of the sensor pin using the tool in figure A_52.
Check by measuring the distance between magnetic end and the sensor support surface (30,24 ÷ 30,26 mm).

➲ The serial numbers of special tools are on page 103.


A_53

**Resetting the dial indicator**

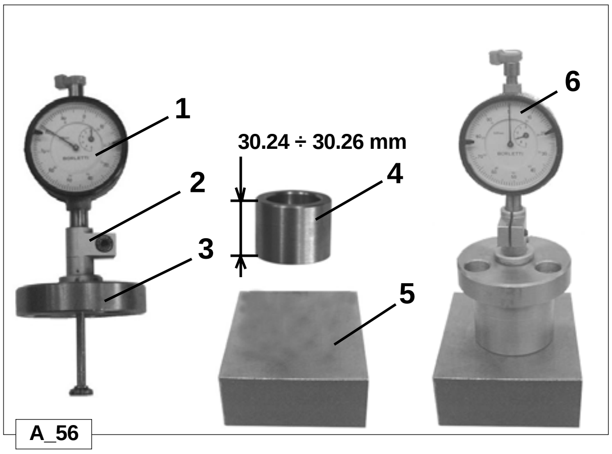
Assemble the dial indicator **1** onto support **2**.
Attach the support with the dial indicator to the gauge **3**.
Insert the master **4** into the gauge **3** and reset the dial indicator.


A_54

**Sensor test**

Remove the master **4** from the gauge **3**; insert the phase sensor and check that the sensor falls within tolerance measurements of 30,015 ÷ 30,035 mm.
See fig. A_53 -A_ 54.


A_55



A_56

## Resetting the dial indicator

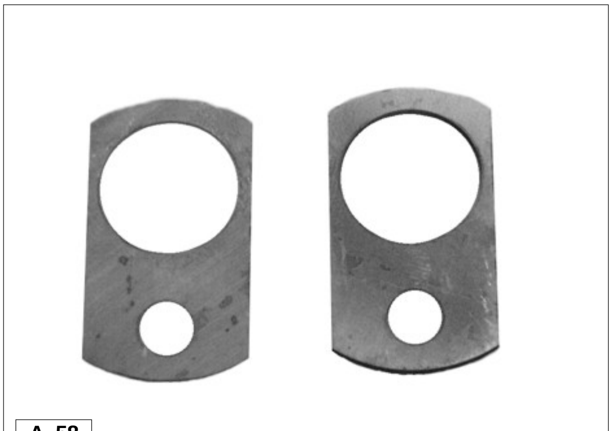
Components:
**1** Dial indicator
**2** Support for dial indicator
**3** Camshaft sensor support surface control gauge measurement: 30,24 ÷ 30,26 mm
**4** Resetting master measure: 30,24 ÷ 30,26 mm for gauge
**5** Resetting reference base
If replacing the sensor, camshaft or engine block via the tool see figure 56.
Make sure that the support surface of the sensor on the camshaft support measures 30,24 ÷ 30,26 mm. Assemble the dial indicator **1** in the support **2**. Insert the support **2** complete with dial indicator **1** into the gauge **3**. Set the master **4** and reset the dial indicator while resting on the base **5** as in **6**.


A_57

## Measuring the depth between the sensor support and the camshaft

Insert the gauge complete with dial indicator onto the sensor support and attach using the three screws.
Make sure the measurements taken are within the specific tolerance limits 30.24 ÷ 30.26 mm.

❍ The three screws for the phase sensor support screws must be tightened to 8 Nm using a torque wrench.


A_58

## Air gap adjustment

The air gap is adjusted using shims measuring 0,2 mm in thickness which are placed between the sensor surface and its support.
The air gap must be between 0,3 and 0,5 mm (see phase sensor assembly diagram page 94).
When adjusting the air gap with shims, it is important to consider any difference between the measurements taken (length of the sensor pin and depth between the sensor support surface and the camshaft) and specifications.

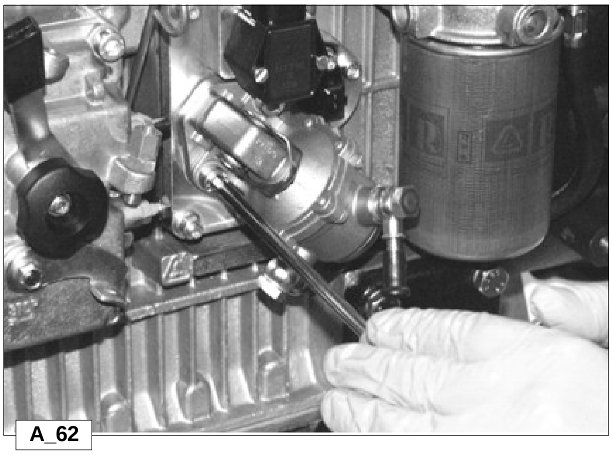

A_59

Example of where to insert the air gap adjustment shims.


A_60

Remove the connector from the position sensor on the injection pump control rod.


A_61


A_62

Unscrew the two screws to disassemble the fuel pump;

❍ when refitting, tighten the flathead screws, the nuts and hexagonal-head screws to 25 Nm.


A_63

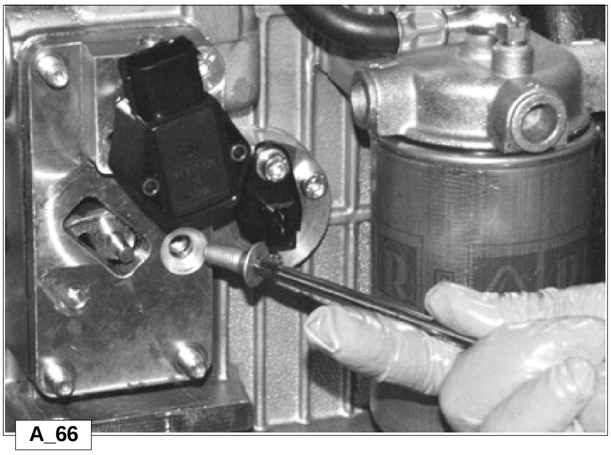
When reassembling, replace the sealing gasket.


A_64

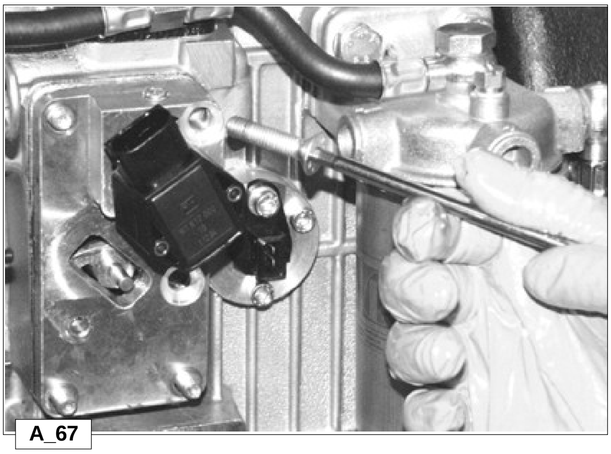
Remove the conical inspection plug.


A_65

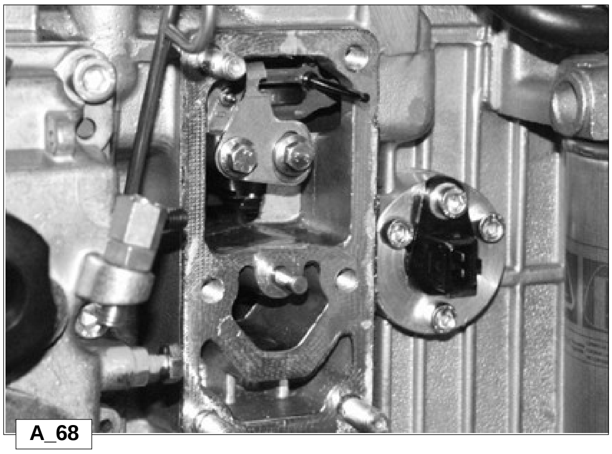
Unscrew the two screws to disassemble the injection pump rod position sensor.


A_66

Remove the three flanged nuts and the flathead screw.

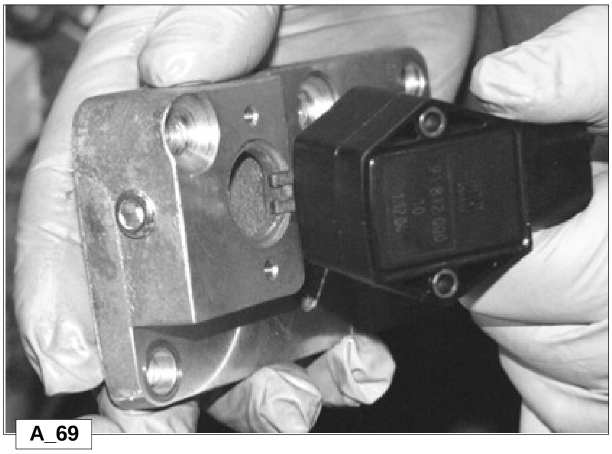

A_67

Unscrew the last screw (flathead) after rotating the sensor anticlockwise.



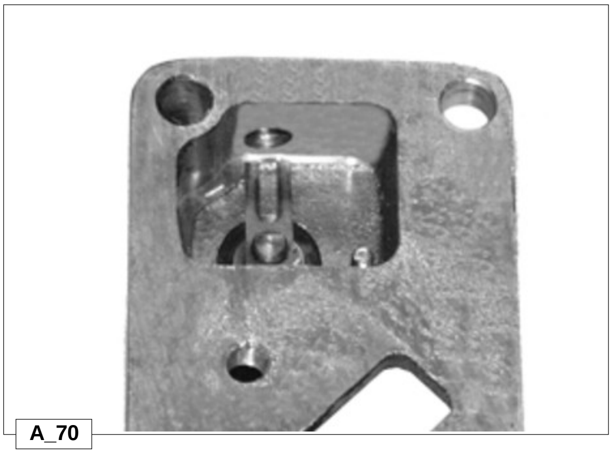
A_68

Remove the cover supporting the sensor and the fuel pump.



A_69

Rotate the position sensor shaft to direct the fork on the side opposite the connector.

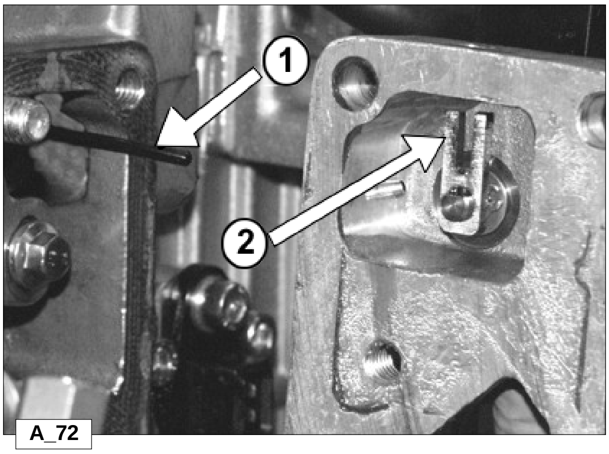


A_70

Insert the fork into the slot in the support.
Rotate the sensor body 180°, keeping the fork in the position shown in figure A _70.

A_71

Tighten only one screw on the position sensor to keep it in the right position.

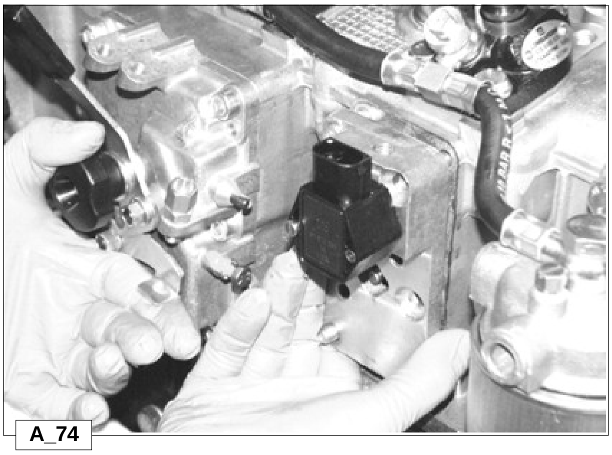



A_72

Set the cover against the crankcase so that the injection pump rod drive pin **1** is inserted between the two prongs of the fork **2**.

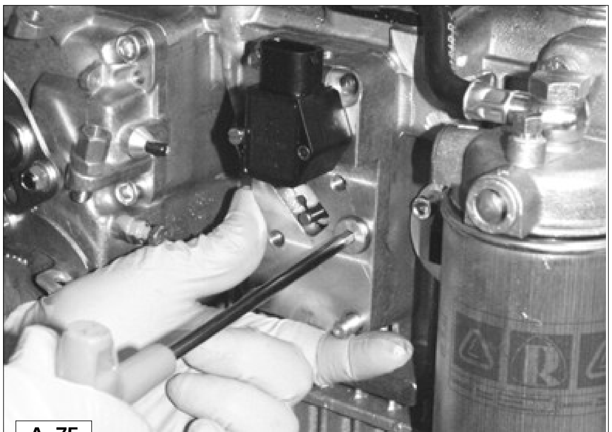
A_73

Look through the upper inspection hole on the cover to make sure that the pin **1** is correctly inserted into the fork **2**.



A_74

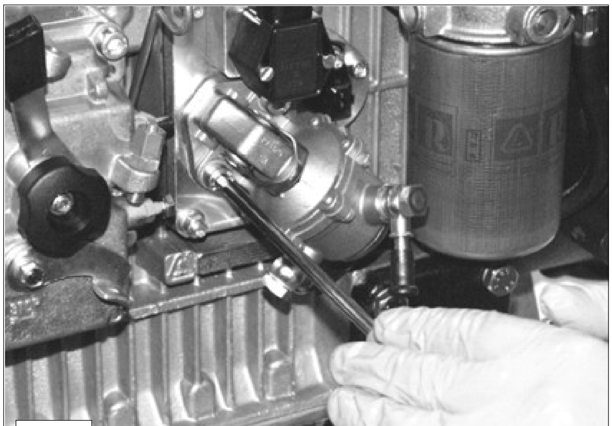
Operate the stop control lever repeatedly to make sure the system is running smoothly.



A_75

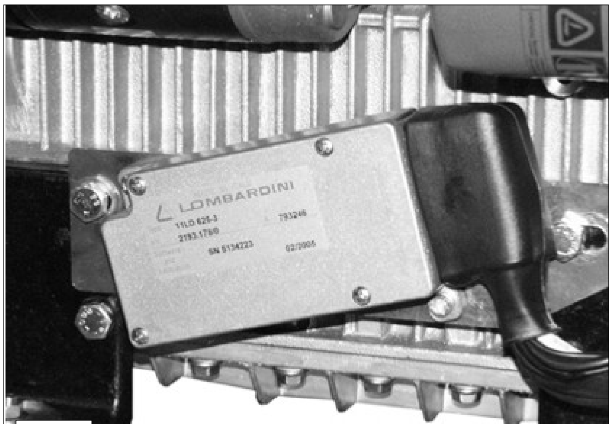
Replace the screws and nuts in the cover in the opposite order to when they were removed and

❍ tighten to 25 Nm.



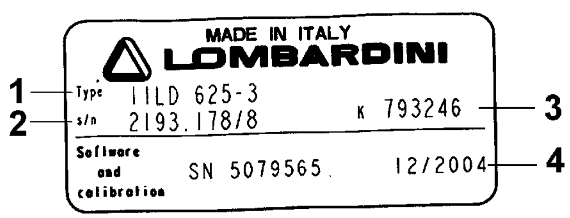
A_76

Refit the fuel pump after replacing the seal; tighten the screws to 25 Nm.




A_77

Correct assembly position of the control unit that runs the engine variator.



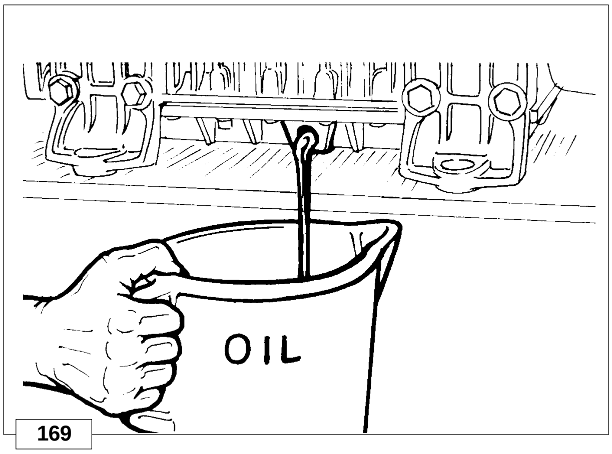

A_78

Example of adhesive plate on the control panel

**1** Engine type
**2** Control panel serial number
**3** Version number (form **K**)
**4** SN plus engine serial number plus date

**When the engines are not used for more than 3 months, they must be protected by the measures described below:**

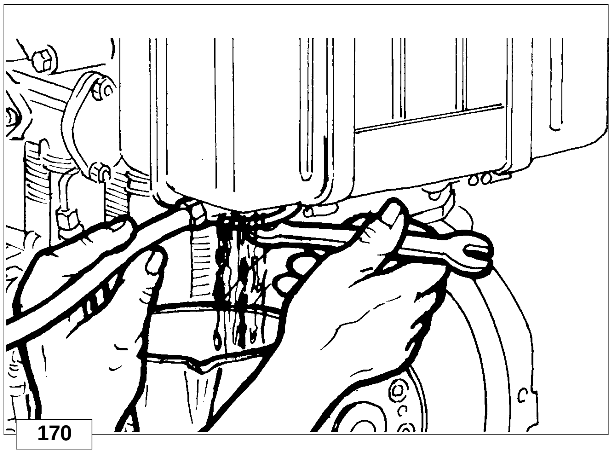
## STORAGE




169

**External engine protection:**

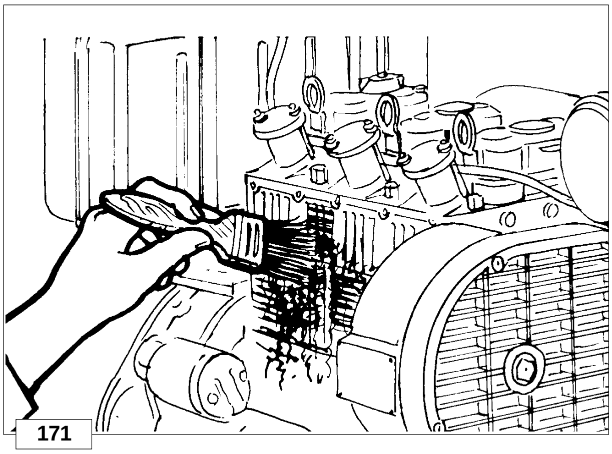
- Start the engine and heat it.
- Remove the drain plug and let the oil flow completely.
- Replace the oil filter with a new one (screw manually the new filter).
- Clean the oil drain plug and after having assembled a new gasket, tighten it.
- Carry out the oil refilling to the upper level of the rod, using AGIP RUSTIA C (for Countries in which this product is not available find an equivalent product on the market).
- Start for about 10 minutes and verify any possible oil leakage, then stop the engine.



170

**Injection systems protection:**

- Empty the fuel tank.
- Replace the fuel filter with a new one.
- Carry out the filling of fuel using 10% of AGIP RUSTIA NT special additives.
- After having performed the air bleeding, start the engine, verify any possible fuel leakage, then stop the engine.



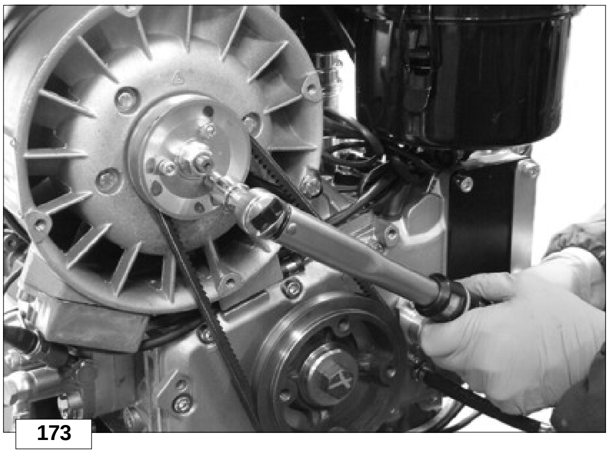
171

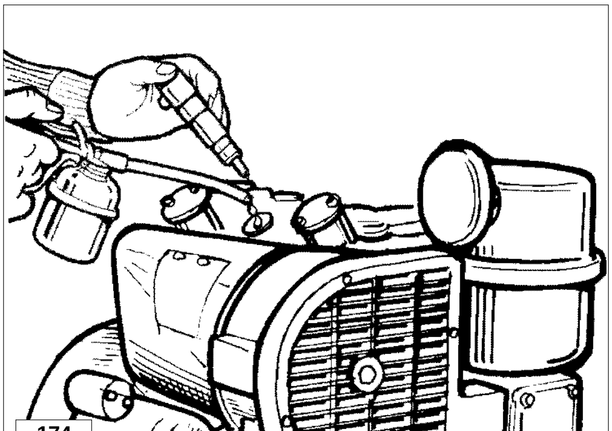
**External engine protection:**

- Clean carefully cylinder cooling system fins and the blowing fan.
- Loosen the drive belt of the blowing fan.
- Protect the external non-painted surfaces with AGIP RUSTIA 100/F.
- Seal with adhesive tape the intake and exhaust systems
- Coat the engine with a nylon or plastic sheet.
- Keep in a dry place. If possible not in direct contact with the ground and away from high voltage electric lines.

## PROCEDURES TO BE CARRIED OUT BEFORE START THE ENGINE


172


173


174

- Remove all protections and coverings.
- Remove the rust preventer from the external part of the engine by means of adequate products (solvent or degreaser).
- Tension the blower timing belt.
- Disassemble the injectors and introduce, by means of a bowl, motor oil on the piston crown ( no more than 2 cc for every cylinder).
- Remove valve covers and spray motor oil on the valves, then turn the crankshaft manually for a few revolutions.
- Start the engine and heat it for about 10 minutes.
- Remove the drain plug and let the protective oil flow completely.
- Reinsert the drain plug.
- Carry out motor oil refilling to the upper level of the rod using the oil recommended by the manufacturer for a normal engine operation.

## MAIN TORQUE SPECIFICATIONS

| COMPONENT | Diameter and pitch ( mm ) | Torque Nm | Sealants |
|---|---|---|---|
| Tank bracket vibration dampers | 8x1,25 | 25 | Loctite 270 |
| Connecting rod | 8x1 | 40 | |
| Injection pump delivery valve union | 18x1,5 | 40 | |
| Bell flywheel side | 10x1,5 | 50 | |
| Central support collar | 8x1,25 | 25 | |
| Intake manifold | 8x1,25 | 25 | |
| Exhaust manifold | 8x1,25 | 25 | |
| Air shroud | 8x1,25 | 15 | |
| Throttle control cover | 8x1,25 | 25 | |
| Rocker arm cover | 8x1,25 | 20 | |
| Timing cover | 8x1,25 | 25 | |
| Cover hydraulic pump flange 1P | 8x1,25 | 25 | |
| Oil pump casing | 8x1,25 | 25 | |
| Blower pulley nuts | 6x1 | 10 | |
| Oil pump nut or union | 8x5 | 25 | Loctite 270 |
| Oil pump gear threading | | | Loctite 270 |
| Tank bracket gasket | | | LoctiteIS 495 |
| Air filter | | 25 | |
| Oil filter | 8x1,25 | 25 | |
| Internal oil filter | 8x1,25 | 25 | |
| Hydraulic pump flange | 8x1,25 | 25 | |
| Nozzle cup | | 70 | |
| Blower assembly | 8x1,25 | 25 | |
| Camshaft gear | 24x2 | 250 | |
| Oil pump gear | 10x1,5 | 35 | |
| Timing gear | 10x1,5 | 40 | |
| Injector (cylinder head fastening nuts for S size, screw for P size) | | 10 | |
| Injection pump control lever | 8x1,25 | 25 | |
| Starting motor | 10x1,5 | 45 | |
| Oil radiator nipple | 16x1,5 | 45 | Loctite 270 |
| Oil filter cartridge nipple | 8x1,25 | 25 | Loctite 270 |
| Rocker arm pin | 8x1,25 | 25 | |
| Governor control external lever pin | 8x1,25 | 10 | |
| Stop control external lever pin | 8x1,25 | 10 | |
| Engine mounting foot | 10x1,5 | 40 | |
| Injector stud bolt | 8x1,25 | 25 | |
| Starter motor stud bolt | 8x1,25 | 25 | |
| Fuel feeding pump | 8x1,25 | 25 | |
| Blower housing stud | 10x1,5 | 12 | Loctite 270 |
| Main bearing support fixing stud bolt, flywheel side | 8 | 25 | Loctite 270 |
| Head stud | 12 | 86 | Loctite 270 |
| Crankcase stud bolt | 8x1,25 | 8-10 | Loctite 270 |
| Injection pump | 8 | 25 | Loctite 270 |

## MAIN TORQUE SPECIFICATIONS

| COMPONENT | Diameter and pitch ( mm ) | Torque Nm | Sealants |
|---|---|---|---|
| Oil sump | 10 | | Loctite 270 |
| Belt guard | 8x1,25 | 25 | |
| Blower crankshaft pulley | 16x1,5 | 250 | |
| Fan pulley | 12x1,5 | 40 | |
| Fuel filter union | 14x1,5 | 40 | |
| Fuel pump union | 10x1 | 12 | |
| Radiator union | 14x1,5 | 40 | |
| Injector high pressure pipe union | 12x1,5 | 20-25 | |
| Speed governor support shaft | 8x1,25 | 22 | |
| Main bearing support, gear case side | 8x1,25 | 25 | |
| Main bearing support, flywheel side | 8x1,25 | 25 | |
| Center main bearing support | 10x1,5 | 30 | |
| Hydraulic pump gear support | 8x1,25 | 25 | |
| Governor control internal lever support | 8x1,25 | 25 | |
| Fuel tank bracket | 8x1,25 | 25 | |
| Drain plug | 14x1,5 | 50 | |
| Cylinder head | 10x1,5 | 55 | |
| Camshaft axle housing screws | | 25 | |
| Flywheel | 12x1,25 | 140 | |

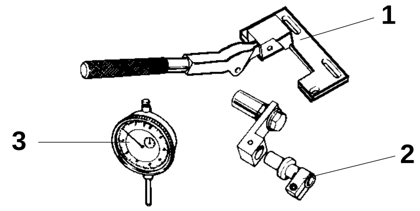
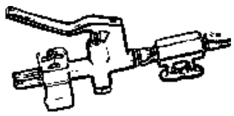
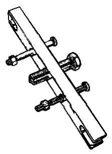
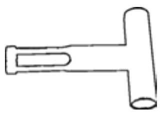
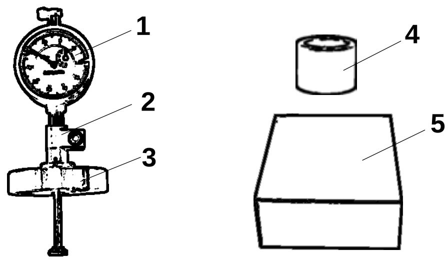
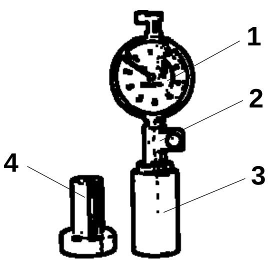
| USE OF SEALANTS ONLY FOR ENGINES WITH VARIATOR | |
|---|---|
| **POSITION** | **SEALANTS** |
| Pump cover C | Loctite 5205 |
| Speed sensor support | Loctite 209079 |
| Phase sensor support fastening screws | Loctite 242 |
| Speed sensor support fastening screws | Loctite 242 |

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

| Resistance class (R) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Quality/ Dimensions | 4.6 | 4.8 | 5.6 | 5.8 | 6.8 | 8.8 | 10.9 | 12.9 |
| Diameter | R>400N/mm$^2$ | | R>500N/mm$^2$ | | R>600N/mm$^2$ | R>800N/mm$^2$ | R>1000N/mm$^2$ | R>1200N/mm$^2$ |
| | 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 | 4.6 | 4.8 | 5.6 | 5.8 | 6.8 | 8.8 | 10.9 | 12.9 |
| Diameter | R>400N/mm$^2$ | | R>500N/mm$^2$ | | R>600N/mm$^2$ | R>800N/mm$^2$ | R>1000N/mm$^2$ | R>1200N/mm$^2$ |
| | 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 |

| SPECIAL TOOLS | DESCRIPTION | Part No. |
|---|---|---|
|  | **1** Valve control lowering tool static injection advance<br>**2** Dial indicator support<br>**3** Dial indicator | **Overall:**<br>1460 - 266<br><br>**1** 1460 - 275<br>**2** 1460 - 270<br>**3** 1460 - 274 |
|  | High-pressure pump for static advance control. | 1460 - 273 |
|  | Injection pump static injection advance tester | 1460 - 024 |
|  | Tool for fitting valve stem seal ring | 1460 - 108 |
|  | Blower control pulley extractor | 1460 - 200 |
|  | Tool for assembling/removing valve half-collets | 1460 - 113 |
|  | Tool for mounting the spring on the tappet rod protection pipe | 1460 - 009 |
|  | Only for engines with advance variator:<br><br>Tool for measuring air gap:<br>**1** Dial indicator<br>**2** Dial indicator support<br>**3** Gauge<br>**4** Master<br>**5** Base | **Overall:**<br>1460 - 272<br><br>**1** 1460 - 274<br>**2** 1460 - 270<br>**3** 2003 - 021<br>**4** 1460 - 269<br>**5** 1460 - 268 |
|  | Only for engines with advance variator:<br><br>Tool for checking phase sensor:<br>**1** Dial indicator<br>**2** Dial indicator support<br>**3** Gauge<br>**4** Master | **Overall:**<br>1460 - 271<br><br>**1** 1460 - 274<br>**2** 1460 - 270<br>**3** 2003 - 020<br>**4** 1460 - 267 |

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R.E.A. 227083 - Reg. Impr. RE 10875
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E-MAIL: atl@lombardini.it
Internet: http://www.lombardini.it

LOMBARDINI



- **2 cylinders**
- **686 cm³**
- **12.5 kW/17.0 HP**
- **3600 rpm**
- **Nm. 40.5@2000**

## Homologation

- EPA TIER 2

## Construction

- 4-stroke diesel engine with cylinders in line
- Liquid-cooled with axial fan.
- Indirect injection with injector-pump on head.
- Single-shaft distribution in head.
- Distribution control with timing belt.
- Double pto on the crankshaft.
- Pto on the distribution.
- Counterclockwise rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Water pump in the engine block.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Aluminium cylinder head.

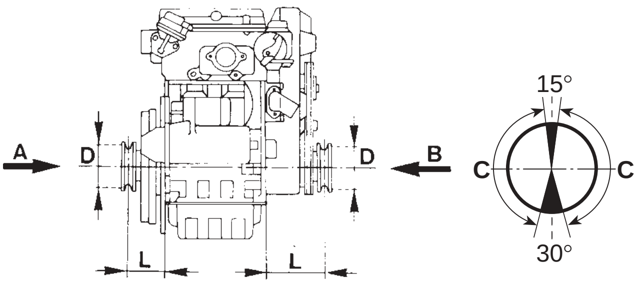
## Applications

- Excavator
- Dumper
- Roller
- Access platform
- Generating set
- Sweeper
- High pressure cleaner
- Lawn mower

## Specifications

| | | |
|---|---|---|
| Cylinders | N. | 2 |
| Displacement | $cm^3$ | 686 |
| Bore | mm | 75 |
| Stroke | mm | 77,6 |
| Compression ratio | | 22.8:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 12.5/17.0 |
| | NB ISO 3046 IFN | 11.7/16.0 |
| | NA ISO 3046 ICXN | 10.7/14.5 |
| Max. torque | Nm. | 40.5@2000 |
| Max. torque 3 P.T.O. | Nm. | 37.0@1800 |
| Min. idling speed | | 900 |
| Water pump delivery at 3600 r.p.m. | l/min. | 40 (~) |
| Oil consumption | kg/h. | 0.009 |
| Oil sump capacity | l | 1.6 |
| Min. allowable oil pressure | bar | 1.5 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Vol. of air required for correct cooling @ 3600 r.p.m. | l/min. | 1240 |
| Vol. of air required for correct combustion @ 3600 r.p.m. | $m^3$/min. | 43 |
| Dry weight | kg | 66 |
| Recommended battery | V/Ah | 12/44 |

Minimum pulley diameters for belt drive



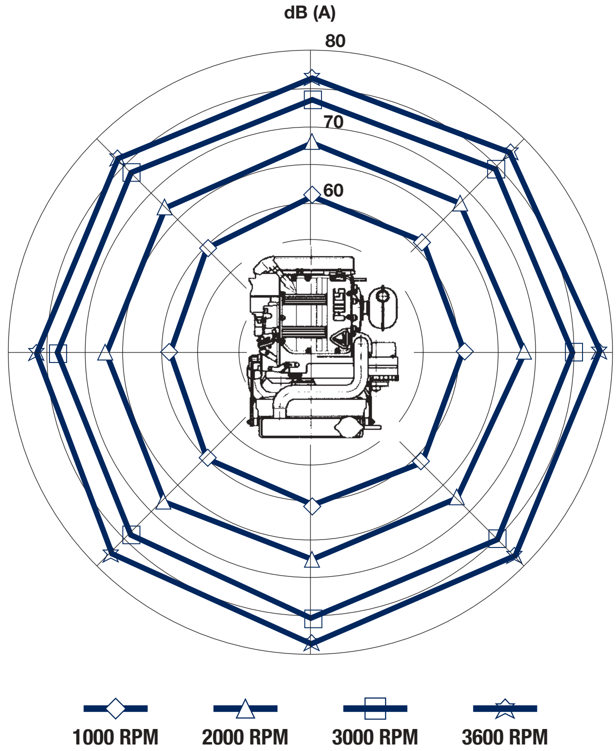

| | | |
|---|---|---|
| V belt | D (mm) ≥ 143 [L (mm) + 101] | $\frac{N\ (kW)}{n\ (RPM)}$ |
| Cogged belt | D (mm) ≥ 99 [L (mm) + 101] | $\frac{N\ (kW)}{n\ (RPM)}$ |

Max. allowable axial load in both directions A-B = 300 kg

C - zone in which the radial load acts on the pulley

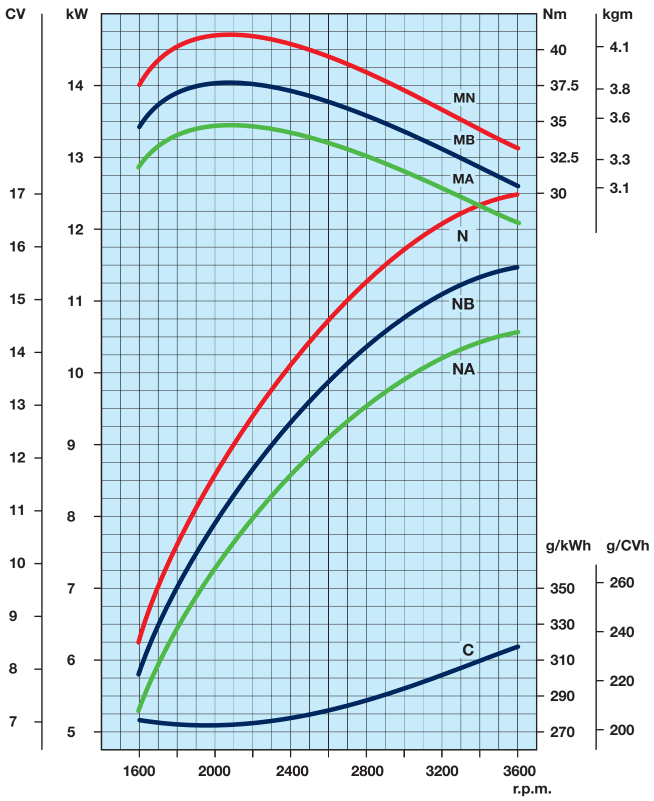
### Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

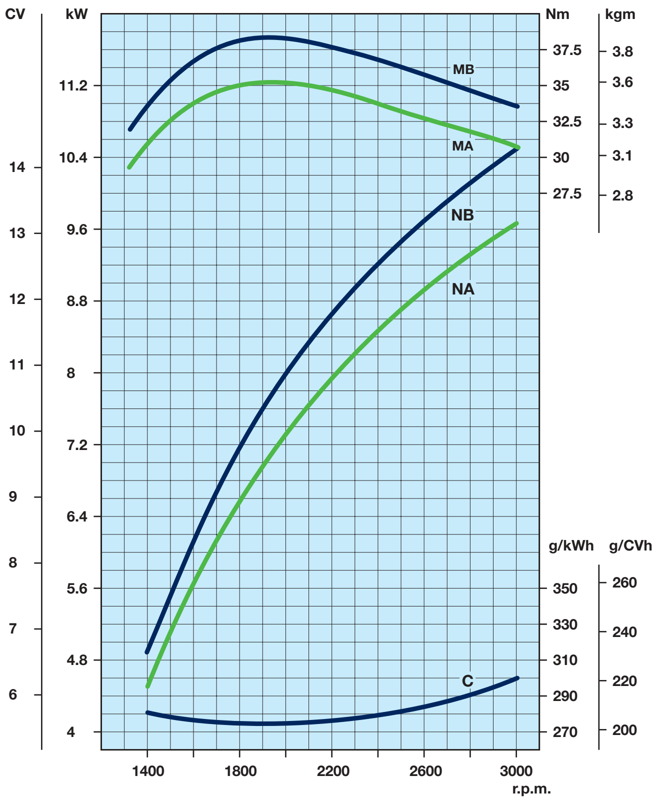


# Curves

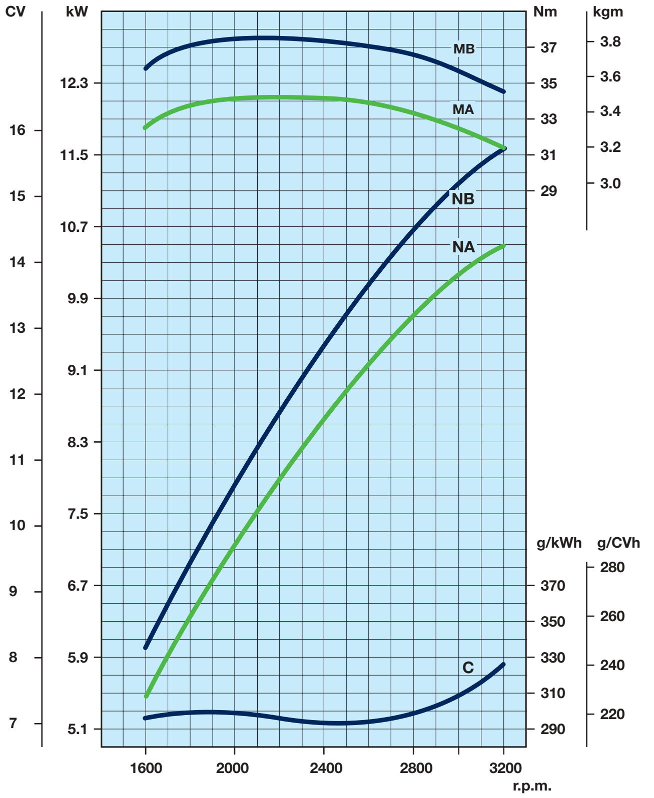
## LDW 702 @ 3600 r.p.m.




## LDW 702 / B1 @ 3000 r.p.m.




## LDW 702 @ 3200 r.p.m.




| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
| **NA** | Power curve - ISO 3046/1 - ICXN - |
| **MN** | Torque curve - (N curve) |
| | **MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

## Output power for fixed speed application (including generating sets)

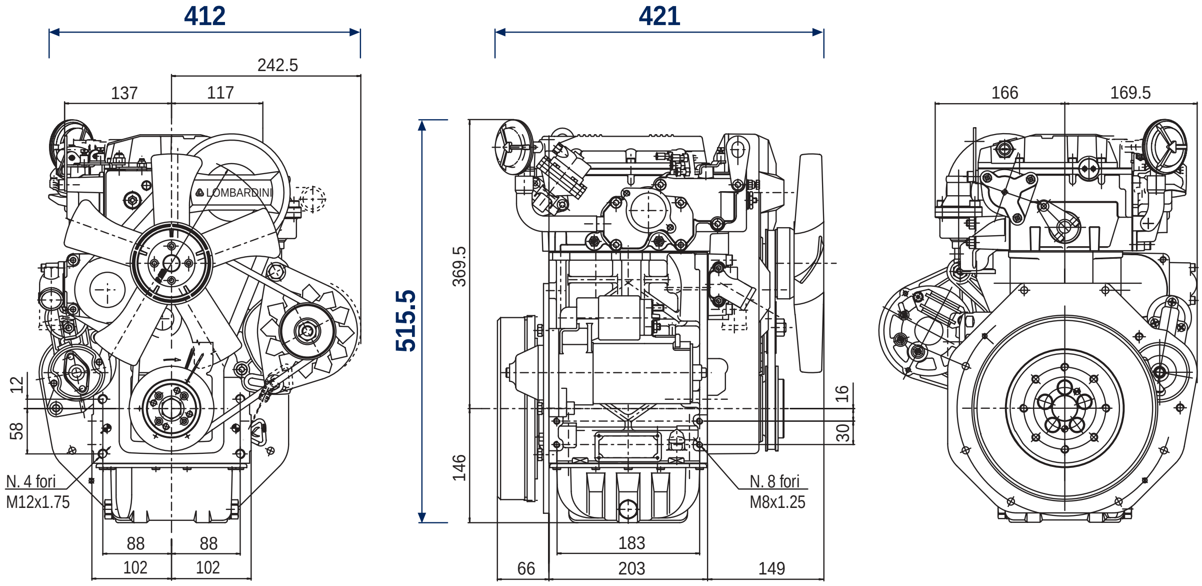
### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3600 | 11.5 | 10.4 |
| 3000 | 11 | 10 |
| 1800 | 6.5 | 5.9 |
| 1500 | 5.5 | 5 |



LOMBARDINI

## Technical drawings *




* More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)

### Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
Flywheel with ring gear
Use, maintenance and spare parts booklet

### Accessories

Different guards according to use
Clutch flywheels
Flanges
Transmission adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators 12V or 24V
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers
Dry air-cleaners mounted and separated
Cyclonic precleaners
Fuel filter on engine
High capacity oil sumps
Cab heating system

ICIM
ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

Files for this product available on www.lombardini.it

| | |
|---|---|
| Data sheet | LDW702DS.PDF |
| Owner manual | LDW702OM.PDF |
| Service manual | LDW702SM.PDF |
| Technical drawing | LDW702TD.DWG |
| Power curve | LDW702PC.PDF |

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mod. 50981/5

LOMBARDINI

# SERIE FOCS Plus

DIESEL

LDW 1003

- **3 cylinders**
- **1028 cm³**
- **19.5 kW/26.5 HP**
- **3600 rpm**
- **Nm. 67@2000**

## Homologation

- EPA TIER 2 ■
- 97/68/CE Step 2 ●

## Construction

- 4-stroke diesel engine with cylinders in line
- Liquid-cooled with axial fan.
- Indirect injection with injector-pump on head.
- Single-shaft distribution in head.
- Distribution control with timing belt.
- Double pto on the crankshaft.
- Pto on the distribution.
- Counterclockwise rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Water pump in the engine block.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Aluminium cylinder head.

## Applications

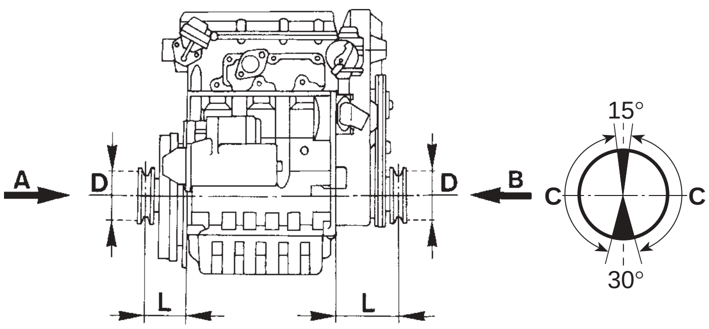
- Excavator
- Generating set
- Refrigerating unit
- Sweeper
- Access platform
- Roller
- Lawn mower
- Dumper

# SERIE FOCS Plus

## Specifications

| | | |
|---|---|---|
| Cylinders | N. | 3 |
| Displacement | $cm^3$ | 1028 |
| Bore | mm | 75 |
| Stroke | mm | 77,6 |
| Compression ratio | | 22.8:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 19.5/26.5 |
| | NB ISO 3046 IFN | 18.0/24.5 |
| | NA ISO 3046 ICXN | 16.5/22.4 |
| Max. torque | Nm. | 67@2000 |
| Max. torque 3 P.T.O. | Nm. | 37.0@1800 |
| Min. idling speed | | 900 |
| Water pump delivery at 3600 r.p.m. | l/min. | 50 (~) |
| Oil consumption | kg/h. | 0.013 |
| Oil sump capacity | l | 2.4 |
| Min. allowable oil pressure | BAR | 1.5 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Vol. of air required for correct cooling @ 3600 r.p.m. | l/min. | 1850 |
| Vol. of air required for correct combustion @ 3600 r.p.m. | $m^3$/min. | 63 |
| Dry weight | kg | 85 |
| Recommended battery | V/Ah | 12/44 |

Minimum pulley diameters for belt drive



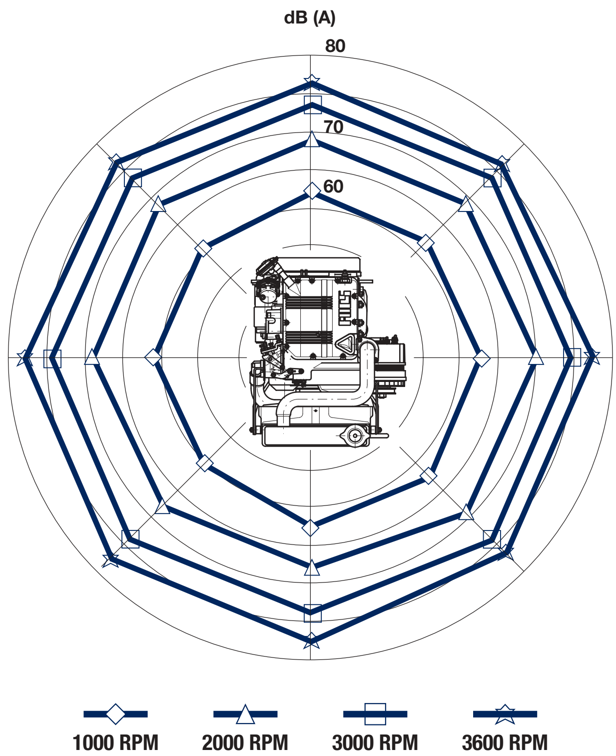

| | |
|---|---|
| V belt | D (mm) ≥ 114 [L (mm) + 101] $\frac{N (kW)}{n (RPM)}$ |
| Cogged belt | D (mm) ≥ 79 [L (mm) + 101] $\frac{N (kW)}{n (RPM)}$ |

Max. allowable axial load in both directions A-B = 300 kg

C - zone in which the radial load acts on the pulley

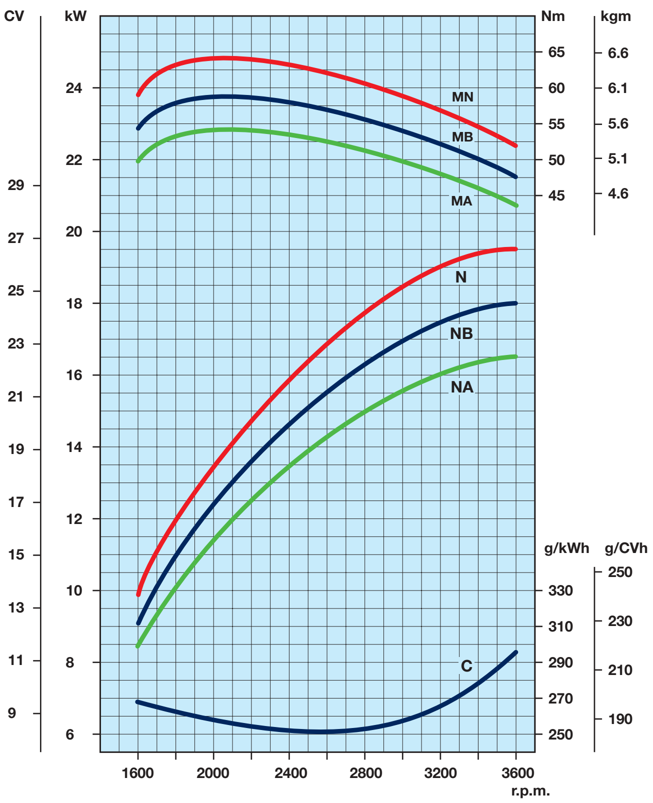
### Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

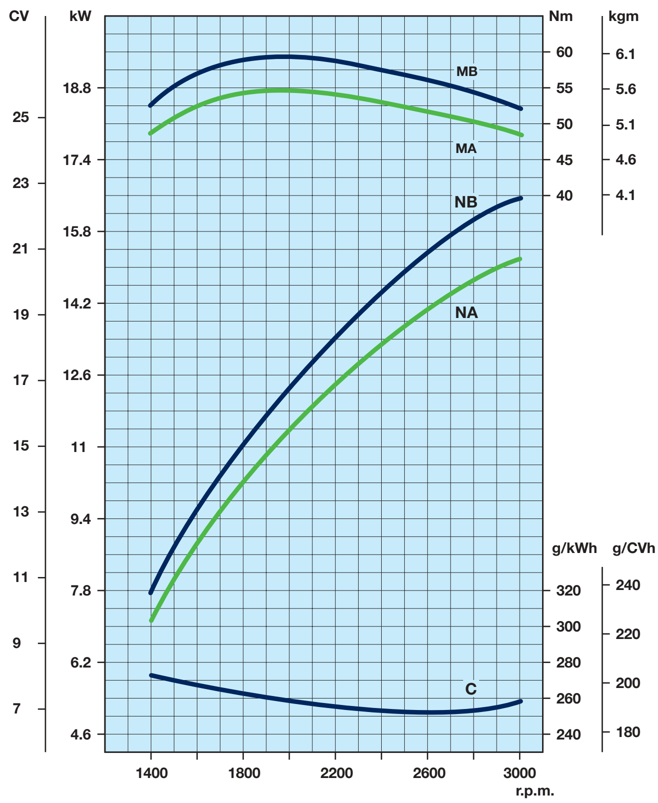


## Curves

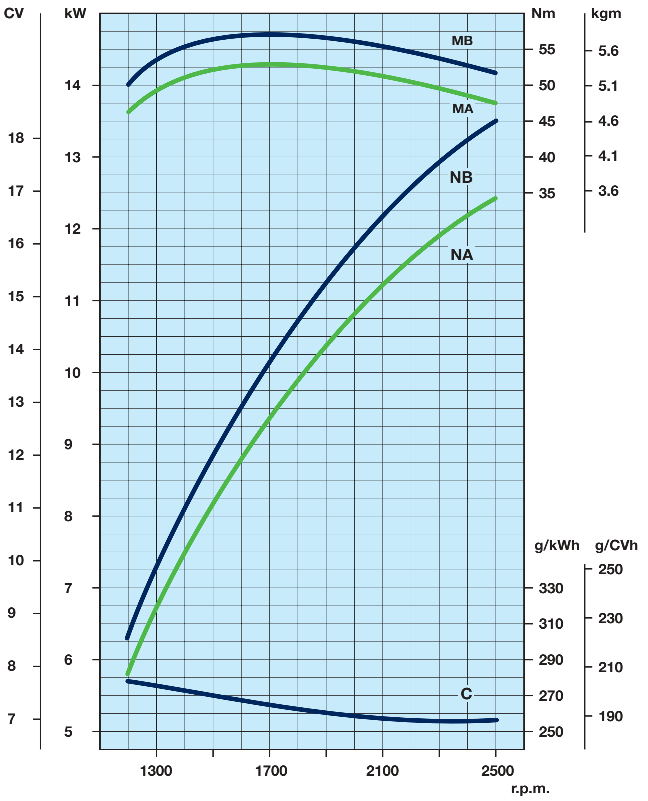
### LDW 1003 @ 3600 r.p.m.




### LDW 1003/ B1 @ 3000 r.p.m.




### LDW 1003 / B5 @ 2500 r.p.m.



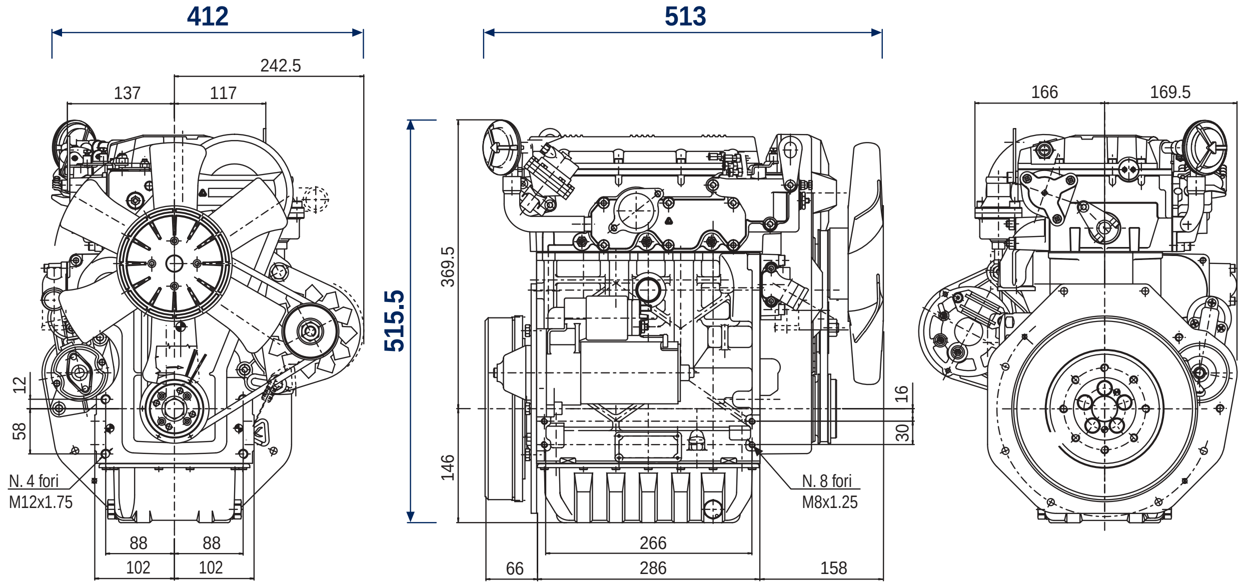

| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
| **NA** | Power curve - ISO 3046/1 - ICXN - |
| **MN** | Torque curve - (N curve) |
| | **MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

### Output power for fixed speed application (including generating sets)

#### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3600 | 18 | 16.4 |
| 3000 | 16.5 | 15 |
| 1800 | 10 | 9.1 |
| 1500 | 8.5 | 7.7 |

## Technical drawings *




* More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)

### Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
Flywheel with ring gear
Use, maintenance and spare parts booklet

### Accessories

Different guards according to use
Clutch flywheels
Flanges
Transmission adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators 12V or 24V
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers
Dry air-cleaners mounted and separated
Cyclonic precleaners
Fuel filter on engine
High capacity oil sumps
Cab heating system

ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

Files for this product available on www.lombardini.it

| | |
|---|---|
| Data sheet | LDW1003DS.PDF |
| Owner manual | LDW1003OM.PDF |
| Service manual | LDW1003SM.PDF |
| Technical drawing | LDW1003TD.DWG |
| Power curve | LDW1003PC.PDF |

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mod. 50986/5

LOMBARDINI

# SERIE FOCS Plus

DIESEL

LDW 1404

- 4 cylinders
- 1.372 l
- 26.0 kW/34.9 HP
- 3600 rpm
- ft-lbs 60.8@2000


## Certification

- EPA TIER 2 ■
- 97/68/CE Step 2 ●

## Construction

- 4-stroke diesel engine with cylinders in line
- Liquid-cooled with axial fan.
- Indirect injection with injector-pump on head.
- Single-shaft distribution in head.
- Distribution control with timing belt.
- Double pto on the crankshaft.
- Pto on the distribution.
- Counterclockwise rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Water pump in the engine  block.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Aluminium cylinder head.

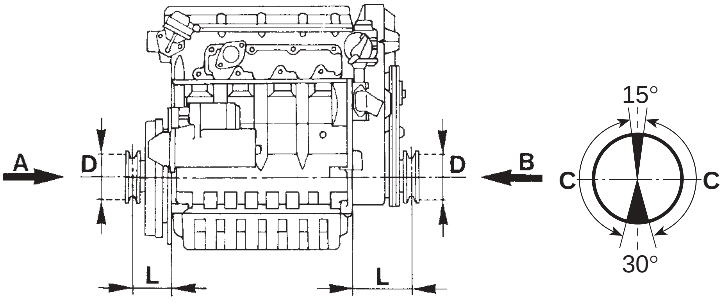
## Applications

- Excavator
- Dumper
- Roller
- Access platform
- Generating set
- Sweeper
- Lawn mower

## Specifications

| | | |
|---|---|---|
| Cylinders | N. | 4 |
| Displacement | l | 1.372 |
| Bore | in | 3.0 |
| Stroke | in | 3.1 |
| Compression ratio | | 22.8:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 26.0/34.9 |
| | NB ISO 3046 IFN | 24.5/32.9 |
| | NA ISO 3046 ICXN | 22.4/30.0 |
| Max. torque | ft-lbs@rpm | 60.8@2000 |
| Max. torque 3rd P.T.O. | ft-lbs | 27 |
| Min. idling speed | | 900 |
| Water pump delivery at 3600 rpm | gpm | 18 |
| Oil consumption | lb/h | 0.042 |
| Oil sump | Qt | 3.5 |
| Min. allowable oil pressure | psi | 21.8 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Combustion air required at max speed | cfm | 87 |
| Cooling air required at max speed | cfm | 3108 |
| Weight | lbs | 216 |
| Recommended battery | V/Ah | 12/44 |

Minimum pulley diameters for belt drive



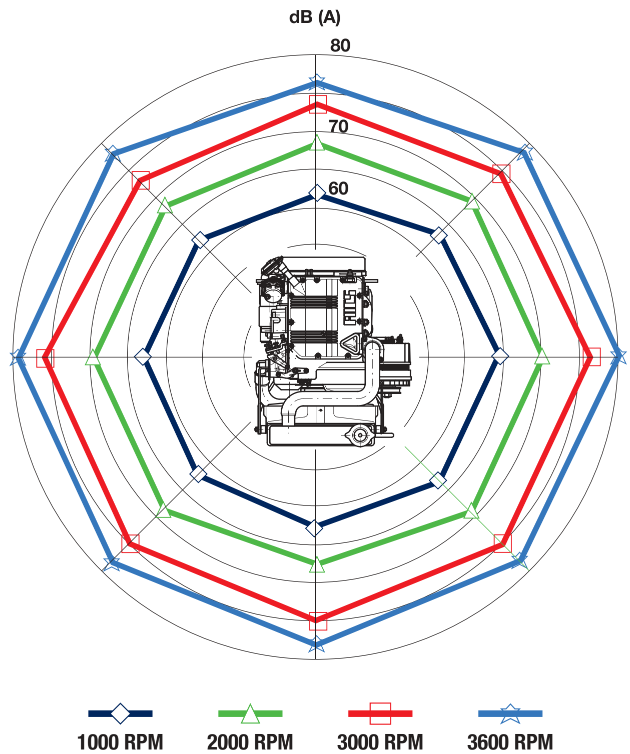

| | | |
|---|---|---|
| V belt | D (mm) ≥ 110 [L (mm) + 101] | $\frac{N\,(kW)}{n\,(RPM)}$ |
| Cogged belt | D (mm) ≥ 72 [L (mm) + 101] | $\frac{N\,(kW)}{n\,(RPM)}$ |

Max. allowable axial load in both directions A-B (continuous) = 661 $lb_f$

C - zone in which the radial load acts on the pulley

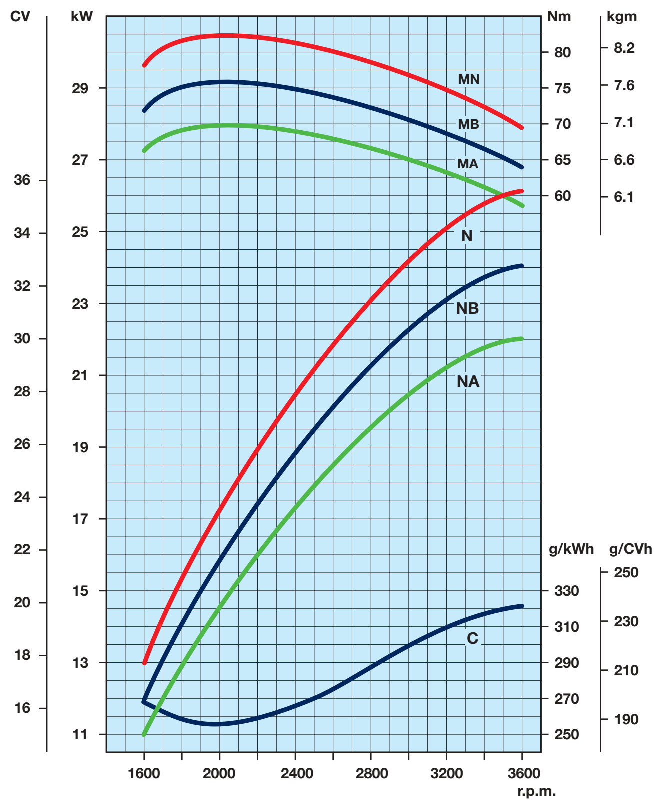
### Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

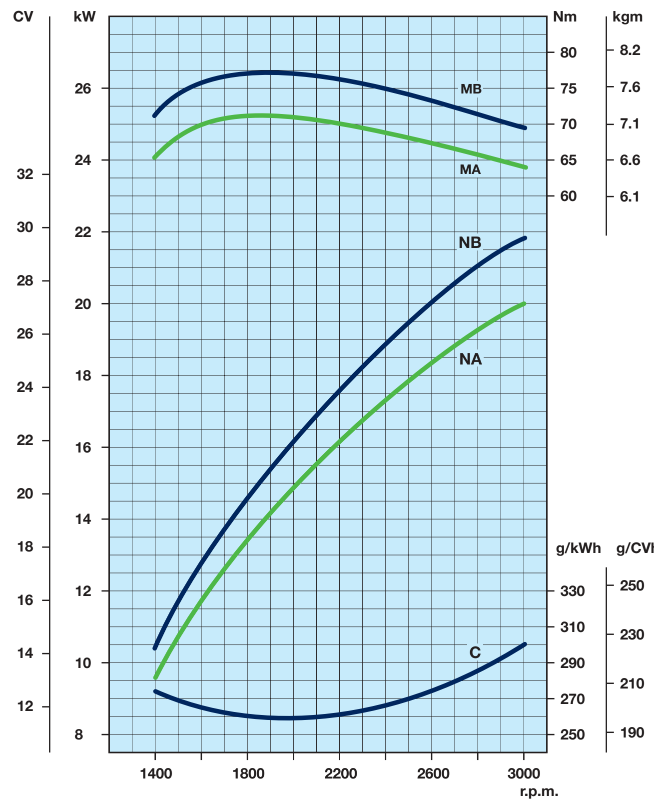


# Curves

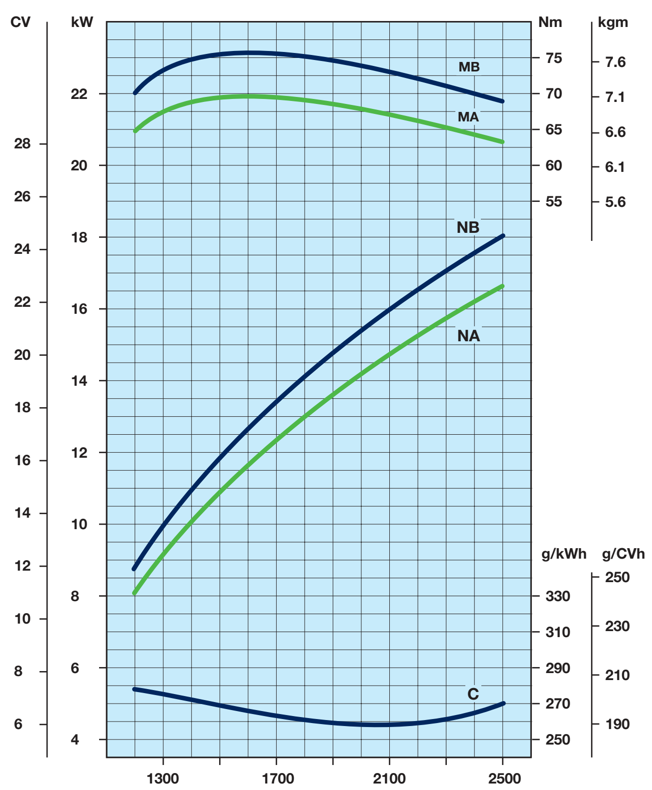
## LDW 1404 @ 3600 r.p.m.




## LDW 1404 B1 @ 3000 r.p.m.




## LDW 1404 B6 @ 2500 r.p.m.




| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
| **NA** | Power curve - ISO 3046/1 - ICXN - |
| **MN** | Torque curve - (N curve)<br>**MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

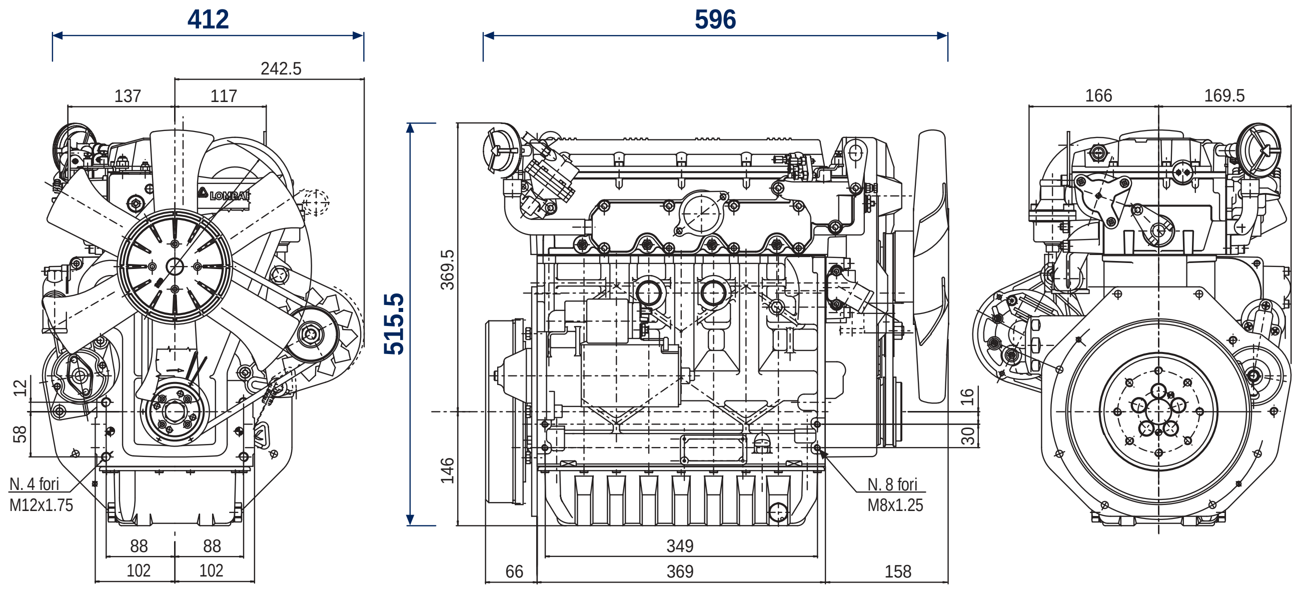
## Output power for fixed speed application (including generating sets)

### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3600 | 24 | 21.8 |
| 3000 | 22 | 20 |
| 1800 | 13.5 | 12.3 |
| 1500 | 11.5 | 10.5 |

# SERIE FOCS Plus

## Technical drawings *




*** More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)**

### Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
Flywheel with ring gear
Use, maintenance and spare parts booklet

### Accessories

Different guards according to use
Clutch flywheels
Flanges
Transmission adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators 12V or 24V
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers
Dry air-cleaners mounted and separated
Cyclonic precleaners
Fuel filter on engine
High capacity oil sumps
Cab heating system

ICIM
IQNet
ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

**Files for this product available on www.lombardini.it**

| | |
|---|---|
| Data sheet | LDW1404DS.PDF |
| Owner manual | LDW1404OM.PDF |
| Service manual | LDW1404SM.PDF |
| Technical drawing | LDW1404TD.DWG |
| Power curve | LDW1404PC.PDF |

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**www.lombardiniusa.com**



06-2005 – mod.50991/2

LOMBARDINI

# SERIE CHD Plus

DIESEL

LDW 1603

- 3 cylinders
- 1649 $cm^3$
- 30.0 kW/40.8 HP
- 3000 rpm
- Nm. 113@1600

## Homologation

- EPA TIER 2 ■
- 97/68/CE Step 2 ●
- ECE R24-03 ▲

## Construction

- 4-stroke diesel engine with cylinders in line
- Fluid-cooled with axial fan.
- Indirect injection.
- Single-shaft distribution with rod, valve levers and hydraulic tappets.
- Geared distribution control.
- Double pto on the crankshaft.
- Two pto on the distribution.
- Counterclockwise, rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Positionable fan and water pump.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Cast iron cylinder head.

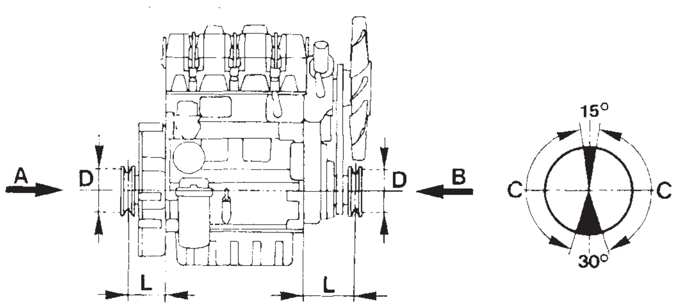
## Applications

- Mini excavator
- Fork lift
- Wood chipper
- Dumper
- Gen set
- Aerial platform
- Compressor
- High pressure cleaner
- Sweeper
- Pump
- Tractor

## Specifications

| | | |
|---|---|---|
| Cylinders | N. | 3 |
| Displacement | cm³ | 1649 |
| Bore | mm | 88 |
| Stroke | mm | 90.4 |
| Compression ratio | | 22:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 30.0/40.8 |
| | NB ISO 3046 IFN | 27.6/37.5 |
| | NA ISO 3046 ICXN | 25.4/34.5 |
| Max. torque | Nm. | 113@1600 |
| Max. torque 3 P.T.O. | Nm. | 39.2@3000 |
| Min. idling speed | | 900 |
| Water pump delivery at 3000 r.p.m. | l/min. | 75 |
| Oil consumption | kg/h. | 0.019 |
| Oil sump capacity | l | 3.8 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Vol. of air required for correct cooling @ 3000 r.p.m. | l/min. | 2475 |
| Vol. of air required for correct combustion @ 3000 r.p.m. | m³/min. | 96 |
| Dry weight | kg | 156 |
| Recommended battery | V/Ah | 12/88 |

Minimum pulley diameters for belt drive



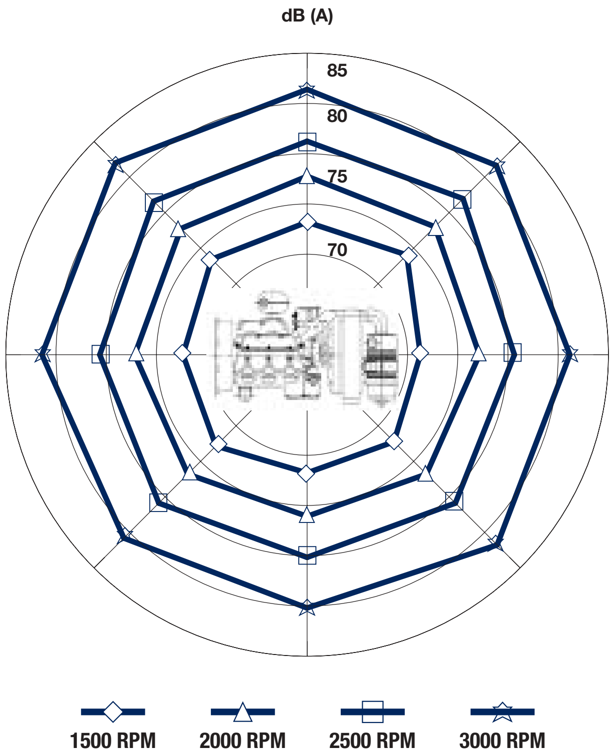

| | | |
|---|---|---|
| V belt | D (mm) ≥ 76 [L (mm) + 118] | $\frac{N\ (kW)}{n\ (RPM)}$ |
| Cogged belt | D (mm) ≥ 49 [L (mm) + 118] | $\frac{N\ (kW)}{n\ (RPM)}$ |

Max. allowable axial load in both directions A-B = 300 kg

C - zone in which the radial load acts on the pulley

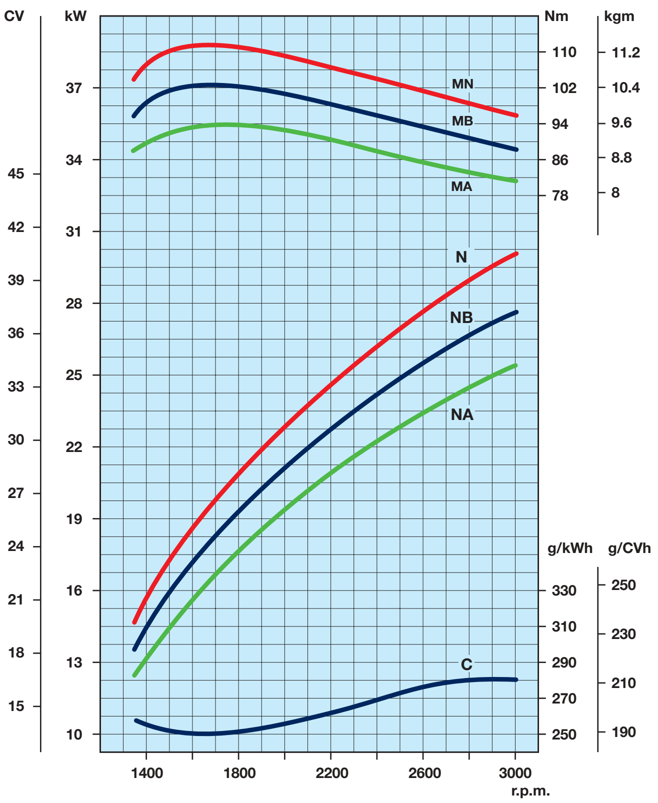
### Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

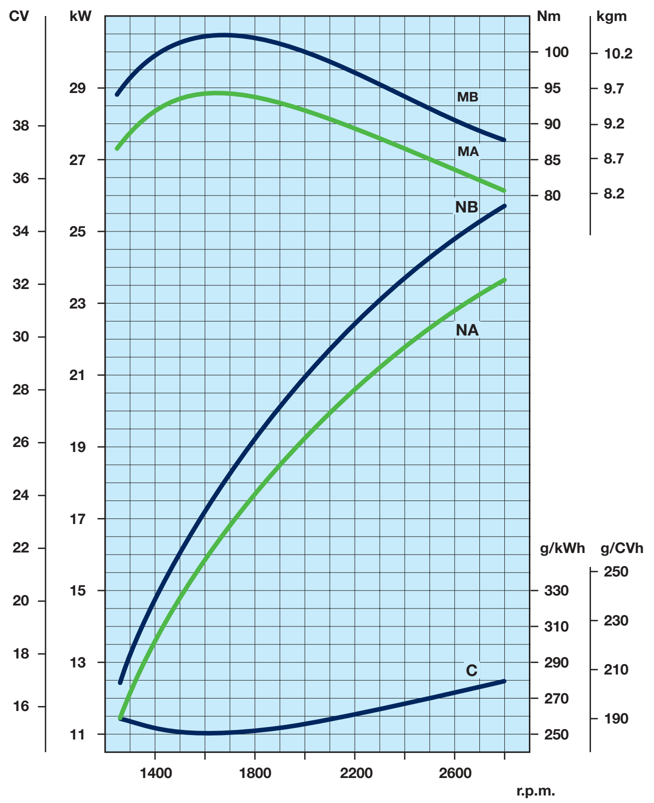


## Curves

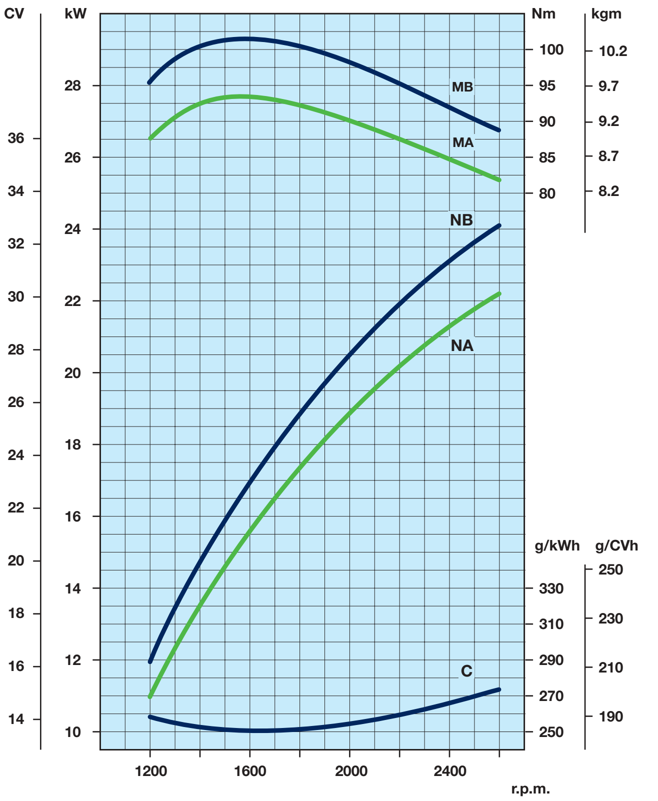
### LDW 1603 @ 3000 r.p.m.




### LDW 1603 B1 @ 2800 r.p.m.




### LDW 1603 B2 @ 2600 r.p.m.



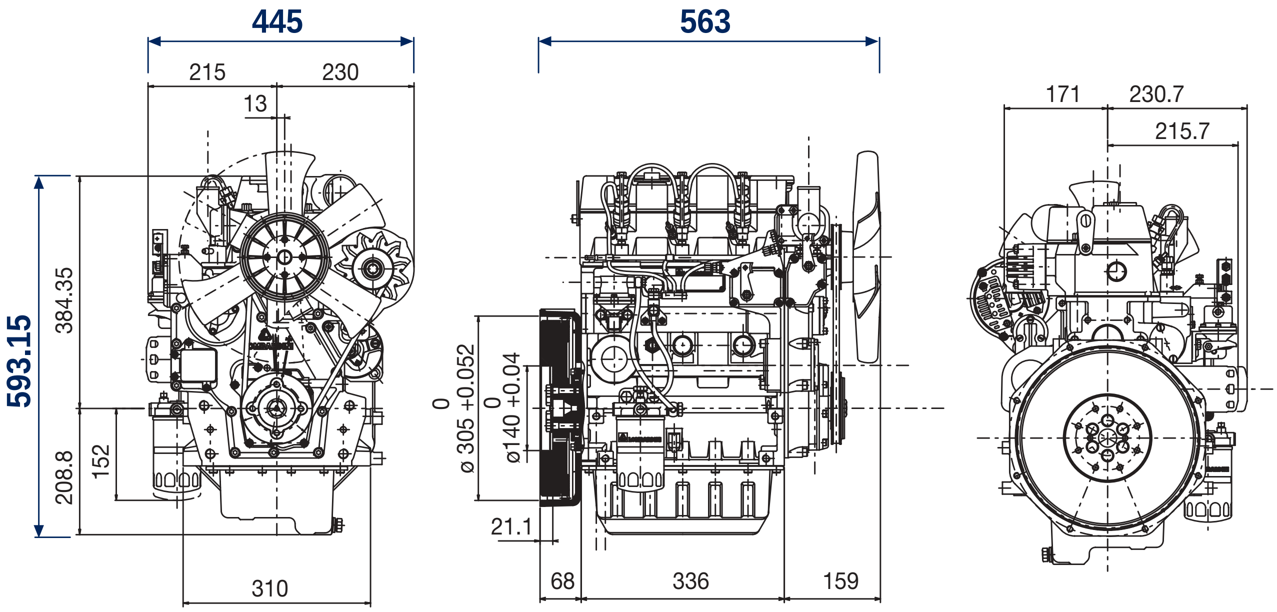

| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
| **NA** | Power curve - ISO 3046/1 - ICXN - |
| **MN** | Torque curve - (N curve) |
| | **MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

### Output power for fixed speed application (including generating sets)

### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3000 | 26.7 | 24.3 |
| 1800 | 18.5 | 16.8 |
| 1500 | 15.5 | 14 |

## Technical drawings *




* More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)

### Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
Flywheel with ring gear
Use, maintenance and spare parts booklet

### Accessories

Different guards according to use
Clutches
Clutch flywheels
Flanges
Hydraulic pump adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers
Dry air-cleaners mounted and separated
Cyclonic precleaners
Fuel filter on engine
Cab heating system
High capacity oil sump

ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

Files for this product available on www.lombardini.it

| | |
|---|---|
| Data sheet | LDW1603DS.PDF |
| Owner manual | LDW1603OM.PDF |
| Service manual | LDW1603SM.PDF |
| Technical drawing | LDW1603TD.DWG |
| Power curve | LDW1603PC.PDF |

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**www.lombardini.it**



mod. 50996/5

LOMBARDINI

# SERIE CHD Plus

DIESEL

LDW 2204

- **4 cylinders**
- **2199 cm³**
- **38.0 kW/51.7 HP**
- **3000 rpm**
- **Nm. 144@2000**

## Homologation

- EPA TIER 2 ■
- 97/68/CE Step 2 ●
- ECE R24-03 ▲

## Construction

- 4-stroke diesel engine with cylinders in line
- Fluid-cooled with axial fan.
- Indirect injection.
- Single-shaft distribution with rod, valve levers and hydraulic tappets.
- Geared distribution control.
- Double pto on the crankshaft.
- Two pto on the distribution.
- Counterclockwise, rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Positionable fan and water pump.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Cast iron cylinder head.

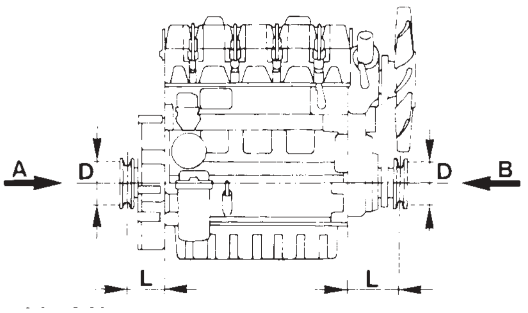
## Applications

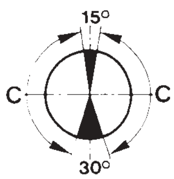
- Mini excavator
- Excavator
- Fork lift
- Dumper
- Gen set
- Aerial platform
- Compressor
- High pressure cleaner
- Sweeper
- Pump
- Tractor

## Specifications

| | | |
|---|---|---|
| Cylinders | N. | 4 |
| Displacement | $cm^3$ | 2199 |
| Bore | mm | 88 |
| Stroke | mm | 90.4 |
| Compression ratio | | 22.5:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 38.0/51.7 |
| | NB ISO 3046 IFN | 34.5/46.9 |
| | NA ISO 3046 ICXN | 32.0/44.0 |
| Max. torque | Nm. | 144@2000 |
| Max. torque 3 P.T.O. | Nm. | 39.2@3000 |
| Min. idling speed | | 900 |
| Water pump delivery at 3000 r.p.m. | l/min. | 100 |
| Oil consumption | kg/h. | 0.025 |
| Oil sump capacity | | |
| with dynamic horizontal stabilizer | l | 4.5 |
| without dynamic horizontal stabilizer | l | 5.7 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Vol. of air required for correct cooling @ 3000 r.p.m. | l/min. | 3300 |
| Vol. of air required for correct combustion @ 3000 r.p.m. | $m^3$/min. | 128 |
| Dry weight | kg | 192 |
| Recommended battery | V/Ah | 12/88 |

Minimum pulley diameters for belt drive



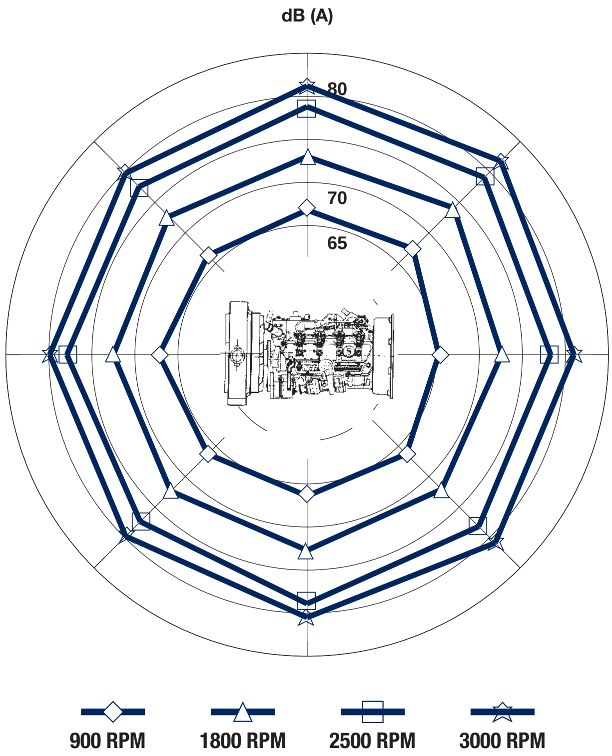

| | | |
|---|---|---|
| V belt | D (mm) ≥ 73 [L (mm) + 118] | $\frac{N\ (kW)}{n\ (RPM)}$ |
| Cogged belt | D (mm) ≥ 46 [L (mm) + 118] | $\frac{N\ (kW)}{n\ (RPM)}$ |

Max. allowable axial load in both directions A-B = 300 kg

C - zone in which the radial load acts on the pulley

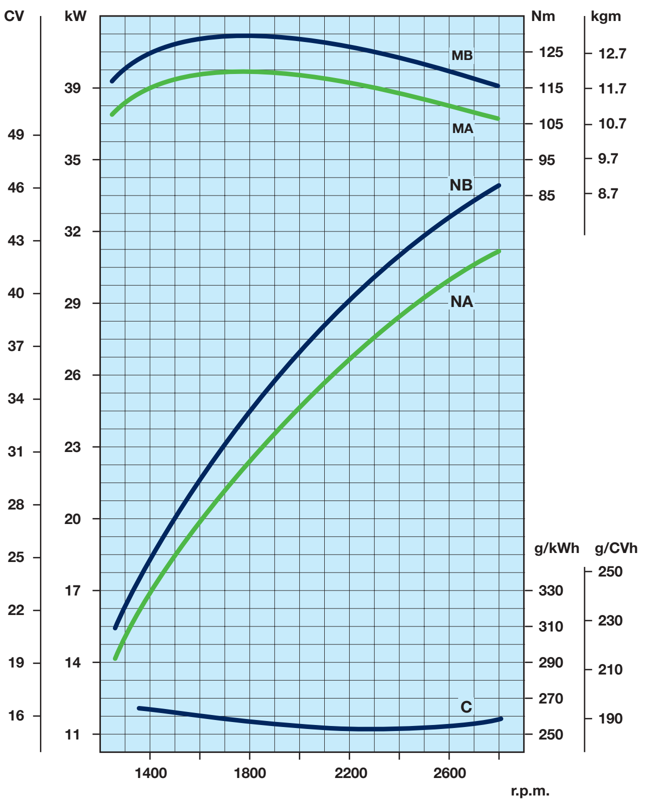
### Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

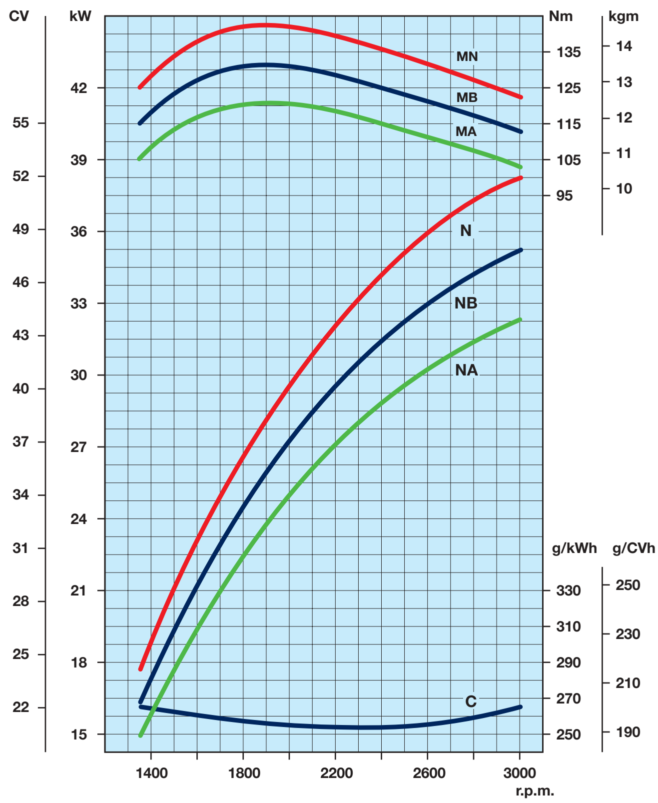


# Curves

### LDW 2204 @ 3000 r.p.m.




### LDW 2204 B1 @ 3000 r.p.m.



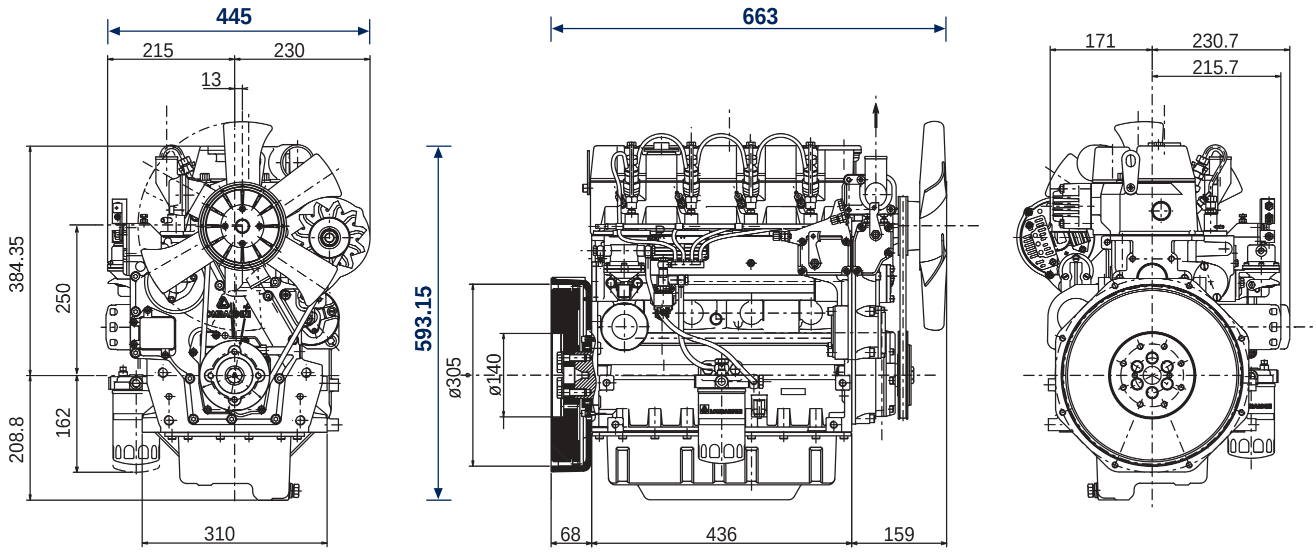

| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
| **NA** | Power curve - ISO 3046/1 - ICXN - |
| **MN** | Torque curve - (N curve) |
| | **MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

## Output power for fixed speed application (including generating sets)

### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3000 | 35 | 31.8 |
| 1800 | 22.5 | 20.5 |
| 1500 | 19.5 | 17.7 |

# Technical drawings *




* More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)

## Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
Flywheel with ring gear
Use, maintenance and spare parts booklet

## Accessories

Different guards according to use
Clutches
Clutch flywheels
Flanges
Hydraulic pump adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers
Dry air-cleaners mounted and separated
Cyclonic precleaners
Fuel filter on engine
Cab heating system
High capacity oil sump

ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

Files for this product available on www.lombardini.it

| | |
|---|---|
| Data sheet | LDW2204DS.PDF |
| Owner manual | LDW2204OM.PDF |
| Service manual | LDW2204SM.PDF |
| Technical drawing | LDW2204TD.DWG |
| Power curve | LDW2204PC.PDF |

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www.lombardini.it



mod. 51001/5

LOMBARDINI

# SERIE CHD Plus

DIESEL

LDW 2204/T

- **4 cylinders**
- **2199 cm³**
- **48.0 kW/65.3 HP**
- **3000 rpm**
- **Nm. 190@1800**

## Homologation

- EPA TIER 2 ■
- 97/68/CE Step 2 ●
- ECE R24-03 ▲

## Construction

- 4-stroke diesel engine with cylinders in line
- Fluid-cooled with axial fan.
- Indirect injection.
- Single-shaft distribution with rod, valve levers and hydraulic tappets.
- Geared distribution control.
- Water-oil heat exchanger.
- Turbocompressor Mitsubishi TD 025L.
- Double pto on the crankshaft.
- Two pto on the distribution.
- Counterclockwise, rotation.
- Forced lubrication with vane pump on the crankshaft.
- Total passage external oil filter.
- Positionable fan and water pump.
- Automatic extra fuel starting device.
- Centrifugal governor.
- Torque regulator.
- Cast iron engine block with re-borable integral liners.
- Cast iron cylinder head.

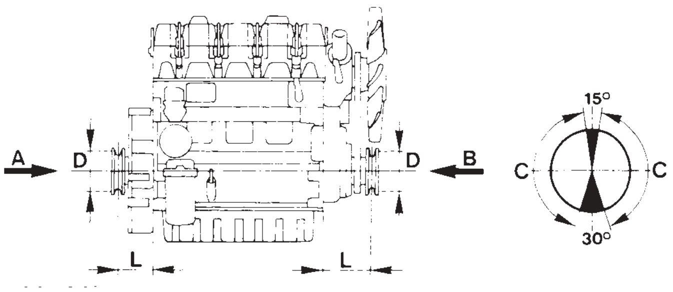
## Applications

- Fork lift
- Excavator
- Gen set
- Compressor
- Sweeper
- Tractor

# Specifications

| | | |
|---|---|---|
| Cylinders | N. | 4 |
| Displacement | $cm^3$ | 2199 |
| Bore | mm | 88 |
| Stroke | mm | 90.4 |
| Compression ratio | | 22.8:1 |
| Rating kW/HP | N (80/1269/CEE) ISO 1585 | 48.0/65.3 |
| | NB ISO 3046 IFN | 44.3/60.2 |
| | NA ISO 3046 ICXN | 40.8/55.5 |
| Max. torque | Nm. | 190@1800 |
| Max. torque 3 P.T.O. | Nm. | 39.2@3000 |
| Min. idling speed | | 900 |
| Water pump delivery at 3000 r.p.m. | l/min. | 128 |
| Oil consumption | kg/h. | 0.032 |
| Oil sump capacity | | |
| with dynamic horizontal stabilizer | l | 4.5 |
| without dynamic horizontal stabilizer | l | 5.7 |
| Max. allowable inclination for short periods of operation (peak values) | | 25° (35°) |
| Vol. of air required for correct cooling @ 3000 r.p.m. | l/min. | 4200 |
| Vol. of air required for correct combustion @ 3000 r.p.m. | $m^3$/min. | 180 |
| Dry weight | kg | 197 |
| Recommended battery | V/Ah | 12/88 |

Minimum pulley diameters for belt drive



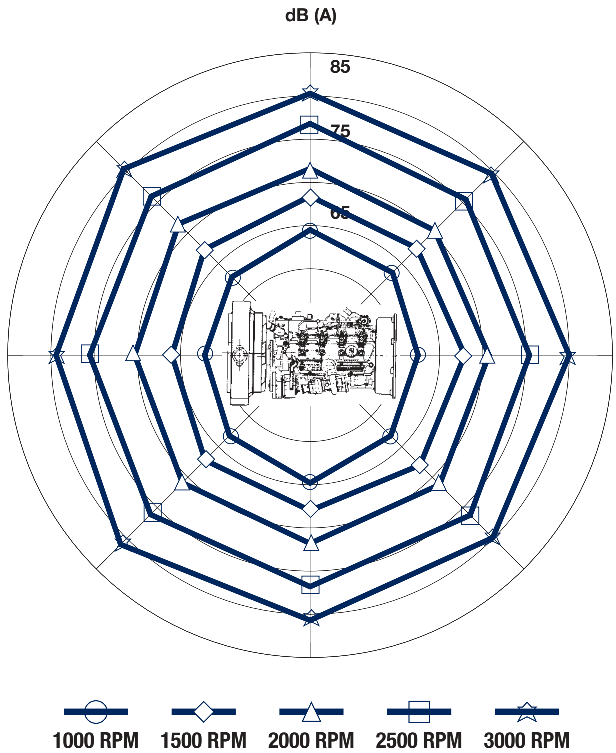

| | | |
|---|---|---|
| V belt | D (mm) ≥ 73 [L (mm) + 118] | $\frac{N (kW)}{n (RPM)}$ |
| Cogged belt | D (mm) ≥ 46 [L (mm) + 118] | $\frac{N (kW)}{n (RPM)}$ |

Max. allowable axial load in both directions A-B = 300 kg

C - zone in which the radial load acts on the pulley

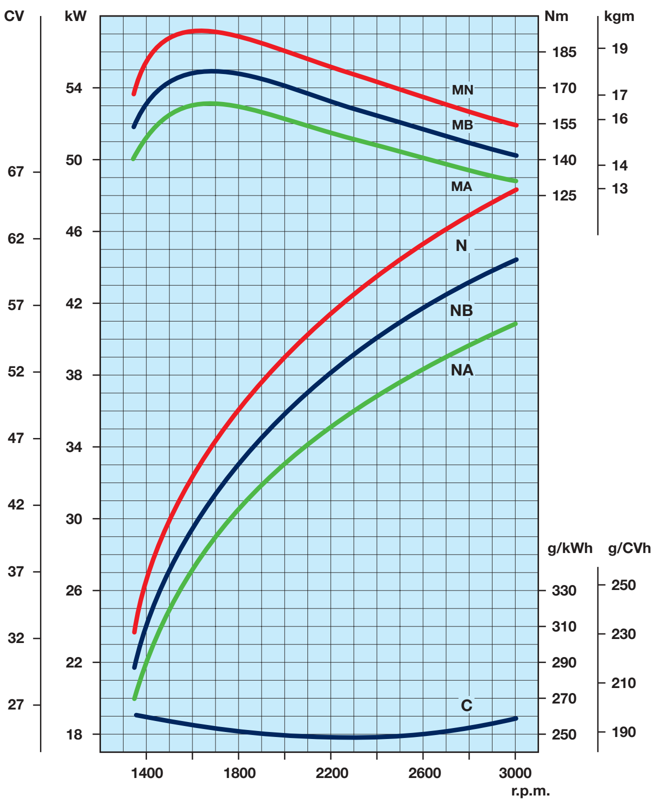
## Sound pressure level dB (A)

Sound level polar diagram open field - 7 meters microphone - no load running engine.

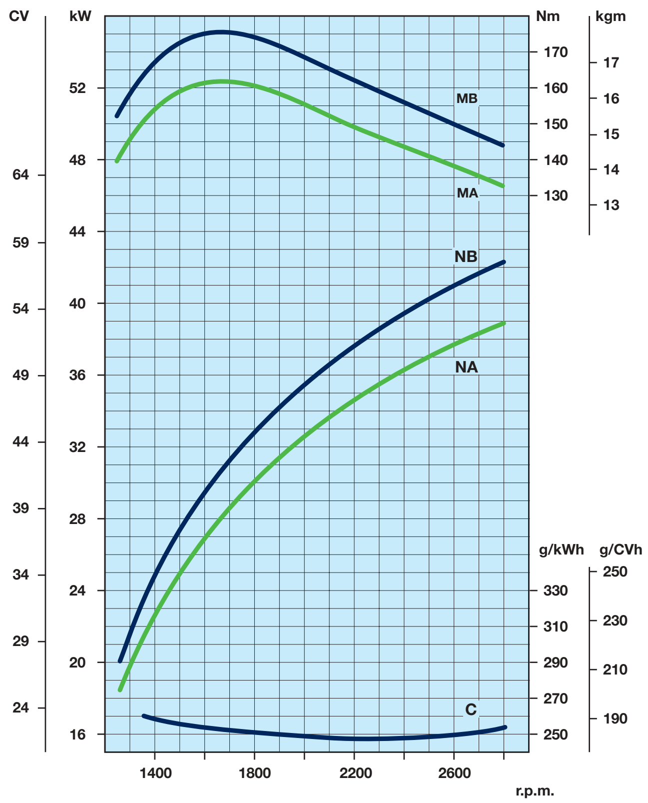


# Curves

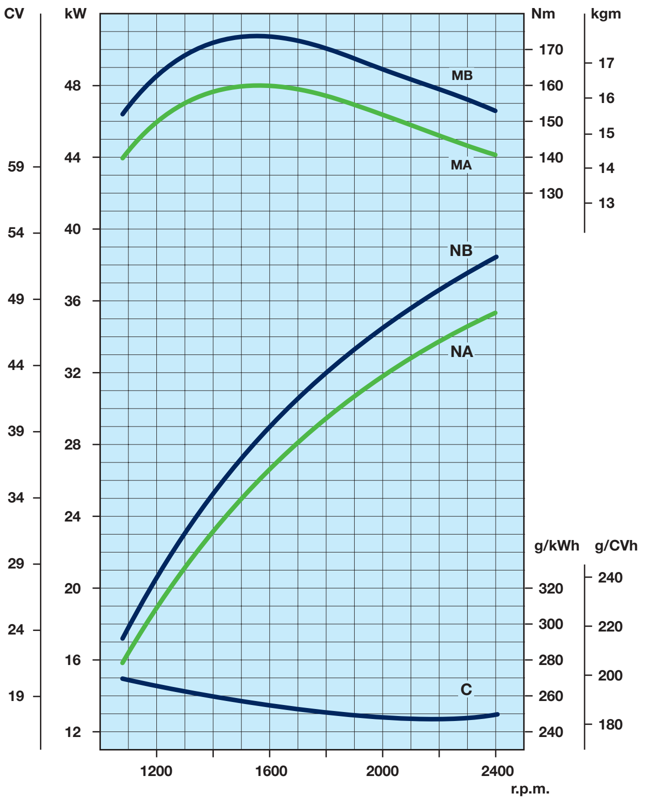
### LDW 2204/T @ 3000 r.p.m.




### LDW 2204/T B1 @ 2800 r.p.m.




### LDW 2204/T B3 @ 2400 r.p.m.




| | |
|---|---|
| **N** | Power curve - 80/1269/CEE - ISO 1585 - |
| **NB** | Power curve - ISO 3046/1 - IFN - |
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| **MN** | Torque curve - (N curve)<br>**MB** (B curve - **MA** (A curve) |
| **C** | Specific fuel consumption - (NB curve) |

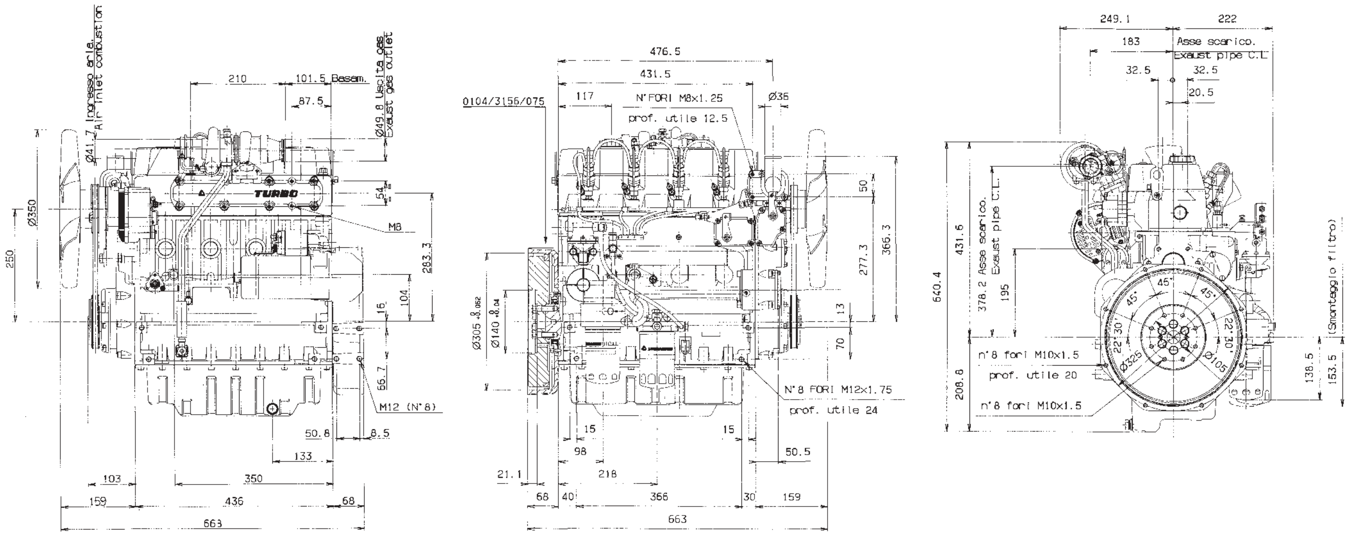
## Output power for fixed speed application (including generating sets)

### Engine power kW

| r.p.m. | Intermittent (NB) | Continuous (NA) |
|---|---|---|
| 3000 | 44 | 40 |
| 1800 | 31.5 | 28.6 |
| 1500 | 26 | 23.6 |

# SERIE CHD Plus

## Technical drawings *




* More specific dimensions are available on www.lombardini.it (see table at the bottom of the page)

### Standard equipment

External oil filter
Intake manifold
Exhaust manifold
Intake fan
Accelerator control
Electric starter and 12V alternator
Thermostatic valve
Fuel feed diaphragm pump
Water pump
Flanging plate
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### Accessories

Different guards according to use
Clutches
Clutch flywheels
Flanges
Hydraulic pump adaptors
Keyswitch panel
Electric stop
Electronic plant for plugs
Alternators
Radiators
Blowing fan
Engine feet
Fuel tanks
Mufflers separated
Dry air-cleaners separated
Cyclonic precleaners
Fuel filter on engine
Cab heating system
High capacity oil sump

ICIM
IQNet
ISO 9001 Cert. n. 0446 - 1405
QS. 9000 Cert. n. 2231/0

Files for this product available on www.lombardini.it

| | |
|---|---|
| Data sheet | LDW2204TDS.PDF |
| Owner manual | LDW2204TOM.PDF |
| Service manual | LDW2204TSM.PDF |
| Technical drawing | LDW2204TTD.DWG |
| Power curve | LDW2204TPC.PDF |

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