WORKSHOP MANUAL

KOHLER® KD 477-2

KOHLER® ENGINES

REGISTRATION OF MODIFICATIONS TO THE DOCUMENT

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

Drafting body	Document code	Model N°	Edition	Revision	Issue date	Review date	Endorsed
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KD 477-2

PREFACE

- Every attempt has been made to present within this service manual, accurate and up to date technical information.
  However, development on the **KOHLER** series is continuous.
  Therefore, the information within this manual is subject to change without notice and without obligation.
  The materials used by **KOHLER** to construct the engine's components undergo strict quality controls and the engine's assembly guarantees reliability and long life.
  The engine has been built to the machine manufacturer's specifications, and it was its responsibility to adopt all the measures needed to meet the essential health and safety requirements as provided for by the laws in force; use of the engine for uses other than the one defined shall not be considered as compliant with the use intended by **KOHLER**, who therefore refuses all responsibility for any injury arising from such an operation.

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

Information presented within this manual assumes the following:

1 - The person or people performing service work on **KOHLER** series engines is properly trained and equipped to safely and professionally perform the subject operation;

2 - The person or people performing service work on **KOHLER** series engines possesses adequate hand and **KOHLER** special tools to safely and professionally perform the subject service operation;

3 - The person or people performing service work on **KOHLER** 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 **KOHLER** 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.

LIMITED 3 YEAR KOHLER® DIESEL ENGINE WARRANTY

Kohler Co. warrants to the original retail consumer that each new KOHLER Diesel engine sold by Kohler Co. will be free from manufacturing defects in materials or workmanship in normal service for a period of three (3) years or 2000 hours whichever occurs first from the date of purchase, provided it is operated and maintained in accordance with Kohler Co.'s instructions and manuals. If no hour meter is installed as original equipment then 8 hours of use per day and 5 days per week will be used to calculate hours used.

Our obligation under this warranty is expressly limited, at our option, to the replacement or repair at Kohler Co., Kohler, Wisconsin 53044, or at a service facility designated by us of such parts as inspection shall disclose to have been defective.

This warranty does not apply to defects caused by unreasonable use, including faulty repairs by others and failure to provide reasonable and necessary maintenance.

The following items are not covered by this warranty:
Engine accessories such as fuel tanks, clutches, transmissions, power-drive assemblies and batteries, unless supplied or installed by Kohler Co. These are subject to the warranties, if any, of their manufacturers.

KOHLER CO. AND/OR THE SELLER SHALL NOT BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND, including but not limited to labor costs or transportation charges in connection with the repair or replacement of defective parts.

IMPLIED OR STATUTORY WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY LIMITED TO THE DURATION OF THIS WRITTEN WARRANTY. We make no other express warranty, nor is any one authorized to make any on our behalf.

Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

To obtain warranty service

Purchaser must bring the engine to an authorized Kohler service facility. To locate the nearest facility, visit our website, www.kohlerengines.com, and use the locator function, consult your Yellow Pages or telephone 1-800-544-2444.

ENGINE DIVISION, KOHLER CO., KOHLER, WISCONSIN 53044

CALIFORNIA EMISSION CONTROL WARRANTY STATEMENT
YOUR WARRANTY RIGHTS AND OBLIGATIONS

The California Air Resources Board and Kohler Co. are pleased to explain the **emission control system warranty** on your 2012 engine. In California, new heavy-duty off-road engines must be designed, built and equipped to meet the State's stringent anti-smog standards. Kohler Co. must warrant the emission control system on your engine for the time period listed below provided there has been no abuse, neglect or improper maintenance of your engine.
Your emission control system may include parts such as the fuel-injection system and the air induction system. Also included may be hoses, connectors and other emission related assemblies.
Where a warrantable condition exists, Kohler Co. will repair your heavy-duty off-road engine at no cost to you including diagnosis, parts and labor.

MANUFACTURER'S WARRANTY COVERAGE:

Your off-road, diesel engine emission control system is covered under warranty for a period of five (5) years or 3,000 hours, whichever occurs first, beginning on the date the engine or equipment is delivered to an ultimate purchaser for all constant speed engines with maximum power 19≤kW<37 and rated speed less than 3,000 rpm, all variable speed engines with maximum power 19≤kW<37, and all variable or constant speed engines with maximum power greater than 37 kW. Your off-road, diesel engine emission control system on variable or constant-speed engines with maximum power less than 19 kW, and for constant speed engines with maximum power 19≤kW<37 and rated speed equal to or greater than 3,000 rpm is covered under warranty for a period of two (2) years or 1,500 hours, whichever
occurs first. If any emission related part on your engine is defective, the part will be repaired or replaced by Kohler Co.

OWNER'S WARRANTY RESPONSIBILITIES:

As the heavy-duty off-road engine owner, you are responsible for the performance of the **required maintenance listed in your Kohler Co. owner's manual**. Kohler Co. recommends that you retain all receipts covering maintenance on your heavy-duty off-road engine, but Kohler Co. cannot deny warranty solely for the lack of receipts or for your failure to ensure the performance of all recommended scheduled maintenance.
As the heavy-duty off-road engine owner, you should however be aware that Kohler Co. may deny you warranty coverage if your heavy-duty off-road engine or emission control related component has failed due to abuse, neglect, improper maintenance or unapproved modifications.
Your engine is designed to operate on commercial diesel fuel (No. 1 or No. 2 low sulfur or ultra low sulfur diesel fuel) only. Use of any other fuel may result in your engine no longer operating in compliance with California's emissions requirements.
You are responsible for initiating the warranty process. The Air Resources Board suggests that you present your heavy-duty off-road engine to a Kohler Co. dealer as soon as a problem exists. The warranty repairs should be completed by the dealer as expeditiously as possible.
Please review the document titled, "Kohler Co. Federal and California Emission Control Systems Limited Warranty Off-Road Diesel Engines", for complete details of your heavy-duty off-road engine warranty. If you have any questions regarding your warranty rights and responsibilities or the location of the nearest Kohler Co. authorized service location, you should contact Kohler Co. at 1-800-544-2444 or access our website at www.kohlerengines.com.

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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 REGULATIONS

GENERAL NOTES

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

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

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

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.
– Some tools are normal workshop ones, while others are special tools designed by the Manufacturer of the engine.
– 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.

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.

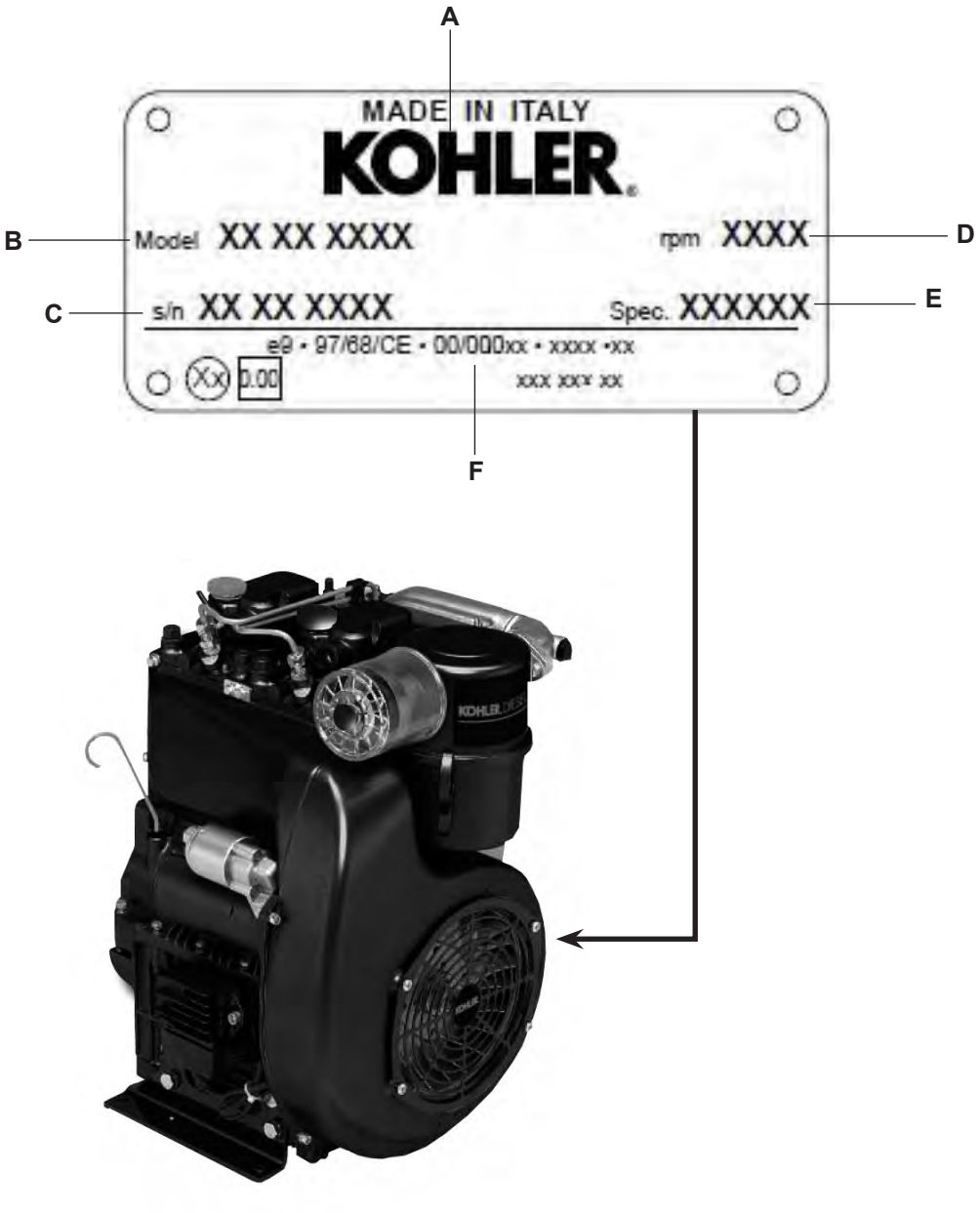
The identification plate shown in the figure can be found directly on the engine.

It contains the following information:

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

Approval data

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



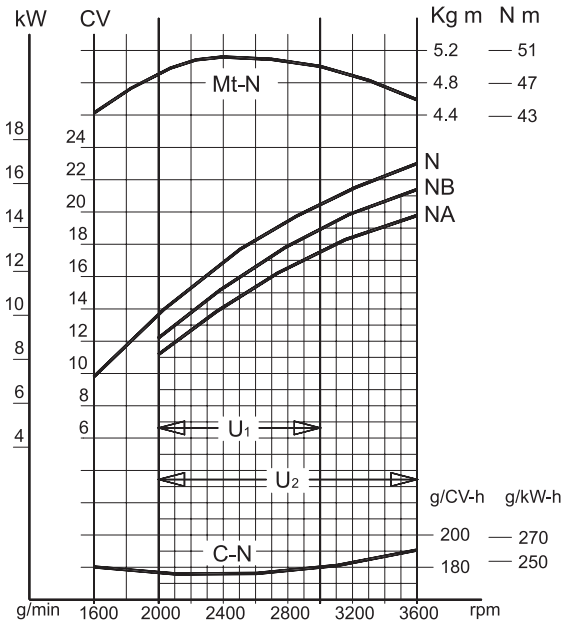
CHARACTERISTICS

ENGINE TYPE			KD 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

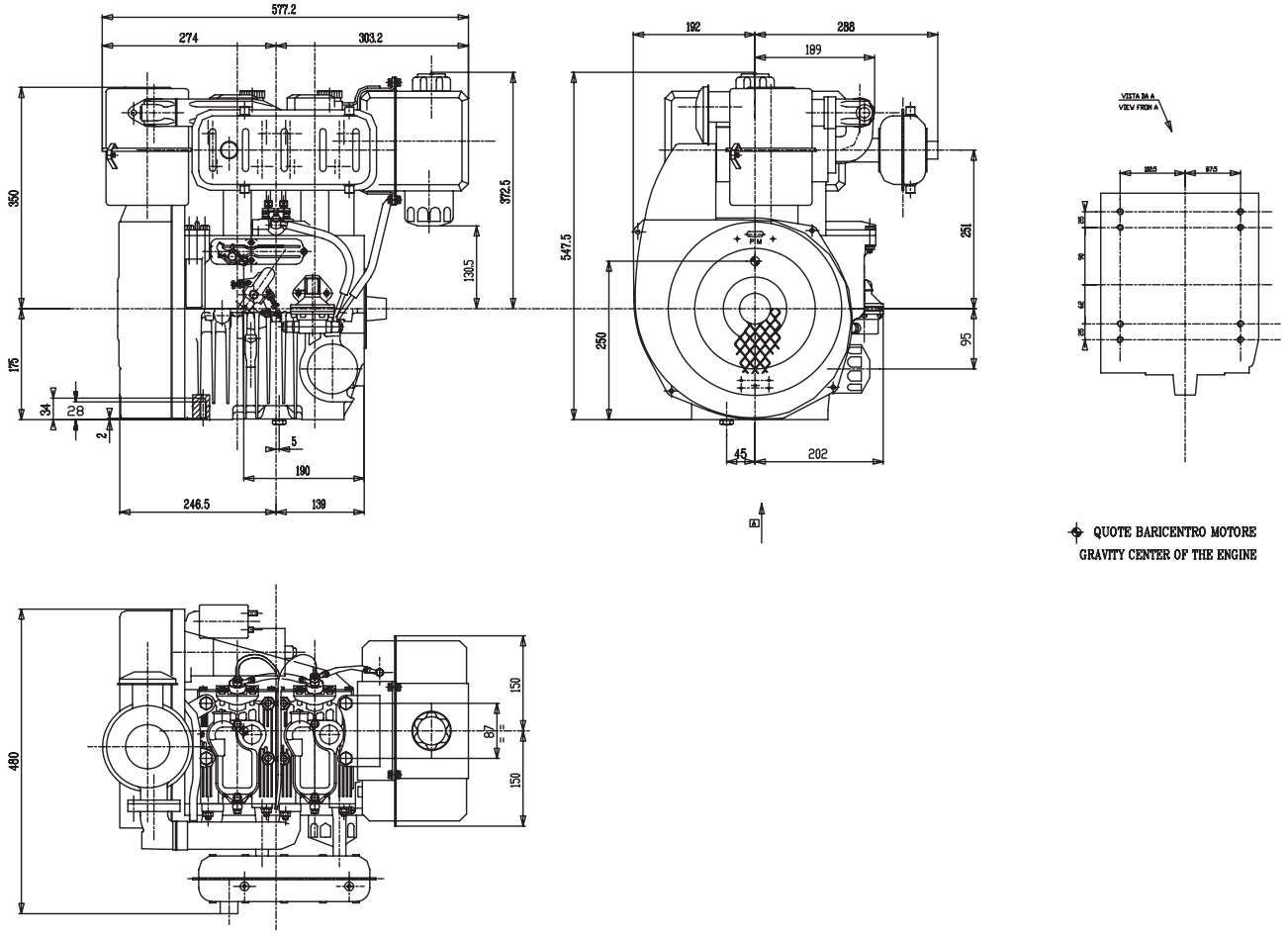
KD 477-2



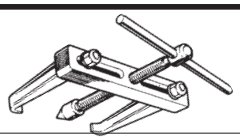
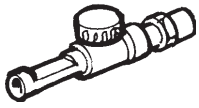
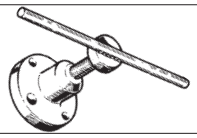
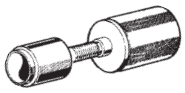
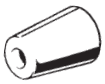
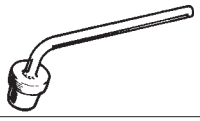
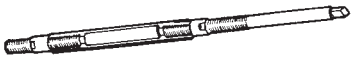
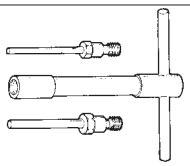
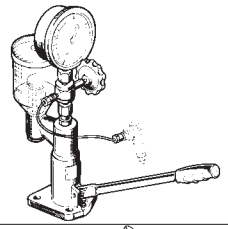
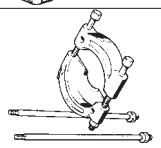
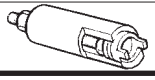
N (80/1269/EEC - ISO 1585) **AUTOMOTIVE RATING** : Intermittent operation with variable speed and variable load.
NB (ISO 3046 - 1 IFN) **RATING WITH NO OWERLOAD CAPABILITY:** continuos ligth duty operation with constant speed and variable load.
NA (ISO 3046 - 1 ICXN) **CONTINUOS RATING WITH OVERLOAD 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 Kohler for power, torque curves and specific consumptions at rates differing from those given above.



Note: Dimensions in mm

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** **00365R0510**	Cutter Ø 38 mm (1.50 inch.) 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.

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.

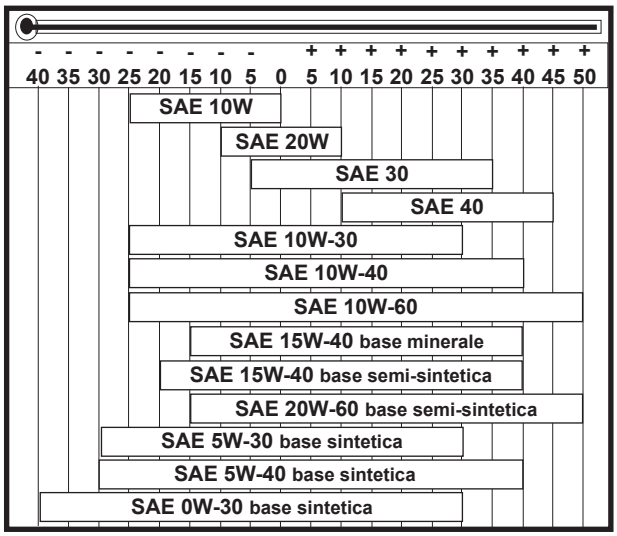
RECOMMENDED OIL

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

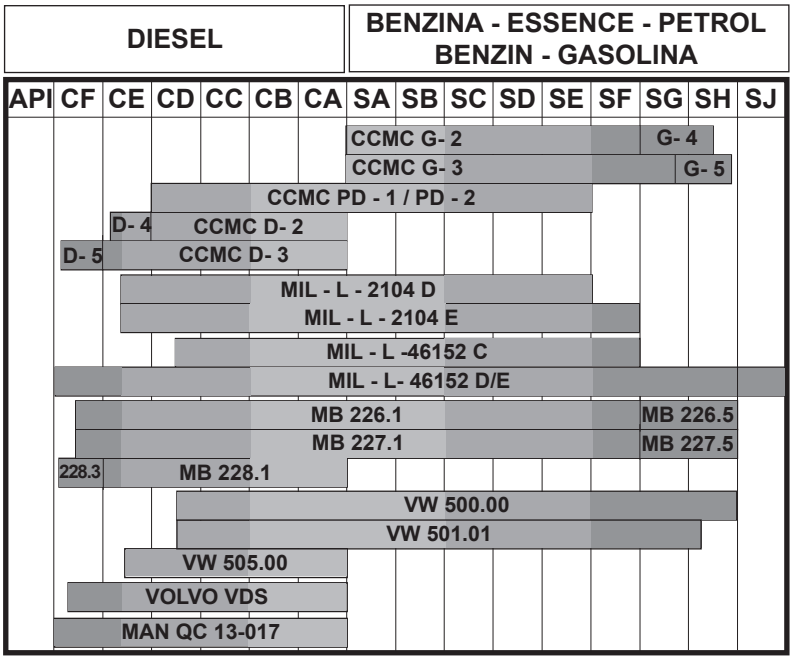
A = Gasoline (Petrol)
B = Light Diesel fuels
E = Heavy Diesel fuels

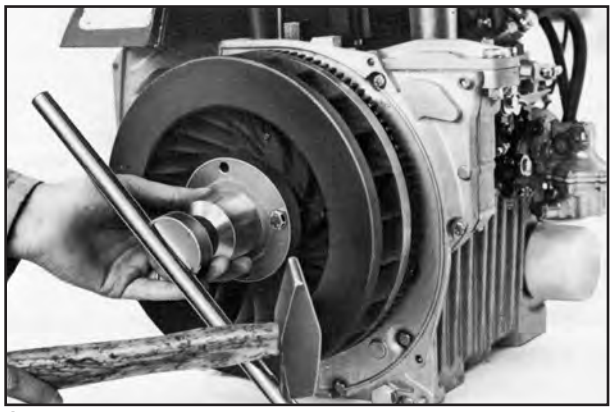
Required levels :

A1-96
A2-96
A3-96

B1-96
B2-96
B3-96

E1-96
E2-96
E3-96



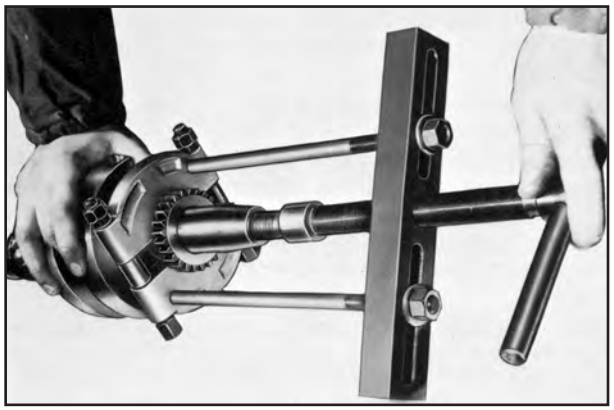


1

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 Kohler spare parts for repair operations.



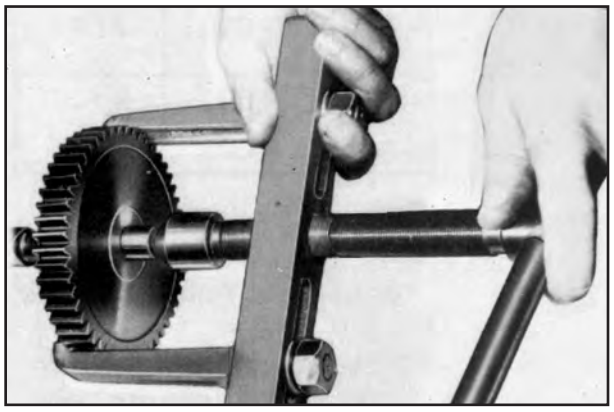
2

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.



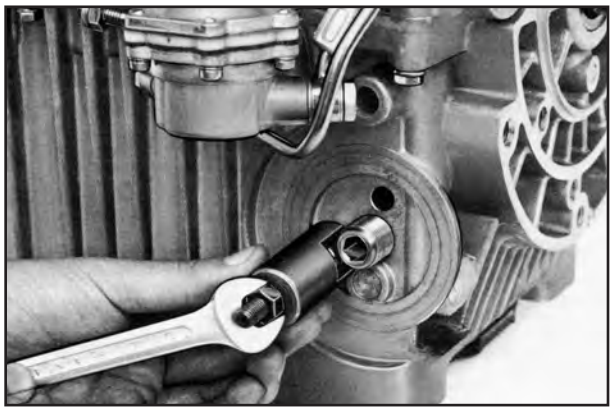
3

Crankshaft gear extraction

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

Camshaft gear extraction

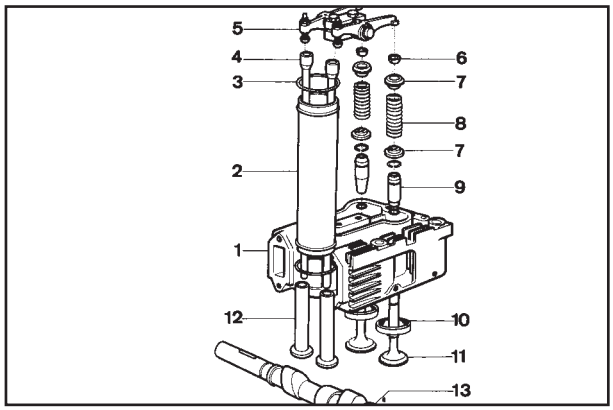
Use extractor cod. **00365R0010** (fig. 3).



4

Oil pressure register valve extraction

Use extractor cod. **00365R0880** (fig. 4).



5

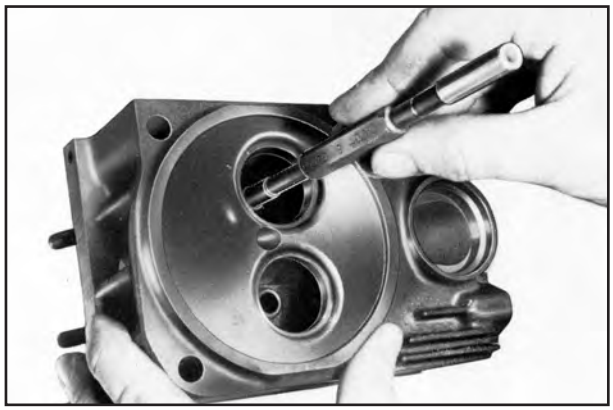
Cylinder heads

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

Valves - Guides - Seats

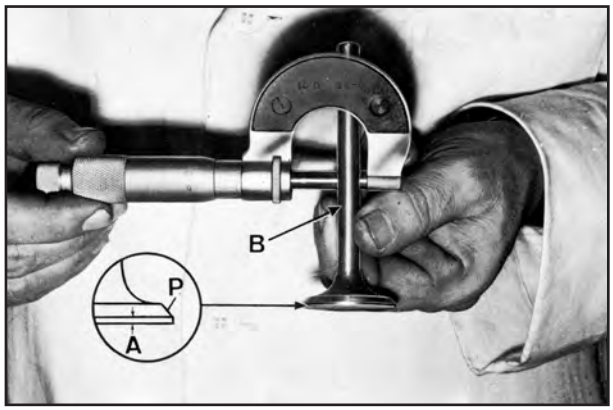
Clean the valves with a wire brush and renew them if the valve heads are deformed, cracked or worn.

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
KD 477-2	Inlet Outlet	7,000 ÷ 7,010	7,000	7,079



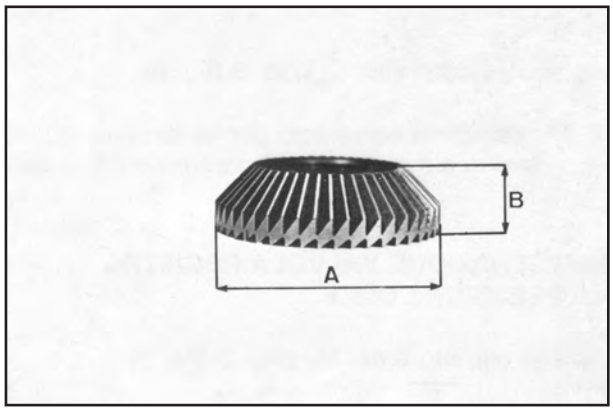
7

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).

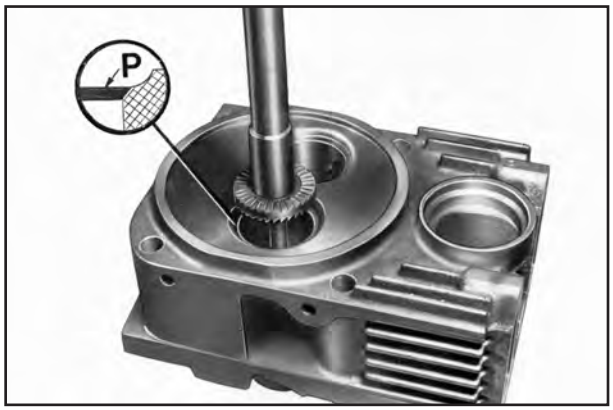
As a result of prolonged engine operation, the hammering of the valves on their seats at high temperature causes the face of the seats to harden and hand grinding is made difficult. It is thus necessary to remove the hardened surface with a **45°** cutter mounted on a valve seat grinding tool (fig. 8). Final fitting can then be carried out manually with the cutters listed below.



8

Cut dimensions for valve seats

Engine	Inlet		Outlet	
	A x B	Ø guide	A x B	Ø guide
KD 477-2	40 x 12 mm	7 mm	38 x 12 mm	7 mm



9

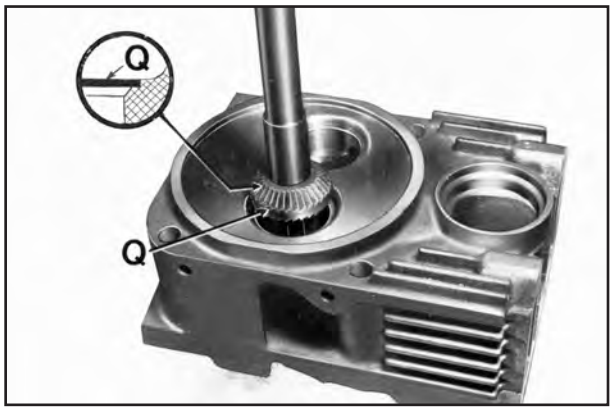
Cutting of the valve seats involves the widening of the valve seat face **P** with a consequent reduction of seal of the valve itself, fig. 9

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:

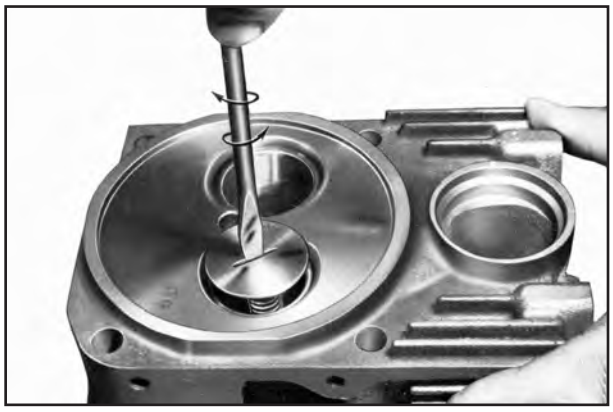
Fitting mm	Max. wear mm
0,9 ÷ 1,1	1,8



10

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.

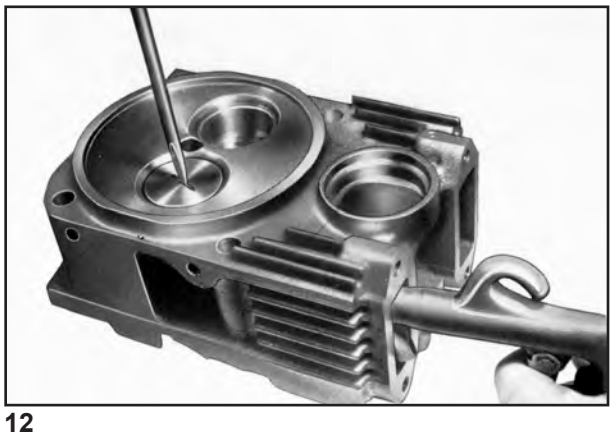


11

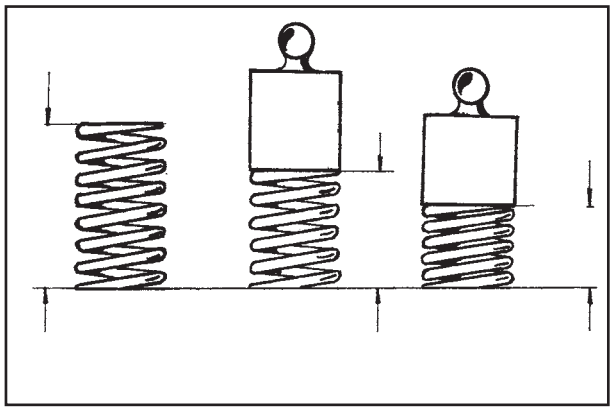
After grinding, wash valve and seat carefully with petrol or paraffin to eliminate any residual grinding paste or cuttings.
To check the worthiness of the seal between valve and seat, after grinding has taken place, proceed as follows:

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.



12

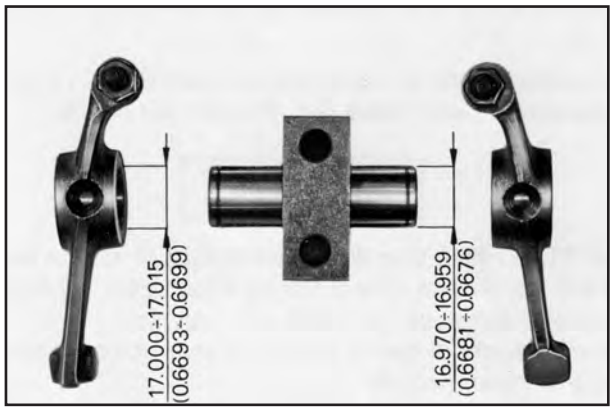


13

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

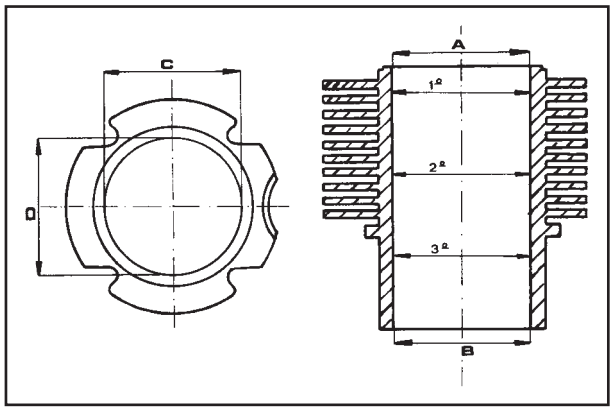
Rocker arms

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.

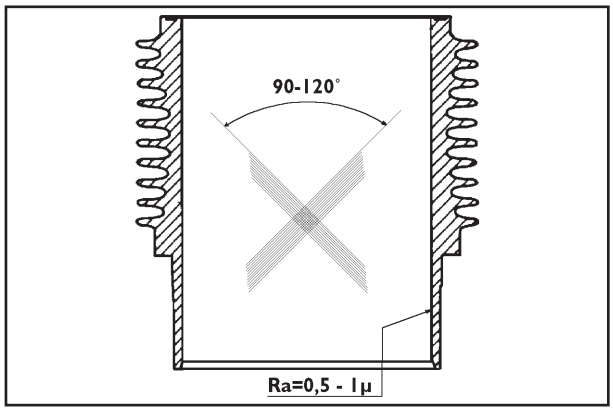
Use a dial gauge to check internal diameters (**C-D**) at three different heights (fig.15).

Maximum permitted taper (**A-B**) and ovality (**C-D**) is 0.06mm.

Diameter of cylinders (fig.15):

KD477-2	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

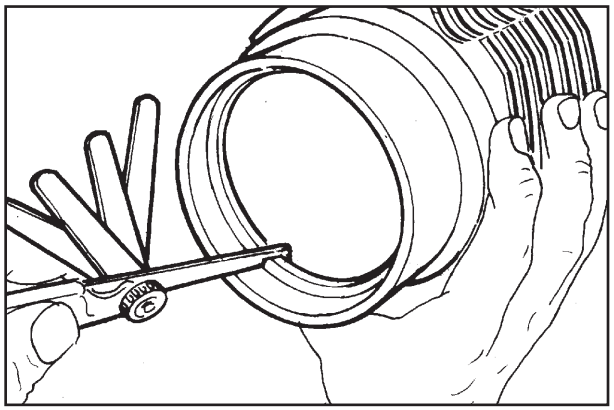
! Do not manually hone the cylinder bore surfaces with emery cloth or other means.

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.

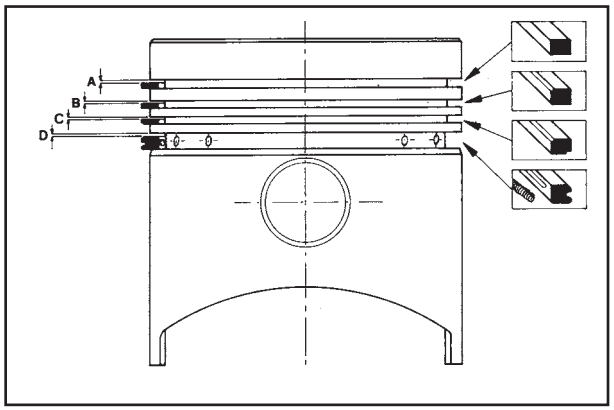
If the taper and ovality of the cylinder exceed the values indicated, then the cylinder and piston must be renewed.



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

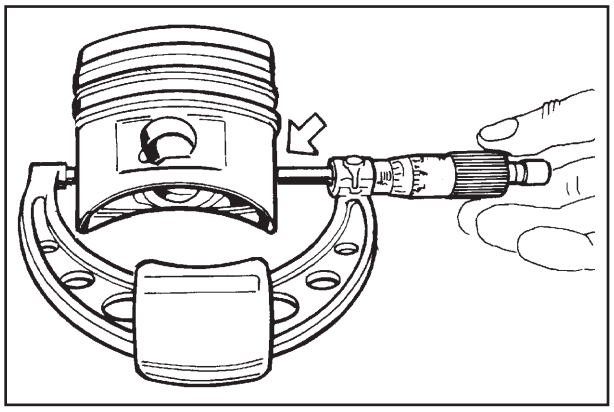


18

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

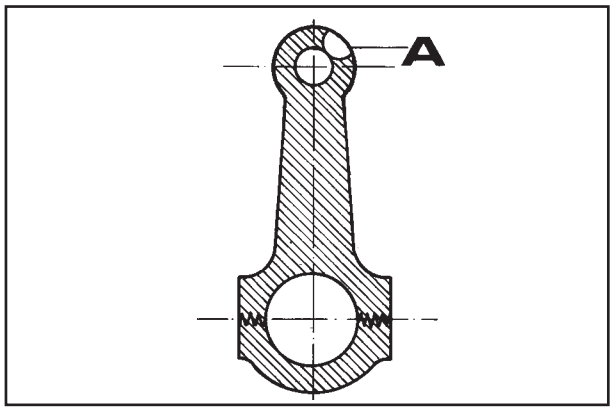
Piston diameter check: The diameter of the piston must be measured at approximately 18 mm from the base (fig.19).

Engine	Diameter mm
KD477-2	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



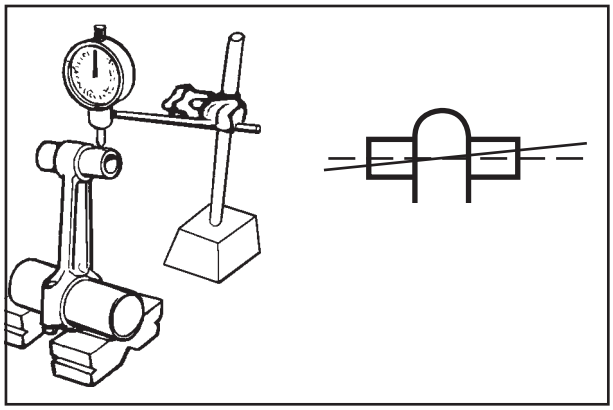
20

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:

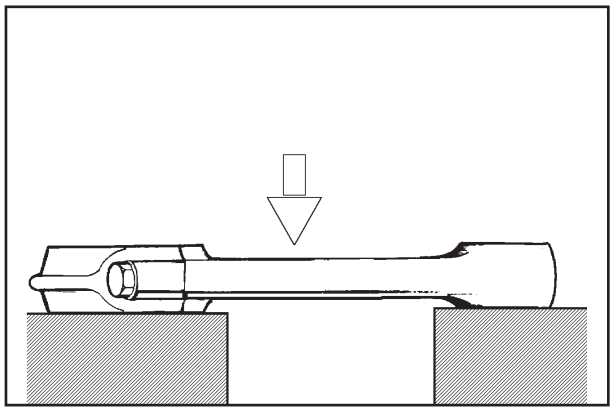
Engine	Ø Piston pin mm	Assy. clearance mm	Max wear mm
KD 477-2	21,997 ÷ 22,002	0,023 ÷ 0,038	0,070



21

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

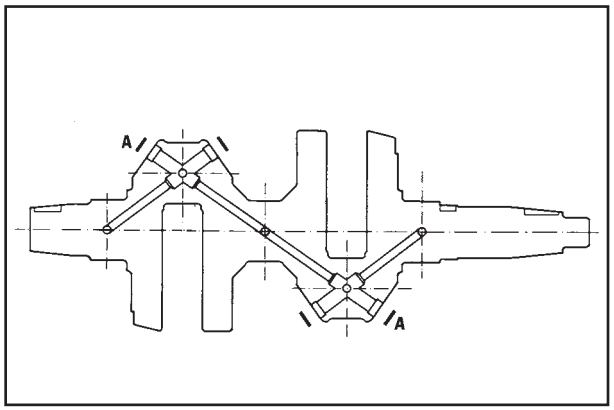
Engine	Weight
KD 477-2	gr. 570 ± 10



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).

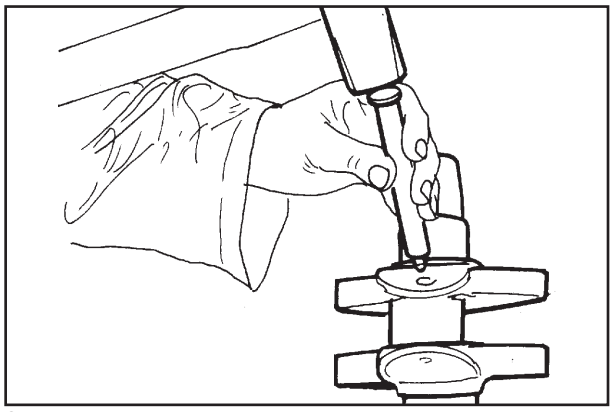


23

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).

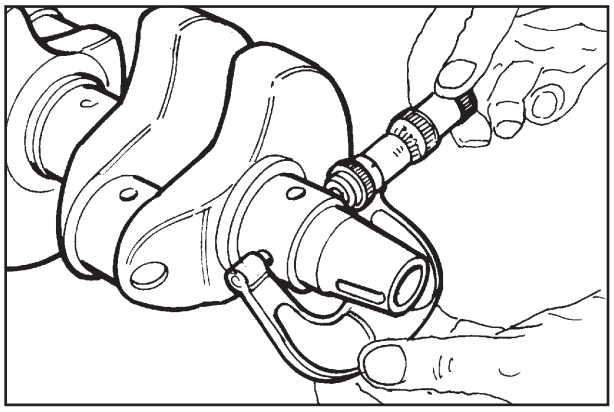


24

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:

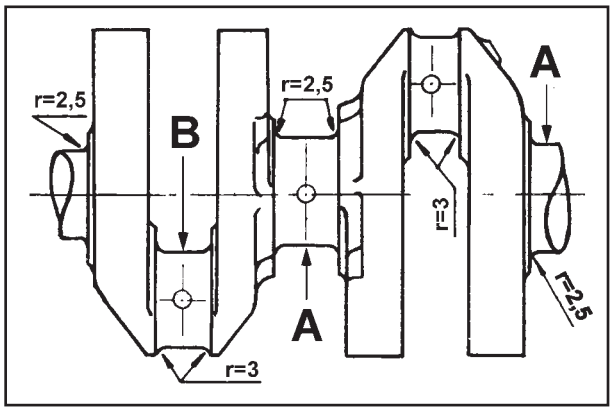


25

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.

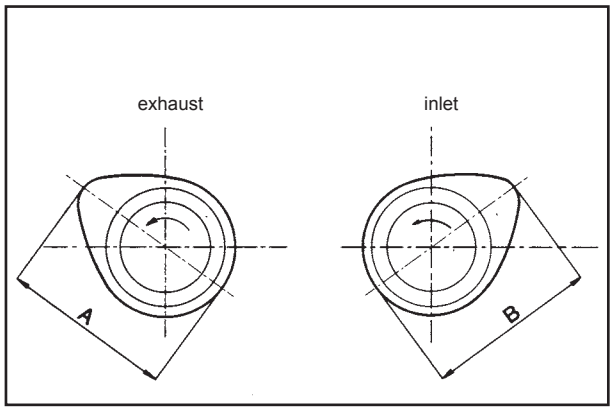
Main bearing bushes with increased external diameters are also available. Table indicates the crankcase boring values.



26

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

! 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.

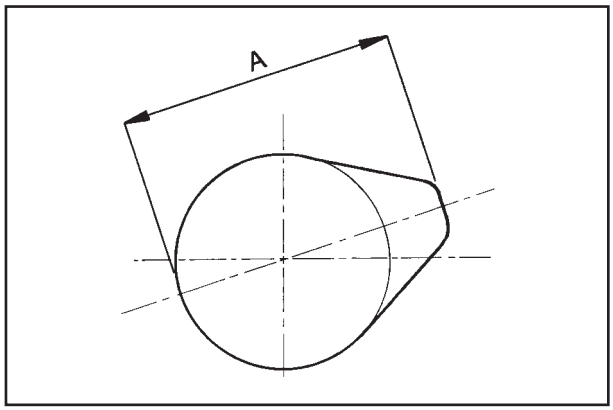


27

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	Measure-ment	Fitting mm	Max. wear mm
KD477-2	A-B	29,95 ÷ 30,00	29,70



28

Injection cam dimensions (fig. 28)

Engine	Measure-ment	Fitting mm	Max. wear mm
KD477-2	A	28,39÷ 28,43	28,30

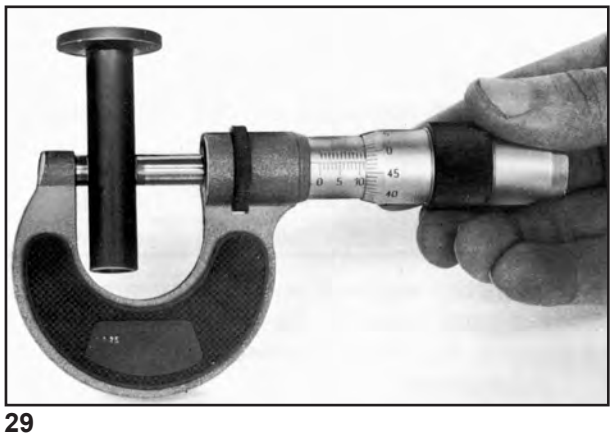
The coupling clearance between pins and respective housings should be:

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.

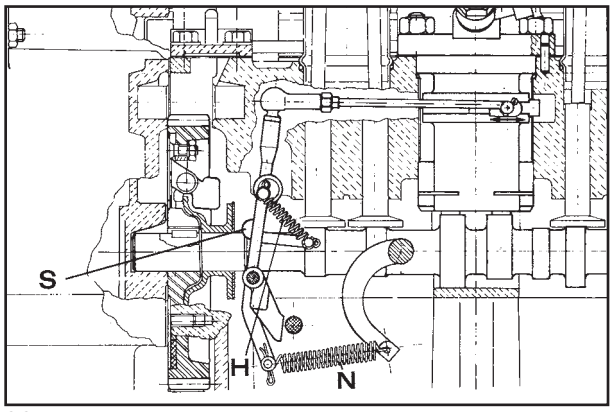


29

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	



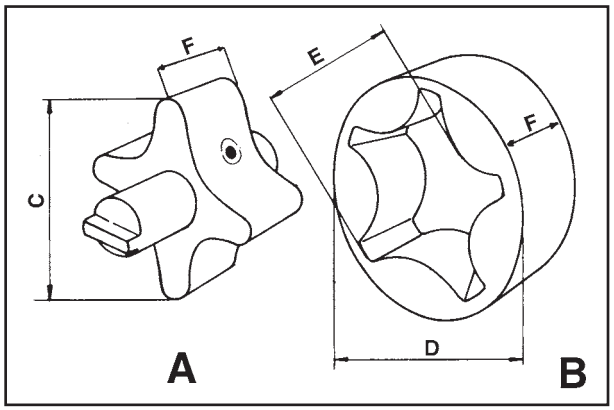
30

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



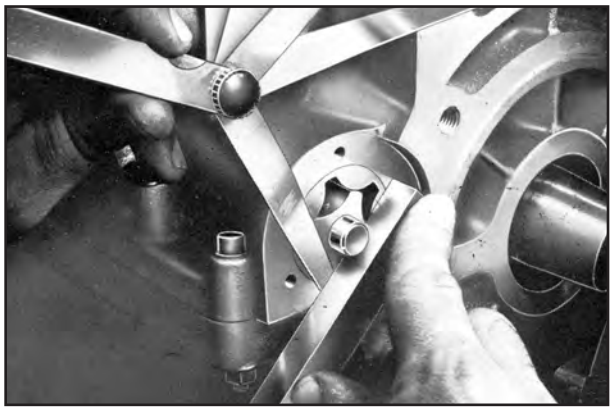
31

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.



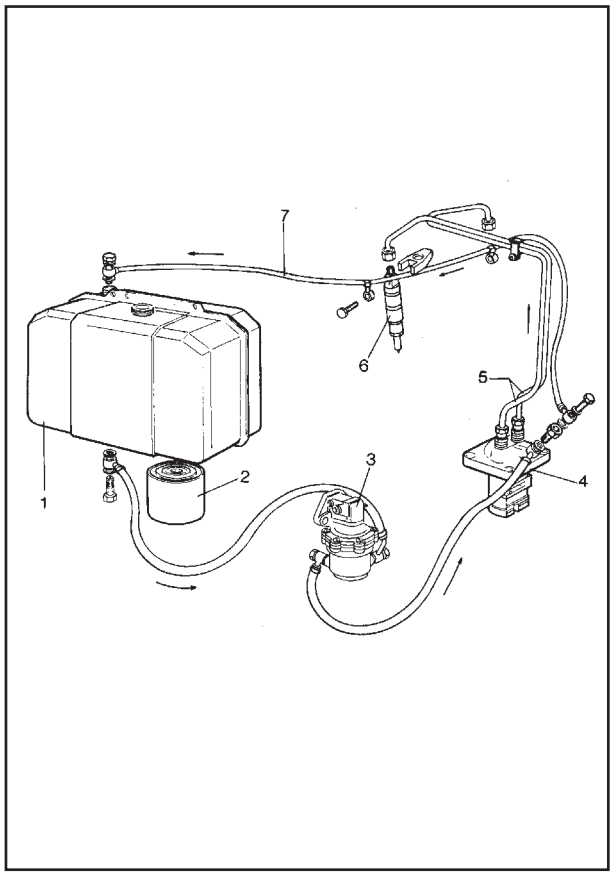
32

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

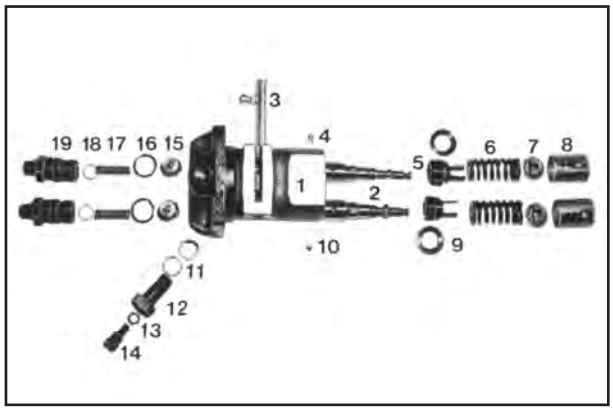


33

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.



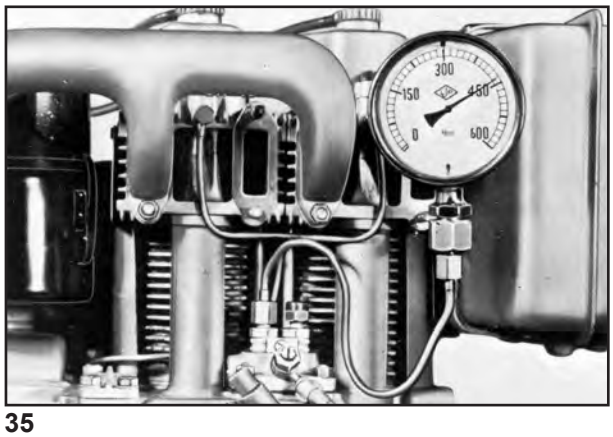
34

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.



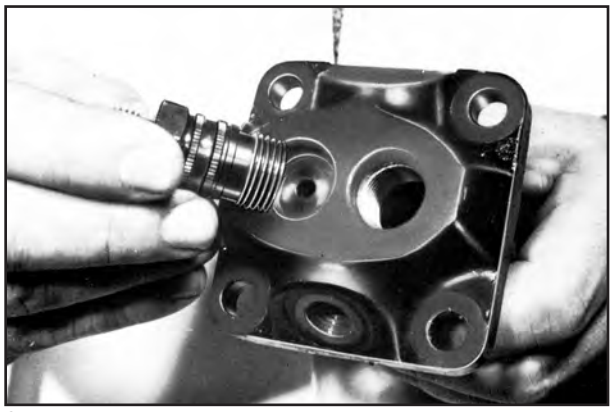
35

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
KD477-2	6	15	4	24 ÷ 26	1500



37

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.

38

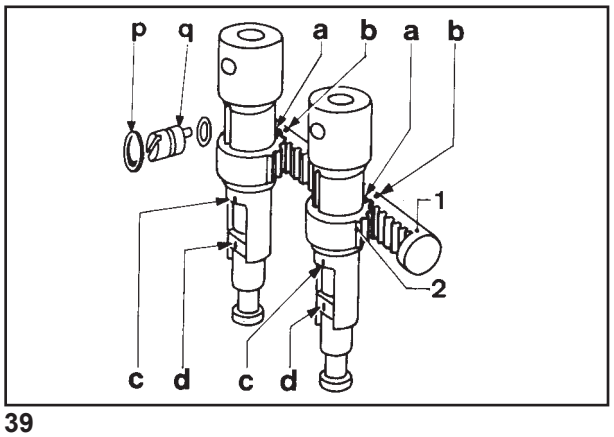
! **IMPORTANT:** The roller tappets (No 8 fig. 34) and the lower plates are not interchangeable as they determine the timing of the pumping elements.

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.



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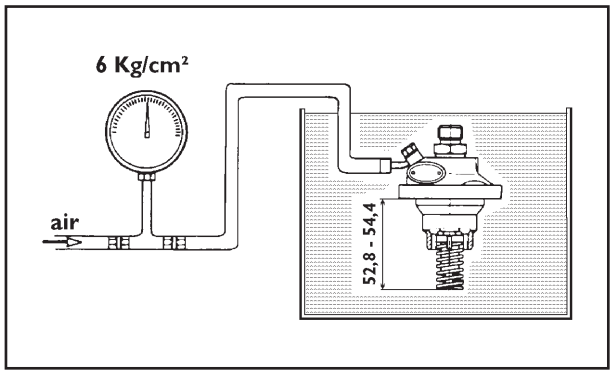
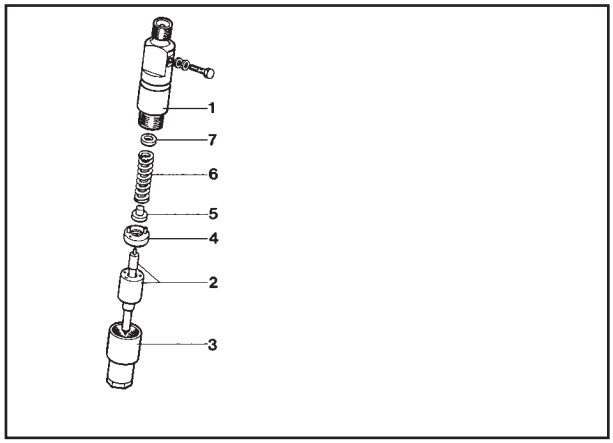


40

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.

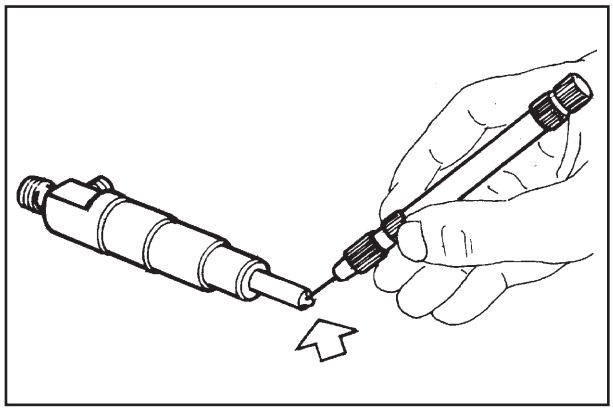
N.B.: Tightness can be checked by compressing the springs to 52.8 ÷ 54.4 mm, which corresponds to the bottom dead centre working position of the pump.



41

Injectors (fig. 41)

1.Body - **2**.Nozzle - **3**.Ring nut - **4**.Plate - **5**.Rod - **6**.Spring - **7**.Adjustment shim.



42

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
KD477-2	0,25

2. Set up injector on a test bench (tool cod. **00365R0430**).

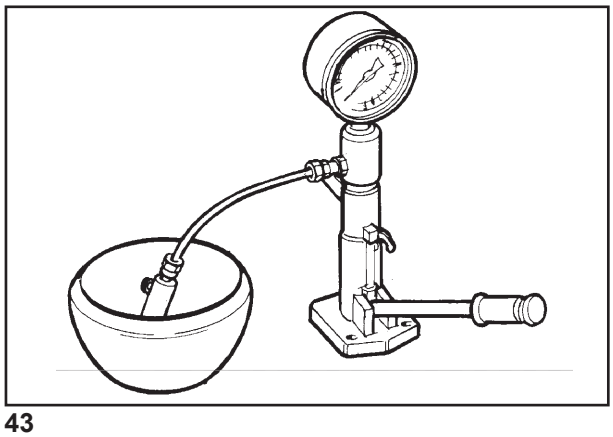
3. Unscrew injector lock coupling (No 3 fig. 41) or nozzle ring nut and insert adjustment shim (7, fig. 41) until the pressure indicated in the table hereunder is reached on the pressure gauge while pumping.

Engine	Setting kg/cm²
KD477-2	225 ÷ 235

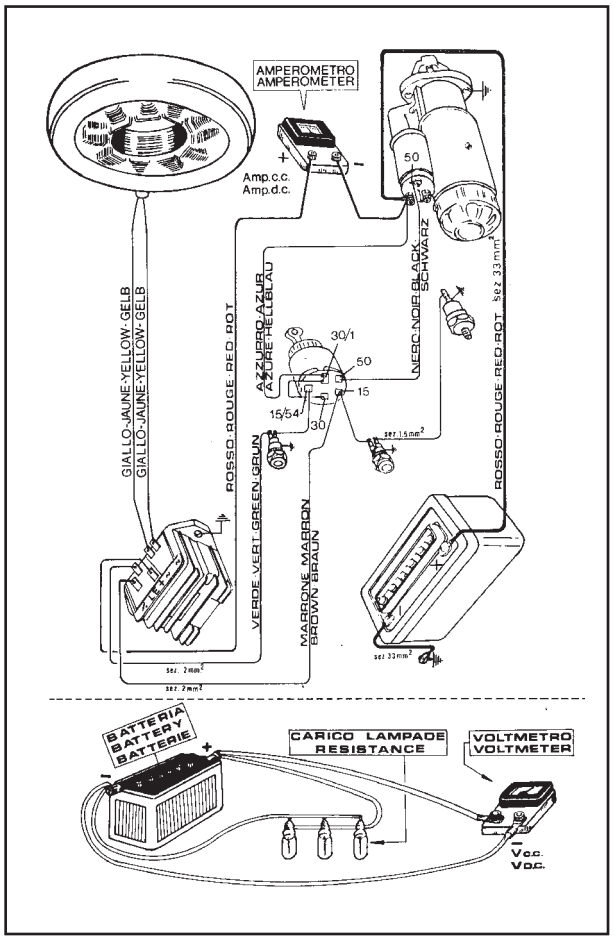
4. Tighten the nozzle ring nut (No 3 fig. 41) at:

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).



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**.

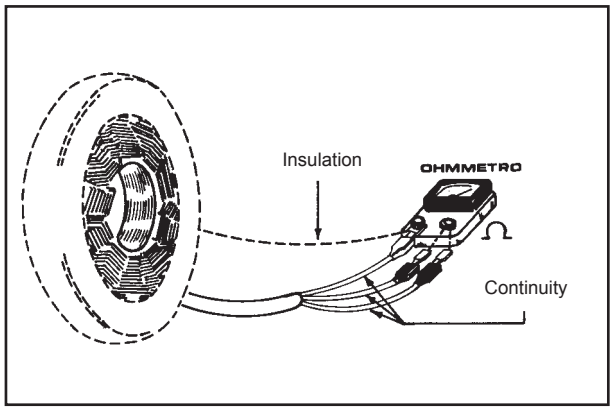
Regulator:
Electronic with controlled diodes and preset for battery re-charging pilot light connection.
12V-24A

Optional external alternator with belt control:
For 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

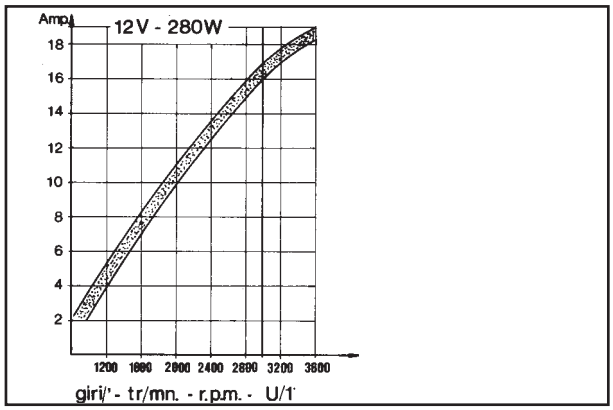
1. Make sure the connections between regulator and alternator are correct and in good condition.
2. Detach from the terminal on the starter motor, the red wire coming from the alternator, and insert a direct current ammeter with a **20 Amp** range between said free terminal and the detached wire.
3. 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.



45

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.

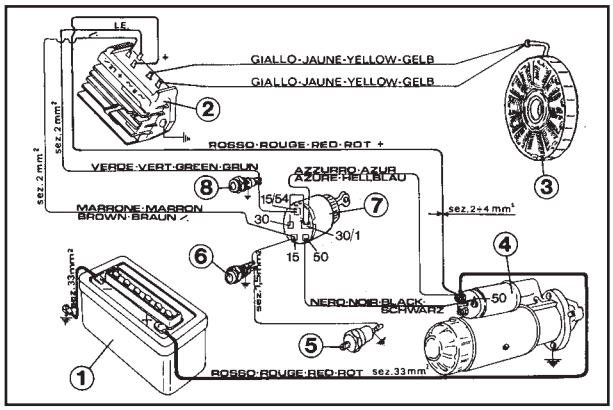


46

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.



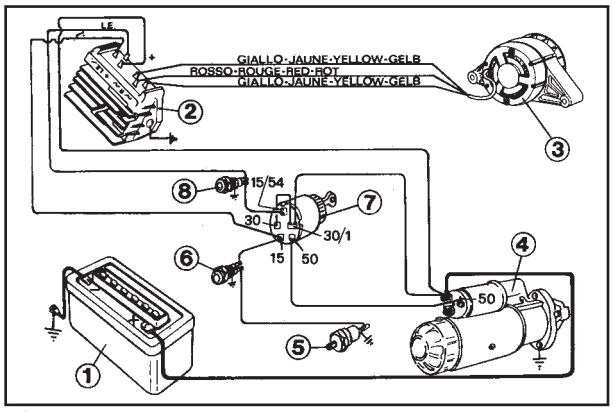
47

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.



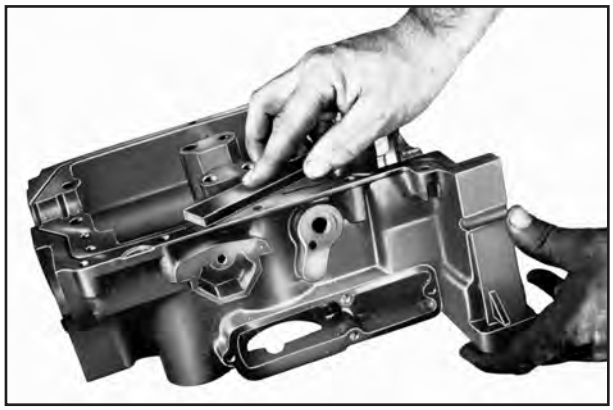
48

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.

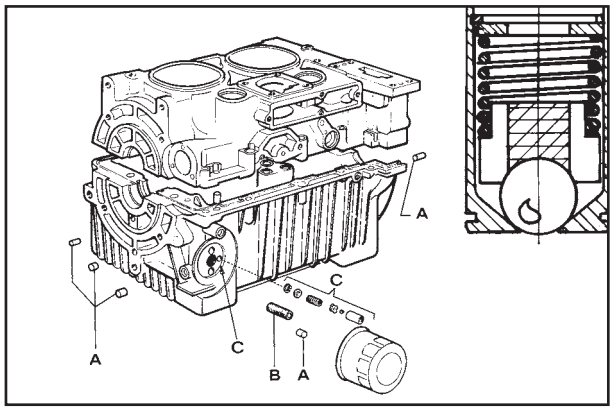
Diagram of electric starting wiring system with external alternator (fig. 48).

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.

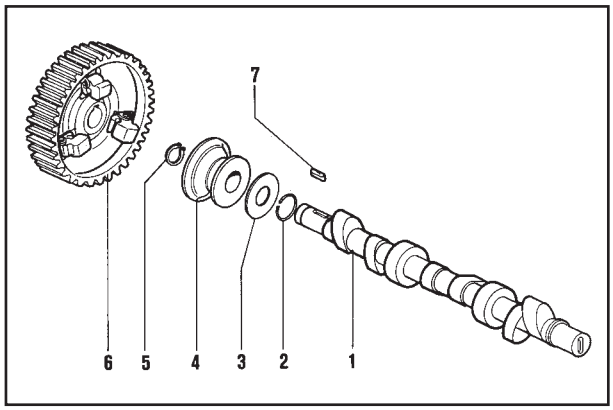


50

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)

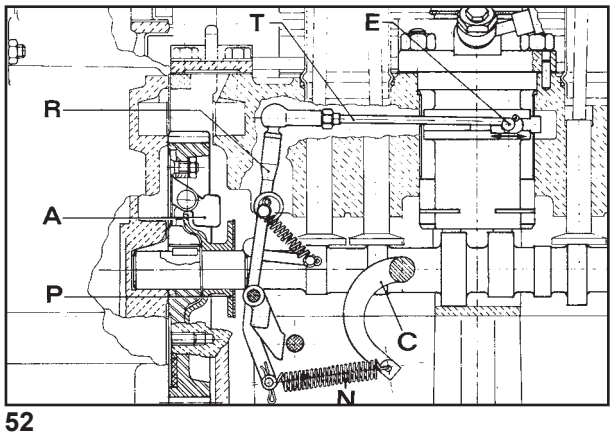
1. Insert plugs (A) into relative seats.
2. Screw in oil filter cartridge connection (B). The connection should protude 11 to 13 mm. from the crankcase.
3. Insert complete oil pressure register valve into its seat (C). Make sure the seat of the valve ball in the casing is free of dirt or scores which could jeopardize the pressure seal.
4. Insert cylinder studs and centering pins.



51

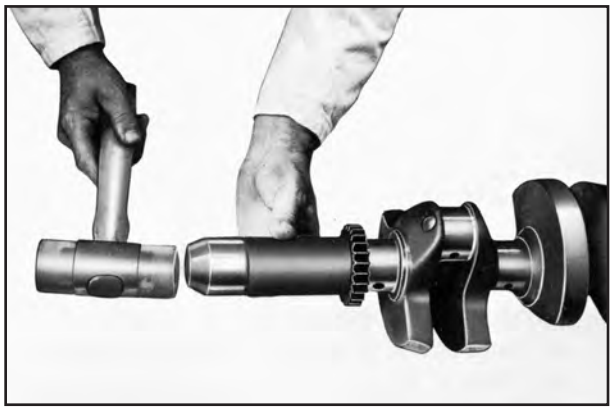
Camshaft preparation
To prepare the camshaft unit (fig. 51) proceed as follows:

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

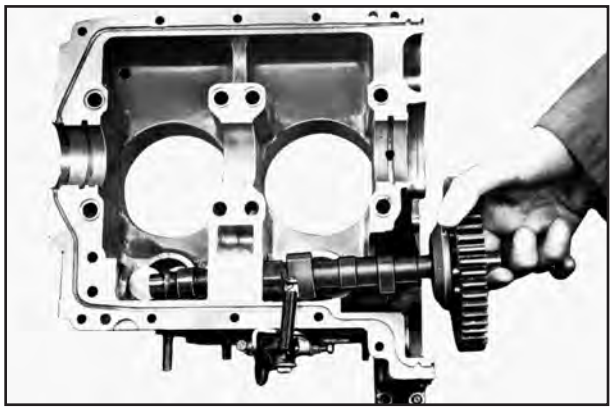
The speed governor is of the centrifugal mass type splined directly onto the ends of the camshaft gear (fig. 52).
Masses (**A**), pushed outwards by the centrifugal force, shift mobile plate (**P**) axially. Said plate actions lever (**R**) connected to injection pump rack bar (**E**) by means of tie 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.

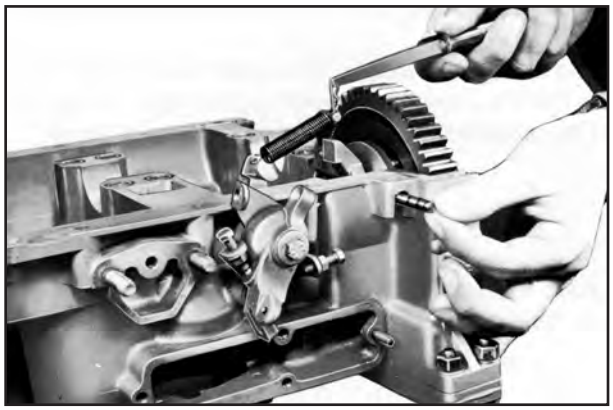
2. Fit interchangeable tappets into housings on crankcase.

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.

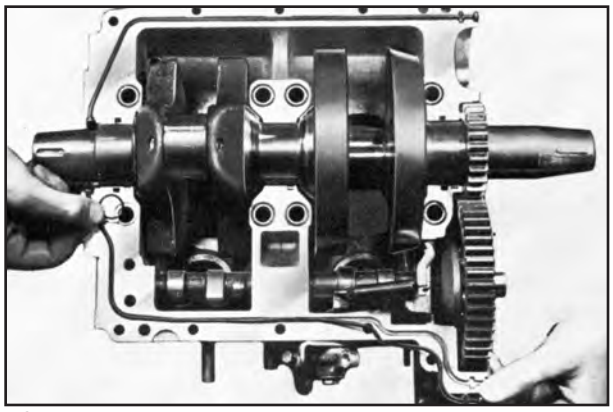
5. Insert main bearings into respective housings and spread with oil slightly.
   The three main bearings are identical and interchangeable.

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).

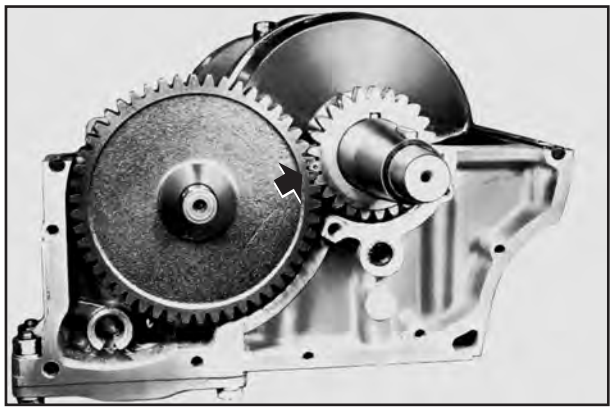


55

! It is advisable to spread a bit of rubber adhesive round the edges of the rubber gasket for better seal.



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).

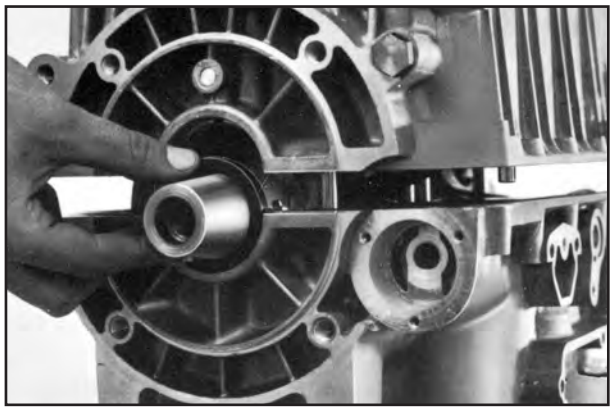
! A warped oil retainer may allow the introduction of air into the engine thus causing crankcase ventilation problems. Use genuine oil retainers with the Kohler.

9. Mount lower crankcase complete with studs, centering pins and bearings.

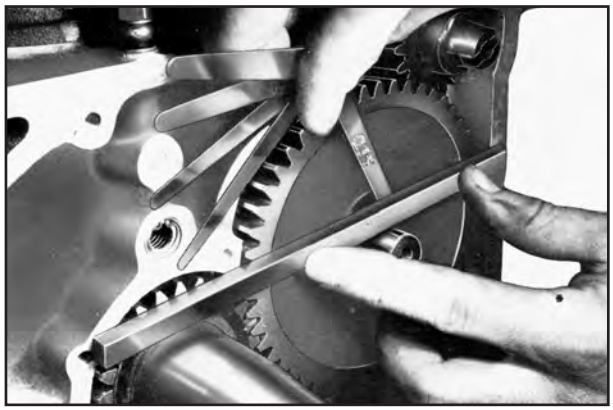
10. Take care to insert the centering pins between crankcases into their respective housings without using force.

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

60

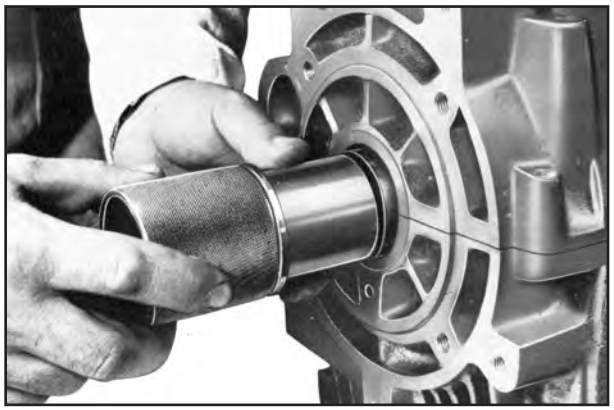
If the axial clearance of the crankshaft becomes excessive after a long working period, add adjustment shims to the engine shaft and camshaft gear until the clearance returns to normal values (fig. 60).

0.2 and 0.3 mm shims are available.

61

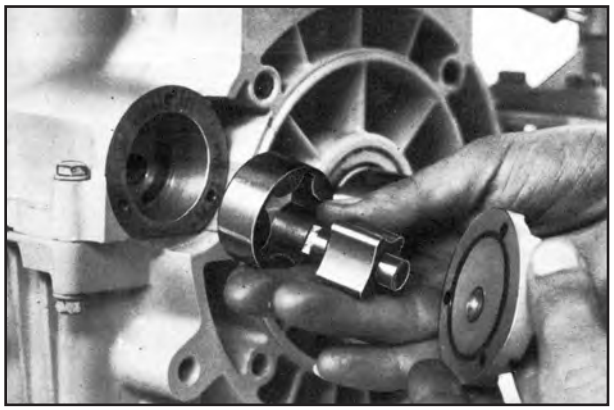
Fitting of oil seal rings
To introduce oil seal ring, flywheel side, use an ordinary cylindrical plug of appropriate size as shown in fig. 61.

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

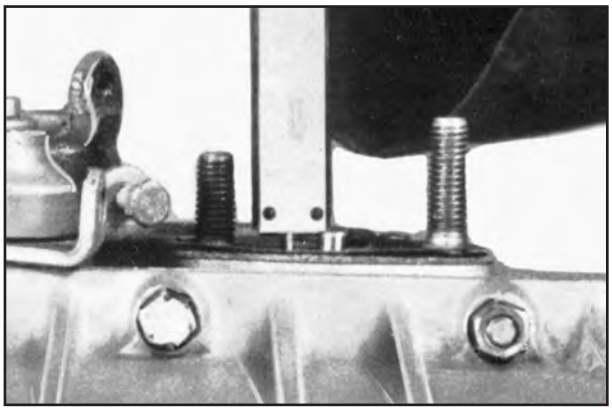


63

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

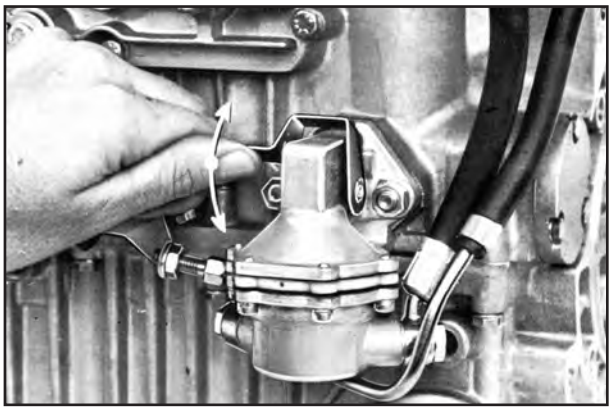
Feeding pump assembly

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:

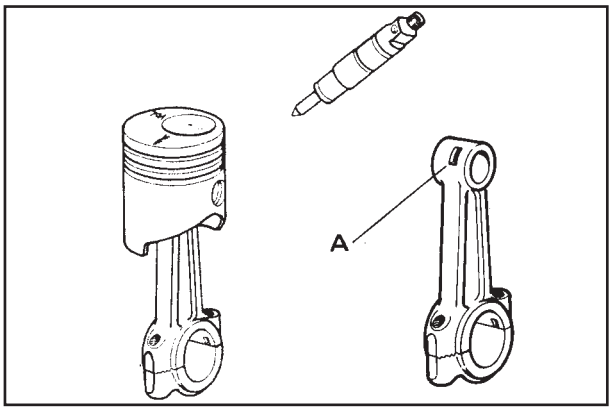
1,7 ÷ 2,1 mm



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.



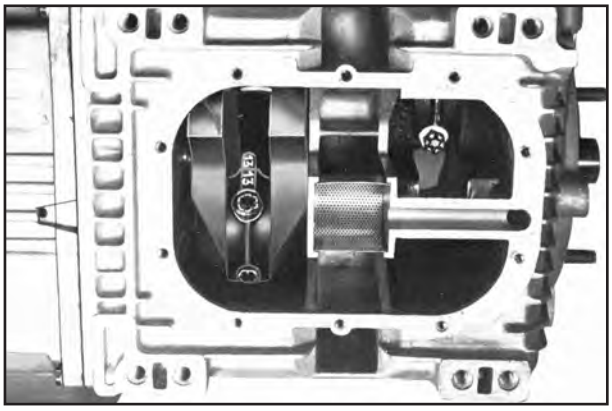
66

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

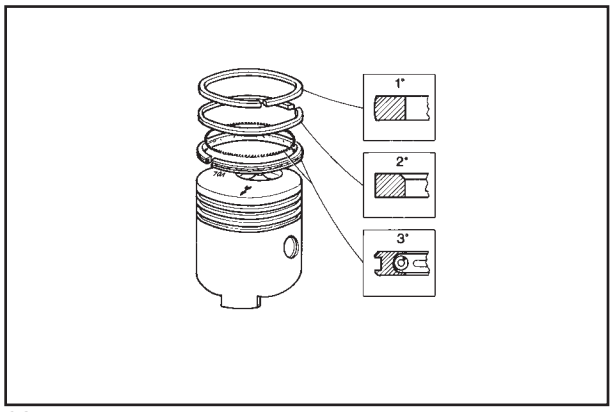
Connecting rod-crankshaft coupling

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

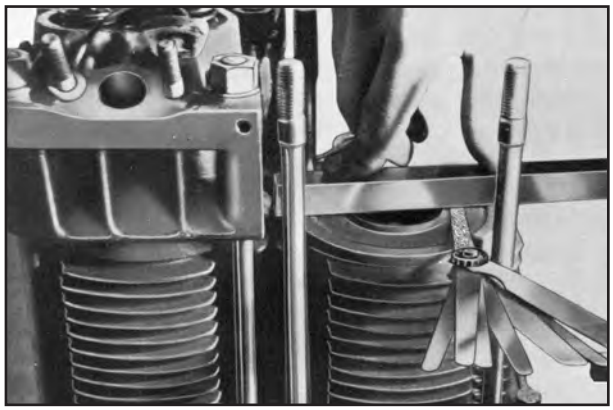
Before mounting cylinders, rotate rings 120° opposite to each (fig. 69) other with the ends of the 1st compression ring in line with the gudgeon pin axis.

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**).

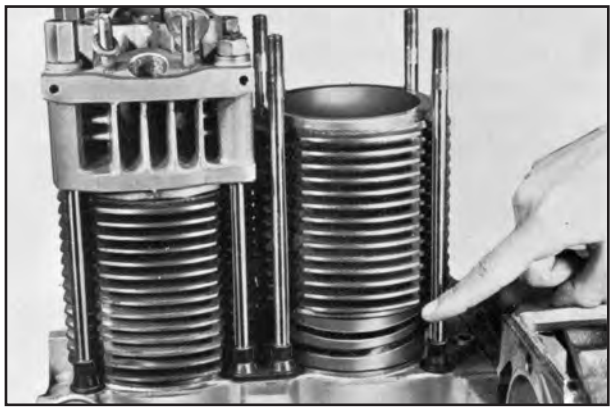


72

Cylinder height adjustement
Between the top face of the cylinder and the piston at top dead center, there must be a clearance of:

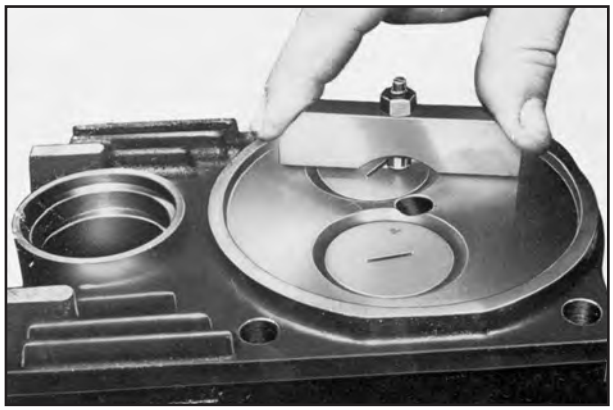
0,25 ÷ 0,35 mm

! 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**

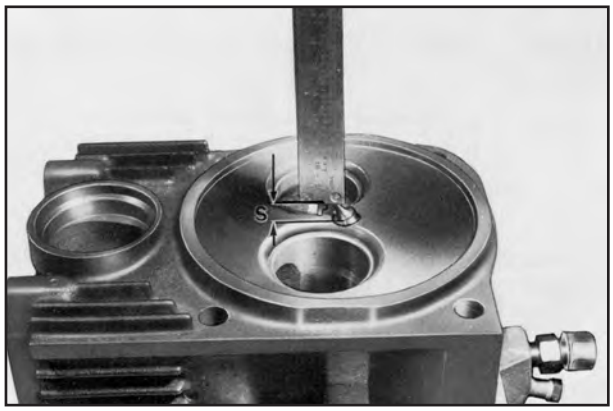


74

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

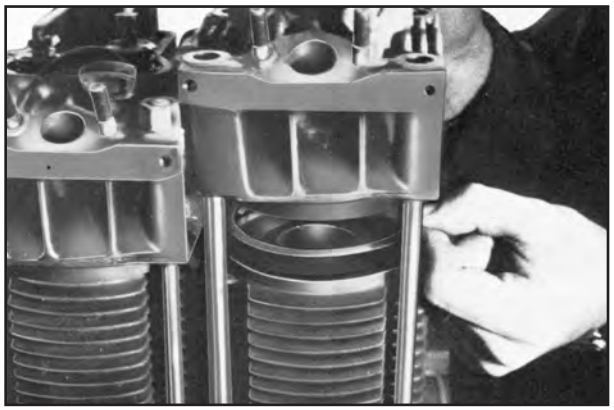
Checking injector protrusion
Before mounting the heads on the cylinders, insert injectors in their housings and after having secured them temporarily, check protusion of nozzles from head surface (fig. 75).

Protusion **S** should be:

2,25 ÷ 2,75 mm

76

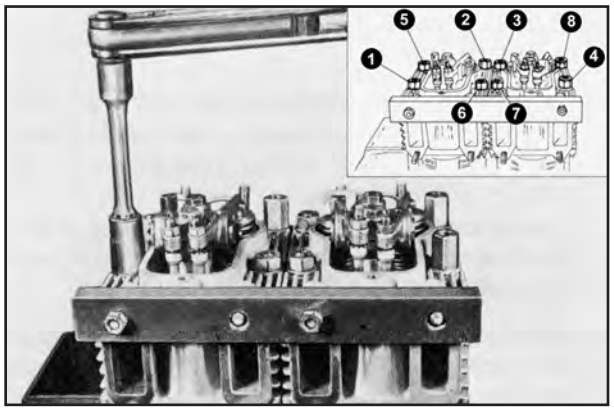
Adjustment is effected by inserting copper washers between the injector and injector supporting faces on the heads (fig. 76). Washer thickness **1 mm**.



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:

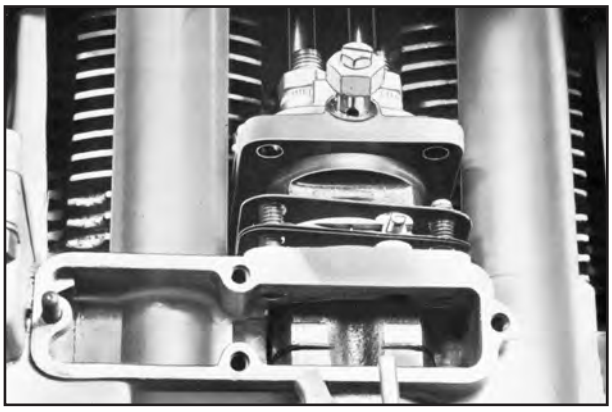
5 kgm (49 Nm)

79

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

0,15 mm
intake/exhaust

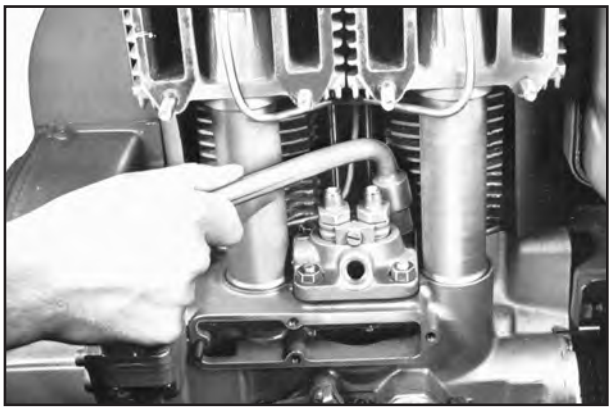
The operation must be carried out with the pistons at their top dead center compression position.



80

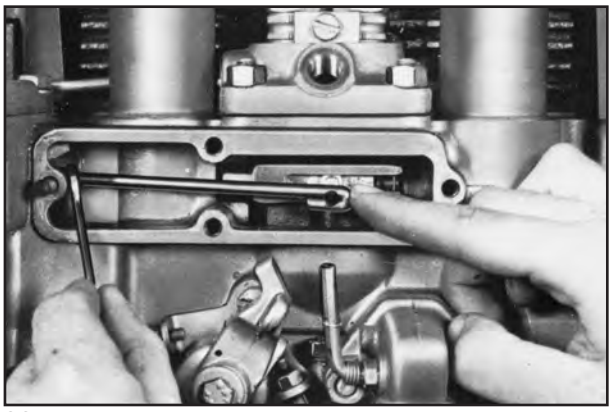
Injection pump fitting
Fit injection pump into timing case inserting adjusting shim between supporting flange and crankcase (fig. 80).

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

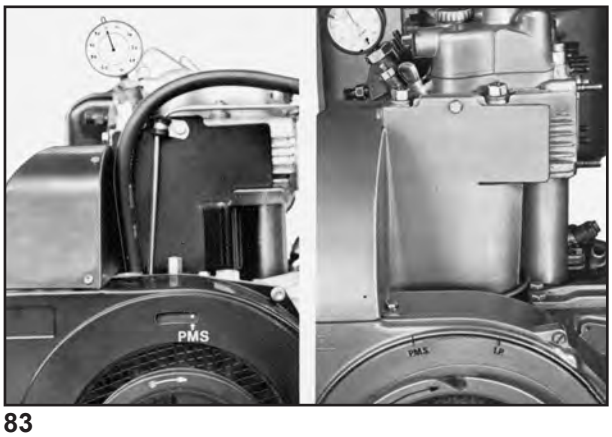
To facilitate tightening of pump nuts on the cylinder side, use the special key (tool od. **00365R0210**) illustrated in fig. 81.



82

Injection pump tie rod connection

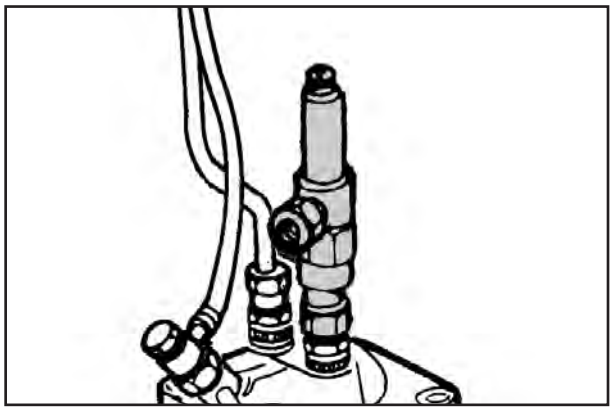
- The injection pump tie rod length, measured from the connecting centre of the rack bar to the centre of the ball joint must be **mm 118 ±1** complete turn.
  Careful operation will avoid uneven running, starting difficulties and power losses.
- Connect tie rod to governor lever, engaging the ball joint to 90° (fig. 82), and to the injection pump rack bar and then insert split pin.



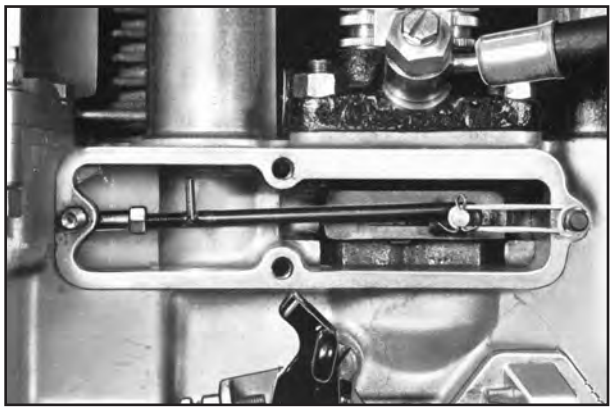
83

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).

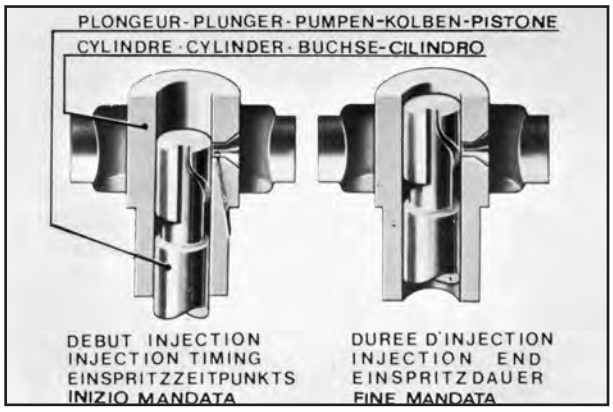
If the flywheel has to be replaced, transfer and punch the above mentioned indications on the new one.



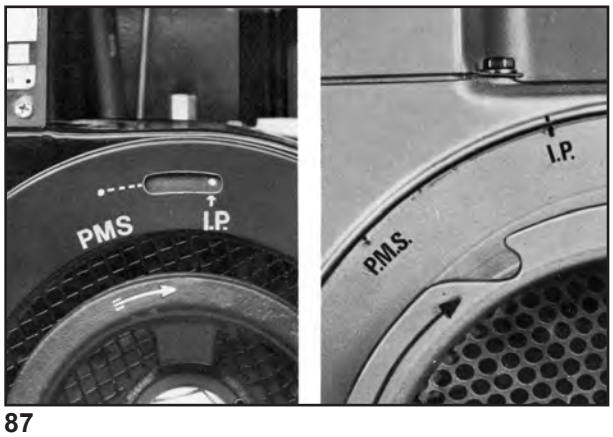
84



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 crankcase.

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

89

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.

90

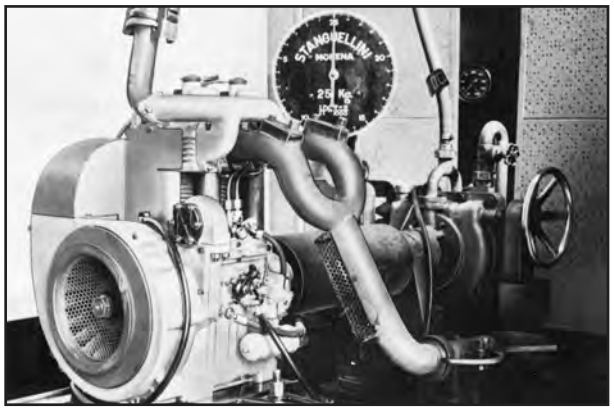
Checking oil pressure

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.**

91

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

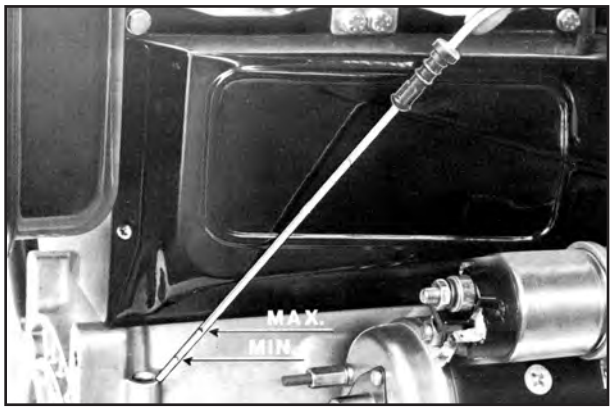
After having placed the engine on the brake (fig. 92), proceed with the following operations:

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.

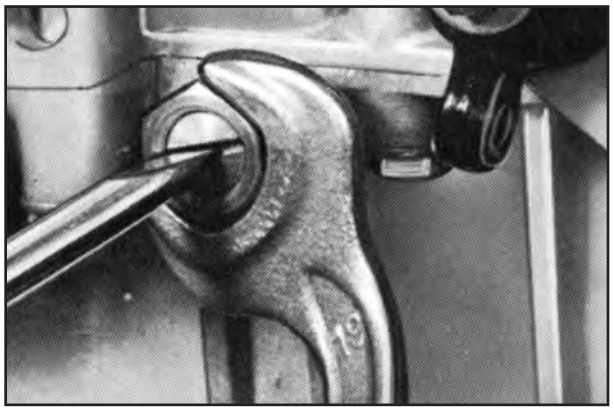


93

Running-in table

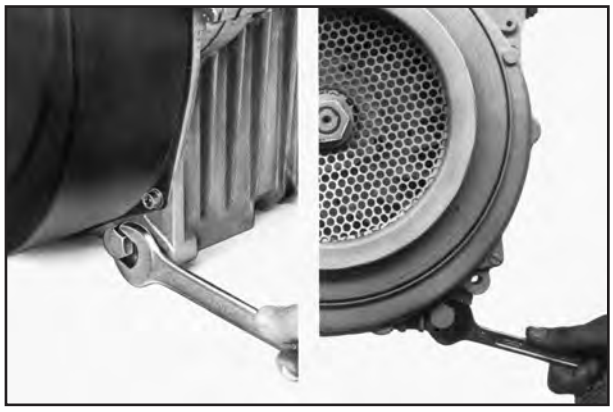
Time (min)	RPM	Load
5	2000	0
15	3000/3600	0
30	3000/3600	30%
30	3000/3600	50%
30	3000/3600	70%
5	3000/3600	100%

Engine power curves are reported at page 12.

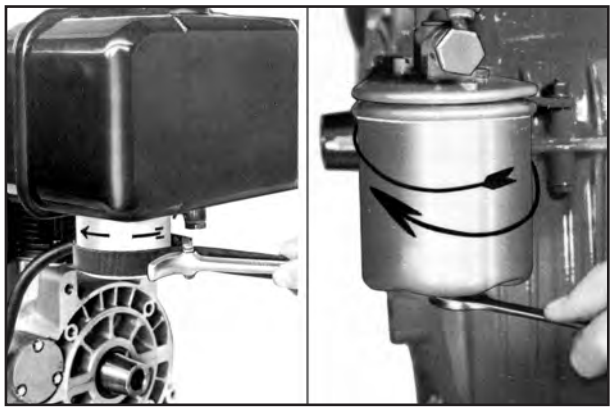


94

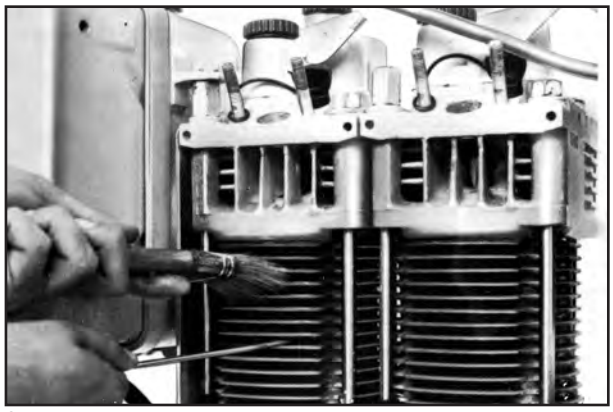
! In order to check that the setting is correct, without tools, accelerate the engine a few times with no load and check the exhaust fumes.
Delivery of diesel fuel is correctly calibrated when the exhaust gas is slightly coloured by smoke; change the adjustment if necessary by turning the adjustment screw (fig. 94).



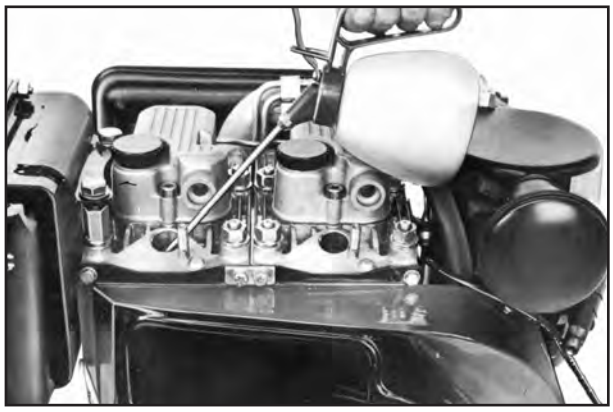
95



96



97



98

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. 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.
- 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

End floats	MIN (mm)	MAX (mm)
Crankshaft	0,10	0,20
Camshaft	0,10	0,20
Oil pump shaft	0,01	0,05

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** **R ≥ 800 N/mm²**		 **= R10 = 10.9** **R ≥ 1000 N/mm²**		 **= R12 = 12.9** **R ≥ 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

Translated from the original manual in Italian language.

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

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