WORKSHOP MANUAL

LGA 280 OHC

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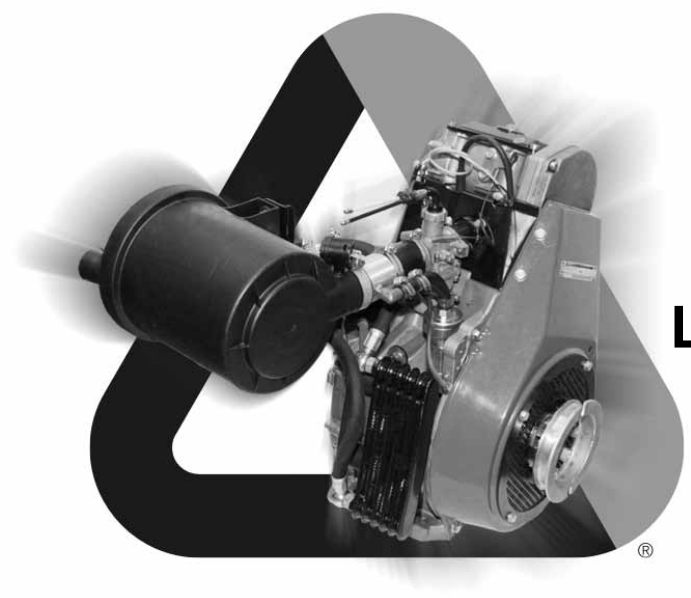
UNI EN ISO 9001 - cert. n° 0446
ISO/TS 16949 - cert. n° 3792

LOMBARDINI® SERVICE
A KOHLER COMPANY



LGA 280 OHC

PREFACE

- Every attempt has been made to present within this service manual, accurate and up to date technical information.
  However, development on the **LOMBARDINI** series is continuous.
  Therefore, the information within this manual is subject to change without notice and without obligation.

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

Information presented within this manual assumes the following:

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

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

3 - The person or people performing service work on **LOMBARDINI** series engines has read the pertinent information regarding the subject service operations and fully understands the operation at hand.

- This manual was written by the manufacturer to provide technical and operating information to authorised **LOMBARDINI** after-sales service centres to carry out assembly, disassembly, overhauling, replacement and tuning operations.

- As well as employing good operating techniques and observing the right timing for operations, operators must read the information very carefully and comply with it scrupulously.

- Time spent reading this information will help to prevent health and safety risks and financial damage.
  Written information is accompanied by illustrations in order to facilitate your understanding of every step of the operating phases.

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REGISTRATION OF MODIFICATIONS TO THE DOCUMENT

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

Drafting body	Document code	Model N°	Edition	Revision	Issue date	Review date	Endorsed
CUSE/ATLO	1-5302-714	51130	**6th**	**05**	15-01-2006	18-04-2011	

5 DISASSEMBLY / REASSEMBLY 40- 91

GENERAL SERVICE MANUAL NOTES

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

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

SAFETY AND WARNING DECALS

- Important remarks and features of the text are highlighted using symbols, which are explained below:

Danger – Attention

This indicates situations of grave danger which, if ignored, may seriously threaten the health and safety of individuals.

Caution – Warning

This indicates that it is necessary to take proper precautions to prevent any risk to the health and safety of individuals and avoid financial damage.

Important

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

SAFETY REGULATIONS

- **LOMBARDINI** Engines are built to supply their performances in a safe and long-lasting way.
  To obtain these results, it is essential for users to comply with the servicing instructions given in the relative manual along with the safety recommendations listed below.
- The engine has been made according to a machine manufacturer's specifications and all actions required to meet the essential safety and health safeguarding requisites have been taken, as prescribed by the current laws in merit.
  All uses of the engine beyond those specifically established cannot therefore be considered as conforming to the use defined by **LOMBARDINI** which thus declines all liability for any accidents deriving from such operations.
- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation in particular, along with the relative routine maintenance work.
- The user must read these instructions carefully and become familiar with the operations described.
  Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- The engine may only be used or assembled on a machine by technicians who are adequately trained about its operation and the deriving dangers.
  This condition is also essential when it comes to routine and, above all, extraordinary maintenance operations which, in the latter case, must only be carried out by persons specifically trained by **LOMBARDINI** and who work in compliance with the existing documentation.
- Variations to the functional parameters of the engine, adjustments to the fuel flow rate and rotation speed, removal of seals, demounting and refitting of parts not described in the operation and maintenance manual by unauthorized personnel shall relieve **LOMBARDINI** from all and every liability for deriving accidents or for failure to comply with the laws in merit.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ.
  In the case of manual start-ups, make sure that the relative actions can take place without the risk of hitting walls or dangerous objects, also considering the movements made by the operator.
  Pull-starting with a free cord (thus excluding self-winding starting only), is not permitted even in an emergency.
- Make sure that the machine is stable to prevent the risk of overturning.
- Become familiar with how to adjust the rotation speed and stop the engine.
- Never start the engine in a closed place or where there is insufficient ventilation.
  Combustion creates carbon monoxide, an odourless and highly poisonous gas.
  Lengthy stays in places where the engine freely exhausts this gas can lead to unconsciousness and death.
- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unles specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Fuel is inflammable.
  The tank must only be filled when the engine is off.
  Thoroughly dry any spilt fuel and move the fuel container away along with any rags soaked in fuel or oil.
  Make sure that no soundproofing panels made of porous material are soaked in fuel or oil.
  Make sure that the ground or floor on which the machine is standing has not soaked up any fuel or oil.
- Fully tighten the tank plug each time after refuelling.
  Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- Fuel vapour is highly toxic.
  Only refuel outdoors or in a well ventilated place.
- Do not smoke or use naked flames when refuelling.
- The engine must be started in compliance with the specific instructions in the operation manual of the engine and/or machine itself.
  Do not use auxiliary starting aids that were not installed on the original machine (e.g. Startpilot').
- Before starting, remove any tools that were used to service the engine and/or machine.
  Make sure that all guards have been refitted.

- During operation, the surface of the engine can become dangerously hot.
  Avoid touching the exhaust system in particular.
- Before proceeding with any operation on the engine, stop it and allow it to cool.
  Never carry out any operation whilst the engine is running.
- The coolant fluid circuit is under pressure.
  Never carry out any inspections until the engine has cooled and even in this case, only open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles. If there is an electric fan, do not approach the engine whilst it is still hot as the fan could also start operating when the engine is at a standstill.
  Only clean the coolant system when the engine is at a standstill.
- When cleaning the oil-cooled air filter, make sure that the old oil is disposed of in the correct way in order to safeguard the environment.
  The spongy filtering material in oil-cooled air filters must not be soaked in oil.
  The reservoir of the separator pre-filter must not be filled with oil.
- The oil must be drained whilst the engine is hot (oil T ~ 80°C).
  Particular care is required to prevent burns.
  Do not allow the oil to come into contact with the skin.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and cold.
  Take care to prevent fluids containing nitrites from being mixed with others that do not contain these substances since "Nitrosamine", dangerous for the health, can form.
  The coolant fluid is polluting and must therefore be disposed of in the correct way to safeguard the environment.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the positive wire of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Only check belt tension when the engine is off.
- Only use the eyebolts installed by **LOMBARDINI** to move the engine.
  These lifting points are not suitable for the entire machine; in this case, the eyebolts installed by the manufacturer should be used.

GENERAL SAFETY DURING OPERATING PHASES

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

SAFETY AND ENVIRONMENTAL IMPACT

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

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

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

- All packaging components must be disposed of in accordance with the laws of the country in which disposal is taking place.
- Keep the fuel and engine control systems and the exhaust pipes in efficient working order to limit environmental and noise pollution.
- When discontinuing use of the engine, select all components according to their chemical characteristics and dispose of them separately.

ENGINE ON ROTATING STAND - SAFETY PRECAUTIONS

Important

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

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

- Hook the lifting device in the engine lifting points, as shown in the figure.

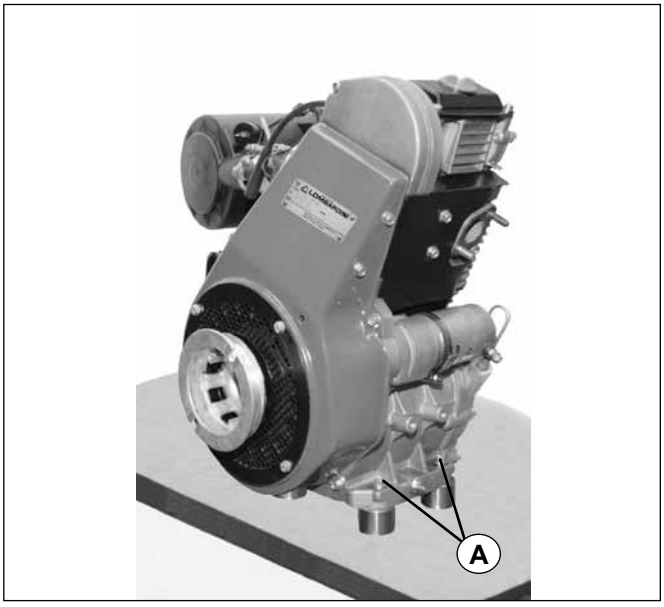
- Before lifting, make sure the weight is correctly balanced by checking its barycentre.

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

- Place the engine on a rotating stand to easily work on it.

Important

The bracket of the lifting point have been designed to lift the engine only. It is not intended nor approved to lift additional weights.
Do not use different methods to lift the engine than those described herein. In case different methods are used, no warranty shall be granted for any consequential damage.

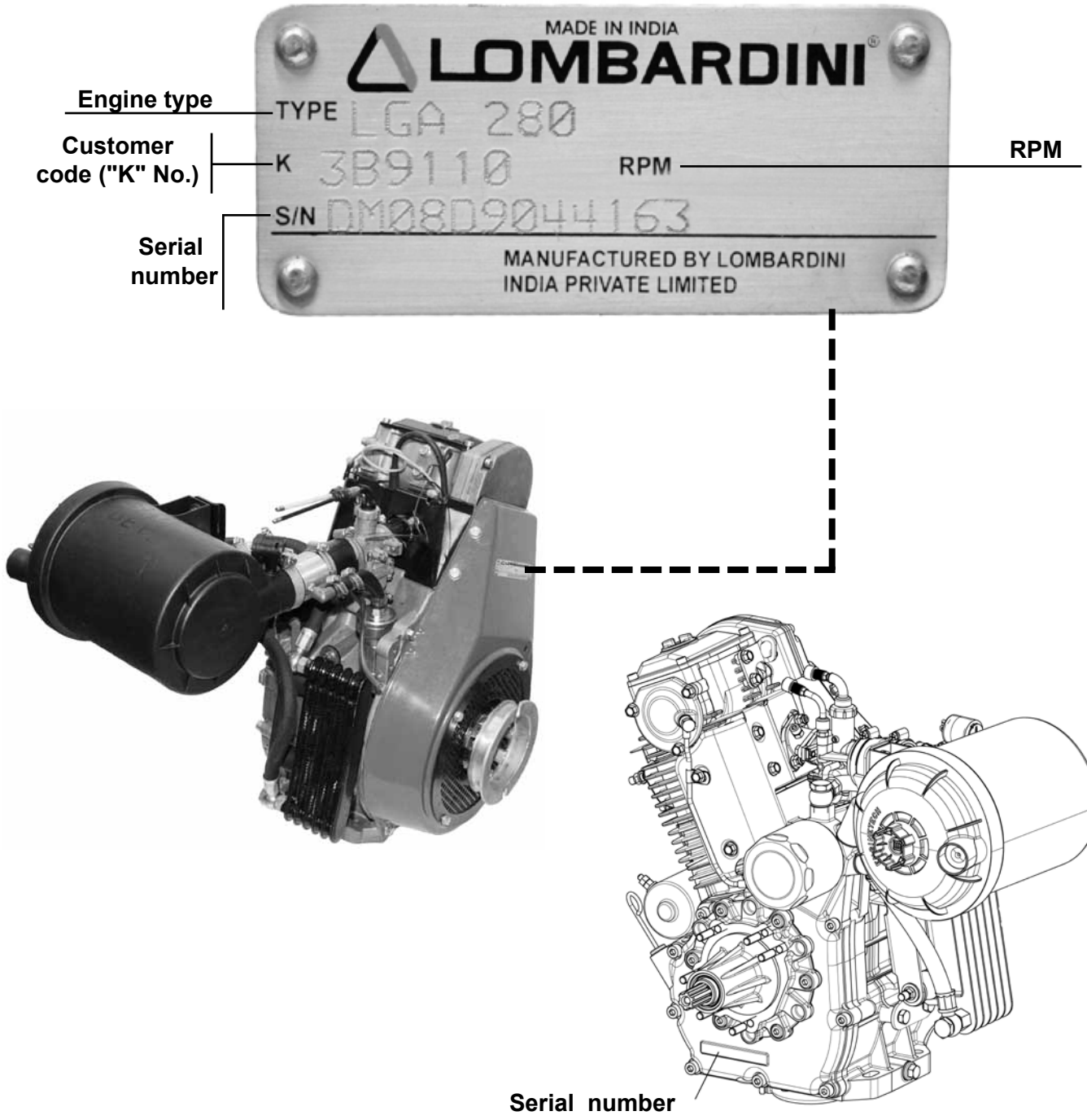


Note: Depending on the type of procedure, the engine may also be rested on the workbench, supported by spacers to prevent damage to the oil sump.
To avoid accidentally overturning the engine, secure it to the bench using 4 screws as shown in figure A.

GENERAL DESCRIPTION OF THE ENGINE

LGA 280 SPECIFICATIONS (forced lubrication)

- Type of engine : Endothermic engine
- 8 and 4-stroke cycle
- OHC driven by toothed belt, timing synchronized throught toothed belt
- Forced-air cooling system with fan flywheel
- Lubrication system: fully forced by trochoidal pump
- Electrical starting with starter motor (0.6 kW)
- Automatic centrifugal decompression device
- Cast iron liner incorporated in the casting.



ENGINE CHARACTERISTICS

ENGINE TYPE		LGA 280 GASOLINE	LGA 280 GPL	LGA 280 CNG
Cylinder	N.	1	1	1
Bore	mm	74	74	74
Stroke	mm	64	64	64
Displacement	Cm³	275	275	275
Compression ratio		8.8 ÷ 1	8.8 ÷ 1	8.8 ÷ 1
Max R.P.M. at no-load	RPM	6200	6200	6200
Rating kW N DIN 70020	kW/RPM	6.2@4400	6.0@4400	5.4@4400
Max torque	Nm/RPM	16.4@2800	15.4@2900	14.3@3000
Oil capacity (without filter)	lt.	1.6	1.6	1.6
Oil capacity (with filter)	lt.	1.7	1.7	1.7
Oil consumption	g/kW.h	0.8	0,8	0.8
Dry weight	Kg.	30.5	30.5	30.5
Spark plug		Champion RC12YC		
Ignition system		Electronics		

LGA 280 OHC

PROBLEMS AND RELATED CAUSES

THE ENGINE MUST BE STOPPED IMMEDIATELY WHEN:

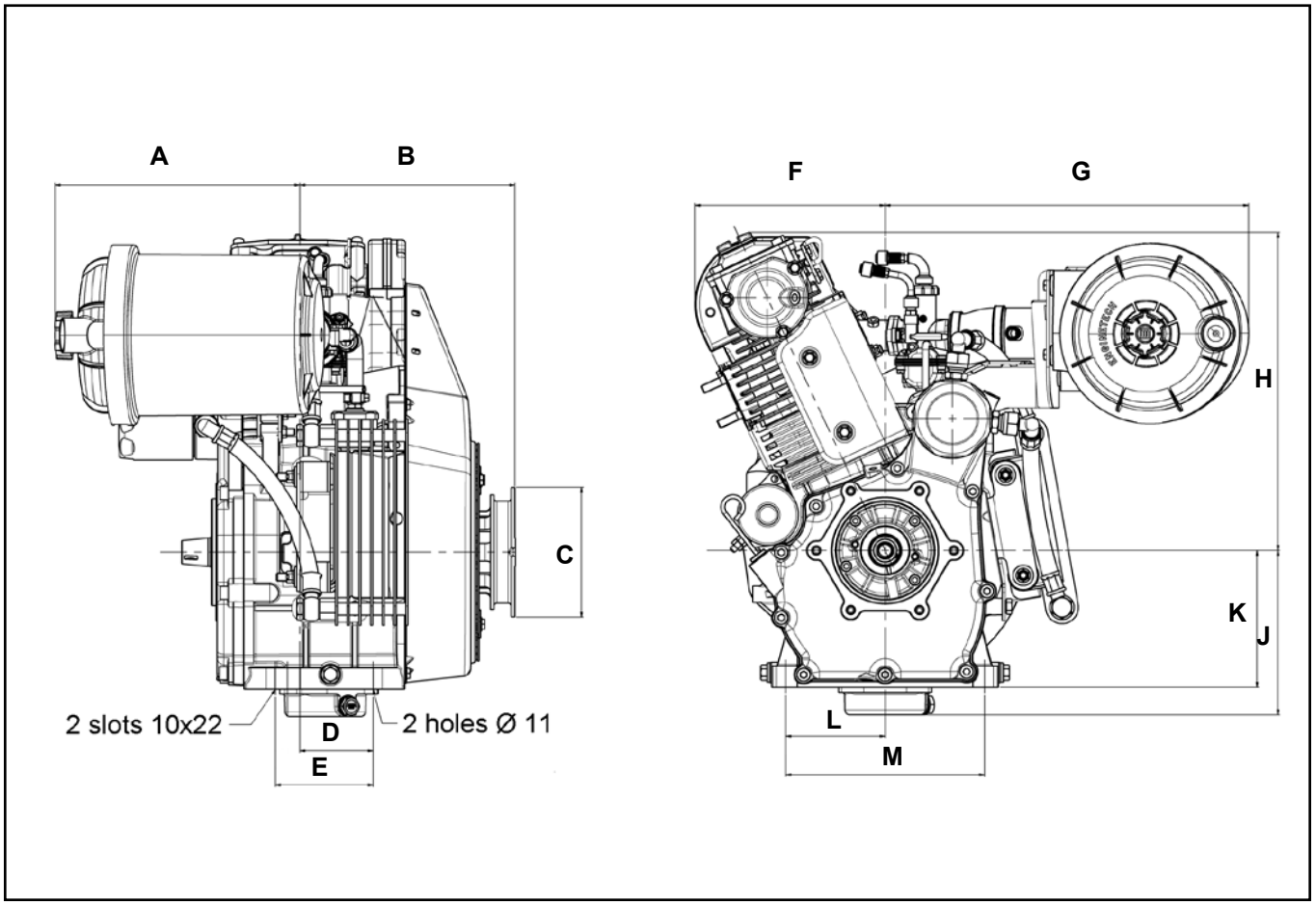
1) - The engine rpms suddenly increase and decrease;
2) - A sudden and unusual noise is heard;
3) - The colour of the exhaust gas suddenly darkens;
4) - The oil pressure indicator light turns on while running;

TABLE OF ANOMALIES ACCORDING TO THEIR SYMPTOMS

The following table suggests the probable causes of some anomalies that may appear during engine operation.
Always proceed systematically. Start from the basic checks before disassembling the engine or replacing its components.

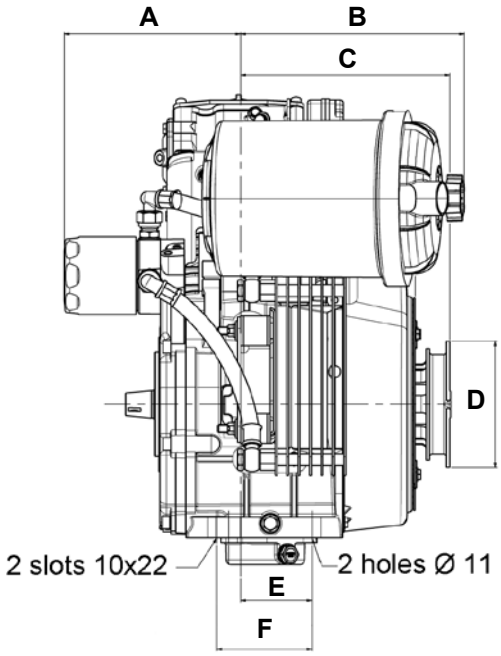
POSSIBLE CAUSES		TROUBLE														
		The engine does not start	Starts and stops	No power	Noisy	White smoke	Black smoke	Hunts	Consumes excessive oil	Overheats	Does not accel.	Spark plug fails to spark	Unstable engine operation.	Poor combustion	High oil pressure	Low oil pressure
IGNITION	Grounded sparking plug	■										■				■
	Disconnected or broken spark cable	■										■				■
	Faulty coil	■	■								■	■	■	■		
	Faulty rotor	■														
	Loosened or oxidized cable clamp	■														
	Demagnetized flywheel	■		■							■	■		■		
FUEL CIRCUIT	Clogged piping	■	■													
	Clogged fuel filter	■	■					■								
	Presence of air in the fuel circuit	■	■													
	Clogged tank breather (cap)	■	■					■								
	Clogged carburettor breathers	■	■				■				■		■			
	Dirty carburettor	■	■				■	■			■		■			
	Blocked carburettor needle valve		■								■					
ELEC-TRICAL SYSTEM	Low battery	■														
	Faulty starting switch	■														
	Faulty starting motor	■														
MAINTENANCE	Air filter clogged		■				■				■					
	Excessive idle operation					■										
	Incomplete running-in					■										
	Engine overloaded									■	■					
	Clogged flywheel and sidewalls									■						
ADJUSTMENTS/ ENGINE REPAIR	Adjust carburetion		■	■				■			■		■			
	Low idling setting		■													
	Worn or blocked piston rings			■		■			■		■					
	Worn or blocked cylinder			■		■			■		■					
	Sticking valves	■	■	■						■						
	Excessive valve clearance				■											
	Broken timing belt	■														
LUBRIFICATION CIRCUIT	Oil level too high					■			■				■			
	Pression regulating valve jammed or dirty														■	■
	Worn oil pump															■
	Air in oil intake pipe															■
	Defective pressure gauge or pressure switch															■
	Oil intake pipe clogged															■
	Oil filter clogged															■

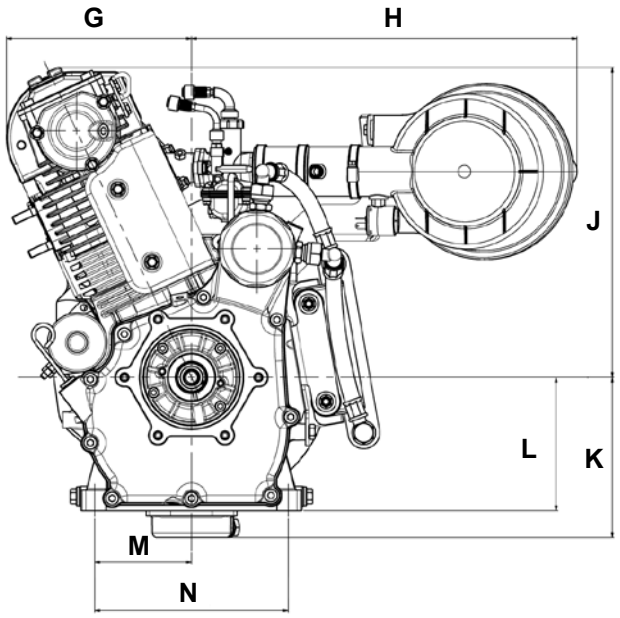
OVERALL DIMENSIONS

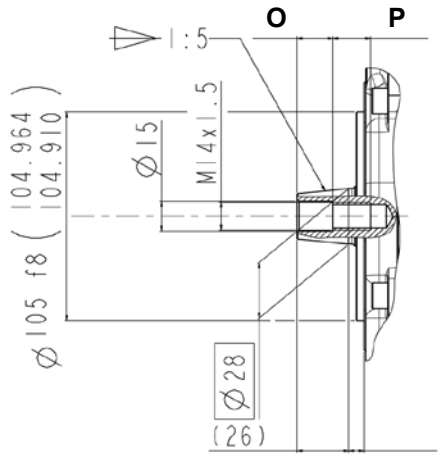


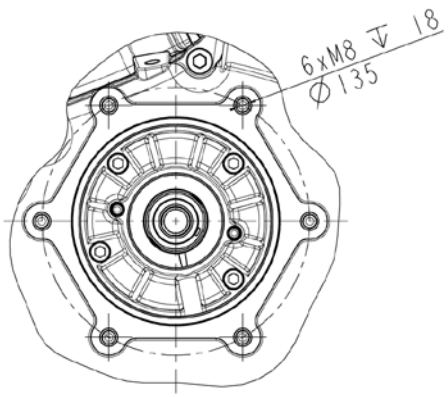
DIMENSIONS (mm)							
A	240.3	**D**	72	**G**	356.7	**K**	134.5
B	211	**E**	96	**H**	312	**L**	97.5
C	127	**F**	186.5	**J**	161.5	**M**	195

OVERALL DIMENSIONS



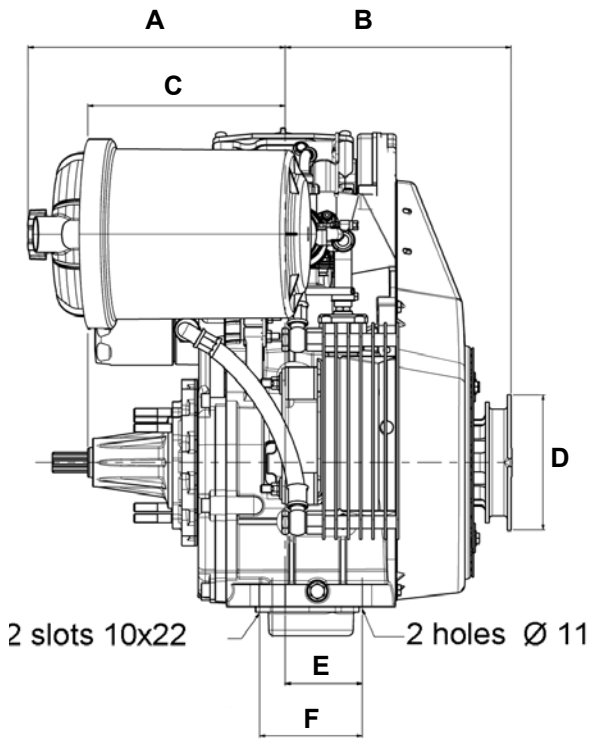


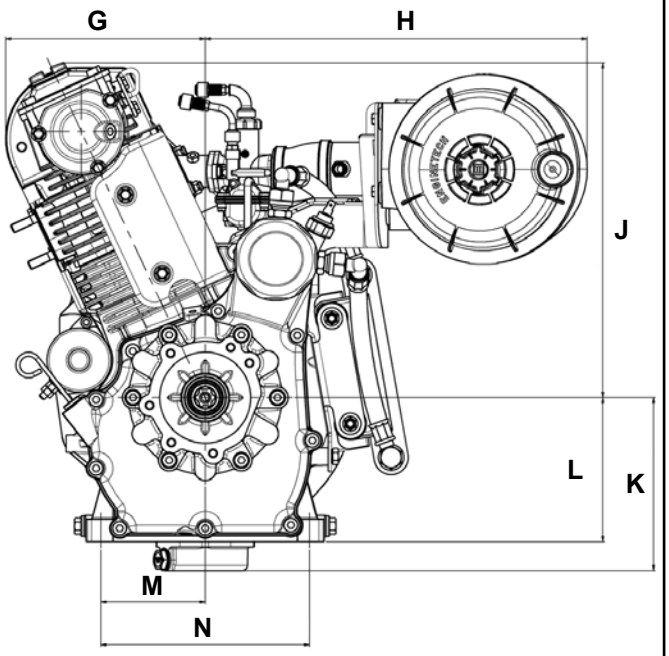


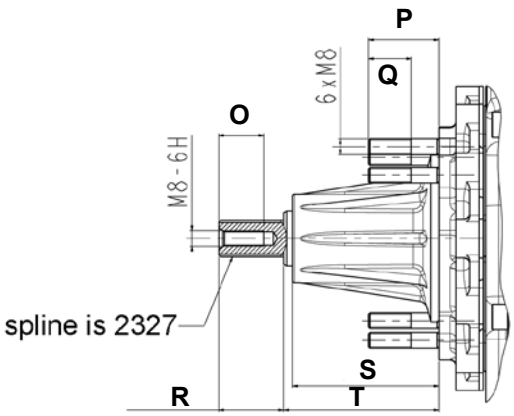


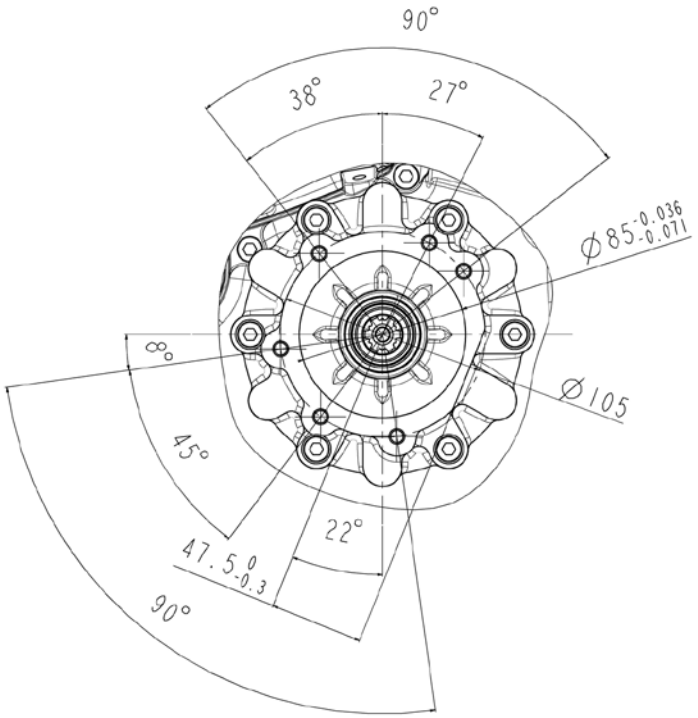
DIMENSIONS (mm)							
A	177.8	**E**	72	**J**	312	**N**	195
B	225.6	**F**	96	**K**	161.5	**O**	18
C	211	**G**	186.5	**L**	134.5	**P**	19
D	127	**H**	388.5	**M**	97.5	**Q**	7.7

OVERALL DIMENSIONS





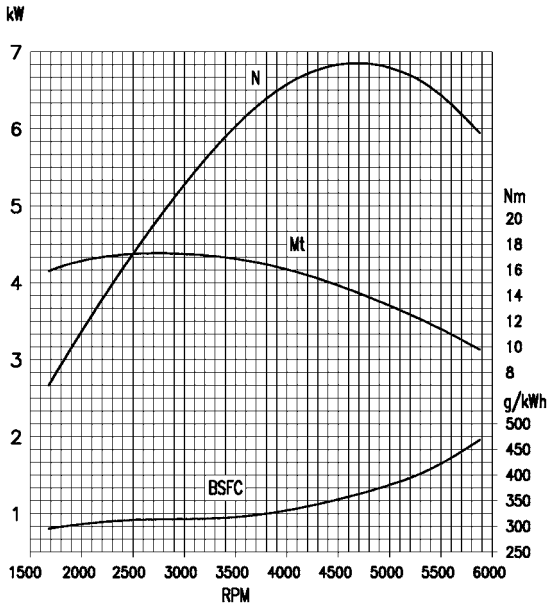




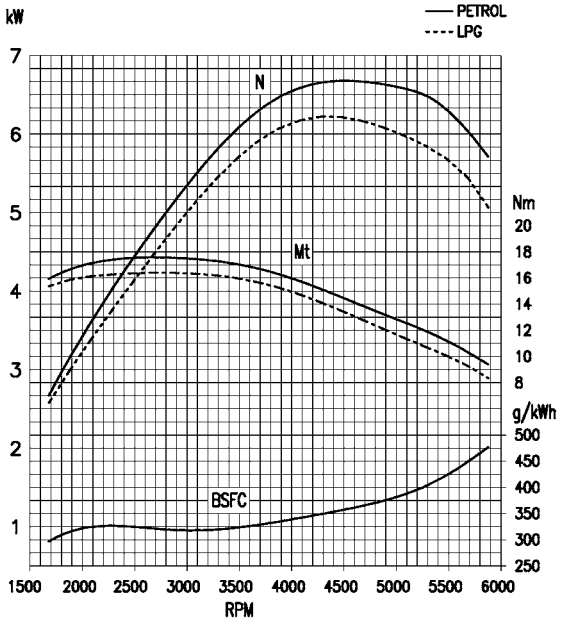
DIMENSIONS (mm)							
A	240.3	**F**	96	**L**	134.5	**Q**	22
B	211	**G**	186.5	**M**	97.5	**R**	33.05
C	184.5	**H**	356.7	**N**	195	**S**	74.6
D	127	**J**	312	**O**	23	**T**	79.25
E	72	**K**	161.5	**P**	36		

PERFORMANCE GRAPH

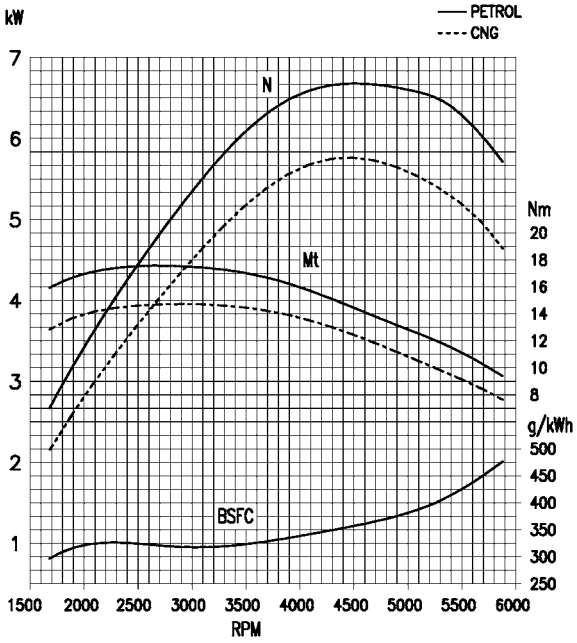
LGA 280 a GASOLINE



LGA 280 LPG



LGA 280 CNG



Legend

N* (80/1269/EEC-ISO 1585) = Power curve.
Automotive power: discontinuous services at variable RPM and load.
Mt* = Torque curve
BSFC* = Specific consumption curve

* The above curves are approximate since they depend on applications and on engine mapping.

- The above power levels refer to the engine equipped with air filter, muffler, fully broken-in suction fan, and ambient conditions of 20°C and 1 bar.
- The maximum power is guaranteed with a tolerance of 5%.
- These power rates are reduced by approx. 1% every 100m of altitude and by 2% for every 5°C exceeding 25°C.

Note: Please contact Lombardini for power, torque, and specific consumption curves at different speeds from the above.

Caution – Warning

Non-approval by Lombardini for any modifications releases the company from any damages incurred by the engine.

ENGINE MAINTENANCE

Important

Non compliance with the operations described in the table involves the risk of technical damages to the engine and vehicle. Any non compliance makes the warranty become null and void.

ENGINE UNSCHEDULED MAINTENANCE

CHANGE	
ONLY AFTER FIRST 1,000 KM	- Engine oil - Oil filter

CHECK	
AFTER FIRST 1,000 KM	- Fuel hoses and connections

ENGINE SCHEDULED MAINTENANCE

PROCEDURE	ELEMENT	FREQUENCY x 1.000 Km										
		1	10	20	30	40	50	60	70	80	90	100
CLEANING AND CHECKING	ENGINE OIL LEVEL	Every 1.000 Km										
	COOLING SYSTEM		■	■	■	■	■	■	■	■	■	■
	AIR CLEANER		■	■	■	■	■	■	■	■	■	■
	FUEL PIPES AND UNIONS		■	■	■	■	■	■	■	■	■	■
	EXHAUST SYSTEM		■	■	■	■	■	■	■	■	■	■
	CANDELE -SPARK PLUGS		■	■	■	■	■	■	■	■	■	■
	VALVE CLEARANCE	Every 5.000 Km										
CHANGE	ENGINE OIL		■	■	■	■	■	■	■	■	■	■
	LUBE OIL FILTER		■	■	■	■	■	■	■	■	■	■
	FUEL FILTER			■		■		■		■		■
	AIR CLEANER CARTRIDGE			■		■		■		■		■
	SPARK PLUG			■		■		■		■		■
	TIMING BELT (*)						■					

Important

Even if the prescribed km have not been covered, the following items must be changed or replaced:
- **engine oil, after one year**
- **timing belt, after four years**

After 100,000 km, continue with the same maintenance intervals.

(*) Once removed, the timing belt must be replaced, even if it has not reached its prescribed service life.
(**) The period of time that must elapse before cleaning or replacing the filter element depends on the environment in which the engine operates. The air filter must be cleaned and replaced more frequently under very dusty conditions.

LUBRICANTS

Recommended oil

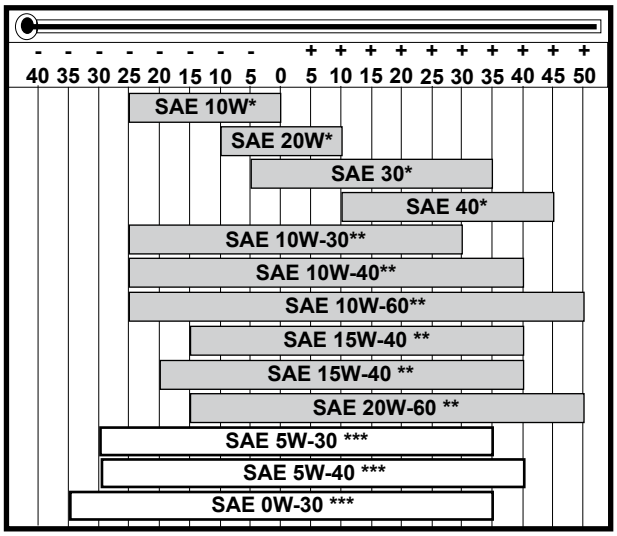
Description	*Oil type*	*Oil characteristics*
Engine oil	**Agip SINT 2000 15W40/50**	**API SJ/CF ACEA A3-98 B3-98 MIL-L-46152 D/E.**
	SAE 20 W 50	**API SF/CC**

Engine oil capacity

Oil volume at max. level (including oil filter)	Litres	**1.7**
Oil volume at max. level (without filter)	Litres	**1.6**
Oil volume at min. level (including oil filter)	Litres	**0.85**

SAE classification

In the SAE classification oils are identified according to viscosity without considering any other qualitative characteristic.
The first number refers to the viscosity when cold, for use during winter (W= winter), while the second number is for viscosity at high temperatures.
The criteria for choosing an oil must include the minimum ambient temperature to which the engine is to be exposed during the winter and the maximum temperature during operation in the summer.
Monograde oils are generally used when the operating temperature varies little.
Multigrade oils are less sensitive to temperature variations.



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

API/MIL Sequences

	DIESEL					BENZINA - ESSENCE - PETROL BENZIN - GASOLINA									
API	**CH-4**	**CG-4**	**CF-4**	**CF-2**	**CF**	**CE**	**CD**	**CC**	**SC**	**SD**	**SE**	**SF**	**SG**	**SH**	**SJ**	**SL**
MIL			L- 46152 D / E													

CORRENTI - CURRENT **OBSOLETI - OBSOLETE**

Key to abbreviations

A.P.I. : (American Petroleum Institute)
MIL : USA military specifications for engine oils issued for logistics reasons
ACEA : European Automobile Manufacturers Association

ACEA Standards – ACEA sequences

PETROL
A1 = Low-viscosity, for friction reduction
A2 = Standard
A3 = High performance

LIGHT DIESELS

B1 = Low-viscosity, for friction reduction
B2 = Standard
B3 = High performance (indirect injection)
B4 = High quality (direct injection)

HEAVY DIESELS

E1 = Obsolete
E2 = Standard
E3 = Heavy conditions (Euro 1 - Euro 2 engines)
E4 = Heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)
E5 = High performance in heavy conditions (Euro 1 - Euro 2 - Euro 3 engines)

FUEL RECOMMENDATIONS

Purchase diesel fuel in small quantities and store in clean, approved containers. Clean fuel prevents the diesel fuel injectors and pumps from clogging. Do not overfill the fuel tank.
Leave room for the fuel to expand. Immediately clean up any spillage during refueling.

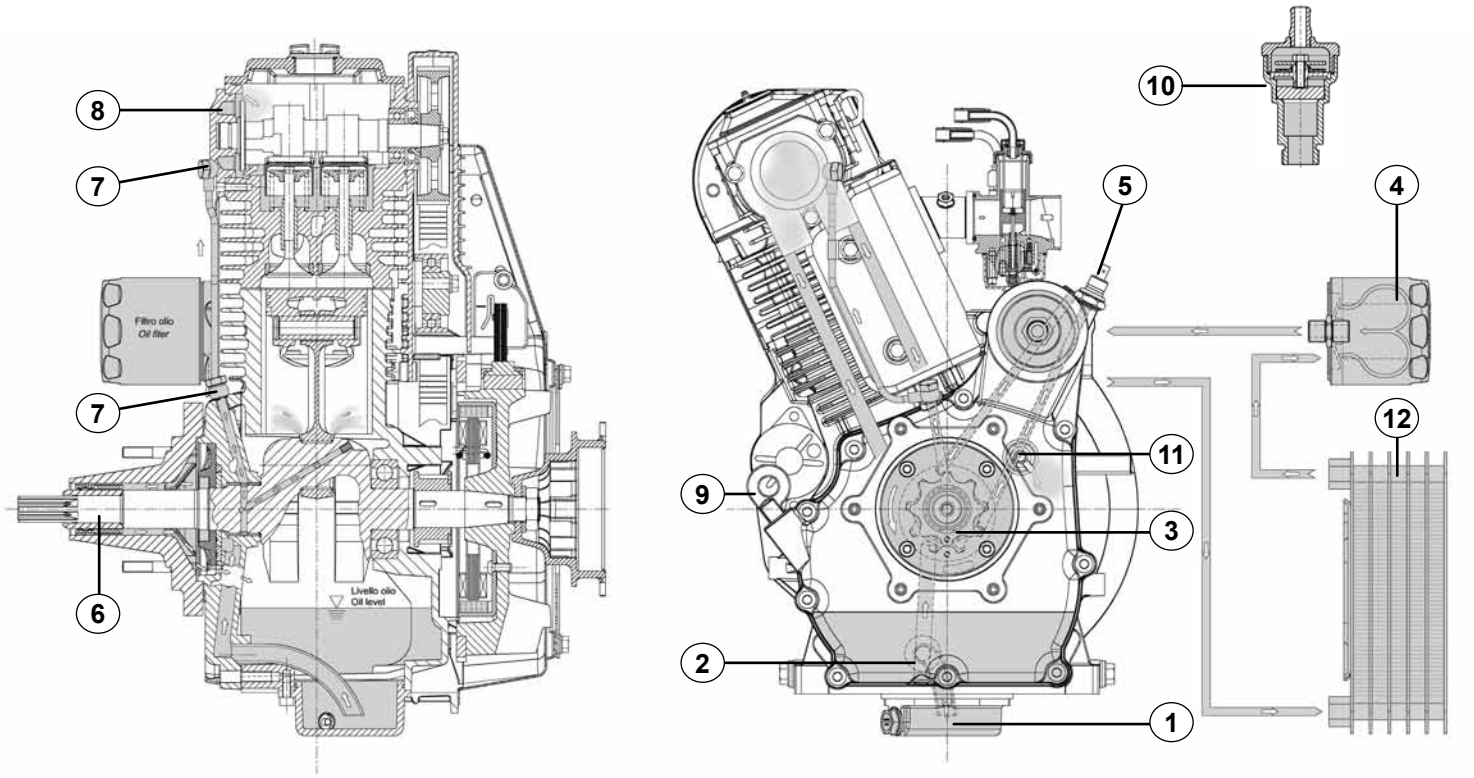
LUBRICATION CIRCUIT

Caution - Warning

The engine can be damaged if allowed to operate with insufficient oil.
Nothing more than lubrication oil can influence the performances and life of an engine.
Use of an inferior quality oil or failure to regularly change the oil will increase the risk of piston seizure, will cause the piston rings to jam and will lead to rapid wear on the cylinder liner, the bearings and all other moving parts. Engine life will also be notably reduced.
The oil viscosity must suit the ambient temperature in which the engine operates.

Caution - Warning

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



Legend

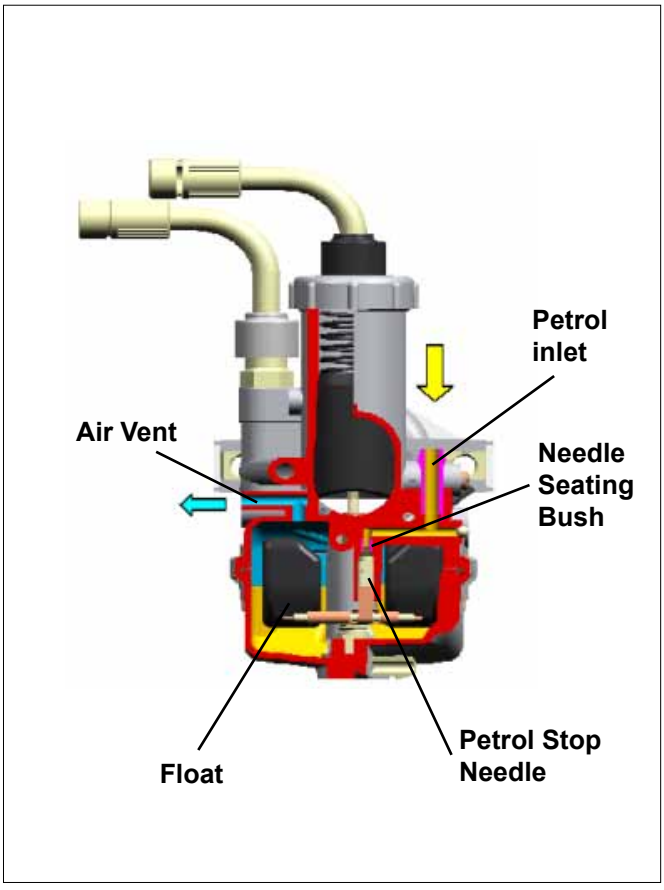
1 Oil sump
2 Oil suction pipe
3 Lube oil pump
4 Oil cartridge
5 Pressure switch
6 Crankshaft
7 Calibrated unions
8 Camshaft
9 Oil dipstick and oil filling location
10 Breather valve
11 By-pass valve
12 Oil - air exchanger

FUEL SUPPLY CIRCUIT

Carburettor type SPACO : FSY 20

Carburettor specification

- Venturi : Oval, (Equivalent Dia. 20 mm)
- Main Jet : 75
- Maximum Air : 100
- Pilot Jet : 30
- Minimum Air : 140
- Groove position: II from Top
- Setting : 1½ ±½
- Progression : 80
- Fuel Inlet : 100
- Float Weight : 4 g
- Float Height : 15.5 ± 1 mm
- Fuel Level : 7.5 ± 0.5 mm
- Starter Jet : 60



Fuel system

Fuel from tank supplies the carburettor through the electric supply pump.
Ensure with engine running, fuel flows continuously from tank to the carburettor.
Downstream of the pump, the circuit is divided into two branches: one goes towards the carburettor with a constriction (length: 10 mm; Ø 2.5 mm) situated near the carburettor mouth.
The second one goes back to the tank.
The Needle Seating Bush is press fitted in the carburettor main body. Petrol Stop Needle along with Float regulates the entry of fuel. Petrol Stop Needle is pushed upwards by Float to seal Needle seating Bush until fuel has reached the specified level. During engine operation, this provides a constant fuel level in the float chamber.
Petrol stop needle is pushed by float to seal needle seating bush until fuel has reached the specified level.
It is important that this level is always constant throughout the operating range: for this reason, the needle is equipped with a spring.
Dismounted the float chamber after 10 minutes of engine running in low idle the fuel level must be 7.5 ± 0.5 mm
A rise in the Fuel level would cause an increase in fuel delivery and consequently enriches the mixture; conversely, lowering of the float level causes a weakening of the mixture.
Fuel in the float chamber is always at atmospheric pressure because of the Air vent.

Idling circuit

At idle the carburettor supplies only the mixture required to keep the engine running at very moderate rpm. The engine needs only a small amount of air when idling and the throttle valve is almost closed in this condition.
Upstream of the throttle valve there is a weak vacuum, insufficient to cause main circuit to deliver any fuel mixture, while downstream of the throttle valve there is a stronger vacuum which activates the idle circuit. The Idle circuit is designed with Mixture controller.

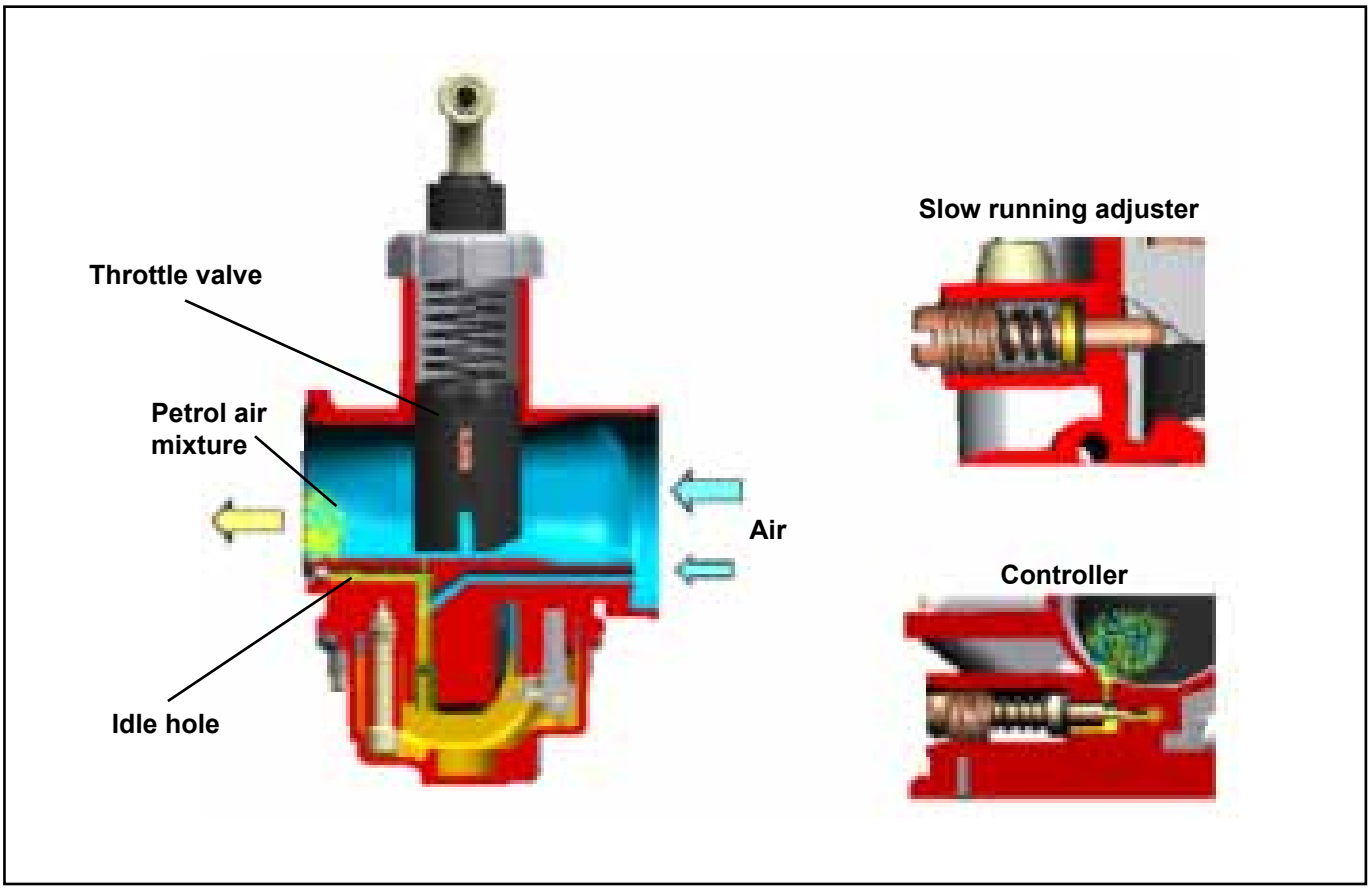
The mixture controller meters the amount of air-petrol, predetermined by the effect of the pilot jet and the air bleed. Screwing in the mixture controller, the idle mixture delivery decreases and viceversa.

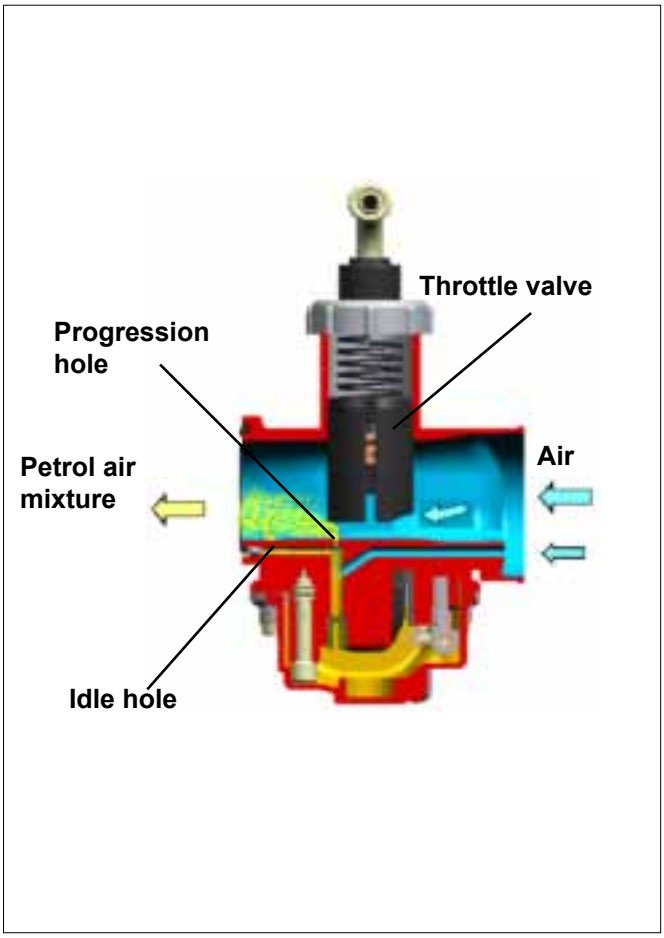
As shown in the figure, the throttle valve is in minimum opening position and it is controlled by the slow running screw.
The throttle valve shown is in the idling position. This is adjusted by the slow running adjustor. In this position the vacuum present downstream of the throttle valve causes mixture to be delivered via idle hole. This Mixture is regulated by tapered tip of the Mixture Controller. Fuel metered through the Pilot jet and air metered by the calibrated passage further mixes with air regulated by the throttle valve opening.
The mixture controller is located downstream of the throttle.
Ensure that the throttle cable has about 1to 2 mm of free play with throttle valve in closed condition.

NB: When the throttle valve is closed, its cable should have about 1 to 2 mm of clearance.

The idle setting is always carried out with the engine fully warmed up. Proceed as follows:

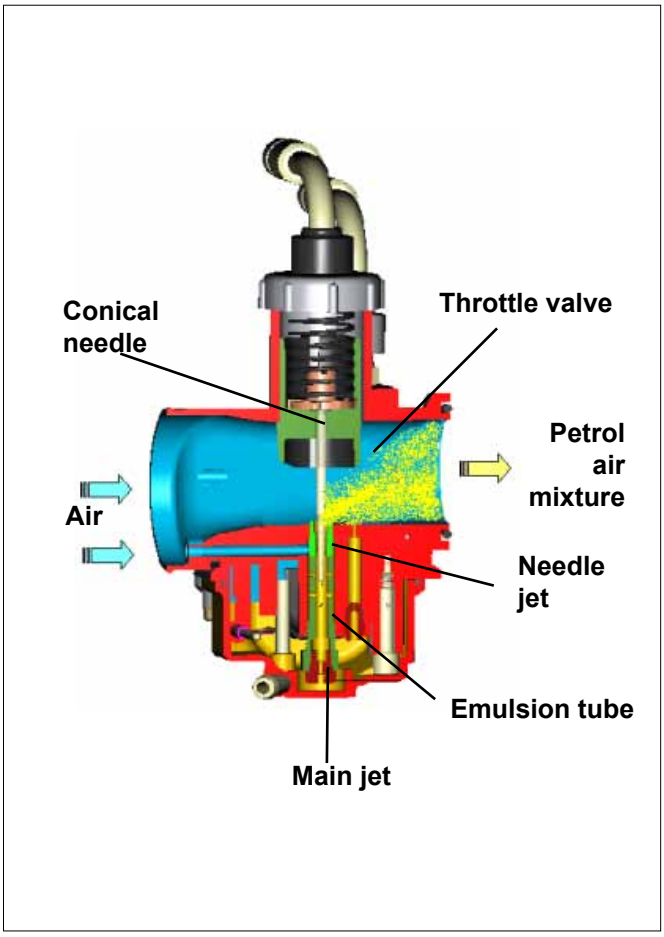
- Screw in the Slow running adjustor to get slightly higher speed than specified. Screw the mixture controller in or out until you obtain the most even running.
- Screw the mixture controller in or out until you obtain the maximum rotation speed according to throttle valve position.
- Then unscrew the Slow running adjustor until you get the desired idle speed again.





Progression system

By progression we mean the transition period between mixture delivery from the idle circuit and the beginning of mixture delivery from the main circuit.
On first opening the throttle, the air drawn into the engine increases and therefore, in order to have a correct mixture, the fuel supply must also be increased.
The idle hole only delivers sufficient fuel for engine idle operation and the main circuit still does not deliver any fuel because of insufficient vacuum upstream of the throttle. The progression passage is therefore necessary to deliver the fuel required during this transition period . The progression passage draws fuel from the idle circuit and is positioned immediately upstream of the closing edge of the throttle valve for a quick response to fuel demand when airflow suddenly increases.



Maximum operation

Following the progression transitional phase, the full circuit begins to operate on next opening of the throttle.
By further opening the throttle valve, the progression holes are uncovered and a vacuum is created in the mixing chamber, due to the speed of the air drawn to the engine. This vacuum is sufficient to cause fuel to be delivered out of the main jet.
In this condition, fuel metered by the main jet and further regulated by the conical needle, needle jet and emulsion tube (the needle jet outlet area varies according to the position of the conical needle fixed to the throttle valve, moving up and down) is mixed with air from the main barrel while the idle circuit deactivates due to increasing charge losses.
The amount of fuel that comes out in the first quarter of throttle valve movement is determined by Pilot Jet, throttle valve cutaway, the size of Needle Jet and by the diameter of Conical Needle at the opening.

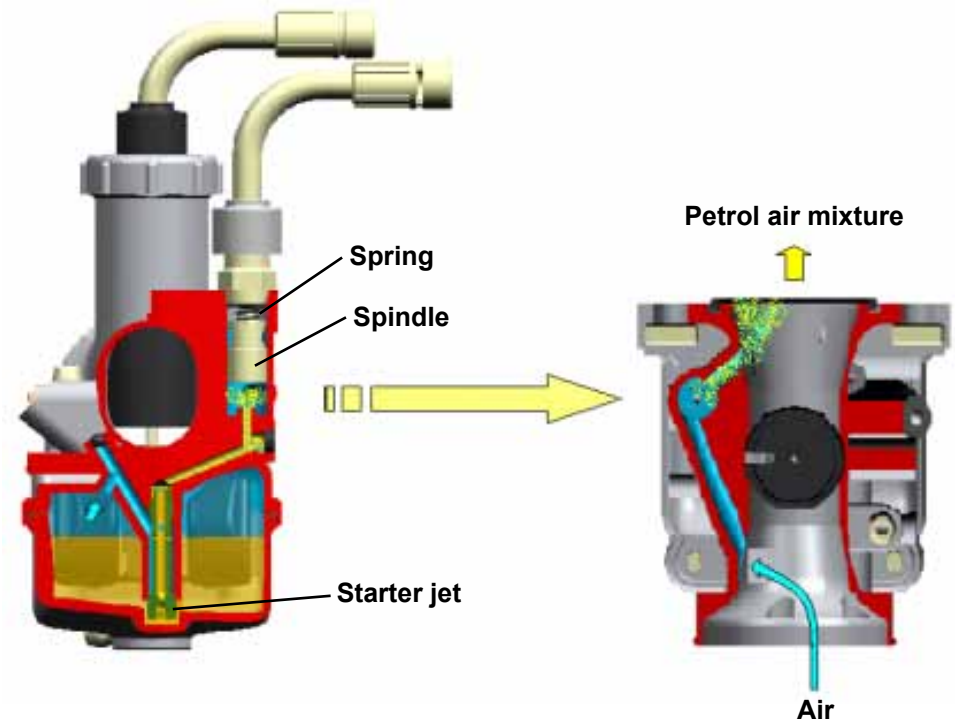
Starter circuit

From three-quarter throttle to full throttle, the amount of fuel depends solely on the size of the main jet.

There are normally no difficulties starting the engine when it is hot.
When starting from cold, the carburettor has to deliver a fuel mixture rich enough to produce a richer and more inflammable mixture quantity in the combustion chamber.

Due to the low engine temperature, a large part of the fuel does not atomize completely and condenses on cold parts of the fuel inlet device and on the combustion chamber.
The starting device operates its own circuit opening a starting device jet and choke spindle.
Start the engine from cold with the throttle closed and choke spindle opened by pulling up the lever.

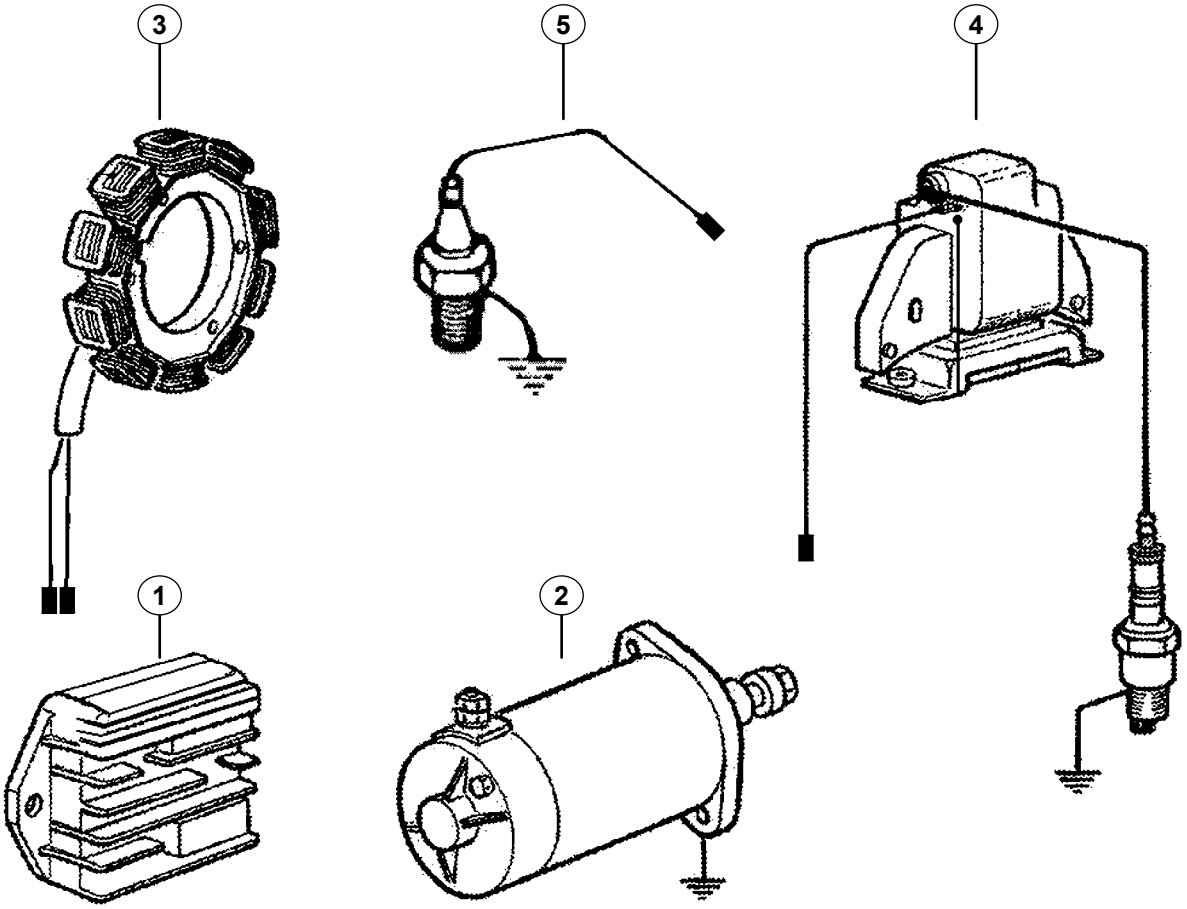
Vacuum present in the barrel downstream of the throttle valve draws mixture through passage from duct and then mixes it with main airflow, so as to obtain a richer mixture during start up phase.
The mixture is composed of fuel metered through the starting device jet, mixed with air from channel and drawn through the starting device jet cross holes.

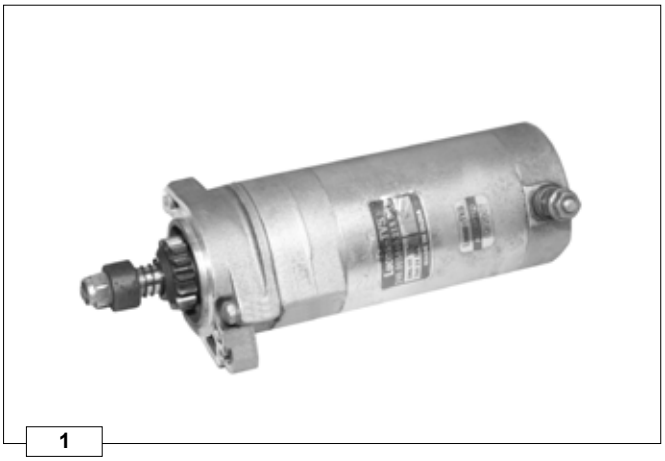


ELECTRICAL STARTING SYSTEM

Legend:

1 Voltage regulator
2 Alternator
3 Starting motor
4 Ignition coil
5 Oil pressure gauge





1

Starting motor

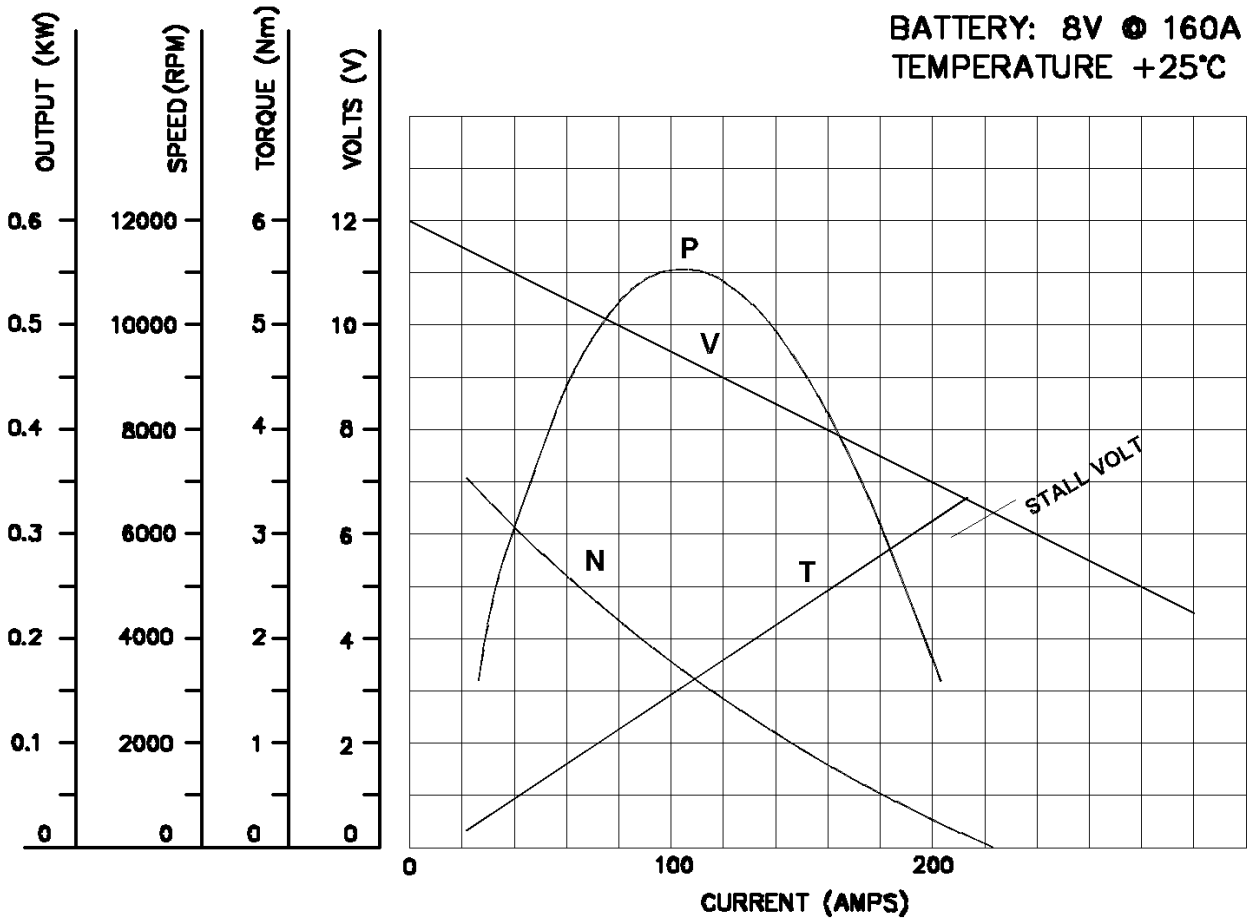
The starting motor is of the LUCAS - TVS SM6 HT type.

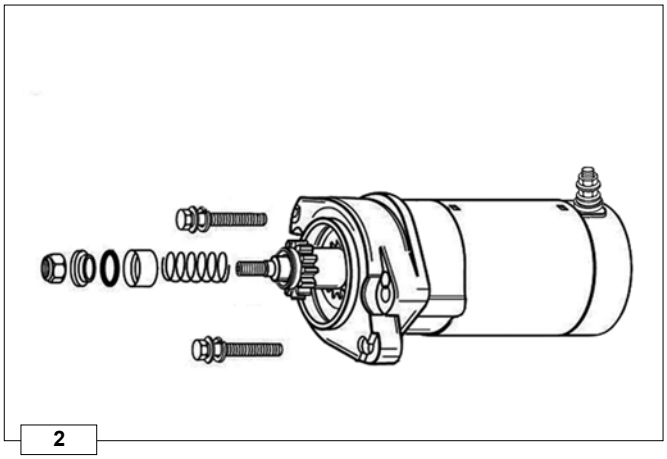
Battery

The battery, which is not supplied by Lombardini, shall have a 12 V voltage and a capacity not lower than 44 Ah.

NOTE: Battery capacity depends on ambient temperature, so batteries with greater capacity are needed when ambient temperature is particularly low.

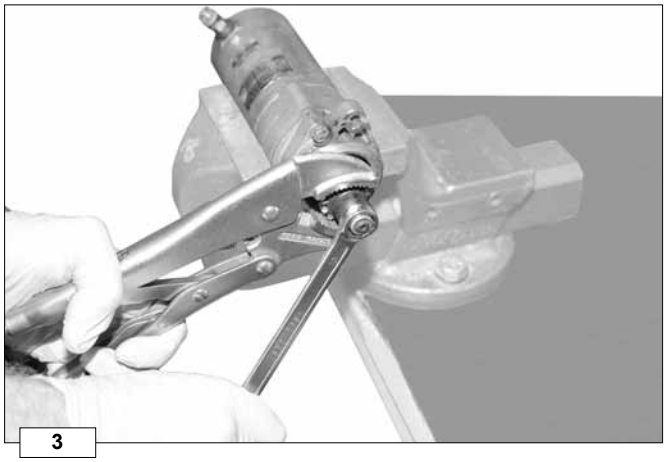
PROVISIONAL PERFORMANCE CHARACTERSISTICS




2

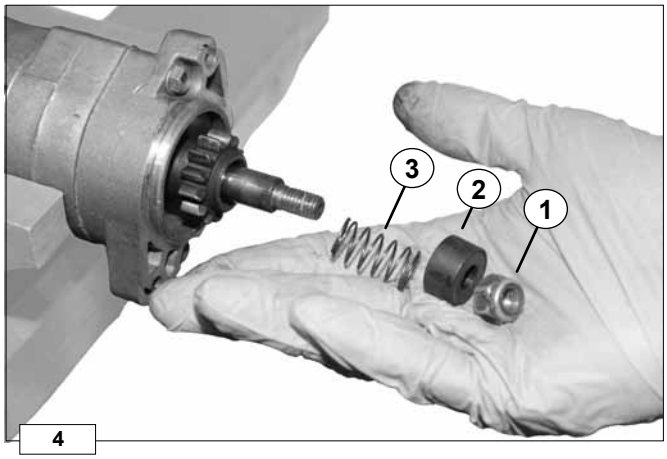
Starting motor – Exploded view

Figure 2 shows starting motor components.


3

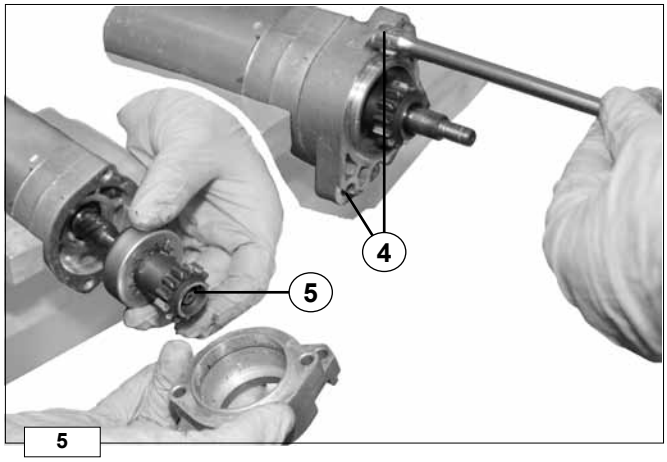
Starting motor – Disassembly

After placing the pinion flush manually, block it as shown in figure.
This is necessary to prevent the rotor from pivoting and allow us to unscrew the locknuts fixing the clutch pinion.



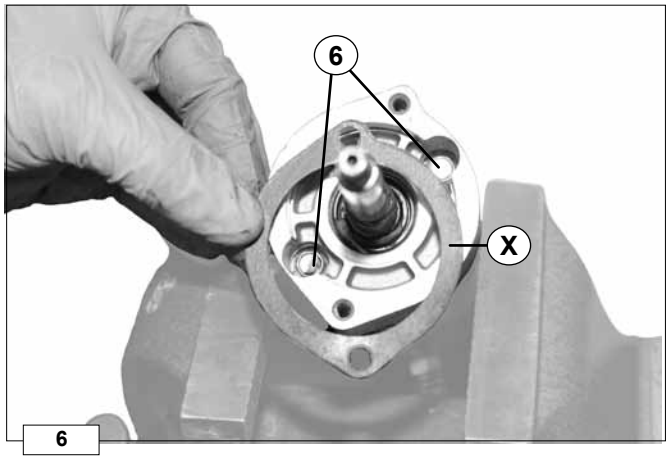
4

When the clutch pinion is replaced, it is also necessary to replace the details (**1-2-3**) shown in figure.
When reassembling, follow a reverse order.



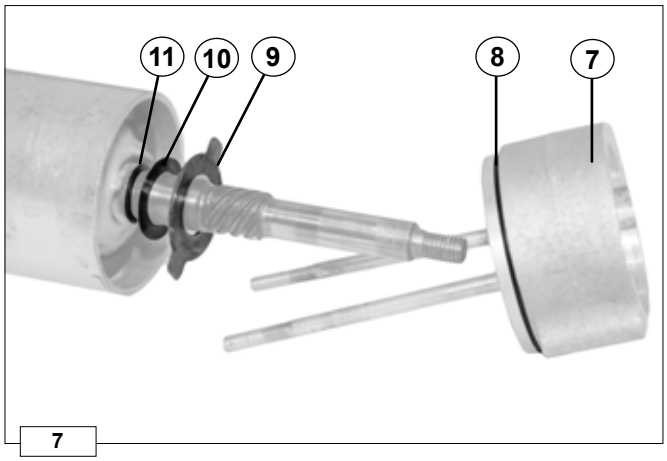
5

Unscrew the two cover fastening screws **4** and remove the clutch pinion **5**.



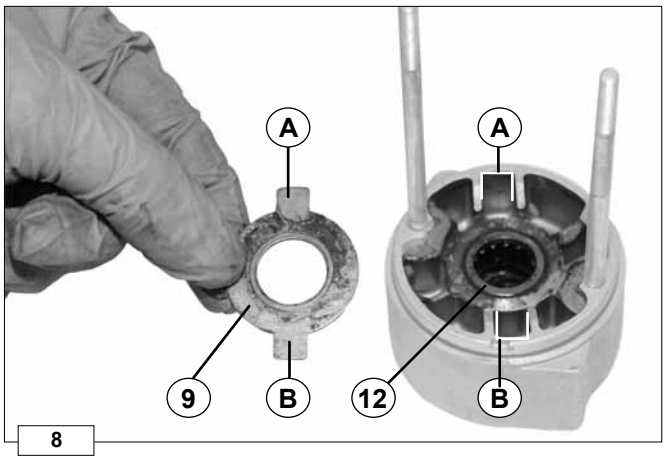
6

Remove the gasket **X** and loosen the 2 screws **6**.



7

Remove the flange **7**.
Check the integrity of the O-ring **8** and replace it if necessary.
Remove the clearance shims **9-10** and the snap ring **11**.

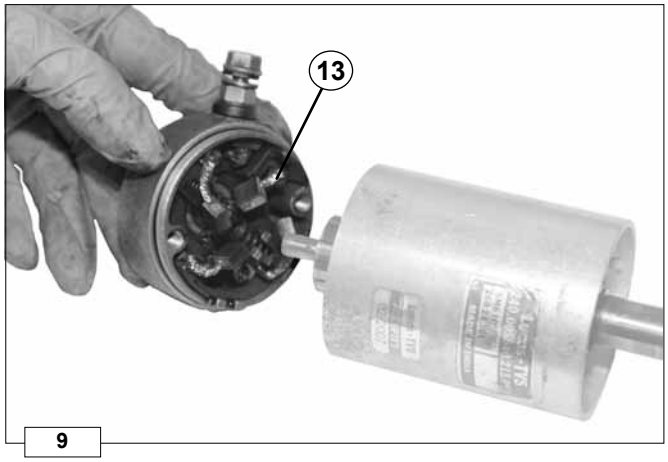


8

Important

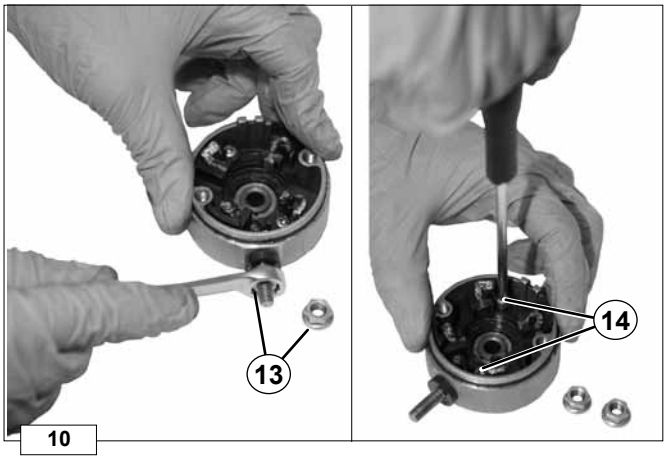
During reassembly, ensure that reference fins A and B on clearance shim 8 are inserted into the correct seats on the flange.

Check the integrity of the roller bearing **11** and replace it if necessary.



9

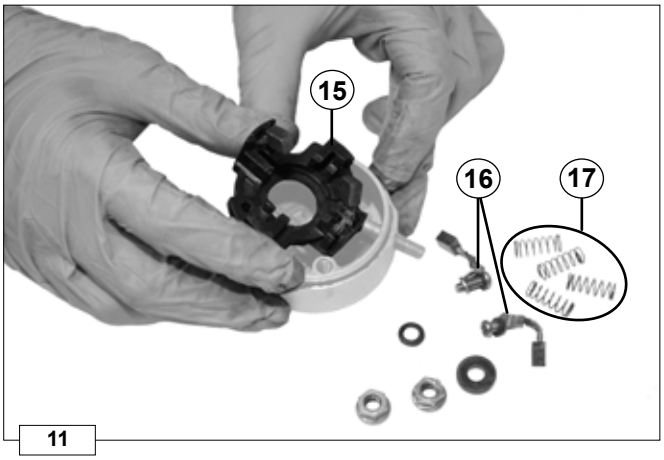
Remove the brush seat cover **13**.



10

Brush holder unit - Disassembly

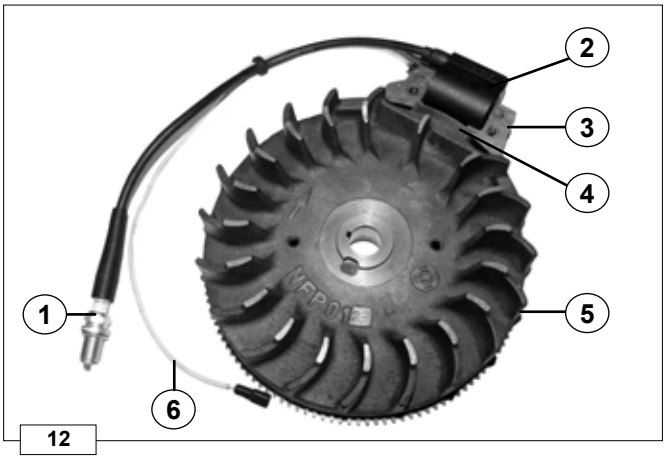
Loosen nuts M6 (**13**) on the power supply terminal, and then loosen the 2 screws **14** securing the brush holder unit to the cover.



11

Brushes - Disassembly

Remove the brush holder unit **15**, unthread the 2 removable brushes **16** and remove the 4 springs **17**.
Check for carbon brush wear and, if excessively worn, replace them all and the 4 brushes.
Check the integrity and load on the springs and replace if inefficient.

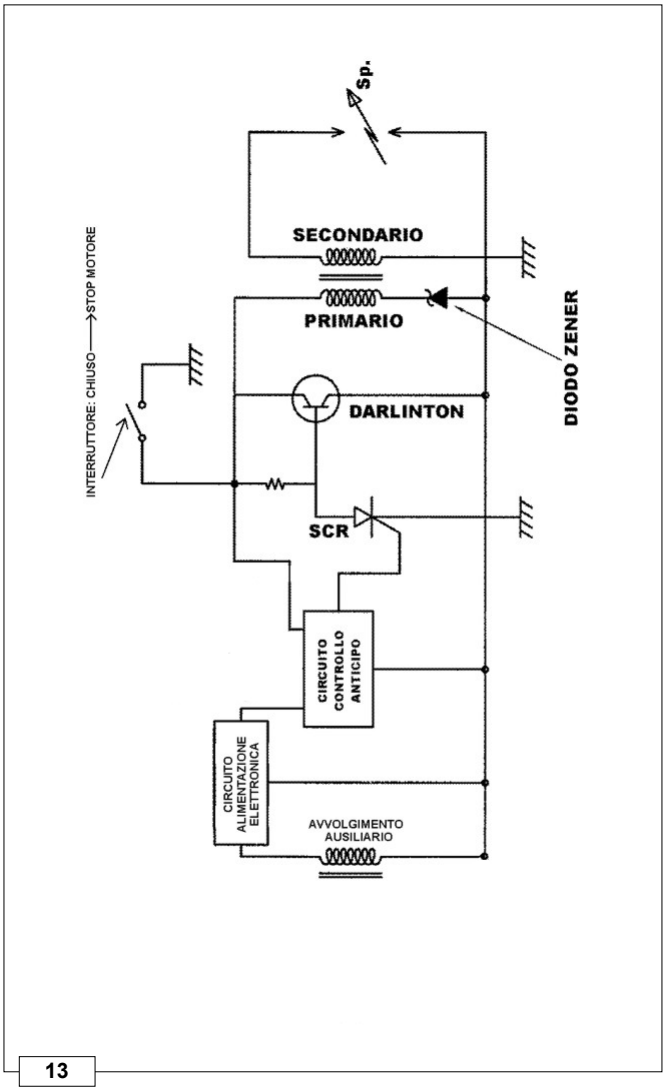


12

Electronic ignition

Legend

1- Spark plug
2- Rotor (coil)
3- Sheet metal pack
4- Inductor (magnet)
5- Flywheel
6- Engine stop cable



13

Electronic ignition: operating principle

Magnet flywheel where the inductor is the flywheel and the rotor is the ignition coil.

Inductor:

The ceramic magnet flywheel on the external circle passes into the flow collector or ignition coil core at every face turn, generating a variable magnetic field.
The magnetic field variation generates current in the primary circuit of the ignition coil that, properly cut-off, induces extra voltage in the secondary circuit, setting off the plug electrode spark.

Rotor:

Ignition coil: digital electronic ignition with inductive discharge, electronic cut-off and curve that varies according to rpm.

Operation diagram:

The coil is composed of three functional parts:

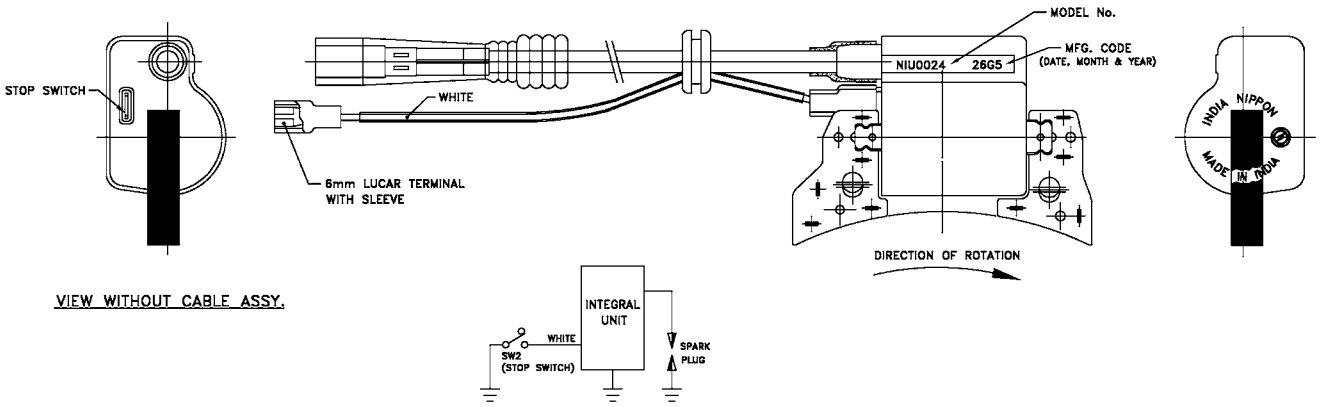
1) Electronic check part
2) Electronic power part
3) Electric part

-Electronic check part
It is composed of a microprocessor that stores the dual advance curve mapping according to rpm in memory.
It is powered by an auxiliary power circuit and on the basis of the external curve selector, it drives the electronic power partin order to run engine in the best possible way, both in petrol and gas operation.

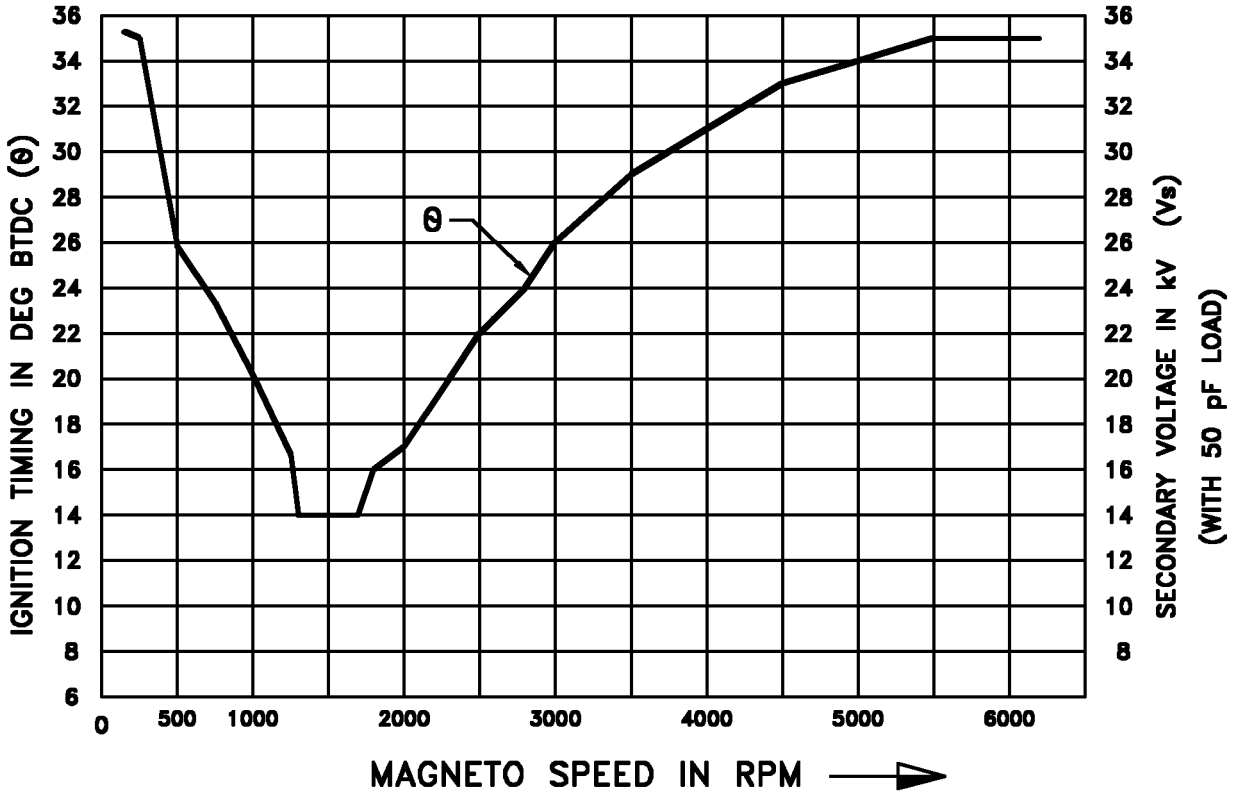
- **Electronic power part**
  It is basically composed of a SCR that drives a transistor couple with Darlinton connection, normally through conduction. The transistors act on the coil primary circuit: using the SCR, the microprocessor opens the Darlinton connection with the correct phase according to engine rpm. The circuit opening during correct phase and at maximum speed generates voltage in the secondary circuit, setting off the plug electrode spark.

- **Electric part**
  It is composed of the primary-and secondary circuit coil (in addition to the electronic power coil).

VARIABLE ADVANCE IGNITION COIL



Ignition advance curve according to number of revolutions




14

Coil check : engine not started

By means of this tester you can check coil performance. The instructions to do this are the following:

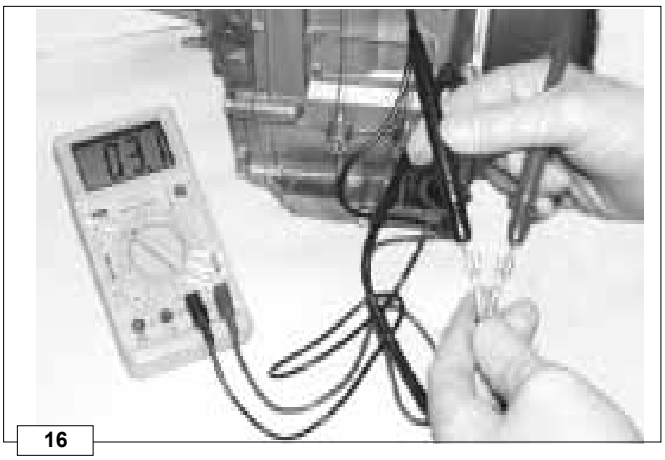
Primary circuit check:

Connect the negative pole of tester to ground, then connect the positive pole to the primary circuit wire terminal.
If the resistance value is equal to 1.8 OHM ± 10%, this means that the primary works correctly.


15

Secondary circuit check:

Connect the tester negative pole to ground. Then put the positive pole of tester into contact with the spark plug connector on the high-tension cable of the secondary circuit.
If the tester should detect a resistance of 22 KOHM ± 10%, the secondary circuit works correctly.


16

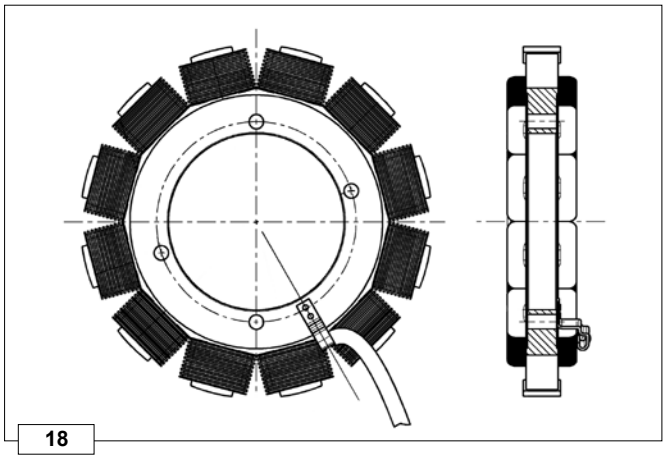
Check continuity of alternator with stopped motor.

Connect tips of tester so that they act as jumper between both alternator poles.
If the tester detects a certain value of resistance 0.4 ± 0.2 Ω, that means that there is continuity in the circuit.


17

Checking the ground insulating alternator with engine stopped

Connect the negative pole of tester to ground. The positive pole is to be connected on the first then on the second pole of both alternator output wires.
If the tester should not detect any variations, insulation of ground is correct.


18

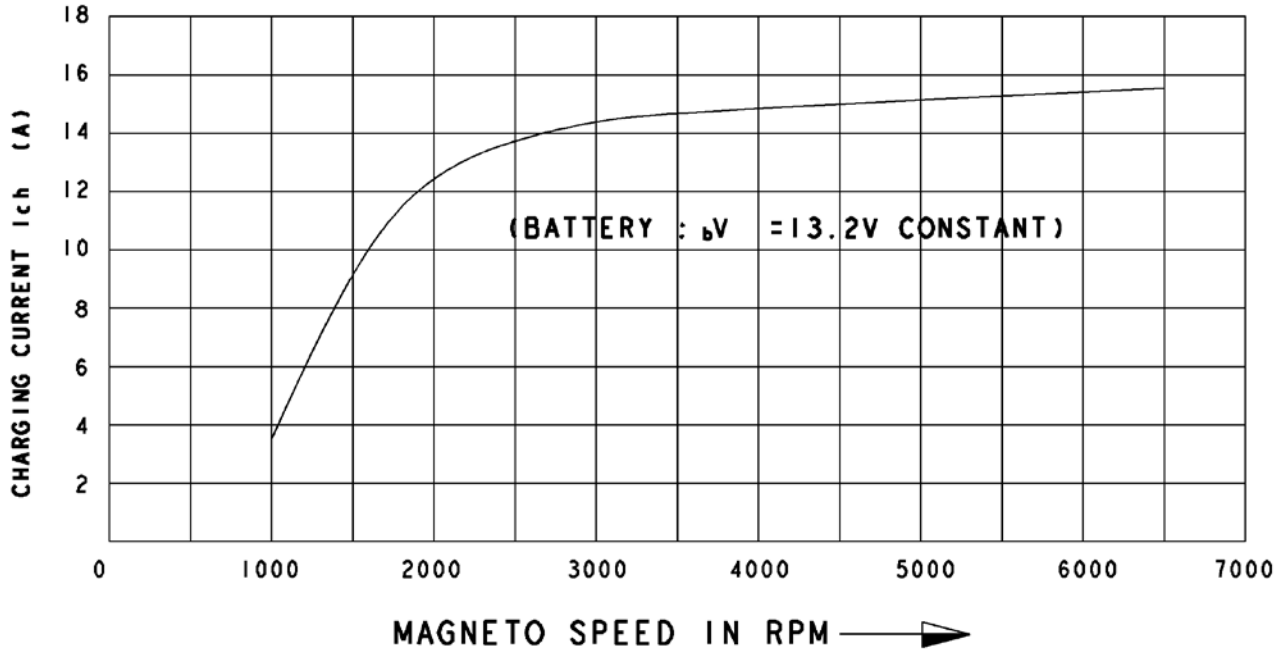
Alternator efficiency check with engine running

Connect the cables of the alternator to an AC 10/40 Volt tester.
Start the engine and check that the voltage shown on the tester is similar to the one shown in the following table .
If the voltage value is lower, this means that the rotor is demagnetised.
In this case, replace the alternator.

R.P.M. (rpm)	Voltage (V ~)*
2000	32
2400	32.4
3000	47.6
3600	57
4400	69.4
5000	78.6
5800	90.8

* Voltage clearance: ± 10%

Current curve versus RPM: constant battery voltage (13,2 V) and room temperature + 25° C



HANDLING AND LIFTING

19

- Attach the engine to a suitable lifting device (lifting beam).
- Hook the lifting device in the engine lifting points, as shown in the figure.
- Before lifting, make sure the weight is correctly balanced by checking its barycentre.

Important

The bracket of the lifting point have been designed to lift the engine only. It is not intended nor approved to lift additional weights.

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

ENGINE STORAGE

- **When the engines are not for more than 6 months, they have to be protected performing the operations described in the following pages.**

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

Important

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

PROTECTIVE TREATMENT

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

Caution - Warning

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

Important

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

PREPARING THE ENGINE FOR OPERATION AFTER PROTECTIVE TREATMENT

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

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

Caution - Warning

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

Important

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

RECOMMENDATIONS FOR DISASSEMBLY

Important

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

– Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
– Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
– In order to operate safely and easily, we recommend positioning the engine on a rotating stand for engine overhauling.

Caution - Warning

When installing the engine, always bear in mind that any variation to the functional systems may involve serious failures to the engine.
Any improvement must be verified at Lombardini's testing laboratories before application of the engine.
In case the approval to a modification is not granted, Lombardini shall not be deemed responsible for any consequential failures or damages to the engine.

Important

During repairs, when compressed air is used, always wear goggles.

General information for a correct repair

Any change to the intake or exhaust systems (e.g. air filter or muffler type, hose length and diameter, etc.) also implies a carburetion adjustment. Lombardini will not be held responsible for engine malfunctions and damages arising from any such changes.

For a safe and reliable operation, strictly keep to the instructions detailed in the maintenance manual as well as to the information below:

- Lock the machine before disassembling the engine.
- Disconnect battery cables if engine is equipped with an electrical starting system.
- Always use suitable tools, in order to avoid damaging engine parts.
- To separate coupled parts, use plastic hammers or punches only.
- During disassembly, mark the parts that are not provided with reference points.
- Clean the disassembled parts with gasoline and compressed air.
- Always replace gaskets, oil sealing rings, washers and locknuts;
- Before reassembling, lubricate all moving parts and mating surfaces.
- When tightening screws, keep to the torque specified.

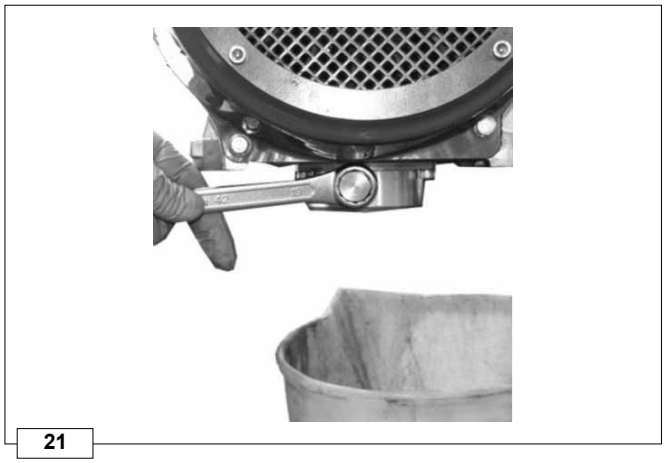
RECOMMENDATIONS FOR REASSEMBLY

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

Important

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

- The operator must wash, clean and dry components and assemblies before installing them.
- The operator must make sure that the contact surfaces are intact, lubricate the coupling parts and protect those that are prone to oxidation.
- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- In order to operate safely and easily, we recommend positioning the engine on a rotating stand for engine overhauling.
- Before proceeding with operations, make sure that appropriate safety conditions are in place, in order to safeguard the operator and any persons involved.
- In order to fix assemblies and/or components correctly, the operator must tighten the fastening elements in a criss-cross or alternating pattern.
- For assemblies and/or components having a prescribed tightening torque, first tighten to a lower torque, then carry out the final torque to the prescribed value.


21

Engine oil - Change

Caution - Warning

Before changing oil, start the engine in order to raise the lubricant temperature.
This operation will make it more fluid and facilitate its discharge.

Open the oil sump drain plug and wait till the spent oil has been drained completely.

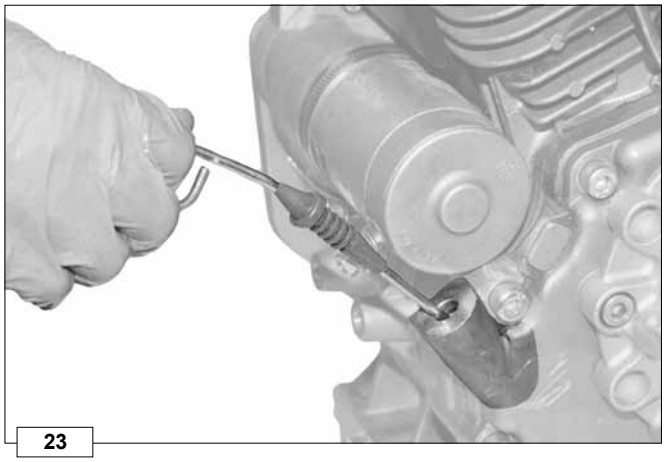

22

Engine oil - Refilling

Important

For refilling, use a clean funnel and pour oil slowly in order to avoid spilling and overflowing.

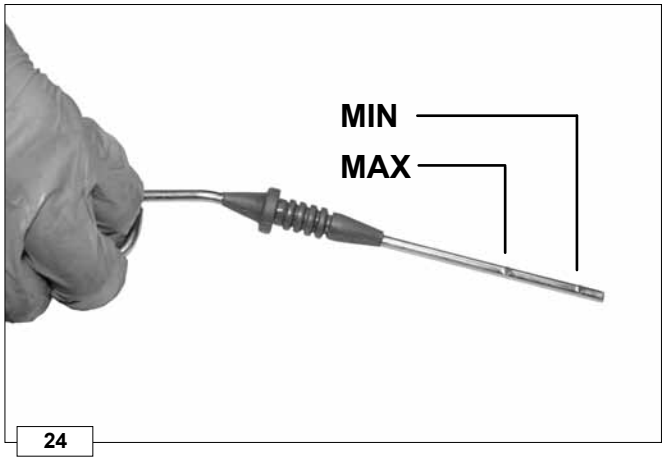
See page 21 for information about recommended oil and capacity.


23

Oil level - Check

Importante

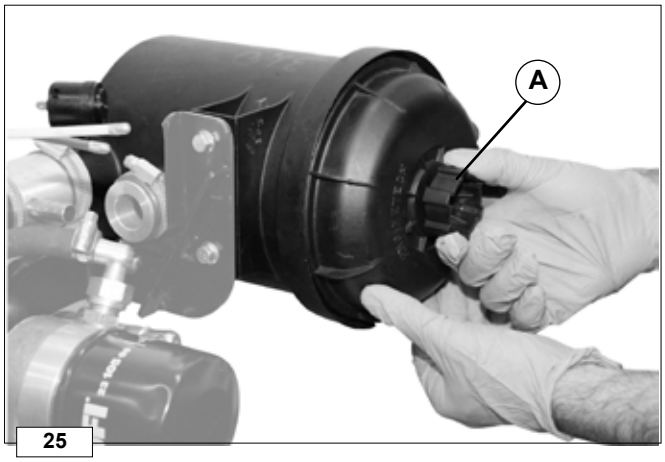
Oil refilling and check must be carried out with the engine turned off, not tilted and on a perfectly flat surface.



24

Oil dipstick - Check

Do not refill the engine with quantity greater than indicated. Refer to the MIN and MAX notches marked on the dipstick.
A correct quantity is reached when oil level is between the two notches.



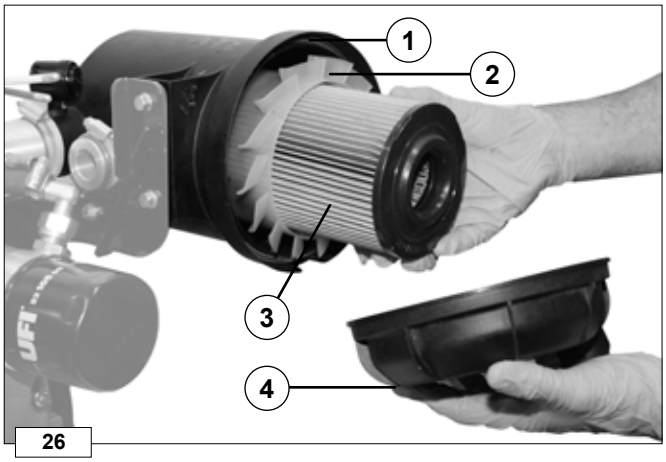
25

Air filter

The air filter is a dry-type one, with a replaceable paper filter cartridge.

Components:

1. Filter body
2. Cyclone
3. Filtering cartridge
4. Cover

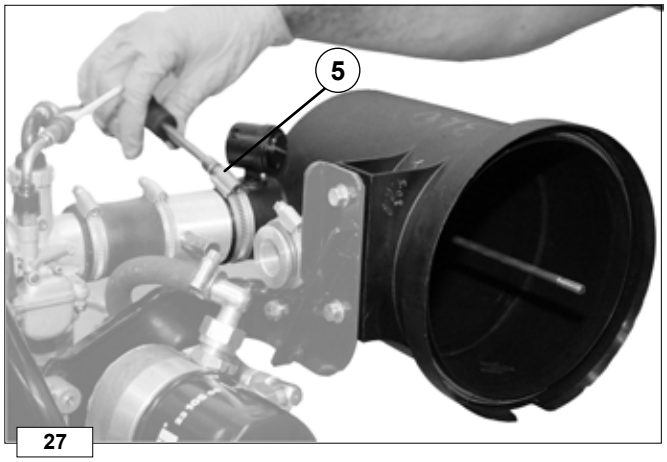


26

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

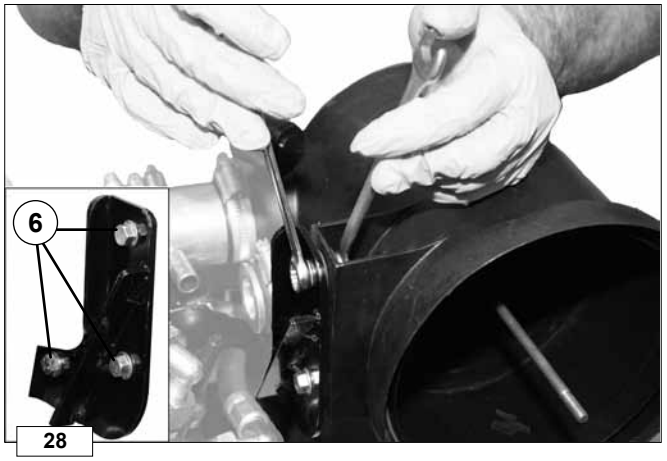
The cartridge can be cleaned by blowing compressed air breadthways outside and inside the cartridge **3**, at a pressure not greater than 5 atmospheres, or in necessity case by knocking the front of the cartridge several times against a flat surface.
Use a lamp to check that the filter element is not damaged or inspect it against the light while slanted. In case of doubt, install a new cartridge.

Caution - Warning
Replace the cartridge after the sixth clean.



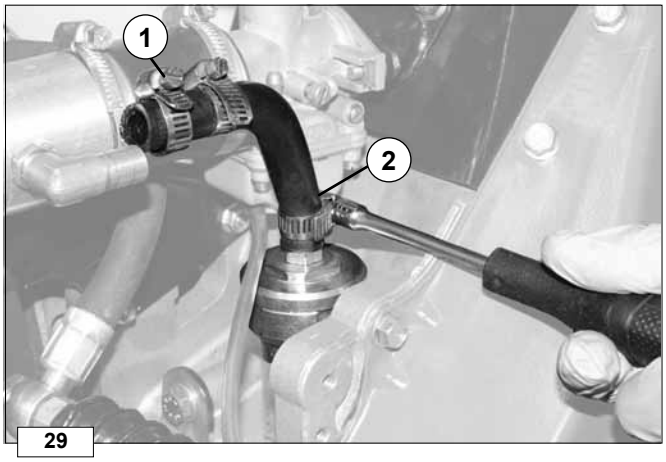
27

Loosen the clamp **5.**



28

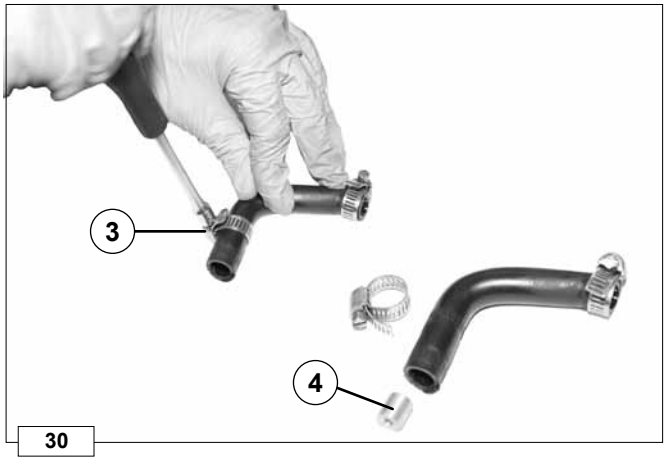
Loosen the 3 bracket fastening screws **6** keeping the nuts locked.



29

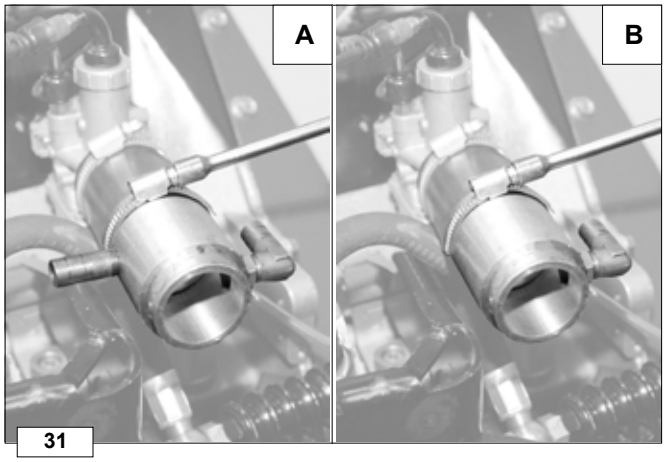
Vapour recovery pipe - Disassembly

Loosen the clamps **1** and **2**, and then remove the pipe from the connection and from the air valve.



30

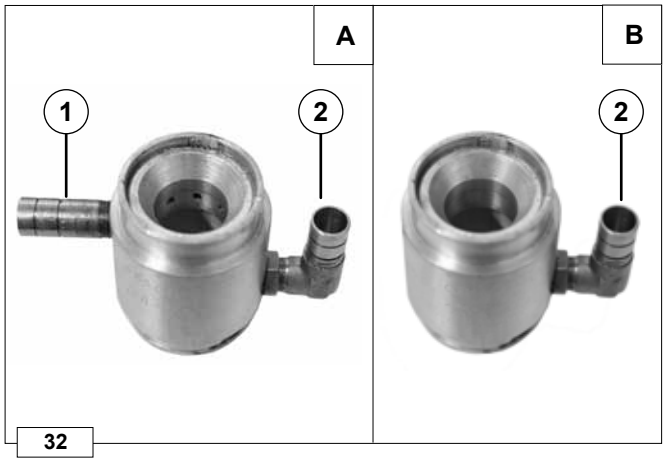
Loosen the clamp **3** and remove the throttle **4**.
Check that the pipe and throttle are both free from impurities or scaling.



31

Mixer / air recovery system - Disassembly

Loosen the clamp and remove the mixer from the rubber sleeve, both for the gas version (**A**) and for the petrol-only version (**B**).



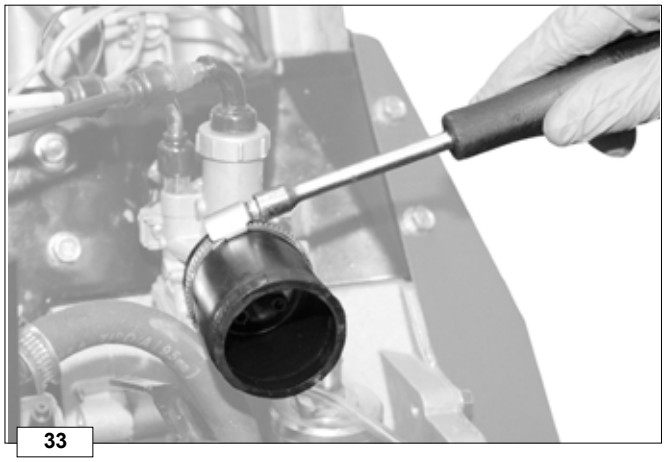
32

Gas version (**A**)

1 - Gas inlet from pressure reducer
2 - Oil vapour recovery union.

Petrol version (**B**)

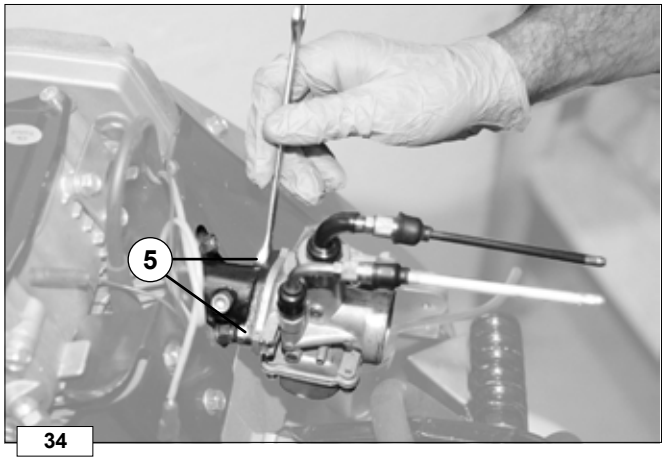
2 - Oil vapour recovery union.



33

Carburettor union hose - oil vapour recovery

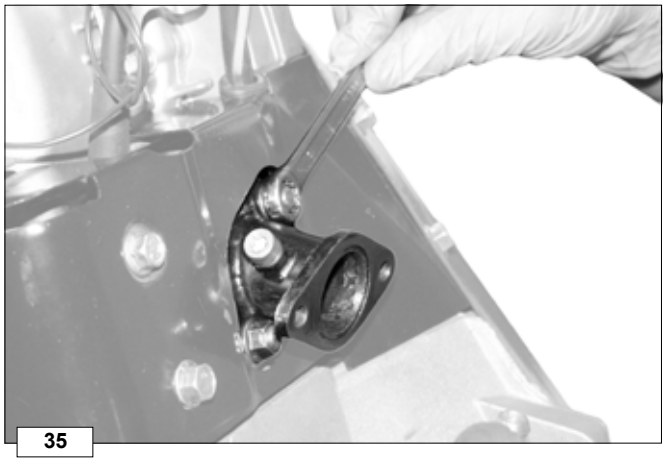
Loosen the carburettor fastening clamps and remove the hose.



34

Carburettor

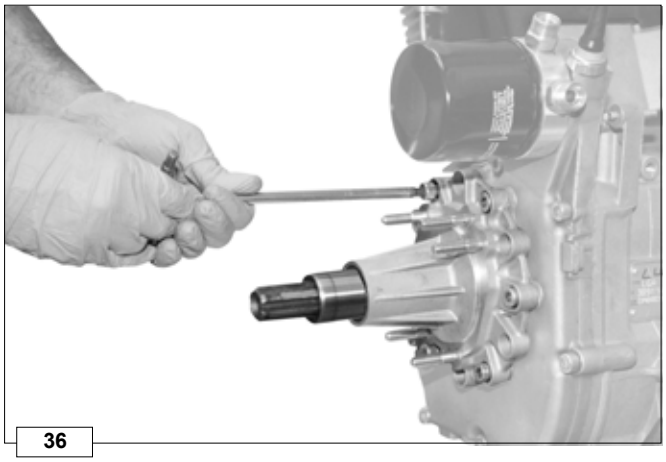
The carburettor, must be disassembled from the head side after removing the two M6 retaining screws **5**.



35

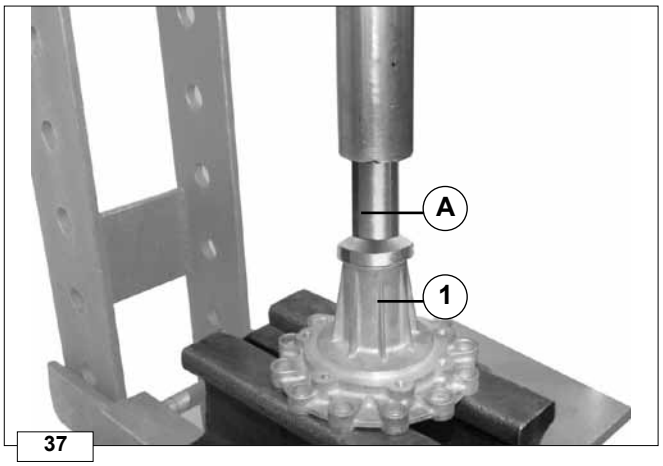
Intake flange - Disassembly

Loosen the 2 M8 nuts and remove the flange.


36

Gearbox coupling flange - Disassembly

Remove the 6 M8 fastening screws.



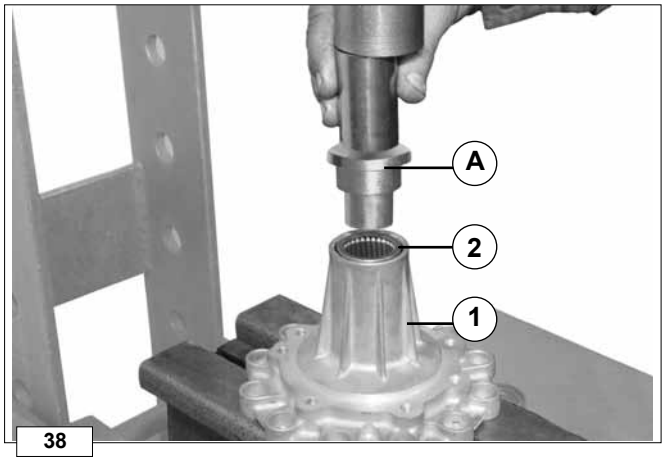
37

Roller bearing and oil seal - Disassembly

Important

Firmly place gearbox extension 1 on the press.

Place bearing assembly tool **A** p/n 1460.137 on the upper oil seal.
Operate the press to remove the roller bearing and the oil seal rings.



38

Roller bearing - Reassembly

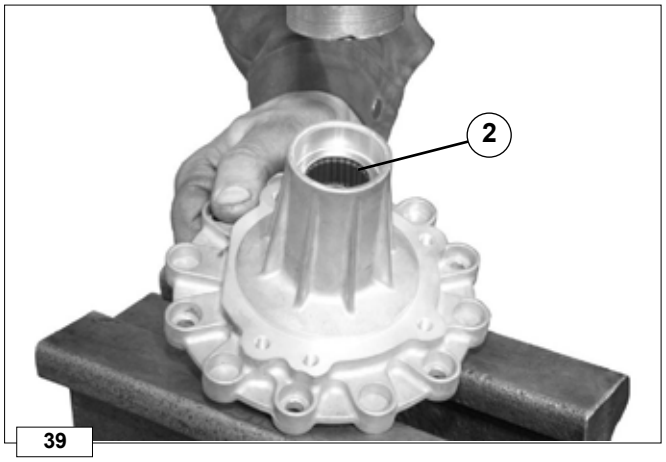
Caution – Warning

Thoroughly wash the gearbox extension and the roller bearing.

Important

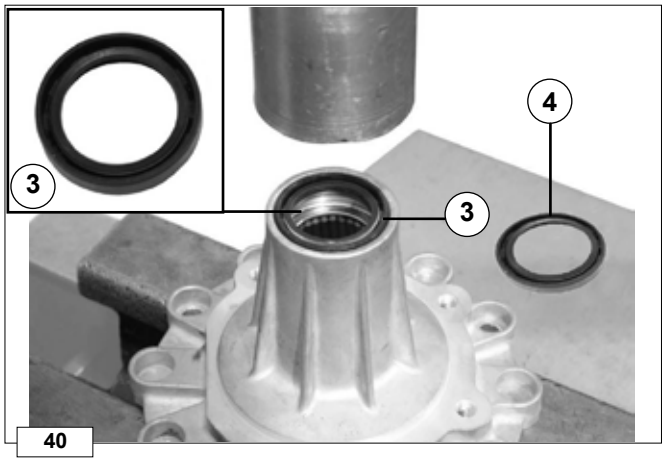
Firmly place gearbox extension 1 on the press.

Place roller bearing **2** on the gearbox extension opening.
Place bearing assembly tool **A** p/n 1460.137 on roller bearing **2**.
Operate the press to assemble the roller bearing.



39

Once assembled, roller bearing **3** should be at the same level of the reference ridge on the gearbox extension.



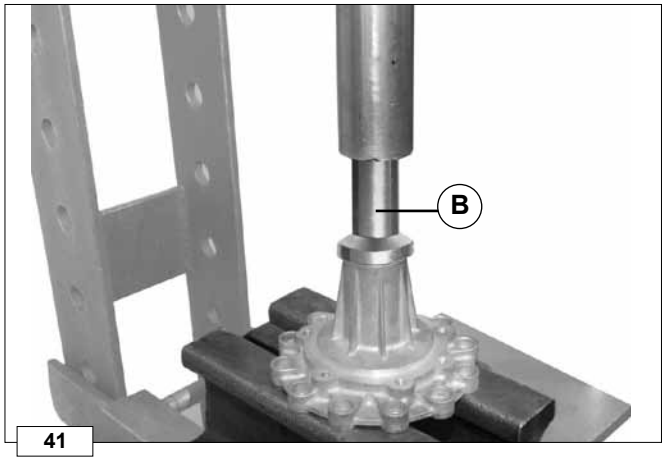
40

Oil seal rings - Reassembly

Caution – Warning

Lubricate the oil seal rings before reassembly.

Place the first oil seal ring **3** on the gearbox extension opening making sure the channel is facing upwards (see figure on the side).



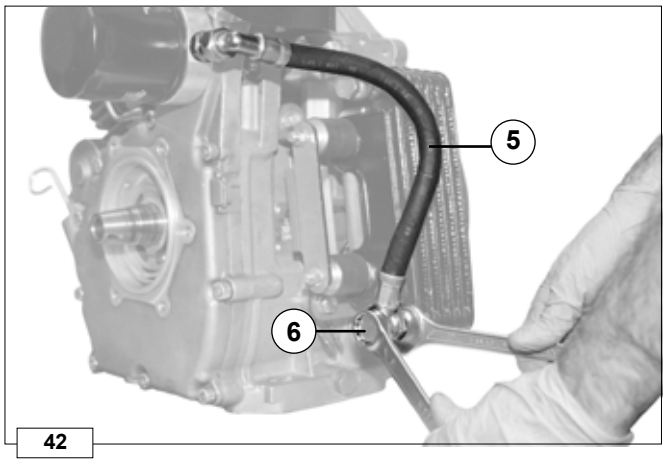
41

Place oil seal ring assembly tool **B** p/n 1460.139 on oil seal ring **3**.
Operate the press to assemble the oil seal ring.

Important

Make sure the second oil seal ring is placed on the first one with its channel facing downwards.

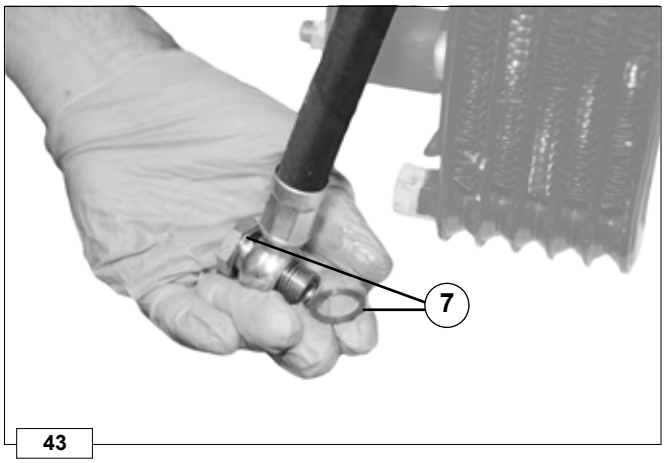
Repeat the same operations for the second oil seal ring, using the assembly tool **B** p/n 1460.139.



42

Oil-air exchanger - Disassembly

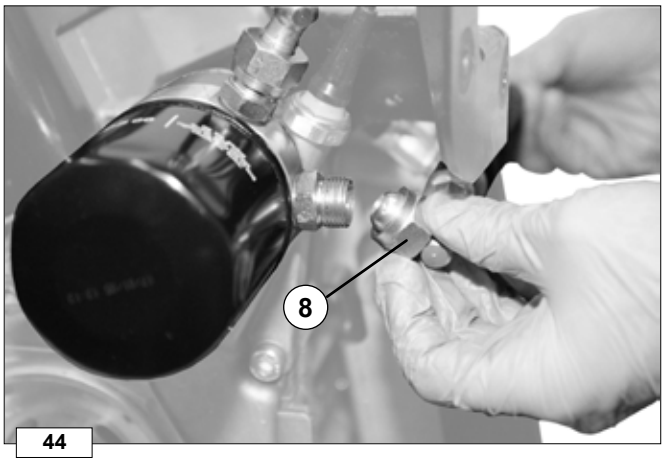
Using 2 spanners, loosen and remove the union **6** securing the oil delivery line **5** to the air-oil exchanger.



43

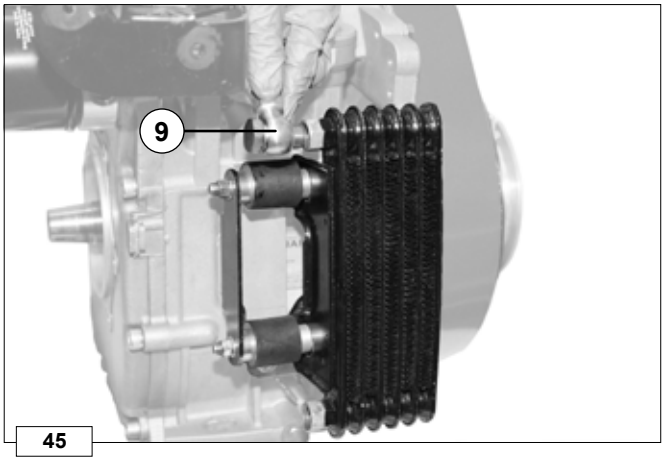
Important

During reassembly, replace all copper gaskets 7.



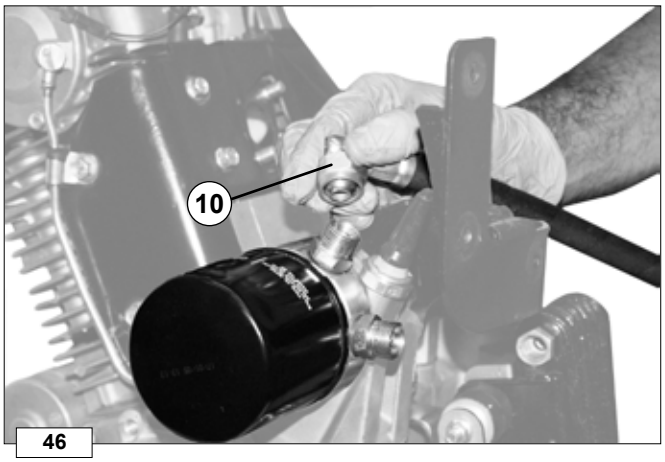
44

Using 2 spanners, loosen and remove the connection union **8** from the oil delivery line on the oil filter flange.



45

Loosen and remove the union **9** connecting the oil return line to the air-oil exchanger.



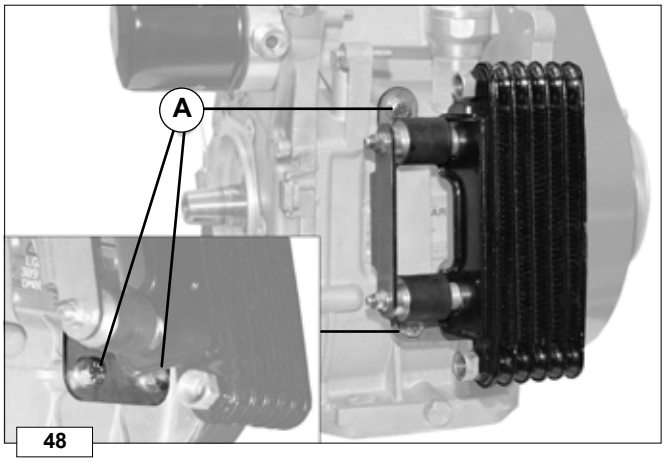
46

Using 2 spanners, loosen the connection union **10** from the oil return line on the oil filter flange.


47

Air filter support bracket - Disassembly

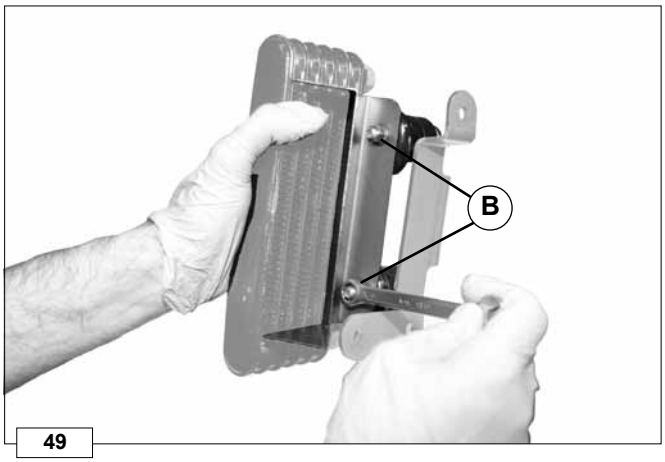
Loosen the 2 M6 nuts fastening the bracket to the crankcase.



48

Oil-air exchanger - Disassembly

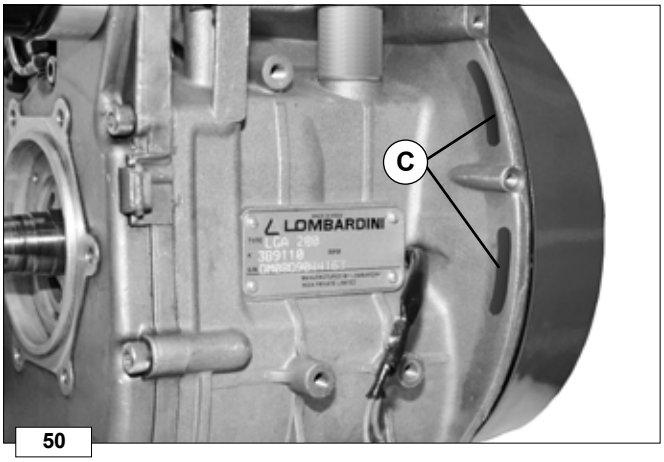
The air-oil exchanger is secured to the crankcase using 3 M8 screws.
Loosen the 3 screws **A** and remove the air-oil exchanger.



49

Air shroud plate - Disassembly

The air shroud plate is located behind the air-oil exchanger.
Loosen the 2 screws **B** and remove the air shroud plate.



50

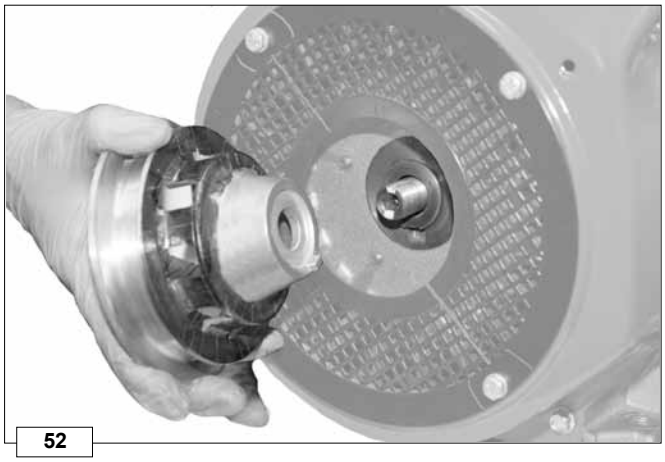
Air-oil exchanger cooling slots

The air-oil exchanger is cooled by a jet of compressed air that is drawn from the rear of the fan/flywheel through the slots **C.**
Check that these slots **C** are free from obstructions.
If obstructed, clean them thoroughly.

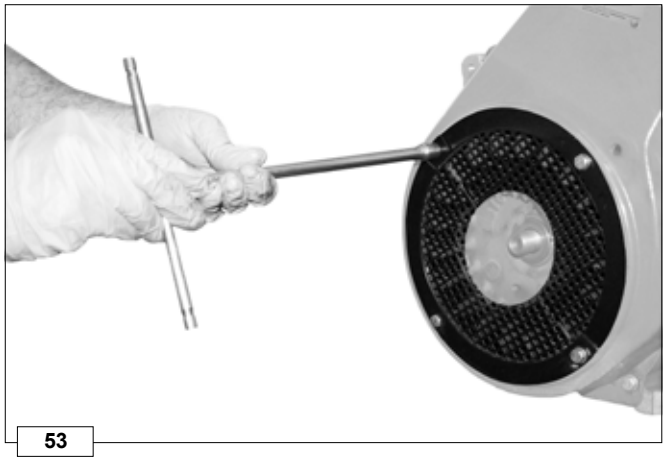

51

Emergency start pulley - Disassembly

Keeping the crankshaft in place with the special tool p/n. 1460.350 page 97, loosen the nut securing the pulley to the flywheel.


52

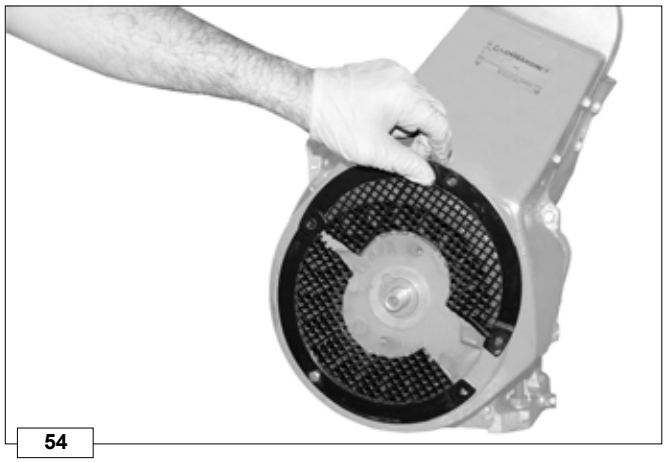
Remove the pulley.


53

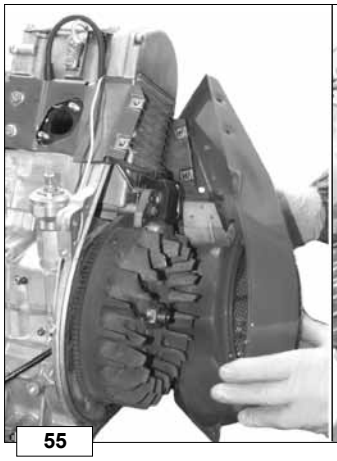
Flywheel mesh screen - Disassembly

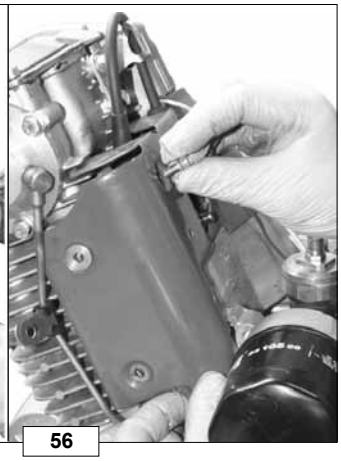
The mesh screen protecting the flywheel is made up of 2 parts, and is fixed to the air shroud with 4 M6 screws.
To remove the screen, remove the 4 screws.

Note: For cleaning inside the flywheel, it is possible to remove the mesh screens without taking out the emergency start pulley.


54

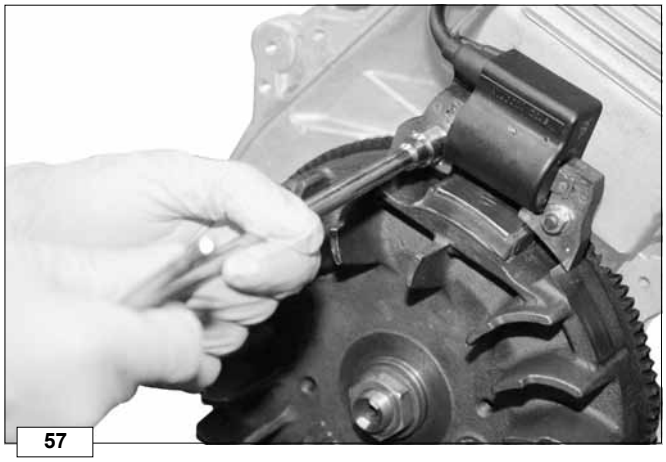
Remove the 2 mesh screens.


55


56

Air shroud and side plates - Disassembly

To disassemble the air shroud, unscrew the two sets of four M6x12 screws both in the upper and lower parts.
The air shroud plates on both sides, intake and exhaust, are fixed to the cylinder by means of four M6x12 screws and two M6x12 screws, respectively.



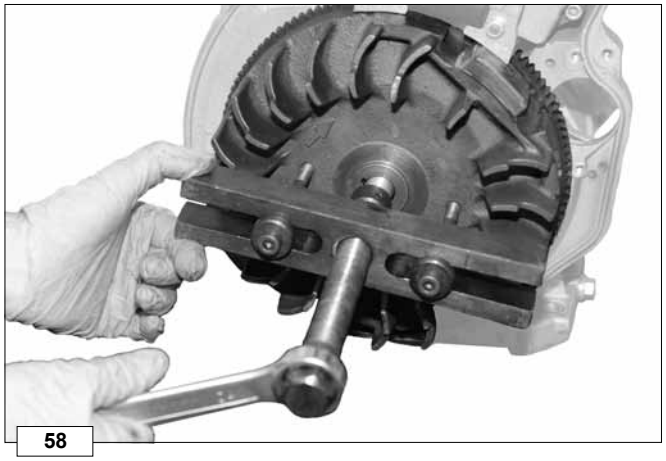
57

Coil - Disassembly

Caution - Warning

Before disassemblying the coil, secure the flywheel with a bolt to prevent it from falling.

To disassemble the coil easily, turn the flywheel so that the magnetic force of magnet and coil do not interfere.
Unscrew the two M6 stop fastening nuts.



58

Fan flywheel- Disassembly

Caution - Warning

During disassembly, work carefully to prevent the flywheel from falling and causing risks to the operator.

To prevent the flywheel from turning during disassembly, use a collar or similar tool.
Loosen the locking nut by turning it anti-clockwise (the threading is of the right-handed type), remove the washer and the flywheel by using the extractor serial number 1460.200.
Check that the conic surface of the crankshaft coupling hole, the key and the key seat are in good conditions.
Check that the cooling fan blades are intact.
If checks reveal any unusual condition, replace the flywheel.

59

Magnet

Important

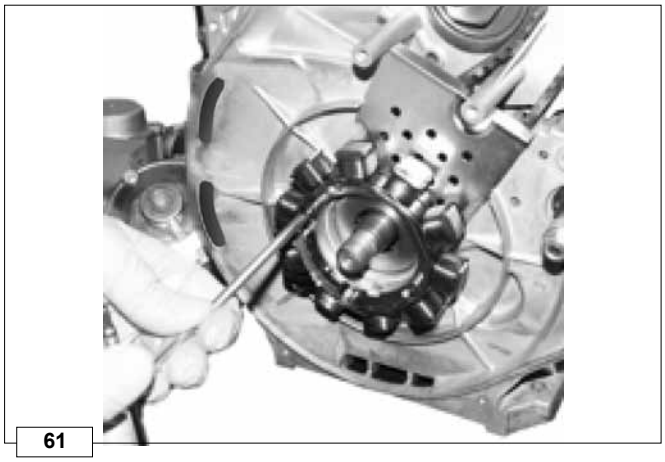
The magnet cannot be disassembled from the flywheel side since this would cause its partial demagnetizing.

Once the flywheel is disassembled, use a ductile iron plate to close the magnetic circuit between magnet and flywheel. When demagnetized, the magnet cannot be replaced: Refer to a repair shop – equipped with a magnetizing device – to have it remagnetized.

60

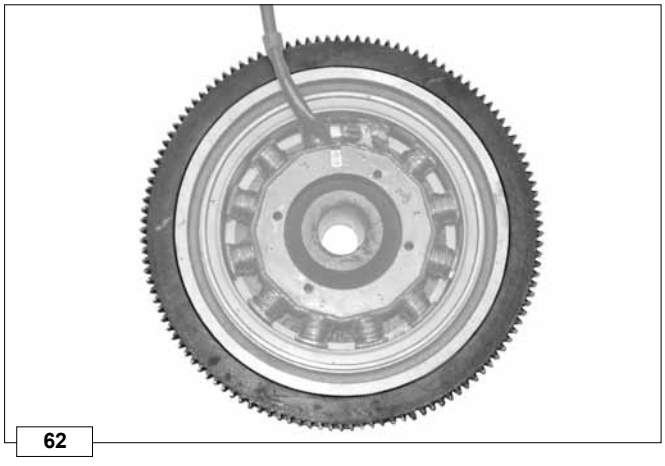
Timing belt external cover - Disassembly

After unscrewing the four M6x20 fastening screws, disassemble the timing belt external cover.


61

Alternator stator - Disassembly

To disassemble the stator, remove the four M5x18 screws that fasten it on the corresponding support.


62

Ring gear for electrical starting with motor - Assembly and disassembly

Important

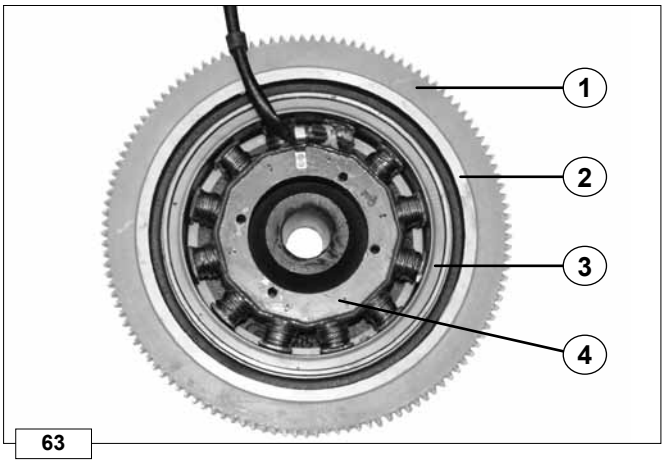
If it is necessary to disassemble the ring gear, do not heat the flywheel to avoid damaging the magnet beyond repair.

Check that the gear teeth are not worn or damaged, since their bad condition would damage the starting motor.
If necessary, replace the ring gear: drill a series of holes close to one another on several points of the ring circle to weaken the piece, then use a chisel to remove it.

Important

To reassemble the new ring gear, slowly heat it for approx.15÷20 minutes up to 300° C max.

Insert the ring gear into the flywheel, making sure it is evenly placed against the seat shoulders and let it slowly cool.

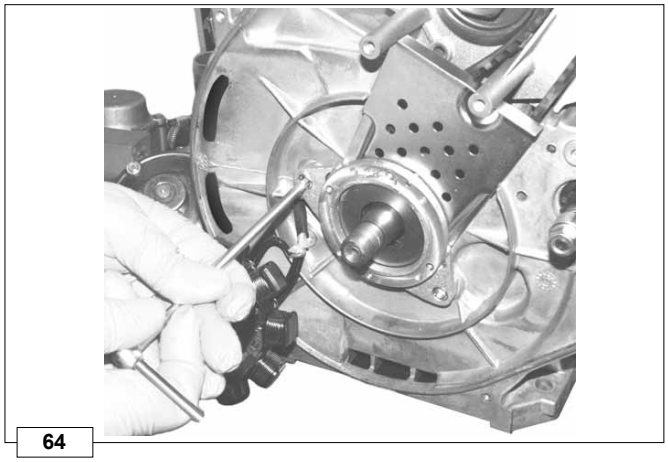


63

Alternator with permanent magnets

1 Ring gear
2 Flywheel
3 Rotor
4 Stator

In this installation, the rotor section is composed by permanent magnets generating a rotating magnetic field.
The number of rotor pole pairs is equal to the number of rotor windings and is evenly distributed on its 360° circle.
Current is taken to stator windings and adjustment is carried out by disconnecting current to the rotor.
Therefore, current supply is not continuous and the battery must dampen voltage picks.



64

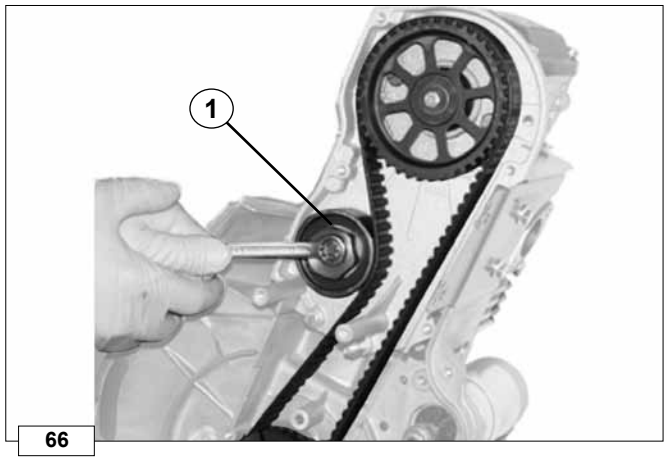
Alternator support - Disassembly

It is fixed to the cover by means of two M6x16 screws and oriented by 2 cylindrical centring pins.
Every pin has a different end diameter and it can only be inserted into one location.

65

Lower guard of synchronous timing belt – Disassembly

To disassemble the cover of the lower timing synchronous belt, remove the two M6x10 bolts fixing it to the housing, in the lower part, and the M6 locknut, in the upper part, by means of a M 6x40 stud bolt equipped with a spacer.



66

Timing synchronous belt - Disassembly

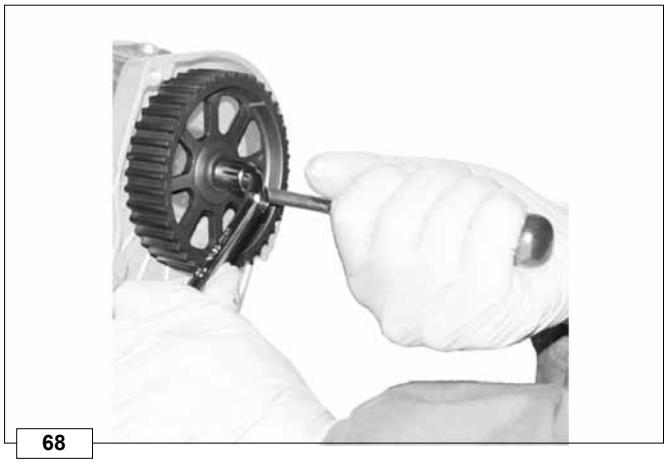
To remove the timing synchronous belt, loosen the M8 bolt **1** marked by the arrow in figure.
This action allows the belt tensioner to turn, thus discharging tension on belt and allow its removal.

67

Remove the belt by pulling it out of the toothed seat on the camshaft.
The timing belt does not need tensioning.
For replacement intervals, see page 20.

Important

When removing the timing belt you need to replace it, even though its scheduled motion period is not over.


68

Camshaft timing synchronous belt - Disassembly

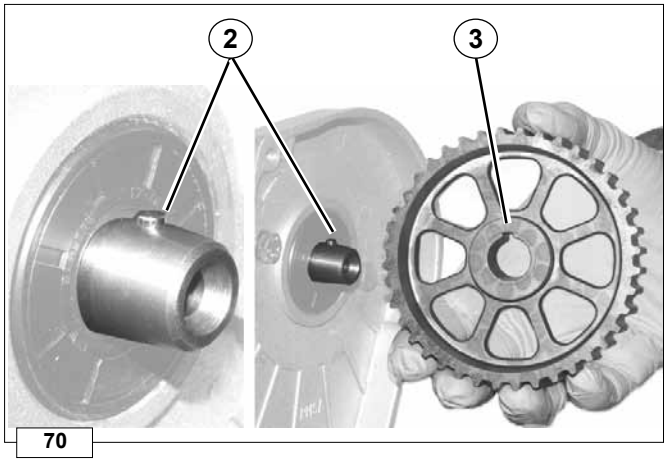
Through one of the synchronous belt outlet – the most suitable one – insert a 10 mm hex. socket wrench equipped with grip on one of the two fastening bolts located on the lower cover
This operation is required to prevent the synchronous belt from turning when the M6x20 fastening bolt is removed from the camshaft.

69

Camshaft timing synchronous belt - Extraction

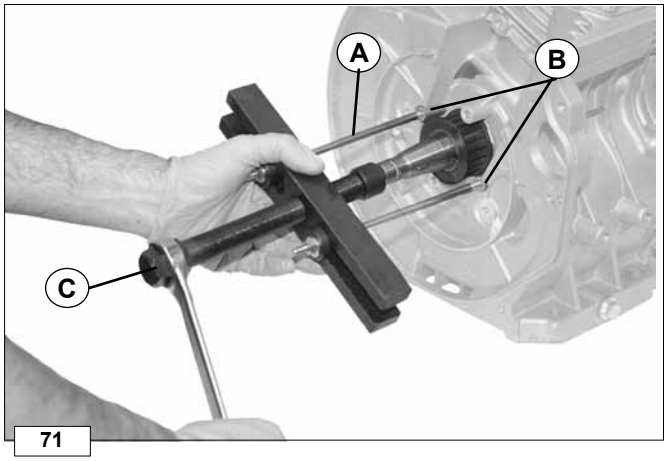
No extractor is needed to extract the synchronous belt.

Important
The Ø 6 washer **1** must be replaced at every disassembly.



70

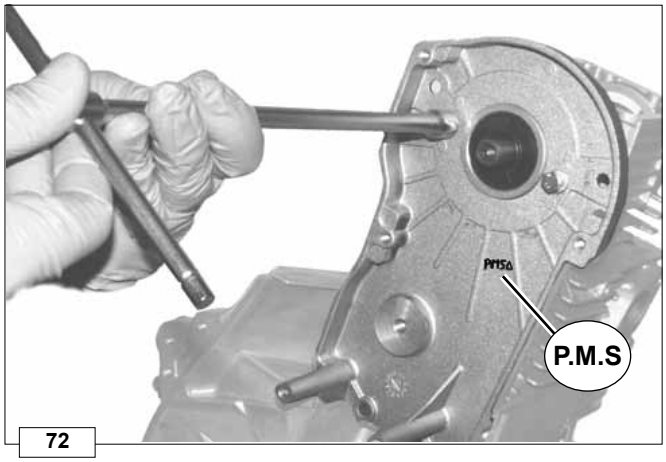
After disassembling the camshaft timing synchronous belt, check if key **2** is in good conditions, as well as its seat on the camshaft and the slot seat **3** on the timing synchronous belt.



71

Driving shaft timing synchronous belt

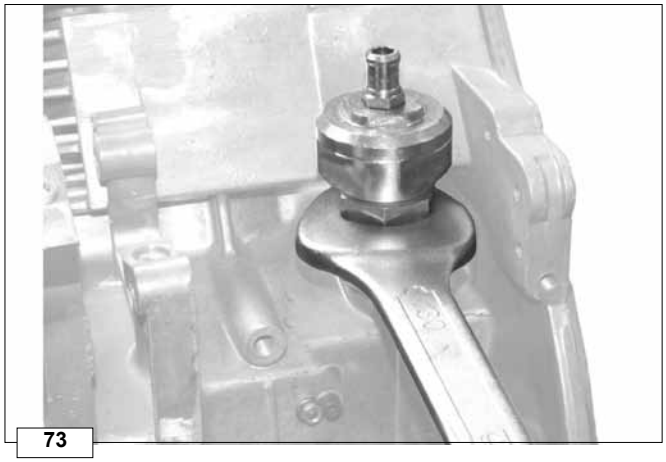
To remove the synchronous crankshaft timing system drive pulley, use extractor p/n 1460.200
The synchronous timing system drive pulley is interference-driven, therefore it is necessary to screw the two tie rods **A** into the corresponding holes in the crankcase **B**, then fasten the extractor screw **C** clockwise to push the crankshaft into the crankcase in order to free the pulley.



72

Timing belt internal cover - Disassembly

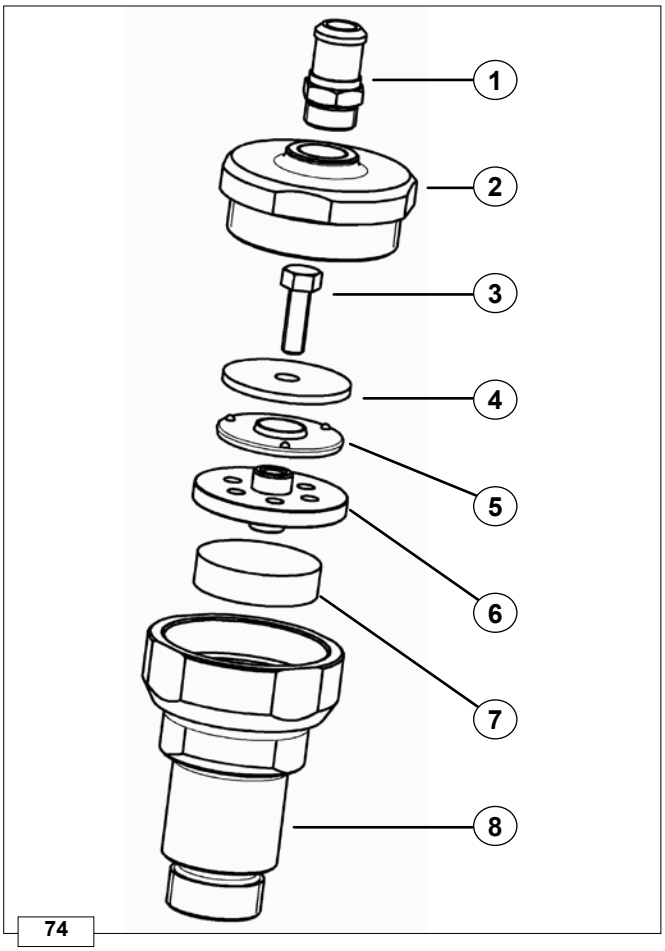
To remove the timing belt internal cover, unscrew the two M6x16 bolts in the upper part and the M6x25 bolt on the lower part.
Next to the rib in the lower part is a mark for camshaft timing.



73

Recirculation vent system

The oil vapours recirculate through the duct **8** (fig. 74**)** towards the filter element **7** (fig. 74**)** which slows them down allowing them to cool.
Cooling down, the air vapours turn into oil, gaining in specific weight and then returning in the sump.
The vapours that did not turn into oil recirculate when the diaphragm opens **5 (**fig. 74**)** until they reach the suction.
The diaphragm **5 (**fig. 74**)** opens and closes as a consequence of the alternate motion of the piston.
Change the diaphragm **5 (**fig. 74**)** if it isn't elastic ar is deformed and change every 50.000 Km.



74

Components:

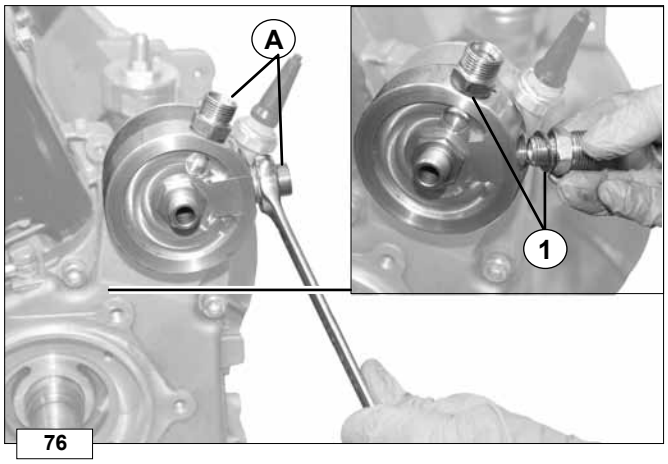
1 Pipe
2 Cap
3 Screw
4 Washer
5 Diaphragm
6 Clutch disk
7 Braid filter
8 Body


75

Oil filter - Disassembly

Remove the oil filter by using the proper wrench.

Important
Mount the new oil filter and tighten only by hand.

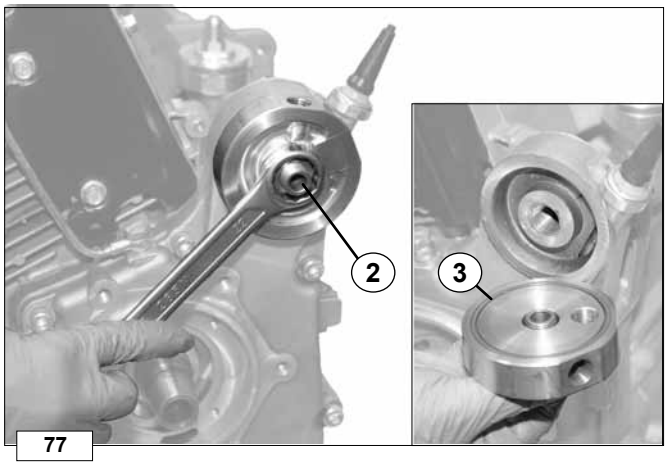


76

Oil filter holding flange - Disassembly

Loosen the 2 fittings **A.**

Important
During reassembly, always replace the copper gaskets 1.



77

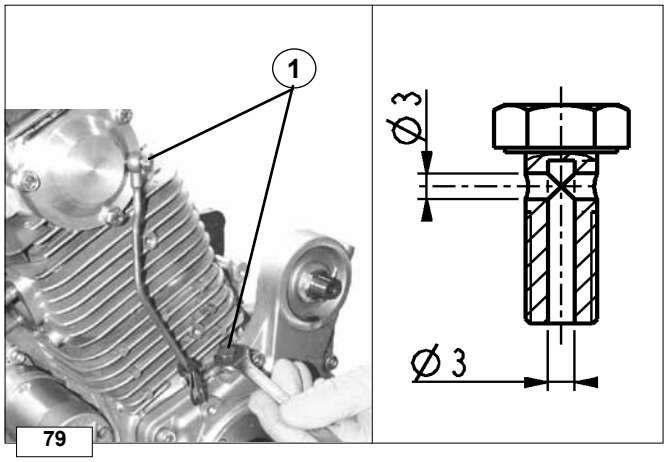
Loosen the nipple **2** securing the flange to the crankcase and remove it.

Caution - Warning
Check the condition of the O-ring 3 and replace it if damaged.


78

Oil pressure sensor - Disassembly

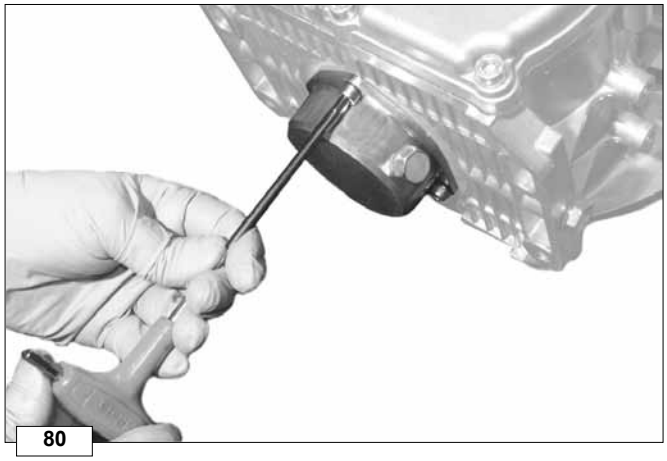
Loosen the sensor and remove it.



79

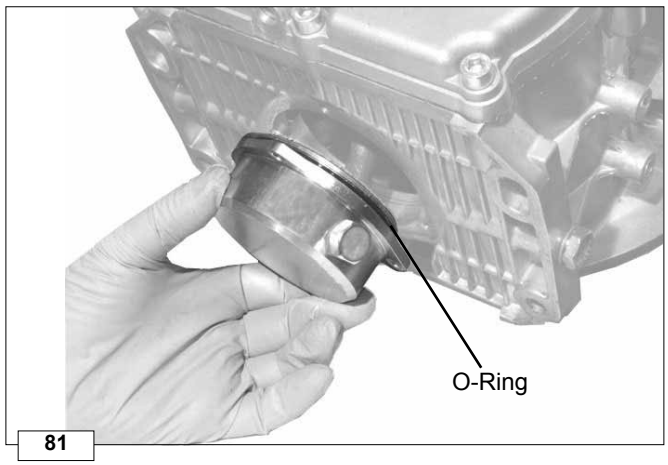
Housing to engine cylinder head forced lubrication pipe

Remove the two calibrated fittings **1** M8x1x20 and take out the lubrication tube.


80

Oil sump - Disassembly

Unscrew the three M6x16 housing fastening screws and remove the oil sump.



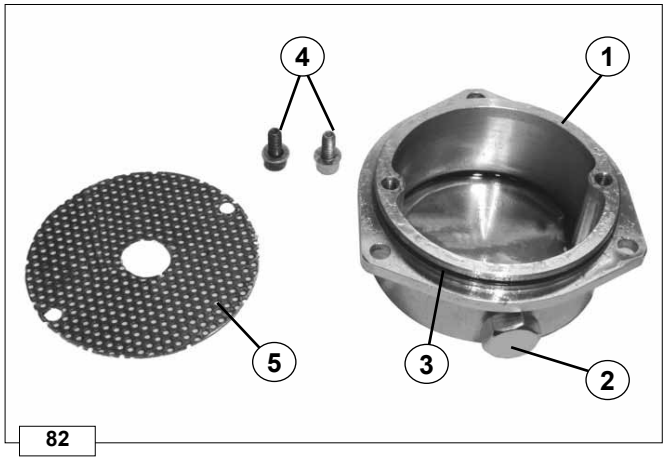
81

Important

When removing the oil sump, take particular care not to damage the sealing O-ring.

Important

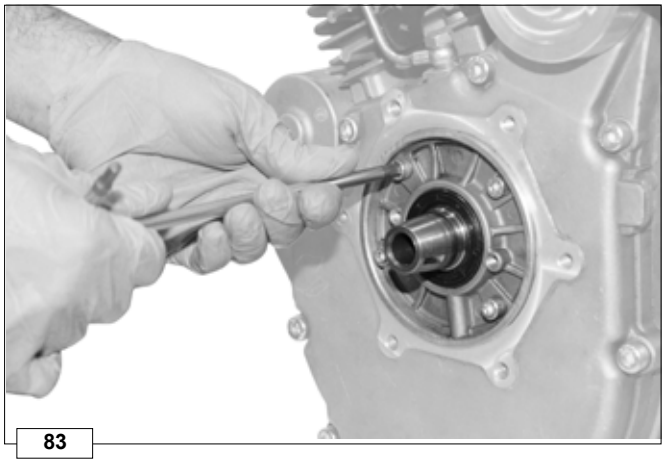
During reassembly, check the integrity of the seal ring and replace if damaged.



82

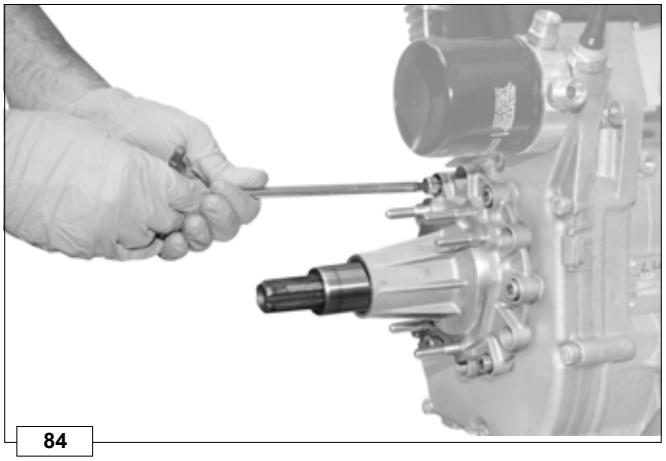
Legend:

1 Oil sump
2 Oil drain plug
3 O-ring
4 M5x16 plate fastening screws
5 Oil filtering plate

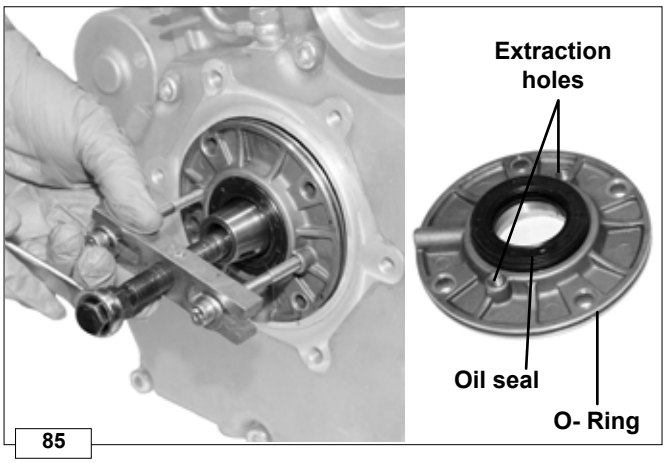

83

Oil pump cover

Unscrew the four M6x16 screws to remove the cover.


84

For the splined shaft version, before opening the oil pump cover, remove the gearbox coupling flange.



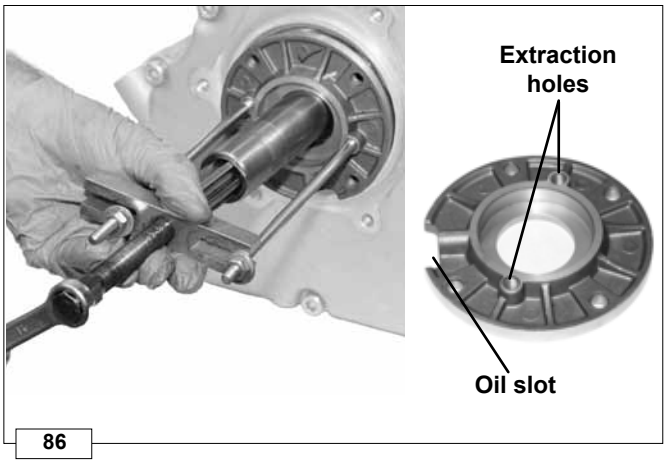
85

Oil pump cover extraction

To remove the cover from its seat, use two of the four screws that you have previously disassembled by fastening them into the appropriate extraction holes; see figure.

Important

When reassembling, replace the O-ring.



86

For the splined shaft version, use two M6 stud bolts, screwing them into the corresponding extraction holes; see figure.

Important

When reassembling, replace the O-ring

87

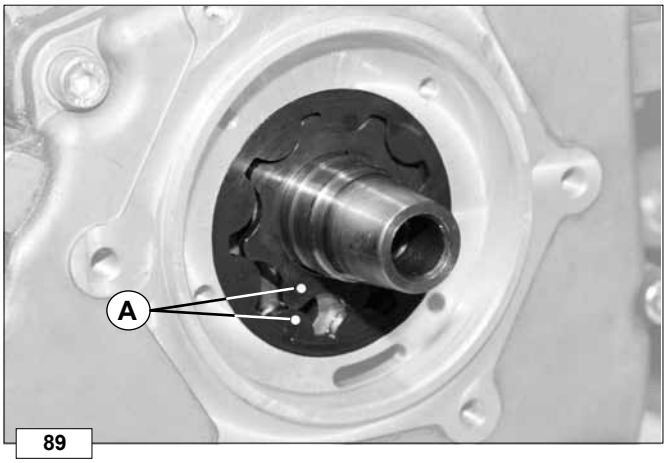
Oil sealing ring extraction (30x47x7)

Extract the oil sealing ring, being careful not to damage the ring seat on the cover.

88

Oil sealing ring insertion

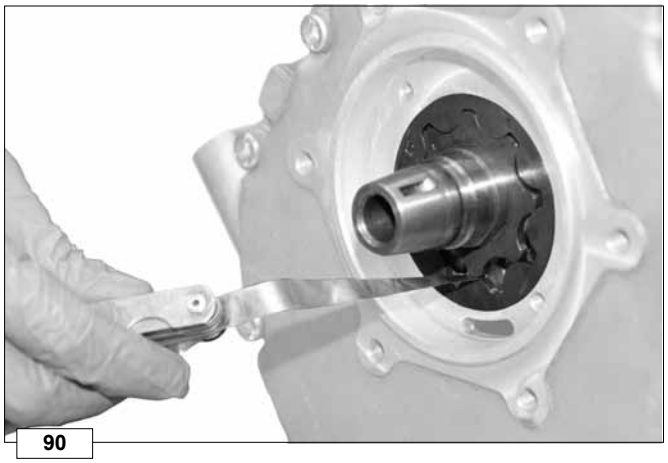
To drive the oil sealing ring into the oil pump cover, use the appropriate plug ref. no. 1460.204, shown on page 97.
It is recommended to use a press for this operation.



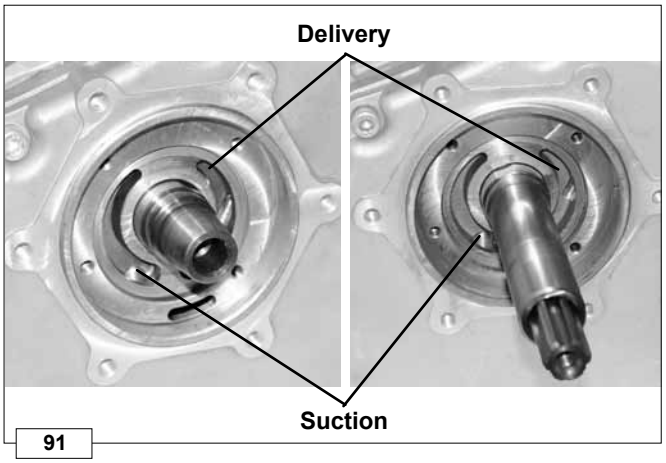
89

Oil pump rotors

Install the oil pump rotors **A** with references on the same side and facing the assembler.


90

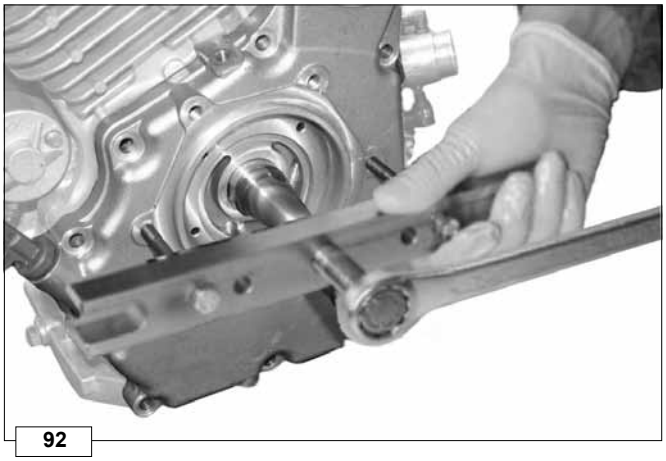
Using a thickness gauge, measure the clearance between the rotor lobe heads.
The maximum value must be 0.171 mm; the wear limit is 0.250 mm.



91

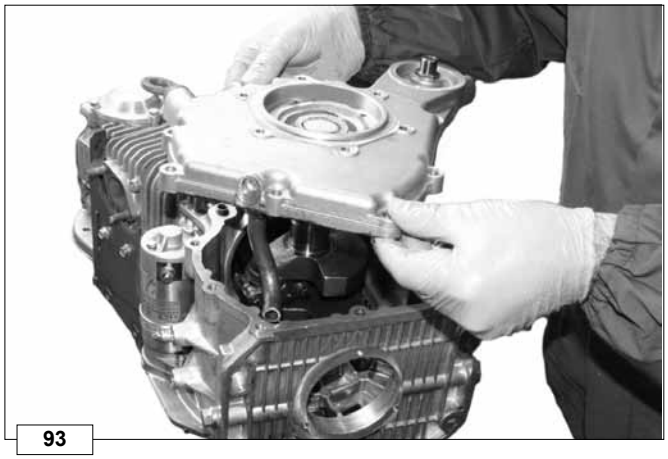
Lube oil suction and delivery ducts

Under the power take-off side cover rotors, there are the intake and exhaust oil pump ducts. See figure.


92

Housing cover, power take-off side - Disassembly

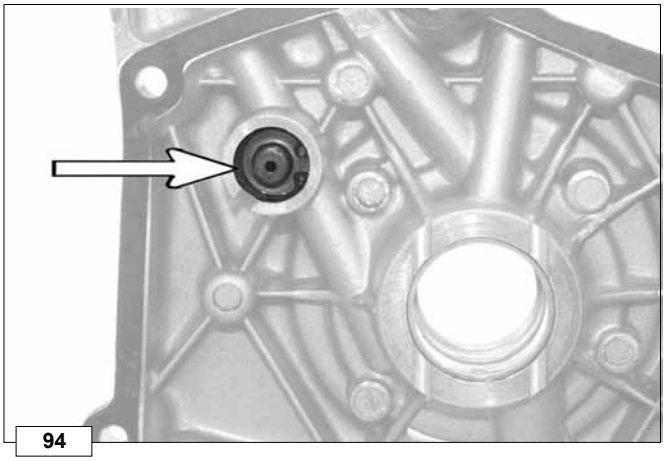
Remove the seven M8x35 screws fixing the power take-off side cover on the housing.By using the extractor serial number 1460.200 see page 97 (the same used to extract the flywheel), place the central screw of the extractor on the crankshaft tang, insert the two bolts supplied in the proper external holes of the extraction lever and tighten them in the two threaded holes on the timing system cover.Fasten the central screw of the extractor by turning it clockwise, until the cover is completely detached.
When reassembling, replace the gasket serial number 4601.174 between cover and housing.
Each time the housing cover on the timing system side is removed, check that the base surface of the engine housing is not deformed. Deformation can be checked for by placing the cover on a surface plate.



93

Power take-off side cover - Disassembly

In order to extract the cover, turn it 45° as shown in the figure, so as to allow the oil suction pipe to pass through housing overall dimensions.
Each time the cover is removed, check that the base surface of the engine housing is not deformed.
Deformation can be checked for by placing the cover on a surface plate.



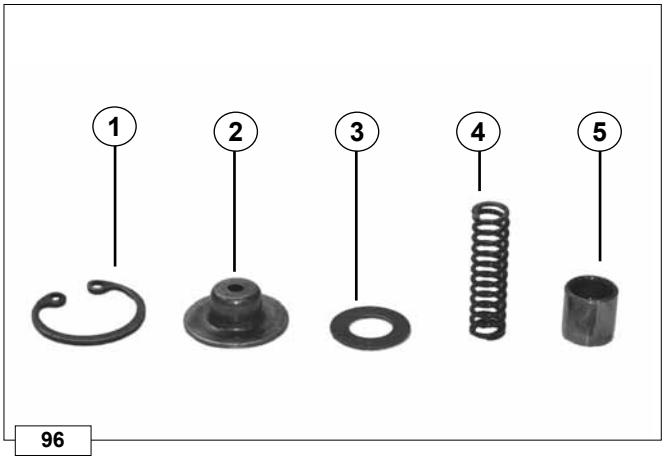
94

Oil pressure regulating valve

The oil pressure regulating valve is located inside the power take-off side cover.

95

When disassembling the oil pressure regulating valve, thoroughly clean all its components before reassembling it.

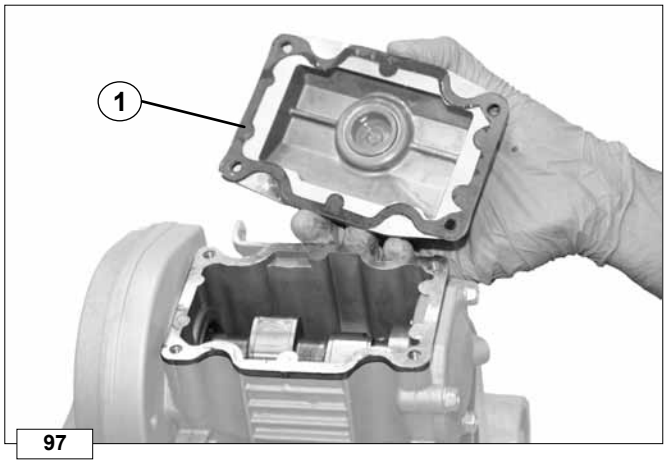


96

Oil pressure regulating valve components

Legend:

1 Snap ring
2 Spring housing cup
3 Flat washer
4 Calibrated spring
5 Plunger



97

Tappet cover disassembly

Remove the tappet cover by unscrewing the four M6x12 screws.

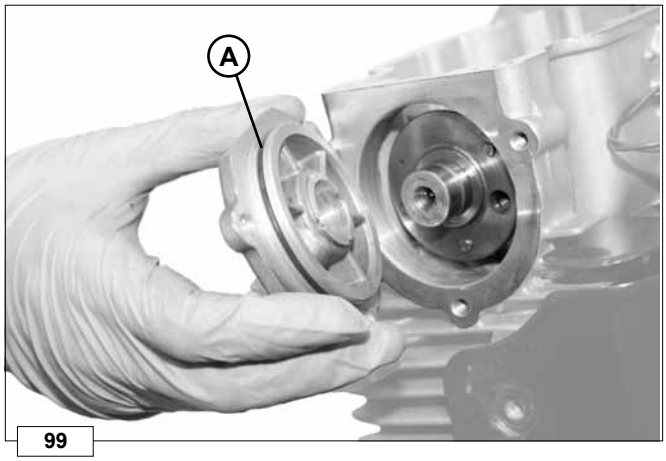
Important

When reassembling, always replace the paper gasket 1.


98

Camshaft support - Head disassembly

Unscrew the three M6x20 bolts fixing the camshaft support on the head.

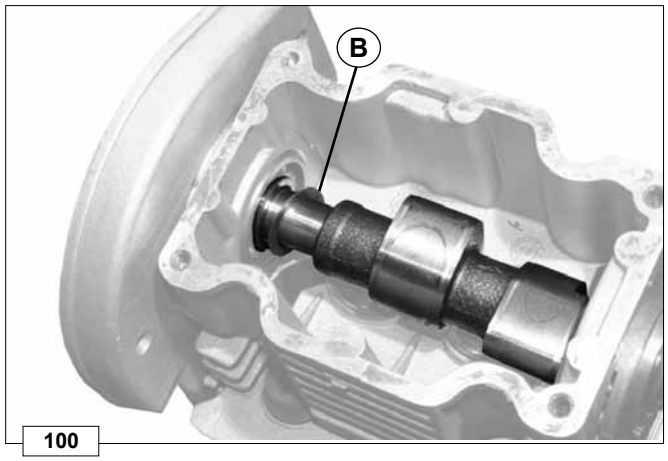


99

Remove the support being careful not to damage the O-ring **A**.

Important

When reassembling, in case of doubt as to the condition of the O-ring, replace it.



100

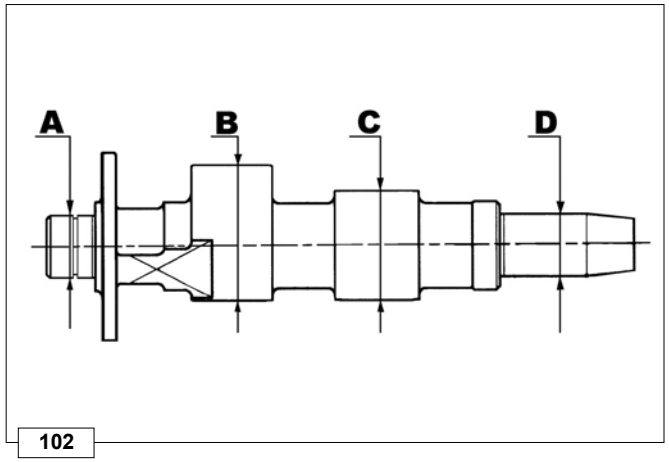
Camshaft (head disassembly)

Turn the shaft with the cams facing upwards and pull it out through the hole on the side support housing which had previously been disassembled.
The clearance ring **B**, which determines the camshaft axial clearance, is located between the camshaft and the ball bearing.

101

Camshaft dimensional check

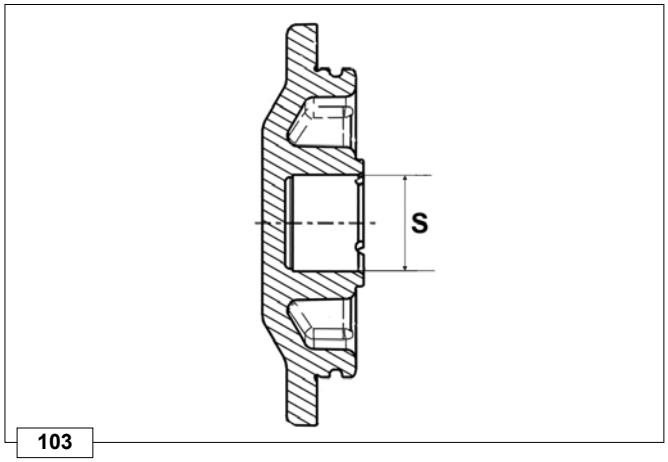
Visually check that the cams and journals are not scratched or severely worn.
Use a micrometer to check that journals diameters and intake/ exhaust cam height are within the reference values detailed in the table of figure 102.



102

Camshaft dimensions

A (mm)		B (mm)		C (mm)		D (mm)	
min	max	min	max	min	max	min	max
18,989	19,0	36,95	37,05	29,98	30,02	16,983	16,994



103

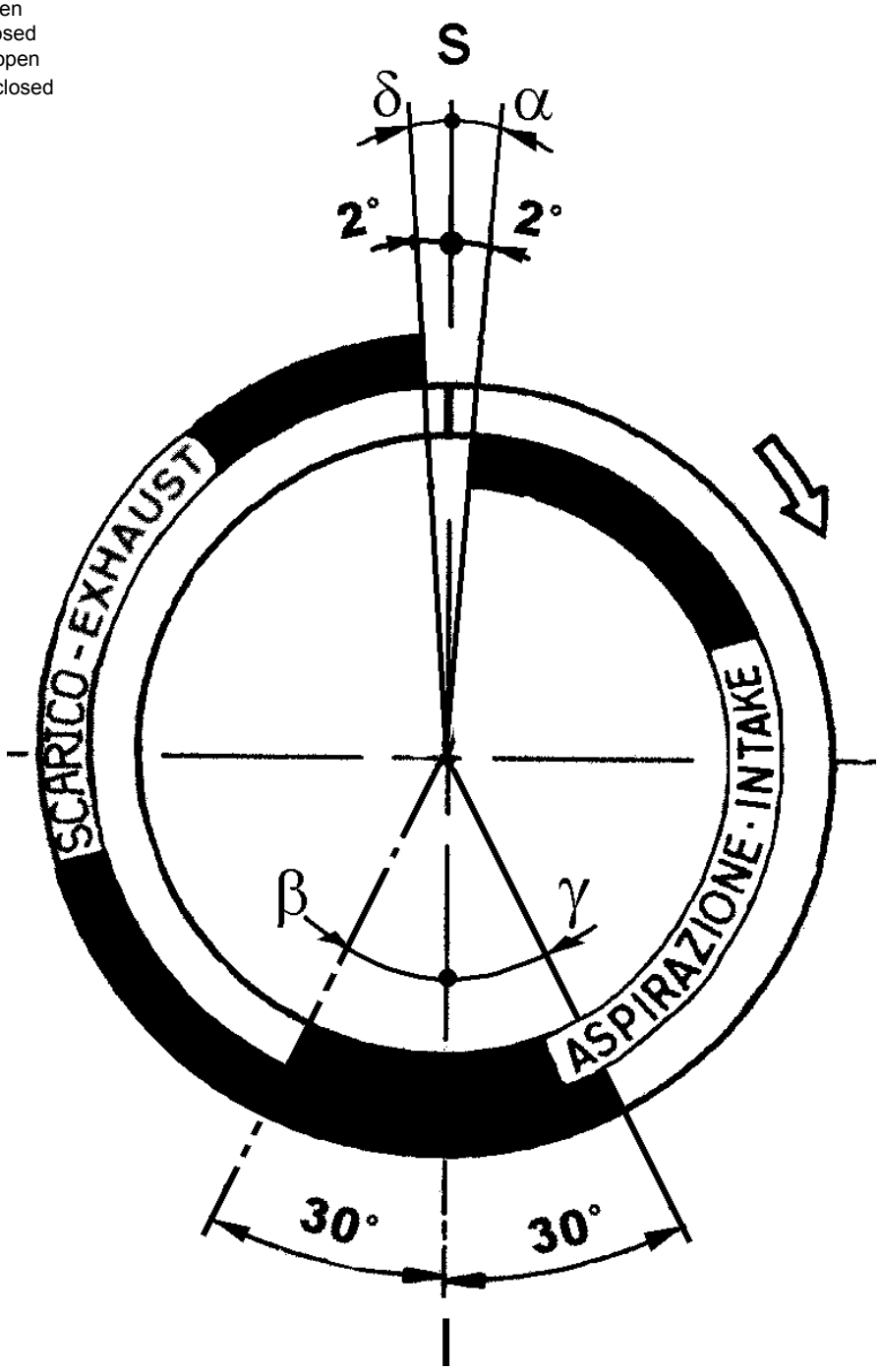
Camshaft and support dimensions

A (mm)	S (mm)	S - A (mm)	Wear and tear limit (mm)
18,989÷19,000	19,060÷19,040	0,40÷0,071	S - A 0,150

Legend

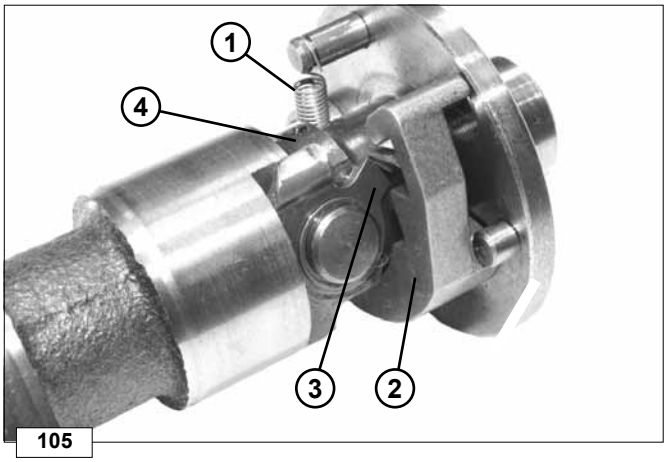
S = piston at top dead centre
I = piston at bottom dead centre

α = intake valve open
β = intake valve closed
γ = exhaust valve open
δ = exhaust valve closed



Timing diagram

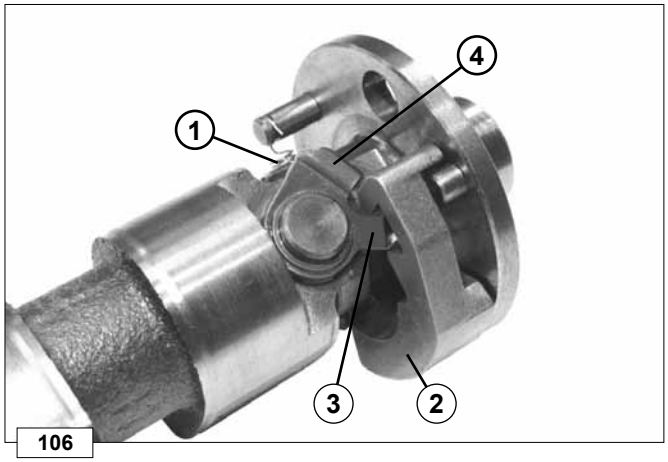
The values on the diagram refer to 1 mm-clearance between tappets and valves, when the engine is cold.



105

Centrifugal decompression device - Operation with the engine stopped

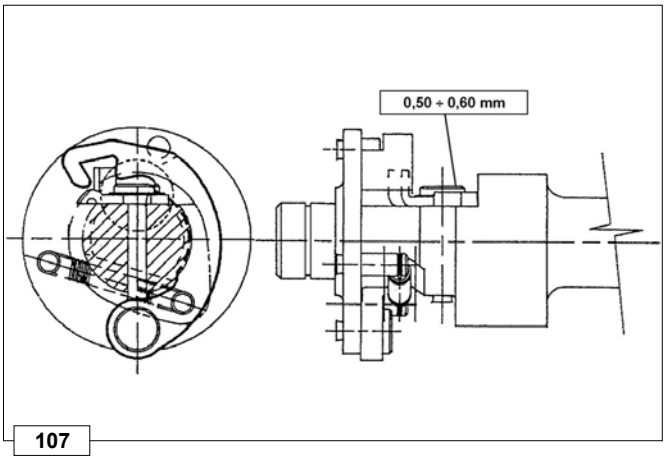
With engine stopped and up to approx. 850 rpm, the pressure exerted by the spring **1**, which actuates the weight **2** by means of the lever **3** through the decompression cam **4**, keeps the exhaust valve open.
This will lower compression in the cylinder, thus helping starting.



106

Centrifugal decompression device - Operation with the engine running

With the engine running, the weight **2** opens, thanks to centrifugal force, and overcomes the resistance of the spring **1** and disconnects the decompression cam **4** to which it is connected through the lever **3**.
In this condition, the exhaust cam controls the valve continuously.



107

Centrifugal decompression device

All engines are equipped with a centrifugal decompression device; check that the centrifugal weight and the spring **1** are in good conditions.
Change the spring if at the X= 34,5 mm, the force is F ≤ 1 N.
The rod protrusion out of cam edge must be, with the device engaged, between 0.50 and 0.60 mm.


108

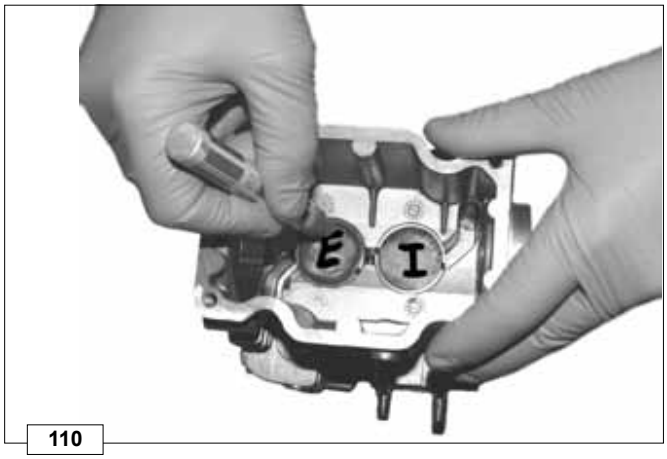

109

Important
Do not disassemble the head while it is hot, in order to avoid any possible distortion.

Head - Disassembly

Use an hexagonal male key to unscrew the four M10x1.5x100 socket-head screws fixing the head on the engine housing.

Important
When reassembling, always replace the gasket serial number 4730.619 between head and housing.



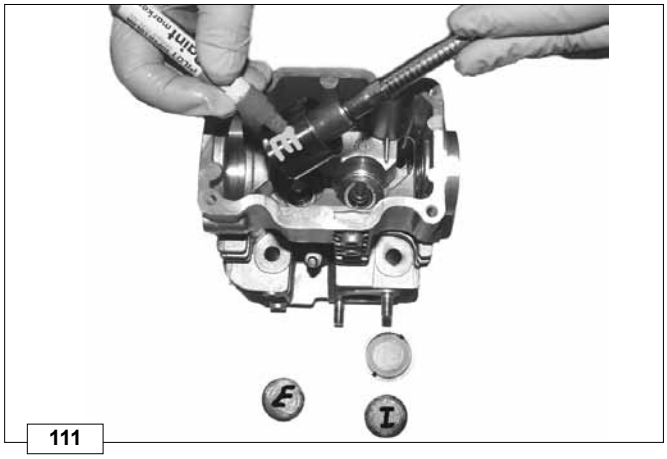
110

Tappets

Check that the tappets are in good general conditions. In case of scratches on the sliding cylindrical side of the head, replace the tappets.

Caution - Warning

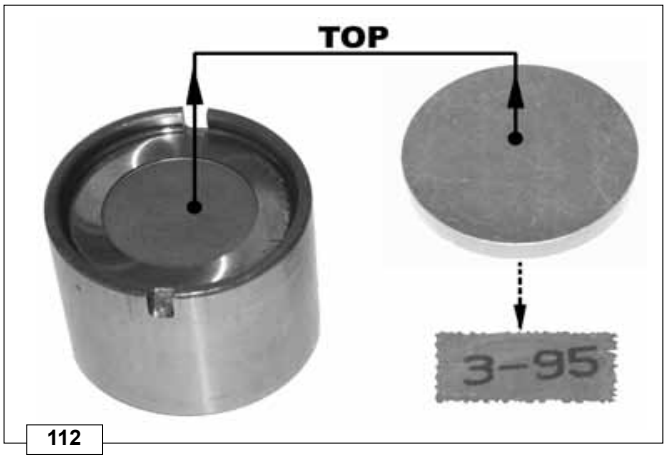
If the old tappets are not worn and can be re-used, they must be marked, as well as the pads used for axial end float adjustment, so as to reassemble them in the correct position.



111

Tappets - Removal

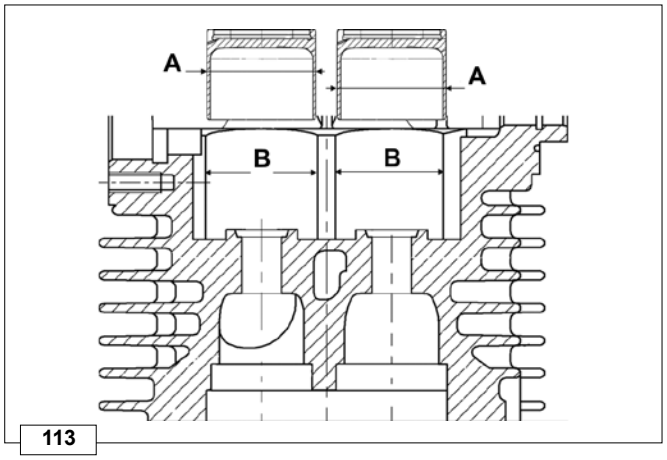
To remove the single pads and tappets and avoid placing them in the wrong position, use a magnet.



112

Valve clearance adjusting pads - Correct assembling order

The valve clearance adjusting pads must be reassembled making sure that the surface having the thickness value marked, is facing the surface where it will have to contact on the tappet socket (fig. 112).



113

Tappet and seat dimensional check (mm)

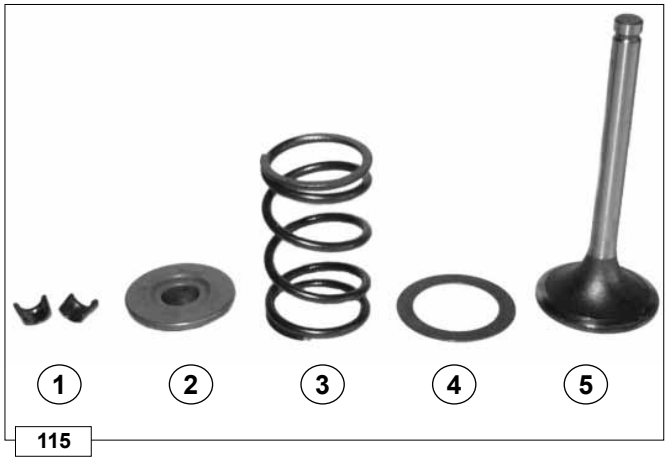
The tappet and seat dimensions are identical both for intake and exhaust.
Using a micrometer, perform the check and then measure the tappet and seat diameter.
When the wear limit has been reached, replace the head.

A (mm)	B (mm)	B - A (mm)	Wear and tear limit (mm)
35,009÷35,034	34,995÷34,975	0,14÷0,059	B - A 0,110

114

Valves - Disassembly

To detach the cotters from the groove on the valve stem, use the tool serial number 1460.113 page 96.
Place the tool on the spring collar and press firmly.

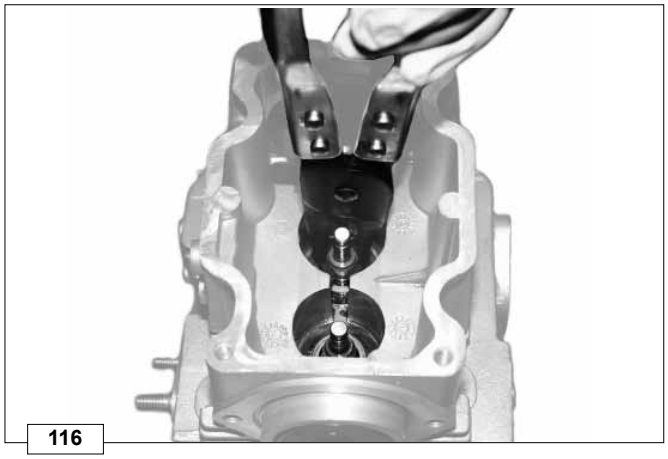


115

Legend:

1 Cotters
2 Upper spring collar
3 Spring
4 Lower spring collar
5 Valve

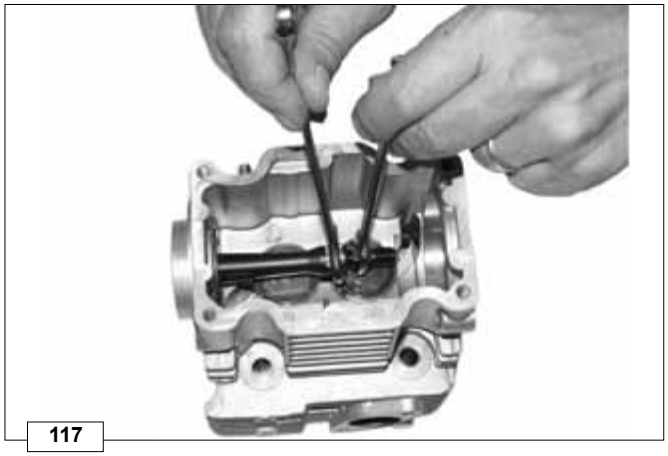
The intake and exhaust valves have both a stellite insert breech.



116

Oil sealing rings on valve stem - Disassembly

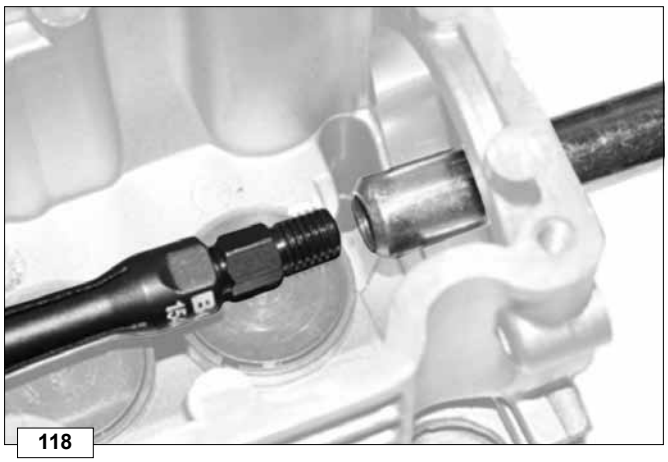
By means of suitable pliers, disassemble the oil sealing rings on the valve stems, located at the top end of the valve guides.
When reassembling, it is advisable to replace the oil sealing rings.



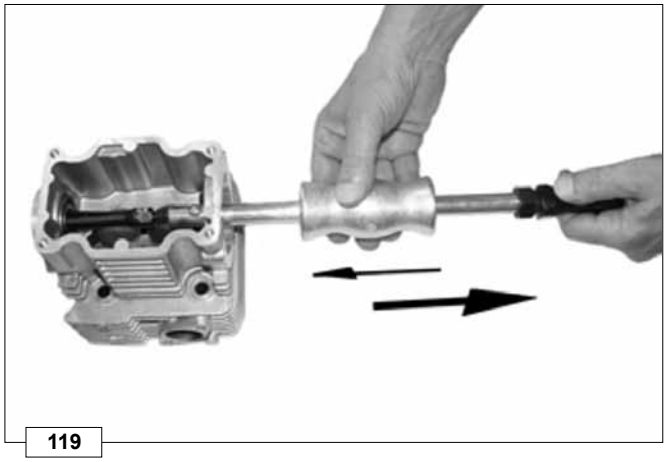
117

Camshaft support ball bearing - Disassembly from head

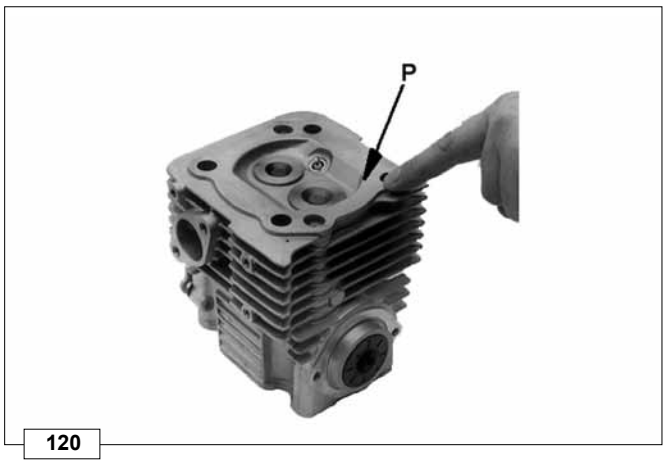
To extract the ball bearing out of its seat, use the expanding mandrel serial number 1460.196 page 97.
Insert the mandrel end, which expands inside the bearing hole.
With two fork spanners (10 mm and 17 mm) make the mandrel expand, so as to cut the bearing on the hidden surface.


118

Screw the beater serial number 1460.195 page 97 on the relevant union by using the expanding mandrel serial number 1460.196 page 97.


119

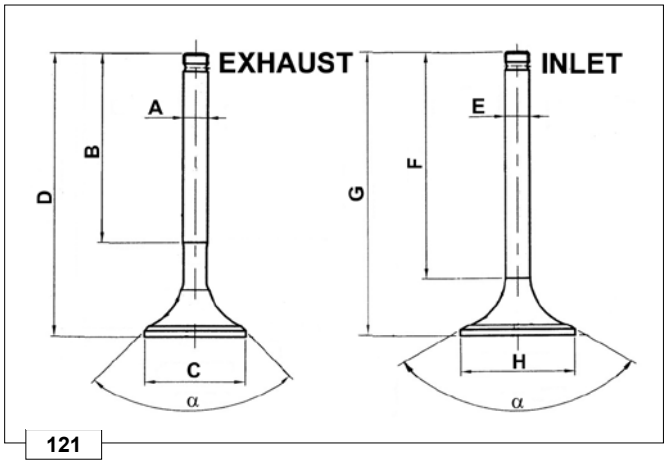
Have the head slide in both directions by exerting a suitable force during the stroke from head to handle.



120

Cylinder head

It is made of die-cast aluminium; the valve seats in sintered material are driven with interference into the corresponding housings on the head.
Valve guides are of the inserted type, can be replaced and both are made of bronze.
Clean the head of any carbon deposits by using a brass wire brush and place it on a surface plate to check that the head base plane on the cylinder **P** is not deformed.
In case of deformation, work the piece again by scalping **0.25 mm** max.

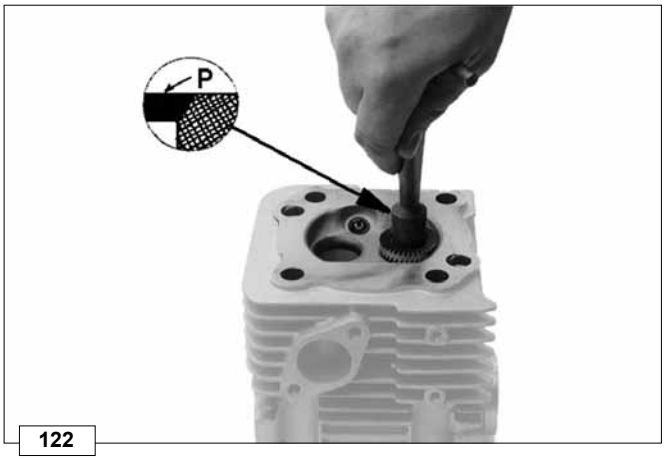


121

Valves - Check

After disassembling and cleaning with a wire brush, check that the valve contact surface is not deformed, burned or worn; in case of an unusual condition, replace the valves.

Exhaust valve (mm)		Inlet valve (mm)	
A	6,97÷6,955	E	6,987÷6,965
B	54,10÷53,90	F	64,50÷64,70
C	28,70÷28,90	G	32,70÷32,90
D	80,70÷80,90	H	80,70÷80,90
α	121°±15'	α	121°±15'
Wear and tear limit (mm)		**6,90**	



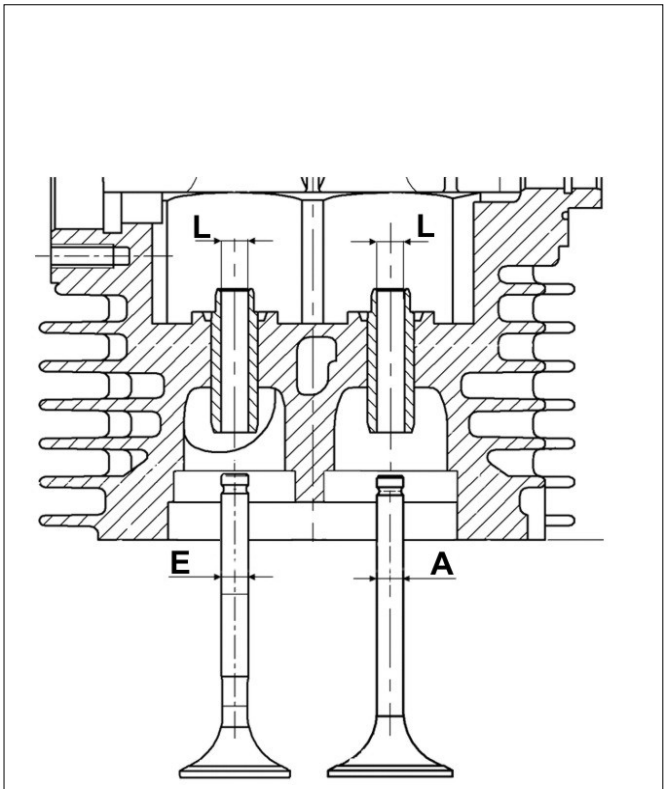
122

In case the valves are in good general conditions, restore the valve contact surface **P** position on its seat by grinding.

123

Valve guides - Check

Check that valve guides are not scratched, seized or clogged with carbon deposits. Valve guide wear can be checked by means of the plug gauge (go-not-go gauge) serial number 1460.103 page 96.
In case the guide diameter is bigger than the max. gauge diameter, replace the guide: the wear limit diameter is 7.09 mm while the plug gauge no-go diameter is 7.097 mm.



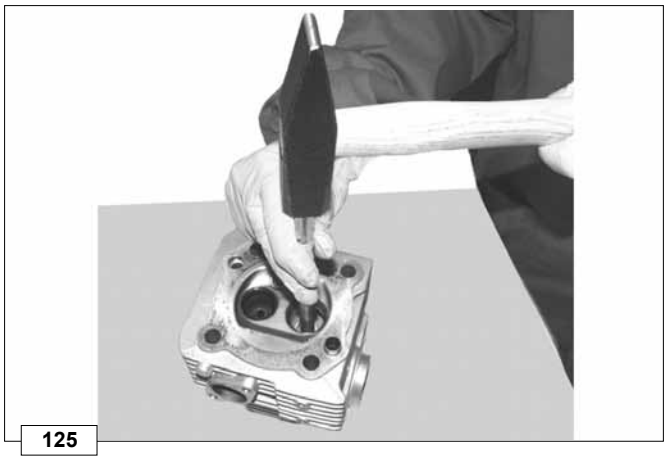
124

Valve and valve guide dimensions after assembly on the head.

	Description	Nominal ϕ(mm)
E	Intake valve	7 -0,013 -0,035
A	Exhaust valve	7 -0,030 -0,045

Internal diameter of new valve guides inserted	
min 7,015 mm	max 7,025 mm

	Nominal clearance	Wear & tear Limit
L-A	0,028÷0,060 mm	0,14 mm
L-E	0,045÷0,070 mm	0,14 mm

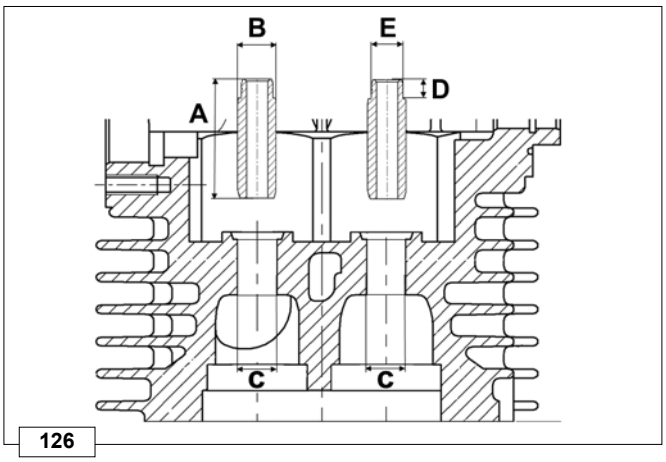

125

Valve guides - Removal

Important

To drive the valve guides in and out it is recommended that you place pressure on the beater using a press

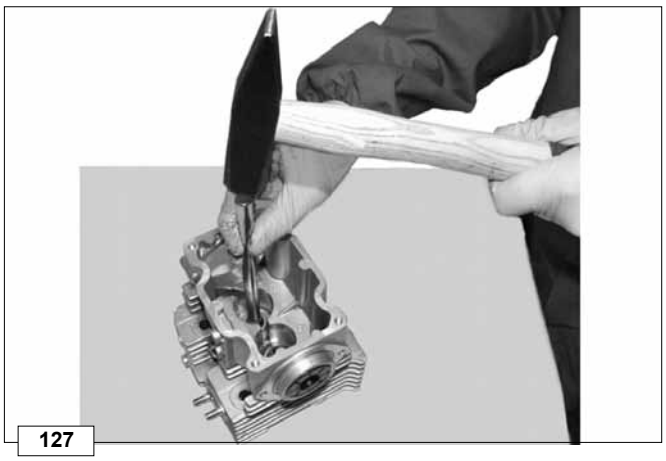
To remove the valve guides from head, use the tool for attaching and removing the valve guides Ref. no. 1460.104 page 96.
Put the beater into the end of the valve guide and press.



126

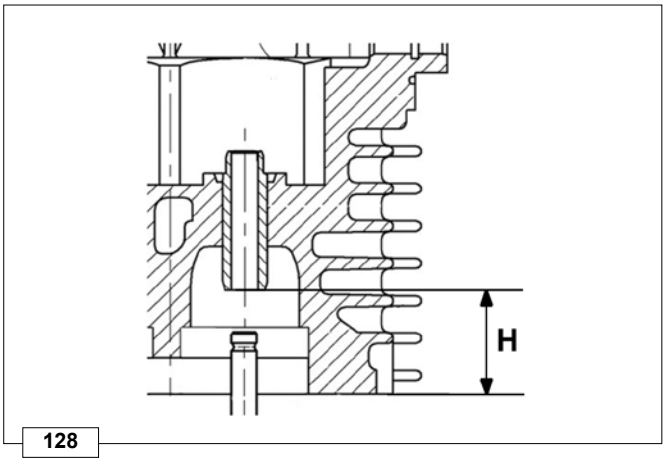
Valve guides – Seats - Replacement

A	mm	37,30÷37,40
B	mm	7,035÷7,045
C	mm	12,000÷12,018
D	mm	5,80÷6,20
E	mm	9,75÷9,85


127

Valve guides - Assembly

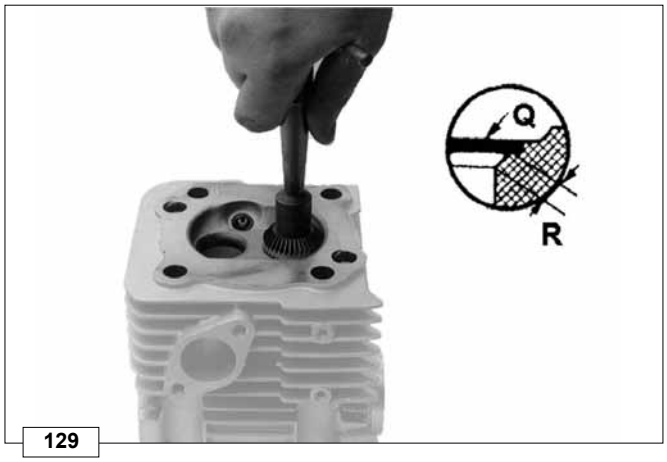
To drive in new special bronze valve guides, use the same beater used previously for removal.
After driving in the new valve guides, use a depth gauge to check the H measurement. See fig. 128.



128

Guide protrusion from cylinder head surface

H = 27.75 ÷ 27.01 mm



129

Valve seats

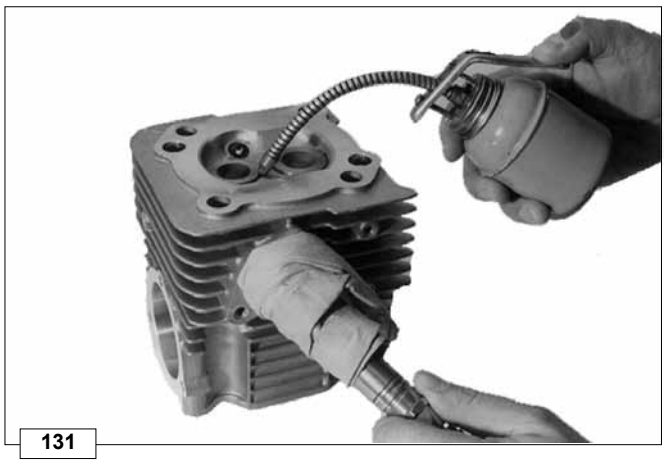
The valve seats are made of special sintered steel with a high quantity of nickel chrome, to make them more resistant to wear and combustion heat.
To regrind them, use conical cutters with angle 120° intake - exhaust.

Caution - Warning

Prolonged use of the engine and the continuous hammering of the valve seats at high temperatures causes hardening of the track P (fig.122 page 68), and makes manual milling impossible. It is therefore necessary to remove the hardened surface layer using a grindstone on a valve seat grinder. The final adjustment can then be performed manually using the cutter mentioned above (fig. 129).
Grinding the valve seats causes the widening of the valve seat support track R. If R is wider than 2,2 mm, mount an upturned cutter and lower surface Q (fig. 129) until R measures: 1.5 ÷ 1.8 mm.

130

The final adjustment of the valve into its seat must be performed by sprinkling fine emery compound onto the seat and rotating the valve back and forth with a light pressure, until the surfaces in figure 130 are perfectly settled.



131

Next, carefully rinse the valve and seat using petrol and spray with compressed air to get rid of any remaining emery compound or shavings.

To check the grip between the valve and its seat after grinding, proceed as follows:

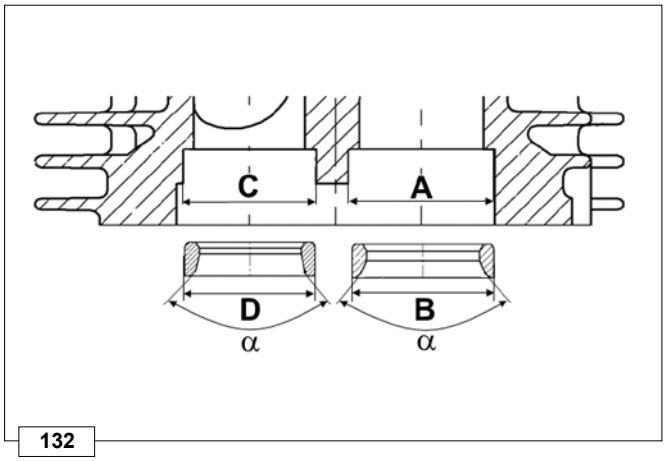
1) Place the valve on its head with spring and stop collars.
2) Pour a few drops of diesel or oil around the valve head.
3) Blow compressed air through the exhaust/intake duct, taking care to plug off the edges of the duct to avoid air leaks (fig. 131).

If air bubbles form between the valve and its seat, remove the valve and adjust by milling the seat. This adjustment can be tested by jogging the valve in its seat, first pushing upwards, then letting it drop freely. If the bounce is significant and uniform, even when the valve is slowly twisted round completely, it means that the adjustment is correct. If this is not the case, continue milling until the right conditions are reached.

If the valve seat needs changing, proceed as follows:

1) Using a 2÷3 mm bit, drill holes into the valve seat and finish off with a chisel without damaging the housing.
2) Remove the seat.
3) Heat the head to 160° - 180° C.
4) Position the new seat using a press.

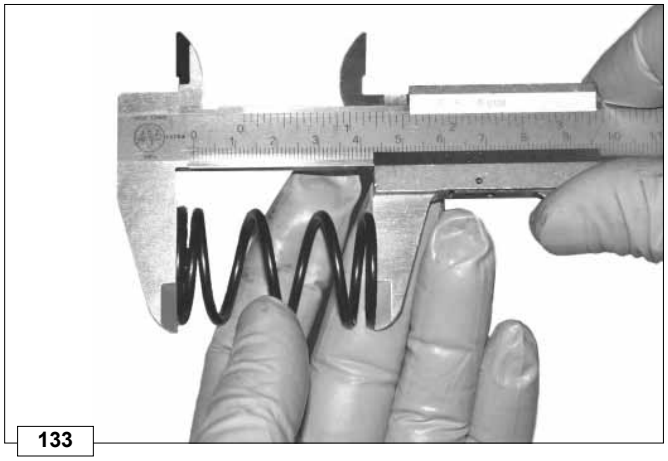
Operations of this kind should preferably be performed in specialist workshops or grinding centres.



132

Valve housings and seats - Dimensions

A	mm	34,000÷34,016
B	mm	31,000÷31,016
C	mm	34,140÷34,125
D	mm	31,140÷31,125
α		120°±15'

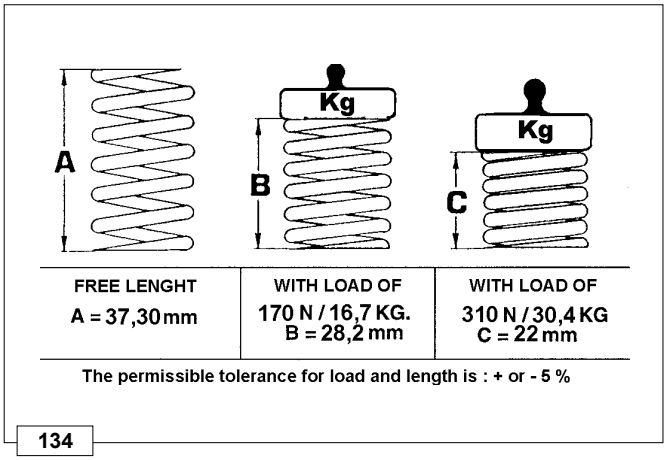


133

Valve springs - Check

Check the overall state of the valve springs. Replace if damaged or if they have lost their original elasticity.
First of all, use a gauge to check that the free length is in line with the measurements given in the table.

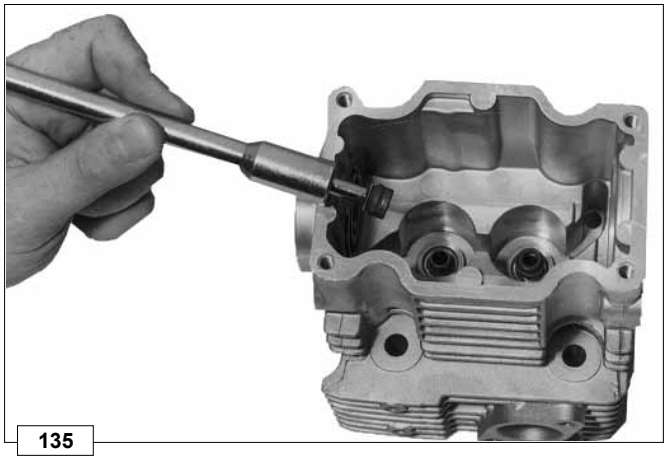
A = 37.30 mm



134

Loaded valve springs - check

Check that the loaded lengths are in line with the values given in the table
If the values are lower than the ones given in the figure, replace the spring.



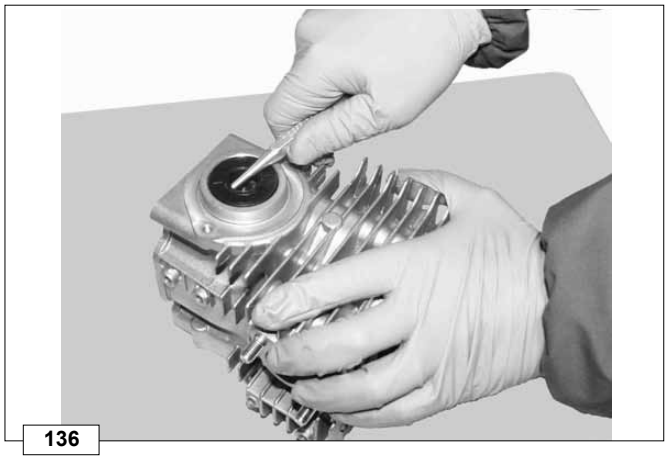
135

Valve stem seal rings positioned on the valve guides – Assembly Ref. no. 4535.015

Caution - Warning

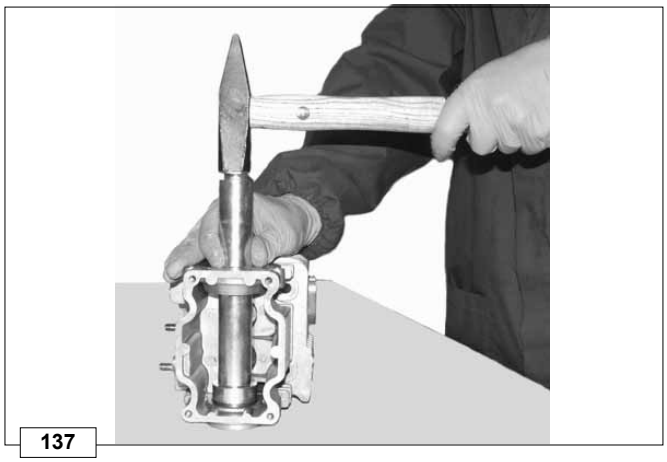
Both valve guides and seal rings must be oiled copiously before the rings can be mounted onto the upper edges of the valve guides.

To avoid warping of the seal rings during assembly, they must first be inserted into the special tool – Ref. No.1460.108 page 96 – then driven in manually, making sure that they line up uniformly.


136

Oil seal ring for camshaft support, distribution side – Disassembly

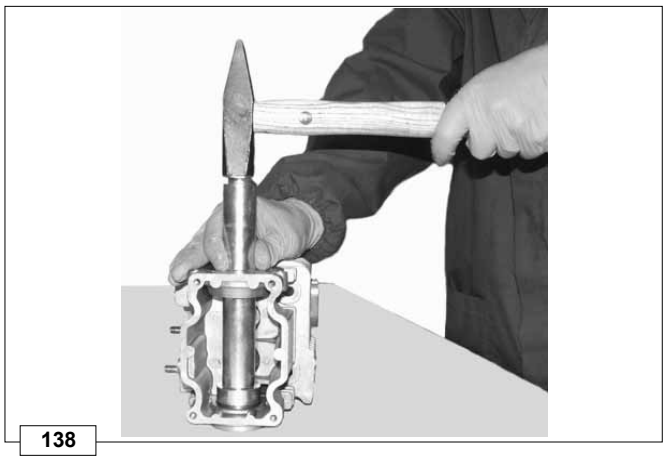
Remove the oil seal ring 17x40x7, taking care not to damage the housing in the cylinder head.


137

Camshaft support bearing 17x40x12, distribution side – Assembly

To avoid damaging the cylinder head, gently lay it on a flat rubber surface.
Insert the bearing manually, lining it up perfectly with the housing, then insert it into the cylinder head using the special tool Ref. no. 1460.107 page 96.

Important
It is recommended the use of a press for this operation.


138

Oil seal ring 17x40x7 for camshaft support, distribution side – Assembly

Lubricate the oil seal ring copiously, along with the surfaces of the cylinder head where it will be inserted.
Gently lower the cylinder head onto a rubber-protected surface.
Using tool no. 1460.111 page 96, insert the oil seal ring into position.

Important
It is recommended the use of a press for this operation.


139

Connecting rod cap fixing bolts - Disassembly

Using a 10 mm double-hex box wrench, unscrew the two M7x1x40 fastening bolts of the connecting rod cap.


140

Connecting rod cap - Disassembly

After unscrewing the fastening bolts, remove the connecting rod cap.


141

Piston and connecting rod - Disassembly

Once the connecting rod cap has been removed, the piston is pulled out of the cylinder by pushing the connecting rod shaft upwards.


142

Connecting rod / piston wrist pin lock tension washer - Disassembly

Using long-nose pliers, remove one of the two tension washers from its groove at the end of the piston wrist pin, where they are slotted to prevent then from slipping off.


143

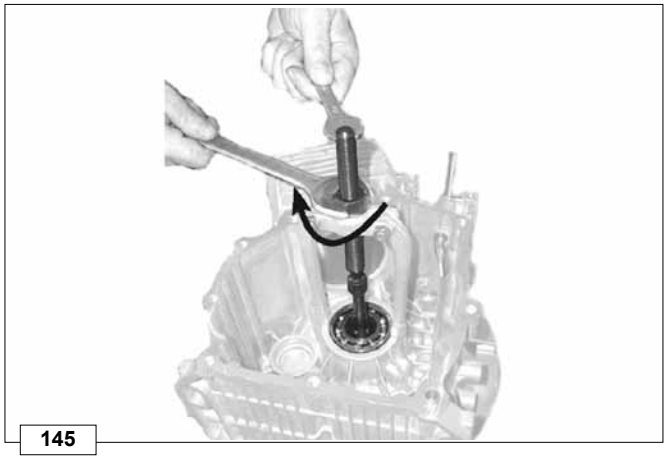
Connecting piston pin - Disassembly

The wrist pin must be removed manually by pressing down on it with a finger.

144

Crankshaft - Disassembly

After performing the previous operations, extract the crankshaft from the crankcase.



145

Crankshaft - Disassembly

The crankshaft is supported by a ball bearing on the timing system side: it must be replaced if noisy or if there is too much radial clearance.
To remove crankshaft bearings on the flywheel side, use the puller, ref. no. 1460.197 with expanding mandrel ref. no. 1460.198 (see page 97).

146

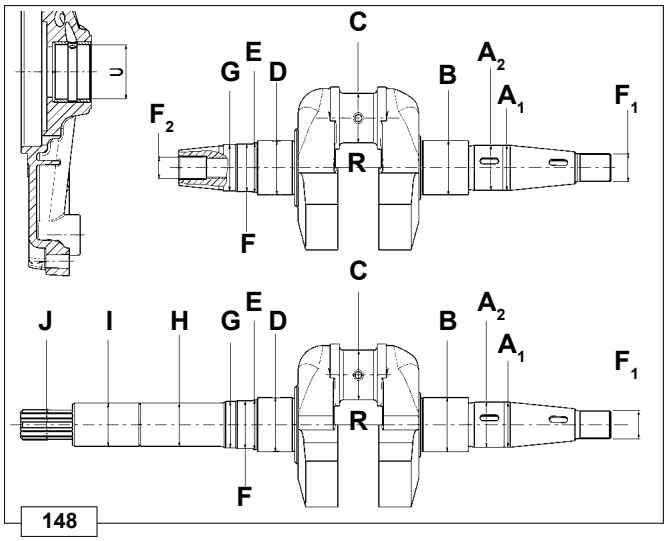
Driving shaft - Check

Important

Check that the main journal and the crank pin have no scratches or seizure marks.

Any light scratches or nicks should be smoothed out using an extremely fine file and polished with an oiled 300÷500 grain emery cloth.
Make sure that conical surfaces, tabs and threads have no defects or nicks.
Using a micrometer, measure two perpendicular diameters to check for wear and ovalisation of the crank pin.

147



148

Pin diameters – Threads – Connecting radius (mm) - Check

A_1	28.967 ÷ 28.980	G	29.975 ÷ 29.988
A_2	29.035 ÷ 29.048	H	27.800 ÷ 27.900
B	34.975 ÷ 34.988	J	19.570 ÷ 19.700
C	31.989 ÷ 32.000	I	27.977 ÷ 27.990
D	34.984 ÷ 35.000	F_1	M18X1.5
E	31.975 ÷ 32.000	F_2	M14X1.5
F*	30.5 ÷ 30.6	R	2.3 ÷ 2.5

F*: Pump driving surface distance.

Wear and tear limit **C**	31,93 mm
Wear and tear limit **D**	34,93 mm
Wear and tear limit **I**	28,08 mm

U	35.030 ÷ 35.050 mm	Wear and tear limit (mm) 35.100
V	32.025 ÷ 32.047 mm	Wear and tear limit (mm) 32.100

Clearance between main bearings and main journals

U - D	0.039 ÷ 0.075 mm	Wear and tear limit (mm) 0.170
V - C	0.025 ÷ 0.058 mm	Wear and tear limit (mm) 0.170

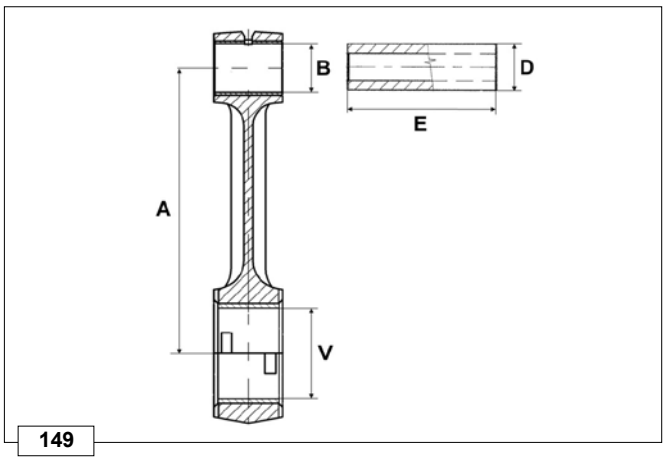
The dimensions refer to tightened half bearings. Crankshaft and connecting rod big end half bearings can be undersized by 0.25 mm and 0.50 mm on the internal diameter.

If the level of wear is above 0.05 mm, grind the crank pin according to the details given in the table on fig. 93.

When grinding the crank pin, tolerance should be allowed as follows: 0.000 and 0.011 mm. The surface should be finished with no scratches and have a roughness of: Ra = 0.4 µ. If the level of wear of the power take-off side pin is above 0.05 mm, grind it according to a roughness of: Ra=0.4 µ.

NOTES: **1)** When grinding the crank pin, the connecting radii **R** should be restored to a value of 2.3 to 2.5 mm in order to avoid damage to the driving shaft.

2) Do not grind the flywheel side journal.



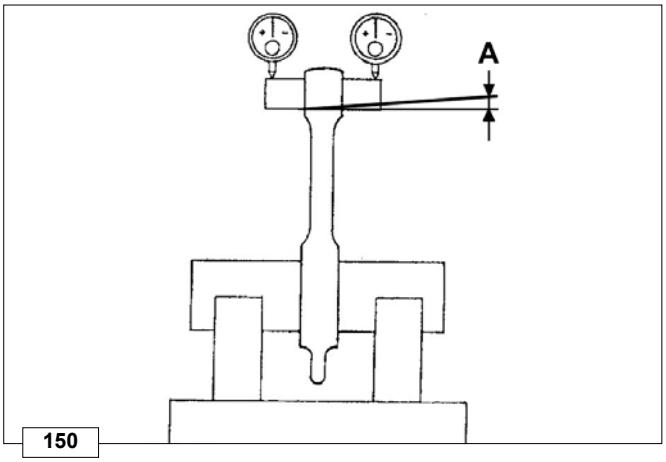
149

Connecting rod equipped with bearings and wrist pin

A	99.950 ÷ 100.050 mm
B	17.015 ÷ 17.025 mm
V	32.025 ÷ 32.047 mm
D	16.986 ÷ 16.994 mm
E	54.700 ÷ 55.000 mm
B - D	0.021 ÷ 0.039 mm

B-D	Wear and tear limit(mm) 0,060

The connecting rod big end bearing is supplied at nominal value or undersized by 0.25 and 0.50 mm on the diameter.



150

To check that big end and small end axes of the connecting rod are parallel, proceed as follows (fig.150).

1)Insert the wrist pin into the hole in the small end of the connecting rod and pass a checking pin into big end.

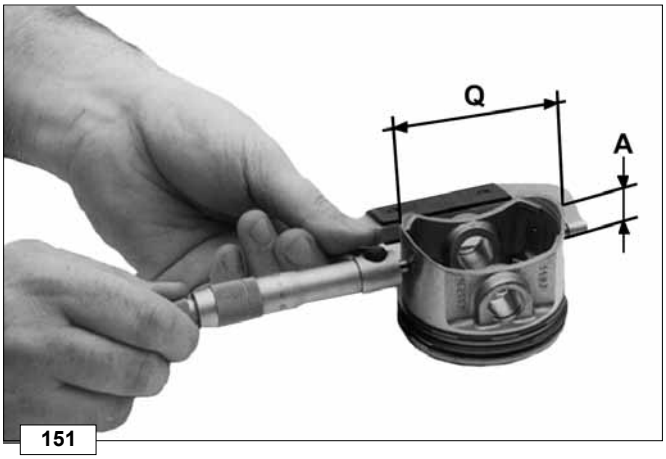
2)Set the ends of the pin onto two blocks on a levelling table.

3)Using a column indicator check that any deviation between the two ends is no higher than 0.015mm (**A**), otherwise, the connecting rod must be squared.

Squaring of the connecting rod is carried out by means of a small mechanical press:

a)Place the connecting rod on two wedges and make sure that it is completely horizontal to the pressing surface.

b)With the aid of the press, gently knock the stem on the side opposite the deviation until it conforms to the straightness tolerance values given in point 3.



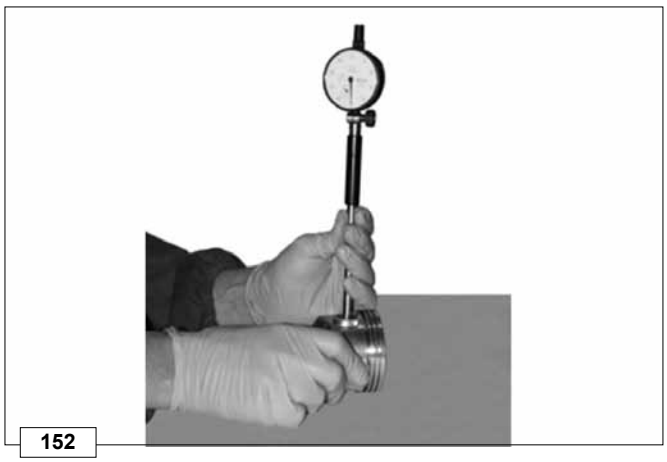
151

Piston and piston rings - Check

Make sure that there are no scratches or seizure marks on the piston. Check for wear by measuring the diameter of the piston at the skirt, 10mm from the base and perpendicular to the wrist pin (fig. 78). Wear of the piston skirt must not exceed by 0.05 mm the minimal value.

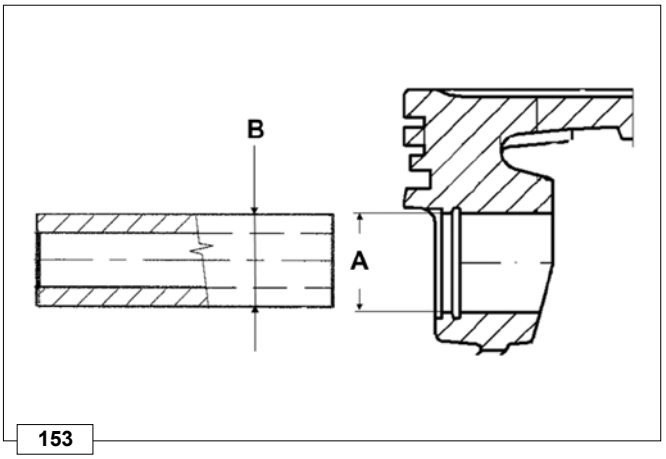
A = 10 mm	
Q =73,945÷73,955 mm	Wear and tear limit (mm) 73,895

If clearance between the cylinder and the piston is higher than 0.23, bore the cylinder and install the piston and new rings.
The pistons increases suggested are 0.50 and 1.00 mm.
Working tolerance for cylinder must be: 0.02 mm
di: 0,02 mmdi: 0,02 mm


152

Wrist pin housing in piston - Check

Make sure that any ovalization in the wrist pin housing in the piston does not exceed 0.10 mm. Otherwise, replace the piston and the wrist pin.



153

A = 16.998 ÷ 17.003 mm	**B =** 16.986 ÷ 16.994 mm
A - B = 0.004 ÷ 0.017 mm Wear & tear Limit (mm) 0.100	
Misalignment 0.8	

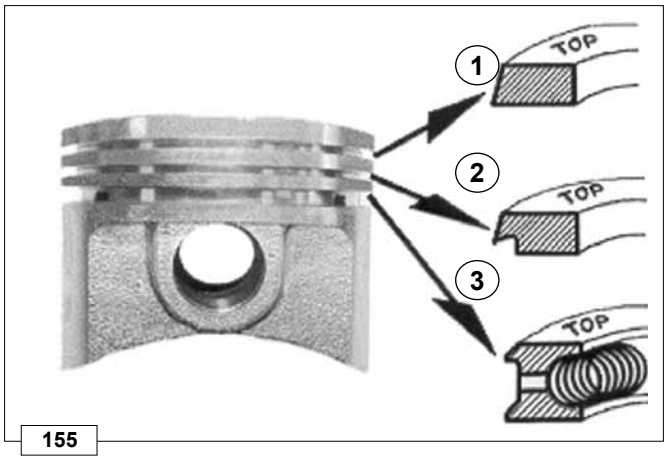
Retaining rings – Check for wear

Remove the snap rings and eliminate any deposit. Check for wear by inserting them into the middle part of the cylinder and measuring the distance between the two free ends, which should be:

	Nominal end gap mm		Max limit end gap mm
	min	max	limit
chromium plated compression ring	0,20	0,40	1
compression ring	0,20	0,40	
chromium plated oil scraper ring	0,20	0,40	

If the distance is greater than the measurements given in the above table, and if the cylinder does not need to be ground, replace the retaining rings.


154

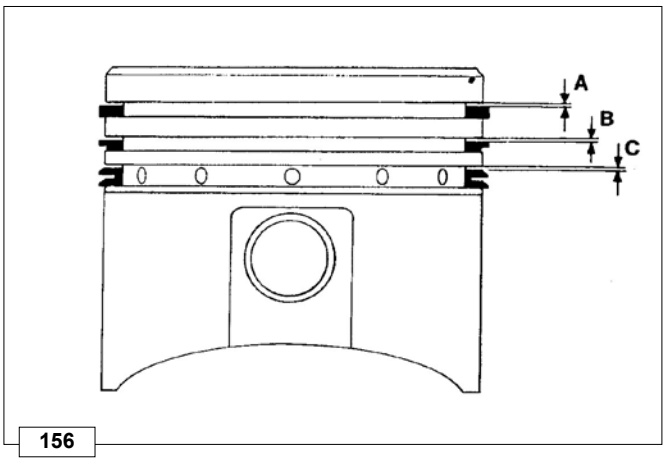


155

Retaining rings – Correct installation direction

When replacing the rings, they must be installed with the mark TOP upwards.
Stagger the position of the edges of the retaining rings at a mutual distance of 120°.

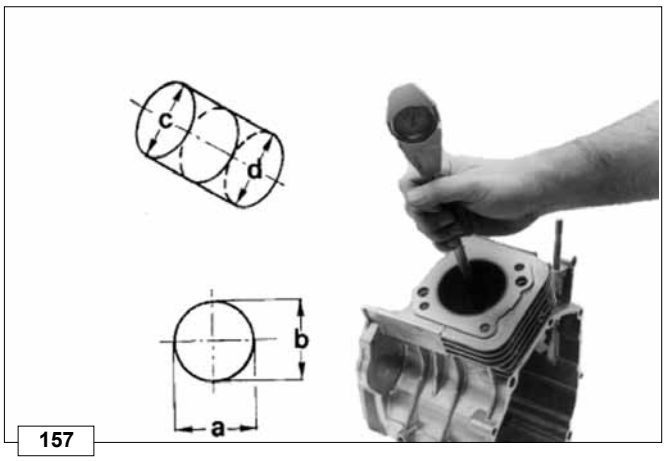
1- Retaining ring used mainly to hold gas between the piston and the casing
2- Ring with no drainage eyelets for oil used mainly for scraping oil against the surface of the casing. May also serve as an extra seal ring.
3- Ring with oil drainage eyelets, aimed at controlling and recovering oil leaving and returning to the sump.



156

Check that the retaining rings move freely in their grooves and that clearance in each groove is:

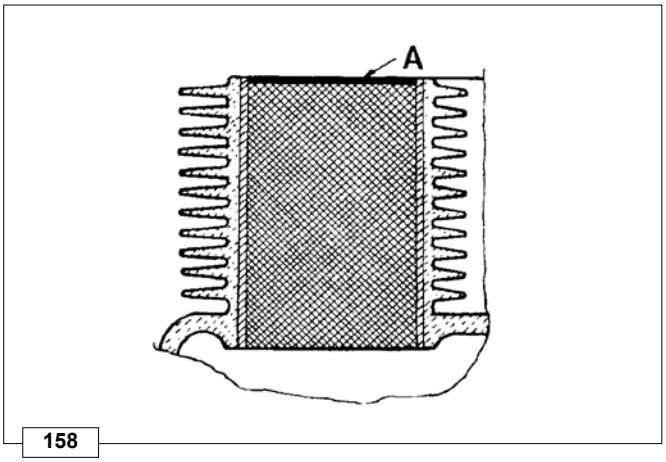
A = Compression ring	0,070÷0,025
B = Seal ring (second groove)	0,065÷0,030
C = Oil scraper ring	0,045÷0,030



157

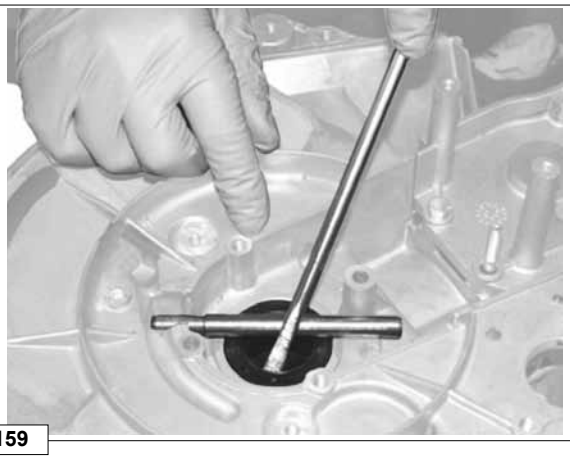
Cylinder

Using the dial indicator, check the two internal diameters (**a-b**) perpendicular to each other and at three different heights (fig. 157).
If conicity (**c-d**) and ovalisation (**a-b**) exceed the 0.6mm limit, bore the cylinder.
If the cylinder is ground, the working tolerance to be respected is: 0/+0.2 mm.
If conicity (**c-d**) and ovalisation (**a-b**) do not exceed the **0.6 mm** limit, and if the cylinder shows no signs of scratching, replacement of the piston rings is all that is required. To allow adjustment between piston rings and cylinder to be as rapid as possible, restore the correct roughness to the whole of the cylinder liner surface coming into contact with the seal rings. This is achieved using the plateau method.



158

If the cylinder has a small ridge in area **A** (fig.158), it must be eliminated using a grindstone followed by a 500 grain emery cloth, in order to avoid damaging the seal rings.
Rinse off with petrol once this operation has been carried out.



159

Oil seal ring in flywheel side housing - Disassembly

Remove the oil seal ring, taking great care not to damage the housing and the case.

160

Oil seal ring in flywheel side housing – Assembly

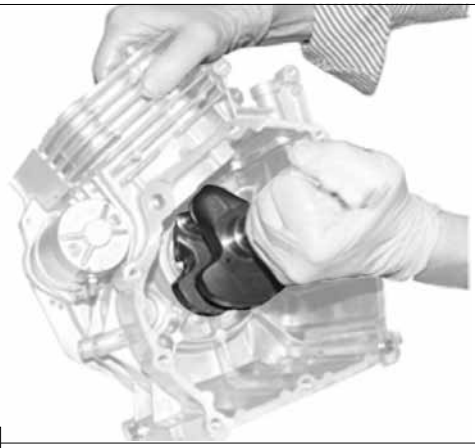
Lubricate the oil seal ring along with its housing.
Attach the oil seal ring to the special tool ref. 1460.176 + 1460.204 page 97.
Insert the oil seal ring into its casing by pressing down on the pad.
It is recommended that you use a press to press down on the pad, where possible.

Caution - Warning
A damaged oil seal ring can cause air to be sucked into the engine setting off venting problems.

161

Insertion of crankshaft bearings on the flywheel side.

Lubricate the bearings and base.
Set the casing onto a flat surface, line up the bearings and press down until completely inserted.
The use of a press is recommended for this operation.



162

Crankshaft - Reassembly

Before reassembling the crankshaft, protect the flywheel edge of the shank using the brush ref. no. 1460.105 page 96.
This prevents damage to the oil seal ring inserted previously during the operation to insert the crankshaft into the case.

163


164

Important
Before installing, lubricate: the wrist pin, the small end and big end of the connecting rod, the piston, the cylinder.

Piston and Connecting Rod

Follow the instructions below to install the piston in accordance with their correct installation direction:

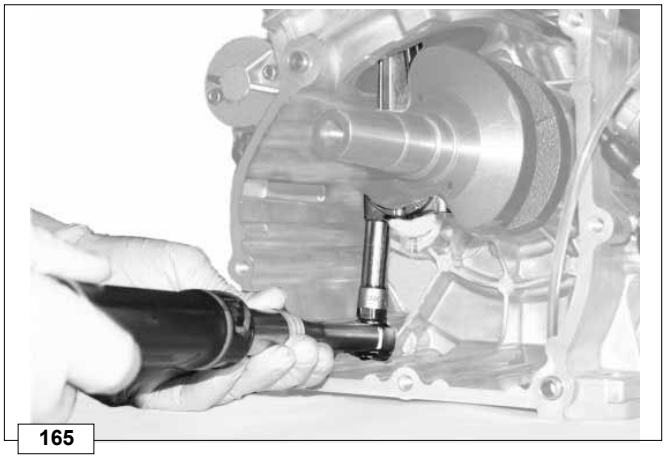
- the connecting rod must be installed on the crankshaft with the marks on the connecting rod big end facing the same side (see fig. 163).

- couple the piston to the connecting rod using the wrist pin, pressing gently with thumb. Insert the two stop pins and make sure they are well positioned in their seats in the piston;

- assemble the piston rings with the sign "**top**" pointing upwards, stagger the position of the edges of the piston rings at a mutual distance of 120° (fig. 155 see page 77);

- insert the piston into the cylinder with the arrow above the crown pointing towards the exhaust fig. 163. Use any normal ring clamp available on the market to tighten the piston rings;

- assemble the connecting rod cap (the mark should be placed on the same side as shown on the connecting rod shaft), fasten the connecting rod screws (fig. 165) by using a torque wrench to: 26 Nm.


165

Cap on the connecting rod big end - Assembly

Tighten the bolts on the cap of the connecting rod big end using a torque wrench to 26 Nm.
It is recommended the use of a series of short twists before the final tightening.

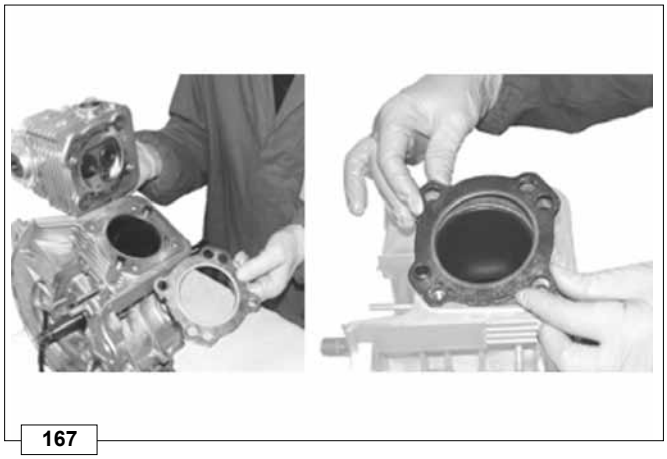
Important
it is advisable to replace the connecting rod bolts whenever they are removed.


166

Power take-off side cover - Assembly

Important
Always replace the seal before re-fitting the cover.

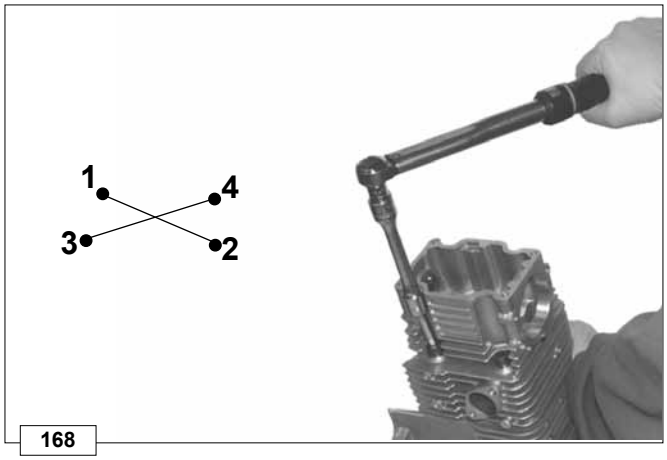
After sealing the two contact surfaces using a seal, mount the casing cover.
The screws must be tightened to the torque of 23.5 Nm.



167

Gasket between cylinder and head - Assembly

Lay the cylinder head gasket on a surface at the top of the cylinder so that the openings in the gasket coincide with the notches in the casing.

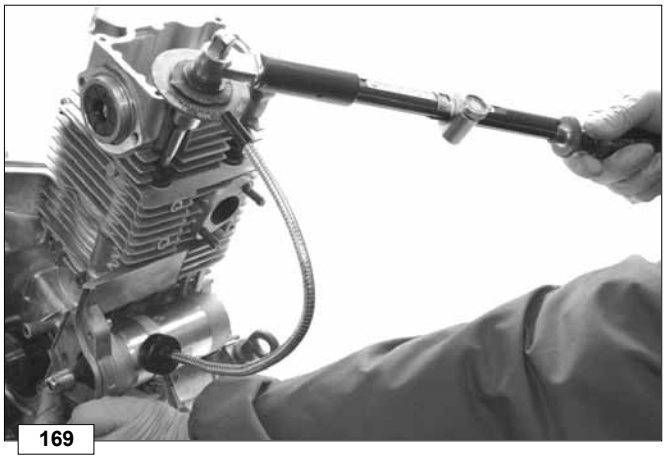


168

Cylinder Head - Assembly

Lubricate the cylinder head bolts using a low viscosity oil, and check fluidity by manually screwing them into the threaded holes, which will later be used to secure the cylinder head.
Following the numerical order in figure 168, the bolts must be screwed by using a torque wrench in progressive stages to the indicated torque:

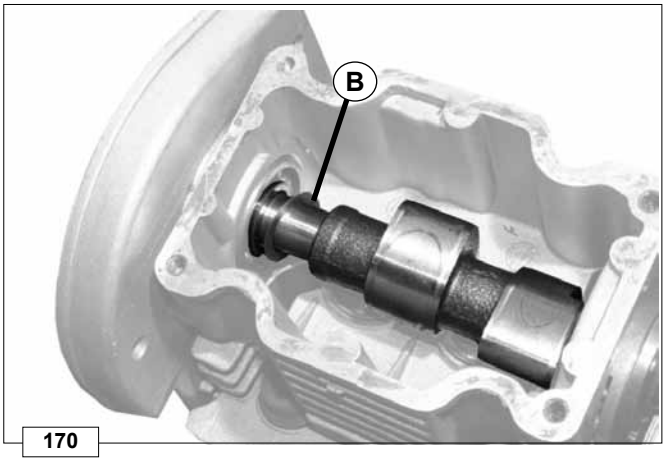
- 1st phase: 20 Nm
- 2nd phase: loosen and screw again to 20 Nm following the numerical order previously indicated (see picture 168)
- 3rd phase: continue screwing with an angle of 75° by using an angle wrench (see figure 169).



169

Important

The cylinder head must never be removed while hot.
The head must not be retightened after the motion test.
At every disassembly, replace the head fastening bolts.



170

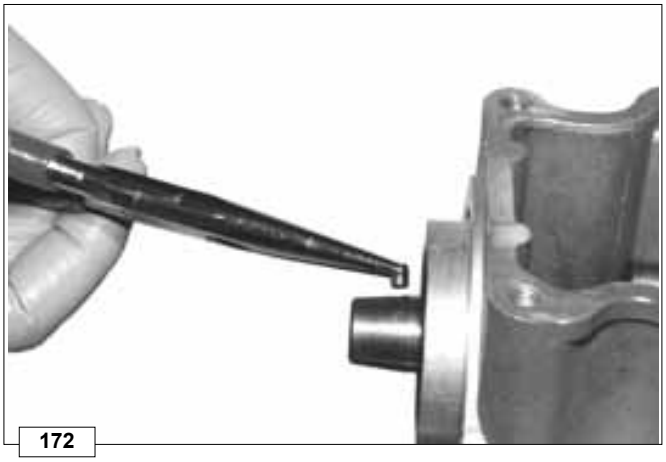
Camshaft - reassembly

After oiling the camshaft bearings, the tappets and the camshaft itself, rotate so that the cams are pointing upwards and insert into the cylinder head.


171

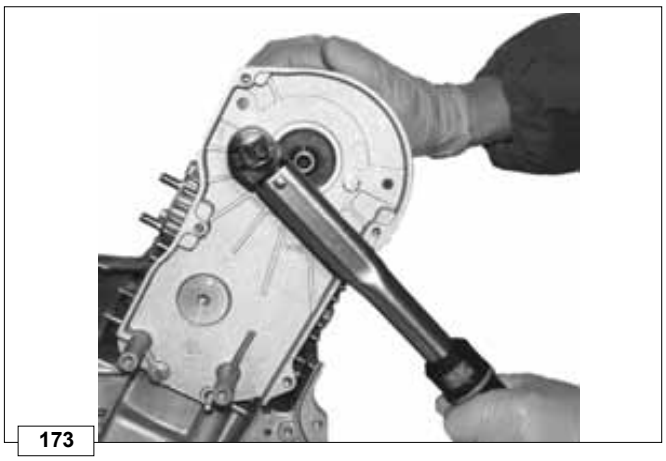
Camshaft support - Assembly

After mounting the camshaft support, screw the fastening bolts by using a torque wrench to 12 Nm.


172

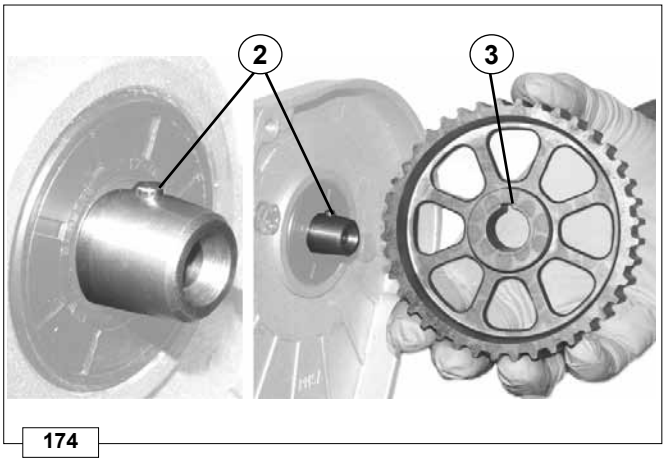
Camshaft control pulley key – Assembly

Insert the cylindrical key into its seat on the camshaft tang.


173

Internal protective guard for timing belt - Reassembly

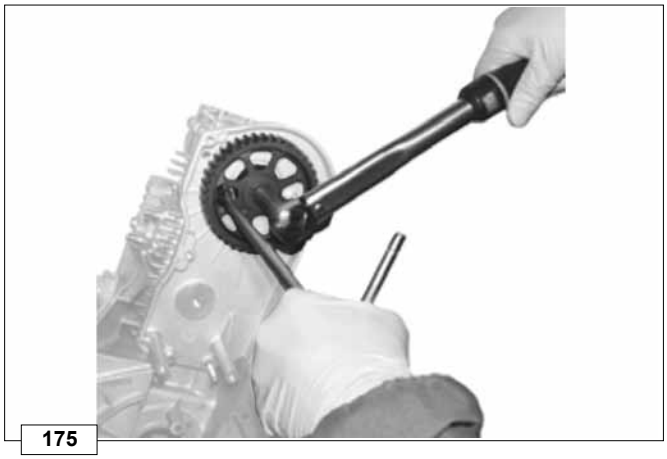
After positioning it carefully, tighten the screws using a torque wrench at a setting of 12 Nm.



174

Camshaft synchronous pulley

Match the key on the camshaft with the toothed pulley on the distribution belt and refit it.



175

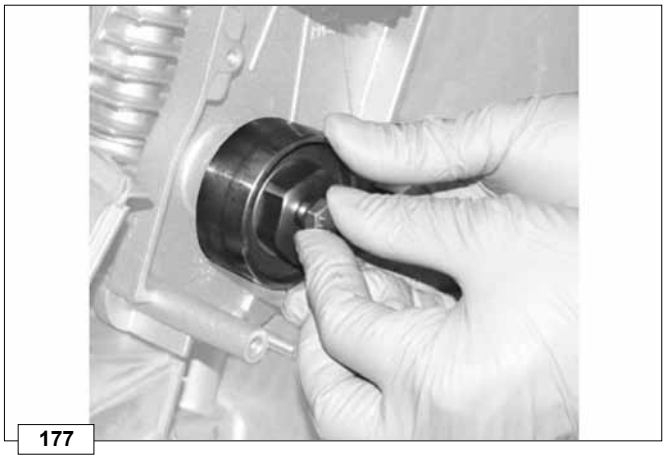
Camshaft toothed synchronous timing pulley

Using the same method used for disassembly, block the toothed pulley for distribution, and screw in the bolts using a torque wrench at 11.8 Nm.

176

Crankshaft toothed synchronous pulley

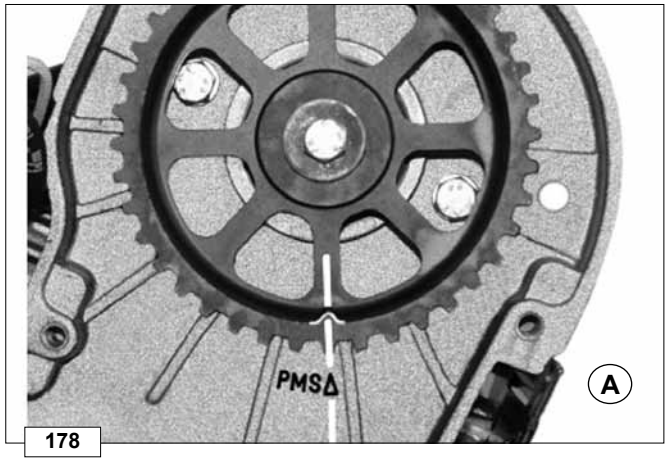
Heat the toothed pulley to 150-180° C for 15÷20 minutes.
Put the key into its seat in the driving shaft. Insert the pulley with the flat surface facing the engine guard and the timing point showing. To stead the pulley, use the tool ref. No. 1460.112 page 96.



177

Belt tightener - Reassembly

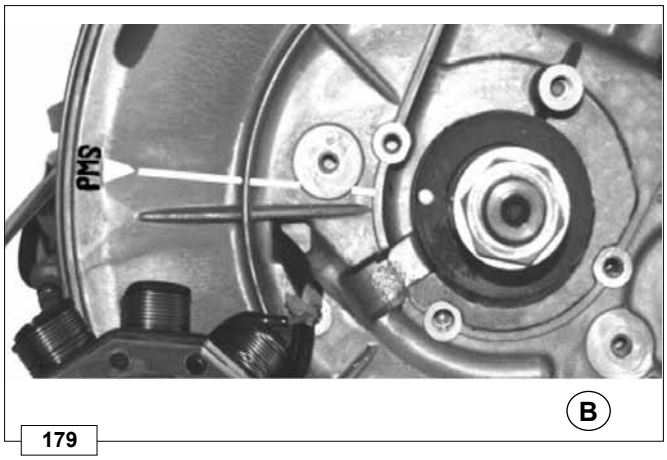
Tighten the support bolt of the belt tightener manually.



178

Timing system: camshaft synchronous pulley

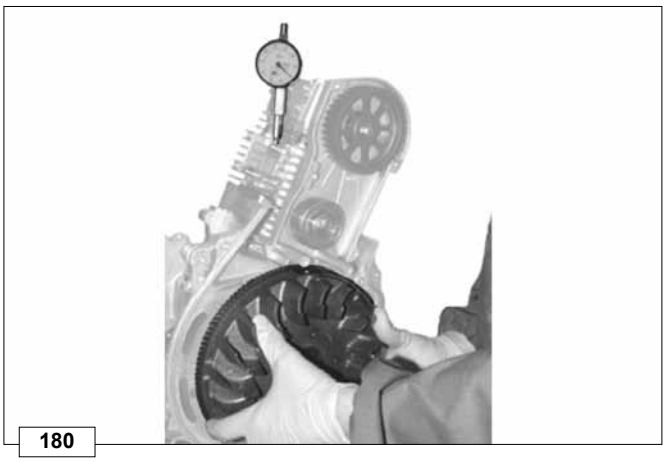
Rotate the toothed pulley controlling the camshaft until it coincides with the appropriate notches, one on the toothed pulley and the other on the belt protection guard.
When the notches coincide, the intake and exhaust cams will be balanced, i.e., regulated for distribution.



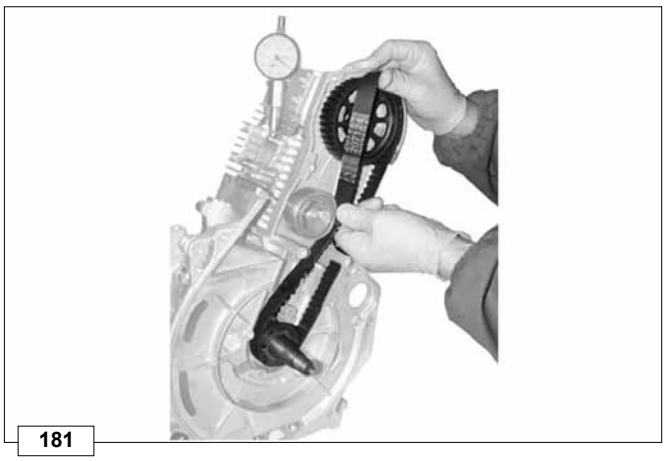
179

Timing system: crankshaft synchronous pulley

Rotate the crankshaft until the reference notch on the toothed pulley controlling it coincides with the notch on the engine guard as in figure 179.
When the reference notches are lined up, the piston is at top dead centre.


180

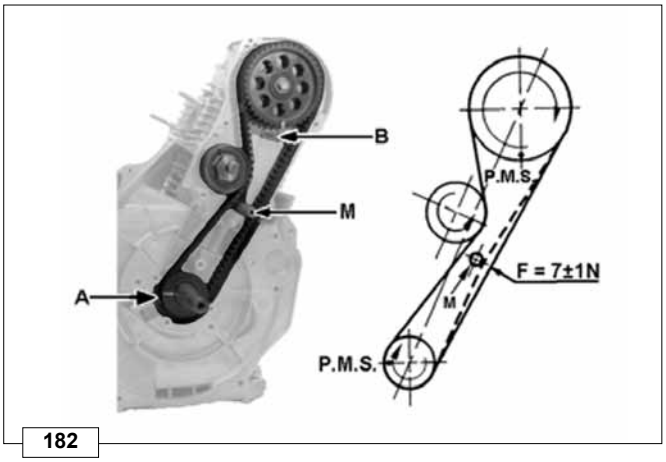
The TDC can also be determined using tool ref. no. 1460.115 page 96.
This consists of a dial indicator holder, an indicator and a tracer.
After mounting the tool, screw the indicator holder into the threaded hole of the previously removed spark plug.
Rotate the crankshaft clockwise until the piston crown and the indictor tracer meet.
Once they are in contact, rotate the crankshaft slowly and keep an eye on the indicator for when the needle measuring hundredths changes the TDC direction.
If in doubt, repeat the operation.


181

Synchronous timing belt

The timing control belt must be installed with the wording facing the operator.
Insert the toothed belt, making sure that the position of the distribution notches is not disturbed.

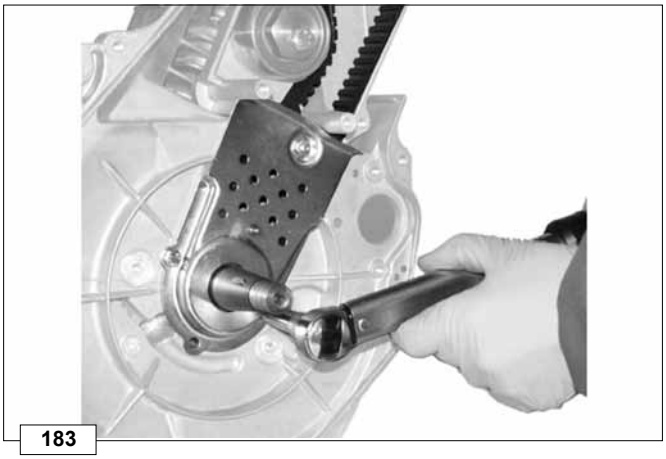
Important
The synchronous timing belt must be replaced when removed, even if its scheduled motion period is not over.
The synchronous timing belt must not be tensioned during its scheduled motion period.



182

Synchronous timing belt

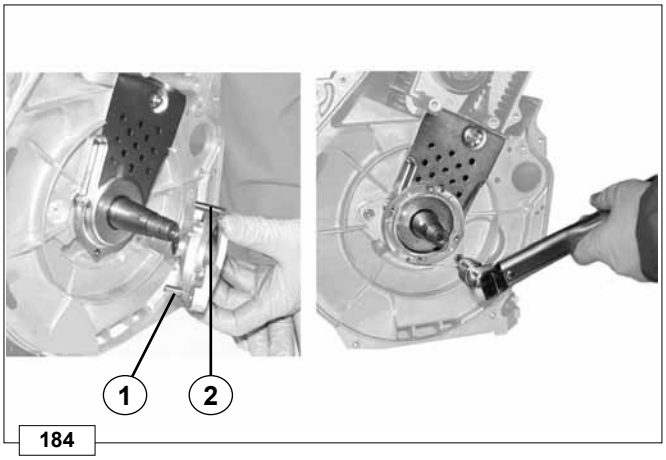
tighten the belt using the belt tightener. Using a dynamometer push the belt until it almost touches the hub **M** (fig. 182). The tension is right when the dynamometer shows a load of 7 ± 1 N. To check phasing, rotate a few times using the flywheel and check again to see whether the reference notches in the guard and cylinder head coincide with the notches in the pulleys, and if this is not so, loosen the belt tightener and repeat the entire process. If phasing is correct, clamp the belt tightener in its final position giving it a tension value of: 23.5 Nm.



183

Lower toothed timing belt cover - Assembly

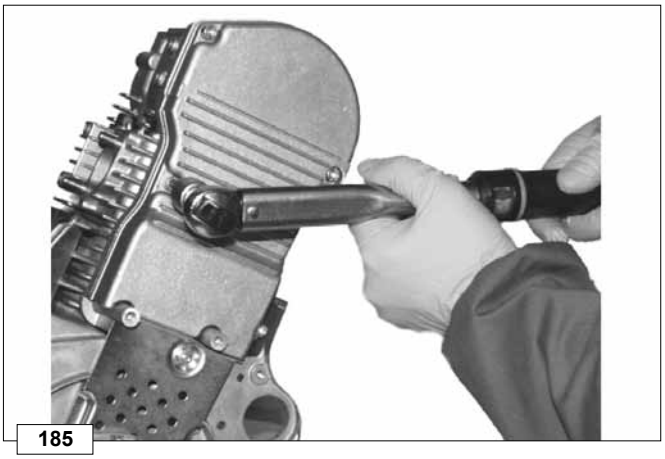
The lower timing belt cover is attached to the lower part of the guard with two screws, to be tightened to 9.8Nm, and with a nut in the upper part, which is to be tightened to 12Nm.



184

Alternator support - Assembly

The alternator support can be assembled in only one direction, which is determined by the two centring pins.
The centring pins have different lengths. The shorter one **1** must be inserted into the hole at the bottom of the guard and the longer **2** goes into the hole at the top.
The two screws are tightened to a 12Nm torque.



185

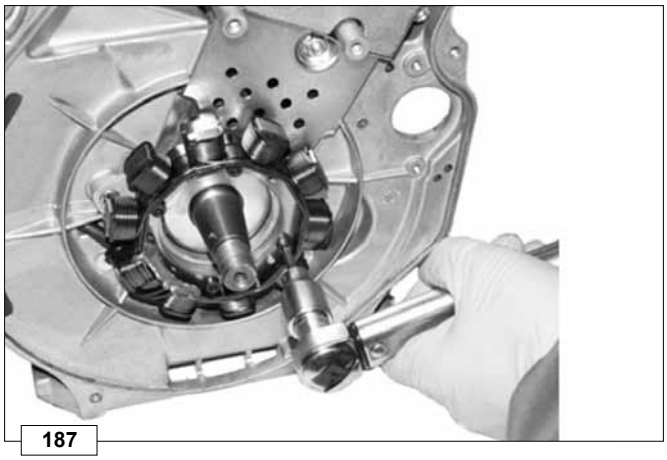
External cover of the lower toothed timing belt - Assembly

The external cover is fixed on with four screws tightened to 12Nm.

186

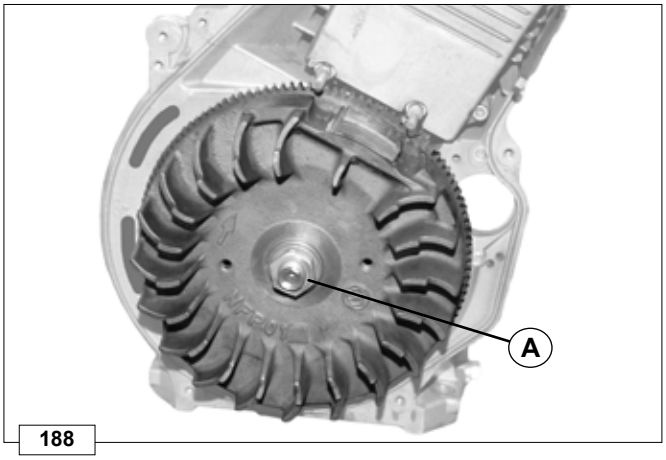
Cable clamp plate for alternator stator – Assembly

After checking that the stator cables are in perfect condition, thread them into their appropriate slots and secure with the steel clamp plate.


187

Alternator stator – Assembly

The alternator armature is fixed to the guard by way of a special support.
There are four fixing screws which must be tightened to 9,8 Nm.



188

Fan flywheel – Assembly

Mount the magnet to the flywheel after checking that it is in pristine condition and that it fixes securely to the wheel.

Caution - Warning
Temporary tighten the bolt A to prevent the flywheel from turning while reassemblying the coil.

189

Coil, Air gap adjustment - Assembly

Mount the coil onto its supports without tightening the screws.
To adjust the air gap correctly, place a curved metal sheet measuring 0.5mm in thickness between the coil pole piece and the magnet.
Tighten the coil's fixing nuts in the final position to a torque of 14±1Nm.


190

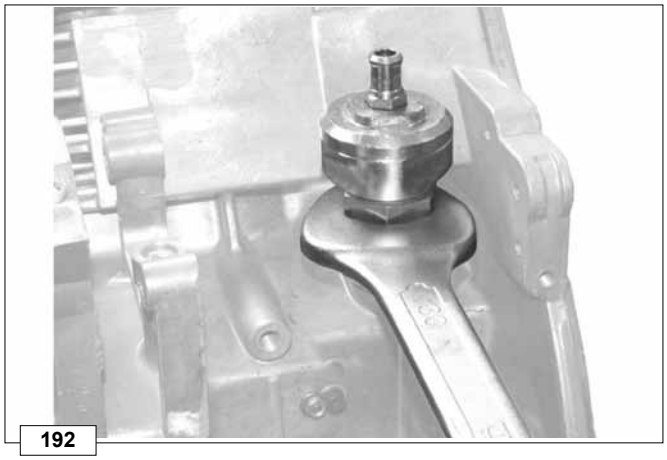
Lateral cooling air shroud – intake side

Check that it is not damaged or deformed.
Remount the side air shroud and tighten to a torque of 9.8Nm.


191

Lateral cooling air shroud – exhaust side

Check that it is not damaged or deformed.
Mount and tighten the bolts to 9.8Nm.

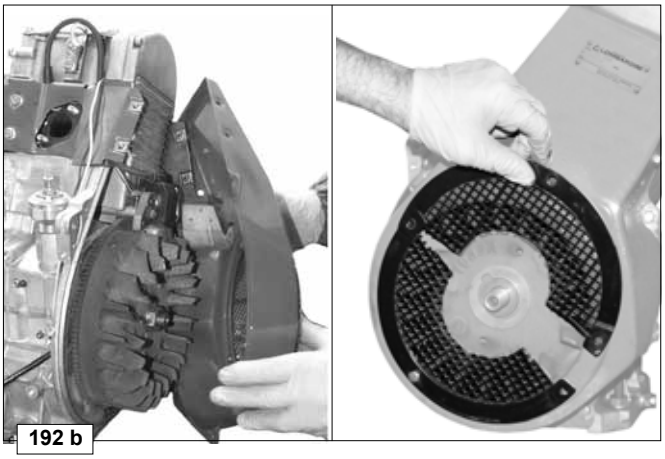

192

Air valve - Assembly

Important

Before reassembling the air valve, carefully clean it by washing it and blowing into it.
Check that the diaphragm is in good conditions and without cranks.

Tighten the air valve union to 10 Nm.


192 b

Cooling air shroud, flywheel side and Flywheel mesh screen - Assembly

Important

Before assembling the shroud, check that there are no dents or broken parts.

Tighten the fastening bolts to 11.8 Nm.

Assembly the two flywheel mesh screens and tighten the 4 screws M6.


193

Emergency start pulley - Assembly

Mount the pulley keeping the crankshaft in place with the special tool p/n. 1460.350 page 97; tighten the nut securing the pulley to the flywheel to 137.2 Nm using a torque wrench.


194

Clearance - Check

Caution - Warning

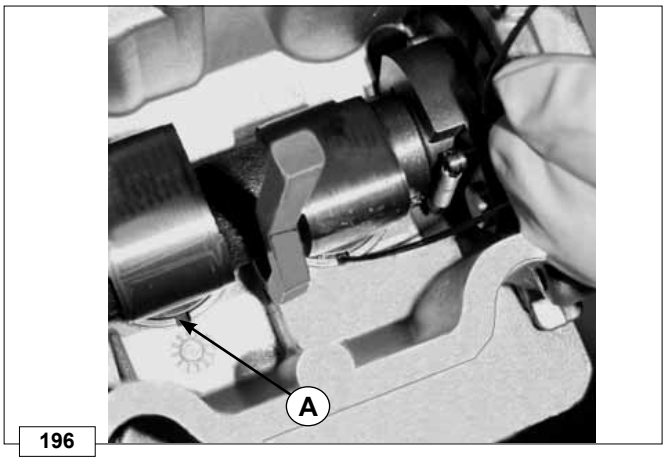
All checks and adjustment operations must be carried out while the engine is cold

Rotate the crankshaft until the piston reaches TDC at explosion level.
Using a thickness gauge, check that clearance is 0.2 mm for the intake valve and 0.20 mm for the exhaust valve.
If clearance does not match these measurements, proceed with the following operations.


195

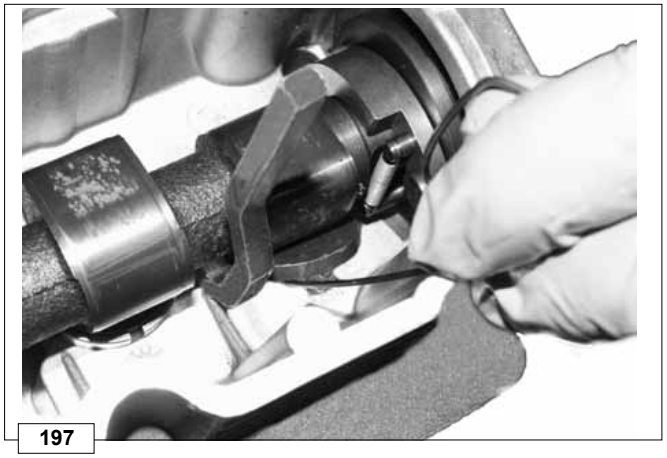
Clearance - Adjustment

Rotate the crankshaft until the piston reaches TDC at explosion level.
This operation allows you to rotate the tappets and bring the lower slots **A** (as shown in figure 196) towards the exhaust side, making removal of the collar easier.



196

Rotate the crankshaft once more so that the valve which is to be adjusted is totally open, i.e. with the tappet flattened by the top of the cam.
Insert tool 1460.109 page 96 into the outside edge of the tappet but not into the adjustment collar see fig. 196- 197.
If the previous operation has been carried out correctly, with the cam rotated again until it reaches its base, the tool will keep the tappet lowered, thus allowing the collar to be disconnected.
Removal of the collar from the tappet is made simpler by inserting a steel tip into the tappet slot **A** (fig. 196).


197

Replace the collar with one of a suitable size.
14 collars are available as spare parts, with thicknesses ranging from 3.6 mm to 4.25 mm.

Thicknesses "A"

3.60 - 3.65 - 3.70 - 3.75 - 3.80 - 3.85 - 3.90 - 3.95 - 4.00 - 4.05 - 4.10 - 4.15 - 4.20 - 4.25

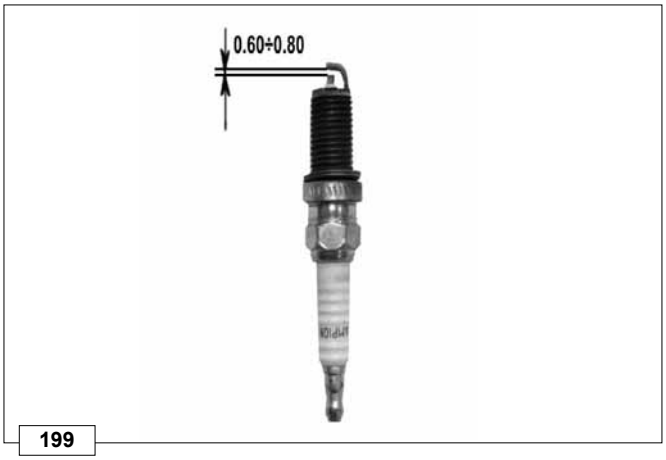
198

Tappet cover - Assembly

Important

Always replace the paper gasket before reassembly.

The fixing screws between the cover and the cylinder head must be tightened with a torque wrench to 10 Nm.
Carefully clean the contact surfaces between cover and cylinder head.
Attach the cover, tightening the screws to 10 Nm.

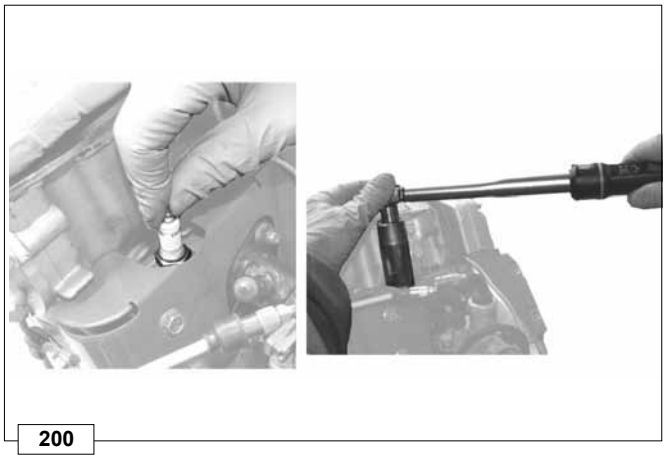


199

Spark plug - Assembly

Clean the electrodes with a metal brush (with brass bristles) and blow compressed air over them.
Using a thickness gauge, make sure that the distance between electrodes is 0.70÷0.80 mm.
If the ceramic insulation is chipped or if the electrodes are worn away, replace the spark plug with a new one with a suitable thermal value.
When replacing, it is advisable to use only recommended spark plugs in order to avoid malfunctioning, which in turn could damage the engine.
Recommended spark plugs is:

Brand: CHAMPION Type: CHAMPION RC12YC



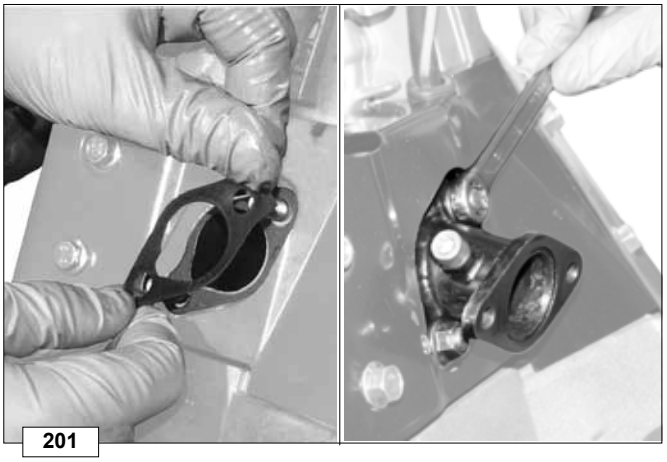
200

Spark plug - Tightening

Important

Follow the spark plug disassembly and reassembly procedures with the engine cold.

The spark plug should be screwed onto the cylinder head initially by hand, and then tightened to 20Nm with the aid of a torque wrench.



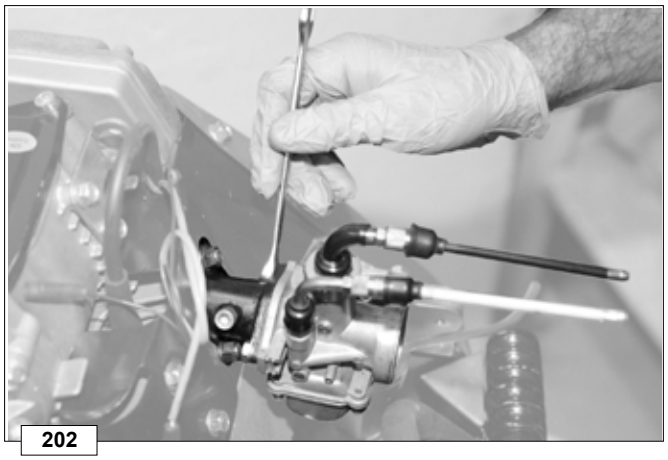
201

Intake manifold - Assembly

Important

Always replace the inlet manifold gasket

Fit the gasket and inlet manifold tightening the 2 M8 fixing bolts.

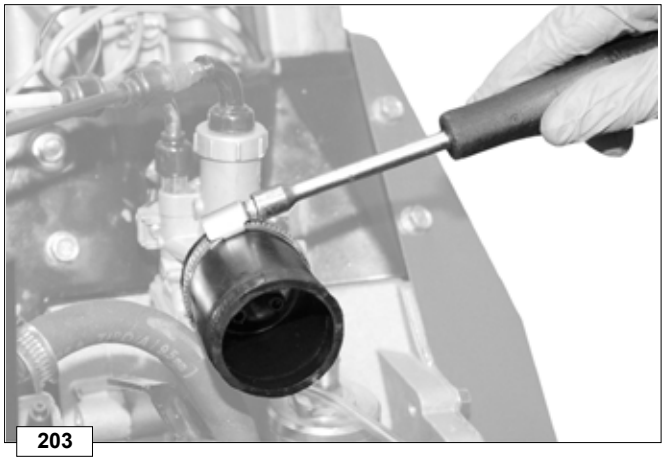

202

Carburetor - Assembly

Important

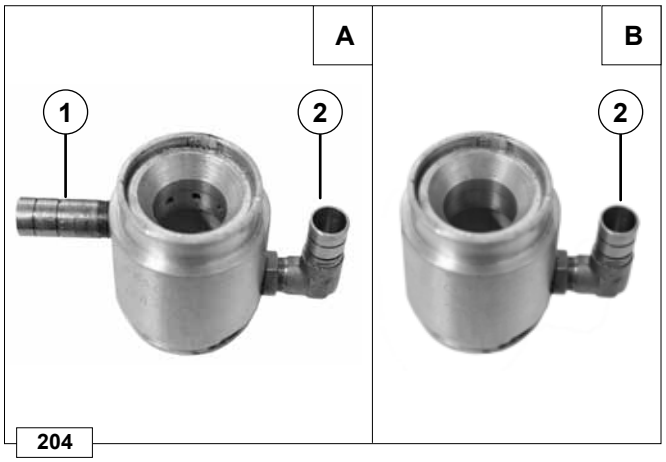
Check that OR ring placed between the intake curve and the carburettor has no cuts, fissures or deformations.

Assemble the carburettor tightening the fixing bolts to the intake manifold at a torque of 12 Nm.


203

Carburettor union hose - oil vapour recovery - Assembly

Assemble the sleeve onto the carburettor and fasten the clamp.



204

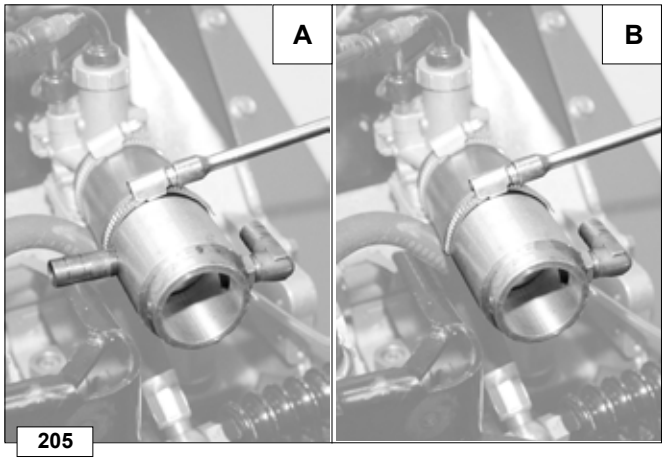
Mixer / air recovery system - Assembly

Gas version (**A**)

1 - Gas inlet from pressure reducer
2 - Oil vapour recovery union.

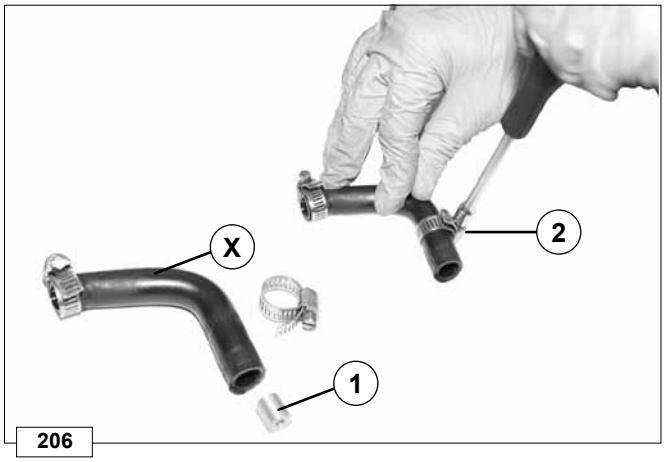
Petrol version (**B**)

2 - Oil vapour recovery union.



205

Assemble the mixer onto the rubber sleeve and fasten the clamp, using the mixer either for the gas version (**A**) or for the petrol-only version (**B**).



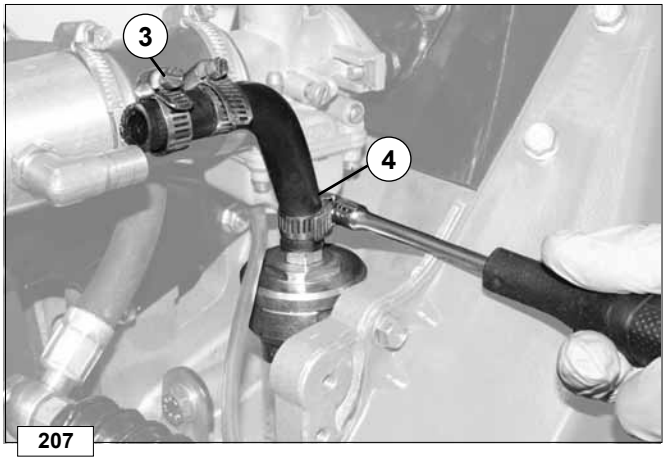
206

Vapour recovery pipe - Assembly

Important

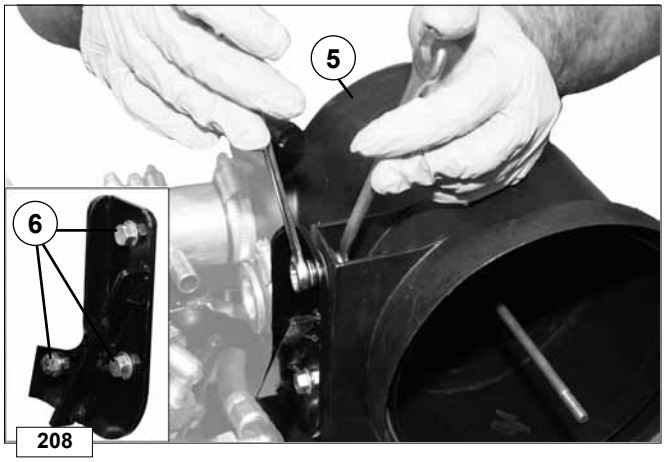
Check that the pipe and throttle are both free from impurities or scaling.

Insert the throttle **1** into the pipe **X** and fasten the clamp **2.**



207

Assemble the vapour recovery pipe onto the connection and onto the air valve.
Tighten the clamps **3** and **4** to secure the pipe.

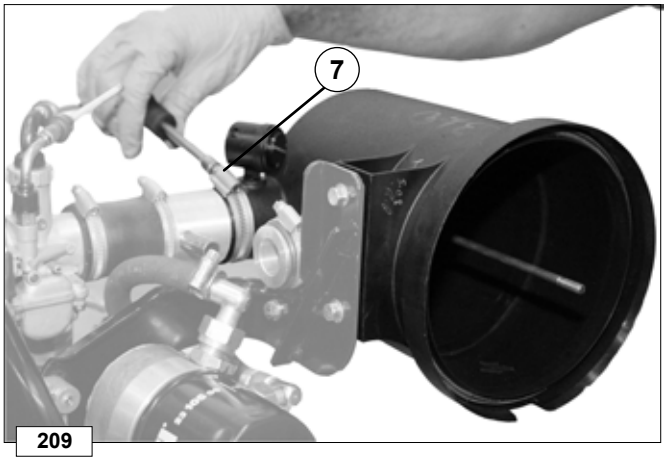


208

Air filter - Assembly

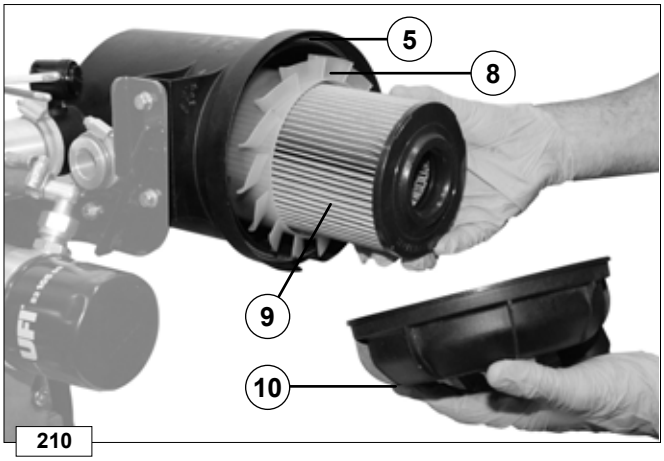
The air filter is a dry-type one, with a replaceable paper filter cartridge.

Assemble the filter body **5** onto the bracket and tighten the 3 fastening screws **6** keeping the nuts locked.



209

Fasten the clamp **7.**



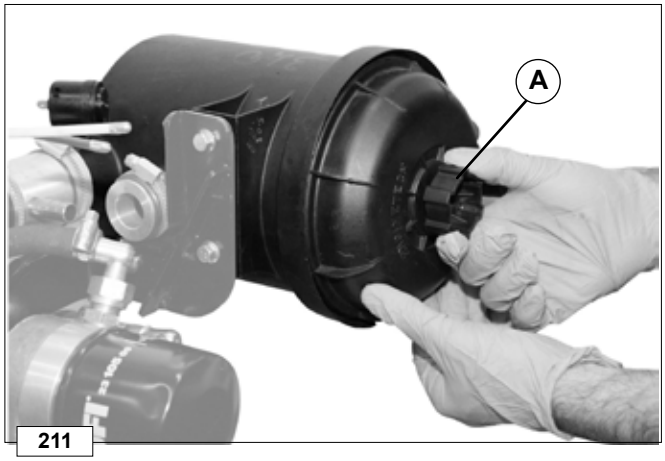
210

Use a lamp to check that the filter element is not damaged or inspect it against the light while slanted. In case of doubt, install a new cartridge.

Caution - Warning

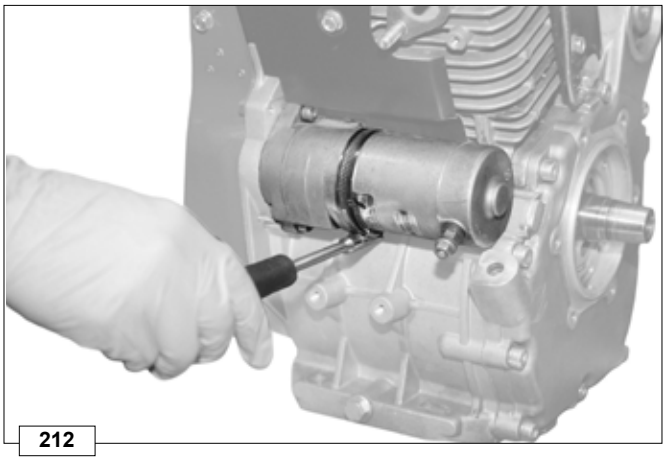
Replace the cartridge after the sixth clean.

Couple the filter cartridge **9** to the cyclone **8** and insert them into the filter body **5.**
Close the filter body with the cover **10.**



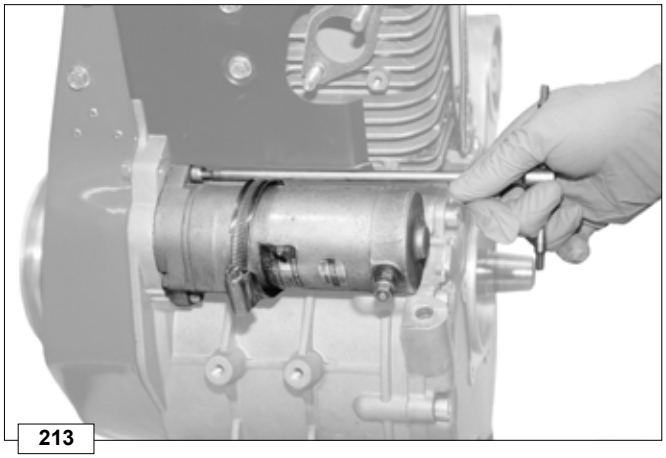
211

Fasten the cover by tightening the fastening knob **A**.


212

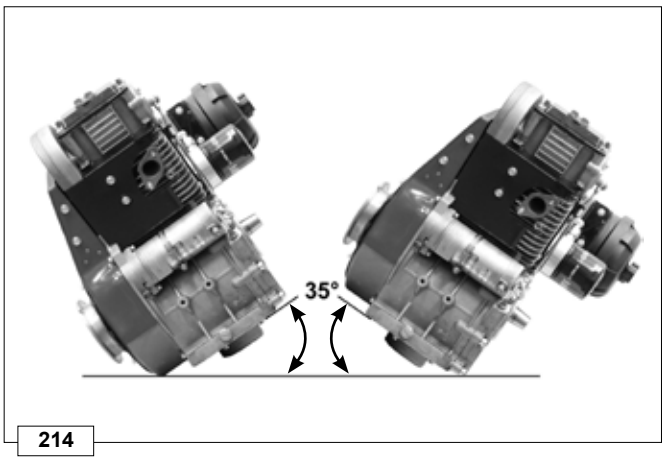
Starting motor locking clip

To avoid that vibrations cause the loosening of the screws fixing the starting motor to the carter, the starting motor has been fixed to the carter also with a clamp.

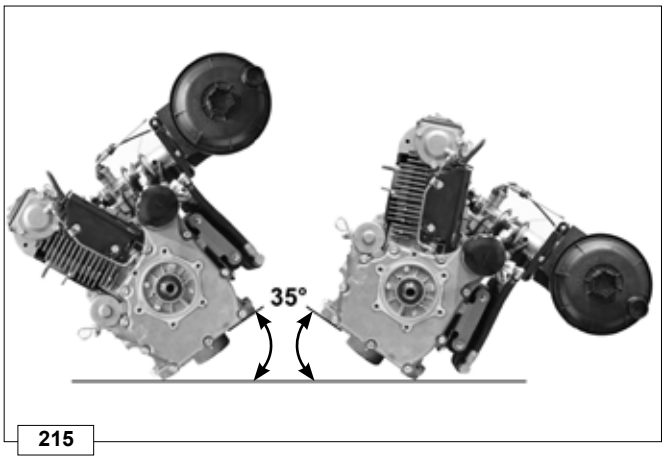

213

Starting motor - Assembly

Fit starting motor so that the pinion gears is coupled correctly with the crown gears.
The two screws fixing the starting motor to the carter must be tightened at 12 Nm.



214



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INSTALLATION

INCLINATION LIMITS OF OPERATION

TIGHTENING TORQUE TABLES

The tables show the tightening torques for standard screws and the main components.

Tightening torques are provided again, along with method and sequence, in the instructions for assembling components and/or assemblies

Table of tightening torques for standard screws (coarse thread)

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

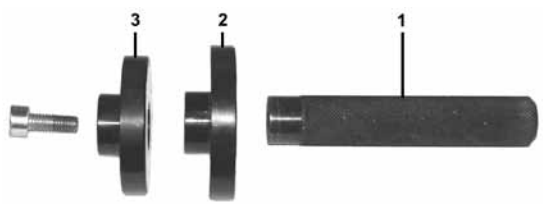
Table of tightening torques for standard screws (fine thread)

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

Table with tightening torques of the main components and use of sealant

Description	Diam. x pitch (mm)	Torque (Nm)	Sealant
Screws for alternator stator	M 5x0.8	8	
Screws for alternator support	M 6x1	10	
Screws fixing air shroud intake and exaust to crankcase	M 6x1	10	
Screws fixing lateral air shroud intake end exhaust to the air shroud flywheel side	M 6x1	10	
Nuts fixing HT Coil	M 6x1	16	
Screws fixing connecting road cap	M 7x1	26	
Screws oil cooler bracket	M 8x1	20	
Screws fixing camshaft cover	M 6x1	10	
Screws fixing crankcase cover	M 8x1,25	26	
Screws fixing lower timing belt cover	M 6x1	10	
Screws fixing starter motor	M 6x1	12	
Air valve (breather)	M 22x1.50	16	
Screws fixing flywheel mesh	M 6x1	10	
Screws cooling air shroud	M 6x1	10	
Spark plug	M 14x1	20	
Intake manifold nuts	M 8x1.5	12	
Nuts fixing carburettor	M 6x1	10	
Oil cooler pipe connections	M 15x1.50	23	
Screw timing belt tightening pulley	M 8x1.25	24	
Screws oil cooler's air shroud plate	M 6x1	12	
Calibrated fittings lubrication pipe	M 8x1.25	14	
Oil sump	M 6x1	10	
Pressure switch	Taper 1/8'x28	24	
Exhaust manifold stud bolts	M 8x1.25	10	
Bolts for gearbox adapter	M 8x1.25	26	
Screws fixing plate oil sump	M 5x0.8	10	
Screws external timing belt guard	M 6x1	10	
Screws internal superior timing belt guard	M 6x1	10	
Screw oil pump cover	M 6x1	10	
Screws fixing camshaft support	M 6x1	10	
Screw fixing camshaft timing pulley	M 6x1	12	
Screws fixing air filter bracket	M 6x1	12	
Screws fixing cylinder head	M 10x1.25	20 + 75°	
Oil filter		15	
Flywheel	M 14x1.5	137.2	
Oil suction pipe	M 14x1	17	
Oil filter union	M 15		
Oil adaptor plug	M 8x1	8	
Drain plug	M 14x1.5	22	
HT Coil stud	M 6	10	
Clamp on stator motor		8	
Stud of oil cooler	M 6	10	
Breather pipe clamp		5	
Grough screw	M 5	5	
GB adpter stud	M 8	10	
Damper in oil cooler	M 8	12	
Oil sump drain plug	M 14x1.5	22	
High pressure pipe with banjo	M 8x1	14	
Engine lifting hook	M 6	10	
Damper nut in oil cooler	M 8	10	

	DESCRIPTION	CODE
	Valve guide check tool	1460.103
	Tool for insertion and removal valve guides	1460.104
	Oil seal installation cone flywhell side	1460.105
	Oil seal installation cone P.T.O. side	1460.106
	Camshaft bearing assembly tool	1460.107
	Valve stem oil seal assembly tool	1460.108
	Valve clearance shim disassembly tool	1460.109
	Head oil seal ring assembly tool	1460.111
	Assembly tool for bearing, oil seal rings and pulley	1460.112
	Valve retainer assembly tool	1460.113

	DESCRIPTION	CODE
	Pulley assembly / disassembly tool	1460.350
	Top dead centre control tool	1460.115
	Tool for roller bearing positioning	1460.137
	Tool for internal oil seal - engine side - positioning	1460.138
	Tool for external oil sel - gearbox side - positioning	1460.139
	Hammer puller Expansion chuck	1460.195 1460.196
	Puller with support Expansion chuck	1460.197 1460.198
	Flywheel puller and timing case cover	1460.200
	1- Handle for pads 2- Tool for crankshaft bearing assembly 3- Tool to assemble oil seal on flywheel side	1) 1460.176 2) 1460.203 3) 1460.204

LGA 280 OHC

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