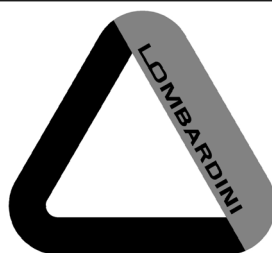


WORKSHOP MANUAL


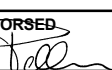

LDA 422 engines, code 1-5302-596

LDA 422

1st Edition



SERVICE

| | | | | | | | | |
|---|-------------------------|-------------------|-----------------------------|-------------|--------------------|---|---|---|
| COMPILER TEGORIATI  | REG. CODE 1-5302-596 | MODEL N° 50881 | DATE OF ISSUE 15-05-2003 | REVISION 00 | DATE 15-05-2003 | ENDORSED  |  | 1 |
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LOMBARDINI

FOREWORD

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

The information in this manual is the exclusive property of Lombardini. Neither partial nor total duplications or reprints are therefore permitted without the express authorization of Lombardini.

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

- 1- the persons who service Lombardini engines have been adequately trained and outfitted to safely and professionally carry out the necessary tasks;
- 2- the persons who service Lombardini engines possess the necessary skills and special Lombardini tools to safely and professionally carry out the necessary tasks;
- 3- the persons who service Lombardini engines have read the specific information concerning the above mentioned Service operations and that they have clearly understood the operations required.

GENERAL SERVICE NOTES

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



| | | | | | | | | |
|---|-------------------------|-------------------|-----------------------------|-------------|--------------------|--------------------------------|--|---|
| COMPILER <i>TECNOLOGIA</i> <i>primella</i> | REG. CODE 1-5302-596 | MODEL N° 50881 | DATE OF ISSUE 15-05-2003 | REVISION 00 | DATE 15-05-2003 | ENDORSED <i>[Signature]</i> | | 3 |
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This manual contains pertinent information regarding the repair of LOMBARDINI air-cooled, indirect injection Diesel engines type **LDA 422**: updated May 15, 2003.

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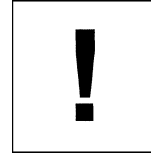
SAFETY AND WARNING DECALS

DANGER



Failure to comply with the instructions could result in damage to persons and property

CAUTION



Failure to comply with the instructions could lead to technical damage to the machine and/or system


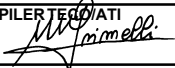
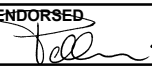


SAFETY INSTRUCTIONS

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

SAFETY AND WARNING DECALS - SAFETY INSTRUCTIONS

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

| | | | | | | | | |
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POSSIBLE CAUSES AND TROUBLE SHOOTING

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

| FAULT FINDING | REMEDIES |
|--|---|
| STARTING PROBLEMS | |
| Faulty fuel pump | Check and, if necessary, replace |
| Presence of air inside the injection system | Purge by operating the fuel pump lever |
| Faulty glow plug | Replace |
| Faulty starting motor or remote control switch | Detect the problem and, if necessary, overhaul or replace |
| Faulty or dirty injector | Check and, if necessary, replace |
| Faulty injection pump | Check and, if necessary, replace |
| Faulty engine stop solenoid valve | Check and, if necessary, replace |
| LOW POWER | |
| Air filter clogged | Clean and, if necessary, replace |
| Diesel fuel filter clogged | Replace |
| Delayed injection | Check and time correctly |
| Inadequate diesel fuel delivery | Verify fuel filter, check injection and fuel pumps efficiency |
| Faulty delivery or advance regulators | Check the assembly and, if necessary, overhaul it |
| THE ENGINE STOPS | |
| Low idling speed | Work on the appropriate register |
| Presence of impurities inside the diesel fuel tank | Empty the tank and clean it, replace the diesel fuel and the filter |
| Absence of air | Clean the air filter and, if necessary, replace it |
| Faulty engine stop solenoid valve | Check and, if necessary, replace |
| THE ENGINE OVERHEATS | |
| Dirt inside head and cylinder cooling system fins | Remove the covers and clean adequately |
| Inadequate engine oil level | Restore |

| FAULT FINDING | REMEDIES |
|---|--|
| WHITE EXHAUST SMOKE | |
| Cold engine | Heat the engine for few minutes at low speed |
| Faulty injector | Check and, if necessary, replace |
| High oil level | Restore the level |
| BLACK EXHAUST SMOKE | |
| Air filter clogged | Replace |
| Incorrect injection pump delivery | Check and restore |
| Faulty injector | Clean and, if necessary, replace |
| NOISY ENGINE | |
| Wrong injection advance | Check the static and dynamic advance and restore |
| Faulty injector | Clean and, if necessary, replace |
| Tappets with excessive clearance | Adjust |
| Excessive wear of the engine internal parts | Overhaul |
| LOW OIL PRESSURE | |
| Insufficient oil level | Restore the level |
| Worn oil pump | Overhaul |
| Worn or damaged crankshaft or small end bearings | Overhaul |
| CLUTCH : SLIPPING | |
| Insufficient idle stroke | Adjust the stroke |
| Weak return spring | Replace |
| Worn or burnt driven disk gasket | Replace the disk |
| SPEED GEAR : SPONTANEOUS GEAR DISENGAGEMENT | |
| Worn or damaged gearbox | Check and, if necessary, replace |
| Incorrectly adjusted control rod | Adjust |
| Wrongly assembled or worn gearbox or coupling spider gears | Overhaul |
| VIBRATIONS TRANSMITTED FROM ENGINE TO FRAME | |
| The silent-blocks anchoring the engine to the frame are not locked correctly or are damaged | Lock or replace |

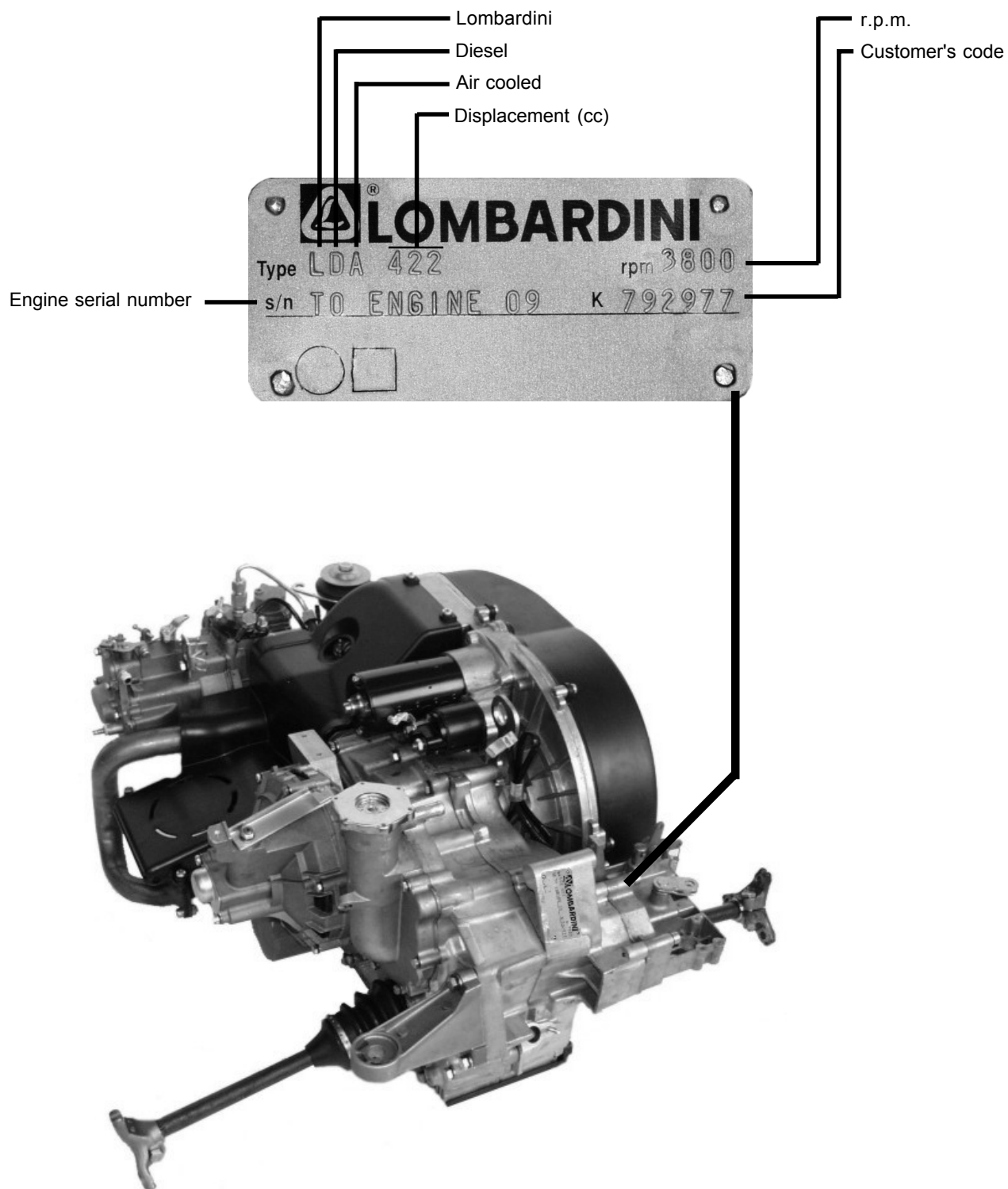




Failure to carry out the operations described in the table may lead to technical damage to the machine and/or system

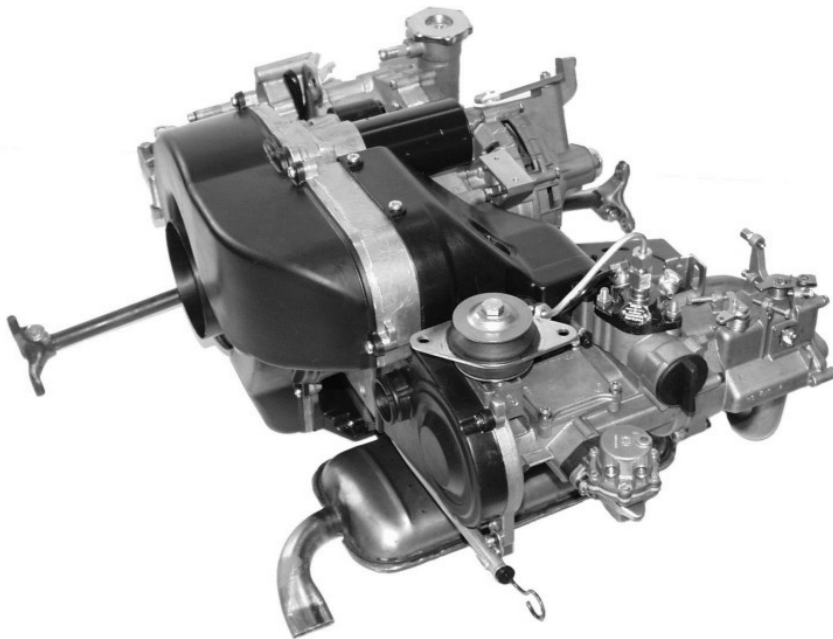
LDA 422 ENGINE MAINTENANCE

| OPERATION | COMPONENT | INTERVAL KM | | | | | | |
|-------------|------------------------------------|-------------------------|------|------|------|-------|-------|-------|
| | | after the first 1000 Km | 1000 | 2000 | 5000 | 10000 | 20000 | 40000 |
| CLEANING | Dry-type air filter | | | | | | | |
| | Injector | | | | | | | |
| | Cooling system (fan, guards, fins) | | | | | | | |
| CHECK | Valve clearance | | | | | | | |
| | Water in the fuel filter | | | | | | | |
| | Integrity of propeller shaft boot | | | | | | | |
| | Low-pressure fuel lines | | | | | | | |
| | Clutch pedal stroke | | | | | | | |
| | Bolts and nuts correct fastening | | | | | | | |
| | Glow plug performance | | | | | | | |
| | Injection Advance | | | | | | | |
| | Injector calibration | | | | | | | |
| REPLACEMENT | Engine oil | | | | | | | |
| | Oil filter | | | | | | | |
| | Fuel filter cartridge | | | | | | | |
| | Dry-type air filter cartridge | | | | | | | |
| | Timing belt | | | | | | | |

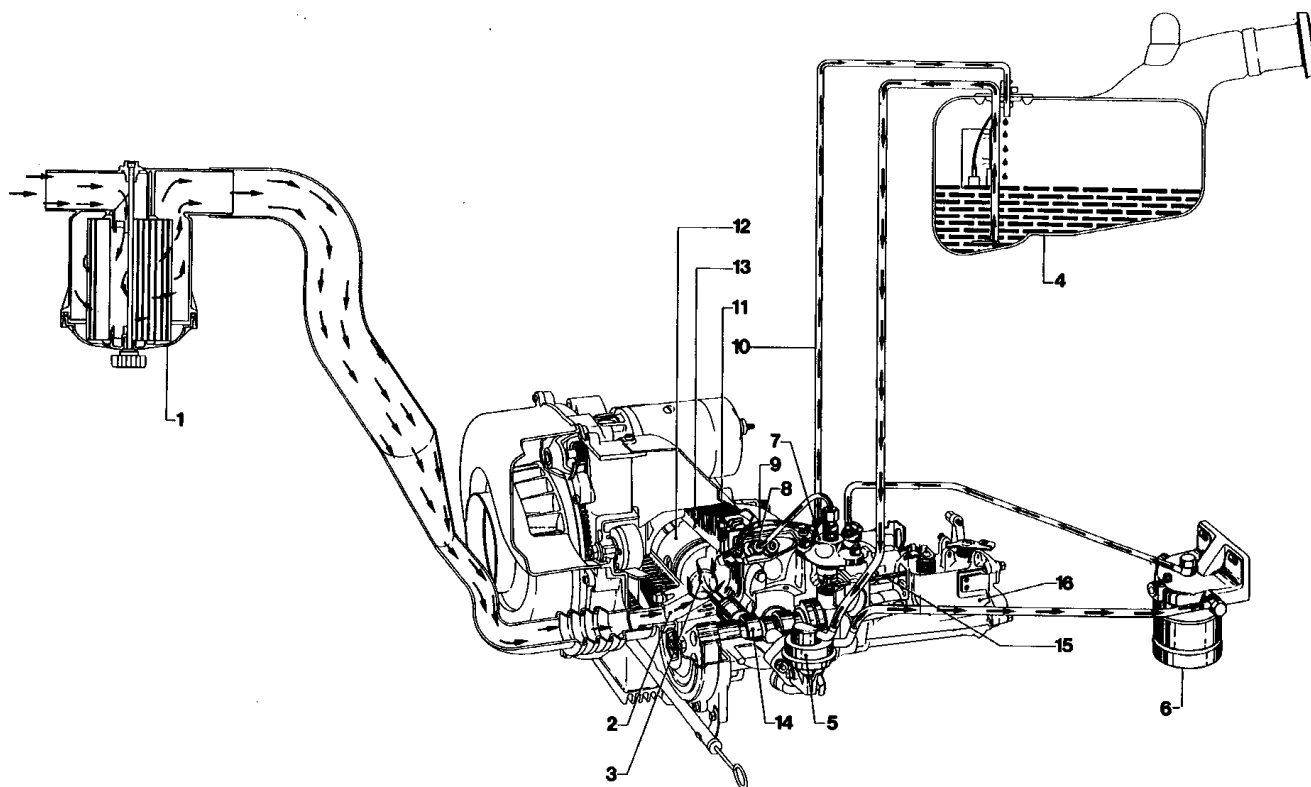


LDA 422 ENGINE MAIN SPECIFICATIONS

- 4-stroke single cylinder engine
- Indirect-injection Diesel-cycle type
- Forced air-cooling system
- Differential gear and gearbox assembly on rear axle
- OHC axle driven by toothed belt
- Lubrication is made through a lobe pump controlled by driving-shaft chain
- Injection system by immersed-type pump, fed by diaphragm fuel pump
- Dry-type cartridge air filter
- Oil filter with cartridge
- Oil type SAE 15 W 40 API CF

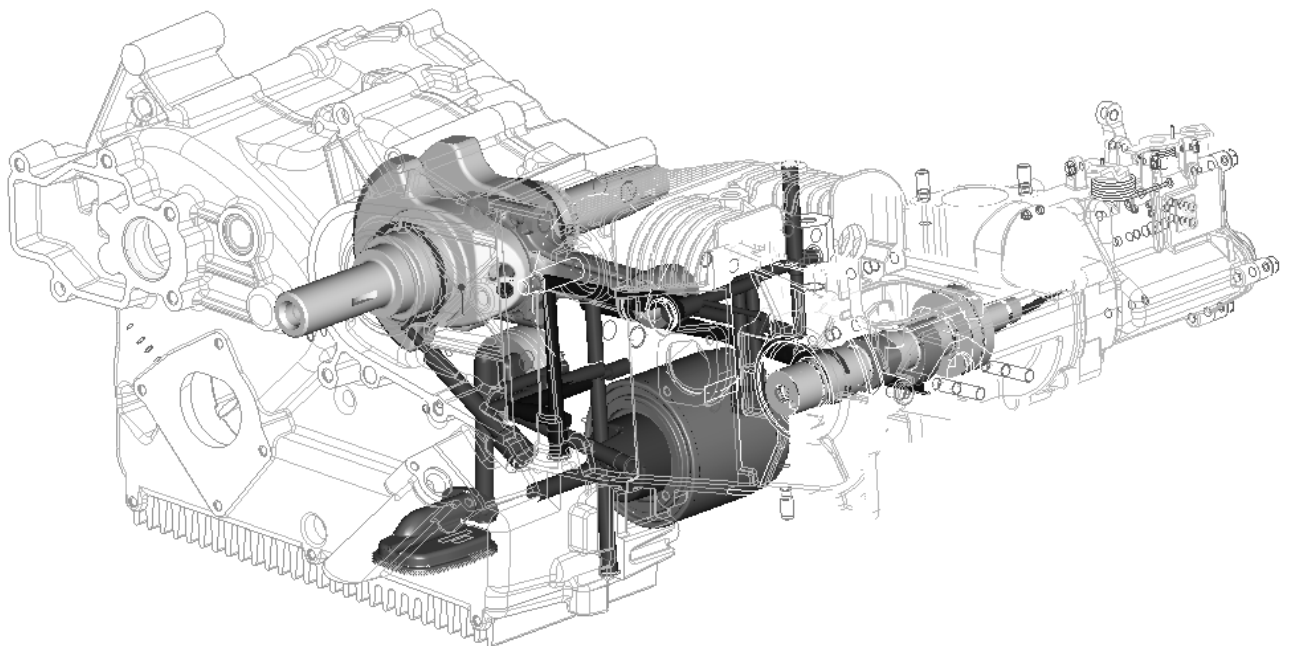
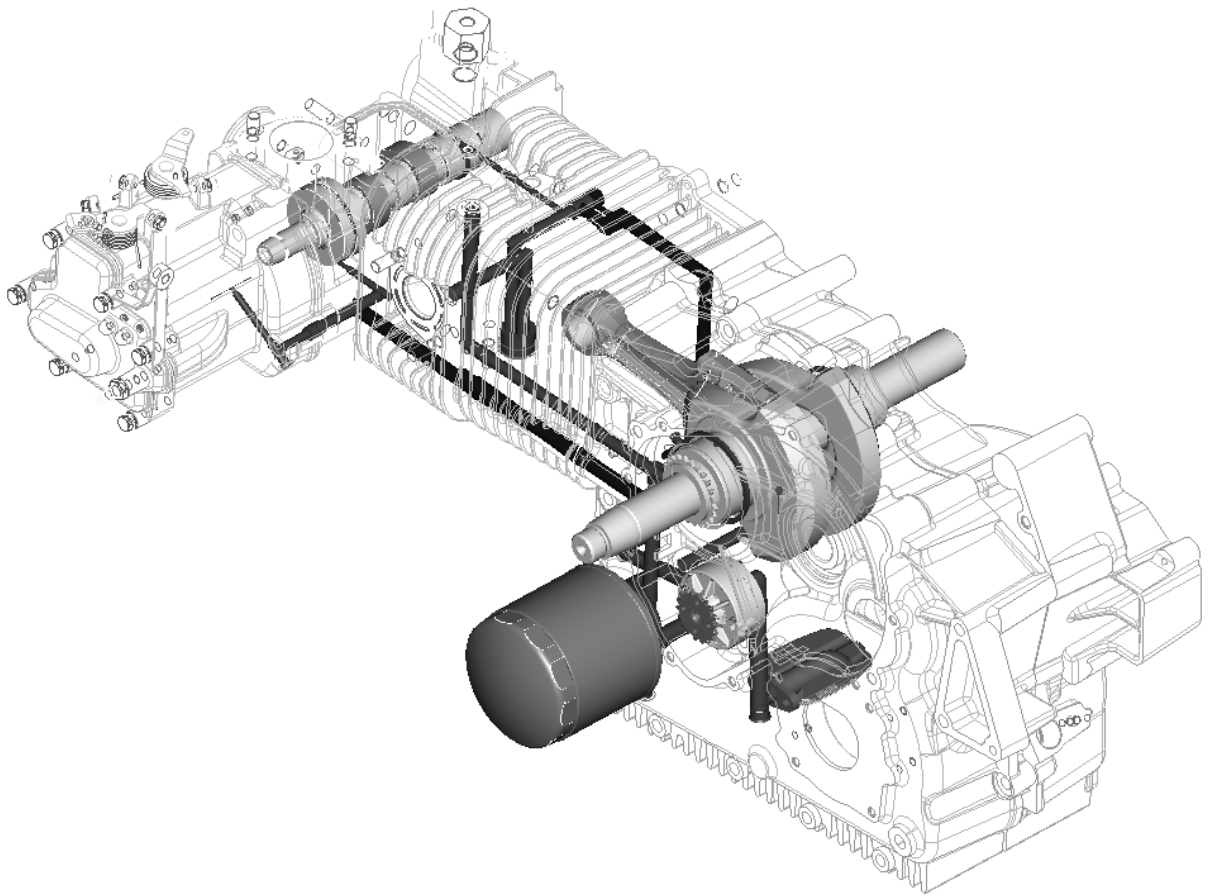

LDA 422

| TECHNICAL DATA | | LDA 422 |
|---------------------------------|-----------------|--------------------|
| Number of cylinders | N° | 1 |
| Bore | mm | 83 |
| Stroke | mm | 78 |
| Displacement | Cm ³ | 422 |
| Compression ratio | | 23 : 1 |
| R.P.M./1' min | | 1100 ± 50 |
| R.P.M./1' max | | 3800 |
| Power kW | kW | 6,3 |
| Max torque at 2800 R.P.M./1' | Nm | 18 |
| Fuel consumption | gr kW/h | 300 |
| Oil quantity without oil filter | l. | 3,0 |
| Oil quantity with oil filter | l. | 3,5 |
| Dry weight | Kg | 94,5 |

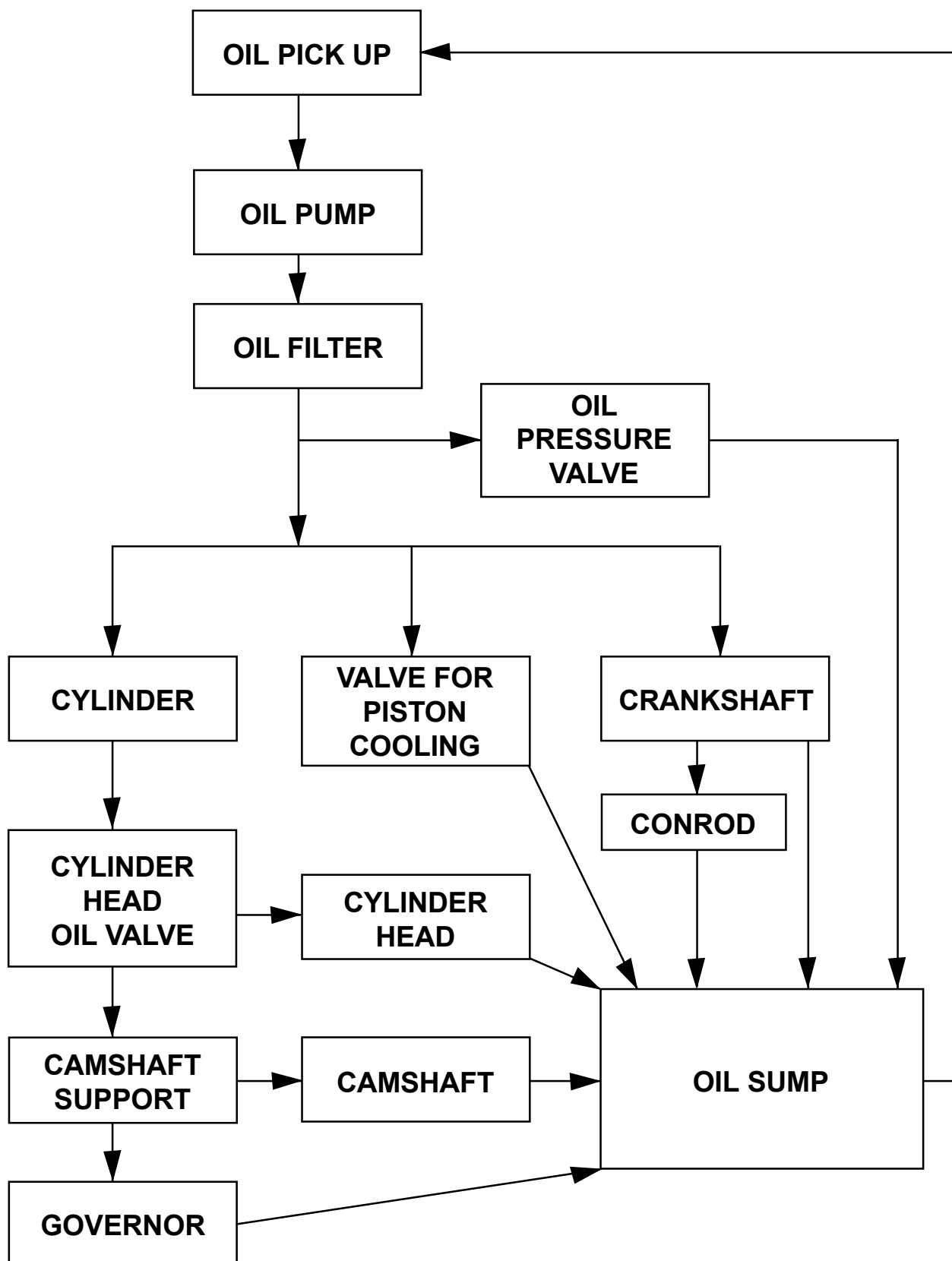


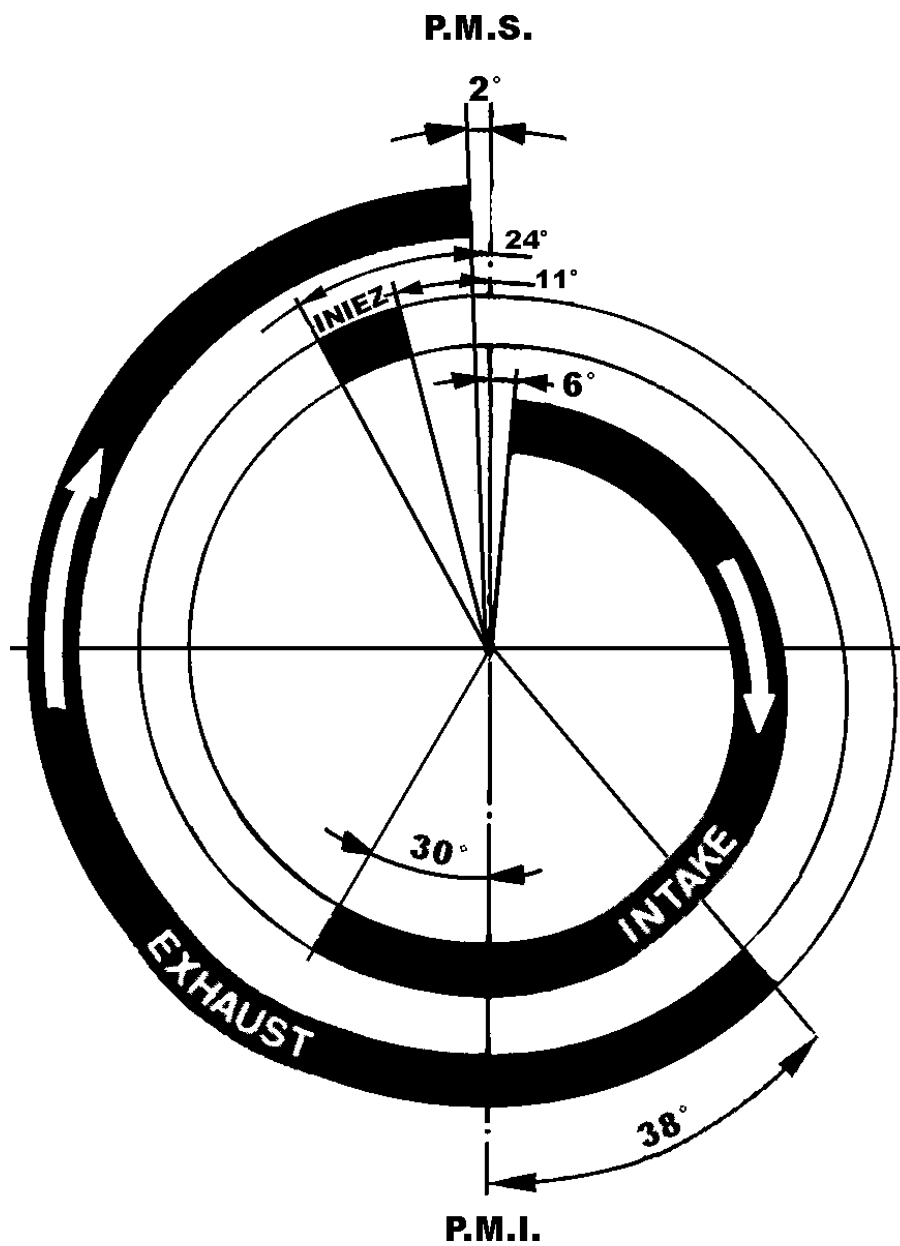
Components :

- | | |
|--|---|
| 1) Air cleaner (paper filtering cartridge) | 9) Fuel return pipe from injector |
| 2) Induction duct | 10) Return pipe to tank of exceeding fuel |
| 3) Induction valve | 11) Preheating plug |
| 4) Fuel tank | 12) Piston |
| 5) Fuel feed pump | 13) Cylinder |
| 6) Fuel filter | 14) Camshaft |
| 7) Injection pump | 15) Delivery adjusting rod |
| 8) Injector | 16) Fuel delivery regulator unit |



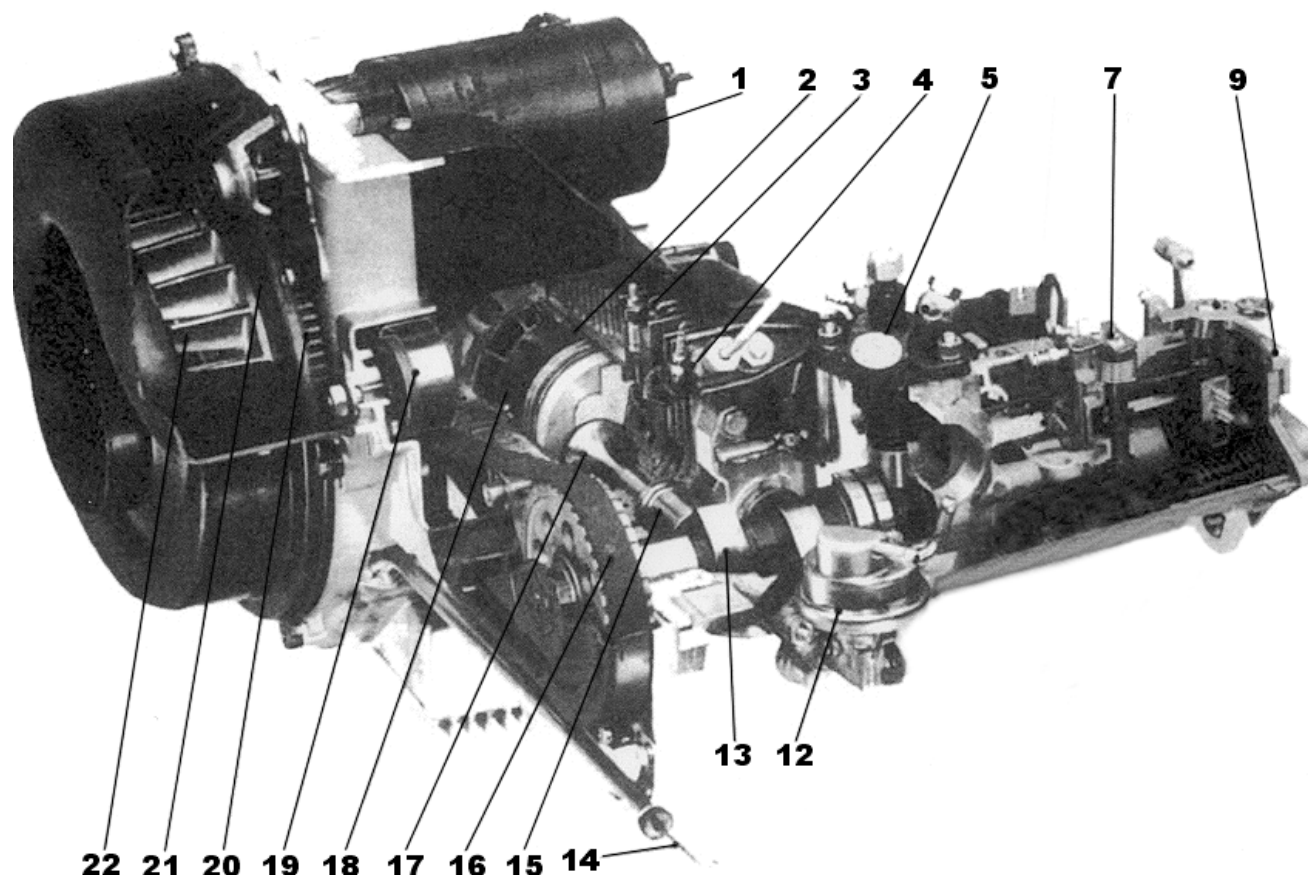
LDA 422 OIL CIRCUIT DIAGRAM





Timing diagram

Data concern 1 mm. cold play between tappets and valves


Components:

- | | |
|----------------------|-------------------------|
| 1) Starting motor | 14) Dipstick |
| 2) Cylinder | 15) Tappet |
| 3) Preheating plug | 16) Timing belt |
| 4) Injector | 17) Induction valve |
| 5) Injection pump | 18) Piston |
| 7) Accelerator lever | 19) Belt tensioner |
| 9) Delivery control | 20) Starting crown gear |
| 12) Feed pump | 21) Starting pinion |
| 13) Camshaft | 22) Rotor with fan |

COOLING SYSTEM
COOLING SYSTEM DESCRIPTION

The engine cooling is carried out by means of air blown by the centrifugal fan, attached on the flywheel, on the cylinder head unit .

The heat is removed from the cylinder and cylinder head through the appropriate finning of themself. Moreover, particularly in the cylinder head area, close to the exhaust valve seat and to the pre-combustion chamber, the heat is removed by the lubrication oil, as previously described in the chapter relative to the lubrication system. When the engine is cold, because of high oil pressure due to the high viscosity, a by-pass valve limits the oil quantity sent to the area to be cooled.

Apart from disassembly and reassembly operations, this handbook also includes checks, setting up, dimensions, repairs and running instructions.

It is necessary to use LOMBARDINI original spare parts for a correct repair.

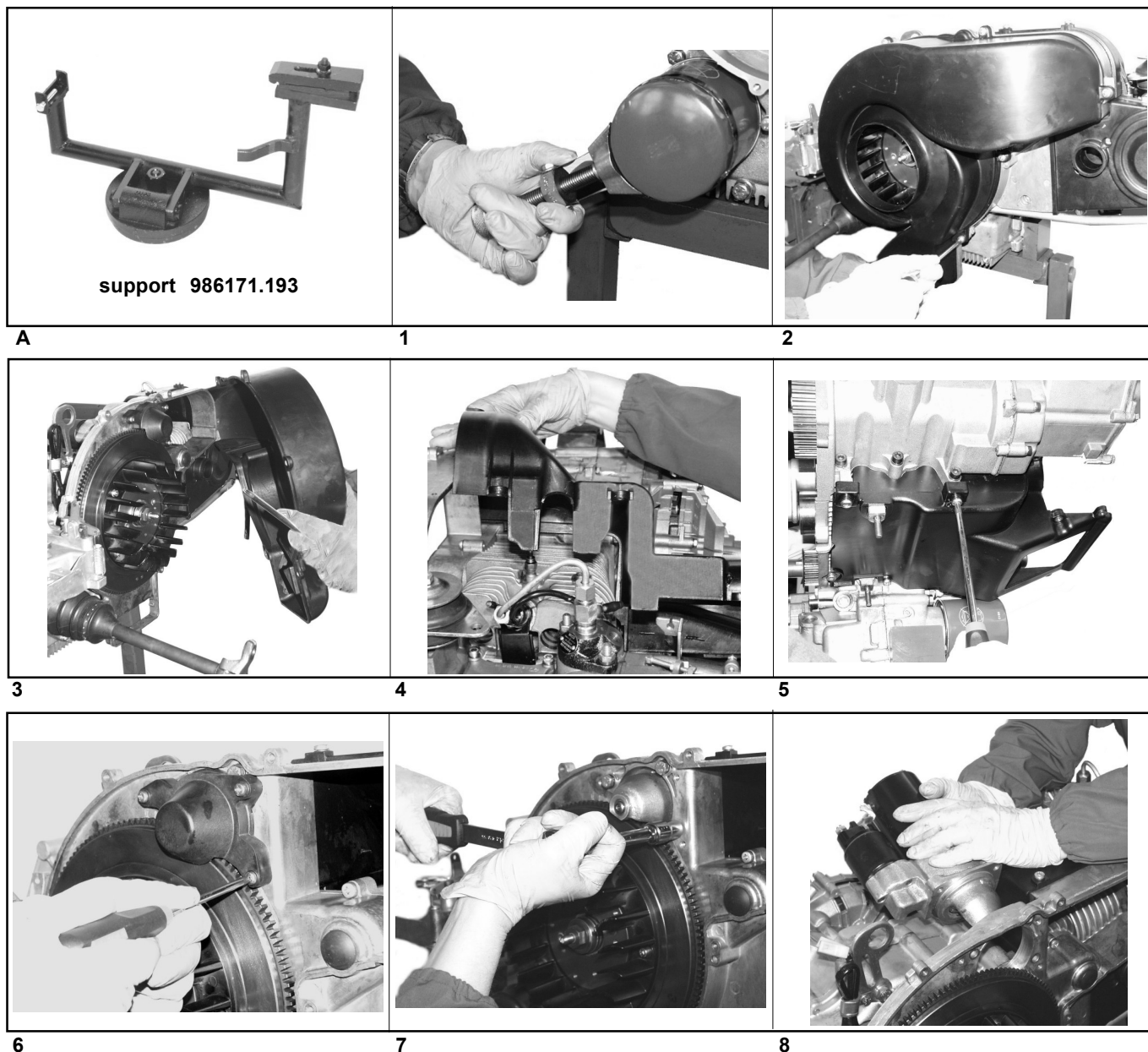


During repair operations, when using compressed air, wear eye protection.

First drain the engine oil through the drain hole, then remove the negative cable (-) from the battery, the electric cables from the alternator flywheel and from the starting motor, the fuel pipes, the controls of accelerator, braking lights, speed gear, clutch, etc, remove the inlet boot and the aprons.

Oil filter and cooling covers and starting motor

Install the engine gear box assembly on support 986171.193, remove the oil filter and remove the scroll cover and the cooling covers by removing the relevant retaining screws. After removing the guard, disassemble the starting motor.

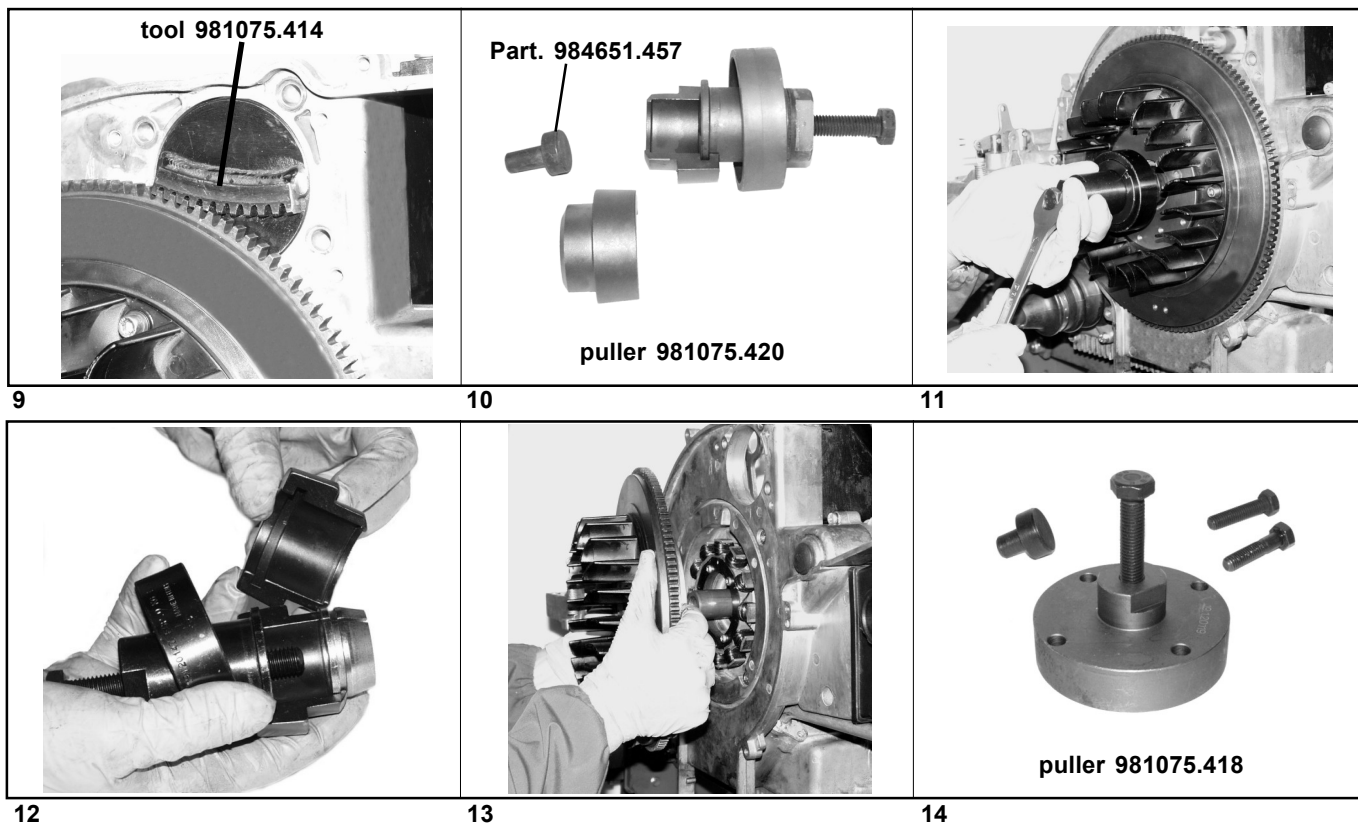


IX DISASSEMBLY/REASSEMBLY

Cooling fan flywheel

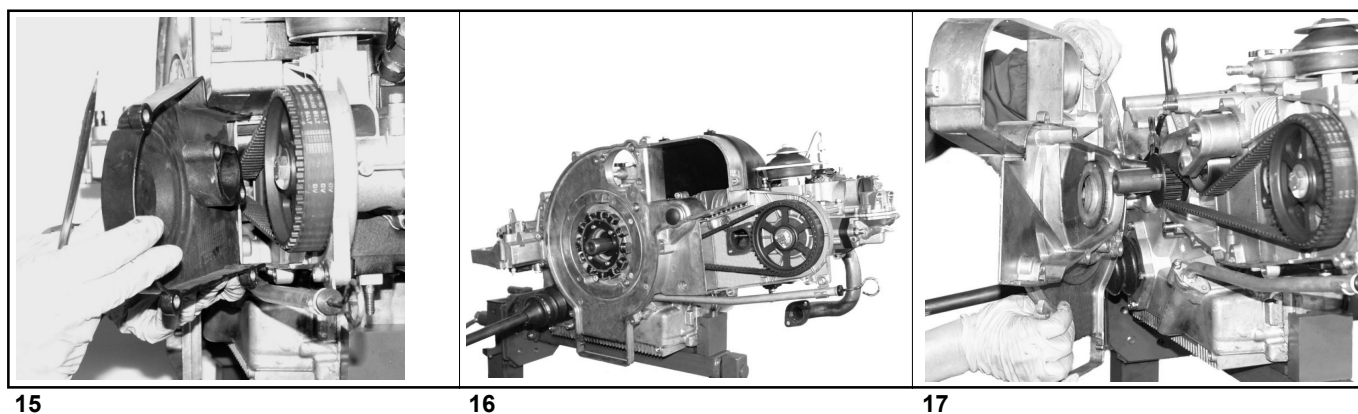
Place tool 981075.414 onto the starting motor (Fig. 9) housing to fix the flywheel, remove the flywheel retaining screw using a 22 mm socket wrench and extract the cone and remove the flywheel (Fig. 11) using extractor 981075.420 (equipped with component 984651.457).

NOTE: After extracting the cone, if flywheel removal should prove difficult use extractor 981075.418 (Fig. 14).



Belt cover and fan scroll

After removing the belt cover (Fig. 15), unscrew the 6 screws and remove the fan scroll together with the stator and detach the alternator cable clamp (Fig. 16÷17).



Assembly and disassembly of timing belt and oil dipstick



Before disassembling the timing belt . Turn the camshaft gear and fit timing pin 8430.123 into its housing on the support (see figure 20) so that it coincides with the hole that can be found on the shaft (the pin must rest against the boss surface).

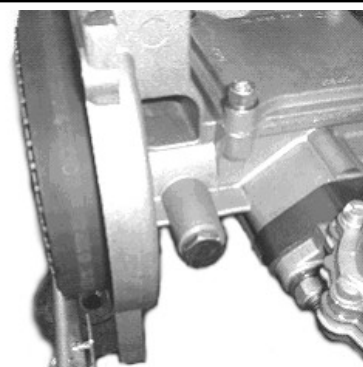


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pin 8430.123

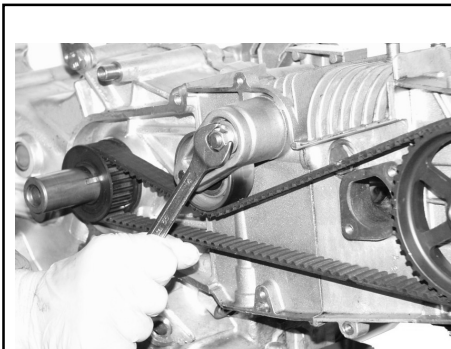
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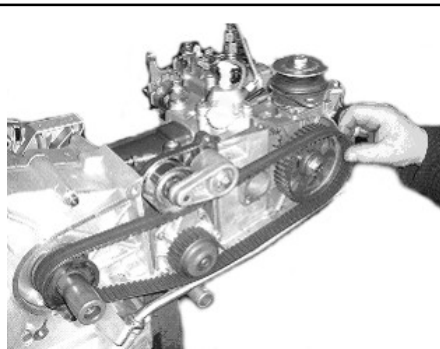
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Loosen the belt tensioner and clamp it up high as shown, remove the timing belt (Fig. 21÷22) and the oil dipstick (Fig. 23) by removing the 3 coupling screws.

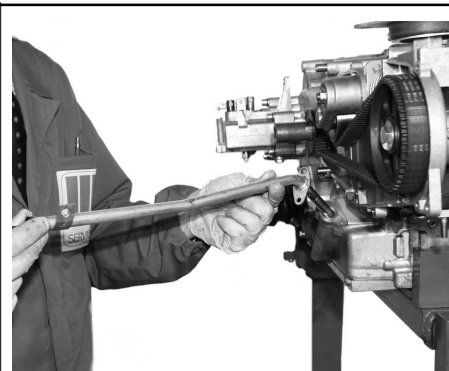
Loosen the timing pulley fastening bolt so that it can turn freely on the shaft.



21



22



23

Drive shaft clamping

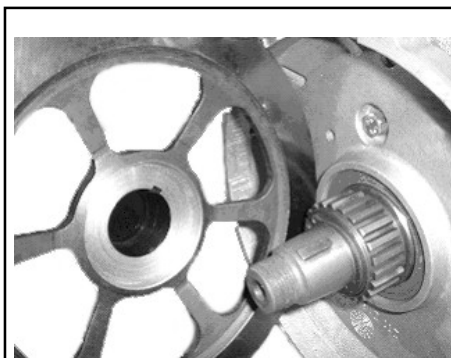
Disassemble the clutch, then fit clamping hub 5900.217 (together with component 8430.124) on the drive shaft and refer to the key for the clutch assembly (Fig. 25). Tighten the hub using the washer and the nut with a 120 ÷ 140 Nm torque (Fig. 26). Then fit timing pin 8430.124 and screw it onto the hub so that it coincides with the hole on the clutch housing pan (Fig. 27).

+ 8430.124

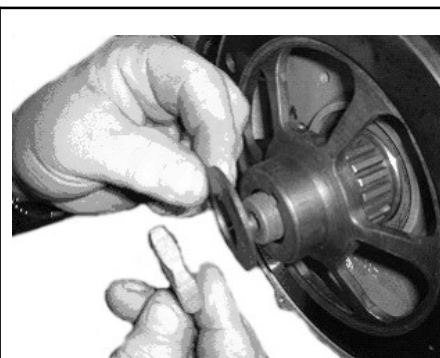


tool 5900.217

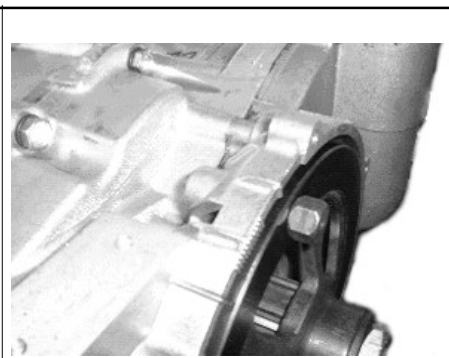
24



25



26



27

IX DISASSEMBLY/REASSEMBLY

Belt assembly

Clamp the belt tensioner in the minimum load position, then fit the belt on the drive shaft pulley and next on the camshaft pulley (Fig. 28).

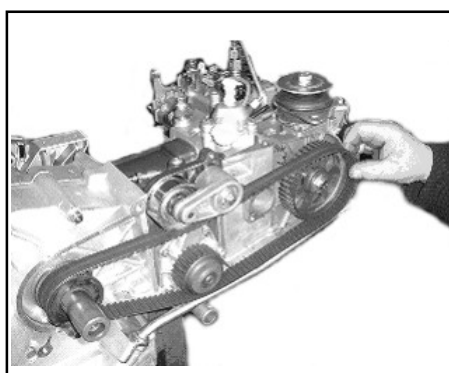
Unscrew the idler nut to tension the belt. Then tighten the belt tensioner nut with a $40 \pm 40,4$ Nm torque (Fig. 29).

Tighten the camshaft pulley to 70 Nm, then fit again the safety washer on the bolt (Fig. 30-31).

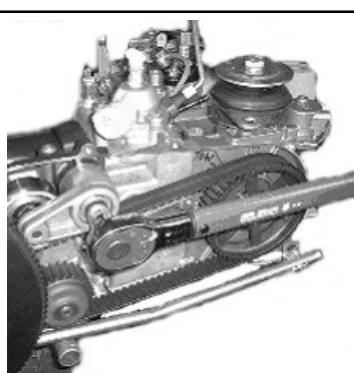
Now remove both pins to allow the shafts to turn, plug the hole on the camshaft support with the washer and the plug (Fig 32-33).

Use the flywheel to rotate the engine for 2/3 revs thus bedding the belt.

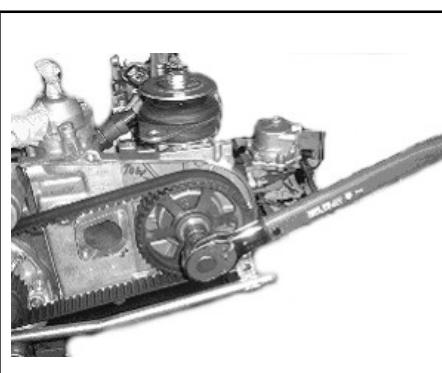
Remove the clamping hub of the drive shaft using a multi-purpose extractor as shown in the figure (34), then reassemble the clutch (Fig. 35).



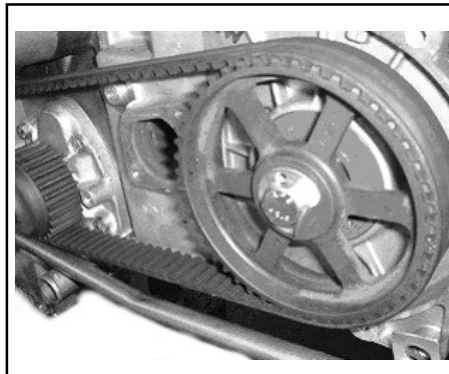
28



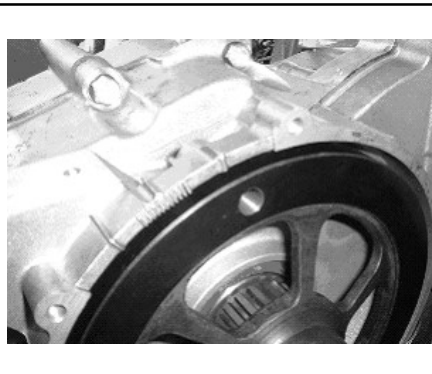
29



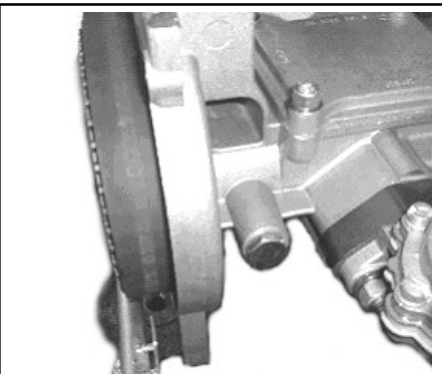
30



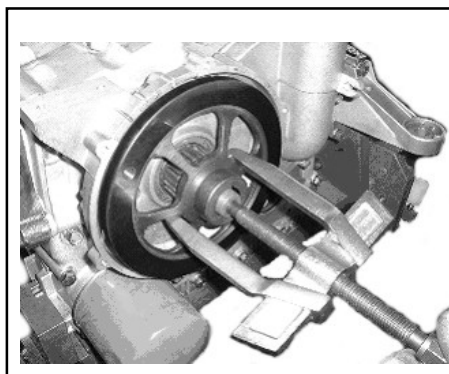
31



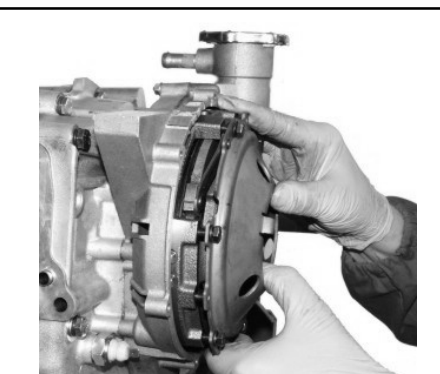
32



33



34



35

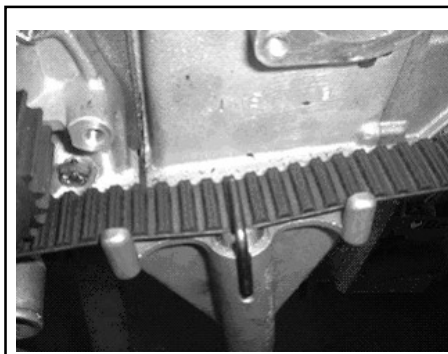
Belt tensioning check

Use the DENSO tool to measure the belt tension, carefully place the denso on the belt tooth as shown in figure 36. The belt tension should be between 25 and 28 Nm, see Fig. 37.

If this is not the case loosen the idler, let it slide downwards and tighten it again to the rated torque, then re-check the tension.



When removing the timing belt you must replace it even though its scheduled life span is not over.



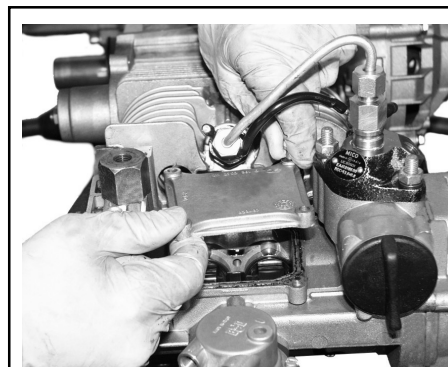
36



37

Injector, fireproof bulkhead

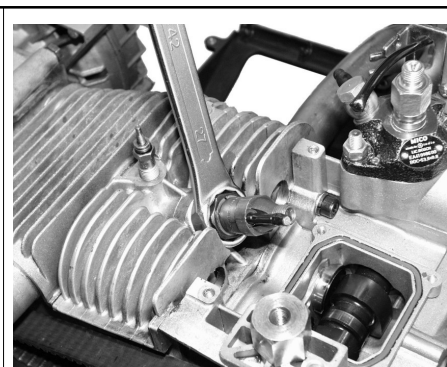
- Remove the tappets cover (Fig. 38)
- When disassembling the injection tube keep the injection pump fitting clamped using a 19 mm wrench (Fig. 39).
- Assemble 981075.413 extractor in place of the injector, as shown in the picture (42), and extract the fireproof bulkhead.



38



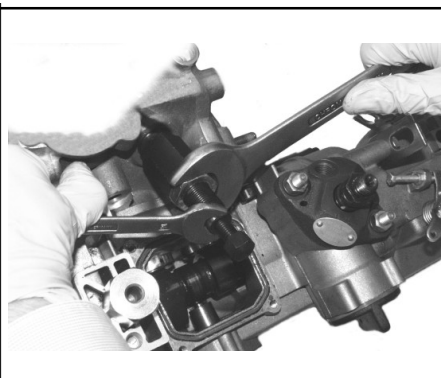
39



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42

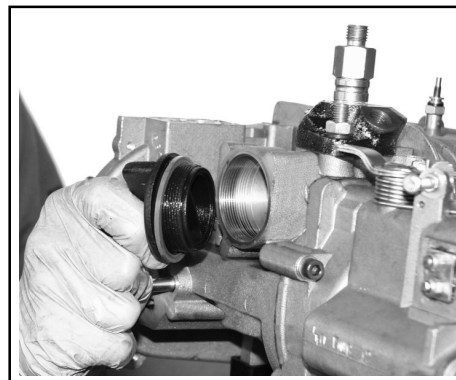


When reassembling the injector always use a new fireproof bulkhead.

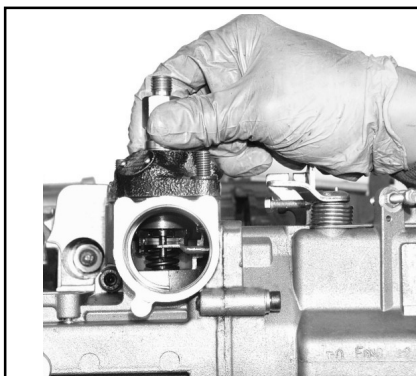
IX DISASSEMBLY/REASSEMBLY

Injection pump

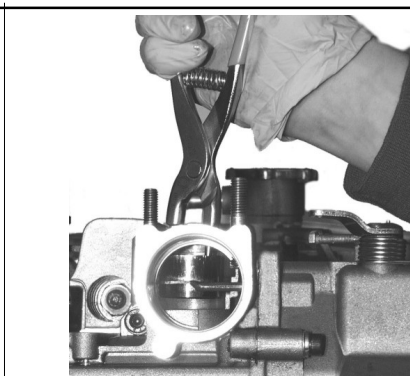
- Remove the inspection plug.
- Disengage the injection pump control rod and extract the pump.
- Remove the injection tappets with the related collar housed inside it (Fig. 45÷46).



43



44



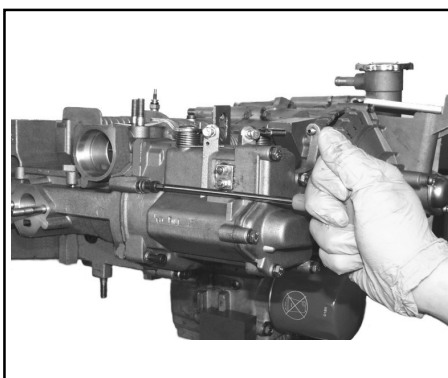
45



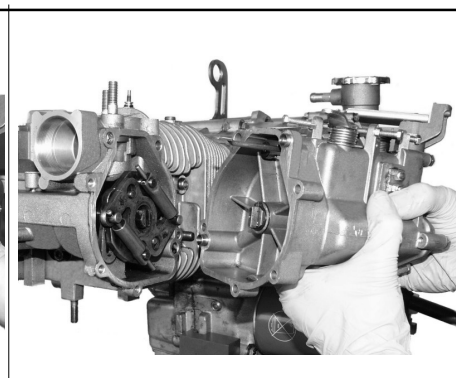
46

Governor assembly

Unscrew the 5 bolts (Fig. 47) and remove the governor assembly (Fig. 48).



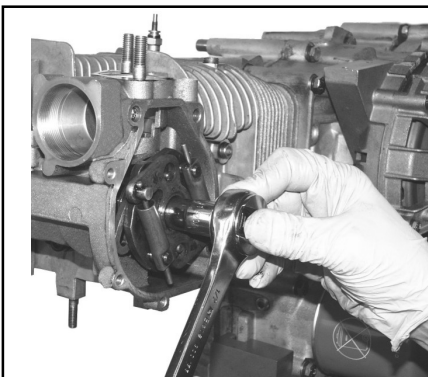
47



48

Injection advance variator

- Unscrew the fixing bolt using a 14 mm wrench, use extractor 981075.421 and turn the screw to remove the weights while keeping the central hexagon clamped (Fig. 51).

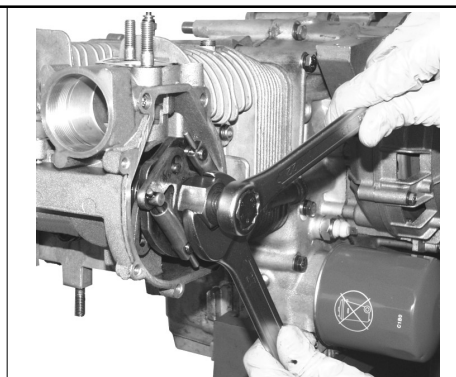


49



puller 981075.421

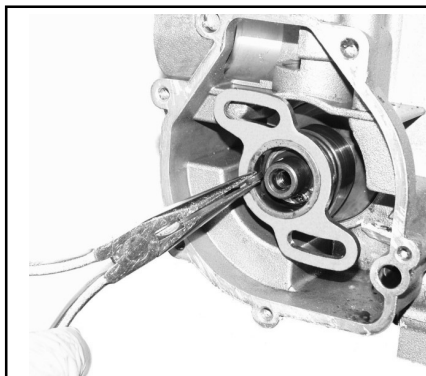
50



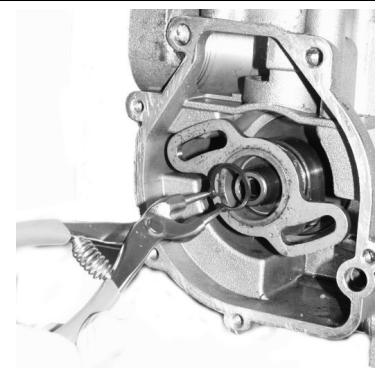
51

Injection pump control cam

Extract the key from its slot (Fig. 52), remove the snap ring (use pliers for internal snap rings), extract the shoulder washer and extract the cam (Fig. 53).



52



53

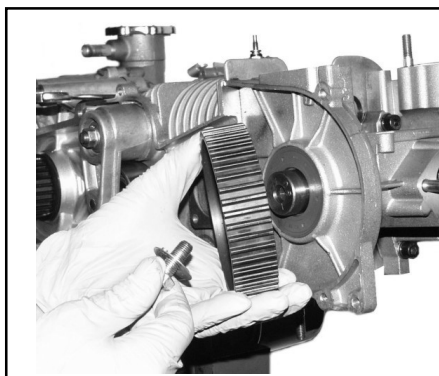
Timing pulley and camshaft sealing ring

Straighten the retaining washer, unscrew the bolt and remove the timing pulley (Fig. 54).

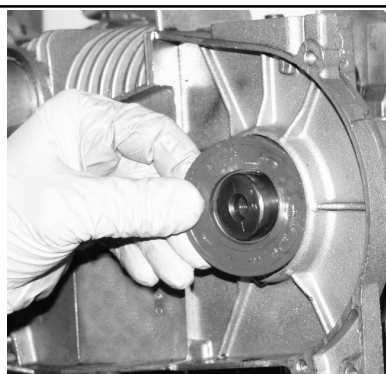
Remove the sealing oil ring (use a screw driver) (Fig. 55), the snap ring (use pliers for internal snap rings) and the clearance shim (Fig. 56).



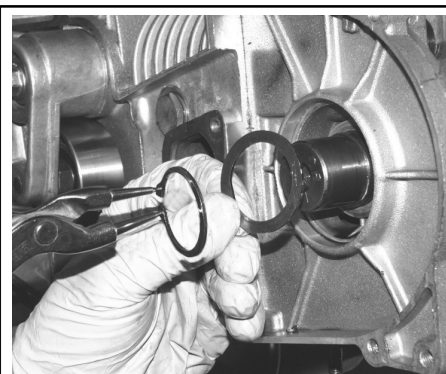
When reassembling replace the sealing oil ring with a new one



54



55

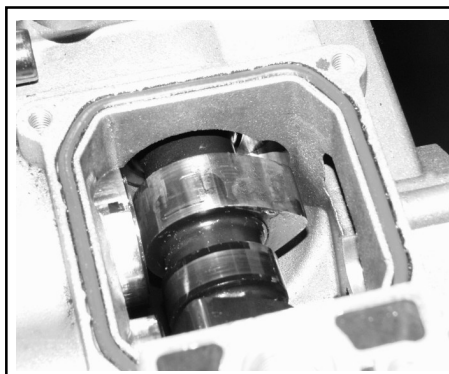


56

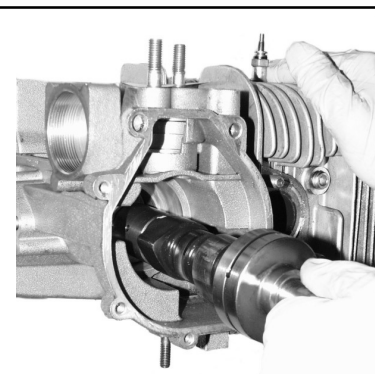
Camshaft extraction

Turn the shaft and position the cam lobe to coincide with the opening provided for it (Fig. 57).

Repeat the procedure on the second cam lobe to extract the shaft completely (Fig. 58).



57



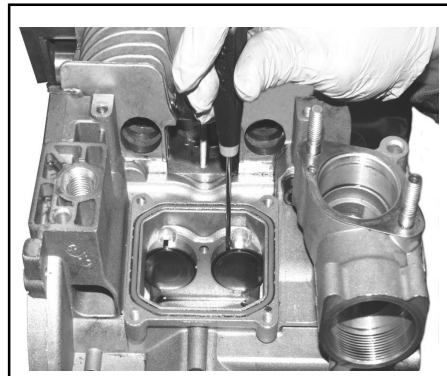
58

IX DISASSEMBLY/REASSEMBLY

Tappet disassembling

Mark the tappets and the adjustment shims, making sure that they are reassembled in the same position.

The collar surface on which the shim identification code is indicated shall be assembled facing the tappets socket.



59



60



61



62

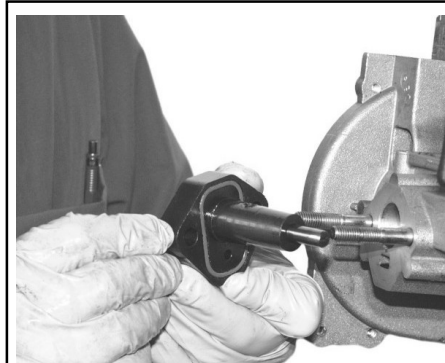
Camshaft support

Disassemble the fuel supply pump, the plastic support, and the fuel supply pump control rod.

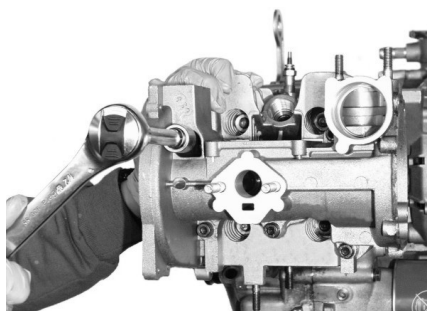
By using the appropriate wrench unscrew the coupling screws to the head and remove the camshaft support.



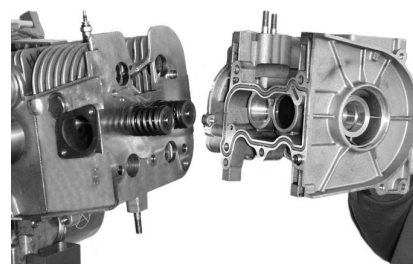
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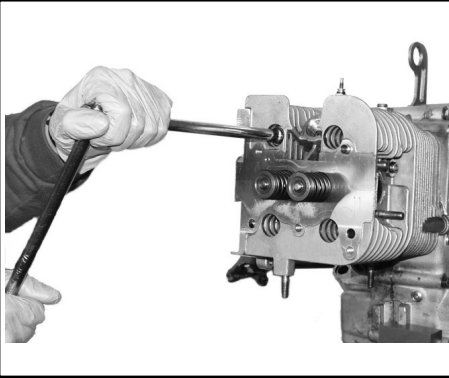
66

Cylinder head

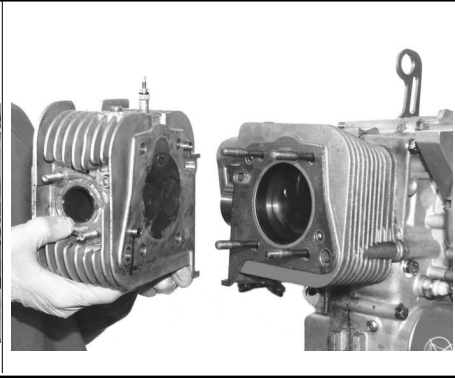
Unscrew the 4 retaining nuts (Fig. 67), extract the cylinder head assembly (Fig. 68) and remove the gasket (Fig. 69).



When reassembling always replace the cylinder head gasket with a new one



67



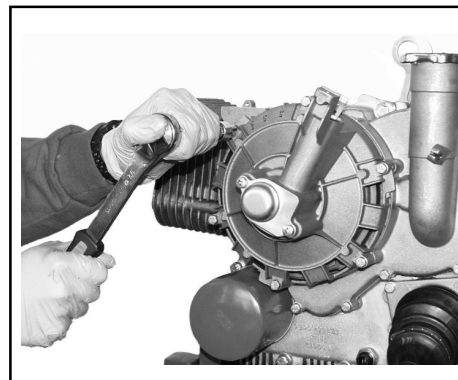
68



69

Clutch

- Disassemble the cover (Fig. 70÷71) and place the stop key 985110.039
- Using pliers extract the snap ring then remove the clutch pressure plate.
- Unscrew the nut (Fig. 73-74), use extractor 981075.419 and extract the clutch by turning the central screw (Fig. 76).



70

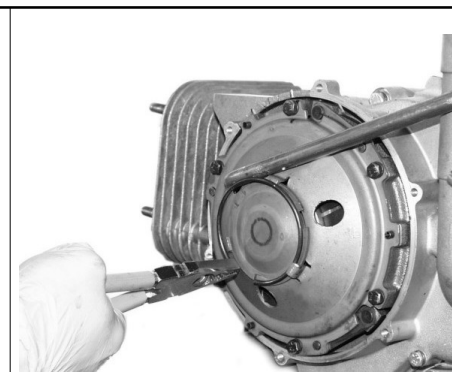


71

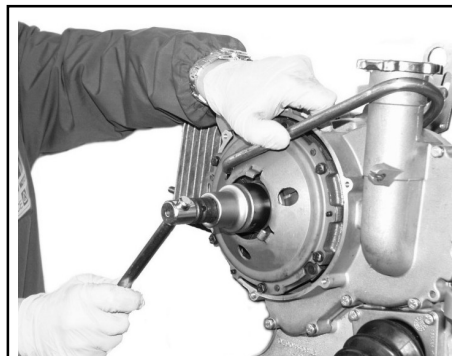


stop key 985110.039

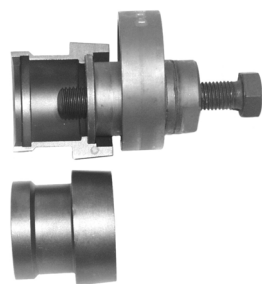
72



73

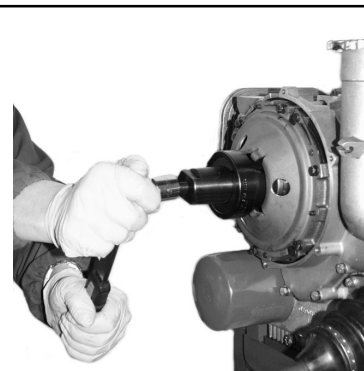


74



puller 981075.419

75



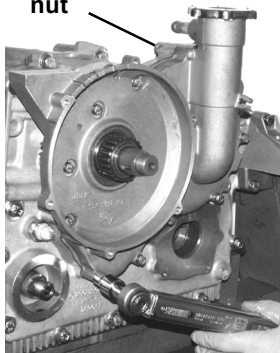
76

Ring gear disassembling

Disassemble the cover by removing the single nut and the 10 screws (Fig. 77), then use the provided tool 981075.412 to clamp the ring gear and unscrew the bolt (Fig. 79).

N.B. When reassembling, the bolt shall be locked by using the same tool.

nut

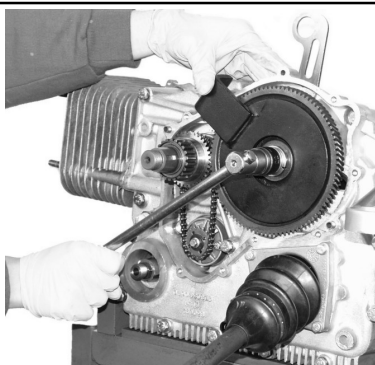


77



tool 981075.412

78



79

Using tool 981075.425 together with component 984651.457 extract the cone (Fig. 81) and remove the ring gear (Fig. 82).



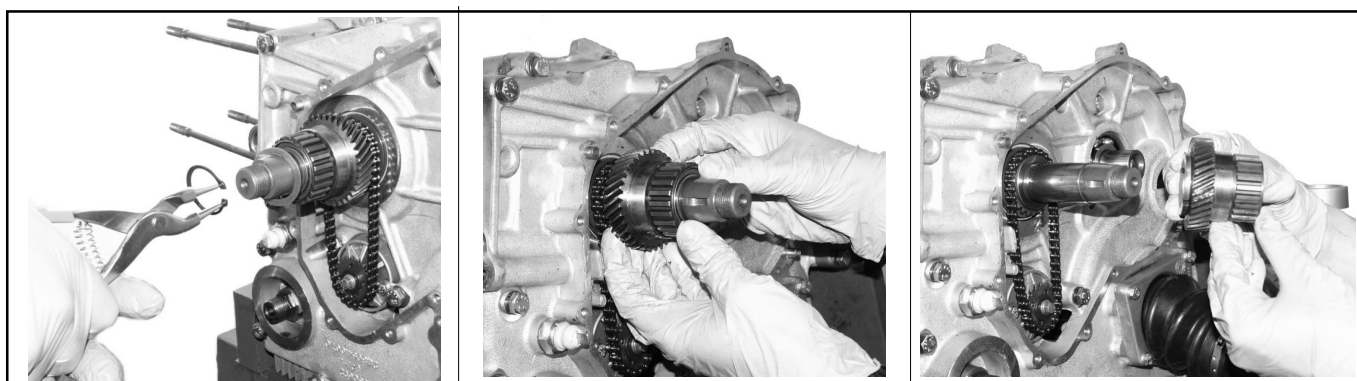
80

81

82

Drive shaft gear

First remove the snap ring using the specific pliers, then remove the clearance shim (Fig. 83) and the camshaft gear (Fig. 84÷85).



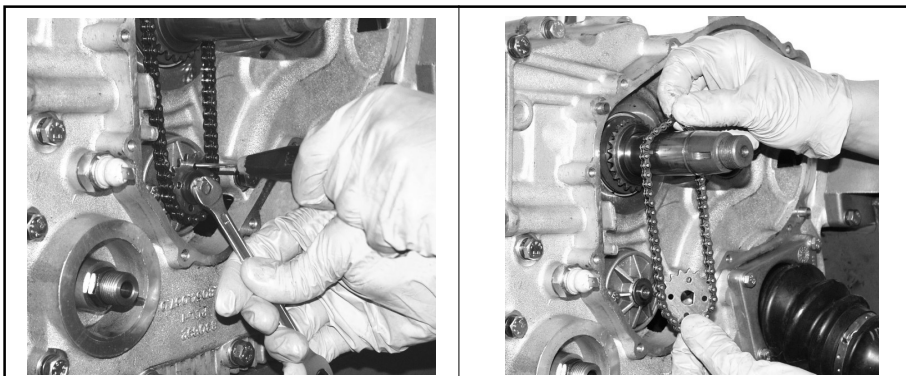
83

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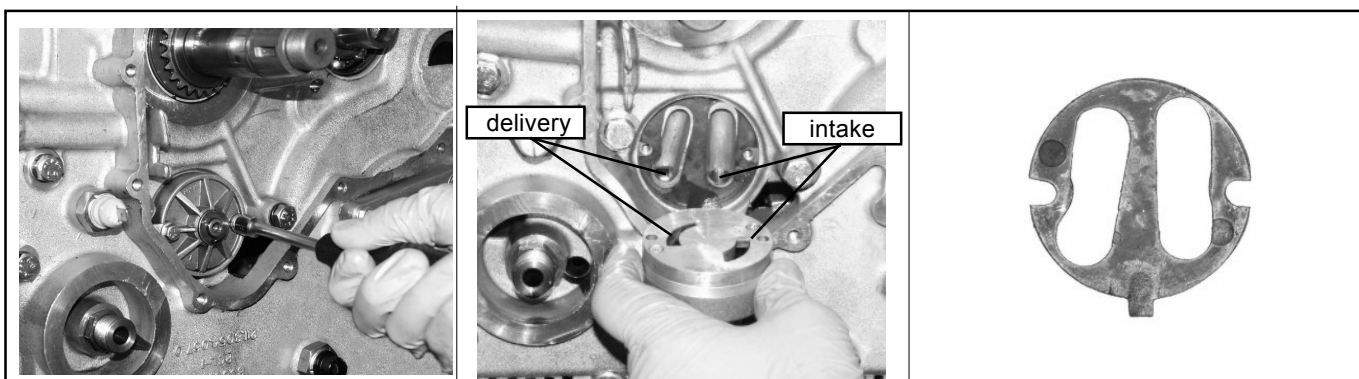
Oil pump gear and oil pump

Hold the oil pump control gear using a screwdriver and unscrew the lock bolt (Fig. 86), then remove the chain (Fig. 87). Unscrew the two bolts which secure the oil pump (Fig. 88) and extract the oil pump noticing the correct sequence for reassembly. (see Fig. 89). Replace the gasket whenever you remove the oil pump (Fig. 90).



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LUBRICATION SYSTEM DESCRIPTION

The oil contained in the engine sump is deaerated through the labyrinth (1) and filtered by the filter (2) before it is sucked by the pump (3) through the suction duct (4).

From the pump the oil is pushed towards a circuit machined in the cylinder head in proximity to particular points to be cooled (5).

The cooling circuit internal pressure is limited by the by-pass valve (7). The by-pass valve is necessary because, with the engine cold and therefore with high oil viscosity the oil pressure would become too high. The diaphragm (6) regulates the oil quantity for the camshaft lubrication.

A by-pass valve (8) regulate the lubrication pressure at a predetermined value. Before being sent to the cylinder head (5), to camshaft support (9) and to the journal bearings (10) the oil is filtered through a total flow filter cartridge (11). In case of obstruction of the filter an internal by-pass valve (12) opens up.

Nearby on the clutch side crankshaft support, a nozzle with a closing valve is fixed. These nozzle valve is preset and has the function of cooling the piston through its oil jet and to lubricate the connecting rod small end bearing and the piston pin.

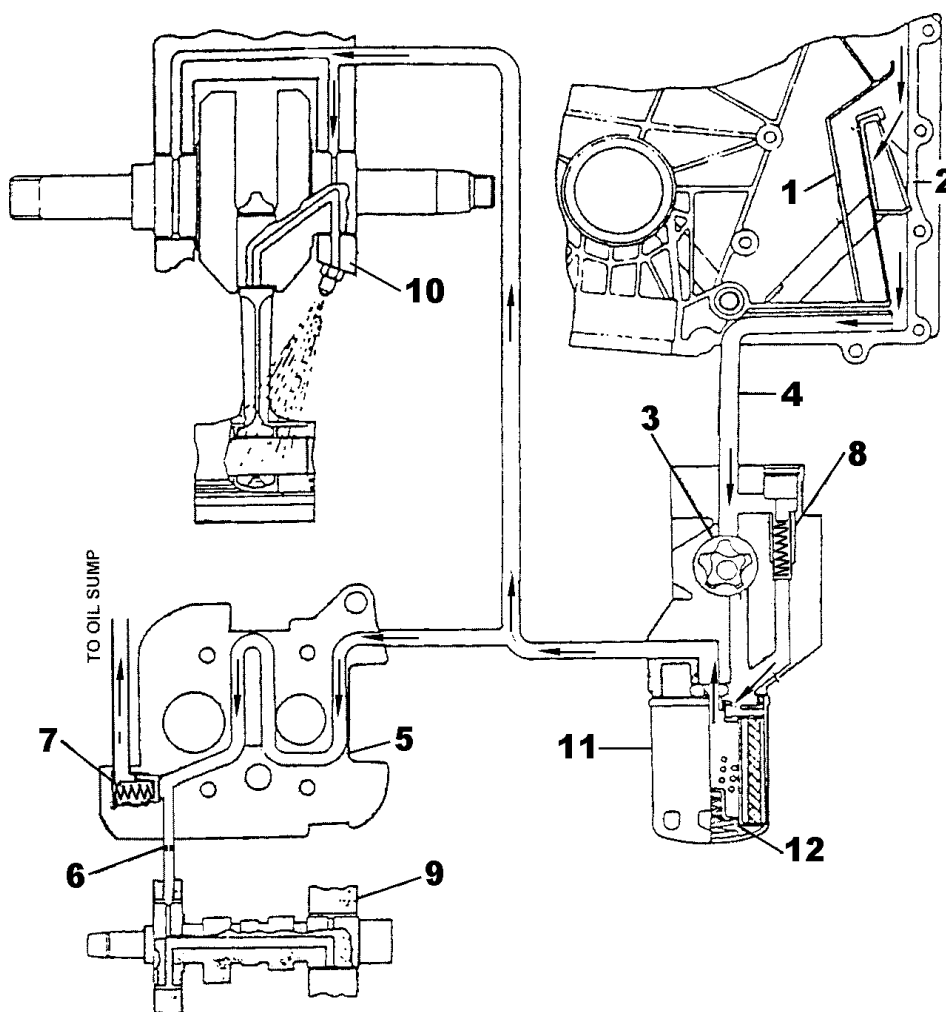
The oil that comes out from the cylinder head and camshaft carrier compartment is returned into the crankcase through an appropriate pipe that is not represented in the figure.

7- Characteristics of the spring located in the oil pressure regulating valve for lubrication and cooling circuits

- By-pass spring free length → 33 mm
- Load exerted by the above mentioned spring at a length of: 27.5 mm → 3.1 ± 0.15 Kg

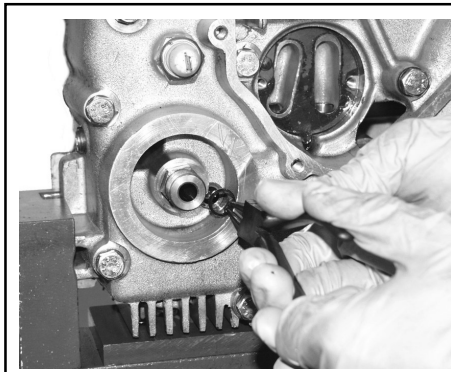
8- Lubrication by-pass

- Spring free length → mm 48
- Load exerted by the above mentioned spring at a length of: 36 mm → 3.4 ± 0.10 Kg
- 29 mm → 5.3 ± 0.13 Kg

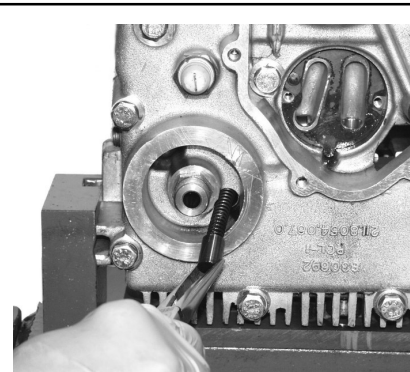


Oil pressure regulating valve

Remove the snap ring, extract the spring and the by-pass valve. Check for possible dirt build up in the ducts and for good spring condition.



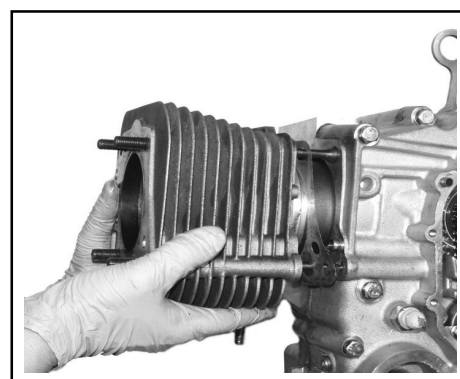
91



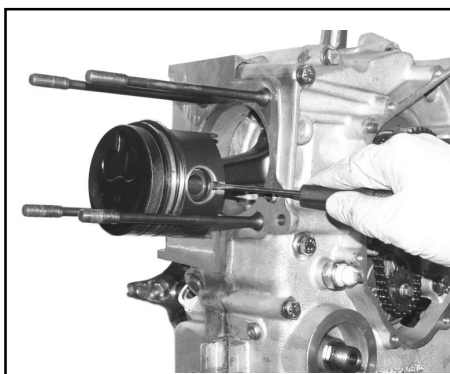
93

Piston – wrist pin

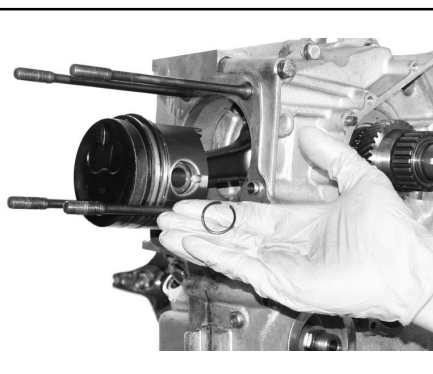
After extracting the cylinder (Fig. 94) remove the snap rings from their seat by means of a screwdriver (Fig. 95÷96), then extract the wrist pin (Fig. 97).



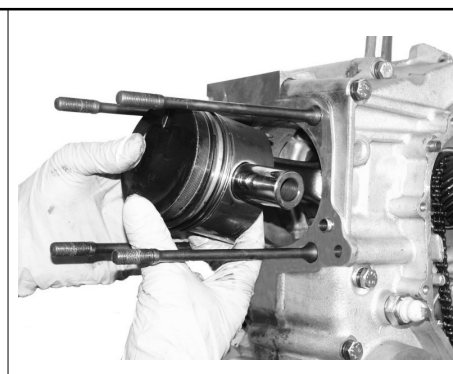
94



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97

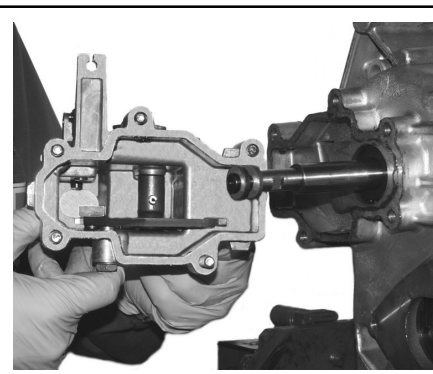
Timing gear and speed gear control box.

Remove the timing gear (Fig. 98).

Unscrew the 5 fastening bolts and remove the speed gear control box (Fig. 99).



98



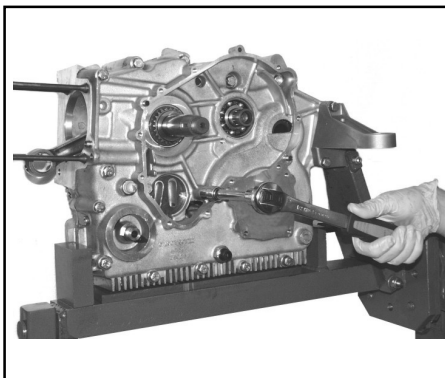
99

Separation of the housing halves

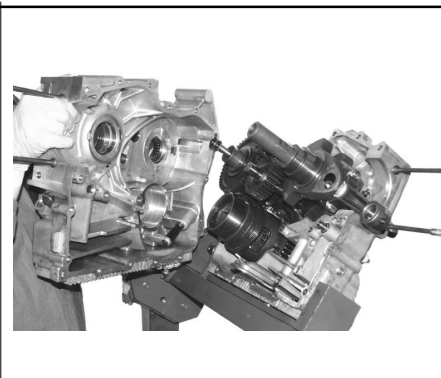
Unscrew the 15 union screws (Fig. 100), position the engine horizontally as shown in the figure and separate the two housing halves by hitting with a mallet.



When reassembling, the shoulder washers which are located between drive shaft and flywheel-side housing should be placed with the 4 lubrication marks turned towards the drive shaft.



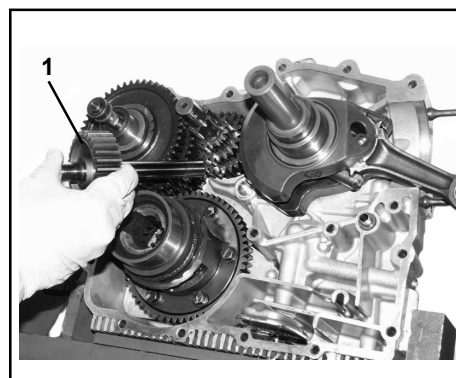
100



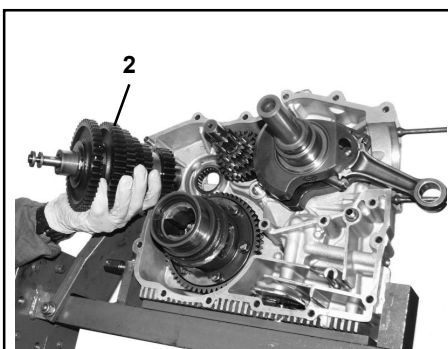
101

Crankshaft – Reverse shaft – Gearbox shaft – Multiple gear – Differential gear assembly

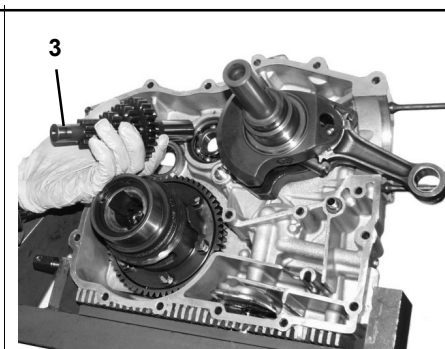
Remove reverse gear “1” (Fig. 102), gearbox shaft “2”, multiple gear “3”, crankshaft “4” and remove differential gear assembly “5” using extractor 981075.411 which is provided (Fig. 107÷108).



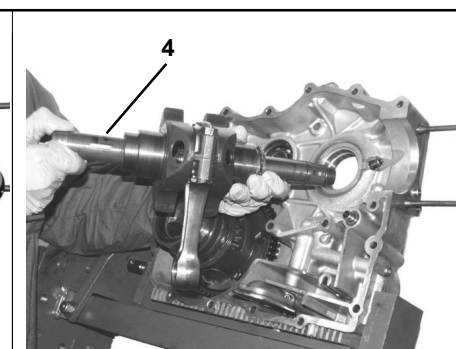
102



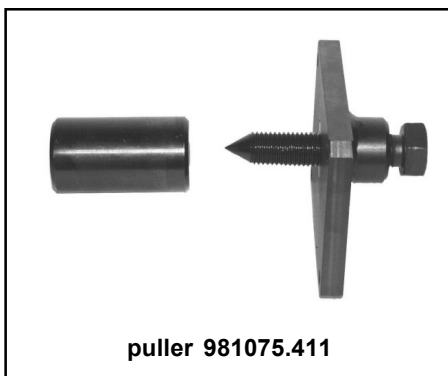
103



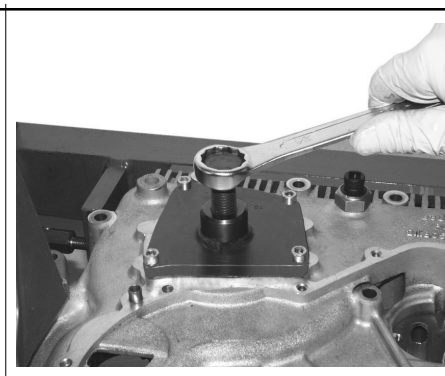
104



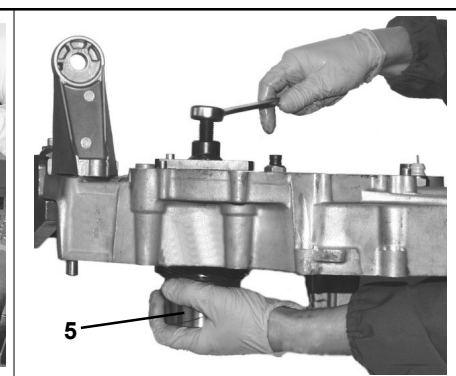
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106



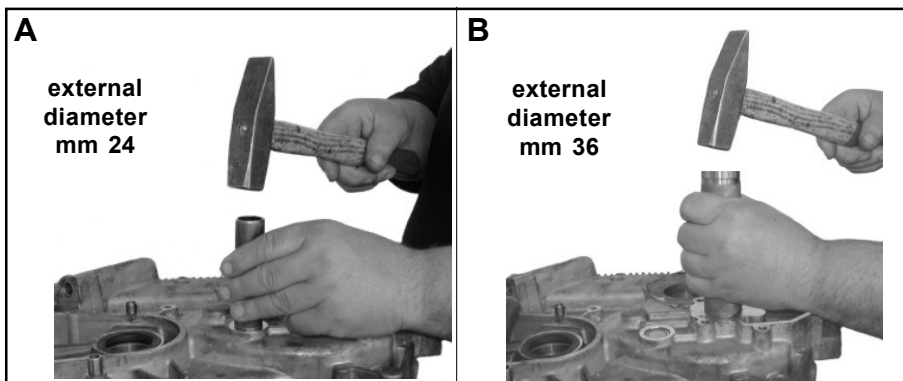
107



108

Flywheel-side housing half – Roller case, multiple gear and roller case, gear

Remove the two gearbox shaft roller cases by using a crop end as a punch, with an external \varnothing of 24 mm for the roller case of the multiple gear "A" and with an external \varnothing of 36 mm for roller case of the gear shaft "B".



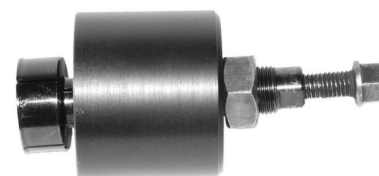
109

110

Clutch-side housing half – Disassembling of gearbox shaft roller case and multiple gear ball bearing.

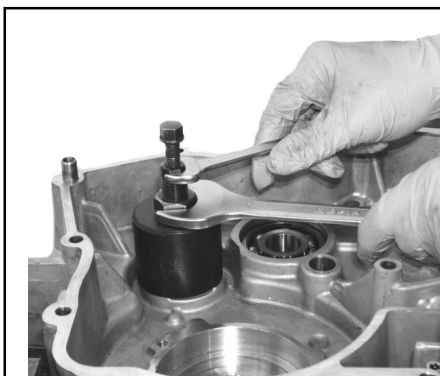
Assemble puller 981075.415 onto the gearbox shaft roller case and work on the central nut until the extraction is completed (Fig.112).

Remove the snap ring "D", work on the opposite side to the one shown in the figure and expel "E" (Fig. 114) ball bearing using a 30 mm external \varnothing punch.

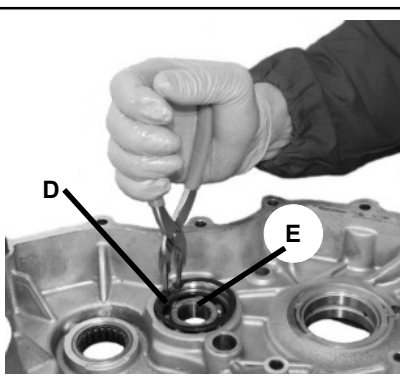


puller 981075.415

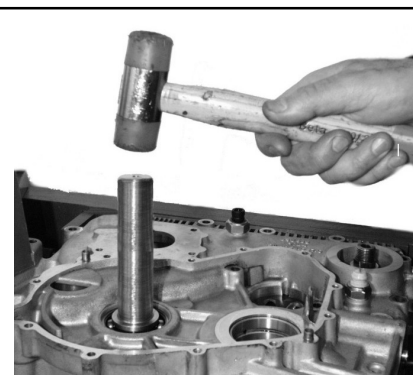
111



112



113



114

FUEL FLOW GOVERNOR DESCRIPTION

From figures 1 and 2 one can see the essential components and the functioning of the governor.

The mass holder (1) is driven in rotation by its own shaft driven in turn by the camshaft.

In to the mass holder (1) there are 4 centrifugal counterweights (2) that act on the push rod (3). The push rod activate's the lever (4) hinged on the pivot (5) which is fixed to the governor housing, the other end of the lever links to the injection pump regulation rod (7).

Between the lever (6) and the lever (4) acts a spring (8) for the starting maximum fuel flow. On the control lever (6) acts : the spring (9) for the idle-speed control ; the spring (20) for the adjust of the fuel flow to the engine rpm ; and through the cup (10) and the shaft (11), the maximum engine rpm control spring (12). The last spring , assembled with pre-load in the frame (17), is futter compressed by the lever (13) which is connected with the speed control lever (14).

The lever (15), which is connected to the engine stop control (16), acts on the lever (4) and then on the injection pump control rod (7). On the governor box a magnet (18) is fixed , its function is to keep the lever (4) in the position of supplementary flow at the engine start position. The lever (6) pushes on the regulation screw (19) that puts in a correct position the rod (7).

Magneto positioning on the governor

Insert the injection pump on the cylinder head and lock it after positioning in may del position.

Loosen the magneto fixing screws and move the magneto itself in order to meet the push rod lever; fix the magneto in this position and check that the release load of the push rod lever is 700 ÷ 800 gr.

Engine stop lever adjustment

Running position: adjust the catch screw (20) of the engine stop lever (16), in such a way that it's internal part does not interfere with the rod control lever (4).

Stop position: adjust the stop screw (21) of the engine stop lever (16), in such a way that the stop does not take place through the rod control lever (4) and the connection rod (7), on the injection pump

Mass play axial play and adjusting spacers

Play : 0,1÷0,16 mm

Spacers : mm 1,2 - 1,3 - 1,4 Tolerance : ± 0,05

The governor main functions are the following:

- Engine low idling speed adjustment
- Engine maximum RPM limitation
- Delivery increase during start up

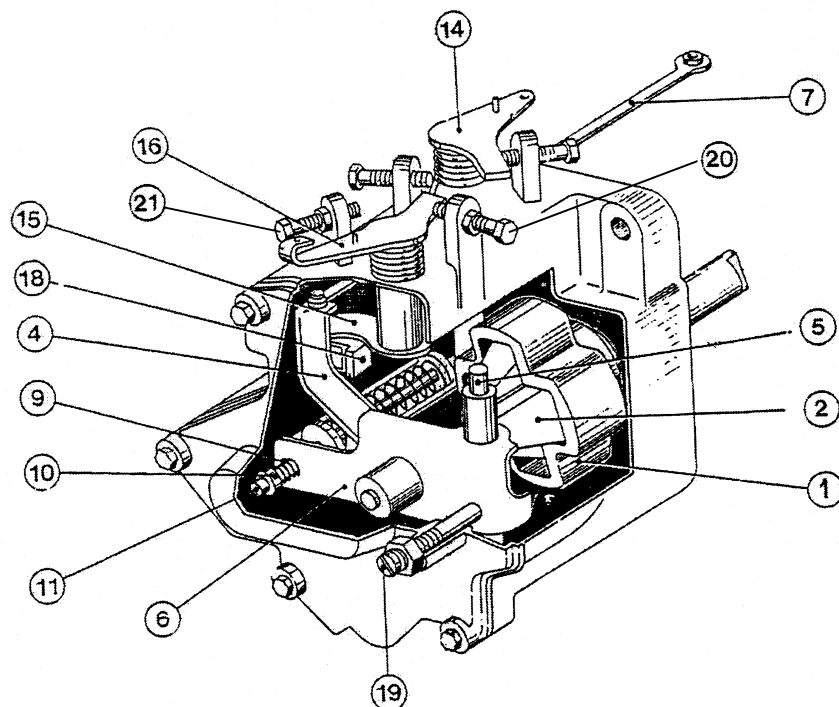


FIG. 1

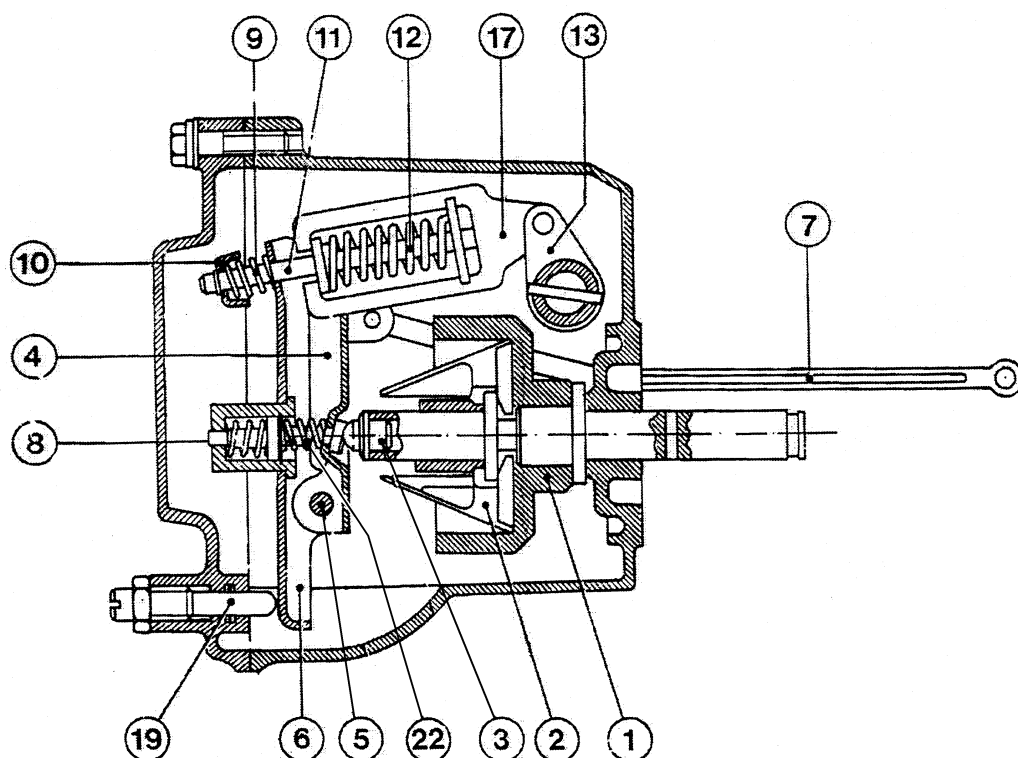
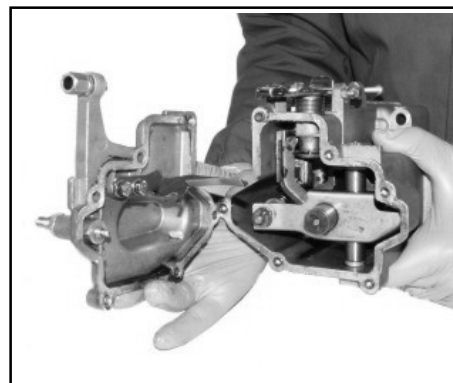


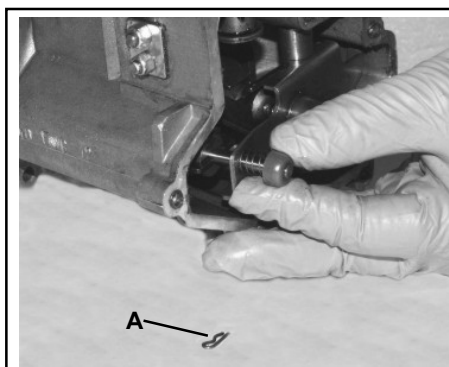
FIG. 2

Delivery regulator:

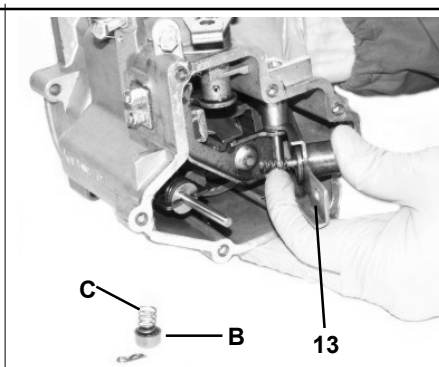
Remove the cover by way of the 6 retaining screws. Remove retainer **A**, cap **B** and idling spring **C**. Set adjustment lever **13** towards the outside, extract supplementary spring **D**, extract retainer **E** and remove pump control rod **6**.



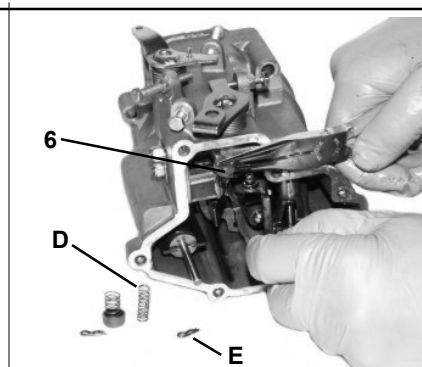
115



116

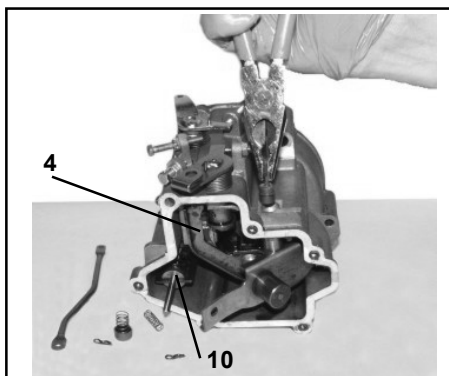


117

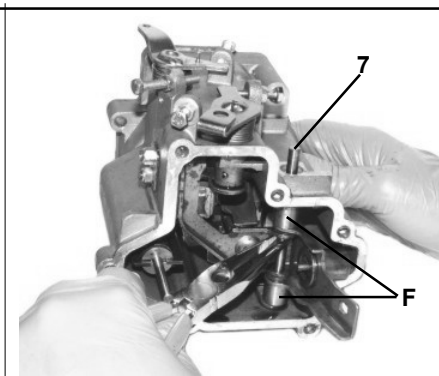


118

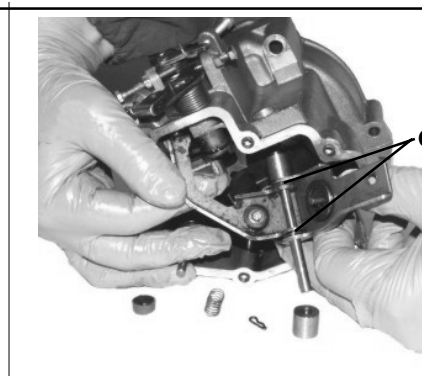
Remove the snap ring, extract pin **7**, disassemble the adjustment lever, rod control lever **4**, spacers **F** and shim washers **G** which are located between the two levers; when assembling follow the correct sequence.



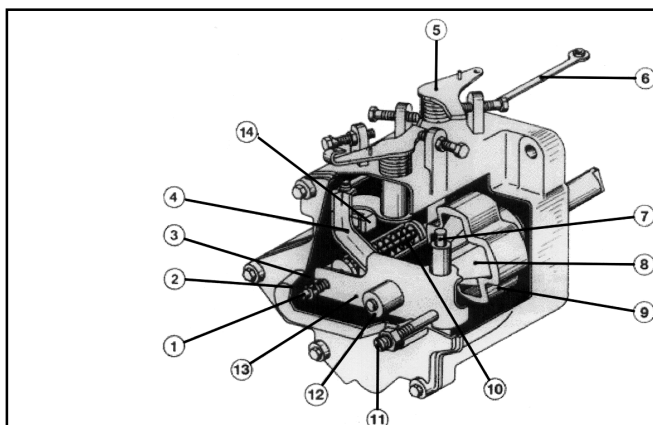
119



120



121



122

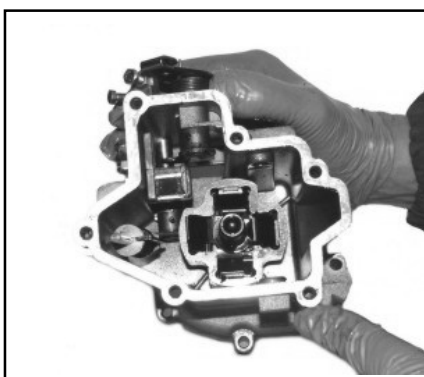
- 1) Shaft
- 2) Cup
- 3) Idling speed governor spring
- 4) Rod control lever
- 5) Throttle control
- 6) Pump connection rod
- 7) Pin
- 8) Centrifugal weights
- 9) Weight container
- 10) Maximum RPM governor spring
- 11) Delivery control screw
- 12) Adjustment spring container
- 13) Adjustment lever
- 14) Magnet

Remove the snap ring from its slot using the pliers which are provided (see Fig. 124) then extract the shaft and the weights holder shaft (Fig. 125).

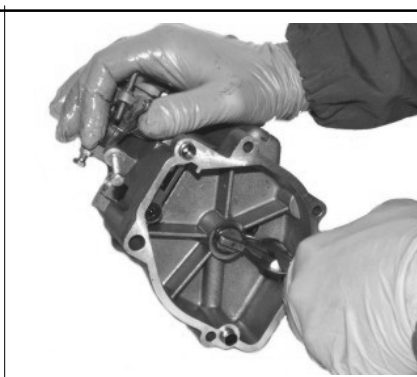
Now unscrew the two retaining nuts **A** (see Fig. 126 ÷ 127), then remove the metal plate and disassemble the magnet holding the lever in extra fuel position (Fig. 122).

If the spring holder shaft for maximum RPM governing has to be replaced, use a pin-driver punch as shown in Fig. 126.

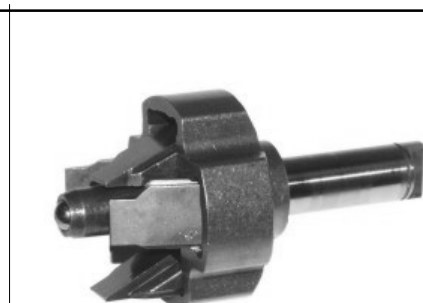
When reassembling follow a reverse sequence than the above-described one.



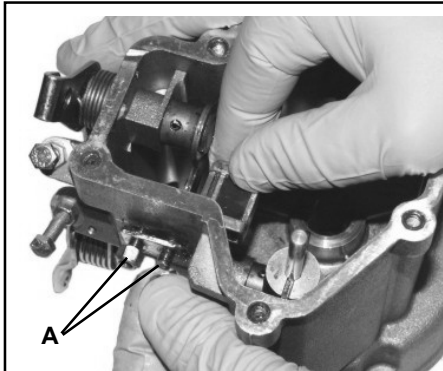
123



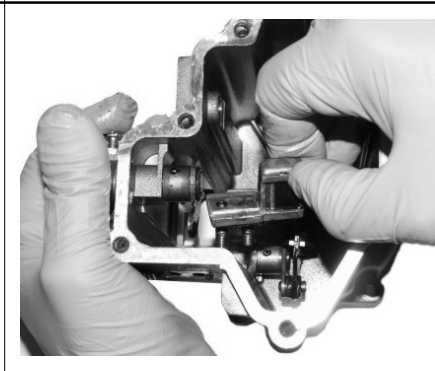
124



125



126



127



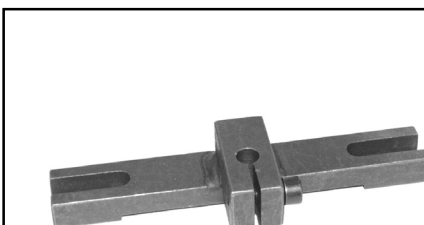
128

Delivery regulator – reassembly

When reassembling is completed, check the axial endfloat of “Z” shaft using the special no-studbolts tool 981075.417 which comprises a bore gauge; axial endfloat should be between 0.10 and 0.16 mm.

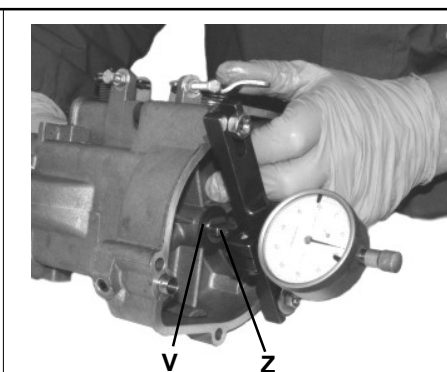
If you find that the axial endfloat is different from schedule, replace clearance shim “V”.

To this end 8 washers having different thickness values are provided.



tool 981075.417

129



130

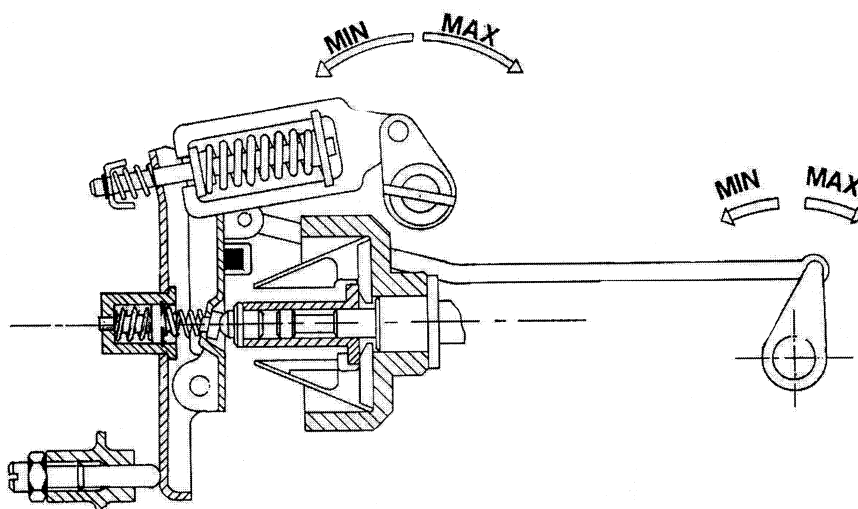
GOVERNOR'S WORKING DESCRIPTION

ENGINE STANDING OR AT STARTING

In these conditions the governor flyweight are completely closed, due to the slider thrust on which acts the minimum and the extra-fuel springs (see fig. 3) . The control lever, pushed at one end by the minimum spring, reacts on the regulation screw. The control rod lever, pushed by the relative extra-fuel spring, puts the pump control rod in the maximum fuel flow position and therefore in the engine start position. Notice that acting on the accelerator lever there will not be any effect on the pump control rod because the control lever is already in contact with the regulation screw ; so this mean that you can start the engine with the accelerator at the minimum position.

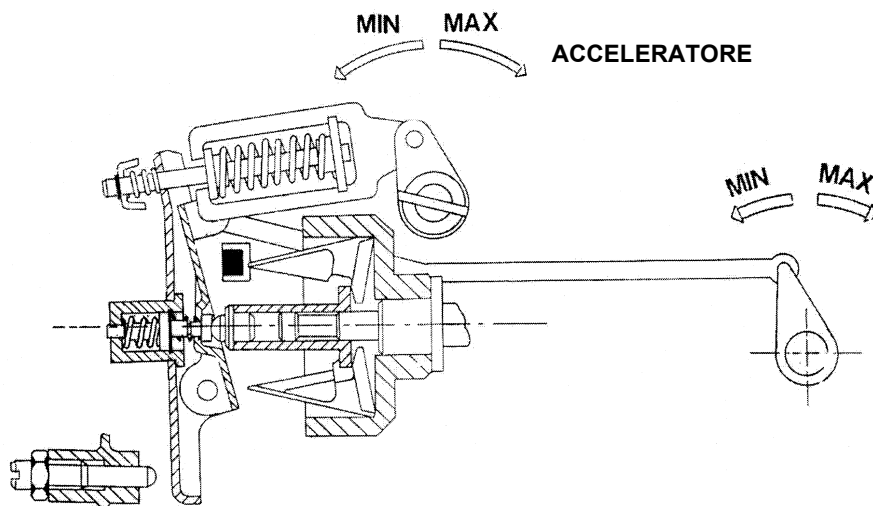
The magnet, with the help of the supplementary spring, keep in the maximum fuel flow position the control rod until the engine has not reached about 2000 rpm.

When the engine exceed 2000 rpm the flyweight centrifugal force exceed the spring and magnet force, so open the flyweight that shift by means of the slider i the control rod lever and then the pump connecting rod i to lower fuel flow positions.



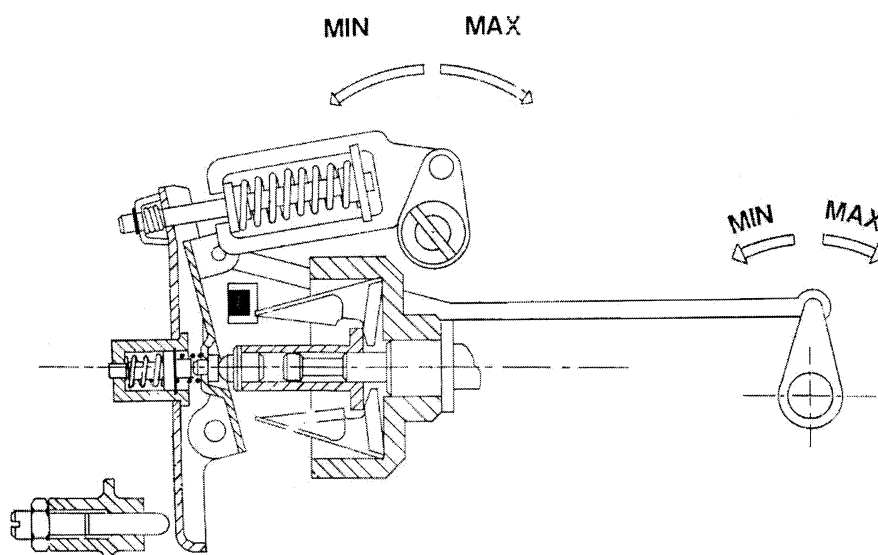
ENGINE AT IDLE SPEED

After the starting of the engine, if someone does not act on the accelerator lever, the governor flyweight are in equilibrium with the minimum spring at about 1200 rpm. The engine speed increasingly open the flyweight moving the slider, the regulation lever until the system do not reach a new equilibrium position; at the same time the pump connecting rod is moved to lower fuel flow positions, for this reason the engine comes back to the initial speed. The opposite happens if the engine reduce the speed. With the engine at idle speed the governor will fluctuate continuously around the equilibrium position in order to maintain the speed as constant as possible.

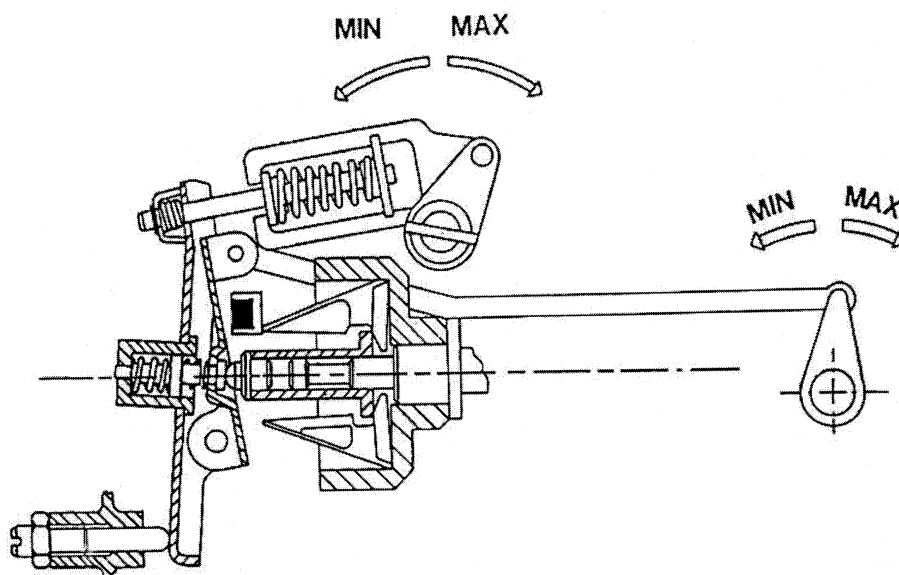


ENGINE AT PARTIAL LOAD

From the minimum position, by acting on the accelerator lever, the minimum spring is completely pre-loaded; after that, the cup. Is push directly on the regulation lever carrying the pump connection rod toward greater fuel flow positions partially closing the governor flyweight. In this situation the injection pump flow regulation rod acts as if it is directly connected to the accelerator lever, that means that the movements of the accelerator lever produce proportional movements of the pump connection rod. At intermediate engine speed, the governor generate a load that compress partially the flow adjusting spring moving the rod control lever, producing consequently change of the pump flow against change of rpm.

**ENGINE AT FULL LOAD**

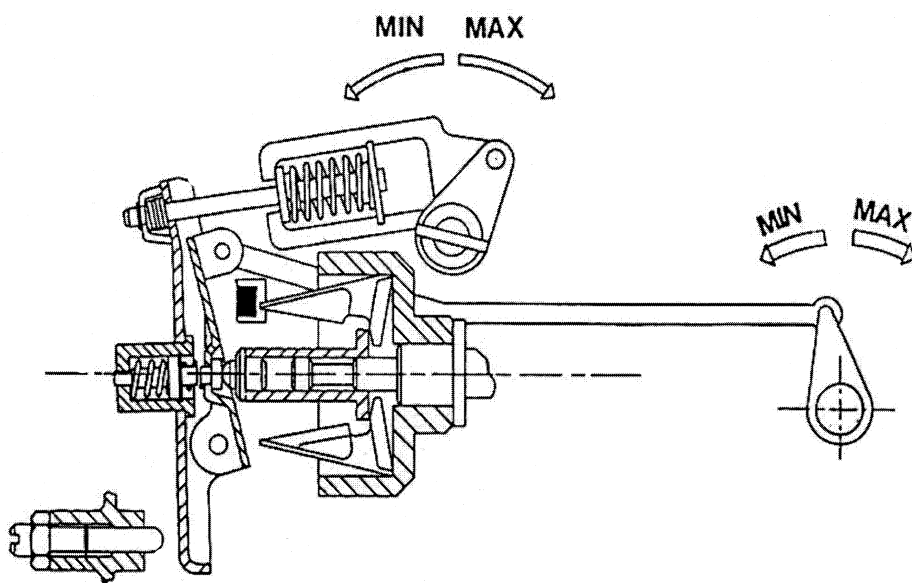
Moving completely the accelerator lever until the position of full load, the lever will touch the regulation screw, after that the maximum rpm regulation spring will be compressed. Starting from low speed, when the speed increases, the governor flyweights centrifugal load compress the flow adjust spring, proportionally reducing the pump fuel flow. This is the working position of the pump connecting rod for maximum fuel flow.



ENGINE AT MAX SPEED

When the engine reaches the maximum working speed the governor flyweights centrifugal force exceeds the reaction of the maximum speed regulating spring; the expanding flyweights move the regulating lever and the pump connecting rod towards a position of lower fuel flow.

If the engine continues to accelerate the flyweights continue to move until the pump connecting rod reaches the position of zero flow. The governor begins to operate at about 3800 rpm and the zero fuel flow occurs at about 4200 rpm.



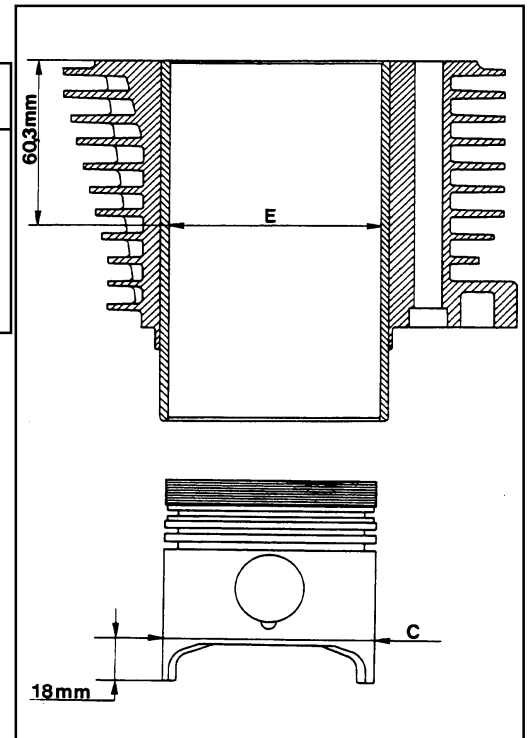
Assembly play

Pistons and cylinders supplied by the Factory as spares are marked with letters of the alphabet. In cases where a cylinder or a piston is to be substituted, it should be replaced with the same letter as the mating component.

In case of a rebored cylinder, the dimension "E" should exceed the dimension "C" on the piston to be fitted (marked on the piston itself), by the value indicated for each part, "clearance on assy".

Cylinder-Piston

| Piece name nominal dimension | Class symbol | Matching class | | Assembling gap "A" |
|--|-----------------|----------------------|----------------------|-----------------------|
| | | Cylinder | Piston | |
| Cylinder normal $E = 83 -0 +0,05$ | A | $83,000 \div 83,010$ | $82,935 \div 82,945$ | $0,055 \div 0,075$ |
| | B | $83,010 \div 83,020$ | $82,945 \div 82,955$ | |
| | C | $83,020 \div 83,030$ | $82,955 \div 82,965$ | |
| Piston normal $C = 82,96 \pm 0,025$ | D | $83,030 \div 83,040$ | $82,965 \div 82,975$ | |
| | E | $83,040 \div 83,050$ | $82,976 \div 82,985$ | |



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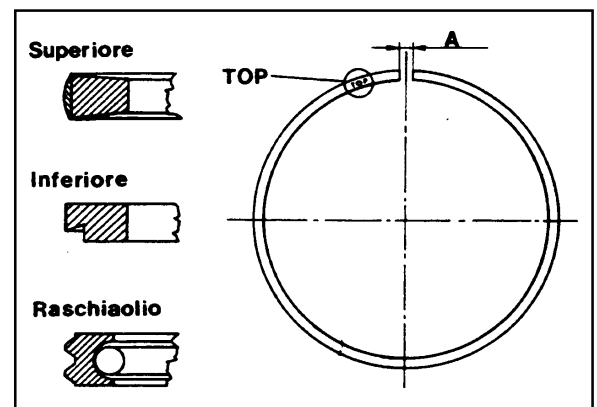
Piston rings

| Part name | Diameter (mm) |
|--------------------|---------------|
| Piston ring, upper | 83 |
| Piston ring, lower | |
| Scraper ring assy | |

Superiore =Upper

Inferiore =Lower

Raschiaolio = Scraper



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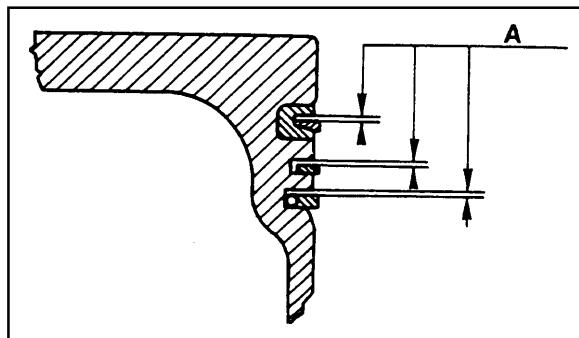
N.B. - Piston rings must be fitted with inscription "**Top**" facing piston crown and the inside spring of scraper ring must be positioned with the joint at 180° from scraper ring joint.

Clearance "A" on assy (mm)

| | |
|--------------------|------------------|
| Piston ring, upper | $0,25 \div 0,50$ |
| Piston ring, lower | $0,25 \div 0,50$ |
| Scraper ring assy | $0,10 \div 0,30$ |

Piston slots - piston rings

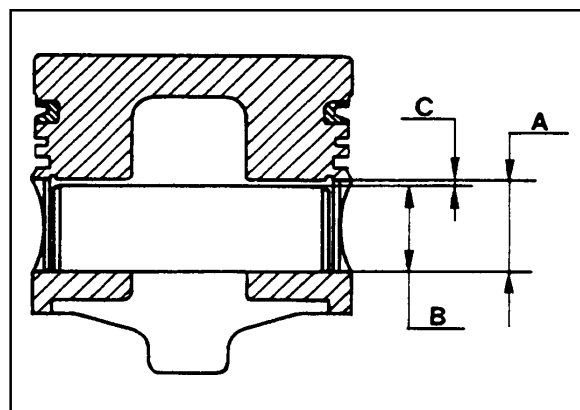
| Part name | | Part name | Clearance -A- (mm) |
|-----------------------------|-------------------|--------------------------------------|--------------------|
| 1 st piston slot | 2,160÷2,190 (Ø80) | Piston ring, upper 2,095÷2,075 (Ø80) | 0,065÷0,115 |
| 2 nd piston slot | 2,040÷2,060 | Piston ring, lower 1,990÷1,970 | 0,050÷0,090 |
| 3 rd piston slot | 3,020÷3,040 | Scraper ring 2,990÷2,975 | 0,030÷0,065 |



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Piston - Piston pin

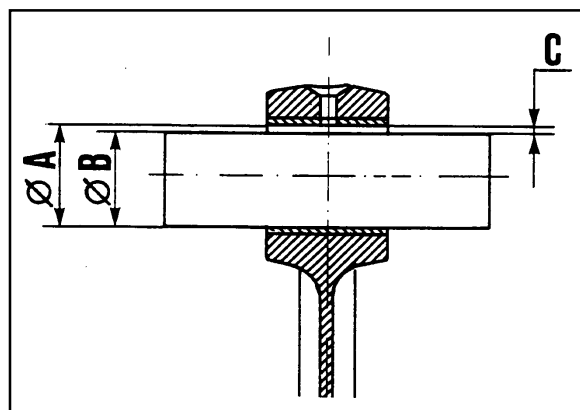
| | |
|--------------------|----------------------|
| Piston "A" | Ø 25 - 0,001 - 0,006 |
| Piston pin "B" | Ø 24,991 ± 0,002 |
| Assembling gap "C" | Ø 0,001÷0,010 |



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Small end bush - wrist pin

| | |
|------------------------|-----------------|
| Small end "A": | Ø 25,006÷25,009 |
| Wrist pin "B": | Ø 24,991±0,002 |
| Clearance "C" on assy: | 0,013÷0,020 |



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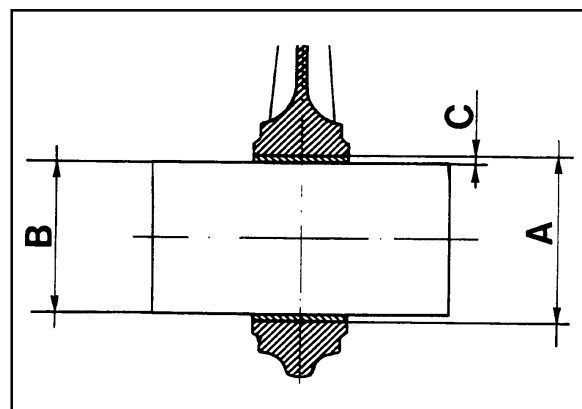
Connecting rod small end bush

| | |
|------------------------|--------------------|
| Con rod S.E. Bush "A": | Ø 28 +0,80 + 0,118 |
| Con rod SM. end "B": | Ø 28 -0 -0,021 |
| Interference | 0,059÷0,118 |

- Parallelism tolerance allowed between big end and small end axis (measured at 125 mm from the stem of the connecting rod) must be = 0,08 mm

Crankshaft - big end

| Part name | Dimension (mm) |
|---------------------------|--------------------|
| Big end "A" | 51,333 - 0 + 0,013 |
| Con-rod bearing, half "C" | 1,535÷1,526 |
| Crankshaft "B" | 48,288 - 0,02 +0 |



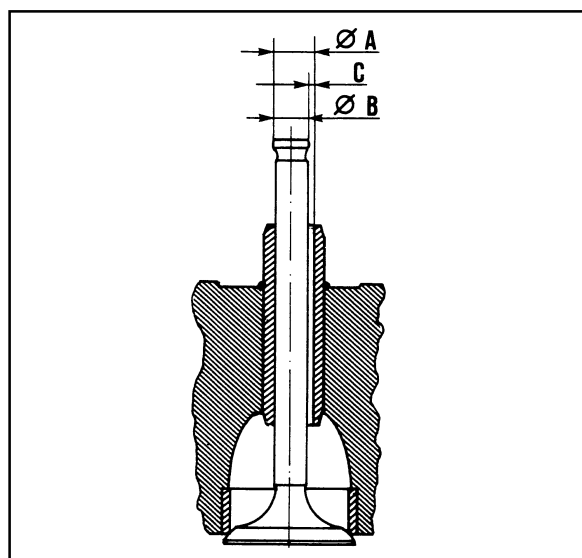
136

Valve guide - valve stem

| Part name | Dimension (mm) |
|------------------------------|----------------|
| Valve guide "A" | 8,015÷8,033 |
| Valve stem exh. and ind. "B" | 7,974÷7,992 |

Clearance "C" on assy 0,023÷0,059

N.B. Dimension of valve guide inside dia. is understood to be after assembly and after machining.



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Valve seat

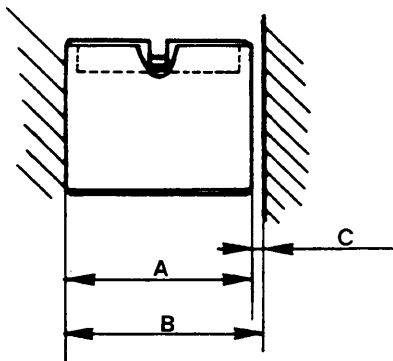
| Denomination | Inlet | Outlet |
|--|---------------|---------------|
| Valve seat chanfer angle | 45 ° ± 5' | 45 ° ± 5' |
| Valve head chanfer angle | 45° 30' ± 7' | 45° 30' ± 7' |
| Valve head diameter | 38,300÷38,600 | 33,300÷33,600 |
| Valve seat housing diameter | 39,988÷40,012 | 34,988÷35,012 |
| Valve seat outside diameter | 40,094÷40,119 | 35,094÷35,119 |
| Valve seat-cylinder head mounting interference | 0,082÷0,131 | 0,082÷0,131 |

Tappet

Tappet dia. "A" 35,000÷35,025

Tappet seat dia. "B" 34,975÷34,995

Clearance on assy "C" 0,005÷0,050

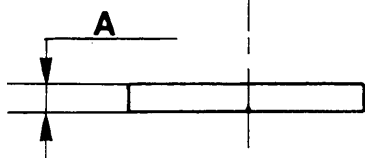


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Valves caps**Thickness "A":**

3,25 - 3,30 - 3,35 - 3,40 - 3,45 - 3,50 - 3,55 - 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 - 4,30 - 4,35 - 4,40 - 4,45 - 4,50 - 4,55 - 4,60

Tolerance ± 0,015



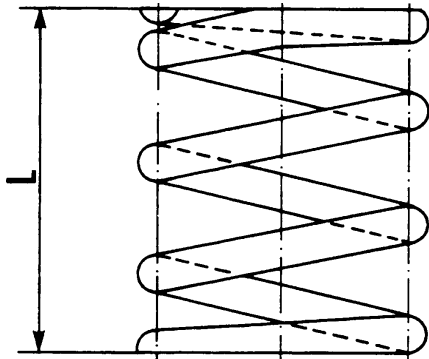
140

Valves - outside spring

Free length "L" mm 53,9

Load at 36 mm height kg 38,9±1,5

Load at 26.5 mm height kg 59,5±2,5



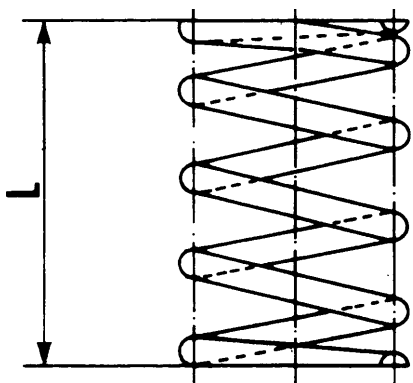
141

Valves - inside spring

Free length "L" mm 41,8

Load at 31 mm. height kg 14,9±0,5

Load at 31 mm. height kg 27,4±1,2



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CRANKCASE - BEARINGS**CLUTCH SIDE MULTIPLE GEAR BALL BEARING**

Bearing external diameter $\varnothing 62,000 \div 61,987$
 Seat diameter $\varnothing 61,979 \div 61,949$
 Assemble interference gap 0,008 mm
 interf. 0,051 mm

NEEDLE BEARING HOUSING

Seat diameter for multiple gear needle bearing flywheel side $\varnothing 25,979 \div 26,000$
 Seat diameter for gear needle bearing clutch side $\varnothing 46,983 \div 46,958$

REVERSE GEAR

| | | |
|--------------------|----------------------------------|------------------------------------|
| Shaft seat | $\varnothing 18,016 \div 18,034$ | Gap $0,016 \div 0,052$ |
| Reverse gear shaft | $\varnothing 18,000 \div 17,982$ | |
| Reverse gear | $\varnothing 17,944 \div 17,962$ | Interference $0,056 \div 0,020$ |

DIFFERENTIAL HOUSING

| Denomination | Dimensions | Matching |
|-------------------|----------------------------------|---------------------------|
| Differential box | $\varnothing 75,970 \div 75,924$ | gap $0,122 \div 0,030$ |
| Differential seat | $\varnothing 76,000 \div 76,046$ | |

CRANKSHAFT - CRANKCASE - BEARING HOUSING

| Denomination | Dimensions | Matching |
|---|--------------------------------|---------------------------------------|
| Timing side half crankcase | $\varnothing 60 0 - 0,030$ | Interference $0,133 \div 0,195$ |
| Clutch side half crankcase | | |
| Free bearing | $\varnothing 60 +0,133 +0,165$ | gap $\varnothing 0,040 \div 0,072$ |
| Machined bearing assembled on the crankcase | $\varnothing 55 +0,010 +0,029$ | |
| Crankshaft | $\varnothing 55 -0,030 -0,043$ | |

Injection pump : "MICO" type F 002 F 10 006

Test conditions

| | |
|--------------------------|------------------------|
| Pumping element dia.: | 6 mm |
| L.H. helix pitch: | 12 mm |
| Test Oil: | SHELL S 93 65 |
| Test Oil temperature: | 40°C±2° |
| Pump inlet pressure: | 0.2 Kg/cm ² |
| Pumping element prelift: | 2÷3 mm |

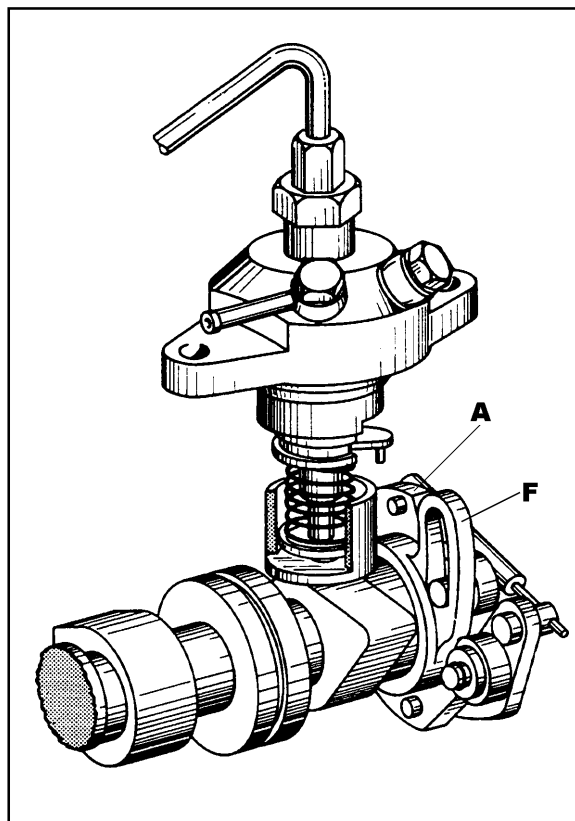
Features of the pump on the bench

Adjusting lever in reference to central position:

| r.p.m. | Delivery mm ³ /cycle | Rack rod stroke form max delivery position |
|--------|---------------------------------|---|
| 1500 | 23,3 ± 0,5 | 9 |
| 1900 | 20,8 ± 1 | 8,3 |
| 2250 | 29 ± 1 | 9,5 |

Adjusting lever in max. delivery position:

| r.p.m. | Delivery mm ³ /cycle |
|--------|---------------------------------|
| 150 | 45 ± 3,5 |

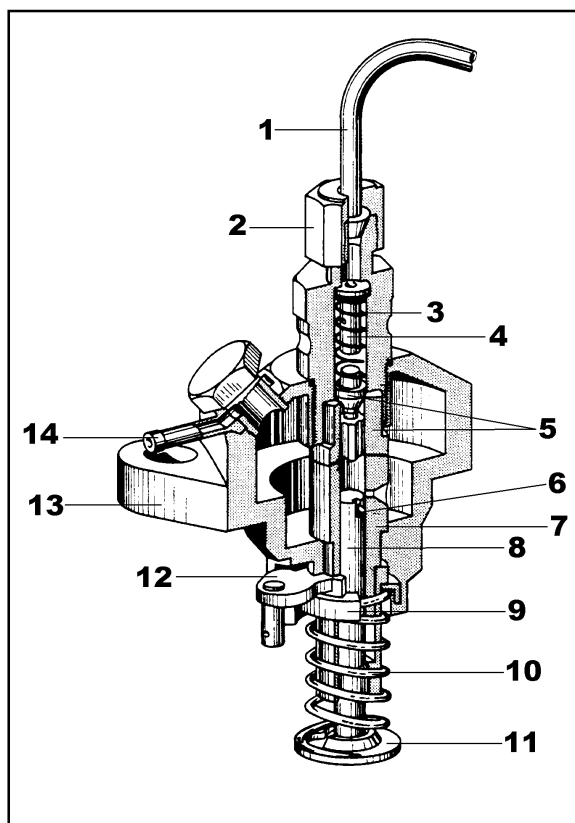


146

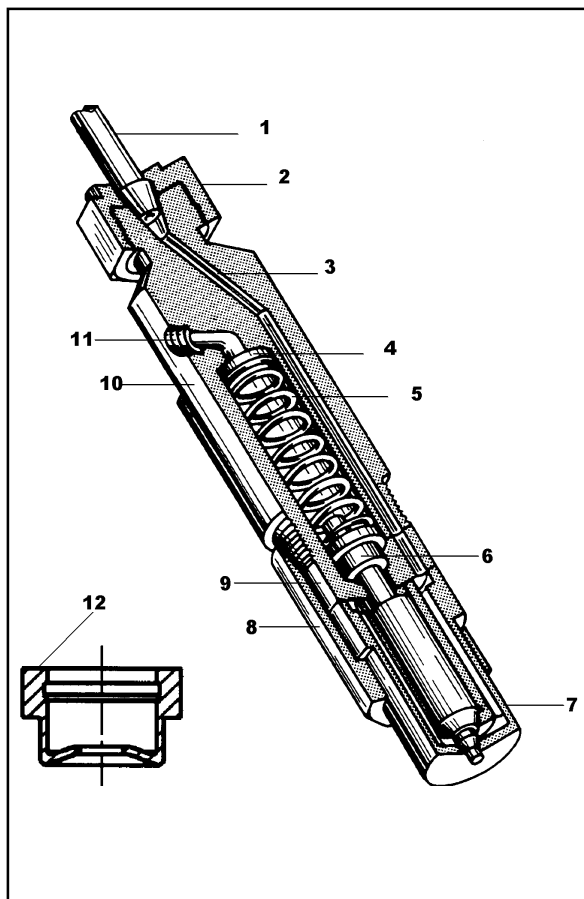
Injection pump

Caption:

- 1- High pressure injector pump delivery pipe
- 2- Nut for connection to the delivery pipe
- 3- Spring
- 4- Filler
- 5- Valve
- 5- Plunger barrel
- 6- Plunger blade
- 7- Plunger barrel
- 8- Plunger piston
- 9- Spring collar
- 10- Spring
- 11- Spring retainer collar
- 12- Delivery control lever
- 13- Pump housing
- 14- Fuel inlet coupling



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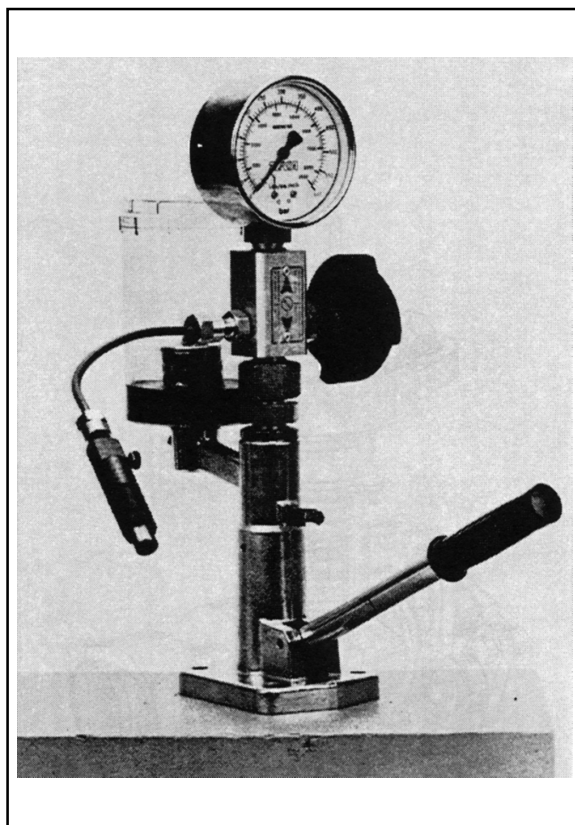


Injector : MICO F 002 C 6 Z 396

Caption:

- 1- High pressure delivery pipe (Ø 6 - Ø 1,75x168)
- 2- Nut for connection to the delivery pipe
- 3- Pressure duct
- 4- Pressure setting shim
- 5- Pressure spring
- 6- Pressure pin
- 7- Nozzle MICO DNO SD 287
- 8- Nozzle clamping ring nut
- 9- Intermediate washer
- 10- Nozzle case
- 11- Connection for leakage recovery
- 12- Fire ring

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Injector setting

Connect injector to a hand pump and check that setting pressure is 150 +10 - 0 bar; Make the required adjustments, if any, by changing the shim over the spring. Eleven different shims are available as spares with size from 1 to 2 mm.

When replacing the spring, setting should be performed at a 10 bar greater pressure (160 bar) to allow for bedding during operation.

Check needle valve sealing by slowly moving the hand pump until approximately 120 bar for 10 seconds.

Injector sealing

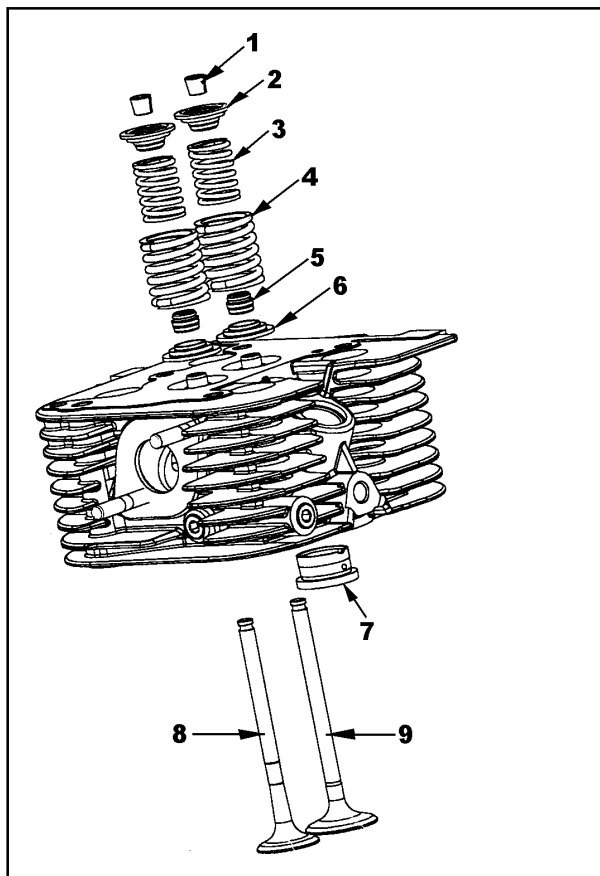
Seal: Keep inside injector a oil pressure 10÷20 kg/cm² lower than the opening pressure. No drop should form on the end of the injector in less than 10 seconds. However a light sweating is allowed.

Caution - The injector jet, because of high output pressure can cause wounds whose consequences can be very serious. Take care that during the tests the jet itself doesn't hit any part of the body.

Cylinder head

Caption:

- 1- Cotteners
- 2- Valve spring upper collars
- 3- Internal valve spring
- 4- External valve spring
- 5- Valve guide sealing rings
- 6- Valve spring lower collars
- 7- Precombustion chamber
- 8- Exhaust valve
- 9- Intake valve



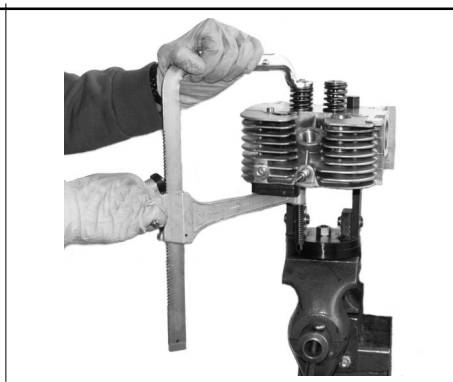
150

Dismantling valves

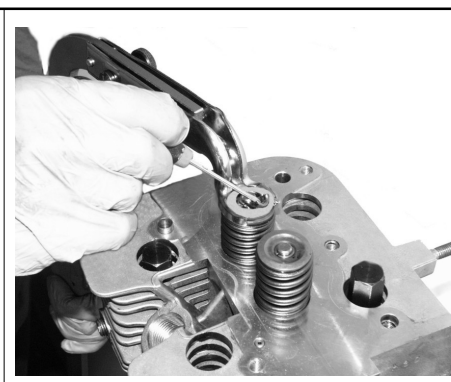
Compress valves springs by using a valve lifting clamp as shown in fig. 157 (the tool was not included in the special tool set as it is commercially available), take away cotteners, halves and release the fixture until spring and valves are removed



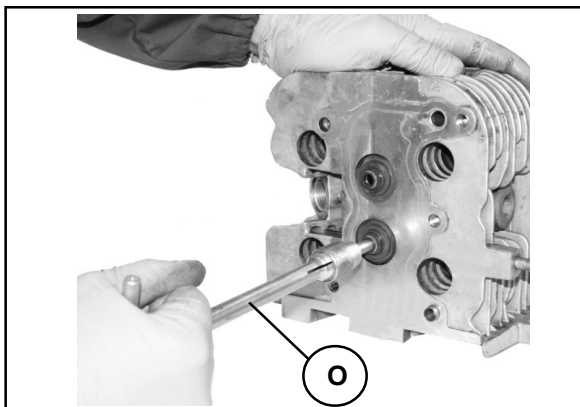
151



152



153



154

Valves grinding

Carefully remove carbon deposit without notching the metal and wash with cleaning liquid.

Inspect valves seats: they shouldn't present indentations or scorings, but they must have a uniform surface so as to assure a perfect valve seal. Otherwise carry out valves seat grinding. This operation must be performed as follows with the best attention: smear valves with fine emery, introduce the valve in its guide and fix wrench "O" to the stem end. Alternately maneuver the wrench by changing, from time to time, position.

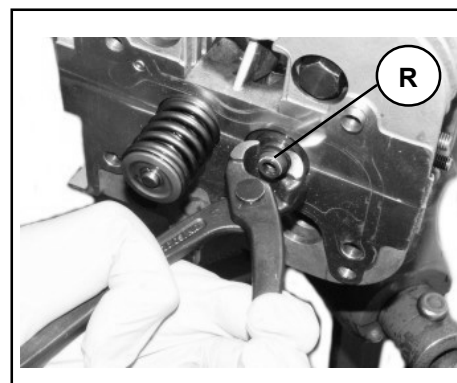
Absolutely avoid that emery is introduced into valves guides. When the operation has been carried out carefully wash and blow cylinder head and valves. For the checking of the perfect seal of valves pour some gasoline (petrol) into admission and exhaust ducts, then check that gasoline (petrol) doesn't flow through valves themselves.

N.B. - If valves seats are worn or with deep indentations it is necessary, before carrying out the grinding, to perform on the valves seats with proper milling cutters.

Reassembly of valves

Prior to valve reassembling, which is done in reverse sequence as to disassembling, always replace the two sealing rings on the valve guides using punch 986290.109.

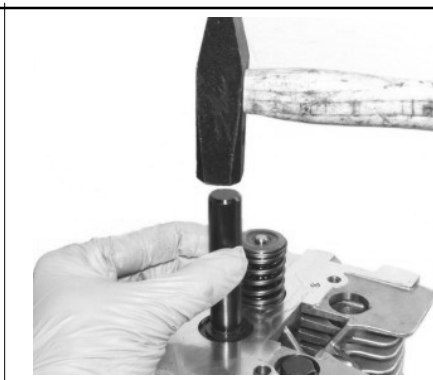
Important - Before reassembling valves lubricate guides and stems.



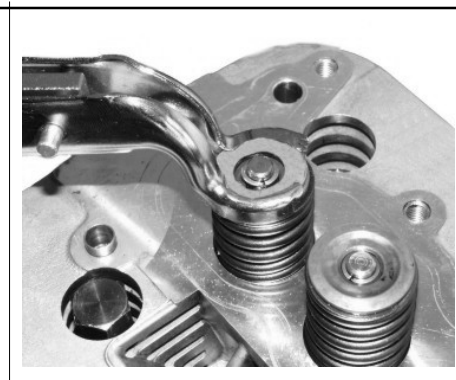
155



156



157



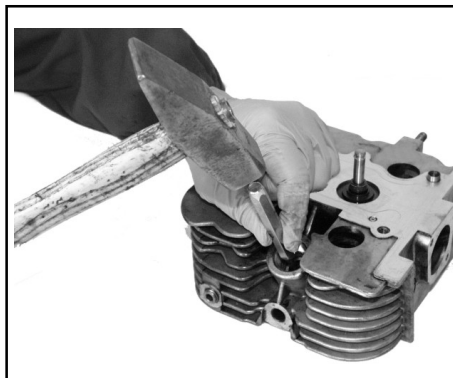
158

IX DISASSEMBLY/REASSEMBLY

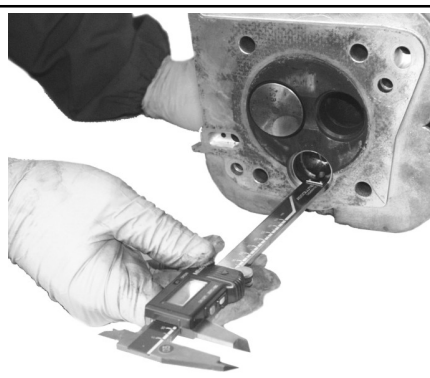
Precombustion chamber – disassembly and reassembly

To extract the precombustion chamber, top the injector seat with a punch (Fig. 159) from the injector seat. This expulsion method causes damages to the precombustion chamber, therefore it must be replaced every time it is extracted. Before assembling the new precombustion chamber, the depth of the seat inside the head shall be measured (Fig. 160÷161); the resulting measurement will determine the most appropriate precombustion chamber of the four of different height that are available. In order to identify them, each precombustion chamber is marked with a paint brush-stroke in different colors according to its height (as indicated in the table). The precombustion chamber shall be inserted into the seat so that the dowel 1 coincides with the appropriate seat 2.

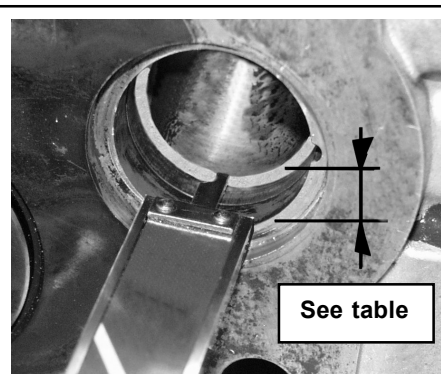
The interference between the precombustion chamber external diameter and the seat internal diameter shall be $0.01 \div 0.05$. The precombustion chamber housing shall conform to the specifications shown in the related table with respect to the head surface.



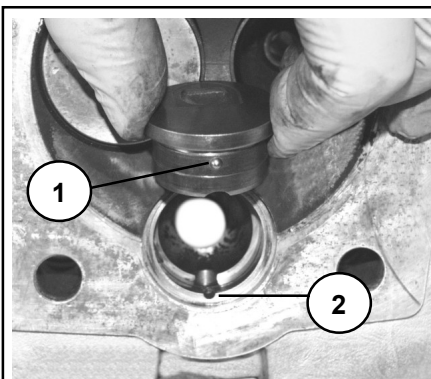
159



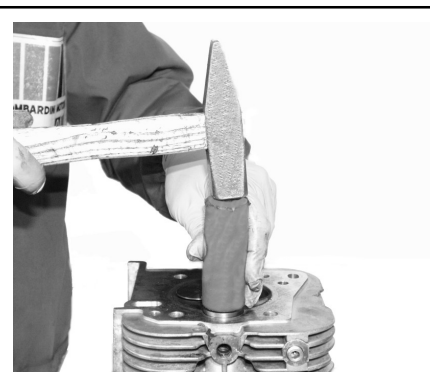
160



161



162



163



164

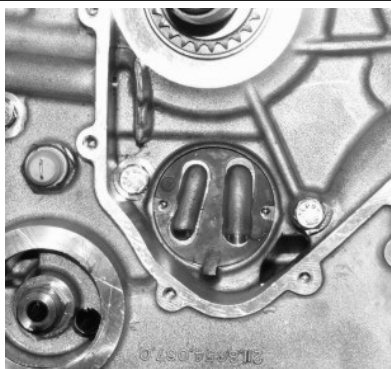
| Class symbol | Color | Prechamber cap thickness | Prechamber seat depth | Recess in cylinder head |
|--------------|--------|--------------------------|-----------------------|-------------------------|
| A | Yellow | $4,080 \div 4,090$ | $4,100 \div 4,109$ | $0,010 \div 0,029$ |
| B | Red | $4,091 \div 4,100$ | $4,110 \div 4,119$ | $0,010 \div 0,028$ |
| C | Blue | $4,101 \div 4,110$ | $4,120 \div 4,129$ | $0,010 \div 0,028$ |
| D | White | $4,111 \div 4,120$ | $4,130 \div 4,140$ | $0,010 \div 0,02$ |

| Piece name | Nominal dimension | Interference |
|---|--------------------------------|------------------|
| Combustion prechamber housing inter. diam | $\varnothing 27,50 \div 27,52$ | $0,01 \div 0,05$ |
| Combustion prechamber exter. diameter | $\varnothing 27,53 \div 27,55$ | |

Oil pump

Clean all parts and check :
 - that the union surfaces are flat.
 - Replace the faulty parts in case of deformation
 - The side play of the rotors and the radial play between the two rotors

If the desired values are not found, replace the faulty parts



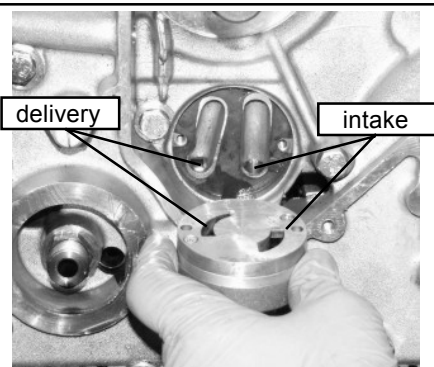
165



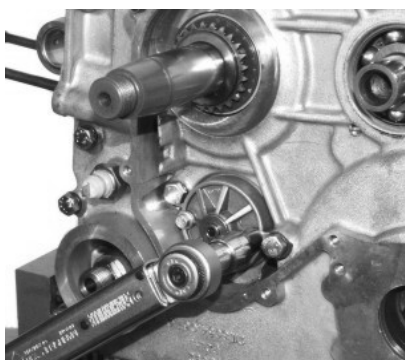
166



167



168



169

Oil pump**Pump:****Pump control:****Pressure adjusting valves:****Rotor seat dia. "A":****Rotor outside dia. "B":****Clear, bet. seat and rotor "C":****Rotor height "D":****Rotor seat depth "E":****Side clear, between rotors and pump body "F":****Radial clearance between rotors "G":****Lubrication pressure with oil at 100°C:****lobe type.**

through a chain gear dragged by the drive shaft
 on pump body.

40,601÷40,626

40,551÷40,576

0,025÷0,075

21,96÷21,98

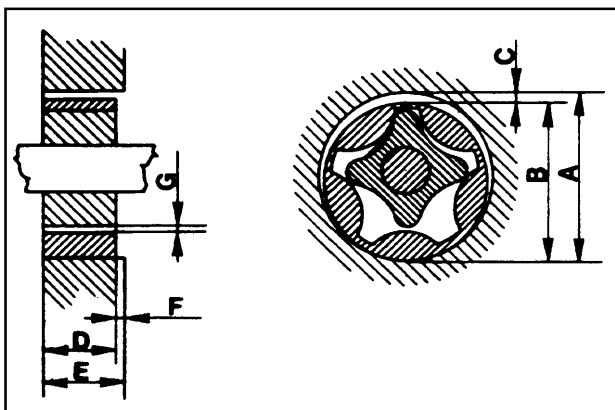
22,00÷22,02

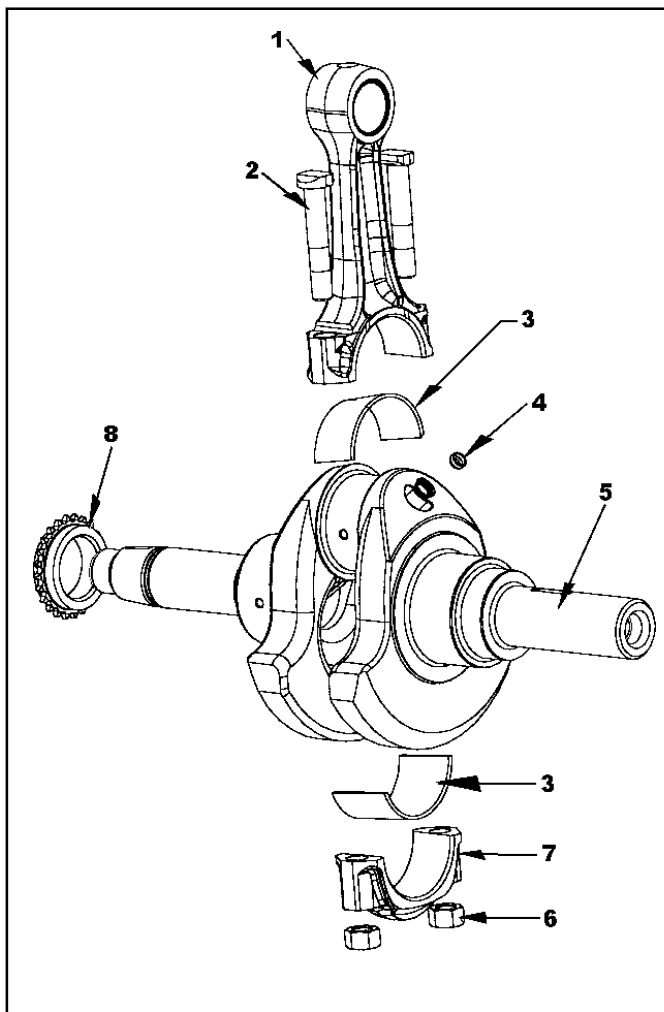
0,02÷0,06

0,02÷0,10

at slow running 1÷2 kg/cm²

at max. r.p.m 3,5÷4,5 kg/cm².



**Drive shaft and connecting rod**

- 1- Connecting rod shaft
- 2- Connecting rod cap fastening screw
- 3- Connecting rod half bearings
- 4- Breech plug
- 5- Crankshaft
- 6- Connecting rod cap fastening nuts
- 7- Connecting rod cap
- 8- Oil pump gear

170

Connecting rod

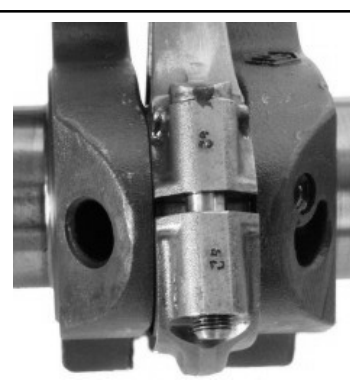
Remove the two retaining nuts and the connecting rod. When reassembling place the connecting rod onto the crankshaft keeping the cap and connecting rod marks oriented in the same way as before the disassembling, see Fig 173. Then tighten the two bolts gradually to a 70 Nm torque.



171

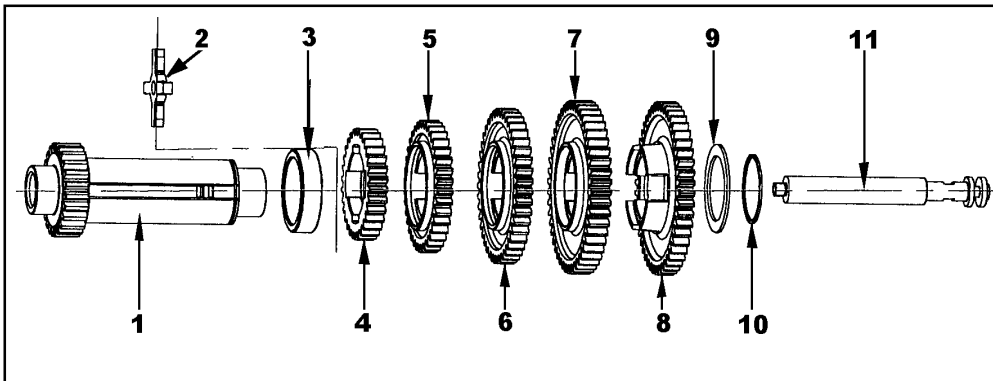


172



173

N.B. - Replacement of con-rod bearings, halves is possible if crankshaft is without scratches, scorings or ovalization.



Caption:

- 1- Gearbox shaft with differential gear control coil
- 2- Speed coupling spider
- 3- Spacer
- 4- 4th speed gear
- 5- 3rd speed gear
- 6- 2nd speed gear
- 7- 1st speed gear
- 8- Reverse gear
- 9- Clearance ring
- 10- Stop ring
- 11- Speed control stem

174

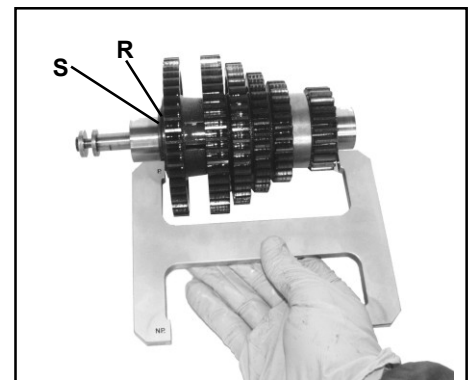
Gear assembly measure check

After reassembling the gears, the spacer "R" (with the groove facing the shoulder washer), the shoulder washer "S", with the snap gauge (go and not go) 984980.324, check the gear assembly measure (mm 132 -0.12 -0.17).

If the gauge does not fit or the play is excessive, replace the shoulder washer with one of higher or lower size as needed.

Once the check is completed reassemble the snap ring.

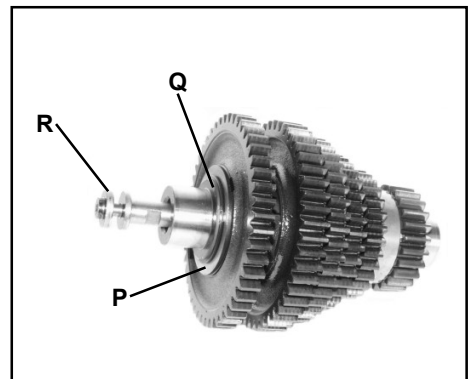
IMPORTANT: the shoulder washer "S" is provided, as spare part, in eight different sizes of thickness. (1,750 - 1,830 - 1,910 - 1,990 - 2,070 - 2,150 - 2,230 - 2,310)



175

Gearbox shaft

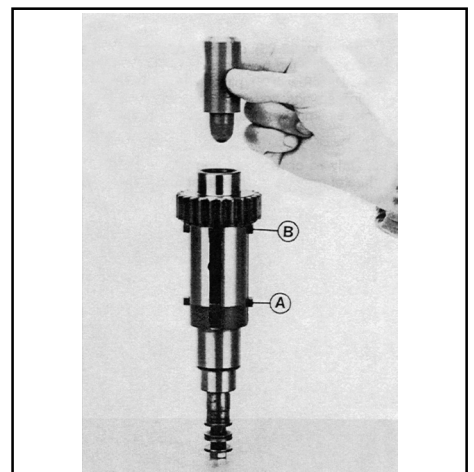
Remove the snap ring "Q", the shoulder washer "P" and the gears. Unscrew the stem "R", set the coupling spiders, one at a time, to coincide with the slot for the sliding groove and extract them from the shaft.



176

Reassembling the gearbox shaft

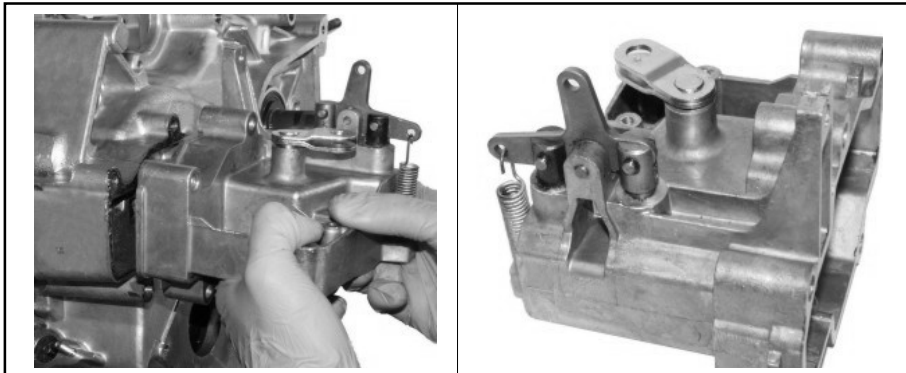
Insert the 1st - 2nd speed coupling spider and reverse "A", caulk by using the punch 986800.255 at a pressure of Nm 15,500 through a hydraulic press. Place the 3rd and 4th speed coupling spider "B", and caulk by using the punch 986800.254.



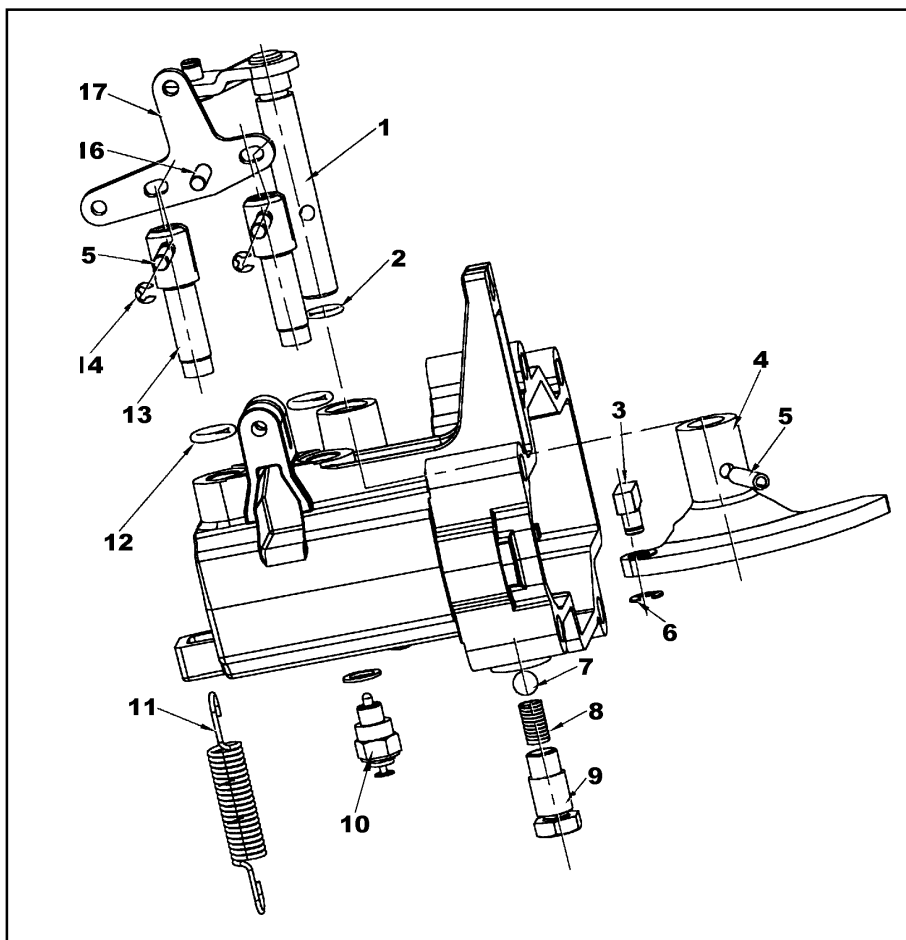
177

Gearbox

After unscrewing the gearbox coupling screws, disengage the gear speed control stem from the selector switch sliding block and disassemble the gearbox.



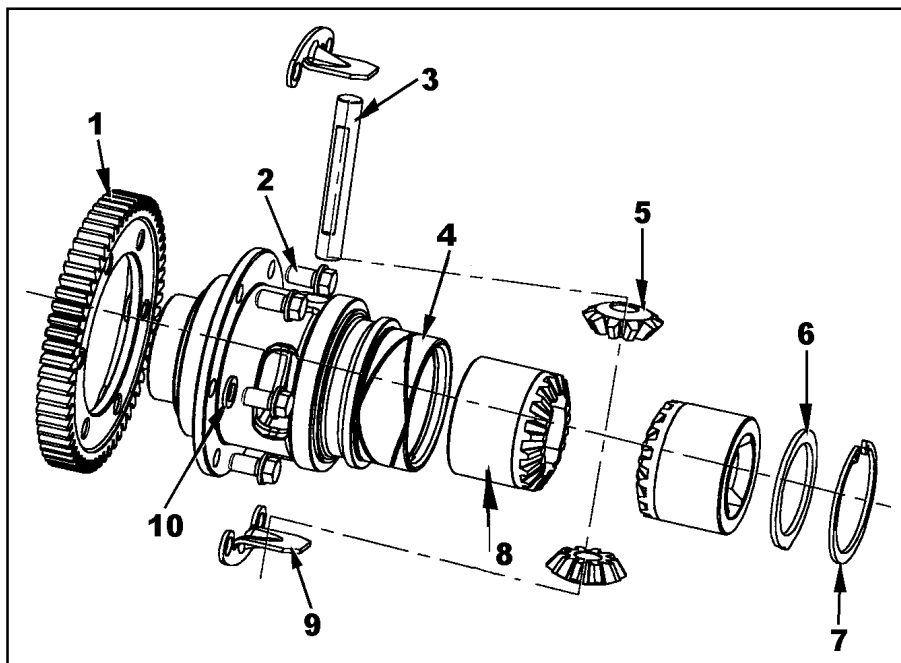
178



179

Caption:

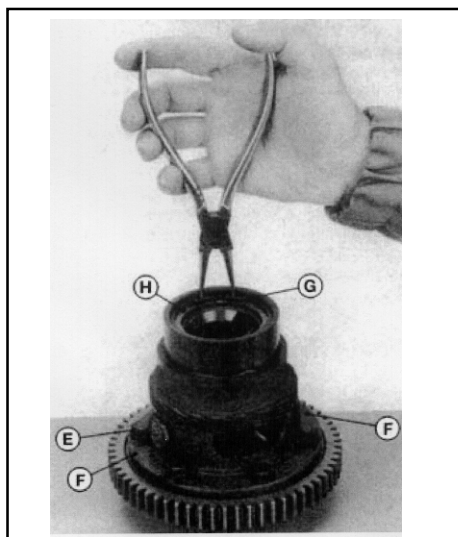
- 1- Lever pin with P.I.
- 2- O-ring
- 3- Sliding block
- 4- Selector switch
- 5- Elastic pin
- 6- Lock ring
- 7- Ball
- 8- Spring
- 9- Spring housing
- 10- Reverse sensor
- 11- Return spring
- 12- O-ring
- 13- Safety pin
- 14- Lock ring
- 15- Pin
- 16- Pin
- 17- Lever

**Differential gear box**

Caption:

- 1- Differential gear ring
- 2- Screws
- 3- Differential gear pin
- 4- Differential gear box
- 5- Differential gear side pinions
- 6- Clearance ring
- 7- Snap ring
- 8- Differential gear crown wheel
- 9- Differential gear pin check squares
- 10- Washers

180

**Differential case**

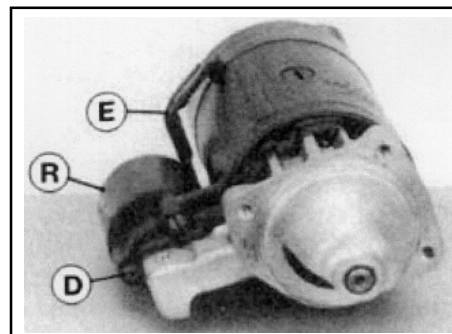
Take away the 6 bolts "E", side pinions pin retaining brackets "F" and drive gear. With the specific pliers remove circlips "G", shoulder washer "H" and crown wheel.

Extract pin and remove side pinions and the other crown wheel. Replace the damaged parts and reassemble by following the reverse procedure of removal. Torque the 6 bolts "E" according to values of locking torque 55÷60 Nm.

181

Remote control switch

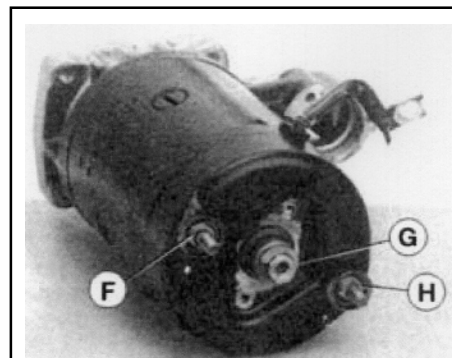
By means of a Screwdriver unscrew the 3 screws "D", disconnect cable "E" and remove remote control switch "R" complete with movable element.



182

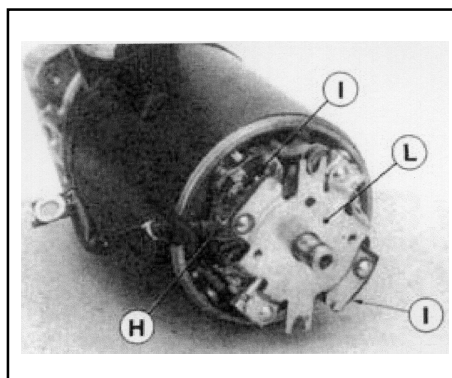
Replacement of the brushes

After removing cap unscrew both nuts "F" take away cir-clip "G" and remove cover.



183

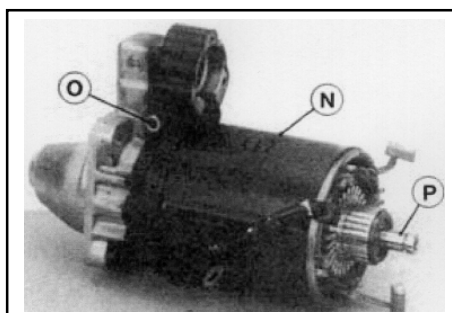
Release the springs "H", take off both brushes "I" connected to the magnetic fields and remove brush holder plate "L". Release copper plated cables by breaking loose both brushes "I", previously withdrawn, then introduce plated cables into the new brushes foreseen with hole and solder (by the countersunk part of the hole) plated cables; be careful to tin penetrate into holes. Fit a new plate with both brushes on which the two new brushes "I" should be fitted. Charge the spring "H" and reassemble the previously removed parts.



184

Armature

After removing cap, cover and brushes holder plate "L" remove stator "N", bolt "O" retaining coupling fork and extract armature "P".

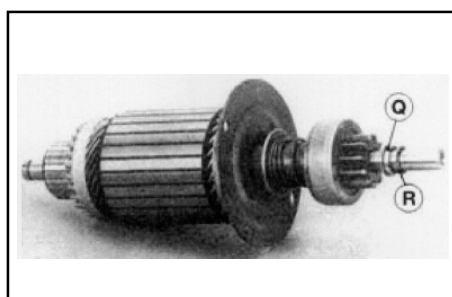


185

Coupling pinion

By means of an inside dia. 15 mm. (0,59") tube remove ring "Q", slip off circlip "R" and take away coupling pinion, assy.

N.B. - For the reassembly of the unit follow the inverse procedure of removal.



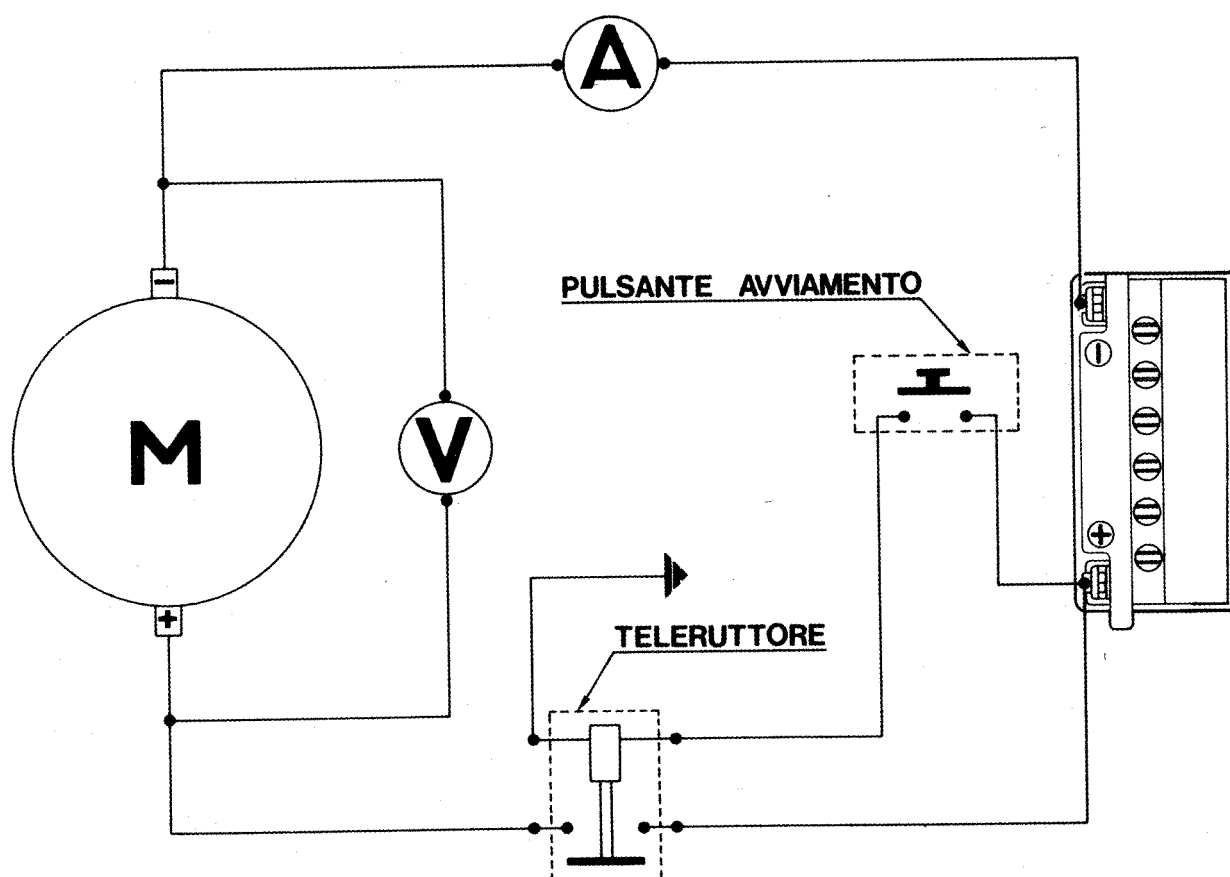
186

Main features of electrical starter

| | |
|-----------------------|-----------|
| Type | MAICO |
| Rated voltage | 12V |
| Rated output | 1,1 kW |
| Direction of rotation | Left hand |

Connection with engine

with pinion and crown gear on the flywheel-fan



Warning: Values within brackets are specific for the test with 66 Ah battery.

- 1) No-load test:** maximum input of no-loaded starter: 7.5 A by feeding voltage of 11.5 (12) V r.p.m. ³ 8.000.
- 2) Under load test:** brake the starter so that the input reaches 390 A by feeding voltage of 7.5 (9) V the torque should be ³ 1 Kgm. and the revolving speed ³ 1200 (1500) r.p.m.
- 3) Start test:** by jammed starter and feeding voltage ³ 5 (6) V the input should result £ 600 (780) A and torque ³ 2 (2.2) Kgm.

Notice :

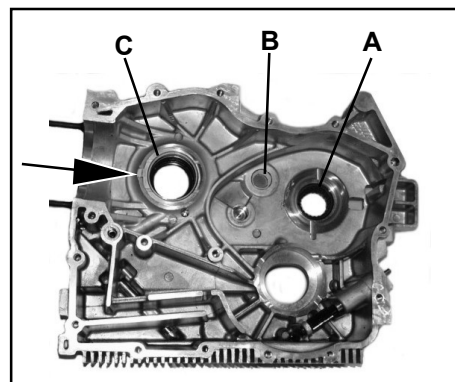
- Above features must be noted with charged battery and after the starter has turned during 30" in the conditions of point 1.

IX DISASSEMBLY/REASSEMBLY

Crankcase, half, flywheel side

Drive shaft and gear cluster d.c. roller bearings:

place crankcase half on a base plate and fit, by using the specific punches 986290.106 d.c. roller bearing "A" of drive shaft and 986290.104 d.c. roller bearing "B" of gear cluster. Position on crankcase, half, duly greased on housing face, to avoid fall during assembling operations, shoulder bearing "C" with 4 tracks for the lubrication facing crankshaft and the appendix placed in its housing as pointed out by arrow in fig. 182.



187



188



189



190

Clutch-side housing half

Place the housing half on a base plate and warm it to 80° C in the ball bearing seat by using a thermal gun. By using the appropriate punch 986290.108 fit the bearing into its seat.



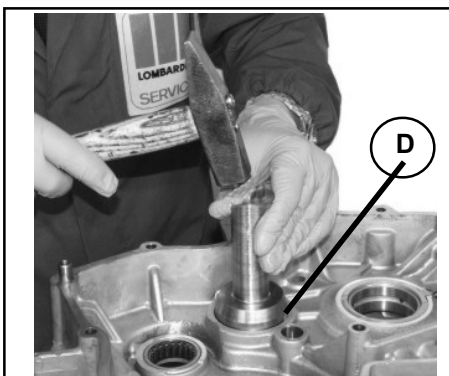
191



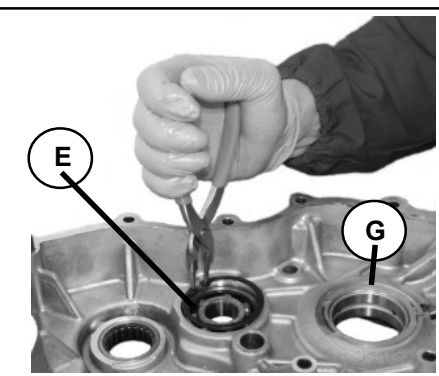
192

Gear cluster ball bearing and drive shaft d.c. roller bearing

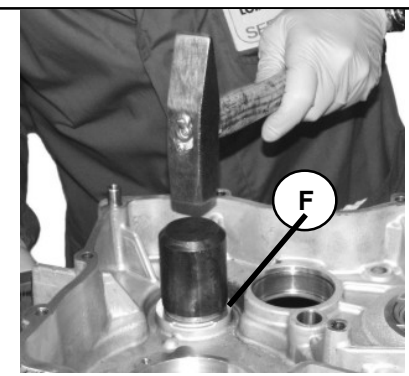
Fit by using, if necessary an outside dia. 50 mm (1.96") punch, ball bearing "D" and with pliers introduce circlip "E". Let crankcase cool and by using the specific punch 986290.105 position d.c. roller bearing "F" of drive shaft. Then in the same way as carried out on crankcase, half, flywheel side, position shoulder bearing "G".



193



194

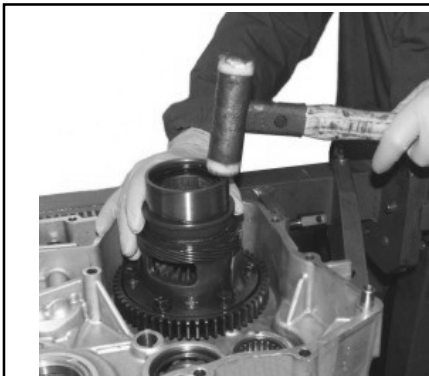


195

Drive shaft, reverse gear shaft, multiple gear, gearbox shaft and differential gear

Insert the differential gear (Fig. 196) assembly, the multiple gear (Fig. 197), the gearbox shaft (Fig. 198), the reverse gear (Fig. 199), the drive shaft (Fig. 200), the oil filter “G” , the pipe “N” and the sealing ring “I” (Fig. 201÷202), as indicated in the figure.

Clean the union surfaces of housing halves (Fig. 203÷204), smear with sealant (Loctite 518) (Fig. 205) and couple the housing halves by setting the screws to the specified torque (Fig. 206÷207).



196



197



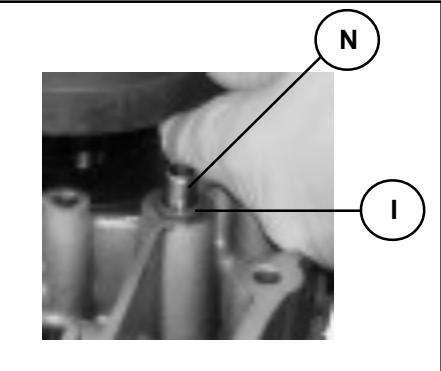
198



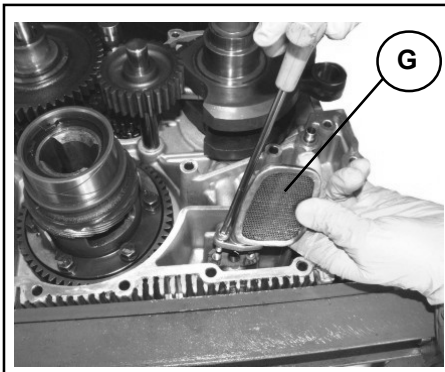
199



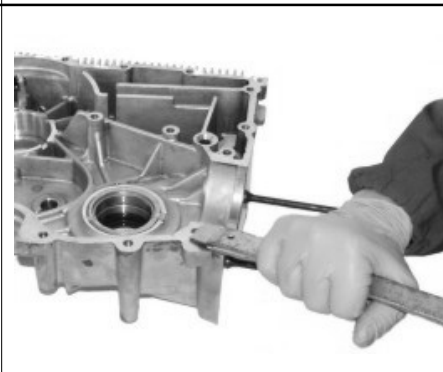
200



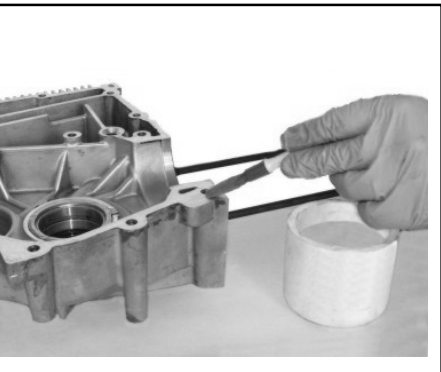
201



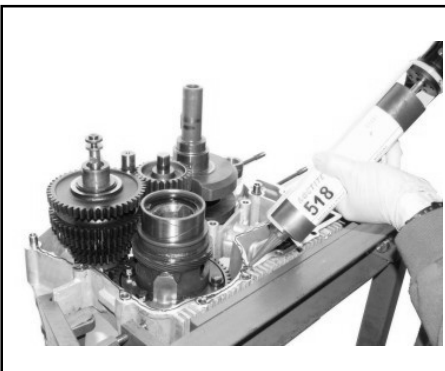
202



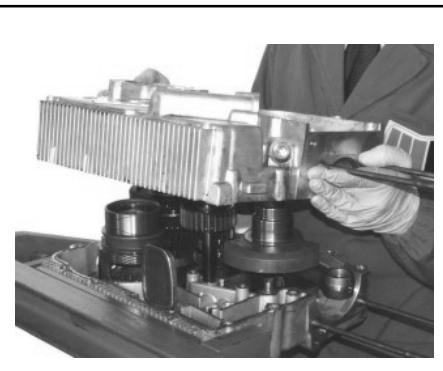
203



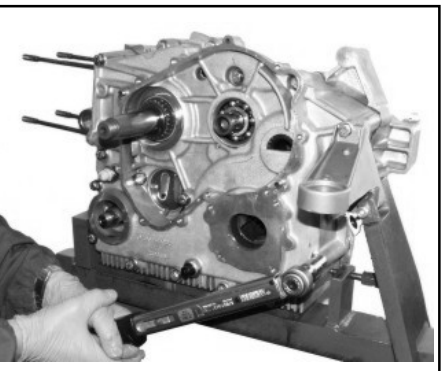
204



205



206



207

Oil pump gear and oil pump - reassembling

When reassembling the oil pump, always replace the seal with a new one.

Reassemble the oil pump paying attention to the correct assembly direction (suction and delivery). We advise you to fill the pump case with oil before the assembly.

Before and after final tightening the two fastening bolts "A" of the pump case to the housing half, check that the pump turns freely by rotating the shaft manually 4 or 5 times. The two bolts "A" are tightened to an 8 Nm torque.

Reassemble the chain after attaching it by using the oil pump control gear. The bolt fastening the gear to the oil pump shaft shall be tightened to a 10÷12 Nm torque.

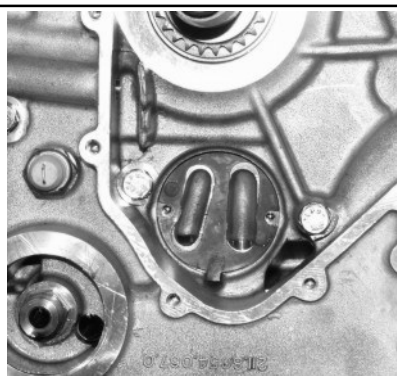
Oil pump pressure check

The oil pressure check shall be performed with the oil at a temperature of 100° C.

Connect the pressure gauge in the place of the pressure or switch placed on the main duct.

Run the engine and measure the following pressure values:

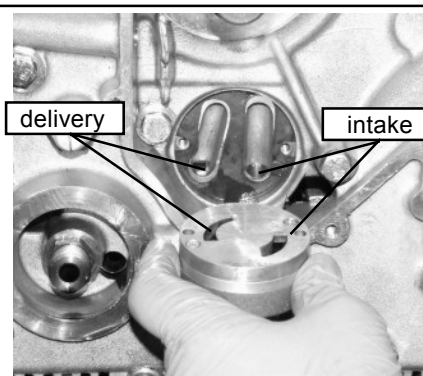
- at minimum rpm $\geq 1 \text{ Kg/cm}^2$
- at 3000 RPM 3.5 to 4.5 Kg/cm²



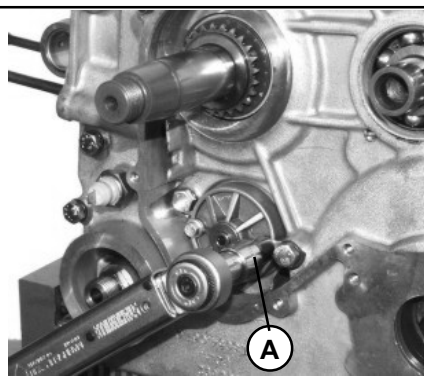
208



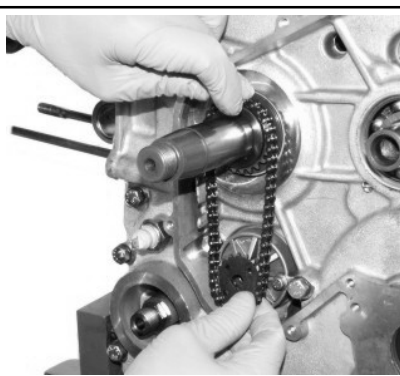
209



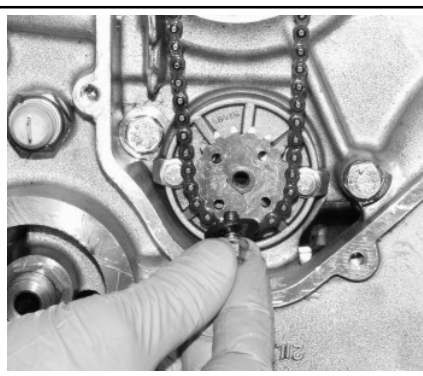
210



211



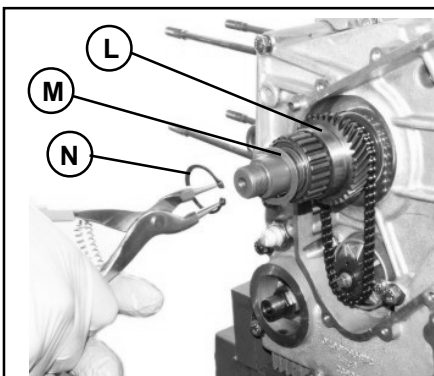
212



213

Engine gear

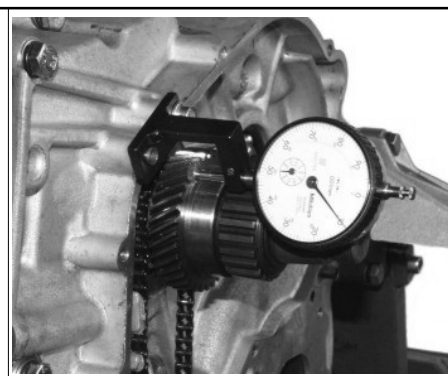
Assemble the gear "L", the clearance shim "M" and the snap ring "N" by using the pliers for internal snap rings. Use the tool 986782.034 provided with a dial indicator on the housing pan and verify that the gear axial endfloat is mm 0.04 ± 0.1 . If this endfloat is not obtained, replace the clearance shim "M" with a washer of appropriate size; 13 washers having different thickness are provided.



214



215



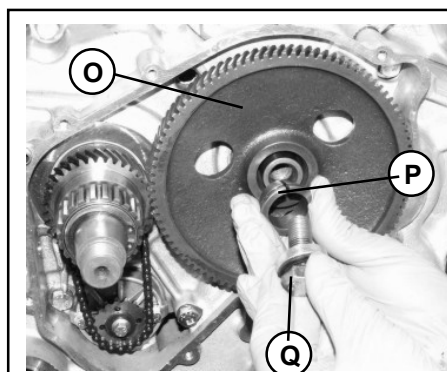
216

Primary gearbox ring gear and clutch housing pan

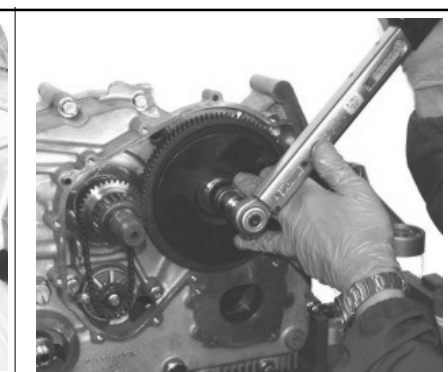
Place the ring gear "O" the cone "P" and lock with the bolt "Q" to a 120 ± 140 Nm torque by using a wrench.

Assemble the oil seal on the clutch housing pan by using the appropriate tool 986290.110.

Smear the coupling surface with sealant (Loctite 510), assemble the clutch housing pan by the 10 bolts and the single nut by tightening them to a 8 Nm torque



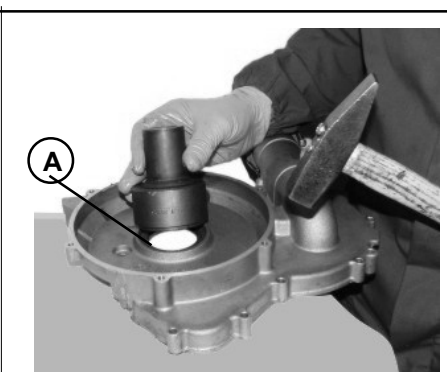
217



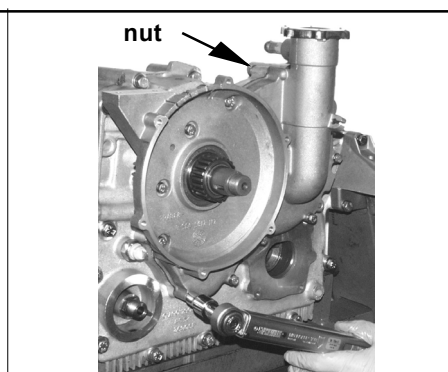
218



219



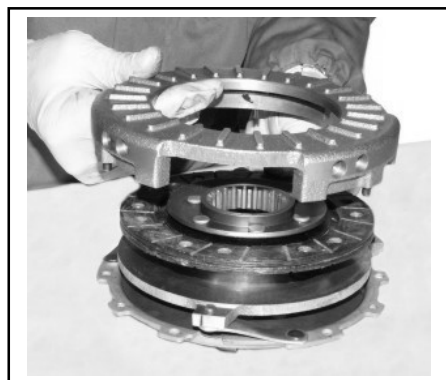
220



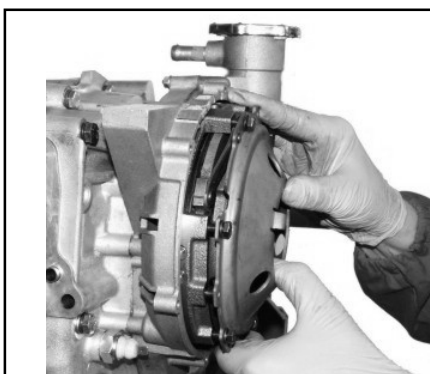
221

Clutch assembly

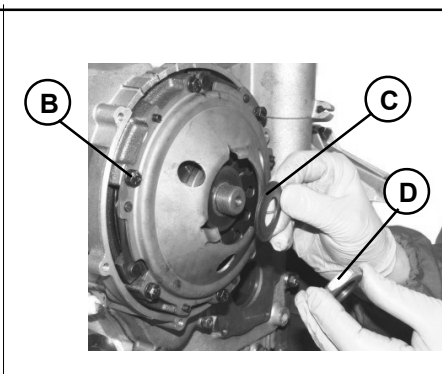
To replace the duct disk no particular tools are required, simply remove the 6 bolts "B" and remove the duct disk. When reassembling, before locking bolts "B", assemble the clutch assembly on the drive shaft to help centering the duct disk, then place washer "C", secure nut "D" 120÷140 Nm and the 6 bolts "B" 10 Nm by fastening the clutch assembly using the appropriate stop key 985110.039. Complete the operations by assembling the clutch pressure cap of the cover retaining ring.



222



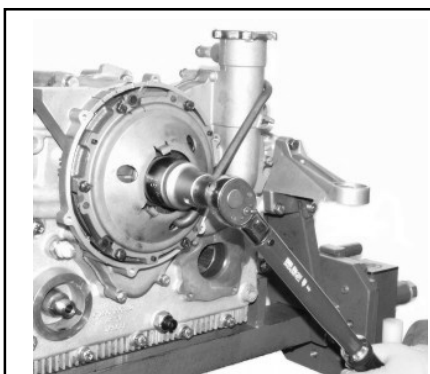
223



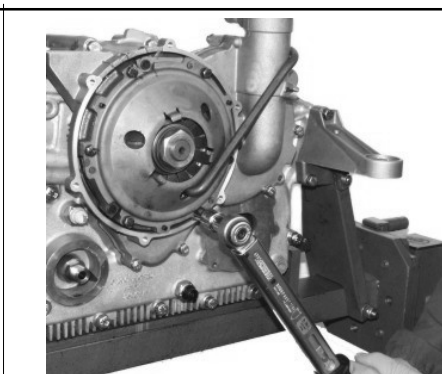
224



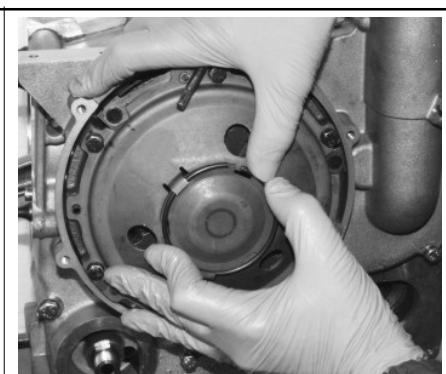
225



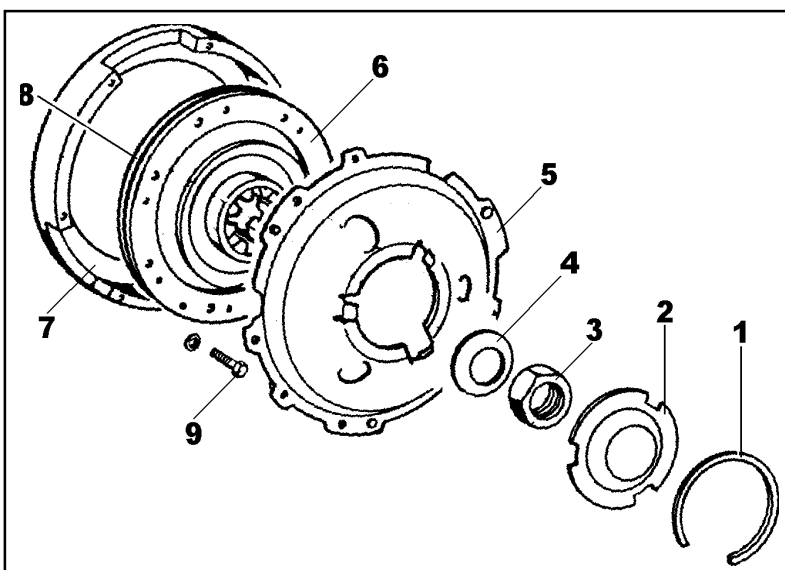
226



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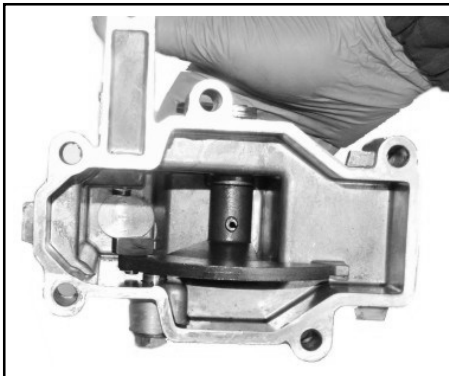
229

Caption:

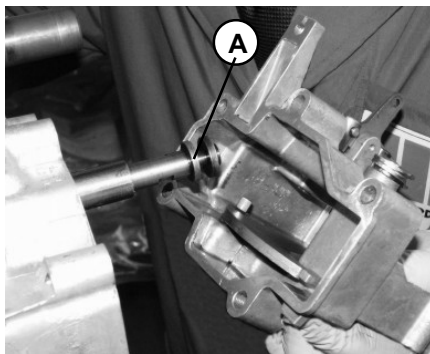
- 1- Collar retaining ring
- 2- Thrust cap
- 3- Nut
- 4- Cup spring
- 5- Clutch pressure pad
- 6- Clutch disk
- 7- Flange
- 8- Centering pin
- 9- Fastening bolt

Speed gear control box

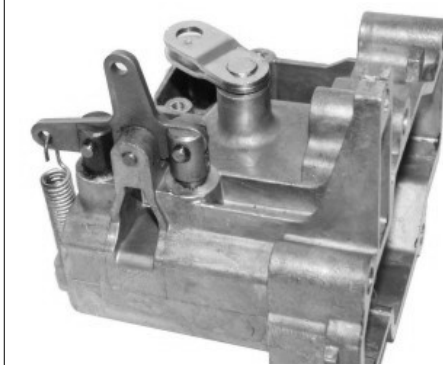
Rotate the drive shaft and bring the gears in a position such to allow stem "A" the maximum protusion, position upper lever in 2nd gear; spread with seal paste (Loctite 510) speed-gear control box union surface, engage sliding bloc of 3rd and 4th gears lever, then the one of reverse, bottom and 2nd gears. Lock the box by means of the 5 securing bolts and check the regular speed gear operation.



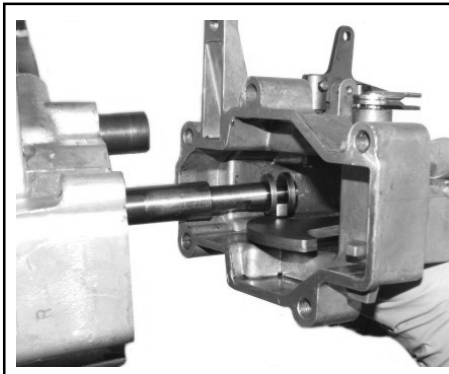
230



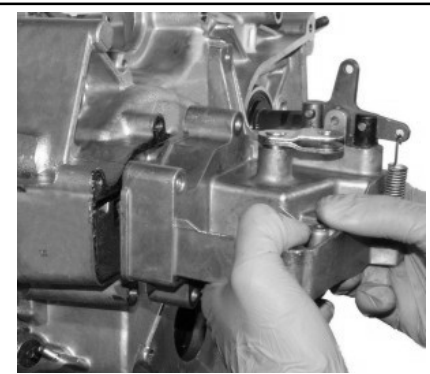
231



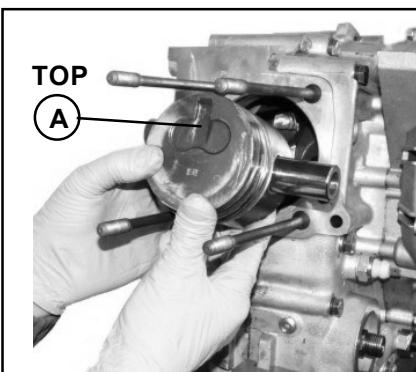
232



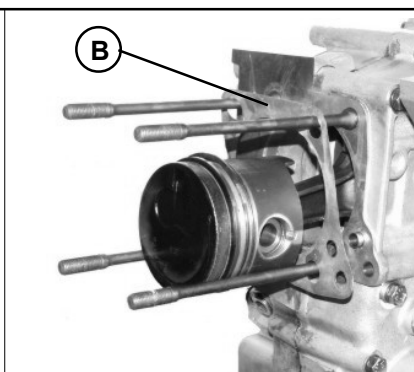
233



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235



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Piston and cylinder

Fit piston with combustion chamber **A** facing upwards; lubricate and turn piston rings so that ring gops result between themselves displaced by about 120°.

Position gasket **B** on crankcase base and after lubricating cylinder barrel introduce the cylinder by using tool 985820.212.

Push cylinder down on crankcase by it self.

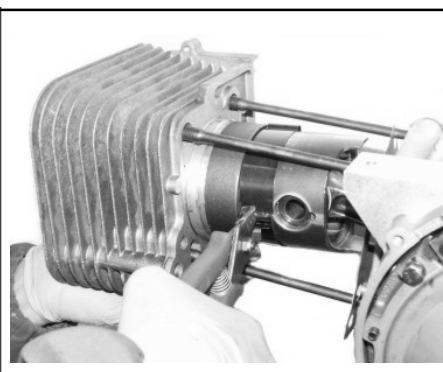


237

tool 985820.212



238



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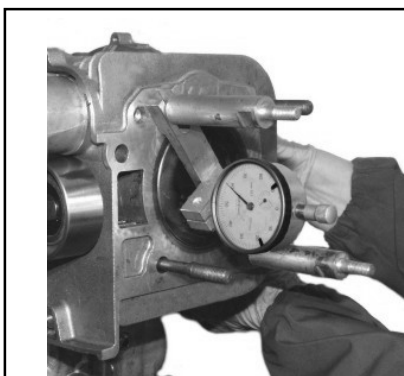
Measure execution for determination of cylinder head gasket thickness

Use the dial indicator on the tool 981075.417 and set it to zero on the surface plate. Assemble the tool on the cylinder by using the 2 head clamping stud bolts , set the piston to the top dead centre and measure on the dial indicator the piston protrusion beyond the zero.

In order to keep the compression rate within the tolerance value, select the head gasket thickness according to the indications of the following specification table.



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| Piston projection (over zero) mm | Gasket thickness | External identification | Compression ratio |
|-------------------------------------|---------------------|----------------------------|----------------------|
| 0,45÷0,60 | 1,50 | 1 notch | 22,5÷23,5 |
| 0,60÷0,75 | 1,65 | 2 notches | |
| 0,75÷0,90 | 1,80 | 3 notches | |

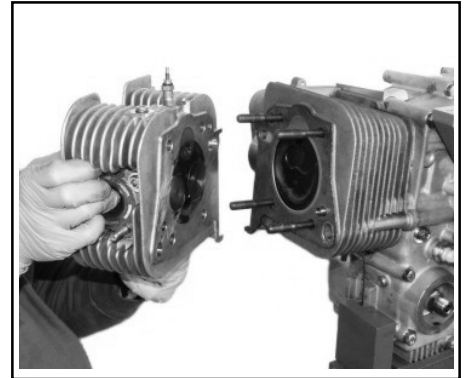
Warning :

The above measurements given for the determination of the suitable gasket are necessary only in case of replacement of one of the following parts: cylinder, piston, con-rod, crankshaft or crank-case, half: if one of the mentioned conditions is absent, the new gasket must be equal (external identification) to the previously fitted one.

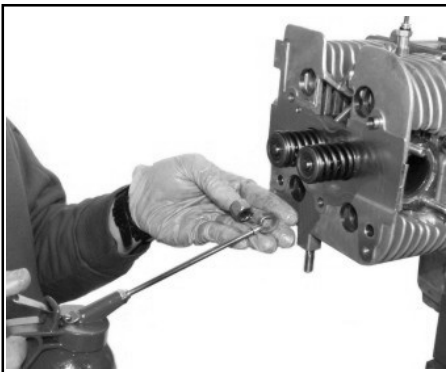
Cylinder head installation

Fit the cylinder head and after lubricating washers, studs and the 4 nuts, in order to carry out a perfect locking act as follows, by bearing in mind that for each tightening stage the sequence pointed out below must be performed according to the diagram in fig. 246.

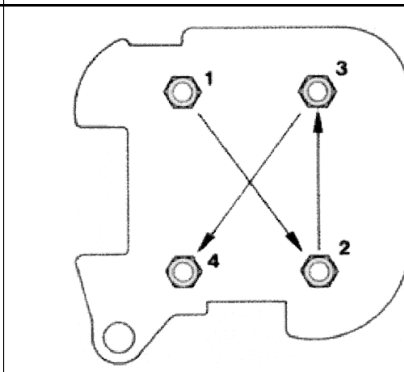
- 1) Torque the four nuts with a locking torque of 5 N.m.
- 2) Torque to 40 N.m..
- 3) Carry out a 90° rotation (1/4 turn).
- 4) Complete the torquing with a second rotation of 90° (1/4 turn).



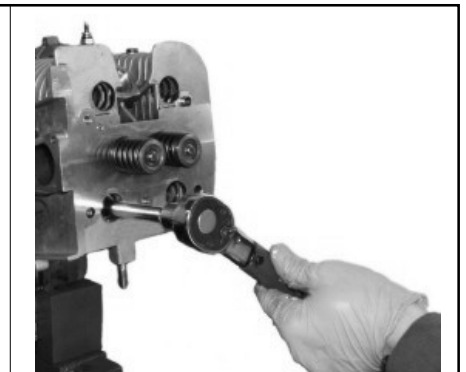
244



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Cylinder-cylinder head securing studs

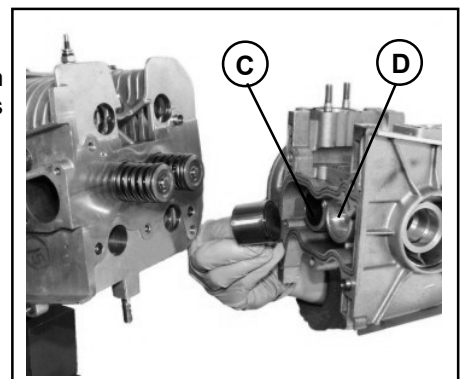
to avoid progressive permanent elongation from repeated torquing operations it is necessary to replace the studs every three dismantling and reassembly operations of the cylinder head. If in doubt, replace them every time.

Camshaft and tappet support

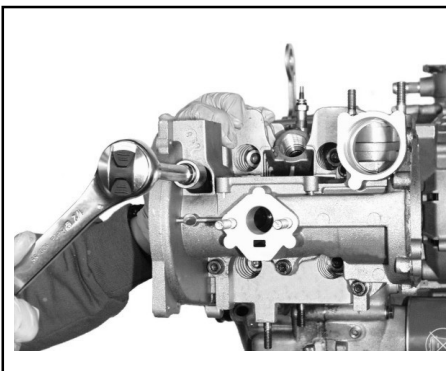
Assemble the camshaft support on the head by tightening the bolts to a 20÷22 Nm torque, lubricate the camshaft supports as well as the intake and exhaust tappet seats "C" and "D" supports.

Fit the tappets fitted with adjustment shims in their seats "C" and "D".
Place the gasket "E".

- Tappet seat diameter 35,000÷35,025
- Normal tappet external diameter 34,975÷34,995
- Seat-tappet : assembly gap 0,005÷0,050



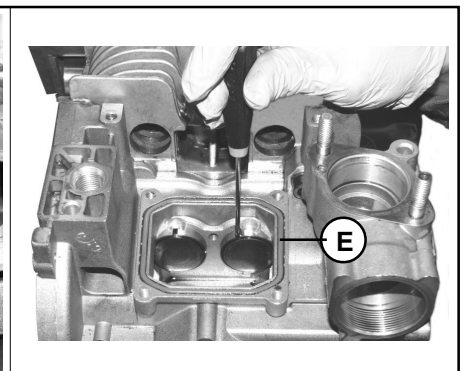
248



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Camshaft

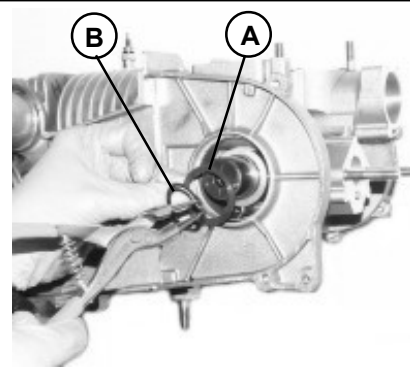
Insert the camshaft into the support, assemble the shoulder washer "A" and the retaining snap ring "B".

Use the dial indicator on the tool 981075.417, assemble it on the support and check that the camshaft axial endfloat is mm 0.15 ± 0.20 .

If the right axial endfloat is not obtained, replace the shoulder washer with one of a higher or lower size as required until the specified endfloat is obtained (to this end 6 washers having different thickness are provided).



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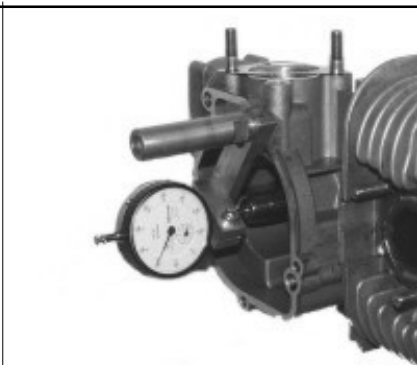


253



Tool 981075.417

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| Shoulder washers | Thickness (mm) |
|------------------|----------------|
| 1 | 1,80 +0/-0,05 |
| 2 | 1,85 +0/-0,05 |
| 3 | 1,90 +0/-0,05 |
| 4 | 1,95 +0/-0,05 |
| 5 | 2,00 +0/-0,05 |
| 6 | 2,05 +0/-0,05 |

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Camshaft

Camshaft pivots diameter

belt side: 31,959÷31,980
regulator side: 55,961÷55,980

Seat diameters of camshaft pivots into the camcarrier

belt side: 32,000÷32,025
regulator side: 56,000÷56,030

Mounting gap between seat and Camshaft pivots

belt side: $0,020 \pm 0,066$
regulator side: $0,020 \pm 0,069$

Cam lift

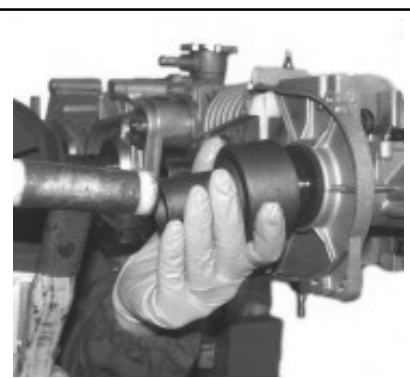
8,29

Camshaft oil seal and timing pulley

Insert by using the proper punch 986290.110 oil seal.



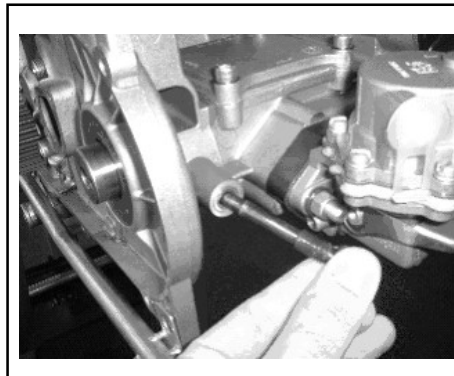
Tool 986290.110



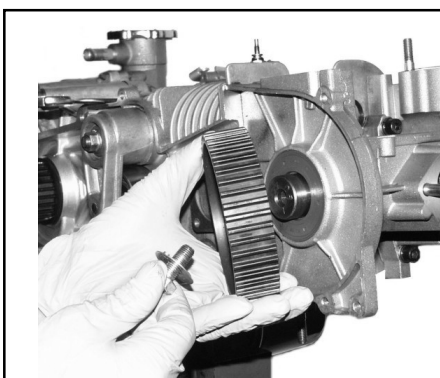
257

Timing pulley

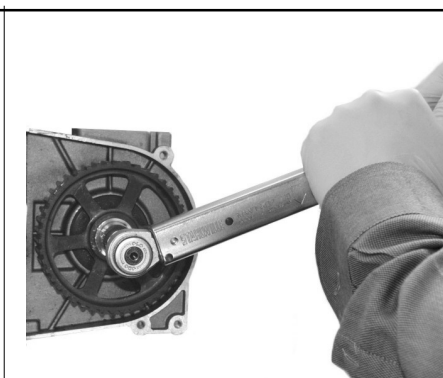
Fit the camshaft clamping pin, assemble the timing pulley, then tighten the bolt as torque specified, refit again the retorning washer



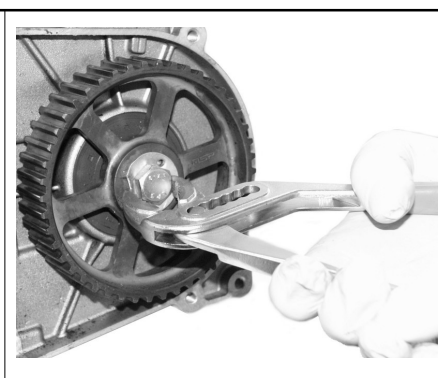
258



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WARNING**Assembly of toothed belt and timing**

The assembly, timing and tension adjustment of the timing drive toothed belt have already been described from page 21 to page 23.

IX DISASSEMBLY/REASSEMBLY

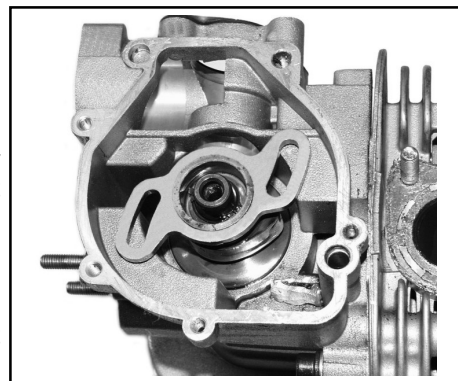
Advance variator

Position injection pump control cam with lobe opposed to regulator hub key and insert centrifugal weights unit making sure that pins of centrifugal weights "L" engage the slots "M".

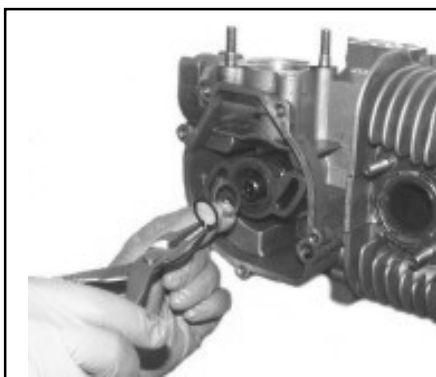
Working on the side opposed to the one shown in the figure, keep the timing gear locked and clamp the weight-holder hub along with the related bolt by tightening it to a 25÷28 Nm torque.

Important :

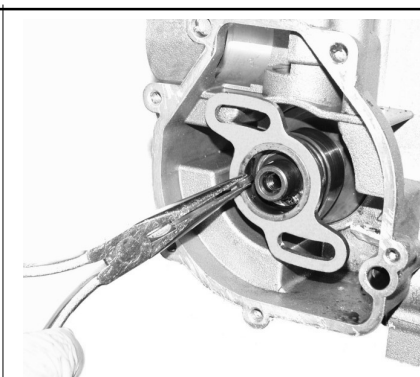
- When the unit is installed check that weights carry out their complete stroke without sticking.



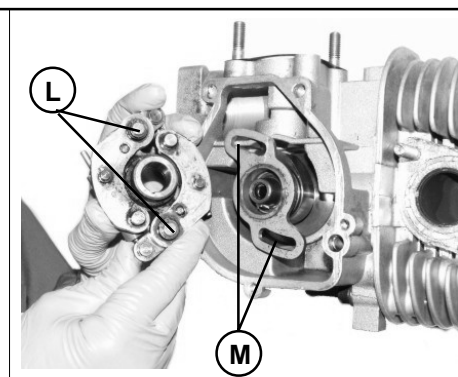
262



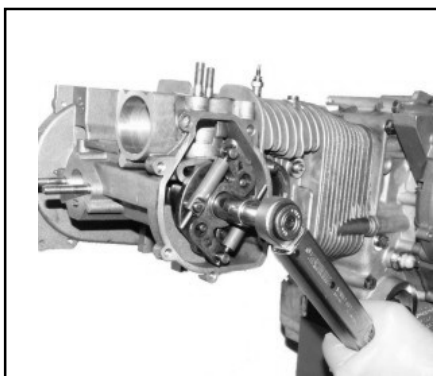
263



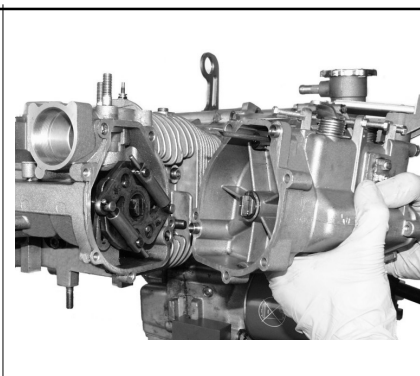
264



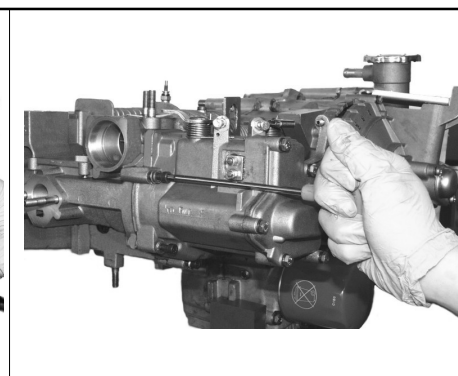
265



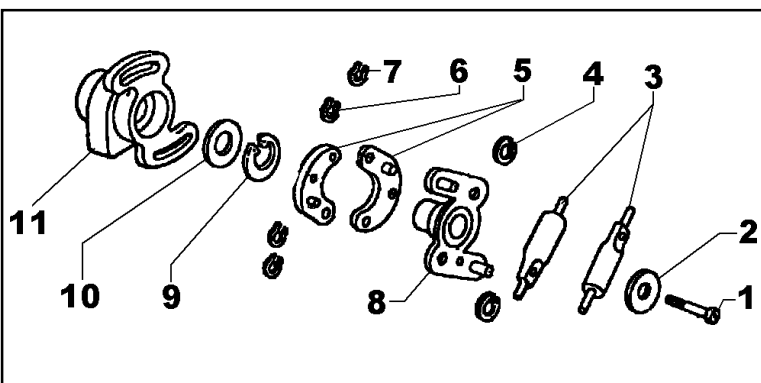
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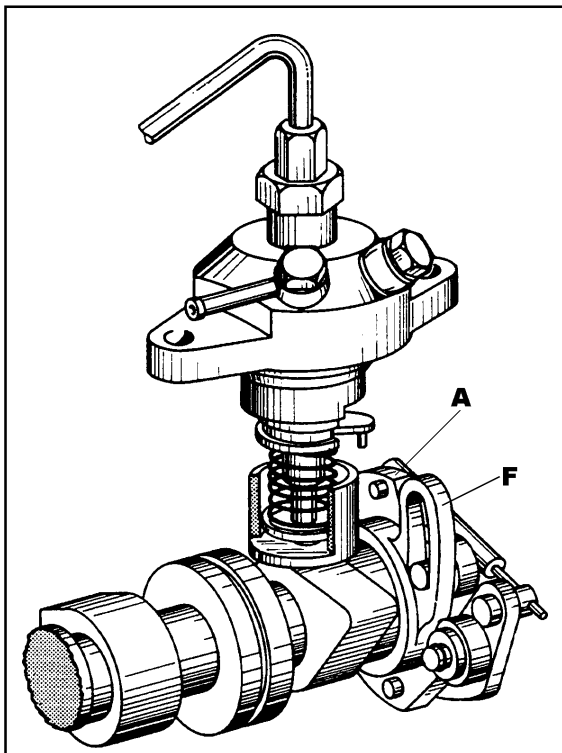


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Injection advance variator

Caption:

- 1- Injection advance variator fastening screw
- 2- Washer
- 3- Calibrated spring cases
- 4- Lock rings
- 5- Centrifugal weights
- 6- Lock rings
- 7- Lock rings
- 8- Counterflange
- 9- Snap ring for shafts
- 10- Washer
- 11- Cam for injection pump with P.I.



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Description of the injection advance regulator

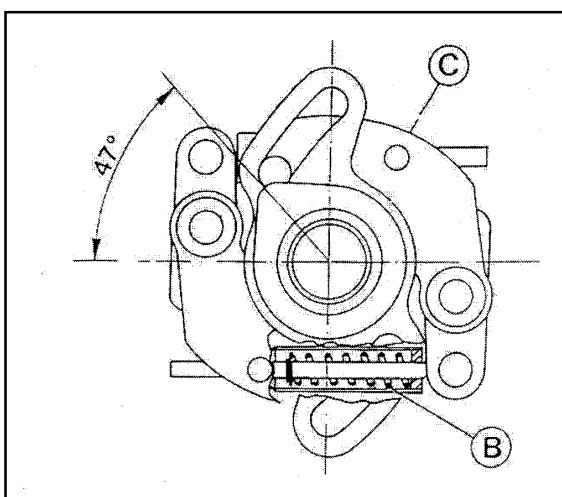
When starting, and at a low idling speed the correct value of injection advance is 11° before P.M.S..

This value increases in accordance with the engine RPM, attains 24° at 3500 R.P.M., then remains constant.

The advance variation is obtained through the injection advance regulator, see fig. 270.

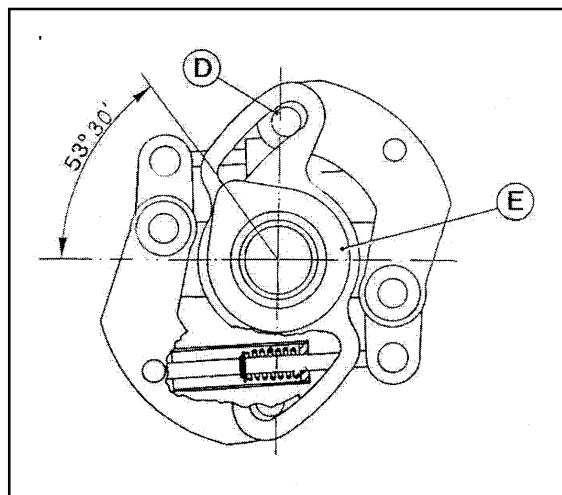
It consists of the flange **A** splined to the camshaft and the carrier, both with the fulcrum on two pins, of the centrifugal weights **C**; of a counterflange **F**, integral with the injection cam and free to rotate on the camshaft, on which two slots are made where the pins **D** connected to the centrifugal weights slide.

Appropriate springs **B** are applied between the centrifugal weights **C** and the flange **A**.



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With the engine stopped and at low idling speed the spring load is higher than the weights centrifugal force, therefore they remain closed, see fig. 271.



272

When the RPM increases, the centrifugal weights force becomes higher than the spring load, the weights move and through the pins **D** engaged into the slots rotating the injection cam.

At 3500 R.P.M. the weights are completely open, see fig. 272 and the injection advance is 24° before P.M.S.

Check of tappets clearance

Rotate the engine and put the piston at T.D.C. in compression stroke. With a thickness gauge check that tappets clearance is 0.30 mm for inlet valve and 0.40 mm for the exhaust valve, with the engine cold.

If such a clearance doesn't occur act as follows:

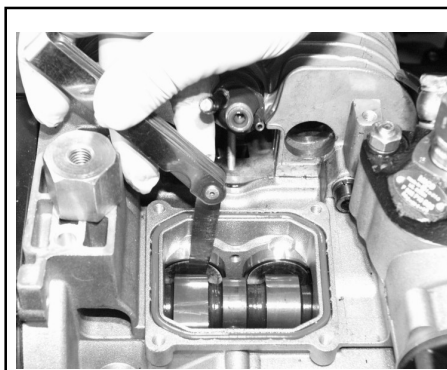
- 1) Rotate backwards the engine about 40° (to avoid the stroke of valves manual lowering and the hitting of valves against the piston). Rotate the tappets so as to position cuts "A" on the upper part to make easier caps removal.
- 2) Insert tool 981075.424 between suction valve cap and camshaft and push so as to compress the tappet. Insert part 2 to hold the tappet and extract part 1.
- 3) Undermine the cap by using a shin point, remove it and replace with another one with a suitable dimension. As spares 28 caps from 3.25 mm. up to 4,60 mm. are pointed out on this page.

Important - The value of the cap appears on one of the surfaces of the cap itself, which on assembly must face the tappet. Make sure that the real thickness of the cap correspond to the recommended value.

Shim thickness for tappet gap adjustment

Thickness 3,25 - 3,30 - 3,35 - 3,40 - 3,45 - 3,50 - 3,55 - 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 - 4,30 - 4,35 - 4,40 - 4,45 - 4,50 - 4,55 - 4,60

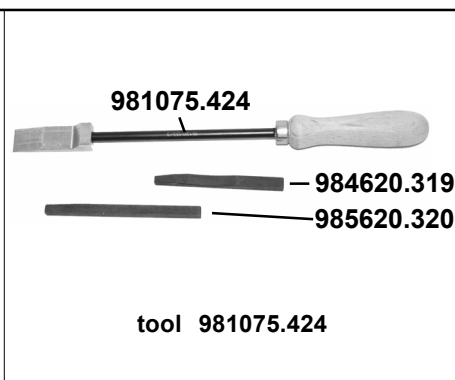
Tolerance $\pm 0,015$



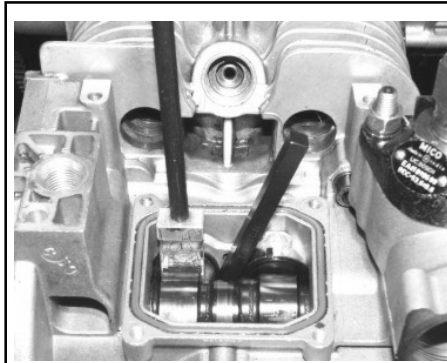
273



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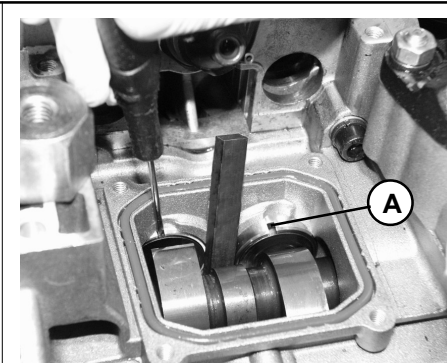
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INJECTION EQUIPMENT DESCRIPTION AND FUNCTIONING

FUEL INJECTION

In the Diesel engine the fuel is injected towards the end of the compression process into the precombustion chamber via the injection pump and relative injector.

The quantity of fuel injected for each cycle is regulated by a function of the power/capacity required through the rotation of the pumping element of the injection pump that is carried out by the regulation rod.

FUEL FLOW CONTROL

The regulation rod is set into action by the governor. The governor is connected to the upper part of the engine and is driven by a shaft connected with the camshaft.

The principal functions of the governor are :

- engine idle speed control
- to limit engine maximum rpm
- to increase fuel flow at the engine starting.

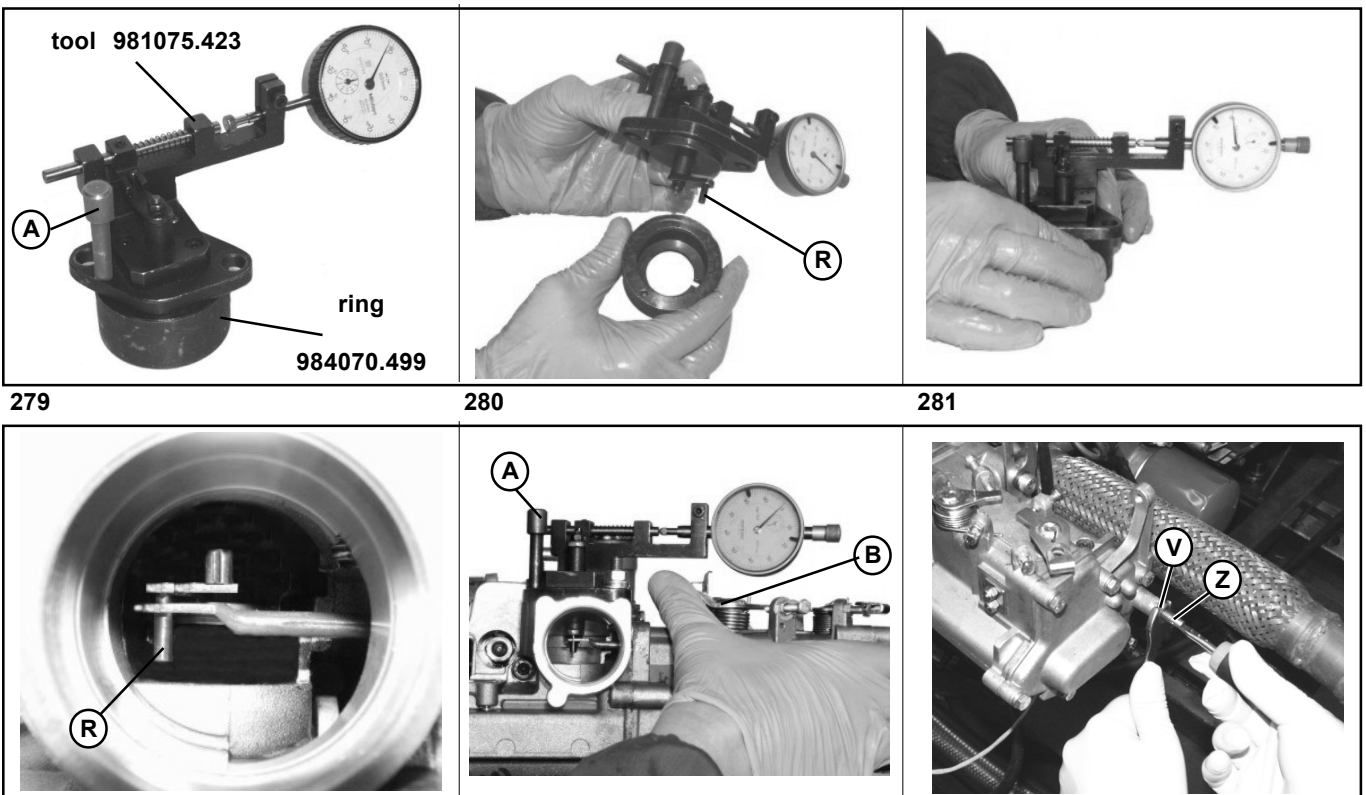
Adjustment of pump control rod

In case of engine overhauling or interventions on delivery control it is necessary to check the position of injection pump control rod and if necessary carry out the adjustment as follows: fit dial gauge on tool 981075.423, insert ring 984070.499 on tool making sure that pin "R" seats in its concerning slot; let tool reference 984070.499 hole match with the one of the ring; insert punch "A" and set to zero dial gauge.

Take away the ring "A" and fit the tool on the place of the injection pump making sure that pin "R" of tool is inserted into the hole of pump control rod, then fit reference punch "A" and lock the tool with both nuts.

Place lever "B" of accelerator to max. position and check that dial gauge is on the previously carried out zero setting position. If these conditions do not occur act on adjusting screw "Z" until such zero setting is realized. Lock, by holding the screw "Z" steady, lock-nut "V" and check by placing more times lever "B" to max position, that the dial gauge result is set to zero.

Warning - The mentioned checking operations must be carried out without injection pump control tappet.



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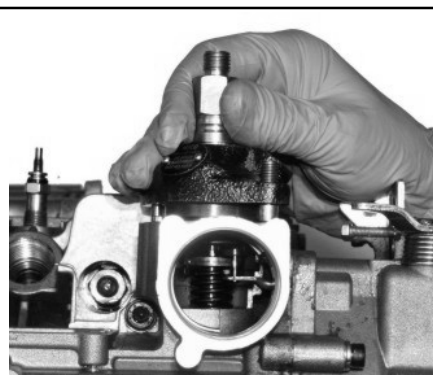
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Injection pump and check static injection advance

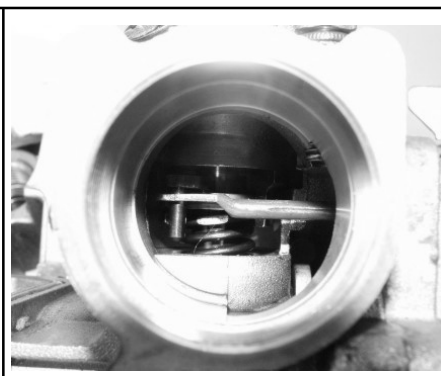
Insert the tappet in its housing equipped with cap, position the shims and the injection pump making sure, before the locking, that pin is correctly inserted into the control rod and reference dowel into its housing.



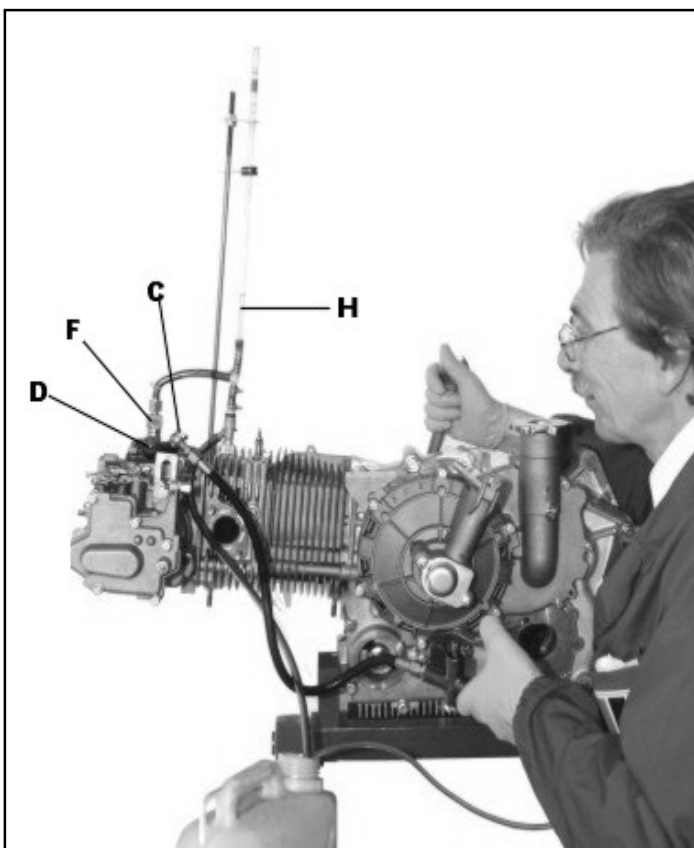
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Then check injection advance timing as follows.

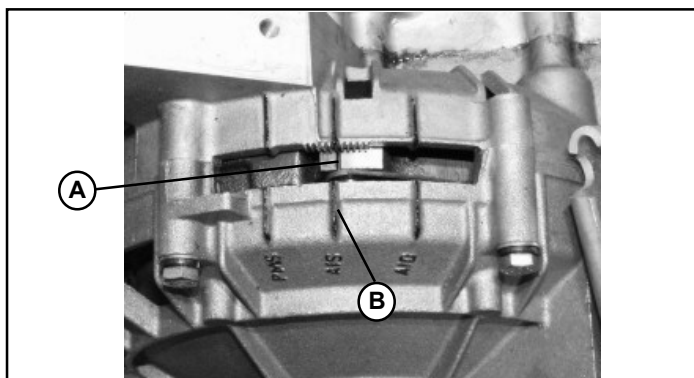
1) Connect delivery pipe "C" of the proper hand pump (for inst. BOSCH Type) to the feed union of injection pump and insert suction pipe into a container filtered and full of gas oil and plug the hole of gas oil recovery "D" by means of a threaded plug.

2) Rotate the engine so as A.I.D. (dynamic injection advance) reference mark coincide on clutch cover (compression stroke).

3) Operate hand pump and bleed the circuit by means of plug on hole "D", previously fitted. Then exert pressure on the gas oil so as it comes out from injection union "F".

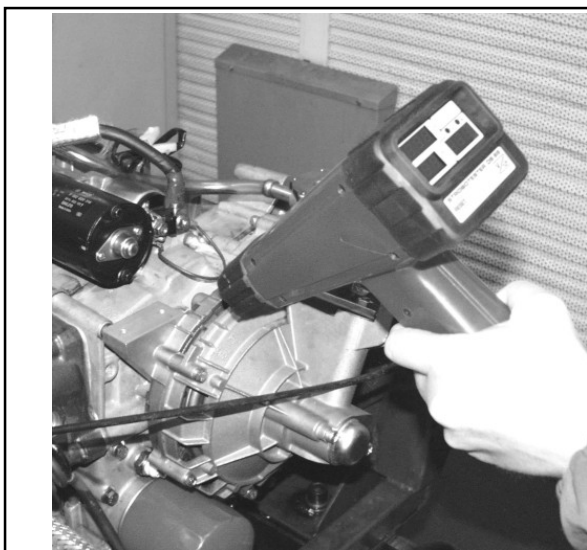
4) Fit a transparent pipe "H" on union "F". Operate again the pump and at the same time rotate the engine towards T.D.C. up the point where the climbing of gas oil in the transparent hose doesn't cease. Timing is correct if in such a point reference mark the clutch is aligned to A.I.S mark (static injection advance 11° before T.D.C.).

If the engine results are advanced or retarded replace the shims below the injection pump (as spares to this aim two packings of 0.2 mm and 0.3 mm are supplied) or fit more packings according to need. Bear in mind that by increasing 0.1 mm. the packing we obtain a retard of 1° and by reducing 0.1 mm the packing we have 1° in advance.



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N.B. - In order to be certain of the correct timing of injection advance repeat more times the test carried out on the point 4.

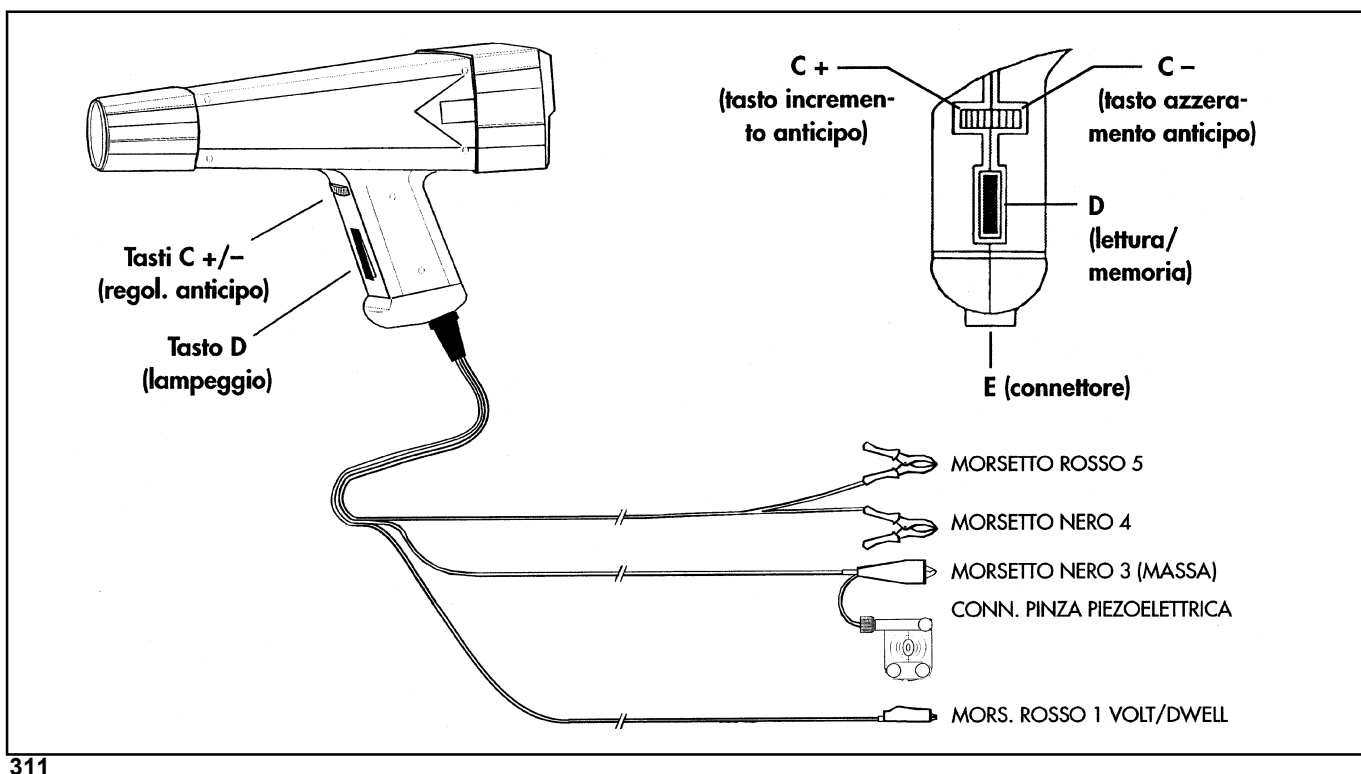


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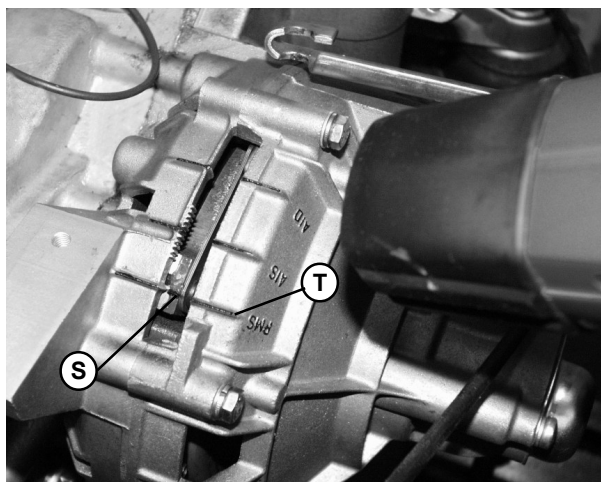
Injection advance dynamic control

The dynamic control of the injection advance is made through a suitable equipment - stroboscopic gun - according to the following:

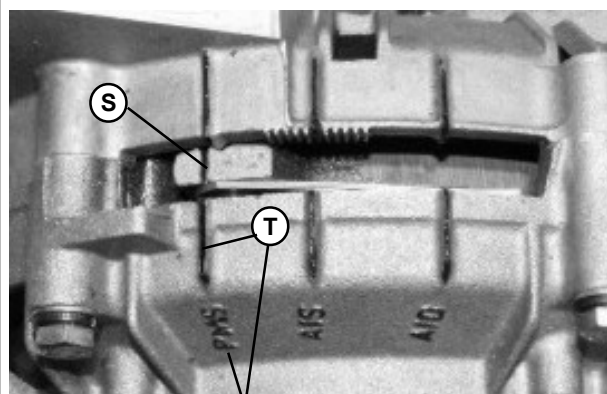
- 1) Clean carefully the injection pipe and check that the sensor coupling zone "V" is free from scoring signs
- 2) Install the sensor "V" of tester, paying attention not to turn it after fastening. Connect the tester supply cable as shown in fig. 311
- 3) Start and heat the engine. With the engine idling at 1200 rpm, use the button on the stroboscopic gun to make path "S" on the clutch flywheel coincide with path "T" of TDC on the clutch cover. Check that the advance read on the tester display is 13°. Increase rpm rating gradually and check that at 3200 - 3500 rpm the advance gradually increased reaches 26°. If the range is lower than the one provided, it is necessary to overhaul the advance variator.



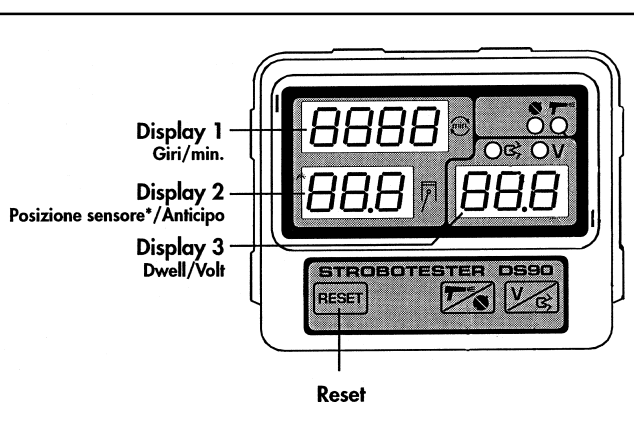
311



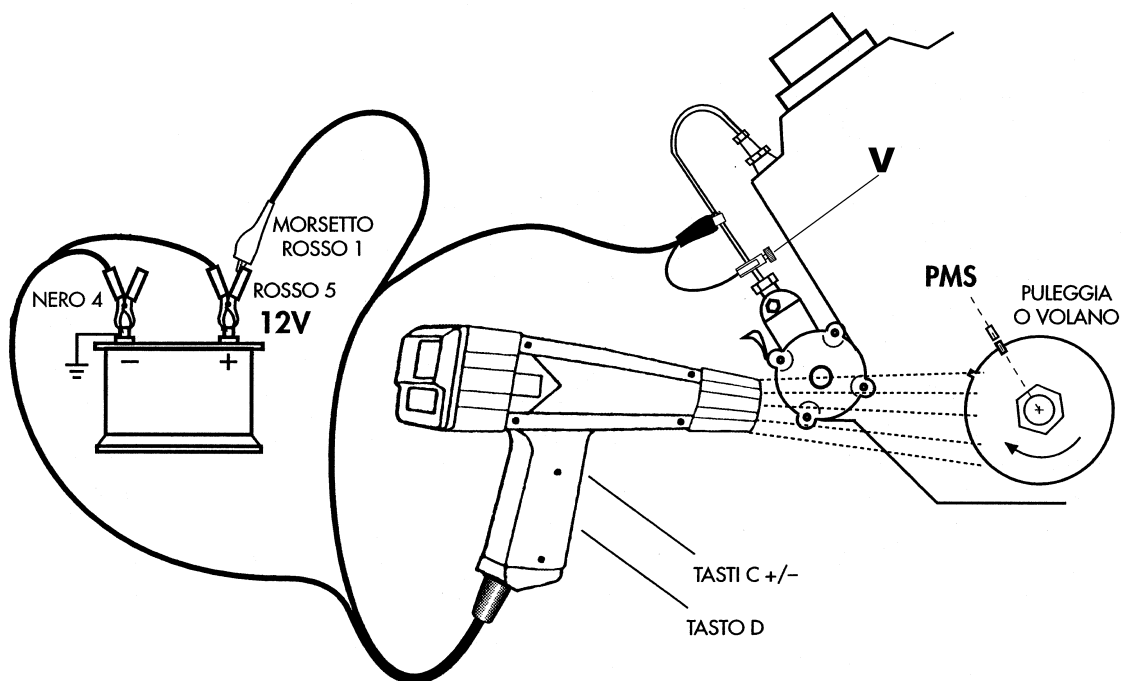
312



313



314



315

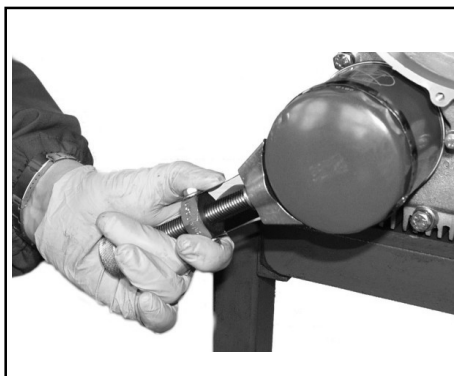
4) If the conditions described at point 3 are not satisfied, and the injection timing is advanced or delayed, replace or increase the gaskets under the injection pump, following the instructions given in Injection pump and checking the static injection advance relevant to the engine static timing.

Reassembling – Oil filter – Injection pump inspection cover – Fuel supply pump – High pressure pipe – Tappets cover

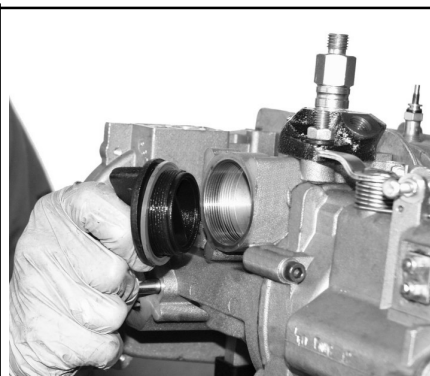
Screw the oil filter on the appropriate union, screw on the injection pump inspection plug, fit the fuel supply pump control rod, then reassemble the pump, fixing it with the appropriate nuts to a 20 Nm torque, as specified.

Reassemble the injection pump-injector high pressure union pipe by tightening it to an 18÷20 Nm torque.

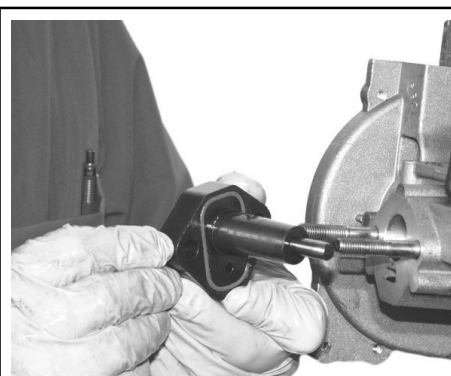
Assemble the tappets cover by anchoring them with the 4 screws tightened to 8 Nm.



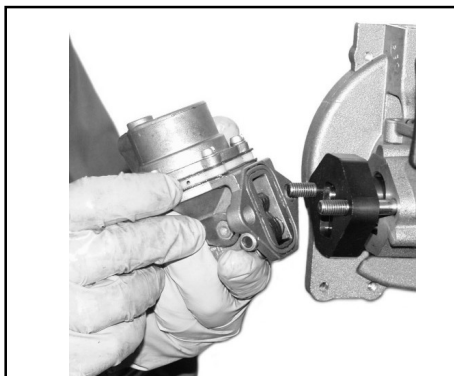
295



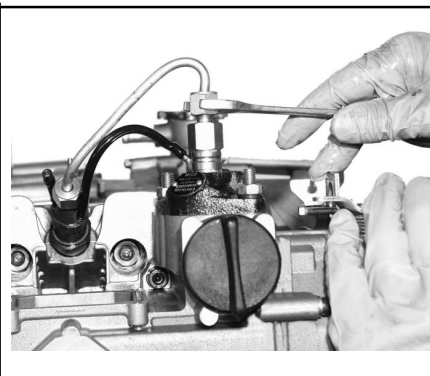
296



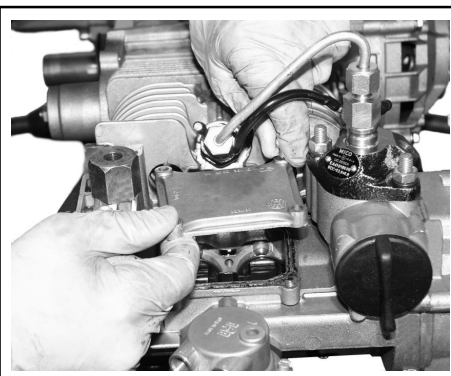
297



298



299



300

Feeding pump

Minimum flow at 2000 r.p.m. of camshaft : ≥ 100 l/h

Control lever stroke : 2,0 mm

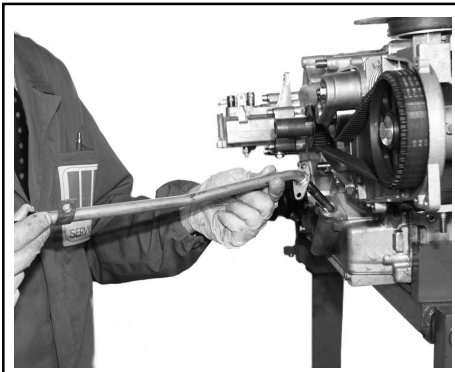
Feeding pressure at 2000 rpm of the camshaft : 0,2 bar

Reassembling – Oil level rod - Starting motor - Flywheel – Fan scroll together with the stator – Belt cover - Exhaust manifold – Cooling covers – Fan scroll cover - Muffler - etc..

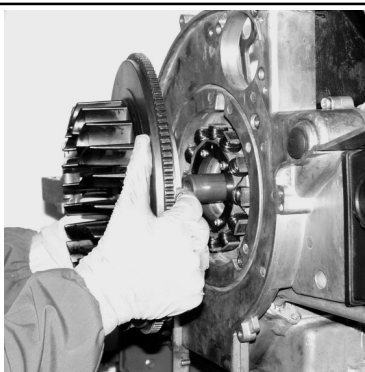
Complete the engine with the above mentioned details



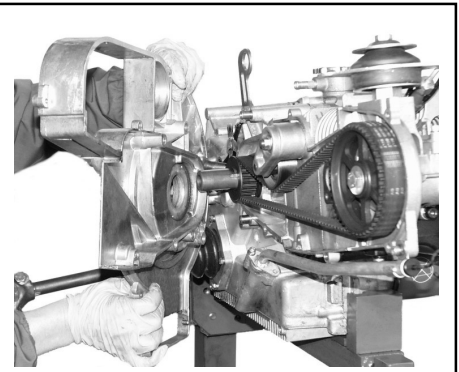
301



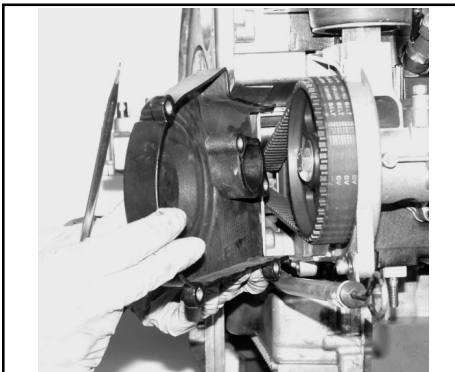
302



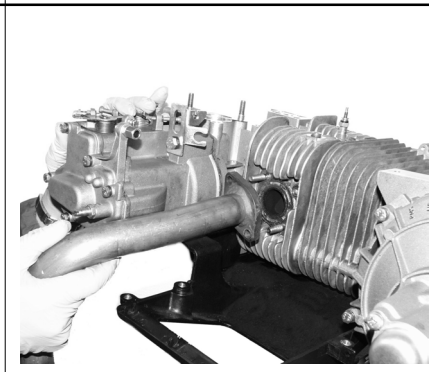
303



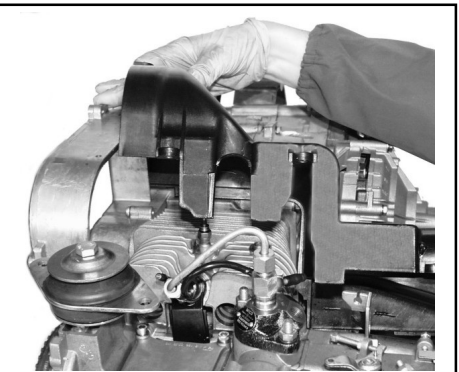
304



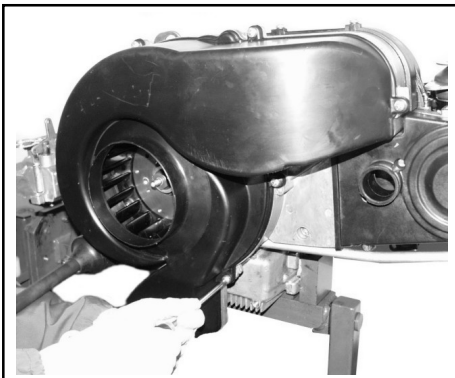
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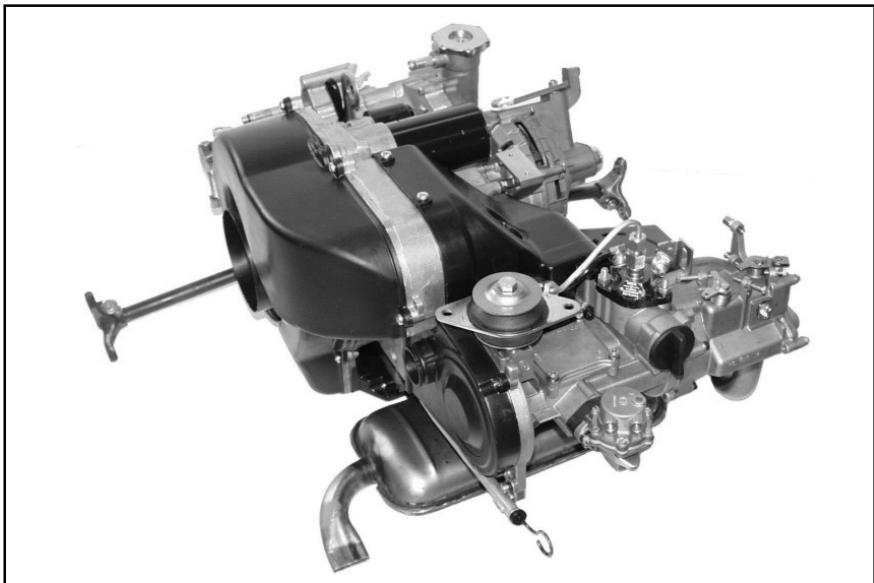
306



307



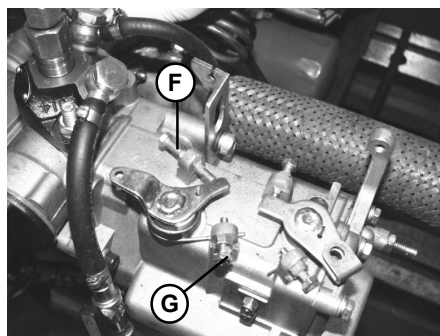
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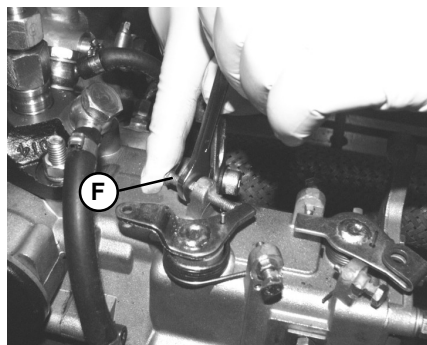
309

Min. and max r.p.m. regulation

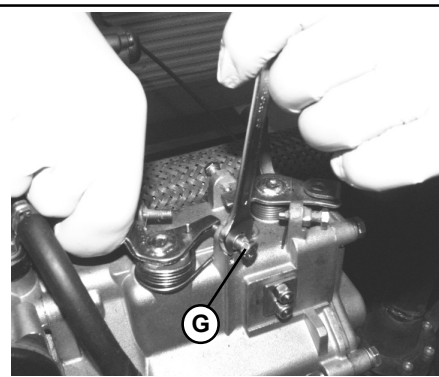
The operations of min. and max r.p.m. must be carried out with a warm engine, as follows: act after unlocking the lock nut, on screw "F" of accelerator lever position so as min. r.p.m. result 1200 and lock again lock nut. loosen the lock nut of screw "G", gradually accelerate the engine until 4150 r.p.m. are reached and by means of a screw limit accelerator lever stroke in this position and lock the lock nut.





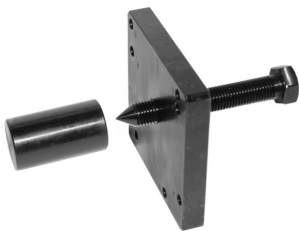

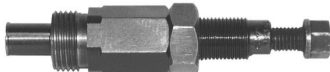


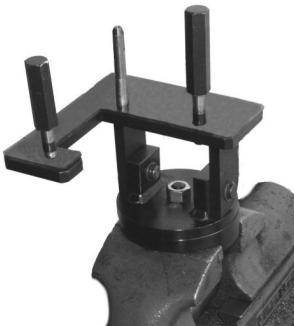
316



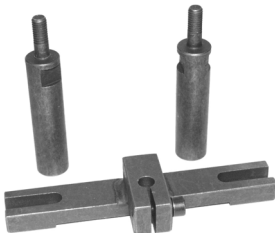


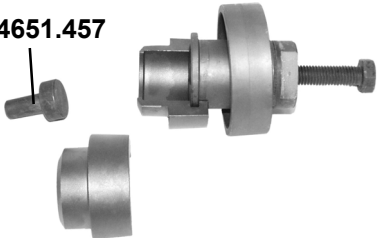



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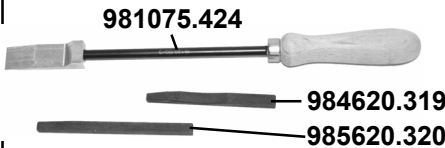
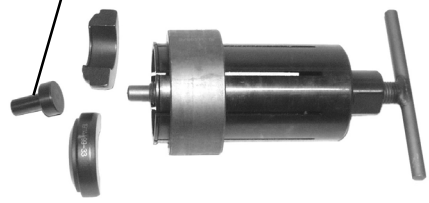
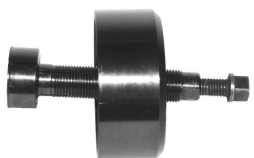





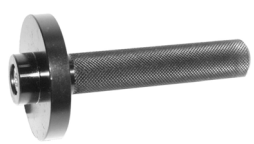
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| DRAWING | DESCRIPTION | LOMBARDINI DRAWING CODE | LOMBARDINI PART CODE |
|---|--|---------------------------------|---------------------------------|
|  | Timing reference tool A.G and Pin for camshaft timing | 5900.217 + part. 8430.124 | 5900.217 + part. 8430.124 |
|  | Pin for camshaft timing | 8430.123 | 8430 123 |
|  | Differential box extraction tool | 981075.411 | 1460.170 |
|  | Primary gear blocking tool | 981075.412 | 1460.169 |
|  | Flame protection cover extraction tool | 981075.413 | 1460.168 |
|  | Flywheel blocking tool | 981075.414 | 1460.172 |
|  | Bearing extractor diam. 35 mm | 981075.415 | 1460.166 |
|  | Head blocking tool | 981075.416 | 1460.165 |

| | |
|----------|--------------|
| X | TOOLS |
|----------|--------------|

| DRAWING | DESCRIPTION | LOMBARDINI DRAWING CODE | LOMBARDINI PART CODE |
|---|----------------------------------|------------------------------------|---------------------------------|
|  | Head seal identification tool | 981075.417 | 1460.163 |
|  | Flywheel extraction tool | 981075.418 | 1460.162 |
|  | Clutch extraction tool | 981075.419 | 1460.181 |
| 984651.457  | Flywheel cone extraction tool | 981075.420 + 984651.457 | 1460.180 + 1460.179 |
|  | Anticipation extraction tool | 981075.421 | 1460.156 |
|  | Engine support tool 422 | 981075.422 | 1460.177 |
|  | Maximum load control tool | 981075.423 + 984070.499 | 1460.184 |

| | | | | | | | |
|-----------|--|--------------------------------|--------------------------|------------------------------------|---------------------------|---------------------------|--------------------------------|
| 80 |  COMPILER TECN.ATI <i>M. P. Imbello</i> | REG. CODE 1-5302-596 | MODEL N° 50881 | DATE OF ISSUE 15-05-2003 | REVISION 00 | DATE 15-05-2003 | ENDORSED <i>John</i> |
|-----------|--|--------------------------------|--------------------------|------------------------------------|---------------------------|---------------------------|--------------------------------|

| DRAWING | DESCRIPTION | LOMBARDINI DRAWING CODE | LOMBARDINI PART CODE |
|---|--|--|-----------------------------------|
|  <p>981075.424 984620.319 985620.320</p> | Valve plates replacement tools | 981075.424 + 984620.319 + 985620.320 | 1460.161 + 1460.182 + 1460.183 |
|  <p>984651.457</p> | Bearing extractor | 981075.425 + 984651.457 | 1460.178 + 1460.179 |
|  | Bearing extractor | 981075.426 | 1460.167 |
|  | Double fork to check the P-NP differential shaft | 984980.324 | 1460.158 |
|  | Clutch stop hook | 985110.039 | 1460.173 |
|  | Buffer handle | 985430.007 | 1460.176 |
|  | Piston insertion spring | 985820.212 | 1460.159 |
|  | Punch to install roller box on the primary shaft of the cover (flywheel side) | 986290.104 | 1460.187 |
|  | Punch for roller box for elbow shaft on clutch side | 986290.105 | 1460.174 |

| | |
|----------|--------------|
| X | TOOLS |
|----------|--------------|




| DRAWING | DESCRIPTION | LOMBARDINI DRAWING CODE | LOMBARDINI PART CODE |
|---|---|------------------------------------|---------------------------------|
|  | Punch for roller box for elbow shaft on flywheel side | 986290.106 | 1460.189 |
|  | Punch for roller box diam35 | 986290.107 | 1460.188 |
|  | Differential bearing punch | 986290.108 | 1460.175 |
|  | Punch to install sealing ring on the valve trach | 986290.109 | 1460.160 |
|  | Punch to install sealing rings | 986290.110 | 1460.157 |
|  | Comparator support to check the play of the engine gear | 986782.034 | 1460.164 |
|  986800.255 986800.254 | Punch to calk the crosspiece | 986800.254 + 986800.255 | 1460.186 e 1460.171 |
| | | | |

| MAIN TORQUE SPECIFICATIONS | | |
|--|---------------------------|------------------|
| POSITION | Diam. and pitch (mm) | Torque (Nm) |
| Connecting rod cap fixing nut | M 10x1 | 70 |
| Flywheel fixing screws | M 14x1,5 | 180÷200 |
| Clutch – flywheel fixing screws | M 22x1,5 | 120÷140 |
| Fan – alternator rotor fixing screws | M 6 | 8 |
| Clutch disk pusher fixing screw | M 6 | 10 |
| Primary ring gear of gear box fixing screw | M 14x1,5 | 120÷140 |
| Differential ring gear fixing screws | M 10x1,25 | 65÷70 |
| Half crankcases assembly screws | M 8 | 20÷22 |
| Clutch housing fixing screws | M 6 | 8 |
| Clutch cover fixing screws | M 6 | 8 |
| Axle shaft hood flange fixing screws | M 6 | 8 |
| Shift-select lever case fixing screws | M 6 | 8 |
| Shift-select lever case fixing screws | M 8 | 20÷22 |
| Fan volute fixing screws | M 8 | 20÷22 |
| Air shroud cover fixing screws | M 6 | 8 |
| Belt tensioner fixing nut | M 10 | 40÷44 |
| Oil pressure switch | M 12x1,5 | 22 |
| Starter motor fixing screws | M 6 | 20÷22 |
| Cylinder head – exhaust system fixing screws | M 8 | 25÷30 |
| Guard tile fixing screws | M 6 | 8 |
| Oil thermal switch | M 22x1,5 | 45÷50 |
| Air shroud fixing screws | M 6 | 8 |
| Cylinder head fixing nuts | M 10x1,25 | 40 Nm + 180° |
| Timing belt cover fixing screws | M 6 | 8 |
| Cylinder head fixing stud bolt | M 14x1,5 | 15 |
| Cam shaft carrier fixing screws | M 8 | 20÷22 |
| Oil pump fixing screws | M 10x1,25 | 70÷75 |
| Timing belt gear fixing screw | M 8 | 25÷28 |
| Injection timing fixing screws | M 24 | 60÷80 |
| Injector | M 8 | 30 |
| Injection pump fixing screws | M 12x1,25 | 15 |
| Spark plug | M 8 | 20÷22 |
| Feed pump fixing nuts | M 6 | 8 |
| Tappet cover fixing screws | M 8 | 19÷21 |
| Cylinder head exhaust manifold fixing nuts | M 6 | 8 |
| Dipstick tube fixing screw | M 6 | 8 |
| Clamp for starter motor fixing screws | M 6 | 8 |
| Starter motor to clamp fixing nuts | M 6 | 8 |
| Oil duct plugs | M 26x1,5 | 6 |
| Injector – injection pump connecting pipe | M 12x1,5 | 18÷22 |
| Stator to volute fixing screws | M 5 | 4 |
| Piston cooling valve | M 7 | 12 |
| Plug wire fixing nut | M 5 | 4 |

Setting up with belt driven alternator

| | | |
|------------------------------------|------|----|
| Bracket to crankcase fixing screws | M 10 | 40 |
| | | |
| | | |

STANDARD BOLT TORQUE SPECIFICATIONS

| DESCRIPTION |  | |  | |  | |
|--------------------------|---|-------|---|-------|---|-------|
| Diameter x pitch (mm) | R ≥ 800 N/mm2 | | R ≥ 1000 N/mm2 | | R ≥ 1200 N/mm2 | |
| | Nm | Kgm | Nm | Kgm | Nm | Kgm |
| 4x0,70 | 3,6 | 0,37 | 5,1 | 0,52 | 6 | 0,62 |
| 5x0,80 | 7 | 0,72 | 9,9 | 1,01 | 11,9 | 1,22 |
| 6x1,00 | 12 | 1,23 | 17 | 1,73 | 20,4 | 2,08 |
| 7x1,00 | 19,8 | 2,02 | 27,8 | 2,84 | 33 | 3,40 |
| 8x1,25 | 29,6 | 3,02 | 41,6 | 4,25 | 50 | 5,10 |
| 9x1,25 | 38 | 3,88 | 53,4 | 5,45 | 64,2 | 6,55 |
| 10x1,50 | 52,5 | 5,36 | 73,8 | 7,54 | 88,7 | 9,05 |
| 12x1,75 | 89 | 9,09 | 125 | 12,80 | 150 | 15,30 |
| 14x2,00 | 135 | 13,80 | 190 | 19,40 | 228 | 23,30 |
| 16x2,00 | 205 | 21,00 | 289 | 29,50 | 347 | 35,40 |
| 18x2,50 | 257 | 26,30 | 362 | 37,00 | 435 | 44,40 |
| 20x2,50 | 358 | 36,60 | 504 | 51,50 | 605 | 61,80 |
| 22x2,50 | 435 | 44,40 | 611 | 62,40 | 734 | 74,90 |
| 24x3,00 | 557 | 56,90 | 784 | 80,00 | 940 | 96,00 |






LOMBARDINI S.r.l.
a socio
unico

42100 Reggio Emilia – Italia - ITALY
Via Cav. del Lavoro Adelmo Lombardini, 2 - Cas. Post. 1074
Tel. (+39) 0522 3891 - Telex 530003 Motlom I – Telegr.: Lombarmotor
R.E.A. 227083 - Reg. Impr. RE 10875
Cod. fiscale e Partita IVA 01829970357 - CEE Code IT 01829970357
E-MAIL: atl@lombardini.it
Internet: <http://www.lombardini.it>

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| 86 |  COMPILER TEC. DATI <i>M. Imbelli</i> | REG. CODE 1-5302-596 | MODEL N° 50881 | DATE OF ISSUE 15-05-2003 | REVISION 00 | DATE 15-05-2003 | ENDORSED <i>[Signature]</i> |
|----|---|-------------------------|-------------------|-----------------------------|-------------|--------------------|--------------------------------|