RR RACE

RR X-PRO

350 - 500

4 Stroke



2025
WORKSHOP MANUAL

Beta
motorcycles

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TABLE OF CONTENTS

PREAMBLE 2

ENGINE TECHNICAL SPECIFICATIONS 4

SPECIAL EQUIPMENT 5

1 ENGINE REMOVAL FROM VEHICLE 6

2 ENGINE DISASSEMBLY 18

2.1 THERMAL UNIT **18**
2.1.1 CYLINDER HEAD: DISASSEMBLING THE MECHANICAL TENSIONER 20
2.1.2 CYLINDER HEAD: DISASSEMBLING THE CAMSHAFT SUPPORT, FIXED PAD AND SPARK PLUG SEAT O-RING 21
2.1.3 CYLINDER HEAD: REMOVING THE CAMSHAFTS .. 22
2.1.4 CYLINDER HEAD: UNCOUPLING FROM CYLINDER 23
2.1.5 DISASSEMBLING THE CYLINDER AND PISTON 25

2.2 DISASSEMBLY OF IGNITION UNIT, TIMING CHAIN AND PADS **26**
2.2.1 STATOR, FLYWHEEL e pick-up unit 26
2.2.2 TIMING CHAIN AND PADS 29

2.3 PINION AND SPACER **31**

2.4 CLUTCH UNIT AND COOLANT PUMP COVER ... **32**

2.5 ENGINE LUBRICATION CIRCUIT **37**
2.5.1 OIL PUMPS CONTROL GEARS 38
2.5.2 HIGH-PRESSURE OIL PUMP 38
2.5.3 INTAKE OIL PUMP AND BY-PASS VALVE 39
2.5.4 OIL PRESSURE CONTROL VALVE 40
2.5.5 PAPER OIL FILTER 40

2.6 COUNTERSHAFT **41**

2.7 PRIMARY GEAR **42**

2.8 ELECTRIC IGNITION **44**
2.8.1 ELECTRIC KICKSTART UNIT 45

2.9 PEDAL KICKSTARTER - Optional **46**

2.10 EXTERNAL GEARSHIFT UNIT **48**

2.11 CRANKSHAFT, GEARBOX UNIT AND INTERNAL GEARSHIFT **49**
2.11.1 NUT ON LEFT SIDE OF CRANKSHAFT 49
2.11.2 OPENING THE CRANKCASE 50
2.11.3 CRANKSHAFT 51
2.11.4 INTERNAL GEARSHIFT UNIT AND COMPLETE GEARBOX 51

2.12 DISASSEMBLY OF PARTS FROM CRANKCASES **53**
2.12.1 RIGHT CRANKCASE HALF 53
2.12.2 LEFT CRANKCASE HALF 54

3 ENGINE ASSEMBLY AND CONTROLS 56

3.1 CRANKCASE HALF **57**
3.1.1 EXTERNAL RIGHT SIDE 58
3.1.2 INTERNAL RIGHT SIDE 61
3.1.3 EXTERNAL LEFT SIDE 63
3.1.4 INTERNAL LEFT SIDE 64

3.2 CHECKING THE CONNECTING ROD AND MOTOR SHAFT **65**

3.3 COMPLETE CRANKSHAFT ASSEMBLY **67**

3.4 GEARBOX UNIT: CHECKS AND REASSEMBLY . **68**
3.4.1 GEARBOX UNIT CHECK 68
3.4.2 PRIMARY UNIT ASSEMBLY 69
3.4.3 SECONDARY UNIT ASSEMBLY 71
3.4.4 CHECKING THE FORKS, FORK PINS AND DESMODROMIC DEVICE 74

3.5 GEARBOX AND INTERNAL GEARSHIFT ASSEMBLY **76**

3.6 CLOSING THE ENGINE CRANKCASE **79**

3.7 BLOCKING THE CRANKSHAFT AT THE TOP DEAD CENTRE AND TIGHTENING THE NUT ON THE LEFT SIDE OF THE CRANKSHAFT **81**

3.8 EXTERNAL GEARSHIFT **82**
3.8.1 CHECKING THE COMPLETE DRIVE SHAFT 82
3.8.2 EXTERNAL GEARSHIFT ASSEMBLY 84

3.9 KICKSTARTER DEVICE - (OPTIONAL) **84**
3.9.1 CHECKING THE KICKSTART SHAFT UNIT AND ASSEMBLY 84
3.9.2 ASSEMBLY OF KICKSTARTER DEVICE (OPTIONAL)86

3.10 ELECTRICAL STARTER UNIT AND PRIMARY GEAR **88**
3.10.1 CHECKING ELECTRICAL STARTER DEVICE ELEMENTS 88
3.10.2 COUPLING IGNITION AND PRIMARY GEARS TO THE MOTOR 89

3.11 OIL PUMPS: INSPECTION AND REASSEMBLY . **91**
3.11.1 INTAKE PUMP ASSEMBLY 93
3.11.2 HIGH-PRESSURE PUMP AND CONTROL GEAR ASSEMBLY 94
3.11.3 CHECKING AND ASSEMBLING THE PRESSURE CONTROL VALVE 95
3.11.4 CHECKING AND ASSEMBLING THE OIL PUMP CONTROL GEARS 96
3.11.5 PAPER OIL FILTER INSERTION 97
3.11.6 CHECKING AND COUPLING THE COUNTERSHAFT 98

3.12 CLUTCH UNIT **100**

TABLE OF CONTENTS

ENGLISH

3.12.1 CHECKING THE CLUTCH CASE, ROLLER BEARING AND INTERNAL CENTRE BEARING 100
3.12.2 CHECKING THE CLUTCH DISCS 101
3.12.3 CLUTCH DRUM AND CAP CHECK 102
3.12.4 CLUTCH UNIT ASSEMBLY 102
3.12.5 CLUTCH UNIT ASSEMBLY 103

3.13 COOLANT PUMP 107
3.13.1 CHECKING THE PUMP UNIT AND DISASSEMBLY 107
3.13.2 PUMP UNIT ASSEMBLY 108

3.14 ASSEMBLY OF COMPLETE CLUTCH COVER 110

3.15 CHECKING AND COUPLING OF TIMING CHAIN, FIXED AND MOBILE PADS 112

3.16 IGNITION SYSTEM 114
3.16.1 IGNITION SYSTEM CHECK 114
3.16.2 COUPLING OF IGNITION SYSTEM TO CRANKCASE 114

3.17 THERMAL UNIT 117
3.17.1 CHECKING THE PISTON, PIN BOLT AND PISTON RINGS 117
3.17.2 CYLINDER CHECK 119
3.17.3 CYLINDER HEAD: DISASSEMBLING AND CHECKING AUXILIARY DEVICES 120
3.17.4 CYLINDER HEAD: DISASSEMBLING AND CHECKING VALVE UNITS 123
3.17.5 CYLINDER HEAD: CHECKING THE CYLINDER HEAD BODY 126
3.17.6 CHECKING THE CAMSHAFTS 127
3.17.7 CHECKING THE CAMSHAFT bearing bridges 128
3.17.8 CYLINDER HEAD: INSERTION OF LOWER CUP AND OIL-SCRAPER RING 129
3.17.9 CYLINDER HEAD: ASSEMBLY OF VALVE UNIT 130
3.17.10 CYLINDER HEAD: REPOSITIONING CALIBRATED DISCS. ASSEMBLING ROCKER ARM PINS AND ROCKER ARMS AND COUPLING THE SPARK PLUG 131
3.17.11 CYLINDER HEAD: INSERTION OF OIL JETS, CENTRING PINS AND SPARK PLUG O-RING 132
3.17.12 PISTON: APPLICATION OF THE OIL-SCRAPER AND SEAL BANDS, APPLICATION OF THE CIRCLIP 133
3.17.13 APPLICATION OF PISTON TO CYLINDER 134
3.17.14 APPLICATION OF PISTON-CYLINDER COUPLING TO CRANKCASE 136
3.17.15 COUPLING HEAD TO CYLINDER 138
3.17.16 COUPLING CAMSHAFTS TO CYLINDER HEAD AND PHASING 139
3.17.17 VALVE BACKLASH 142
3.17.18 CHECKING AND COUPLING OF MECHANICAL TENSIONER TO ENGINE 144
3.17.19 COUPLING CYLINDER HEAD COVER GASKETS AND CYLINDER HEAD COVER 146

3.18 PINION COUPLING 147

3.19 RELEASING THE CRANKSHAFT 147

3.20 COUPLING OIL CAPS 148

3.21 COUPLING GEARSHIFT LEVER 149

4 REASSEMBLY OF ENGINE IN THE VEHICLE 150

TABLE OF ENGINE COMPONENTS TIGHTENING TORQUES 165

TABLE OF FRAME/ENGINE TIGHTENING TORQUES 168

TABLE OF SUPERSTRUCTURE TIGHTENING TORQUES 168

RECOMMENDED ENGINE MAINTENANCE 169

RECOMMENDED LUBRICANTS AND LIQUIDS 170

PREAMBLE

This publication is intended for workshops specialised in repairing motorbikes and motorcycles.
Where prescribed, use special Betamotor tools.
Use Betamotor spare parts only. For their codes, refer to the spare parts manual for the specific vehicle or version.
The warranty and liability on vehicle safety lapses when maintenance or repairs:

- Are **NOT** performed by workshops specialised in repair of motorbikes and motorcycles.
- Are **NOT** carried out carefully following the requirements contained in the technical documentation;
- Are **NOT** carried out using special Betamotor tools, where required;
- Are **NOT** carried out using Betamotor official spare parts.

Carefully read this manual in its entirety before working on the engine. Good knowledge of all components making up the engine and all the procedures to be followed for inspection and maintenance help lengthen the life of the engine.
The paragraphs have been enhanced with schematic illustrations highlighting each topic in order to make the text immediately understandable.

Informative note

Betamotor S.p.A. is committed to a policy of ongoing improvement of its products. This is why you might notice slight differences between the content of this document and the vehicle on which you are about to carry out repairs and/or maintenance. Betamotor S.p.A. models are exported to a number of countries where there are different rules concerning the Highway Code and vehicle type-approval procedures. Betamotor S.p.A. therefore reserves the right to modify its products and technical documentation at any time without prior notice, thank you for your understanding.

We respect and defend the environment

Everything we do has an impact on the whole Planet and its Resources. To safeguard the interests of the entire Community, Betamotor S.p.A. would like to raise the awareness of customers and technical service operators about ways of using the vehicle and disposing of its parts entirely in compliance with applicable regulations in terms of environmental pollution, waste disposal and recycling.

SAFETY

Carbon monoxide

- *Exhaust gases contain carbon monoxide, which is poisonous. Carbon monoxide may cause loss of consciousness and lead to death. If the engine needs to be started, make sure the location is well-ventilated. Never start the engine indoors.*
- *The engine can be started indoors only if fitted with the appropriate exhaust gas extraction devices.*

Petrol

- *Petrol is extremely flammable and can be explosive under certain conditions.*
- *Keep sources of heat, sparks and flames away from the work area.*
- *Always work in a well-ventilated area.*
- *Never use petrol as a solvent for cleaning. Do not handle it unless strictly necessary.*
- *Never use petrol to clean components by means of compressed air.*
- *Keep out of the reach of children.*

Engine oil

- *Motor oil can cause skin conditions if it remains in contact with the skin often and for prolonged periods.*
- *In case of contact with engine oil, wash with soap and water as soon as possible.*
- *In case of contact with the eyes, rinse them with plenty of water and seek medical advice.*
- *If swallowed, do not induce vomiting in order to prevent the product from entering into the lungs; seek immediate medical advice. If you believe the product has entered the lungs, take the person concerned to hospital immediately.*
- *Waste oil contains dangerous substances that are harmful for the environment. In order to change it one must be equipped for disposal, in compliance with applicable laws.*
- *Do not discard waste oil into the environment.*
- *Keep out of the reach of children.*

Coolant liquid

- *In some situations, the ethylene glycol contained in the coolant is flammable and its flame is invisible. Should ethylene glycol catch fire, it can cause burns even though its flame is invisible.*
- *Do not bring the coolant into contact with hot parts. These parts could be hot enough to cause the liquid to ignite.*
- *The coolant (ethylene glycol) may irritate the skin and is poisonous if swallowed.*
- *Should the coolant come into contact with the skin, immediately remove contaminated clothing or footwear and wash with soap and water. In the event of contact with the eyes, rinse with plenty of clean water and seek medical advice immediately. Should it be swallowed, do not induce vomiting in order to prevent the product from entering the lungs. Administer clean water, immediately take the person concerned to hospital, and show this product to hospital staff.*
- *In the event of exposure to a high concentration of vapours, move the person concerned to an uncontaminated area and seek medical advice if necessary.*
- *Do not remove the radiator cap when the engine is still hot. Since the coolant is pressurised, it may spurt out violently and cause burns.*
- *The coolant contains dangerous substances that are harmful for the environment. In order to change it one must be equipped for disposal in compliance with applicable laws.*
- *Do not disperse coolant into the environment.*
- *Keep out of the reach of children.*

Hot parts

- *The engine and the exhaust system get very hot and remain at that temperature for a long time, even after the engine has been turned off. Wait for them to cool down before handling these parts or carrying out work on areas around them. Wear insulated gloves.*

WARNINGS

The information contained in this paragraph is important to ensure the operations carried out on the engine are performed without causing damage.

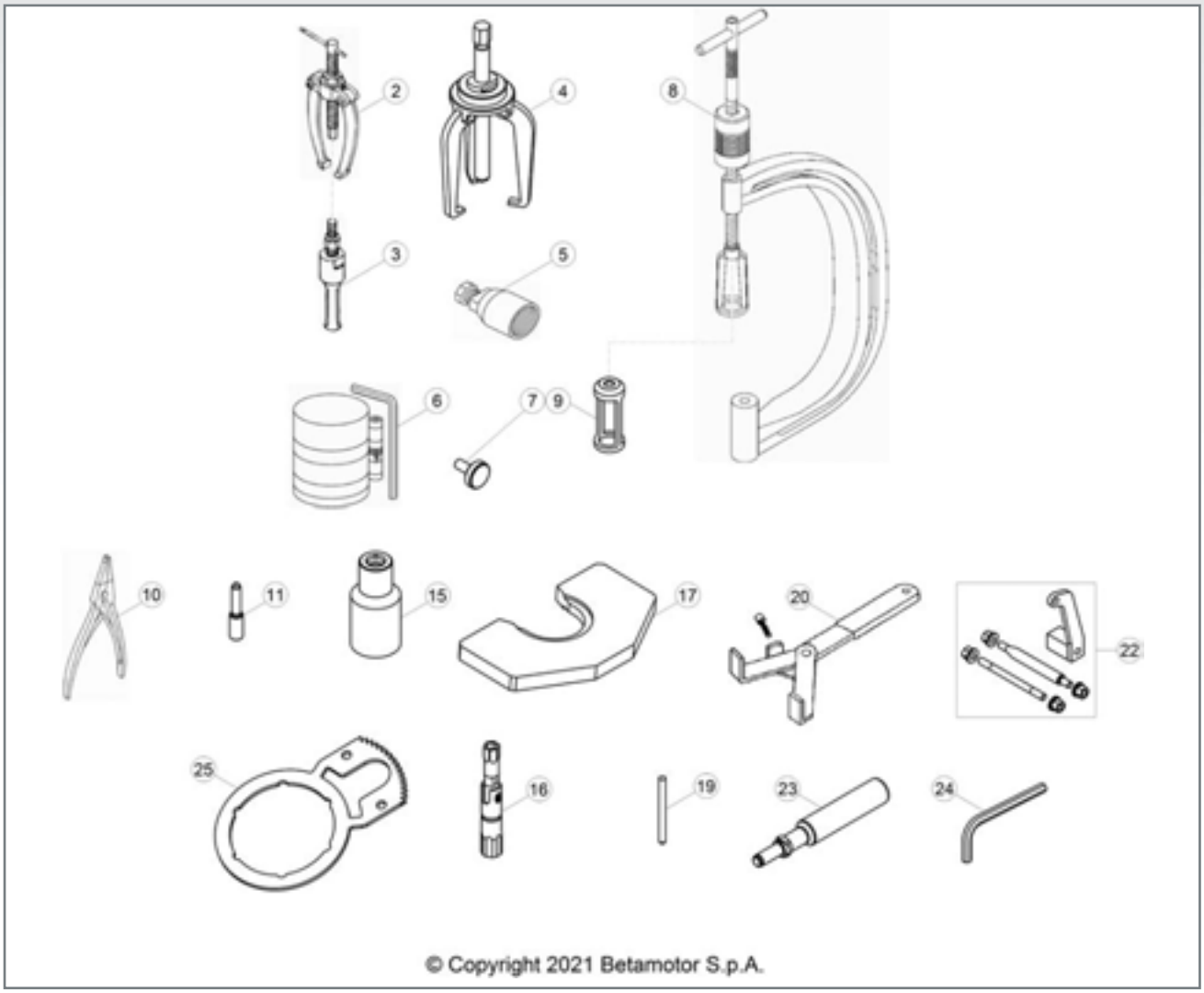
- *Before disassembly, thoroughly clean the motorcycle.*
- *While disassembling it, clean all the parts and place them in containers accurately following the order of disassembly.*
- *Always use special tools wherever necessary and when required.*
- *Always use glues, sealant and lubricants wherever required. Follow the indications concerning their technical features.*
- *Always replace parts such as gaskets, O-rings and safety washers with newly supplied parts.*
- *When loosening or tightening nuts or screws, always start with the larger ones or from the centre. Always adhere to the specified tightening torques.*
- *Use only Betamotor original spare parts.*

ENGINE TECHNICAL SPECIFICATIONS

Type	Single cylinder, 4-stroke, liquid-cooled with countershaft and electric starting			
Bore x stroke RR 350	88x57.4			
Bore x stroke RR 390	88x63.4			
Bore x stroke RR 430	95x60.8			
Bore x stroke RR 480	100x60.8			
Displacement [cm³] RR 350	349.1			
Displacement [cm³] RR 390	386			
Displacement [cm³] RR 430	431			
Displacement [cm³] RR 480	478			
Compression ratio RR 350-390-430-480	13.19:1	12.5:1	12.3:1	11.9:1
Distribution	4 valves			

TRANSMISSION				
	RR 350	RR390	RR430	RR480
Primary transmission	28/76	28/76	31/72	31/72
1st gear ratio	12/31	12/31	12/31	12/31
2nd gear ratio	15/28	15/28	15/28	15/28
3rd gear ratio	19/28	19/28	19/28	19/28
4th gear ratio	20/24	20/24	20/24	20/24
5th gear ratio	27/27	27/27	27/27	27/27
6th gear ratio	28/24	28/24	28/24	28/24
Secondary transmission	Chain			

SPECIAL EQUIPMENT



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2. *Bushing extractor code 36.25081.000;*
3. *Internal 20-30 mm bearing extractor code 006.14.016.00.00;*
4. *Extractor for gears code 006.14.015.00.00;*
5. *Flywheel extractor code 36.25173.000;*
6. *Elastic bands for segments code 006.14.017.00.00;*
7. *Chain tensioner equipment code 006.14.005.00.00;*
8. *Valve assemb./disassemb. tool code 01.00043.000;*
9. *Valve spring assembly insert code 006.14.003.00.00;*
10. *Special ring pliers code 36.25097.000;*
11. *Screw to lock crankshaft to the TDC code 006.14.011.00.00;*
15. *36 mm casing nut wrench code 006.14.002.00.00;*
16. *Special wrench for spark plug RR4T MY'10 code 020.44.010.00.00;*
17. *Connecting rod disassembly tool code 029.14.007.50.00;*
19. *Valve guide differential gauge code 006.14.018.00.00;*
20. *Clutch inner hub fastening equipment code 006.14.004.00.00;*
22. *Engine fixing code 006.14.014.00.00;*
23. *Pin elastic ring tool code 022.14.020.00.00;*
24. *Special wrench code 006.44.000.00.00;*
25. *Special wrench code 037.14.002.50.00.*

Symbols

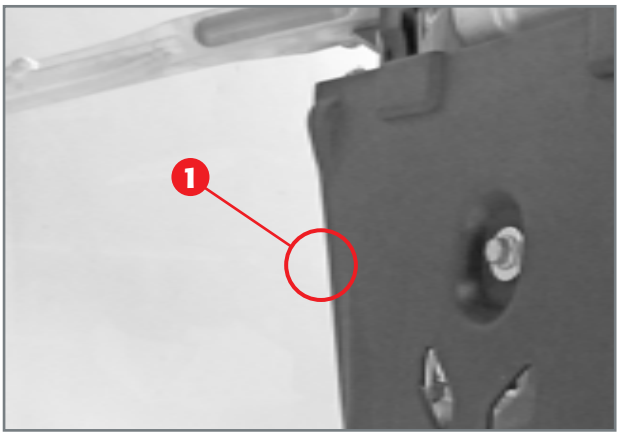
6Nm
Value
Tightening torque

Medium resistance threadlocker

Silicone paste

Grease

1 ENGINE REMOVAL FROM VEHICLE

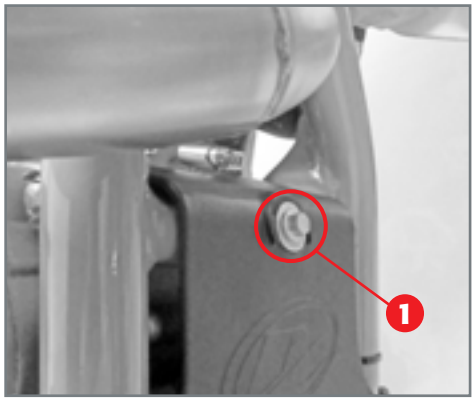


Rear engine guard fixing screw.

Carefully wash the vehicle.

Before removing the engine from the vehicle, it is necessary to empty the following liquids:
- Engine oil;
- Gear/clutch unit oil;
- Coolant liquid.

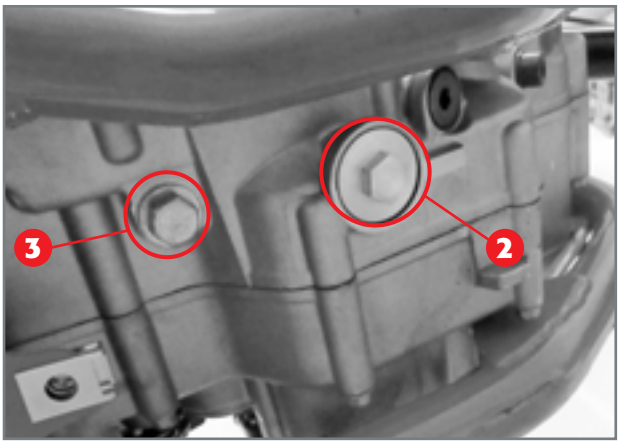
In order to access the oil drain plug, remove the engine guard connected to the frame by means of the three screws **1**.



Front engine guard fixing screws.

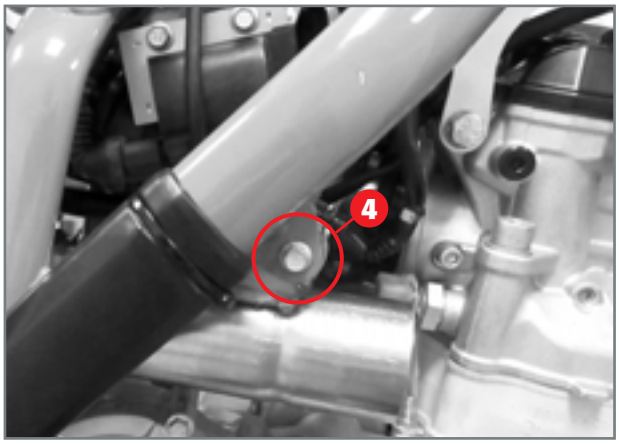
Remove screw **2** to empty the motor oil, and remove screw**3** to empty the gear oil.

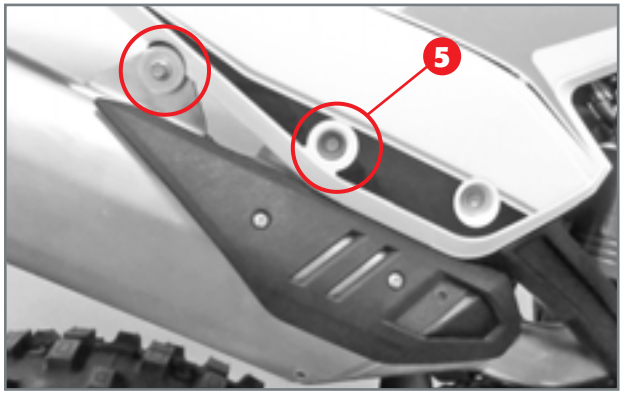
WARNING!
Waste oil contains dangerous substances which are harmful for the environment. In order to change it one must be equipped for disposal, in compliance with applicable laws. Do not dispose of used oils in the environment.



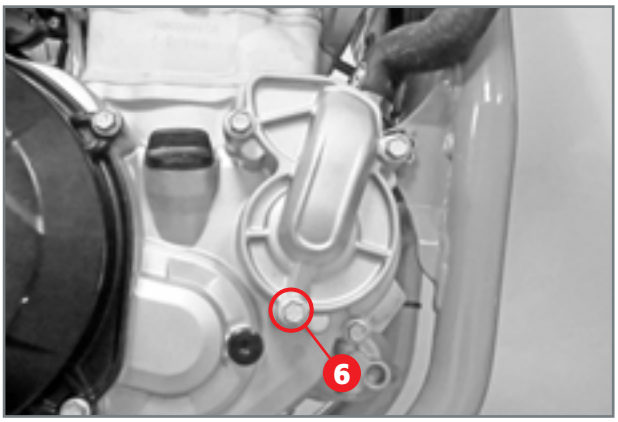
Screw 2 for draining motor oil and 3 for draining gear oil.

Remove the exhaust pipe.
Remove screw **4**.





Remove the screws **5**.
Remove the silencer from the vehicle.

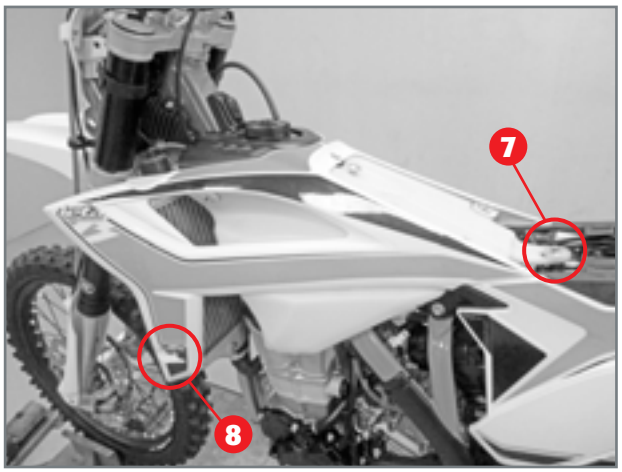


Drain the cooling system through screw **6** and let the liquid outflow into a container (the cooling circuit contains 1.3l of liquid).

Remove the radiator cap.

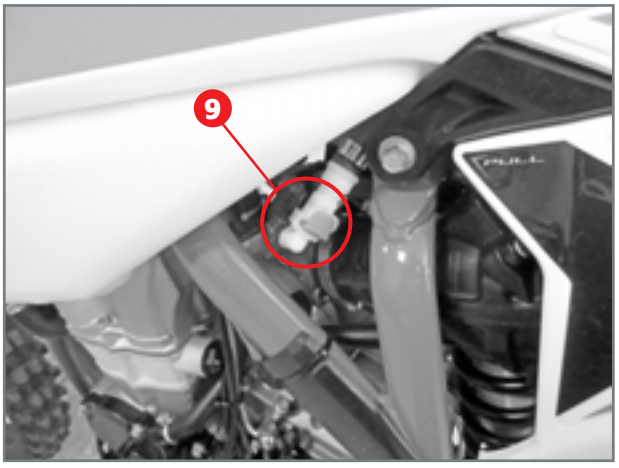


Place the vehicle onto an adequate stand.



Remove the seat.

Remove the screw **7** fastening the tank to the frame, and the screws **8** (one per side) fastening the side panel to the radiator.



Disconnect the tank ventilation pipe.

Disconnect the petrol pipe by pressing the relevant button of quick coupling **9**.

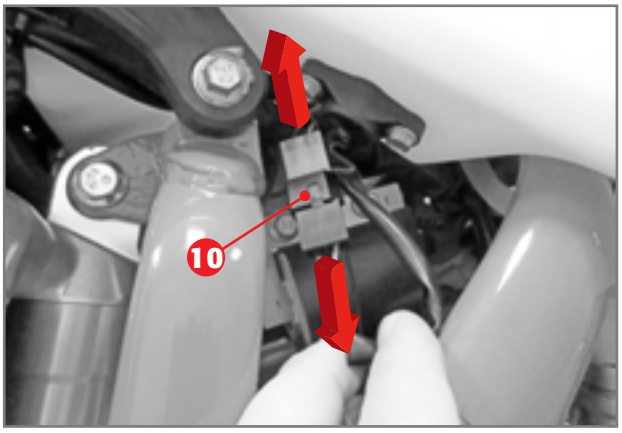
ATTENTION!
Fire hazard! Fuel is easily flammable.



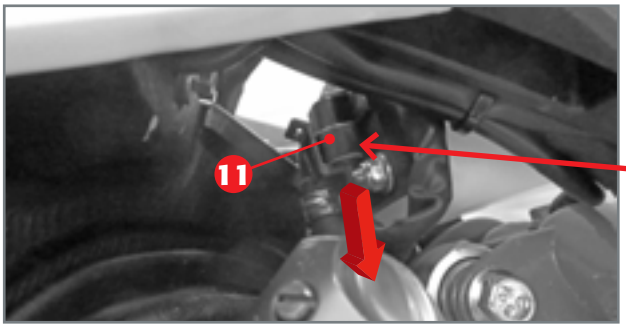
Do not carry out the operation near open flames or lit cigarettes and always turn off the engine.



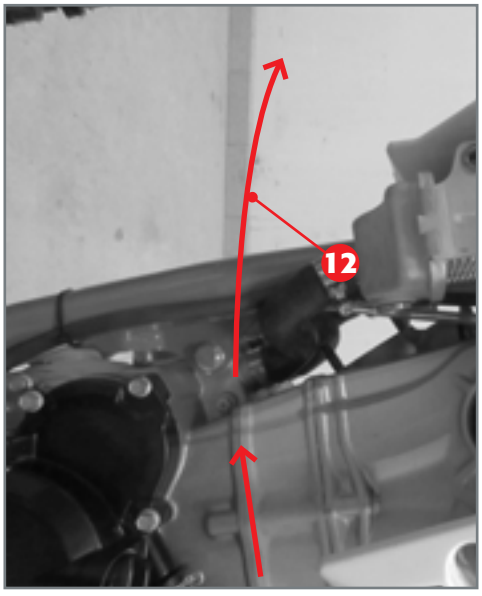
Wipe off any traces of spilled fuel immediately.



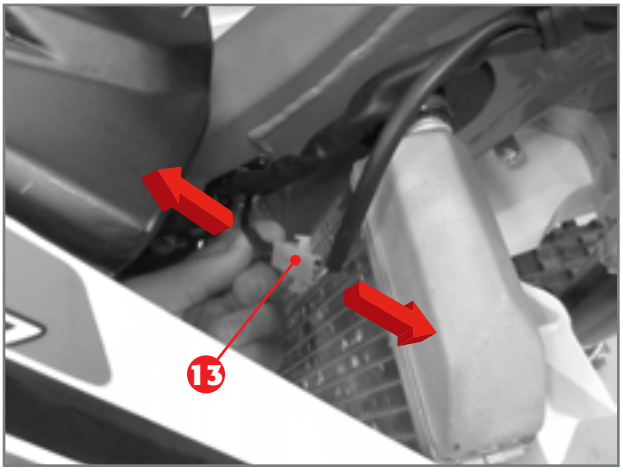
Disconnect the electric connectors **10** and **11**.





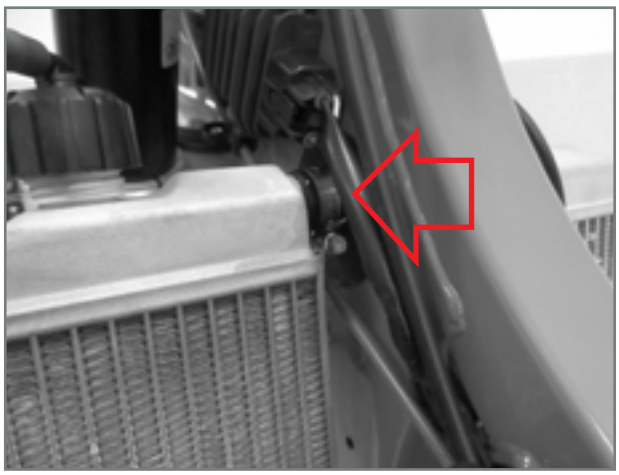


Lift the tank slightly and:
remove pipe **12**.

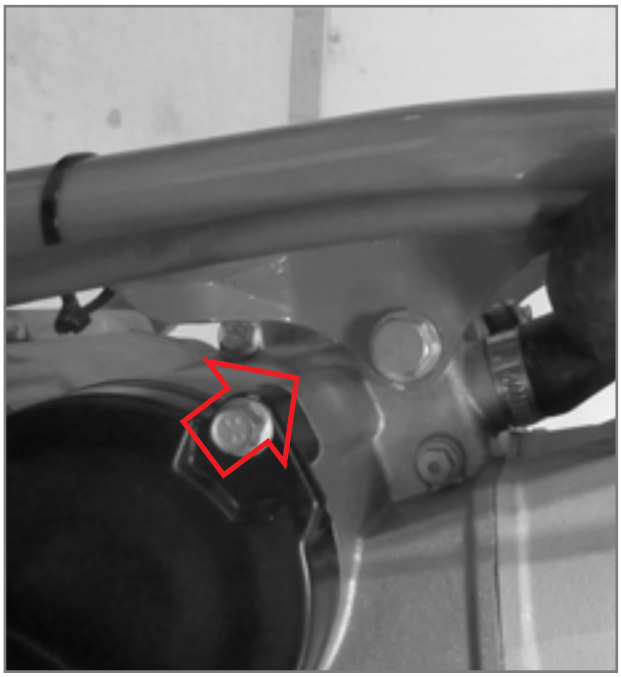


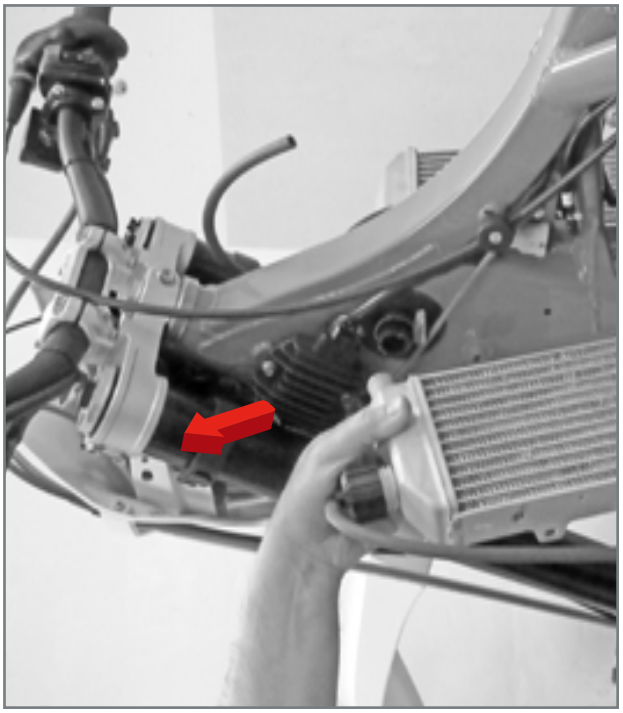
Disconnect connector **13**.

Lift the tank from the back and remove it backwards.

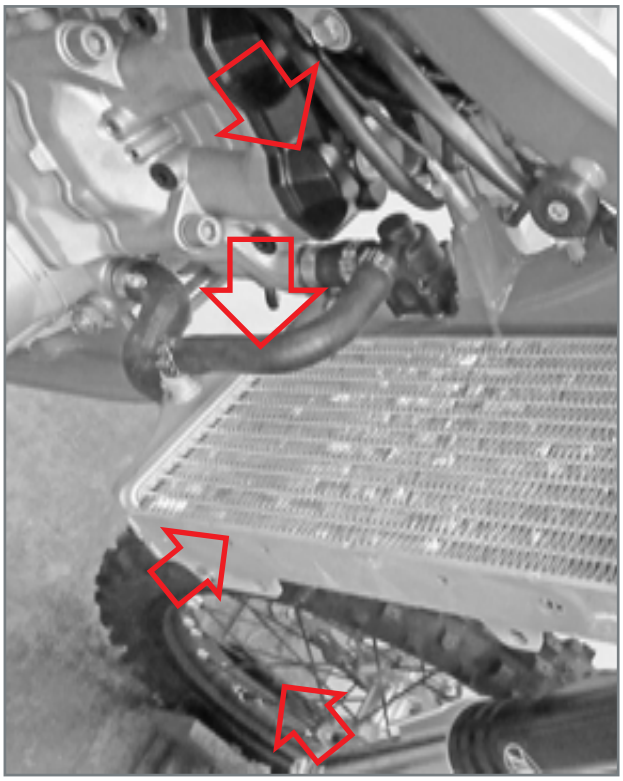


Remove the protection grids from the radiators. Disconnect the water hoses from the engine and from the left radiator.





Remove the fixing screws and remove the left radiator.



Disconnect the water hoses from the engine and from the right radiator.

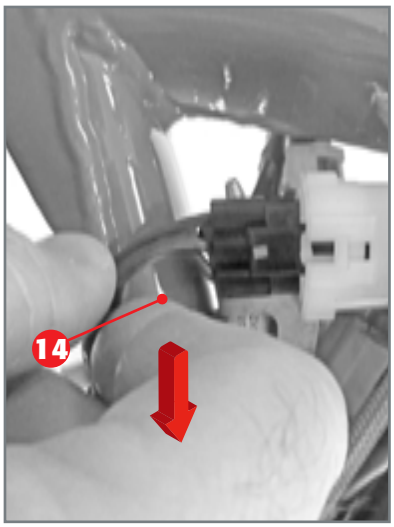


Remove the fixing screws and remove the right radiator.

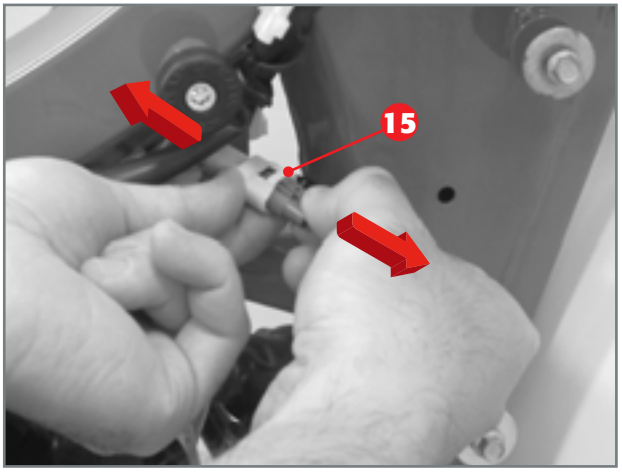


Disconnect the spark plug cap. Cut all straps binding the engine's electric system to the clutch pipe and to the frame.

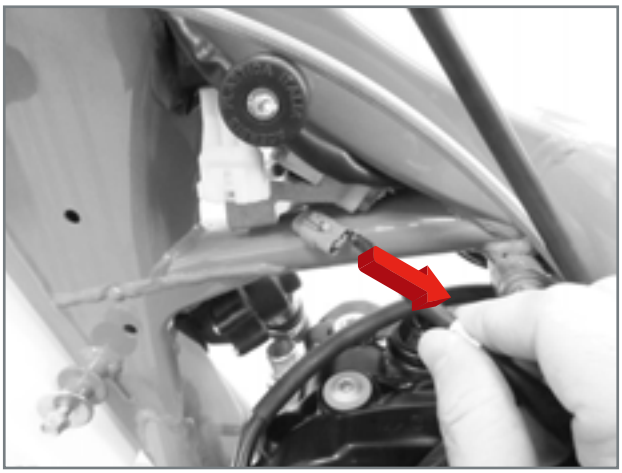
Disconnect the engine ventilation pipes.

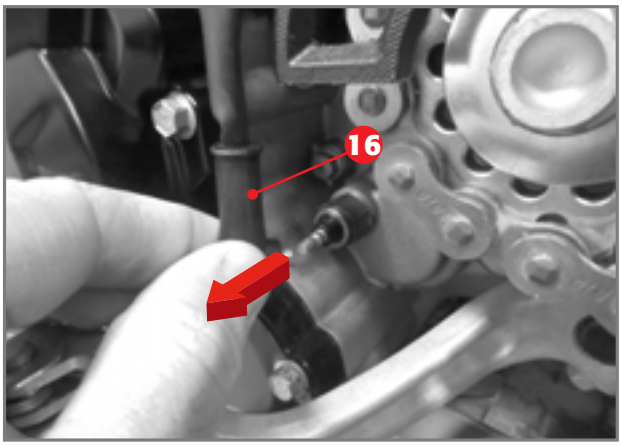


Release the connector **14**.



Release the connector **15** and remove the engine wiring from its seat.

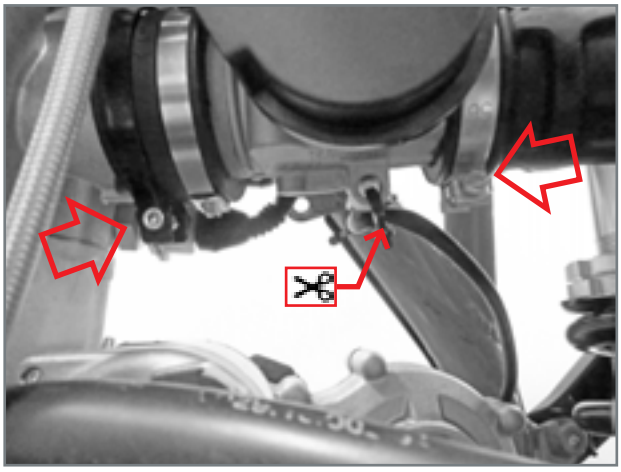




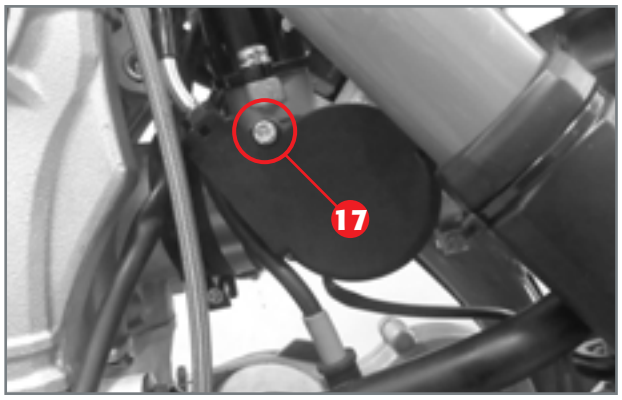
Release the connector **16**.



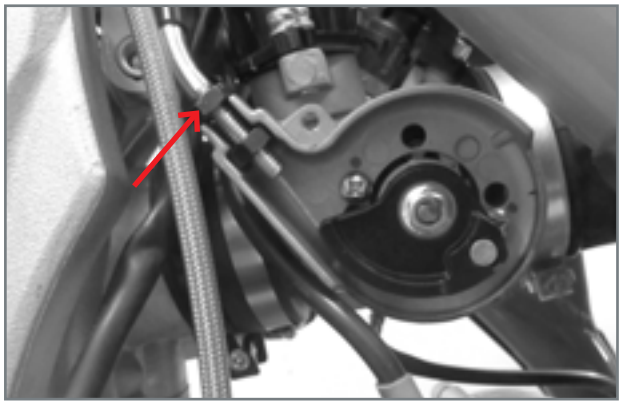
Remove the starter motor cable fixing nut.



Loosen the throttle body straps from the air filter sleeve and from the manifold.
Cut the plastic strap as shown in the figure.

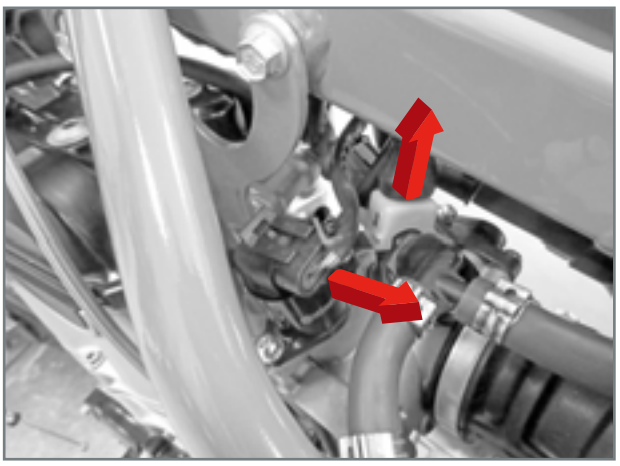


Remove the screw of the throttle body cover **17** and the cover itself.

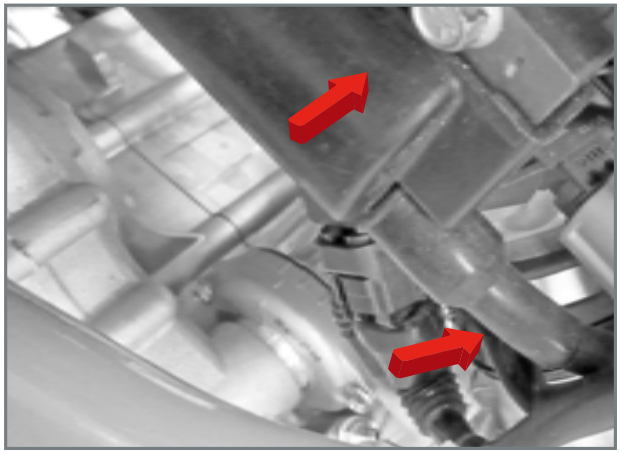


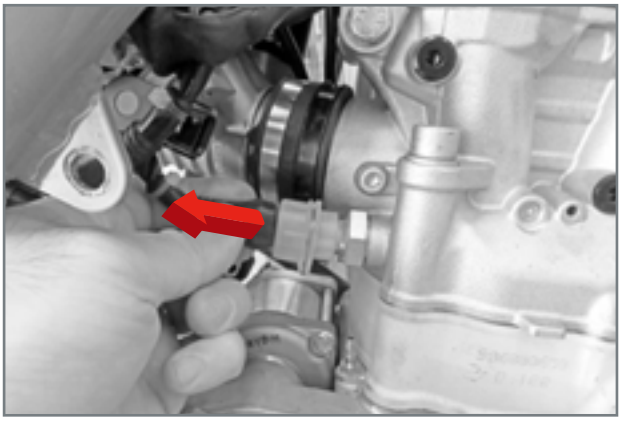
Injection versions gas cables.

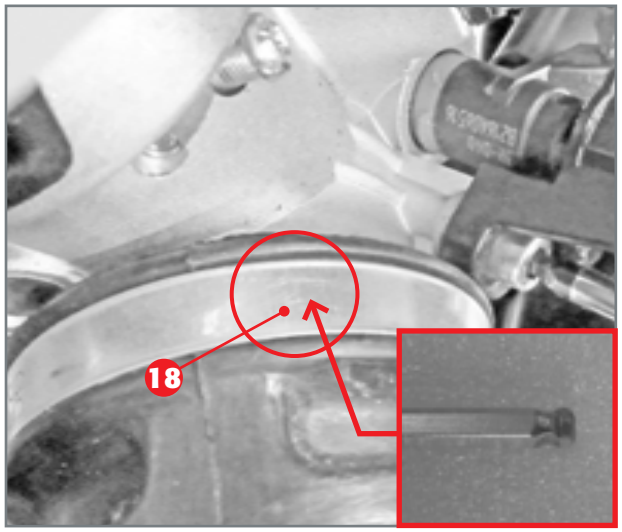
Loosen the adjustment nuts and release the gas cable.



Disconnect the electric connectors as shown in the figure.

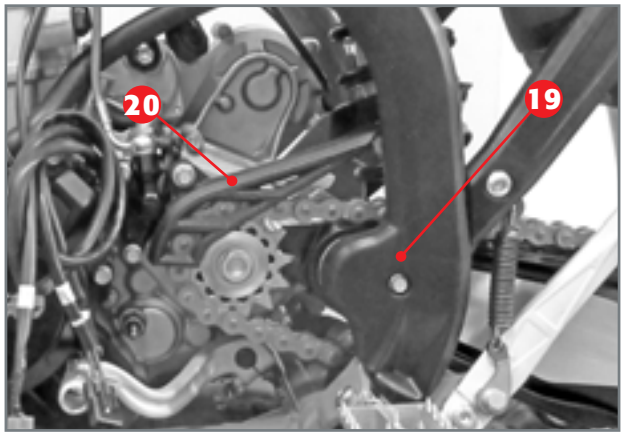




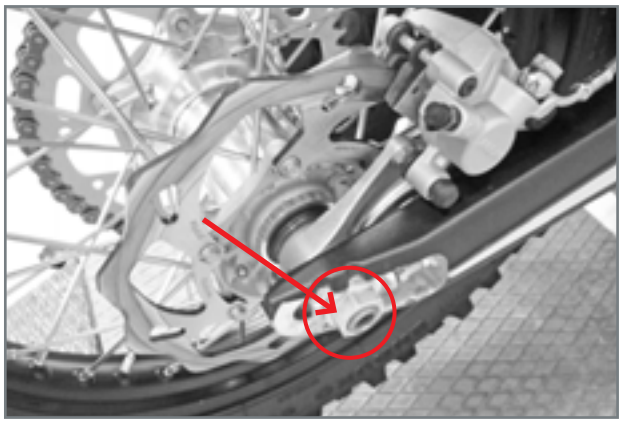


Remove the screw **18** fastening the injector to the throttle body, using a spanner as shown in the picture.
Remove the entire injector from the throttle body.

WARNING!
Make sure no foreign objects get into the injector housing. It is recommended to plug the housing with a clean cloth.



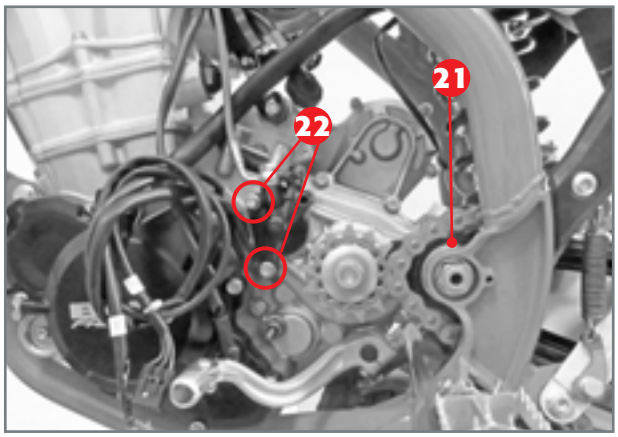
Remove the frame guards **19** (one on each side) and the pinion guard **20**.



Remove the rear wheel nut.

Extract the pin enough to allow the wheel to advance towards the front of the vehicle.

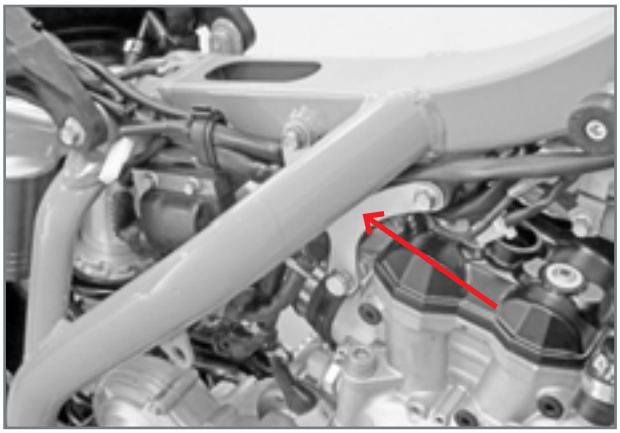
Rotate the rear wheel lifting the chain in the pinion zone, so that the chain of the pinion itself is released.



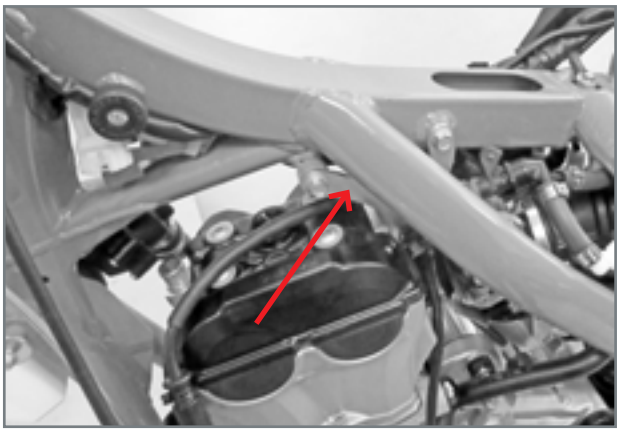
Rest the chain against the upper wedge **21**.

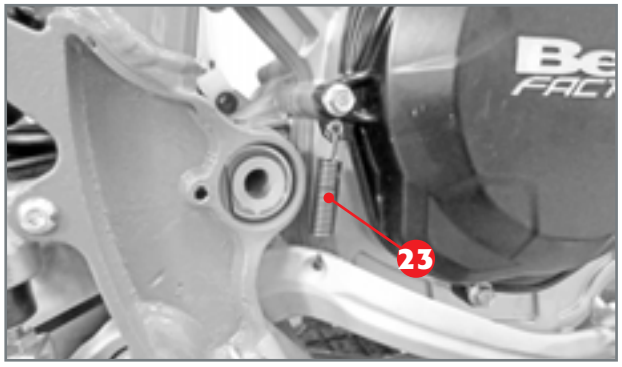
Remove the screws **22**fixing the clutch actuator to the crankcase half.

WARNING!
Do not activate the clutch lever with actuator decoupled from engine.

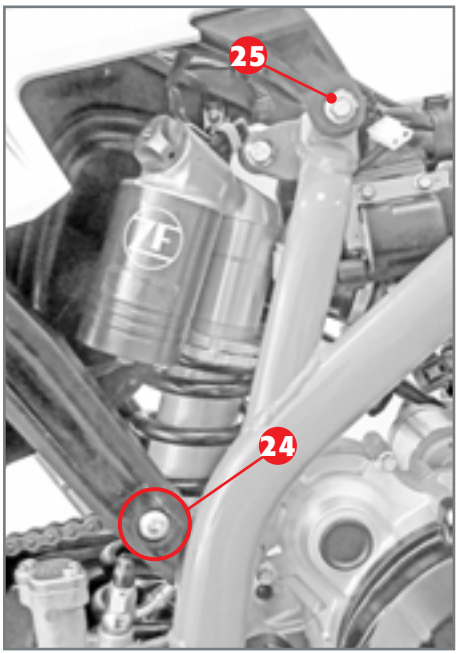


Remove the head connections.

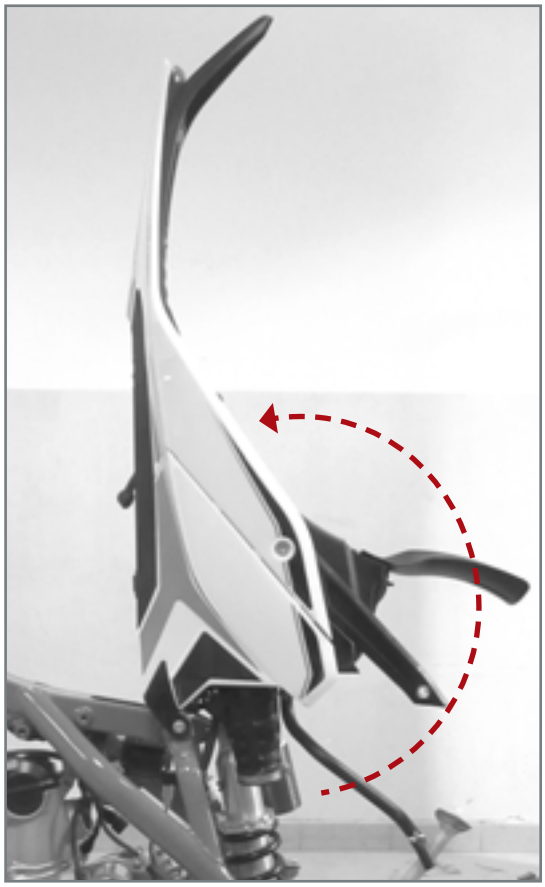




Release and remove the brake pedal return spring **23**.
Remove the Kickstart lever (if present - optional).

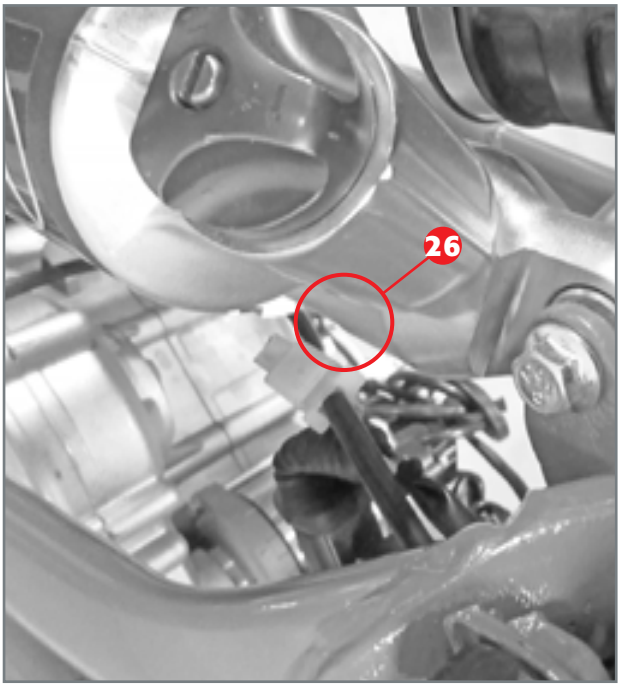


Remove the subframe lower fixing screws **24** (one on each side) and loosen the upper screws **25** (one on each side).

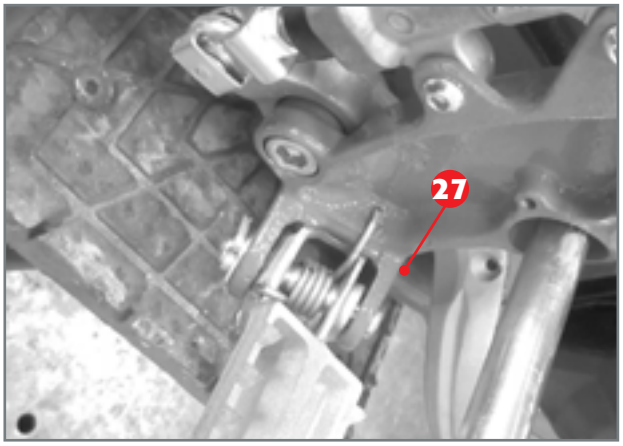


Rotate the entire filter box unit.

Remove the throttle body.

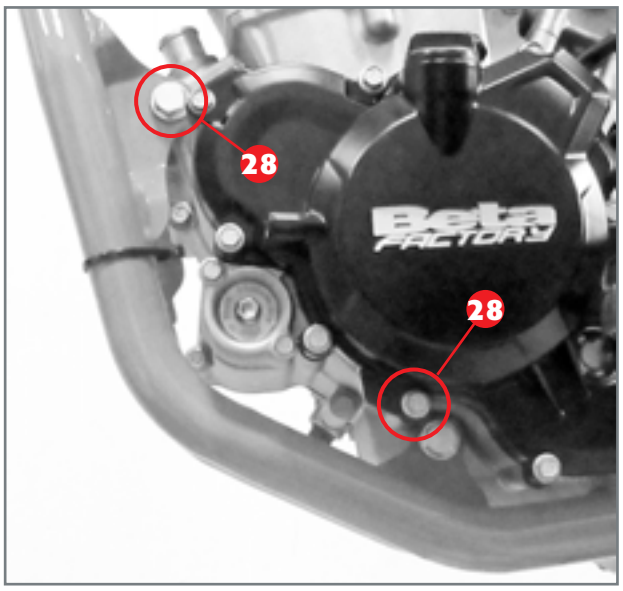


Remove the upper shock-absorber pin **26** .



Remove the swingarm pin **27**.

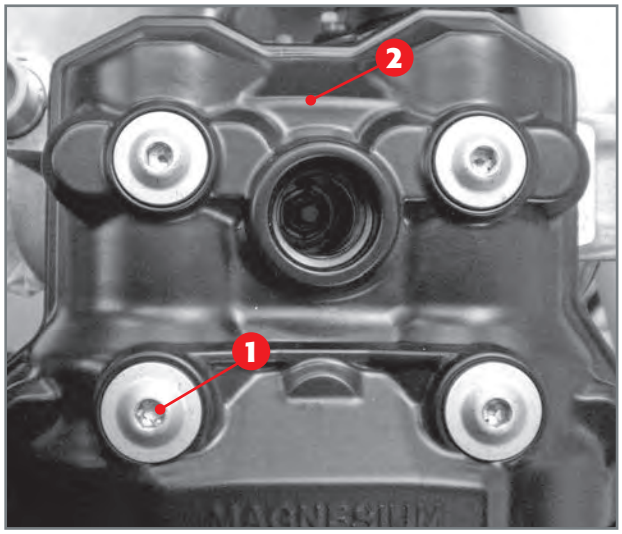
Move the complete swing-arm unit towards the rear.



Remove the engine pins **28**.

Extract the engine from the frame and apply it to the specific stand, code *36.25132.000*, using the specific front fixing bracket, code *006.14.014.00.00*.

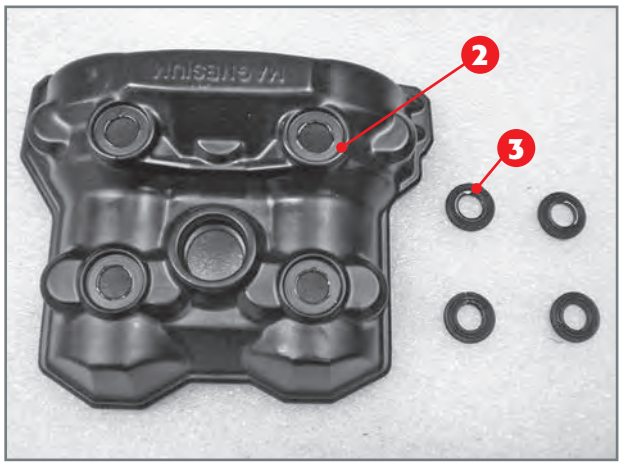
2 ENGINE DISASSEMBLY



The four screws 1 of the cylinder head cover 2.

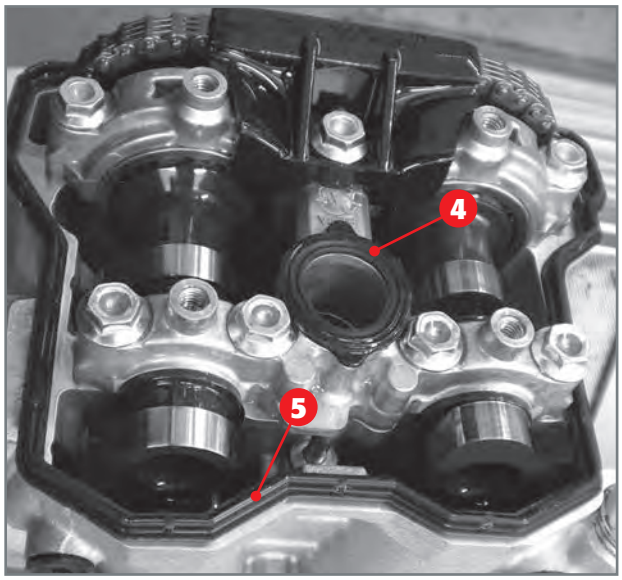
2.1 THERMAL UNIT

The thermal unit is comprised of the head, cylinder and piston.
Before removing the cylinder head, bring the piston to the TDC and block the crankshaft: proceed as shown below.



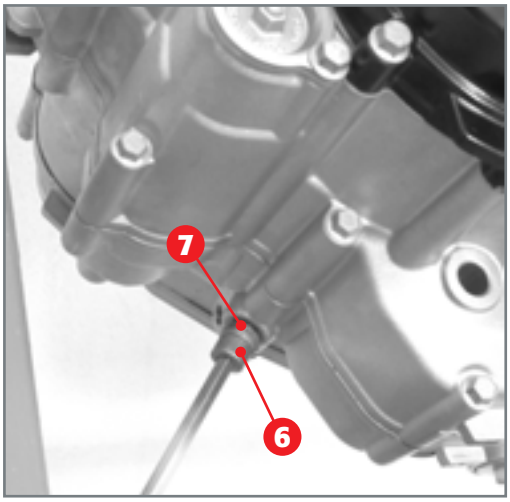
The cylinder head cover 2 and the four gaskets 3.

Remove the 4 screws **1**, the cylinder head cover **2** as well as the 4 screw gaskets **3**.



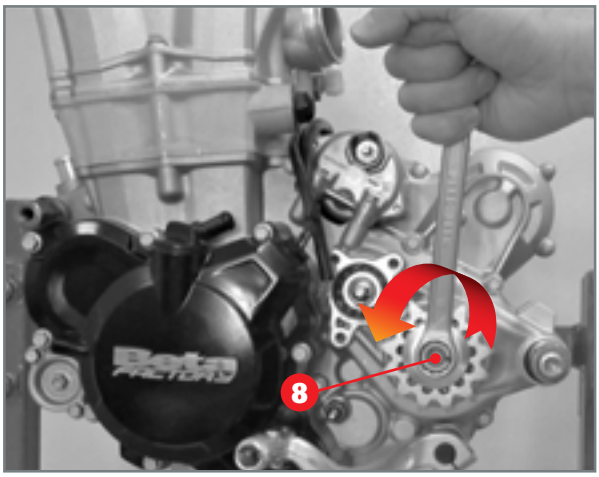
Spark plug gasket 4 and cylinder head cover gasket 5.

Remove the spark plug gasket **4** and the cover gasket **5**.



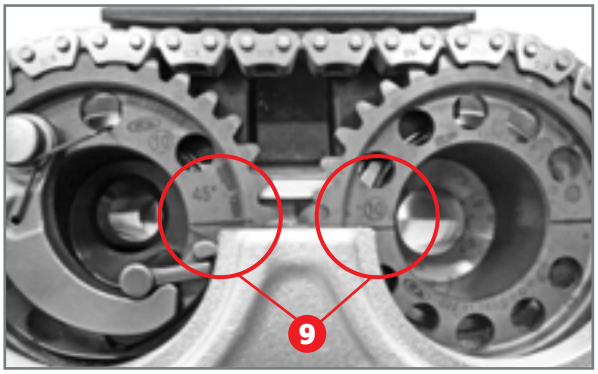
Crankshaft blocking screw 6 with copper washer 7.

Remove the crankshaft blocking screw **6**, remove the copper washer **7** and put the screw back into its seat without tightening it all the way.
Alternatively, use the special engine locking tool*(code 006140110000)*.



Rotation of transmission shaft.

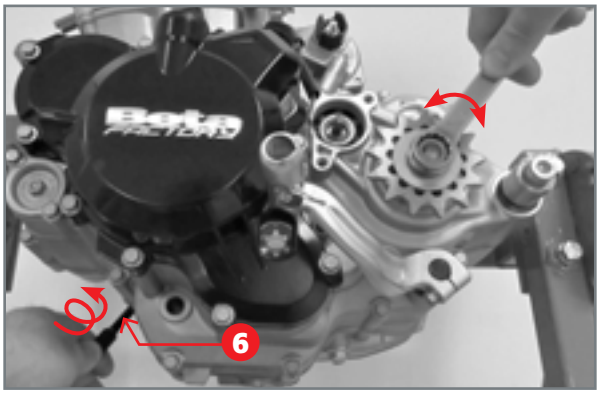
After having engaged the 6th gear, turn the transmission shaft **8** anti-clockwise - using an open-end spanner or similar - until the lines **9** on the toothed profiles of the camshafts are aligned.



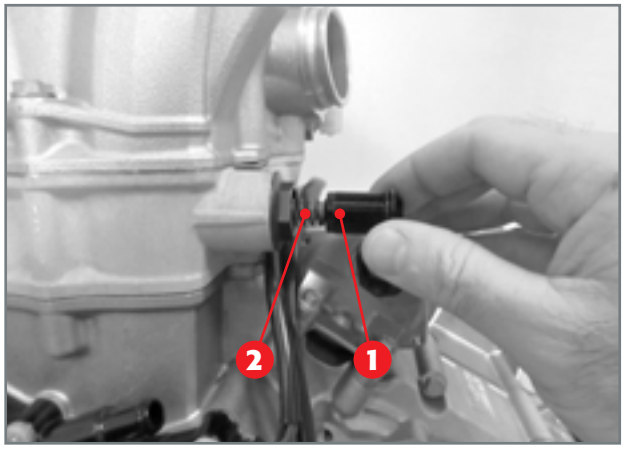
Alignment of camshafts.

Turn the transmission shaft in such position and, at the same time, turn the shaft blocking screw **6** manually until it engages in the seat present on the crankshaft, preventing its rotation.

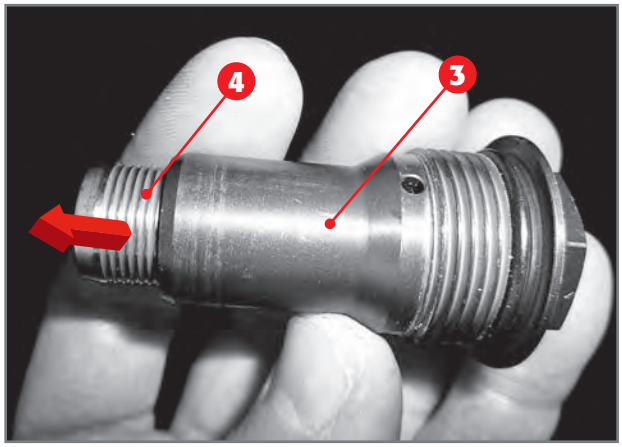
This way the crankshaft is blocked, by means of the screw **6**, at the Top Dead Centre (TDC) and now all the parts can be disassembled.



Blocking the crankshaft at TDC. Please note the locking screw 6 and the movement of the transmission shaft set with the open-end spanner.



Cap and spring removal.



Tensioner support complete with piston.

2.1.1 CYLINDER HEAD: DISASSEMBLING THE MECHANICAL TENSIONER

A chain which is not well-tensioned can cause:

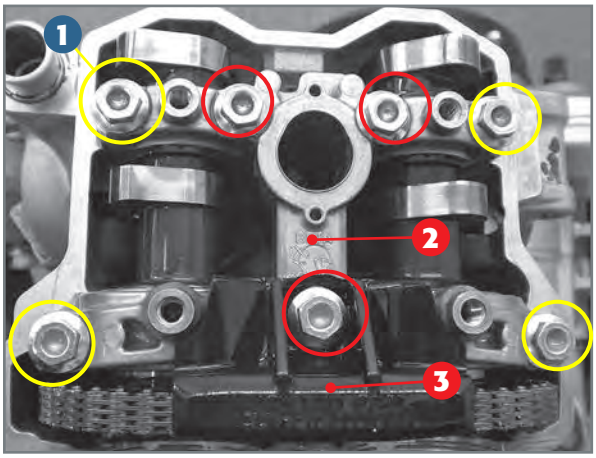
- excessive vibrations of the chain which could make it skip teeth on the camshafts thus damaging the engine;
- incorrect and premature wear of the support bearings of the camshafts.

The engine is equipped with a mechanical tensioner in order to provide the chain with proper tensioning.

To remove it, proceed as follows:
remove the cap **1** and the spring **2**.

Fully unscrew the tensioner support **3** from the cylinder.

To remove the piston **4**, just push it out from the tensioner support **3**.

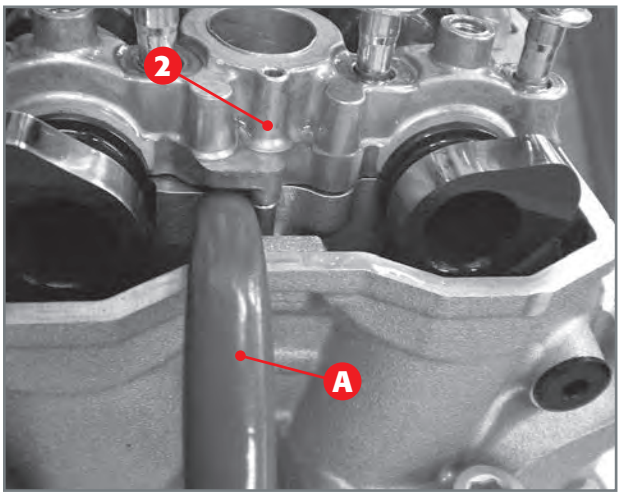


Fixing screws 1, camshaft support 2 and fixed pad 3. The four outer screws circled in blue must be removed first.

2.1.2 CYLINDER HEAD: DISASSEMBLING THE CAMSHAFT SUPPORT, FIXED PAD AND SPARK PLUG SEAT O-RING

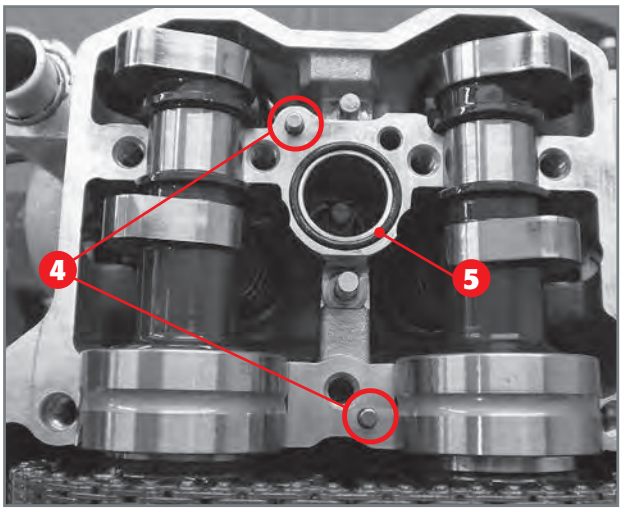
To remove the camshafts, disassemble the camshaft support **2** and the fixed pad **3**. Then loosen the seven screws **1** of the camshaft support, starting with the four outer ones (indicated in yellow in the figure) and then the inner ones. Remove the fixed pad **3**.

ATTENTION!
Disassemble the camshafts only after having disassembled the hydraulic tensioner.



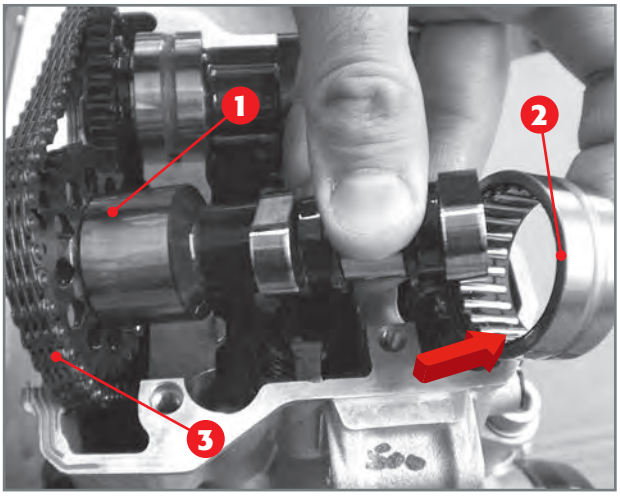
Uncoupling camshaft support 2 from cylinder head.

Using a plastic rod **A** or something similar, lever the head surface and the camshaft support **2** in order to lift it and remove it.

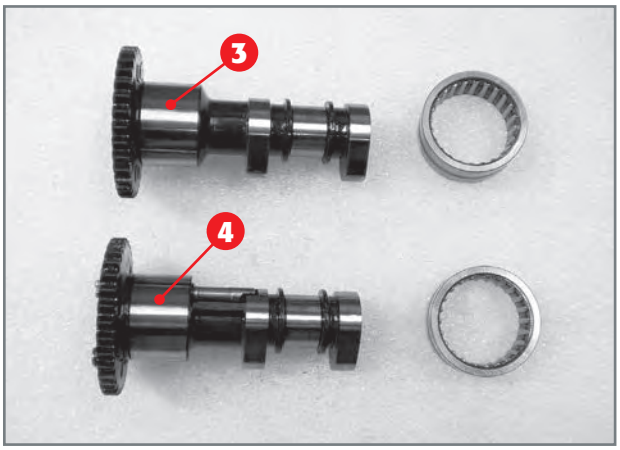


Two centring pins 4 and spark plug housing O-ring 5.

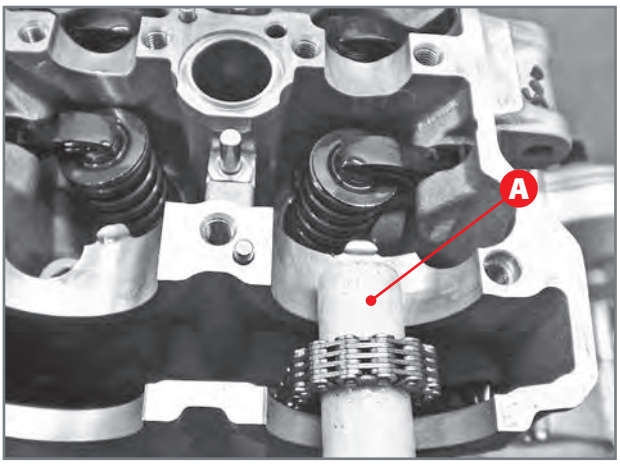
When uncoupling, pay attention to the two centring pins **4** located underneath the camshaft support.
Remove the spark plug housing sealing O-ring **5** between the cylinder head and the camshaft support.



Removal of intake camshaft 1, bearing 2.



Camshafts (3 intake, 4 exhaust) with bearings.



Plastic rod to support chain.

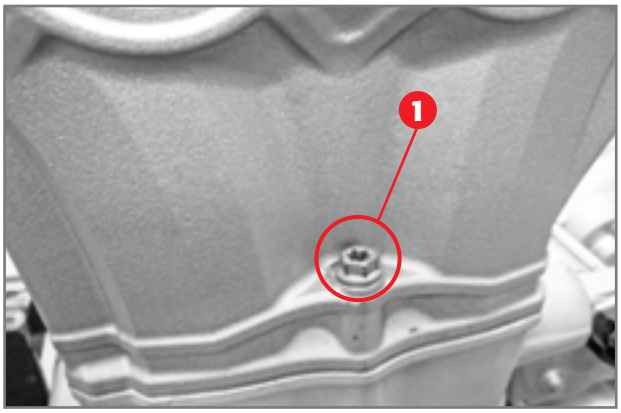
2.1.3 CYLINDER HEAD: REMOVING THE CAMSHAFTS

Lift the intake camshaft **1**, pull out the bearing **2** and remove the chain **3** from the gear on the shaft.

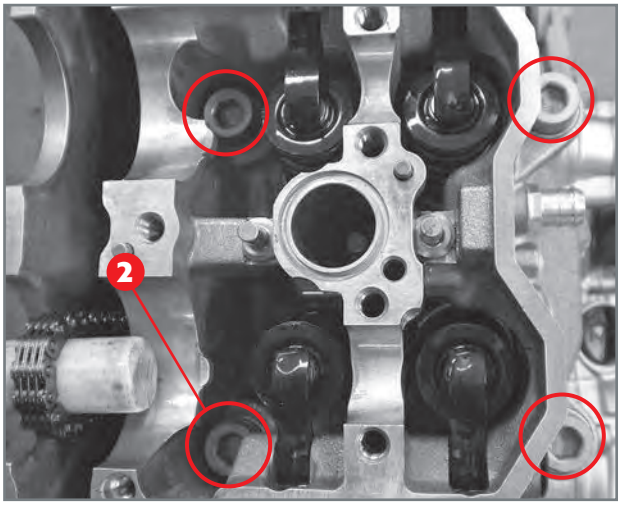
ATTENTION!
The hydraulic tensioner must already have been removed in order to remove the camshafts.

In order to remove the exhaust camshaft **4**, repeat the operations described for the removal of the intake camshaft.

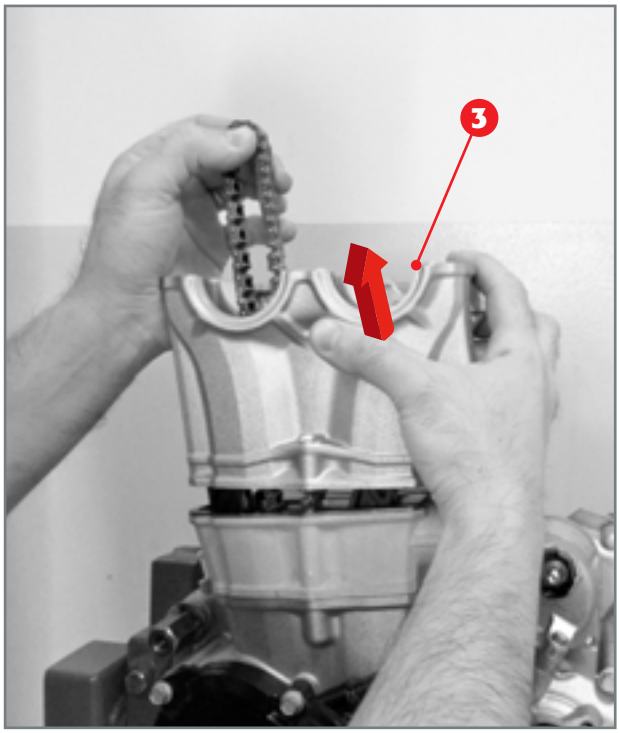
WARNING!
*Make sure the chain does not fall inside the compartment dedicated to it. For this purpose, it is recommended to place a plastic rod (or the likes) **A** between the chain and the head.*



Chain-side head fixing screw.



Head fixing screws 2.



Head removal 3.

2.1.4 CYLINDER HEAD: UNCOUPLING FROM CYLINDER

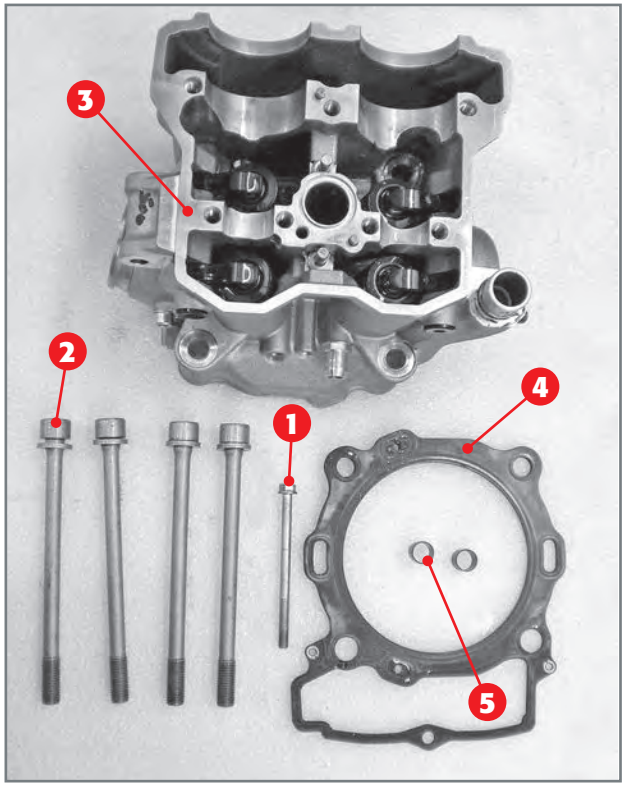
Five screws fasten the head to the cylinder.
Remove the cylinder head screw **1** on the outside of the chain-side cylinder head.

Remove the four cylinder head fixing screws **2**, in a criss-cross pattern. Start with one of the two screws outside the cylinder head compartment.
Then remove the respective washers.

Lift the cylinder head **3** with one hand and at the same time with the other hold the chain in tension.
With the cylinder head lifted a few centimetres, drop the chain inside the compartment and pull out the head.

ATTENTION!
Should the chain fall inside, place it in tension before lifting the head.

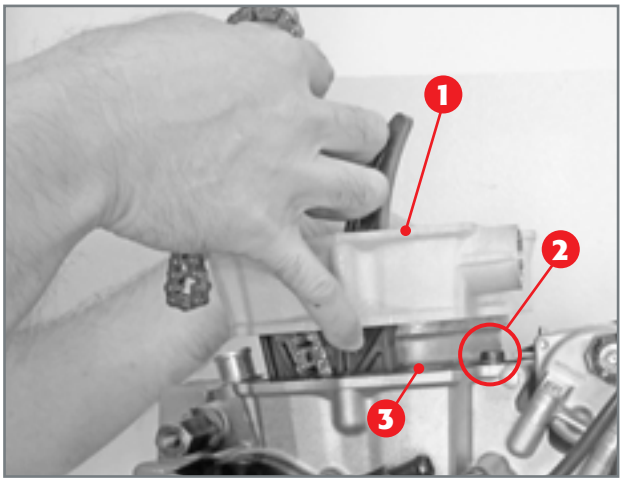
WARNING!
During lifting of the head, pay attention to the centring bushes.



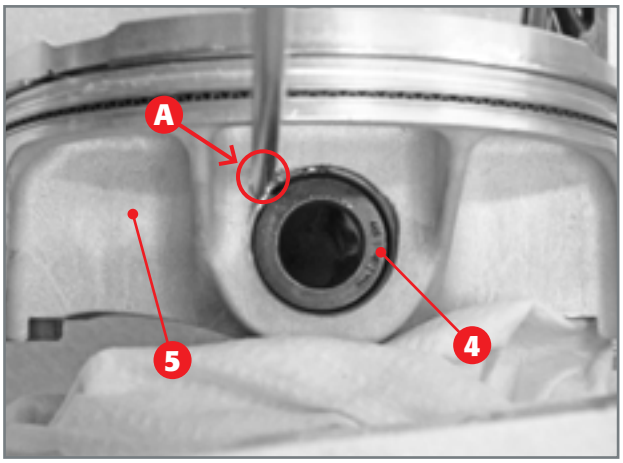
Cylinder head elements:

1) M6x80 screw;
2) M10x1.25 cylinder head screws,
3) Complete cylinder head;
4) Cylinder-head gasket;
5) Centring bushes.

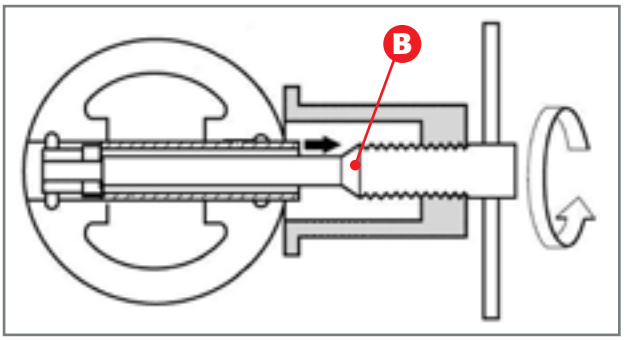
Remove the head gasket **4** and the two centring bushes **5**.



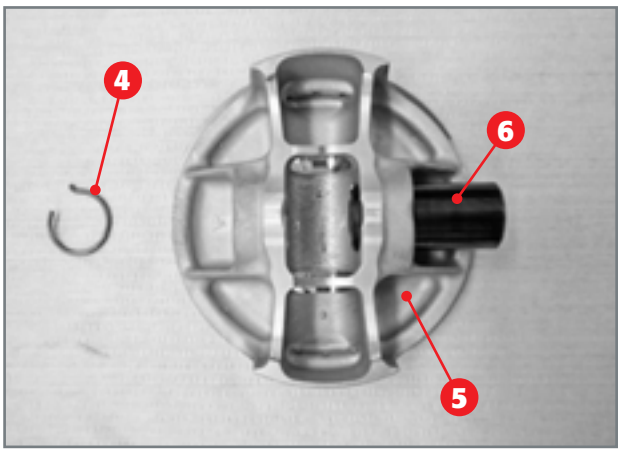
Cylinder removal.



Removal of elastic ring 4 from right hand side of piston.



Removal of pin bolt.



Bottom view of piston 5, elastic ring 4 and pin bolt 6.

2.1.5 DISASSEMBLING THE CYLINDER AND PISTON

Lift the cylinder **1** by a few centimetres, remove the two centring bushes **2** (both located on the chain side) to prevent them from falling inside the crankcases and continue removing the cylinder. Remove the cylinder gasket **3**.

Place a clean cloth between the piston and the crankcase to keep foreign objects or simple solid residues from falling inside the base. Using a suitable tool to insert the specific seat **A**, remove the elastic ring **4** on the right hand side of the piston **5**.

ATTENTION!
Be careful not to drop the elastic ring inside the engine.

Remove the pin bolt using a universal extractor for pin bolts **B**.
Remove the piston and the pin bolt from the connecting rod foot.

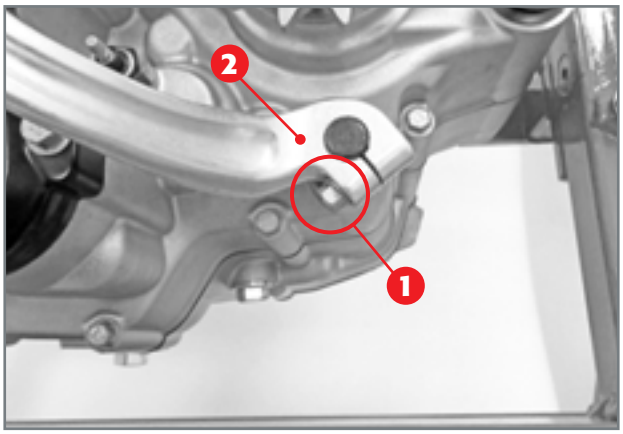
In the figure, it is possible to see the piston **5** (bottom view), the circlip **4** and the pin bolt **6**.

2.2 DISASSEMBLY OF IGNITION UNIT, TIMING CHAIN AND PADS

The ignition unit consists of the flywheel (or rotor), the pick-up and the stator, which is one with the flywheel cover.

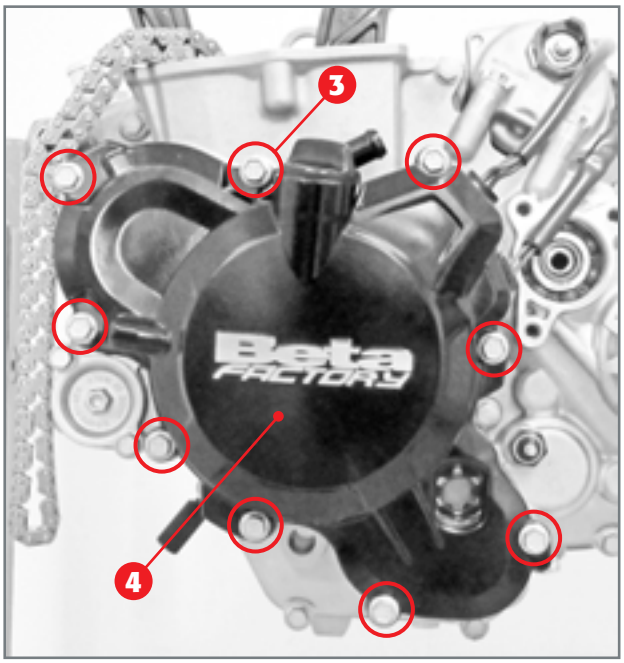
2.2.1 STATOR, FLYWHEEL E PICK-UP UNIT

Remove the screw **1** which connects the gear lever **2** to the drive shaft.

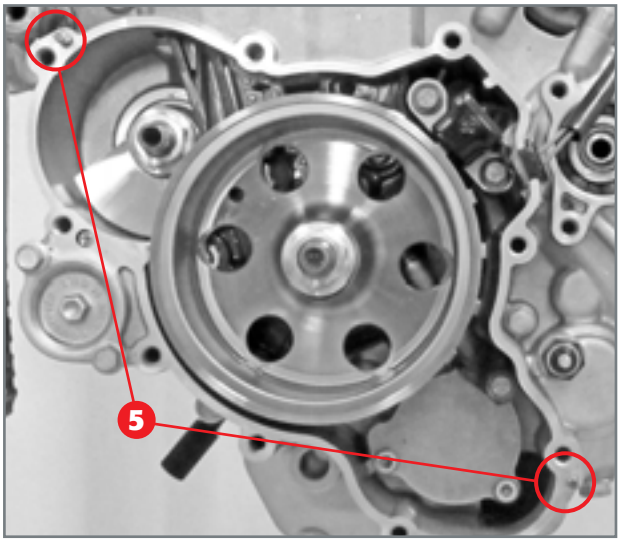


Removal of gear lever.

Remove the screws **3** which fasten the flywheel cover **4** to the left crankcase half. Remove the flywheel cover and the gasket placed between the crankcase and the cover.

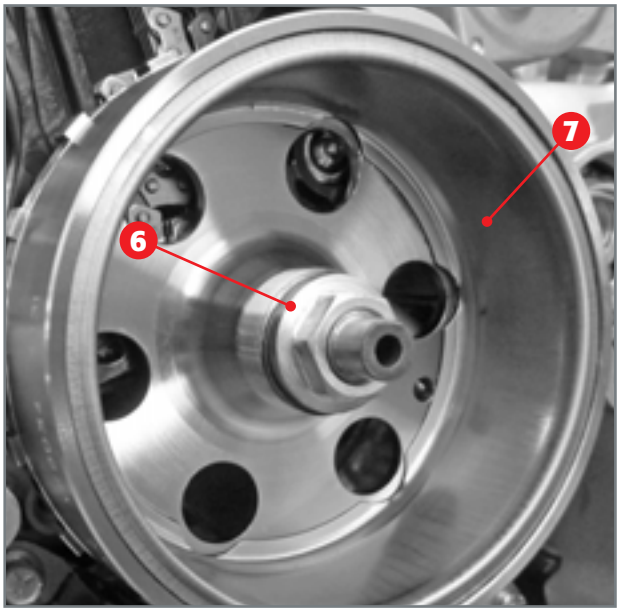


Fixing screws 3 of ignition cover 4.



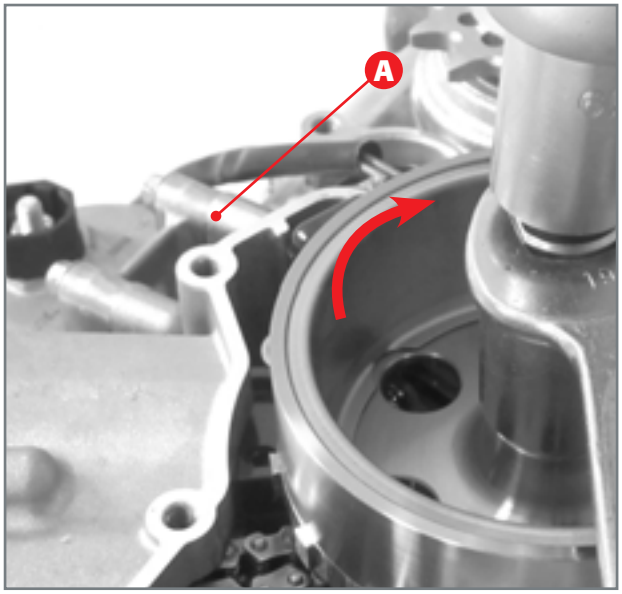
Two centring pins 5 dedicated to the flywheel cover (injection version).

Pay attention to the two centring pins **5** on the crankcase half.



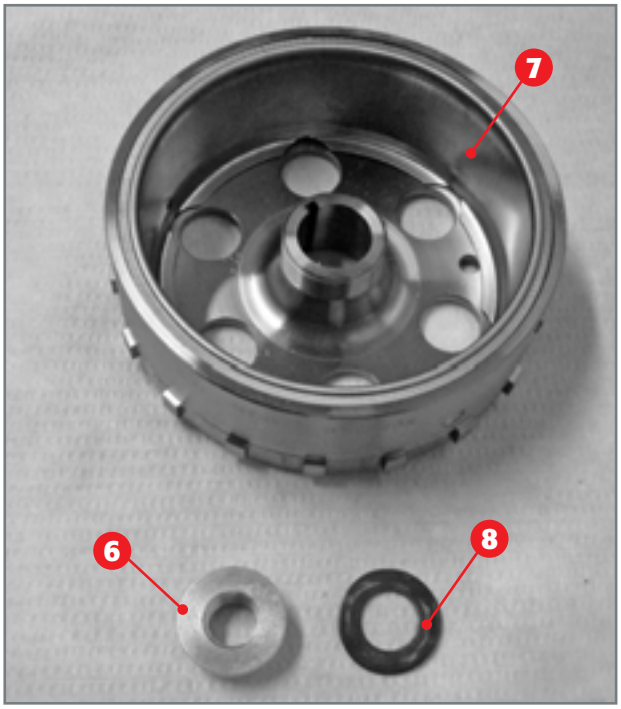
Nut 6 which fastens flywheel 7 to the crankshaft (injection version).

Remove the tightening nut **6** which fastens the flywheel **7** to the crankshaft.
Once the nut has been unscrewed, pay attention to the special elastic washer (**8** shown in the following images) placed between the nut and the flywheel.



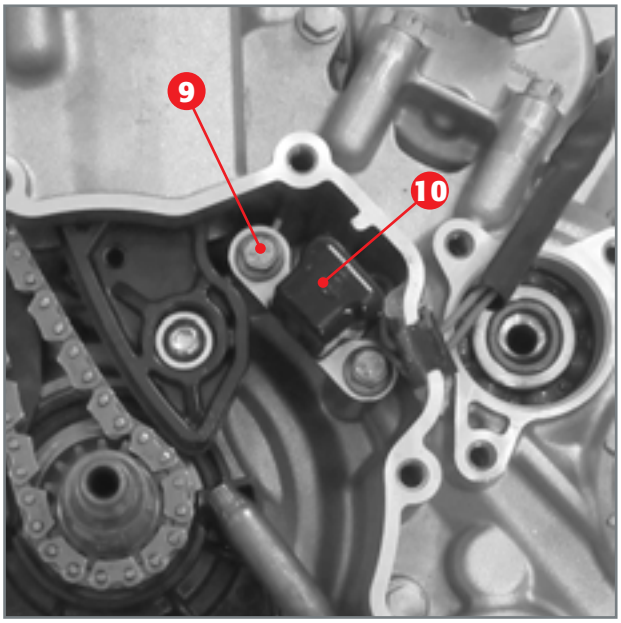
Starter flywheel removal (injection version) with special gear puller A.

To remove the flywheel, screw the relevant extractor **A** (code *3625173*) onto the threaded segment on the flywheel and, using a box spanner, tighten the screw on the extractor.



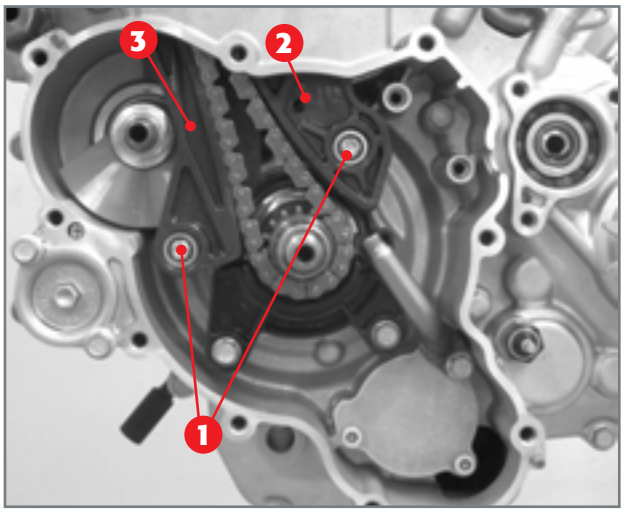
Flywheel 7, nut 6 and special washer 8.

The image to the side shows the flywheel **7** (rear view), the special elastic washer **8** and the tightening nut **6**.

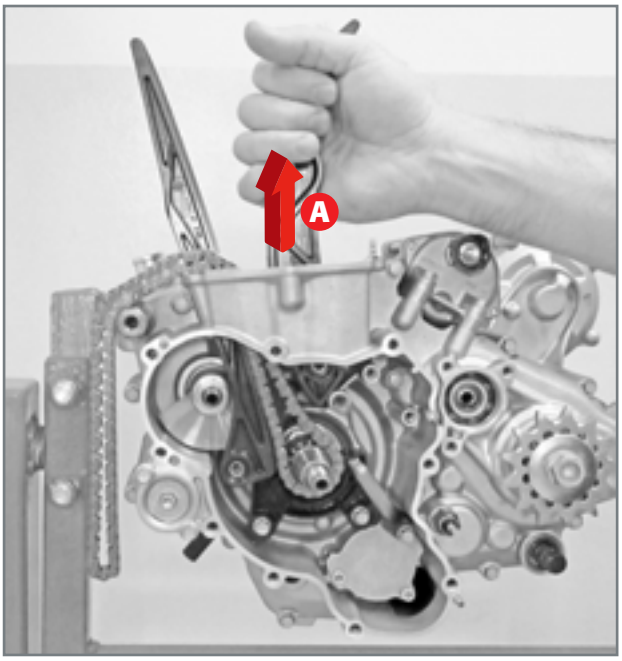


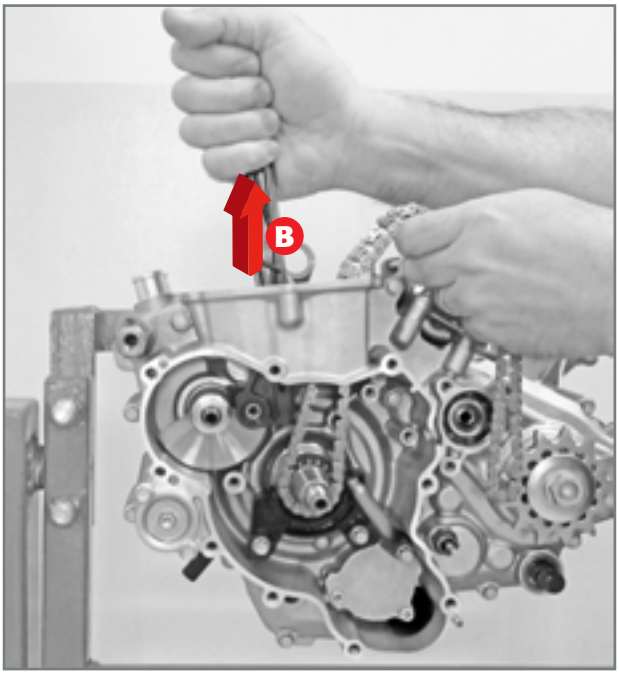
Remove the screws **9** and the pick-up unit **10**.

Remove the unit from the crankcase.



Fixing screws 1 of mobile pad 2 and fixed pad 3.

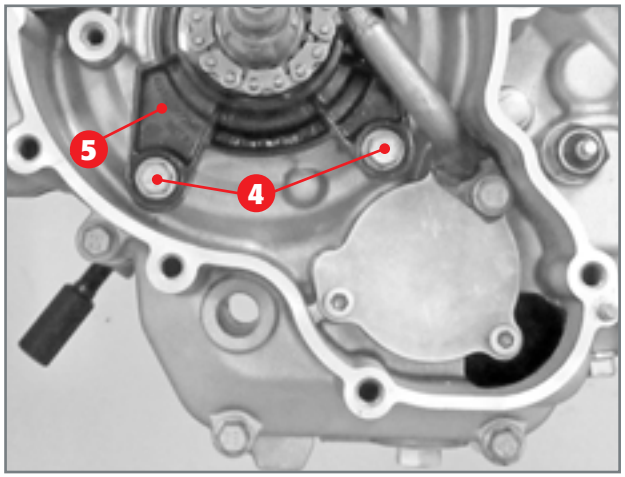




Extraction of chain pads.

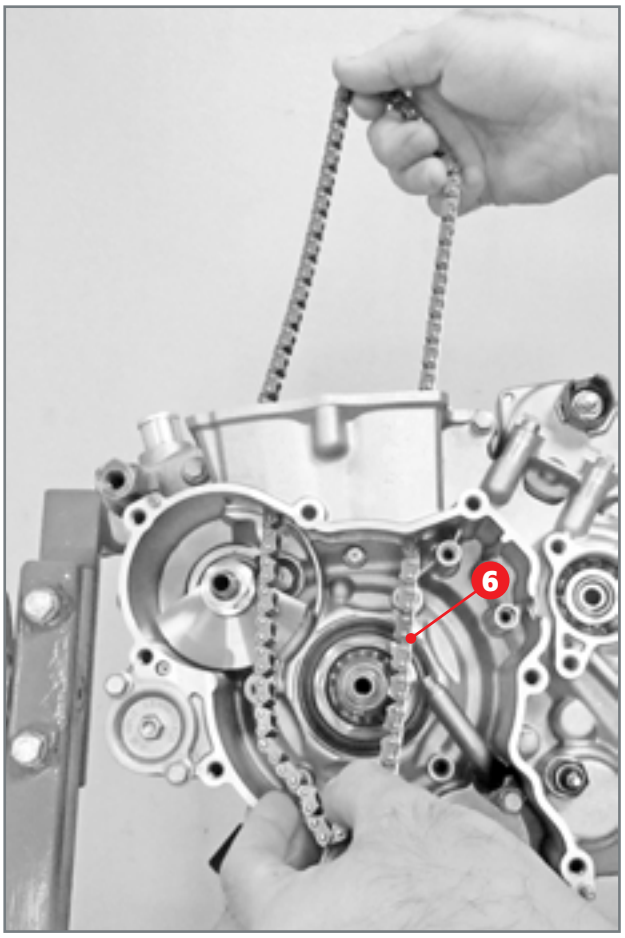
2.2.2 TIMING CHAIN AND PADS

Remove the fixing screws **1** of the mobile pad **2** and the fixed pad **3**.
Extract pad **2**, then pad **3**, by pulling them upwards.



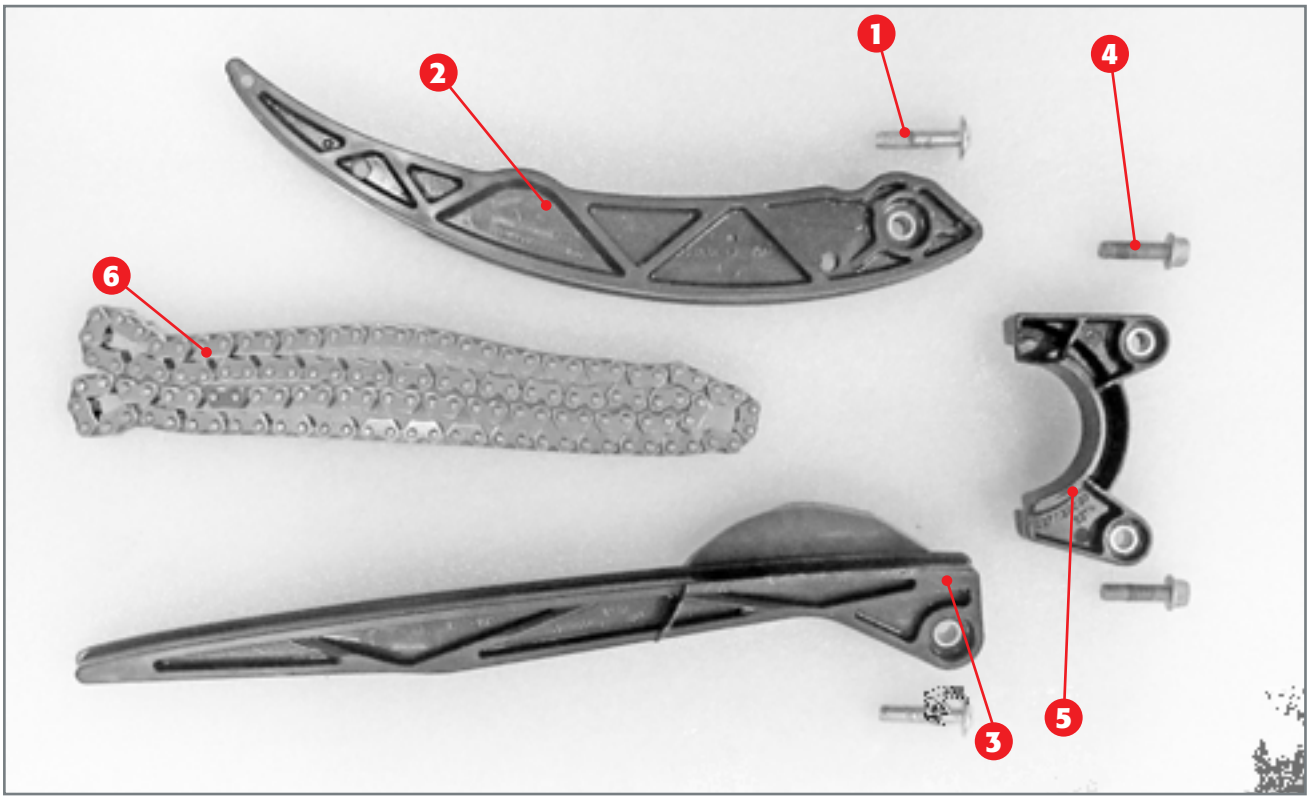
Chain guard protection and oil jet.

Remove the two screws **4** and then the chain guard **5**.
Pay close attention to the respective bushes while extracting the mobile and fixed pads and the timing chain.

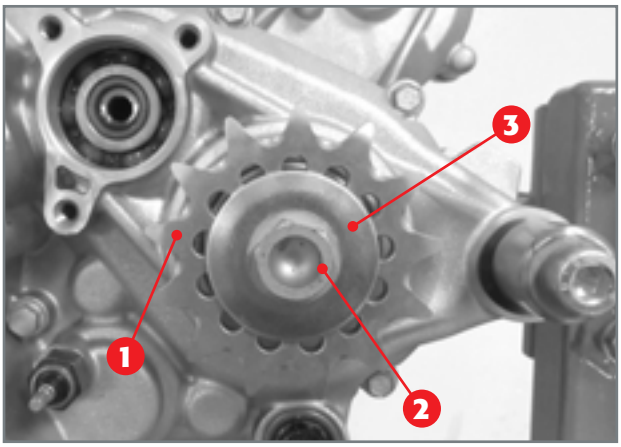


Removal of timing chain.

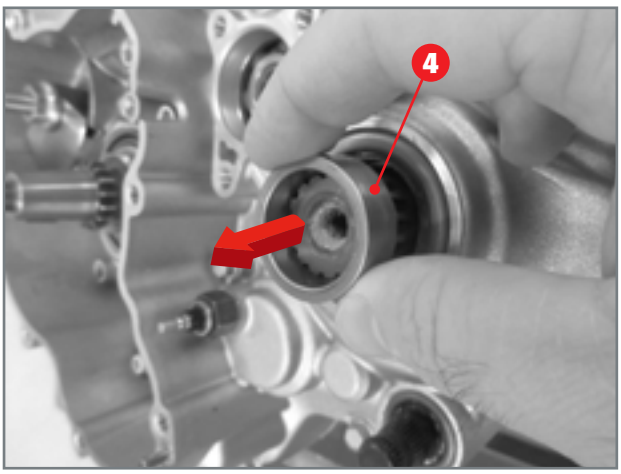
Remove the timing chain **6**, freeing it from the gear on the crankshaft, and pull it downwards.



Two pad fixings screws 1; mobile pad 2; fixed pad 3; oil jet fixing screw 4; chain guard 5; timing chain 6.



Pinion 1, screw 2 and washer 3.

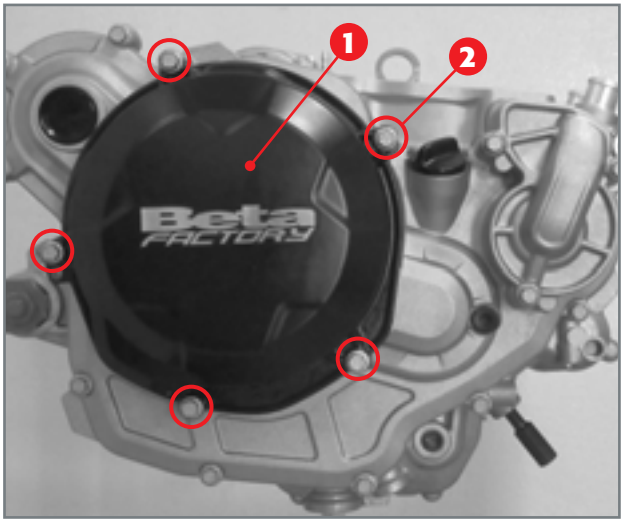


Pinion spacer 4.

2.3 PINION AND SPACER

In order to remove the pinion **1**, loosen the screw **2** completely and take off the washer **3**.

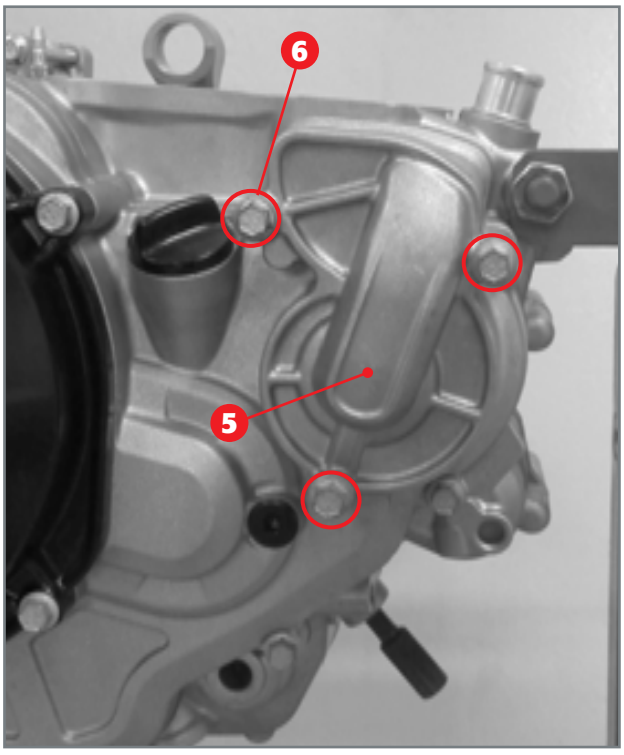
After removing the pinion, pull off the spacer **4**.



Outer clutch cover 1 and respective screws 2.



Inner clutch cover 3 and respective screws 4.

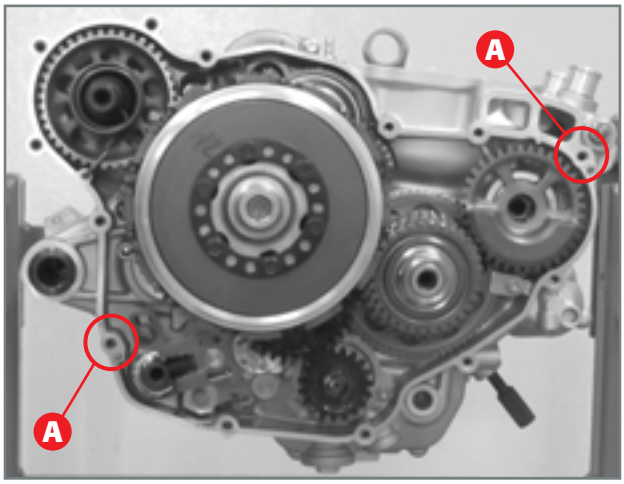


Pump cover 5 and respective screws 6.

2.4 CLUTCH UNIT AND COOLANT PUMP COVER

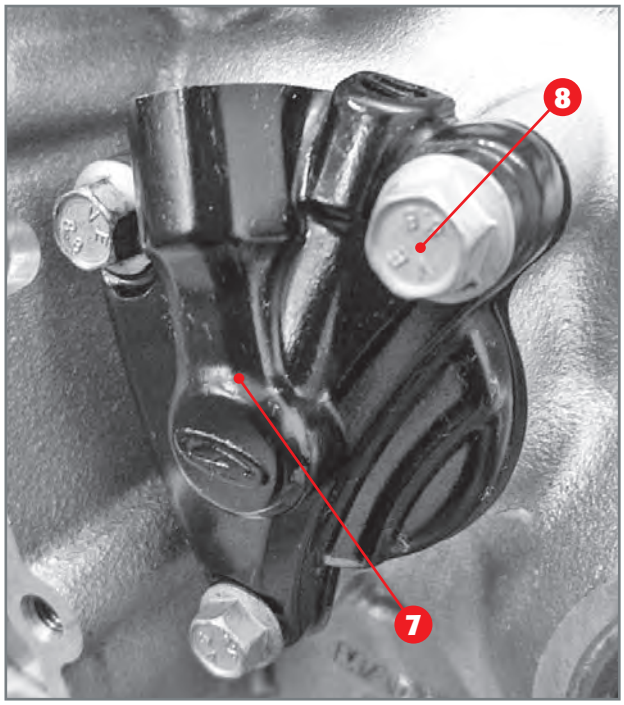
In order to access the clutch unit, the outer clutch cover **1** must be removed by loosening the screws **2**.

On the other hand, when doing a complete overhaul of the clutch unit, of the other elements housed in the outer right side of the crankcase half or of the engine, the inner clutch cover **3** must be removed by loosening the screws **4** and the water pump cover **5** loosening the screws **6**.



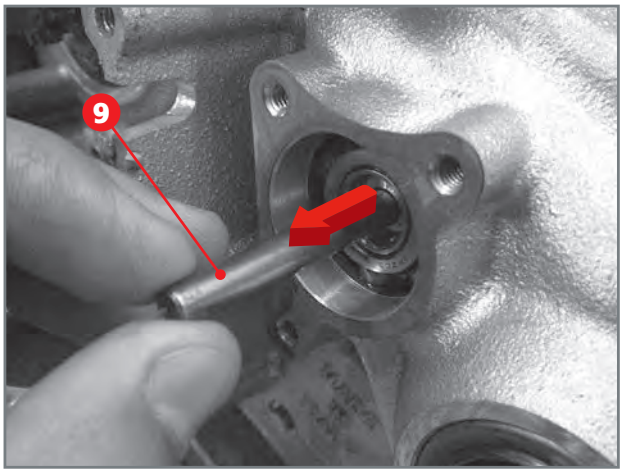
Two centring pins A for inner clutch cover coupling.

Pay attention to the two reference pins **A** placed between the right crankcase half and the inner clutch cover while disassembling.



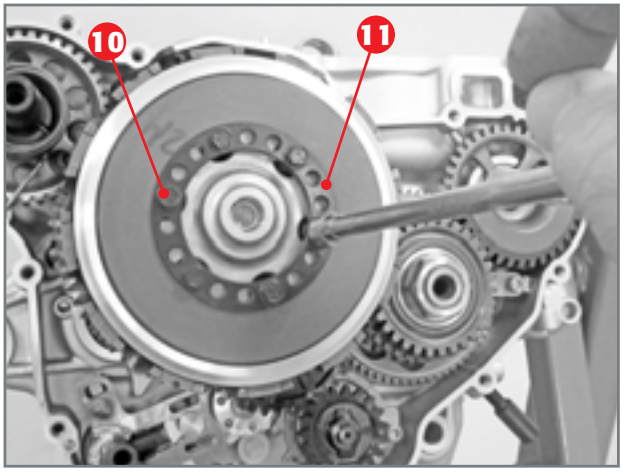
Hydraulic actuator 7 and three screws 8 for crankcase half coupling.

If only the clutch actuator pipe was removed during the disassembly of the engine from the vehicle, remove the complete hydraulic actuator **7** from the outside left crankcase half by fully undoing the three screws **8** that secure it to the crankcase half. Remove the gasket in between the actuator and the crankcase half.

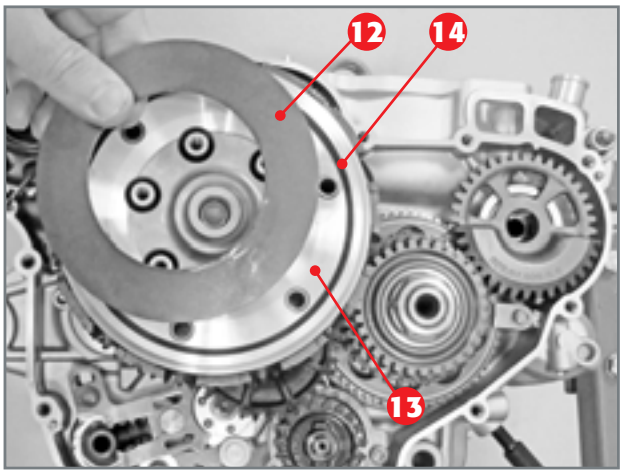


Extraction of clutch rod 9.

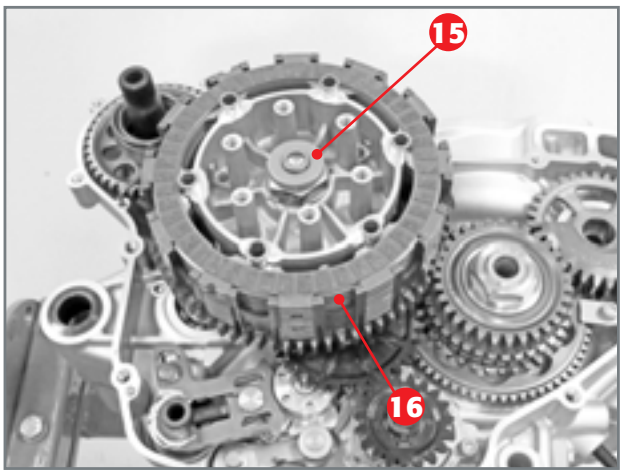
Extract the clutch control rod **9**.



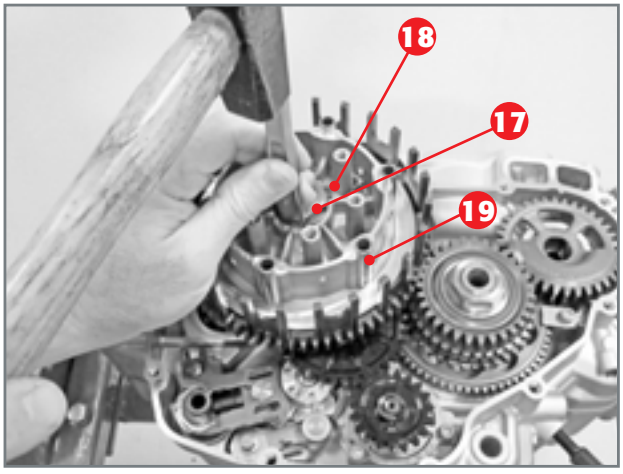
Remove the screws **10** that secure the ring **11** to the clutch drum.



Remove the spring washer **12**, the pressure plate **13** together with the ring **14**.

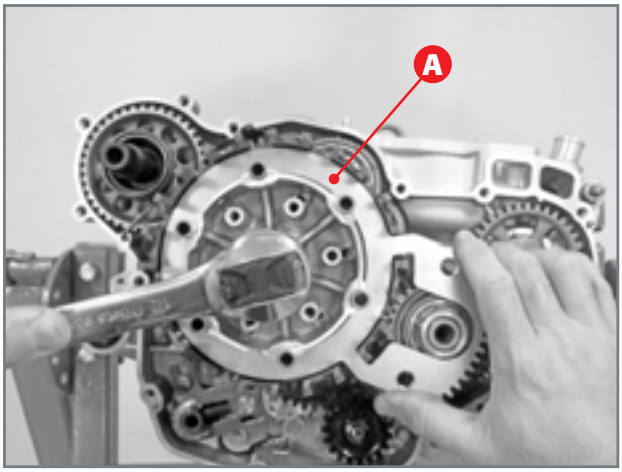


Then remove the complete pressure plate assembly **15** and the clutch disc unit **16**.



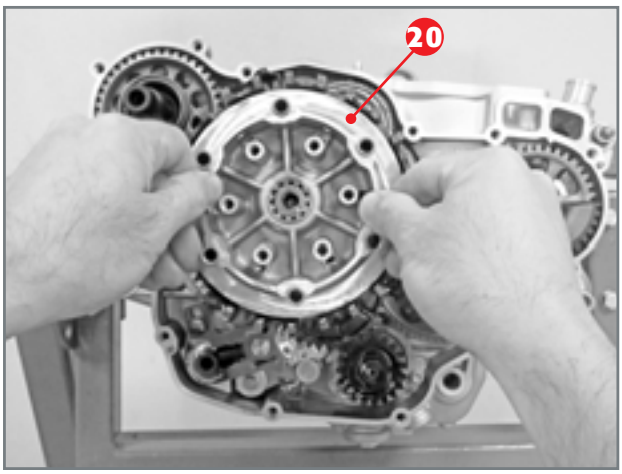
In order to complete the disassembly of the clutch assembly, it is necessary to open the safety washer **17** using a chisel and remove the nut **18**.

ATTENTION!
*Do not remove the sliding pins **19**.*



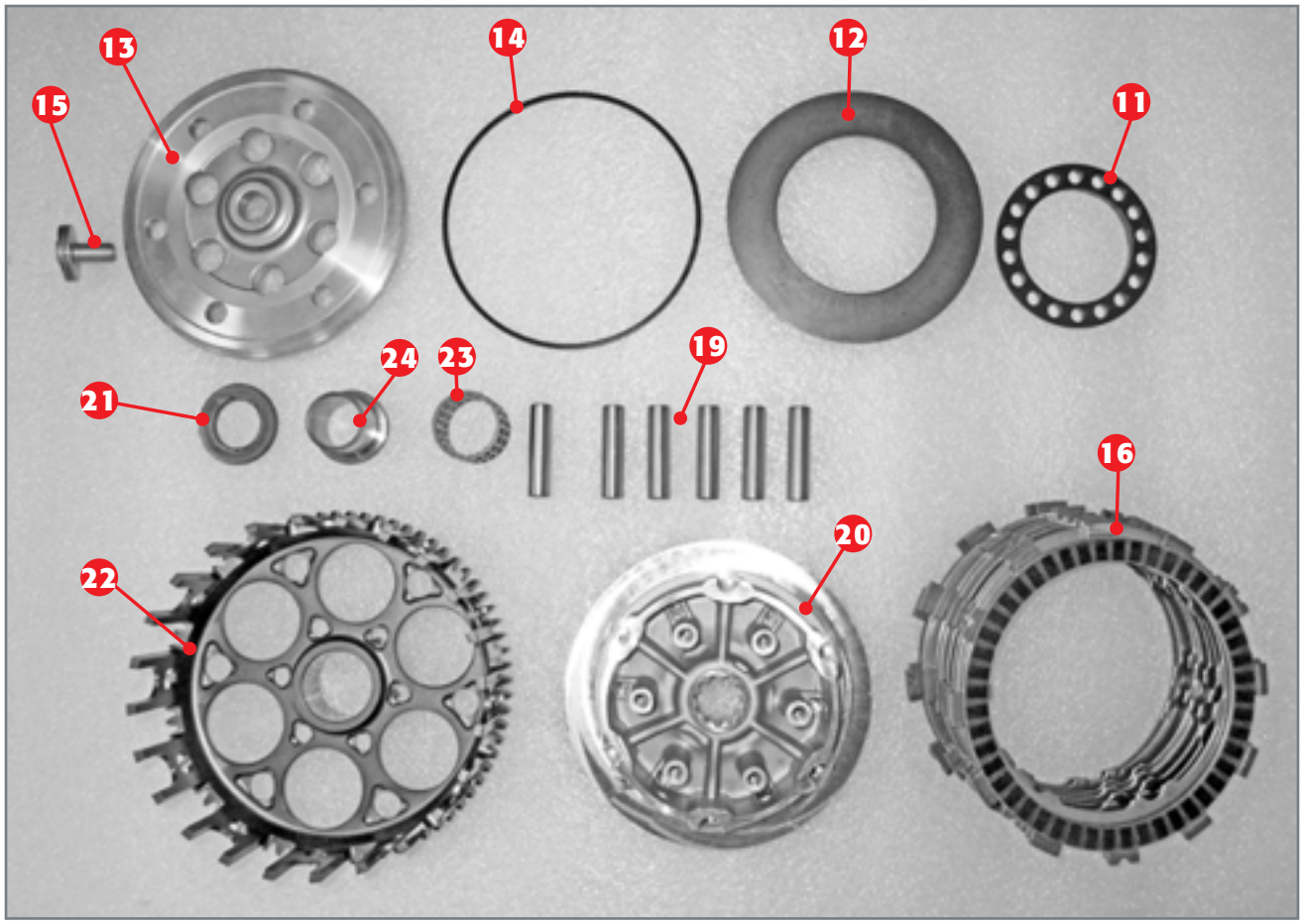
To unscrew nut **18**, the clutch drum must be blocked with the appropriate tool **A** (cod. *037.14.002.50.00*). Then remove the nut and relevant safety washer.

ATTENTION!
Do not use the pneumatic gun.



Remove the clutch drum **20** complete with sliding pins and then remove the shim washer **21**, the endbell **22**, the roller cage **23** and the fifth wheel **24**.

Extract the clutch drum **17**, the washer **18**, the clutch case **19**, the roller cage **20** and the centre bearing **21**. It is possible to remove the sliding pins **22**.



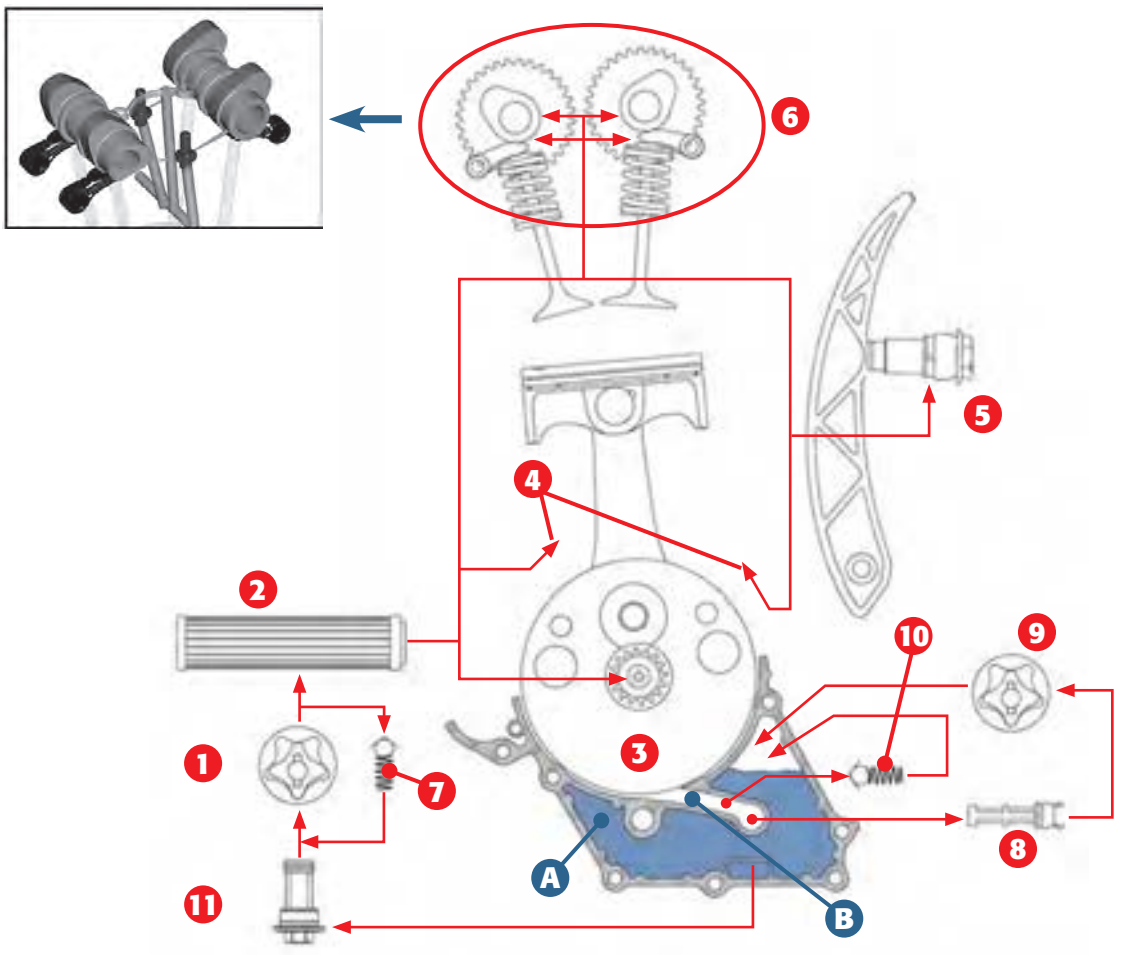
***11** Ring, **12** Spring washer, **13** Pressure plate, **14** Ring, **15** Thrust bearing, **16** Clutch disc unit, **19** Slip pins, **20** Clutch drum, **21** Needle bearing, **22** Slew bearing, **23** Spacer washer, **24** Clutch bell.*

2.5 ENGINE LUBRICATION CIRCUIT

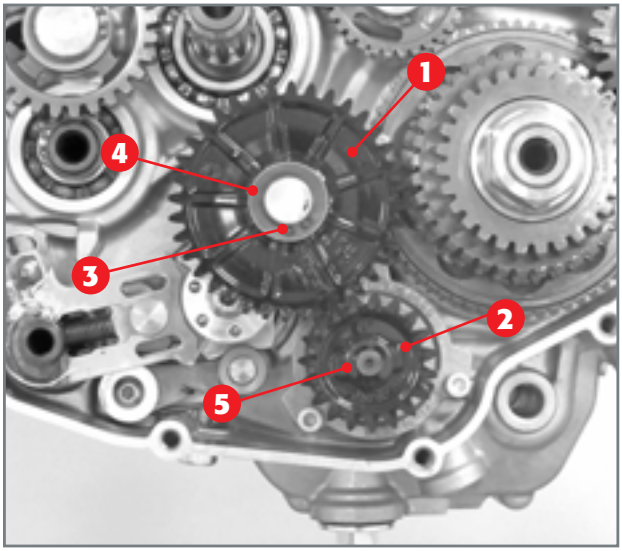
The high-pressure pump (or delivery) **1** - with less displacement - sends the oil purified by the paper filter **2** to the crank mechanism **3**, to the piston oil jets **4**, to the tensioner **5** and to the cylinder head jets and camshafts* **6**. The valve **7** controls the pressure.
When oil has lubricated the cylinder head and has seeped through the tensioner, it flows along the timing chain to the ignition unit compartment **A**. When oil has lubricated the crank mechanism and the piston-cylinder coupling, it goes to the crank mechanism compartment **B** from which it is sucked by an intake pump (or recovery) **9** – with higher displacement -, passing through the oil filter **8** and sent to the ignition unit compartment **A**. There it is sucked once again by the pump **1** after being filtered through the wire metal filter **11**.
The valve **10** controls the pressure between the external casing on the ignition unit side and the crank mechanism compartment.

ENGINE LUBRICATION CIRCUIT:

1) High-pressure pump;
2) Paper oil filter;
3) Crank mechanism;
4) Piston oil jets;
5) Hydraulic tensioner;
6) Cylinder head oil jets;
7) High-pressure valve;
8) Internal filter;
9) Low-pressure pump;
10) By-pass valve;
11) Wire metal filter;
A) Ignition unit compartment;
B) Crank mechanism compartment.



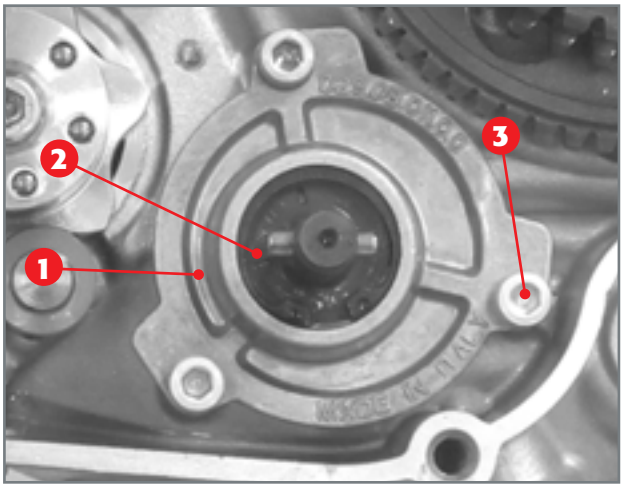
** Part of the lubricant sent to the cylinder head is used for the hydrodynamic support of the camshafts.*



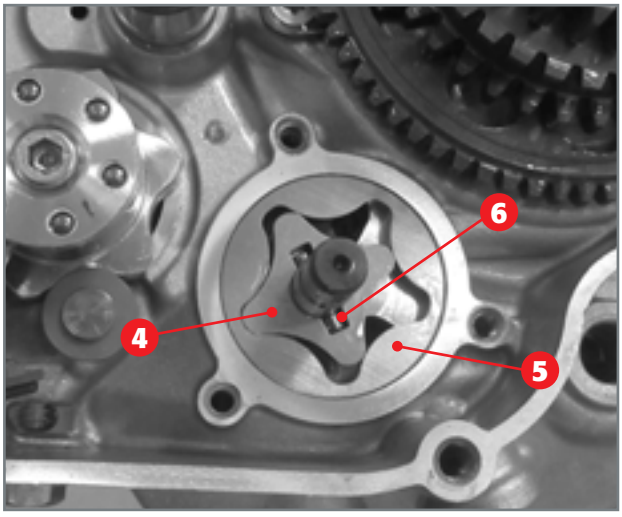
Gear unit for oil pump control.
1) Gear meshing with clutch gear;
2) Oil pumps control gear;
3) Circlip;
4) Thrust washers;
5) Benzing ring

2.5.1 OIL PUMPS CONTROL GEARS

The two oil pumps are controlled by a gear unit driven by the clutch gear.
In detail, the gear **1** engages with the clutch case, and **2** is the oil pump control gear.
To dismantle the gear **1**, remove the circlip **3** and thrust washers **4** (one below the gear).
To disassemble the gear **2** simply remove the Benzing ring**5**.



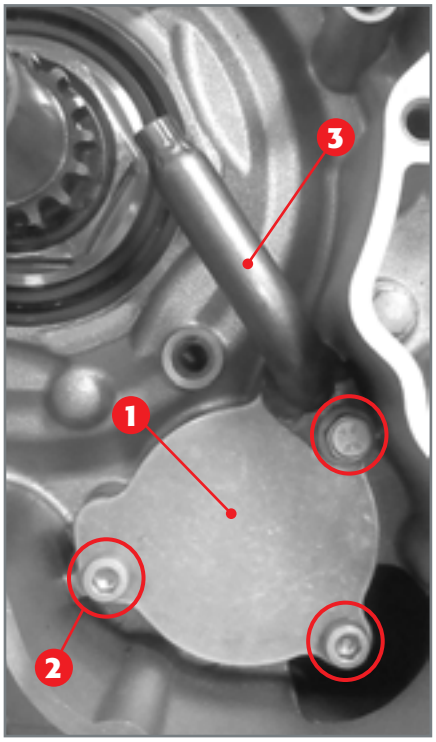
Disassembly of high-pressure pump cover.



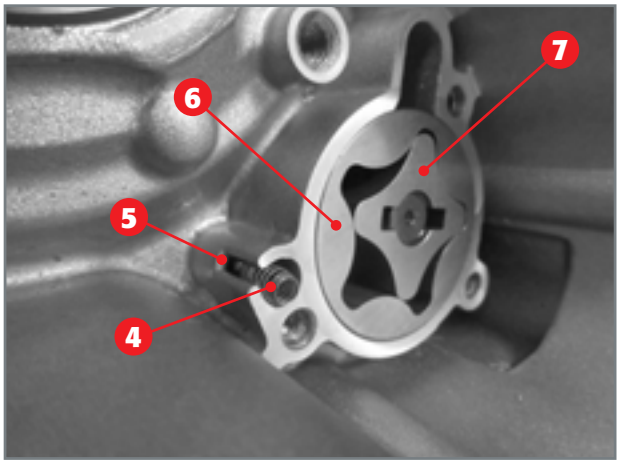
High-pressure pump. 4) Internal rotor; 5) External rotor; 6) Roller.

2.5.2 HIGH-PRESSURE OIL PUMP

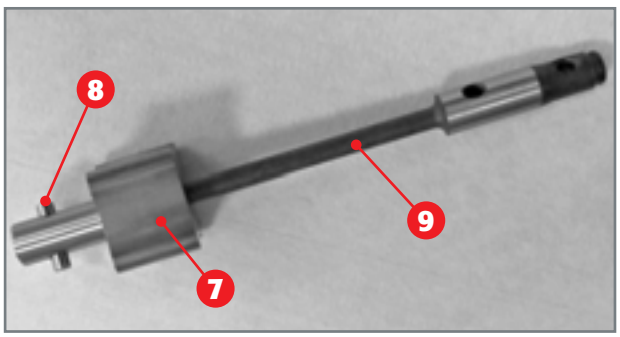
The high-pressure pump, located in the external right crankcase half, is enclosed under the cover **1** which can be disassembled by removing the roller **2** and the screws **3**.
After having removed the cover, extract the internal rotor **4**, the external rotor **5** and the roller **6**.



Cover and screws of low-pressure pump.



Low-pressure oil pump and by-pass valve.

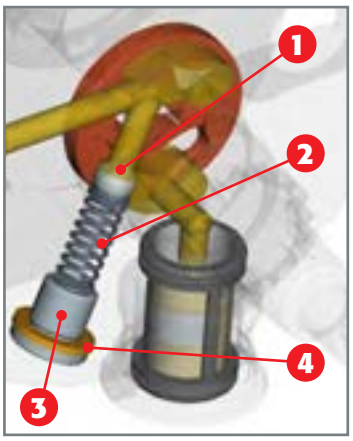


Internal rotor 6, roller 7 and drive shaft 8.

2.5.3 INTAKE OIL PUMP AND BY-PASS VALVE

The intake pump and the one-way valve are in the left
crankcase half (on the outside) inside the ignition unit compartment.
They are enclosed under the cover **1**, which is removed by removing the screws **2** and the jet **3**.

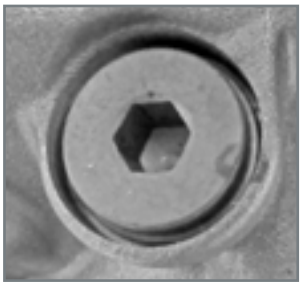
Extract the one-way valve consisting of the spring **4** and the ball **5**.
Then extract the external rotor **6** and the internal rotor **7** together with the roller **8** and the drive shaft **9**.



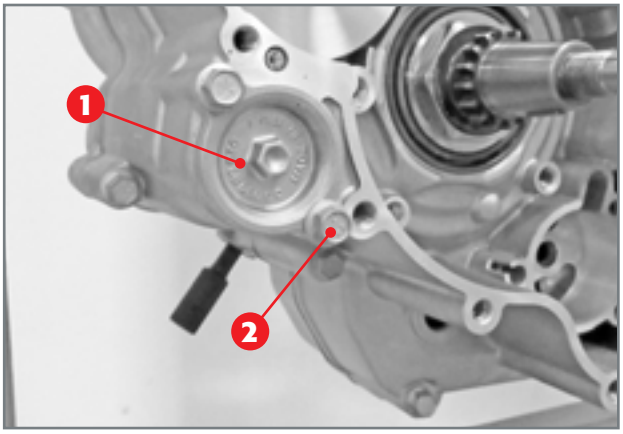
Pressure control valve layout.



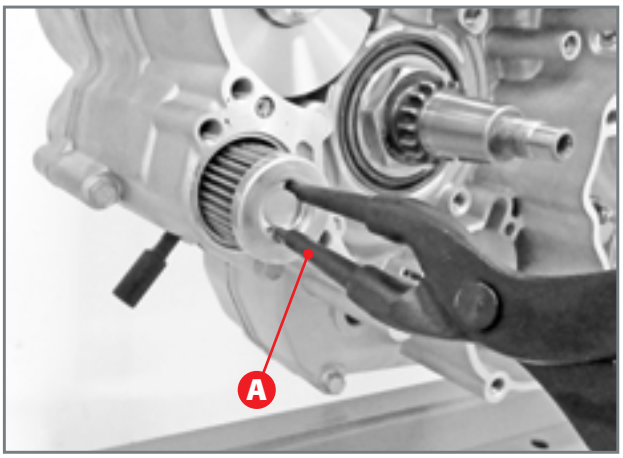
Rivet on pressure regulator.



Pressure regulator.



Paper oil filter cap 1 and relative fixing screws 2.



Extraction of filter with pliers A.

2.5.4 OIL PRESSURE CONTROL VALVE

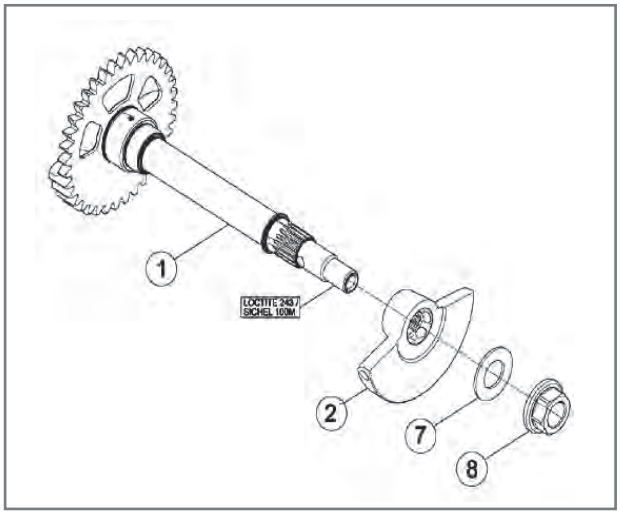
The pressure control valve is located in the bottom of the right-hand side crankcase near the motor oil drain plug.
The valve consists of the ball **1** and the spring **2** kept in place by the screw **3** and washer **4**. To disassemble, simply remove the protection rivet with a 6mm drill tip.

WARNING!
Protect the mechanical parts from any shavings.

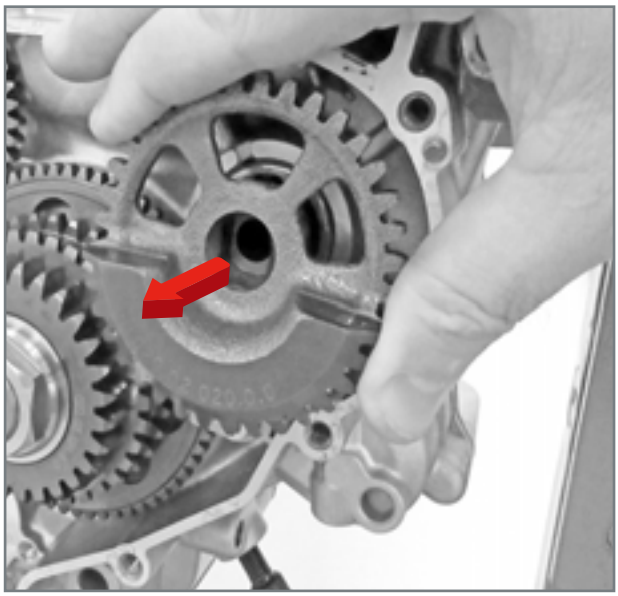
In order to disassemble the valve, remove the screw, pull out the washer, the spring and the ball.

2.5.5 PAPER OIL FILTER

In order to extract the paper oil filter, remove the cover **1** by loosening the two screws **2** completely. Once the cover has been removed, use a pair of opening pliers **A** to extract the filter.
While extracting the cover, be careful of the specific O-ring applied onto the cover.



Exploded view of countershaft.
1) Shaft;
2) Counterweight;
7) Elastic washer;
8) M12x1 nut.



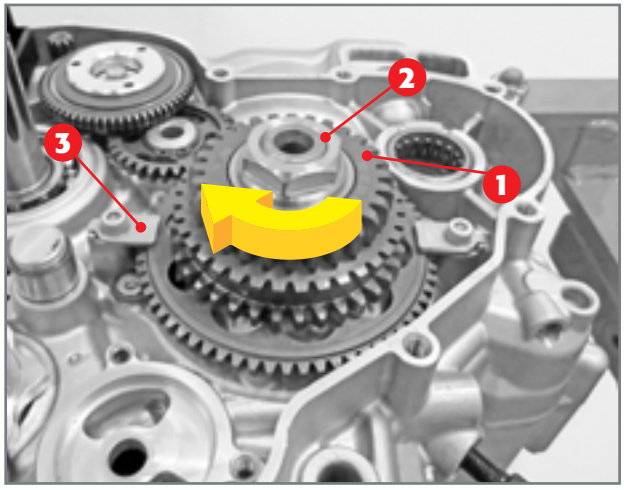
Extraction of countershaft.

2.6 COUNTERSHAFT

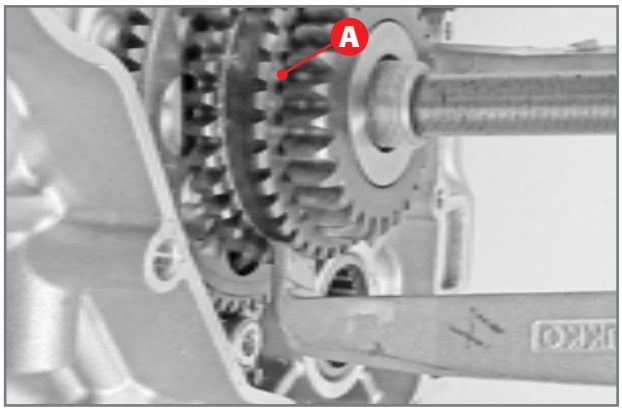
The countershaft has the task of balancing a part of the inertial forces produced by the crank mechanism.
The countershaft is mainly made up of the shaft **1** and counterweight **2**. The elastic washer **7** and nut **8** have the task of assuring coupling of the complete shaft to the base.

ATTENTION!
Do not use the pneumatic gun.

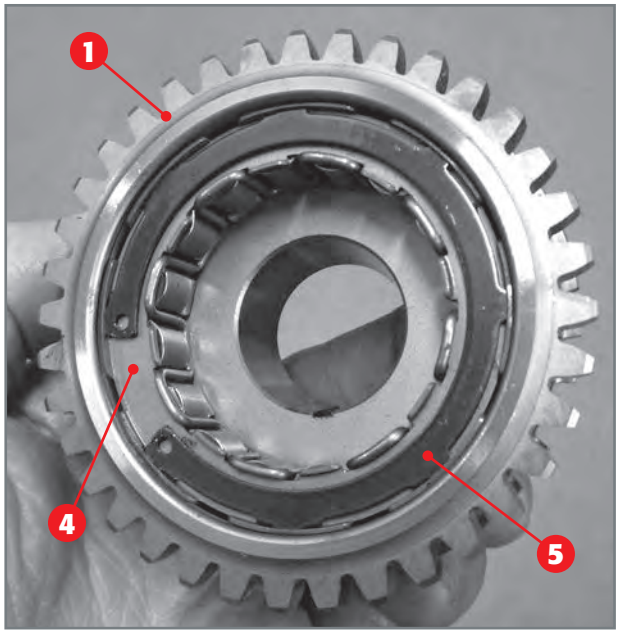
In order to disassemble the shaft, remove the nut **8** which can be accessed through the ignition unit compartment. Extract the elastic washer **7** and the counterweight.
Pull the countershaft out through the right-hand side crankcase **1**.



Primary gear 1 and relative nut 2.



Extraction of primary gear with appropriate extractor A.



Primary gear 1, complete with free wheel 2 and specific circlip 3.

2.7 PRIMARY GEAR

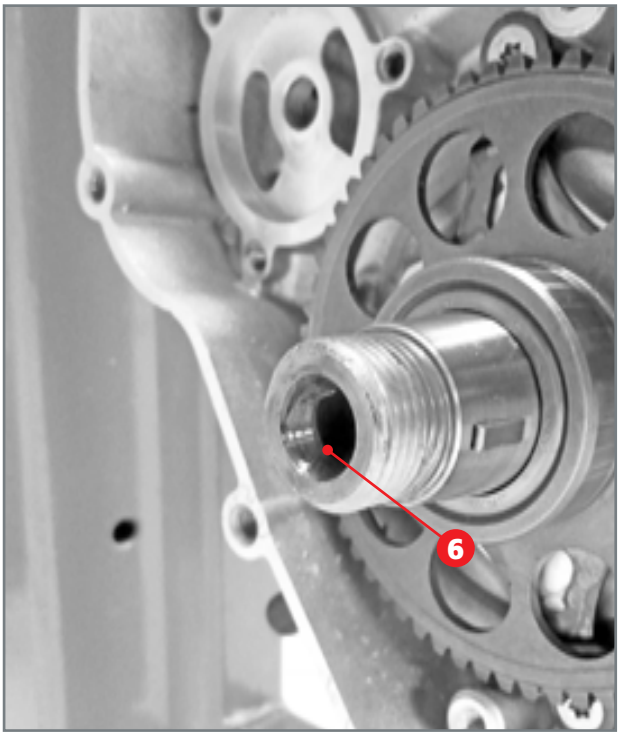
The primary gear **1**, located in the right crankcase half, is fastened to the crankshaft.
In order to disassemble it, remove the nut **2** which must first be previously heated using a blow-dryer or similar instrument.

WARNING!
*To be unscrewed, the nut **1**must be rotated clockwise.*

Note:
It is recommended to previously remove the safety stops from **3**in order to prevent deterioration while disassembling the gear **1**.

Extract the primary gear using the relevant extractor **A**.
(code *006140150000*)

Notice that the primary gear houses the free wheel device **4** inside it, which can be removed by taking out the circlip **5**.

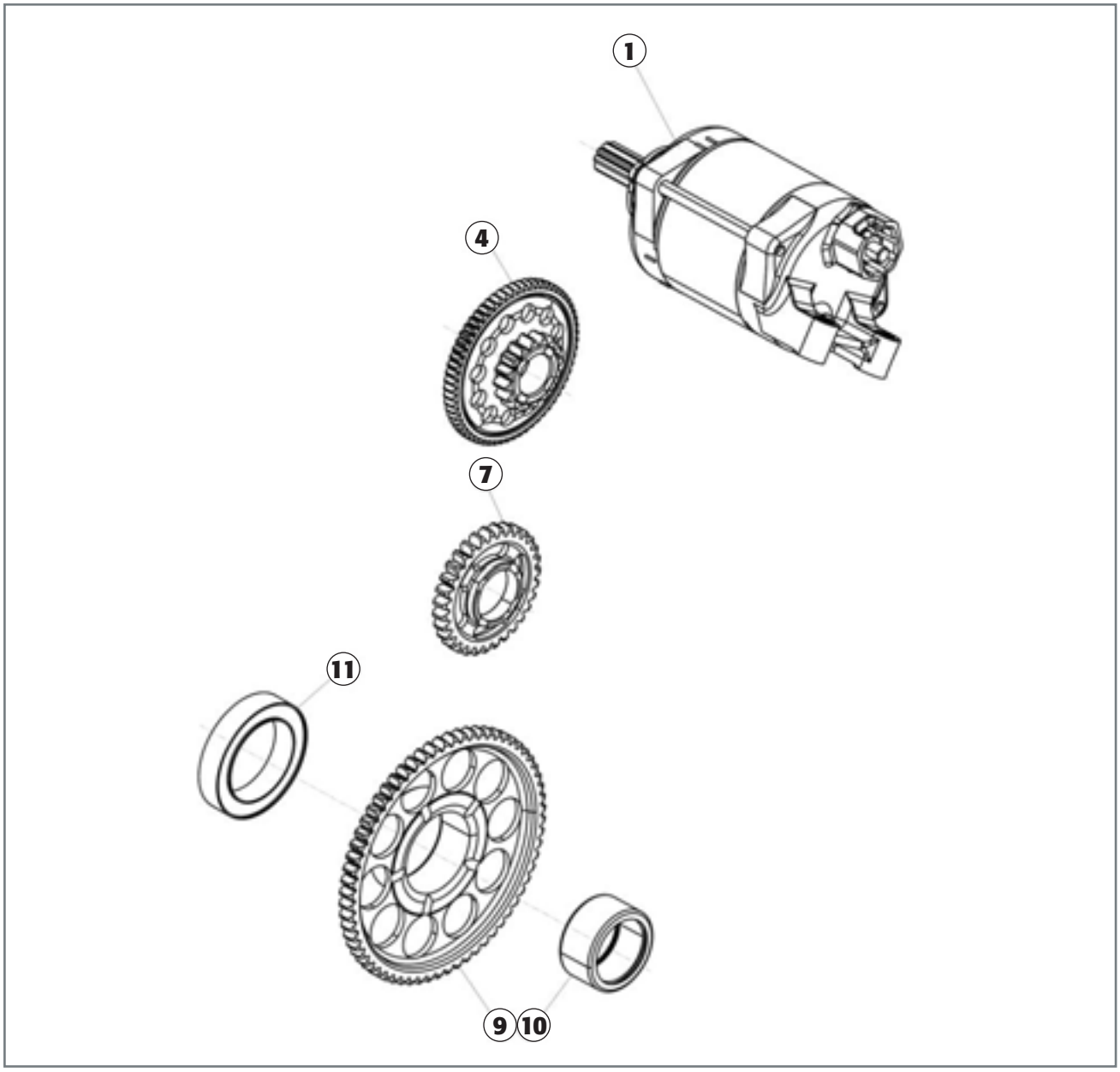


Remove the Woodruff key **6**.

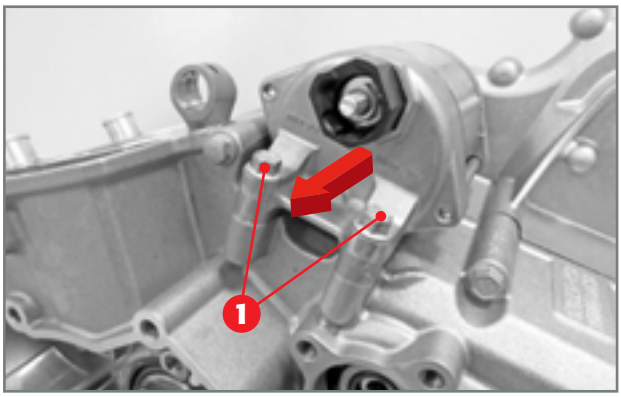
2.8 ELECTRIC IGNITION

Electric ignition can be carried out by means of the starter motor **1** which engages on the gearwheel **4** with the function of torque limiter.
The gearwheel **4** (torque limiter) transmits motion to the idler wheel **7**, which will then engage with the starter gear **9**.
The roller bearing **10** supports the starter wheel **9**, while the free wheel **11** is internally engaged on the starter wheel **9** and externally on the primary gear, thus allowing it, depending on rotation direction, to pull the crankshaft.

EXPLODED VIEW OF ELECTRIC KICKSTART.
1) Starter motor;
4) Torque limiter;
7) Idler wheel;
9) Ignition gear;
10) Roller bearing HK2516;
11) Free wheel.

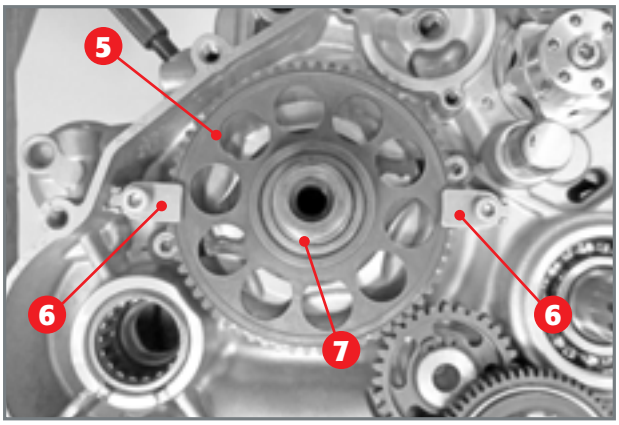


2.8.1 ELECTRIC KICKSTART UNIT



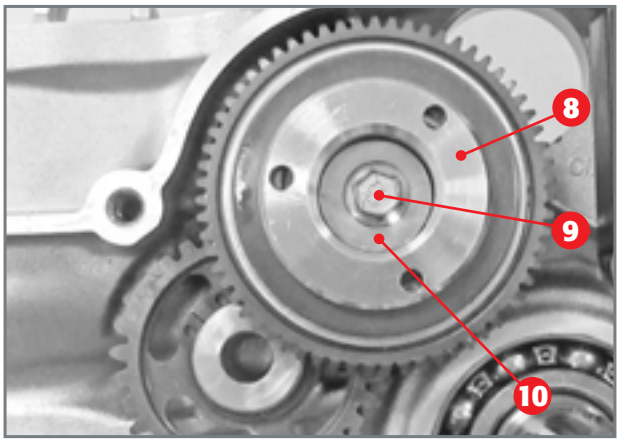
Screws 1 fixing the starter motor to the crankcase.

Remove the two screws **1** which fasten the starter motor to the crankcase and pull out the starter motor.



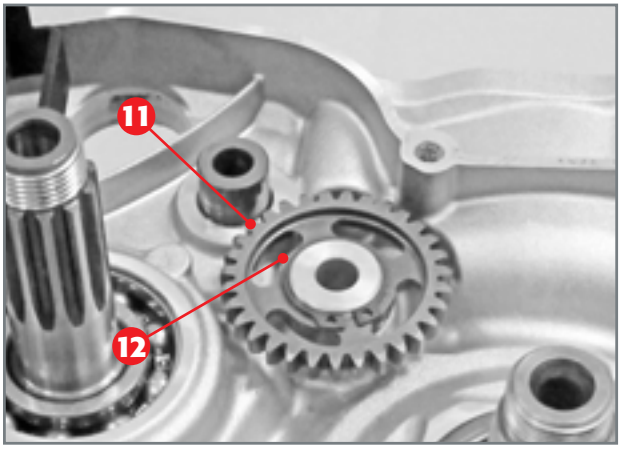
Removal of pin 6.

To extract the kick-start gear **5**, if not already done at par. 2.7, disassemble the primary gear (see par. 2.7), the safety stops **6** and key **7**. The kickstart gear is pulled out manually.



Torque limiter 9, screw 8 and washer 10.

In order to disassemble the torque limiter **8**, completely loosen the screw **9** which fastens the torque limiter to the crankcase. Pull out the washer **10** together with the limiter itself.

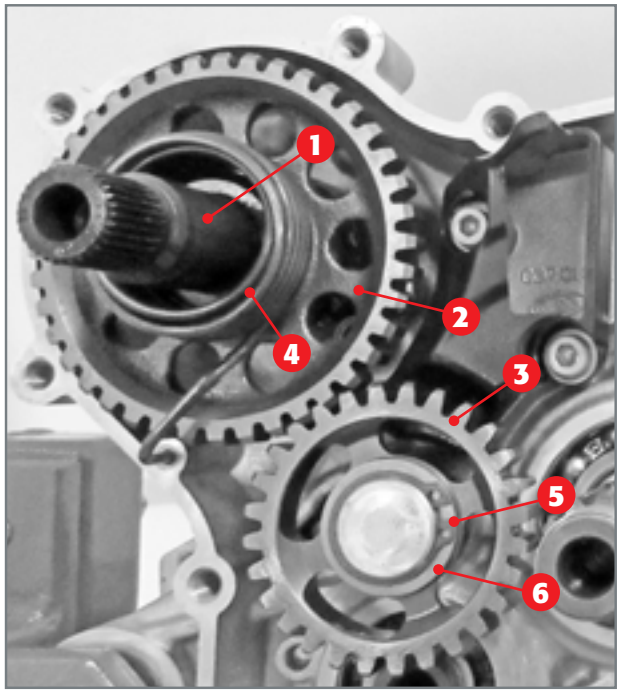


Idler wheel 11 of electrical kickstarter device.

In order to remove the idler wheel **11**, just remove the circlip **12** and pull out the gear.

2.9 PEDAL KICKSTARTER - OPTIONAL

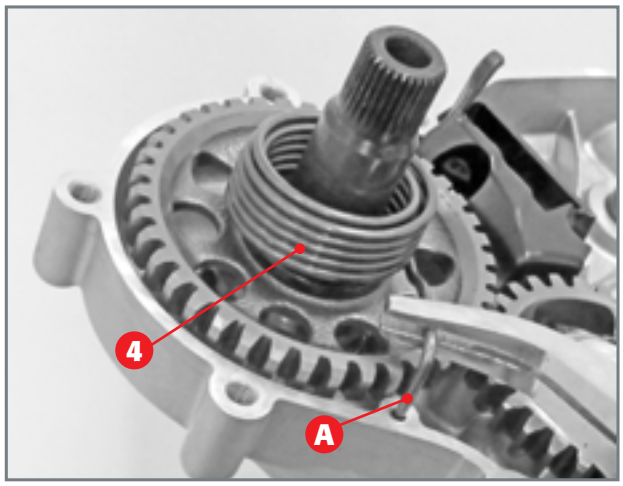
The pedal kickstarter consists of the pedal which, attached to the kickstarter shaft **1**, moves the kickstarter gear **2**. This gear moves the idler wheel **3**, which engages in its turn with the clutch case. The device recoils thanks to the spring **4**.



The pedal kickstarter and removal of circlip 5 of idler gear 3.

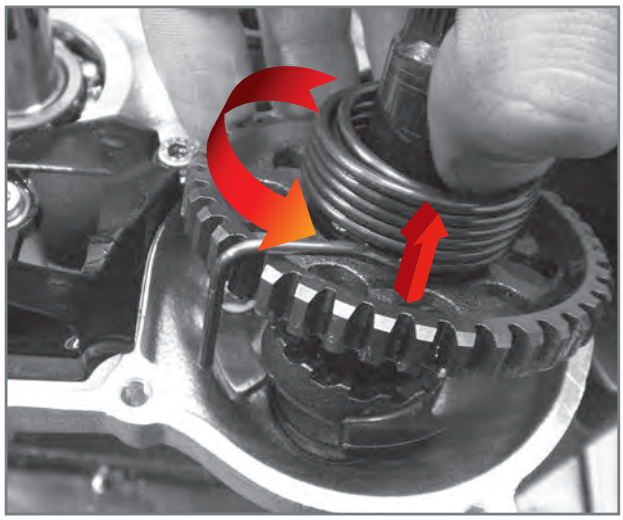
Remove the circlip **5**, the external thrust washer **6** and the idler gear **3**.

Using a pair of pliers, pull the end **A** of the spring **4** out of the housing hole on the crankcase and move it to a resting position by turning it anti-clockwise.

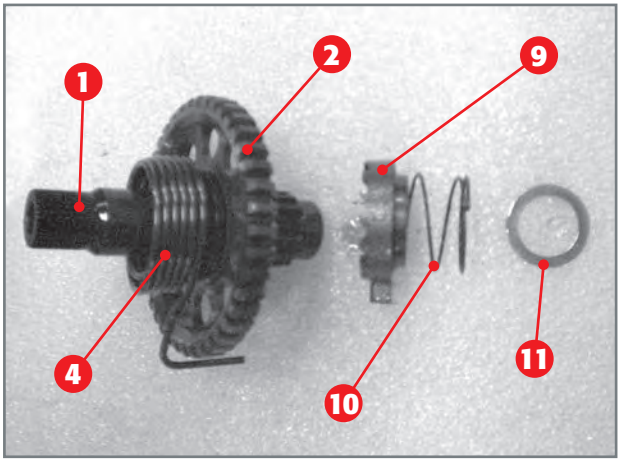


Releasing spring from crankcase.

Turn the shaft anticlockwise and pull it off together with the sleeve **9**, the spring **10** and the thrust washer **11.**



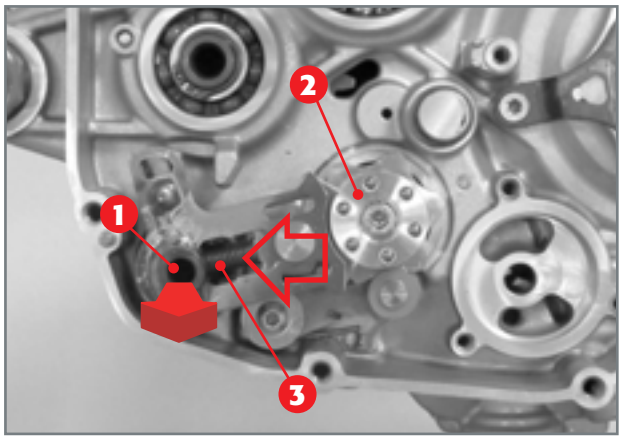
Extraction of shaft from crankcase.



Complete manual kickstart shaft.

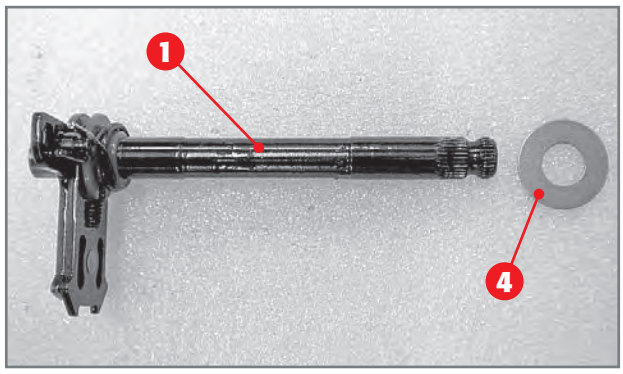
Note: *pay attention to the reference pins for centring the inner clutch cover (par. 1.4).*

2.10 EXTERNAL GEARSHIFT UNIT

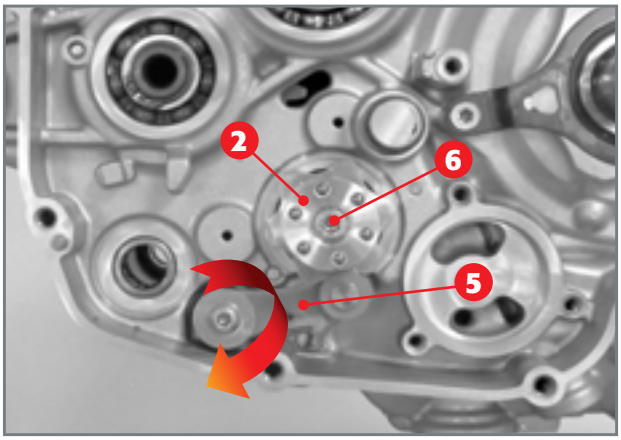


Disassembly of gear shaft.

The external gearshift consists of the drive shaft **1** on which the movable and fixed pawls are applied. The fixed pawl is the guide of the movable pawl, which has the task of engaging the stop cam **2**. In its turn, this is fastened to the internal gearshift and is kept in the fixed position by the cam stop lever.
In order to disassemble the drive shaft, just keep the movable pawl return spring **3** compressed and extract the shaft together with the specific washer **4**.

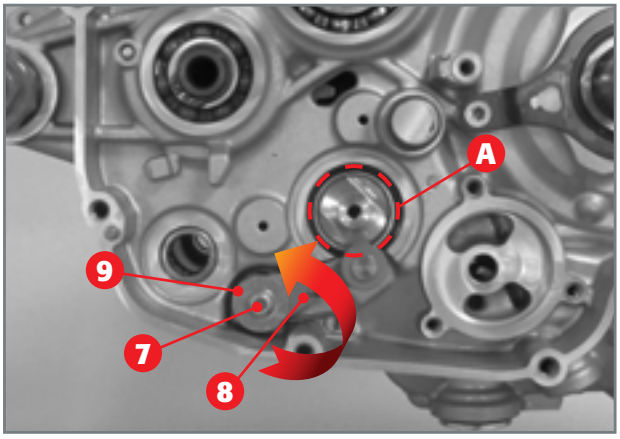


Gearshift with washer.



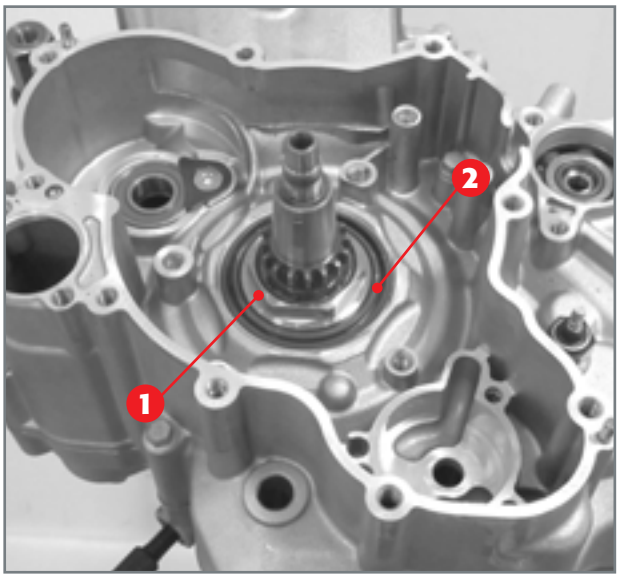
Disassembly of stop cam.

In order to disassemble the stop cam **2**, keep the cam stop lever moved **5**, loosen the screw **6** and pull out the stop cam.

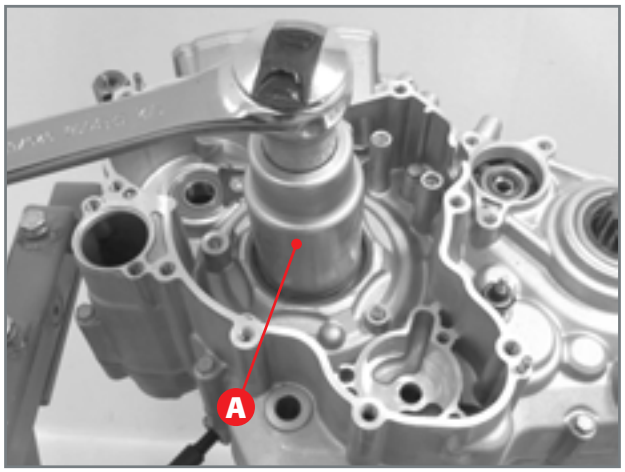


Disassembly of cam stop lever.

In order to disassemble the stop lever, loosen the screw **7** enough to allow the lever to move axially and go over the cylinder segment **A** of the desmodromic device. Bring the return spring **8** to the rest position and remove the screw, the washer **9**, the spring together with the spacer (not shown in the image) and finally the cam stop lever.



Crankshaft fixing nut B.



Removal of crankshaft blocking nut with special socket wrench A.

2.11 CRANKSHAFT, GEARBOX UNIT AND INTERNAL GEARSHIFT

To access the crankshaft, gearbox unit and internal gearshift, the left and right crankcases must be detached. Below are the required instructions.

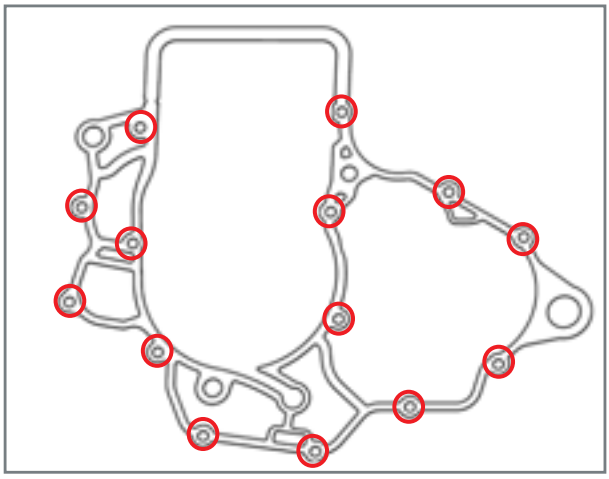
2.11.1 NUT ON LEFT SIDE OF CRANKSHAFT

In order to loosen the nut **1** on the left-hand side of the crankshaft, heat it with a blow-dryer or similar instrument. Then loosen the nut with a special socket wrench **A** (code *006140020000*) and remove it.

WARNING!
When re-assembling, the oil seal 2 must be replaced since the heating required for disassembly damages it.

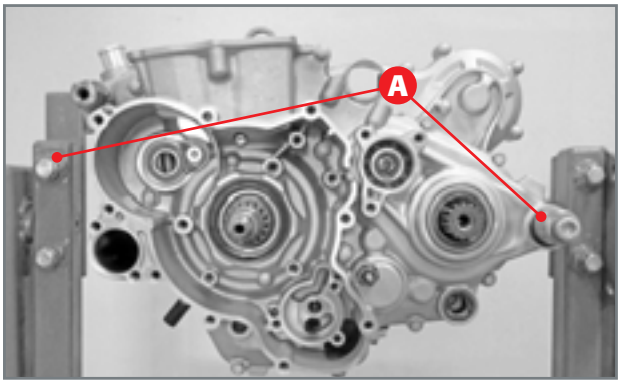
2.11.2 OPENING THE CRANKCASE

Remove the screws as shown in the figure.



Fixing screws of left side casing.

Loosen the two screws **A** which fasten the engine to the support stand.



Two screws A fastening the engine to the support stand.

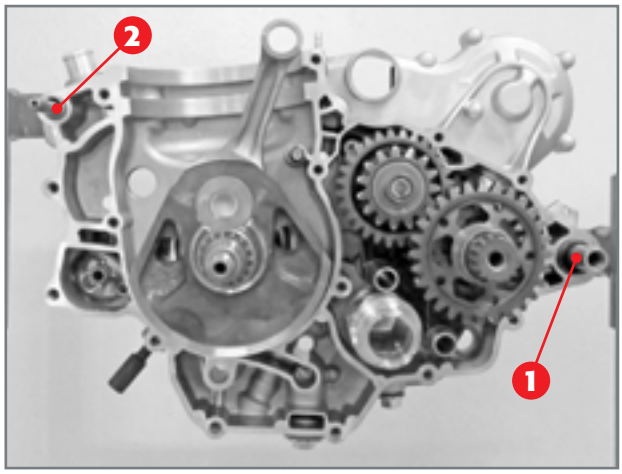
Hit the left crankcase half gently with a rubber or plastic hammer until it detaches from the right crankcase half. Remove the two screws blocking the engine to the equipment and disassemble the crankcase manually.



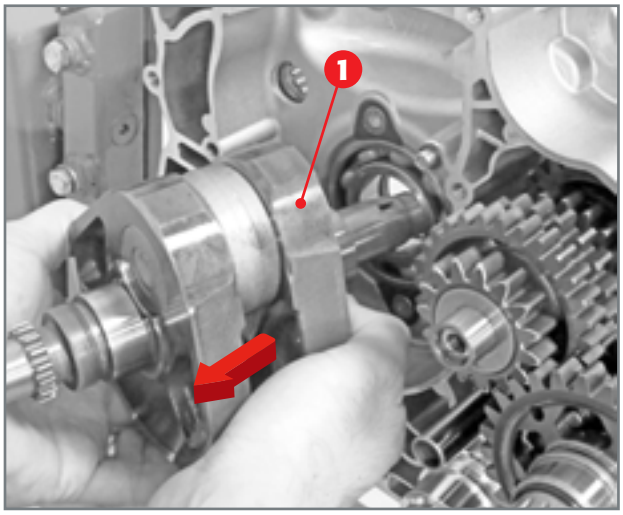
Disassembly of crankcase.

WARNING!
The gearbox unit and the crankshaft must remain inside the right crankcase half.

Remove the back **1** and front reference bushes **2** to position the crankcase correctly. Remove the gasket between the two half-casings.



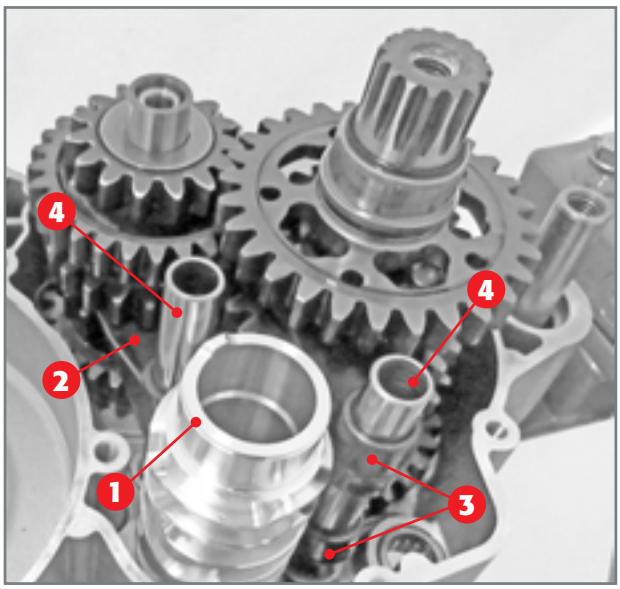
The left crankcase half (inside) with the reference pins 1 and 2.



Extract the forks together with the drive bushes.

2.11.3 CRANKSHAFT

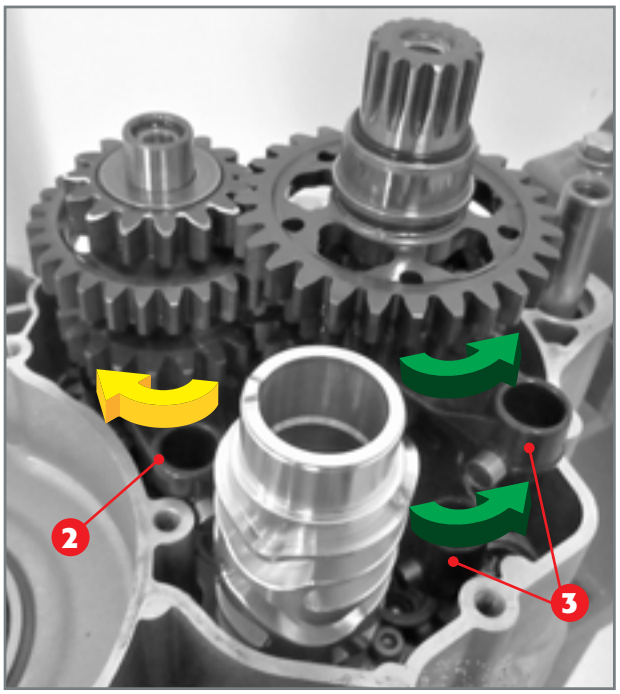
Remove the crankshaft fixing screw.
The crankshaft **1** can be pulled out manually. Should there be resistance, tap the right end of the crankshaft lightly with a plastic or rubber hammer.



Removal of fork support pins 4.

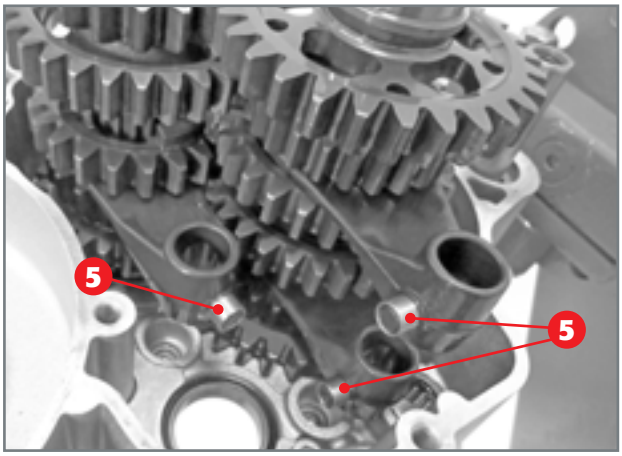
2.11.4 INTERNAL GEARSHIFT UNIT AND COMPLETE GEARBOX

The internal gearshift unit is made up of the desmodromic device **1** on which the fork **2** and two forks **3** are engaged. The forks, supported by the pins **4**, drive the sliding wheels of the gearbox, allowing the desired ratio to be engaged. The desmodromic device is controlled by the stop cam present in the external gearshift unit (par. 2.10)
Extract the two pins **4** manually so that the forks can be released and removed.



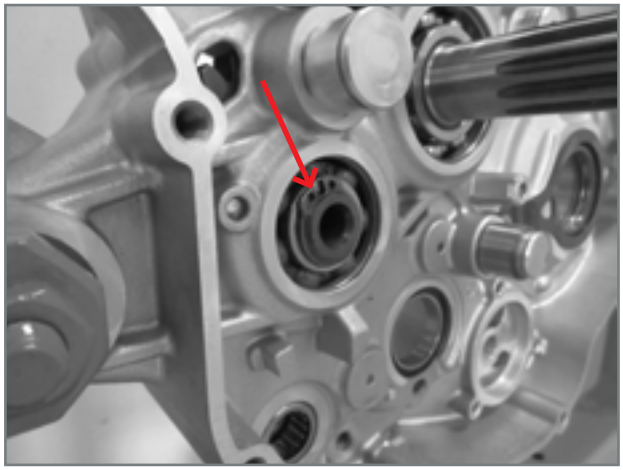
Disengaging the drive forks from the desmodromic device.

Rotate the forks **3** driving the sliding wheels on the secondary shaft anticlockwise.
Execute the same operation, although in reverse, on the fork**2** which drives the sliding gear on the primary unit, to release it from the desmodromic control.
Extract the desmodromic device.



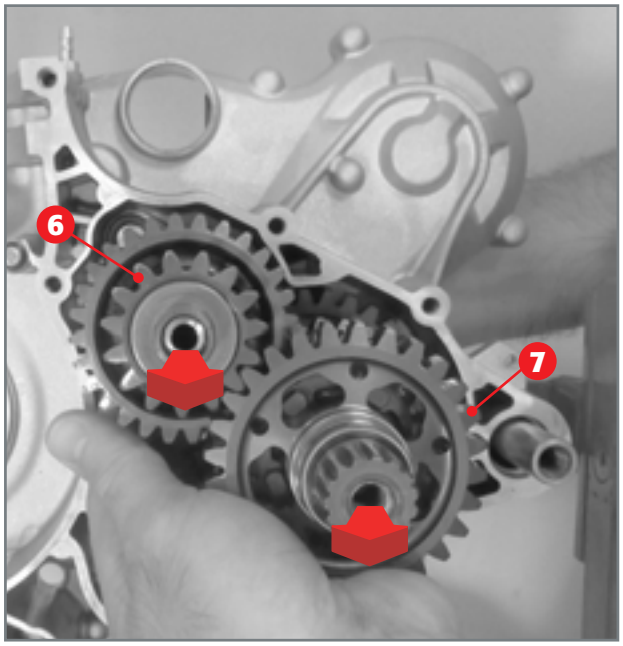
Extraction of forks from gearbox unit.

Extract the forks together with the guide bushes **5**.



Removal of the circlip.

WARNING!
Make sure the circlip on the secondary shaft has been removed (par. 2.9).



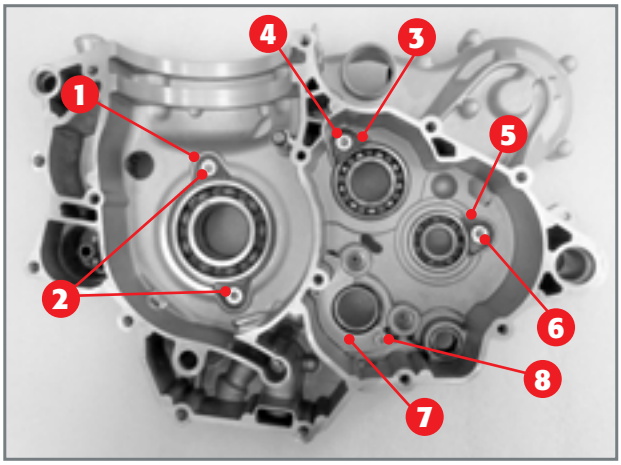
Extraction of complete gearbox unit: 6 primary unit, 7 secondary unit.

Extract the whole gearbox unit consisting of primary **6** and secondary **7** unit.

2.12 DISASSEMBLY OF PARTS FROM CRANKCASES

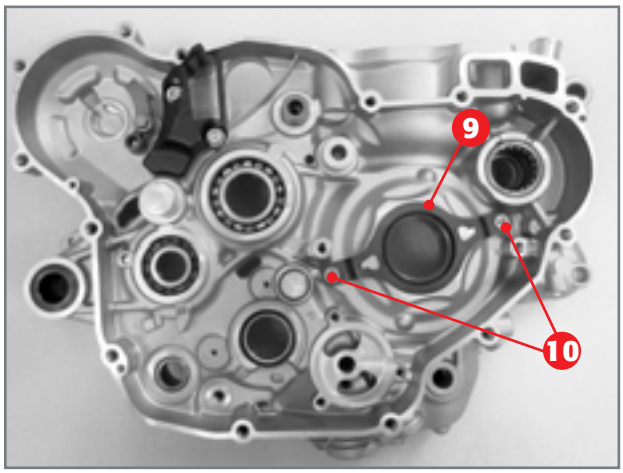
Once the crankcases have been detached, it is necessary to remove the various components attached to it.
The correct positioning of some bearings applied to the crankcases is ensured by locking devices such as plates or simple screws. In order to disassembly these bearings, the safety devices must be disassembled as well.

2.12.1 RIGHT CRANKCASE HALF



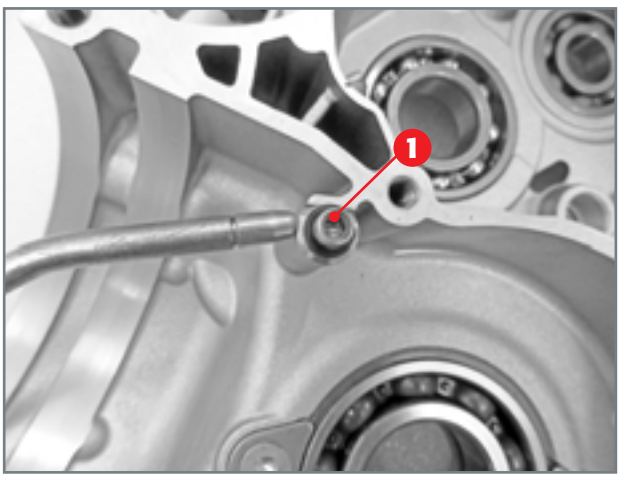
Safety devices present on the inside of the right crankcase half.

On the inside, the plates **1** are those which assure the correct positioning of the support bearing of the crankshaft. All you need to do is remove the two screws **2** to disassemble them.
The plate **3** is the one relating to the main shaft support bearing of the gearbox. It can be disassembled by removing screw **4**.
The plate **5** holds the bearing of the secondary shaft of the gearbox in place. It can be disassembled by removing screw **6**.
The screws **8** hold the retaining plate **7** of the desmodromic device support bearing in place.



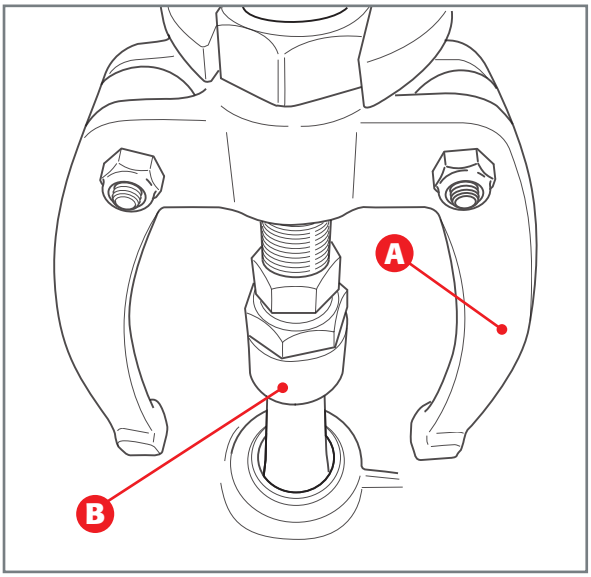
On the outside the oil seal blocking plate **9** is applied. It can be removed by taking off the two screws **10**.

2.12.1.1 Piston oil jets



Location of piston oil jets.

In order to allow the check and cleaning of part of the lubrication circuit, it is advisable to blow compressed air into the piston oil jets **1**.
The other oil jet is located on the left casing (par. 2.12.3).



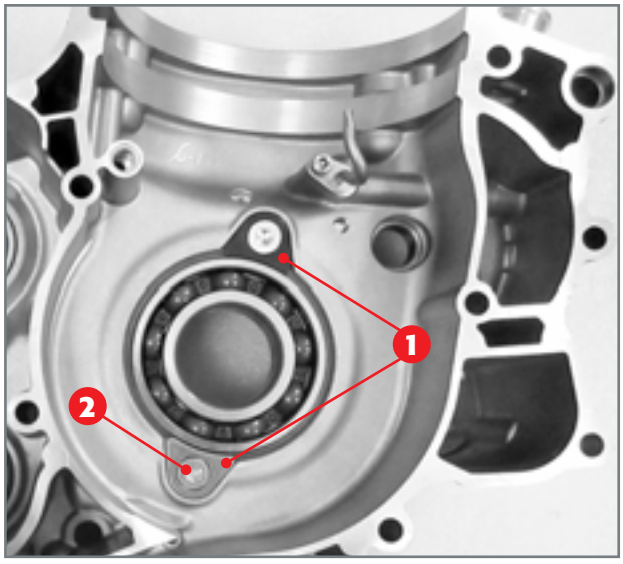
Extraction of countershaft bearing.

2.12.1.2 Extraction of countershaft support bearing

To extract the countershaft bearing, use the extractor **A** (*code 3625081*) together with the extractor **B** (*code 006140160000*). It is recommended to place two aluminium plates between the legs of the extractor and the crankcase half.

2.12.2 LEFT CRANKCASE HALF

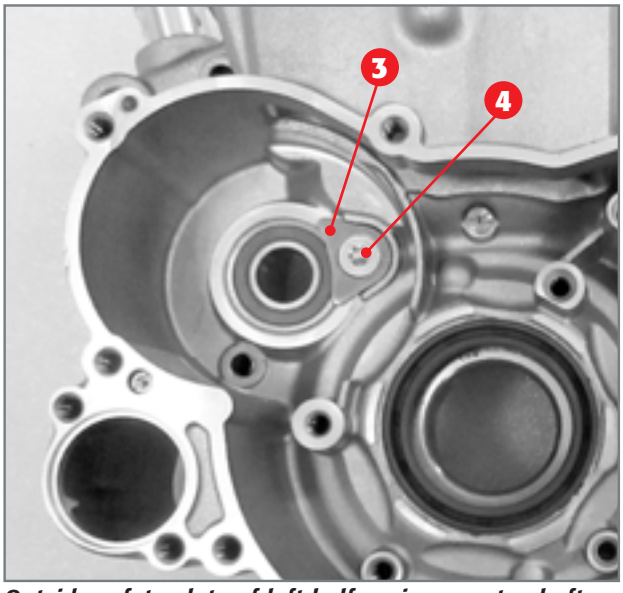
On the left crankcase half, three safety plates are present, two of which are applied internally and one is external.
The plates **1** on the inside are the ones relative to the crankshaft support bearing of the gearbox. They can be disassembled by removing the two screws **2**.



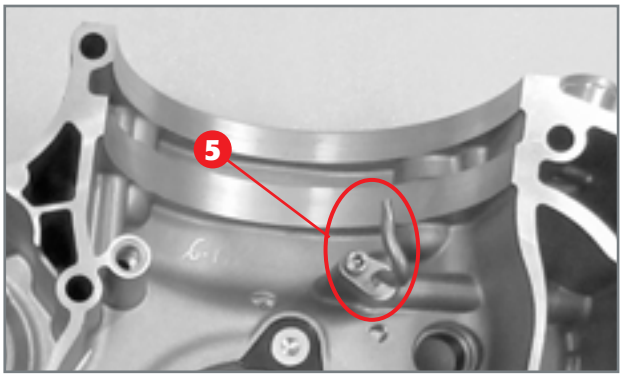
Inside safety plates of left half-casing crankshaft.

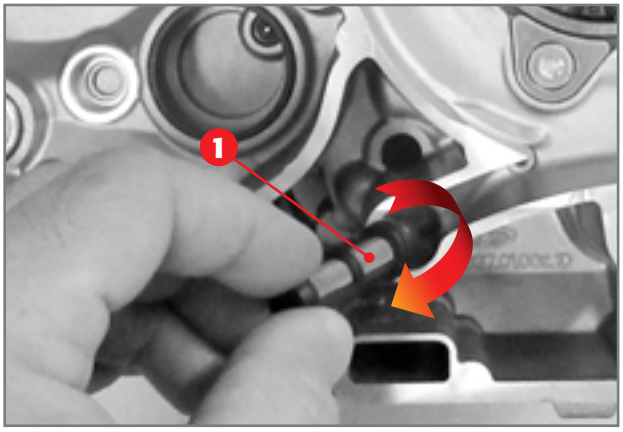
The plate **3** is the one relative to the bearing which supports the countershaft. It can be disassembled by removing the screw **4**.

For checking and cleaning part of the lubrication circuit, it is advised to use compressed air in the piston **5** oil jet.



Outside safety plate of left half-casing countershaft.

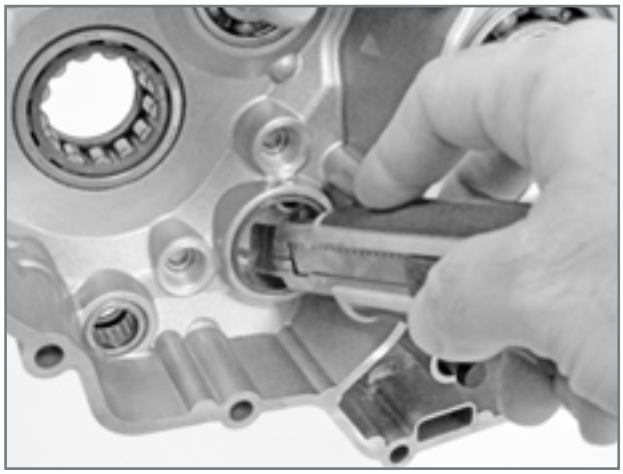




Disassembly of inner filter.

2.12.2.1 Inner oil filter

The inner oil filter **1** must be pulled out from the inside of the left crankcase. Its removal can be aided by using a soft pin to push it from the outside towards the inside, tapping with a small hammer.



Extraction of desmodromic device bearing.

2.12.2.2 Extraction of desmodromic device bearing

Simply use a cutter to remove the bearing dedicated to the device on the inside left crankcase half.
Should it appear scratched or damaged, it must be replaced.

3 ENGINE ASSEMBLY AND CONTROLS

Before reassembling the engine, a series of important controls must be carried out to ensure correct functioning of the engine. The bearings must be replaced if there is any play or jamming during rotation. The bushing or the plain shaft bearings must be replaced if worn, cracked or scratched.
It is however recommended to refer to the periodical maintenance table.
In order to insert the bearings in the crankcase halves, bring the crankcase halves to a temperature of 150°C and keep them at that temperature for 20 minutes.
Place said crankcase halves on a large surface where their whole seal surface can rest. When the bearings cool down, they drop into their seats on their own.

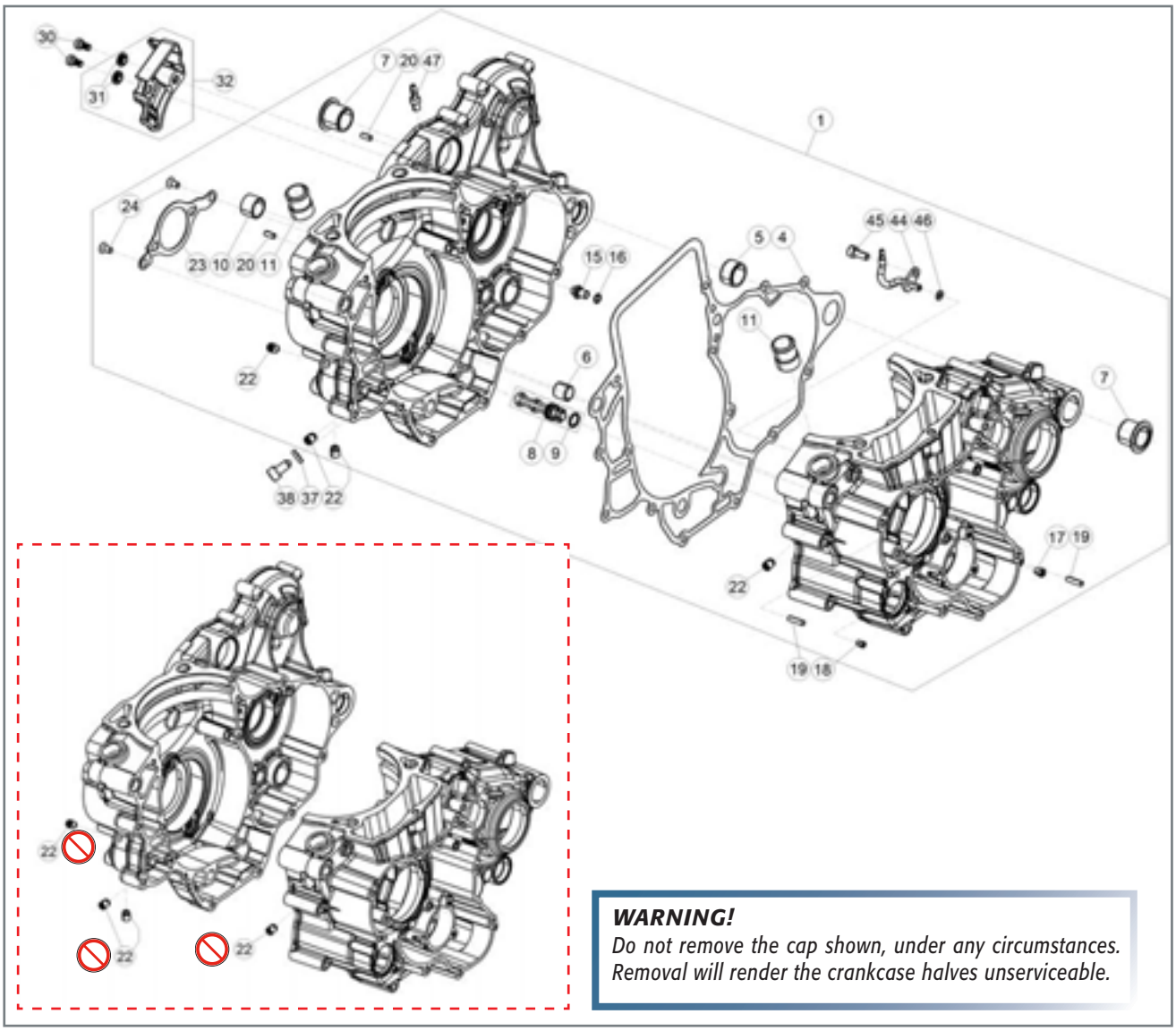
3.1 CRANKCASE HALF

The crankcase halves have some parts that require care, and their integrity and condition must be checked. The checks and assembly operations of the individual parts coupled to the crankcases are described below. Clean the threading and oil passages thoroughly using a degreaser and compressed air.

ATTENTION!
It is absolutely necessary to replace the crankshaft oil seals present on the outside of the left and right crankcase halves. This is due to the extreme heating they undergo when being disassembled.

In general, the crankcase halves must be replaced when:
- the oil pump crankcases show scratches or meshing signs (par. 2.11);
- in case they do not fit into their seats, once the new bearings are inserted and the crankcase half is left to cool off.

DETAILED VIEW OF CRANKCASE UNIT.
1) Engine crankcase;
4) Crankcase gasket;
5) Grub screw;
6) Grub screw;
7) 17x21x19 bush;
8) Crankcase oil filter
9) 8x1.5 ring;
10) 15x18x12.5 bush;
11) Water connector;
15) Complete oil jet;
16) 6x1.5 O-ring ;
17) Jet;
18) Jet;
19) 4x15.8 pin;
20) 4.0x9.8 pin;
22) Cap;
23) Plate;
24) M5x10 screw;
30) 5x12 screw;
31) Bush;
32) Conveyor;
37) Copper washer;
38) TDC screw;
44) Jet;
45) M4x10 screw;
46) 3.5x1.5 O-ring;
47) Connector.

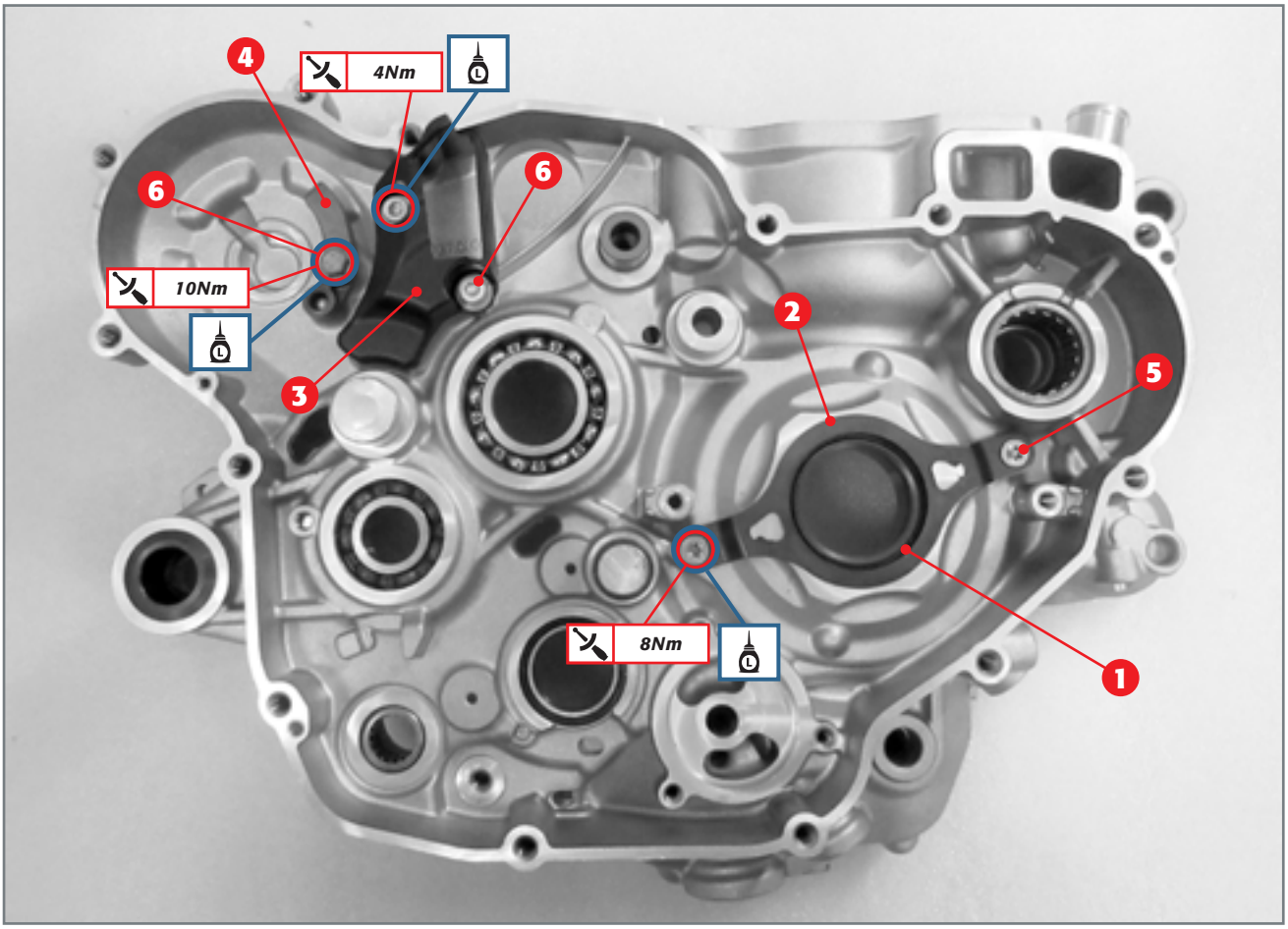


WARNING!
Do not remove the cap shown, under any circumstances. Removal will render the crankcase halves unserviceable.

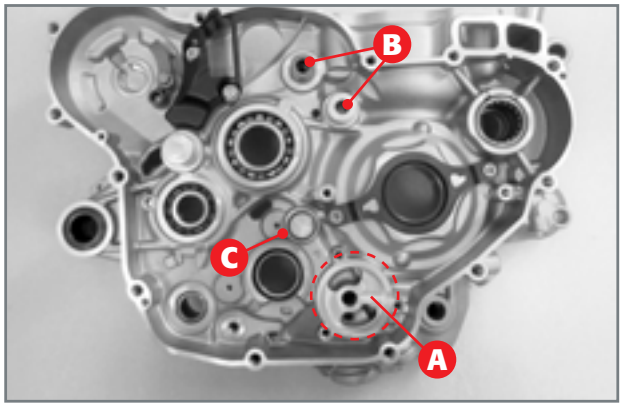
3.1.1 EXTERNAL RIGHT SIDE

Pull out the crankshaft oil seal **1** and replace it. Check that the oil seal fixing plate **2** is not bent. If so, have it replaced.
Check the integrity of the oil incline **3**. Should it be worn, have it replaced.
Check the state of use of the kickstart ramp **4**(optional). It must be replaced if it shows signs of meshing or chipping.
The table below contains indications for fixing the screws of the above-mentioned elements.

Screw number	Screw size		Threadlocker application	Tightening torque [Nm]
	Threading diameter [mm]	Threading length [mm]		
5	M5	10	Medium resistance threadlocker	8
6	M5	12	Threadlocker medium-resistance	4
(optional)	M6	20	Threadlocker medium-resistance	10

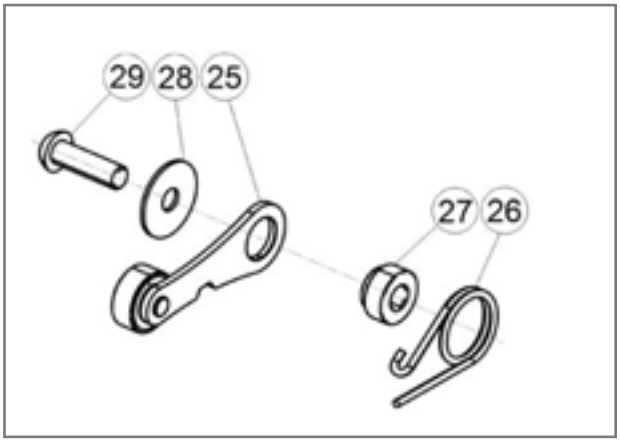


Elements present on external right crankcase half.



The crankcase half will definitely need to be replaced if:

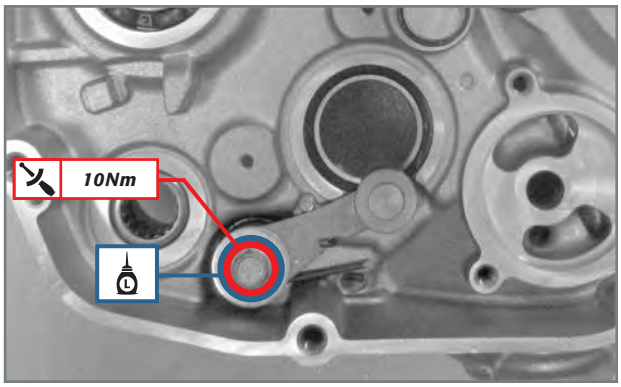
- the oil pump compartment **A** shows deep scratches or meshing signs;
- the two pins **B** for the idler wheel and torque limiter show traces of abnormal wear or meshing;
- the bushing **C** of the idle gear of the oil pump control is damaged.



EXPLODED VIEW OF STOPPING DEVICE

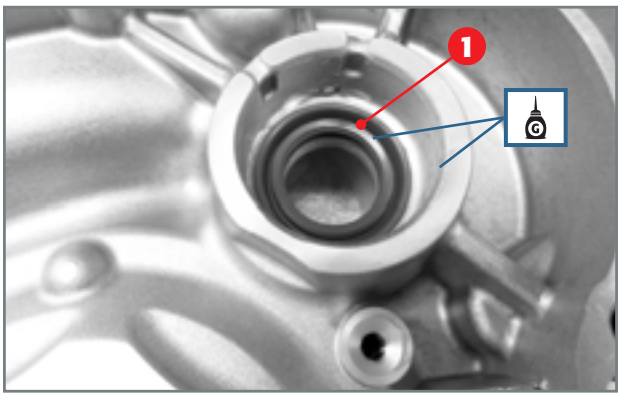
25) Lever;
26) Spring;
27) Spacer;
28) 6x20x1 washer;
29) M6x20 screw

Apply the gear stopping device as follows.
Keeping the tightener on the lever **25** facing towards the crankcase half, apply the spacer **27** onto it, by inserting the smaller diameter segment in the lever. Apply the spring **26** so that the hook inserts into the groove present on the lever **25** and then apply the washer **28** and the M6x20 screw **29**, whose threading must be spread with medium strength threadlocker.



Stopping device coupled with the crankcase half.

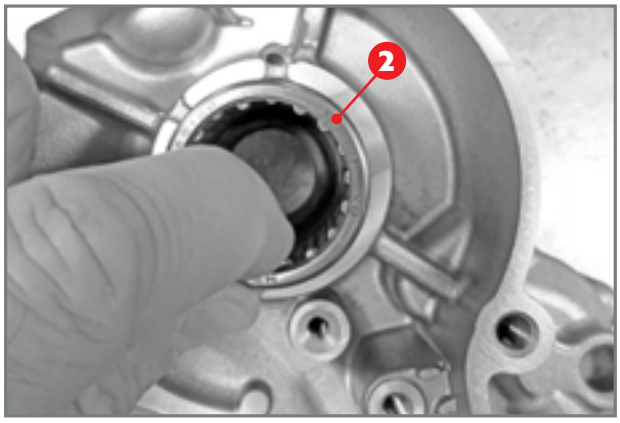
Apply the entire device on the crankcase half so that the straight segment of the spring rests on the edge of the engine carter half. Tighten the screw to the indicated torque.



Application of oil seal 1.

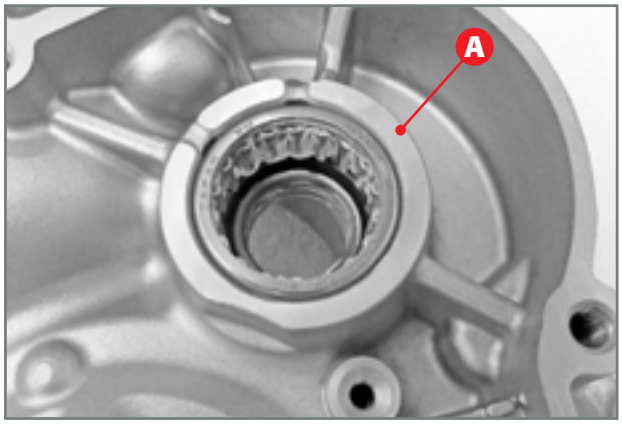
3.1.1.1 Insertion of oil seal and countershaft support bearing

In order to insert the oil seal and countershaft support bearing, proceed as follows.
Grease the oil seal and bearing housing. Insert the new oil seal **1** greasing the inside of it.



Insertion of bearing 2.

Apply the new bearing **2** paying close attention that it is aligned with its seat.



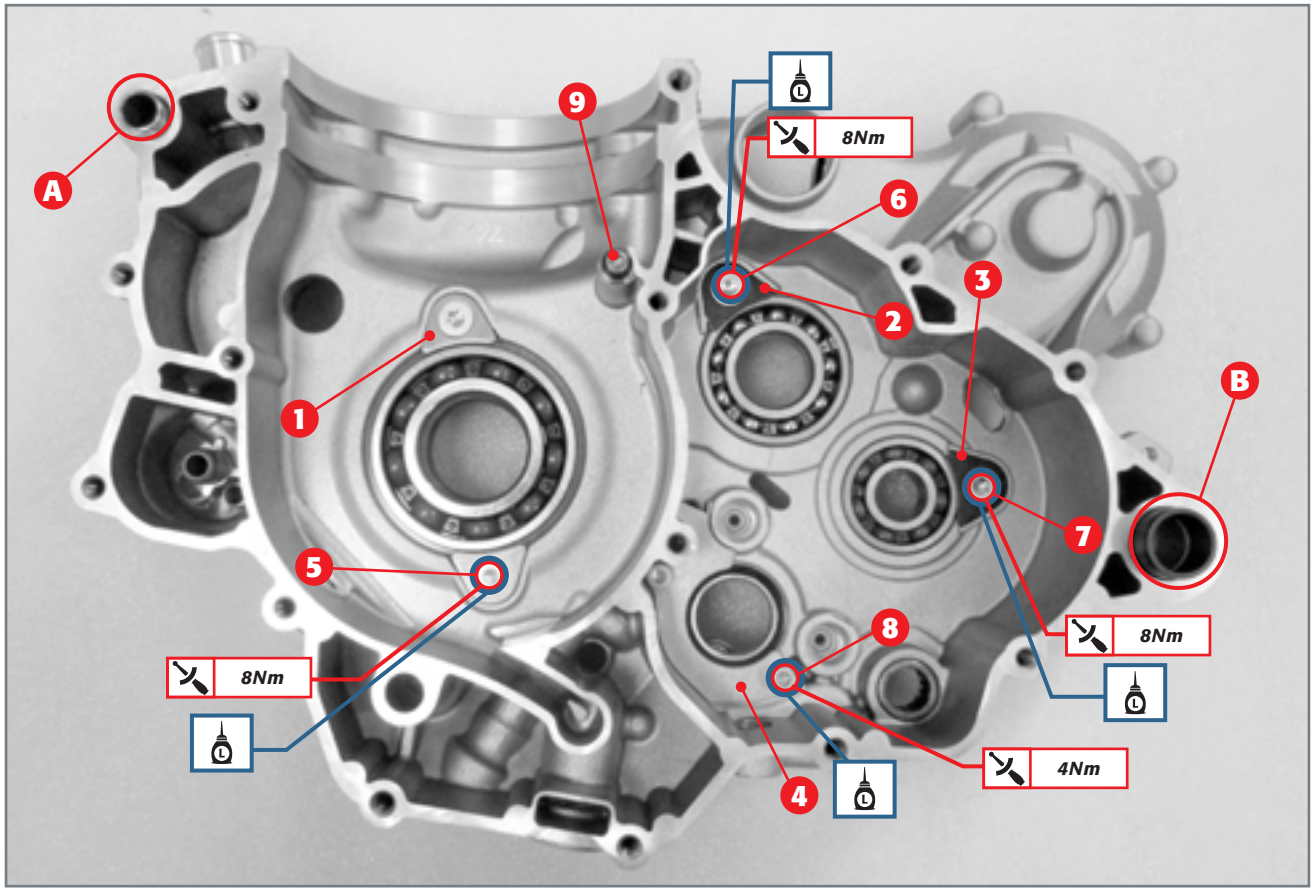
Oil seal and bearing unit coupled to the left crankcase half.

Use a press or similar instrument to push the bearing until the outside surface is flush with the surface **A**.

3.1.2 INTERNAL RIGHT SIDE

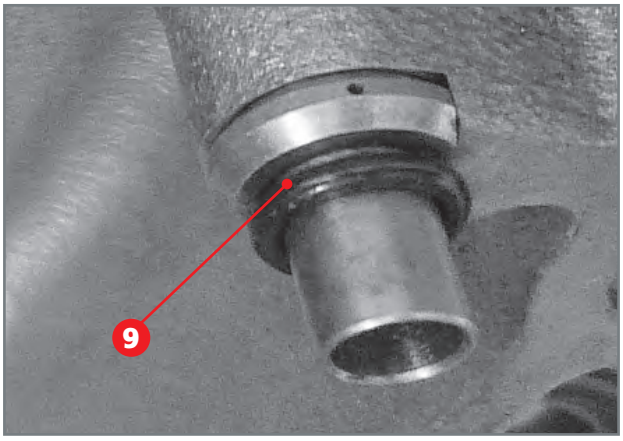
Check the flatness of the crankshaft **2** bearing retaining plates **1**, of the main shaft bearing retaining plate **3,** of the secondary shaft bearing retaining plate, and **4** of the desmodromic device bearing retaining plate.
The table below carries the indications for application of the fixing screws of these plates and for fixing the desmodromic device support bearing.

Screw number	Screw size		Threadlocker application	Tightening torque [Nm]
	Threading diameter [mm]	Threading length [mm]		
5	M6	12	Threadlocker medium-resistance	8
6	M6	12	Threadlocker medium-resistance	8
7	M6	12	Threadlocker medium-resistance	8
8	M5	10	Threadlocker medium-resistance	4

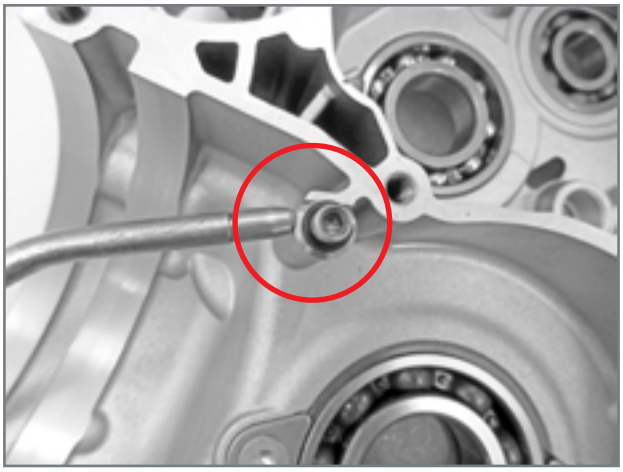


Elements present in the internal right side carter.

Insert the two reference bushes **A** and **B** in their respective housings.



Piston oil jet O-ring and detail of through hole.



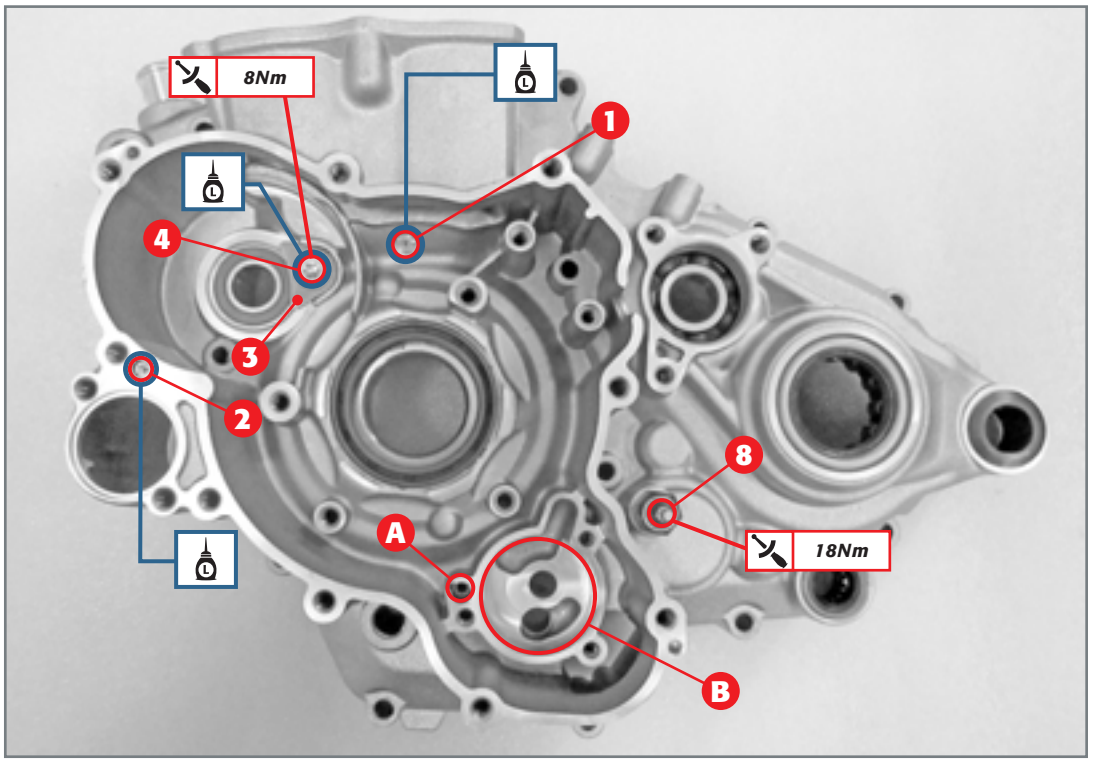
Make sure the piston oil jets are positioned correctly and free of obstructions.
Make sure that O-ring **9** is correctly positioned by checking its state. Should the O-rings have cracks or deformations, they must be replaced.

Note: *blow compressed air into the oil jet on the outlet side. So that the internal filter can be cleared from any dirt*

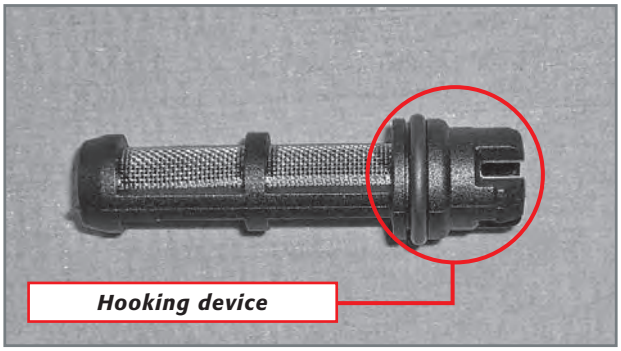
3.1.3 EXTERNAL LEFT SIDE

Make sure that oil jets **1** and **2** are not obstructed. In case they have been replaced, couple them to the crankcase using a small amount of medium strength threadlocker, being careful that the threadlocker does not block the holes. Then tighten them all the way.
Make sure that the oil passage **A** is well clean, and the countershaft bearing retaining plate **3** is not deformed. If it is, replace it.
The table below carries the indications for application of the screw **4**.
The crankcase half will definitely have to be replaced if the oil pump compartment **B** has deep scratches or signs of meshing.

Screw number	Screw size		Threadlocker application	Tightening torque [Nm]
	Threading diameter [mm]	Threading length [mm]		
4	M6	12	Threadlocker medium-resistance	8



Elements present on external left crankcase half.

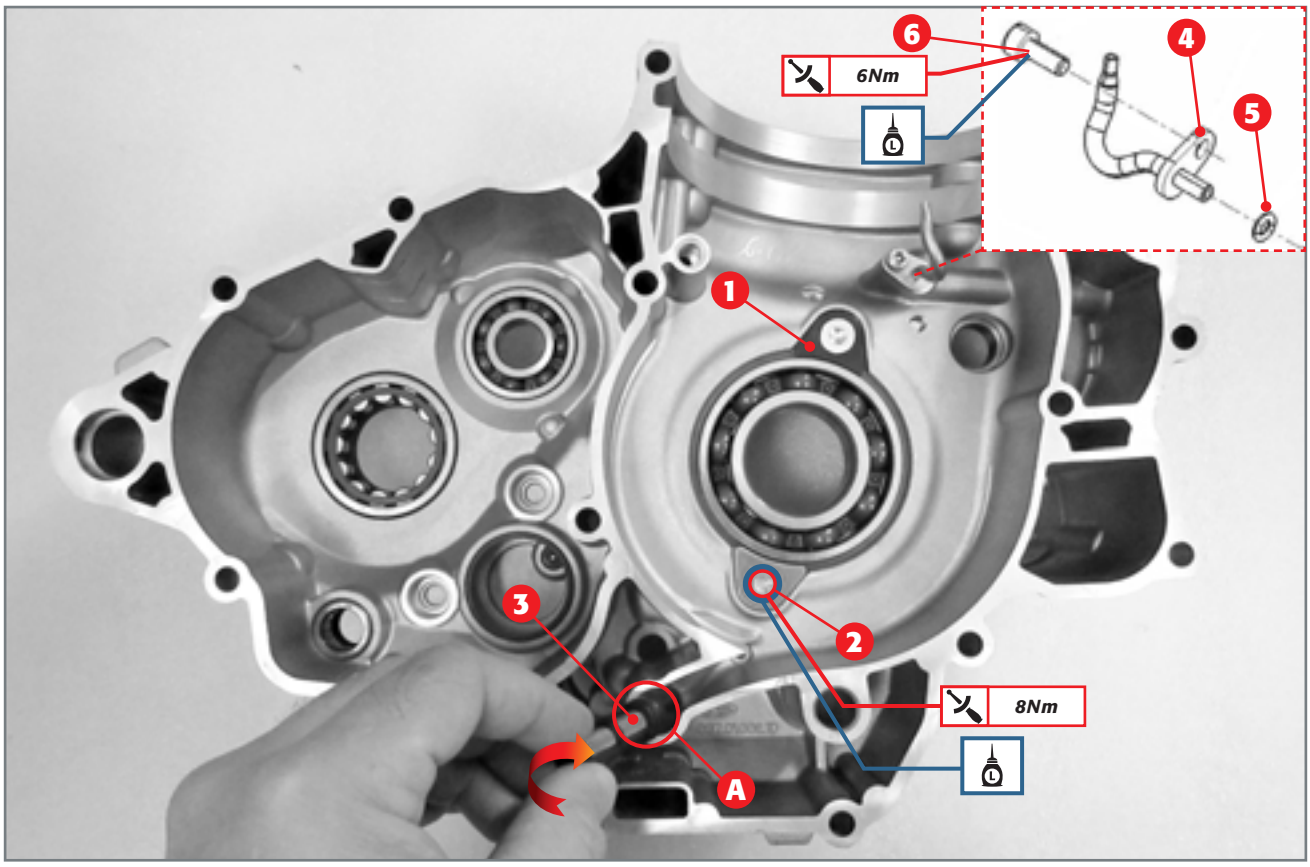


3.1.4 INTERNAL LEFT SIDE

Clean the inner filter thoroughly and check the integrity both of the wire metal and the hooking device. Should the filter be deteriorated in any of these parts, replace it.

Check the state of the two crankshaft bearing retaining plates **1**. If they are deformed, have them replaced.
The table below carries the indications for application of the screws.
Insert the inner filter **3**in its seat **A** present in the crankcase and push it all the way down until you hear the hooking device click.
Apply the oil jet **4** after application of O-ring **5**.
Apply the screw **6** after application of medium resistance threadlocker. Tighten to the specified torque.

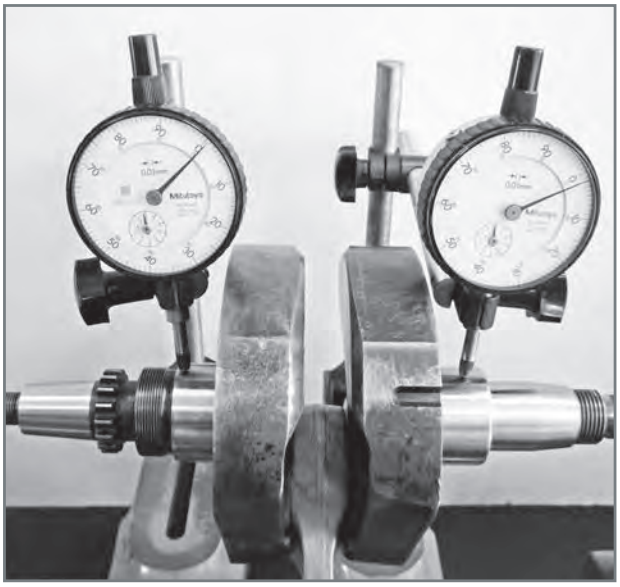
Screw number	Screw size		Threadlocker application	Tightening torque [Nm]
	Threading diameter [mm]	Threading length [mm]		
2	M6	12	Threadlocker medium-resistance	8
6	M4	10	Threadlocker medium-resistance	6



Elements present on inside left crankcase half.

3.2 CHECKING THE CONNECTING ROD AND MOTOR SHAFT

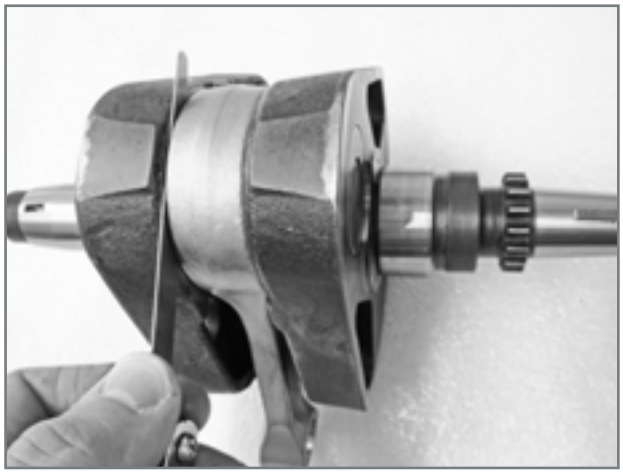
After having checked the state of wear of the coupling surfaces, check the offset of the half shaft axes by placing the crankshaft in between two tailstocks or similar instrument. Control the maximum measurement variation during a complete turn, using comparators positioned on the coupling surfaces with the crankshaft bearings.



Deflection/Off-centring of crankshaft.

Allowed limit value: 0.03mm

Check the axial play between the connecting rod head and the half shafts.



Connecting rod axial play.

Recommended play:
0.42÷0.65mm

Check the radial play of the connecting rod head bearing by placing the crankshaft on a stable support. Then position a comparator in axis with the connecting rod, and pressing lightly in the direction of the crank lever axis, check that the measurement detected does not exceed the service limit.



Connecting rod radial play.

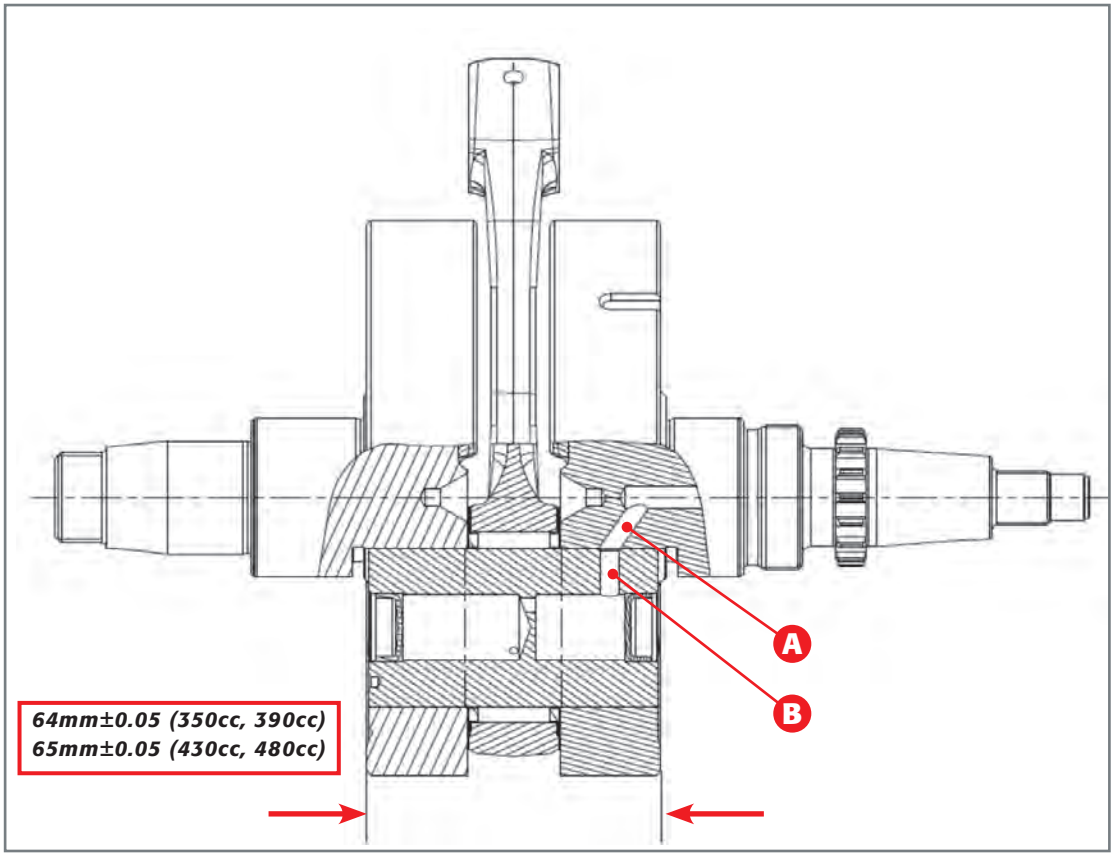
Maximum play: 0.04mm

If play is greater, replace the connecting rod.

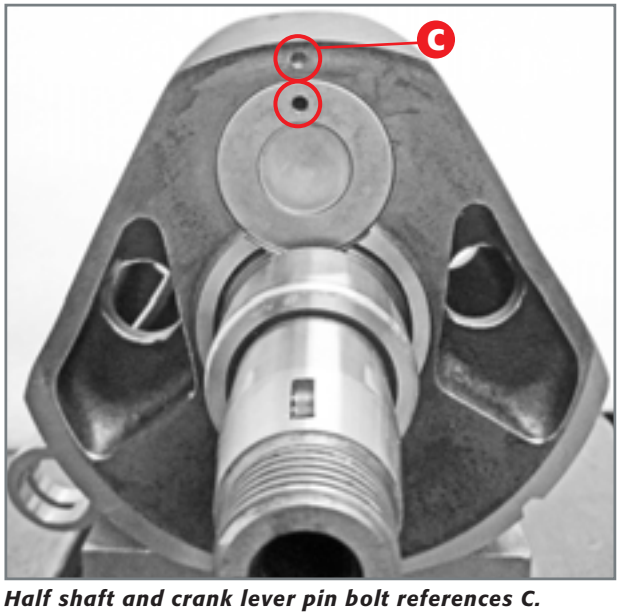
Make sure that the chain control gear is free of chipping or signs of abnormal wear. Replace the crankshaft should it be deteriorated.

The distance between the two opposite sides of the half shafts must be :

64mm±0.05 (350cc, 390cc)
65mm±0.05 (430cc, 480cc)



Crankshaft oil passages.



Half shaft and crank lever pin bolt references C.

If the two half shafts are detached for replacement of the connecting rod, pay close attention when repositioning the crank lever with respect to the half shafts. The holes for oil passage **A** on the half shaft must coincide with those present on the crank lever **B**.
Incorrect positioning would cause an irregular oil flow rate thus damaging the connecting rod head bearing.
The references **C**, which must be aligned, are found on the half shaft on the flywheel side and on the crank lever of the pin bolt.



Bore meter verification of inside diameter of connecting rod foot.

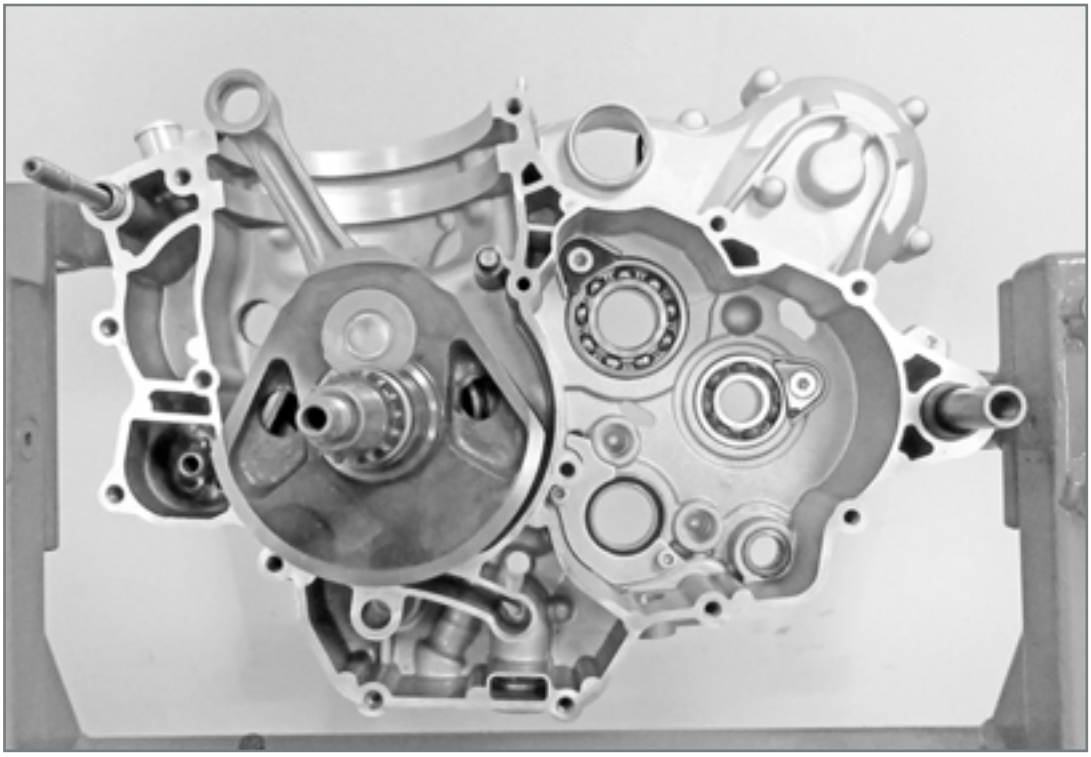
Use a bore meter to check the inside diameter of the connecting rod foot which must not exceed the following service limit:

Service limit 18.04mm (350cc, 390cc)
19.04mm (430cc, 480cc)

Remember that the measurement must be made placing the axis of the feeler in parallel with the axis of the connecting rod.

3.3 COMPLETE CRANKSHAFT ASSEMBLY

When all the aforementioned controls have been carried out and the worn parts replaced, grease the crankshaft oil seal on the right crankcase half and couple the crankshaft to the left crankcase half. Keep the gear present on the crankshaft towards the left. In order to carry out this operation, you must just push the shaft axially towards the crankcase.



Insertion of crankshaft in the right crankcase: note the position of the gear.

3.4 GEARBOX UNIT: CHECKS AND REASSEMBLY

The gearbox unit consists of the gearshift and of the gearbox proper. The gearshift in its turn is divided into external and internal gearshift.
The checks and procedures for inspecting and reassembling these units to the engine are set out below.

3.4.1 GEARBOX UNIT CHECK

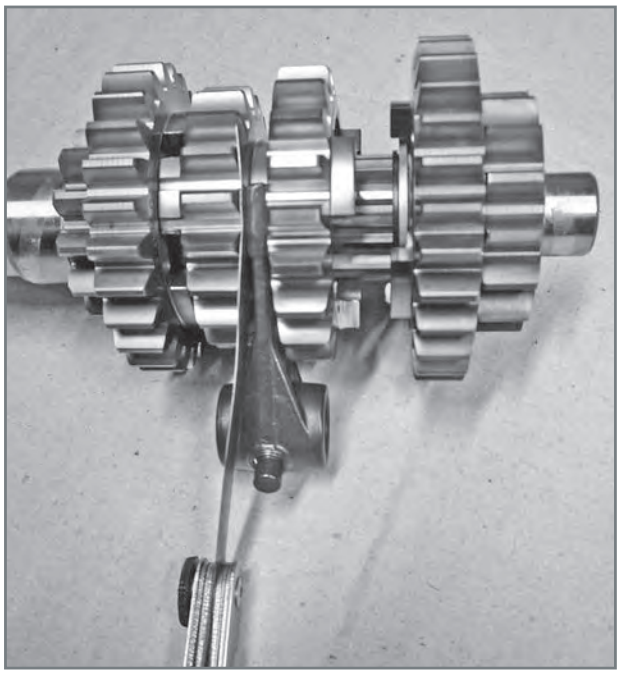
While holding the gearbox units horizontal, use a thickness gauge to check the axial play between the gearshift forks and the gearwheels. The measured play must not exceed the service limit indicated below:

service limit: 0.4mm

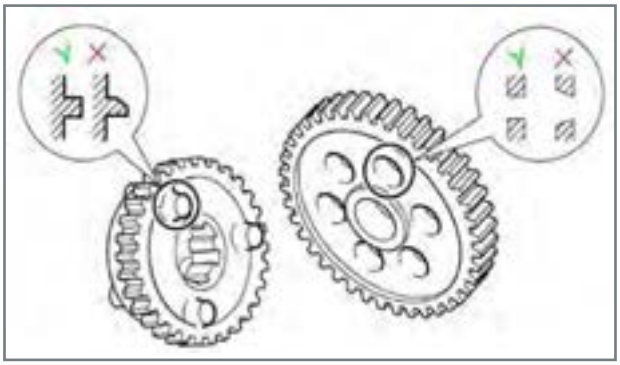
If the measured axial play is greater, before replacing either the gearwheels or the forks, check the state of wear of the latter (par. 2.4.4).

Remove the various elements and check that:

- the support surfaces of the main shaft and secondary shaft show no abnormal wear or signs of seizure;
- the sides of the teeth are free from chipping or abnormal wear;
- the sliding areas of the gearwheels show no abnormal wear or traces of seizure;
- the front claw clutches of the gearwheels are not chipped or rounded;
- the roller bearings are intact and efficient;
- none of the thrust washers show traces of abnormal wear or meshing.
- Should any of these defects be found, replace the concerned parts.



Checking wear of forks and gearwheels

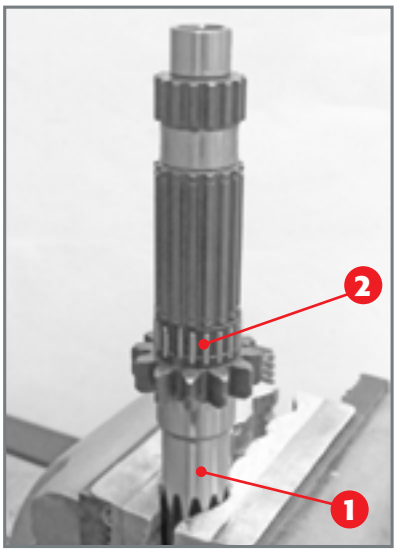


Check gear couplings

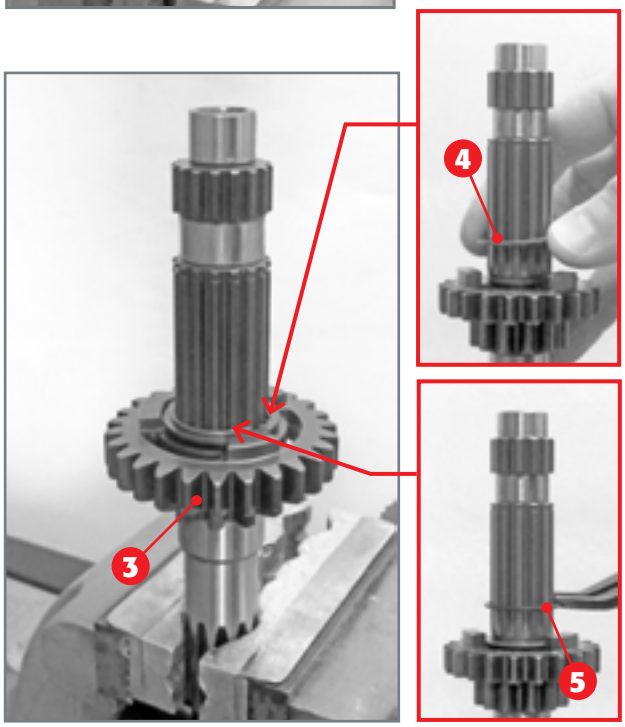
3.4.2 PRIMARY UNIT ASSEMBLY

Before proceeding with reassembly, clean all the parts thoroughly and oil with gear oil. Always replace the circlips.

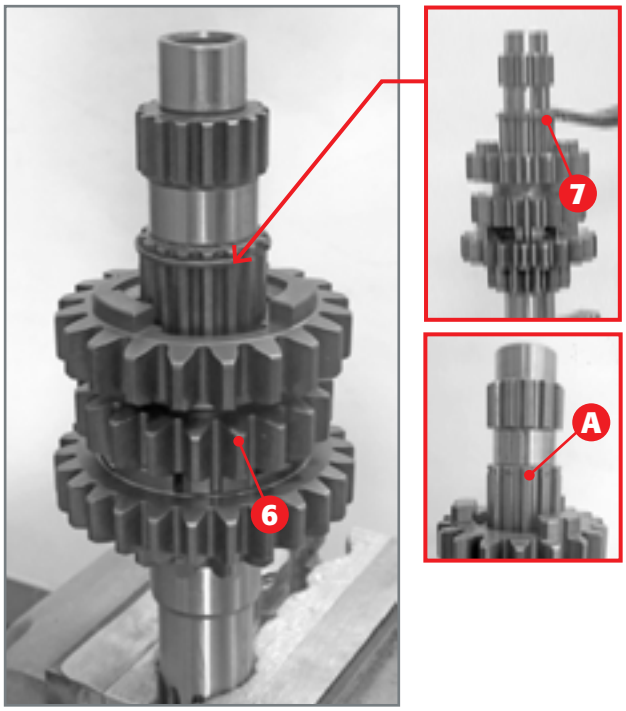
Clamp the main shaft **1** (using protective jaws), as shown in the figure.
Apply the roller bearing **2**.

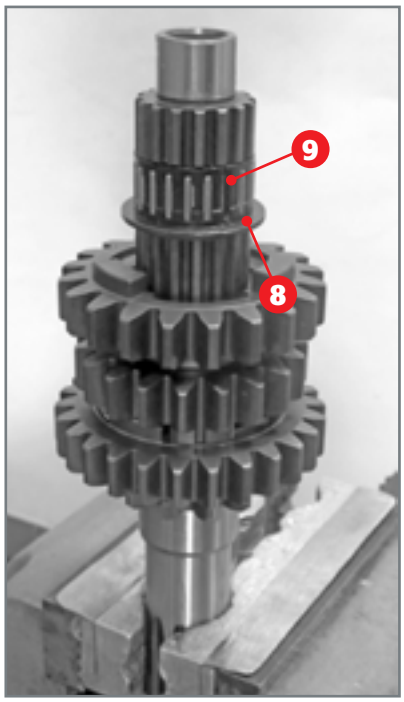


Apply gear **3** (V), washer **4** and circlip **5**.

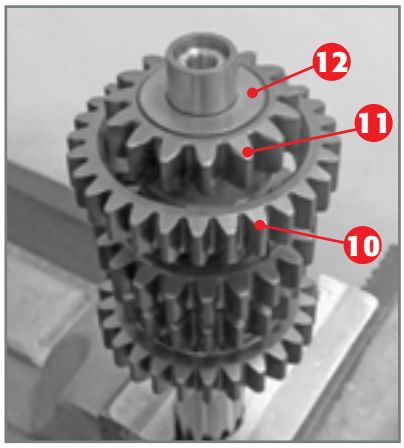


Insert gear **6** (III – IV) and circlip **7**, taking care to place it in groove **A**.

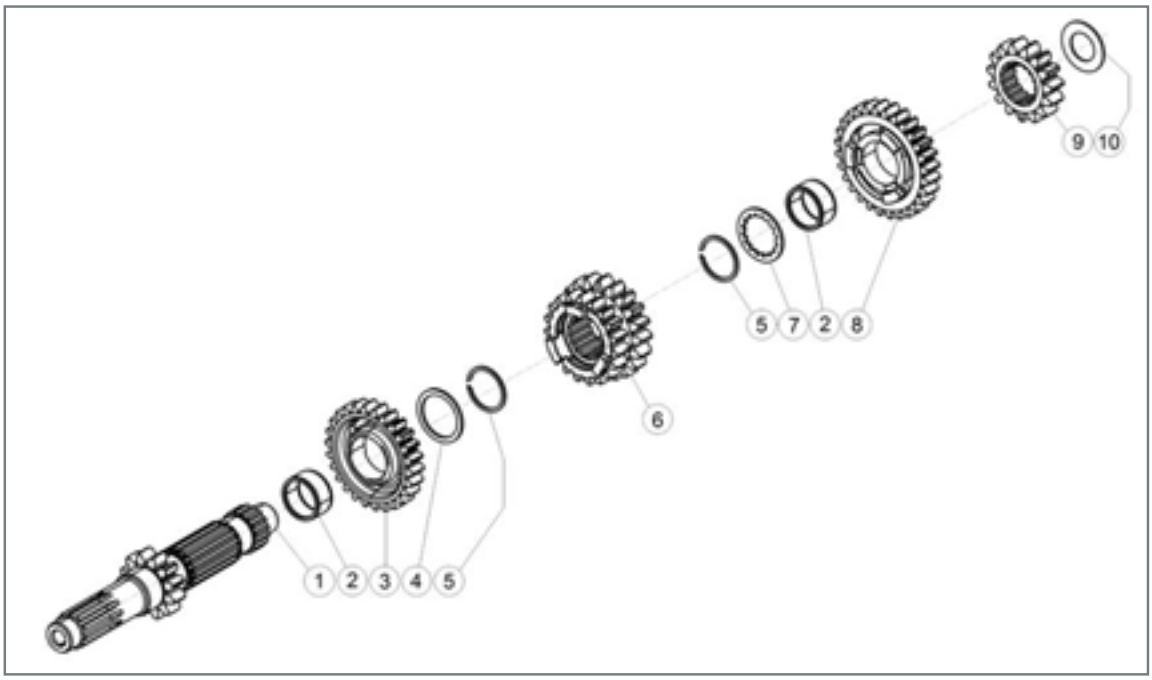




Apply the toothed washer **8** so that it engages in the broaching and the roller cage **9**.



Insert gears **10**(VI),**11** (II) and the washer **12**.



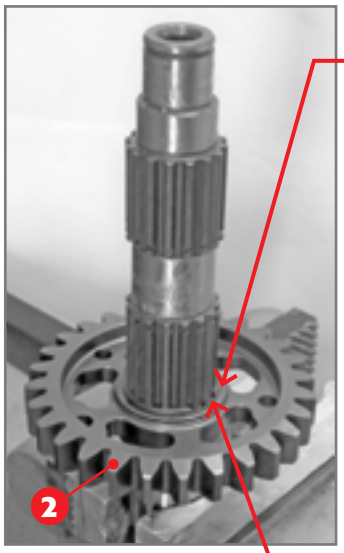
EXPLODED VIEW OF PRIMARY UNIT:
1) Gear main shaft; 2) Roller cage; 3) Fifth gear on primary 4) Thrust washer 26.32.1.5; 5) Circlip; 6) Third and fourth gear on primary; 7) Washer 23.32.1.5; 8) Sixth gear on primary; 9) Second gear on primary; 10) Washer 17.30.1

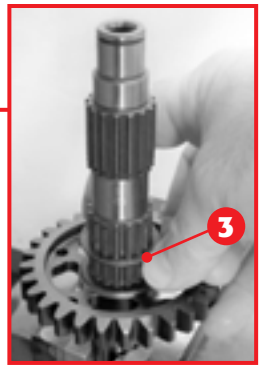
3.4.3 SECONDARY UNIT ASSEMBLY

Before proceeding with reassembly, clean all the parts thoroughly and oil them by using gear oil. Always replace the circlips.
Clamp the secondary shaft (using protective jaws), as shown in the image.

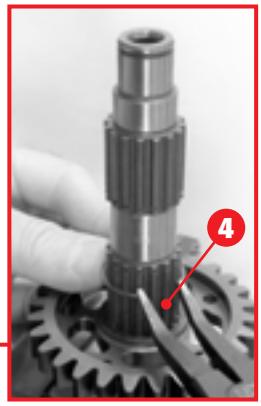


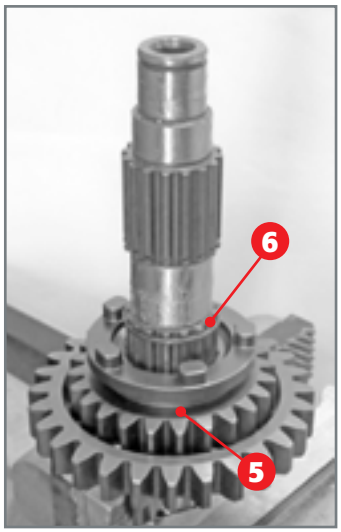
Apply the roller cage **1**.



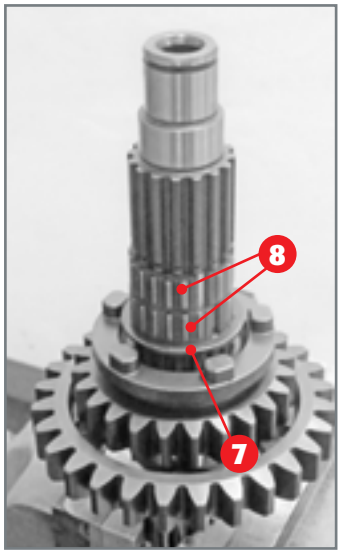


Insert gear **2** (I), washer **3** and circlip **4**.

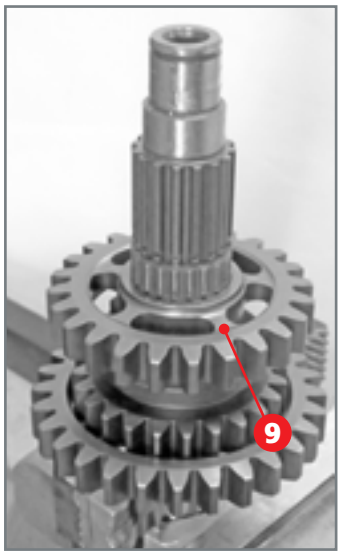




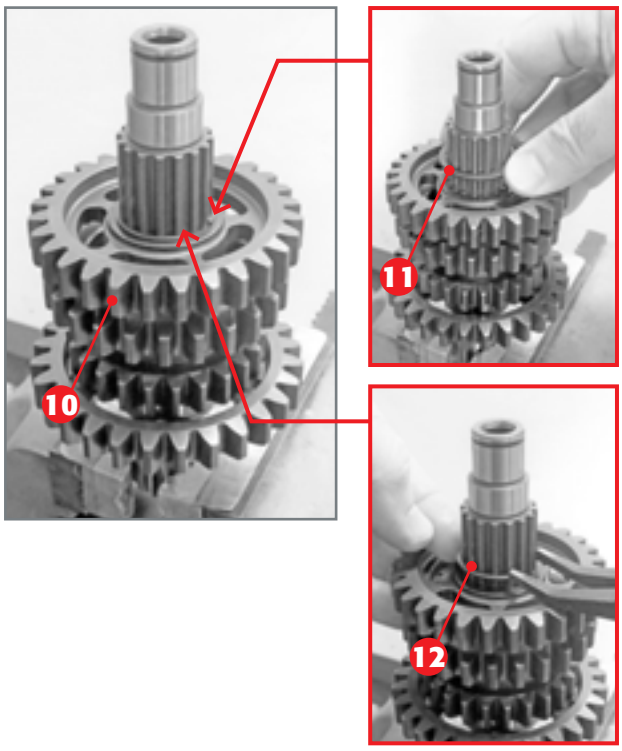
Insert gear **5** (VI) and circlip **6.**



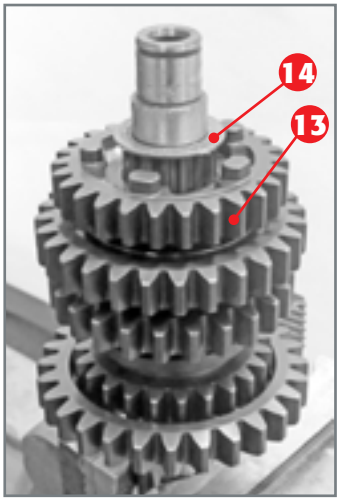
Insert washer **7** and the two roller cages **8**.



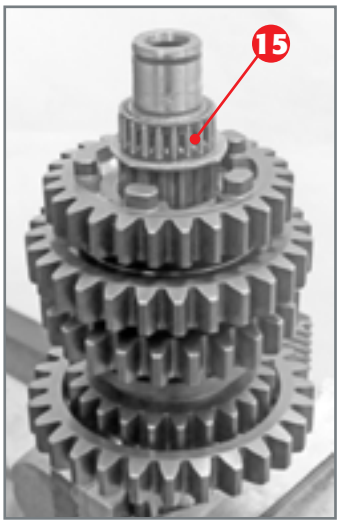
Insert gear **9** (IV).

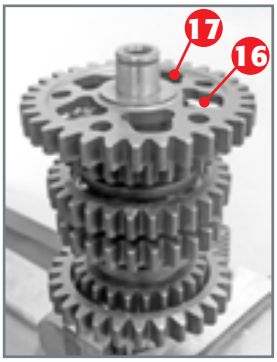


Insert gear **10** (III), washer **11** and circlip **12**.

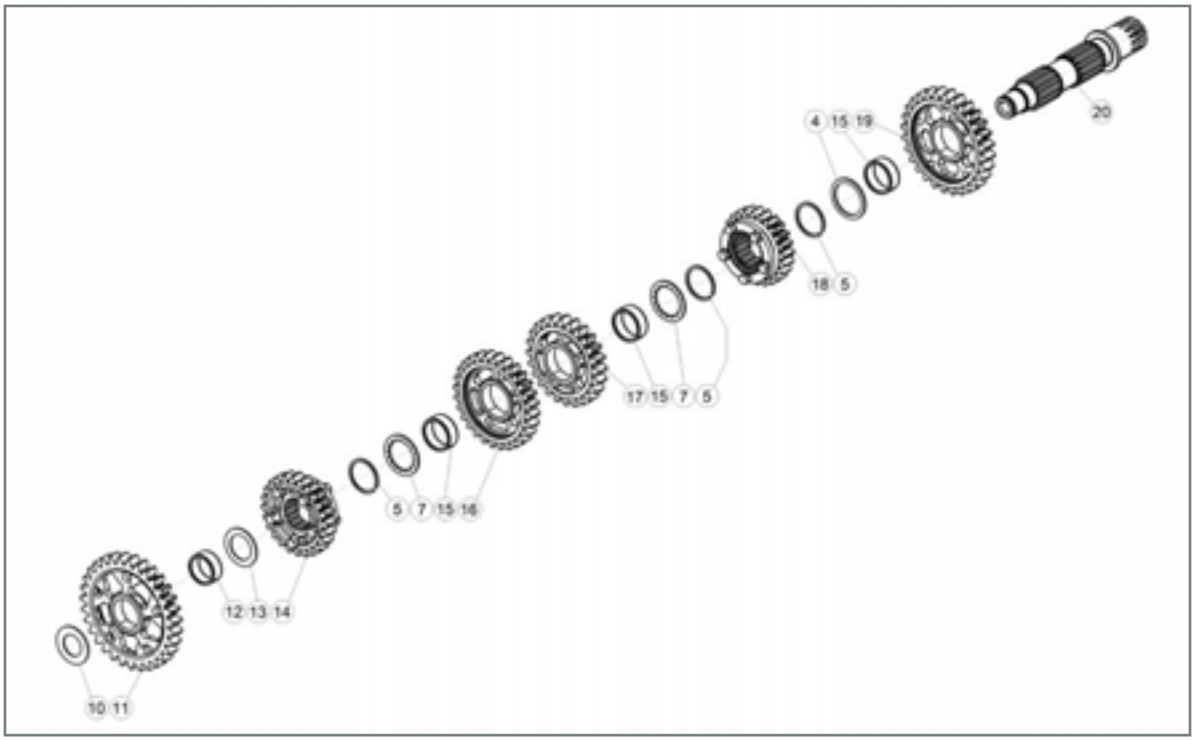


Insert gear **13** (V) and washer **14.**





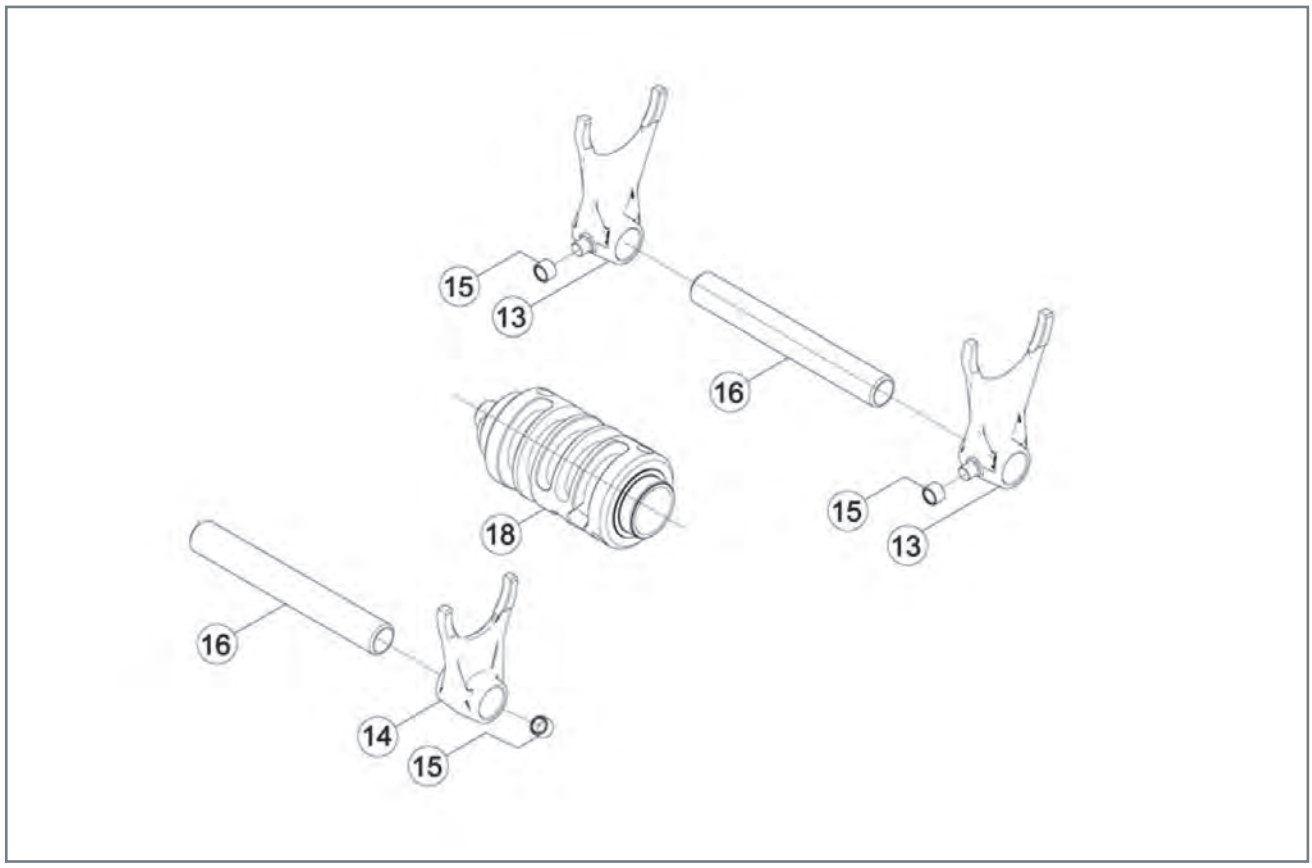
Insert roller cage **15** followed by gear **16** (II) and washer **17**.



EXPLODED VIEW OF SECONDARY UNIT:
4) 26.32.1.5 thrust washer; 5)Circlip; 7)23.32.1.5 thrust washer; 10) 17.30.1 thrust washer; 11) First gear on secondary; 12)K 20.24.10 roller bush; 13)20.30.1; thrust washer; 14)Fifth gear on secondary; 15)K22.26.10; roller bush 16)Third gear on secondary; 17)Fourth gear on secondary; 18)Sixth gear on secondary; 19)Second gear on secondary; 20) Secondary shaft

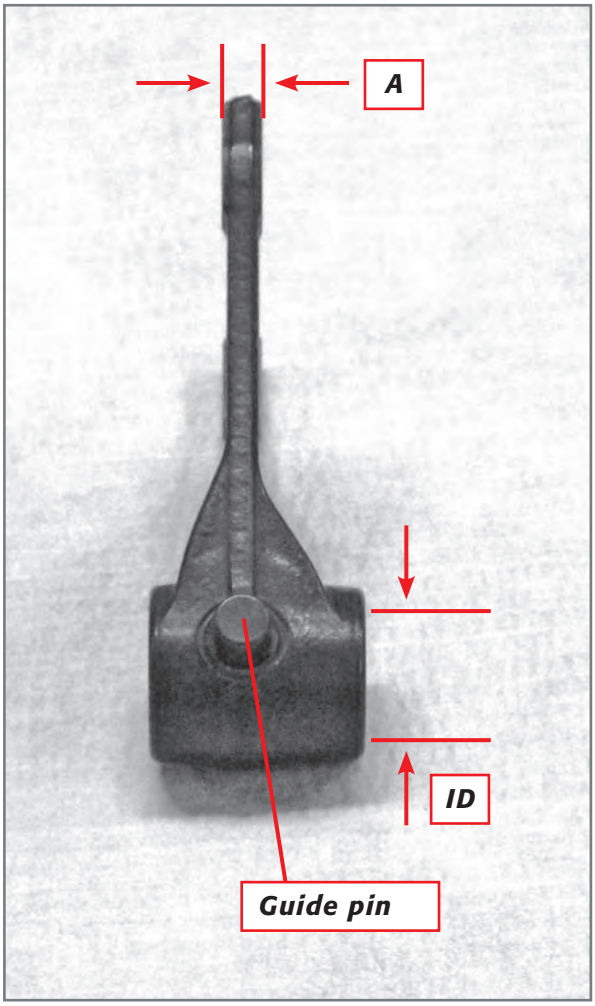
3.4.4 CHECKING THE FORKS, FORK PINS AND DESMODROMIC DEVICE

The internal gearshift consists of:
- two forks **13** which drive two gears on the secondary unit;
- one fork **14** which drives one gear on the primary unit;
- three guide pin bushes **15**;
- two fork pins **16**;
- desmodromic gearshift **18** whose rotation drives the forks thus selecting the desired gear.



EXPLODED VIEW OF INTERNAL GEARBOX CONTROL UNIT:
13) 1st - 4th fork;
14) 5th-6th fork;
15) bush;
16) fork pin;
18) desmodromic control

Make sure that the guide pins that support the bushes **15** have no traces of meshing or abnormal wear and that the bushes are not worn.



Make sure the distance **A** between the outer faces of the fork is not less than the minimum indicated below:

Minimum acceptable distance: 4.25mm

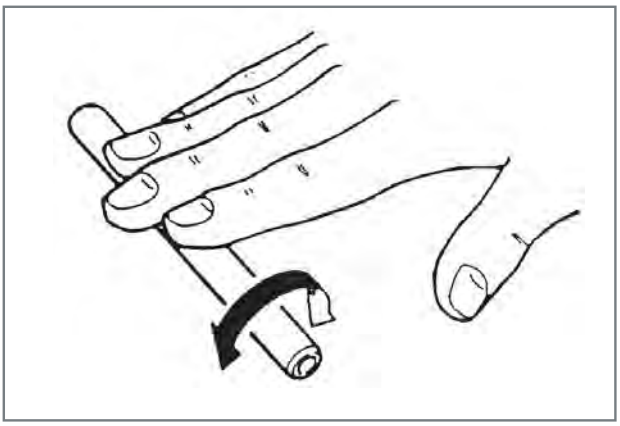
Check to make sure that the inside diameter D of the fork pin seats is below the limit:

Fork inside diameter limit: 13.83mm

Make sure that the fork pins on which they slide have an outside diameter above the limit (to be measured in the sliding areas of the forks and in the housing areas with the crankcases):

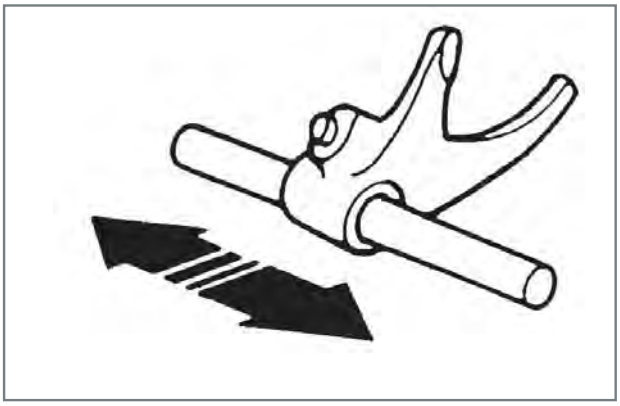
Fork pin outside diameter limit: 13.75mm

Make sure that the desmodromic control device has no corroded or worn areas, especially in the grooves in which the guide pins of the forks are engaged.



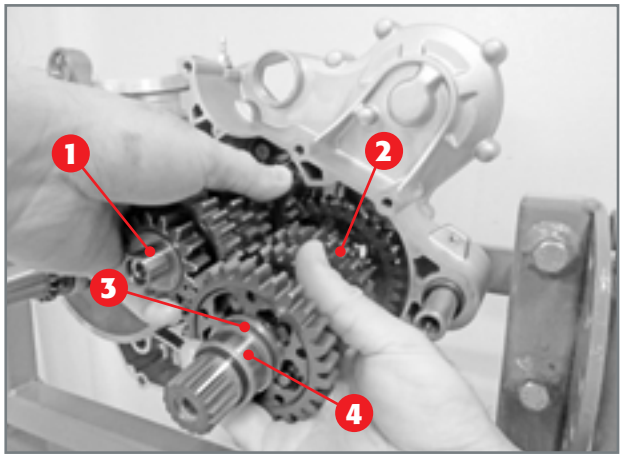
Fork pin check

Roll the fork pin on a perfectly flat surface: if deformations are present, proceed with replacement.

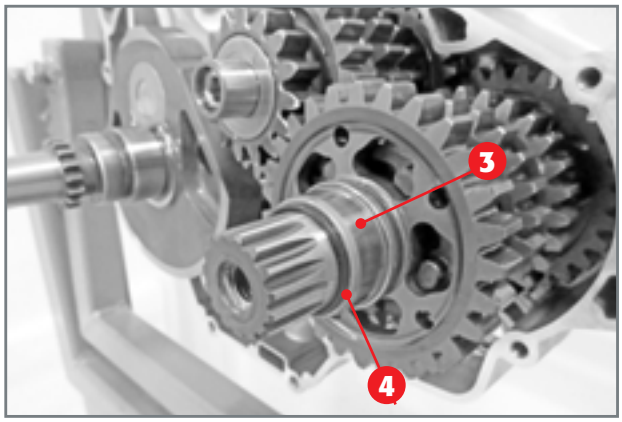


Check fork sliding on pin

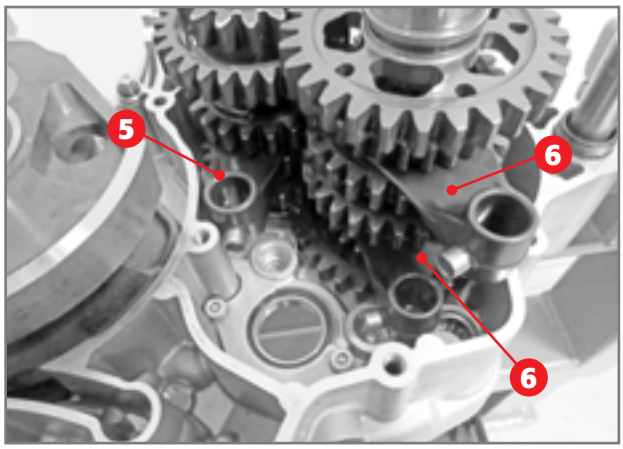
Slide the gearshift forks on the respective pins: if the movement is difficult and jamming occurs, replace both the fork and the pin.



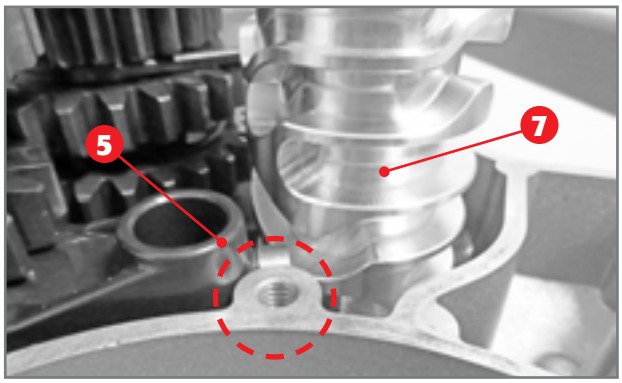
Insertion of gearbox in left crankcase.



Detail of centre bearing 3 and O-ring 4 coupled to the secondary shaft.



Application of forks to gearwheels.



3.5 GEARBOX AND INTERNAL GEARSHIFT ASSEMBLY

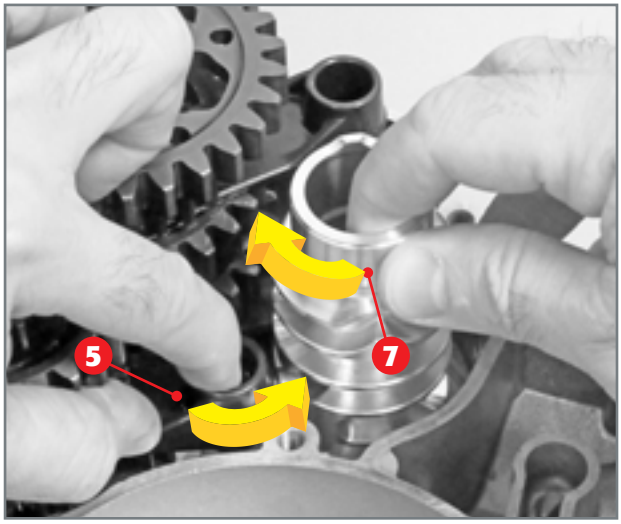
Insert the entire primary **1** and secondary unit **2** into the respective seats on the left crankcase half simultaneously. Remember to oil the gears with plenty of gear oil and to grease the shafts supporting them with graphite grease in the mating areas with the bearing. Make sure that all the parts slide properly.

Insert the centre bearing **3** and the O-ring **4** on the secondary unit.

Introduce the forks together with the guide bushes on the gear tracks. Namely: the smaller fork **5** drives the sliding gear on the primary unit, while the other two (**6**) drive the sliding gears on the secondary unit.

Note: *the two forks **6** are interchangeable and their positioning is univocal, since the drive pin must face the desmodromic device. Place the forks in their original positions if none of the components are replaced.*

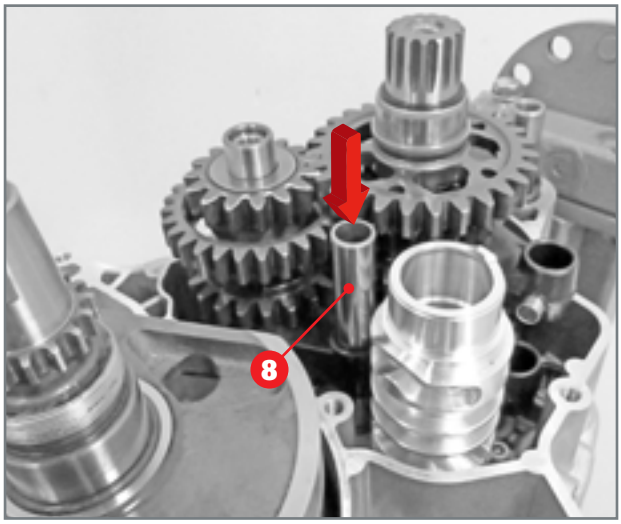
Insert the desmodromic device in the specific bearing. The operation is made easier by placing the desmodromic **7** in a way that the third track from below is facing the fork **5** as shown in the figure.

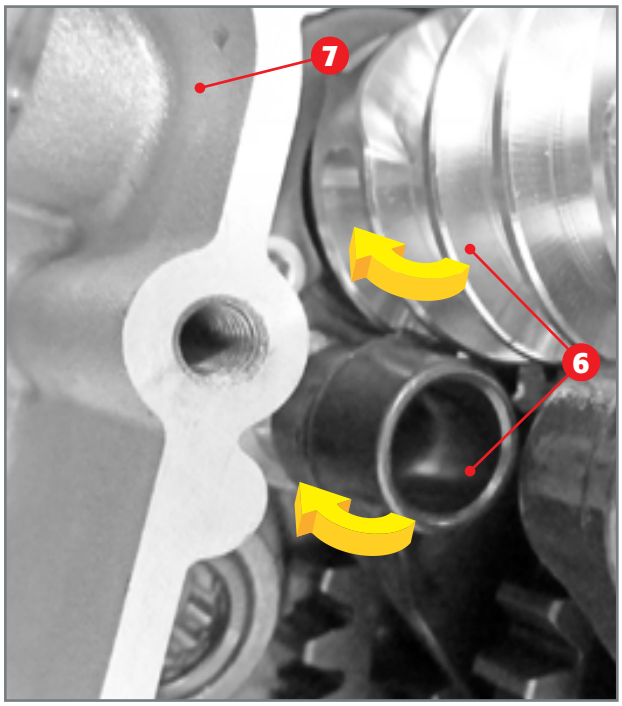


Positioning of fork 5 of the primary unit in the central guide of desmodromic device 7.

Rotate the desmodromic **7** clockwise and the fork **5** anticlockwise until both parts are connected.

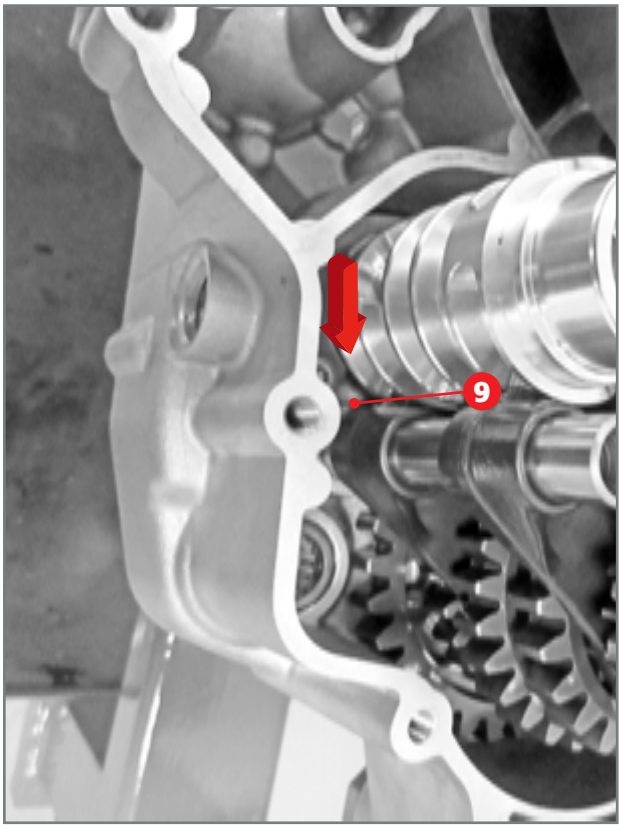
Insert the fork pin **8**.





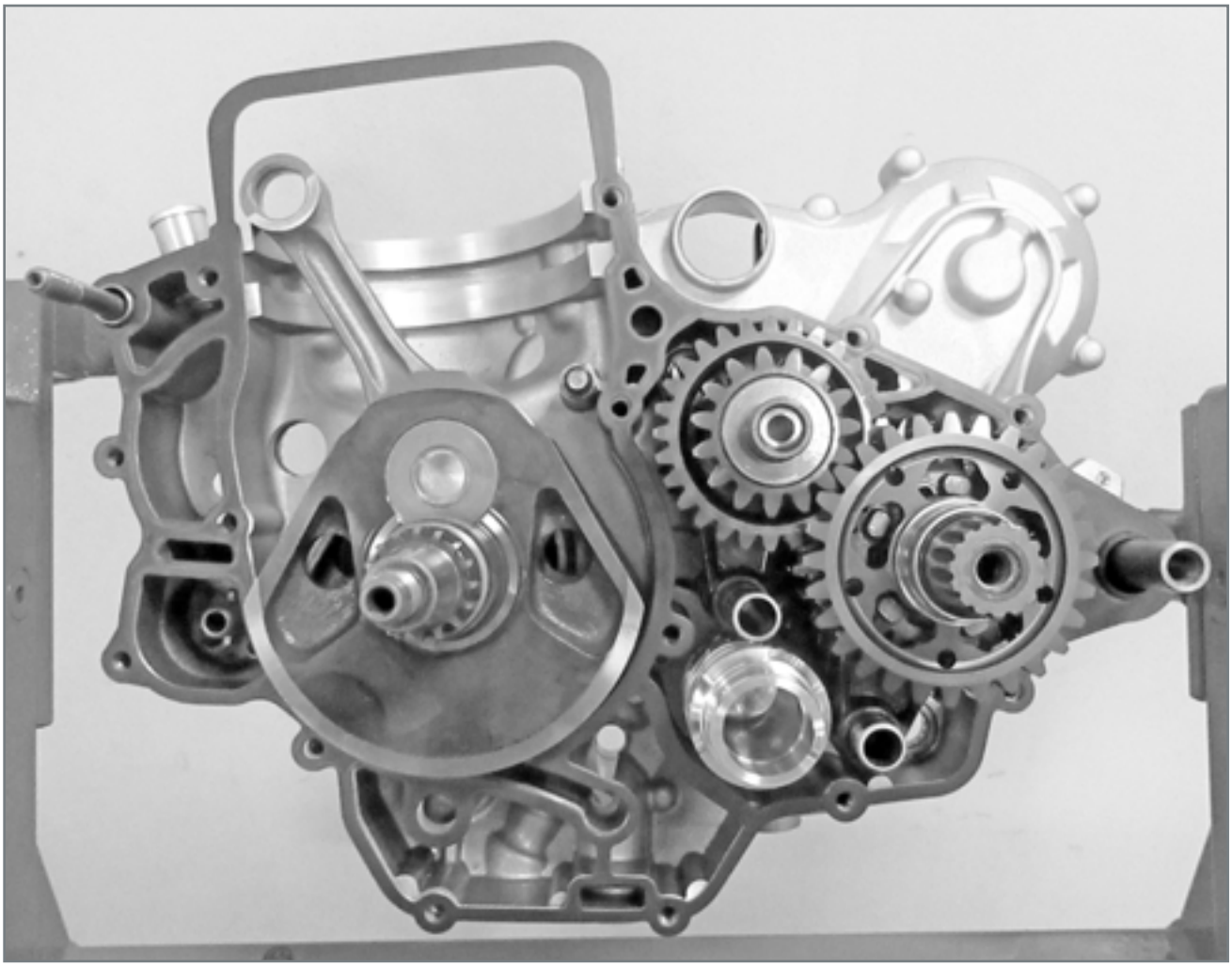
Positioning of the secondary unit forks 6. In the external guides of the desmodromic device 7.

Position the two forks **6** of the secondary unit in the external guides of the desmodromic device **7** and, just like the primary unit fork, insert the fork pin first in the pins and then in its proper seat. Remember to oil the shafts, forks and the desmodromic device with plenty of gear oil.



Insert the fork pin **9**.

Place a new crankcase gasket.



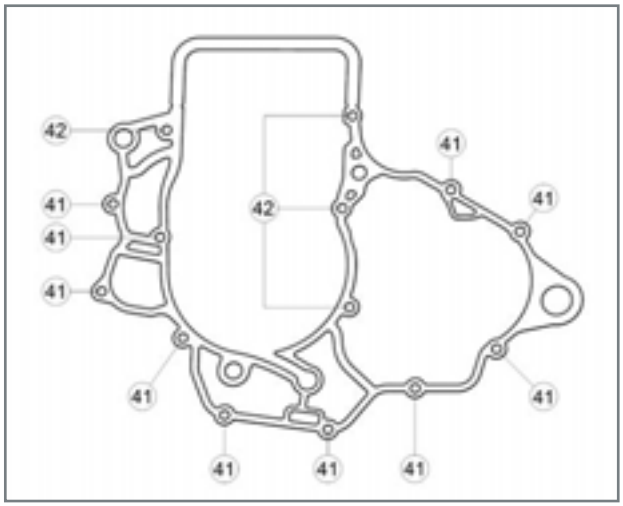
View inside the right crankcase with crankshaft, oil jets, gearbox shafts complete with gearwheels, internal gearshift and gasket.

3.6 CLOSING THE ENGINE CRANKCASE

Put the left crankcase half near the right crankcase half.
Make sure that the shafts and the pins on both the crankcases are aligned with their corresponding housings and the crankcase half is not in disarray.
To facilitate progressive nearing and aligning of the two crankcase halves, connect two screws on opposite sides and tighten them bit by bit. If the crankcase halves tend to capsize, do not insist tightening them. Rather loosen the screws and reposition the crankcase correctly.

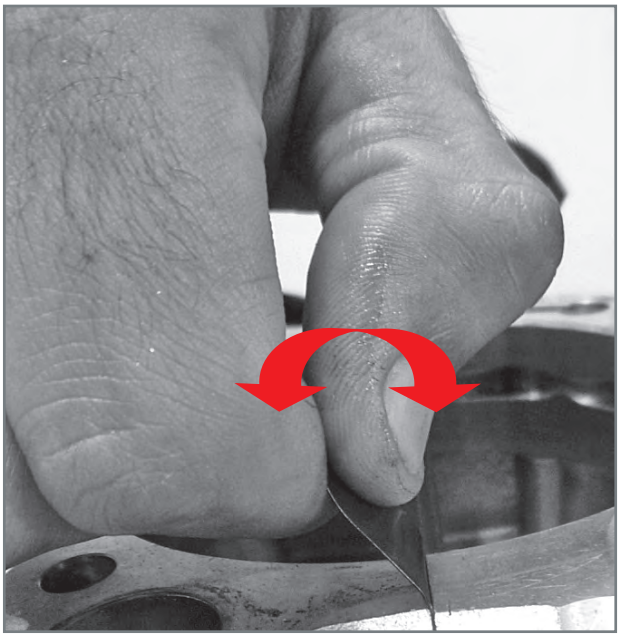
Make sure that the two crankcase halves match perfectly one with the other. Assemble the screws according to their length as indicated in the figure.
The table below contains indications for applying these screws.
It is recommended to tighten them in a criss-cross pattern using a torque of 10Nm.

Apply the two screws for fixing the engine to the engine support (*code 3625132 000*).



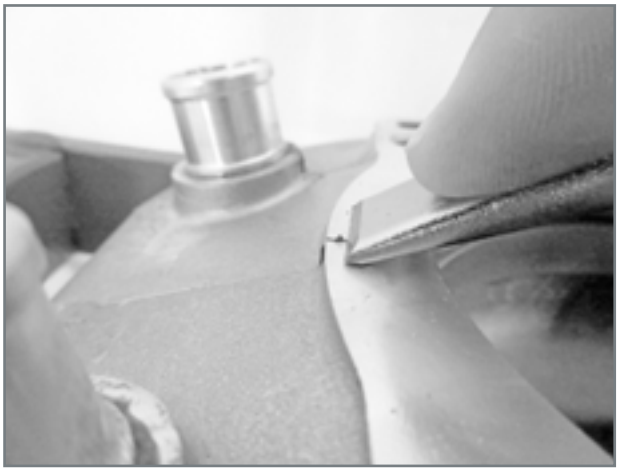
Positioning of crankcase coupling screws.

Screw number	Screw size		Threadlocker application	Tightening torque [Nm]
	Threading diameter [mm]	Threading length [mm]		
41	M6	60	NO	10
42	M6	70	NO	10

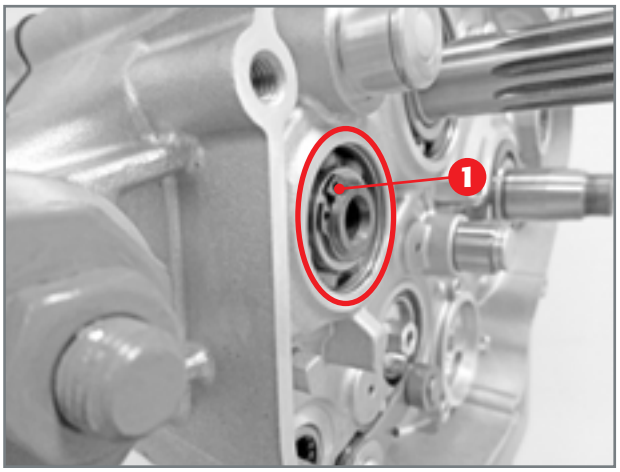


Cutting extra piece of gasket between engine crankcase halves.

Cut the extra piece of gasket in between the two crankcase halves in the area of the cylinder.
This can be done easily by bending the gasket several times.



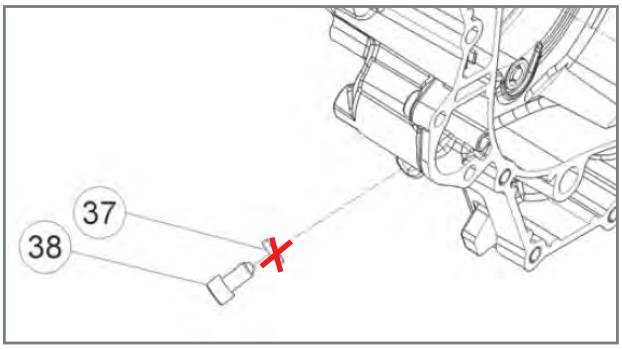
ATTENTION!
Should there be any leftovers, proceed to remove them paying attention to not scratching the surface of the crankcase halves.



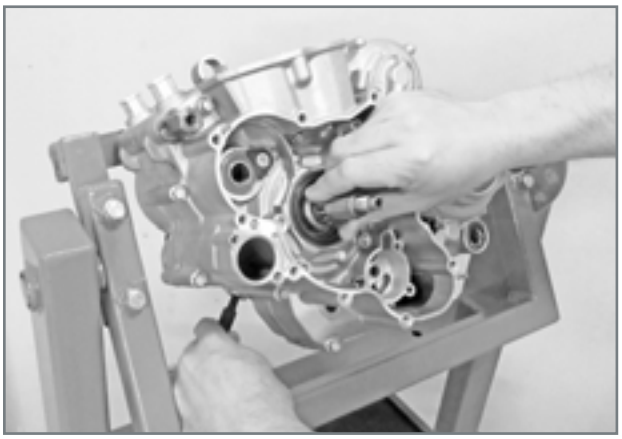
Apply circlip **1** on the gearbox secondary as shown in the figure.

3.7 BLOCKING THE CRANKSHAFT AT THE TOP DEAD CENTRE AND TIGHTENING THE NUT ON THE LEFT SIDE OF THE CRANKSHAFT

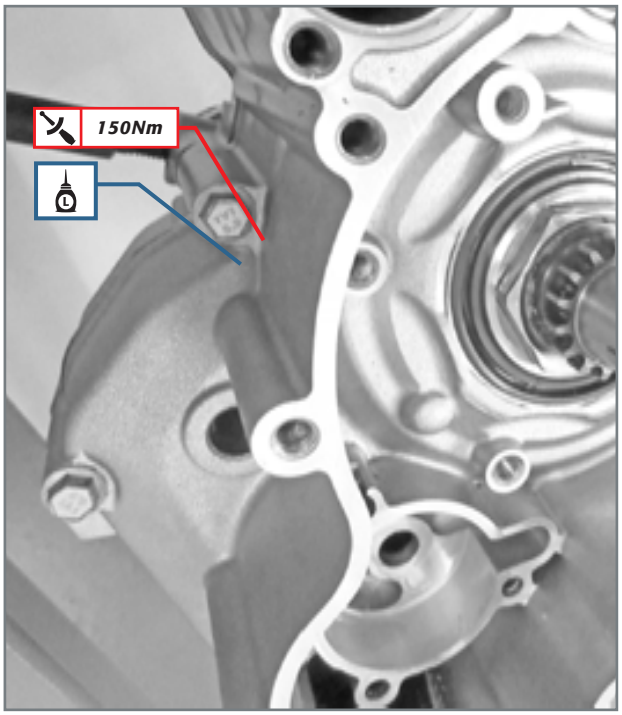
To block the crankshaft in the Top Dead Centre, insert the special conical-end screw **38**, without applying the washer **37** or the special engine locking tool *code 006140110000*, in its seat on the right crankcase half. Spread the threading on the left-hand side of the crankshaft with medium strength threadlocker.



To block the crankshaft, apply only the screw 38 to the crankcase.



Cover the threading on the left-hand side of the crankshaft with medium strength threadlocker. Tighten the nut using the special socket wrench *(code 006140020000)* to the indicated torque.



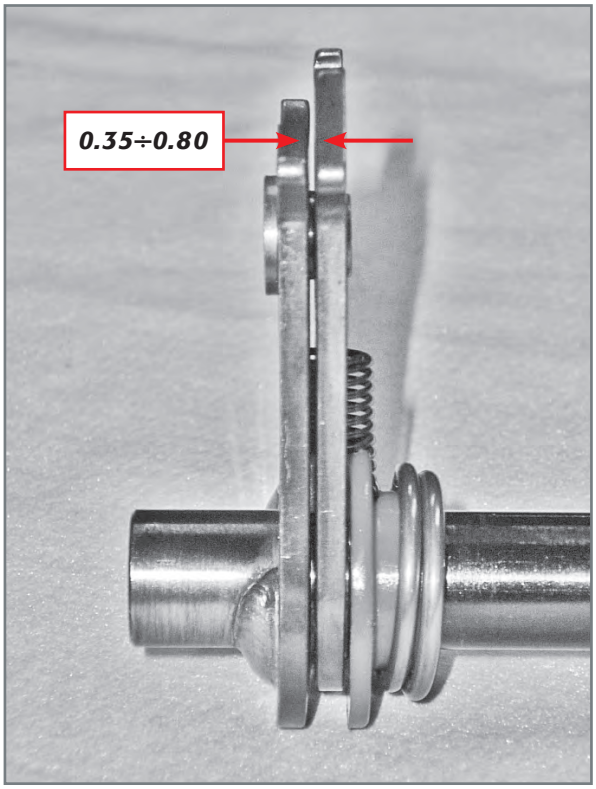
Nut on left side of crankshaft.

3.8 EXTERNAL GEARSHIFT

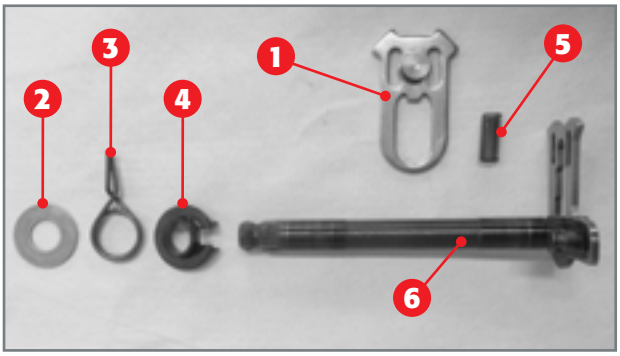
Before reassembling the external gearshift, check its state of use. While for the stop cam it is enough to make sure it is free from abnormal wear or meshing, the gearshift drive shaft needs more in-depth inspections.

3.8.1 CHECKING THE COMPLETE DRIVE SHAFT

With the complete device, make sure that the distance between the movable pawl and the drive shaft is between **0.35÷0.80mm**.
Should the distance be greater, replace the movable pawl.

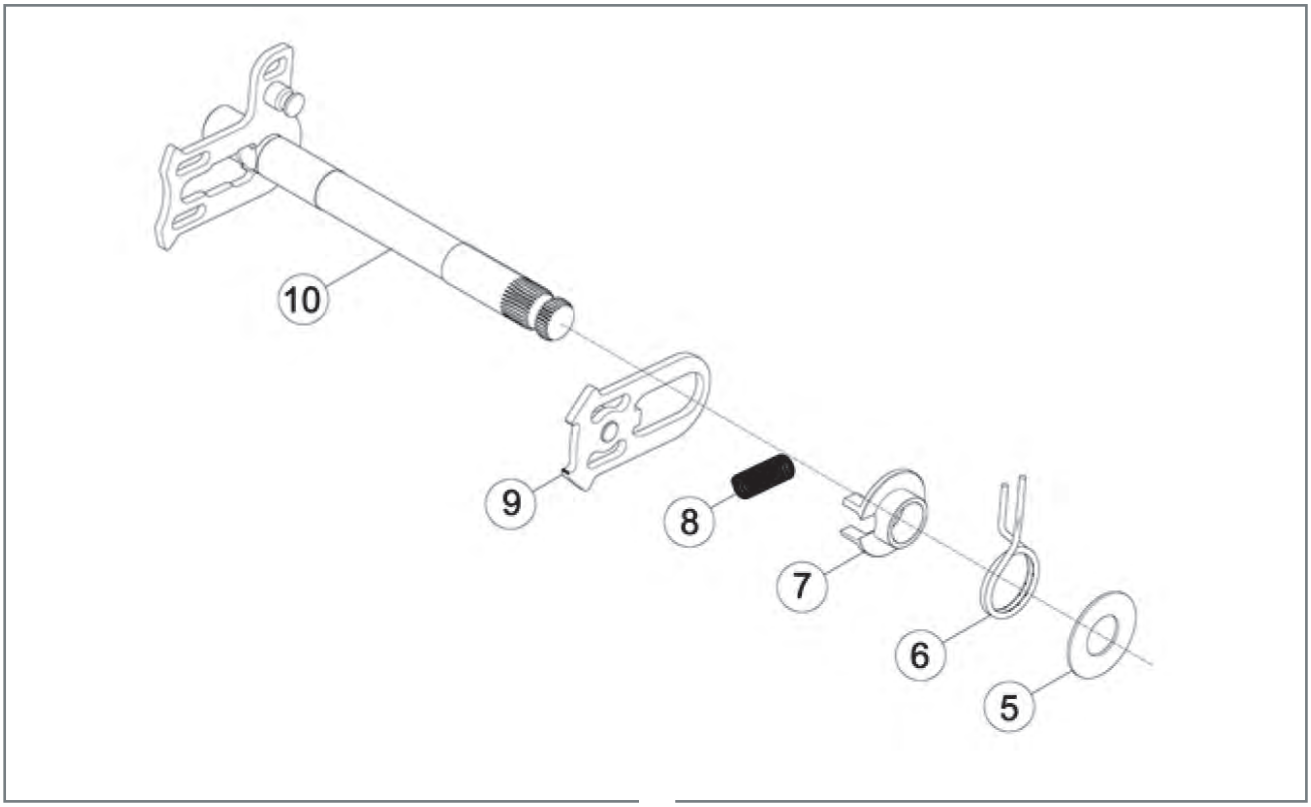


Allowed distance between shaft and pawl.



Complete drive shaft: 1) Movable pawl; 2) Thrust washer; 3) Gearshift return spring; 4) Spring guide; 5) Spring; 6) Gearshift drive shaft.

In order to replace the movable pawl **1**, disassemble the thrust washer **2**, the return spring of the gearshift **3**, the spring guide **4**, the spring **5**, which must be compressed and pulled out of its seat, and the pawl, moving it completely towards the shaft **6**.



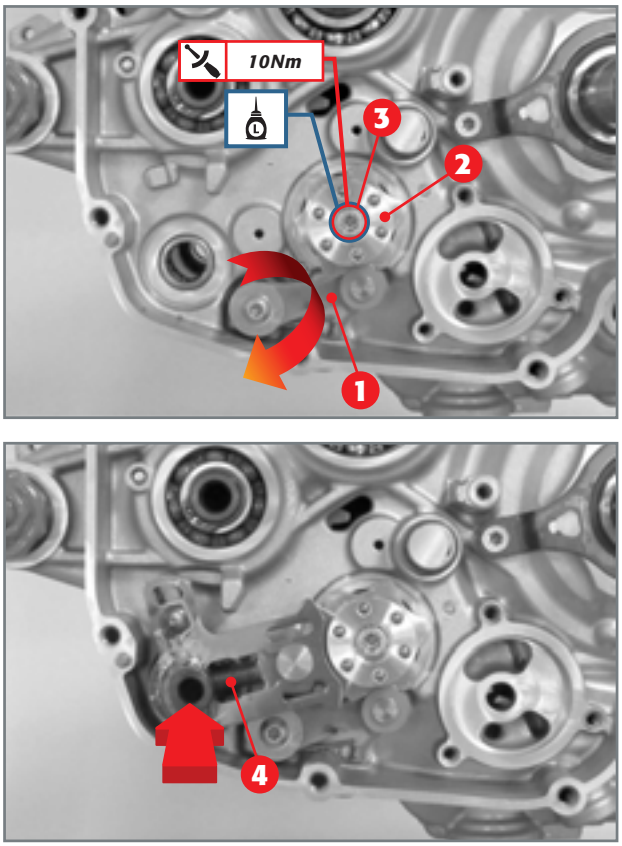
EXPLODED VIEW OF GEARSHIFT.
5) 14x30x1 thrust washer;
6) Gearshift return spring;
7) Spring guide;
8) Pawl return spring;
9) Movable pawl;
10) Gearshift shaft.

For reassembly, couple the movable pawl **9** to the drive shaft **10** and, while compressing it, insert the spring **8** between the movable pawl and the drive shaft. Then apply the spring guide **7**, the gearshift return spring **6** and finally the thrust washer **5** (14x30x1).



Gearshift drive shaft: note the gearshift return spring position.

The gearshift return spring must be positioned as in the figure to be able to carry out its function.



POSITIONING OF STOP CAM ON DESMODROMIC DEVICE.

1) Stop lever;
2) Stop cam;
3) M6x30 screw;
4) Movable pawl return spring.

3.8.2 EXTERNAL GEARSHIFT ASSEMBLY

Keeping stop lever moved **1** in such a way that the spring is compressed, position the stop cam **2** on the protruding end of the desmodromic gearshift (external right crankcase). The stop cam has only one correct position, which is determined by the specific shape of the end of the desmodromic device and of the bottom part of the stop cam.
Fit the M6x30 fixing screw **3** after having applied medium-resistance threadlocker: tighten to the indicated torque.
Insert the drive shaft together with the washer in its seat keeping the return spring **4** of the movable pawl pressed.

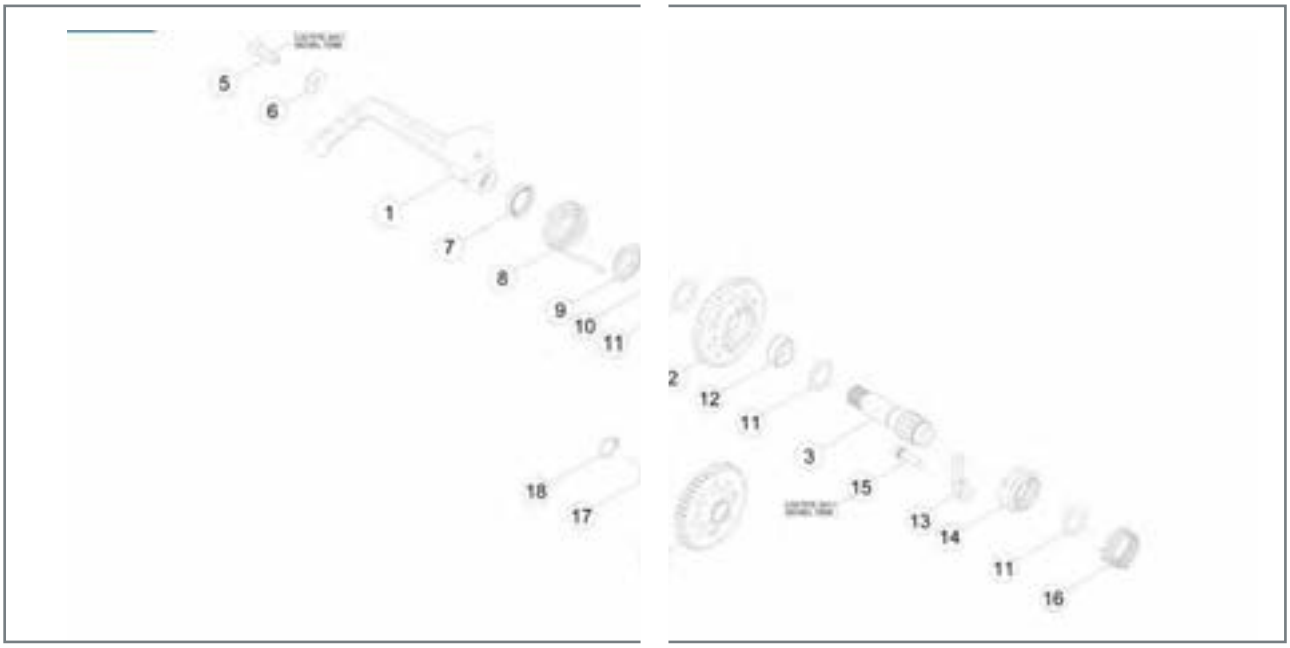
Should you wish to test correct operation of the entire gear unit, just temporarily couple the external gearshift lever and simulate the operation of changing gears, by lifting and lowering the gearshift lever and having the main shaft of the gear unit rotate. The whole device works properly if no abnormal jamming occurs.
Please note that if the unit operates without oil, the device is noisier than usual.

3.9 KICKSTARTER DEVICE - (OPTIONAL)

Before coupling the kickstarter to the crankcase half, some important checks must be carried out.

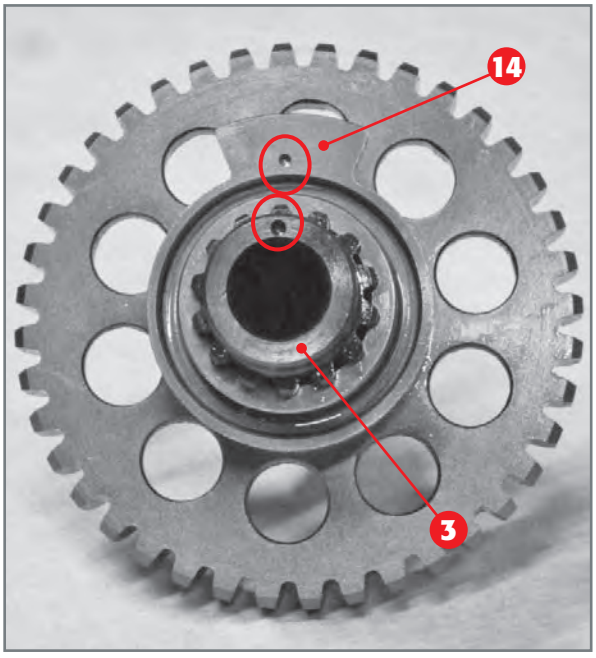
3.9.1 CHECKING THE KICKSTART SHAFT UNIT AND ASSEMBLY

In order to disassemble all the parts of the kickstart shaft, pull off the washer **11** at the end of the shaft (on the side of the spring **16**), the spring **16**, the kickstart sleeve **14** and the lever return spring **8**, which must be pulled in the radial direction so that it is extracted from its hole to be unfastened from the shaft. Pull out the kickstart spacer **9**.

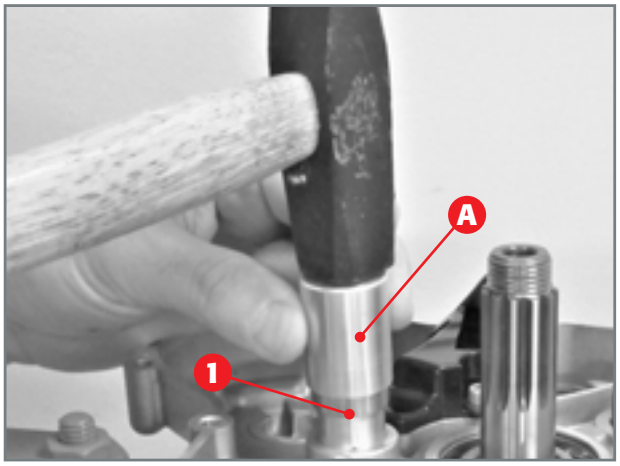


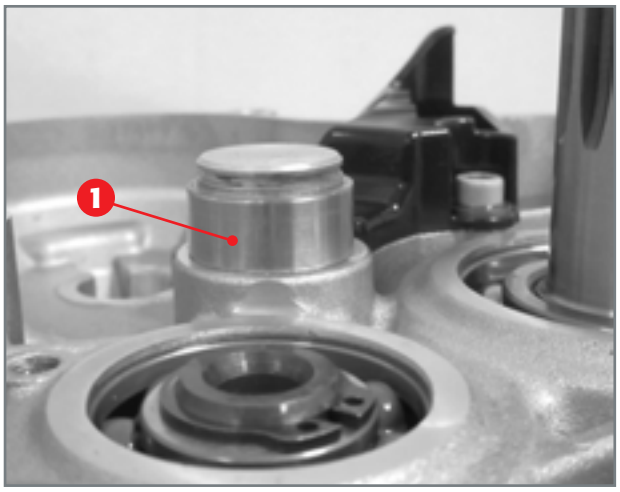
EXPLODED VIEW OF COMPLETE KICKSTART SHAFT:
2) Kickstart gear;
3) Kickstart shaft;
8) Kickstart return spring;
9) Kickstart spacer;
10) 20E circlip;
11) Washer thickness 20x28x1 DIN 988;
12) K20x24x10 roller bearing;
14) Kickstart sleeve;
16) Spring.

Widen the circlip **10**, thus slipping off the washer **11**, and the kickstart gear **2** as well the roller bearing **12** and the washer **11**. This frees the kickstart shaft **3** from all other elements.
Make sure that the side of the kickstart gear teeth **2** have no signs of meshing or superficial wear. Make sure that the front teeth (sleeve side **14**) are not chipped. Replace any part that shows the aforementioned defects.
Make sure that the front teeth of the sleeve **14**are not chipped and that the spring **16** is capable of putting enough pressure on the sleeve **14** so that this can pull the wheel **2**.
Also check to make sure that no washers have any abnormal or excessive wear. If so, replace them. Make sure that the spring **8** has no cracks or abnormal deformation. Replace if it is not able to bring the external kickstart lever back to the rest position.
For reassembly, follow the above disassembly procedure in reverse order.
Pay attention to the correct positioning of the sleeve **14** with respect to the shaft **3**. The front of the shaft, as well as the sleeve **14** has a reference mark: the two reference marks must match.



Positioning of sleeve on small shaft.





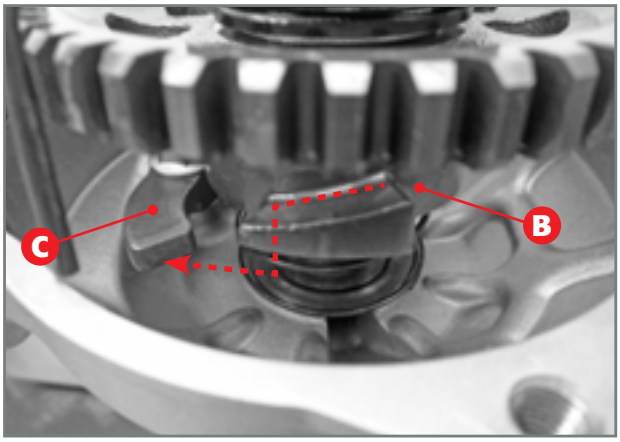
3.9.2 ASSEMBLY OF KICKSTARTER DEVICE (OPTIONAL)

In case you are assembling an aftermarket kickstarter kit, you must:

- apply the bushing provided with the kit
- apply the kickstarter ramp (par. 3.1.1)
- apply the kickstart shaft unit (for assembly par. 3.9.1)
- apply the idler gear
- Apply the oil seal on the inner clutch cover (par. 3.14).

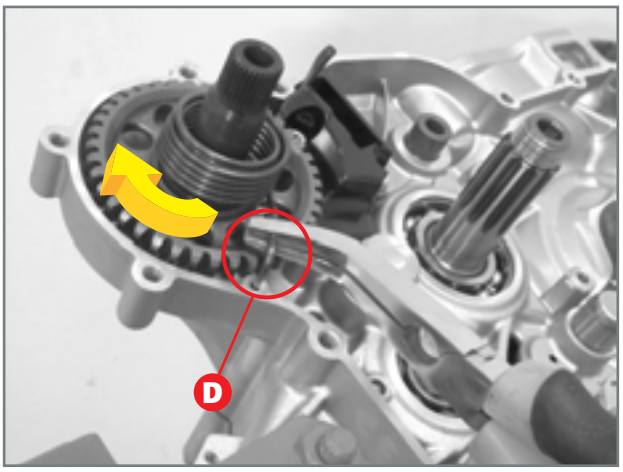
To apply the bushing **1** provided with the kit, you must use the special tool **A** *code 037.14.001.00.00* also provided with the kit.
Slightly insert the bushing **1** on the supporting pin, place the special tool **A** (*code 037.14.001.00.00*) on the bushing **1** then give a sharp blow on the head of the special tool with a hammer.

The bushing must be flush with the surface on the crankcase half.



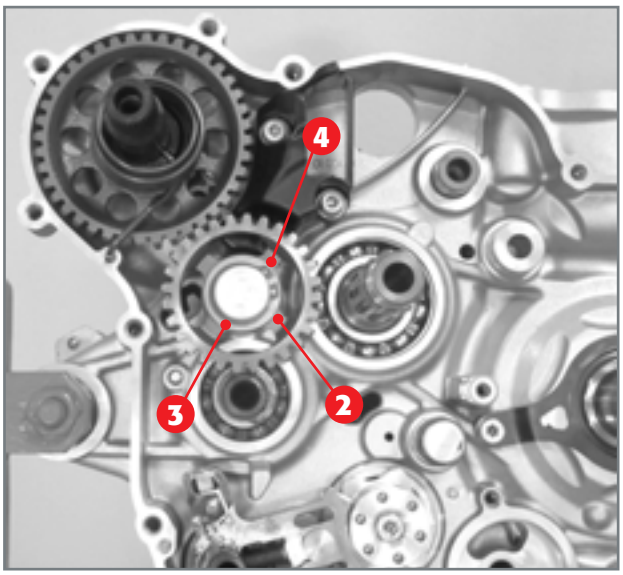
Positioning of sleeve A below lever B.

Insert the complete kickstart shaft in its housing, keeping the ribbed facing outwards and making sure that the lever **B** on the kickstart sleeve is positioned below the lever **C** bolted onto the right crankcase half (external side).



Insertion of kickstart return spring

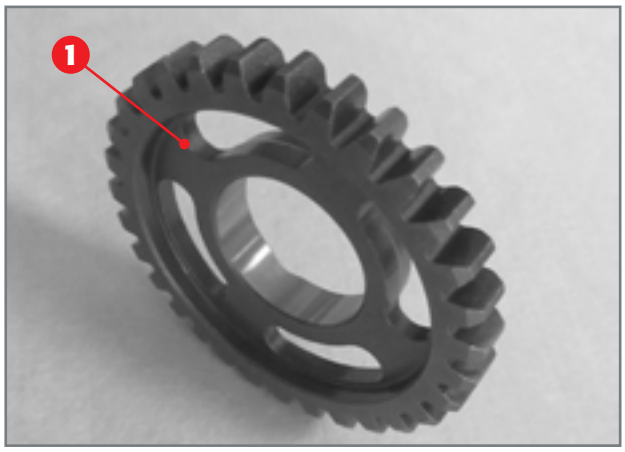
Turn the spring clockwise until it fits into the specific hole **D**.



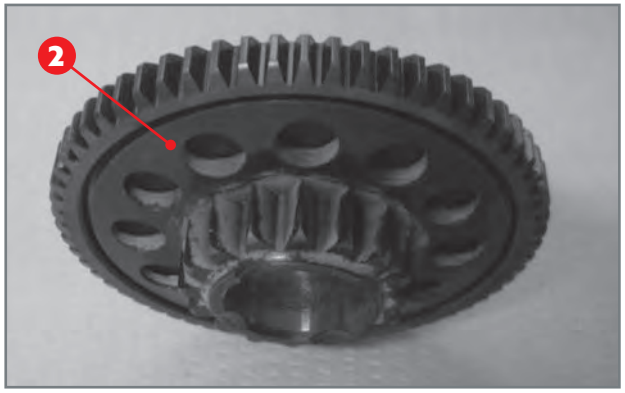
Kickstart device unit coupled to the crankcase.

Lubricate the supporting pin, apply the idler gear **2**, the thrust washer **3** and the circlip **4**.

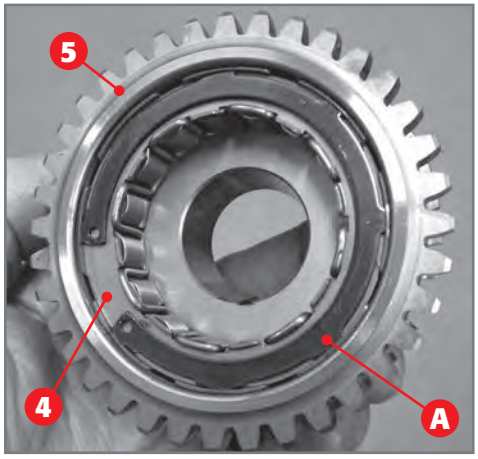
Make sure that the idler gear rotates freely.



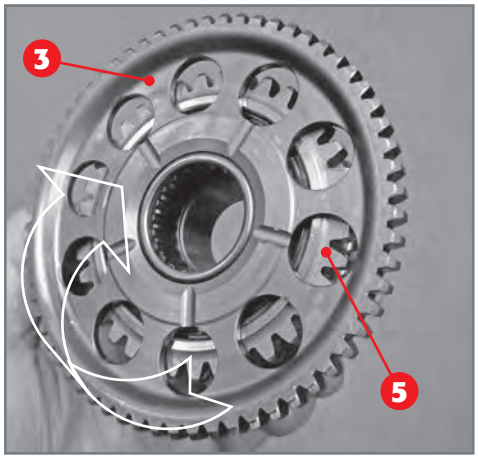
Idler wheel 1.



Torque limiter 2.



Free wheel coupled to the primary gear.



Primary gear complete with free wheel coupled to ignition gear.

3.10 ELECTRICAL STARTER UNIT AND PRIMARY GEAR

Carry out the following controls before assembly.

3.10.1 CHECKING ELECTRICAL STARTER DEVICE ELEMENTS

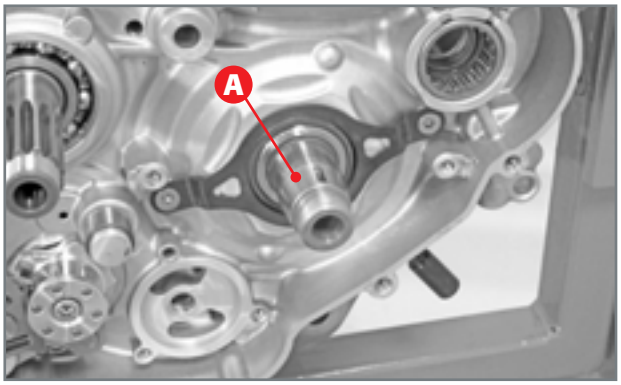
Make sure that the teeth of all the gearwheels of the device are intact, free from chipping or signs or abnormal wear.
Pay attention to the teeth of the idler wheels **1** and torque limiter **2** and between the gears and respective support pins. Replace them if they show signs of meshing or seizure.

Make sure there are no traces of meshing on the housing of the roller bearing on the starter gear **3**. Mount the starter gear temporarily on the crankshaft, together with the roller bearing and check to see if there is excessive play.
To check the correct functioning of the free wheel **4** proceed as follows.
Insert the starter gear **3** on the free wheel **4**and primary gear unit **5**. Keeping the primary gear blocked **5** and turning the kickstart gear **3** clockwise, it must run freely. Turning the kickstart gear **3** anti-clockwise, it must be blocked without idling.

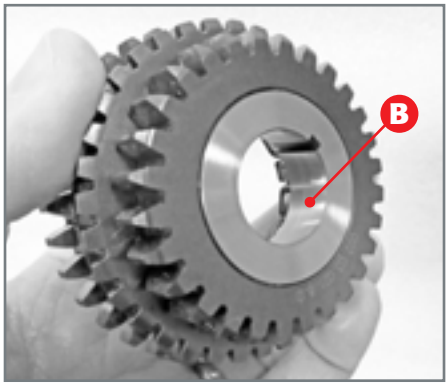
To replace the free wheel, disassemble the special circlip **A** and remove the free wheel.
During disassembly make sure that the lugs on the outer edge of the special circlip **A** are coupled in the slots of the free wheel and in the groove inside the primary gear.

3.10.2 COUPLING IGNITION AND PRIMARY GEARS TO THE MOTOR

Thoroughly degrease the conical part **A** on the right side of the crankshaft and **B** of the primary gear.

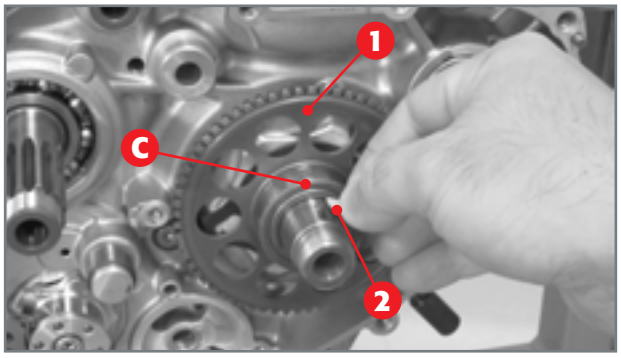


Conical segment A on right side of crankshaft.

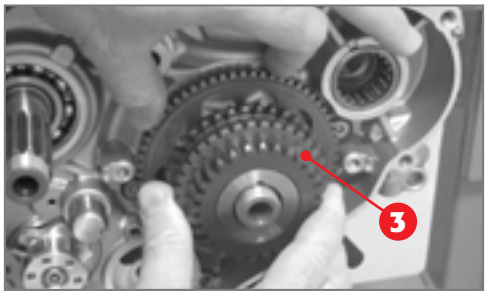


Conical segment B main gear.

Lubricate the segment **C** of the starter gear **1** with motor oil and couple it to the crankshaft.
Insert the Woodruff key **2** in the specific seat.
Apply the primary gear **3** to the crankshaft and while turning the gear clockwise, push it towards the crankcase half until you perceive meshing between the gear and the Woodruff key.



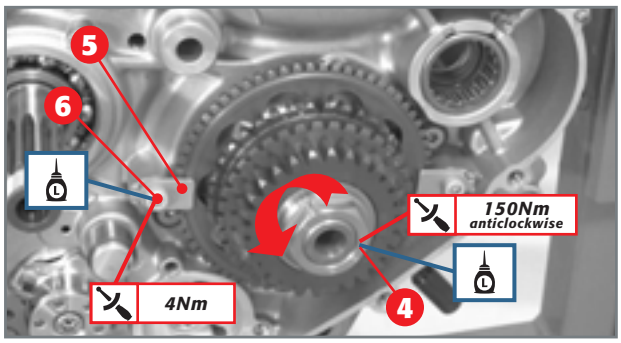
Positioning Woodruff key in specific seat.



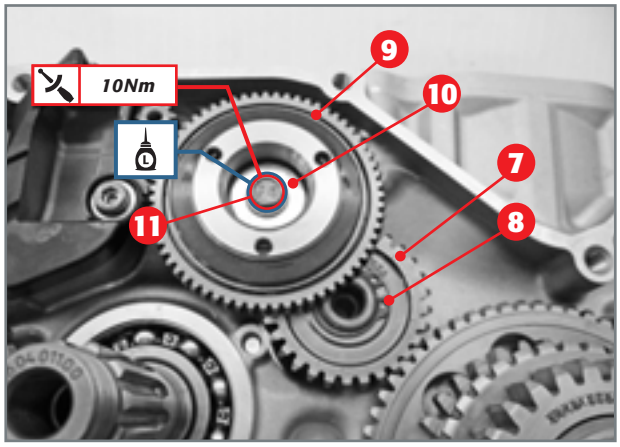
Insert the locking nut **4** applying the threading with a medium strength threadlocker and tighten to the indicated torque.

WARNING!
it must be tightened anti-clockwise.

Apply the two safety plates **5** bound to the casing with screws **6**. Tighten to the specified torque.



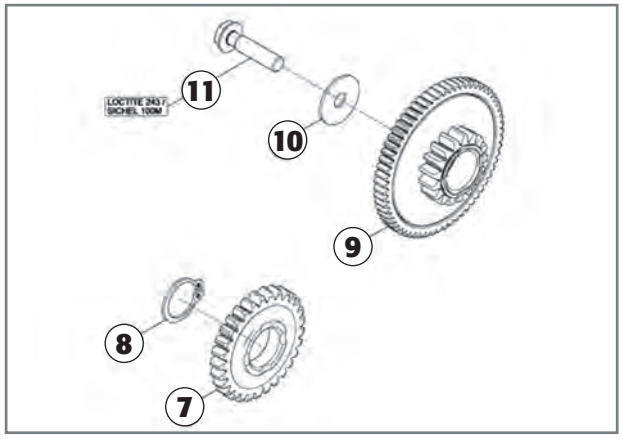
Coupling primary gear to crankshaft.

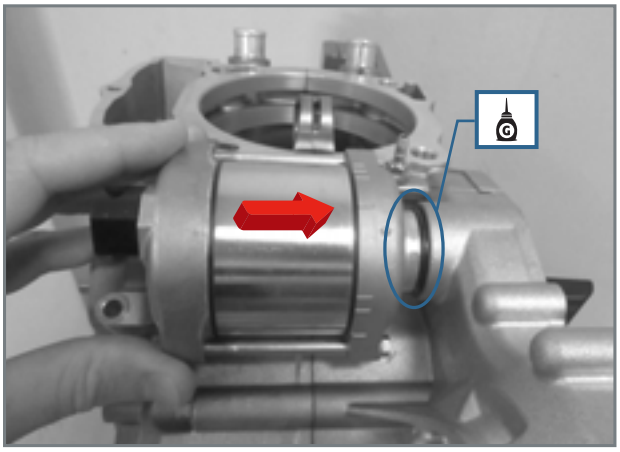


Coupling electrical starter gear unit.

Lubricate the pin of the idler.

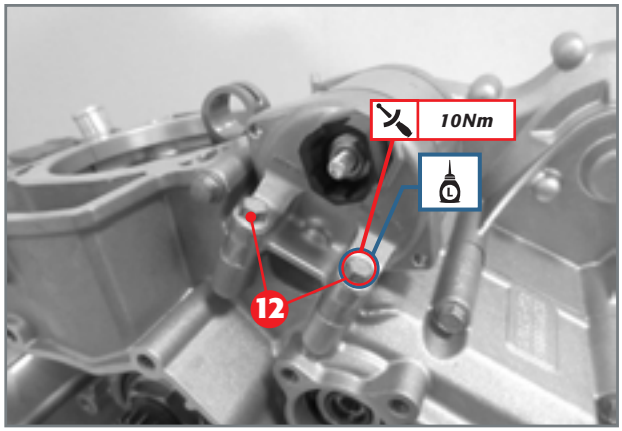
Couple the idler wheel **7** to the pin and apply the circlip **8** .
Couple the torque limiter **9** to the pin on the crankcase half. Insert the washer **10** and the screw **11** after having spread the threading with medium strength threadlocker.
Tighten the screw to the indicated torque.





Insertion of the start motor in the crankcase half. Note zone G to be greased.

Apply a light layer of grease in the area shown and insert the motor in its housing.

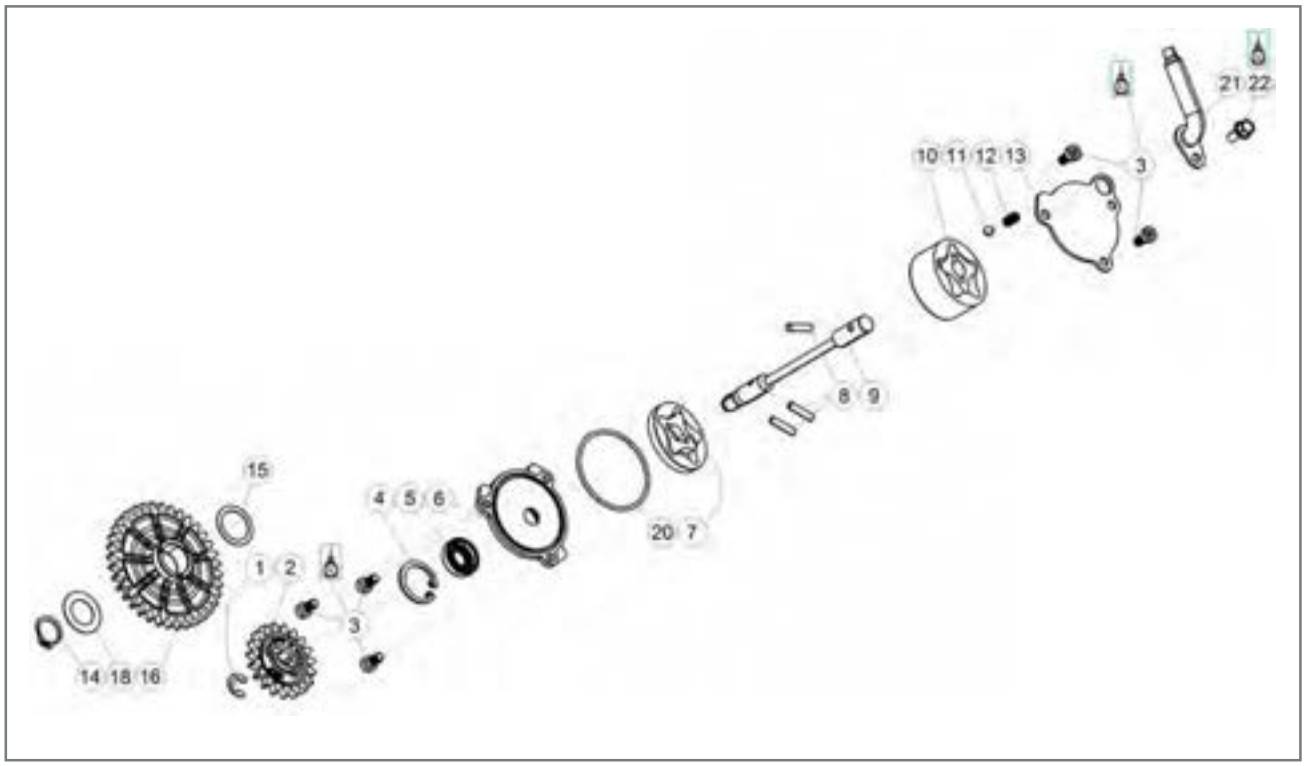


The two fixing screws 12 of the start motor.

Apply medium strength threadlocker on the two screws **12** and tighten them to the indicated torque.

3.11 OIL PUMPS: INSPECTION AND REASSEMBLY

As shown in paragraph 1.5, the motor is equipped with two oil pumps: one is for intake (higher displacement) located in the outside of the left crankcase half and the other for high-pressure (less displacement) located on the outside of the right crankcase half. The two pumps are driven by a gear cascade meshing with the clutch case.



EXPLODED VIEW OF OIL PUMP UNIT.
1) Benzing ring;
2) Oil pumps control gear;
3) M5x12 screw;
4) Circlip;
5) Oil seal;
6) High-pressure pump cover;
7) High-pressure oil pump;
8) Roller; 9) Oil pump shaft;
10) Intake pump;
11) Ball;
12) Spring;
13) Low-pressure pump cover;
14) Circlip;
15) 18x23x0.5 washer
16) Idler gear;
18) 15x25x0.5 washer
20) 45x2 O-ring;
21) Oil jet;
22) 5x12 screw

Proper operation of the pump depends:

- On the sliding surface with the rotors;
- On the radial play between the two rotors and between the external rotor and pump compartment;
- On the axial play of the rotors with respect to the sliding surfaces;
- On the O-ring seal and the oil seal (on the high-pressure pump cover).

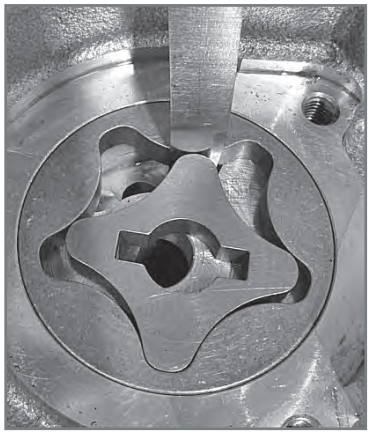


Oil intake pump: note the dot on the two rotors. The dot must face the inside of the engine.

Should the sliding surfaces with the rotors present deep or evident traces of corrosion, replace the deteriorated part.
To measure the radial play between the internal and external rotor and between the external rotor and the crankcase, proceed as follows:
Note: *Insert the two rotors in their specific seat with the reference dot facing the inside of the engine.*

Using a thickness gauge, check that the play does not exceed that allowed, equal to:
Maximum radial play: 0.20mm

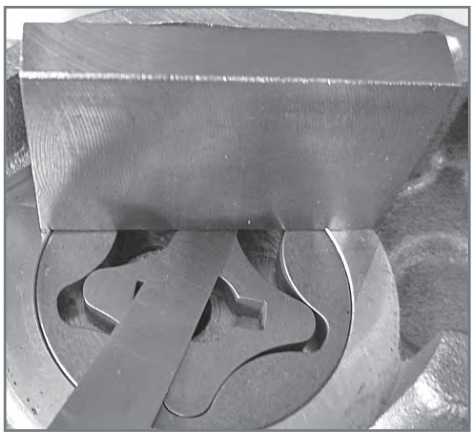
Take a thickness gauge again and a rectified reference surface and verify that the axial play does not exceed the maximum allowed amount:
Maximum axial play: 0.1mm
Should play be greater, replace the rotors.



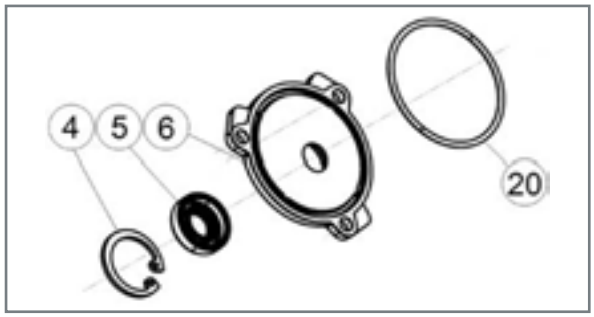
Evaluation of radial play between internal and external rotor.



Evaluation of radial play between external rotor and crankcase.



Evaluation of axial play between rotors and sliding surfaces.



Exploded view of high-pressure pump cover. 4) JS24 Circlip; 5) 10x22.6 oil seal; 6) Oil pump cover; 20) 45x2 O-ring.

As for the high-pressure pump (located in the outside right crankcase half), one must check that the oil seal **5** is not worn (it is recommended to replace it). In order to disassembly it, the circlip **4** must be removed. Check the state of use of the O-ring **20**and replace it if needed.

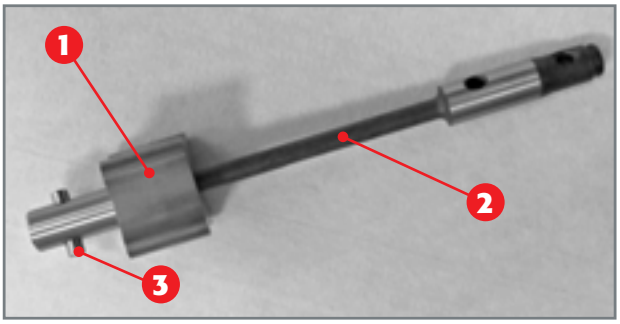


Checking oil pump control shaft.

Also check that the drive shaft is not too marked in the area **A** where the oil seal slides.

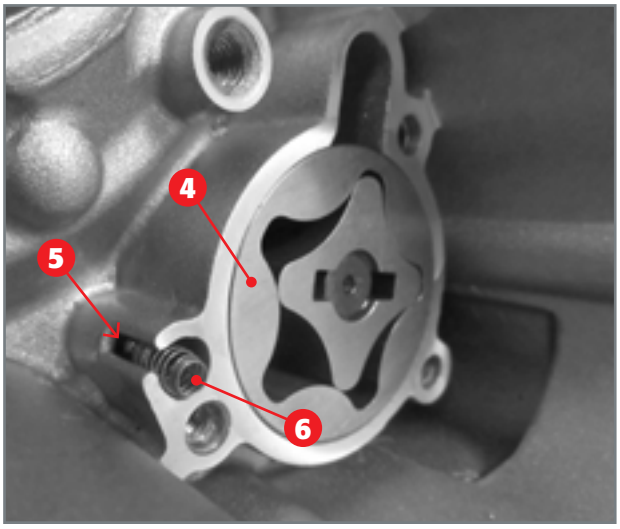
3.11.1 INTAKE PUMP ASSEMBLY

Insert the internal rotor **1** on the shaft **2** so that the dot on the front of the rotor faces inwards. Then insert the roller **3** on the shaft.



Shaft intake pump internal rotor and roller unit.

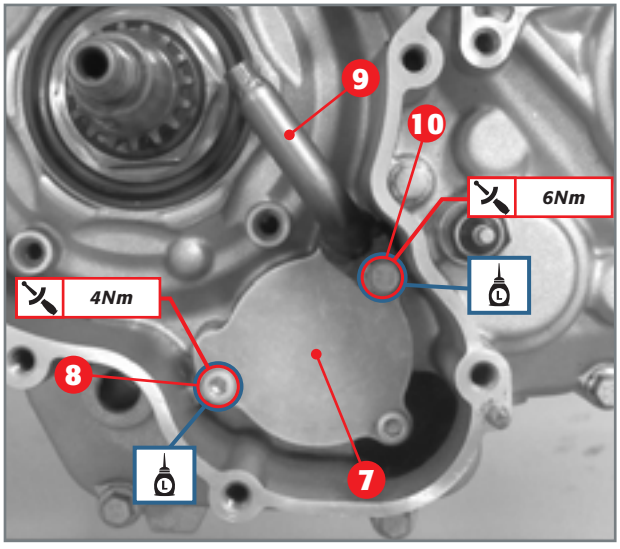
Use motor oil to lubricate the seat of the rotors on the outside of the crankcase half, insert the external rotor **4** and the internal shaft-rotor unit in its proper seat.
Insert the ball **5** (diameter 5.5mm) and the respective compression spring **6**.
Lubricate with motor oil and, while rotating the protruding segment of the drive shaft (from the outside of the right crankcase half), make sure it rotates freely and does not jam.



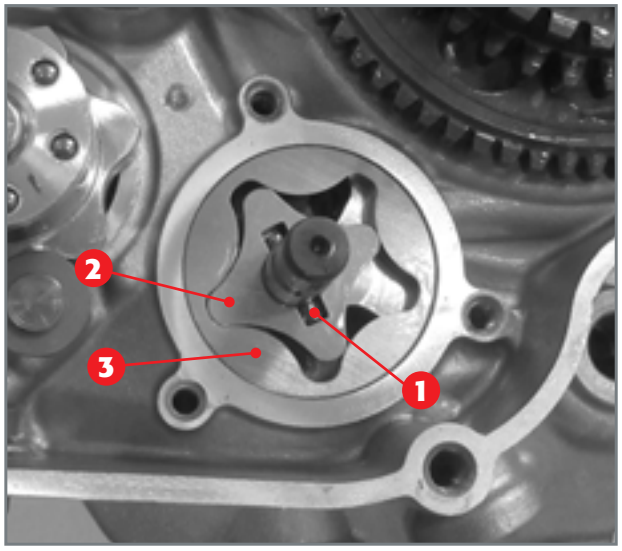
Complete intake pump coupled to the crankcase.

Apply the cover **7** and fasten it using the screws **8**, after placing the threadlocker: tighten to the specified torque.

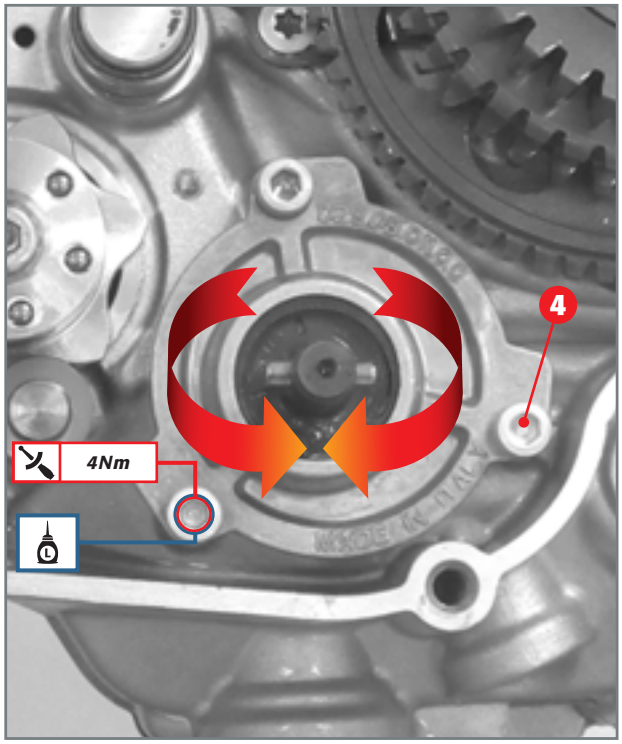
Apply the oil jet **9** and fasten it using the screw **10**, after placing the threadlocker. Tighten to the specified torque.



Coupling the oil intake pump cover to the crankcase.



Coupling the high-pressure pump rotors to the control shaft.

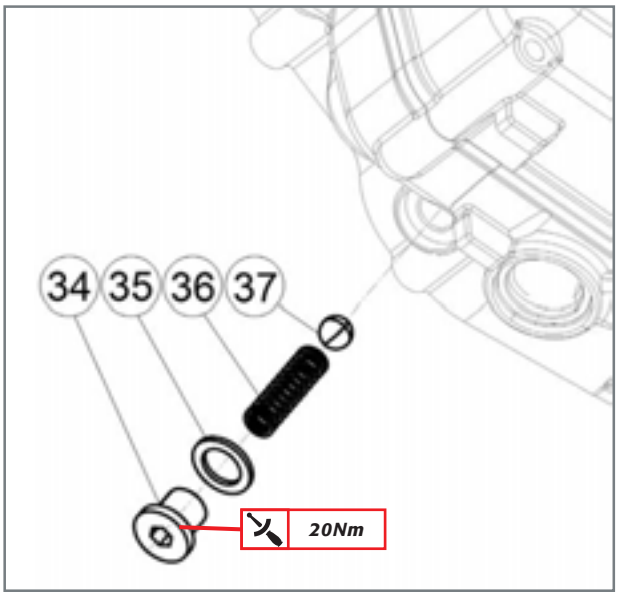


Coupling high-pressure pump cover to crankcase.

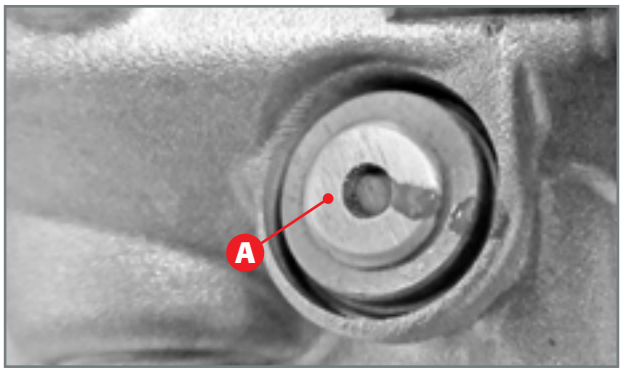
3.11.2 HIGH-PRESSURE PUMP AND CONTROL GEAR ASSEMBLY

Lubricate the area where the pump is housed (outside right crankcase half), and insert the roller in its hole **1**. Then insert the internal rotor **2** and the external rotor **3**, making sure to position them with the reference dot facing the inside of the engine.
Lubricate the pump body with motor oil.

Grease the oil seal, insert the cover in the end of the shaft and press towards the crankcase. Insert the three screws **4** after having applied them with spread medium strength threadlocker. Tighten them to the indicated torque.
Turn the shaft holding on to the protruding end and make sure it rotates freely without getting jammed.



PRESSURE CONTROL VALVE.
34) Screw;
35) Thrust washer;
36) Spring;
37) Ball.



3.11.3 CHECKING AND ASSEMBLING THE PRESSURE CONTROL VALVE

The pressure control valve is made up of the ball **37**, spring **36**, calibrated washer **35** and screw **34**. Check the length of the free spring on this component:

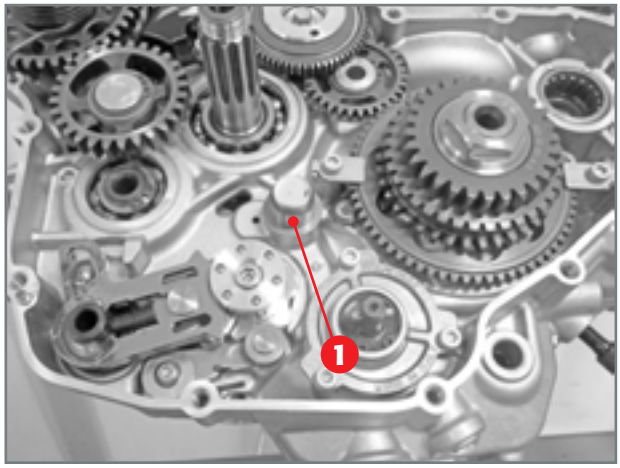
Service limit: 29.5mm

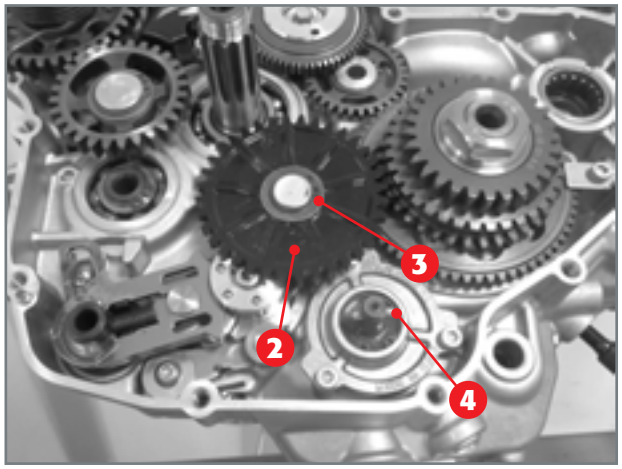
Tighten the screw to the indicated torque.

WARNING!
If one of these elements making up the control valve is not inserted, engine functioning will be jeopardised.

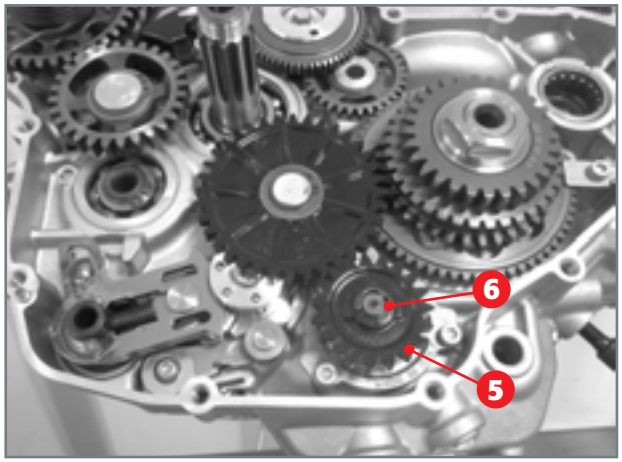
WARNING!
*Always restore the original thickness value of the washer **35**. If this must be replaced, replace it with one of the same original thickness.*

WARNING!
Once valve assembly is complete, apply a 6 mm diameter x 8 mm length aluminium rivet A in the hexagonal slot. This device prevents accidental dismounting of the pressure regulation valve.





Coupling pump control gearwheels to crankcase.



Coupling pump control wheel.

3.11.4 CHECKING AND ASSEMBLING THE OIL PUMP CONTROL GEARS

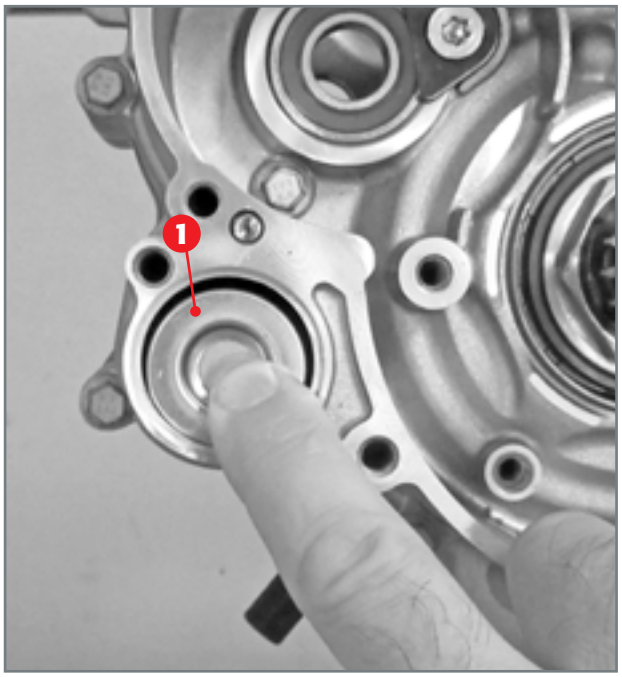
The oil pumps are controlled by a gearing cascade which is driven by the clutch case.
The gearwheels, being made of plastic, must not have chips, grains or signs of abnormal wear.

Couple the thrust washer **1** to the pin and lubricate it with gear oil.

Couple the pump control idler wheel **2** to the pin so that the most protruding segment faces the casing.
Then insert the thrust washers **3** and circlips to prevent the wheels from coming off the pins.

Note: *check for the roller* **4**.

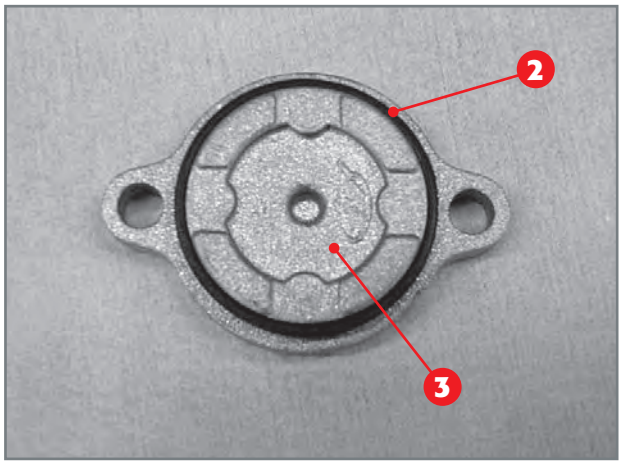
Couple the oil pump control wheel **5**to the end of the shaft so that the groove on the gear inserts into the roller. Then apply the Benzing ring **6**, so that the gear does not slip off.



Paper oil filter application.

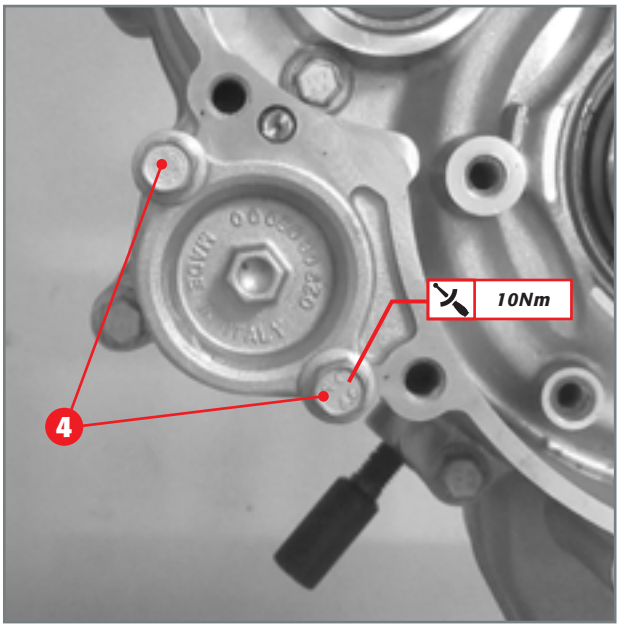
3.11.5 PAPER OIL FILTER INSERTION

Lubricate the rubber gasket on the filter. Insert the filter **1** into its housing and push it towards the inside of the engine as far as it can go.



Paper oil filter cover complete with O-ring.

Insert the O-ring **2** onto the oil filter cover **3** and apply the unit to the crankcase half.



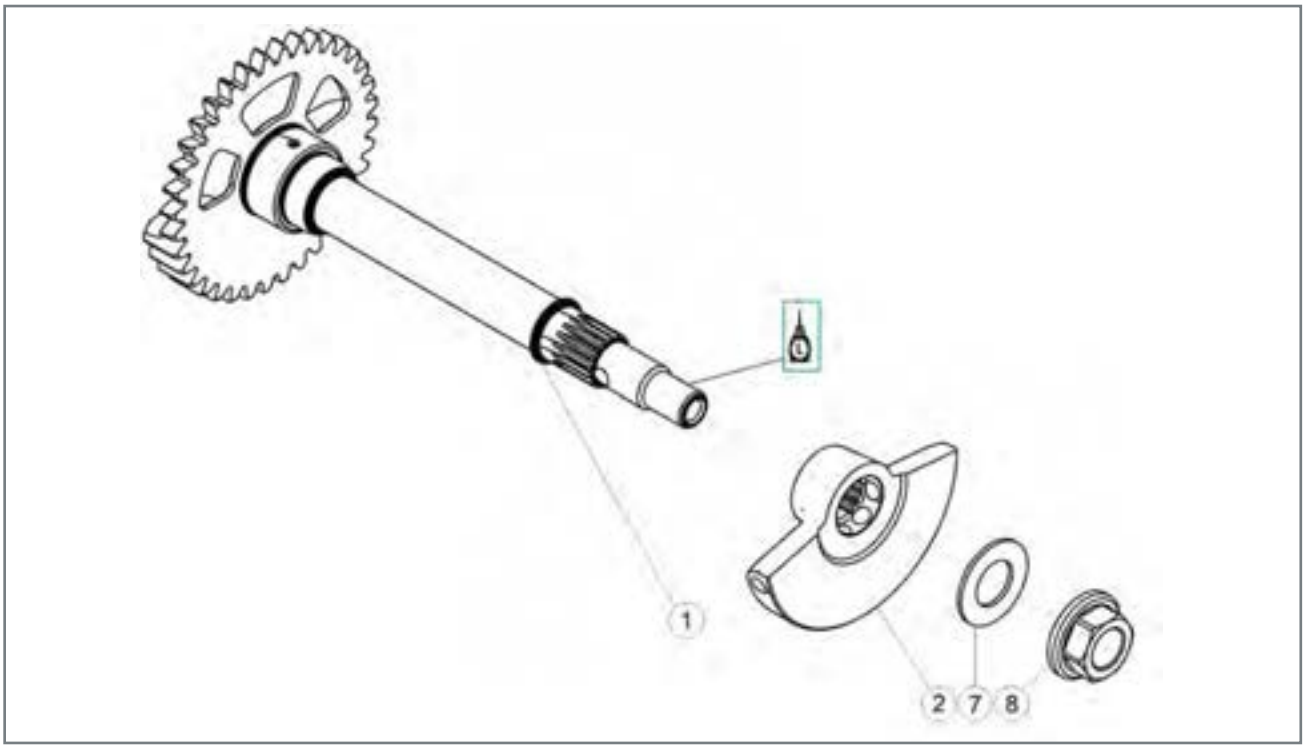
The two paper oil filter cover fastening screws.

Apply the two M6x16 screws **4** to be tightened to the indicated torque.

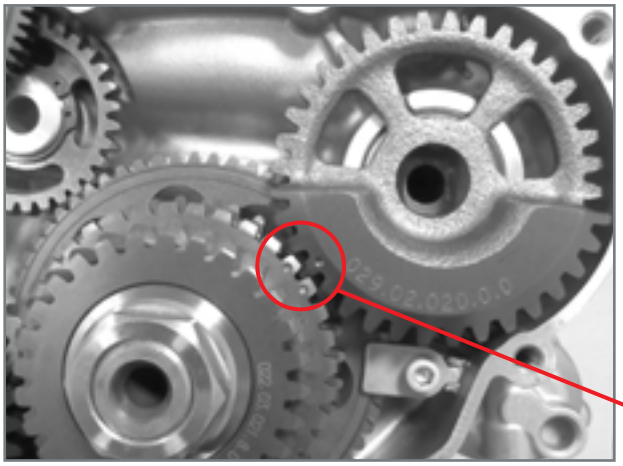
3.11.6 CHECKING AND COUPLING THE COUNTERSHAFT

Check the state of use of the areas where the shaft rests on the bearing. Should they show signs of abnormal wear, have the shaft replaced. Make sure that the toothed segment of the shaft does not have traces of abnormal wear.

EXPLODED VIEW OF COUNTERSHAFT
1) Shaft;
2) Counterweight;
7) Elastic washer
8) M12x1 nut



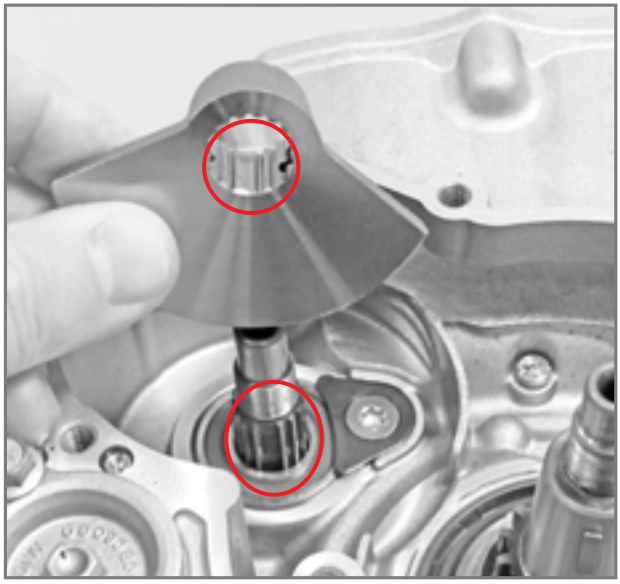
Grease the oil seal and insert the countershaft in its seat. Position it so that the reference sign on the shaft is between the two reference signs on the primary gear.



Coupling countershaft to crankcase.

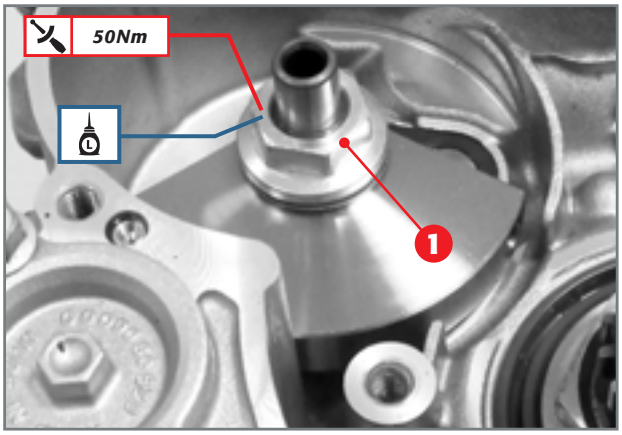


Enlargement of references.



Detail of grooved profiles for coupling.

While keeping the countershaft in place, insert the counterweight on the left side depending on the position set by the grooved shaft.



Countershaft nut.

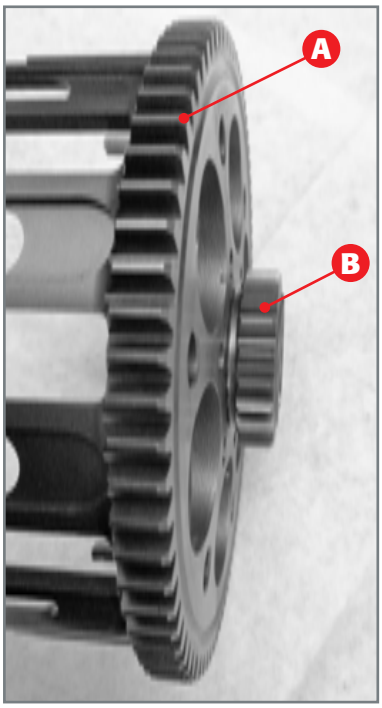
Then couple the elastic washer and the nut **1** after having applied medium strength threadlocker on their threading. The nut must be tightened to the indicated torque.

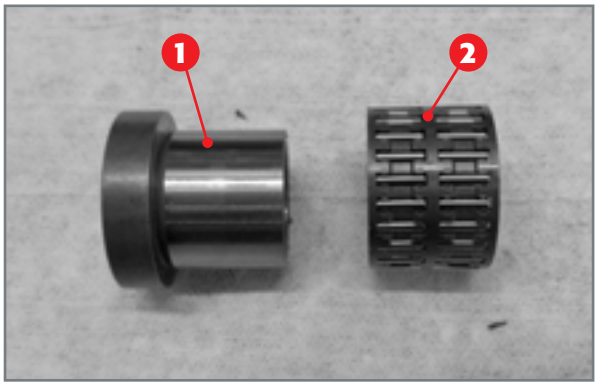
3.12 CLUTCH UNIT

Before reassembling the clutch unit, it is required to carry out some checks on the various components described below.

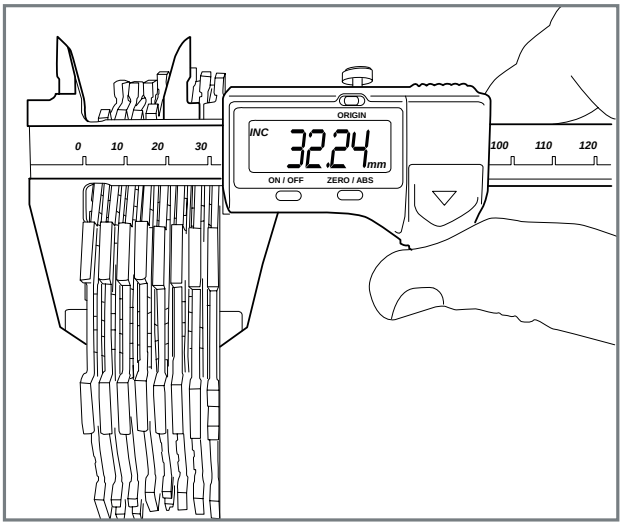
3.12.1 CHECKING THE CLUTCH CASE, ROLLER BEARING AND INTERNAL CENTRE BEARING

Before reassembling the clutch case, make sure that the sides of the teeth **A**, designated for main transmission and **B**, designated for meshing with the kickstart idler gear and oil pumps, have no superficial nicks or abnormal wear.



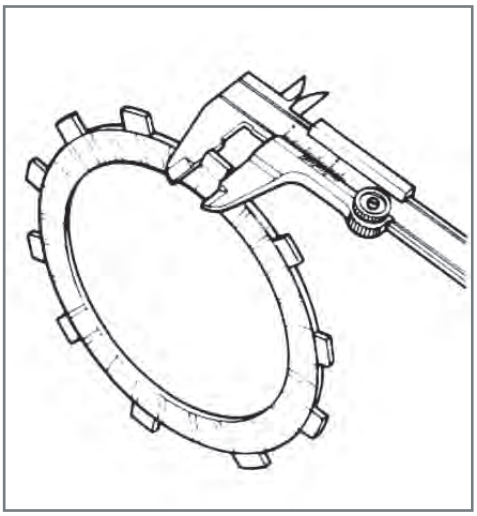


Check the condition of the internal centre bearing **1** which must show no traces of meshing or abnormal wear. Check the condition of the roller bearing **2** . If worn, it must be replaced.

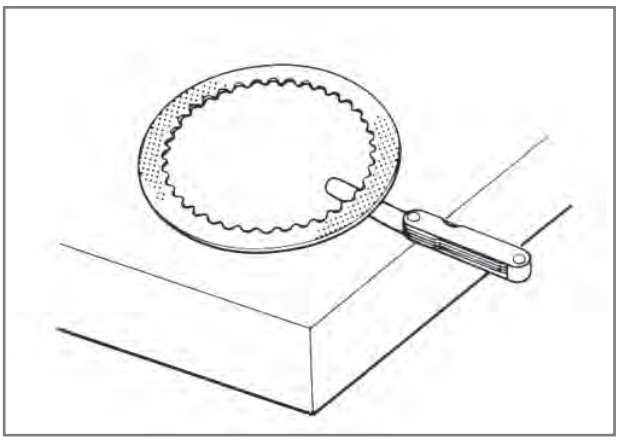


3.12.2 CHECKING THE CLUTCH DISCS

The clutch discs are divided into driving and driven: eight driving discs and seven driven discs. The driving discs have cork inserts on both sides which wear out due to the driven discs sliding on them. One needs to check that the thickness of the clutch pack (driven and driving discs) is not lower than a minimum set value equal to:
minimum thickness of complete disc pack: 31.6mm

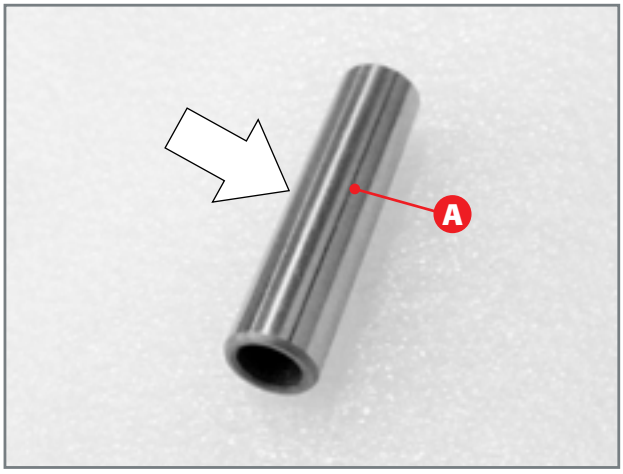


The other measurement that needs to be checked is the thickness of the teeth of each driving disc, which must not be less than the minimum set at:
minimum driving disc tooth thickness: 13.3mm

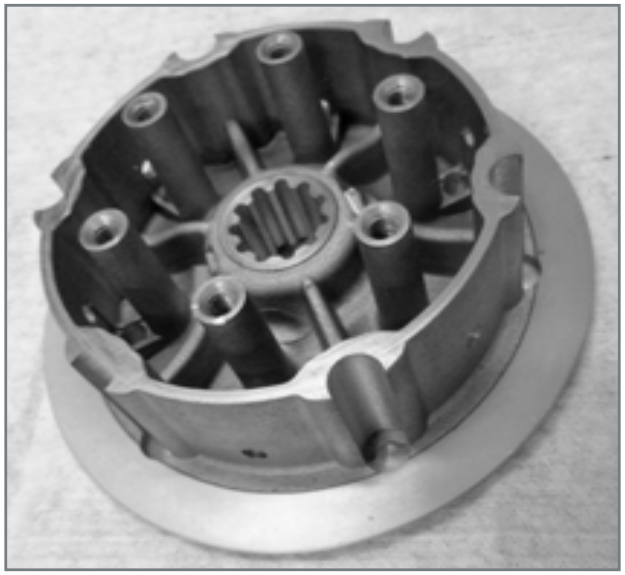


Also check the distortion of the driven discs. This operation is carried out by placing the driven discs on a perfectly flat surface and using a thickness gauge to check that any gap between the disc and the surface is not greater than:
allowable distortion of driven discs: 0.10mm

3.12.3 CLUTCH DRUM AND CAP CHECK

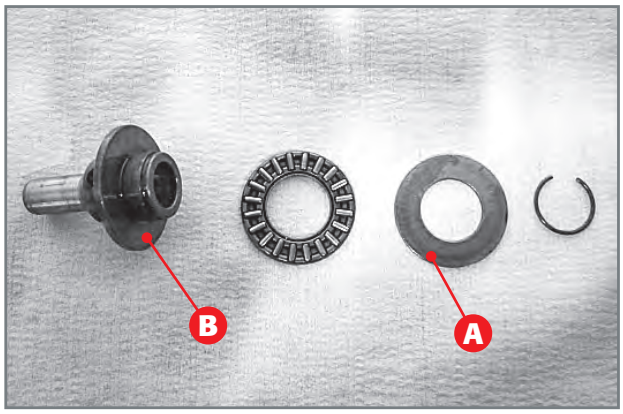


The clutch drum engages with the driven clutch discs by means of the sliding pins **A**: make sure that the area shown in the figure is free from meshing or abnormal wear. If so, replace the sliding pins.



Make sure that the disc friction area is free from scratches, meshing or abnormal wear. If so, replace the clutch drum
Also check that the radial holes on the clutch drum are not obstructed and are free from sediments.

3.12.4 CLUTCH UNIT ASSEMBLY

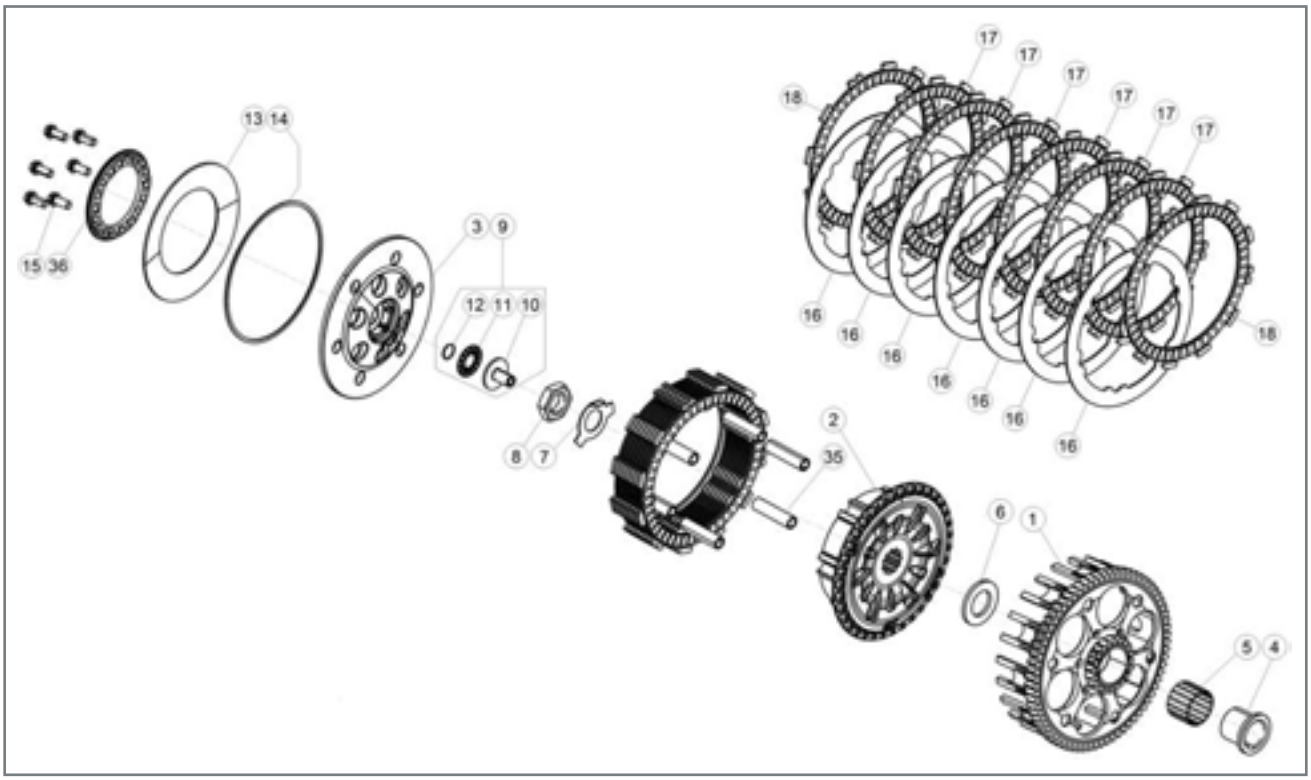


Thrust bearing device.

Lubricate the end of the primary gearbox shaft, the internal centre bearing **4** and the roller bearing **5**. Fit the roller bearing **5** and the centre bearing **4** on the clutch case **1**. Mount the unit on the primary shaft; in order to make insertion of the clutch case easier, slightly turn the kickstart idler gear (optional), the idler gear for oil pump control and the case, thus making meshing easier. Fit the washer **6**, which the clutch drum **2** rests against. Fit the sliding pins **35** on the drum. Apply the safety washer **7** and, after applying medium strength threadlocker, fit the lock nut **8**.

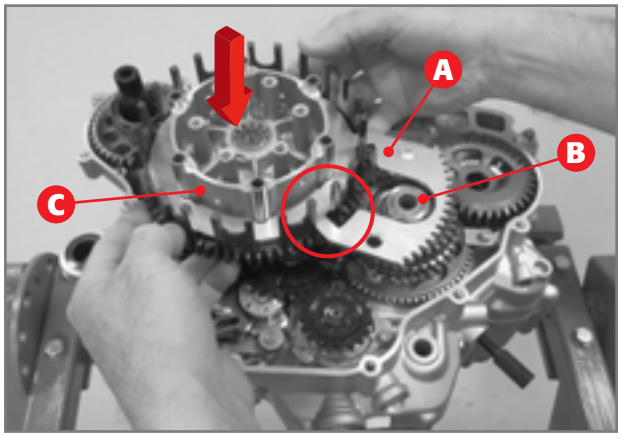
3.12.5 CLUTCH UNIT ASSEMBLY

Lubricate the end of the primary gearbox shaft, the internal centre bearing **4** and the roller bearing **5**. Fit the roller bearing **5** and the centre bearing **4** on the clutch case **1**. Mount the unit on the primary shaft; in order to make insertion of the clutch case easier, slightly turn the kickstart idler gear (optional), the idler gear for oil pump control and the case, thus making meshing easier. Fit the washer **6**, which the clutch drum **2** rests against. Fit the sliding pins **35** on the drum. Apply the safety washer **7** and, after applying medium strength threadlocker, fit the lock nut **8**.

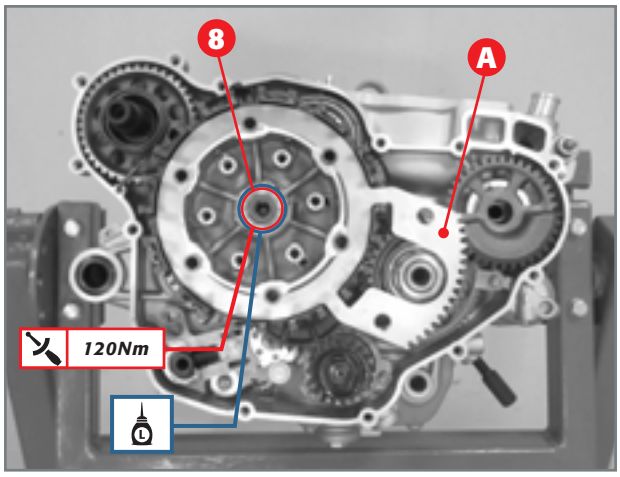


EXPLODED VIEW OF CLUTCH UNIT:

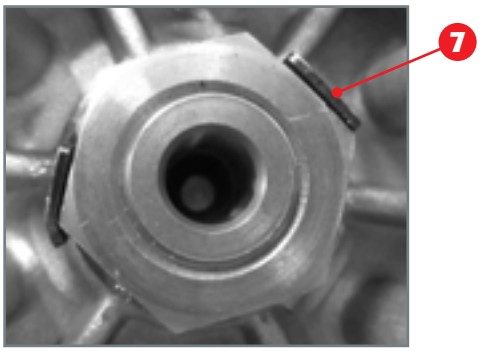
1) ***Main transmission crown***
2) ***Clutch hub***
3) ***Pressure plate***
4) ***Main transmission crown bushing***
5) ***Rolled bushing***
6) ***Washer***
7) ***Washer***
8) ***Nut***
9) ***Complete lifter clutch push rod assembly***
10) ***Lifter clutch push rod assembly***
11) ***Bearing cage***
12) ***Circlip***
13) ***Spring washer***
14) ***Ring***
15) ***Special screws***
16) ***Clutch driven disc***
17) ***Clutch driving disc***
18) ***Clutch driving disc***
36) ***Ring***



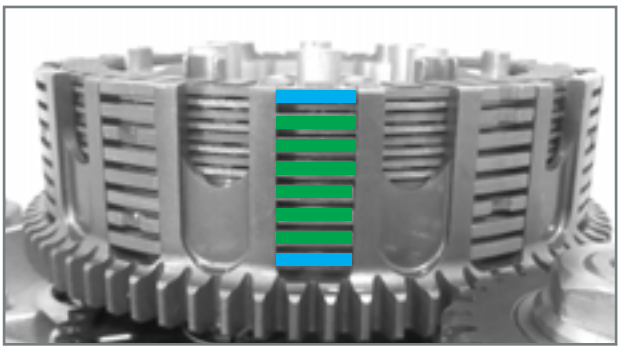
Note: *Before applying the safety washer* ***7*** *and the nut* ***8,*** *it is recommended to place the special tool A (code 029.14.002.50.00) on the assembled unit and make sure that it gets in position correctly with respect to the clutch case and the primary gear nut* ***B****.*
In other words, the special tool must connect the two arms on the resting slots of the driving discs, and rest against the surface of the clutch drum ***C****.*



To tighten the nut **8** the clutch drum must be held blocked with tool **A** *(code 037.14.002.50.00)*. Tighten to the specified torque.

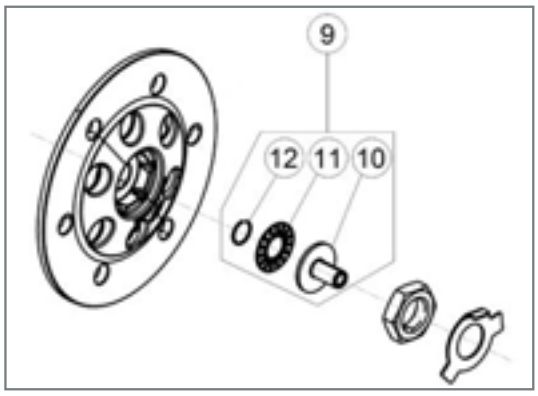


Having tightened the nut, fold the two locking fins on the safety plate.

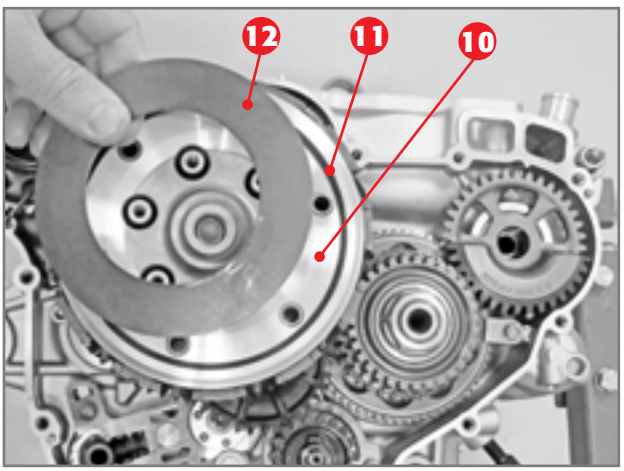


Lubricate the clutch discs with gear oil and apply the driving disc with BLUE edge and a driven disc. Then alternate the driving discs with GREEN edge and the driven discs.
The other driving disc with BLUE edge will close the disc pack.

Please note that the driven discs must be inserted so that the connecting radius on the teeth faces inwards towards the engine.



Insert the thrust bearing assembly **9** (after lubricating it with gear oil) in the hole on the gearbox main shaft and check free axial sliding.



Clutch cap assembly

Fitting the pressure plate **10**, the ring **11** and the spring washer **12**.

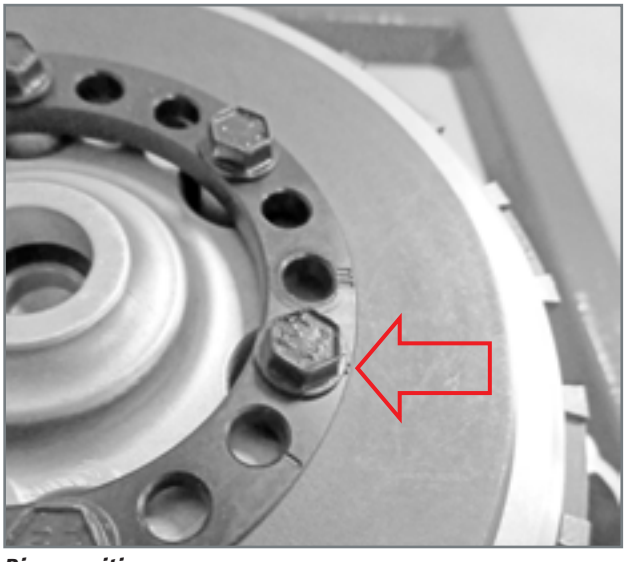
> ***WARNING!***
> *The spring washer must be fitted so the side with the larger diameter rests on ring **11**.*



Detail of correct fitting of the spring washer.

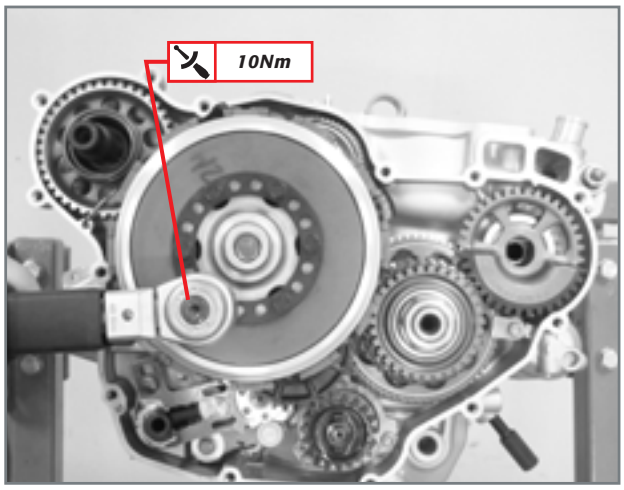


Detail of incorrect fitting of the spring washer.

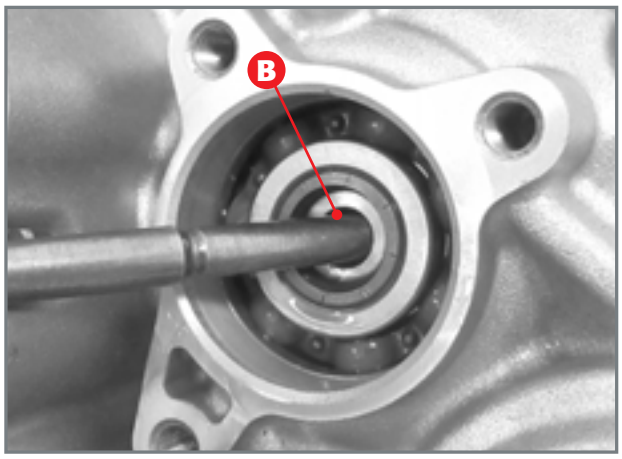


Ring position.

Fit the ring as shown in the diagram by positioning it so that a screw lines up with the III mark.

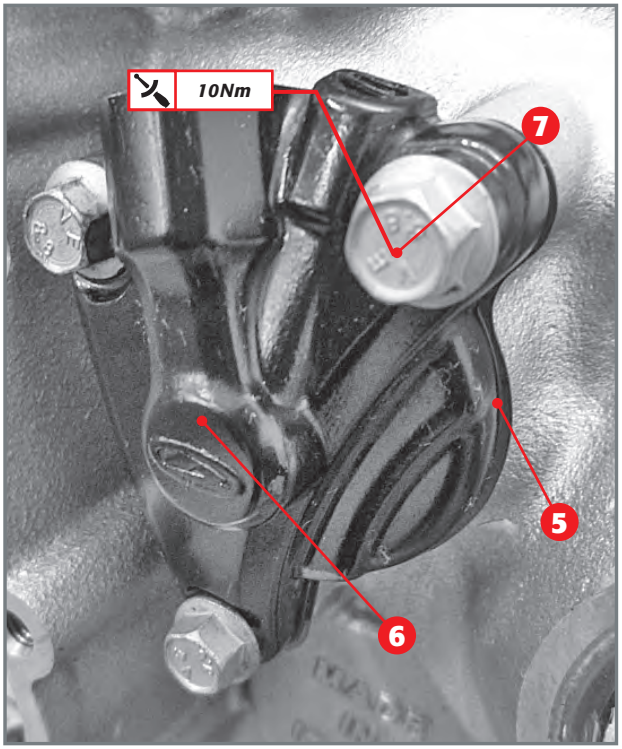


Proceed to tighten the six screws in a crisscross order and tighten them to the torque indicated.



Insertion of clutch rod in housing B.

Insert the clutch rod in the seat **B** from the left side of the engine, turning the smaller section towards the inside of the engine.



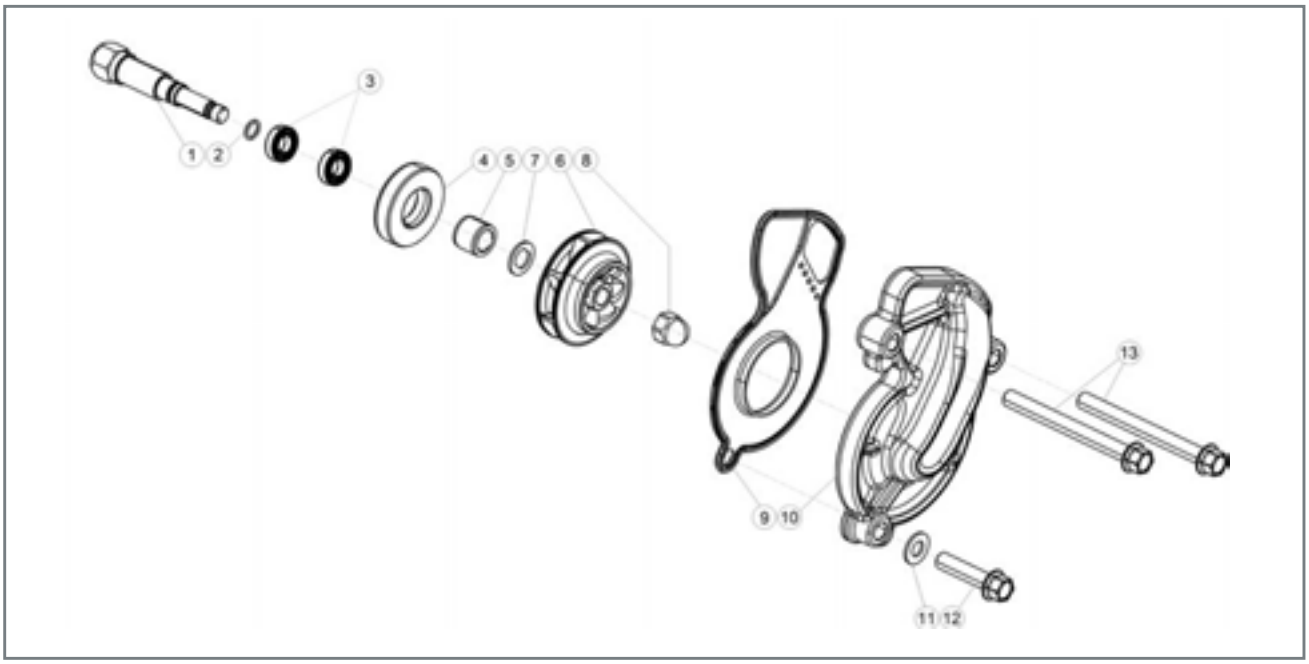
Application of the gasket 5, actuator 6, M6x30 screw 7 and two M6x20 screws 8.

If only the clutch actuator pipe was removed during the disassembly of the engine from the vehicle, operating on the actuator as well, proceed as follows.
Apply the gasket **5,** the complete hydraulic actuator **6**, the M6x30 screw **7** and the two M6x20 screws **8** to the left crankcase half. Tighten the three screws to the indicated torque.

3.13 COOLANT PUMP

The water pump must assure the correct flow rate of coolant, depending on the set rotation speed, in order to remove the required amount of heat from the power unit.
The shaft **1** is supported by two bearings while sealing of coolant and gear oil is ensured by the O-ring **2** and oil seal **4**.
The impeller **6** is fastened to the shaft **1** and the coupling is ensured by tightening the nut **8** onto the shaft **1**.

EXPLODED VIEW OF WATER PUMP UNIT.
1) Water pump unit;
2) 5.5x1 O-ring;
3) Bearing;
4) Oil seal;
5) Bush;
6) Impeller;
7) Washer;
8) Blind nut;
9) Septum;
10) Cover;
11) 6x10x2 copper washer;
12) M6x25 screw;
13) M6x60 screw.

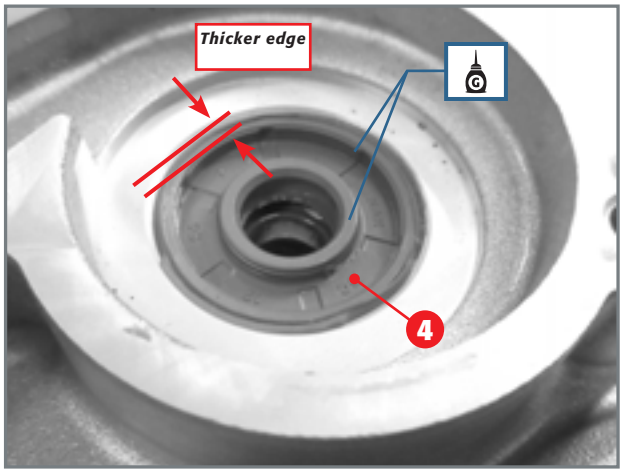




Inner clutch cover with water pump.

3.13.1 CHECKING THE PUMP UNIT AND DISASSEMBLY

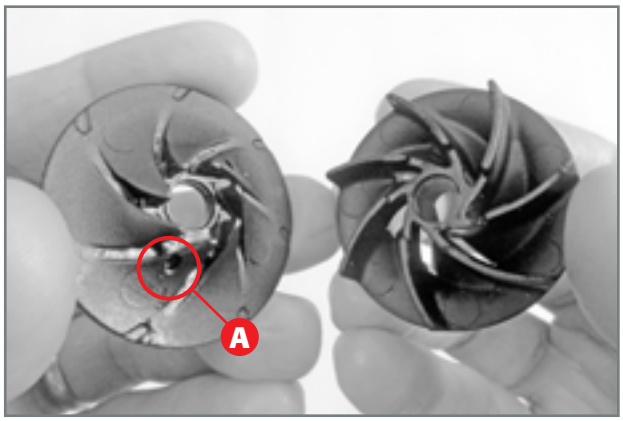
Disassembly of the entire pump unit can be done only with the entire clutch cover removed.
Disassembly of the pump unit is performed by removing the nut **8** which allows you to extract the impeller **6**, the washer **7**, and the shaft **1**. This can be removed by pressing the threaded part of shaft towards the inside of the clutch cover.
Extract the oil seal **4** and, heating the bearings **3**, remove them.
Once the shaft is pulled off **1** from the crankcase, it is recommended to replace the O-ring **2**.
Replace the oil seal **4** every time and if the bush **5** is marked in the area of contact with the oil seal, replace it as well.



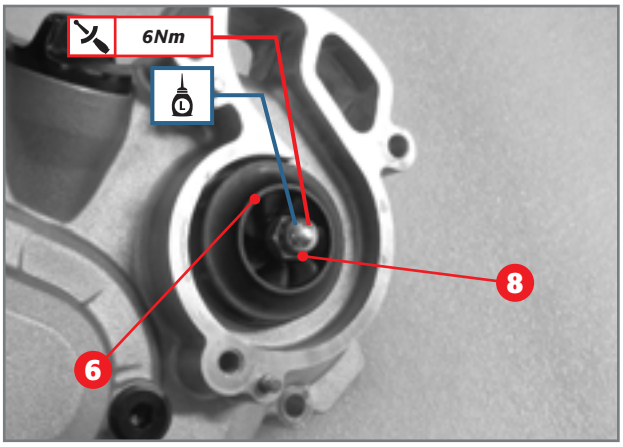
Application of oil seal on inner clutch cover.

3.13.2 PUMP UNIT ASSEMBLY

Heat the concerned area to couple the bearings **3** to the inner clutch cover. They must be pushed until they are flush with the shoulders on the pump body.
Grease the oil seal housing. Position the oil seal **4** so that the thicker edge faces the outside of the cover. Insert the oil seal in the inner clutch cover, having it enter the seat very slowly to keep it from deteriorating.



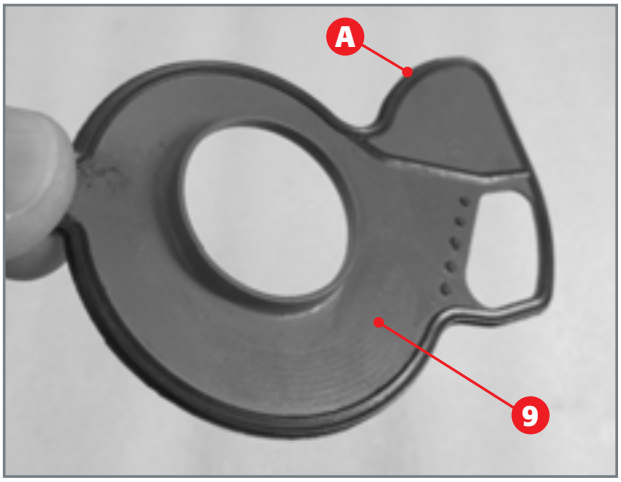
Note: *the water pump impeller is made up of two parts.*
It is recommended to clean the slots and the pinhole ***A****.*
Recouple both parts.



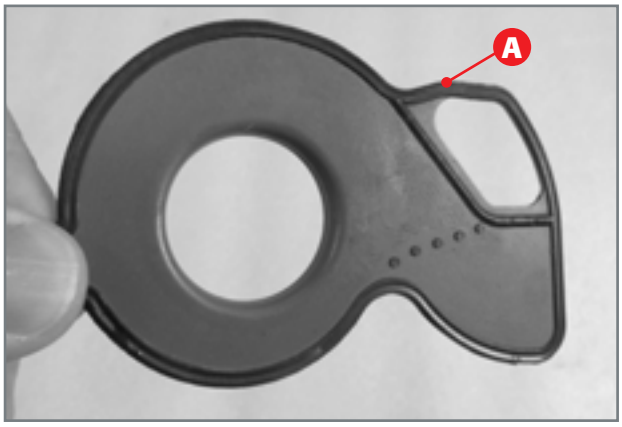
Complete coolant pump unit.

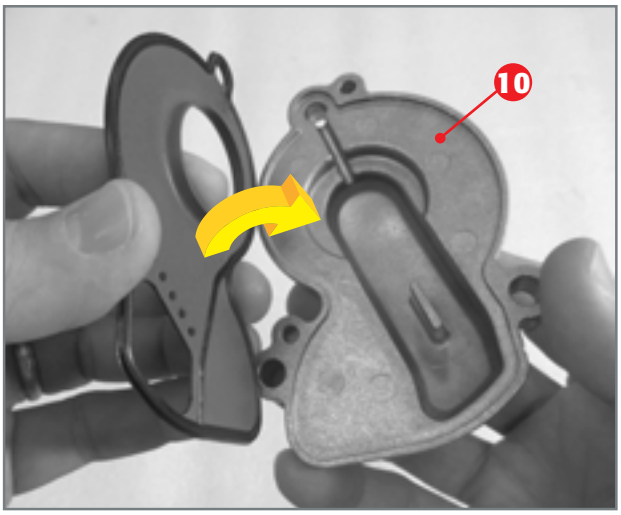
Couple the shaft **1** with the O-ring **2** to the inner clutch cover and then insert the bush **5**, the washer **7**, and the impeller **6**.
Then couple the blind nut **8** to the threaded segment of the shaft after having applied medium strength threadlocker. Tighten it to the indicated torque.

When coupling is complete, check that the pump unit turns freely without meshing or friction.
Check the axial play of the pump unit. Make sure it is not beyond 0.3 mm.
It is recommended to replace the gasket in between the inner clutch cover and the pump cover.

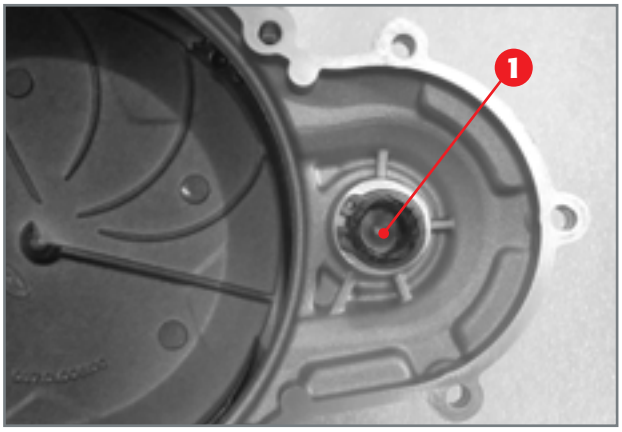


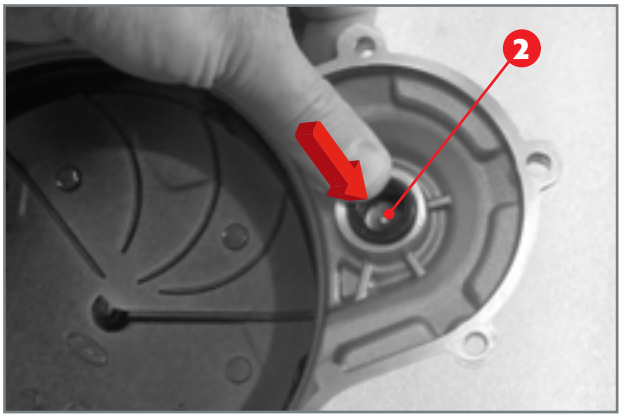
Make sure that the gasket **A** of the septum **9** is intact, otherwise have it replaced.

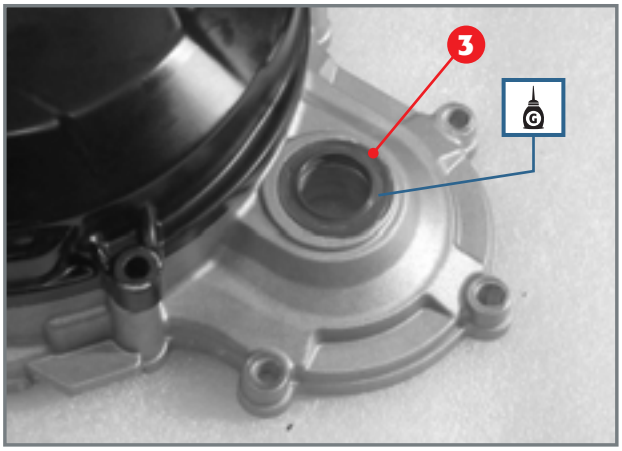


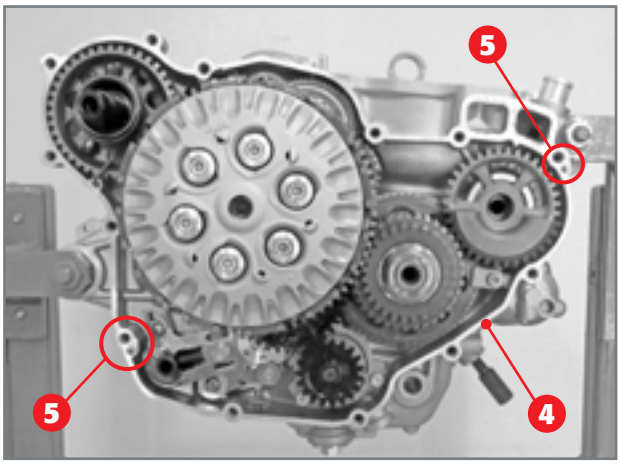


Couple the septum to the water pump cover **10**.









Positioning of gasket 4 and centring pins 5.

3.14 ASSEMBLY OF COMPLETE CLUTCH COVER

Should you need to assemble the kickstarter kit (optional), it is necessary to remove the circlip **1** and push the cap **2** outward.

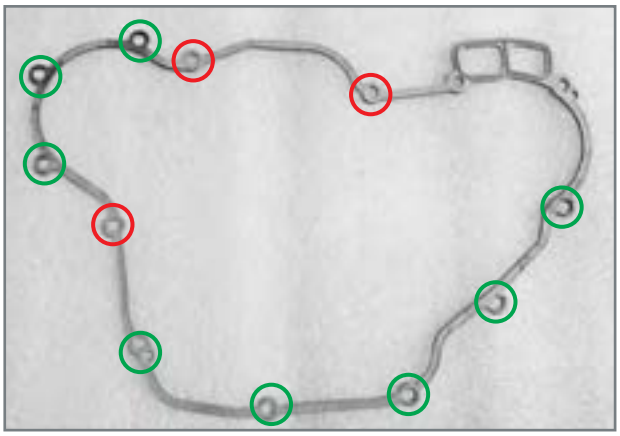
Apply the oil seal **3**, provided with the kit, from the outer side as shown in the figure. Grease the oil seal.

Apply a new gasket **4** placed between the right crankcase half and the inner clutch cover using the two reference pins **5** to keep it in place.



Application of complete inner clutch cover on right crankcase.

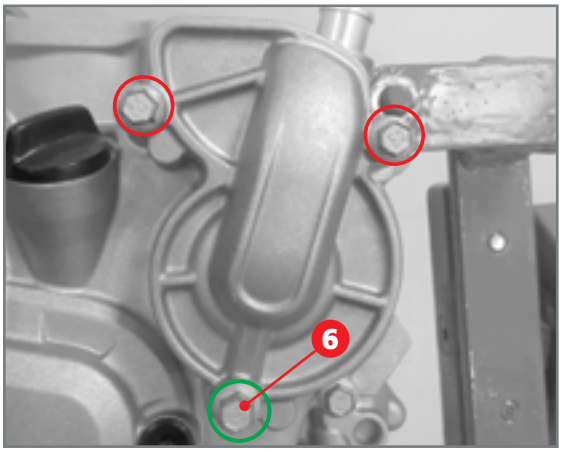
Couple the inner clutch cover to the right crankcase half and turn the water pump impeller until the pump shaft perfectly inserts in the housing on the countershaft which drives it.



Positioning of M6x25 screws.

Apply the screws by following the figure diagram and its relevant table.

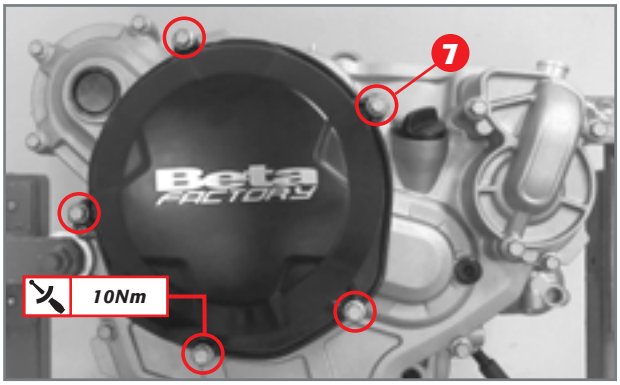
Colour	Screw size		Tightening torque [Nm]
	Threading diameter [mm]	Screw length	
	M6	25	10
	M6	60	10



Coolant pump cover: pay attention to the washer 6.

Couple the water pump cover to the inner clutch cover applying the M6x40 screws, making sure to apply the copper washer **6** to the lower screw of the pump cover.
Fasten all screws at the indicated torque following a criss-cross pattern.

Colour	Screw size		Tightening torque [Nm]
	Threading diameter [mm]	Screw length	
	M6	25	10
	M6	60	10

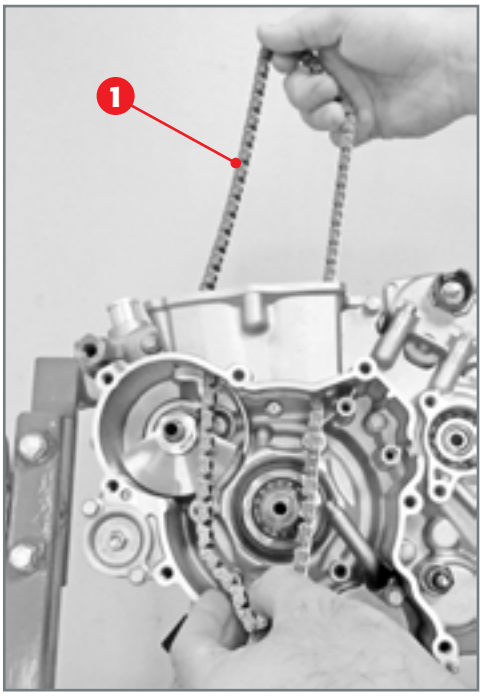


The screws 7 fastening the outer clutch cover to the internal cover.

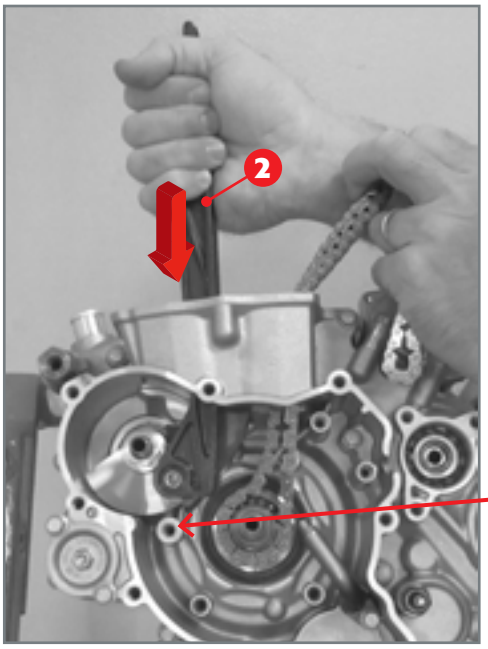
If only the outer clutch cover was removed, put it back on the inner cover, fasten the screws **7** and tighten to the indicated torque.

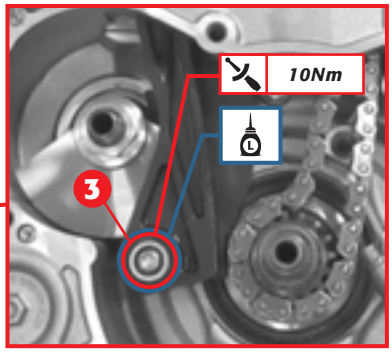
3.15 CHECKING AND COUPLING OF TIMING CHAIN, FIXED AND MOBILE PADS

The chain has the task of transmitting motion from the crankshaft to the camshafts present on the cylinder head. The links must be checked to make sure there is no excessive radial or axial play between them.
Both the fixed and mobile pads ensure that the chain slides properly. The tensioner ensures the correct tensioning. It is possible to assemble the tensioner only after the thermal system and the camshafts have been re-assembled.
Make sure that the guides do not have deep traces caused by the rotation of the chain.

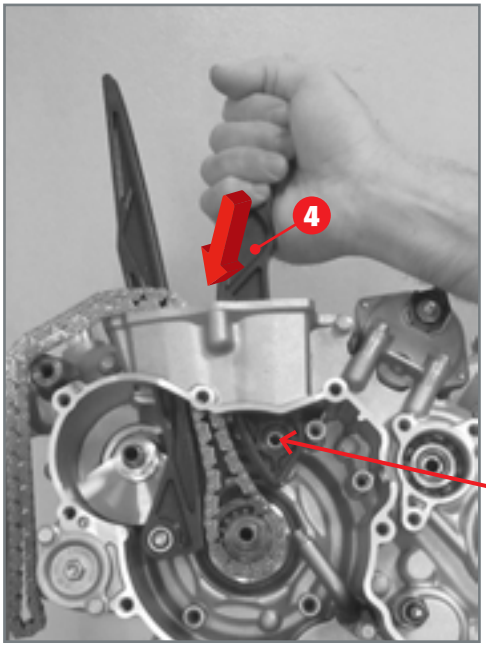


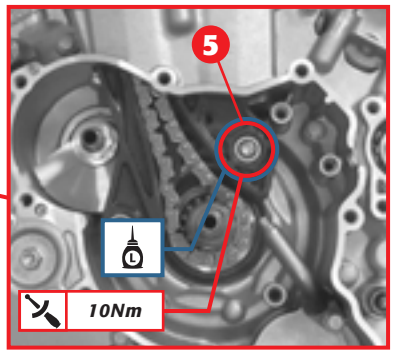
Insert the chain **1** and engage it in the control gear on the crankshaft.



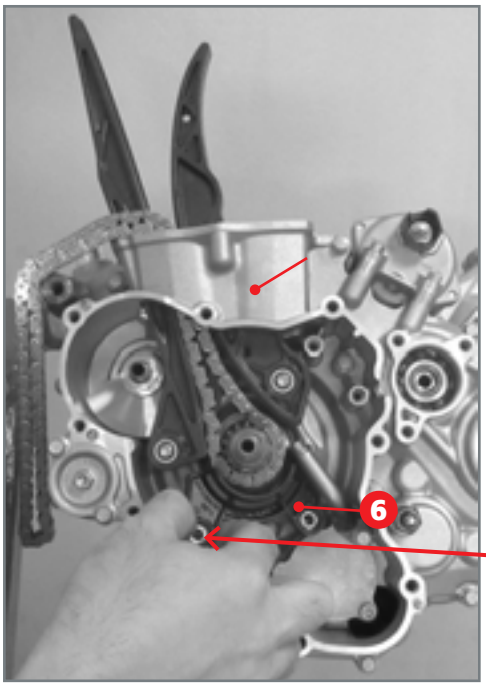


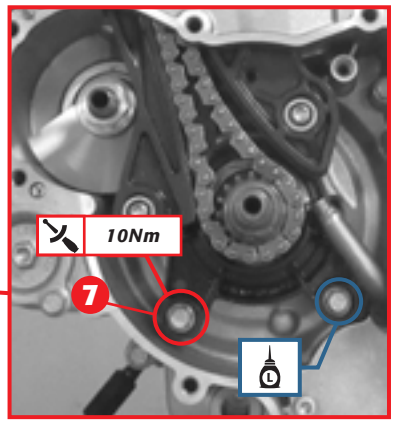
Insert the fixed pad **2**, apply the specific bush and the screw **3** in the lower eyelet, after application of medium strength threadlocker. Tighten to the specified torque.



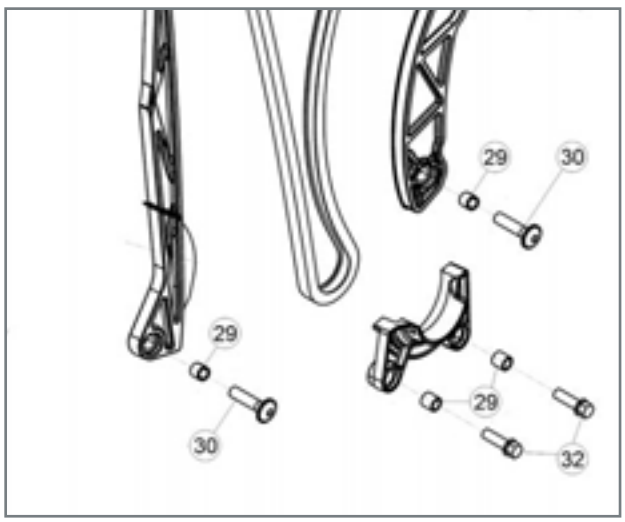


Insert the sliding pad **4**, apply the specific bush and the screw **5** in the lower eyelet, after application of medium strength threadlocker. Tighten to the specified torque.





Apply the lower guard **6**, the specific bushes and screws **7** in the eyelets, after application of medium strength threadlocker. Tighten to the specified torque.



Mounting bushes in lower eyelets of pads.

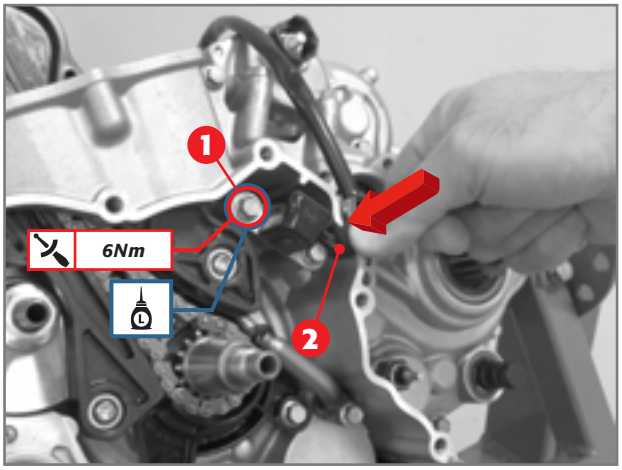
3.16 IGNITION SYSTEM

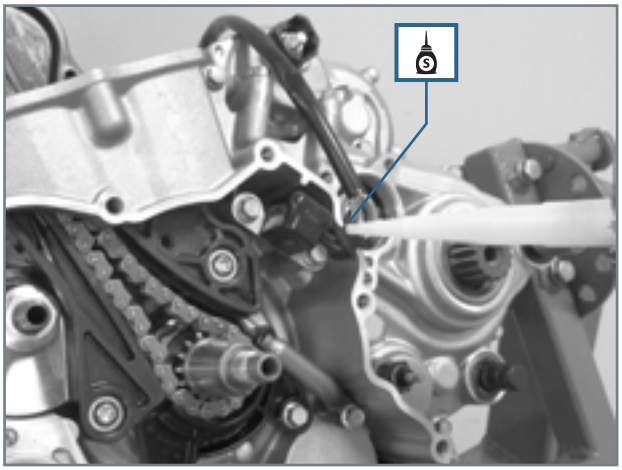
Before reassembling the ignition system, it is recommended to make sure it is in good working order.
The ignition system consists of the magnetic pick-up, the stator unit and the flywheel. The system is completed by the electronic control unit, the ignition coil and the spark plug, which are not dealt with in this text.

3.16.1 IGNITION SYSTEM CHECK

Accurately degrease the various elements and carry out the checks.
The main check is the one concerning the electrical inspection which can be done by using a standard tester. The resistance values detected at the terminal heads must respect those carried in the table (at 20°C).

Element	*Cables*	*Resistance values*
Pick up	*Red – Green*	*100Ω ± 20%*
Stator	*Black - Black*	*0,46Ω ±20%*

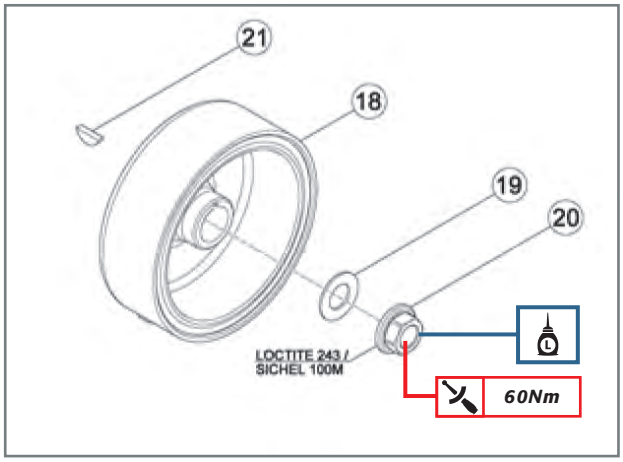




3.16.2 COUPLING OF IGNITION SYSTEM TO CRANKCASE

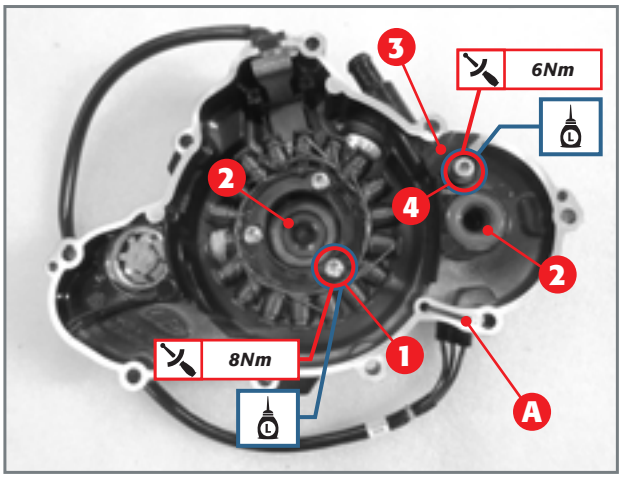
Set the pick-up on the crankcase so that the two holes on its support coincide with the two holes on the crankcase.
Cover the threading of the two screws **1** with medium strength threadlocker and tighten them to the indicated torque.

Push the cable gland **2** in its seat. Then apply a small quantity of motor silicone on the area indicated.



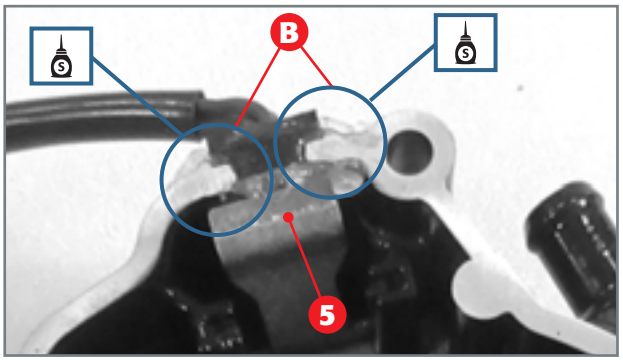
Exploded view of flywheel. 18) Flywheel; 19) Elastic washer; 20) M12x1 nut; 21) Woodruff key

Thoroughly degrease the crankshaft conical section, apply the Woodruff key **21** in the appropriate groove present on the crankshaft, couple the flywheel **18**, the elastic washer **19** and the nut **20**, after having spread the threading with medium strength threadlocker. Tighten the nut to the indicated torque.



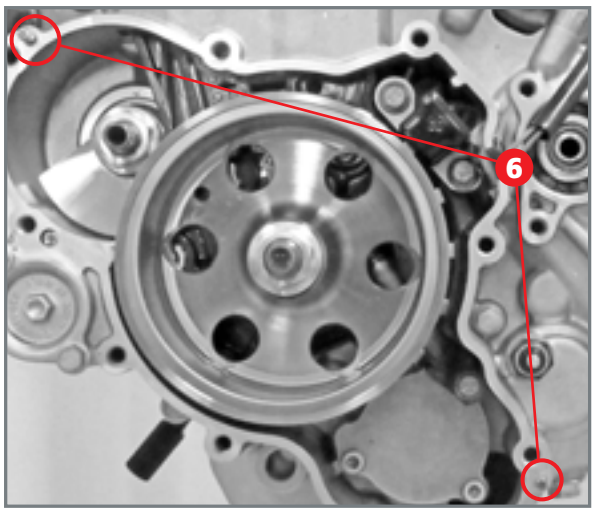
Couple the stator to the flywheel cover by means of screws **1**. Cover the threading with medium strength threadlocker and tighten them at the torque indicated.
Insert the cable gland in its specific seat and check its perfect tightness.

Check the state of use of the two oil seals **2** . If they are deteriorated, they must be replaced.
Blow compressed air in the hole **A** making sure the lubrication pipe is perfectly clean. Also check the state of use of the chain guide **3**. If it is deteriorated, it must be replaced. In that case, before putting on the screw **4**, apply it with medium strength threadlocker and tighten it to the indicated torque.

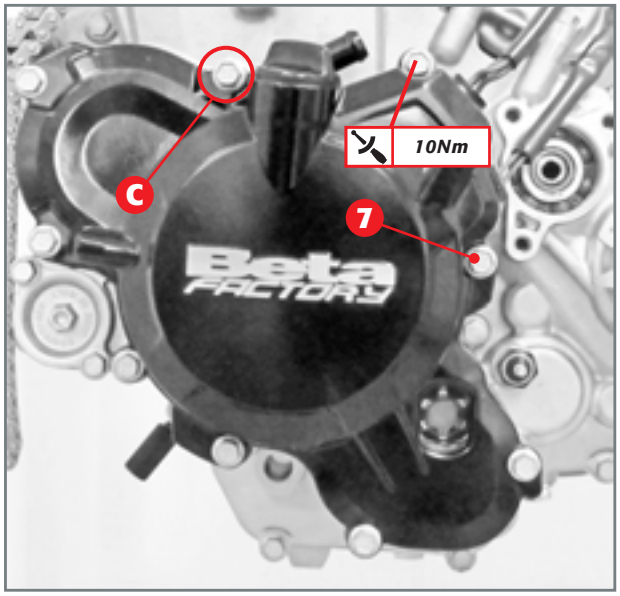


Application of cable protection plate 5. Note the two zones B where a drop of gasket paste must be applied.

Reposition the plate **5** which must be inserted in the relevant guides and pressed towards the outside of the cover.
When coupling it to the left crankcase half, apply a drop of gasket paste in the two zones **B**, in order to ensure perfect sealing between the cover and the crankcase half in the concerned zone.



Insert the centring pins **6** on the crankcase and fasten a new gasket.



Flywheel cover coupled to crankcase.

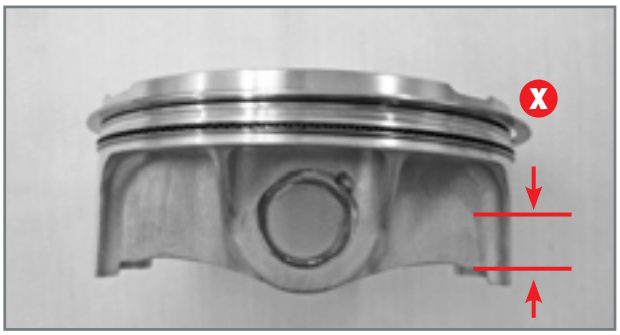
Grease the oil seal on the flywheel cover and couple it to the left crankcase with the M6x25 screws **7**.

Notice that a copper washer (12x6.3x1) **C** must be applied to the screw.
Tighten the screws at a torque of 10Nm.

3.17 THERMAL UNIT

Before assembling the thermal unit, thorough controls must be carried out on the cylinder, piston, pin bolt, piston rings, cylinder head and the timing unit described hereafter.

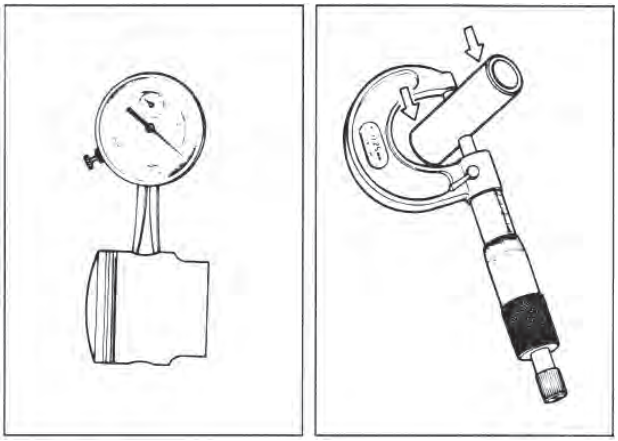
3.17.1 CHECKING THE PISTON, PIN BOLT AND PISTON RINGS



Position to measure the outside diameter of the piston.

Remove carbon sediment from the top of the piston and wash the entire piston with specific degreasing agent.
Do not use sharp points or tools for cleaning.
Then carry out a careful analysis of the piston which must be free from forcing, scratches, cracks or any type of damage.
Analyse the outside diameter of the piston whose service limit is carried in the table below concerning their specific class. The diameter must be measured at a distance **X** from the inner edge of the skirt, perpendicularly to the axis of the pin bolt.

Displacement [cm³]	Measurement X [mm]	Service limits based on relevant class [mm]	
		1	2
350	6	87.92	87.93
390	6	87.92	87.93
430	6	94.92	94.93
480	5.5	99.92	99.93

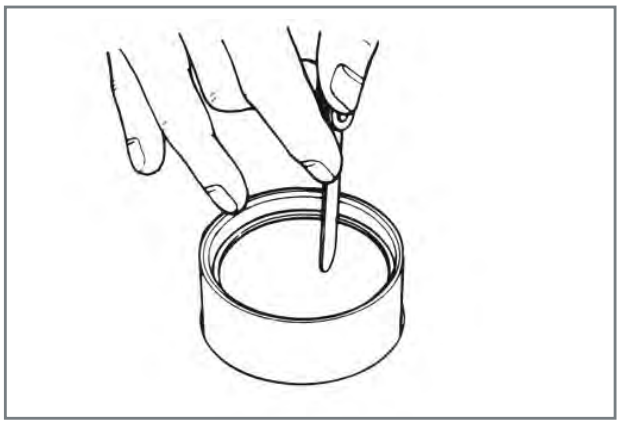


Measurement of pin bolt seat and pin bolt.

Check the size of the pin bolt seat located on the piston and the size of the pin bolt. This last control must be made at the end of the pin bolt itself in the area where it is engaged with the piston.

Displacement [cm³]	Size limit [mm]	
	Pin bolt seat	Pin bolt
350 -390	18.04	17.98
430-480	19.04	18.98

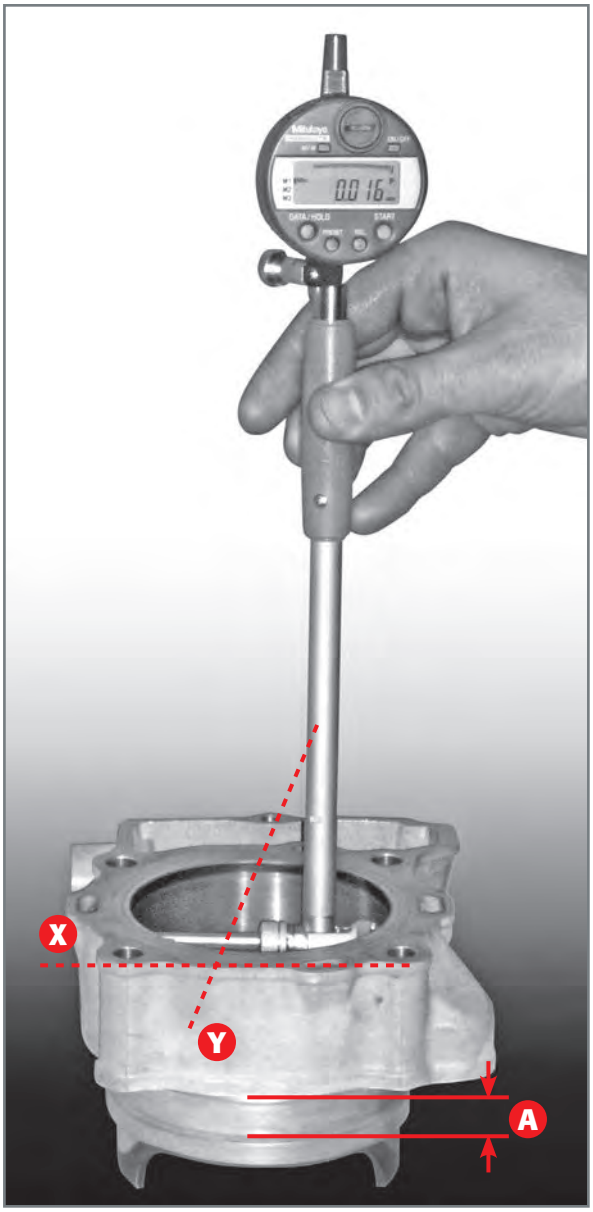
See the relative chapter regarding crankshaft and connecting rod controls for controls on connecting rod foot (par. 2.2).



Elastic band wear limit check.

In order to check the state of use of the elastic band and oil-scraper band, the band must be inserted in the cylinder so that its axis is aligned with the axis of the cylinder. Then measure the distance between the two opposite edges.
The respective service limits are set out in the table below.

Displacement [cm³]	*Service limit of elastic band [mm]*	*Service limits of upper and lower oil-scraper band [mm]*
350-390 430-480	***0.8***	***1.0***



3.17.2 CYLINDER CHECK

Make sure the bore is within the service limits of the relevant class carried in the table below.
Carry out measurement at a distance **A** from the top of the cylinder (surface between cylinder and cylinder head). To measure it correctly, it must be done according to the **X** and **Y** directions orthogonal to each other. Consider the maximum measurement to determine the cylinder wear.
The difference between the two measurements is the ovalization.

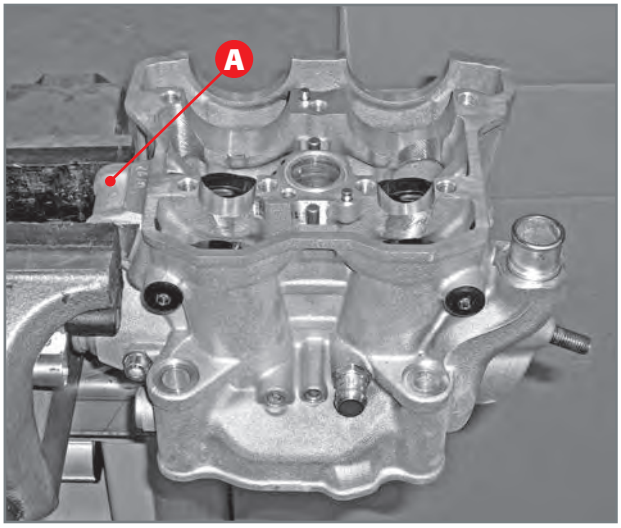
This measurement must be carried out by placing the bore meter in such a way that its axis is perpendicular to the axis of the crankshaft.

Displacement [cm³]	Measurement A [mm]	Service limits based on relevant class [mm]		
		1	2	Ovalization [mm]
350	30	88.022	88.034	0.015
390	30	88.022	88.034	0.015
430	30	95.022	95.034	0.015
480	30	100.022	100.034	0.015

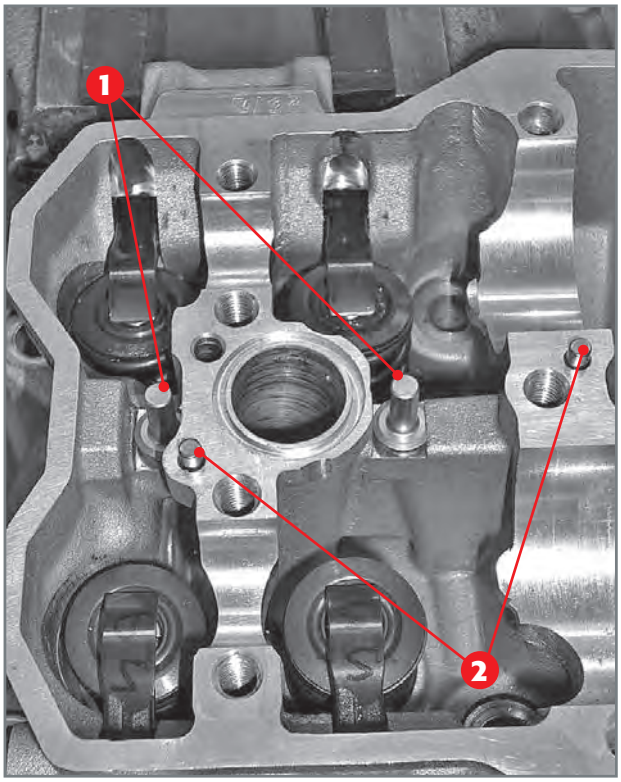
3.17.2.1 Coupling play

The following table sets out the coupling play between cylinder and piston.
In order to calculate the coupling play between cylinder and piston, a subtraction must be carried out between the diameter of the cylinder and that of the piston.

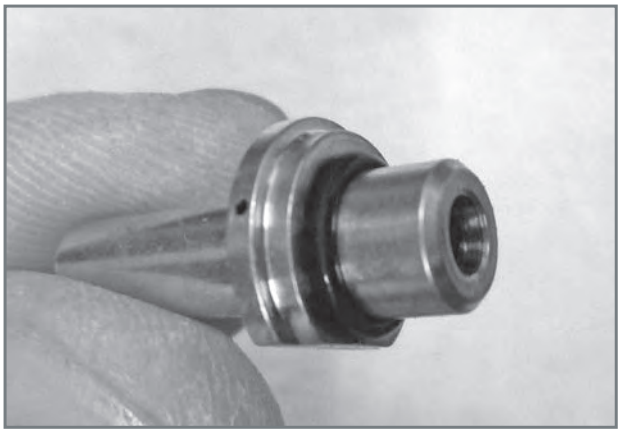
Displacement [cm³]	Coupling play based on relevant class [mm]				Coupling play limit based on relevant class [mm]	
	Class 1		Class 2		Class 1	Class 2
	Min	Max	Min	Max		
350	0.035	0.057	0.037	0.060	0.10	0.10
390	0.035	0.057	0.037	0.060	0.10	0.10
430	0.035	0.057	0.037	0.060	0.10	0.10
480	0.045	0.067	0.047	0.070	0.12	0.12



Blocking cylinder head on vice.



The oil jets 1 for the lubrication of the cylinder head and the two centring pins 2.



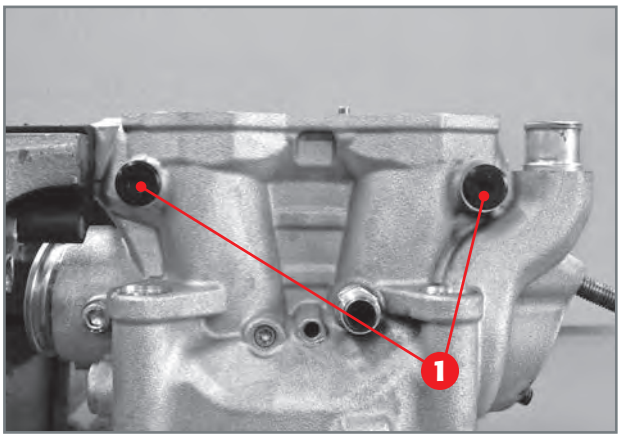
Detail of the lubrication oil jet 1.

3.17.3 CYLINDER HEAD: DISASSEMBLING AND CHECKING AUXILIARY DEVICES

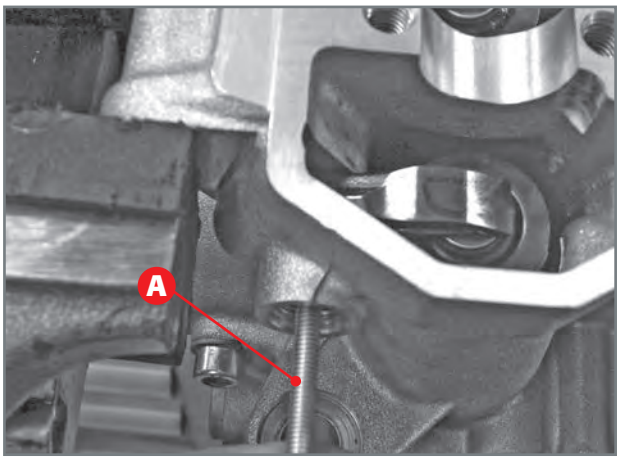
Before disassembling the cylinder head, clean the entire unit thoroughly. The various elements must be cleaned and decontaminated bit by bit as they are disassembled. Proceed as follows for disassembly and inspection of the cylinder head. Clamp the cylinder head using protective jaws, gripping it at the head connection **A**. Disassemble the spark plug using the special spark plug wrench *(code 020440100 000)*.

3.17.3.1 Lubrication jets and centring pins

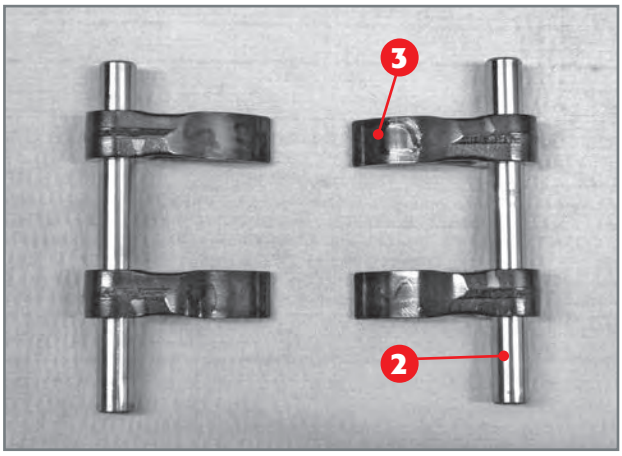
Pull out the two oil jets **1** for lubricating the cylinder head and make sure the holes are free from any impurity. Take off the O-rings. If damaged, replace them.
Pay attention to the two centring pins **2**.



Closing caps for rocker arm support shaft seats.



Application of M4 screw to allow the removal of the rocker arm support shafts.



Rocker arm/shafts unit.

3.17.3.2 Rocker arm/shafts unit

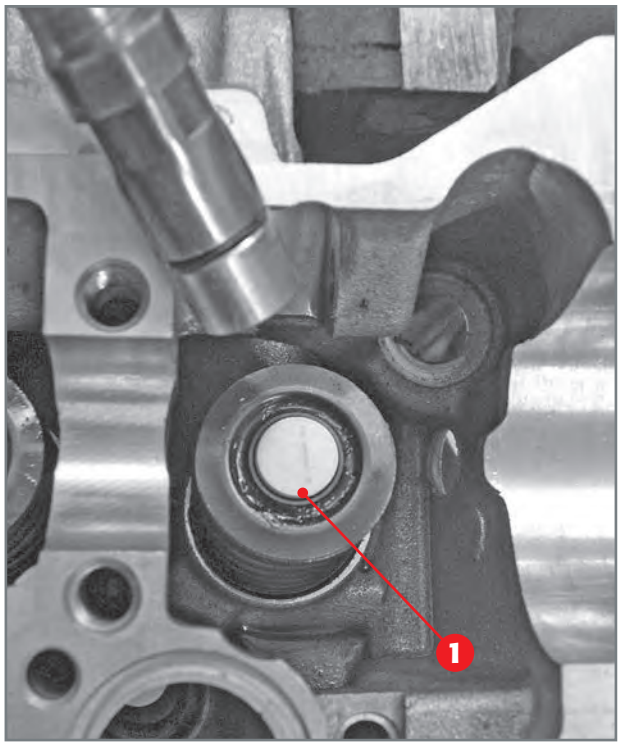
Disassemble the two caps **1** which keep the rocker arm pins in place.
Make sure the face of the cap facing the shaft does not have deep traces or signs of wear. If so, replace the caps.
Check the state of use of the two O-rings between the caps and the cylinder head.

The rocker arm pins have a threaded hole (M4) at the end so that they can be extracted. To pull them out, just screw a sufficiently long M4 screw **A** in this hole and pull out. In this way, the rocker arms can be extracted.

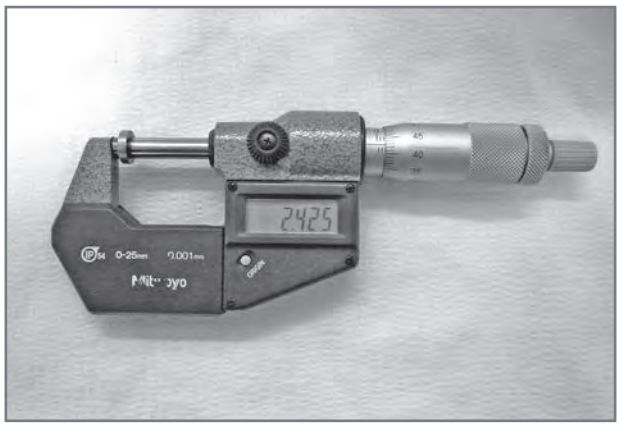
Make sure the outside diameters of the pins **2** and the inside diameters of the holes on the rocker arms **3** respect the following service limits:

Shaft service limit: 6.98mm
Rocker arm service limit: 7.03mm
Play limit: 0.05mm

Check to see that the contact areas between the rocker arm and the calibrated discs, and between the rocker arm and the cams are not chipped or particularly worn. If so, replace the rocker arm.



Removal of calibrated discs from seats.



Calibrated discs measured with a (digital) thickness gauge.

3.17.3.3 Calibrated discs for valve backlash adjustment

Using a magnet, pull out the calibrated discs **1** from the seats in the cups.
Once the calibrated discs are extracted, measure them with a thickness gauge.

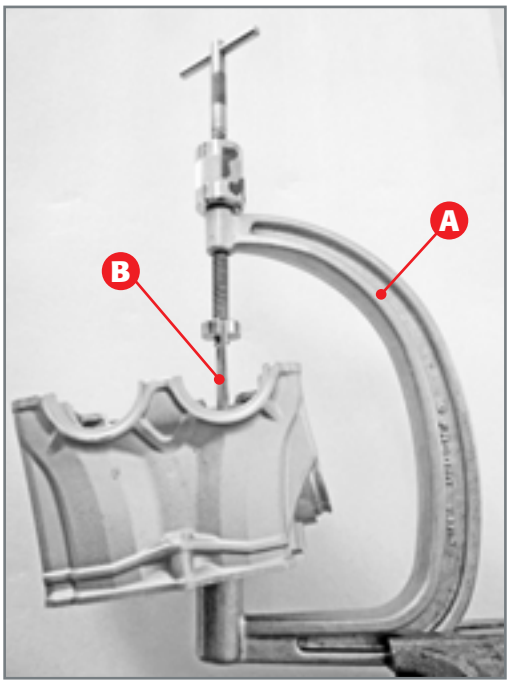
The calibrated discs range from 2.00mm to 3.200 according to the intervals carried in the table below.

Thickness interval[mm]	*Step [mm]*
2.000 ÷ 2.300	*0.050*
2.325 ÷ 3.000	*0.025*
3.050 ÷ 3.200	*0.050*

Once you have done the measurement, take note and mark the calibrated disc depending on its original position.
Should the calibrated discs be deteriorated, replace them with others having the same dimensions. Thus you can know whether to replace it with a thicker or thinner calibrated disc when determining the valve backlash.

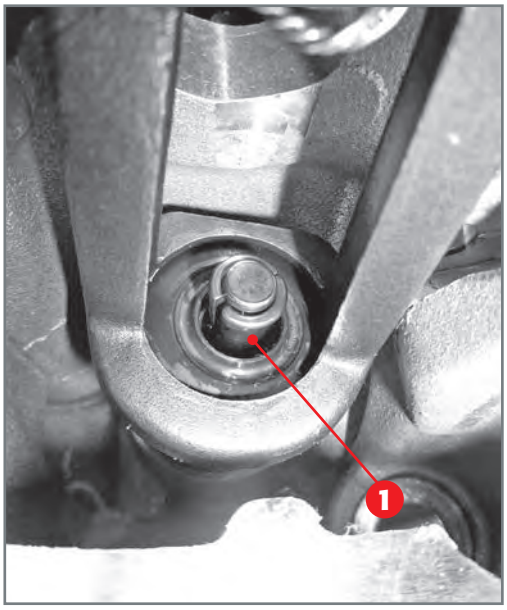
3.17.4 CYLINDER HEAD: DISASSEMBLING AND CHECKING VALVE UNITS

Clamp the spring removal/assembly jaw **A** *(code 0100043 000)* and apply the spring removal/assembly tool onto it **B** *(code 006140030 000)*. Then position the cylinder head and disassemble the springs.



Positioning of cylinder head on device for valve spring disassembly.

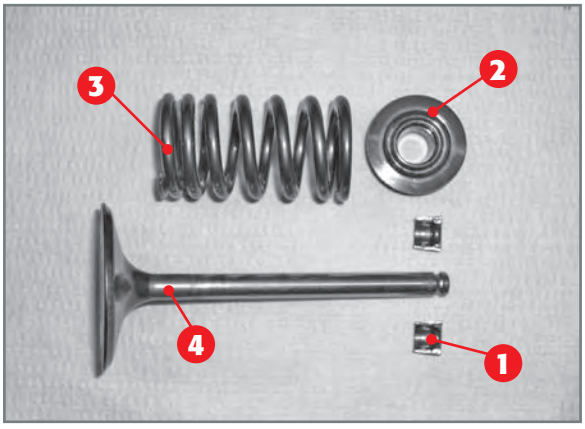
Compress the spring as much as necessary to extract the half-cones **1**.



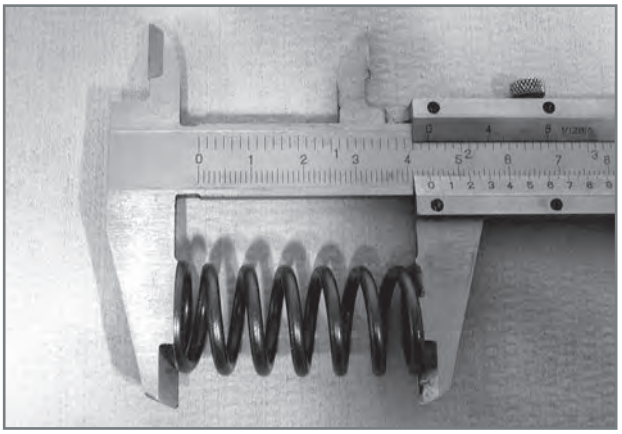
Extraction of half-cones.

After extracting the half-cones, release the spring and extract the cup **2**, the spring **3** and the valve **4**.

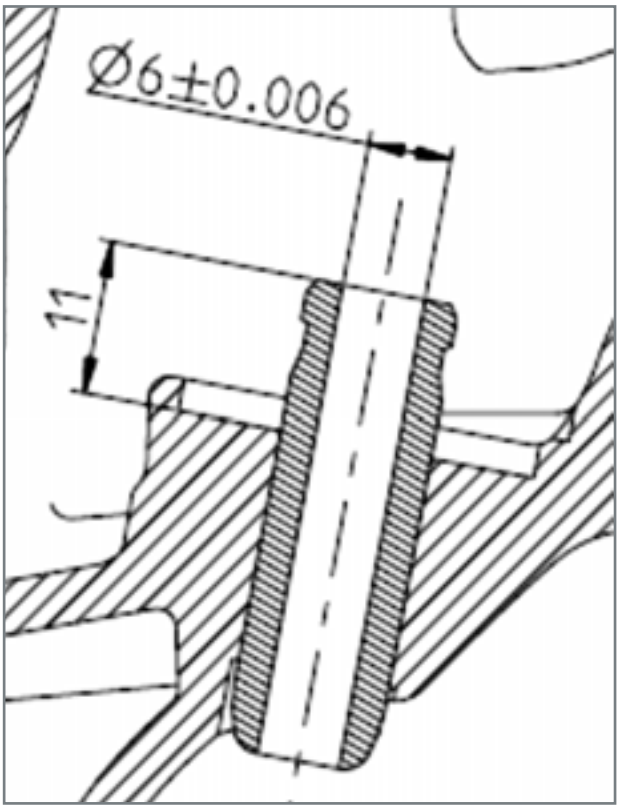
> ***ATTENTION!***
> *Mark all the pieces you disassemble. Pay particular attention to the valves.*



Valve unit.



Measuring length of free spring.



Reference dimensions for processing and fitting the valve guide.

3.17.4.1 Springs

Each valve is retained by a spring. The length of these springs must be checked while they are loose:

service limit = 42 mm

Should the springs be shorter, have them replaced.

3.17.4.2 Valve guides, valves and seats

Make sure that the valve guides are free from scratches or any type of nicks. To check the correct diameter, introduce the gauge in the valve guides from the side of the combustion chamber *code 006140180 000*. If the gauge can enter, the valve guide must be replaced at a rectification workshop.
To this purpose, comply with the data shown in the drawing.
Remember that when replacing the valve guides, the seats of the valves must be repassed as described later on.
Brush the valve mushroom head thoroughly and degrease the entire valve.
Make sure that the valve stems are free from scratches or any type of nicks. Measure the diameter of the valve stems, making sure it is not less than the service limit:

Valve stem diameter service limit: 5.95mm

Otherwise, replace the valve.
Play between the valve and the valve guide must not be greater than the limit carried below:

Play limit between valve and valve guide: 0.08mm

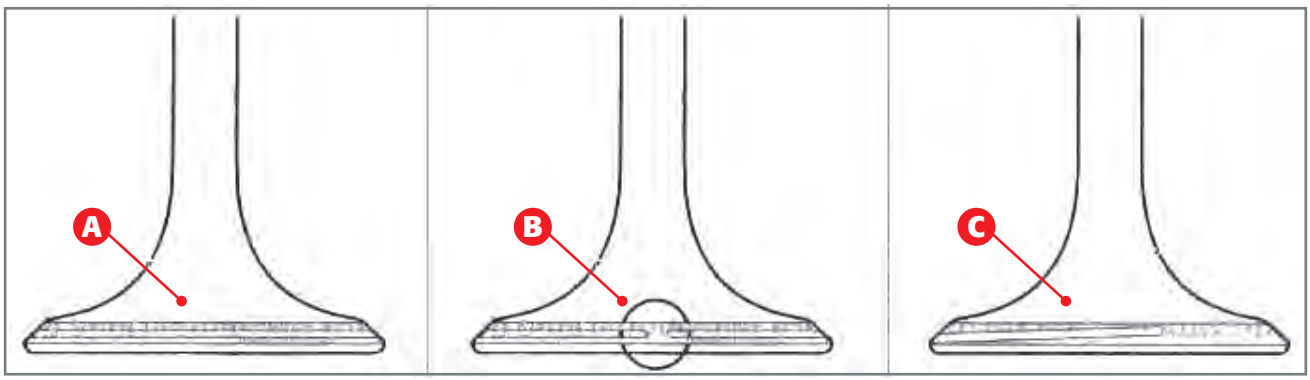
Check that the valve mushroom and seat contact area is not dented: if so, replace the valve.
Check the state of wear of the valve seats and the sealing surface. In order to do this, apply a light layer of Prussian blue paint on the contact zone of the valve with the seat. Then insert the guide valve until you press it against the seat and turn it on its own axis.

Taking the valve out, the paint will be missing in the contact zone. Its width must not be greater than the following service limit:

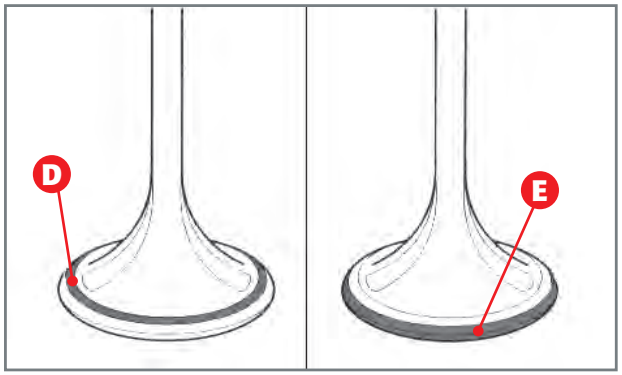
Width service limit of valve seat contact zone: 1.9 mm.

The contact zone can principally take on three different appearances, as shown in the figure:

A - correct;
B- incorrect (contact face damaged);
C - incorrect (uneven seat width).

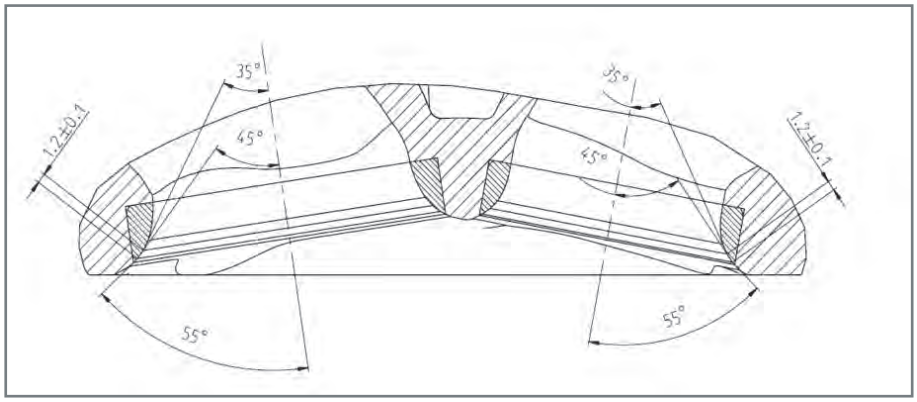


Valve-seat contact conditions: A) Correct; B) Incorrect - contact face damaged-; C) Incorrect - uneven width.



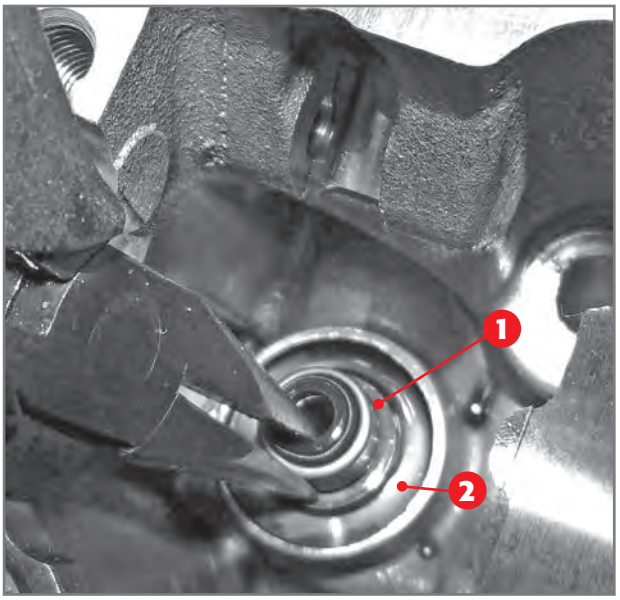
Positioning of contact area: D) too high; E) too low.

Also check the correct positioning of the contact area. It must be neither higher (case **D**) or lower (case **E**).
Should the incorrect conditions described above occur, the valve seats must be rectified, respecting the conditions carried in the following drawing.

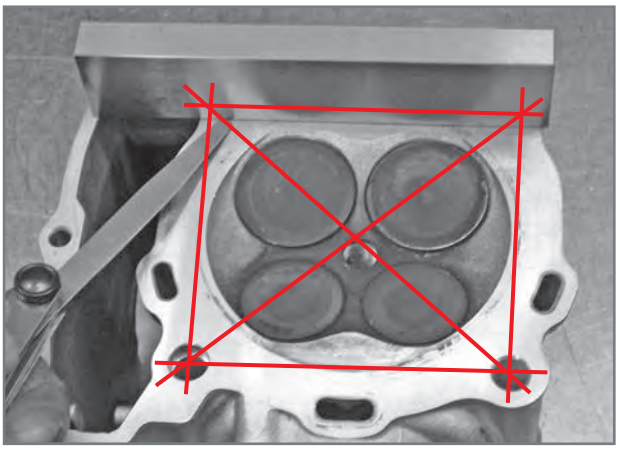


Taking the valve out, the paint will be missing in the contact zone.

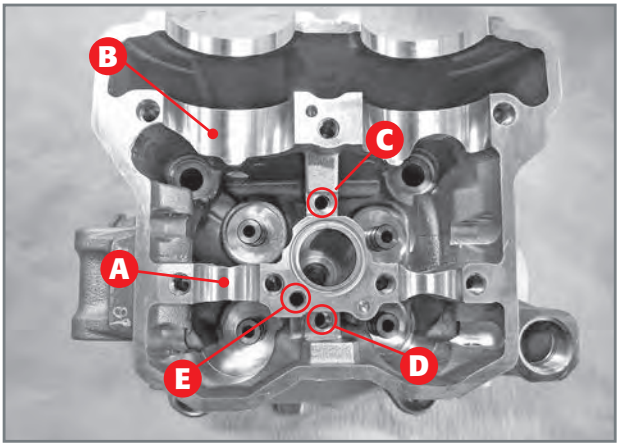
If the valve seats are beyond recovery, replace the cylinder head.



Removal of valve stem oil scraper rings.



Reference dimensions for processing and fitting.



3.17.4.3 Oil-scraper rings and lower cup

Should there be excessive oil consumption or a white-like exhaust smoke which cannot be blamed on the oil-scraper bands on the piston, replace the oil-scraper rings **1**, intended to prevent excess oil leakage.
It is recommended to replace them every time the cylinder head is overhauled.
In order to replace them, use needle-nose pliers to pull them out, being careful not to nick the valve guide.
Once the oil-scraper ring is extracted, the lower cup can be pulled out **2**.

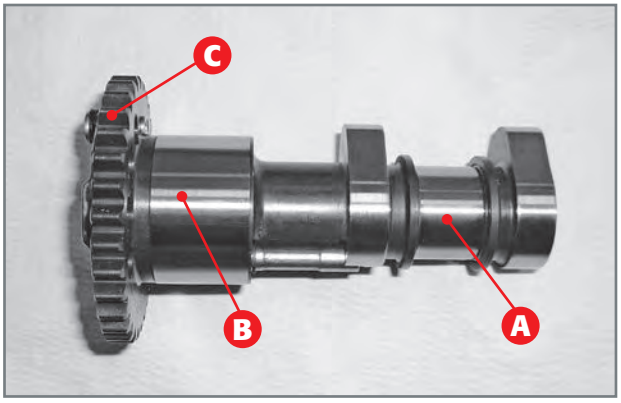
3.17.5 CYLINDER HEAD: CHECKING THE CYLINDER HEAD BODY

Check the flatness between the head and cylinder coupling surfaces.
This can be done with a rectified block and a thickness gauge by positioning the block according to the directions shown in the figure.
The service limit is as follows:

cylinder head service limit: 0.05mm

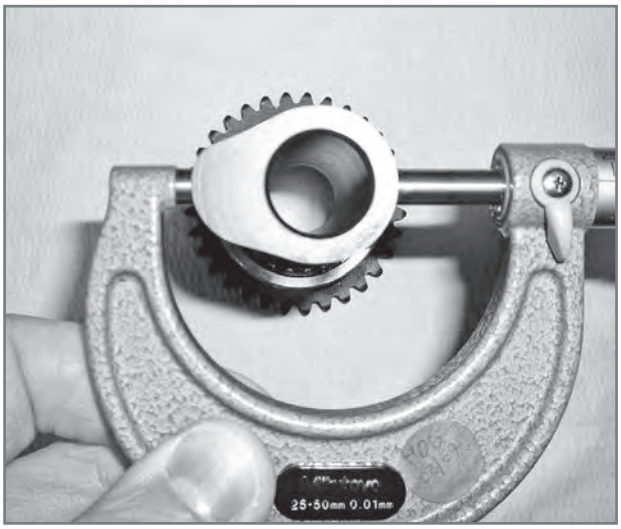
Check that the state of use of the sliding zones **A** with the camshafts and **B** of the camshaft support bearing housing are free of scratches or signs of meshing.
Clean the oil passages for lubricating the cylinder head by blowing compressed air into the holes **C**, **D** and **E**.

3.17.6 CHECKING THE CAMSHAFTS



Cam zones to be checked.

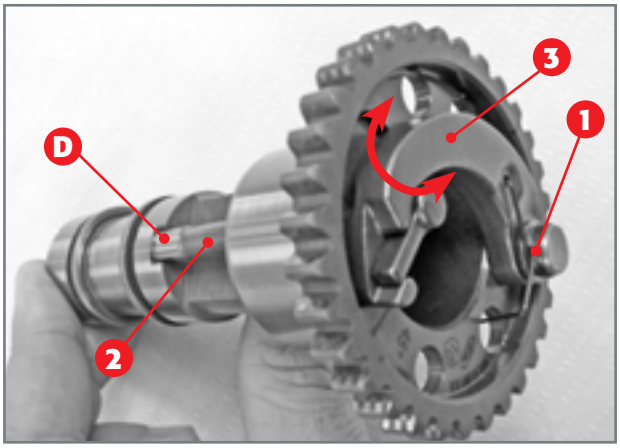
Verify the zones **A** and **B** on the camshafts making sure they have no traces of meshing or abnormal wear. Make sure the sides of the teeth **C** are not chipped or have no trace of abnormal wear.
The zone **A** comes into contact with the cylinder head becoming part of a hydrodynamic support bearing. Zone **B** on the other hand supports the roller bearing.



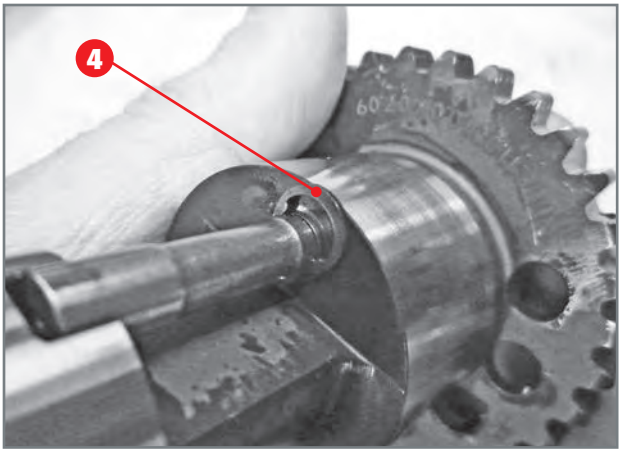
Cam height measurement.

Make sure that the shafts in the cam zones are free of abnormal colouring which is typical when working without oil.
Use a thickness gauge to check the wear limit of the cams referring to the values carried in the table.
Sometimes the cams can be scratched and this can be accepted, provided that the profile is within the envisaged limits of wear.

	Intake		Exhaust	
.	Nominal size [mm]	Limit size [mm]	Nominal size [mm]	Limit size [mm]
350 - 390	34.1	34.0	33.75	33.65
430	34.1	34.0	33.4	33.3
480	33.75	33.65	33.4	33.3



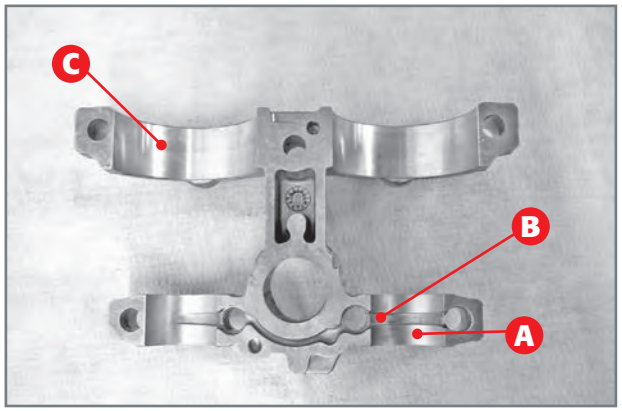
Check on the exhaust camshaft that the spring **1** of the centrifugal decompressor recalls the rest of the device so that the cylinder segment **D** of the rod **2** protrudes completely without any play.
Turn the lever **3** all the way to make sure the device is not jammed.
Make sure that the cylinder segment **D** of the decompressor is not worn or chipped.
Should it be deteriorated, replace the decompressor shaft.



Extraction of Benzing ring from decompressor shaft.

In order to extract it, remove the Benzing ring **4** and pull the shaft out. Operate inversely to reassemble it. When replacing the decompressor shaft, replace the Benzing ring as well.

3.17.7 CHECKING THE CAMSHAFT BEARING BRIDGES

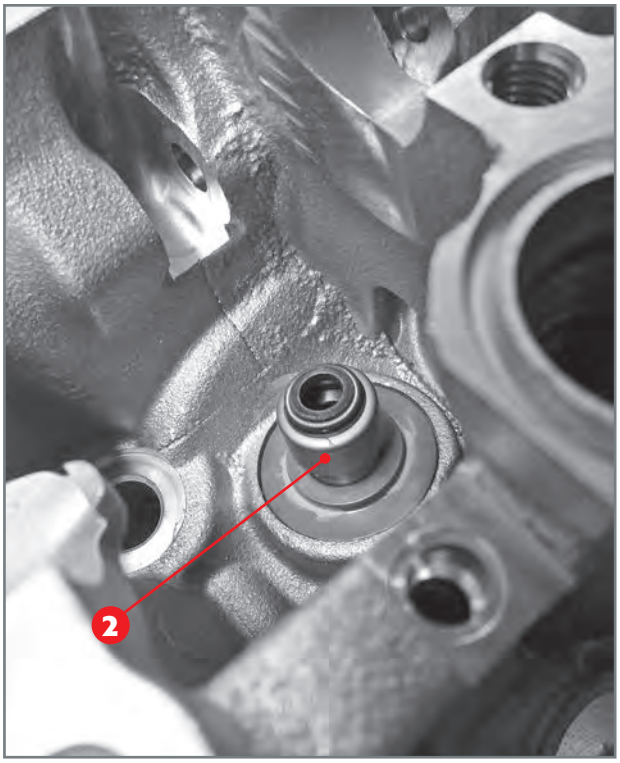


The camshafts supports fasten the shafts so that they maintain the correct position while operating. The support in the zone **A** has a channel **B** intended to lubricate the camshaft to allow the hydrodynamic support of the shaft itself. Therefore, make sure that the zones **A** are free from scratches or traces of corrosion.
Make sure the zones **C** for housing the roller bearings have no traces of meshing or scratches.

WARNING!
If the support needs to be replaced, the cylinder head must be replaced as well.



Insertion of lower cup.

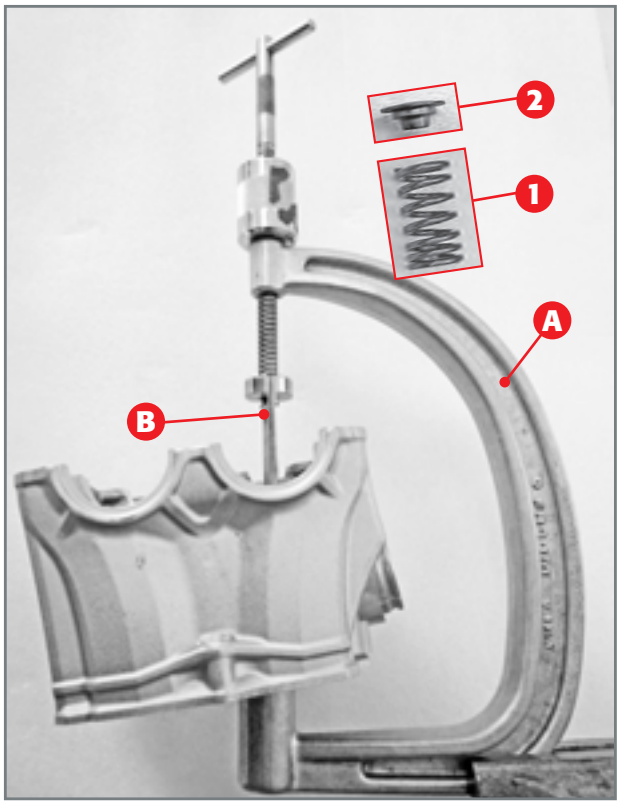


Insertion of oil-scraper ring.

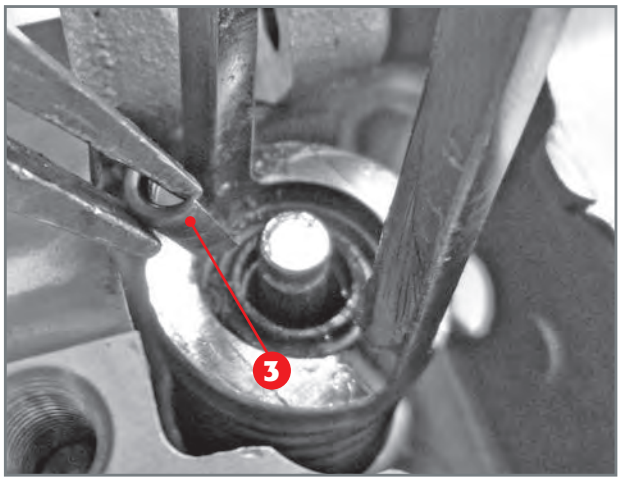
3.17.8 CYLINDER HEAD: INSERTION OF LOWER CUP AND OIL-SCRAPER RING

If the lower cups and oil-scraper rings were disassembled*, reassemble them as follows.
First insert the lower cup **1** facing the flat part downwards. Lubricate the upper part of the valve guide lightly and insert the oil-scraper ring **2**. Pay close attention that while inserting the valve stem seal, its axis is aligned with that of the valve guide. The oil-scraper ring must be pressed towards the bottom of the cylinder head until it is flush with the valve guide.

** Remember the valve stem seals must be replaced once they have been taken off.*



Positioning of cylinder head on device for valve spring disassembly/assembly.



Spring compression, half-cones insertion. Insertion of valve stem seal.

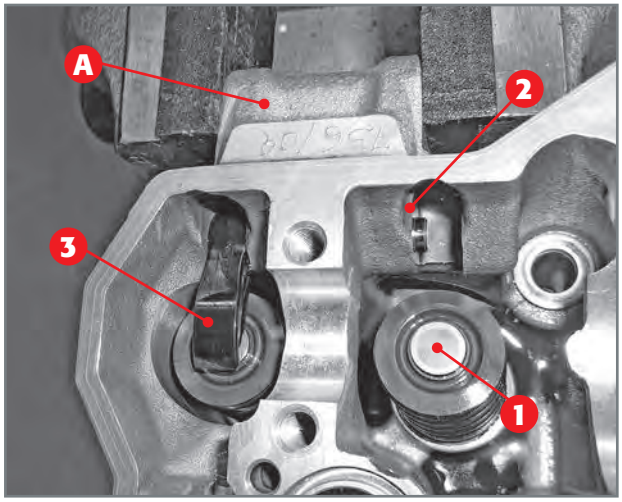
3.17.9 CYLINDER HEAD: ASSEMBLY OF VALVE UNIT

Clamp the spring removal/assembly jaw **A** *(code 0100043 000)* and apply the spring removal/assembly tool onto it **B** *(code 006140030 000)*.
Insert the valve stem in the valve guide* from the combustion chamber side.
Place the valve in the specific lower housing of the jaw and insert:

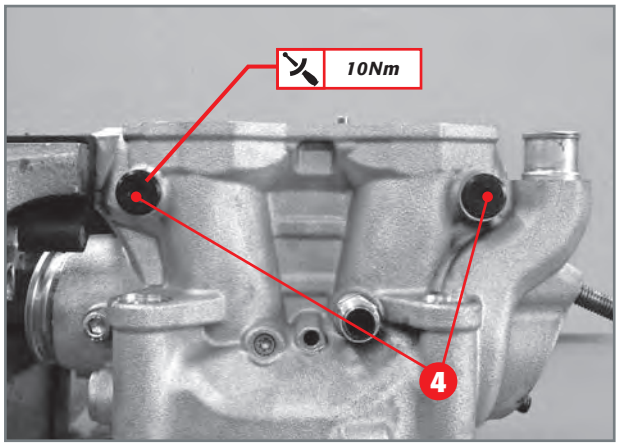
- The spring **1**, being careful to insert it so that the segment with the smaller pitch faces downwards;
- The upper cup **2**, turning the flatter part upwards.

Compress the spring as much as necessary to extract the two half-cones **3**. To facilitate their insertion, apply a small amount of grease on the stem in the half-cone housing zone.

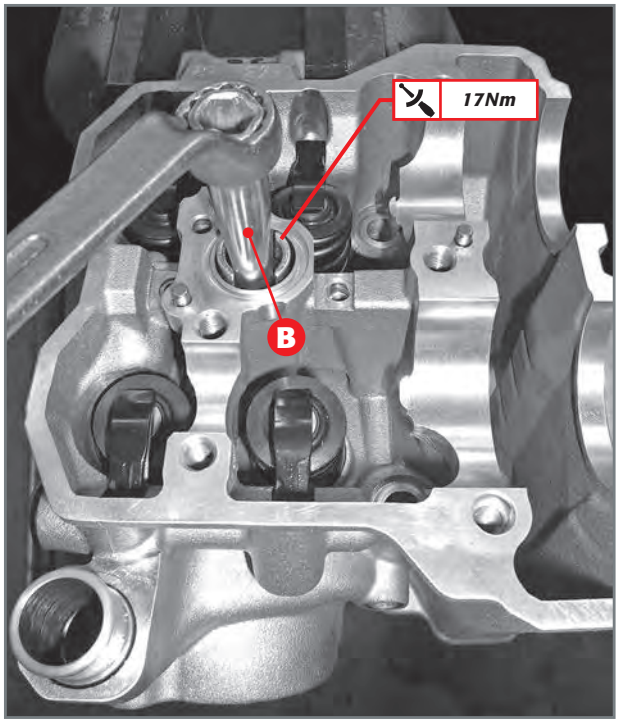
** If the valves, valves guides and their seats have not been replaced, the valves must be put back in their original positions.*



Insertion of pin 1, external rocker arm 2.



Application of two rocker arm pin caps.

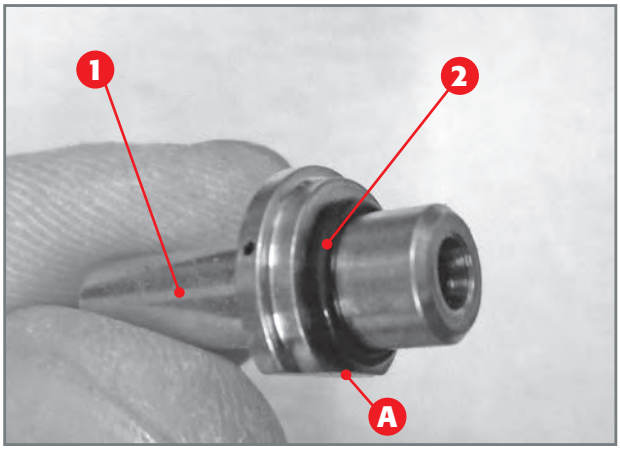


3.17.10 CYLINDER HEAD: REPOSITIONING CALIBRATED DISCS. ASSEMBLING ROCKER ARM PINS AND ROCKER ARMS AND COUPLING THE SPARK PLUG

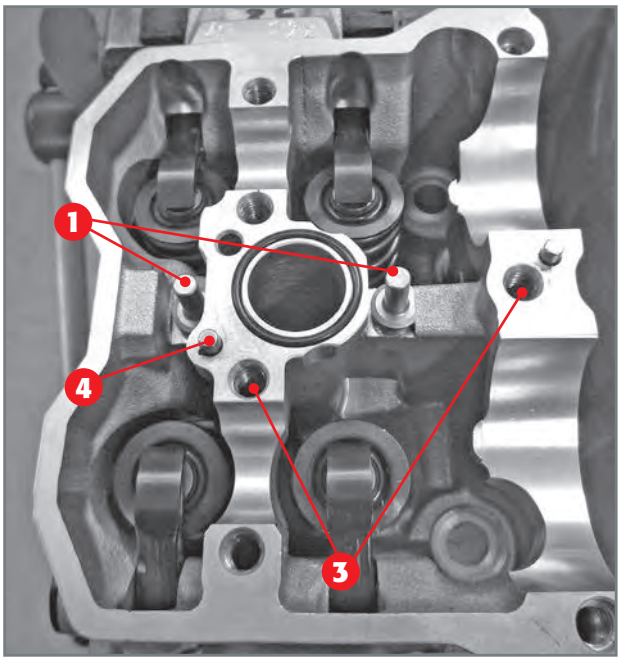
Clamp the cylinder head using protective jaws, gripping it at the head connection **A**.
Put the calibrated discs **1**back in place in their original positions (if not deteriorated see par . 2.17.3.3).
Insert the rocker arm shaft **2** partly in the specific seat as much as needed to be able to insert the outermost rocker arm **3** into the cylinder head first. Having fastened the outermost rocker arm to the shaft, push the shaft further until it reaches the seat of the innermost rocker arm. Having coupled the innermost rocker arm to the shaft, push it all the way into the cylinder head.

Couple the two caps **4** with the O-rings to the cylinder head. They must be tightened to the indicated torque.

Apply the spark plug on the special wrench **B** *(code 020440100 000)*, introduce the unit in the specific housing and tighten to the indicated torque.



Oil jet with O-ring. Note flat reference area A on the side of the jet.



Overhead view of complete cylinder head.

3.17.11 CYLINDER HEAD: INSERTION OF OIL JETS, CENTRING PINS AND SPARK PLUG O-RING

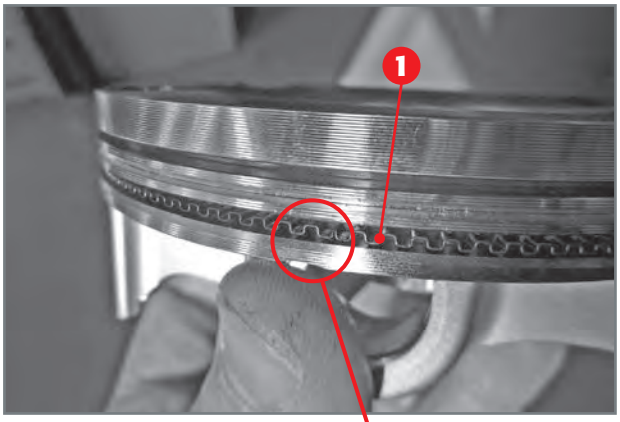
Insert the oil jets **1** with the O-rings **2** in their specific seats on the cylinder head.

The positioning of the jets **A** is univocal thanks to the specific flat side.
If the centring pins **3** have been removed, put them back in place on the cylinder head. Apply the spark plug housing sealing O-ring **4** between the cylinder head and the camshaft bearing bridge.

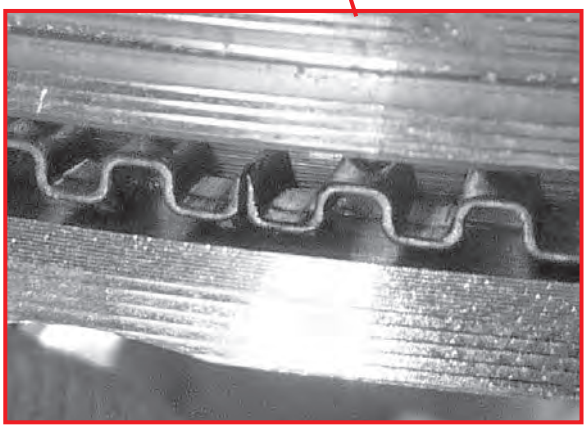
3.17.12 PISTON: APPLICATION OF THE OIL-SCRAPER AND SEAL BANDS, APPLICATION OF THE CIRCLIP

3.17.12.1 Piston: application of the oil-scraper and seal bands

Oil the segment seats abundantly and apply the central oil-scraper band in the lower seat of the piston **1**, paying close attention that the two ends face one another but do NOT overlap.
The two ends must be aligned in axis with the pin bolt.

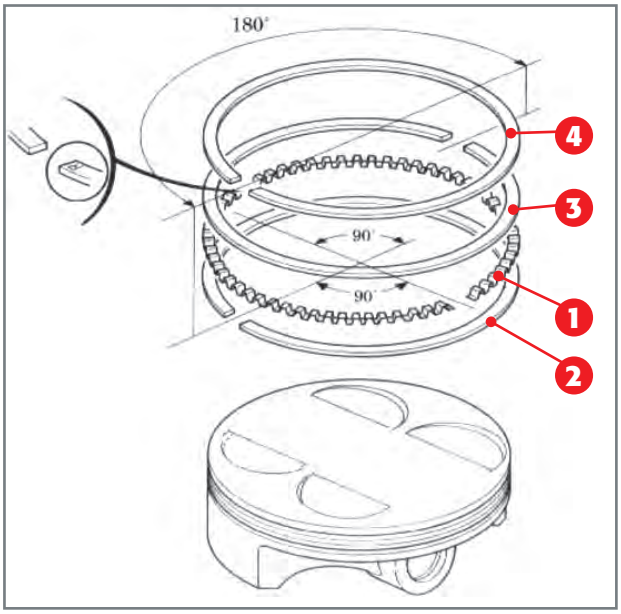


Application of the central oil-scraper band.

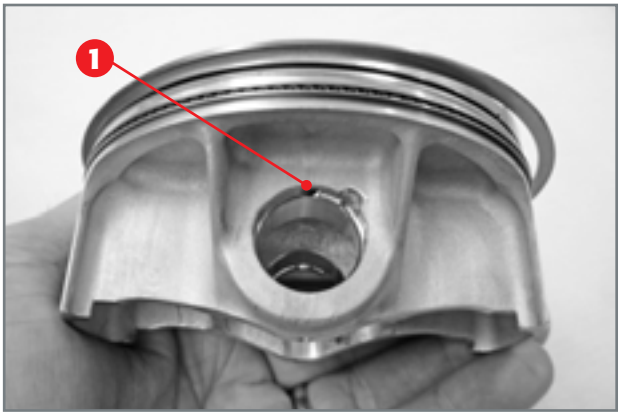


Detail of positioning of two edges.

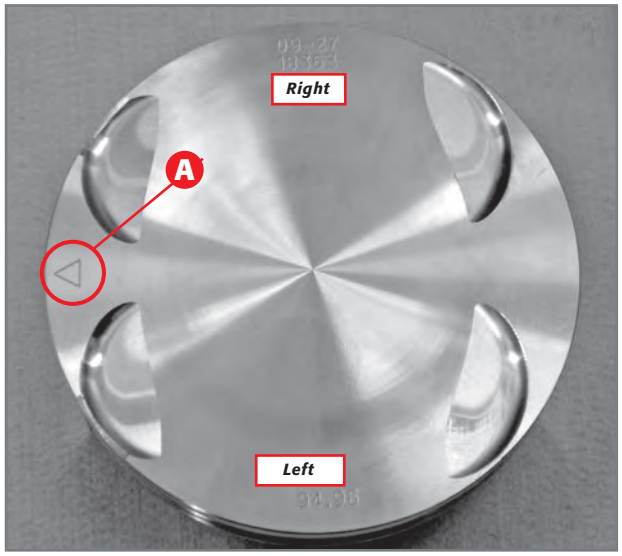
Apply the two lower **2** and upper oil-scraper rings **3** and then the seal band **4**.
The two oil-scraper rings must be placed so that their openings face the higher segment of the skirt and at 180° to each other. Assembly of the seal band **4** must be done keeping the reference (letter or number) facing upwards and the opening must face the same way as the opening of the lower oil-scraper ring **2**.



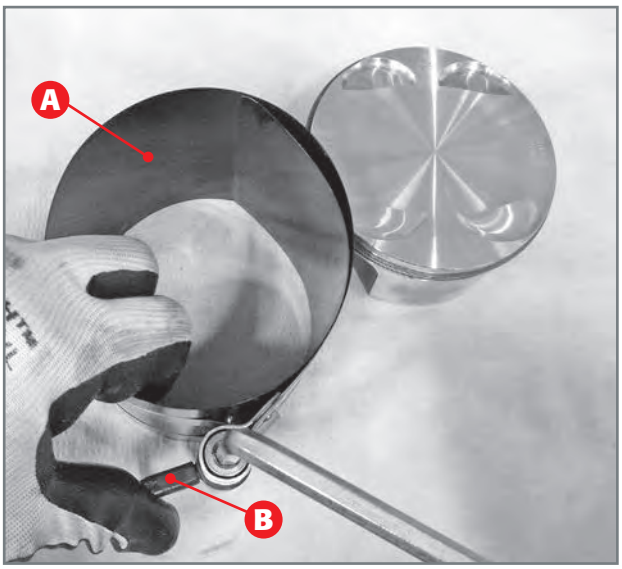
Application of piston segments.



Application of circlip 1 to piston.



Identification of piston right and left side.



Preparation of elastic friction band A.

3.17.12.2 Piston: circlip application

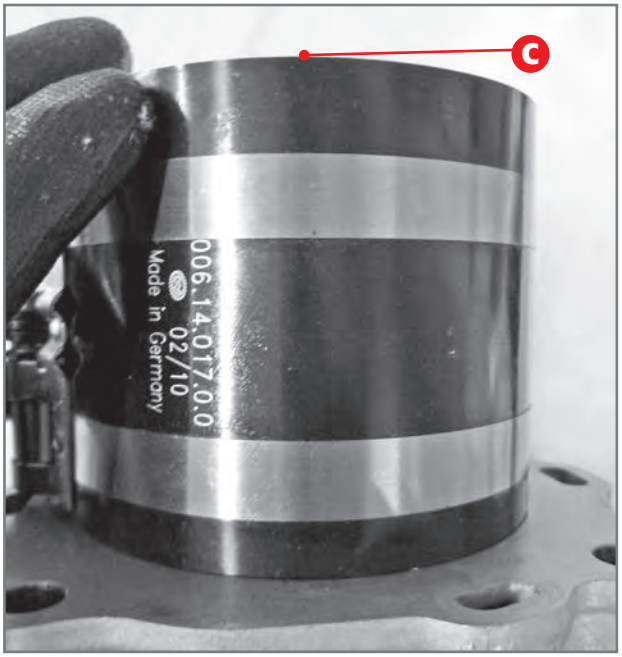
Generously lubricate the seats for the pin bolt with motor oil and the circlip **1** in the left pin bolt seat, being careful to position it so that the lug on the circlip inserts itself in the specific seat on the piston.

In order to identify the right and left side of the piston, as a reference just use the arrow **A** stamped on the piston crown which must face the exhaust manifold.

3.17.13 APPLICATION OF PISTON TO CYLINDER

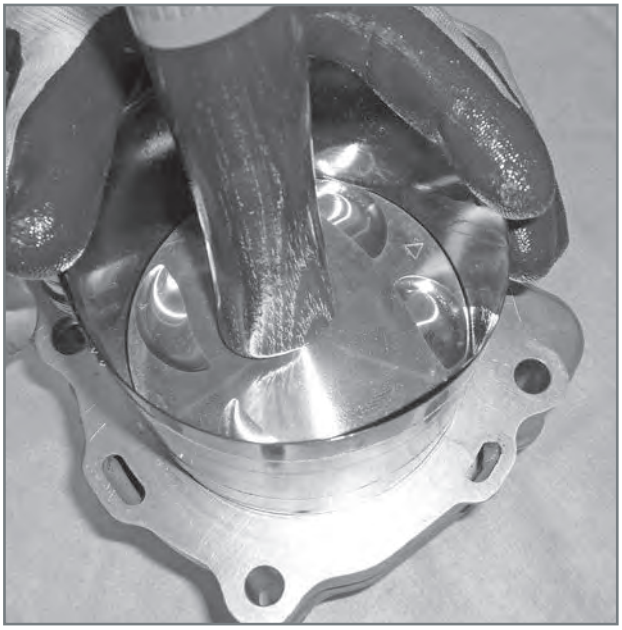
To couple the piston to the cylinder, place the cylinder while keeping the top facing upwards. Oil the cylinder with plenty of motor oil.
Prepare the elastic friction band **A** *(code 006140170000)* as shown in the figure.
Press the green locking lever **B** and turn the hex key anti-clockwise until the band reaches a dimension similar to that of the piston. Oil the inside of the band abundantly and insert the piston with all its segments inside of it. Press the green locking lever again and turn the hex key clockwise to tighten the segments and piston well.

ATTENTION!
The elastic band has edges which could be sharp. Be very careful when handling it.



Application of the complete piston band on cylinder.

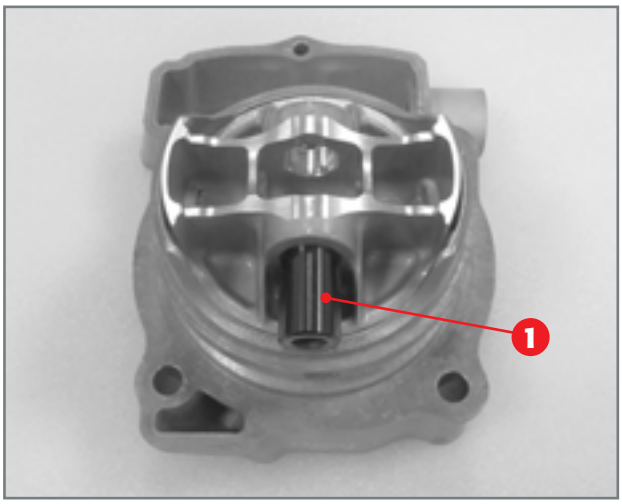
Press the piston downwards having the higher segment of the skirt protrude a bit from the band. Rest the unit on the cylinder, making sure that the contact zones of the band rest correctly on the cylinder surface. For this purpose, make sure that the upper edge **C** of the band is perfectly aligned with the contact surface of the cylinder.
Note: When positioning the complete band-piston unit on the cylinder, be careful to place them so that the arrow stamped on the crown of the piston faces the exhaust manifold.



Insertion of piston into the cylinder.

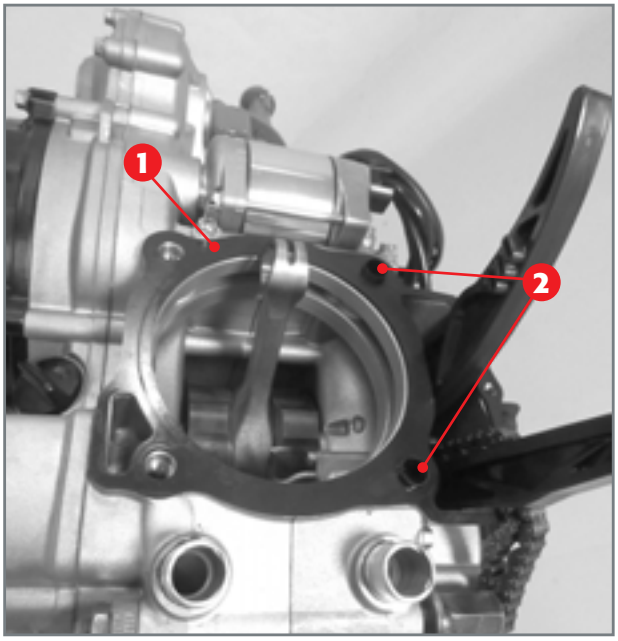
Holding the band firm with one hand, push the piston inside the cylinder, making sure that the axis of the piston is aligned with that of the cylinder. Towards the end of insertion it might be necessary to use the wooden handle of a hammer or a similar tool to lightly tap the piston crown in order to facilitate its complete insertion in the cylinder.

ATTENTION!
During the whole operation, hold the band firm with one hand without moving it. Make sure that the segments insert themselves correctly in the cylinder when passing through the band. Should there be excessive resistance when inserting the piston into the cylinder, do not insist in order not to deteriorate the parts: assess the cause.



Application of pin bolt to piston.

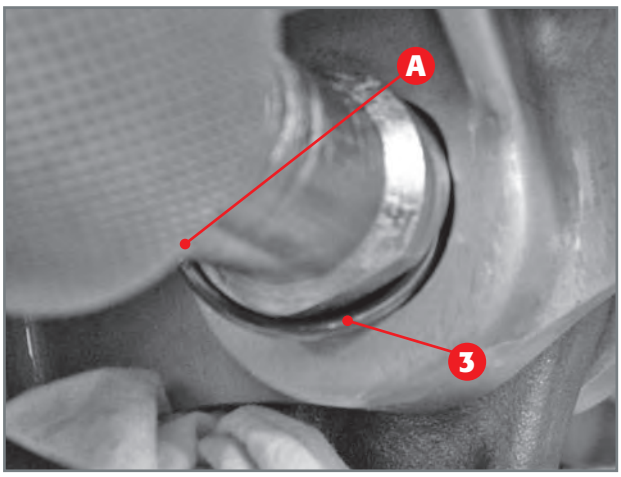
When the piston has been inserted into the cylinder and the band has been removed, press the piston towards the bottom of the cylinder so that the pin bolt seats come out from the lower edge. Apply the pin bolt **1** into the right-hand seat as much as needed to allow it to be coupled with the connecting rod.



Application of cylinder/crankcase gasket and of centring bushes.



Passing the chain through the cylinder.



Circlip insertion.

3.17.14 APPLICATION OF PISTON-CYLINDER COUPLING TO CRANKCASE

Apply a new piston-cylinder gasket **1** to the crankcase and couple the two centring bushes to the left crankcase **2**.
Lubricate the foot of the connecting rod abundantly with motor oil.

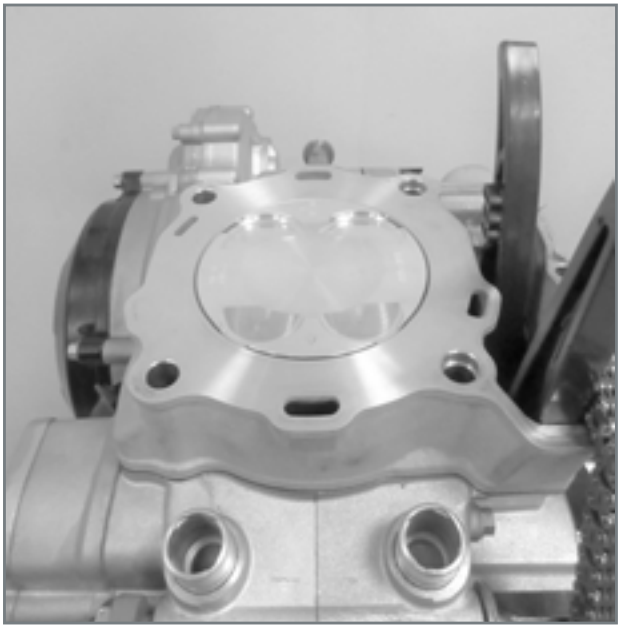
Displacement [cm³]	*Cylinder/crankcase gasket thickness [mm]*	*Quantity*
350 - 390	*0,5*	*1*
430	*0,3*	*1*
480	*0,3*	*2*

Insert the timing chain in the proper compartment in the cylinder and bring the piston/cylinder unit close to the connecting rod.
Once the pin bolt reaches its housing in the foot of the connecting rod, push the pin bolt inside until it is inserted all the way. It may be helpful to use an aluminium cylinder (or similar tool) during this phase.

ATTENTION!
The elastic band has edges which could be sharp. Be very careful when handling it.

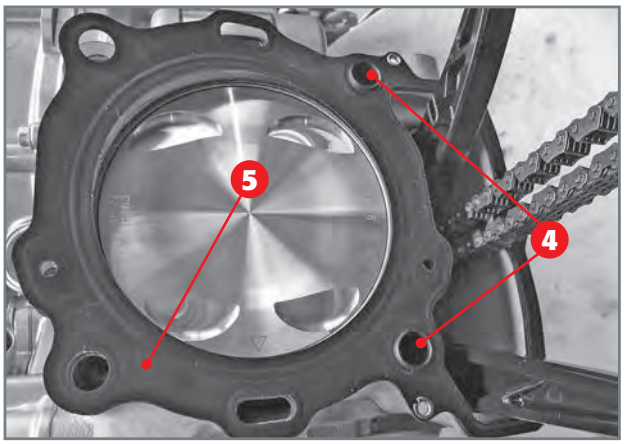
Apply the lug to the circlip **3** in the pin bolt seat. Insert the cylindrical part of the special tool **A** into the pin bolt and, having one of the two flat surfaces of the tool coincide with the part of the circlip to be inserted, turn and push the special tool towards the engine until the circlip is fully inserted into a seat.

Once the operation is complete, remove the previously inserted cloth.



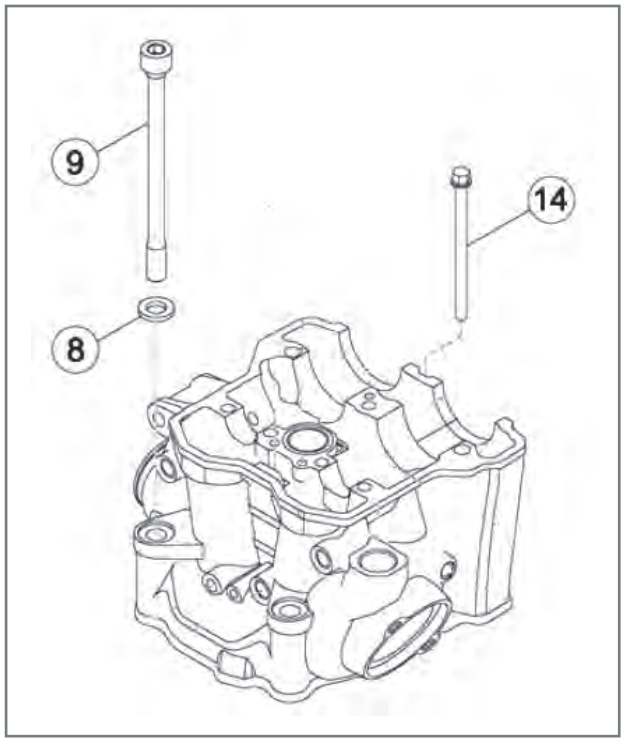
Coupling cylinder to crankcase.

Push the cylinder towards the crankcase making sure the two centring bushes on the left crankcase are correctly inserted in the seats in the lower part of the cylinder.

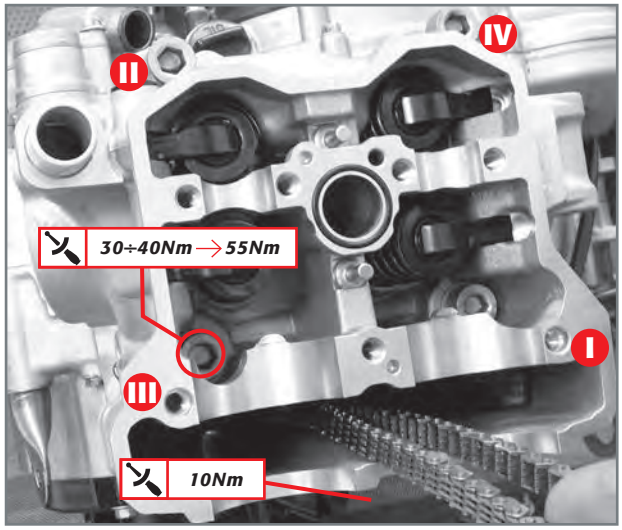


Application of guide bushes 4 and gasket 5 to cylinder.

Apply to the cylinder the two guide bushes **4** and the gasket **5** coupling with the cylinder head.



Application of components for coupling the head and cylinder to crankcase.

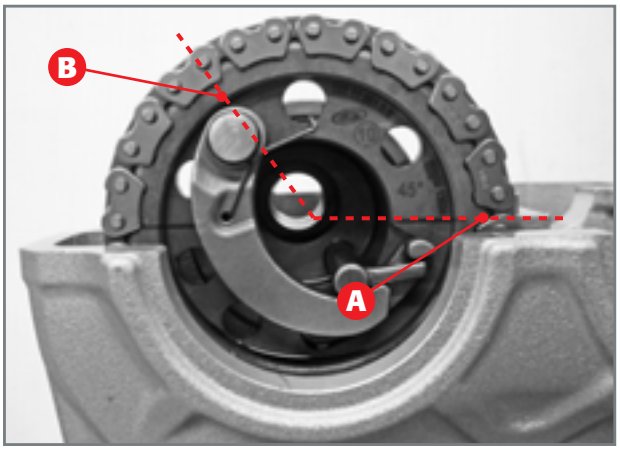


Tightening order of screws coupling the head and cylinder to crankcase.

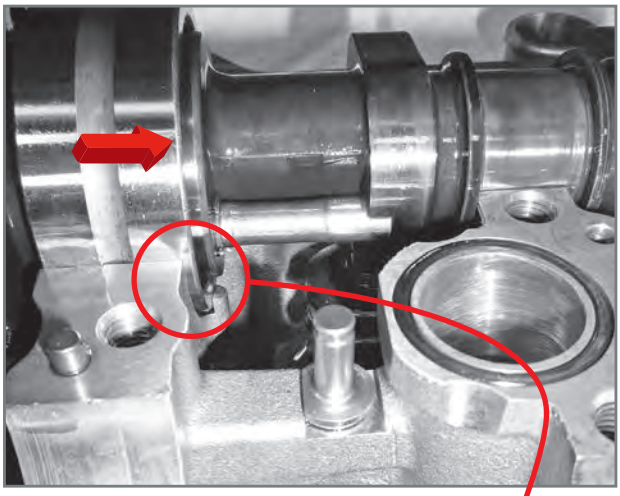
3.17.15 COUPLING HEAD TO CYLINDER

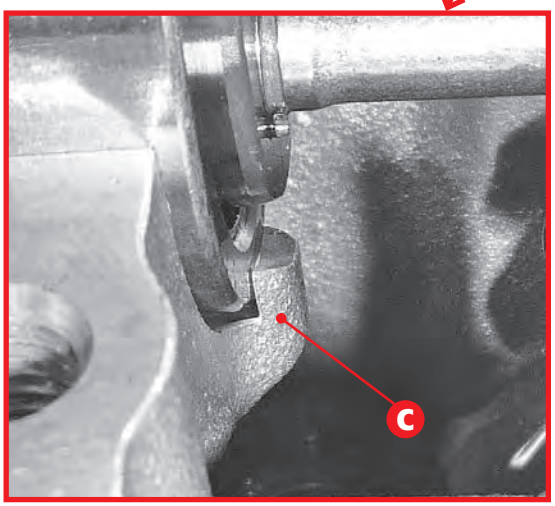
Introduce the timing chain in the compartment on the cylinder head. Keeping the chain tight, place the head on the gasket making sure it inserts perfectly into the two centring bushes on the cylinder.
Lubricate the four washers **8** and insert them into their specific seats on the outside and inside of the cylinder head. Then insert the four M10x1.25 screws **9** - after having lubricated them- and the M6x80 screw **14** which connect the head and cylinder to the crankcase.

Tighten the four screws in two stages following a criss-cross pattern and starting with one of the two screws inside the head.
The first tightening can be done at 30÷40Nm, while the second and last one is fixed at 55Nm.
The screw **14** must be tightened to the indicated torque. Keep the chain lifted so that it does not fall inside the chain compartment.



Positioning camshaft.


Positioning camshaft bearing.

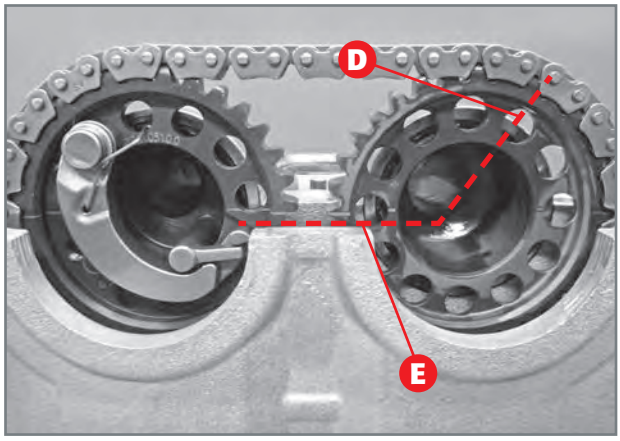


Detail of positioning bearing against shoulder C.

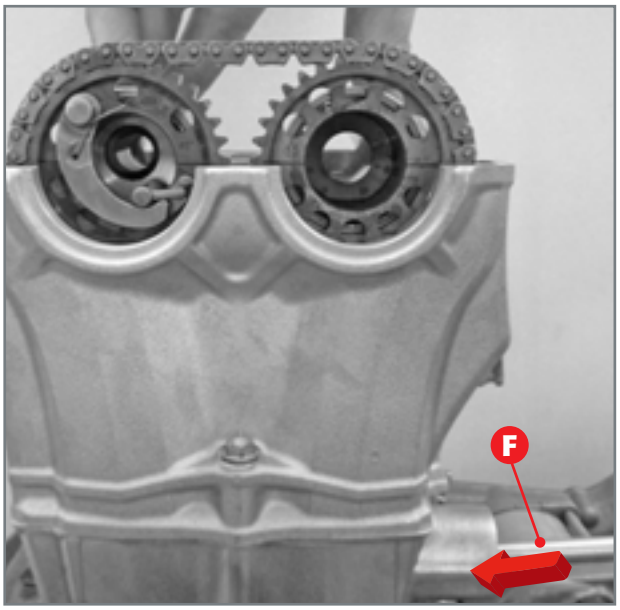
3.17.16 COUPLING CAMSHAFTS TO CYLINDER HEAD AND PHASING

Couple the bearings to the camshafts and lubricate them with motor oil.
Widening the timing chain, insert the exhaust camshaft upon whose gearwheel the timing chain must be placed. It is advisable already in this phase to position the shaft so that the reference notches **A** are horizontal with the cams facing upwards according to the approximate direction **B**.

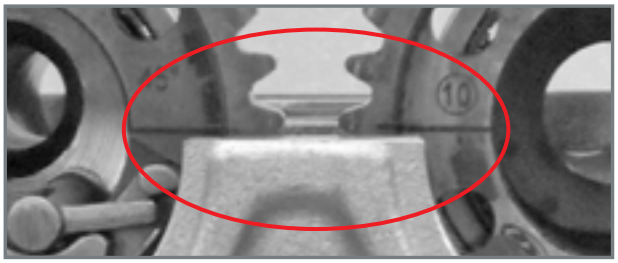
Lift the camshaft slightly and move the bearing so that it is flush with the shoulder **C**.
Having carried out the above-mentioned positioning, rest the camshaft on the cylinder head.



Application of components for coupling cylinder head



Phasing check. Note the pressure that the cylinder F exerts on the chain.



Detail of correct alignment of engraved notches on gearwheels of camshafts.

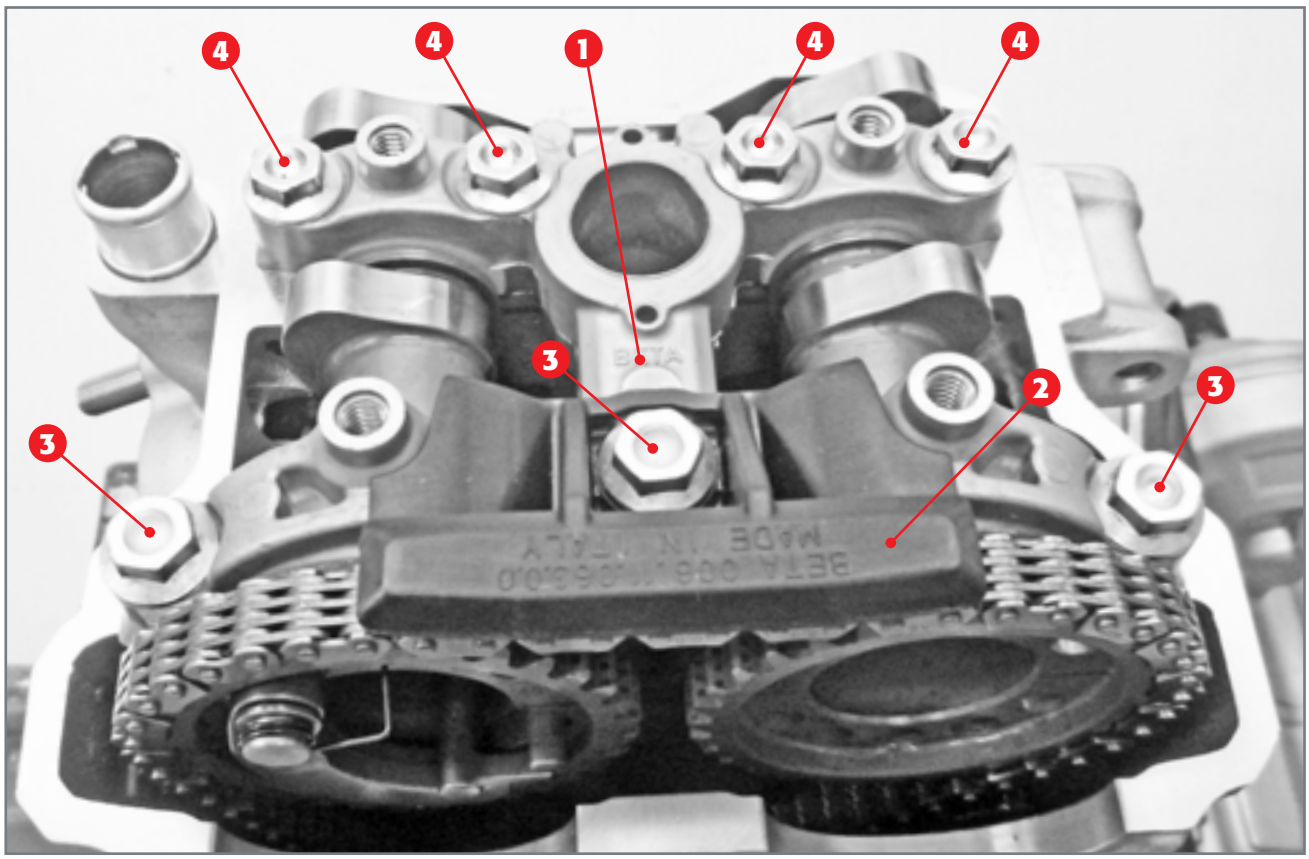
Lift the chain again and insert the intake camshaft placing the chain on the gearwheel. Place the shaft so that the cams face upwards according to the approximate direction **D** and the references **E** carved on the gear are horizontal.
Position the bearing in the same way as for the exhaust camshaft.

Holding the camshaft still with one hand, insert an aluminium cylinder **F** in the housing of the hydraulic tensioner as far as needed to be able to push the movable guide against the timing chain. Make sure that the notches engraved on the two gearwheels are aligned one with the other. If so, the phasing is correct. If not, release the cylinder **F**, lift the timing chain so that the gearwheels disengage allowing the needed rotation to obtain correct phasing.
Having checked phasing, extract the cylinder **F**.

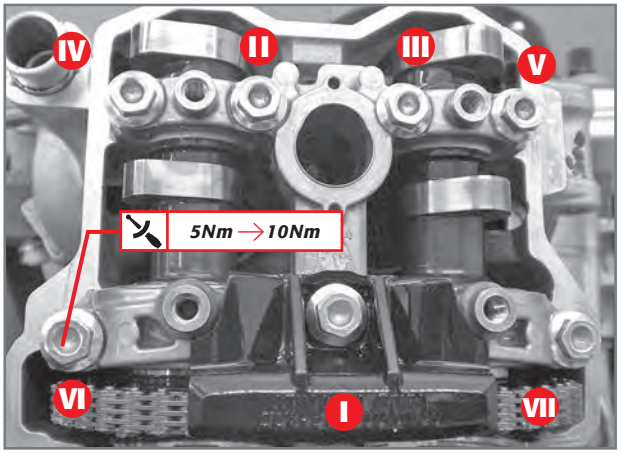
Lubricate the entire camshaft unit with motor oil and apply the support **1**, making sure it is perfectly engaged both on the shafts and on the centring pins.

WARNING!
Make sure that pins, oil jets and O-rings are present, as detailed in par. 3.17.11

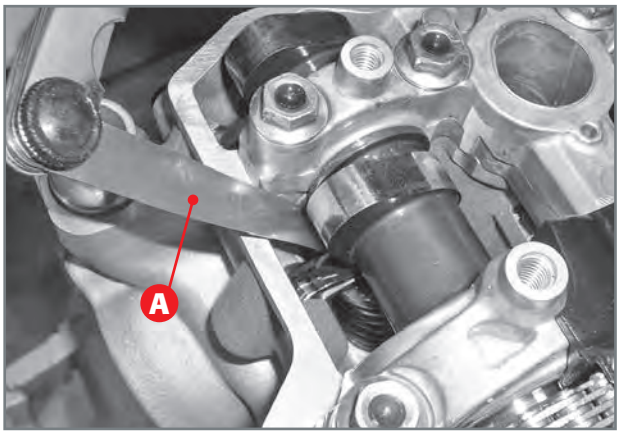
Apply the fixed pad **2** and insert the three M7x38 screws **3** in the holes on the chain side and the four M7x33 screws **4** in the four remaining holes.



Application of camshaft bearing bridge 1, fixed pad 2, three M7x38 screws 3 and four M7x33 screws 4.



Tightening order of camshaft bearing bridge screws.



Checking valve backlash with thickness gauge.

Tighten the seven screws by hand until they are flush.
Check the correct position of the camshaft bearings as described on page 138.
Proceed with tightening in two moments, following the order indicated in the figure.
Carry out the first tightening operation at a torque of 5Nm and the second at 10Nm. At the end of this operation, make sure the camshaft moves freely.

3.17.17 VALVE BACKLASH

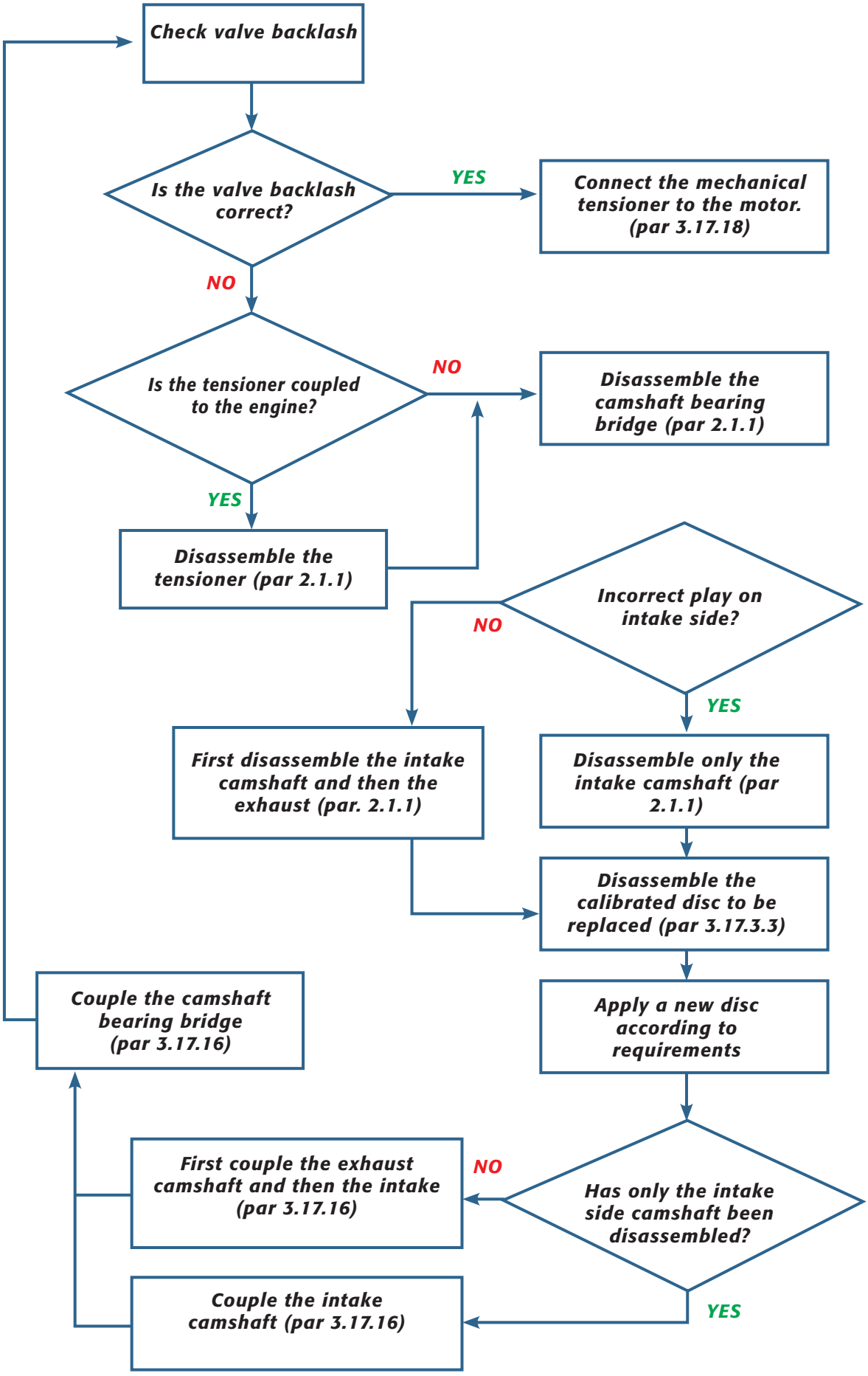
Checking for valve backlash must be carried out by placing a thickness gauge **A** *(code 006140210000)* in between the cam and the rocker arm. This control can be done even without the hydraulic tensioner coupled to the engine.

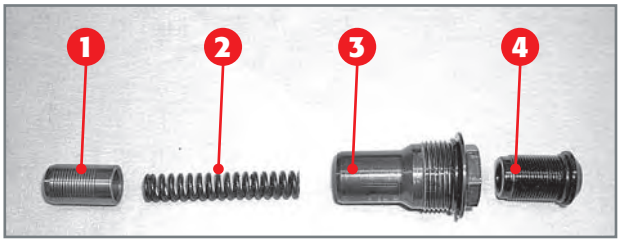
ATTENTION!
The piston must be positioned at the Top Dead Centre (par. 3.7)! Following the order of this text, this position is already fixed.

Play must be within the values carried on the table below.

Side	Minimum [mm]	Maximum [mm]
Intake	0.10	0.175
Exhaust	0.125	0.20

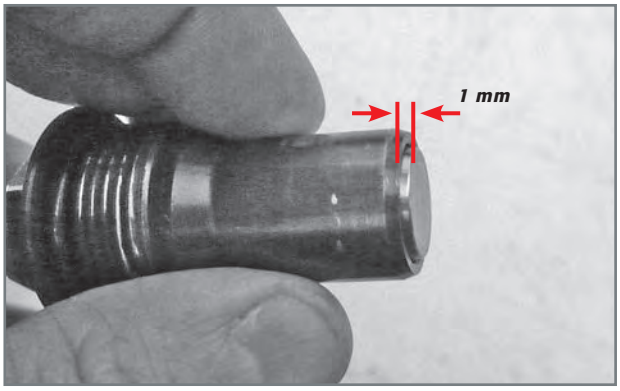
If the play measured is greater than that indicated, the calibrated disc must be replaced with a thicker one. On the contrary, if the valve backlash is less than that indicated, replace the calibrated disc with a thinner one.
The value of the needed thickness can easily be assessed by calculating the difference between the detected play value and the one required.
The following is a layout for calibrated disc replacement.


Check valve backlash
Is the valve backlash correct?
YES
Connect the mechanical tensioner to the motor. (par 3.17.18)
NO
Is the tensioner coupled to the engine?
NO
Disassemble the camshaft bearing bridge (par 2.1.1)
YES
Disassemble the tensioner (par 2.1.1)
Incorrect play on intake side?
NO
YES
First disassemble the intake camshaft and then the exhaust (par. 2.1.1)
Disassemble only the intake camshaft (par 2.1.1)
Disassemble the calibrated disc to be replaced (par 3.17.3.3)
Apply a new disc according to requirements
Couple the camshaft bearing bridge (par 3.17.16)
First couple the exhaust camshaft and then the intake (par 3.17.16)
NO
Has only the intake side camshaft been disassembled?
YES
Couple the intake camshaft (par 3.17.16)

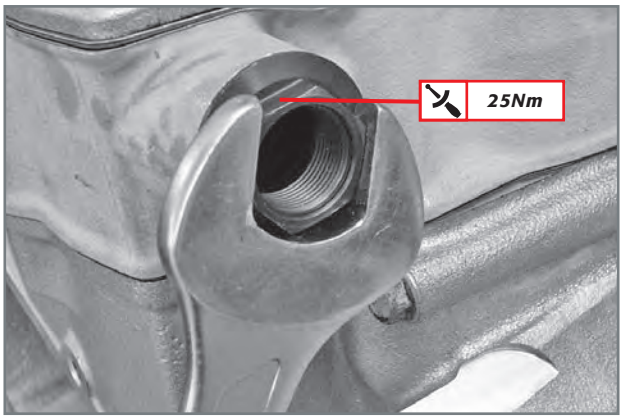


3.17.18 CHECKING AND COUPLING OF MECHANICAL TENSIONER TO ENGINE

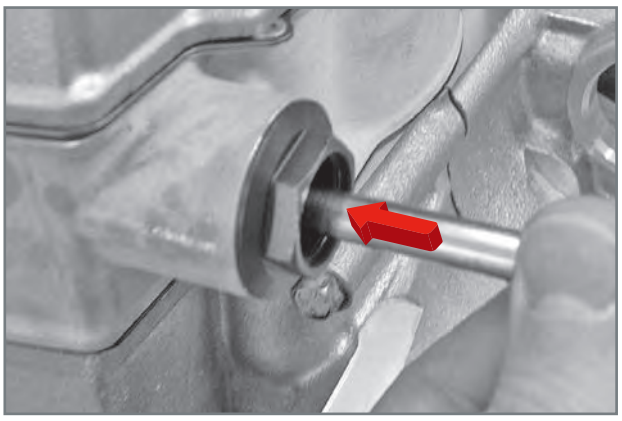
The mechanical tensioner consists of:
1. a piston;
2. a spring;
3. a support;
4. a cap.

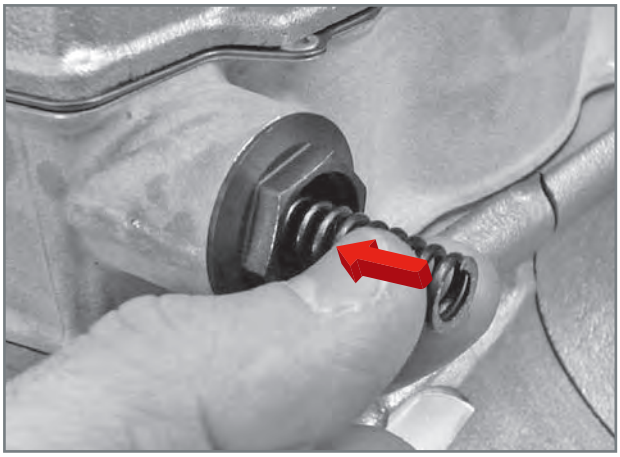


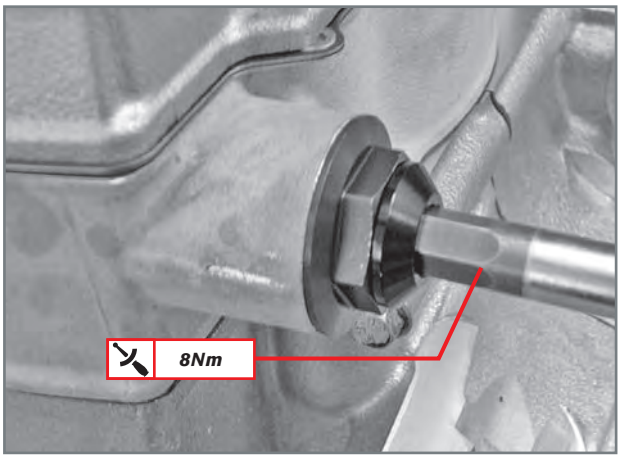
Make sure the piston shows no signs of abnormal meshing.
Check that the length of the spring is not lower than the following limit value:
Spring limit length: 74mm
Insert the piston into the support and push it until it sticks out of the edge of the support by approximately 1 millimetre.



Insert the tensioner support in the specific seat on the cylinder, tightening it to the indicated torque and push the piston towards the front of the engine.

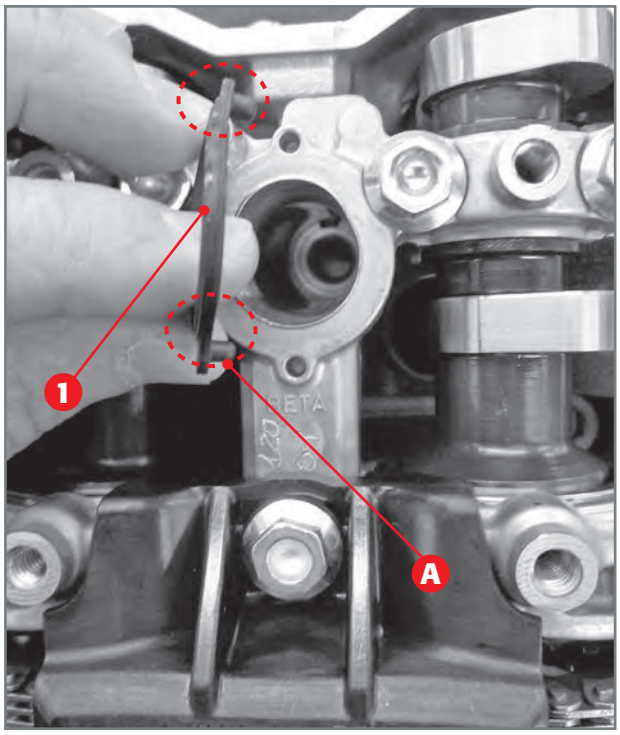






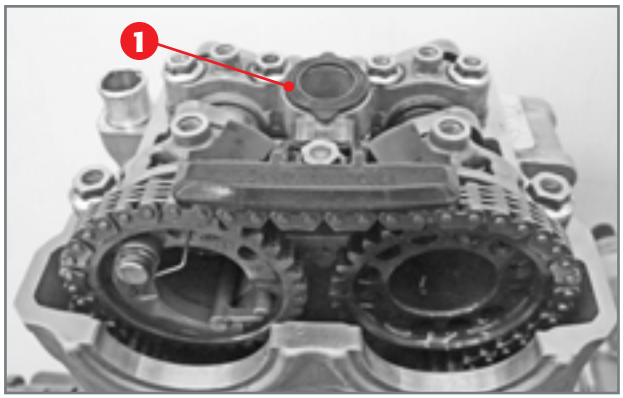
Insert the spring in the support and apply the cap to be tightened to the indicated torque.

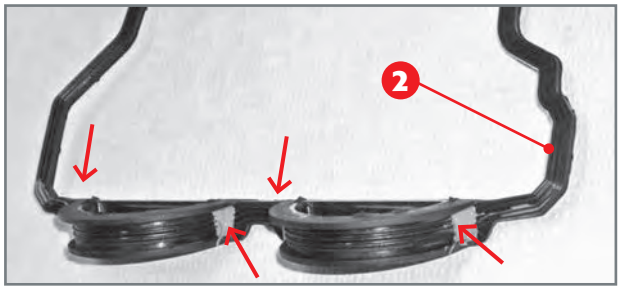
3.17.19 COUPLING CYLINDER HEAD COVER GASKETS AND CYLINDER HEAD COVER



Application of spark plug gasket.

Apply the spark plug gasket **1** to the camshaft bearing bridge inserting the two pegs **A** in the specific seats and positioning it so that it recopies the shape on the support.



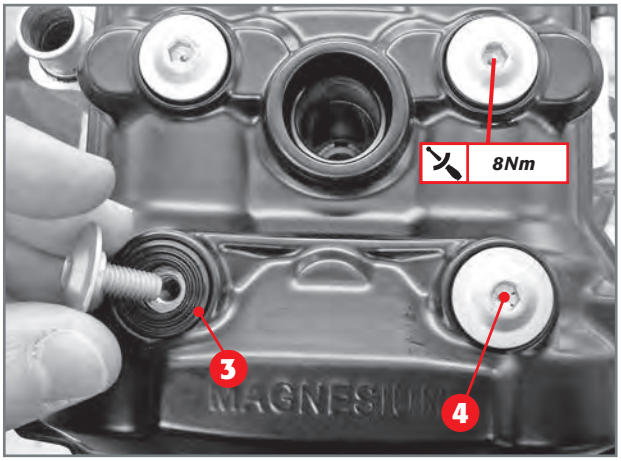


Edges where the gasket paste must be applied.

Apply a few drops of gasket paste in the edges of the cylinder head cover gasket **2**.

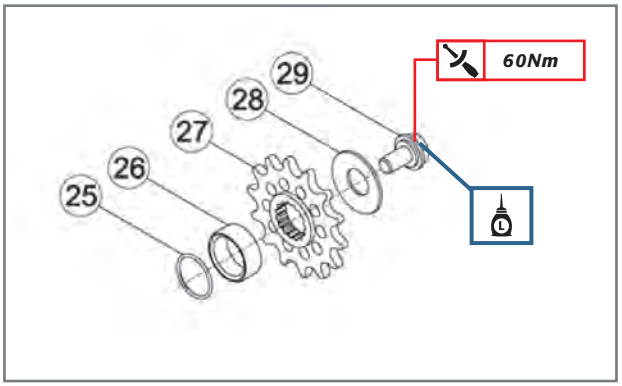

Insertion of gasket in groove on cylinder head cover.

Insert the gasket in the cylinder head cover so that the protruding part fits perfectly into the groove in the cover.



Application of rubber rings 3 and fixing screws 4.

Place the complete cover on the cylinder head making sure that the gasket covers the surface correctly.
Apply the four rubber rings **3** to the cover and insert the four screws **4** which fasten the cover to the cylinder head. Tighten the screws in a criss-cross pattern to the indicated torque.

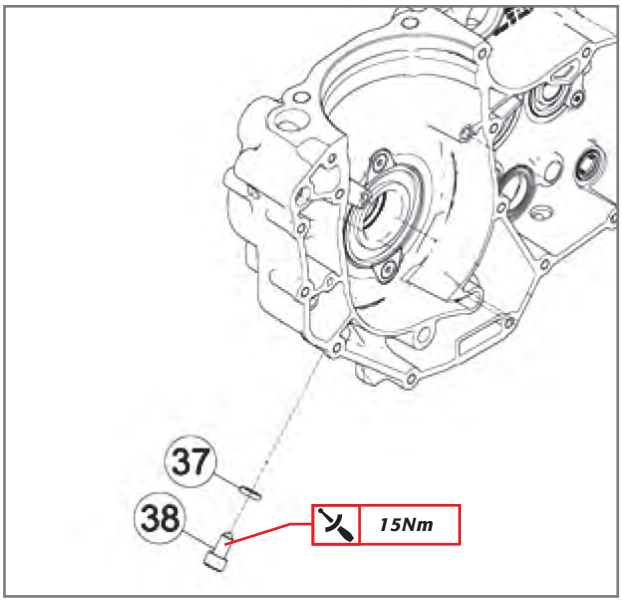


Exploded view of pinion unit. 25) O-ring 25x12x1.78; 26) Spacer 27) Pinion; 28) Washer; 29) Screw.

3.18 PINION COUPLING

If the O-ring **25**is not coupled with the secondary shaft (par. 3.5) insert it followed by the spacer **26**.
Then apply the pinion **27**, the washer **28** and the screw **29** which must be spread with medium strength threadlocker: tighten to the specified torque.

ATTENTION!
Do not use pneumatic devices!

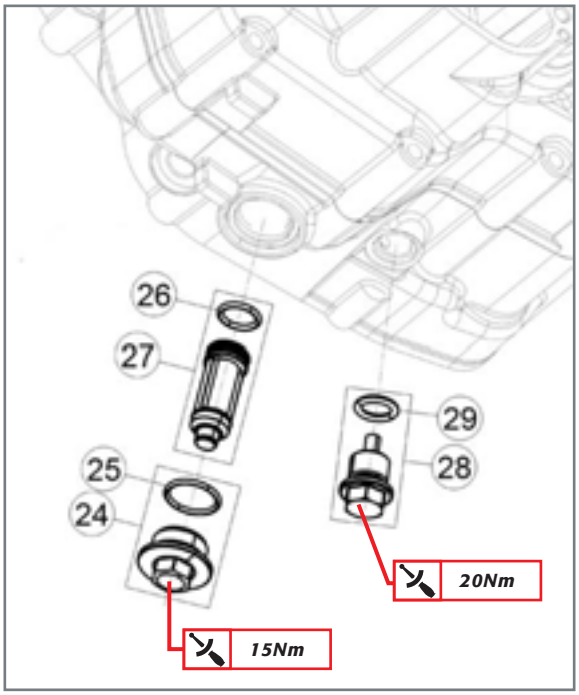


3.19 RELEASING THE CRANKSHAFT

Remember that according to the order of this text, the crankshaft is blocked at the Top Dead Centre. Its release occurs by removing the screw **38** (or the special tool code *006.14.011.0.000*). In case the special tool is used, replace it with the screw **38** and apply the copper washer **37** to said screw. Therefore reapply the screw-washer unit, tightened to the specified torque.

3.20 COUPLING OIL CAPS

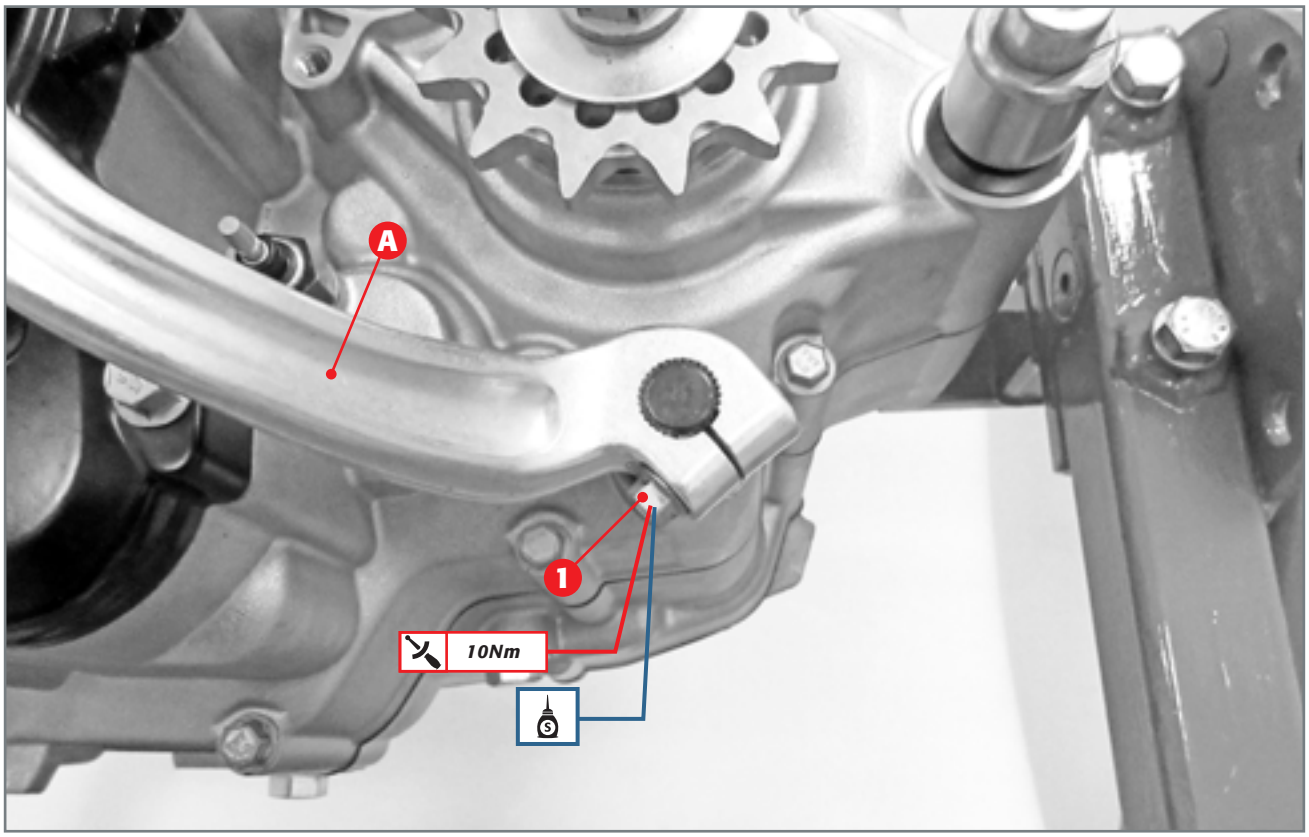
Couple the engine oil drain plug **24** in the lower part of the right crankcase half, complete with O-ring **25**, with wire metal filter **27** and O-ring **26**. Tighten to the specified torque.
Apply the magnetic screw **28** with the O-ring **29** to the gear oil drain hole: tighten to the indicated toque.



EXPLODED VIEW OF OIL DRAIN CAPS.
24) Motor oil drain plug;
25) 27x2 O-ring;
26) 20x1.5 O-ring;
27) Metal filter;
28) Magnetic screw;
29) 11x2.5 O-ring.

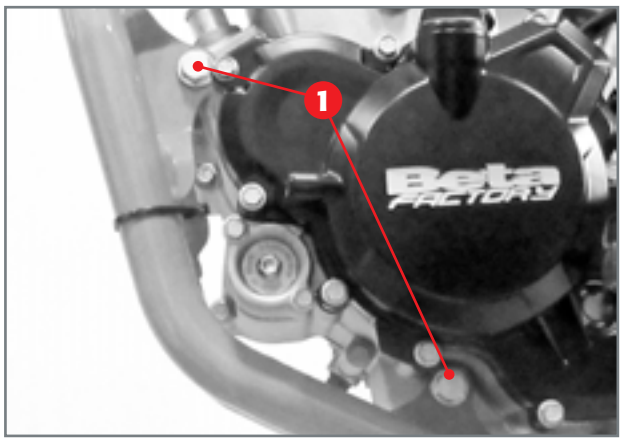
3.21 COUPLING GEARSHIFT LEVER

Couple the gearshift lever to the drive shaft by positioning it so that the part **A** of the lever coincides with the upper edge of the oil level inspection window.
Tighten the screw **1** to the specified torque after having applied medium strength threadlocker.



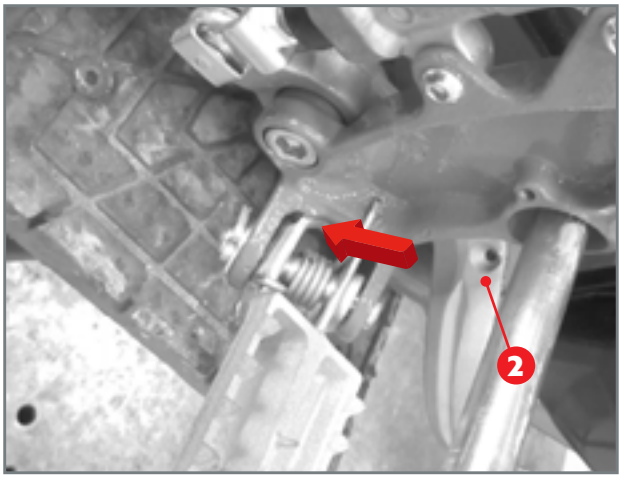
Positioning of gearshift lever.

4 REASSEMBLY OF ENGINE IN THE VEHICLE



Insertion of engine pins.

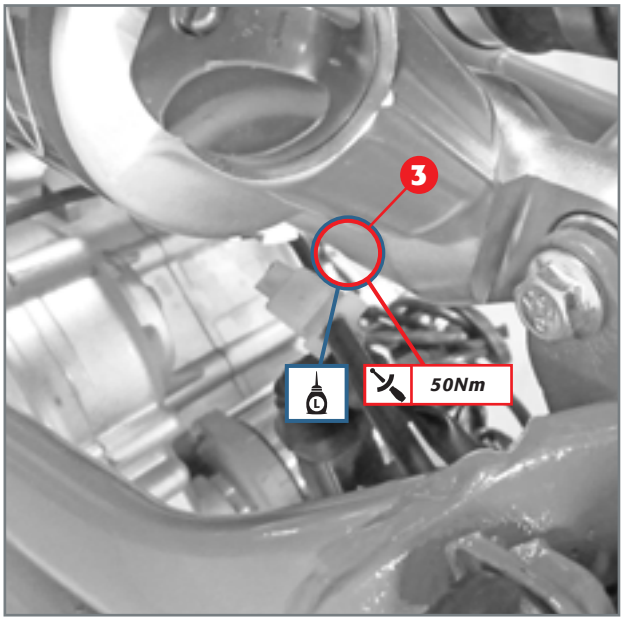
Insert the engine in the frame. We recommend insertion from the frame's left side.
Insert the engine pins **1**.



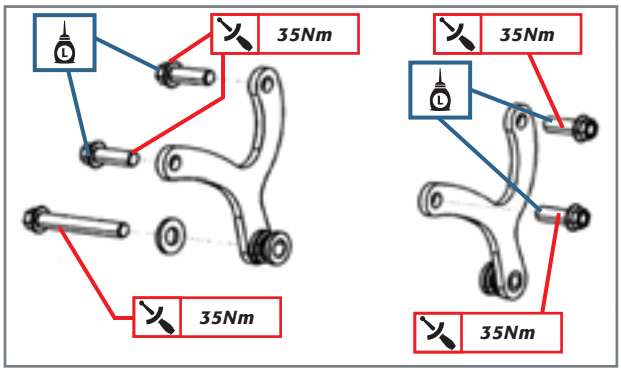
Reposition the swingarm in its correct position. Insert the swingarm pin **2** from the right side.



Note: *pay attention that the notch on the pin head is aligned with the notch on the frame.*

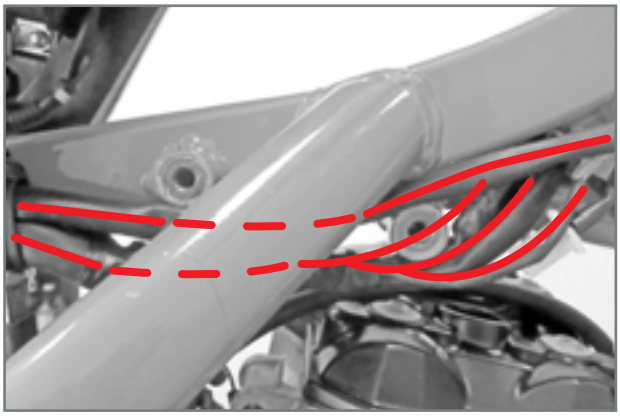


Insert the upper shock-absorber pin **3**.

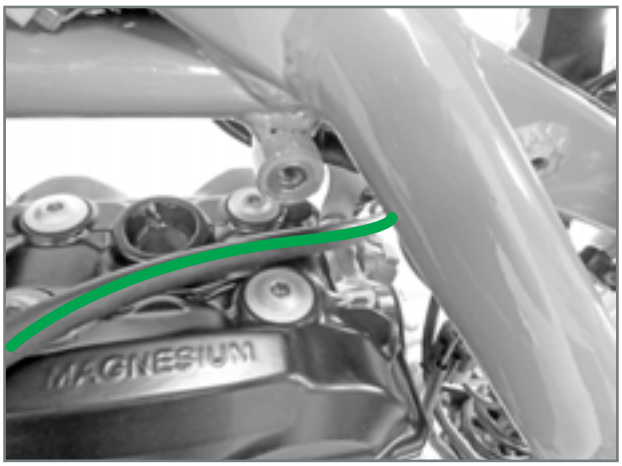


Apply the head connections.

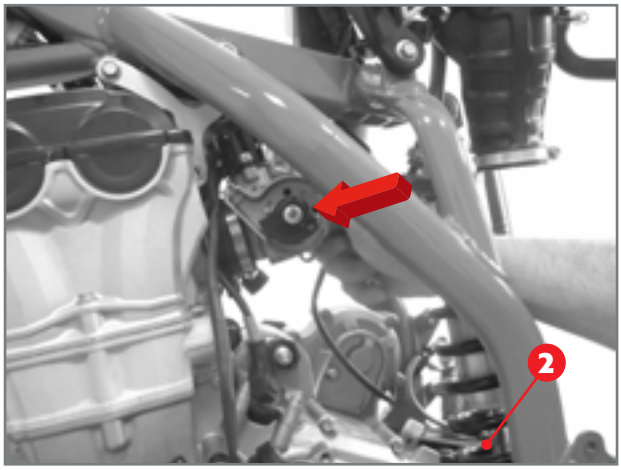
Tighten the nuts and bolts following the table below.



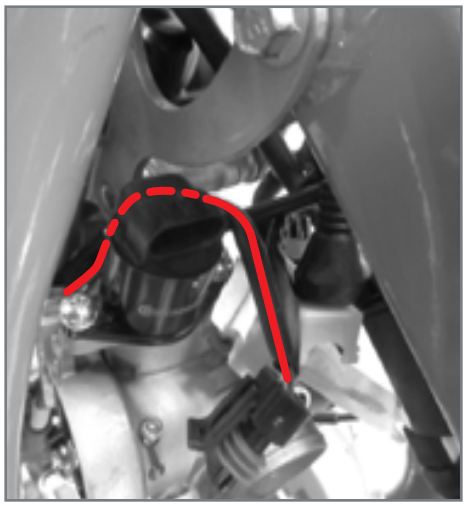
Note: *make sure to run the electrical system as shown in the figure*



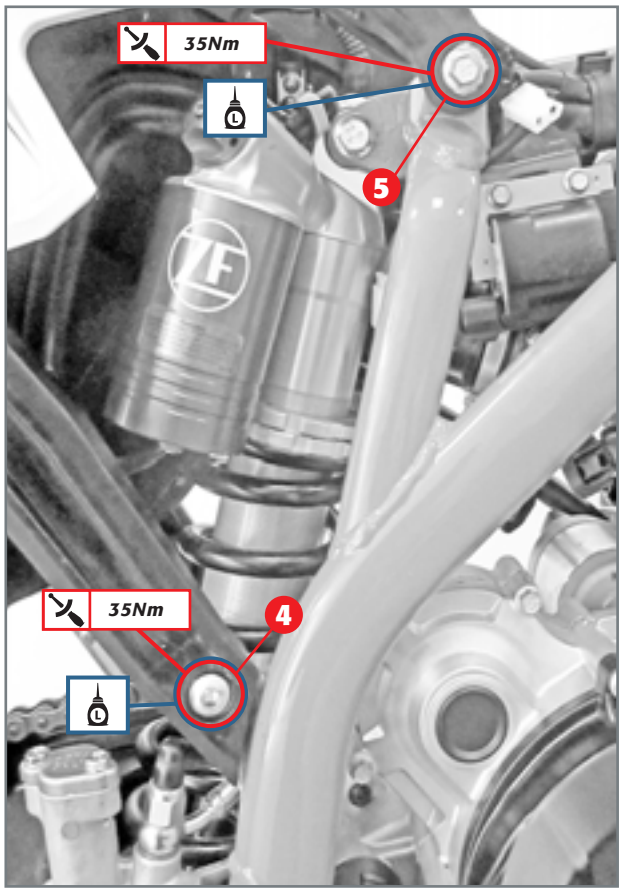
Fixing	Screw	Torque [Nm]	Threadlocker
Head connection bracket to frame. Front fixing	M8 x 16	35	Medium-resistance threadlocker
Head connection bracket to frame. Rear fixing	M8 x 16	35	Medium-resistance threadlocker
Head connection brackets to engine	M8 x 70	35	
Engine pins	Special	45	
Swingarm pin	M16 x 245	125	



Put the throttle body on the engine.



Pay attention to the wiring layout shown in the figure.

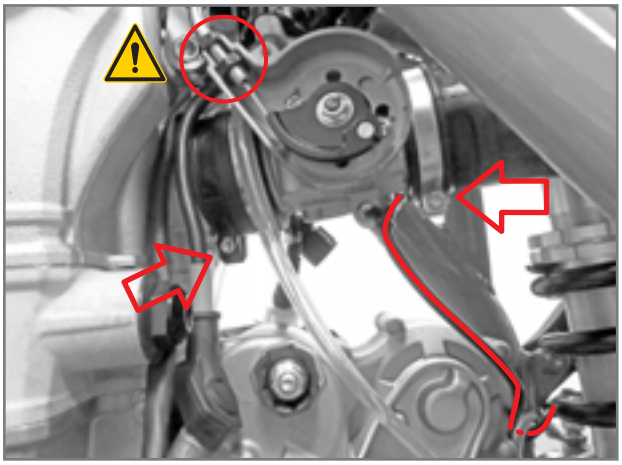


Rotate the filter box in its normal position. Apply the lower fixing screws **4** (one each side) prior application of medium strength threadlocker and fasten to the indicated torque.

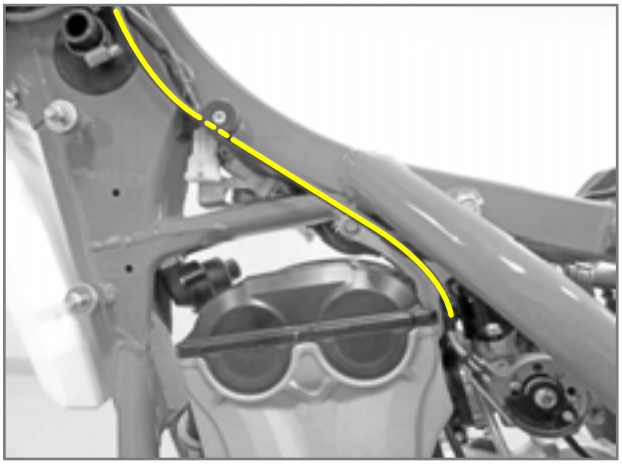
Tighten the upper screws **5** to the indicated torque.

Note: *we recommend removing the upper screws (one each side) and apply medium strength threadlocker.*

ATTENTION!
During rotation, make sure the injector does not hit anything.



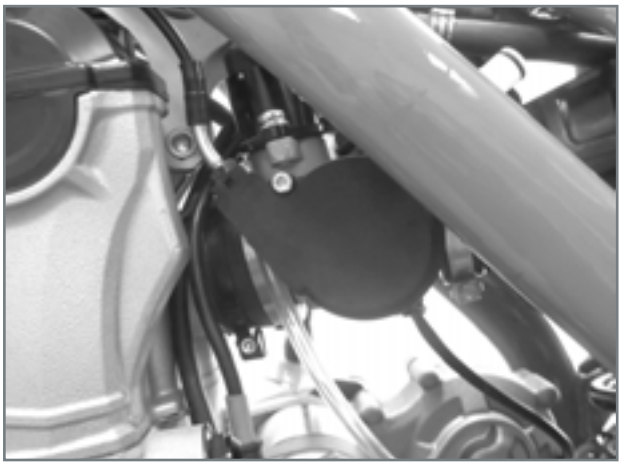
Make sure the filter box sleeve is correctly inserted inside the throttle body, fasten the two filter box side and manifold side straps.



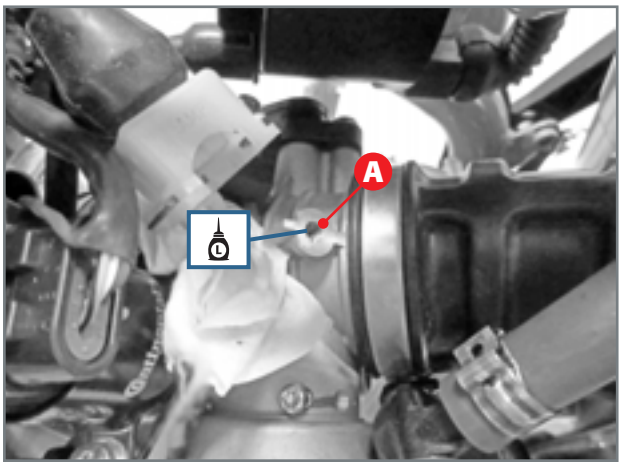
Set the gas cable on the left side of the frame and make it pass outside the head connection.
Apply the gas cable to the throttle body and tighten the nuts.

WARNING!
At the end of the operation, check for correct gas play.

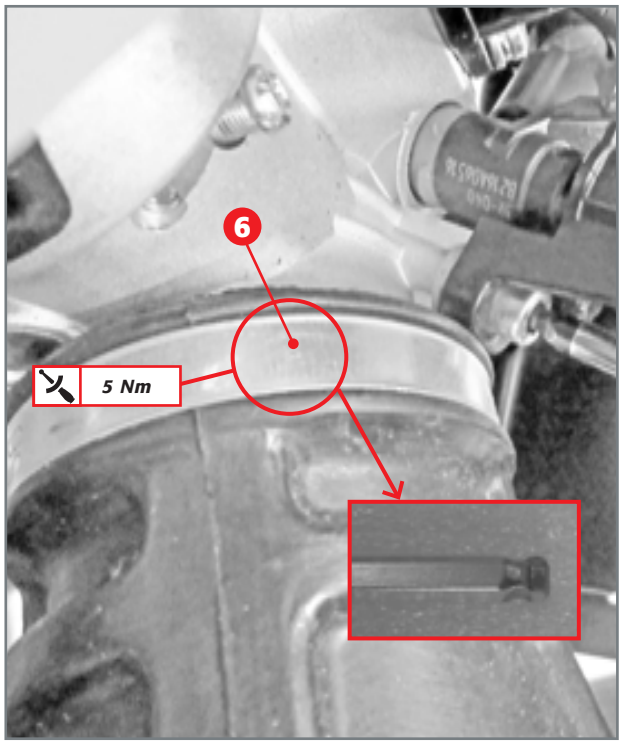
Secure the electrical wiring as shown in the figure.
Reassemble the engine steam vents.



Apply the throttle body cover and the relative screw.
Connect the stop connectors.

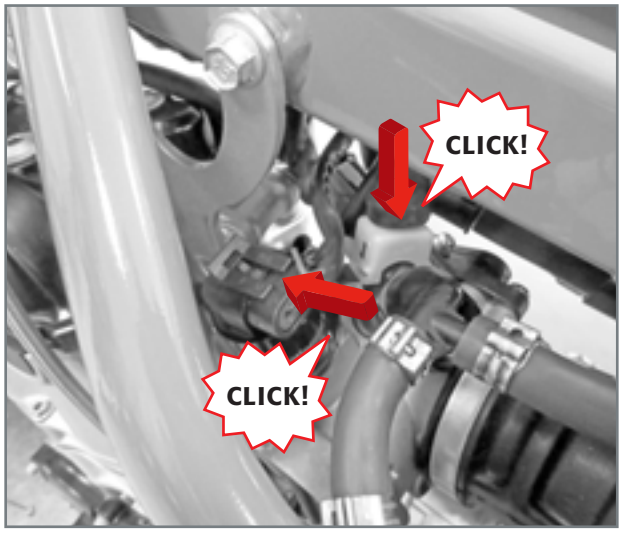


Apply a drop of medium resistance threadlocker to threaded bore **A**.
Remove the protective cloth previously applied in the injector housing.
Put the injector into its seat on the throttle body and push it all the way in.



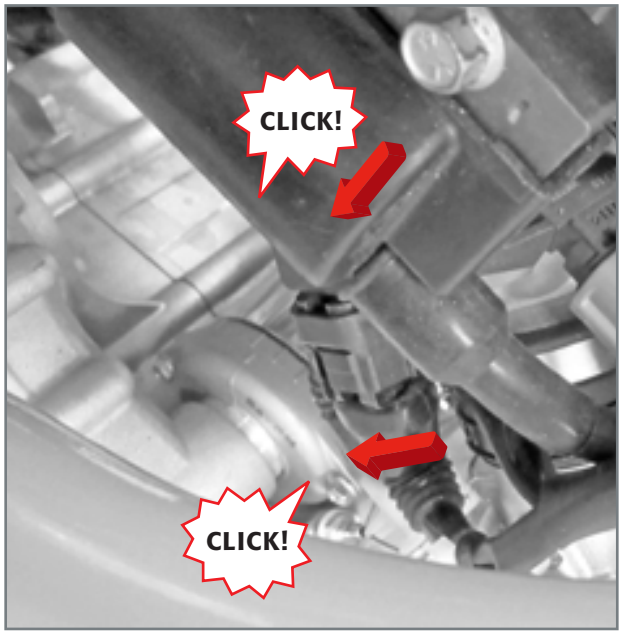
Fit the screw **6**.

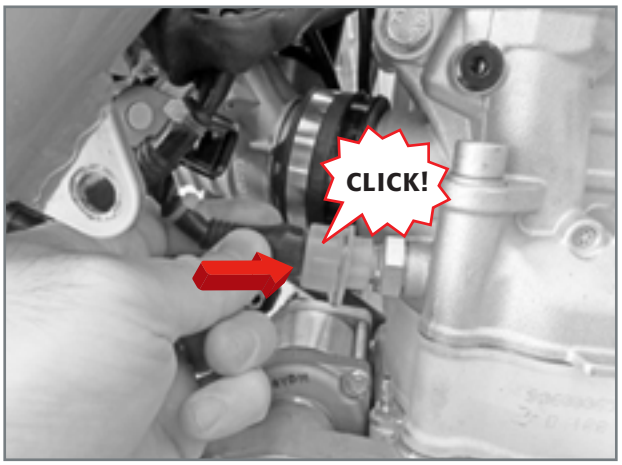
WARNING!
*Take the utmost care to make sure screw **6** is perfectly aligned with the respective threading. Should the screw not be perfectly aligned with the threading, **DO NOT FORCE IT while tightening. Instead, remove it and reposition it properly.** We recommend using a key like the one shown in the figure during handling. Tighten to the specified torque.*

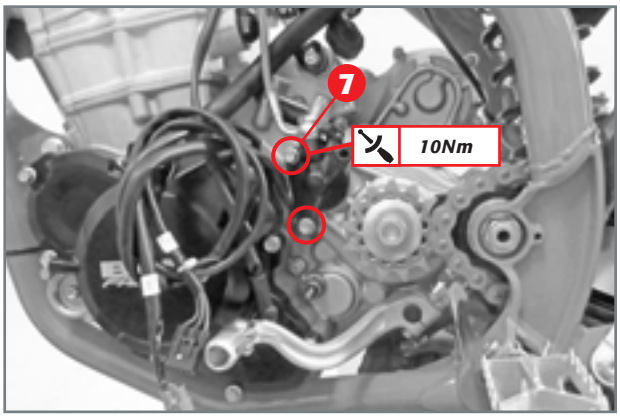


Connect the electric connectors as shown in the figure.

***Note:** before making the connection, it is advisable to blow compressed air in the connectors and treat them with spray for electrical contacts.*



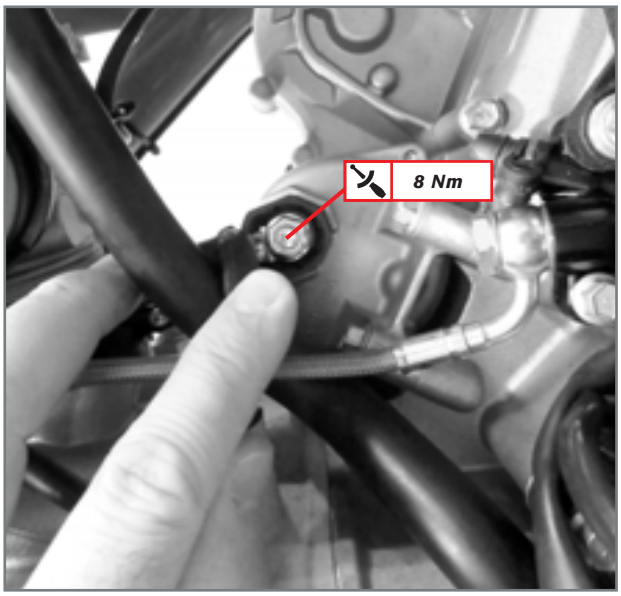




Apply the unit clutch actuator to the two fixing screws **7**.
Tighten to 10Nm.

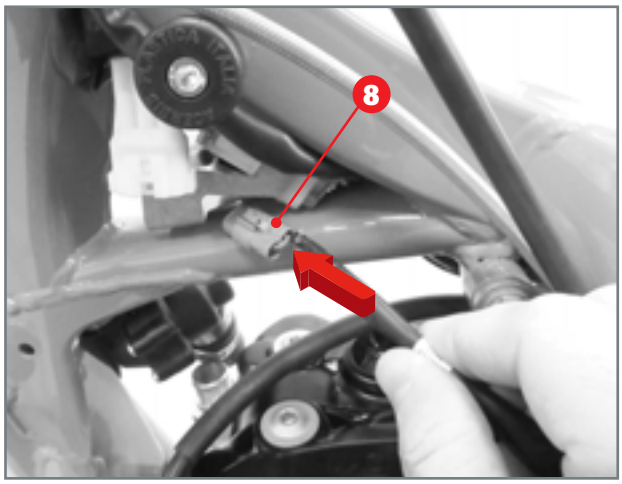


Apply the spark plug cap.

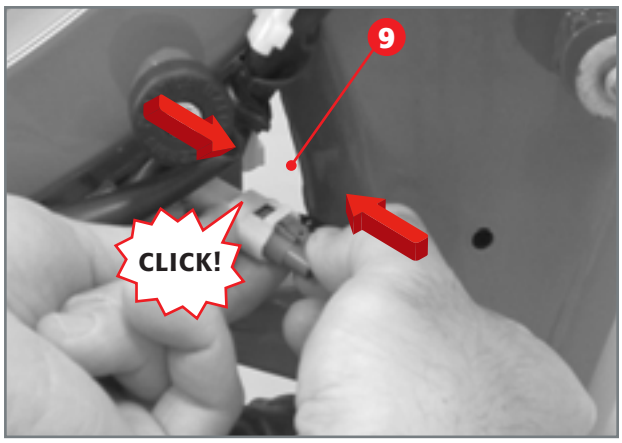


Apply the start motor cable and tighten the nut to the indicated torque.
Cover the connection using the specific protective cap.

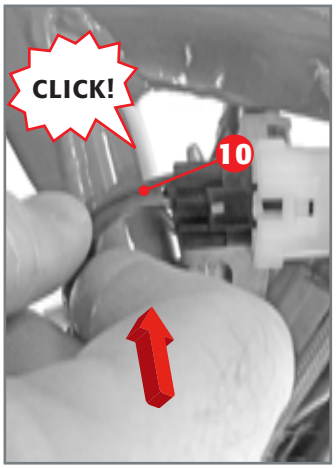
Note: *It is advisable to protect the electrical connector with a light veil of technical vaseline.*



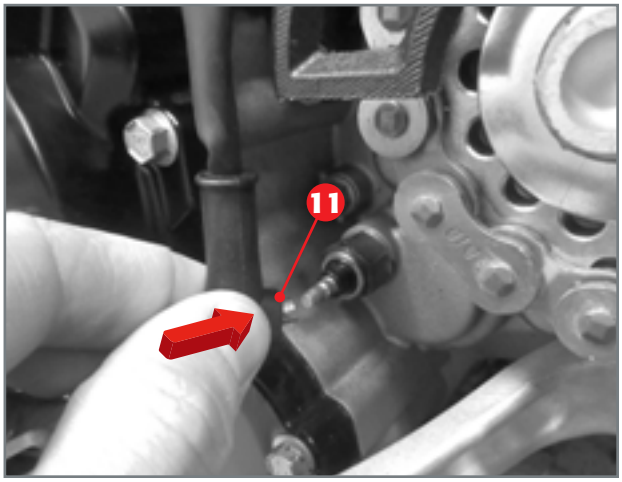
Insert connector **8** as shown, and connect it to the electrical system.



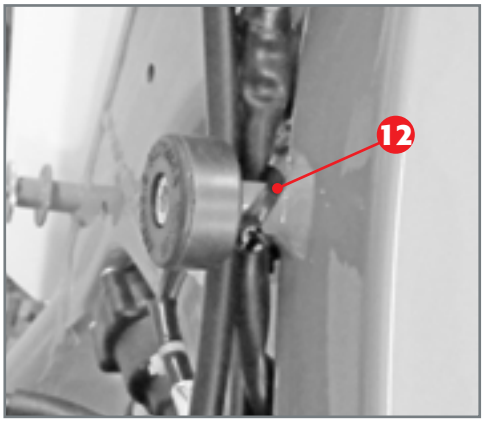
Connect connector **9** to the electrical system



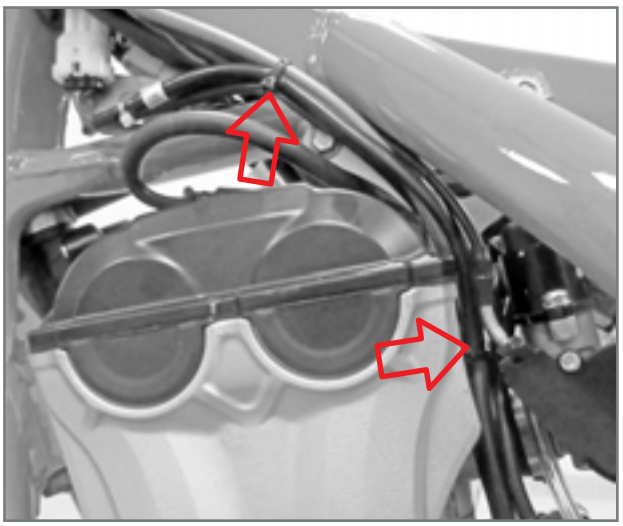
Connect connector **10** to the electrical system.



Fasten connector **11** to the sensor.

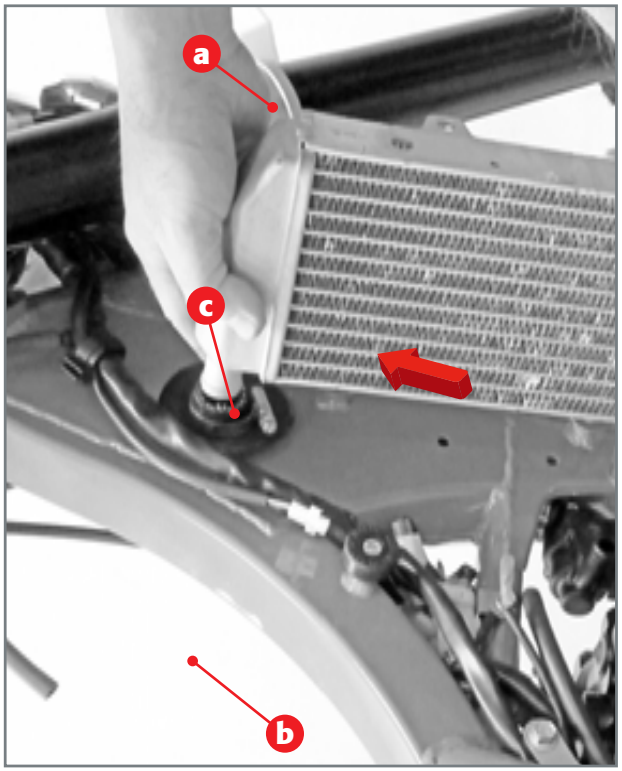


Apply a plastic tie **12** in order to collect the cables and pipes as shown.

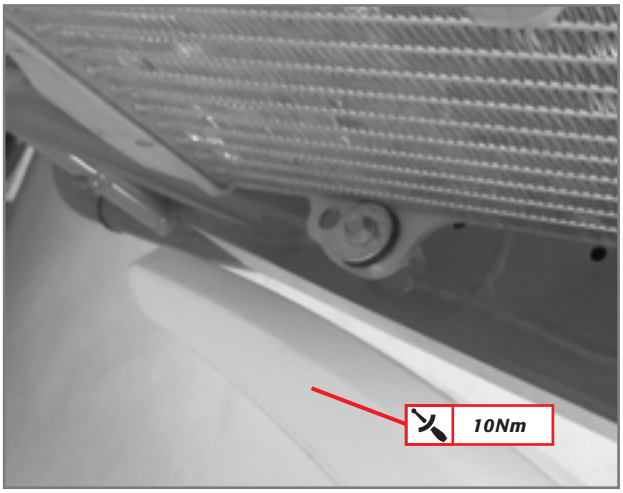


Connect the ventilation pipes to the engine.

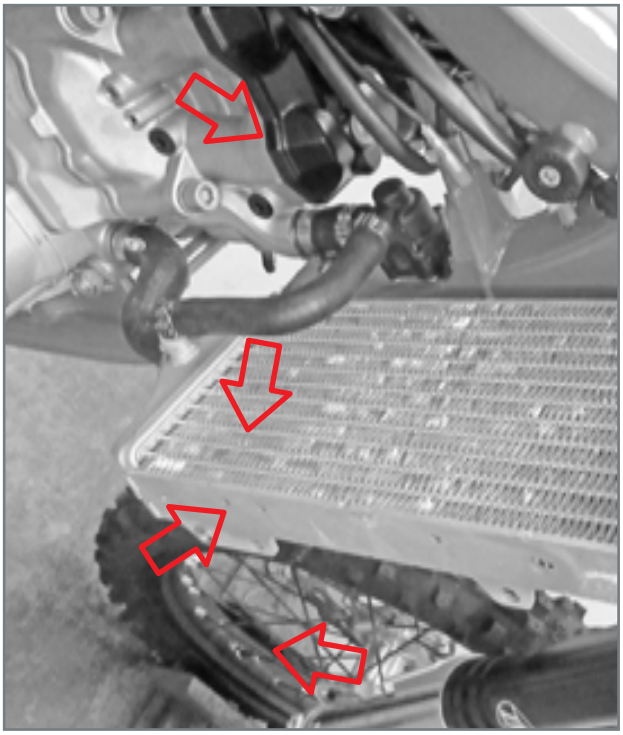
Fix the cables from the engine to the gear actuator tube.



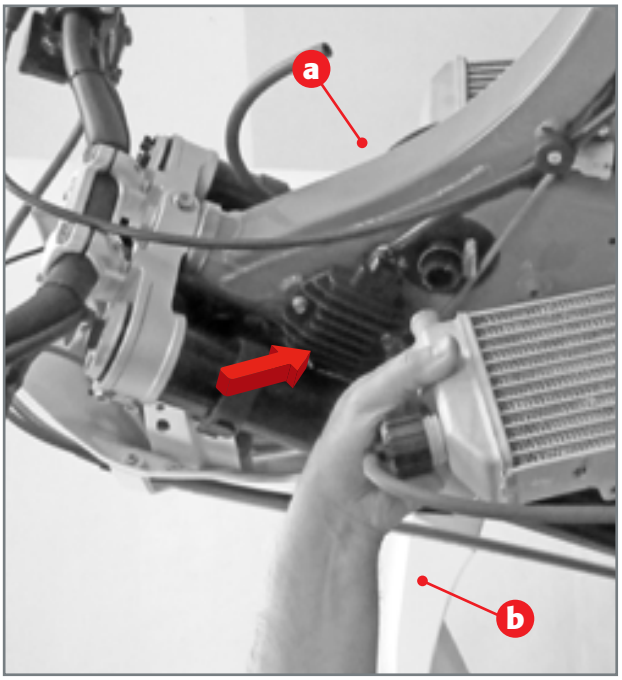
Apply the right radiator to the frame. The operation is easier if pipes are inserted observing the order shown in the figure.



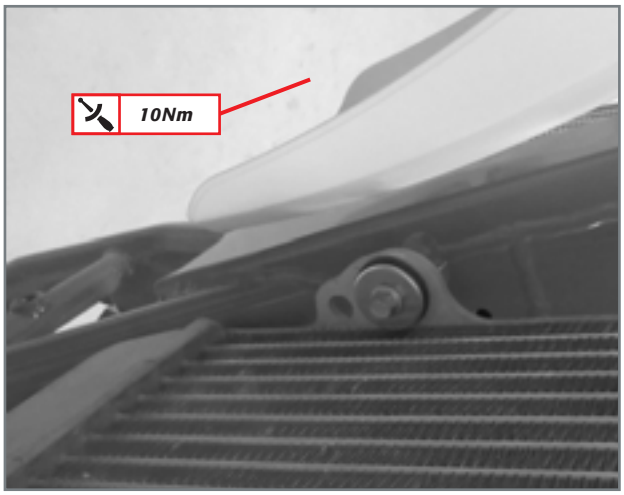
Apply the fixing screws and tighten them to the specified torque.



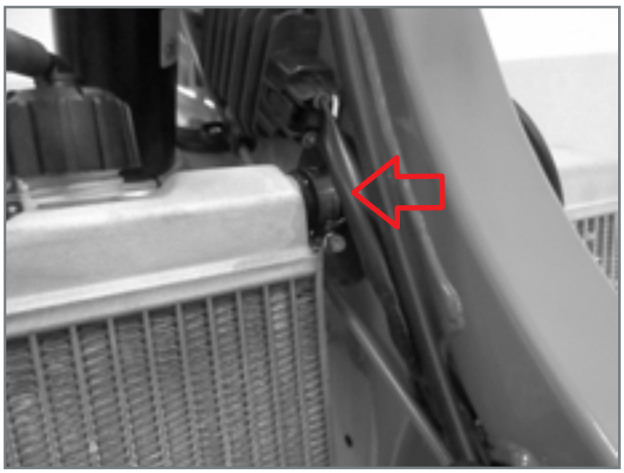
Tighten the clamps indicated.



Apply the left radiator to the vehicle. The operation is easier if pipes are inserted observing the order shown in the figure.



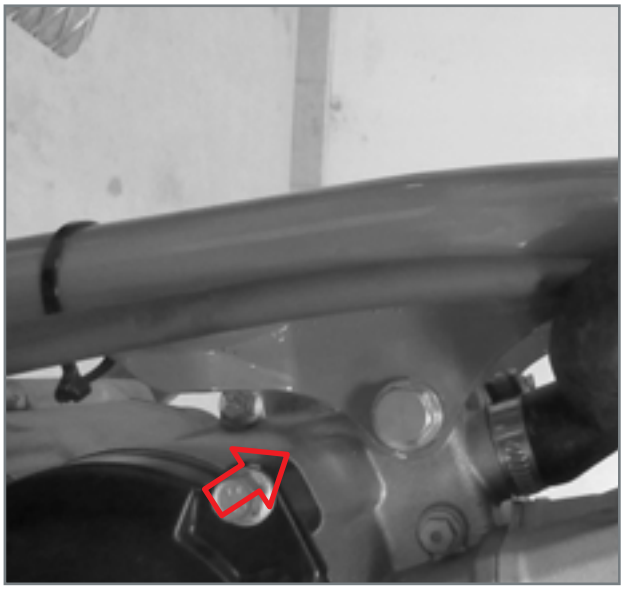
Apply the fixing screws and tighten them to the specified torque.

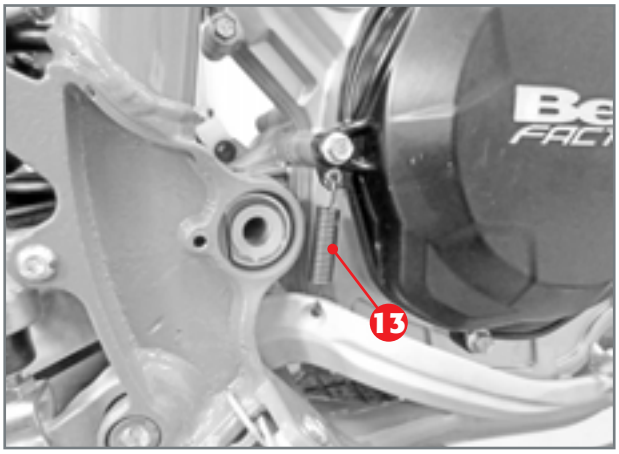


Tighten the clamps indicated

Apply the radiator grids paying attention to their correct insertion.

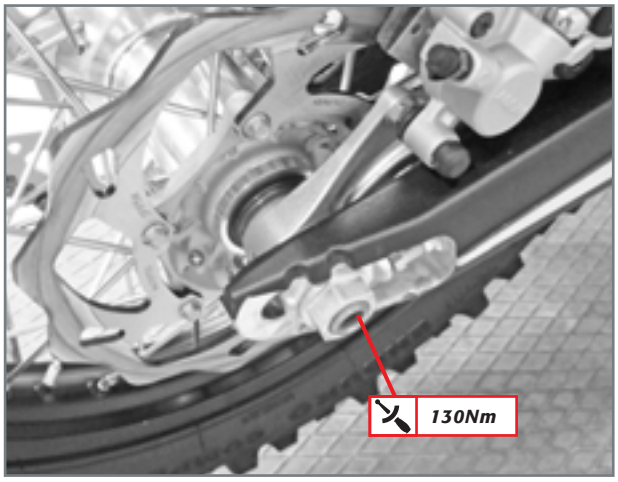
Insert the liquid coolant. Remember to keep the vehicle in vertical position. To optimize draining tilt the vehicle slightly to the right.





If present, apply the Kickstart lever (optional). Apply the dedicated medium-strength threadlocker on the screw and fasten at 25Nm. Apply the brake pedal return spring **13**.

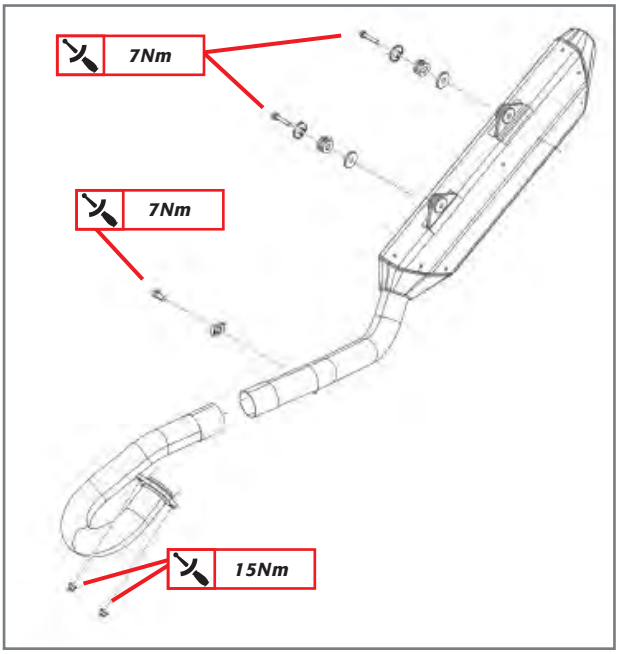
Mount the chain on the pinion.



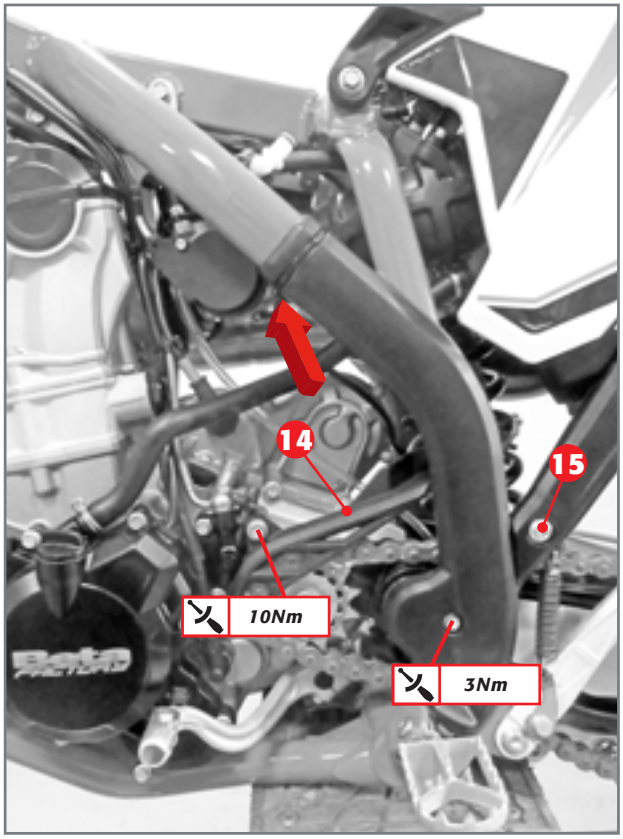
Move the wheel towards the rear, mounting the adjustment frames according to the image.

WARNING!
Before fastening the rear wheel, check for its correct alignment.

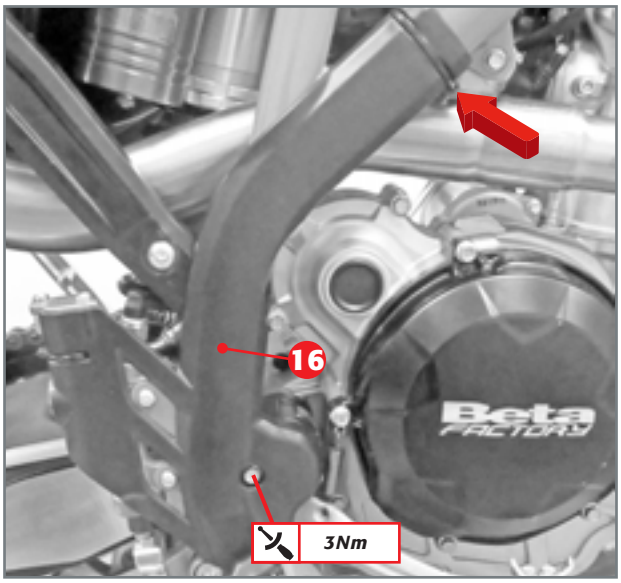
Tighten the nut to the indicated torque.

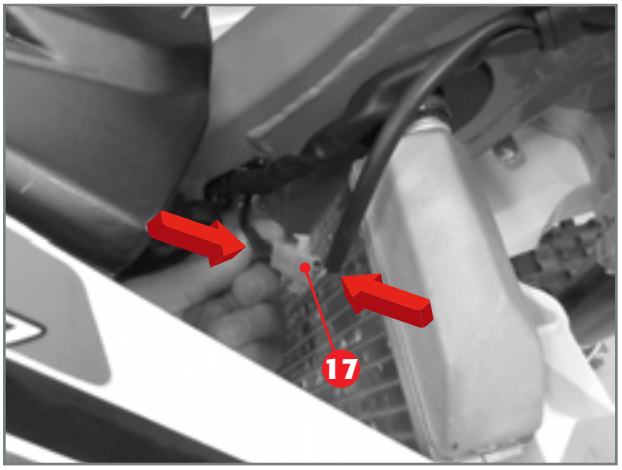


Apply the silencer to the vehicle and then the exhaust manifold; fasten to the torque indicated in the figure.

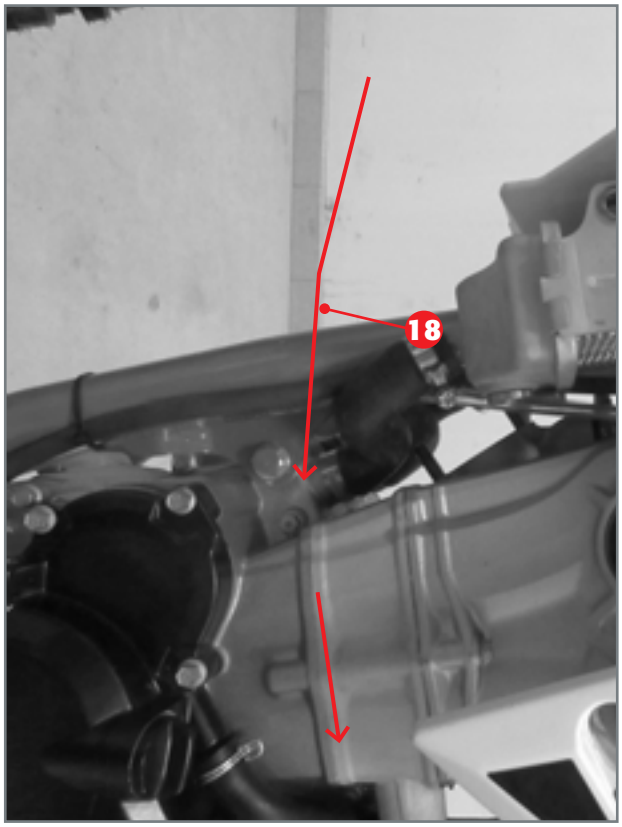


Apply the pinion guard **14** and the frame side guards **15** and **16**.
Tighten the screws at 10Nm and apply the fixing straps between side guards and frame.

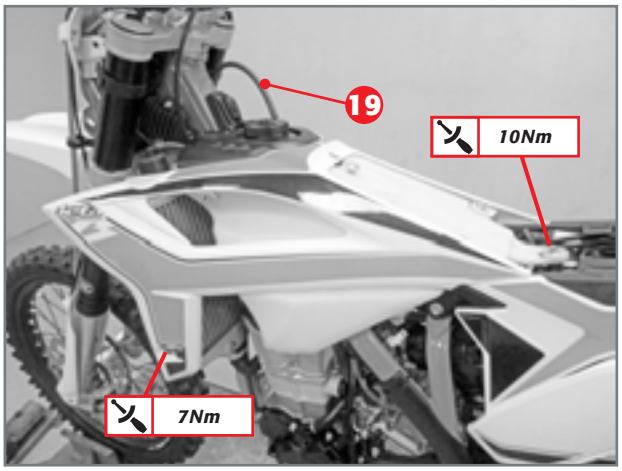




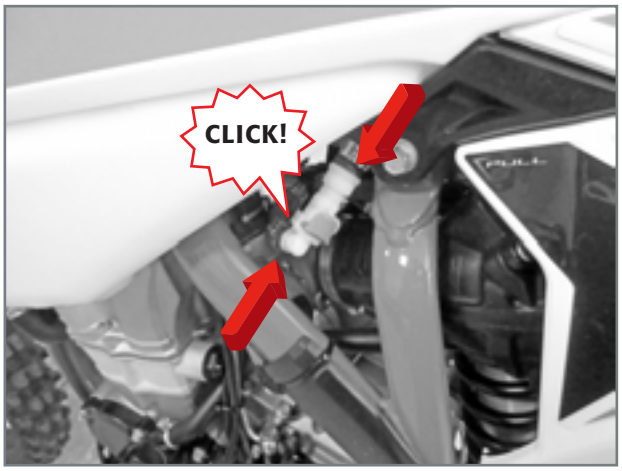
Place the tank on the vehicle and connect connector **17**.



Insert pipe **18** observing its path as shown in the figure.
Push the tank towards the front and downwards.

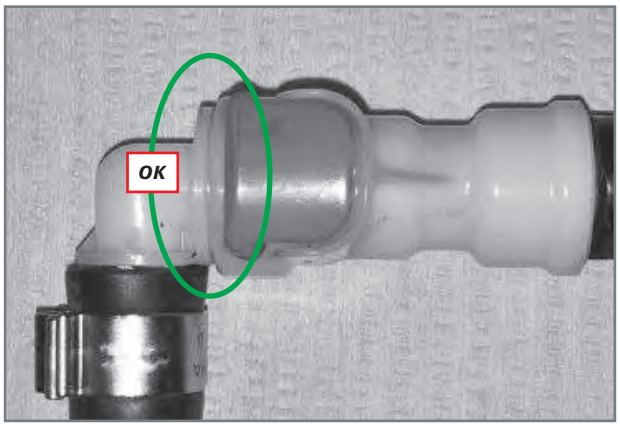


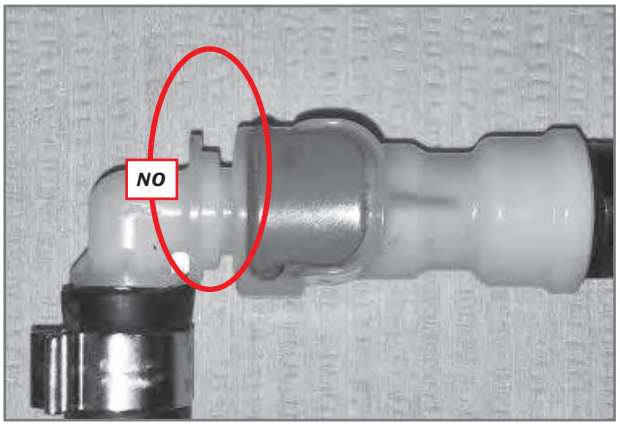
Tighten the tank screws to the indicated torque.
Reconnect pipe **19**to the tank.



Connect the petrol fittings by fully engaging them.

ATTENTION!
Make sure that the petrol quick-release couplings are fitted properly.



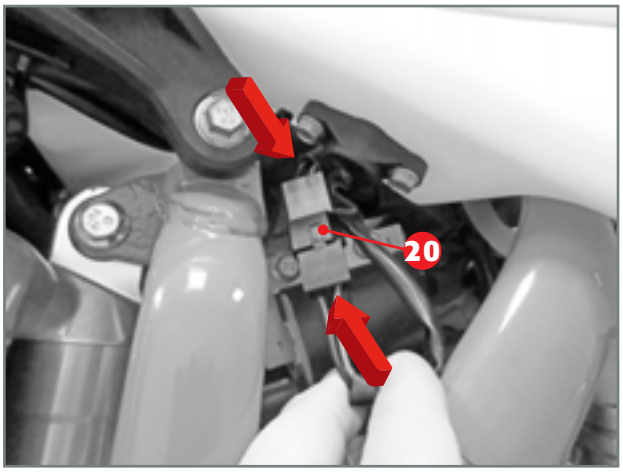


ATTENTION!
Make sure that the petrol quick-release couplings are fitted properly.

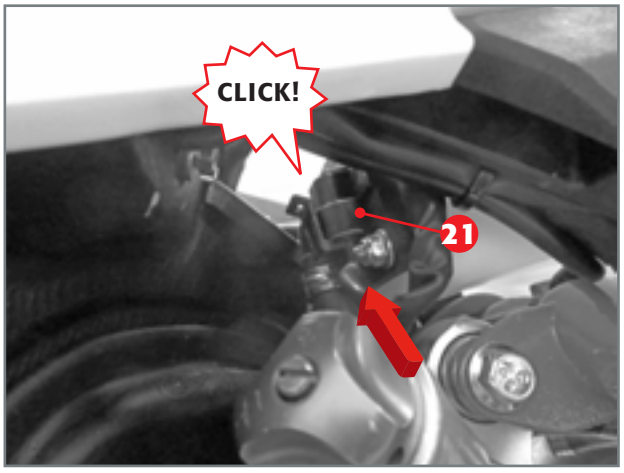
Fasten the screws to the tank to the indicated torque.

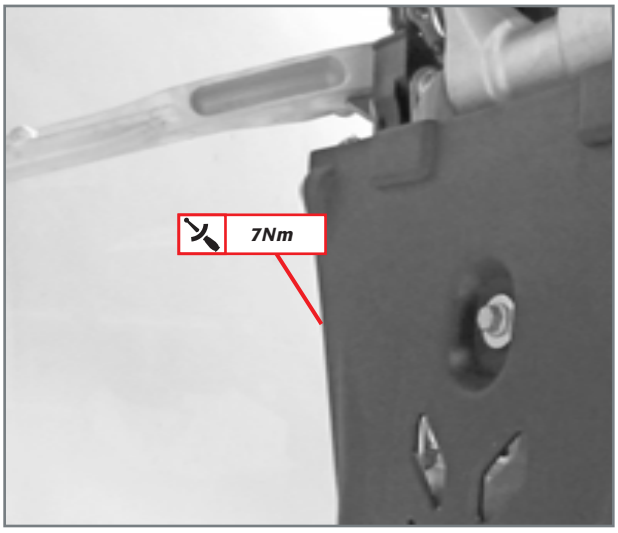
Apply the seat.

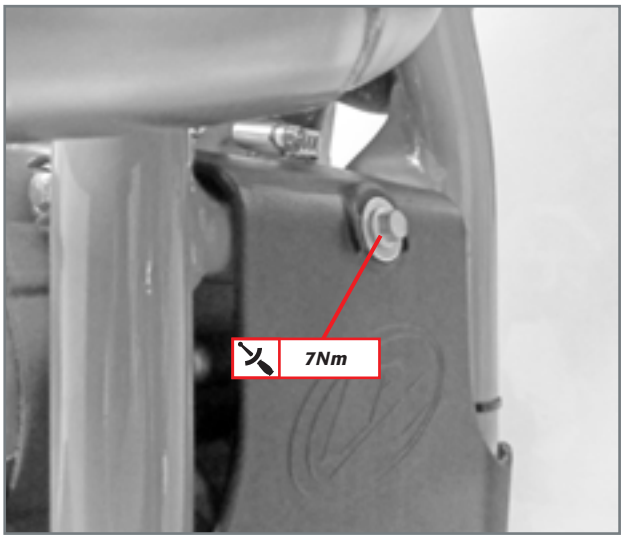
After removing the motorcycle from the stand, reapply the engine guard plate with the three fixing screws. Tighten to 10Nm.



Reconnect connectors **20** and **21**.







Apply the engine guard and relative screws.

Tighten to the specified torque.

TABLE OF ENGINE COMPONENTS TIGHTENING TORQUES

Fixing	Threading diameter x length [mm]	Quantity	Threadlocker	Torque [Nm]	Notes
Outer side right crankcase half					
Oil seal fixing plate	M5 x 10	2	Medium-resistance threadlocker	6	
Oil incline	M5 x 10	2	Medium-resistance threadlocker	4	EN AW7075
Kickstarter lever	M6 x 20	1	Medium-resistance threadlocker	10	
Inner side right crankcase half					
Crankshaft bearing fixing plates	M6 x 12	2	Medium-resistance threadlocker	8	
Gearbox main shaft bearing fixing plate	M6 X 12	1	Medium-resistance threadlocker	8	
Secondary gearbox shaft bearing fixing plate	M6 X 12	1	Medium-resistance threadlocker	8	
Desmodromic control bearing fixing	M5 X 12	2	Medium-resistance threadlocker	4	EN AW7075
Outside left crankcase half					
Countershaft bearing fixing	M6 X 12	12	Medium-resistance threadlocker	8	
Oil jet	M5	1	Medium-resistance threadlocker		Tighten all the way
Oil jet	M4	1	Medium-resistance threadlocker		Tighten all the way
Neutral sensor	M10	1		18	Pitch 1.25
Inside left crankcase half					
Crankshaft bearing fixing plates	M6 x 12	2	Medium-resistance threadlocker	8	
Crankshaft					
Left-hand side nut	M32	1	Medium-resistance threadlocker	150	
Right-hand side nut	M20	1	Medium-resistance threadlocker	150	Left thread
Crankshaft blocking	M8x16	1		15	With copper spacer
Gearshift					
Stop cam	M6 x 30	1	Medium-resistance threadlocker	10	
Gear stopping device lever	M6 x 20	1	Medium-resistance threadlocker	10	
Gearshift lever	M6 x 25	1	Medium-resistance threadlocker	10	
Electric kickstarter device					
Torque limiter	M6 x 25	1	Medium-resistance threadlocker	10	
Starter motor	M6 x 20	2	Medium-resistance threadlocker	10	
Ignition gear	M5 x 12	2	Medium-resistance threadlocker	4	EN AW7075

Fixing	Threading diameter x length [mm]	Quantity	Threadlocker	Torque [Nm]	Notes
Engine lubrication					
Oil jet	M4	10	Medium-resistance threadlocker	6	
Oil pump covers	M5 x 12	5	Medium-resistance threadlocker	4	EN AW7075
Chain oil jet	M5 x 12	1	Medium-resistance threadlocker	6	
Oil pressure control screw	M12 x 10	1		20	
Paper oil filter cap	M6 x 16	2		10	
Countershaft					
Locking nut	M12	1	Medium-resistance threadlocker	50	
Clutch					
Drum nut and clutch case	M18	1	Medium-resistance threadlocker	120	
Clutch pressure cap	M6 x 25	6		10	
Clutch actuator	M6 x 20	2		10	
Clutch actuator	M6 x 30	1		10	
Outer clutch cover	M6 x 25	6		10	
Outer clutch cover	M6 x 30	1		10	
Inner clutch cover	M6 x 25	10		10	See water pump cover screws as well
Inner clutch cover	M6 x 60	5		10	See water pump cover screws as well
Water pump					
Impeller blind nut	M6	1	Medium-resistance threadlocker	6	
Cover	M6 x 40	4		10	
Timing chain guards					
Fixed and movable guides	M6 x 25	2	Medium-resistance threadlocker	10	
Chain guide on flywheel cover	M5 x 10	1	Medium-resistance threadlocker	4	
Chain guard	M6 x 20	2	Medium-resistance threadlocker	10	
Ignition system					
Pick-up unit	M5 x 12	2	Medium-resistance threadlocker	6	
Stator winding	M5 x 30	3	Medium-resistance threadlocker	6	
Flywheel	M12	1	Medium-resistance threadlocker	60	
Spark plug	M12	1		17	
Cover	M6x25	9		10	

Fixing	Threading diameter x length [mm]	Quantity	Threadlocker	Torque [Nm]	Notes
Head					
Rocker arm pin caps	M10	2		10	
Head	M10	4		40➔55	Lubricate threading and washers. Follow a criss-cross pattern
Head	M6	1		10	
Camshaft support	M7 x 38	3		8➔10	Follow a criss-cross pattern
Camshaft support	M7 x 33	4		8➔10	Follow a criss-cross pattern
Exhaust flange stud	M8 x 30	2	Medium-resistance threadlocker		
Electric fan sensor	M12	1		20	
AIS valve fitting	M10	1		10	
Cover	M6 x 12	4		8	
Mechanical tensioner					
Tensioner cap	M24	1		25	
Small tensioner cap	M16	1		8	
Chain pinion					
Pinion	M10 x 18	1	Medium-resistance threadlocker	60	Do not use pneumatic devices!
Gearbox oil fumes vent					
Bored screw	M6x1	1	Medium-resistance threadlocker	6	
Oil drains					
Motor oil plug	M20	1		15	
Gearbox oil magnetic screw cap	M14	1		20	
Pedal kickstart (Kickstarter)					
Kickstart lever	M8 x 26	1	Medium-resistance threadlocker	25	Do not use pneumatic devices!

TABLE OF FRAME/ENGINE TIGHTENING TORQUES

Fixing	Diameter x pitch [mm]	Quantity	Threadlocker	Torque [Nm]	Notes
Front engine pin	M10 x 1.25	1		45	
Lower engine pin	M10 x 1.25	1		45	
Head connection bracket to front frame	M8x20	2	Medium-resistance threadlocker	35	
Head connection bracket to rear frame	M8x16	2	Medium-resistance threadlocker	35	
Head connection brackets to engine	M8x65			35	
Swingarm pin	M16 x 1.5	1		125	

TABLE OF SUPERSTRUCTURE TIGHTENING TORQUES

Fixing	Diameter x pitch [mm]	Length [mm]	Quantity	Threadlocker	Torque [Nm]	Notes
Tank to the frame	M6 x 1	30	1		10	Application of grease
Tank side panel to the radiator	M6 x 1	20	2		7	

RECOMMENDED ENGINE MAINTENANCE

The required engine maintenance only depends on the level of use and respect of the periodical inspections. The following frequency intervals refer to normal use, as long as the engine has not worked in extraordinary conditions and that the periodic inspections and interventions have been correctly carried out.

	30h 200l	60h 400l	90h 600l	120h 600l	150h 800l	180h 1200l
Driving clutch discs (coated)	I	I	S	I	I	S
Clutch springs	I	I	S	I	I	S
Main shaft gearbox bearings	-	-	S	-	-	S
Case / clutch hub	I	I	I	I	I	I
Cylinder	-	-	I	-	-	I
Piston and segments	-	-	S	-	-	S
Camshaft superficial appearance	-	-	I	-	-	I
Valve springs	-	-	I	-	-	S
Valves	-	-	I	-	-	S
Valve guides	-	-	I	-	-	I
Connecting rod	-	-	S	-	-	S
Countershaft bearings	-	-	S	-	-	S
Crankshaft bearings	-	-	S	-	-	S
Gearbox superficial appearance	-	-	I	-	-	I
Pressure control valve Pressure regulator	-	-	I	-	-	I
Oil seals for water pump + bush	-	-	S	-	-	S
Oil pumps control gearwheels	-	-	S	-	-	S

I = INSPECT AND REPLACE IF REQUIRED *S = REPLACE*

RECOMMENDED LUBRICANTS AND LIQUIDS

APPLICATION	PRODUCT	QUANTITY
Gearbox and clutch	Liqui Moly racing Synth 10W50	800 ml* - 750ml**
Engine	Liqui Moly racing Synth 10W50	800 ml* - 750ml**
COOLANT LIQUID	Liqui Moly Coolant ready mix RAF 12 PLUS	1300 ml*

* *Following the complete engine overhaul.*
** *Following routine maintenance interventions.*

NOTE:



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