INTRODUCTION 0

SUMMARY

0.1 INTRODUCTION

0.1.1 FOREWORD

This manual provides the information required for normal servicing.
This publication is intended for use by aprilia Dealers and their qualified mechanics; many concepts have been omitted on purpose as their inclusion would be superfluous. Since complete mechanical explanations have not been included in this manual, the reader must be familiar with basic notions of mechanics, as well as with basic repair procedures. Without such familiarity, repairs and checks could be ineffective and even hazardous. Since the repair and vehicle check instructions are not exhaustive, special care must be taken to avoid damage and injury. To ensure maximum customer satisfaction with the vehicle, aprilia s.p.a. continuously improves its products and their documentation. The main technical modifications and changes in repair procedures are communicated to all aprilia dealers and agencies worldwide. Such modifications will be entered in subsequent editions of the manual. Should you need assistance or clarifications about the inspection and repair procedures, please contact the aprilia SERVICE DEPT., they will be glad to give you any information on the matter, or supply you with any detail on updates and technical changes applied to the vehicle.

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First edition: April 2003

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0.1.2 REFERENCE MANUALS

OWNER'S MANUALS

aprilia part# (description)			
8104896	I	F	D
8104895	P	E	UK
8104897	NL	DK	SF
8104894	GR	J	UK

CHASSIS WORKSHOP MANUAL

aprilia part# (description)	
8140874	I
8140877	E
8140875	F
8140876	D
8140878	UK

ENGINE TECHNICAL MANUAL

aprilia part# (description)	
8140880	I
8140883	E
8140881	F
8140882	D
8140884	UK

CD FOR THE NETWORK - ENGINE

aprilia part# (description)					
8CM0086	I	E	F	D	UK

CD FOR THE NETWORK - CHASSIS

aprilia part# (description)					
8CM0084	I	E	F	D	UK

0.1.3 ABBREVIATIONS/SYMBOLS/CONVENTIONS

= number
< = less than
> = greater than
≤ = less than or equal to
≥ = more than or equal to
~ = approximately
∞ = infinity
°C = degrees Celsius (centigrade)
°F = degrees Fahrenheit
± = plus or minus
a.c = alternating current
A = Ampere
Ah = Ampere per hour
API = American Petroleum Institute
AT = high voltage
AV/DC = Anti-Vibration Double Countershaft
bar = pressure measurement unit (1 bar = 100 kPa)
d.c. = direct current
cc = cubic centimetres
CO = carbon monoxide
CPU = Central Processing Unit
DIN = German industrial standards (Deutsche Industrie Norm)
DOHC = Double Overhead Camshaft
ECU = Electronic Control Unit
rpm = revolutions per minute
HC = unburnt hydrocarbons
ISC = Idle Speed Control
ISO = International Standardisation Organisation
kg = kilograms
kgm = kilograms per metre (1 kgm = 10 Nm)
km = kilometres
km/h = kilometres per hour
kΩ = kilo Ohm
kPa = kiloPascal (1 kPa = 0.01 bar)
KS = clutch side (from the German "Kupplungsseite")
kW = kilowatt
ℓ = litres
LAP = racetrack lap
LED = Light Emitting Diode
LEFT SIDE = left side
m/s = metres per second
max = maximum
mbar = millibar (1 mbar = 0.1 kPa)
mi = miles
MIN = minimum
MPH = miles per hour
MS = flywheel side (from the German "Magnetoseite")
MΩ = MegaOhm
N.A. = Not Available
N.O.M.M. = Motor Octane Number
N.O.R.M. = Research Octane Number
Nm = Newton metre (1 Nm = 0.1 kgm)
Ω = ohm
PICK-UP = pick-up
BDC = Bottom Dead Centre
TDC = Top Dead Centre
PPC = Pneumatic Power Clutch

RIGHT SIDE = right side
SAE = Society of Automotive Engineers
TEST = diagnostic check
T.B.E.I. = crown-head Allen screw
T.C.E.I. = cheese-head Allen screw
T.E. = hexagonal head
T.P. = flat head screw
TSI = Twin Spark Ignition
UPSIDE-DOWN = inverted fork
V = volt
W = watt
Ø = diameter

GENERAL INFORMATION 1

SUMMARY

1.1. STRUCTURE OF THE MANUAL

1.1.1. CONVENTIONS USED IN THE MANUAL

- This manual is divided in sections and subsections, each covering a set of the most significant components. Refer to the index of sections when consulting the manual.
- Unless expressly specified otherwise, assemblies are reassembled by reversing the dismantling procedure.
- The terms "right" and "left" are referred to the rider seated on the vehicle in the normal riding position.
- Motorcycle operation and basic maintenance are covered in the "OWNER'S MANUAL".

In this manual any variants are identified with these symbols:

OPT	optional
#	catalytic version
-	all versions
MP	national certification
SF	European certification (EURO 2 limits)

VERSION:

I	Italy	GR	Greece	MAL	Malaysia
UK	United Kingdom	NL	Holland	RCH	Chile
A	Austria	CH	Switzerland	HR	Croatia
P	Portugal	DK	Denmark	AUS	Australia
SF	Finland	J	Japan	USA	United States of America
B	Belgium	SGP	Singapore	BR	Brazil
D	Germany	SLO	Slovenia	RSA	South Africa
F	France	IL	Israel	NZ	New Zealand
E	Spain	ROK	South Korea	CDN	Canada

1.1.2. SAFETY WARNINGS

The following precautionary warnings are used throughout this manual in order to convey the following messages:

Safety warning. This symbol appears, whether in the manual or on the vehicle itself, to indicate a personal injury hazard. Non-compliance with the indications given in the messages preceded by this symbol may result in grave risks for your and other people's safety and for the vehicle!

DANGER
Indicates a potential hazard which may result in serious injury or even death.

WARNING
Indicates a potential hazard which may result in minor personal injury or damage to the vehicle.

NOTE The word "NOTE" in this manual precedes important information or instructions.

1.2. GENERAL RULES

1.2.1. BASIC SAFETY RULES

CARBON MONOXIDE
Should it be necessary to perform some operations with the vehicle running, make sure to work outdoors or in a well-aerated room.
Avoid starting the engine indoors.
In case you are working indoors, use a gas exhaust system.

DANGER
Exhaust gases contain carbon monoxide, which is extremely toxic if inhaled and may cause loss of consciousness or even lead to death.

FUEL

DANGER
The fuel used in internal combustion engines is highly flammable and can become explosive under particular conditions.
Refuelling and engine service should take place in a well-ventilated area with the engine stopped. Do not smoke when refuelling or in the proximity of sources of fuel vapours, avoid flames, sparks and any element that could ignite fuel or provoke explosions.

DO NOT DISPOSE OF FUEL IN THE ENVIRONMENT.

KEEP AWAY FROM CHILDREN.

HIGH-TEMPERATURE COMPONENTS
The engine and the components of the exhaust system become very hot and remain hot for some time after the engine has been stopped.
Before handling these components, wear insulating gloves or wait until the engine and the exhaust system have cooled down.

USED GEARBOX AND FORK FLUIDS

DANGER
Wear latex gloves when servicing.
Gear fluid may cause serious damage to the skin if handled daily and for long periods.
Wash your hands carefully after handling engine oil.
Take it to the filling station where you usually buy it or to an oil salvage centre.
Wear latex gloves when servicing.

DO NOT DISPOSE OF FLUID IN THE ENVIRONMENT

KEEP AWAY FROM CHILDREN.

BRAKE FLUID

WARNING
When handling the brake fluid, take care not to spill it on the plastic, rubber or painted parts, since it can damage them. When carrying out the maintenance operations on the braking system, use a clean cloth to cover these parts.
Always wear safety goggles when working on the braking system.
The brake fluid is highly irritant. Avoid contact with your eyes.
If the brake fluid gets in contact with your eyes, carefully wash them with fresh water and immediately seek medical advice.

KEEP AWAY FROM CHILDREN.

COOLANT

Coolant contains ethylene glycol that is flammable, under certain conditions. When ignited, ethylene glycol produces invisible flames that might cause burns.

DANGER
Take care not to spill coolant onto hot engine parts and exhaust system. It may ignite and produce invisible flames.
Wear latex gloves when servicing.
Although toxic, it has a sweet taste that might attract animals. Never leave coolant in open container or in a position easily reachable by animals.

KEEP AWAY FROM CHILDREN.

Do not remove radiator cap when engine is still hot. Coolant is under pressure and might cause burns.

HYDROGEN GAS AND BATTERY ELECTROLYTE

DANGER
The battery electrolyte is a toxic, caustic substance containing sulphuric acid and thus able to cause severe burns in case of contact with the skin.
Always wear tight gloves and protective clothes when handling this fluid.
In case of contact with skin, rinse with plenty of fresh water.
Always use a protection for your eyes since even a very small amount of the battery fluid can cause blindness. In the event of contact with your eyes, carefully wash them with water for fifteen minutes and then consult immediately an eye specialist.
Should you accidentally drink some fluid, drink abundant water or milk, then drink magnesia milk or vegetable oil and immediately seek medical advice.
The battery gives off explosive gases and must be kept away from flames and sources of ignition or heat; do not smoke near the battery.

KEEP AWAY FROM CHILDREN.

Battery fluid is corrosive.
Do not spill it, especially on plastic parts.
Make sure that the electrolyte acid is suitable for the type of battery used.

GENERAL PRECAUTIONS AND INFORMATION

Follow these instructions closely when repairing, disassembling or reassembling the motorcycle or its components.

DANGER
Using bare flames is strictly forbidden when working on the motorcycle. Before servicing or inspecting the motorcycle: stop the engine and remove the key from the ignition switch; allow for the engine and exhaust system to cool down; where possible, lift the motorcycle using adequate equipment placed on firm and level ground. Be careful of any parts of the engine or exhaust system which may still be hot to the touch to avoid scalds or burns.
Do not put any vehicle parts into your mouth: vehicle components are not edible and some of them are harmful or even toxic.
Unless expressly specified otherwise, assemblies are reassembled by reversing the dismantling procedure. Where a procedure is cross-referred to relevant sections in the manual, proceed sensibly to avoid disturbing any parts unless strictly necessary. Do not polish matt-painted surfaces with polishing paste.
Never use fuel instead of solvent to clean the motorcycle.
Do not clean any rubber or plastic parts or the seat with alcohol, petrol or solvents. Clean with water and mild detergent.
Always disconnect the battery negative (-) lead before soldering any electrical components.
When two or more persons service the same motorcycle together, special care must be taken to avoid personal injury.

BEFORE DISASSEMBLING ANY COMPONENTS

- Clean off all dirt, mud, and dust and clear any foreign objects from the vehicle before disassembling any components.
- Use the model-specific special tools where specified.

DISASSEMBLING THE COMPONENTS

- Never use pliers or similar tools to slacken and/or tighten nuts and bolts. Always use the suitable spanner.
- Mark all connections (hoses, wiring, etc.) with their positions before disconnecting them. Identify each connection using a distinctive symbol or convention.
- Mark each part clearly to avoid confusion when refitting.
- Thoroughly clean and wash any components you have removed using a detergent with low flash point.
- Mated parts should always be refitted together. These parts will have seated themselves against one another in service as a result of normal wear and tear and should never be mixed up with other similar parts on refitting.
- Certain components are matched-pair parts and should always be replaced as a set.
- Keep away from heat sources.

REASSEMBLING THE COMPONENTS

DANGER
Never reuse a circlip or snap ring. These parts must always be renewed once they have been disturbed.
When fitting a new circlip or snap ring, take care to move the open ends apart just enough to allow fitment to the shaft.
Make it a rule to check that a newly-fitted circlip or snap ring has located fully into its groove.
Never clean a bearing with compressed air.

NOTE *All bearings must rotate freely with no hard spots or noise. Replace any bearings that do not meet these requirements.*

- Use ORIGINAL **aprilia** SPARE PARTS only.
- Use the specified lubricants and consumables.
- Where possible, lubricate a part before assembly.
- When tightening nuts and bolts, start with the largest or innermost nut/bolt and observe a cross pattern. Tighten evenly, in subsequent steps until achieving the specified torque.
- Replace any self-locking nuts, gaskets, seals, circlips or snap rings, O-rings, split pins, bolts and screws which have a damaged thread.
- Lubricate the bearings abundantly before assembly.
- Make it a rule to check that all components you have fitted are correctly in place.
- After repairing the motorcycle and after each service inspection, perform the preliminary checks, and then test ride the motorcycle in a private estate area or in a safe area away from traffic.
- Clean all mating surfaces, oil seal edges and gaskets before assembly. Apply a thin layer of lithium grease along the edges of oil seals. Fit oil seals and bearings with the marking or serial number facing outwards (in view).

ELECTRICAL CONNECTORS

To disconnect the electrical connectors, follow the procedures below. Failure to comply with these procedures may lead to irreparable damage to the connector and the wiring as well.
If present, press the special safety hooks.

WARNING
Do not pull cables to disconnect the two connectors.

- Grasp the two connectors and disconnect them by pulling them in the two opposite directions.
- In case of dirt, rust, moisture, etc.., thoroughly clean the inside of the connectors with compressed air.
- Make sure that the cables are correctly fitted inside the connector terminals.

NOTE *The two connectors have just one correct positioning. Make sure to position them in the right direction.*

- Then fit the two connectors. Make sure they are correctly coupled (a click will be heard if hooks are present).

TIGHTENING TORQUE SETTINGS

DANGER
Always remember that the tightening torque settings of all wheel, brake, wheel shaft and other suspension parts play a fundamental role to ensure vehicle safety. Make sure that these values are always within the specified limits.
Check fastening parts tightening torque settings at regular intervals. Upon reassembly, always use a torque wrench.
Failure to comply with these recommendations could lead to the loosening and detachment of one of these parts with a consequent locking of the wheel or other serious troubles affecting the vehicle manoeuvrability, and thus the risk of falls and serious injuries or death.

1.3. DANGEROUS ELEMENTS

1.3.1. WARNINGS

FUEL

DANGER
The fuel used to operate engines is highly flammable and becomes explosive under particular conditions.
Refuelling and engine service should take place in a well-ventilated area with the engine stopped.
Do not smoke when refuelling or in the proximity of sources of fuel vapours, avoid flames, sparks and any element that could ignite fuel or provoke explosions.
Take care not to spill fuel out of the filler, or it may ignite when in contact with hot engine parts.
In the event of accidental fuel spillage, make sure the affected area is fully dry before starting the engine. Fuel expands from heat and when left under direct sunlight.
Never fill the fuel tank up to the brim. Tighten the filler cap securely after each refuelling.
Avoid contact with skin. Do not inhale vapours. Do not swallow fuel. Do not transfer fuel between different containers using a hose.
DO NOT DISPOSE OF FUEL IN THE ENVIRONMENT.
KEEP AWAY FROM CHILDREN.

Use only premium grade unleaded petrol, min. O.N. 95 (RON) and 85 (MON).

LUBRICANTS

DANGER
A good lubrication ensures the vehicle safety.
Failure to keep the lubricants at the recommended level or the use of a non-suitable new and clean type of lubricant can lead to the engine or gearbox seizure, thus causing serious accidents, personal injury or even death.
Gear fluid may cause serious damage to the skin if handled daily and for long periods.
Wash your hands carefully after use.
Do not dispose of oil in the environment.
Take it to the filling station where you usually buy it or to an oil salvage centre.

WARNING
When filling the vehicle with this oil, take care not to spill it out. Immediately clean spilt oil, or it might damage the vehicle paintwork.
In case of contact with oil, the tyres surface will become very slippery, thus becoming a serious danger for your safety.
In case of leaks, do not use the vehicle. Check and trace the cause of leaks and proceed to repair.

ENGINE OIL

DANGER
Engine oil may cause serious damage to the skin if handled daily and for long periods.
Wash your hands carefully after use.
Do not dispose of oil in the environment.
Dispose of gearbox fluid through the nearest waste oil reclamation firm or through the supplier.
Wear latex gloves when servicing.

FRONT FORK FLUID

DANGER
Front suspension response can be modified to a certain extent by changing damping settings and/or selecting a particular grade of oil. Standard oil viscosity: SAE 20 W. Different oil grades can be selected to obtain a particular suspension response (choose SAE 5W for a softer suspension, 20W for a stiffer suspension).
The two grades can also be mixed in varying solutions to obtain the desired response.

BRAKE FLUID

NOTE *This vehicle is fitted with front and rear disc brakes. Each braking system is operated by an independent hydraulic circuit. The information provided below applies to both braking systems.*

DANGER
Do not use the vehicle in case brakes are worn out or do not work properly. The brakes are the parts that most ensure your safety and for this reason they must always be perfectly working. Failure to comply with these recommendations will probably lead to a crash or an accident, with a consequent risk of personal injury or death.
A wet surface reduces brakes efficiency.

DANGER
In case of wet ground the braking distance will be doubled, since both brakes and tyre grip on the road surface are extremely reduced by the water present on the road surface.
Any water on brakes, after washing the vehicle or driving on a wet road surface or crossing puddles or gips, can wet brakes so as to greatly reduce their efficiency.
Failure to comply with these recommendations may lead to serious accidents, with a consequent risk of severe personal injuries or death.
Brakes are critical safety components. Do not ride the vehicle in case brakes are not working at their best.
Check for brakes proper operation before every trip.
Brake fluid is an irritant. Avoid contact with eyes or skin.
In the event of accidental contact, wash affected body parts thoroughly. In the event of accidental contact with eyes, contact an eye specialist or seek medical advice.
DO NOT RELEASE BRAKE FLUID INTO THE ENVIRONMENT.
KEEP AWAY FROM CHILDREN.
When handling brake fluid, take care not to spill it onto plastic or paint-finished parts or they will damage.

DANGER
Do not use any brake fluids other than the specified type. Never mix different types of fluids to top up level, as this will damage the braking system.
Do not use brake fluid from containers which have been kept open or in storage for long periods.
Any sudden changes in play or hardness in the brake levers are warning signs of problems with the hydraulic circuits.
Ensure that the brake discs and brake linings have not become contaminated with oil or grease. This is particularly important after servicing or inspections.
Make sure the brake lines are not twisted or worn.
Prevent accidental entering of water or dust into the circuit.
Wear latex gloves when servicing the hydraulic circuit.

DISC BRAKES

DANGER
The brakes are the parts that most ensure your safety
and for this reason they must always be perfectly working; check them before every trip.
A dirty disc soils the pads.
Dirty pads must be replaced, while dirty discs must be cleaned with a high-quality degreaser.
Perform the maintenance operations with half the indicated frequency if the vehicle is used in rainy or dusty areas, on uneven surfaces or for racing.
Check brake pads for wear.
When the brake pads wear out, the level of the fluid decreases to automatically compensate for their wear.
The front brake fluid reservoir is located on the right handlebar, near the front brake lever.
The rear brake fluid reservoir is located under the right fairing.
Do not use the vehicle if the braking system leaks fluid.

COOLANT

DANGER
Coolant is toxic when ingested, contact with eyes or skin may cause irritation.
In the event of contact with your skin or eyes, rinse repeatedly with abundant water and seek medical advice. In the event of ingestion, induce vomiting, rinse mouth and throat with abundant water and seek medical advice immediately.
DO NOT RELEASE INTO THE ENVIRONMENT.
KEEP AWAY FROM CHILDREN.

DANGER
Take care not to spill coolant onto hot engine parts. It may ignite and produce invisible flames. Wear latex gloves when servicing.
Do not ride when coolant is below the minimum level.

Coolant mixture is a 50% solution of water and antifreeze. This is the ideal solution for most operating temperatures and provides good corrosion protection.
This solution is also suited to the warm season, as it is less prone to evaporative loss and will reduce the need for top-ups.
In addition, less water evaporation means fewer minerals salts depositing in the radiator, which helps preserve the efficiency of the cooling system.
When the temperature drops below zero degrees centigrade, check the cooling system frequently and add more antifreeze (up to 60% maximum) to the solution, if needed.
Use distilled water in the coolant mixture. Tap water will damage the engine.
Refer to the chart given below and add water with the quantity of antifreeze to obtain a solution with the desired freezing point:

Freezing point °C	Coolant % of volume
-20°	35
-30°	45
-40°	55

NOTE *Coolants have different specifications. The protection degree is written on the label.*

WARNING
Use nitrite-free coolant only, with a protection until at least -35°C.

DRIVE CHAIN

Check drive chain operation, wear, slack and lubrication at regular intervals.
The vehicle is equipped with an endless chain with a joint link.

WARNING
If too slack, the chain can come off the front or rear sprockets thus leading to serious accidents and damage to the vehicle, with consequent serious personal injury or death.
Do not use the vehicle if the chain slack has not been correctly adjusted.
To check the chain, take it with your hand where it turns on the rear sprocket and pull it as to separate it from the sprocket itself.
If you can move the chain apart of the front sprocket for more than 3 mm (0.125 in), change chain, front and rear sprocket.

DANGER
If not properly maintained, chain can early wear out and lead to the damage of both front and rear sprockets.
Perform chain maintenance operations more frequently if the vehicle is used on dusty or muddy areas.

TYRES

WARNING
If tyres are excessively inflated, the vehicle will be hard, difficult and uncomfortable to ride.
In addition, the roadworthiness, mainly on wet surfaces and during cornering, will be impaired.
Flat tyres (insufficient pressure) can slip on the rim and make you lose the control of the vehicle.
In this case too, both vehicle roadworthiness, manoeuvrability and brake efficiency will be impaired.
Tyres changing, repair, maintenance and balancing must be carried out by specialized technicians using suitable equipment.
When new, tyres can have a thin slippery protective coating. Drive carefully for the first kilometres (miles).
Never use rubber treating substances on tyres.
In particular, avoid contact with fluid fuels, leading to a rapid wear.
In case of contact with oil or fuel, do not clean but change the tyres.

DANGER
Some of the factory-assembled tyres of this vehicle are provided with wear indicators.
There are several kinds of wear indicators.
For more information on how to check the wear, contact your Dealer.
Visually check if the tyres are worn and in this case have them changed.
If a tyre deflates while driving, stop immediately.
Avoid hard brakings or moves and do not close throttles too abruptly.
Slowly close the throttle grip, move to the edge of the road and use the engine brake to slow down until coming to a halt.
Failure to comply with these recommendations may lead to accidents, with a consequent risk of personal injuries or death.
Do not install tyres with air tube on rims for tubeless tyres and vice versa.

1.4. RUNNING-IN

1.4.1. RUNNING-IN

Correct engine running-is essential to ensuring proper performance and durability.
If possible, drive on hilly roads and/or roads with many bends, so that the engine, the suspensions and the brakes undergo a more effective running-in.
During running-in, change speed.
In this way the components are first "loaded" and then "relieved" and the engine parts can thus cool down.
Even if it is important to stress the engine components during running-in, take care not to exceed.

WARNING
Only after the first 2000 km (1250 mi) of running-in is it possible to obtain the best acceleration performance from the vehicle.

Keep to the following indications:

- Do not open the throttle completely if the speed is low, both during and after running-in.
- During the first 500 km (312 mi) pull the brakes with caution, avoiding sharp and prolonged brakings. This ensures a correct bedding-in of the pads on the brake discs.
- During the first 500 km (312 mi), never exceed 4000 rpm (see table).
- From 500 km (312 mi) up to 1000 km (625 mi), never exceed 5000 rpm.

DANGER
After the first 1000 km (621 mi), have the checking operations indicated in the column "After running-in" carried out by an aprilia Authorised Dealer, see REGULAR SERVICE INTERVALS CHART, in order to avoid hurting yourself or other people and/or damaging the vehicle.

- Between the first 1000 km (625 mi) and 2000 km (1250 mi) drive more briskly, change speed and use the maximum acceleration only for a few seconds, in order to ensure better coupling of the components; never exceed 5500 rpm (see table).
- After the first 2000 km (1250 mi) you can gradually squeeze some more power out of your engine.

Recommended maximum rpm	
Mileage Km (mi)	rpm
0-500 (0 - 312)	4000
500-1000 (312-625)	5000
1000 – 2000 (625-1250)	5500

GENERAL TECHNICAL INFORMATION 2

SUMMARY

2.1. TECHNICAL INFORMATION

2.1.1. TECHNICAL DATA

ENGINE	
Model	MY660
Type	Single-cylinder, 4 strokes with 4 valves and one overhead camshaft
Number of cylinders	1
Total displacement	660 cu. cm (40.27 cu in).
Max. rated power (at the crankshaft)	35 Kw (47 HP) at 6250 rpm
Max. torque	59.0 Nm (6.02 Kgm) at 5250 rpm
Bore/stroke	100.0 mm /84.0 mm (3.94 in /3,31 in).
Compression ratio	10 : 1
Idling speed	1500 ± 100 rpm
Water temperature	80°C (176°F).
Oil temperature	55 ÷ 60 °C (131 ÷140 °F)
Standard compression pressure (at sea level):	650 kPa (6.5 kg/sq. cm, 92.4 psi) at 800 rpm
Valve timing: Intake opens at Intake closes at Exhaust opens at Exhaust closes at	 25° BTDC 55° ABDC 60° BBDC 20° ATDC
Intake valve clearance	0.09 – 0.13 mm (0.0035 – 0.0051 in.)
Exhaust valve clearance	0.16 – 0.20 mm (0.0063 – 0.0079 in.)
Ignition	Ignition via transistor (digital) coil
Starting	Electric starter
Spark advance	9.0° BTDC at 1,400 rpm
Air filter	With dry filter cartridge
Clutch	
Type	Multiplate, wet clutch with control on the left side of the handlebar
Driving plates 1	# plates: 4
	Inner diameter: 128 mm
	Thickness: 2.90 – 3.10 mm (0.114 – 0.122 in.)
Driving plates 2	# plates: 2
	Thickness: 2.92 – 3.08 mm (0.115 – 0.121 in.)
Driving plates 3	# plates: 1
	Inner diameter: 128 mm
	Thickness: 2.90 – 3.10 mm (0.114 – 0.122 in.)
Clutch plates	# plates: 6
	Thickness: 1.50 – 1.70 mm (0.059 – 0.067 in.)
	Maximum oval: 0.20 mm (0.0079 in.)
Clutch springs	Length when not under compression: 55.6 mm (2.19 in.)
	Service limit: 52.82 mm (2.08 in.)
	# springs: 5
Lubricating system	
Type	Dry pan with separated oil tank
Oil filter	Paper type
Engine oil quantity	2900 cu. cm (0.63 gal)
	Periodic oil change: 2500 cu. cm (0.55 gal)
	When changing oil filter: 2700 cu. cm (0.60 gal)
Cooling system	
Type	Liquid
Water pump	Centrifugal pump with single intake
	Reduction ratio: 27/28 (0.964)
Thermostatic valve	Start opening at: 71°C (160 °F) Complete opening at: approx. 85°C (185 °F)

TRANSMISSION SYSTEM				
Gear ratios				
Ratio	Primary	Secondary	Final ratio	Total ratio
1st	36/75 = 1: 2.083	12/30 = 1: 2.267	15/44 = 1: 2.933	15.278
2nd		16/26 = 1: 1.632		9.930
3rd		20/23 = 1: 1.300		7.028
4th		22/20 = 1: 1.091		5.556
5th		26/20 = 1: 0.960		4.700
FUEL SYSTEM				
Type		Electronic injection		
Throttle		Ø 45.5 mm		
FUEL SYSTEM				
Fuel		Premium-grade unleaded petrol, minimum octane rating 95 (RON) and 85 (MON), as per DIN 51 607.		
SPARK PLUGS				
Standard		NGK CR7E		
Spark plug electrode gap		0.7 – 0.8 mm (0.027 – 0.031 in.)		
Resistance		5 KΩ		
ELECTRIC SYSTEM				
Generator (with permanent magnet)		12 V – 290 W		
Starter motor		12 V – 0.8 kW		

2.1.2. LUBRICANT TABLE

LUBRICANT	PRODUCT
Engine oil	RECOMMENDED: IP EXTRARIDE 4, SAE 15W – 50. As an alternative to recommended oils, top brand oils meeting or exceeding CCMC G-4, A.P.I. SG specifications can be used.
Front fork fluid	RECOMMENDED: IP F.A. 5W or IP F.A. 20W. When you wish to obtain an intermediate response between those offered by IP F.A. 5W and IP F.A. 20W oils, you may mix the different products as follows: SAE 10W = IP F.A. 5W 67% of volume, + IP F.A. 20W 33% of volume, SAE 15W = IP F.A. 5W 33% of volume, + IP F.A. 20W 67% of volume,
Bearings and other lubrication points	RECOMMENDED: IP AUTOGREASE MP. As an alternative to recommended grease, use top brand rolling bearing grease that will resist a temperature range of -30°C to +140°C (- 22 °F to + 284°F), with dripping point 150°C to 230 °C (302°F to 446°F), high corrosion protection, good resistance to water and oxidisation.
Battery terminals	Use neutral grease or Vaseline.
Chains	RECOMMENDED spray grease: IP CHAIN SPRAY.
Brake fluid	RECOMMENDED: IP F.F. DOT 4 (the braking system is also compatible with DOT 5). ***NOTE*** *Use new brake fluid only. Do not mix different makes or types of oil without having checked bases compatibility.*
Engine coolant	RECOMMENDED: IP ECOBLU – 40° C (- 40°F). ***NOTE*** *Use only nitrite-free antifreeze and corrosion inhibitors with a freezing point of - 35°C (- 31°F) as a minimum.*

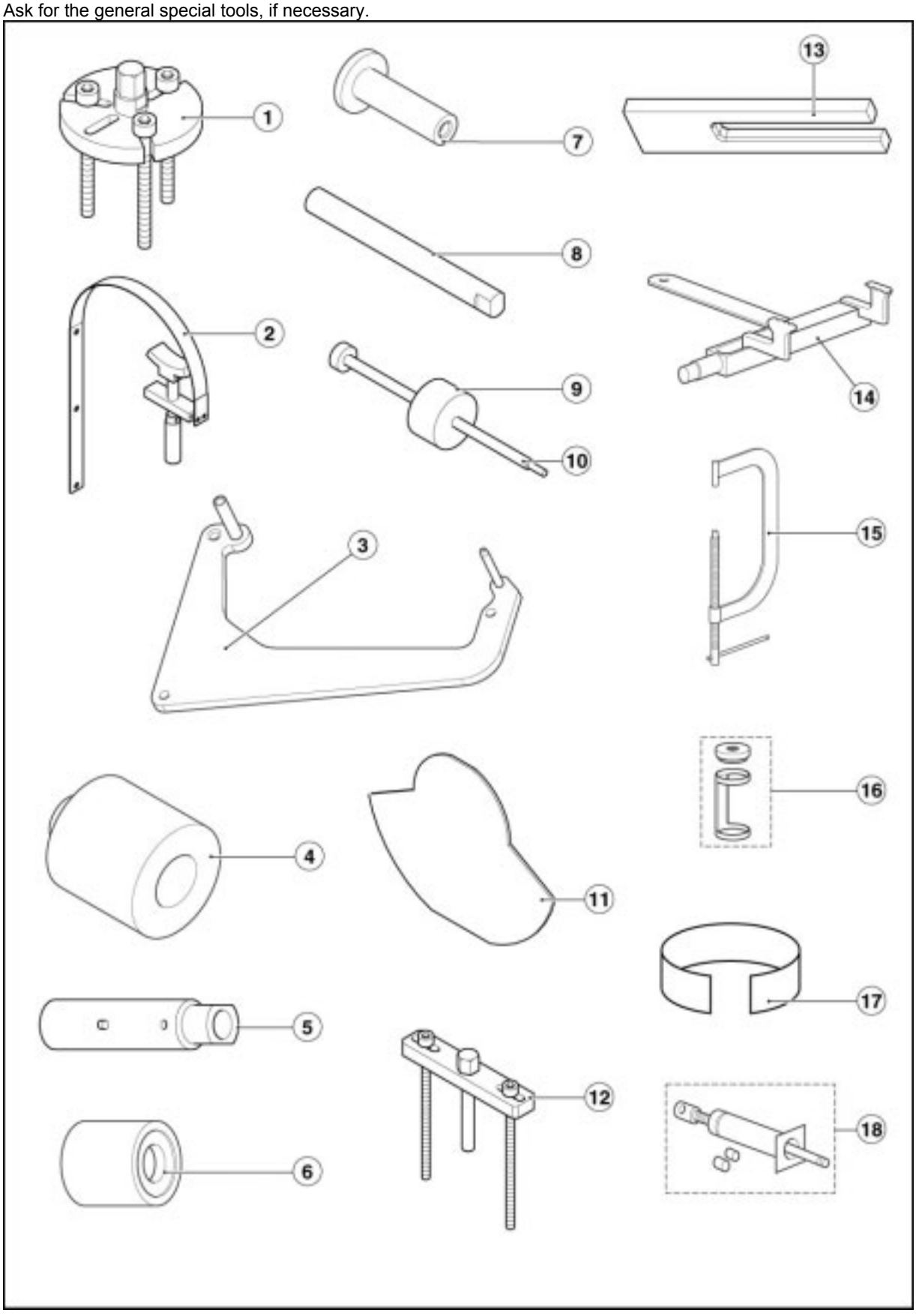
2.1.3. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 - 1.5	
Valve cover and timing cover screws	0.8 - 1.2	
Oil channel hose screws 1	1.6 - 2.0	
Spark plug	1.0 - 1.5	
Oil channel hose screws 2	1.7 - 2.3	
Oil channel hose side screw 2	0.8 - 1.2	
Intake manifold clamps screws	0.3 - 0.4	
AIS tube screws	0.8 - 1.2	
Sensor	1.6 - 2.0	
Thermostat cover screws	0.8 - 1.2	
Exhaust stud bolts	1.3 - 1.7	
Camshaft plate screws	0.8 - 1.2	Loctite 242 on thread

2.1.4. SPECIAL TOOLS

In order to perform assembly, reassembly and settings correctly, special tools suitable for the task must be used.
The use of special tools avoids the potential risk of damage as a result of inappropriate tools and/or improvised methods.
The special tools developed specifically for this vehicle are listed below.
Ask for the general special tools, if necessary.



Pos.	Description	Part number
1	Flywheel puller	8140837
2	Flywheel rotor locking tool	8140838
3	Engine support plate	8140839
4	Crankshaft spacer	8140845
5	Crankshaft adapter	8140844
6	Water pump installing tool	8140841
7	Crankshaft installing tool	8140846
8	Crankshaft installing tool	8140847
9	Rocker arm shaft puller weight	8140849
10	Rocker arm shaft puller	8140848
11	Flywheel cover opening	8140850
12	Crankcase separation tool	8140853
13	Connecting rod locking tool	8140840
14	Clutch locking tool	8600391
15	Valve spring compression tool	8140179
16	Valve spring compression tool adapter	0276474
17	Piston ring compression tool	0276357
18	Puller for piston-gudgeon pin	8600388

ENGINE 3

SUMMARY

3.1. ENGINE ACCESSORIES

3.1.1. REMOVAL

- Position the engine on the engine support (no. 8140839).

NOTE *Before removing the accessories, drain all fluids from the engine and set a suitable collector under it.*

- Undo the two screws and loosen the clips.
- Remove the throttle body.

- Remove the spark plug.

- Loosen and remove the two screws and remove the secondary air hose, collect the metal gasket.

- Remove the oil delivery hose, collect the O-ring.

- Release the clamp and remove the oil tank breather hose.

- Loosen and remove the two screws, remove the oil hose and collect the four washers.

- Loosen and remove the two screws and remove the starter motor.

- Release the clamp and remove the crankcase breather tank hose.

- Loosen and remove the screw and remove the speed sensor.

- Loosen the screw and disconnect the neutral sensor.

- Loosen and remove the screw and remove the cable guide.

- Remove the hose, collect the dowel and the snap ring.

- Loosen and remove the screw (1), remove the cable ring (2).
- Loosen and remove the two screws, remove the oil delivery hose and collect the four washers.

- Refit the accessories as above described, following the procedure in the reverse order.

3.1.2. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 ÷ 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 ÷ 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 ÷ 1.2	
Bearing plate and oil filter screws	0.8 ÷ 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 ÷ 1.2	Loctite 620 on thread
Oil Drain screw	2.7 ÷ 3.3	
Chain sprocket nut	11.0 ÷ 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 ÷ 0.6	Loctite 620 on thread
Oil pump screws	0.8 ÷ 1.2	
Oil pump gear cover screws	0.35 ÷ 0.45	Loctite 620 on thread
Counter shaft nut	6.0 ÷ 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 ÷ 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 ÷ 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 ÷ 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 ÷ 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 ÷ 1.2	
Water pump and water pump union screw	0.8 ÷ 1.2	
Speed sensor and oil filter cover screws	0.8 ÷ 1.2	
Oil filter bleed screw	0.3 ÷ 0.7	
Cylinder screws	4.8 ÷ 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 ÷ 1.2	
Head screws	4.8 ÷ 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 ÷ 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 ÷ 1.2	
Timing gearwheel screws	1.8 ÷ 2.2	
Water hose union screws	0.8 ÷ 1.2	
Chain guide screw 1	0.6 ÷ 1.0	
Freewheel-rotor screws	2.7 ÷ 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 ÷ 1.2	
Chain tensioner screw	1.8 ÷ 2.2	
Flywheel nut	7.0 ÷ 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 ÷ 1.2	Loctite 620 on thread
PK screws	0.6 ÷ 0.8	Loctite 620 on thread
Stator screws	0.8 ÷ 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 ÷ 1.2	
Oil outlet hose screws	0.8 ÷ 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 ÷ 1.0	
E/S gears cover screws	0.8 ÷ 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

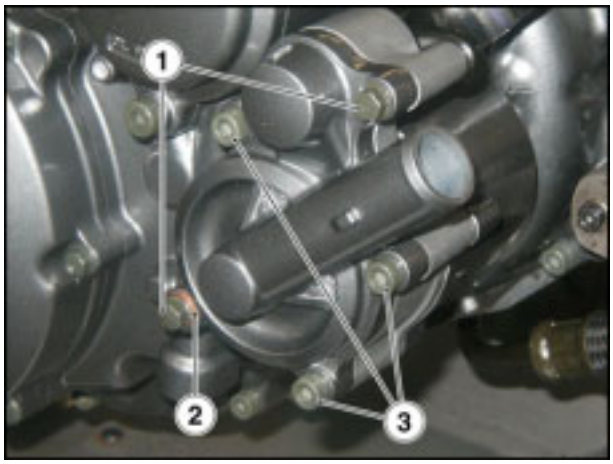
3.2. WATER PUMP

3.2.1. REMOVAL

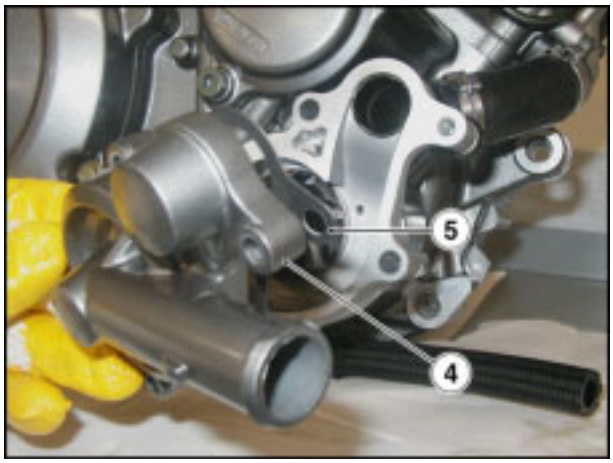
WARNING
Usually, it is not necessary to remove the coolant pump except in case the coolant level is extremely low or the coolant contains engine oil.

NOTE *Before removing the components, set a rag under the pump.*

- Unscrew and remove the two screws (1).
- Collect the washer (2).
- Loosen and remove the three screws (3).



- Remove water pump cover (4).
- Remove the gasket (5).

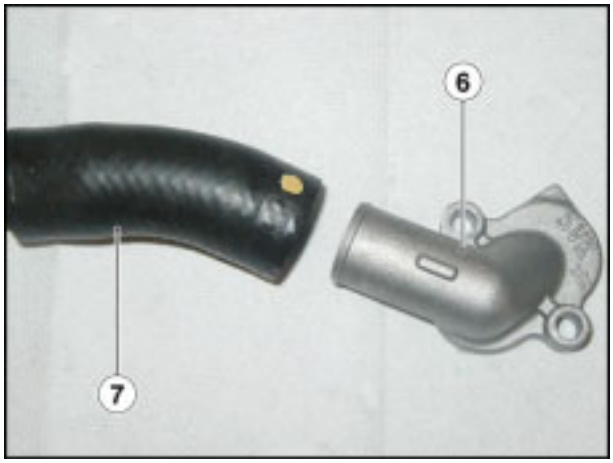


- Release and remove the two screws.

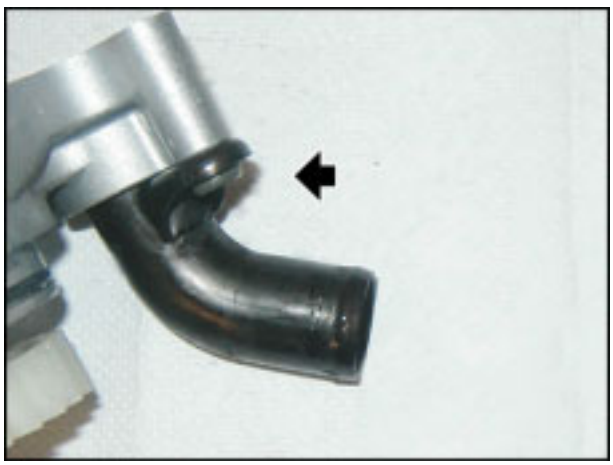
- Remove the pump unit.

- Release and remove the clamps.

- Remove water jacket joint (6).
- Slide out the water pump breather hose (7).



- Unscrew and remove the screw.
- Slide out the water pump outlet hose and collect the O-ring.



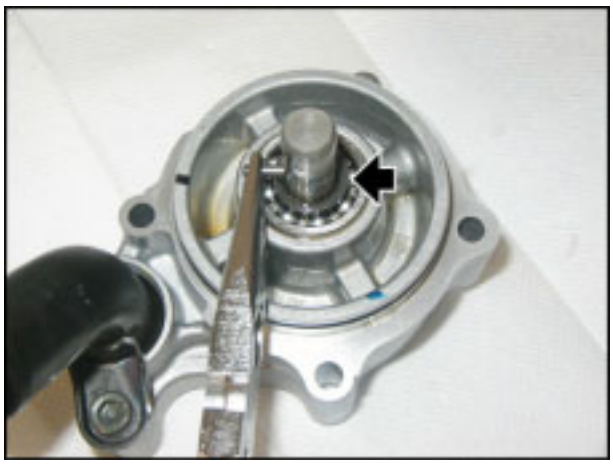
- Remove the seal.

3.2.2. DISASSEMBLY

- Remove the circlip.

- Remove the crankshaft gear.

- Slide out pin and washer.

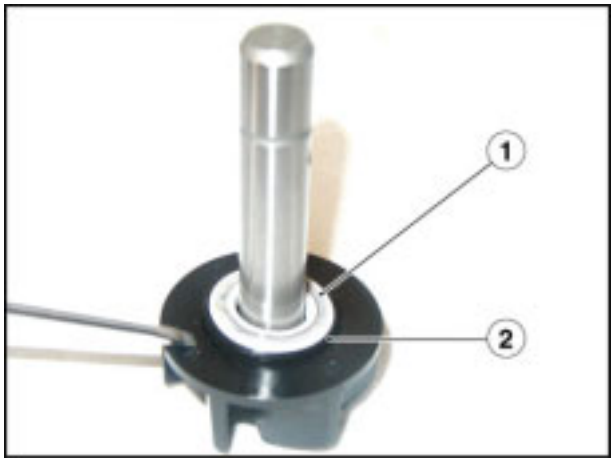


- Remove the rotor shaft assembly.

WARNING
Carefully remove the component, do not damage it.

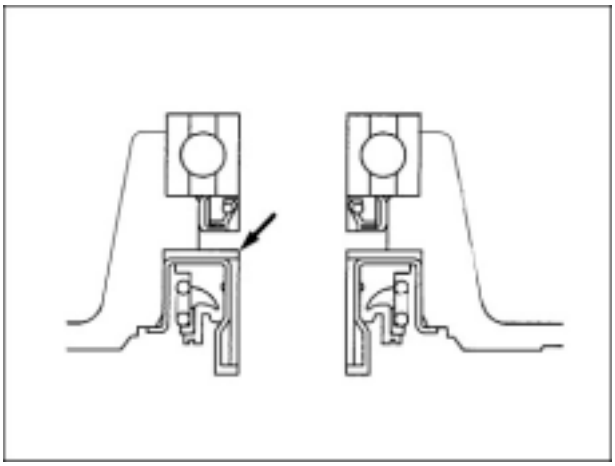
- Remove the support (1) and rubber dampener (2) from the rotor, using a screwdriver for flathead screws.

WARNING
Carefully remove the component, do not damage the rotor.



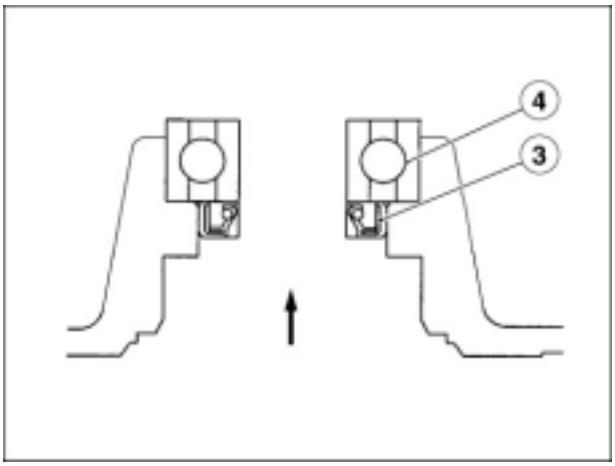
- Remove the water pump seal using a small screwdriver.

WARNING
Carefully work in the direction indicated by the arrow to avoid damaging the water pump seal edge.



- Remove the oil seal (3) and the bearing (4);

WARNING
Carefully work in the direction indicated by the arrow to avoid damaging the components.



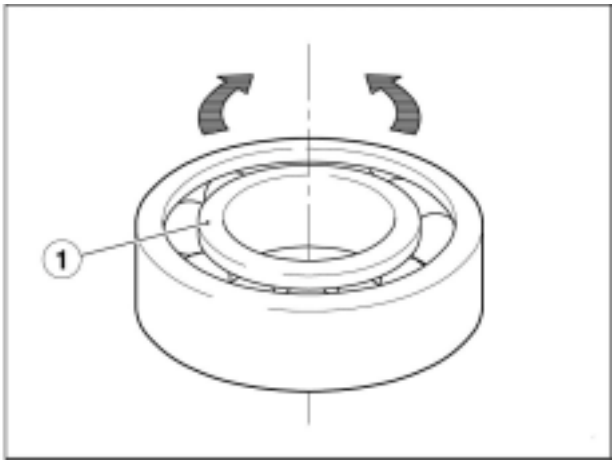
- Remove the seal.

3.2.3. CHECK

Component
Ensure that water pump cover, water pump housing, rotor, rubber damper are not damaged or worn. Replace if necessary.
Ensure that the water pump outlet hose, radiator outlet hose, water jacket outlet seat are not damaged or worn. Replace if necessary.

SEALS
Check that all seals are intact; change them if they are damaged or worn.

BEARINGS
Manually turn the inner ring (1), it should turn smoothly with no noise and/or hard spots.
No axial play should be noticed.
Faulty bearings should be changed.



3.2.4. REASSEMBLY

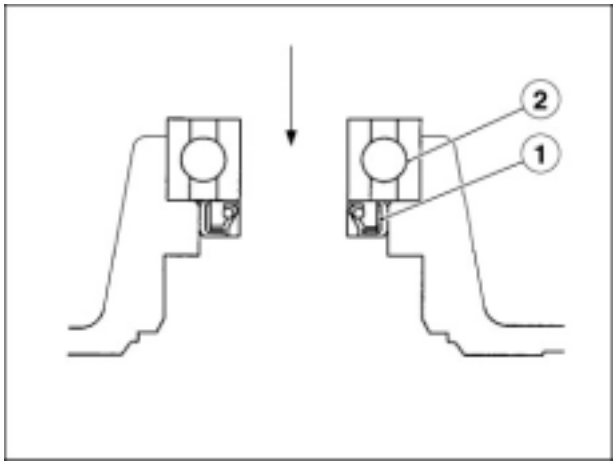
NOTE *Lubricate the oil seal before installing, see (LUBRICANT TABLE).*

Apply an emulsified solution on the oil seal outer diameter to help installation, see (LUBRICANT TABLE).

- Install a new oil seal (1) to the water pump housing. Install the oil seal using a suitably sized drift.

NOTE *Lubricate all bearing balls with engine oil, see (LUBRICANT TABLE).*

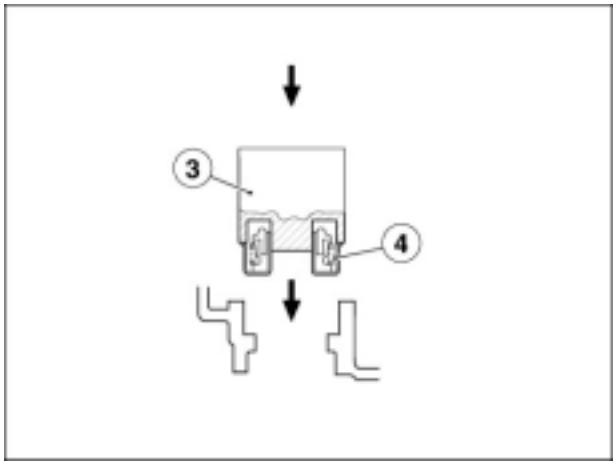
- Fit the bearing (2).



- Using water pump installation tool (3) (no. 8140841), install a new water pump gasket (4).

NOTE *Before refitting the water pump, apply an emulsified solution to the outer diameter to help installation, see (LUBRICANT TABLE).*

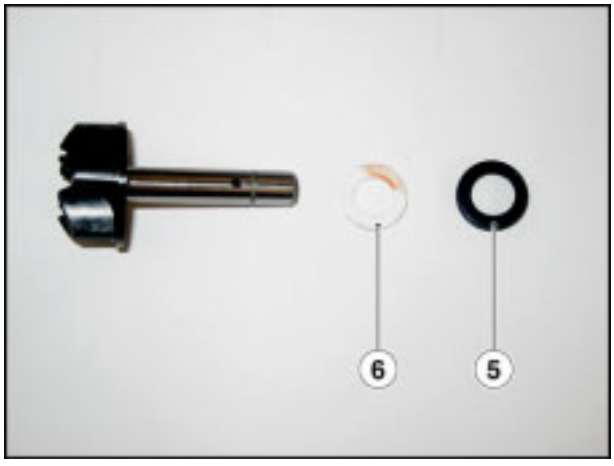
WARNING
Never lubricate the water pump seal with oil or grease.



NOTE *Before refitting the rubber damper, apply an emulsified solution to the outer surface to help installation, see (LUBRICANT TABLE).*

- Install a new rubber damper (5) and a new support (6).

NOTE *Ensure that the rubber damper and its support are flush with the rotor.*

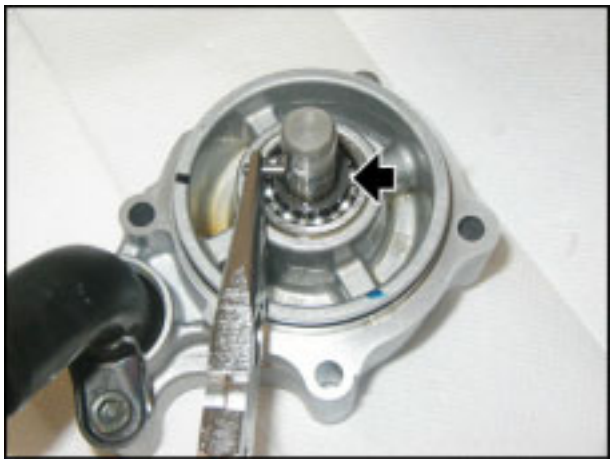


- Check rotor shaft inclination by resting a rule on damper (that should be flush with the rotor).
- Set a gauge on the reference rule and measure depth at right and left ends, at the damper.
- Turn the reference rule by 90° with respect to current position and repeat the same procedure.

Rotor shaft inclination limit: 0.15 mm (0.006 in).

- Should the reading not comply with allowed range, repeat rubber damper (6) and support (7) installation.
- Install the crankshaft assembly.

- Slide in washer and pin.



- Install the rotor shaft gear with marking facing out (in view).

- Install a new circlip.

NOTE *Once installed, manually turn the rotor shaft and ensure it turns smoothly, with no jamming and/or noise.*

3.2.5. INSTALLATION

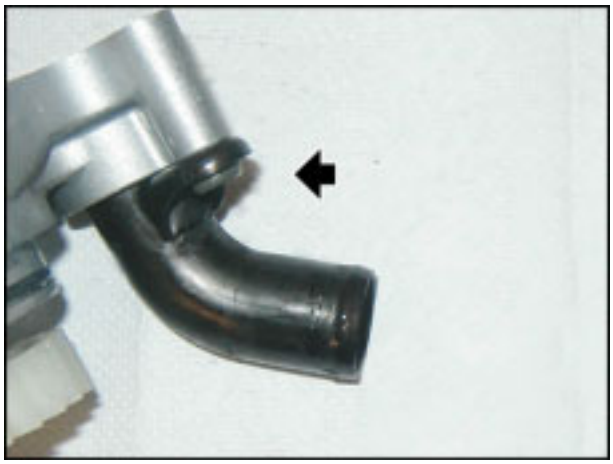
WARNING
When installing, only use new seals and clamps.

NOTE *Lubricate the oil seal before installing, see (LUBRICANT TABLE).*

Apply an emulsified solution on the oil seal outer diameter to help installation, see (LUBRICANT TABLE).

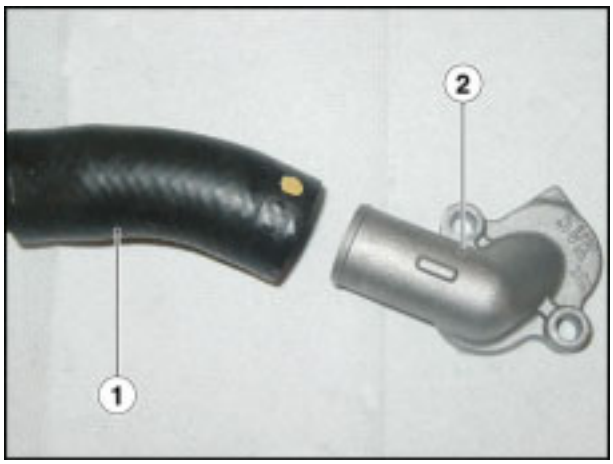
- Install the seal.

- Slide in the water pump outlet hose together with O-ring.
- Tighten the screw.



- Install the water pump breather hose (1) and water jacket joint (2).

NOTE *Install water pump breather hose so that it contacts the water jacket joint jut.*

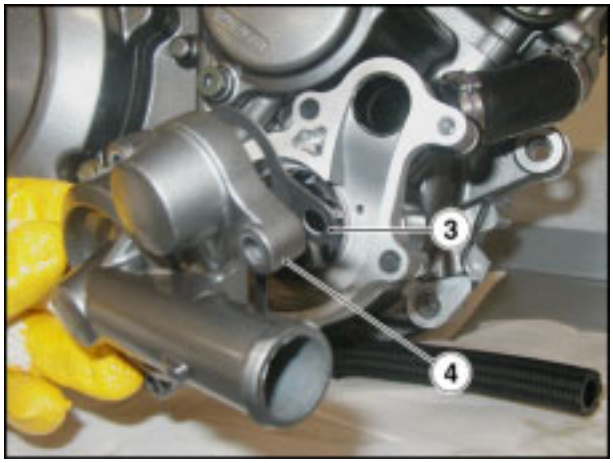


- Change the two clamps with new parts of the same type.
- Secure the two clamps.

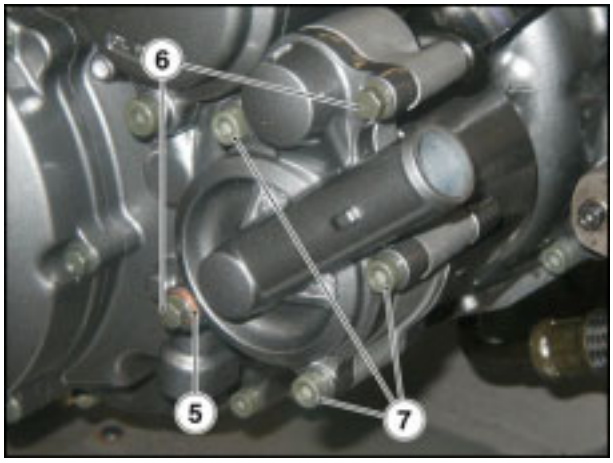
- Install the pump unit.

- Tighten the two screws.

- Install the gasket (3).
- Install water pump cover (4).



- Install the washer (5).
- Tighten the two screws (6).
- Tighten the three screws (7).



- Fill the cooling system with specified quantity of recommended coolant.
- Ensure there are no leaks, repair or change any faulty parts, if necessary.
- Measure radiator cap opening pressure and change it if reading is lower than threshold value.

3.2.6. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

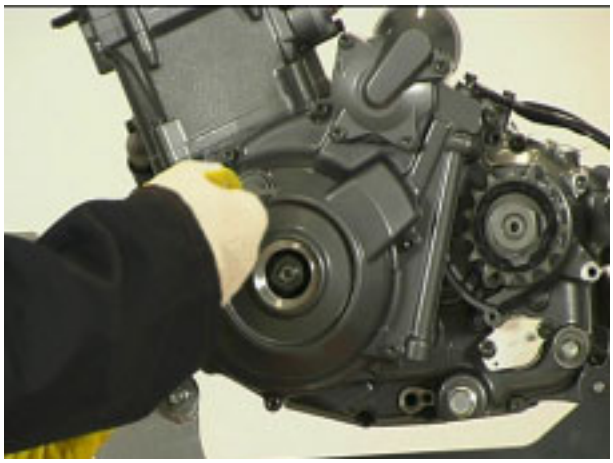
DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

3.3. CYLINDER HEAD

3.3.1. REMOVING THE CYLINDER HEAD

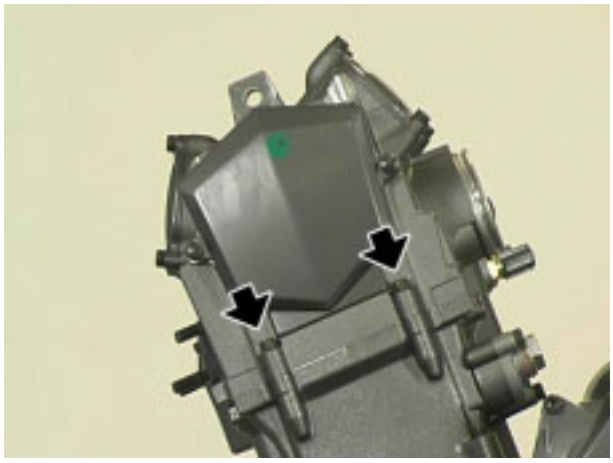
- Using the suitable special tool (no. 8140850), loosen and remove the flywheel cover giving access to the crankshaft.

- Using the suitable special tool (no. 8140850), loosen and remove the flywheel cover giving access to the timing reference.



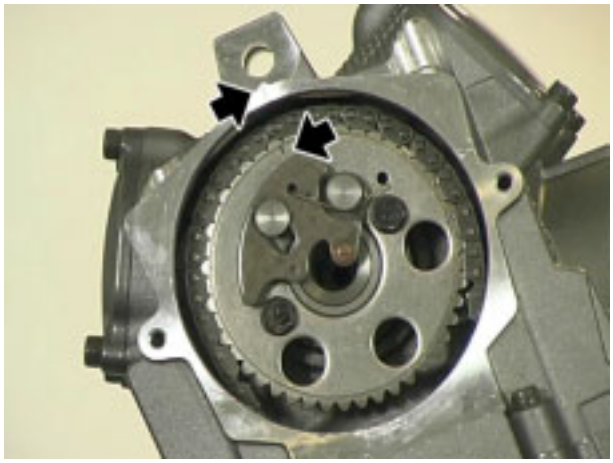
- Turn the crankshaft counter clockwise so to bring the piston to top dead centre in the combustion stage.
- This position is reached when flywheel reference mark “I” matches flywheel cover mark.

- Release and remove the two screws.



- Remove the gearwheel inspection cover, collect the seal.

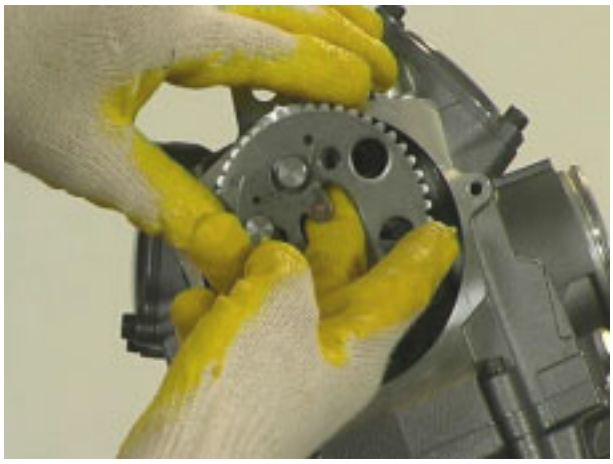
- Ensure that reference mark “I” on camshaft gearwheel matches cylinder head fixed reference mark.



- Loosen and remove the two screws and remove the timing chain tensioner.

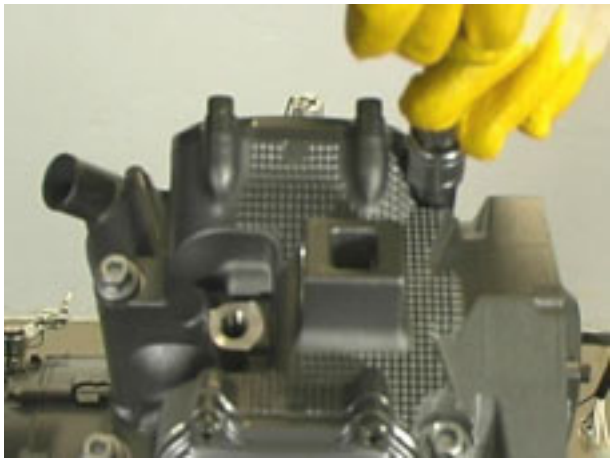
- Hold the flywheel nut with a wrench, loosen and remove the two screws on the camshaft gearwheel.

- Remove the camshaft gearwheel.



- Fix the timing chain with a tie.

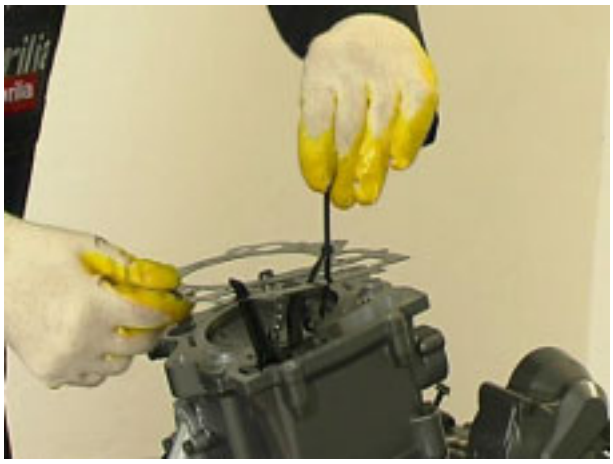
- Loosen and remove the four stud bolts in the order shown and collect the washers.



- Release and remove the two screws.

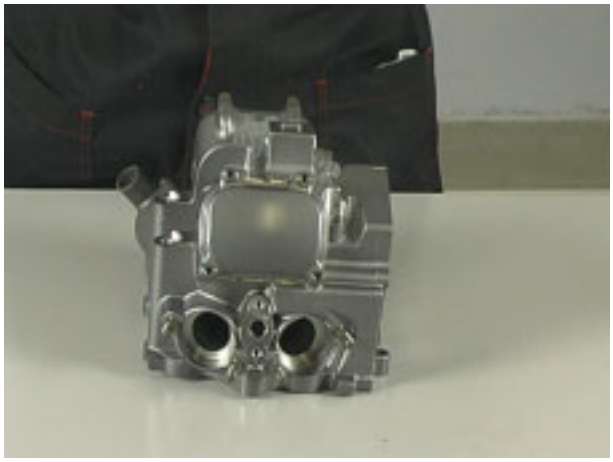
- Remove the cylinder head, pay attention to the timing chain and to the decompression system since it is free to move in its housing.

- Collect the seal and the two centring dowels.

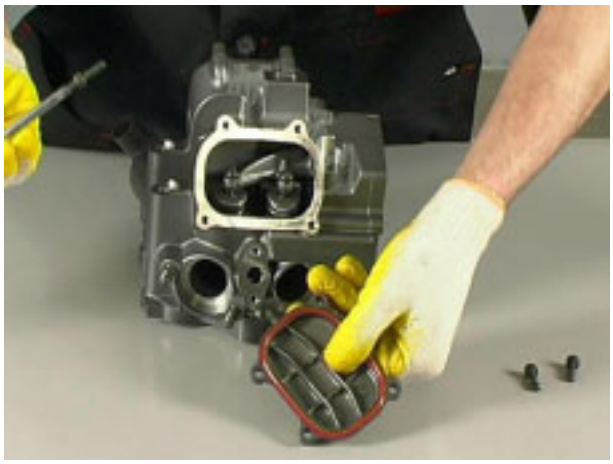


3.3.2. REMOVING THE ROCKER ARMS AND CAMSHAFT

- Working on either side, loosen and remove the four screws.



- Working on either side, remove the tappet cover, collect the O-ring.



- Loosen and remove the two adjuster screws.

- Remove the bearing snap ring.

- Using the suitable puller (no. 8140848), remove the decompression shaft.

- Using the suitable puller (no. 8140848), remove the exhaust rocker arm shaft.

- Remove the exhaust rocker arm.

- Using the suitable puller, remove the intake rocker arm shaft.

- Remove the intake rocker arm.

- The camshaft hole is shaped to ease removal.
- Carefully remove the camshaft, pay attention to the decompression chamber lever pin.

3.3.3. REMOVING THE VALVES AND VALVE SPRINGS

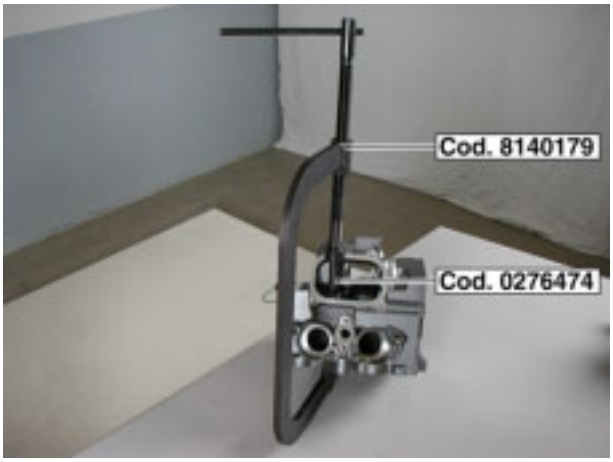
NOTE *The following procedure applies to all valves and their components.*

- Remove the rocker arms and camshafts, see (REMOVING THE ROCKER ARMS AND THE CAMSHAFTS).

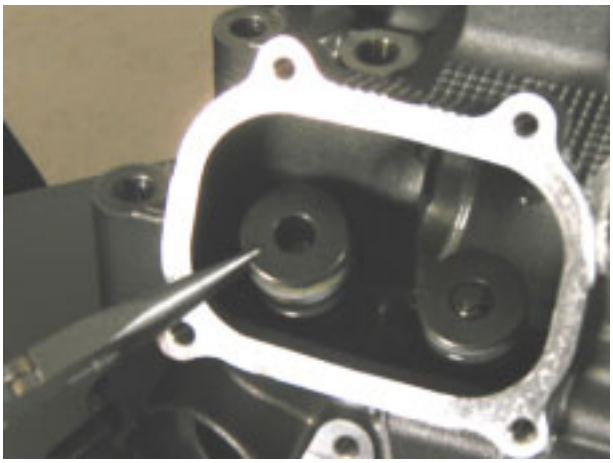
NOTE *Before removing the cylinder head components (valves, valve springs, valve seats), ensure that the valves are closed and seal correctly.*

NOTE *While removing, carefully mark the position of each part to ensure installation in the correct position.*

- Using valve spring compression tool (no. 8140179) and adapter (no. 0276474), remove the valve collets.

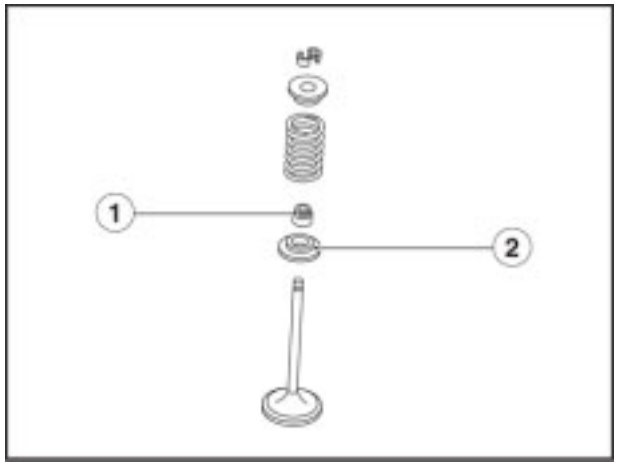


- Remove the valve spring retainer.



- Remove the valve spring.

- Remove the valve stem oil seal (1) and valve spring seat (2).



- Remove the valve.

3.3.4. CHECK

CHECKING THE HEAD

- Using a rounded-tip scraper, eliminate scale from combustion chamber.

NOTE *Do not use a tool with sharp edge or the spark plug thread and valve seats might be damaged or scratched.*

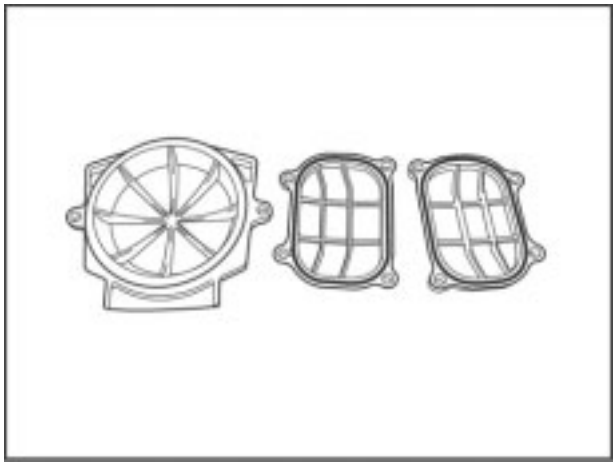
- Check for damages or scratches in the head and change, if necessary.
- Check for mineral deposits or rust in the head water jacket, eliminate them.

- Using a reference bar and a feeler gauge positioned transversally, measure head deformation.

Maximum head oval: 0.03 mm (0.0012 in.)

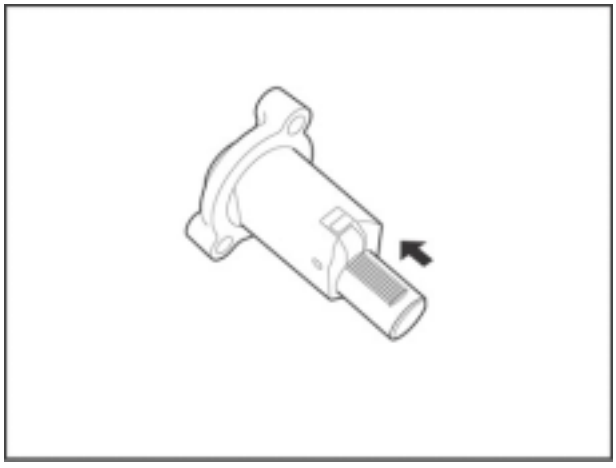
CHECKING THE TAPPETS COVERS AND THE CAMSHAFT GEARWHEEL COVER

- Check for damage or wear, change the faulty part(s).



CHECKING THE TIMING CHAIN TENSIONER

- Check for damages and change the part, if necessary.
- Check single-direction cam operation: if movement is jamming, change chain tensioner housing.
- Check for damage or wear on: timing chain threaded plug, copper washer, spring, single-direction cam, gasket, chain tensioner rod; change the faulty parts if necessary.



CHECKING THE CAMSHAFT GEARWHEEL

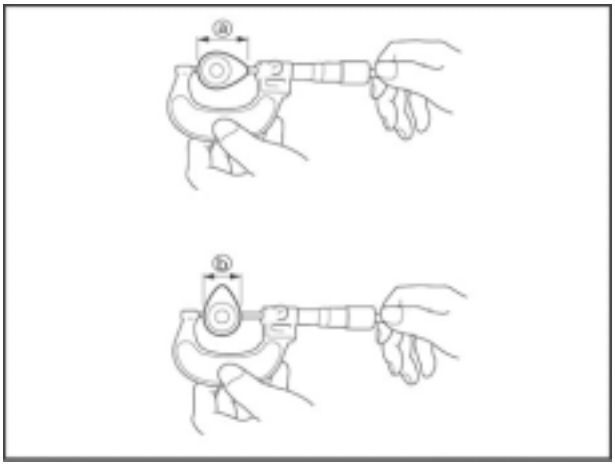
- Check camshaft gearwheel for proper operation: change timing chain and camshaft gearwheel as a set if you notice damages or hard spots.

CHECKING THE CAMSHAFT

CAMSHAFT LOBES

- Check for blueish stains, pitting, scratches and, if so, change camshaft and its gearwheel.

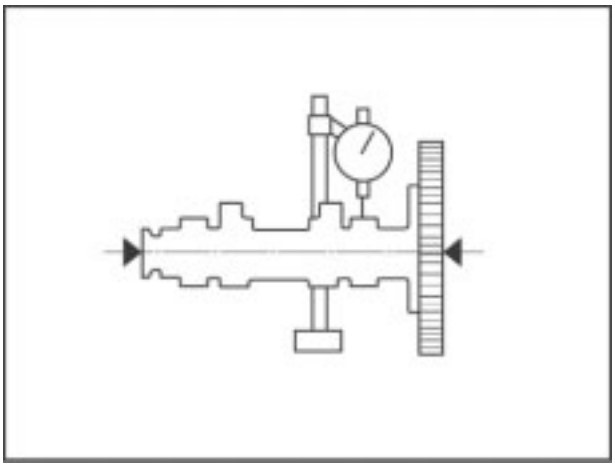
- Check with a micrometer camshaft lobes dimensions (a) and (b):



Camshaft lobes dimensions:

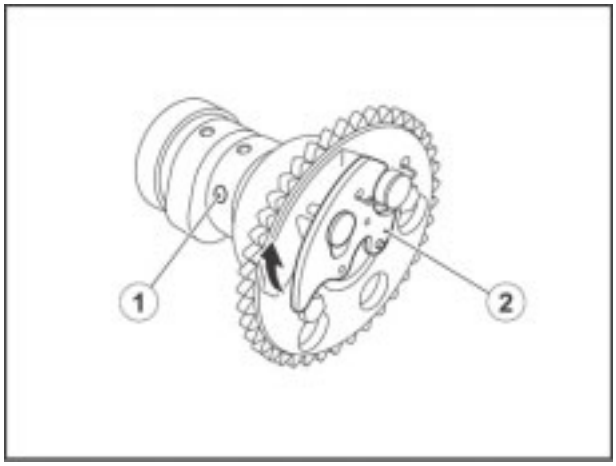
	Value	Limit
Intake		
a	43.488 ÷ 43.588 mm (1.7121 ÷1.7161 in)	43.388 mm (1.7062 in.)
b	36.959 ÷ 37.059 mm (1.4551 ÷1.4590 in)	36.840 mm (1.4504 in.)
Exhaust		
a	43.129 ÷ 43.229 mm (1.6980 ÷ 1.7019 in.)	42.983 mm (1.6922 in.)
b	37.007 ÷ 37.107 mm (1.4570 ÷ 1.4609 in.)	36.886 mm (1.4522 in.)

- Secure the camshaft in horizontal position, as shown, turn it and check its out of round with a dial gauge; change the part, if needed.



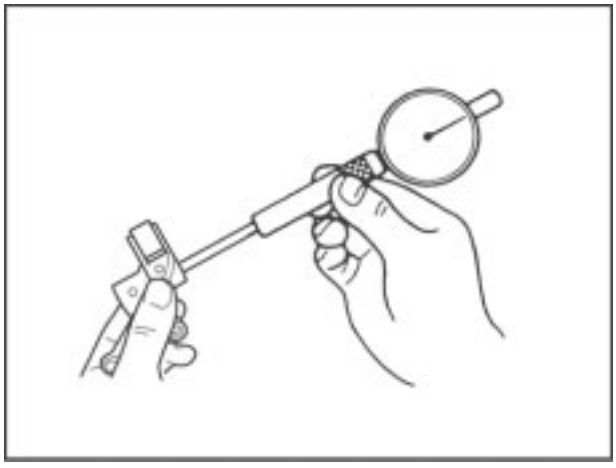
Maximum camshaft out of round:
0.040 mm (0.0016 in.)

CHECKING THE DECOMPRESSION SYSTEM



- Check decompression system with the camshaft gearwheel and decompression pin installed to the camshaft.
- Check that decompression lever pin (1) comes out further than the camshaft.
- Check that decompression cam (2) is free to move with no jams.

CHECKING THE ROCKER ARMS AND ROCKER ARM SHAFTS

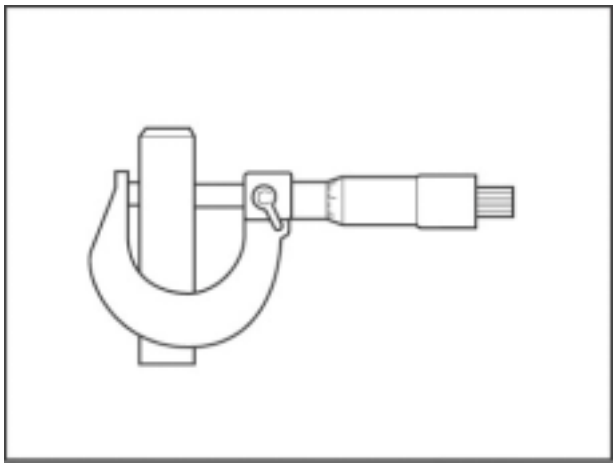


NOTE *The following procedure applies to rocker arms and rocker arm shafts.*

- Using an inside micrometer gauge, check rocker arm inner diameter and change, if necessary.

Rocker arm inner diameter:
12.000 ÷ 12.018 mm (0.4724 ÷ 0.4731 in.)

Service limit: 12.036 mm (0.4739 in.)



- Check that the rocker arm shaft outer diameter does not show blueish stains, pitting, scratches and if so, change the part.
- Using a micrometer, check rocker arm shaft outer diameter and change, if necessary.

Rocker arm inner diameter:
11.981 ÷ 11.991 mm (0.4717 ÷ 0.4721 in.)

Service limit: 11.955 mm (0.4707 in.)

- Calculate rocker arm to rocker arm shaft clearance.

NOTE *Calculate clearance as follows: rocker arm inner diameter - rocker arm shaft outer diameter.*

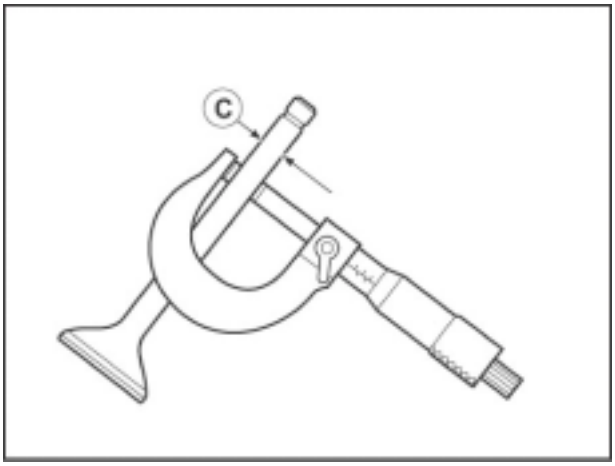
- Change the part if calculated clearance exceeds indicated limit value.

Rocker arm – rocker arm shaft clearance:
0.009 ÷ 0.037 mm (0.0004 ÷ 0.0015 in.)

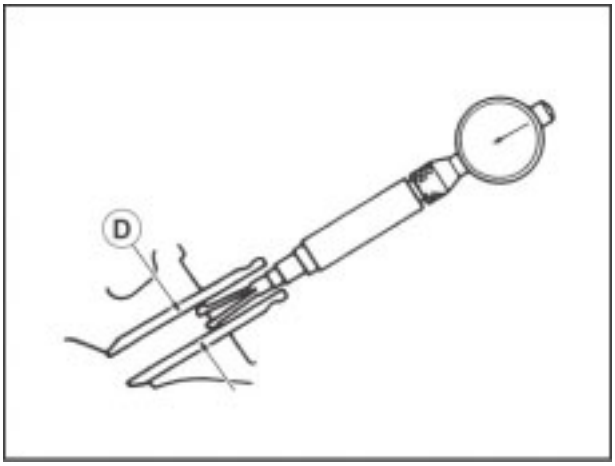
Service limit: 0.081 mm (0.0032 in.)

CHECKING VALVES AND VALVE GUIDES

NOTE *The following procedure applies to all valves and valve guides.*



- Using a micrometer, measure valve stem diameter (C).



- Using an inner micrometer gauge, measure valve guide inner diameter (D).
- Calculate valve stem to valve guide clearance (G) as follows:

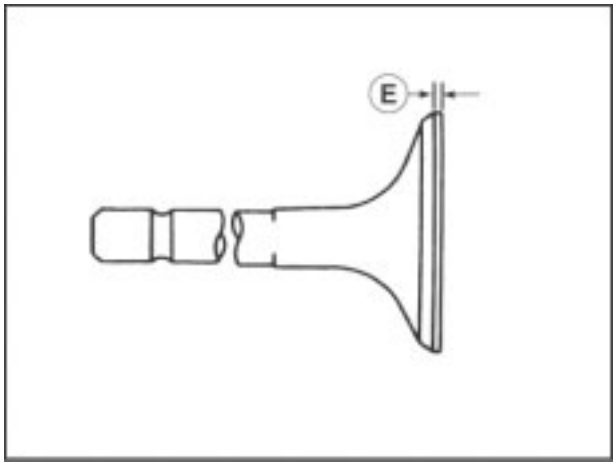
G = c – d

Valve stem - valve guide clearance:

	Value	Limit
Intake		
	0.010 ÷ 0.037 mm (0.0004 ÷0.0015 in)	0.08 mm (0.0031 in)
Exhaust		
	0.025 ÷ 0.052 mm (0.0010 ÷ 0.0020 in.)	0.10 mm (0.0039 in)

- Change the valve guide if clearance is outside specified range.

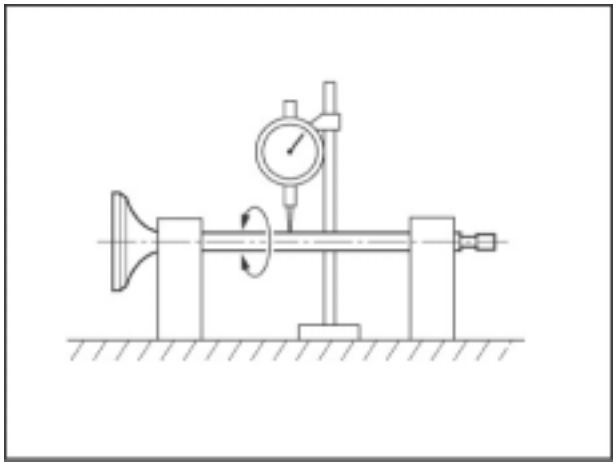
- Carry on checking valves and valve guides by eliminating scale from valve face and seat.
- Ensure that the valve face does not show pitting or marks of wear; grind valve face if necessary.
- Check that valve stem end does not have a "mushroom" shape or has a larger diameter; if so, change the valve.
- Check that thickness (E) of valve edge complies with indicated values and change valve, if needed.



Valve edge thickness:
0.80 ÷ 1.20 mm (0.0315 ÷ 0.0472 in.)

- Check that valve stem out of round falls within indicated values, change the valve if needed.
- Clamp the valve in horizontal as shown and turn it, use a dial gauge to check run out; change the part if necessary.

NOTE *When installing a new valve, always change the valve guide, too. Change valve stem oil seal every time valve is disturbed (removed or changed).*

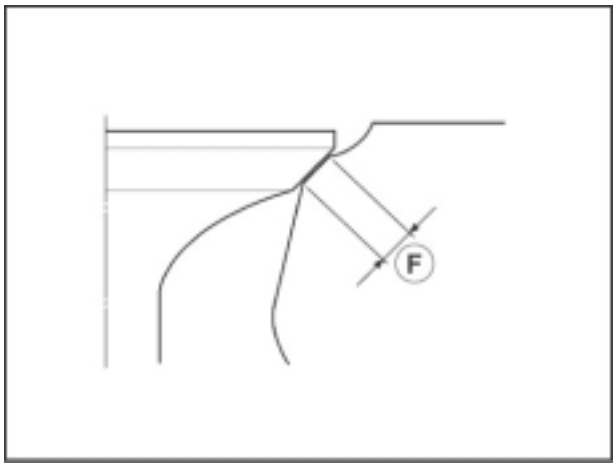


Maximum stem runout:
- **0.010 mm (0.0004 in.)**

CHECKING VALVE SEATS

NOTE *The following procedure applies to all valves and the valve seats.*

- Eliminate scale from valve face and valve seat.
- Ensure that the valve seat does not show pitting or marks of wear; change cylinder head if necessary.
- Check that valve seat complies with the indicated values and change the head, if needed.



- A- Apply Prussian blue (Dykem) on valve face.
- B- Install the valve to the head.
- C- Press the valve in the valve guide and in its seat so as to leave a clear mark. Prussian blue will no longer be in the areas where valve seat and valve face are in contact.
- D- Using a gauge, measure valve seat width. Should reading not fall within specified values, lap valve face and follow next indications.

Valve seat width:
Intake: 1.00 – 1.20 mm (0.0394 – 0.0472 in.)
Exhaust: 1.00 – 1.20 mm (0.0394 – 0.0472 in.)

- Lap valve face and valve seat, as follows.

NOTE *Once head or valve and valve guide have been changed, valve seat and face should be lapped.*

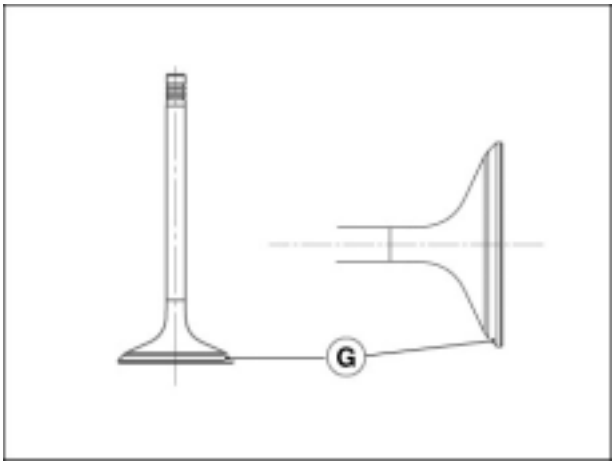
- A - apply a (coarse grain) lapping compound to valve face (G).

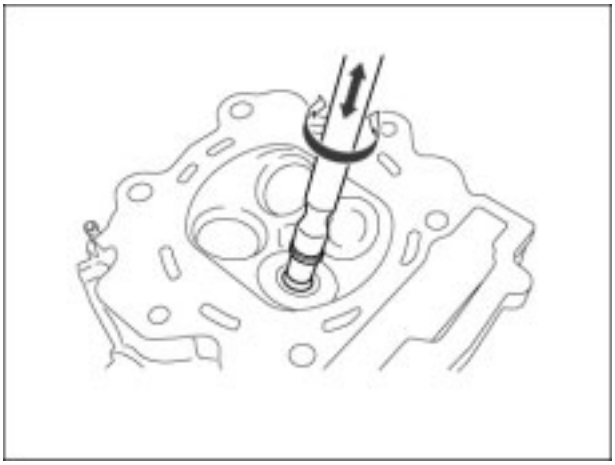
WARNING
Ensure that the lapping compound does not enter in-between valve stem and guide.

- B - Apply molybdenum disulphide oil on valve stem.
- C- Install the valve to the head.
- D - Turn the valve until valve face and seat are flat, carefully remove any residues of lapping compound.

NOTE *For lapping best results, slightly tap on valve seat while rotating it with your hands.*

- E - Apply a (fine grain) lapping compound to valve face and repeat steps B, C and D.
- F - After lapping, ensure you remove any trace of lapping compound from valve face and seat.
- G - Apply Prussian blue (Dykem) on valve face.
- H - Install the valve to the head.
- I - Press the valve in the valve guide and in its seat so as to leave a clear mark.
- J - Using a gauge, measure valve seat width again. Should reading not fall within specified values, grind and lap valve seat.





CHECKING VALVE SPRINGS

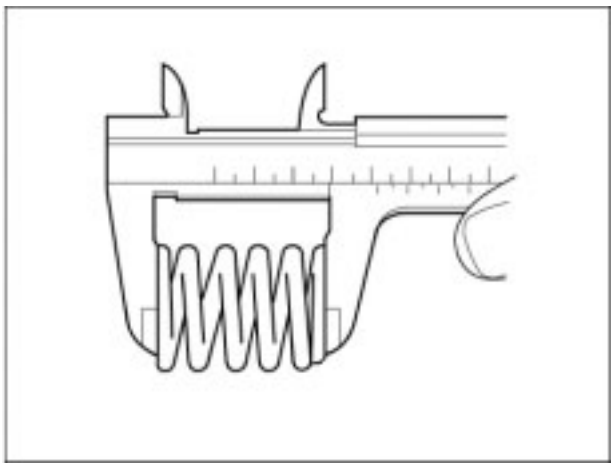
NOTE *The following procedure applies to all valves and the valve seats.*

- Using a gauge, measure valve spring uncompressed length. In case reading is not within indicated values, change valve spring.

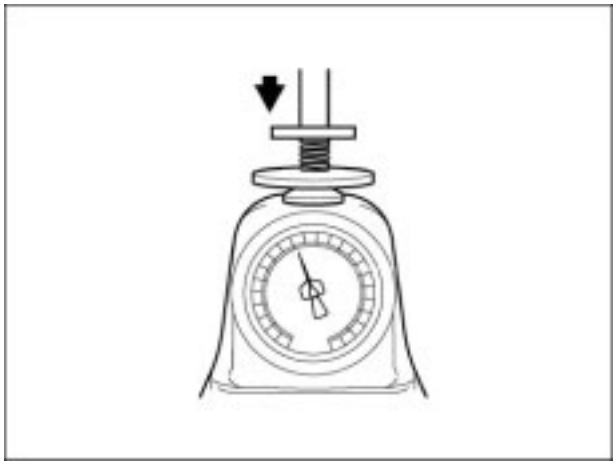
Valve spring uncompressed length:

Intake: 40.38 mm (1.59 in.)
Service limit: 38.36 mm (1.51 in.)

Exhaust: 40.38 mm (1.59 in.)
Service limit: 38.36 mm (1.51 in.)



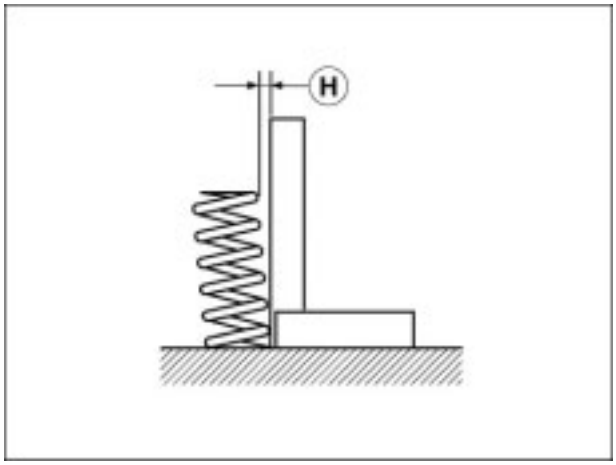
- Using a dynamometer, measure the compressed spring force with installed spring length of 35.00 mm (1.38 in). In case reading is not within indicated values, change valve spring.



Compressed valve spring force (installed):

171 - 197 N at 35.00 mm
(17.44 - 20.09 kg at 35.00 mm,
38.44 - 44.29 lb at 1.38 in).

- Resting on a reference surface and using a square, measure valve spring inclination (H). In case reading is not within indicated values, change valve spring.



Maximum spring inclination:

2.5 ° /1.8 mm (2.5 ° /0.071 in).

3.3.5. INSTALLING THE VALVES AND VALVE SPRINGS

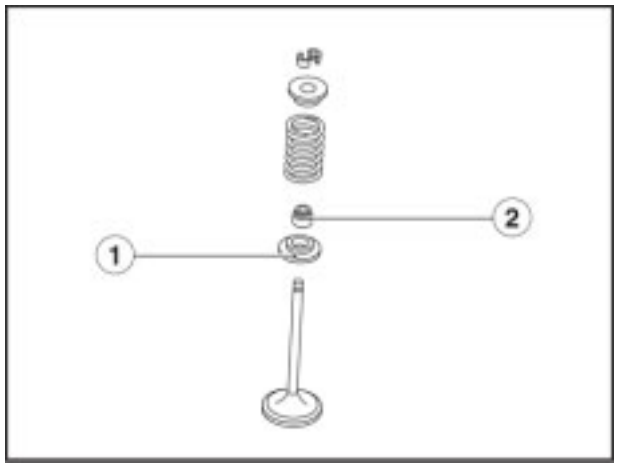
NOTE *The following procedure applies to all valves and their components.*

- Deburr the valve stem ends.
- Lubricate the valve stem and the valve stem oil seal with oil, see (LUBRICANT TABLE).

- Install the valve.

- Install the valve spring seat (1) and seal ring (2).

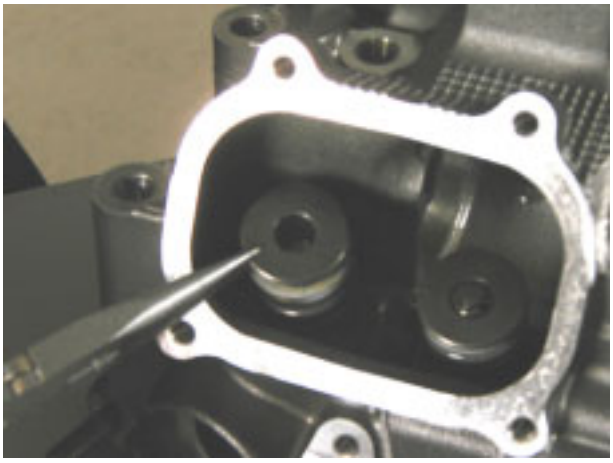
NOTE *Lubricate the oil seal before installing, see (LUBRICANT TABLE). Apply an emulsified solution on the oil seal outer diameter to help installation, see (LUBRICANT TABLE).*



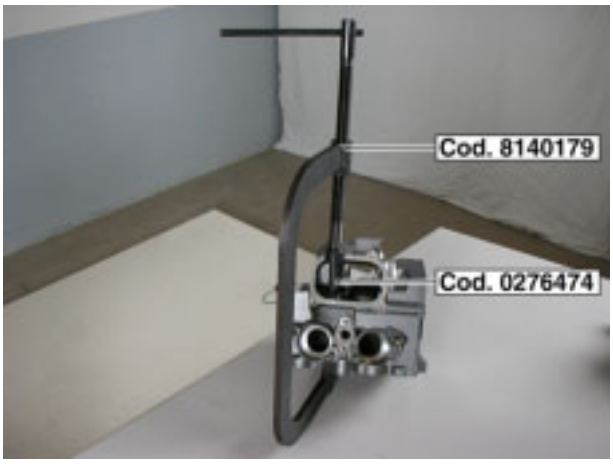
- Install the valve spring.

NOTE *Install the valve spring end with bigger pitch upward. Install the spring with coloured end up.*

- Install the valve spring retainer.



- Compress the spring with suitable tool (no. 8140179) and install valve collets using adapter (no. 0276474).
- Lightly tap with a mallet onto valve tip to secure valve collets to valve stem.



WARNING
Do not tap excessively hard on the valve or it might damage.

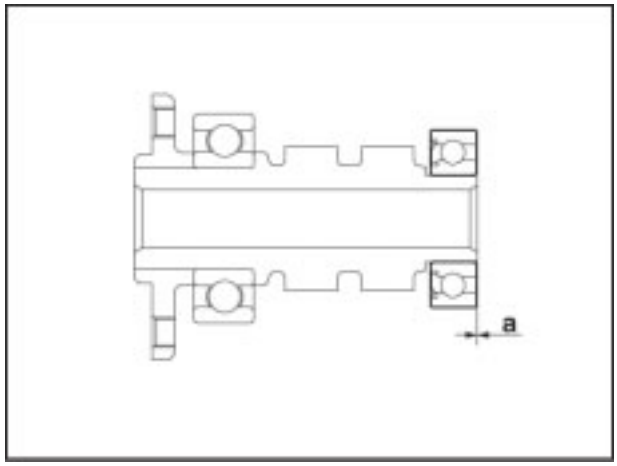
3.3.6. INSTALLING THE CAMSHAFT AND ROCKER ARMS

NOTE *Smear bearing with engine oil, see (LUBRICANT TABLE) and install it so that the oil seal faces (a) the camshaft.*

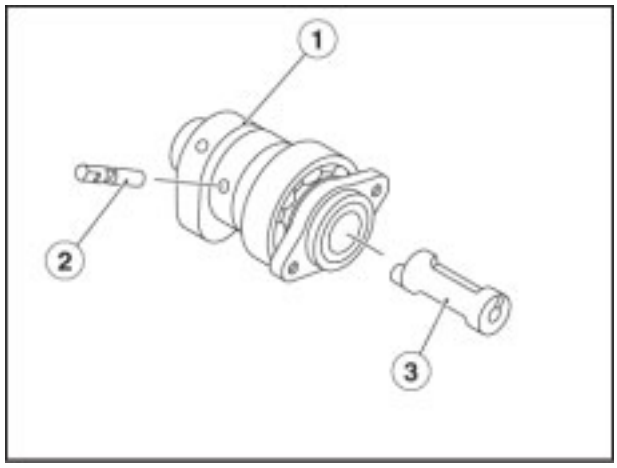
Lubricate the oil seal before installing, see (LUBRICANT TABLE).

Apply an emulsified solution on the oil seal outer diameter to help installation, see (LUBRICANT TABLE).

- Install bearing to camshaft so as the value a is = 0 mm (0 in).

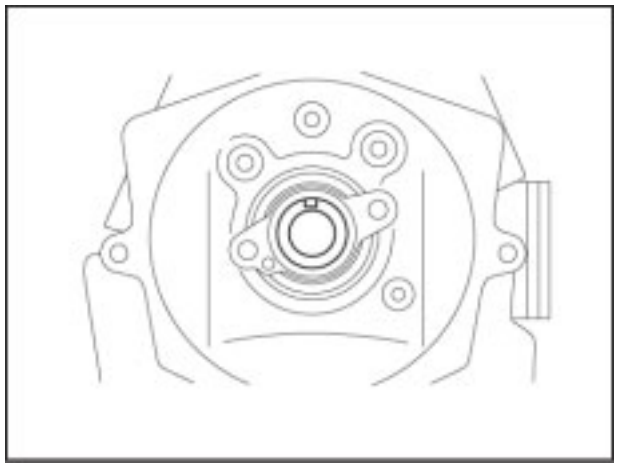


- Lubricate the camshaft (1), see (LUBRICANT TABLE), the decompression lever pin (2) and decompression lever (3).
- Install the compression lever pin and decompression lever to camshaft, as indicated.



- Install the camshaft upward.

NOTE *Carefully install the camshaft, pay attention to the decompression lever pin.*



NOTE *Lubricate shafts and rocker arms before installing, see (LUBRICANT TABLE).*

- Using puller (no. 8140848), install the exhaust rocker arm shaft.

NOTE *Ensure the rocker arm shaft is fully home in the head.*

- Install the exhaust rocker arm.

- Using puller (no. 8140848), install the intake rocker arm shaft.

NOTE *Ensure the rocker arm shaft is fully home in the head.*

- Fit intake rocker arm.

- Install the bearing snap ring.

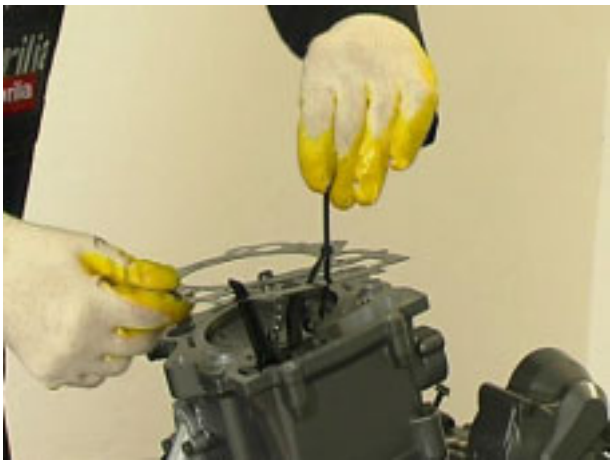
- Fit and tighten the two screws.

3.3.7. INSTALLING THE HEAD

- Install the two centring dowels.

- Install a new head gasket.

NOTE ***Aprilia*** *provides an additional gasket to be fitted under the head to compensate for any possible tolerance inaccuracy in the mating surfaces.*



- Install the head.

- Insert four new washers.

NOTE *Install washers with rounded surface facing the bolt seat.*

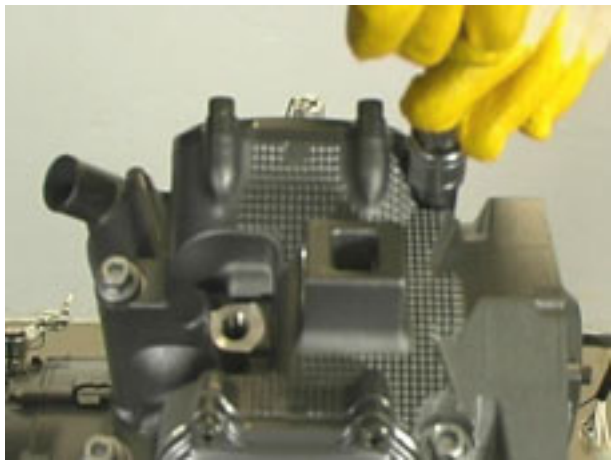
Lubricate head bolt threads and sealing surfaces with engine oil.

- Tighten the four head bolts in the sequence shown.

NOTE *Tighten the head bolts following the tightening sequence shown and the correct torque, in two stages.*

- Tighten the two longer head bolts (on the right side) to the specified torque.

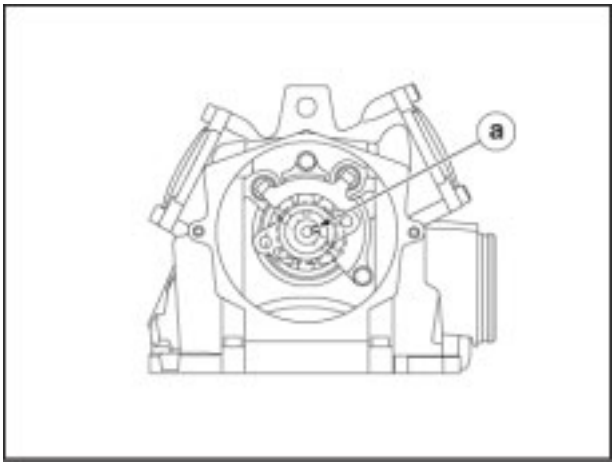
Tighten the two shorter head bolts (on the right side) to the specified torque.



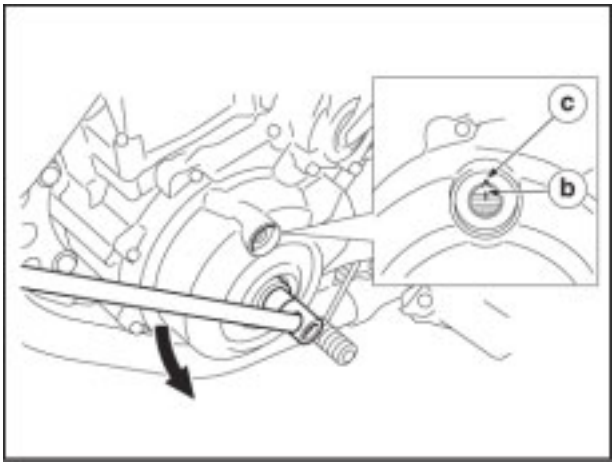
- Tighten the two lower bolts to the specified torque.

WARNING
When performing the following procedure, be careful not to turn the crankshaft otherwise damages or valve wrong setting might derive.

- Ensure that slot (a) on decompression lever is in the position shown.

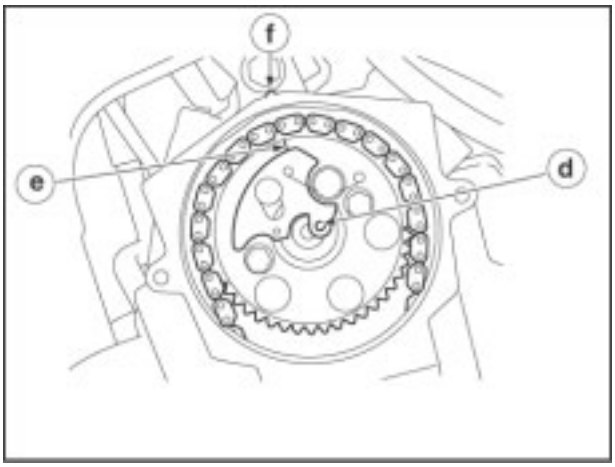


- Set the flywheel rotor so as reference “I” (b) matches fixed reference (c) on magnet cover.



- Install the timing chain to the camshaft gearwheel.
- Install the gearwheel to the camshaft, insert jut (d) on decompression lever slot (a).

NOTE *When installing the gearwheel ensure to keep the timing chain taut at the exhaust end.*

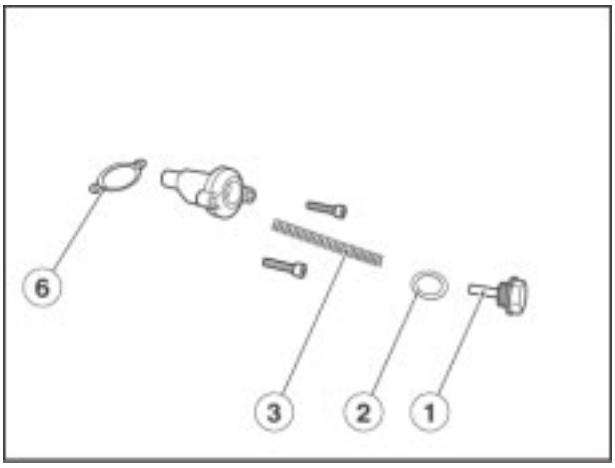


- Ensure reference “I” (e) on gearwheel matches fixed reference (f) on the cylinder head.

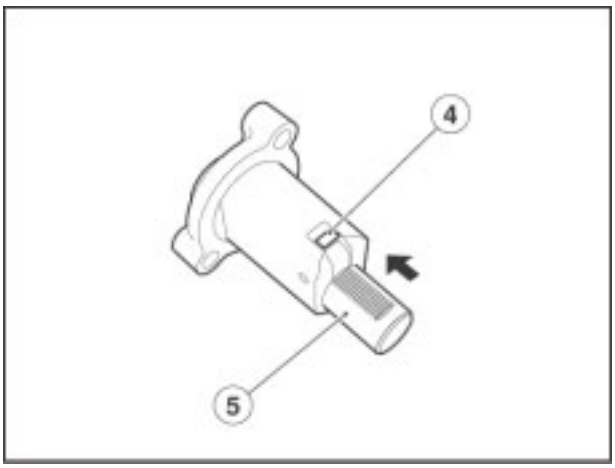
- Snug the two screws of the camshaft gearwheel.

- Install the chain tensioner as follows:
- 1 – Remove the chain tensioner threaded plug (1), copper washer (2) and spring (3).
- 2 – Release the chain tensioner single-direction cam (4) and push its rod (5) completely inside the chain tensioner housing.
- 3 – Install the tensioner and the timing chain seal (6) to the cylinder assy, tighten the two screws to the specified torque.

NOTE *Install the gasket with the chamfered side facing the chain tensioner end.*

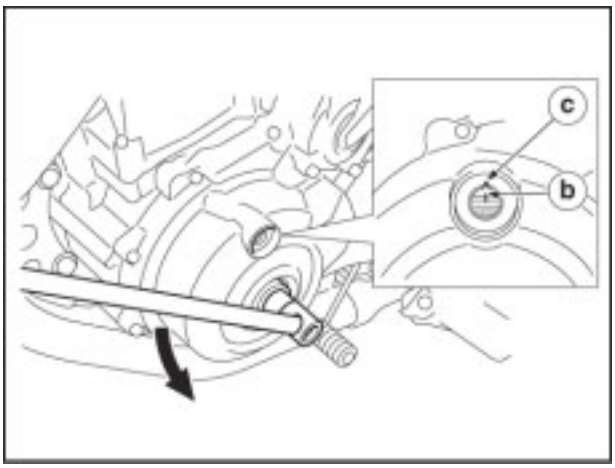


- Install the spring (3) and chain tensioner threaded plug (1), tighten plug to the specified torque.

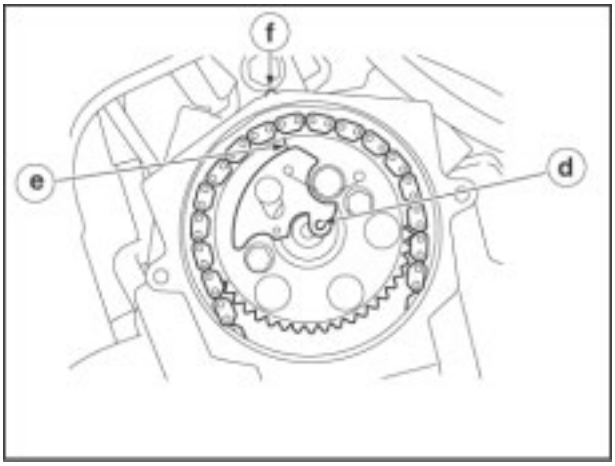


- Turn the crankshaft a few times counter clockwise and check reference “I”.

NOTE *Set the flywheel so as reference “I” (b) matches fixed reference (c) on flywheel cover.*



NOTE *Ensure reference "I" (e) on gearwheel matches fixed reference (f) on the cylinder head.*



- If these references are not aligned, correct by repeating the same indicated operations; restart from installation of the camshaft gearwheel.

- Tighten the two gearwheel screws.

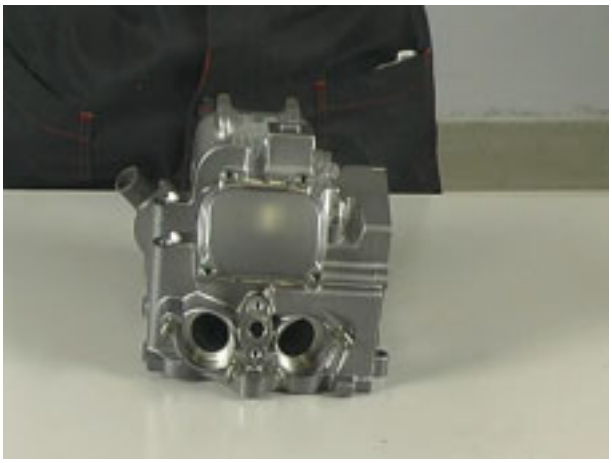
WARNING
Tighten the two screws to the specified torque; loose parts might seriously damage the engine.

- Measure the valve clearance and adjust, if necessary (see ADJUSTING THE VALVE CLEARANCE).

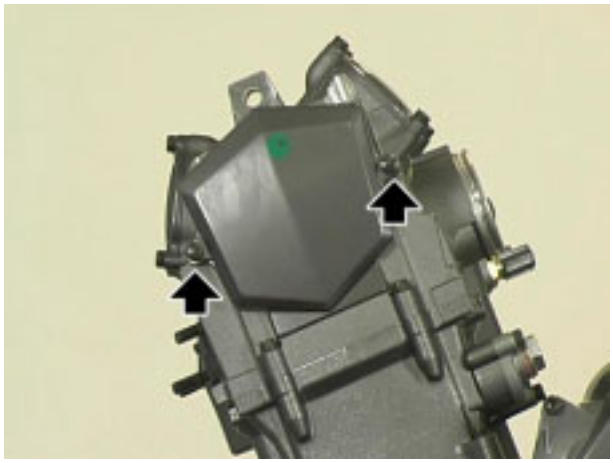
NOTE *Smear the O-ring with grease, see (LUBRICANT TABLE).*

- Once renewed the O-ring, install the tappet cover in its seat.

- Working on either side, tighten the four screws of both covers.



- Fit the camshaft gearwheel cover.
- Tighten the two screws.



3.3.8. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

3.4. CYLINDER AND PISTON

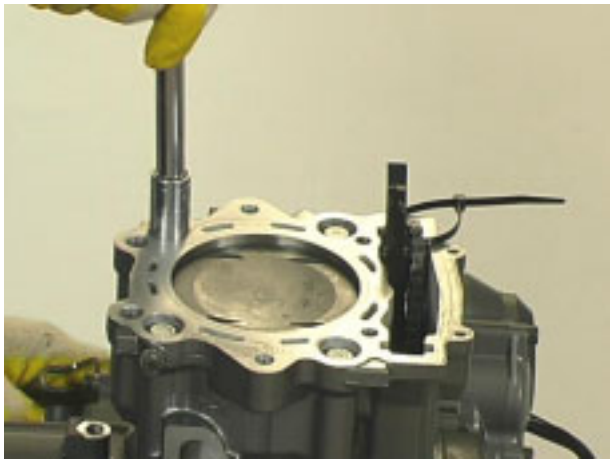
3.4.1. REMOVAL

- Before removing the cylinder, first remove the cylinder head.
- Remove the timing chain slider on the exhaust side.

- Release and remove the two screws.

- Remove the cooling system union, collect the seal.

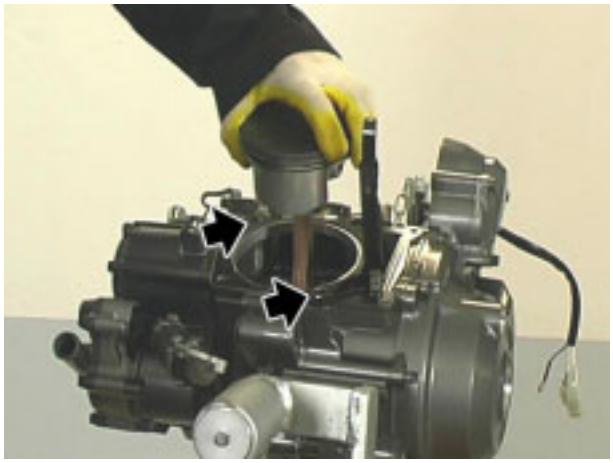
- Loosen and remove the four stud bolts in the order shown and collect the washers.



- Release and remove the two screws.

- Remove the cylinder, pay attention not to damage the chain and the piston.

- Collect the centring dowels and the seal.



NOTE *Before removing the gudgeon pin circlip, block off the casing opening with a clean cloth to prevent the circlip from falling inside the crankcases.*

- Mark the piston crown exhaust side to ensure correct reassembly.

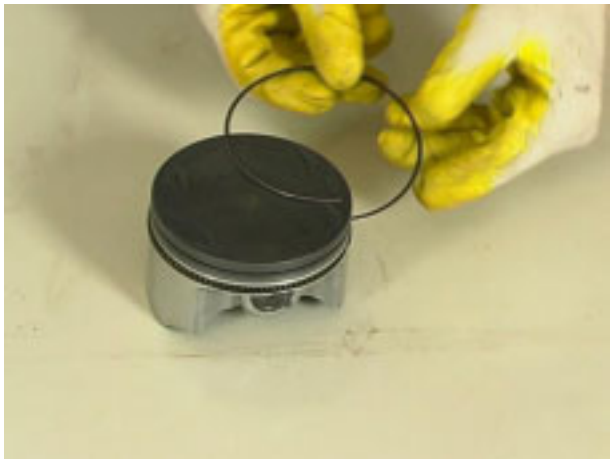
- Remove the gudgeon pin circlip.

- Using the puller for piston gudgeon pin (no. 8600388), remove the gudgeon pin.

WARNING
Do not use a hammer to remove the gudgeon pin.

- Remove the piston.

- Remove the top ring, the second ring, and the three scraper rings.



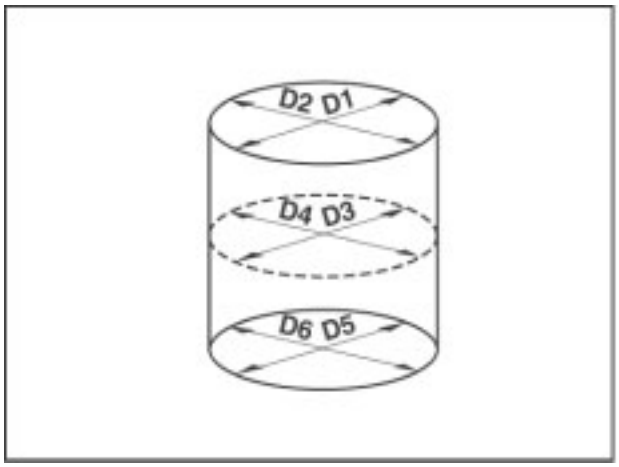
3.4.2. CHECK

CYLINDER

- All sealing surfaces should be clean and flat.
- Ensure that all threads are in good condition.
- Inspect the cylinder sliding surface and check for jams or scratches, check if the sealing surfaces are damaged.

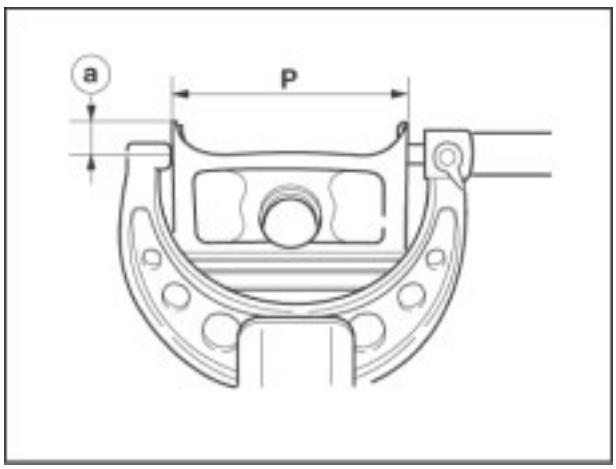
NOTE *If the cylinder liner grooves are evident, change cylinder and piston.*

- Remove deposits from cylinder cooling air space.
- Measure cylinder bore at three points: on the top edge, at a distance of **42 mm from top edge** (1) and on bottom edge; to calculate wear limit, the highest value is considered.



Cylinder bore "C":
100.000 – 100.010 mm (3.9370 – 3.9374 in.)
C= max. D1 or D2
Taper limit "T":
0.05 mm (0.002 in.)
T= max. D1 or D2 – max. D5 or D6
Out of round limit "R":
0.05 mm (0.002 in.)
R= max. D1, D3, D5 – min. D2, D4, D6

- If reading does not comply with given range, change cylinder, piston and piston rings as a set.
- Measure diameter of piston skirt "P" with a micrometer [a=10 mm (0.39 in) from piston bottom edge].
- Calculate piston-cylinder clearance as follows:



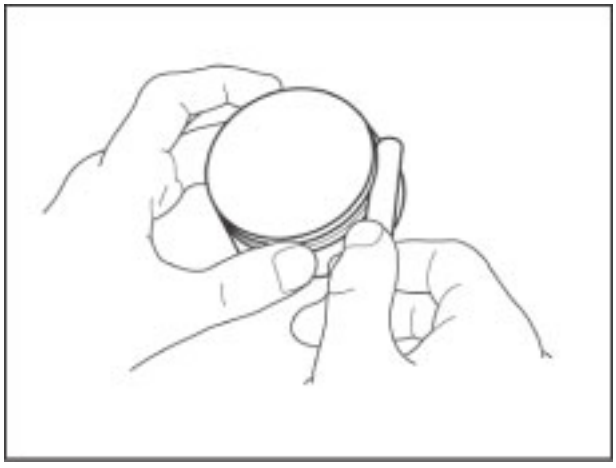
Piston – cylinder clearance
G = C – P

Piston – cylinder clearance:
0.030 – 0.055 mm (0.0012 – 0.0022 in.)
Service limit: 0.13 mm (0.0051 in.)

- If reading does not comply with given range, change cylinder, piston and piston rings as a set.

PISTON RINGS

- Eliminate scale from piston ring grooves and from piston rings.
- Measure the piston ring side play, change piston and piston rings as a set if out of range.



Piston ring side play:
Top piston ring:
0.030 – 0.080 mm (0.0012 – 0.0031 in.)
Service limit: 0.13 mm (0.0051 in.)
Second piston ring:
0.030 – 0.070 mm (0.0012 – 0.0028 in.)
Service limit: 0.11 mm (0.0043 in.)

- Install the piston ring to the cylinder.
- Make the piston ring flush with piston crown.
- Measure piston ring end gap and change it if needed.

NOTE *It is not possible to measure the oil scraper ring end gap: if it shows excessive play, change the three piston rings.*

Piston ring end gap
Top piston ring:
0.20 – 0.35 mm (0.0079 – 0.0138 in.)
Service limit: 0.60 mm (0.0236 in.)
Second piston ring:
0.35 – 0.50 mm (0.0138 – 0.0197 in.)
Service limit: 0.85 mm (0.0335 in.)
Oil scraper ring:
0.20 – 0.70 mm (0.0079 – 0.0276 in.)

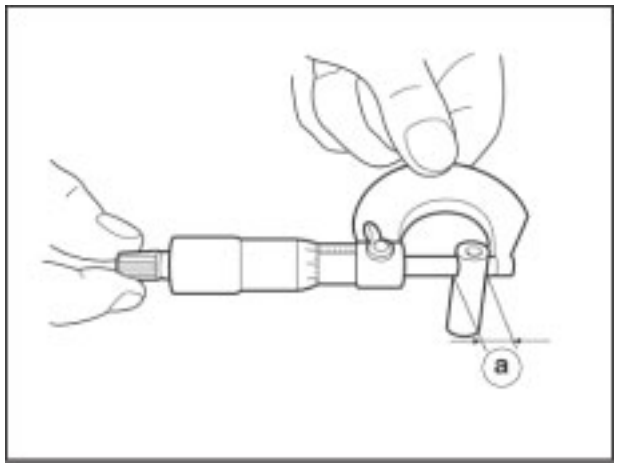
GUDGEON PIN

- Remove combustion residues from piston crown and from above top piston ring.
- Check if there are cracks in the piston or shrinkage marks on piston sliding surface (seizure); change piston if necessary.

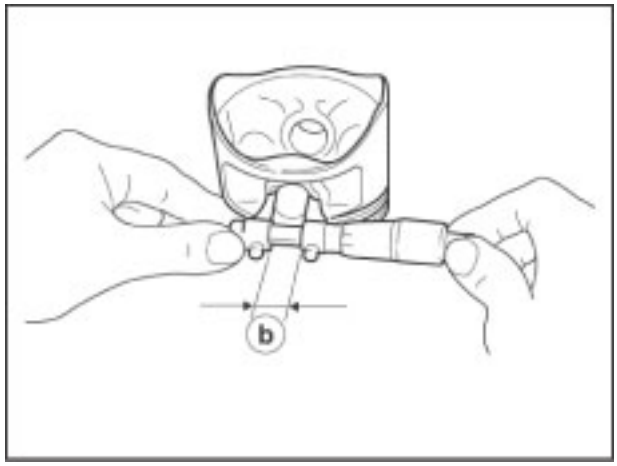
NOTE *Small streaks on piston liner are allowed.*

- Measure gudgeon pin outer diameter (a), change the gudgeon pin if out of allowed tolerance.

Gudgeon pin outer diameter:
22.991 – 23.000 mm (0.9052 – 0.9055 in.)
Service limit: 22.971 mm (0.9044 in.)



- Measure gudgeon pin inner diameter (b), change the gudgeon pin if out of allowed tolerance.



Gudgeon pin inner diameter:
23.004 – 23.015 mm (0.9057 – 0.9061 in.)
Service limit: 23.045 mm (0.9073 in.)

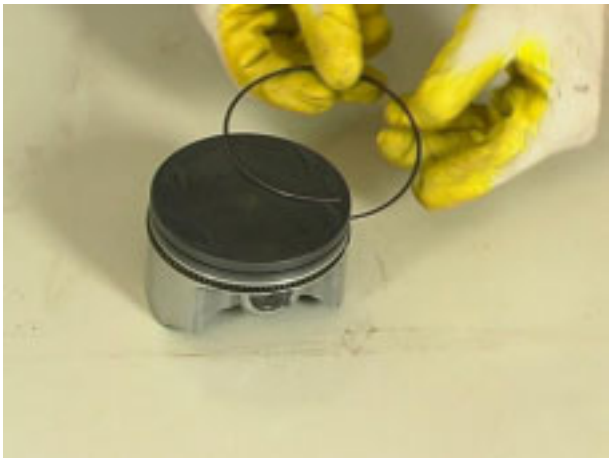
- Calculate gudgeon pin to gudgeon pin hole clearance, change gudgeon pin and piston as a set if reading is out of allowed tolerance.

Gudgeon pin – piston clearance: G = b – a
0.004 – 0.024 mm (0.0002 – 0.0009 in.)
Service limit: 0.074 mm (0.0029 in.)

3.4.3. INSTALLATION

NOTE *When installing the piston rings, ensure the manufacturer reference or marking is facing up.*

- Install the top piston ring, the second ring, the oil scraper spring ring, the bottom oil scraper ring and the top oil scraper ring.



- Fit the piston and install the gudgeon pin.

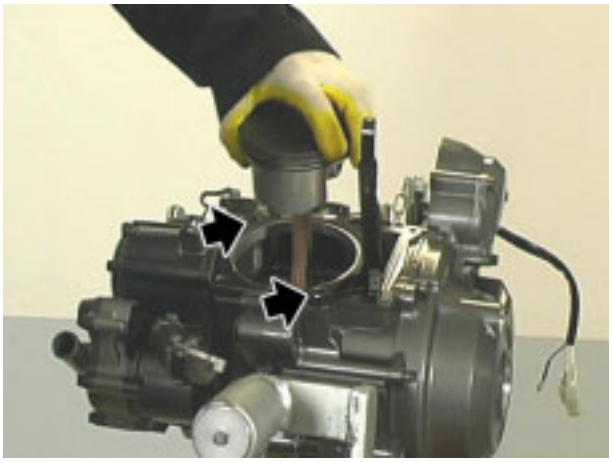
NOTE *Ensure that piston marking is facing the cylinder exhaust side. Before fitting the gudgeon pin, lubricate it with engine oil.*

NOTE *Before fitting the gudgeon pin circlip, block off the casing opening with a clean cloth to prevent it from falling inside.*

- Change the gudgeon pin circlip.

- Install a new cylinder gasket.

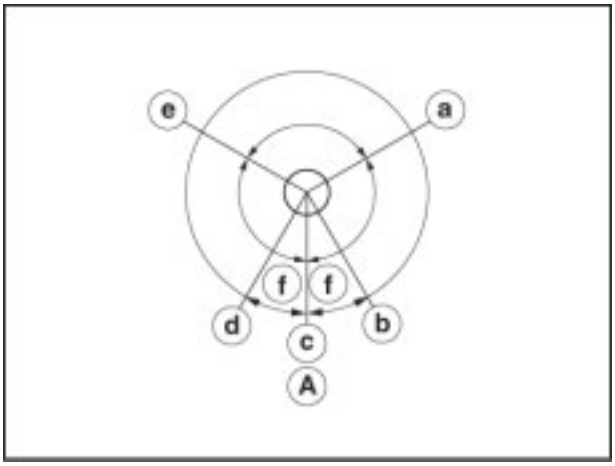
- Fit the locating dowels.



- Lubricate the piston, the piston rings and the cylinder with engine oil.

- Check piston rings misalignment: measure ring end gap angles, as shown:

a – top ring.
b – top oil scraper ring
c – oil scraper spring ring
d – bottom oil scraper ring
e - second ring
f- 20 mm (0.79 in.)
A - exhaust side



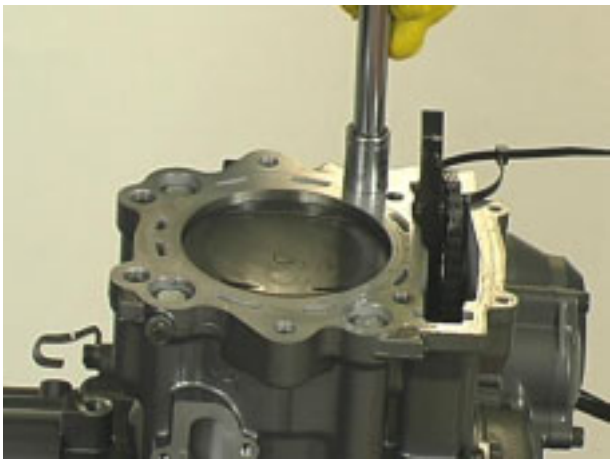
- Using the suitable special tool (no. 0276357), compress the piston rings and install the cylinder.

- Install the timing chain guide (exhaust side).

NOTE *Route the chain and its guide (exhaust side) through the timing chain notch.*

- Install four new washers with rounded surface up.

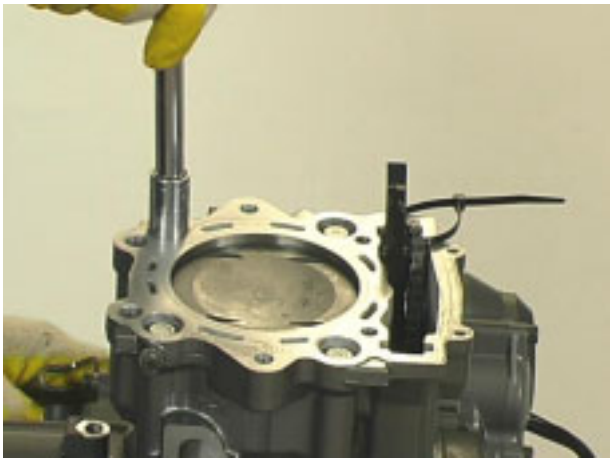
WARNING
Cylinder stud bolts are similar in pairs. The ones on timing side are longer.



- Fit the four cylinder stud bolts, install the two punched bolts on timing side.

NOTE *Lubricate cylinder bolt threads and sealing surfaces with engine oil.*

- Tighten the four cylinder stud bolts to the tightening torque specified for each one.



- Tighten the two screws.

- Change the seal, tighten the two screws and secure the cooling system fitting.

3.4.4. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

3.5. CLUTCH

3.5.1. REMOVAL

- Working in a cross pattern, loosen the seven screws by one fourth of a turn at a time until removing all seven screws. When you have loosened all screws completely, remove them.

- Place a container of adequate capacity under the clutch.
- Remove the clutch cover, collect the seal and the two centring dowels.

- Working in a cross pattern, loosen the five screws by one fourth of a turn at a time until removing all five screws.
- Collect the clutch springs.

- Remove the pressure plate, collect disengagement shaft and pushrod.

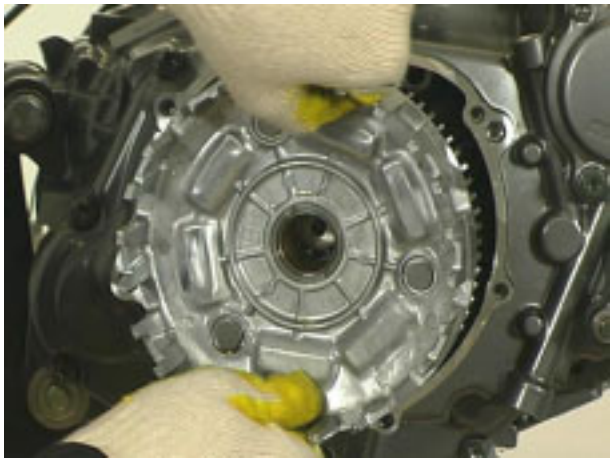
- Remove the thirteen clutch plates.

- Remove the clutch damper spring and its housing.

- Straighten the lock washer, fit the universal clutch locking tool (tool no. 8600391), loosen and remove the clutch hub nut and collect the lock washer.

- Remove the clutch hub and collect the thrust washer.

- Remove the clutch housing.



3.5.2. CHECK

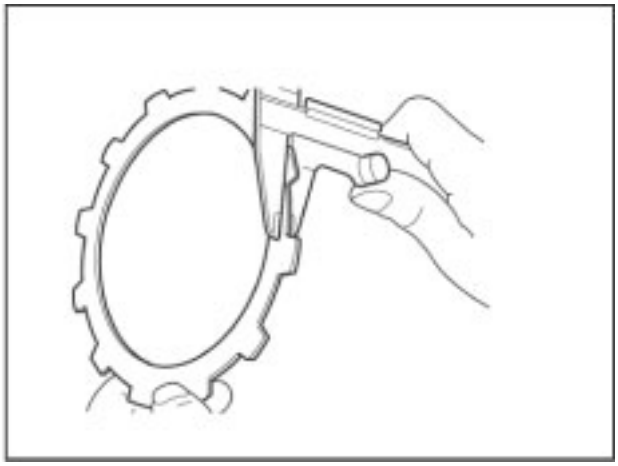
CLUTCH PLATES

- Rest the friction plates and steel plates on a flat surface and check for cracks and deformation.

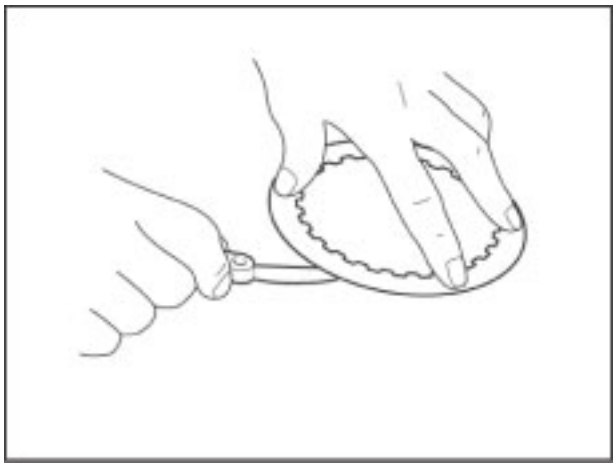
Max. allowed flatness error 0.20 mm (0.0079 in.)

NOTE *The steel plates should not be scratched or stained.*

- Measure driving plates thickness in four locations, change them all if not complying with recommended values.



Driving plate thickness 1:
2.90 – 3.10 mm (0.114 – 0.122 in.)
Service limit: 2.80 mm (0.110 in.)
Driving plate thickness 2:
2.92 – 3.08 mm (0.115 – 0.121 in.)
Service limit: 2.80 mm (0.110 in.)
Driving plate thickness 3:
2.90 – 3.10 mm (0.114 – 0.122 in.)
Service limit: 2.80 mm (0.110 in.)



NOTE *Check the clutch plates for wear measuring the complete plate pack.*

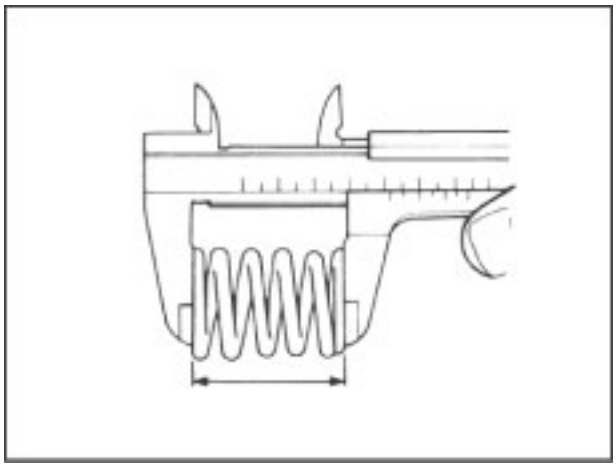
Do not measure the steel plates and the friction plates separately, since this value is unimportant for wear check.

CLUTCH SPRINGS

NOTE *The following procedure applies to all clutch springs.*

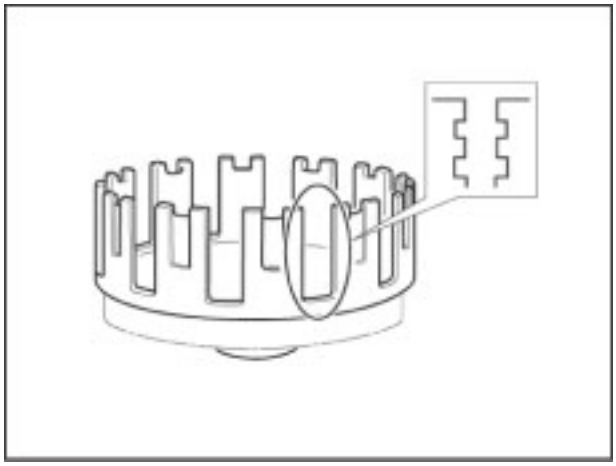
- Check the springs for damages and change all springs, if needed.
- Measure the spring uncompressed length and change all springs if necessary.

Clutch spring uncompressed length:
55.6 mm (2.19 in.)
Service limit: 52.82 mm (2.08 in.)



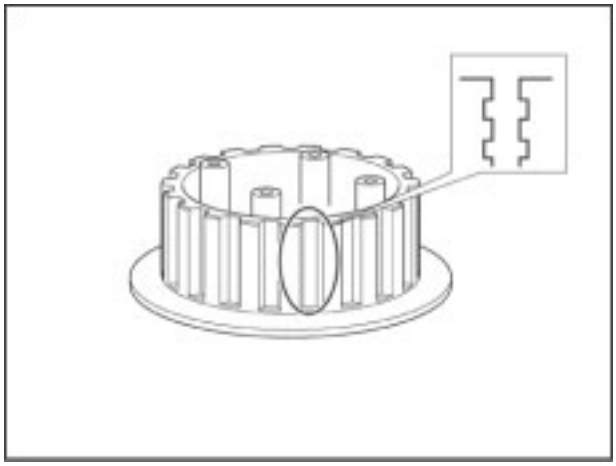
CHECKING THE CLUTCH HOUSING

Check the clutch housing for damages and wear that might affect clutch operation. Possibly deburr the teeth or change the housing.



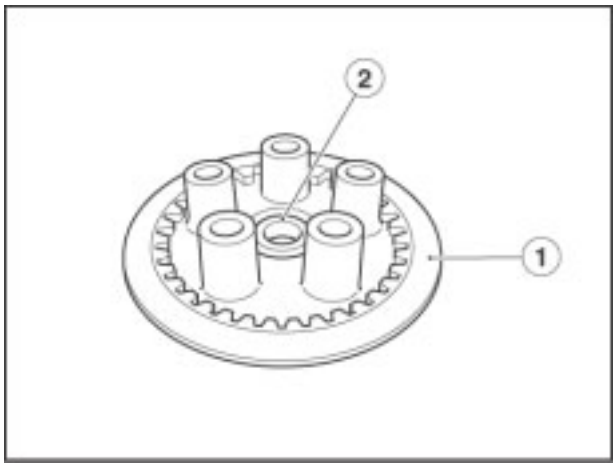
CHECKING THE CLUTCH HUB

Check the clutch hub for damages and wear that might affect clutch operation. Change the housing if necessary.



CHECKING THE PUSHER PLATE

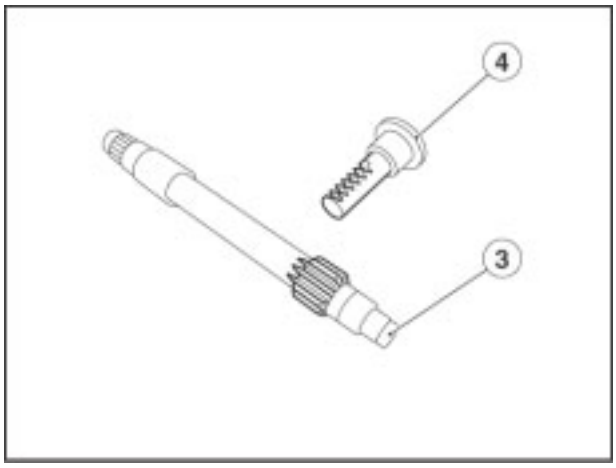
Check the pusher plate and bearing for damages and wear. Change the components, if necessary.



CHECKING THE RELEASE LEVER SHAFT AND RELEASE ROD

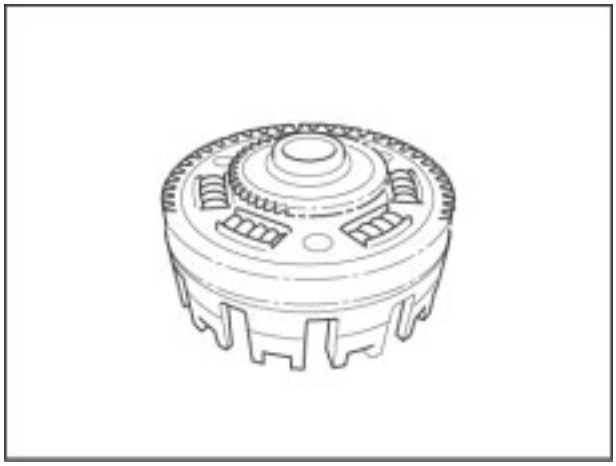
Check release lever shaft (3) sprocket teeth and release rod teeth (4) for damage or wear. Change all parts as a set, if necessary.

Check the release rod support for wear or damages, change if necessary.



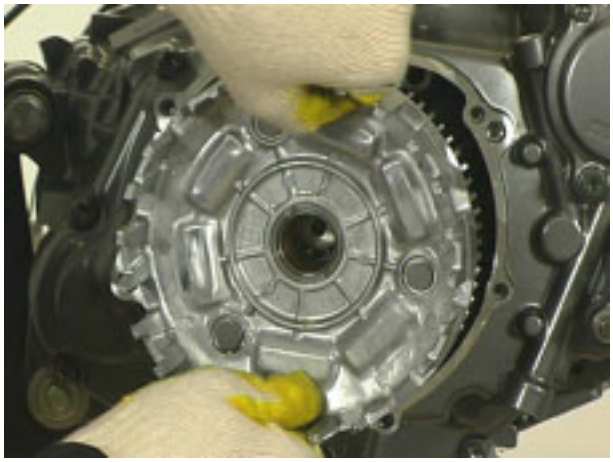
CHECKING THE PRIMARY DRIVEN GEAR

Check the primary driven gear for damages or wear and change the primary drive driving gear and the clutch housing as a set, if necessary.
Check that it is not excessively noisy during operation; change primary drive driving gear and the clutch housing as a set, if necessary.



3.5.3. REASSEMBLY

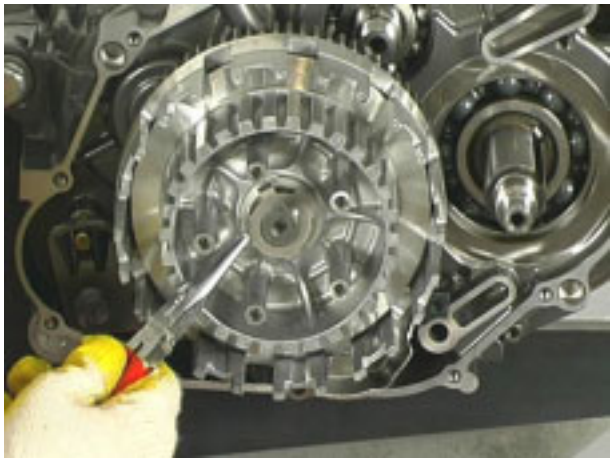
- Install the clutch housing.



- Insert the washer.

- Install the clutch hub.

- Install a new locking washer.



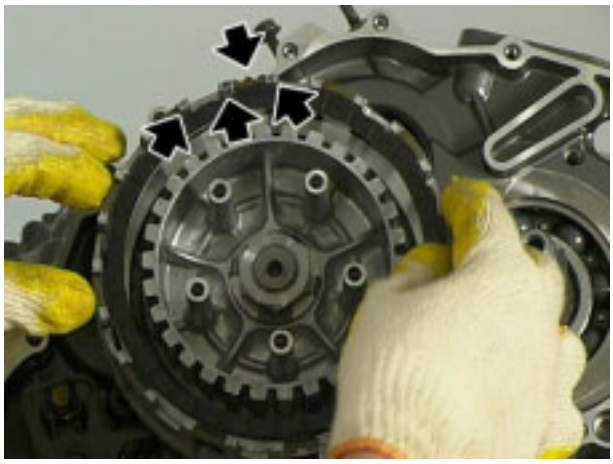
- Using clutch locking tool (no. 8600391), tighten clutch hub nut to the specified torque

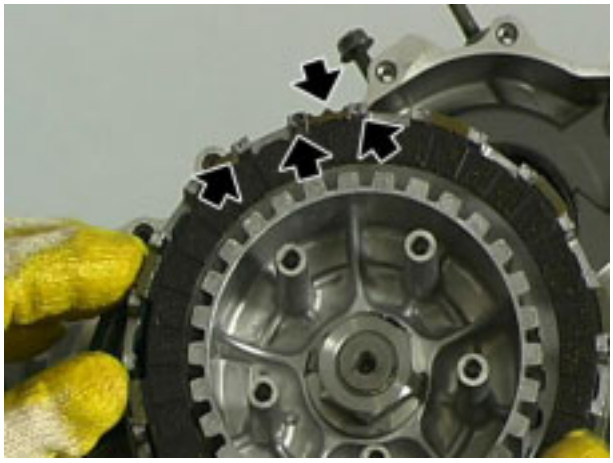
- Bend the locking washer.

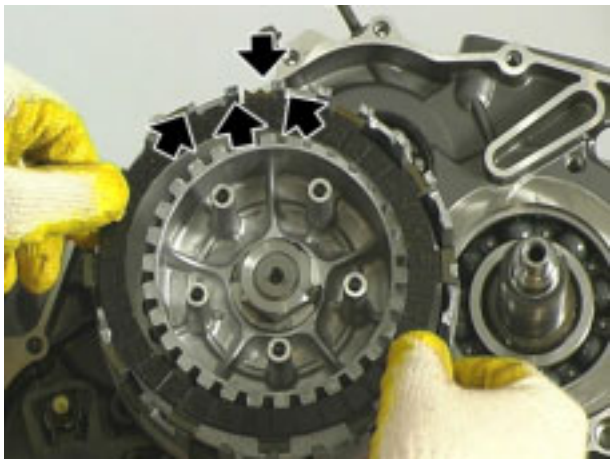
- Turn the clutch housing with arrows up.
- Lubricate the driving plates and the driven plates with engine oil.

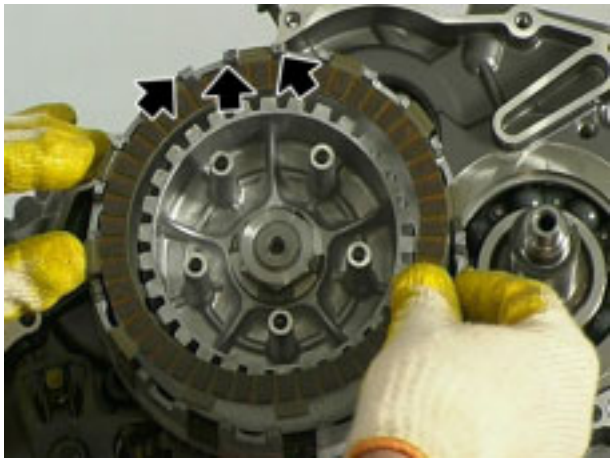
- Install the damper spring seat and the spring, with “OUTSIDE” reference outward.

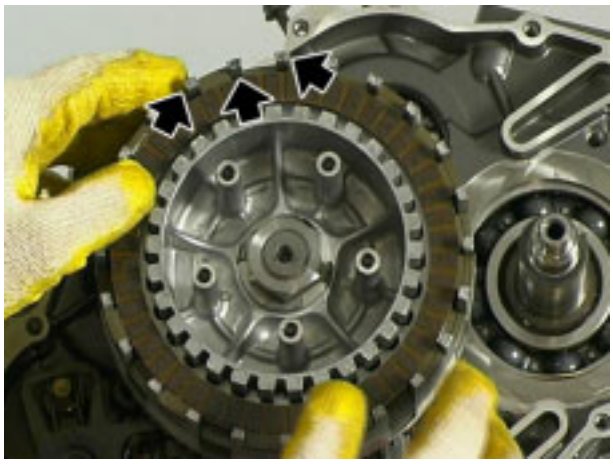
- Install the thirteen clutch plates, position them correctly.

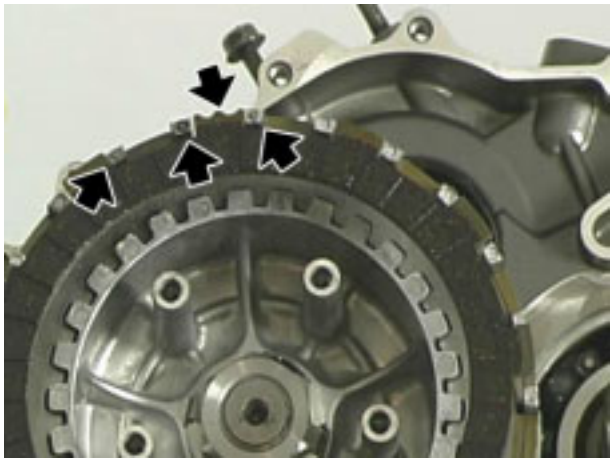


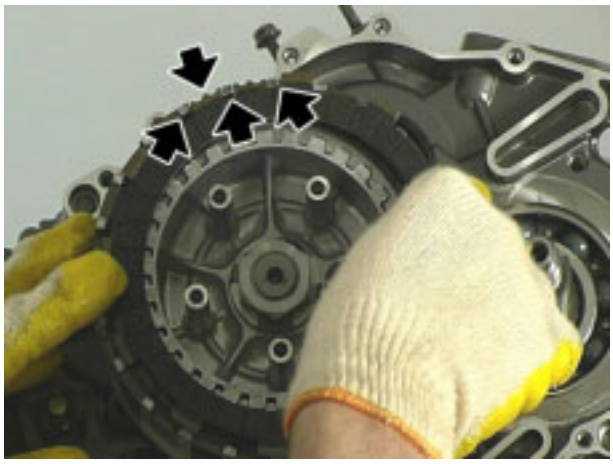












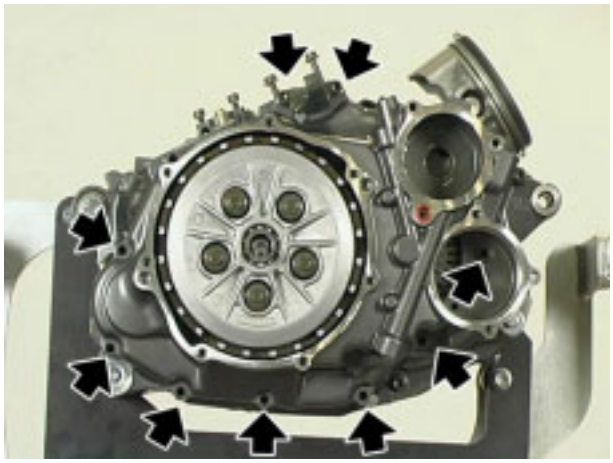
- Position the clutch pusher plate with disengagement shaft.
- Install the springs.

- Tighten the screws with washers to the specified torque.

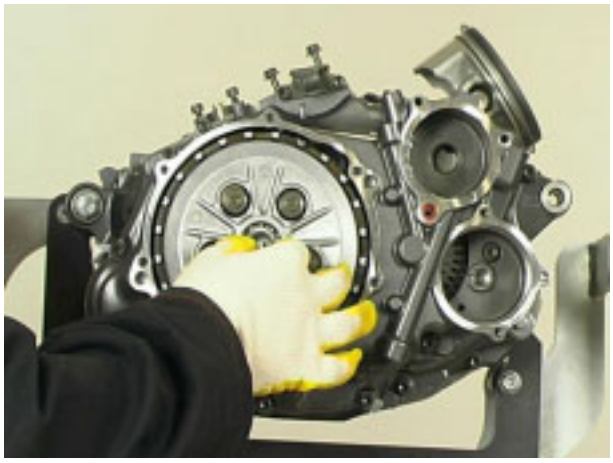
- Install the centring dowels.

- Change the gasket and install the right casing.

- Correctly fit the screws and tighten in a cross sequence.



- Turn the disengagement shaft so as teeth face the vehicle rear end.



- Install the centring dowels.

- Install a new seal.

- Install the clutch casing.

- Tighten the screws in a cross pattern.

- Fit the spring.

- Set the release lever with “UP” upward.
- Align the release lever reference mark to the clutch casing one.

- Fit shim.

- Fit the circlip.

- Install the spring to the release lever.

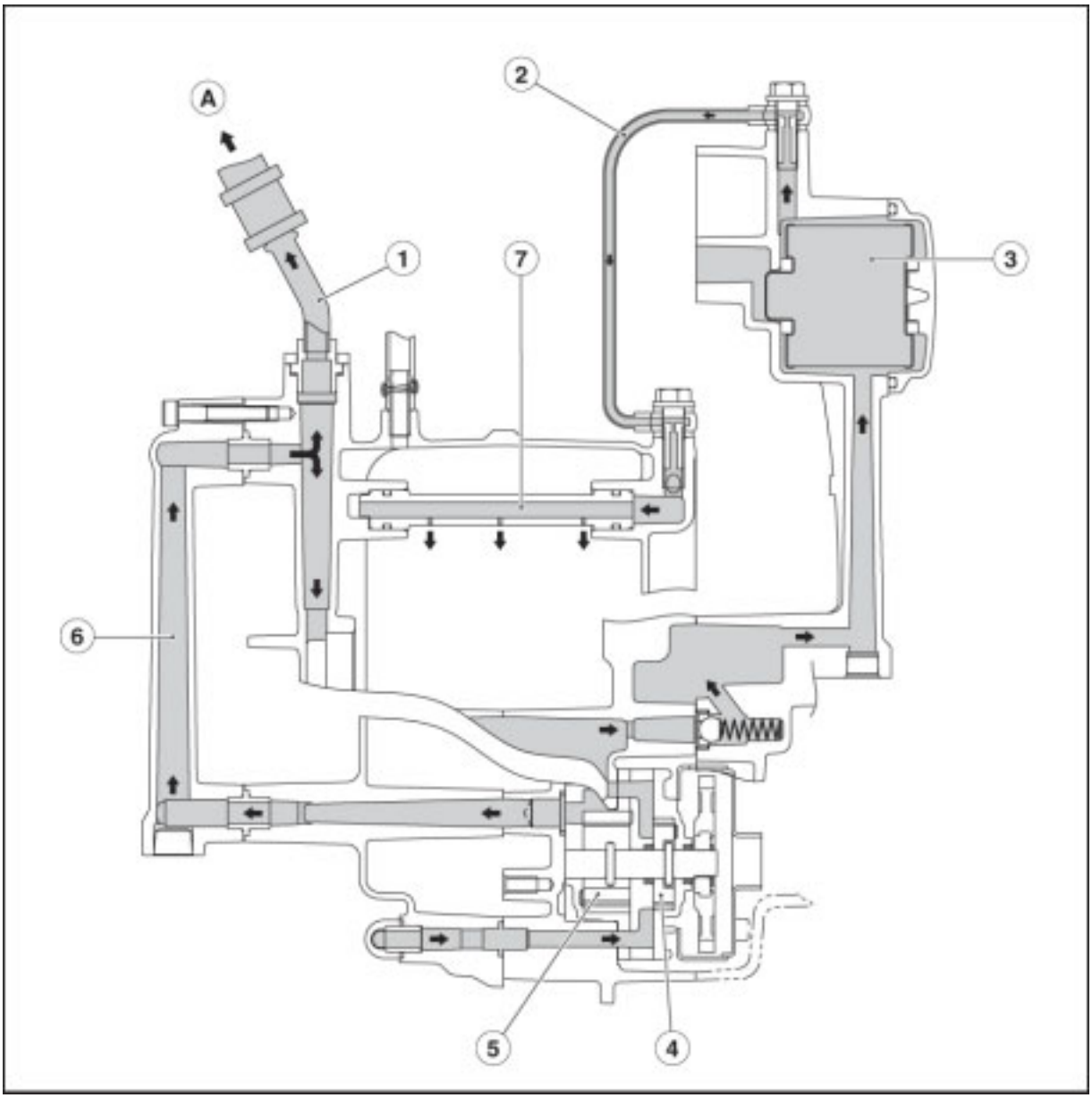
3.5.4. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

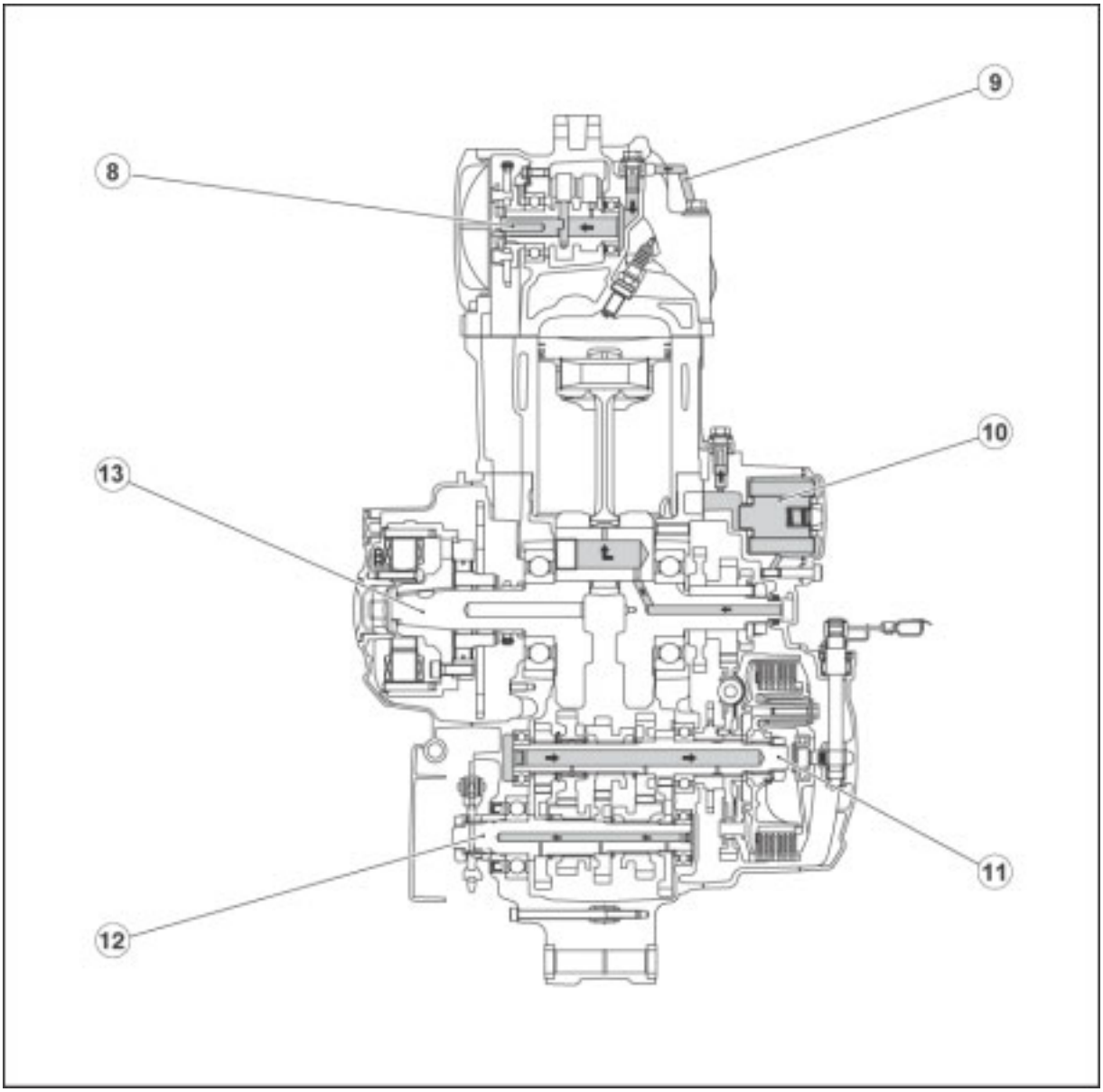
3.6. OIL PUMP

3.6.1. LUBRICATION SYSTEM DIAGRAM



Key:

A – To oil tank
1. Oil delivery hose 2
2. Oil delivery tube 2
3. Oil filter
4. Oil pump rotor 1
5. Oil pump rotor 2
6. Main shaft
7. Oil delivery tube 3



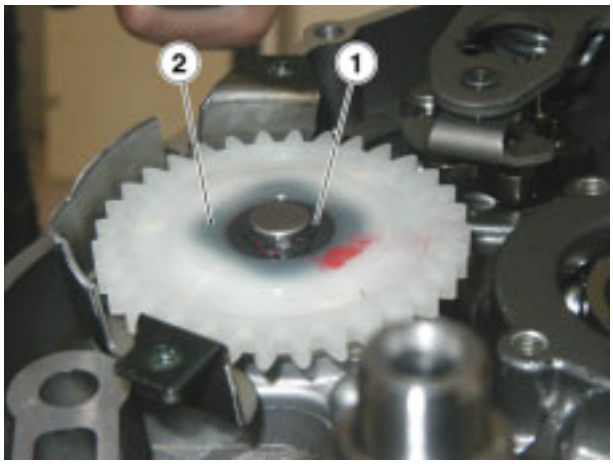
Key:

8. Camshaft
9. Oil delivery tube 1
10. Oil filter
11. Main shaft
12. Driving shaft
13. Crankshaft

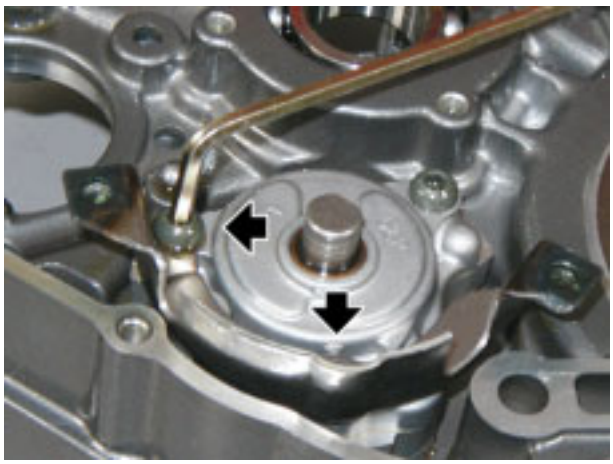
3.6.2. REMOVAL

- Before removing any components, place a container of adequate capacity under the engine.
- Remove the clutch, see (REMOVING THE CLUTCH).
- Loosen and remove the two screws and remove the oil baffle plate.

- Remove the safety snap ring (1) and the oil pump gear (2).



- Release and remove the two screws.



- Remove the oil baffle plate, collect the O-ring.

- Unscrew and remove the screw.

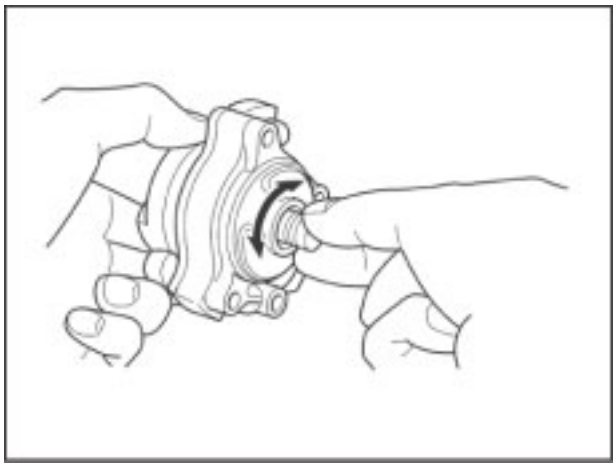
- Loosen and remove the three screws and remove the filter.

- Remove the oil pump unit, collect the two O-rings.

3.6.3. CHECK

Check oil pump driven gear for damages, wear or cracks. Change the part, if necessary.

Check oil pump operation, change the oil pump as a set if faulty.



3.6.4. INSTALLATION

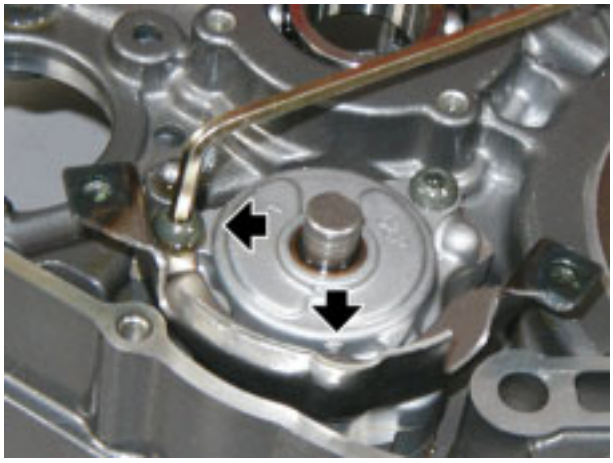
- Change the two O-rings and install the oil pump unit.

- Fit the filter and secure it tightening the three screws.

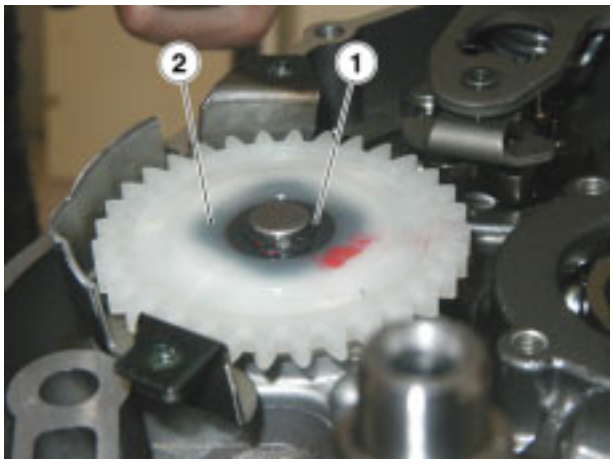
- Tighten the screw.

- Change the O-ring.
- Install the baffle plate and tighten the two screws.

- Tighten the two screws.



- Install the oil pump gear (2) and change the safety snap ring (1).



- Install the baffle plate and tighten the two screws.

3.6.5. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

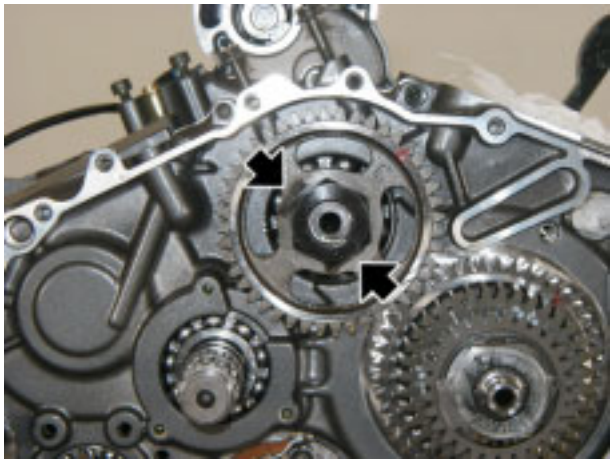
DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

3.7. COUNTER SHAFT DRIVEN AND DRIVING GEAR

3.7.1. REMOVAL

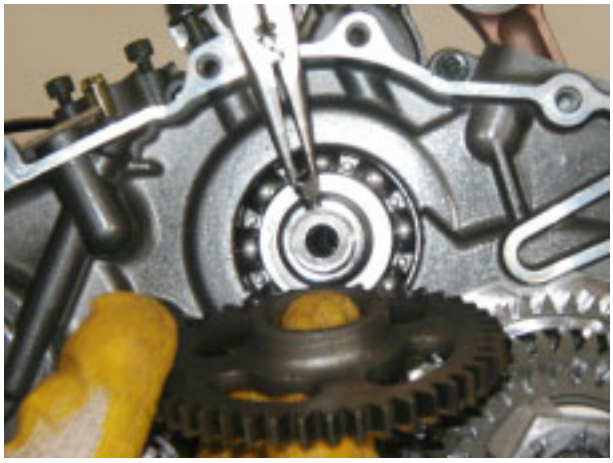
- Before removing any components, place a container of adequate capacity under the engine.
- Remove the water pump unit, see (REMOVING THE WATER PUMP).
- Remove the clutch housing, see (DISASSEMBLING THE CLUTCH).
- Remove the right casing cover, see (HOW TO TAKE THE ENGINE CRANKCASES APART).

- Straighten the safety washer.



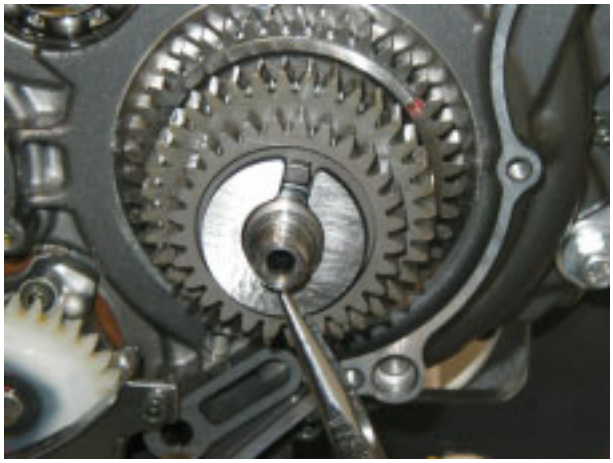
- Loosen and remove the balancer driven gear nut, collect the washer.

- Remove the driven gear and collect the key.

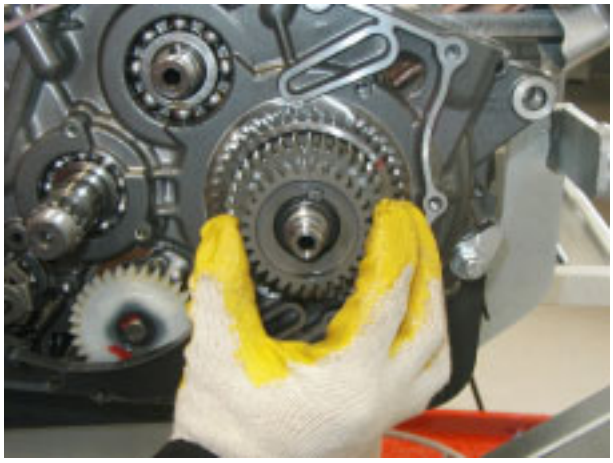


- Using the connecting rod locking tool (no. 8140387), lock the con rod while loosening and removing the balancer driven gear nut.
- Collect the washer.

- Remove the washer.



- Remove the water pump driving gear.



- Remove the primary drive driving gear.

- Remove the balancer driving gear and remove the key.

- Remove the washer.

3.7.2. CHECK

Check counter shaft driven gear and driving gear, water pump driving gear and primary drive gear for damage or wear.
Change the parts, if necessary.

3.7.3. INSTALLATION

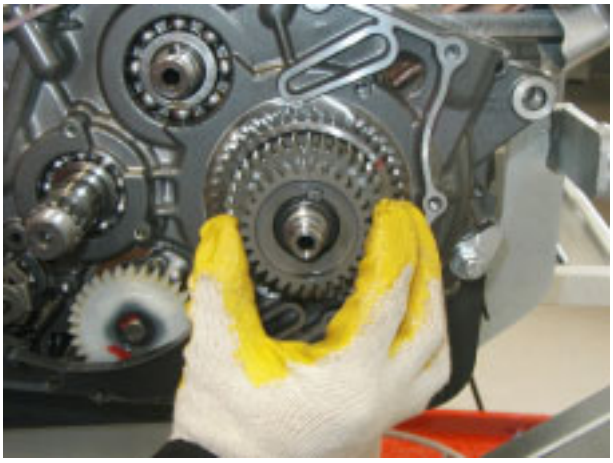
- Insert the washer.

- Install counter shaft driving gear.

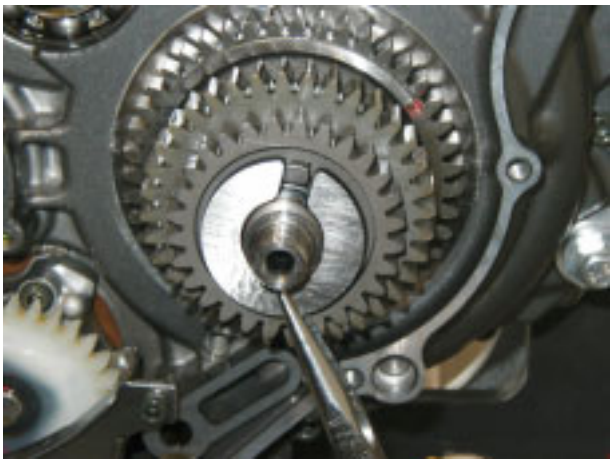
- Install the key with rounded surface up.

- Install the primary drive driving gear.

- Install the water pump driving gear.



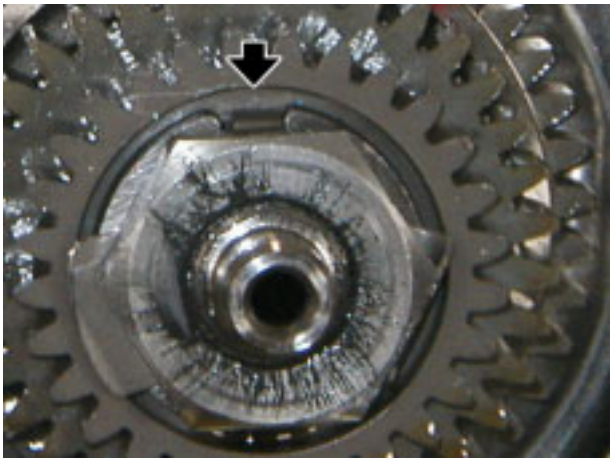
- Insert a new washer.



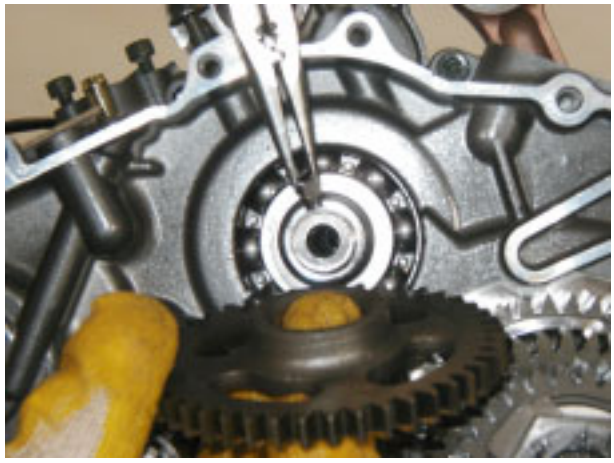
- Install a new lock washer and nut.

WARNING
Ensure that the washer edge is inside keyway.

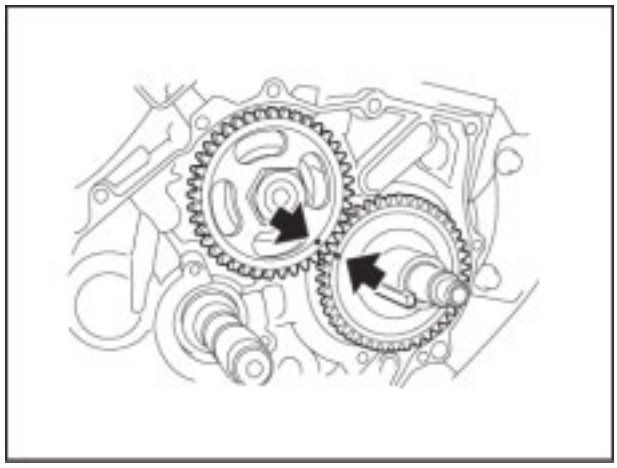
Tighten primary drive gear nut to the specified torque and bend the edges.



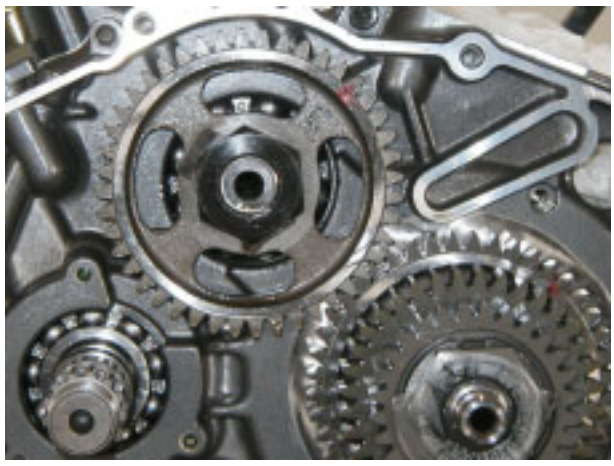
- Insert key and counter shaft driven gear.



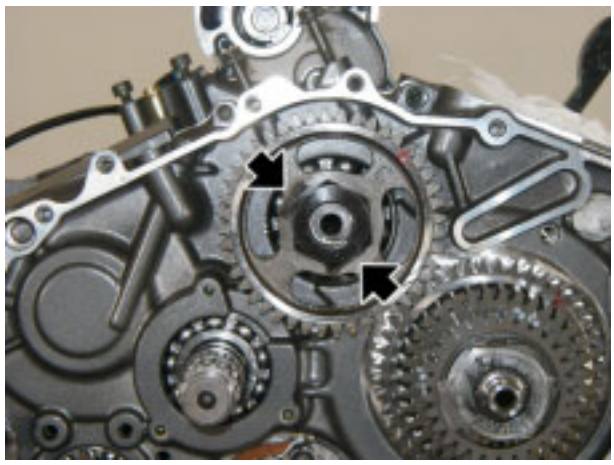
WARNING
Align counter shaft driving gear reference mark to driven gear mark.



- Tighten countershaft driven gear nut to the specified torque.



- Bend the lock washers edges.
- Install the right casing cover, see (HOW TO ASSEMBLE THE ENGINE CRANKCASES).
- Install the clutch housing, see (REASSEMBLING THE CLUTCH).
- Install the water pump unit, see (INSTALLING THE WATER PUMP).



3.7.4. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 - 1.5	
Valve cover and timing cover screws	0.8 - 1.2	
Oil channel hose screws 1	1.6 - 2.0	
Spark plug	1.0 - 1.5	
Oil channel hose screws 2	1.7 - 2.3	
Oil channel hose side screw 2	0.8 - 1.2	
Intake manifold clamps screws	0.3 - 0.4	
AIS tube screws	0.8 - 1.2	
Sensor	1.6 - 2.0	
Thermostat cover screws	0.8 - 1.2	
Exhaust stud bolts	1.3 - 1.7	
Camshaft plate screws	0.8 - 1.2	Loctite 242 on thread

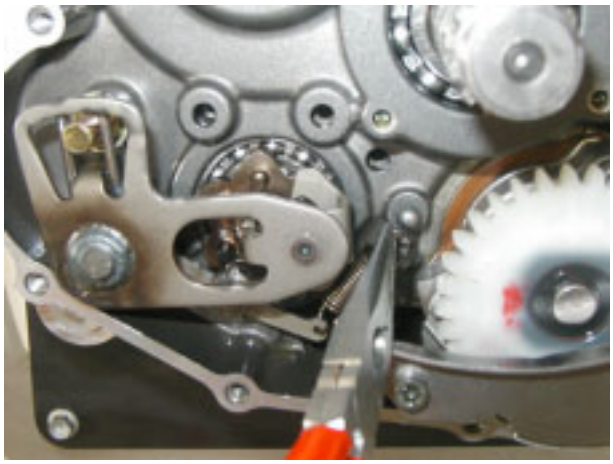
3.8. GEAR SHIFT SELECTOR

3.8.1. REMOVAL, INSPECTION, REFITTING

REMOVAL

- Remove the clutch, see (REMOVAL).
- Remove the right casing, see (HOW TO TAKE THE ENGINE CRANKCASES APART).

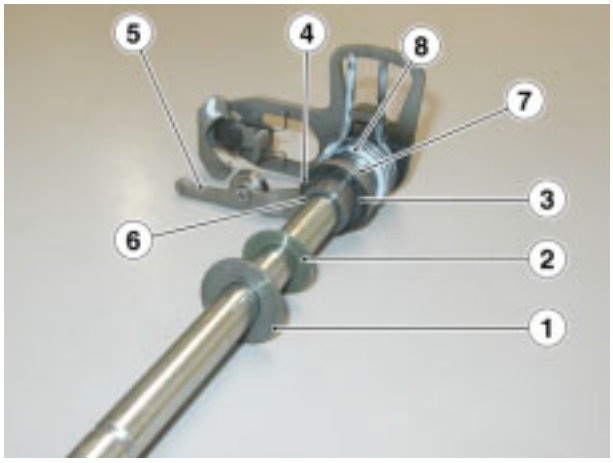
- Working on clutch side, release gear shift selector spring.



- Working on generator side, remove the snap ring.

- Working on clutch side, remove the gear shift selector and collect washer and oil seal.

- To disassemble the gear shift selector, proceed as follows.
- Slide out the two washers (1) and (2).
- Remove the snap ring (3).
- Remove the washer (4).
- Slide out the stop lever (5).
- Slide out the spacer (6)
- Remove the washer (7).
- Remove the lever spring (8).



CHECK

CHECKING THE STOP LEVER

Check the stop lever for damages or wear and ensure that roller can turn freely.
Change the components, if necessary.

Check for gear shift selector spring damage or wear.
Change the part, if necessary.

CHECKING THE GEAR SELECTOR

Check selector shaft and its teeth for damage or wear.
Change the part, if necessary.

Check for lever spring damage or wear.
Change the part, if necessary.

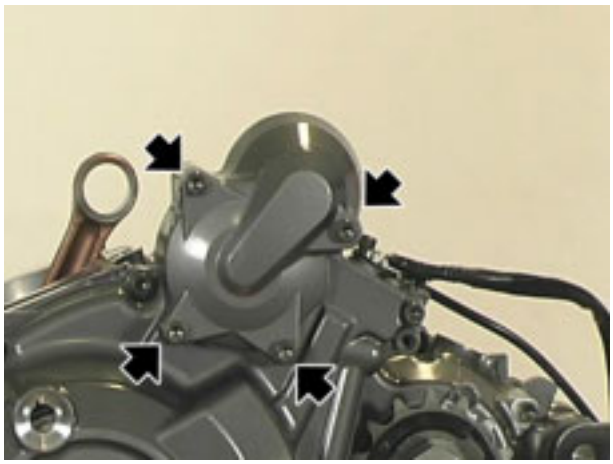
REASSEMBLY

- Lubricate the oil seal and then reassemble following the disassembly procedure in the reverse order.

3.9. GENERATOR SIDE

3.9.1. REMOVAL

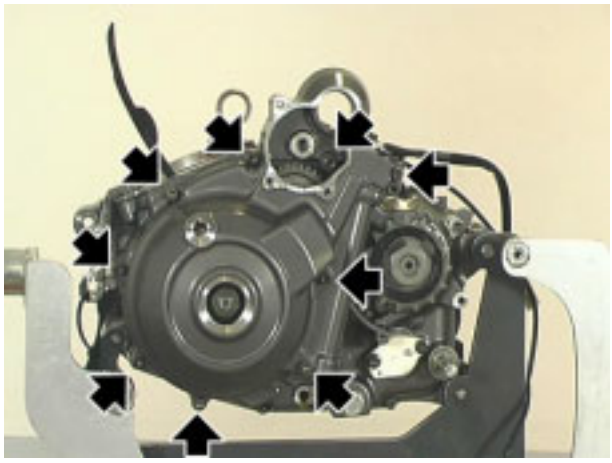
- Release and remove the four screws.



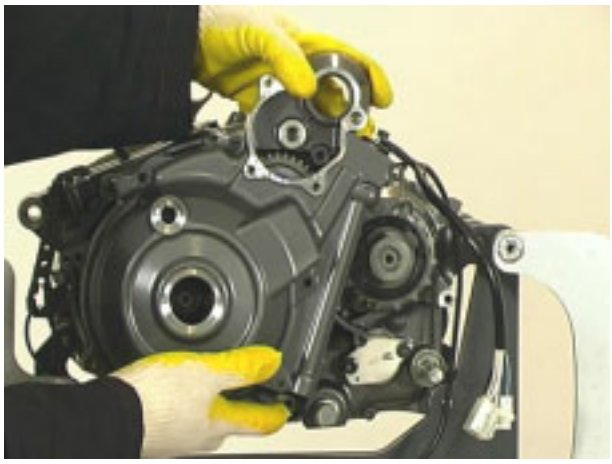
- Remove the cover together with torque limiter.

- Collect the centring dowel.

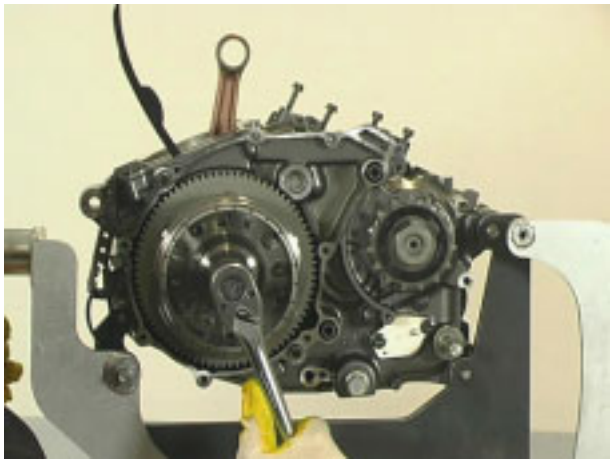
- Loosen the nine screws in a cross pattern.
- Mark the screws with different length.



- Remove the flywheel cover with gasket, starter motor idle gear, four dowels and two O-rings.



- Undo and remove the flywheel nut.

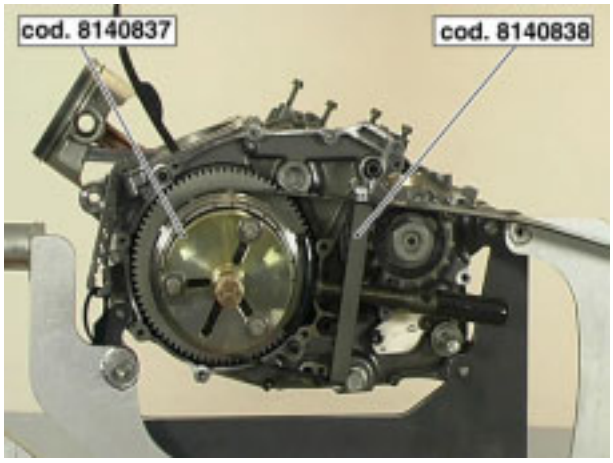


- Collect the washer.

- Position the flywheel locking tool.
- Ensure flywheel is correctly locked.

WARNING
Do not touch the top projecting part of the flywheel with the locking tool.

- Heat the flywheel with a suitable heater.
- Using the suitable puller, remove the flywheel from the crankshaft.

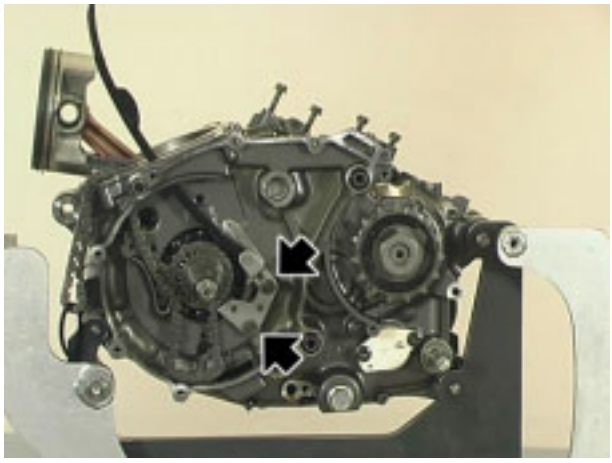


- Remove the key.

- Remove the starter clutch and the roller bearing.

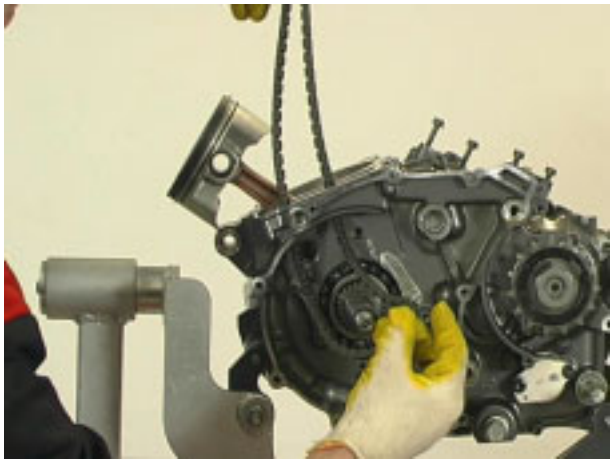
- Remove the washer.

- Release and remove the two screws.



- Remove the rear chain slider.

- Remove the timing chain from crankshaft.



3.9.2. CHECK

CHECKING THE BEARINGS AND OIL SEALS

Carefully clean with a mild solvent the two crankcases, the ball bearings and all bearings seats. Clean the sealing surfaces and ensure they are not damaged.

NOTE *Set the two crankcases on a flat surface to avoid damages.*

Check that the crankcases are not cracked or damaged.
Ensure that all threads are in good condition.
Check that all oil seals that are in place are not worn or damaged.
Check play, smooth movement and deformation of all ball bearings.

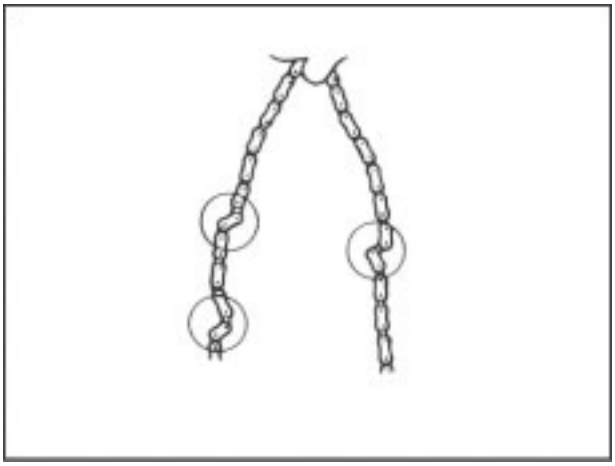
NOTE *Lubricate the ball bearings with engine oil before checking.*

In case the inner ring does not move smoothly and is noisy, it is faulty and should be changed.

CHECKING THE TIMING CHAIN AND GUIDES

Check timing chain for damage and hard spots.
Change the timing chain and camshaft gearwheels as a set, if necessary.

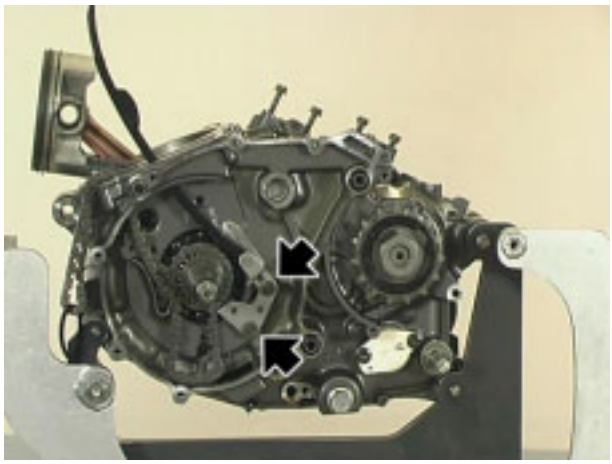
Check timing chain guides for damage.
Change the components, if necessary.



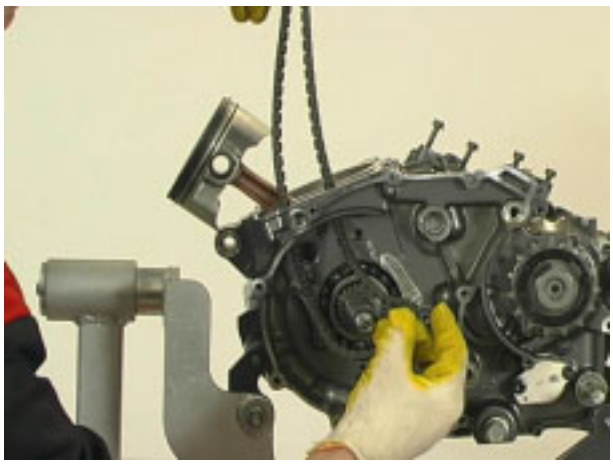
3.9.3. REASSEMBLY

- Fit the rear chain slider.

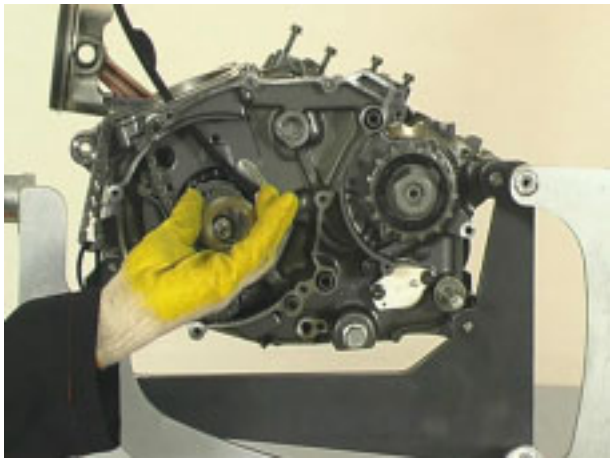
- Tighten the two screws.



- Fit the timing chain to crankshaft.



- Insert the washer.



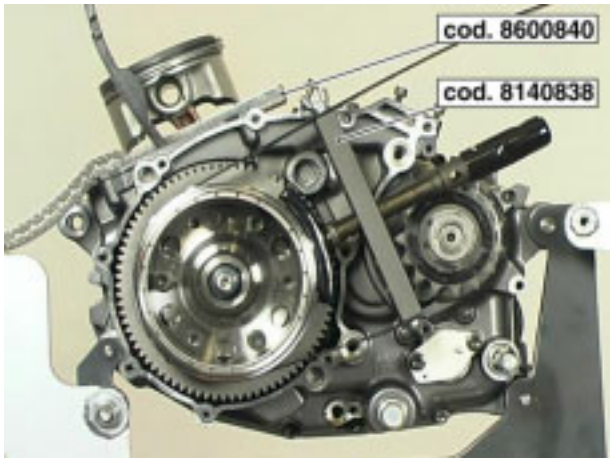
- Install the roller cage.

- Install the starter gear.

- Fit the key into the crankshaft.

- Install the flywheel, pay attention to the correct positioning of the key in its seat.

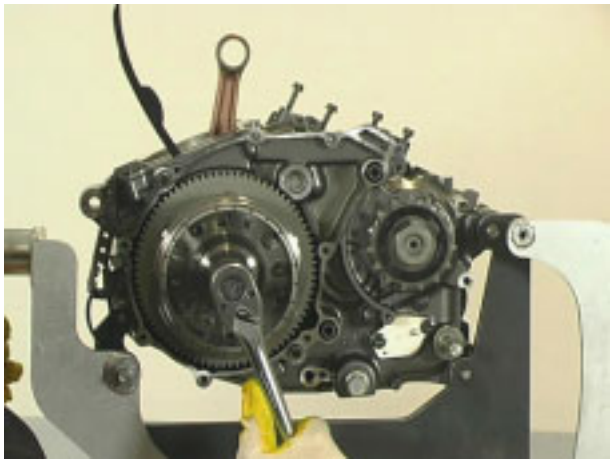
- Set the piston locking tools (no. 8600840) and flywheel tools (no. 8140838).



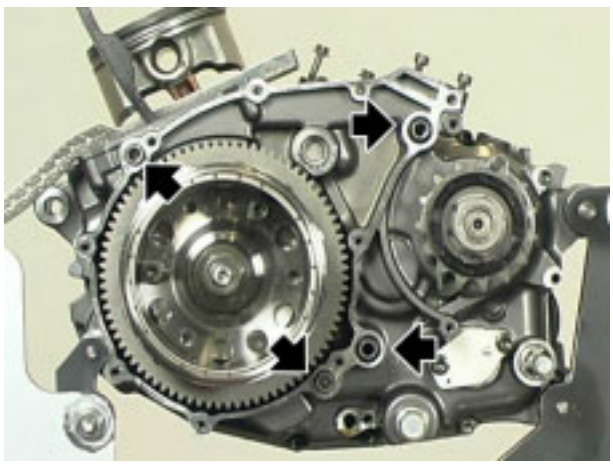
WARNING
Avoid touching the flywheel projecting parts with the locking tool.

- Fit the washer into the crankshaft.

- Tighten the nut to the specified torque.



- Position the two front and two rear dowels with O-rings to the crankcases.

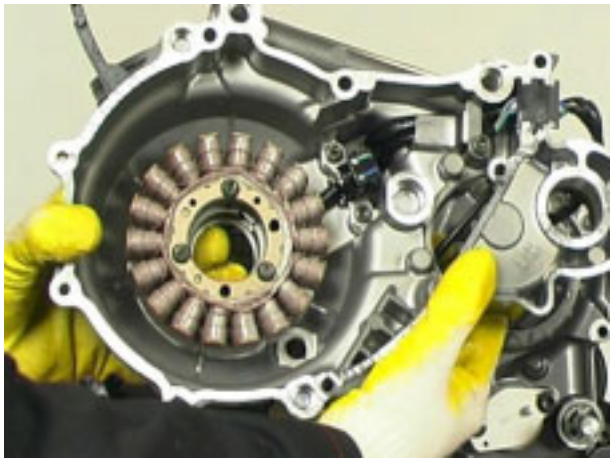


- Install a new seal.

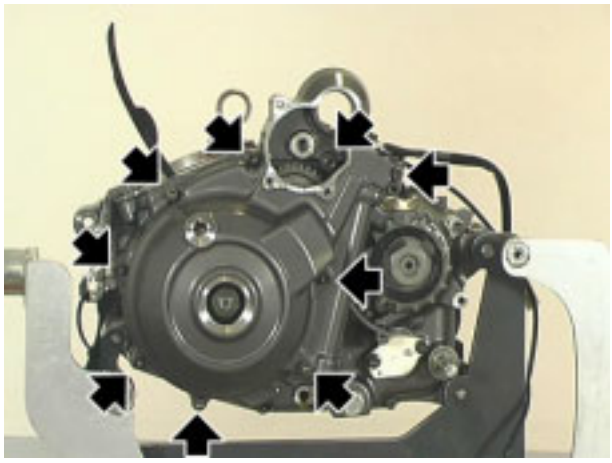
- Set the starter motor idle gear.

- Insert the pin.

- Fit the flywheel cover complete with stator.



- Correctly fit the nine screws and tighten in a cross sequence.

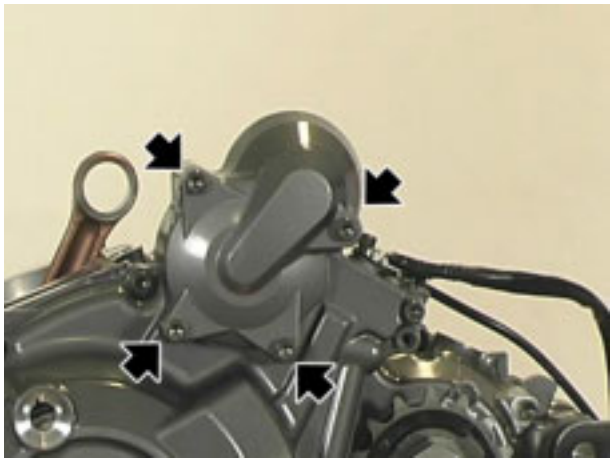


- Fit the starter motor torque limiter.

- Fit the centring dowel.

- Install the torque limiter cover with a new gasket.

- Correctly fit the four screws and tighten in a cross sequence.



3.9.4. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

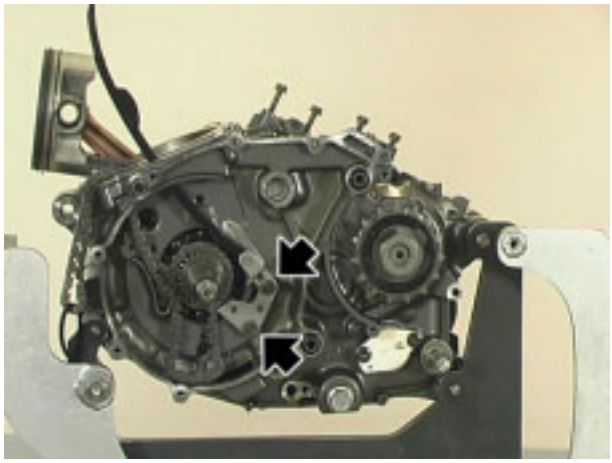
DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

3.10. ENGINE CRANKCASES

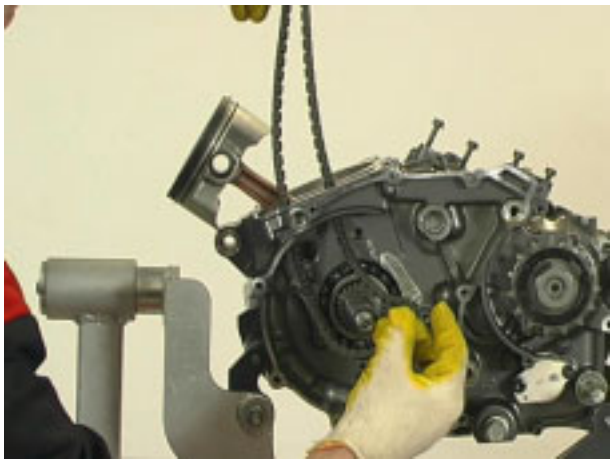
3.10.1. HOW TO TAKE THE ENGINE CRANKCASES APART

- Before removing any components, place a container of adequate capacity under the engine.
- Remove all accessories.

- Loosen and remove the two screws and collect the washers.
- Lift the timing chain guide on intake side and remove it.



- Remove the timing chain.



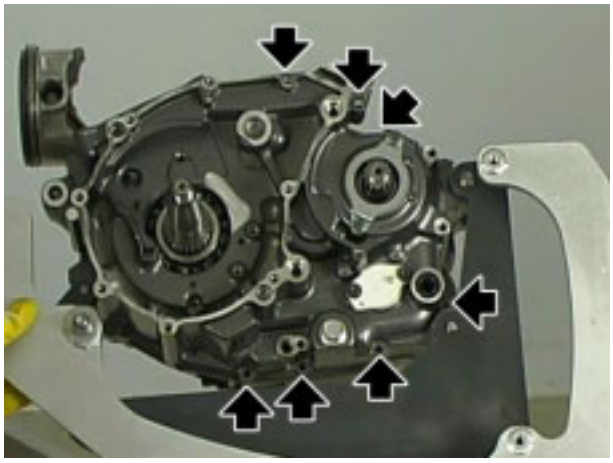
- Straighten the washer.

- Undo and remove the nut and collect the washer.

- Remove the front chain sprocket.

- Remove the circlip.

- Working in a cross pattern, loosen the seven screws by one fourth of a turn at a time until removing all seven screws.
- Release and remove all screws.

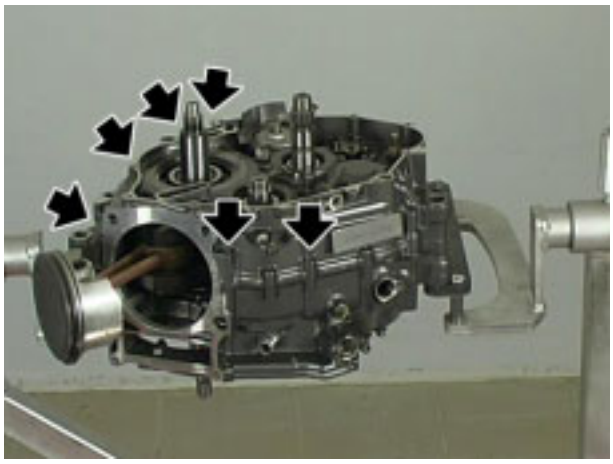


- Loosen and remove the two screws and remove the support.

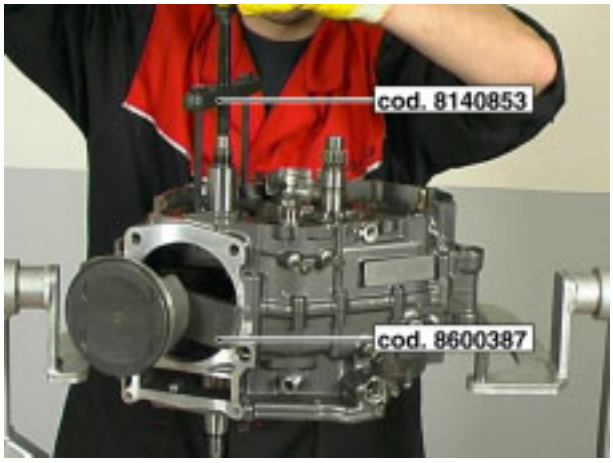
- Remove the circlip and the oil pump gear.

- Unhook the spring and remove the complete gearbox shaft stop lever.

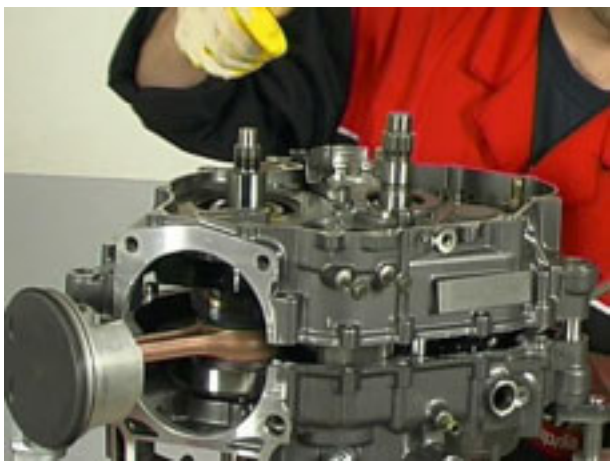
- Working in a cross pattern, loosen the six screws by one fourth of a turn at a time until removing all six screws.
- Release and remove all screws.



- Use the connecting rod locking tool (no. 8600840) and the crankcase puller (no. 8140853) and separate the two crankcase halves.



- Tap the crankcases lightly with a hammer to separate the crankcases. After they become separated, remove both tools.

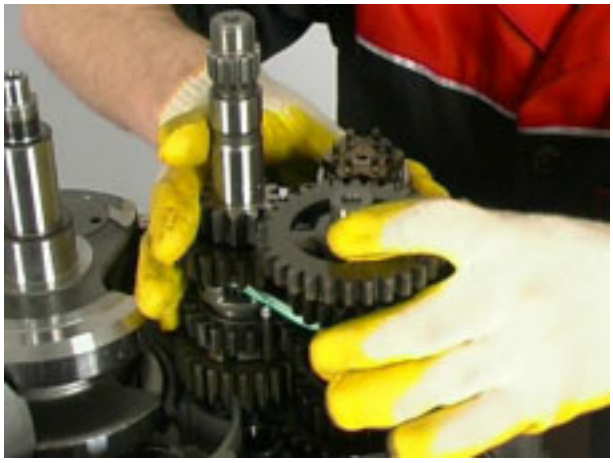


- Remove the right casing.

- Tie the gearbox shafts with rubber bands.

- Remove the counter shaft.

- Remove the gearbox shafts assembly.



NOTE *Secure crankcase to engine supporting plate (no. 8140839).*

- Use the crankcase puller (no. 8140853) to remove the crankshaft.

3.10.2. CHECK

CHECKING THE BEARINGS AND OIL SEALS

Carefully clean with a mild solvent the two crankcases, the ball bearings and all bearings seats. Clean the sealing surfaces and ensure they are not damaged.

NOTE *Set the two casings on a flat surface to avoid damages.*

Check that the casings are not cracked or damaged.
Ensure that all threads are in good condition.
Check that all oil seals that are in place are not worn or damaged.
Check play, smooth movement and deformation of all ball bearings.

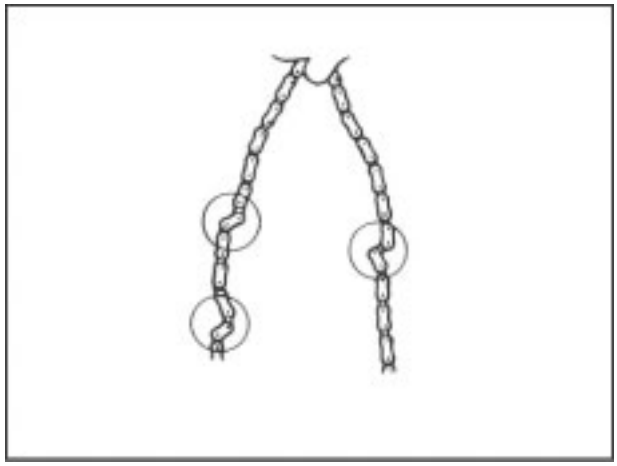
NOTE *Lubricate the ball bearings with engine oil before checking.*

In case the inner ring does not move smoothly and is noisy, it is faulty and should be changed.

CHECKING THE TIMING CHAIN AND GUIDES

Check timing chain for damage and hard spots.
Change the timing chain and camshaft gearwheels as a set, if necessary.

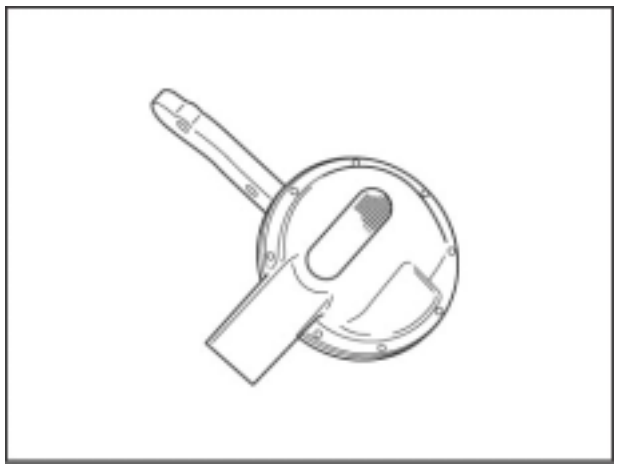
Check timing chain guides for damage.
Change the components, if necessary.



CHECKING THE OIL FILTER AND THE OIL DELIVERY TUBE

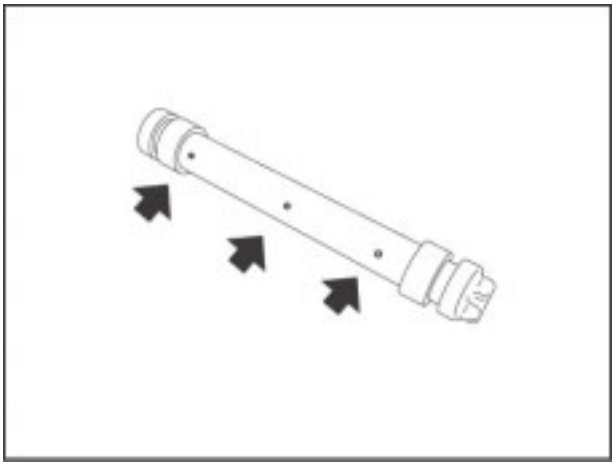
Check oil filter for damage.
Change the part, if necessary.

Clean oil mesh with petroleum and check the mesh to ensure there are no damages.



Check oil delivery tube for damage.
Change the part, if necessary.

Ensure that the oil delivery tube holes are not clogged and blow with compressed air to clean them, if necessary.

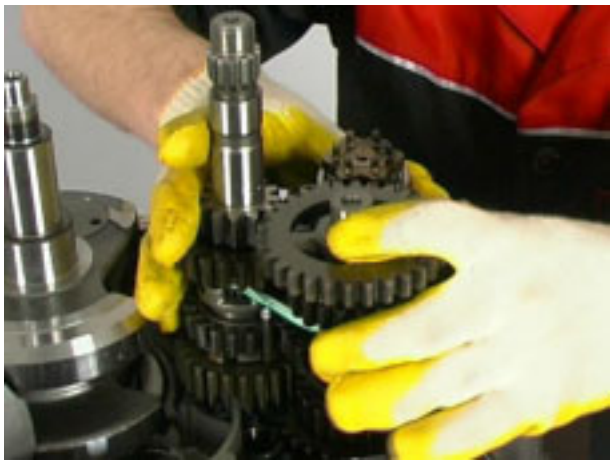


3.10.3. ASSEMBLING THE CRANKCASES

NOTE *Before reassembling, change and lubricate the oil seal and the bearing balls.*

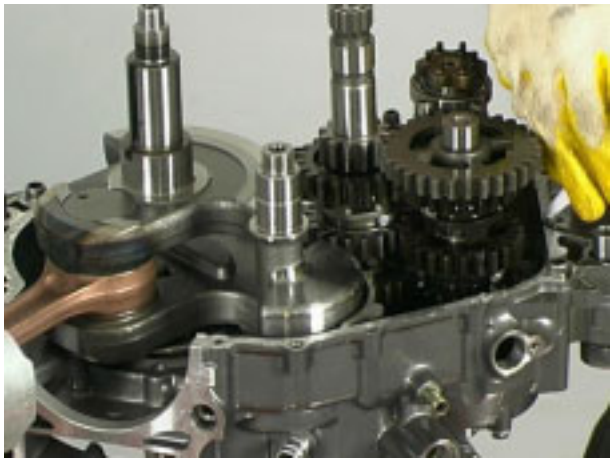
- Install oil seals and bearings to the casings.
- Using the special tool (no. 8140846), install the crankshaft to the left casing.

- Install the complete gearbox to the left casing, ensure that shafts can smoothly turn.



- Install the counter shaft.

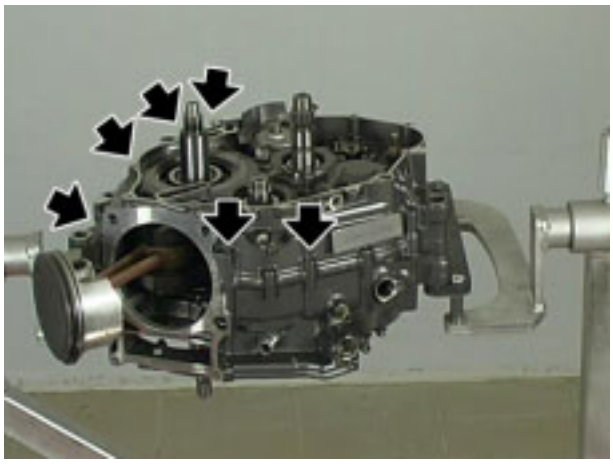
- Apply some sealant on the sealing surfaces of both casings.



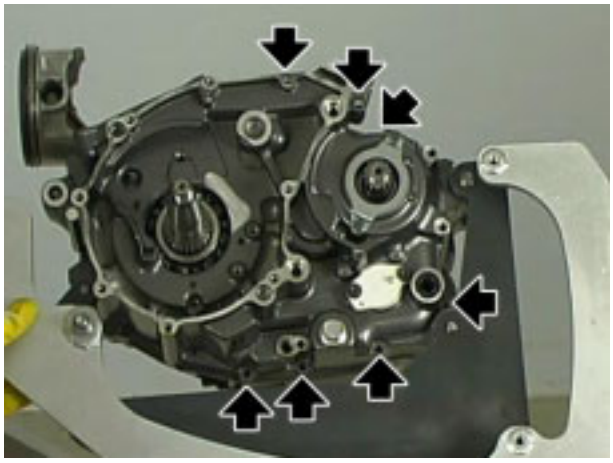
- Install the right casing to the left casing, tap with a mallet, if necessary.

NOTE *Ensure that shafts turn correctly.*

- Install the six screws on left casing.
- Tighten the six screws to the specified torque, in a cross pattern.



- Install the seven screws on right casing.
- Tighten the seven screws to the specified torque, in a cross pattern.



- Install the complete selector shaft.

- Secure the spring.

- Insert the circlip.

3.10.4. TIGHTENING TORQUE SETTINGS

DESCRIPTION	TIGHTENING TORQUES (Nm)	NOTES
ENGINE		
Oil seal plate screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Threaded pin	2.0 - 2.4	Loctite 620 on thread
Clutch casing and Flywheel casing screws	0.8 - 1.2	
Bearing plate and oil filter screws	0.8 - 1.2	Loctite 620 on thread
Oil inlet hose screw	0.8 - 1.2	Loctite 620 on thread
Oil Drain screw	2.7 - 3.3	
Chain sprocket nut	11.0 - 13.0	Engine oil 10W-40 on thread
Neutral light switch screws	0.2 - 0.6	Loctite 620 on thread
Oil pump screws	0.8 - 1.2	
Oil pump gear cover screws	0.35 - 0.45	Loctite 620 on thread
Counter shaft nut	6.0 - 8.0	Engine oil 10W-40 on thread
Engine sprocket nut	7.0 - 9.0	Molykote G-n plus grease on thread
Drum nut	8.0 - 10.0	Engine oil 10W-40 on thread
Clutch screws	0.8 - 1.0	Engine oil 10W-40 on thread
Clutch cover plate screws 1	0.8 - 1.2	Loctite 620 on thread
Clutch cover screws 1 and 2	0.8 - 1.2	
Water pump and water pump union screw	0.8 - 1.2	
Speed sensor and oil filter cover screws	0.8 - 1.2	
Oil filter bleed screw	0.3 - 0.7	
Cylinder screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder side screws	0.8 - 1.2	
Head screws	4.8 - 5.2	Engine oil 10W-40 on thread, head and washer
Cylinder-head upside-down screws	3.5 - 3.9	Engine oil 10W-40 on thread, head and washer
Head side screws	0.8 - 1.2	
Timing gearwheel screws	1.8 - 2.2	
Water hose union screws	0.8 - 1.2	
Chain guide screw 1	0.6 - 1.0	
Freewheel-rotor screws	2.7 - 3.3	Loctite 620 on thread
Chain tensioner body screws	0.8 - 1.2	
Chain tensioner screw	1.8 - 2.2	
Flywheel nut	7.0 - 9.0	Engine oil 10W-40 on thread
Stator cables plate screw	0.8 - 1.2	Loctite 620 on thread
PK screws	0.6 - 0.8	Loctite 620 on thread
Stator screws	0.8 - 1.2	Loctite 620 on thread
Flywheel cover screws	0.8 - 1.2	
Oil outlet hose screws	0.8 - 1.2	Sealant Threebond TB 1215 on thread
Starter motor screws	0.8 - 1.0	
E/S gears cover screws	0.8 - 1.2	

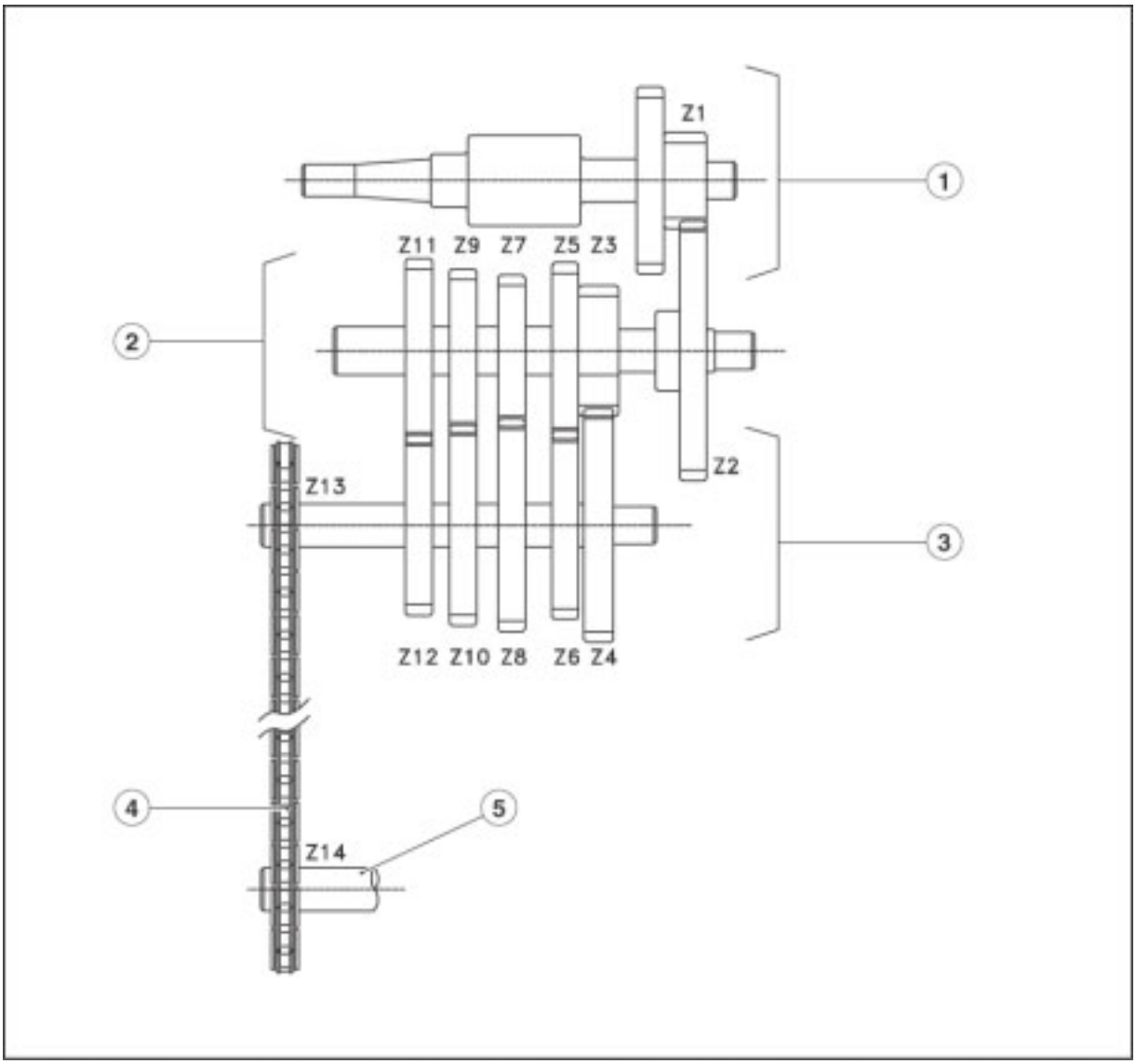
DESCRIPTION	TIGHTENING TORQUES (Nm)	Notes
ENGINE		
Valve adjustment nuts	1.2 ÷ 1.5	
Valve cover and timing cover screws	0.8 ÷ 1.2	
Oil channel hose screws 1	1.6 ÷ 2.0	
Spark plug	1.0 ÷ 1.5	
Oil channel hose screws 2	1.7 ÷ 2.3	
Oil channel hose side screw 2	0.8 ÷- 1.2	
Intake manifold clamps screws	0.3 ÷ 0.4	
AIS tube screws	0.8 ÷ 1.2	
Sensor	1.6 ÷ 2.0	
Thermostat cover screws	0.8 ÷ 1.2	
Exhaust stud bolts	1.3 ÷ 1.7	
Camshaft plate screws	0.8 ÷ 1.2	Loctite 242 on thread

GEARBOX 4

SUMMARY

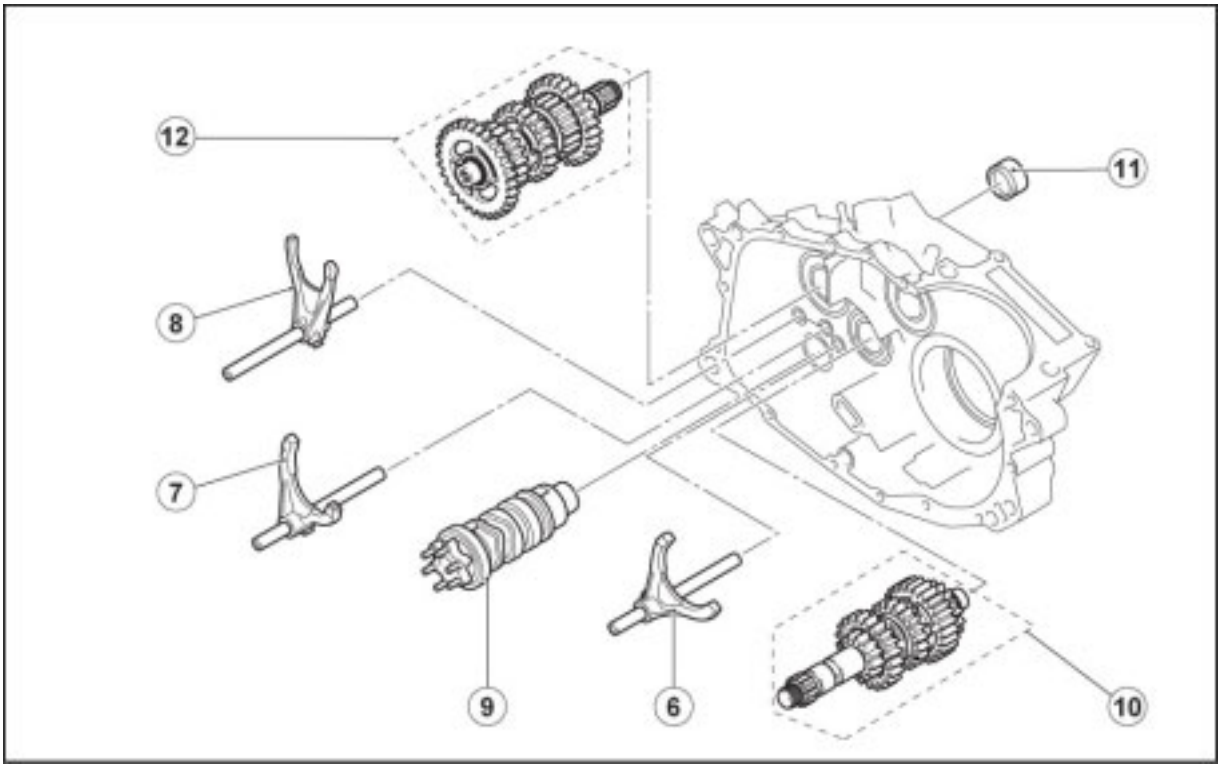
4.1. GEARBOX SHAFTS

4.1.1. DIAGRAM



Key:

1. Counter shaft
2. Primary shaft
3. Secondary shaft
4. Chain
5. Wheel shaft



Key:

6. Gearbox fork “C”
7. Gearbox fork “R”
8. Gearbox fork “L”
9. Gearbox drum
10. Primary shaft assembly
11. Spacer
12. Secondary shaft assembly

4.1.2. MAIN SHAFT DISASSEMBLY

- Remove the circlip.

- Remove the second-speed gear.

- Remove the safety retaining washer.

- Remove the fifth-speed gear and collect retainer, spacer and safety washer.

- Remove the circlip.

- Remove the third-speed gear.

- Remove the circlip.

- Remove the safety washer.

- Remove the fourth-speed gear.

4.1.3. TRANSMISSION SHAFT DISASSEMBLY

- Remove the circlip.

- Remove the first-speed gearwheel and collect the washer.

- Remove the fourth-speed gearwheel.

- Remove the circlip.

- Remove the third-speed gearwheel and collect the safety washer.

- Remove the fifth-speed gearwheel.

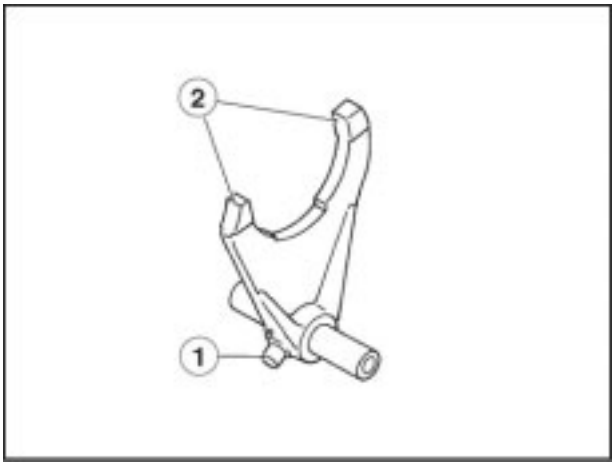
- Remove the circlip and then the second-speed gearwheel, collect safety washer and seal.

4.1.4. CHECK

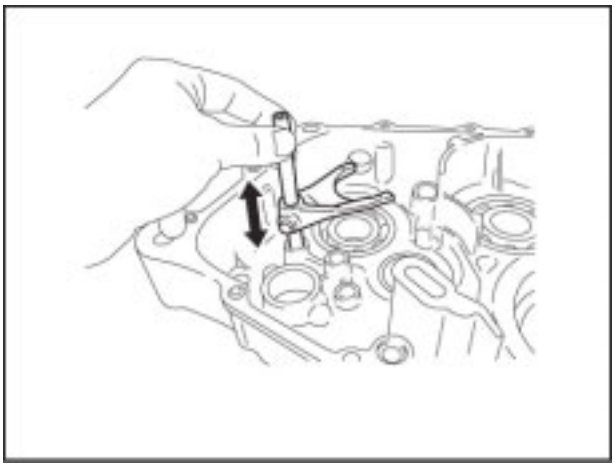
CHECKING THE GEARBOX FORKS

NOTE *The following procedure applies to all gearbox forks.*

Check gear shift fork cam roller (1), gear shift fork tooth (2) for damage, deformation and wear.
Change the gear shift fork, if needed.



Check fork movement, change the forks if it is not smooth.

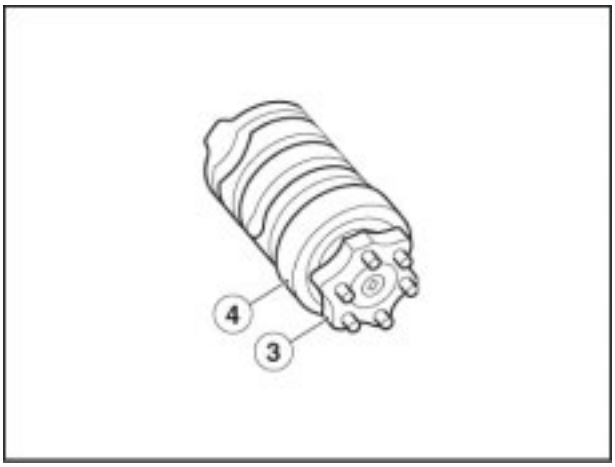


CHECKING THE GEAR SHIFT DRUM UNIT

Check gear shift drum for damage, scratches and wear, change the unit if necessary.

Check gear shift drum area (3) for damage and wear, change the unit if necessary.

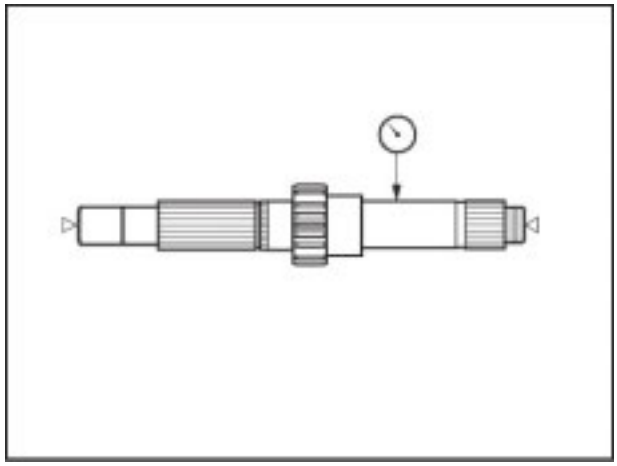
Check gear shift drum bearing (4) for damage and pitting, change the unit if necessary.



CHECKING THE GEARBOX

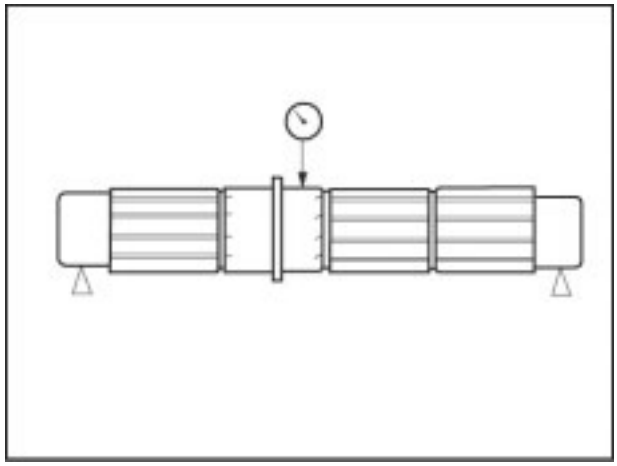
With a dial gauge and a centring device, measure primary shaft runout, change the shaft if reading does not comply with recommended values.

Maximum primary shaft runout:
0.08 mm (0.0031 in.)



With a dial gauge and a centring device, measure secondary shaft runout, change the shaft if reading does not comply with recommended values.

Maximum primary shaft runout:
0.08 mm (0.0031 in.)



Check drive gears for wear and pitting and change faulty gears, if necessary.

Check gear clutch dogs for cracks, damage and wear and change the faulty ones.

Check drive gear movement, change the faulty ones.

4.1.5. REFITTING THE PRIMARY SHAFT

- Install fourth speed gear.

- Insert the safety washer.

- Change the circlip.

- Install third speed gear.

- Change the circlip.

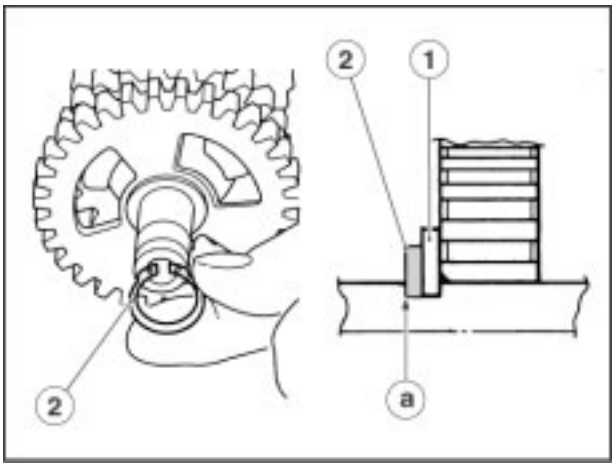
- Fit the safety washer, the spacer, the retainer and install the fifth speed gear .

- Fit the safety washer.

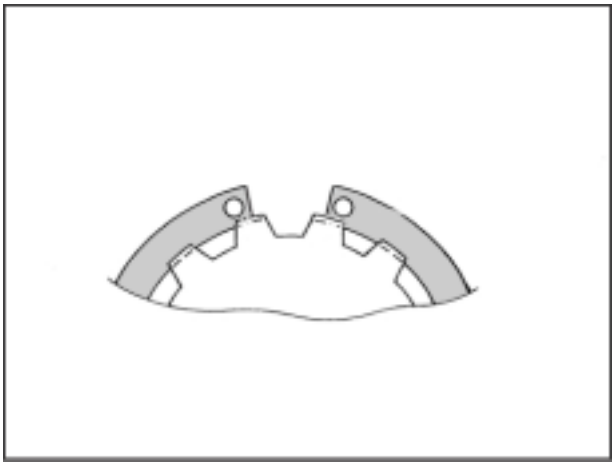
- Install second speed gear.

- Change the circlip.

NOTE *Ensure that the sharp edge (a) of circlips (2) is on the opposite side with respect to safety washers (1) and relevant gears.*



NOTE *Install circlips so that both edges are at the centre of every groove.*



4.1.6. REFITTING THE SECONDARY SHAFT

- Install second speed gear completed with seal and safety washer.

- Change the circlip.

- Install the fifth speed gear.

- Install the third speed gear and safety washer.

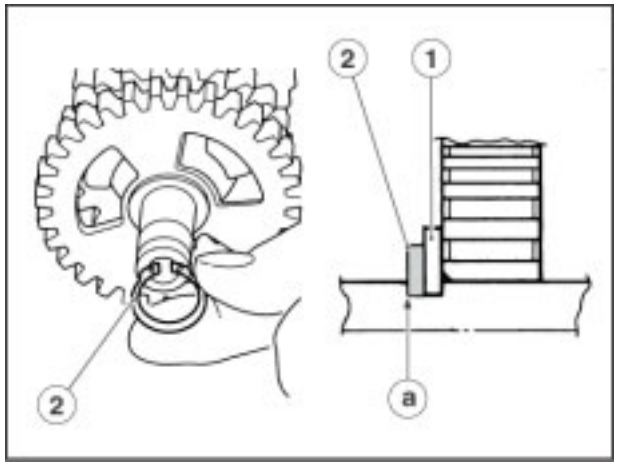
- Change the circlip.

- Install the fourth speed gear.

- Install the first speed gear and washer.

- Change the circlip.

NOTE *Ensure that the sharp edge (a) of circlips (2) is on the opposite side with respect to safety washers (1) and relevant gears.*



NOTE *Install circlips so that both edges are at the centre of every groove.*