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engine V990 RR

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workshop manual



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INTRODUCTION

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0.1. INTRODUCTION

0.1.1. INTRODUCTION

- 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 inasmuch as their inclusion would be superfluous for such an audience. 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 prevent 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 supplied in subsequent editions of the manual. In case of doubt regarding specific repairs or checks, contact the **Aprilia** SERVICE DEPARTMENT; we will be pleased to provide all necessary information and assistance as well as keeping you updated on changes and modifications to the vehicle.

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0.1.2. REFERENCE MANUALS

PARTS CATALOGUES

Aprilia part# (description)
3974     

SPECIAL TOOLS CATALOGUES

Aprilia part# (description)
001A00     

OWNER'S MANUALS

Aprilia part# (description)
8104334   
8104691   
8104692   
8104693   
8104704 
8104694 
8104695 

CYCLE PARTS TECHNICAL MANUAL

Aprilia part# (description)
8140737 
8140738 
8140739 
8140740 
8140741 
8140742 

ENGINE TECHNICAL MANUAL

Aprilia part# (description)
8140743 
8140744 
8140745 
8140746 
8140747 
8140748 

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
AC	= alternating current
A	= Ampere
Ah	=Ampere per hour
API	= American Petroleum Institute
HV	= high voltage
AV/DC	= Anti-Vibration Double Countershaft
bar	= pressure measurement (1 bar =100 kPa)
DC.	= Direct Current
cc	= cubic centimeters
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 Standardization Organization
Kg	= kilograms
Kgm	= kilogram meter (1 kgm =10 Nm)
km	= kilometers
kph	= kilometers per hour
kΩ	= kilo Ohm
kPa	= kiloPascal (1 kPa =0.01 bar)
KS	= clutch side (from the German "Kupplungseite")
kW	= kiloWatt
/	= liters
LAP	= racetrack lap
LED	= Light Emitting Diode
LEFT	
SIDE	= left side
m/s	= meters 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
TP	= flat head screw
TSI	= Twin Spark Ignition
UPSIDE-	
DOWN	= inverted fork
V	= Volt
W	= Watt
Ø	= Diameter

GENERAL INFORMATION

SUMMARY

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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:

	OPTIONAL
	CATALYTIC VERSION
-	ALL VERSIONS
MP	NATIONAL CERTIFICATION
SF	EUROPEAN CERTIFICATION (EURO 1 LIMITS)

VERSION:

	ITALY		GREECE		MALAYSIA
	UNITED KINGDOM		HOLLAND		CHILE
	AUSTRIA		SWITZERLAND		CROATIA
	PORTUGAL		DENMARK		AUSTRALIA
	FINLAND		JAPAN		UNITED STATES OF AMERICA
	BELGIUM		SINGAPORE		BRAZIL
	GERMANY		SLOVENIA		SOUTH AFRICA
	FRANCE		ISRAEL		NEW ZEALAND
	SPAIN		SOUTH KOREA		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 very serious risks for your and other people's safety and for the vehicle!

**WARNING**

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

**CAUTION**

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

IMPORTANT: *The word "IMPORTANT" in this manual precedes important information or instructions.*

1.2. DANGEROUS SUBSTANCES

1.2.1. WARNINGS

FUEL

**DANGER**

The fuel used to operate engines is highly flammable and becomes explosive under particular conditions. Refueling and engine service should take place in a well-ventilated area with the engine turned off. Do not smoke when refueling or when near fuel vapors' sources. Avoid contact with bare flames, sources of sparks or any other source which may ignite the fuel or lead to explosion.

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 rim. Tighten the filler's cap securely after each refueling.

Avoid contact with skin. Do not inhale vapors. Do not swallow fuel. Do not use a hose to transfer fuel between different containers.

DO NOT RELEASE FUEL INTO THE ENVIRONMENT.

KEEP IT AWAY FROM CHILDREN.

Use only premium grade unleaded gas, min. O.N. 95 (N.O.R.M.) and 85 (N.O.M.M.).

LUBRICANTS

**DANGER**

A good lubrication ensures the vehicle's 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's or gearbox's seizure, thus leading to serious accidents, personal injury or even death.

Gear 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 into the environment.

Take it to the filling station where you usually buy it or to an oil salvage center.

**WARNING**

When filling the vehicle with this oil, take care not to spill it out since it could damage the vehicle paintwork.

In case of contact with oil, the tires 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**

Prolonged or repeated contact with engine oil may cause severe skin damage.

Wash your hands thoroughly after handling engine oil.

Do not release into the environment.

Dispose of engine oil through the nearest waste oil reclamation firm or through the supplier.

Wear latex gloves during 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 grade is 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 in perfectly working order. 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 the brakes' efficiency.

**DANGER**

In case of wet ground, double the braking distance since both brakes and tires drives 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 ditches, 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 the brakes proper working order 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 IT 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 entry 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 in perfectly working condition; 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 on racetracks.

When the disc pads wear out, the fluid's level 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 is leaking fluid.

COOLANT**DANGER**

Coolant is toxic when ingested and is an irritant, contact with eyes or skin may cause irritation. In the event of contact with 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 IT 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 anti-freeze. This is the ideal solution for most operating temperatures and provides good corrosion protection.

This solution is also suited for 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 cooling system's efficiency.

When temperature drops below zero degrees centigrade, check the cooling system frequently and add more anti-freeze (up to 60% maximum) to the solution.

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 anti-freeze to obtain a solution with the desired freezing point:

Freezing point °F (°C)	Coolant % of volume
-4° (-20°)	35
-22° (-30°)	45
-40° (-40°)	55

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

**WARNING**

Use nitrate-free coolant only, with a protection until at least -31°F (-35°C).

DRIVE CHAIN

Check drive chain operation, 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 tension has not been correctly adjusted.

To check chain, take it with your hand where it turns on the rear sprocket and pull it as to separate it from the crown itself.

If you can move the chain apart of the front sprocket for more than 3 mm (0.125 in), change chain, crown and pinion.

**DANGER**

If not properly maintained, the chain can undergo early wear out and lead to the damage of both crown and pinion.

Perform chain maintenance operations more frequently if the vehicle is used on rainy or dusty areas.

TIRES

**WARNING**

If tires are excessively inflated, the vehicle will be hard and uneasy to ride, thus making you feel not at your ease.

In addition the roadworthiness, mainly on wet surfaces and during cornering, will be impaired.

Flat tires (insufficient pressure) can slip on the rim and make you lose the control of the vehicle.

In this case as well, both vehicle roadworthiness, handling and brake efficiency will be impaired.

Tires changing, repair, maintenance and balancing must be carried out by specialized technicians using suitable equipment.

When new, tires can have a thin slippery protective coating. Drive carefully for the first kilometers (miles).

Never use rubber treating substances on tires.

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 tires.

**DANGER**

Some of the factory-assembled tires 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 tires are worn and in this case have them changed.

If a tire 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 can lead to serious accidents and consequent personal injuries or death.

Do not install tires with air tube on rims for tubeless tires and vice versa.

1.3. RUNNING-IN

1.3.1. RUNNING-IN RECOMMENDATIONS

Running-in the engine is essential to ensure its duration and correct functioning.

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 over do it.



WARNING

You can expect the best performance levels from the vehicle only after the first 1500 Km (932 mi) of running-in.

Keep to the following indications:

- Do not open the throttle completely if the speed is low, both during and after the running-in.
- During the first 100 Km (62 mi) pull the brakes with caution, avoiding sharp and prolonged brakings. This ensures a correct bedding-in of the pads on the brake disc.
- During the first 1000 Km (621 mi) never exceed 6000 rpm (see table).



WARNING

After the first 1000 Km (621 mi), Dealers carry out the checks indicated in the column "After running-in", see (REGULAR SERVICE INTERVALS CHART), in order to avoid hurting yourself or other people and/or damaging the vehicle.

- Between the first 1000 Km (621 mi) and 1500 Km (932 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 7500 rpm (see table).
- After the first 1500 Km (932 mi), you can expect better performance from the engine, however, without exceeding the maximum allowed [11000 rpm].

Engine maximum rpm recommended	
Mileage Km (mi)	rpm
0÷1000 (621)	6000
1000÷1500 (621÷ 932)	7500
over 1500 (932)	11000

GENERAL TECHNICAL INFORMATION 2

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2.1. GENERAL TECHNICAL INFORMATION

2.1.1. TECHNICAL DATA

ENGINE	
Model	V990 NG
Type	4-stroke V 60° twin-cylinder, with 4 valves per cylinder, DOHC.
No. of cylinders	2
Total displacement	60.88 in ³ (997,6 cm ³)
Max. rated power (to driving shaft)	102 kW (137 HP) at 9500 rpm
Max. torque	107 Nm (10.7 kgm) at 7750 rpm
Bore/stroke	3.82 in / 2.66in (97 mm/67,5 mm)
Compression ratio	11,8 ± 0,4: 1
Camshaft during intake stroke	266° , valve lifting = 0.465 in (11,8 mm)
Camshaft during exhaust stroke	259° , valve lifting = 0.417 in (10,6 mm)
Valve advance (with valve clearance 0.039 in)	
opening during intake stroke	25° before TDC
closing during intake stroke	61° after BDC
opening during exhaust stroke	64° before TDC
closing during exhaust stroke	15° after BDC
Valve clearance during intake stroke	0.0043 – 0.0071 in (0,11 – 0,18 mm)
Valve clearance during exhaust stroke	0.0087 – 0.0114 in (0,22 – 0,29 mm)
# Engine revolutions at minimum rpm	1280 ± 100 rpm
# Engine revolutions at peak rpm	11000 ± 100 rpm
Ignition	electronically controlled
Starting	Electric starter
Spark advance	At start: 5° before TDC, additional advance depending on specific consumption levels
Starter motor gear ratio	$I = 49/9 * 30/11 * 64/30 = 31,677$
Clutch	Multiplate wet clutch, hydraulically operated, control on left side of handlebar and PPC device - # 9 friction discs; thick 0.138 in (3,5 mm) - # 10 steel discs; thick 0.059 in (1,5 mm)
Lubricating system	Dry sump with separate oil tank and oil cooler
Lubrication pressure	min 50.7 PSI (350 kPa) (3,5 bar) at max 80°C (176°F) and 6000 rpm
Air cleaner	Dry filter cartridge
Cooling system	Liquid coolant
Coolant pump gear ratio	$i_{wp} = 28/27 * 28/28 = 1.037$
Coolant pump delivery (with thermal expansion valve open)	26.4 gal/min (100 l/min) and 9000 rpm
Thermal expansion valve opening start temperature	65 ± 2 °C (149 ± 5 °F)
Engine dry weight	~ 148 lb (67 Kg)

GEARBOX	
Type	Mechanical, 6 gears with foot control on engine's left side

CAPACITIES	
Engine oil	oil change 226 in ³ (3700 cm ³) - oil and oil filter change 238 in ³ (3900 cm ³)

TRANSMISSION RATIOS				
Ratio	Primary	Secondary	Final drive	Total ratio
1st	31/60 = 1: 1,935	15/34 = 1: 2,267	16/40 = 1: 2,500	1:10,968
2nd		19/31 = 1: 1,632		1:7,895
3rd		20/26 = 1: 1,300		1:6,290
4th		22/24 = 1: 1,091		1:5,279
5th		25/24 = 1: 0,960		1:4,645
6th		26/23 = 1: 0,885		1:4,280

FUEL SYSTEM	
Type	Electronic injection (Multipoint)
Choke	Ø 2.24 in (57 mm)

FUEL	
Fuel	Premium-grade unleaded gas, minimum octane rating 95 (ROM) and 85 (MON).

SPARK PLUGS	
Standard	NGK R DCPR9E
Electrode gap	0.031 in (0,8 mm)
Resistance	5 kΩ

ELECTRIC SYSTEM	
Generator (permanent-wound type)	12 V – 500 W
Starter	12 V – 0,9 kW

2.1.2. LUBRICANTS CHART

LUBRICANT	PRODUCT
Engine oil	<p>RECOMMENDED:  EXTRA RAID 4, SAE 15W - 50 or  Agip TEC 4T, SAE 15W - 50.</p> <p>As an alternative to recommended oils, top brand oils meeting or exceeding CCMC G-4, A.P.I. S.G. specifications can be used.</p>
RSV R fork oil	<p>RECOMMENDED:  F.A. 5W,  F.A. 20W; as an alternative,  Agip FORK 5W or  Agip FORK 20W.</p> <p>When you wish to obtain an intermediate response between those offered by  F.A. 5W and  F.A. 20W oils or  Agip FORK 5W and  Agip FORK 20W, oils, you may mix the different products as follows:</p> <p>SAE 10W =  F.A. 5W 67% of volume +  F.A. 20W 33% of volume, or  Agip FORK 5W 67% del volume +  Agip FORK 20W 33% of volume.</p> <p>SAE 15W =  F.A. 5W 33% of volume +  F.A. 20W 67% of volume, or  Agip FORK 5W 33% of volume +  Agip FORK 20W 67% of volume.</p>
RFACT (RSV R OPT) Fork oil type "R FACTORY"	ÖHLINS 5W
Bearings and other lubrication points	<p>RECOMMENDED:  BIMOL GREASE 481 -  AUTOGREASE MP or  Agip GREASE 30.</p> <p>As an alternative to recommended grease, use top brand rolling bearing grease that will resist a temperature range of -22°F - +284°F, with dropping point 302°F - 446°F, high corrosion protection, good resistance to water and oxidation.</p>
Battery lead protection	Use neutral grease or Vaseline.
Chains	Spray grease RECOMMENDED:  CHAIN SPRAY or  Agip CHAIN LUBE.
Brake fluid	<p>RECOMMENDED: The system is filled with  Autofluid FR. DOT 4 (the braking system is also compatible with DOT 5);  Agip BRAKE 5.1 DOT 4 (the braking system is also compatible with DOT 5).</p> <p>NOTE Use new brake fluid only. Do not mix different brands or types of oil without having checked bases compatibility.</p>
Clutch fluid	<p> F.F., DOT 5 (Compatibile DOT 4) ;  Agip BRAKE 5.1 DOT 5 (the braking system is also compatible with DOT 4).</p> <p>NOTE Use new clutch fluid only</p>
Engine coolant	<p>RECOMMENDED:  ECOBLU -40 °F -  Agip COOL.</p> <p>NOTE Use only nitrite-free anti-freeze and corrosion inhibitors with a freezing point of -31°F as a minimum.</p>

2.1.3. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
ENGINE				
Components mounted on engine				
Engine oil intake flange	4	M6x20	8.11	–
Engine oil unload plug	1	M12x1.5	14.75	–
Pinion	1	M10x35	36.88	–
Clutch control cylinder	3	M6x45	8.11	–
Coolant unload screw	1	M6x25	8.11	–
Gear lever screw	1	M6x16	8.85	–
Crankcase				
Selector rollerball bearings / crankcase screw [flywheel side (MS)]	1	Torx M6x12	8.11	Loctite 243
Rollerball bearings selector/ crankcase [clutch side (KS)]	1	M6x20	8.11	–
Crankshaft ball bearings / crankcase [clutch side (KS)]	3	Torx M6x12	8.11	Loctite 243
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	3	M6x45	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	13	M6x65	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	1	M6x80	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	5	M6x45	8.11	–
Cover (magnetic screw)	1	M12x1.5	14.75	–
Crankcase neutral sensor	1	–	2.95	Loctite 574
Oil filter cover	2	M6x20	8.11	–
Crankcase / 60 nozzle	1	–	4.43	–
Bearing flange [flywheel side (MS)]	2	M6x12	8.11	Loctite 243
Oil pump				
Oil pump	–	–	–	–
Oil pump housing	–	–	–	–
Oil pump cover	4	M6x45	8.11	–
Clutch				
Primary shaft [clutch side (KS)]	1	M24x1.5	125.39	Loctite 648
Clutch spring	6	M6x30	8.11	–
Disengagement shaft	1	M12	22.13	–
Primary drive (spring plate / primary drive gear / clutch housing)	8	M8x25	22.13	–
Primary drive (spring plate / primary drive gear / clutch housing)	8	M8	22.13	Loctite 648

Head, cylinders				
Camshaft support / front head	6	M6x30	8.11	–
Front head (water hose)	1	M18x1.5	By hand	Loctite 275
Front head cap	1	M18x1.5	By hand	Loctite 243
Rear head water hose	2	M18x1.5	By hand	Loctite 275
Camshaft support / rear head	4	M6x30	8.11	–
Camshaft support / rear head	2	M6x45	8.11	–
Camshaft support / rear head	2	M6x55	8.11	–
Exhaust stud bolt	8	M6x16/20	7.38	Loctite 275
Rear head	1	–	By hand	Loctite 275
Head / crankshaft (stud bolt)	8	M10x171	4.43	Loctite 648
Cylinder / head (unpainted cylinder version)	8	M8x45	19.91	–
Head / studbolt (unpainted head version)	8	M10x4	42.78	–
Head / chain housing	2	M6x100	8.85	–
Rear head / bushing flange	2	M6x35	8.11	–
Rear head / bushing flange	2	M6x20	8.11	–
Front head / Driven gear (timing chain) - Intake camshaft	6	M6x45	8.11	Loctite 243
Front head / Upper chain guide	2	M6x16	8.11	–
Rear head / Driving gear (timing chain) - Intake camshaft	6	M6x11.5	8.11	Loctite 243
Rear head / Counterweight + Driven gear (Upper countershaft assy) - Upper countershaft	1	M14x1	36.88	Loctite 243
Rear head / Upper chain guide	2	M6x35	8.11	–
Valve cover	10	M6x23	6.64	–
Intake flange	4	M8x25	14.01	–
Cylinder / chain tensioner	2	M16x1.5	22.13	–
Water temperature sensor	1		14.75	–
Mount bracket fitting	2+ 2	M10x40 M10	29.5	Loctite 243
Ignition system, starter motor				
Crankshaft position sensor / flywheel cover	1	M6	8.11	Loctite 243
Flywheel cover / alternator	12	M6x35	8.11	–
Magneto flywheel / freewheel housing / flywheel ring	6	M8x18	22.13	Loctite 648
Magneto flywheel / crankshaft	1	M16x30	95.88	Loctite 648
Ignition unit cover / cable bracket	1	M5	5.16	–
Camshaft position sensor / front head	1	M6x15	8.11	–
Starter motor	2	M6x30	8.11	–
Clutch housing, coolant pump				
Coolant pump impeller	–	–	By hand	–
Coolant pump cover	1	M6x25	8.11	–
Coolant pump body	3	M6x55	8.11	Loctite 243
Clutch housing	10	M6x35	8.11	–
Clutch housing	1	M6x50	8.11	–
Clutch housing	3	M8x55	14.01	–
Clutch housing	1	M8x65	14.01	–

2.1.4. SPECIAL TOOLS AND EQUIPMENT

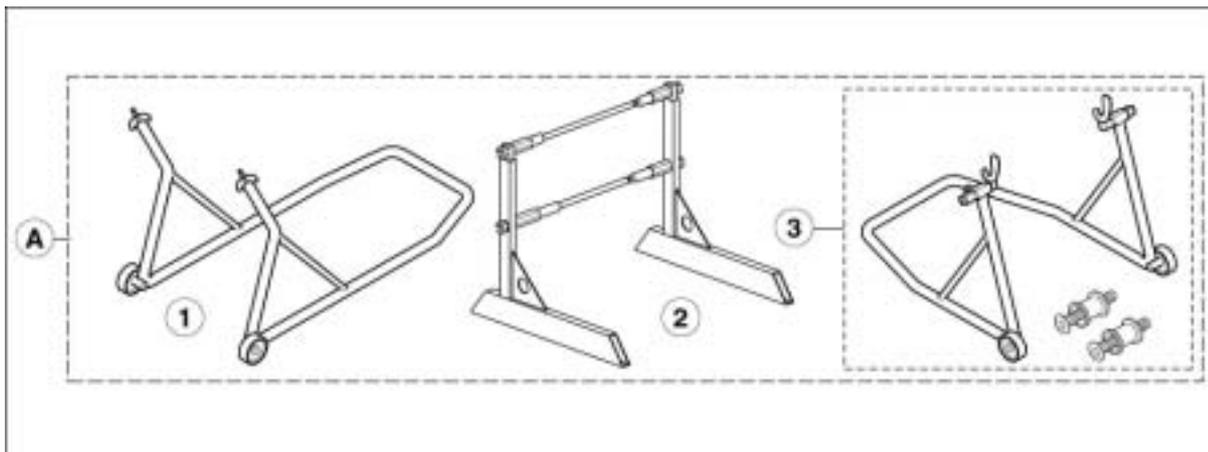
In order to perform assembly, reassembly and settings correctly, special tools suitable for the task must be used. The use of special tools prevents the potential risk of damage as a result of inappropriate tools and/or improvised methods.

Below is a list of the special tools designed especially for this specific vehicle. If necessary, request the multi-purpose special tools.



CAUTION
Before using the special tools, consult any documents attached.

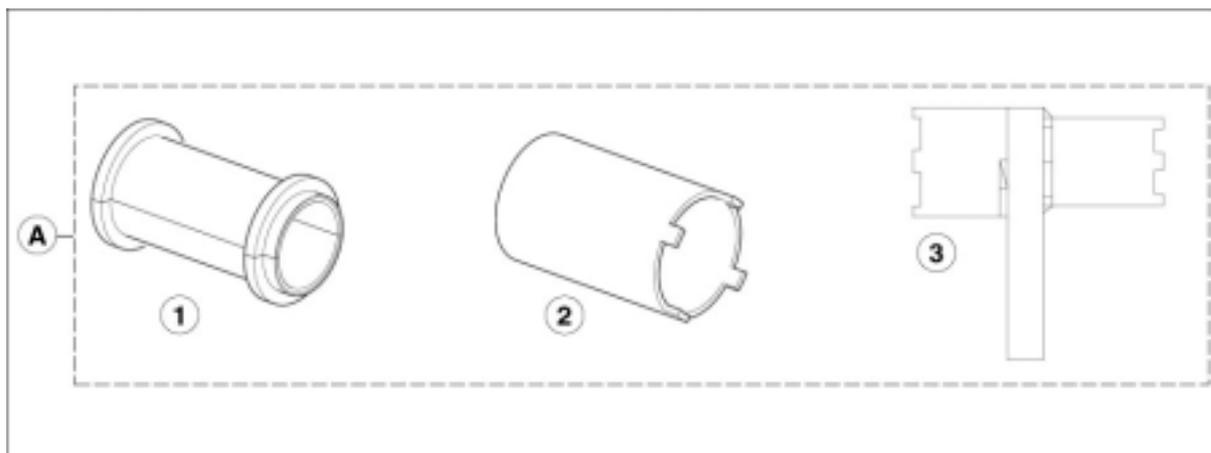
SUPPORT STANDS



Pos.	Aprilia part# (tool description and function)
A	8140176 (complete support stand kit)
1	8146486 (front support stand)
2	xxxxxxx N.A. [center stand]
3	8705021 (rear support stand)

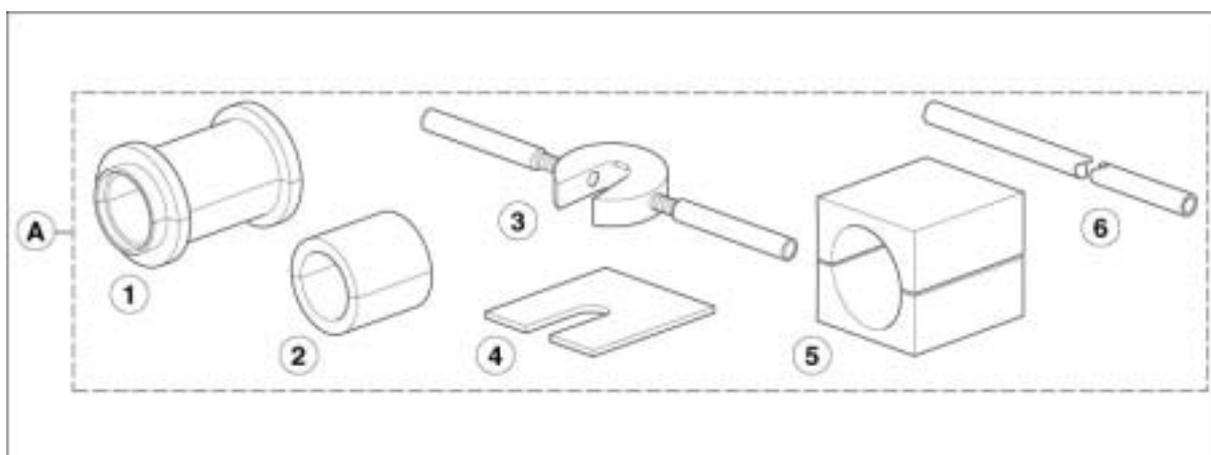
xxxxxxx N.A. = available only with the **Aprilia** kit part# 8140176 (complete support stand kit)

FRAME TOOLS



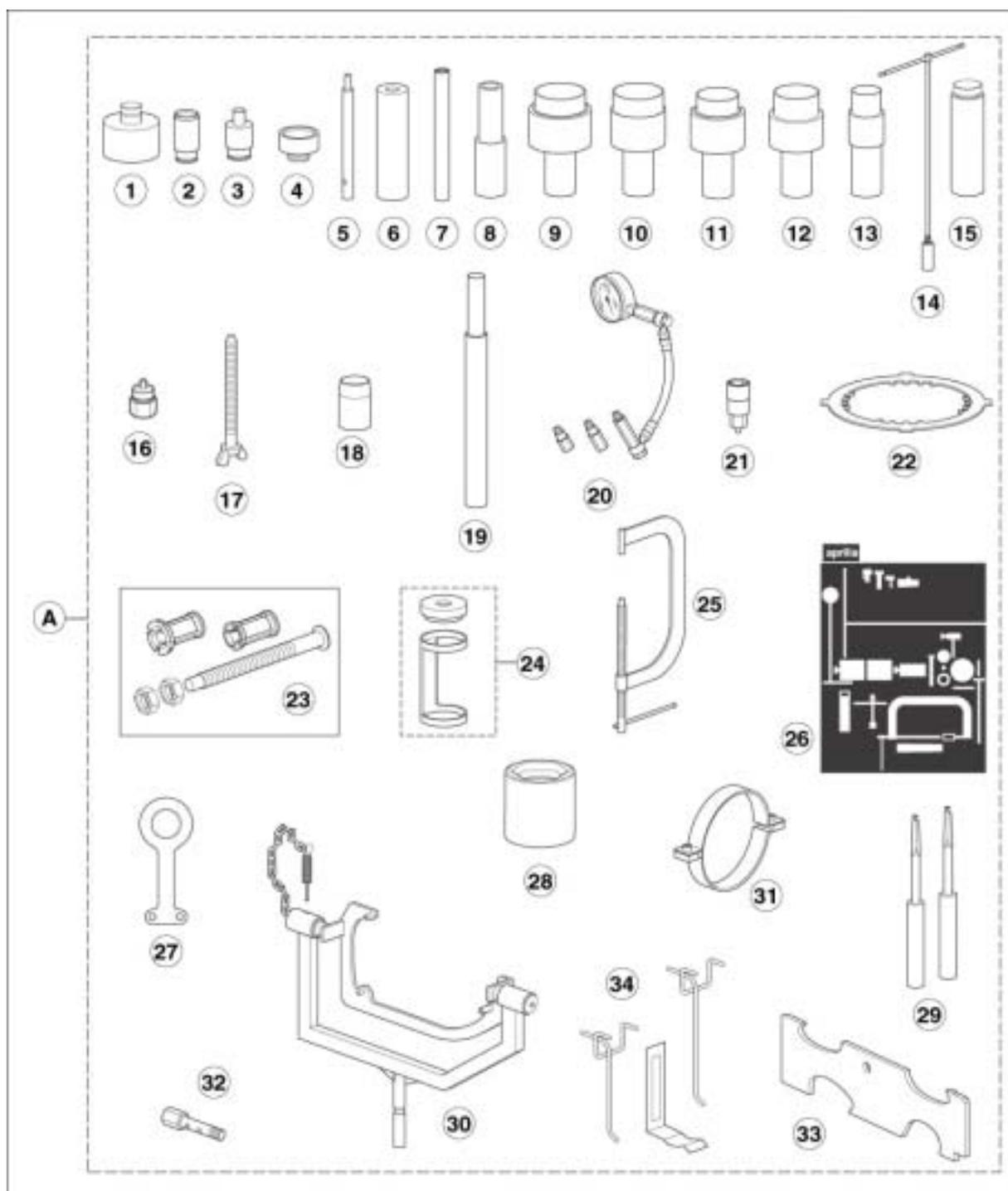
Pos.	Aprilia part# (tool description and function)
A	8140203 (complete tool kit for frame included)
1	8140189 [oil seal fitting tool - Ø 1.69 in (43 mm) hole. Kit accessory Aprilia part# 8140151 (complete tool kit for fork included)]
2	8140190 (steering tightening tool)
3	8140191 (rear fork pin and engine support tightening tool)

FORK TOOLS



Pos.	Aprilia part# (tool description and function)
A	8140151 (complete tool kit for fork included)
1	8140145 (Ø 1.61 in sealing ring fitting tool)
2	8140146 [weight to be applied to the tool: Aprilia part# 8140145 (Ø 1.61 in sealing ring fitting tool)] and Aprilia part# 8140189 [oil seal fitting tool - Ø 1.69 in (43 mm) hole. Kit accessory Aprilia part# 8140151 (complete tool kit for fork included)]
3	8140147 (spacer holding tool)
4	8140148 (spacer/pumping element separating plate)
5	8140149 (protection element for disassembly operations)
6	8140150 (drilled rod for pumping element bleeding)

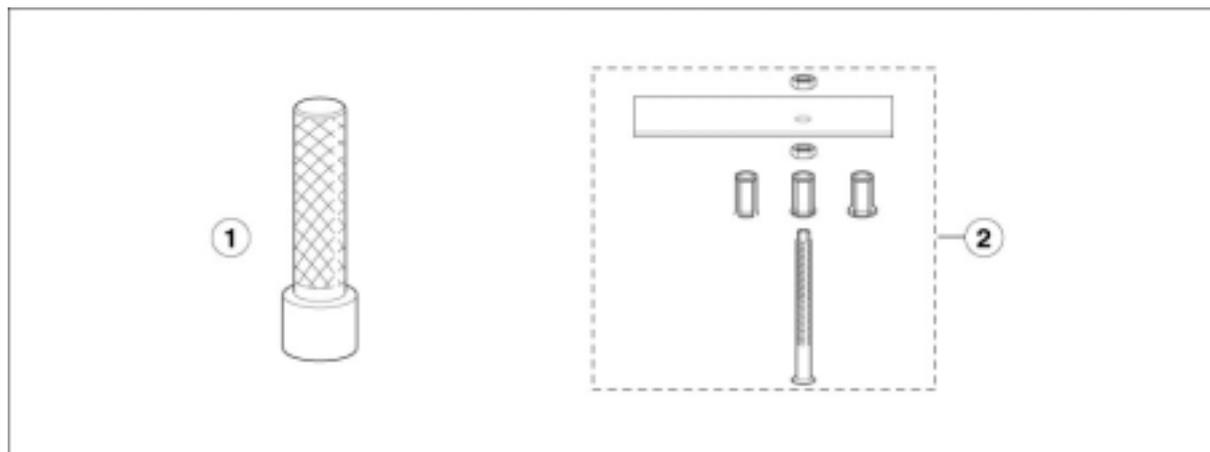
ENGINE TOOLS



Pos.	Aprilia part# (tool description and function)
A	8140175 (complete tool kit for engine included)
1	0277680 (gearshift secondary shaft oil seal assembly pad)
2	0277660 (upper countershaft oil seal assembly pad)
3	0277670 (coolant pump shaft housing oil seal assembly pad)
4	0877257 (assembly pad for water pump shaft seat sliding ring)
5	0277510 (valve guide disassembly pad)
6	0277210 (valve guide assembly)
7	0277695 (valve guide oil seal assembly pad)
8	8140155 (gearshift shaft oil seal - clutch shaft oil seal assembly pad)
9	0277725 (driving shaft bush inserter pad)
10	0277720 (driving shaft sleeve puller pad)
11	0277537 (lower countershaft bush inserter pad)
12	0277727 (driving shaft - clutch cover bush inserter pad)
13	0277729 (insertion pad for lower balance shaft clutch cover bushes)
14	8140177 (plug socket wrench)
15	0277252 (flywheel magneto cover removal tool)
16	0277730 (flywheel removal hexagonal bolt)
17	0240880 (threaded bolt to lock the drive shaft at the TDC)
18	0277308 (gearshift secondary shaft guide bush)
19	8140178 (pin installation and removal pad)
20	8140181 (fuel-oil pressure gauge-compression)
21	8140182 (rotor bolt bush)
22	0277881 (clutch blocking tool)
23	8140156 + 8140157 + 0276377 (clutch cover sleeve puller)
24	0276479 (valve spring compression tool)
25	8140179 (valves disassembly and reassembly bow)
26	8157143 (adhesive for tool holder panel RSV mille)
27	8140183 (engine lifting eye hook)
28	8140184 (primary transmission nut disassembly bush)
29	8140185 (clutch disc extraction hook lever)
30	8140188 (engine support)
31	8140186 (piston ring compression tool)
32	8140197 (perforated bolt for fuel pressure test fuel)
33	8140205 (camshaft template)
34	8140426 (panel hooks)

Pos.	Aprilia part# (tool description and function)
1	8140196 [Plurigas (Italian)]
1	8140578 [Plurigas (English)]
2	8140192 (chain installation kit)
3	8140180 (bearing extractors)
4	8140202 (exhaust gas analysis probes)
5	8140267 (intake flange for vacuumeter)
6	8140256 (vacuometer)
7	8140424 (OHLINS fork wrench)
8	8140199 (tool panel)
9	8140426 (panel hooks)
10	8140432 (pushing extractor)
11	8140187 (engine support stand)
12	8124838 (battery charger M.F.)
13	0897651 [LOCTITE [®] 243 blue (0.61 in ³)]
14	0899788 [LOCTITE [®] 648 green (0.176 oz)]
15	0899784 (LOCTITE [®] 574 orange)
16	0297434 (LOCTITE [®] 767 Anti-Seize 15378)
17	0297433 [MOLYKOTE [®] G-N (1.76 oz)]
18	0897330 (multi-purpose grease bp lz)
19	0297386 [SILASTIC 732 RTV (3.5 oz)]
20	8116067 (LOCTITE [®] 8150)
21	8202222 (panel adhesive sheet)
22	8140074 (lower countershaft bush inserter pad)
23	8140204 (rear stand supports)
24	0277295 (hose clamp installation pliers)

TOOLS USED FOR OTHER Aprilia



Pos.	Aprilia part# (tool description and function)
1	0877650 (handle for pads)
2	0277265 (extractor for balance shaft, gearbox input and output shaft)
-	8116050 (engine oil)
-	8116053 (grease  Bimol Grease 481)
-	8116038 (grease LUBERING ST)
-	xxxxxxx N.A. (AP-LUBE temporary lubricant)
-	xxxxxxx N.A. (grease DID CHAIN LUBE)
-	8116031 (Fluid "Biosolvent" frame detergent)
-	8116945 ("ACRILICON 28" cyanoacrylic glue)
-	xxxxxxx N.A. (MOTUL MOTOWASH degreaser)
-	8116043 (ANTI-SEIZE MOTAGEPASTE AS 1800 antiscuff paste)
-	xxxxxxx N.A. (alcohol)
-	0898011 (fluorescent green LOCTITE® 275)
-	xxxxxxx N.A. (LOCTITE® 572)

xxxxxxx N.A. = not available

ENGINE

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3.1. ENGINE ACCESSORIES

3.1.1. REMOVING ENGINE ACCESSORIES

- Loosen the screws securing the starter motor; remove it from its housing.



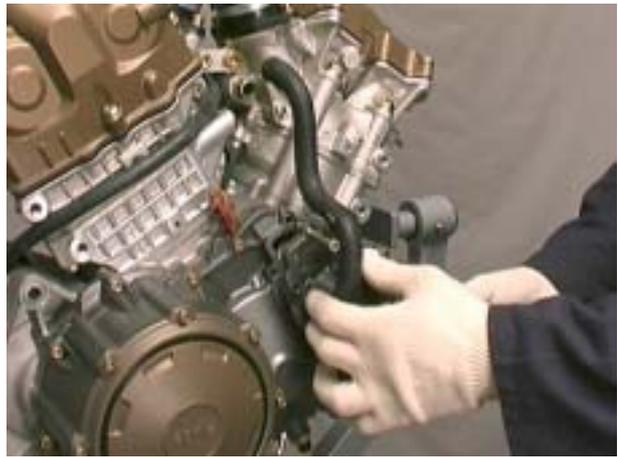
- Disconnect the line from the front head.



- Remove the four screws securing the water pump cover.



- Remove the cover together with the cooling circuit lines.



- Disconnect the two lines connected to the three-way manifold and remove the entire unit.



3.1.2. REFITTING ENGINE ACCESSORIES

- Fit the water pump cover together with the cooling circuit lines.



- Tighten down the four screws to the specified torque.



- Fit the front head line.



- Locate the three-way manifold.
- Attach the two lines to the heads.



- Fit the starter motor and tighten down the two screws to the specified torque.



3.1.3. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Ignition system, starter motor				
Crankshaft position sensor / flywheel cover	1	M6	8.11	Loctite 243
Flywheel cover / alternator	12	M6x35	8.11	–
Magneto flywheel / freewheel housing / flywheel ring	6	M8x18	22.13	Loctite 648
Magneto flywheel / crankshaft	1	M16x30	95.88	Loctite 648
Ignition unit cover / cable bracket	1	M5	5.16	–
Camshaft position sensor / front head	1	M6x15	8.11	–
Starter motor	2	M6x30	8.11	–

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Clutch housing, coolant pump				
Coolant pump impeller	–	–	By hand	–
Coolant pump cover	1	M6x25	8.11	–
Coolant pump body	3	M6x55	8.11	Loctite 243
Clutch housing	10	M6x35	8.11	–
Clutch housing	1	M6x50	8.11	–
Clutch housing	3	M8x55	14.01	–
Clutch housing	1	M8x65	14.01	–

3.2. ALTERNATOR SIDE

3.2.1. ALTERNATOR SIDE DISASSEMBLY

- Remove the engine's speed sensor.



- Loosen the screws around the perimeter of the alternator's casing.



- Remove the casing and keep the gasket.



Engine V 990 RR

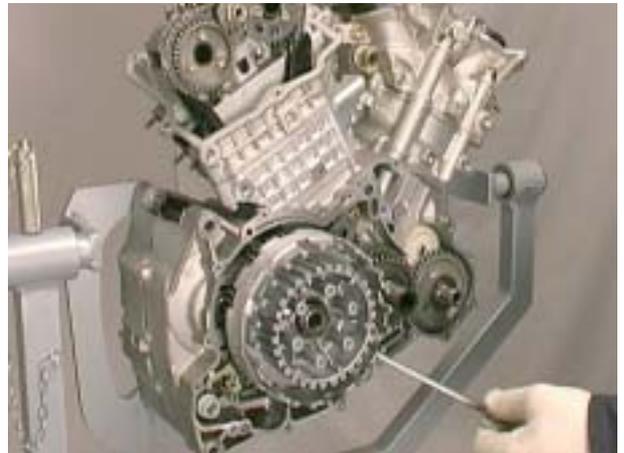
- Turn the engine counterclockwise with the special tool until the front cylinder is at TDC (top dead center) at the ignition point.



- This position corresponds to alignment of the “IN” and “EX” reference marks



- Screw on the driving shaft locking tool without tightening it down too hard.



- Check that the driving shaft is locked by turning it in both directions.



- Loosen the screws securing the alternator's flywheel.



- Fit the special flywheel's extraction tool.



- Heat up the hub for 5-10 minutes with the special hot air blower.
- Remove the flywheel assembly complete with flange and free wheel.

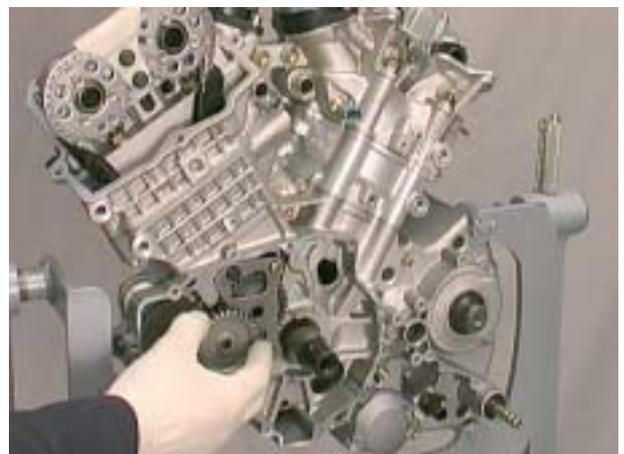




- Extract the driving shaft key.



- Remove the idler gear and double starter gear.



3.2.2. ALTERNATOR SIDE REASSEMBLY

- Fit the double starter gear and idler gear.



- Fit the key to the driving shaft.



- Fit the freewheel gear and flywheel assembly with flange to the driving shaft.

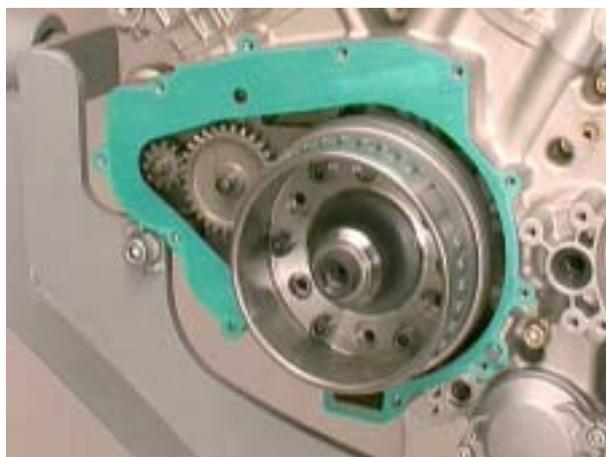




- Tighten the flywheel screws as per the specified procedure.



- Fit the gasket to the engine casing.



- Fit the ignition cover using the special tool.



- Tighten the perimeter screws to the specified torque.



- Remove the special tool.



- Fit the closing screw and O-ring.



Engine V 990 RR

- Fit the engine's speed sensor.

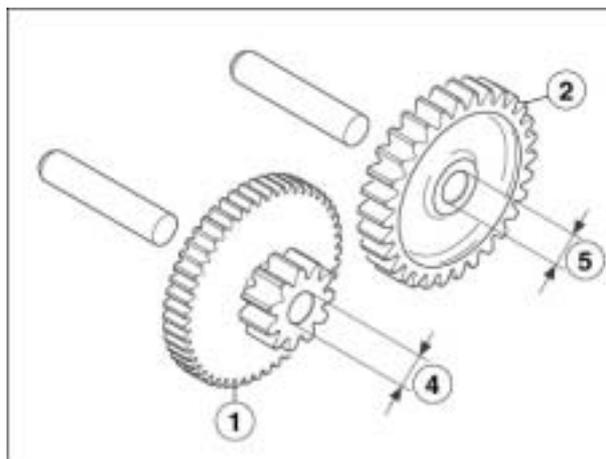


3.2.3. CHECK

NOTE If the tothing of the double starter gear is distorted, the tothing of the starter motor must also be checked.

Check the tothing of the double starter gear (1), idler gear (2) and the freewheel gear (3) for broken material or distortion.

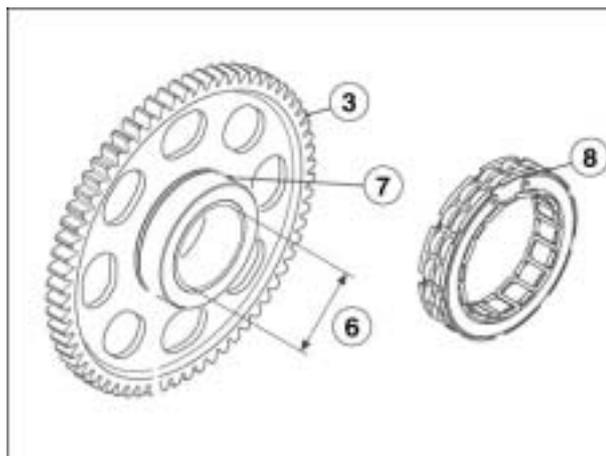
Check the bush of the freewheel gear (3) for signs of rolling and grooves.



Measure the gear bearing's diameter.

- Double starter gear:
wear limit (4) max. Ø 0.3976 in (10.10 mm).
- Idler gear:
wear limit (5) max. Ø 0.3968 in (10.08 mm).
- Freewheel gear:
wear limit (6) max. Ø 1.381 in (35.07 mm).

NOTE The bush inside the freewheel gear (3) must be inserted so that it is fixed and unable to move freely.



Should signs of distortion be encountered on the sliding surface, or materials found to be broken, the freewheel gear must be replaced.

Check the sliding surface (7) of the freewheel for wear. Clean the cone of the magnetic hub of any LOCTITE® residues.

Make sure the cone and the slot for the key are in a perfect state of repair.

NOTE If the cone or the slot for the key are damaged, the magnetic hub must be replaced.

Remove the freewheel (8) from the relevant housing and check the freewheel's rollers (8) for signs of wear.

Check whether the external helical spring is preloaded enough to keep the rollers in place.

Check the sliding surface of the freewheel inside the relevant housing for signs of wear.

NOTE Should the sliding surface show signs of distortion or deep grooves, the freewheel housing must be replaced.

3.2.4. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Ignition system, starter motor				
Crankshaft position sensor / flywheel cover	1	M6	8.11	Loctite 243
Flywheel cover / alternator	12	M6x35	8.11	–
Magneto flywheel / freewheel housing / flywheel ring	6	M8x18	22.13	Loctite 648
Magneto flywheel / crankshaft	1	M16x30	95.88	Loctite 648
Ignition unit cover / cable bracket	1	M5	5.16	–
Camshaft position sensor / front head	1	M6x15	8.11	–
Starter motor	2	M6x30	8.11	–

3.3. CLUTCH SIDE

3.3.1. CLUTCH SIDE DISASSEMBLY

- Disassemble the clutch cover by undoing the screws around its perimeter.



- Disengage the membrane from its seat in the casing.



- Immobilize the shaft with an Allen key and unscrew the retaining nut.



- Remove the washer, disk, membrane and aluminum disk.





- Undo the perimeter screws around the clutch casing and remove the casing itself.





3.3.2. CKECK

Ckeck whether there are damages on the sealing surface; also check that all the threads to ensure that these are in perfect conditions.

Check the bushing mounts of the crankshaft and of countershaft for signs of rolling or grooves.

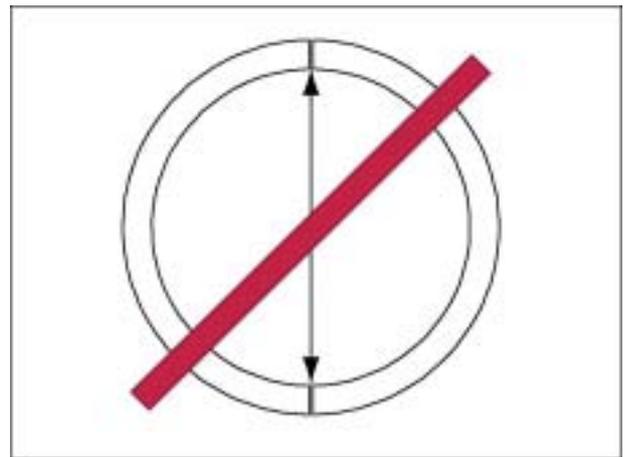
Measure the diameter of the two bushing mounts.

- Crankshaft bushes:
wear limit Ø 1.183 in (30,04 mm).
- Countershaft bushes:
wear limit Ø 0.79 in (20,06 mm).



CAUTION
Make a number of measurements, particularly in the directions of the axes of both cylinders, avoiding the mating surface of the 2 half-shells. None of the average values must exceed the maximum value.

Measure the radial play of the crankshaft and countershaft.



BUSHING MOUNTS

IMPORTANT The size group of the main bushes is also marked with a colored dot.

If the colored marking on the clutch housing is no longer clearly legible, calculate the diameter based on the average of a number of different measurements.



CAUTION
Take a number of measurements, especially in the direction of the axis of both cylinders.

Clutch housing hole	Bushing cover marking	Clutch housing marking
Ø 1.2960 – Ø 1.2964 in	red	red
Ø 1.2964 – Ø 1.2968 in	blue	blue
Ø 1.2968 – Ø 1.2973 in	yellow	yellow

3.3.3. CLUTCH SIDE REASSEMBLY

- Fit the gasket.
- Fit the clutch casing, making sure that the water pump's transmission is correctly aligned.



- Tighten the screws around the casing's perimeter to the specified torque.



- Fit the washer, aluminum disk, membrane disk and washer to the disengaging shaft.





- Screw the nut on hand tight.
- Immobilize the shaft with an Allen key and tighten the retaining nut to the specified torque.



- Fit the membrane into its seat in the casing.



- Fit the clutch cover and tighten the perimeter screws to the specified torque.



3.3.4. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Clutch housing, coolant pump				
Coolant pump impeller	–	–	By hand	–
Coolant pump cover	1	M6x25	8.11	–
Coolant pump body	3	M6x55	8.11	Loctite 243
Clutch housing	10	M6x35	8.11	–
Clutch housing	1	M6x50	8.11	–
Clutch housing	3	M8x55	14.01	–
Clutch housing	1	M8x65	14.01	–

3.4. CLUTCH

3.4.1. CLUTCH DISASSEMBLY

- Undo the six screws securing the clutch plate.



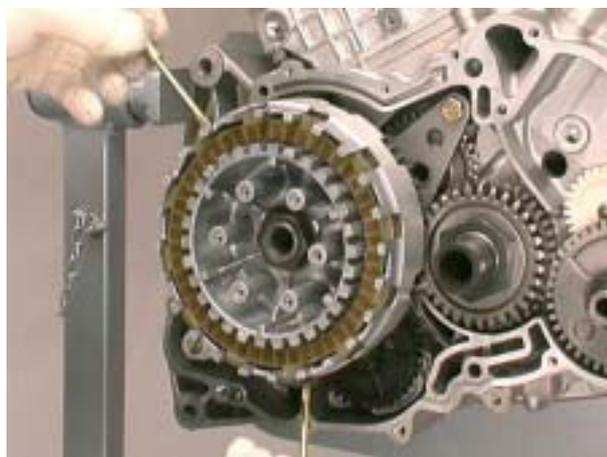
- Remove the clutch plate.



- Extract the entire disengaging shaft assembly.

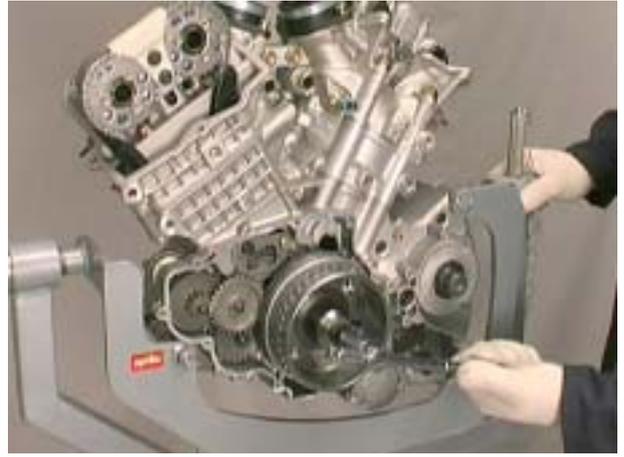


- Remove the clutch discs with the appropriate tools.



Engine V 990 RR

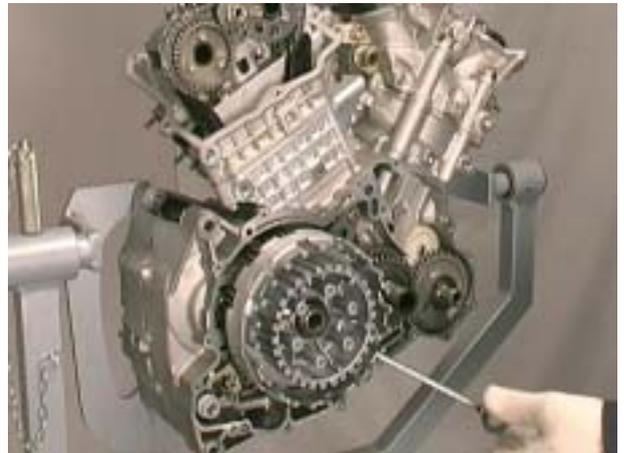
- Turn the engine counterclockwise with the special tool so as to bring the front cylinder to the TDC (top dead center) in the ignition position.



- This position corresponds to alignment of the “IN” and “EX” reference marks.



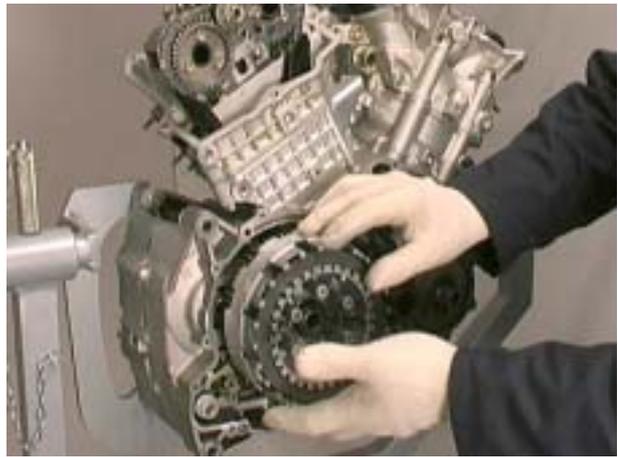
- Screw on the driving shaft locking tool without over tightening it.



- Check that the shaft is locked by turning it in both directions.



- Fit the clutch locking tool into the housing and clutch hub.



- Undo and remove the central lock nut.



- Remove the clutch locking tool, spring washer and clutch hub.





- Remove the clutch housing and thrust ring.



- Extract the oil pump's driving gear from its seat in the clutch housing.



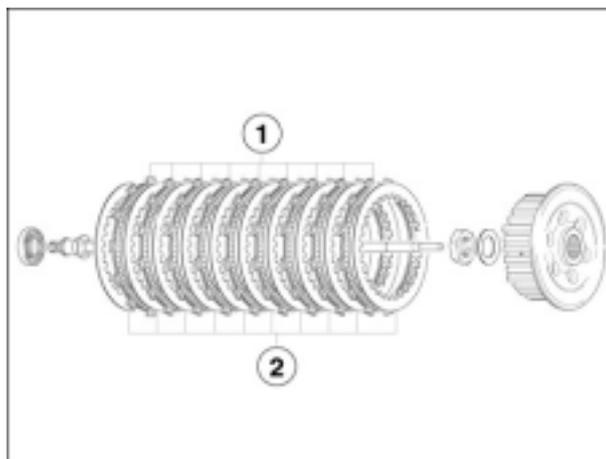
3.4.2. CHECKING THE CLUTCH

Check the lined discs (1) and steel discs (2) for cracks or any distortion (3) by placing them on a flat surface.

Max. permissible distortion (3): 0.0059 in (0,15 mm).

NOTE The steel discs (2) must not present scores and temper colors.

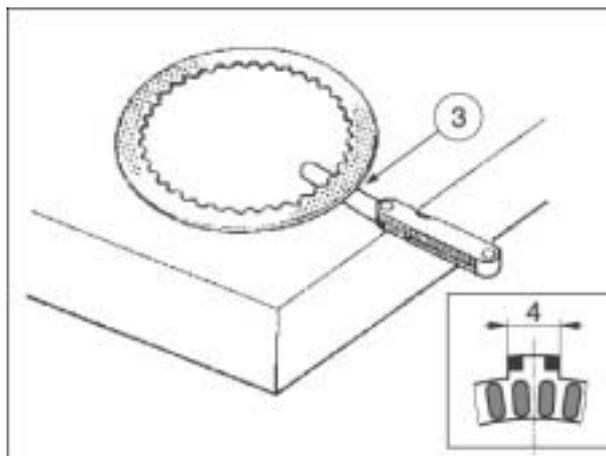
Measure the width (4) of the driving element.



Wear limit (4) min. 0.539 in (13,7 mm).

NOTE Check the wear of the clutch discs, measuring the entire clutch disc unit.

Do not measure the steel disc unit and the friction disc unit separately; it is useless for wear checking purposes.



Measure the entire clutch disc unit (includes ten steel discs and nine friction discs).

Wear limit min. 1.823 in (46,3 mm).

NOTE The wear of one or more clutch discs (steel or friction discs) requires the replacement of the entire clutch disc unit (includes ten steel discs and nine friction discs).

No partial replacement (of the worn discs only) is allowed.

NOTE The replacement of the entire clutch disc unit requires also the replacement of the clutch spring unit. It is not possible to install a new clutch disc unit with a used spring unit.

Measure the length of the individual clutch springs in the released position.

Wear limit min. 1.732 in (44 mm).

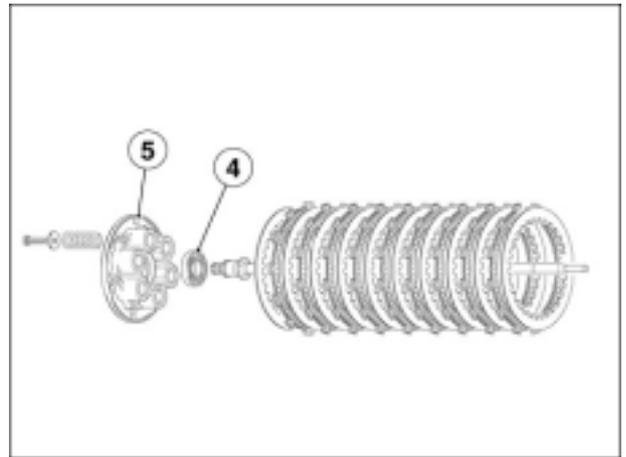
NOTE The wear of one or more clutch springs requires the replacement of all clutch springs. No partial replacement (of the worn springs only) is allowed.



Engine V 990 RR

Check the smoothness and slack of the ball bearings (4) on the spring plate (5) and, where necessary, replace them.

NOTE When removing and refitting the ball bearings, heat the spring plate to 80 – 100 °C (176 – 212 °F) and use a suitable assembly punch.



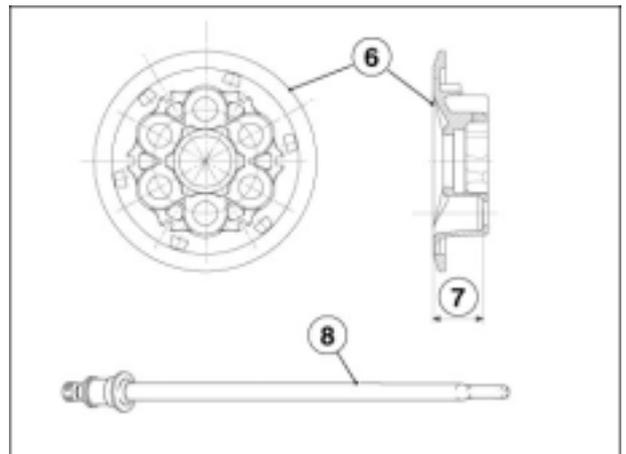
Check the compression surface (6) of the spring plate (5) for signs of wear and make sure it is flat.

Max. permissible distortion (6): 0.0039 in (0,1 mm).

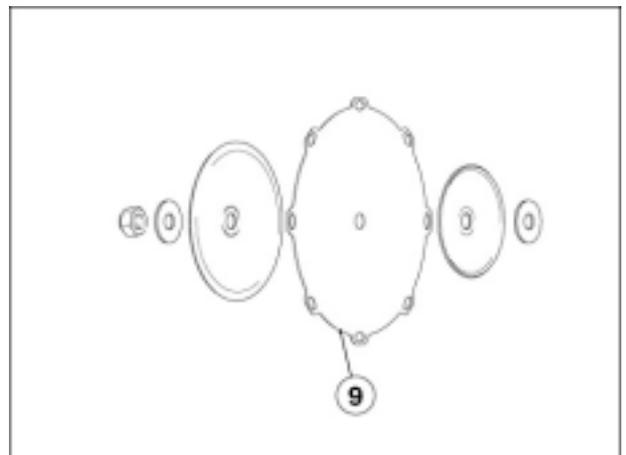
Check the depth (7) of the spring plate.

Wear limit (7) max. 1.319 in (33,5 mm).

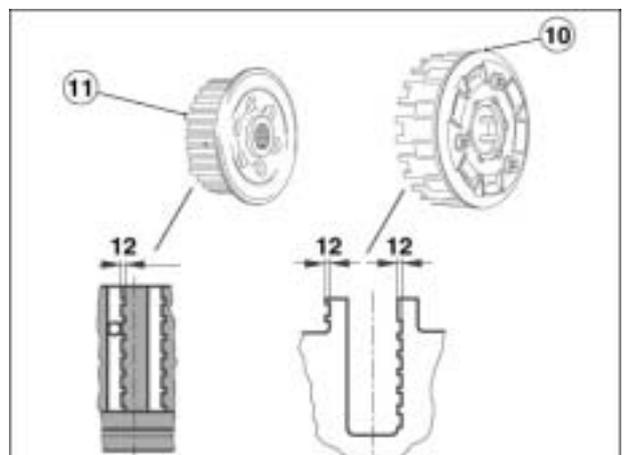
Check the eccentricity of the disengaging shaft (8), also checking for signs of rolling on the oil seal sliding surface.



Check the diaphragm (9) for cracks and, where necessary, replace it.



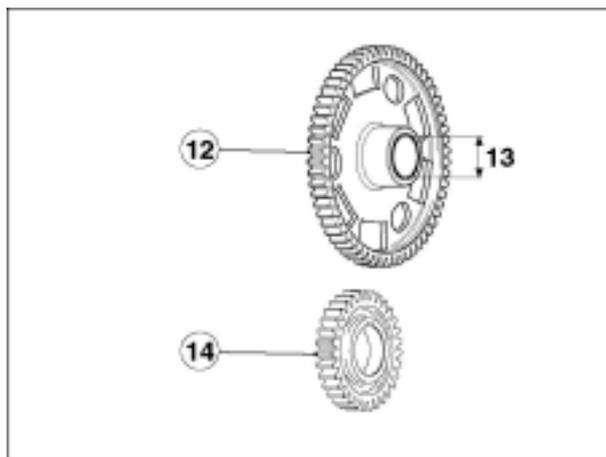
Check the external tooting of the clutch hub (10) for any dents (11).



Wear limit (13) Ø max. 1.1835 in (30,06 mm).

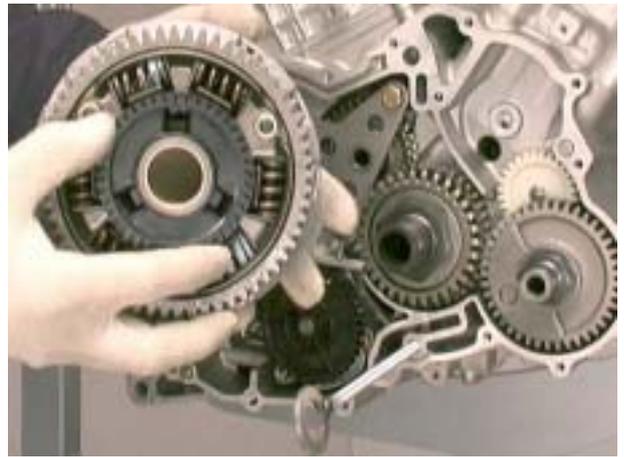
Check the sides of the clutch gear (12) and driving gear's teeth (14) for breakage and distortion.

IMPORTANT If the clutch or driving gears are worn, the primary transmission gear pair must be replaced as an entire unit.



3.4.3. CLUTCH REASSEMBLY

- Fit the oil pump's driving gear to the clutch housing.
- Check that the clutch gear is correctly engaged.



- Fit the assembly on the driving shaft.

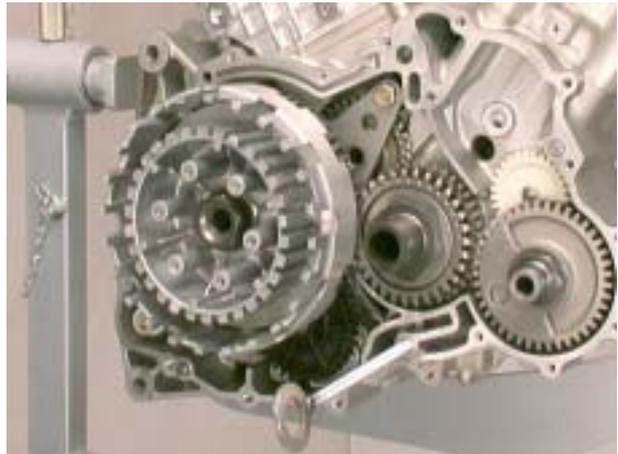


- Fit the thrust ring.

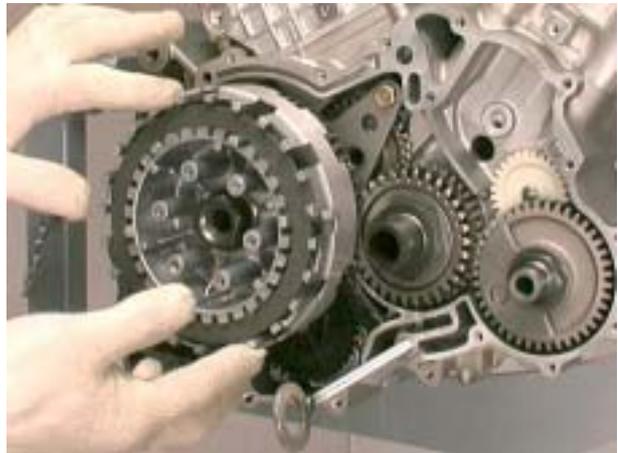


- Fit the clutch hub and spring washer and set the lock nut hand tight.





- Fit the clutch locking tool on the housing and clutch hub.

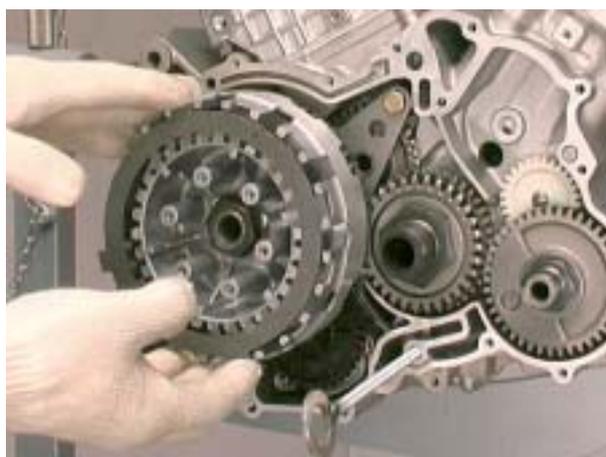


- Tighten the lock nut as per the specified procedure.

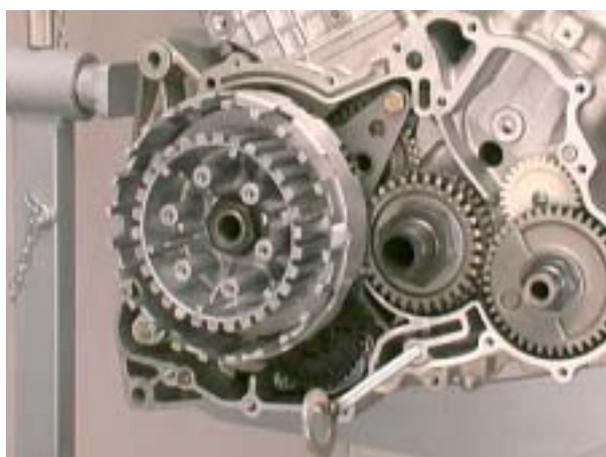




- Remove the clutch locking tool.



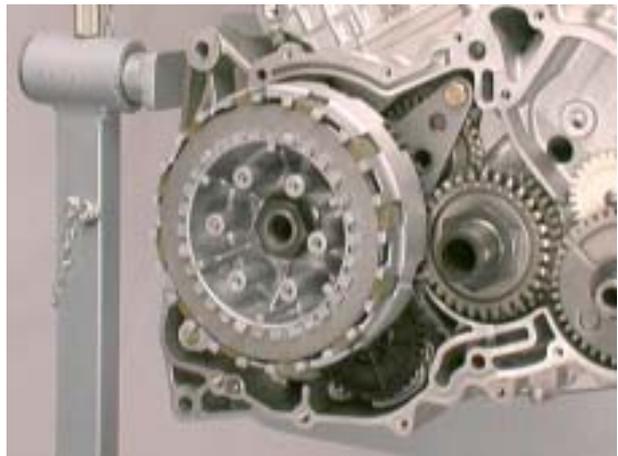
- Unscrew the driving shaft locking tool.



- Lubricate the clutch discs and fit them to the housing.
- The first disc is marked with a reference on its external diameter.



- Fit the friction and steel discs alternately.



- The upper friction disk must fit into the offset groove.



- Oil the clutch disengaging shaft and fit it into the hole in the primary shaft.



Engine V 990 RR

- Fit the clutch plate.



- Fit the clutch springs and tighten their screws to the specified torque.



3.4.4. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Clutch				
Primary shaft [clutch side (KS)]	1	M24x1.5	125.39	Loctite 648
Clutch spring	6	M6x30	8.11	–
Disengagement shaft	1	M12	22.13	–
Primary drive (spring plate / primary drive gear / clutch housing)	8	M8x25	22.13	–
Primary drive (spring plate / primary drive gear / clutch housing)	8	M8	22.13	Loctite 648

Engine V 990 RR

3.5. COOLANT PUMP

3.5.1. DISASSEMBLY, CHECKING, REASSEMBLY

**CAUTION**

The coolant pump only needs disassembling in the event of oil or coolant leakage.

Check the drainage hole for any signs of oil and coolant leakage.

PUMP DISASSEMBLY

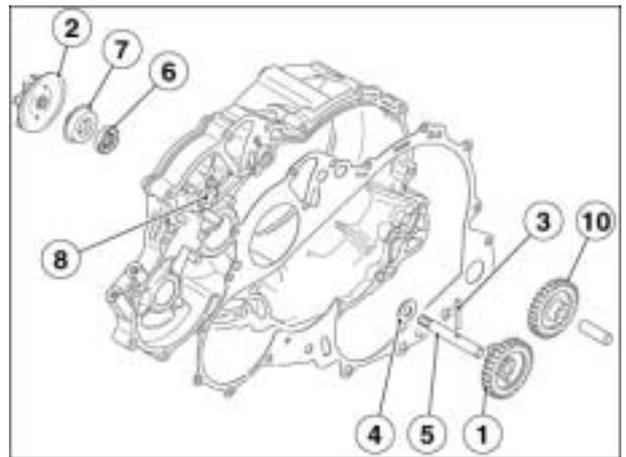
Hold the coolant pump gear (1) still when loosening the impeller (2).

Slide the coolant pump gear (1) up and off, and remove the pin (3) together with the washer (4).

**CAUTION**

Take care not to damage the thread of the coolant pump shaft.

Remove the coolant pump shaft (5) in the direction of the coolant pump gear (1).



IMPORTANT To facilitate removing the oil seal (6) and the sliding-ring gasket there are two holes inside the clutch cover.

**CAUTION**

In order to extract the two components (6) (7) correctly, repeat the following operation alternately on both holes.

- Insert a punch in the hole and strike moderately only once with a light hammer. Repeat the operation on the second hole.

PUMP INSPECTION

Check the impeller (2) for signs of damage or distortion and, where necessary, replace it.

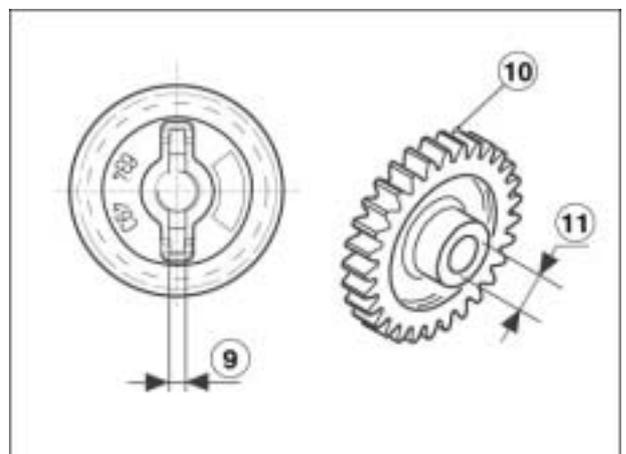
Check the coolant pump shaft (5) for signs of rolling around the oil seal's sliding area and, where necessary, replace it.

Measure coolant pump's shaft housing slot (8) on the clutch cover.

Slot wear limit (8) Ø max. 0.398 in (10.10 mm).

Check the coolant pump gear's teeth for signs of damage or broken material (1). Also check the distance of the grooves which protrude from the central slot (9) to accommodate the pin.

Slot wear limit (9) Ø max. 0.146 in (3.70 mm).



Check the teeth of the coolant pump's idler gear (10) for signs of damage or broken material.

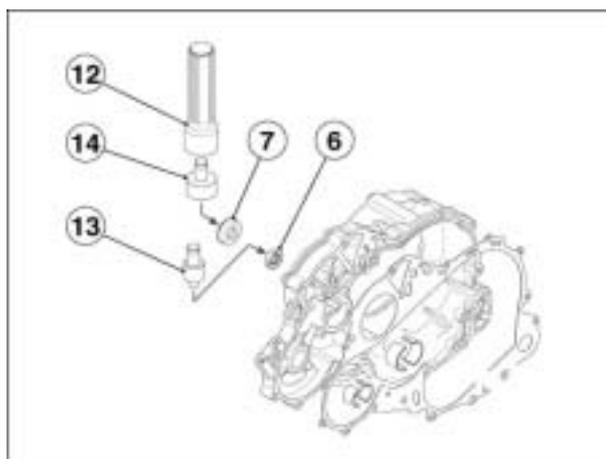
Measure the housing slot (11).

Slot wear limit (11) Ø max. 0.402 in (10.22 mm).

PUMP ASSEMBLY

IMPORTANT Have the appropriate tools **OPT** at hand:

- (12) handle for pads;
- (13) code 0277670 (coolant pump shaft housing oil seal assembly pad);
- (14) code 0877257 (assembly pad for coolant pump shaft seat sliding ring).



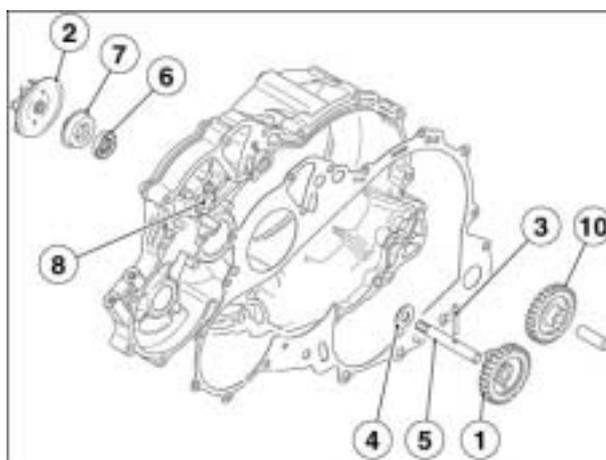
IMPORTANT The closed side of the oil seal must be fitted so that it faces the impeller (2).

Insert the oil seal (6) all the way into the slot using the assembly punch.

Insert the sliding sealing ring (7) all the way in using the assembly pad.



CAUTION
Take care not to damage the impeller (2).



Tighten the rotor (2) completely on the shaft (5) of the coolant pump by hand.

Coat the coolant pump shaft (5) with MOLYKOTE® G-N and insert it from the outside all the way onto the oil seal assembly.

Install the washer (4) on the coolant pump shaft.

Install the pin (3) in the coolant pump shaft slot and engage the coolant pump gear (2).

IMPORTANT Feel that the pin is perfectly inserted in the slot in the coolant pump gear.

Tighten the impeller (2) by hand, holding the coolant pump gear (1) still.

3.5.2. TIGHTENING TORQUES

DESIGNATION	QUANTITY	SCREW / NUT	TORQUE (Nm)	NOTES
Clutch housing, coolant pump				
Coolant pump impeller	–	–	manually	–
Coolant pump cover	1	M6x25	11	–
Coolant pump body	3	M6x55	11	Loctite 243
Clutch housing	10	M6x35	11	–
Clutch housing	1	M6x50	11	–
Clutch housing	3	M8x55	19	–
Clutch housing	1	M8x65	19	–

3.6. HEAD COVERS

3.6.1. REMOVING THE CYLINDER HEAD COVERS

- Remove the spark plugs.
- Dismount the timing sensor.
- Remove the screws securing the front head cover.
- Remove the head cover.



Engine V 990 RR

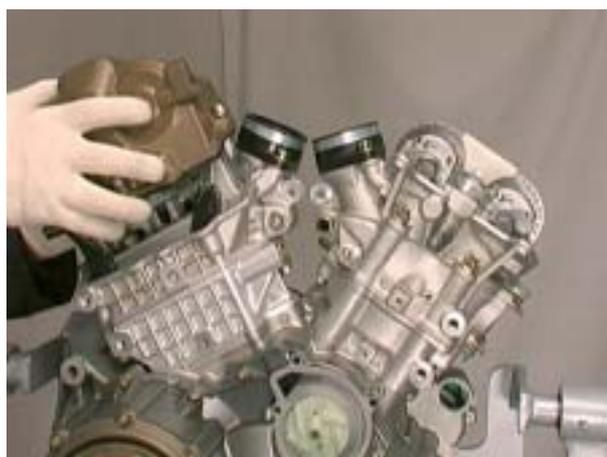
- Remove the cover gasket.



- Repeat it for the rear head.

3.6.2. REFITTING THE CYLINDER HEAD COVERS

- Fit the gasket to the cover.
- Fit the head cover.
- Tighten the screws down to the specified torque.
- Repeat it for the front head.



Engine V 990 RR

- Fit the timing sensor and tighten down its screw to the specified torque.



- Fit the spark plugs.



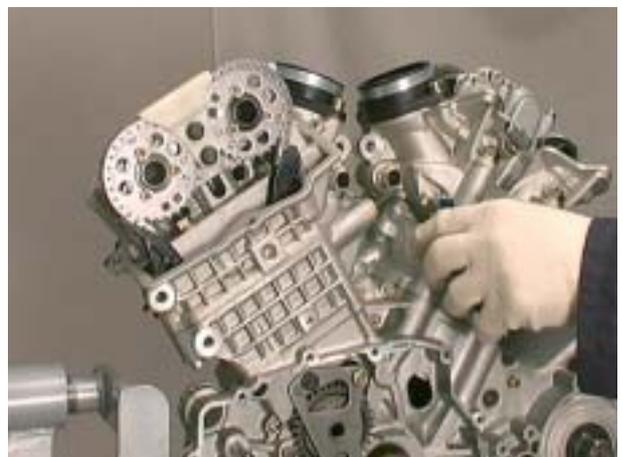
3.6.3. TIGHTENING TORQUES

DESIGNATION	QUANTITY	SCREW / NUT	TORQUE (Nm)	NOTES
Head, cylinders				
Camshaft mount / front head	6	M6x30	11	–
Front head (water hose)	1	M18x1.5	manually	Loctite 275
Front head cap	1	M18x1.5	manually	Loctite 243
Rear head water hose	2	M18x1.5	manually	Loctite 275
Camshaft mount / rear head	4	M6x30	11	–
Camshaft mount / rear head	2	M6x45	11	–
Camshaft mount / rear head	2	M6x55	11	–
Exhaust stud bolt	8	M6x16/20	10	Loctite 275
Rear head	1	–	manually	Loctite 275
Head / crankcase (stud bolt)	8	M10x171	6	Loctite 648
Cylinder / head (unpainted cylinder version)	8	M8x45	27	–
Head / stud bolt (unpainted head version)	8	M10x4	58	–
Head / chain housing	2	M6x100	12	–
Rear head / bushing flange	2	M6x35	11	–
Rear head / bushing flange	2	M6x20	11	–
Front head / driven gear (timing chain) - intake camshaft	6	M6x45	11	Loctite 243
Front head / upper chain guides	2	M6x16	11	–
Rear head / driven gear (timing chain) - intake camshaft	6	M6x11.5	11	Loctite 243
Rear head / counterweight + driven gear (upper countershaft assembly) - upper countershaft	1	M14x1	50	Loctite 243
Rear head / upper chain guides	2	M6x35	11	–
Valve cover	10	M6x23	9	–
Intake flange	4	M8x25	19	–
Cylinder / chain tensioner	2	M16x1.5	30	–
Water temperature sensor	1	0	20	–
Mount bracket fitting	2+ 2	M10x40 M10	40	Loctite 243

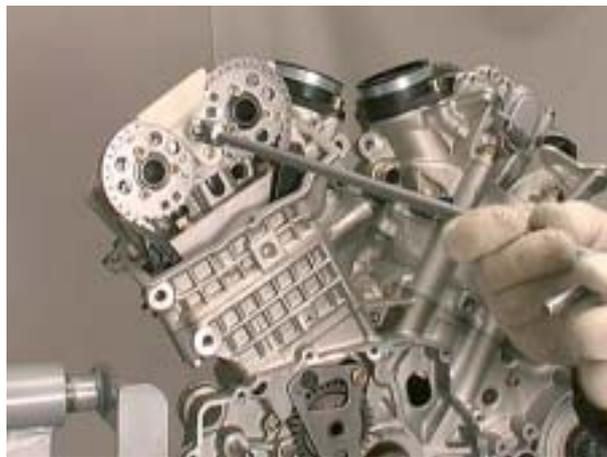
3.7. CYLINDERS AND PISTONS

3.7.1. REMOVING THE FRONT CYLINDER AND PISTON

- Unscrew the nuts securing the mounting bracket.
- Remove the screws on the second mounting bracket.
- Loosen the closing screw complete with gasket and remove the entire chain tightener.



- Remove the upper chain guide bracket.



- Remove the camshaft gear wheels.



- Remove the fixed chain guide shoe.



- Loosen the two screws on the timing unit.



Engine V 990 RR

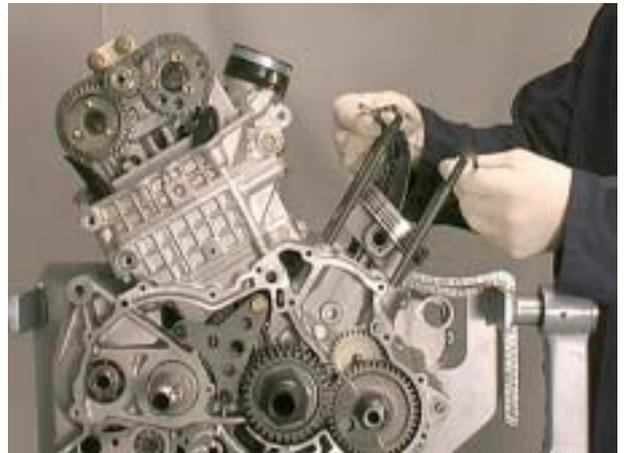
- Remove the nuts on the cylinder stud bolts.



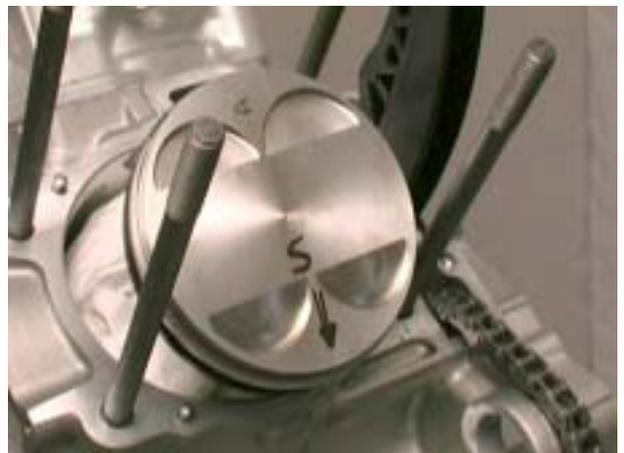
- Extract the cylinder together with the complete head, taking care not to damage the piston.
- Cover the opening in the base with a clean cloth.



- Remove the cylinder base gasket from its seat.



- Mark the piston crown on the exhaust side to ensure it fits back in the correct orientation.



- Remove the gudgeon pin lock ring.



- Remove the gudgeon pin and extract the piston.



3.7.2. REFITTING THE FRONT CYLINDER AND PISTON

- Fit the piston with reference to the mark previously made on its crown.



- Fit the gudgeon pin with an appropriate tool.



- Fit the gudgeon pin lock ring.



- Fit the cylinder base gasket.



- Turn the piston rings so that the mating ends are spaced by 120 degrees.



- Fit the piston ring compression tool.



- Lubricate the piston and cylinder.



Engine V 990 RR

- Remove the cloth used to cover the hole in the base.
- Fit the piston into the cylinder together with the entire head.
- Take care not to damage the piston.



- Remove the piston ring compression tool.



- Complete the insertion of the cylinder by sliding the chain upwards.



- Install the nuts on the stud bolts and tighten them to the specified torque.



- Tighten the two screws on the timing unit to the specified torque.

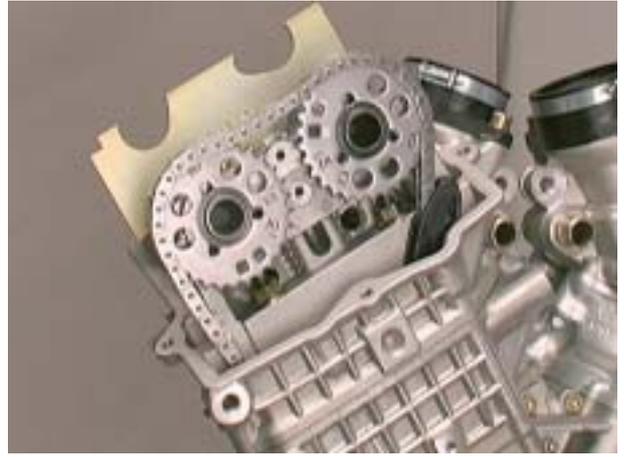


- Align the camshafts using the special tool on the eccentric hubs.



Engine V 990 RR

- Fit the gear wheels to the camshafts and line up the "IN" and "EX" marks.



- Tighten the screws on the gear wheels as per the specified procedure.



- Fit the fixed chain guide shoe.



- Fit the whole chain tightener into its seat.



- Tighten down the closing screw, complete with gasket, to its specified torque.



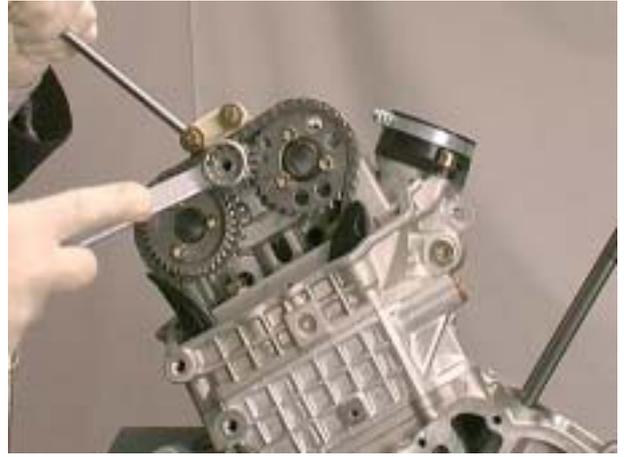
- Fit the upper chain guide shoe and tighten the screws to the specified torque.



Engine V 990 RR

3.7.3. REMOVING THE REAR PISTON AND CYLINDER

- Slacken the countershaft gearing locknut, using a punch fitted into the countershaft as a lever.
- Make sure not to load the timing chain during the step.



- Remove the upper chain guide shoe.



- Loosen and remove the closing screw and gasket and extract the entire chain tightener assembly.





- Remove the camshaft gear wheels.



- Remove the fixed chain guide shoe.



- Remove the two screws on the timing unit.



Engine V 990 RR

- Remove the nuts on the cylinder stud bolts.



- Cover the opening in the base with a clean cloth.



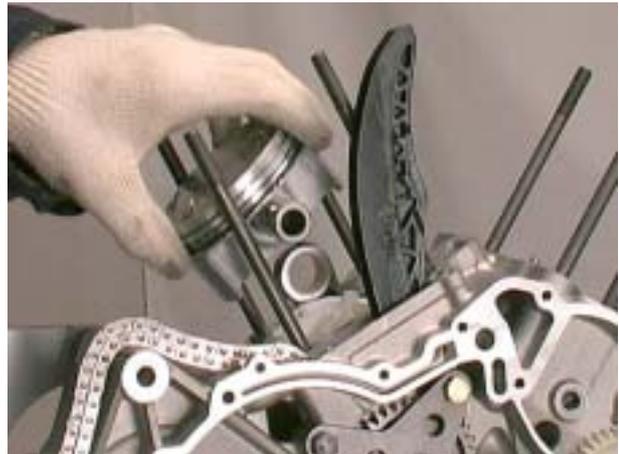
- Remove the cylinder base gasket from its seat.
- Mark the piston crown on the exhaust's side to ensure correct reassembly.



- Extract the gudgeon pin lock ring.



- Push out the gudgeon pin and remove the piston.



3.7.4. REFITTING THE REAR CYLINDER AND PISTON

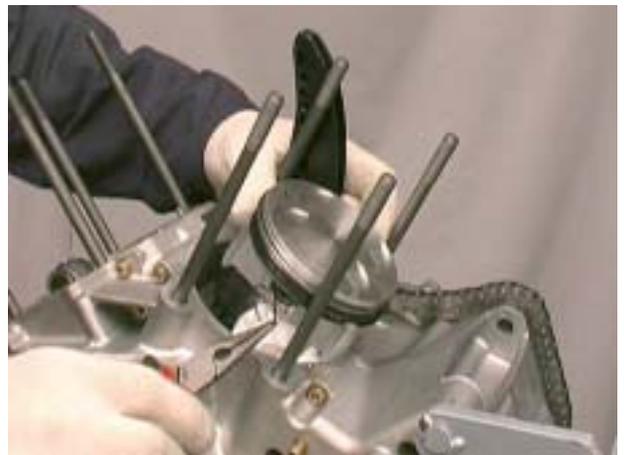
- Fit the piston, using the mark previously made on the crown to orient it.



- Fit the gudgeon pin with the appropriate tool.



- Fit the gudgeon pin lock ring.



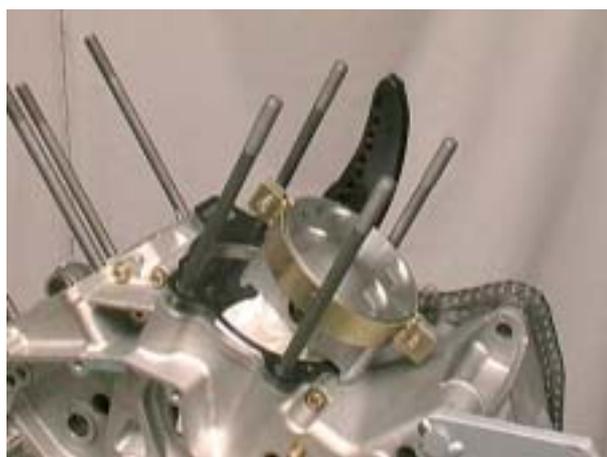
- Fit the cylinder base gasket.



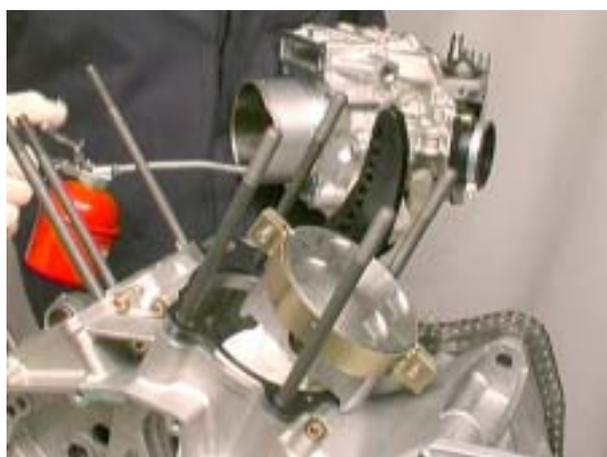
- Turn the piston rings so that the mating ends are spaced by 120 degrees.



- Fit the appropriate ring compression tool.



- Lubricate the piston and cylinder.



- Remove the cloth covering the opening in the base.



Engine V 990 RR

- Fit the piston together with the complete head assembly.
- Take care not to damage the piston while doing this.



- Remove the ring compression tool.



- Finish fitting the cylinder by sliding the timing chain upwards.



- Fit the nuts to the cylinder stud bolts and tighten them to the specified torque.



- Tighten the two screws on the timing unit to the specified torque.



- Align the camshafts using the appropriate tool fitted to the eccentric hubs.



Engine V 990 RR

- Fit the gear wheels to the camshafts and align the “IN” and “EX” marks.



- Fit the countershaft gearing and tighten the screws on the gear wheels as per the specified procedure.



- Fit the chain tightener assembly into its seat.

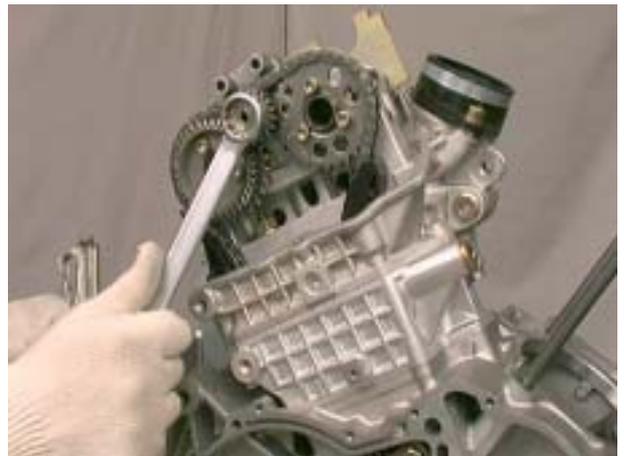


- Tighten the closing screw, complete with gasket, to the specified torque.
- Fit the countershaft key and adjust it by knocking lightly with a hammer.
- Fit the gearing to the countershaft so that the reference marks are aligned.



Engine V 990 RR

- Fit the counterweight and tighten the nut to the specified torque.



- Fit the upper chain tightener shoe and tighten the screws to the specified torque.



3.7.5. CHECK

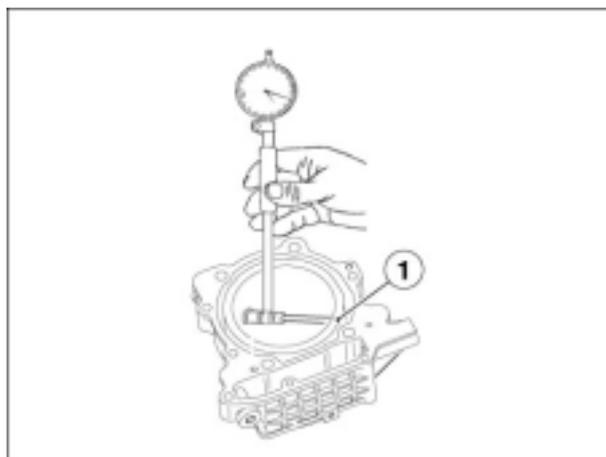
CYLINDERS

All the gasket surfaces must be cleaned and flat. Flatness of the gasket surfaces:

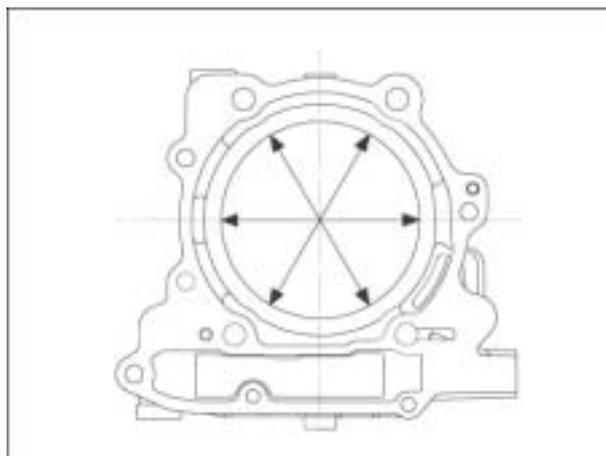
Max. permissible distortion: 0.00157 in (0,04 mm).

Make sure all the threads are in a perfect state of repair. Examine the sliding surface of the cylinder to check for any friction and scratches, and check whether the gasket surfaces show signs of damage.

NOTE If there are evident grooves on the nikasil lining inside the cylinder, replace the cylinder complete with piston.



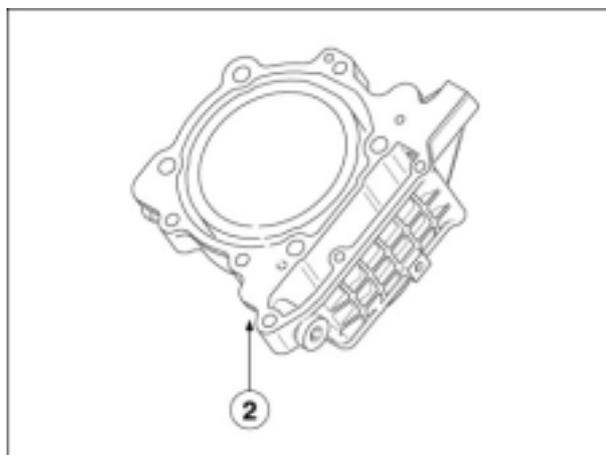
Clean the cylinders cooling cavity of any lime scale. Measure the bore of the cylinder in three places at a distance of 1.77 in (45 mm) from the upper edge (1); consider the highest value for the wear limit.



NOTE The size group "A" or "B" is punched onto the lower side of the cylinder (2).

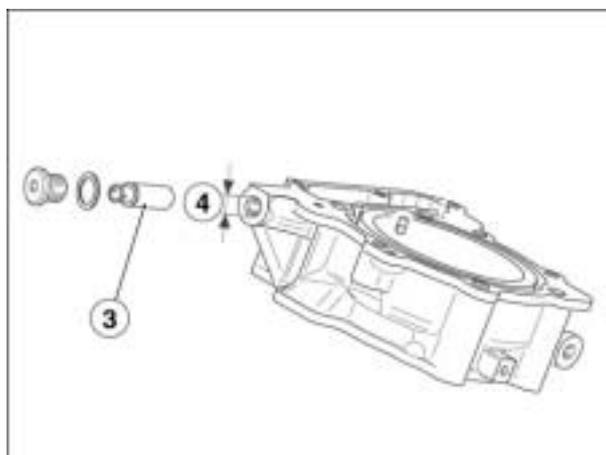
- Size group "A", dimension when the cylinder is new:
bore \varnothing 3.8189 – 3.8194 in (97,000 – 97,012 mm);
wear limit: max. \varnothing 3.8199 in (97,027 mm).
- Size group "B", dimension when the cylinder is new:
bore \varnothing 3.8194 – 3.8199 in (97,012 – 97,025 mm);
wear limit: max. \varnothing 3.8205 in (97,040 mm).

NOTE In order to assess the wear limit, the assembly play must be determined.



Make sure the chain tightener (3) and the guide in the cylinder are in a perfect state of repair.

- Chain tightener (3) / hole on the cylinder clearance (4):
wear limit (hole \varnothing – chain tightener \varnothing):
max. 0.0031 in (0,08 mm).
- Hole for chain tightener in the cylinder:
wear limit (4): max. \varnothing 0.5539 in (14,07 mm).



Engine V 990 RR

PISTONS AND GUDGEON PINS

Clean the piston crown and the area above the upper piston ring of any residual combustion products.

Check the piston for any cracks and the sliding surface of the piston for signs of compression (picking-up); Where necessary, replace the piston.

NOTE *Minor ridging on the piston lining is tolerable.*

PISTONS WEAR LIMITS

With an external micrometer, measure the piston diameter at a height of **0.39 in (10 mm)** across the gudgeon pin axis.

- "Red" piston:
max. wear limit \varnothing 3.8157 in (96,918 mm).
- "Green" piston:
max. wear limit \varnothing 3.8161 in (96,930 mm).
- Piston play – measurement:
cylinder diameter minus piston diameter;
max. wear limit 0.0035 in (0,090 mm).

NOTE *If the wear limit is exceeded, a new piston must be used or the cylinder replaced, complete with piston.*

If the piston is replaced, the two circlips securing the gudgeon pins must always be replaced, along with the actual gudgeon pins.

Take special care when matching the cylinder – piston:

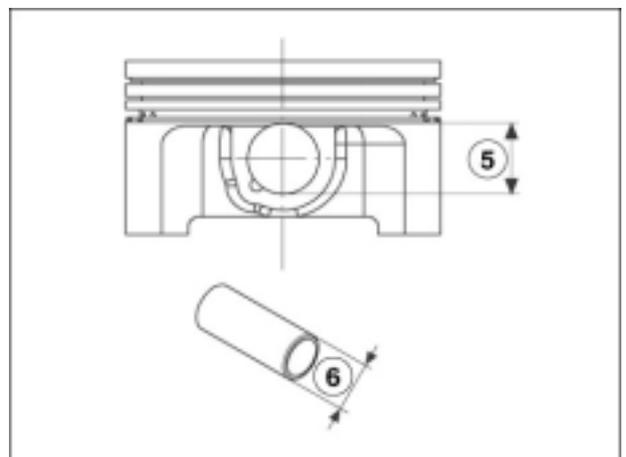
"Red" piston – Cylinder "A".

"Green" piston – Cylinder "B".

Use an external micrometer to measure the gudgeon pin hole's diameter in the piston in the direction of lift and the gudgeon pin's diameter at either end as well as in the middle.

- Gudgeon pin hole in the direction of lift:
wear limit (5) max. \varnothing 0.8668 in (22,018 mm). Gudgeon pin:
wear limit (6) min. \varnothing 0.8661 in (21,998 mm).

Check the wear of the gudgeon pin circlips with the bent ends.

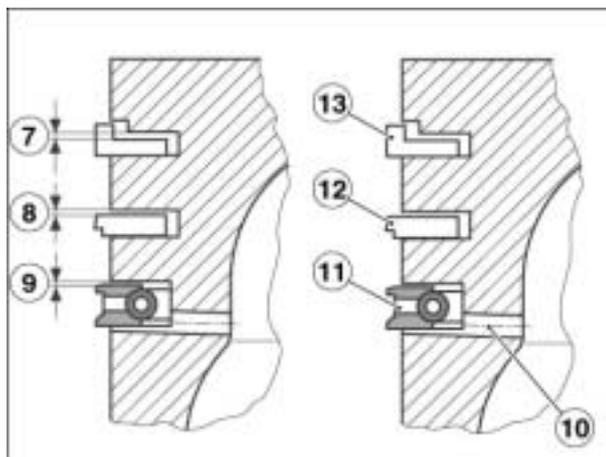


Measure the end play (7) (8) (9) of the piston rings inside the grooves.

- L-section ring:
wear limit (7) max. 0.0047 in (0,12 mm).
- Tapered protruding ring:
wear limit (8) max. 0.0047 in (0,12 mm).
- Scraper ring:
wear limit (9) max. 0.0039 in (0,10 mm).



CAUTION
The piston rings are fragile.



Carefully remove the piston rings from the piston.

NOTE The piston ring groove can be cleaned using a scraper or an old piston ring.

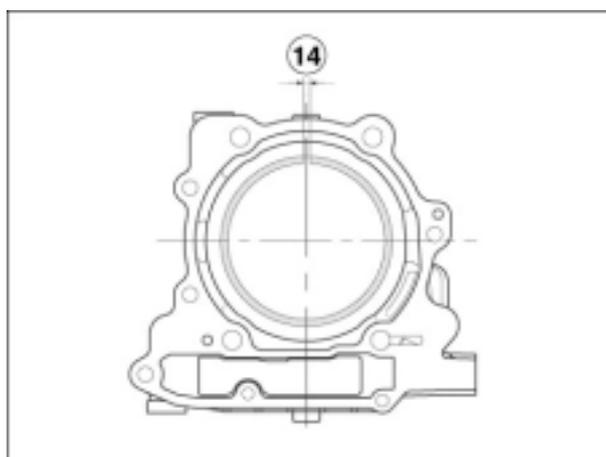
Clean the piston ring grooves and the oil return holes (10) in the scraper ring groove; then, blow a jet of compressed air inside.

Check the scraper ring (11), the tapered protruding ring (12) and the L-section ring (13) to make sure the sliding surface is cleaned.

Measure the piston ring gap (14) with a feeler gauge.
Max. wear limit 0.039 in (1,00 mm).

NOTE In order to measure the gap required, insert the piston ring in the cylinder and push it inside so that it is lined up with the piston.

The cylinder's bore must not show any signs of wear.

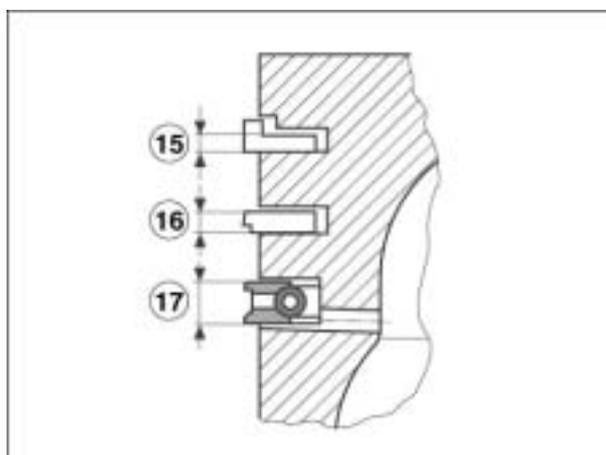


Measure the thickness of the rings with a micrometer.

- L-section ring:
wear limit (15) min. 0.0335 in (0,85 mm).
- Tapered protruding ring:
wear limit (16) min. 0.047 in (1,2 mm).
- Scraper ring:
wear limit (17) min. 0.096 in (2,45 mm).

Fit the scraper ring (11), the tapered protruding ring (12) and the L-section ring (13) from the bottom up; the word "TOP" on the rings must face up.

NOTE Rotate the piston rings so that the three gaps are staggered by approx. 120°.



3.7.6. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Head, cylinders				
Camshaft support / front head	6	M6x30	8.11	–
Front head (water hose)	1	M18x1.5	By hand	Loctite 275
Front head cap	1	M18x1.5	By hand	Loctite 243
Rear head water hose	2	M18x1.5	By hand	Loctite 275
Camshaft support / rear head	4	M6x30	8.11	–
Camshaft support / rear head	2	M6x45	8.11	–
Camshaft support / rear head	2	M6x55	8.11	–
Exhaust stud bolt	8	M6x16/20	7.38	Loctite 275
Rear head	1	–	By hand	Loctite 275
Head / crankshaft (stud bolt)	8	M10x171	4.43	Loctite 648
Cylinder / head (unpainted cylinder version)	8	M8x45	19.91	–
Head / studbolt (unpainted head version)	8	M10x4	42.78	–
Head / chain housing	2	M6x100	8.85	–
Rear head / bushing flange	2	M6x35	8.11	–
Rear head / bushing flange	2	M6x20	8.11	–
Front head / Driven gear (timing chain) - Intake camshaft	6	M6x45	8.11	Loctite 243
Front head / Upper chain guide	2	M6x16	8.11	–
Rear head / Driving gear (timing chain) - Intake camshaft	6	M6x11.5	8.11	Loctite 243
Rear head / Counterweight + Driven gear (Upper countershaft assy) - Upper countershaft	1	M14x1	36.88	Loctite 243
Rear head / Upper chain guide	2	M6x35	8.11	–
Valve cover	10	M6x23	6.64	–
Intake flange	4	M8x25	14.01	–
Cylinder / chain tensioner	2	M16x1.5	22.13	–
Water temperature sensor	1	0	14.75	–
Mount bracket fitting	2+ 2	M10x40 M10	29.5	Loctite 243

3.8. CYLINDER HEADS

3.8.1. REMOVING THE FRONT CYLINDER HEAD

- Unscrew and remove the four countersunk screws securing the head to the cylinder.



- Remove the cylinder from the head and keep the head gasket.

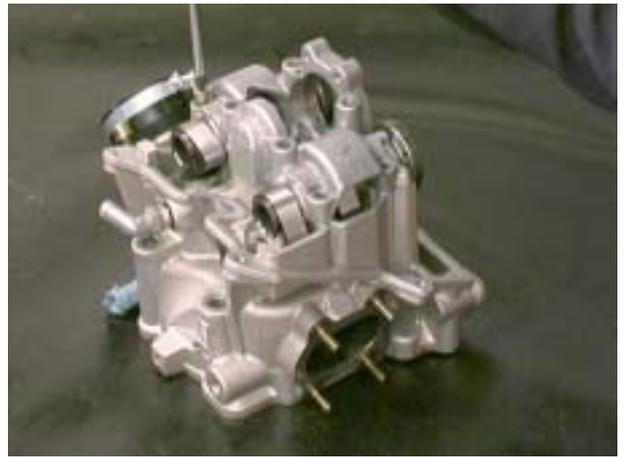


- Loosen the two screws securing the bushing plate.



Engine V 990 RR

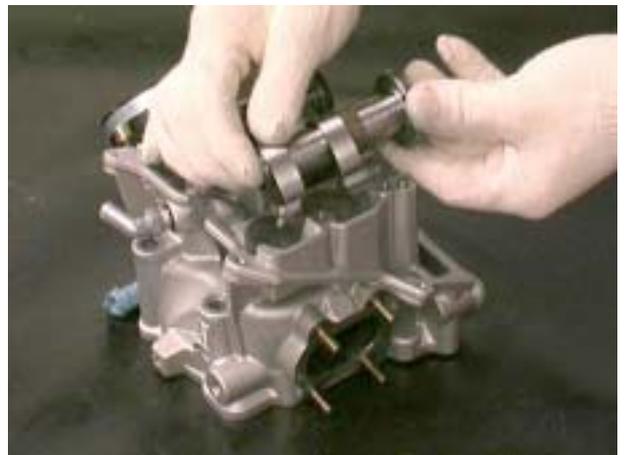
- Loosen the eight screws securing the camshaft U-bolt.



- Remove the U-bolt.

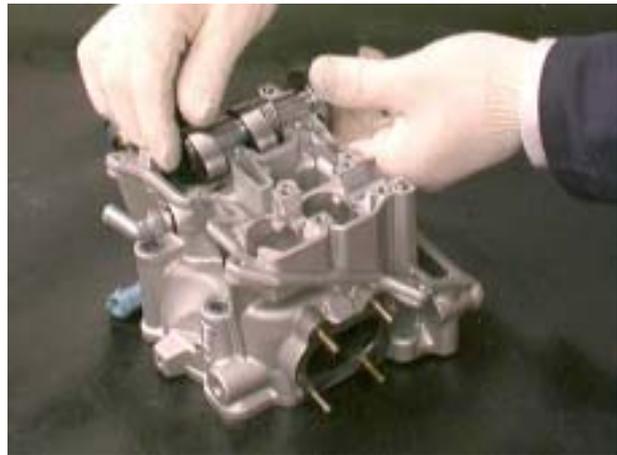


- Remove the camshafts.



3.8.2. REFITTING THE FRONT CYLINDER HEAD

- Fit the camshafts after oiling their seats with engine oil.



- The intake camshaft is marked with three grooves.



- Fit the camshaft U-bolt.

- Tighten the screws down to the specified torque starting from the innermost in a diagonal pattern.

Engine V 990 RR

- Fit the gasket to the cylinder head.



- Fit the cylinder.



- Tighten down the four screws securing the cylinder to the head to the specified torque.
- Check the play of the valves with a feeler gauge.
- The measured values must be within the specified tolerance; if not, replace the shims.

Valve clearance:

- intake valve 0.11 – 0.18 mm
- exhaust valve 0.22 – 0.29 mm



3.8.3. REMOVING THE REAR CYLINDER HEAD

- Loosen and remove the four countersunk screws securing the head to the cylinder.



- Remove the cylinder from the head and keep the head gasket.



- Loosen the two screws securing the bushing plate.



Engine V 990 RR

- Countershaft disassembly.



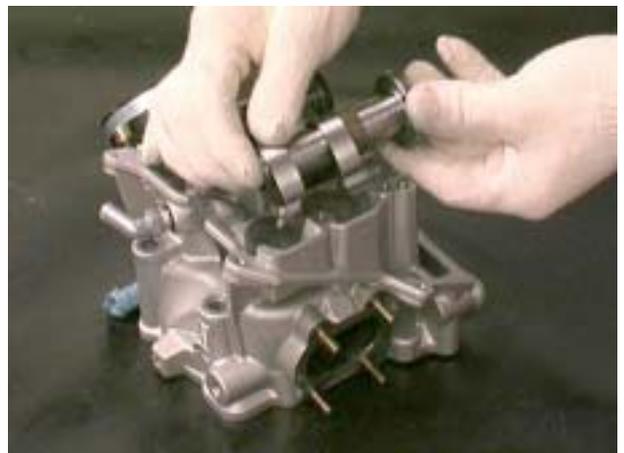
- Loosen the eight screws securing the camshaft U-bolt.



- Remove the U-bolt.

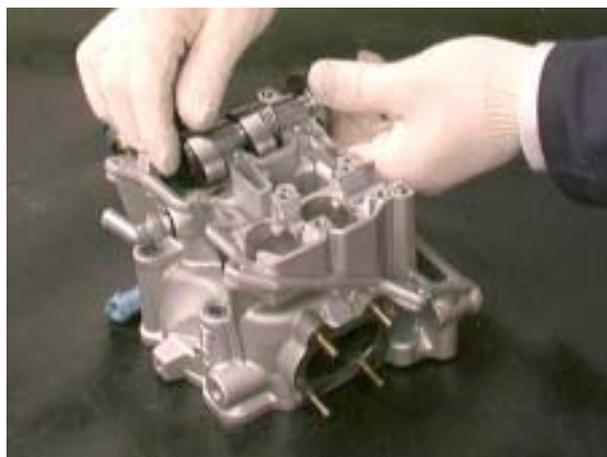


- Remove the camshafts.



3.8.4. REFITTING THE REAR CYLINDER HEAD

- Fit the camshafts after oiling their seats with engine oil.



- The intake camshaft is marked with three grooves.



- Fit the camshaft U-bolt.



- Tighten the screws down to the specified torque starting from the innermost in a diagonal pattern.



Engine V 990 RR

- Fit the countershaft in its seat.



- Position the bushing plates.



- Tighten down the bushing plate screws to the specified torque.



- Fit the gasket to the cylinder head.



- Fit the cylinder.



- Tighten down the four screws securing the cylinder to the head to the specified torque.
- Check the play of the valves with a feeler gauge.
- The measured values must be within the specified tolerance; if not, replace the shims.

Valve clearance:

- intake valve 0.0043 – 0.0070 in (0.11 – 0.18 mm)
- exhaust valve 0.0086 – 0.0114 in (0.22 – 0.29 mm)



Engine V 990 RR

3.8.5. REMOVING THE VALVES

- When removing the valves, mark the parts with their position and the cylinder to which they belong so as to facilitate correct reassembly.



- Extract the valve's buckets and shims with a magnet.



- Compress the valve's springs with the special arch and compression tool.





- Extract the cone halves with a magnet.



- Unload the valve's springs.
- Remove the valve's spring seats and the springs themselves.



Engine V 990 RR

- Extract the springs.



- Remove the valve stem oil seal.



- Extract the valve spring housing cap.



3.8.6. REFITTING THE VALVES

- Fit the valve spring housing cap.
- Fit the valve stem oil seal with the appropriate assembly pad.
- Oil the valve stem and sit the valves into their seats.
- Fit the valve springs with the colored mark uppermost.





- Fit the valve spring caps.



- Compress the valve springs with the compression tool and the special arch.



- Fit the cone halves.



- Release the arch and check that the cone halves are correctly installed in their grooves on the valve.



- Fit the shims and valve buckets



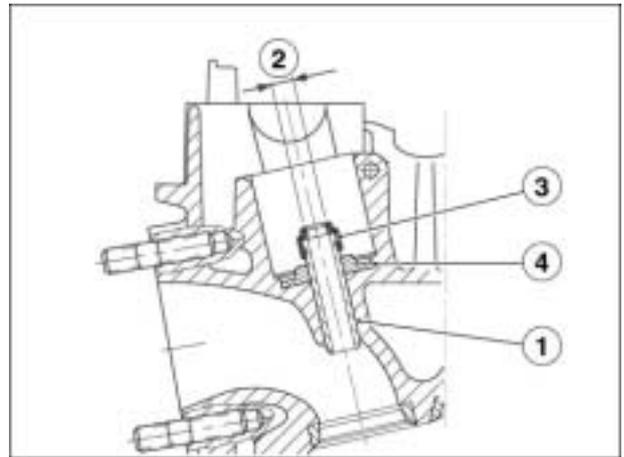
Engine V 990 RR

3.8.7. VALVES GUIDE

Use a dial gauge to measure the wear of the valve guide (1).

Wear limit (2): max. Ø 0.238 in (6.05 mm).

NOTE If the valve guide is worn, it can be replaced.



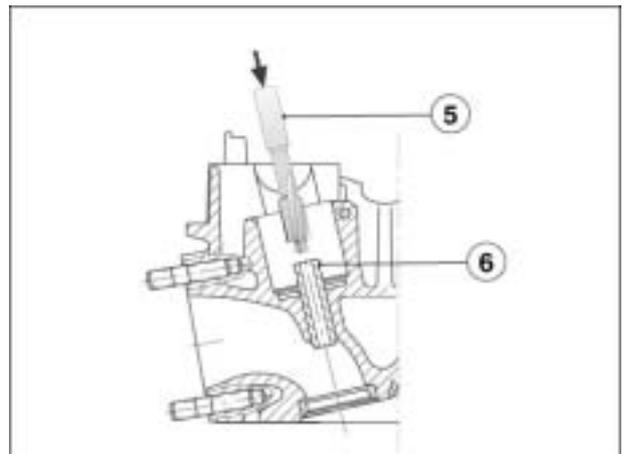
REMOVING THE VALVES GUIDE

Slip off the valve stem seal (3) and remove the valve spring shim (4).

NOTE Replace the valve stem seal (3).

Remove the valve guide with a reamer (5) as far as the start of the notch (6).

NOTE The sharp edge of the valve guide must be removed as, otherwise, the head slot risks sliding when the valve guide is removed.

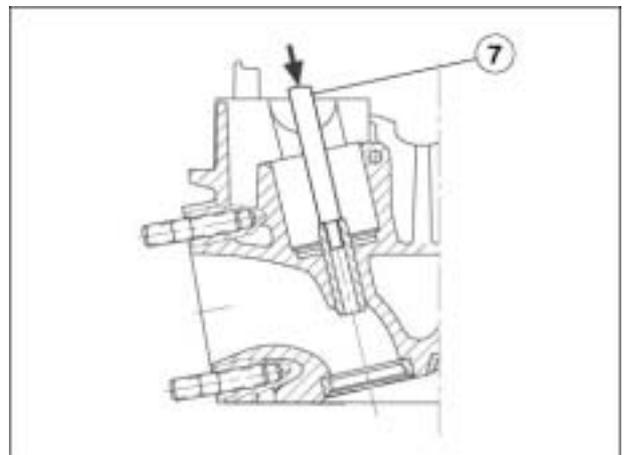


Have the appropriate special tool **OPT** (7) at hand cod. 0277510 (valve guide removal drift).

NOTE Do not heat the head.

Use the pad (7) to remove the rest of the guide valve in the manifold's direction.
Check the valve guide slot for tailings.

NOTE Should any signs of picking-up be found, replace the head.



INSTALLING THE VALVES GUIDE



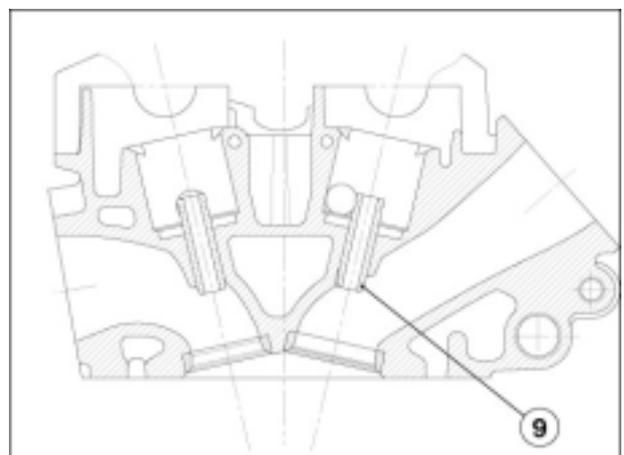
CAUTION

Use MOLYKOTE® G-N to prevent damages to the head hole or to the valve guide.

Apply a coat of MOLYKOTE® G-N on the head hole and on the valve guide assembly edge.

NOTE Have the appropriate special tool **OPT** (7) at hand cod. 0277695 (valve guide oil seal fitting drift).

Using the assembly pad (8), insert the new valve guide in the head; work from the oil chamber towards the combustion chamber until the assembly punch reaches a level position.



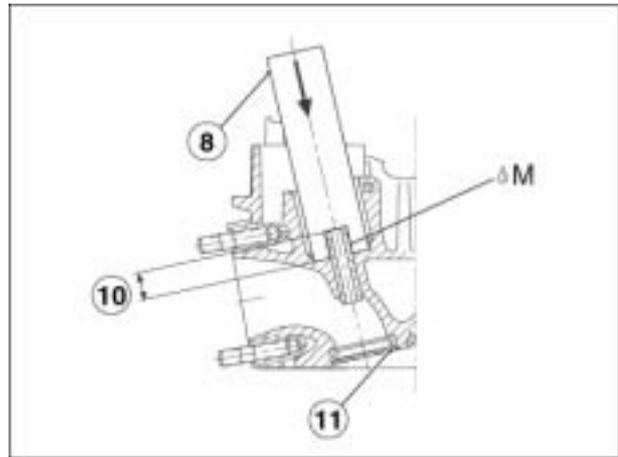
NOTE The exhaust valve and intake valve guides are different.

The intake valve guide has a longer smoothed surface (9). Check how much the head (10) of the valve guide protrudes on the camshaft side.

(10) Protrusion = 0.524 ± 0.0079 in ($13,3 \pm 0,2$ mm).
Bore the valve guide with a $\varnothing 0.236$ in (6 mm) F7 reamer.

Hole of the valve guide $\varnothing 0.2364 - 0.2369$ in (6.006 - 6.018 mm).

NOTE Use cutting fluid only to lubricate the reamer.



The reamer should only be turned in the cutting direction, never in the opposite direction, and cleaned of tailings at frequent intervals, again always removing it in the direction of the cut.

After having bored the valve guide, clean the head thoroughly and grind the valve seat (11), smoothing the valve seat with a valve seat reconditioning device, and grind the valve.

Check the contact mark using the relevant marking paste (Prussian blue).

Engine V 990 RR

3.8.8. CHECK

Clean the combustion chamber of all combustion residue and the deposit from the air space.

Check the condition of the spark plug threads and the mounting threads.

Check that the oil ducts are clear; clean them by blowing through with compressed air, if necessary.

Check that the sealing surfaces are flat and undamaged.

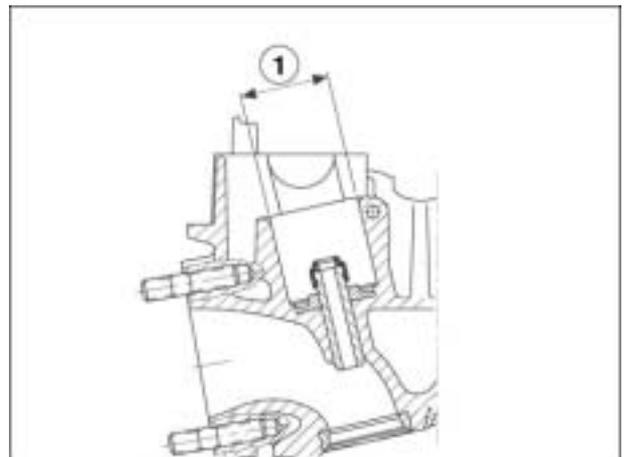
Max. deformation 0.012 in (0.03 mm).

**WARNING**

If necessary, grind the sealing surfaces with a precision grinder.

Check the condition of the valve buckets and the cylinder head guide.

- Cylinder head valve bucket boring (1) :
- **wear limit : Ø max. 13.22 in (33,58 mm).**
- Bucket :
- **wear limit : Ø min. 13.16 in (33,44 mm).**
- Radial bucket play :
- **wear limit : Ø max. 0.031 in (0,08 mm).**

**CAMSHAFTS AND CAMSHAFT BUSHINGS**

Check the cams for breakages, deformation and wear; replace the camshaft, if necessary.

Measure the play of the camshafts :

Fit the camshafts to the head.

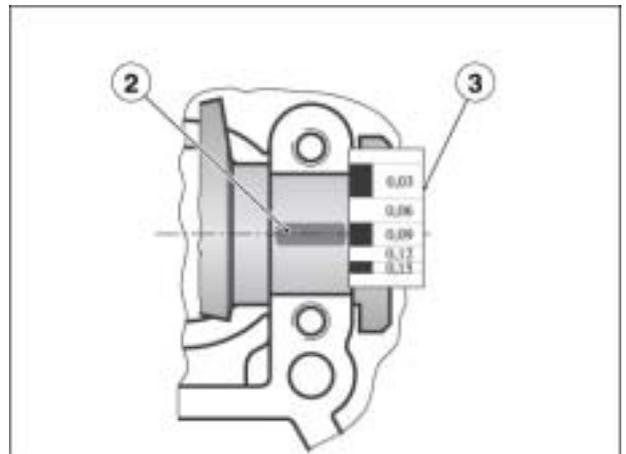
Apply a plastic gauge (2) to the camshaft journals.

Fit the clamps as specified and secure them with M6 socket-head screws.

Remove the socket-head screws and clamps.

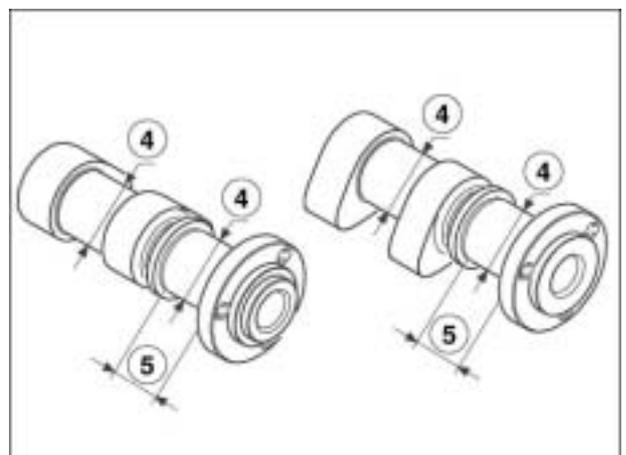
Measure the maximum thickness of the plastic gauge after compression with a graduated scale (3).

Max. wear limit 0.024 in (0,060 mm).



Measure the camshaft and head journals. If the wear limit has been exceeded, replace the worn components.

- Camshaft journals :
- **wear limit (4) Ø min. 9.43 in (23,950 mm).**
- Head journals :
- **wear limit Ø max. 9.46 in (24,040 mm).**



Fit the intake and exhaust camshafts in their mounts on the cylinder head and measure their axial play with a dial gauge.

- Camshaft axial play:
- **wear limit : max. 0.157 in (0,40 mm).**

Measure the camshaft and head axial contact surfaces. If the wear limit has been exceeded, replace the worn components.

- Camshaft axial contact surface (5) :
- **wear limit : max. 10.93 in (27,77 mm).**
- Head axial contact surface:
- **wear limit : min. 10.67 in (27,10 mm).**

IMPORTANT If a camshaft is replaced, the buckets must also be replaced.

UPPER COUNTERSHAFT

Check the wear of the countershaft:

IMPORTANT The bushing journal (6) is slightly conical; and thus the measurement must be done at the center of the journal.

- Bushing journals (6) :
- **wear limit \varnothing min. 13.77 in (34,98 mm);**
- Ball bearing pin (7) :
- **wear limit \varnothing min. 5.894 in (14,97 mm).**

IMPORTANT The bushing (8) is slightly conical.

Check the internal diameter (8) of the bushings in the plate and check for wear and dents.

IMPORTANT Fit the countershaft and measure its radial play with a dial gauge.

Measure the bushing's radial play.

Radial play max. 0.275 in (0,70 mm).

If the maximum radial play is exceeded, the worn component must be replaced.

IMPORTANT If the bushings are worn, the entire bushing plate must be replaced.

Fit the countershaft to the head (7) (rear) and measure its axial play with a dial gauge.

Wear limit : max. 0.0157 in (0,040 mm).

IMPORTANT If the axial play wear limit has been exceeded, replace the bushing plate.

Fit the countershaft to the rear head.

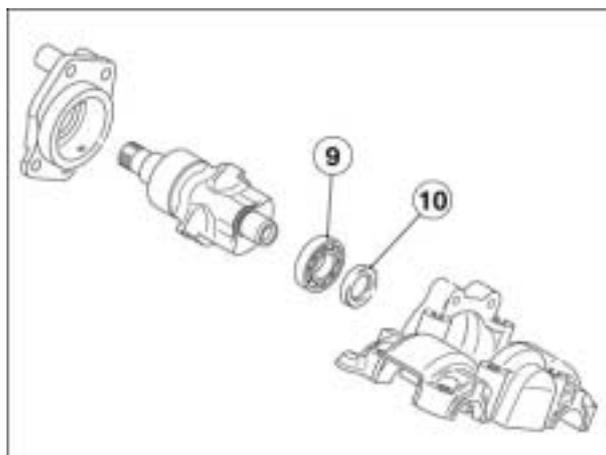
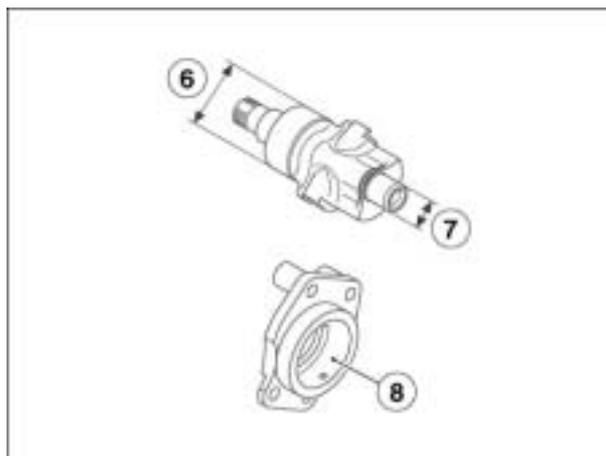
Check its running, check for pitting and check the play of the ball bearing (9) in the clamp.

Interference = \varnothing minimum 0.012 in (0,030 mm).

IMPORTANT Lubricate the ball bearings with engine oil before checking them.

If the inner race does not run freely and silently or if it runs noisily, the bearing is defective and must be replaced.

Check for wear and damage of the oil seal (10) behind the ball bearing (9).



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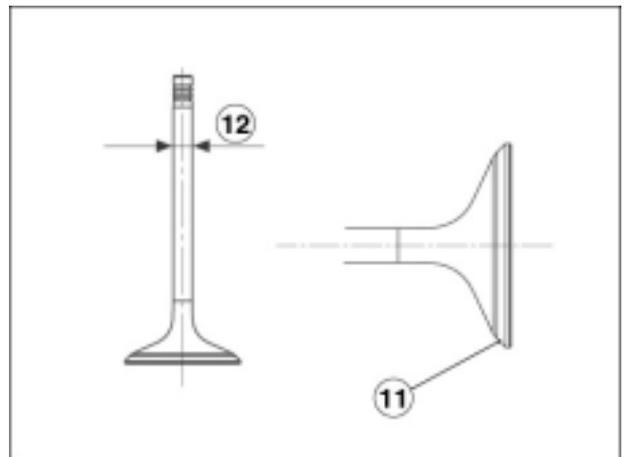
VALVES

**WARNING**

Replace the valves one at a time. Do not mix components.
Each valve must be fit in its matching seat.
Mark it for this purpose before disassembly.

**WARNING**

The valve head (11) is reinforced by induction hardening; the valve head may therefore not be ground out but the valve must be replaced if necessary.
Grinding with abrasive paste is possible, whereas grinding the valve at the end of the stem is not allowed.



Remove any combustion residue from the valves.
Check the valve head (11) with a wire rule.
The valve head surface may not be concave; replace if necessary.

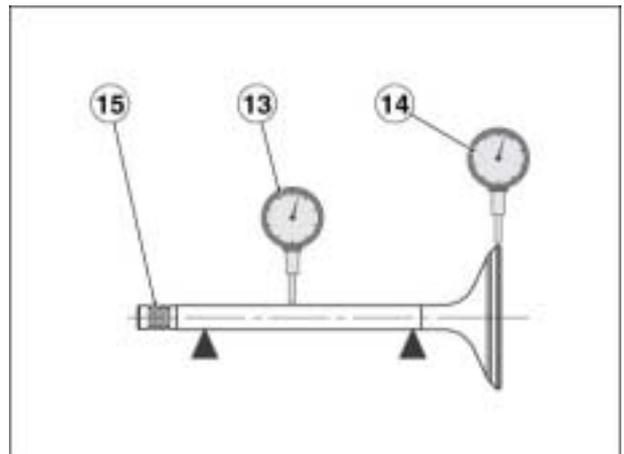
Check the diameter of the valve stem with a micrometer.

- intake valve :
wear limit (12) Ø min. 2.34 in (5,950 mm);
- exhaust valve :
wear limit (12) Ø min. 2.337 in (5,935 mm).

Check the run-out of the valve :

- valve stem :
run-out (13) max : 0.02 in (0,05 mm);
- valve head :
run-out (14) max . 0.02 in (0,05 mm).

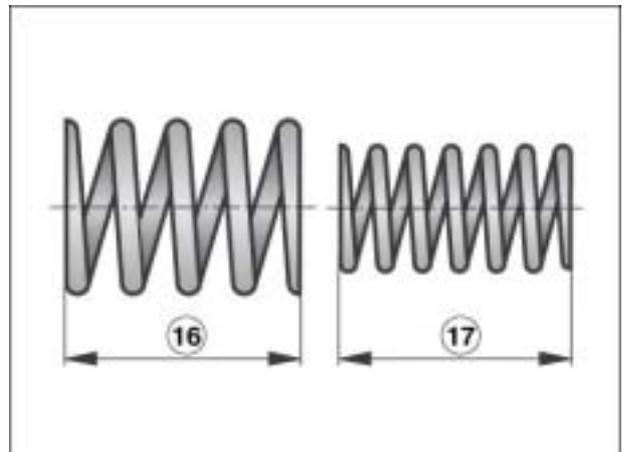
Check the condition of the valve half-cone mounting grooves (15).

**VALVE SPRINGS**

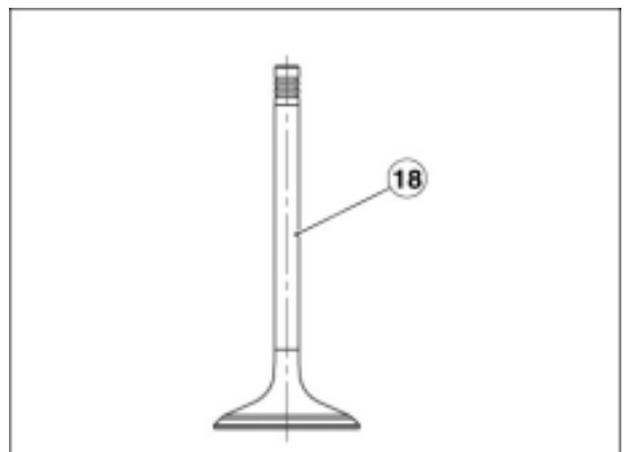
Measure and visually inspect the valve springs for breakage, deformation and lack of tension.

Measure the no-load length of the springs.

- Valve springs:
wear limit (16) min. 17.09 in (43,4 mm);
- Valve springs:
wear limit (17) min. 16.1 in (40,9 mm);

**VALVE HEAD INSPECTION AND REFACING**

Remove any combustion residue from the valves.
Apply Prussian blue contact patch paste to the valve head surfaces.
Fit the corresponding valve (18) and rotate it under light pressure from a valve lap.
Remove the valve and inspect the surface.



Inspect the width of the valve head (19) and contact patch, and check for wear.

- Intake valve A:

contact patch (19) : 1.0 - 1.4 mm (0.039 - 0.055 in)

Ø (21): 37.7 mm (1.48 in)

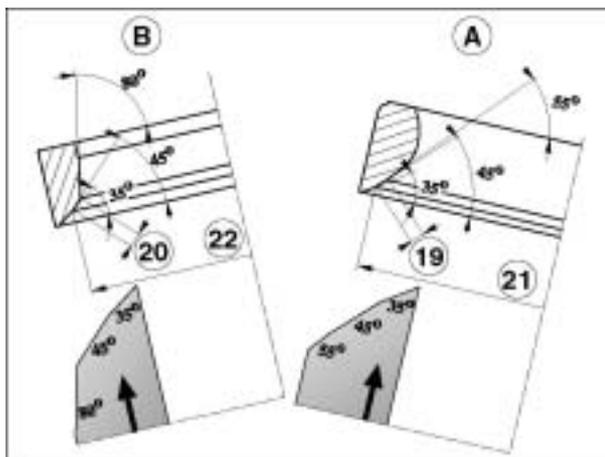
- Exhaust valve B:

contact patch (20) : 1.25 – 1.55 mm (0.049 - 0.061 in)

Ø (21): 30.3 mm (1.19 in)

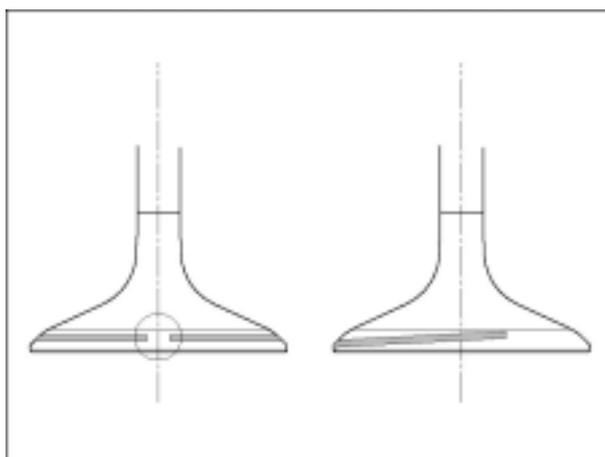
IMPORTANT The circular patch on the valve head surface and valve itself must be continuous and without any break.

If the width of the valve head is not within the wear limits or the patch is not continuous, the valve head may be refaced.



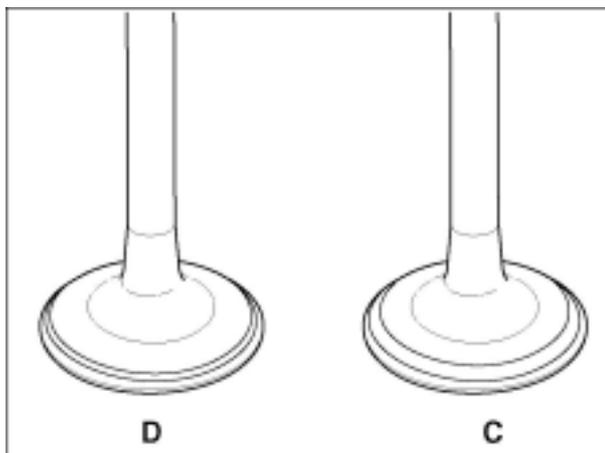
Inspect the valve head surface for :

- Irregular head width :
- Replace the valve and reface the head.
- Face damaged :
- Replace the valve and reface the head.



- Contact patch: too high (C) or too low (D) :
- reface the valve head.

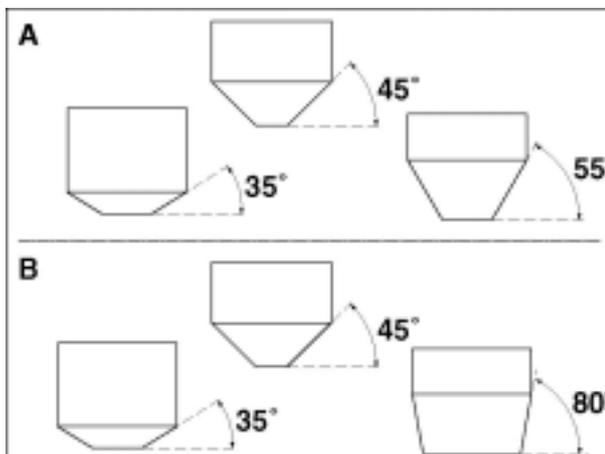
IMPORTANT If the valve surface is burnt, badly worn or without even contact, the valve must be replaced.



REFACING THE VALVE HEAD

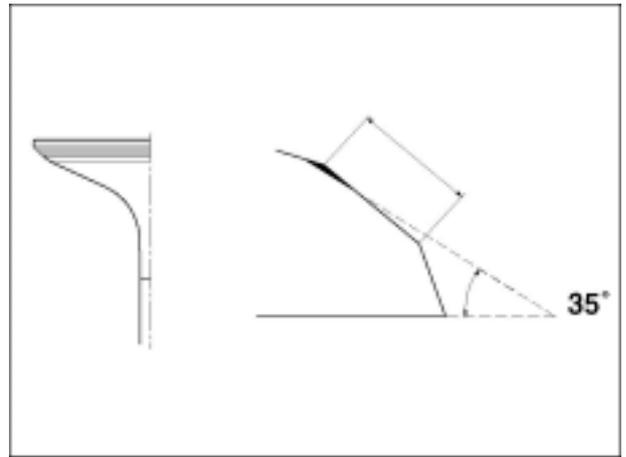
IMPORTANT Use only a specific valve head grinder to reface the valve heads.

A: intake
B: exhaust

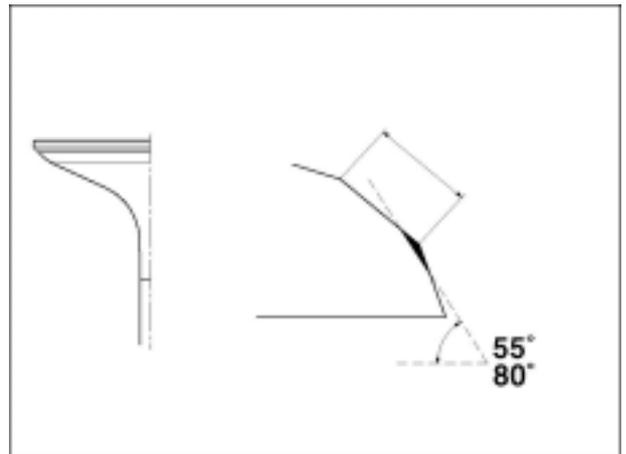


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- If the valve contact patch is too high :
 - Reface at 35° with the valve head grinder.

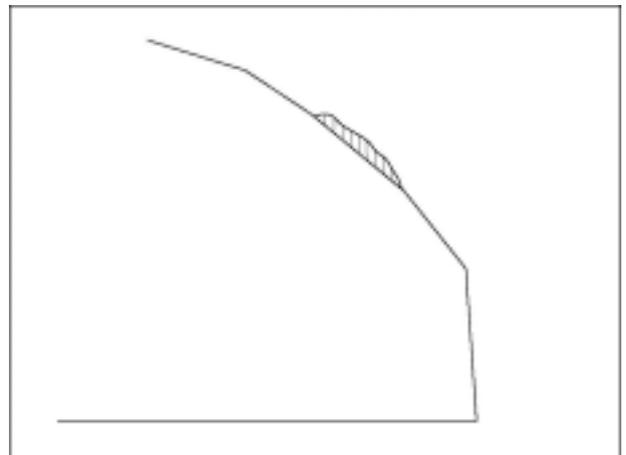


- If the valve contact patch is too low:
 - Reface at 55° (intake) or 80° (exhaust) with the valve head grinder.



Reface at 45° with the valve head grinder to remove any roughness or unevenness from the head and bring the valve head to within the following values :

- Intake valve A:
contact patch (19) : 1.0 - 1.4 mm (0.039 - 0.055 in)
- Exhaust valve B:
contact patch (20) : 1.25 – 1.55 mm (0.049 - 0.061 in)



After refacing the head, use the valve grinding paste.
Rotate the valve with light pressure.

IMPORTANT Applying excessive pressure can damage the valve head.

To prevent uneven grinding, change the rotation angle.
Paste must not enter the guides.

After using the grinding paste, clean the head, cylinder and valve itself.

3.8.9. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Head, cylinders				
Camshaft support / front head	6	M6x30	8.11	–
Front head (water hose)	1	M18x1.5	By hand	Loctite 275
Front head cap	1	M18x1.5	By hand	Loctite 243
Rear head water hose	2	M18x1.5	By hand	Loctite 275
Camshaft support / rear head	4	M6x30	8.11	–
Camshaft support / rear head	2	M6x45	8.11	–
Camshaft support / rear head	2	M6x55	8.11	–
Exhaust stud bolt	8	M6x16/20	7.38	Loctite 275
Rear head	1	–	By hand	Loctite 275
Head / crankshaft (stud bolt)	8	M10x171	4.43	Loctite 648
Cylinder / head (unpainted cylinder version)	8	M8x45	19.91	–
Head / studbolt (unpainted head version)	8	M10x4	42.78	–
Head / chain housing	2	M6x100	8.85	–
Rear head / bushing flange	2	M6x35	8.11	–
Rear head / bushing flange	2	M6x20	8.11	–
Front head / Driven gear (timing chain) - Intake camshaft	6	M6x45	8.11	Loctite 243
Front head / Upper chain guide	2	M6x16	8.11	–
Rear head / Driving gear (timing chain) - Intake camshaft	6	M6x11.5	8.11	Loctite 243
Rear head / Counterweight + Driven gear (Upper countershaft assy) - Upper countershaft	1	M14x1	36.88	Loctite 243
Rear head / Upper chain guide	2	M6x35	8.11	–
Valve cover	10	M6x23	6.64	–
Intake flange	4	M8x25	14.01	–
Cylinder / chain tensioner	2	M16x1.5	22.13	–
Water temperature sensor	1	0	14.75	–
Mount bracket fitting	2+ 2	M10x40 M10	29.5	Loctite 243

3.9. TIMING UNIT

3.9.1. REMOVING THE FRONT TIMING UNIT

- Loosen the screws securing the roller bearing flange.



- Remove the flange assembly complete with roller cage.



- Extract the bushing and remove the mobile shoe.



- Mark the timing chain with a colored dot so as to reassemble it in the same direction of rotation.



- Extract the idler gear.



- Keep the washer.

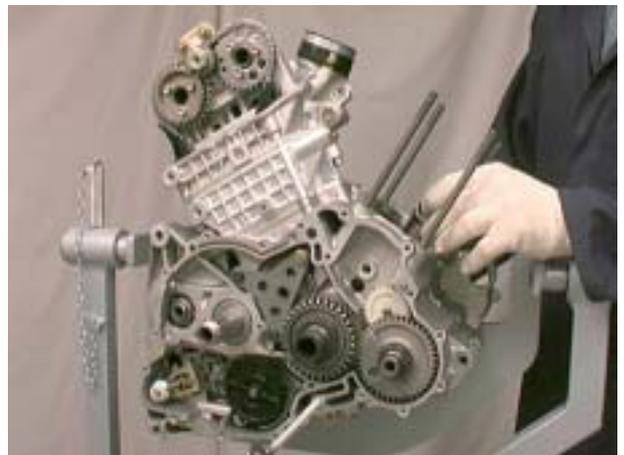
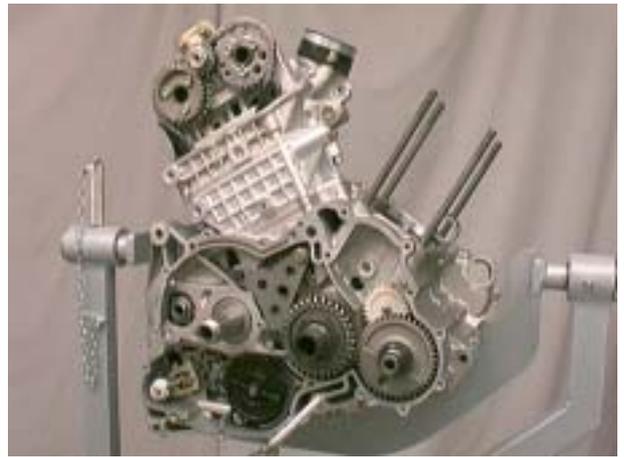


- Extract the timing chain.

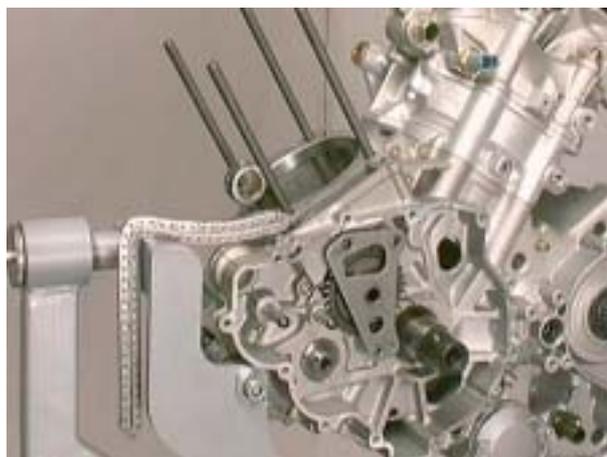


3.9.2. FRONT CYLINDER TIMING UNIT REASSEMBLY

- Turn the driving shaft until the front cylinder is at the TDC (top dead center) position.
- Screw the driving shaft locking tool on without over tightening.
- Check that the driving shaft is locked by turning it both directions.
- Fit the timing chain using the reference mark made during disassembly.



- Fit the idler gear and flange assembly complete with roller cage to the engine casing.



- Mount the mobile shoe and fit the bushing into its seat.



- Tighten the retaining screws to the specified torque.

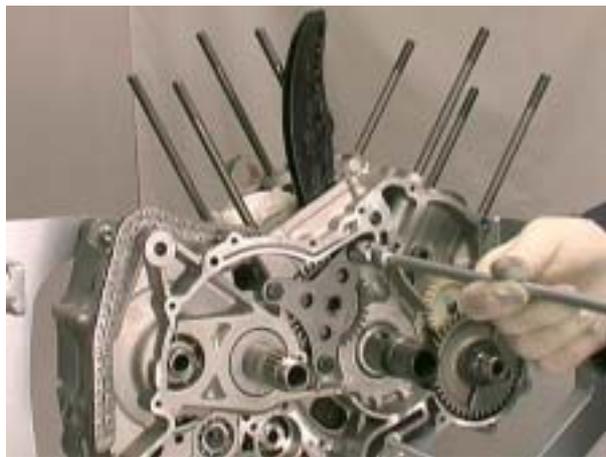
**WARNING**

The wheel perforations serve as a reference for correct positioning.



3.9.3. REMOVING THE REAR TIMING UNIT

- Loosen the screws securing the roller bearing flange.

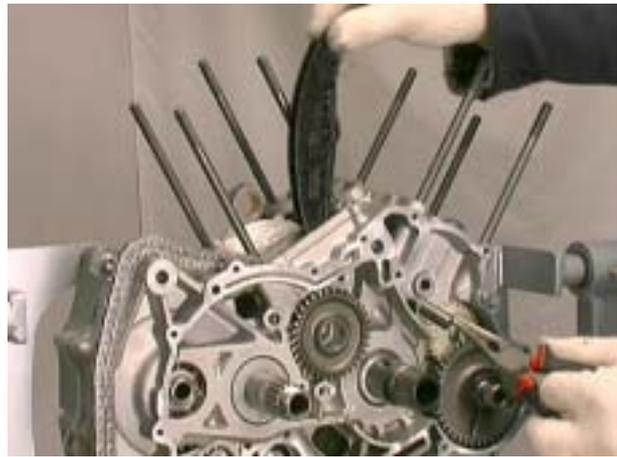


- Remove the flange assembly complete with roller cage.



- Extract the bushing and remove the mobile shoe.

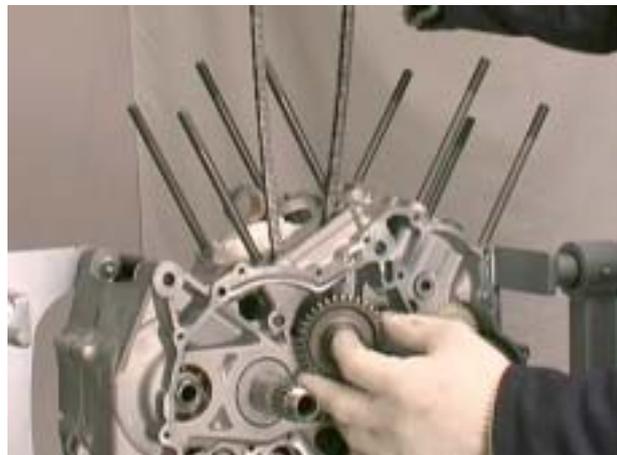




- Mark the timing chain with a colored dot so as to reassemble it in the same direction of rotation.



- Extract the idler gear.



- Keep the washer.



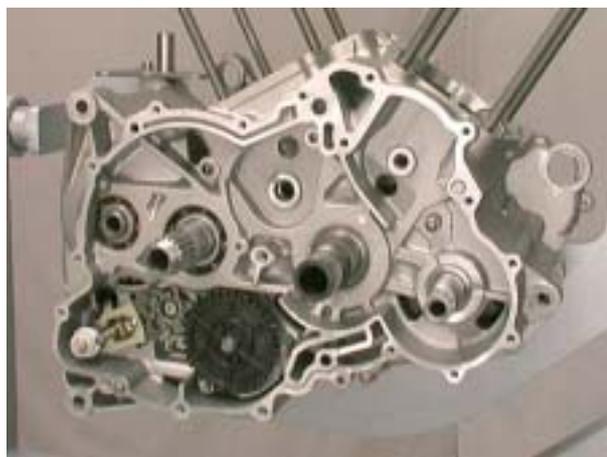
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- Extract the timing chain.

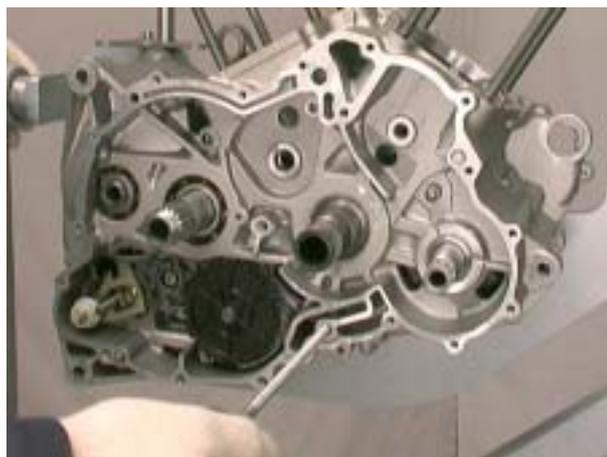


3.9.4. REAR CYLINDER TIMING UNIT REASSEMBLY

- Turn the driving shaft to the point corresponding to the TDC (top dead center) position of the rear cylinder.



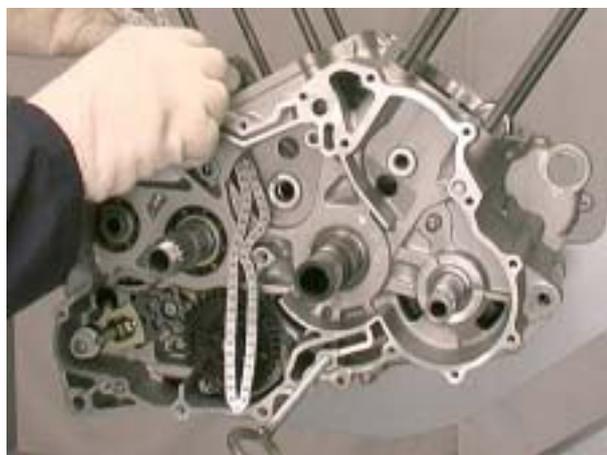
- Screw on the driving shaft locking tool without over tightening.



- Check that the driving shaft is locked by turning it in both directions.

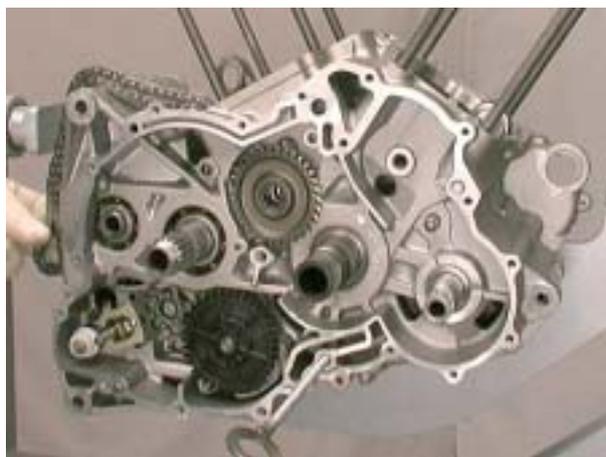


- Fit the timing chain taking note of the references marks made during disassembly.

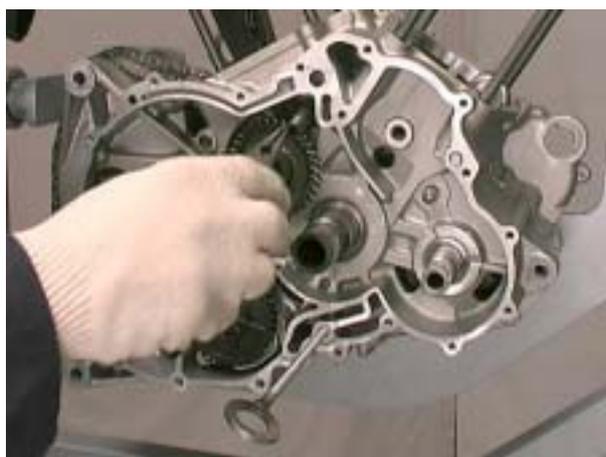


Engine V 990 RR

- Fit the idler gear to the engine casing.



- Fit the mobile shoe and mount the bushing in its seat.



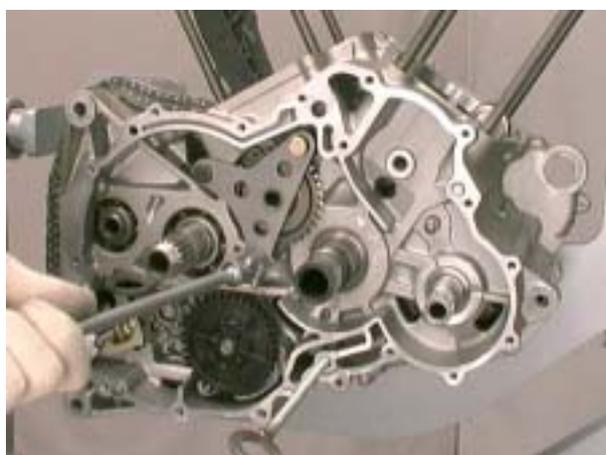
- Fit the flange assembly complete with roller cage.



- Tighten the retaining screws to their specified torque.

**WARNING**

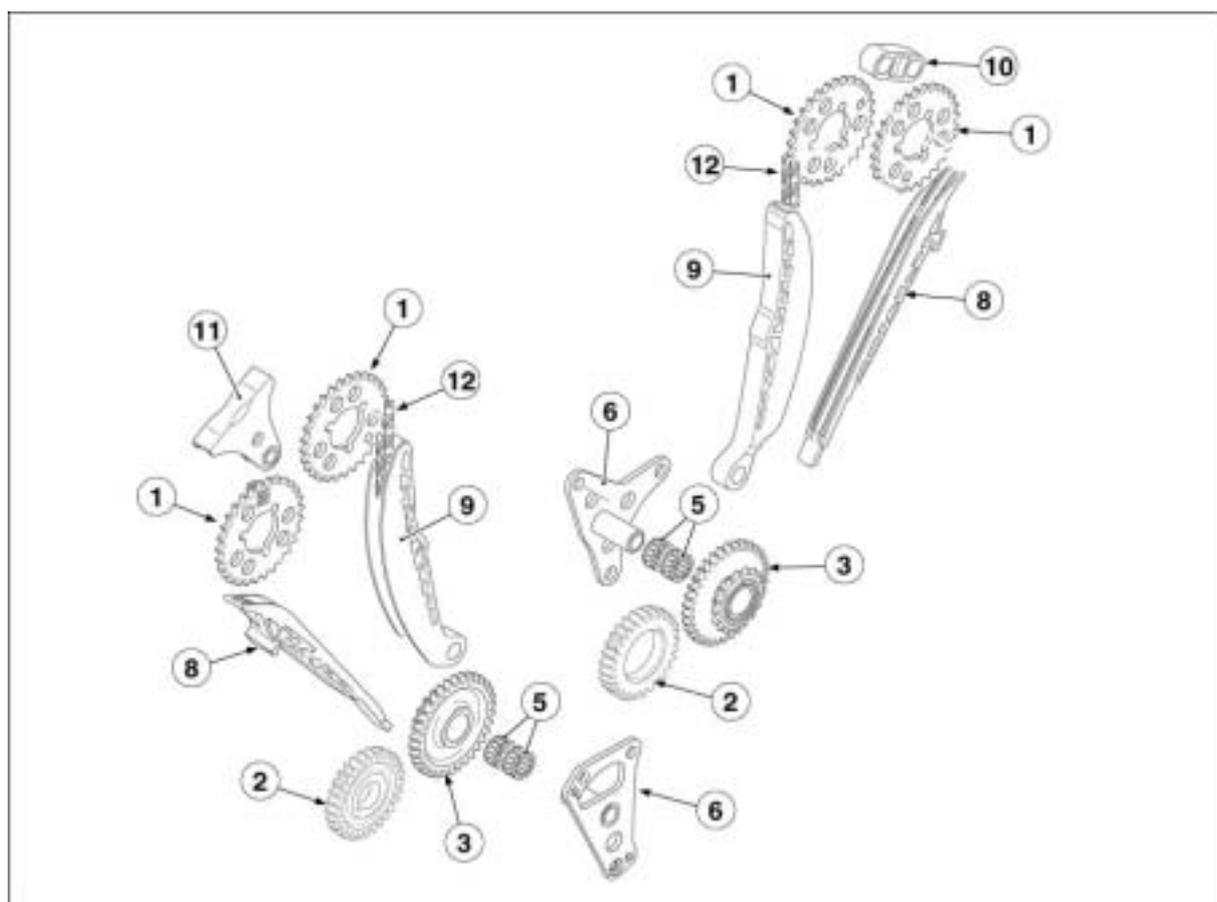
The wheel perforations serve as a reference for correct positioning.



3.9.5. CHECK

**CAUTION**

Set the front and rear cylinder timing drive assemblies aside in distinct groups so that when reassembling you will be sure to refit the parts in the same housing.



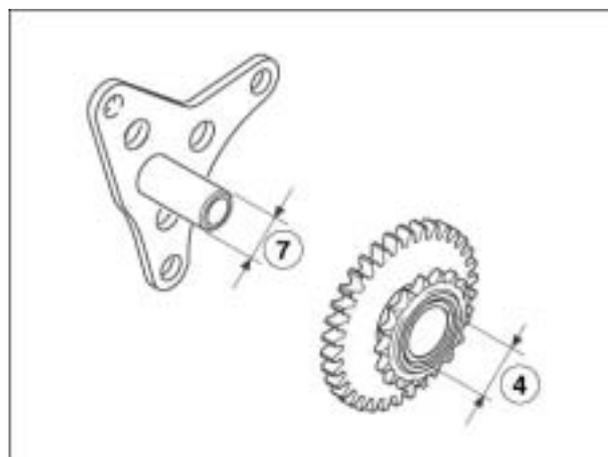
Check the sides of the timing gear (1), drive gears (2) and intermediate drive gears (3) for broken materials or distortion.

Check the slots of the idler gears (3) for wear.

Wear limit (4) max. 8.667 in (22,015 mm).

Check the roller bearings (5) for wear.

Check the two bearing flanges (6) for wear around the sliding area of the roller bearings (5).



Engine V 990 RR**Wear limit (7) max. 0.63 in (15,98 mm).**

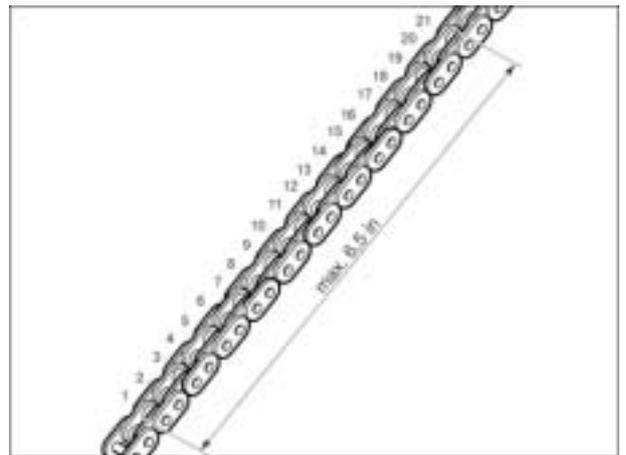
Check the chain guide shoe (8), the chain tightener shoe (9), the chain guide (10) and chain guide bracket (11) for any traces of rolling.

Max. depth of the rolling traces: 0.047 in (1,2 mm).

Check the teeth of the two timing chains (12) for any signs of distortion.

Tighten the timing chain and count 21 pins. Measure the distance between the exterior of the first and 21st pin.

Max. wear limit: 6.5 in (165,2 mm).



3.9.6. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Head, cylinders				
Camshaft support / front head	6	M6x30	8.11	–
Front head (water hose)	1	M18x1.5	By hand	Loctite 275
Front head cap	1	M18x1.5	By hand	Loctite 243
Rear head water hose	2	M18x1.5	By hand	Loctite 275
Camshaft support / rear head	4	M6x30	8.11	–
Camshaft support / rear head	2	M6x45	8.11	–
Camshaft support / rear head	2	M6x55	8.11	–
Exhaust stud bolt	8	M6x16/20	7.38	Loctite 275
Rear head	1	–	By hand	Loctite 275
Head / crankshaft (stud bolt)	8	M10x171	4.43	Loctite 648
Cylinder / head (unpainted cylinder version)	8	M8x45	19.91	–
Head / studbolt (unpainted head version)	8	M10x4	42.78	–
Head / chain housing	2	M6x100	8.85	–
Rear head / bushing flange	2	M6x35	8.11	–
Rear head / bushing flange	2	M6x20	8.11	–
Front head / Driven gear (timing chain) - Intake camshaft	6	M6x45	8.11	Loctite 243
Front head / Upper chain guide	2	M6x16	8.11	–
Rear head / Driving gear (timing chain) - Intake camshaft	6	M6x11.5	8.11	Loctite 243
Rear head / Counterweight + Driven gear (Upper countershaft assy) - Upper countershaft	1	M14x1	36.88	Loctite 243
Rear head / Upper chain guide	2	M6x35	8.11	–
Valve cover	10	M6x23	6.64	–
Intake flange	4	M8x25	14.01	–
Cylinder / chain tensioner	2	M16x1.5	22.13	–
Water temperature sensor	1	0	14.75	–
Mount bracket fitting	2+ 2	M10x40 M10	29.5	Loctite 243

3.10. OIL PUMP

3.10.1. REMOVING THE OIL PUMP

- Remove the circlip.
- Extract the oil pump gear.
- Extract the pump shaft pin
- Undo and remove the four retaining screws and extract the entire oil pump assembly.



- During this operation, take care that the pin of the internal suction pump rotor does not fall into the casing



- Extract the external rotor of the engine casing suction pump.



- Disassemble the oil filter cover and seal ring.



- Extract the oil filter cartridge from its seat



3.10.2. OIL PUMP OVERHAUL

- Extract the internal suction pump rotor from the pump shaft.



- Remove the pin.



- Remove the oil pump cover.



- Remove the internal delivery pump rotor.



Engine V 990 RR

- Remove the pin.



- Extract the pump shaft.



- Extract the external delivery pump rotor.



3.10.3. REFITTING THE OIL PUMP

- Fit the oil filter cartridge into its seat.



- Fit the oil filter cover together with its seal ring, and tighten the retaining screws to their specified torque.



- Lubricate and fit the external suction pump rotor into its seat in the casing.



Engine V 990 RR

- Fit the pump shaft together with internal suction pump rotor.



- Fit the pump body on the casing



- Fit the external delivery pump rotor



- Install the pin to the shaft



- Install the internal delivery pump rotor.



- Fit the oil pump cover



- Tighten the cover screws to their specified torque



- Install the pin to the pump shaft through the slot in the cover.



Engine V 990 RR

- Fit the oil pump gear



- Lock the gear in place with its circlip.



3.10.4. CHECKING THE OIL PUMP

Check the oil pump rotors, the sliding surfaces of the external rotors in both pump casings and the thrustbearing surfaces for any signs of grooving.

Using a feeler gauge, measure the free play between:

- outer rotor of the suction pump and engine crankcase;
- outer rotor of the pressure pump and body of the pressure pump.

Max. wear limit 0.0098 in (0,25 mm).

Measure the end play of the rotors.

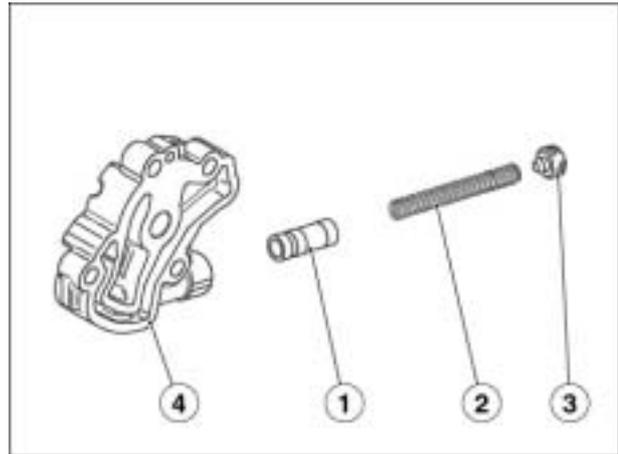
Max. wear limit 0.0059 in (0,15 mm).

NOTE If the play exceeds one of the two wear limits, the defective component must be replaced.

Make sure the adjusting piston (1) slides smoothly in the oil pump lid (4).

Check the adjusting piston and oil pump lid for any signs of wear:

- adjusting piston (1);
wear limit min. \varnothing 0.393 in (9,975 mm);
- oil pump lid (4);
wear limit max. \varnothing 0.395 in (10,035 mm);
- compression spring (2);
minimum length of the spring when not compressed: 2.205 in (56,0 mm).



Engage the adjusting piston (1) with the cone end facing forwards and insert the compression spring in the slot on the oil pump lid (4).

Apply LOCTITE® 648 on the caps' thread (3).

Screw the cap (3) **0.079 in (2 mm)** further in than the outer edge of the neck of the oil pump lid (4) and secure it in place by punching in four more points.

3.10.5. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Oil pump				
Oil pump	–	–	–	–
Oil pump housing	–	–	–	–
Oil pump cover	4	M6x45	8.11	–

3.11. ENGINE CRANKCASE

3.11.1. GEARS DISASSEMBLY

- Undo the front cylinder timing drive pinion's retaining screw.
- Remove the external counterweight, pinion and internal counterweight



Engine V 990 RR

- Remove the key



- Unscrew the nut on the countershaft.



- Remove the spring washer and counterweight.



- Undo the nut on the driving shaft using the special tool.



- Remove the spring washer and primary transmission gear from the driving shaft.



- Remove the countershaft drive gears on the driving shaft and countershaft.





- Remove the rear cylinder timing drive gear.



- Remove the driving shaft key.



- Remove the upper washer and coolant pump drive gear.





- Remove the coolant pump's idler gear.



- Extract the lower washer from the countershaft.



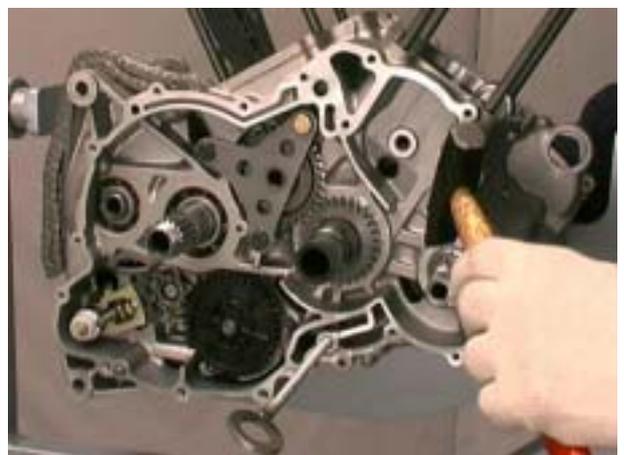
- Remove the countershaft key.



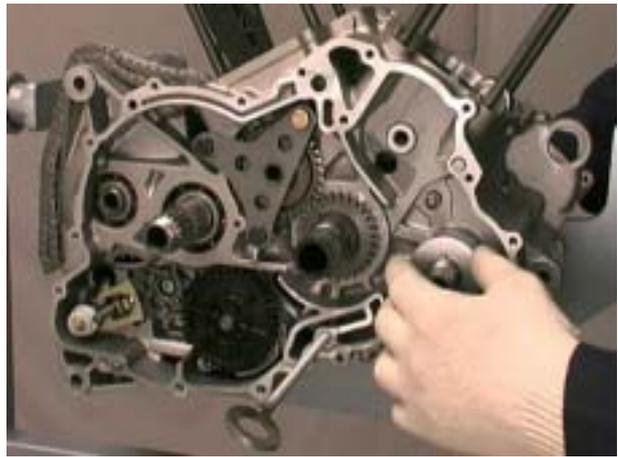
Engine V 990 RR

3.11.2. REFITTING THE GEARS

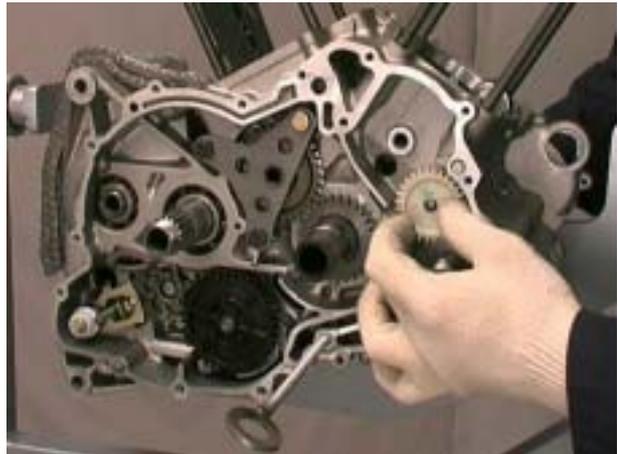
- Install the engine's shaft key.
- Fit the rear cylinder timing drive gear in such a way that the reference mark on the idler gear is aligned with that on the engine casing.
- Install the countershaft key by lightly knocking with a hammer.



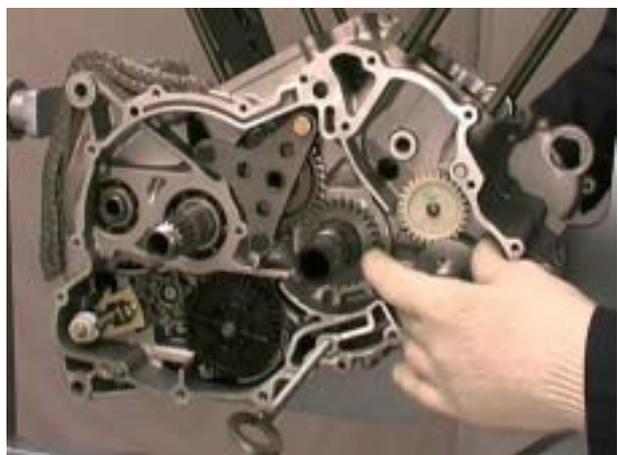
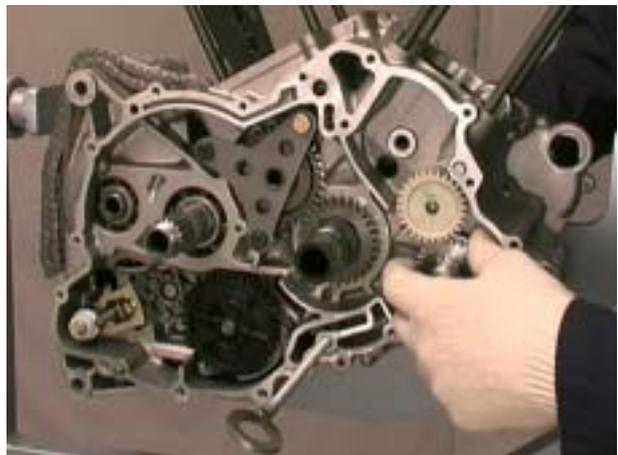
- Slide the lower washer on the countershaft



- Fit the coolant pump's idler gear.



- Install the coolant pump's drive gear and upper washer.



Engine V 990 RR

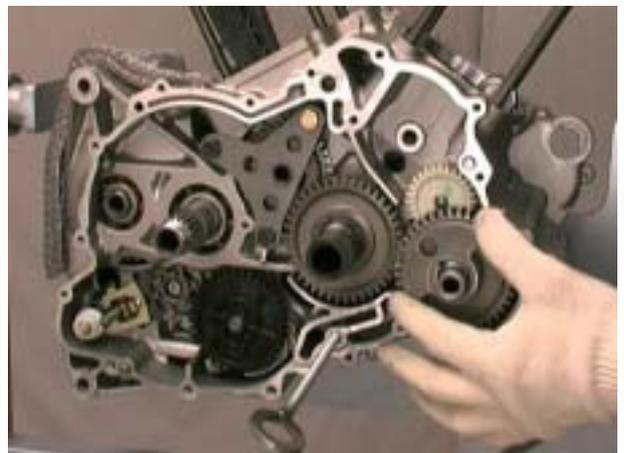
- Fit the countershaft's drive gear to the driving shaft.

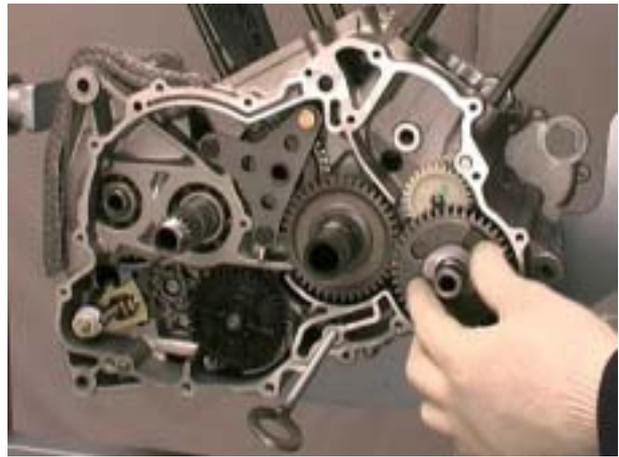


- Repeat the operation on the countershaft, making sure the gear's reference marks are aligned.

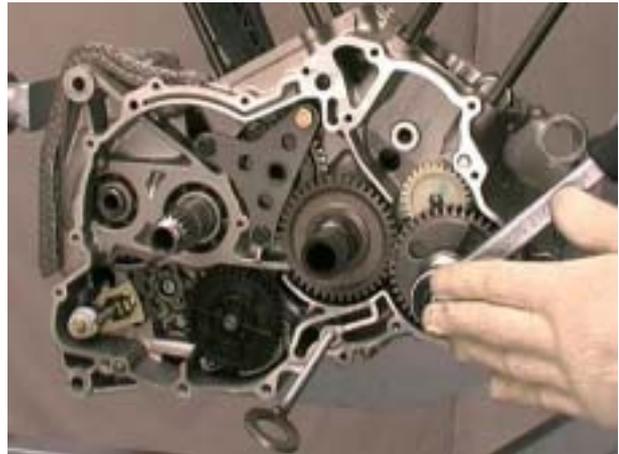


- Fit the counterweight and spring washer.





- Screw on and tighten the retaining nut to the specified torque.

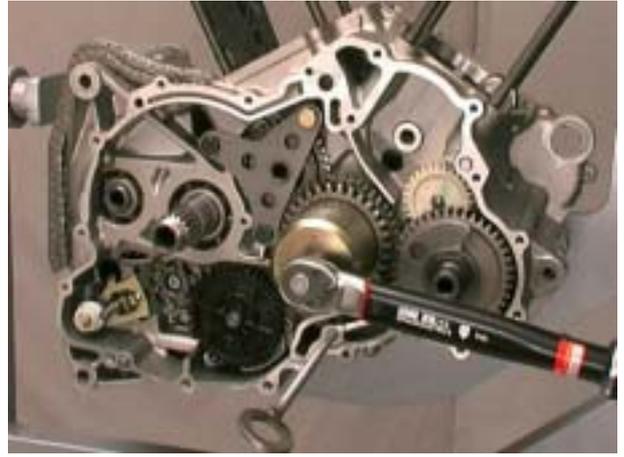


- Fit the primary transmission's gear and spring washer.



Engine V 990 RR

- Tighten the nut on the driving shaft to the specified torque.



- Install the countershaft key by lightly knocking with a hammer.



- Fit the internal counterweight.



- Align the idler gear's reference with that on the flange and fit the pinion to the countershaft.





- Fit the external counterweight and tighten the securing screw as per the specified procedure.



3.11.3. OPENING THE CRANKCASE

- Remove the washer from the driving shaft.
- Remove the circlip and thrust washer from the gearbox secondary shaft.
- Undo and remove the twenty screws uniting the casing halves.



- Separate the two half casings by knocking lightly with hammer.



- Remove the gaskets from the half casing contact surfaces.



- Remove the countershaft



Engine V 990 RR

- Extract the driving shaft



- Extract the shafts on which the gearshift forks run



- Remove the secondary shaft shift forks



- Move the primary shaft gearshift fork away from the selector cylinder guide



- Remove the selector cylinder



- Push the third and fourth gear selector gear upwards and extract the fork from the primary shaft



- Lay the half casing in a horizontal position



Engine V 990 RR

- Use a plastic mallet to knock on the secondary shaft and push the two shafts out of their seats together with the gearshift gears.



3.11.4. CHECKING THE CRANKCASE

Clean the two sections of the engine casing, the ball bearings and all bearing housings thoroughly with a gentle solvent.

Clean all the gasket surfaces and check for damage.

NOTE Place the two halves of the engine half-casing on a flat surface to prevent damage.

Make sure the two halves of the engine half-casing do not show cracks or signs of damage.

Make sure all the threads are in a perfect state of repair.

Make sure all the oil seals remaining in their slots are not worn or damaged.

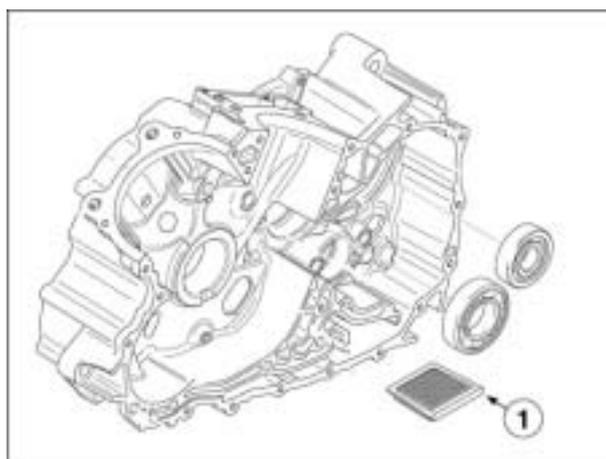
Check the slack of all the ball bearings and make sure they slide smoothly and are not distorted in any way.

NOTE Use motor oil to lubricate the ball bearings before performing the check.

If the inner race does not turn easily and silently, or if it makes a noise, it means the bearing is defective and needs replacing.

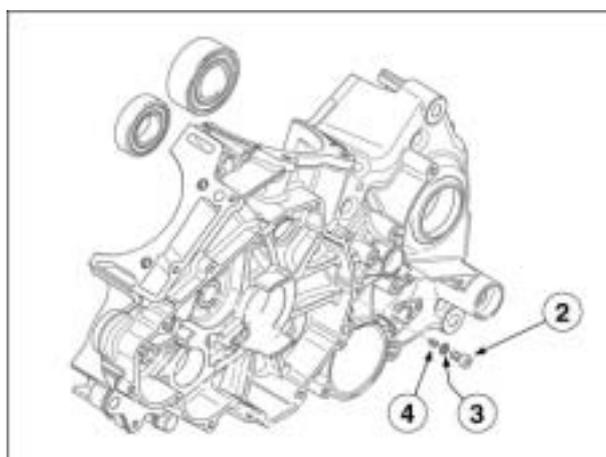
Remove the oil gauze (1).

Clean the oil gauze with naphtha and check the mesh of the gauze for possible signs of damage.



Unscrew and remove the screw (2), the seal (3) and the nozzle (4).

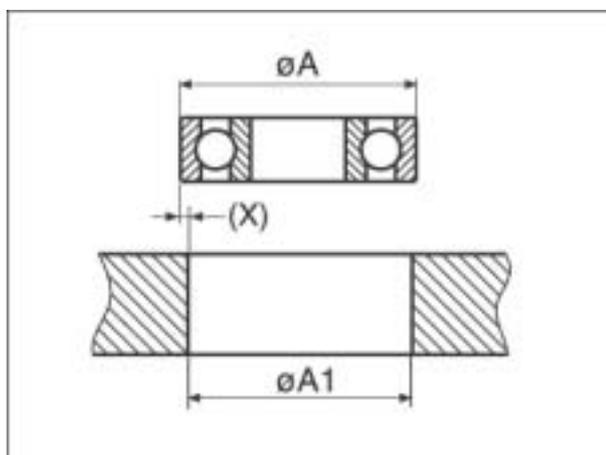
Make sure the galleries are clear in all the lubrication holes in the two halves of the casing and, where necessary, clean them by blowing a jet of compressed air.



INSTALLING THE BALL BEARINGS

Check the interference between the bearing and the engine casing hole.

Interference (X) = ($\varnothing A$) minus ($\varnothing A1$): 0.00039 in (0,01 mm).



Engine V 990 RR

DRIVE SHAFT MAIN BUSHES AND BALANCE SHAFT MAIN BUSHES**CAUTION**

The main bushes may only be replaced by authorized repair shops suitably skilled in the use of the relevant measuring equipment and tools.

Measure the inner diameter of the drive shaft main bushes on both crankcase halves.

Drive shaft main bushes: wear limit \varnothing 1.81 in (46,035 mm).

Measure the inner diameter of the balance shaft main bushes on both crankcase halves.

Balance shaft main bushes: wear limit \varnothing 1.26 in (32,060 mm).

**CAUTION**

Make a number of measurements, particularly in the directions of the axes of both cylinders, avoiding the mating surface of the 2 half-shells. None of the values must exceed the limit value. Measure the radial play between the main bushes and the corresponding areas of the drive shaft. Check the radial play between the main bushes and the corresponding areas of the balance shaft.

Make sure that there are no wear or sliding traces on the axial thrust bearing surfaces for the drive shaft, in both crankcase halves.

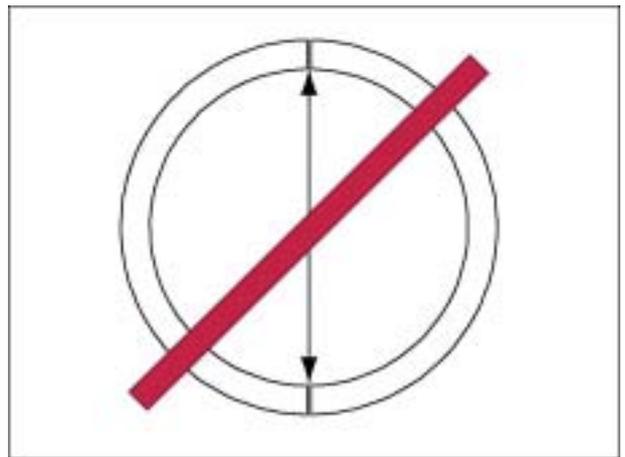
Make sure that there are no wear or sliding traces on the axial thrust bearing surfaces for the balance shaft in the crankcase half, clutch side.

**CAUTION**

Check the end play of the drive shaft.
Check the end play of the balance shaft.

Clean the diameter of the main bush housing inside the engine casing.

Determine the main bush size group based on the colored markings on the engine casing.

**CAUTION**

The lower main bush of the driving shaft, fly-wheel side, features a lubrication hole.

NOTE The size group of the main bushes is also marked with a colored dot.

If the colored marking on the engine casing is no longer clearly legible, calculate the diameter based on the average of a number of different measurements.

**CAUTION**

Take a number of measurements, especially in the direction of the axis of both cylinders.

Driving shaft		
Bush seat hole in the engine crankcase halves Ø in	Main bushes marking	Engine casing marking
1.9645 – 1.9649	red	red
1.9649 – 1.9653	blue	blue
1.9653 – 1.9657	yellow	yellow

Countershaft		
Bush seat hole in the engine crankcase halves Ø in	Main bushes marking	Engine casing marking
1.4137 – 1.4141	red	red
1.4141 – 1.4145	blue	blue
1.4145 – 1.4149	yellow	yellow

ENGINE HALF-CASING CYLINDRICAL PINS

Use a micrometer to check the wear of the cylindrical pins of the starter motor's drive assembly and coolant pump's idler gear.

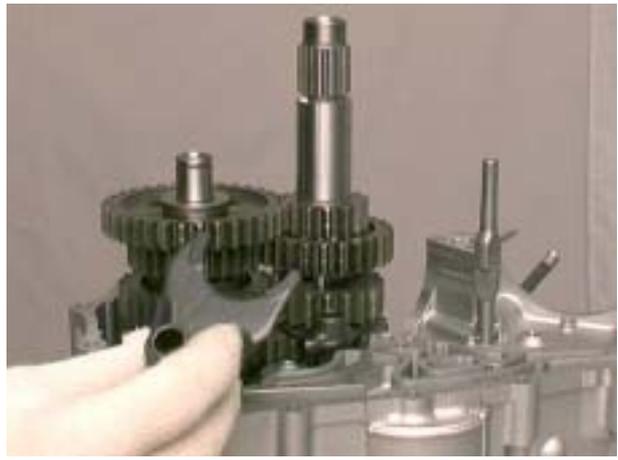
Wear limit Ø 0.393 in (9.990 mm).

3.11.5. REASSEMBLING THE CRANKCASE

- Fit the gearshift shafts into the casing.
- Knock alternately on the two shafts with a plastic mallet to seat them.
- Push the third and fourth gear selector gear upwards and seat the fork on the primary shaft.



- Position the gearshift forks on the secondary shaft.



- Mount the selector cylinder.



- Fit the forks in their tracks on the selector cylinder.



Engine V 990 RR

- Position the shafts on which the gearshift forks run.



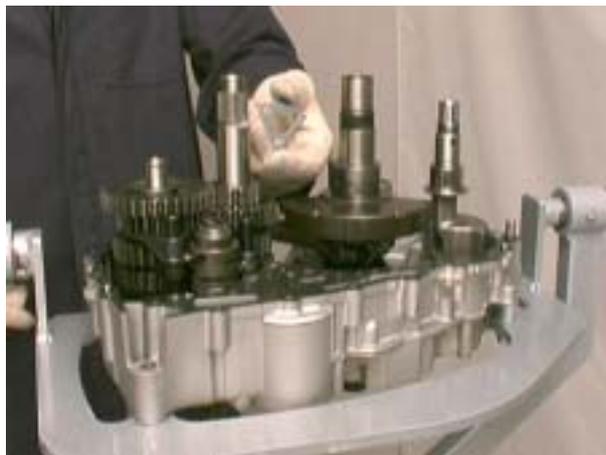
- Lubricate the driving shaft and countershaft pins and install them.





- Fit the gaskets into the half casing contact surfaces.

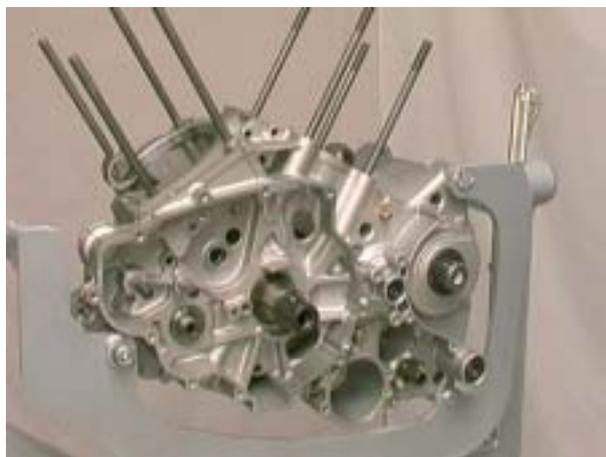




- Unite the two half casings by lightly knocking them together with a hammer.



- Turn the engine block to the vertical position



- Tighten the twenty screws uniting the casing to the specified torque



- Fit the thrust washer and circlip to the gearbox secondary shaft



- Fit the washer to the driving shaft



3.11.6. CONNECTING RODS DISASSEMBLY

- Before disassembling the connecting rods and covers, mark them so as to refit them in the same position and direction of rotation.



- Undo the connecting rod screws.



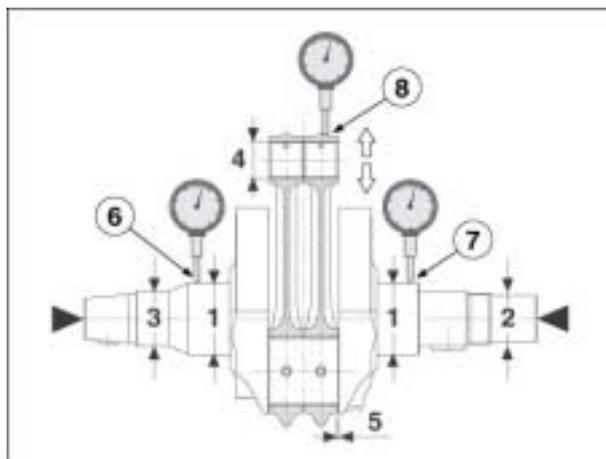
- Remove the covers.



3.11.7. CHECKING THE DRIVING SHAFT

Check the wear of the driving shaft:

- main bush area (engine crankcase) (1);
wear limit min. \varnothing 1.809 in (45,955 mm);
- support bush area (flywheel cover) (2);
wear limit min. \varnothing 1.180 in (29,970 mm);
- area of the freewheel gear bearing (3);
wear limit min. \varnothing 1.376 in (34,960 mm);
- connecting rod small end (4);
wear limit max. \varnothing 0.867 in (22,030 mm);
- end play between connecting rod and crank arm (5);
max. limit 0.024 in (0,60 mm);



NOTE Measure the eccentricity of the driving shaft between the ends.

- driving shaft eccentricity, flywheel side (6);
max. limit 0.00079 in (0,020 mm);
- driving shaft eccentricity, clutch side (7);
max. wear limit 0.00079 in (0,020 mm).

NOTE Do not reuse the engine crankcase gaskets after they have been removed.

Use exclusively new original **Aprilia** gaskets.

NOTE Use a comparator to determine the end play of the driving shaft once the two halves of the casing are coupled.

End play of the driving shaft max. 0.0197 in (0,5 mm).

Use a comparator to determine the radial play (8) of the connecting rod small end.

Max. wear limit 0.00236 in (0,060 mm).

Measure the radial play between the main bushes (engine crankcase) and the corresponding areas of the drive shaft (1).

Permissible radial play max. 0.00236 in (0,060 mm).

The radial play is determined based on the following values:

- maximum value of the inner diameter of the main bushes (engine crankcase) minus diameter of the main bush area (engine crankcase) on the drive shaft.
- Measure the inner diameter of the main bushes (engine crankcase).



CAUTION

If the max. permissible radial play is exceeded, the worn part must be replaced.

Measure the radial play between the support bushes (clutch cover) and the corresponding area of the drive shaft (2).

Permissible radial play max. 0.00256 in (0,065 mm).

The radial play is determined based on the following values:

- maximum value of the inner diameter of the support bushes (clutch cover) minus diameter of the support bush area (clutch cover) on the drive shaft.
- Measure the inner diameter of the support bushes (clutch cover).

Engine V 990 RR

**CAUTION**

If the max. permissible radial play is exceeded, the worn part must be replaced.

The following components must also be checked for wear or broken material:

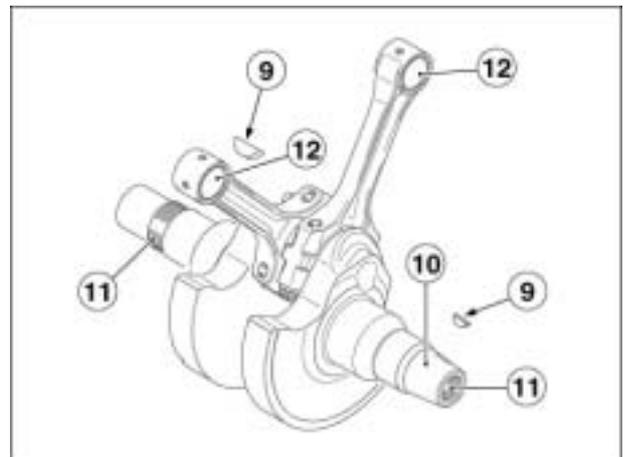
Key (9) and grooves in the driving shaft.

Coloring of a bearing housing.

Conical surface (10) of the drive shaft - flywheel side.

Clean the thread (11) of any LOCTITE® residues and make sure it is in a perfect state of repair.

Check to make sure the bush (12) inside the connecting rod small end is correctly installed and centered (on the longitudinal axis).

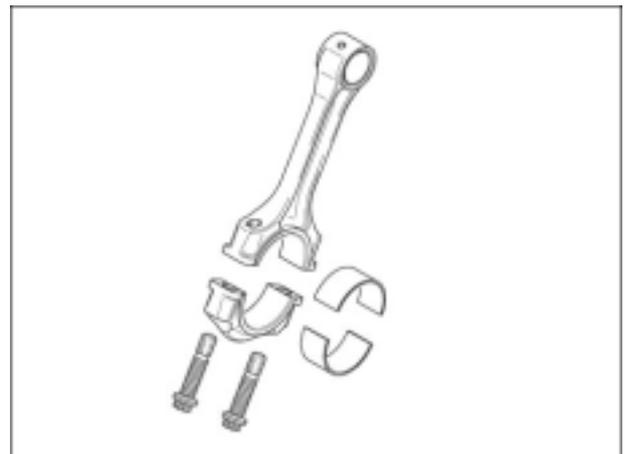


Check the bushes for signs of wear, distortion and altered coloring.

Check the connecting rod housing for wear:

- connecting rod pins;
wear limit min. Ø 1.653 in (41,98 mm);
- connecting rod big end (after having tightened down the screws);
wear limit max. Ø 1.655 in (42,050 mm).

NOTE None of the values may exceed the limit value. In the event of wear, the whole connecting rod, complete with cover, must be replaced.



Measure the radial play of the connecting rod big end.

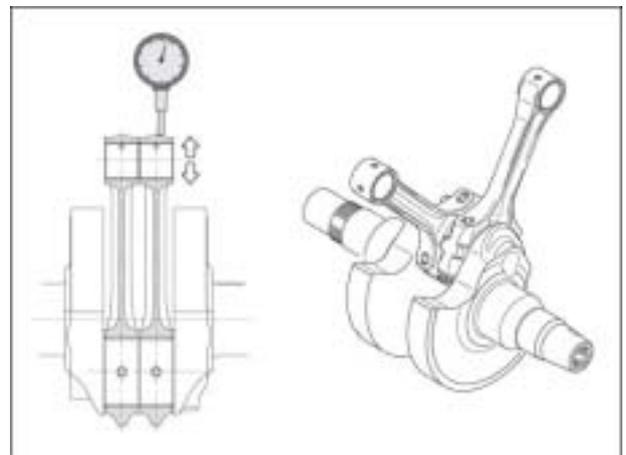
Max. wear limit 0.0028 in (0,070 mm).

Measure the radial play of the connecting rod end with a comparator.

Radial play 0.00079 0.00177 in (0,020 - 0,045 mm).

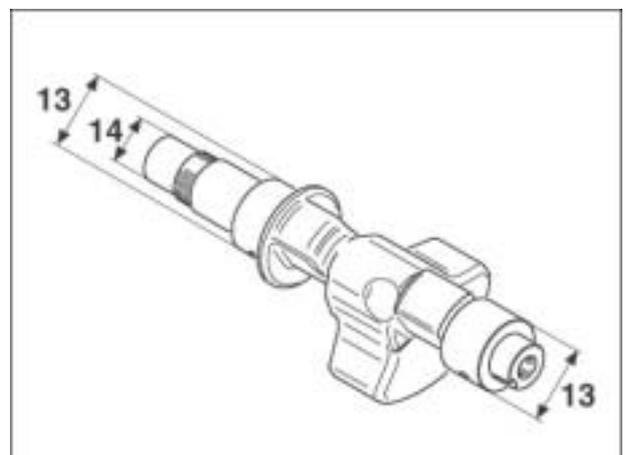
If the radial play is greater than 0.00177 in (0,045 mm), the bushes of the size corresponding to the colors blue or yellow must be chosen based on the following table, and must be inserted in place of the red bushes.

Bush color	Thickness (in)
Red	0.0579 – 0.0581
Blue	0.0581 – 0.0583
Yellow	0.0583 – 0.0585

**COUNTERSHAFT AND COUNTERSHAFT MECHANISM**

Check the wear of the countershaft:

- main bush area (engine crankcase) (13);
wear limit min. Ø 1.259 in (31,980 mm);
- support bush area (clutch cover) (14);
wear limit min. Ø 0.787 in (19,990 mm).





CAUTION
If the max. permissible radial play is exceeded,
the worn part must be replaced.

Measure the radial play between the main bushes (engine crankcase) and the corresponding areas of the balance shaft (13).

Permissible radial play min. \varnothing 0.00236 in (0,060 mm).

The radial play is determined based on the following values:

- maximum value of the inner diameter of the main bushes (engine crankcase) minus value of the diameter of the corresponding areas of the main bushes (13) on the balance shaft.
- Measure the inner diameter of the main bushes (engine crankcase).



CAUTION
If the max. permissible radial play is exceeded,
the worn part must be replaced.

Measure the radial play between the support bushes (clutch cover) and the corresponding area of the balance shaft (14).

Permissible radial play min. \varnothing 0.00236 in (0,060 mm).

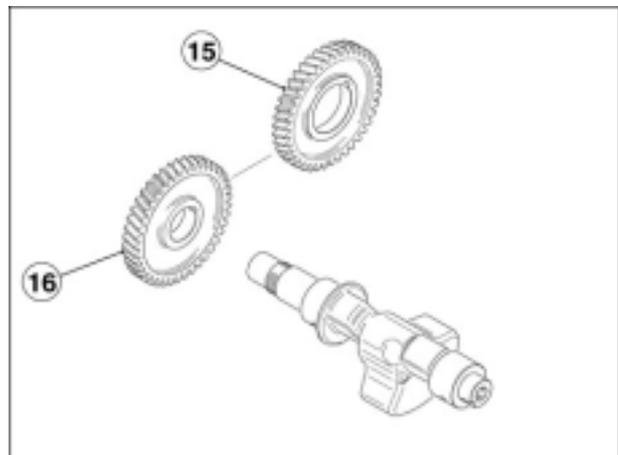
The radial play is determined based on the following values:

- maximum value of the inner diameter of the support bushes (clutch cover) minus value of the diameter of the corresponding area of the support bushes (14) on the balance shaft.
- Measure the inner diameter of the support bushes (clutch cover).

NOTE Once the two halves of the engine casing have been coupled, check the end play of the countershaft with a comparator.

Permissible radial play of the countershaft max. 0.0118 in (0,30 mm).

Check the sides of the teeth of the driving gear (15) and driven gear (16) for any signs of broken material or distortion.



3.11.8. REFITTING THE CONNECTING RODS

- Fit the covers to the connecting rods, using the reference marks made during disassembly
- If fitting new connecting rods, make sure the references and part numbers correspond
- Lubricate the connecting rod screw contact surfaces



- Tighten the screws diagonally using a torque wrench and goniometer



3.11.9. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (FtLb)	NOTES
Crankcase				
Selector rollerball bearings / crankcase screw [flywheel side (MS)]	1	Torx M6x12	8.11	Loctite 243
Rollerball bearings selector/ crankcase [clutch side (KS)]	1	M6x20	8.11	–
Crankshaft ball bearings / crankcase [clutch side (KS)]	3	Torx M6x12	8.11	Loctite 243
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	3	M6x45	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	13	M6x65	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	1	M6x80	8.11	–
Crankcase [flywheel side (MS)] / crankcase [clutch side (KS)]	5	M6x45	8.11	–
Cover (magnetic screw)	1	M12x1.5	14.75	–
Crankcase neutral sensor	1	–	2.95	Loctite 574
Oil filter cover	2	M6x20	8.11	–
Crankcase / 60 nozzle	1	–	4.43	–
Bearing flange [flywheel side (MS)]	2	M6x12	8.11	Loctite 243

GEARBOX

4

SUMMARY

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4.1. GEAR SELECTOR

4.1.1. REMOVING THE GEARSHIFT SELECTOR

- Before proceeding, select sixth gear
- Extract the entire selector shaft assembly
- Undo the screw securing the index plate.
- Lower the index lever and extract the index plate





- Undo the screw securing the index lever and remove the assembly



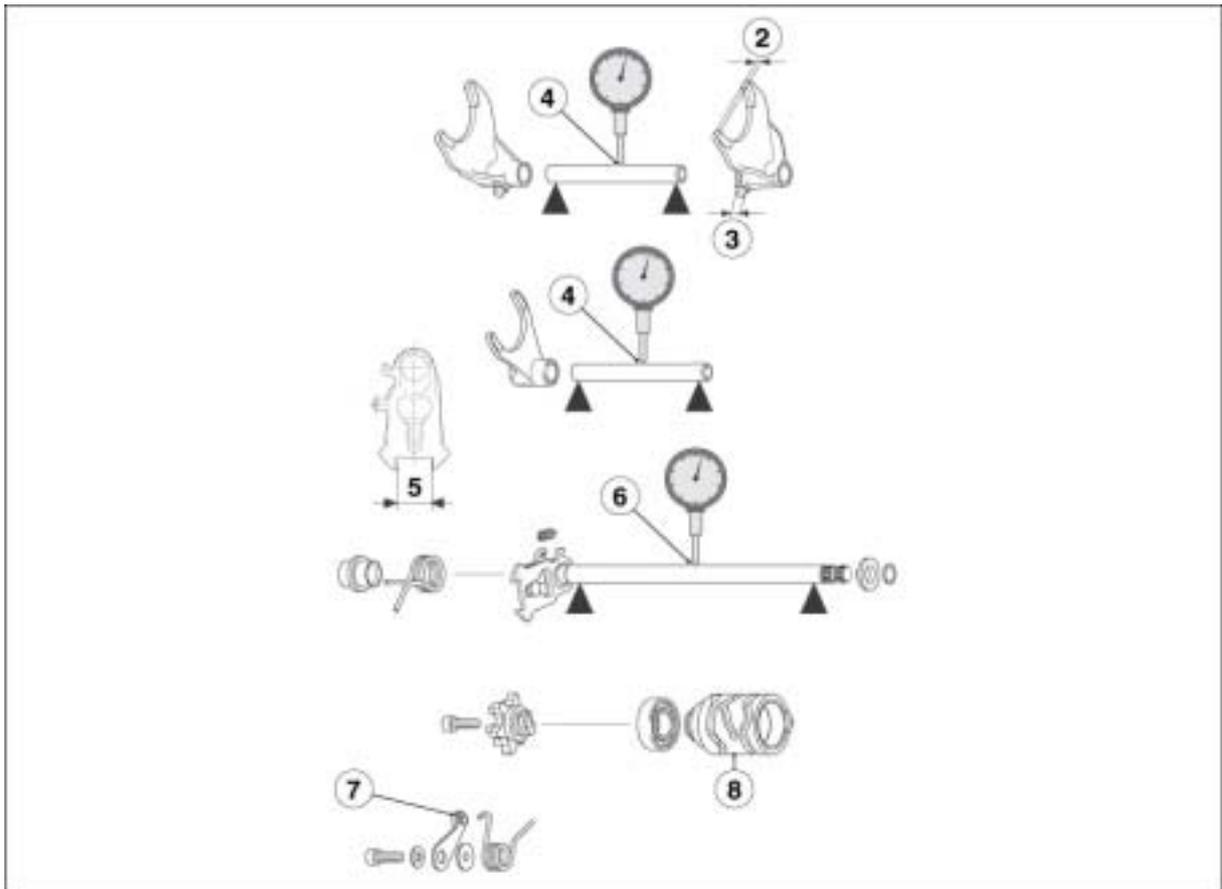
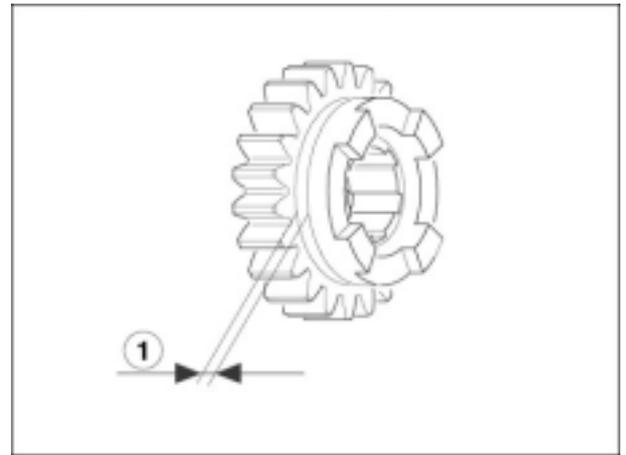
4.1.2. GEAR SELECTION

Check the end play of the gearshift forks inside the corresponding grooves in the selection gears.

Max. wear limit 0.0059 in (0,15 mm).

NOTE If the wear limit is exceeded, you must determine which component needs replacing by checking the gearshift forks and selection gears.

Width of the groove (1) of the selection gears.



Max. wear limit 0.171 in (4,35 mm).

Thickness (2) of the gearshift forks. Check the degree of wear on the chromium-plated thrust bearing surfaces of the gearshift forks.

Max. wear limit 0.1555 in (3,95 mm).

NOTE If the chromium finish is missing in some points, replace the fork in question.

Check the diameters (3) of the gearshift fork guide pins.

Wear limit min. Ø 0.230 in (5,85 mm).

Check the eccentricity of the two fork shafts (4).

Max. permissible eccentricity 0.00079 in (0,02 mm).

Check the wear of the ratchet gear in the area in which it comes into contact with the index plate pins.

Wear limit (5): visual inspection.

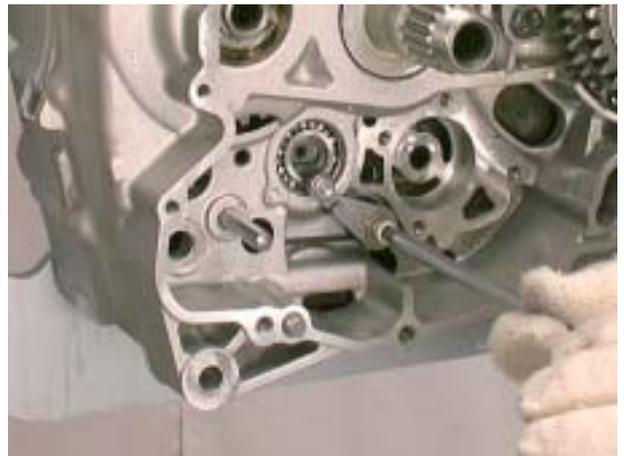
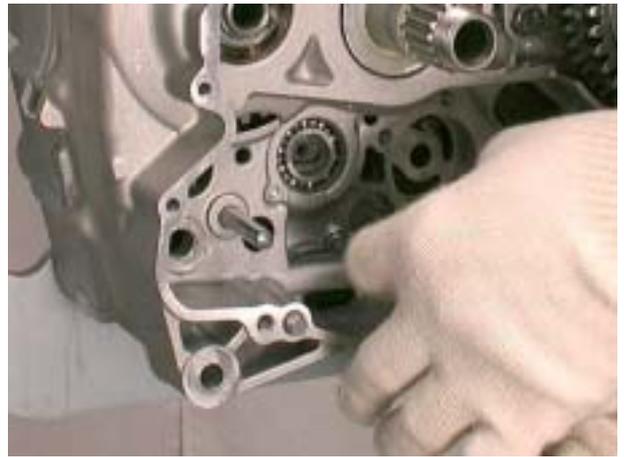
Check the eccentricity of the selector shaft (6). Also check for any signs of rolling on the sliding surface of the shaft sealing ring.

Max. permissible eccentricity 0.0098 in (0,25 mm).

The roller (7) of the positioning lever must turn freely. Check the wear of the guide tracks (8) of the shift cam.

4.1.3. REFITTING THE GEAR SELECTOR

- Fit the index lever spring to the casing.
- Install the lever and tighten the retaining screw to the specified torque
- Lower the lever and fit the index plate
- Tighten the index plate's retaining screw to the specified torque.



- Seat the selector shaft assembly



4.2. GEAR SHAFTS

4.2.1. REMOVING THE PRIMARY SHAFT

- Remove the second gear's fixed gear
- Extract the circlip
- Extract the shim ring and sixth gear's idler gear



- Extract the roller cage and shim ring



- Extract the circlip



- Remove the third and fourth gear's fixed gear



Engine V 990 RR

- Extract the circlip



- Remove the shim ring and fifth gear's idler gear



4.2.2. REMOVING THE SECONDARY SHAFT

- Remove the shim ring
- Remove the first gear's idler gear, roller cage and shim ring
- Remove the fourth gear's fixed gear



Engine V 990 RR

- Extract the circlip



- Remove the third and fourth gear's idler gears and their roller cages



- Extract the shim ring



- Extract the circlip



- Remove the sixth gear's fixed gear



- Extract the circlip



- Remove the shim ring and second gear's idler gear





4.2.3. CHECKING THE GEARBOX

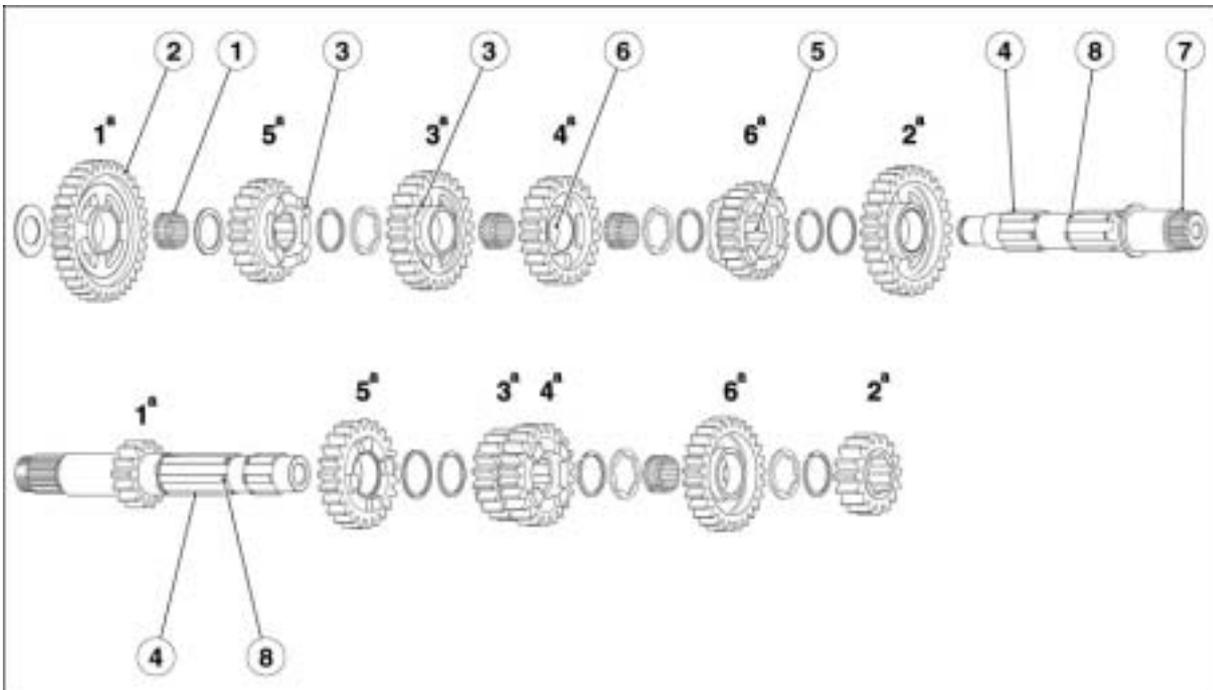
Check the following components for wear:

- Roller bearings (1);
- Sides of the teeth (2) of all gears.

IMPORTANT Small gray marks and tiny hollows are tolerated up to a maximum corresponding to approx. 0.5% of the sides' surface area.

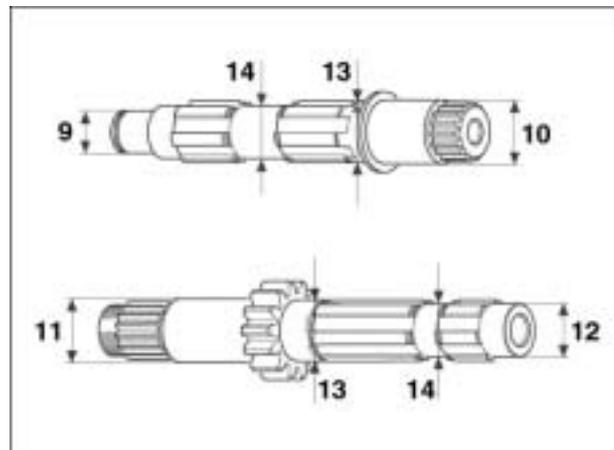
- clutch claws (3) and clutch holes of the gearbox gears;
- grooved profiles (4) of the secondary and primary shafts;
- check the running of all selection gears (5) on both the secondary and primary shafts;

- idler gear's bearing seats (6);
- triangular tooth profile (7) of the chain pinion;
- the grooves for circlips (8) on the secondary and primary shafts must have sharp edges.



Check the wear of the secondary and primary shaft seats:

- wear limit (9) \varnothing min. 0.786 in (19,972 mm);
- wear limit (10) \varnothing min. 1.178 in (29,915 mm);
- wear limit (11) \varnothing min. 1.180 in (29,965 mm);
- wear limit (12) \varnothing min. 0.983 in (24,972 mm);
- wear limit (13) \varnothing min. 1.143 in (29,03 mm);
- wear limit (14) \varnothing min. 0.983 in (24,978 mm);



Engine V 990 RR

- eccentricity (15) \varnothing max. 0.00079 in (0,02 mm).

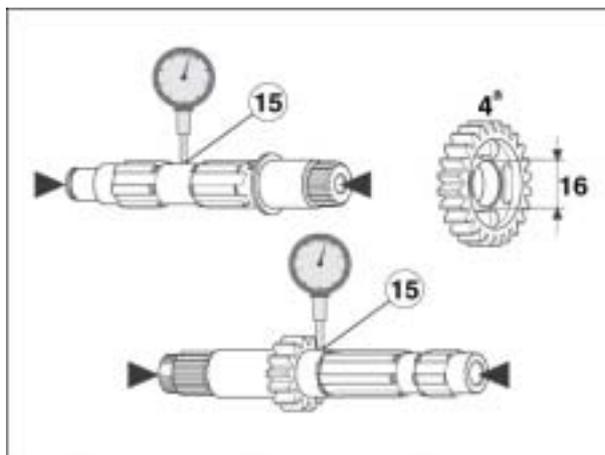
IMPORTANT Should the sides of the teeth be worn, both gears of the pair in question must be replaced.

Should the engagement teeth or mating slots prove worn, the meshing gears in question must be replaced.

- Check the internal diameter of the third, fourth and sixth gear's idler gears.

Wear limit (16) \varnothing max. 1.143 in (29,022 mm).

- Make sure there are no rolling traces and grooves on the second and fifth gear's idler gear bushings and measure the internal diameter of the gears.



- Make sure there are no rolling traces and grooves on the freewheel bushings (15 - 16) and measure the internal diameter of the bearings.

Wear limit \varnothing max. 1.147 in (29,125 mm).

- Make sure the lubrication hole of the secondary shaft is clear.

4.2.4. REFITTING THE PRIMARY SHAFT

- Fit the fifth gear's gear and shim ring to the shaft



- Fit the circlip



- Fit the third and fourth gear's fixed gear



Engine V 990 RR

- Fit the circlip



- Fit the shim ring and roller cage



- Fit the sixth gear's idler gear and shim ring.





- Fit the circlip



4.2.5. REFITTING THE SECONDARY SHAFT

- Fit the second gear's idler gear and shim ring to the shaft.



- Fit the circlip



- Fit the sixth gear's fixed gear



- Fit the circlip



- Fit the shim ring



- Fit the roller cages for the third and fourth gear's idler gears



- Fit the third and fourth gear's idler gears.



- Fit the circlip



- Fit the fourth gear's fixed gear
- Fit the shim ring, roller cage and first gear's idler gear to the shaft



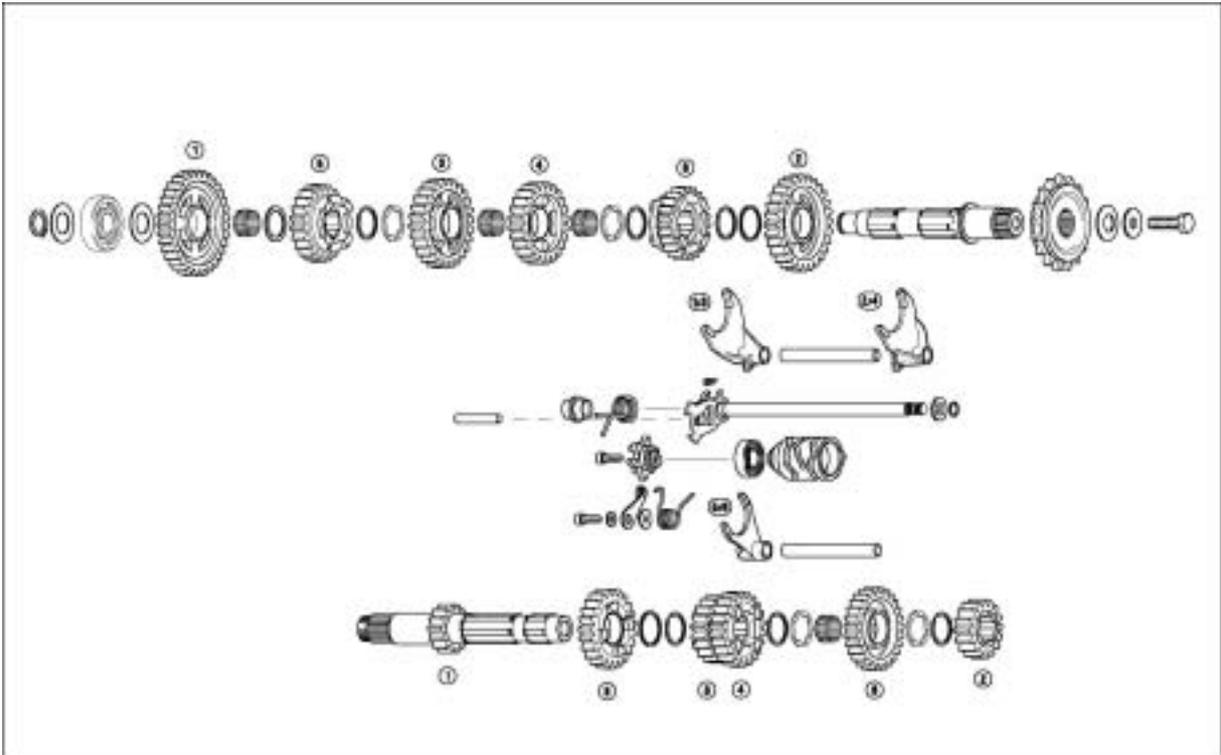


- Fit the shim ring.



4.3. GEAR

4.3.1. GEAR





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