00/2005-10

MOTO GUZZI

Engine V1100

workshopmanual

USA

Cod. 8140899

INTRODUCTION 0

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0.1. INTRODUCTION

0.1.1. FOREWORD

This manual provides the information required for normal servicing.
This publication is intended for use by **Moto Guzzi** Dealers and their qualified mechanics; certain information has been omitted intentionally, as this manual does not purport to provide a comprehensive treatise on mechanics. The persons who will use this manual must be fully conversant with the basics of mechanics and with the basic procedures of motorcycle repair. Without such familiarity, repairs and checks could be ineffective and even hazardous. Since the repair and vehicle check instructions are not exhaustive, special care must be taken to avoid damage and injury. Repairing or inspecting a motorcycle when one does not possess such basic knowledge or training could result in improper servicing and make the motorcycle unsafe to ride. For the same reason, certain basic precautions have been omitted in the descriptions of repair and inspection procedures; you are therefore invited to take special care to avoid damage to motorcycle components or injury to persons. **Moto Guzzi s.p.a.** undertakes to constantly improve the design of its products and the relevant literature to ensure that the customer is satisfied with the product. The main technical modifications and changes in repair procedures are communicated to all **Moto Guzzi** dealers and agencies worldwide. Such modifications will be included in subsequent editions of the manual. Should you require assistance or clarifications regarding inspection and repair procedures, please contact the **Moto Guzzi** SERVICE DEPT., which will be pleased to help, as well as providing you with updates and technical modifications regarding the vehicle.

For further details, see REFERENCE MANUALS.

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0.1.2. REFERENCE MANUALS

PARTS CATALOGUES

guzzi part# (description)	
GU077_00	I F D NL E UK USA

OWNER'S MANUALS

guzzi part# (description)	
05.90.00.30	I F D NL E UK
05.90.00.31	USA

CHASSIS WORKSHOP MANUAL

guzzi part# (description)	
8140856	I
8140857	F
8140858	D
8140859	E
8140860	UK
8140861	USA
8CM0077	I F D E UK
8CM0078	USA

ENGINE WORKSHOP MANUAL

guzzi part# (description)	
8140894	I
8140895	F
8140896	D
8140897	E
8140898	UK
8140899	USA

CD FOR THE NETWORK

guzzi part# (description)	
8CM0093	I F D E UK
8CM0094	USA

0.1.3. ABBREVIATIONS/SYMBOLS/CONVENTIONS

= number
< = less than
> = greater than
≤ = less than or equal to
≥ = greater than or equal to
~ = approximately
∞ = infinity
°C = degrees Celsius (centigrade)
°F = degrees Fahrenheit
± = plus or minus
A.C. = alternating current
A = Ampere
Ah = Ampere per hour
API = American Petroleum Institute
AT = high voltage
AV/DC = Anti-Vibration Double Countershaft
bar = pressure measurement (1 bar = 100 kPa)
D.C. = 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 OrganisationOrganization
kg = kilograms
kgm = kilogram meter (1 kgm = 10 Nm)
km = kilometers
km/h = kilometers per hour
kΩ = kilo Ohm
kPa = kiloPascal (1 kPa = 0.01 bar)
KS = clutch side (from the German "Kupplungsseite")
kW = kilowatt
l = liters
LAP = racetrack lap
LED = Light Emitting Diode
LEFT SIDE = left-hand 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 meter (1 Nm = 0.1 kgm)
Ω = ohm
PICK-UP = pick-up
BDC = Bottom Dead Center
TDC = Top Dead Center
PPC = Pneumatic Power Clutch
RIGHT SIDE = right-hand side
SAE = Society of Automotive Engineers
SAS = Secondary Air System

TEST	= diagnostic check
T.B.E.I.	= crown-head Allen screw
T.C.E.I.	= cheese-head Allen screw
T.E.	= hexagonal head
T.P.	= flat head screw
TSI	= Twin Spark Ignition
UPSIDE-DOWN	= inverted fork
V	= volt
W	= watt
Ø	= diameter

GENERAL INFORMATION 1

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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. For quick reference, see the summary of sections.
- • Unless expressly specified otherwise, assemblies are reassembled by reversing the assembly procedure.
- • The terms "left" and "right" are referred to the motorcycle when viewed from the riding position.
- Motorcycle operation and basic maintenance are covered in the "OWNER'S MANUAL".

In this manual any variants are identified with these symbols:

OPT	optional
#	catalytic version
-	all versions
MP	national certification
SF	European certification (EURO 1 limits)

VERSION:

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

1.1.2. SAFETY WARNINGS

The symbols and warnings used throughout this manual have the following meanings:

Safety warning. When you find this symbol on the vehicle or in the manual, be careful of the potential risk of personal injury. Disregarding the instructions identified by this symbol may compromise the safety of the user, the motorcycle and third parties.

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

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

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

1.2. GENERAL RULES

1.2.1. BASIC SAFETY RULES

CARBON MONOXIDE
When an operation must be performed with the engine running, position the motorcycle outdoors in a well-ventilated area.
Never run the engine in an enclosed place.
Use an exhaust emission extraction system when working indoors.

DANGER
Exhaust gases contain carbon monoxide, a poisonous gas which, if inhaled, may cause loss of consciousness or even death.

FUEL

DANGER
The fuel used to operate engines is highly flammable and becomes explosive under particular conditions.
Refueling and maintenance operations should be carried out in a well-ventilated area, with the engine off.
Do not smoke when refueling or in the proximity of sources of fuel vapors. Avoid contact with bare flames, sources of sparks and any other source which may ignite fuel or lead to explosion.

DO NOT DISPOSE OF FUEL IN THE ENVIRONMENT.

KEEP AWAY FROM CHILDREN.

HOT COMPONENT PARTS
The engine and exhaust component parts become hot when the engine is running and will stay hot for some time after the engine has been stopped.
Wear insulating gloves before handling these components or allow for the engine and the exhaust system to cool down before proceeding.

USED GEARBOX AND FORK FLUIDS

DANGER
Wear latex gloves when servicing.
Prolonged or repeated contact with gear fluid may cause severe skin damage.
Wash your hands thoroughly after handling.
Dispose of it through the nearest waste oil reclamation firm or through the supplier.
Wear latex gloves when servicing.

DO NOT DISPOSE OF FLUID IN THE ENVIRONMENT.

KEEP AWAY FROM CHILDREN.

BRAKE FLUID

WARNING
Brake fluid can damage plastic, rubber or painted parts. When servicing the brake system, protect all such parts with a clean cloth.
Always wear safety glasses when servicing the brake system.
Brake fluid is highly irritant. Avoid contact with the eyes.
In case of contact with the eyes, rinse abundantly with cool, clean water and immediately seek medical attention.

KEEP AWAY FROM CHILDREN.

HYDROGEN GAS AND BATTERY ELECTROLYTE

DANGER

The battery electrolyte is a toxic, caustic substance containing sulfuric acid and thus able to cause severe burns in case of contact.
Wear close-fitting gloves and protective clothing when handling this fluid.
If any battery fluid gets on your skin, rinse the affected area with abundant fresh water.
Take special care to protect the eyes; even a very small amount of battery fluid can cause blindness. If battery fluid comes in contact with the eyes, flush with abundant water for fifteen minutes and contact an eye specialist immediately.
If battery fluid is swallowed accidentally, drink abundant water or milk. Seek medical attention immediately and keep drinking milk of magnesia or vegetable oil in the meantime.
The battery gives off explosive gases. Keep the battery well away from any sources of ignition, such as flames, sparks, or any heat sources; do not smoke near the battery.
Make sure the area is well ventilated when servicing or refilling the battery.

KEEP AWAY FROM CHILDREN.

Battery fluid is corrosive.
Avoid spillage. Take special care not to spill battery fluid on plastic parts.
Make sure that the electrolyte fluid you are using is the suitable type for your battery.

GENERAL PRECAUTIONS AND INFORMATION

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

DANGER
Using bare flames is strictly forbidden when working on the motorcycle. Before servicing or inspecting the motorcycle: stop the engine and remove the key from the ignition switch; allow for the engine and exhaust system to cool down; where possible, lift the motorcycle using adequate equipment placed on firm and level ground. Be careful of any parts of the engine or exhaust system which may still be hot to the touch to avoid scalds or burns.
Never put mechanical parts or other vehicle components in your mouth when you have both hands busy. None of the motorcycle components are edible. Some components are harmful to the human body or toxic.
Unless expressly indicated otherwise, for the reassembly of the units repeat the disassembly operations in reverse order. Where a procedure is cross-referred to relevant sections in the manual, proceed sensibly to avoid disturbing any parts unless strictly necessary. Do not use polishing pastes on matt paints.
Never use fuel instead of solvent to clean the motorcycle.
Do not clean rubber or plastic parts or the seat with alcohol, gasoline or solvents. Use only water and mild soap.
Always disconnect the battery negative (-) lead before soldering any electrical components.
When two or more persons service the same motorcycle together, special care must be taken to avoid personal injury.
For further warnings, see DANGEROUS ELEMENTS.

BEFORE REMOVING ANY COMPONENTS

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

DISASSEMBLING THE COMPONENTS

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

REASSEMBLING THE COMPONENTS

DANGER
Never reuse a circlip or snap ring. These parts must always be replaced once they have been removed.
When fitting a new circlip or snap ring, open the ends just enough to allow fitting to the shaft.
Make a rule to check that a newly fitted circlip or snap ring is fully housed in its groove.
Never use compressed air to clean bearings.

NOTE *All bearings must run freely with no hardness or noise. Replace any bearings that do not meet these requirements.*

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

ELECTRICAL CONNECTORS

Disconnect electrical connectors as follows: failure to follow these instructions can seriously damage the connectors and the wiring.
Press the special safety hooks, where fitted.

WARNING
Never separate two connectors by pulling on the wiring.

- • Grasp both connectors and pull them in two opposite directions until they become separated.
- • Remove dirt, rust, moisture, etc., from inside the connectors with compressed air.
- • Make sure that the wires are securely crimped to the terminals inside each connector.

NOTE *A connector will fit properly only in the matching connector and when inserted in the correct fitting position.*

- • Reconnect the two connectors. Make sure they are correctly coupled (if fitted with hooks, it should click audibly into place).

TIGHTENING TORQUES

DANGER
Always remember that the tightening torques of all wheel, brake, wheel shaft and other suspension parts are essential to ensuring safe operation of the motorcycle and must be set to the indicated values. Make sure that these values are always within the specified limits.
Regularly check the tightening torques on all fastenings, and always use a torque wrench when fitting them.
Failure to observe these instructions can result in parts loosening or coming away, thus jamming a wheel or creating other problems which would affect the handling of the motorcycle, potentially resulting in serious injury or death.

1.3. DANGEROUS ELEMENTS

1.3.1. WARNINGS

FUEL

DANGER
The fuel used to operate engines is highly flammable and becomes explosive under particular conditions.
Refueling and maintenance operations should be carried out in a well-ventilated area, with the engine off.
Do not smoke when refueling or in the proximity of sources of fuel vapors. 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, as 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 with heat and when left under direct sunlight.
Never fill the fuel tank up to the rim. Tighten the filler cap securely after each refueling.
Avoid contact with the skin and the inhalation of vapors; do not swallow fuel or pour it from a receptacle into another by means of a tube.
DO NOT DISPOSE OF FUEL IN THE ENVIRONMENT.
KEEP AWAY FROM CHILDREN.

Use only premium grade unleaded gasoline with a minimum octane rating of 95 RON and 85 MON.

LUBRICANTS

DANGER
Correct lubrication is essential to the safety of the motorcycle.
Failure to maintain the lubricant level or the use of incorrect, old or dirty lubricant can cause the engine or transmission to seize, resulting in accident, serious injury or death.
Prolonged or repeated contact with gear fluid may cause severe skin damage.
Wash your hands thoroughly after handling.
Do not dispose of oil in the environment.
For disposal, contact the nearest waste oil reclamation firm or the supplier.

WARNING
Avoid spillage when filling the vehicle with oil. Immediately clean up any spilt oil, which can damage painted parts.
Oil on the tires can make them very slippery and dangerous to use.
In case of oil leaks, do not use the motorcycle. Identify the cause of the leak and repair it.

ENGINE OIL

DANGER
Prolonged or repeated contact with engine oil may cause severe skin damage.
Wash your hands thoroughly after handling.
Do not dispose of oil in the environment.
For disposal, contact the nearest waste oil reclamation firm or the supplier.
Wear latex gloves when servicing.

FRONT FORK FLUID

DANGER
Front suspension response can be modified to a certain extent by changing damping settings and/or selecting a particular grade of oil. Standard oil: SAE 20 W. Choose suitable viscosity grades according to the desired setup (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 brake system is operated by an independent hydraulic circuit. The information provided below applies to both brake systems.*

DANGER
Do not drive the vehicle if the brakes are worn or not operating correctly. The brakes are the vehicle's most important safety component and using the vehicle with the brakes in less than perfect operating condition comprises a high probability of traffic accident, which can result in serious injury or death.
The brakes are significantly less effective on a wet road surface.

DANGER
If the road surface is wet, maintain a double braking distance, as both the brakes and the grip of the tires are significantly less effective in such conditions.
Water on brakes, whether due to a recent wash or picked up from a wet road surface, puddles or drains, can result in significantly reduced brake efficiency.
Failure to observe these instructions can result in serious accidents, with the risk of serious personal injury or death.
The brakes are essential to your safety. Do not drive the vehicle if the brakes on not in perfect operating condition.
Always check the brakes before riding the motorcycle.
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 the eyes, contact an eye specialist or seek medical attention.
DO NOT DISPOSE OF BRAKE FLUID IN THE ENVIRONMENT.
KEEP AWAY FROM CHILDREN.
Avoid spillage. Brake fluid can damage plastic or painted parts.

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

DISC BRAKES

DANGER
The brakes are the vehicle's most important safety component
To ensure your personal safety, they must be in perfect working order and should be checked before every ride.
Dirty pads must be replaced.
Dirty or oily discs must be cleaned with a high-quality degreasing product.
If the vehicle is often used on wet road surfaces or on dusty or rough tracks, or in case of use in competition, reduce the service intervals by half.
Check brake pads for wear.
When the brake pads are worn, the fluid level lowers to compensate for the wear.
The front brake fluid reservoir is on the RH side of the handlebar, next to the front brake lever.
The rear brake fluid reservoir is located under the RH side fairing.
Do not use the vehicle if the brake system leaks fluid.

TIRES

WARNING
An over inflated tire results in a hard, uncomfortable and less secure ride.
Over inflation also affects grip, especially on curves and wet surfaces.
An under inflated tire (insufficient pressure) can slip on the wheel rim, resulting in loss of control.
Under inflation also affects grip and handling, as well as braking efficiency.
Tire replacement and repair, and wheel servicing and balancing are delicate operations. They should be carried out using adequate tools and are best left to experienced mechanics
New tires may be covered with a thin layer of protective coating which is slippery. Drive carefully for the first few kilometers (miles).
Never use any kind of rubber treatment product on the tires.
In particular, do not allow the tire to come in contact with liquid fuel, which rapidly deteriorates the tire rubber.
In case of contact with oil or fuel, do not clean but replace the tire.

DANGER
Some of the factory-assembled tires on this vehicle are equipped with wear indicators.
There are various types of wear indicators.
For more information on how to check wear, contact your Dealer.
Check the wear visually and have the tires replaced when they are worn.
If a tire deflates during a ride, do not attempt to continue the trip.
Avoid sudden braking or steering maneuvers, and do not decelerate rapidly.
Slowly decelerate and move to the edge of the road braking with the engine until you come to a standstill.
Failure to observe these instructions can result in serious accidents, with the risk of serious personal injury or death.
Never use tube tires on tubeless tire rims, or vice versa.

1.4. RUNNING-IN

1.4.1. RUNNING-IN

Proper engine running in is essential to preserving engine life and performance over time.
Twisty roads and gradients are ideal to break in engine, suspension and brakes effectively.
Varying speed frequently is also recommended.
This will vary the amount of stress placed on vehicle components continuously, allowing engine parts to cool down when less stressed.
While it is important to put a certain amount of stress to engine components during the running-in period, it is equally important to spare the engine at this stage in the vehicle's life.

WARNING
Top acceleration performance is only obtained after covering the first 2000 km (1243 mi).

Follow these recommendations:

- Do not open the throttle completely when the engine is running at low speed, both during and after the running-in period.
- Until you have covered the first 100 km (62 mi), use the brakes gently and avoid harsh, prolonged braking. This will help the brake pads bed in properly against the brake disc.
- During the first 1000 km (621 mi), never exceed 5000 rpm (see table).

WARNING
After covering the first 1000 km (621 mi), perform the checks listed in the "After running-in" column, see REGULAR SERVICE INTERVALS CHART to avoid personal injury to yourself or third persons, or vehicle damage.

- After the first 1000 km (621 mi) and until covering 2000 km (1243 mi), drive more briskly, varying speed and using maximum acceleration for just a few seconds, in order to ensure better component coupling; never exceed 6000 rpm (see table).
- After the first 2000 km (1243 mi) you may run the engine harder, however, without exceeding the maximum rpm allowed (7600 rpm).

Recommended maximum rpm	
Mileage km (mi)	**rpm**
0-1000 (621)	5000
1000-2000 (621-1243)	6000
Over 2000 (1243)	7600

1.5. POSITION OF THE SERIAL NUMBERS

1.5.1. POSITION OF THE SERIAL NUMBERS

These numbers are necessary for vehicle registration.

NOTE *Altering the vehicle's identification numbers is punishable by law with heavy fines and penalties. Altering the frame number voids the warranty.*

ENGINE NUMBER

The engine number is stamped on the left-hand side, next to the engine oil level plug.

TECHNICAL INFORMATION 2

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2.1. TECHNICAL INFORMATION

2.1.1. TECHNICAL DATA

ENGINE	
Type	twin-cylinder, 90° V transversal, 4-stroke engine
Number of cylinders	two
Cylinder arrangement	V, 90°
Total displacement	1064 cm^3 (65 in^3)
Bore/Stroke	92 x 80 mm (3.6 x 3.1 in).
Compression ratio	9.6 : 1
Starting	electric
Engine idling speed	1100 ± 100 rpm
Clutch	single plate, dry clutch with cush drive damper
Lubricating system	System under pressure, adjustment by valves and vane pump
Air filter	cartridge, dry
Cooling system	air cooled
CAPACITIES	
Engine oil	Engine oil and oil filter change 3600 cm^3 (219 in^3)
Gearbox fluid	500 cm^3 (30.5 in^3)
Transmission fluid	380 cm^3 (23.2 in^3)
TIMING SYSTEM	
Timing diagram:	2 valves, with rods and rocker arms
Values with inspection clearance between rocker arms and valve	intake 0.10 mm (0.0039 in.) exhaust 0.15 mm (0.0059 in.)
TRANSMISSION SYSTEM	
primary drive	gear, ratio: 26/35 = 1:1.3461
gearbox	Mechanic, with 6 speeds, controlled by a pedal on engine left side
overall gear ratios:	
1st gear	17/38 = 1:2.2353
2nd gear	20/34 = 1:1.7
3rd gear	23/31 = 1:1.3478
4th gear	26/29 = 1:1.1154
5th gear	31/30 = 1:0.9677
final drive	with cardan joint
ratio	12/44 = 1:3.6667
FUEL SYSTEM	
Type	Electronic injection (Weber – Marelli) with stepper motor
Choke	Ø 36 mm (1.417 in.)
Fuel	Premium grade unleaded fuel, minimum octane rating 95 (RON) and 85 (MON).
SPARK PLUGS	
Internal (long life)	NGK PMR8B
External	NGK BPR6ES
Electrode gap	0.6 – 0.7 mm (0.024 – 0.028 in.)

2.1.2. LUBRICANT TABLE

LUBRICANT	PRODUCT
Engine oil	RECOMMENDED: Agip RACING 4T 5 W 40 As an alternative to recommended oils, top brand oils meeting or exceeding CCMC G-4 A.P.I. SG specifications can be used.
Transmission fluid	RECOMMENDED: Agip TRUCK GEAR 80 W 90
Gearbox fluid	RECOMMENDED: Agip ROTRA MP/S 85 W 90
Bearings and other lubrication points	RECOMMENDED: IP BIMOL GREASE 481, IP AUTOGREASE MP or Agip GREASE SM2. As an alternative to recommended grease, use top brand rolling bearing grease that will resist a temperature range of -30°C to +140°C (-22°F to +284°F), with dripping point 150°C to 230°C (302°F to 446°F), high corrosion protection, good resistance to water and oxidization.

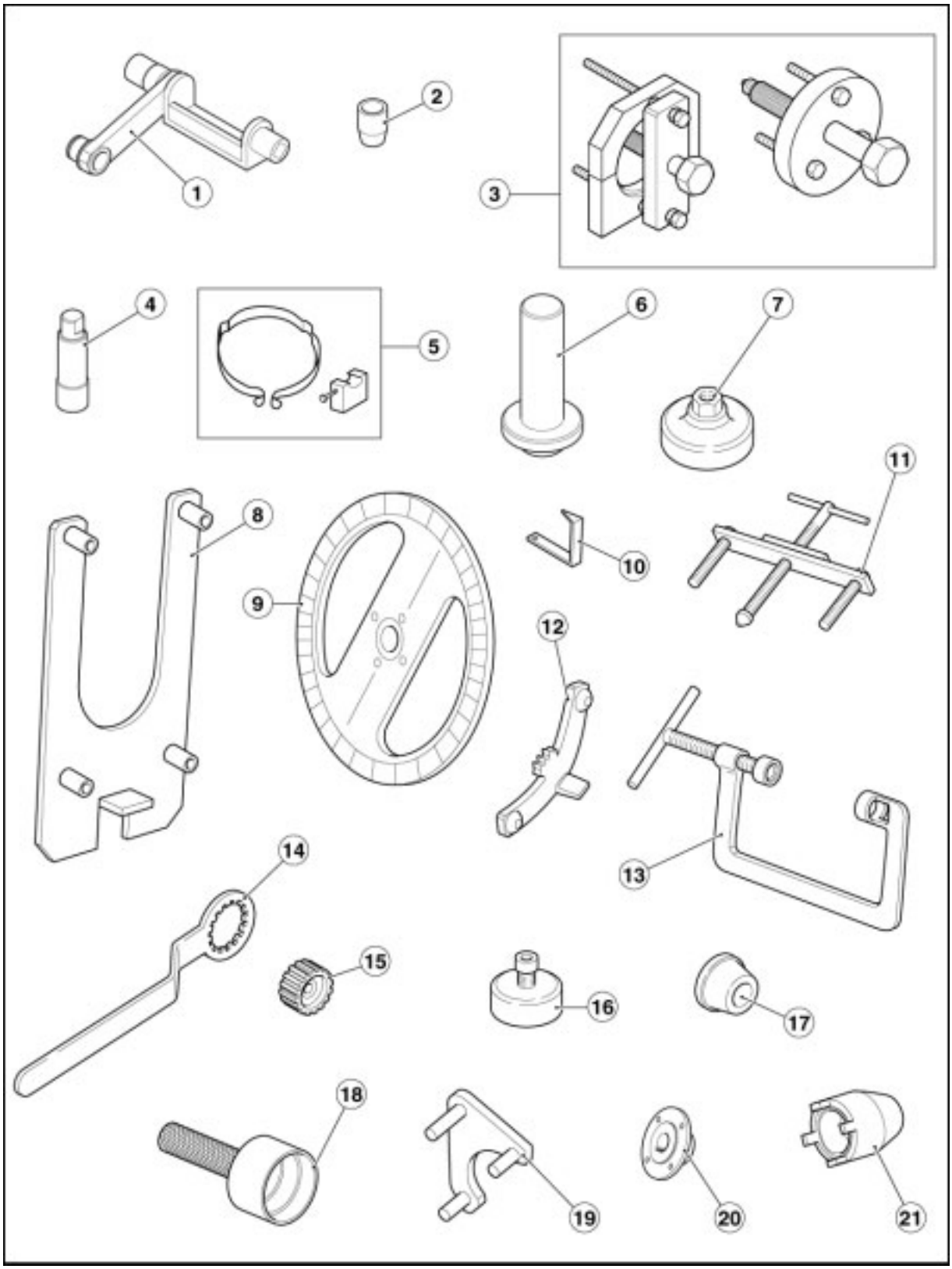
2.1.3. TIGHTENING TORQUES

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (Nm)	Note
HEAD UNIT				
head taper cap	6		4	
stud bolt M8x42	4	M8	35	
adjuster	4		/ / /	
Nut	4		8-11	
Hex.head screw DA M6x16	4	M6	6-8	
stainl.st. TBEI screw M6x25	16	M6	10	
stainl.st.flanged TBEI screw M5x16	4	M5	6-7	
oil/head temperature sensor M12x1.5	1	M12	10-12	
head temperature sensor casing M10x1.5	1	M10	10-12	
TIMING UNIT				
Hex.head screw DA M6x20	3	M6	8-12	
nut M18x1.5	1	M18	150	
belt tension			50	
LOCKS				
stud bolt M10x35	2	M10	40	
Linkage	1		42	
nut EA ZB M10x1.5	2	M10	40-42	
head bolt	1		40-42	
stud bolt M8x75	2	M8	35	
stud bolt M8x66	1	M8	35	
Hex.head screw DA M8x25	2	M8	25	
Flathead Allen screw M4x8 UNI 5933	1	M4	5	
TCEI screw M4x10	2	M4	5	
Hex.head screw DA M8x25	1	M8	25	
TCEI screw DA M6x30	2	M6	8-12	
TCEI screw DA M8x55 cl. 8.8 UNI 5931 dacromet	1	M8	23	
TCEI screw M6x16	2	M6	8-12	
TCEI screw DA M6x30	1	M6	8-12	
TCEI screw DA M6x40	2	M6	8-12	
TCEI screw DA M6x60	1	M6	8-12	
fitting M24x1.5	2	M24	40	
TCEI screw DA M6x55	1	M6	8-12	
TCEI screw DA M6x20	2	M6	8-12	
copper line nipples M18x1.5	1	M18	20	
plug with rod	2		/ / /	
magnetic plug M10x1.5	1	M10	20	

DESCRIPTION	QUANTITY	SCREW / NUT	TIGHTENING TORQUE (Nm)	Note
LUBRICATION UNIT				
TCEI screw DA M8x30	4	M8	25	
drilled screw M8x1.25	1	M8	15-18	
plug M18x1.5	1	M18	40	
plug M32x1.5	1	M32	40	
CRANKSHAFT UNIT				
connecting rod screw	2		60-62	
nut EBFM ZB MF25x1.5	1	M25	120	
FRAME UNIT ON ENGINE				
TCEI screw DA M6x40	2	M6	8-12	
reduction	4		20	
IGNITION UNIT				
TCEI screw DA M8x45	1	M8	22	
TCEI screw DA M10x60	1	M10	see nut	
nut M10x1.5 flanged	1	M10	30	
TBEI screw DA M8x50	1	M8	/ / /	
nut EBFM DA MF16x1.5	1	M16	80	
spark plug NGK BPR 6ES	2		20-30	
spark plug PMR8b	2		13-15	
TCEI screw M6x16	4	M6	8-12	
FUEL FEED CONTROL UNIT				
TCEI screw M5x12	2	M5	6-7	
stainl.st.flanged TBEI screw M5x16	2	M5	6-7	
TCEI screw DA M6x25	6	M6	8-12	
GEAR SHIFT UNIT				
Screws securing clutch housing to gearbox	14	M6	13	
Screws securing bearing to clutch housing	3	M6	10	
Clutch housing stop screws	1	M8	24	
Ring nut on clutch shaft	1	M22x1	100	
Neutral sensor on gearbox	1	M8x1	10	
Magnetic plug	1	M10	24	
Oil filler cap	1	M18x1.5	28	
Union for breather hose	1	M10	8	

2.1.4. SPECIAL TOOLS

Suitable special tools are necessary for correctly removing, refitting and adjusting.
Unsuitable tools and/or improvised procedures could cause damage that might be avoided if the special tools are used.
Following are the special tools designed specifically for this vehicle.
If necessary, request the general special tools.



Pos.	Description	Part no.
1	Belt tensioning tool	05.94.86.30
2	Front cover installation cone	05.91.17.30
3	Gearbox opening tool	05.91.25.30
4	Tool for removing internal spark plug	05.90.19.30
5	Piston ring compression tool	05.92.80.30
6	Timing cover seal drift	05.92.72.30
7	Wrench for removing cover on sump and filter	01.92.91.00
8	Support for gearbox	14.92.96.00
9	Degree wheel for checking timing	19.92.96.00
10	Index for checking timing	17.94.75.60
11	Tool for removing flange on flywheel side	12.91.36.00
12	Tool for locking flywheel and starter gear	12.91.18.01
13	Tool for removing and installing valves	10.90.72.00
14	Tool for locking clutch body	30.91.28.10
15	Clutch installing tool	30.90.65.10
16	Tool for installing seal on flywheel-side flange	14.92.71.00
17	Tool for assembling flywheel-side flange with seal onto crankshaft	12.91.20.00
18	Tool for installing seal on flywheel-side flange	19.92.71.00
19	Tool for retaining camshaft gear	14.92.73.00
20	Hub for degree wheel	65.92.84.00
21	Tool for removing clutch hub	05.91.26.30

ENGINE 3

TABLE OF CONTENTS

3.1. REMOVING THE ACCESSORIES

3.1.1. REMOVING THE STARTER MOTOR

- Loosen and remove the two screws and set aside the washers.

- Slide out the starter motor.

3.1.2. REMOVING THE BLOW-BY SYSTEM

- Loosen the oil recovery line fitting and remove the oil recovery line from the crankcase.

- Remove the tie.

- Loosen the two clamps securing the oil breather line.

- Remove the two oil breather lines.

- Loosen and remove the oil recovery line positioning screw.
- Release the oil recovery line.

- Remove the complete blow-by system.

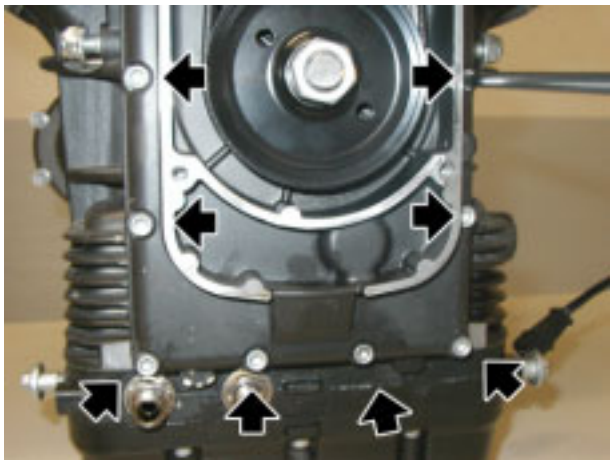
3.2. GENERATOR

3.2.1. REMOVING THE GENERATOR

- Loosen and remove the six screws and set aside the bushings.

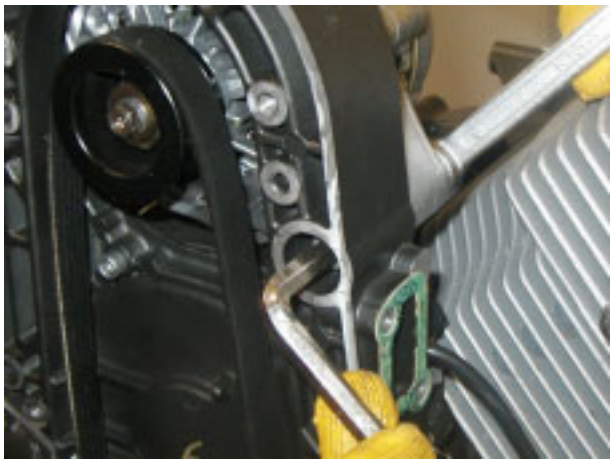
- Remove the cover.

- Loosen and remove the eight screws.



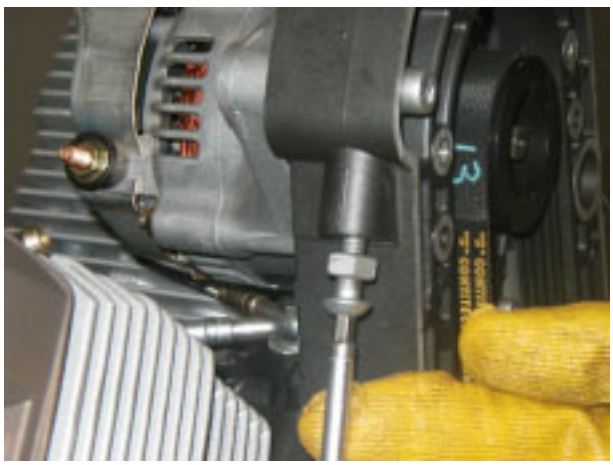
- Loosen and remove the two screws.

- Loosen the nut and set aside the screw.



- Loosen the screw.

- Loosen the nut and release the adjuster, so that the generator is free to slide down.

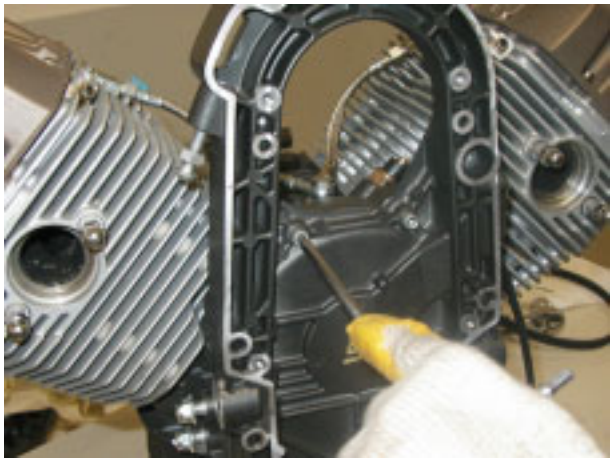


- Completely loosen and remove the screw.

- Remove the belt and the generator complete with pulley.

- Using an air gun, loosen and remove the nut and set aside the spacer.
- Slide out the lower pulley.

- Loosen and remove the two screws.



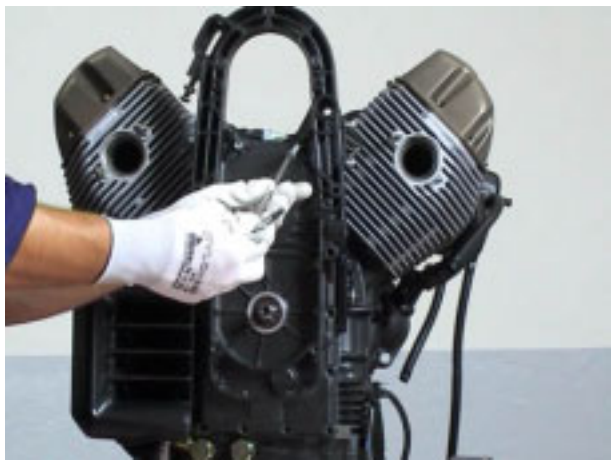
- Remove the generator subframe.
- Remove the seal, if necessary.

3.2.2. INSTALLATION

- If previously removed, change the seal using the timing cover seal drift (part no. 05.92.72.30).

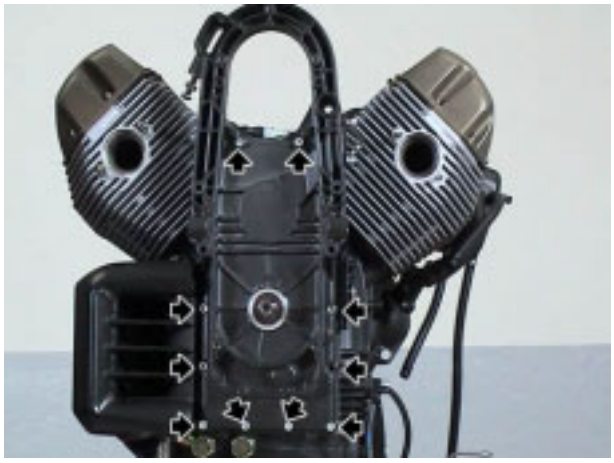
- Change the gasket and position the generator subframe, using the front cover insertion cone (part no. 05.91.17.30).
- Remove the front cover insertion cone (part no. 05.91.17.30).

- Tighten the two screws.



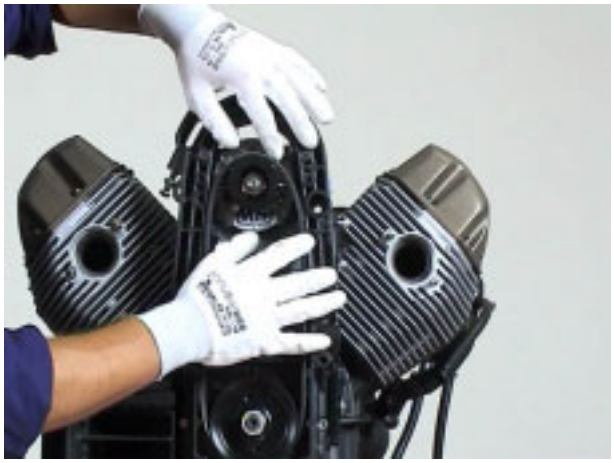
- Tighten the eight lower screws.

- Tighten the ten screws; proceed in steps and in a cross pattern.



- Position the lower pulley and the spacer.
- Tighten the nut to the specified torque.

- Position the generator and the timing belt.

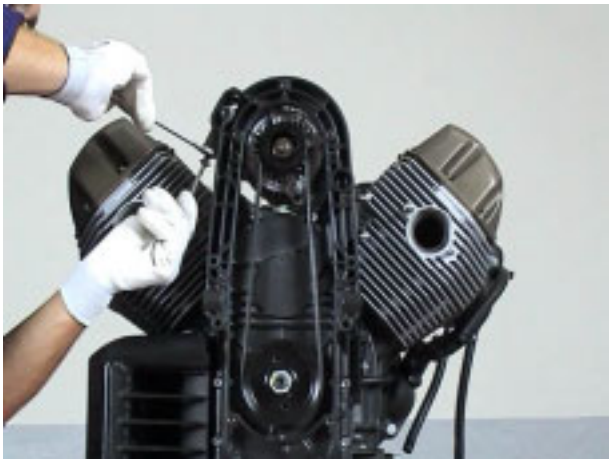


- Position the screw and tighten it.

- Position the screw and nut and tighten them.

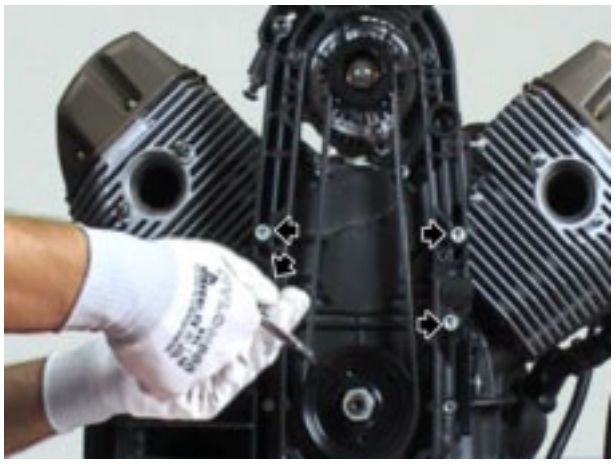
- Using the belt tensioning tool, tension the belt to the specified value and tighten the adjuster.
- Remove the belt tensioning tool.

- Tighten the lock nut.



- Tighten the generator retaining screws.

- Tighten the four screws; proceed in steps and in a cross pattern.



- Fit the timing cover.

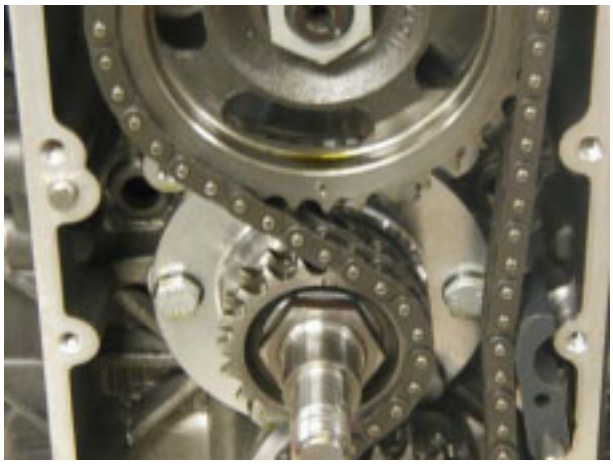
- Tighten the five screws; proceed in steps and in a cross pattern.

3.3. TIMING SYSTEM

3.3.1. REMOVAL AND INSTALLATION

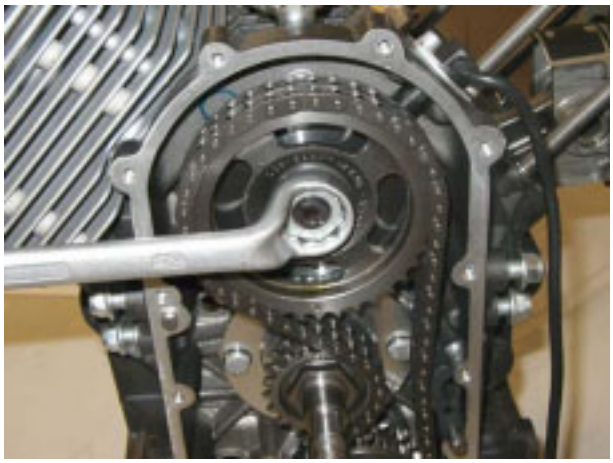
REMOVAL

- Remove the engine from the frame, see chassis manual, see REFERENCE MANUALS.
- Remove the generator following the instructions given in REMOVAL.
- Remove both heads, see REMOVING THE HEADS.
- Mark the timing references to be restored upon reassembly.

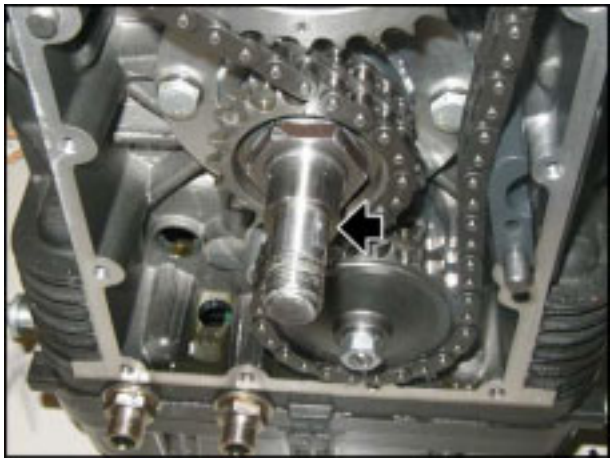


- Using the suitable tool (part no. 12.91.18.01) lock the starter gear.

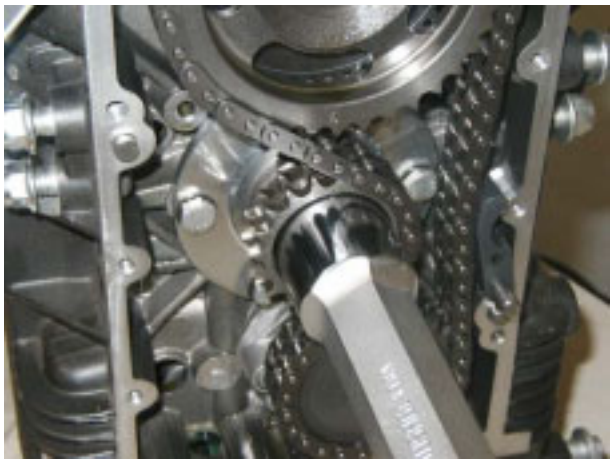
- Loosen the central nut securing the camshaft gear and set aside the washer.



- Remove the key.



- Loosen and remove the central nut securing the timing drive gear on the crankshaft and set aside the washer.

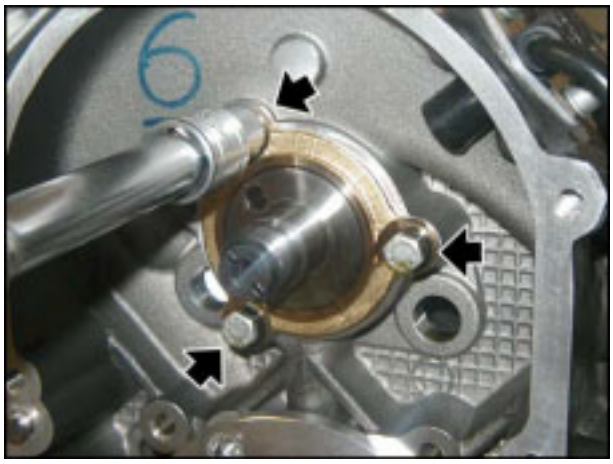


- Loosen and remove the nut and set aside the washer.

- Slide out the chain tensioner and set aside the spring.
- Remove the three gears with the chain.

- Slide out the pick-up ring and set aside the dowel.

- Loosen and remove the three screws and set aside the washers.



- Slide out the flange.

- Slide out the tappets from their seats on either side.

- Slide out the camshaft.

REASSEMBLY

NOTE *To refit the timing system, suitably heat the engine with a heater so as to correctly fit the camshaft while avoiding damage.*

- Follow the removal instructions in reverse order.

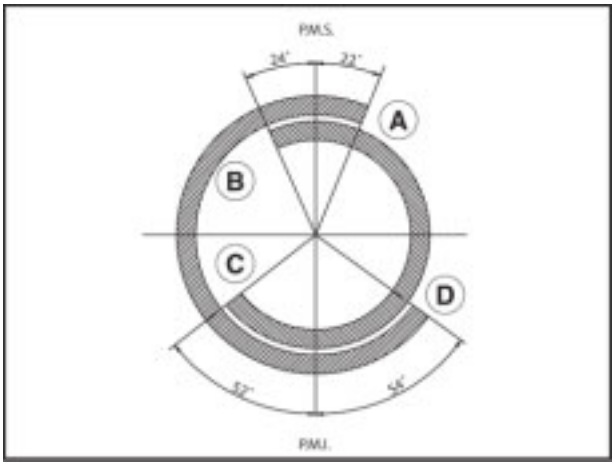
3.3.2. TECHNICAL DATA

Timing data:

INTAKE
A Opens at 22° before TDC
D Closes at 54° after BDC

EXHAUST
C Opens at 52° before BDC
B Closes at 24° before TDC

Intake valve clearance 0.10 mm (0.0039 in.)
Exhaust valve clearance 0.15 mm (0.0059 in.)



DIAMETER OF THE CAMSHAFT SUPPORTS AND RELEVANT SEATS ON CRANKCASE

	SHAFT SUPPORT Ø mm (in)	CRANKCASE SEATS Ø mm (in)	ASSEMBLY CLEARANCE mm (in)
Timing side	47.000-46.984 (1.85039 - 1.84976)	47.025-47.050 (1.85137 - 1.85236)	0.025-0.066 (0.00098 - 0.00260)
Flywheel side	32.000-31.984 (1.25984 - 1.25921)	32.025-32.050 (1.26082 - 1.26181)	

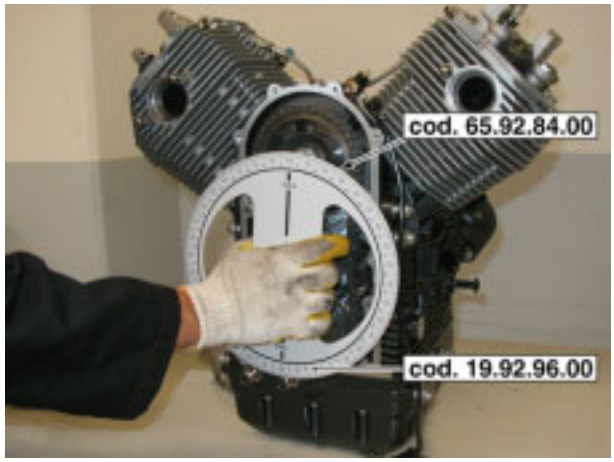
TAPPET-TO-SEAT ON CRANKCASE COUPLING

	SEATS Ø mm (in)	TAPPETS OUTER Ø mm (in)	ASSEMBLY CLEARANCE mm (in)
Production	22.021-22.000 (0.86697 - 0.86614)	21.996-21.978 (0.86598-0.86527)	0.004-0.043 (0.00016 - 0.00169)
Oversized on Ø 0.05 mm (0.00196 in.)	22.071-22.050 (0.86893 - 0.86811)	22.046-22.028 (0.86795 - 0.86724)	0.004-0.043 (0.00016 - 0.00169)
Oversized on Ø 0.10 mm (0.00394 in.)	22.121-22.100 (0.87090 - 0.87008)	22.096-22.078 (0.86992 - 0.86921)	0.004-0.043 (0.00016 - 0.00169)

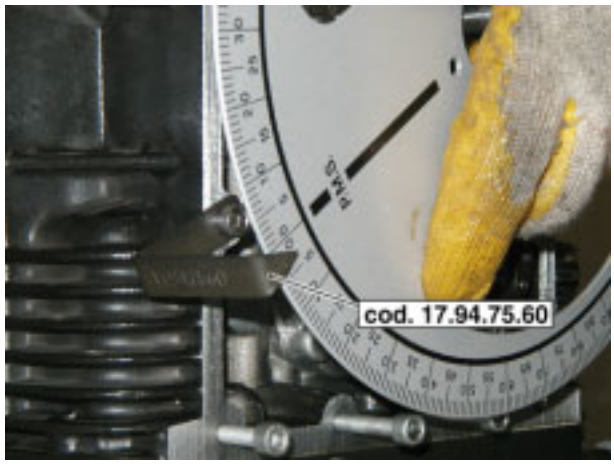
3.3.3. TIMING

To check the timing proceed as follows:

- Set clearance between the rocker arms and valves to 1.5 mm (0.059 in);
- Fit the degree wheel hub (part no. 65.92.84.00) with the degree wheel (part no. 19.92.96.00) in crankshaft groove; insert the spacer and secure it to the crankshaft using the nut.



- Secure the index (part no. 17.94.75.60) to the threaded hole to the left of the crankcase using a screw.

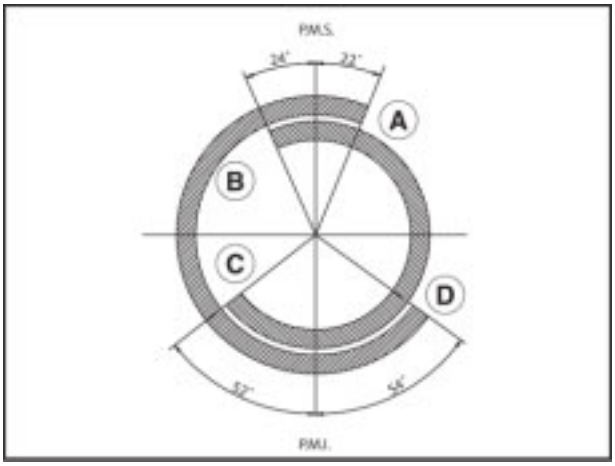


- Fit a dial gauge support in the left cylinder external spark plug hole, and fit a dial gauge on the support.

- Turn the crankshaft until the left cylinder piston is at top dead center (with valves closed).
- Reset the dial gauge and make sure that the reference marks (on timing gears and engine sprocket) are perfectly in line; look through the gearbox inspection glass to make sure the reference marked “S” perfectly matches the mark at the center of the hole.
- Point the index to “P.M.S.” (TDC) zero of the degree wheel.

- Check the timing, with reference to the timing diagram, considering that:

A – intake starts before TDC
B – exhaust ends after TDC
C – exhaust starts before BDC
D - intake ends after BDC



- Screw the dial gauge and its support into the right cylinder external spark plug hole.
- Secure the index (part no. 17.94.75.60) in the threaded hole to the right of the crankcase using a screw.
- Turn the degree wheel clockwise until reference “D” matches the reference at the center of the gearbox inspection hole (valves closed).
- Repeat the procedure described previously for the left cylinder.

- If the check shows that everything is fine, set operation clearance between the rocker arms and valves [intake 0.10 mm (0.0039 in), exhaust 0.15 mm (0.0059 in)].
- Remove the degree wheel hub (part no. 65.92.84.00), the degree wheel (part no. 19.92.96.00), the index (part no. 17.94.75.60) and the support with the dial gauge.
- Refit the spark plugs and all parts previously removed.

3.3.4. MEASURING THE SENSOR GAP

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

- Fit a flat washer on the sensor and measure its thickness.

- Position the sensor on the timing cover and place it against the pick-up ring.

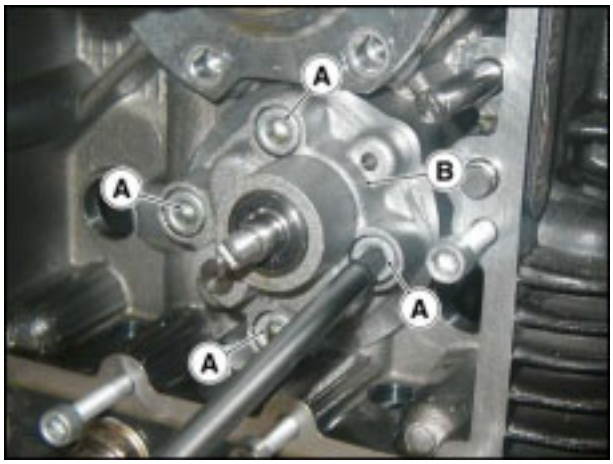
- Measure the clearance between the plate and cover using a feeler gauge. Subtract the flat washer thickness from this value to determine the gap between the sensor and the pick-up ring.

- Remove the washer, smear the plate with suitable sealant, fit the sensor and tighten the screws to the specified torque.

3.4. OIL PUMP

3.4.1. REMOVING THE OIL PUMP

- Drain all engine oil.
- Remove the generator, see REMOVING THE GENERATOR.
- Remove the timing system, see REMOVING THE TIMING SYSTEM.
- Loosen and remove the four oil pump securing screws (A).
- Remove the oil pump (B).



3.5. HEADS

3.5.1. REMOVING THE HEAD COVERS

NOTE *The following procedure applies to both head covers.*

- Loosen and remove the eight screws and set aside the bushings.

- Remove the head cover and set aside the gasket.

NOTE *Repeat the same procedure described above in reverse order to refit the head cover.*

Upon reassembly, replace the head cover gasket with a new one.

3.5.2. REMOVING THE HEADS

NOTE *The following procedure is valid for both cylinder heads.*

- Remove the head cover, see REMOVING THE HEAD COVERS.

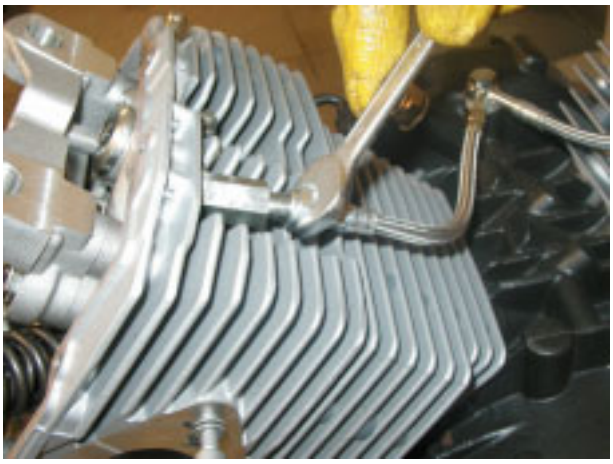
- Unscrew and remove the external spark plug.

- Turn the crankshaft to set the left cylinder to TDC in combustion stage (valves closed).
- Loosen and remove the two screws.

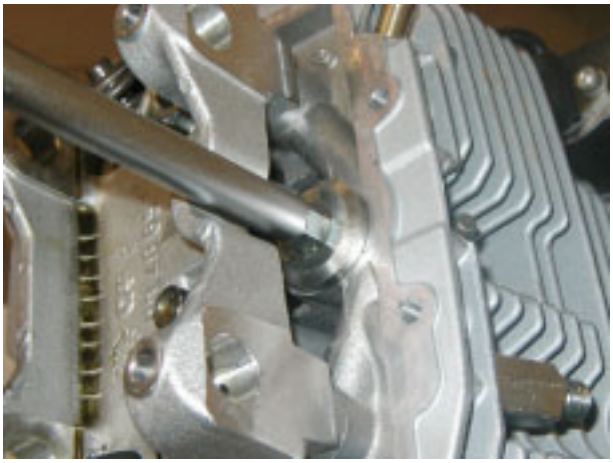
- Remove the rocker arm shafts.

- Remove the rocker arm and set aside the three washers.

- Loosen the nut and disconnect the line delivering oil to the head.



- Loosen and remove the threaded plug.



- Loosen and remove the socket nut and set aside the washer.

- Loosen and remove the four nuts and set aside the relevant washers.

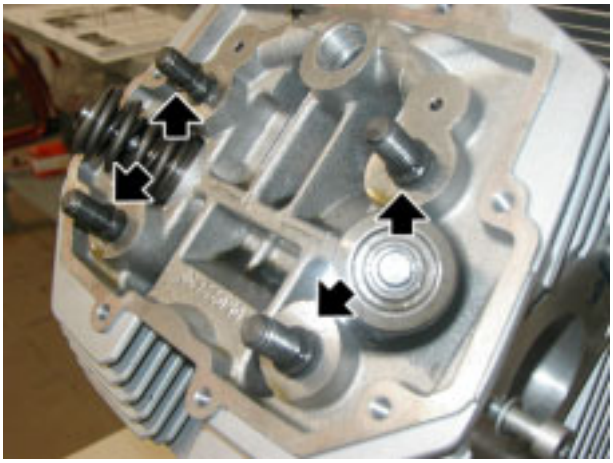
- Remove the rocker arm support.

- Slide out the two rocker arm rods

- Using the suitable special tool (part no. 05.90.19.30), loosen and remove the internal spark plug.

- Loosen and remove the two screws and set aside the two washers.

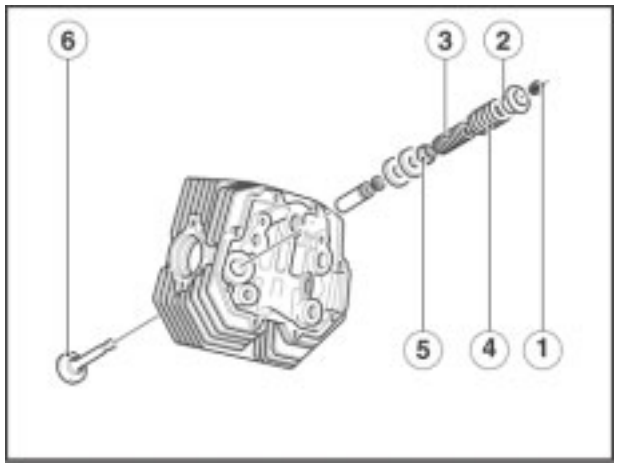
- Slightly detach the head from the cylinder and remove the four O-rings.



- Slide out the head and set aside the gasket.

- Fit the special tool (part no. 10.90.72.00) on top retainer and at the center of the valve to be removed.

- Tighten the tool screw until it starts pulling, then tap the tool head (working on top retainer) with a mallet so as to detach the two valve cotters (1) from top plate (2).
- Once the two valve cotters (1) are detached, screw in until they can be removed from their seats on the valves; loosen the tool and remove it.
- Slide out the top retainer (2).
- Remove the internal spring (3).
- Remove the external spring (4).
- Remove the bottom retainer (5) and the shims, if necessary.
- Remove valve (6) from inside the head.



3.5.3. CHECKING THE COMPONENTS

HEADS

Make sure that:

- Surfaces in contact with the cover and cylinder are not scratched or damaged to the point where they compromise sealing.
- Check that clearance between valve guide holes and valve stems is within the recommended limit.
- Check valve seat condition.

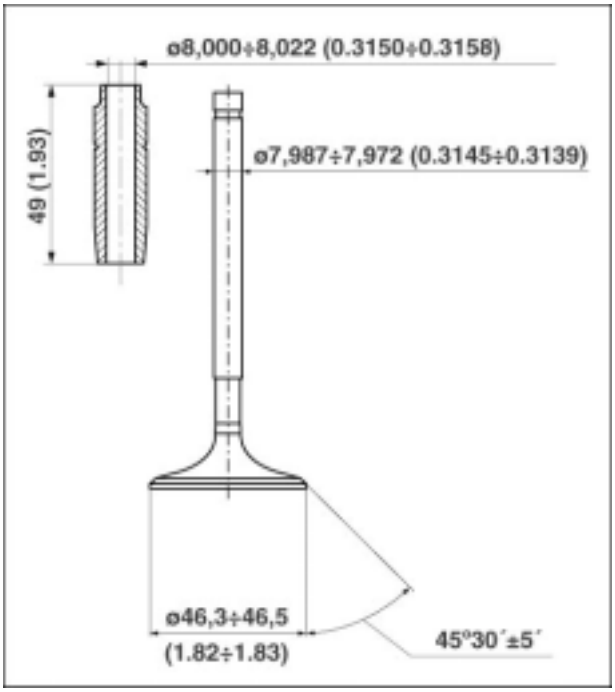
VALVE GUIDES

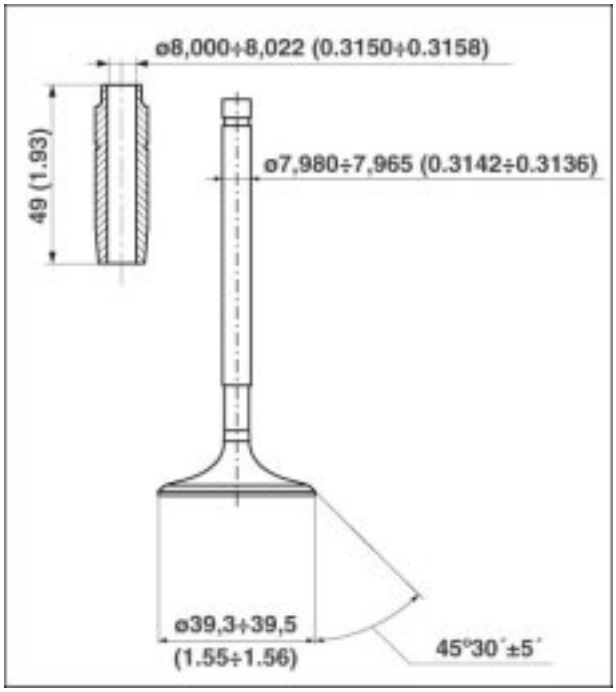
Use a drift to remove the valve guides from the heads.
The valve guides should be changed only if clearance between them and the valve stem cannot be eliminated by changing the valves only.
To fit the valve guides to the head proceed as follows:

- Heat up the head in an oven at about 60°C (140°F).
- Lubricate the valve guides.
- Fit the circlips.
- Press the valve guides using a drift.
- Using a bore reamer, grind the holes where the valve stem slides, taking the inner diameter to the specified value. Interference fit of the seat on the head and valve guide should be 0.046 - 0.075 mm (0.0018 - 0.0030 in)

VALVE-TO-GUIDE COUPLING

	INNER ø OF VALVE GUIDE mm (in)	VALVE STEM ø mm (in)	ASSEMBLY CLEARANCE mm (in)
Intake	8.000-8.022 (0.3150-0.3158)	7.972÷7.987 (0.3139÷0.3145)	0.013-0.050 (0.0005÷0.0020)
Exhaust	8.000-8.022 (0.3150-0.3158)	7.965 ÷ 7.980 (0.3136 ÷ 0.3142)	0.020 ÷ 0.057 (0.0008 ÷ 0.0022)

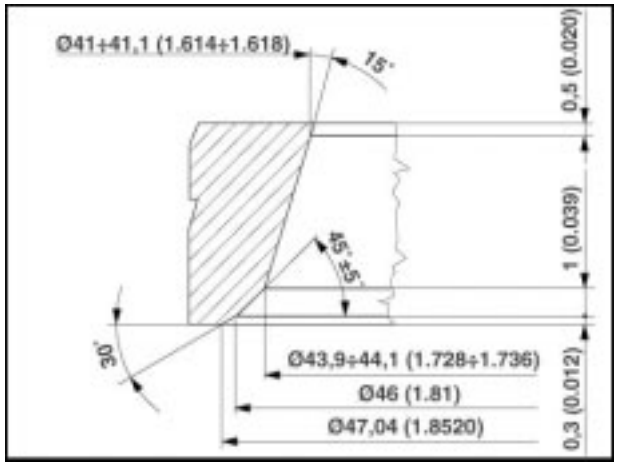




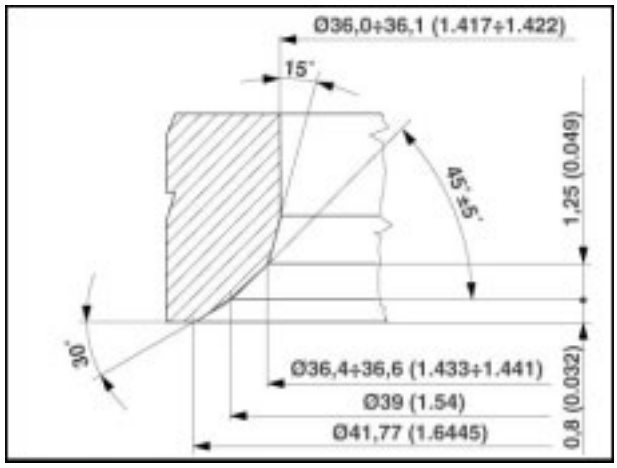
VALVE SEATS

Grind the valve seats with a cutter.
Seat slant angle is 45°± 5'.
After milling, grind to ensure correct coupling and perfect sealing between the valve head and the ring nut.

INTAKE VALVE SEAT DETAIL VIEW



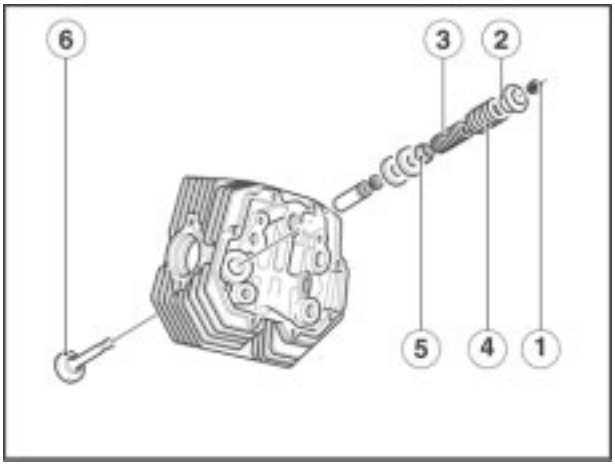
EXHAUST VALVE SEAT DETAIL VIEW



3.5.4. REASSEMBLING THE HEADS

NOTE *The following procedure applies to both cylinder heads.*

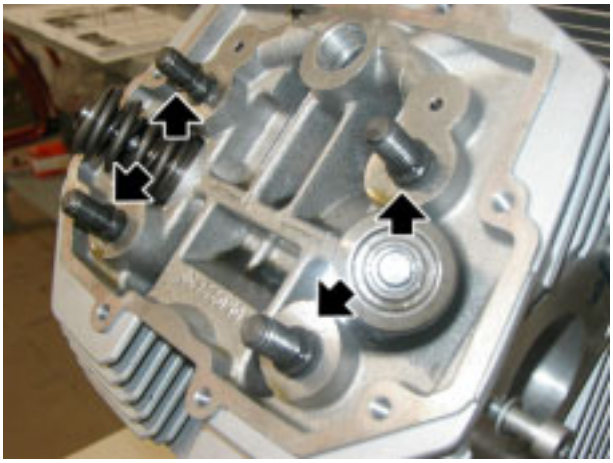
- Refit the valve (6) inside the head.
- Fit the bottom retainer (5) and the shims.
- Refit the external spring (4).
- Refit the internal spring (3).
- Fit the top retainer (2).
- Position the two valve cotters (1) in their seats on the valves.
- Compress the spring with the suitable tool (part no. 10907200), then install the valve cotters.



- Remove the special tool (part no. 10.90.72.00)

- Change the cylinder-head gasket.
- Install the head.

- Change the four O-rings.



- Fit the two washers and tighten the two screws.

- Using the suitable special tool (part no. 05.90.19.30), tighten the internal spark plug.

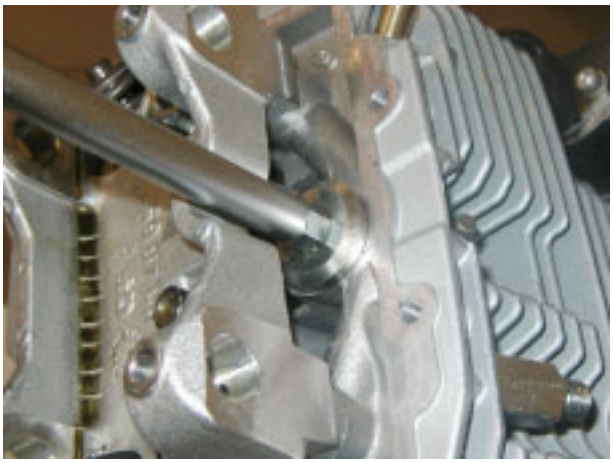
- Install the two rocker arm rods.

- Install the rocker arm support and change the four O-rings.

- Fit the four washers and tighten the four nuts.

- Install the washer and tighten the socket nut.

- Tighten the threaded plug.



- Connect the line delivering oil to the head and tighten the nut.

- Fit the six washers and install the rocker arms.

- Install the rocker arm shafts.

- Turn the crankshaft to set the left cylinder to TDC in combustion stage (valves closed).
- Tighten the two screws.

- Install the external spark plug.

- Change the gasket and install the head cover, see REMOVING THE HEAD COVERS.

3.6. CYLINDERS AND PISTONS

3.6.1. REMOVAL, CHECK AND INSTALLATION

NOTE *The following procedure applies to both cylinder heads.*

REMOVAL

- Remove the head, see REMOVING THE HEADS.
- Slide out the gasket.

- Remove the cylinder clear of the stud bolts; do not damage the piston.

- Cover the crankcase opening with a clean rag.
- Release the gudgeon pin circlip.

- Remove the gudgeon pin.

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

CHECK

Checking cylinder wear:

Cylinder diameter is to be measured at three heights, turning the dial gauge by 90°.
Make sure that the cylinders and pistons belong to the same class (A,B,C).

CLASS SELECTION FOR CYLINDER ø UP TO ENGINE NO. KR014485 mm (in)

CLASS A	CLASS B	CLASS C
92.000-92.006 (3.62204 - 3.62227)	92.006-92.012 (3.62227 - 3.62250)	92.012-92.018 (3.62250 - 3.62275)

CLASS SELECTION FOR CYLINDER ø UP TO ENGINE NO. KR014486 mm (in)

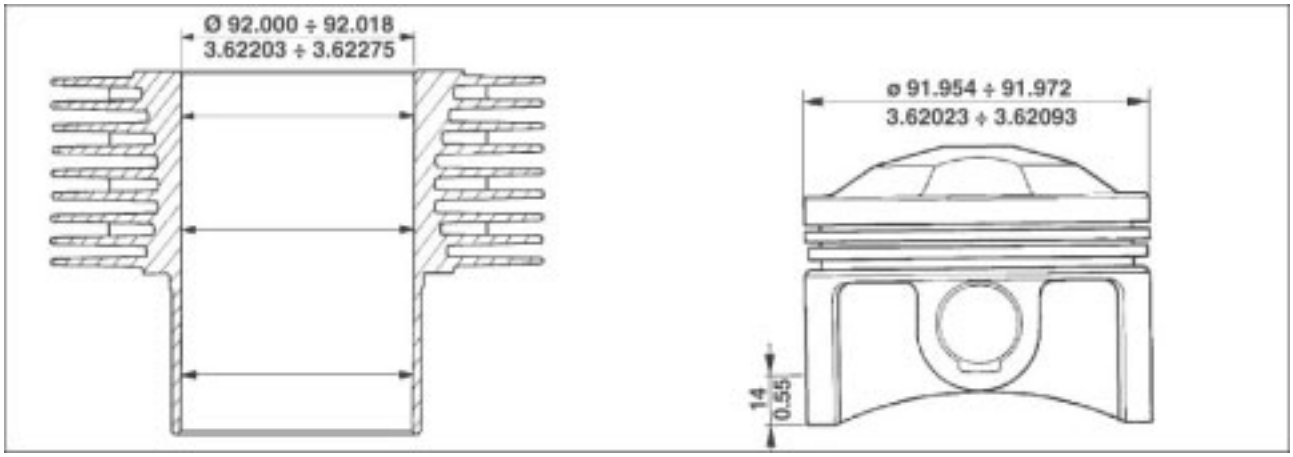
CLASS D	CLASS E	CLASS F
92.000-92.010 (3.62204 - 3.62243)	92.010-92.020 (3.62243 - 3.62282)	92.020-92.030 (3.62282 - 3.62322)

CLASS SELECTION FOR PISTON ø UP TO ENGINE NO. KR014485 mm (in)

CLASS A	CLASS B	CLASS C
91.954-91.960 (3.62022 - 3.62046)	91.960-91.966 (3.62046 - 3.62070)	91.966-91.972 (3.62070 - 3.62093)

CLASS SELECTION FOR PISTON ø UP TO ENGINE NO. KR014486 mm (in)

CLASS D	CLASS E	CLASS F
91.942-91.952 (3.61975 - 3.62014)	91.952-91.962 (3.62014 - 3.62054)	91.962-91.972 (3.62054 - 3.62093)



Checking the pistons

During overhaul, remove scaling from the piston crown and ring grooves; check clearance between the cylinder and piston on the diameter (refer to the relevant class); if it exceeds the reference value, replace the cylinders and pistons.

The pistons of an engine should be balanced; a difference in weight is allowed up to 1.5 grams (0.0033 lb).

Check the piston rings and oil scraper ring.

Every piston fits:

- 1 top ring;
- 1 intermediate ring;
- 1 oil scraper ring.

Piston ring end gaps must be offset.

Assembly clearance measured between ring thickness and grooves on the piston:

- Sealing rings and oil scraper ring 0.030 - 0.065 mm (0.00118 - 0.00256 in)

Gap between the piston ring edges when fitted to the cylinder:

- Top ring and intermediate ring 0.40 - 0.65 mm (0.00158 - 0.00255 in)
- Oil scraper ring 0.30 - 0.60 mm (0.00118 - 0.00236 in)

INSTALLATION

NOTE *The following procedure applies to both cylinder heads.*

- Fit the piston

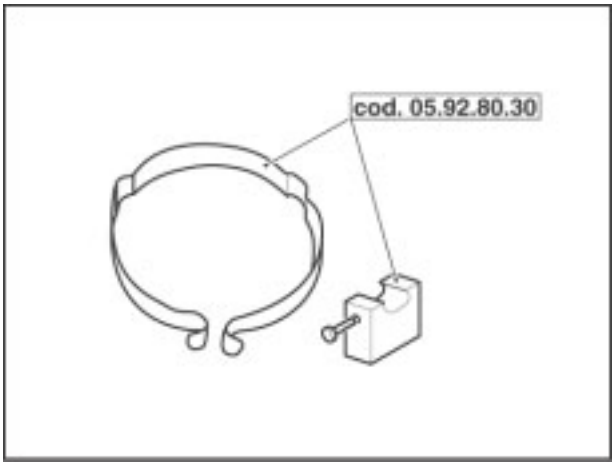
NOTE *Check the correct piston position referring to the reference marks on the piston crown. Never match pistons to cylinders of different classes.*

- Fit the gudgeon pin.

- Fit the gudgeon pin circlip.

- Remove the rag used to avoid that foreign matter enters the crankcase.
- Turn the piston rings so that the end gaps are at 120 degrees one from the other.
- Lubricate the piston and cylinder.
- Using the suitable piston ring compression tool (part no. 05.92.80.30), fit the cylinder.

WARNING
During this operation, make sure not to damage the piston.



- Remove the piston ring tool (part no. 05.92.80.30) and position the cylinder.

- Fit the gasket at the cylinder base.

- Install the head, see REFITTING THE HEADS.

3.7. FLYWHEEL

3.7.1. REMOVAL, CHECK AND REASSEMBLY

REMOVAL

- Remove the clutch, see REMOVING THE CLUTCH.
- Fit the locking tool (part no. 12.91.18.01) to the flywheel and loosen the six flywheel screws; work in a cross pattern and in steps.

- Remove the flywheel.

CHECK

- Make sure that the flywheel mating surface is not scratched.
- Check that surface mating with crankshaft is not deformed; if it is, replace the flywheel.

REASSEMBLY

- Perform the removal procedure in reversed order.

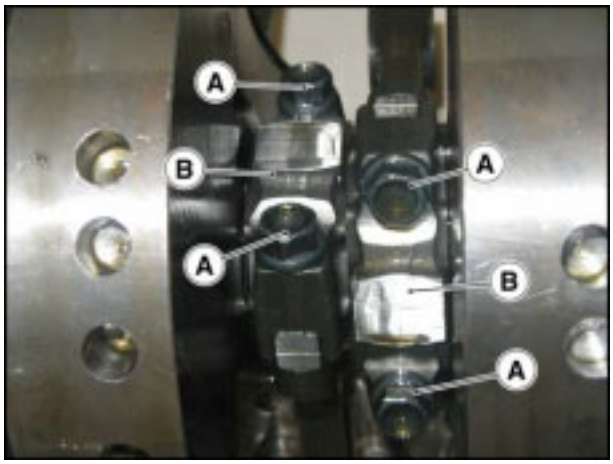
NOTE *Respect flywheel position reference marks.*

WARNING
Replace the screws upon reassembly as they are subject to considerable stress and load.

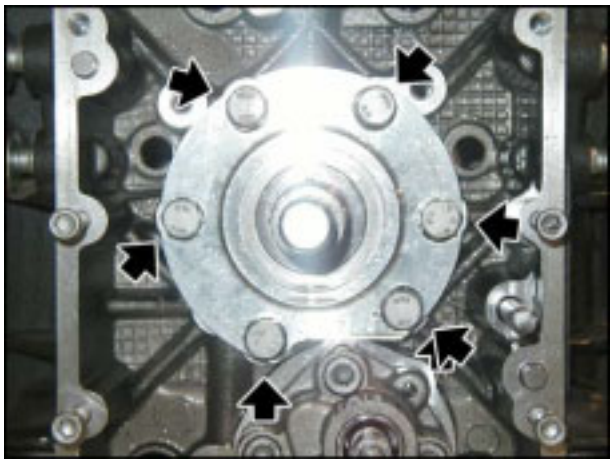
3.8. CRANKSHAFT AND CONNECTING RODS

3.8.1. REMOVAL

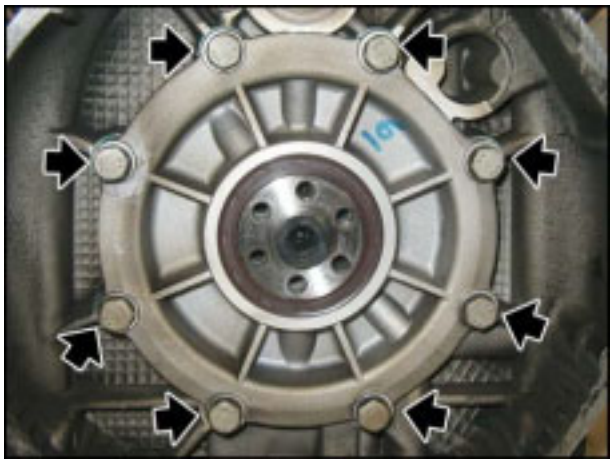
- Remove the heads, see REMOVING THE HEADS.
- Remove the cylinders and pistons, see REMOVAL, CHECK AND INSTALLATION.
- Remove the clutch, see REMOVING THE CLUTCH.
- Remove the flywheel, see REMOVAL, CHECK AND REASSEMBLY.
- Remove the timing system, see REMOVING AND REFITTING.
- Remove the oil sump, see REMOVAL, CHECK AND REASSEMBLY.
- From inside the crankcase, loosen the jointing bolts (A) and remove the connecting rods (B).



- Loosen and remove the six screws and set aside the washers.
- Remove crankshaft flange on generator side.



- Loosen and remove the eight screws and set aside the washers.



- Using the suitable special tool (part no. 12.91.36.00), remove the crankshaft flange.
- Remove the seal, if necessary.

- Slide the crankshaft from the back.

3.8.2. CHECK

WARNING
During this operation flammable vapors are generated and metal particles might be ejected at high speed. We therefore recommend to avoid bare flames or sparks in the work place; the operator should wear suitable goggles.

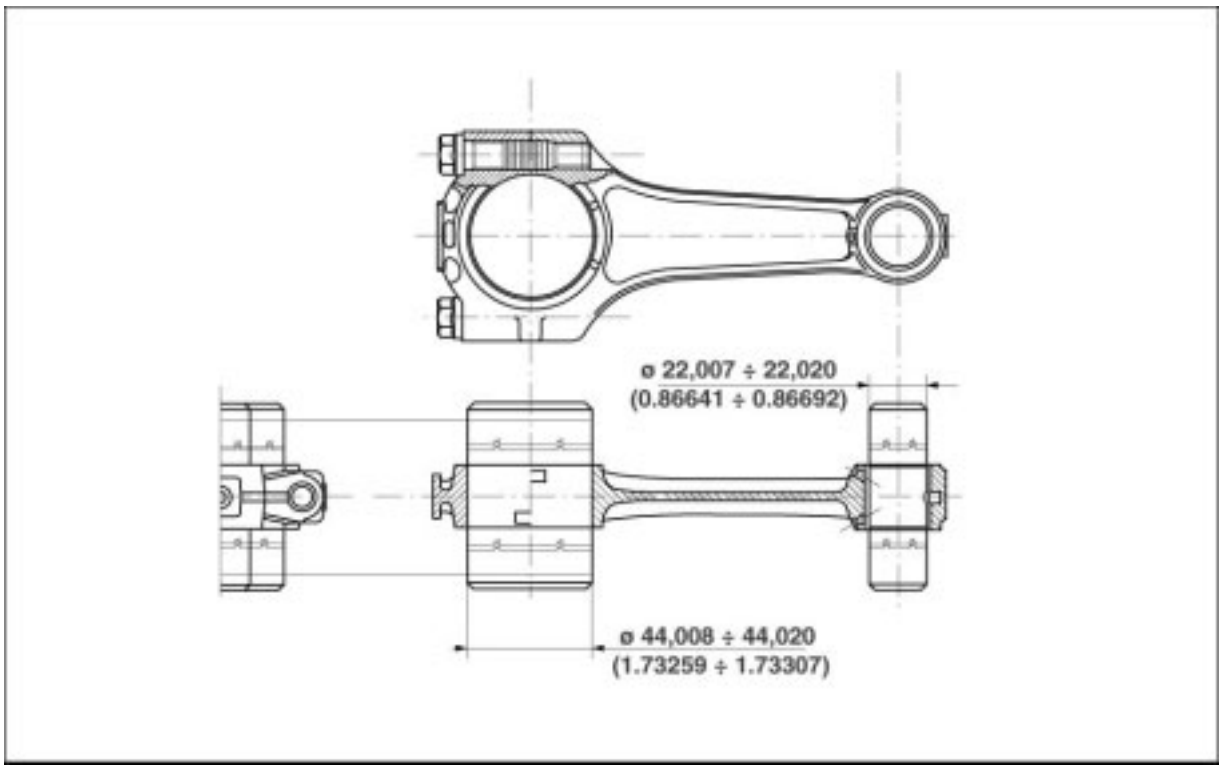
CONNECTING RODS
When overhauling the connecting rods, perform the following checks:

- Bushing condition and clearance between the bushings and gudgeon pins;
- Axes parallelism;
- Con-rod bearings.

The bearings are of the thin shell type, with antifriction alloy to prevent settling; replace them in case of jamming or wear marks.
When changing the bearings, it might be necessary to grind the crank pin.
Before grinding the crank pin we recommend to measure its diameter in the more worn area, as shown in the figure, in order to calculate the bearing undersize class and to set the crank pin final diameter (after grinding).

Checking axes parallelism.

Check that the con-rods are straight before refitting them.
This means that you should check that the con-rod big end and small end bores are parallel and coplanar.
The maximum parallelism and alignment error of the two axes of the con-rod big and small end measured at a distance of 200 mm (7.873 in) is ± 0.10 mm (0.00393 in).



Con-rod bearings thickness

STANDARD BEARING (PRODUCTION) mm (in)	Bearings for crank pin ø undersized by mm (in)		
	0.254 (0.00999)	0.508 (0.01999)	0.762 (0.02999)
From 1.535 (0.06043) to 1.544 (0.06079)	1.662 (0.06543)	1.789 (0.07043)	1.916 (0.07543)
	1.671 (0.06578)	0.798 (0.07079)	1.925 (0.07579)

Crank pin diameter (B): mm (in)

Standard ø	Undersized by mm (in) **0.254 (0.00999)**	Undersized by mm (in) **0.508 (0.01999)**	Undersized by mm (in) **0.672 (0.02645)**
44.008 - 44.020 mm (1.73259 - 1.73307 in).	43.754 - 43.766 mm (1.72259 - 1.72307 in).	43.500 - 43.512 mm (1.71259 - 1.71307 in).	43.264 - 43.258 mm (1.70330 - 1.70307 in).

Gudgeon pin-to-bushing coupling

Inner Ø of the bushing fitted and machined mm (in)	gudgeon pin Ø mm (in)	Gudgeon pin-to-bushing clearance mm (in)
22.007 (0.86641) 22.020 (0.86692)	21.994 (0.86590) 21.998 (0.86606)	0.009-0.026 (0.000354-0.001024)

Connecting rod weight table

Con-rod total weight g (lb)	Weight of small end side (rotating) g (lb)	Weight of big end side (rotating) g (lb)	Color of weight selection class
642 ± 2.5 (1.4153 ± 0.0055)	165 ± 1 (0.3638 ± 0.0022)	476 ± 3.5 (1.0494 ± 0.0077)	White
647 ± 2.5 (1.4263 ± 0.0055		479.5 ± 3.5 (1.0571 ± 0.0077)	Light blue
652 ± 2.5 (1.4374 ± 0.0055)		483 ± 3.5 (1.0648 ± 0.0077)	Orange

Crank pin diameter on flywheel side (C)

STANDARD PRODUCTION mm (in)	UNDERSIZED BY mm (in)		
	0.2 (0.0078)	0.4 (0.0157)	0.6 (0.0236)
52.970 (2.08542) 53.951 (2.12405)	53.770 (2.11692)	53.570 (2.10905)	53.370 (2.10118)
	53.751 (2.11617)	53.551 (2.10830)	53.351 (2.10042)

Journal diameter on timing side (A)

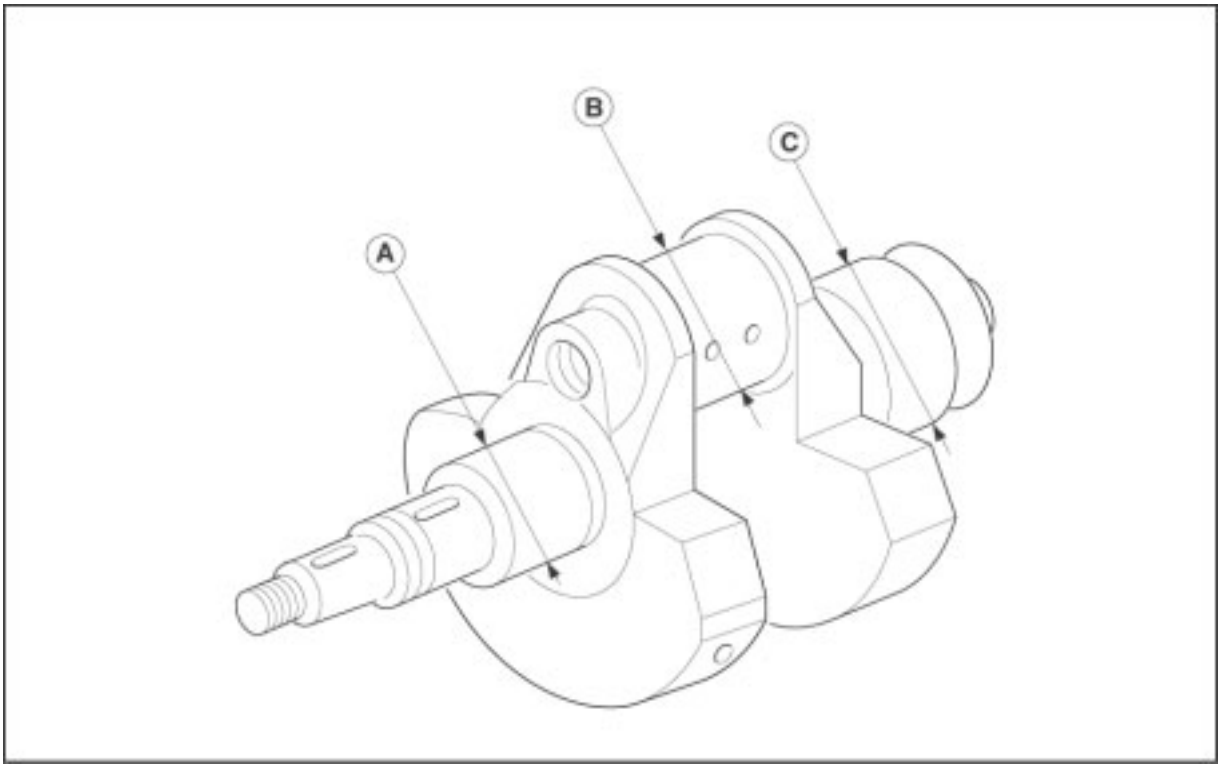
STANDARD PRODUCTION mm (in)	UNDERSIZED BY mm (in)		
	0.2 (0.0078)	0.4 (0.0157)	0.6 (0.0236)
37.975 (1.49507) 37.959 (1.49444)	37.775 (1.48720)	37.575 (1.47932)	37.375 (1.47145)
	37.759 (1.48657)	37.559 (1.47869)	37.359 (1.47082)

CRANKSHAFT

Inspect the journal surfaces; grind them if they are scratched or oval (refer to undersize tables) and change the complete flanges with main bearings.
Undersize values are: 0.2-0.4-0.6 mm (0.0078 – 0.0157 - 0.0236 in)

Assembly clearance values are:

- Between bearing and journal on timing side 0.028 - 0.060 mm (0.00110 - 0.00236 in);
- Between bearing and journal on flywheel side 0.040 - 0.075 mm (0.00157 - 0.00295 in);
- Between bearing and crank pin 0.022 - 0.064 mm (0.00087 - 0.00252 in);



WARNING
When grinding the crankshaft pins/journals refer to the shoulder radius value that is:

2.0 - 2.5 mm (0.079 - 0.984 in) for the crank pin, 3.0 - 3.2 mm (0.118 - 1.260 in) for the journal on flywheel side, 1.5 - 1.8 mm (0.059 - 0.071 in) for the journal on timing side.

CHECKING THE WEIGHT FOR CRANKSHAFT BALANCING

The connecting rods with bolts fitted, shall be balanced in weight.
Allowed difference is 4 grams (0.0088 lb).
Apply a weight of 1850 grams (4.0785 lb) to the crankpin to statically balance the crankshaft.

3.8.3. REASSEMBLY

CONNECTING RODS

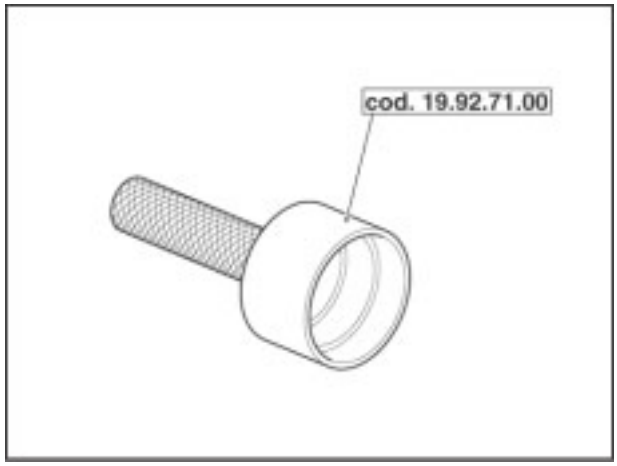
Perform removal instructions in reverse order, consider the following warnings:

- Replace the screws upon reassembly as they are subject to considerable stress and load.
- Assembly clearance between the bearing and crank pin is minimum 0.022 mm (0.00087 in), maximum 0.064 mm (0.00251 in);
- Clearance between the connecting rod shims and crankshaft shims is 0.30 mm (0.01181 in) - 0.50 mm (0.01968 in);
- Tighten the bolts on the caps with a torque wrench to the specified tightening torque.

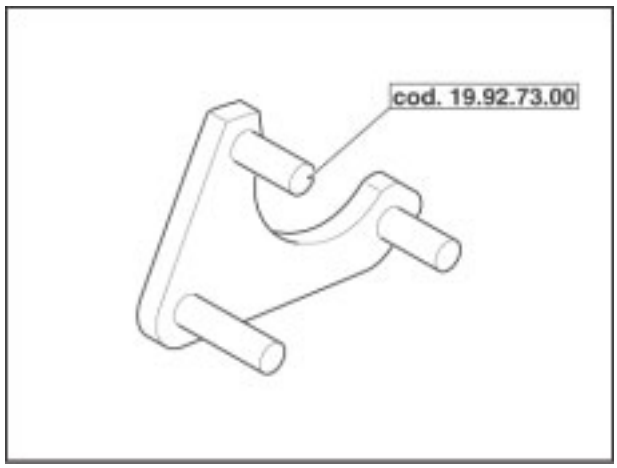
CRANKSHAFT

- Correctly set the crankshaft support flanges considering their assembly position (indicated by the holes);
- Apply Teflon tape to the two lower rear screws to avoid oil leaks.

- Using the suitable seal tool (part no. 19.92.71.00), install the seal on the flywheel-side flange.



- Hold the camshaft with the suitable tool (part no. 14.92.73.00), and install the flange with seal.
- To complete reassembly, follow the removal procedure in reverse order.



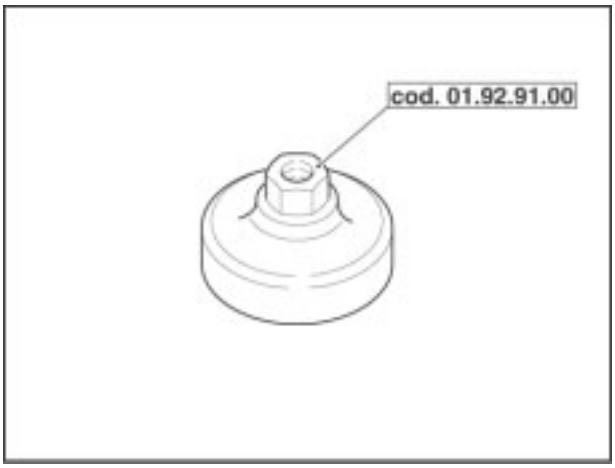
3.9. OIL SUMP

3.9.1. REMOVAL, CHECK AND REASSEMBLY

REMOVAL

NOTE *To remove the oil sump it is necessary to place a suitable container under the sump to collect used oil and drain all oil from the sump.*

- If necessary, remove the filter with the suitable special tool (part no. 01.92.91.00).

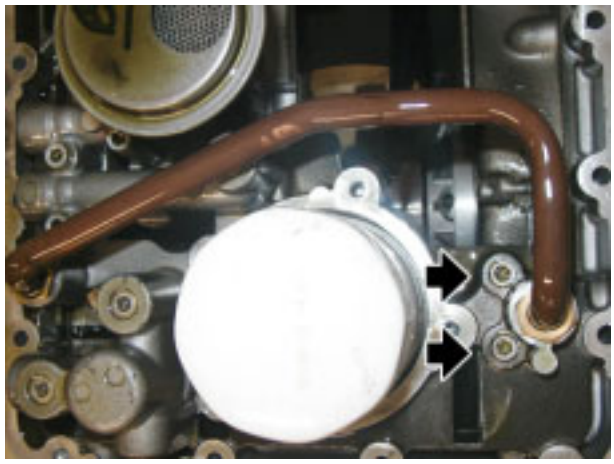


- Loosen and remove the oil level plug and set aside the O-ring.

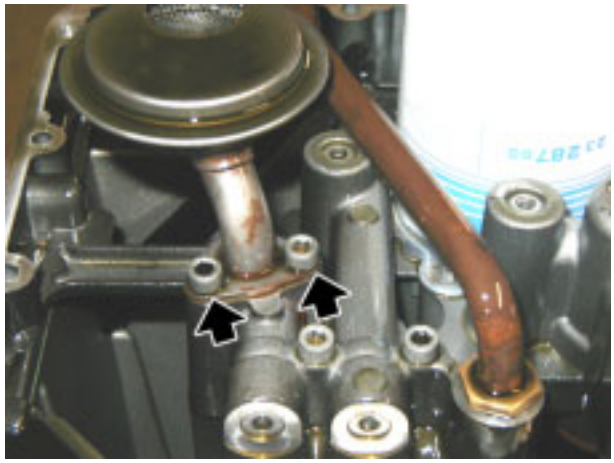
- Loosen and remove the fourteen screws securing the oil sump to the crankcase.

- Loosen and remove the four screws and remove the black oil sump.

- Loosen and remove the two screws.



- Loosen and remove the two screws.
- Remove the mesh filter and set aside the gasket.



- Remove the black flange and set aside the seal.

- Once these parts are removed, it is possible to access the oil pressure control valve and the thermostatic valve. Remove them, if necessary.

CHECK

- Check that the mesh filter is not dirty; wash and blow with compressed air, if necessary.

REASSEMBLY

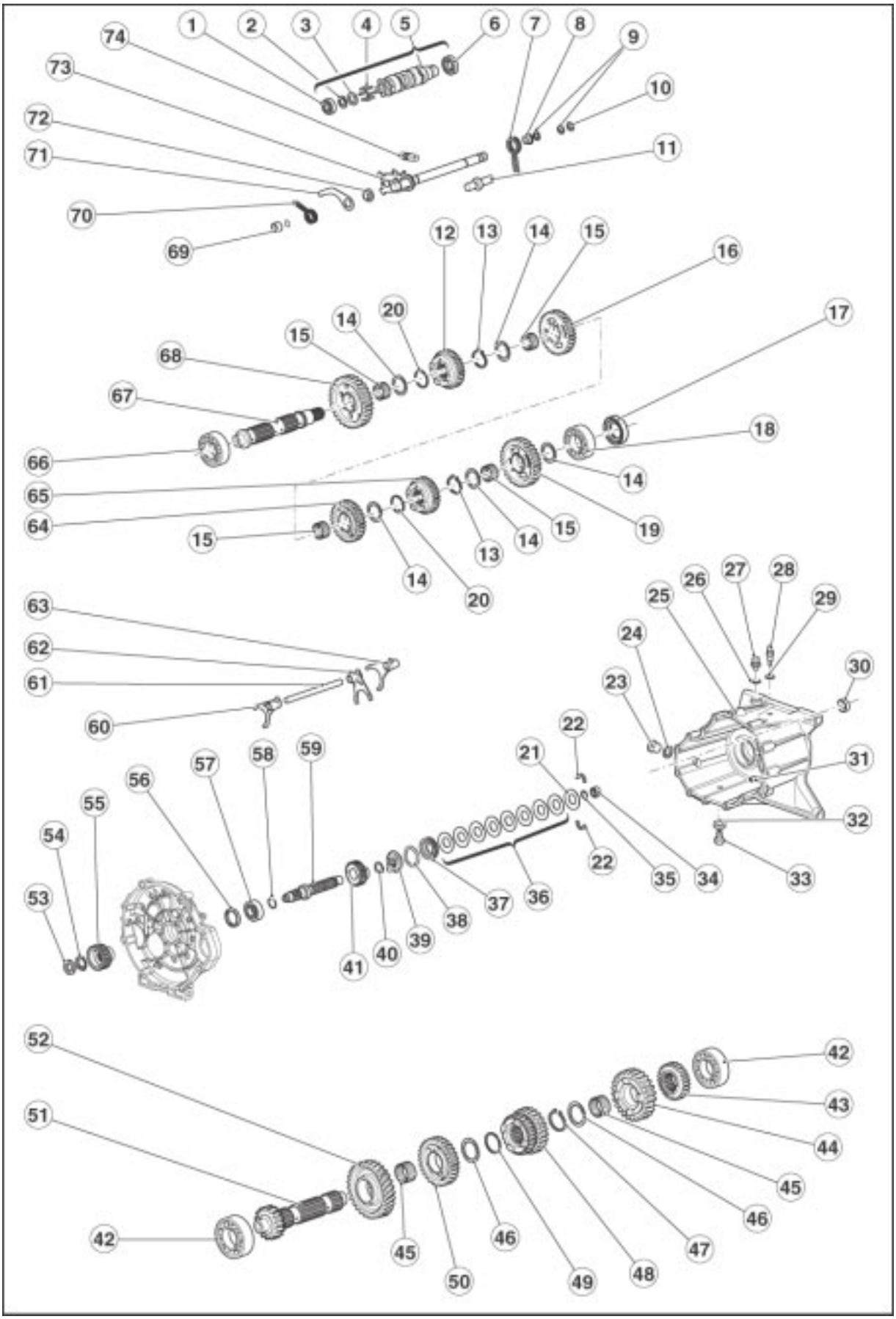
- On assembly, perform removal operations in reverse order, remember to replace the gasket.

GEARBOX 4

TABLE OF CONTENT

4.1. GEARBOX

4.1.1. DIAGRAM



Key:

1. Ball bearing
2. Circlip
3. Shim
4. Peg
5. Complete Desmodromic
6. Ball bearing
7. Spring
8. Spacer
9. Circlip
10. Fifth wheel
11. Pin
12. Gear
13. Circlip
14. Washer
15. Roller cage
16. Gear
17. Seal
18. Ball bearing
19. Gear
20. Circlip
21. Retainer
22. Split ring
23. Oil plug
24. Washer
25. Gearbox
26. Aluminum gasket
27. Breather plug
28. Neutral sensor
29. Gasket
30. Seal
31. Bushing
32. Gasket
33. Oil drain plug
34. Roller bearing
35. Circlip
36. Belleville washer
37. Spring pusher
38. Shaped washer
39. Sleeve
40. Circlip
41. Idle gear
42. Ball bearing
43. Gear
44. Gear
45. Roller cage
46. Washer
47. Circlip
48. Gear
49. Circlip
50. Gear
51. Primary shaft
52. Transmission gear
53. Ring nut
54. Washer
55. Clutch inner body
56. Seal
57. Ball bearing
58. O-ring
59. Clutch shaft
60. Fork
61. Fork pin
62. Fork
63. Fork
64. Gear
65. Gear
66. Ball bearing
67. Secondary shaft
68. Gear
69. Spacer
70. Spring
71. Index lever
72. Bushing
73. Complete preselector
74. Spring

4.1.2. OPENING THE GEARBOX

- Remove the starter motor, see REMOVING THE STARTER MOTOR.
- Make sure that the gearbox is in neutral.
- Loosen and remove the screw and remove the gear shift lever.

- Loosen and remove the plug.

- Place a suitably sized container under it, unscrew and remove the plug; drain all oil from the gearbox, as described in the reference chassis manual, see REFERENCE MANUALS.

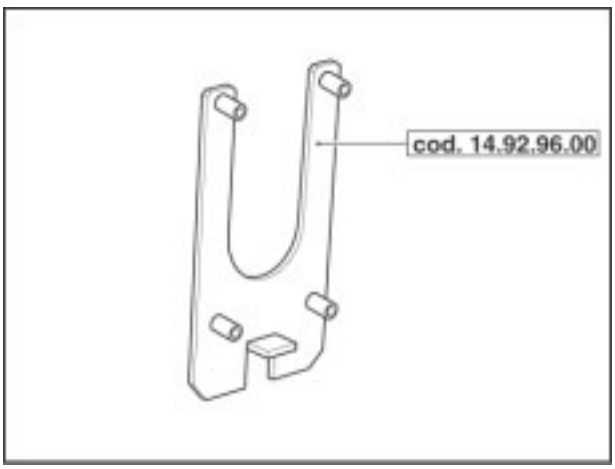
- Loosen and remove the three screws.

- Loosen and remove the two screws.

- Loosen and remove the screw.

- Remove the gearbox.

- Place the gearbox on the suitable gearbox support (part no. 14.92.96.00) and in a vice.

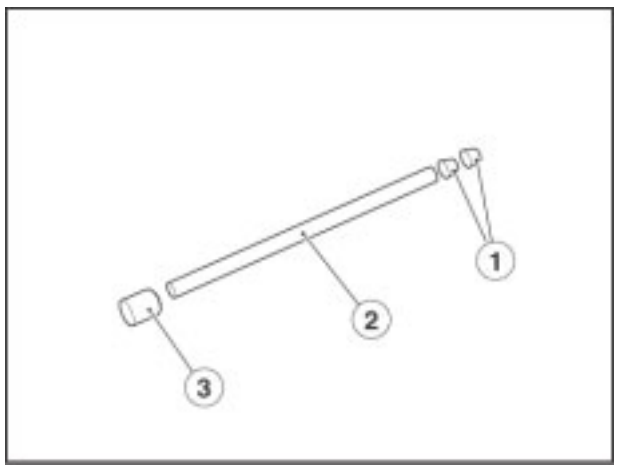


- Loosen and slide out the odometer fitting and set aside the stop washer that stays inside the gearbox.

- Slide out the cylinder and set aside the O-ring and the washer.

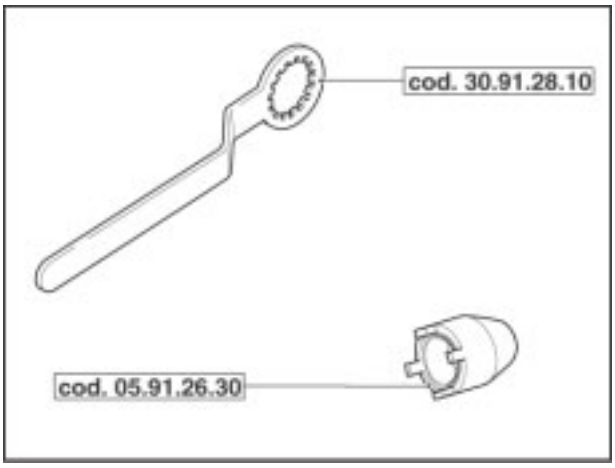
- Remove the thrust bearing and cap.

- Slide out the two bushings (1) and remove the rod (2); set aside the bushing (3).

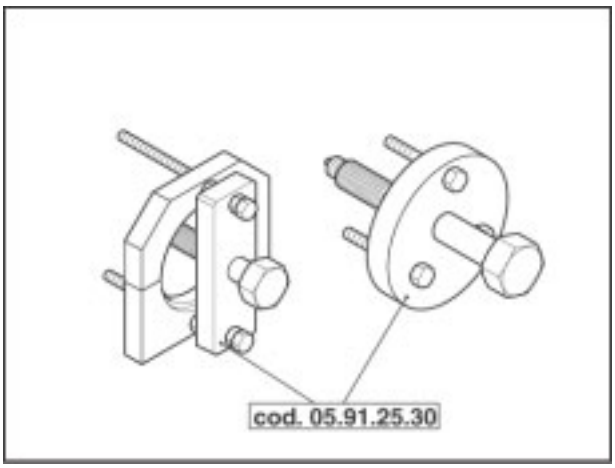


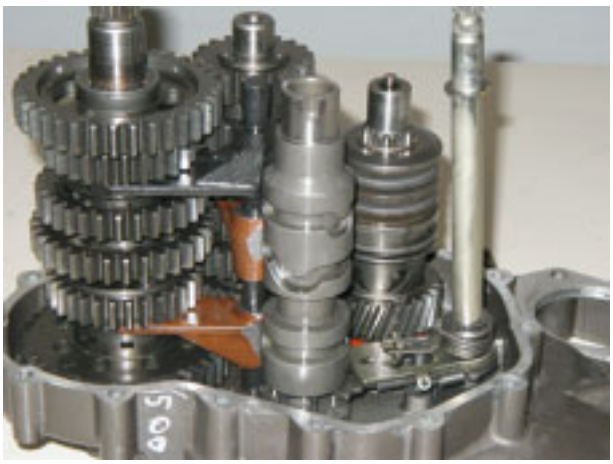
- Bend the washer ends.

- Using the suitable pin wrench (part no. 05.91.26.30) and clutch locking tool (part no. 30.91.28.10), loosen and remove the ring nut; set aside the inner clutch body.



- Using the suitable tool (part no. 05.91.25.30) open the gearbox.

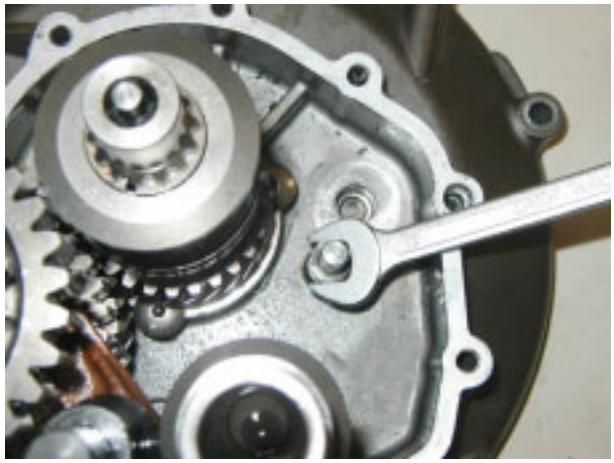




- Open the gearbox, see OPENING THE GEARBOX.
- Release the spring.

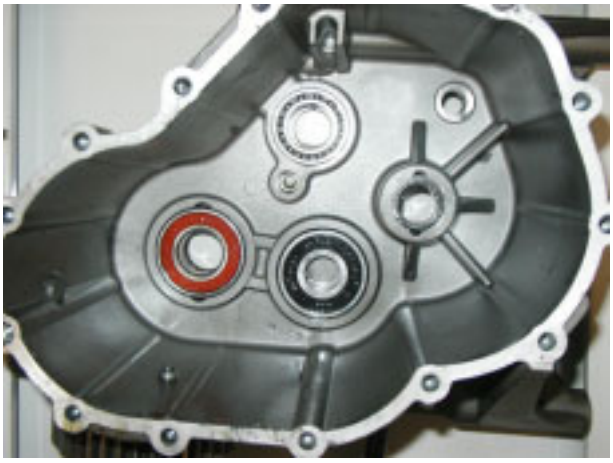
- Press on the selector to help remove the complete transmission lever.

- Loosen and remove the reference threaded pin.



- Use elastic bands to tie the gearbox shafts and remove the unit.

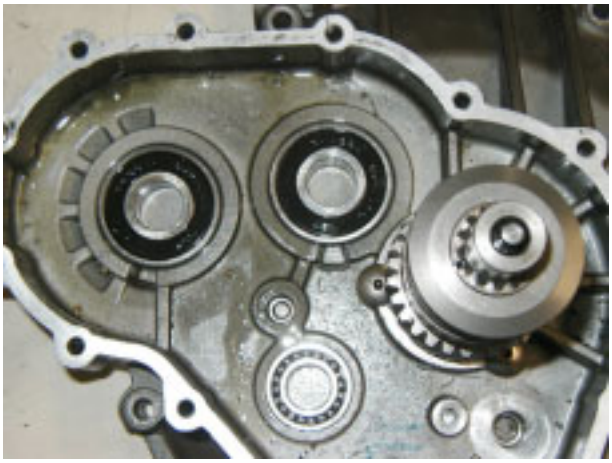
- Remove the bearings from the gearbox.



- Place the gearbox shafts on a bench and remove the elastic bands, paying attention not to damage the unit.
- Separate the shafts and mark the forks before removal.

- Slide out the forks and set aside the shaft.

- If necessary, replace the bearings and remove the clutch shaft.



4.1.3. DISASSEMBLING THE PRIMARY SHAFT

- Open the gearbox, see OPENING THE GEARBOX.
- Work on the primary shaft from the side of the second speed gear.

- Remove the second speed gear, set aside the roller cage.

- Remove the sixth speed gear and set aside the washer.

- Remove the circlip.

- Remove the third and fourth speed gear.

- Remove the circlip and set aside the washer.

- Remove the fifth speed gear and set aside the roller cage.

- Using a suitable heater, heat up the shaft and remove the transmission helical gear.

4.1.4. DISASSEMBLING THE SECONDARY SHAFT

- Open the gearbox, see OPENING THE GEARBOX.
- Work on the secondary shaft from the splined side.

- Remove the washer.

- Remove the second speed gear and set aside the roller cage and the washer.

- Remove the circlip.

- Remove the sixth speed gear.

- Remove the circlip and set aside the washer.

- Remove the fourth speed gear and set aside the roller cage.

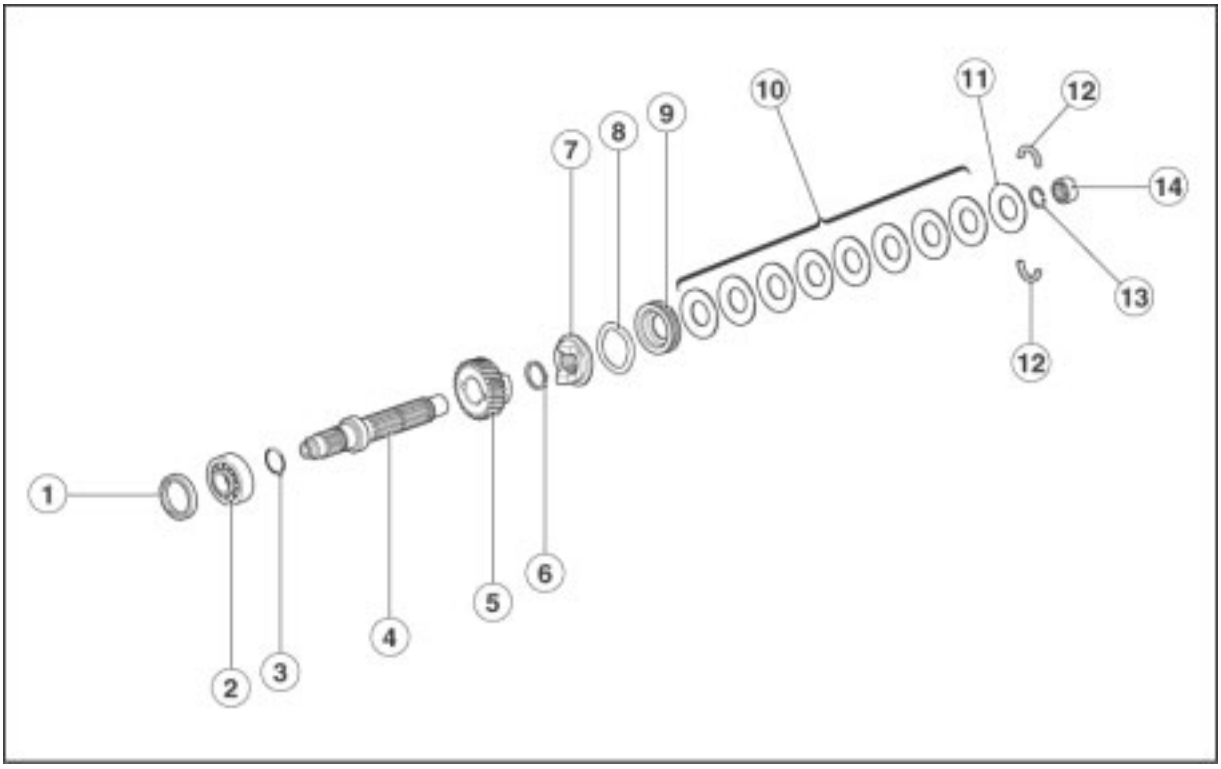
- Remove the third speed gear and set aside the roller cage and the washer.

- Remove the circlip.

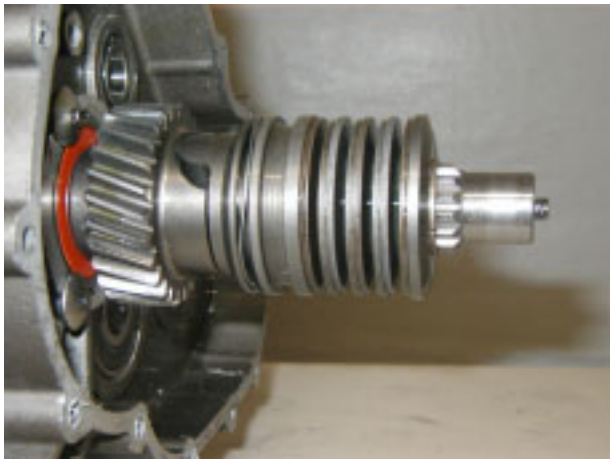
- Remove the fifth speed gear.

- Remove the circlip, the washer and slide out the first speed gear; set aside the roller cage.
- If necessary, remove the bearing.

4.1.5. DISASSEMBLING THE CLUTCH SHAFT



- Open the gearbox, see OPENING THE GEARBOX.
- If necessary, working on engine side, remove the cover seal (1) and bearing (2); set aside the O-ring (3).



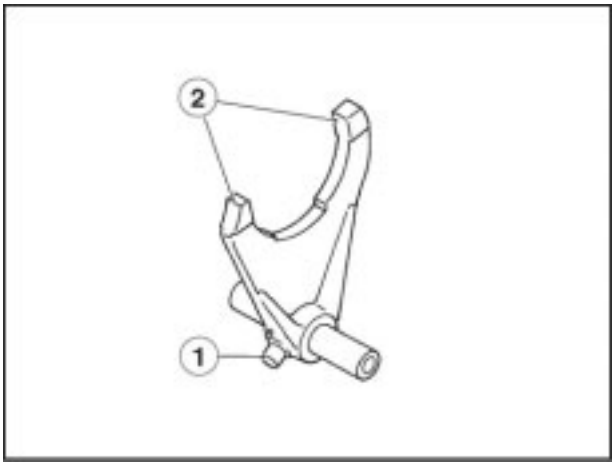
- Working on the gearbox side, remove the circlip (13) and the two split rings (12); set aside the roller bearing (14).
- Remove the retainer (11).
- Carefully remove the Belleville washer (10).
- Remove the spring pusher (9) and set aside the shaped washer (8).
- Remove the coupling (7).
- Remove the circlip (6).
- Remove the idler gear (5).
- Set aside the clutch shaft (4).

4.1.6. CHECK

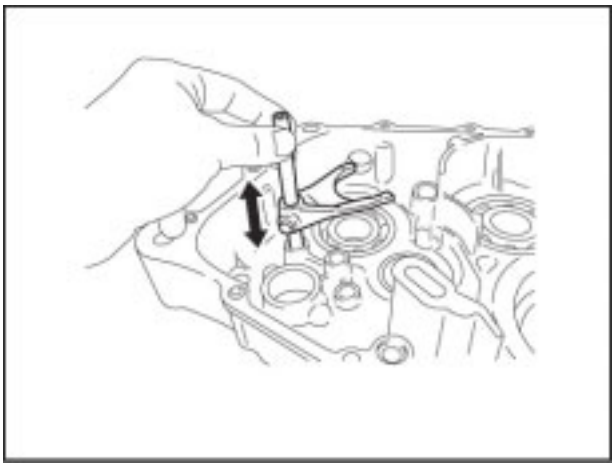
CHECKING THE GEAR SHIFT FORKS

NOTE *The following procedure applies to all gear shift forks.*

Check the fork cam roller (1) and fork teeth (2) for damage, deformation and wear.
Replace the fork if necessary.



Check fork movement; replace the forks if movement is irregular.

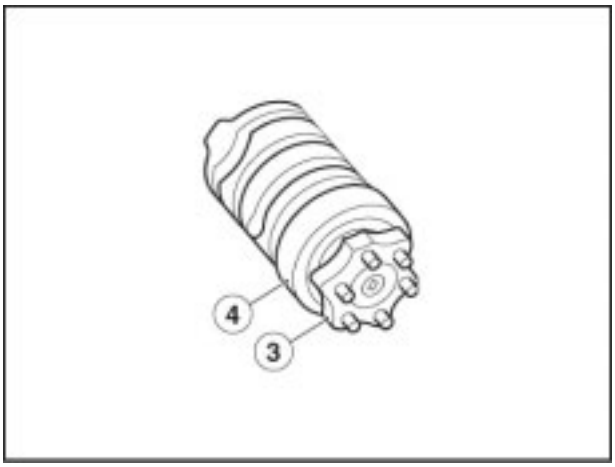


CHECKING THE DESMODROMIC UNIT

Check the gear change drum for damage, scratches and wear marks and replace the desmodromic if necessary.

Check the desmodromic end (3) for damage and wear marks and replace it if necessary.

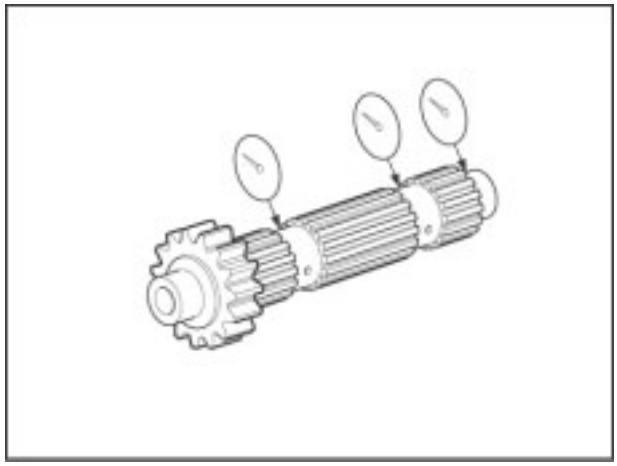
Check the desmodromic bearing (4) for damage and stains; replace the desmodromic if necessary.



CHECKING THE GEARBOX

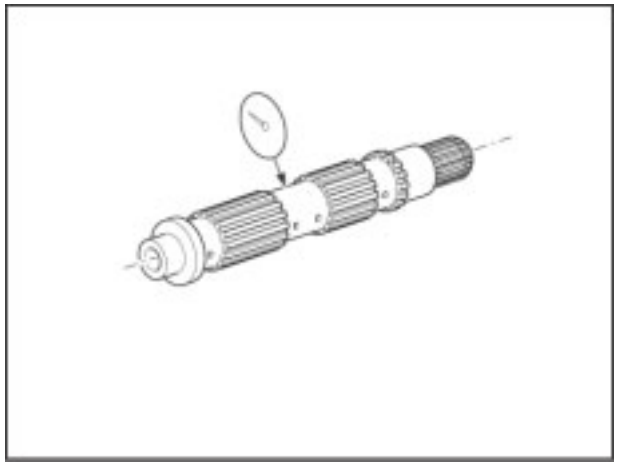
Using a gauge and a centering unit, measure primary shaft runout and replace it if it does not comply with the specifications.

Primary shaft limit runout:
0.08 mm (0.0031 in)



Using a gauge and a centering unit, measure secondary shaft runout and replace it if it does not comply with the specifications.

Secondary shaft limit runout:
0.08 mm (0.0031 in.)



Check the transmission gears for stains and wear; replace the faulty gears, if needed.

Check gear clutch dogs for cracks, damages and wear marks; replace the faulty ones if necessary.

Check transmission gear movement. If it is irregular, replace the faulty part.

4.1.7. REASSEMBLY

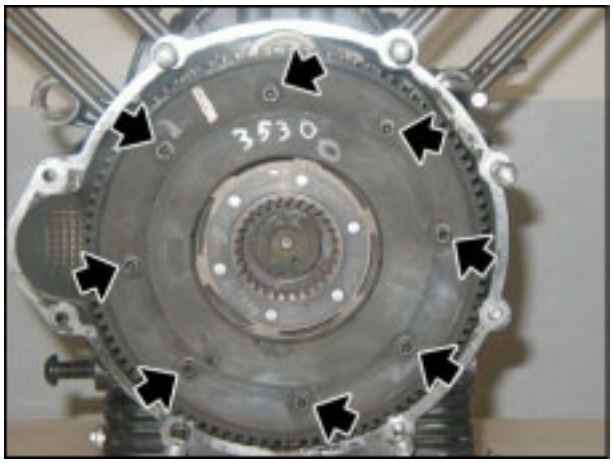
NOTE *To reassemble the clutch shaft, the secondary shaft and the primary shaft and to close the gearbox, follow the removal instructions in reverse order. Remember to replace all the seals, circlips and snap rings removed with new ones.*

4.2. CLUTCH

4.2.1. REMOVING THE CLUTCH

- Remove the gearbox unit, see REMOVING THE GEARBOX.
- Fit the locking tool (part no. 12.91.18.01) and tool (part no. 30.90.65.10) to compress clutch springs on the flywheel.

- Loosen and remove the eight screws securing the flywheel gear wheel.



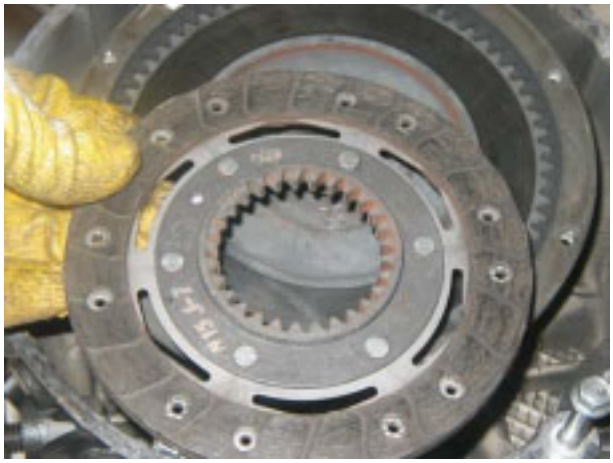
- Remove the gear wheel.

From inside the flywheel, remove:

- the clutch plate;

- the intermediate plate;

- the second clutch plate;



- the pusher plate nut;

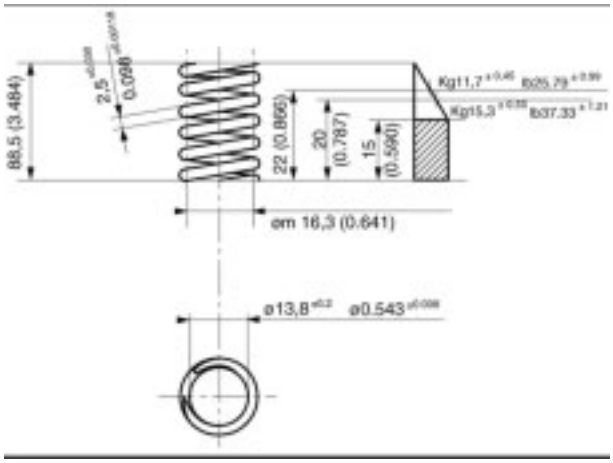
- the pusher plate together with springs.

4.2.2. CHECKING THE COMPONENTS

Clutch springs

Check the springs for yielding and deformation:

- Springs compressed to 22 mm (0.8661 in) should give a load of 11.25 - 11.70 kg (24.80 - 25.79 lb);
- Springs compressed to 20 mm (0.7874 in) should have a load of 14.75 - 15.30 kg (32.52 - 33.73 lb);



Spring pusher plate

Check that the plate is not worn at the hole where the retainer works, and that surface mating with the driven plate is perfectly flat.
Check that the toothing inside the flywheel is in good condition.

Driven plates

Check that the surfaces mating with the driven plates are perfectly smooth and flat and that external teeth working inside the flywheel are not damaged; replace the plate, if necessary.

Starter gear wheel

Check that the surface mating with the driven plate is perfectly smooth and flat.
Also check toothing where the starter motor sprocket works; make sure it is not damaged or worn;
change the gear if necessary.

Clutch inner body

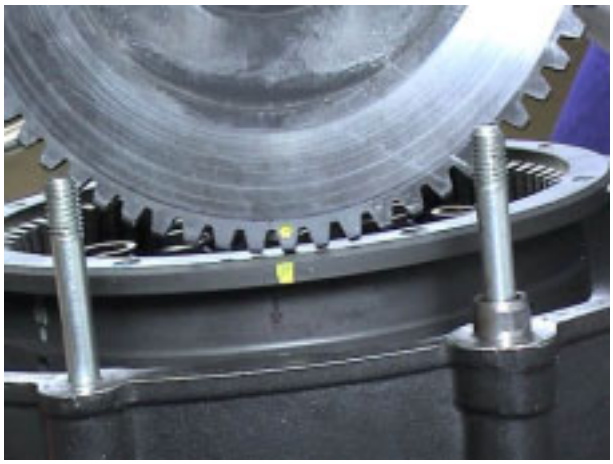
Check that the teeth are not worn in the areas in contact with the plates.

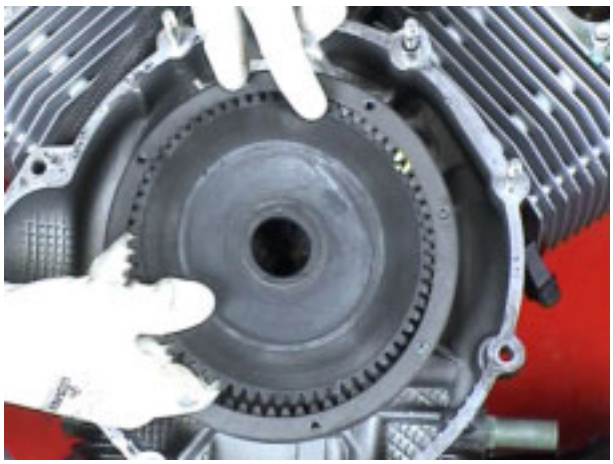
4.2.3. REFITTING THE CLUTCH

Fit the following parts in the flywheel as follows:

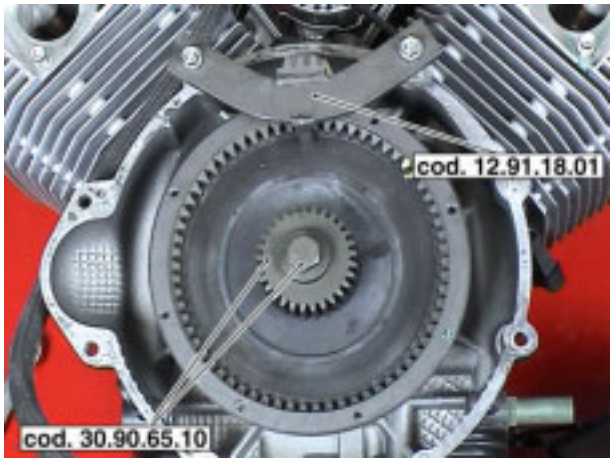
- the spring pusher plate together with springs.

- Ensure that the reference mark on the pusher plate tooth matches the flywheel reference mark.





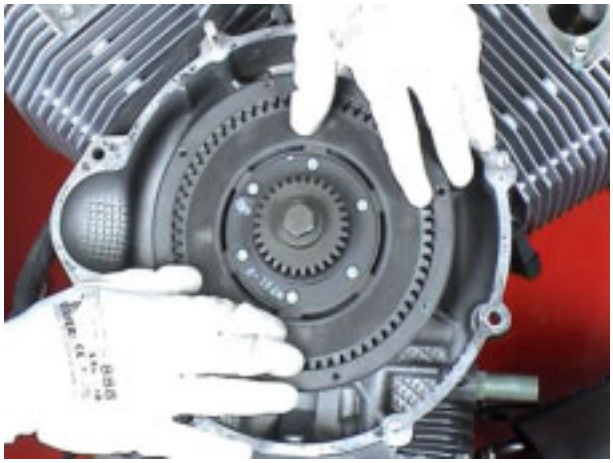
- Fit the locking tool (part no. 12.91.18.01) to flywheel and tool (part no. 30.90.65.10) compressing the clutch springs.



- Remove the locking tool (part no. 12.91.18.01)

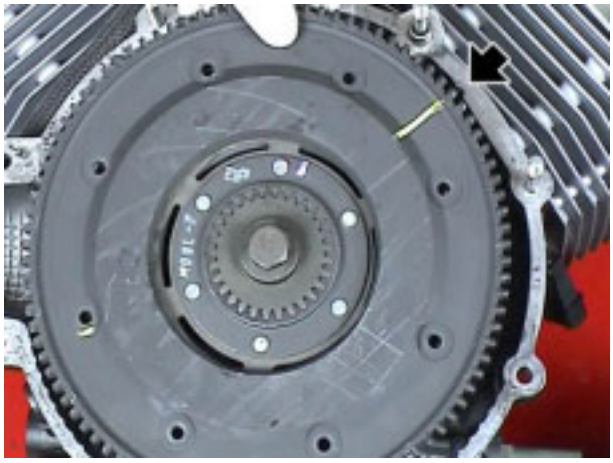
- Fit the clutch plate.

- Fit the intermediate metal plate.

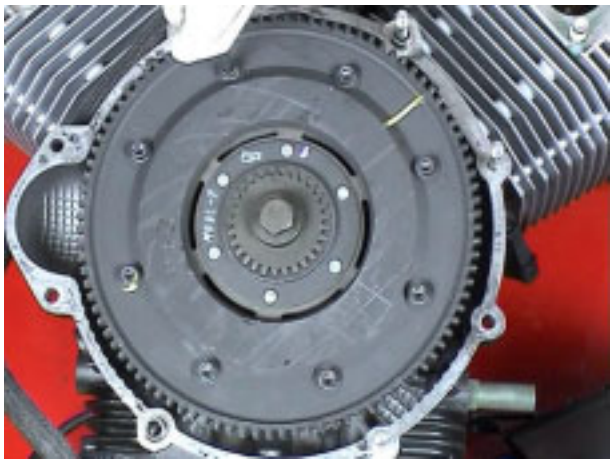


- Fit the clutch plate.

- Position the gear wheel aligning the reference mark to the flywheel one.



- Tighten the eight screws securing the gear wheel to the flywheel to the specified torque; proceed in a cross pattern.



- Remove tool (part no. 30.90.65.10) compressing the clutch springs.

- Fit the spring cap.
- Install the gearbox.

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