

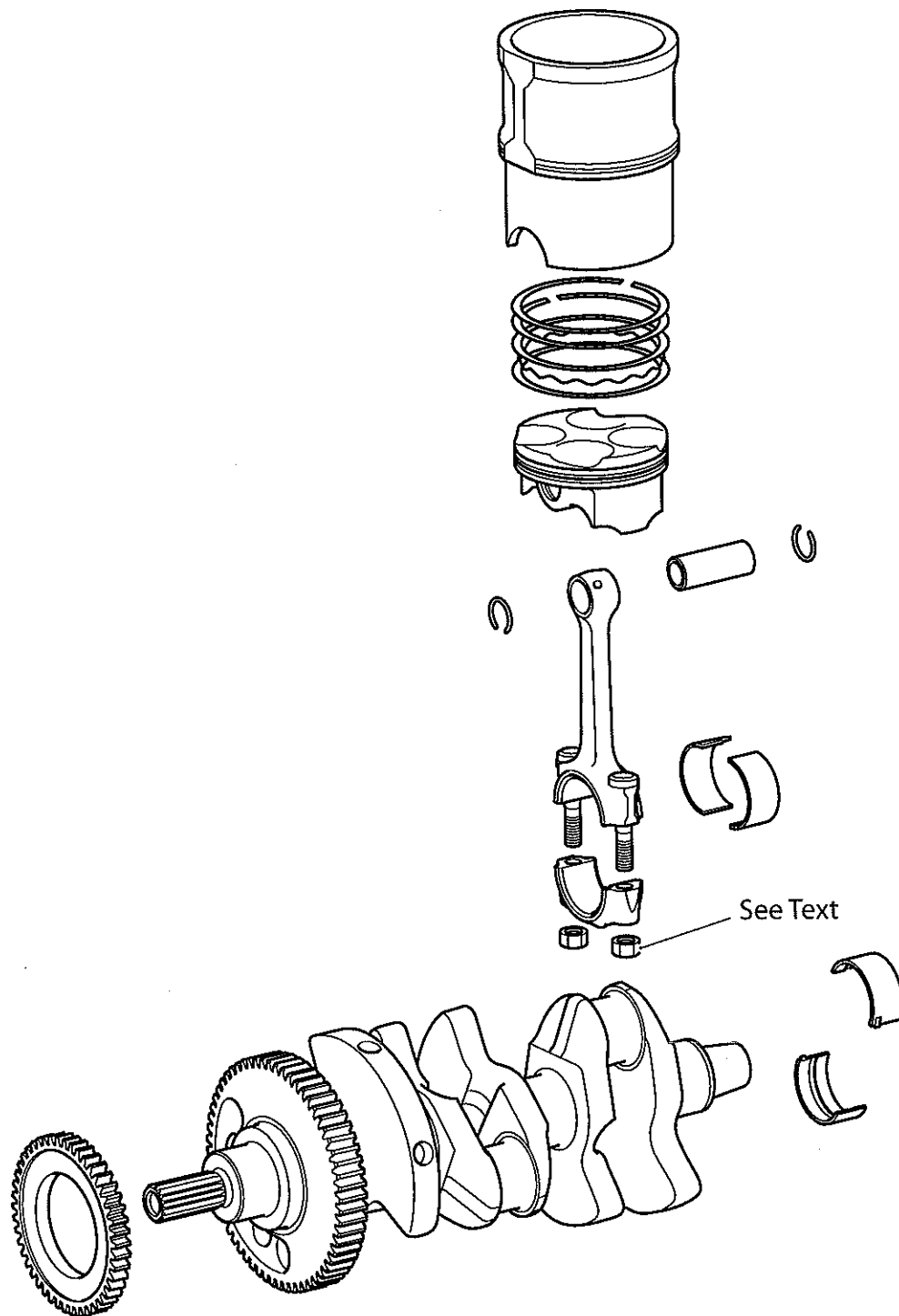
5 Crankshaft, Connecting Rods and Pistons

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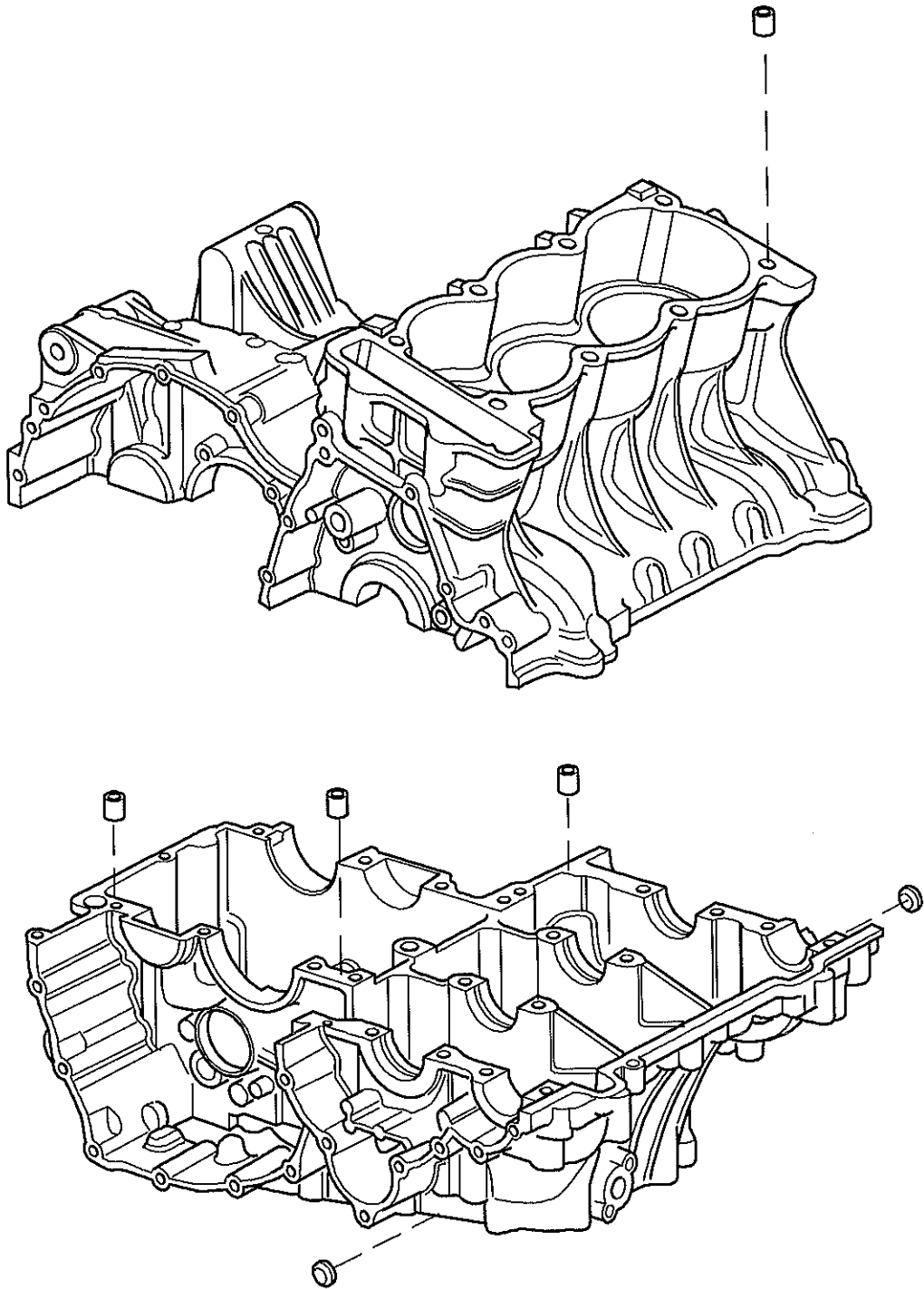
Crankshaft, Connecting Rods and Pistons

Exploded View - Crankshaft, Connecting Rod, Piston and Liner



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Exploded View - Crankcase



Crankshaft, Connecting Rods and Pistons

Crankcases

Caution

The upper and lower crankcases are machined as a matched set and must never be assembled to non-matching halves. Doing so may cause seizure of the engine.

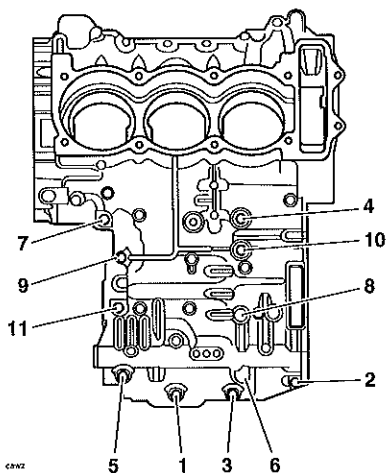
1. Remove the engine from the frame (see page 9-3).
2. Remove the sump (see page 8-11).
3. Remove the engine covers.
4. Remove the clutch (see page 4-6).
5. Remove the oil pump drive chain and gears (see page 8-9).

Disassembly

Caution

Failure to follow the correct screw release sequence may result in permanent crankcase damage.

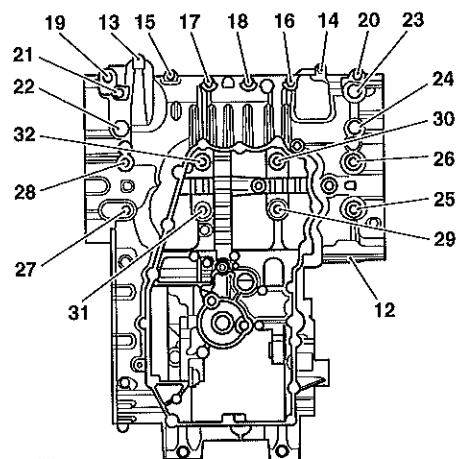
1. Working on the upper crankcase bolts first, release the bolts in the sequence shown below.



Upper Crankcase Bolt Release Sequence

2. Invert the engine to give access to the lower crankcase bolts.

3. Release the lower crankcase bolts in the sequence shown in the diagram below.



Lower Crankcase Bolt Release Sequence

4. Separate the lower and upper crankcases ensuring that the 3 locating dowels remain in the upper crankcase.

Caution

Do not use levers to separate the upper and lower sections of the crankcase or damage to the crankcases could result.

Note:

- At this point the transmission shafts, balancer, crankshaft, bearings etc. can be removed.

Note:

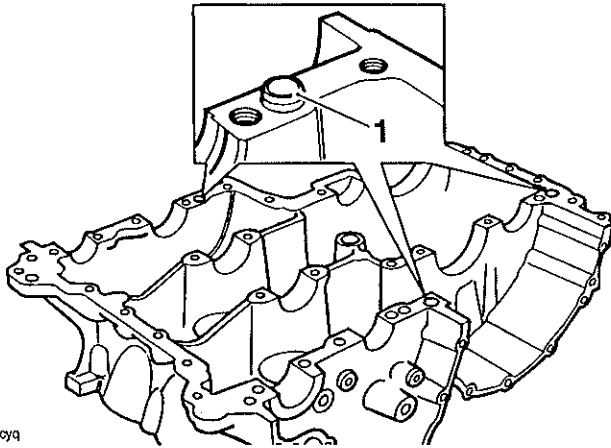
- The position of each individual bearing screw prior to removal.

Assembly

1. Use high flash-point solvent to clean the crankcase mating faces. Wipe the surfaces clean with a lint-free cloth.
2. Fit the gearbox shafts (if removed), ensuring the locating ring on the input shaft is in position in the circlip groove on the crankcase.
3. Ensure that the transmission is in neutral.

Crankshaft, Connecting Rods and Pistons

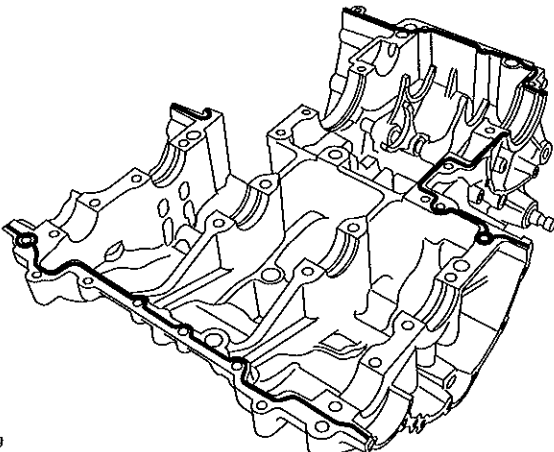
4. Ensure that the 3 locating dowels are in position in the upper crankcase.



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1. Locating dowels

5. Apply a thin bead of silicone sealant to the lower crankcase mating faces. (At the factory, Three Bond 12155 is used).



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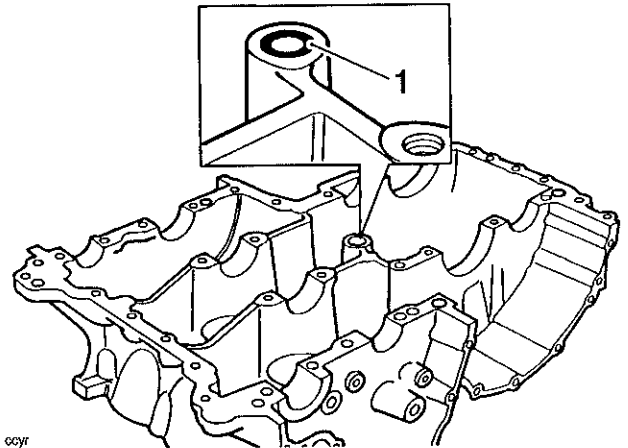
1. Sealer areas

⚠ Caution

Do not use excessive amounts of sealer. The extra sealer may become dislodged and could block the oil passages in the crankcases causing severe engine damage.

6. Install and lubricate the crankshaft bearing shells with clean engine oil (see bearing selection before proceeding).
7. Lubricate the crankshaft journals with clean engine oil.

8. Locate a new oil gallery O ring to the upper crankcase.



ccyr

1. O ring

9. Position the lower crankcase to the upper, ensuring that all selectors engage correctly. An assistant may be required to support the crankcase during alignment.
10. Fit the screws into the lower crankcase and hand tighten until the bolt heads are near contact with the crankcase.
11. Invert the engine.
12. Fit the screws into the upper crankcase and hand tighten until the bolt heads are near contact with the crankcase.

Note:

- The crankcase screws are tightened in stages.
- Two different sizes of crankcase screw are used. All screws are tightened through the first stage of the tightening procedure but only the M8 size screws are tightened at the second stage.

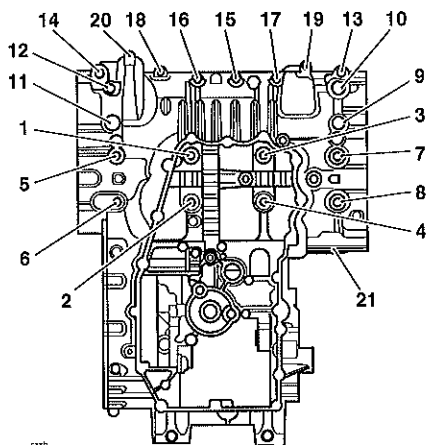
⚠ Caution

Failure to follow the correct screw tightening sequence may result in permanent crankcase damage.

Crankshaft, Connecting Rods and Pistons

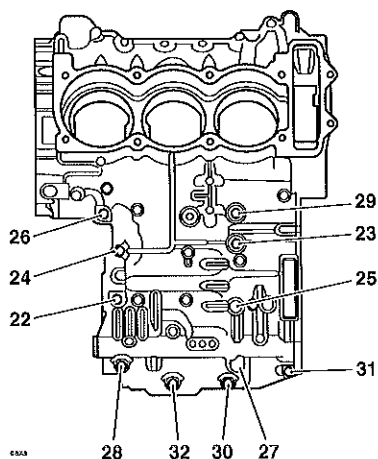
Stage 1 - all screws

1. Invert the engine.
2. In the correct sequence, tighten all lower crankcase screws to **12 Nm**.



Lower Crankcase Bolt Tightening Sequence

3. Invert the engine.
4. In the correct sequence, tighten all upper crankcase screws to **12 Nm**.



Upper Crankcase Bolt Tightening Sequence

Stage 2 - M8 screws only

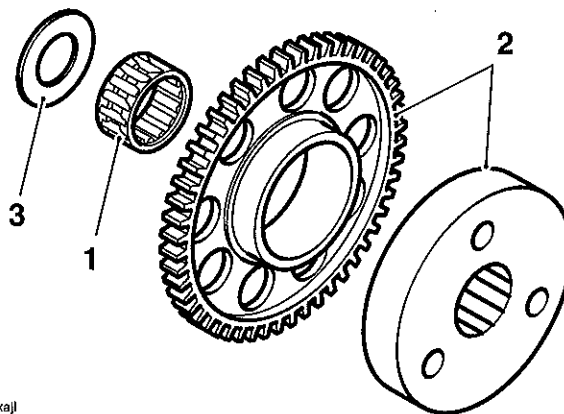
1. In the correct sequence, tighten only the M8 size upper crankcase screws (numbers 22 to 29) to **28 Nm**.
2. Invert the engine.
3. In the correct sequence, tighten only the M8 size lower crankcase screws (number 1 to 14) to **28 Nm**.
4. Rotate the crankshaft clockwise. Check for tight spots and rectify as necessary.
5. Refit the oil pump drive chain and gears (see page 8-10).
6. Refit the clutch (see page 4-9).

7. Refit the engine covers.
8. Refit the sump.
9. Install the engine in the frame (see page 9-5).

Crankshaft

Removal

1. Remove the sprag clutch (see page 7-20).



1. Needle roller bearing
2. Gear/sprag clutch assembly
3. Plain washer

2. Remove the alternator rotor from the crankshaft (see page 17-14).
3. Separate the two halves of the crankcase (see page 5-4).
4. Remove the connecting rods (see page 5-7).
5. Remove the cam chain (see page 3-15).
6. Release and remove the crankshaft from the upper crankcase.

Note:

- Identify the location of each bearing shell.
 - Remove all bearings and inspect for damage, wear, overheating (blueing) and any other signs of deterioration. Replace the bearings as a set if necessary.
7. Remove the balancer (see page 6-3).

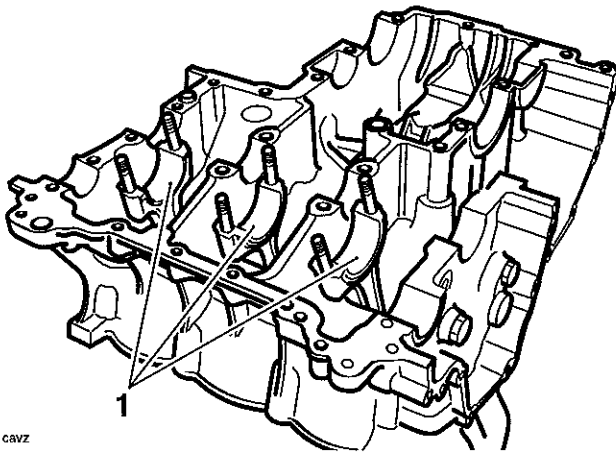
Crankshaft, Connecting Rods and Pistons

Installation

! Caution

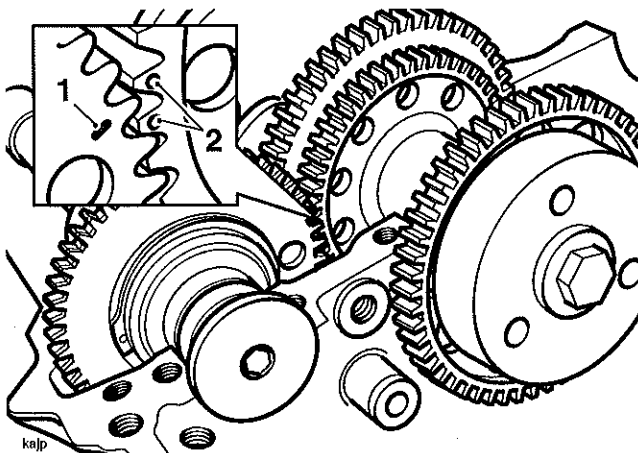
Always check the bearing journal clearance (see page 5-11), before final assembly of the crankshaft. Failure to correctly select crankshaft bearings will result in severe engine damage.

1. Select and fit new main and big end shell bearings using the selection processes detailed later in this section.



1. Big end shells

2. Lubricate all bearings with engine oil.
3. Ensure that the crankshaft is clean, and that the oilways within the crank are clean and free from blockages and debris.
4. Refit the balancer (see page 6-4).
5. Install the crankshaft ensuring that the crank pins align with the big ends and that the crankshaft and balancer gear markings align as shown in the next illustration.



1. Balancer backlash and drive gear markings
2. Crankshaft markings

6. Refit the connecting rods (see page 5-8).

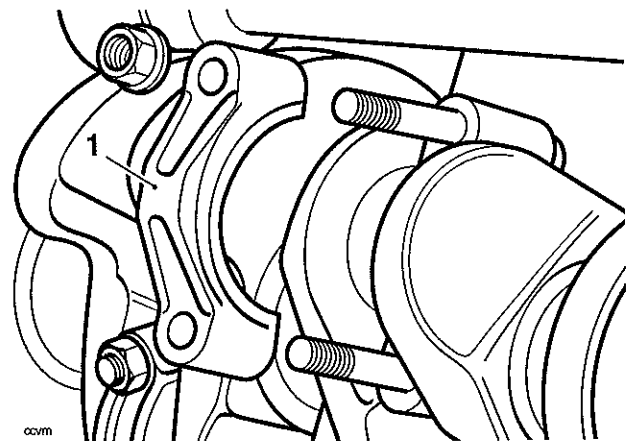
7. If removed, refit the transmission shafts.
8. Assemble the crankcases (see page 5-4).
9. Assemble the alternator rotor (see page 17-15).
10. Assemble the sprag clutch (see page 7-22).
11. Assemble the cam chain (see page 3-17).

Connecting Rods

Removal

Connecting rods may be removed from the engine after first removing it from the frame. The cylinder head must be removed and the crankcase halves separated.

1. Mark each big end cap and connecting rod to identify both items as a matched pair and to identify the correct orientation of the bearing cap to the connecting rod.
2. Release the connecting rod nuts and remove the big end cap. Ensure that the bearing shell remains in place in the cap.



1. Big End Cap

Note:

- It may be necessary to gently tap the big end cap with a rubber mallet to release the cap from the bolts.
3. Push the connecting rod up through the crankcase and collect the piston and connecting rod from the top.
 4. Label the assembly to identify the cylinder from which it was removed.

Crankshaft, Connecting Rods and Pistons



Caution

Never re-use connecting rod bolts or nuts. If the connecting rod cap is disturbed, always renew the bolts and nuts. Using the original nuts and bolts may lead to severe engine damage.

5. Remove the liner using tool T3880315 (see page 5-15).
6. Detach the piston from the connecting rod (see page 5-12).

Installation

Note:

- Connecting rod bolts and nuts are treated with an anti-rust solution which must not be removed.
- Clean the connecting rod with high flash-point solvent.
- Remove all bearings and inspect for damage, wear and any signs of deterioration and replace as necessary.



Warning

Connecting rod bolts and nuts **MUST** only be used once. If the bolts or nuts are removed or undone for any reason, new bolts and nuts **MUST** always be used.

Re-using bolts can cause connecting rods and their caps to detach from the crankshaft causing severe engine damage, loss of motorcycle control and an accident.

1. Fit new connecting rod bolts to the big end.

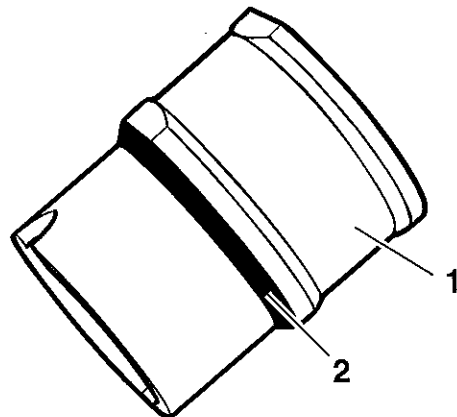
Note:

- Ensure the piston is fitted correctly to the connecting rod.
 - If a previously run engine is being rebuilt, always ensure that the piston and con-rod are assembled in the same orientation as prior to strip-down.
2. Apply molybdenum disulphide grease to the upper inner surface of the connecting rod big end.

Note:

- Avoid touching any bearing surfaces of the bearing shells with the hand.

3. Apply silicone sealer to the liner-to-crankcase mating face.



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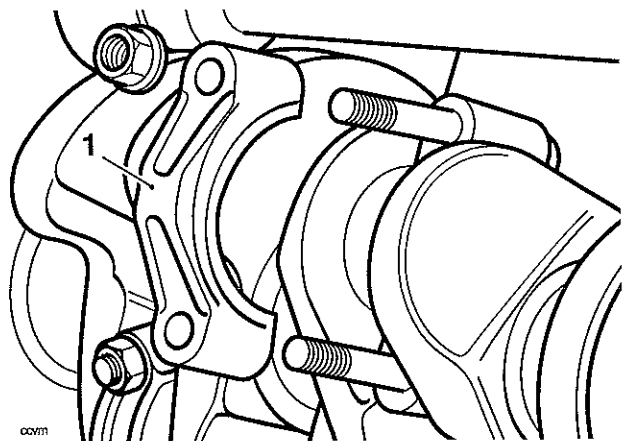
1. Liner

2. Sealer Area

4. Fit the piston and connecting rod assembly into the liner from the bottom.
5. Fit the liner into the crankcase ensuring that the arrow/dot on the piston faces forward.

Note:

- Ensure that the piston/liner/connecting rod assembly aligns correctly with the crankpin during assembly into the crankcase.



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1. Big End

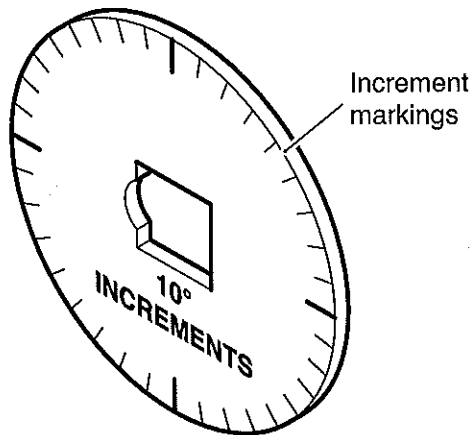
6. Select big end bearing shells (see page 5-9).
7. Lubricate both halves of the bearing shells with engine oil and fit to the connecting rod and big end cap.
8. Align the connecting rod to the crankshaft and fit the big end cap. Tighten the cap (using new nuts and bolts) as follows:

- Lubricate the threads of the bolt and the face of the nut with molybdenum disulphide grease. Tighten the nuts progressively in five stages as follows:

! Caution

The torque characteristics of the connecting rod nuts and bolts are sensitive to the rate at which they are tightened. If all the torque is applied in one action, the bolt may be stretched and the nut may become loose when in service resulting in an expensive engine failure.

- Tighten to **22 Nm**.
- Release by **140°**.
- Tighten to **10 Nm**.
- Tighten to **14 Nm**.
- Tighten through **120°** of nut rotation as measured using the Triumph torque turn gauge 3880105-T0301.



cbxt

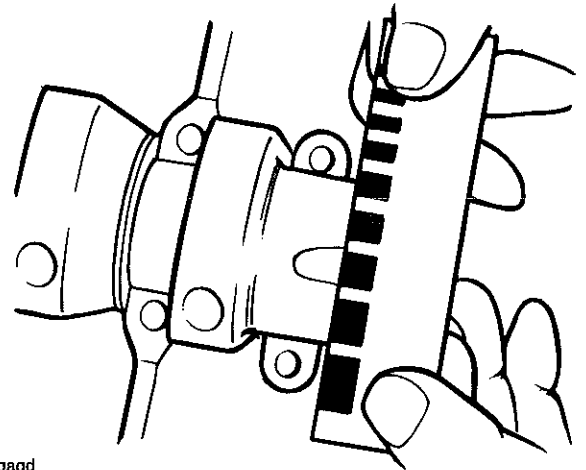
Service Tool 3880105-T0301

Connecting Rod Big End Bearing Selection/Crankpin Wear Check

- Measure the bearing and crankpin clearance as follows.

Note:

- Do not turn the connecting rod and crankshaft during the clearance measurement as this will damage the 'Plastigage'. The crankpin clearances are measured using 'Plastigage' (Triumph part number 3880150-T0301).**
- Remove the big end cap from the journal to be checked.
 - Wipe the exposed areas of the crankpin, and the bearing face inside the cap.
 - Apply a thin smear of grease to the journal and a small quantity of silicone release agent to the bearing.
 - Trim a length of the Plastigage to fit across the journal. Fit the strip to the journal using the grease to hold the Plastigage in place.
 - Release the nuts and remove the cap being measured. Using the gauge provided with the Plastigage kit, measure the width of the compressed Plastigage.
 - Lubricate the threads of the bolt and the face of the nut with molybdenum disulphide grease. Refit the bearing and cap and tighten the big end nuts (see page 5-8).



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Crankshaft, Connecting Rods and Pistons

Checking the Measured Clearance

Con rod big end bearing/crankpin clearance

Standard:	0.036 - 0.066 mm
Service limit:	0.1 mm

Note:

- If the measured clearance exceeds the service limit, measure the crankpin diameter.

Crankpin diameter

Standard:	34.984 - 35.000 mm
Service limit:	34.960 mm

Note:

- If any crankpin has worn beyond the service limit, the crankshaft must be replaced. Due to the advanced techniques used during manufacture, the crankshaft cannot be re-ground and no oversize bearings are available.

Connecting Rod Bearing Selection

Minor differences in connecting rod dimensions are compensated for by using selective bearings. For further information on bearing part number to colour cross-references, see the latest parts information.

1. Select the correct big end bearing shell as follows:
 - Measure each crankpin diameter.
 - Note the connecting rod marking.
2. Select the correct bearings by matching the information found with the chart below.

Big end bearing selection chart

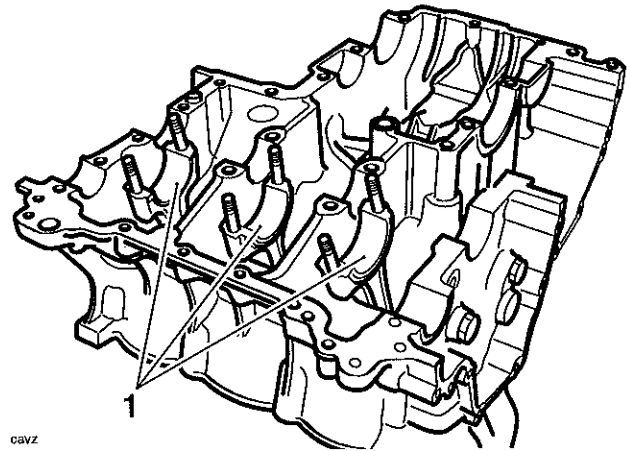
Shell Colour	White	Red	Red	Blue
Rod Marking	5	5	4	4
Con-rod Big End Bore Dia.	38.008 38.000	38.008 38.000	38.018 38.009	38.018 38.009
Crankpin Dia.	35.000 34.992	34.991 34.984	35.000 34.992	34.991 34.984
Running Clearance	0.066 0.036			

For instance:

Con-rod Mark	5
Con-rod Big End Diameter	38.002
Crankpin Diameter	34.987
Required Bearing	Red

Note:

- Repeat the measurements for all connecting rods and their respective crankpins.
 - It is normal for the bearings selected to differ from one connecting rod to another.
3. Install the new bearings in the connecting rod.



1. Big end bearings

! Caution

Always confirm, using the Plastigage method, that the running clearance is correct before final assembly. Severe engine damage could result from incorrect clearance.

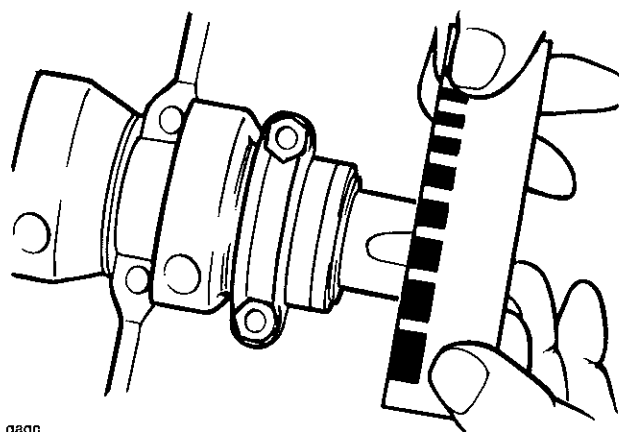
Crankshaft, Connecting Rods and Pistons

Crankshaft main bearing/journal wear

Main Bearing Selection Chart (all dimensions in mm's)						
Shell Colour	White	Red	Red	Blue	Blue	Green
Crankcase Bore	41.121	41.121	41.130	41.130	41.139	41.139
	41.113	41.113	41.122	41.122	41.131	41.131
Journal Dia.	37.976	37.968	37.976	37.968	37.976	37.968
	37.969	37.960	37.969	37.960	37.969	37.960
Running Clearance	0.043	0.044	0.044	0.043	0.043	0.044
	0.020	0.020	0.021	0.019	0.020	0.020

Minor differences in crankshaft dimensions are compensated for by using selective bearings. For further information on bearing part number to colour cross-references, see the latest parts microfiche.

- Measure the bearing to crankshaft main journal clearance using Plastigage (Triumph part number 3880150-T0301) (see page 5-8).



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Checking crankpin clearance using Plastigage

Crankshaft main bearing/journal clearance

Standard:	0.019 - 0.044 mm
Service limit:	0.07 mm

If the clearance exceeds the service limit, measure the diameter of the crankshaft main journal.

Crankshaft main journal diameter

Standard:	37.960 – 37.976 mm
Service limit:	37.936 mm

Note:

- If any journal has worn beyond the service limit, the crankshaft must be replaced. Due to the techniques used during manufacture, the crankshaft cannot be re-ground and no oversize bearings are available.

Select bearings as follows:

1. Measure and record the diameter of each crankshaft main bearing journal.
2. Measure and record each main bearing bore diameter in the crankcase (bearings removed).

Compare the data found with the chart above to select bearings individually by journal.

For example:

Crankshaft Journal diameter	37.972 mm
Crankcase Bore	41.135 mm
Bearing Required	Blue

Note:

- It is normal for the bearings selected to differ from one journal to another.
- It is also normal for there to be two options of bearing shell colour. In such cases, pick the shell size which gives the greater running clearance.

Caution

Always confirm, using the Plastigage method, that the running clearance is correct before final assembly. Severe engine damage could result from incorrect clearance.

Crankshaft, Connecting Rods and Pistons

Crankshaft End Float

Standard	0.05 - 0.20 mm
Service Limit	0.40 mm

Note:

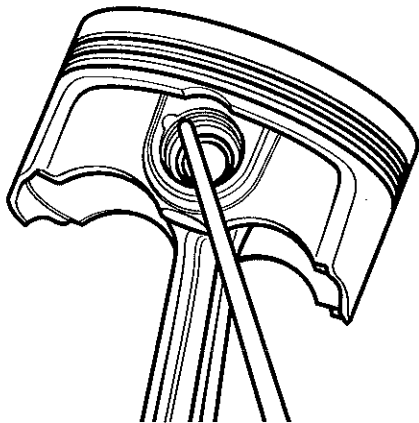
- Crankshaft end float is controlled by the tolerances in crankshaft and crankcase machining. No thrust washers are used. If crankshaft end float is outside the specified limit, the crankshaft and/or the crankcases must be replaced.

Pistons

Disassembly

Note:

- It is not necessary to remove the connecting rods from the crankshaft.
1. Remove the cylinder head (see page 3-17).
 2. Remove the liner, using tool T3880315 (see page 5-15).
 3. Remove the gudgeon pin circlip from one side of the piston.



Removing the Gudgeon Pin Circlip

4. Remove the gudgeon pin by pushing the pin through the piston and rod toward the side from which the circlip was removed.



Caution

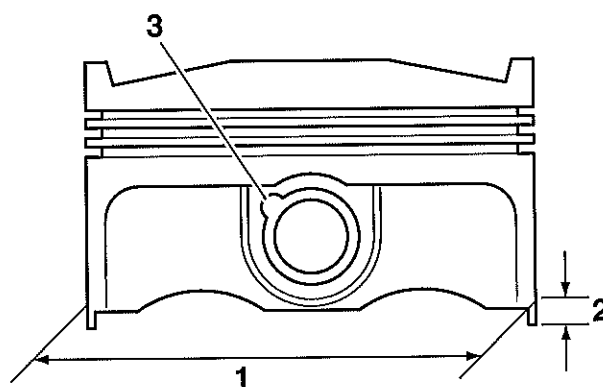
Never force the gudgeon pin through the piston. This may cause damage to the piston which may also damage the liner when assembled.

Note:

- If the gudgeon pin is found to be tight in the piston, check the piston for a witness mark caused by the circlip. Carefully remove the mark to allow the pin to be removed.
5. Piston rings must be removed from the piston using hand pressure only.

Piston Wear Check

1. Measure the piston outside diameter, 5 mm up from the bottom of the piston and at 90° to the direction of the gudgeon pin.



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1. Piston outside diameter
2. Measurement Point
3. Circlip removal groove

All Cylinders	78.980 – 78.970 mm
Service limit	78.930 mm

Replace the piston if the measured diameter falls outside the specified limit.

Crankshaft, Connecting Rods and Pistons

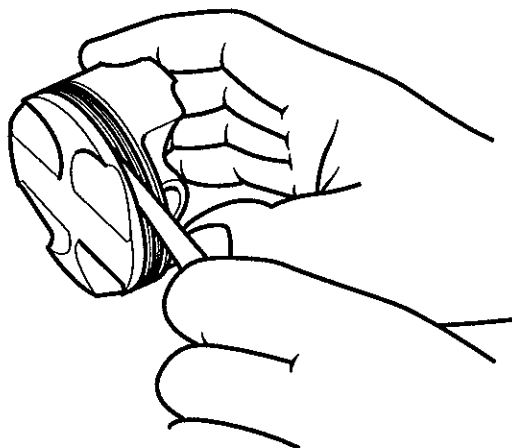
Piston Rings/Ring Grooves

Check the pistons for uneven groove wear by visually inspecting the ring grooves.

If all the rings do not fit parallel to the groove upper and lower surfaces, the piston must be replaced.

Clean the piston ring grooves.

Fit the piston rings to the pistons. Check, using feeler gauges, for the correct clearance between the ring grooves and the rings. Replace the piston and rings if outside the specified limit.



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Piston Ring to Ring Groove Clearance Check Piston ring/Groove Clearance

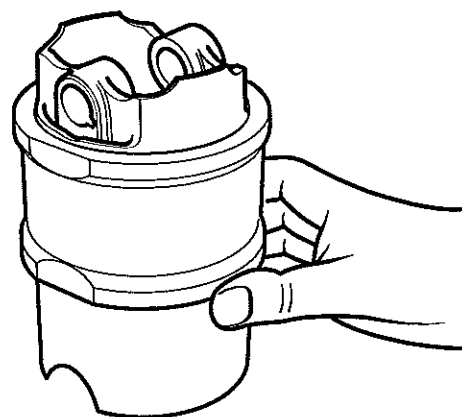
Top ring	0.02 - 0.06 mm
Service limit	0.075 mm
Second	0.02 - 0.06 mm
Service limit	0.075 mm

Piston Ring Gap

Note:

- **Before final assembly the piston ring gap, when fitted in the liner, must first be checked.**

1. Place the piston ring inside the liner.
2. Push the ring into the top of the cylinder, using the piston to hold the ring square with the inside of the bore. Continue to push the ring into the bore until the third groove of the piston is level with the cylinder top, around full circumference of cylinder.



ccvj

Aligning Piston Rings using the Piston

1. Remove the piston and measure the gap between the ends of the piston ring using feeler gauges.

Piston Ring End Gap Tolerances

Top	0.28 - 0.49 mm
Service limit	0.61 mm
Second	0.43 - 0.64 mm
Service limit	0.76 mm
Oil Control	0.33 - 0.89 mm
Service limit	1.03 mm

2. If the ring gap is found to be too small, the ring end must be carefully filed until the correct gap is achieved. If the gap is too large, replace the rings with a new set. If the gap remains too large with new rings fitted, both the piston and liner must be replaced.

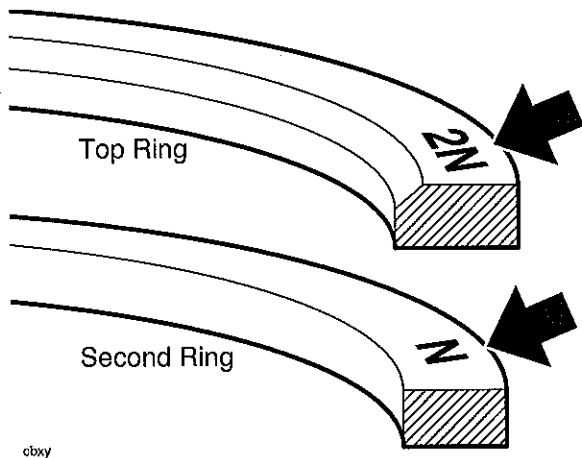
Crankshaft, Connecting Rods and Pistons

Piston Assembly

1. Clean the piston ring grooves and fit the piston rings to the piston.

Note:

- The top ring upper surface is marked 'N' and can be identified by a chamfer on the inside edge.
- The second ring upper surface is marked '2N' but is plain on the inside edge and has a bronze appearance.
- The oil control rings can be fitted with either face upward.



Piston Ring Identification

1. Fit the piston onto the connecting rod.

Note:

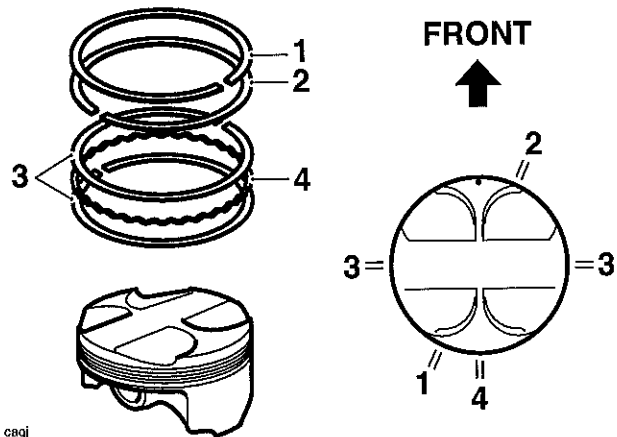
- **Connecting rods may be fitted either way around. However, ensure all three are fitted the same way.**
2. Align the small end in the connecting rod with the gudgeon pin hole in the piston.
 3. Lubricate the piston, small end and gudgeon pin with clean engine oil and fit the gudgeon pin.
 4. Fit new circlips on both sides of the gudgeon pin ensuring the circlips are correctly fitted in the grooves.



Warning

Failure to use new gudgeon pin circlips could allow the pin to detach from the piston. This could seize the engine and lead to an accident.

5. The piston ring gaps must be arranged as shown in the diagram below.



1. Top Ring
2. Second Ring
3. Steel Oil Control Rings
4. Oil Control Ring Expander

Note:

- The top ring gap should be positioned in the 7 o'clock position, the second ring gap in the 1 o'clock position and the steel oil control ring gaps in the 9 & 3 o'clock positions (one in each position).
6. Fit the piston into the liner using a gentle rocking motion to engage the rings in the bore.

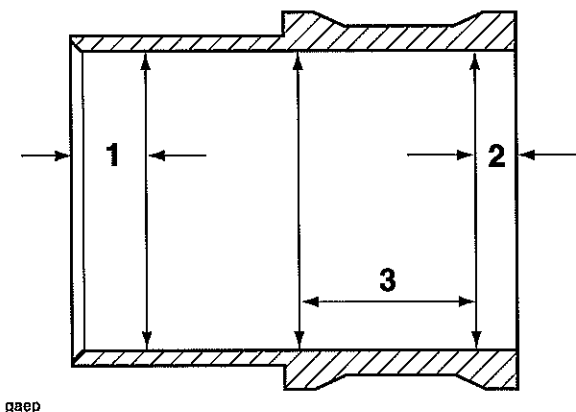
Cylinder Wear

Measure the inside diameter of each cylinder using an internal micrometer or similar accurate measuring equipment.

Crankshaft, Connecting Rods and Pistons

Cylinder bore diameter

Standard:	79.040 – 79.060 mm
Service limit:	79.110 mm



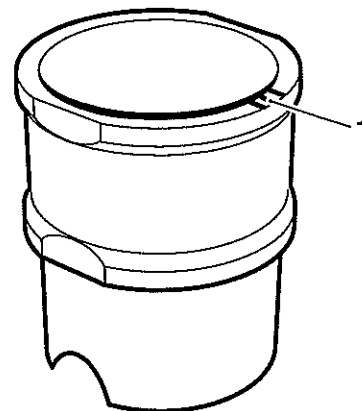
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Test Positions For Bore Wear Check (bore shown in section)

1. If any reading is outside the specified limits, replace the liner and piston as an assembly.

Cylinder Liners

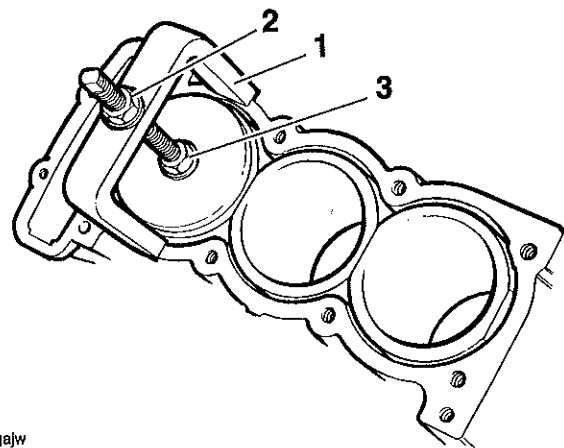
Removal



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Paint Mark

1. Mark each liner to identify correct orientation and the cylinder number from which it has been removed.
2. Turn the crankshaft until the piston in the liner to be removed is at the bottom of its stroke.



galw

1. Tool T3880315

2. Extraction nut

3. Locking nut

3. Check that the locking nut on tool T3880315 is loose, then fully unscrew the extraction nut.
4. Carefully fit the tool fully into the cylinder bore, positioning the tool legs on the crankcase. Turn the locking nut clockwise until the rubber sleeve on the tool tightly grips the bore of the liner.
5. Check that the tool legs are positioned to allow withdrawal of the liner, then turn the extraction nut clockwise to extract the liner. Take care to ensure that the piston / connecting rod is not allowed to fall against the inside of the crankcase.

Crankshaft, Connecting Rods and Pistons

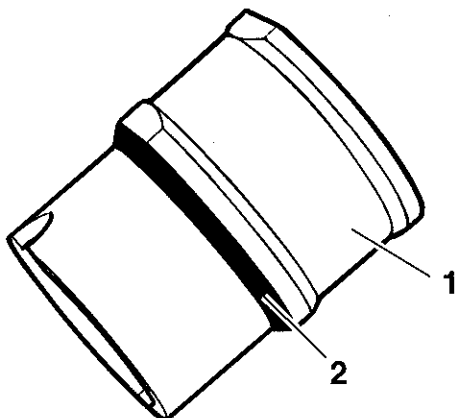
6. Turn the locking nut anticlockwise to release the liner.

Note:

- The tool must be used to release the seal between the liner and the crankcase.
- It is not intended that the tool is used to fully extract the liner. Once the seal is released, the tool must be removed and the liner extracted by hand.

Installation

1. Thoroughly clean the liner removing all traces of old silicone sealer.
2. Remove all traces of sealer from the crankcase bores.
3. Apply silicone sealer to the liner to crankcase mating face.

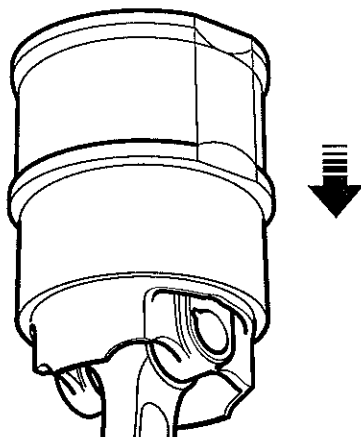


ccvk

1. Liner

2. Sealer Area

4. Fit each liner over the piston using a gentle rocking motion to allow compression of the piston rings.



ccvl

Arrowed: Liner-piston fitment

Note:

- The liners have a large chamfer at the bottom of the bore enabling fitting of the piston without need for a piston ring compressor.

Caution

Fit each liner over whichever piston is at TDC. When turning the engine, do not allow the pistons to contact the inside of the crankcase and also do not allow fitted liners to lift off the crankcase base.

5. Continue fitting each liner in turn until all are fitted and sealed.

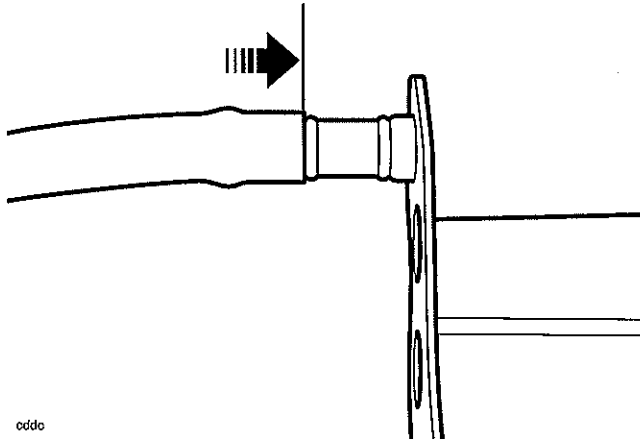
Note:

- When the liners have been fitted, they should not be disturbed. If it is necessary to remove the liner after fitting, the sealer must be re-applied.

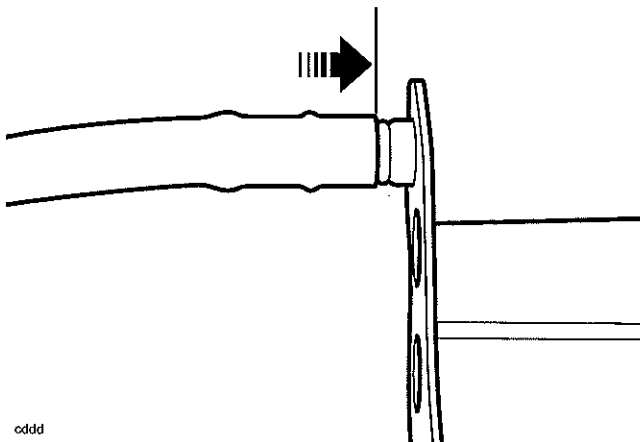
Crankcase Breather

The upper crankcase is fitted with a labyrinth type breather system, which requires no maintenance. However, when assembling the crankcases, ensure that the breather hose is not damaged and is securely fitted to the breather as follows:

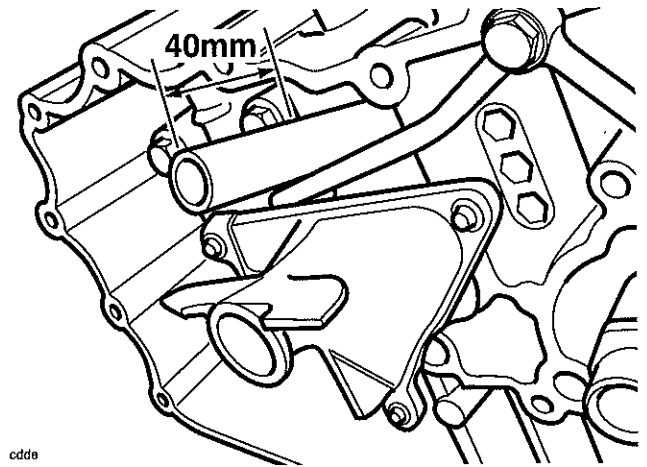
1. If the hose is **220 mm** in length, the hose should be pushed **half-way on** to the breather outlet.



2. If the hose is **240 mm** in length, the hose should be pushed **fully on** to the breather outlet.



3. In both cases, the hose is retained by means of a spring-clip and protrudes into the sump as shown below.



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