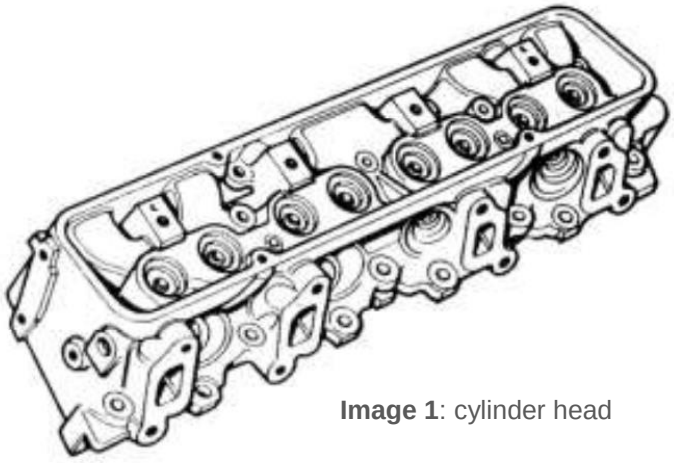

Image 1: cylinder head

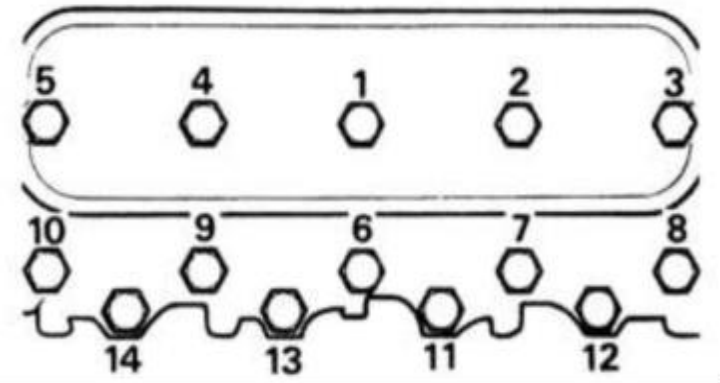

Image 2: 1973 MGBGTV8 Workshop Manual Supplement cylinder head bolt tightening sequence

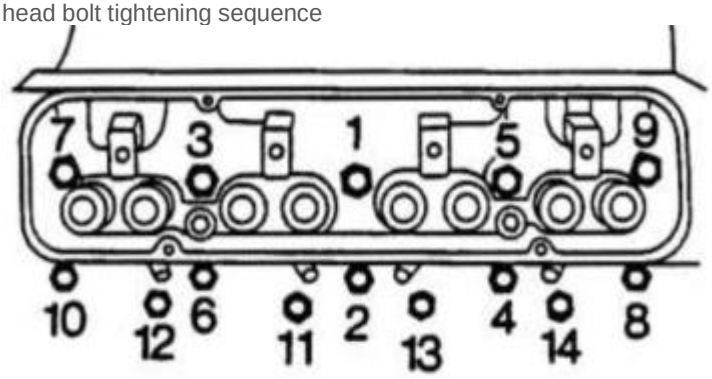

Image 3: 2003 Rover Overhaul Manual cylinder head bolt tightening sequence

MGBGTV8 – Cylinder Head Removal and Replacement

For most of us the first step in any significant engine work is to consult the Workshop Manual and check the manufacturer's procedures and technical data. Knowing the origins of their V8 engine it will not surprise MGBGTV8 owners that there are two official Manuals for their engine but what will surprise them is the conflicting data they present. The documents in question are the MGBGTV8 Workshop Manual Supplement (AKD 8468) released in 1973 by the Service and KD Division at Cowley ("MG V8 Supplement") and the Rover Overhaul Manual (Publication Part No. LRL 0164ENG 2nd Edition) published by Land Rover in 2003 ("Rover Manual"). The former publication was written in 1973 when the Rover V8 was still a relatively immature product with another 20 years of development and production ahead of it. It is one of the benefits of owning this long-lived engine that much of the service experience is incorporated in an updated official manual. The purpose of this article by **Jim Livingstone** is to identify the significant updates as they affect the operations involved in removing and replacing the engine cylinder heads.

There are several specific areas where the instructions in the MG V8 Supplement are questionable and alternatives should be considered when removing and replacing a V8 cylinder head. The areas are:

Cylinder Head Bolt Tightening Sequence

The original Rover V8 engine has an oddly asymmetric head bolt pattern. The service loadings on the head bolts are affected by multiple factors (cylinder pressure, bolt strain, thermal expansion, etc) and are consequently not evenly distributed but why the inlet side of the head should have 5 bolts while the exhaust side has 9 has puzzled this writer. Rover appear to have recognised this anomaly by relaxing the clamping force on the exhaust side by first reducing the assembly torque on the outer (exhaust) row of bolts and later by deleting the bolts altogether. Rover also adopted a more conventional diagonal bolt tightening sequence which contrasts with the MG recommendation which sees the inlet side tightened in advance of the exhaust side. The different sequences are contrasted in **Images 2 and 3**.

Head Bolt Lubrication and Tightening

The MG V8 Supplement specifies that the threads of the Cylinder Head bolts are coated with **3M Lubricant-Sealant EC776** prior to assembly whilst the Rover Manual specifies that they are **lightly oiled** only. One of the purposes of thread lubrication is to give a more consistent torque/tension relationship where assembly torque is specified as the tensioning parameter. The same assembly torques are specified for the inner bolts (those surrounding the bores) in both Manuals so it can be assumed that the treatments have similar friction characteristics. Later Rover engines changed the assembly technique to **angular tightening** * and single use bolts which the writer interprets as the adoption of a **torque to yield strategy** **. Though the bolts are not interchangeable with those used earlier the same lightly oiled treatment of the threads is specified. Note, the two terms highlighted in yellow above and the term below are explained in the footnotes on page 3.

Head Bolt Anti-Seizure Measures

In the MGBGTV8, steel head bolts engage in threads in the aluminium alloy casting of the cylinder block/crankcase. The consequences of combining dissimilar material will be familiar to most readers and the resulting **galvanic action can cause seizure of components**. Without going into the complex chemistry of the reaction it is standard practice to slow it by introducing an insulating or sacrificial layer between the materials. Fasteners are commonly zinc coated to provide the sacrificial layer but this can have strength implications (**hydrogen embrittlement** ***) in high stress applications and Rover specified uncoated bolts. An alternative is to employ a sealant to exclude the electrolyte which is a necessary constituent of the reaction. Use of either EC776 or oil on the bolt threads should actively reduce the risk of seizure. It is worth noting here that there are numerous products on the market specifically advertised as having anti-seize properties. However, many of these also have significant friction reducing side effects which if not

allowed for could result in overstressing of the bolts when the standard torque is applied.

Inlet Manifold and Gasket
The MG V8 Supplement specifies the same bolt thread treatment for Manifold bolts as the Cylinder Head bolts. **Silicon grease** is specified for the end seals and **Hylomar SG32M** for around the coolant passages of the manifold gasket. The MG V8 Supplement specifies a particular sequence for the tightening of the bolts on the gasket and end seals the logic for which is not obvious. The author does not have an equivalent Rover Manual for this area for comparison.

Exhaust Manifold Assembly
The MG V8 Supplement specifies the application if a single drop of **Loctite 40** to the lead thread of each exhaust manifold bolt and a very low torque of 13 lb ft for their assembly (a more usual torque figure for a 3/8" UNC bolt would be 30 lb ft / 40 Nm). This is presumably to avoid the high stresses caused by differential expansion over the long manifold face by allowing slippage. The application of Loctite appears to be a thread locking rather than a corrosion prevention measure and in the experience of the writer is not likely to be effective.

Cylinder Head Gasket Assembly
Both manuals appear to be in agreement in this area by specifying an all metal gasket and dry assembly. The Rover Manual reserves the composite gasket for later models which Rover identify as suffix B engines.

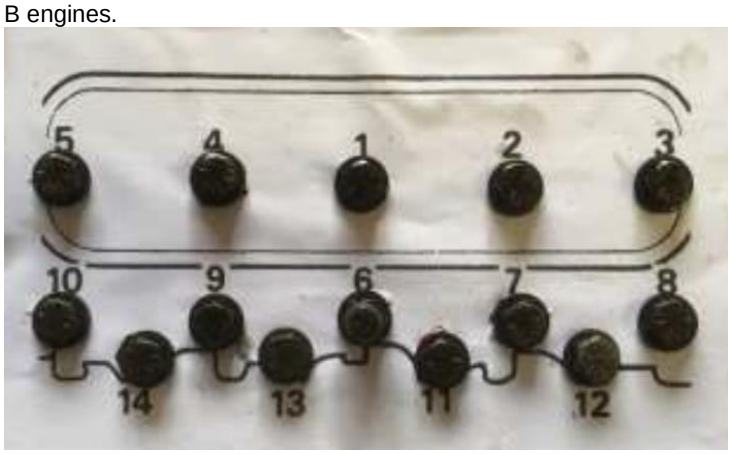

Image 4: Bolt storage (using a MG template stuck to the lid of a shoe box)


Image 5: Cylinder head surface inspection

Procedure
The following is the procedure adopted by the writer for a recent cylinder head removal and replacement. It is based on the Rover Manual procedure and his experience from previous engine overhauls.

1. Remove the cylinder head having progressively loosened the bolts in the reverse.order to that specified in **image 3**.
2. Retain the bolts in their original positions – **see image 4**.
3. Clean the head, block and manifold joint surfaces with a plastic scraper and inspect both for flatness and damage – see **images 5, 6 and 7**.


Image 6: Exhaust port inspection (note the leakage on cylinders 1 and 7)


Image 7: Exhaust manifold inspection

Image 8: 7/16" UNC die nut for bolt thread cleaning

4. Clean any residue of sealant from the head bolts with a 7/16" UNC die nut and from the block threads with a 7/16" UNC tap – see **image 8**.
5. Place a new metal gasket on the block dowels.
6. Carefully lower the cylinder head on to the dowels
   Note: to avoid damaging the head surface on the steel dowels screw a couple of 7/16" UNC studs into block holes **12** and **14** in **image 3**.
7. Lightly oil the head bolts and assemble them with their washers into their original holes.
8. Progressively tighten the bolts in the order specified in **image 3**. Take all up to 60 Nm and then only 1 to 10 up to 90 Nm.
   Note: If your torque wrench has not been calibrated recently it may be prudent to confirm its accuracy at 90 Nm. The writer did this with a digital weighing device – see **image 9**.

Image 9: Confirming calibration of torque wrench

9. To cure the exhaust port leakage the writer assembled the tubular manifold with new 3/8" UNC x 1.1/8" stainless steel bolts and tightened them until the gap was closed. The torque required was significantly under the safe limit for a 3/8" UNC bolt.
10. On the inlet side the writer used black silicon sealant sparingly on both end seals and round the water passages. This had been used on the previous engine build and appeared to have been effective. The gasket was preformed into the shape of the mating surface and assembled before the sealant cured. It was held in place by the bolts in the end clamps while the manifold was assembled and its bolts progressively tightened to a torque of 28 lb ft / 38 Nm.

Explanation of Terms

- *** Angular tightening**: where an angle of bolt rotation is specified rather than a torque. For example, the Rover Manual specifies the following for Suffix B V8 engines. "Cylinder head bolts: Stage 1 20 Nm/15 lbf ft; Stage 2 Further 90°; Stage 3 Further 90°". The objective is a more accurate tensioning of the bolt by removing the variability due to friction effects. The tension now is due to bolt strain which is a factor of angle turned and thread pitch.

- **** Torque to yield**: this process realises the potential of the bolt by tensioning it to its maximum allowable stress level. Advantages are – tighter and more consistent clamping, smaller bolt sizes, greater resistance to fatigue failure, less likelihood of loosening. A disadvantage is that the bolt cannot be reused. Yield is the point at which the stress/strain relationship becomes non linear and the material leaves the elastic region to enter the plastic region and permanent deformation. It is a sensitive process to manage and its application is generally restricted to the manufacturing environment where sophisticated machinery can detect the onset of yield.

- ***** Hydrogen embrittlement**: when high strength steels have been exposed to hydrogen through processes such as plating their ductility and strength can be adversely affected.