Gaskets: theory and practice

Gaskets have been around for a long time, and tend to be taken for granted. However, they perform an extremely important function in keeping fluids – water, oil, and even air – in the right place by sealing potential leakage paths in an assembly. Over time gaskets have evolved as greater demands are placed on their performance and as materials have evolved and changed. The result of these changes is that some of the procedures that were accepted practice when Rileys were building cars are no longer appropriate, and the following is intended to describe some of these as well as some practical applications.

In theory, if two surface that have been machined flat are clamped together nothing should be able to leak through the joint. However, in practice, this does not happen as the surfaces are never truly flat; if they were it would be very difficult to separate them. There are likely to be machining marks left on the surface, and the surface may well be very slightly distorted or bowed – more of that later.

In order to make the joint between the two surfaces leak-proof, a relatively soft material in the form of a gasket can be clamped between the surfaces. This will distort when compressed and bridge the machining marks or other surface irregularities that may be present. Provided that there is no major damage on either surface that may hold them apart the gasket should effect a seal. This will be satisfactory to deal with the 'micro' irregularities such as machining marks, but may not cope with the 'macro' distortion such as a surface that is bowed or physically damaged.

There are a number of different materials that may be used in the manufacture of gaskets, and some which were available thirty years or more ago have been superseded or withdrawn because they contained asbestos.

<u>Paper gaskets.</u>

The paper used in the manufacture of a paper gasket is an oil-resistant product, and typically is available in thicknesses of 0.006", 0.010" and up to 0.032" or their metric equivalents. For particular applications multiple layers of paper can be laminated to produce gasket thicknesses of ¼" or more. Paper gaskets are very effective for sealing against micro surface defects. As the thinner gasket papers will compress very little when fitted important dimensional relationships between the two parts being clamped together will be maintained.

A major disadvantage of the use of paper as a gasket material is that over time the gasket will shrink while in storage, and the larger the gasket the more significant this becomes. If it is vacuum-packed as soon after manufacture as possible the shrinkage can be reduced, but this is not fool-proof.

<u>Cork gaskets.</u>

Pre-war at least, thin layers of cork were often used to make up gaskets. Two layers could be laminated, often either side of a sheet of fine calico, to make the material less fragile. Cork gaskets are relatively soft and were often used between faces where the clamping force might be quite uneven or relatively low, as in a pipe flange with just two securing bolts. They were specified when sealing flanges on pipework carrying liquids such as water or fuel, or under the flange on covers such as rocker covers.

Because the majority of cork that has been available for many years has not been of adequate quality to make cork gasket sheet, the cork gasket material currently available is actually a composite. Cork granules are bonded together with a rubber material which is then formed into a sheet. In this case the properties of the rubber binder are as important as the cork. For example, if the cork composite is to be used to seal against petrol, the rubber binder must be petrol-resistant; many cork/rubber composites are not suitable in this instance.

Because a cork-based gasket is relatively soft, it will not support a sealing face if this is not very rigid. For example, if the clamping face is part of an aluminium component and has a lug extended to one side that carries the clamping bolt, when the bolt is tightened the lug will be pulled into the gasket. Eventually the lug may crack and break away from the sealing face.

The gasket that RRSL now supplies for 12/4 and 15/6 rocker covers is a particular type of composite cork gasket. In this case two thin layers of cork composite formed from cork granules bonded with a polyurethane binder form a sandwich around a thin 0.05mm aluminium foil. The sandwich is held together with a 'medium-tack' adhesive. This gasket may be re-used a number of times, with suitable care.

<u>Copper or brass lamination with asbestos filling.</u>

This is the type of gasket that was developed in the early days of motoring in areas were temperature in particular could be a problem, particularly around combustion chambers. Either side of the gasket is faced with a thin copper or brass sheet trapping a layer of asbestos filler between the two. On one side the copper sheet is formed into a lip around a cylinder bore and this is then rolled over to seal against the outer face of the other copper lamination, such that the edge of the gasket around the cylinder bore is sealed by the copper. Usually a cylinder head gasket will have copper sheets that are of different thicknesses, with the thicker sheet forming the seal around the cylinder.

As well as being used for cylinder head gaskets copper/asbestos gaskets were used everywhere where temperature might be an issue, such as exhaust flanges.

<u>Aramid fibre gaskets</u>

Aromatic polyamide or 'Aramid' fibres are made from long-chain polymer molecules resulting in a high-strength material. Kevlar and Nomex are particular well-known brands. When mixed with a flexible elastomeric binder and formed into a sheet the resulting material makes a very effective gasket material. The properties of the sheet can be varied depending upon the binder and the possible additions of other fibres.

Aramid gasket material is available in a wide range of thicknesses, the thinnest usually being 0.25mm, or about 0.010". Unlike paper gaskets of a similar thickness aramid gaskets do not shrink when in store, and often they can be used in place of paper gaskets.

<u>Asbestos replacement</u>

In 1999 the use of asbestos was banned, which resulted in what can only be described as a panic in the motor industry, particularly among those supplying after-market spare parts. Initially there was no reliable alternative for the asbestos filler found in cylinder head gaskets, resulting in a plethora of gasket failures. In due course new materials, including Aramid fibres, were developed which generally proved satisfactory when faced on both sides with a copper film. However, a number of the materials being used in sheet-form in place of the asbestos resulted in gaskets with a relatively short life, requiring further investigation. When a gasket was assembled with a pressure-sensitive film between the gasket and the face of the cylinder head or block it was found that the pressure across the face of the gasket could vary significantly across the gasket as shown by the sensitivity of the film. In areas where the pressure in the gasket was reduced there was a tendency for the gasket to fail. The reason for the variations in the clamping pressure was that the actual thickness of the filler material varied slightly, and consequently the clamping pressure across the face of the gasket varied when compressed between two flat surfaces. Improvements in the quality of the filler material overcame these issues.

Current cylinder head gaskets

There are two different styles of cylinder head gasket offered by RRSL. The Nine gasket is similar to the familiar copper/asbestos gasket, but with the asbestos being replaced with sheets of an aramid fibre material called Cemjo, manufactured by Federal Mogul. Other cylinder head gaskets are also manufactured from sheets of Cemjo, but laminated on either side of a tin-plated steel core 0.21mm thick. The Aramid layers are cleated and bonded to the steel core. Depending on the gasket, passages through the gasket that carry oil either have a metal eyelet fitted or in the case of the Cemjo faced gaskets have a ring of gel applied to the face around the hole to ensure an effective seal when compressed against the head or block.

Preparation of surfaces to be sealed with a gasket

As stated earlier, if two perfectly flat surfaces are bolted together in theory a gasket between the surfaces will not be required to effect a seal. In practice micro-variations in the surface will compromise the seal, and in the old days liquid shellac could be painted onto the faces. After tightening up the joint this hardened in situ and sealed the faces. Another commercially available product was called Osotite, which I believe was based on shellac, and worked in a similar way.

In years past, another method to seal two undamaged flat faces one to the other without adding the extra thickness of a gasket was to lay a length of good quality wool thread (think knitting) around each passage or orifice in the face to be sealed, making sure that the two ends of the thread are side by side and overlap. A thin smear of soft grease on the surface will help and holds the wool in place. When the faces are clamped together the rings of compressed wool effectively create a seal, preventing fluids from leaking across the face from the passage.

In reality today, and in the world of pre-war Rileys, the need is to seal surfaces that are no longer fresh and new. It is very likely that surfaces to be sealed are not flat and have sustained damaged due to historic abuse. There may be burrs on the edges of surfaces where levers have been applied in the past, or damage due foreign bodies being trapped between flat faces before they are bolted together. In order to have the best chance of creating a leak-free joint the damaged should be removed. Ideally the faces should be re-machined, but in practice this is often unrealistic. However, much can be done with the use of fine flat files and oil stones.

In extreme cases surface damage will be visible to the naked eye. Otherwise the damage can be detected by laying a flat fine-cut file on the (clean and dry) surface and gently drawing it across the face. The presence of damage can often be felt as the file passes over it. Alternatively the file will have been in contact with high points on the surface which will show up as bright spots. If the damage is more minor, but still significant, the same process can be done but using a small flat oil stone in place of the file to pinpoint the damage. Very useful in this context are oil stones made from hard translucent Arkansas stone which is sourced in America. The very finest Arkansas stones are intended to polish surfaces, and are very effective in high-lighting high spots on an apparently otherwise flat face. Any damage to the surface can be removed by careful use of a file – flat needle files are particularly useful – or the oil stone.

Gasket compounds

As already mentioned, shellac and Osotite were traditionally used to aid the sealing of gaskets or for sealing particularly flat surfaces when used without a gasket. Later red Hermetite was introduced, to be used with or occasionally without a gasket. This was very effective, but was messy and set hard which could make subsequent dismantling quite challenging. Today there are many proprietary sealing compounds, including silicon sealants or 'Gaskets in a tube'. Silicon sealants can be very effective but often contain acetic acid and this can be particularly damaging on magnesium alloys. They are often used to replace a gasket altogether, but this can cause a problem if in the original design of the assembly the thickness of a gasket was being allowed for in the way it was dimensioned. In addition, usually too much silicon is applied and excess sealant will be extruded from the side of a joint, and if inside an engine or gearbox should this fall off it has the potential of blocking important passages and oilways.

Surprisingly no sump gaskets were specified by the Riley company originally, and it can only be assumed that shellac or Osotite was used in place of a gasket. RRSL has decided to make available suitable sump gaskets, to help reduce the amount of oil that otherwise might drip onto the drive. These are manufactured in an Aramid fibre.

Personally, if I need to use a gasket compound I prefer either Wellseal or Blue Hylomar. Both are very effective and stay soft, so later dismantling is much easier. For guaranteed success all surfaces, including both sides of the gasket, should have a thin layer applied, and all metal surfaces should be thoroughly degreased before the gasket compound is applied. Because both of these products stay soft they can be applied to the surfaces some time before the joint is made.

In my humble opinion the use of silicon sealants or similar is to be discouraged. It is better to use the appropriate gasket, with a gasket compound if required.

Warning!

Gaskets made from Aramid fibre, as are many replacements today, are not intended to be used with gasket compounds, according to the manufacturers of the material. If the gasket joint is bolted up 'dry' the metal faces will tend to grip the gasket. If a gasket compound is used on the face of the gasket it will act as a lubricant and as the joint is tightened the gasket will tend to slip and extrude sideways out of the joint. This is a problem particularly with gaskets that have a narrow sealing face such as front timing case gaskets. Rather than relying on the gasket compound to take up discrepancies in the surfaces it is very important to ensure that the surfaces are flat and free from damage before assembly and assemble the gasket 'dry'.