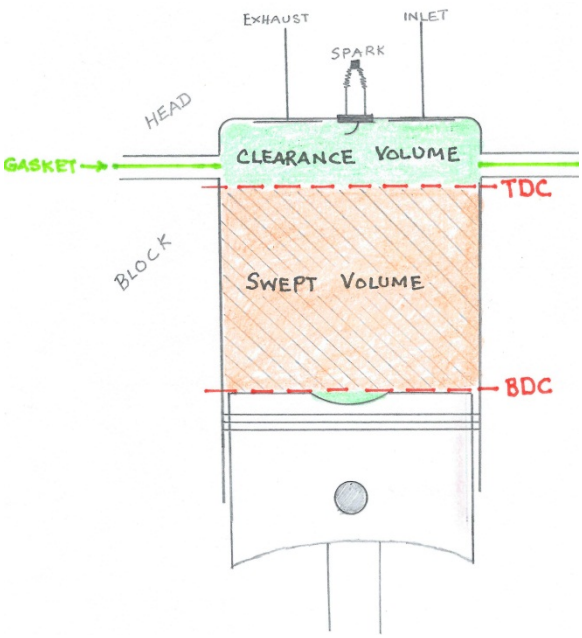
Understanding Compression Ratio

As built, our MGB cars with their 1800 B-Series engines had a variety of Compression Ratios (CR) depending on the year and engine configuration. The Compression Ratio is a measure of how much the cylinder volume is reduced in the compression stroke before ignition. A CR of 8:1 would mean that the volume in the cylinder is reduced to 1/8th. Compression Ratio affects power since the more highly compressed the air-gas mixture is in the cylinder, the more power is generated on ignition. Our cars were either Low Compression with CRs around 8.0:1 or High Compression with CRs around 8.8:1 depending mainly on cylinder head and piston configurations. A higher Compression Ratio means the air-gas mixture is squeezed more by the piston in the cylinder resulting in higher cranking pressures. Cars with CRs of 8.0 usually have cranking pressures of around 130 pounds and CRs of 8.8 usually crank at around 160 pounds.

But what is the Compression Ratio? How is it defined, measured, calculated? Each cylinder has a maximum or *Total Volume* when the piston is at the bottom of the stroke (called Bottom Dead Centre or BDC). When the piston is at the top of the stroke (called Top Dead Centre or TDC) the minimum volume is called the *Clearance Volume*. The volume decrease when the piston moves from BDC to TDC is called the *Swept Volume*.



Total Volume = Swept Volume + Clearance Volume

CR = Total Volume ÷ Clearance Volume =
(Swept+ClearanceVolumes)÷ClearanceVolume

The Swept Volume on an unaltered 1800 B-Series engine per cylinder is 1800÷4= 450 cc. This can also be calculated by the formula:
SV=Stroke x $(1/2Bore)^2$ x π = 8.9 x $(0.5x8.026)^2$ x 3.1416 = 450 cc
The *Clearance Volume* is the sum of : Combustion Chamber volume, Gasket Thickness volume, Block Deck to TDC volume & Piston Dish volume

There were two variants of Combustion Chamber volume. On 18G series engines the cylinder heads had 43cc combustion chambers and they had 6.2cc dished pistons. The 18V series engines had cylinder heads with smaller 39cc combustion chambers with 16.2cc dished pistons. The volume caused by the standard gasket thickness is about 3.2cc and the volume between TDC and the block deck is usually about 5.1cc.

So, on an 18G series engine the Clearance Volume would equal [43+3.2+5.1+6.2 = 57.5 cc] and the CR equals [(450+57.5)÷57.5 = 8.8]

On an 18V series engine the Clearance Volume would equal [39+3.2+5.1+16.2 = 63.5cc] and the CR equals [(450+63.5)÷63.5 = 8.1]

There are a number of ways of increasing your Compression Ratio. You can shave the block deck, shave the cylinder head, increase the bore or reduce the piston dish.

For example if you put the 6.2cc dish pistons into an 18V engine instead of the 16.2cc pistons the new Clearance Volume = 39+3.2+5.1+6.2=53.5cc and the new CR=(450+53.5)÷53.5 = 9.4 ! Flat top pistons would get you up to a CR of 10.5.

Overboring the cylinders isn`t as dramatic. For example, a .03" overbore increases the Swept Volume from 450 cc to 459 cc. On an 18V engine with 16.2 cc pistons this would change the CR to (459+63.5)÷63.5 = 8.23 from 8.1.

When shaving the cylinder head you have to be careful that you don't take too much off, particularly on the 18V heads with the 39cc Combustion Chambers. Engines with these heads had a small cutout (called an eyebrow) cut into the top edge of the cylinder. This was because these heads were not as deep and without this notch the exhaust valves would contact the cylinder wall at high RPMs. A 40 'thou' shave (.040") on a

43cc combustion chamber head would bring the chamber volume down to 39cc and you could run into this issue.

How high to go? British Automotive recommend max CR of 9.1 for street cars. Peter Burgess says 9.7 for road use, rally cars up to 10.8, racing 11.5-12.5:1. The higher one goes with CR the greater the chance of preignition (early detonation). Higher CRs usually require higher octane fuel to avoid this.

Alternatively one may have to retard ignition timing to avoid pre-ignition and this robs horsepower so you may lose your gains. It is probably wise to stay under 10:1 for normal use.

Cheers 'til next time.

Dave Burns

Reference:
British Automotive www.mgbmga.com
How to Power Tune MGB 4 Cylinder Engines by Peter Burgess

(Note: Taken from the Fall 2012 issue of the Octagon, the magazine of the MG Car Club of Toronto)