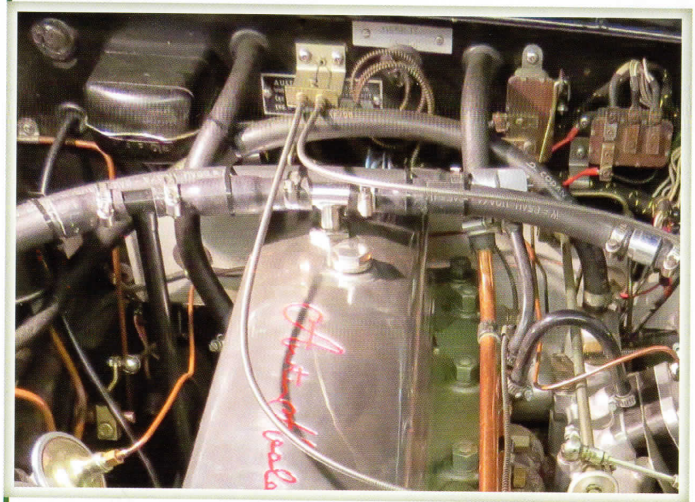
Positive Crankcase Ventilation

by Tony Ball



My 63 BJ7 leaks oil - which is not a particularly interesting way of starting an article for the Austin Healey Club magazine.

It's more like a statement of the bleeding obvious.

However the leak rate is now about 5% of what it was a year ago - without recourse to an external rear main crankshaft seal.

The previous consequence of a weekend trip was a 6 inch pool of oil below the bell-housing and dozens of drips from various parts of the downstream chassis where oil was smeared liberally over the surfaces by the air stream under the car. This was accompanied by high oil consumption and a messy, smelly car and garage.

I also had problems with fumes in the cockpit on the overrun and a smutty engine bay in the area around the oil clogged rear air filter.

This collection of issues probably seems very familiar to fellow readers.

I have fixed all of these things and gained some other notional benefits following a lot of research, some trial and error and an outlay of about £200.

This article tells the story.

Purists and xenophobics should look away now as the solution described below includes some "foreign" components.

Leaks from the rear main crankshaft oil seal are partly the result of the unreliable scroll type of oil thrower which is supposed to collect oil droplets from the crankshaft surface where they are attempting to escape under cover of darkness and send them back to the crankcase from whence they came via a hoped for Archimedes screw effect.

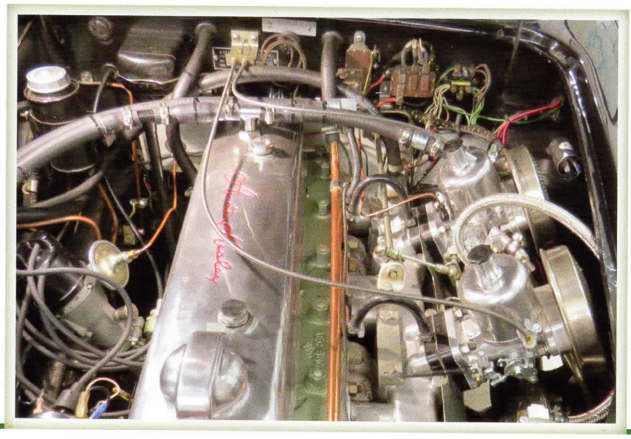
One well known solution is to fit an additional modern crankshaft seal external to the crank case. However, I believe that these items should be fitted with the engine out of the car in shop conditions to ensure good dimensional control of the drillings.

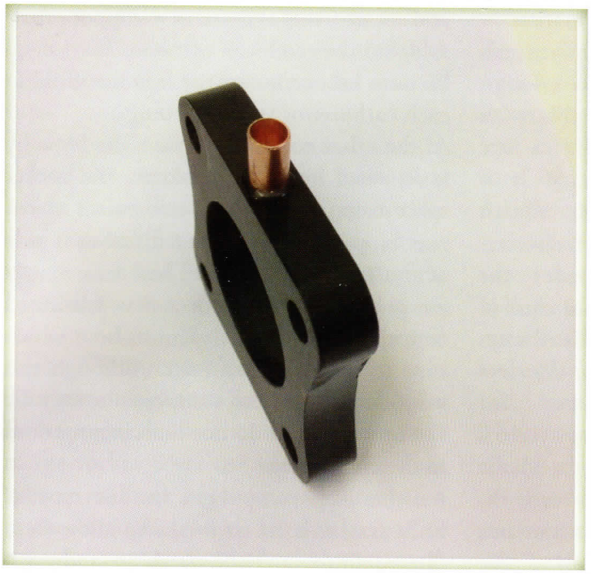
I couldn't face such a large scale job like this having done two recent gearbox change outs because of clutch problems - so I tried something different; Positive Crankcase Ventilation.

Another cause of the rear main leak is the inherent positive pressure in the crankcase resulting from "blow-by" which is the leakage of gas past the piston rings on the compression and particularly the power stroke. The older and more worn the engine, the greater is the blow-by and the greater the crankcase pressure.

A leak occurs from a pressure vessel because there is a leak path in the walls of the vessel through which a contained fluid can leak and when there is a higher pressure inside the vessel to drive the fluid through the leak path to the lower pressure environment outside.

Therefore, if the internal pressure of the ves-





sel (crankcase) can be reduced below atmospheric pressure, there is little to encourage the oil to attempt an escape though the leak path in the form of the rear main seal or any other gap in a gasket or seal elsewhere in the crankcase.

The standard Healey crankcase and rocker areas are vented by connecting the tappet cover and rocker cover vents to the rear air filter where the blow-by gas is supposed to be drawn into the carburettor intake and be burned as part of the air/fuel combustion. However, this is a passive process and it results in a build up of oil which has dropped out of the gas stream and then clogs up the rear filter. Also, when the throttles are closed from power to overrun the residual blow-by gas has nowhere to go and finds its way out of the air filter into the engine bay leaving smuts behind and then creeping into the cockpit - a bit like the effects of a farty passenger - or a farty driver for that matter.

My solution was to design and fit a bespoke positive crankcase ventilation system. This system harnesses the vacuum in the inlet manifold and uses it to draw blow-by gas from the crankcase into the manifold in a controlled manner leaving a slight vacuum in the crankcase. The clever part of a PCV system is the PCV valve which is a kind of combined check valve and pressure controlled variable orifice. There is another fart analogy that comes to mind - but I won't go there.

This solution is not new and my internet research revealed several others who have tried it. The difficulty I had was to find a PCV valve that would work given that the engine was not designed for a PCV system - and how would I know that it was working properly after I had fitted it?

I was deep into looking for other high capacity 6 cylinder engines of a similar era which did have PCV valves fitted when I discovered an adjustable PCV valve - perfect!

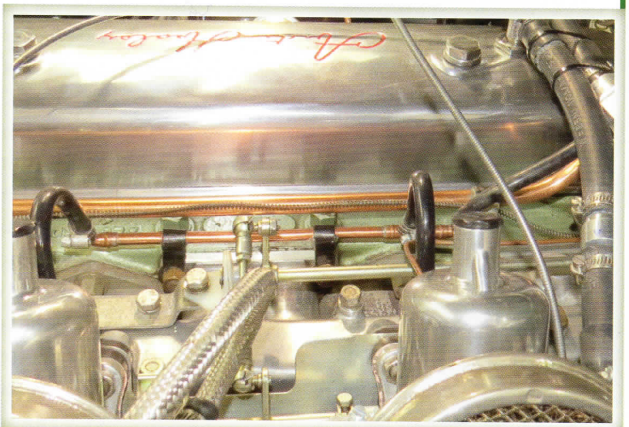
This is a surprisingly new product which on the face of it should have been developed and marketed decades ago.

Any remaining xenophobic flatulent purists who have made it this far really should turn the page now.

This is an American product arising from the hot rod community where customised engines are often far from standard with unique internal pressure characteristics resulting from big valves, porting work, wild camshaft profiles and suchlike. The PCV valve I have utilised came from M/E Wagner; mewagner.com - whom I do not represent in any way - by the way. Their patented product is a very clever device about the size of your thumb and contains two linked adjustable circuits; one for idle and one for cruise. It is set up using a vacuum gauge to tune the circuits to the actual vacuum characteristics of your engine. It retails at 129 USD.

So the first part of my solution was identified but - where and how to fit it to the car? The PCV valve is designed to control a gas stream and such things do not work effectively if they have to swallow liquids at the same time, so I decided to include a catch can in my system. This is a "knock-out" pot intended to capture oil droplets entrained in the blow-by gas by slowing down the flow rate so that they will coalesce onto an enlarged internal surface area and gather in a contained pool before they arrive at the PCV valve.

There are dozens of catch can variants on



the market. I chose a small simple design of about a third of a litre capacity. It is small enough to fit discreetly under the shroud clear of the distributor. Some Healeys prepared for competition have a large catch can fitted in the area behind the front offside wheel arch but my car has a brake servo which occupies this space.

The can I selected has a screw off bowl which seals onto a large "o-ring" a bit like the screw off canister type of oil filters.

It's intended for a BMW.

Well - I did warn you.

It retails at about £25.

I added some stainless steel wool and a mesh screen to the bowl to increase the internal surface area. I avoided the variants which have sight tubes and drain valves as they are potential leak paths which may compromise the vacuum. The bowl is removed periodically to dispose of the collected oil responsibly in the same way as sump oil after a change. My collection rate is about a teaspoon full every 100 miles.

Having found a suitable location for the can I plumbed it in using oil resistant vacuum hose. There is a "spare" connection on the inlet manifold of my BJ7 which seemed to be suitable for the vacuum connection.

I decided not to use this in favour of a more symmetrical arrangement where the connection to the vacuum source is split using a tapping drilled into each of the thick black phenolic heat insulating spacers which separate the carburettor bodies from the manifold. I made up a small manifold to split the flow stream using copper tubing supported by steel strips attached to the manifold to head bolts. This arrangement is quite neat and harmonises well with the adjacent copper heater pipe.

The PCV valve is partially hidden and located between the new copper manifold and the catch can exit hose. Two small vacuum hoses connect the new manifold to each carburettor spacer tapping.

At the other end of the system the blow-by is removed from the crankcase and rocker space using the existing exit points at the rear tappet cover and the distributor side of the rocker cover tee. These two outlets are joined together with a new fabricated copper pipe tee and a vacuum hose which runs to the catch can inlet. Although this solution uses modern components, they are "yester-tech" and do not look incongruous in the engine bay.

Another key component in this type of PCV system is an air intake to allow fresh filtered air to enter the crankcase and complete the breathing process. In a vee engine the PCV air intake is typically at one end of one bank and the blow-by exit is at the other end of the opposite bank where the PCV valve plugs into the rocker cover. This optimises the ventilation of the whole crankcase and both rocker areas.

The best available equivalent in a straight 6 is to locate the inlet breather at the opposite end of the rocker cover to the blow-by exit. This means that the other (carburettor) side of the rocker cover tee should not be used as the inlet breather connection as it would "short circuit" the internal engine spaces which would not be purged effectively.

I had planned to replace my rocker cover as the original was somewhat battered and warped and it occurred to me that the alloy aftermarket types available have a Monza type of flip up oil filler cap that have scope for minor modification.

I have converted the filler cap to double as an air intake filter by introducing a mesh screen with a filter layer behind it and with holes drilled in the pressure plate. Air flows in through the annulus between the sealing ring and the outer cap, it goes through the filter element and into the rocker space though the new holes drilled inside the sealing ring.

Another feature of an effective PCV system is good baffling in the immediate area of the blow-by exit locations. Without good baffling, oil will be drawn out of the engine unnecessarily and overload the catch can and PCV valve. The alloy rocker cover I used had no baffle below the outlet to the tee as supplied, so I had to fabricate one from a folded piece of plate and secure it using a second nut on the threaded tee connection inside the cover. There was just enough room for this arrangement. The lack of a baffle in this location in the aftermarket alloy covers is a problem. Even

without a PCV system, oil will be flicked up the outlet by the rocker arms and valve caps increasing oil loss into the rear oil filter.

The original rear tappet cover outlet on the side of the engine does have a baffle plate inside the outlet tube but on my car this was crimped flat such that it was almost closed. This had the effect of increasing the gas flow speed close to the outlet and drawing out nearby oil droplets. I managed to re-shape it to reduce this problem.

The plumbing arrangement described so far leaves two connections unused; one side of the rocker cover tee and facing it - the tube at the back of the rear oil filter. After further thought I decided not to leave these connections blanked off and pointing at each other pointlessly. This would have looked silly.

This type of PCV system relies upon a vacuum to make it work and there is no vacuum at wide open throttle (WOT). This condition does not persist for very long in road driving but when it does occur it coincides with a high rate of blow-by and high crankcase pressures which are not dealt with by the PCV. It is possible for the inlet breather to act as an outlet in these conditions but I decided to create a second outlet route for WOT conditions by reconnecting the rocker cover tee to the rear air filter - but with a non-return valve included in this length of vacuum hose. This valve is normally closed to preserve the crankcase vacuum by preventing inward flow from the air filter but it will open when the crankcase pressure increases above atmospheric allowing gas to flow out into the filter and be drawn into the carburettor by the high inflow rate occurring at WOT. It was important that this valve should have a low cracking pressure of about 1-2 psi. Before fitting it I checked this pressure through my ability to blow it open - and I don't even play the trumpet.

This system contains all of the features of a modern PCV arrangement and it may be the first time an adjustable PCV valve has been used on a Healey.

I have pretty much fixed the rear main leak, the farty smells have gone and the engine bay and rear oil filter stay clean. Oil consumption has reduced.

There are other theoretical benefits from a PCV & catch can system including;

Reduced emissions.

Better conditioned oil where the blow-by is removed before it contaminates the oil with petrol, acids and water vapour from the combustion chamber.

Reduced "windage"; the resistance given to the movement of the crankshaft by the contents of the crankcase.

Improved piston ring seal

Removal of oil from the inlet air/fuel mixture. Oil is combustible but it has the effect of reducing octane rating in the combustion process and will probably exacerbate pinking.

There is a fair bit of imagination, patience and creativity needed to make a system like this fit and work effectively without changing the character of the car but it is a very cost effective winter project if you have similar oil related problems and you like this kind of challenge. I am not a Healey expert but I thought my experience with this system may be useful to others and I would welcome any comments on this arrangement by others who have attempted this kind of thing.

I can't see much of a downside to this arrangement other than the possibility of the leaning out of the air/fuel mixture by the additional gas stream entering the manifold downstream of the carburettor. I am still tuning this system to ensure that the air/fuel mixture is not leaned out. So far the engine runs very smoothly at normal temperature with no signs of faltering or lack of power from a lean mixture.

There is of course the lack of the oil leak auto rustproofing system to consider.