SU Carbs Cruise Control Vaporisation!

SU Carbs

Done properly, and not fiddled with afterwards, SUs will keep their tune for many thousands of miles. A superb quote that I have seen attributed to Lawrie Alexander of British Sportscar Centre is that "90% of the problems with SUs are due to Lucas electrics" i.e. the ignition system. Before setting-up the carbs it is essential that the valve clearances, plug gaps, points gap/dwell and timing including operation of the centrifugal and vacuum advance mechanisms are correct and any defects causing erratic or rough running are fixed.

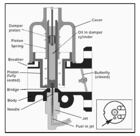
The MGB was originally provided with HS4 carbs for all markets, the rear having a vacuum advance port above the butterfly. In August 1971 with the then new 18V engine all export markets changed to HIF carbs - 18V584Z for North America, 18V581/582/583Y for other export markets. North American engines now had the vacuum source on the inlet manifold, other markets still from the rear carb but now underneath the butterfly. UK or 'home market' cars stayed with HSs on 18V581/582/583F engines, then in November 1973 they switched to HIFs on 18V779/780F engines (late CB, November 1973) again with a port under the rear carb butterfly, and non-North American export models had the same engines and carbs. With the change to rubber bumpers UK and non-North American export models moved the vacuum source to the inlet manifold. In December 1974 North America changed to a single Stromberg/Zenith carburettor on 18V797/798 engines until the end of production. Other export markets continued with HIFs and the same engines as the UK until the 1977 model year at which point all LHD cars were to North American spec - and only roadsters as North American GTs ceased production in December 1974. There were several additional carb spec changes during production.

Theory:

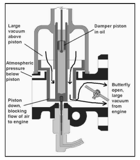
I'm not going into the theory of carburetion in general, just the specifics of the SU, but the job of the carburettor is to feed a mixture of air and atomised fuel into the engine, in appropriate quantities and volumes for the conditions, so as to achieve good combustion and so best performance and economy. These conditions vary according to how fast the driver wants go, whether the engine is hot or cold, accelerating or steady speed etc. Too much fuel in the air (or too little air for the fuel) - a rich mixture - will result in sluggish performance, fouled plugs, poor economy, and in extreme cases can wash the oil off the cylinder walls causing rapid engine wear. Too little fuel in the air (or too much air for the fuel) - a weak mixture - will cause hesitant running and miss-firing, poor performance, overheating, and paradoxically poor economy just like a rich mixture.

The SU carb is brilliantly simple in its design, with very little to go wrong. However the later HIF (which stands for 'Horizontal Integral Float', by the way) is a bit more complex than the earlier HS, which I *think* stands for 'Horizontal Side float'. Why not HSF then? Who knows? The 'Horizontal' in both cases refers to the direction of air flow into the engine, as opposed to the 'down-draft', or 'semi down-draught' you might see applied to some other designs of carb. Visual identification is simple - on the HIF the float chamber is contained within the main body of the carb and actually surrounds the bottom of the jet whereas on the HS the float chamber is to one side of the main body of the carb and has an external pipe connecting it to the jet. Whilst technically the HIF is an improvement over the HS, for a

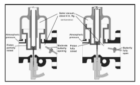
number of reasons there is no good reason to convert to HIFs if you already have HSs, and if you are converting to SUs from Zenith/Stromberg or an aftermarket conversion and have the choice of HSs or HIFs then HSs would be marginally preferable for their simplicity. The diagrams below are of an HS unless otherwise indicated, click on a thumbnail for a full-size image in a different window.



Put simply the SU carb consists of a butterfly valve on the engine side of the carb connected to the throttle pedal and this controls the volume of air being pulled through the carb and into the combustion chambers. However there is another independent 'valve' in the air passage, and this is the large piston which is on the air-cleaner side of the butterfly. The piston is relatively free to rise and fall depending on how much the butterfly is open or closed as will be seen later. Attached to the bottom of the piston is a tapered needle projecting downwards into the open end of a tube (the jet) containing liquid fuel, the height of which is controlled by a float and valve in the float chamber (not shown). With the butterfly mostly closed i.e. at idle the piston will be at the lower end of its travel so it is blocking most of the air passage through the carb. Also the widest part of the needle is in the jet so blocking most of its opening, and therefore little fuel is being mixed with the air, but the ratio of air to fuel (given correct adjustment of the carb) will be correct. With the butterfly fully open the piston will be fully raised allowing the maximum amount of air to flow through the carb, the needle will have its narrowest portion in the end of the jet, so unblocking most of its opening, and the maximum amount of fuel is being mixed with the air, but again the ratio of air to fuel will be correct. Generally this state of affairs will be obtained for any throttle butterfly opening, and hence any vertical position of the piston in the air passage and the needle in the jet. If you look through the carb it is not the same diameter all the way through. Across the top of the jet there is a raised portion the width of the throat - the bridge. This restricts the diameter of the carb throat at that point, which has the effect of speeding the airflow over it and hence over the top of the jet. This lowers the air pressure above the jet (Bernoulli's Principle) which is what causes fuel to be drawn up into the airflow to produce the mixture. So as well as the thickness of the needle in the jet controlling how much fuel is drawn up, the speed of the air flowing past the jet is also having the same effect. In steady state conditions although the **volume** of air increases as the butterfly opens and the piston rises, the **speed** of the air across the top of the jet remains much the same. However as the piston rises the narrowing needle allows more fuel to be drawn up from the jet even though the speed of the airflow is much the same. Later on we will see what happens when the speed of the airflow increases for the same needle position in one case, and the size of the jet orifice is increased for a constant volume and speed of airflow in another case.

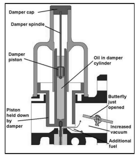


So how does opening the butterfly cause the piston to rise, and the needle with it? With the engine at idle the butterfly is mostly closed and the piston is mostly lowered. But far from 'idling' in the usual sense of the term i.e. doing nothing, the engine is acting like a large vacuum pump due to the action of the pistons in the cylinders. On the engine side of the butterfly i.e. in the inlet manifold there will be quite a large vacuum, which is measured in inches of mercury (in. Hg.), and can be up to 18 or 20 in. Hg. However between the butterfly and the piston there will only be a few in. Hg., and on the air cleaner side of the piston the air will be virtually at atmospheric pressure i.e. 0 in. Hg. Now consider the instant the driver opens the throttle a significant amount, say to accelerate away from traffic lights. The butterfly opens, but with the piston still mostly closed the large vacuum that existed on the engine side of the butterfly is now present between the butterfly and the piston. The piston has a couple of holes on the butterfly side near its base with passages to the space above the piston and its large skirt, so the vacuum is applied above the skirt. Although there is a gap between the edge of the skirt and the inside face of the piston cover it is a very small gap, so virtually none of the vacuum 'leaks' away. Now below the piston skirt there is a passage way to the two breather holes in the air filter flange, so the whole of the bottom of the skirt is at atmospheric pressure. Vacuum above, atmospheric below, causes the piston to rise. This increases the air flow into the engine and raises the needle out of the jet, which increases the fuel flow into the engine, so more mixture in the cylinders, a bigger bang when the plugs fire, and the engine accelerates the car.

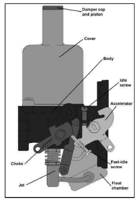


So how does the piston know how far to rise? As the piston rises it 'unblocks' the flow of air into the space between the butterfly and the piston, which reduces the vacuum there and above the piston. This reduces the difference in air pressure above and below the piston, which reduces the force causing it to rise. The piston will continue to rise, and continue to reduce the vacuum above the piston, until it reaches the point where the air pressure both sides of the piston and skirt are largely equal again. It will stabilise at a point where the vacuum between the butterfly and piston, and hence above the piston, are more or less at the same level it was before accelerating. It is this feature that causes this type of carburettor to be called a 'constant depression' or 'constant vacuum' carburettor i.e. no matter how big the throttle opening is under steady state conditions the vacuum between butterfly and piston will always be much the same. If you manually raise the piston further than it wants to go, the vacuum between the piston and the butterfly and above the skirt reduces, and when released the piston will fall back to its previous level. Similarly if the piston is manually pushed down the vacuum between piston and butterfly and above the skirt increases trying to pull it back up again, and when released the piston will rise back to its former level, and the amount of vacuum between butterfly and piston will be maintained.

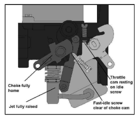
That is generally the case, but in practise there is a physically large but quite weak coil spring between the top of the piston and the outer cover pressing down on the piston and so restricting its rise somewhat. This is another feature to ensure the correct balance of air to fuel across the range of throttle opening, and means that a progressively larger vacuum is required the higher the piston rises. However the difference in vacuum between idle and full throttle piston heights is relatively small compared to the up to 20 in. Hg or so available in the inlet manifold. The spring strength, carb throat diameter, needle shape and jet size are all chosen to give the correct mixture across the operating range of the carb in any particular application. For a larger or smaller engine, single or multiple carbs, with or without supercharger, etc. the carb throat size, needle shape, jet size, spring strength etc. will all be chosen to give the correct results for that application. You can't just bolt on a bigger carb without doing anything else and expect your car to go faster, indeed it will probably perform worse. Likewise if you make changes to engine capacity, breathing, valve timing etc. you probably won't get the best out of them unless you change the carb parameters as well. What changes to make under what circumstances is a huge subject.



That is basically it. However whenever the throttle is suddenly opened the volume of air passing through the carb is able to increase faster than the volume of fuel can increase coming out of the jet. This has the effect of weakening the mixture, which causes the engine stumble when accelerating. To counteract this on top of the large piston there is a cylinder filled with oil - the damper cylinder. Attached to the outer cover there is a small damper piston sitting in this oil. As the large piston tries to rise the damper cylinder also rises, and because the damper piston is fixed this has the effect of forcing the damper piston further into the cylinder. As the lower end of the cylinder is sealed, and oil is not compressible, the only way the large piston can rise is for oil to be forced past the damper piston. The dimensions of both damper cylinder and damper piston are carefully set to that the oil flows past at a known rate, and hence controls the rise of the large piston. This damps or slows down the rise of the large piston, so that for a short time (a couple of seconds or so) the increased vacuum between butterfly and large piston causes the air flow across the top of the jet to increase in speed, which sucks more fuel out of the jet relative to the **volume** of air that is flowing even though the needle hasn't yet moved, so enriching the mixture to avoid the stumble. But when the throttle butterfly is closed there is no such need to control the movement of the large piston, so the damper piston is designed to be ineffective when the large piston is falling, so it falls immediately.



Another occasion when the ratio of air to fuel has to be altered from the norm is on starting from cold. When everything is cold the fuel doesn't atomise as well and so doesn't combust as well inside the engine, so again you get the effects of a weak mixture and indeed the engine may not start at all. To counteract this we have a choke. Well, it is called a choke but that is a hangover from earlier carbs where the air flow through the carb throat was manually restricted or 'choked' as a way of enriching the mixture. In both types of SU carb it is done by increasing the amount of fuel for a given amount of air (rather than reducing the amount of air for a given amount of fuel as in the other design of carb) and so is an enrichment device rather than a choke. But no matter, 'choke' is the generic term, so that is what we shall use. The HS and HIF types differ in how they enrich. The HS has a very simple mechanism for lowering the jet relative to the needle, so increasing the size of the outlet, which allows a given speed of air passing over the end of the jet to draw out a greater quantity of fuel, so enriching the mixture. In the HIF there is a separate valve which opens and adds more fuel to the air stream via separate passages in the carb body. Both types allow the amount of enrichment to be continuously varied i.e. they are not a simple on/off switch. As mentioned before a mixture that is too rich causes a number of problems so you should endeavour to have the minimum amount of enrichment for smooth running. In practice every car is different and you will have to learn how much yours needs under various conditions. As well as varying from car to car it also various according to the ambient temperature and how long the engine has been switched off. Even though the temperature gauge may show fully cold if the engine has only been off for a couple of hours, as opposed to overnight, it may restart with no choke or only minimal choke, you will have to learn. For example my roadster (HSs) needs full choke to start from fully cold then immediately pushed in about half-way, then gradually pushed in further as the engine warms up. By contrast the V8 (HIFs) needs full choke to start and for the first few seconds, then gradually pushing back in as the engine warms. However a pal's 78 (HIFs) is the same as the roadster and others with 4-cylinder HIFs have said the same. Also it is better to drive off immediately after starting and not let the engine warm through idling, unless you have to defrost windows etc., in which case push the choke back to just enough to keep it running, even if it needs more to actually drive off.



Another feature of the choke control on the MGB is that when correctly adjusted the first 1/4" of movement actually only increases the idle speed - the fast idle - and doesn't enrich the mixture. This is very useful if you are scraping frost, once it will idle at that amount of choke, even though you may have to add more choke once you drive off. In both carbs the choke control turns a cam which is sitting under the fast idle adjustment screw. As the choke is pulled the cam is turned and it gradually lifts the screw, which opens the butterfly a little more than the normal idle setting. Again the amount of choke to fast-idle is a matter of balance - too much fast idle will cause the engine to race before you have enriched the mixture sufficiently for slow running, which makes for difficult slow running in traffic. Insufficient fast idle may cause the engine to tend to stall even though the mixture is enriched, so you apply more choke until the idle speed is suitable, by which time the engine is over-choked causing the aforementioned problems of plug fouling and oil dilution.

Pistons, Covers and Dampers:

Dampers
Piston Balls *March 2013*
Drop-test

It is vital not to get pistons and covers mixed up. The original part numbers are for a pair matched in the factory to meet a specified drop-test characteristic, and mixing them up can significantly change the operating performance of the carbs.

There are some misconceptions about covers though, one being that you have to mark the cover relative to the carb body to get it back at the right orientation. Incorrect as the fixing holes are not equidistant round the periphery so each cover can only go back in one orientation. Whilst two of the holes are either side of the intake, the third one has to be one side or the other of the port on the engine side otherwise it would project into the port.

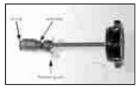
Another one is that you must mark each cover and piston so it goes back on the right body. Ideally yes, but not strictly correct as within each era of carb there is only one part number for each cover piston/assembly so they can be fitted to either the front or the rear carb.

The interesting thing is that HS carbs and early HIF carbs have a breather rib in the cover neck, and that rib faces in different directions - towards the air-cleaner on the front carb and forwards on the rear carb. This is because the fixing holes in the carb body are mirror images with the hole nearest the engine being one side of the port on one carb and the other side of the port on the other carb. So the cover is at one orientation on the front carb and a different orientation on the rear.

But later HIFs have the both ribs facing the air cleaners, and that is because instead of the fixing holes being mirror images, the hole nearest the engine is to the rear of the port on both carbs, so the covers are at the same orientation. At first I joked that it must have been someone with OCD not being able to stand seeing the offset any more. But that is highly unlikely, and I think it must have been for emissions reasons. Because they are a matched pair to meet a drop-test, unless the piston and the cover were perfectly circular you will get small difference in the drop-test depending on the relative orientation of the piston in the cover, and so you would get different operating characteristics depending on whether the cover/piston assembly were fitted to the front or the rear carb. With how the emissions limits tightened in later years for North America, maybe that difference was enough to cause problems meeting them. And by moving the position of the engine-side hole to be the same on both carbs, each cover and piston could be tested at a known orientation, and that would be the same when fitted to either carb. Maybe.

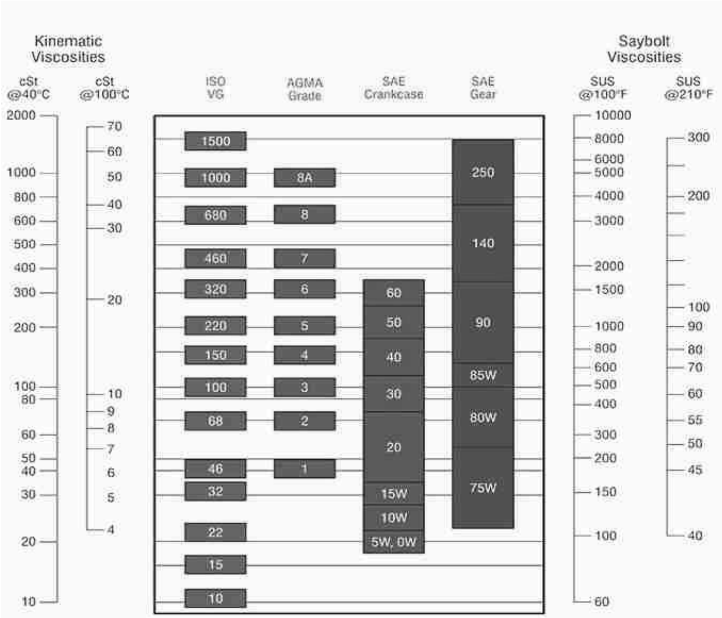
Dampers

Oil
Oil-level
Breather *November 2013*
Ball-bearing suction chamber
Retaining clips

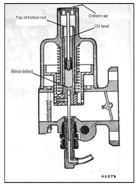


The damper consists of a brass cylinder on a rod inserted into an oil reservoir in the piston. It has a large clearance to the rod and a small clearance to the walls of the oil reservoir. At the top it is retained by a solid disc, and at the bottom by a circlip, and these two components allow it to damp piston movement when it is going up, but not when it is moving down. When the piston starts to move up the oil in the reservoir lifts the damper up the rod until it reaches the solid disc, which closes off the hollow centre of the damper so no oil can pass through. At that point the piston can only rise further as oil passes through the small clearance between the outside of the damper and the sides of the oil chamber. However when the piston is falling it pulls the damper downwards, opening up the space at the top, and with the circlip at the bottom both ends of the damper are 'open'. Thus oil can move freely through the centre of the damper, allowing the piston to fall without any restriction. Because the damper has to move up a very small distance when the piston starts rising before it starts damping, on very small throttle openings you may detect a slight hesitation as the mixture is not being enriched. On larger throttle opening normal damping covers up this initial hesitation.

Oil: A lot of opinions on what oil should be used in the damper. The Leyland Workshop Manual lubrication chart shows the same oil as used in the crankcase i.e. 20W/50 for temperate climates but 'thin cycle oil', 3-in-1, SAE 90 gear oil are all mentioned in various quarters. SU Burlen sell their own SAE 20 but at 瞿8 for 100ml (double that from 3rd-party sellers) it's a bit expensive and is yet another product to keep on the shelf when you already have engine oil. Thin oils will give less damping and allow the piston to rise more quickly which will cause flat-spots i.e. stumbling on acceleration. The proponents of SAE 90 gear oil say 'thicker is better' but this is a mis-nomer as the actual viscosity of 20W/50 crankcase oil almost exactly parallels that of SAE 80 to 90 gear oil as this chart from Precision Lubrication shows:



Oil-level: *December 2011*



Some confusion over this, and the manuals don't help. HS drawings show the oil level being **below** the top of the oil reservoir, whereas HIF drawings in the same manuals show it **above**. I have seen a claim that it has to be above so the outside of the reservoir is lubricated where it moves up and down again against the cover, but if HSs didn't need it why do HIFs? If you **do** try to keep it above, then you will be continually topping-up, and some people do say they have to keep topping-up. I have maintained my HIFs below, the same as my HSs, for around 90k with no ill-effects so far. All I do is unscrew the plastic cap, lift it up, and press it down again. If I can feel the resistance of the oil before the plastic cap reaches the cover, then I have enough, and the distance before tells me how much 'reserve' I have left. I don't have to top up from one year's end to the next. The oil only needs to reach the **bottom** of the damper piston in the oil reservoir to do its job, not the top, so to maintain it much above that is overkill.

March 2013: Just having discovered HIFs (and maybe some HSs) have ball-bearing assemblies between the piston and cover, I did wonder whether the higher level would initially drain down and lubricate the bearings, then stabilise, and only be topped-up again at the next service. As long as you only check at the recommended service intervals you will be fine, but if you keep checking weekly then you probably will have to keep topping-up. But as part of my research into the bearings I came across these historic SU technical documents on the SU Burlen site.

The HS document clearly shows the oil level below (a long way below) the top of the hollow rod, and the text states "... pour oil into the hollow piston rod to within about 1/2" from the top of the rod ..." (the text is a bit fragmented, you have to jump from the second line in section 4 to below the drawings in the second column).

The HIF document, Tuning - General page section 4 has three sub-sections depending on whether the suction chamber is 'standard' (i.e. no ball-bearings), has 'early' ball-bearings and the damper retaining clip, or 'later' ball-bearings. Not that it matters, because the two drawings and all three descriptions show the oil level is **below** the top of the hollow piston rod! So I go back to my Leyland Workshop Manual and Haynes to double-check what they say ... and start to wonder if I should have left well alone!

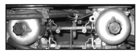
- Workshop Manual, section D, HS carbs: Has a drawing clearly showing the oil level about 1/2" below the top of the hollow rod. I can't see anything in the text about damper oil level, and the only reference to lubrication is that if sticking occurs, "the whole assembly should be cleaned carefully and the piston rod lubricated with a spot of thin oil".

- Workshop Manual, section D, HIF carbs: The drawing shows the oil level to be **above** the top of the hollow rod, and the text says to "Top up with new engine oil (preferably S.A.E. 20) until the level is 1/2 in. (13mm) above the top of each hollow piston rod". However the lubrication chart in the same manual shows the same oil as used in the crankcase i.e. 20W/50 for temperate climates.
- Workshop Manual, engine emission control supplement, Section 4 - carburetters (sic), HS carbs (single carb and dual): In four places the drawings appear to show the oil level **above** the top of the hollow rod, and the text states "Top up the piston damper with the recommended engine oil until the level is 1/2-in. above the top of the hollow piston rod. **NOTE.** - On dust-proofed carburetters (sic), identified by a transverse hole drilled in the neck of the suction chambers and no vent hole in the damper cap, the oil level must be 1/2-in. **below** the top of the hollow piston rod". However the drawing shows a drilled cap, but the oil level below, which contradicts the text.
- Workshop Manual, engine emission control supplement, Section 4-D - HIF carburetters (sic): The drawing clearly shows the oil level above the top of the hollow rod, and the text confirms that. You can't see whether the damper cap has a hole or not, but the cover has the angled rib at the neck which indicates the internal drilling, which replaced the hole in the cap. On HS carbs this would mean the oil level should be below, and not as shown and stated.
- Haynes, HS carbs, section 17 (vehicles not fitted with emission control equipment): The drawing clearly shows the oil level below the top of the hollow rod, but the text (sub-section 7, Maintenance) states "... top up the hollow piston rod until the oil level is 1/2 in (12.5mm) **above** the top of the rod." i.e. a direct contradiction.
- Haynes, HS carbs, section 23 (emission control equipped vehicles): No drawings, but the text states "Top up the piston damper to 1/2 in (12.7mm) above the top of the hollow piston rod. (On dust-proofed carburettors with no vent in the cap, 1/2 in. below the top of the piston rod)."
- Haynes, HIF carbs: There are no drawings of oil level and nothing in the text covering oil level.

The upshot? The Workshop Manual and Haynes do largely seem to agree with each other, in that **the text** indicates HS carbs with a hole in the damper cap have it above and those without below, whereas HIF carbs have it above regardless. However they are not without their contradictions and both disagree with the SU documents which show and state that it is always below for both carbs. If you do decide to top it up to above, then don't expect it to remain there for very long. Only put it to that level at each recommended service interval, allowing it to drop below the top of the hollow rod (but still be high enough to perform the damping action) in between services.

There is currently a long thread on a BBS about plugs oiling, and oil pooling on top of pistons, and after many posts the person who started it all said he has just noticed that there is oil in the throat of the carbs while they have been sitting on the bench, and wondering whether it could be from the carb damper, saying he did top up the dampers recently. At the moment we don't know to what level he filled them, and if they are HSs or HIFs, but there is another possible cause of **complete** draining of the oil from an HIF, rather than just what is above the top of the reservoir. And that is that while the reservoir on HSs seems to be blind-drilled, that on HIFs seems to be through-drilled, then plugged. If the plug is faulty or gets dislodged somehow, then that carb could drain completely.

Breather *November 2013*



As the piston rises and falls inside the suction chamber the damper oil chamber also rises and falls. Unless there is some way of equalising the pressure above the oil reservoir increasing air pressure will resist the rise of the piston in addition to the resistance of the damper, and resist its fall which should be immediate. Originally there was a breather hole in the damper cap which allowed the space above the damper to be kept at atmospheric pressure. However in dusty environments this would draw dust into the carb on each fall of the piston which when mixed with the oil makes a very effective grinding paste as well as clogging up the works and progressively restricting the free rise and fall of the piston.

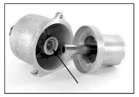
Subsequently a web was moulded into the side of the piston cover, which was drilled into the suction chamber above the main piston skirt. These carbs had a non-drilled damper cap and were termed 'dustproofed'. This internal drilling results in suction chamber vacuum being placed above the damper as well as above the piston. This is not a problem if the spring and other components take account of the probable increased 'lift'. Incidentally SU Burlen state in their description of a damper cap that "... some are externally vented (hole in the top) and some are internally vented (angled hole in the Suction Chamber) these are termed dustproof and non-dustproof respectively." Surely they have the terminology the wrong way round - the externally vented being non-dustproof and the internally vented being dustproof?

However the situation is very confused regarding webs or no webs, drilled or not drilled, and vented cap or not vented cap. My 73 roadster has the webs, but they are not drilled. They also have vented damper caps, so probably are correct. But the V8 has no webs, no drilling, and non-vented caps - so how is the space above the damper vented? They also have the ball-bearing arrangement between the piston cover and the outside of the damper oil chamber, instead of the plain and very close-fitting earlier arrangement. So perhaps the ball-bearing arrangement has a larger clearance that supplies sufficient venting. This will also result in piston lift vacuum being above the damper as well as above the piston.

Another thought is that if a vented cap is fitted to carbs with one of these internal venting arrangements, that would introduce an air-leak into the suction chamber, which could limit its rise as the throttle is opened, and definitely upset the mixture.

Ball-bearing suction chamber *March 2013*

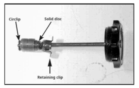
I've only ever claimed to be 'still learning', and this is a case in point. I got involved in a discussion about the Moss supercharger for the MGB when someone mentioned "needle rollers on the piston slide" of the HIF44 carb in that system. Whilst I could imagine ball bearings between the piston and cover to reduce friction and the chances of sticking, I couldn't see how needle rollers would do that, nor does the SU have a 'slide' like some other designs of carb do. I started Googling the HIF44, found no reference to 'needle roller' but did find one reference to 'a ball bearing' but no explanation. Again, it would have to be a minimum of three balls around the circumference to keep the piston centralised, and there would have to be a minimum of two sets to stop the piston tilting. So then I Googled 'SU ball bearing' and started to find more references.



Whereas originally the hollow rod of the piston slid in the cover directly, metal to metal, at some point SU started fitting two ball bearing assemblies, each containing six balls, to reduce friction and sticking as part of their emission reduction developments (see "Ball Bearing Suction Chamber Assembly" here). No clear indication of when, but it has to be in the late 60s/early 70s, and whilst it was definitely applied to the HIF it could also have been in late HSs as well. Originally the balls might have been loose as the V8 Register published a note about the risk, and Geoff Allen also mentioned it in a talk on the development of the V8. Later the balls were held in a plastic sleeve which retained them when the cover and piston were separated, this SU technical article does talk about two types of ball bearing assembly in the section on damper oil level. I have had my V8 HIF covers off and pistons out a number of times and never even noticed them, let alone had ball bearing dropping out, so wondered if I even had them. I found a picture of the cover on the Rimmer site which clearly shows the sleeve and lower balls, and whilst not wishing to remove my covers just for this I did remove the damper cap and peering inside can see the top of the same plastic sleeve between the piston and the cover. This does seem to indicate that mine have the later arrangement, but the same SU document describes that the early arrangement has retaining clips so the damper can only be lifted, not fully removed, whereas the later arrangement does not have the clip and the damper can be completely removed. And mine have the retaining clip! So maybe I've just been lucky not to lose my balls ...

I then started wondering whether this explained why the manuals show the HS damper oil level as being below the top of the hollow rod, whereas the HIF shows it above. I.e. at each service interval you fill it above, the excess runs down to lubricate the bearings, then you top it up again at the next service interval. It could also explain why there are periodic complaints about the HIF 'losing all its oil' if people are trying to **maintain** the oil level above the top of the hollow rod all the time, and not just at the service interval. But more of this in Damper Oil Level.

Retaining clips *March 2013*

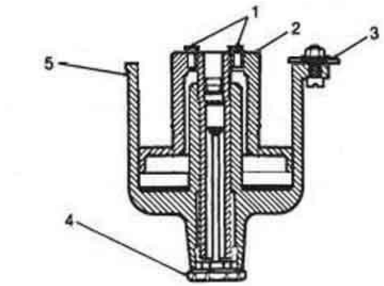


These only seem to have been fitted to HIF carbs, and only for a period. Originally the piston and cover assembly was much like the HS in that the hollow rod of the piston slid in the cylinder inside the cover. Then as part of emissions reduction two ball-bearing assemblies were fitted between the two, to reduce sliding friction and hysteresis. It is these that have the retaining clip, which means the damper can only be raised and tilted to one side for topping-up, not completely removed. Subsequently there was a version without the clip, although whether this used a different ball bearing assembly or just did away with the clip, isn't known. The only purpose I can see is to avoid mixing up pistons and dampers, which could result in different rise-times during acceleration for each piston. This SU Technical document (4 Check the piston damper oil level) emphasises that the bearing retainer is not to be displaced from the piston rod, but I accidentally pulled mine out many years ago and it didn't seem to make any difference to anything. Nevertheless after reading this I decided to re-fit it. There are two ways to do this, and if you have the 4-cylinder this is probably the easiest way: Remove the air cleaner, unscrew the damper cap, lift the piston as high as you can with a finger-tip, and hopefully that will lift the top of the hollow rod far enough for you to press the clip back in again. On the V8 it's a bit of a fiddle to remove the air-box then grope around the back of the carbs to lift the piston, reaching across the engine to reinsert the clip, so it's probably easier to remove the cover and piston from the carb body. Then unscrew the damper cap, lift the piston up inside the cover compressing the spring, until the top of the hollow rod has been raised high enough to reinsert the clip. Despite refitting it came out again the next time I went to top-up, so I left it out, and again it doesn't seem to have made any difference.

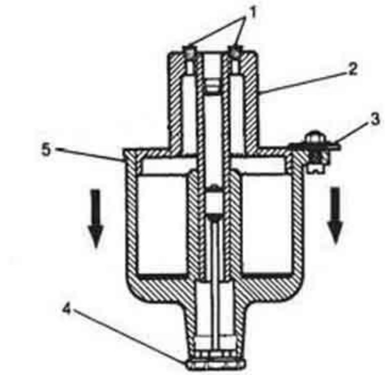
Drop-test: *April 2019*

This checks the clearance between the piston skirt and the inside of the piston cover, and is normally only needed if no other reason can be found for running problems. The clearance can be too small meaning the piston sticks either going up or down, or could be too large meaning it doesn't rise far enough as the throttle is opened. The former can be caused by dirt or crud on the skirt or the inside of the cover, but if there are otherwise clean witness marks on both or either there is a problem with the size. There is no equivalent evidence for too large a clearance - unless you are in a position to observe piston height under large throttle openings and load e.g. on a rolling-road, only the drop-test. Pistons and covers are originally supplied as a matched pair, but over the course of time and owners parts could have been replaced incorrectly, or damaged, and particularly covers swapped between pistons if both have been removed at the same time and not kept apart.

The drop-test measures how long the cover takes to fall from the piston, while holding both inverted, and is performed as follows:



- Remove the cover (5) leaving the damper (4) in place (see Note).
- Remove the spring and put to one side.
- Remove the piston (2) and invert to drain the oil.
- Block the two holes (1) in the base of the piston (butterfly side) with Blu-tak or similar.
- Invert the cover and put the piston inside to lie in what is now the bottom (residual oil may result in some damping as it goes in).
- Attach a large washer (3) to one of the fixing tabs of the cover with a screw and nut, this will stop the cover in the correct position for timing.
- With cover and piston inverted hold the piston in one hand and the cover in the other. With the piston fully in the cover you are ready to start timing.



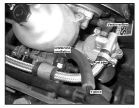
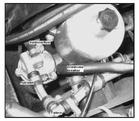
- While holding the piston let the cover go and time how long the cover takes to fall to where it is stopped by the washer reaching the piston skirt.

The SU Burlen pages for both HS and HIF say: "For carburetters 38.0 mm (1.5 in) to 47.6 mm (1 7/8 in) bore, the time taken should be 5 to 7 seconds.". Other sources give slightly different timings, but I'd rather go by the SU information

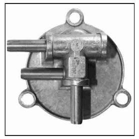
Note: There seem to be different views about leaving the dampers in place, some remove them but SU Burlen specifically says to fit it, with its washer where provided. If you find one of yours takes too long to drop, then try the test again on both carbs but this time with the damper removed. If the two are now very close (albeit dropping faster) then the damper on the slow one is at fault - maybe the shaft is bent, or the (damper) piston not free on its spindle. However that would also be revealed by removing the air cleaners and lifting each piston fully up against damper pressure, then releasing, where both should drop sharply and at the same rate. That check should have been done way before you get into the drop-test.

Ports and Vent/Overflow Pipes: There is often confusion about which hose goes on which port of SUs. If you get the inlet and vent hoses reversed for example, the carb will flood petrol out of one of the ports and/or the jet.

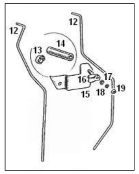
HS carbs:

HS carbs are a mirror image of each other (except for the jets which are NOT handed), each with its own fuel inlet and vent/overflow ports. The main fuel feed pipe has a T-piece which feeds the rear carb from a side tapping, the straight-through tapping feeding the front carb. From October 1969 and the 18GG/GH/GJ/GK engines the carbs also had a crankcase ventilation port which removed the need for a separate PCV valve. These are joined together by a Y-piece and connected to the front tappet chest cover port. Click on the thumbnails to see which port is which but basically non-NA cars have the fuel inlet ports pointing straight across the car to the rocker cover, and the vent/overflow ports are the same size pointing straight across the car in the opposite direction i.e. to the left-hand wing. The ventilation ports are larger and point diagonally upwards, towards the front of the car on the front carb and the rear of the car on the rear carb.

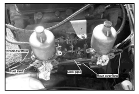
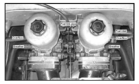


North American emissions-controlled vehicles may have a different arrangement with a three-port float chamber lid on the front carb although this is not listed in the Parts Catalogue. One of the ports is the fuel inlet from a filter on the inner wing, another is a fuel outlet that goes to the rear carb, and the third is the overflow going to the charcoal canister. The rear carb should have a conventional 2-port with fuel inlet and overflow.



The vent/overflow ports are connected with a short length of rubber hose to two individual steel pipes which carry any overflow safely down past the exhaust. Bee came to me with them just dangling, so I looked closely at a concourse winner of the same year (and colour!) which had them retained by one of the rear engine mount to chassis bracket bolts, so that is how I fixed Bee's. However this means that as the engine rocks the carb end of the pipes moves up and down, but the clipped part stays still, which stresses the short piece of rubber hose connecting them to the carbs. Subsequent research has shown that these run side-by-side to the rear of the engine mount and originally were attached with a P-clip to a bracket (AHH7382 was NLA), which mounts to the side of the block on the lower engine mount bolt. Used until the introduction of the 18V engine in 1971 for export cars, and until November 1973 for UK cars i.e. until the change to HIF carbs when the P-clip was mounted using the mechanical fuel pump blanking plate rear bolt. With the bracket NLA at the time (and access to the lower engine mount bolt restricted with the engine in-situ) I eventually changed Bee to use the engine restraint bracket (also missing when she came to me) which has a convenient hole for a bolt and P-clip to hold the pipes, which allows them to move with the engine.

HIF carbs:

HIF carbs are **mostly** a mirror image of each other, but this time both the floats and the jets are handed, and the fuel feed arrangements are different. The jets are colour-coded black and white according to which carb they go in, and I *think* the black one goes in the front carb. The right-angled pick-up pipe should more-or-less face the butterfly, and the adjuster mechanism engages with a tab on the body of the jet. It might be possible to install the wrong jet with the pick-up pipe facing the other way, but it may also be the case that the cover plate then won't fit correctly. Note that although the manuals and SU Burlen's web site show the jet bearing having a washer above it, a phone call to Burlen elicited the information that later versions did not have it! The fuel feed pipe connects to the front (4-cylinder) or left-hand (V8) carb only, which as well as feeding the float valve in that carb goes straight through the carb body to an 'outlet' port on the other side. A short (very short in the case of the V8) length of rubber hose goes straight across from that port on the front/left-hand carb to a mirror-image inlet port on the rear/right-hand carb. There is a matching outlet drilling on the other side of the rear/right-hand carb, presumably for triple carb setups, but it is plugged on MGB carbs. The crankcase ventilation ports are connected individually via a flame/oil traps to the associated rocker cover. Click on the thumbnails for details of which port is which, but basically the fuel inlet and outlet ports are at the back of the carbs pointing straight across the car, with the inlet on the left-hand carb immediately above its mixture screw, and the blanked-off outlet port of the right-hand carb the same. The vent/overflow ports are immediately in front of those, also pointing straight across the car, and the same size as the fuel inlet/outlet ports. The crankcase ventilation ports are in front of those, are larger, and pointing diagonally upwards as well as across the car. On 4-cylinder chrome bumper cars the vent/overflow ports and crankcase ventilation ports are plumbed similar to HS carbs, but the former are held by a retaining clip bolted to a stud on the engine restraint bracket. On 4-cylinder rubber bumper cars the pipes are clipped to one of the studs for the mechanical fuel pump blanking plate on the block. The V8 has hoses from the vent/overflow ports going being the carbs to a T-piece behind the right-hand carb, then a single down-pipe clipped to a bolt on the bell-housing.

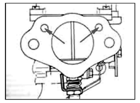
October 2020:

The 4-cylinder HIF vent/overflow arrangement is much the same as for HS carbs but the V8 is quite different. Hoses from the carbs go under the air-box to a plastic washer tee GWW401 behind the off-side carb. Another short piece of hose goes down to metal pipe BHH1570 which has a support bracket under the top off-side bell-housing bolt, then a longer section of hose goes down past the off-side of the bell-housing. Vee had none of that when she came to me and I had no idea what was supposed to be

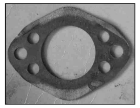
there, didn't fancy fuel running down onto the exhausts, so I did basically the same with hoses and tee and in the same position, but without the metal pipe to support it all. Apparently these pipes are very rarely seen in the wild, and I can imagine that unless someone remembers to attach the metal pipe to the bell-housing bolt when the engine and gearbox are reassembled out of the car, they won't go back on at all as you can't access that bolt once the two are back in the car!

Flange gaskets *March 2017*

Air filter:



The air-filter gaskets (HS and HIF are the same) are handed and must be installed the right way up. The flange has breather holes that maintain the underside of the piston at atmospheric pressure, so when inlet manifold vacuum is applied above the piston it can rise correctly to deliver the correct mixture. V8 HIFs are different in that there are no less than nine holes in the carb flanges. Again the gaskets must be installed the right way up to leave the breather and fixing holes clear, and that cover the other holes.

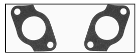


While doing the clutch change on a friend's 78 I found these gaskets, which have holes in both upper and lower positions, and so cannot be fitted the wrong way round. However! You still have to fit the base-plate for the air filter the right way round or the holes will be blocked whichever gasket you use or how you install it! It wasn't obvious from the running of the car that they were blocked, but Keith's car failed it's emissions test this year having passed just a year earlier, done very little mileage since, no changes other than a new choke cable (which **was** fully releasing the choke) even during the clutch change apart from having the air-filters removed. When I went to setup the carbs for air-balance and mixture I found the filter bases upside down, hence the auxiliary ports were blocked. In the end the balance and mixture were just about spot-on, only the balance under choke was out, which wouldn't have affected the emissions test anyway, so I can only assume I put the filter cans on the wrong carbs hence the bases upside down, and that was enough to affect the reading. Correcting that and a precautionary weakening of the mixture by just 1/8th turn to show 3.8% on my Gastester passed the retest at almost the same figure.

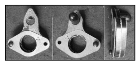
Originally the air-filter cans were clearly handed and as long as you kept them, the bases, bolts and gaskets together as two assemblies you are unlikely to get them on the wrong carbs. But at some point they seem to have been modified so the cans are identical, so if you keep them assembled but mixed up and fit them to the wrong carbs you **will** get the bases upside down. The Parts Catalogue shows different part numbers for the front and rear cans for all years, but you can definitely fit the later ones on the wrong carbs and it isn't immediately obvious. Originally common to all markets they changed for the 72 model year (from straight intakes to curved?) to three different sets for UK, North America, and the rest of the world (export cars changed to HIF the previous year so it wasn't to do with that). UK changed to use the 'rest of the world' set in November 73 with the 18V 779/780 engines and all twin carb engines had those to the end.

Inlet Manifold:

What follows applies to the 4-cylinder, for the V8 inlet manifold see here.



Together with the spacer blocks 12H712 between heat shield and carbs there are three gaskets AEC2083 per carb to secure the carbs and heat shield to the inlet manifold. These gaskets are also handed but with these it's not a case of blocking holes but simply aligning the outline with the carb flanges and distance pieces. I think these were originally fitted dry (no fluids normally) but I use a smear of copper-grease on all the gasket surfaces in preference to conventional sealants, both hardening and non-hardening.



North America single carb used induction heater AUD9148 as the spacer block.

Floats and Valves

Is there are fuel in my float chambers?

February 2023: **Something to watch out for with replacement valves.** Father Ted on the MGOC forum sent his carbs away to SU Burlen to be rebuilt, but when they came back even though the fuel pump clicked then stopped while filling the float chambers, as soon as he started the engine both started overflowing. It turns out they had fitted the larger V8 float valves which are available in two types - one with an internal spring and one without, and they had used the unsprung. It's my belief that the spring helps keep the valve shut if the float should vibrate. FT sent them back at his own cost and they replaced them with the smaller valve which are sprung, and no overflow. More info on float valves here.

One of the biggest benefits of the HS carb over the HIF is that the floats and valves are so easy to access on the HS compared to the HIF, which really need to be removed from the car. The bottom cover on the HIF is also submerged in fuel, and any weakness in the seal can cause significant seepage, enough to drain the float chamber while parked. The

HS float chamber lid does have a gasket, but it is above the level of the fuel, so really only protects against seepage if the fuel is sloshing about inside, or if the float chamber should flood due to a faulty valve or float as the overflow port is above the join between chamber and lid.

January 2026: A pal in America has been experiencing intermittent flooding for a while despite swapping sundry parts (at the same time he has had fuel delivery problems where the pump chatters away but no fuel is delivered - but that is a whole other story). Overflowing can be caused by several things including floats not rising (punctured or binding), float valves not closing (worn or contaminated with dirt), float valves being overwhelmed by excessive pump pressure, or even float chamber lid/carb body faults where fuel can bypass a closed valve. An incorrect float height may not cause overflowing but can cause hot-start problems. It's relatively easy to keep swapping parts (on HS, less so on HIF) but that can be expensive and frustrating when the problem continues, and even with an apparent fix the fault can return. At the end of the day you may need to resort to fault diagnosis from first principles:

- As two float/valve assemblies are unlikely to resist exactly the same pressure block off the feed pipe to each carb in turn and see if the non-overflowing carb now overflows as well. If so then the problem is excessive pump pressure.
- With HS carbs whilst the front and rear float lids are mirror images it should be possible to swap them over complete with floats and valves by re-routing the inlet hose just for testing. With the lids removed check for dirt in the float bowls as this could be causing weeping valves, and you can compare the fuel levels in each float bowl. With HIFs check for dirt on the bottom cover.
- If the fault moves with the HS lid try blowing through the inlet whilst raising the float with a finger and note how much pressure is needed to stop the flow. You can use the other lid as a comparison, and maybe further check by lowering the lid with float into a container while connected to a pump.
- With HIFs you are limited to lifting the float with the bottom cover removed, although I suppose you could lower the whole carb into a container of petrol!
- It may now be time to swap HS floats over - HIF are 'handed', but both types can be checked for fuel sloshing round inside, drop them in water and check they float to the same level, or weigh them (bear in mind volume is also a factor of buoyancy and hence fuel level).
- With both HS and HIF you can swap valve inners (check for wear ridges on the tips), then valve outer (check it is tight) one at a time between the two lids or carbs and see if the fault remains with the component just moved. Note that having moved one or two components over i.e. they are working with different partners you may find that the overflowing has stopped, or indeed now happens on both! Either situation implies that the problem is with one or more of those components.
- Note the Leyland Parts Catalogue depicts a sealing washer for the HIF but not the HS, the Workshop Manual depicts it with 'as required' so presumably to adjust the float height with solid plastic floats. Suppliers don't show them for either. Check any washer is undamaged and if there is no washer check the closing surfaces of lid/carb body and valve body are undamaged.
- If, having moved components over the fault stays with the lid (HS) or carb body (HIF), it sounds like fuel is bypassing the closed valve somehow. If HS and the problem only occurs when the lid is fitted to the carb the float could be fouling the walls of the float chamber.

Bear in mind that on the HS4 at least the overflow port is significantly higher than the jet bridge so even with a stopped engine and the choke control pushed home (i.e. minimal clearance between needle and jet) excess fuel will come up the jet and run into the inlet manifold before it comes out of the overflow. Only if the rate of fuel leaking through or past the float valve is greater than that coming up the jet will the the fuel level in the float chamber continue to rise and eventually come out of the overflow, this could take a long time especially with the North American charcoal canister system. Because of that the test for any seepage has to be how frequently the fuel pump clicks with the ignition on but engine stopped - the factory limit for this is that is should not click more frequently than once every 30 seconds. If it clicks less frequently then the valve could still be seeping but it won't cause a problem in normal use as the engine at idle will be using more fuel than is seeping so the correct float chamber level will be maintained. When doing this test for extended periods you should disconnect the coil to prevent it overheating.

Also bear in mind that (like incorrect float height) if the seepage is enough to raise the fuel level in the float chamber but not overflow it will be resulting in a rich mixture and possible hot-start problems.

See here for a bench test of a float chamber.

Floats
Valves

Floats:
Float Height

All HS carbs used the same float for both front and rear carbs - originally AUD9904, currently it seems to be WZX1300.

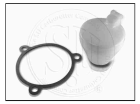
North American 4-cylinder HIF carbs used AUD3571 in the front carb and AUD3570 in the rear, currently WZX1510 and WZX1509 respectively.

UK HIF and V8 carbs used CUD2774 in the front/left carb (as viewed from the driving seat) and CUD2773 in the rear/right, however these also seem to use WZX1510 and WZX1509 respectively now.

There are also 'StayUp' float kits for all versions which have a closed cell construction and Burlen claim they are unsinkable. However on one forum someone had one sink, returned it to Burlen, who said it must have been damaged during handling ... which surely makes it no different to any other float ... apart from being nearly twice as expensive!

January 2026: A pal in America has been experiencing intermittent flooding for a while on an HS carb despite replacing sundry parts and swapping things round. The problem moved with the float and weighing the two StayUp type one weighed 7.8gm whilst the other weighed 14.5gm (see Ship Displacement and Archimedes Principle) which is a huge discrepancy in percentage terms. I contacted Joe Curto the reknowned carb specialist in America asking if he could possible weigh both original and StayUp types for me and he promptly replied with the following information:

> "I weighed 3 used factory floats (hollow plastic) and they are 7.3 Gr, I weighed 2 Nytrophyl (Sta-Up) copies and they too are 7.2 ish Gr. Sta-Up is the trade name for SU, I have my own as does Moss I have seen a few heavier but not in a while. Yes 14 gr is out of line"

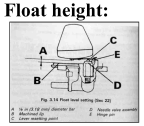


Originally HS floats had a metal tab that could be bent to adjust the height, but in the 1970s all-plastic floats were introduced that were non-adjustable. If these are found to give too high a float level you can add washers under the valve and measure the effect of those directly. If it's too low and there are no washers then you can add float lid gaskets, but you will have to measure them and compare with the distance you are short with the rod under the float. However I found my HS plastic floats - with no washers on the valves - to be almost exactly in the middle of the tolerance range for height adjustment. Subsequently white HIF floats at least seem to have gained adjustable metal tabs, and black 'StayUp' floats do as well.

If the float cracks it can take in fuel, which makes it heavier, so the level of fuel in the float chamber and hence the jet has to rise higher than it should before it shuts off the fuel flow. This can give rise to mixture imbalance, hot-start problems and eventually overflowing. If you have repeated overflowing always check the float for fuel by shaking or weighing before automatically changing the float valve.

With the lid (HS) or bottom cover (HIF) removed, on HS carbs grip the thicker, splined end of the float hinge pin with a pair of pliers and withdraw (can take some force) to release the float. On HIFs unscrew the hinge pin. On HIFs it is wise to replace the cover seal, they harden in use.

Float height:



This is given quite a close tolerance in the workshop manuals if not a single value, but according to SU Burlen typically for the HS carbs on MGB it is 3 to 5mm with the adjustable float and steel needle, or 1.5 to 5mm for the 'fixed' nylon float and Delrin needle, and for HIFs 0.5 to 1.5mm. If having problems with a car or carbs new to you or that have had work performed on them and it could be fuel related, check this height. Easy on HS's - just remove the lids, invert, and slide a bar or drill between the lowest part of the float and the machined edge of the lid, you can also compare fuel level in the two float chambers. HIFs will have to be removed and the whole carb inverted, a straight-edge laid across the centre of the float chamber at right-angles to the pivot i.e. crossing the centre of the 'U' of the float, and estimate (measuring being tricky without wire gauges) the vertical gap between the nearest part of the float and the straight-edge. Note that an excessive gap could be due to an incorrect or faulty valve holding the float too high or too low. If the float is too high - or is too heavy - it could result in difficult hot-starting in hot weather from heat expansion forcing fuel up the jet flooding the inlet manifold.

September 2024: With a pal in the USA having continual hot-starting problems (which are more likely to be down to flooding than so-called vaporisation) and running problems we have been checking float heights and other aspects.

Valves:
Seepage/overflow

With the float removed the inner of the float valve should fall out. This has a conical point at one end, and a spring-loaded pin at the other. The outer can be unscrewed with a 11/32" socket.

Original float valve inners were steel tipped against a brass seat. The tip of the inner eventually develops a wear ridge, and this can cause seepage when the valve should be closed, and eventual overflow. Someone in America developed an alternative - Grose Jets (jets?) which used a ball valve, and were said to be superior. They may well have been, but then a Viton tipped valve was developed by SU that was equally as good. Subsequently the Grose products were produced by a different company, and people started finding those became worse than the original SU items, let alone the Viton-tipped versions. Outers for Viton-tipped seem to have a conical seat, i.e. different to the earlier flat seat. This is probably Viton is a resilient material, and the sharp edge of the original seats would almost certainly cause a ridge to be developed in the Viton in short order. It makes one wonder if a conical seat for the original steel-tipped inners would have delayed the development of a wear ridge, if not prevented it altogether.

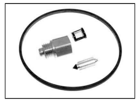
Three different part numbers were used at various times:

18G (HS carbs) used AUD9096
UK 18V HS carbs used AUD9095
US 18V HIF carbs used CUD2795
UK 18V HIF used AUD9095 i.e. the same as the 18V HS carb
V8 (HIF) used CUD 2795 i.e. the same as the USA HIF! These have a larger hole in the outer than my UK 18V HSs, but the V8 inners seem to be compatible with the UK 18V HS outers.

Replacements can be confusing to identify. SU Burlen lists 'standard' (HS?) kits as:

Viton Tip 0.070" Spring Loaded VZX 1100
Viton Tip 0.096" Spring Loaded VZX 1101
Viton Tip 0.096" (presumably not spring-loaded) WZX 1102. Note that this valve has been known to cause the carbs to overflow when the engine is running.

From what I can tell 4-cylinder MGBs use the smaller 0.070" spring-loaded type, VZX 1100. HIF kits are:



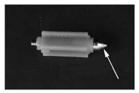
"Delrin" .070" Small bore VZX 1099
Viton 0.070" With an additional spring on the outside of the valve plunger WZX 1097
Steel 0.096" Spring Loaded VZX 1095
Viton 0.096" Spring Loaded WZX 1096
Interestingly Googling both V and W versions of these HIF numbers usually shows them with a small filter before the valve.

The above VZX numbers replace WZX equivalents, so if searching on part number you may need to try both.

My V8 uses the larger bore i.e. 0.096, spring-loaded. And whilst originally they were steel tipped it's probably best to get the Viton-tipped now, i.e. WZX 1096. However neither the old or the replacements had filters. As that is the only spring-loaded Viton-tipped, it's probably best to get those for 4-cylinder HIFs as well.

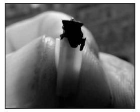
Seepage and Overflow: Small particles can cause slight flooding, getting trapped as the valves would never normally be fully open. Sometimes these can be washed out by disconnecting the fuel pump, running the engine to empty the carbs, then reconnecting the fuel pump. The resulting rush of fuel through the now wide-open valves can dislodge particles. These may not be a problem in HS carbs as the needle to jet clearance is large, and there is room for them to lie in the bottom of the float chamber. They can be more of an issue in HIFs as there are more orifices to get blocked, and they will lie directly under the jet.

Many years ago I started getting overflow from the right carb in the V8. The above trick did not help, so I changed the float valve, but still had the problem. It was only then I discovered the float had fuel in it, impossible to see in the brown float. I tried putting it in hot water to discover the source of the leak, but that, pressure and shaking did not give any indication of where it might be, so replacement was the only option. Incidentally this happened away from home which could have stranded me as fuel was pouring out. But by that time I had added in-line fuses for both the fuel pump and overdrive so it was a simple matter to cross-connect the overdrive switch wire with the fuel pump wire. This allowed me to turn the pump on and off using the OD manual switch so I turned it on for a few seconds to put some fuel in that carb and drove off. As that float chamber emptied - taking much longer to empty than it did to fill - the engine started to stumble so I gave it another few seconds to fill again and we got back home that way. The fuel pump fuse is strongly recommended in any case but even without fuses it will be quite easy to connect the OD switch wire (yellow in most cases) to the pump wire (white).



More recently I have been taking some voltage measurements for a pal, with the ignition on but the engine not started for several minutes at a time over a few days. During these time the fuel pump was giving a very occasional tick, as expected, anything less frequent than once every 30 secs, i.e. more than 30 secs between clicks, is not indicative of a problem. A couple of times I thought I got a whiff of fuel, but couldn't track it down or even be sure I had smelt it, even though the garage doors were both closed. Then one time I turned off the ignition, but could still hear an occasional 'tick'. After a short search I tracked it down to a carb overflow hose, dripping onto a sheet of paper. Had that not been there I probably wouldn't have heard it. Looked like the rear carb, and with the overflow hose removed from that carb it was damp, but the front wasn't. Removed the lid and float from it to extract the inner, to find a very definite ridge in the tip. I've lost track of when I had these carbs rebuilt, but it was many years ago. As luck would have it I had just found the unused new V8 float valve from all those years ago when helping another pal with a float valve problem - this time blockage with debris. I could see that the V8 HIF outer had a bigger hole through the middle compared to the roadster HS outer, but didn't fancy using that in case it caused an imbalance. The inners seem identical, so I fitted the new V8 inner to the original roadster outer, refitted the float, lid and supply hoses, and switched on. Left it a minute or more and no sign of any seepage with a piece of blue paper towel (which makes a very good indicator of fluids by going dark) under the overflow port, so refitted the overflows and air cleaners. Turned the ignition on again and after the initial couple of clicks waited ... and waited ... and waited, and eventually after two minutes with no click gave up and declared it

'fixed'. Temporarily perhaps, I've ordered a pair of Viton-tipped, and shall replace both when one or other shows any problems. This was a tiny seepage, much less than would be used at idle let alone running, and does show that if your pump is clicking more often than you think it should, it could take several minutes before anything will come out of the overflow. Even longer on North American spec with charcoal canister where it has to go right across the engine compartment and through the canister and anti-runon valve before it appears on the ground.



The opposite problem can occur where large lumps of debris can block the valve rather then wedging it open, as in this example from Peter Ugle. The debris is thought to be from the inside of a Gates Barricade hose where it had been pushed onto a very tight port, with rough edges scraping part of the hose inner away.

But 300 miles later with new lengths of hose exactly the same thing had happened again, and peering inside the inner liner had been rucked up. Peter slit a length of unused hose and found that even scraping with a finger-nail delaminated it. So it looks like it needs a clearance to be slid on without damage, and even then I can imagine that clamping it up onto the ridges of a filter would chop bits off it. Gates Barricade binned, more conventional hose substituted!

May 2016: Just before Vee's MOT I discovered a leak from where the supply hose replaced just a few months ago attached to the near-side carb, fixed by tightening the clip although it didn't move very much. The day after the MOT while looking at something else I discovered the overflow hose was leaking on the same carb. Obviously the float valve wasn't seating properly (a hang-over from the filter change last year?) and timing the ticks from the fuel pump they were about every 15 seconds. They shouldn't occur more frequently than once every 30 secs, otherwise a problem with a float valve or pump inlet non-return valve is indicated. The first trick is to run the engine with the fuel pump fuse disconnected to drain the carbs, then when the engine has stopped reconnect the fuse in the hope that the now wide-open float valve and high-rate of fuel flow flushes out any debris that might be there. After that clicks were more than 30 secs apart, although less than the 60 secs plus after I had changed the pump hoses. So not leaking now, but that still left the overflow hose to deal with. A few days later after a run - and when cool - I gave up waiting after 2 minutes without a click, but I'll lay a couple in for stock anyway.

Is there any fuel in my float chambers? *April 2025* If the engine won't start basically the two things to check are for the presence of a spark and fuel. HS carbs are easy to check just by removing the float lid which isn't really feasible with HIFs but there is an alternative method, which can also be used with HSs. If you put a tube on the overflow port of each carb in turn and blow **very gently** fuel will bubble up the jet if there is any in the float chamber, and this can be seen by removing the air-cleaners and manually lifting the piston. Not really feasible with the V8, and removing 4-cylinder air-cleaners is a bit of a faff, it can also be seen by removing the piston cover and piston. Take care **not** to get components mixed up between carbs, take care of the needles while they are out, and on refitting.

Needles *November 2021*

See here for information on needle selection.

Originally HS carbs had fixed needles and the jet has to be centred on the needle to prevent the one rubbing on the other, inhibiting piston free movement, causing wear and upsetting the mixture. North America changed to swinging/bias needles on AUD326 carbs/18GH engines in 1969. Home market cars didn't get them until 1971 with AUD492 carbs on 18V engines. The jet bearing kits differ between the two - WZX1341 for fixed needles and WZX1442 for bias/swinging needles. The difference is that the jet bearing for fixed needles has a larger clearance in the jet nut to enable centring, that for bias/swinging needles is basically a snug fit in the nut to hold it in one position, the needle moving to fit the jet.

Fixed needles have a screw that locks it into the piston, swinging have the needle going through a guide AUD4288 and the fixing screw secures that into the piston. The needle is loose in the guide and there is a spring AUD3306 above to keep it pressed down onto the top of the guide.

Jets *June 2012*

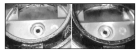
Jet Height

4-cylinder cars have 0.090" jets, V8s (and MGC) 0.100". HIF carbs have different jets to HS and in both cases there are different jets for front and rear (left and right from the driver's perspective for V8) carbs.

There are two different types of jet bearing for the HS4 with different threads which affects how far the jet moves with each turn of the mixture adjusting nut - coarse and fine. However everything encountered on an MGB should be the coarse thread, the fine thread only applies to other marques such as the Mini where it has Waxstat temperature-controlled mixture. Those jets have a red plastic elbow between the flexible pipe and the jet tube instead of black.

Jet Height:

Some recommend getting the starting point for setting-up from a depth gauge and figures of .060" to .085" are given. Personally I've never seen the need when you are going to use the lifting pins and engine note for the final setting, it is only a starting point, and it means removing the cover and piston and putting them somewhere safe, as well as poking things down inside onto the jet. But Miles Bannister recently commented that when checking his he found them at different heights, and when setting them to the same height the car ran noticeably better. My first thought was that using the lifting pin to determine final settings is 'dynamic' based on what the engine is actually doing and not a theoretical measurement, much like dynamic timing is preferable to static, which again is only a starting point. Carbs like anything else have a tolerance in component manufacture, which may well result in very small differences in settings between carbs **for an identical mixture**, and that would be preferable to a theoretical jet height. But ever interested I decided to check Bee and Vee.



Vee was quite different at .106" for the right carb and .070 for the left. Now unusually this year Halfords had adjusted the carbs to pass emissions only a couple of weeks previously, normally I pre-adjust them up a quarter turn or so then back down afterwards, but this year I obviously didn't do it enough. So I have no idea how the Halfords mechanic adjusted them i.e. one, both, same direction or different. I did have a quick fiddle on my return using the lifting pins, and thought I had got them right, but perhaps not. The difference put one jet noticeably above the jet bearing and the other noticeably below. Wondering if the bearing height is going to be the same as a theoretically adjusted jet I measured both the bearings and found the right at .0735" and the left at .080, so perhaps not. Now one person who recommends .060" for HSs says .085" for the same size HIFs, but the V8 has 1.75" HIFs rather than the 1.5" as used on the 4-cylinder. So I did the same as Miles and split the difference, setting them both to .088. Weather too poor to take her out to try, and check the lifting pins when fully warm, hopefully tomorrow. (March 2013: I don't know whether I ever did this or forgot about it with so much poor weather and not being able to take her out, all I can say is that she is running as fine as ever at the moment).

May 2024: A thread on the MGOC forum where jet height was discussed and mystification as to why Bee runs well at .045" - which I had rechecked and confirmed whereas it's usually .060" to.085" that is mentioned. I started wondering whether I had .100" jets installed instead of .090" i.e. for HS6! Jet pipes have a coloured plastic band as well as the coloured elbow so I started investigating. Couldn't get a clear statement of what the coloured bands would be for HS6 from either MGOC or SU Burlen, but the latter stated I should have a green band on the rear carb and pink on the front on a 4-cylinder MGB - subject to colour change over the intervening 30+ years ... and I have what appears to be black on the front and yellow on the rear! Browsing SU I came across AUD9148 described as "Right Hand 30? HS jet with black jet head. Identifying sleeve colour is Yellow", not clear whether that is front or rear, so asked Burlen and they said it would be on the front carb of the Special Tuning version. Parts Catalogue Special Tuning HS6 states AUD9148 for the front and AUD9149 for the rear, and browsing that shows it has a yellow band! So either I have HS6 carbs, or .100" jets in HS4s. I'm bound to have set these carbs up from scratch at least once, but I can't recall any issues with the starting position of two full turns down as a starting point, then needing to wind them back nearly a turn to get the highest idle. Maybe I'll count how many turns/flats are needed to wind them up to flush ... or maybe not. Burlen also mention that the correct mixture is set by the the height of the fuel in the jet, which is governed by the floats and valve, plastic floats are not adjustable so there's bound to be some variation between them.

Butterflies and Spindles: *December 2021*

The 'poppet' butterfly WZX1329 with the sprung valve on later carbs that opens when the throttle is closed at high rpm. This allows some air (and fuel of course) into the engine as it is slowing down which reduces emissions, closing fully at idle, the spring faces the carb inlet. These can cause problems, on my V8 in below zero weather they would ice up and stick open causing a racing idle. I soldered them shut which can be done just by removing the carbs from the engine. Some opt to replace them with the early plain disc WZX1323 which needs a lot more work and care. The claim that removing the spring and valve shaft from the air-flow improves performance is nonsense on anything other than a race car since it can only have any effect - and then a tiny amount - when the butterfly is fully open.

Both types of disc are fitted to the shaft with the special bifurcated screw AUC1358 as pictured. The ends are opened up slightly once fitted so there is no chance of the screw coming out and being swallowed by the engine. Note that the butterfly should have chamfered edges so that it is fully seated just before it reaches 90 degrees to the carb throat. To get them correctly aligned tighten them with the idle screw fully backed off to be sure the butterfly is fully closing off

the throat, double-checking (by squinting through against a light source) before opening the ends up in case it needs readjustment. Don't bend the ends by more than 45 degrees or they can fracture and the bits get into the engine.

Shafts and bushes can wear causing vacuum leaks (difficulty setting-up and rough running) or inability to stall the engine using the idle screws. A tricky repair without specialised equipment needing the old bush to be drilled out and an oversize one pressed in, then reamed to the size of a new shaft. You may get away with - certainly reduce the problem by - just replacing the shaft.

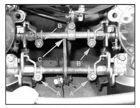
Return Springs and Linkages:

Linkages
V8

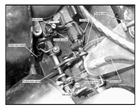
There has been a lot of discussion as to how many return springs were fitted to the SU carbs, in particular whether the choke has one, and it's all quite confusing. The Parts Catalogue for up to September 1976 has one page entitled Accelerator pedal - choke control - all versions except V8' listing item 12 'spring-cable return' AEC2075 qty 2 for UK car numbers 101 to 332032. The next page is entitled 'Accelerator cable and fittings - manual not V8' lists the same item three times - 'spring-return' qty 2 for the same UK car numbers 101 to 332032 i.e. HS carbs which seems to be correct i.e. two cable return springs and two accelerator cam return springs. Then it has 'spring-choke return' qty 1 UK car number 332033-on i.e. HIF carbs; and 'spring-throttle return' qty 2 'except Zenith carb' with no indication of car number which implies both HS and HIF which wouldn't be correct for HIF. For September 76 on 'Carburettor fittings not USA Canada' it lists item 10 AEC2075 'spring-throttle return' qty 3 which is definitely incorrect and item 21 AEC2075 'spring-choke return' qty 1.

HS carbs have torsion springs on the choke quadrants and not on the accelerator quadrants, but HIF carbs have them on both accelerator quadrants. Logically where there are torsion springs additional springs on each carb are not required (as per V8 practice), but they are where there are no torsion springs, plus a cable return spring regardless. So again logically HS carbs need three on the accelerator (two quadrants plus one cable) and one on the choke (cable, which is what mine have), and HIF need one on the accelerator (cable) and one on the choke (cable), and the Workshop Manual does only show two springs. However several cars seem to have them on HIF choke quadrants making three for the choke (including a pal's 78), with others reporting that with only one on the choke it does not return properly. Moss for the HIF only shows one spring for the throttle and none for the choke, and Brown & Gammons do not differentiate between HS and HIF showing 3 throttle and 1 choke which is what Moss shows for HS.

For completeness both Catalogues show one 'Spring-throttle return' with the Zenith carb, the 76-on catalogue also lists one 'Spring-throttle return' with the **pedal** parts but the earlier Catalogue doesn't.

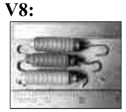


Mine (HSs) originally had four springs with the throttle cable one hooked over the pin of the cable clamp rather than using the correct 'link washer' 12A4. The attachment points on the heat shield may give some clue - the Parts Catalogue for up to September 76 shows it with three tags sticking out with holes in (confirmed by various owners) which also goes to support three springs, but my 73 UK roadster with 48G Gold Seal engine heat shield only has one tag, and four holes on the bottom edge making five potential attachment points in all! However two of them are not holes but slots, so it is possible these have been added later with a hacksaw rather than a drill, which could reduce the original holes to three. But having said that, the slots are actually more logical places to attach the two throttle springs as they have a better alignment. The Parts Catalogue for September 76 on shows four tags, although whilst three are of the same size and look in about the right positions for springs on the linkages the fourth is larger and right off the rear so maybe for something else entirely. My throttle always tended to be a bit jerky on small movements, lubricating the old cable and even replacing with a complete new inner and outer making no difference. I temporarily disconnected the fourth spring and on a short drive it did seem to be smoother. The pedal return pressure doesn't seem to have been lightened to any significant degree, so hopefully there will be no increased risk of sticking. There wasn't, but at some point I did reinstall the throttle cable spring and have not noticed the jerkiness I had before.



On a friends UK 78 (HIF) whilst there are holes on the choke quadrants and the throttle lever for 3 springs I can't see anywhere to hook a spring on either of the throttle cams. Neither is there a hole in the choke lever for a spring (maybe missing link washer 12A4), and only the front carb choke quadrant has a torsion spring (probably an error). There is only one hole either side in the flange on the heat-shield, assuming these are for the choke springs that leaves nowhere for throttle cam springs. However there are two holes and one tab with a hole in the centre, which suggests two of those could be for the throttle and choke levers as on HSs, leaving the two outer holes for throttle cam springs again as on the HSs, but as I say nowhere obvious on the cams to attach them.

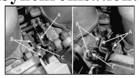
V8:



Only one throttle return spring - BHH1781 which is shorter than the SU items at a stated 1.75" 'free' length, plus two torsion springs AUD4272 and 4273 on the butterfly spindles and two more AUD4417 and 4418 on the choke spindles. BHH1781 is not listed in the Parts Catalogue for the V8 and no one seems to have one. Similar to the 4-cylinder springs AEC2075 at a stated free length of 2.75", the springs themselves on my two cars are the same length it is only the wire ends that are longer on the 4-cylinder, so it would be easy to shorten a 4-cylinder spring to suit the V8. Whilst my V8 spring **is** shorter overall than one from the 4-cylinder it is only by about 1/4", not the 1" that is indicated by the stated lengths. Both are barely stretched when fitted to a released throttle which logically seems to be correct, if the V8 spring was 1.75" closed it would have to be stretched at least 1/2" to be fitted. I've never had any indication of throttle sticking open, and there are two torsion springs on the spindles after all making three in all, the same as the 4-cylinder HS (three coil springs) and HIF (one coil spring plus two torsion springs) installations. However BHH1781 is also used on the Stromberg carb which was fitted for several years on North American spec and a couple of suppliers there list it - if they will post it and you can stand the postage cost. At least one of them cross-references BHH1781 with AEC2075 which is obviously incorrect so you need to be careful.

MGOC show it for the Stromberg here (but I can't find it on their web site) in April 2022. At least they did, after finding this for someone and them getting one I got an email saying there was only one left, so I'm afraid I bought it. Well, I say 'bought', but after a week it hadn't turned up. Complained, and they said they still had one on the shelf so it obviously hadn't been sent, and to order it again. But of course because it had been the last one it had been processed as 'sold' so that page showed 0 available and no 'buy' button! So back onto them and they corrected that, so I was able to purchase it - but it was 50p dearer!! That's neither here nor there but I moaned about it anyway, and they said I should have contacted them direct!!! Maybe they should have got it right - three times. At least this one came in two days.

Synchronisation:



On the face of it a simpler system for the V8 as there is just one lever on each carb plus an adjustable link between them, but space is limited and the adjuster is at an awkward angle. With the carbs balanced for air-flow at idle as the throttle cable starts to open the left-hand carb (it acts directly on this carb) it should start to move the right-hand carb at the same instant. The adjuster is set such that it takes up any free play in the linkage, without one carb holding the other off its idle screw.

Dates and Codes *January 2023*

The following information has been assembled by Fred Horner in America. It covers North American cars which diverged in type and spec from non-North American with the Mk2 and later, and ends with 1974 as after that North America changed to the single Zenith carb:

Year	First Prod	Type	Spec	Date Code	Example	Notes
1962	5/62	HS4	AUD52	X	9X10	Small hole for float bowl
1963	1/63	HS4	AUD52	A	6A4, 9A3	
1964	8/63	HS4	AUD52	B		
1965	10/64	HS4	AUD135	C	C8, 4C13, C105	
1966	10/65	HS4	AUD135	D	5D1, 4D5	
1967	11/66	HS4	AUD135	E	4E11, 4E12, 4E3	
1968	10/67	HS4	AUD265	F	4F, F	Boss for breather
1969	10/68	HS4	AUD326	G	4F, 4FG8, F5	Breather
1970	10/69	HS4	AUD405	FG	4FG8, 4FG9	Breather
1971	9/70	HS4	AUD465	H	H3, H4	Breather, no vacuum
1972	5/71	HIF4	AUD493	J	7J6, 7H10	Breather, no vacuum
1973	8/72	HIF4	AUD550	L	7L8	Breather, no vacuum
1974	8/73	HIF4	AUD550	N	7N1	Breather, no vacuum

For completeness all RHD and non-North American LHD from Clausager, for 1977 models-on all LHD were to North American spec.

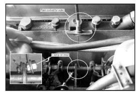
Year	Type	Spec	Needle	Type	Notes
1968	HS4	AUD278	FX	Fixed	
1969	HS4	AUD325	FX	Fixed	Breather
1971 UK	HS4	AUD465	AAU	Biased	Breather
1971 other	HIF4	AUD434	AAU	Biased	Breather
1973	HIF4	AUD616	AAU	Biased	Breather
1974 RB	HIF4	FZX1001	ACD	Biased	Breather, no vacuum
1977	HIF4	FZX1229	ACD?	Biased	Breather, no vacuum

Throttle Cable and Pedal

Cable Adjustment
Throttle pedals

Just intending to put Bee back in the remote garage and bring Vee back to the house, I was suddenly reminded that I had been intending to look at the throttle cable for a while - like 15 years - as it was a bit sticky and jerky especially in the lower gears, so much so I've always slipped the clutch for small pedal movements in low gears/low speeds. Got the inner out to find a broken outer strand - ah ha! Thinking one wouldn't make much difference I started peeling it off only to discover the cable kinked a couple of inches from the pedal end to reveal another broken outer strand plus one or two inner strands. Oh well, have to replace it now and in fact it is a wonder it hasn't broken already, but had to put it back to get the car back in the garage, up the slope of the drive. By now I had found that the pedal end of the outer had become dislodged, because although it was wedged in the guide, the flanges had been broken off the guide (AHH5308) so it, and hence the cable, was floating about in the cavity in the inner wing. As the inner was damaged where it passed through the body it could well have been caused by the broken guide, so now I need one of those as well. But how to get the bits of the broken flange out which were still screwed to the body inside the cavity? I removed the pedal cover which gave me just enough room to get a Pozidrive bit and a selection of 1/2" and 1/4" socket extensions and a UJ to undo the screws, which fortunately were under a layer of old grease or Waxoyl and not corroded. The cable should be easy to source but what about the guide? And if and when I do find one it's going to be fun getting the screws started without cross-threading them.

Got both cable and guide very quickly from Sussex Classics, plus new screws for the pedal box as I had three odd ones (they supplied five but there are only four holes), and bottom and cover seals for good measure as I intended to repaint the cover. The guide had a bit of flashing in the cable and screw holes but a moments work with a needle file soon removed that. With the pedal box cover removed again I found I could start the guide screws by hand (slim hands wedged behind the pedal support frame and in the access hole for the 'trumpet'), much easier than I had anticipated. I had screwed them up from the inside of the cabin first to make sure the threads were good and clear. Once started I used the same combination of bit, extensions and UJ to tighten them. Lubricated the new cable by gripping the outer gently in the bench vice, then fed the inner in slowly while I daubed Copper Grease on it, dragging it in to the outer. Once fully in worked the inner back and fore to distribute it, then removed the inner hanging it up to keep it clean. Fitted the outer into the guide, then with clean newspaper over the carpets and seats to avoid getting grease on them and picking up dirt, fed the free end of the inner up through the throttle pedal slot and through the hole in the firewall shelf, the guide, and into the outer.



Clamped the free end into the carb linkage. Needed a couple of goes to get the travel right so the pedal hit the stop bracket on the toeboard just as the butterflies hit their stops, then adjusted the pedal back-stop to remove excess play, but still leave the 12 thou clearance between the finger on the throttle interconnecting spindle and the choke spindle. Much smoother now, no jerking.

Stripped and repainted the cover with two coats of Hammerite Smooth, then stuck on the self-adhesive upper seal. Replaced the bottom seal, which was fun. In the end I chose to remove the pedals, then slacken the four bolts holding the pedal frame to the horizontal part of the firewall. I left the two upper bolts to the vertical part, but had enough play to lever the frame upwards gently while I removed the old seal with a flat blade, and slid the new seal into place. Note that it is handed left and right as well as back and fore. Retightened the four bolts, ensuring that the holes in the seal for the cover lined up with those in the firewall, and refitted the pedals, greasing the pivots and clevis pins with copper grease.

Three of the cover screws are easy to fit, but the fourth is in the very narrow gap between the cover and the edge of the wing. I chose to put the screw in the cover, then carefully move the cover into position but raised up a bit so it didn't push the screw out, then got it started using a screwdriver bit handle, 1/4" extension, and appropriate bit. Fitted the other three screws loosely, then tightened all four down. Job done.

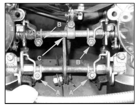
Update August 2005: Having done a few hundred miles now the cable seems nearly as sticky and jerky as before. Oh well, at least I know it is sound. Subsequently I removed the 3rd spring from the throttle cable which has improved things. *2022:* At some point (no idea when) I put the 3rd spring back and I've not been aware of any problems for a long time.

Cable adjustment:

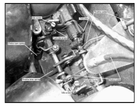
Four aspects:

- Leaving a little free-play in the cable with the pedal released so the butterflies are held open at idle by the idle screws and not the cable. If the butterflies are left hanging on the cable it can result in an inconsistent idle speed.

- Having enough pedal travel to fully open the butterflies. If the pedal can't fully open the butterflies you are obviously missing out on some performance.
- Making sure that the pedal hits its stop when fully open fractionally before the carbs are fully open so you don't stretch the cable and stress the linkage at the carb.
- Finally adjust the pedal back-stop so that there is just a fraction of free play with the pedal released and the back-stop isn't pushing the pedal down and pulling on the cable.

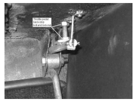


On HS carbs there should be 12 thou free-play between the finger on the throttle interconnecting shaft and the underside of the choke interconnecting shaft, on HIF cars it's 12 thou where the clamp fingers sit in the butterfly quadrants. This is set by positioning the cable inner in the clamp at the carb end. Pedal travel for full carb opening is set by the positioning of the inner in the cable clamp at the carbs. To replace the cable the inner has to be removed from the pedal end, then the new inner removed from its outer, threaded up through the bulkhead and cable guide, then the outer threaded onto the inner being careful not to fray the end.



4-cylinder HIFs are different in that they have a moulded nipple each end of the inner, and the outer has a threaded adjuster where it attaches to the bracket at the carb end to set free-play at idle and full carb opening. The pedal end nipple has to be small enough to pass through the hole in the body and the guide, but the hole in the guide must be small enough to retain the outer. The outer support bracket at the carb end is slotted to facilitate cable replacement there.

V8 HIFs are different again as there is a moulded nipple at the carb end, plain with a screw clamp at the pedal end giving adjustment, as well as a threaded adjuster on the outer at the carb end, both adjusting free-play and full carb opening.

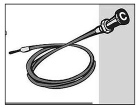


The final aspect is pedal back-stop adjustment that takes up free play in pedal movement, i.e. if you can lift the pedal up when the carbs are on their idle screws. It's important that this adjustment does not start applying a force to the cable by pushing the pedal down. The RHD back-stop screw is adjusted from the footwell and LHD from the heater shelf.

Choke Control

There was a manual choke control for twin SU carbs, the North American single Zenith from 1975 on had a coolant-operated automatic choke.

Dash Control



The manual choke was originally a round knob engraved with the letter 'C', changing to one with a 'fan' symbol (representing a shutter-valve) and the word 'LOCK' with an arrow. There were two types - one in hard plastic, and another with a soft rubber moulding holding a disc with the legend and picture. One can imagine this was the later type provided for safety reasons, and is one I can remember on Minis in the 70s. North America got a 'T-handle' choke knob for the 1970 model year, with the word 'CHOKE' as well as 'LOCK' and the arrow, and all (Clausager, but see below) cars got this type from the start of rubber bumpers.

I had assumed that early versions of the 'C' knob at least were 'push-pull' rather than 'twist to lock' based on my (from memory!) 64 Mini, but Dave O'Neil has sent me a scan of a Mk1 handbook which describes it as the 'twist to lock' type. There were two types - BHH526 for North America, Sweden and Germany, and BHH653 for elsewhere. BHH526 has a safety symbol in the Parts catalogue so I suspect that was a soft knob, with the other being hard.

The shutter-valve symbol is not very appropriate and neither is the word 'choke', as they really apply to fixed-jet carbs where mixture enrichment is performed by restricting the air supply, whereas SU carbs perform enrichment by adding fuel to the same air volume.

Which type of knob (hard or soft) was provided when - and even what part number they were is pretty confusing. According to the Parts Catalogue the original UK choke cable changed from BHH653 to BHH651 with HIF carbs (and the new 18V 779/780 engines) for chassis number 332033 (some) to 336650 (all). This cable has the CB round knob, but a longer inner needed for the HIF fittings. It changed again to BHH650 at

chassis number 3602301 and the start of rubber bumpers, and the 77 and later catalogue lists it as BHH2064 which suppliers show as the T-handle. However Clausager says the T-handle type was provided on all cars from the start of rubber bumpers, whereas BHH650 as indicated by the catalogue is shown by suppliers as the soft 'shutter' type. Various suppliers list the two 'shutter' types interchangeably, and even the 'hard' shutter type is shown by some for the earliest UK cars - a case of "what we have is the one you want", I'm sure.

If the V8 was the same as the 4-cylinder I'd have expected that to have two entries as well but the Parts Catalogue only shows one - BHH1121, and Googling that comes up with a round knob from most suppliers, you have to search for BHH1121A for the T-handle. The drivers handbook dated 1976 shows a CB on the front and only the CB front lights, but it's drawings initially show the T-handle ... until it comes to using the choke, then it shows a round knob, and for the remainder of the handbook, even though it shows the V8 binnacle. The only CB V8 brochure I have seen doesn't show the V8 dash, and modern pictures online are no help as they could well have been replaced. My 75 V8 has a T-handle and an original brochure shows the same, although the brochure is only for the RB model. Clausager shows a 74 with a T-handle but says it probably should have a round knob.

After many years use due to wear the choke control can fail to lock at all, or in some cases lock but suddenly release at inopportune moments. In some cases, with the 'twist to lock' type, this can be due to twisting of the cable inner tending to turn the choke knob in the anti-clockwise (i.e. unlocking) direction, and so if the inner is released from the carbs and turned in the appropriate direction the twist can be made to aid the locking action rather than oppose it. But mostly it is simply due to wear in the locking mechanism as indicated in the accompanying photos and descriptions (click the thumbnail on the left). Note these only apply to 'twist to lock' types, not friction lock types (which may never have been used on MGBs) although these also eventually suffer from a failure to lock. Putting a twist in the cable so the knob is turned **towards** the locked position, rather than **away** from it, will help prevent it becoming unlocked spontaneously. However putting a twist in the cable to achieve this tends to unwind the strands, so don't go mad, it only needs a partial turn.

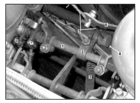
On the 'twist to lock' types wear occurs on both the knob shaft and a 'wedge' clipped into the body that attaches to the dash. So by purchasing a new cable it is possible to fit the inner and the 'wedge' from the new cable to the old outer, leaving the run of the outer in position and just undoing the nut on the back of the dash to pull the outer forward to access the wedge, rather than removing the whole thing then having to thread the new cable (inner and outer) through the most advantageous path to get smooth operation. Of course if the old outer is damaged, or is stiff in operation because it is poorly routed, then you will have to remove and replace the whole thing anyway. May be advantageous to pull out the knob, put a spot of grease on the shaft, push it back in till the grease lines up with the wedge and twist it back and fore a few times to distribute it. Then pull the knob in and out a few times wiping the shaft each time to wipe off any excess or you will get grease on the handles of your handbag.

May 2011: John Tait in Australia found his new choke cable failed to lock after just 10 starts. Opening it up he found the locking wedge is made of plastic and had deformed!

Martin Roberts's tool to aid removal of the cable from the dash on pre-77 cars.

The 77 and later choke control needs a special spanner to get up into a small gap between the centre console and the dash front.

June 2008:

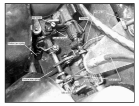


Chrome bumper cars had a curious arrangement - which often causes confusion - at the carb end where the cable inner was fixed, and it was the movement of the outer sliding up and down the inner which lifts the lever on the choke interconnecting shaft. It's quite a neat way of running the cable to avoid clutter above the carbs, but does mean there has to be space for the outer to move around without fouling anything or it can make the choke control stiff. It also makes the cable very easy to adjust - you just slacken the trunnion screw and pull the inner through it to the required position.

September 2018:

When export models from 1971 (18v engines) and UK cars part way through the 1974 model year gained HIF carbs, they retained the 'upside down' HS choke arrangement even though the throttle cable bracket had provision for a choke cable, which was used to secure the inner.

February 2009:
Rubber bumper cars (and all V8s) the factory used the more conventional arrangement of fixed outer and moving



inner using a top-down choke cable. However it's more tricky to adjust - you have to slacken the trunnion screw as before, lift the choke lever up to the required position while pulling the inner down, then tightening the trunnion screw with your third hand!

HS choke components:

Quite complicated with no less than 11 components. At least they are (nearly) all visible, unlike the HIF carb.

HIF choke set-up:

Although the external components of the HIF choke are much simpler than the HS things still need to be assembled and adjusted correctly for the choke to work properly.

In both cases the clamps on the interconnecting shaft need to be positioned quite carefully - these operate the choke cams as the cable is pulled and the shafts rotate, from a finger on the clamps sitting in a hole in its cam. As well as ensuring both carbs operate in unison - rotational positioning on the shafts, they also need to be in the correct position along the shaft. Pressed too tightly against the shaft sockets on the carb they can cause the choke to bind, but positioned too close together the shaft can slide back and fore and one or other clamp may become disconnected from its choke cam.

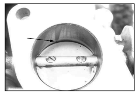
V8:

The V8 inner is different in that it has a nipple on the end that fits into a slot in a trunnion between the carb choke cams. The only adjustment consists of a simple clamp on the cable outer so you just have to slacken that while pulling the outer up to the required position, then tighten the clamp, and that is just before the cable (dash control fully home) starts to lift the trunnion. As with the others there are adjustments on the carbs to set and balance the amount of fast-idle.

HIF choke valve:

John Maguire in Oz rigged up a bench-test after having problems with a float valve towards the end of a full restoration. As part of that he took the choke valve out and describes its operation. Also shown is an exploded view of the valve components.

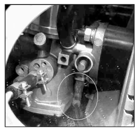
Vacuum Port: *June 2017*



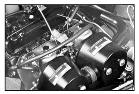
Information from various sources indicates that all MGBs up to the 18GK engine in 1971 had HS carbs, the rear carb having a vacuum port on the upper surface of the throat between the piston body and the manifold flange.

North American 18GK engines in 1971, despite still having HS carbs according to Clausager, then seem to have the distributor connected to a port on the inlet manifold. They had AUD 465 HS carbs, but whether these carbs still had the port but it was capped, or whether there was no port, isn't known.

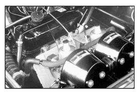
With the first 18V engines for the 1972 model year all export models gained HIF carbs. North-American models had different carbs to other export markets and did not have the vacuum port, other export markets may have had HIFs with the port, but it's not known whether it was used for vacuum advance.



UK didn't get HIFs until November 1973, and these have the vacuum port on the rear carb as before, but now on the bottom as the butterfly opens the other way. Clausager and the Parts Catalogue show UK carbs changing to FZX1001 with needle ACD in September 74 with rubber bumpers and this is when the vacuum port was deleted and the source became the inlet manifold.



However the brochure for RB cars publication No. 3089 shows the vacuum pipe going to the rear carb and not the inlet manifold. Either the carbs didn't change immediately or the photo was of a pre-production car and the changes made for production. *Thanks to Nigel Kidd for spotting that ... in a scan of the brochure I had sent him!*



Clausager shows a 1975 with a vacuum connection to the top of the front carb, which would be wrong for an HIF on an MGB, the same picture shows a manifold port capped off so the carb vacuum is almost certainly a user modification.

Some people have spoken of drilling the body to add a port to change from manifold vacuum to carb vacuum, even though it makes no difference under normal driving conditions, and if this is what has been done here it has been done incorrectly as the port should be underneath.

From the start of the 1977 model year all export models were to North American spec, including cars for Japan which meant they got LHD cars despite being an RHD country.

V8s always had HIFs with a vacuum port below the throat of the near-side carb.

Whether the port is above or below the throat depends on which way the butterfly pivots as it opens. If the top of the butterfly moves towards the carb, then the port will be at the top, to be presented to manifold vacuum as soon as possible, and this is how it is on HS carbs. If the bottom moves towards the carb then the port will be on the bottom, and this is how it is on HIFs. How the accelerator cable acts on the throttle spindle indicates which way the butterfly moves. On HSs the cable lifts a lever on the manifold side of the spindle, showing that the top of the butterflies will move away from the inlet manifold, and the vacuum port is at the top. But on HIFs the cable lifts the lever on the air-cleaner side of the spindle, showing the bottom of the butterflies moves away from the inlet manifold, so a vacuum port would need to be on the bottom. The V8 pulls a lever that is above the spindle away from the carbs, so again the bottom of the butterflies moves away from the inlet manifold, and hence the vacuum port is on the bottom. The parts catalogue indicates the change from the cable pulling up the inlet manifold side, to pulling up the carb side, occurred at chassis number 332033 in the UK and 25800 elsewhere, which coincides with the change from HS to HIF in each case, indicating that all HIFs - if they had a vacuum port - would have had it underneath. Clausager also shows a 'post-76' car with the vacuum pipe going to the inlet manifold on p67, and on p80 he says the final carbs on UK cars 'possibly for the 77 model year' have much shorter necks to the bellhousings of the suction chambers, but the carbs on p66 and p67 seem to be identical.

Certainly the V8 suffers from fuel trickling down from the port into the vacuum capsule and rotting the vacuum advance diaphragm. 4-cylinder cars may not as the pipe always has to rise to go over the rocker cover. After two V8 failures of the very expensive capsule I fabricated a small separation chamber which I mounted above the carb port, so fuel trickles back to the carb.

Setting-up:

Note that in the UK MGBs first registered before 1st August 1975 the emissions test simply comprises a visual inspection for excessive smoke. Cars first registered on or after 1st August 1975 will fail if they emit more than 4.5% CO or more 1200ppm hydrocarbons. For cars first registered before 1st September 2002 if it can be shown the car is fitted with an earlier engine it is tested to the standards applicable to the engine, i.e. visual inspection only for an engine first used before 1st August 1975.

Note that if carbs have been removed and refitted check there is some free-play in the throttle and choke spindles that run between the two carbs. The flange nuts may need to be slackened and the carbs repositioned slightly to achieve this. Also the spindle clamps may need to be slackened and the amount of engagement with the cams reduced to give a little fore and aft play.

The engine must be fully warmed up to begin with, and the engine at run 2500rpm for one minute if not driven at normal road speeds immediately before. For the duration of the setting-up process each three minutes the same must be done, to 'clear its throat'.

The basic requirement for good twin SU set-up is that the carbs should be matched - and that means matching springs, needles, jets, air flow and mixture. Springs, needles and jets should always be replaced in pairs. If you have modified the 'breathing' in any way - air cleaners, carbs, combustion chambers, exhaust - you may benefit from a different needle to standard. For example K&N filters may need a richer needle, see SU Needles. While the earlier metal floats can be adjusted to give the same fuel height in the float bowl, it looks like the later plastic ones cannot easily be, except by placing washers between the needle valve and the housing if the fuel level is too high. The float height on HSs is supposed to be such that, with the float chamber lid held upside down, the float should just rest on a 1/8" to 3/16" round bar placed across the middle of the lid parallel to the hinge pin.

Fixed needles on HS carbs must be installed with the shoulder near the top flush with the bottom face of the piston.

Swinging needles (HS or HIF) must be installed with the bottom of the needle carrier, flush with the recess in the piston.

With the earlier fixed needles the jet must be centred so that the piston drops smartly and freely onto the bridge with a metallic click. This test should be done with the jet screwed up to be flush with the bridge, if it drops cleanly here then it will definitely do it when the jet is lowered to its normal running position. If it binds with the jet raised the jet needs to be recentered by slackening the jet bearing nut, pressing the piston down then retightening the jet bearing nut. Recheck, and repeat until the piston drops cleanly. **Note** that whilst it is easier to do this check with the damper unscrewed, with the damper fitted and oil in the reservoir the piston should still drop smartly, the damper should only retard the upward movement.

Tip: A float valve can sometimes stick in the closed position, particularly if the car is not used for some time. Running the engine will empty that float chamber which will cause poor idle and running. Rapping the top of the (HS) float chamber with the handle of a screwdriver can often free the valve.

Tip: The opposite effect is dirt in the float valve that stops it closing when the float chamber is full and it overflows. Disconnect the fuel pump and run the engine until the float chambers empty and the engine stops. Reconnect the fuel pump and the resulting rush of fuel into the float chambers will usually clear the dirt away. If it happens again immediately either the float could be punctured and full of fuel so it doesn't float, or the valve could be worn. If it happens frequently change the in-line filter (if fitted) or investigate the causes of dirty fuel e.g. internally corroded fuel tank. Check the float height after replacing the float valve, or float.

Tip: Many HIFs, and possibly some HSs, have a 'poppet valve' in the butterfly which opens under conditions of high manifold vacuum i.e. the overrun. This was an emissions measure which simulates opening the throttle slightly until the manifold vacuum drops closer to its normal value at idle. This valve can stick open and cause a high idle, sometimes only during certain circumstances e.g. warming up and be OK the rest of the time. One of my V8 carbs was doing this so I soldered them shut, which needs minimal dismantling to perform. Some recommend replacing the butterfly with the solid item, which has the same effect plus removes a small obstruction from the throat of the carb, but needs much more dismantling and it can be fiddly to get the new butterfly to seat properly in the throat, which leads me onto my next tip.

Tip: A high idle that cannot be brought down to normal by use of the idle screws is **not** being caused by a vacuum leak. A vacuum leak only lets in air, whereas the engine needs fuel to run. Therefore if the engine is still running when the idle screws are backed right off there is some other problem allowing fuel as well as air into the engine. This could be one or more of the following:

- No slack in the throttle cable i.e. the throttle pedal stop is causing the cable to hold the butterflies open. On HS4 there should be 12 thou (for manuals, 20 thou for automatics) free play between the finger on the throttle interconnecting spindle and the choke spindle. My WSM incorrectly states 0.12" i.e. 120 thou, but it also states 0.3mm which equates to 0.012" i.e. 12 thou. On HIF this is measured where the finger on the clamp sits in the slot on the butterfly lever for each carb. My Haynes adds to the confusion by having a drawing Fig. 3.17 showing the measurement taken at the clamps on a page for HS4 carbs, but it is in the section on HS4 for emission control equipment vehicles. It has very little on HIF slow-running and synchronisation except for the statement 'largely as described in Section 21' which is for HS4 carbs, but continues 'but with reference being made to Fig. 3.19'. However 3.19 is the exploded drawing of the whole carb so not much help in these adjustments, I suspect it should read 'Fig. 3.17'.
- Maladjusted fast idle screws holding the butterfly open, see here for correct adjustment.
- Maladjusted throttle interconnecting clamps and spindle - one carb fully closed is holding the other one slightly open. Go through the full set-up sequence below. There should be **detectable** sideways free-play in the interconnecting spindle. If the clamps are pushed hard against both carbs they could be causing friction preventing the butterflies from fully closing. OTOH there must not be so much movement that the finger on the clamp can become disconnected from the slot in the lever that opens the butterfly.
- Butterfly poppet valve not seating - solder it closed or fit a plain butterfly.
- Butterfly not seating properly - check the carb throat seat is clean and reseat the butterfly. You may need to remove the carbs, back off the idle screw, raise the piston, and squint through the carb against a light source looking for a line of light around the edge.
- Worn throttle spindle and/or bushes - this can cause a vacuum leak as well as allowing mixture to bypass the butterfly.

I repeat: With both idle screws fully backed off both butterflies should be fully closed and should be more than enough to cause the engine to stall.

The main adjustments: *Updated March 2023*

Note: There are two different types of jet bearing for the HS4 with different threads which affects how far the jet moves with each turn of the mixture adjusting nut - coarse and fine. However everything encountered on an MGB should be the coarse thread, the fine thread only applies to other marques such as the Mini where it has Waxstat temperature-controlled mixture.

- Remove the air filters, slacken the throttle and choke bar clamps, two on each bar, and back off the fast idle screws that bear on the choke cams.
- Screw each jet up (nut under the carb on HS, screw on the side of the body for HIF) until it is flush with the bridge (**NOT** as high as it will go), then screw it down two full turns to give the basic start-point for the mixture.
- Start and run the engine up to temperature, adjust the idle screws to give a reasonable idle speed.

- Using a tube to listen to the hiss in each intake, or by using a balance meter such as Gunson's, independently adjust each idle screw so you get the same hiss or meter indication in both carbs while still retaining a reasonable idle speed.
- On each carb in turn adjust the jet height to give the correct mixture for your spec:
  - On UK cars first registered after 1st August the mixture is set by adjusting the each jet in turn to get the highest idle speed, rechecking back and fore as the balance tube makes them interdependent. You should find that there is a small range of adjustment where nothing happens, beyond that the idle speed starts to fall as the mixture goes rich or weak. From the highest idle point weaken first one then the other until the idle speed **just** starts to fall, no further. The MOT requires these cars to have a CO reading below 4.5%, but adjusting to achieve that should only be done after the carbs have been fully balanced for air flow and mixture, and then only by adjusting both carbs by the same amount in the same direction.
  - Otherwise mixture is set by adjusting for highest idle as above, then fine-tuned by using each piston lifting pin in turn. When a piston is lifted 1/32" it should cause the engine speed to momentarily increase then settle back down - note that the pin itself can be pushed up quite a way before it starts lifting the piston. This isn't easy both from the point of lifting the piston the correct amount as well as hearing changes in the engine note, you may need to 'train your ear' as here, or if still struggling you could try the emissions-controlled HSs method as here. If the speed stays up the mixture is too rich, if the engine speed immediately falls the mixture is too weak. Each carb should be adjusted independently so that it gives the correct, and more importantly the same, results. If you still struggle to detect the momentary rise with the lifting pins then use the method for UK emissions tested cars above i.e. go for the highest idle, about mid-way between where it just starts to drop when weakened and just starts to drop when enriched. After adjusting each carb the other should be rechecked as the balance tube between them makes them interdependent. Adjusting HS jet nuts may well need a special spanner even with the air-cleaners off, even more so with them in-situ. If you have had to adjust one carb noticeably more than the other from the starting point, that indicates there is a problem on one of the carbs, probably the one you had to adjust more. See here for more info on jet height.
- Recheck the air balance again, adjusting idle screws independently as before if required.
- The throttle spindle clamps should be set such that there is a small amount of free play in the throttle cable and interconnecting spindle before the butterflies start to open, and that both butterfly cams start moving at the same time. There is a lever on the throttle spindle that rests on the underside (HS, above on HIF) of the choke spindle when the throttle is closed. Insert a 12 thou (for manuals, 20 for automatics) feeler gauge between the lever and the choke spindle, lightly press down on the part of the clamp that engages with the throttle cam and tighten each nut. Note that my WSM incorrectly states 0.12" i.e. 120 thou, but it also states 0.3mm which is correct, and for HIF carbs it is measured where the finger on the clamps is in the slot of the throttle quadrants. Check afterwards to ensure that the slight play described above exists, that both butterflies start opening at the same instant, and also that there is about 1/32" end-float on the interconnecting spindle. The 12 thou isn't critical but if too small and you need to reduce the idle speed you may not be able to as that reduces the clearance. Likewise if the clearance is too large the throttle pedal will have to be moved more before it starts opening the throttle, and increasing the idle speed increases the clearance.
- Run the engine at 1500 rpm and check that the air balance is still correct. If it is not the throttle spindle clamp(s) will have to be readjusted. Persevere with this, it is important to get both air balance and clearances right - and more important to get them balanced off-idle than at idle for obvious reasons. If you find this difficult to set your throttle spindles/bushes may be worn i.e. can be waggled up and down or from side to side.
- From now on only ever adjust the idle screws **by the same amount and in the same direction** to obtain the required idle speed. If you start altering them independently you will upset the balance and have to go back several steps.
- The throttle pedal should reach the stop on the floor (or the floor itself for later pedals) just as the butterflies reach fully open but without stretching the cable - the butterflies and cable should not act as the throttle stop. Adjust this with the cable clamp on the throttle spindle (HS) or adjuster on the outer at the carb end (HIF). Take up any free play in the throttle pedal with the screw and lock-nut bolt located near the pedal hinge, make sure there is still the required clearance between the finger on the throttle interconnecting shaft and the choke interconnecting shaft.

Choke:

- The choke operates in two phases - opening the throttle slightly first (fast-idle), then enriching the mixture. Make sure the choke cable is routed such that it has a clear run when the choke knob is out, otherwise stiff operation can result.
- Adjust the choke interconnecting spindle clamp screws at the carbs such that enrichment commences at the same time on both carbs as the choke is operated i.e. after the fast idle movement has taken place. For HSs the movement of the jets can be observed, for HIFs there are index marks on the enrichment cams and enrichment commences when they are under the middle of the fast-idle screws.
- See here for how the chrome bumper 4-cylinder choke cable attaches at the carb end, it is unusual in that it has a fixed inner and moving outer. There can be quite a lot of movement of the choke spindle lever and fast idle cams before the jets start to move, so set the choke knob at about 1/2" to 5/8" out, then with the cable inner clamp screw slackened pull the inner through the clamp to move the choke lever (for the HIF top-down choke cable lift

the choke lever up while keeping the cable under tension) until the jets are just about to move, and tighten the clamp screw. NB: John Twist covers this briefly on the MGA but just says to 'pre-load the cable somewhat'. Unless you pre-set the control first you will be guessing how much cable needs to be pulled through the lever clamp to give half an inch of fast-idle before enrichment starts.

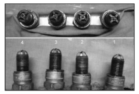
- Adjust the choke cable lever on the interconnecting shaft so that when the choke knob is about 2/3rds out the lever makes an angle of about 90 degrees with the cable, again to avoid stiff operation. You will probably have to go through a couple of iterations of adjustment of the choke lever and the trunnion to get both the angle of the lever and the fast-idle distance of the choke knob satisfactory. Pictures
- Independently adjust the fast idle screws such that as the choke is operated both throttle butterflies start to open at the same time, and gives the correct fast idle speed (e.g. 1000rpm when the engine is hot) when the choke knob is in its maximum 'fast idle' position i.e. just before enrichment starts, and check the air-flow is balanced.
- The fast idle screws in the butterfly cams must be clear of the choke cams when the choke control is pushed fully home.

Damper:

- Check the oil-level in the piston damper. The most sensible way to do this is to unscrew the damper cap lift it up, and press it down again. If you feel the resistance of the oil before the damper cap reaches the dashpot cover you have enough oil. If you try and maintain the oil level at the recommended top-up position of 1/2" above the top of the hollow rod you will be forever topping up which will wear out the damper cap threads and the damper cap will shoot up out of the dashpot cover under hard acceleration. The correct top-up oil is engine oil of whatever grade is correct for your local climatic conditions, e.g. 20W/50 for temperate climates. When you do have to top it up there is no point in filling it to above the top of the hollow rod as any oil above this point is rapidly drawn into the engine, hence the frequent topping-up if you try and maintain it at this level. However see Damper Oil Level

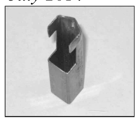
Herb Adler describes using a Colortune. I never got on with them on single-carb engines, so for years never contemplated it for the MGB where you either have to buy two or keep swapping them between pairs of cylinders. Herb describes how it is easy to tell between rich and not rich, less so between just right and slightly either side. Eventually he bought a second one, and even more eventually I first bought one then a second on eBay. I still don't see the colour change between slightly weak and slightly rich any clearer, I can hear the revs change just as easily for coarse adjustment. The only thing I did find with two is that with one carb a bit weaker than the other there is a visible difference in the increased richness when blipping the throttle, but lifting the piston reveals that anyway.

Important: Once the carbs are correctly set up only ever make further adjustments to both carbs by the same amount and in the same direction. Once you start adjusting the carbs independently you will have to go through the above set up to get them balanced again.



As periodical conformation of the mixture you can check the plug colour. These from the roadster all look pretty good to me, perhaps the back pair are just a smidgen richer. I decided to weaken that carb a tad, and given that it's awkward to turn the HS nuts with the air cleaners on I made a box-spanner, which worked a treat.

July 2014



HS carbs are usually adjusted with the air cleaners off, as they restrict access to the adjusting nuts. However if you just want to make a small change to the mixture it's a bit of a palaver to take them off and replace them for something that only takes a second or two. There is a pukka SU spanner, but it's flat, albeit heavily cranked, so I can't really see it being much easier with one of those. So I decided to make a 'box' spanner to do the job, and found an offcut of some 15mm square tubing that I reckoned would suit. I have a spanner which is the correct size for the adjusting nuts, so used that to find a bolt with the same-sized head, to use as a mandrel to form a hex in one end of the square tubing. I used a steel wedge to open out the sides of the square section until I could start to get the head of the bolt in, then hammered it in, and used hammer and vice to make a hex end that was a good fit to the bolt head. The jet has a plastic part below the adjusting nut that carries the enrichment lever that pulls the jet down when the choke is pulled, so I cut one flat off the hex, and for a little way down the tubing, to clear that. Then below the five remaining sides of the hex I cut the edges back half a flat further, to give some 'swing' room to turn the nut one flat at a time. The square section at the lower end gives quite a good grip to turn the nuts - but they shouldn't be stiff anyway, and it works a treat. But if you wanted to you could fit a short tommy-bar through the lower end, or maybe even the handle of a stubby screwdriver, to give a better grip.

Heat Shield:

Gaskets

Fitted adjacent to the inlet manifold with spacer blocks 12H712 to the carbs.

Originally a thin sheet-steel plate with two blocks of asbestos on the back to shield the carb float chambers from exhaust manifold radiation. Asbestos not such a good idea, and current replacements have two pieces of woven material silvered on one side. Can't say I'm impressed with the thickness, time will tell if it's adequate. Bee's has always been pretty manky and I knew almost half of the rear block was missing, so as part of the head conversion to unleaded I decided to treat her to a new one. Spring holes and tabs a bit different to the original - but at least the original ones are present, plus two more tabs in that area. One large tab near the right-hand edge not there, but then it wasn't used so doesn't matter. The new one has two off-set holes near the top edge, for what I can't imagine.

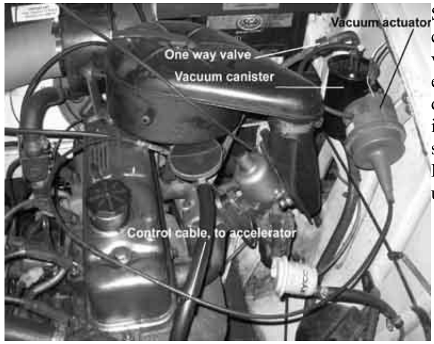
November 2018:

Even though the silvered cloth on the back of the new shield is rather thin compared to the old asbestos - I did wonder if it would be thick enough, despite some very hot weather in the summer this year I had no problems starting or running as usual. Unlike some with summer running problems who seem to think that vaporisation or vapour lock is 'common' and down to the fuel. I'd love to get my hands on one of these.

THE NEVERENDING SAGA OF BB AND WW - Cruise Control

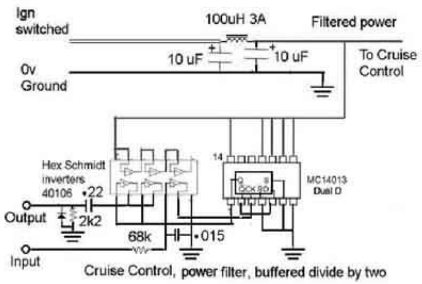
by Herb Adler

Many, many years (~15) ago I fitted a cruise control to my Daihatsu. After about five years I replaced the car and removed the cruise control. I eventually gave the car to my son, its commercial value was about $150, with the cruise control bits in a box, for him to refit. He never did, and 10 years later I got the box back, so the unit is about 15 years old. Now the big decision, fit it to the Wolseley or the MGB. For what ever reason I opted for the Wolseley, maybe more space to fiddle around in, and relative easy access behind the dash. The cruise control is a Command AP50D, the D stands for digital, as opposed to earlier analogue units. It consists of a vacuum actuator, an electronic control unit, a dash mounted control pad, and lost by this time, speed sensing magnets, to fit on the drive shaft. I wouldn't have used the magnets anyway, as I've had the drive shaft balanced, and these magnets would unbalance it again. Current model of this type is the AP60B, which seems to be very similar, except that the control pad only has three buttons instead of four. The old unit has an On button and an OFF button, the new unit has just the one button, presumably push ON and then push OFF.



So the project was broken down into two parts, mounting the actuator and connecting the cable to the carby. I have found, in the past, that for the vacuum you must have a separate vacuum chamber, isolated from the engine vacuum by a one way valve. This is necessary as when a higher demand is put on the engine, by opening the throttle, the engine vacuum is decreased and the cruise becomes limited in its ability, whilst the separate chamber keeps the vacuum up. I have sourced these from Mitsubishi cars, at the wreckers. This chamber also needs to be fitted under the bonnet.

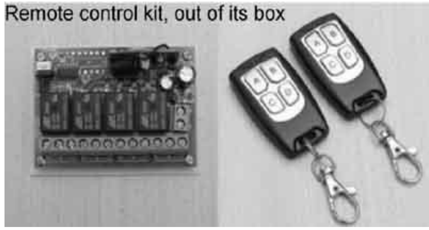
The other part of the installation is the electrics. These gave me the most troubles, particularly with getting a speed signal. I had planned to use the ignition pulses as the signal. This involved a lot of trial and error before I got it right. The ignition pulses are related to ground speed, but only in a manual car. The first trial was to use the pulses from the points end of the coil. To get rid of multiple pulses from ringing and contact bounce, I copied the input filter circuit from the RVC tachos. This worked well, except that the cruise only worked above 50 MPH. Not good, as I wanted to control it down to a minimum of 40 KPH (24 MPH). Scratch the bald spot to think of another way. Ahhh! Yes use a signal from an ignition lead. Made a clip on sensor, again it worked well, except it only controlled up to 40 MPH.



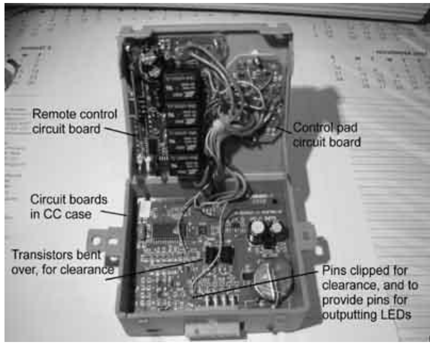
Cruise Control, power filter, buffered divide by two

So I need a signal of more than one cylinder's ignition and less than the four from the points. A divide by two circuit seemed the way to go.I found the power filter necessary, since the cruise control would drop out, if something like the indicators was turned on.

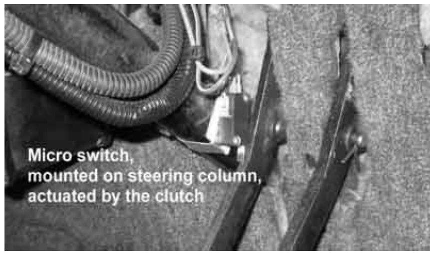
So some more bench fiddling, but then the BB's clutch packed it in. So with having to fix the clutch, then Christmas and 6 weeks holidays, a lot of time had slipped by. In my earlier tests, I found that the dash mounted control pad was dangerous, in that I had to significantly take my eyes off the road to use it. Our family Hyundai has the controls on the steering wheel, a much better location, and yes one can buy a wheel fitted control at about $180, but not necessarily compatible with the old unit.



Fortuitously I found a 4 channel remote control kit, on eBay for around $15, comprising two key ring fobs and a receiver, with relay outputs. I used this, with one of the fobs mounted on the steering wheel and the relay contacts wired across the control pad's switches. Initially I was going to have the control pad, the remote receiver, the cruise control box and the speed signal electronics, in another box (with power filtering also built in), all separately mounted behind the dash. Count it, that's space for four boxes I had to find.



Still messing around with it all, on the bench, I looked at all the pieces and thought that there seemed to be enough extra room in the cruise box to mount both the remote receiver and the control pad circuit boards, in the lid. And so it turned out to be. Another side effect of this is that the wiring of the different boards was simplified, in that it was all inside the one box, no external looms to worry about, except for the power filter and divide by two circuit, which still were in a separate box. Note that the screw terminals of the remote were removed.



As part of the functioning of the cruise control, a cancel signal needs to be wired in. This comes from the brake light switch, so that when you are braking the cruise control is turned off and not trying to keep your speed up. With a manual car it is strongly advised to also have a cancel signal, from the clutch, so that the engine isn't over revd when you change gears. This entailed the fitting of a switch to the clutch. All tested and working. An advantage of using the engine revs as a speed source, is that I can now cruise at very slow speeds, because I'm in a lower gear, for those engine revs.

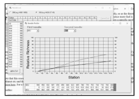
SU Needles

Last updated 05-Feb-2026

Updated November 2013: I downloaded the following needles a long time ago, extracted from a needle selection program that no longer seems to be available. Note the dimensional errors in SM and SN from a number of sources, I give both, corrected versions at SM* and SN*.

There is an online comparison program here but whereas at one time I'm sure it used to allow you to scroll through needles getting a graphical comparison now you have to select specific needles which is useless unless you know which ones you are interested in. It also complicates matters by categorising needles in terms of 'annulus area' and 'low to high vacuum'.

There is also a downloadable Windows program for purchase here, but this is less easy to use than the online one was, probably easier now.



I wrote my own Windows program that gives a graphical comparison just by scrolling up and down but you can download the two lists of needles 0.090 for 4-cylinder and 0.100 for V8. If you load those into a spreadsheet you can sort on the position you are interested in, and if your spreadsheet is clever enough to have a graphing feature and you can use it you may also be able to see how two or more profiles compare along all the stations.

Bear in mind that if you want a needle that is richer somewhere in the range you would normally use one with the same dimensions at the idle position (the majority of 0.090 needles are 0.890 at station one and 0.100 needles are 0.990). You can choose one that is thinner (or thicker) at idle but to get the correct idle mixture you would need to set the jet higher (or lower), which will have the side effect of moving the effective station at a specific throttle opening.

Please note that this resource is to help you choose an *alternative* needle to standard if you have a non-standard system e.g. different air filters, exhaust etc. and the standard needle is giving flat-spots or other problems, the MGOC has suggestions for various levels of modification here. For a list of *standard* needles, springs etc. through the years have a look at Paul Tegler's info.

0.090 Needles:

A5_ 890 850 826 800 782 765 746 730 711 694 676 660 __0 __0 __0 __0
AA_ 890 850 800 767 735 710 689 661 638 614 591 566 540 __0 __0 __0
AB_ 890 850 800 785 768 750 732 718 702 688 671 657 640 __0 __0 __0
AC_ 890 850 820 800 783 765 746 730 710 694 676 660 640 __0 __0 __0
AC2 890 850 820 800 783 765 746 730 710 694 676 660 640 __0 __0 __0
AD_ 890 850 820 800 780 760 740 720 700 680 660 640 620 __0 __0 __0
AE_ 890 850 810 780 763 754 745 737 728 718 710 700 __0 __0 __0 __0
AF_ 890 850 814 780 758 727 710 695 680 665 650 632 __0 __0 __0 __0
AG_ 890 850 795 745 702 665 630 598 567 540 510 485 460 __0 __0 __0
AH_ 890 862 830 803 775 756 733 711 690 670 650 630 610 __0 __0 __0
AH1 890 860 820 790 765 750 730 710 690 670 650 630 610 __0 __0 __0
AH2 890 850 820 794 770 748 726 704 683 662 640 620 600 __0 __0 __0
AI_ 890 850 817 798 780 765 750 732 712 693 685 675 __0 __0 __0 __0
AJ_ 890 850 815 790 767 745 723 703 683 663 640 620 __0 __0 __0 __0
AK_ 890 860 825 795 786 780 770 764 755 747 738 730 __0 __0 __0 __0
AL_ 890 850 816 796 781 770 760 748 738 726 715 705 __0 __0 __0 __0
AM_ 890 850 810 780 753 730 704 680 655 630 606 583 560 __0 __0 __0
AN_ 890 855 827 807 787 770 753 740 730 720 710 700 690 __0 __0 __0
AO_ 890 850 820 793 766 737 705 673 640 608 576 544 510 __0 __0 __0
AP_ 890 850 817 796 777 765 752 745 736 727 720 710 __0 __0 __0 __0
AQ_ 890 850 800 760 724 694 668 642 620 600 580 558 536 __0 __0 __0
AR_ 890 850 820 795 771 748 730 712 696 680 660 640 __0 __0 __0 __0
AS_ 890 845 790 750 720 692 665 635 610 586 560 533 510 __0 __0 __0
AT_ 880 856 833 809 785 761 738 714 690 666 643 619 __0 __0 __0 __0
AU_ 890 840 815 790 773 755 737 717 698 680 660 640 __0 __0 __0 __0
AV_ 890 850 805 773 742 717 700 675 650 625 600 590 580 __0 __0 __0
AW_ 900 850 807 780 757 735 713 693 674 655 637 618 600 __0 __0 __0
AX_ 890 843 807 775 750 730 710 692 675 660 645 630 615 __0 __0 __0
AY_ 890 850 805 768 741 720 694 669 643 617 590 565 538 __0 __0 __0
AZ_ 890 850 815 790 755 710 662 615 575 532 490 445 405 __0 __0 __0
AAA 890 850 814 785 755 720 674 630 600 580 560 540 520 500 480 460

AAB 890 850 824 785 752 715 670 610 560 537 516 493 470 448 448 448
AAC 890 855 835 811 788 765 742 720 698 676 655 631 610 590 570 550
AAD 890 855 827 807 787 770 753 740 730 720 710 700 690 680 670 660
AAE 890 850 833 803 773 745 715 680 653 627 600 590 580 570 560 550
AAF 890 855 827 800 775 750 715 680 653 627 600 590 580 570 560 550
AAG 890 850 830 800 773 745 715 686 658 647 636 625 614 605 595 584
AAH 890 855 832 812 790 764 736 705 674 644 619 593 566 540 515 490
AAJ 890 855 832 812 789 770 747 716 672 640 620 600 580 560 540 520
AAK 890 855 830 807 784 760 735 708 677 645 613 580 550 520 490 460
AAL 890 850 830 800 771 745 715 680 653 627 600 590 580 570 560 550
AAM 890 850 824 785 752 715 673 630 590 567 543 519 496 472 448 448
AAN 890 855 835 815 797 781 767 757 750 745 740 735 730 725 720 715
AAP 890 855 835 811 788 770 760 750 740 730 720 710 700 690 680 670
AAQ 890 855 827 801 775 754 732 718 701 688 672 655 642 625 612 595
AAR 890 850 827 795 770 745 715 686 658 647 636 625 614 605 595 584
AAS 890 850 830 802 775 750 718 688 665 648 630 612 596 577 560 542
AAT 890 855 832 810 784 760 745 725 708 691 674 657 640 623 606 589
AAU 890 850 828 806 780 745 710 675 647 620 590 560 530 500 470 440
AAV 890 855 835 815 792 768 746 720 698 674 650 627 602 578 554 530
AAW 890 855 832 810 788 765 742 715 683 652 620 590 560 530 500 470
AAX 890 855 833 810 790 772 758 750 745 740 735 730 725 720 715 710
AAY 890 855 830 807 782 758 744 732 723 717 712 707 700 690 680 670
AAZ 890 855 832 805 777 754 732 718 701 688 672 655 642 625 612 595
ABA 890 855 825 802 775 750 718 688 665 648 630 612 596 577 560 542
ABB 890 855 830 807 782 758 745 725 708 691 674 657 640 623 606 589
ABC 890 855 827 810 770 760 745 725 708 691 674 657 640 623 606 589
ABD 890 850 828 803 765 740 710 675 647 620 590 560 530 500 470 440
ABE 890 850 830 800 775 758 717 699 676 653 630 612 596 577 560 542
ABF 890 855 832 809 785 761 737 712 687 664 642 618 595 572 550 525
ABG 890 855 832 807 784 760 737 717 697 677 656 635 614 593 572 500
ABH 890 850 825 790 760 730 705 693 682 670 656 640 630 620 610 600
ABJ 890 850 830 800 765 725 715 686 658 647 636 625 614 605 595 584
ABK 890 855 833 812 793 775 757 742 728 717 704 692 680 668 656 644
ABL 890 855 832 810 790 770 757 745 737 730 723 715 709 700 694 686
ABM 890 855 835 815 795 777 762 750 740 730 720 710 700 690 680 670
ABN 890 855 832 805 777 754 732 712 692 672 652 632 612 592 572 552
ABP 890 855 831 808 787 766 743 722 700 685 672 659 646 633 620 607
ABQ 890 855 828 803 778 753 730 707 685 660 638 615 590 570 550 530
ABR 890 855 830 803 775 745 715 681 653 620 600 590 580 570 560 550
ABS 890 855 835 814 789 765 746 728 713 692 674 656 640 620 600 580
ABT 890 855 833 810 785 763 747 734 722 711 700 689 678 666 655 645
ABU 890 855 834 814 795 777 759 745 730 718 710 703 695 688 680 670
ABV 890 865 835 815 797 775 732 720 708 691 674 657 640 623 606 589
ABW 890 865 840 815 786 761 728 704 680 663 637 614 590 567 543 519
ABX 890 850 832 803 775 746 715 697 678 665 645 625 605 585 565 545
ABY 890 850 827 798 771 720 653 621 589 557 525 493 461 429 429 429
ABZ 890 865 840 815 790 761 730 704 676 650 624 596 570 544 517 490
ACA 890 865 840 815 790 764 735 720 706 680 640 604 565 526 489 450
ACB 890 865 840 815 790 757 724 704 675 640 615 590 565 540 515 490
ACC 890 850 834 812 794 775 758 744 728 715 700 685 670 655 640 625
ACD 890 850 828 806 779 752 713 680 665 650 635 620 605 590 575 560
ACE 890 850 830 806 785 744 722 709 698 683 670 659 646 633 620 607
ADA 890 865 838 812 781 751 715 691 649 621 591 565 538 509 481 455
ADB 890 865 840 810 780 750 715 678 642 615 586 560 532 505 477 450
ADC 890 850 822 806 785 763 742 720 700 685 672 659 646 633 620 607
ADD 890 850 828 803 778 753 730 707 685 660 638 615 590 570 550 530
ADE 890 855 832 807 787 765 725 715 708 691 674 657 640 623 606 589
ADF 890 850 822 803 775 746 730 707 685 660 638 615 590 570 550 530
ADG 890 855 833 808 780 754 732 718 701 688 672 656 640 620 600 580
ADH 890 855 835 811 783 757 727 721 710 700 690 680 670 660 650 640
ADJ 890 873 844 824 803 782 764 750 740 730 722 715 710 705 700 695
ADK 890 865 838 812 780 749 708 661 619 594 570 546 522 500 474 450
ADL 890 865 838 812 781 750 710 678 640 608 584 557 531 505 480 455
ADM 900 868 837 812 787 760 735 709 683 658 632 605 580 555 530 500
ADN 900 873 845 825 802 779 760 742 732 724 716 708 700 693 685 678
ADP 890 850 833 813 783 748 725 712 696 685 675 656 640 620 600 580

ADQ 900 868 838 813 788 760 735 713 692 670 650 630 610 593 575 560
ADR 860 852 843 826 806 786 766 740 711 681 652 625 598 572 546 521
ADS 890 850 838 811 768 739 709 691 682 665 650 640 627 616 603 590
ADT 890 855 835 811 788 770 756 740 734 727 719 710 700 690 680 670
ADU 890 855 835 813 787 752 732 707 700 677 656 635 616 596 576 553
ADX 890 855 835 810 788 738 670 610 578 548 530 516 500 483 468 450
ADY 890 856 832 810 785 765 750 734 720 707 691 679 665 650 636 620
ADZ 890 850 834 801 762 732 702 687 672 660 650 640 627 616 606 595
AEA 890 850 835 815 797 781 767 757 750 745 740 735 730 725 720 715
AEB 890 855 835 812 787 762 743 724 708 691 674 656 640 620 600 580
AEC 900 870 842 817 790 757 718 681 645 610 580 550 523 497 470 445
BA_ 890 856 822 805 794 777 760 743 727 710 694 677 __0 __0 __0 __0
BB_ 890 850 825 800 775 750 725 700 675 650 625 600 575 __0 __0 __0
BD_ 900 856 822 805 794 777 760 750 740 730 720 710 __0 __0 __0 __0
BE_ 890 840 805 773 740 705 670 634 600 565 530 495 460 __0 __0 __0
BF_ 890 850 820 796 764 720 680 635 591 549 505 463 420 __0 __0 __0
BG_ 890 850 815 782 745 695 647 600 557 515 474 430 390 __0 __0 __0
BH_ 890 850 812 775 753 740 731 722 714 705 696 688 680 __0 __0 __0
BI_ 890 855 808 777 751 730 714 705 701 697 694 690 __0 __0 __0 __0
BJ_ 890 855 824 794 769 749 734 725 721 717 714 710 __0 __0 __0 __0
BK_ 890 855 815 785 762 738 722 715 710 706 703 700 695 __0 __0 __0
BL_ 890 855 810 777 750 730 715 707 700 698 693 690 688 __0 __0 __0
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BN_ 890 855 816 784 758 738 724 714 707 703 701 700 __0 __0 __0 __0
BO_ 890 855 835 815 800 787 770 757 750 740 730 720 710 __0 __0 __0
BP_ 890 850 814 780 740 715 695 673 650 625 600 580 560 __0 __0 __0
BQ_ 890 850 820 790 750 725 705 685 662 640 616 594 570 __0 __0 __0
BR_ 890 850 817 785 757 750 741 735 728 720 710 700 690 __0 __0 __0
BS_ 880 856 836 817 798 778 760 740 720 701 683 664 __0 __0 __0 __0
BT_ 880 856 835 813 792 771 749 726 705 684 663 640 __0 __0 __0 __0
BU_ 900 850 800 770 745 720 695 675 655 625 602 580 560 __0 __0 __0
BV_ 890 845 810 785 760 740 720 700 680 660 640 620 600 __0 __0 __0
BW_ 890 855 818 790 765 742 718 693 670 645 620 596 570 __0 __0 __0
BX_ 890 850 805 770 750 735 720 705 687 670 655 640 __0 __0 __0 __0
BX1 890 850 827 810 792 777 760 750 740 730 720 710 __0 __0 __0 __0
BY_ 880 840 805 775 745 725 709 690 670 653 635 620 600 __0 __0 __0
BZ_ 880 843 810 752 719 686 653 622 590 560 530 500 470 __0 __0 __0
BB2 890 850 810 787 762 735 712 685 659 632 604 577 550 __0 __0 __0
BB3 890 850 810 780 750 718 687 654 622 589 554 526 494 __0 __0 __0
BB4 890 850 810 780 742 706 670 638 602 564 528 495 460 __0 __0 __0
C__ 890 845 810 770 742 710 683 660 635 613 594 575 560 __0 __0 __0
CA_ 890 855 840 825 810 807 803 803 803 803 803 803 803 __0 __0 __0
CB_ 890 850 805 770 745 725 710 695 680 665 650 635 620 __0 __0 __0
CC_ 890 850 810 780 750 725 698 670 640 610 580 550 520 __0 __0 __0
CD_ 890 850 815 775 735 700 690 678 666 654 643 630 620 __0 __0 __0
CE_ 890 850 820 795 777 760 745 735 720 710 695 682 670 __0 __0 __0
CF_ 890 850 830 805 787 767 747 727 707 687 667 647 __0 __0 __0 __0
CG_ 900 840 810 790 765 750 735 722 707 693 678 664 650 __0 __0 __0
CH_ 900 840 805 782 767 760 756 752 747 743 738 733 730 __0 __0 __0
CJ_ 900 840 815 795 775 761 747 734 720 705 692 677 664 __0 __0 __0
CK_ 900 840 810 790 775 770 766 762 757 753 749 745 740 __0 __0 __0
CL_ 900 840 800 775 760 750 746 742 737 733 728 724 720 __0 __0 __0
CM_ 880 840 805 775 740 718 700 685 668 652 635 620 600 __0 __0 __0
CN_ 890 850 812 780 750 720 690 665 640 620 600 580 560 __0 __0 __0
CO_ 890 850 810 787 765 747 730 725 720 717 714 710 __0 __0 __0 __0
CP_ 890 850 813 793 775 757 740 735 730 725 720 715 __0 __0 __0 __0
CP4 880 852 825 790 757 725 690 655 620 585 545 510 470 __0 __0 __0
CQ_ 880 852 825 798 768 737 706 676 646 615 585 555 525 __0 __0 __0
CR_ 880 852 830 805 780 754 725 697 670 640 613 585 556 __0 __0 __0
CS_ 890 850 822 792 765 725 706 690 672 655 638 620 605 __0 __0 __0
CS1 890 850 810 770 730 692 660 630 600 570 540 510 480 __0 __0 __0
CS2 890 850 810 770 730 690 650 615 580 546 510 475 440 __0 __0 __0
CT_ 890 850 810 770 738 706 675 643 610 580 547 515 485 __0 __0 __0
CU_ 890 850 825 800 775 735 715 700 683 665 647 630 610 __0 __0 __0
CW_ 890 850 810 790 780 770 763 754 745 736 727 718 __0 __0 __0 __0
CX_ 890 850 810 796 788 780 771 763 755 748 740 730 __0 __0 __0 __0

CY_ 890 850 800 760 738 715 695 680 670 660 655 650 645 __0 __0 __0
CZ_ 890 850 827 806 785 745 727 710 693 675 657 640 625 __0 __0 __0
D1_ 890 850 820 802 793 785 776 770 764 759 752 748 __0 __0 __0 __0
D2_ 890 850 815 800 795 790 785 780 775 770 765 760 __0 __0 __0 __0
D3_ 890 850 830 810 800 794 785 778 772 764 757 750 __0 __0 __0 __0
D4_ 890 855 825 805 790 780 767 756 745 733 721 710 __0 __0 __0 __0
D6_ 890 855 825 805 793 785 776 770 764 759 752 748 __0 __0 __0 __0
D7_ 890 855 817 795 785 778 770 765 759 752 747 740 __0 __0 __0 __0
D8_ 890 850 817 785 767 760 750 740 730 720 710 700 __0 __0 __0 __0
D9_ 890 852 825 806 791 778 764 750 736 723 710 696 __0 __0 __0 __0
DA_ 890 840 820 800 788 784 780 776 773 769 765 761 __0 __0 __0 __0
DB_ 890 850 820 800 780 753 717 674 620 557 493 430 368 __0 __0 __0
DC_ 890 840 820 805 796 794 792 790 787 785 783 780 __0 __0 __0 __0
DD_ 890 855 835 817 798 782 767 752 740 730 720 710 __0 __0 __0 __0
DE_ 890 855 825 802 772 745 734 729 723 717 712 707 __0 __0 __0 __0
DH_ 890 850 822 800 775 740 720 710 700 690 680 670 660 __0 __0 __0
DJ_ 890 850 822 795 765 730 710 700 690 680 670 660 650 __0 __0 __0
DK_ 890 850 817 787 755 720 700 690 680 670 660 650 640 __0 __0 __0
DL_ 890 850 820 795 770 745 715 700 685 670 655 640 625 __0 __0 __0
DM_ 890 840 810 791 780 775 770 765 760 755 750 745 __0 __0 __0 __0
DN_ 885 850 820 800 782 770 760 750 740 728 717 705 __0 __0 __0 __0
DP_ 890 850 810 777 750 735 723 715 710 703 698 690 688 __0 __0 __0
DQ_ 890 850 815 785 760 730 710 700 690 680 670 660 650 __0 __0 __0
DR_ 880 850 800 768 735 705 675 650 635 627 618 608 600 __0 __0 __0
DS_ 890 850 805 776 759 740 725 710 695 680 670 660 __0 __0 __0 __0
DT_ 880 840 810 780 760 740 723 712 709 705 703 701 700 __0 __0 __0
DU_ 890 850 810 775 755 740 730 720 710 700 690 680 __0 __0 __0 __0
DV_ 890 840 822 810 792 781 780 780 780 780 780 780 __0 __0 __0 __0
DW_ 890 850 815 795 780 765 752 740 728 714 700 686 __0 __0 __0 __0
DY_ 890 850 790 765 740 715 690 665 643 620 610 600 590 __0 __0 __0
DZ_ 890 850 827 795 770 745 715 700 685 670 655 640 625 __0 __0 __0
E2_ 880 845 810 775 750 725 700 675 646 626 605 590 570 __0 __0 __0
E21 890 850 826 788 763 736 711 685 660 640 620 600 580 __0 __0 __0
E3_ 880 862 830 803 775 747 720 693 665 638 620 600 582 __0 __0 __0
E31 880 845 817 790 760 730 700 675 646 626 605 590 570 __0 __0 __0
E4_ 880 840 800 780 760 739 718 695 673 631 630 610 590 __0 __0 __0
EA_ 890 850 810 780 750 720 695 670 645 620 595 570 545 __0 __0 __0
EB_ 890 855 835 815 795 777 762 750 740 730 720 710 __0 __0 __0 __0
EC_ 890 850 810 775 740 705 675 645 625 605 585 570 555 __0 __0 __0
ED_ 890 850 825 805 785 760 740 720 700 680 660 640 620 __0 __0 __0
EE_ 890 850 800 777 750 735 720 715 709 703 696 690 __0 __0 __0 __0
EF_ 890 850 820 795 770 740 720 710 700 690 680 670 660 __0 __0 __0
EG_ 880 850 800 768 740 710 685 665 650 637 620 610 600 __0 __0 __0
EH_ 890 850 820 805 788 775 770 770 770 770 770 770 770 __0 __0 __0
EI_ 890 850 810 775 730 690 660 635 618 600 590 580 570 __0 __0 __0
EJ_ 890 850 805 760 715 680 650 625 605 590 580 570 560 __0 __0 __0
EK_ 890 850 827 810 792 777 762 750 750 750 750 750 __0 __0 __0 __0
EL_ 890 850 800 775 747 720 700 680 660 640 620 600 580 __0 __0 __0
EM_ 890 850 810 780 763 747 730 725 720 715 710 705 __0 __0 __0 __0
EN_ 890 850 813 778 740 706 680 657 643 632 620 610 600 __0 __0 __0
EO_ 880 850 806 773 746 720 697 677 668 659 650 640 630 __0 __0 __0
EP_ 890 850 835 815 795 775 755 750 750 750 750 750 __0 __0 __0 __0
EQ_ 890 850 817 785 760 746 732 720 710 700 690 680 __0 __0 __0 __0
ER_ 890 850 833 810 777 740 725 712 706 706 706 __0 __0 __0 __0 __0
ES_ 890 850 818 790 770 755 748 740 730 730 730 730 __0 __0 __0 __0
ET_ 880 860 845 825 803 781 773 770 770 770 770 __0 __0 __0 __0 __0
EU_ 890 850 825 805 785 770 755 745 740 740 740 __0 __0 __0 __0 __0
EV_ 900 855 815 780 750 725 705 690 680 670 660 650 __0 __0 __0 __0
EW_ 890 850 825 810 790 775 755 745 740 740 740 __0 __0 __0 __0 __0
EX_ 880 862 835 810 785 760 735 710 685 660 635 610 580 __0 __0 __0
EX1 880 865 840 816 794 770 745 720 698 675 650 627 602 __0 __0 __0
EY_ 880 856 835 812 789 741 716 708 704 701 698 __0 __0 __0 __0 __0
EZ_ 880 865 838 798 775 751 737 726 716 706 696 __0 __0 __0 __0 __0
FA_ 890 850 810 770 720 670 630 600 585 576 567 560 550 __0 __0 __0
FB_ 890 850 806 767 729 700 687 676 667 658 650 643 635 __0 __0 __0
FC_ 900 865 830 795 760 730 710 700 690 680 670 660 650 __0 __0 __0

FD_ 880 865 840 805 780 760 750 740 730 720 710 __0 __0 __0 __0 __0
FE_ 890 850 810 775 740 710 695 686 678 671 664 657 650 __0 __0 __0
FF_ 890 856 822 790 757 720 700 672 651 639 622 __0 __0 __0 __0 __0
FG_ 890 850 795 750 710 678 650 625 600 580 560 540 520 __0 __0 __0
FH_ 890 850 820 800 790 780 770 760 750 740 730 720 __0 __0 __0 __0
FI_ 890 850 825 790 760 730 705 693 682 670 656 640 630 __0 __0 __0
FJ_ 900 850 810 775 760 745 725 710 700 680 665 650 __0 __0 __0 __0
FK_ 890 850 830 812 796 784 772 760 748 736 724 712 __0 __0 __0 __0
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FM_ 900 830 796 772 750 727 703 680 657 635 612 600 __0 __0 __0 __0
FN_ 890 850 810 775 735 690 660 630 610 580 550 __0 __0 __0 __0 __0
FO_ 890 850 818 785 760 745 731 729 727 725 723 721 __0 __0 __0 __0
FP_ 898 855 826 799 778 762 754 750 743 735 728 720 __0 __0 __0 __0
FQ_ 890 850 820 795 774 758 745 735 725 715 705 695 __0 __0 __0 __0
FR_ 890 850 810 780 750 728 705 685 663 642 622 600 __0 __0 __0 __0
FS_ 890 850 827 810 785 760 750 740 730 720 710 700 __0 __0 __0 __0
FT_ 890 850 820 795 772 753 738 728 724 720 720 720 __0 __0 __0 __0
FU_ 890 850 820 800 780 763 750 740 733 728 724 714 __0 __0 __0 __0
FV_ 890 850 830 800 773 745 715 686 658 647 636 625 614 __0 __0 __0
FW_ 890 850 810 775 750 725 700 675 665 665 665 665 665 __0 __0 __0
FX_ 890 855 827 800 775 750 715 680 653 627 600 590 580 __0 __0 __0
FY_ 900 850 810 775 750 735 720 710 700 680 660 640 620 __0 __0 __0
FZ_ 890 850 813 789 770 756 748 740 735 730 725 720 __0 __0 __0 __0
G2_ 875 835 810 785 765 745 725 705 690 674 660 642 __0 __0 __0 __0
GA_ 890 850 795 770 740 715 690 670 650 632 615 597 580 __0 __0 __0
GB_ 890 850 820 795 771 748 730 712 696 685 680 670 __0 __0 __0 __0
GC_ 890 850 830 800 773 740 705 665 630 605 590 575 560 __0 __0 __0
GD_ 890 850 833 810 790 766 753 743 738 738 738 738 __0 __0 __0 __0
GE_ 890 845 820 793 766 739 712 686 656 643 627 627 627 __0 __0 __0
GER 890 850 825 795 760 725 690 660 640 620 615 610 605 __0 __0 __0
GF_ 890 850 795 770 745 730 720 715 710 703 696 690 __0 __0 __0 __0
GG_ 890 870 845 825 808 790 780 770 758 745 732 720 __0 __0 __0 __0
GH_ 890 845 820 786 753 695 635 586 570 565 565 565 __0 __0 __0 __0
GI_ 890 850 825 790 750 715 690 670 665 665 665 665 __0 __0 __0 __0
GJ_ 890 840 817 792 770 745 717 696 675 654 632 611 590 __0 __0 __0
GL_ 890 840 820 795 772 750 727 706 685 664 642 621 600 __0 __0 __0
GM_ 890 860 842 817 782 770 758 750 745 740 735 730 __0 __0 __0 __0
GN_ 890 855 835 810 780 755 725 700 675 650 625 600 575 __0 __0 __0
GO_ 890 860 845 825 792 777 765 755 750 745 740 735 730 __0 __0 __0
GP_ 890 850 800 760 750 725 696 666 636 606 577 550 520 __0 __0 __0
GR_ 890 850 820 790 770 750 730 710 690 670 650 630 610 __0 __0 __0
GS_ 890 850 815 785 755 725 700 675 650 625 600 575 550 __0 __0 __0
GT_ 890 850 820 795 770 745 710 675 640 605 570 535 500 __0 __0 __0
GU_ 890 855 830 805 775 745 705 670 635 600 565 530 __0 __0 __0 __0
GV_ 890 855 836 820 804 800 796 793 793 793 793 793 793 __0 __0 __0
GW_ 890 850 830 800 775 760 745 730 715 700 685 670 660 __0 __0 __0
GX_ 890 855 835 815 795 775 755 735 720 700 680 660 640 __0 __0 __0
GY_ 890 855 832 812 790 770 753 740 730 720 710 700 690 __0 __0 __0
GZ_ 890 855 835 811 788 765 742 720 698 676 655 631 610 __0 __0 __0
H1_ 880 850 820 792 762 735 707 686 665 644 622 601 580 __0 __0 __0
H2_ 880 850 820 792 762 735 707 684 661 638 615 592 570 __0 __0 __0
H4_ 890 850 810 778 760 741 720 702 683 663 640 620 __0 __0 __0 __0
H6_ 890 855 820 800 780 760 740 720 700 680 660 640 __0 __0 __0 __0
HA_ 890 850 825 805 785 770 756 740 727 711 698 680 670 __0 __0 __0
HB_ 890 850 825 805 785 776 764 752 743 732 720 710 700 __0 __0 __0
HC_ 890 855 822 805 785 770 755 751 747 743 739 735 __0 __0 __0 __0
HD_ 890 855 825 810 795 780 766 762 758 754 751 748 __0 __0 __0 __0
HE_ 900 845 817 800 787 780 776 772 769 766 763 759 755 __0 __0 __0
HF_ 900 845 820 805 797 790 787 784 780 776 774 770 766 __0 __0 __0
HG_ 890 845 823 802 782 753 737 720 700 680 660 640 620 __0 __0 __0
HV2 890 840 800 778 756 734 712 690 668 646 626 602 580 __0 __0 __0
HV3 890 840 800 780 760 740 720 700 680 660 640 620 600 __0 __0 __0
HV4 890 840 800 782 764 746 728 710 692 674 656 638 620 __0 __0 __0
JM_ 890 850 810 780 752 729 702 680 653 627 600 590 580 __0 __0 __0
L__ 890 850 810 790 770 750 735 720 710 700 690 680 __0 __0 __0 __0
L11 890 840 801 772 745 722 702 675 650 625 600 575 550 __0 __0 __0

L12 890 850 810 780 755 730 702 675 650 625 600 575 550 __0 __0 __0
LS_ 880 850 800 770 735 705 680 658 636 613 590 570 550 __0 __0 __0
LS1 880 850 800 765 730 710 698 678 660 640 620 600 580 __0 __0 __0
M__ 890 855 832 808 785 763 745 726 707 688 669 650 __0 __0 __0 __0
M1_ 890 850 817 796 777 757 737 717 698 678 659 640 __0 __0 __0 __0
M2_ 890 850 817 800 785 765 745 725 705 688 669 665 __0 __0 __0 __0
M5_ 890 850 817 792 776 760 745 729 712 696 680 666 __0 __0 __0 __0
M6_ 890 850 817 801 786 770 754 738 723 707 691 676 __0 __0 __0 __0
M7_ 890 850 822 807 792 777 762 747 732 717 702 687 __0 __0 __0 __0
M8_ 890 860 827 812 797 782 767 752 737 722 707 692 __0 __0 __0 __0
M9_ 890 850 827 810 792 777 762 747 732 717 702 687 __0 __0 __0 __0
MA_ 890 850 817 795 780 765 750 735 720 705 690 675 __0 __0 __0 __0
MB_ 890 850 817 790 767 740 715 680 653 627 600 590 580 __0 __0 __0
MME 890 850 813 780 740 707 673 636 600 563 530 495 460 __0 __0 __0
MO_ 890 855 835 815 800 788 775 763 750 738 725 713 __0 __0 __0 __0
MOW 890 855 837 820 808 795 783 770 758 745 732 720 __0 __0 __0 __0
MW_ 890 855 840 825 813 803 792 780 768 757 746 735 __0 __0 __0 __0
1__ 890 850 814 785 770 755 740 725 710 695 680 670 660 __0 __0 __0
2__ 890 850 814 785 767 749 732 714 696 678 660 650 640 __0 __0 __0
3__ 890 850 814 785 765 744 723 703 683 661 640 630 620 __0 __0 __0
4__ 890 850 814 785 761 737 714 692 668 645 620 610 600 __0 __0 __0
5__ 890 850 814 785 758 733 705 680 653 627 600 590 580 __0 __0 __0
6__ 890 850 814 785 755 725 696 666 636 606 577 550 520 __0 __0 __0
7__ 890 850 814 785 755 720 686 650 620 587 553 520 490 __0 __0 __0
20_ 890 855 822 792 760 730 703 677 647 624 600 580 560 __0 __0 __0
21_ 890 855 827 800 775 750 723 697 671 646 628 608 590 __0 __0 __0
24_ 880 845 815 785 755 725 702 682 667 650 636 625 610 __0 __0 __0
24A 880 845 815 785 760 738 716 698 680 660 640 620 600 __0 __0 __0
24B 880 845 815 795 775 755 735 715 695 675 655 635 615 __0 __0 __0
61_ 890 850 805 775 747 725 709 690 670 653 635 620 600 __0 __0 __0
62_ 890 850 810 780 750 734 719 700 685 670 650 635 620 __0 __0 __0
69_ 890 850 805 785 765 750 740 730 720 710 700 690 __0 __0 __0 __0
80_ 890 850 800 780 758 733 705 680 653 627 600 590 580 __0 __0 __0
81_ 890 850 800 770 742 719 699 680 653 627 600 590 580 __0 __0 __0
O7_ 890 850 815 795 780 770 760 750 740 730 720 710 __0 __0 __0 __0
P4_ 880 845 810 785 755 730 700 675 645 618 590 562 535 __0 __0 __0
P6_ 880 845 810 775 738 703 670 638 603 570 540 505 473 __0 __0 __0
P61 880 845 810 770 746 715 684 653 620 590 560 530 500 __0 __0 __0
PJ_ 890 850 822 807 796 790 785 780 775 770 765 760 __0 __0 __0 __0
QA_ 890 850 820 796 770 745 720 695 668 642 615 590 565 __0 __0 __0
QW_ 890 850 825 802 780 755 731 708 685 660 636 613 590 __0 __0 __0
R3_ 890 850 805 776 759 740 722 703 687 670 650 632 __0 __0 __0 __0
R6_ 890 850 810 770 732 700 665 630 600 570 540 510 480 __0 __0 __0
R32 880 840 805 776 759 740 722 703 687 670 650 632 __0 __0 __0 __0
RLB 890 850 810 770 732 693 660 626 592 560 526 495 460 __0 __0 __0
RLS 890 850 804 760 725 692 660 626 592 560 526 495 460 __0 __0 __0
RO_ 890 850 810 770 740 710 685 660 633 605 580 558 530 __0 __0 __0
RS_ 890 850 823 810 803 795 786 780 775 770 765 760 __0 __0 __0 __0
S__ 890 850 822 806 790 774 758 740 724 708 690 675 __0 __0 __0 __0
S4_ 895 852 820 790 765 744 722 700 677 656 634 612 590 __0 __0 __0
S5_ 895 852 815 780 753 730 707 684 663 639 616 593 570 __0 __0 __0
S6_ 890 850 805 770 743 715 690 666 640 620 590 568 545 __0 __0 __0
TB_ 890 850 810 780 750 730 710 698 678 660 640 620 600 __0 __0 __0
V2_ 890 850 820 795 775 756 738 718 698 678 658 640 __0 __0 __0 __0
V3_ 890 850 826 804 783 764 746 726 706 686 666 646 __0 __0 __0 __0
VS_ 890 850 810 770 748 725 710 695 680 665 650 635 __0 __0 __0 __0
W3_ 880 830 805 780 763 745 730 710 694 677 660 650 __0 __0 __0 __0
WX_ 890 850 814 785 775 765 755 746 736 728 718 709 __0 __0 __0 __0
WX1 890 850 820 795 777 765 755 746 736 728 718 709 __0 __0 __0 __0

0.100 Needles:

Note: SM and SN reputedly have incorrect dimensions in most published sources. Claimed correct dimensions are at SM* and SN* respectively.

A9__ 980 946 913 880 850 834 818 802 787 770 755 740 722 706 __0 __0
AKN_ 990 962 933 905 870 820 782 747 718 690 660 630 600 570 540 510

BAA_ 990 950 925 895 870 850 823 792 760 729 697 665 633 600 567 534
BAB_ 990 950 924 897 876 858 840 822 803 784 759 734 710 690 670 650
BAC_ 990 950 932 907 875 852 823 763 703 642 580 520 460 400 400 400
BAD_ 990 950 928 900 873 852 830 808 782 755 730 702 675 650 624 598
BAE_ 990 950 915 885 860 840 815 790 768 743 729 715 700 685 670 655
BAF_ 990 950 930 905 875 832 800 768 738 709 677 646 616 584 554 523
BAG_ 990 950 928 900 873 845 810 782 758 735 713 690 670 648 625 603
BAH_ 995 967 939 909 881 848 781 740 703 677 661 649 636 624 618 618
BAJ_ 990 950 932 905 877 845 810 782 758 735 713 690 670 648 625 603
BAK_ 990 950 932 907 875 852 823 792 760 729 697 665 633 600 568 526
BAL_ 972 957 926 898 870 826 787 752 727 703 678 653 629 605 580 555
BAM_ 990 950 915 880 848 821 796 773 750 730 713 692 672 650 630 610
BAN_ 990 950 925 905 882 853 820 790 755 725 698 668 638 608 578 548
BAP_ 990 962 934 899 861 826 791 757 723 688 653 618 584 550 516 482
BAQ_ 990 950 930 905 880 845 810 787 767 745 725 705 685 665 645 625
BAR_ 990 950 915 895 877 853 820 790 755 725 698 668 638 608 578 548
BAS_ 990 950 925 905 880 845 810 787 767 745 725 705 685 665 645 625
BAT_ 990 950 918 887 860 840 815 790 768 743 729 715 700 685 670 655
BAU_ 990 950 925 893 862 830 800 780 770 764 758 752 747 740 734 728
BAV_ 995 967 939 909 881 851 800 757 727 700 682 667 655 645 635 625
BAW_ 990 950 918 887 860 827 799 774 755 735 715 700 690 680 670 650
BAX_ 990 958 926 896 861 814 774 742 718 694 673 652 630 610 590 570
BAY_ 990 956 926 895 858 815 774 742 718 694 673 652 630 610 590 570
BAZ_ 990 952 926 896 866 820 781 751 727 703 678 654 629 605 580 560
BBA_ 990 957 934 899 861 826 791 757 723 688 653 618 584 550 516 482
BBB_ 990 956 926 896 865 815 774 742 718 694 673 652 630 610 590 570
BBC_ 990 950 930 902 873 848 820 752 687 620 554 487 420 420 420 420
BBD_ 990 950 920 900 880 862 844 825 818 808 798 788 778 768 758 748
BBE_ 990 950 930 905 882 850 820 780 757 733 710 690 670 650 630 610
BBF_ 990 950 929 905 877 845 813 795 777 761 744 720 695 670 647 623
BBG_ 990 950 932 905 878 852 829 806 783 760 737 713 690 668 644 622
BBH_ 990 950 920 890 860 827 799 780 767 753 740 727 713 700 687 675
BBJ_ 990 950 932 905 877 855 827 798 770 740 712 683 655 627 598 570
BBK_ 990 950 920 890 860 827 799 780 767 753 740 727 713 700 687 675
BBL_ 990 950 925 893 862 830 825 820 818 808 798 788 778 768 758 748
BBM_ 990 950 930 905 870 843 795 750 740 730 710 690 670 650 630 610
BBN_ 990 950 925 905 874 862 846 830 820 805 800 790 780 770 760 750
BBP_ 990 950 912 886 859 832 803 775 752 727 710 689 669 647 627 607
BBQ_ 990 950 930 908 877 852 813 795 777 760 744 720 695 670 647 623
BBR_ 990 950 926 902 881 861 840 825 810 788 770 750 730 710 690 670
BBS_ 990 950 915 885 870 850 823 806 792 777 763 748 734 719 709 689
BBT_ 990 960 932 903 877 850 827 807 792 778 765 753 740 725 713 700
BBU_ 990 950 932 907 876 859 840 822 805 788 770 752 734 718 700 680
BBV_ 990 950 932 907 875 852 829 805 773 742 710 679 648 617 595 552
BBW_ 990 950 923 900 870 832 792 750 717 682 647 610 577 540 505 470
BBX_ 990 950 932 905 875 852 829 806 782 755 730 702 675 650 624 598
BBY_ 990 950 915 882 867 848 821 803 790 775 761 746 732 717 707 687
BBZ_ 980 954 924 892 862 819 780 751 713 678 653 629 605 580 560 540
BC__ 990 950 910 880 850 825 803 785 765 750 730 720 710 700 __0 __0
BCA_ 990 955 930 897 854 795 730 676 639 575 519 498 450 400 400 400
BCB_ 990 950 912 886 859 841 823 806 792 777 763 748 734 719 709 689
BCC_ 990 950 924 897 855 820 800 790 775 770 759 734 710 690 670 650
BCD 1000 960 930 902 872 843 814 786 757 727 700 670 640 610 580 550
BCE_ 990 950 900 872 835 795 768 740 705 675 645 615 585 555 525 495
BCF_ 990 950 930 899 858 825 784 739 674 623 577 533 502 472 444 444
BCG_ 990 950 914 886 837 786 736 665 582 493 414 331 331 331 331 331
BCH_ 990 950 920 892 863 833 800 772 745 722 700 678 656 634 612 592
BCJ_ 995 967 939 909 881 848 781 740 703 671 650 630 610 600 590 580
BCK_ 990 953 922 903 881 832 800 768 738 709 677 646 616 584 554 523
BCL_ 990 950 930 902 873 848 813 795 777 760 744 720 695 670 647 623
BCM_ 990 960 932 905 882 860 842 827 815 806 797 790 785 780 775 770
BCN_ 990 960 932 905 880 857 837 820 805 724 786 780 775 770 765 760
BCP_ 990 950 929 905 881 858 835 804 793 781 759 737 715 693 671 649
BCQ_ 990 950 914 886 860 835 802 780 758 733 714 692 672 652 632 612
BCR_ 990 950 927 907 888 868 828 800 770 742 719 690 664 637 610 583
BCS_ 990 950 930 910 885 850 811 795 775 755 735 715 695 670 650 630

BCT_ 990 950 926 902 881 845 805 787 771 755 740 725 710 695 680 660
BCU_ 990 950 923 900 883 845 813 793 777 761 744 720 695 670 647 623
BCV_ 995 962 933 904 875 832 788 746 687 637 571 497 445 445 445 445
BCW_ 990 950 926 902 879 844 815 795 775 755 735 716 695 671 655 635
BCX_ 990 950 924 897 860 835 810 785 775 770 765 760 755 750 745 740
BCY_ 990 960 932 911 891 874 860 850 841 835 830 827 823 818 815 810
BCZ_ 990 960 932 905 875 836 808 789 763 736 710 690 670 650 630 610
BDA_ 990 950 918 888 859 832 803 775 752 727 710 689 669 647 627 607
BDB_ 990 955 932 912 895 880 865 853 844 837 830 828 824 820 817 813
BDC_ 990 955 926 898 871 844 816 797 777 762 748 733 717 703 687 673
BDD_ 990 962 937 907 850 795 753 720 694 673 653 635 618 602 585 570
BDE_ 990 950 923 900 879 853 820 790 755 725 698 668 638 608 578 548
BDF_ 990 950 931 909 896 886 878 868 863 857 851 840 830 820 810 800
BDG_ 992 964 936 909 881 848 781 740 703 671 650 630 610 590 570 560
BDJ_ 988 955 933 904 878 841 799 763 729 676 616 540 490 450 450 450
BDK_ 964 950 930 899 858 825 784 739 674 623 577 533 502 472 442 412
BDL_ 990 955 924 893 865 834 798 774 743 710 680 650 620 590 560 530
BDM_ 990 955 927 900 874 846 822 805 790 777 765 753 740 728 715 703
BDN_ 990 950 940 917 887 847 808 757 723 688 653 618 584 550 516 482
BDP_ 990 950 924 897 866 837 803 746 685 636 586 538 487 444 444 444
BDQ_ 990 960 932 905 883 863 847 831 818 805 790 770 750 730 710 690
BDR_ 990 950 920 895 870 837 805 760 715 670 625 580 535 490 445 400
BDS_ 990 950 931 904 879 851 826 780 701 621 543 505 470 435 435 435
BDT_ 990 950 927 898 873 858 815 792 772 720 690 658 627 597 566 534
BDU_ 990 973 945 922 903 887 872 858 848 839 833 829 825 822 819 815
BDV_ 990 970 934 906 880 855 837 816 794 770 748 728 708 688 668 648
BDW_ 990 963 945 924 897 855 824 801 789 775 763 750 740 728 716 704
BDX_ 990 962 944 922 899 865 835 817 798 790 782 773 766 757 750 741
BDY_ 990 960 940 920 897 855 824 801 788 778 768 759 749 738 728 720
BDZ_ 990 956 935 906 878 852 829 809 792 777 759 735 716 706 700 691
BEA_ 990 955 935 907 874 845 820 798 776 755 734 715 695 687 680 673
BEB 1000 973 945 924 900 878 858 841 827 815 807 800 793 787 780 773
BEC 1000 973 945 923 900 874 849 830 817 806 800 795 790 785 780 775
BED_ 990 974 937 910 889 860 843 818 797 772 750 730 710 690 670 650
BEE_ 990 956 935 902 869 838 807 788 768 743 699 660 639 630 620 610
BEF_ 990 968 941 917 892 862 830 805 784 770 761 753 750 746 742 733
BEG 1000 973 944 923 903 882 864 849 838 829 824 821 817 815 810 808
BEH_ 990 964 942 916 896 865 840 816 796 776 756 736 716 696 676 656
BEJ_ 990 960 932 908 883 860 832 813 800 790 780 770 760 750 740 730
BEK_ 990 967 936 919 893 864 830 787 775 748 731 716 700 684 668 652
BEL_ 990 960 940 920 897 855 825 793 772 758 741 728 712 698 684 670
BEM_ 990 961 941 917 891 865 830 802 782 772 768 765 762 759 756 753
BEP 1000 973 946 922 895 865 840 820 806 796 790 785 780 776 772 767
BEQ 1000 973 944 922 898 872 847 827 810 800 796 790 785 780 775 770
BER_ 990 960 933 913 882 855 833 812 800 788 777 767 757 747 737 727
BES_ 990 960 929 902 872 847 817 780 756 725 695 665 635 605 575 547
BEU_ 990 960 939 900 861 821 765 722 678 639 611 584 550 517 500 490
BEV_ 990 960 932 901 875 850 825 807 802 785 775 765 750 735 720 705
BEZ_ 990 960 930 896 863 839 813 797 787 765 747 732 717 700 690 680
BFA_ 990 956 931 895 859 833 807 787 773 759 745 730 711 701 695 686
BFB_ 990 960 937 902 860 830 769 746 718 674 630 620 610 600 590 580
BFC_ 966 952 932 897 855 815 773 732 685 640 596 534 503 472 472 472
BFD 1000 963 932 914 898 880 858 834 802 768 731 696 658 624 590 554
BFF_ 990 955 927 900 875 853 832 814 800 791 784 780 775 770 765 760
BFG_ 990 960 932 908 885 864 845 831 820 807 796 785 775 765 755 745
BFH 1000 970 944 920 895 872 852 840 830 820 815 810 805 800 796 790
BFJ 1000 970 944 922 894 860 846 830 820 813 806 800 794 787 780 775
BFK_ 990 960 932 905 876 857 837 825 813 804 795 785 775 765 755 745
BFN_ 990 958 921 898 883 857 823 800 778 752 733 710 690 669 648 628
BFP_ 990 958 920 898 881 863 845 827 813 797 783 767 753 738 728 707
BFQ_ 990 958 922 898 887 872 845 827 813 797 783 767 753 738 728 707
BFR_ 990 958 922 896 882 862 836 811 788 762 748 734 718 703 687 672
BFS_ 990 955 933 910 884 854 825 792 755 720 684 648 610 575 540 505
BFT_ 990 967 937 910 884 855 828 795 775 750 725 701 676 652 632 610
BFU_ 990 967 937 910 884 855 828 795 761 732 709 687 662 637 619 576
BFV_ 990 955 944 912 885 852 830 812 793 785 777 770 767 753 746 737

BFW_ 990 962 939 914 887 860 830 799 768 736 705 674 643 618 550 550
BFX_ 990 960 932 908 883 860 844 827 812 798 785 772 759 746 733 720
BFY_ 990 950 936 897 866 834 798 774 743 710 680 650 620 590 560 530
BFZ_ 990 960 933 913 886 859 837 815 800 788 777 767 757 747 737 727
BGA_ 990 963 932 910 845 813 763 717 665 638 603 576 550 525 505 485
BGB_ 990 963 932 908 848 813 763 707 660 640 618 584 560 530 510 490
BGC_ 990 962 939 917 891 864 839 814 785 756 727 698 668 639 610 580
BGD_ 990 962 939 913 887 858 832 810 776 753 722 690 658 626 594 562
BGE_ 990 962 944 917 883 861 832 814 798 790 782 773 766 757 750 741
BGJ_ 990 962 934 907 874 839 788 735 725 714 700 640 595 548 500 450
BGK_ 990 968 930 910 883 840 790 730 715 683 665 655 644 631 618 605
BGL_ 990 967 940 917 888 854 800 750 735 714 693 671 650 630 610 590
C1__ 990 950 916 889 861 840 818 796 778 760 740 730 720 710 __0 __0
CIW_ 990 955 930 905 875 856 836 819 800 780 760 752 746 740 __0 __0
CV__ 990 940 900 867 840 815 795 775 760 745 732 720 710 700 __0 __0
DF_ 1000 979 960 910 880 850 820 782 750 725 700 685 670 655 640 __0
DG_ 1000 979 960 905 870 836 804 772 740 710 689 670 653 636 620 __0
DX__ 990 958 926 888 859 830 775 740 705 670 635 600 565 530 __0 __0
GK_ 1000 940 890 850 810 780 750 720 690 660 630 600 570 540 __0 __0
K__ 1000 950 905 865 830 800 777 760 740 722 705 685 667 650 __0 __0
KA__ 990 950 920 895 876 855 835 814 793 784 780 780 780 780 __0 __0
KB__ 990 950 917 900 886 872 860 850 845 840 835 830 825 __0 __0 __0
KC__ 990 935 900 870 840 820 800 785 765 750 730 715 695 675 __0 __0
KD__ 990 950 908 883 856 830 775 740 705 670 635 600 565 530 __0 __0
KE__ 990 950 917 900 885 870 848 838 830 822 815 808 800 792 __0 __0
KF__ 990 950 910 890 875 855 835 820 810 800 795 790 790 790 __0 __0
KG__ 990 950 915 895 875 855 841 834 827 820 810 800 790 780 __0 __0
KH__ 990 935 883 863 843 825 805 785 760 735 710 685 660 __0 __0 __0
KI__ 980 940 900 865 830 800 777 760 740 722 705 685 667 650 __0 __0
KK__ 990 950 925 893 860 828 795 738 615 517 420 420 420 420 __0 __0
KL__ 990 950 925 895 870 850 823 792 760 729 697 665 633 600 __0 __0
KM__ 990 950 924 897 876 858 840 822 803 784 759 734 710 690 __0 __0
KN__ 990 962 933 905 870 820 782 747 718 690 660 630 600 570 540 510
KO__ 990 950 925 895 870 850 825 795 765 740 715 690 670 650 __0 __0
KP__ 990 950 920 893 867 842 817 780 700 635 580 523 465 418 __0 __0
KQ__ 990 950 930 903 880 855 820 795 775 755 735 715 695 675 __0 __0
KR__ 990 950 932 907 875 852 823 770 710 658 603 570 534 500 __0 __0
KS__ 990 950 920 892 875 850 790 750 700 650 600 550 500 450 __0 __0
KT_ 1000 950 905 870 845 822 802 790 775 760 750 740 730 720 __0 __0
KTA 1000 950 895 865 835 815 802 788 775 760 750 740 730 720 __0 __0
KU__ 990 950 927 897 868 840 812 783 756 729 700 673 645 618 __0 __0
KV__ 990 950 913 880 838 800 736 650 580 506 435 363 363 363 __0 __0
KW_ 1000 950 910 877 840 805 770 730 695 661 630 600 570 540 __0 __0
KW1 1000 950 915 885 851 820 790 760 728 695 663 630 600 570 __0 __0
KW2 1000 950 905 875 845 815 788 760 728 695 663 630 600 570 __0 __0
KWR 1000 950 900 870 840 810 786 760 728 695 663 630 600 570 __0 __0
LB1 1000 960 925 895 870 850 830 820 810 800 790 780 770 760 __0 __0
LB2 1000 950 910 895 860 840 825 815 805 795 785 775 765 755 __0 __0
LFN_ 990 940 885 850 815 780 750 723 695 668 640 610 585 556 __0 __0
LBA 1000 960 930 906 883 863 848 839 830 821 812 804 796 788 __0 __0
MC_ 1000 950 915 885 851 820 790 760 728 684 640 600 555 510 __0 __0
53_ 1000 950 900 858 815 777 738 700 668 636 606 579 552 530 __0 __0
55_ 1000 950 900 858 815 780 740 700 670 640 620 600 570 550 __0 __0
58_ 1000 950 900 858 815 780 744 712 685 660 640 620 600 580 __0 __0
OA6 1000 960 917 887 856 825 794 762 731 700 670 640 610 580 __0 __0
OA7 1000 960 930 902 872 843 814 786 757 727 700 670 640 610 __0 __0
OA8 1000 970 940 913 888 860 835 808 782 755 730 702 675 650 __0 __0
RA_ 1000 940 880 830 785 753 722 690 658 627 595 564 530 500 __0 __0
RB__ 990 950 907 866 825 784 740 700 657 615 575 532 490 450 __0 __0
RC__ 990 946 900 855 810 765 720 674 627 583 537 492 446 400 __0 __0
RD__ 990 950 900 865 835 810 790 770 757 742 730 715 703 690 __0 __0
RE__ 990 950 920 890 856 805 753 712 670 628 587 543 501 460 __0 __0
RF_ 1000 950 900 863 825 788 750 712 675 637 600 570 540 510 __0 __0
RG_ 1000 950 905 870 836 802 768 732 700 665 630 600 570 540 __0 __0
RH_ 1000 950 915 878 846 813 780 750 720 690 660 630 600 570 __0 __0
RI__ 990 950 912 881 846 804 763 722 670 605 567 525 490 450 __0 __0

RJ_ 1000 950 910 870 844 818 792 766 740 714 688 662 630 610 __0 __0
RK_ 1000 950 915 880 854 830 805 780 756 732 708 683 660 635 __0 __0
RL_ 1000 950 920 890 860 835 810 785 760 735 710 685 660 635 __0 __0
RN__ 990 950 920 890 859 808 760 721 688 651 617 581 547 510 __0 __0
RP__ 990 950 905 870 850 832 820 815 809 800 794 786 778 770 __0 __0
RR__ 990 950 922 895 860 808 760 721 688 651 617 581 547 510 __0 __0
RU_ 1000 950 890 840 810 785 756 733 710 688 660 636 610 590 __0 __0
RV_ 1000 950 890 840 810 785 755 730 700 670 645 618 590 560 __0 __0
SA__ 990 950 915 885 860 840 815 790 768 743 720 700 680 660 __0 __0
SB__ 990 950 910 875 840 800 760 720 695 670 640 620 590 570 __0 __0
SC_ 1000 950 915 882 865 845 823 800 790 780 770 760 750 740 __0 __0
SD_ 1000 950 912 880 862 842 822 800 790 780 770 760 750 740 __0 __0
SE_ 1000 950 915 903 888 870 852 845 840 840 840 840 840 840 __0 __0
SF_ 1000 950 913 895 883 870 858 850 845 840 840 840 840 840 __0 __0
SG_ 1000 950 917 900 887 878 869 862 859 855 855 855 855 855 __0 __0
SH__ 990 952 917 885 865 845 820 793 770 743 722 700 680 660 __0 __0
SJ__ 990 950 920 895 875 855 835 815 792 770 750 730 710 690 __0 __0
SK__ 990 954 930 900 867 833 800 770 740 714 695 676 650 __0 __0 __0
SL__ 990 950 920 890 867 833 800 770 740 714 695 676 650 630 __0 __0
SM__ 990 950 915 885 865 845 835 820 800 780 765 750 740 730 __0 __0
SM*_ 990 950 915 885 855 825 795 765 735 710 690 670 650 630 __0 __0
SN__ 990 950 915 885 865 845 835 820 800 780 765 750 740 730 __0 __0
SN*_ 990 950 915 890 865 845 835 820 800 780 765 750 740 730 __0 __0
SO_ 1000 960 920 890 860 830 804 778 750 743 737 730 722 __0 __0 __0
SP__ 990 950 915 892 871 852 834 810 786 762 738 714 690 666 __0 __0
SQ_ 1000 950 915 880 854 830 812 794 775 757 738 719 700 680 __0 __0
SR__ 990 950 920 890 860 830 804 778 750 743 737 730 722 715 __0 __0
SS__ 990 945 905 860 840 800 755 715 655 590 535 485 450 420 __0 __0
ST__ 990 950 925 895 870 852 831 805 787 770 753 737 710 690 __0 __0
SU__ 990 950 902 868 834 802 764 728 690 655 620 586 552 518 __0 __0
SV__ 990 955 923 890 867 845 818 790 755 720 685 665 653 640 __0 __0
SW__ 990 955 925 880 860 840 820 795 770 745 720 695 670 645 __0 __0
SX__ 990 950 902 868 840 808 774 744 713 686 657 630 600 572 __0 __0
SY__ 990 950 910 875 855 825 780 750 690 630 575 525 490 460 __0 __0
SZ__ 990 945 903 858 837 798 753 707 643 570 508 470 445 420 __0 __0
TA__ 990 950 915 882 867 852 831 805 787 770 753 737 710 690 __0 __0
TC__ 990 950 915 890 870 850 832 825 815 805 795 785 775 765 __0 __0
TD__ 990 950 925 900 875 845 803 770 730 678 631 585 538 490 __0 __0
TE__ 990 950 920 895 870 837 805 760 715 670 625 580 535 490 __0 __0
TF__ 990 960 925 890 855 820 782 748 714 680 645 610 575 540 __0 __0
TG__ 990 950 922 895 878 862 847 837 827 818 812 806 800 794 __0 __0
TH__ 960 920 908 893 878 863 848 825 740 650 550 490 440 400 __0 __0
TJ__ 990 950 920 895 877 860 845 840 830 820 810 800 790 780 __0 __0
TK__ 990 950 920 900 885 870 860 855 845 835 825 815 805 795 __0 __0
TL__ 990 950 920 890 860 835 810 793 776 759 746 733 720 710 __0 __0
TM__ 990 950 920 894 867 842 814 785 775 770 770 770 770 770 __0 __0
TN__ 990 945 910 870 850 820 780 730 665 600 535 500 475 450 __0 __0
TO__ 990 950 920 893 865 845 830 820 810 800 790 780 770 760 __0 __0
TP__ 990 955 920 900 875 856 836 819 800 780 760 752 746 740 __0 __0
TR__ 990 950 920 890 869 840 817 791 765 738 710 685 630 620 __0 __0
TS__ 990 950 915 880 853 833 812 782 742 710 675 610 550 490 __0 __0
TT__ 989 941 904 883 861 825 799 780 766 748 733 721 715 __0 __0 __0
TU__ 990 950 910 880 850 830 810 793 776 759 746 733 720 710 __0 __0
TV__ 990 950 925 900 880 860 840 825 810 800 795 785 775 765 __0 __0
TW__ 990 950 925 895 870 852 831 805 775 750 722 700 680 660 __0 __0
TX__ 990 950 918 887 860 836 825 805 775 750 722 700 680 660 __0 __0
TY__ 990 950 918 887 860 836 825 805 775 750 722 700 680 660 __0 __0
TZ__ 990 950 915 893 870 847 827 805 787 770 753 737 710 690 __0 __0
WO2 1000 950 910 870 835 810 785 760 732 710 683 657 630 610 __0 __0
WO3 1000 950 910 878 845 822 800 780 755 735 712 690 670 650 __0 __0
WO4 1000 950 900 860 820 794 768 740 712 690 660 634 610 580 __0 __0
ZA__ 990 950 905 875 847 822 800 778 758 737 710 675 630 585 540 __0
ZB__ 990 950 915 890 865 840 820 795 775 755 735 710 670 630 590 __0
ZC__ 990 950 910 880 855 830 810 785 765 745 725 695 650 605 560 __0
ZD__ 990 950 900 865 840 815 790 770 745 720 690 650 605 560 515 __0
ZE__ 990 950 895 858 830 805 782 760 732 703 673 629 584 540 495 __0

ZF__ 990 950 890 850 821 798 775 750 720 687 650 608 563 520 475 __0
ZG__ 990 950 890 845 815 790 765 740 710 675 630 590 540 500 450 __0
ZH__ 990 950 915 893 870 847 820 795 775 755 735 715 695 675 __0 __0

Vaporisation! *April 2019*

An example?

An exclamation mark as more and more people are jumping to this as a cause of running and hot-starting problems, without any diagnosis. Americans talk of 'vapor lock' and vaporisation and I think this is where people have picked it up from.

The first thing to remember is these cars have run in desert states - America, Australia and the Middle East for decades without these problems.

The second thing to remember when people start blaming ethanol is that America has had oxygenated fuels for far longer than we have, and in greater concentrations, and again don't report problems.

The third thing to remember is how our fuel systems work. We have a pump at the back of the car applying 3psi or so to the fuel. At the front we have the carbs, with float chamber and float valve, and the top of the float chamber is open to atmosphere via the vent port/over flow. No one has yet explained to me how, with 3psi of pressure from the pump, and the carbs open to atmosphere at the front, the pump can't push any air in the pipes out of the vent, and keep pushing until the float chambers fill up with fuel and the float valve closes.

Yes, modern fuels do have higher volatility, but as the vast majority of us don't get the problem it can't be the reason a few do.

Yes fuel can boil or vaporise, in hot weather I can hear it boiling at switch-off in the V8 carbs. But if that happens in the pipes why isn't the fuel pump pushing it out? The only way the carbs wouldn't fill is if the fuel was vaporising at the rate of a pint every 30 seconds, which is impossible in the relatively short length of pipe that is exposed to heat, and even if it were the pump would be chattering away like billy-oh.

Yes Americans do get vaporisation, but in cars with engine driven pumps which are pulling fuel from the back. With the pump pulling the pressure is lowered, so it is more likely to boil (see comment here when a pump was mounted in the engine compartment of an MGB). With our pusher pumps the pressure increase reduces the chance of boiling. Also an engine-driven pump is only running at engine speed, so with vaporisation at idle they can get fuel starvation from the pump not being able to keep the float chambers full of fuel. Our electric pumps should be capable of delivering a pint in 30 seconds whatever the engine speed. There are any number of American YouTubes around talking about vaporisation/vapour lock and percolation (?). And the recommended solutions? Fit an electric pump at the back!

There is also the question of just how hot things have to get to cause a problem. With the best will in the world the UK doesn't get heat waves very often. But when they do, on organised runs that can get 100 or more MGs, one would expect to find several cars stuck by the roadside or failing to start if it were a generic problem, and I've never come across anyone with that problem. Very occasionally something else (I always stop and check unless they have other cars with them), but never that. Incidentally problems hot-starting are unlikely to be vaporisation anyway, more like fuel expansion with heat-soak and overflowing into the inlet manifold i.e. flooding.

Another possibility is when at switch-off heat-soak causes the fuel in the line between pump and carb to heat up and expand, which can increase the pressure to higher than normal pump pressure, and if the float chambers are full with the float valves closed that could force them open raising the fuel level there and in the jet. But there is more chance of the fuel in the float chamber expanding and raising the level in the jet, possibly to the point where it overflows into the inlet manifold causing a grossly rich mixture at restart. And it was only offered as a theory anyway, from tests sponsored by the FBHVC carried out by Manchester University on an XPAG engine. Some notable observations:

- "At a temperature of 75蚓 20% to 30% of the classic petrol would have evaporated. While at 75蚓 nearly twice that volume of modern petrol has evaporated." But what does that actually mean in an engine?
- "With over 40% of modern petrol evaporating at typical under bonnet temperatures, it is surprising classic carburetted engines manage to run at all." But as we know they do, and most of them without problems in the hottest weather - in the UK at least.
- "Two thermocouples, one in each carburettor, at the bottom of the transfer pipe connecting the float chambers to the carburettor body (shown in photo 2 and photo 3). Typically, this was 42蚓, which was surprisingly low considering that this part of the carburettor is positioned under 1" away from the 400蚓 exhaust manifold."
- "When the engine was running, the highest petrol temperature of 42蚓 was in the transfer tubes. At this temperature, less than 10% of modern petrol will evaporate, insufficient to cause any problems."
- It puts running and hot-starting problems down to two factors - "As the petrol in the carburettors gets hotter, more of it boils. The pressure of this vapour forces petrol out of the carburettor jet, which collects in the inlet manifold making the mixture temporarily richer. The vapour bubbles in the jet then cause the carburettor to deliver a much weaker mixture when the engine is running or cranking." I.e. one enriches the mixture and the other weakens it, therefore compensating for each other at least?

- It suggests: "However, if the problem is not too bad, it is possible to nurse the engine back into life using the choke to enrichen (sic) the mixture." which is all a bit vague as you wouldn't know whether the problem was excessively rich and choke would make it worse, or excessively weak. But this doesn't seem to have been quantified, only theorised from the temperature readings.
- It has been suggested that adding a return pipe to MGB fuel systems will prevent problems: "Modern cars do not suffer from these problems for two reasons. Firstly, the petrol in the pipes and injectors is held under high pressure, which increases the boiling point. Secondly, as soon as you switch the ignition on, the hot petrol in the engine bay is recirculated back to the fuel tank, allowing the engine to start on a new charge of cold petrol." But the return pipe for a carb-equipped MGB would have to come directly off the feed pipe, not through the carburettors, so it cannot have any effect on what is inside the float chambers, jets or inlet manifold. Injectors are completely different as there is no reservoir and the circulating fuel is within a few mm of the nozzle injecting it into the throttle body or intake.
- Insulating fuel pipes has also been mentioned, about which they say: "Unfortunately, insulation does not stop the transfer of heat, it only slows it down. Once the engine has stopped and the petrol is no longer flowing, the petrol will heat up, no matter how well insulated the parts of the fuel system are. Benefits will only arise if the heating is delayed for a sufficient time to allow the under-bonnet temperature to fall below 45蚓."
- As far as preventing vaporisation problems goes their tests on various fuels show that higher octane vaporises less quickly than standard 95 octane. I've always used higher octanes in the roadster, but only ever supermarket 95 in the V8, and only once in the V8 have I experienced anything that could possibly have been put down to heat effects on fuel, and that was flooding not vaporisation.
- An Australian writes: "Temperatures measured are no where near what we experience during an Australian summer. This makes me question how does my MG TF run when the ambient air temperature is 45 degrees Celsius. No modification to the original design specifications have been incorporated, I do use 98 octane rated fuel." To which the author replies: "Australian summers - The distillation curves shown in the article are for UK winter fuel (intended to work at around 0 degrees Celsius). I would be very surprised if fuel in Australia were not supplied in different volatility grades chosen to match ambient temperatures, just as we get winter/transition and summer fuel in the UK. Hence the reason your TF continues to run in your summer." To which I can only say "Can it really be as simple as that? And why don't we have summer grades that allow UK cars to run in hot weather?"

Over the years I've done some simple tests in hot weather:

- In the roadster at 26C ambient the engine compartment in stop-start traffic got up to 50C.
- On another occasion of 30+C ambients the V8 engine compartment on two days got up to 64C.
- Testing the V8 cooling system shut in the garage on a 30C day (exhaust piped outside), at a fast idle (from wedged throttle), I measured the air going into the grille at 41C.

On none of these occasions was running or hot starting compromised. The only time I have had hot starting problems was the V8 when I inadvertently left the plugs in for 25k in 2011, and again in very hot and humid weather in 2014 at Coningsby when the Canadian Lancaster arrived. Definitely in that second case it was flooding as I could smell it, but cranking with the throttle wide open got it going after a few minutes.

The bottom line? I would love to get my hands on a car where the owner is claiming vaporisation as the cause of his problems, but until then - with the possible exception of vaporisation in the exposed jet-pipe of HS carbs, I simply don't believe that it's even possible in our cars. Even with the jet pipe it is at atmospheric pressure both ends, so apart from when actually boiling the levels in the float chamber and jet should still be the same and hence at a normal level. If it **is** the jet pipe that is causing the problem, then holding a wet cloth round both of them should pretty-well instantly get the car going again. I did wonder about my new heat shield as it only has a thin layer of shiny cloth as the insulator instead of the asbestos slabs, but just as there were no problems with the old one despite having a large chunk of one of the slabs missing for 30 years, there have been no problems with the new one.

An example? *September 2024* As above I've said for a long time I'd love to get my hands on one. Well, I've still not done that but the next best thing is Bill in Philadelphia USA who has had hot-starting and running problems for years in one of his two MGBs (but not the other one ...) - getting him to try various things and come back to me with the results. Not ideal, as the way one person perceives and explain things can be quite different to another, especially when we are 'two nations separated by a common language'. He hasn't yet offered to pay for flights over there but he has said he would put me up on more than one occasion!

I've been in communication with Bill for years about various aspects of his two MGBs. One of them - a 76 converted from single Stromberg to twin HS SU - has had continual hot-start problems as well as stumbling and cutting-out at junctions and similar. The other is an earlier model also with HS SUs and does not have the problem - which makes makes him an ideal candidate to back up my contention that hot-start problems are not generic to the MGB but due to circumstances on a particular car. Every summer this problem comes round and this year was no exception, despite adding heat insulation to the float bowls, fuel lines in the engine compartment, stainless steel heat shield, and others.

He is determined to find and fix the cause, and I'm equally interested as hopefully it will help others with the same problem. But one of the difficulties in remote diagnosis is that it's only when Bill thinks to mention something that I can get a light-bulb moment. A case in point was when we were investigating the emissions control system his car has with the carb vents/overflows piped to the charcoal canister, when he mentioned that on removing the hose from the front carb there was

liquid fuel in it. Never mind 'light-bulb' but a battery of flood-lights suitable for a football pitch! There should **never** be fuel from the vent as that indicates there is or has been an overflow, and with the jet and bridge at a lower level than the vent port fuel must be coming from there and running into the inlet manifold as well - exactly my theory of flooding and not fuel starvation. The question is what caused that overflow.

We agreed he should check the float heights, but he chose to replace them with adjustable StayUp, and new float valves. Not something I would have done as changing things can cause other problems.

The most obvious test if you suspect the float valves is to turn on the ignition but not start the engine - removing the wires from one of the coil spade terminals first to prevent the coil overheating (some electronic systems don't need that but best to be on the safe side) - and timing the clicks which once the float chamber has been topped-up shouldn't be more than once every 30 secs. (This is to check seepage through the float valves as they wear. Slower than once every 30 secs is fine as that is less than the consumption at idle so the fuel level won't rise and flood no matter how long it is left. *More frequently than that and more fuel could be seeping in, which will raise the fuel level and make the mixture richer, which will affect the idle speed as well as eventually overflow*. Bill did that and reported that it clicked six to eight times, then started chattering away ten to the dozen at which point he switched off (his other car has never done this". Six or eight times in 30 secs is way too much, never mind the chattering. I asked him to do it again with the overflow hoses removed from both carbs and to watch and listen, only switching off if fuel started to flood out of one of the carbs.

He did this test after changing the floats and valves, and this is the main problem with remote diagnosis - it was only because he had sent me a video this time that I realised the situation was far far worse. The six or eight click he mentioned were as soon as he switched on for a start, which would be fair enough if the car had been standing for some time. But it was every time he switched on, even when it had been turned off then immediately turned back on again (see first section of the video here). There had been suspicions about a Hardi pump not working correctly and when he sent me pictures it had been fitted incorrectly with both ports facing straight down, which traps air and causes the pump to click more frequently than it should, as had been the case with local pal Geoff. Rather than move the pump, which had been installed in a different place anyway, he decided to go the whole hog and fit a new SU in the original location and eliminate the pump as a cause altogether, with strict instructions from me as to how it needed to be orientated i.e. with the outlet port above the inlet so it can purge itself of air. Another thing I noticed in a photo was a fuel filter between tank and pump which also raised a red flag (Why? What problem was it intended to solve?). Back to the video, he started the engine a number of times and on two occasions the initial idle had a stumble and needed a rev to get it to stabilise at about 900-1000 rpm, which seems to be needed with modern fuel. Previous videos had shown the idle at barely 500-600 which I think is too low, but he hadn't altered the idle screws - more indications of mixture problems when there is the low idle.

As if that wasn't bad enough he sent me another video with the ignition left on and the pump chattering away like billy-oh, exactly as if it were pumping fuel, but with nothing coming out of the vents. It was either going onto the floor (which it wasn't), it couldn't have been pumping out of the jets at that rate with the pistons fully down and it was going for several minutes, which left only one thing - the pump itself, in the shape of the non-return valve in the inlet stuck open so the diaphragm was repeatedly sucking the same fuel from the tank and pushing it back again. Dirt in the valve? Remember that filter between tank and pump? It's still there with the new pump and a picture of the fuel level in the float chamber also showed what looked like debris at the bottom despite a fuel filter in the engine compartment as well. He is going to clean that out, then we will have to watch for it coming back. Chattering can also be caused by air in the pump or pipe to the carbs (slack input hose connections? Perforated pick-up pipe inside the tank?) when the float valves are fully closed, but that should never happen after the engine has been run without disconnecting hoses or pipes. *Another day showed just a few clicks when switching on, and the 'debris' turned out to be marks in the casting and not bits so the test will have to be repeated*.

The next test to conclusively prove the 'continual chattering' problem (if it happens again) to the pump and not the carbs is disconnect the fuel feed from both carbs and block it, then repeat the 'ignition on not started' test. Now there should be no fuel flow at all, only reverse seepage from the one-way valve in the pump, and there could be many minutes between clicks of the fuel pump.

Bill sent me three more videos. The first is a delivery check i.e. the carb feed to the front carb removed and directed into a container - and the result was shocking, proving that a video (to update the adage (all adages are 'old' by definition)) saves a thousand words. Turning on the ignition the pump was chattering away like billy-oh, with only fits and starts of fuel coming out, and very discoloured. It took 20 seconds before the pump settled down to a more normal rate with continual pulses of fuel, noticeably cleaner, and no obvious bubbles. This video has an example of the frequent clicking at switch on which shouldn't happen unless the ignition has not been on for a week or more (clip repeated three times) in the first section, and the delivery check in the second section:

The second video was with the feed into the container blocked off and the pump clicked about once every 10 secs - three-times more frequently than the 30 seconds minimum between clicks it is supposed to be. The third video was with the feed connected back up to the front carb, more clicks than would be normal turning on the ignition but then the hose had been off the carb. When that stopped clicks every 10 secs as before. So either the rear carb float valve was seeping in videos 2 and 3 and the front carb not contributing to it in video 3, or the float valves are OK and it is the one-way valve in the pump that is seeping back. The first question is why the fuel was so discoloured at the start of video 1 - as it ran clear shortly after then that can't be coming from the tank, so it must be occurring as it is sitting in the lines and the pump when parked up. Pipes? Hoses? The second question is why it is taking 20 secs to start delivering fuel properly - chattering away like this indicates there is no fuel in the pump and it was having trouble pulling it from the tank. Air leak on the inlet side? Pump banjo/bolt incompatibility?

At another switch-on to take the car for a good hard run the pump chattered away for 20 secs and showed no sign of stopping so he started the engine anyway. Just after that the chattering slowed from very rapid (as at the start of the delivery check in the above video) when no fuel was coming out, to regular pulsing (when it was in full flow), then stopped. I've had that myself after having disconnected and reconnected things at the pump. So I'm convinced that, somehow, his pump is emptying while parked i.e. air is getting in from somewhere. On his return from the 'good hard run' there was again liquid fuel in the carb vent hoses, so he still has the overflowing/flooding problem as well.

We keep going, the 'chattering' symptoms i.e. lack of fuel reaching the carbs would seem to be opposite to those needed for hot-start problems i.e. flooding, but he still has the latter as well. You never know, when we find and fix the chattering issue the flooding issue may get worse and be easier to find! Hope springs eternal (but hopefully not pushing fuel into the inlet manifold ...).

October 2024: In an effort to get to the bottom of Bill seeing liquid fuel in his overflow hoses I've more than once asked him to do an 'ignition on engine not started' check with the hoses off the carb overflow ports. Since from the above video it became obvious how useful a video can be in remote diagnosis I've also asked him to film the test. The test needs the wiring to be removed from one of the coil spades to prevent that over-heating with points and some electronic ignition systems (but best to remove it on all cars to be sure). The object of the exercise is to time the clicks from the fuel pump, and watch the ports for any fuel appearing. The clicks should not be any more frequent that once every 30 secs (after an initial few depending on how long the ignition has been off) in any event as that does mean that either fuel is seeping past the float valves (or the non-return valve in the pump inlet is leaking back). Even where the clicks are more than 30 secs apart it could mean that feel is seeping past the float valves, but in normal use i.e. engine running even at idle it should still be using more than that i.e. it will never overflow. However for whatever reason that hasn't happened so far. Instead Bill replaced both floats and valves in both carbs but still had the same issue and wondered if it could be a faulty float chamber lid which of course it could be and was already in my mind. He ordered a 2nd-hand lid for the front carb, but had also been asking the

chap he bought the floats and valves from what could be wrong and sent his lids off to him to have a look at. He said both had damaged tips and he had replaced them and was returning the lids.

However he has had a major incident at home where this car was badly damaged in a fire which brought any further testing and diagnosis to an end, with no resolution. As I mention at the outset he has two MGBs with twin HSs and the other one hasn't had any problems of this nature, which surely indicates very strongly if not proves that his issues at least are down to this specific car and are not generic.