

FITTING WEBER DCOE's TO A SPITFIRE, HERALD OR GT6

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This is a very popular conversion for Triumphs using the 'SC' 4-cylinder engine as well as its bigger 6-cylinder brother as used in the GT6 and 2000 saloon. Webers are most commonly associated with the tuning brigade, however, contrary to some belief, a set of Webers will not turn a daily driver into one that is an unmanageable beast to drive. In fact, because of their more efficient design, they will tend to produce a more flexible engine, with a smoother idle, when set up properly for a specific engine. A properly set-up Weber system will be on par with fuel injection, and they are quite popular with the home tuner due to their ease of setting up. They will also not lose their tune overtime (contrary to what is commonly believed), and I personally think they are better than S.U's in this regard. 40 DCOE's are the most common fitment for the Spitfire, Herald (single or dual 40's) and the GT6 (triple 40's) while many Spits have also use a single 45mm. (Some have also used the DGAV downdraught carburetor). 42mm DCOE's were also made, but are quite rare. Obviously the dual or single set-up works best on Spits with the 8-port cylinder head, i.e. MkIII Spitfires onwards which use a modified version of the Works aluminium 8-port head. This results in the desirable 'single feed' system, i.e. one choke per cylinder. Mk1 and MkII Spits have the 6-port "siamesed" head, though a lot of early Spitfires have had 8-port heads fitted, as the first step, before any further tuning is done. All the GT6s used a 12-port head, so triple Webers fit the bill there. (For interests sake, the cylinder head on the MkI was not as good as later models – in 1968, the MkII was given the same head as the TR5/TR250, a much better breathing item. Also the manifolds for the MkI are different to the later models).

8-PORT HEAD OF THE SPITFIRE, MkIII ONWARDS IS ESPECIALLY SUITED FOR A DUAL WEBER D.C.O.E SET-UP...



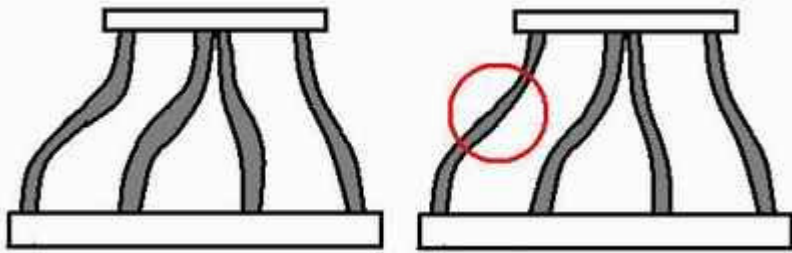
...WHILE THE EARLY 6-PORT HEAD WILL HAVE TO MAKE DO WITH ONE.



MANIFOLD(S):

The major expense (apart for the carbs themselves) will be the intake manifold. Doing it the easy way, one would go and import a nice new manifold from the UK or USA, and you will be able to bolt the thing on in 5 minutes. The current cost of this approach will be in the region of R3000-R4000, which is why I investigated another approach. Aluminum manifolds for the Nissan 1400 (dual 40mm) are readily available, are relatively cheap (~R800) and the relative distance between centers of the 1st and 2nd (3rd & 4th) intake ports is exactly the same as the Spitfire. This was the closest manifold I could find off the shelf. The crunch comes when you have to cut the manifold in half (!) because it is too long (from 2nd to 3rd port). The oval ports of the manifold are also too large – the major axis is 34mm, compared to the Spitfire head port diameter of 31mm – so the top and bottom of each port will need to be filled with weld before the manifold is bored to the correct diameter of the head. It is best to drill the hole in the manifold for the locating dowel before taking it to the machine shop so that they have a reference to bore the ports to. The flange on the head side needs to be machined to at least 1mm higher than exhaust manifold flange – you can take more off if you please, but things start to get a bit thin (and the aluminum is extremely soft. On my car the exhaust manifold flange is 9mm thick and the inlet, 10mm). Other than that it was just a lot of work with a file to get it to fit between the exhaust manifold. The outside of each half of the Nissan manifold needs to be taken back to the original profile (of the S.U. manifold), but on the insides not too much has to be removed to get it to fit. In some parts the profile of the manifold is larger than the S.U. flange, so some material has to be taken from this area of the manifold to create a flange for the manifold lugs. A lot of work is needed to blend the machined ports nicely into the manifold, removing the dips and furrows created by the extra weld. Start off with a rotary file on a drill to get the most obvious blemishes out, avoiding not only sudden curves or dips, but sudden changes of cross-

sectional area. After the basic shape of the port is defined, it can be finished of with finer and finer emery (also with an electric drill), concentrating on the entire flow of the manifold – as the surface finish straight out of the cast is not the best. (However, a polished finish is best avoided). The outside runners have a slightly longer and more restrictive path than the inner ones, but they can be improved by filing and smoothing out some of the outside wall, improving the path of the fuel mixture.



After this you can opt to weld the manifolds back together (and pray that everything stays nice and straight!) or just run two separate ones. They are also much shorter than the S.U. manifold – 90mm compared to 130mm. For the GT6s, I'm not at all sure how close an after-market Nissan 6-cylinder manifold would be, but I'm sure its worth some investigation. Manifolds for GT6s are available overseas.

THE TWO HALVES OF THE NISSAN 1400 MANIFOLD, WITH THE SOFT-MOUNT “DONUTS” FITTED.



TRIPLE WEBERS ON A (MUCH MODIFIED) MkIII GT6



MAIN VENTURI'S (CHOKES):

This is the main starting point to setting up the Webers, and their function is to increase the pressure that will draw the air-fuel mixture from the main jets. For 40mm DCOE's, the chokes used range from 24 to 36mm, while for the 45mm DCOE, the applicable chokes range from 28 to 40mm. Smaller chokes will, simply, provide less passage (and greater velocity) of the air/fuel mixture at the bottom end, but will become a bit breathless at the top end; larger chokes will give more top end urge, at the expense of bottom end response. Standard Spitfires develop their maximum power from 5500 to 6000rpm, so theoretically the following chokes apply to engines with one choke per cylinder (i.e. dual carbs):

- 948cc 24mm
- 1147cc 27mm
- 1296cc 29mm
- 1493cc 32mm

The 2-litre GT6s develop maximum power at ~5000rpm, and for them:

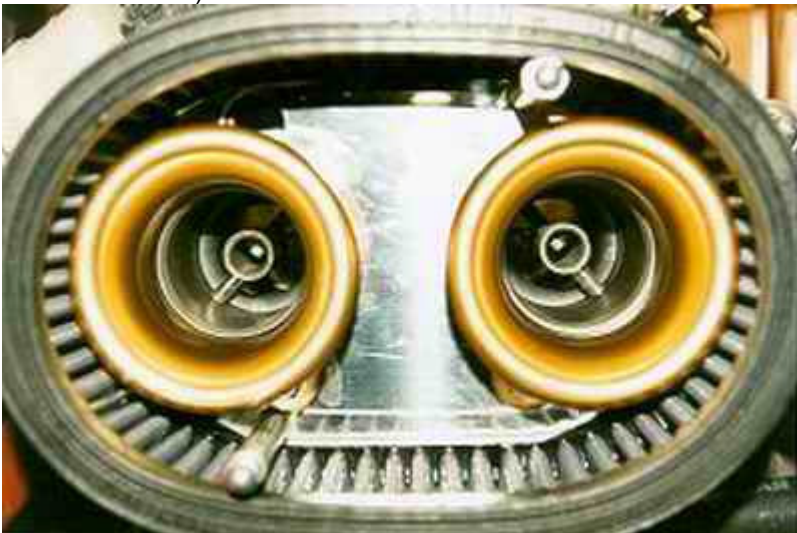
- 1998cc 27 - 32mm

The carbs I got had 32mm chokes installed – too large for my Spit, so I had to find the correct chokes to suit the smaller engine. With a Spitfire, GT6 or 13/60 Herald, it is best to start with 28mm sizes and see how you go. Most guys are using 28, 29 or 30mm chokes, while those using full race cams normally go for a 32. (For a single 45 DCOE on a fast road or race application, 32s or 34s are usually used). The 28mm size is no longer in the production (so I have been told), so finding them was a quite a problem – I managed to find two locally quite cheaply, but the last two had to come from Jo'burg (at R145 each). It might be easier to use 30mm chokes which will do the job and seem to be more readily available.

AUXILIARY VENTURIS:

Auxiliary venturis sit behind the main venturis in the carburetor body and are sized as 3.5, 4.0, 4.5, or 5.0; however 4.5s are the only ones suitable for use in a 40 D.C.O.E. They house the nozzle's which spray the fuel mixture from the main jets, down through the main venturis. In the 45mm DCOE the aux. venturis are held in place with a small screw, which works well. The 40mm, however, relies on a spring type clip which (especially if used for a while) fails to hold the venture securely. To overcome the problem I had with loose venturis, I used an O-ring under each ram tube to hold them in. Others drill and tap their carbs so they can use screws as per the 45's.

THE REAR INTAKE. THE RAM TUBES ARE HOLDING THE AUXILIARY VENTURIS IN (WITH THE O-RINGS JUST VISIBLE). THE MAIN CHOKES ARE SITTING JUST BEHIND THE AUXILIARY ONES.



MAIN JETS:

The main jet assembly is made up of the air corrector, emulsion tube and main jet. A nice rule of thumb to use when selecting main jets is to multiply the choke size by a multiple of 3.9 to 4.3. i.e., main jets from 109 to 120 (i.e. 1.09 to 1.20mm) are acceptable for a carb with 28mm chokes. Add 50 (0.50mm) to the main jet and you will get an approximation for the air corrector jets. Race cars tend to use a smaller air corrector (150-170) than a road application (180-200). I'm using '200' air correctors (which means a 2.00mm air corrector jet), mainly because they were at hand, and for the fact I'm not going race my car – even though theoretically, they are a bit big. Air correctors are not too important, however emulsion tubes are. They are approximately dependent on cylinder capacity, and are as follows:

- 948cc F11
- 1147cc F11
- 1296cc F11 (or F16, F9)
- 1493cc F16 (or F2, F9)
- 1998cc F16 (or F9)

IDLE JETS:

The idle jets provide the fuel path for the engine at idle, though they don't themselves control the mixture. They do however control the progression from the closed throttle to the main jet circuit – important for initial acceleration and part throttle driving. Weak mixtures will cause stuttering & hesitation during throttle opening; too rich and the surging will occur. For Spitfires anything in the region of 40, 45 or 50s will be fine. Air bleeds can be changed to alter the mixture strength. In order from weak to rich air bleeds: F2, F8, F11, F9, F6 (these are only the commonly used ones). Start with a F9 air bleed – F8s are also popular, as are F11s.

EXHAUST VALVE & PUMP JETS:

These two components are the principle ones making up the circuit used on acceleration. As the throttle is depressed, the accelerator pump is activated, spraying fuel down into the manifold through the pump jet, helping to reduce the tendency for a weak mixture to be produced during rapid acceleration. Most common sizes for the accelerator pump used in Spitfires are 35, 40, 45 or 50s. A larger size will feed a greater amount of fuel. The exhaust valve sits in the bottom of the fuel chamber, and as well as regulating the promptness of the circuit (i.e. slow acceleration will not bring the circuit into play), it also discharges the excess fuel that the pump circuit uses on acceleration. If the hole is large, more fuel will flow back to the fuel chamber, however a blank valve may be used, so that the maximum amount of fuel is fed into the chokes when you put your foot down. Size is up to you; 40s, 50s, 60s and 100s are all being used on Spitfires. More than just a few (mostly the racers) have used blanked valves (size "0") too.

FLOAT LEVEL NEEDLE:

This needle valve on the inside of the top cover regulates the level of fuel inside the fuel chamber according to the demands of the engine – thus different sizes are approximately dependant on how much power each carburetor must feed. For (sensible) power outputs they are as follows:

POWER PER CARBURETOR	NEEDLE VALVE SIZES (mm)
Up to 60bhp	1.50
61 to 110	1.75
111 to 150	2.00

The float level is also critical and is controlled by the two floats acting on the needle valve. Holding the cover vertically (with the tab of the floats just touching the ball of the valve) the distance from both floats to the inside of the cover should be 8.5mm. Holding the cover so that the floats fall to their maximum downward position, the distance should now be around 15mm (i.e. the stroke should be ~6.5mm).

FUEL SUPPLY:

On Spitfires, Heralds etc, the fuel is supplied to the carburetors by an engine driven mechanical fuel pump, via fuel line that should be running either around the front or the rear of the engine. It seems to me that the Spitfires up to the Mk IV had fuel lines around the front of the engines, with the 1500's around the back. All pictures of GT6's and Heralds that I have seen have their lines running around the front. It doesn't really make a massive difference but if the lines run around the front the fuel in the lines does receive unnecessary heating from the engine. (With the S.U's you need a fuel chamber top with an outlet for the rear carburetor, in order to run your lines around the back - as with the 1500's). With the Weber installation, lines rerouted up the passenger side bulkhead, and along the top of the bulkhead (alongside the brake line), to the two carburetors is neat and cool.

A fuel filter should be placed somewhere in the system. An electric fuel pump is preferable to the mechanical one; they can easily be hidden in the boot, behind the fuel tank cover and provide more than enough fuel for even the Webers to use. A steel cover will need to be bolted across the mechanical fuel pump aperture on the engine block. Some tuners use this cover to mount a crankcase breather pipe, or even an extra oil-feed to the rocker shaft. The connections on the carburetor float chamber cover should be the highest point of the whole system – to prevent vapour locking. Also, use new copper washers (of the correct size) on the fuel connections of the carburetor – used copper, even new fiber ones, will not seal properly.

COOLING SYSTEM MODS:

The S.U. manifold is a heated item (useful in the U.K, but not too necessary here). Most after market manifolds for Webers do not make provision for a passage of cooling water, so the outlet of the heater (at the back of the block) will need to be connected to the inlet on the water pump with some heater hose and copper pipe either above or below the inlet manifold.

ANCILLARIES:

Most pictures of Spits with Webers that I have seen on the internet have been running open ram tubes, and they sure do look nice! They also do a brilliant job of pulling any road grit into the carb and engine. I opted to use a set of K&N air filters, and while not being cheap they will be the last set of filters you put on the car. Even when dirty, they have a greater airflow than a clean foam filter! However with certain manifolds used, the carbs may be too close together for them to. Filing out the 4 bolt holes on the back filter plate allowed the filters to be offset. With the 90mm long manifolds used, I calculated that you get away with up to a 75mm deep filter, before the inner wheel arches start to cause clearance problems. However, 60mm deep filters are more than adequate (calculations from K&N data show that they are good for 140bhp each).

Another addition is to use ram tubes inside the filters. In the case of 40mm carbs, they are a good idea as they help (together with an appropriate o-ring) to hold the auxiliary venturis in the carburetor body. However the shortest off-the-shelf ones you get are 30mm deep - anything longer and you should watch out that the front filter plate is not inhibiting air flow. (They may also need some work in order to get the flanges to fit inside the filter element). You may also need to source the linkages to connect the two throttle shafts, and the linkage for the accelerator cable. You can get hold of any of these linkages (at a price) but most, if not all, seem to be designed using twin accelerator cables for race applications. The kit I chose came with a ballast weight that bolts on the end of the accelerator pedal and it's basically your choice if you want to run two cables (means drilling the bulkhead) or one.

The other item needing attention is the breather pipe from the tappet cover (to the emission valve on the S.U. manifold). This can simply be left to breathe to the atmosphere anywhere convenient. An anti-vibration or "soft-mount" system is strongly recommended; this consists of thick rubber "doughnuts" between the carb and manifold, and nylon bushes for behind the nuts.

COSTS:

Costs can be one of the main limiting factors in this type of project. Buying brand new wasn't really an option for me, and by phoning around managed to bring the entire project to under R3500 – not too bad when you consider

one brand new 40 DCOE will cost in the region of R2500. I managed to find two 40's nearby, which were in not too bad a condition, for under R1000. They were "type 32", as used on the 1750cc Alfa's. (The different types of the same model carburetor differ in the stroke of the accelerator pump, amongst other things).

Chokes are around R100 each. Good quality anti-vibration doughnuts are around R50 each (two per carburetor), with bush kits for the nuts at around R25 per carburetor. Linkages may also be a problem. If the carbs that you buy had only been run individually, you will need to buy the necessary linkages to connect the two throttle shafts (around R250). A new throttle linkage for the accelerator cable (from R500 to R800) is also needed as the S.U item doesn't really work well enough. Emulsion tubes are also available, but some suppliers only sell sets of four - fine if you have dual carbs, but a bit of a waste if you are only running one. The price I got quoted for a set of four was R700. Emulsion tubes are critical to the setting up of the carb to suit the engine, so if you aren't buying new, make sure you have some that will get the engine running reasonably.

Air filters are another concern; foam ones (TGI's) will do the job, K&N's will do them properly for R430 per filter. Ram tubes are around R200 per pair. Of course, selling the S.U.s to a fellow Spitfire, Sprite or Mini driver will help to recover the expenses (just make sure the Webers are working first...).

ALL THE BITS AND PIECES. THE LINKAGE SHOWN IS THE S.U. ONE, MODIFIED WITH A ROLLER – IT WAS HOWEVER CHANGED.



EFFORT & TIME REQUIRED FOR THE PROJECT:

If you have sourced a actual Weber manifold for your Triumph from overseas, and have that as well as new (or overhauled) carburetors with all the correct parts with you on Friday night, you can have a running car by Sunday. However if you are modifying a locally sourced manifold, the machinists need about three or four days, to do the

job correctly. The manifold will then need about another two days worth of flowing out. With new carbs, you normally get a choice of the jets etc. that you require. However, with a second hand pair, one should bank on the fact that they will not be jetted for your engine – this could mean as much as a week trying to find all the correct parts.

Actual effort is minimal; the cooling system must be drained to just below the level of the inlet manifold so that the connections there can be broken. Disconnecting the battery is always a good idea. With that done ALL the nuts holding on both manifolds must be slackened off evenly, then they must all come off, save for the two lower outer ones of the exhaust manifold – just to stop it falling off. The inlet manifold can then come off, and the works starts to fit the new one on. It's important to look down the ports of the new manifold to ensure that there is no mismatch along the run from the manifold to the head port. It's probably better to fit a new manifold gasket, but if it's reasonably new, fitting paper gaskets under the new inlet manifold (with gasket sealant) will be fine. The manifold can then be bolted up, the soft-mount doughnuts fitted, and the carburetors fitted. You can then fiddle with fuel lines, linkages etc. - this may take more time than expected.

Synchronization of the carbs must be done with the filters off. Normal idle is around 900 to 1100 rpm for modified engines.

SETTING UP & INITIAL IMPRESSIONS:

I have to admit that initial impressions were not too good. The car seemed to be running on 3 cylinders, it wouldn't come down to an idle, and the carbs were spitting back out the ram tubes something terrible. The engine was rocking all over the place, and turning off resulted in running-back, throwing a cloud of fuel out the mouth of the carbs. Worrying? Slightly.

The running on was present with the S.U's so I forgot about that for a while. I changed the cold plugs (N6Ys that I had been using) with a set of N9Ys. The spitting back and failure to idle was a sign of a weak mixture (or a retarded ignition timing), so, convinced I had an air leak somewhere, I changed the soft-mount doughnuts for new thin gaskets, but with only with a little improvement. (I then changed back to the soft-mount system, as running a solid system is not recommended).

Enriching the mixture slightly and advancing the ignition improved things dramatically, the spitting back disappeared, and the engine returned to idle, albeit slowly. The stiffness of the new accelerator cable may be preventing the linkage from returning fully – taking the cable out and setting up the idle speed and then fitting the cable loosely should fix the idle for good.

A high quality throttle linkage really pays dividends when the time comes to set up the idle. I have got it to idle at about 1000rpm, only slightly more than with the S.U's – and the idle is a lot smoother. I have been able to advance the ignition more than with the S.U's (without the pinking), and the running on I have been plagued with for the past 4 months has gone. Pick up is very good and at idle the engine is very smooth.

Some time should be spent in the following week or so after fitment to address any problems you encounter when you use the car – I for example had to fiddle more with the idle settings, as well as the mixture, which had to be leaned off slightly. The extra power is quite noticeable, and the engine feels a lot more flexible than before. The induction noise is terrific, and while Webers may use a bit more fuel than S.U's, but it has been said that it is partly down to the fact that they make the car much more fun to drive!



THE FINAL SETUP SHOWING THE NEW THROTTLE LINKAGE



WEB ADDRESSES:

Some web addresses which had some useful and interesting input to the project.

- www.teglerizer.com (brilliant, tons of pictures @ /dcoe/dcoepictures.htm)
- www.canleyclassics.com (proposed prod. run for GT6 Mk1 inlet manifolds)
- members.aol.com/dvandrews/webbers.htm
- www.sumidel.com/manifolds.htm (manifolds for Jaguar, Austin Healy, MG)
- www.triumphspitfire.com
- www.gt6man.freeserve.co.uk

SOME SUPPLIERS:

- Windsor Garage, Voortrekker Road, Parow: Complete new carburetors (DCOE), lots of spares (jets, emulsion tubes, air correctors, linkages, chokes etc)
- Master Parts, Strand Road, Bellville: Complete new carburetors (DCOE), air filters (K&N and TGI), some new small parts.
- Motor Drive, Boompies street, Bellville: Manifolds, large range of second hand bits as well as a dynamometer.
- Rola Motors, Jo'burg, importers and part-finders