TUNING TWIN SU CARBURETTORS: PART 1 of 2
MATCHING THE CARBURETTORS AND PREPARING FOR TUNING
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My article was first published in Rapier News, the newsletter of the Rapier Register. Some recommendations and dimensions may be specific to the Lagonda Rapier but the principles are applicable to any twin SU carburettor application.

This article is in two parts. In the first I discuss matching the carburettors and preparing them for tuning. In the second part I run through the methods available to synchronize the carburettors and optimise the mixture. I should emphasise that I have presented a personal view based on around fifty years of playing with SU carburettors, with a great deal of help from publications on the subject, old and new. Any errors are my own.

The aims of carburettor tuning are to produce maximum power, a smooth-running engine, and a rapid response to opening the throttle. An optimum mixture throughout the rev range will also reduce the possibility of harming the engine. An excessively weak or rich mixture reduces engine power. In addition, a weak mixture leads to higher combustion chamber temperatures which may contribute to pre-ignition and the eventual demise of pistons. Carburettor tuning has to be done methodically. Optimum performance will never be achieved if one carburettor piston is appreciably heavier than the other, a piston “sticks” in its suction chamber, or air flow through the carburettors is not balanced. There is no point in trying to optimize the mixture if the carburettors are mechanically below par.

Before tackling the carburettors, it is worth mentioning that this is a good time to ethanol-proof your fuel system[1], starting with the rubber diaphragm in the SU electric fuel pump, followed by a new Rapier Register washer for the reserve tap*, and a new flexible fuel hose; all of which are available in ethanol-resistant materials. The solder holding together brass carburettor floats is apparently susceptible to the corrosive effects of ethanol. Ethanol-proof floats and needle valves are available. Given the age of most pre-war fuel tanks, fitting an ethanol-proof fuel filter is a wise precaution. Burlen Ltd can supply any carburettor parts which may be required.

One point to note is that SU electric fuel pumps are available in high-pressure or low-pressure variants, determined by the strength of the diaphragm spring. Our cars* should have the low-pressure version, otherwise carburettor flooding may be a problem. Measuring fuel pressure is an easy matter, but outside the remit of this article.

MATCHING THE CARBURETTORS
It is rare for the carburettors in old cars not to have been “messed about with” over the years. Before attempting to optimize the mixture, I recommend ensuring that the carburettors are first matched as closely as possible and any defects are resolved.

Two SU carburettors of the same choke size, 1 1/8 inch in the case of standard Rapiers*, can vary from each other as a result of wear or substitution of non-standard parts over the years. Never assume they are identical twins! The only way to get everything right is to remove the carburettors and examine them on the bench. After disassembling (not a difficult job), the main parts can be compared. It is not unknown to find that the pistons, needles or jets are different from each other! Clean everything as you go with “carburettor cleaner spray” and a soft cloth.

Pistons, needles and suction chambers

Remove the carburettors from the engine. Remove the suction chambers and have a look inside. Are the suction chambers and their screw caps the same type? Look particularly at how the suction chambers are vented; either via a hole in the screw cap or through an internal drilling in the case of later carburettors. If piston dampers and/or piston springs are present (they were not a feature early SU carburettors), are they the same? Lift out the pistons, taking care not to bend the needles.

<u>Needles</u>

Slacken the needle-retaining screws and remove the needles from the pistons. It may be necessary to use WD40 and gentle heat. Are the letters and numerals stamped on the needles the same? Do the needles look worn? Are they bent? Roll them on a flat surface, pressing a finger on the parallel shaft of the needles, while looking at the tips.

<u>Piston weight</u>

When the throttle is opened it is important that both pistons rise in perfect harmony, otherwise each carburettor will deliver a different amount of fuel. Liberate the digital scales from your kitchen and weigh each piston – they should have the same weight. Have a look at the lower part of the pistons – are the various holes the same in each piston?

<u>Piston drop test</u>

The periphery of the pistons must not touch the inside of the suction chambers and the clearance between piston and chamber should be the same for both carburettors. Having cleaned the pistons and suction chambers, now is the time to do a “drop test” (Figure 1). The aim of the test is to check that the clearances are the same, in which case both pistons will fall at the same rate under their own weight. Block the holes in the lower part of the pistons with adhesive tape. Place the pistons in their suction chambers, then allow them to drop, holding one in each hand. Do they fall at the same rate? If not, check for signs of contact between the periphery of the “slow” piston and the inside surface of its chamber. If there are signs of contact, very lightly polish the “high” area inside the chamber, otherwise try swapping the pistons and suction chambers over.

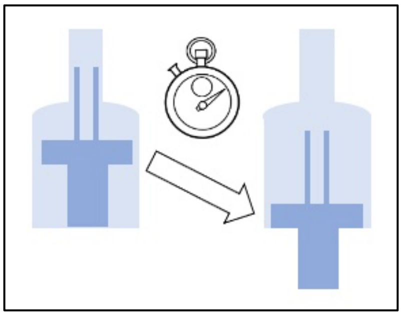

Figure 1. The piston drop test.

Replace the needles, setting them so that the shoulder is exactly flush with the bottom of the piston.

Float chambers and needle valves

Float chambers

Are the float chambers a matching pair? Are they properly vented to air, either via a special corrugated washer under the float lid fixing nut or overflow pipes? Remove the lids from the float chambers. Are the needle-valves identical? Do the “forks” operated by the floats move freely on their spindles? Remove the spindles and lie the forks side-by-side on a flat surface – are they symmetrical? Lift out the floats – are they a pair? Vigorously clean out the tubes that run through the floats with a pipe cleaner and some spray: they tend to collect surface oxidation inside the tubes and the floats can “stick” as a result. You might need to use a small nylon “bottle brush”. Clean out the float chambers. If possible, blow everything through with compressed air.

Needle valves

Replace the needle valves and the forks and adjust the float heights. This adjustment sets the fuel level in the float chambers and consequently in the jets. The level of fuel in the jets is not critical[2] but should be very approximately 3/8in (9.5mm)* below the bridge of the carburettor (the raised, flat section where the needle enters the carburettor body). The important factor is that the fuel level in both jets should be equal. Invert the float chamber lid. When the fork is resting on the needle valve (ie the needle valve is closed), a rod of the appropriate diameter (a bolt or drill-bit will do) should just slide underneath the curved part of the forks. If necessary, remove the forks again and carefully bend the arms with fine-nosed pliers. Unfortunately, there are several different recommendations for the diameter of the rod, but at least this method will equalize the fuel level. The Burlen website[2] indicates the rod diameter should be 7/16in for the standard T1 float chambers, whereas other sources[3] recommend 3/8in or 5/16in. The thinner the rod, the higher the fuel level. For a given setting of the forks, the resulting fuel level depends on the weight of the floats, the density of the fuel, the “closing pressure” of the particular type of needle valve and the pressure delivered by the fuel pump, so it is probably unsurprising that recommendations vary. My interpretation is that the fuel levels should be equal and not so high that fuel emerges from the jets when they are in their normal running position, in which case petrol will flood the carburettors, nor so low that engine power is reduced due to a weak mixture. The resulting fuel level in the jets should be checked later after re-mounting the carburettors and re-connecting the fuel pump (see below).

Carburettor bodies and jets

Have a close look at the carburettor bodies – are they a matching pair? Check the amount of radial “play” in the spindles – it should be minimal. If there is excessive clearance between the spindles and the carburettor bodies, air will be drawn through the gap when the throttle is closed, leading to a weak mixture and possible difficulty in obtaining a slow tickover speed. Hold the carburettor bodies up to the light. Do the butterflies close properly when the spindles are rotated after the slow-running screws have been slackened? Are the carburettor levers tight on the spindles, or loose and wobbly?

If the engine has been running reasonably well, measure the depth of each jet below the bridge of the carburettors with a digital calliper depth gauge and make a note. This will be a rough guide when re-assembling. Remove the jets and inspect them. They should be identical in every respect. Have the openings of the jets worn oval as a result of poor jet-centering?

Re-assemble the carburettors carefully with new jet seal kits and new gaskets and fibre washers, with a smear of light oil on all the threads and on the steel piston rod. The piston and the suction chamber should be kept free from oil.

<u>Centring the jets</u>
The needles and the jets need to be concentric: at no point in their travel should the needles touch the jets. If there is contact, friction between needle and jet will reduce the speed with which the piston is able to rise and fall and amount of fuel being vaporized will be incorrect. First, position the jets as high as possible: screw the jet-adjusting nuts right up and then push upwards on the jets so they are firmly up against the jet adjusting nuts. Now slacken-off the jet-locking nuts (the large, thin nuts next to the carburettor bodies). This will allow the jet bearings (jet holders) some freedom to "float" slightly. With the pistons at the bottom of their travel and with upward finger pressure on the bottom of the jets, wiggle the whole assembly slightly. The idea is that the jet settles centrally around the thickest part of the needle. Now tighten the jet-locking nuts. Fully-lift the pistons with a finger and let them drop under their own weight. They should fall easily with a soft "clunk" as they reach the bottom of their travel. If not, repeat the process until both pistons fall at the same rate, with the all-important clunk as they reach their destination.

<u>Jet height</u>
Now set the initial jet height. Use the depth gauge part of a digital vernier calliper to set the flat upper face of each jet an equal distance below the bridge of the carburettor body by unscrewing the jet-adjusting nuts the required amount. The absolute distance below the bridge is not critical at this stage, but 4mm would be appropriate just to get the engine started. If you measured the depth of the jets below the bridge at an earlier stage (see above) and the engine had been running reasonably well, use this measurement (or the average of both measurements if, as likely, the jet depths were different). Having done this, mark the outward- facing flat of each jet-adjusting hexagon with Tippex to make it easier to ensure that both hexagons are turned by an equal amount when finally adjusting the jet heights to obtain the desired mixture (see Part 2 of this article). Screw-in the idle screws until both butterflies are just open. The exact amount doesn't matter at this stage.

Re-mount the carburettors on the inlet manifold, using new gaskets. Do not tighten the flexible connector between the carburettor spindles, and don't re-connect the accelerator lever or choke levers at this stage. Re-connect the fuel lines and turn on the fuel pump until the float chambers fill and the ticking of the pump stops when the needle valves close. Now make a final check that the fuel level in the jets is equal: it may be necessary to re-adjust the fork in one float chamber slightly. To do this, carefully remove the suction chambers followed by the pistons, taking care to avoid bending the needles. Set aside each piston with its matching suction chamber. Shine a torch down into the carburettors. Fuel should be visible only when the jets are manually lowered from their normal resting position. If fuel overflows the jets when they are in their normal running position, then either the floats are set too high or the needle valves are incontinent.

Assuming no fuel can be seen above the jets, check the actual fuel level by lowering each jet, gently pulling downwards on each jet “head” until the fuel level can be seen just overflowing the top of it. Now measure the depth of the jets with your digital callipers. The absolute depths are not critical, but they should be equal, and around 3/8in (9.5mm)* below the bridge. If one jet has to be pulled down significantly further before you can see fuel overtopping it, then the fuel level in that carburettor is too low, and the float chamber fork should be bent away from the float slightly. Turn on the fuel pump again for a few moments until it stops ticking, then re-check. This sounds complicated but is straightforward in practice. The jets can now be pushed fully up against the jet-adjusting nuts again, and the pistons and suction chambers replaced.

N.B. After switching off a hot engine, petrol can sometimes be seen overflowing the jets. Tests at Manchester University[4] demonstrate that carburettor temperature can rise after switch-off to such an extent that volatile modern fuel can literally boil in the jets causing vapour and liquid fuel to bubble out of the top, like coffee in a percolator.

The carburettors are now ready for tuning. Part 2 of this article deals with balancing the carburettors and adjusting the mixture.

BIBLIOGRAPHY

1. The website of The Federation of Historic Vehicle Clubs has a useful section on the effects of modern fuel on carburation. https://www.fbhvc.co.uk/fuels
2. The Burlen website has a clear explanation of the workings of SU carburettors http://sucarb.co.uk/technical-carburetters-introduction
3. Rapier Data Book. Paul Nickalls. Rapier Register
4. Classic Engines, Modern Fuel. Paul Ireland. Veloce Publishing 2020. ISBN 978-1-787115-90-3