1. Basic Principals

- When any gas or other fluid flows through a duct, the velocity is highest at the smallest cross-sectional area and the pressure is greatest at the largest.

- Elementary thermodynamics deals only with steady laminar flow:

    - steady flow assuming that the movement is in one direction
    - laminar flow assuming that there is no eddying or swirling, no turbulence.

- Duct, air moves faster at the centre line, then progressively slower away from this line. It can be pictured as a moving central rod of air surrounded by thin concentric cylinders of air, each of them moving a little slower than the one it encloses. Near the walls, the rate of decrease is faster than in the central section.

- Turbulent flow, however, has components moving at right angles to the mean line of flow, and this will further decrease the rate of flow or require a Greater pressure difference to maintain the same flow.

- The dimensionless Reynolds number is a measure of this turbulence

- Though the difference between a smooth bore and a highly polished one is nil to all intents and purposes, a lot can be done to prevent their becoming unnecessarily high. For example, the crossbar supporting the auxiliary venturi in weber carburettors is carefully shaped -streamlined to avoid causing unnecessary turbulence and the throttle plates and spindles are kept as thin as adequate mechanical strength will permit. In the port, there is the inevitable obstruction of the valve stem, though the biggest single obstruction is the valve head itself given that the lift has to be kept within kinematically feasible limits. It is very difficult indeed to improve on a discharge coefficient of 70% with the valve fully open

- One of the worst forms of obstruction to flow, and a sort that can easily be avoided, is a step from a larger to a smaller bore. If the carburettor is larger than the inlet manifold or the manifold larger than the port in the cylinder head, the flow is significantly reduced. Besides the obvious tendency to cause swirling and eddying, there is another factor that makes matters even worse: Thermodynamics can show that when air flows through a hole in a plate, the downstream side will contract to a throat which is smaller in area than the hole thus giving an even smaller effective area. After the throating it will, of course, again expand to the diameter of the duct, but by then the damage has already been done. Blending and rounding the sharp edges will ameliorate matters to some degree hut will not prevent the contraction of the flow unless the blend is over a considerable length and that my give rise to other problems making one regret having chosen the wrong bore carburettor manifold. As an illustration of this point carburettor uses a smaller bore auxiliary venturi when the diameter of the main venturi is less than 32mm because the standard auxiliary venturi would be a mismatch and form a step.

- The fuel were flush with the nozzle and the air flow were steady , then according to Bernoulli's basic equation the flow of fuel from the nozzle would he strictly proportional to the flow of air through the venturi.

- Further, to avoid spilling and to cope with surge from vehicle motion and the inevitable engine vibration and rock, the fuel level has in fact to be some way below the nozzle. From this it follows that in practice there will be a definite minimum air speed below which there can be no discharge from the nozzle because there will not be enough depression to lift the fuel to the height of the nozzle. This entails providing an auxiliary system for dealing with very low gas speeds. It also follows that the point at which discharge from the nozzle begins can be controlled within certain limits by adjusting the fuel level.

- The fuel level is below the nozzle also has the disadvantage that the flow of fuel will not be directly proportional to the air speed through the venturi. The fuel flow from the nozzle will increase at a higher rate than the flow of air through the venturi, so a correction system is essential to maintain the right mixture strength through the speed range.

- The approximate ratio of specific gravities is 557:1 fuel to air. As inertia is proportional to mass and an accelerating force is also proportional to mass, fuel will obviously tend to lag behind air when set in motion. Once the fuel has reached a steady speed it will also have a greater tendency to continue in a straight line when the mixture column is arrested or has to round a sharp bend.

- In a well atomized mixture, each tiny droplet is enclosed in a sort of spherical halo of vapour, the latter occupying a very much greater volume than the droplet it encloses. Well atomized mixture looks very much like wet steam; dry steam is invisible, just as is pure petrol vapour. The petrol-air mixture is formed when the emulsified fuel is broken up by the air stream through the venturi as it emerges from the nozzle.

- During idling, when the mass flow is very small, vaporization is certainly complete by the time the gas passes the inlet valve, the depression in the inlet manifold being considerable and fairly steady. Vaporization takes place much faster when pressures are low. With small throttle opening, it should be complete at some point during the inlet stroke, but at large throttle openings and high rpm a proportion will not vaporize until combustion is actually taking place.

- When cold, a lot of fuel will pass through the engine unburnt and even with a warm engine it can safely be assumed that any fuel that arrives in the cylinder in the form of a blob or large drop will turn to carbon but will not contribute to the power output.

- The stoichiometric mixture, the chemically correct one, for current petrol is about 15 parts of air to one of petrol by weight. This is, in practice, too weak under the majority of conditions, about 14:1 normally being considered the weak limit and 11:1 about the richest. This is not hard and fast, though, so much depending on engine design. But a mixture richer than 7:1 or weaker than 21:1 is to all intents and purposes non-inflammable and certainly cannot be made to fire in an engine.

- Unlike the diesel engine, the petrol engine is able to use almost all the available oxygen for combustion, and too much spare oxygen will cause exhaust valve erosion and burning; the spark plugs won't like it either. The better the engine design, the better will be the capability of burning weak mixtures without any resultant had effects; but this applies only to a heavily loaded engine when the pressures and hence the temperatures are high enough to cause damage. There is no worry on that score when the load is light

2. Carb and Tuning

- A great deal of trouble is taken by manufacturers to obtain the best possible compromise and this — very important includes counting the pennies.

- There are two ways of getting extra power from an engine:

    1. Raise the brake mean effective pressure (bmep) in the cylinders

    2. Leave the pressure the same but raise the rpm at which peak pressures occur. Brake horsepower (bhp) varies directly with the bmep and rpm

- Torque is directly proportional to brake effective pressure, so the torque and bmep curves are of identical shape for any given engine; only the scale differs.

- Among the simplest techniques for obtaining high bhp is to raise the compression ratio,

- The rise in ratio increases the thermal efficiency of the engine (hence the bmep) and, other things being equal, the extra power is gratis and not at the expense of increased fuel consumption. But that is not all by any means: there is an additional gain from an increase in volumetric efficiency. When the clearance space at top dead centre is reduced, the scavenging at the end of the exhaust stroke will be more effective.

- It is worthwhile, though, to make sure that the mixture at full chat was not on the weak side before, as higher temperatures will be generated by the higher pressures, increasing the danger of damage caused by over-weak mixture.

- It has even been known for concave pistons to give better results than flat-top ones in spite of not giving quite as high a ratio as would be possible with flat tops.

- Larger inlet ports and valves normally require a richer setting for the lower rpm range and this, as pointed out elsewhere, does not mean a richer mixture. Large valves and ports do not give good low-speed torque: if they did, manufacturers would be perfectly ready to provide them. Neither will large ports do much good anywhere in the range if the enlargement leads to spoiling the shape of the port. Racing engines may have very large ports,

- When an engine is run with open exhaust ports, there is a quite startling loss of power throughout the whole range, the reason for this being the total loss of the extractor effect.

- As kinetic energy depends on the mass and the square of the velocity, a high velocity is desirable. Therefore it is best to choose a pipe diameter which will comfortably accommodate the mass flow at full output and full rpm, but no more.

- When four cylinders discharge into a common manifold with short branches, there is a certain amount of interference between cylinders but the effect on performance will be comparatively small and negligible in the lower range.

- Also, most carburettors tend to go rich as they age; worn needle valves and worn fulcrum pins both allow the float level to rise. It is only during idling that worn throttle spindles cause weakness by allowing extra air to enter when the manifold depression is large.

- The exhaust valve opening point has no direct effect on carburation and can he left out of the discussion, but the top overlap, the inlet opening and exhaust closing phase, has a great deal of influence.

- This danger is unlikely to arise with camshafts intended for road engines because too late an inlet closing will play havoc with tractability at the lower end of the rpm scale. The top overlap, as mentioned before, is intended to give some spill-through when the column of gas chasing down the exhaust pipe behaves like a piston and sucks mixture from the opening inlet valve, thus setting the mixture column in motion before the piston proper begins to descend and takes a hand. Too great a spill—through will waste fuel down the exhaust pipe, except perhaps in a very restricted range where the cadenacy effect may correct this Ideally, one could take advantage of this effect and aim at widening the bhp or torque peak, but in practice it is full of snags.

- Very high valve lifts as such can do little except overstress the valve gear

3. Main System

- Extended auxiliary venturis on a DCOE are of no advantage whatever for racing (when the engine operates between the torque peak and the rev limit all the time).

- No one on a racing circuit is likely to use revs below the range at which the camshaft and exhaust system are fully 'on song'

- As a footnote it may be added that, when 4.5 auxiliary venturis are replaced by extended ones, the next size, 5.0, is usually chosen in order to reduce, to a limited extent, the additional pulse damping. 5.0 is the largest size available for the 45 DCOE

- The pump jet is also in operation during full-throttle running. There being sufficient depression at high revs and a wide throttle opening to lift the weight holding down the delivery valve ball. Once the flow has been initiated, only the weight returning the ball to its seat will stop it entirely because the pump jet orifice lies below the fuel level in the float chamber. This is one important reason for not mounting DCOE carburettors with the trumpets tilted upwards more than about five degrees, or the siphon effect will overcome the weight and the flow will continue in the form of a dribble which will enrichen the mixture detrimentally.

- The pump jet is the only one that delivers fuel in liquid form and not as an emulsion so, unless the gas velocity is sufficiently high, there will be very little break—up of the stream. Fuel reaching the combustion chamber Form is effectively useless or worse.

- In addition to the depression in the venturi, high gas speeds past the pump jet are in themselves capable of drawing fuel because of the streaming effect of the low-pressure area which forms downstream of an obstruction.

- The very mixed blessing conferred by the fact that there are, in most cases, several combinations of main jet, air jet, emulsion tube, nozzle and pump jet that will all produce the same flat—out maximum power.

- The gas flow through the carburettor is pulsating, and a larger nozzle will transmit the pulses to the well more sharply than a smaller one.

- Small nozzles as well as long auxiliary venturis have a damping effect on pulses from the engine. A small-bore nozzle Is on the whole better from the economy aspect and, unless the pulse energy transmitted to the well at high revs is so weak as to demand a very rich setting that can spoil the lower range, it is better to try a small one first. Engines with fairly large cylinders and siamesed inlet ports normally prefer larger auxiliary venturis.

- The emulsion, tube, besides living up to its name by assisting in the mixing of air and fuel on the way to the nozzle, has most influence during acceleration.

- Another factor often lost sight of is that increasing a main jet from, say, 100 to 105 is a larger percentage increase than changing from 180 to 185. This ¡s further complicated by the fact that the length of the calibrated orifice, with its effect on drag remains the same.

- It can he said that a large main jet with large air jet can - other things being about right- give the same mixture at full speed as a smaller main with a smaller air jet. The difference however, is that in the first instance the mixture will be richer in the lower range than in the second. The other rule, somewhat safer, more consistent, and less hedged around with ifs and buts, is that a change of one size of main jet will have a much greater effect on the mixture strength than one size of air jet.

- The mixture is bound to be weak upon sudden opening of the throttle. The acceleration of the air through the air jet will be almost instantaneous but the greater inertia of the liquid fuel will not allow it to join the air stream rapidly enough. For this reason, an accelerator pump is fitted.

4. Emulsion Tube

- Information from the manufacturer indicates broad categories which are some help (table below) as the numbering of emulsion tubes is a mere coding with no reference in their dimensions.

61450 series (DCOE) Emulsion Tube Applications

Tubes mainly used for touring cars	F4
Tubes mainly used for sports cars	F2, F4, F11, F14, F15, F16
Tubes with bigger diameter for engines with strong vibrations or high compression.	F9, F11, F14, F15, F16
Tubes to increase richness on slow running (without high holes).	F4, F17
Tubes with many holes to reduce richness at high rpm if air jet is bigger than 2.00.	F6, F12
To eliminate weak mixture during lower acceleration range, tubes without high holes.	F7, F8
To eliminate richness during higher acceleration range, tubes with high holes.	F2, F9, F10, F12, F14, F16
To make mixture richer during gentle acceleration by increasing reserve: tubes with low holes and small external diameter, used with larger air jet to avoid richness at high revs.	F4, F17
Tubes for fuels containing alcohol or for very large main jets	F1, F2 F3, F4, F5, F17

- Air from the air corrector discharging from the cross-drillings in the tube will tend to drag fuel with it towards the nozzle, and it should be clear that the float level too has a considerable effect on this.
- Thick tubes give a certain amount of capillary damping to the fuel by reducing the annular space (between well wall and tube) it has to flow through.
- During full throttle acceleration, the emulsion tube has a certain amount of influence.
- On part throttle cruising and during gentle acceleration the emulsion tube has considerable influence.
- Thin emulsion tubes should be used with large main jets.

- Upper holes cause a weaker mixture at all revs, and the more upper holes there are the further up the range the weakening will reach.

- Low holes cause richness at large throttle openings.

- Another point arises for road cars and for many cars intended for rallying. For flexibility and good consumption figures, high holes arc desirable because they help to achieve a good break-up of the fuel supplied. A finely divided, homogenous mixture makes for better distribution between cylinders and for better combustion, hence greater engine efficiency.

- A petrol-air emulsion is totally unstable; it cannot be considered a state but only a continuous process. In other words, emulsion will only exist while emulsification is taking place. The better emulsified the discharge from the aux venturi nozzle; the greater the chance of the fuel remaining in finely divided suspension on the way through the manifold to the cylinders.

- DCOE tubes, part number 6145O.xxx run up to F20 at the moment

- When ¡t comes to the DCOE models, many accepted basic settings were built around the emulsion tubes found in carburettors when purchased.

- It is sad but true that, before the right tube can be chosen, one has to find out what is wanted, which means that some tube or other has to be fitted to get the thing running. Unless the main jets are very large, F15 and F11 are fairly middle-of-the-road for a first choice when there is no precedent and there is a barrel per cylinder.

5. Main Jets

- It is a fact, not sufficiently well known, that constant-depression carburettors (like SU’s) are more accommodating, especially for low and medium-speed acceleration, when all is not well with the engine. This is because, in spite of the driver’s heavy foot on the throttle pedal, the carburettor pistons will not lift any higher than is necessary to pass the air the engine is able to breathe in.

- Further, it can be taken that the main affects the total range while the air corrector has more and more say as the revs rise, though at no time is its effect negligible.

- In general, it can be said that large main jets with large air jets give a setting rich in the lower and middle range, while small mains with small air jets achieve the opposite.

- A very large pump jet or high-speed bleed can enrichen the top-end mixture to such an extent that a larger air corrector may be needed in order to prevent over-richness. This may, of course, in certain contexts achieve the desired mixture slope but, on the whole, large pump jets or opened-out high-speed bleeds making up for the main system weakening off too much in the top range cannot be recommended.

- When there is a carburettor barrel for each cylinder, the inlet stub is usually fairly short and always straight or nearly straight. Another advantage is that the pulses from the engine will, under these conditions, be equally spaced and fairly heavy and low speed gasp should not occur with such a set-up unless the engine or the setting is at fault.

- Using the same venturi in a 40 vs. 45, the pressure experienced by the charge will increase more in the larger 45 after passing through the venturi and promote more precipitation of fuel from the charge.

6. Idle and Progression

- When the engine is idling, the depression in the inlet manifold is large though not as great as when the engine is on the overrun. Depression is fairly steady in either instance, with no pronounced pulses if the carburettor is feeding four or more cylinders. To keep the engine running with no load requires very little mixture, but the compression pressure is of course very low indeed and the degree of exhaust gas dilution is considerable even with the mildest of camshaft timings.

- In practice, the idling jet that gives correct progression Will also be able to look after the idling with the mixture screw not too far open.

- The final setting of the idle must be done with the engine really hot — stinking hot after a run.

- When, at the desired idling speed, turning the mixture screw either way slows or roughens the engine, ¡t can be assumed that it is correctly set. If it is very touchy indeed to the smallest movement either way it can mean one of three things:

    - that the set—up is just very touchy
    - there is something wrong with the engine
    - the idling jet is much too large. This only applies, though, to engines using one carburettor.

- If the carburettor is mounted with the float bowl facing to the side, the mixture strength will depend on which way the car is cornering at any given time. For racing cars, of course, idling is not relevant and racing carburettors where the wells are arranged in the centre of the float chamber arc not prone to surge.

- On racing cars, where idling as such is not a criterion, the mixture screws should be opened no further than is necessary to ensure that the inlet tract and progression duct do not go too dry on the overrun. As the idling orifice is the only possible source of fuel during this time, an idling mixture screw set too wide will wet the inlet tract too generously. This is of course true for road cars as well, but as they have a reasonable idling speed there is little risk of the screw’s being too wide or too close without resulting in repeated stalling in traffic, so it is unlikely to go unnoticed.

- The progression orifice (or orifices) is above the throttle plate during idling and therefore effectively at atmospheric pressure. This means that during idling, air is drawn through it, thus further emulsifying the idling mixture.

- At the same time, the depression is still acting on the idling orifice which goes on supplying fuel, though to a decreasing extent as the throttle opens further.

- When the idle is finally set, it is worthwhile shorting out each plug ¡n turn and noting whether the drop in revs is about the same in each case

- One factor outside the carburettor can still be weak ignition: it is easier for a weak spark to jump the gap of the plug when the mixture in the chamber is on the rich side.

- The two reasons for suggesting drilling throttle plates or chamfering the throttle plates at all are, firstly, the makers themselves suggest them and, secondly, the damage can easily be made good — the hole can be closed with a spot of solder, the chamfer can be eliminated at no more cost than the price of a new throttle plate and screws.

- In order of ascending size, the air bleed orifice diameters are: F6, F13, F9, F8, F2. F11 has the same bleed diameter as F8 but the axial bore is smaller; similarly, F4 has a larger axial bore than F2. Codes to the right of F2 are rarely of interest today, and it is rare that F4 or F11 will solve any problems one of the others cannot cope with. Nonetheless exceptions exist and serve to add a bit of interest and variety. Size of the fuel orifice, while keeping the same air bleed, will increase the strength of fuel—richness of the emulsion with little increase in its volume. The bulk of the air forming the slow—running mixture is, of course, regulated by the setting of the throttle stop. But how to arrive at the correct F number is in the end always a matter of 'suck it and see', the art being to know which way to move when it turns out wrong.

- Over many years now, the DCOE carburettors have shown their ability to match the demands of all engines in good order and any stage of tune without resort to anything in the way of fiddles except perhaps an exceedingly rare instance of a change in throttle plate angle.

- If decent progression cannot be obtained, on an engine intended for the road, there is something wrong with the engine one way or another. As the sizes of the venturis, nozzles, emulsion tubes, and so on are not relevant to progression in itself, this point can be settled fairly conclusively before embarking on setting the main system. With racing engines this will not apply and on the dynamometer little useful information on progression can be obtained. But track tests will soon show whether the slow—running jet is adequate or not.

- On all DCOE carburettors, the slow-running jets are fed direct ly from the float chamber and not via the well and main jet. Their fade-out being is controlled entirely by the lack of depression at the progression holes. The action of the depression in the slow-running ducts and jets is not only pure suction, there are also the factors of drag and the differing inertia of air and fuel, so the relative distances between air bleed, fuel orifice and mixture duct all have an effect. On the DCOE they are fairly close.

- Good idling is more the business of the engine and inlet tract than of the carburettor, providing of course that the carburettor is sound and the accelerator linkage has no vices. In discussing carburettor faults as possible causes of poor idling, we must assume that all had been well previously and the trouble has only just begun, that the float level and fuel feed are in order, that there are no air leaks between the carburettor and the cylinder head (gasket faults or cracks in the inlet manifold) and of course that there is nothing wrong with the engine or the ignition.

- A quick test on the 28/36 DCD when it does not respond to the throttle stop screw or mixture screw very readily, the idle remaining fast and rich, is to slacken the stage two slow running jet holder about half a turn. If the second stage is properly closed there will be no response, the progression holes then being of course fully covered. If there is a change in the note or feel of the engine, something is wrong. ,This trick will check for faulty closing of the second stage on all progressive carburettors

- Frequently, the throttle plate will be completely free when the engine is not running, yet once engine suction puts a load on the throttle plate it will stick. Sometimes, it is worth giving the spindle a light tap axially in both directions — a light tap it will have to be or the edge of the throttle plate may cut into the barrel. If all this fails, the carburettor will have to come off.

- It is best not to use a hand brace or a machine for drilling out the lead plugs in the carb body; far better to hold the drill (3/32in or 2.4mm) in a pin chuck and do it by hand. Finger power is ample for lead, as long as the drill is sharp — then there is no risk of cutting into the alloy of the carburettor body. More often than not it will be found that just as the point of the drill is about to break through, the plug will stick to the drill and can be withdrawn. If it does not, the remainder of the plug can be pulled out with the point of a scriber or a bradawl.

- If Messrs Weber's lead plugs are available, well and good, but they are often not: in their absence, lead shot size No 1 (3.6mm diameter) will do the trick. It is best to avoid using anglers' split shot: a piece can detach itself when the plug is tapped home, and there is no way of finding out whether this has happened until it is too late.

- Yet the first little movement of the throttle relies on accurate synchronization for obtaining identical delivery from the progression holes - it is a matter of fractions of a millimetre. Messrs Weber's renowned accuracy counts for nothing when actuated by Fred Bloggs's Iash-up of a linkage.

- Having set the idle to what seems about right, it is good practice to check that the idle mixture is under complete control. Weakening the mixture on each barrel by half a turn of the screw, one barrel at a time, should cut the relevant cylinder

- Taking first the case of a single carburettor feeding four or more cylinders, we will assume for the sake of argument that the correct idling speed is 800rpm and that this has been satisfactorily set the engine, of course, being at full working temperature. Don't go off, after having done the idle, for a cup of tea and a natter while the car is left to cool off in a northerly wind! Speed up the engine very slowly to, say, 1,300rpm by means of the throttle stop screw, noting whether the response is even and in proportion to the degree of opening. Often, when the very first part of progression is wrong, the response will be erratic. For instance, the engine may speed up a certain amount with the first quarter turn, while the next quarter turn has no effect at all. Then a further quarter turn may either speed it up a lot or, on the other hand, the engine may still ignore it in terms of revs. It may go rough and lumpy, pop from the exhaust or even spit through the carburettor. Or it may be just rough and lumpy with black smoke from the exhaust, and the spark plugs, if examined, will show newly formed soot. (And don't try any serious tuning with a tatty assortment of old plugs from the odds and sods).

- The weak symptoms would show conclusively that the slow-running jet is too small — and of course the converse. A quick and reliable way to test whether the hesitant behaviour is due to richness or weakness is to give the mixture screw half a turn, towards rich if weakness is suspected, towards weak if it appears the other way. The engine will quickly show its appreciation of the improved mixture. It is wise to make sure of not getting lost, by remembering exactly where the mixture screw was for correct idling — it is, after all, the only datum to work from. If weakness was the fault and the symptoms were very pronounced, it is better to change to the next size jet before resetting the idle and starting the test again.

- Once the revs go above 2,000, it is worth keeping an eye on the auxiliary venturi in case the main system shows signs of coming in. This depends a great deal on the size of the first-stage venturi.

- There is always a slight delay in response to mixture screw movements, and hurried large movements can give the wrong impression. Patience may or may not be a virtue, but in checking idle and progression it is essential.

- A simpler way of making sure is to cut out each cylinder in turn by shorting out the spark and note whether the drop in revs is near enough the same each time. This manoeuvre is worthwhile as a final check for all idle settings.

- The DCOE and the 46 or 48 IDA also differ from all other models by having slow-running jets fed directly from the float chamber, not via the main jet and well. With these two types, the slow-running jet works a long way up the range at part throttle openings. This is because they are designed for feeding one cylinder from each barrel, a set-up in which the main system at large throttle openings has to contend with heavy pulses making for richness. On part throttle these pulses are subject to considerable damping and then the main system tends to go weak.

- An element of guesswork, and a lot of looking at precedents followed 'by testing, reigns supreme as far as slow-running settings go.

7. Accelerator Pump

- On the one hand, it is far easier to ring the changes on a piston pump, where the discharge bleed, the strength of the spring the length of the stroke arc easily altered.

- On all Weber carburettors with piston pumps the actual delivery stroke is performed by the spring when the throttle is opened.

- Usually, finding the right bleed is sufficient to get things right. A heavy spring with a large pump jet and bleed will give a short, sharp delivery, while a light spring, a small pump jet and a closed bleed will go on delivering fuel for a second or so.

- For the DCOE, two lengths of pump rod are available, and also two different spring rates.

- The only way of obtaining a rapid response from a piston pump is to use a blank pump discharge bleed, but this means that the total fuel quantity pumped by the piston differs little whether the pedal is moved slowly or rapidly. This, of course, may ruin a fuel consumption figure, unless the delivery is small under all conditions.

- It is in relation to avoiding our old bugbear, bottom end gasp, that the pump has a considerable say, and it is essential to establish whether the long slow delivery or the short sharp squirt is the answer to the problem.

- None of these three items (rod length, discharge bleed, spring) have any effect on the delivery from the pump jet at full chat when it is acting as a high-speed fuel bleed.

- Thanks to the inertia of the fuel, when the throttle is suddenly opened there is a rush of air to the inlet ports - which is bad enough - and there is also a pressure rise in the inlet tract that will cause the suspended fuel to fall like rain to the floor of the duct.

- When the gas speed in a distributing manifold is high, the stream of fuel delivered from the pump jet will be carried round bends and corners: consequently gasp on sudden wide throttle opening at high revs is very rare and, should it occur, easily cured. The carrying capacity of an air stream increases rapidly with speed, and so does its ability to break up the fuel into droplets. (In passing, this is one reason why the over-ambitious enlargement of ports and manifolds, with its consequent reduction of inlet tract velocities, is such a pitfall for ill-advised 'tuners'.)

- The fear is that manifold heating will raise the temperature of the intake gas to a degree which will cause a loss of volumetric efficiency because of a reduction in the density of the charge. This may be true for small throttle openings, but once the throttle is fully open the whole tract, except for the inlet ports and valves, will cool to such a degree that the amount of heat picked up by the gas will be very small indeed, and the effect on density less than that caused by variations in barometric pressure or ambient temperature.

- It should also be appreciated that, on part throttle, volumetric efficiency is of no consequence, the engines being deliberately strangled under these conditions anyway.

- Anything that removes the need for over-rich mixture, with its attendant ills of higher fuel consumption, accelerated engine wear due to bore washing, and dirtier exhaust emissions, has to be of benefit.

- Before describing some more tricks to overcome low-speed gasp, it must be pointed out that the heavy pump spring also demands the heavy throttle spring in order not to make the throttle lazy in returning to idle.

- To prevent the fuel from hitting the wall of the inlet tract so close to the carburettor and so far from the inlet valve, the pump jet can be angled slightly in the horizontal plane; to the right in the right-hand barrel and to the left in the other one. The exact angle depends on the shape of the manifold in question. It is easy enough when dealing with the right—hand barrel to file the flat on the jet till it can be turned to the desired angle.

- Another way, of course, is to block the original hole and then drill a new one at the required angle — but this is considerably more difficult and likely to add quite a few trophies to the collection of broken small drills and ruined jets.

- When there is a barrel per cylinder, a pump jet greater than 45 ¡s highly improbable unless the cylinder is very large, and rarely is a stroke greater than 10mm necessary.

- A lazy throttle return can be speeded up by using the lighter pump spring and increasing the pump jet by one size.

- It must again be stressed that over-richness from the pump will have little effect on hard acceleration through the gears, though it may produce all sorts of hesitations when the pedal is used more gently.

8. Floats

- When the centre of buoyancy of the float or floats is in the same plane as the vertical centre line of the main well, the angle the surface of the fuel takes up in the float chamber due to the car's motion has the minimum effect on mixture ratio. Accelerating, braking and cornering none of these will cause enough variation in mixture to be noticeable. The optimum practicable in this respect is fully realized with the DCOE the DCO 3 and the earlier DCO,

- On the whole, it is best to arrange that the fulcrum pin of the float should be leading the float when the car is in motion. That ideal is of course impossible with the horizontal carburettors when they are mounted on the left (nearside), but that has never yet given rise to any bothers.

- When an air box or directly mounted filter is used, the vent must not be disregarded: if this vent is blanked off, liquid fuel will discharge from the nozzle, the idle and progression holes.

- The horizontal DCOE pattern, however, are bad offenders for reasons best known to themselves. Partly, but not entirely, it is the result of their having to be mounted ‘out on a limb’, so to speak. The likelihood of the fuel frothing up at certain rpm is too great to make it worthwhile to wait and see: assume that it will and use the well-established flexible mounting method. Besides, the rate of wear of the needle valve will be high as well, in the absence of a mounting with some damping effect.

- The secondary forces, due to the finite length of the connecting rods, act in a vertical plane at the centre of the engine and at twice engine speed. The resultant vibration shakes the carburettor, along with everything else mounted on the engine. There is only a negligible chance that this vibration will he communicated to the carburettor at very much diminished amplitude, or even that the carburettor will be placed at its still centre. Nonetheless, it does happen, and those claiming success without a resilient mounting are unlikely to be quiet about it rather the reverse, because being able to

- Six-cylinder engines do not suffer from this type of vibration. Some V engines generate rocking couples but they are neither of a frequency nor in a plane to cause frothing in the carburettor. Engine rock is quite a different matter and is common to all four-cylinder engines not fitted with a torque stay. It has a low frequency, and all that is necessary is to use a spring-loaded needle valve. Also, on horizontal carburettors, the fuel level should be as low as the setting will permit - but never lower than 9mm for the 40 DCOE, and that is already too low for the 45DCOE. As usual, exceptions exist but do not disprove the rule.

- The calibration of the needle valve is determined by the maximum rate of consumption, the delivery pressure of the fuel pump and the number of carburettors. Most mechanical pumps generate ample pressure to deal with all contingencies as long as their standard rev range is not exceeded by too much.

- Although the gauge pressure taken at idling speed drops when the engine goes on to full power, the needle valve does not see it like that: some of the static pressure is now converted into flow energy (velocity head) and the equivalent total differs little from the static reading..

- Large spring loaded needle valves -over 2.00 and a pressure of 3.5lb/sq. in may combine to give rise to flooding.

- On the whole, needle valves should not be larger than necessary, and with road cars 1 .75 to 2.00 is amply large enough.

- Floats for the DCOE models and a few others are available in different weights, the lighter ones having, of course, a greater buoyancy and therefore exerting a greater thrust on the needle valve. This would appear superficially to be a good method of dealing with high fuel pump pressures, but on balance it is the last way to choose. The lighter the float the more it will be affected by fuel surge.

- On the fast corner, the surface of the fuel will lie at an angle to the horizontal, and if there is enough buoyancy in the float for one half of it to close the needle valve as well as raise the other half, starvation will occur if power is called for. Setting the fuel level higher with lighter floats does not cure this sufficiently.

- Bernoulli's basic equation relates air velocity through the venturi with fuel velocity from the nozzle. It also relates the height of the nozzle's lower edge above the level in the well with the minimum air speed required to raise the fuel this distance. When no fuel is being discharged from the nozzle, the level in the well will not differ from the level in the float chamber. So it is obvious that fuel will begin to discharge from the nozzle at a lower air speed if the float level is high. In other words, the main system comes into action earlier with the higher float level. A smaller venturi, giving a greater air speed through the throat for the same throttle opening and rpm, will, of course, also bring the main system in earlier owing to the higher velocity of the air past the nozzle. The critical distance between the lower edge of the nozzle and the static level in the well is never less than 5mm or more than 12mm, Outside these limits, it is very difficult to maintain proportionality with a simple main jet, air corrector and emulsion tube system, although this does not mean that exceptions cannot exist. Some carburettors, it will be noticed, are quoted with quite a range of float levels, while others are specified with the same level again and again. In fact, the float level is dependent on the needle valve type and float weight.

- For the DCOE carburettors, two different float weights are available, 23g and 26g, the latter being by far the more usual and, without going into detail, preferable.

- If a DCD with a 1.75mm needle valve supplied enough fuel before modification, then two 40 DCOEs both with 1.75mm needle valves will have the same margin as before if the rate of consumption doubles — which is fairly improbable since it implies that the power will also not be far from double. Here, there must be a clear distinction made between fuel consumption in mpg which is merely an average, and the maximum rate of consumption which occurs at full chat, at the bhp peak and beyond it. An engine running at say, 120bhp will probably use fuel at a rate of between 8 and 9 gallons per hour. If the rating of the fuel pump is no more than this, even the largest needle valve made (3mm) will not prevent weak running at full power, with the risk of consequent disaster. As a datum, a 1.5mm needle valve will pass a bare 6 imperial gallons per hour at a fuel line pressure of 2.5 lb./sq. in. So if this size were used in a twin-carburettor set-up with a fuel pump giving that pressure, the combined capacity of 12 gallons per hour would leave a comfortable margin for our 120bhp example. In a single carburettor with the same pump pressure, it would take a 2mm needle valve to pass about 10 gallons per hour. This is border-line if the car is going to be driven hard, and a 2.25mm needle valve or a more potent pump would be safer. Clearly, where a big increase in consumption is likely, making sure the pump can deliver the required amount of fuel with an adequate margin has to come before thinking about float weights or needle valve sizes. Electric pumps, when working on their limit, are prone . to get too warm; this increases their electrical resistance and lowers the output .

- The DCOE series do not present any additional problems, and Fig 8:6 should make it all clear. As can be seen, there is no return stirrup fitted to these needle valves. The 38 DCOE 25 is an exception, for not only is there a stirrup fitted but the valve itself is also slightly longer (part number 62420.011 instead of the normal 62420.004). The float too differs, weighing 23g instead of the usual 26g.

- It is far more important to have all the levels the same than to worry about half a millimetre — at the bridge gauge, of course: at the tongue it would be fatally far out.

- Oddly, there is no gauge listed for checking the amount by which the needle valve protrudes from the carburettor lid — one only hopes that all is well when the needle valve is screwed home. However, if there is more than one carburettor on the engine, it is wise to check that all the needle valves protrude by the same amount, whatever it may be.

9. Starting Devices

- It is wrong to think that a cold engine needs a richer mixture than a warm one but, at low speeds and with cold metal everywhere, the amount of mixture arriving in the cylinder in combustible form is a very small proportion of the mixture leaving the carburettor.

- Further emulsification will take place at the bleeds under the side cover. The moment the engine fires, the well will be emptied and additional emulsification will occur from air entering the base of the starting jet. This multiple emulsification will assist the break—up of the starting mixture and help to prevent excessive condensation on the cold metal of the inlet tract.

- Additional linkage is usually provided so that there is a position of the choke control just a little way out that gives a useful fast idle while the engine is cold, but with the actual starting device out of action. The fact that the car can be driven almost immediately without the starting unit, especially when each cylinder is fed from a separate carburettor barrel, is not a sign that the mixture is too rich, but merely that the fuel atomization is very good in Weber carburettors.

- Ignoring its existence has led to quite a lot of trouble: sticking due to dirt, with consequent poor starting and idling, is the lesser evil. When the retaining circlip falls out

- Many people ignore the choke on these carburettors an d on the DCOE, using the accelerator pump instead, and if this appears the best way, well and good. The thing to avoid is jiggling the throttle pedal at the same time as using the choke: one or the other method, not both. Moving the pedal with the choke in action produces a lot of fuel from the pump jet and at the same time prevents the starting plunger from operating as it should. Even if the engine is not flooded, which is quite likely, all that wet petrol swilling about is hardly beneficial. The starting units incorporated in the DCOE, DCNL, DCNF and IDF are in principle simpler, but are more difficult to service once they give trouble, especially on the DCOE. They have no automatic weakening-off valve like the DCD type, but they do have a starting well which richens the mixture at cranking speed. The starting jets have a size (fuel) and a code (characteristic) but the air corrector is invariable at 1.50mm. These carburettors were primarily designed for use when one barrel supplies only one cylinder. With the heavy pulses under these conditions, the engine will run without choke after a very short time. In fact, many drivers never use the choke at all. Many a DCOE comes in for servicing with the plungers stuck firmly down from sheer lack of exercise. Superficially, one could say that, if the choke is not used it does not matter that the plungers are stuck down on their seatings. If they are immovably stuck, that would be fine, but there is a chance that a blow—back can raise a plunger, after which it might well not re-seat and so would provide a chronically rich mixture on that barrel. If the choke is used regularly and the control is correctly adjusted to make sure the plungers return to their seats, there is no good reason to experience trouble from that quarter. When the plungers do not seat properly, the idle and slow-running are simply lousy and out of control by the mixture screws: things can be made richer, but they cannot be made weak. So the symptoms are clear and unmistakable. The important thing is not to confuse them with the problems caused by the throttle not closing properly or bad progression.

- With the carburettor off the car, there is a simple test to find out whether or not the plungers are seating properly: turn the carburettor upside down and fill the delivery duct (see Fig 10:9) with petrol or very thin penetrating oil. If this does not seep away, the plungers can be considered to be in working order. Bear in mind that the plungers are pulled onto their seating by the depression in the inlet stub when the engine is running normally: if they hold merely under spring pressure, their ability to seal in action will be better.

- The starting jets on the DCOE can also corrode in with remarkable tenacity. A soak with a good penetrating oil will never come amiss, and it is important to have a screwdriver that is the right fit and does not damage the slots. If the jet refuses to come out and the slots become more and more chewed, the jet will have to be sacrificed to some kind of extractor. Should that fail, it means drilling it out without ruining the thread in the carburettor body — and good luck: a great deal of it will be needed.

- A thin oil is adequate if the carb will be in action shortly, but if it is going to be on the shelf for days or weeks, engine oil would be better. The special oils used for mothballing machinery should be avoided: they become too tacky for the light moving parts and fine threads in a carburettor.

- The components of the starting unit on the DCNL carburettors are identical to those on the DCOE and, although the change of corrosion or sticky carbon from excessive b1owback is logically neither greater nor smaller.

10. Air Filters and Intakes

- The distance from the mouth of the carburettor to the nearest obstruction must be at least equal to the bore diameter of the carburettor intake. On the DCD this equals 39mm; on the DCOE, IDA, etc. the bore of the trumpet, not the diameter of the entry flare is the deciding measurement.

11. Misc.

- The small advantage a balance passage between the barrels of a DCOE carburettor might give at idling speed is more than offset by disadvantages at other times.

- Engine test results from many sources seem to show that the maximum pressure in the cylinder should be reached at about 12 degrees after top dead centre.

- Also during this time a great deal of heat will be transmitted to the water jacket, and detonation is frequently accompanied by higher water temperatures.