

Cylinder tuning – Part 3

PART 1 Introduction to tuning a Lambretta Engine

PART 2 Introduction to tuning cylinders the MB way

PART 3 Explaining advanced tuning

PART 4 Explaining advanced port timings

I have a room I call the reference library. It's full of books and magazines, I hardly ever refer to them, some I've only glanced over and some I've never read. My old mans a designer, I asked him once if he read magazine and technical articles on what he does and he firmly said 'no' and continued to say he found he was lead on by what others said and found it influenced his thoughts! That's exactly how I felt reading similar things in my game. Of course I've read books on 2-strokes, looking back I just glanced over certain aspects including listening to other dealers who said this works or that woks! Today it's even worse than ever with forum experts and people back into it again and my mate said down the pub! I've always been one to try and test my ideas and find out if it worked by the seat of my pants. I've always done this right back to my first Lambretta, but even before that I was building models, push bikes, skateboards or ramps! I'm good with my hands and like making things. Looking back I've often been influenced by things I've read or been told and have regretted it a few times!

2-stroke tuning has come on a long way over the last few years, when I started there were books but were hard to find, it was days of no internet or computers, we don't know how well off we are now, there is so much free information at the tip of your fingers! In the early 80's all I had was the old Lambretta manual, which I read inside out and knew it back to front by the time I was 15. Building my first Lambretta from a pile of scrap was quiet easy, but you never stop learning and 30 + years later I still learn because I want to know about these things. We had the old 60's Performance Tuning book which must have been brilliant in the 1960's and we had the Dave Websters tuning book. These two books where very good at addressing tuning issues and information, but I also found they where full of fresh air and didn't really give anything away. I'm one for a rule that works, tell me to do it this way and I will try to see if it works, if it does then great, lets move on to the next thing that works, if it didn't work then I found out why, I'm not one for grey areas! You could say I have concrete thinking, but I don't, some of the best things I've done are thought of from looking outside the box! And this is how I've usually worked for many years, this is how I look at tuning, I don't copy but I have tried what others have done until I say what I do I think is better!

The first book I read back to back was Graham Bells book, this book talks a lot sense in a reasonably easy to way to read and is still a good book and often quoted today 25 years later..... but you can not take everything as gospel as it just doesn't work in a low revving shopping trolley Lambretta. It's aimed at high revving multi geared reasonably modern motors not a vintage engine like we have to work with. I will make a lot of reference to Bells book as we carry on. As I've said we and Lambrettas have come on a long

way in the last 30 years. I like to think I've been at the forefront of Lambretta development over that time and as the computer became popular I put a lot of my findings down into our old MB Developments Web site that Ian did for me. Today I still see people cutting and pasting and reiterating and printing information that I have found and documented in my old web site like they are the experts. When Sticky did the first Spanners manual I was chosen to do the technical, tuning and advancement side of the book and again was chosen on the second print. We did discuss doing a tuning book based on my old information and Sticky toyed with the idea but deciding not to print a tuned book because, as soon as it went to press it was out of date with everything coming along new. In 2012 I decided to redo it all again and make a ever growing tuning book which can be updated daily. Within a few days people were pasting links and others were reading it and reiterating information on forums like they knew everything about a subject I had written! It's god dam frustrating that people take in what I've written and invented or developed and some make out they have done it..... BUT I've done this site to help people and paste links into our web sales site to try and earn us money. Perhaps I'm daft, I'm shooting myself in the foot and yes I'm loosing business to others who offer an inferior service at a lower cost, but I enjoy writing, I enjoy setting the standards that others follow, and I have a need to do it, without writing it down I forget, I must be getting old. Re addressing the old site made me realise how much I know or did know and have forgotten so I'm glad I wrote it all down in the first place.

Today with the internet super highway, similar people and people who know much more than me are writing tuning articles and technical papers. The world is full of real experts and then there are ones who can read something, take it in and reiterate it like they are experts but can not do the job! Of course there are very knowledgeable people on forums. It's something that is here to stay, it will not go away so I and my business have to work with the modern times, like it or not! I've got special computer programs that I've looked at and it just goes over my head. I'm sure Ian could look at them, work it out show me and I would learn about the science of the 2-stroke engine more in depth and produce more power and maybe understand the Lambretta engine and develop it to push the limits even more. But is it all about MAXIMUM POWER? No it is not! Indeed there is a new breed of tuner good at taking in complicated computer programs or understanding boring university papers on tuning! Personally I'm more practical, more one to try something, find out how or why something works over another. I was one of the first to work with Allgears dyno in the 1990's used for tuning articles for Scootering, Taffspeed bought that dyno and was the first Scooter Shop to use one to develop their engines and then the fad started, nearly every Scooter Tuner has a dyno these days and horse power has increased because of them. When I got a dyno I found many, many times that it proved what I already knew from many years of trying and testing by the seat of my pants, but that's what you get when your always tinkering to improve engines!

2-STROKE BASICS

I'm not going into the basics of how a 2-stroke works, there is plenty of information in books and on the web, just ask a forum and see who comes up

with what. What I will be doing is trying to show what works and why it works on a Lambretta engine. As I've said I've learnt from many years of riding Scooters. My test track is the open road and long distances at silly speeds, not 3 laps around a race track. I have developed my products from riding to work as a commuter Scooter and then at weekends to Rallies. I've ridden thousands of miles to the other side of Europe, I've won the coast to coast race, I've raced and run a race team and my engines have won many races and championships. I guess you could say I know what I'm on about based on a very long history of riding Scooters. Today I don't ride Lambrettas like I use to, as I'm older and appreciate my health so I push bike and walk to work. I'm a big fan of anything two wheels, I have an Enduro and Trial bike as well as a BMW GSA which as often as I can I like to tour Europe and I average 12'000 miles a year. I do the odd rally on this and I'm often criticised for turning up on a Motorbike..... which really does get on my tits, these people were not around in the 80's, 90's, 2000's I really don't have to prove anything by riding a Lambretta these days. Whilst I'm at it when did you see all the racing hero's in the last 30 years doing rallies on Scooters? The answer is hardly never and that includes the major dealers! Today by chance I rode a customers Race-Tour engine, the bike was a bit of a shed but it didn't stop me enjoying the ride and thrash to set up jetting and what a perfect engine the RT is, nothing over kill but powerful and fast at the same time pulling away from 30mph in 4th. In the right hands and road conditions it would keep up with the fastest tuned Scooter this was designed on the history and experience I have.

So I'm going to see where this article goes, to try and hopefully explain the technical side of things that people constantly give advice on forums and down the pub without them having any real knowledge to the subject apart from what they have read. I will refer to Graham Bells book as most have it and use it for information, if I had Blairs book which a lot use I would use that but I've never even seen a copy.

A performance engine will need parts bolted together to make it work, it's the same for a standard, mild or a full race tune. You need a carb, crankshaft, cylinder and piston assembly, an exhaust, clutch, gearbox and tyre. It will not work without any of these parts, obvious really! But get each one to talk with each other and you can design that engine to do what you want it to do, go that step further and it can do more..... but this comes at a cost! The basic Lambretta engine started at just over a horse power, the best produced by Innocenti was around 10 bhp! Today we have pushed it to over 40bhp! This finds any weak link in any engine. Early tuners pushed limits by swapping the first weak link, the piston! I then reset the standard by developing the con rod and crank, others altered the ignition to improve that and it goes on, we perfected CNC clutches, gearboxes and now even tyres! 30bhp is quiet normal, more and more we are seeing high 30bhp and some with long stroke cranks are hitting 40+bhp. We were the first ever to hit 40bhp in the mid 90's when others only managed 30bhp, I was so far ahead of the times but people forget!

Take all these individual parts, turn them into better made stronger parts and you can push the limits without it breaking something internally. Early

standard pistons used weak cast iron rings and weak pistons, this was cured by swapping to a modern piston and you could find some more power, at the time within the limits of points ignitions! Then con rods either snapped or big end bearings melted, give it too much power and the clutch burnt out. Size of carb and type of exhaust allowed the engines to gain power, torque and revs, the more you push this the quicker it would find a weak link! And this is all based around we are doing our best to get silly power outputs with reliability from a very poorly designed engine where the casing its self limits us with a crank that is too narrow and cylinder stud spacing too small to get what we really would like!

The main ingredients to get power comes down to only these

- The cylinder set up
- The exhaust
- The carb

Really the crankshaft, drive chain, clutch and gears don't make an engine go faster but they talk to the whole package to make it work right and these parts are important for reliability and allowing power to the road. Cylinder and head design is a science on it's own as is the exhaust system, both can be as complicated as you want to make it. Sometimes simple is best, a standard 4 ported Lambretta cylinder can produce up 40bhp but needs to be very complicated to get it to do that. Over complicated multi ported Reed Valve engines like the TS1 or RB may never see that 40bhp but may be easier to do and ride! But a simple 4 ported cylinder like a standard GP200 done correctly may quiet easily do high teens to mid 20 brake horse power and suit 90% of people!

I see so often complaints about a cylinder set up, questioning ignition or carburation when the symptoms are obviously the exhaust! We should look at exhausts and how they work as these will either hinder or help an engine.

Theories for port timings and exhausts really is a mine field, I could baffle you and my self at the same time. I don't want to waffle too much as it really is not needed, it's about what works and why, and why some cylinder kits and exhausts perform in a way that will suit one customer to another.

EXHAUSTS

Exhausts totally effect how a Lambretta runs, some are so badly designed it totally effects the running and will restrict an engines power output. For instance a Swift/Taffspeed/JL3 road pipe totally limits revs but has decent low down power with increased standard like low down performance. People love it, I hate it, it does not rev and I don't think it particularly gives good power or torque! But people like it as it seemingly pulls from nothing and this impresses people and makes for a good touring two up engine. There are some ADS pipes doing similar but rev even less and don't rev much over 5-6000rpm, if you like going slow then great, it suits you. These pipes may not have high horse power but promote high torque so to get top speed throw overly high gearing with these pipes, providing the basics of the engine is correct and you can get away with it. Common high gear ratios for these

exhausts are 4.5 – 4.3:1

The opposite is say a NK, JL4, Kegra/JL2 and lately so ADS pipes where the power is flat as a fart until the exhaust comes on song at around 6000rpm and screams to 10'000rpm! These pipes get the the top speeds in terms of mph but has no low down torque so the gearing needs lowering to suit the engine to try and stay in the power band and are a pain to ride two up or into the wind. Common low gear ratios for these exhausts are 5.7 – 5.2:1

So one pipe works from say 3000 – 6000 and another from 6000 – 10000 out of these rev ranges the engine doesn't work well! With normal usable standard gearing of a Lambretta usually say 4.80:1 which is SX200 gearing 6000rpm is 60mph (as the Sx200 gear box does 10mph per 1000rpm, dead easy to work out and use as an example). One bike may only do 60mph flat out and in theory another would not even start to work until 60mph in fourth and could do up to 100mph flat out!

I've always preferred a pipe what I consider to work. I see the benefits of a low revving and a high revving pipe, but really a customer wants the best of both worlds and pipe that joins and works from a low revving pipe to a high revving pipe. This is very difficult to get right, the more you tune a cylinder the harder it gets. Do a cylinder with a good all round spread of power port timings and it is easier to design a pipe which works. Ok it may not give massive horse power and torque but what this article is about is finding an engine which suits most peoples requirements and to shown a well designed cylinder and exhaust will be very fast and powerful which can ride-able like a Wolf in Sheep's clothing plodding kind of way until opened up, then wow..... Perfection!

Lets face it, most Scooterists are happy to do 50 – 70mph, with normal gearing this is 5000 to 7000rpm with power below and power above, it's not thrashing an engine, most parts MB sell are well happy at 12'000rpm building in one big safety factor even for the fastest of engines.

You can get confused between port timings and power from exhausts! So many people say my bike has a flat spot till around 5000rpm and it needs setting up on a dyno to get jetting right! Most of the time it's the exhaust design where it pushes revs too high and the engine doesn't work low down and doesn't talk to the port spec, or the porting spec is wrong to start with.

You can jet these engines as much as you want, what you get is this; you will have set the carb and main jet to work when the engine is on song where the exhaust and port timings are talking to each other and working, this is usually called the power band. You need to fuel the engine at this point, all's well and good if you are in the power band and you know how to ride it but as soon as you are out of this power band the jetting is so over jetted the engine won't run cleanly..... so people then down jet the needle/atomiser/slide or idle jet and when this happens you run weak rolling off the power band and boom a seize or holed piston! This is why power jets are coming in fashion, as a power jet allows you to weaken off the mid range and richen up the top end when needed.

Lets not get confused with crap modern day fuels which do not help. Lets not get tied up with compression ratios or ignition timings. These do effect how an engine runs but are separate to port timings, like I say it's getting lots of factors to talk to each other, these little things are really important to how an engine will work or work reliably. These little things are really massive, miss match them with a poorly designed cylinder with poor port timings and you can go round in circles with problems that we see daily.

OVER PORTING AND MISMATCHING

There is a lot of talk on forums from people who just don't know what they are talking about, they read motor bike books and look at cylinders badly over tuned which is where they think they know port timings. I've used nearly every port timings going from standards to mild tuned to full race tuning in Lambrettas, Vespas and Other 2-strokes. I read port timings like reading a book. What may work on a multi cylinder, multi geared Jap engine really does not equate to a Lambretta with big bodywork and four wide spread gears! It's about getting a Lambretta to ride reliably, with driveability and rideability! To do this we don't want over sized or miss matched port openings 'port timings or port durations' what is oversized depends on how you look at the engine, how that engine is to perform and in what part of the rev range. Take a 99% Joe Bloggs Lambretta riders needs..... it must pull through each gear without seemingly going backwards when hitting a hill or driving into the wind, be rideable, driveable and be reliable.

It's easy to over port or have mismatched port timings, There are a lot of cylinders on the market coming from dealers with over sized porting, yes they work but do they work as good as they should? Some Mugello's run 160/165 degrees of inlet port timings, with small transfer timings of 116/118 degrees then an exhaust timing of 180 degrees. These are renown to be a pig to set up and have all sorts of running problems, it's a piston port cylinder, things need tweaking the best they can to make them something like decent. But you are limited as you can not add metal back on where it has been removed! Rapido's have similar inlet and exhaust timings but a larger transfer timing of 130/132 degrees, you need to give these some throttle to make them work so are hard to drive low down and both cylinders tend to spit back out of the carb! One cylinder floods up with the porting another seems weak with the porting. I will refer to both cylinders throughout the article, not because I don't like them or I'm having a go at the suppliers but because there are so many and everyone should know some one with one so you can compare to your own engine.

Do a decent stage 4-5 tune and you get rideability, torque, pulling power and will rev. Do them right and nearly any carb set up works, jetting is easier and most exhausts work! Go further look at the RB Reed cylinder which has 138 degrees transfer duration with exhaust in the high 180 degrees and again it becomes a hard to set up bike, there is not enough blow down period (the difference between exhaust and transfer timings openings) to get around it you need to raise the exhaust timing well into the 190 degrees..... or totally rework the cylinder height so the exhaust stays the same and the transfers are reduced to low/mid 120 degrees!

Look at the TS1 cylinder, it's a classic and well done from day one but not perfect, I, like others tweaked it to produce more power and with a better spread of power with very small alterations. The TS1 runs 130/132 degrees transfer timings, it's a Reed engine so you don't worry about the inlet timing, you need to look at the transfer and exhaust durations, usually 130/185 degrees, either machine the base of the cylinder by 0.5 – 1.00mm or use a longer con rod at 110mm and smaller packers to reduce transfer timings down into the mid 120's, this will also reduce the exhaust timings making the cylinder more of an all round performer over a high rev monster style of engine. BUT do this and raise the exhaust port back to 185 degrees and watch the power increase from low down to full power.

These are the basics, it's said you can tweak to 1 degree either way and a cylinder can perform better or worse!

Onto PART 4 Explaining advanced port timings

If you have any questions please email mark@mbscooters.co.uk