MZ250 Race Preparation

for the financially challenged

Introduction

The aim of this guide is to give some practical advice on building an MZ250 for racing in the BMCRC MZ250 class. The regulations for 2002 season are used as a guideline. It is not intended as a tuning reference so the settings and timings are for example only, but are mostly workable – I have to say that because mistakes can be very expensive in this game! Some definitive theory books are listed at the end.

The MZ formula is simple - basically stock carburettor, stock exhaust header and diffuser cone, max diameter of expansion chamber no more than stock, and clutch must be crank-mounted as stock. Other standard parts specified, like barrel, head, cases, frame etc. but some parts are 'open' eg wheels, brakes and tyres.

Engine

Bottom end

Crank stays more or less standard - some people lighten and rebalance the crank wheels but it is lots of work for little gain in this class. The best place to spend the effort is making sure it gets assembled properly, perfectly true and check it for out-of-round.

Bigend needs to be replaced with a silver plated cage type for racing (£20), to a conrod that has been checked for damage. The standard (original MZ) rod has proved perfectly reliable, but the crankwheels can be modified to accept a japanese rod and bearing kit which some prefer. Fit new little end, main bearings and crankcase seals.

Most people take a lot of weight off the clutch which is crank-mounted and very heavy – show it to a machinist or a tuner and ask them to shave it, which makes the engine more responsive but it is optional, at least to start with. The clutch has a tendency to work loose from the taper, and then ruin the taper in the boss (clutch centre) and the lightening might help this. Best prevention is to make sure the taper is perfectly clean and undamaged on assembly, and then tightened fully using a suitable locking tool to prevent the crank turning (see suppliers list). If it is scored then replace it. It can be modified to key the boss to the crankshaft which guarantees the thing stays put.

Gearbox should be refurbished while the cases are apart - simple enough, no real modifications necessary except that 3rd gear suffers from a slight design defect that can be rectified with some attention from a specialist – see Burwins or Holmshaw. Change ALL the bearings (they really don't cost much), the oil seal, and check the thrust washers, selector forks and gear teeth for condition. Replace anything less than perfect because they get punishing stress in racing. The little layshaft bearing in the blind hole can be removed easily by heating the case evenly to about 150 celsius, when it will literally fall out: clean the case thoroughly, wait till the wife (or other likely objector) is about 5 miles away and put it in the oven, face down on a tray. Open the windows, give it 15 minutes at gas 5, and you will hear it hit the tray. Drop the new one in while it is hot.

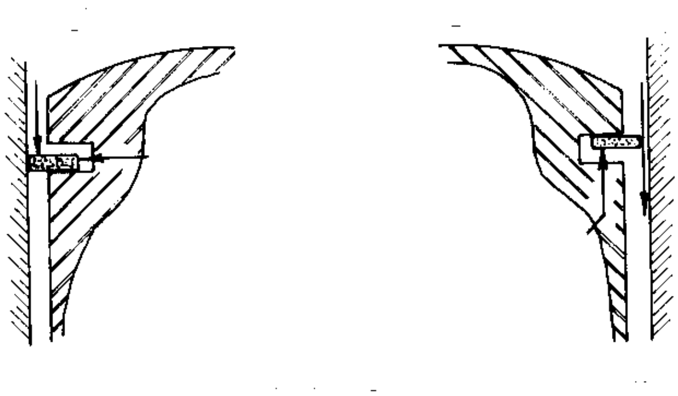
Gearchange action can be a bit fickle on these boxes, so pay attention to the condition of the 'detent roller' which is the indexing roller on a sprung lever arm in the primary drive case. It lives behind the driven primary gear. Replace it if it looks burred over.

Top end

The MZ piston goes in the bin. It is far too heavy, has too many rings and is made of spat-out cardboard or something equally unsuitable for racing. The best piston material and manufacturers are Japanese but there are a number of patterns to choose: the type of piston depends on whether you go piston-ported or reed valve in your tune - whichever you choose you need a 70mm nominal size (69.5 is the MZ standard) with an 18mm gudgeon pin.

Get the barrel bored to match the new piston with a 0.08mm diametral clearance. Be fussy and state you want a careful job, sparked off (honed) to exactly parallel in the bore, exactly perpendicular to the cylinder bottom face (not the liner spigot).

The Suzuki TS250 piston has two rings, about 1.3mm thickness which is good for roughly 8000 rpm and has a long skirt for piston porting. The RM250E piston has a single 1mm ring which is good for 9500 rpm, has a shorter crown height and skirt length which is OK for reed valve use. One of the speed-limiting factors is ring thickness, which determines what speed 'ring flutter' sets in but 8k is fine (see below).

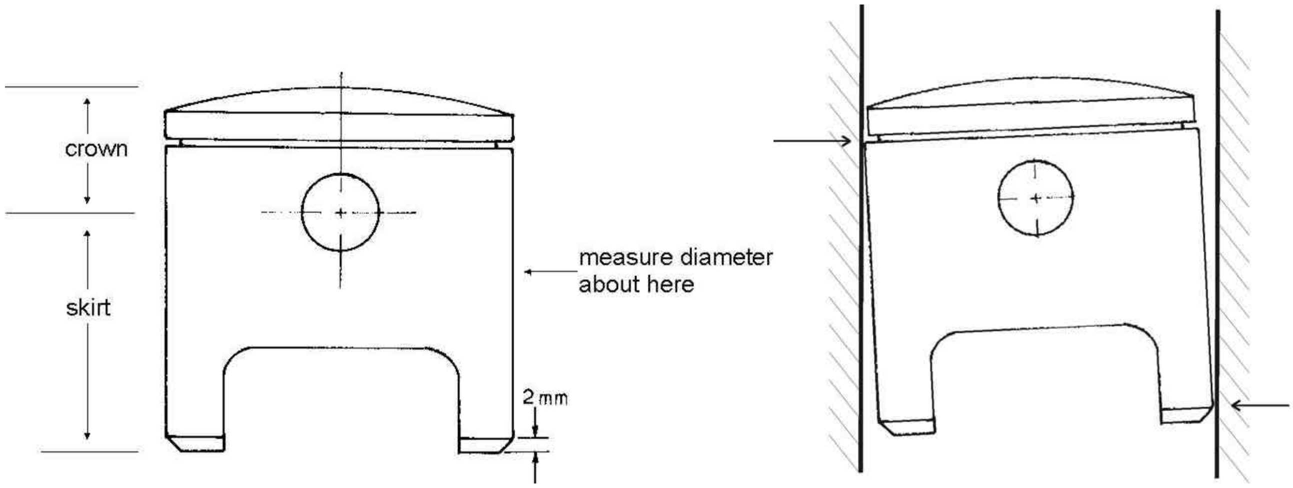


pictured left, piston ring with proper gas seal formed when ring is in contact with lower land and combustion pressure can reach behind it

pictured right, 'flutter' condition is when acceleration forces at TDC exceed pressure forces and ring leaves lower land. Sealing thrust against bore is lost – pressure can escape .

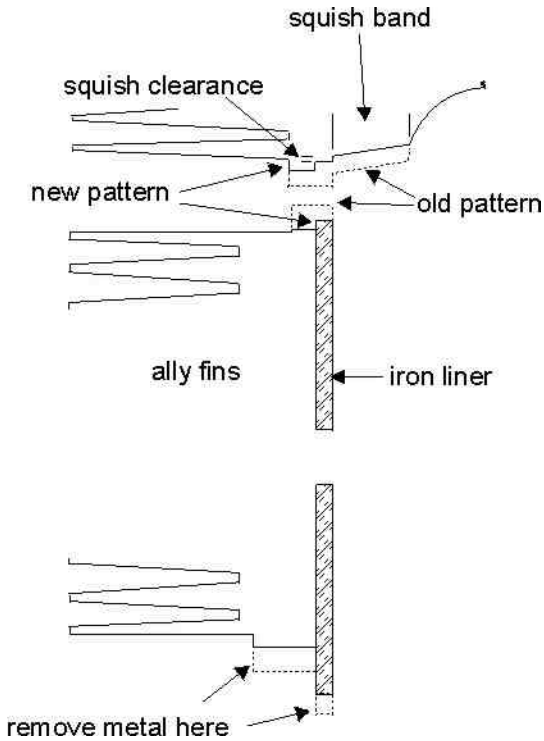
Both can be run with one ring to reduce friction, if 20:1 fuel/oil mixture is used to maintain good compression seal (this mixture is the subject of great debate). But the pipe and carb sizes allowed will not flow much more than 8500 rpm. I use the RM piston and a reed valve from a RD350 and I can get it to rev on to over 9000, without useful power up there but it makes the motor nice and flexible.

Prepare the piston by chamfering the edges of the skirt, 2mm deep (LH diagram, below). Very carefully stress-relieve the whole outer edge of skirt and pin boss, by filing smooth any nicks and sudden changes in section of the casting. Finish the worked areas with 1200 wet-or-dry using plenty of kerosene, white spirit or thin oil (WD40?) as a lubricant. Relieve the top ring land slightly also, at least along the exhaust-facing edge as this bears the thrust here (RH diagram) and can scuff up as the piston wears - the piston rocks forwards on the power stroke, and you need to make sure the pressure (thrust) is shared by the bottom of the skirt on the inlet side and the face just below the ring lands.



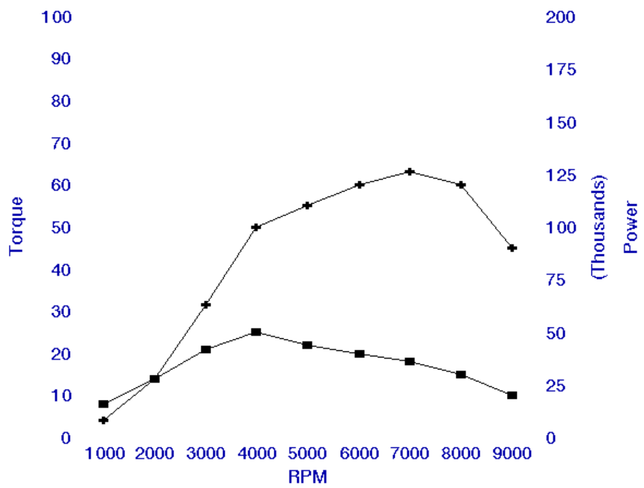
Pictured left, piston details. Pictured right, correct thrust points for a 'rocking' piston – crown must be relieved to allow this

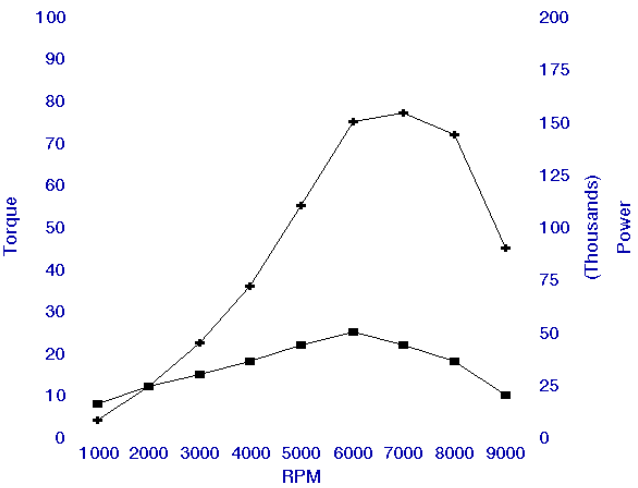
When the piston is chosen the barrel has now got to be shortened at both ends to make up for the different piston skirt and crown height. The basic principle is to set the exhaust port height by removing metal from the top of the barrel (do this after any reshaping to the top of the port), and then set the piston to its correct TDC position ('deck clearance') by shaving at the bottom. This bottom face has to be turned true to the bore so be particular about it. The liner spigot (the part of the iron cylinder liner that locates in the crankcases) must be shortened also to match the cases - decide whether to use a gasket, and what type, and account for this in the measurement. Personally I don't use any gaskets at all, just a good quality sealant like Wellseal and carefully prepared surfaces. These measurements have to be exact so spend a good deal of time over it, using modelling clay to take moulds of clearances etc.



Then the inlet port needs to be modified - it will need moving upwards - using metal epoxy (eg Devcon 'F' aluminium putty) to build up the floor to give your chosen port timing, and a die grinder or a Dremel (a flexible shaft in a drill doesn't really go fast enough) to remove metal from the roof. There are arguments about whether to leave some of the cylinder liner 'tongue' in place, which serves to improve the piston thrust-face contact with the liner on the road machine as it passes the port which of course is on the thrust side of the barrel for a forward-rotating engine but I am of the opinion that the pistons wear too fast on a racing machine for this to be of much benefit. Make a spigot at the top of the barrel for mating to the head by machining so the liner protrudes by 1-2mm or so from the top face - see head preparation later.

For a piston-controlled inlet port the usable range for timing is probably 155 to 175 degrees total 'open' duration.. There are many schools of thought, but the setting affects the cylinder filling efficiency as a function of speed, and increasing the duration has the effect of moving the torque peak up the speed scale. As power itself is the product of torque and speed, the shape of the power peak (and thus the tractability of the engine) is directly affected by the port timing. The diagrams below illustrates this (with kind permission of John Wood and Rob Carrick, 'Villiers Singles Improvements Handbook') – note the maximum torque has not changed in magnitude between the diagrams, but its changed position has affected the power delivery markedly.



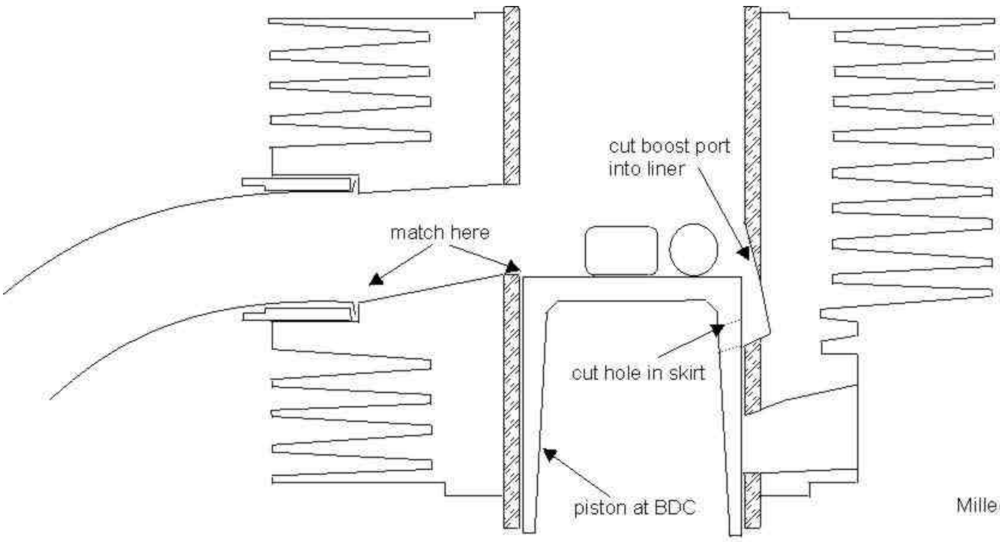


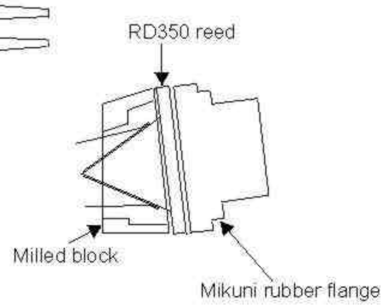
As with most tuning parameters, the relationship between torque and port timing is not simple, and other factors need to be considered as the carburettor, inlet tract, port and crankcase space act as a resonant cavity with the pulses of air movement in the system. It really does warrant some extra reading. All this also affects the jetting requirement – for example I use a 240 main in my reed-valve engine, but some of Tony Holmshaw's piston-port tunes use 200 and some Burwin's use less than 150 - it is an effect in the carburation that causes this, called 'loading-up' or 'triple-carbing' at low speeds .. reed valves don't do it so the fuel delivery requirements are totally different.

The exact shape of the inlet port tract is down to how much work you can put in to it, regarding the above, but as a guide it needs to point downwards for good flow, and the port opening wants to be no less than 90% of the cross-sectional area of the carburettor, but no more than 120%. Theoretically, if an air passage such as the inlet tract is 'necked' slightly at a transition, like the opening at the cylinder wall, the velocity is increased and the turbulence is less detrimental, which can give good flow but at the same time a gradual taper outwards along the length increases the flow capacity (reduces the effect of turbulence at the walls of the passage). Ideally the two should be combined but make sure the passage does not have any sudden changes of shape, nor bulge out unnecessarily as the stream velocity will drop at the wide spots causing fuel ‘drop-out’ (basically it condenses onto the walls, coming out of the mixture) and further turbulence, which is bad for the gas flow. Also, a slightly rough finish to the walls of the inlet tract will improve flow by causing micro-turbulence along them, which actually reduces drag at the boundary – it is a bit like a cushion of already-moving air – so don’t polish them finely, just use emery paper in small circular movements.

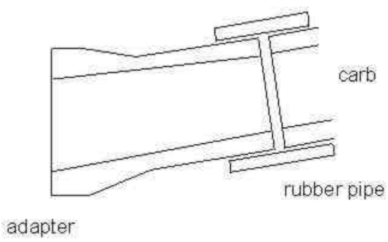
Now you need a means of attaching the carburettor. It needs a short pipe and some sort of flange: some people use the original connector and chop it down, re-angling the carb at the same time because now it won't clear the crankcases (the barrel has been shortened!) or weld a pipe to a flat plate, bolt up and glue this to the barrel and use a hose to attach the carb to the pipe. It needs to be bored out to match the bored-out carb (see later) and carefully matched to the barrel opening.

This is where the reed block goes if you are using one - it needs to be mounted close up to the barrel so as not to leave a large chamber behind the piston, so pick a reed cage that is not too wide or you will end up breaking into the stud drillings when machining out the cavity for it to fit into. Best of luck if you are doing this, it is not easy to get it to fit *and* not leak!

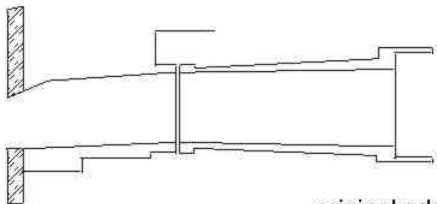




Reed block adapter



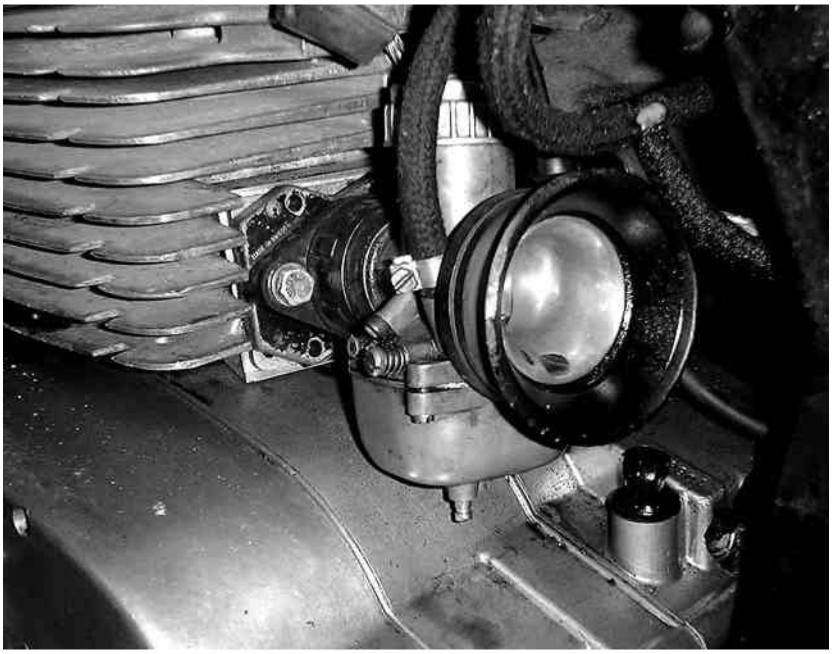
alternative adapter



original adapter

original port shape

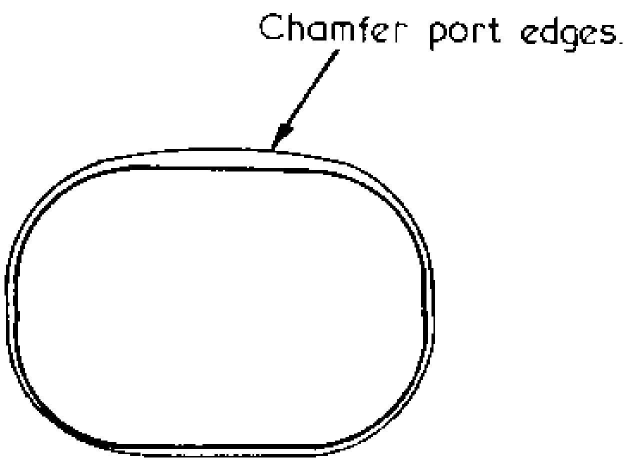
The face of the barrel will need to be 'flattened' at the port opening to take your flange or reed block (unless you are using the original connector). You can either get this milled out in one hit (I have done this and it is pricey but neat), or cut off the fins at the back of the barrel across the opening to give an open space to work in. This can be done by carefully hacksawing down from the base of the barrel parallel to the port flange, but it takes a bit of time and effort. Worthwhile in that it gives a lot of room to work the port. My reed block is bolted to the barrel using M4 socket cap bolts (allen type) threaded into the cut faces of the fins – they are conveniently wider towards the centre and can be tapped into.

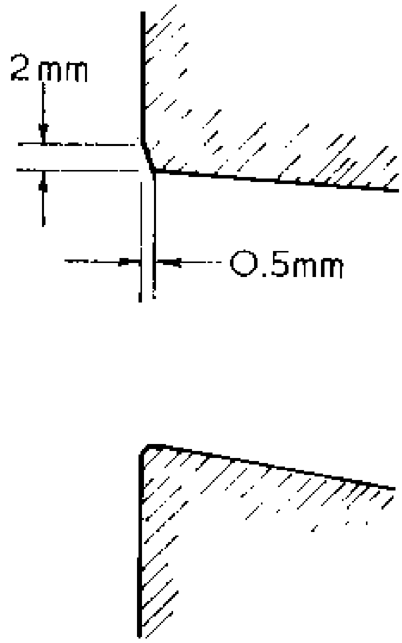


Exhaust Port timing is good at 190 - 195 degrees open duration (32 to 34 mm TDC-to-opening) for these speeds with no mods to main transfers, except some cleaning of the casting burrs, and the addition of a seventh ('boost') port at the back of the piston. This gives extra transfer time-area needed for top speed, and helps piston crown cooling. It has the form of a little trough in the back of the barrel, pointing upwards fairly steep - 15 or 20 degrees from vertical - and a matching hole or slot in the piston below the rings, about 12 - 15mm wide. Make sure it stays a few millimetres clear of the ring ends or there could be trouble. With a reed valve this can connect down to the reed chamber on the cylinder side, and I have done this myself but for the sake of crankcase compression I think it might be better not to.

Exhaust port shape is a matter of preference, depending on which tuning book you have read (if any) but it should look vaguely like the sketch. It helps the smooth flow of gas if the port floor is matched to the BDC position of the piston, or just below it, and will increase ring life if the perimeter is well rounded at the corners to help 'ease' the ring back into its groove as it passes the port.

Finally all the port edges need to be chamfered but the machinist should do this when it is rebored – see diagram.





Compression needs to be raised to about 7:1 from exhaust closing (12.5:1 or so from BDC) with the currently allowed fuel at max 97 octane. This raises the heat of combustion considerably and the exact value is a matter for some experiment - be warned it changes (i) jetting (ii) exhaust pipe tuned length and (iii) required spark plug heat range. NGK number 9 plug is normal with these values but could be in range 8 to 10 (see later).

The head can be skimmed to shape on a lathe or a vertical mill: the squish band should be retained and a recess made to match a spigot turned into the top of the barrel. This spigot and its recess form the compression seal - don't bother with a gasket but make sure the match is good i.e. lap them together with grinding paste. Squish clearance needs to be set either in the head, or by leaving a 'deck clearance' at the top of the cylinder liner when the barrel is machined (see previous diagram). Minimum squish 0.8mm (too small and the piston will clout the head – the conrod stretches at high speed) and a useful setting is 1.0 mm. Leaving it in the barrel can make machining the head a simpler job but I find it easier to change if it is in the head - and the variation between pistons means you might need to reset it after a new piston. It can be increased slightly using different thickness paper base gaskets but don't be tempted to use more than one to make up a size – it won't be a reliable seal and an air leak at the base is a disaster.

Exhaust

Exhaust header and diffuser cone have to be standard. To complete the expansion chamber, forget the calculations. It is near impossible to correct for the small header diameter, which coupled with the small chamber diameter (fixed by regulations), variations in ignition timing and compression ratio all affect the exhaust gas temperature and bugger up the calculations without an accurate measurement. Most of the simple models use engine speed and port duration as a basis and some even have

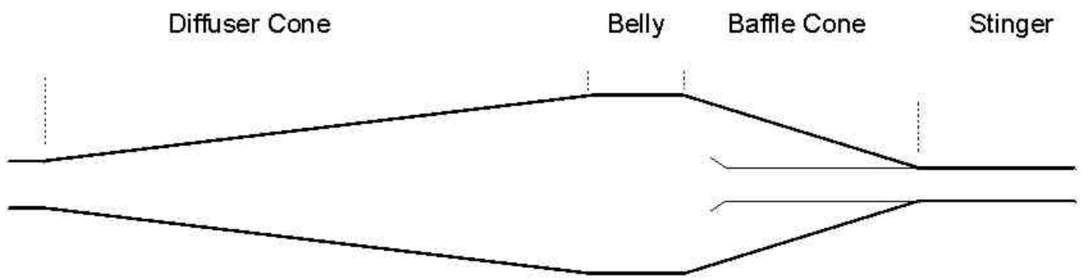
BMEP correction, but these all make assumptions about the speed of sound in the gas which is heavily temperature dependent, and the degree of taper in the header section is critical (where the MZ pipe has zero).

Best to make up a few pipes (or borrow some) and dyno it - for a starting point roughly you need about 2 to 4 inches of belly between the diffuser and baffle cone, with a 12 degree cone. There are as many variations in this as there are bikes - steeper cones, shallower cones, shorter and much longer bellies ... you are heading for about 30 BHP at 8000 rpm with these class rules, but don't aim for an absolute figure, find a pipe that appears to give a good peak then dial in the jetting and timing to match it.

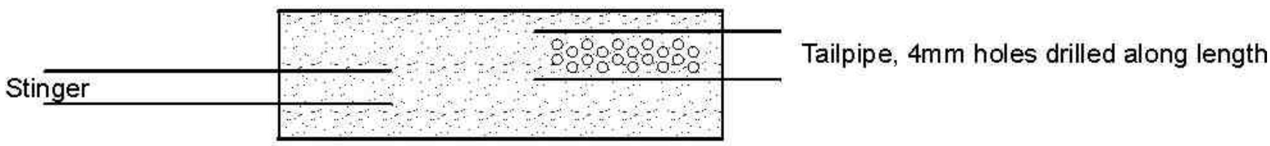
There is some good information in how to form cones in sheet steel in the A. Graham Bell book (see refs) if you are any good at tin-bashing and welding. I have even tried hydro-forming using a Karcher garden pressure washer – good for fancy shapes but not much point with the restrictions we have in this class. The picture below shows my up-swept pipe made in this manner.

Set the stinger (bleed tube from the expansion chamber) to start inside the chamber – up to but no further than the start of the rear cone. This both improves the strength of the return pulse and reduces the emitted sound level, by preserving pressure energy in the chamber (courtesy 'Batwings' Hoyt McKagen). Flare the internal end of the stinger, and you can drill a few 4mm holes down the side too, just to help the flow out of the chamber. Then an end can is put on the outside end of the stinger to bring the noise level within regulation. This can be home made or there are several off-the-shelf cans available.

Expansion Chamber



End Can



Aluminium tube, loosely packed with glassfibre

Ignition

Ignition is best with a PVL Kart magneto - these are supplied anticlockwise for Kart fitment so they need to be mounted with the stator plate reversed in this case, but check when you buy it. The kit comprises a rotor and stator forming the generator, and a coil containing some electronics – it produces a short, high energy spark. Just needs mounting somewhere on the frame (the leads are not very long mind you) with an earth connection to the engine.

I am working on an electronic timing variator for these, as they are fixed as standard, normally set about 17 or 18 degrees BTDC (1.8 to 2.0 mm). Burwins and Holmshaw sell a mounting plate for these to fit them to the cases, or one can be turned from a piece of ally bar, or fabricated from plate cut to shape (tricky this way to get it to sit square and central!) but there is a very small clearance rotor-to-stator and no margin for error.

Carburettor

Carb gets bored out to max (normally 33mm without weakening the carb body). Some of the older castings can be bored to 35mm, some of these show better power on the dyno but not always as usable on the track. You need to drift out the brass spray baffle in the carb throat in order to do the boring - remove the main jet and unscrew the needle jet tube a couple of turns, tap it to start it moving, then unscrew the needle tube a bit more and carry on gently tapping until you run out of thread on the needle tube. Then you need a square ended drift to go in its place, that can be cocked slightly to one side against the bottom of the baffle so you don't damage the thread, and drift it the rest of the way out.

Shape the baffle shoulder to give a smooth air path where it meets the floor of the throat, because now you have machined into it and the shoulder will stick up. Put the baffle stub back carefully, locating it pointing the right way in the splines and drift it back down using a small tube that fits over and pushes on the shoulder.

The fuel passages to the float valve are a bit roughly made and fuel flow can be a problem. The pipe connection needs opening up a little and the cross-drilling inside might need aligning – you have to drill through the end of this passage and then plug it up afterwards, but have a good close look and see if it needs it. The valve orifice itself benefits from enlarging but be careful as the edge of the drilling forms the seat of the valve and the seal needs to be checked afterwards.

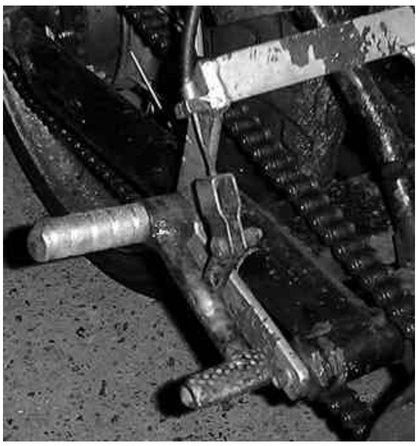
I think there is work to be done on the fuel delivery/airflow curves on these carbs. There is no air-bleed adjustment as they are 'primary choke' type carbs, and this means adjustments have to be made to the height of the spray baffle and the root diameter of the needle jet (top of the jet tube) which is complicated by the lack of different sizes available, so the whole area of adjustment gets overlooked. Some good texts on this are John Robinson, and A Graham Bell (see refs).

Dialling in the jetting ... no two ways about it, this takes time – read the books! The carburation circuits are not ideal in the BVF and are even less suited to Reed Valve modifications. There is no magic formula to determine the engine's metering demads so start with a big jet and work downwards for safety: if you run too lean ie with too small a jet you may not even complete one lap! The only guide I can safely give is that 300 is very big and 100 is very small. These sizes are the metering orifice diameter in hundredths of a mm so 220 is 2.20mm, 195 is 1.95mm etc.

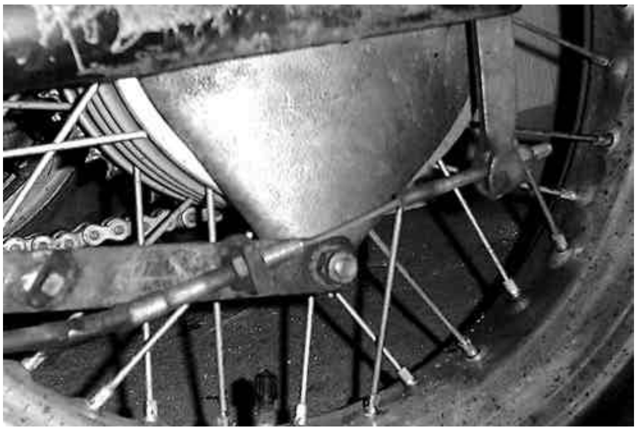
Frame

General aims: chop off anything that doesn't make it go faster or stop quicker - the stand and footrest lugs (saw through the main downtube section about 2 inches below the swingarm pivot – see photo), the battery tray, the pump mounts etc. Chuck out the airbox, sidepanels, oil tank, and mudguards (the front might be useful if you keep the 18 inch wheels, and the little plastic section of the rear is a useful splash guard). Obviously the lights aren't allowed, and the horn is not much use so the entire wiring loom and all the bits & bobs can go. Renew head race bearings (fit the sealed type) and swingarm bushes. Attend to engine mounts (see below).

Footrests



Rearsets need making up or buying - Burwins and LeMoto make a set which can be bought as individual parts, or a complete kit with brackets and cable. Connecting the rear brake appears to be the biggest problem but the TS rear hub has an internal cable attachment which is very tidy. I cheated and bought the Burwins footpegs and made my own mounting bracket (photo, right) the advantage being the cable is available as a spare part from them. Then all I had to do was weld a threaded cable stop on to the torque arm (photo,). The bracket can be made from one-inch square tubing, or something similar, just three pieces welded to form a sort of 'C' section to mount across the rear frame stays. This can be attached with jubilee clips - remember that no welding is allowed to the frame in current regulations (2002). There is a 6mm stud in the main downtube that can be used, where the airbox used to go.



Engine Mounts

Replace rear engine mount inserts and check mount plates for cracks. These are a little bit flimsy and tend to crack, so can be reinforced in a number of ways or stiffened ones can be bought to fit.

Upper (cylinder head) mount needs modification to fit the shortened cylinder arrangement: the original one works fine if one side is attached by a stout strap, and the studs in the head are replaced by solid stand-offs. The position of the engine in the frame (up or down) determined by this mount affects the drivetrain angle so pay attention to it!

Alternative arrangements for the upper mount include using a solid bar attached to the frame stud, and rubber mounts in place of the cylinder head studs. Mine are Peugeot 505 exhaust mounts, which are cheap, quite hard and durable lasting most of a season.

Fork yokes and headstock, Forks, Rear shocks

Summary: shorten rear shocks by unscrewing the top eye and threading down the damper rod, then shorten the spring by the same amount by cutting with an angle grinder (make sure both springs are identical); fit a bottom yoke in place of the top yoke so the forks can be adjusted up and down, as per photo below (drive out the headstock tube and fit it upside down or it will foul on the top bearing housing); rework the fork damper valves as described (resize rebound hole, clean up compression valve housing).

Regarding steering geometry, you have to think carefully about what is going on here. The MZ road settings are a bit spongy and unresponsive but can be sorted out with a little work. Dropping the forks down the yokes (i) reduces rake angle and (ii) reduces trail, both of which increase sensitivity, which is what you want but the reduction in trail happens much faster than the rake change as the forks drop down which reduces stability a lot. You need to find a balance that suits your riding style, body position, weight etc by experiment, adjusting the position in the yokes by 5mm steps or so. A good reference is John Bradley's 'The Racing Motorcycle' which looks in detail about chassis tuning and other aspects of setting up a racing bike.

You will observe many different fork positions relative to yoke on other people's bikes, but this is affected by (i) fork stanchion length if it has been modified and (ii) preload spacers that some people use. Best measurement for comparison is the height to the bottom of the headstock on a bike with exactly the same wheels and rear shocks as yours, but if you measure their rears you can correct the front measurement for differences in this.

Adjusting the rear shock length shifts the ride height, hence centre of gravity but also alters rake & trail, so the front height has to be adjusted by a similar amount to give the same geometry. It also affects the angle of the swingarm, and thus the angle in the drive train between the front and rear sprockets which affects the 'anti-squat' action, ie propensity to wheelie but it is not hugely sensitive to this because the power delivered is not exactly massive. This is a big issue on Motocross bikes. When I shortened my MZ rears by 25mm I noticed the difference at the start line (easier to keep the front down), and some might argue the traction at the front is improved accelerating out of corners but I don't think anyone would admit to noticing a reduction in rear traction, both of which are theoretically happening when you change this drive angle.

Bear in mind that use of preload *only* shifts the ride height, it *does not* stiffen the spring. You need to change the spring itself to change the spring rate. Preload spacers can be used at the front to increase useful travel of the shock - the ride height changes when these are used so the fork position in the yoke needs compensating for them to correct the geometry. Different oil levels in the front changes the spring rate slightly due to the pneumatic action of the air pocket in the fork - a higher oil level will give a stronger spring action (pressure builds up quicker with compression).

I use 250ml per leg with standard length stanchions, no preload spacers, sidecar springs. Works for my body weight. At the rear I have shortened the standard MZ shocks by 25mm and dropped the front from the standard position an additional 15mm to increase sensitivity.

The fork damper design is a bit agricultural, to be polite. It works reasonably well with SAE30 engine oil or EP80 gear oil (both of which are about the same viscosity) but it tends to froth up. It can be improved if the 3mm bleed hole in the damper rod is welded up and redrilled at 2mm – this stiffens the rebound damping to a level that works with 20 to 30 weight fork oil, preferable for its anti-froth properties. If the hole is much smaller, I have found other problems with cavitation and poor oil flow.

The lower valve can stay standard with the above modification – again I have found problems when the throttle plate holes are reduced. But the recess in the fork leg that the valve lives in can be very roughly machined which makes the valve washer stick, so take it apart and smooth out the ridges carefully with emery paper or a die-grinder. A lathe would be the best way, but it only needs tidying, be careful not to make the throttle plate a slack fit in the leg.

Wheels and tyres, Brakes

Summary: Braided steel brake hose, racing pads, high spec fluid, racing tyres, new wheel bearings. Optional 17 inch wheels, giving greater tyre choice inc. slicks & wets, lighter handling & more responsive.

Fitting front wheels: alignment of the forks and headstock must be carried out before the yoke and wheel spindle pinch-bolts are tightened, or mudguard and forkbrace where fitted. It is simple enough, but important to do otherwise the fork action may be slightly stiff: with the bottom yoke pinch bolts tightened, and the top yoke, headstock centre nut, wheel spindle nut and spindle pinch-bolt a little more than finger-tight, bounce the forks up and down a few times to align the sliding parts. Tighten the top yoke pinch-bolts, headstock nut and spindle nut in that order, and bounce it again. Then tighten the wheel spindle pinch bolt. Check that all is sliding freely before tightening the mudguard or forkbrace. If not loosen the spindle and yoke pinchbolts, bounce it a few more times and try again.

Rear sprocket carrier can be modified for interchangeable sprockets, which is useful for fine-tuning the gearing when you are in close competition. The standard 48 tooth rear is useable with 3 different fronts (say 17, 18 and 19 teeth with 18 inch wheels) but the condition needs to be checked carefully, the original ones don't tend to be very round which makes the chain tension a bit of a lottery. One of the best 100-quids I spent was on the split sprocket kit from Tony Holmshaw – see photo, right – so you don't need to remove the rear wheel and carrier to dial-in the gearing. Anything that contributes to a hassle-free race meeting is good in my book.

The recommended 17 inch rim sizes are 2.15 front (WM3) and 3.50 rear. These give the greatest range of tyre fitments, including the '50' profile slicks and wets. Alternately 1.85 front (WM2) and 3.00 rear work with the Dunlop intermediates (KR364) but it is wise to check tyre availability and suitability with a specialist. These low profile types are very sensitive to the rim width.

General preparation

Scrutineering is a bit like an MoT, the bike is checked for compliance with the regulations and for race-worthiness – ie that the bike has been carefully prepared for the meeting. It helps alot if the machine is clean as this is a good sign that attention has been paid to it since the last meeting and will not raise doubt over your commitment to the safety of yourself and others.

Ensure after you have worked on the bike all nuts and bolts etc are secure. Do not over-tighten things as you will strip the threads easily on the engine and wear them quickly elsewhere as on a race bike they are undone and done up so often. Make sure NOTHING is touching the wheels that shouldn't be - ie the exhaust, caliper bolts etc. Especially in a "loaded position".

Chain tension should be checked with weight on the suspension also. ACU regulation for 2002 requires a chainguard at the entry points to sprockets to prevent clothing etc becoming entangled so a rear guard must be fabricated and fitted to the swingarm covering the lower segment of the sprocket.

ACU regulations also require any oil-retaining plugs to be fixed with lockwire to prevent spillage if they work loose. For the MZ this is the two plugs in the gearbox underside and the filler bung (see photo). Breathers have to be routed to a catch-tank of a specified size – technically this includes the hole in the gearbox oil filler bung and carburettor float bowl breather on the MZ.

The throttle control must return to the closed position when released, and an on/off switch must be fitted to the handlebars (not a 'kill' button with momentary action – photo shows my left clipon, which has both!).

Numbers must be displayed in the designated colours, currently white numbers on green backgrounds. One at the front, one either side at the back. Burwins do a nice matching set of clipons and front number bracket, shown in these photos.

Information

Book References

A Graham Bell ‘Performance Tuning: Two Stroke’
John Robinson ‘Motorcycle Engine Tuning: Two Stroke’
Gordon Jennings: ‘Two Stroke Tuners Handbook’
G P Blair: ‘The Basic Design of Two Stroke Engines’
John Bradley: ‘The Racing Motorcycle’
Tony Foale: ‘Motorcycle Handling and Chassis Design – the Art and Science’

Suppliers

Dartford Karting - PVL Kart magneto, it is the 'Small Bore' model.

Tony Holmshaw motorcycles - full tuning range including pipes, reboring, crankshaft rebuilds, port work, new and secondhand MZ parts, advice etc; specialities include modified rear sprocket carrier and split sprockets

Burwins motorcycles - full range of tuning parts and services as above, new and secondhand MZ parts, specialities inc clip-ons, rearsets, engine mounts

LeMoto - special chassis parts inc modified shocks, fork yokes, rearsets, seat units etc

Talon Engineering (Southampton) – alloy wheel rims, fancy stuff
Central Wheels (Birmingham) – all manner of wheel related stuff
Hagon (E London) – wheels, shock treatment.
Maxton – shock experts

Tony Hartlen: vintage and racing motorcycle engine machinist. 01483 202540 near Guildford, Surrey

Alec Jay: wheel builder, vintage restoration. 01403 752774 near Horsham, W. Sussex

Table: Piston displacement

Crank degrees against mm ATDC

Angle	Disp.
0	0.00
1	0.01
2	0.02
3	0.06
4	0.10
5	0.15
6	0.22
7	0.30
8	0.40
9	0.50
10	0.62
11	0.75
12	0.89
13	1.04
14	1.21
15	1.38
16	1.57
17	1.77
18	1.98
19	2.21
20	2.44
21	2.69
22	2.94
23	3.21
24	3.49
25	3.78
26	4.08
27	4.39
28	4.71
29	5.04
30	5.38
31	5.74
32	6.10
33	6.47
34	6.85
35	7.23
36	7.63
37	8.04
38	8.45
39	8.88
40	9.31
41	9.75
42	10.20
43	10.65
44	11.12
45	11.59
46	12.06
47	12.55
48	13.04
49	13.54
50	14.04
51	14.55
52	15.06
53	15.59
54	16.11
55	16.64
56	17.18
57	17.72
58	18.26
59	18.81
60	19.37
61	19.92
62	20.48
63	21.05
64	21.61
65	22.18
66	22.75
67	23.33
68	23.90
69	24.48
70	25.06
71	25.64
72	26.22
73	26.81
74	27.39
75	27.98
76	28.56
77	29.15
78	29.73
79	30.32
80	30.90
81	31.48
82	32.07
83	32.65
84	33.23
85	33.81
86	34.38
87	34.96
88	35.53
89	36.10
90	36.67
91	37.24
92	37.80
93	38.36
94	38.92
95	39.47
96	40.02
97	40.57
98	41.11
99	41.65
100	42.19
101	42.72
102	43.25
103	43.77
104	44.29
105	44.80
106	45.31
107	45.81
108	46.31
109	46.80
110	47.29
111	47.77
112	48.25
113	48.72
114	49.19
115	49.65
116	50.11
117	50.55
118	51.00
119	51.43
120	51.87
121	52.29
122	52.71
123	53.12
124	53.53
125	53.92
126	54.32
127	54.70
128	55.08
129	55.46
130	55.82
131	56.18
132	56.53
133	56.88
134	57.22
135	57.55
136	57.87
137	58.19
138	58.50
139	58.81
140	59.10
141	59.39
142	59.68
143	59.95
144	60.22
145	60.48
146	60.73
147	60.98
148	61.22
149	61.45
150	61.68
151	61.89
152	62.10
153	62.31
154	62.50
155	62.69
156	62.87
157	63.04
158	63.21
159	63.37
160	63.52
161	63.67
162	63.80
163	63.93
164	64.05
165	64.17
166	64.27
167	64.37
168	64.47
169	64.55
170	64.63
171	64.70
172	64.76
173	64.82
174	64.87
175	64.91
176	64.94
177	64.97
178	64.99
179	65.00
180	65.00

An interesting discussion on tyres and handling

A mailing-list posting (one of Michael Moore's – see above):

Subject: MC-Chassis Re: Black rings

Dave w asked:

<<
a comparison to other cruisers whose equal front & rear sizes made them "theoretically" unable to steer "on lean angle alone."

Is there anything to this, or is this a case of a motojournalist knowing what he likes in a bike's handling but not why it handles like that...
>>

The actual statement is far too general. There are all sorts of parameters that determine both steering and tyre size effects on handling.

Cornering force on an upright tyre (as one tries for in a car) comes from slip angle, i.e. we have to steer a little more than the path of a curve to generate a force that pushes the vehicle towards the turn centre. So the cornering force can be directly controlled by the driver, depending soley on his steering input.

Bike steering is somewhat more complex. A tyre that is cambered in relation to the road surface creates a cornering force due to what's known as "camber-thrust" the mechanism for this is akin to a rolling cone which tends to steer about it's apex. The cambered tyre is just like a slice of a cone.

Now, obviously the cornering force so generated depends on lean angle and tyre characteristics / sizes etc. At any given road speed this camber thrust may be either
too little, too much or just right to provide the cornering force that the rider wants. If it's just right then the rider need apply no steering angle to the handlebars in order to corner as he wishes. However, if the camber thrust is not exactly correct then he must apply either some negative or positive steering angle to detract from or add to the cornering force. This corrective steering angle generates this corrective force by slip angle as with a car.

It is because much of the cornering force comes from camber thrust that actual steering angles on a bike are much less than with a car.

Some bikes need little effort to go where we wish yet others seem to need "holding down" to stay on line whereas some need "lifting up", this "feel" is a direct result of how much and in which direction we need to apply corrective slip angles to adjust for the difference between the camber thrust generated and the cornering force required.

Just as with a car, we do not steer by the front wheels alone. Conventional (non-RWS) cars must generate cornering force from the rear tyres also, thus the rear must also have a slip angle, this is achieved by the car body adopting a yaw attitude inward of the desired cornering path.

Likewise on a bike, if the camber thrust from the rear tyre doesn't balance the required cornering force at the rear then the bike must adopt a yaw attitude to correct the imbalance by adding or subtracting cornering force by means of slip angle.

So to claim that equal size tyres are incapable of "steering by lean angle alone" is quite obviously a gross over-simplification at best. There are so many factors involved and NO BIKE steers by lean angle alone under ALL cornering conditions. A wet road will affect camber thrust around the same corner at a given speed, and so any corrective steering torque will also depend on road conditions. This is just one reason, amongst others, that gives a different "feel" to the bike when it's raining.

Tony Foale.

Acknowledgements

Tony Holmshaw: 'what a nice man – and so reasonably priced'

Martin Baldwin & Mike Wright (Burwin Motorcycles) and of course Anne Baldwin

John Wood for the loan of pictures from his book 'Villiers Singles Improvements Handbook', also some bright ideas in the making of my bikes and this booklet and an interesting website http://www.lortim.demon.co.uk

Michael Moore (Eurospares, San Francisco) fantastically interesting archive and contacts website http://www.eurospares.com

Some other interesting sites from interesting people:
http://www.22000rpm.com
http://home.mira.net/~iwd
http://www.freeyellow.com/members/batwings/best.html
http://www.ctv.es/USERS/softtech/motos/

Someone in Spain on rec.motorcycles.racing once helpfully pointed out that the MZ250 is locally known as 'La Maceta' which means Flower Pot. That makes us the Flower Pot Men?