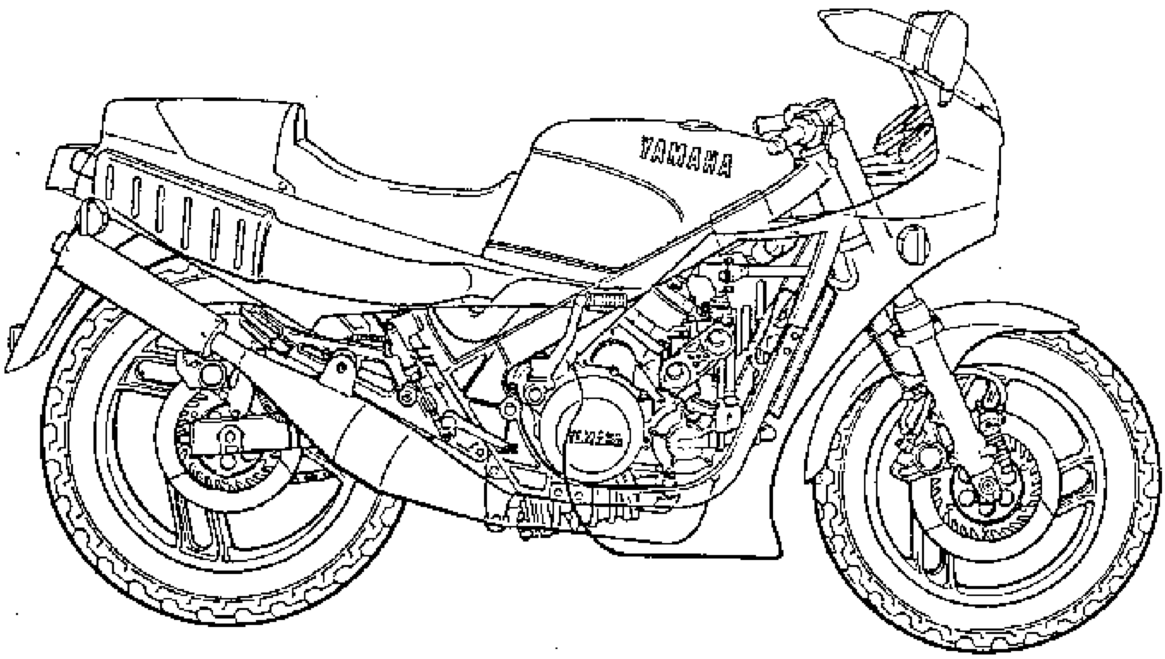
Tuning for

YAMAHA RD/RZ 500 LC

(All Models from 1984 to present)



A Guide for beginners and advanced

from

Martin Kieltsch

(mechanical engineer)

Release 1.3

Wolfenbüttel/Germany, January 2007

Foreword

Since May '87 I have owned an RD 350 YPVS (German Model-Code: 31K) and up to now I've driven about 197.000 km with this wonderful bike. As I used it the way it was designed to be used, almost every single part was exchanged or rebuilt at least once (Remember: RD means **R**ace **D**eveloped).

In December 1991 I started to publish my first tuning-manual for this bike which proved to meet exactly the demands of German RD riders. This first version just contained the adaptation of different books where I added the concrete statements for the RD (which I tried on my own!).
After getting myself an RD500 in April 1995 the matching book followed soon. In contrast to my first book, I had to mix up my own thoughts and experience with the knowledge of some other guys at the beginning: Thanks to Thomas Fried, Michael Bähr and Matthias Nagel there were much more info and photos included.
In the meantime I got an engineering degree, which helped people trust my methods a little bit more. I don't claim to know everything, all that's written is not a must but a can. If you know better, do it your way, but let me know.

At this point I want to apologise in advance for my rather bad English. I’m not a native speaker, it will sometimes sound a little funny to you and I've often chosen the wrong words. Thanks to Stephen Jago (UK) and Wyn Belorusky (USA) who corrected special bike related vocabulary it should be clear what’s meant. Due to Jill Becker (UK) being in charge of the grammar it should be “very British”.
Despite the fact that modern Software offers fairly good proofing assistance, you will certainly find many, many mistakes. Please don't mind the ttyping errohrs, I'm schure all of you Couldd heve done it better!!!

Because I want to improve engine performance and reliability I'd like to point out that you should keep your bike in a fairly good condition. Keep an extra eye on carburettor setting, oil-pump setting and the cooling system. Pistons, cylinders and cranks shouldn't be too old or badly worn.
If you think you don't need to follow this you will find the weakest point of your engine very quickly.

You can imagine that I must dismiss any liability for any damage which might occur as a result of methods or modifications suggested in this book. I must stress that most of the stuff described subsequently is only legal for race use on a closed circuit. If things are described to be legal for road use, I can only promise that for Germany.

Contents

Introduction

Objectives of work

Most of the subsequent modifications do not result in an astonishing rise of engine performance.
My personal objectives were:

- To reach at least 100% of the promised stock engine performance (65 KW / 88 HP).
- To gain 10 - 15% performance without much increased engine rpm or noise.
- To minimise costs by mostly using stock parts.
- Not to lose too much reliability.
- To be convenient for everyday riding (that means no gas/oil mixing, no changes in jetting when weather changes, ...).
- To show methods which can be used by total "greenhorns".

Due to frequent requests I have included modifications for high performance and high revs which decrease significantly the reliability of your engine. (For example the RD500 race specs from the Internet which were also published in the RZ500 Owners Club News Letter). **If you don't have the required expertise just leave these out**.

At the end of the modifications chapter I have listed my suggestions for different tuning stages which you can use as an orientation (If you're unsure what to do).
I also included useful comments about different aftermarket stuff and addresses where you can get it.

Tools and other useful stuff

For tuning and maintenance you will need such common tools as:

- Drilling machine with flexible shaft
- High speed mini-drill (Dremel, Proxxon)
- Grinders (parabolic or conic, tungsten-carbide or HSS)
- Files Flat (3 x 15)
  Square (ca. 10 x 10)
  Round (∅ ca. 8)
  rather coarse, not too fine (must be suitable for Aluminum)

- A set of small files
- Impact driver
- Several wrenches from 6 to 32 mm size
- Set of hexagon socket-screw wrenches ("Allen key")
- Torque wrench 0 ... 100 Nm

For engine assembly and disassembly (consider having this done at your local dealer):

- Rotor mounting tool
- Clutch holding tool

Other helpful stuff:

- Small mirror (appx. 150 x 150)
- Silicone based sealing compound (Dirko / Dirko HT from Elring)
- Alcohol, Aceton or brake cleaner for degreasing
- Sandpaper 60 ... 1000
- Fine steel wool

If you are about to do some heavy porting work, I'd advise using some conic or parabolic tungsten carbide grinders (don't use the cheap HSS, they wear quickly when grinding cast iron). You can do it with a file, too , but it will take much more time.

For the exact finishing and deburring of the port shapes at the sleeve you have to use the file set.

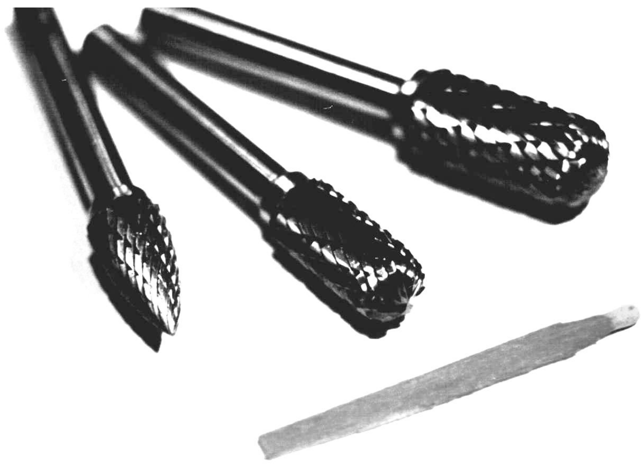


Figure 1: Several grinders

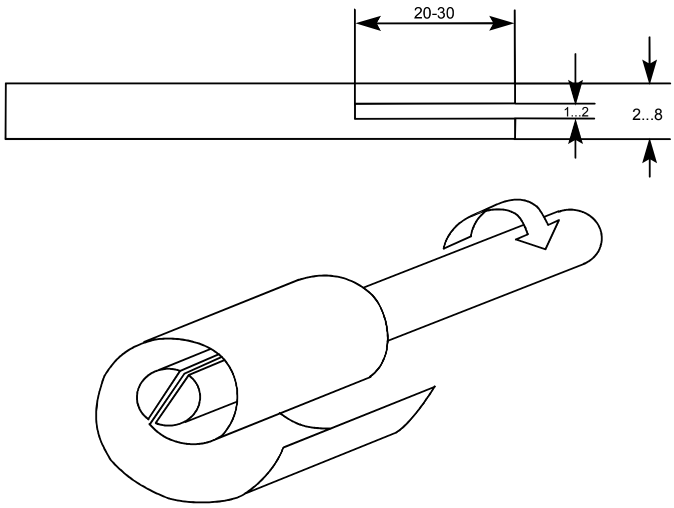


Figure 2: Polishing shaft

For polishing I've used a self made shaft in a high speed mini drill. You just have to make a 20 mm slot at one end and roll up some sandpaper with the grinding surface on the outside. With this tool polishing is really fun; begin with #60 to #100 and then increase in steps to #1000 (from #600 on you should polish with some water).

For shaping the intake and transfer ports it’s enough to use #200 sandpaper without polishing.

I use to mount almost everything that needs a gasket with the silicone based sealing compound Dirko (which got myself the nickname Mr. Dirko):

- Clutch cover
- Lower cylinder gasket
- Power-Valve-bushes
- Hoses for cooling liquid
- Intake manifold
- Everything which comes in contact with oil/water and doesn’t get too hot

Dirko HT is more resistant against heat and I use it only for the head gasket. First degrease the surfaces very carefully and put a thin film of Dirko HT on the head and cylinder mating surfaces. After inserting the gasket tighten the head screws in 2 or 3 steps to 22 - 25 Nm. Make sure that you use the copper washers and capnuts for the middle row of the head bolts. If you forget them, it will result in leakage of coolant because it has contact with the coolant liquid inside the head!
If you have used brand new head gaskets, retorque the heads the next day after having warmed up and cooled down the engine. Repeat the procedure after a few hundred kilometres.
Meanwhile I use head gaskets more than once because they are quite expensive (50,- DM) and Dirko HT enables you to use them 2 or 3 times.

In my RD350 I haven’t had very good experience with gaskets from top end or engine sets. Especially the Vesrah ones (silver coloured head gaskets) were of very poor quality. They don’t even seal a stock engine, never mind a tuned one. So if you’re offered a silver one, take another or change your dealer
The Prox gaskets seem to be a good choice in stock engines. I only heard of failures in highly tuned RD350 engines.

Typical Bugs

An RD 500 is not a touring bike. Anyone who only wants to ride and have fun should get himself an FZR or some other four stroke scrap, anyway these are even faster than the RD's ... .
This chapter gives you an overview of things you should check more often than you used to do. If you want to perform tuning specs, you should avoid the most common bugs which yield in a reliable engine even if you keep it in stock state.

Plugs

What is the thing an RD rider has to know best to become happy with the bike? Filling up fuel or oil? Sliding one knee on the ground? No, missed it! If you drive by an RD500 with the fuel tank up – don't worry , he's just changing plugs. The resistor type spark plugs foul quite often when the mixture is too rich. The resistor is built in as a radio interference suppression.
Solution: Get new ones in a tenfold pack (no joke, you really need them), replace all plugs at once and throw away the old ones to avoid screwing them in accidentally some other time (about 20,- to 25,- DM)
If you are too stingy for that replace at least the front or the rear bank at once.

If you are really stingy you can sandblast the old ones or lay them in alcohol or acetone for a few weeks. I was told this would make them work again; just cleaning them up is definitely not enough.

You can influence the plug consumption if you use the NGK BR8HS for everyday riding. They have a lower heat rating which indicates the ability of the plug to drain the combustion heat out of the cylinder head. As a consequence they get hotter during engine operation and clean themselves up.
The main disadvantage is that if you run the engine with **constant high** load, the BR8 plugs **could** get too hot and **could** melt the pistons ("could" means not that they will do so). The opposite is right for the plugs with higher heat rating. They foul very often when riding with low speed, but they can bear even racing temperatures.

You can also use all plugs without the R (Resistor type) option. This will reduce significantly the number of fouled plugs and the costs per plug, but according to YAMAHA Germany it may influence the power valve system by electromagnetic radiation. I never heard of that neither did I experience this problem in any of my power valve equipped bikes .... .

There are special plugs available by NGK which have different electrode forms and/or materials (BR ..HV/HGV/HP). As these are quite expensive (12,- DM for BR..HG to 25,- DM for BR..HV/HGV/HP) I don't really recommend them.
At specialised race shops as UCB (see appendix) you can even get finer steps of heat ratings such as 8.5, 9.5 and 10.5 (about 25,- DM). They can help you in special setup problems, for example if your plug reading is too rich with a BR10 but too lean with a BR9 plug. The main disadvantage is that these are only available with M14x19mm thread, so you have to use 6.3 mm spacers to get a thread of M14x12.7

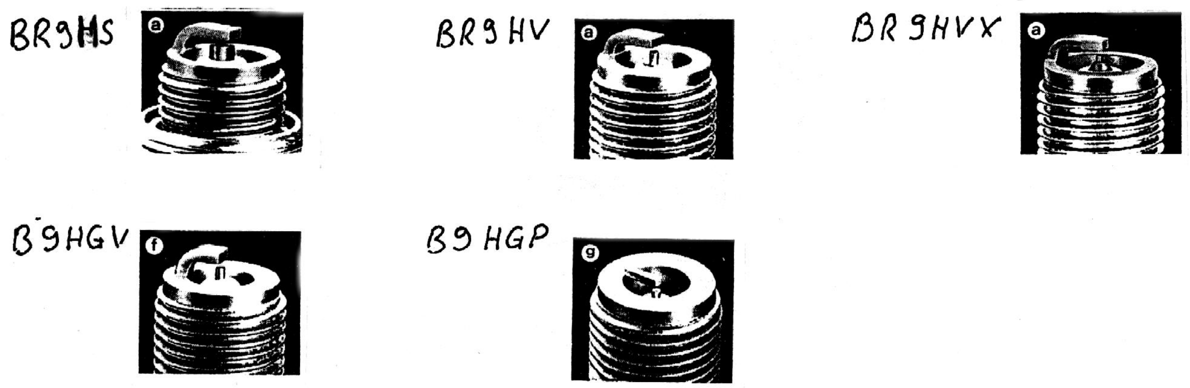


Figure 3: Different spark plugs

Here are my favourite plugs and recommendations:

NGK BR8HS	**Riding around town, normal riding, riding in Winter**
NGK B8HS	See BR8HS, no radio interference suppression
NGK BR9HS	**Fast road use, race use for stock/mildly ported engines**
NGK B9HS	See BR9HS, no radio interference suppression
NGK BR10HS/B10HS B10HV	Very high compression, race pipes, heavy porting, not recommended for "normal" engines

Table 1 : Plug recommendations

In the YAMAHA race specs they recommended the NGK B10H, B10HV or the Nippon Denso W31FSG (Authors comment: see Table 1)

Engine

All German RD500 47X/1GE were delivered with 65KW / 88 HP. As far as I know the Japanese RZV had around 67 HP due to restrictions in Japan.
With 172 HP per litre displacement the engine naturally has some twostroke typical bugs.

With increasing mileage you should watch the connecting rod bearings. If you have dismounted the cylinders, you can measure the tolerances. The side clearance of the lower bearing should be 0.25 – 0.75 mm (0.01 – 0.03 inch) (**Beware: In older YAMAHA workshop manuals there was a wrong value of 0.1 mm**). If this is exceeded, either the bearing washers are worn or the interference fit of the crank gets loose. Anyway you will have to rebuild the crank if this occurs.
The small end free play should be 0.4 – 0.6 mm (0.015 – 0.025 inch). If this is exceeded YAMAHA claims a maximum tolerable limit of 2 mm.
To measure the runout limit support the crank at the middle bearings and then measure the two outer bearings. The max. acceptable limit is 0.03 mm.

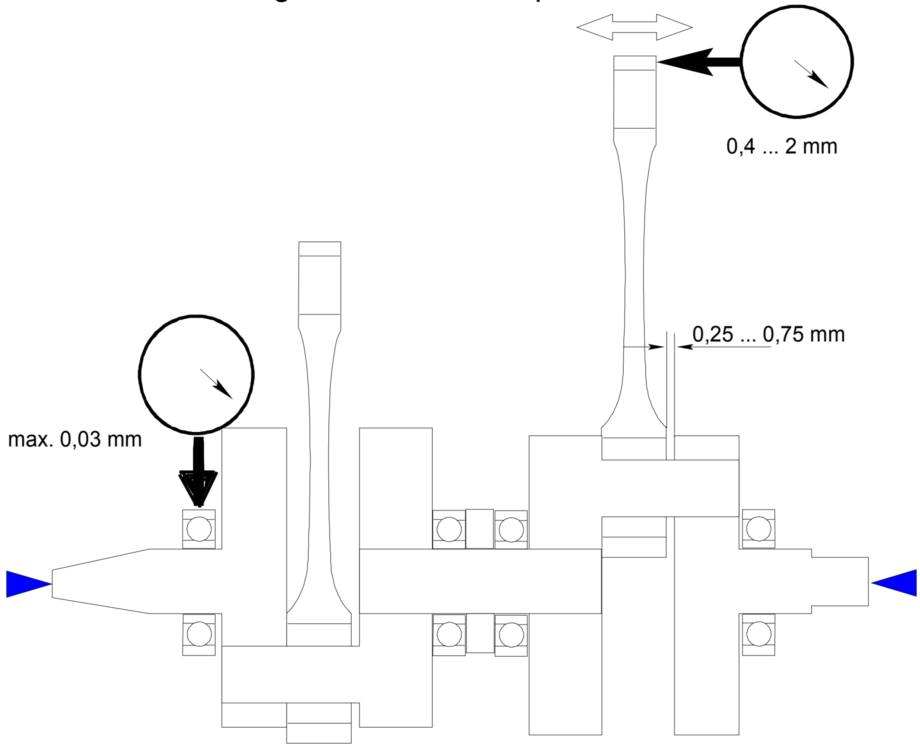


Figure 4: Crank tolerances

The rear cylinder bank suffers more often from seizures or crank damage than the front one. One reason is the thermally unfavourable position of the rear bank and that the compression is slightly higher than at the front. Due to the gear coupling of the cranks the rear one is up to four degrees behind the front one. As the CDI is controlled by the position of the front crank this means the rear cylinders run up to four degrees higher ignition advance!
In addition the carbs are not all at the same height and the higher ones supply the rear bank. So the fuel level is always lower than front, especially when fuel supply is disturbed (running out of fuel before switching to RES).
Some riders report that the diaphragm inside gas petcock was oscillating under high engine revs due to pressure pulses in the vacuum line. As a result the fuel flow was very low which resulted in seizures and other damage. You can avoid this if you always ride on PRI because in this position the diaphragm is released mechanically

and not by vacuum. Others fitted two standard gas petcocks from other bikes to avoid this.

In most cases it hurts the rear left cylinder and then you can read it in the classifieds. I'm always amused when I read that people were looking for a left rear cylinder, because both rear cylinders are identical except the Power Valves. (If you are looking for the Valves you can change front, right and rear, left.)
Principally the same operation is possible for the front bank, too.

As in all YAMAHAS of the 80's the YPVS bushes have the same inferior design to fix the bearing bush to the cylinder with a half moon shaped retaining tag. Around mileage's of 20.000 km they work loose and then oil leaks out. Usually it is caused by either a broken tag or a loose fixing screw.
At the outer bushes the fixing eyelet often breaks as it's too weak. The result is the same as above. You can either weld it or use a big washer to fix the bush again.

Naturally the Power Valve System suffers from carbon built up in the exhaust port. If they get too thick the servomotor can hardly rotate the Valves which you can hear. When they are stuck completely the control unit tries to pull it in the right position with an discontinuous ssst ssst ssst. In this case you have to take the cylinders off and perform a cleaning job.

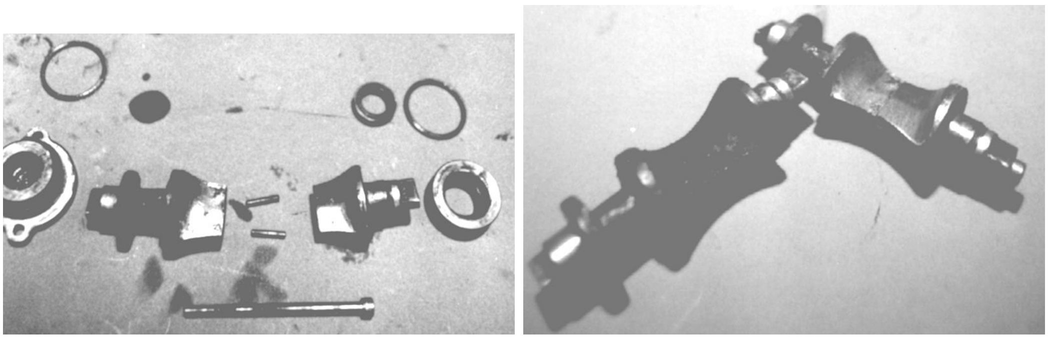


Figure 5: YPVS Valves (unmounted, with and without carbon coating)

YAMAHA recommends inserting the bushes into the cylinders with an O-Ring and MoS_2 grease.
I prefer to "glue" them in with a silicone based sealing compound (Dirko from Elring).
First clean and ungrease the cylinders and the bushings. Then grease only the bearing surfaces.

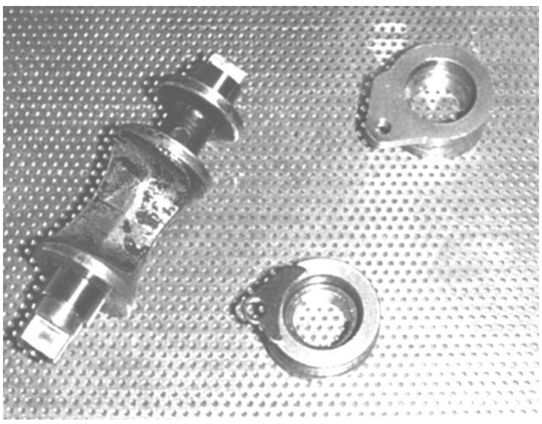


Figure 6: Emil Schwarz Power Valve bush

The outer surface is treated with Dirko and then you can push the bushing into the cylinder. To complete the operation use Loctite for the screw of the quarter moon shaped holding plate (M5x12), because this is the first step for the O-Ring to lose its function. If you lose this screw the bushing will move, wear the bore and then oil and ugly sounds will get free.
From Emil Schwarz you can get special bearings either with an integrated holding plate (about 150,- DM) or he converts them to roller bearings (about 300,- DM). These won't come loose ever (I used them for more than 100.000 km in the 350 and thanks to Dirko I never had problems).

As a preservative modification you should remove the fairing brackets at the lower cylinder head. If you crash the bike they can tear some material from the head and this could turn the head into scrap!

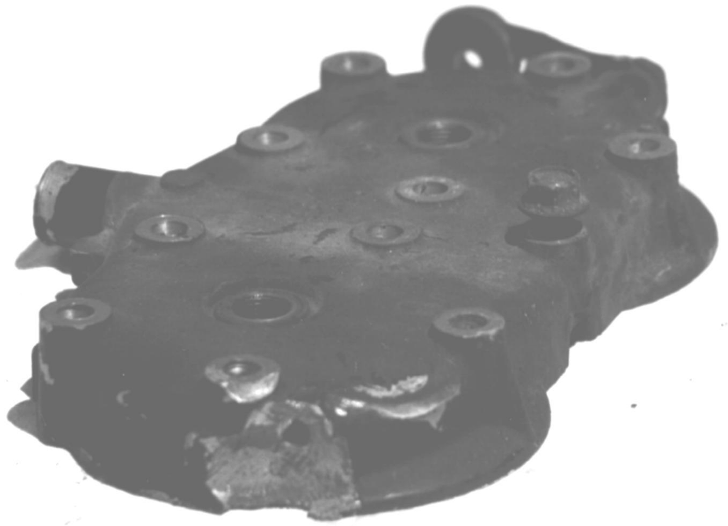


Figure 7: Damaged lower cylinder head

In stock bikes you can set the oil pump somewhat leaner. In the RD500 Club Newsletter they recommended setting the actuation lever 1.6 mm (1/16 inch) leaner (Marking 1 and 2). In this state I had an oil consumption of about 1 l per 1000 km.

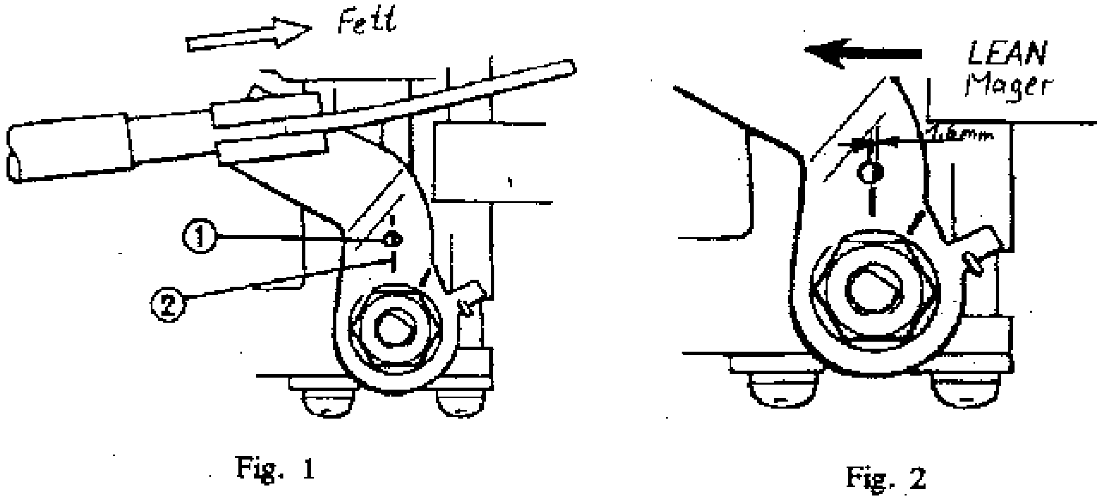


Figure 8: Oil pump setting (Courtesy RZ/RD 500 Owners Club Newsletter)

Some people experienced an oil consumption up to 4 l per 1000 km after longer periods of store. In my opinion the hydrostatic oil pressure has some negative effect on the spring loaded ball valves inside the pump and they stuck open after re-activating the bike. If you don't use the bike for a longer time you should drain the oil tank to prevent this effect. Just use the hose at the lower oil tank and attach it after draining the whole tank. But don't forget the sticker "Caution – No Oil !" on the tachometer, I always tend to forget these things after a while .... .

Generally the gearbox is more healthy then the Gamma gearbox which often suffers severe damages due to the lack of an oil pump. But there are one or two things you can do:
Armin Collet changes the drive gear for the balancing shaft from the front to the rear crankshaft. First remove the clutch cover and the primary gear assemblies.
Then put the front gear on the rear crank. Instead of matching the markings on the gears you have to turn the crank 14 teeth in clockwise direction (Match the 14'th tooth with the marking on the balancing shaft gear). When putting on the clutch you normally have to align the markings on the primary gears with the housing markings. In this case you have to turn the rear crank one tooth in counter-clockwise direction.
But: Don't forget to mount the water pump drive onto the front crank and **do not mistake the front and rear primary gears**. Otherwise you'll have a very unhealthy 6° higher ignition advance at the rear crank!

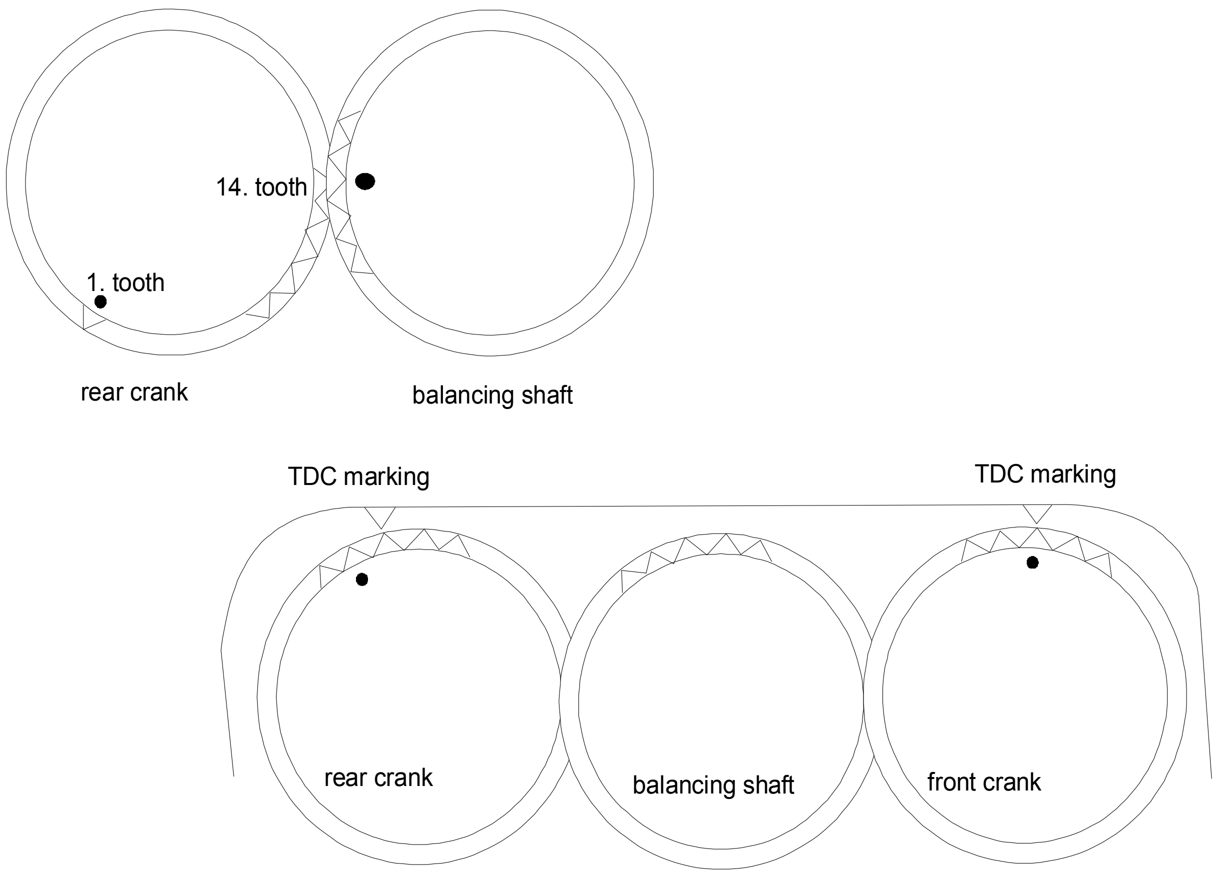


Figure 9: Modification of balancing shaft drive

If you want to reduce friction you can remove the thin friction gears in front of the primary gears (These remove any clearance between crank and clutch gear). **But beware: This is not a road modification**, because when changing the throttle slightly from drive to brake (and vice versa) your bike will make you know how cowboys feel in a rodeo!
This only works properly when you operate the throttle in the digital on/off racing mode!
For racing you can also get rid of 1.2 kg when you remove the balancing shaft and get your cranks rebuilt and balanced separately. If you do so, you can close the hole with the balancing shaft cap on the left side (Part No: 90338-42165).

If you want to save weight on an RZV500 you can also change the left side of the upper crank. The European RD's 47X and 1GE don't have the additional "flywheel mass" to smooth engine behaviour, so you can cut it off or get yourself an European crank end (Part No: 47X-11412-00, Crank 1). The Part No. of the fitting cap to close the hole is 90338-47102.

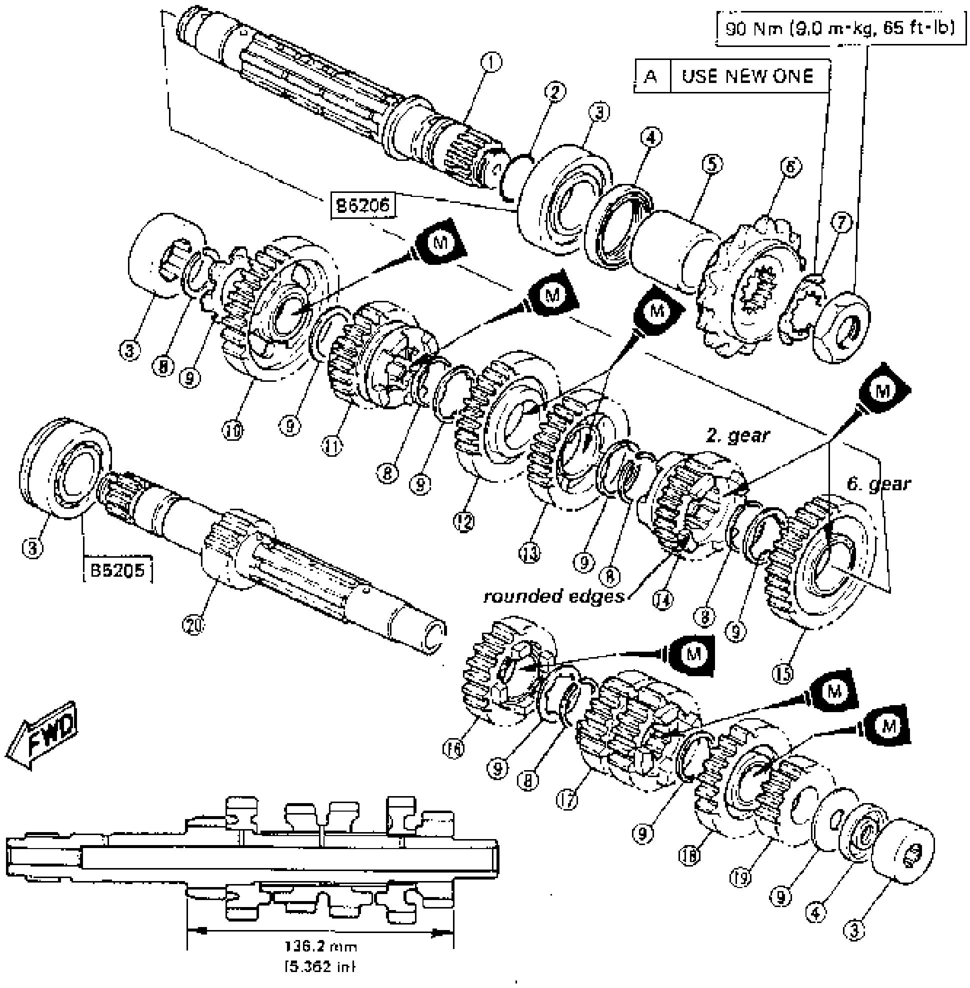


Figure 10: Gearbox (47X)

On bikes with higher mileage the second gear sometimes jumps out. If this happens too often and the cause is not a worn shift lever (unprecise shifting due to the long shift actuation travel) you should consider changing some transmission gears.
Sometimes the 6’th gear dogs which pick the second gear can have rounded edges at the contact surfaces. In this case the connection is not that stable and can slip off.
If the gear selector fork is somewhat coloured or worn you should replace it, too.
The Part No.’s are:

# 2. gear	(No.14, 23 T)	47X-17221-00	approx. 90,- DM
# 6. gear	(No.15, 32 T)	47X-17261-00	approx. 125,- DM
Gear selector fork 1		47X-18511-00	approx. 45,- DM

Carbs

The stock RD Carbs have no idle mixture screw which has the advantage that the mixture is always constant. Why the YAMAHA engineers chose to connect them to a two carb assembly is also not quite clear. The midrange/top end jetting of the first 1984 series (German 47X) was quite rich (nozzles O-0, idle air jet #1.1, main jet #195) which was responsible for most of the fouled plugs on these bikes.
In the later models from 1985 (1GE) they made it much leaner by using leaner nozzles N-8, bigger idle air jets #1.4 and smaller main jets #165).

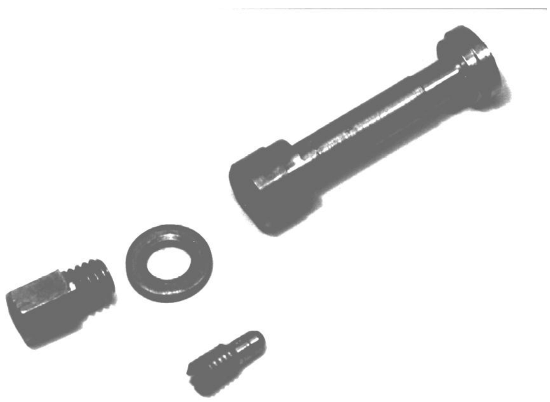


Figure 11: Nozzle, main jet, idle jet

Because of this reason you have to be very careful in the 1GE models when you change the carb setup!
A typical situation would be to run out of fuel at high speed. Due to the lower fuel level in the carbs the engine runs leaner in this moment; maybe too lean!
The next way to kill an engine is to give it more air than normal with leaks in the air filter housing or at the manifolds. Take care that the upper cover is tightened well and that it fits in the air filter housing. The next place to look is the sealing surface where the air filter assy attaches to the carbs. At this location there are two big O-rings which seal the clean air. I use to add some Dirko in this region to maintain proper sealing. There are rumours that the first series suffered from leaky intake manifolds due to hard rubber getting cracks. The later models should have the proper rubber compound which stays elastic. Anyway it’s worth checking the manifolds if you have the carbs off.

One thing that concerns almost all RD’s is leaking fuel from the carb overflows. This happens more or less often preferentially on the lower left carb. Due to the vacuum gas petcock the carb begins to leak as soon as the engine is running. In most cases the effect vanishes without any repair after a while otherwise you have to disassemble the carbs and check the needle valves.
If you are very rich, you can order them from YAMAHA (Needle Valve Assy, Part No.: 29K-14190-28) for 60,- DM per carb. If you want to save money get yourselves some used ones from old RD/RZ350YPVS carbs. They fit and from ’85 the part number is identical.
In Germany you can order carb repair kits for about 25,- DM per carb from the company DiFi in Hamburg. You can use the LC or the YPVS kits, but the old LC had steel cones whereas the YPVS has rubber cones which sealed better.

If you don’t mind the leaking carbs your lower fairing will do soon. The ABS plastic suffers from lengthy fuel contact. It will absorb the fuel, the paint becomes loose and after a while the plastic cracks easily.
To prevent this I’ve made longer draining hoses for the carb overflows to get the fuel directly somewhere under the bike.

Chassis

As the majority of you will know the Japanese RZV had an aluminum frame. As they are quite rare in Germany I heard prices in the range of 1.500,- to 6.500,- DM. A pretty expensive way to save 4,5 kg, especially if you consider that aluminum frames of that time were not as stiff as steel constructions. I’d guess they won’t do a good job to high speed weaves for example.
It makes more sense to change some small things.

The stock bicycle tires (120/130) with the Slip-stone or Scrap-ohama profiles have to be changed to better ones. On the stock wheels I prefer METZELER in the 120/80 and 150/70 dimensions. With other wheels you can use up to 180, but more of that later.

The stock shock was very good for that time as it has adjustable spring preload and rebound damping. As far as I know the RZV’s (51X) had a softer spring.

One thing you should change is the anti dive. For my taste the action point of the front brakes is beyond any acceptable limit, even if you use steel braided brake lines. This is caused by the anti dive actuation piston, which has to travel a few millimetres when applying pressure (travel = flow of brake fluid = brake lever travel = bullshit) . You just have to get rid of the anti dive connection brake line and close the thread

with an M10x1.25 mm screw. Within this operation you can also change to steel braided brake lines if you haven't used them yet. In addition you can also remove the thin sheet metals between the brake pads and the piston. They have the job to prevent slant pad wear but unfortunately they have a negative effect on the action point, too.
After this the front fork will be much too soft especially when braking (You can believe this, I tried it out!). The simple solution is to use more oil to make the air chamber above the oil level somewhat smaller. This gives you some more progression at the end of the spring travel.
Some time before getting rid of the anti dive I had fitted White Power (Technoflex is almost the same) front fork springs with an air chamber of 170 mm at full spring travel (Oil: White Power 15). After some testing I now use an air chamber of 130 mm which means an additional 28 cm³ of oil per side. The 28 cm³ are the cylinder volume of the 30 mm inner diameter of the fork and the 40 mm difference in the air chamber.

Many plastic parts of the bodywork suffer from the heat of the pipes. To protect the plastics from the radiation heat attach aluminum tape at all inner sides of the seat and lower fairing in order to reflect it.
I did the same procedure with the inner fuel tank surfaces and fuel hoses.
Some race shops offer heat resistant mats and/or strips. I used these to wrap the upper pipes in order to reduce the surface temperature.

Unlike the RD350 the front fender is fixed at the fork and not at the fork bridge. When braking it can come in contact with the bridge, make some noises and some time it breaks at this location. You can prevent it by using a soft layer (rubber or foam) between the fender and the bridge.

Electric circuit

As in the 350 the rear lights don't last very long. This is a result of the filaments horizontal position in the bulb. If you modify the holder with the help of some pliers you can achieve a vertical position, which improves the bulb reliability.
If you crashed your bike you can also use the FZR600/FZ70 rear lights as they are identical. A friend of mine used the FZR1000 lights where the bulbs also last longer.

The servo motor couldn't have been positioned more godawful. If you were grilled all the time and you had bear all the dirty splash water you would go on strike, too.
So don't blame the servo if it does. I did it a favour and made some extra protection from heat resistant material.

If you're looking for a new one you can also take the TZR250 servo as it is all the same (the parallel twin model 2MA/1KT). It's also possible to exchange the motor inside as it is a common used type.

If the Power Valve doesn't work at all (no sst sst when switching on the ignition) it could be some other things:

- First check: Power Valve fuse ok? (It melts sometimes without defect in the system)
- Second check: With the ignition on, check for +12 V at the brown cable at the Power Valve control unit connector (unplug the connector and measure). If there's no voltage, it maybe a problem with the harness (brown = 12 V plus when ignition is on) or a loose contact in the connectors (control unit and/or servo motor).

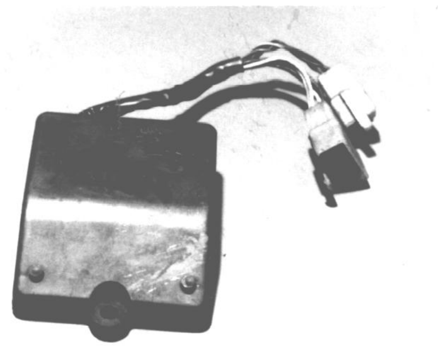


Figure 12: YPVS control unit RD350 (31K)

If all was ok and it still won't work it should be a damaged control unit. But don't spend too much time on searching only for RD500 units, the RD350YPVS (same colours as RD500) and TZR250 (1KT) Power Valve controls also fit to the RD500.; you just have to change the connectors.
Using the TZR control unit has a very favourable side effect: Instead of opening the Valves at about 6.500 rpm it waits until 7.500 rpm. BDK (England) can change your stock control unit to adjustable opening rev's. They do this to increase midrange power.
In my special midrange power test (Wheelie when shifting from first to forth gear) the TZR control unit performed very well and therefore I still use it in my bike.
As the cable colours are slightly different you have to use the following table to connect the cables.

YPVS control unit 1KT-00	Harness RD500
black	black
brown	brown
black/yellow	**black/white**
black/red	black/red
black/blue	**black/yellow**
white/blue	white/blue
white/red	white/red
yellow/blue	yellow/blue

Table 2: Wiring of the TZR Power Valve control unit

Mods

Stock carbs

Maintenance

After fitting the carbs onto the inlet rubbers, you must synchronise the position of the carb slides. This means that you use the adjustment screw on the carb assy and the cable adjuster to adjust all slides to the same height.
This is extremely important, because if you leave this maintenance work, it is possible that one slide hangs lower than the other. The result would be a seizure caused by the leaner mixture on one cylinder.
To perform the synchronisation properly it's insufficient to use the YAMAHA workshop method. If you use these markings at half throttle the slide position near idle position can differ. This is caused by tolerances in the transmission linkage between the two carbs.
Pull the throttle or the actuator wheel at the carbs a few degrees so that the slides just start to move upwards. Then push something under the slide cutaway - for example an 8 mm allen key - as a gauge to set the upper and lower slide to the same position (use the linkage adjustment screw). After performing the same to the other engine side you have to use this method to balance the right and the left carb assy with the cable adjusters.

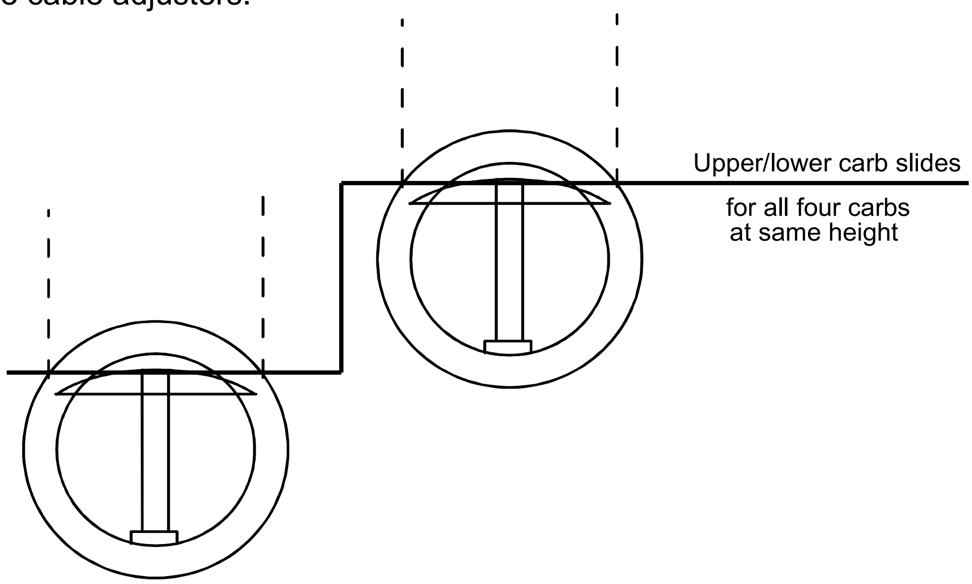


Figure 13: Carb synchronisation

When you hold the throttle at the position so that your allen key just slips under one slide it should be the same at all other carbs.

Take care that you pull and release the throttle a few times before, during and after adjustment. Check your work at least twice.

Wash the filter element in a solvent (I prefer fuel), pour a little motor oil on it and squeeze out before reinstalling. For Moto-Cross purposes there are special air filter oils, but you can also use any regular motor oil (for example 15-W40).

The second most important work to do is to clean the needle jets at least once a season. If some vent drillings are sealed with dirt the engine will run rough at middle rpm's and fuel consumption rises.
Replace the main jet with a screw M5x50 or longer. You can now push out the needle jet (towards the slide) by tapping on the screw without damaging it.
After cleaning reverse the steps to mount it. Align the pin in the carb housing and the groove in the needle jets.

Jetting

The right carburettor setting is very important for two strokes.
In contrast to common carb types the RD500 doesn’t have an idle mixture screw but an idle air jet. The idle mixture can be controlled either by changing the idle jet (bigger jet = more fuel = richer mixture) or by changing the idle air jet (bigger jet = more air = leaner mixture). The same system can be found at the main jet system, but the main air jet can’t be changed so easily.
Stock RD's have the following setup (parts which can be exchanged are in bold font):

	47X	**1GE**	**51X**
Identification	47X00	1GE00	
Main jet	**#195**	**#165**	**#145**
Main air jet (lower cylinder)	# 1.6	<=	<=
Main air jet (upper cylinder)	# 1.8	<=	<=
Idle jet	**#22,5**	<=	**#25**
Idle air jet	**# 1,1**	**# 1.4**	**# 1.4**
Slide cutaway	**2.0**	<=	**1.5**
Nozzle	**O-0 (475)**	**N-8 (475)**	**Front: N-6 (487)** **Rear: N-8 (487)**
Needle	**5 LT 14 (3. Pos. From top)**	<=	<=
Starting jet (Choke)	**#40**	**#60**	<=
Swimmer height	**24 mm ± 1 mm**	<=	<=
Fuel level	**1.5 mm ± 1 mm**	<=	<=
Needle valve size	**2.8**	<=	<=

Table 3: Stock carb setups

Author's comment: The nozzles of the 475 type (47X/1GE) have seven drillings whereas the 487 type (RZV, 51X) only have five. So N-8 (475) would be somewhat leaner then N-8 (487) due to the two additional drillings.

Figure 14: Needle positions

As some of you may reckon the rear cylinders have a bigger main air jet which composes a leaner mixture for the rear bank even when the main jets are all the same. Remember that the rear bank doesn't have very good airflow to be cooled and that they are supplied with warmer coolant than the front bank, it's another reason for the frequent rear cylinder damages. A sensible way to increase performance would take this into account and supply the rear bank with really cool water (more of that later on ...).

Another not so common way to influence the mixture is the fuel level in the float bowl. The height of the fuel level adds a hydrostatic pressure from the bottom of the nozzle on the vacuum at the top of the nozzle which is created by the flowing air. If you use a bigger needle valve (stock 2.8 mm) the dynamic fuel level will be higher which results in a richer mixture.

Armin Collet who is a well known RD tuner in Germany uses needles 4L6 at richest position (5'th). At the rear bank he even uses some thin washers to get them at position "5.5" or "6". This is a modification which goes hand in hand with some other tuning he did: He removes the connection tube between the intake manifolds and closes the hole. The tuning contains some mono-petal reeds and a removed bridge in the reed cage. As he always keeps his secrets I can't say much about the porting, but in the 350 he uses a quite big intake port in connection with stock exhaust and modified transfer ports (see porting section). In this engine there were #160 mains in the front bank and #165/#168 in the rear bank. The idle air jets were #1.3 in connection with #25 idle jets. As the most work has to be put in the correct combination it's required to take the bike to him and have the setup done at his dyno (about 800,- DM reed/jetting mods).
In a hidden test by a motorcycle magazine they measured a stock RD500 on a dyno before and after the Collet modifications. Result: In the midrange around 6.000 rpm there were up to 5 extra HP. Top performance was not effected. Overall they appreciated most the improved road use qualities of the bike due to the much better midrange torque.

The idle air jets bear a number which represents the hole's diameter in millimetres (so #1.1 has a 1.1 mm inner diameter). To get the mixture leaner you don't have to use new air jets as you can rebore them. If you haven't drills that small see a jeweller or watchmaker, they can help you.
If you prefer to spend lots of money on that you can order from Mikuni (Order No.: BS30/97 + size. From 0.5 to 0.8 in 0.1 mm steps and from 0.85 to 2 in 0.05 mm steps).

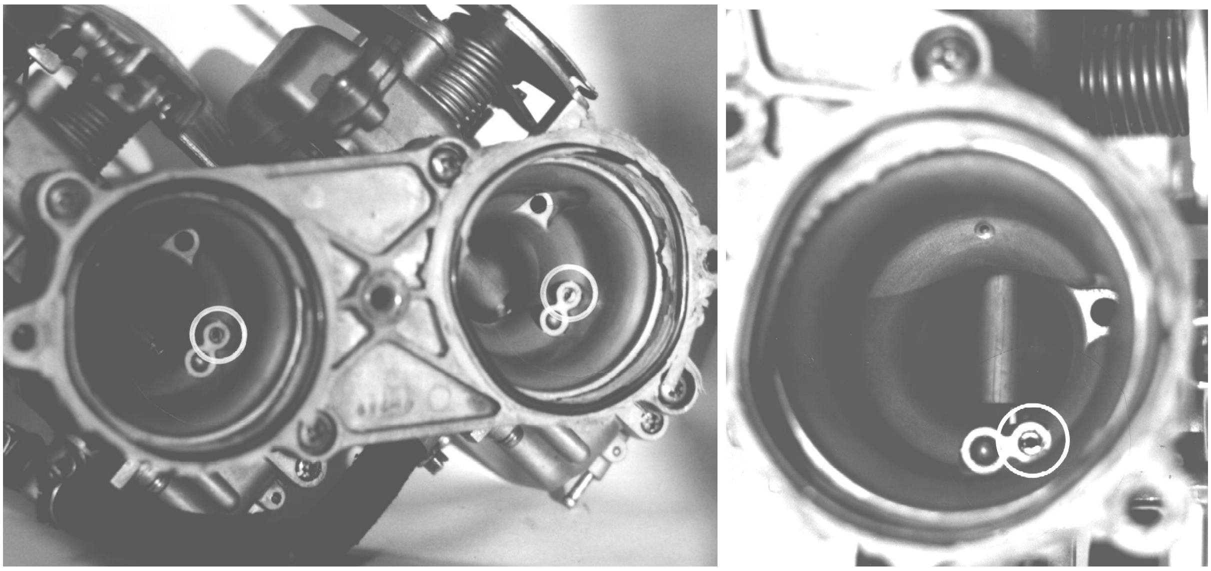


Figure 15: Idle air jets

A very easy modification is to remove the rubber snorkels in the top air filter cover (see Figure 16). This gives the engine a boost in top end power. The intake noise increases slightly.
If you remove the rubbers, you ought to check the plug colour. If it is too lean, use 5 or 10 numbers bigger main jets (#165 => #175 or #180; #195 check plug colour and jet's fuel flow as described in The jet size problem on page 28, then you may use #175 or #180, too)

In the first step I used modified reed cages, fibre reeds, the described porting and slightly increased compression. This resulted in a too lean low end mixture which I corrected with idle jets #35 and idle air jets of #1.6 (I was lacking the fitting idle jets, so I used what was in stock). Ideal would be an idle jet of #25 or #27.5 combined with #1.3 or #1.4 idle air jets.
In this version I used #180 main jets adding #22.5/#27.5 power jets (former RD350 idle jets) with stock needle position.

Removing the complete air filter is a quite complicated thing. I would recommend keeping at least the "elephant ears".

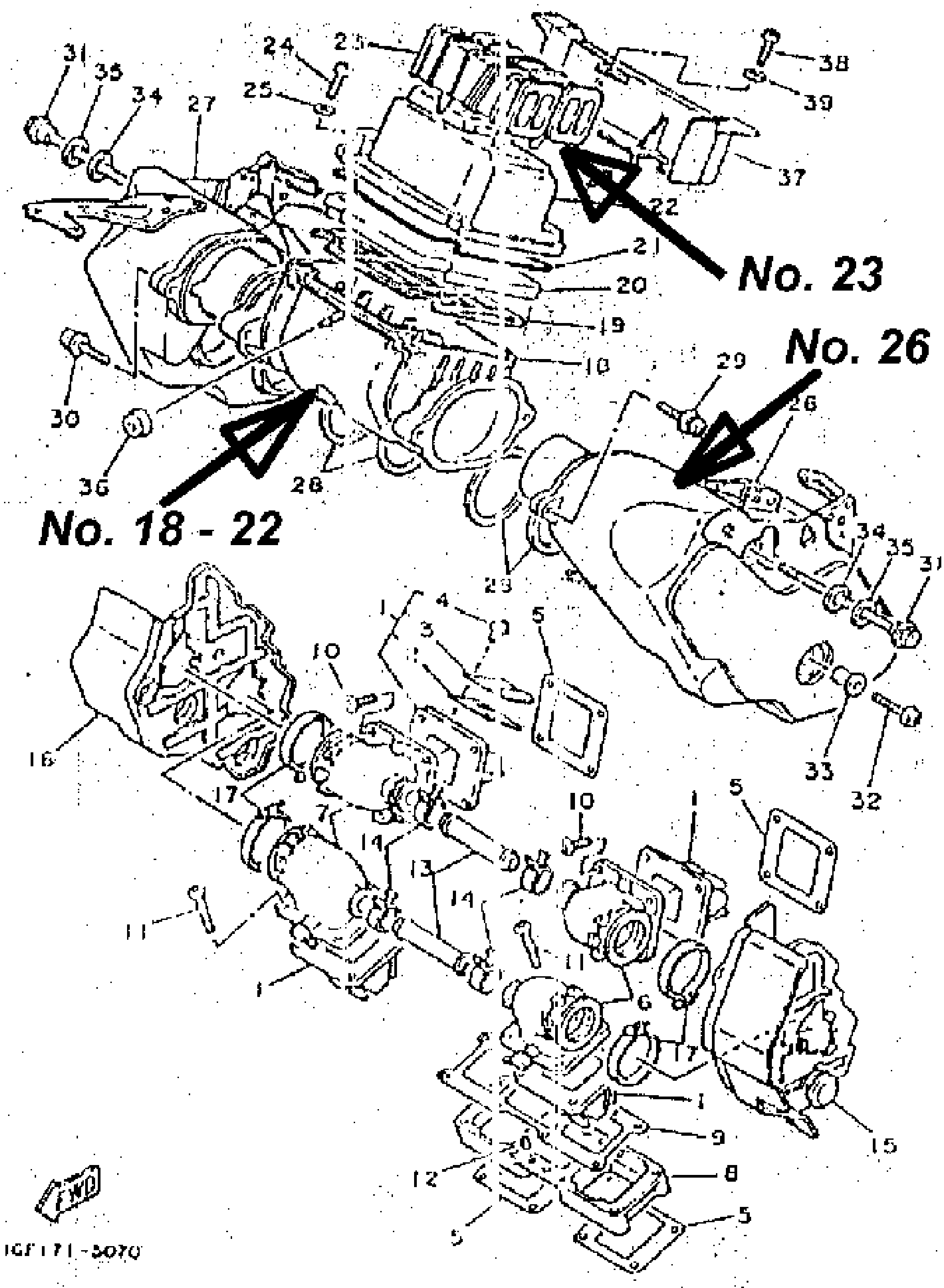


Figure 16: Stock air filter (rubber snorkels No. 23, elephant ears No. 26/27, top air filter housing No. 18 – 22)

In one version they changed the hard plastic intake venturi at the elephant ears to a bigger diameter. In the first trial they removed everything, but it did not work properly. So they exchanged the plastic venturi for a cola can and it worked.
They claimed to have used #320 main jets in combination with heavy porting and Jolly Moto pipes. In my opinion this would be a case for a power jet conversion because of the big main jet. If you use such big sizes you have to consider the free

annulus area between the nozzle bore and the needle outer diameter. It doesn't make sense to use a main jet with a bigger cross section area than the annulus area. With the help of a power jet you can add further fuel to your combustion despite cross section area limitations!

The German tuning company WiWa only removes the top air filter housing and fits big foam air filters to the upper end of the elephant ears. The engine was heavily ported (higher compression, Boyesen reeds, WiWa pipes, Tuning labour: about 3.500,- DM). They recommended a main jet from #200 upwards. Later use of Jolly pipes with carbon silencers decreased the noise level significantly with slight gains of top end power.

Thomas Fried got rid of all the plastic scrap; he only uses a shield to prevent the air stream disturbing the carb intake flow. In his version he modified the carb's main air jet in addition to the usual re-jetting to maintain optimum mixture at all engine speeds and loads. As he is a perfectionist he could not give some data yet as it was not running perfectly.

The YAMAHA race specs for the RD500 contained quite unclear information about the carb setup. They stated: "Air Cleaner: remove ; Remarks: Add shroud to carb flange (air inlet)(Use intake silencer) ; Carburetor setting: Mainly change MJ on STD. ; Remarks: Test in actual run (MJ 260 – 300)".
My interpretation is that they used a solution similar to the WiWa modification. They kept the elephant ears and added a kind of silencer / high flow filter to the top end.

In the RD/RZ 500 Club Newsletter from April 1998 they had some info about BJ MacDonald having developed an air filter kit to cope with the jetting problems above. It contains two big oval air filters and appropriate main jets, and mounting material. In addition you can order a set of needles which remove the 4000 – 5.500 partial throttle burble. The prices are 250 $ for the filter kit and 70 $ for the needles. (BJSHRCE@AOL.COM or phone him at +1-609-588-8775)

At this point I have to add the info that the RD/RZ350YPVS nozzles fit into the RD500 carbs (concerning the pure geometry). The 31K has a nozzle P-0 345, the 1WW is equipped with N-8 532. They have only five drillings and as a result they make the midrange somewhat richer. This makes sense if you've extremely ported the engine or you're running open carbs. This gives you some cheap experimental stuff.
For the RD350 there was also an intake kit available (from Ledar, German distributor: Götz), which was specially designed to work together with K&N type air filters flanged to the carbs by a filter spacer of 60 mm length. The nozzles of this kit were bleed type and they're said to atomise the fuel somewhat better (see Figure 17).

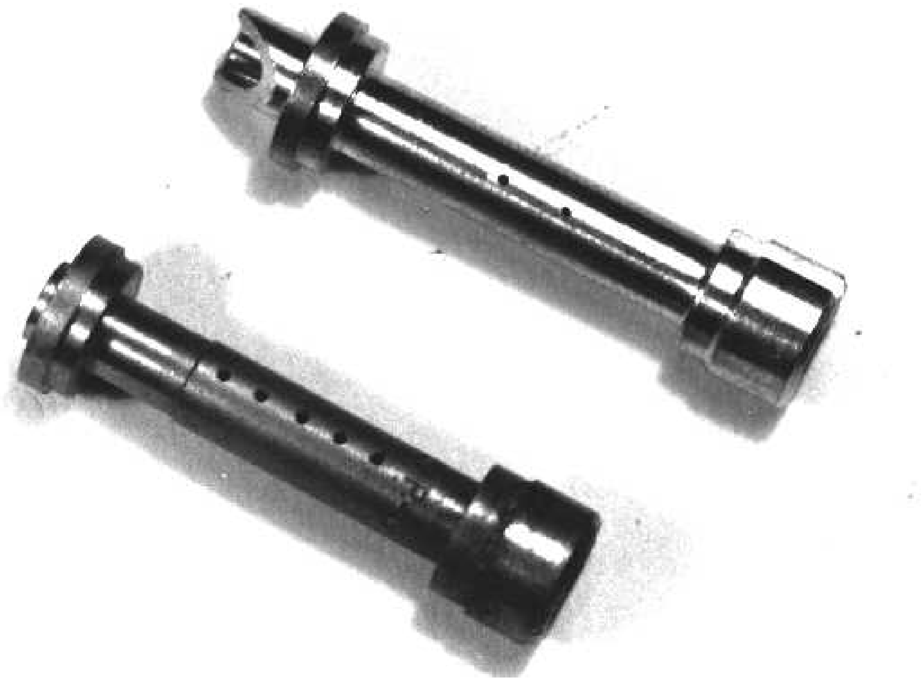


Figure 17: Nozzles, front RD350 O-0, rear: Ledar intake kit

At the end of this chapter I'd like to give you a summary of the stock carb setups I gathered by now.

Mods	Idle and idle air jet	Power jet	Main jet
Stock 47X	# 1,1	--	# 195
Stock 1GE	# 1,4	--	# 165
Rubber snorkels removed	stock	--	# 170 ... # 175
Above 1300 m (4.200 ft) altitude	#20	--	# 155 ... # 160
Boyesen-reeds / modified cages or RD350YPVS-cages	# 1,1	--	# 175 ... # 190
Perforated air filter cover	# 1.1.. # 1.3	--	# 220 ... # 230
Collet-tuning (closed balancing pipe, mono reeds, needles 4L6)	# 1.3 # 25	--	# 160 front # 165/168 rear
Porting, RZ350 reeds, snorkels removed, stock pipes , modified baffles	# 1.3 # 30	#30	# 165
Jolly-Moto pipes	stock	--	# 195
WiWa pipes	stock	--	# 230
Open air filter + Jolly-Moto pipes	unknown	--	# 320
Open air filter + WiWa pipes + porting + Boyesen reeds	unknown	--	# 200
UNI-Filter (Lance Gamma) + pipes + porting + Boyesen reeds (nozzles changed, too)	# 1.2	# 1.0	# 250

Table 4: Stock carb setups for modified engines

Power jet conversion

Originally the RD500 carbs were developed as power jet types. In the RD/RZ Owners Club newsletter there was an article about how to activate the power jet circuits.

Modern carbs share the work of building a proper mixture between several systems which become active at certain events (engine speed and load). The main jet circuit is active from ¼ throttle to full, so you have to lean out the ¼ to ¾ range if you enlarge the main jet to maintain crisp throttle response.

This can be done by the power jet system. It works with a quite small main jet and adds the missing fuel at high engine load/speed by the “bypass” power jet. Here it was recommended to reduce the main jet by some 20% and then to add the rest with the power jet (Example: before: main #195, after : main #165 and #30 power jet). The great advantage you have is that you can tune the midrange and the top end jetting quite separately, as full throttle mixture is controlled by changing the power jet.
One great danger is that you get too lean in the ¾ throttle range and the engine runs quite hot at this state. So if you try to travel longer distances at 180 – 200 km/h it maybe better to use full throttle or to slow down!

The conversion is quite simple as the passages are all cast-in and only have to be drilled open.
First look in the carb bell and locate the dimple which is cast in at the top. You just have to open it with a 1.5 mm drill. The direction is about 45° upwards from horizontal level (=air flow direction).

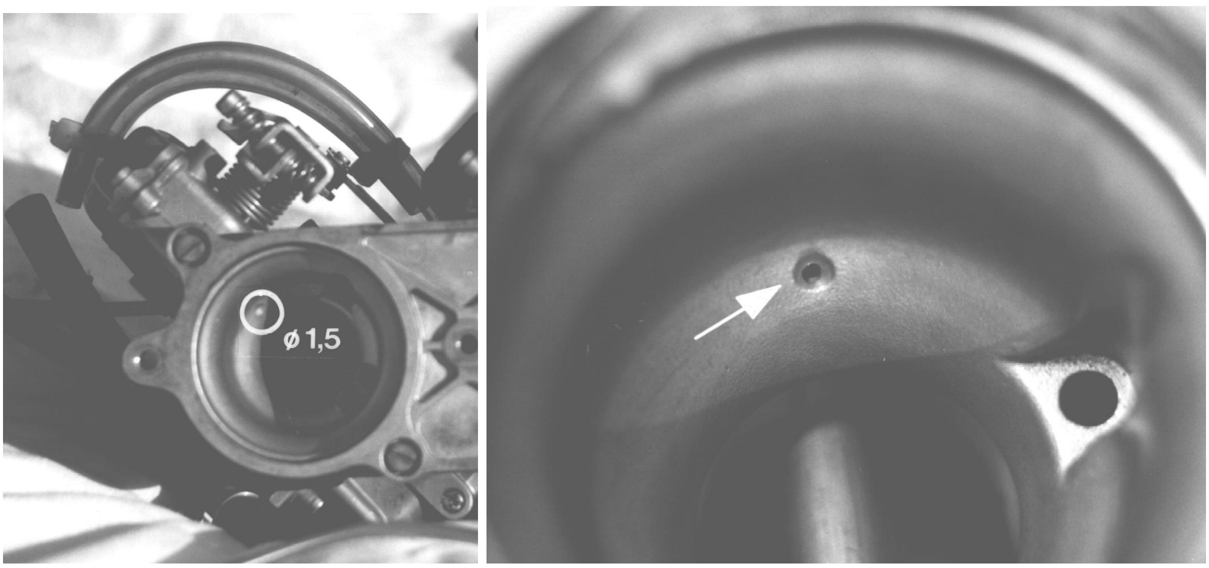


Figure 18: Power jet discharge location (left: stock, right: modified)

The 1.5 mm bore has a connection with passage 1 which goes in the left direction. Just before the end of passage 1 there is passage 2 which goes down to the float bowl. Your job is now to connect them by inserting your 2.5 – 3 mm drill in passage 2 and drill carefully through to passage 1. Tap in a 6 mm deep M4 thread (drill in a 3.3 mm bore to a depth of 10 mm and then tap the thread) at the open end of passage 2 and carefully clean all passages.

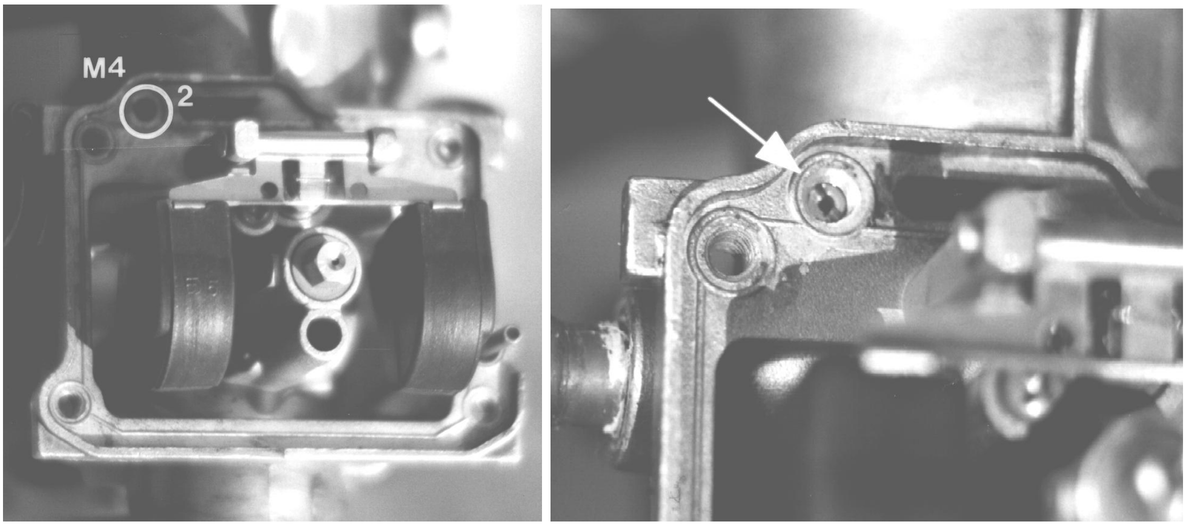


Figure 19: End of passage 2 (left: stock, right: modified)

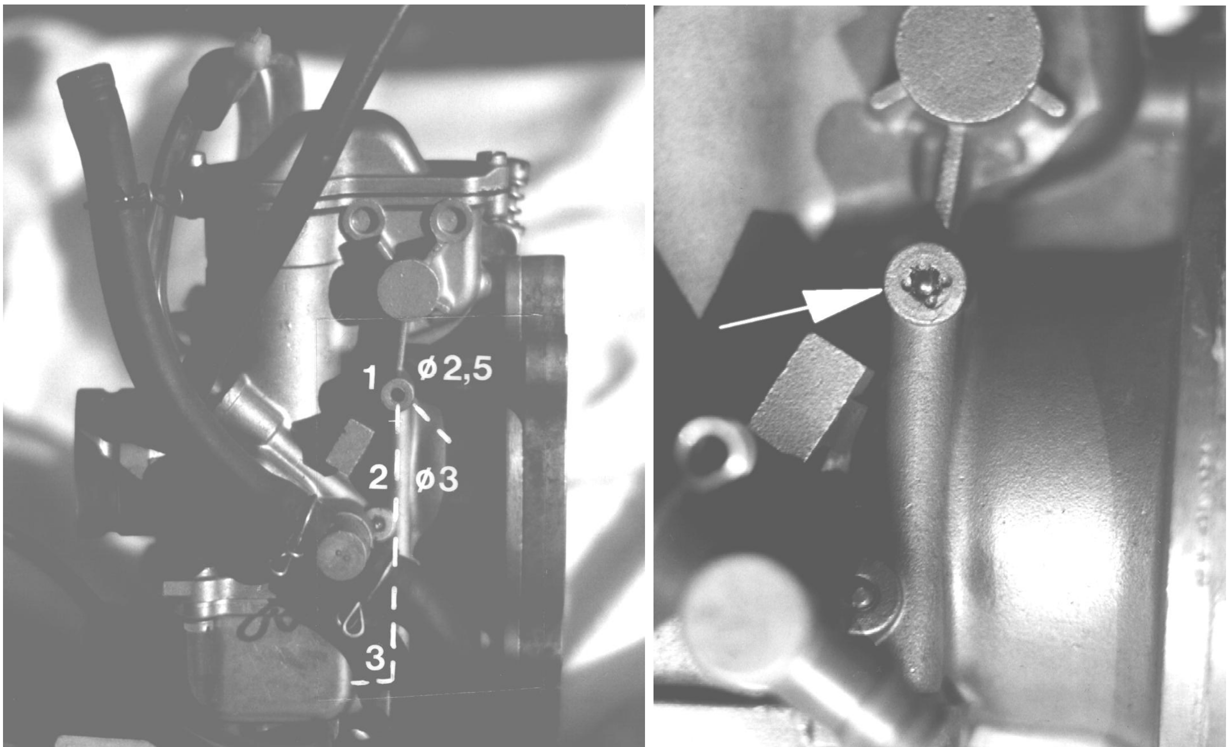


Figure 20: Left: passages in the carb, Right: closed end of passage 1

Then you have to close the open end of passage 1 with a self made brass plug (∅2.5 mm, 3 mm long) or some other fitting stuff. I used a 2.5 mm sphere from an old roller bearing and sealed and fixed it with Loctite and some hits with a centre punch. Take care that there is no leak here because additional air will weaken the mixture and lead to engine damage!

If you take the direction from passage 2 there is a matching passage in the float bowl which I named passage 3. It will connect the power jet circuit to the fuel supply. To achieve this you have to drill a 2.5 mm hole at the bottom of passage 3 (there is also a dimple cast. Be careful because you can easily destroy your float bowl when drilling an undesired air vent at this location!

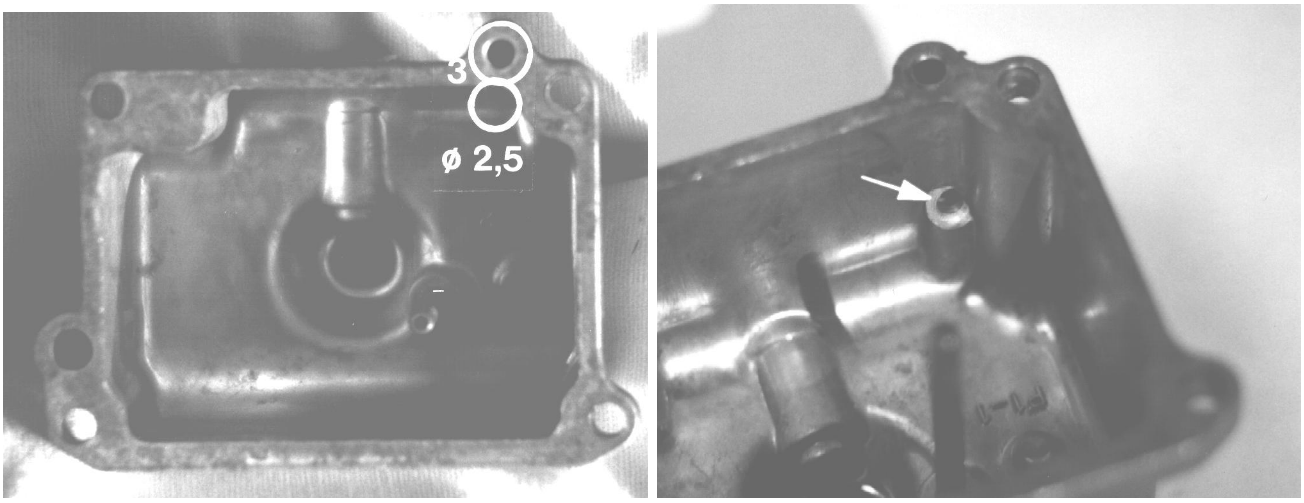


Figure 21: Float bowl (left: stock, right: modified)

Repeat this procedure approximately three more times to convert all your carbs. If you don’t dare to perform this on your own, you may send them to a experienced tuner or give it to your favourite workshop.

The basic jetting recommendations were not that comprehensive. They advised tuning the normal way up to ¾ throttle and using the power jet for the ¾ to full range. The main jet should be some 20% smaller and you should make up the difference with the power jet (start with the power jet being a little big). If the engine has flat spots in the upper range the power jet could be too rich.
The result after fine tuning should be a good crisp throttle response and a proper mixture at high engine speed
In the Lance Gamma version with open air filters and race pipes they used #250 main jets and #1.0 idle air jets as power jets.

Another example can be found in the RD350 history. The first YPVS models had a main jet of #240. The 1WW from 1986 were equipped with power jet carbs and jetted

with #185 main jets and #60/65 power jets. If you add the sizes you almost get the former #240 (185+65=250); the power jet fills 26% of the whole size.
At the beginning I tried to keep these proportions by replacing the #195 mains with #170 and using #27.5 RD350 idle jets as power jets. This did not work for several reasons. One of them was that the RD350 idle jets have not the same diameter as the Mikuni power jets (Part No.: N100606 + size from #30 to #150). Compared to the Mikunis the #27.5 idle jets were about #60 in Mikuni size! The second thing was that the fuel flow of my stock #195 jets equalled about #165 in current Mikuni scale. These two deviations resulted in a far too rich mixture and I think I don't have to tell how the bike ran? You never heard me cursing so much, but read on to the next chapter ... .

The jet size problem

A small problem in finding a setup for my RD500 following a reed conversion led me to a fundamental carburettor problem.

After re-jetting from stock #195 main jets (stock YAMAHA with Mikuni marking) to #180 (Götz) with #22.5 power jets (using RD/RZ 350 idle jets with 4 mm thread) the engine was running very poorly. The mixture was far too fat in mid-range and top-end and I was wondering why, because the conversion would have required a slightly fatter jetting. Then I changed main jets to #170 (Mikuni) and it made no difference at all.
Just before going nuts I had the idea of measuring my jet store – with some amazing results - .

The Mikuni jet number should indicate the fuel flow which is not the same scale for all measured jets.
Mikuni claims to deliver lots with a maximum variation of ± #10. This means if you buy a main jet labelled #180 it's just sized in the range from #170 to #190.
The jet number is linear dependent on the fuel flow which means a #120 main jet has 20% more fuel flow compared to a #100 jet. Do not mistake fuel flow with jet bore diameter! This dependency is not linear!
I saw in an older jet chart that Mikuni also claims the jet number to represent the fuel flow in ccm per minute. This is only true for a special test combination of fuel, pressure and jet-type. As far as I know nowadays the jets are measured with air and the difference in pressure (before and after the jet venturi) leads to the jet number.
Obviously the method changed about one decade ago.

I found that some of my jets had differences between label and fuel flow of #30 numbers and more.

The stock RD500 #195 jets had all a fuel flow of about #165 (present Mikuni labelling). The #180 jets from Götz had almost the same flow rate as the #170 Mikuni (#173 and #171). What made it even worse was that the #22.5 idle jets had a bore which compared to Mikuni #60 power jets (Mikuni number N100606).
With that knowledge I dared reduce the jet size to stock #195 (= front #163, rear #168) combined with #30 power jets which lead to a usable engine behaviour.

For this reason I'd advise anyone who is going to change jetting to make his own jet measurements. The values will be different but the intention is to compare "unknown" with "known" jets and to judge if the jet label is in a valuable range.

I used a rinsing bottle for battery acid (diameter about 70 mm, about 180 mm height) with an 80 mm hose with 5 mm inner diameter (to screw in the jets).
Pour in an exact amount of water (small bucket with scale or letter scales) and measure the time in which the whole amount has flowed out.
To avoid deviation in measuring you should follow exactly the following instructions.

- Clean the jet very carefully and pour in a full bottle charge of water before starting.
- Make about 5 to 10 measures for one single jet. (Typical values would be: 129s, 125s, 122s, 122s, 121s, 123s, 120s)
- Clean the values from obviously too high/low times (here 129 and 125), calculate the average time and standard deviation (mean-square error). See your math teacher or use a scientific calculator to perform that point. (Average = 121.6 ; standard deviation = 1.14 => The right time is between 120.459 s and 122.74 s with a likelihood of 68.3%)
- The flow rate in ccm per minute is calculated by: 125 [ccm] x 60 / flow time [s] = flow rate [ccm/s] (121.6 s lead to 61.67 ccm/s). Make the same calculation for the min/max values of the standard deviation to judge the accuracy of this single jet measurement.
- Make a diagram (scale paper or PC/EXCEL) where the x-axis is the jet size (labelled number) and the y-axis represents the flow rate.
- Connect the average points with a straight. This is your reference straight for future measurements with your special equipment (Here: Y=0.397*X).
- To calibrate your individual testrig to the statement flow rate = jet label you have to introduce a proportional factor k to convert the straight to Y=k*0.397*X. For our "good" jets (which are not too far away from our reference straight) this is calculated: k = Jet No. / Flow rate [ccm/s] (For the jet #170 with 110.4 s and 67.93 ccm/s the value for k is 2.5024). Calculate the k value for all jets and use the average k value (here 2.5188) for your converted reference straight.

- Now you can directly use the measured times to compare to the reference straight by calculating the corrected flow rate: y = 2.5188 x 125 x 60 / flow time [s].

My test setup had the disadvantage that you have to measure quite exactly. If you use a higher test volume (250 ccm) the measurement will be more accurate but it will double the time you need! As an example I've listed my measurements (for 125 cc):

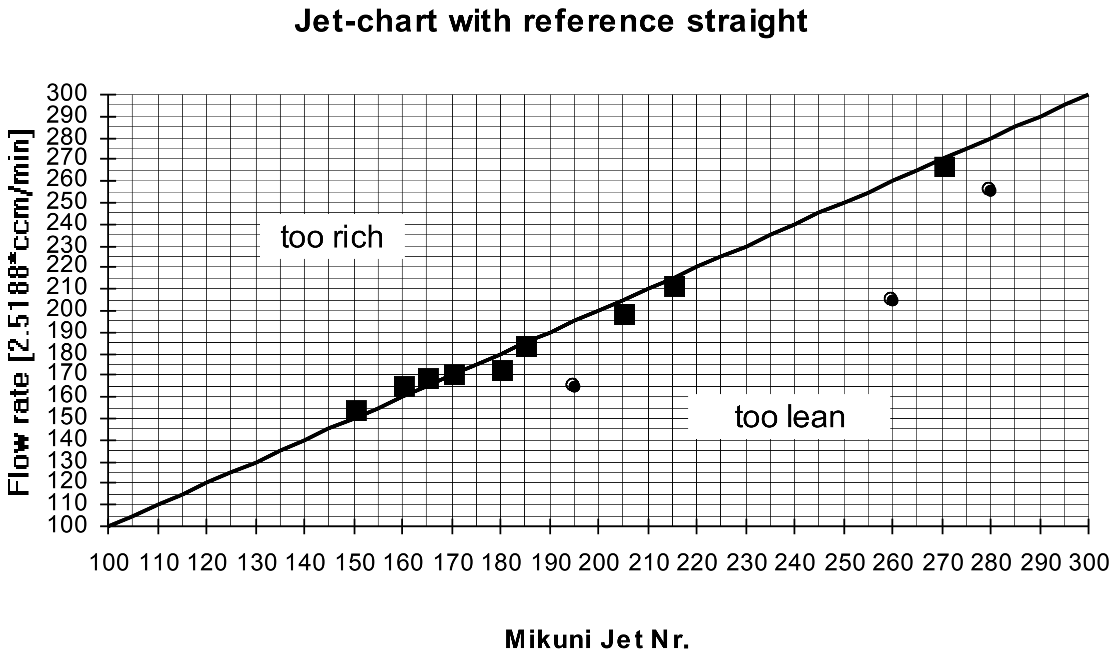


Figure 22: Reference straight for the corrected flow rate

The conclusion from the whole thing is: **Do not trust any jetting specifications** without comparing it to your own experience or at least two other independent origins. If you want to find a carb setup use a complete set of new jets purchased completely from one source. **Do not work with old jets** unless you've measured them thoroughly and have compared them to new ones.

Jet-No. (Mikuni) #	Average 125 ccm [s]	Std. deviation [s]	Flow rate (calculated) [ccm/min]	k-factor [ ]	Jet-No. (calculated) #	Jet No. Max. #	Jet No. Min. #
150	122	1.211	61.48	2.4400	**155**	***156***	***153***
160	113.75	2.121	65.93	2.4267	**166**	***169***	***163***
165	111.857	2.2677	67.05	2.4609	**169**	***172***	***166***
170	110.4	1.91	67.93	2.5024	**171**	***174***	***168***
180	109.4	3.0956	68.56	2.6256	**173**	***178***	***168***
185	102.6	2.5099	73.10	2.5308	**184**	***189***	***180***
205	94.8	1.923	79.11	2.5912	**199**	***203***	***195***
215	89.2	0.836	84.08	2.5571	**212**	***214***	***210***
270	70.4	3.4	106.53	2.5344	**268**	***282***	***256***
			Average k= 2.5188				

Table 5: Jetsize measurement part one

Jet-No. (Mikuni) #	Average 125 ccm [s]	Std. deviation [s]	Flow rate (calculated) [ccm/min]	k-factor [ ]	Jet-No. (calculated) #	Jet No. Max. #	Jet No. Min. #
195	112.75	3.507	66.52	2.9315	**168**	***173***	***162***
195	116	2.16	64.66	3.0160	**163**	***166***	***160***
195	116	0.81	64.66	3.0160	**163**	***164***	***162***
195	114.8	1.3	65.33	2.9848	**165**	***166***	***163***
260	92.25	1.5	81.30	3.1980	**205**	***208***	***202***
280	73.75	1.8	101.69	2.7533	**256**	***263***	***250***
			Average k=	**2.9833**			

Table 6: Jetsize measurement part two (out-of-range jets)

Other (i.e. bigger) Carbs

Before you attempt to install larger carburettors onto your RD engine I must warn you that this is not a one-weekend-job! Finding a complete new carb setup is an extremely difficult thing and what you need over and over is expertise. Even if you are experienced enough some engine failures and increased maintenance will follow the conversion.
The every-day-behaviour of a bike gets worse if you use race carbs, because most of them have neither an idle adjustment screw nor a starting system (choke).

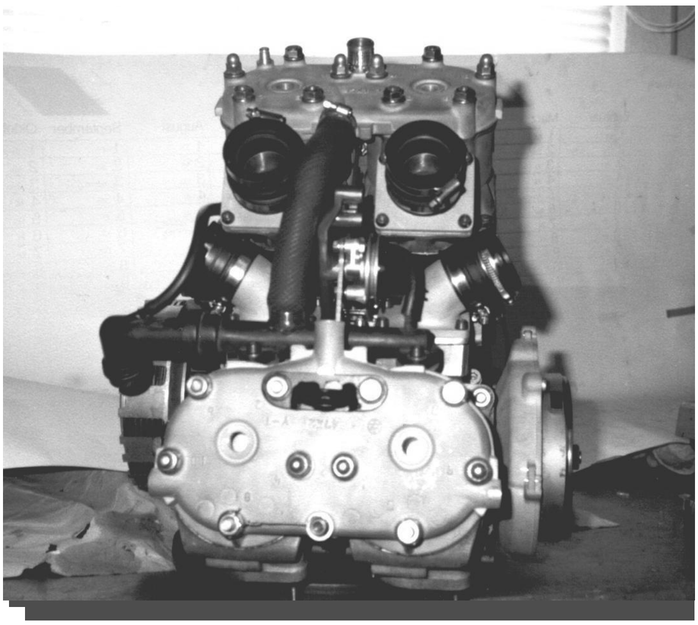
What eases the whole thing is if you get data from other RD's with bigger carbs.

Problem number 1: What carburettor type and size should I take? TM30 with slingshot slide or rather a big VM 34 PowerJet with round slide?
Answer: Either you buy a complete kit from someone who managed to run it with his RD or you try to purchase exactly the carbs from one of the following setups. The second way is to try your own setup with cheap carbs you already own.
The bigger the carb bore the more unreliable and the less convenient the whole engine will get. Modern 125 cc race bikes use 34 to 38 mm carbs but compared to the old-fashioned RD's they've got giant intake cross sections.
The performance optimum for an **extremely** tuned RD engine is around 34 mm. But beware: These big ones live and die with the gas velocity in the venturi bore. You must at least mount some race pipes and somewhat bigger reeds to increase gas flow. Otherwise they will not work! I would only recommend such big carbs for race (ab)use on tracks where you have much full throttle operation, because mid range power is reduced substantially.
In my opinion the optimum for the tiny stock reed cages is about 28 .. 30 mm because you can install these onto the stock manifolds and it works. If you modified the reeds it will be 30 or 32 mm.

To get the carbs slightly bigger you can modify the venturi bore; I heard from values of up to 29 mm and they said it improved top end revs and performance. If I modified the stock carbs I'd do it the Cagiva/Dell'Orto way: They've got an oval carb bore of 28 mm x 32 mm. You can also machine the bore in shape of a rectangle with rounded edges, which gives you more cross section compared to a round bore.
The Mikuni TM30-6 slingshot would fit quite well (around 1000,- DM for a set of four) but the 32 mm RGV Carbs ('89) would be also possible.

A catalogue from the USA (Spec II) claimed a 12% top end (9000 Rpm) and 16% mid range (5000 Rpm) power increase on an air cooled and race-pipe equipped RD350. The same test-bike proved that the 34 mm carbs only had advantages above 9000 Rpm. With a TZ reed conversion they obtained "terrific power increases from 6500 Rpm up". (*Authors comment: Only with this conversion the gas velocity was sufficient for the 34mm carb size. It's the same problem which will occur in the RD500 engine when fitting 34 mm carbs*)
On the RZ350 (31K or 1WW) they claimed a 13% performance increase.
Their recommendation was 32 mm for riding around town and short race tracks, and 34 mm for high-speed race tracks where maximum power is required.

Problem number 2: How the hell do the larger carbs fit to my engine?
Answer: If you don't manage to slip them on with warming and oiling the flange you have to think about other flanges.
Thomas Fried did some hand-tailored manifolds just by holding a chunk of aluminum to the engine, sketching the shape and then grinding his ass off for about 90 (!) hours. The clamping of the carbs was done by a round rubber flange.



If I did this I'd use a slanted plate of aluminum and some universal intake manifolds from Mikuni.

Figure 24: Mikuni universal manifolds

Figure 25: TM34 at RD350

For the 350 I did this and it worked well. In the Internet I found that Trinity Racing sells so called Stage IV manifolds for the Quad Banshee, which are quite similar to my adapter plate solution (www.trinityracing.com).

To avoid contact to the generator cover it will be necessary to change the lower left carbs position slightly (see VM 34 Round Slide Carbs). The Italian carb manufacturer Dell'Orto provided tolerable carb angles up to 30° out of the vertical position.

Since 2000 you can get a intake manifold kit from Marco Böhmer. He's welding them from steel and they can bear the rubbers from the MotoGuzzi V35 where the Mikuni TM30-6 fit staight. In this case you have to adapt some own ait filter, as this doesen't fit the stock elephant ears (The carb layout is changed similar to Thomas Fried's solution)

Problem number 3: How do I keep stock cables (gas petcock, oil pump, throttle cables) in use?

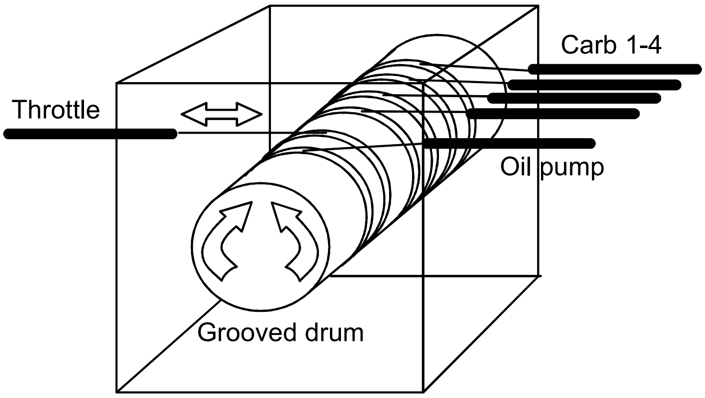


Figure 26: Cable distributor

Answer: Because the stock carb bore is only 26 mm the stock throttle cable is limited to this stroke via the cable distributors (2 carburettor open + 2 carburettor close + oil pump).

To increase the max. stroke I'd propose the following cable distributor, which you can find on the RGV250 in a three cable version.

Design a housing with a grooved drum on some roller bearings. By the relation between the groove diameters you can influence the maximum stroke. For example if the incoming cable from the throttle is on a 30 mm diameter you need a 39 mm diameter for the outgoing cables to run 34 mm carb stroke. The oil pump groove can stay at the same diameter as the throttle cable groove (in this case 30 mm). If you have problems with the actuation torque at the throttle to open the carbs you can either get weaker carb slide springs or add a torsional spring at the drum which helps you to lift the carb slides.

Due to different carb designs the outgoing cables have to be tailored to the carbs you use.
Another way would be using modified RG500 carb cables. They have the necessary five cables for the carbs and the oil pump.

The vacuum line to actuate the gas petcock and the oil supply can be attached in the auxiliary plate as well as to the balancing pipe opening in the stock manifolds. Otherwise you have to "open" and "close" the petcock by using "PRI" and "ON". If you remove the oil pump I'd recommend gas oil mixtures from 1:30 to 1:50 with synthetic or racing two stroke oil (Castrol TTS/XTS/747, Bel-Ray Si-7/H1-R, Motul 600/800).

The Mikuni TM-carburettors (flat slide) are more convenient if you must find a new setup, due to their smooth bore design, which produces an increased nozzle vacuum compared to the VM type (round slide). On the other hand the VM's are much cheaper, especially if you take used ones.

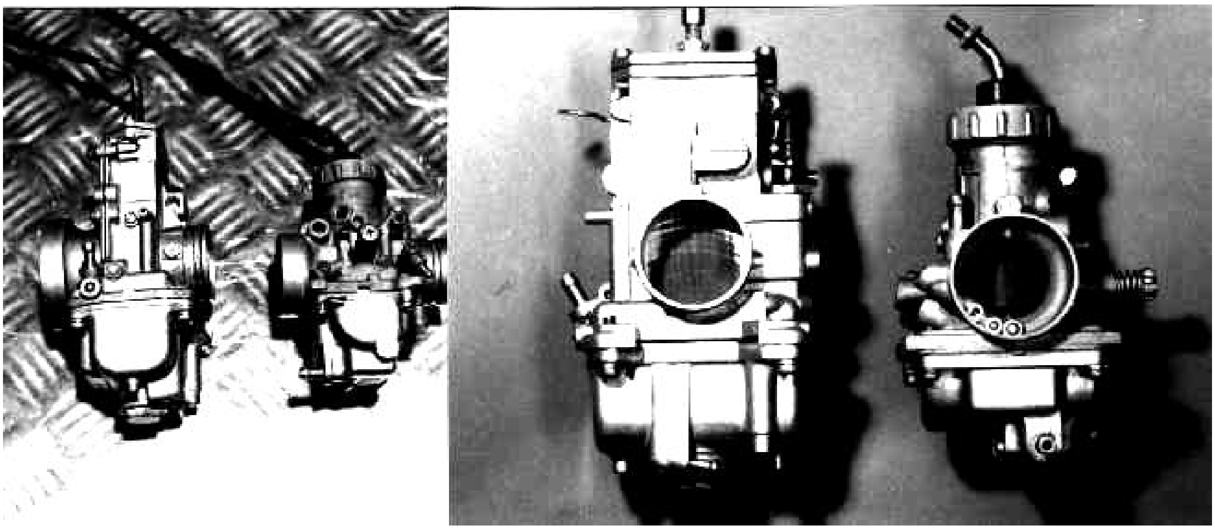


Figure 27: Carbs Mikuni TM34 and VM26 (RD350) in comparism

Finding a Setup

The balancing pipe between the flanges can be left out, because it is said to make it difficult to find a clean setup with big carbs. An auxiliary plate is even easier to manufacture if you don’t use a balancing pipe.

When you’ve finished all the fitting work the great moment is there: The first time you let the engine run. The normal case will be great disappointment, because it will not run as well as you expected it to run. There might be weak throttle response, reduced max. rpm, engine runs like choke is out, ...

With the Colortune spark plugs you can tune the idle and low end mixture by observing the combustion colour. You should first have a look at some well running stock engines to judge the right colours. The ideal mixture between gas and air which is around 1:14 (mass proportions) leads to Lambda-values around one. A weak mixture increases the Lambda value, a fat mixture decreases it.
Two stroke engines need a Lambda of around 0.9 (slightly fat) for optimum performance but in the mid-range a leaner mixture (Lambda around 1+) gives better throttle response.
A fat combustion is followed by a bright orange colour, a lean by a light blue. With this indicator you can pre-set the idle and the needle jet.
If you've got plenty of money you can use a Lambda tester instead. The Bosch LSM 11 gives you the measured value on a digital display. As it uses a heated UEGO sensor, it can be used even for twostrokes. Info: Marco Böhmer (Tel.: +49/9256/953344 16:00 to 21:30 CET/Germany).

Now it's time to have a short ride to test or change the pre-sets and to find a temporary needle position.
My favourite order of finding a setup is: Idle mixture screw, idle jet, and a temporary needle position for the low end. After that do the full throttle test to find a temporary main jet. Then try to optimise mid range behaviour and finally check your setup again because the single systems influence each other and it could be necessary to correct one of the "temporary" states.

The idle system should be adapted to the mostly used circumstances. In race use with gas/oil mixture you must have a quite big idle jet of #60 to #90. If you want to ride around town a maximum of #40 is required to avoid plug fouling during low-throttle operation. Use the idle mixture screw to fine-tune the idle mixture.

For the purpose of finding the main jet you need to read the plugs. At the beginning you must look out for an appropriate test area. It should contain at least an one kilometre straight with a slight uphill slope. The result is when you were riding with full throttle the engine is fully loaded at max. Rpm. The second possibility is to perform the same test on a dyno.

Put in a set of plugs which are suitable for your tuning stage (i.e. NGK BR9ES or B10ES). Take care that you are not running short of fuel. If you want to reproduce the tests later you should also note weather conditions (like: sunny, dry, 25°C, 1025 mbar).

Then warm up the engine and ride at least one kilometre with full throttle condition at max. Rpm with max. possible speed. At the end of the straight, simultaneously press the kill switch and release the throttle to zero. Notice the achieved revs and speed to compare with the other runs. (An electronic bike speedometer with max. speed memory can help you much in this testing)
Then screw out the plugs and look at the porcelain. It should be a quite dark brown with a black ring around at the end of the plug thread. if you haven't the desired colour try to get it rather darker than too light.
The ideal jet size is one number fatter than the jet with maximum speed.

In the internet I found a jetting instruction from Dale Alexander which was a little different from mine, but it made sense. It recommended warming up the engine for 10 minutes (blipping the throttle) with an old pair of plugs to remove oil out of the lower crankcase. If you do the test without warming up the old oil will darken the plugs and make things look richer than they really are.
Then screw in a brand new pair of plugs and warm up the plugs again by not giving full throttle to the engine for at least 2 minutes. This is very important because if you push a full throttle load of fuel onto a cold plug it will foul or at least get too dark due to that fuel overload. Start with 1/3 throttle with no more than 6000 Rpm. Then steadily move up the throttle and rpm until the first straight (about 1 minute after starting). When the straight comes up, roll the throttle on very slowly, 6500 shift to 4th, 7500 shift to 5th, 8500 shift to 6th and then bring the throttle up to full slowly. This should ensure that all residual oil has come out of the crankcase and that the plugs will see a somewhat representative mixture.

For the needle type and position you can use the criteria “best acceleration” similar to finding the idle mixture.
But don't worry, most carb kits which you can purchase have a quite usable setup so there's "only" main jet, idle mixture and needle position left

If you are very ambitious to optimise part load mixture perform acceleration and speed testing with different bushes which shorten max. slide stroke. This makes the slide position reproducible and you can have a look at the mixture at different slide positions.
You can influence the quality of your setup by using more or less steps in slide position. Normally three levels should be sufficient; this would arrest the slide at 7, 14 and 21 mm for a 30 mm carb.

The needle and the needle jet bear a marking which contains letters and numbers.
For the needle jet a "higher" letter (“G” is higher than “F”) and a higher number represent a richer mixture (Main influence at 15% - 50% throttle opening). Take care

that you have the same series number to compare these markings. The German 47X has a P-0 (475), the 1GE is equipped with N-8 (475) whereas the RZV has N-6/N-8 (487). The RD350 also has N-8 but of the 457 Series.
Despite identical geometric shape (all nozzles are suitable) there are differences in mixture relevant details like number, position and diameter of cross bores.

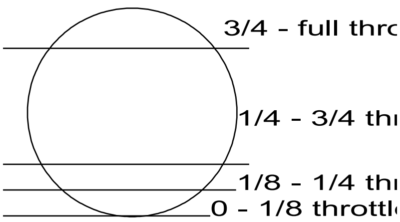
lean fat
P-6 > P-8 > Q-0 > Q-2 > Q-4 > Q-6 > Q-8 > R-0

Needle marking is quite similar. The main influence lies at 15% - 75% throttle opening, so needle type and position is a substantial part of your mid-range setup.

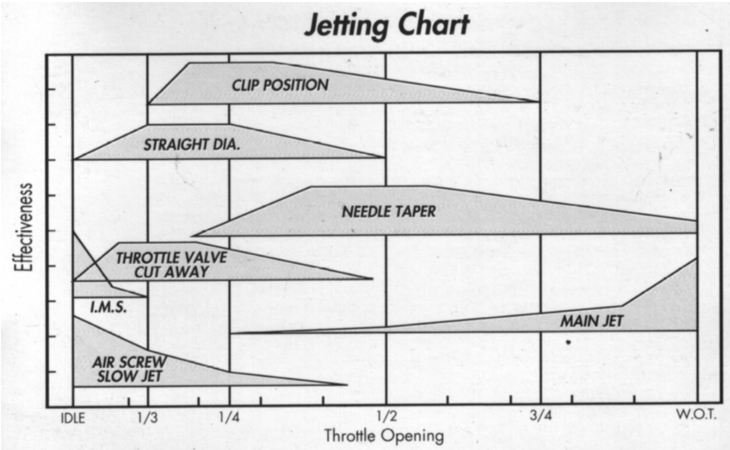
The first number represents the needle length and therefore the mixture above half throttle. The second letter denotes the needle diameter and therefore it influences the mixture below half throttle. The last digit is a code for other features such as cone angle or other geometric features.

A needle 8L1 would enrich the mixture above half throttle compared to a needle 6L1.
A needle 6P1 would enrich the mixture below half throttle compared to a needle 6D1.
You can judge for yourself what component to change

As a guide to which component has an influence in which range you can use the following Figures.



- 0 to 1/8 - throttle (0 to 4.5 mm) idle jet, idle mixture screw
- 1/8 to 1/4 - throttle (4.5 to 9 mm) idle jet, slide cutaway, nozzle
- 1/4 to 3/4 - throttle (9 to 27 mm) nozzle, needle
- 3/4 to full throttle (27 to 36 mm) main jet



Quick Jetting Guide

1) IDLE. Set idle speed to proper r.p.m. by adjusting the IDLE SPEED SCREW. Turn the IDLE MIXTURE SCREW or AIR SCREW to achieve highest speed and best response. After adjustment has been made reset IDLE SPEED SCREW to proper r.p.m.

2) OFF IDLE to 1/4 THROTTLE. The SLOW JET and SLOW AIR JET are most effective in this range. When you want a richer mixture in this range use a larger SLOW JET or a smaller SLOW AIR JET. The opposite holds true for a leaner mixture.

3) 1/4 TO 3/4 THROTTLE. The JET NEEDLE is the most effective component in this range. Raising the needle by lowering the clip position at the top of the needle will richen the mixture. Lowering the needle will lean the mixture

4) WIDE OPEN THROTTLE. Changing the MAIN JET effects this range. Select the size which offers the best W.O.T. performance, then install one size larger MAIN JET for ideal engine durability.

Figure 28: Range of influence for carb components

It’s likely that the race bikes specifications are not too far away from what you will use in your bike. Because of this reason I’ve listed some TZ250/500 carb setups with 34 mm carbs.
Another source for carb setups are Italian 125 cc bikes. These are intended to be used on-road and they have around 30 to 35 HP.
The disadvantage is that these bikes always use Dell’Orto PHBH/PHBE carbs instead of Mikuni types. This makes it difficult to compare them to known setups.
The Dell’Orto’s are quite cheap, have a cable based choke and they come with a comprehensive English language setup manual. Unfortunately I’ve no other data than the Mito street and racing setups.

Model	**TZ 250**	**TZ500**
Pre-mix	1:15	1:15
Carb	VM34SS	VM34SS
Main jet	#230-#270	#280-#380
Idle jet	#60	#50
Nozzles	N-8	N-8
Needle	6DH3 (3. Pos.)	6F22 (3. Pos.)
Slide cutaway	2.0	2.0
Idle mixture screw	1.0 turn out	1.5 turns out
Swimmer height	21.9 mm ± 1 mm	33 mm ± 1 mm

Table 7: TZ race bike setups

Model	**Mito II**	**Mito II Racing**
Lubrication	Autolube pump	<=
Carb	PHBH 28 RD	PHBH 28 RD
Main jet	# 148	#175
Idle jet	#48	#55
Düsenstock	266 BC	266 T
Nozzles	X 33 (2. Pos.)	SX 18 (2 Pos.)
Power jet	#95	#80
Choke jet	#65	#65
Slide cutaway	60	40
Idle mixture screw	1.5 turns out	1.5 turns out
Swimmer weight	6.5 g	<=

Table 8: Cagiva Mito II street and race setup

By the way: The TZ 500 has similar bore/stroke dimensions (56 x 50,7 mm) as the RD 500 (56,4 x 50 mm) and the Cagiva Mito (56 x 50,6 mm).
The Mito-carbs have an oval bore to combine the big cross section area for good top end performance with quite high flow speed at idle and low load state.
Have a look at the percentage of about 39 (31) % of the power jet on the combined jet size of #243 (#148 + #95) or #255 (#175 + #80)!

This can only be a guide because the different circuits influence each other. If you have a lean idle mixture you can use either the idle mixture screw or the idle jet. If you change the main jet to a very different value it can be necessary to rejet the lower end circuits, too.

VM 34 Round Slide Carbs

From Glenn v. d. Geld from the Netherlands I got data for his VM34 conversion, which was used for racing. He bought the bike in that state, but it was not running with the stock pipes for road use, so he changed back to stock carbs.
The race type carbs used were Mikuni VM34 without idle speed screw from the TZ models.
Somehow they used the elephant ears to bring the air to the carbs. The cylinders had the described porting job done at intake, exhaust and the sleeves. In the engine someone had used the RZ350 reed cages (which is a must if you use 34 mm carbs).
This was combined with self-made race pipes which were quite loud.
To mount the lower left carb there was a slanted spacer under the manifold which gave the needed clearance between the float bowl and the generator housing.

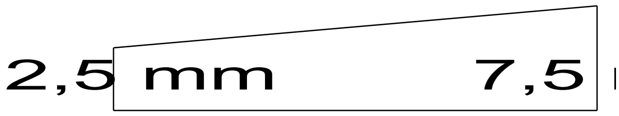


Figure 29: Slanted spacer

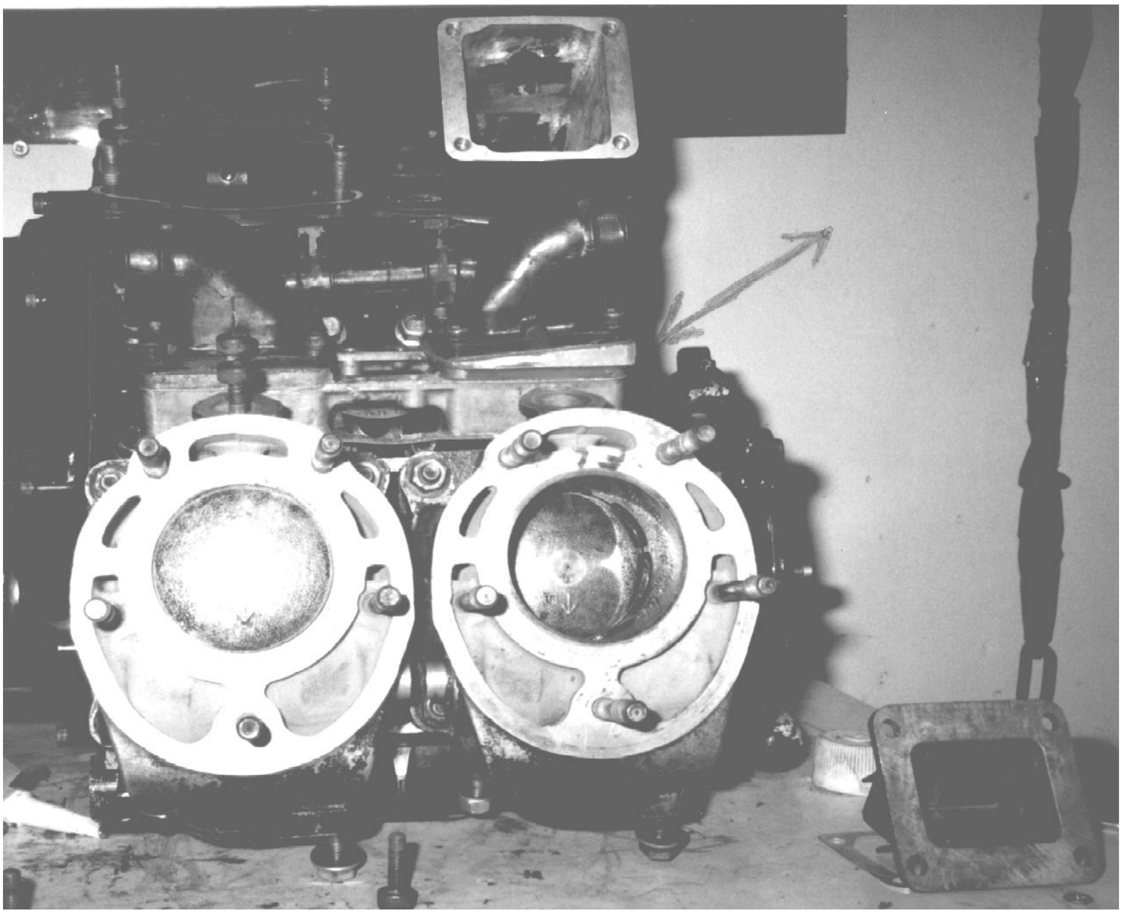


Figure 30: Lower cylinder bank with slanted plate

On the chassis the brakes were changed to Lockheed race callipers and floating cast iron disks without anti dive.
The setup used was:

Carbs VM34	Front cylinder	Rear cylinder
Main jet	# 270	<-
Idle jet	#70	<-
Slide cutaway	2.5	<-
Nozzle	O-2 (159)	<-
Needle	6F9, Pos. 2	6F4, Pos. 2

Table 9: Setup VM34

Figure 31: Engine view (sleeve mods, reed cages, reed housing lower cylinder bank)

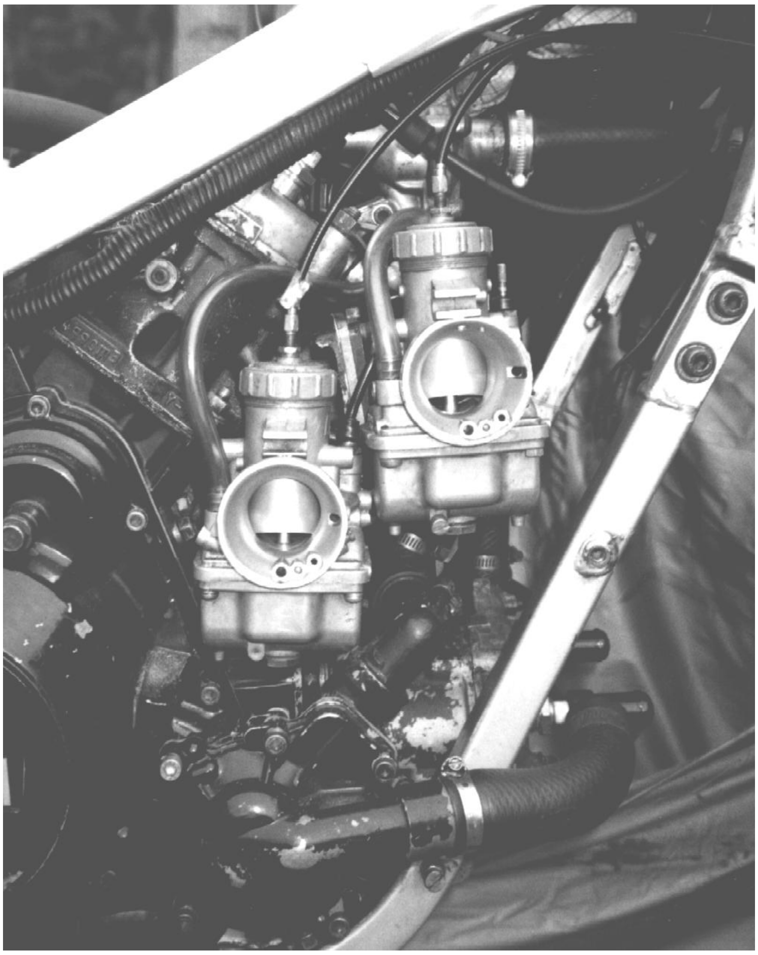


Figure 32: VM34 mounted to the engine

TM30-6 Slingshot Carbs

If I should give advice which carb size is the best for most RD500 it would be 30 or 32 mm. This is a good compromise between road use and performance gain.

In August '96 I tried the 30 mm Mikuni slingshot carbs (That means the slide is round with a flat back side) on my RD350. The result was very convincing:
For the two cylinder bike I guessed a 3 to 5 HP boost at the top end without losses in the midrange. In the RD500 it would be 6 to 10 HP more!

These carbs fit in the stock RD500 flanges and the outer carb dimensions are not much bigger than stock. Only the lower left carb has to be distanced away from the generator cover (see Figure 29).
To get clean air it should be ok to use big foam air filters for Weber automotive carbs. Marco Böhmer uses them for his RD350 and they work well.

Unfortunately there is no fitting for the gas petcock vacuum-line so you'll need to manufacture one on your own. I fitted it to the balancing pipe between the stock flanges using a glued in tube (two component adhesive).

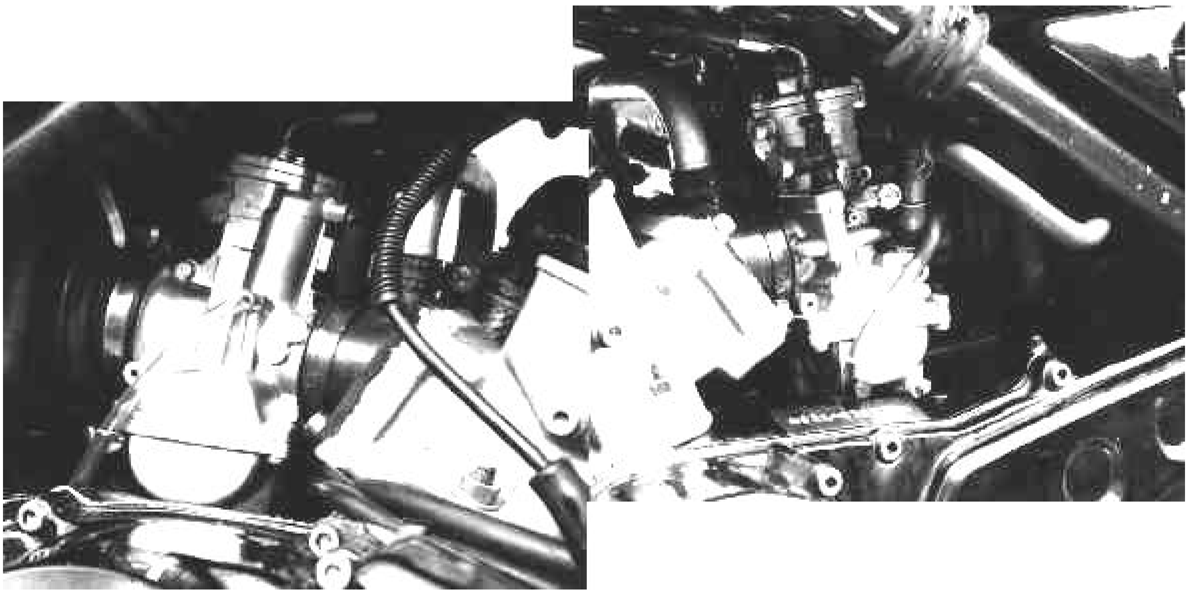


Figure 33: Mikuni TM30-6 slingshot carbs (RD350)

The cable distributor should look like the one I sketched before.

The TM30 choke is a problem in the RD500. You will have to convert them to a choke actuator for the handlebar as they have choke knobs at the carbs. But don't worry, the RGV250 cable based choke system will fit in the TM30 carbs and you can attach the cables to the stock choke lever.

After testing the TM30 carbs for more than one year on the RD350 I can strongly recommend it for everyday use around town and race tracks. I even found other guys who found similar setups and quite similar results without knowing my setup. Both were riding with Jolly-Moto pipes which required a slightly fatter main jet.
I’ve listed the RD350 setups as starting values for your RD500 engine; they should be on the rich side of the truth.

Carbs	TM30-6 (Mikuni delivery state)	TM30-6 (31K modified, stock pipes)	TM30-6 (31K modified, Jolly's)
Main Jet	#195	#150	#165 - #190
Power-Jet	#70	#55	#50 - #60
Needle	5EL68, Pos. 3	5EL68, Pos. 3	5EL68, Pos. 2
Needle Jet	N-9	N-9	N-9
Idle Jet	#40	#27,5	#27,5
Idle Mixture Screw	2 $^{1}/_{4}$ turns	1 $^{3}/_{4}$ turns	1 $^{1}/_{2}$ turns

Table 10: Setup Mikuni TM30-6 (RD350)

Fuel injected RZ350

In Winter 2006 I came in contact with Steve Murphree, an US citizen who had successfully replaced the carbs on his 1985 RZ350 with a “shareware” EFI (Electronic Fuel Injection) system called MegaSquirt. He's a very kind guy and shares all of his experience on his Homepage (http://www.smcomp.com).
Because a) you can find a more detailed description there and b) very few would do such a conversion on their own I'll just give you an idea of what's required to repeat that project on your bike.
Anyway, I'd strongly suggest that you contact Steve for assistance, if you're interested.

The ECU (Electronic Control Unit) uses open source and can be modified by anyone who knows how to program in C. Only the PCB (Printed Circuit Board) has to be ordered from a few distributors (complete kit is around 200 $). You can assemble the kit on your own or get the box completed by the distributor; troubleshooting and help is done via an Internet community (http://www.megasquirt.info). Reading and understanding the documentation alone is a task for a few weeks!
There are also a couple of useful additions like ignition modules or the stimulator board or testing the ECU.

Next Problem is setting the parameters for the injection. For this purpose there's a Freeware called MegaTune from Eric Fahlgren which is running even on the oldest Laptop (DB9 Serial connector required). Here you can set lot's of stuff that also has to be read up and understood before you can start running your engine.
Usually you test carb's by riding and comparing to your memory or dyno charts. With the MegaSquirt you get a data-recording feature for free (Freeware called MegaLogViewer). You can even attach several O2-Sensors available on the market and have the AFR/Lambda value recorded.

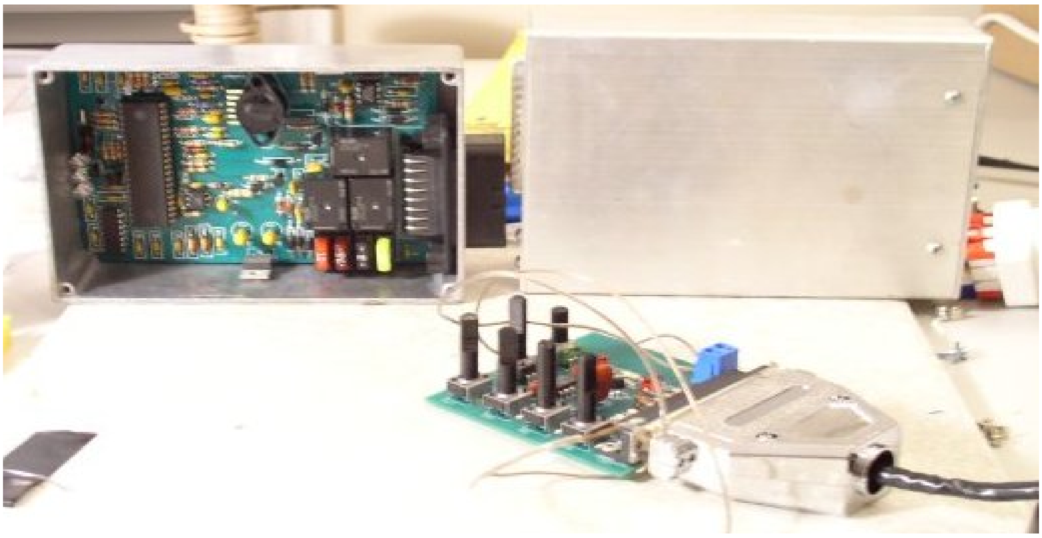


Figure 34: Steve's MiniMegaSquirt ECU (testing with stimulator board)

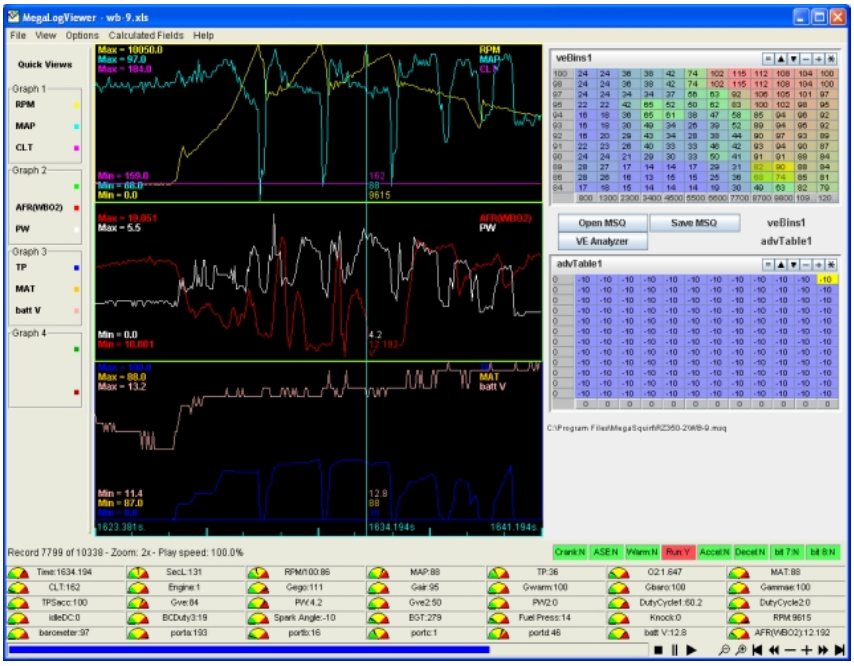


Figure 35: Screenshot from the data-recording Software

After having purchased the electronics-part you need some more hardware.

Every EFI system needs pressurized fuel to inject it to the engine. So he got an external & small high-pressure fuel pump from Walbro.
Then you need some injectors which have to be well chosen. Too big and you'll drown the RZ engine while idling; too small and you'll run too lean on WOT which will soon melt your pistons. Next point to look at would be availability and price. Steve ended up with using Yamaha R6 throttle bodies which are quite cheap to get (around 110 Euro for a set of 4). These have another advantage compared to “standard automotive stuff” - they have CV slides which keep the intake gas velocity in reasonable regions.
The Manifolds need to be angled to avoid the flat bar (over the carbs) on the RZ frame

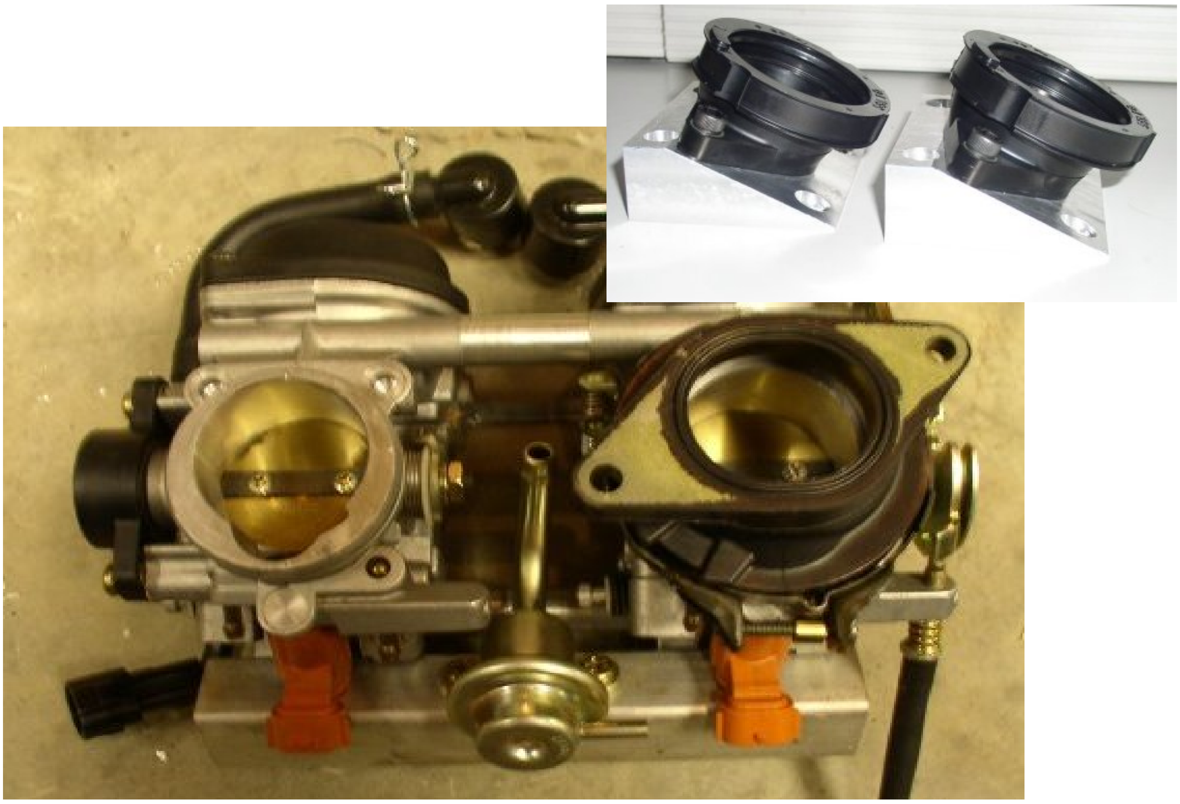


Figure 36: R6 Manifolds, throttle bodies & pressure regulator reworked to fit the RZ350.

The main trick for the whole system is that it doesn't use a mass-flow sensor but calculates the mass of air from manifold pressure and intake air temperature. This saves the expensive and hard-to-tune heated wire sensor that you can find in most automotive injection systems.
If you know the “mass of air that got into the cylinder at the current working cycle” you can use an injector to get the exact required fuel for a desired Air/Fuel ratio. Ideally this is 14.7:1 for gasoline, but MegaTune can handle also alcohol-fuels.

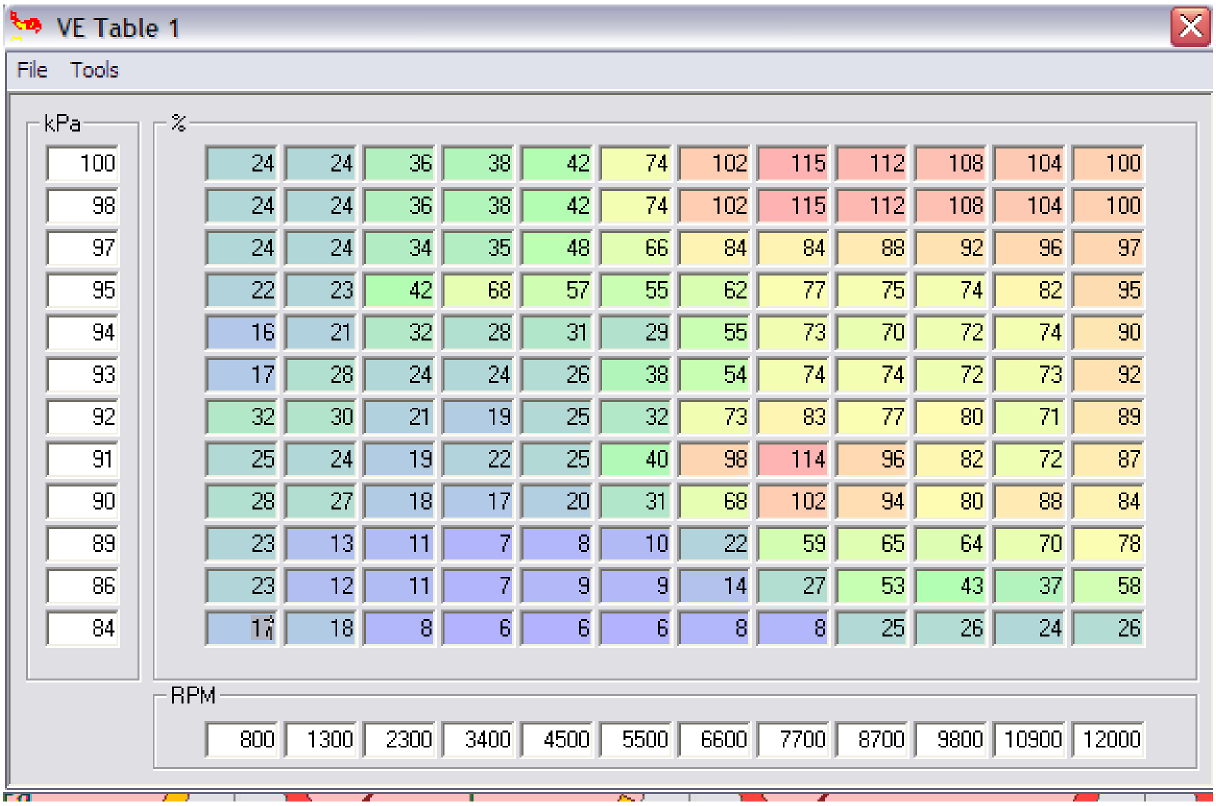
The injector is nothing but an electronically controlled valve that sprays the atomized fuel info the manifold (up to now it woks almost as a carb).

At the beginning you assume that the VE (Volumetric Efficiency) is 100% at every state of the engine, which would mean that with every stroke the piston gets a 350 ccm of air into the engine and you inject the correct amount of fuel for a 14.7 ratio (that'd be a value of 100 in the table). This VE-table is the central tuning element in the FI system.

Finding a setup here means to determine how much your engine deviates from the “ideal” i.e. which correction you need to make the engine working well at every point of the Table (Manifold pressure vs. Rpm vs. VE value). A higher number means injecting more fuel, a lower number means a leaner setting.

I'll give you an example: If you find that at a point of the VE table and an “old” VE value of 60 the measured AFR is 15:1 but you'd rather like a 13:1 (better for max. performance) you need to set the value from 60 to 72 (60 * 15 / 13).

If it now comes to your mind “how the hell do I tune this without a O2 Wideband sensor and a dyno?” the answer is: Like you'd do it with your carb; it's a long try and error work, just that “changing jets” is now only hooking up the laptop and doing some mouse-clicks.



kPa \ RPM	800	1300	2300	3400	4500	5500	6600	7700	8700	9800	10900	12000
100	24	24	36	38	42	74	102	115	112	108	104	100
98	24	24	36	38	42	74	102	115	112	108	104	100
97	24	24	34	35	48	66	84	84	88	92	96	97
95	22	23	42	68	57	55	62	77	75	74	82	95
94	16	21	32	28	31	29	55	73	70	72	74	90
93	17	28	24	24	26	38	54	74	74	72	73	92
92	32	30	21	19	25	32	73	83	77	80	71	89
91	25	24	19	22	25	40	98	114	96	82	72	87
90	28	27	18	17	20	31	68	102	94	80	88	84
89	23	13	11	7	8	10	22	59	65	64	70	78
86	23	12	11	7	9	9	14	27	53	43	37	58
84	17	18	8	6	6	6	8	8	25	26	24	26

Figure 37: Steve's VE table for his RZ350

In the table above note that for example at WOT and around 8000 you need 15% richer setting than at 12000. You'll have a problem to get this result with a carburettor. In fact you'll either run too rich at 12k or too lean at 8 k!

The other main advantage of his EFI to a carb is that weather is compensated automatically. The ECU has sensors for air-pressure and temperature, so if you have found a good setup on one day in spring it'll automatically work summer & winter – another feature that you'll never have with a carburettor!

The only disadvantages were:

- 5 pounds more weight.
- more load on the battery / generator (fuel pump needs 48 W = 4A)
- Not as easy to install and tune as a set of carbs; Thus additional costs for assistance service.

I'd compare the whole thing with convincing a Windows user to get Linux.
You'll have a lot of effort getting all needed drivers and setting up the system, but once it runs, it's stable and convenient.
Currently (Dec. 2006) I'm in contact with Steve and he's putting together an ECU and collecting all the required hardware. I'm planning to have my own RZ350 running by Spring 2007. Steve's next project will be his RZ500.

Figure 38: Engine completed

Intake system

Reeds

There are different types of reeds available for the RD/RZ engines.

The reed-valves have the task to ensure that fresh gas/air mixture does not escape into the carburettor while the piston is going down. A slight disadvantage of this construction is the fact that the incoming gas has to open the reeds before entering the cylinder. This causes a slight pressure loss.

You can gain low- and mid-range power if you use “softer” (which mostly means thinner) reeds.

Now comes the second important thing about reeds: The natural resonance frequency of your reed assembly depends on weight and stiffness. It’s one of the factors that determine the redline of your engine because if you reached the max. rev-state, the reeds come to a state of undefined oscillation which is not synchronised to the engine needs.

If you use lighter material, you can have a lower stiffness (gain in mid-range power) without changing this characteristic frequency. You can also use a thicker reed of the same material to gain more top end power, because this raises the resonance frequency.

Carbon fibre reeds are said to have a broadband effect: They should increase power especially in low and mid range but also at the top-end. The disadvantage is that these are not quite as reliable as fibre or steel reeds.

The following Figure summarises the effects of thickness and material on engine behaviour.

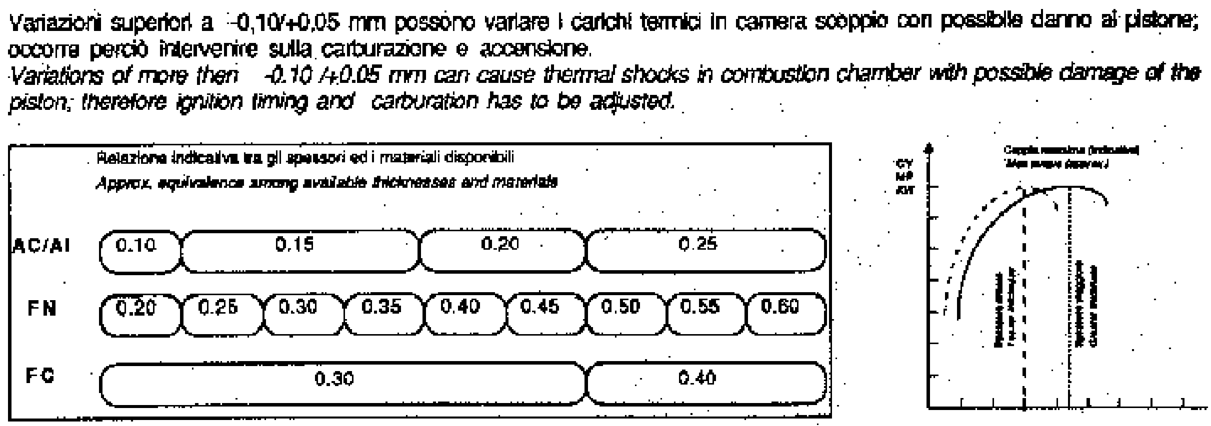


Figure 39: Reed influence on engine performance (origin: Adige, Italian reed manufacturer)

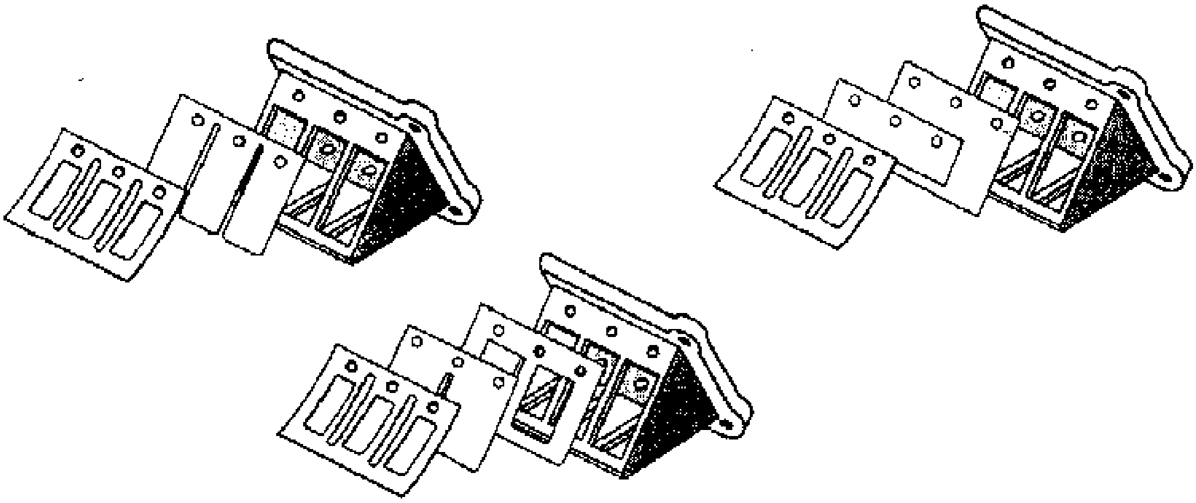


Figure 40: Different reed types (multi-petal, dual stage, mono-petal)

In any case you will benefit from removing all the burrs in the stock cages and converting the backs of the bridges to a streamline profile. Be careful with your file and only work against the flow direction (rasp from rubber to metal). Otherwise the rubber can come loose and the cage becomes a neat deco object for your living room.

If you want to use the stock reed assembly you should modify it regarding the YAMAHA race specs. If you enlarge the 37.5 x 30 mm rectangle to the required 39 x 39 mm you have to match the rubber manifold to the new dimensions. I would only recommend it for high performance applications; in mild stages it's enough to remove the burrs and to modify the upper edge of the cage ports (3 mm dimension).

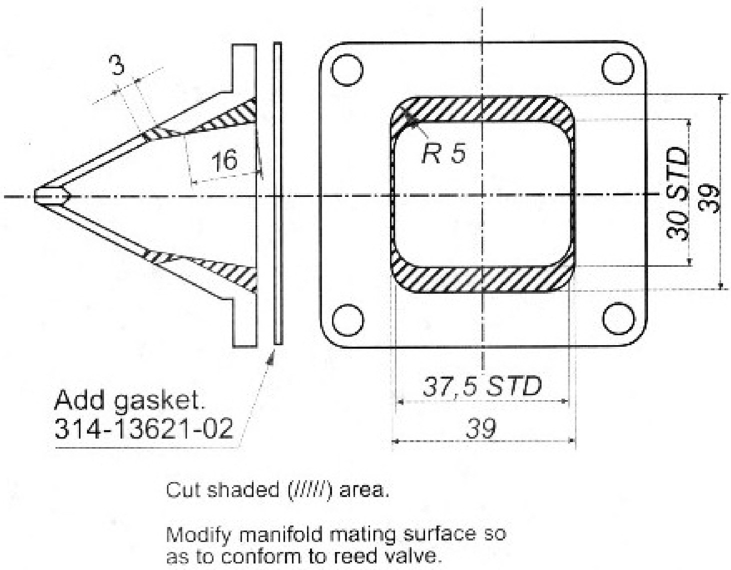


Figure 41: Reed mods (YAMAHA race specs)

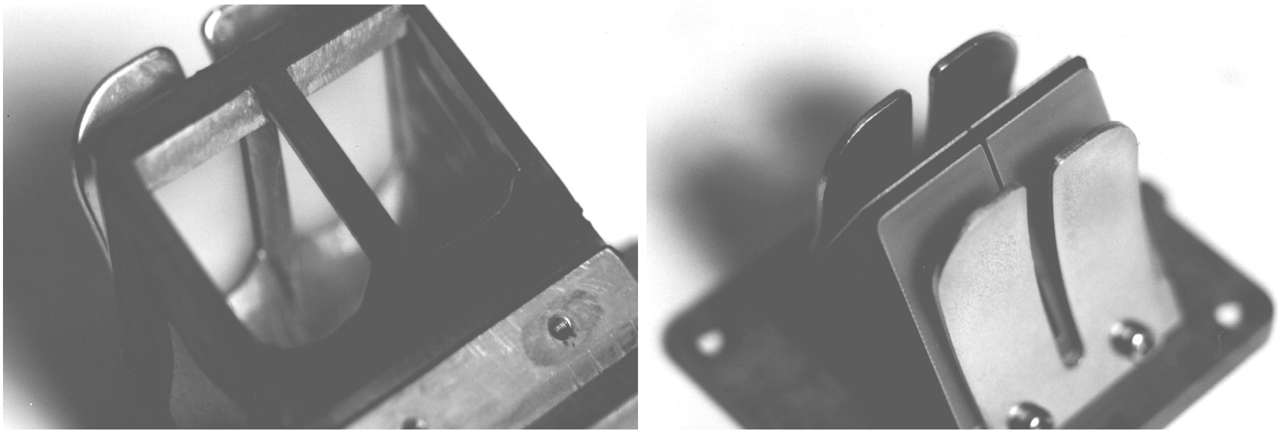


Figure 42: Modified stock cages with fibre reeds (HyTech by Götz)

When using Boyesen or mono-petal reeds on stock reed cages you can remove the bridges in order to increase cross section area. In Germany you can get them from Zupin and the set contains all reeds for the RD500. If you can get them for the ‘80-’82 RD350LC (without YPVS) it will fit in the RD500 too; you just need two sets.

In contrast to the catalogue specifications the Götz fibre and carbon-reeds (RD350LC) are not Boyesen type but standard two pedal reeds. They are packed in a set for both cylinders, so you only have to order two sets (and not four as stated in the catalogue).
Moreover they offer so called Superval reeds which consist of several smaller reeds which are just turned about 90 degrees. They claim to obtain even more midrange power, but I haven’t tried yet nor do I know anyone who had done so. If you order them use the RD350LC (80-82) types.
At this shop you can also get plenty of reed stuff for different 80 cc bikes. They offer several multi-petal reeds for the YAMAHA DT80 which are somewhat bigger than the RD500 cages. The 6 petal cages are said to be 46 mm broad, so you would have to open the reed housing slightly (stock: 44,5 mm broad).

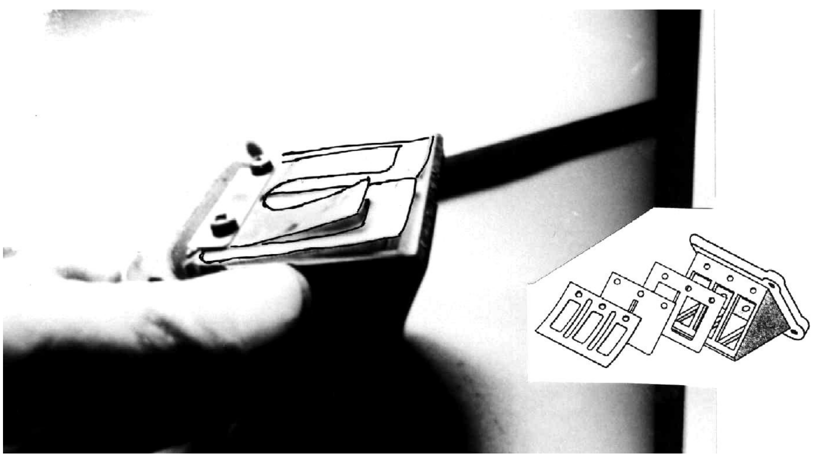


Figure 43: Boyesen-reeds (RZ350)

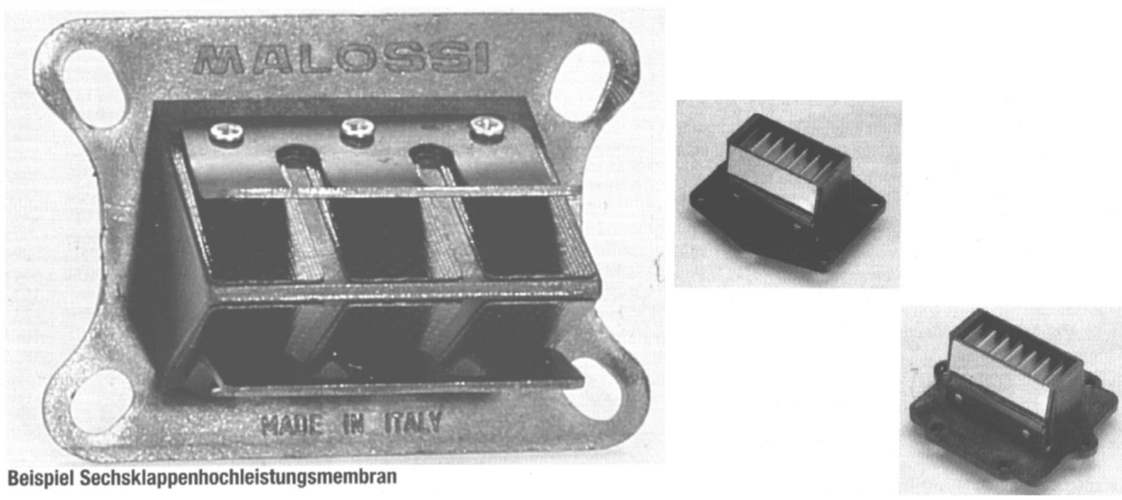


Figure 44: Left: 6 petal reeds for DT80, Right: Superval reeds

This gives you plenty of possible combinations as:

Example 1: Instead of the 0,15 mm thick stock steel reeds you use fibre reeds of 0,4 mm thickness (Götz 69,-). These reeds are a little bit harder and lighter (weight -33%) which tunes the upper mid-range and the top end. You gain a better throttle response and a better acceleration.

Example 2: Instead of the stock reeds you use mono-petal types (Orma) including the Collet setup. This gives you up to 5HP more in the most used mid-range.

Example 3: Instead of the stock reeds you use Boyesen-type reeds which have a so called “vented” or “dual stage” design. That means that there is one big reed petal with one or two holes in it which are covered by another thinner reed.
This has the effect of combining the advantages of having gains at mid-range (thin auxiliary reed) and at the top-end (thicker main reed).
In Germany they are available at Zupin for about 200,- DM (four cylinder set).

Example 4: Instead of the stock steel reeds you use other cages with fibre or carbon reeds. Either you can use the RZ350 cages which are cheap to get (and have the same mounting holes) or you try to fit the 6-petal-cages from Götz or take them from old 80 cc MX-bikes. Any bigger cage will be highly appreciated as the bigger cross section area increases the flow. This gives you more power in every range but especially in the middle and upper.

The first three examples are for those of you who are not mechanics and only want to optimise the engine. The RZ reeds wont bolt straight into the RD500 cylinders!
You will have to broaden the intake area by about 1.5 mm at each side to take the bigger cages. Dependent on the thickness of the wall you may have to use epoxy or

welding material to close the holes. Concerning tightness this location is not stressed that much but take care that you have absolutely no leaks here because they will cause severe engine damage (mixture leaning out due to additional air).
At the lower cylinder bank it is even more difficult because first you will have to manufacture a new reed housing plate to take the RZ cages. Then you will have to use epoxy very carefully when broadening the intake passages in the crankcase. Due to the bolts which are located directly near the intake area there isn't much space left.
I decided to make a compromise between expense and performance and used the RZ reed cages at the upper and CR80 cages at the lower bank. In the rear cylinders I had to use plenty of epoxy as the wall thickness was not sufficient. As I used Boyesen reeds I got rid of the bridges in the cages.
The CR80 reed cages are 44.5 mm broad and fit perfectly into the stock reed housing. You just have to modify the mounting holes. In these cages I used Boyesen reeds as well as removed bridges.
After fitting the cages into the cylinders you have to match the rubber manifolds to the new cage dimensions.
With hindsight I have to admit that (with stock carbs) the first step (modified stock cages with fibre reeds) performed the same as the RZ/CR reed stage. The bigger reeds even required more jetting changes. (I'm sure it will work better when I fit the TM 30 carbs .... .)

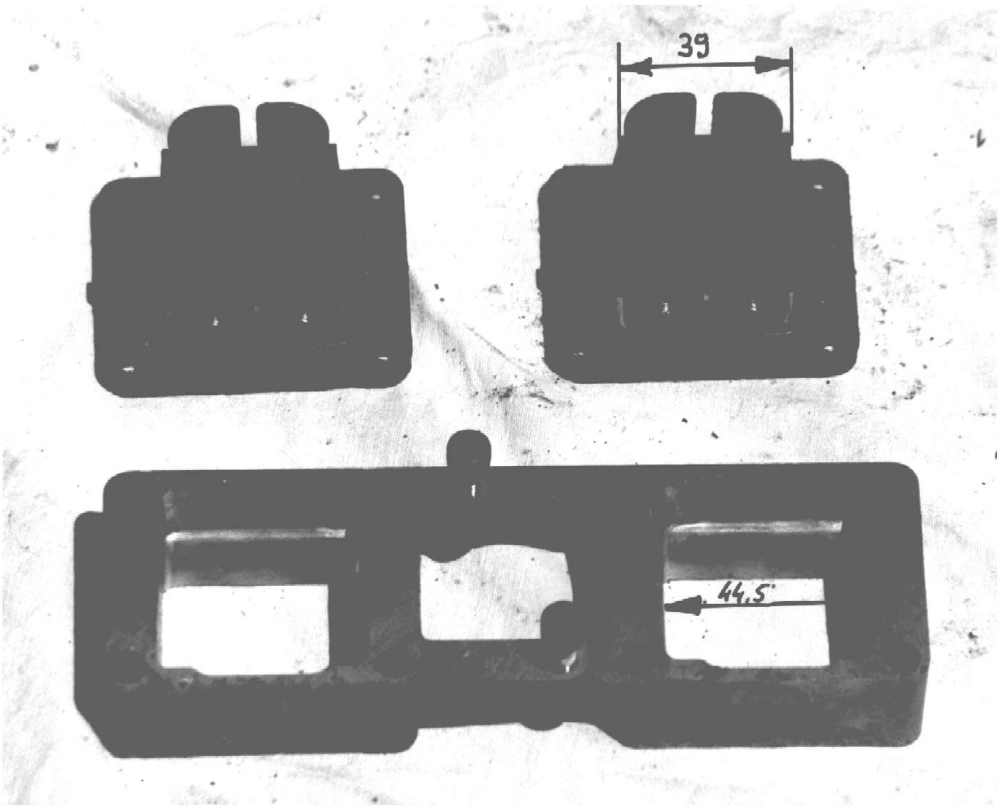


Figure 45: Stock lower reeds with housing plate

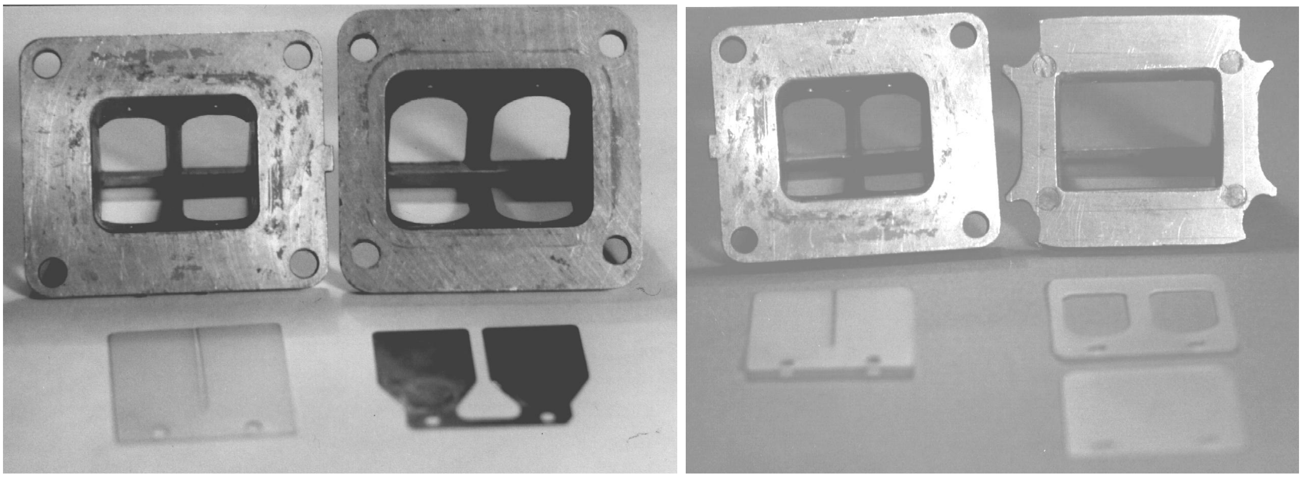


Figure 46: Left: RZ350 cages, Right: CR80 cages with bridge removed

If you want the most power for race applications you can try the TZR250 reed cages. I use them in my RZ350 and they perform very well. In the RD500 you have to consider that they are slightly broader than the RZ350 cages. As they fit in the 350 they are difficult to find and not that cheap. New ones cost around 400,- DM for a set of four (Part No: 1KT-13610-00 Reed Valve Assy)
For the TZR 250 cages the TZR 125 carbon-reeds can be used. Here you have to order four sets (about 70,- DM each) from Götz. Stock fibre reed petals are available at YAMAHA for about 12,- DM each (Part No: 1KT-13613-00).

Porting

To increase gas flow the intake area of the rear cylinders has to be machined as described below:
The port basically stays in stock shape. The only thing you have to do is to cut down the bridge from 10 to 6 mm according to the Yamaha race specs.

It's also worth smoothing the intake surfaces with #200 sand paper. It has no advantages to polish in this area, because the flow velocities aren't high enough.

At the back of the bridge you can grind some kind of aeroplane wing cross section shape. This makes it easier for the airflow to get into the crankcase.

If reliability isn't the main thing, you can increase the port width by about 1 mm (left and right). Additionally you can narrow the bridge from stock 10 mm to a value around 4 mm (=> increased piston wear) and increase port height at the top and bottom port edges.

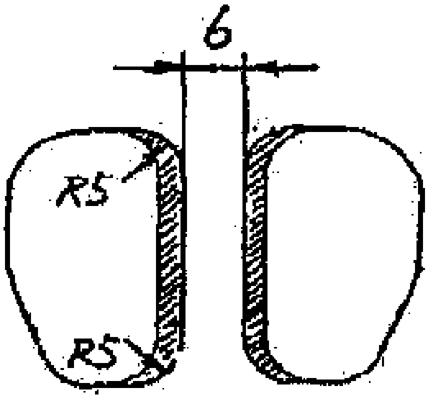


Figure 47: Modified intake port shape (YAMAHA race specs)

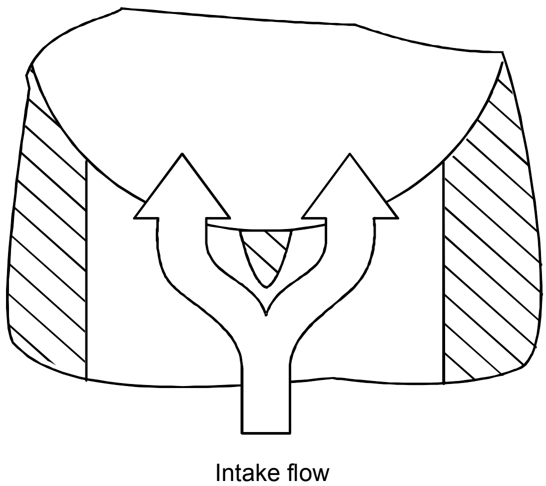


Figure 48: Section of the intake area (reed housing)

Crankcase

Matching the case to the cylinder

This chapter is not that important for increasing engine performance but if you've already opened the crankcase for rebuilding, you should rework it as follows.

Check out if the top half of the crankcase has an edge in the scavenging port area. Sometimes the cylinders don't match perfectly to the crankcase port shape.

If you have such an engine, remove the edges with a file, a die grinder or other milling tools. Be careful not to cut too deep at once. You can put the cylinder onto the top crankcase half and feel with your fingers how much material is left.

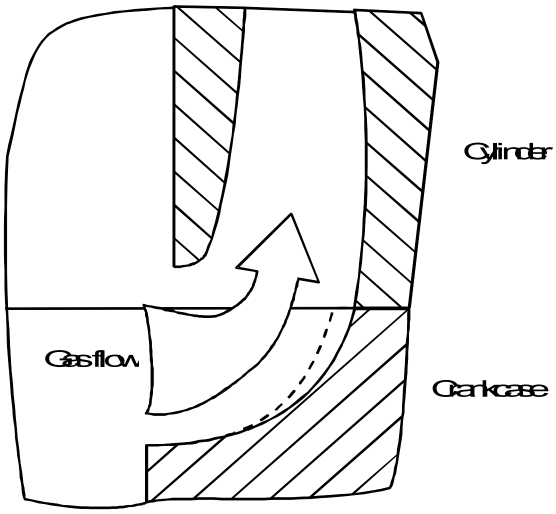


Figure 49: Section through cylinder and crankcase along the scavenging-port

In the rear cylinder bank the bridge is continued in the crankcase. You can use the aeroplane cross section shape here, too.

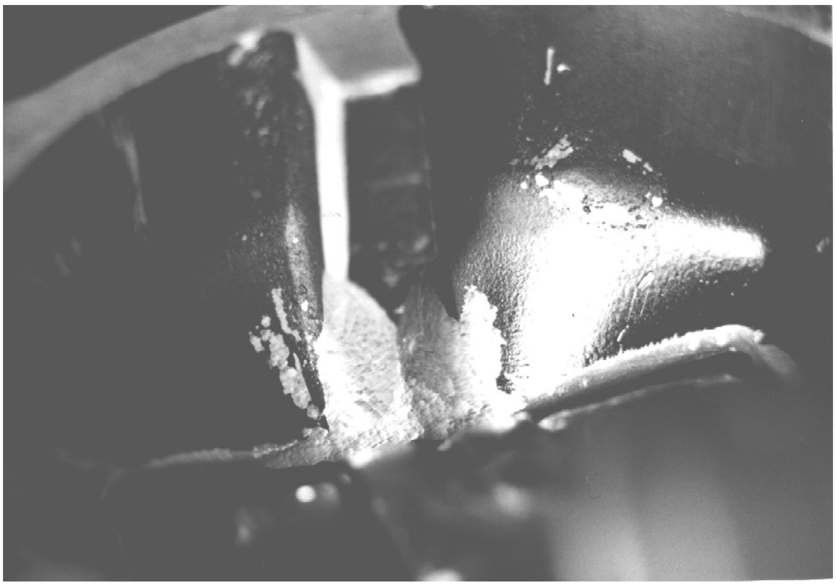


Figure 50: Continuation of intake port bridge in the crankcase

After finishing the milling job you can polish the reworked area or – if you're as lazy as I was – just smooth it with #200 sandpaper.

Before you mount the cylinders onto the crankcase, you have to cut the gaskets to their new shape with a sharp knife. Just use the sealing surface either of the crankcase or the cylinder as the reference pattern and cut the gaskets where they tide over. Finally I would recommend mounting the gaskets with a thin coating of Dirko on both sides if you use them for a second time. The stock gaskets are already coated with a sealing compound.

Cylinder sleeves

At the upper cylinders the sleeve is not as streamlined as it would be necessary. This is a result of the quite thick aluminium embedding of the cast iron sleeve. The boost port flow is forced to go by some sharp edges which you should rework to radiuses.
If you think about how the gas gets from the crankcase into the scavenging ports you will recognise exactly the regions where to manufacture the radiuses.

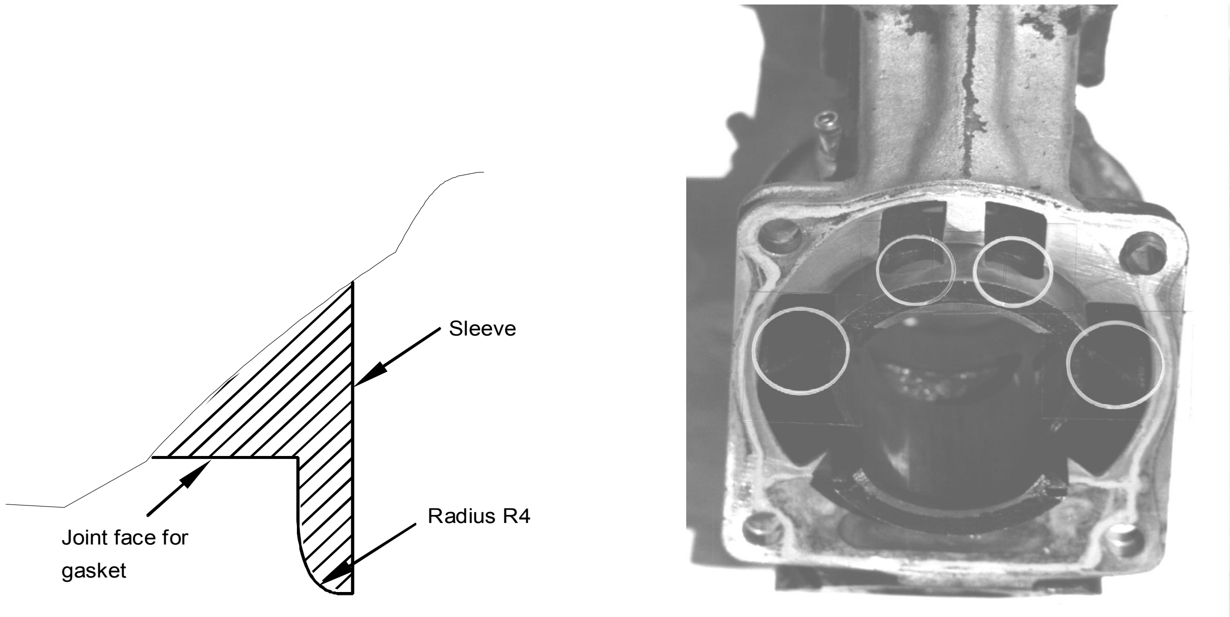


Figure 51: Upper cylinder, stock sleeve

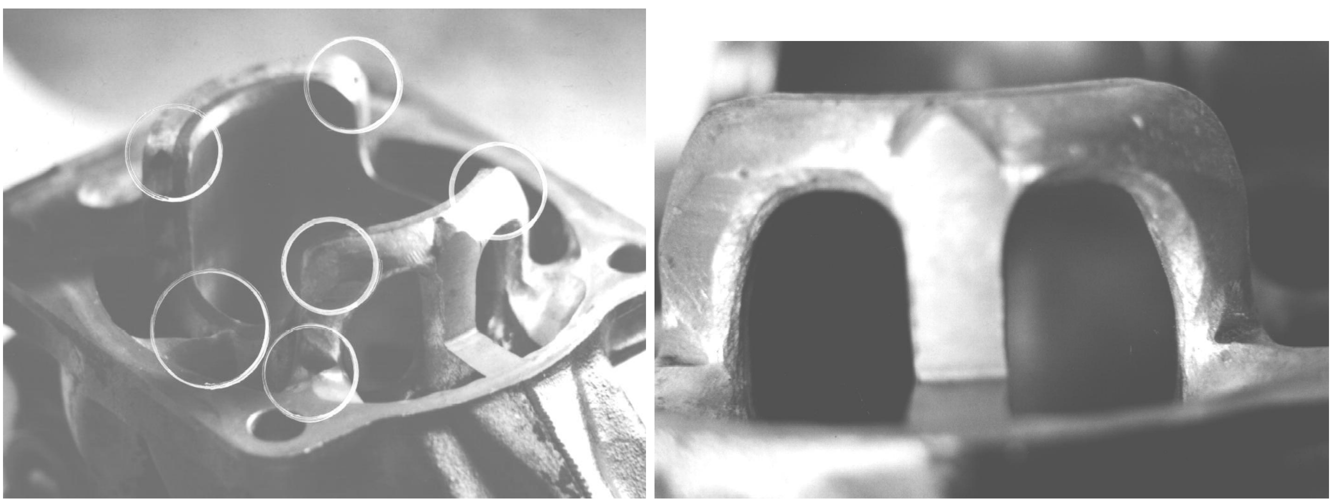


Figure 52: Upper cylinder, modified sleeve

At the lower cylinder bank the sleeve is easier to modify because you haven't got to grind as much as at the rear bank. Here it is mainly required to round the boost port area.

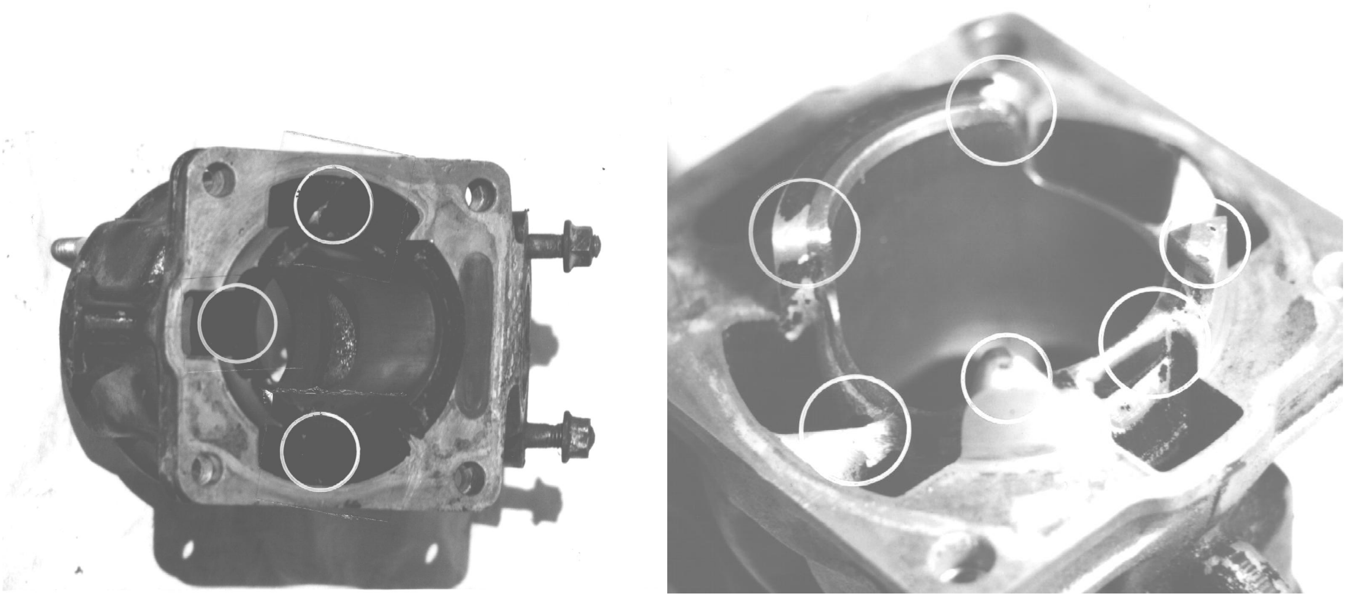


Figure 53: Lower cylinder, left: stock, right: modified

Pistons

As you may already know pistons wear quite rapidly in RD engines. In normal conditions they should last about 20-30.000 km. After that mileage you should use new ones when opening your engine; if not, just wait until they seize or other damage occurs ... . With rising mileage they become more and more sensitive to cracking. In this case the whole piston skirt may come off and result in severe (i.e. very expensive) crank failure. Another bug of the first models (and the TZR as well) are the cotter-pins in the ring grooves. The can get loose at higher mileage and if they do the ring turns around and gets caught when passing a port area. This leaves a very deep scar in the sleeve (Stock pistons are only available in two overbores). YAMAHA claims that the newer pistons would be somewhat more resistant against this effect.

In mildly tuned engines I always use Prox pistons because they are stock quality but for half of the stock costs (about 160,- DM complete kit with gudgeon pin and rings).
In Germany they are imported by Großewächter and distributed through your local dealer. If you want to use them for the RD500 you have to purchase two for the DT/RD125LC (rear bank) and two for the TZR250 (front bank). However, the DT pistons have the steps 56.5, 56.75, 57.0, ... whereas the TZR ones are available in 56.4, 56.65, 56.90, 57.15, ...

Forged pistons are slightly lighter and have thinner rings which allows much higher maximum revs. (When using Prox pistons you have the risk of ring breaking if you combine them with pipes revving more than 11.500 rpm.)
The disadvantages are the high price of about 400,- for a set of two and the and a higher thermal expansion of the material. In order to avoid early seizures it is recommended to increase piston clearance from stock 0,06 – 0.065 mm to 0,07 - 0,075 mm with Wiseco pistons.
If you still want to order them do me a favour and don't order them at Wiseco Germany (Wößner GmbH) because the people are very arrogant and unfriendly. For example they don't sell single pistons, even if you beg for it over and over! (Meanwhile you can get them from Großewächter or from Marco Böhmer.)
There are rumours that in Germany they sometimes have a problem with delayed delivery of up to two months. To make it even more complicated they don't appear under RD500 in the latest catalogue but with TZR250 and MX,IT,DT125 (Wiseco Nr. 236). I know plenty of people who use four of the TZR pistons in their engines.
Regarding the dimensions you can also use the single ring type pistons for the YZ125 (1984, Wiseco No. 512). In the RD500 Club Newsletter they said that these pistons wear very quickly and that the ring locating pin is too close to the boost port region. This bears the danger of the ring getting caught in the port and breaking.

If you had severe engine damage such as torn rods you may need new cylinders. At Großewächter and Wiseco you can have the sleeve rebuilt. They machine the bore to bear a new cast iron sleeve and then you can start at the stock 56.4 mm bore again. Statement from Wiseco: The degree of damage is not relevant! The costs for this labour are between 350,- and 500,- DM per cylinder.

The piston skirt should be machined and polished to a knife-like shape as shown in Figure 54.
You can widen the ports in the inlet skirt about 1 mm all around, but if you do so the risk of cracking rises significantly. I'd recommend leaving them as they are when using Prox or stock pistons, because making them slightly bigger doesn't result in a noticeable increase of performance.
For the Wiseco pistons it's a little different. Due to the constant thickness of the piston skirt and the tougher material you can increase the port area, but don't do too much. Just 1 or 1 ½ mm around the port shape is enough.
In the YAMAHA race specs they even use four front pistons (at the rear bank without porting in the skirt). The German tuner WiWa uses four TZR pistons as well.

In the next step you ought to bring in some lubrication bores at the inlet bridge and at the exhaust skirt. Don't forget to deburr with a 90° counterbore. (see Figure 55, too)

The bore at the intake bridge maintains lubrication at the smaller bridge and the bore at the exhaust area is originally from Armin Collet, who is very experienced in RD tuning.
You're right if you think that the outlet side bore comes in contact with the exhaust port area in TDC, but don't be afraid, it works!
These pistons won't have the typical dark or seized exhaust skirt area (see Figure 56, middle) even after thousands of kilometres.

The last process is – you may have guessed already – to polish the top side of the piston to avoid too much oil-carbon deposit.

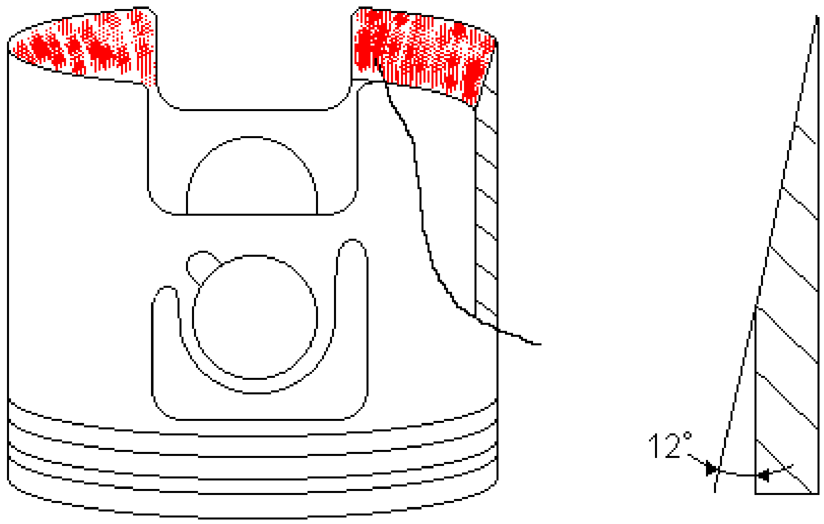


Figure 54: Piston skirt cross section after machining

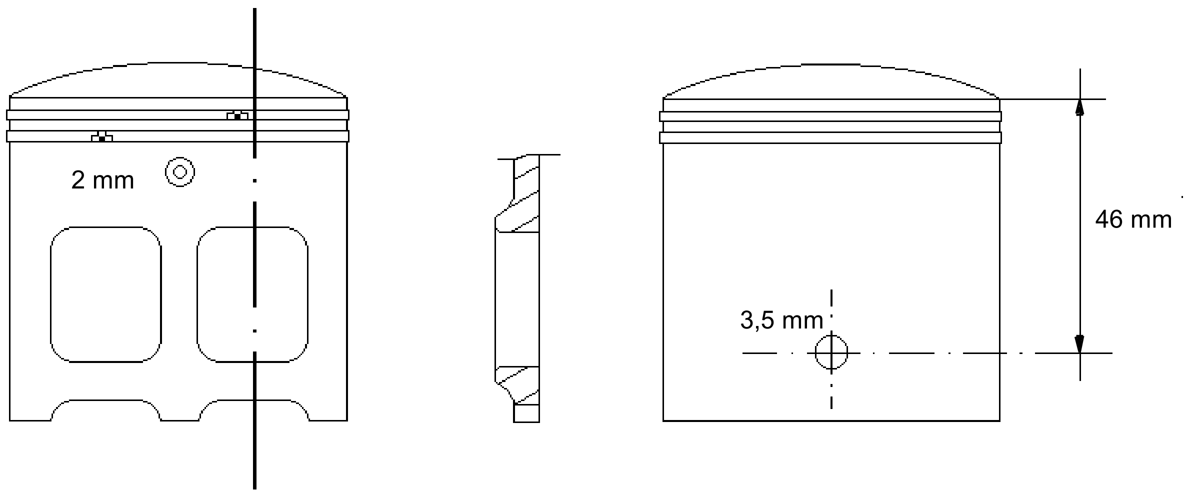


Figure 55: Piston lubrication holes

Figure 56: Damaged pistons: left: broken ring, middle/right: seized

In the YAMAHA race specs they required a quite extreme piston modification. The skirt should be machined to be 8 mm shorter and they leave out the lower piston ring in order to decrease friction losses. The recommended piston clearance was 0.055 to 0.065 mm (instead of stock 0.06 to 0.065 mm).
Furthermore they use the same pistons in all cylinders. In road use I'd dissuade doing so, but if you machine the pistons that way you can add the lubrication bores and machine the skirt to the knife-shape.
In any case don't wonder if you can hear heavy piston tilt noise during engine operation. Due to the tilting these won't last very long.

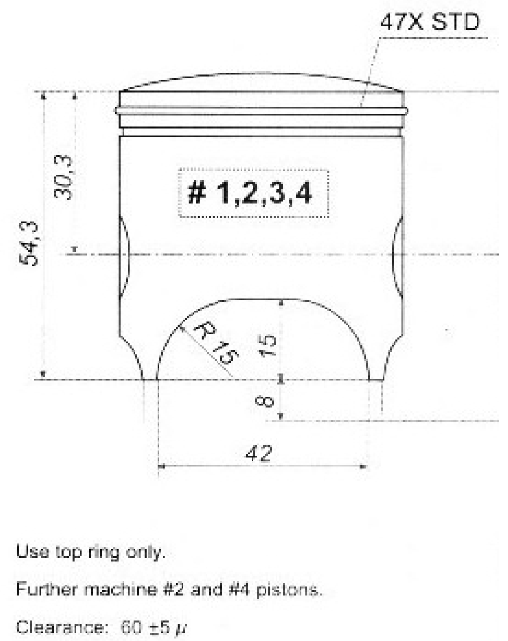


Figure 57: YAMAHA race modifications for the pistons

Scavenging Ports

Converting the scavenging system is a very tricky piece of work even for a skilled person and you need a very tiny die grinder. Even if you manage to perform this difficult task you have no guarantee that it works. For this reason I have decided not to change the port layout, but only to do some minor optimisation.

At the rear bank YAMAHA obviously forgot the matching joint surface between the boost port and the transfer port in the crankcase. In the part catalogue and workshop manual they were there, but in my engine they were missing. So you’ll have to machine some big radiuses in this area to maintain free flow.

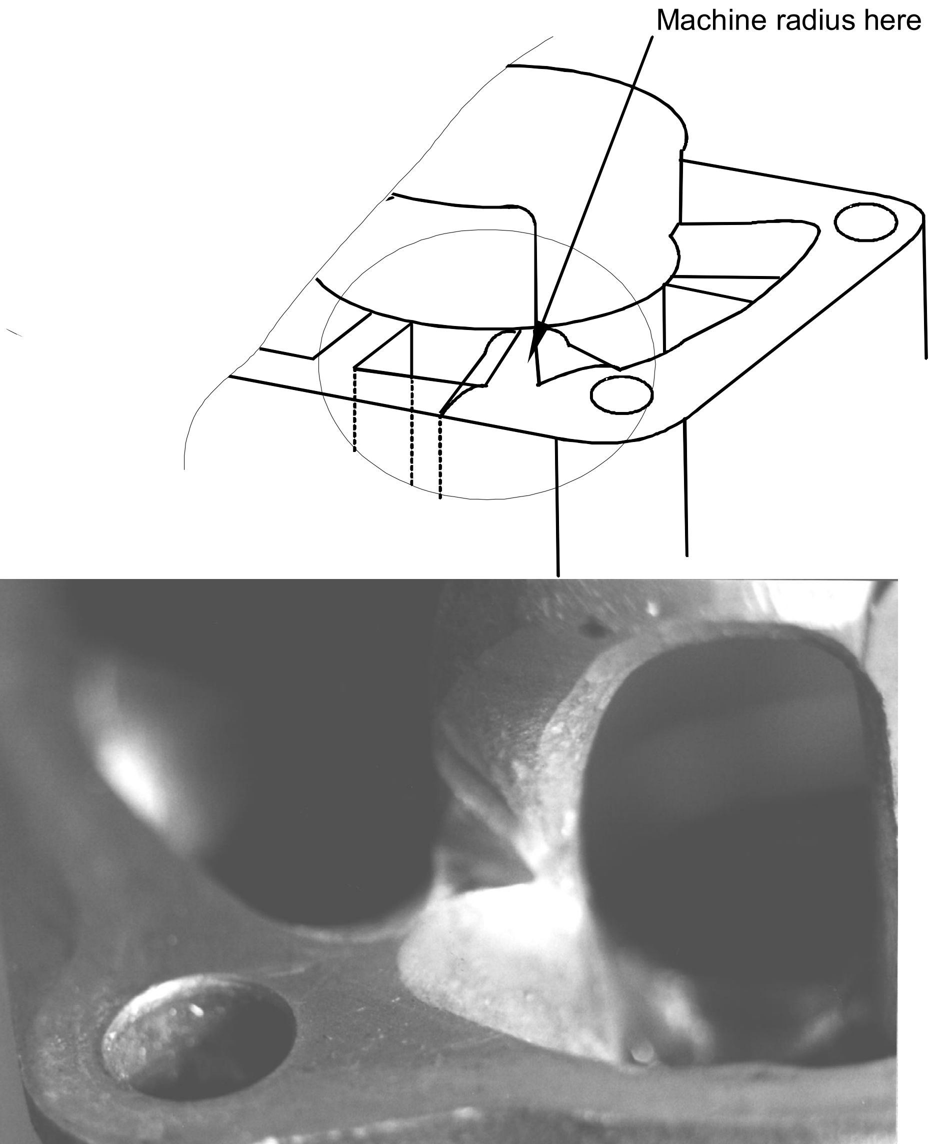


Figure 58: Region between boost port and transfer port

The bridge which separates the two scavenging ports should be ground to a wing shape (similar to the inlet port bridge). The sleeve gets a little radius in this area. (see Figure 59). If you machined the pistons it could be necessary to lower the sleeve some mm in the port area.

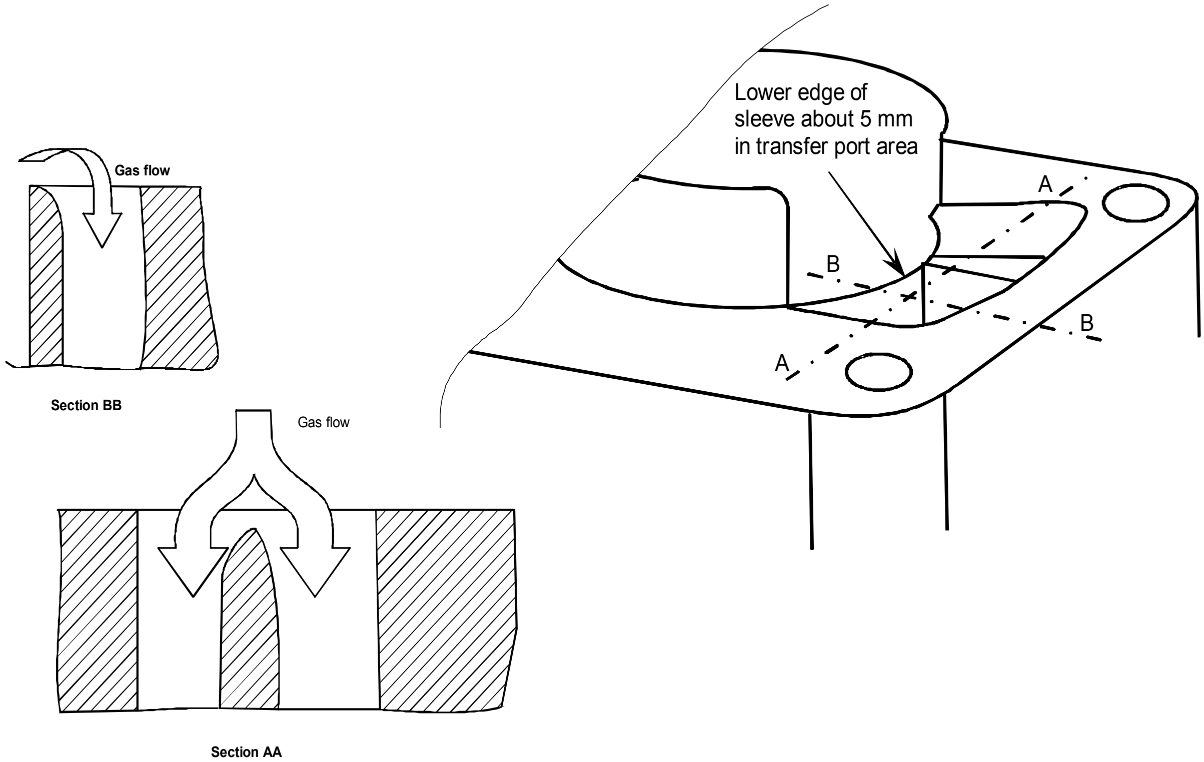


Figure 59: Transfer port mods

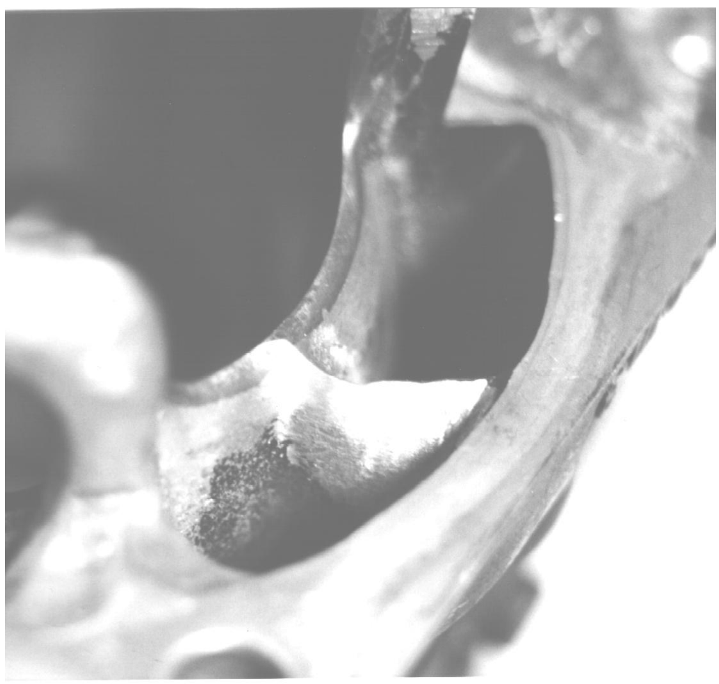


Figure 60: Transfer port bridge

All scavenging ports have some burrs at the sleeve which you can mill with a spherical cutter. This is a problem of manufacturing because the (cast iron) sleeve is put in the cylinder mould and then the aluminium is cast around the sleeve. It is quite difficult to position the sand core for the ports 100% accurately so this always leaves some burrs where they bother engine performance.

After finishing the other steps you can smoothen the port surface with #200 sand paper. If you have too much time you can polish but it doesn't make a difference at all.

YAMAHA required to bring all ports to the new height of 30 mm (stock: 30.5 to 31.5) which is a tricky piece of work. In Germany you can have it done at WiWa.
But you can do this as well through the back door by using a second base gasket (or a thin aluminium plate with base gasket shape) at the bottom and milling the top cylinder surface (value = thickness you added at the bottom). This has to be done by a skilled mechanic because the sealing surfaces of both cylinders must be exactly parallel and both distances between top and bottom surface must be within 1/100 mm. (By the way: You can't use these with only one gasket any more. Therefore I'd strongly recommend a marking.)
If you raise the ports very much, you may have to rework the lower port edges (they must line up with the top of the piston in BDC).

Generally it's better to use broader rather than higher ports, because this will have the lowest influence on the resonance in you engine; your mid range power will benefit from this. Altered ports always take performance from the bottom to the top.

Armin Collet usually machines the ports to a special shape in order to reach an undisturbed flow from the ports to the rear compression chamber area. It seems to work as his RD500 and RD350 engines always have a very good midrange. In contrast to the YAMAHA mods which give a short and strong pressure pulse the Collet style yields in a broader but weaker pulse. The effect on the torque is that in the first case you have high performance at the price of a small usable power band. The Collet version broadens the power band at the cost of top end power.

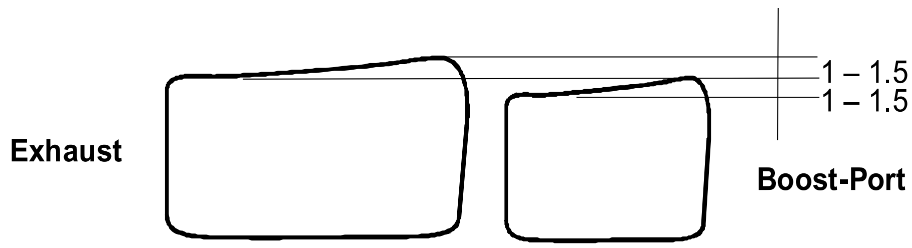


Figure 61: Collet style transfer ports

Cylinder head

A higher compression will improve torque in the lower and middle engine speed range. As a side-effect, the fuel consumption will decline.

The maximum possible compression ratio is mainly influenced by the fuel type, ignition timing and combustion chamber shape. If you exceed the limit the combustion will detonate which will damage either the piston or the rod/crank bearings or all of them.
The octane value numbers the ability of the fuel to resist these undesired detonations. If you altered the compression ratio I'd recommend only premium fuel (leaded or unleaded) with at least 98 octane. In stock engines YAMAHA recommends the German "Super bleifrei" (an unleaded mix between premium and regular with 95 octane).
Another feature which influences the needed octane value is the ignition timing. An advanced ignition requires higher octane values and vice versa.

There are two main ways to determine the compression ratio. In four stroke engines they use the whole displacement of a single cylinder for the calculation. In two strokes the Japanese use the volume above the Piston when it just closes the exhaust port. European two stroke constructors like Aprilia or Cagiva use the whole displacement.

$$\varepsilon = \frac{V_d + V_c}{V_c}$$

V_d = Volume of displacement (Either whole cylinder or from upper edge of exhaust)
V_c = Volume of combustion chamber in TDC
ε = Compression ratio

Yamaha claims the compression to be 1:6.6 (ε = 6.6) for all models.
In my 47X engine I measured a combustion chamber of 12.05 ccm rear and 12.25 ccm front (combustion chamber in TDC filled with oil up to the beginning of the spark plug thread). This yields to a compression value of 1:6.49 rear and 1:6.4 front.

In general you can find recommendations for machining about 0.5 to 1 mm, YAMAHA recommended up to 2.8 mm for maximum performance (chamber volume 11.3 ± 0.3 ccm, ε = 7.7). If you do this, reworking the squish area is inevitable. They also recommend the 0.7 mm straight section which I learned is necessary to keep the head gasket proof (see Figure 66).

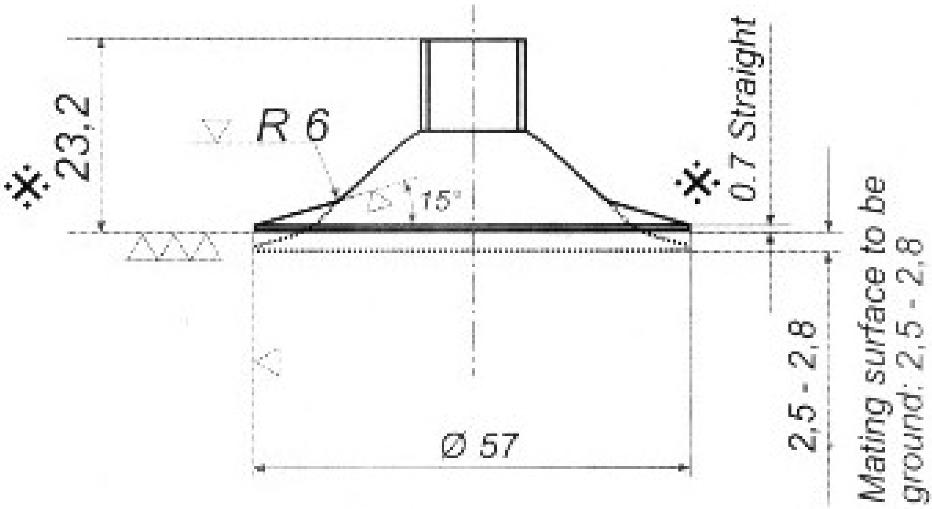


Figure 62: YAMAHA race mods for the head

Armin Collet has a very cheap possibility to increase compression: He removes the middle sheet of the head gasket, which is about 0.3 mm thick. (Compression increased to 1:6.86 / 1:6.75).
Thomas Fried machined the head some 0.5 mm and after reworking the squishband he had a 1:11.5 compression (calculated with the whole displacement).
Another guy claimed to have 128 HP with his extremely tuned RD500 and he machined the pistons and cylinders to the same dimensions as they were different.
This is partly right and responsible for the different head dimensions. The front one (Marking 47X**1**-Y1) has a 0.7 mm straight section, the rear one (Marking 47X**2**-Y1) hasn't. He machined the pistons to the same dimension from gudgeon pin to upper piston edge as his Wisecos had some 1/10 mm deviations. After that you can modify the rest and maintain the optimum squish band of 0.75 to 0.9 mm.
My recommendations for stock engines: Mill the front cylinder upper mating surface about 0.2 mm and at the rear bank about 0.5 mm. The front head has to be machined about 0.4 mm to maintain the same compression chamber in all cylinders. (This is the cheapest way because you don't have to rework a squishband)
The compression ratio should be around 1:7.13 to 1:7.16; the rear squishband is 0.9 mm, the front one 1.1 mm.
I would guess the maximum (road-) usable value would be roundabout 7.5 to 7.7. Standard stock engines like the TZR or RGV have values about 7 to 7.5; the TZ-Racers claim 12.5 (or 8.3 in Japanese sight). Italian 125 cc bikes hang around 1:15 (calculated with full displacement).

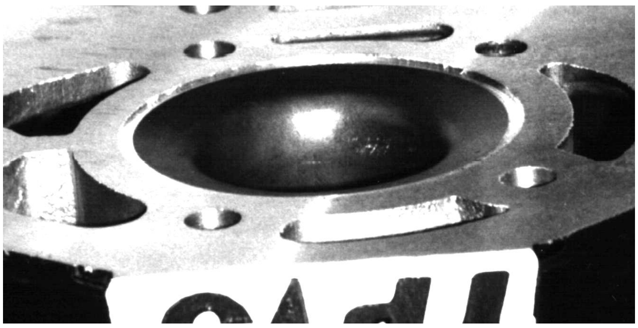


Figure 63: Milled cylinder head with reworked 0.7 mm straight (RZ350)

-

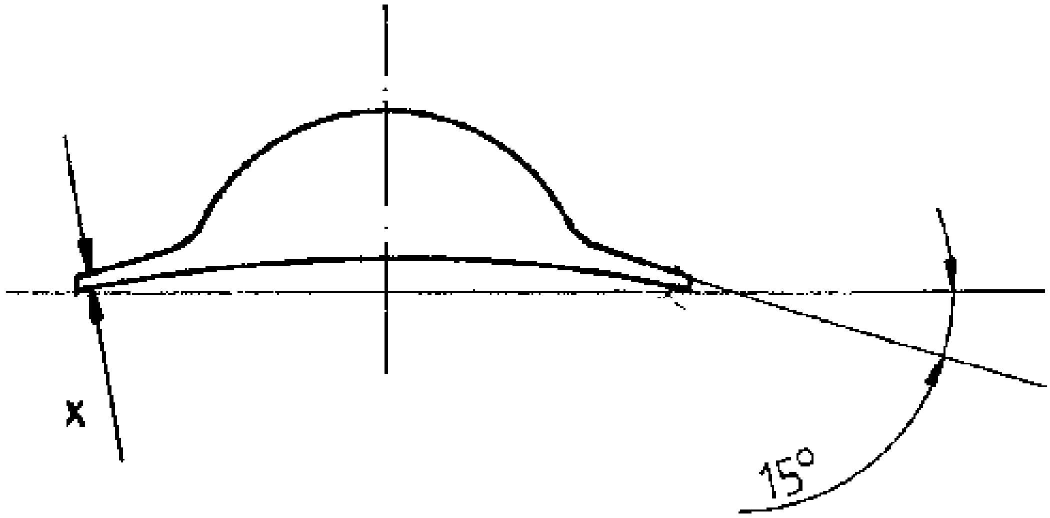


Figure 64: Cross-section of the stock combustion chamber in TDC position

(optimum dimension X: 0.75 – 0.9 mm or 0.03 – 0.035 inch)

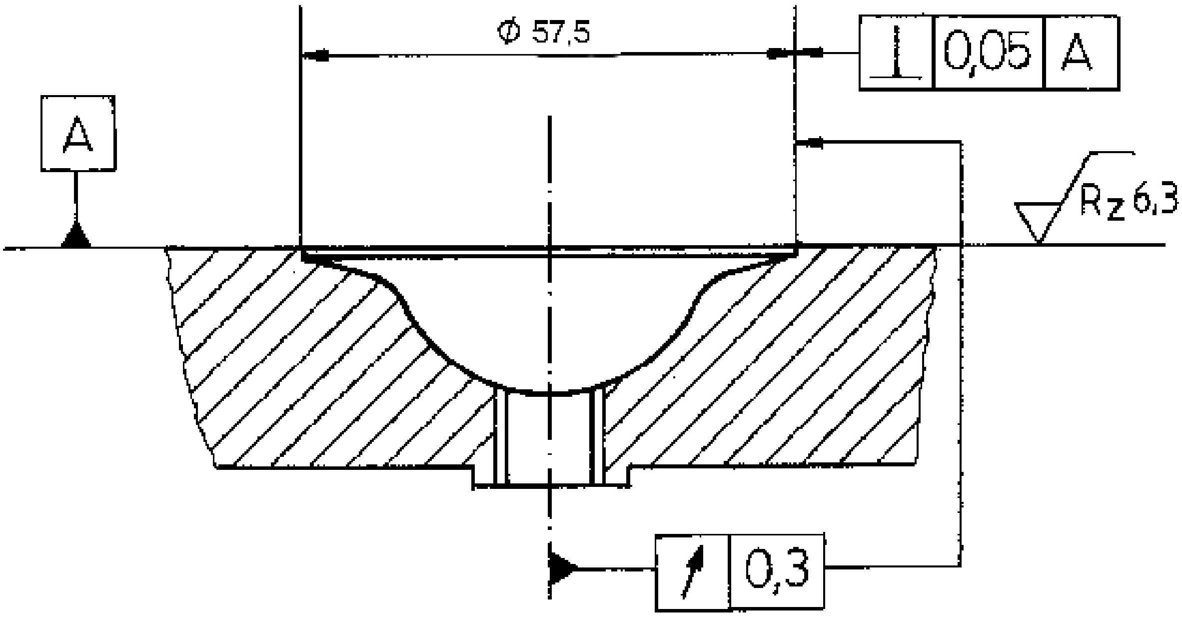


Figure 65: Cross-section of the cylinder head with rework dimensions

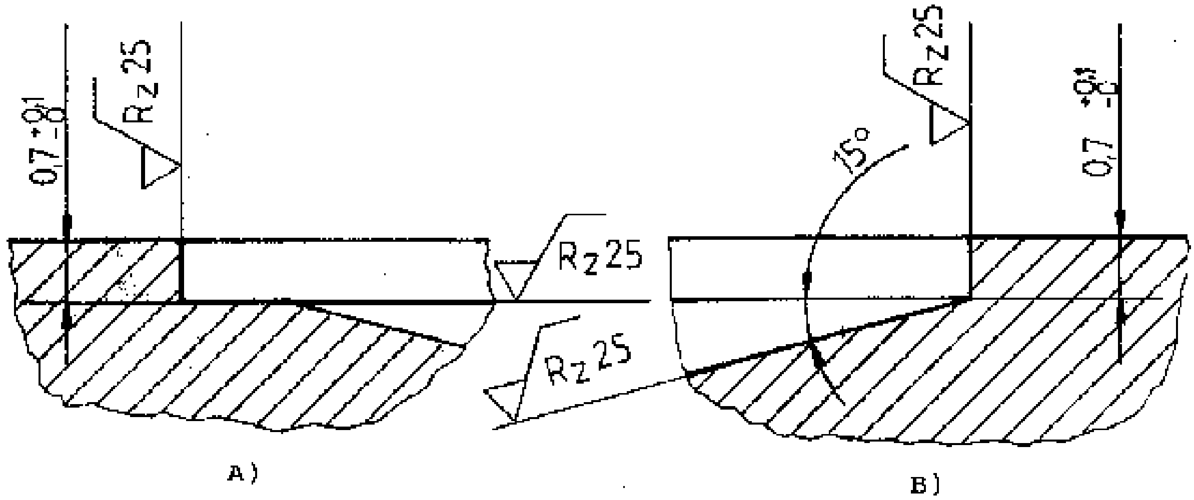


Figure 66: Reworked squish-area; A) The easy way: edge with 90° and 0.7 mm height. ; B) The better way: angle of 15° remains.

A more accurate method to measure compression is to use a pressure gauge. In this case I can give you some values of experience: My current engine (about 12.000 km since last rework) gives 8.5 bar (120 Psi) with open Power Valves. If you stop the idle running engine with the ignition switch, the Valves are closed, which will increase the compression about 1 Bar (14 Psi) to 9.5 bar (133 Psi).
The RZ Owners Club Newsletter 4/98 gave values of 125 to 155 Psi (8.9 – 11 bar).

What is very important before the assembly is the finish of the cylinder head's joint face. It has to be absolutely fine-ground otherwise it will be leaky (You will realise it when cooling liquid pours out of the overflow at full throttle operation).

At this point I'd like to dissuade from a too high compression ratio! If it doesn't result in immediate disaster you will shorten the lifetime of your crank and pistons a lot. An engine with high compression runs much hotter than a mildly tuned one and it is much more sensitive towards jetting faults!
In any case you should run 98 octane fuel (premium unleaded or premium leaded) in your engine.

Exhaust system

Porting

These modifications and the head milling are most important for optimum performance so just have an extra eye on performing this very carefully.

YAMAHA required only a mild altering of about 0.5 mm to a new height of 26 mm. They broadened the port from 39 to 41 mm. Take care that the radiuses between the side and lower edges stay stock (R10) whereas the radiuses at the top edge should be enlarged from R7 to R9 in order to maintain ring durability.

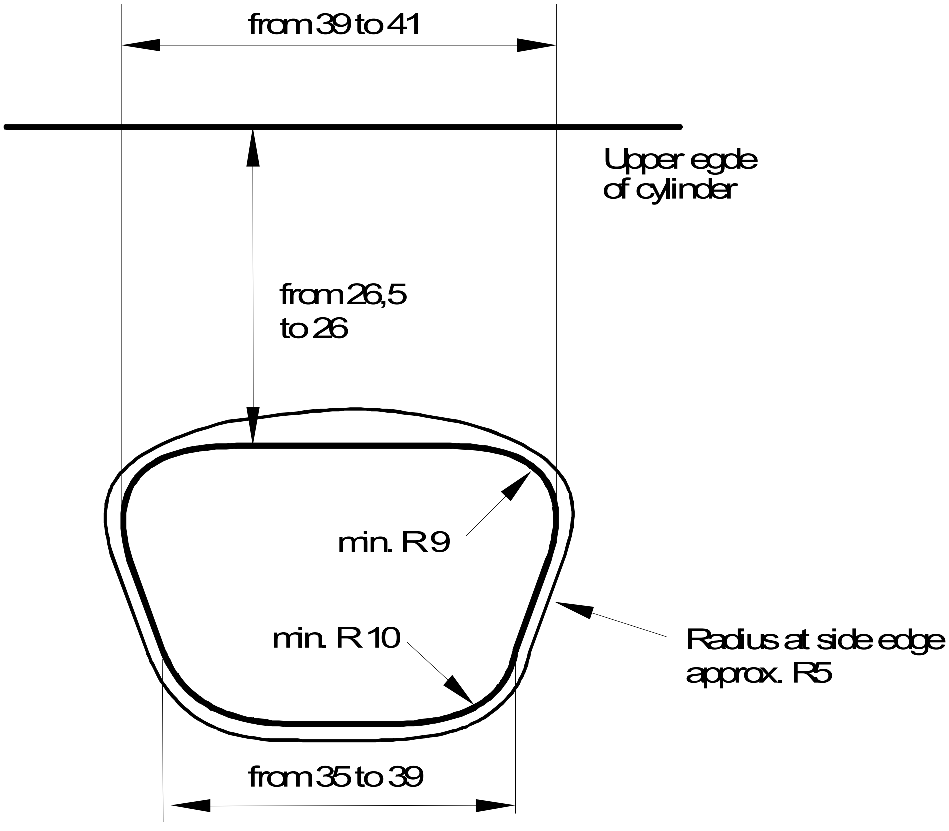


Figure 67: Exhaust port seen from the cylinder

The most important constant for the point where the engine has its peak performance is the height of the exhaust port. If you broaden the port it will result in an higher engine torque, but at the same rpm level. If you change the port height by one and a half mm it will change the max. performance rev by about 350 rpm if you use the same pipes. A good value for the port height of any two-stroke in road use is half of the engine stroke (54 mm / 2 = 27 mm). As you can see shorter pipes would be a much easier way to increase the engines redline.

The exact formula for the tuned pipe length is:

$$L_A = \frac{\alpha_0 \bullet c_s \bullet 1000}{12n}$$

L_a: Length of exhaust [mm]

α_0: Port opening angle [°]
c_S: Sonic speed in burnt gas (approx. 520 m/s)
n: Desired rev of max. performance [rpm]

If you insert the YAMAHA race specs you will get a port opening angle of about 200° with 26 mm left to the top of the cylinder. In a race pipe with a two cone design (one opening cone, a straight cylinder in the middle and one closing cone with a tube and muffler) the exhaust length is measured from the port to the middle of the closing cone. With the given pipe lengths of 863/825 mm you reach the predicted 10.000 to 10.500 rpm.

After that you should remove lots of aluminium in the port to get a smooth way from the oval shape at the cylinder to the round form of the exhaust gasket. I did this by inserting the gasket and marking the material to be removed. YAMAHA gives the dimension ∅37 (stock ∅32). A cross section along the port is shown in Figure 68.

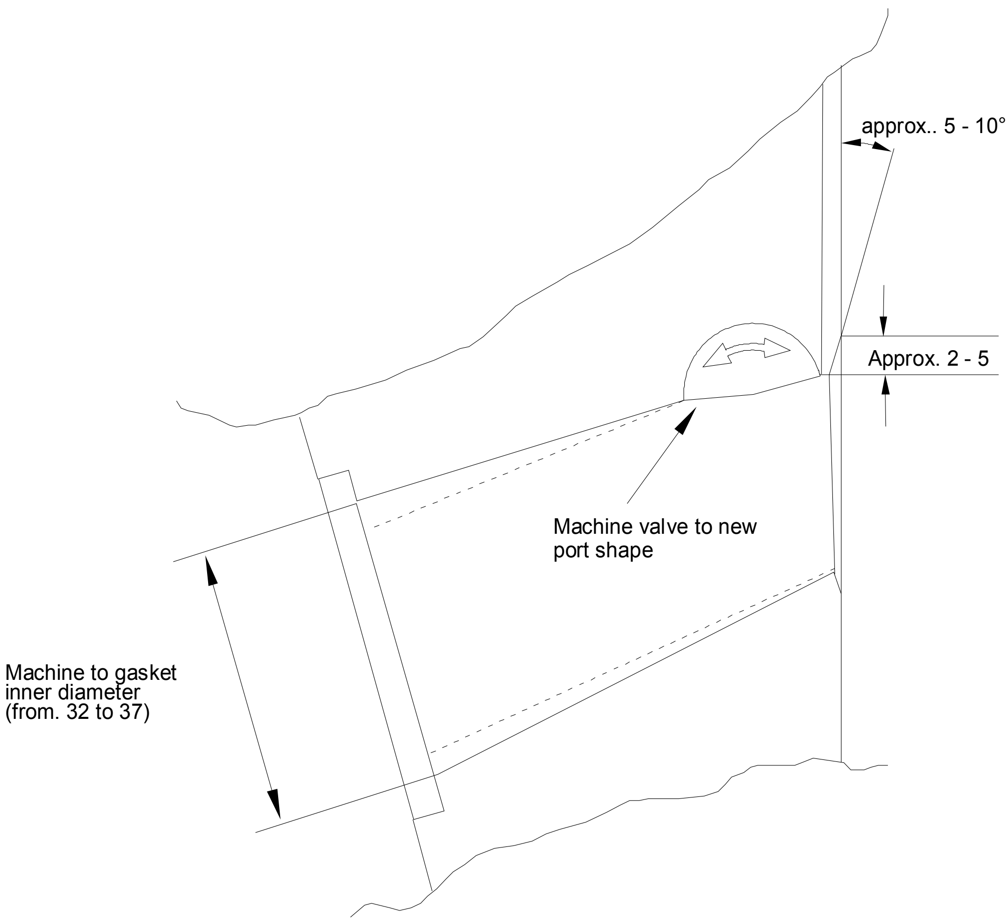


Figure 68: Cross section along flow way

When performing this point I should stress that it is very important that you have a close look at the power valves.
On the one hand they should fit perfectly into the port shape, but on the other hand this should be the same for both cylinders in mounted position!
To check this out I use either the engine block or the cylinder head. Mount the cylinders on a common joint surface such as the cylinder head and connect both valves.

> *Only in this configuration you can see if both valves fit well! After remounting the cylinders to the engine check that the servo motor has driven the valves in this position after turning on the ignition switch. Just have a look at them before mounting the pipes, or if you prefer, feel them with one finger. If the position is not perfect you can adjust it with the cables.*

As a final operation it is important to polish all milled surfaces. I've used a small high speed drilling machine (Proxxon, Dremel, ...), my special polishing shaft (see Figure 2) and lots of sandpaper (#60 to #1000).

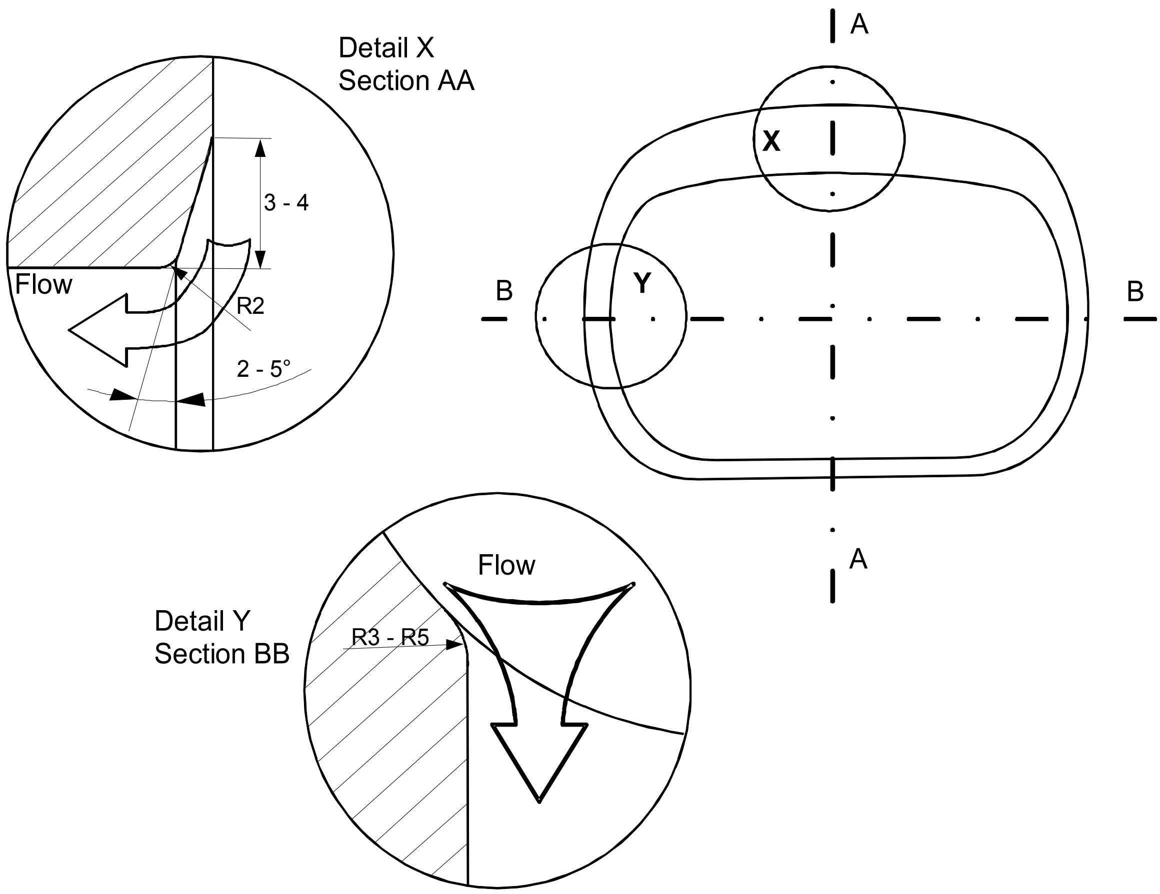


Figure 69: Details of chamfering and radii at port edges

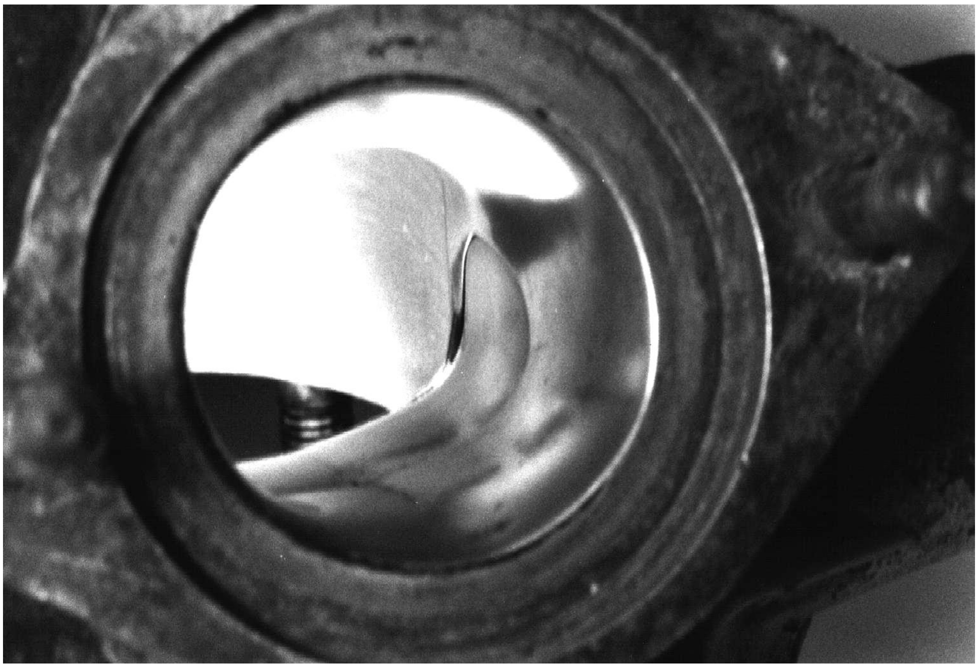


Figure 70: Exhaust port machined and polished (RD350)

Pipes

My personal attitude to most race pipes is that several companies make money with nothing but promises of high performance. So if you're looking for pipes that work I can only recommend a few.

In Europe there are the quite expensive (about 2400,- DM) **Jolly Moto** pipes. They offer good midrange power and have max. performance at about 11000 rpm. They are available in standard or GP configuration (both lower pipes on the right side) and with optional carbon fibre silencers. Most people use them with stock jetting (#195 in the 47X) and they work, only a few found difficulties in finding a setup.
The low-end is acceptable and what is even more appreciated is the silencers offer good sound absorbtion. With closed Power Valves they are at stock level, when performing hard acceleration they become louder. The fitting to the bike is not as easy and good as stock. The pipes are mounted with springs and an adapter at the cylinder. After a few thousand kilometres oil will leak out here and complete mounting/dismounting takes quite a long time.

In Germany you can get **WIWA** pipes which also increase performance by 5 to 7 HP. The main disadvantage is that they are custom made and this requires the whole bike to be present in Augustdorf/Germany. There the carb setup is done in dyno tests (The pipes require a larger jetting, they claimed to use mains #230 including the porting job and open filters).

This company also offers modifications of the stock exhaust. They remove the double wall in the middle pipe area.

From England I got the performance curve of the Nikon pipes. According to the people I talked to I feel they're quite similar to the Jolly's.
The dyno curve is somewhat disappointing, but if you look at the difference the pipes gave 12-13 HP more which is very good (if they used the same bike). I'd assume that they used a very weak engine and/or the dyno speed measurement was not properly synchronised to the engine. If you convert the curves from the 8.000 rpm to a 9.500 rpm peak (as it should be ...) then the bike pulled 82 HP stock and about 96 HP with the Nikon pipes.

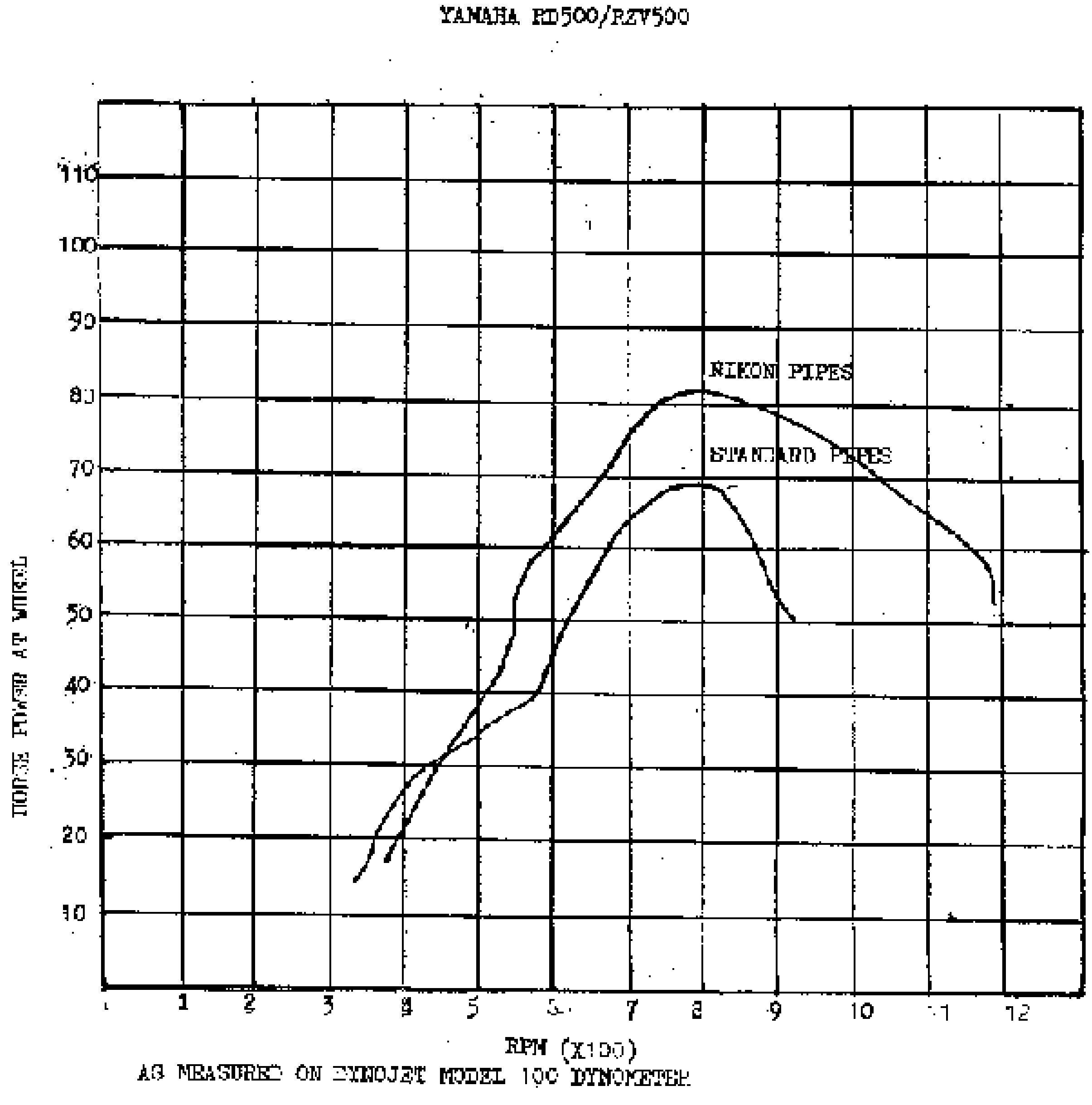


Figure 71: Nikon performance curve

For those of you who are naturally born pipe-smiths I've included the drawings of the YAMAHA race specs pipes. They claimed to have 30% extra HP at 10.500 rpm for the whole tuning work (and lots of extra noise I'd guess ...). I'd recommend to change the ∅20 mm diameter at the end to a ∅22 mm.
If you use a self-built muffler take care that the inner diameter of the tube is not less than 22 mm, the length should be around 25 cm. This helps the engine to run a little bit cooler. With bigger carbs and/or high flow air filters it is absolutely essential, otherwise you won't find a good setup.

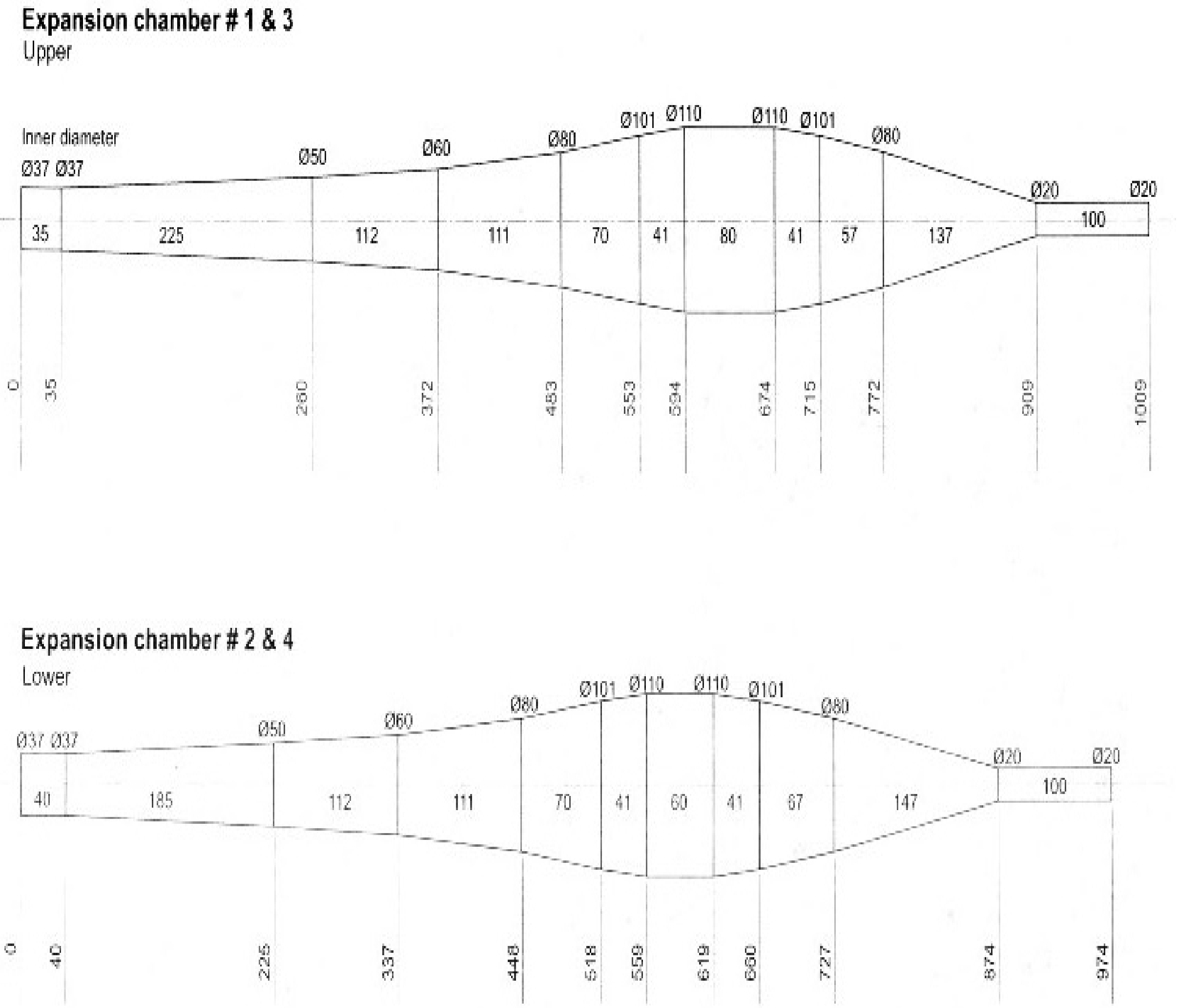


Figure 72: YAMAHA race pipe dimensions

In the newer RD350 models (1WW/1WX/1WT) the manufacturing of the small end tube restricts maximum revs and engine performance. The reason is production finishing accuracy for the "diameter" 20 mm of the little tube at the end of the closing cone. This tube is formed by the two halves of the pipe which are put together in a welding jig. The cross section shape is not a circle but a hexagon which cuts off

some area compared to the desired round shape. You can find a similar tube in the lower RD500 pipes
The positioning and welding process has certain deviations. So there are pipes with a wider tube which are “good” and there are pipes with a narrower tube which restrict power. If there is carbon built-up over the years a “good” pipe can turn into a “bad” one due to the narrower cross section area. I’ve seen pipes with a one mm thick carbon coating inside this tube! Anyway even the YAMAHA stock dimension of 20 mm is too narrow, so I’d advise anyone to widen the tube as follows:

Dismount the silencers from the lower pipes. Take an arbour of 22 mm diameter and drive it into the tube with a heavy hammer (I named my arbour “anal intruder” ...). Another possibility is to use a long enough screw with a M22 thread and a welded T-bar at the end. After driving this into the tube you just have to screw it out. After performing the widening remount the silencers.

Those of us who don’t live in restricted areas (like me in Germany) can build some new mufflers. Take a stock one as an example but leave out the labyrinth at the end and use a wider perforated tube of 22 mm diameter. When ready wrap the tube with mineral wool and tighten it together with wire.
The new sound will be a little bit deeper and somewhat louder than stock. The performance result is convincing: Top- and midrange power is significantly higher which yields to faster acceleration and lower piston temperatures due to cooler exhaust gases.

You can also use some ready-to-use universal silencers with 22 mm inner diameter as you can get from Götz (about 100,- DM each) or other Moto Cross shops.

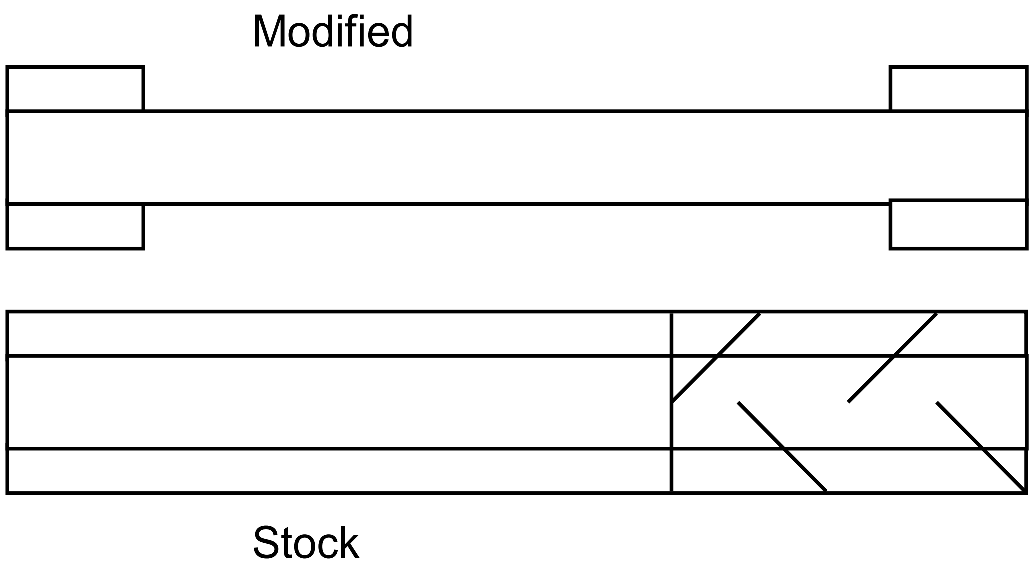


Figure 73: Silencer baffle modification

Porting work summary

As a summary of the porting work the YAMAHA race specs follow below. They show quite well what and where to make modifications.

In my current quartet of cylinders I decided to spend a lot of work on the sleeve mods especially for the upper cylinders. The intake port was modified as described below.
At the exhaust port I split it into front and rear: At the rear bank I only modified the upper port edge, machined the YPVS valve to the port shape and polished the whole thing.
At the front bank I broadened the port to the given dimensions in addition to the other mods.
The transfer port’s shapes were not touched, except deburring where necessary.

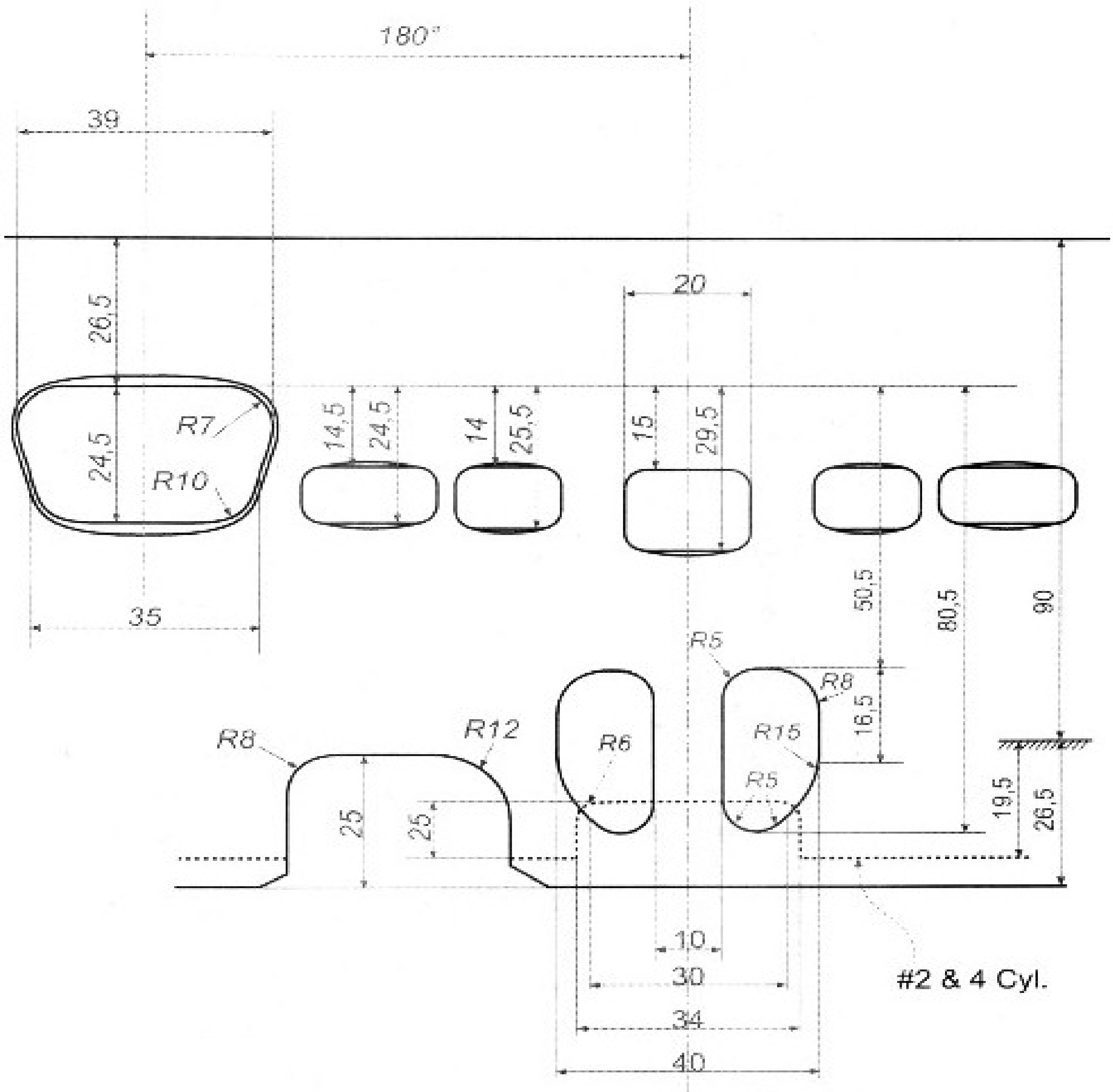


Figure 74: Stock port configuration (YAMAHA race specs)

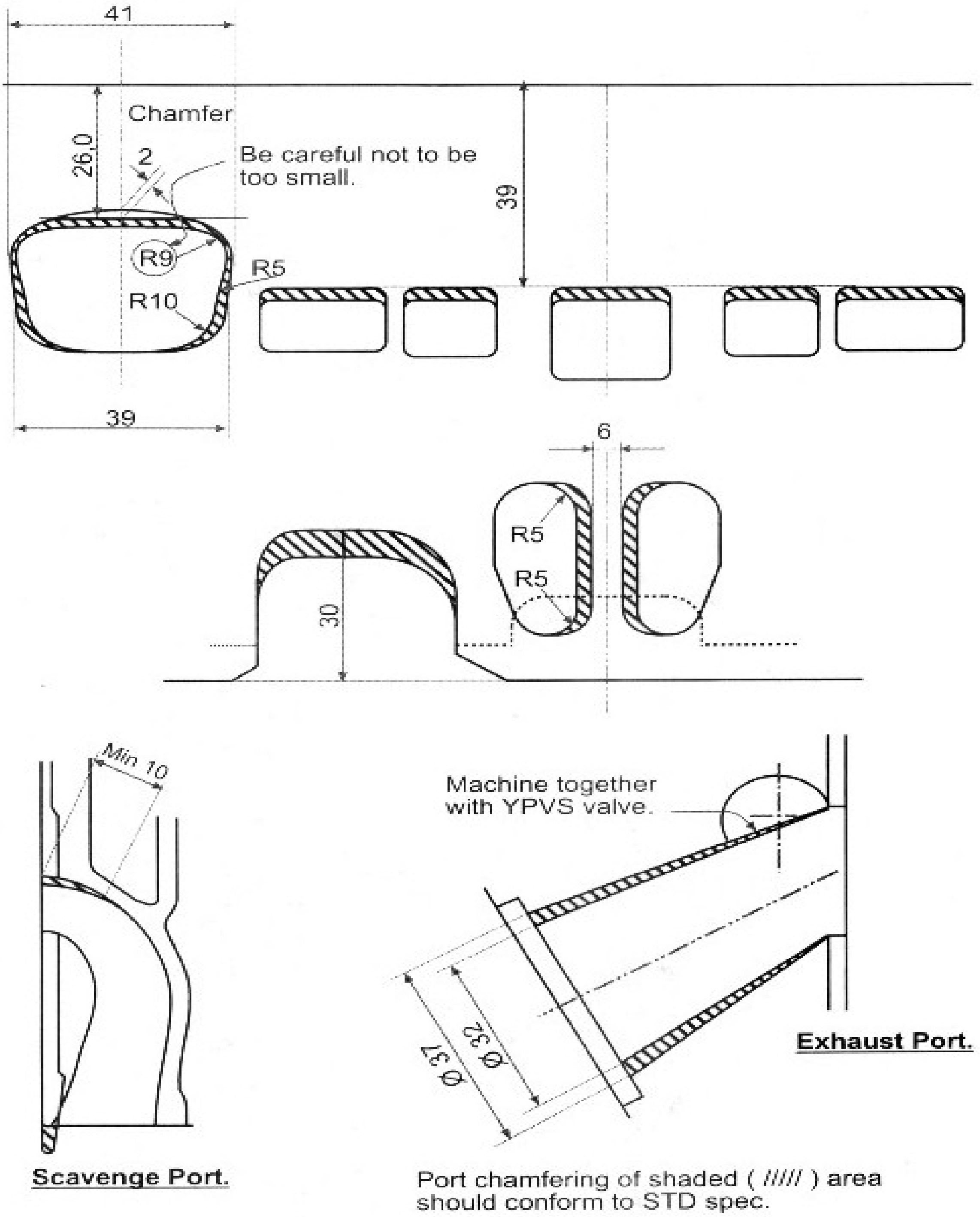


Figure 75: Modified port configuration (YAMAHA race specs)

Cooling System

Most of you would say: “My cooling system is ok. Only in summer when driving around town the temperature sometimes reaches the red zone”

This is right, because the stock temperature gauge gauges anything else but engine temperature. If you fit a digital one you will see that in summer 80° - 90° C is normal and when driving around steep mountains it will climb over 100° C.
Current race bikes run with 55 °C $\pm$ 5° water temperature, so everyone will agree that improvements in the cooling system are to be made.
As a beginning you can leave out the thermostat and use only 2% anti-freeze in the cooling liquid to increase its specific heat capacity. Turning on the stock fan with a separate switch gives you about 10 °C lower temperatures.

Radiator

To improve cooling performance significantly there is no other way than a bigger radiator. This "bigger" can mean two things: area and thickness.
I was searching quite long for fitting radiators from other bikes and I found only a few to fit in the RD500 package limitations.
First there is the RGV250 ('91) radiator with the dimensions 370 mm x 225 mm x 24 mm; the older ones are only 16 mm thick. The next size is the GSXR750/1100W (same as RF600/900) with 380 mm x 320 mm x 24 mm. Many Gamma riders use the ZXR750/400 radiator which needs 400 mm x 330 mm x 24 mm.
I got the GSXR type quite cheap and fitted it to my bike. The radiator height had to be shortened some 3 or 4 cm to maintain maximum steering angle and plug access. With hindsight it might have been better to get one custom made, because the costs for purchasing and modifying added up to some 500,- DM. The second thing was that I had to change the position of all parts beside the radiator as CDI or Power Valve control and I had to leave out the lower oil tank.

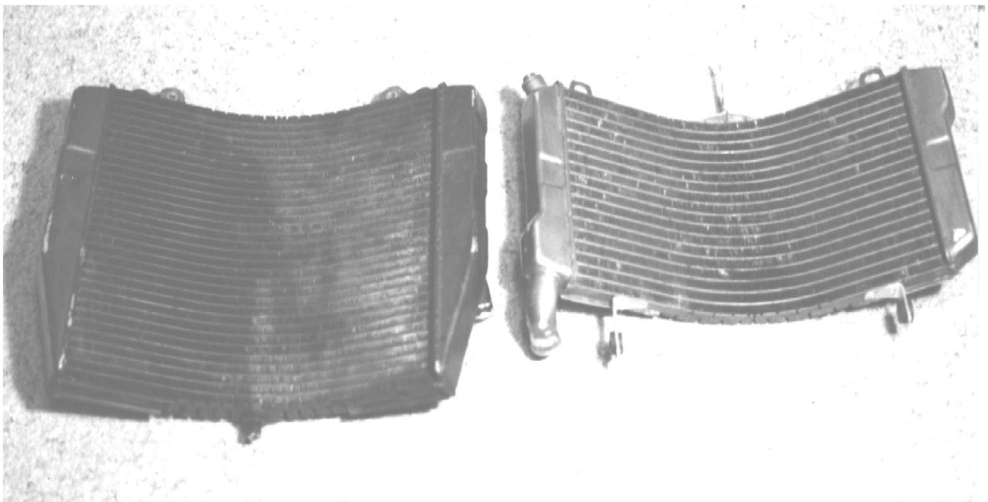


Figure 76: Radiators GSXR750W and RGV250 in comparism

When thinking about the sick construction of the whole engine I got another sick idea. To keep the rear bank always running cooler than the front I'd suggest using two radiators. The exit of radiator 1 is put to the entrance of the water pump. Then the coolant flow to the rear bank is redirected through radiator 2, which then supplies the rear bank with very cool stuff. The exit of the rear head is connected to the entrance of radiator 1 to close the circuit.
Due to very big radiator area you obtain very low coolant temperature and due to the radiator arrangement you have the rear bank as the cooler one.
In Europe I'd use the Aprilia AF1-125 radiators which have the dimensions 410 mm x 160 mm x 30 mm. If you arrange them up-end they fit into the package, only plug access will make a problem to think about.
The second way is to use the RGV250 radiator in connection with a Suzuki TS250X radiator (250 mm x 100 mm, trapezoidal shape) for the rear bank. On newer bikes the 1998 Aprilia RSV Mille uses this dual radiator concept, which could fit the RD500.

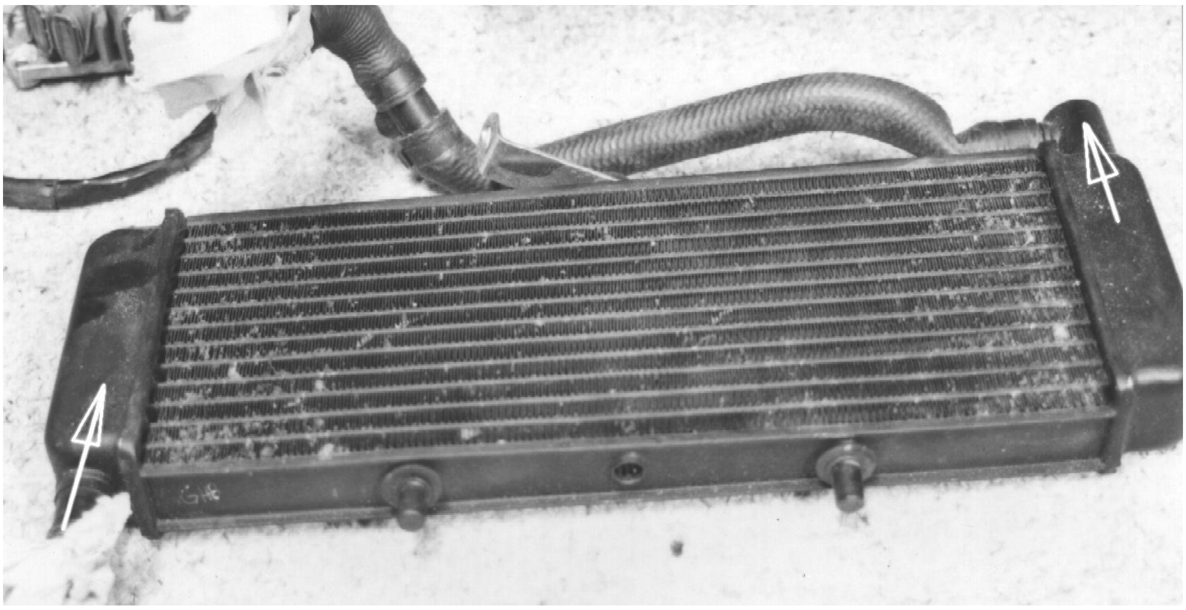


Figure 77: Radiator AF1-125

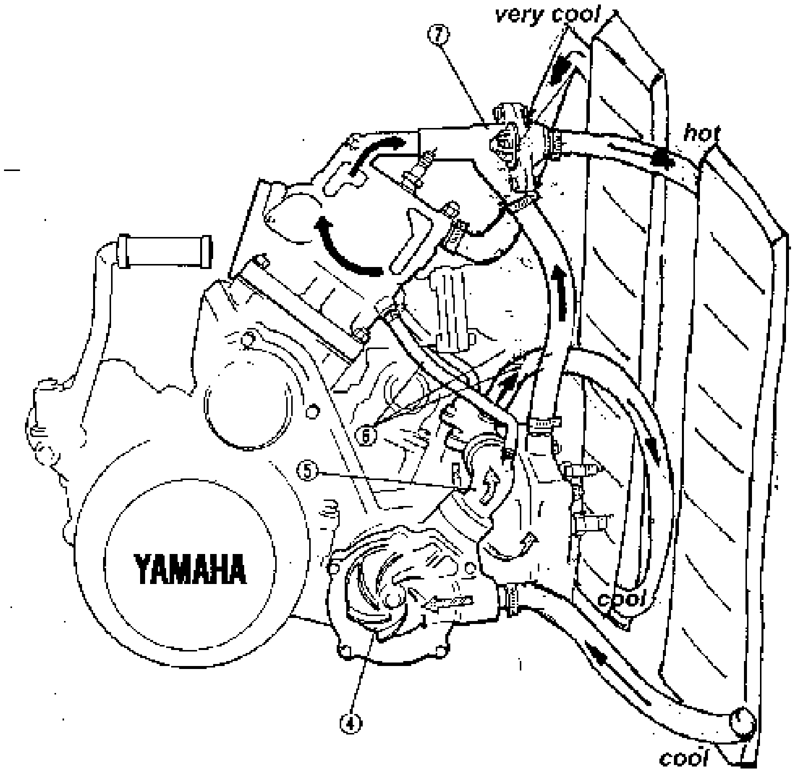


Figure 78: Concept with two radiators

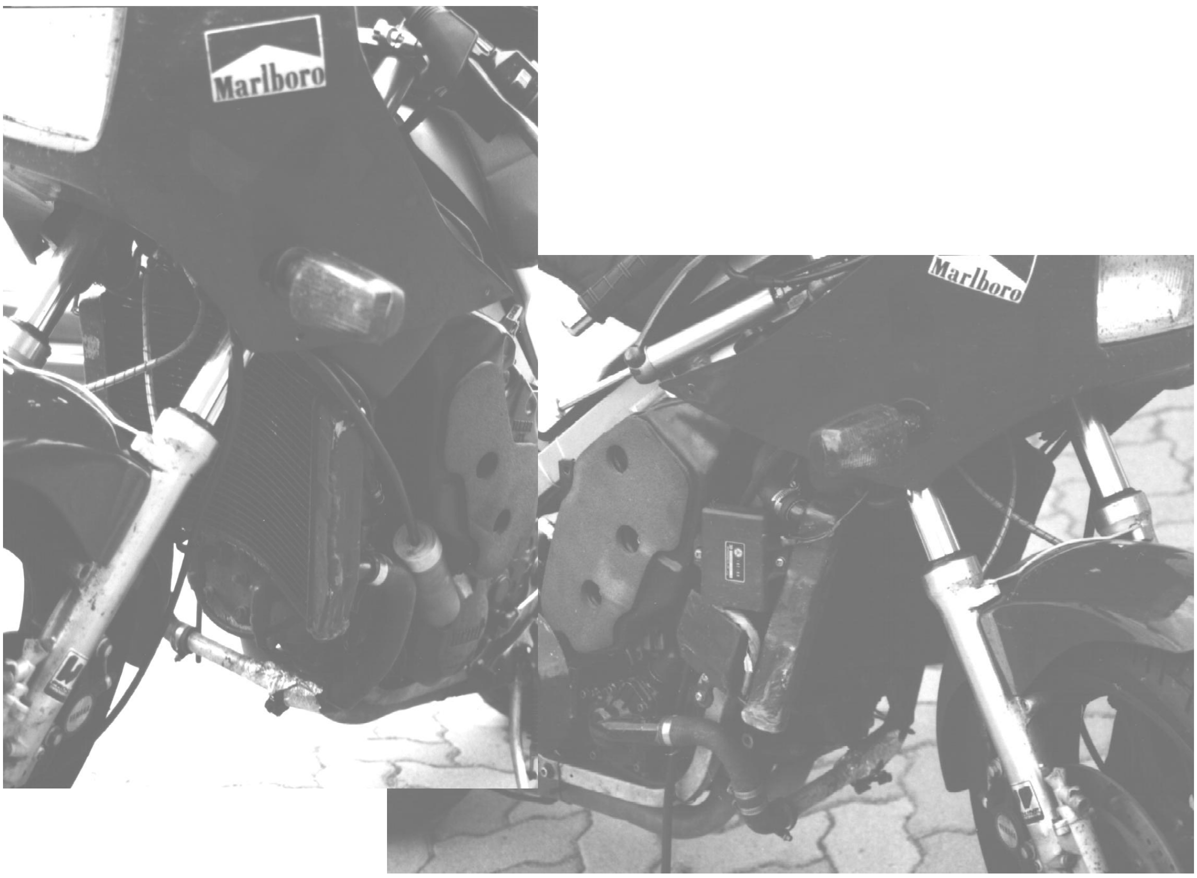


Figure 79: GXSR750W radiator fit to RD500

Clutch

The stock RD clutch tends to slip when maintenance was poor or when the engine has more power. I can offer three solutions:

- First just try some special light gearbox oil like Bel-Ray MC-4. I found that this prevents/reduces clutch slip during engine warm up or when the friction plates are somewhat worn. If the oil doesn't help you ought to open the engine and modify the clutch springs (you may also use a set of new friction plates).

- Use 6 washers of 1.5 to 2 mm thickness and 14 mm bore. The outer diameter should equal the clutch spring's outer diameter (You may have to manufacture that on your own). These washers are mounted with the clutch springs and increase pressure about 15 to 20 Newton each (about 20% increase) which enables the clutch to transfer a higher torque.

- The same effect can be reached by using reinforced clutch springs. You can get them in several bike stores such as Hein Gericke, Polo or Götz for about 20,- DM a set. There are reinforced YAMAHA springs, too (Part No.: 90501-23141). In the WiWa tuning they use the FZR1000 (2LA) springs with green marking.

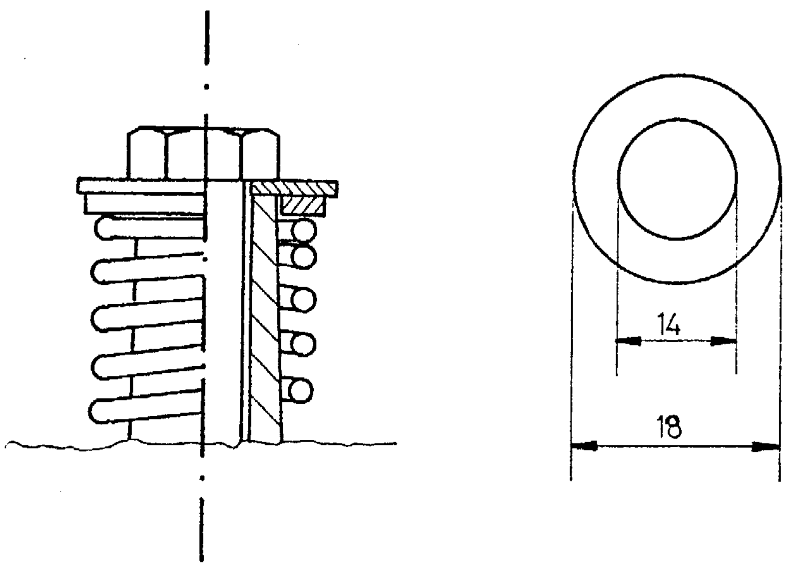


Figure 80: Clutch spring with washer

In the YAMAHA race specs they recommend leaving out the cushion rings in the clutch assembly. In a stock bike they maintain low clutch noise level at the price of slightly higher friction.

Electronics

Stock ignition

The advance curve is necessary for high performance twostrokes because the combustion speed is not constant. It depends on:

- Rich/lean mixture
- Compression
- Turbulence in combustion chamber
- Spark energy (CDI, plug, cables, …)
- Rpm

The optimum is reached when you have the max. combustion pressure at about 30° after top dead centre (ATDC). As the combustion takes some non-constant time you need to start the combustion at different timings vs. rpm. If you start too early, detonations can occur; if you start too late you'll have significant power losses and higher exhaust gas temperature.
An experience from different tuners is that using "reduced compression and increased advance" gives better performance than "high compression with low advance".

Theoretically you have to retard ignition when you run extremely high compression. To prove that I've looked up the TZR 250 ignition curve and compared it to the RD ones. (The TZR has a higher compression than the RD500 but the cylinders are quite similar to the lower bank.)

Stock RD's don't have an explicit rev limiter, but they don't support high rev's via rapidly decreased advance over 9000 rpm. This results in engines revving higher, but not having adequate power over 9000 rpm. Furthermore the exhaust gas temperatures become unnecessarily high.

A way to increase top end power in stock but especially in tuned engines is to make use of BDK modified CDI units. They change the blackbox in a way that enables you to adjust the gradient of the ignition curves and they remove a speed limiter circuit which cuts off a certain percentage of the ignition energy above 9.800 rpm.
This goes together with the sequence above because you don't advance ignition significantly in the critical mid-range but only above 6.000 rpm.

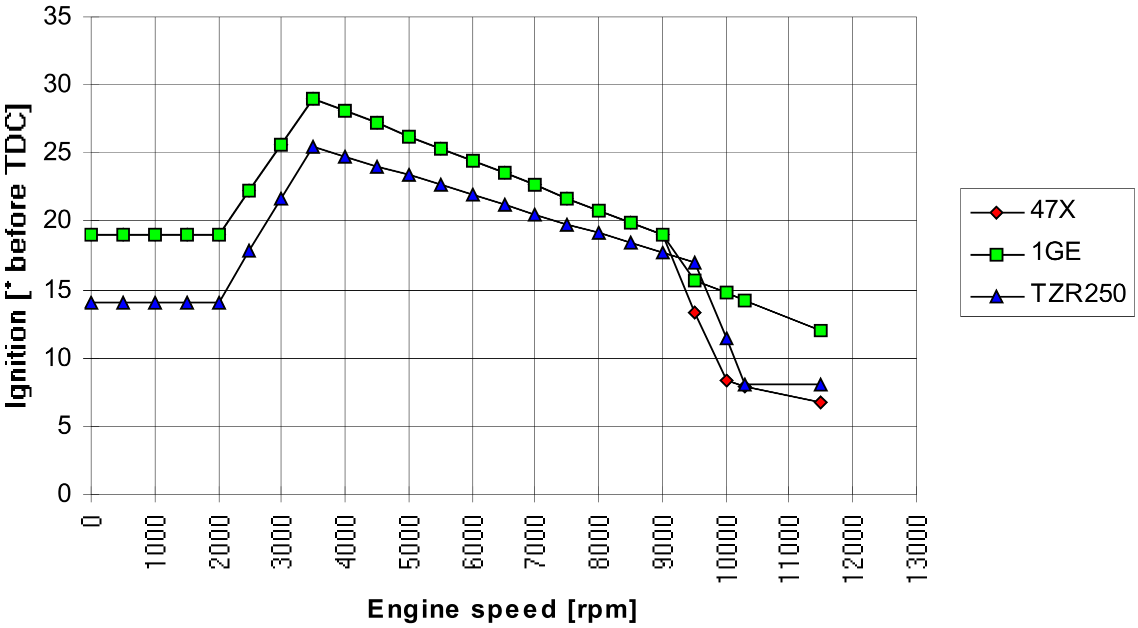


Figure 81: Ignition curves: European RD500 47X/1GE and TZR250 (1KT, 2MA)

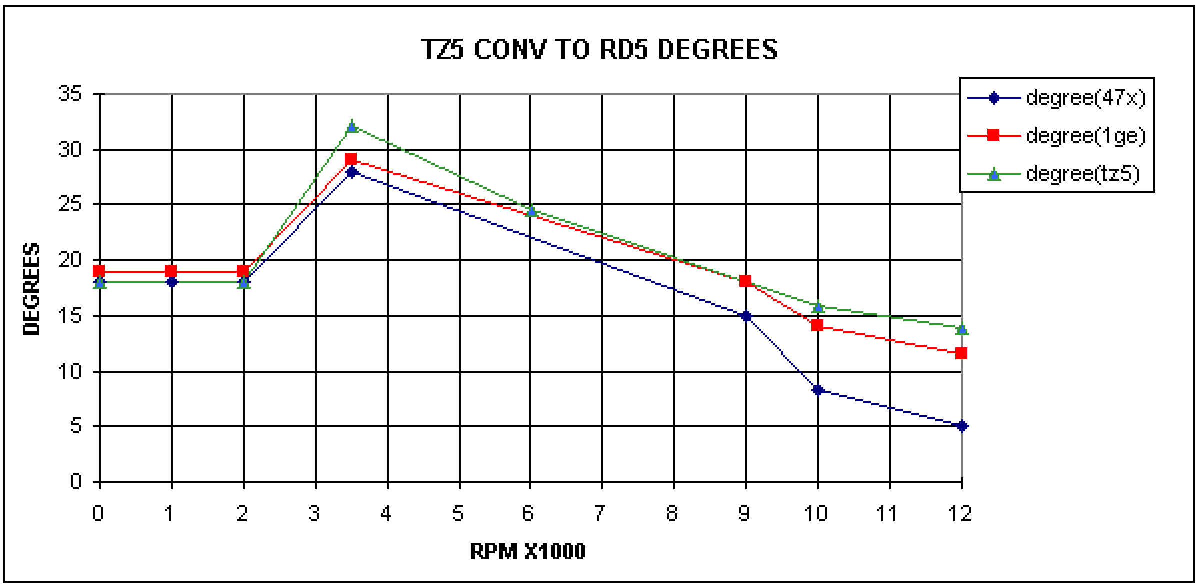


Figure 82: BDK CDI mods for RD500

YAMAHA recommends increasing ignition advance by five degrees. This can be achieved by milling the three holes in the generator cover counterclockwise to slotted holes. But if you want to hear my opinion this was state-of-the-art in 1985 when they used high octane race fuel. When the regulations were changed to standard filling station stuff many teams did a lot of hard work to readjust compression to get the engines reliable. I strongly believe this won't work with 98 octane unleaded fuel.

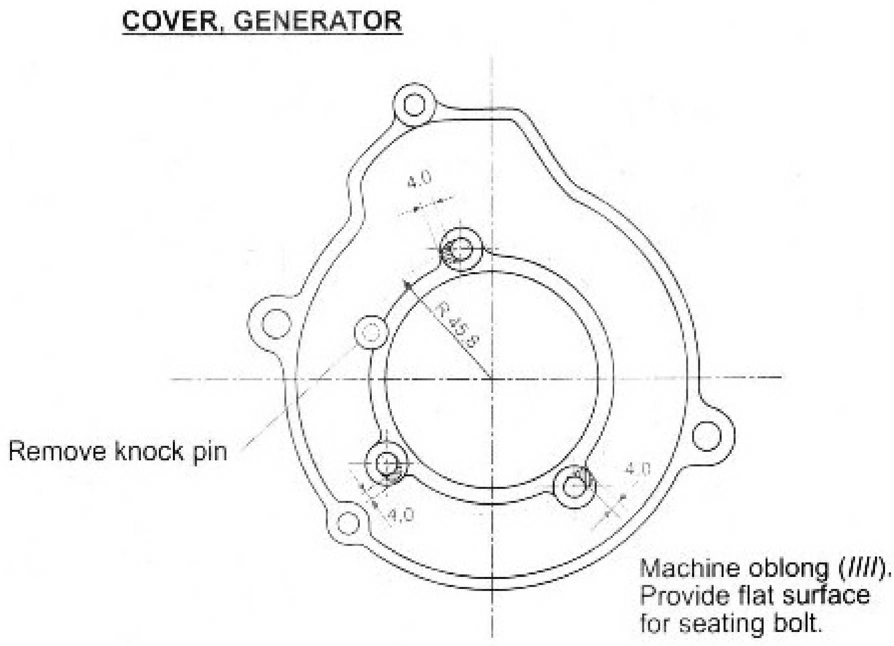


Figure 83: Advance ignition by generator cover modification (YAMAHA race specs)

To give you an idea about what happens with the performance when changing ignition advance I found a good example in the Internet. It was in a site containing tuning info for the Honda RS125 of the years 1992-1994. In the appendix I've added a data sheet of the 1993 RS125 which included the ignition advance: For the 125 cc they stated 22.5 ° BTDC @ 7.500 rpm, the 250 cc engine had 17° BTDC @ 10.000 rpm and 20° BTDC @ 7.000 rpm. Have a look at the TZR curve (Figure 81) and you'll see that this would exactly fit the straight if the retard circuit did not influence it at 9.600 rpm.

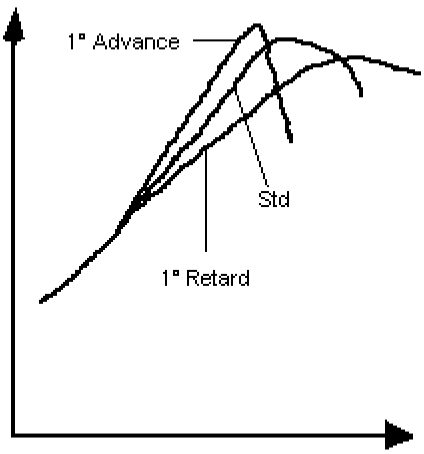


Figure 84: Ignition influence on engine performance (RS125)

Another way is to make use of two TZR250 CDI units. If you altered compression quite high (lets say 1:8) you can use one CDI for each bank. The cable colours are similar to the RD500 harness. Red, green and brown for operating current, white-red and white-green for the pick-up, white-black for the kill switch. The black and orange cables from each CDI have to be connected to one ignition coil each. The Power Valve Control unit is only connected with one CDI via the black-yellow cable. This would be a good compromise between race ignitions and street use:

- Charging system works
- Ignition advance fits the high compression ratio
- Cheap to do

On the market there are several ignition systems that would fit to an RD (PVL, Dyna-FS, Motoplat) but all of them are either far too expensive or they lack the Power-Valve output (or both). If the PV doesn't work the engine is a lame duck in low and midrange.
In 2005 I had the pleasure to help testing two promising systems on my RZ350YPVS that are affordable for everyone and meanwhile one system is available for the RD/RZ500, too.

To give you an idea of the potential I'll let you know the results from RZ350 testing.
In the first tests of the CDI on my race RZ350 during a track day I used three curves: One stock, one with mildly increased advance and one with significantly increased advance. Test-criteria was top speed stored in digital speedo at the end of the straight. As this is my favourite track for SuperMotard riding (www.harzring.de), I can compare the values to being good or bad.

The results:

Stock 31K: **106,9 km/h**
Curve 1: **107,7 km/h**
Curve 2: **112,3 km/h**

With the last curve you have a better performance in all the used range (5 – 10.000 rpm), especially when accelerating from the last corner to the straight. Overall the engine responded more crisp and max. rpm increased from 9.500 to 10.000 rpm.

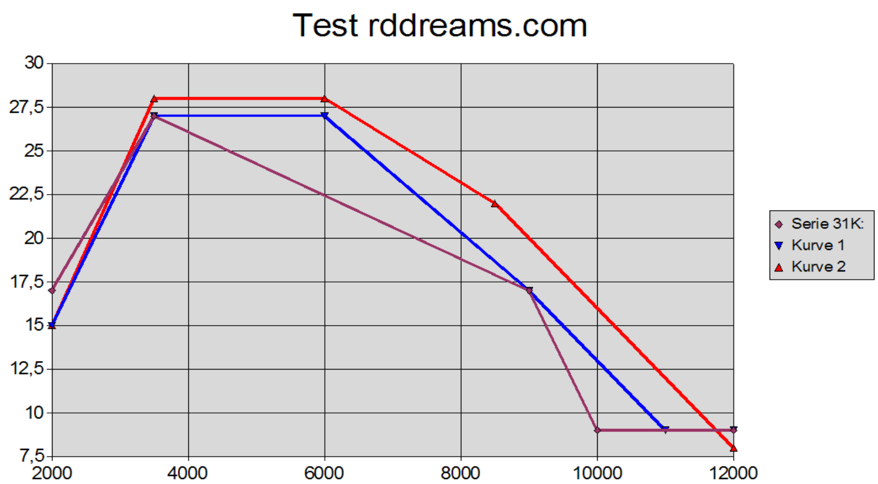


Figure 85: Advance curves used for CDI prototype (31K = Stock RZ350 curve)

What made me wonder was that even with the stock curve the bike was faster than the last time I was on that track. Stock curve was originally intended as a counter probe to see if the curves 1 & 2 really are an improvement.

> *By the way: The bone stock engine directly came from a 10 year barn-storage and was totally worn out (6.5 bar compression). So it a) could bear a very high advance and b) it wouldn’t have been too bad seizing the whole crap!*

One proof for the observation that a digital ignition is an improvement even with stock setting can be found at PVL's web pages.
They state that modified engines with higher compression must retard timing.

They recommend these advance settings in mm before TDC for using their digital ignitions:

	Analogue System	Digital System
50 ccm / 60 ccm / 80 ccm	1,4 to 1,6 mm	1,2 to 1,4 mm
125 ccm	1,2 to 1,4 mm	1,0 to 1,2 mm
175 ccm	2,2 to 2,4 mm	
250 ccm	1,8 to 2,2 mm	0,8 b to is 1,0 mm
Engines for open class	2,2 to 2,4 mm	

Table 11: Advance recommendations for kart-engines (PVL)

CDI from www.zeeltronics.com

During the test with the first CDI I came in contact with Borut Zemlijc from Slowenia who also had build ignition systems for the air-cooled RD’s and the RD350LC.
He first build some RZ350 stuff for me to test and after we made that work properly he also forwarded me an RD500 CDI-prototype.
His concept has multiple boxes that you can get separately. His “trick”: There’s a CDI that fires as soon as the pickup pulse arrives. Then there’s a second box called VCDI that can “delay” the pickup pulse. So you can control the ignition advance vs. engine rpm.
In the RD500 you can choose between several options. If you want “just the stock box replaced” he can program the stock curve and you just need the one CDI (about 80 Eur) and one VCDI (about 100 Eur). If you want to control front/rear bank separately, you'll need a second VCDI and to program the advance curves you'll need a handheld (about 50 Eur).

His features

- 10 programmable curves. Easy & fast programming.
- CDI for 2 stock double HT coils with wasted spark (RD500 stock configuration)
- Programming with separate handheld. Changing on running engine possible.
- Rev limiter (one rpm)
- Reasonable pricing

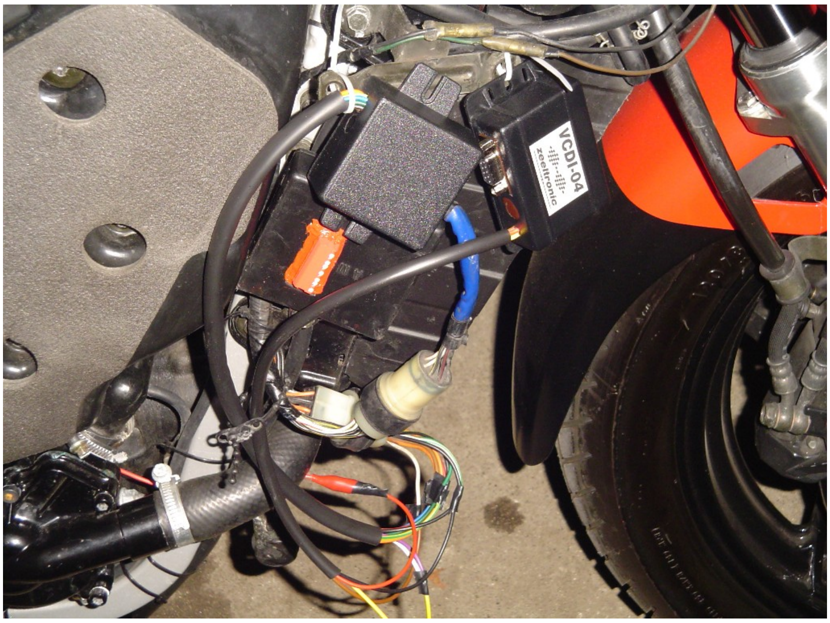


Figure 86: CDI (left), VCDI (middle) (prototypes from www.zeeltronic.com)

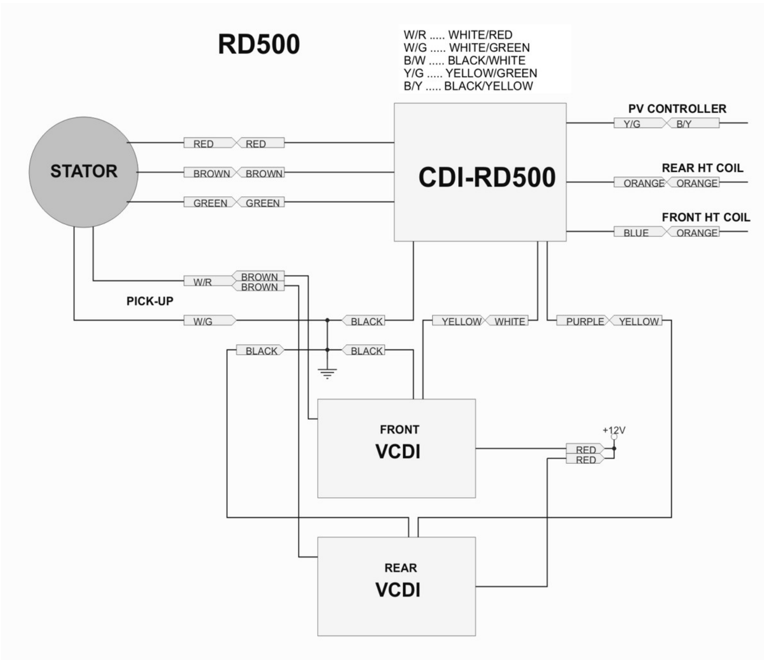


Figure 87: Wiring with two VCDI's (front/rear bank with separate advance curves)

The performance results were impressive. Marco Böhmer tested two RZ350 on a dyno. A stock 1WW and a tuned one with TM30 carbs and SoniX/JL pipes. Both used a high advance curve like curve 2 in Figure 85 (the exact curves are confidential).
The tuned RZ increased from 47 kW to 54 kW at the rear wheel (= plus 9.5 HP) !
The stock bike added 4 kW (= 5,5 HP) !
The stock bike didn't need to be re-jetted, but the rpm of max. performance decreased significantly by some few 100 rpm. So you'd need some transmission rate changes in order not to loose Vmax.

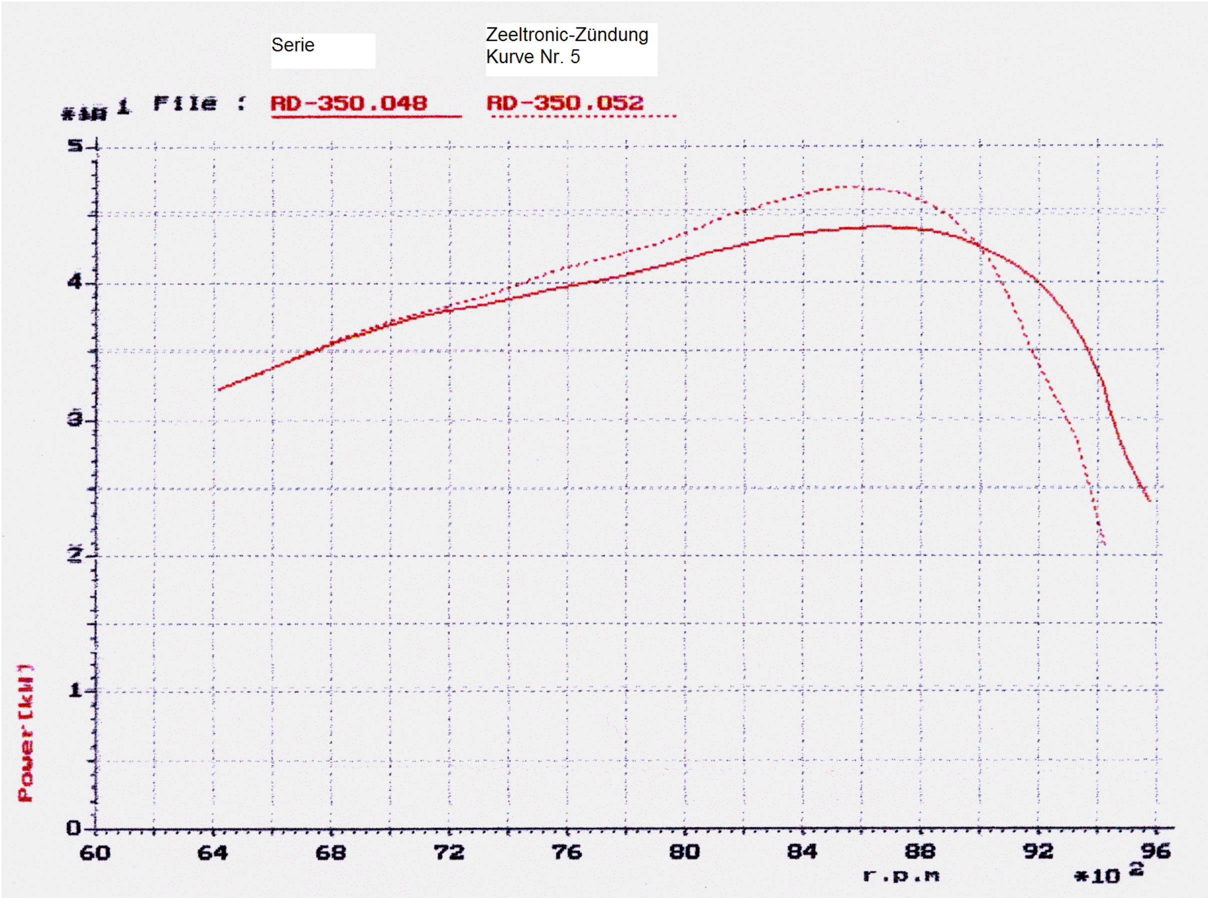


Figure 88: RZ350 Dyno curves (rear wheel power) for stock and modified advance curve.

In the BDK dyno curves there were measured about +8 HP with the BDK modifications on the ignition advance.

Necessary settings

The VCDI needs a reference point (Static-Angle), in order to tell the processor where the crank is when the pickup-signal arrives. The position used is when the Pickup approaches the first edge of the bump on the rotor. In my RZ350 engines (all 31K stators) that was 34,6° +/- 0,75° BTDC. (Unfortunately I hadn't an RD500 at my place where the small plug on the stator cover would come off undamaged ...)

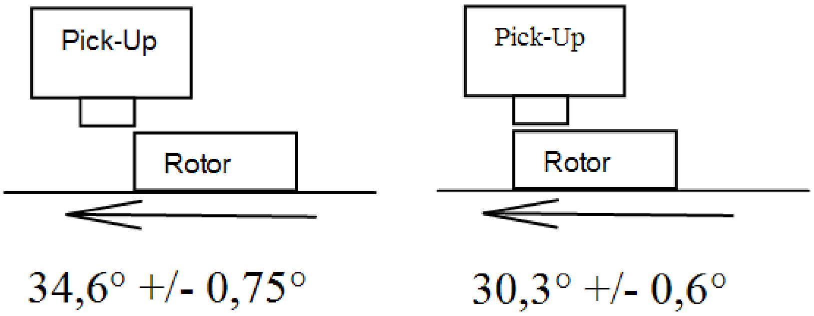


Figure 89: Reference position Pickup/Rotor (left)

To check that in a working engine you need a dial gauge and a timing light. (Manual can be found on www.zeeltronic.com).
With the gauge you can put the engine at a reference position of let's say 20° BTDC . Here you put a mark on the rotor.
Then you set a curve to be 20° BTDC all the rpm range and start the engine and check the mark with the timing light. If it's where you put it, everything is fine, if not readjust the static angle until the 20° mark is exactly matching.

The other setting needed is the compensation time. That's a time constant, that quantifies the delay between pick-up signal and spark production in the CDI. If it would not be compensated, it would result in advance changing at different revs.
The test is easy: Use the config described above and then rev the engine up – if the marks stays constant everything is fine; if it moves with rpm then try to adjust the compensation value. With the RZ350 CDI I found 30 milliseconds a good value – I assume it'll be the same with the RD500 CDI.

Power-Valve modifications

As already mentioned in the exhaust port chapter the rpm of max. torque/performance strongly depend on the height if the exhaust port. The Power Valve system changes the port height vs. engine rpm and so you can have both – good low/midrange and a high max. performance. At low rpm's the valves are closed, at high rpm's the are opened by the control box.

The specific rpm's for opening/closing are model dependent and differ. The coding is done via the printed circuit board and you can change existing boxes to operate at other rpm’s. BDK offers to make it completely programmable via DIP switches, but they are quite expensive (140 GBP).

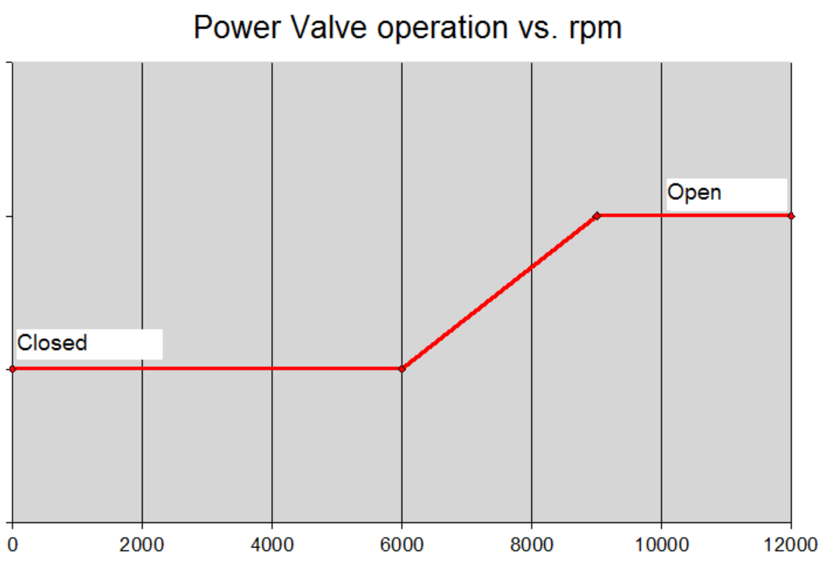


Figure 90: Power-Valve operation vs. engine-rpm (RZ350)

The method to find out the optimum actuation points is fairly easy:

- Unplug the PV control box at open position and testride or dyno the bike.
- Notice usable power band (e.g. from 6.500 to 10000)
- Unplug the PV control box at closed position and testride or dyno the bike.
- Notice usable power band (e.g. from 3.000 to 7000)

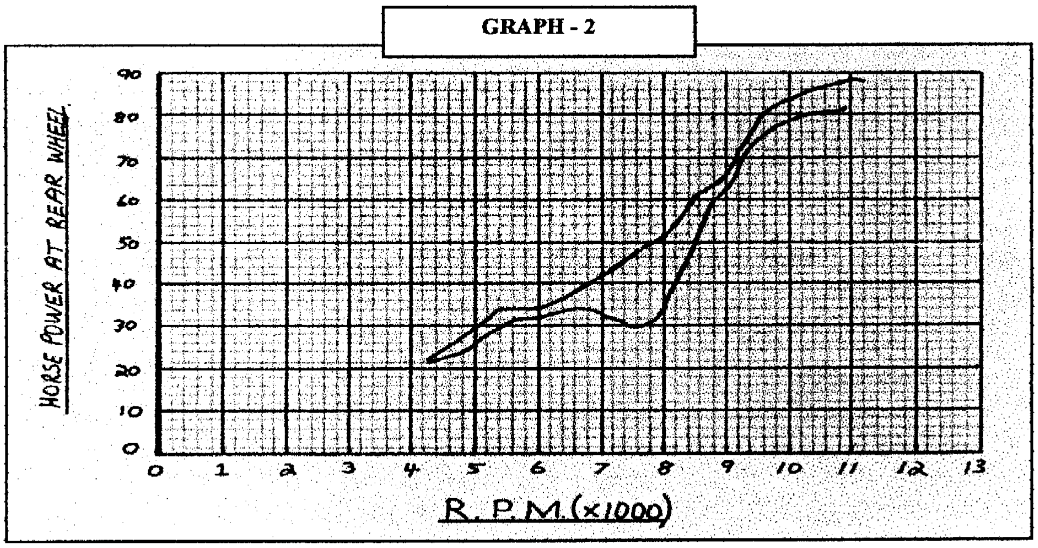
Model	Starts opening @	Fully open @
RD350 (31K)	**5550 U/min**	**9450 U/min**
RD350 1WW	**6000 U/min**	**10200 U/min**
TZR250 (1KT, 2MA)	5850 U/min	10050 U/min
RD500 (47X, 1GE)	6150 U/min	7950 U/min
Curve 14	6000 U/min	8550 U/min
TZR MOD1	5700 U/min	9000 U/min

Table 12: PV operating rpm’s (Source: BDK)

If you have a dyno at hand, the best actuation rpm’s are around the peak performance rpm’s. For the rest of the world it’s a try & error issue.

What the BDK conversion can do is proved in the following Figure. Most of the effect comes from the modified Power Valve control unit (other part from increased ignition advance), as there was a terrific loss in midrange power due to heavy porting (Stan Stephens). I can confirm that effect for one RD500 in Germany who had similar flat-spots in the performance. After setting the PV box to 7500/10200 rpm the nasty behavoiuor was completely gone!

The necessary modification of the control unit can be done at BDK, but you can also send the box to Frank Landrock from Aachen (Germany). He'll do the mods for as little as 20,- Euro plus shipping; you can find the address in the appendix.
Here's the recommended PV settings that proved best so far:



Tuning Feature - BDK Engineering 01508 480118

Graph 2 shows Roger Browns Dino Curves, the lower one shows the effect of a Stan stevens Tune The higher curve is the same motor, but with the BDK ignition at full advance. To regain the midrange power B.D.K modified the powervalve opening times. Quite impressive.

Figure 91: BDK modified Stan Stephens engine (later Power Valve opening), (courtesy of GP500 Club Newsletter, England)

Model	Starts opening @	Fully open @	Curve
Stock RD500 (47X, 1GE)	6900 U/min	9300 U/min	8
RD500 with pipes (Jolly)	7500 U/min	10200 U/min	18

Table 13: Recommended PV operating rpm's (Source: BDK)

Another sensible modification is to enhance the actuation angle of the valves. This can be done "mechanically" be using different pulleys, but there's also an "electronic" (and thus cheaper) way of doing it.

As mentioned before a deeper closing of the valve gives you some low/midrange gains.
The control unit gets the position information via a potentiometer inside the Power Valve motor. If you modify one arm of the resistance you can fool the control box and it regulates different "open" and "closed" positions.

You have to use the white-black cable on the control box and insert a resistance of 400 – 1200 Ohm. After re-adjusting the “open” position with the cables, the closed position is up to 2.5 mm deeper than before.
On my bike the wheelie-test proved that to be a good mod …

This issue can be transferred to the RGV & Aprilia models. They use the same principle to control the exhaust port valve.
Unfortunately in this engines there’s a guillotine type used, so there is no “deeper closing”, but you can use the servo motors in the RD. I have tried it on my own that the YPVS control box can use the RGV motor as an actuator. In this case you’ll have to manufacture new pulleys because the RGV is different here.

Programmable Power-Valve-Controller (PPV) from www.zeeltronics.com

While testing all the CDI stuff I also requested a programmable Power-Valve from Borut (www.zeeltronic.com) and so he build a prototype for me.
The features:

- Program PV opening percentage vs. engine rpm
- Program PV open and close postion
- PV test
- No new hardware needed to change settings: The handheld is the very same that you already use for the VCDI programming
- Medium range pricing (about 100 Eur.)

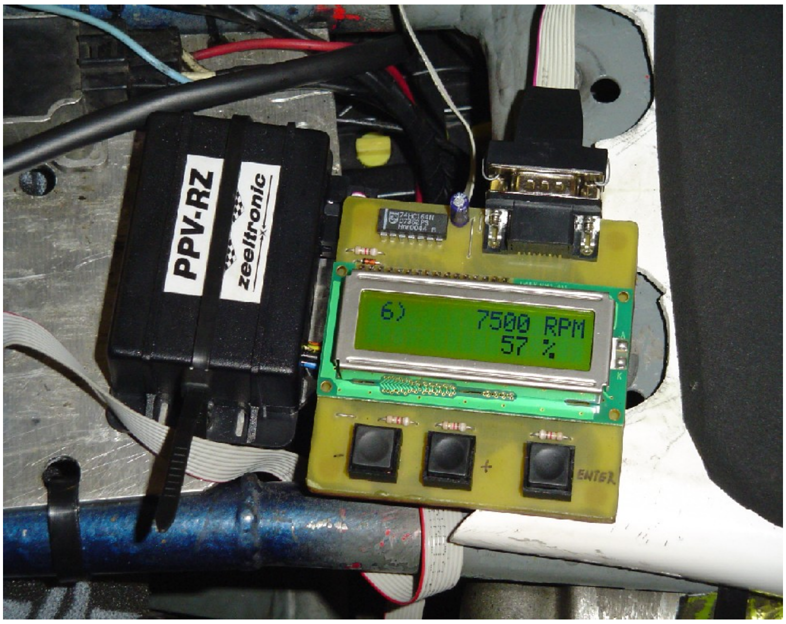


Figure 92: PPV mounted on my Race RZ350 (Handheld is a prototype)

With this device you can benefit of all performance increases by different rpm and deeper closing without having to modify the stock box.

On the RZ350 we found that setting a curve that opens in a rather progressive way (Tuning 2) makes the engine more “explosive” whereas a linear opening (Tuning 1) calms down the performance characteristics.

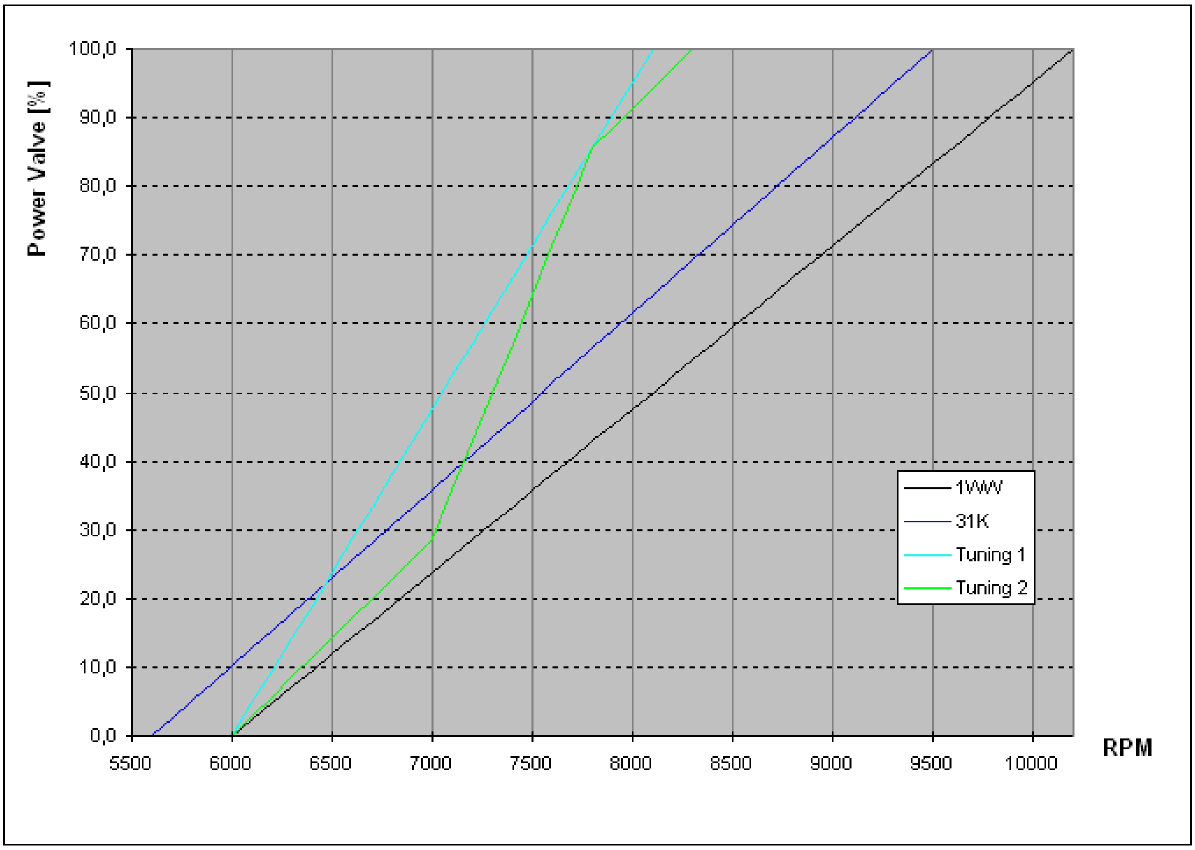


Figure 93: Opening examples for RZ350 (1WW/31K Stock, Tuning 1/2 from Hans K.)

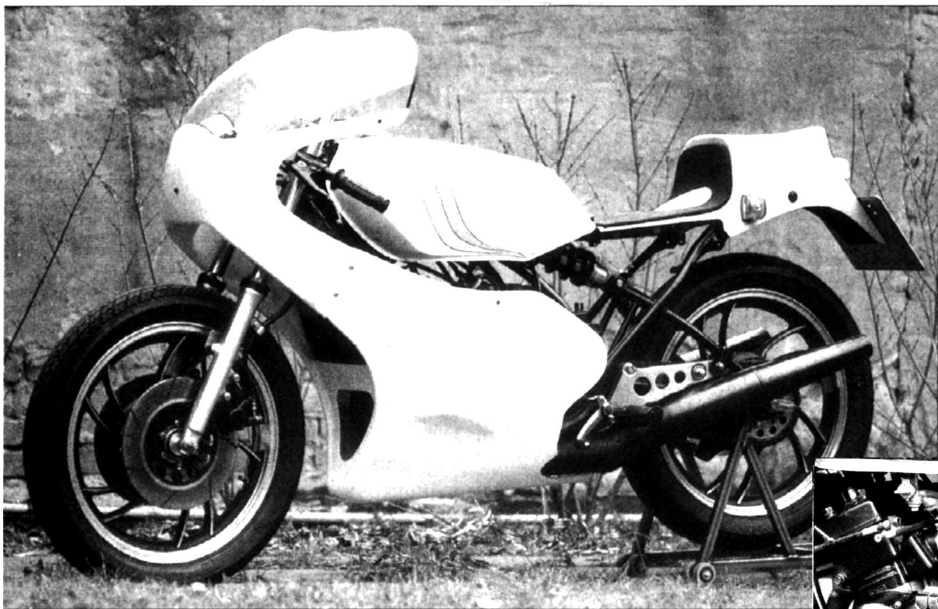
Driving Resistance

If you want your bike to run faster you can either increase engine performance or you can use the small amount of power in a more economic way.

If you put in a 100% of energy (= fuel consumption) there are only some 25% which you can use for moving your bike somewhere else. These 25% have to compete against the driving resistance which consists of:

- Drag resistance
- Mechanical grade of efficiency
- Rolling resistance
- Acceleration resistance

Each time you ride the sum of engine output equals the driving resistance. At lower speed the drag is low too so you can accelerate quite fast (great acceleration resistance). At high speed the drag eats up the whole engine output and the possible acceleration is almost zero.
To show you the potential which is hidden in this chapter I'd like to give you an example:
In an article in the German magazine "mo" (9/84) they presented the RD350LC of Bernd M. Hilla from Berlin. As I knew him I can confirm the given info; unfortunately he cannot as he died of cancer a few years ago.



Die Verwandtschaft zur Serienmaschine ist dieser Rennmaschine anzusehen, wenn sie auch mit Verkleidung, Sitzbank, Lenkerstummel und durch Abbau von Straßen-Teilen von 160 auf 137 kg erleichtert wurde. Ein Rennen kann man damit nicht gewinnen, aber viel Spaß haben – und genau

Wenig Änderungen, z.B. K + N-Filter, am Motor

Figure 94: Hilla-RD350LC (Magazine "mo" 9/84)

In stock condition a RD350LC is good for about 43 - 44 rear wheel HP and about 185 - 190 km/h. Bernd carefully (pedantically to be more precise) adjusted ignition, mixture and carb-setup which resulted in 53.86 HP at 8.770 rpm (measured at the back wheel on a Mitsui dyno).
Despite the TZ fairing he managed to reduce weight from 165 kg to 137 kg. He used all tricks to reduce friction such as a non-o-ring-chain or bearings without seals.
To reach a higher speed with low engine revs he had to use quite a big transmission ratio.
The result was convincing: Measured 220 km/h at the Berlin Avus motorway (10 km straight, three lanes, no speed limit).
Without the whole optimising he would have reached about 205 km/h with 54 HP or he'd have needed 67 HP to reach 220 km/h.

Drag Resistance

The drag resistance (in HP) is proportional to the third power of the vehicle velocity.
To imagine it better I'll give you an example: Lets assume a motorbike of the make Yosukawonda ZXY750 has a drag resistance of 10 HP at 100 km/h. If you double speed you have an eight (2^3) times higher drag resistance! In this case you'd need about 80 HP for 200 km/h.
So it's quite clear that if you want to reach high speed you've some work to do in the field of aerodynamics.

As anyone will know drag depends on the product of vehicle shape cross section and an aerodynamic value called C_w.
You can influence both by using a slim fairing but this is lots of work.
Many shops offer race fairings for several bikes, some even in carbon fibre. At Sebimoto for example you could get a Ducati 916 fairing for about 850,- DM in fibreglass or 1600,- DM in carbon fibre.
Thomas Fried uses a modified old NSR500 fairing for his bike and in the US you can get some beautiful YZR500 (91) bodywork from Wyn Belorusky (either fibre or carbon).
So the drivers position "upright" is cancelled and changed to the position “bend over”.

If you want to use the stock fairing you can modify it the following way:

- Smaller (or even no) mirrors
- Smaller (or even no) flashers
- Shorten the windscreen and lower handlebars

But: Don’t destroy the whole work by driving in jeans and fancy jacket. A good leather suit which fits not only protects you better from injury but also assists optimum top speed!

Driveline

Most of the losses here are caused by a dry chain. Missing lubricant can cost you up to 5 km/h at top speed.
All racebikes use chains without O-rings and mostly in quite small dimensions (520 for 250 cc and 500 cc). The difference with or without O-rings is about 1 – 1.5 rear wheel HP. In Germany the company Goede Motorsport offer 520 front sprockets in order to use a 520 chain. The rear one has to be tailored in the desired size. With this conversion you’re not fixed anymore to the few aftermarket sprockets and in addition to the reduced friction you even save some weight.

I felt that the new X-ring chains have less friction compared to standard O-ring chains. This is an alternative for those who want to maintain street use.

To optimise gearbox losses use the lowest possible amount of low-viscosity gearbox oil (I use Bel Ray MC-4).

Rolling Resistance

Rolling resistance is caused by the wheel bearings, the not 100% released brake pads and the tire rubber being deformed while the wheel spins under load.

The biggest share is held by the tires, but you can improve that point by using a harder rubber compound (bad for cornering!) or increase tire pressure about 0,5 to 1 Bar (obstructs tire warming during operation = bad for cornering!).
The rolling resistance is also reduced if you decrease wheel loads which means to get rid of some “unnecessary” parts of your bike (see next point).

If you have a look at modern 125 cc bikes like the Cagiva Mito you will see that these ones have no wheel bearing seals and even open bearings (without cover) in the race versions. If you let these wheels roll free they keep spinning for a very very long time ... .

To copy this in your RD just use special wheel bearings and remove the stock oil seals. If you only ride in dry conditions and maintain it regularly you can also remove the bearing’s integrated covers. Maintain means to lube it with some motor oil because if you use plenty of bearing grease it will be hurled out during rotation.

	stock (standard bearings)	low friction (larger clearance)
Wheel bearing front	6302 2RS	6302-C3
Wheel bearing rear	6303 2RS	6303-C3

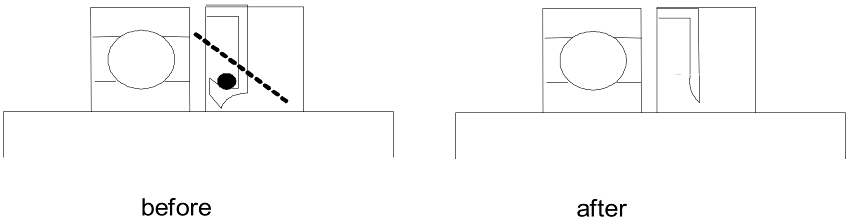


Figure 95: Oil seal modifications

As mentioned before the state of you brake system influences the rolling resistance. If the pads are not released 100% after braking you will have a residual brake torque of up to 10 Nm (this destroys about 3 HP at 230 km/h).
If this occurs you have to perform a cleaning or overhauling operation.
To clean the piston in the caliper remove one at a time from the fork and press the brake lever slightly a few times to get the piston about 5 mm out of the caliper (not too much, because if it slips completely out you will have an awful mess and you must rebuild the caliper!). Don't forget to block one piston with pliers when pumping the other out.
Then clean the piston with brake cleaner spray and/or air pressure and push it back into the caliper with the help of two big pliers. Repeat this once or twice to be sure all the dirt is removed. After that you can block the first piston and clean the second one.

Weight

For the purpose of race use the weight reduction is an essential part of the necessary modifications. On a stock street bike there is plenty of scrap to remove.
The first 15 – 20 kg are quite cheap but after that a rule of thumb says that every additional kg costs about 1000,- DM.

- For race use remove all street parts such as: mirrors, flashers, lights, horn, ignition switch, sidestand, radiator ventilator, plastic covers, coolant surge tank, ...
- Race fairings are much lighter than stock ones, especially if you use carbon fibre. In addition they improve aerodynamics.
- Change nuts and bolts which are not important to aluminium type. The suspension and main chassis ones can be made out of titanium.
- Replace steel mounts by aluminum or carbon fibre.

- Magnesium rims are a few kilograms lighter than stock rims
- Jolly Moto pipes save 3 – 4 kg per pipe compared to stock material
- Getting rid of the oil pump and tank (use pre-mixture 1:30) gives you another 2 kg and an additional good look (free sight below seat).
- The RZV frame saves about 4.5 kg compared to the RZ/RD steel frame.

Counting teeth

The transmission ratio should match the performance characteristic of your engine to the most common driving situations.

A shorter secondary reduction ratio is needed when you usually drive around town or you live in a region with nice small roads or if you've got a speed limit to follow.
The Advantages are:

- Good acceleration / good draft to Vmax
- Can hold Vmax even with worse conditions (headwind/uphill)
- Very good for Wheelies

Disadvantages would be:

- High engine revs during long distance travelling (very bothering)
- Doesn't get faster with good conditions (tailwind/downhill)
- Rev's up to or more than redline on straights

The longer ratio is recommended when you usually drive on unrestricted motorways (or if you p..s on restrictions). If you do so you shouldn't bother to lay down quite often to reach (or to hold) top speed

The Advantages are analogously:

- Gets very fast with good conditions (tailwind/downhill)
- Moderate engine revs (convenient for long trips)

Disadvantages would be:

- Less acceleration
- In tight conditions, you must shift down to 5.'th gear
- Obstructs Wheelies (My favourite KO criterion for undoing mods)

Naturally there are physical limits about the desired top speed. Don't expect your bike always to run faster when you make the transmission ratio longer. I've a good approximation formula which tells you how much performance your RD requires to get to a desired speed value.

$$V_{\max}(P_2) = V_{\max}(P_1) * \sqrt[3]{\frac{P_2}{P_1}}$$

P1 = performance before (stock); P2 = performance after tuning ; Vmax (P1) = Vmax with performance P1

Table 14 assumes that stock RD's have the claimed 88 HP and a top speed of 223 km/h (average of several magazine tests). With a top speed of 226 km/h the 1GE is slightly faster. These are not speedometer values but real vehicle speed. I'm sorry for crushing your illusions, but the very optimistic stock speedometers usually claim about 245 – 255 km/h at top speed.

V_{max}	Required performance
[km/h]	[HP]
223	88
225	90.4
227	92.8
229	95.3
231	98
233	100.4
235	103
237	105.5
239	108.3
241	111
243	113.8
245	116.7

Table 14: Required performance (47X)

In Germany you can get front and rear sprockets in several sizes:

15, 17	Hein Gericke, Götz, Polo, ...
38, 44, 45	Hein Gericke, Götz, Polo, ...
14 ,15, 16, 17	Goede Motorsport (530 and 520)
39, 40, 41, ...	Goede Motorsport (530 and 520)

At several stores you can get sprocket ruffians without mounting holes for a 520 chain. At Götz they have 40,42, 44, ..., to 56, Goede offers them including the matching bores to use them in the RD500.
A front sprocket should cost around 25,- DM , a rear one around 30,- DM in steel and around 70,- DM in aluminum.

I used 14/40 with a 150/70VB18 rear tire which was enough for wheelies up to fourth gear (This was the reason why I scrapped the 14/38 final drive ratio). The top speed was about 211 km/h @ 11.000 rpm (speedometer: 225 km/h). Due to bothering high

speed weaves and speed limit of 100 km/h I usually don't use more than 200 km/h (160 mph).
If you have a Garfield style body, you can even use 15/47. I know a guy who is 1.90 m (6 ft 3 in) and over 100 kg. He only uses country roads and the top speed in this configuration is about 200 km/h.
In the Yamaha race specs they recommended using 36/16 or 35/15. I feel this will be too long for most tracks I know, for example at the annual French RD500 club meeting in Lurcy Levy the 14/40 was ideal despite the 700 m straight.

If you change the total amount of teeth for more than two or three teeth, you may have to cut the chain or use a longer one. Example: If you want to use 15/44 instead of the stock 15/38 you will need a 106 link chain instead of a 102 link stock one.

If you decide to use a 520 chain you can find the matching front and rear sprockets at Goede Motorsport. They supply RD500 520 front sprockets for about 30,- DM.
If you have some RD/RZ350 stuff left, you can also make use of these rear sprockets. They don't fit perfectly, you may have to rebore the 8.5 mm mounting holes slightly. In Germany there is lots of supply for the RD/RZ sprockets in the sizes 36, 37, 39, 40, 41 and 45.
15/41 would equal 14/38; 16/41 is almost stock ratio, 16/44 is slightly shorter than 14/38 and 16/45 equals 15/42.

If you use another rear wheel in 17 inch with another tire the tables are not valid. In this case you have to use the rule of three to calculate the right ratio. I'll give you my example for using the 150/60ZR17 instead of the 150/70VB18.
The tire manufacturer supplies values for the rolling circumference of the tires of 1848 mm for the 150/60ZR17 and 2014 mm for the 150/70VB18.
My objective was to maintain a ratio similar to the 14/40 I used before.

The equation for the new ratio is: $\frac{1848}{2014} * \frac{40}{14} = 2.621$

The 2.621 ratio can be reached using 15/39, which will be slightly longer than the 14/40 with the former tire. If you have problems to use the 39 teeth sprocket at your new wheel, you can also go to 16/42 (slightly shorter) or 17/44 (longer) or 17/45 (shorter).

U/min	15/38 stock	17/44 2% shorter	17/45 4,5% shorter	15/44 15% shorter	15/45 18% shorter	17/38 12% longer
6000	132.96	130.14	127.25	114.83	112.28	150.69
7000	155.12	151.83	148.46	133.97	130.99	175.80
8000	177.28	173.52	169.66	153.11	149.70	200.92
9000	199.44	195.21	190.87	172.24	168.42	226.03
9200	203.87	199.55	195.11	176.07	172.16	231.05
9400	208.30	203.89	199.35	179.90	175.90	236.08
9600	212.74	208.22	203.60	183.73	179.64	241.10
9800	217.17	212.56	207.84	187.55	183.39	246.12
10000	221.60	216.90	212.08	191.38	187.13	251.15
10200	226.03	221.24	216.32	195.21	190.87	256.17
10400	230.46	225.58	220.56	199.04	194.61	261.19
10600	234.90	229.91	224.80	202.86	198.36	266.22
10800	239.33	234.25	229.05	206.69	202.10	271.24
11000	243.76	238.59	233.29	210.52	205.84	276.26
11200	248.19	242.93	237.53	214.35	209.58	281.28
11400	252.62	247.27	241.77	218.18	213.33	286.31
11600	257.06	251.60	246.01	222.00	217.07	291.33
11800	261.49	255.94	250.25	225.83	220.81	296.35
12000	265.92	260.28	254.50	229.66	224.55	301.38

U/min	15/38 stock	15/40 5% shorter	14/38 7% shorter	15/42 10% shorter	14/40 12% shorter	14/42 18% shorter
6000	132.96	126.31	124.10	120.30	117.89	112.28
7000	155.12	147.36	144.78	140.35	137.54	130.99
8000	177.28	168.42	165.46	160.40	157.19	149.70
9000	199.44	189.47	186.14	180.45	176.84	168.42
9200	203.87	193.68	190.28	184.46	180.77	172.16
9400	208.30	197.89	194.42	188.47	184.70	175.90
9600	212.74	202.10	198.55	192.48	188.63	179.64
9800	217.17	206.31	202.69	196.49	192.56	183.39
10000	221.60	210.52	206.83	200.50	196.49	187.13
10200	226.03	214.73	210.96	204.51	200.42	190.87
10400	230.46	218.94	215.10	208.52	204.34	194.61
10600	234.90	223.15	219.24	212.52	208.27	198.36
10800	239.33	227.36	223.37	216.53	212.20	202.10
11000	243.76	231.57	227.51	220.54	216.13	205.84
11200	248.19	235.78	231.65	224.55	220.06	209.58
11400	252.62	239.99	235.78	228.56	223.99	213.33
11600	257.06	244.20	239.92	232.57	227.92	217.07
11800	261.49	248.41	244.06	236.58	231.85	220.81
12000	265.92	252.62	248.19	240.59	235.78	224.55

Table 15: Velocities for different final drive ratios (150/70VB18)

Chassis

The RD’s are most famous for two things: Being very fast on small roads where cornering is more important than top speed and having a severe high speed weave problem.

Both are true and in my experience high speed weave is mostly caused by too low weight on the front wheel combined with an excitation from the tire-to-road and/or wind-to-bike interaction.

But there are some other factors you should watch:

- Tire profile (especially at the rear below 3 mm) and pressure
- Steering head bearing (worn / too stiff/loose / wrong assembly) (special “zero-tolerance” bearings available from Emil Schwarz)
- Fork (oil-type and -level, pressure different left/right)
- Swingarm (worn bearings)
- Rear shock (worn, insufficient damping)
- Too little weight on the front wheel (running low fuel, upward driver position while high speed driving)

Figure 96: Michael Bähr's almost stock RD500 (47X)

Tires

In my opinion the stock YOKOHAMA/DUNLOP tires are not worth a single penny and they wear faster than you can watch them. I never use anything else than METZELER, because of the unique grip and durability. They offer the stock and bigger sizes in standard rubber and a softer type called CompK.
You can use the stock dimensions 120/80V18 ME33 and 130/80V18 ME99 if you use it for everyday riding and you are not going that fast.

In Germany other tires have to be approved by the TÜV; you can get the necessary papers from Michael Bähr. The sizes are:

Front	Rear
ME 33 120/80VB18TL CompK	ME1 150/70VB18TL CompK
	ME99 150/70VB18TL CompK

My tip for sporty/race drivers: Use ME33 120/80 and ME1 150/70 both in CompK.

If you don’t value grip that much you should use the 130/80 ME99, because they last much longer. But caution: If you have a fluent driving style they offer quite good grip but they have a tricky-to-cope-with sliding characteristic. If they lose grip, they lose it in an instant and the rear wheel performs the slide of your life. This occurs when the tires are cold and/or you try to perform hard acceleration during cornering. The ME1 is much more good-natured; the range before losing grip is broader and better to control.

In the stock dimensions you can also get Michelin radial tires TX11/23 which are said to be very good (I never tried them myself). These wear very quickly and I heard of delays in delivery.

Meanwhile Bridgestone offers radial tires in stock RD500 dimensions. The BT53 F/R are said to decrease the high speed weaves. A friend of mine tried them on his RD350 and they were not too bad compared to the Metzeler standard rubber compound. On the RZ350 most people in Germany use the BT45 which is also available in the RD500 sizes.

Don’t try to save money on using other, cheaper tires. They are your life insurance and any crash could be your last. Even if you’re not hurt you will spend more than the “saved” money rebuilding the bike!

Figure 97: The author during tire testing (1995 OMK-races, Zandvoort, Netherlands)

Suspension

As in the field of tires you can’t save much money in the suspension area. The White Power stuff is not a bargain, but it works very well when you have a sporty riding style. Meanwhile Benny Wilbers (the company’s “brain”) has gone to Technoflex and they offer the same range of products sometimes slightly cheaper than White Power.
The Technoflex shocks are of improved quality compared to White Power. They have Teflon-coated internal bushes and the damping adjustment is done by an aluminum ring instead of a plastic one. The basic version can be adjusted in 22 steps, where step 10-12 is the required setting. So you can have it either softer or harder; the White Power shock has only the top 11 clicks to make it harder then basic setup.
Of course these are completely rebuildable and the manufacturers require this service every 20.000 km.
If you use a 17” rear wheel you can compensate the smaller cornering clearance by ordering a slightly longer shock. Technoflex offers an adjustable solution (for example 0 mm to +10 mm) for the fully adjustable shocks (bound/rebound/spring preload).

The stock suspension doesn’t offer many opportunities for adjustment.
If you need maximum cornering clearance you’ll need to adjust the stock rear shock to the hardest position. The workshop manual states click 5 of 5; on my bike it had bolt nuts on thread. The optimum pre-load is the one which has a negative spring

travel of 35 mm (35 mm difference between unloaded state and with driver in normal position).
The rebound damping can be adjusted in 4 steps and YAMAHA recommended the second as a basic setting. I had difficulties to spot where the single steps are, because there is no clear marking. If you look at the adjuster in step one the Number one should be at nine-o-clock position. To make it harder turn anti-clockwise.
I was always running on hardest position of pre-load and damping, because of missing cornering clearance.

The stock fork cannot be adjusted nor has it an air support. If you want the front end to become harder, do not use heavier oil types, but increase the oil level in the fork. The reduced air chamber gives you a better progression at the end of the spring travel. The oil level (actually the length of the air chamber above the oil level) is measured when it’s pressed completely down with removed spring (see Chassis, page 15).
If you’ve got severe problems and there’s no money to get progressive fork springs (White Power, Technoflex, Wirth, ...) it may be a solution to manufacture some spring spacers to increase pre-load. I’d say 15 – 20 mm should be enough if you combine it with a smaller air chamber.

The anti dive can be adjusted steplessly and the completely screwed in adjuster means a soft compression damping; if you turn it out completely the damping is at hardest position. When I had this active I mostly had it in the soft position, only for racing I turned it to hard. As I mentioned before I meanwhile got rid of this feature and compensated it with more oil and White Power fork springs.

Brakes

If you’re not used to modern bikes the stock brakes are not a bad choice.
But if you want to use your bike the sporty way, there is work to be done.

I used several brake lining makes and all were more or less usable. Meanwhile I’d recommend using race types (available from several manufacturers like Ferodo, EBC, Girling, Brembo, ...) because they improve brake efficiency (at the cost of reduced life-cycle).
In long-term average my linings lasted between 20 and 25000 km at the front and between 6-12000 km at the rear. Race pads wear much quicker, they can be down after only 1000 or 2000 km!

Compared to the stock rubber hoses, steel braided ones significantly improve brake actuation accuracy. Prices vary very much on quality (aluminum, stainless steel,

adjustable or anodised banjos) and quantity (2, 3, 4 or 5 hose kit). Generally it's much cheaper if you leave out the anti dive.
If you trust your own work, you could make them on your own. Some companies offer universal kits which have to be screwed together (the other kits were pressed). If you don't need to have them approved this is not a bad choice, in Germany these are only legal for race use.
Another option to get a better stock brake is to make use of a 6/8 inch hand lever assy (the stock one is 5/8 inch). You can find these in all modern big bikes such as YZF750, ZXR750, ZX9-R, ... The effect is that you decrease lever travel at the cost of higher lever actuation force. For my taste it was the optimum mix between actuation force and lever travel, because with the big hand pump this relation stays quite constant even at high brake temperatures.

If you are about to replace worn stock discs you should use the Brembo or Spiegler cast-iron disks for the RD's. They offer better high temperature fading resistance and they are delivered with special high-friction brake pads (Price: approx. 320,- DM a set). If you want to use them for racing they do crack at the holes due to thermal overload (I had two sets doing so, the same disks work properly in the RD350). In Germany I heard of problems approving the Brembos as they only have the 47X type in the approval.

For racing I'd recommend at least floating discs, if possible of bigger diameter. Brembo also offers such kits, with 320 mm discs and four piston calipers, but with 2500,- DM these kits are far too expensive. In this case you may think of swapping the front end with an FZR or other modern bike.
If you prefer spending less money, choose the ABM floating discs for the RD (about 800,- DM a set).

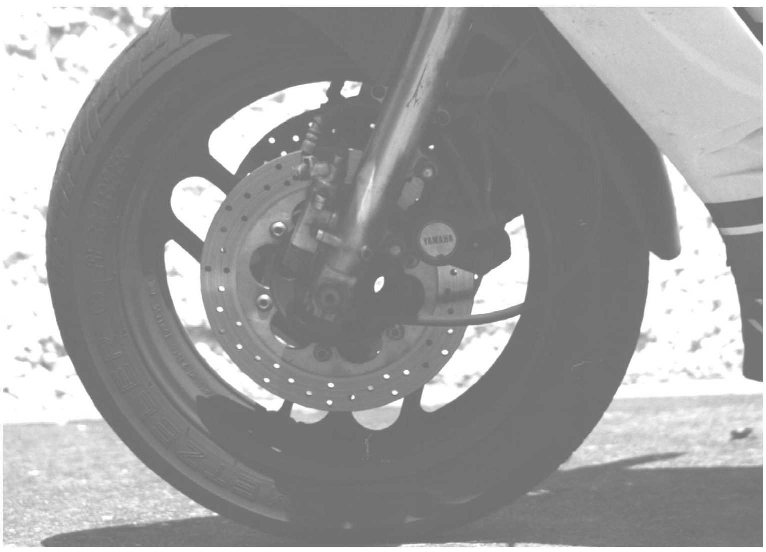


Figure 98: Spiegler cast iron disks

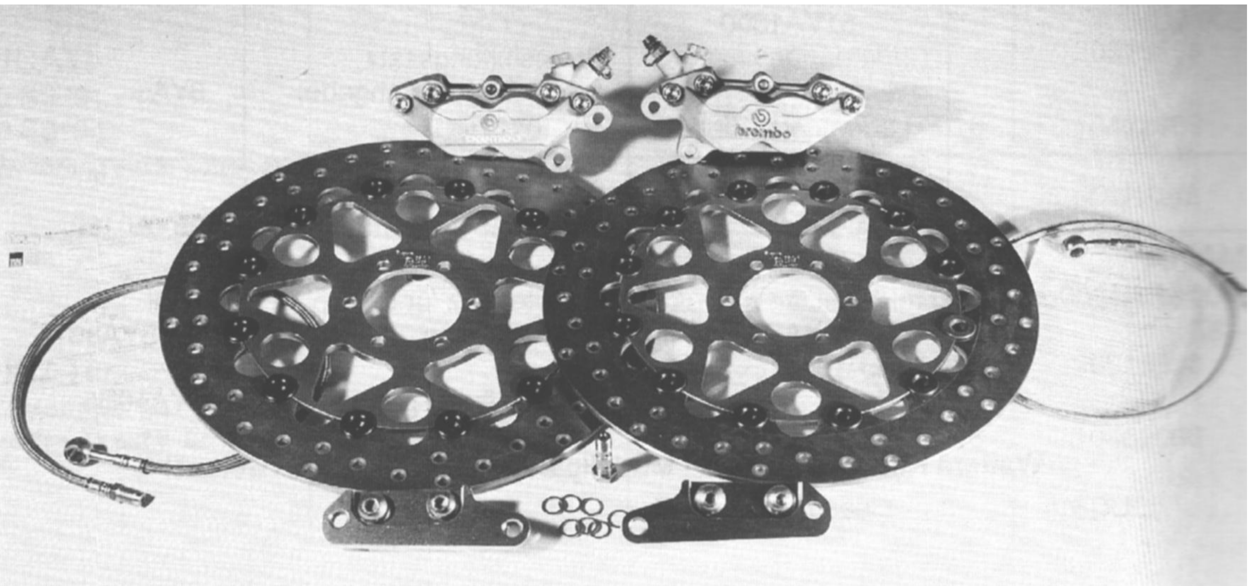


Figure 99: Brembo 4 piston caliper Kit (Courtesy of Brune catalogue)

Miscellaneous

Stock RD’s often lack some cornering clearance when you want to go fast.
In my bike the side stand scratched at left cornering. I modified the endstop between stand and holder. If you mill a 1 or 2 mm groove in the stand it can stop in a higher position. It may be necessary that you bend the shift lever slightly to avoid contact to the side stand.

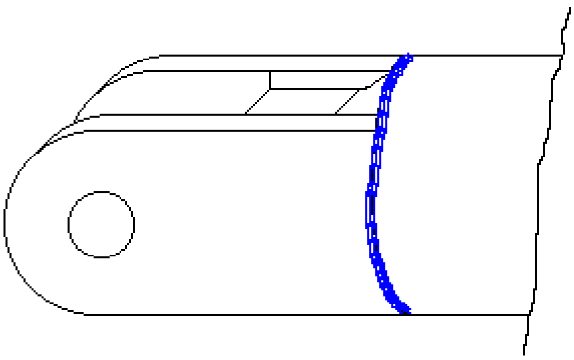


Figure 100: Side stand groove

Sometimes the pipes come in contact with the tarmac. You can cope with it if you mount them a little higher.
You only have to modify the brackets to slotted holes using a file. When you’ve mounted them check for enough clearance to the swingarm and frame.

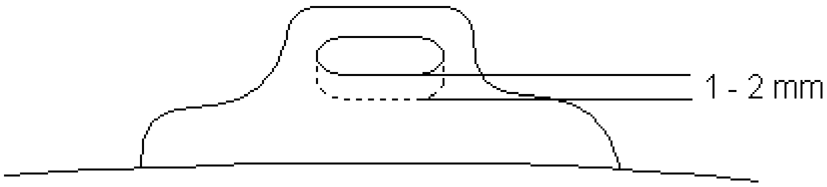


Figure 101: Pipe mounting

On both of my RD's a steering damper is doing a really good job especially on my favourite small roads.
First I was using the RD500 without because my damper was not approved by the German TÜV. Every time the front wheel touched the ground after wheeling there was a very bothering kickback (sometimes it smashed the handlebars from end position to end position!). These kickback effects occurred as well during hard acceleration on uneven road.

Figure 102: Steering damper (RD350)

After re-mounting the damper to the bike kickback was totally eliminated. On my "test track" it improved the maximum cornering speed significantly due to the fabulous feedback of stability and security. Unfortunately it had almost no effect on high speed weaving.
(I still use it without approval, but it will be worth the penalty if I get caught.)

The main disadvantage is the high price and the poor range of available kits (in Germany). The cheapest kits begin at 300,- DM (LSL). You can try to get used ones and have them rebuilt or you've got to make your own brackets using a new damper (about 100 – 120 mm stroke).

Stages

At this point it’s time to summarise and put together single mods which make sense to be carried out together. The numbered costs are German prices and they assume that you do the work yourselves, except crank rebuilding and cylinder rebore.
Don’t take the stages too seriously, they should only be a kind of proposal for people who are not sure what to do and what to leave out.

Stage I

For those who don’t want to put too much work into their bike or who are just too lazy, I’d recommend at least to perform the following points:

- Power Increase about 5% (dependant on starting state!)
- Charge: a few hours work and about 200,- Eur. costs for parts.
- Optimum adjustment of Power-Valve System (look inside or feel with finger) after removing pipes.
- Optimum carb synchronisation.
- Removed snorkels in the air filter cover, Jetting #170 - #175
- Fibre reeds (if wanted).
- Modify stock Power-Valve box

Stage II

For those who are already rebuilding their engine and who know how to use a file or die grinder. Just add the following points to complete the top end job:

- Power Increase about 10 - 15% (estimation)
- Charge: about several days up to some weeks work and up to about 500,- Eur. for parts/labour costs.
- Fibre or Boyesen reeds.
- Porting: exhaust, intake and scavenging ports.
- Piston: Skirt sharpened, bottom polished.
- Mill Cylinder head 0.5 mm and rework squish band.
- Power-Jet conversion (if wanted), appropriate jetting required
- Programmable Ignition and Power-Valve
- Chassis: Steel braided brake lines

Stage III

Those who drive quite crazily and who own a second RD for everyday driving but who still want to keep their bike for road use should add the following points:

- Increase of power to about 15 - 25% (estimation)
- Charge: about several weeks of work and up to some thousand DM for parts/labour costs.
- Perforated air filter cover or air filter kit (BJ Mac Donald)
- Bigger reed cages from the RZ350 (if wanted)
- Race pipes (Jolly Moto, WIWA).
- Crankcase modification.
- Welded cranks.
- Appropriate jetting required.
- Bigger radiator (RGV, Mito)
- White-Power fork springs/rear shock/steering damper
- Modified brake system (cast iron disks or floating disks)
- If wanted complete conversion of rims, fork, brakes (e.g. GXSR, FZR, ...)

Stage IV

For those who use their RD only on race tracks:

- Increase of power about ? (Record: measured 289 km/h for an Austrian RD500 measured in Hockenheim).
- Charge: Rob your local bank and prepare for a long, long winter .... .
- Bigger carbs: Mikuni TM30-6.
- Leave out lower piston ring and shorten piston.
- Modification of scavenging port height and radius..
- Chassis conversion to 17 inch magnesium rims and radial tires (fork, swingarm, rims, brakes, fairing, weight reduction).
- Sambiase aluminum frame.
- Reduction of driving resistance.
- Get rid of the oil pump and use mixture 1:25 - 1:35 (e.g. with fully synthetic or castor based oils like Shell Racing M).

Nice ones

As I regularly participate in two stroke meetings I've seen many nice RD's and captured them on celluloid. For some of you these are rather boring, as in other countries people are less restricted concerning swapping bike parts.

If you want to spend a bunch of money there is lots to buy. If you sum up the value of the single parts Thomas Fried put in his RD you could afford a midsize car ... .Just to mention a few: Brembo 320 mm disk and four piston caliper kit, Magnesium wheels with 170/60 and 120/80 (18/16 inch) tires, TiN coated fork, NSR500 bodywork, Sieker pipes, open air filters, excessive usage of aluminum, titanium and carbon fibre, Weight 159 kg without fuel, excessive engine modification (Vmax about 250 km/h).

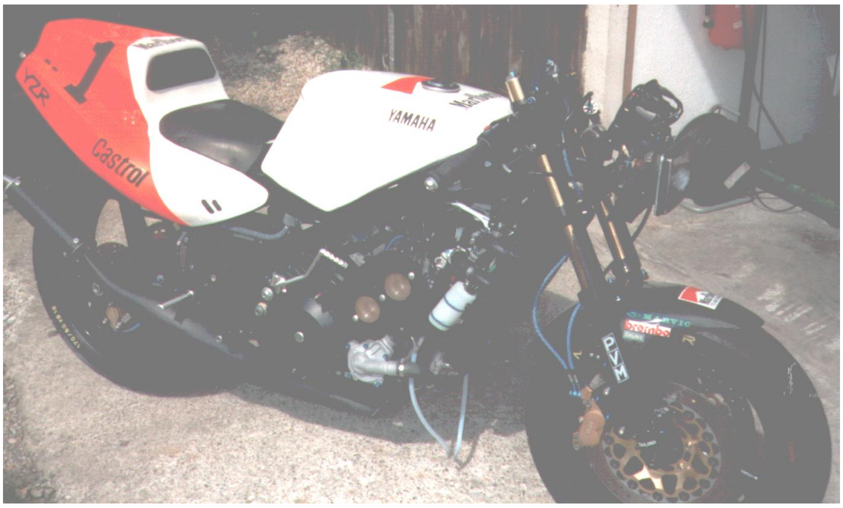


Figure 103: Fried RD500 (Twostroke meeting in Schweich/Mosel, Germany, Aug. '95)

Another guy who spent lots of money on his RD had fitted White Power upside down forks (2.500,- DM) , 17 inch PVM magnesium wheels including 6 piston calipers (5.000,- DM) , steering damper, custom made swingarm (1.500,- DM), Jolly Moto pipes (2.000,- DM) and a WiWa tuned engine (5.000,- DM).

Figure 104: How to spend a fortune on an RD500 ...

Of course there will be people who can't afford such expensive modifications. In my opinion it should be enough to swap fork and rims. If you use YAMAHA parts there will be less problems than with other makes:

If you just want some stock parts to rebuild a crashed bike you can use the FZ750 (1FN) parts of that time. This was built from '84 to '87.
For the stock fork you can get an adjustable damper kit from Technoflex (Peter Schief). Combined with progressive fork springs this is said to improve handling qualities.
Stock brake disks are quite expensive when you order them from YAMAHA. The SRX600, RD350YPVS, or XJ600/900 had the same disk dimensions. They all fit to the stock front wheel but they are not vented but massive type.

The FZ750 (2KK later than '88) could donate rims and fork including 282 mm brake disks. If you want it the cheapest, you can use the front wheel without the fork, but you'll have to make an adapter plate to fit the calipers. The advantages are obvious: The FZ has 17 inch wheels which are half an inch broader than the RD ones. So you can make use of the very good Metzeler radial tires MEZ1 in racing compound. In addition you'll have a very good brake system included.
You can also use the FZR600 or FZR1000 parts instead. The forks all have the same bearings, so they will all fit easily into the RD frame. The FZR forks even have an adjustable spring preload.

Figure 105: FZ wheel and brakes in RD500 fork (anti dive closed)

If you prefer very good handling you shouldn't get too big tires. Dieter Glatting from Neckarsulm converted his RD500 to FZR600 wheels and fork. At the front end you need the complete assembly of brake system, fender, wheel and disks, spindle and fork.
The disadvantage he mentioned was the decreased maximum steering angle, which made it difficult to handle when parking.
At the rear end you have to use some tricks because the RD swingarm is some 16 mm broader than the FZR one.
The brake assembly and the sprocket holder were identical with the RD pendants, keep them as spare parts.
The sprocket has to be distanced about 10 mm away from the holder. Dieter did it by using 6 single spacers (∅ 8.1 mm x ∅ 16 mm x 10 mm), better would be a big ring which is 10 mm thick and which carries six 8.3 mm bores.
The same thing was done to distance the disk 6 mm away from the stock mounting surface (6 spacers ∅ 8.1 x ∅ 16 x 6).
Then he manufactured new axle spacers for the right and left side (Chain side plus 10 mm = 18 mm broad, Brake side: 6 mm longer).
He used parts for about 2500,- DM and was absolutely satisfied with the handling and the brakes. According to him this was mainly caused by the radial tires in the dimensions: 110/70 ZR17 and 150/60ZR18 Metzeler MEZ1.
Info: Dieter Glatting Tel.: +49/7132/81836 (Neckarsulm, Germany).

A similar conversion was published in the RD/RZ club newsletter, but he had some other dimensions for his spacers, as he did not distance the disk, and used the stock rear brake. Info on that from: Ron Atchinson or Wyn Belorusky at Atch@colint.com or RZVWyn@aol.com (I've included a copy of Ron's drawings in the appendix).

The FZR600 sprocket carrier also fits into the RD500 rear wheel which gives you some more cheap possibilities to get different sprockets for the stock chain. For the FZR there is much more supply of different sizes as 43, 44, 45, 46, and 47.
To convert your bike to a 520 chain you won't have to use expensive custom made rear sprockets. Simply take RD/RZ350YPVS or TZR/TDR250 parts (38, 39, 40, 41). They have the same mounting holes but on a 136 mm diameter instead of 135 mm in the RD500 sprocket carrier. So it could be necessary to widen the mounting holes to 8.7 mm.

In 1997 I participated in a German race series (MuZ Skorpion Cup) where I tested the METZELER MEZ1 racing tires. They performed that convincingly that I decided to use them on my RD350YPVS. The only problem were the smallest available sizes 110/70ZR17 and 150/60ZR17. This meant at least other rims but as the swingarm was too narrow to bear the 150/60 tire I had to look for another. I finished in using a

Cagiva Mito 125 front end and rims combined with a Honda NS400R swingarm and a Yamaha YZF 6 piston caliper.
Compared to the state before, this bike handled fantastically! No more high-speed weaves, superb cornering and superior tires. This gave me the last push to repeat the swapping in my RD500 as it always had a more or less intensive high speed weaving problem.
To keep it as easy and cheap as possible I used a RGV250 (‘91) 4.5 x 17 inch rear wheel assembly (including brake) and changed the wheel bearings from 20 mm to 17 mm diameter. The wheel spacers had to be manufactured, but these were all easy to make (Drawings within appendix). If you choose to maintain a 20 mm spindle, you just have to change the dimensions.
The brake carrier slides on a custom made stopper, which was screwed to the stock swingarm with the help of a plate with two welded nuts inside the swingarm profile. This saved looking for someone to weld aluminum.
At the front end I mixed up FZR1000 (2LA) fork yokes with the RGV lower ends and RGV brakes and wheel. (This was just a mixing of two bargains; for you it’ll be much easier to use the complete FZR front end ..).
As expected the handling is superb now and the brakes deserve their name even under race conditions. The 110/70ZR17 and 150/60ZR17 METZELER ME Z1 Racing tires have an excellent grip and they even last quite long (my first rear one had 3.500 km). The best improvement is that you can brake deep into a corner or even correct while cornering, which caused very difficult handling before.

To make it easier for you to have a look in the classifieds I’ve made a list of the (German) YAMAHA Model codes I know:

Model Code	Year	Remarks
FZR1000, 2 LA	87/88	41 mm fork, 18 inch rear wheel
FZR1000, 3LE	89	43 mm fork, 5.50 x 17 rear wheel
FZR1000, 3LE	90 -	USD fork, 5.50 x 17 rear wheel
FZ750, 1FN	85/86	Same stuff as RD500
FZ750, 2KK	89-90	39 mm fork, 3.5 x 18 rear wheel
FZ750, 3KT	91-	39 mm fork, 3.5 x 18 rear wheel
FZR600, 3HE, 3RG, 3RH	88/89	38 mm fork, 3.5 x 18 rear wheel
FZR600, 3HE, 3RG, 3RH	90-92	38 mm fork, 4.0 x 18 rear wheel
FZR600R, 4JH	93	41 mm fork, 5.0 x 17 rear wheel
YZF750	1992	USD fork, 6 piston calipers, 5.0x17 rear wheel

Table 16: Yamaha sport bike model codes

To give you an example how it could look I have some pictures from Ralf Klöpper. He combined an FZR 1000 (2LA) front end with an FZR (3LE) 5.5x17 rear wheel and fitted the RGV ('91) bodywork. The tires were 120/70ZR17 and 180/55ZR17 MEZ1.

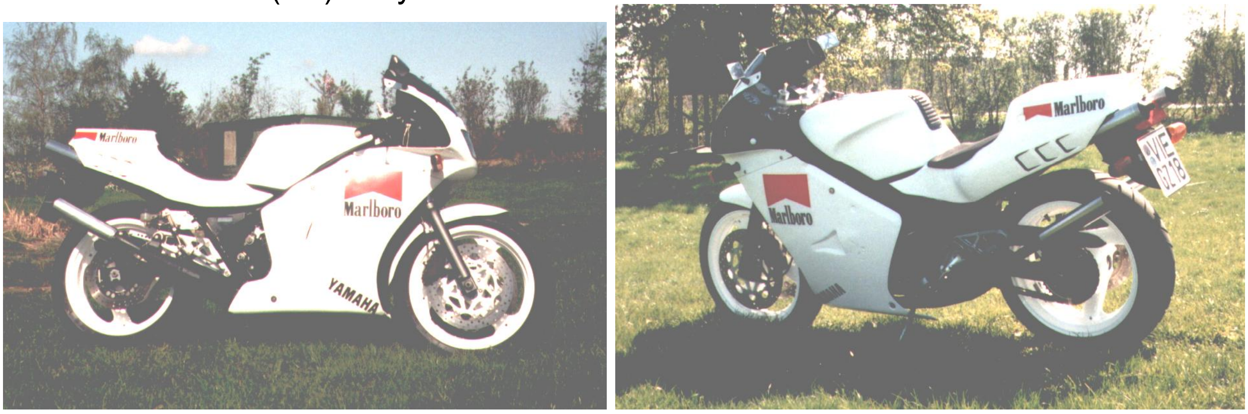


Figure 106: Klöpper RD500 (FZR conversion, RGV Bodywork, Jolly pipes)

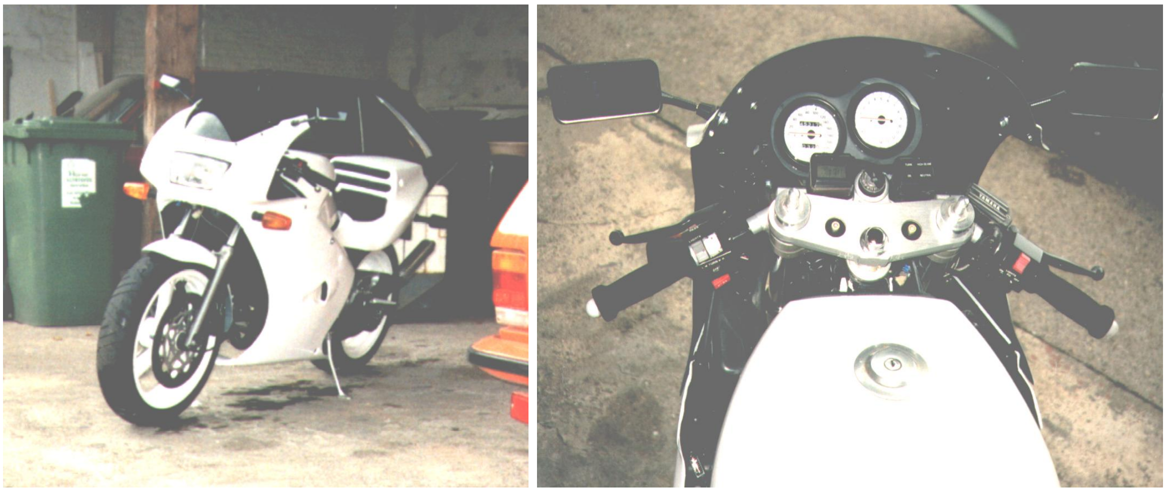


Figure 107: Klöpper RD500 front sight, cockpit

Figure 108: Sambiase frame (courtesy of French RD500LC club)

In France there is a company called Sambiase which manufactures custom made frames which have identical brackets as the stock frame. The difference is just that it's made from aluminium and it weighs only 8 kg. The pictures of Jerome Buscails

RD500 project are downloaded from the French RD500 club homepage (www.multimania.com/rd500lc). You want it for your RD? Then prepare to spend about 5.000 – 6.000 US$!

The French RD500 LC club has an annual meeting at a race track of Lurcy Levy in the middle of France. There I saw the more GP style pipes than ever before, here are some examples:
In addition to the Figaroli pipes with carbon silencers this one has FZR1000 17 inch wheels and brakes.

Figure 109: Figaroli GP style pipes

The next guy used CBR900 swingarm, fork and wheels combined with custom made pipes.

Figure 110: CBR900 swingarm and fork

There would be something missing if I wouldn't add some pictures of the world's most beautiful RZV500. I think nobody ever spend that much work (and money) on one of these.

Just a shortlist of the mods: Base RZV500R, Frame modified to "deltabox" look, Dry weight 295 ponds, carbon fibre seat and fairing, all bolts either aluminium or titanium, custom made pipes, GSXR 750 front end, GSXR 750 modified swingarm, full spec engine (porting, heads, reeds, 28 mm carbs)

Figure 111: Wyn Belorusky's RZV500

Last but not least a nice replica of Wyn Belorusky's "Aluminum Import". It belongs to Stephen Jago and he used the ZXR400 upside-down fork, the RGV250 gullwing swingarm and got his pipes custom made. The fairing was transplanted from the FZR 600 and the two DE lights were hidden in the FAI ducts (Seat: Harris GP500).

Figure 112: Stephen Jago's RD500

Last page

That’s all folks. If you have made similar or different experiences, just let me know. I always appreciate good information. The fastest way will be e-mail to maki500@gmx.de but you can also write or call.
Maybe the next release will contain your data to help the others all around the world to get their bike into moving like that ....

Addresses

Here are some addresses of the German RD-scene, naturally without claiming to be complete. As far as I am concerned I've made my own experience with most companies and products, so I've added a very subjective rating

- 👍👍 very good product, you **must** have this
- 👍 good thing, but quite expensive
- ☜ ok, but not needed urgently; for people with too much money
- 👎 too expensive, negative effects
- 👎👎 total scrap

Mitsui Maschinen GmbH Kundendienst, z.Hd. Herrn Meier Postfach 3251 32584 Löhne	technical data for all YAMAHA models	
Emil Schwarz Daimlerstr. 8 73660 Urbach ☎ +49/7181/995290 FAX: +49/7181/995291	Zero clearance steering bearings ca. 80,- € special power-valve-bearings ca. 65,- € needle bearing conversion for swingarm and linkage ca. 250,- €	👍 👍👍 👍
Wilbers Products Alfred Motzer Str. 84 48527 Nordhorn ☎ +49/5921/6057	Technoflex products fork springs ca. 80,- € rear shock 400,- to 600,- € steering damper ca. 200,- €	👍👍 👍👍 👍 👍👍
Harald Haungs Raiffeisenstr. 8 74906 Bad Rappenau ☎ +49/7264/4561	tire approval for German TÜV 120/80 ME1/ME99 100/80 ME33 ca. 35,- € 130/80 ME99 on stock rim ca. 45,- € solo seats with TÜV approval	👍👍 👍👍 ☜
Großewächter Mechanische Werkstatt Soar 25 32139 Spenge ☎+49/5225/38 26 FAX:+49/5225/93 50 http://www.gw-racing-parts.de	Prox pistons Wiseco pistons (company only deals with other companies) Prox crank rebuild parts engine rebuild aluminum welding, reboring and plating of cylinders	👍 ☜
BRC-Brockhausen Beverstrang 17 48231 Warendorf ☎+49/2584/586	Prox pistons crank rebuild	👍

Alne Lederbekleidung Römerstr. 13a 63843 Niedernberg/Main ☎+49/6028/8402	protective leather wearing (quality as good as Schwabenleder) from 650,- € upwards tested it myself more then once and it worked very well	👍👍
WIWA Rennsporttechnik Nordwestring 50 32832 Augustdorf ☎+49/5237/1061	crank rebuild engine tuning (1200,- - 1500,- €) RD-pipes ca. 500,- €	👍 ☜ ☜
Moto Aktiv Hohlweg 7 35091 Cölbe-Reddehausen ☎+49/6427/9230-0 motoaktiv@t-online.de	race track sessions (ca. 200,- - 300,- €) race series for stock bikes (ca. 160,- €) annual 24h race for 50 – 125 cc bikes	👍 👍 👍👍
RM-Products Gradnerstr. 185 A-8054 Graz (Austria) ☎ +43/361/281565	race accessories, tuning specs (power reeds 90,- €) (38 mm Mikunis 350,- €)	☜
Götz GmbH Postfach 1261 72372 Hechingen ☎+49/7471/922150	fibre and carbon reeds (40,- €) Spiegler-brake rotors (200,- €)	👍👍 👍
Goede Motorsport Siegburger Str. 122 537St. Augustin ☎+49/2241/92134657 FAX: +49/2241/921347 goede.motorsport@t-online.de	Sprockets in several sizes, custom made	
UCB Racing Service Charlottenstr. 64 56338 Braubach / Rh. ☎ +49/2627/1945 Fax +49/2627/8800	Heat resistant mats and bindings Race accessories	
Martin Weichenhan Kleiner Weg 14 26529 Osteel	Nikon-Import Germany RD350 & RD500 pipes	☜
GL-Motorradtechnik Konrad-Adenauer-Str. 106 72461 Albstadt ☎+49/7432/14141	Jolly-Moto-Import Germany RD350 & RD500 pipes	👍

Micron-Systems GmbH Dr. Mack Str. 96 90707 Fürth ☎+49/911/705494	RD350-pipes in grand-prix-style (both silencers on the right side) Dynojet-carb-kit RD 350 LC	👎 ☜
A. Sieker Im Krummen Kamp 12 - 16 32547 Bad Oeyenhausen ☎ +49/5731/94959	Pipes for RD500, RGV250	
Gimbel Kesslerstr. 7 79206 Braisach	130/80 ME99 on PVM rims (1500,- € !) fairings, solo seats, footrests, ...	👎
Zupin-Moto-Sport GmbH Werner v. Siemens Str. 8 83301 Traunreut ☎+49/8669/8576-0 FAX:+49/8669/2328	Boyesen fibre reeds ca. 50,- € Boyesen Rad Valves (Banshee) 250,- €	👍 ☜
Armin Collet 66687 Wadrill ☎+49/6871/2907 colletarmin@aol.com	Yamaha dealer RD350 crank with 56 mm stroke (900,- €) RD500 crank with 52.6 mm stroke (900,- €) engine tuning RD350 (1500,- €) engine tuning RD500 (3000,- €)	 👎 👎 ☜ ☜
Brune GmbH Wöste 6 48291 Telgte ☎+49/2504/5648 or 1732	Mikuni-carbs and parts (jets, needles,...) Brembo-brake rotors RD 350 (90,- €/Pc.)	☜ 👍
Trinity Racing 2238 W Sequoia Ave. Anaheim, CA 92801 ☎+1/714-778-5123 http:\\www.trinityracing.com	Specialised on Quad Banshee (350 cc, similar to RZ) Big Bore Kits 420/500/570 cc (!) Nitrous kits, race ignition Two Stroke Tuning	
B.D.K. Race Engineering Hellington Corner, Bergh Apton Norwich Norfolk NR15 1BE Tel.: 44 1508/480469 Fax: 44 1508/480118	CDI repair (60 £) CDI conversion to adjust ignition advance (120 £) Big-bore-bits, Nikasil-plating, carb-kits, ...	👍 👍

Stan Stephens Motorcycles Potobello Parade Fawkham Road West Kingsdown Kent Tel.: +44-474/854332 Fax: +44-474/853540	pipes, cylinder tuning, ☜ Nicasil-plating, chassis tuning Big-bore-bits (375 ccm for RD350) (catalogue is very interesting)
Bernd Heimann Diepne 3 58642 Iserlohn ☎+49/2374/10922 Fax: +49/23074/16275	silencer polishing chrome platings cheap (as private)
C. Siegmund Konrad-Adenauer-Str. 18 69514 Laudenbach ☎+49/6201/44336 Fax:+49/6201/45744	Mikuni carbs and parts
Stephen Topham Zur Quelle 17 32351 Stemwede ☎+49/5474/9011 Fax:+49/5474/9012	Mikuni carbs and parts Assistance in questions about carbs & finding setups
Fa. PSR Peter Schief Holsteinstr. 2 23812 Wahlstedt ☎+49/4554/2994	Technoflex suspension parts (shocks, forks, springs, steering damper) 👍 Suspension repair/rework Adjustable damper kit for stock fork RD500
Spiegler Bremstechnik Kunzenweg 16 79117 Freiburg ☎+49/761/61101-0 Fax:+49/761/64814	brake disks and calipers ☜ steel braided linings with TÜV approval 👍 floating brake disk kit for RD
LSL Hauptstr. 406 47809 Krefeld-Oppum ☎+49/2151/555915 Fax:+49/2151/548416	floating brake disk kit for RD ☜ superbike style handlebars steering damper kits 👍
Manfred Weihe Koblenzer Str. 243 32584 Löhne ☎+49/5731/82036	Yamaha-dealer with mail order service 👍 3G3 - TZ-pistons 80,- € ☜

Sebimoto GmbH Brückenstr. 34 63179 Obertshausen 2 ☎+49/6104/74632 Fax+49/6104/971421	very cheap fairings in fibreglass and carbon fibre for all common big bikes as Ducati 916, Cagiva Mito, CBR 600, ... custom made carbon fibre plates 2 - 4 ct/cm²
DIMO Kunststofftechnik Franz-Wenzel-Str. 3 53474 Bad Neuenahr-Ahrweiler ☎ +49/2641/4653 FAX: +49/2641/36494	Fibreglass fairings and seats in stock shape for RD500 and other bikes
Jam Parts Brennereistr. 5 71282 Hemmingen ☎+49/7150/970565	Custom made aluminum swingarms from 700,- € upwards
Verlag Schober ☎ +49/6353/2020 Fax: +49/6353/8306	Reprints of the YAMAHA workshop manual and part catalogue (60,- and 25,- €)
Martin Bode Fridrichrodaer Str. 70b 12249 Berlin ☎+49/30/7756789 ☎+49/171/3228901	Tips for extreme tuning on RD350LC/YPVS parts
Thomas Fried Mettenufer 4 94469 Deggendorf ☎+49/991/4312	Tips for carb setup & tuning for LC and RD 500 (Call or write in German, cause he doesn't speak any English at all!)
RD/RZ 500 Owners Group Wyn Belorusky 4285 Pondapple Dr. Titusville, FL 32796 ☎ +1/407-268-4228 RZVWyn@aol.com http://www.rzrd500.com	Very interesting RD500 newsletter Annual club due: 20,- US$
RD500LC Club de France Didier Daumin 53 BIS Rue de la Fosse aux Loups F-5800 Nevers, FRANCE	Annual Meeting on race track in the middle of France Highly recommended !

Frank Landrock Stephanstrasse 47 52064 Aachen ☎ +49/170/5353005 landrock@gmx.de	Modification for the Power-Valve control box 20,- €
Sonic Speed Marco Böhmer Förstenreuth 18 95236 Stammbach ☎+49/9252/7371 FAX:+49/9256/953343 sonic.speed@gmx.de http://soni-x.de	Soni-X & Jolly pipes Intake-Manifold-Kit for RD500 (to fit Mikuni TM30) Carb setup for open air filters (jetting, needles, carb modification) Crank rebuild (He's the best in germany!), stroker cranks Prox-pistons, White-Power, Götz-dealer Wiseco-pistons, Brembo-brakes and much more Used and new parts for all RD350 cheap (as private) (calls from 16:30 to 21:30 CET)
Martin Kieltsch mechanical engineer Rotheweg 10 38302 Wolfenbuettel-Ahlum ☎ +49/5331/77584 maki500@gmx.de http://home.arcor.de/martin.kieltsch	Up to date tuning manual releases RD 350 YPVS maintenance manual RD 350 YPVS (31K/1WW) (only in German, 100 pages, 280 figures, 25,56 €) tuning manual RD500 (English & German , 25,56 €) ***Please think of the time zones. I do not appreciate calls late at night. My "office times" are workdays 5 pm to 9 pm and 9 am to 9 pm (all CET) at the weekend***

Interesting Internet sites:

http://www.rzrd500.com	Homepage of the RZ/RD500 Owners Club, Bulletin Boards for RD350/500 and other twostrokes
http://rd500lc.free.fr	Homepage of the french RD500 Club Info's for annual meeting in France
http://www.rd350lc.de	Best German RD Homepage – even one of the best worldwide (mostly German language) Interesting discussion forum around RD-topics
http://www.ifrance.com/rd-rz350lc/index.htm	French RD site with model history
http://rd.linefeed.com/	THE English RD page ! Bulletin Boards for RD350/500 and other twostrokes

Articles about RD 500 (from German magazines)

Motorrad:	18/83, 22/83, 4/84, 7/84, 10/84, 14/84, 15/84, 16/84, 12/85, 15/85, 13/86, 19/98 (Gebrauchtkaufberatung)
MO:	8/86
Motorrad, Reisen & Sport:	6/84, 9/84, 12/84, 16/84, 24/84, 14/85

Appendix

As some of you won't be used to metric units, I've compiled several conversions for bike relevant units.

Length					
mm	**inch**	**m**	**ft**	**km**	**mls**
0.10	0.0039	1	3.28	1	0.6
0.20	0.0079	2	6.56	5	3.1
0.30	0.0118	3	9.84	100	62.1
0.40	0.0157	5	16.4	1000	621.5
0.50	0.0197	10	32.8	5000	3107.5
0.60	0.0236	20	65.6	10000	6215
0.70	0.0276	30	98.4		
0.80	0.0315	50	164		
0.90	0.0354	100	328		
1.00	0.0394	200	656		
2.00	0.0787	300	984		
3.00	0.1181	500	1640		
4.00	0.1575	1000	3280		
5.00	0.1969				
10.00	0.3937				
20.00	0.7874				
30.00	1.1811				
40.00	1.5748				
50.00	1.9685				

Velocity	
km/h	**mph**
30	18.6
50	31.1
80	49.7
100	62.2
130	80.8
160	99.4
170	105.7
180	111.9
190	118.1
200	124.3
210	130.5
220	136.7
230	142.9
240	149.1
250	155.3
260	161.5
270	167.7

Volume	
litres	**gallon**
1	0.22
2	0.44
3	0.66
5	1.10
6	1.32
7	1.54
8	1.76
9	1.98
10	2.20
12	2.64
15	3.30
20	4.41
25	5.51

Pressure	
Bar	**PSI**
1	14
2	28
3	43
4	57
5	71
6	85
7	100
8	114
9	128
10	142
11	156
12	171
13	185
14	199

Temperature	
°C	**°F**
0	32
10	50
15	59
20	68
25	77
30	86
38	100
50	122
60	140
70	158
80	176
90	194
100	212
110	230

Weight	
kg	**lb**
1	2.2
2	4.4
3	6.6
4	8.8
5	11.0
10	22.1
15	33.1
20	44.1
30	66.2
50	110.4
100	220.7
150	331.1
200	441.4
250	551.8

Torque	
Nm	**lbft**
1	0.738
2	1.476
3	2.214
5	3.69
10	7.38
20	14.76
30	22.14
40	29.52
50	36.9
60	44.28
70	51.66
80	59.04
90	66.42
100	73.8

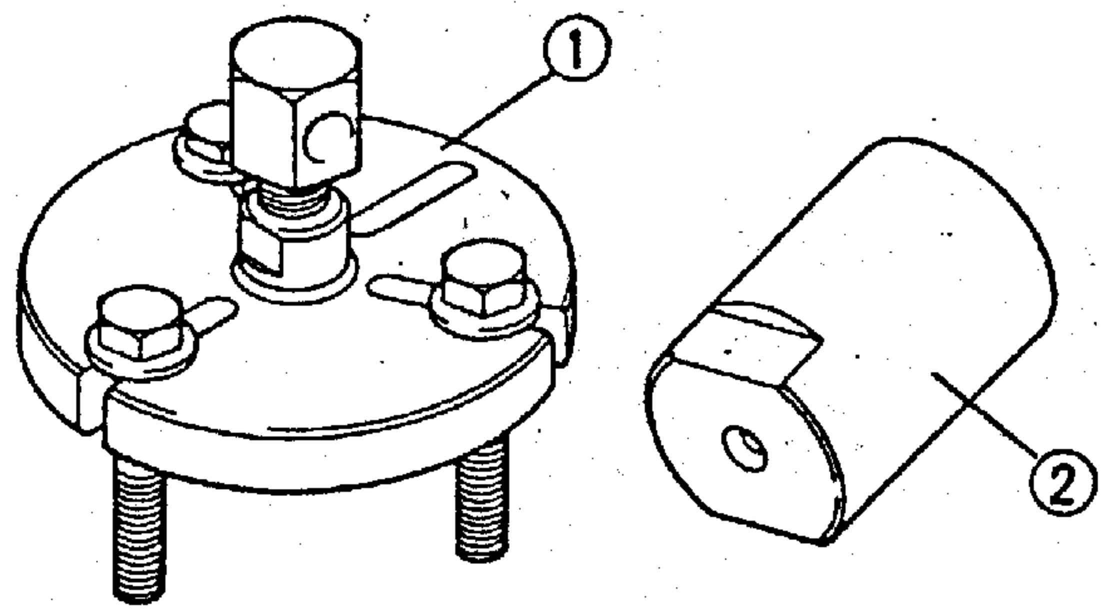


Figure 113: Flywheel puller tool

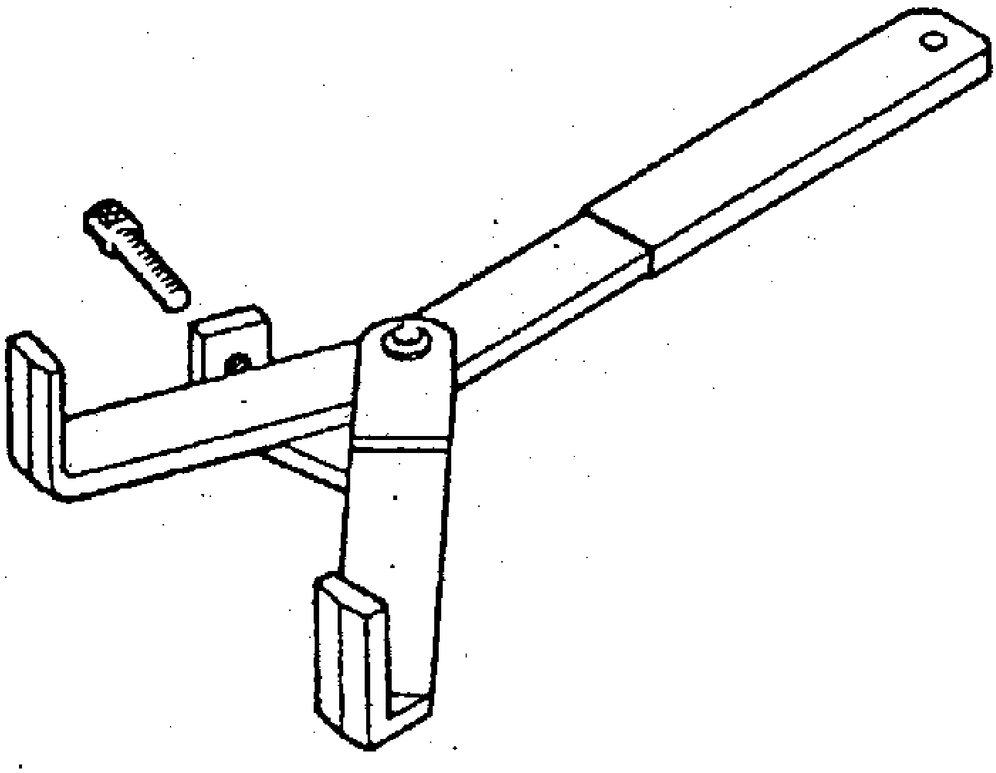


Figure 114: Clutch holding tool

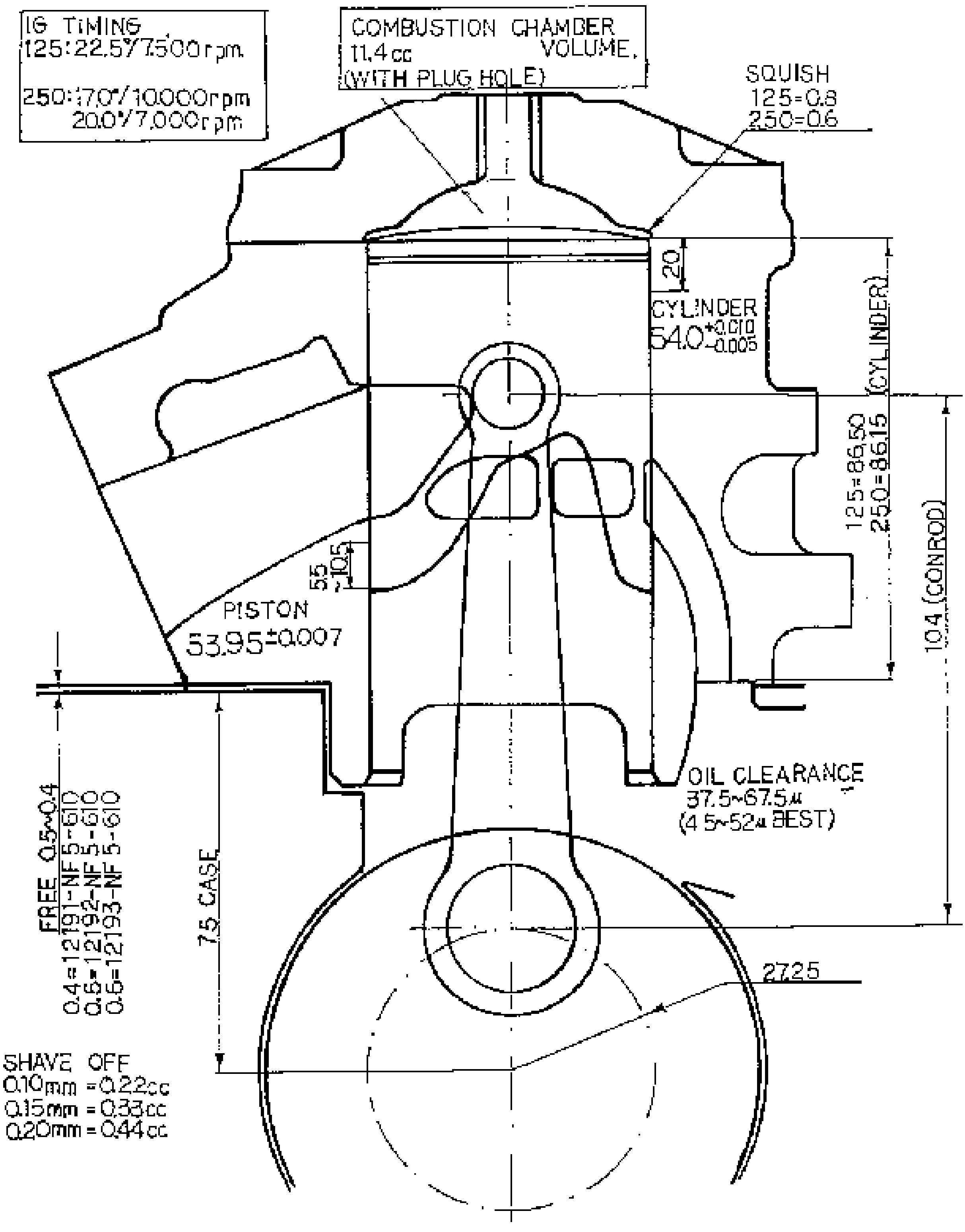


Figure 115: 1993 Honda RS125 specs

Spacers for the FZR600 rear wheel in the stock RD500

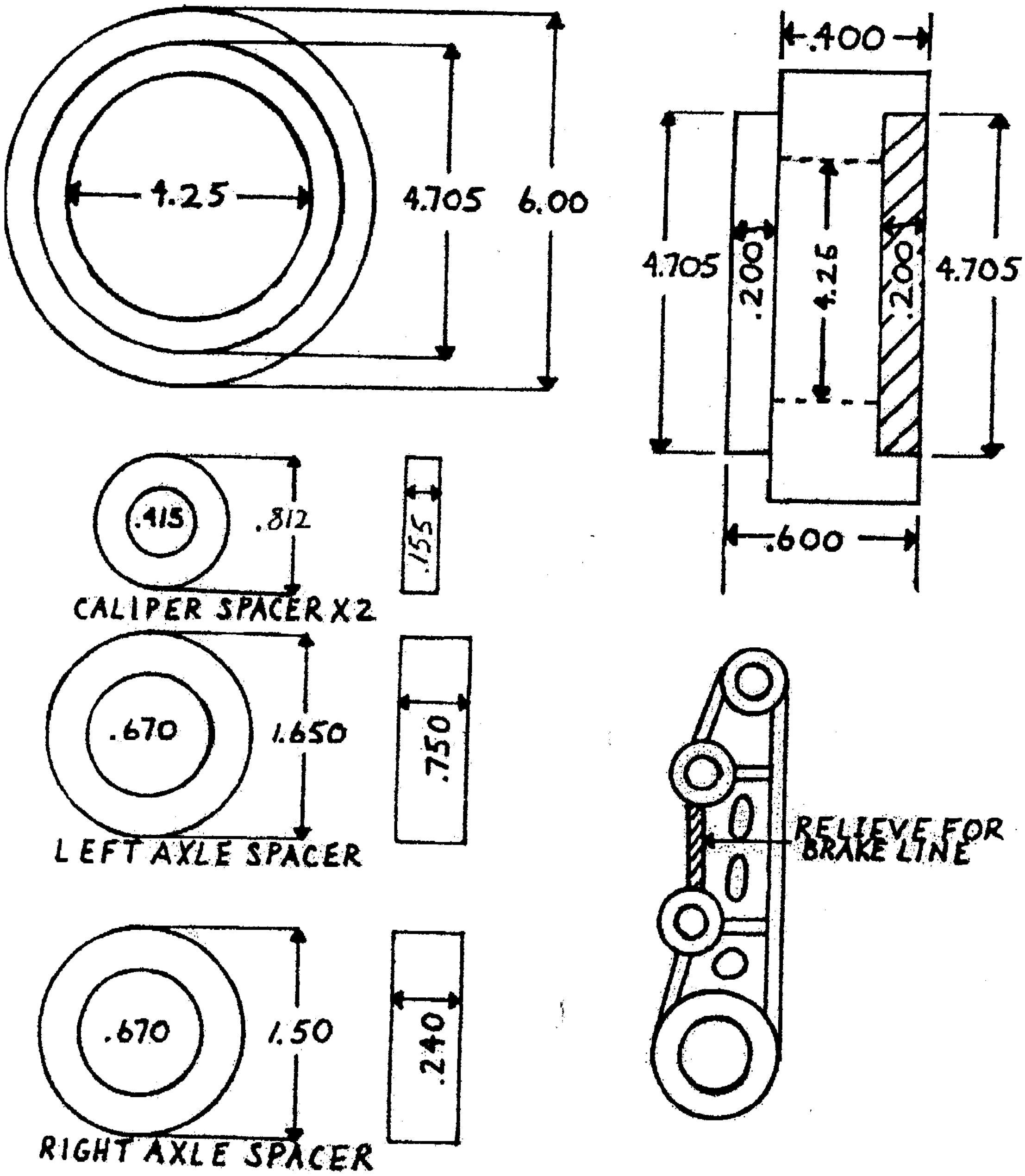


Figure 116: Usage of FZR600 rear wheel in RD500 stock swingarm (courtesy of Ron Atchinson / RD500 newsletter April 98), Dimensions given in inch

Spacers for the RGV250 (91) rear wheel in the stock RD500

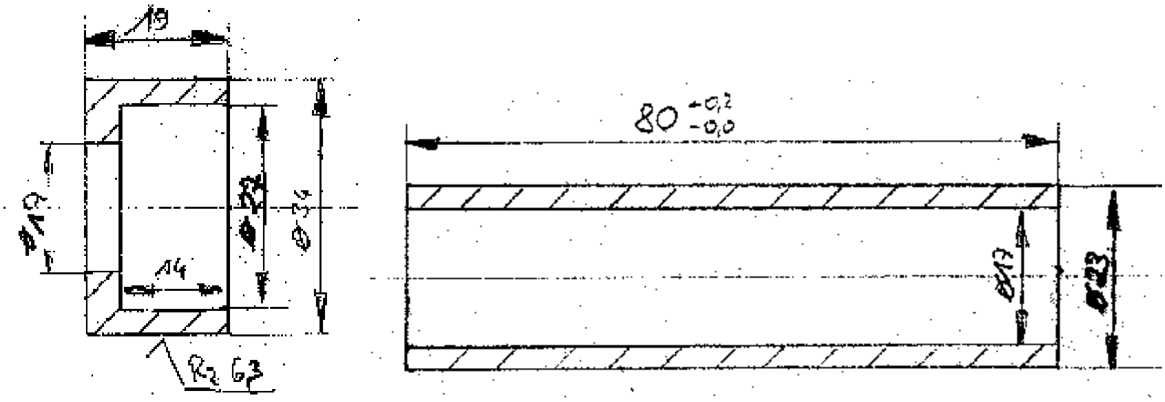


Figure 117: Left Wheel spacer and bearing spacer (between wheel bearings)

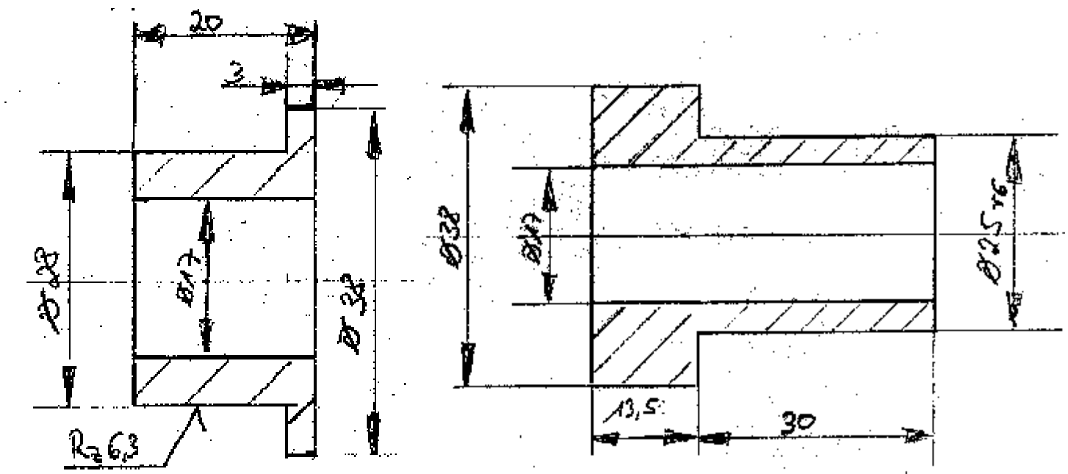


Figure 118: Right wheel spacer and brake carrier spacer

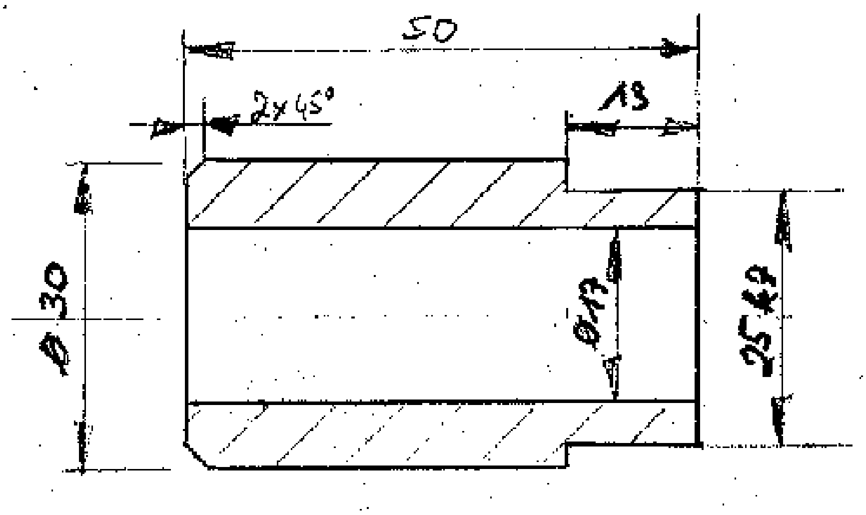


Figure 119: Bearing spacer in the sprocket carrier

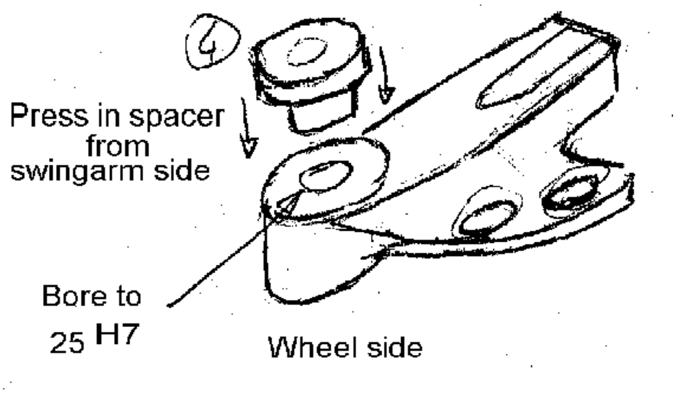


Figure 120: Press in brake carrier spacer from swingarm side

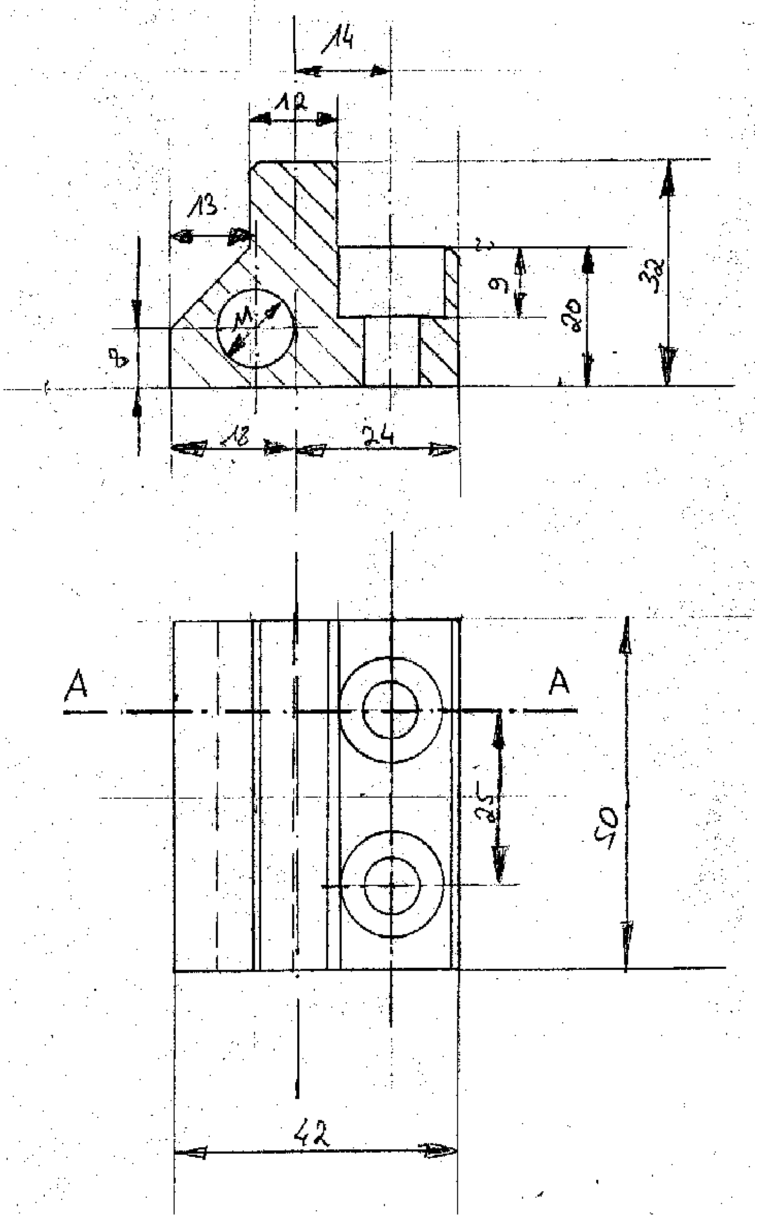


Figure 121: Brake anchor at the swingarm (mount with plate with two welded nuts)

Dyno Testing

To make a realistic picture of your tuning efforts it's best to use the same dyno on the same day with identical adjustments. I know that this is difficult so try to use at least the same dyno for testing.

Most common dynos measure the angular acceleration of a heavy barrel with a known mass inertia. The rear wheel torque is calculated with inertia and acceleration. After the acceleration part you can also measure your gearbox losses by letting the engine roll out. The deceleration of the barrel gives you the gearbox torque losses. If you add both curves you will get the "clutch" torque.
Up to this all dynos differ only a few per cent, because no engine Rpm was measured. To calculate engine performance the computer needs information about the current engine revs. To get the angular acceleration all dynos have their own tachometer at the barrel. The difficulty is to synchronise it to the bike's tacho properly. Some mechanics do that quick and dirty by just performing a short ride with let's say 4000 Rpm. If the dyno's tach shows 2000 Rpm you just type in a conversion factor of 2 and afterwards the dyno shows the same (inaccurate) value rather than your tachometer. This leads to somewhat higher "measured" performance than there really is, because the torque is assigned to a too high Rpm value. **Remember: Dyno owners are salesmen, and you won't come back if you were disappointed by an honest dyno test, so they will always use a conversion factor that leads to a higher performance if you don't request special settings!**
A proper dyno has an inductive coil to measure engine Rpm directly using a clamp on the ignition cables!

One disadvantage of "clutch" values is that you can't compare them directly to other measurements. To get this possibility you must change engine revs with rear wheel velocity. The performance is now calculated with the "right" dyno Rpm and the diagram shows rear wheel performance about vehicle velocity. This is what you really get out of your bike.
This will always be very disappointing for the owner and most workshops won't supply this data without customer request.

In Figure 71 on page 72 it seems to me that they measured rear wheel horsepower (dyno) and engine rpm (clamp at ignition cable). So this may be an excuse for the quite low stock performance of 70 HP.