

CHAPTER 12: CYLINDER HEADS Vol.2

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Assembling the engine. Servicing cylinder heads, vol.2.

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Introduction

This is a continuation of the engine strip series but it will deal with only the BASICS of what to do with your heads. The way they actually work is fairly complex and I don't want to muddy the waters here by going in to how they flow and the relative merits of different valve sizes, shapes, etc. as that is a topic for another day.

The effects of freshening up the top end of an engine can be dramatic. Rings that work and valves that seal can make a jaw-dropping difference to how an engine performs. A sad top end can easily rob an engine of 25% of its power. For a cost of a few hundred dollars you can restore that 'Brand New' feel and have an engine that is far, far more enjoyable. As I've often said before I don't recommend that a total freshen up be undertaken without at least checking the big end shells and preferably taking the whole sorry old lump to bits. Oddly enough if you suddenly get the motor to produce 25%+ more power if there is anything a bit sad in the bottom end? Well, this is the time it will show itself up!!!!

So you've got the complete heads off and on the bench. All of the next bit will essentially cover ALL the pushrod models, regardless of valve size or whatever.

Firstly, actually servicing them is NOT beyond the bounds or skills of your average home mechanic. The thing is that it requires a fair few special tools that most people don't have. For that reason I'd recommend that you simply take them to a reputable cylinder head shop, plonk them on the counter and say 'Go for it'.

This isn't to say though that you can't, or shouldn't, take them to pieces yourself and see how they work and if they need more serious work than a simple valve-lap.

I haven't gone into the actual mechanics of valve seat cutting here for the simple reason that most owners won't have the tools to do it or the need to buy them. As I've said, they are expensive and most places, even fairly large workshops, will nowadays tend to farm such work out to specialist head servicers or engine rebuilders. When you are looking for someone to do the job try and find someone who is familiar with older, air-cooled motors. While the essential technology is the same with any head produced in the last 40 odd years knowledge of the peversities of air-cooled engines is an advantage. Look for the wizzened little old bloke out the back and try and catch his eye.

Types of damage to valves and seats

Next thing we should look at is what sort of damage may occur to the valves and seats.

Firstly lets look at catastrophic damage caused by **cam-chain/gear failure**. If this occurs usually the piston will biff a valve. This can also occur if the machine is over-revved and the usual result in that case is that the engine will only run on one cylinder, oddly enough the one without the bent valve! Sometimes a bent valve won't be obvious to the naked eye. The simple check to see if valves are bent, or simply if they are so worn and or burnt about the seat that they are no longer seating correctly is very simple.

Take the head and hold it so the port is upwards and pour some kerosene or Metho into the port. If a valve is sealing properly no sign of dampness should appear in the combustion chamber around the valve for at least five seconds. If the valve is bent the liquid will usually just gush out. Repeat this with both heads and all four valves. If any of them are leaky the heads need to come to bits. A full service is the easiest and cheapest way out of it, simply re-lapping old valves results in a hodge-podge repair and if the valve is substantially bent it won't work anyway.

Valves are also prone to burning if the **tappet clearance** is set too tight or servicing is neglected. A burnt valve is usually fairly obvious as the super-hot gas will just cut through the edge of it and there will be a V shaped cut in the edge of the valve.

Valve seats are a different matter. These are shrunk into the alloy of the head by cooling them drastically and heating the head before they are pressed in to a very tight interference fit. The seat material is very hard, it has to take a lot of punishment with the hot valves pounding it up to 120 times a second and, in the case of the exhaust seats, superheated gasses flowing over it. Strangely enough the material handles this pretty well. It's designed to after all! But, with older motors it is possible for the seats to come loose in the alloy of the head. If this happens they are usually shattered by the pounding valve and the results are messy so when the heads are off it's worth heating 'em up and having a poke at the seats to see if they move at all. Any signs and it's time to get the head shop to install new seats for you. I recommend that after they are installed they also be peened in around the edges to further discourage 'em from moving.

If the **valve guides** ARE loose in the head, (This usually makes a horrid 'Clacking' noise when the engine is running.) then oversize guides have to be fitted. It is important to remember that Guzzi guides come out of the head **DOWNWARD** into the combustion chamber. They are retained by a circlip around the guide and to get 'em out the head should be heated to several hundred degrees, (The kitchen oven on 'High' for a couple of hours will work. make sure the cook is out before you try it as it's a bit stinky!) before the guide can be knocked up just far enough to get the circlip off and then biffed **DOWN** into the combustion chamber using a suitable mandrel that fits into the bore of the guide. Installing new ones is a reverse of the extraction; it is sometimes necessary to ream the head to accept the oversize guide. Don't forget to re-install the circlip and ream the guide to fit the new valve stem.

Removing the valves – general

To actually get the valves out you will need a valve spring compressor of some sort. As it is when the valves are seated, if they are in good condition they will be holding the valves up against the seat with a pressure of between 80 and 100lbs. To get them out you need to compress that spring so you can extract the collets, (What you yanks call the 'Valve Keepers' I believe?). These are cone shaped widgets, two per valve, that have a raised, semicircular, bit on their insides that sits in a groove in the valve stem when they are installed. These in turn are simply compressed into the groove in the valve by the retainer cap on top of the springs which itself is cone shaped in the hole the valve pokes through.

What you have to do is get something to press on the head of the valve from the combustion chamber side and then clamp down on the cap that retains the collets and the springs around the valve. Now since it's being held there by a spring that is holding the valve against the head with a force of 100lbs or so you obviously aren't going to be able to press the spring down with your fingers.

There are a variety of valve spring compressors, most of which look a bit like a carpenter's 'G'-clamp. One end presses on the head of the valve and then a tubular collar with a hole in it on the other end fits on the retainer cap. When the compressor is used, either by screwing down a threaded bit to compress the spring or using a lever system, the cap will move towards the head of the valve and the collets will remain on the valve stem from where they can be extracted with a magnet before the compressor is released and the cap can move above where the collets sat until the springs are at full extension. At that point the compressor can be removed and the valve springs, cap, seat and shim stack underneath, removed. The valve can then be extracted from the guide from the combustion chamber side.

Now the thing is that there is a really, really, easy way for anyone with a shed to make themselves a far better valve spring compressor than the types usually available from auto shops. It bolts to a wall in your workshop above a bench and works on a simple system of levers. The thing is it's impossible to easily describe so I'll have to mail some diagrams to somebody cleverer than me so they can be posted up.

Removing the valves – 4-valvers

The procedure for all four valves is the same but please **BE CAREFULL**. If the compressor slips off the cap as the spring is being compressed the collets will shoot off like bullets, along with the cap and springs if you aren't unlucky enough to be hit by them. This can be **DANGEROUS**, OK, so if you have any doubts about your abilities? Don't attempt it. I don't want to get sued by some overzealous dumb-cluck who's lost an eye to an errant collet.

Once the valve is out take the springs, (There are two, an inner and outer one.) and the cap off and store them in a safe place and remove the spring seat from the guide and the shims beneath it. Don't lose any of these bits, they are important.

Inspection of the valves, springs, guides and seats

Now you can examine the valve.

Its head, especially on exhaust valves, will be black or grey with build-ups of carboniferous deposits on it. How much muck there is on them will be a fairly good indication of the state of the rings and guides. If they are really horrid and crusty it's usually a sign that you've been burning oil. Where does oil get into the combustion chamber? Past the rings and down the guides, that's where!

Take the valve and pop it back into its guide. Pull it down so the end of its stem is flush with the upper end of the guide. Now try rocking it from side to side. If there is anything but the very barest of discernable play you know that they're going to need work!!!! On any engine that has done over the following mileage, chances are there will be **bigish wear**:

- Small-valver: 80,000 miles (about 130,000 km)
- Mid-valver: 70,000 miles (about 115,000 km)
- Big-valver: 40,000 miles (about 65,000 km)

To check the **valve stems** you'll need a micrometer, simply check them against the specs in the manual or just against a bit of the stem that doesn't go through the guide at the top and compare wear. Usually you will find that on any machine that has done a few miles the exhaust valves will be 'Donald Ducked' so expect to replace them. Inlets, because they run a lot cooler, (in normal operating conditions the neck of your exhaust valve will be glowing dull red!) tend to last a lot longer but don't be surprised if they need replacement, they really aren't that expensive.

Springs are easy. Just measure 'em with a vernier and see if they are within spec. Any doubts? Throw 'em away.

The most likely candidates for excessive wear though are the **valve guides** and before I go into that I'll post this as an explanation of the vital nature of guides is warranted so that people don't skimp on these very important components.

Stems and guides - general

OK, guides. What are they and why are they so important?

In your Guzzi the guides are made of sintered bronze. Sintering is a process where a powdered material is formed into a shape by compressing it under great pressure. This basically re-forms the metal but has the added benefit that it makes the finished product slightly porous. This in turn means that it will absorb a bit of oil, and this is vital for something like a valve guide.

When your engine is working hard the valves get hot. Bloody hot!! As previously mentioned your exhaust valve, which is made of a forged steel alloy, is glowing dull red. It'll be at or over 1,000°C most of the time and it really doesn't take a lot to push it over the edge to the point where it will become so hot that it will weaken and/or melt and when that happens, you'll know about it!!!!!! When the exhaust valve starts to open the gasses rushing past it are only slightly cooler than the flame of an oxy-acetylene torch. If you stick a torch on a valve it won't last long.

The good thing is that the amount of time that this sort of serious heat is being applied to the valve is really quite short in terms of the 720 degrees of rotation in the cycle of the engine, for probably about 2/3rds of that time the valve is closed, and when it's closed it can be dumping that heat. Where does it dump it? Through two places, the valve stem, and the part of the valve that contacts the valve seat in the head.

It is for this reason that it is VITAL that your valves and guides be in good condition. If there is too much clearance betwixt valve and guide there will be a space filled with gas so that no conduction can take heat away, only radiation. Result? Valve overheats. Also because the valve can flop about in the guide it will mean that the valve won't seat as quickly or as accurately as it should so it can't dump heat there either!!!! You can, no doubt, see where this is heading!?!?! The same holds true of the inlet valves but to a lesser extent of course as they continually have cooling, fresh, charge flowing over them when the valve is open.

So the trick for good heads that will work well is for the valves to be correctly fitted to the guides and for their heads to be concentric with the seats. This is what you pay the bloke at the head shop to do for you unless you want to shell out a couple of grand for a decent set of Neway valve tools. Even these won't give you as good a result as a Serdi head centre though!

Stems and guides - 'K-Liners' <http://www.cylinderheadshop.co.uk/K-line.html>

If the valve stems check out OK then the seating faces of the valves can simply be ground back to shape and then the seats cut to suit as long as the guides are OK. Chances are though that the guides will be worn. This in itself is not a cause for replacement though as long as they guides are still firm in the head. If they are firm, but worn internally the answer is to use a product called 'K-Liners' in the guides. These are an interrupted scroll bronze liner that is inserted into the original guide and then forced into the parent material by using a 'Disruptor', (Basically a ball on a stick!) that is bashed through it before the liner is reamed back to original size. Not only does this keep the valve concentric with the seat, meaning less material needs to be removed from the seat to get the valve to seal but also the liner is actually superior to the parent material in it's ability to hold oil due to it's scrolled nature.

After a workshop head service

When the heads are serviced it is important to remember that both in service, and during the re-cutting of the seats and valves material is removed. This means that the valve will sit slightly higher in the head than it did previously. For this reason it is important that you supply your head shop with a few **extra shims** for under the seat of the spring as for the stack height, and therefore the seating pressure, to be correct additional shim will be needed under the seat to pre-load the springs sufficiently. Having said that, I'm sure that there are many, many machines out there that have not had this done and the heads are simply re-assembled with their original shimming. Unless you're riding 10/10ths it probably won't matter if the seating pressure is a trifle low, but if you're going to do the job I always recommend you do it right.

Most head shops will **bead blast** the heads for you, not only as a matter of courtesy but because it will enable them to detect any cracks, loose valve seats etc. easier. It is worth asking that prior to this they install a plug in the oil feed gallery for the rocker feeds, (Any old bolt with an 8 x 1.25 pitch thread and some PTFE tape on it is fine.) and a bit of duct tape over the feeds to the rocker gear. This will help prevent errant bead particles getting trapped in the galleries although it is VITAL that you blow them out with compressed air and ensure they are perfectly clean again before you press the heads back into service. Plugging the boltholes for the inlet manifolds is also a good idea on heads so equipped. On early models with threaded exhaust ports it's well worth taping up these threads too and making sure they are scrupulously clean before the threaded collars are re-installed on completion of reassembly of the motorbike.

One final point. When the heads are off it is a good idea to have the mating surface with the barrel **checked for flatness**. While Guzzi big block heads are not particularly prone to warping if a head gasket has blown then there is usually a good chance that the head will be warped. Check particularly for any signs of gas leaking into the pushrod tunnels. It is very easy and cheap to have the heads 'Decked' or 'Faced' while they are being serviced but unless it is necessary I'd suggest not doing so as it is removing material which as well as reducing the life expectancy of the head will also raise the compression which can, in some circumstances cause problems and brings the valves closer to the piston on overlap.

If I've left stuff out or any questions? Fire away!