CHAPTER THREE

Oilhead Rocker End Play Adjustment for Dummies

Where Our Ham Fisted Hero Chases Those Pesky Tiny Gaps All Over His Heads.

- Or -

In Pursuit of the Coveted ADVrider Merit Badge ! ! !

JohnJen
Guzzler
Marc
&
In a surprise guest appearance
Trevor

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So Ya Wanna Jump Into The Fire Eh?

OK, right off the bat we are going to be dealing with a few procedures and circumstances that range from being potentially destructive to plain old dangerous of men and machine and device. For this reason (and a few others) it is STRONGLY recommended that you read this entire chapter AT LEAST ONCE, BEFORE you proceed.

If normal common sense is ignored and/or these instructions aren't followed with an eye on safety and proper situational awareness, any number of 'bad things' could happen. We could make an extensive list of possible dire consequences ranging from breaking (or at least severely hurting) parts of yourself to mangling your cylinder heads.

We ARE NOT responsible for your actions, lack of same, nor the consequences (unless they're all good, in which case we will all bask in the limelight). We are providing you with a set of our experiences and procedures with the aim of helping YOU adjust the rocker end play on YOUR bike. As such YOU are the one performing this adjustment and it's YOUR job to make sure that the procedures are performed properly. We are only providing the basic details of how we perform this maintenance function.
This chapter does not and can not be complete in every detail nor does it try to be. It assumes that you are familiar with many things concerning your bike and your ability to operate and maintain it correctly. If you have questions regarding, or are confused by, ANY of the material presented here, get it cleared up BEFORE you begin.

In short KNOW what you will be doing BEFORE you make the attempt. It is YOUR RESPONSIBILITY to get all of this right.

OREPAD Not Just Another Pretty Name.

Ok everybody, here's yet another bed time story of horror and anguish and bloody knuckles.. This one is entitled OILHEAD ROCKER END PLAY ADJUSTMENT for DUMMIES (OREPAD) and it tells the tale of a minor / major adjustment technique to quiet that savage valve train noise and tighten up control of the valves all at the same time. It introduces a **hammer** and a **torque wrench** to your existing tools, and like OVAD, this procedure might require plenty of patience until you get the technique worked out. These new tools are required for this procedure because we will be beating your valve train into precise submission then squeezing all the wiggle room out of the studs in your heads… (oooo, kinky!!!)

A NOTE of Multi-Dimensional Importance,

My personal preference is to use Uh-Mericun dimensions for the gap settings for ***this*** job, due mostly to the fact that it allows us to use nice round multiples of 1. Granted we are talking thousandths here but (in this case) it seems easier to deal with easy multiples rather than quarters or tenths or hundredths of a millimeter. In this case it just works out that way… If you're of the metric mindset then use the supplied metric numbers (I will supply metric equivalents in parentheses). And of course rounding up or down in the metric universe is suggested as it will greatly simplify the numbers rattling around in your head.

A NOTE On Picture Orientation,

The pictures shown in these pages were all taken on the left cylinder. The right cylinder is a mirror image of the left, so the intake and exhaust rockers swap positions, as do the 15mm head nut and the end T-45 screw…

Introducing NEW TOOLS

The proper use of and access to a properly rated torque wrench as explained in this diatribe is both necessary and essential for this job… We will be loosening one of the main head stud nuts on each cylinder during this procedure. This requires that we put it back the way we found it when done. These head nuts on Oilheads are torqued using the newer technique of setting the torque wrench to a specified setting (just like the 'old' ways) but then we add a specified number of degrees of rotation (or twist) to the nut using the torque wrench to arrive at the necessary amount of tension on the head. This means if you don't have a torque wrench and are not familiar with how to use one, it would be best to find a friend who can answer yes to both of the aforementioned criteria. If you haven't got a friend who can meet this essential criteria then start looking, or posting, or getting new friends… This procedure isn't the best place to start learning.

Just what is a proper sized torque wrench you ask? Well for this job we need one that can be used as low as 18Nm (13.2ft-lbs.) and up. Why do I bring this up? Well, torque wrenches have a range of accuracy that ***starts*** at roughly 20% of their full rated capacity,. In our case this means, after we do the math, in order to be sure that with the torque wrench set at 18Nm we will actually apply (close to) 18Nm, that the maximum capacity of the torque wrench can't be larger than say 90Nm. Yes you could use a 150Nm or even higher rated torque wrench but what we really want here is a repeatable, consistent and accurately applied amount of torque for these screws and nuts and the lower rated torque wrench assures us of better results. Suitable choices can be found from Snap-On, Mac, from Craftsman and others as well…

As for the hammer or mallet, well, the goal here is NOT to beat the heads into misshapen and mangled metal monuments using mindless methods of mechanical mayhem and mendacity. For this reason we suggest a small to medium metal headed mallet or a medium sized hard plastic headed one. Rubber headed mallets usually don't provide enough energy transfer to be effective under the tightly controlled conditions we will need. However there will undoubtedly be those who will insist that the rubber headed mallet that has been passed down from father to son for countless generations and has earned its rightful place in the pantheon of tools that have been used for nigh on 300 years, simply must be used, tradition dictates it so… But for us non-generational encumbered types I recommend a small to medium metal headed or a very hard medium weight plastic (like Delrin) headed mallet. The reasons will become clear after a bit…

But Wait There's More

We will also need access to feeler gauges, very thin feeler gauges. The easiest way to find said gauges is in a set. The set I use starts at the small end with a thickness of 0.0015" (.038mm) then jumps to 0.002" (.051mm) then to 0.025" (.0635mm) then to 0.003" (.0762mm) and then by 0.001" (.0254mm) there after. These sets can usually be found at better automotive parts and supply businesses.. Also NAPA has sets in this range. The acceptable range of clearances called for by BMW for this procedure starts at 0.002" and stops at 0.016" (.05mm to .40mm). Having the 0.0015" (.0381mm) gauge means we can measure in as small as 0.0005" (.0127mm) increments if we should so choose. This isn't essential but it is good to know it's possible (for those of you with the go/no-go mindset)…

The one tool that you probably don't have in your tool kit is a T-45 bit. This is a Torx bit of somewhat large size that is needed for the 3 rocker holder screws. The rest of the tools needed are the usual ratchets and Allen headed sockets etc. as described in OVAD, to be able to get the valve covers off.
We will talk about the stubby handled ratchet later…

And now a word from our sponsors…

Do you suffer from mechanitis, do your tools really measure up? Do you wish you had a never ending abundance of torque ready to apply by hand? Are you afraid of stripping your bolts in front of the neighbors? Well if the answer is yes to any of these and countless other mechano-conflagrations then our home study course is for you… Yes, yes, when you're finished with our course you'll have obtained that pinnacle of tweakerdom, the coveted and widely sought after ADVrider's Merit Badge as sanctioned by the Tweaker's R-US Club International. And you'll have earned it the old fashioned way, by working for it! (Not available in stores) Stay tuned for further developments with film at eleven. And now back to our regularly scheduled diatribe.

Welcome back, now at this point I'm sure that you're thinking, "hell, with a range of allowable end gaps from 0.002" (.05mm) all the way to 0.016" (.40mm) why all this fuss… I mean mine measure only 0.012" or so (.3048mm), I still have plenty of allowable range left… Why do I NEED to go to all of this trouble?" Well, mostly because what we are doing here is tweaking, and being a card carrying member in good standing (or is it, still standing?) of the super secret society Tweaker's R-US, means that you just can't leave well enough alone… It just HAS to be adjusted back down to the absolute minimum that the spec will allow… I can just hear it all now 'I just gotta get it, I just have to earn that tweakers merit badge somehow…. And this looks like it should do it alright… Where's that hammer, I'll show you a thing or two…'

Right about now I would advise you to put down the hammer and back away from the bike… Take a deep breath and repeat after me… "I love my bike, I love to ride my bike, I love to ride my bike AND make it home without ANY strange mechanical noises spoiling my buzz…"

So, ok, how close to perfection do I have to be to earn that coveted merit badge? Well practical experience has lead me to shoot for 0.0025" to 0.003" (.0635mm to .0762mm). Trying to hit that 0.002" (.0508mm) is just way to tedious. And the next answer is I don't mess with the rockers until I see a minimum of 0.005" (.127mm) gap on both sides (intake and exhaust). Anything smaller than 0.005"(.127mm) is just asking for a headache. Can you wait until the gaps are larger? Of course, but then again there is that merit badge to think of, and well, your status as a member in good standing in the supercilious Tweaker's R-US Club…

The BIG Question Asked and Answered

Ok, so WHY do I need to test both my own personal and my engine's metal on this again? Well, for two reasons and maybe a third if you want to earn that merit badge.

Reason #1

The valve train gets fairly noisy when the rocker end gaps get large. The larger they get the more noise they make… Is this 'bad'? no, not really, especially if you want to draw attention to yourself… The only downside MIGHT be a little accelerated wear on the rockers and end block surfaces…

Reason #2

Keeping the rocker end play at or near minimum spec also helps keep the valve action closer to the designed timing in the overall scheme of things. It's not critical mind you but it is an adjustment that is a tweakers delight in that it does help keep the valve train tightly controlled and performing at near peak performance. How's that you ask?

Well, lets presume that the rocker end gap has opened up to near the maximum allowed, say 0.014" (.3556mm). And so as a mental exercise lets imagine that the rocker is 'allowed' to travel up and down 0.014" (.3556mm) before it contacts either of the end block surfaces. Now since the rocker has mass and wants to fall when not being used to open the valves it also has to be raised up that same 0.014" (.3556mm) by the push rod before the rocker will begin to open the valves. Remember how much fussing we did to match up the valves? Well this adjustment isn't anywhere near as critical, but in effect we are delaying the opening of the valves and to even less of a degree how far they open. Now do you really want to earn that merit badge? Do you really want to keep your membership in the near superfluous Tweaker's R-US Club International? Say YES ! ! !

Reason #3

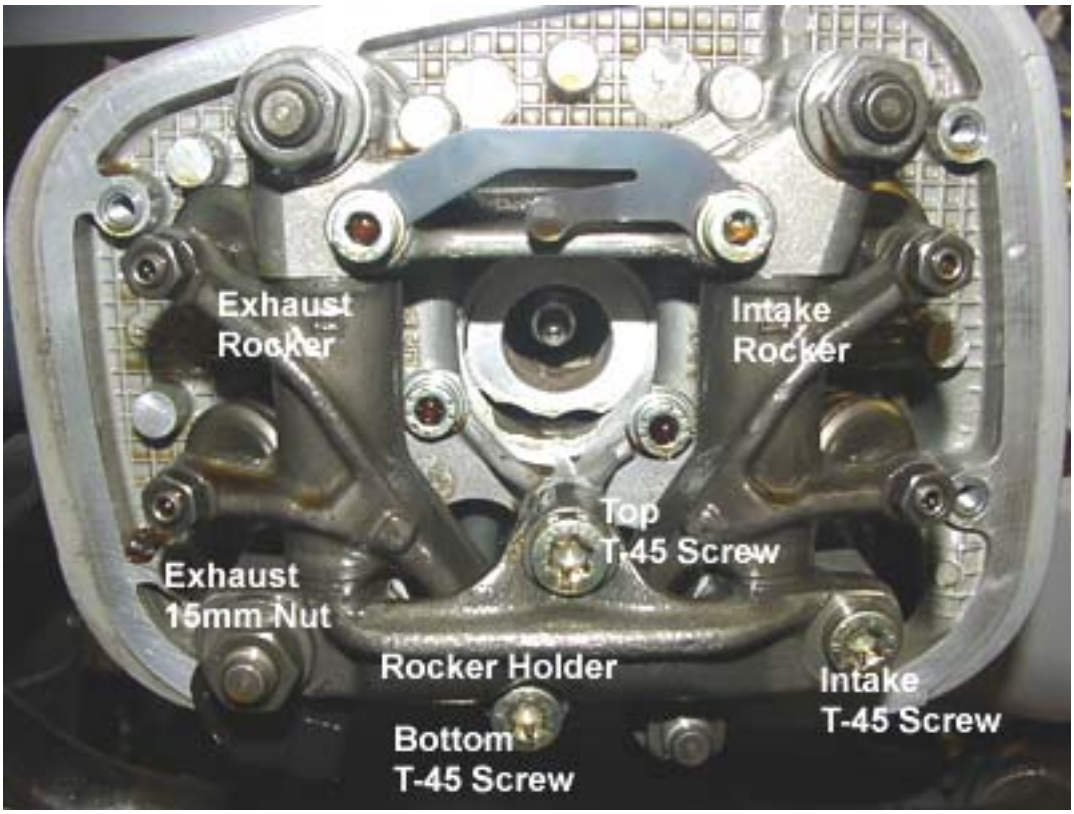
That merit badge would look so cool stuck on the side of your tool box in the place of honor, right next to the Snap-On decal or the equally coveted Mac Tools sticker… Wouldn't it? Or you could whip it out and impress all your friends at those tech day seminars, just think of all the possibilities ! ! !

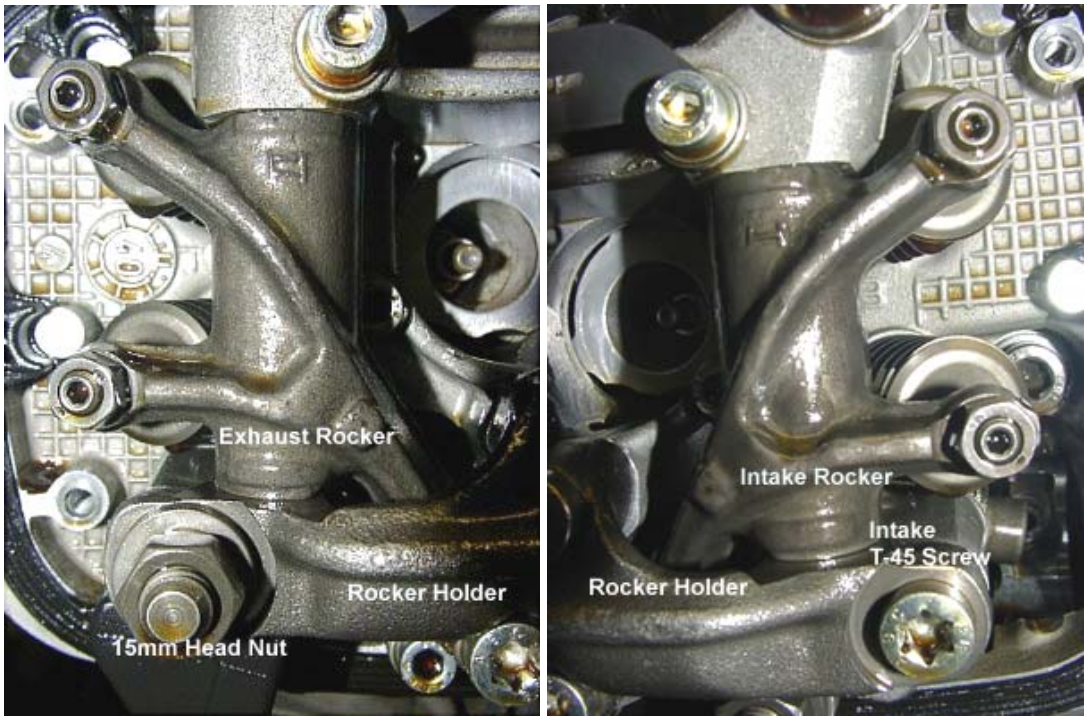
Justification Is A Wonderful Thing

Ok, so you have convinced yourself that this is a must do sorta thing already and we haven't even described the process in detail yet, so you really don't have a clue what you're about to get yourself into… But the lure of the merit badge has sunk it's hook in deep and the pull is strong so you're committed, or soon will be, once you start down this iterative loop-sided road with a reverse half twist thrown in just because it just HAS to fuck with your mind. (You didn't think that earning this merit badge was going to be EASY did you?)

Naming Names and Pointing Out Parts

Before we begin lets cover the basics of just what we're talking about here and what the various parts and pieces are…





Rockers - Rocker Arms (Intake and Exhaust)

These terms are nearly synonymous. These are the pieces that rotate and push the valves open and where we make our adjustments for matched valve gap. They are in turn pushed by the push rods that are pushed by the 'bump' or lobe of the cam.

Rocker Shaft Bearing Cap - Rocker Holder - Rocker Block

This is the piece that spans both rocker arms and holds them in place from the bottom. It has 3) T-45 screws and 1) head stud with a 15mm nut holding it in place. It can be moved in relation to the rockers so that the amount of vertical free play of the rockers can be controlled. The term rocker block is somewhat of a hold over from the airheads but it draws attention to the area of contact between the rocker and the rocker shaft bearing cap. This contact area is the pivotal (pun intended) point where the rocker meets the rocker holder at 2 places of contact, top and bottom. It's the juncture of the rocker holder and bottom contact area of the rocker where we measure the end gap.

The Cliff Notes Version

This procedure is performed best if added during the early part of an OVAD. Think of it like we are going to insert a few extra steps near the beginning, after the valve covers have come off and before we actually begin adjusting the valve gaps themselves.

So the short hand version of events goes like this…

1. Start an OVAD and open up the valve covers and rotate the engine so that the rockers are loose for the side you're working on.
2. Measure the existing valve gaps. (just because)
3. Measure the rocker end gaps on both sides (intake and exhaust) and decide to proceed with OREPAD or not.
4. If OREPAD is warranted or if you just have to earn that merit badge, back off the lock nuts and open up the valve gaps, a bunch – or not, as the case may be.
5. Loosen the rocker holder's screws and nut (but not too much).
6. Adjust the position of the holder for the desired rocker end gap.
7. Tighten the rocker holder's screws and nut to the specified torque.
8. Proceed with the rest of an OVAD

See, it's really simple. Right?

Well, there is a ***little*** more involved but in a nut shell that's all there is too it. Except for that iterative loop-sided road with a reverse half twist thrown in, it's a piece of cake, Trust me...

If You're Not Skeerded Yet, Just Wait Till You Read This!

And now a word about iterative loops.
It is a fact of life that not everything will always go as planned. In this case the laws of probability and Mr. Murphy and backyard quantum mechanics everywhere, just have to insist that complication inexorably rear it's ugly head and force you to deal with it on it's terms. As such, if both of your rocker holders DON'T cause any change in the rocker end gaps as they are tightened down to their final torque settings, then you won't need to learn much about iterative loops.

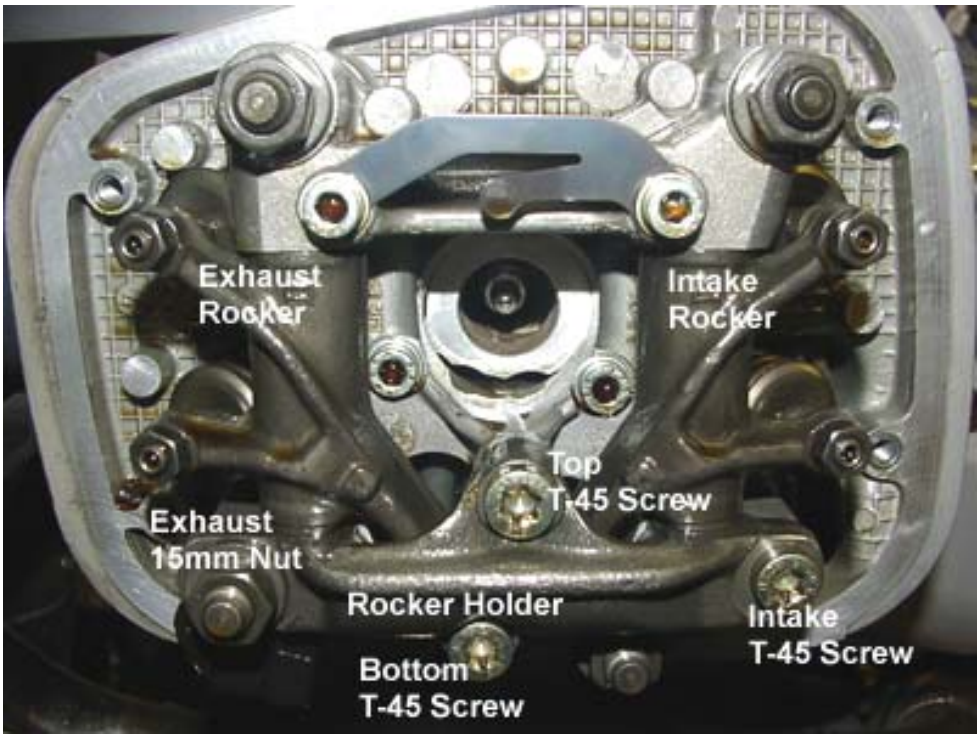
On the other hand, as mentioned above, it is more than likely that you ***will*** need to visit this strange and head squeezing land of wonder and befuddlement. This means that the step by step procedures as outlined in a nice and neat sequential series of numbered steps will have to go sideways (and you along with them) as you adapt the techniques and skills mentioned herein to suit your particular situation. In other words you'll have to improvise a procedure that works for you on your engine. Perhaps a simple solution will work or perhaps a more complicated series of back and forth steps will be needed… In any event the steps and tricks and methods contained in this diatribe need to be adapted with the aim of achieving results that work for you.

One thing to note, once you have figured out a set of techniques that work for you on your engine, you will most likely always need to use them. In other words, if a cylinder wants to change during the torque down sequence, it will ***always*** want to change on you and in the same way. So the same technique, once you have it honed to perfection, will most likely always be needed. UNTIL the heads are changed or other major work is done. But we won't go there now…

So now on with those pesky details…

Step 1

Prepare the engine just like you would if you were going to adjust the valves (which you will need to do AFTER you finish this procedure) up to the point of checking the valve gaps (as described in OVAD). Which means that both rockers are loose on the side you are working on… (OVAD step # 37)



Step 2

Measure the valve gaps for 2 reasons. First is to make sure there are in fact gaps to be measured and second so you'll know just how much they have changed from your last OVAD expedition. Then loosen the lock nuts and back off the adjusters (open the gaps a bunch). Ok, I can hear the groans and moans from here… I spent HOURS getting those da***d little adjusters gaps all nice and perfect and matched etc., and NOW you're telling me to just throw it all AWAY??? Hey, get over it, boy some peoples kids… Just think of all the practice you've got under your belt now and when you do it again it'll be all that much EASIER… Really It Will, Trust Me….

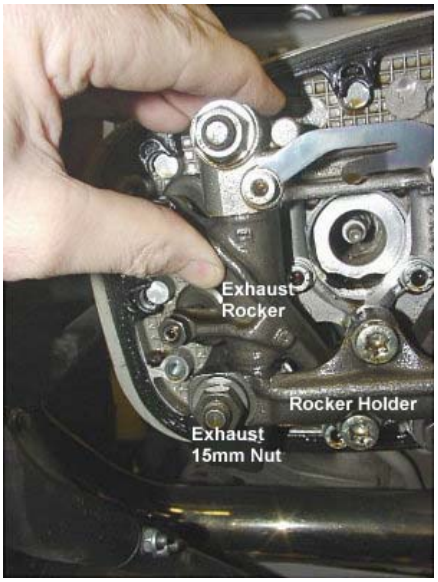
Step 2½

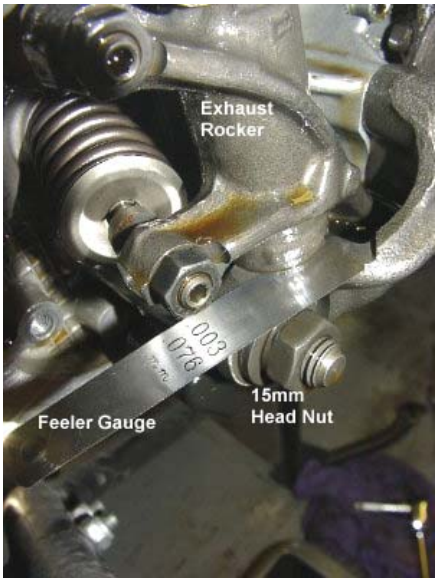
OK so there is a slight chance you won't have to lose your precocious valve gap setting's, BUT be warned YOU DO NOT WANT THE VALVE GAPS TO CLOSE DOWN AND INTEREFERE WITH THE ROCKER END PLAY ADJUSTMENTS, or you'll be back in here so fast, doing ***all*** of this ***all over again***… How does one determine if the gaps ARE large enough? By making sure that the rocker arm can rotate between the push rod and the valve stem WHILE the rocker is pushed into the top of it's vertical play. In other words while being pushed hard up into the top rocker block the rocker will 'click' as it rocks back and forth from one limit to the other. As long as the rocker arm can rotate and move from one limit of its travel of the other, you're ok. However, don't count on it… Note that the relationship between the size of the rocker end gaps and the chance of being able to leave the valve gaps alone is inversely proportional. In other words the larger your rocker end gaps are the less the chance of being able to leave the valve gap adjusters alone. Believe me, the odds are you will ***have to*** loosen up the adjusters and open up the valve gaps, ***especially*** the first time you perform this procedure.

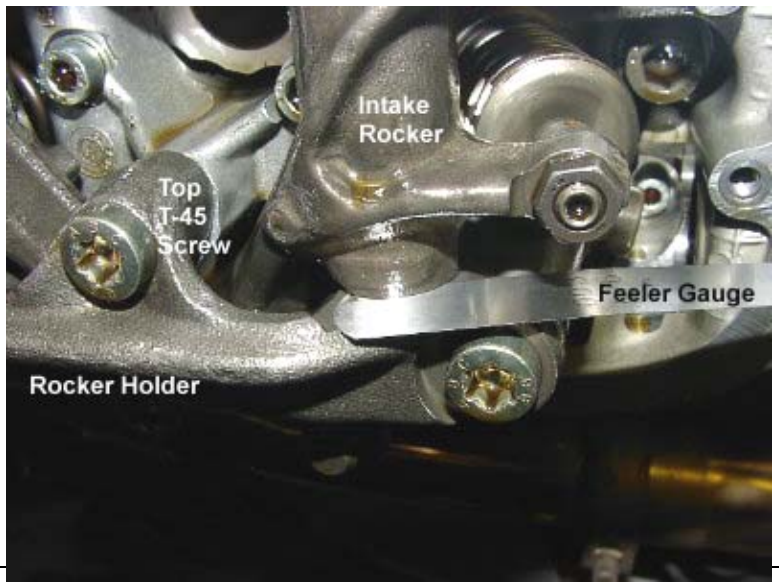
Step 3

With the adjusters backed off (or after you have MADE SURE that the rocker arm to valve stem gaps still exist) so that there is NO CHANCE for any interference, raise the exhaust rocker arm with your thumb and insert a feeler gauge, say use the 0.003" (.0762mm) gauge. Insert it between the bottom of the exhaust rocker and the rocker holder. Make sure that the feeler gauge fits cleanly in the gap and is not twisted or messed with by any of the parts in it's vicinity. Does it fit easily? Then increase the width of the feeler gauge till you determine just what the gap really is… Next measure the intake rocker arm gap. It probably is different. It's just not worth the effort of closing the gaps if they are 0.004" (.1016mm) or less. My advice is to wait until you have gaps of 0.005" (.127mm) or larger at ***both*** rockers. I know that the coveted merit badge is calling your name, but unless you want to call it some animated, unsuitable for inclusion in this near family oriented diatribe, names, I'd wait… Trust me.

These 2 sets of pictures show the technique of lifting the rocker to make room for the feeler gauge. You'll also notice that the rocker holder has a limited area for the feeler gauge to fit into… Do not bind the feeler gauge or stuff it in sideways, but do get as much of the feeler gauge between the rocker and rocker holder as possible. We used 2 pictures to show this because it is a 2 handed operation and with both hands in place not much else can be seen…

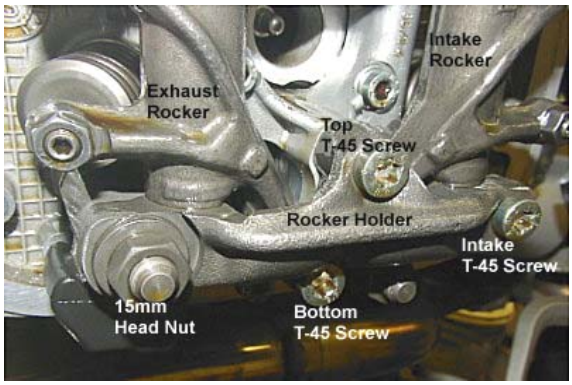


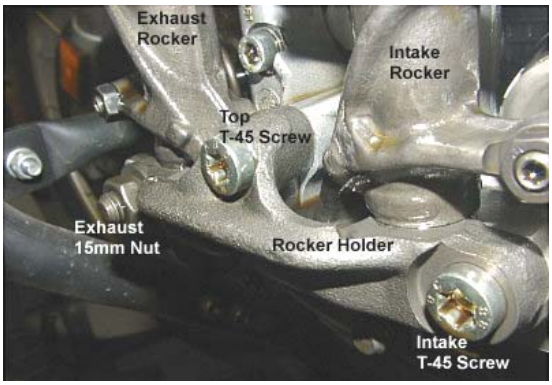




Techno-Break

Ok, at this point you're probably wondering just what the heck has gotta move to make the adjustment etc… Well if you look closely you'll see that the rocker holder is held in place by 3) T-45 screws and 1) 15mm nut.





This holder in effect can move around with respect to the rocker arms which we will, in due course, take advantage of to narrow the gap between the bottom of the rocker and the rocker holder. Now this holder needs only to be moved a very small amount AND it needs to close up both gaps so that they are the same or nearly so for both the intake and exhaust rockers. The task at hand is to control the rocker holder so that the corrections we make to it's placement are controlled and precise enough to close the gap and keep it where we want it (and this is the tricky part) AFTER all the screws are torqued back down.

Ok a Re-Cap

We have backed off the valve adjusters enough (or have MADE SURE that the rocker arm to valve stem gaps still exist) so that they cannot mess with the rocker arm end gap readings and we know what the gaps are for both rockers. Next, we need to setup the rocker holder so that we can make our adjustments. And now…

A Peek Forward

We will be loosening all 4 fasteners so we can move the rocker holder precisely where we want it… The easiest way to accomplish this is to hand tighten the 3) T-45 screws and the 1) 15mm nut using the same holding torque, so that we can fix the rocker holder in place for precise movement with the mallet. Once we have achieved the proper rocker end gap and have tightened the screws and nut down (by hand), we are then ready to use the torque wrench for the final settings.

Step 4

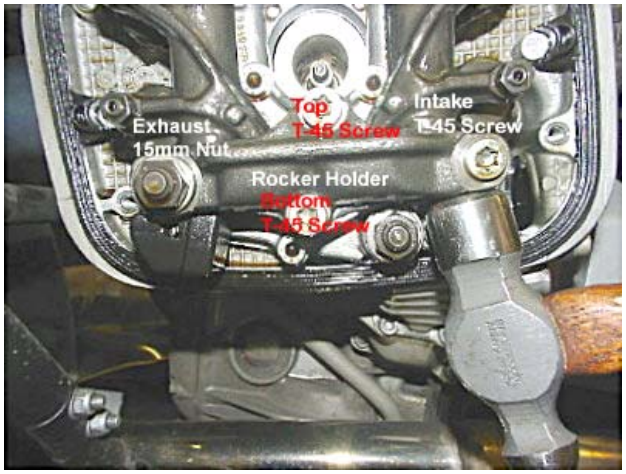
Use your T-45 bit and loosen the three screws on the rocker holder. Then ***lightly and evenly*** tighten them down just a 'touch'. How much is a 'touch'? Well, the ratchet you used to loosen the screws needed to have some leverage just to break them free but in the next step you'll move the T-45 bit to a stubby handled ratchet. Using this stubby ratchet you need to be able to loosen and tighten those 3 screws by hand as you make your adjustments. So being able to use the stubby ratchet to loosen the screws ***easily*** by hand is the 'touch', but at the same time we need to hold the rocker holder in place and not allow it to move on it's own.

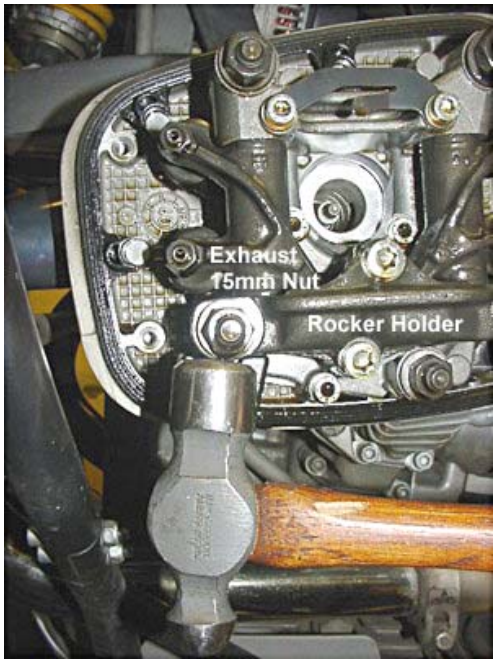
Step 5

Now loosen the 15mm nut on the head stud and LIGHTLY tighten it down with the same amount of torque you used on the T-45 screws. Again it needs to be able to be loosened and tightened by hand using the stubby ratchet with the same amount of holding force (ie. applied torque). And yes you can use the extension (or not) with the T-45 bit, or even use a 15mm deep socket instead of a normal socket and an extension…

Mondo-Techno-Break we gotta lota splain'n to do…

Ok why all this fuss with the stubby ratchet? Well, as your first step, you're going to figure out, by developing a 'feel' for how tight all the screws and studs need to be vs. how strong of a mallet blow needs to be impacted on the rocker holder to get it to move by as little as 0.001" (.0254mm) with each mallet strike, sorta kinda… In other words, as you make the screws tighter the amount of movement of the rocker holder will be less, given the same striking force. Or conversely, using a stronger striking force in order to move the rocker holder only a slight bit per impact, after more holding torque has been applied. Now there is a practical and efficient limit to the amount of wind up required by each impact as well as metal deformation on the rocker holder itself. In other words we don't want to have to hit the rocker holder all that hard to get it to move, but we also don't want it to be too soft of a blow either, nor do we want it to change AFTER the adjustment is made. What this means is we will be changing the amount of tension on these fasteners to find the optimum holding force of the rocker holder to the head to allow us to position it with respect to the rockers and have it stay in place AND allow precise control of the amount of movement of the holder as a result of each blow of the mallet. The proper amount of bolt tension is what is meant by a 'touch'. Now you see why the recommendation for a small headed mallet, using a framing hammer or 5lb sledge hammer is *way* too much overkill.





So what we need do is to clamp down the rocker holder by using the stubby ratchet so that ALL of the fasteners are equally tight, then tap the rocker holder so it moves up till the gap at each rocker is closed down to the ideal 0.0025" to 0.003" (.0635mm to .0762mm) Then we tighten the T-45 screws and lastly the 15mm head nut to the specified torque and we're done, RIGHT? If only it were that simple…

Fortunately, in many cases it can be just that simple, BUT there is usually at least ***one friggen*** screw or set of screws (and hopefully NOT the head stud nut) that just has to move the entire rocker holder around so that the end gaps DO change their gaps after all of the final torque is applied. In other words you're going to have to learn how to compensate for this movement of the rocker holder with respect to the final gap position BEFORE you begin to tighten the screws down to their final torque setting… Oh JOY

Remember I promised you an "iterative loop-sided road with a reverse half twist thrown in just because it just HAS to fuck with your mind", well this is it…

Step 6

Now there are 2 things that can happen with 3 different outcomes to the rocker end gaps after we have applied the final torque to the T-45 screws and 15mm head nut.

The first reaction is that the end gaps don't change. This is the best of all possibilities because we don't need to take any corrective action. This also means you'll be done much quicker than either of the next 2 possibilities. The second reaction, which has 2 different paths, is that the end gaps DO change after the final torque has been applied.

The first (**path-a**) is the end gap closes or tightens up.

The second (**path-b**) is the end gap opens or loosens up.

The amount of change and the direction of the change of the end gaps, and what you do about it, is where you have the opportunity to earn that merit badge.

And to make this even more interesting each path has 2 possible levels of complication. The most likely is the easier to deal with but in order to be complete we will cover all possibilities. Now in all fairness the likelihood of having to deal with the 2nd level of complication on either path-a or path-b is remote. When does this 2nd level rear it's ugly head? Only when the change in the end gap is as large (or larger) than the desired end gap itself or 0.0025" to 0.003" (.0635mm to .0762mm).

Now most of the time the gap shift or change is usually only a few thousandths. But then we are only talking about a few thousandths as our desired end gap… But the idea of these chapters is to prepare you for any and ALL eventualities, and gap changes of greater than the desired final end gap ARE possible.

And in the unlikely event of a water landing… uh, sorry, wrong speech… If the change in gap is very large one way to meet it half way is to increase your desired end gap to say 0.004" (.1016mm) or even more. Remember the goal is to match the rocker end gaps at as small a gap as is possible.

> *Also note that you **NEVER** want to leave the feeler gauge in place when you tighten any fastener. What inevitably happens is it gets 'stuck' and your only recourse is to loosen the fastener to get it unstuck. This of course messes with the placement of the rocker holder and you get to start over again… Now if the gap opens up it **may** not get stuck but don't count on it… Huh? I hear the peanut gallery mutter… It seems that **because** the feeler gauge is left in place, the rocker will grab it and not let go. So let this be a warning, don't leave the feeler gauge in place when applying torque.*
>
> *Also, you may have DAMAGED your feeler gauge if you have gotten it stuck, and removed it. Look at the gauge, if you notice any creases in the gauge, GO BUY A NEW ONE. Or at least DO NOT use the damaged portion of the feeler gauge on this (or any other) procedure. You may have also changed the thickness of the gauge by squeezing it between the rocker holder and the rocker arm. Feeler gauges don't work well at all, as shims.*
>
> *Scary huh? Moral of the story here… Remove your feeler gauges before tightening these fasteners.*

Step 6 path-a

Path-a has the end gaps closing down after torque is applied. We can compensate for this by making the gap larger ***before*** we add torque to the screw or nut. The issue then becomes ***how much*** do we increase the gap so that it winds up at our desired 0.0025" to 0.003" (.0635mm to .0762mm) when we reach the final torque on the screws and/or nut. Fortunately we can usually ***ADD*** the exact amount that the gap changes to the initial gap setting and wind up where we want to be. Simple.

Except when the change in gap is larger than our initial gap settings. This is where the 2nd level of complication growls and starts chewing on our noggins. And where the REAL He-Men Tweakers get to EARN their right to stay in the 'Club' (not to mention that Merit Badge).

So say the gap closes more than 0.0025" to 0.003" (.0635mm to .0762mm), in which case the gap after the final torque has been applied is ZERO or even less than ZERO.

Less than ZERO, I hear you say, how can the gap be less than ZERO? Well it is possible (although it is VERY RARE) that the rocker holder is under tension and is pushing on the rocker, in which case we would need to ***more*** than double the desired final end gap of 0.0025" to 0.003" (.0635mm to .0762mm) to compensate for our gap setting. In other words we would compensate by starting at more than double the initial gap, 0.003" x 2 = 0.006" (.0762mm x 2 = .1524mm) say to 0.007" or even 0.008" (.1778mm to .2032mm) in order to wind up at our desired 0.0025" to 0.003" (.0635mm to .0762mm) end gap after final torque has been applied and the end gap closes down. You will have to determine how much is enough by trial and error, or to put it another way, here is your "iterative loop-sided road".

Step 6 path b

Path-b has the gap opening up, and all we need to do is ***SUBTRACT*** the change in the gap from the initial desired gap of 0.0025" to 0.003" (.0635mm to .0762mm) to wind up where we want to be. Well, that is, unless the gap change is greater than our starting gap. Yes there is a 2nd level of complication here as well. In this case we would need to deliberately make the starting gap (I can hear the howl from here) less than ZERO. 'Ok wise guy how do I make the gap less than ZERO?' Well, ya sorta have to sneak up on it (see Tips & Tricks #2 below). This isn't as hard as it may sound and in most cases the gap doesn't change this much (or it shouldn't). This is where the iterative loop comes into play again and where REAL He-Men Tweakers get to EARN their right to stay in the 'Club' (not to mention that Merit Badge), Wait-A-Minute didn't I say the same thing in path-a? yo! deja-vu.

So say we start out at our desired initial gap of 0.0025" to 0.003" (.0635mm to .0762mm) and after the final torque has been applied we wind up at say 0.005" (.127mm). Now we need to compensate for the gap change by subtracting the change from our initial desired gap. 0.005" - 0.003" = 0.002" = change in the initial gap setting. We then subtract the change in gap from our initial desired gap 0.003" – 0.002" = 0.001" to arrive at our compensated start gap setting. (metric equations .127mm - .0762mm = .0508mm) then (.0762mm - .0508mm = .0254mm compensated start gap setting). Which means we set the gap at 0.001" (.0254mm) and after final torque has been added we wind up at our desired end gap of 0.0025" to 0.003" (.0635mm to .0762mm). This is the easy non-iterative loop-sided road part of path b.

If you're not so lucky and the change in the gap is larger than 0.003" (.0762mm) then the hunt begins (and yes there will be a test), we don't just GIVE that merit badge away you know, you have to wrastle it to the mat…

Here again I refer you to Tips & Tricks #2 below. The idea is to keep closing up the gap (as in mallet strikes) as we add more torque to the screw or nut that is causing the gap to change as we add torque.

This approach essentially neutralizes the change in gap as the added torque is applied, up until we stop making adjustments and let the gap open up at our desired 0.0025" to 0.003" (.0635mm to .0762mm).

Tips & Tricks #1

Is there a way to avoid or at least dodge this changing of the gaps? Well, Yes, there is, er, might be, er, could be, well, maybe, sorta.

We have found that much of the time if you tighten down the 2 center T-45 screws ***first*** (and if the end gaps don't change) then these 2 screws will tend to hold the rocker holder in place so that the 2 end fasteners (intake T-45 screw and exhaust 15mm nut) can't change the rocker holder (much). This is a 'good thing' in that when this trick works the amount of change at the rocker end gaps is lessened, and so the amount of compensation is lessened.

Tips & Tricks #2

Sneak up on the final end gap. This is done by slowly tightening the T-45 screw(s) and/or the 15mm nut by hand to ever tighter amounts of torque and watching (by measuring and adjusting if possible) the end gap as it changes. Remember, as the screws tighten up, the amount of movement of the rocker holder due to mallet impacts lessens so there comes a point where it's better to loosen the screws, make an adjustment then tighten and measure. Also remember that the T-45 screws only need 18Nm (13.2ft-lbs) of torque (which is roughly double what you can apply by your hand alone). And be aware that the gap changes ***might*** not be linear as more torque is applied, which means that most of the change may happen under low applied torque or higher torque as it is applied.

Tips & Tricks #3

This trick is a cousin to trick #1, only it is not position related. The screws and nut are spread out along the length of the rocker holder and it might be the fastener that is closest to the rocker end gap that is causing the change during the tightening process. This means that (at least in part) you ***might*** be able to control or at least minimize the amount of change of rocker holder during the tightening process… How? Well, by tightening the fasteners that are the furthest away from the movement you ***might*** be able to help lock the rocker holder into position and thus minimize the changes to your advantage. Now this may not work all the time because perhaps 2 or even 3 of the fasteners are guilty of allowing/causing the rocker holder to move… This technique can still be used but it will be up to you to figure out which of them tend to fix the holder in place and use them to help anchor it down…

Tips & Tricks #4

Hitting the rocker holder ***hard*** is usually not considered a 'good' thing for many reasons. Not only is the deformation of the rocker holder itself not 'good', but as all of the fasteners become more and more tightened, the movement due to the mallet impacts of the rocker holder stays much more localized. This means the rocker holder will tend to slightly warp as the screws limit the movement of the rocker holder as it is forced to move by the mallet impacts. This technique takes much finesse and a delicate touch... As you sneak up on the desired final gap clearance and begin to torque everything back down, you have to check the clearance again and again since they will probably change as you add torque. But this allows you to know how much correction needs to be made to the gap during a gradual build up leading to the end results.

Tips & Tricks #5

We want the 2 gaps (intake and exhaust) to be as close to identical as possible for one important reason… We want the rocker holder to be as close to perfectly perpendicular to the rockers and especially be parallel to the surfaces of the ends of the rockers so that the 2 surfaces (when they do touch) have as large a contact patch as possible to minimize wear. While this might seem like a nit picky sort of a thing, in the long run (like 100's of k miles) it will mean NOT having to replace these parts because they are heavily worn.

Tips & Tricks #6

As we mentioned previously, we would like to torque the T-45 screws down first for a couple of reasons. #1 they are much easier to deal with and #2 once they are locked down the ability of the head nut to move the rocker holder (and thus mess with our exhaust rocker end gap settings) should be diminished. This is an especially GOOD thing because having to torque and then loosen that head nut over and over again is a MAJOR PIA, mostly due to the final torque twist of the wrench. SO after the T-45 screws are down to their specified 18Nm and we check to make sure that the end gaps are where they should be, then we tighten the head nut next.

Mid course check…

Make sure that the rockers are not bound up between the valve stem and the push rod… If you backed off the lock nuts and opened up the rocker to valve gap you ***should*** be ok, but check here just to be sure… If the valve stem to rocker arm gap has closed up… You know what you ***must*** do… ***Back To Step #2***

Step 7

The next step is to torque the 15mm nut to 20Nm and then after noting the position of the wrench add 180° of additional rotation to the nut. It is usually better and easier to reset your arm to a comfortable position so that you can make the last 180° of rotation in one continuous constant sweep of your arm. No jerks or speed ups then slow downs with a stop or two in between just to be sure…. We want one constant, easy paced, continuously made sweep of your arm till the end. If that doesn't happen, then back the nut down and do it ***all*** over again. This also implies having to compensate for any change in (most likely the exhaust) rocker end gap. This is the very reason why it's not recommended to learn torque wrench technique with this procedure.

Tips & Tricks #7

Now there is yet another approach you can take. This entails adding torque to the screws and nut in small amounts that then adds up to say half of the final torque. At each step you measure the gap and determine if corrective action is needed. It would go something like this.
After hand tightening you then add say 1/8th of a turn using the torque wrench set to 9Nm (for the T-45 screws). Check the gaps. Then add another 1/8th of a turn, and check the gaps. Corrective action could be applied (or not) as needed, especially early during this build up process. After the torque wrench clicks at 9Nm then set it for 18Nm and add that as the final adjustment. And yes check the end gaps. Then go for the head nut using the same technique. Add 1/8th of a turn till 10Nm is reached then go for the 20Nm setting then add the last 180° of rotation. Of course you can mix and match which of the T-45 screws and or head nut is torqued down and in which order based on what works for you and your engine. Also remember to check the end gaps every time you add torque.

Step 8

Now if the mechano-gods are smiling when you check your rocker end gaps again, after all 4 fasteners are all nice and snugged up to their desired final torque settings and you're still in the sweet zone of 0.0025" to 0.003" (.0635mm to .0762mm) you're done, with this cylinder. Move on to the other cylinder.

Step 9

If by some freak of the mechano-gods perverse sense of bemusement, this last torque sequence has shifted either of the rocker end gaps (most likely it will be the exhaust rocker end gap) then you need to apply the techniques of Steps 6 & 7 and Tips & Tricks 1-7 mentioned above to the 15mm head stud nut as well, in order to dial in the desired rocker end gap (remember that iterative loop section above, before Step #1?).

Tips & Tricks #8

You do NOT want to have to mess with the T-45 screws as they are already setup correctly. That is, unless you have to…. Remember that "reverse half twist" thingy, well here it is…

Some times the T-45 screws HAVE to be re-loosened to allow the rocker holder to move into it's pre-final hand torque position so that it will then change into the correct position (during the final torque down sequence of the 15mm nut). And unless you're *very* careful to keep the intake rocker end gap that *is* in the correct position from changing, you'll be repeating ***all*** of the previous steps AND adding the 15mm nut (with it's final torque) to the mix as well. And perhaps you'll discover the best way is to torque the 15mm head nut down ***first*** then follow up with the T-45 screws…

Step 10

But the first thing to do is measure both rocker end gaps (most likely only the exhaust rocker end gap has changed) and see what the amount of change actually is… Hopefully it will be only 0.001" or 0.002" (.0254mm to .0508mm), which makes the compensation ***much*** easier…

Step 11

Repeat for the other side till done.

Step 12

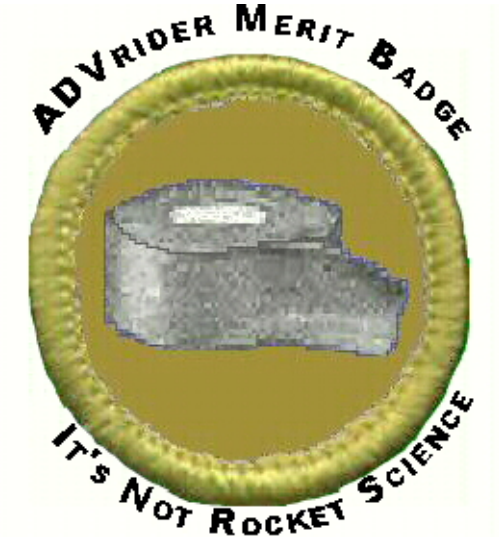
Once both sides are done, continue on with an OVAD (step #38) as described by that procedure. If you're really lucky and the lock nuts on the rocker adjusters weren't loosened and the adjuster's backed off just to make sure that there was adequate clearance then it MIGHT only need a small adjustment. Chances are however after bringing the rocker arm end gaps into tight tolerance yet again, the valve gaps will need tweaking. The amount of adjustment that will be needed probably won't be as bad as the first time an OVAD was done but it probably won't be a slight adjustment either.

Tips & Tricks #9

Now if you really want to add another layer of tweak to your carefully constructed method (and a stripe of blood to the merit badge)… you can rotate the engine 2 full revolutions and check the side you just adjusted again. Just to make sure it really is as close as you think it is. Also be aware that I am not suggesting that the first time you do this adjustment you seriously consider this trick. The second time you close up your rocker end gaps, and you are much more familiar with the do's and hell no's, it can be used as a form of confirmation… Wadda think I am, sick ***and*** twisted? No, don't answer that…

Film at Eleven

Ok so you've struggled thru not only a full on OREPAD but an OVAD as well and you're looking for that prize that's buried in the bottom of the box. Where's that Merit Badge?, well right here of course



And by now you must be wondering what's up with our home study course, of course… Yes, of course it's all true what everyone has said about our course,. It's the proper course to take, of course. And of course it's the course of action that will lead, of course to the real ADVrider's Merit Badge as sponsored by the Tweaker's R-US Club International LLC. This is of course, the course you've just taken in your spare time at home. Congratulations, of course on successfully completing the course, of course we assume you did in fact complete the course of course…

And of course there will be other courses, due to be offered in due course, of course.

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