the great canadian nitrous knowledge thread

After getting 'THE WOK' finished and attending two car events this summer and because of the airspeed forum, I have received a lot of questions regarding engine assembly; tuning and nitrous etc. So I figured it would be a lot of fun to do a complete engine series starting with engine build up and finishing at the track. There is so much to cover in between so I'm hoping this will be an informative topic that will give a lot of people an idea of what it takes to design, assemble, tune and maintain a stroker motor. This will be impossible to do without mentioning product manufacturers, so I will do my best to give the reasons I choose them. And if you have any questions or comments I will do my best to answer them, so please no e-mails post them here as someone else is probably wondering the same thing you are.

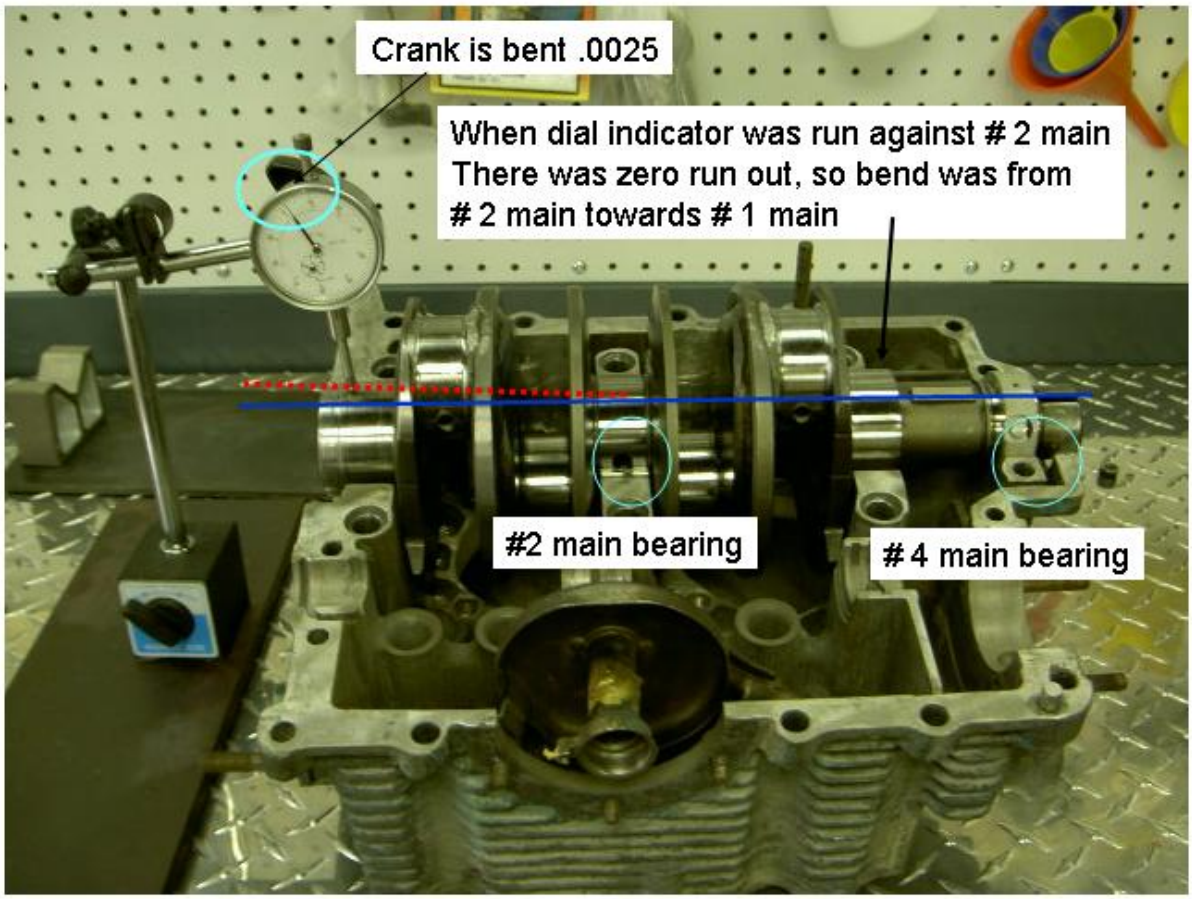
LET'S GET ROLLING. The motor being covered is the same motor that's been in [and out] of my car over the last few years. It was designed and built as a test/relearning motor that I could base my future engines from and experiment with tuning aids and performance enhancers and overall it has proved quite durable. But at the same time I have suffered from many mechanical failures. Three cams and lifter sets, piston ring failure and a bent crank. Some things you can't control, just learn from them and carry on and make adjustments along the way. Remember speed costs money, so throw your Bentley manual out the window, break out the charge cards and let's build a motor.

Tools, tools, tools, you don't need a lot of special hand tools but you will need some,
Good quality measuring equipment. Most are available at princess auto, KMS, tools, Lordco,
Sears, etc.

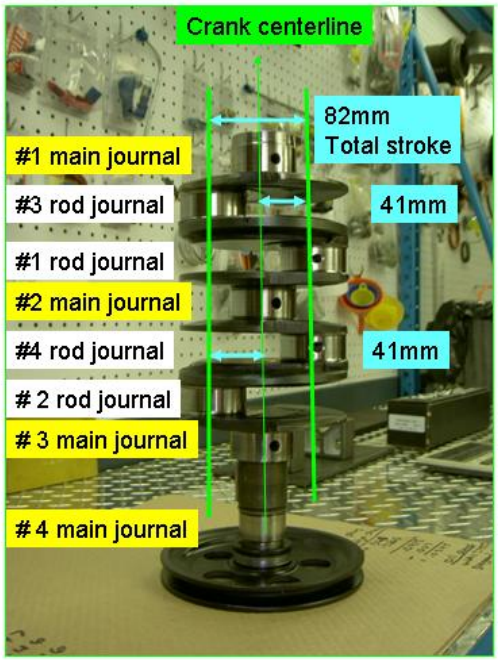
This is the reason my motor came apart again. This problem is the same thing they talked about on monster garage, seizing #1 main bearing. For me I could care less about the failure, but what caused it is the most important.
Oil starvation, bent crank, align bore. All these points came up, and like I said learn from mistakes. This is like the “which came first the chicken or the egg” thing. I may never know if the crank bent causing the failure or the crank bending is the result. But I’m sure I’ll figure it out…..later topic.

So the first thing after everything was disassembled was inspection of parts. Knowing the crank was having a bearing failure; it was the first thing to check.
If you don't have a set of V blocks to rest the crank on to check it, you can rest the crank in the one case half so that is running on only 2 bearings. #2 and #4 are the best, as you can measure the run out on the #1 main journal and the #3 main journal using a dial indicator. The picture really shows how to check it using the dial indicator/magnetic base, just set it to zero and slowly rotate the crank.

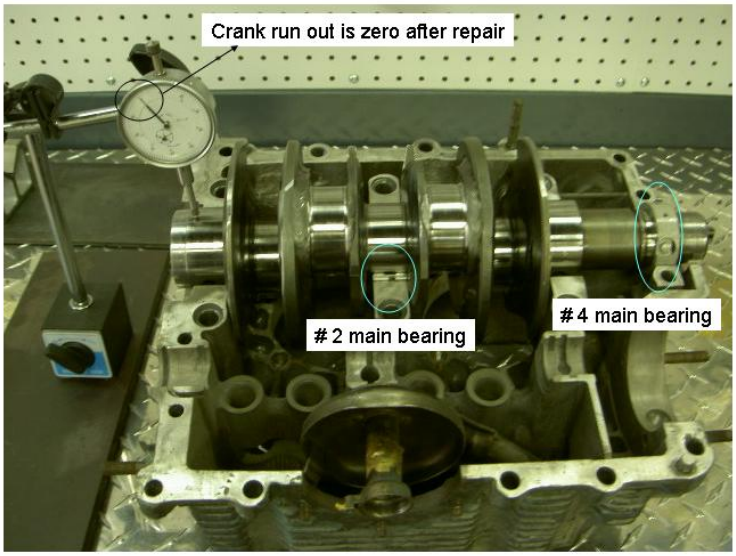
In this photo the end of the crank was bent .0025 "from the #2 bearing forward, when I measured it at the #3 journal it was still straight. My theory is the seizing bearing was causing the one end of the crank to bind/lock up ,and with the rest of the crank easily rotating and applying a great deal of force into the rest of the crank ,this caused the bend.
Seems to make sense, But what caused the seizing bearing?.....later



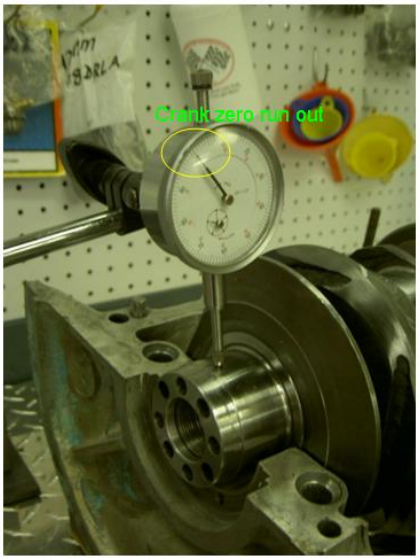
This crankshaft is a Demello full circle crankshaft, the reason I bought this crank is due to it great reputation for smooth running at high rev's and also because it is the same crank the USA military uses in it combat vehicles. And because of my vehicles weight I wanted more rotating mass [yes it's heavier than most cranks] to help prevent on line bog when releasing the clutch at the track. You should of heard bob at Demello when I told him I bent my crank, anyway he took care of it for me and repaired it a.s.a.p.
Sorry, I should have posted this photo earlier, so if you're not sure of the layout of a VW crankshaft you would know what I was talking about.
Note the 4 main journals are all in a row down the center and the rod journals are on the outer portion. You can see from the crank centerline to the centerline of each of the rod journals is 41mm for a total of 82 mm total. This means that this crank will move a piston up and down a cylinder 82 mm every rotation.
So why put a bigger crankshaft into a motor?
Easy, torque produced from any engine comes from the energy being released from the ignited fuel. So more fuel = more energy =more torque. In the case of a larger crankshaft, just think of a syringe. Pull up on the plunger and take in 10 cc of fluid, this time pull back on the plunger and take in 20 cc of fluid. You just stroked a syringe; it's the same as going from a stock 69mm stroke to an 82 mm stroke. I think you get it.



Well now my crank is back and it's time to check and measure it. So back into the case it goes for the same test as before. This time, much better results. Dead straight! Thanks Bob.

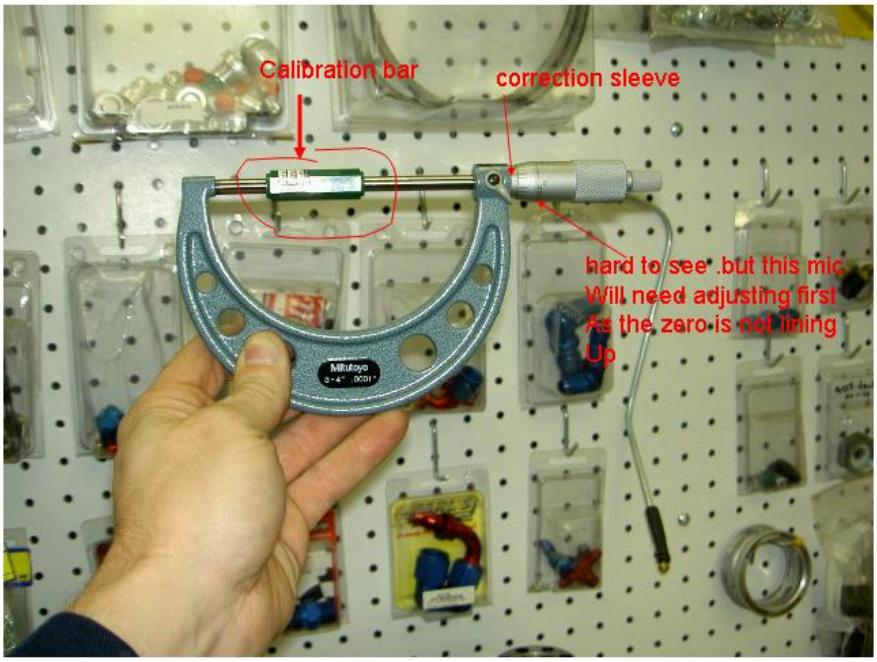


This is a better shot of where the dial indicator is set when measuring crank run out.
This same procedure is used when checking for a bend/run out at the #3 main journal.

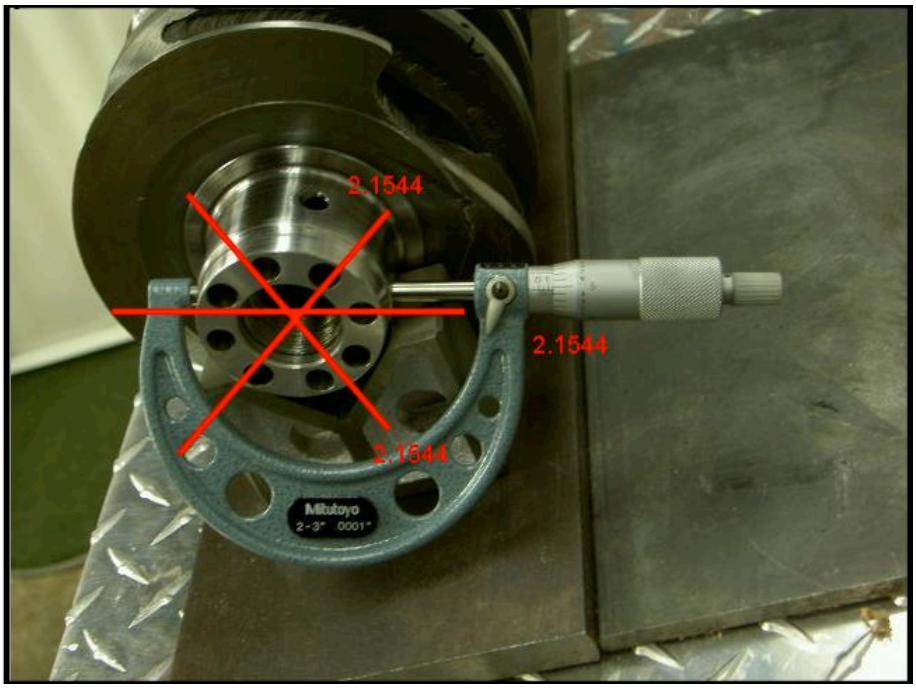


Now that I have a straight crank, better check all the journals for roundness and size.
In order to do this you need to use a micrometer.

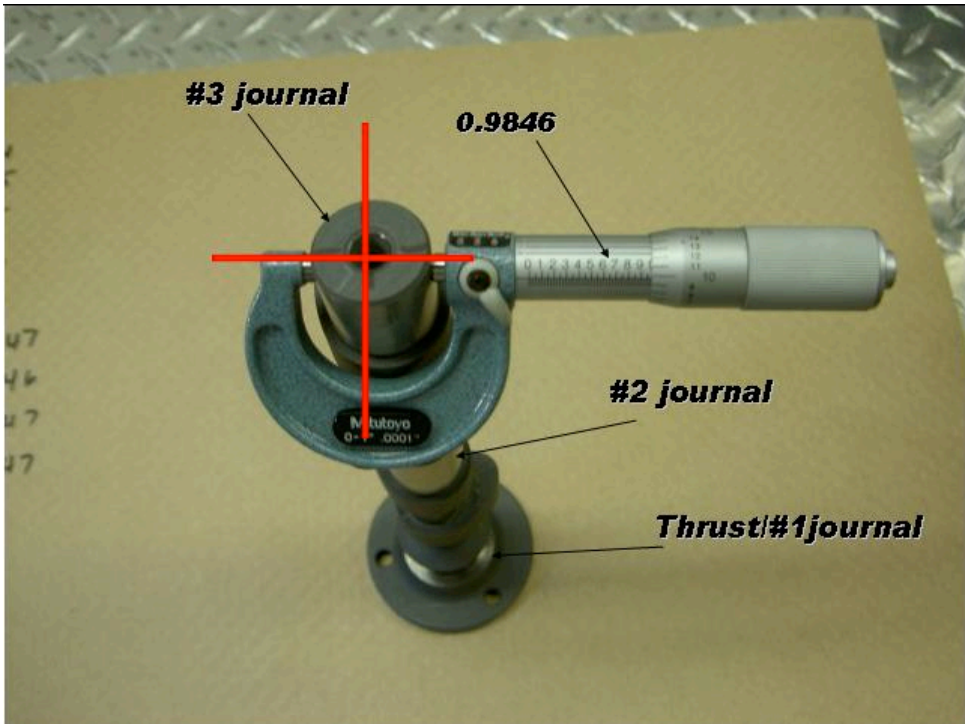
Before you use any measuring tool it is important to make sure it's calibrated.
In this case a preset block is inserted between the measuring points of the micrometer and it is used to calibrate it to zero.
Look close this tool is out and will need adjusting, which is done by using a supplied tool to align the marks.



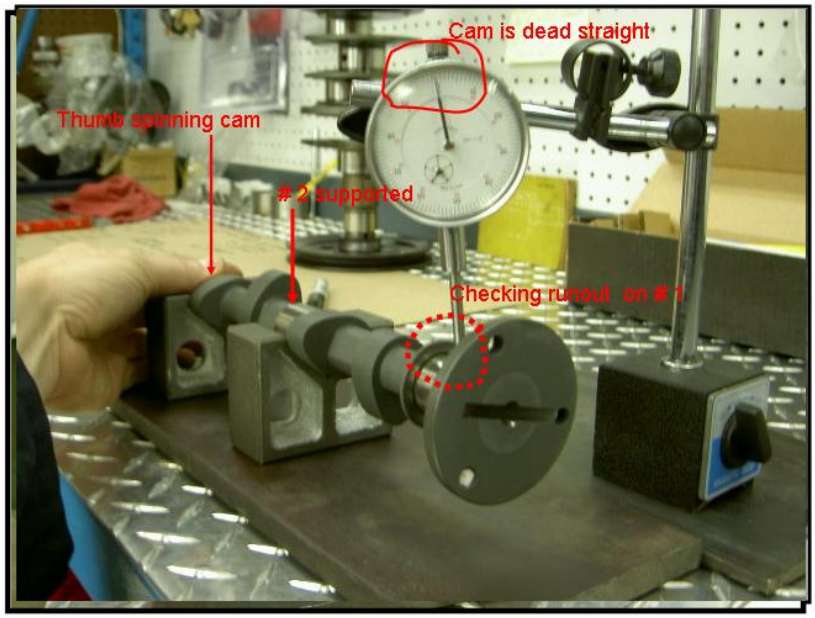
With my crank supported in the v blocks you can see that I checked the #1 main journal in 3 places.
Bob did his work and it is perfect, measuring at 2.1544". You need to take your time and measure all 4 main journals and all 4 rod journals using the same technique. Record all these measurement as you are going to need these very soon.



Now we can use the same technique on the cam that we used for the crank.
First measure all 3 bearing journals and record their measurements. In this case they measure 0.9846”

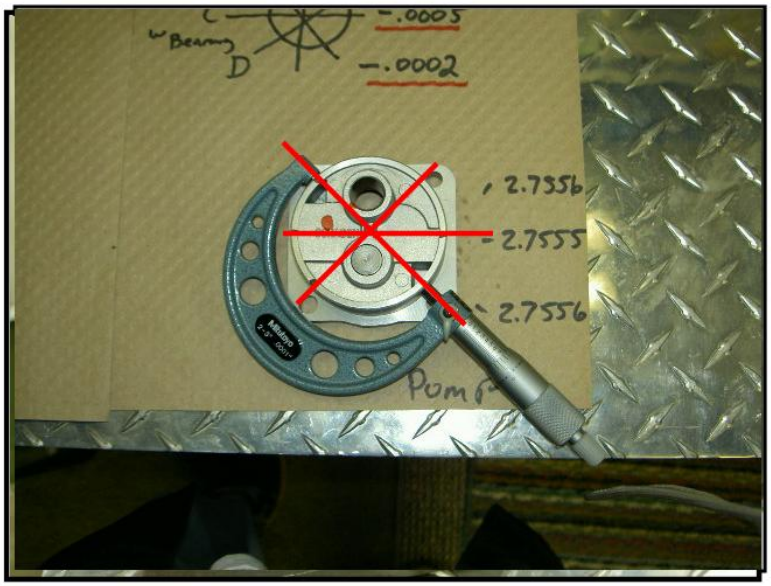


Hey you got the tools, so better check run out on the cam.
Check it like this as well as support it at each end and put the dial indicator on #2 journal and check for run out as well

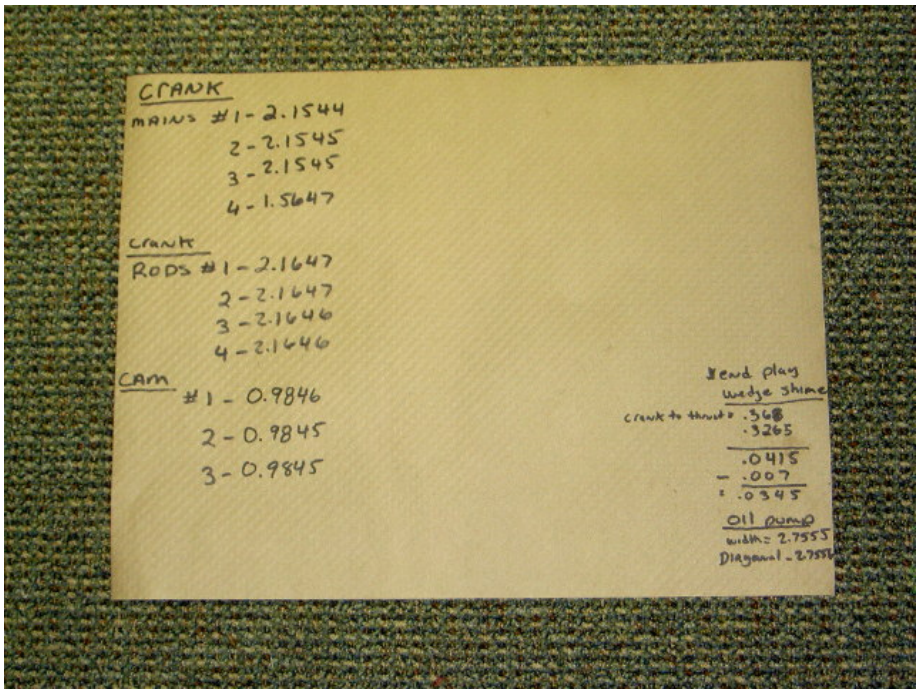


Now I know I said toss the Bentley book out. That is because we are building a performance motor and not a stock motor so remember the rules have changed. But in the case of run-out for the crank and cam and crank and cam journal size it is to be used as a reference only.

Cam run-out = .0008" max/crank run-out = .0008" max
Let's worry only about measuring run-out and recording journal diameters; we will get into the details later.
Better measure that new oil pump housing and make sure its round. Again record the measurements. Not bad .0001"out of round.



You can see I started a chart with everything I have measured.
This is going to be a huge help when we start measuring out the case, and working out oil clearances, and endplay, etc.
Don't worry it will all come together.



Well I think it's a good start and I hope easy to follow.
I can't believe all we did was measure 3 things. Next is the case…

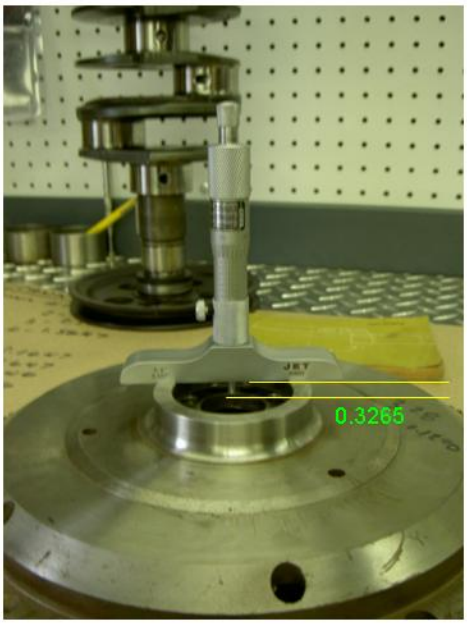
Posted by: slammedbus Nov 8 2005, 09:28 PM
Hey Jim. I always explain torque advantages from a stroker to my students like this.
You exert a force on a lever that is 69 mm long and get X amount of torque.
What would happen to the amount of torque if I made that lever 82mm long?
And applied the same amount of force?? Seems to sink in to the little uns.

Remember that a crankshaft is the component that turns linear piston motion into rotation, and rotation is measured in torque.
I think we are at the point where engine displacement becomes a topic. Engine displacement is basically the amount that is displaced from the point at where the piston starts its movement to the point at which it stops moving, that total volume times the number of cylinders is the total engine displacement and VW engines seem to be measured in cubic centimeters [cc's]. There is many online engine displacement calculators available, so look one up and plug in some bore and stroke numbers, you can see quickly what affects what.
So go back to the syringe for a moment, as it's easy to visualize. If you increase the size of the plunger [piston] or increase the amount you pull the plunger back [crankshaft], you have increased the amount of fluid you have drawn into the syringe [displacement].
Now we go the other way. When the fuel is ignited it causes the piston to be pushed back down the cylinder, the bigger the piston the greater the force pushing on it. The piston is connected by a rod, which in turn is connected to the outer journals of the crankshaft. And the farther away the outer rod journals are away from the main bearing journals the greater the leverage will be. That leverage from the rotating crank is measured in torque. So by increasing the crankshaft or the piston size we are going to generate more torque. Remember "there is no replacement for displacement".
So build them big and burn lots of fuel because the power comes from the fuel, great to see some input.

Since I'm still in a measuring mode and my case will not be back till next Friday I finished up pre-measuring my crankshaft endplay. First the reason this is a little harder to do is because this is a wedge-mated crankshaft. Which means the end of the crank which the flywheel bolts onto has a taper machined on it and the flywheel has the mating surface welded up and machined to the exact same taper as the crankshaft? When these two pieces are put together and torqued they become an almost inseparable piece. If you have ever tried to take a tie rod off of your steering knuckle you know how strong a taper fit can be. So since it's a lot of work to separate a wedge-mate its best to try to minimize the amount of times you need to do it. As well you can damage the wedge-mate surfaces from repeat assembly/disassembly.
You can see here the actual taper machined into the crankshaft end.

First install your #1 main bearing onto the crank, using your depth gauge measure down to the bearing. I try this in a few different spots and take the average reading, as its very hard to get a 100% same reading at all spots you'll most likely be a .001" out on average.
You see I got .368"

Then, measure with your depth gauge spanned across the flywheel down to the mating surface of the flywheel. We get 0.3265"



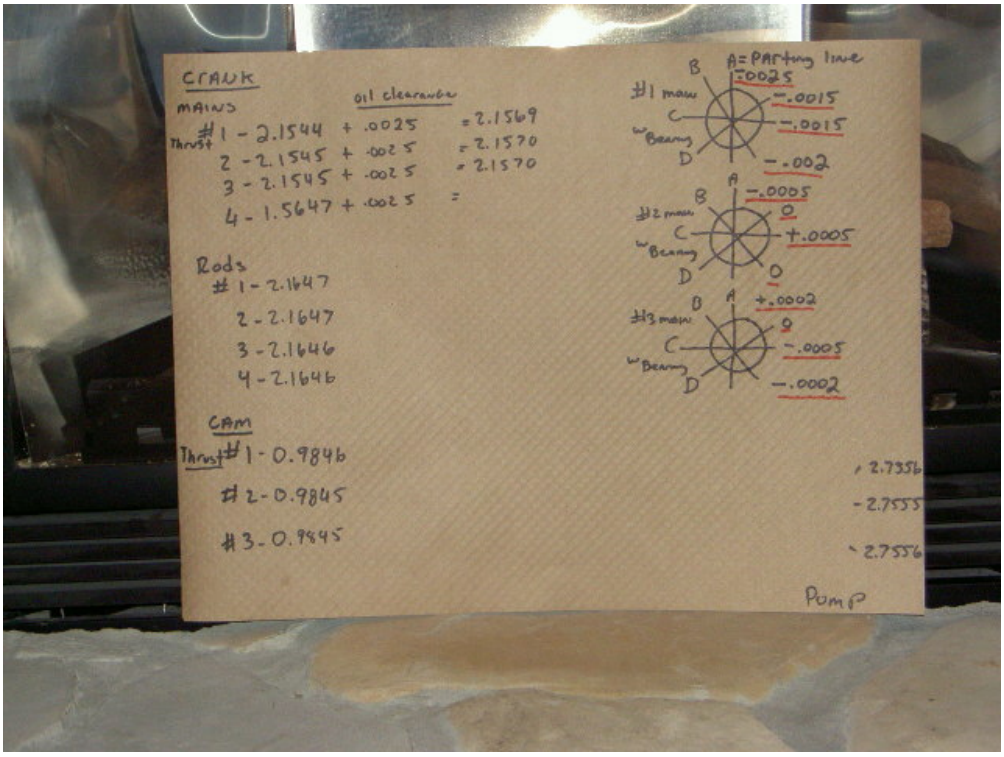
Now what we do is minus the two numbers and come up with the dimension between the end of the #1 bearing and the flywheel we get.0415"
Between the two parts you need to run a minimum of 3 shims this will set your endplay, as well as keep the flywheel from contacting and destroying the bearing. I'm going to run .007" endplay so I needed to get .0345" in shims. What luck, I have 3 that work out perfectly. Shims are available in all kinds of thicknesses, and last time I was at airspeed I picked up a whole bunch of sizes so I would have a good assortment at home when the time came.

We will see how good this pre measurement works out after the bearing is preloaded in the case and the flywheel is torqued up. I'm interested to know myself. Again the measurements are marked down on the chart. I might start measuring out the rods while I wait for my case.

THE CASE

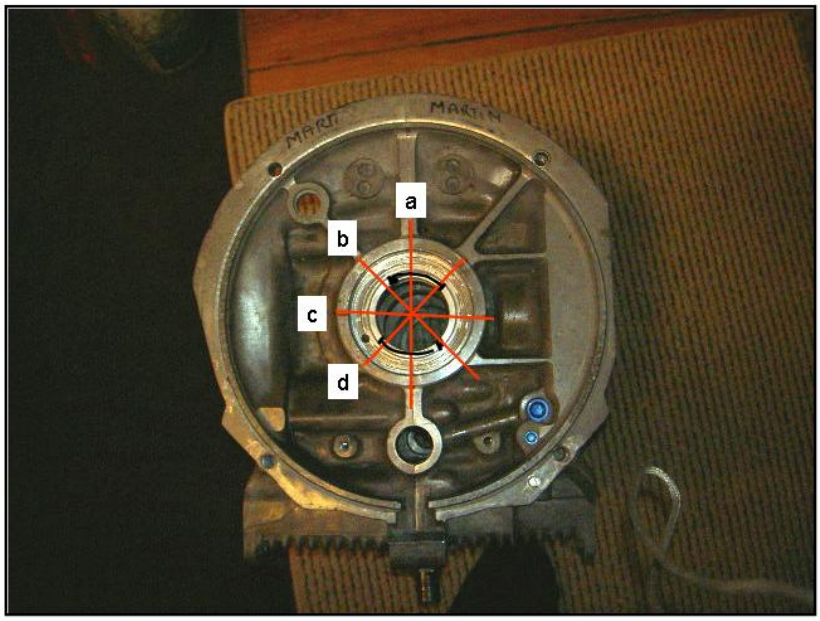
This is probably the most overlooked part in any build, but it is the most important.
In my opinion with aftermarket parts being made everywhere, and by everyone there is no standard of quality or dimension. *"The name goes on before the quality goes in"*
Keep that in mind and check everything 3 times, because I can guarantee the one thing you overlook may be quite costly and frustrating in the end. But don't worry *"live and learn and don't do it again"*. Like I said before, I figured out what caused my bearing failure so let's get the crank spinning and see if it all makes sense.

Where to start?
First we need to come up with some kind of dimension. So let's look at the chart.
A good radial main bearing oil clearance for a VW motor is between .0025"-.0030"
So if we add that to the main bearing size we get 2.1569" as a target. Not deadly important as we are just getting started.



Now set your bore gauge. First set your mic to the target dimension .2.1569" Then set you bore gauge in between the two pads on the mic and rotate the dial to ZERO. You will need to rock the bore gauge in the mic to get it dead on.
Once you try it you will know what I mean. I have made 2 marks one on either side of zero. Left is black and right is red.
So anything in the black is above the target dimension, and anything in the red is less than the target dimension.

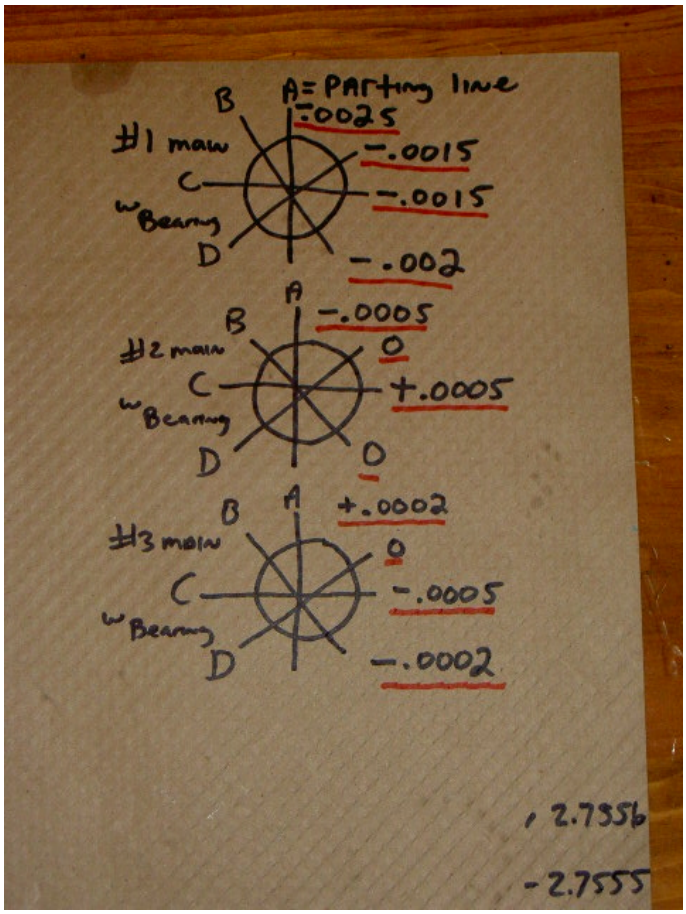
You need to understand that it is impossible to bolt a case together and torque it up and have the bores dead round. The main bearings need to be in the case to align the two halves. But you can take some rough measurements without bearings to see if the case looks close to specs. Those dimensions are in the Bentley book. After rough measuring mine I knew I was in trouble, but getting closer to my answer of why my bearing failed.
Since I never use the stock #3 bearing I seem to have a endless supply of them so what I do is load up my case with those. Yes, #1 / 2 / 3 main bores are all the same dimension.
Take a look at my # 3 bearing in the #1 bore you can see I marked 2 black areas on the bearing. Those are there to remind me to watch out for the oil galleys in the bearing, which will upset your measurements. You can also see the locations of measurement points a / b / c / d these are the 4 points I take measurements from. Remember them, as I will refer to them many times. What was done was to take a measurement at one point, loosen the case and rotate the bearing to the next point, torque it up and re-measure. This was done for 4 measurement reference points on all 4 bearings.
CASE TORQUE IS HUGE AND WE WILL GET TO THAT LATER.



Sounds like a lot of work but it goes a lot quicker than you think.

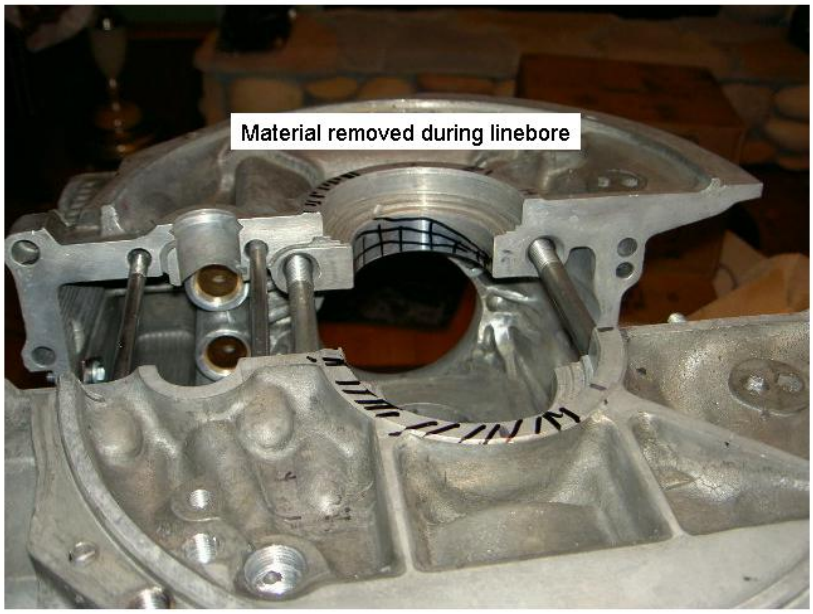
This is how you use a bore gauge. It is self-correcting because the 2 wheels keep it straight, and all you have to do is rock it back and forth in the bearing bore and watch the gauge. You will figure it out quick once you try one.

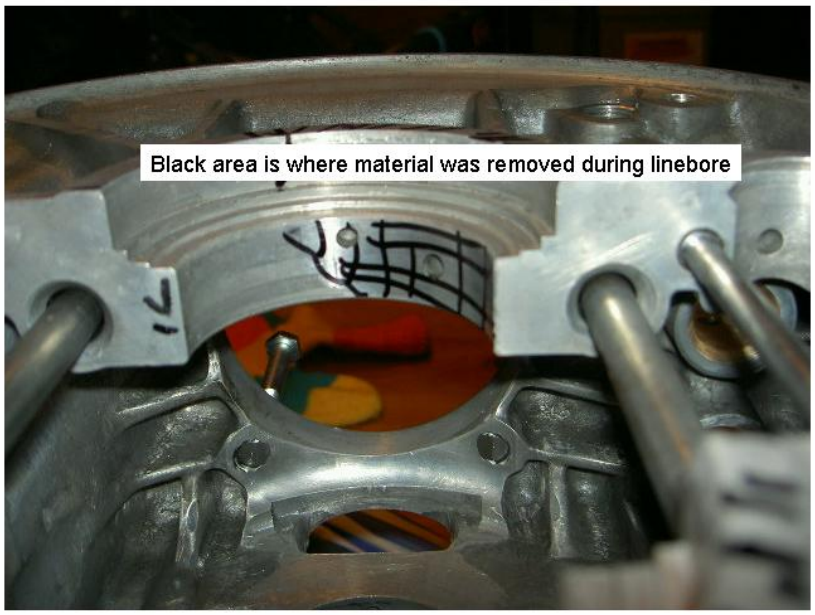
This is what I ended up with



#2 and # 3 mains were almost dead on with less than 0.0005" out of round!
But look at #1 main bearing. You can see that there is in the end no radial clearance.
I could not even turn my crank with the case halves just resting together, and the crank would be pinched and unable to turn.

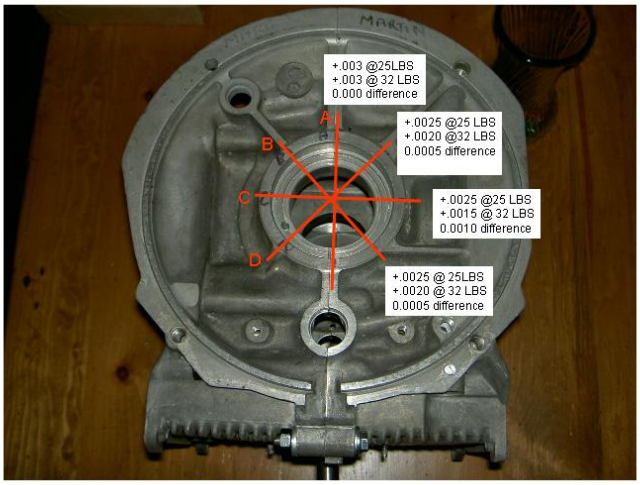
I was going to line bore my case myself but I figured I will send it to Rocky at http://www.rockyjennings.com. This guy knows his stuff and has an excellent web site. Shipping back and forth is cheap as well. Under $40.00 cdn to send my case from Vancouver. Rocky inspected my case, and I told him to make the call. End result: re bore to stock dimension #1 main bore only. He ended up taking out about .0025" with the cutters set at stock dimension. Not bad if I remember that's how much it measured small!
Take a look you can see the areas in black are where material was removed.





If you don't think it's out of round trust me it's less than .0002"out.

Well with the case back and a quick check with the old #3 bearing in #1 main again it was time to install the main bearing set I would be using.
This I found very interesting and added more pieces to my puzzle of bearing failure. With the bore gauge set and case torqued to 25 ft/lbs then later increased to 32 ft/lbs.
I took my measurements. But this time as I was using the bearing set I will run in the motor. Bearings were not rotated or moved.



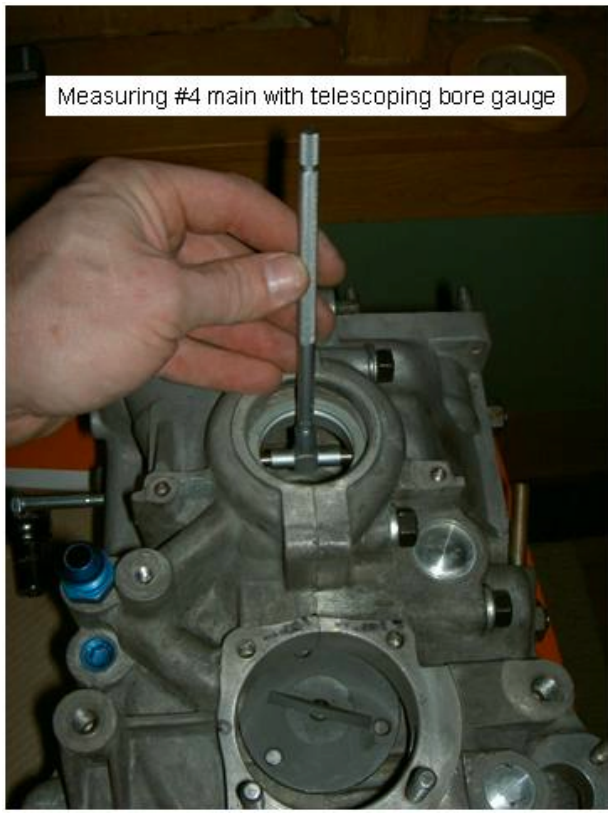
You can see that the dimension at 'A' parting line of the case does not change.
With measuring point 'B' &'D' changing less than .0005", but at measuring point 'C' there was a difference of .001" wow!
Again note this is bearing radial clearance, take note.

I opened the case up and slipped my cam bearings in as well, so I could measure them and again torque the case up to 25 ft/lbs on the 6 large nuts. Wow! My measurements changed. So I marked them down and retorqued to 32 ft/lbs.
Take a look the dimension at 'A' stayed the same between the first round of measuring and the second round of measuring, But all the other dimensions changed by about .001" smaller. As well as note the dimensions at both 25 and 32 ft/lbs changed the same amount from the first set of measurements to the second set of measurements.

Maybe the #1 main by design is slower to compress than the other bearings. I tried this again with another new #1 main bearing with almost the same results. Can't explain it but take notice that you may want to run your bearing set through a few torque cycles to make sure you get an accurate radial oil clearance.
#1 radial oil clearance 0.0025" Measuring #2 radial oil clearance 0.0025"

Measuring #3 radial oil clearance 0.003"

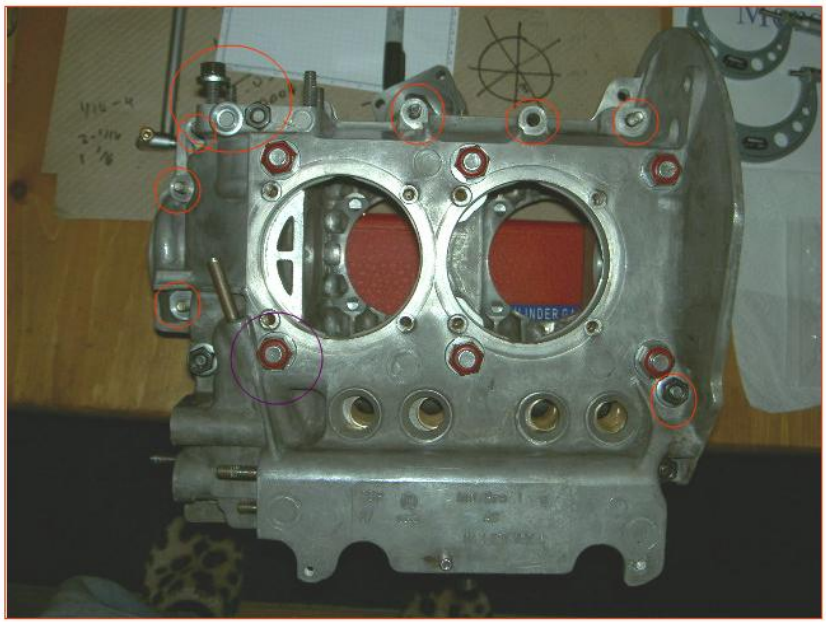
Now, it's a bit different to measure #4 main radial clearance. But this is what I like to do. First take your crank measurement of 1.5647" and add say .001". Set your mic to that dimension 1.5657", and insert your telescoping bore gauge between the two mic pads. Note the drag as you rock the bore gauge between the center points of the mic and remember that feeling.



Then take your set telescoping bore gauge and go to your case.
Insert the telescoping bore gauge into the bearing in all 4 positions and roll the gauge back and forth past center and see if there was any contact. In this case there was not, so I will increase another .001", set mic at 1.5667" and go through the whole procedure again.
What I ended up with is a reading of between .0025" and .0030"radial oil clearance for the #4 main bearing which is excellent. That same technique I just described will be used again later.

For kicks and giggles I oiled up all the main bearings and install the crank into the case and torqued it up, and she spins as free as could be!!!!!

So the three questions are:
What caused the failure?
What has been learned?
What is being done to prevent it from happening again?
The cause? It's simple, first don't believe everything you read or heard.
If you don't have firsthand knowledge of something you better learn quick and triple check everything.
As for my case this is how it goes. I measured out my radial main bearing oil clearance and never checked it again. But now I know that my #1 main seems to compress an additional .001" after a couple rounds of torqueing. So right off the bat my .0025" oil clearance dropped to .0015". As you can see here my case has all the small outside bolts and the 6 inner bolts modified with a gene berg conversion, larger hardware.

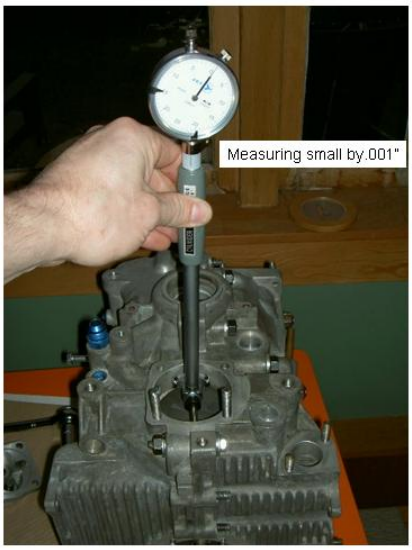


These instructions come with the parts and instructions about modifying your engine case torque to increase case life. Sounded good to me, so I did it. Hey, it comes from Gene Berg so it must be good info. What they don't tell you is that the case deforms when more torque than the factory 25 ft/lbs is applied. That's my fault for not triple checking that. So you can see by increasing my torque I most likely lost another .001 clearance. I was running an oval main bore and .0005" radial clearance. No wonder things seized up.
What's been learned? Run bearings through a few torque cycles, don't trust everything you read or heard, and you can modify your bearing clearance by modifying your case torque if needed. If you are going to run higher case torque get it line bored torqued to your specs.
Prevention
Correct measuring of all parts is #1
Modifications to crankshaft end play, bearings, and oil system, all which will be covered later.

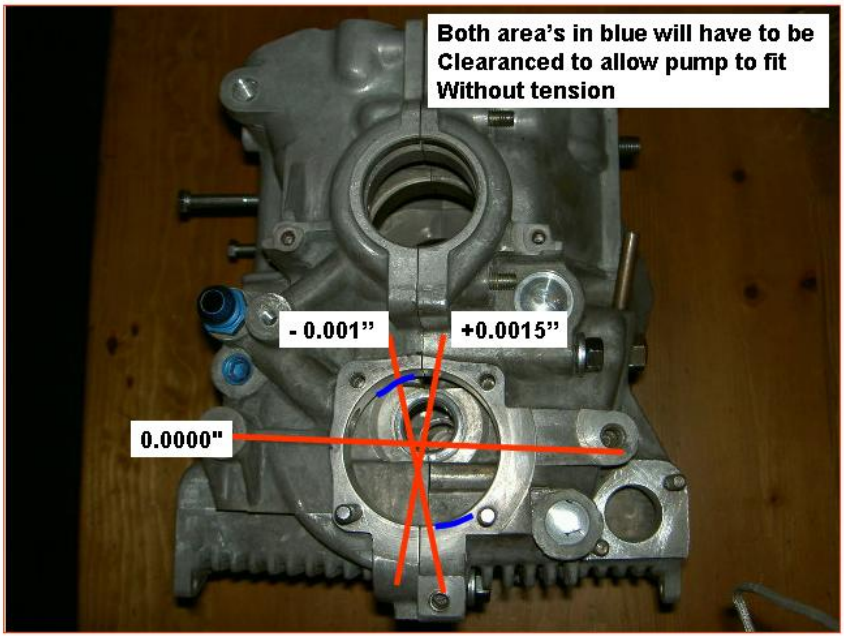
QUOTE (OUTKAST @ Dec 1 2005, 02:53 AM)
You are Amazingly gifted,
Never realized the amount of knowledge needed to do a proper build up or the potential variables to get caught up in.
Your thread is extremely interesting and understandable. Thanks for taking the time and effort to do this for the forum members.
Great job

Thanks, I'm glad you are finding it easy to follow.
This last section with some of the case variables is a bit much but I hope the info there will help someone else down the road.

Using the previous measurements from my new Shadeck oil pump I set my mic and set the bore gauge. The case was torqued up with all the bearings and the camshaft installed. It was time to measure out the oil pump bore.

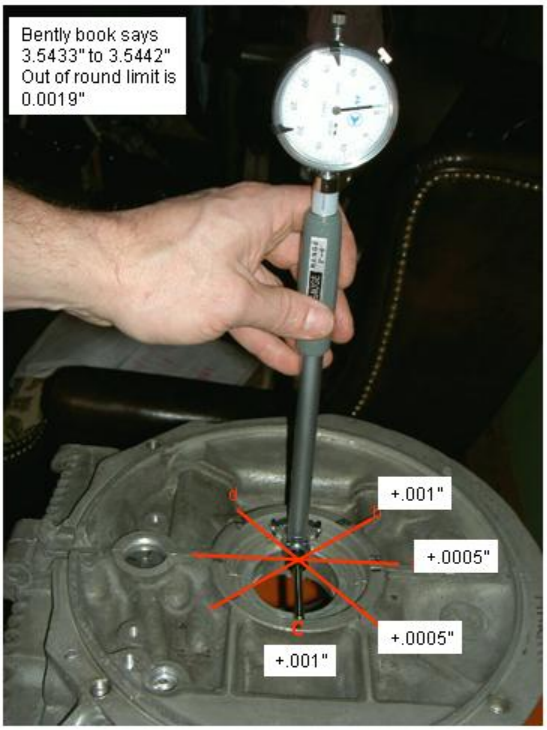


Since my pump was almost perfect, and without a stock pump to take measurements from I had to assume that the spec in the Bentley book would help give me an idea of pump to case clearance. My book says pump bore is 2.7560"- 2.7580" minus my 2.7555" pump housing and I get a clearance of 0.0005"- 0.0025".
So with this mind, I will need to clearance my housing to better fit my pump.



The areas in blue and the width will need a little clean up and be re measured.
What I used was a flapper 220 grit sanding wheel mounted in a drill and was very careful to keep it square to the pump bore.
Now if I have the 6 large nuts torqued up but the outer bolts loose I can just about slide it in. It is tight and has about .001" clearance all around it.
My concern was that since the case was not even at the parting line that installing the pump could toss it out of whack.
With the pump in and the case fully torqued up cam and crank spin freely!

Better check that oil seal as well. Don't want a leak here.



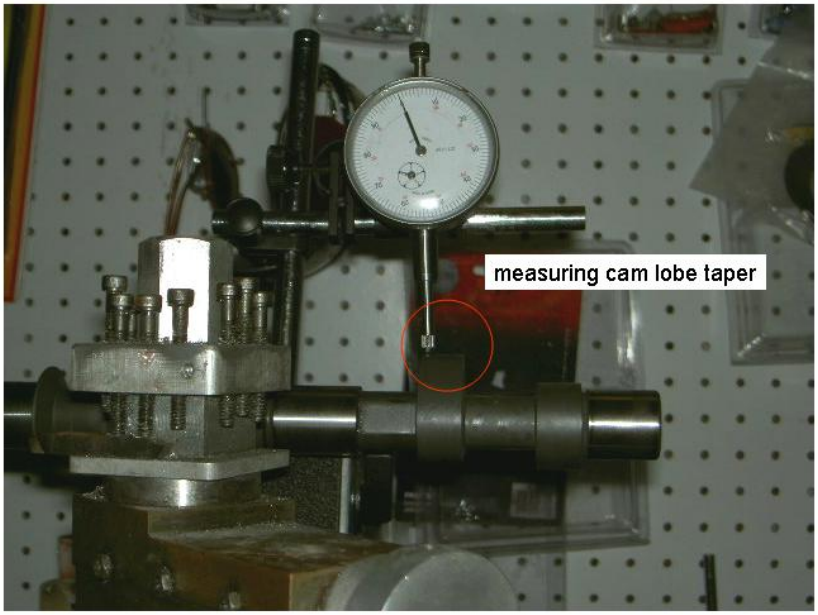
You can see that my seal bore is well within limits and is good to go.
Next is the camshaft and lifters. Then its preassembly time!!!

Posted by: Hansk Dec 1 2005, 10:24 PM
Nice article Jim. Sure shows the way things should be done. Awesome! Especially when using today's replacement and aftermarket parts. Like, having to get your brand new case re-machined to get it within tolerance. I'm sure 99.999% of the motors never get checked out like this. If they were, the manufacturer would have a huge pile of them returned back to their doorstep. Maybe even through their front window

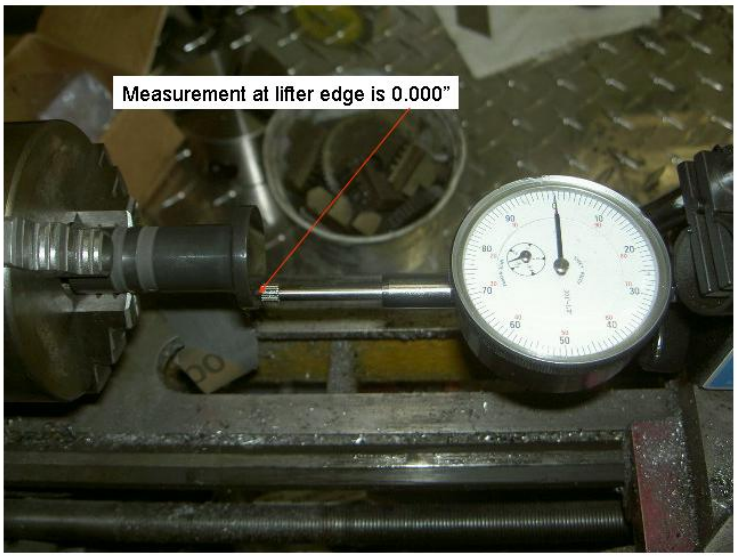
You have no choice but to do it this way. Because there are a lot of good quality parts out there and a lot of poor quality parts being produced. It is up to you in the end to make them fit and work together. Remember, on average these kinds of motors are putting out on ONE cylinder what a complete stock motor put out on all its FOUR cylinders.
So assembly is going to be slow, as there are a lot of things that will creep up. Now you can understand why a well-assembled motor is expensive and labor intensive.
What will I do next time? Find a seasoned original case and get it machined. As I believe the quality of any new Brazilian mag case is poor. Or bite the bullet and get Rocky to machine up an oxyboxer case, which is probably the smartest move.

Since the mystery of what caused my #1 bearing failure is solved, and the crank spins very freely with the case torqued up its time to move on to the CAMSHAFT.
Now since I have gone through 3 cam and lifter sets I can honestly say there is no for sure combination to use .so I'm officially done with steel lifters and have moved on to schubecks composite lifters. My advice to anyone using a performance camshaft is if you want to gamble with steel lifters just make sure that you buy products from the same manufacture and follow their break in procedure, will cover that later on.
In order for any cam and lifter combination to work there has to be lifter rotation/lubrication. This is needed or the cam would contact the lifter in the same spot ever time and cam and lifter failure would be rapid. As well as the cam and lifter contact surface is lubricated from oil thrown off of the rotating crank [splash lube]. That is why on a new steel lifter set it is important to keep the revs up around 1800 rpm .this makes sure that enough oil is splashed onto the lifter contact surface while the new cam and lifter work harden themselves. Again we are at the break in thing again and that will be later. But for me I don't need to worry about cam break in this time!!!!

In order to get the lifter to rotate there is 2 things needed lifter crown and camshaft taper. Camshaft taper is measured on the nose of all the cams lobes. The nose is the highest part of the cam or the pointy end if you like. Easy to measure by setting your cam in v blocks, or better yet a lathe. I have turned one of the lobes straight up and zeroed my dial indicator on one end of the lobes nose.

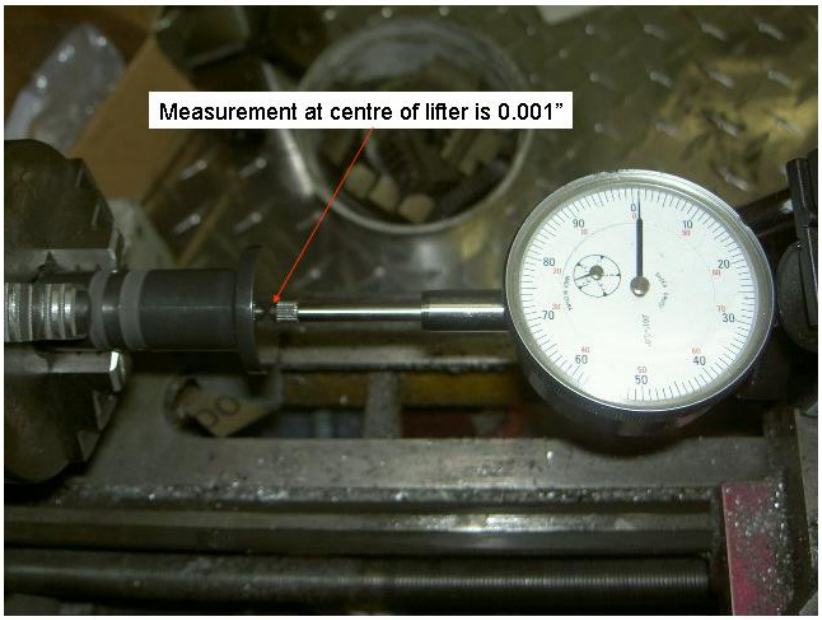


Since my dial indicator is mounted on the floating table of the lathe it easy to slide the dial indicator along the nose of the cam lobe by cranking the table back and forth.
This lobe has 0.001" taper, not bad. It should be between 0.001"-0.002" taper on all lobes .If not return your camshaft. CHECK ALL 4 LOBES !!!

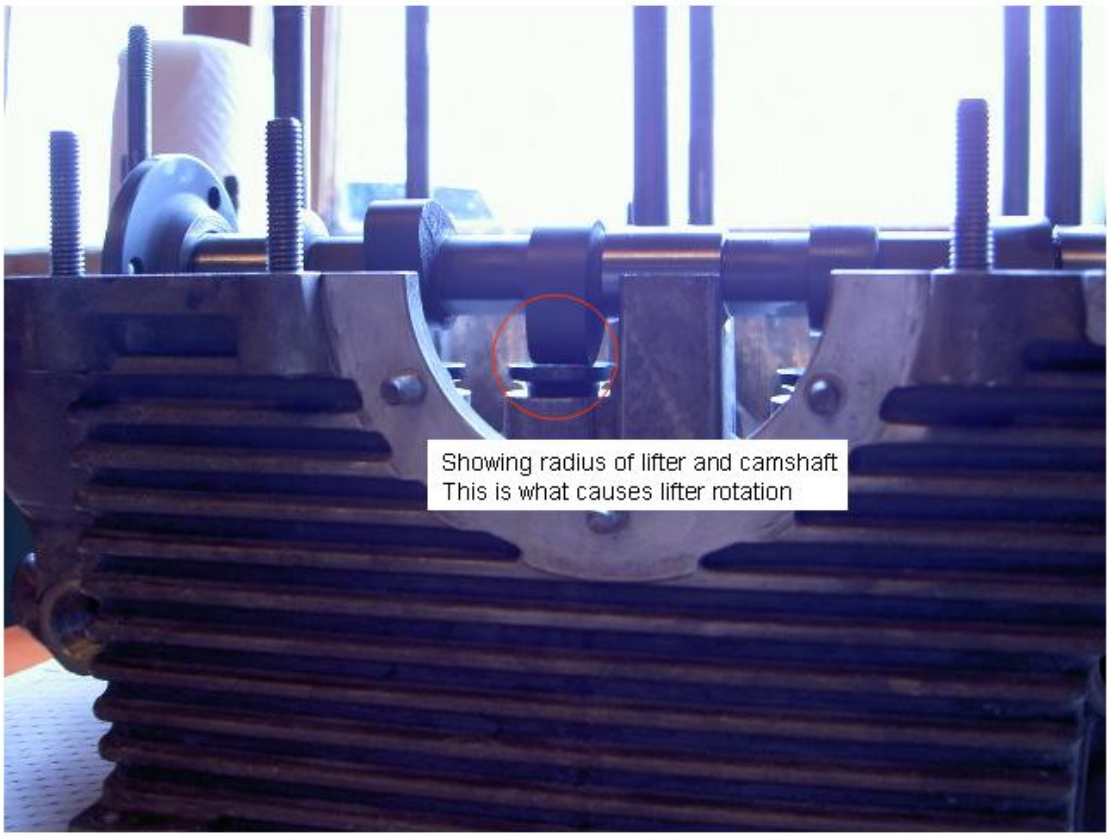


With the lifters mounted in the lathe the dial indicator is zeroed on the edge of the lifter face to start.

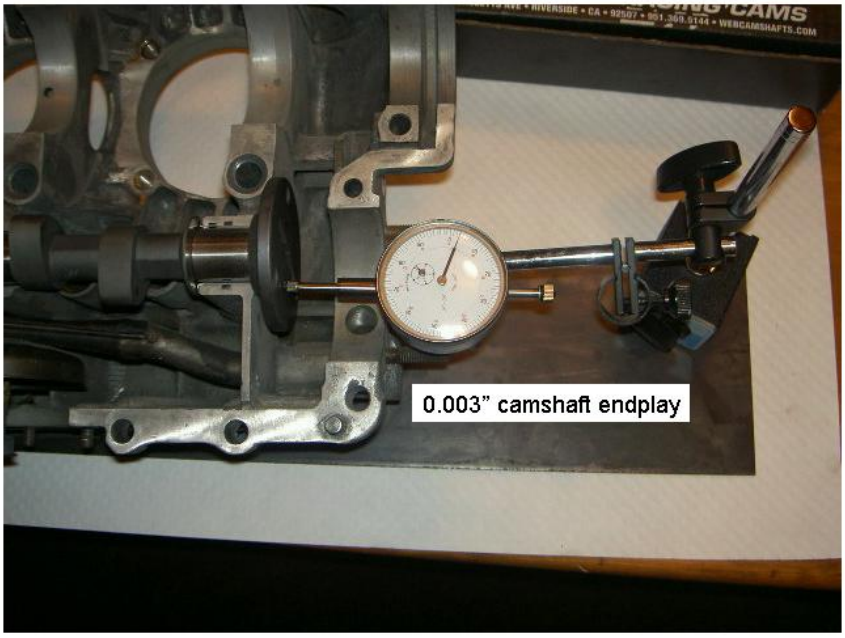
Now it’s easy because the dial indicator is mounted on the floating table you can sweep the dial indicator across the lifter face, past centre and over to the other edge of the lifter face.
This lifter has a positive crown of 0.001" I would like to see more but schubecks says it’s enough with this lifter design. Most of my other steel lifters had 0.002"-0.0025" positive crown.



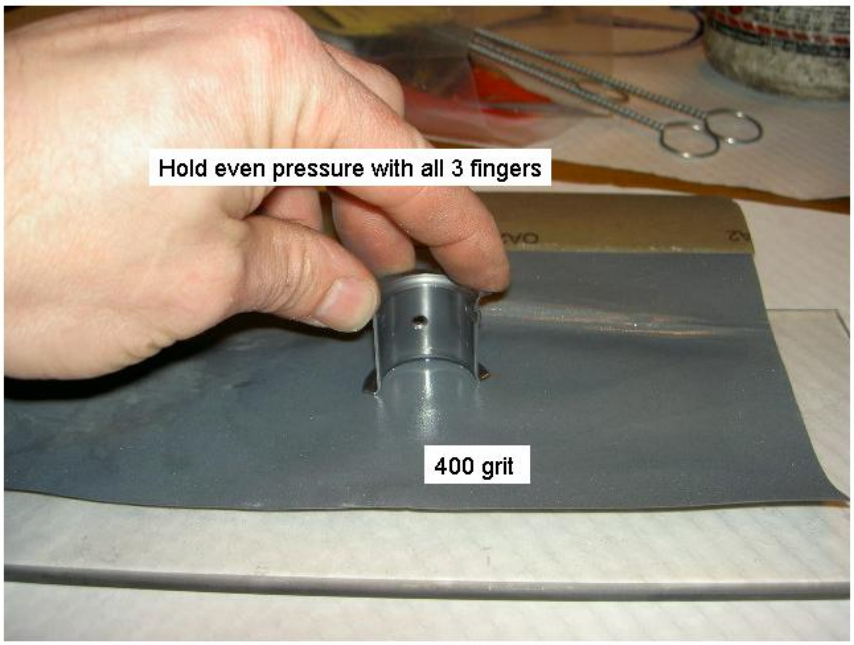
Take a look at this photo and you can see how it all works. With the combination of the cam lobe being offset to one side of the lifter centerline, plus a taper on the lifter nose plus a crown on the lifter .every time the camshafts lobe wipes across the lifter face it will make it rotate. Now you can see why motor oil with high shear resistance is so important to cam and lifter survival.



With cam bearings mounted in the case halves it’s time to set end play first. You can see I’m running 0.003" end play.

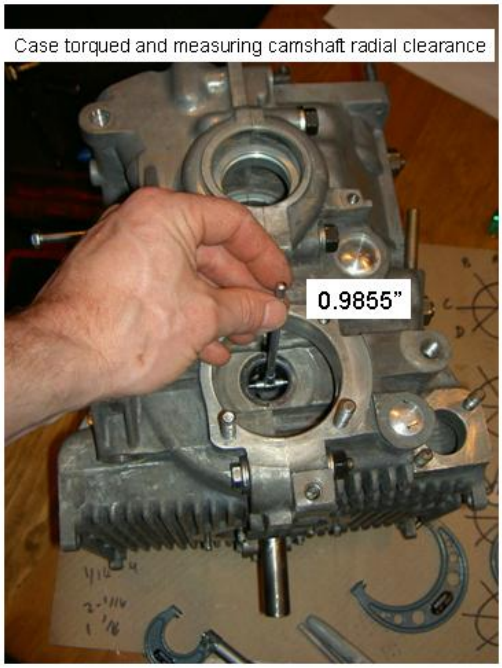


This was not the case right away .on first try the cam would hardly drop into the bearings so I had to hand clearance one of the thrust sides of the #1 thrust bearing. This is best done using a sheet of 400-600 grit emery paper on a glass surface. Put some oil on it and use even /light pressure and try 10 scrubs at a time and re-clean the bearing and test end play again. Remember there are 2 bearing halves to do so take your time and get them dead on. As well as make sure you take material off from the same sides [I always do the forward edge].it’s easy to forget which way the cam bearings fit into the case.



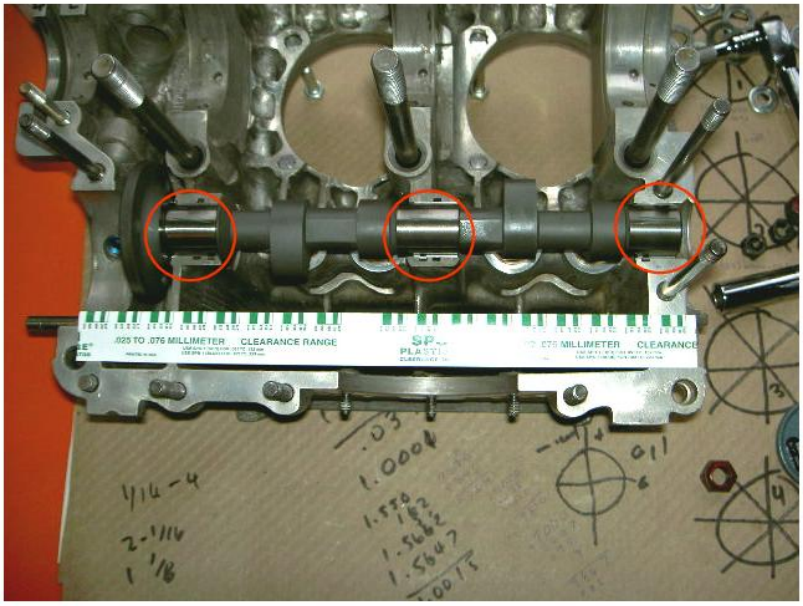
well with the end play set its time to oil the cam up and install it in the case and torque it up with the main bearings installed to aide in case alignment

Now you can reach in a cylinder bore and try to rotate the cam. Well it turned smooth but not as free as I liked so out she comes.
Re-torque the case and set the telescoping bore gauge to the camshaft dimension recorded earlier and start increasing the telescoping bore gage .0005" at a time until you get a slight drag as it rocks past centre.



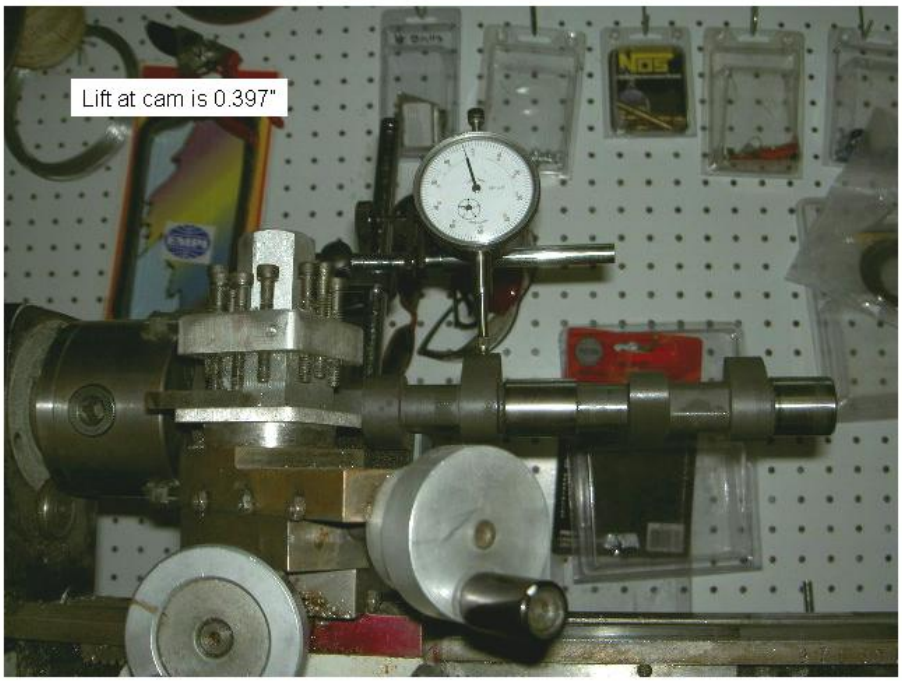
I ended up with 0.9855"so minus the cam journal measurement of 0.9846" and that gives me a radial cam clearance of 0.0009 "that’s ok for a stock motor but not a performance motor .we need more oil cushion due to the loads being put on the cam from high rpm and valve spring pressures.

Good thing to do at this point is to use plastigauge on all the cam journals to do two things. First see if you measured correctly as well as to see if it’s only one bearing tight.
Lay a piece of the plastigauge on all 3 journals

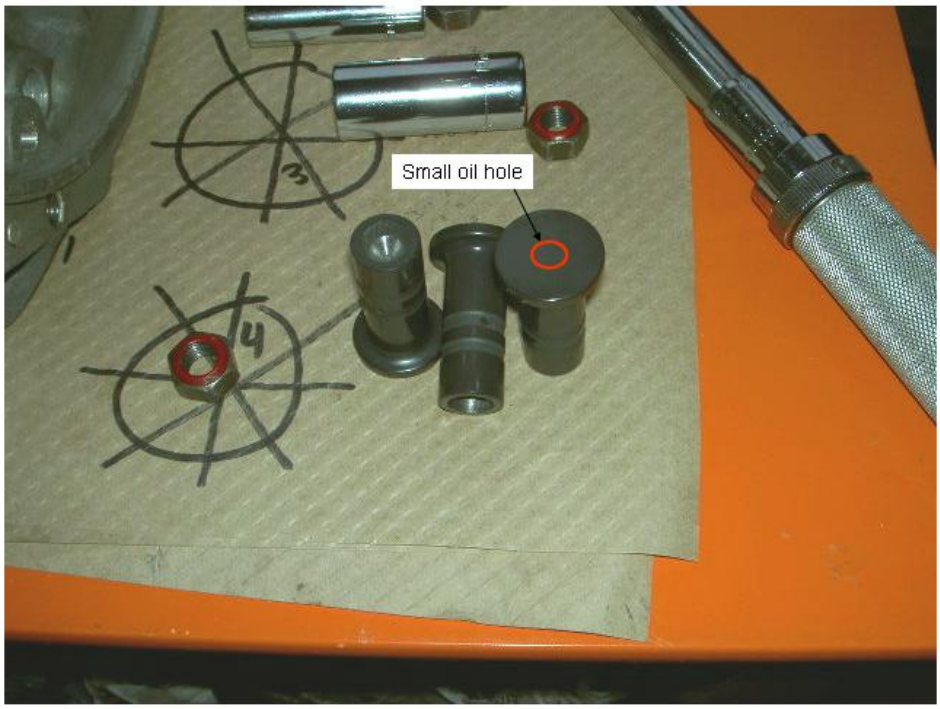


Re-torque the case and don't turn the cam. Unbolt and take a look. First you should have an even pattern on all the journals and use the paper package to check your measurements. Mine were all good and look we're pretty close at 0.001".yes plastigauge does work.
-well I wanted more radial clearance so I put the cam back into my lathe and using some lube and 3 stages of emery cloth 220-400-600 grit I took another .0009" off all 3 journals which by the way took me to the stock min dimension of 0.9837" so my new camshaft radial oil clearance is 0.0018"
remember my initial cam journal measurement of 0.9846" if you compare that in a Bentley book you will see that this camshafts journal were ground larger than the factory max of 0.9842".check all your parts!!!!!

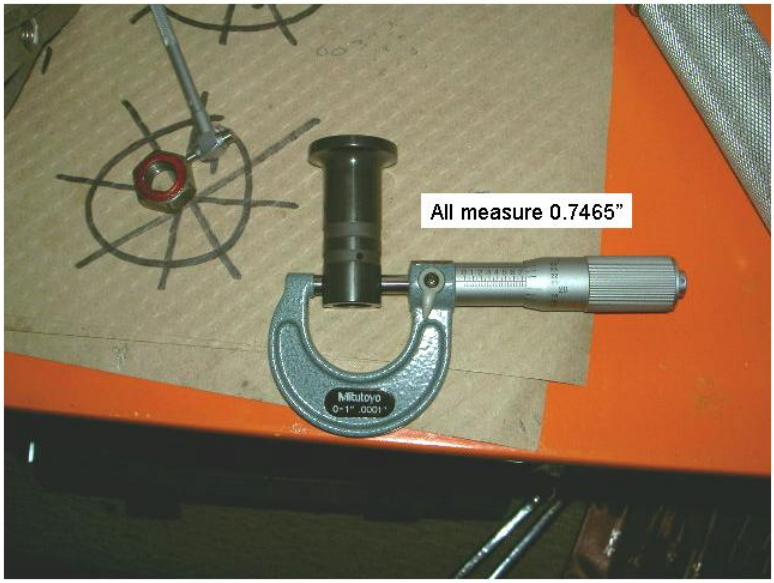
While the cam was in the lathe I checked all the lobes for lift using the dial indicator. Not bad 0.397" lift will need that for later when setting up cam timing.



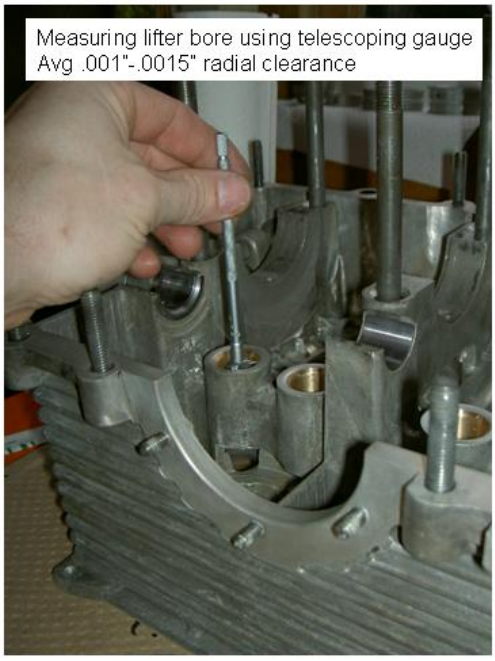
These are http://www.schubeckracing.com/ composite lifters repackaged by http://www.webcamshafts.com/ camshafts .http://www.airspeedparts.com/ now stocks these lifters. First inspection there is a small oil hole just like the http://www.scatvw.com/ lube a lifters. Just another way to keep oil on the lifter face during low rpm use/idle. So what's the big deal, weight around 51 grams/higher pushrod cup so you can use a shorter pushrod/never wear out ,swap all the cams you want and run any spring pressure!!And not worry!!



Measured all the lifters at 0.7465".

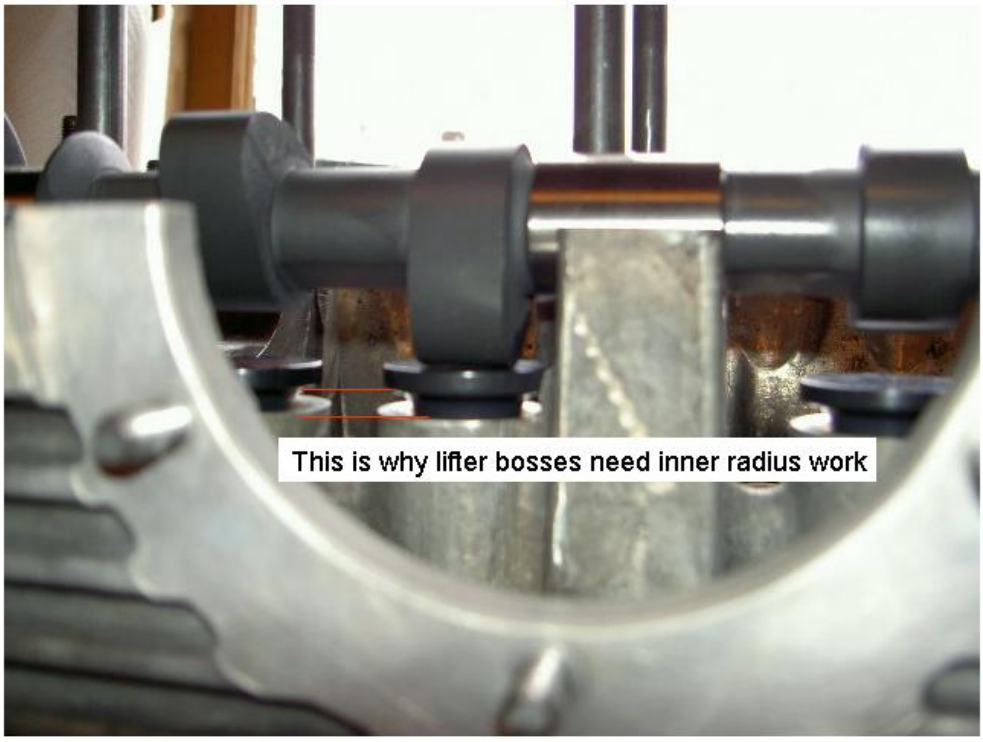


Set the telescoping bore gauge and start testing for radial clearance. I ended up with 0.001"-0.0015" radial lifter clearance

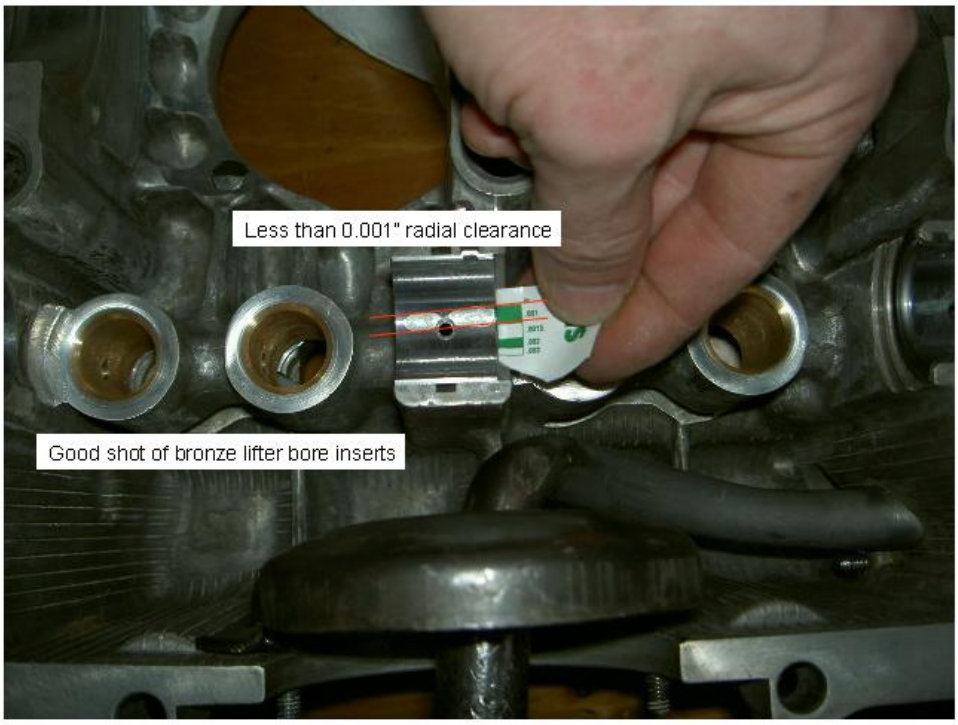


I took the same measurement off the mic and slid it up the lifter ,you can see it doesn't look like it but there is a small radius starting a fare way down which will take some attention.

Without added clearance in the case to allow for the lifter radius you can see how high the lifter sits and at this point there is no way my cam would clear .these lifters really need to drop all the way in?



So thanks to Darren k. for lending me a slick tool he made to blend in a little more radius on the lifter bores which allows the new lifter to drop all the way in. Well know one knows for sure but there is a rumor that these lifters are ok to run in an aluminum case but not in a magnesium case. Schubecks told me it was ok .but I was concerned and have taken some info I've read and decided to re-bush the lifter bore with silicon bronze.



The job was done by VALLEY VW. And even though there prices was fair the shipping was not and I even had issues with the radius at the tops and slight tapper in a few bronze sleeves at the bottom .but she's all good now. So if you are going to run these in a mag case talk to my friend ROCKY at http://www.rockyjennings.com/ in walla walla Washington he is now set up for doing single orders at any time with a price of $150.00 us .take a look at his website it's great.
-next is rods and bearings a look at full flow and case prep and its short block time.

Posted by: Cameron Dec 16 2005, 03:54 PM
Tolerance is the amount of variation permitted on dimensions, or surfaces of machine parts. The tolerance is equal to the difference between the maximum and minimum limits of any specified dimension. For example, if the maximum diameter of a shaft is 2.000 inches, and its minimum limit is 1.998 inches, the tolerance for this diameter is 0.002 inch. By determining the maximum and minimum clearances required on operating surfaces, the extent of these tolerances is established. As applied to the fitting of machine parts, the word tolerance means the amount that duplicate parts are allowed to vary in size, in connection with manufacturing operations, owing to unavoidable imperfections of workmanship. Tolerances may also be defined as the amount that duplicate parts are permitted to vary in size, in order to secure sufficient accuracy without unnecessary refinement. The terms "tolerance" and "allowance" are often used interchangeably, but according to common usage, "allowance" is a difference in dimensions prescribed in order to secure various classes of fits between different parts.

I copied that from the machinist's bible, Machinery's Handbook.

The point I am trying to make is that VW (and all other auto parts manufacturers) try to keep their tolerances tight, but because of small inaccuracies in tooling and the machinery used to run cutting tools, there are always small variations in parts. Engine builders try and work around these variations. With VW cases, these variations are usually irrelevant. VW crankcases are flexible; you proved that with your torque test. Usually things can be out a couple of thousandths, and when you torque it up, everything comes into alignment. You can put a crankshaft between centers, push on it with your hand, and deflect it by 0.005. Once you start running 200HP through your case, things are moving all over the place anyways. Because of huge horsepower, and shock loads, the engine case and crankshaft are deflecting 0.010 to 0.015 inches. Probably more than that with really serious horsepower. I'm constantly amazed on how much horsepower we can run through these things!

With all the measurements made on your case, you have shown that most of it was within tolerance. You have not measured the main bearing line to see if it is straight, or on centre. Or from the centre line to the cylinder deck.

You are measuring your camshaft and lifters in a three jaw chuck. These chucks are notoriously not accurate, for being on centre. When you buy a three jaw chuck, the manufacturer supplies a card telling you what the run out will be, check yours. You should measure your camshaft in the case, on vee blocks, on rollers, or best, between lathe centers, because

that was the way it was made. The way you are demonstrating is a very inaccurate way of measuring a camshaft.

These comments were meant as constructive criticism, and not meant in a mean spirited way. I appreciate what you are trying to accomplish, but I wonder about your methods.

-Cameron I welcome all input and am glad to see you have taken the time to look at things closely.
-as well if anyone has specific knowledge relating to something I'm talking about, please take the time to post the information for all to read and benefit from.

---With all the measurements made on your case, you have shown that most of it was within tolerance. You have not measured the main bearing line to see if it is straight, or on centre. Or from the centre line to the cylinder deck. ----
-I have measured the engine case main bore to see if it's straight using the feeler gauge under the straight edge/felt pen on the main bearings and spin test methods as well as torqued it up and ran the straight edge along both parting seams ,these ways are very crude but are not bad for a quick check, also before rocky bored my #1 main I had him re-inspect the main bore and I believe he dropped a machined bar down the bolted case to check for alignment also have one other check for this but will bring it up later as it's a so-so deal but effective.
I did not add these photo's as they turned out very poor as you can imagine trying to hold a camera in one hand and perform a measuring task is not easy.
I will try to add these photos when I finish the case clearance/cleaning/oil galley/bearing pre fit information.
-Cameron if you have a good method of measuring/checking the main bore alignment please post it as it is one of the most difficult things to measure. And I'd love to know it.
- I know some tasks are out of logical order, but my main goal was to deal with the bent crank/seizing #1 bearing deal first. Yes I agree the main bore alignment should of being covered with the main bore measuring photos .but it just didn't happen. But you are right it needs to be covered.

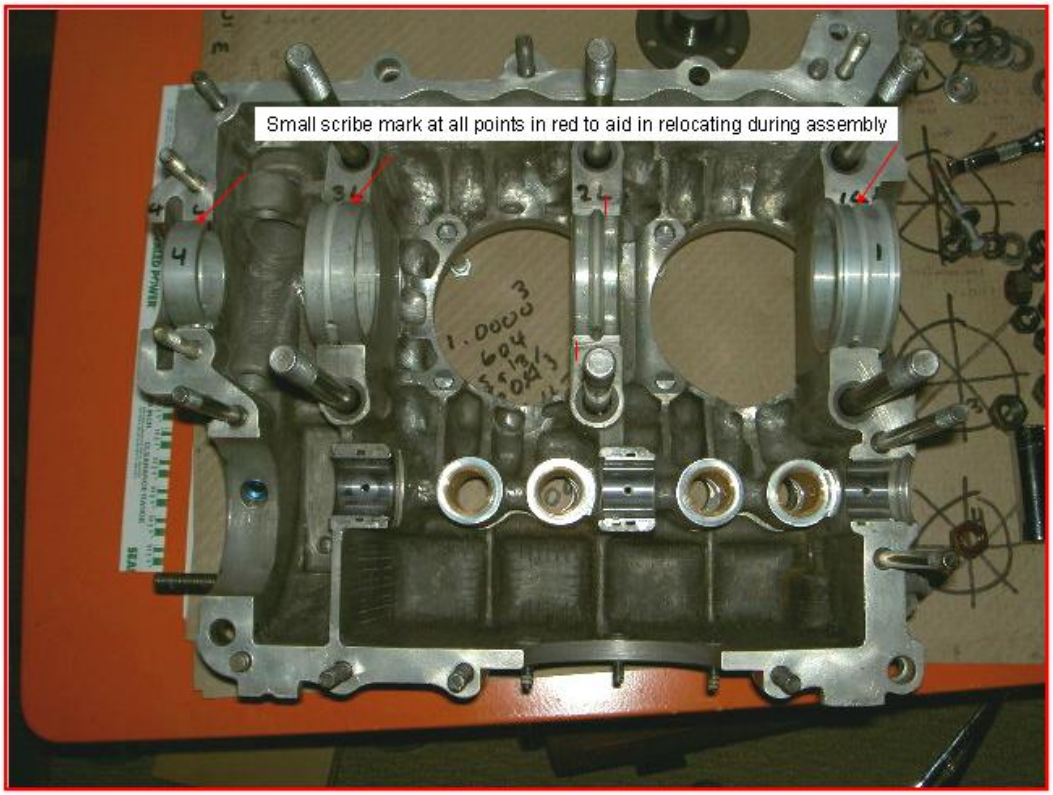
-crank centerline to cylinder deck will come soon I have to finish resizing my rod bearings first, this was originally done and yes my case was out .015" on the #3/4 side.

-with the camshaft photo's showing lobe taper and resizing etc ,I had already finished resizing the 3 camshaft main journals and taking all the measurements. And originally was planning to take photos as I went along but did not want to grab my camera with my dirty oily hands so I figured I would take them at the end. Unfortunately I removed my cam and cleaned it then realized I forgot to take the photo's .so I quickly clamped it in the chuck and took the needed photos. So yes work was performed using a live centre to support the camshaft at the one end as well as I used a dial indicator to make sure it was running true before work was performed.
-as for the lifters I lightly clamped them in the chuck with the dial indicator riding on the outer edge of the lifter face I slowly rotated the lathe chuck by hand and watched the needle on the dial indicator .making sure all the lifters were all centered first before any measurement were taken.
-I now realize that someone my look closely at the photos and attempt modifications using the photo's as a reference, this could be potentially dangerous or give bad results so I will make updates when time permits and show proper photos of the cam in the lathe using the live centre for support and accuracy.i'm sure you can imagine that taking some of these photos is not easy and they will need to be set up and taken after the actual task is done, but I hope the end result of what to look for is demonstrated.
- As far as my methods, I believe my measuring methods are in good practice but my photo's need to reflect a more accurate representation of the event. I'm glad Cameron has pointed it out.
If anyone else see's something that needs clarification, please bring it up as I would like to keep the information I'm providing as accurate as possible.
-there is a few reason's I wanted to start this topic and one of them is to make people realize that you are dealing with 99% aftermarket parts when building a performance motor and what oem parts there are, are usually modified and care must be taken upon assembly. As most manufactures build parts to their specs and not vw's specs. But it can be done.

Well it's been awhile and my short block is together, so let's see if I can get us up to date this week. We left off with the cam now being able to spin freely in a fully torqued up case. So with all the crank/main bearing measurements finished, this points to a smooth rotating operation as well, but let's make sure.
what we are doing here is a final check for crankshaft endplay /bearings and rotating assembly
with the left case half exposed and all the bearing locator dowels in place, install THE BEARING YOU MEASURED ,NOT A NEW SET!!!.There is a reason. Great example -since my #2 main split set was marked up from all my measuring I decided to use another #2 split set from the same manufacture and just replace them, yes I did not measure them and I should have because with my crank in and the case torqued I noticed there was a initial effort needed to start the rotation then it was smooth. After I had measured my end play and took the case apart I noticed that there was a shinning surface on the outer edges of my new replacement split bearing set. So I bolted the case together and torqued it up. Using my calibrated bore gauge a noticed this set of bearings measured only .001-.0015"radial oil clearance, too tight. Man good thing I double checked. So remember you spent all the time measuring with one bearing set, so use them!!!!

if you have never installed a crank and bearing assembly it can be a little difficult to get the whole assemble to locate smoothly at times on the dowel pins
-first install your #2 split bearings and bolt the case together lightly, note how both bearing halves line up ,you will probably need to slide either of the bearings one way or another to get both ends to match use a long plastic rod through the #1 bore to tap either bearing to get both to line up.

Now that the #2 bearing are aligned, take the case apart and install all the other bearings. Lightly scribe the location of all the bearings in relation to the case half.



--I'm sorry my pictures of installing the #3 bearing and heating the gears and installing them are un-viewable , I will try to do it again later on a old crank and post some photo's soon----------

take a look at how this split bearing is blocking half of the oil supply hole in the case, will need to fix this.

Let's measure the location of the #1 oil groove in the bearing in relationship to the oil supply hole in the case. First take your calipers and measure from the oil hole to the back part of the bearing web. And lock the calipers.

Take the calipers and compare it on your bearing. No problem here its dead on the rear part of the oil groove in the bearing and the rear part of the oil supply hole are a dead match!

Measure from the front part of the oil supply hole to the front edge of the bearing web and lock caliper. When the measurement is compared to the groove on the bearing you can see 2 things, first half of the oil supply hole in the case is covered as well if I lathed the bearing oil groove forward it would cut into the dowel pin hole. It was recommended to me to lathe the groove forward but, it was decided to only enlarge the bearing groove only at the point where it relates to the case oil supply hole.

Marked out what I wanted to do and used a small round file on the #2 bearing, remember its steel backed so it's hard to file.
the #1 bearing was a bit more work but by trying a few things what worked best was a small bit in the dremel followed by a small sanding disc in the dremel to smooth it out. It turned out great even though the picture is a bit unclear and rough looking.
Note the #3 bearing also received the same treatment as the #1 bearing. And the #4 was good to go

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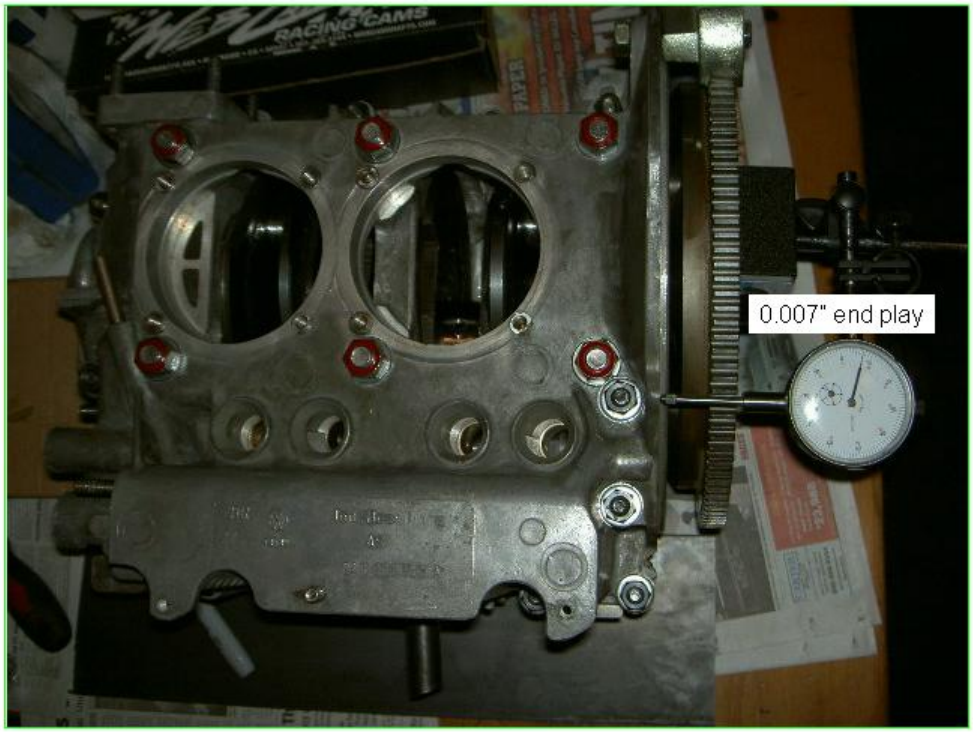
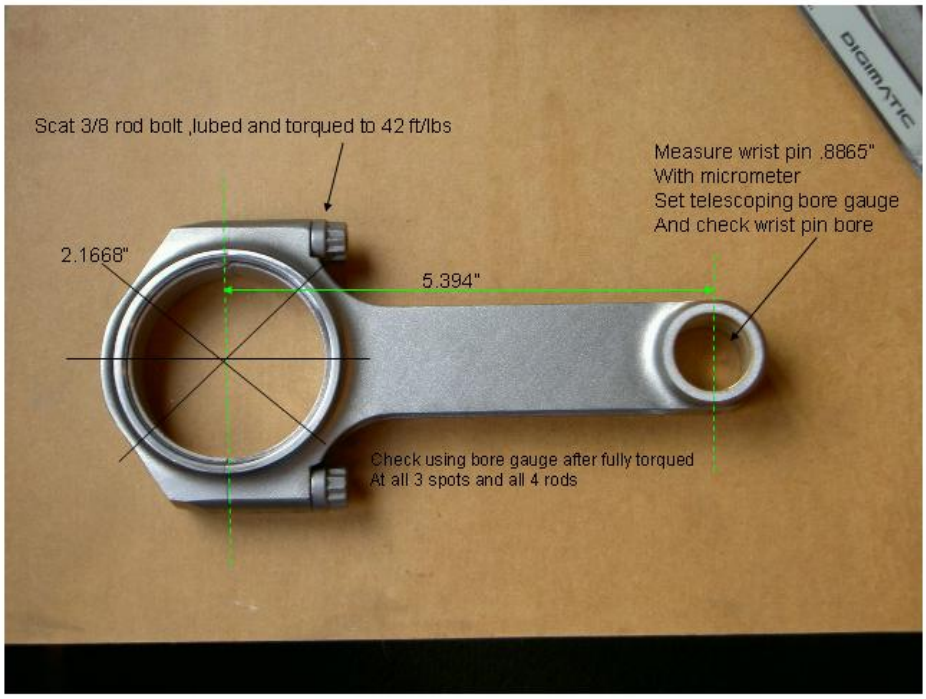
Well now that we know we got the correct radial clearance and the bearings are going to get full oil pressure let's try the assembly in the case. Install the crank assembly with all the bearings and torque up the case.
Since you are using a wedge mated crank/flywheel special care is needed to avoid damaging the wedge mated surface. Use one dowel pin in the crank shaft end to aid in alignment of the crank and flywheel also pay attention to the position of the flywheel and the crank ,there should be some reference marks to get them together in the correct position and oil up the threads on the glad nut .I use a flywheel lock tool which I'm sure http://www.airspeedparts.com/catalog/index.php?cPath=29_33&osCsid=44dbf4b20282fca4d7ac2cba2358d8fe carries them, and slowly tighten the gland nut up, I'm using a 2 foot long breaker bar on my 36mm socket. You could torque it to 50 lbs but trust me you will know when your flywheel is fully set against the end of the crank. Leave the flywheel lock in place and set the magnetic base of your dial indicator onto the flywheel. Set the needle against the case and zero the dial. Now all you have to do is grab the flywheel and gently move it back and forth and note your endplay on your dial indicator .well my calculate shim pack actually worked out!! I can't believe it!!I got damn near .007", may tighten it up a hair.
When you get a wedge mated crank from http://www.demellocranks.com it comes with the endplay marked on it, mine said that the endplay was .040" so if I took my shims of .0345" we get .0055".so there is a slight difference, that's why you have to check. But not bad

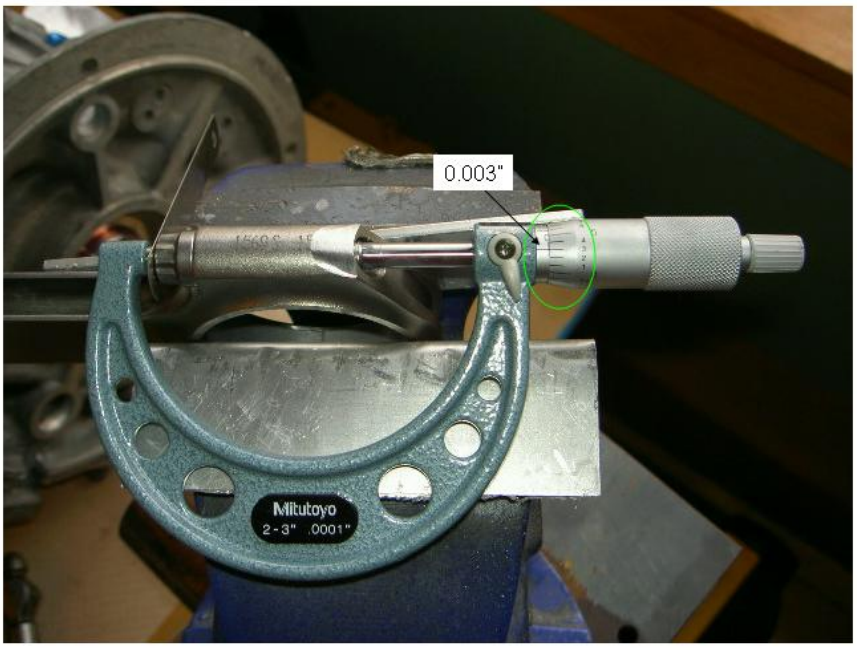


I did install the cam and crank with the oil pump and torqued it all up again one last time and again both the cam and crank spin beautifully with zero binding and no initial effort to overcome before rotating as before with the other split bearing. So next is hanging some rod's and last check/clean of the case.
This is a shot showing one of the SCAT h beam connecting rods I'm using. These are high quality pieces and there price makes them even more attractive when building a performance motor. Once again I have tried to do my best to take more accurate photos, but it's not always possible. Let's check the rods and bearings.
the length is 5.394 " which is determined by measuring from the centre points of the wrist pin bore and the rod bearing bore, the bore gauge is used to measure the radial oil clearance of the connecting rod bearing after it is fully torqued up and the telescoping bore gauge is used to measure the wrist pin bore.



The rod bearings I'm using are CLEVITE 77 ROD BEARINGS these are a high quality bearing that are made to take the shock loads in high performance/race engines. These bearings are standard vw rod journal size and were purchased locally at HIGH PERFORMANCE ENGINES IN BURNABY. Next time I will also use their main bearing set which I believe can be ordered with extra .001 " oil clearance!!
You need to apply special supplied grease on 2 spots of the rod bolts; the reason is to reduce friction when torquing the rods, that way a more accurate reading is given.

you have probably heard of so much discussion on rod bolt stretch ,since I don't have a actual arp rod bolt stretch gauge ,and for that matter have never used one I will show you another way to check your bolts. First you need to know that once something is tight any time you go past that point you are applying torque to the fastener, which in the end causes it to stretch. Don't stretch it enough and it could loosen or if you over stretch it, it may snap. If I remember for these bolts when torqued they should have around .005-.006 inches of stretch. In fact I tested all mine and found one that stretched .008 so I have replaced the set.
rod bolts are very important .they are the only link keeping your connecting rods together during high rpm .you can imagine at times that the upper portion of the rod will try to separate from the lower section do to inertial and load. That is why these bolts are extremely strong and have such huge tensile strength, around 190,000-200,000 psi. So accurate measurements are needed for reliable operation.
Each rod was assembled with a main bearing set installed .with the bolts lubed up both bolts were snugged hand tight and measured. A point was taken on the micrometer scale and noted. In this case it ended up lining up at .003"



with the rod now supported in a pair of soft jaws in my vise its ready to torque up. This is very important as it will protect the rod and allow a secure way to hold when torquing.

Torqued to 42 ft/lbs

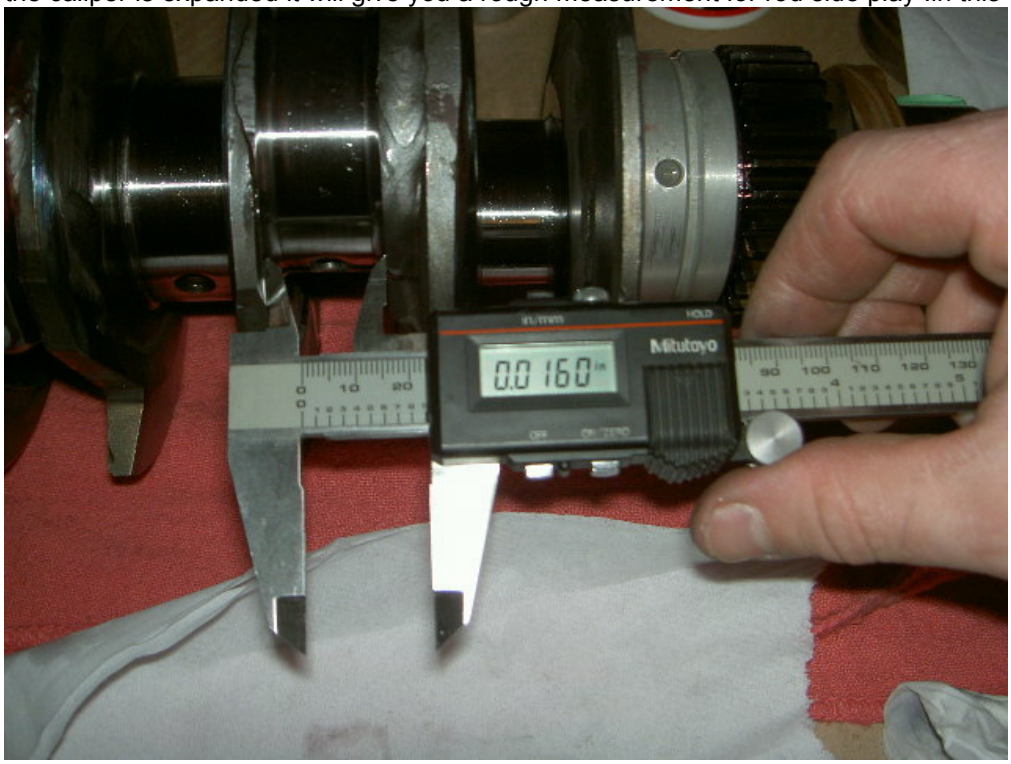
once the rod is torqued again it was mounted sideways in the vise and the bolts re-measured .in this case I have now .008" .so .008"-.003"=.005" stretch at 42 ft/lbs=ok!!

Now I now this isn't the best way, but hey if you use your head there are always more ways to do things. The reason there is a thick feeler gauge on one end is just to give a level platform for the micrometer to sit against. Notice the spot where I had clearanced the rods to clear my case.
since its all torqued I set my bore gauge to my measurement from my spec sheet of the cranks rod journal diameter of 2.1647"and measured the radial oil clearance of my rod bearings .good at just over .002",again next time I would have this measurement first and have my crank ground to allow .003" radial clearance

When ALL THE RODS BOLTS ARE CHECKED AND ALL THE RADIAL CLEARANCES CHEKED ON ALL 4 all parts were disassembled.

There are a few more steps to go before those rods get bolted onto the crank, here we go. Remember all parts will stay in the exact spot and should never get mixed up during this process.
rod caps measured at 0.8925"

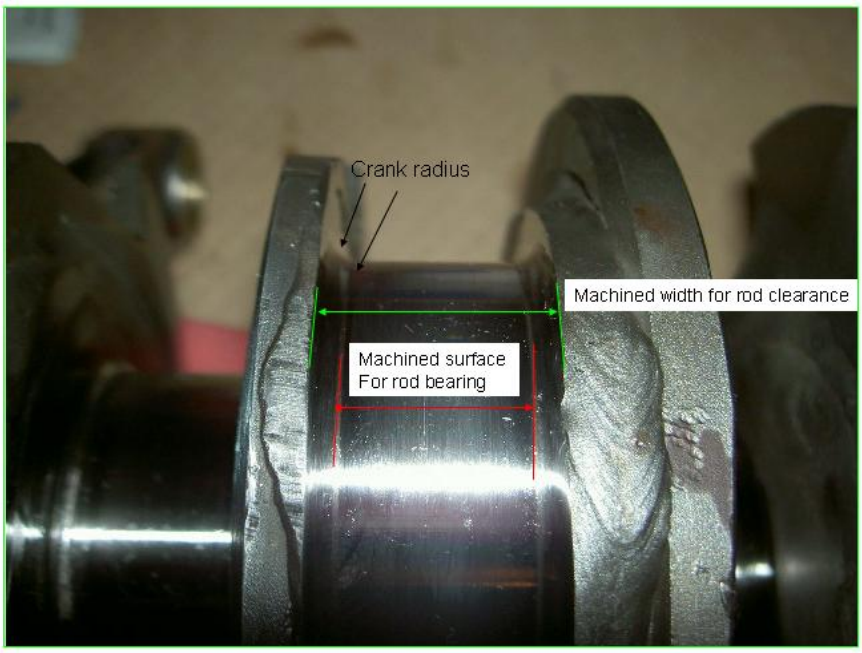
After the measurement of the rod cap is taken I zero the caliper and transfer it between the cranks rod journal width, when the caliper is expanded it will give you a rough measurement for rod side play .in this case 0.016"



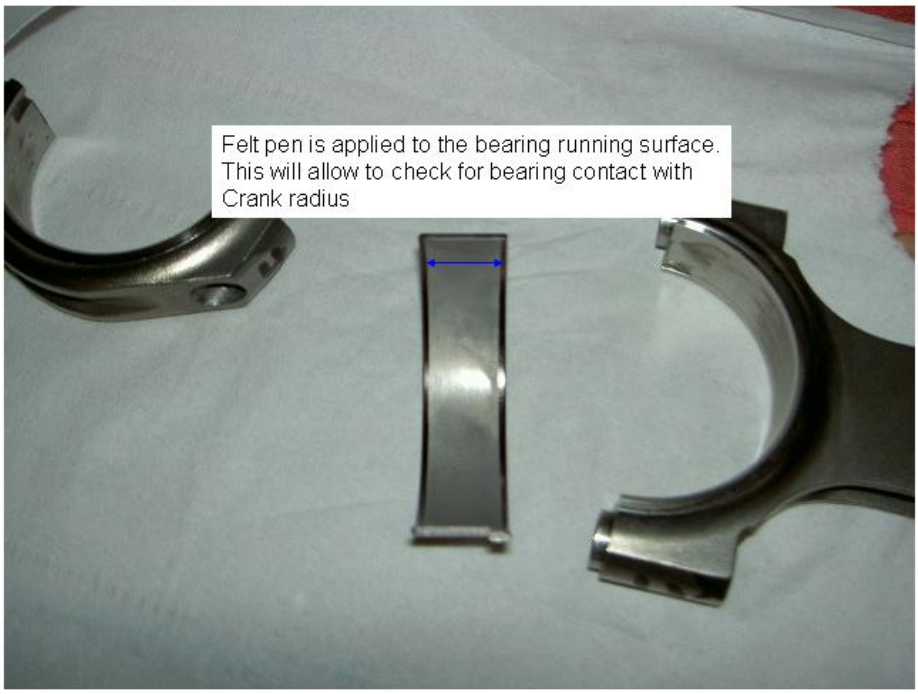
Measure rod bearings 0.6890"

Caliper measurement of rod bearing width is compared to ground surface on crank. Note it's pretty much the same so the bearings will need to be modified and rechecked.

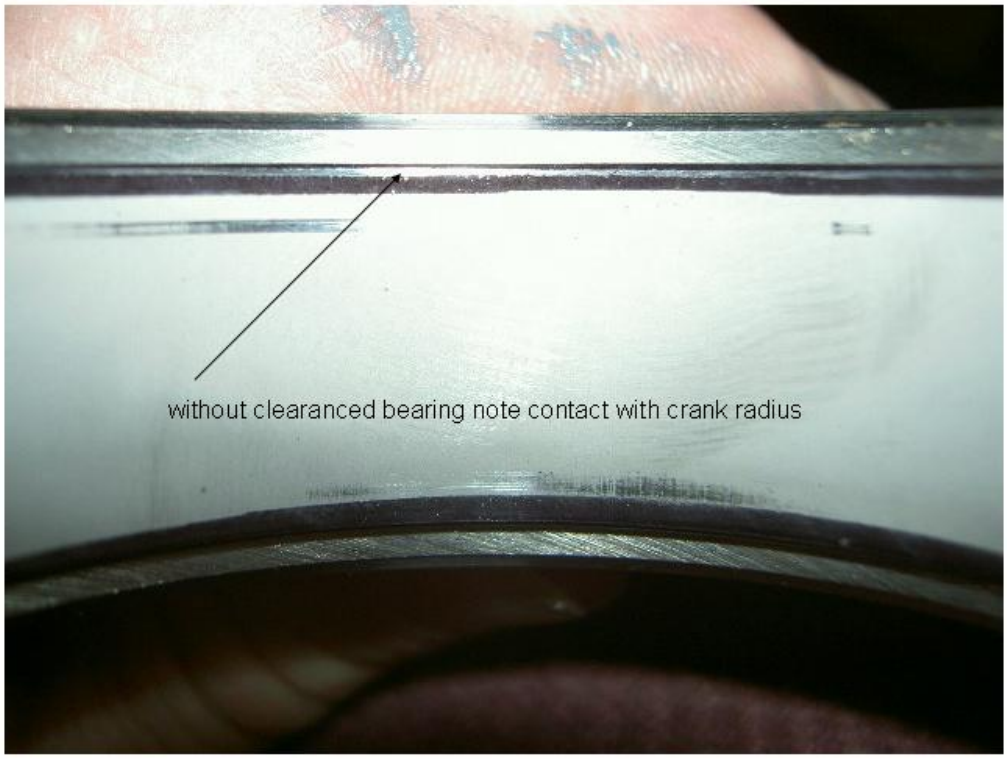
You can see in this photo a better shot of the ground bearing surface width as well as the radius from the ground surface to the cranks webs. It is this radius that gives the crank its strength against bending but is also causes a point for bearing contact.
One more time, a better photo showing radius/machined surface for bearing and machine width for rod side clearance.



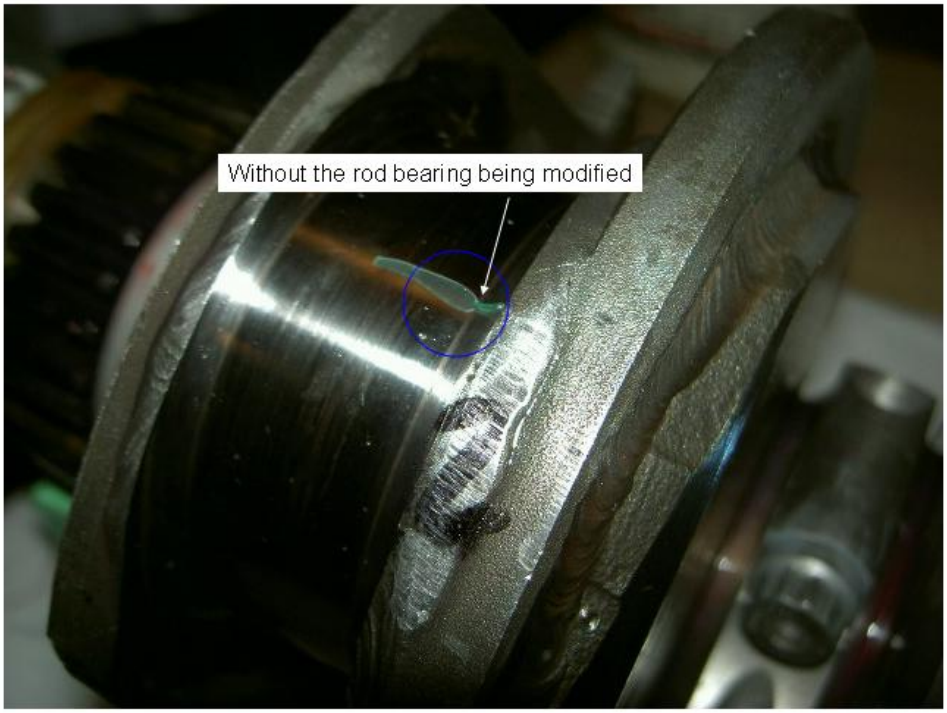
Since I know I have radial clearance and rod side clearance it's time to closer check the bearings for contact with the crank radius. I apply felt pen to the top of each bearing sides, when the felt dries a light film of oil is applied to the bearings and the rod is assembled on the crank and torqued up to specs.



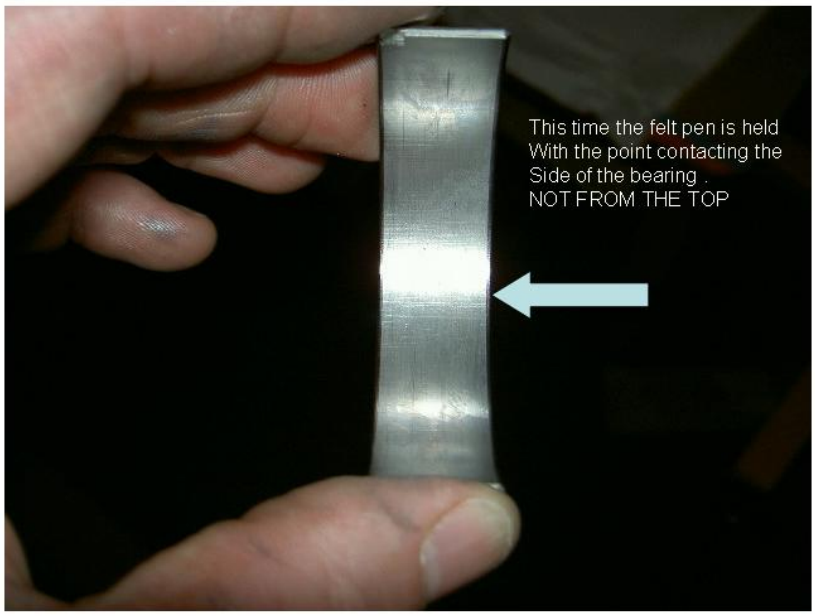
With the rod pushed against one side of the crank then the other side and rotated a bit back and forth .once disassembled it can be inspected for contact. In this case you can see that the outer edge of the bearings do in fact touch the crank radius.



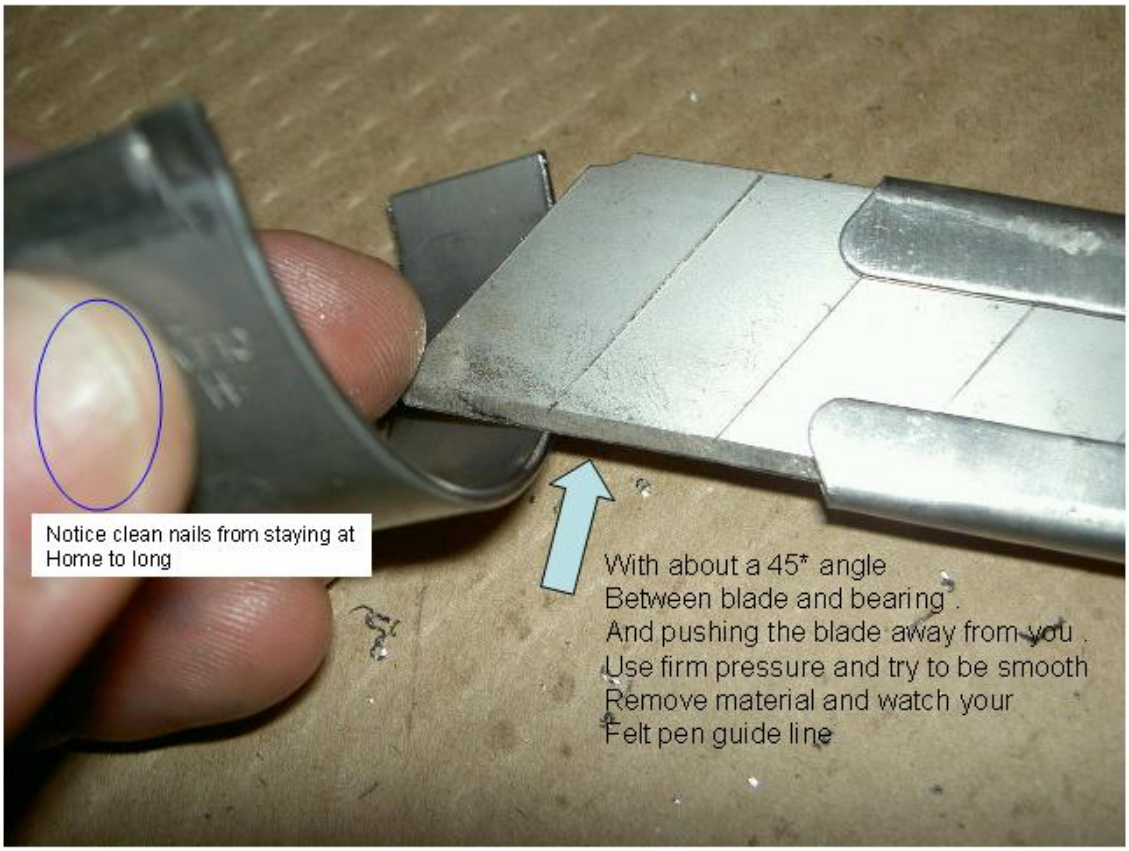
a different way to check is also to apply a small piece of plastiguage on the crank covering into the radius and with the large part of the connecting rod with one bearing shell installed in its place it into the d=crank full against one side and push down squarely into the crank. Notice the bearing edge contact point is at the very edge of the ground bearing surface. Again just another way to double check for rod bearing contact.



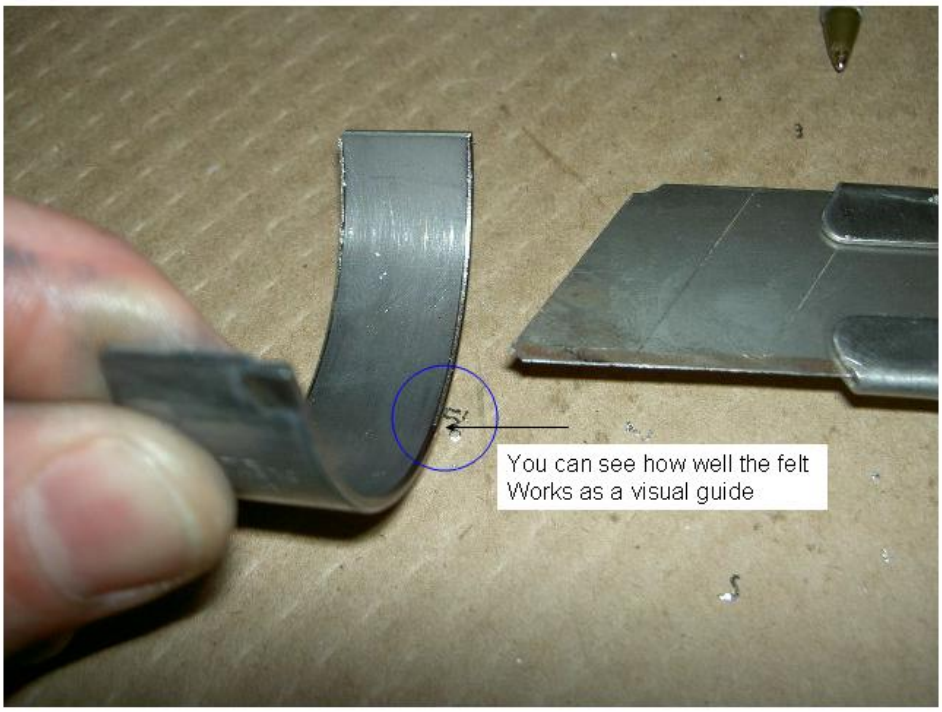
Now this time felt pen is applied to the sides of the bearings, this will act as a visual guide.



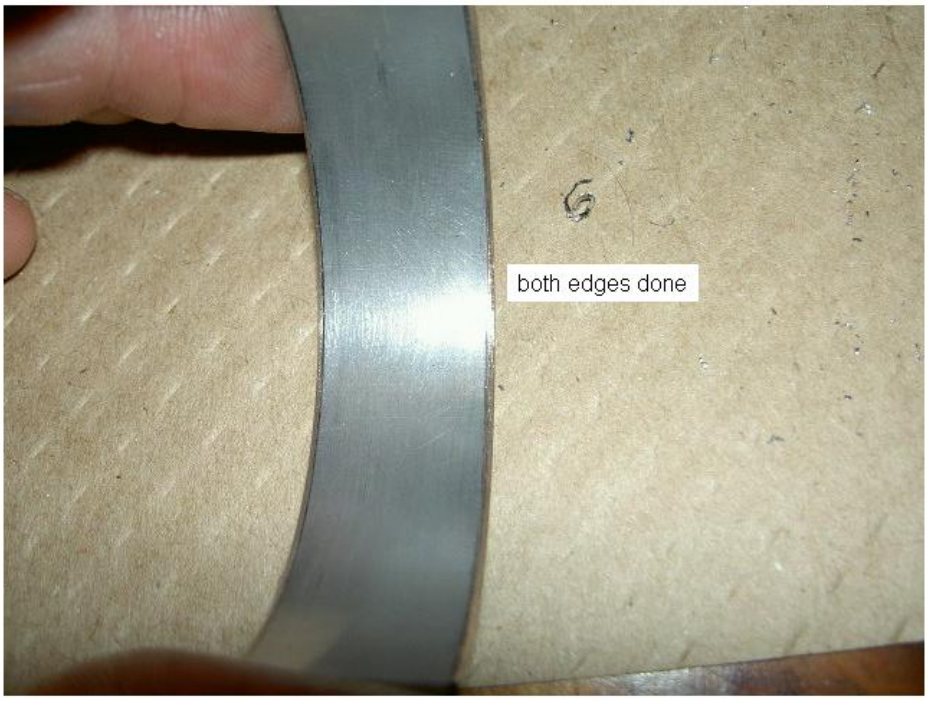
This is how I modified my bearings using an olfa knife. You can see I hold it at about a 45 deg angle and push the knife away from me. You need to practice on an old bearing to get this technique down first.



Now you can see why the felt is needed it really helps keep things true

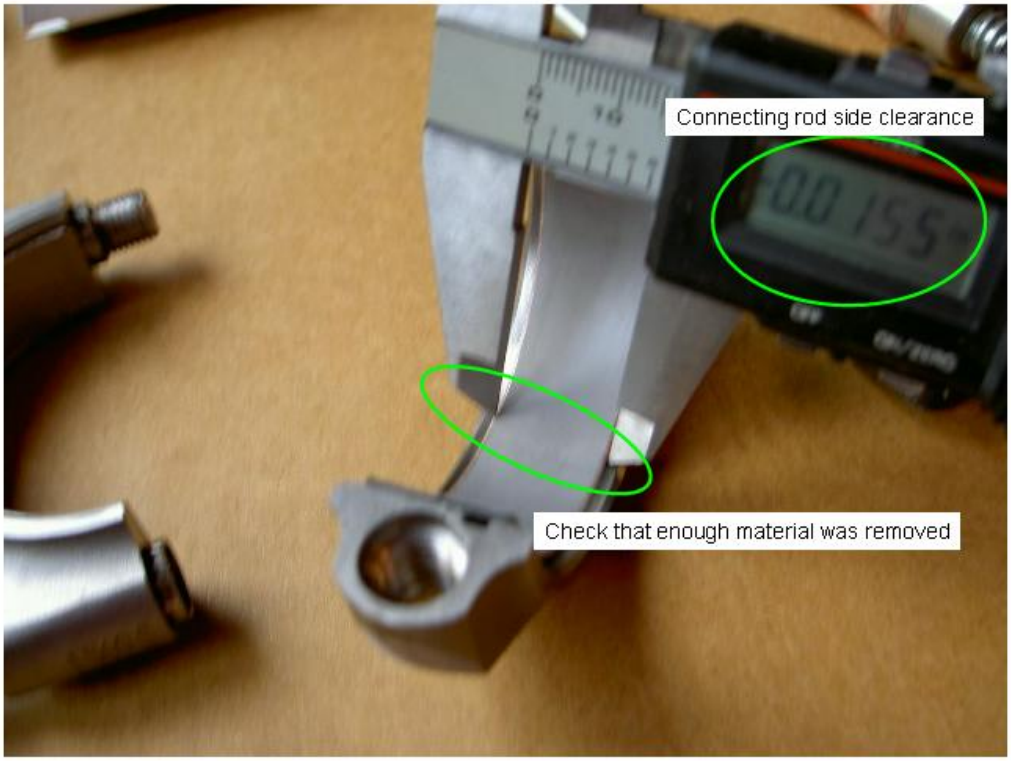


Both edges done

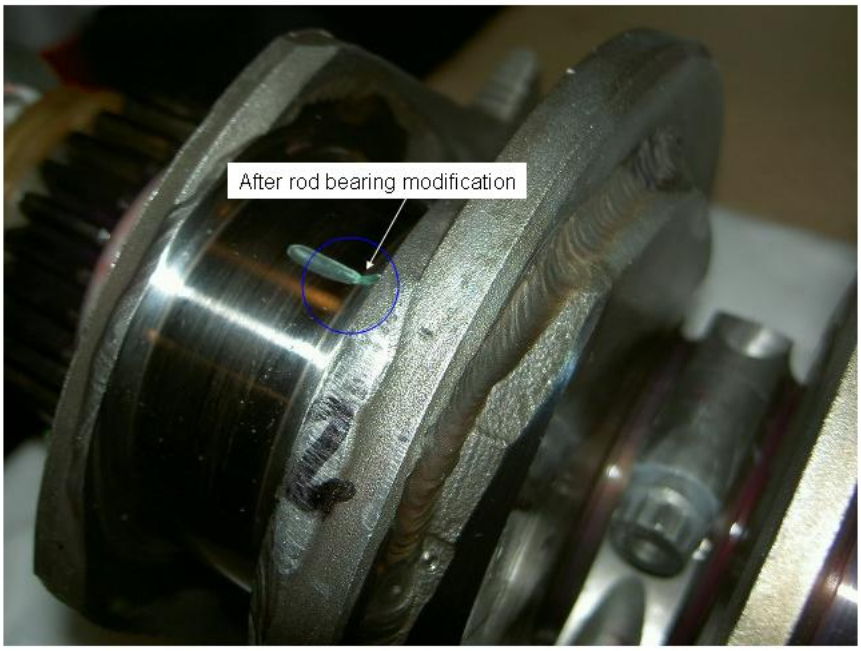


Holding the 600 grit emery paper at a 45 deg angle the cut edges are lightly sanded to make sure there are no sharp edges, then using brake clean the bearing is fully cleaned

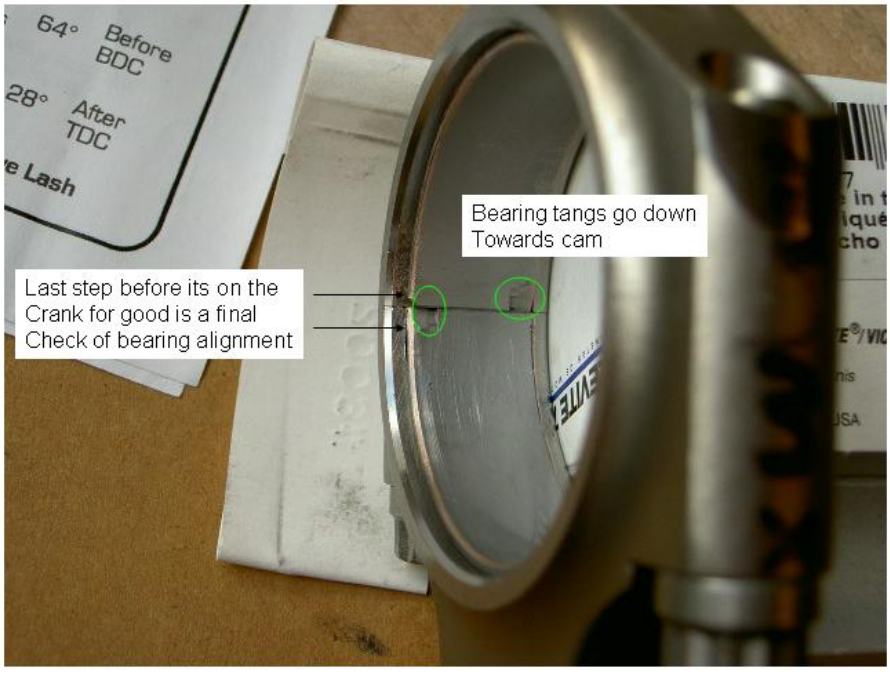
With the cleaned bearing back in the connecting rod cap the caliper is set to the bearing width of 0.8925" minus .015" for side clearance and the bearing is checked to make sure it is narrowed enough on both sides.



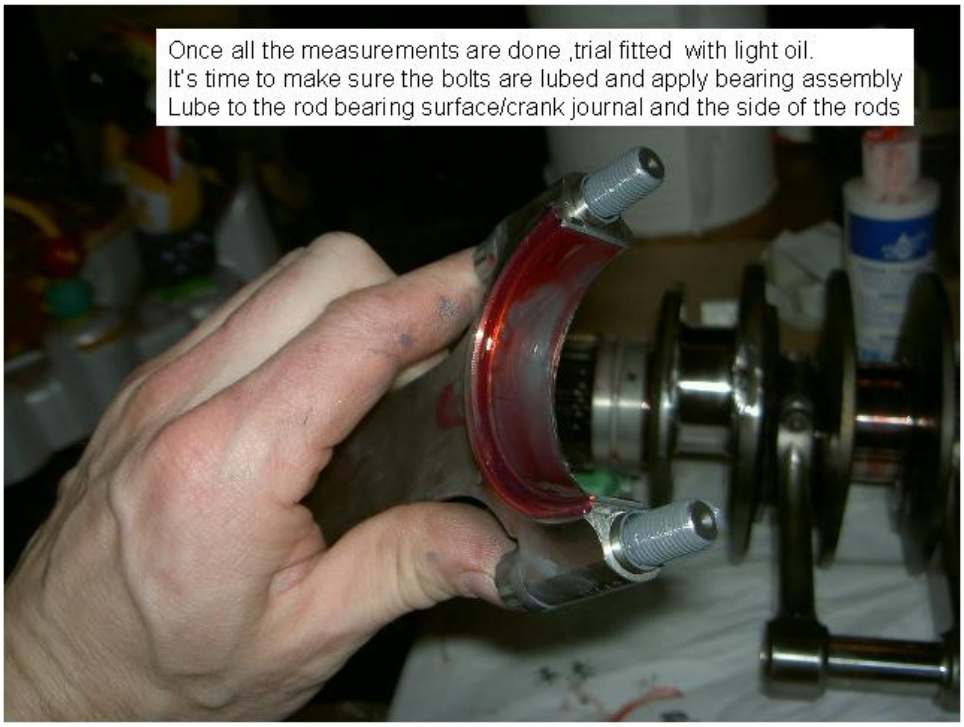
Now using the same plastiguage method as before you can see the added clearance. Now only 7 more bearing shells to go



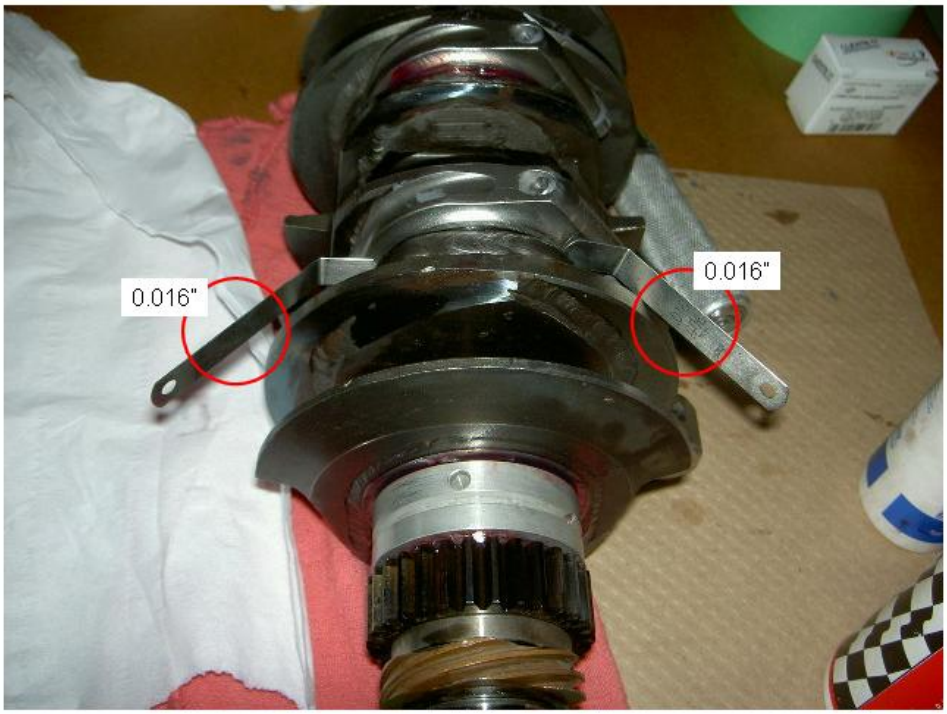
Now before the rods bolt up I always do one last trial fit and double make sure the bearing ends align, remember they can be moved to line up and it's very important to check, also note the bearing tangs should locate down towards the cam. This is done for the reason of allowing more oil spill off to go directly back onto the cam and to the oil pan instead of onto the case roof.



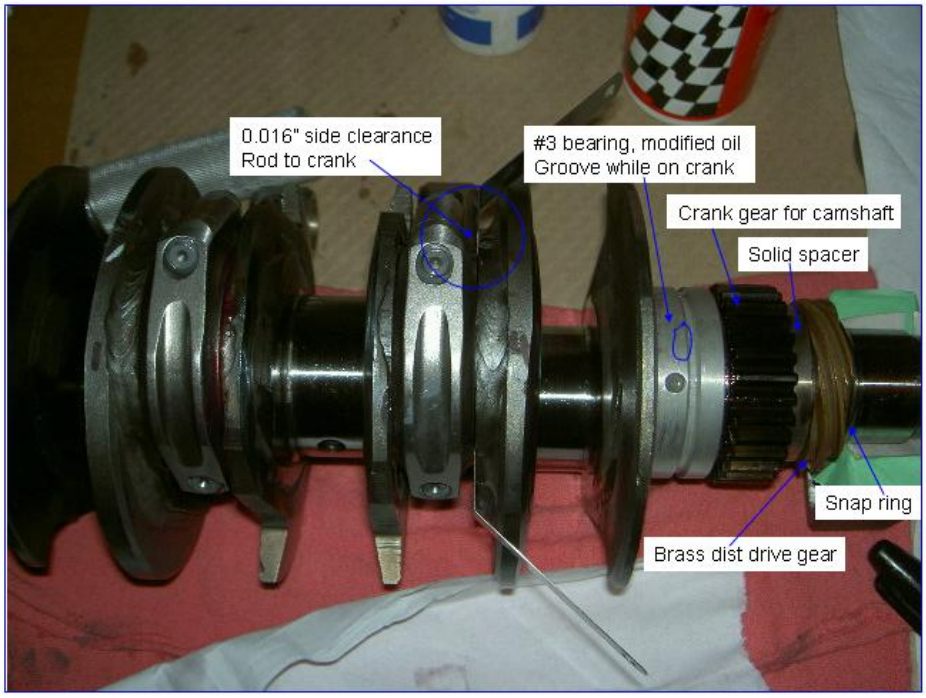
ahh my fingers!!!!Nope just kidding, since everything is good now and everything is triple checked a good dose of assembly lube is used on the bearing surfaces and the rod sides. Now this rod is going to be used for checking TDC/DECK HEIGHT /AND CASE CENTRE LINE. All other rods were installed and checked for side clearance and wrapped up waiting for final assembly.



As noted all rods had their side clearance checked this is done by having the rod fully torqued up on the crank and pushed to one side. I like to use 2 feeler gauges in order to make sure it is contacting evenly.
This case this rode has 0.016" side clearance.



I set this photo up so you can actually see the rod side clearance as well as the way the #3 bearing sits[modified later for oil groove on the crank, very difficult]
the order in which it goes is #bearing/cam gear/solid spacer/brass dist gear/snap ring.
Will try to get a picture of the #3bearing and end gear assembly from another motor when I get a chance as well as all lubes used.



Jim

that is some awesome detail on build technique, etc.
If you haven't already, you should whip up a web page with that info.
I put a lot of stuff on my page, but nothing with that much detail.
Keep up the great work
MM

Thanks mike and all others for the positive input !!!!!!!!!!
Hmmm a web site, yes it is almost done!!!!!!!! That is a very good idea .will either uploads it on there as well or link from it to here.

I'm pleased to see that so many find the information helpful and I hope it answers many questions you may of had or never understood, and I tried to make it easy to follow along no matter what engine building level you are at. And I must admit it's been awhile since I had looked at this post and it was great re reading it again.

The reason for the thread stopping was due to a sudden loss of all extra time I had, 2 young kids and one a newborn, starting a side venture, work, and the testing of new nitrous products filled all the time very quickly.
I have close to 150 images with about 20% of them edited. They pick up where I left off and end up with the instillation and tuning a special nitrous system.
I must admit after Bruce gave me the heads up today I did in fact pull out the disc with all the new images and text and have started putting some order to them, as well I'm sure you can all relate to the amount of time it takes to edit and add text to the photo's as well .so I promise I will make a effort in 2007 to pick up this thread again. With even more info and images

the motor is in fact still together and runs great on and off the bottle and there is allot more in it .it has proven to be able to take a constant pounding on and off the track and with way over 50, 100 plus mph nitrous assisted passes and countless ice cream runs with my oldest daughter it has proven to be a excellent street / strip combination and constant work horse.

best time in almost full street trim (no front passenger or rear seat),weight with driver 1850 lbs ,evening track conditions (slick) ,fan belt and all lights on has been 11.375 sec @ 119.37 mph.
watch for 3 even quicker dialed in performance nitrous cars this year.
Tip of 2006
if you don't want to break anything, don't race.
But if you want to learn something, RACE!!!!