This article is to address any questions on how to properly build a GSR shortblock. The components used were Manley/Full race connecting rods, CP 81.5mm 9.8:1 pistons, OEM bearings and other OEM components.

Before I begin this article the shortblock was overbored from 81mm to 81.5mm. Overboring the cylinder walls 0.5mm is proper engine building technique. This is done to ensure that the cylinder wall is a true circle from the top of the bore to the bottom.

The list of tools that you'll need to do a proper bottom end assembly are the following:

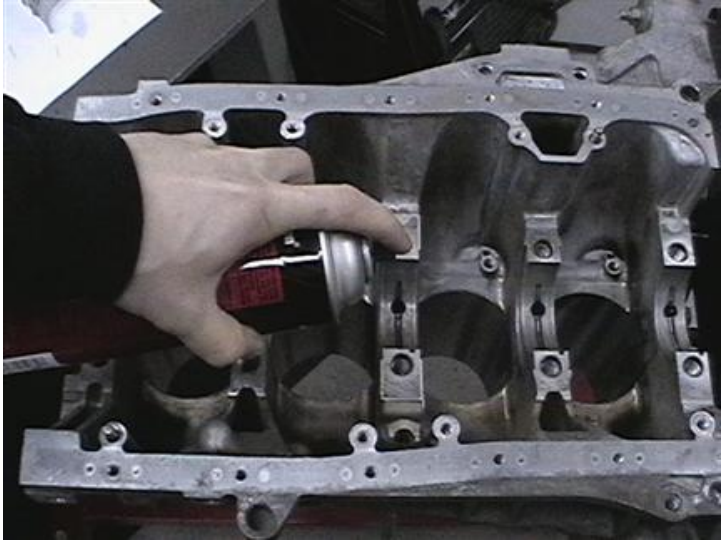
1. Dial bore gauge
2. Rod stretch gauge tool
3. Micrometer
4. 3-4" machinist measurement tool
5. 2-3" machinist measurement tool
6. Plastic gauge
7. Torque wrench
8. Feeler gauges
9. Ring filer
10. Tap set
11. Ring compressor

Other supplies that you'll need are:

1. Brake Kleen
2. Credit card/plastic straight edge
3. Arp bolt assembly lube
4. Clevite bearing lubricant
5. SAE 30 wt oil

The beginning of this article is going to start with the engine taken completely apart. You'll have to dis-assemble the entire block to get to the point where pictures start.

The first step is to clean down all the bearing surfaces, lets start with the mains/block girdle. Use fresh, clean paper towels and Brake Kleen to wipe down all the surfaces:

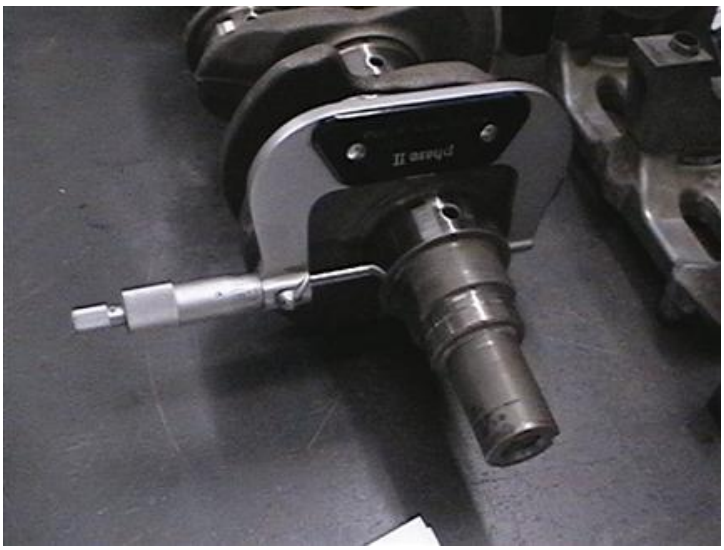


Take all the main bolts and wipe them down, its very important to have the threads clean to get accurate torque readings:

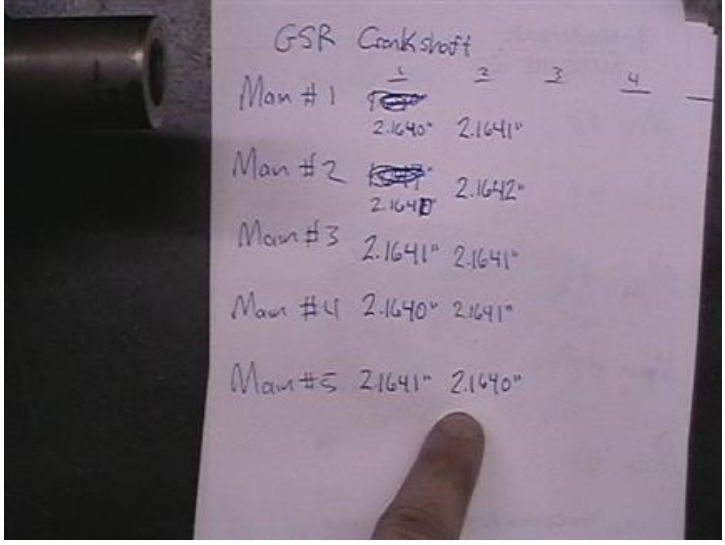
Next wipe down all the bearings surfaces on the crankshaft:

After all the bearing surfaces and main bolts are cleaned, we have to move onto checking all the clearances. Pictured here is a 2-3" machinist micrometer, its accurate to 0.0001" and is essential to measure clearances such as the crankshaft bearing surfaces, piston skirt, etc. The 2-3" simply signifies the range for which the micrometer is able to measure. Here is a picture for reference:

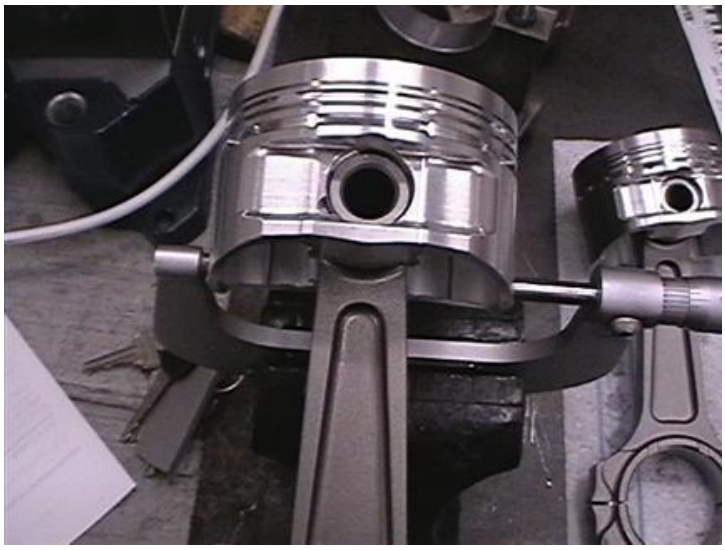
We'll start checking the clearances on the crankshaft at the bearing surfaces. Using the 2-3" mic measure across the crank bearing surface, do this at 4 seperate locations spaced approx. 45 degrees apart from each other. The purpose of measuring at various locations is to check that the crank has is a true circle, the service limit that Honda recommends is measurements within 0.0001" of each other:



Log all measurements that you take on a log journal, you can keep track of your engine build easier, and you can refer to the measurements if a future tear down occurs:

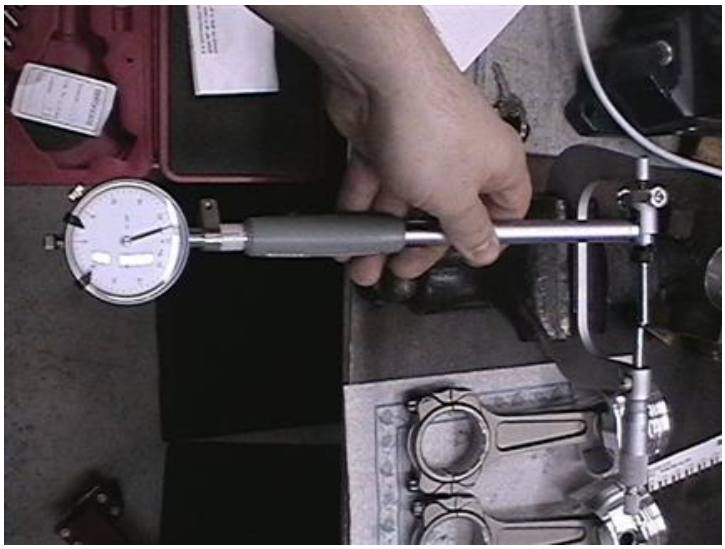


Next we will measure the piston size to ensure that the right bore size piston is being used, as well as to choose which piston is going to be sized properly to each cylinder bore. Variation in piston size to the 0.0001" is common, and cylinder bore variation as well. Use the 3-4" machinist mic to check the size. In order to measure the piston size, measure approx. 0.5" below the wrist pin:



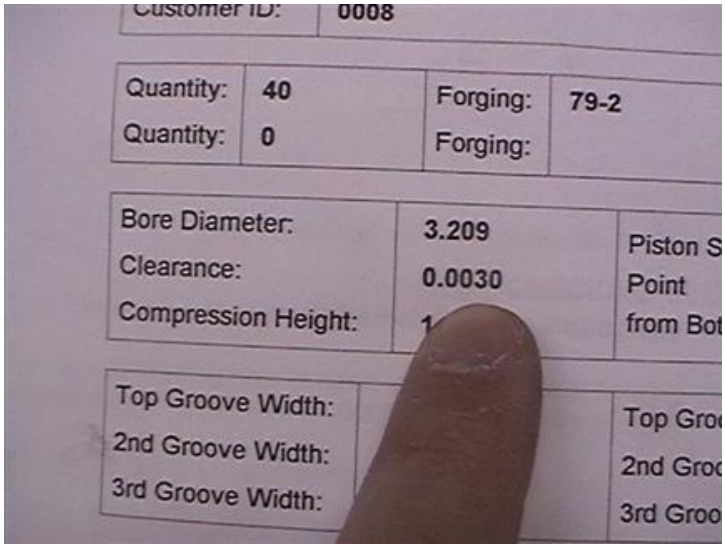
The CP pistons are accurate to the 0.0001", which means each piston is dead accurate to each other. This step is not need if you are using CP pistons, all other pistons you'll have to take this step.

Next we'll move onto measuring the bore size of each cylinder. A dial bore gauge tool is needed in order to accurately measure the bore. Here is a reference picture:

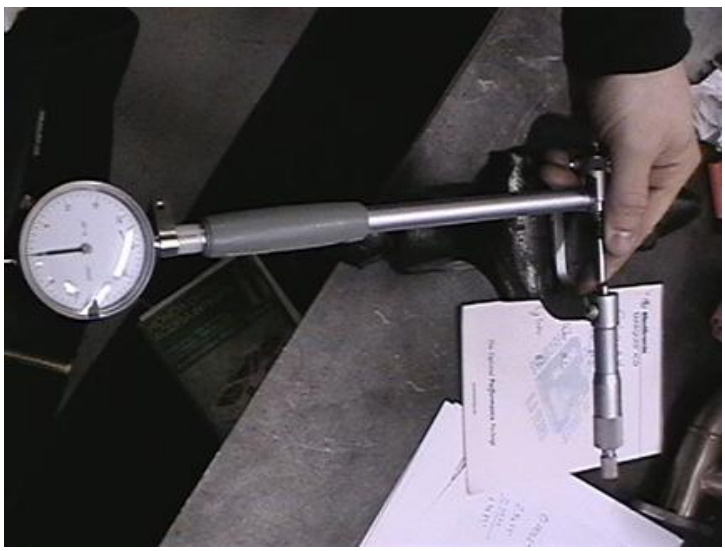


In order to use the dial bore gauge, there is various "anvils" or arms that you match to the bore size of the engine. 81.5mm bore is approximately 3.2", so the 3.2" anvil is to be used:

In order to measure the bore size accurately, the piston-to-cylinder wall clearance has to be known. Different piston manufactuers have different piston to wall clearances. CP piston uses 0.0035" clearance for forced induction. I chose to go with a 0.004" piston to wall clearance on my engine, the 0.001" extra clearance is to be able to give the piston more room to expand while under the extreme cylinder temperatures at high boost levels. Here is the CP piston spec sheet calling for the 0.003" clearance:

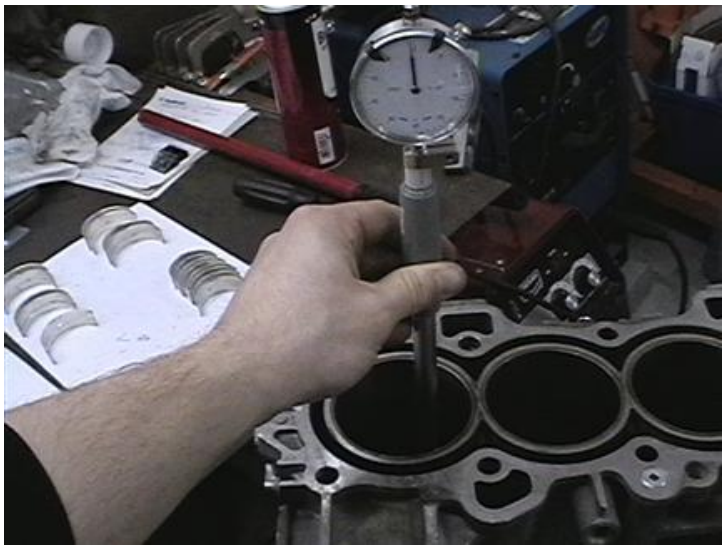


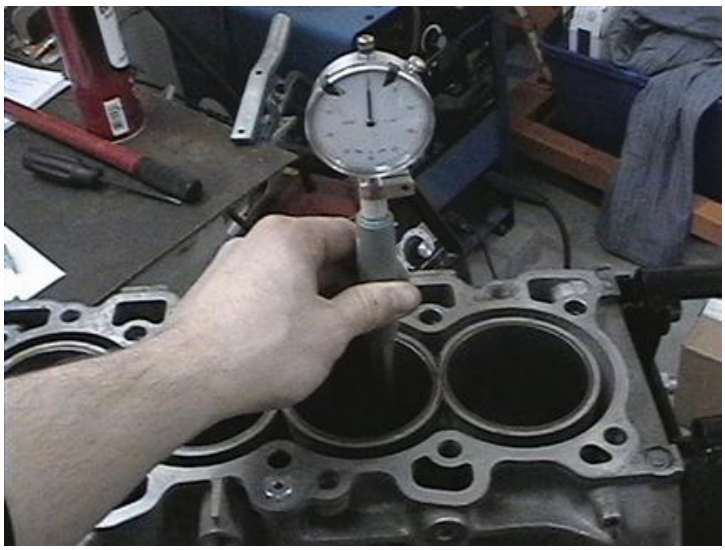
With the proper anvil installed into the dial bore gauge, use the 3-4" micrometer to "zero" the dial bore gauge. Zeroing the gauge allows to show the difference in the cylinder wall size from the target cylinder wall clearance. You have to take the 3-4" machinest micrometer and set it to the size that we desire. The bore size is 3.209 for 81.5mm, and the piston to wall clearance I choose was 0.004. Take the dial bore gauge tool and install it within either end of the mic, since this is what we want the cylinder wall spec to be "zero" the gauge, here is a picture of this occuring:

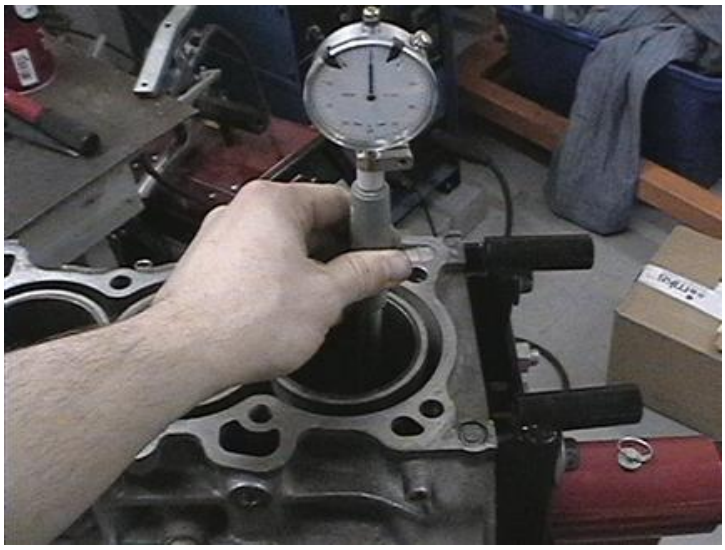


The dial bore gauge reads accurate to the 0.00005". In order to measure the cylinder wall properly rock the

dial bore gauge back and forth, watching the dial gauge while doing so. You'll find a maximum and minimum reading, the middle of the readings is the true bore size. Here is the dial bore gauge measuring the cylinder wall:

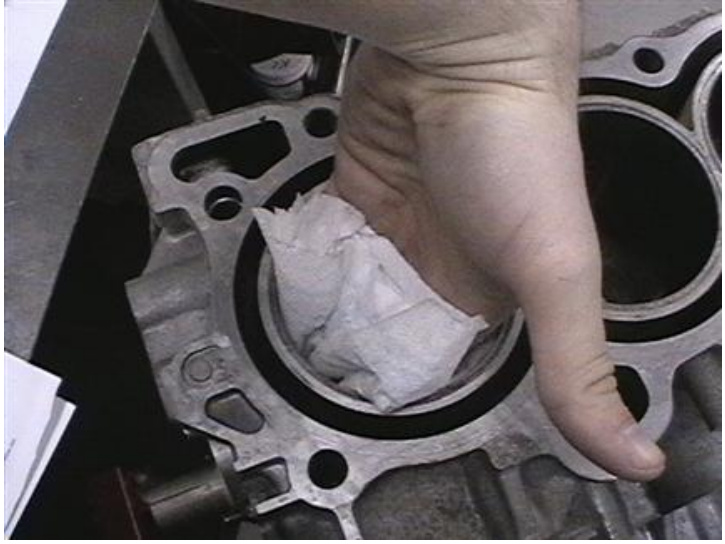




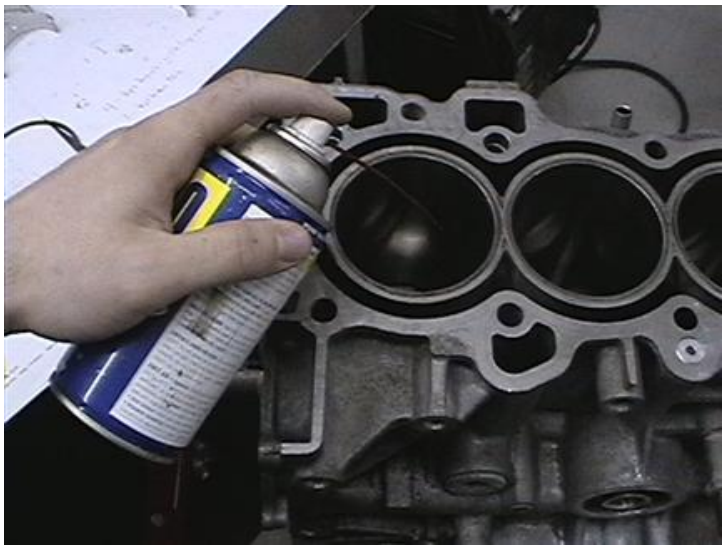


As you can see from the pictures the readings between each cylinder are dead accurate, this is what you get from a properly machined cylinder wall. You need to run the dial bore gauge from the top of each cylinder to the bottom, you shouldnt see much fluctation in the gauge reading. Anything past the 0.0001" is so minimal dont worry about it. In going from the top of the sleeve to the bottom you are checking that the bore and hone done by the machine shop is true throughout the bore.

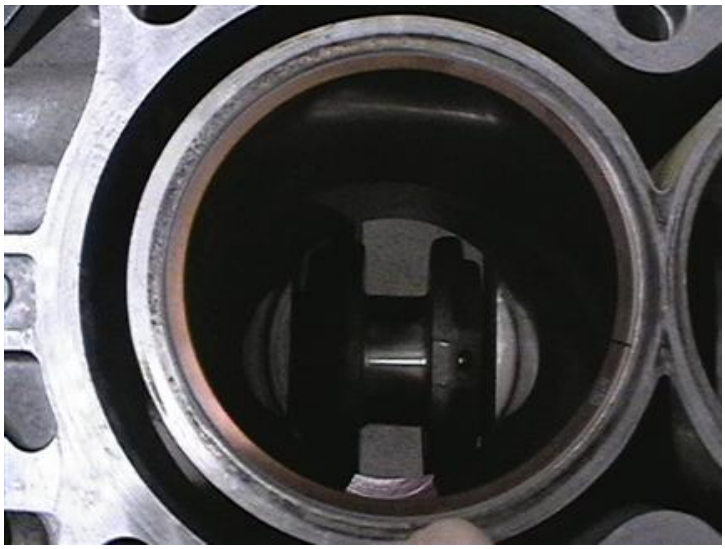
Next we are going to move onto gapping the piston rings. The cylinder walls have to be super clean in order to get the most accurate readings. Brake kleen and some fresh, clean paper towels need to be used to wipe down the cylinder walls. Here is a pic:



After the dirt is cleaned from the cylinder wall, use WD-40 to lubricate them so that the piston rings dont scratch the cylinder walls:



Once the cylinder walls are lubricated, the rings should be sized. The first compression ring should be placed into the bore.

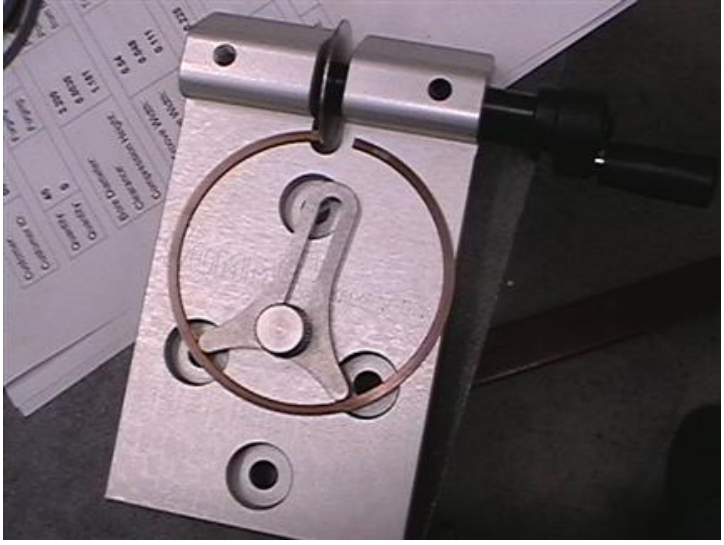


Using a piston slide the ring down to approximately the end of the piston skirt or about 3”.

Once the ring is square within the bore, take the feeler gauge to measure the "gap" in the ring. The top compression ring for the CP pistons needs to be sized between 0.017-0.021". The formula for sizing the top and bottom compression rings is bore size (in inches) x 0.006", and then add 0.004 for the secondary compression ring gap. Using the formula, my top ring gap was 0.019." My feeler gauge set was not made in sizes such as 0.019", so a combination of 0.015" and 0.004" feeler gauges are used together in order to get the desired size:

Here you can see the gap on the ring within the cylinder bore:

Simply slide the feeler gauge into the ring gap, the rings are undersized so you'll have to use a ring filer to open up the gap to the desired size, and in this case 0.019". Here is a picture of the ring filer used:



Small amounts of filing should be done on the rings. Its easy to grind to much off, and have to purchase a new set of rings. I made about 4 iterations on the grinding before I reached 0.019". When sliding the feeler gauge into the gap there should be a slight drag, indicating the clearance is reached.

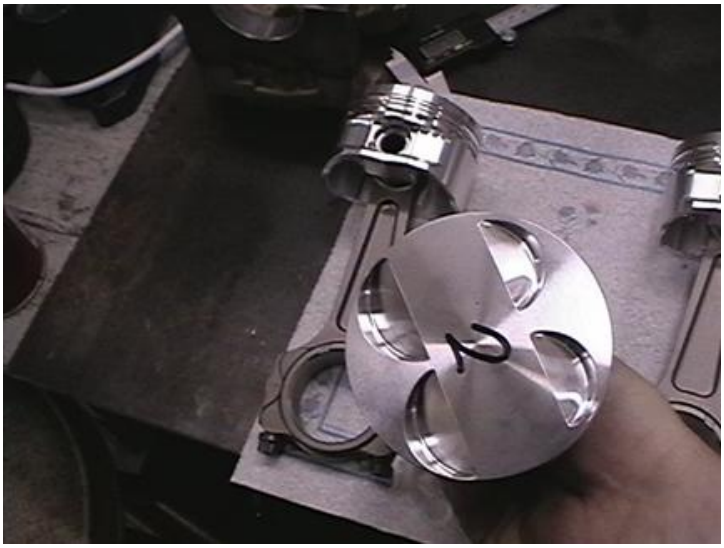
There is both a top and bottom compression ring on a piston. The above steps were done to the top compression ring, the next steps will be done to the bottom compression ring. Here is a picture of both the top and bottom compression ring, top compression ring is bronze color and has a moly coating, the bottom compression ring is black/grey color:

The bottom compression ring has a different ring gap spec. Installation of the bottom piston rings is the same as the top compression rings. Here is a picture of me using a combination of feeler gauges to achieve 0.023" and checking the ring gap within the bore:

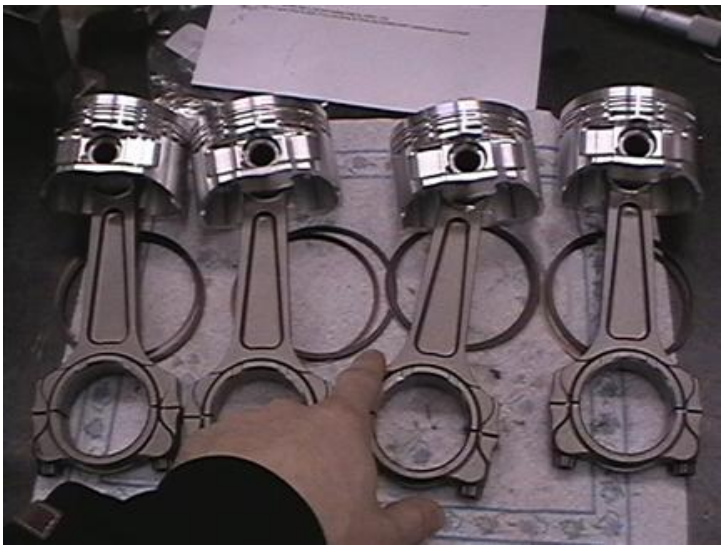
Filing of the rings was needed again. Take the measurements in small increments to achieve the size needed,

and in this case 0.023".

Each piston and rod assembly should be numbered to keep things consistent. Use a simple Sharpie marker to write on the top of the pistons:



Keep each ring set that is checked and filed, with the piston rod assembly for that bore. Here is how I did this:



Make sure that you always lay the piston/rod assemblies on a paper towel, or something soft. You have to make sure that the pistons dont get scratched up.

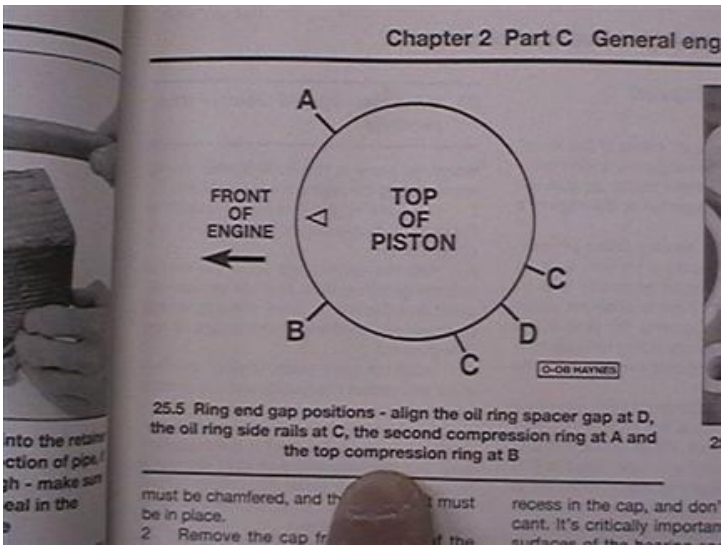
The top and bottom compression rings are not ready to be installed onto the pistons. The bronze rings is to be installed on the "top" slot of the piston, and the grey ring is to be installed on the "bottom" slot of the piston. There is numbers etched into the rings, make sure that there are facing upward. Here is a picture of them installed properly:

Next the oil rings need to be installed onto the pistons. The oil rings consist of the oil rails and the seperator rail. Here is a picture of the rail and seperator rings:

Simply slide the seperator ring into the alloted groove, and place the oil rail rings on either side of the seperator ring:

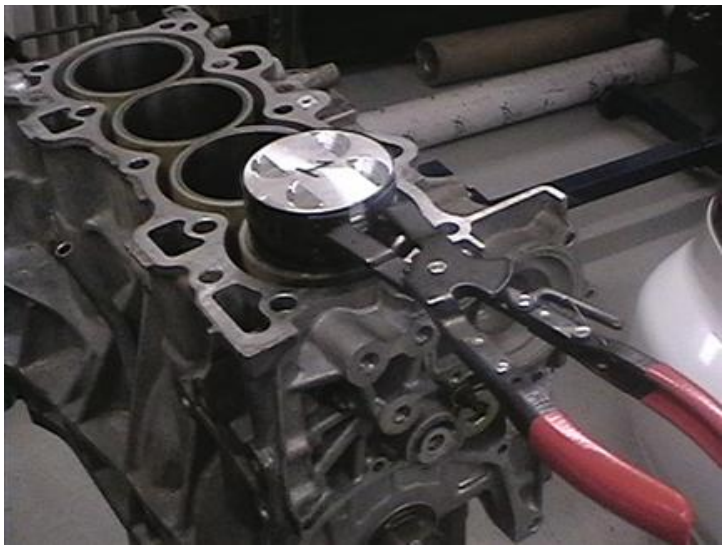
Make sure that you are putting the sized rings from each cylinder bore to the correct piston that is numbered.

Now that the rings are installed into the piston grooves, the placement of the rings in relation to the piston is essential. You can place the compression rings 180 degrees apart from another, and likewise with the oil rail rings so there is no overlap. I choose to go with the OEM way of positioning the rings, here is a schematic of the ring position the OEM way:

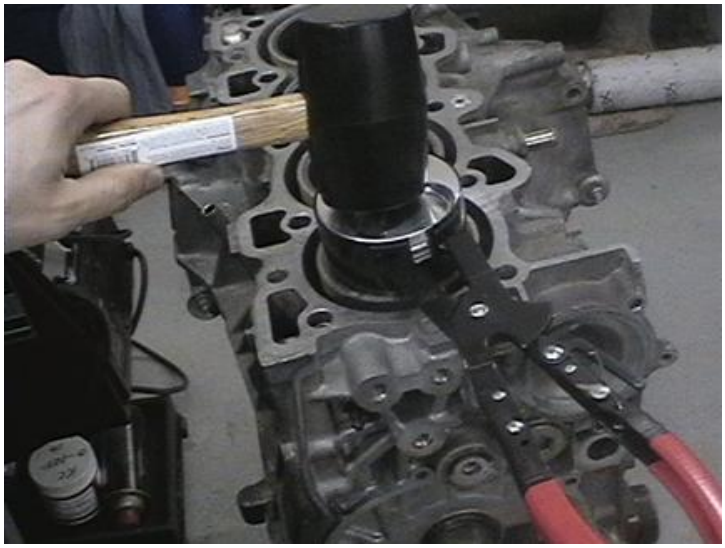


The piston and rod assembly is ready to install into the bore. Lubricate the cylinder walls with SAE 30wt motor oil, as well as the piston with the rings installed. A ring compressor is needed to in order to install the pistons.

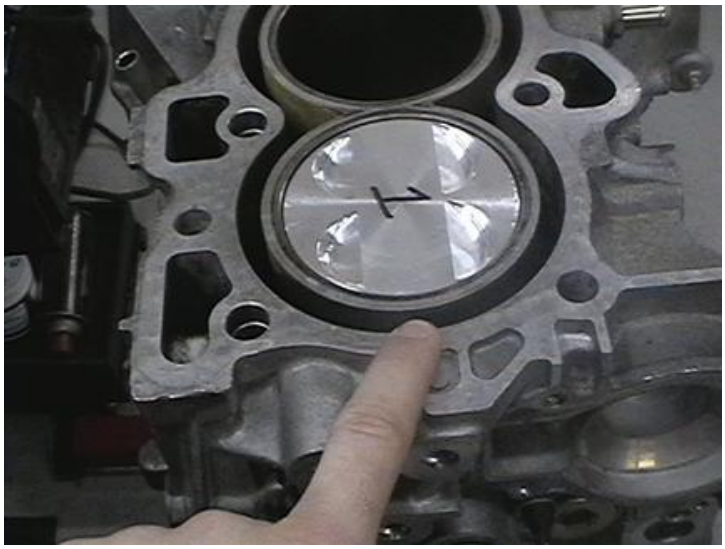
Here is a reference picture of the one used in this article. The scissor type ring compressor that I use is hands down the best, and are affordable. They give even compression all the way around the piston/ring, and have less chance of breaking of the rings when installing into the bore.



Line up the piston into the bore. Make sure that the piston is in its proper orientation meaning the exhaust valve reliefs are on the exhaust side of the engine. Take a rubber mallet and being tapping the assembly into the bore:



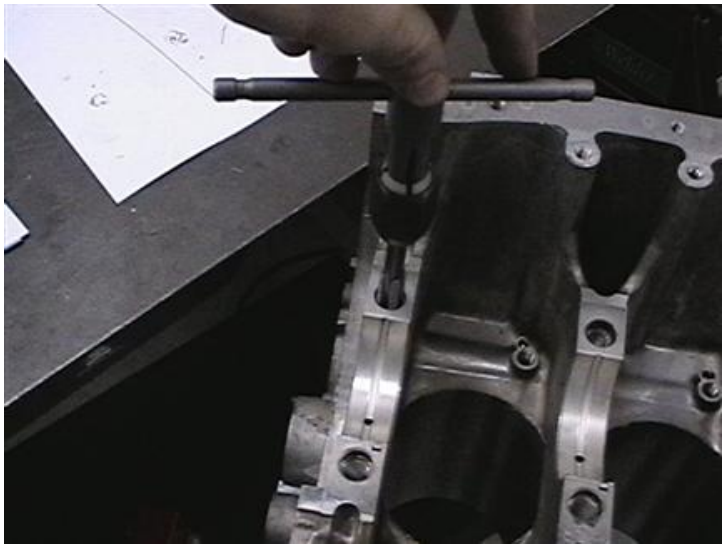
This is tricky when doing this for the first time. Its very easy to break a ring tapping it into the bore. The key is to have the piston level in the bore:



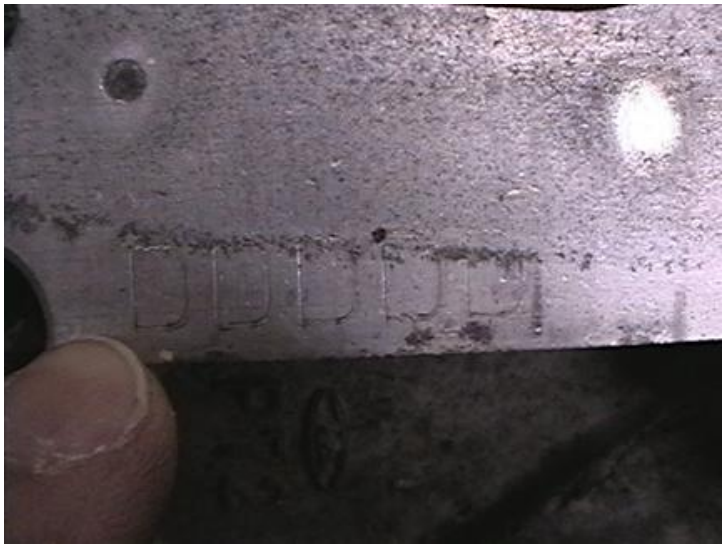
Here is what the pistons look like in each bore when installed properly. Notice that each numbered piston is installed into the corresponding cylinder:

Next we'll move onto sizing the main and rod bearings.

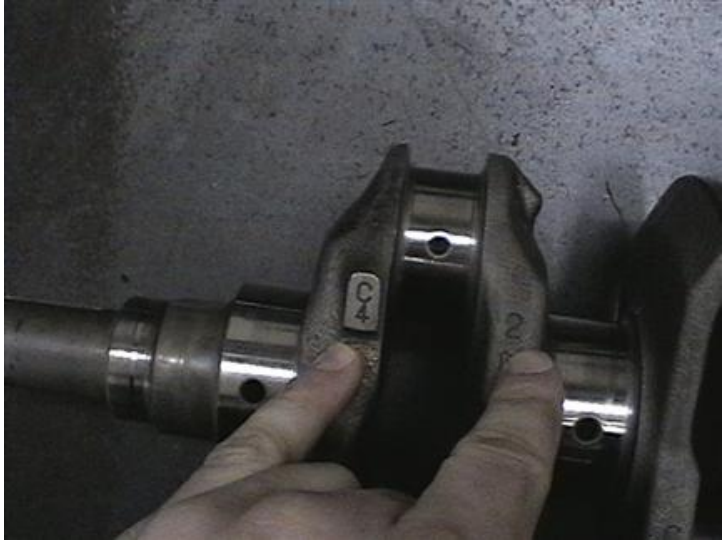
Before the bearings are installed the main bearing bolt holes need to be chased with the corresponding tap size. This is done to ensure that no dirt, metal, etc is stuck in the threads. The dirt gives a false torque reading, so its essential to do this:



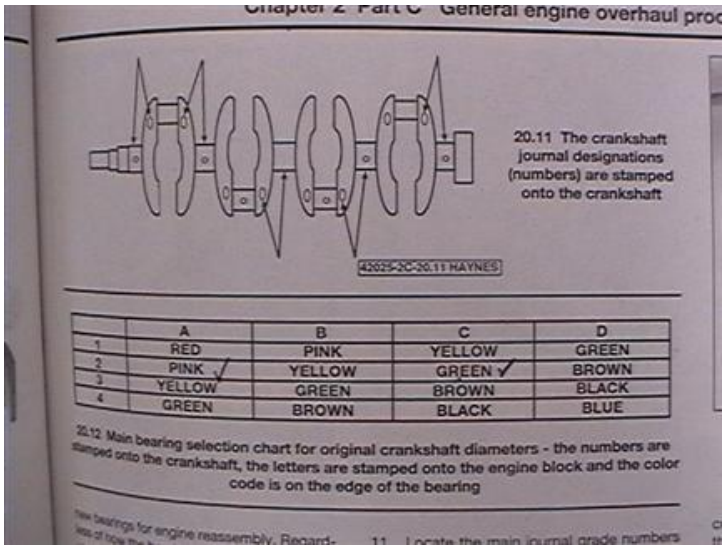
If you choose on using OEM bearings (I suggest you do this) you'll need to know what color bearings to purchase. On the block is stampings as pictured here:



Its hard to see but the letters are D,D,D,D,D. The crankshaft has the corresponding numbers and letters in order to find out what colors are needed. Here are the markings on the crankshaft:



The letters on the block in correspondance to the numbers on the crankshaft signify the color rod bearings that need to be used. Here is an illustration from a shop manual:



General engine overhaul proc

20.11 The crankshaft journal designations (numbers) are stamped onto the crankshaft

42025-2C-20.11 HAYNES

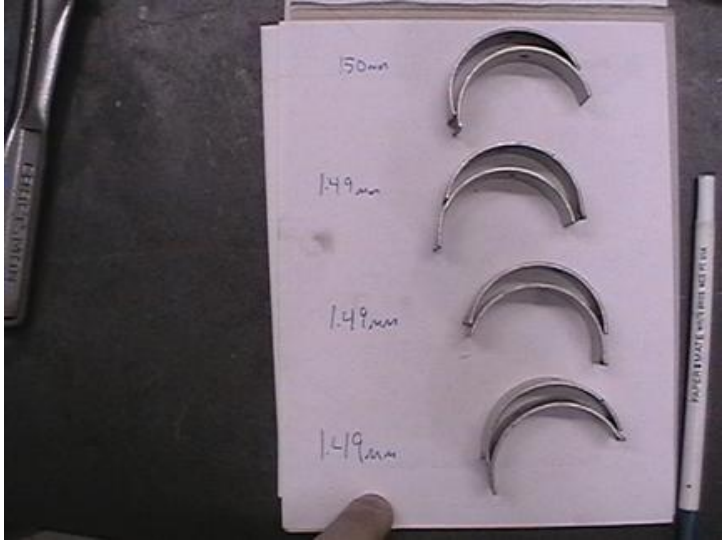
	A	B	C	D
1	RED	PINK	YELLOW	GREEN
2	PINK ✓	YELLOW	GREEN ✓	BROWN
3	YELLOW	GREEN	BROWN	BLACK
4	GREEN	BROWN	BLACK	BLUE

20.12 Main bearing selection chart for original crankshaft diameters - the numbers are stamped onto the crankshaft, the letters are stamped onto the engine block and the color code is on the edge of the bearing

The rod bearing colors for me turned out to be all brown. I like to run my rod clearances on the loose end to ensure that there is adequate oil clearance at the journal, and less frictional contact.

In order to check the size of the bearing to know what to order from Honda I use, a used set of main/rod bearings. I mic the thickness on the bearing in millimeters and going by the bearing size/color chart from Earl Laskey i can determine what color is needed without ordering the bearings and checking to see if they are correct. In some cases the bearing wont be correct and a larger color will need to be used, and the bearings are not returnable. Here I am using a digital micrometer to check the thickness of the used bearing:

Here I logged down the colors according to the sizing chart, and the numerical values I measured for the use rod bearing. I used Earl Laskeys size/color chart to find out what the used bearing colors are:



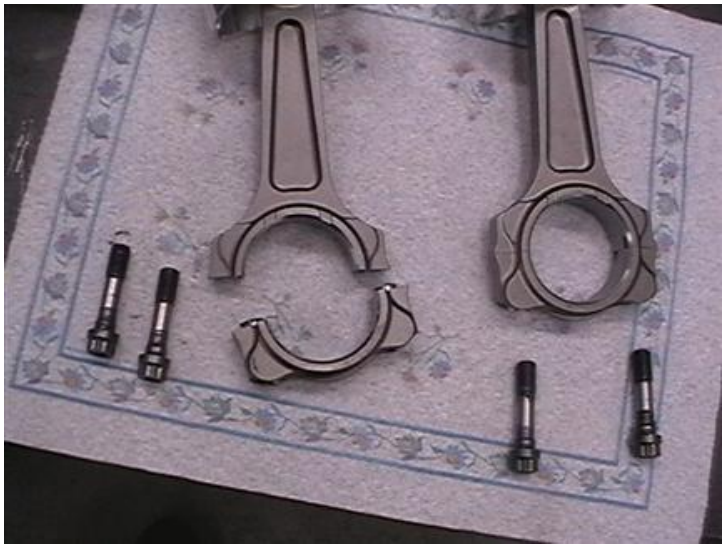
Main Bearing thickness by color

- Blue 2.013-2.010 mm 0.0793"- 0.0791"
- Black 2.010-2.007 mm 0.0791"- 0.0790"
- Brown 2.007-2.004 mm 0.0790"- 0.0789"
- Green 2.004-2.001 mm 0.0789"- 0.0788"
- Yellow 2.001-1.998 mm 0.0788"- 0.0787"
- Pink 1.998-1.995 mm 0.0787"- 0.0785"
- Red 1.995-1.992 mm 0.0785"- 0.0783"

Rod bearing thickness by color

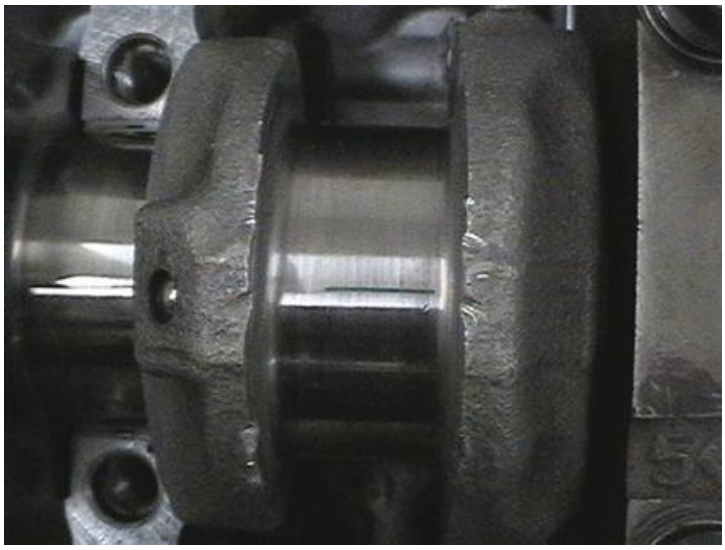
- Blue 1.510-1.507 mm 0.0594"- 0.0593"
- Black 1.507-1.504 mm 0.0593"- 0.0592"
- Brown 1.504-1.501 mm 0.0592"- 0.0591"
- Green 1.501-1.498 mm 0.0591"- 0.0590"
- Yellow 1.498-1.495 mm 0.0590"- 0.0589"
- Pink 1.495-1.492 mm 0.0589"- 0.0587"
- Red 1.492-1.489 mm 0.0587"- 0.0586"

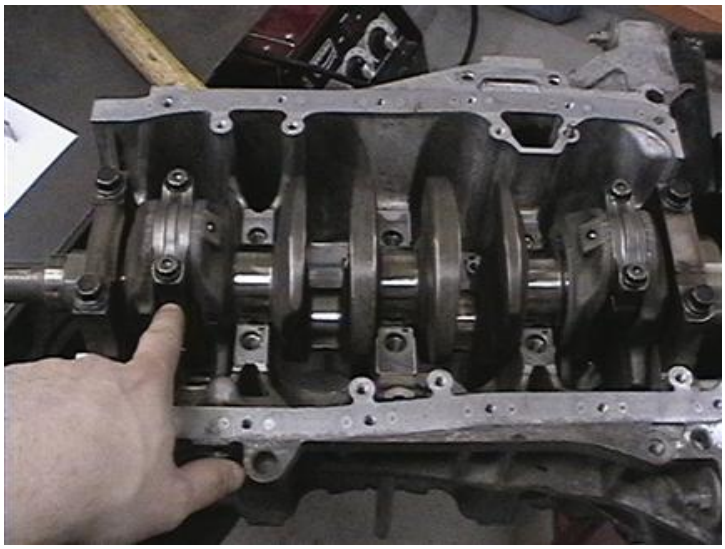
The crankshaft is ready to be layed into the main journals in order to check the rod bearing clearances. The used rod bearings need to be installed into the rod journals. In order to do so the rod cap needs to be taken off of the rod, simply take out the two rod bolts as shown here:



Each rod has a top and bottom journal, place the used bearings into the journals. Note the bearing "tang", make sure you get the "tang" line up properly in the journals. Its almost like a key, so its hard to mess this up:

Now its time to place the plastic gauge into the rod journal and measure the rod bearing clearance. You want to use the green plastic gauge packet, it's the only size that will measure to the 0.0001" that Honda calls for. Simply break off a piece of the plastic gauge and place it into the rod journal. Tighten down the rod cap onto the rod.





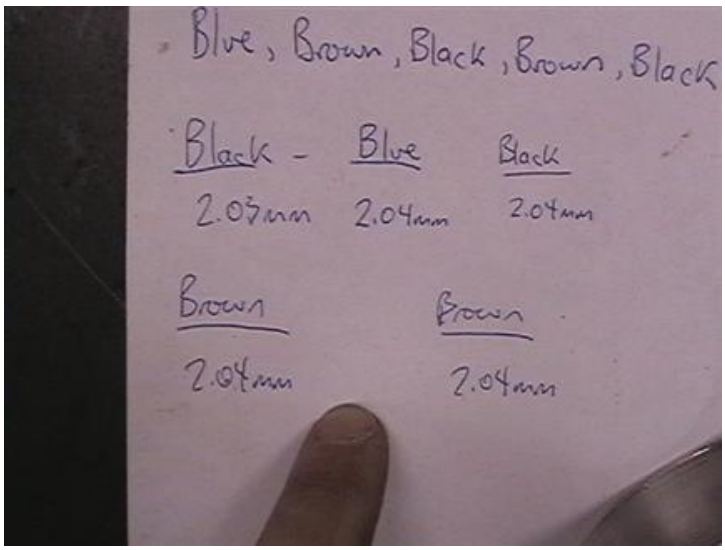
Note in the last picture that the two main caps are installed to hold down the crankshaft and keep it from rotating. This is very important, if the crankshaft moves while the plastic gauge is in the journal its smears and you'll have to do it all over again. Torque down the rod bolts on the rods to the manufacturers recommended specs, in the case of the Manley's its 48 ft-lbs. Its better to use a rod stretch gauge tool to dial in the proper torque spec on the bolts, but for checking the bearing clearances its alright to just torque the bolts down.

Now that you have torqued the bolts down, its time to loosen the bolts back up and take off the rod caps to check the plastic gauge. Plastic gauge works by squishing to a certain width. The width of the plastic gauge corresponds to the bearing clearance. On the plastic gauge packet there is various widths and corresponding

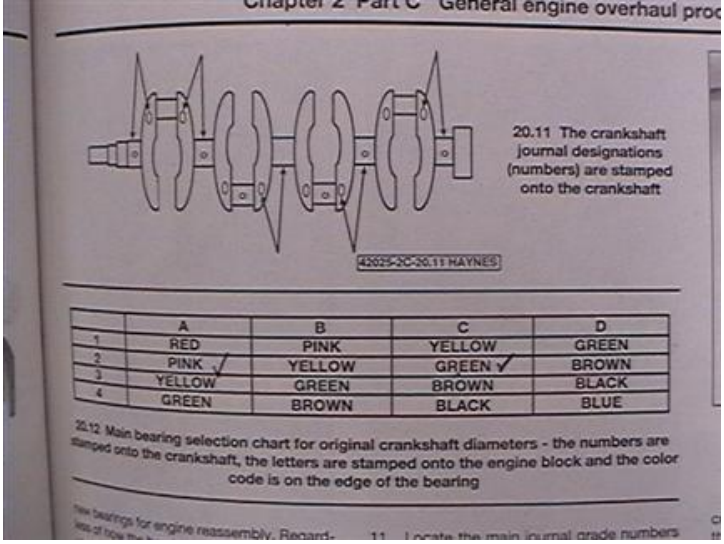
clearance chart. Here is the rod bearing plastic gauge clearances:

The plastic gauge stuck to the rod journals on the crankshaft primarily, but you can see by the last picture that the plastic gauge stuck to the rod journal. It doesn't matter how it sticks, just measure the clearance with the width chart. Here you can see all the bearings are within 0.0015". The rod clearance chart in the shop manual is between 0.0012-0.0017". I like to go with a looser clearance on the rod bearings. JG engine dynamics found that 0.002" clearance was optimum; I didn't want to go that large so I went with the pink color rod bearings. This gives me the extra 0.0002" clearance to at the edge of the factor suggested rod clearance of 0.0017". Using used bearings works very well since you can determine the color bearing before ordering, this is invaluable for both saving time and money when building engines.

Next we move onto sizing the main bearings. Again I went with the used main bearings in the same manner as the rod bearings. I measured the thickness of each of the bearings and logged the measurements on paper. Here is the thickness of each bearing I measured:

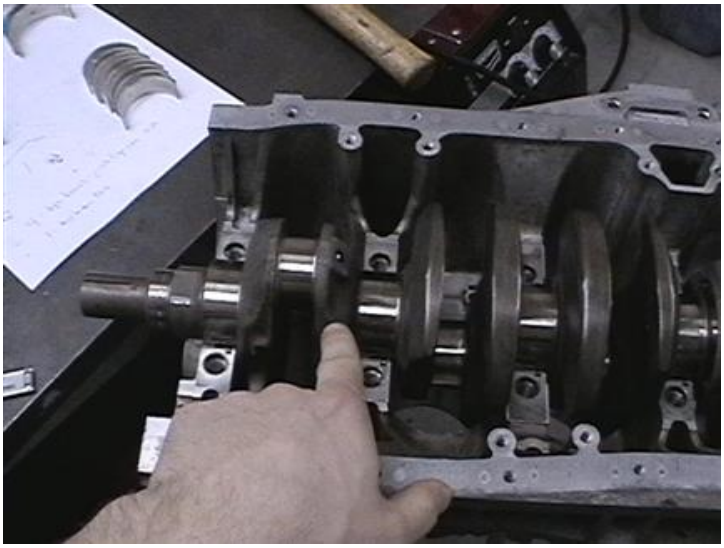


On the crankshaft there is a number, and stamped onto the block is the corresponding letters. Here is the chart from the shop manual:

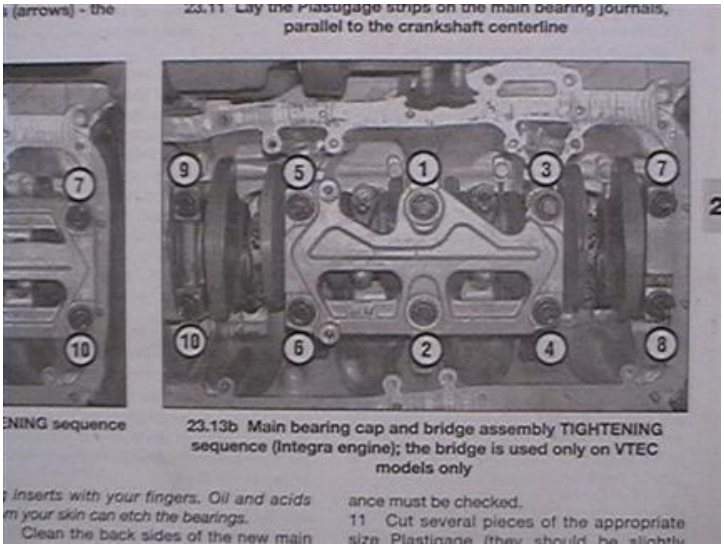


I found that I needed the following bearing colors: blue, brown, black, brown, black. Knowing the used bearing size, I could determine the difference if any from the desired colors for each bearing.

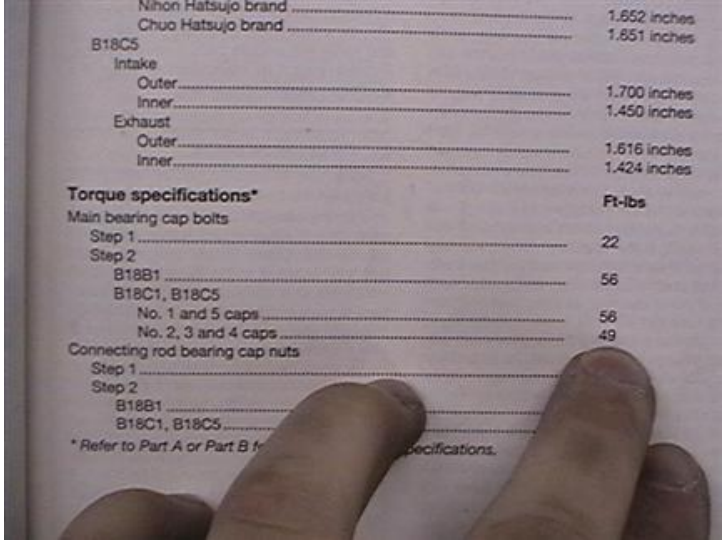
Placing the crankshaft into the main journals, and placing the plastic gauge in each journal the main cap bolts needed to be tighten down.



The torque sequence is as follows:



The main cap torque specifications are as follows:

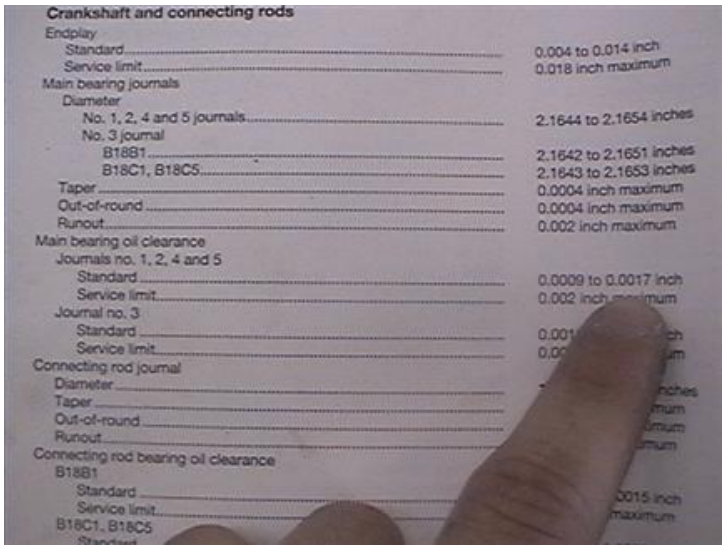


Nihon Hatsujo brand	1.652 inches
Chuo Hatsujo brand	1.651 inches
B18C5	
Intake	
Outer	1.700 inches
Inner	1.450 inches
Exhaust	
Outer	1.616 inches
Inner	1.424 inches

Torque specifications*	Ft-lbs
Main bearing cap bolts	
Step 1	22
Step 2	
B18B1	56
B18C1, B18C5	
No. 1 and 5 caps	56
No. 2, 3 and 4 caps	49
Connecting rod bearing cap nuts	
Step 1	
Step 2	
B18B1	
B18C1, B18C5	

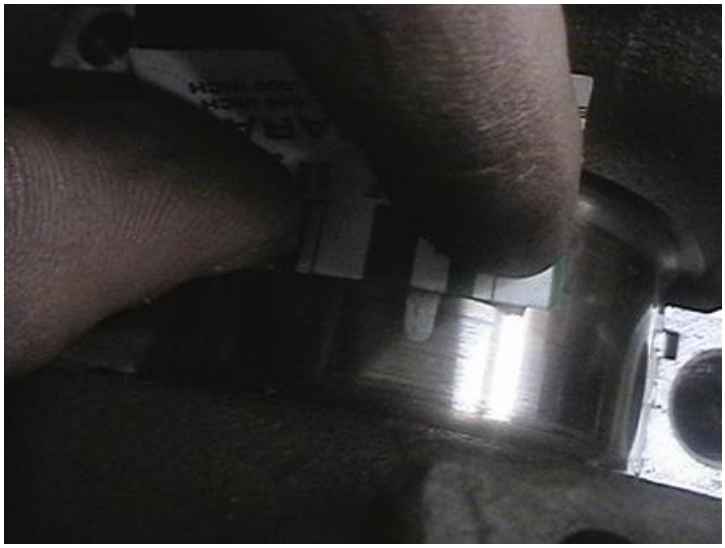
* Refer to Part A or Part B f... ...ecifications.

Now that the main caps are all torqued down to spec, they have to be loosened and taken off to measure the plastic gauge width. The bearing clearances for the 2,3,4 (girdle) main caps are the following:

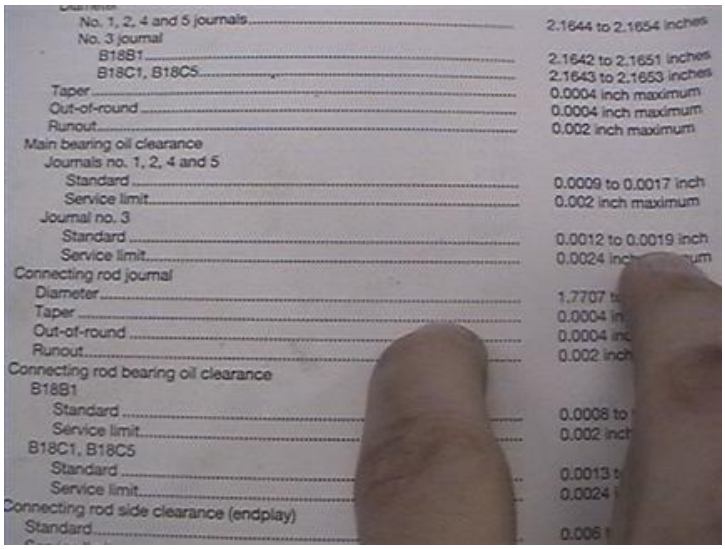


Crankshaft and connecting rods	
Endplay	
Standard	0.004 to 0.014 inch
Service limit	0.018 inch maximum
Main bearing journals	
Diameter	
No. 1, 2, 4 and 5 journals	2.1644 to 2.1654 inches
No. 3 journal	
B18B1	2.1642 to 2.1651 inches
B18C1, B18C5	2.1643 to 2.1653 inches
Taper	0.0004 inch maximum
Out-of-round	0.0004 inch maximum
Runout	0.002 inch maximum
Main bearing oil clearance	
Journals no. 1, 2, 4 and 5	
Standard	0.0009 to 0.0017 inch
Service limit	0.002 inch maximum
Journal no. 3	
Standard	0.001... ...ch
Service limit	0.00... ...m
Connecting rod journal	
Diameter	...nches
Taper	...mum
Out-of-round	...mum
Runout	...mum
Connecting rod bearing oil clearance	
B18B1	
Standard	
Service limit	...0015 inch maximum
B18C1, B18C5	
Standard	

Here is the corresponding plastic gauge for journals 2,3,4:



The bearing clearance for main caps 1 and 5 are the following:



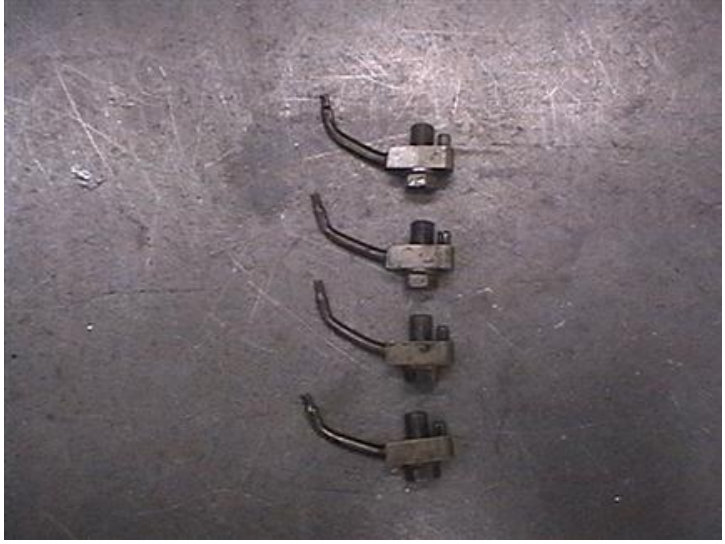
No. 1, 2, 4 and 5 journals	2.1644 to 2.1654 inches
No. 3 journal	
B18B1	2.1642 to 2.1651 inches
B18C1, B18C5	2.1643 to 2.1653 inches
Taper	0.0004 inch maximum
Out-of-round	0.0004 inch maximum
Runout	0.002 inch maximum
Main bearing oil clearance	
Journals no. 1, 2, 4 and 5	
Standard	0.0009 to 0.0017 inch
Service limit	0.002 inch maximum
Journal no. 3	
Standard	0.0012 to 0.0019 inch
Service limit	0.0024 inch
Connecting rod journal	
Diameter	1.7707 t
Taper	0.0004 in
Out-of-round	0.0004 inc
Runout	0.002 inch
Connecting rod bearing oil clearance	
B18B1	
Standard	0.0008 to
Service limit	0.002 inch
B18C1, B18C5	
Standard	0.0013 t
Service limit	0.0024
Connecting rod side clearance (endplay)	
Standard	0.006 t

Here is the corresponding plastic gauge for journals 1 and 5:

The bearing clearances are all within spec, so for the first main cap I'll use a blue color, for journals 2,3,4 and 5 a brown bearing color (this is what the used bearing colors where measured and the corresponding colors from Earl Laskey sizing chart). This leaves a 0.0015" clearance for all the main caps, which is within spec.

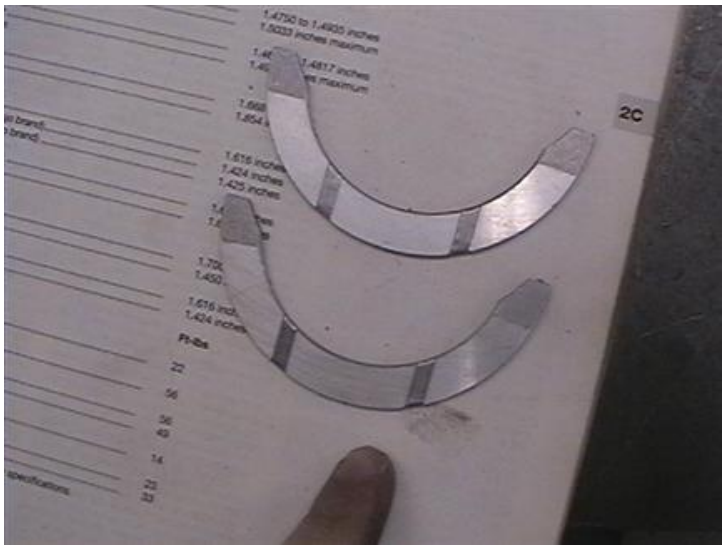
Now that the plastic gauging to the journals has been done, it has to be taken off. Using a credit card, or other plastic flat edge piece scrap off the plastic gauge. Don't use cleaning solvent to clean the bearing surfaces, they have a special coating for break in that will be eaten away.

The piston oil squirters are ready to be installed. Clean the squirters with Brake Kleen as pictured here:

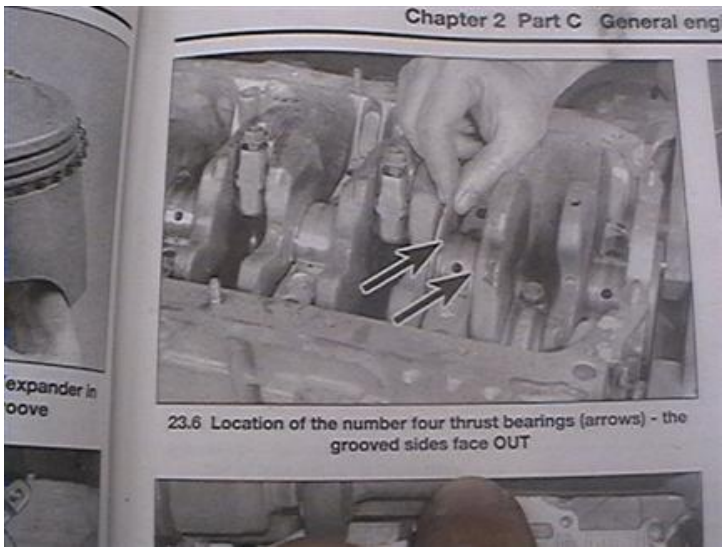


Simply put the piston oil squirters into the doweled area that you removed them from and torque down by hand until tight. There is no torque spec for these, just don't over do tightening them down.

Next the thrust washers have to be installed into the journals. Pictured here is the thrust washers:



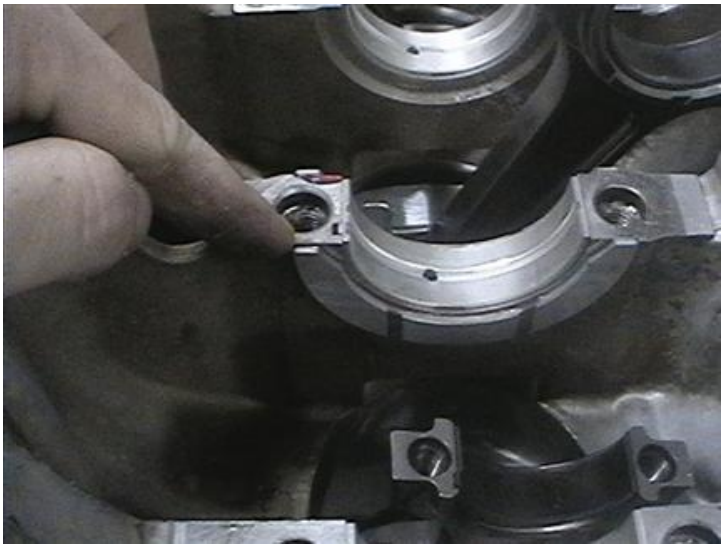
The thrust washers have to be installed with the groove ends outward as pictured in the shop manual:

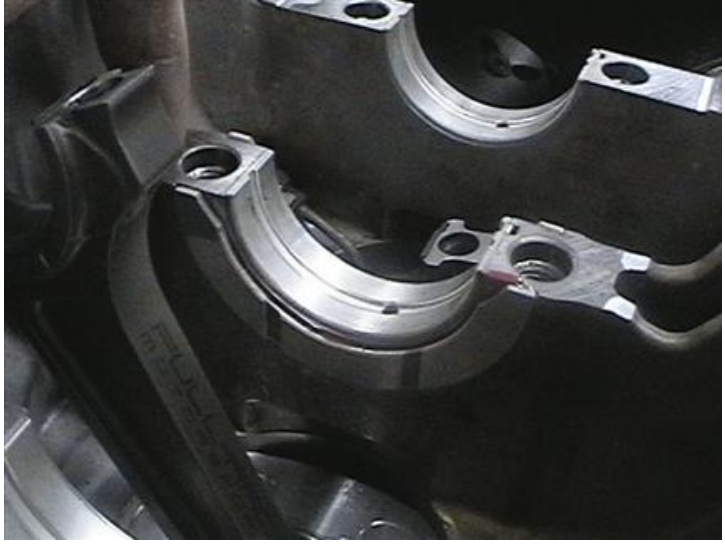


The thrust washers are to be installed on main number 4. In order to hold the thrust washers into place before placing the crankshaft into the main journals, put engine assembly lubricant. Here is the picture of the Clevite bearing lubricant used:

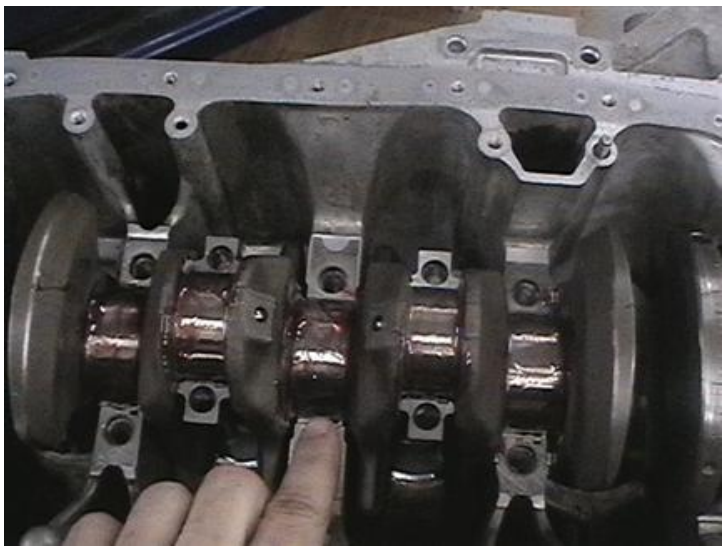
Pictured is the lubricant placed onto the inward face of the thrust washers:

Pictured is the thrust washers with the lubricant helping attaching them to the metal surface. Note the thrust washers groove facing outward:

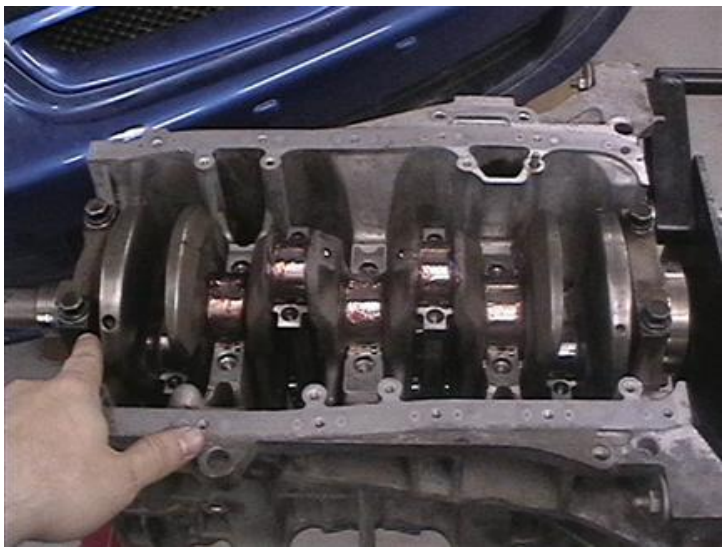




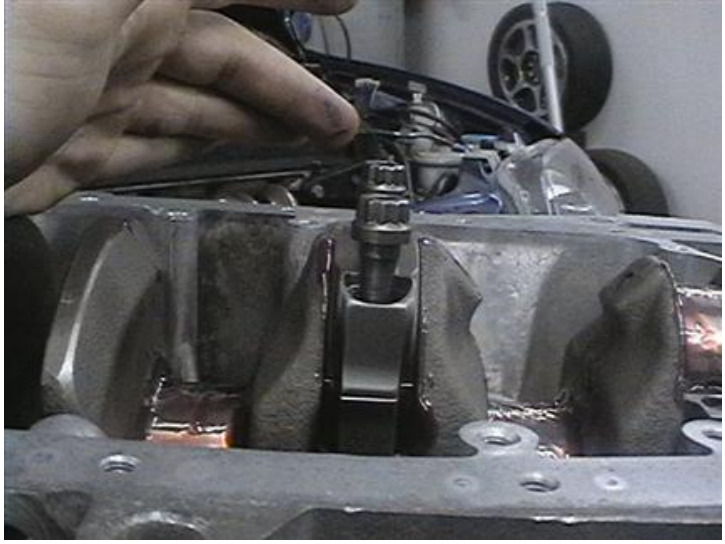
Now that all the bearings are sized, order them from Honda or Acura. I have done this already, so I am ready to install them into the engine. Place the bearings into all the journals. Use the Clevite bearing lubricant and place in all bearing journals, and thrust washer surfaces:

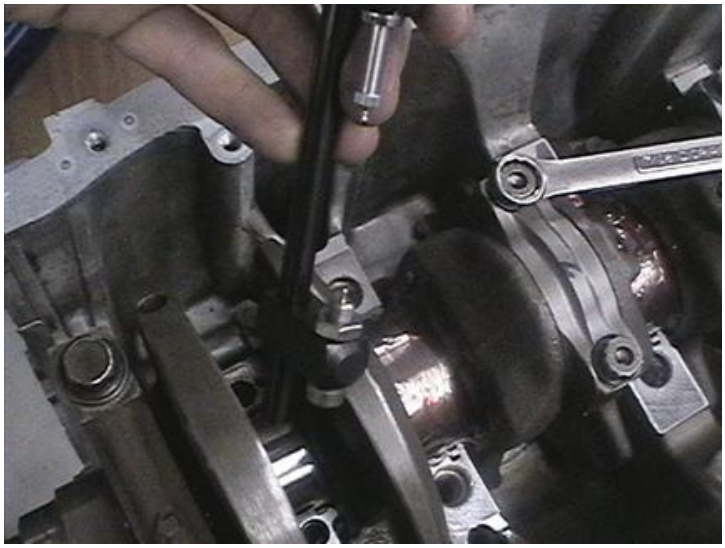


The rods are now ready to be installed. Install main caps 1 and 5 and torque them down to hold the crankshaft in place.



Apply the arp assembly lubricant supplied with the Manley rods onto the rod bolt ends. This is essential to apply the assembly lubricant because the torque spec/stretch length calculated from the manufactuer is using the lubricant. If installed dry, the torque/stretch spec will be off and you wont have the proper torque on them. Simply install the rod caps onto the rods, and torque the rod bolts down so they are snug:

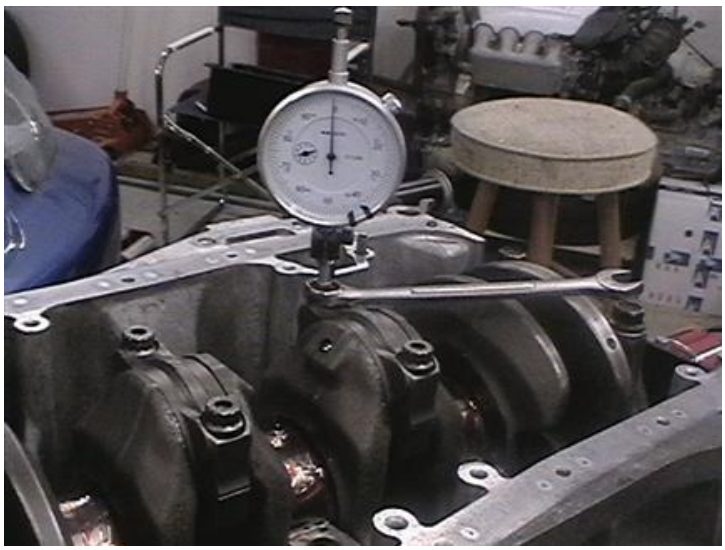




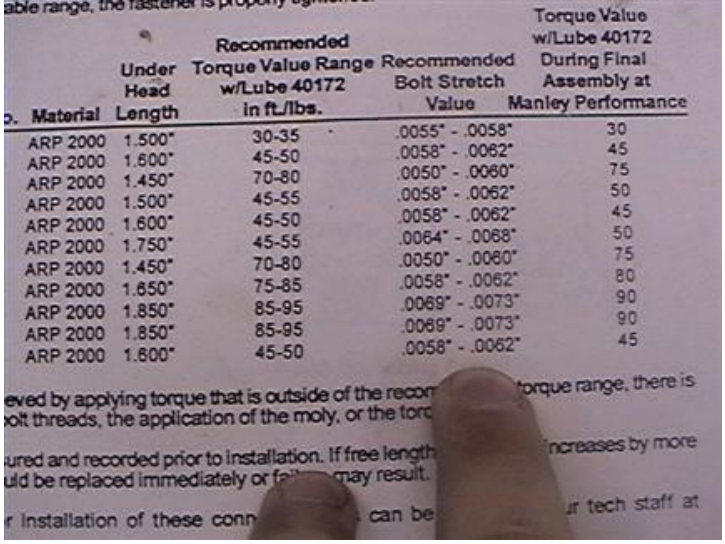
To properly install the rod caps a rod gauge stretch tool must be used. A rod when torqued down stretches, and a corresponding stretch length can tell the torque spec. This is the most accurate way to tighten a bolt down. Here is a pictorial reference of the rod stretch gauge tool used:

On either side of an aftermarket rod bolt there is a dimple. These dimples allow for the pin ends of the rod gauge stretch tool to sit themselves properly. Here a pic of the top and bottom of the arp 3/8 rod bolts:

Set up the rod stretch gauge tool so that it bites on the top and bottom of the rod bolt. Then preload the the tool to about 0.02 0.04”, and zero the gauge face. Here is a picture of the tool set-up and zeroed.



Manley recommends stretching the rod bolts to 0.0058 to 0.0062” as shown in the rod spec sheet:

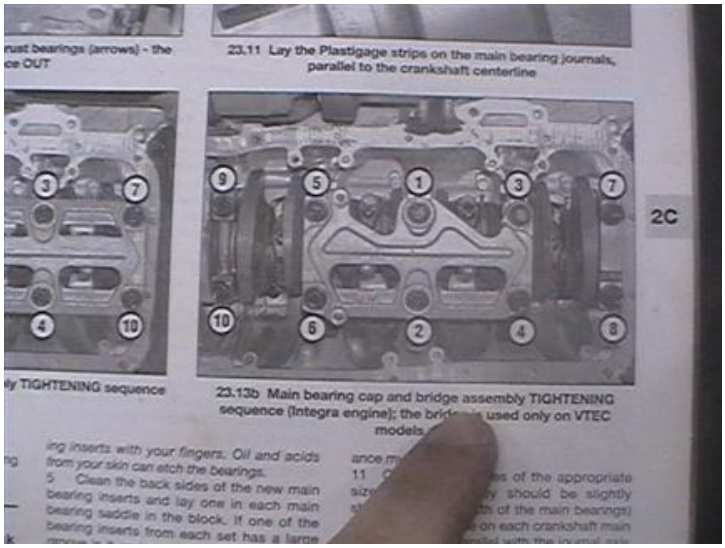


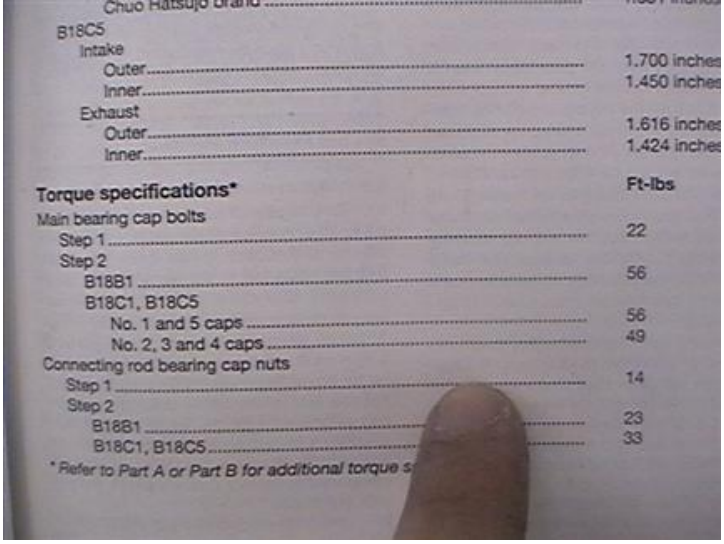
Material	Under Head Length	Recommended Torque Value Range w/Lube 40172 in ft./lbs.	Recommended Bolt Stretch Value	Torque Value w/Lube 40172 During Final Assembly at Manley Performance
ARP 2000	1.500"	30-35	.0055" - .0058"	30
ARP 2000	1.600"	45-50	.0058" - .0062"	45
ARP 2000	1.450"	70-80	.0050" - .0060"	75
ARP 2000	1.500"	45-55	.0058" - .0062"	50
ARP 2000	1.600"	45-50	.0058" - .0062"	45
ARP 2000	1.750"	45-55	.0064" - .0068"	50
ARP 2000	1.450"	70-80	.0050" - .0060"	75
ARP 2000	1.650"	75-85	.0058" - .0062"	80
ARP 2000	1.850"	85-95	.0069" - .0073"	90
ARP 2000	1.850"	85-95	.0069" - .0073"	90
ARP 2000	1.600"	45-50	.0058" - .0062"	45

Using a 7/16" box wrench and a pipe to give extra leverage, tighten down the rod bolt till its stretches with spec. I choose to go with a value of 0.0060 to be in the middle of the recommended stretch.

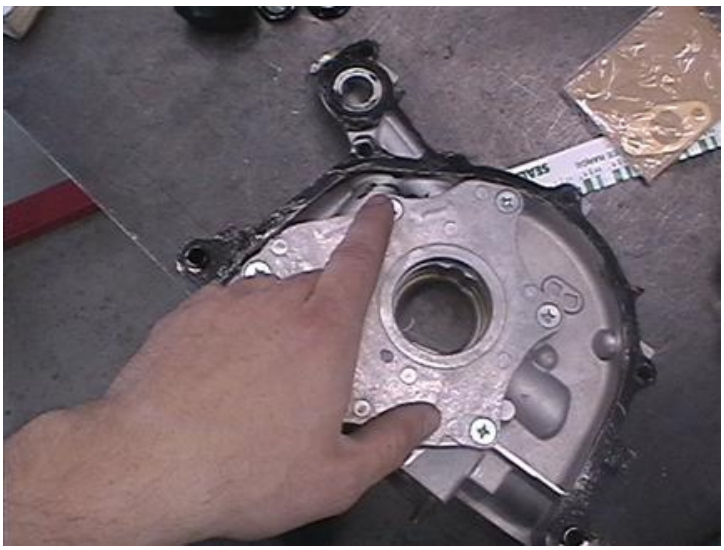
Next the main caps are ready to be installed. Using the graphite bolt compound to help the main bolts overcome friction and give a more accurate torque reading, install the main caps and girdle onto the block:

Torque down the main caps in sequence and specs as listed below:

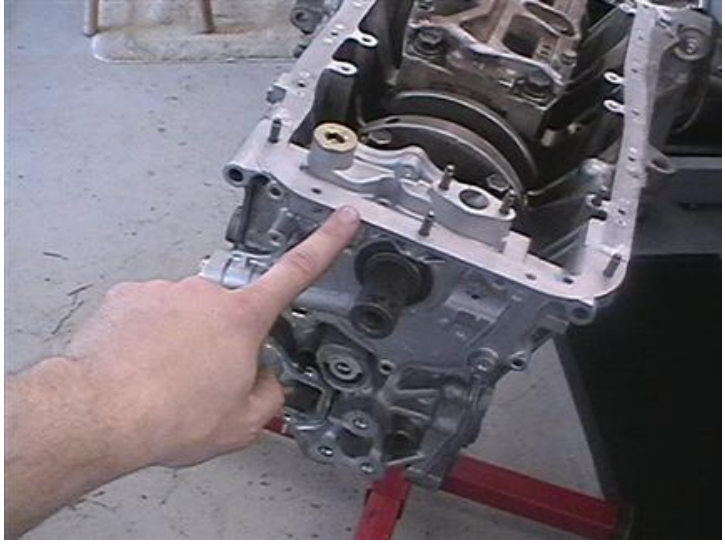




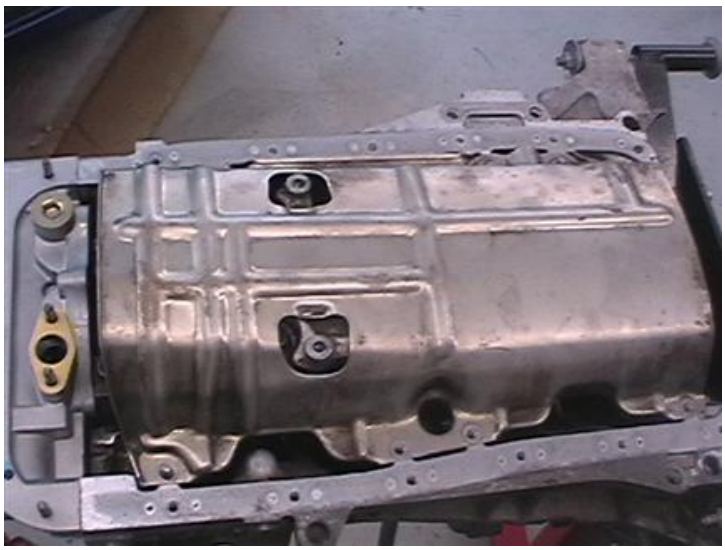
The oil pump needs to be installed. Use a gasket sealer on the pump to ensure no oil can leak. Pictured is the sealant used, and sealant applied to the oil pump:



Here is what it looks like installed:



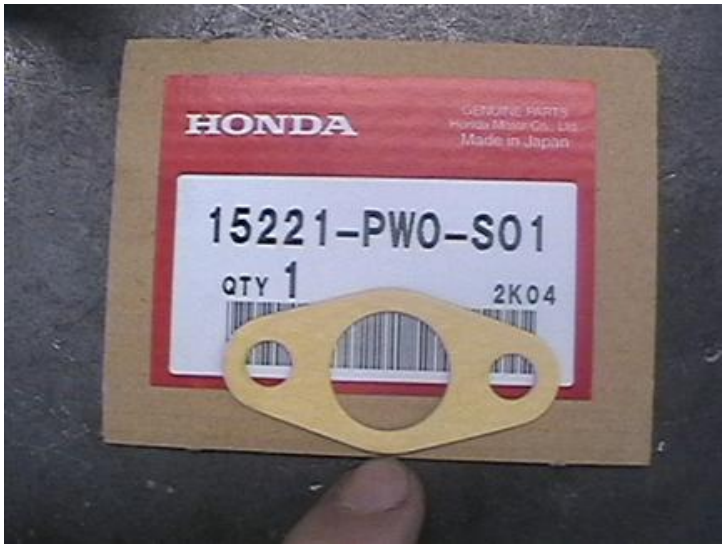
Next the windage tray needs to be installed onto the engine. Here is the windage tray, and windage tray installed:



Lastly the oil pick up must be installed. Pictured is the oil pick-up:

Notice the pick up neck:

The following gasket needs to be installed:



Place the oil pick up on the engine, and tighten down:

The finished product: