

# **BUDGET ENGINE REBUILD**

## **Part 1: "The Tear Down"**

*by Dennis Mignogno*

For those of you who don't know me my wife and I bought a 1941 4 door Champion. The engine in the Champion was toast beyond repair. The plan is to build a daily driver on a budget for my wife. Since I was a certified ASE master mechanic I will rebuild an engine myself. This article will walk you through how I will do a budget engine rebuild. A budget engine rebuild can be done with hand tools and a small amount of specialty tools you can buy inexpensively or borrow from good friends. An engine rebuild is not hard. The trick is knowing what to let the machine shop do. The engine for our Champion will be a 4.3 liter V6 from a 1990 S10 pickup, which a friend gave me for free. Free is good. My friend told me the engine ran great; he just didn't need it.

Before tearing down the engine I wanted to find out what condition it was in. So I mounted the engine on my engine stand along with the starter so I could run a compression test. To run a compression test, remove the spark plugs and connect a compression gauge to each cylinder one at a time. Crank the engine over three times and check the reading. The reading on my engine at each cylinder was 150 psi. This is a good reading and a good sign that the engine did run as good as he said it did. If you have low compression on one cylinder you can do an air leak test to determine where the problem is located. To do an air leak test rotate the crankshaft so the cylinder in question is at top dead center. Apply air to the cylinder, about 10 psi, and listen for an air leak. If you hear air leaking at the exhaust there is a problem with the exhaust valve. If you hear air at the intake the problem is an intake valve. If air is coming from the crankcase you have a piston ring problem.

Since the compression on my engine was good I started the tear down. If this is the first time you've ever done this I suggest you place the bolts from each item in marked baggies. I removed the valve covers and intake manifold to find a large amount of sludge build up. This usually occurs with cheap oil and a lack of oil changes. Next I removed the valve rockers and push rods. Make sure to check all parts for wear as you go. Next I removed the valve lifters. If the lifters are flat bottom lifters check the bottoms for wear. If the lifters are worn then most likely the camshaft is worn and they will need to be replaced. The 4.3 liter uses roller lifter and showed no wear. Now remove the head bolts and heads making sure to check the old gaskets for defects. Remove the crankshaft harmonic balancer using a puller. Remember if you don't have one this is where good friends come in handy. Next remove the timing chain and gears. Now remove the camshaft. Don't drop it; they break easy when dropped and makes for a bad day.

Now rotate the engine over and remove the oil pan. Inspect the bottom of the oil pan for any metal particles. Any particles that won't pass through the oil pickup screen will end up in the oil pan. My engine had no particles in the oil pan, another good sign. Remove the oil pump and pickup tube. Now comes the moment of truth time to inspect the bearings. First number all of the connecting rod end caps so you know which one is

which when it is time to reassemble. Now remove the number one connecting rod cap and inspect the bearing. The biggest thing to look for are any grooves in the bearing and on the crankshaft journal. If grooves are present you will need to have the crankshaft ground or replaced. I was lucky no grooves or unusual wear. Remove each piston as you go. I use a piece of wood and tap the piston out. If there is a large ridge at the top of the cylinder wall you will need a ridge cutter to remove the ridge before you remove the piston. The ridge on the 4.3 was small, so I was able to tap the pistons out. Always put the rod cap back on the connecting rod as soon as you remove it. Never interchange the rod caps with another rod. After you have removed the pistons it is time to remove the main bearing caps. Use the same numbering process and then remove and inspect the bearings.

Now that the engine is apart it is time to decide what the machine shop needs to do for you. I always recommend that at a minimum they cook the block and install new freeze plugs and camshaft bearings. I have seen too many folks not replace the cam bearings causing low oil pressure. The first place the oil goes once it leaves the oil pump is through these bearings and if they are worn the pressure is lousy. On my 4.3 I had the machine shop cut the ridge and hone the cylinders. While the engine block is at the machine shop have them order you a rebuild kit. They will even check the crankshaft for the proper bearings. I ordered a kit with a full gasket set, main bearings, rod bearings, cam bearings, piston rings, freeze plugs and oil pump. The kit and the machine shop work only cost me \$360. Not bad for a budget build.

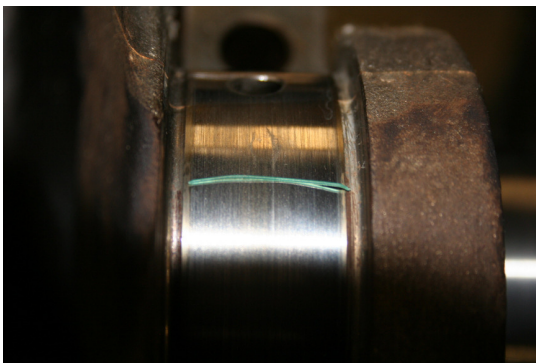
While the block was at the shop I disassembled the heads. You can buy a valve spring compressor for \$9. I removed the valves one at a time, keeping them in order so they can go back into the proper place. I inspected each valve and found no wear. I find on newer engines that you don't find valve wear like you did back in the sixties and seventies. Now it is time to clean everything. I recently bought a water base parts cleaning tank. For a cleaning solvent I'm using Simple Green. The trick here is to be patient. I soak the parts for 24 hours and find that most of the gunk and carbon are gone. The rest of it comes off with a little brushing. Look for part 2 next month. The block will be back and I will start the rebuild.

## BUDGET ENGINE REBUILD

### Part 2: “The Short Block”

*by Dennis Mignogno*

Last month I walked you through how I tore down my 4.3 liter and sent the block to the machine shop. Well, the engine block is back and it is time to reassemble the bottom end. The first thing I do is run a tap in all of the bolt holes to make sure the threads are clean. Next, find a service manual so you have the torque specs and bearing oil clearances. Once that is done it's time check the new main bearings for proper oil clearance. This is done using plastigage. Do not use any oil on the bearings when you're checking oil clearance. Install the main bearings in the block and main bearing caps. Carefully place the crankshaft in the block. Place a strip of plastigage across the bearing journal surface and install the bearing caps. When you torque the bolts always cut the torque spec into thirds. If the spec is 75 lbs torque the bolts to 25 lbs first, then 50 lbs and then finally 75lbs. After you have torqued the bolts remove them and the bearing caps and check the oil clearance by comparing the chart on the plastigage paper and the plastigage on the bearing journal. If the oil clearance is wrong you will need to talk to you machine shop guy. If the clearance is good remove the crankshaft and apply oil to the bearings and install the crankshaft. Don't forget to install your new rear main seal.



Now it's time to install the pistons. The first step is to make sure the piston ring grooves are clean and then install the piston rings on the pistons. Most pistons have three grooves. The bottom groove is the oil ring groove, and the top two grooves are compression rings. The piston rings come with instructions that show you which way they go. First install the oil rings and then the compression rings. Be careful not to spread the rings too far when installing them on the pistons. Piston rings will break and this makes for a bad day. Once the piston rings are installed oil the cylinders and the piston rings. You will need a piston ring compressor to install the pistons in the cylinders. Remember, in part #1 I said if you don't have the tool find a friend who does. Make sure that the gaps in the piston rings are not lined up together. The gaps should be staggered around the piston. Install the ring compressor on the piston. Then insert the piston in the cylinder. Tap the piston down into the cylinder. I use a hammer handle to tap the piston

into place. Once the piston is in plastigage the rod bearing using the same process we used on the main bearings.

Next, install the new oil pump. A trick to help the oil pump prime is to remove the oil pump cover and pack the pump with white lithium grease. In all the engines I have rebuilt I have never had a problem getting the oil pump to prime using this method.

Install the oil pickup tube in the oil pump. The 4.3liter engine has a pickup tube that can be adjusted. To adjust the pickup tube leave it a little loose in the oil pump. I place a  $\frac{3}{4}$  inch block on the bottom of the pickup tube and then place the oil pan on the engine. This will push the pickup tube to the proper location. Remove the oil pan and the block and tap the pickup tube into the oil pump. Install the new oil pan gasket and the oil pan.

Now rotate the engine block over so it is upright. Time to install the camshaft. Make sure to oil all the bearing surfaces and slide the camshaft carefully into the block. They make a tool which you can install on the front end of the camshaft which acts as a handle to help you install the camshaft. I use a long bolt with the proper threads to do the same thing. Once you have installed the camshaft it's time to install the timing chain and gears. Check your service manual for the proper orientation of the gears. There are dots on the face of the gears. On most engines the dots on the gears line up with each other, but check the manual. Now replace the crankshaft seal on the timing cover. Make sure the gasket surfaces are clean. Install the new gasket and timing cover. Then install the vibration dampener. Make sure you torque the vibration dampener bolt to its proper torque. It makes for a bad day when you're driving down the road and your vibration dampener falls off. Now the short block is done. Next month we will tackle the top end.

# **BUDGET ENGINE REBUILD**

## **Part 3: "The Top End"**

*by Dennis Mignogno*

Last month we reassembled the short block. Now its time to finish the rebuild by assembling the top end. If you remember, my valves were in good shape so I didn't need any machine shop work. I soaked the heads in my parts cleaning tank overnight and then hit them with my pressure washer. I also soaked the valves in the parts washer and then used a wire wheel to clean any carbon off the valves. When you do this make sure you are not heavy handed on the valve face. You can damage a valve face with a wire wheel. Now that everything is clean, reinstall the valves one at a time. I apply a little oil on each valve when I install them. This helps on initial start up. Make sure you install new valve seals on the valves. If you don't install the valve seals the engine will smoke on initial start up. After I install each valve spring and keepers I tap on the valve with a plastic mallet to make sure the keepers are properly seated.

Now that the heads are reassembled, time to install the heads on the block. Take the time to run a tap in the head bolt holes in the block to clean out any debris. Also clean the threads on all of the head bolts. Make sure all gasket surfaces are clean and install the head gaskets and heads. Install the head bolts and torque them to the proper torque.

Most manufacturers have a torque sequence for installing the head bolts. If they don't, torque the head bolts in a clockwise pattern starting in the center and working your way out. Also, as I stated in last month's article, divide the torque setting into thirds and torque the bolts accordingly. Now that the heads are on, install the push rods and rocker arms. Make sure you thoroughly clean the push rods and rocker arms. Oil passes through these components so it is important that no dirt is in the oil passages. Check your service manual for the proper valve adjustment. Each engine is different. The 4.3 liter I'm rebuilding uses hydraulic lifters so the adjustment is to tighten down the rocker until all play is gone and then tighten down an additional  $\frac{3}{4}$  of a turn. On a mechanical lifter the adjustment is done with feeler gauges and is usually done with the engine hot.

Now install the intake manifold and the exhaust manifolds. I normally try to install everything I can on an engine before I install it. It is usually a lot easier to install components on the engine while it is on the engine stand than in the engine compartment. I do not, however, install the distributor or the carburetor. It is too easy to damage these components. I also prime the oil system before I install the distributor. There are two ways of priming the oil system. The first is to take an old distributor shaft and grind the drive teeth off the shaft on the bottom end and cut the top of the shaft off so it can be put in a drill. Put the shaft in the drill and slide the shaft down onto the oil pump. Run the drill for about a minute or two and you will have primed the engine. The other way is to install the distributor and crank the engine over with the coil wire out. Crank the engine over until the oil light goes out or you show pressure on the gauge.

Time for some tips. I never use synthetic oil in a fresh rebuild. Piston rings don't break in as well when you use synthetic oil. If you want to use synthetic oil, wait until your first oil change. Don't be cheap -- always use fresh antifreeze. While the engine is out, now is a good time to detail the engine compartment and change any engine hoses.

I hope after reading this some of you will consider doing an engine rebuild yourselves when the opportunity presents itself. You can save a lot of money and it is very satisfying. Let's recap. The 4.3 liter engine \$free\$. An engine rebuild kit and machine shop work \$360. Hearing the engine you just rebuilt start up for the first time \$priceless\$.