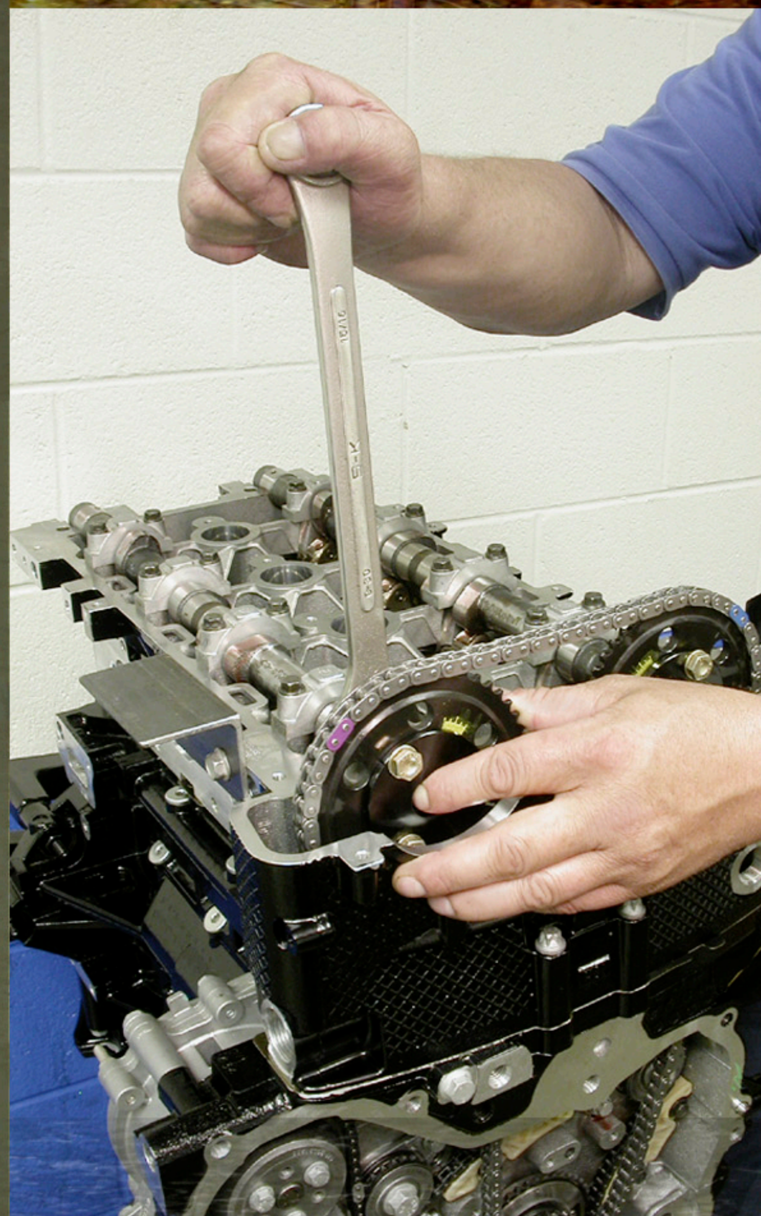
BUILD YOUR OWN

300+ hp Ecotec Four Cylinder Performance Engine

PART 4 of 4

This is the fourth and final installment in the building of a 300 hp Ecotec four cylinder engine. The main goals of this installment are to show how to get all the components working together properly. The most important of these details is making sure the camshafts are 'timed' properly to the crankshaft and reciprocating components. This procedure is painstakingly covered here for you to replicate—which is great for you as it is absolutely critical you get this 'right'. Then you'll see how to mount the air inlet system, which includes the intake, intercooler, and supercharger. Also, details on how to install many of the covers that seal up the engine are discussed.

While these steps are time-consuming and critical to the successful operation of your newly powerful Ecotec 2.0 L engine, you can perform the work knowing you are in the final stages of building a great engine that will provide thrills for many miles to come. Enjoy!



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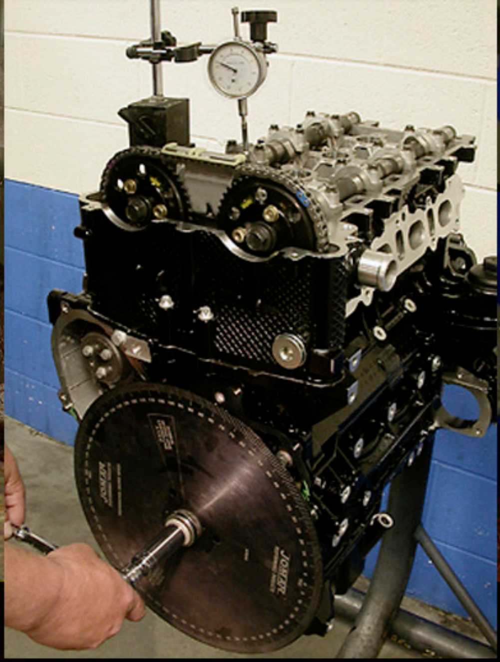
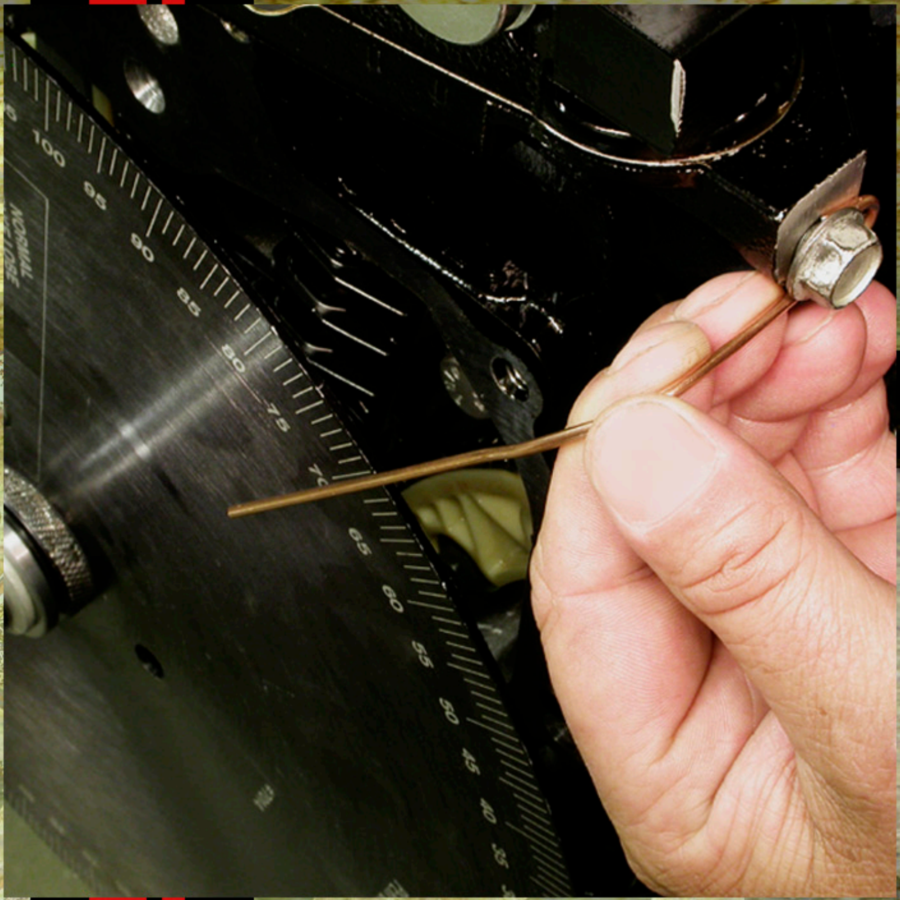
Checking the cam timing in relation to crank location

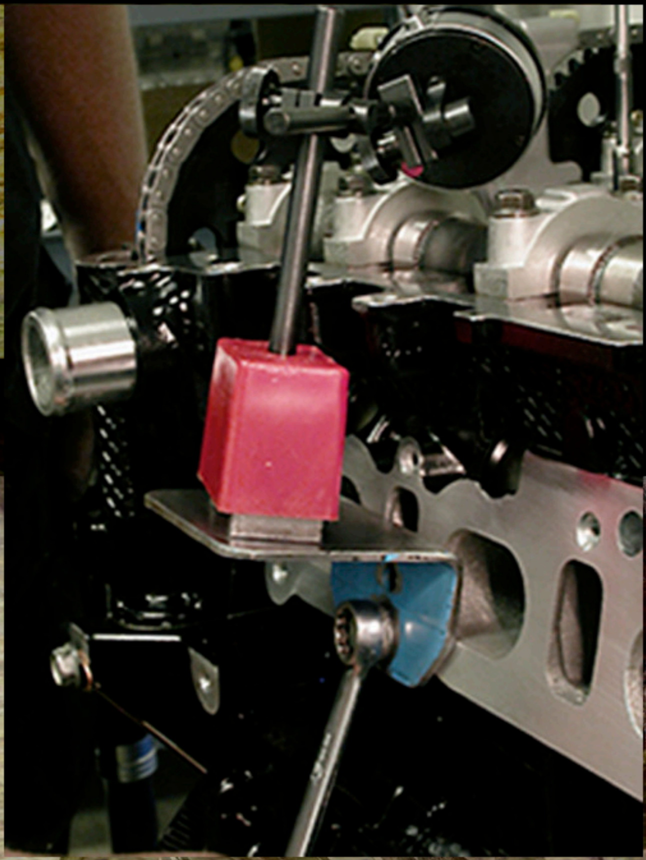
96. It is important to know exactly where the 'timing' of the camshafts is in relation to the crankshaft location. This is even more important on a dual overhead camshaft (dohc) engine than a cam-in-block, pushrod engine because if, for example, the intake cam is improperly phased in relation to the crankshaft on a dohc engine, the intake valve and piston on many cylinders will come in contact with each other. To avoid this problem, you are about to see how to determine the exact 'timing' of the cams in relation to the crankshaft and how to set the timing of the cams on an Ecotec engine.



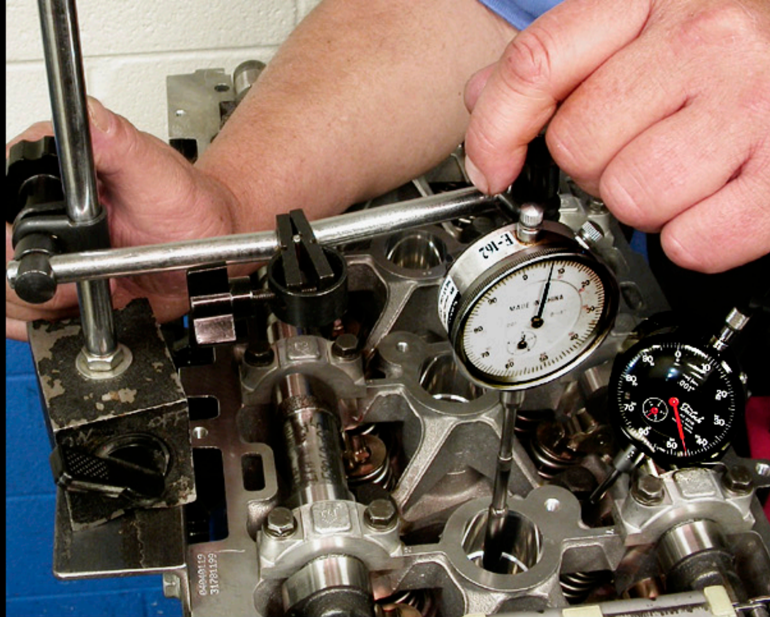
97. Install degree wheel on snout of crank. A large degree wheel needs to be acquired for this activity. Bolt it handtight (*for now*) to the snout of the crankshaft.



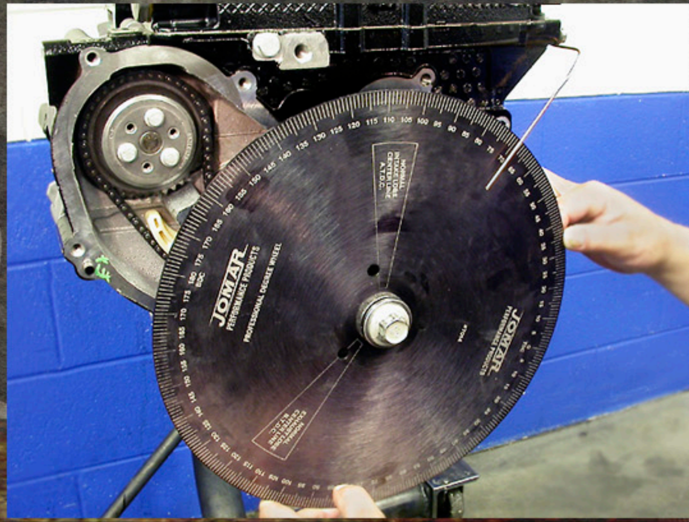
98. Create a wire 'pointer' and mount it firmly on the engine block. The end needs to be placed close to the surface of the degree wheel face so the numbers can be read clearly without variation.



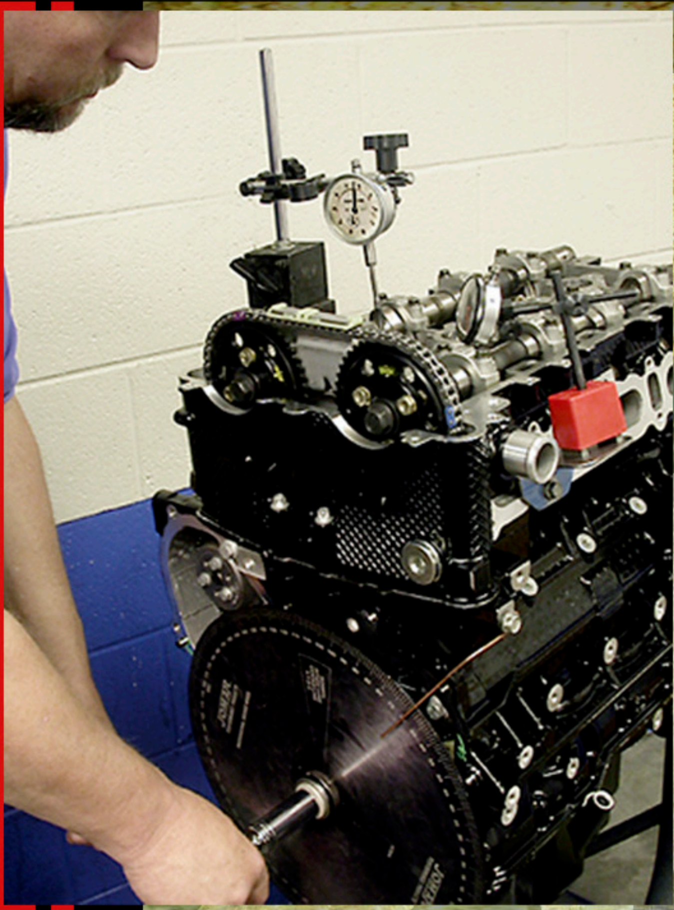
99. Two dial gauges with stands will also be needed to measure the piston location and valve locations. Simple angle-iron mounts with a hole drilled into one of them work great—mount them on the side of the head and affix the dial bore gauges to these with their magnetic bases.



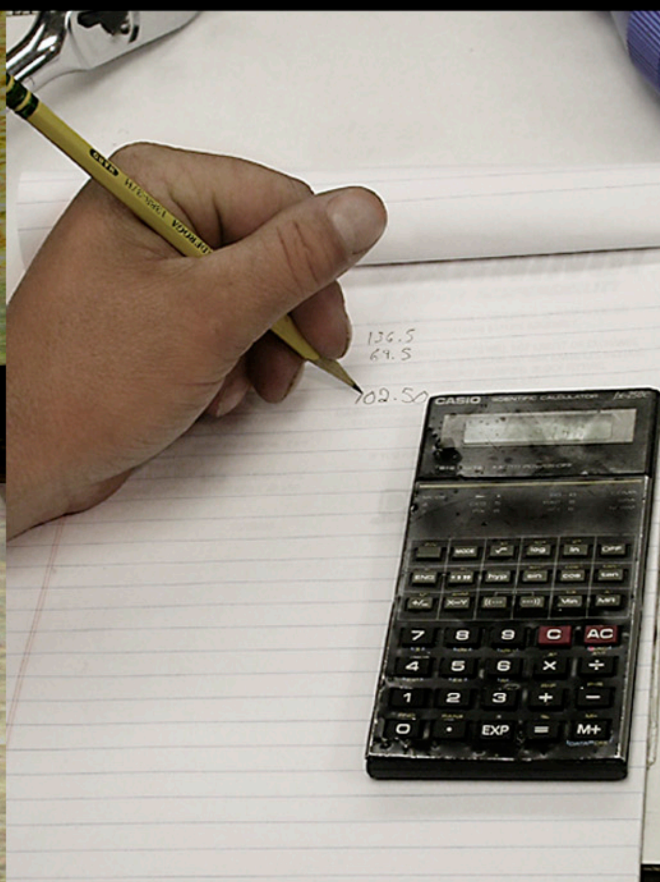
100. On the No. 1 cylinder, install the dial gauge so its plunger reaches down through the spark plug hole to touch to top of the piston. The other dial bore gauge plunger should rest on a retainer of one of the No. 1 cylinder intake valves. Align both gauges so the plungers are 'in line' with the stroke of the piston or valve—so their measurements are accurate.



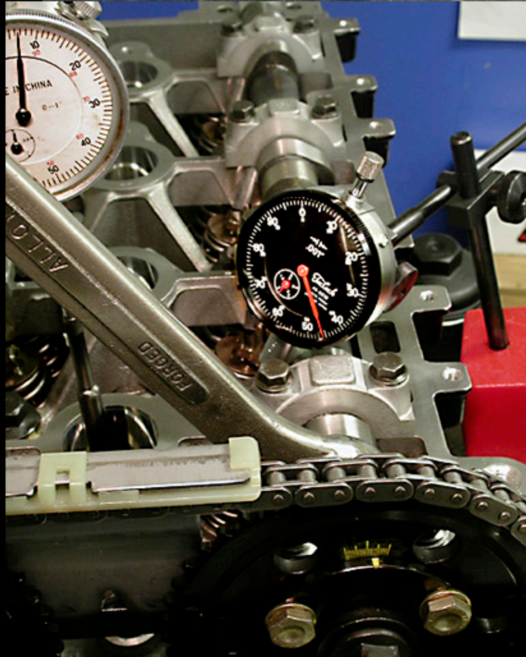
101. Work the crankshaft rotation back and forth until Top Dead Center is located on the dial gauge—the piston will change direction at TDC, so keep 'zeroing' in on this location. Then 'zero' out both gauges by rotating the dial until the pointer is aimed at 'O' on the gauge. Also rotate the crank degree wheel until it reads 'O'. As a caution, never rotate the crank more than a few degrees to avoid the chance of the valves hitting the top of the pistons—remember, you don't know where the cams are located in relation to the cam!



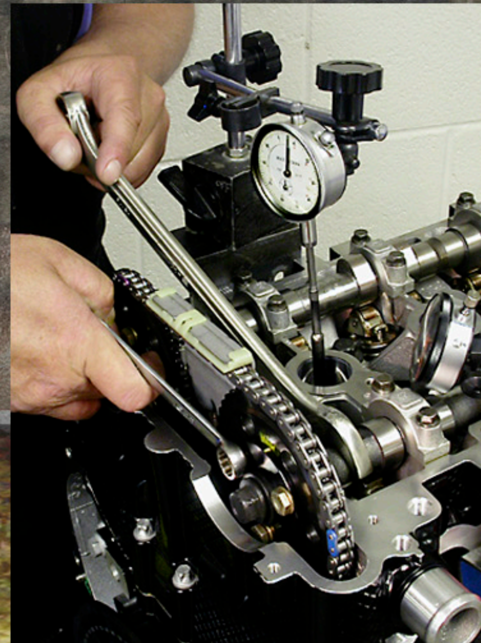
102. Rotate the crank until the valve lift reaches 0.050 inch and stop. You are going to read the degree wheel, then rotate the crank around to 0.050 inch lift on the other side of TDC, so make sure you take good notes of these points. As a note, you could pick any valve lift number you'd like, but most engine builders use 0.050 inch lift because this is enough to eliminate any slack in the valvetrain but not so much you get false readings on the camshaft lobe.



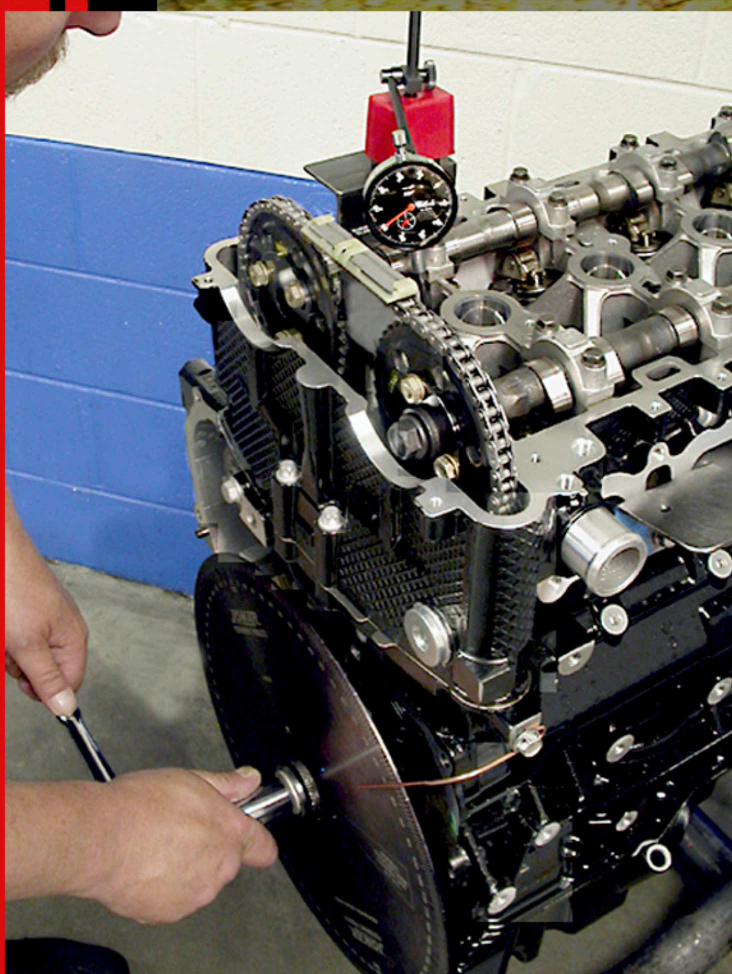
103. So you've written down the crank position (*in degrees*) for both before and after TDC at 0.050-inch valve lift, now what, right? Well, add these two numbers together and divide by 2 to determine the centerline of the intake cam lobe location in relation to the crank location (*also in degrees*).



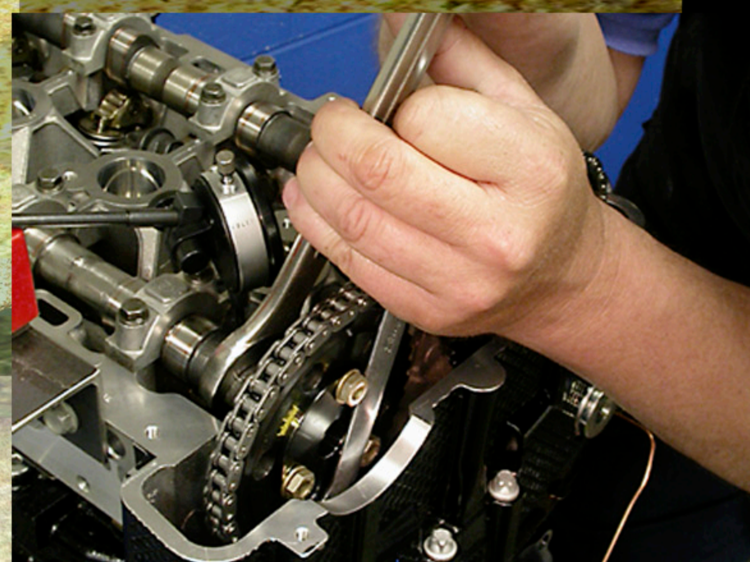
104. The intake cam was supposed to be centered at 102 degrees on the crankshaft. The 0.050 inch lift numbers were 136 degrees and 69.5 degrees. Adding these together and dividing the sum by 2, equaled 102.25—which for most engine builders would be called 102 degrees.



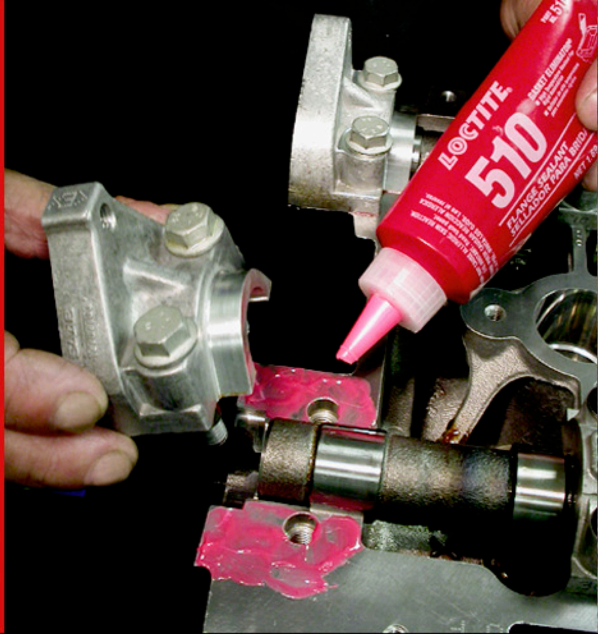
105. With that, we snugged down the intake cam gear holddown bolts to hand tight in preparation for doing the exhaust cam timing. You'll torque these down in the final steps of this process.

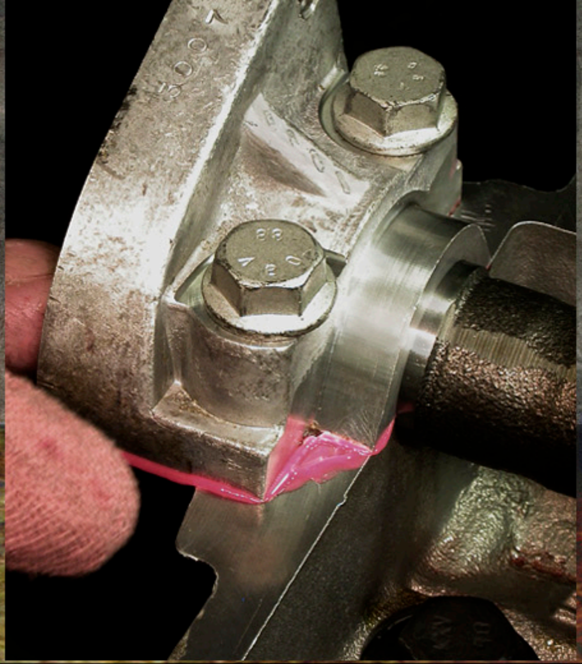


106. Move the valve height dial gauge to an exhaust valve on the No. 1 cylinder and repeat the process of determining TDC, zeroing the gauges and degree wheel and running through 0.050 inch lift at before TDC and after TDC, recording the degree wheel location at each point.



107. Once you have done the math on the cam lobe centerline location (*in this case, the cam showed 149.5 + 80, which was divided by 2 to equal 114.75—close enough to 115 degrees, which is what we wanted*). You will probably have to twist on the hex portion of the exhaust cam with a 15/16s inch open-end wrench to get the cam gear to line up with the correct position needed on the exhaust cam. With both cams located properly, torque the three 13 mm head bolts to 89 in-lbs with one drop of red Loctite on each bolt and then torque the center 18 mm bolt (*with one drop red Loctite on the threads*) to 65 ft-lbs. Finish this entire process by positioning the crank with the No. 1 piston at TDC.

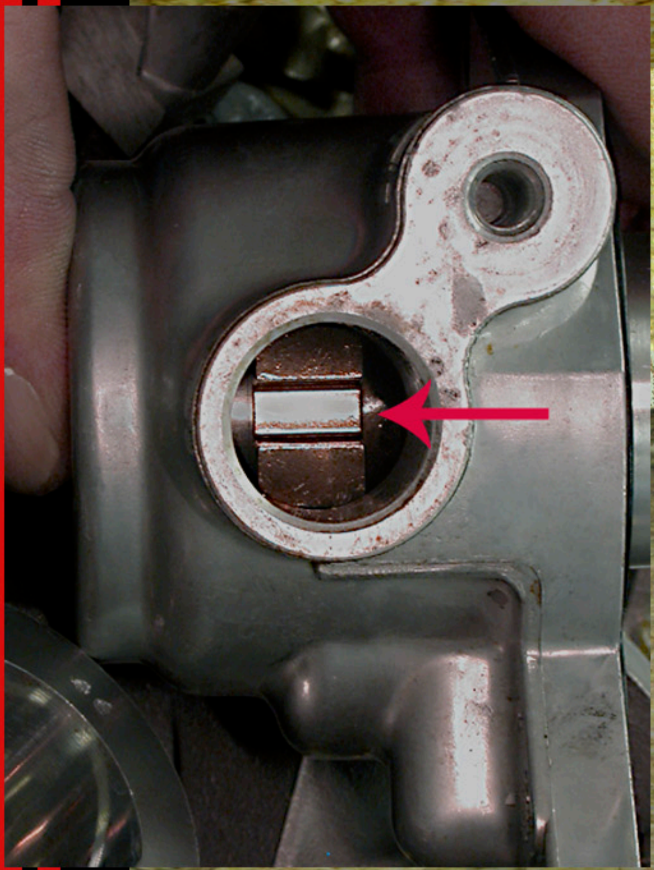


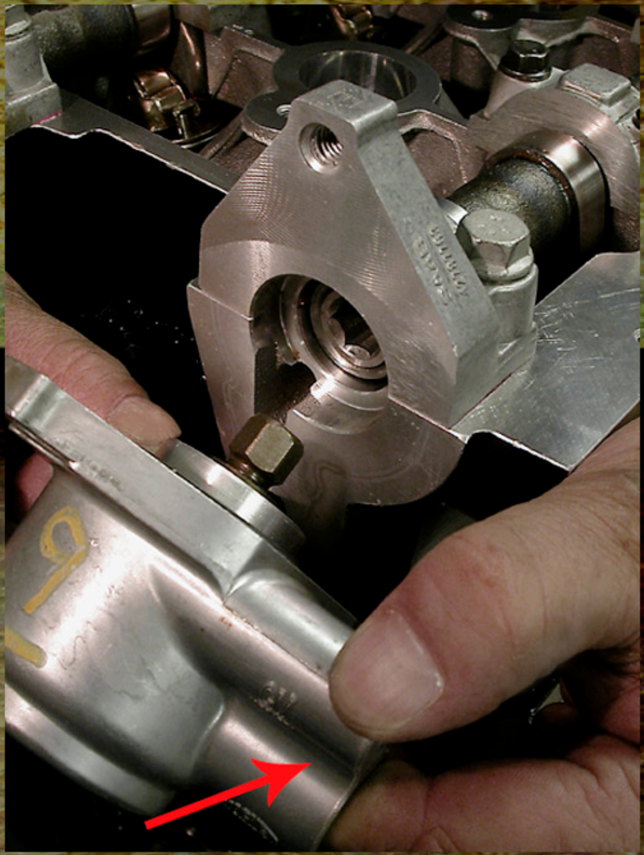


Installing cylinder head top end components

108. The two rear cam caps sit outside of the valvecover and therefore require a light coat of Loctite 510 flange sealer (*a non-hardening sealer*) to be applied to the mating point between these two metal parts. The caps should then be torqued to 15 ft-lbs.

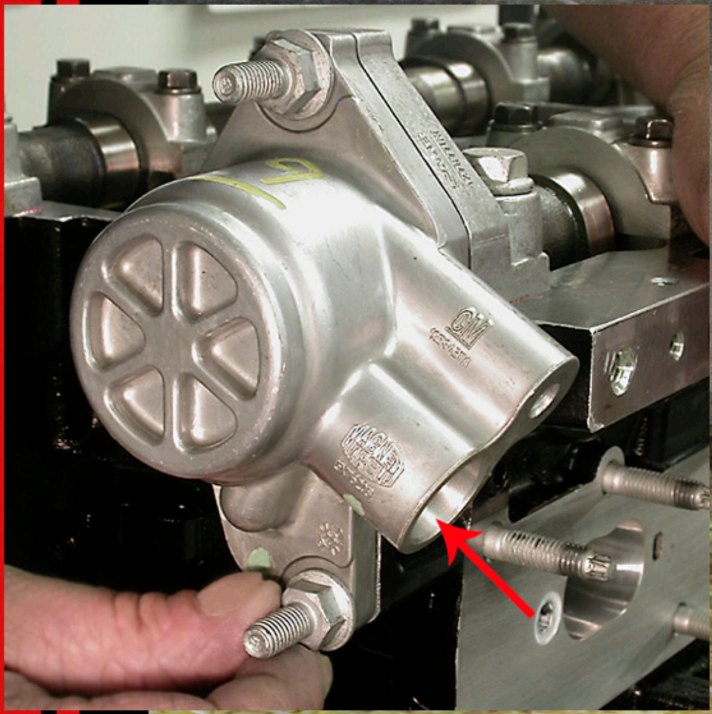
109. It is important to completely wipe off any sealer that is forced out of the mating point between the cap and cylinder head to avoid it getting into the engine oiling system.

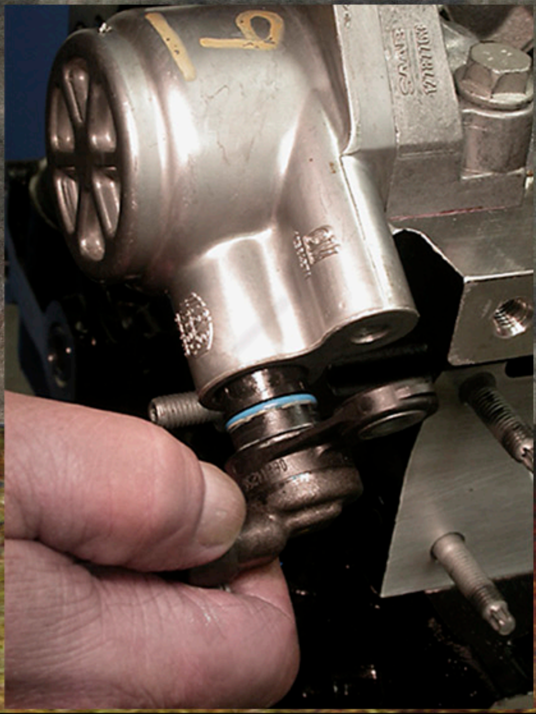




110. A key step that needs to be carefully completed is the installation of the cam sensor wheel and body. This notch (*arrow*) is read by the sensor to indicate where the engine is in its firing order, so it is critical to get it installed on the hex gear drive in the properly clocked location.

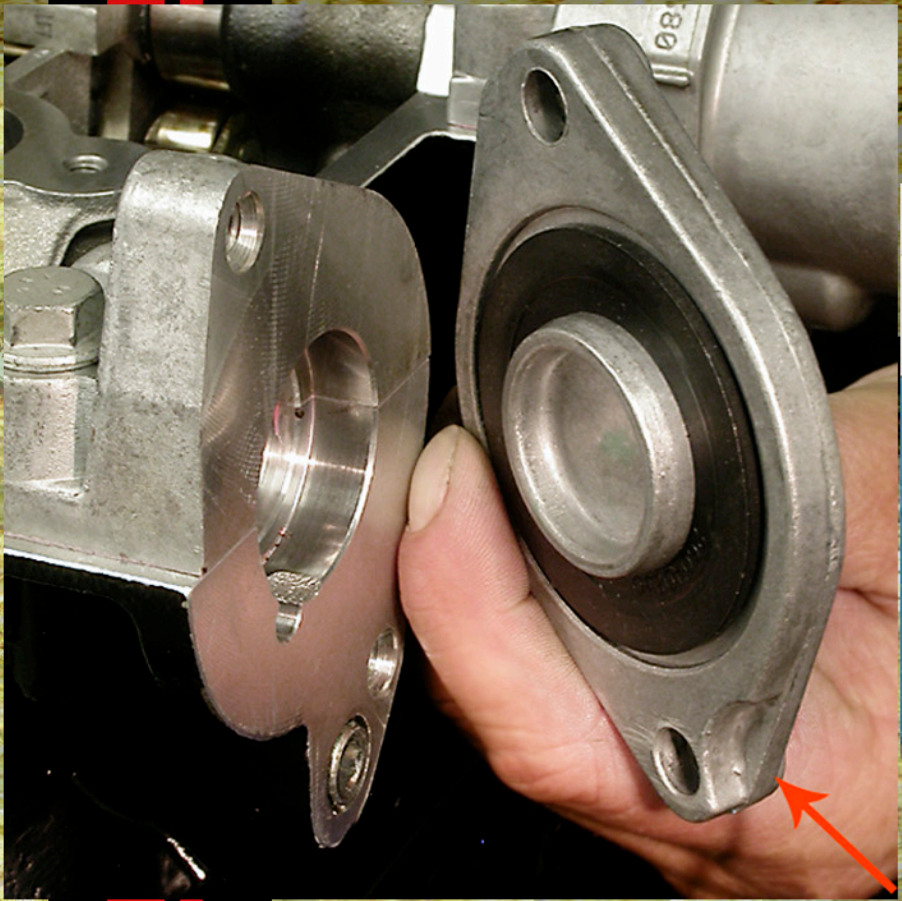
111. As you can see, there is a male and female hex engagement that must go together. To get the sensor wheel installed correctly, place the notch in the 4 o-clock position (*arrow*) when looking at the wheel body from the back of the engine. Make sure the engine is on the No. 1 piston's compression stroke and slide it onto the hex drive gear coming off the exhaust camshaft.

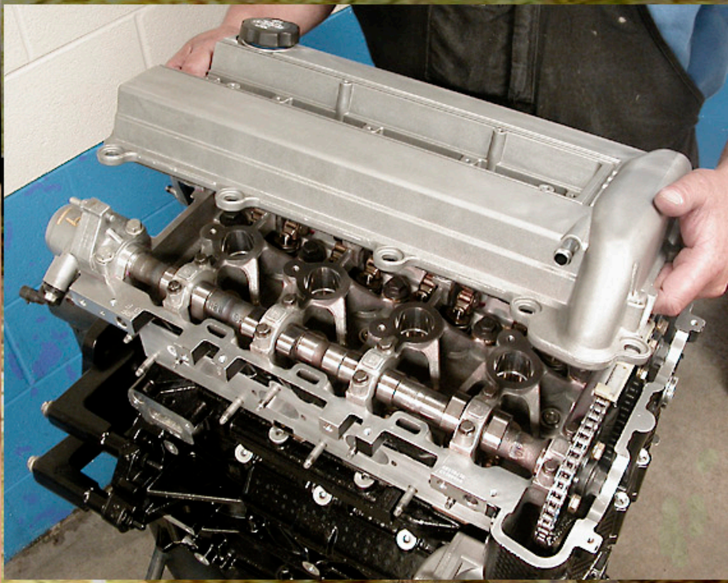




112. The stud/bolts holding the cam sensor body on the head should be torqued to 10 ft-lbs with a drop of red Loctite on their threads. You should be able to see the notch by looking up the hole for the sensor. (*arrow*)

113. The cam sensor should now be installed in the sensor wheel body by torquing the bolt/stud to 89 in-lbs.



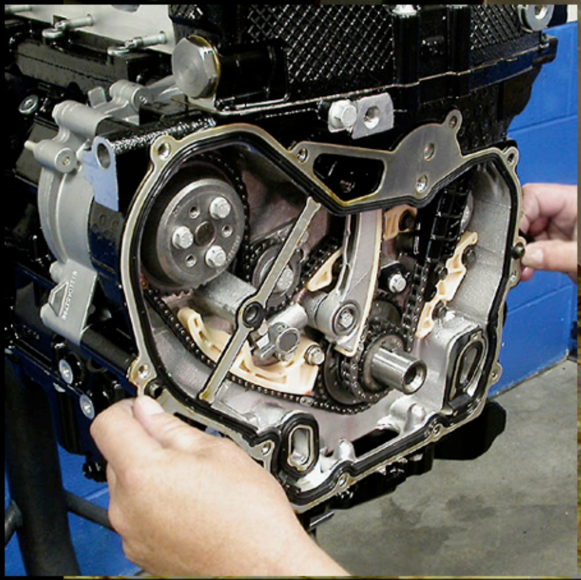


114. The rear cam cover plate on the intake cam side needs to be installed with the notch in the face of the cover (*arrow*) located near the bottom bolt. This is to clear the Allen head bolt in the block—if you don't do this, the plate will leak profusely on startup of the engine ! Torque the two 13 mm bolts to 10 ft-lbs.

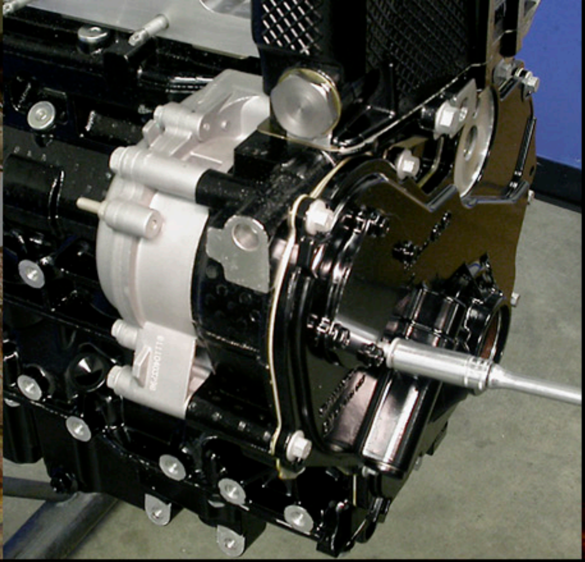
115. The valve cover, with its compression style gasket, can now be installed. Torque the bolts to 89 in-lbs.

Installing front cover/oil pump and systems

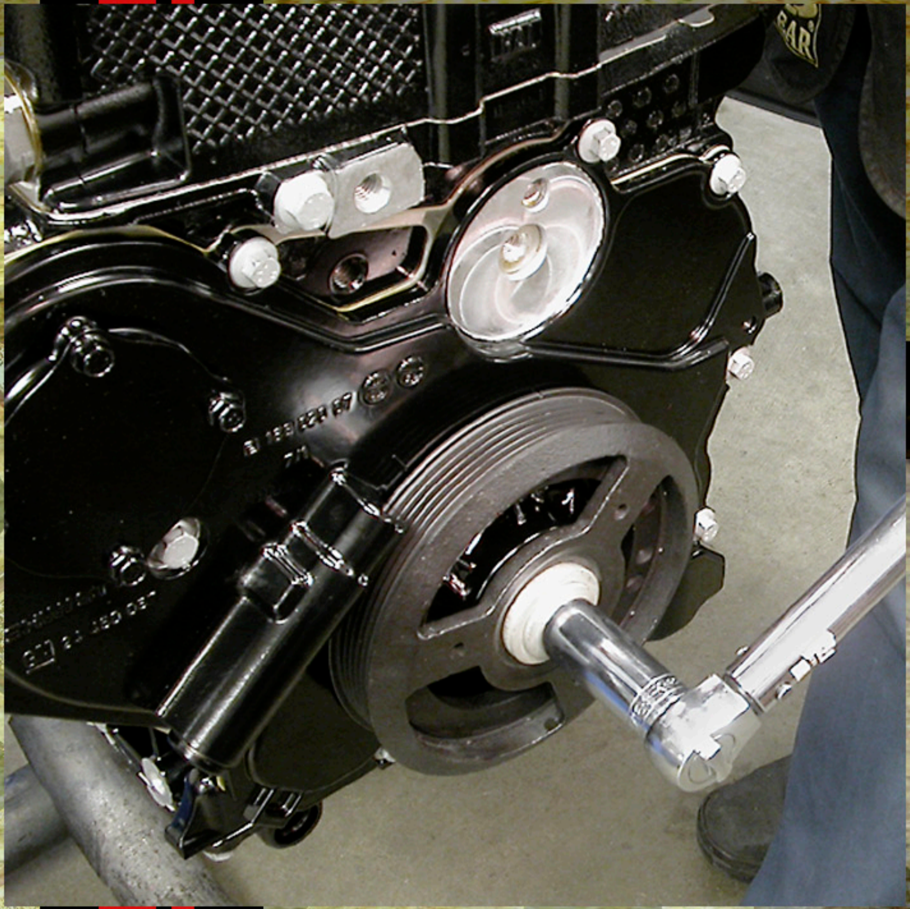
The final steps of installing the front cover with the integrated oil pump require attention to detail, but are not difficult.

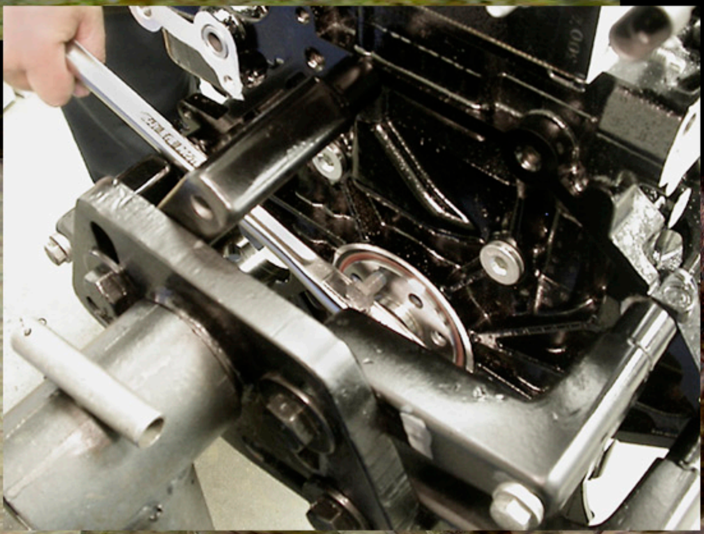


116. Position compression-style front cover gasket on the dowels protruding from the block in preparation for installing the cover.



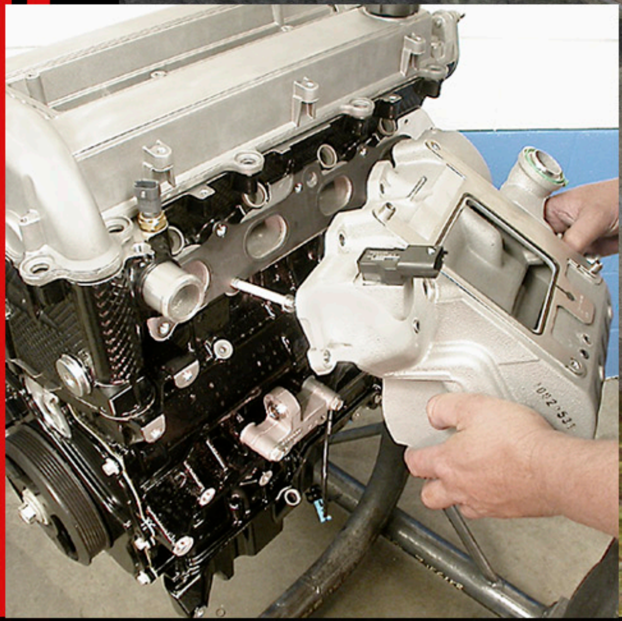
117. Rotate the oil pump until it is clocked to locate on the key so it will slide on the crankshaft. Then, install the integral front cover/oil pump over the gasket and locate it on the dowels. Install the front cover bolts to hand tight and install the final water pump bolt to hand tight. Now torque the front cover bolts down to 10 ft-lbs in a radial pattern and install the water pump bolt to 12 ft-lbs.





118. Slide the integral harmonic balancer/front pulley on the crank with its pointer located on the TDC position (*this will allow it to mate with the oil pump drive*) and torque the NEW bolt (*GM pn 11589123*) to 76 ft-lb (*100Nm*) and twist 125 degrees (*+/- 4 degrees*). Apply engine oil to the bolt threads before installing.

119. When torquing the harmonic balancer bolt down, hold the crank in position with a breaker bar wedged between three bolts threaded at least ½ inch deep into the crank flange.



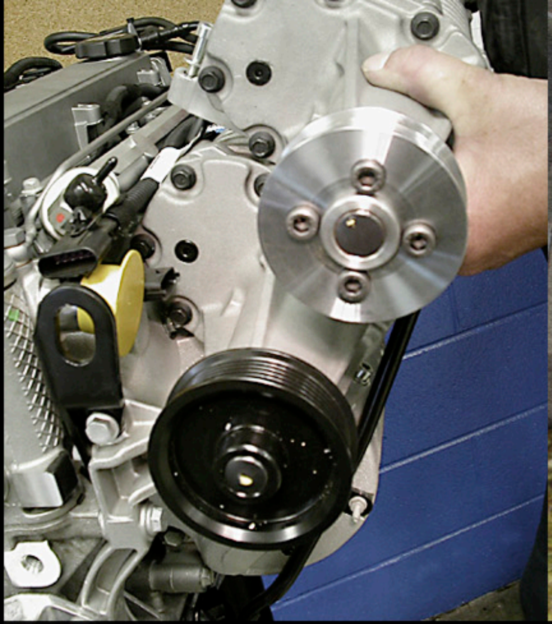
Installing intake system

120. The intake manifold is initially installed on these two E12 Torx studs that have been torqued to 100 in-lbs. Then, install the five 13 mm bolts to 15 ft-lbs. Apply a drop of red Loctite to the threads of every fastener here.

121. GM Performance Division has found the production single pass intercooler can be modified to make real power gains by modifying it to pass the coolant water through the cooler multiple times. The intercooler they are currently running is a 2-pass system (*left*), which means the coolant goes up and back before heading back to the radiator at the front of the vehicle. A 3-pass system (*right*) was tested, but power gains were minimal. This aluminum plate coolant manifold was TIG welded on the intercooler body to allow that to occur.

122. The factory fuel injectors need to be replaced with these performance units that flow 5.64 gallons per second (gps) if you are making more than 230 hp. To do this, lift the tang locking the electrical connector on the fuel injector and pull the connector off. Then, pop this clip off (*arrow*) the injector body and pull up on the injector. Make sure to apply a light dab of fuel injector lube on the new injector O-ring before pushing it into the body to minimize the chances of the O-ring folding over and causing a lead when it seats in the injector bore.

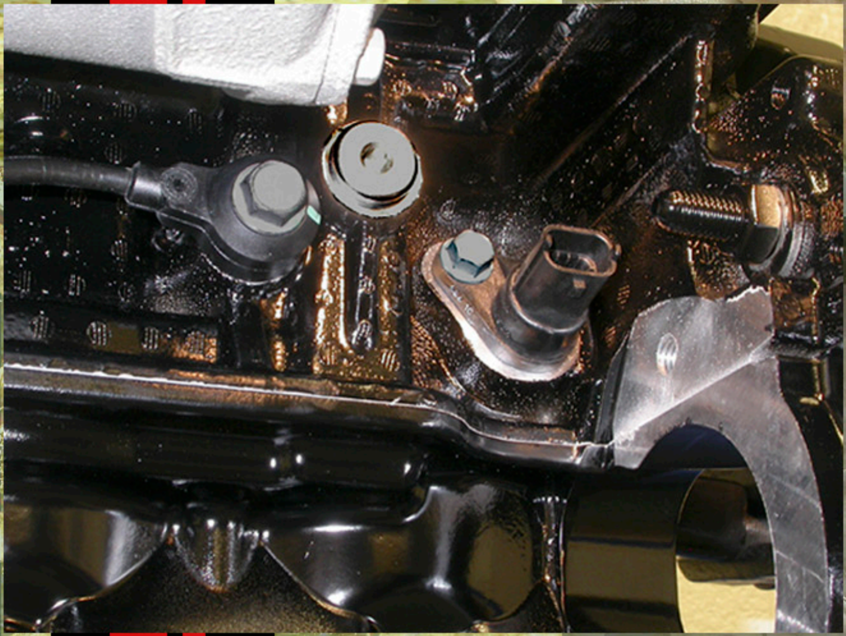
123. The stock supercharger can make the 300 hp and needs to be installed with the factory 8 mm bolts and studs torqued to 18 ft-lbs. The pulley will need to be replaced with a smaller unit to take advantage of the new performance camshaft, valvesprings, pistons and fuel injectors.

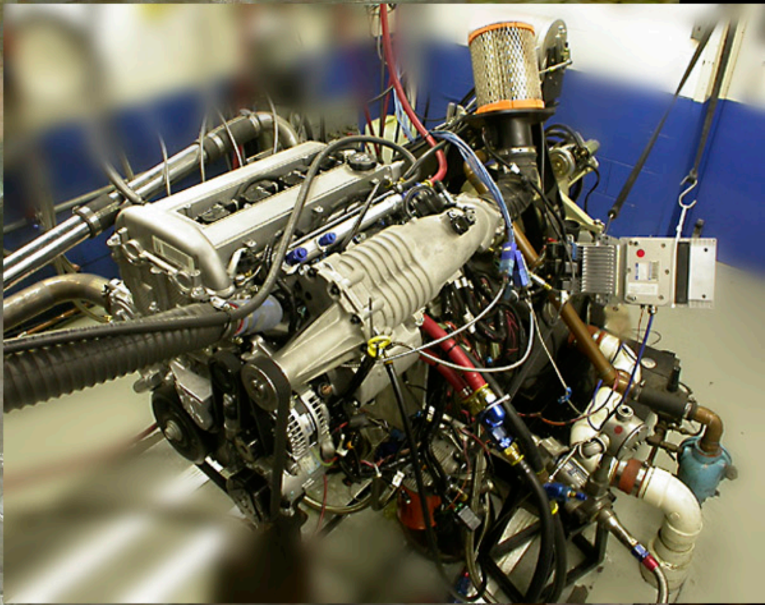


124. The new GMPP 73 mm pulley increases the RPM of the blower vanes, which increases the inlet air boost to the engine. It is installed by removing the bolt holding the stock pulley in place, using a pulley puller on the stock pulley and pressing the pulley on with a pulley installer. Torque the holddown bolts to 16 ft-lbs after applying one drop of red Loctite to the threads.

Ignition system install

125. The stock 'coil-on-plug' ignition is more than capable of firing the air-fuel mixture on this newly built hottie. 'Colder' spark plugs are used to handle the increased compression, engine heat and power output. The spark plugs receive a light coat of copper-slip thread prep to minimize the chances of them galling in the aluminum cylinder head and are torqued to 12 ft-lbs.

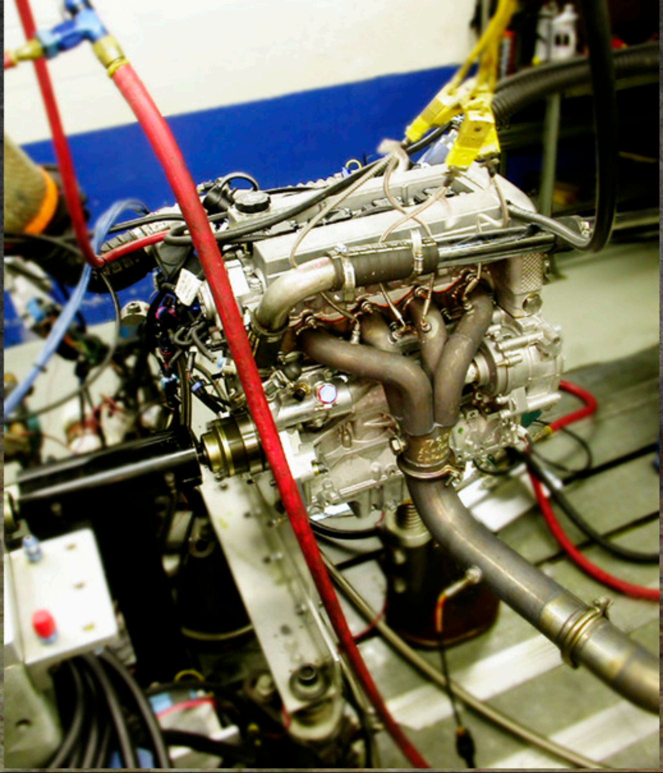




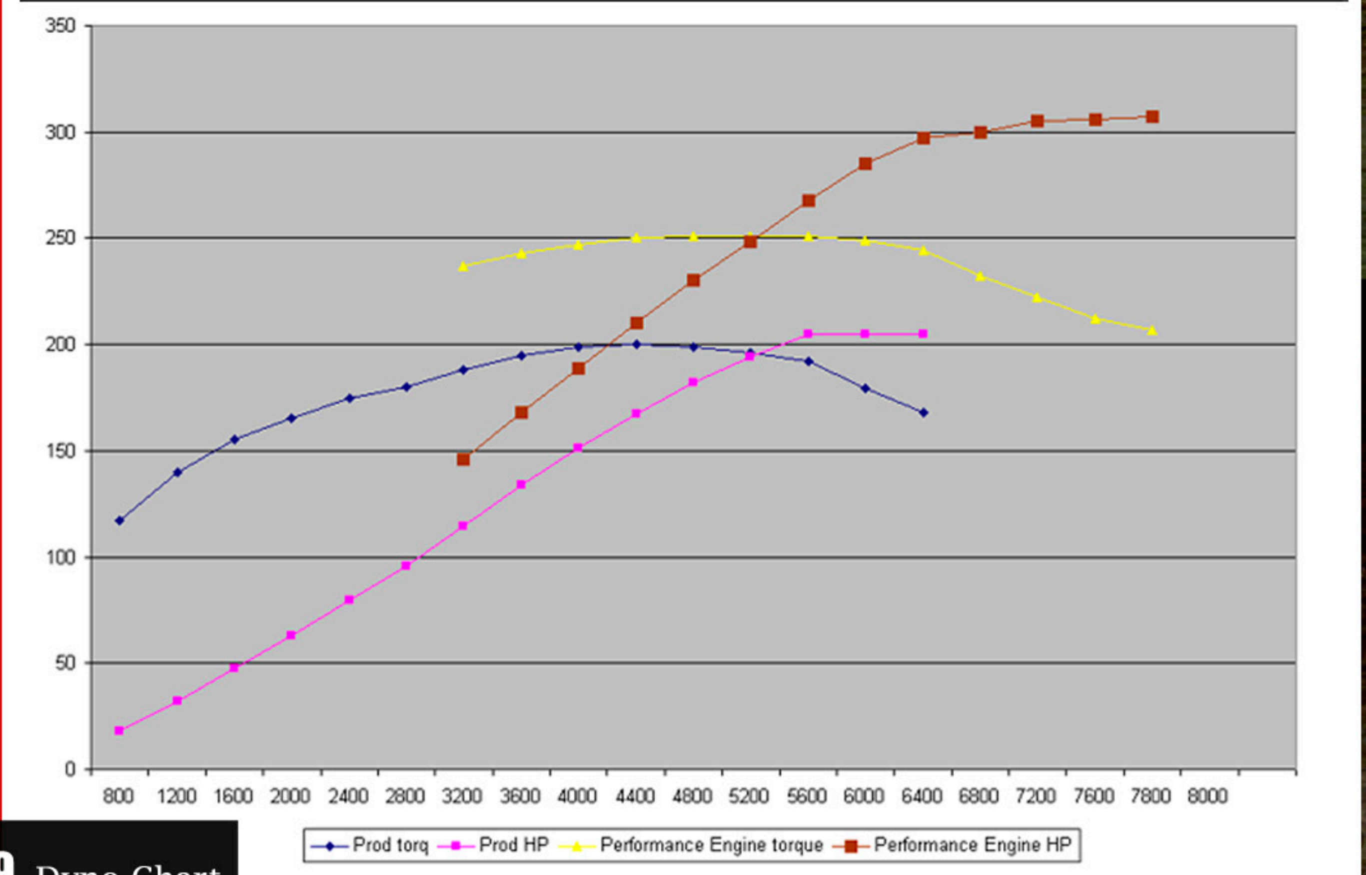
Various external component installs

126. On the intake cam side of the engine block, torque the crank location sensor to 18 ft-lbs, and engine knock sensor to 89 in-lbs.

127. The front engine accessory drive (FEAD) needs to be modified to work with the smaller front pulley. Also, the fuel injector rail has been modified by welding on a male bunge to attach a braided steel line onto it and run the other end to as fuel pressure with gauge.



128. As an FYI, this 300 hp Ecotec runs a custom shorty tube header, stock wiring harness and a modified thermostat housing for the application it is being bolted intos. Check out the dyno chart to see exactly what kind of power this engine produced.



129. Dyno Chart

Thanks for reading about this Ecotec engine buildup. This great engine architecture will be the focus of many more articles in the future, so keep checking up on

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for more information.