This chapter is not just a basic step-by-step section for “how to assemble your engine.” I assume that you already have a basic understanding of engine building and assembly procedures and will focus on those things that make an Ford FE project unique, along with procedures that will improve your engine's performance. The information is organized in engine-build-process order. Some of these concepts have been addressed in earlier chapters, but warrant repeating in the context of the overall build process.

**Finishing the Block Prep**

With your chosen block all finish-machined and mounted to an engine stand, you can prep for assembly. All desired grinding and oiling modifications have been made. The next thing to do is check every threaded opening and oil passage in the block one last time. Few things are more frustrating than having to disassemble a block for more drilling, cutting, or grinding.

For final cleaning, I use a variety of products, one after the other. The first is hot water with a strong detergent. Using rifle brushes and household scrubbing brushes, aggressively go over every surface and follow with a stream of hot water from a garden hose. Mounting a Moroso cylinder-cleaning brush into a cordless drill seems to do a really good job of cleaning up the cylinders.

Certain types of debris seem resistant to hot soapy water but readily come off with brake cleaner. WD-40 removes yet another layer of crud, such as machining oils and embedded debris. It is always a surprise to see how much grime and debris remains behind after the first wash. Once confident in the cleanliness, I use a rubber-tipped air-blow gun to thoroughly dry the block, concentrating on all the threaded holes and galleys. The last step is to wipe down all machined surfaces with WD-40. If a machined surface is truly clean, it will rust almost instantly.

Make a last check for missing galley plugs. The one behind the distributor is easy to miss, as are the small ones used on the oil-pan rail.
on original side oilers. Also look out for the 1/8-inch NPT plug near the oil filter mount on some truck and service blocks because it was an accessory compressor oil-return line provision.

**Cam Goes In First**

The first parts installed in a new engine are the cam bearings. I’ve used a fabricated tool to pull in the bearings, but the common hammer and expanded mandrel installer works just fine as long as you use it properly and pay close attention. Installing the front cam bearing from the rear of the block allows use of the alignment cone, giving you a better chance of getting it in straight.

On a traditional top-/center-oiling FE, the location of the oil-feed hole in the center three cam bearings is not critical due to the annular grooves in the block. Most builders install them at the 3 o’clock position. The front and rear bearings only go in one way to line up the feed holes. On side oilers, the cylinder deck feeds must line up with the holes in the cam bearing. You can darken the build room and use a small LED flashlight to look directly through the hole you’re trying to line up.

With cam bearings in place, I always test fit a known straight and dimensionally correct cam to verify the installation. Bearing deformation during installation causes most binding and tight spots. A careful effort with a knife and a Scotchbrite pad often remedies the problems. New cams can be bent, or have journals on the high side of diameter specs. I’ve turned an old camshaft into a bearing cutter by machining a flat onto each journal, leaving the corners sharp, which is useful for problem blocks.

Install the engine’s “real” cam using oil on the journals. Installing it now allows you to be gentle and smooth on the bearings, minimizing the inevitable bumps from each lobe as it goes into place. It also allows you to install the cam without lube on the lobes, making the job less messy. A touch of lube on the cam front face and you can install the thrust plate. Mount a magnetic dial indicator and check cam-thrust clearance, a quick task with no other parts in the way. The cam should turn easily by hand using the timing sprocket as a handle. Put the proper lube on the cam lobes and go on to the next step in assembly: the crankshaft.

**Main Bearings, Rear Seal and Crankshaft Installation**

Check bearing clearances using a dial bore gauge. Plastigage is useful, but is not precise or reliable enough for performance work. Install your desired main bearings into the block without a rear seal. Install and torque the main fasteners according to the specification using the desired lubricant. Install the cross bolts in 427 engines, and yes, they indeed do make a difference.

Measure the chosen crankshaft journal with a micrometer. Lock the micrometer in the measured position
and lightly clamp it into a vise (aluminum jaws) with the open end facing upward. The dial bore gauge fits into the mounted micrometer and adjusted to read “zero” as you sweep it though the mic’s measuring faces.

Now take the dial bore gauge and slip it into the corresponding main bearing bore. It reads clearance directly as the difference between the bearing inner diameter and the crank journal. The target range for main bearings in iron-block engines is .0028 inch with anything between .0025 and .0030 inch considered acceptable. Aluminum blocks are targeted to about .0020 inch because they enlarge as they warm up.

If you come up with improper clearance, disassemble and inspect the suspect bearing and cap before rushing to judgment. The smallest particle of debris caught under the cap’s bolt face or the bearing shell impacts the reading.

Clearance adjustment can be handled by touch-grinding the crankshaft, or by using selective-size bearings. Either option is perfectly acceptable and yields good results. I prefer to use selective-size bearings because altering the crankshaft makes future service problematic. You can use mix-and-match selective-size bearings either as a complete set or as half-shells to get the desired clearance.

No manufacturer supplies a .001-inch oversize or undersize bearing for the FE. Fortunately, you can use selective-size bearings for the 351 Cleveland engines with minor work. The only difference is the small locating tang, which is in the wrong up position for an FE. Either remove the tang (it’s an assembly aid only and does not prevent the bearing from spinning), or add an extra tang slot.

With vertical bearing clearances measured and addressed you can move to the thrust measurement. Remove all the main caps, lubricate the bearings, and install the block half of the rear main seal. Use a really, really thin film of Motorcraft TA-31 silicone on the seal where it contacts the block, and offset the seal edges relative to the cap face by .100 inch. Lay the crank into place and install main caps, except for the rear one. Install the cross bolts for those spots if equipped. You may need to use a flashlight and a plastic mallet to properly position the caps. The cross bolts must go in smoothly. You do not want to draw the fasteners into place; they should thread in with your fingertips. Torque the vertical fasteners on numbers-1, -2, and -4 main to specification, leaving the thrust cap fasteners and cross bolts finger tight.

Set up a magnetic dial indicator and measure thrust clearance. I use a big screwdriver to wedge the crank backward and forward in the block several times with the last motion being forward. If clearance is sufficient (between .008 and .0012 inch), I torque the vertical fasteners on the thrust cap and recheck before moving ahead. If you do not have enough clearance, you need to remove the crank and make some changes.

Some Genesis blocks have the machined chamfer, where the thrust surface meets the crank journal area, cut smaller than stock. This interferes with certain bearings, causing inadequate thrust clearance, as the bearing gets spread out and deformed upon installation. If present, the problem can be resolved by enlarging the chamfer with a sharp file. On some blocks, the outside diameter or the machined thrust area is too small. If interference is found during assembly, it’s usually best to reduce the bearing thrust diameter on a lathe, although block modification is possible. If you need to thin the thrust bearing a touch, it can be sanded with 600-grit and WD-40, on a sheet of glass or a granite table. Try to remove material only from the non-loaded front face.

Before installing the rear cap, you need to check a couple things. When using main studs, be certain that they do not protrude beyond the oil pan gasket surface. Otherwise, the studs will interfere with the windage tray or even the oil pan itself. Also do a quick inspection to be sure the drain holes seal into the rear main cap, and verify that they are not blocked off by the pan gasket or windage tray.

For rear main cap assembly I use Motorcraft TA-31 gray silicone. A dab is applied in each corner and a very thin layer on the flat areas between the seal groove and up to the pan rail. Avoid getting silicone near the bearing end of the cap. The FE uses vertical side seals that go into grooves in the main cap. The nails

Motorcraft TA-31 silicone seems to be very durable and oil resistant. It was originally intended for diesel applications.
are tapped between the cap and each side seal to force those seals against the block. I use the same RTV silicone as assembly lube for both the side seals and nails.

Install the bearing and the rear main seal. Slip the lubed side seals a little ways into their grooves and wiggle the whole assembly into position by hand. You should be able to start it far enough for the fasteners to be used as guides. Use a plastic mallet to tap the cap into place, alternating with light taps to the side seals so they slide down toward the block. Lube the nails and use a small hammer to tap them down flush with the pan rail. Torque the vertical main fasteners to spec. Assembled properly, the nails are below the pan rail, and side seals are either a tiny amount above or below. A razor blade or a dab of silicone levels the pan gasket surface. You should see a tiny amount of silicone around the cap to block interface on the rear of the engine, which is a visible indication of a complete seal.

For the cross bolts, I use the common ARP lube on the threads, but a small amount of RTV on the washers and bolt undersides. This prevents oil seepage. I torque these to 45 pounds working side to side from the center cap out.

At this point, you should be able to turn the crank smoothly by hand with no stiff spots or dragging. If you need to use a wrench on it to get the crank to spin, something is wrong.

**Pistons, Rings and Rods Assembly**

I suggest you assemble all the pistons, rings and rods as a group before installing any of them into the engine. This work is comparable to that of building any other engine. Nothing is particularly unusual or FE specific about the procedures. I just recommend following good shop practices. The assumption is that all the parts have been cleaned and inspected beforehand. FE engines are pretty forgiving as far as piston-to-valve and piston-to-cylinder-head clearances. But these clearances need to be checked, and you may well find yourself repeating the piston-installation process.

Most if not all connecting-rod manufacturers recommend tightening the rod bolts to torque or stretch specification and loosening them several times before final assembly. This cycling process serves to burnish the threads and respective contact surfaces. Bolts that are cycled several times are more consistent in the way they take up tension and load. Connecting-rod manufacturers recommend one of three ways to determine proper rod-bolt installation: torque, torque angle, or stretch.

Torquing to a “foot-pounds” specification is the least accurate
method of installation, but literally millions of engines have been successfully built with nothing beyond a basic torque wrench. Since torque wrenches measure friction, a defined lubricant and the aforementioned cycling of the fasteners are keys to a successful outcome.

Torque angle is a means to reach a stretch specification using fairly simple tools. It can be very useful in tight clearance areas and where a stretch gauge cannot be used. The fastener is initially tightened to a modest torque value, and then further tightened an additional number of degrees. An example would be a specification of 35 ft-lbs and 45 degrees.

The first step in actual assembly is to measure bearing clearances. Similar to the process used for the mains, the crank is measured with a micrometer, which in turn is used to “zero” set a dial bore gauge. Assemble each rod bearing into a connecting rod, torque the rod cap into place, and use the dial bore gauge to get the reading. You can target a similar .0025 to .0030-inch range for desired clearance. On factory FE rod journals, there are no available selective bearings, which means that machining the crank or rods is your only choice if adjustment is needed. Most stroker combinations use 2.200-inch big-block Chevy-size journals and numerous clearance-adjusting options are available. I also test fit the piston pin in the rod. Clearances here are among the tightest in the engine at .0008 to .0010 inch, and should have already been set at this point by your machine shop. The fit should be glass smooth with no tightness.

Piston preparation involves careful inspection and some detailing. The oil return holes that are in the root of the oil ring groove are a common place to find burrs and chips, so you need to remove these imperfections. Also spend a little time to smooth off any sharp edges around valve reliefs and at the lower edge of the piston skirt. Clean and lubricate the piston pin and test fit it in the pin hole. The pin should slide in and rotate freely with no drag. Piston skirt clearances should have been set by your machine shop, but can be verified by using the same micrometer and dial bore gauge technique used for bearing clearances. Be aware that the use of a torque plate during machining changes the actual measured clearance, but you should be reasonably close.

Most pistons have a single- or double-spiral-lock retainer. I find it easiest to install the locks on one side first before installing the pin. Installing the spiral locks is a matter of spreading them out a bit and winding them into the groove. On an FE you install the pistons with the
valve relief pockets on the intake manifold side of each bank. Connecting rods have a large chamfer on one side of the big-end bore, and a small chamfer on the other. The larger chamfer always faces the crankshaft counterweight, and the smaller one faces the adjoining rod.

Hold a piston in one hand, slide the pin partway in, and then put the rod into position. Slide the pin the rest of the way in and install the other spiral lock. The piston rings are installed next, starting with the oil expander, then the oil-ring rails. The second ring is installed next using a ring expander tool, and then the top ring is installed. Do not wind the two upper rings into place. Winding or overexpansion causes the rings to deform and results in a compromised ring seal and reduced ring life. There are a few theories regarding gap placement, but the only really important thing is not to line them up; the rings do slowly rotate when the engine is running.

Although many people and companies recommend a variety of supposedly magical elixirs and powders for prelubrication and break in, I prefer plain old non-synthetic engine oil. Oil is the lubricant from the second the engine fires up until it is removed from service. Any fancy stuff is either washed away during pre-lubrication or instantly dissipates on fire-up. Cylinders get a small amount of oil massaged into the surface. Bearings get a few drops wiped onto them along with a film on the crank journal. I put a bit on the piston skirts and a thin film on the rings. I do not assemble anything dry, but you do not want to dunk the piston or have it dripping wet.

Use a tapered ring compressor. If you don’t have one, buy one. Older clamp-style compressors certainly work, but once you’ve installed pistons with the tapered design, you’ll throw your old one away without a moment’s regret. Install one piston/rod assembly at a time. Tighten the fasteners to specification and rotate the engine to check for smoothness. If you install a piston one cylinder at a time, it helps to isolate any problems that may occur. As the piston pairs are put together on each journal you can check the rod side clearance. This clearance should be between .016 and .020 inch on the average FE build, but is more forgiving than other clearances in the engine (it runs fine at .012 inch and at .025 inch).

Bring each piston to the top and check the deck clearance. You are again checking the work of your machinist. My preference is to be either “zero” or down from the deck by no more than .005 inch, but anywhere between .003 inch positive and .010 inch below deck runs just fine. The pistons should all be very close to each other in deck clearance; differences of only a few thousandths are really inconsequential. Leave the engine with number-1 piston at top dead center.

Timing Chain, Cam Degreeing and Front Cover Installation

With the cam and crankshaft in the block, next go to the timing set. On the majority of FE projects the basic Cloyes set is pretty intuitive. (I already covered the component selection in Chapter 6.)

The crankshaft sprocket is a light push/press fit on the shaft. Cam and crank sprockets go “dot to dot” for setup. With both cam and crank at their “number-1, top dead center” positions and the crank key installed,
put the crank sprocket on and slide it back within 1 inch of its final position. Take the cam sprocket, loop the chain over it, and hook them over the crank sprocket. You should be able to use the cam dowel pin as a guide to push and tap the whole assembly into final position, working alternately from top to bottom. A plastic mallet and a piece of aluminum tubing over the crankshaft snout come in handy. This should only take a light touch, not a heavy beating. Temporarily install the cam bolt and washer.

At this stage, you need to degree the cam. Install the degree wheel on the snout of the crank, and make a pointer from a piece of welding rod to indicate TDC. Install the appropriate lifter in the number-1 intake position. I use a magnetic-mounted dial indicator to read the lifter movement. Since cam lobes may be asymmetrical, you cannot simply assume that the point of highest lift is the centerline. To determine the intake lobe’s centerline, you need to find the spot .050 inch below maximum lift on either side of the lobe’s peak and then split the difference between them on the degree wheel.

Experience tells you whether the engine wants a particular cam installed at any given degree position. Lacking direct experience, it is usually best to use the suggestions from the cam grinder as the first point of reference. If you are satisfied with the installed intake centerline, you can now continue to rotate the engine and check intake and exhaust opening events against the cam-card specifications. The Cloyes timing sets allow changes in increments of 4 degrees. Based on dyno testing, changes of only 1 or 2 degrees seem to have a very nominal impact on performance and are not worthy of much concern on the first try of a cam combination. If everything checks out, remove the degreeing hardware.

Next, install the cam bolt, washer, and fuel-pump eccentric. Use red Loctite and torque to specification for a secure fit.

The front seal should be installed into the cover and lubricated. Glue the timing-cover gasket into place. Slide the sheetmetal oil slinger onto the crank snout. Place the cover in position using the crank damper spacer as a centering guide. Most of the timing-cover bolts go into either water or oil, so Teflon paste should be applied to the threads before installation to inhibit corrosion and ensure an accurate seal is attained.

With the cover bolted on and the damper spacer slid into place, you can install the damper itself. Check the fit by measuring its inside diameter and comparing that to the crank snout. It needs to be a press fit, but not be too tight. Each damper manufacturer has a desired specification and honing may be needed. The damper key is a simple 1/4-inch-square stock, and needs to go in after the damper spacer is installed. You should be able to start the damper installation with a large dead-blow plastic mallet, but you need to use a press or bolt to complete the installation. A threaded stud and a bearing washer/nut is the right way to do this. Because the FE damper bolt is both large in diameter and long, plenty of them have been installed using the bolt itself to pull the damper into place. I cannot remem-

Valvespring pressure testers are a necessity in a professional shop, but they are very expensive. Checking and adjusting spring pressure is a task that your shop should handle as part of the cylinder head assembly work.
You do need to use the proper thick washer and to torque that big bolt to specs, or it will come loose.

**Cylinder Head Assembly**

Often cylinder heads are assembled before the block is completed. Springs and retainers are chosen to meet the needs of the camshaft and application. I strive to get installed heights within about .050 inch of coil bind. On solid-roller cam applications, a stiffer spring causes fewer problems than one that is too weak, especially in regards to seat pressure.

On an FE engine it is important to get the valve-tip heights close to equal relative to both the head’s deck and the rocker mounts. Significant differences in tip height require uneven pushrod lengths and cause potentially odd geometry issues. In addition they require a wide array of shims to equalize installed heights for the springs. They run okay in the farm truck, but are decidedly not desirable in any kind of performance use.

Factory FE heads used umbrella-type valve seals, but everything today uses a positive viton seal that presses onto the guide boss. You need to establish installed height and position the requisite shims and the spring locator before installing the seal. Install the valves using oil as lubricant. In a commercial shop, an air-powered spring compressor is used, but the Mondello “big purple C-clamp” is startlingly effective for low volume and home use. Available through Goodson or Mondello, the clamp is simple, portable, and safe—much safer than the old-style, over-center hand-lever compressors.

**Cylinder Head Installation**

Clean the decks of the block with thinner or brake cleaner. Install the head-locating dowels by tapping them into place with a small hammer. Starting with the split sides in first on a slight angle make this a bit easier. If using studs, install them now with a touch of ARP lube, lightly seating them in the block.

On engines utilizing domed pistons, paint a couple piston tops with magic marker or machinist’s dye and mount the heads without gaskets. Turn the engine over through a couple cycles. It should rotate smoothly with no interference. If it clicks or binds, the interference points are clearly visible as witness scrapes in the marker or dye. Modify the heads and pistons as needed and try again. Smooth, interference-free rotation means you have at least .041 inch (a gasket’s thickness) of clearance.

Next, check for adequate piston-to-valve clearance. Install head gaskets with the coolant openings facing forward on both decks. There is no correct “up” or “down,” but there is a definite “front” and “rear.” I prefer using clay to do the check because it allows me to see both vertical and radial clearance in one test. I first use silicone-spray lubricant on the piston dome and the combustion chamber to prevent the clay from sticking. Then I pack both valve pockets with clay and install the head using a couple head fasteners. Lifters, some reasonably close pushrods, and the rockers for the test cylinder follow. Fastener torque and valve adjustment need not be perfect, but should be close for accurate results.

Rotate the engine through two complete revolutions. The clay puts up a little resistance but you should remember ever seeing a stripped or broken FE damper bolt.

**The valvespring installation removal tool from Mondello Performance Products is almost embarrassingly simple and effective at removing almost any valvespring.**
not have to force it. If you hit a hard stop, take things apart to find out why. Remove all the valvetrain parts and the cylinder head. The clay should show a clear impression of each valve. I use an X-acto knife to take clean-edged pie-shaped cuts from the clay. This allows me to see clearance both vertical and radial around each valve. The standard desired measurements of .050-inch radial and around .100-inch vertical apply. With the exception of maximum-effort race applications, FE engines rarely have problems vertically, but radial clearance can be an issue with some pistons. Obviously if you do not have enough, the pistons are coming back out for machining.

If all the clearances are okay and everything looks good, the heads can be bolted down for good. If you have a Genesis block, be sure that the oil-feed hole to the heads lines up with the head-gasket opening. It is common to need an extra oil hole drilling in the gasket. Be sure to use lube on all threads, as well as on the underside of the head-bolt washers and the nuts or bolt heads. Follow the factory torque pattern, which is essentially a spiral from the middle outward. Torque should be the same as was used during torque plate honing. Go to a light torque value to seat the head, then run the pattern going to full torque on each fastener in a single full sweep. Walk away from the engine for an hour and then do a cold re-torque. This allows the head gasket and fasteners to relax and take an initial set. Loosen each fastener and retorque it again in a full sweep. If you paint mark the fastener you’ll find that this process gets another few degrees of rotation for a given torque value.

**Lifters and Pushrod Length Check**

Install the lifters after using the manufacturer's specified cleaning and lubrication process. On flat tappets, this means using a high-pressure lube on the contact face and oil on the sides. With rollers, each supplier has a different procedure. Some want a full wash followed by an oil bath, while others use a particular assembly grease that they do not want washed away.
With lifters installed, set the cam to the base circle, which is the lowest lift point, and again install the rocker assembly on one head. Adjust the adjuster so that only two or three threads show below the rocker arm body. Use a traditional ball/ball-style pushrod-length checker and extend it, taking up all of the lash in the valvetrain by touching against the ball end of the adjuster. Unbolt the rocker assembly, remove the checking pushrod and measure it using a 12-inch dial caliper. When you call your chosen pushrod supplier and specify the length as “bottom of cup,” they will know exactly what you need. Traditional FE engines use a 3/8-inch cup at the rocker end, which is different than other engines. Be sure to specify that when ordering.

Every engine combination is a little different, but common pushrod lengths run between 8.900 and 9.100 inches on roller cams, and between 9.100 and 9.350 inches on flat tappets. If you come up with something radically different, you’d best recheck the measurements.

Intake Installation

In Chapter 10, I described the detailed process to verify and correct intake manifold fit on an FE. Now you finally get to install it “for keeps.” Use a very thin layer (not even a bead; more like a translucent coat of paint) of TA-31 RTV silicone around all the water openings and the intake ports. Install the gasket, which should have been trimmed to match the ports during the fitting process. Add another really thin layer of silicone on the gasket and a fat bead on the front and rear seal areas on the block. Carefully set the intake into place and use the distributor as a locating dowel. Use a plastic mallet to move the manifold around as necessary for fastener and port alignment.

Install the fasteners being certain to get them all started by hand. If you are using a fuel log on a 2x4 setup, don’t forget to install it now. There is a factory torque value for intake bolts, but you almost never get to use it. Truth is, many of the
fasteners on aftermarket intakes are very hard to reach even with a box-end wrench. Working from the inside out to the ends, snugly tightening the fasteners by hand is fine. If you use a flashlight to sight down alongside the ports, you’ll see the tiniest amount of silicone squeezed out, which is your visual indication of a good seal. Remove the distributor and be sure that the silicone in the front wall has not pushed into the opening. After several hours you can use a razor blade to trim the silicone on the front and rear seal area for a more professional appearance.

**Valvetrain Assembly**

The rocker arm assembly on an FE is unique, even in installation. I really prefer using studs to mount the rocker assemblies. They are easier on the threads in the cylinder head and make installation simpler. If you choose to use bolts, be certain that you have the correct length in each position. If they are too long they bottom out giving you a false torque reading, and may pull the threads out of the head when running. On Edelbrock heads, if you use the wrong-length stock bolts, they break through the top of the port.

The first assembly step is to lube the ends of the pushrods. Slip each pushrod through the hole in the intake and center it in the lifter. Using a flashlight helps to be sure they end up in the right place; it’s easy to miss. Set all the rocker adjusters so that they are showing two or three threads below the rocker body. If you are using the factory tin drain trays, set them in place. Now set the rocker assembly into place by lining up the pushrod cups with the arm adjusters. It is a bit of a juggling exercise to keep all the pushrods in place while starting the fasteners. Tighten the fasteners a small amount at a time moving from one to the other in order to prevent bending the shaft. Go slowly and continue to monitor the pushrod position as you tighten them. Once they are all snug and the rocker stands are visibly in contact with the head, you can bring them up to torque.

When both rocker assemblies have been installed, you can rotate the distributor has been correctly installed, you can use its location as a reference point to ensure that other intake measurements are much more accurate.

When the distributor has been correctly installed, you can use its location as a reference point to ensure that other intake measurements are much more accurate.

Note the intake pushrod hole clearance. You want to rotate the engine through several cycles during test assembly to verify smooth operation of every pushrod at all valve-opening positions. Hard contact when the engine is running causes the pushrod to pop off the rocker arm.

I often need to modify the pushrod holes for clearance. Typically, they get checked, marked where they hit, and rechecked after altering the holes on a Bridgeport mill. You can use a die grinder to do the same job by hand.

This shows the distributor hole and the oil galley plug that is overlooked most often. Leaving this plug out results in nearly zero oil pressure during prelubrication. Not getting it tight enough causes interference with the distributor, either preventing installation or binding it up to make timing changes impossible.

This is a manifold marked for milling to correct angle and height variances. If everything is measured properly, a single milling operation can correct numerous dimensional variances.

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the engine. Look, listen, and feel for any interference. The engine is a bit harder to turn but should still be smooth and quiet. Clicks, snaps, and tight spots need to be investigated and corrected.

Valve lash for solid lifters (or preload for hydraulics) can now be set. Most solid lifters specify a hot lash setting. Since the engine is cold you need to do an initial approximate setting. On iron block-and-head combinations, there is roughly .004-inch growth in lash from cold to hot. On engines using iron blocks and aluminum heads the growth is around .009 inch. An aluminum block and heads gains somewhere around .016 inch in lash as they warm up, which often requires nearly zero cold lash.

The same growth factor applies to hydraulic-lifter preload. Therefore, if the cam manufacturer wants .020-inch hot preload, you need to provide a greater amount when cold. With some performance hydraulic systems running near zero lash, inadequate cold preload results in a noisy valvetrain when warmed up.

**Oil Pump, Windage Tray and Oil Pan**

When installing the oiling hardware, the first step is to test fit the pump driveshaft into the distributor. I’ve seen cases where they do not fit due to burrs or damage. It is far easier to check and correct this before the pan is on.

If you are using a windage tray, test fit it next. Glue a pan gasket to it and bolt it onto the block with just a couple fasteners. Rotate the crank to check for clearance. Try the dipstick. Sometimes they interfere and some trimming may be required. If all is good, remove the tray and put a dab of silicone in the spots where the timing cover and rear cap meet the block. All that’s required is a very thin smear along the sides, then remount it again using only a few bolts on each side.

Next, slip the driveshaft into the oil pump with the retainer clip toward the upper end. The pump gasket goes on and the two 3/8-inch bolts get a dab of red Loctite before snugging the pump up onto the block. While most builds will use common automotive bolts, we have used studs and safety-wired nuts on road-race applications. We use an extremely small layer of silicone on the pump inlet gasket to prevent any possibility of air intrusion. The pump pickup is mounted using two 5/16-inch fasteners that have either Loc-tite or safety wire as insurance against loosening. Some pickups may require modification to clear the windage tray—a test fit is a good idea before final installation.

Now check pan-to-pickup clearance. Instead of clay I use a straight-edge (or ruler) and a 12-inch dial.
You need to use the correct screw-in core plugs for the engine or the engine could suffer a catastrophic failure. The correct Ford or reproduction plugs provide a proper seal and adequate clearance. However, hardware store screw-in plugs can contact the cylinder before they are tight enough to seal.

A quick screw-in core-plug tool can be made from a deep socket and a nut. With a tool such as this, you can ensure the core plug is properly installed and be sure to use Teflon paste.

Once the screw-in core plug is in place, it should be installed a touch deeper than this example. If the plugs stick out too far from the block, motor-mount interference can result.

When using common FE core plug kits, check the sizes — 1.750-inch diameter is too small for many blocks. The correct diameter is 1 49⁄64 inches.

drill, spin the pump counterclockwise. You should see around 75 pounds of pressure on the gauge in a minute or so. Oil should come up through the rockers and shafts shortly afterward. When you see oil from all sixteen rockers, you’re all set.

If no pressure happens, it’s usually due to a missing oil-galley plug. Spin the pump and you see a missing one behind the distributor as a stream of oil though the opening in the intake. Missing the one behind the timing gear is seen as a waterfall viewed through the fuel-pump opening on the side of the timing cover. I know this because I’ve done both.

Assuming that everything went well, you can install the valve covers. Knowing that you’ll be doing an inspection and hot lash, no sealant is used at this time.

Carburetor, Water Pump, Distributor, Wires and Plugs

You are finally on the homestretch, installing the last group of external parts.
The distributor is dropped into place after locating the number-1 cylinder on the compression stroke. Lubricate the drive gear and the seal. I usually start by setting it at 20 degrees before TDC as a fire-up position. Once close to position, you will likely need to rotate the engine around a bit to get it to drop all the way down onto the pump shaft. The body where the clamp goes should be nearly flat against the intake. If you can see the side of the seal, it's likely the distributor is still not seated.

Plugs and wires are pretty basic. There are a few tips worth mentioning: Use a small amount of anti-seize lubricant on plug threads going into aluminum heads. Also use a bit of dielectric grease on the plug wires, on the plug boots and at the distributor cap. Route the wires away from linkage and heat, keep number-7 and -8 separated, and keep them away from the distributor magnetic-trigger leads.

Carbs are a simple bolt-down with a couple caveats. Check for clearance throughout the throttle travel. Some carbs interfere with the intake at the throttle plates. Others hit the throttle linkage. Still others might have a vacuum passage that overhangs the intake’s mounting flange and leak. Carburetor spacers usually solve these problems, but you need to check. The factory throttle linkage on a 2x4 setup is designed to be set for wide-open throttle, not to vary the progressive opening of the two carbs.

The assumption here is that you are going to put your engine on the dyno for testing and tuning. This requires only the basics as far as front-end dress.

A mechanical water pump is a simple bolt-on item that requires four fasteners with Teflon paste, one bypass hose, and you’re done. The damper-mounted pulley, a water-pump pulley, and a short belt complete the test package. Working with an electric pump is even easier because the bypass opening on the intake is plugged and a belt is not needed. For dyno testing, a water outlet is used but no thermostat is installed.

Stand back and admire your work. Now, you’re ready to fire this engine up!

**Max-Performance FE Engine Builds**

As I’ve detailed, there are many different head, intake, block, and rotating assembly combinations that produce respectable and reliable power. At Survival Motorsports, we’ve built dozens of FE engine combinations. On page 139 are two engine recipes that provide a sound parts combination for a fast and humane max-performance FE Engine.

*Page 139 (top left): This stroker provides exceptional torque and horsepower on the lower end of the powerband. Therefore, it is ideally suited for the street. The engine delivers 510 ft-lbs of peak torque at 4,200 rpm. As you can see, the engine consistently builds horsepower all the way up to its 490-hp peak at 5,200 rpm.*

*Page 139 (top right): This particular 482 Roller Cam FE powerband is somewhat similar to the 390 stroker combination. It produces maximum torque of 620 ft-lbs at 4,300 rpm and it hits a maximum 613 hp at 5,800 rpm.*

**LEARN ABOUT BUILDING MAX-PERFORMANCE FE ENGINES**

How to Build Max-Performance Ford FE Engines

## Ford 390 Stroker Build Recipe: 490 hp, 503 torque

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## Services

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Notes:
- Total Services: 1,102.27
- Total Parts and Services: 18,159.71