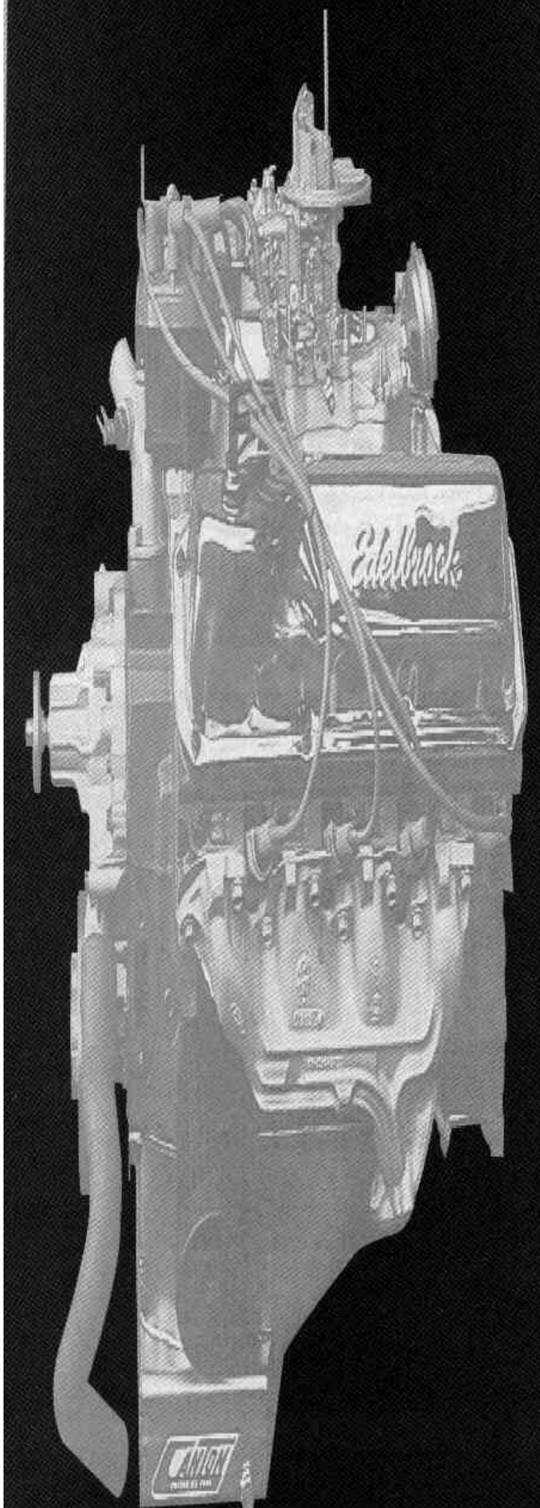



# DOWN & DIRTY

## The 400M Ford: 468 Lb-Ft, 380 HP for Less Than $2,000

By John Newman



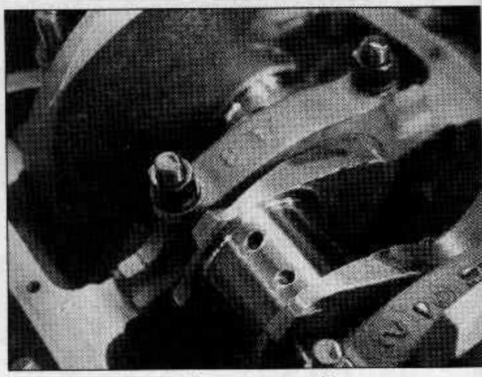

We're going to demonstrate how to build a cheap 406ci Ford that runs on pump gasoline. We'll also show you how to save money by skipping steps that aren't critical to the success of a 5,200-rpm street thumper. Our scratchy ol' 406 makes 380 horsepower and at least 450 lb-ft of torque—for less than $2,000.

### First, the Basics

A 406-inch Windsor, based on the 351ci Ford, is light for its displacement but costs a lot of money to build and involves a stroker crankshaft assembly. For our thumper, we used a 400M block. The 351M/400 engine is nothing like a 351 Windsor. The bellhousing bolt pattern is the same as that in a 429/460 big-block, while the engine design is basically a Cleveland small-block. These yeoman-duty motors never had more than 8.0:1 compression, and all were smog engines. Hence, there are thousands of them awaiting revival in salvage yards.

The 351M was produced between 1974 and 1979 in passcars, while the high-torque, low-rpm 400 prodded large cars and pickups through 1981. When new, these slugs never

Photography: John Newman



**Since our street thumper won't ever see more than 5,200 rpm, we cinched the crank down with the stock two-bolt mains and ½-inch ARP studs.**

produced more than 173 hp. Regardless, "M"-series engines are plentiful, cheap, and usually show little cylinder wear, even after 150,000 miles.

If cost is a major concern, as it was with our project, then the 351M/400 engine family is the best place to begin. In addition, we adhered to three important rules while building our torquer:

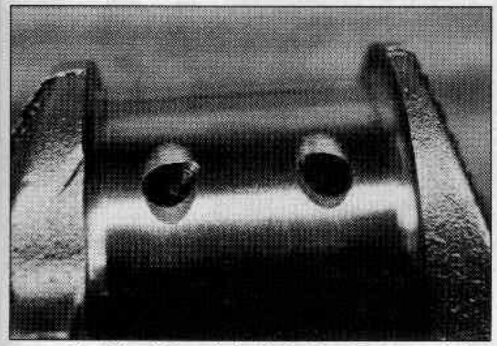
1) Don't overcam. Although a cam with 330-degree duration may make the engine sound great, it won't make much torque down low in the powerband. We used a 268-duration cam, which gave us a flat powerband and grunt from 2,000 to 5,200 rpm that pulls like a turbine.

2) Don't overport. Total airflow at high rpm is not even a consideration—the idea is to keep the port velocity high. For a 351M/400 combination, use the OEM two-barrel casting, which features an open-chamber design and flows well. Match the gaskets to the heads and keep the port velocity up by using a low-rise dual-plane manifold. Less is more in port size, as long as the ports can flow enough to meet the demands of engine speed up to 5,500 rpm.

3) Don't overcarb. If you choose a four-barrel carburetor, make sure it's equipped with vacuum secondaries and flows approximately 650 cfm. If emissions or class restrictions dictate, then a two-barrel that flows 500-600 cfm will suffice.

We came up with the 400M combination after our conversation with Barrie Poole. The "Border Bandit" out of Sandy Elliott Ford in Windsor, Ontario, Canada, was a dominant NHRA Super Stock racer in the late '60s and early '70s. What follows is Poole's combination, updated with 1998 camshaft technology.

Our nest egg was a 135,000-mile wheezer worthy of 65 rear-wheel horsepower at 5,000 rpm. Testing it at a friend's Porsche emporium proved all



**Sheldust Crankshaft & Engine turned the 400M crankshaft 0.010/0.010 inch, leaving the standard fillet radius on either side of the journals. Sheldust also chamfered the oil holes and polished the journals.**

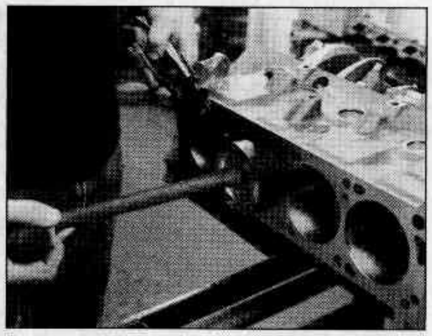
the more insulting. The mechanics laughed as the 400-cuber developed less power than the weakest under-3.0L Porsche engine they had ever run on the dyno. We smiled, knowing that the retest would be a different story.

## Now Get to It

Start with the 400-inch engine. If that isn't feasible, get a 351M and locate a decent 400-inch crank and rods, which will drop right in. Either way, to displace 406 cubic inches you need the 4.00-inch stroke and the 4.030-inch pistons. Work with two-barrel heads exclusively. The ports in the four-barrel castings are far too large to run on the street—it would take a blower to fill them up and maintain port velocity. Along with their open-chamber design, the two-barrel heads—like those of a Chevy rat—have far larger ports than most small-block Chevrolets.

We selected high-quality, low-cost Silv-O-Lite cast pistons that were 0.030 inch oversize. The combination of the reverse-dome pistons, stock cylinder heads that were shaved 0.025 inch, and the 0.030 overbore produced a static compression ratio of 9.45:1. That's just about right for an iron-head street engine on pump gas. Our rings were nothing more than a $29 package with a moly-filled top ring, a cast second ring, and a three-piece oil-control set. That might have cost a little power at 8,500 rpm, but the slight drag at our theoretical 5,200-rpm peak wasn't worth the rapid wear rate of low-tension rings. This engine should stay together for at least 50,000 miles without your having to lay a finger on it.

The most critical area of the thumper is the camshaft. We needed one with about 220 degrees of duration at 0.050-inch lift, not too much overlap, and plenty of flow at low-to-medium valve lift. It had to open the valves quickly, raise them high, and then close



**With a 0.303-inch overbore and 0.025 inch removed from the cylinder head surface, the deep-dish Silv-O-Lite pistons produce a static compression ratio of 9.45:1.**

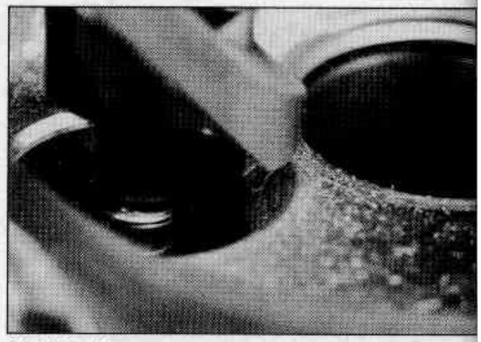
them quickly without slamming the valve on the seat too hard. The Comp Cams X-Treme Energy #268 camshaft employs new reduced overlap technology, which is just the ticket for a smooth idle, and maximum power/torque between 2,000 and 5,200 rpm. (See specification comparison elsewhere in this article.)

The 268-degree camshaft fills the cylinders fast and lets them build pressure as if the engine had 11.5:1 compression. If passing the smog test is important, this type of camshaft will also be clean when it comes to the sniffer. The Comp Cams kit comes complete with a timing set, lifters, springs, retainers, locks, and the camshaft.

Sheldust Crankshaft & Engine in Pacheco, California, took the clunker apart and checked its dimensions. They also cleaned and inspected the block and heads prior to machine work. Then we got the damage report: The oil rings were locked solid in the piston grooves, five cam lobes were flat, and several guides were worn to death. Reasons enough why the engine mustered only 65 wounded ponies on the dyno. On the positive side, the block was perfectly sound and would clean up with the 0.030 overbore.

Sheldust measured the block from the center of the main bearing saddles to the outside corners of the deck and discovered a 0.015-inch difference between the largest and smallest measurements. That required decking both sides of the block at the head-mounting surface. The main saddles were straight, so the block wasn't align-bored or -honed, saving us $125. Sheldust bored the block 0.024 inch and finish-honed it to 0.030 inch using very fine stones to assure a good ring seal.

Next, we got into the act with a die grinder, abrasive rolls, and a couple of carbide burrs to match the gaskets to the intake and exhaust ports, as well as the intake manifold. We also cleaned up



**At $125-$175, a standard three-angle valve job is money in the bank. If you lap the valves and assemble the heads yourself, you can save $50.**

the combustion chambers and relieved a little of the rough casting behind the exhaust valve. While none of this delivers a dump-truck-load of torque, it does help promote a broader torque curve.

Instead of using tube headers (that would have been too easy), we spent more than 16 hours opening up the stock exhaust manifolds. If we were going to use headers, we would have selected a tri-Y design known for making torque.

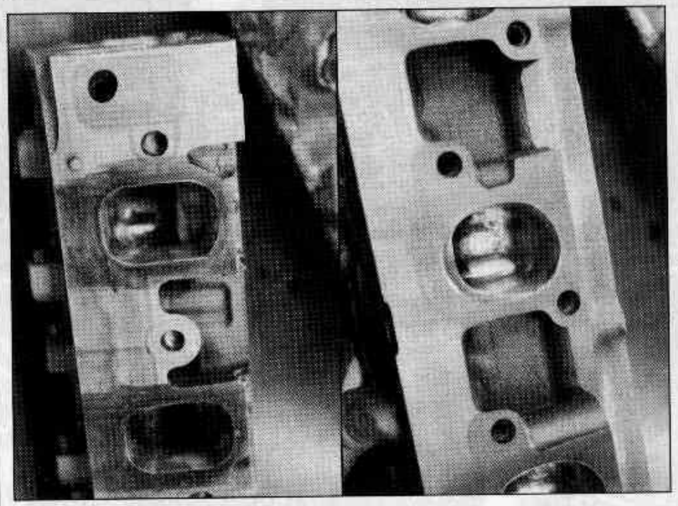
Sheldust installed new cast-iron valve guides because they don't wear the valve stem like bronze silicon guides do. Moreover, cast-iron guides are best for the street with unleaded fuel and are far less costly. A three-angle valve job is simple to implement and yields excellent results. And at an average price of $125-$175, it's a good value. If you assemble the heads yourself, you save about $50. You can also lap in the valves by hand before assembly and get a better seat seal. We added stainless-steel valves to the recipe; they cost $150 but are lighter than the stockers and will hold a seal longer.

To clean it up, the crankshaft was turned 0.010/0.010 inch undersize, leaving the standard fillet radius on the sides of each journal. We polished the journals, and the grinder chamfered the oil holes at no extra charge. Considering its prime function, we decided not to balance the reciprocating assembly and saved another $175. We kept $150 more in our pocket by using press-fit wristpins rather than the full-floating type. Once the pins are pressed in (with the rod end red-hot), they stay in place and never work themselves into the cylinder walls.

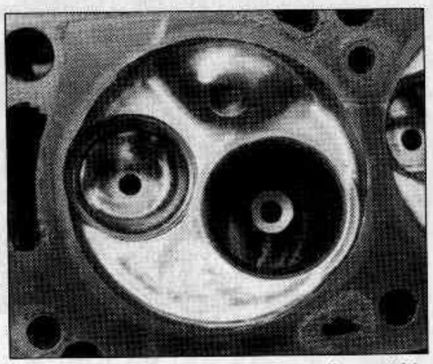
The Melling oil pump was a bolt-on affair. The pickup was adjusted ⅜ inch from the bottom of a Canton 8-quart oil pan.

## Puttin' It All Together

Assembly was straightforward. We installed the camshaft first to make sure it spun freely. (We prefer to turn the



We used the intake and exhaust gaskets as porting templates for the cylinder heads and intake manifold. By doing the work ourselves, we saved time and several hundred dollars.



**We used a die grinder, abrasive rolls, carbide burrs, and lots of sweat cleaning up the combustion chambers. The overall effect is a broader torque curve.**

engine upright, with the camshaft bore facing the ceiling, to keep from scraping the cam bearings.) Our crankshaft was in spec, and after all the pistons and rods were installed, the assembly rotated with ease.

When we installed the cam timing gears, we checked the cam against the manufacturer specs. Most "production" shops no longer take the time to degree-in the camshaft, although we must note that the last 15 cams we've used have all been right on the money. Still, better safe than confused.

We used the stock rocker arms and Comp Cams pushrods during the build-up process. Make sure the pushrods turn by finger pressure when the valves are fully closed. If they don't, the machine shop hasn't measured the pushrods' stock height and subtracted the amount of material removed from the heads and the deck. Take this amount off the top of the valve stems. We could have bypassed this step with rocker arm studs and adjustable rocker arms, but they would have added $350 to our total cost.

We kept everything super-clean; followed the check-and-double-check procedures for the ring gaps, bearings,

## Cost Review*

| ITEM/SERVICE | PRICE |
|---|---|
| **Holley carburetor** | **$280.00** |
| **MSD ignition and coil** | **$175.00** |
| Intake manifold | $154.00 |
| Cam and kit | $215.00 |
| **Stainless-steel valves** | **$148.00** |
| Pistons | $98.00 |
| Rings | $29.00 |
| Clevite bearings (mains, rods, and camshaft) | $63.00 |
| **ARP rod bolts** | **$35.00** |
| **Fastener set** | **$125.00** |
| Gasket set | $48.00 |
| Oil pump | $25.00 |
| Deep oil pan and pickup | $118.00 |
| Abrasive rolls | $12.00 |
| Core plugs (brass for water jackets) | $21.00 |
| Bore and hone to 0.030-inch over | $155.00 |
| Install cast-iron valve guides | $100.00 |
| Three-angle valve job (seats and valves) | $145.00 |
| Surface heads | $95.00 |
| Install cam bearings | $47.00 |
| Deck block | $55.00 |
| Clean, inspect, and mag heads | $35.00 |
| Clean and inspect block and rotating assembly | $85.00 |
| Machine and polish crank to 0.010 inch/0.010 inch | $76.00 |
| Press-fit pins | $60.00 |
| Resize rods | $85.00 |
| **Our Total** | **$2,484.00** |
| **Maximum Savings** | **$763.00** |
| **Maximum Low-Buck Deal** | **$1,721.00** |

***Note:** Prices were established by shopping around, buying some parts from mail-order suppliers, and asking for discounts. Items in bold are not absolutely necessary for success, so their cost can be subtracted for maximum savings.

thrust surfaces, and other components; and then set the distributor on top dead center No. 1 before installing the intake manifold. But even with the long-block completed, we had lots to do before we could fire the engine. We needed fuel, and we needed fire.

We chose a high-performance mechanical fuel pump and plumbed in a good filter downstream of the carburetor. Using the formula for carburetor size—(engine cid [406] x max rpm [5,200]) divided by 3,456 (a constant)— we found that our engine needed 610 cfm. A 550-cfm Holley two-barrel delivers nearly that much air if you are restricted by configuration (as we were). A far better bet is a 650-cfm vacuum-secondary Holley spread-bore four-barrel, which gives excellent overall performance and good throttle response.

We could have kept the Ford ignition, but we used an MSD 6-AL ignition box and a Super Blaster Coil. The stock Ford electronic distributor works just great with the OEM ignition, and it passes smog on a street engine, but we splurged on the MSD goodies.

Since this engine motivates a '79 Ford Ranchero, we chose used dual catalytic converters (as per the factory) that flow 750 cfm each. A complete after-cat system by West Coast Muffler in Concord, California, gave us a 3-inch-diameter system joined with a two-into-one Flowmaster venturi Y-pipe in a single Flowmaster Big Block muffler. This system delivers more mid-range torque than a dual-exhaust system and costs less.

With a bag of torque, it isn't necessary to run a 5,000-rpm stall speed or 4.56:1 gears to get the car off the line. For $175, our skinflints installed an overused 3.25:1 limited-slip differential in the Ranchero's 9-inch housing. A key part of the overall combination is the transmission/torque converter package. We selected a 2,200-rpm stall converter to launch the car, but one with close internal clearances to maintain fuel efficiency during cruise mode. In high gear, this converter puts the engine at 2,280 rpm at 65 mph.

The bottom line? Poole's combination generated 375-plus lb-ft of torque at slightly more than 2,000 rpm—where most street driving is done. At 4,400 rpm, it peaked out at 456 lb-ft. In addition, the 406 generated 382 hp with all emissions gear intact. With a little fine-tuning, it would be easy to get 400 hp from this low-dollar thumper.

This time, we impressed the Porsche contingent. No Porsche has ever made 450 lb-ft of torque, or so much power, at such low engine speed. When we told them how much the project cost, they just about threw us out of the shop—$2,000 wouldn't even pay for a valve job on one of their client's dual-overhead-cam engines.

Even if you don't tread a righteous path, you can still make 400 hp and 450 lb-ft of torque with a street thumper. You can duplicate our engine combination for two grand and keep it "smog friendly" for everyday service. Just be sure to plan the complete package before you put hand to wrench. If you do, you can be rewarded with a super street thumper that takes no prisoners. **HR**

## Street Engine Cam Specification Comparison

| | COMP CAMS HIGH ENERGY 268-DEGREE CAM | COMP CAMS X-TREME ENERGY 268-DEGREE CAM |
|---|---|---|
| **Part number** | 32-221-3 | 32-000-5 |
| **Grind number** | FC 268H-10 • | FC 5433-5216 H110 |
| **Intake lobe** | 268 degrees/ 218 degrees at 0.050 inch | 268 degrees/ 224 degrees at 0.050 inch |
| **Exhaust lobe** | 268 degrees/ 224 degrees at 0.050 inch | 268 degrees/ 230 degrees at 0.050 inch |
| **Valve lift (1.73:1 rocker)** | 0.494-inch intake/ 0.494-inch exhaust | 0.524-inch intake/ 0.529-inch exhaust |
| **Lobe separation** | 110 degrees | 110 degrees |

**Note:** The Comp Cams High Energy 268-degree cam has been one of our favorite hydraulic grinds for years, and it's complimentary to the smog issue. The new X-Treme 268 is stronger, produces more power with less overlap, and has minimal pollution problems with the sniffer.