CAMS&CARBS

We swap 3 bumpsticks and 3 mixers for our Trick-Flow-topped 470 dyno test.

Story & Photos By Andy Finkbeiner

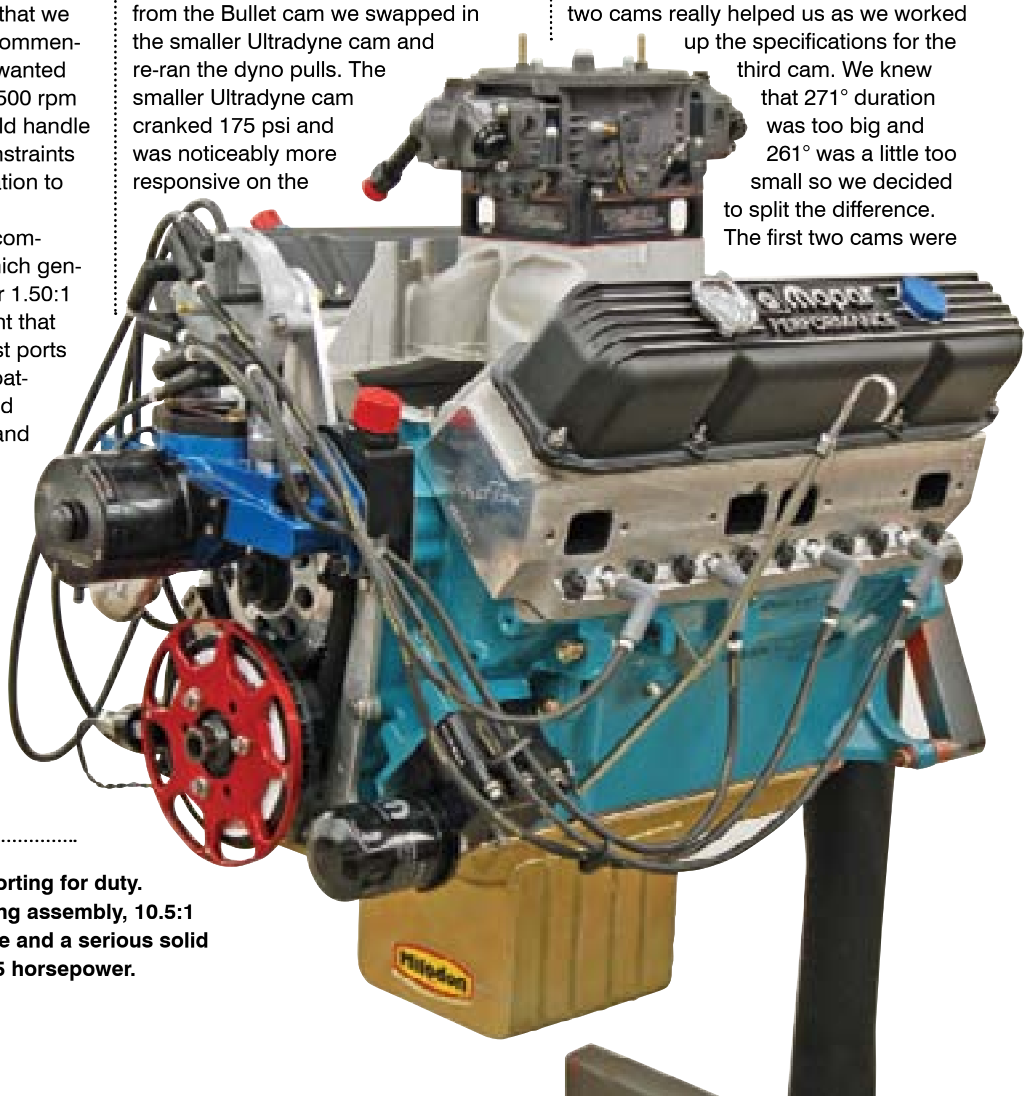
Last issue we covered the build of our pump gas 470 inch B-block with Trick Flow's new CNC ported heads. This issue we'll delve into the dyno testing as we try different cams and carbs in an effort to see what works best on this combo.

Given that we had one of the first pair of Trick Flow heads on an engine there wasn't much tribal knowledge that we could tap into for camshaft recommendations, but we did know that wanted the power to peak at around 6500 rpm and that the valve springs would handle 0.700" lift. Given those two constraints we felt we had enough information to pick our first cam.

The folks at Bullet Cams recommended a 271°/0.460" lobe which generated 0.690" gross lift with our 1.50:1 rocker arms. Bullet also thought that the excellent Trick Flow exhaust ports would work well with a single pattern cam so they recommended the same lobe for both intake and exhaust. The Bullet cam was ground on 109 centers and installed 4 degrees advanced at 105°. In addition to the cam from Bullet we had an older Ultradyne roller camshaft on hand that was left over from a previous project. The Ultradyne cam was a single pattern with a 261°/0.434" lobe so it was 10 degrees smaller than the Bullet cam. The Ultradyne cam was ground on 108 and installed at 104 for our testing. In our first round of dyno tests with the 850 carb we found that the larger Bullet cam made 662 hp at 6400 rpm and 590 ft-lbs of torque at 5100 rpm. Cranking compression was 165 psi with the Bullet cam. While peak power was impressive, the engine seemed a bit lazy on the dyno and it didn't accelerate quite as hard as we expected.

Once we had the data we needed from the Bullet cam we swapped in the smaller Ultradyne cam and re-ran the dyno pulls. The smaller Ultradyne cam cranked 175 psi and was noticeably more responsive on the dyno. Peak power did drop to 649 hp at 6300, but peak torque was up to 603 ft-lbs at 5200 rpm. In the 3500 to 5000 rpm range the Ultradyne cam had a significant torque advantage, sometimes as much as 50 ft-lbs better than the larger Bullet grind. This extra torque down low would be very noticeable on the street, especially in a heavy car or with "highway" axle ratios.

Seeing the performance of the first two cams really helped us as we worked up the specifications for the third cam. We knew that 271° duration was too big and 261° was a little too small so we decided to split the difference. The first two cams were



Low deck 470 CID engine reporting for duty. Trick Flow heads, SCAT rotating assembly, 10.5:1 compression, Mopar M1 intake and a serious solid roller camshaft adds up to 685 horsepower.

both single pattern grinds which had seemed to work but when we talked with Dwayne at Porter Racing Heads he suggested going split pattern to see if the extra exhaust duration would carry the power curve a little higher. After a short discussion with Dwayne he ordered a custom roller with 264°/268° duration and 0.446"/0.445" lift from Comp Cams.

The Comp cam was a compromise on the dyno with low speed torque almost as good as the Ultradyne cam and peak power almost as good as the Bullet. Peak numbers for the Comp grind were 664 hp at 6300 rpm and 606 ft-lbs at 5500. Just goes to show that small changes in camshaft specifications can make big differences to the power curve of an engine, and just gives you a slight bit of insight into what can be accomplished with new VVT/VCT computer-controlled engines.

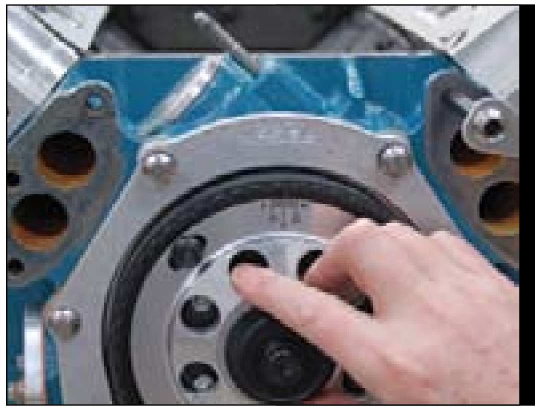
Once we had the camshaft design dialed in we decided to try a few different carburetors to see how the engine would respond. The mass flow meter was telling us that the engine was using roughly 800 cfm of air at peak power so we didn't think the 850 carb was undersized, but you never know until you run the test.

First carb up was a Holley 950 that had been retrofitted with annular boosters by carb builder Mark Whitener. The large annular boosters cost some airflow but they vaporize the fuel better due to the multiple discharge holes in the booster. Our thinking was that with the cold weather (air temp was in the 40's Farenheit) the fuel could use some help vaporizing. That idea was confirmed when we saw large increases in bottom end torque. Peak power and torque levels were essentially unchanged from the 850, but bottom end torque was increased by as much as 50 ft-lbs at some points below 5000 rpm. Given results like that, an annular booster style carb might just be a good choice as the winter carb on your hot rod.

Since our engine has a Mopar M1 4500 intake it seemed obvious to at least bolt on a Dominator carb for some testing. Holley is now making a 950 Dominator but we didn't have one available so we tried a 1050 cfm Dominator which we did have on hand. The engine really liked something about the combination of the Dominator carb and the M1 intake picking up 22 hp to give us a peak power of 686 HP at 6500 rpm and 611 ft-lbs of torque at 5700 revs. Not only did the peak numbers increase significantly, but the engine made more power at every single point from 3500 to 6500 rpm. We don't know for sure why this combination worked so well but our guess is that the annular boosters improved fuel vaporization at the low end while the superior airflow of the Dominator improved the top end. Whatever it was it sure worked since our Trick Flowed pump gas 470 is now knocking on the 700 hp door.

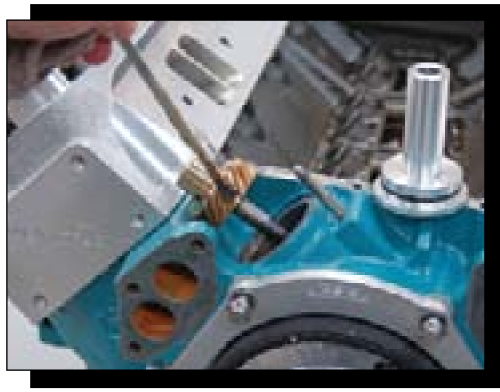
Bear in mind, every carb we tried was a double-pumper, if you want long life from your rings and cylinder walls you'd be well advised to give up a few ponies and use a vacuum or air-valve secondary type carb, the extra fuel from a double pumper has to go somewhere under street conditions, and that "somewhere" is fuel wash and oil dilution.

Stay tuned, we'll take one last look at some additional tweaks and tricks next time. ▶▶▶▶▶▶▶▶▶▶



Adjusting the camshaft installed centerline is as easy as loosening up four nuts on the drive wheel and then rotating the cam. The Jesel belt drive is very accurate. If the cam is ground properly the lines on the drive gear will typically agree exactly with the calculated advance or retard figures.

With almost 600 psi of spring force at max lift the pushrod cups see a lot of pressure. Therefore, we put a dab of extreme pressure grease in each cup during assembly. The pushrods have a hole in each end to feed oil directly to the pushrod cup. The direct oil feed keeps the ball and cup fully lubricated when running high spring force.

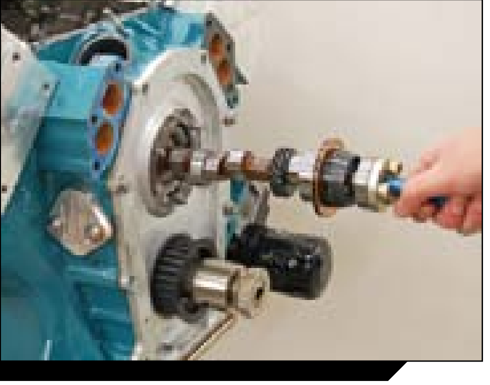


A dab of grease on the bronze gear is a good idea during assembly. A bronze gear is required when using a steel (not chilled iron) camshaft. Milodon supplied the standard length bronze gear for this engine.

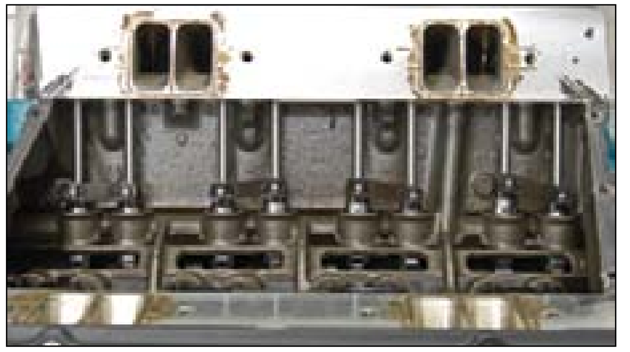
RIGHT: One old time hot rodder trick is to use AMC lifters in a Chrysler engine. The AMC lifter on the right has pushrod oiling as well as pin oiling while the standard Chrysler lifter on the left has neither. The AMC lifter is Comp part number 848, the Mopar lifter is a Comp 829.

We tested three different solid roller camshafts with fairly classic results. The smallest cam made the most torque while the largest cam had the most peak power. The compromise cam split the difference. In other words, we did not discover free lunch.

The Jesel belt drive provides for hassle free cam swaps. The oil pan gasket isn't disturbed and the belt is dry. The black flange on the nose of the cam controls the camshaft end play.

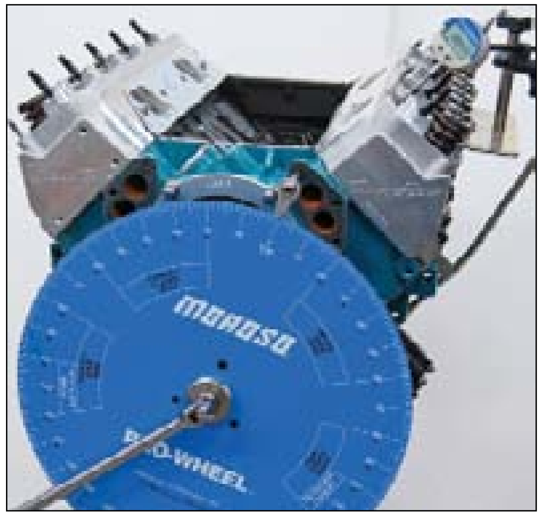


ABOVE: A close up view of the Comp 848 AMC lifter shows the oil passages. High pressure oil is fed from the gallery down to the pin via the small angled hole. The larger hole picks up low pressure oil from the lifter side clearance and directs it up to the pushrod cup. These AMC lifters work just fine in a stock block as long as the lobe lift isn't too large. We didn't have any oil pressure problems at 0.460" lobe lift but we were probably close to the limit.



This view of the valley shows the AMC 848 lifters in place using the Comp 829-L link bars. The standard AMC link bars are too long so you have to order individual lifters and then add the Chrysler link bars. Another option is to buy lifters with pushrod oiling capability from Crane or Morel.

Dialing in the new camshaft requires standard tools such as a large diameter degree wheel, a pointer and a dial indicator mounted solidly to read pushrod travel. Digital dial indicators are available for under $50 these days and make the job much easier since you can reset the zero point with a button push.

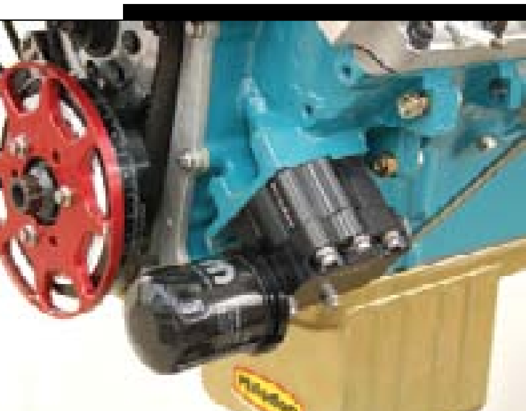


The Bullet cam had 0.460" lobe lift which works out to 0.690" gross lift using 1.50 rocker arms. We're reading 0.693" lift here which means that the rocker arm ratio is a tickle more than 1.50. Not really a problem, but the valve springs are only rated to 0.700 lift so we are getting very close to max travel. Always check for coil bind.

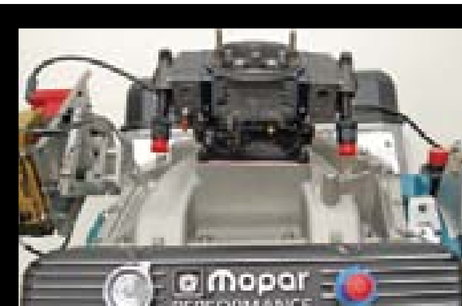
RIGHT: We make marks on the parts to get everything to line back up correctly. Here you can see the mark for the rotor location as well as the mark for the TDC pointer. Marking the parts is an easy way to reduce assembly errors when multiple people are working together.

These three NGK plugs have different amounts of projection. A non-projected plug is on the right while the plug on the left has extra projection. We're using a #6 heat range since this is a pump gas engine and NGK has a lot of OEM plugs in this range. Evidently the OEM engineers have different thoughts on both projection and gap since we found a lot of choices in the catalog. Wider gaps and more projection are said to make more power but we haven't seen it yet, they are also said to resist fouling better.

We prefer to use our own ignition system on the dyno so a plate was made to hold it on the back of the engine. High end parts from MSD supply a lot of juice to the plug. This is the same setup that we use on high compression race motors so it might be overkill for this engine.



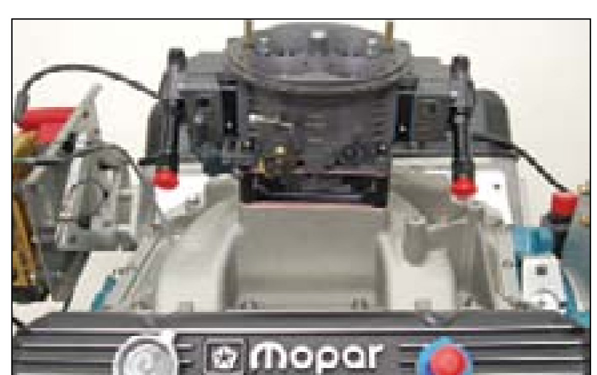
The tiny "teacup" oil filter is handy when priming the engine since it doesn't hold a lot of oil. We're running a System One screen type of filter (which E-Booger isn't fond of) on the dyno so this little filter is just for assembly and transport. The Milodon billet oil pump assembly saves a few pounds and looks great.



RIGHT: Baseline testing was done with a new Holley 850 Ultra XP. Part number for the Ultra XP version is 80804. These newest carbs from Holley are fully adjustable including idle airflow as well as jetting on all circuits. The new Ultra XP carbs also include larger fuel bowls with O-ring inlets, bowl drains, adjustable linkage and lightweight all aluminum construction. All testing was run with the Mopar M1 4500 intake manifold and a Wilson adapter.

Our 850 Ultra XP carb came with billet metering blocks that are drilled and tapped for screw in jets for the idle, main and power circuits. The emulsion jets can also be changed as can the air bleeds in the main body. We only needed to change the main jets on our carb.

TOP RIGHT: We also tested a new Holley 950 which had been converted to annular boosters. The annular boosters increased low speed torque by up to 50 ft-lb when compared to the 850 carb but peak power stayed the same. Annular boosters work really well with cold air and fuels with low vapor pressure since they discharge the fuel through a lot of tiny holes. The downleg booster in the 850 carb works better at higher engine speed and with high RVP fuels.



RIGHT: We decided to try a 1050 Dominator on the engine just to see what would happen. Not only did the Dominator add 22 hp at the top end, it made more torque everywhere. We expected to see some power gains at high speed with the larger carb but the big increase in torque was unexpected. We're guessing that the intake manifold and spacer combination had something to do with those results as well as the annular boosters in the Dominator.

The dyno cell at Gray's Automotive is equipped with a mass air flow sensor as well as fuel turbines so both airflow and fuel consumption can be measured. Keeping track of these two items allows many of the other measurements such as BSFC and volumetric efficiency to be calculated.

Wide band O2 sensors in each exhaust pipe keep track of the air fuel ratio during the dyno tests. Running unleaded fuel is a bonus for the dyno operator since there isn't any lead to foul the O2 sensors.

Just for fun the engine was weighed on a chassis scale after dyno testing. Ready to run the 470 weighed 516 pounds which is about 100 pounds lighter than a stock 400.

The post dyno tear down shows an excellent wear pattern on the valve tips. The rocker arm geometry at 0.690" lift is good enough to generate a narrow and properly centered wear pattern.

One item we noticed during tear down is the large mismatch between the ports in the intake manifold and in the head. The template in this picture is an exact match to the cylinder head port and shows just how much material needs to be removed from the intake manifold to get a match. We will be porting this intake before the next round of dyno tests.

One word of caution to anyone trying to duplicate our build is that you will need to spend a fair amount of time getting an intake manifold gasket to line up with the ports in the Trick Flow head. The ports are machined full size so the gaskets have to fit perfect at all four corners. If your engine block isn't machined exactly correct then it will be very difficult to get the factory tin style intake gasket to line up on all eight ports. We are able to get this gasket to line up well enough to make 685 horsepower but there was still some mismatch. It is something that we need to keep working on – and we will.

Sources:

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Olive Branch, MS, 662-893-5670
www.bulletcams.com

DIAMOND RACING
Clinton Twp, MI, 877-552-2112
www.diamondracing.net

HOLLEY
Bowling Green, KY, 866-464-6553
www.holley.com

GRAY'S AUTOMOTIVE
McMinnville, OR, 503-620-4353
www.graysengines.com

JESEL
Lakewood, NJ, (732) 901-1800
www.jesel.com

MILODON
Simi Valley, CA, 805-577-5950
www.milodon.com

TRICK FLOW
Tallmadge, OH, 330-630-1555
www.trickflow.com

SCAT CRANKSHAFTS
Redondo Beach, CA, 310-370-5501
www.scatenterprises.com