2003 CENTENNIAL HARLEYS • WILD DEUCE

ELECTRONICALLY REPRINTED FROM

American RIDER®

HARLEY-DAVIDSON® RIDING AT ITS BEST

Win it all DREAM GARAGE SWEEPSTAKES

EZ 100 HP
DAVE MACKIE ENGINEERING

FIRST LOOK!

HARLEY'S 103-INCH ROAD KING

www.riderreport.com
OCTOBER 2002

64: MAINTENANCE TECH:
Cleanliness vs. Laziness
68: PERFORMANCE TECH:
Give Your Harley a Quick Stop
71: HEY JOE:
Detonation

Mega Power

100 HORSES FROM MACKIE'S MEGA-SPHERE.

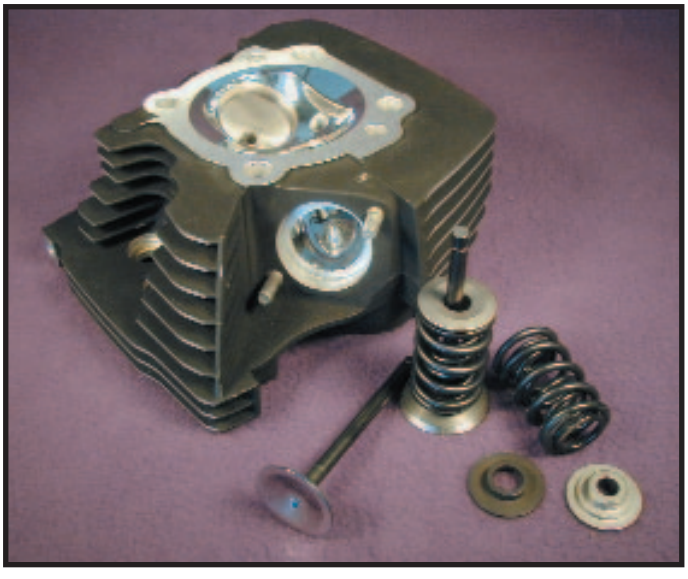
by Joe Minton

We Harley owners like to modify our bikes' engines, mainly to improve power. That word power has about as many meanings as there are folks using it. On one extreme the bagger rider wants the power to be able to pass traffic uphill, fully loaded, from 50 mph—with the bike in high gear. At the other end of the performance spectrum the TT (tavern-to-tavern) pilot is more interested in hitting the rev limiter in each gear from one stop to the next—earth-shaking burnouts with flames and smoke. Both of these Harley owners have a hard time getting exactly what they want for a couple of reasons.

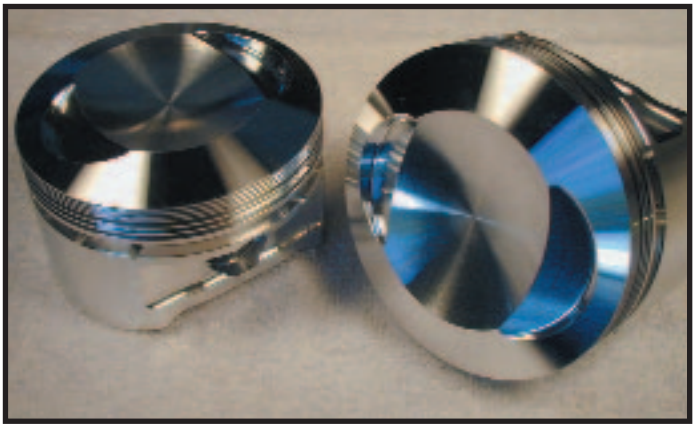
First, there is the confusion about what the word power means. To one person it is the amount of peak horsepower an engine can deliver at high rpm. To another it is the ability to pass a truck going uphill in top gear. The problem is that both owners use the same word to describe two very different engine tuning setups. They may not get what they want, usually due to a misunderstanding between themselves and the people trying to satisfy their needs.

Second, engine performance depends upon a compatible collection of parts and settings. As often as not, these collections are misbalanced. Combining all the best parts doesn't work as well as combining all the best *matching* parts. I have tested highly modified (and very expensive) engines that, on the road, did not perform as well as a very slightly altered stock engine.

American Rider has run many stories suggesting bagger-type engine modifications. This time I'd like to consider that sometimes-elusive "TT" engine. If anything, this is harder to do



Mackie "Mega-Sphere" modified Twin Cam head with a set of Black Diamond valves, springs and retainers, all made to Mackie's specs.



Special JE Pistons have a very large squish surface surrounding the slightly dished center portion, creating a highly efficient combustion chamber. The dome's shape controls compression pressure at the time of peak pressure.

Combining all the best parts doesn't work as well as combining all the best *matching* parts.

The Mackie cams were developed to complement the Mega-Sphere head. They provide a high 0.590-inch valve lift to take full advantage of port flow. Quick opening and moderate closing intake timing is part of the reason for the wide powerband.

because there are so many suppliers making all types of performance parts—components that may not produce the best overall results when mismatched. For instance, the most common mistake made by well-meaning shops is to fit a high-rpm camshaft together with an exhaust that kills top-end power. The result is an engine that doesn't run well at either end of the rpm range. What is needed is a proven and well-balanced *combination* of performance components.

They exist, and here's a perfect example of one. Steve Serdula of Harding Harley-Davidson, a dealership in Corning, New York, contacted us about a 95-inch kit the shop had been installing on customer bikes for a couple of years. Serdula sent us dyno charts with impressive numbers: 106 pounds-feet of torque and 108 horsepower. What caught my attention was that the engine produced more than 100 pounds-feet from just below 3,500 rpm to just under 5,500. A nice torque spread, and it reached 100 horsepower at 5,200 rpm with a peak 6,000. This is a first-gear tire-smoker!

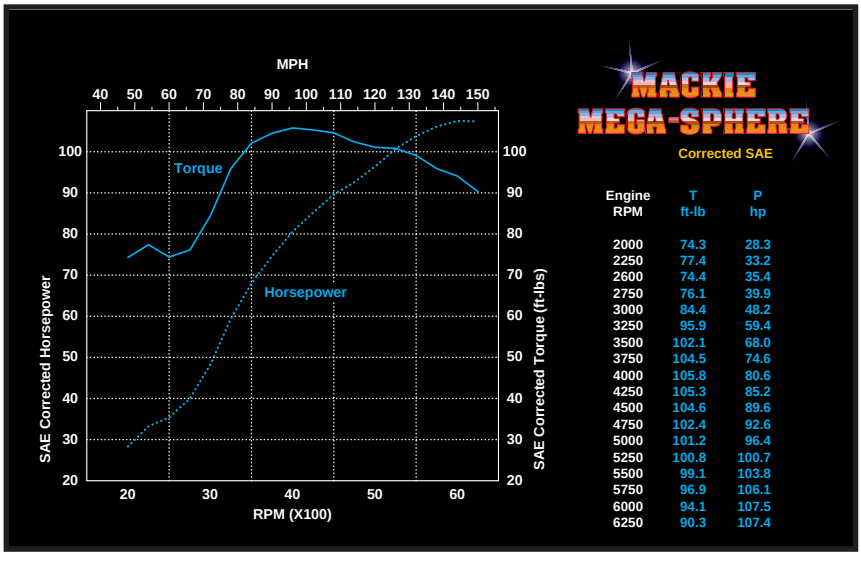
The combination of parts and services that make this kind of power possible was developed by Dave Mackie of Ventura, California. The Mackie kit consists of cams, pistons and cylinder-head porting.

The JE Piston company makes the slugs to Mackie's specifications. Andrews Products produces the DM590 camshafts for Mackie. The cylinder head components are also high-quality parts from proven suppliers. Black Diamond makes the larger-than-stock exhaust and intake valves, springs and titanium retainers. The carburetor used in the dyno test (not included in the kit) was an S&S "G" model fitted with a Thunder Jet.

Mackie also recommends the White Brothers E Series two-into-one exhaust system, which was fitted to the engine that delivered the accompanying dyno chart (14 discs, no end cap). Particularly noteworthy is the very wide powerband. This engine really gets with it from about 3,200 to 6,200 rpm. By the way, I believe that this engine would be even better if it were fitted with the White Brothers large baffle, 18 discs and the closed end cap. The closed cap might lose a couple of horsepower above 5,500 rpm, but the power would start sooner.

Mackie's combination (there are several others) clearly works well. Equally important to the correct selection of his components is the service he provides. Serdula makes a point of stating that. The engine represented by our dyno chart is in Harding's old (last year's) demo bike and had 5,000 reliable (and probably harsh) miles on it when sold.

The shop sends the cylinders and heads to Mackie Engineering and gets them back ready to install. This "100/100" motor (100-horsepower/100-plus-pounds-feet) is an R&R (remove and replace) job for the shop—with a couple of weeks or so between the "R" and the "R." Any mechanic capable of changing pistons can build this engine and get the same result. Think about that; you don't have to wonder about the result. This is a proven combination.



Engine RPM	T ft-lb	P hp
2000	74.3	28.3
2250	77.4	33.2
2600	74.4	35.4
2750	76.1	39.9
3000	84.4	48.2
3250	95.9	59.4
3500	102.1	68.0
3750	104.5	74.6
4000	105.8	80.6
4250	105.3	85.2
4500	104.6	89.6
4750	102.4	92.6
5000	101.2	96.4
5250	100.8	100.7
5500	99.1	103.8
5750	96.9	106.1
6000	94.1	107.5
6250	90.3	107.4

DYNO CHART BY ROBERT LAMARCHE

As tested at Harding's Harley-Davidson, the Mackie Mega-Sphere modified cylinder heads with JE pistons, Black Diamond valves and Andrews cams, all made to Mackie specs. An S&S carb and White Brothers E pipe was used.

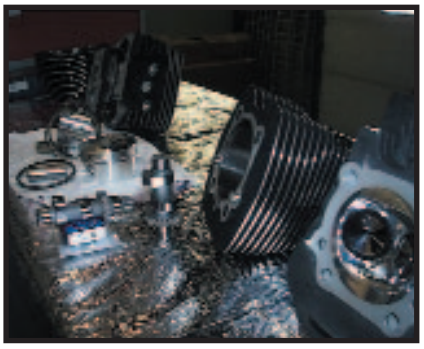
Equally important to the correct selection of his components is the service he provides. Serdula makes a point of stating that.

How much power an engine can make is ultimately determined by how much air it can process. Most readers know the theory that more air gives you more power. Equally important is what you do with that air once it gets into the engine. It is the dual struggle to get more air into an engine and to make the most of it that "fuels" the aftermarket performance industry.

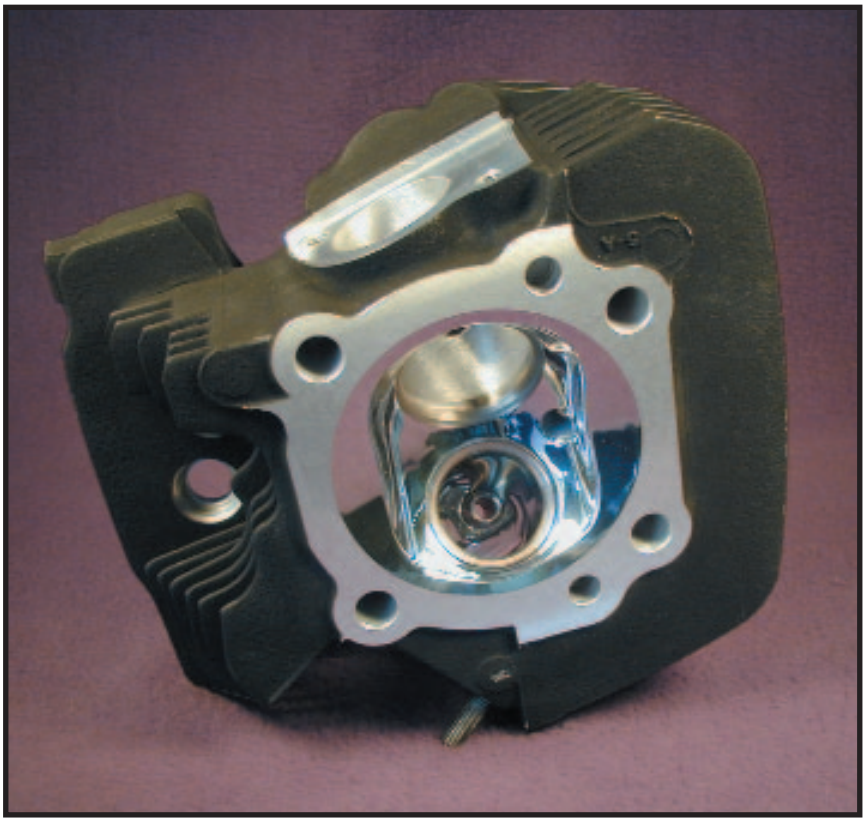
Mackie polishes the chamber and exhaust port (top) to reduce heat transfer while giving the intake port a brushed finish to enhance air/fuel mixing.

If air didn't weigh anything, it could start and stop instantly, and engine design would be ever so much simpler. However, it does have mass and has inertia. It is this simple fact that accounts for all the different camshaft and exhaust system designs, and port and combustion chamber shapes.

Then there is the nature of how gasoline burns and sometimes explodes. Gasoline needs to be evenly stirred into the air trapped in the combustion chamber. There it must be



The Mackie components await assembly at Harding H-D, 3,000 miles from their origin. The pistons are fitted to the customer's jugs.



Mackie's modified Twin Cam head has a large squish area matching the shape of the top of the JE piston. This promotes efficient burn.

vaporized and separated into its chemical components, hydrogen being the most important, before it can burn and produce pressure—power.

The combustion-chamber shape largely determines how gasoline is mixed, vaporized, broken down and burned. A poorly shaped chamber may do none of these things very well. I consider the Evo chamber to be such an example. Mackie's Mega-Sphere chamber shape, on the other hand, is an excellent example of what a chamber should do. It has a 20-degree angle around the outer edge of the pistons with a slightly larger, almost matching, angle machined into the modified heads.

The pistons get very close to the heads at TDC and squeeze the air/fuel mixture into the center of the chamber. This is a "squish" band and has several advantages. First it reduces the chance of explosive burning, the dreaded detonation that has destroyed many engines (See *Hey Joe*, page 71). This, in turn, allows higher cranking pressures and more even combustion. Higher cranking pressures, without detonation, increases power output and efficiency.

No burning takes place within the squish area at the time of peak cylinder pressures and the engine runs cooler as a result. A well-tuned high performance engine should get much better fuel mileage while running cooler than the stock motor from which it was derived.

Mackie machines a semi-spherical depression into the top of the piston so that, at top dead center, the actual burning area is nearly spherical. Such a compact chamber means that the flame front has less distance to travel and the air/fuel mixture is stirring itself as fast as it can. This is similar to how skaters pull their arms in to increase the speed of a spin.

The Mega-Sphere chamber design is part of the reason this motor has such a wide powerband. Its excellent turbulence keeps the burning and the consequent chamber-pressure rise quick enough to be efficient at high rpm. That efficiency shows in the power curve; notice how little the power changes from 5,500 rpm through 6,250 where they stopped the dyno run. This engine would probably have produced more than 100 horsepower through 6,750 rpm.

Like a lot of tuners and engine builders, Mackie doesn't like to talk about his cam designs. Some things are clear though: The DM590 provides 0.590 inch of intake-valve lift. To take advantage of the higher port flow, it is necessary to open the valves farther (and quicker, too). This sort of lift is useless when combined with stock intake ports. However, while the stock intake port flow does not increase airflow much beyond 0.450-inch lift, Mackie's ports continue to increase flow rate substantially beyond 0.550. The cam properly feeds the Mega-Sphere ports.

The fact that this engine starts doing good work at about 3,000 rpm makes it clear that the intake valve is closing much sooner than many cams designed for very high-rpm operation.

I can recommend Mackie's services and products without hesitation. The Mackie kit delivers the performance qualities that we all want: A wide powerband and plenty of power for any reasonable need. Perfect.

For information contact Dave Mackie Engineering, 2065-H Sperry Avenue, Ventura, California 93003; (805) 658-6969; www.davemackie.com.

Thanks to Steve Serdula and the folks at Harding Harley-Davidson, 26 Bridge Street, Corning, New York 14830; (607) 937-8351; www.hard ingharley.com.