WAKING THE DEAD

REVIVING THE LT1, WHICH MANY WRONGFULLY CONSIDER A "DEAD" PLATFORM

BY ERIC ANDERSON, PHOTOS BY MATT SPROUSE

Designing and building an engine that will produce a zillion-horsepower and an equal amount of torque really isn't all that difficult. Most anyone can pick and choose "race" parts out of a catalog and put them together. However, while the peak power figures may be astonishing, the engine's characteristics and street manners will likely be just as ghastly.

Unfortunately, this happens all too often. While some street machine enthusiasts bow down to peak figures, the real winners are those that put the time and research into designing an engine they'll be comfortable with that also makes enough power to meet their realistic needs. Engines with cams so big they have no vacuum at idle, need throttle input at idle to keep them running, or are soft off-idle due to a lack of low-end torque are not meant for mainly street-driven cars.

While this applies to essentially all makes and models of engines, we've noticed General Motors' Gen II small-block LT1 V-8 has suffered a considerable, if not life-long, drought when it comes to informative "from scratch" build stories.

The Gen II family of V-8s includes the 5.7L LT1 and LT4, and the small-bore 4.3L L99. These engines were available in a variety of vehicles including Corvettes (Y-Bodies), Camaros/Firebirds (F-Bodies), and Caprices/Roadmasters/Fleetwoods (B-Bodies) between '92-'97. Externally they all look the same, except for the cast iron heads on B-Body LT1s and L99s, and the powder coated red intake manifold on LT4s.

With the introduction and quick, yet steady rise of the Gen III LS-series engines, the once widely-used LT1 has somewhat fallen by the wayside. Despite the cutting-edge technology and outstanding power levels associated with the LS-series engines, the LT1 remains a formidable foundation for a performance engine build.

Knowing the LT1 was still worthy of our attention, we assembled a naturally-aspirated 396ci LT1 that is a monster on the dyno and that will handle anything we can throw at it on the track, but that is docile enough to idle through rush hour traffic with ease and great drivability.

In addition to building a powerful, street friendly engine, we wanted our fellow street machine enthusiasts to know that despite its 10-year absence from dealer showrooms, the LT1 is far from a "dead" platform, which many wrongfully consider it to be.

COMPONENT SELECTION

Rather than choosing the common displacement of 383ci, which is created by over-boring the stock four-inch cylinders to 4.030 inches and using a crankshaft with a 3.75-inch stroke, we opted to build a 396. To achieve 396ci using a small-block V-8 like the LT1, the same 4.030-inch bore is required in addition to a crankshaft with a longer stroke of 3.875 inches.

Since the foundation of every high performance engine is a strong bottom end, we knew our rotating assembly had to consist of high quality forged steel components. This is a point of contention for many enthusiasts; and while engines have made a lot of power with cast iron rotating assemblies, when designing this powerplant, we wanted both the strength and the security forged steel components provide.

We started by selecting a forged crankshaft from Lunati's "Racer Series." The "Racer Series" offers a budget conscious blend of strength and performance at a lesser price than Lunati's upscale "Pro Series." Rather than using knife-edged counterweights that direct oil towards the swinging connecting rods, Lunati's crankshafts feature a contoured wing design, which sends oil away from the rods. This design feature helps decrease power-robbing windage. To handle harmonic balancing duties, we chose a Super Damper from ATI Performance Products.

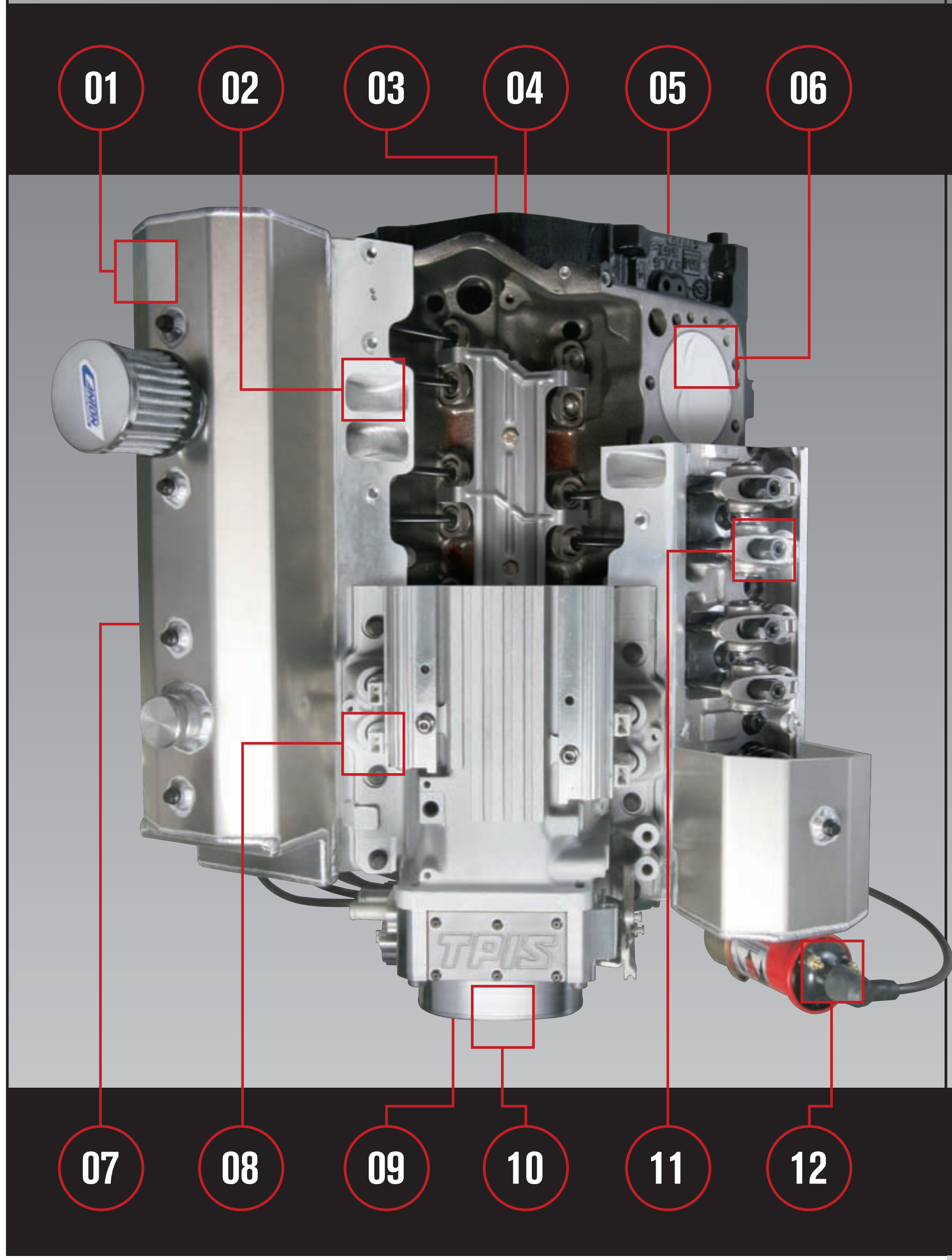
Another part of the 396 equation involves using a 5.85-inch connecting rod. Standard 5.7-inch rods are too short to use with the increased size of the crankshaft counterweights, and longer 6.0-inch rods push the wrist pin too far into the piston's ring package, which decreases piston strength and can prevent the rings from sealing well. After much research, we chose a set of Lunati's "Pro Mod" 5.85-inch forged I-beam connecting rods. Since we have no plans to add boost to our 396, we're confident Lunati's forged I-beams are the perfect choice for our engine, as opposed to their H-beam rods.

Next, we worked with the folks at Diamond Pistons to create a dished forged piston that would work with our cylinder head plans to create a pump gas friendly compression ratio. Unlike conventional dished pistons, which feature a "D" shaped dish with a ridge around the outside edge, Diamond created a unique, concave dish design incorporating the necessary valve reliefs. Diamond's concave design provides a more consistent surface for the flame front to travel across and maximizes quench. This increases the speed of the burn across the piston and as a result improves the quality of combustion.

Before we could assemble our shortblock, we needed to perform the necessary machining. Starting with a two-bolt main block, we enlisted the strength of a set of billet steel four-bolt splayed main caps from Oliver Racing Products, which are more rigid than the stock center caps. We also strapped the stock front and rear main caps by fastening a piece of billet steel on top of the stock caps for increased strength.

Despite the increased throw of the

396 LT1 COMPONENTS




01

VALVE COVERS – CANTON
With breather stacks on both sides, these sheet metal valve covers will allow the crankcase to breath during high rpm periods.


02

CYLINDER HEADS – AFR
The increased velocity from the 195cc intake ports in these CNC ported "Eliminator" cylinder heads will help our 396 remain street friendly.


03

CRANKSHAFT – LUNATI
This forged steel, 3.875-inch stroke "Racer Series" crankshaft is very strong, and features the necessary length stroke to achieve 396ci.


04

OIL PAN – CANTON
Featuring baffling, directional runners, and a number of trap doors, this Road Race oil pan will help keep oil near the oil pump pick-up.


05

CONNECTING RODS – LUNATI
At 5.85 inches, these "Pro Mod" forged I-beam connecting rods are the minimum (and the only recommended) length for use in a 396.


06

PISTONS – DIAMOND PISTONS
The concave design of the dish in these forged pistons is unique and contributes to our 92-octane friendly compression ratio of 11.1:1.


07

SPLAYED MAIN CAPS – OLIVER
The outer holes in these billet steel caps are at a 10-degree angle toward the outside, which increases overall holding strength.


08

FUEL INJECTORS – FAST
These 36 lb./hr. injectors provide a consistent spray pattern, and when flow tested, all eight were perfectly matched to one another.


09

CAMSHAFT – TPIS
The ZZ-X, which is a hydraulic roller cam, provides healthy off-idle torque, is very street friendly, and has an aggressive, lopey idle.


10

THROTTLE BODY – TPIS
With two 58mm openings, which are 10mm larger than stock, this billet aluminum throttle body is capable of flowing over 1,100 cfm of air.


11

VALVETRAIN – COMP CAMS
"Hi-Tech" series 1.7:1 roller rocker arms and pushrods, and "High Energy" series hydraulic roller lifters make up the valvetrain.


12

IGNITION – MSD
A Pro-Billet LT1 distributor, Blaster 2 coil, and 8.5mm spark plug wires will provide a strong and consistent spark to ignite our 396.

crankshaft, the only clearancing needed involved grinding a small amount of material out of the oil pan rail and the bottom of each cylinder bore to allow the rods to rotate freely.

With our short-block designed, we moved on to locating a set of cylinder heads capable of adequately feeding our 396 while maintaining its street manners. Our experience led us to Airflow Research (AFR) and their recently released "Eliminator" line of aluminum heads. We chose their 195cc Competition Port heads, which are CNC ported and feature 2.08-inch intake and 1.60-inch exhaust valves, with 58cc combustion chambers.

Until AFR released the "Eliminator" line, a 396 like ours would've needed 210cc intake ports to provide enough air to make decent power. However, with AFR's new design, a 195cc intake port is sufficient for our 396. The smaller intake port means increased port velocity, which results in improved drivability and low-end performance.

To help control heat, reduce friction, and to further increase the efficiency of the piston and combustion chamber designs, we coated the top and skirts of each piston, the combustion chambers, and the valve faces using coatings from Calico Coatings.

On the tops of the pistons we used Calico's CT-2 coating. This ceramic coating helps disperse heat across the piston, which reduces temperatures and the likelihood of detonation. We coated the skirts of the pistons using Calico's CT-3 coating, which is a dry film lubricant. This graphite-based coating decreases the amount of friction between the cylinder walls and the piston skirts, which reduces overall wear.

We used the same CT-2 ceramic coating to coat the combustion chambers and valve faces as we did on the piston tops. Combining the coated pistons with the coated combustion chambers and valve faces greatly increases the efficiency of the combustion process and the ability of each component to withstand heat.

Between the dished piston from Diamond and the 58cc chambers in our AFR heads, we achieved our desired compression ratio of 11.1:1, which is only slightly more than the stock ratio of 10.5:1. That might sound high for street use, but thanks to the LT1's reverse-cooled cylinder heads, compression ratios up to 11.5:1 are easily possible using the same 92-octane gas available at most any gas station in America.

Before choosing a camshaft, we contacted the GM fuel injection experts at TPI Specialties (TPIS). Their considerable experience building powerful and reliable LT1s for street and race use resulted in a short conversation about which cam would be ideal for this project and why. We selected TPIS' ZZ-X hydraulic roller camshaft, which features a duration of 239/239 degrees at .050-inch of lift and a gross lift of .558/.558-inch (with 1.5:1 rocker arms) with a 112-degree lobe separation angle. While not the wild, solid roller that some like, this cam provides healthy vacuum at idle, doesn't surge at low rpm, and won't require our attention every few months to adjust the valve lash.

To top off the AFR heads and to work with the TPIS camshaft, we selected valvetrain components from Comp Cams. Instead of using 1.5:1 or even 1.6:1 roller rocker arms, we opted to go with Comp's more aggressive 1.7:1 "Hi-Tech" stainless steel rocker arms mounted on ARP rocker studs. The rockers work with Comp's "Hi-Tech" 5/16-inch pushrods and "High Energy" hydraulic roller lifters. The increased rocker ratio results in a total valve lift of .632/.632-inch. Using 1.7:1 rockers helps shift the valve lift numbers into the sweet spot where the ports flow the most without using a camshaft with higher lift numbers.

The benefit of using higher ratio rocker arms as opposed to a higher lift cam is that increased lift numbers are possible without having to move the whole valvetrain further. Higher lift cams require the pushrods and lifters to travel further, which is hard on components and robs power; whereas higher ratio rocker arms provide more valve lift and valve open time (duration) while increasing only the distance the valves travel.

Knowing a stock 48mm or even a larger 52mm throttle body couldn't provide enough air for our 396, we chose a billet 58mm unit from TPIS. To match the larger throttle body, we increased the size of the openings in the stock LT1 intake. To deliver fuel to our 396, we selected a set of 36 lb./hr. injectors from Fuel Air Spark Technology (FAST).

Knowing our LT1 will see time on a road course, we looked to Canton Racing Products for a Road Race oil pan capable of keeping the oil from sloshing around during acceleration, braking, or hard cornering. To distribute the oil, we chose a Melling oil pump outfitted with a 3/4-inch pick-up from Canton. To better accommodate the large rocker arms from Comp, we installed a set of Canton's fabricated aluminum valve covers with baffled breather stacks.

Well aware of the ignition problems that have sidelined many LT1s, we were eager to replace the stock Opti-Spark with MSD's Pro-Billet LT1 distributor. Boasting improvements in every area the stock component lacked, MSD's distributor should easily handle igniting our 396. Rounding out the ignition upgrades are a Blaster 2 coil, 8.5mm Super Conductor spark plug wires, and a 6AL Ignition Control.

ENGINE PERFORMANCE

After choosing the necessary components for our project 396 LT1, we worked with TPIS/Cottrell Racing Engines to assemble, dyno, and tune the engine. Combining our research and TPIS' LT1 experience was sure to produce exceptional results.

With over 550-horsepower, a torque curve that resembles a tabletop boasting near 450 foot-pounds of torque or more from 2,800 rpm all the way to 6,500 rpm, and street manners that should amaze most, our LT1 has easily met our requirements of a high performance, street friendly engine. We didn't use the most expensive parts to achieve the highest power figures; instead, we built a high performance engine that walks the line between street and race, but that would be at home under the hood of most any street machine, whether an early street rod or a late-model sports car. Not only that, but our LT1 creation should easily achieve over 20 mpg on the highway in our six-speed equipped '85 Camaro! That's hard to beat.

Everyone, please give a warm NSMC welcome to the LT1; it's most definitely back from the "dead." NSMC

DYNO TESTING & TUNING

With a wide-band oxygen sensor monitoring each cylinder, we were able to closely examine our LT1's air/fuel ratio and adjust the programming as necessary. As Jim Hall operated the engine dyno at TPIS/Cottrell Racing Engines, TPIS' Chris Dorman handled the tuning. Chris' tuning knowledge was obvious as it only took three dyno pulls to perfect the tune for our 396. Because we designed our LT1 to be street friendly, we performed all of the dyno pulls using 92-octane fuel containing 10-percent ethanol.

EASILY REPLICATED

While a few of the components in this engine build are LT1-specific (ignition, cylinder heads, and some fuel injection related items), there's no reason an enthusiast couldn't follow exactly what we did to create similar performance numbers and engine characteristics using a Gen I small-block Chevrolet V-8 (283-400ci). However, there are a few differences between Gen I V-8s and Gen II V-8s (LT1, LT4, and L99) that are important to be aware of.

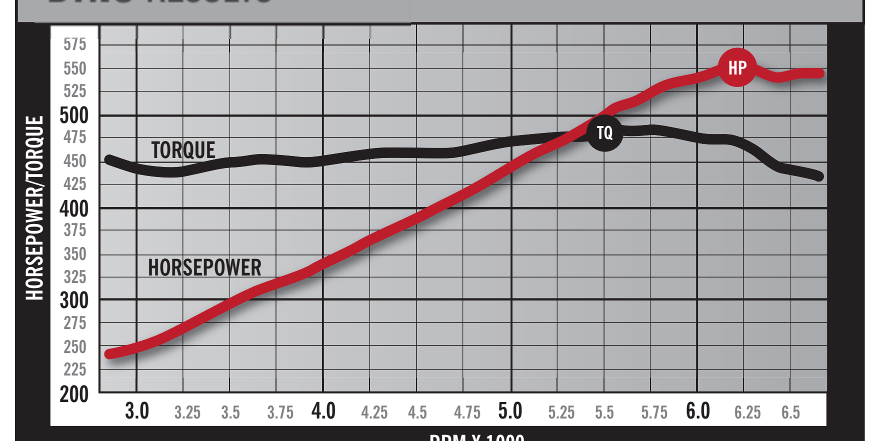
Gen II V-8s utilize reverse-flow cooling, which means the cylinder heads are cooled before the rest of the engine. This feature, combined with the use of aluminum heads, allows for higher compression ratios than what is normally considered "safe" for street use with a Gen I V-8. Other major differences include a cam-driven water pump and an optical pick-up distributor (Opti-Spark).

While you may not be comfortable with a compression ratio of 11:1, the use of aluminum heads (like AFR's "Eliminator" heads), well-designed pistons, and coatings on the piston tops and skirts, combustion chambers, and valves to decrease temperatures and friction, should easily (and safely) allow compression ratios near 10.5:1 with a Gen I V-8. A lower compression ratio will result in reduced power figures, but the difference should not be major.

Finally, using a single plane carbureted intake (or a fuel injected intake like TPIS' MiniRam) in place of the LT1 intake would work well and would make good power.

If you're after an engine capable of producing big power while remaining easy to drive on the street, we challenge you to follow our lead by building an engine much like our 396 LT1.

DYNO RESULTS



HORSEPOWER — TORQUE (FT.-LBS.)

HP PEAK HORSEPOWER: 552 @ 6,200 — TQ PEAK TORQUE: 484 FT.-LBS. @ 5,500

From 3,000-6,000 rpm, our naturally-aspirated 396ci LT1 boasts a near linear horsepower increase of almost 100-horsepower per 1,000 rpm! With over 450 ft.-lbs. of torque at 2,800 rpm, there's no shortage of low-end muscle for our street friendly LT1. We can't wait to get it on a track!

SOURCES

AIRFLOW RESEARCH (AFR)
(877) 892-8844
www.airflowresearch.com

AUTOMOTIVE RACING PRODUCTS (ARP)
(800) 826-3045
www.arp-bolts.com

CANTON RACING PRODUCTS
(203) 481-9460
www.cantonracing.com

COMP CAMS
(800) 999-0853
www.compcams.com

DIAMOND PISTONS
(877) 552-2112
www.diamondracing.net

FUEL AIR SPARK TECHNOLOGY (FAST)
(877) 334-8355
www.fuelairspark.com

LUNATI
(662) 892-1500
www.holley.com

MSD IGNITION
(915) 857-5200
www.msdignition.com

OLIVER RACING PRODUCTS
(800) 253-8108
www.oliver-rods.com

TPI SPECIALTIES (TPIS)
(952) 448-6021
www.tpis.com