SLEDGEHAMMER

CALLAWAY ENGINEERING'S 880-HP, TWIN TURBO, 254-MPH STREET CORVETTE

By Jeff Smith

The '88 Corvette sits on the apron alongside the 7.5-mile oval at the Transportation Research Center (TRC) in northwest Ohio, idling comfortably at 700 rpm. It looks much different—sleeker—than either a production Corvette or the "production" Callaway twin-turbocharged cars. This silver devil has a very hungry look about it.

The Corvette has made a couple of tentative top-speed passes with John Lingenfelter behind the wheel, but the results are not encouraging. The car is suffering from a high-speed misfire. Tim Good, the Callaway Chief Engineer, is disappointed. The sleek Corvette runs *only* 210 mph on what sounds like six cylinders. A TRC employee offers that anything over 200 mph is "respectable."

"By the way," the man asks, "how fast you guys trying to go?"

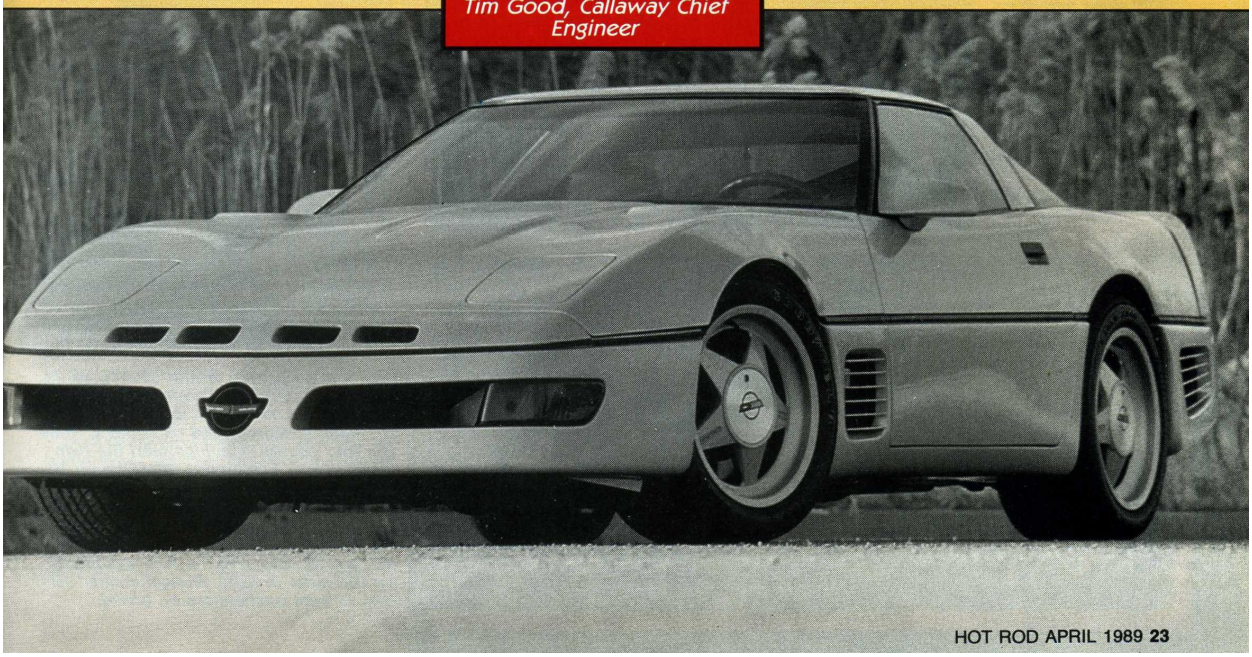
"It should run over 250," Good replies. Later, Good reflected, "That's when they began to think we were a little crazy!"

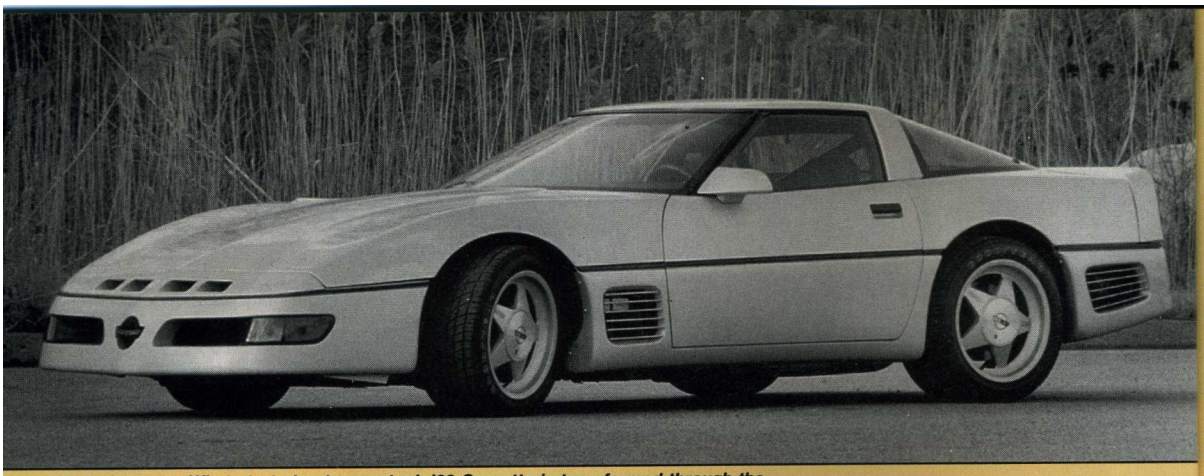
While 250 mph from a street car *is* a lofty goal, this was no top-speed shot in the dark. Far from it. This latest Callaway effort is in fact a very carefully calculated response to an international duel of the titans. Reeves Callaway, the man behind the production, twin-turbocharged Corvettes, plans to prove that a no-nonsense, American hot rod can bury the best the world has to offer. The result: Sledgehammer.

> "Here is a Corvette that you can chase after an Indy car with and also give it to your mother to drive to the store!"
>
> *Tim Good, Callaway Chief Engineer*

The goal for Sledgehammer is simple: Run 250 miles an hour, but make it happen with a car with a "wide dynamic range" that can easily encompass both the 6.8 road horsepower necessary to cruise at 60 mph *and* 250 miles per hour. Add to this "must do" list such amenities as air conditioning, ABS brakes, power steering, and a boulevard ride. This was to be no temperamental, high-strung bullet; instead, a display of virtually limitless, tractable power that is available on demand, anytime. While theoretically attainable, the engineering challenges were imposing.

Good's pocket calculator had already predicted the necessity of producing 1012 horsepower to push a stock-bodied Corvette to the double century mark. Obviously, aerodynamics would play a significant role in forging the Sledgehammer. Tony Cicale is recruited to help with the aerodynamics, while Paul Deutschman will design the body panels. The aero pieces not only give



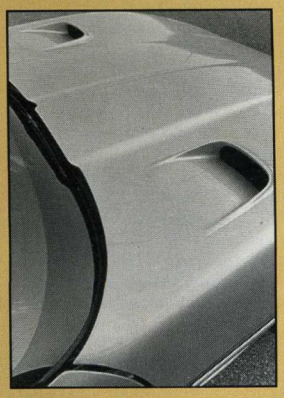


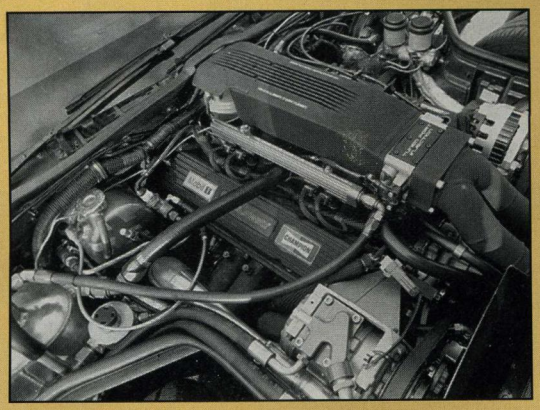
Sledgehammer. What started out as a stock '88 Corvette is transformed through the magic of Callaway Engineering into a street car with 250-mph abilities. The Paul Deutschman-styled body panels for the Sledgehammer will soon be offered by Callaway as bolt-on body panels. The pieces will be constructed of durable GE Xenoy plastic and will bolt to a Corvette in the stock body panel locations for easy installation. Currently, Callaway is finalizing the tail treatment to differ slightly from the Sledgehammer prototype.

the Corvette its distinctive appearance but also allow it to efficiently cut through the wind, neutralize lift, and generate the downforce necessary to prevent the Sledgehammer from becoming an airborn projectile at Mach .33.

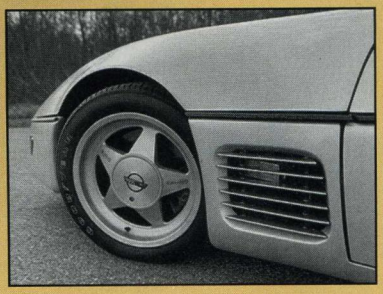
While Deutschman conspires to cheat the wind, Callaway contemplates a serious infusion of horsepower. Based in part on Callaway's earlier aerodynamic experience with his 712-horsepower Top Gun Corvette that ran 235.55 mph, Good's calculator predicts that they will need at least 900 horsepower. Since Callaway's signature is the strength of his twin-turbocharged production Corvettes, a heavy-handed, twin-turbocharged Mouse motor is a foregone conclusion.

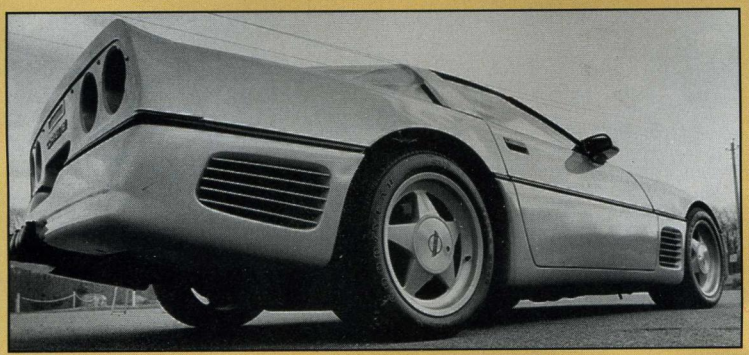
Enter John Lingenfelter. Callaway contracts Lingenfelter to assemble two 350-cid Mouse motors "with all the right parts"—one engine to be a development piece, while the second is slated for the run against the wind. In anticipation of the high power levels, John uses a Chevrolet Bow-Tie block precision-machined for a Cosworth forged crank-



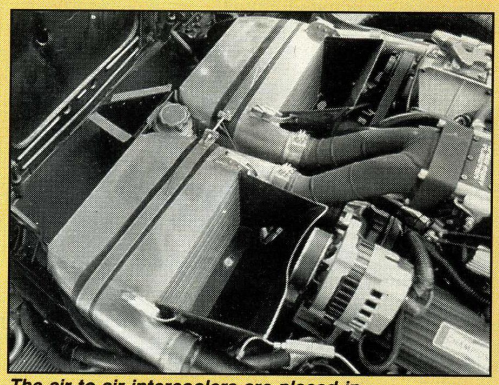


Who says you need 32 valves and overhead cams? Callaway's Lingenfelter-built 350 Chevy cranks out 880 horsepower and 772 lbs.-ft. of torque with the help from two AiResearch turbochargers, intercooling, EFI, and a whole lotta help from friends.

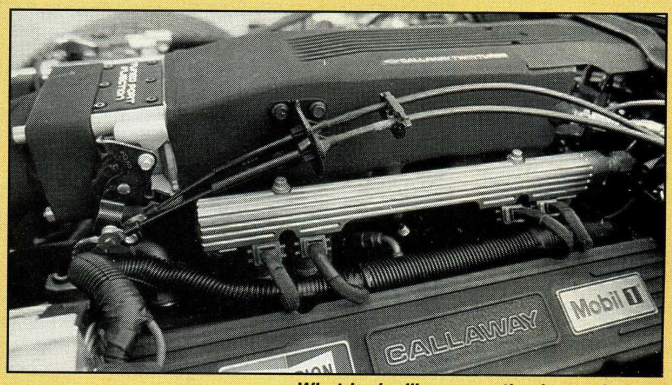




The Sledgehammer is stuffed with vents, gills, and breathers. The foglight openings and the small oval in the nose feed the engine radiator and oil coolers, while the four square openings feed the twin intercoolers, exiting out of the hood. The "gills" behind the front tires are the air intakes for the engine. Finally, the vents in the rear quarter-panels act as ducts for the transmission and rearend coolers on the left side, and the A/C condenser on the right. In total, Sledgehammer carries 10 heat exchangers on board.



The air-to-air intercoolers are placed in the high-pressure area in the nose to keep the 22-psi charge from the turbochargers well below detonation levels. The ducting directs the air exiting the intercoolers through the hood vents.



What looks like an exotic electronic fuel injection manifold is actually a simple Holley tunnel ram machined to accept eight Rochester electronic fuel injectors and a fabricated top, complete with an enlarged factory throttle body.

shaft and special Cosworth-designed pistons, connected to a set of Crower rods. Speed-Pro supplies the rings and bearings, while Pontiac-designed small-block, raised-port aluminum cylinder heads are outfitted with 2.02-inch intake and special heat-resistant, Inconel steel 1.60-inch exhaust valves.

By design, the engine is intended to be run on the track for long periods at wide-open throttle and at high boost levels—the ultimate dyno test. Initially, Callaway intends to use a very exotic, individual-runner induction system with 16 electronic fuel injectors. Unfortunately, the system produces an unacceptably rough idle. Further experimentation reveals that a simple, Holley tunnel ram manifold base with a fabricated plenum top and an enlarged throttle body is more than adequate. By working with Rochester Special Products, Callaway utilizes eight specially designed, 75 lbs./hr. fuel injectors with the proper dynamic range working in conjunction with a Zytek Formula 1 sequential electronic fuel injection computer.

All of this is in preparation for the addition of a pair of special hybrid AiResearch TO4B turbochargers from Turbonetics' Bob Keller, matched with a pair of stainless-steel wastegates from Richard Lee. The turbos are coupled to the Mouse motor with a custom-built set of stainless-steel 2-inch headers, along with a fabricated stainless-steel resonator designed to withstand 1000 horsepower. Finally, the exhaust is routed to *four* SuperTrapp mufflers exiting out the rear. Ignition is by an MSD 7-A firing through a Callaway-built billet-aluminum distributor.

According to Callaway, "Making the horsepower was actually the easy part." Once dyno testing begins, Good and company systematically exchange boost for cam timing in order to produce an acceptable idle quality. Beginning with a large cam and 15 psi of boost, the little

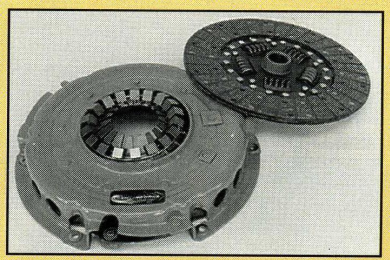
> "The acceleration from 190 to 230 mph will shove you back in the seat!"
>
> *John Lingenfelter, Engine Builder and Driver*

Mouse motor cranks out well over 1000 horsepower with tremendous torque and outrageously high exhaust gas temperatures. By pulling 35 degrees of cam duration and bumping the boost to 22 psi, the engine makes 880 horsepower at an easy 6250 rpm with a smooth 650-rpm idle! That, friends, is 2.5 horsepower per cubic inch. The torque peak is an oh-my-goodness 772 lbs.-ft. at 5250 rpm. Still, the engine is capable of running on everyday pump premium with up to 15 psi of boost. The final cam profile is a Cam Techniques piece from Dave Generous with 232 degrees of timing at .050-inch cam lift and .558-inch lift. This is combined with a Jesel shaft rocker assembly and Crane roller lifters.

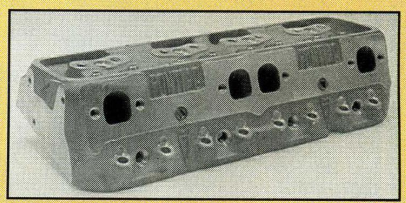
What kind of a drivetrain do you put behind an 880-horsepower engine? While you might assume a race-bred, dual-disc clutch and a Lenco trans, Callaway amazingly ends up with a single disc, 10.5-inch Midway Industries Centerforce experimental setup from Bill Hays. Callaway integrates the system with the Corvette hydraulic release mechanism and bolts in a Doug Nash 5-speed trans graced with a Nash overdrive normally found on the 4+3 production Corvettes. All this is tied to a blueprinted but otherwise stock Dana Corvette rearend with a 3.07 gear! With a set of specially built P275/40ZR17 Goodyear tires mounted on a set of production Callaway Dymag investment-cast 9.5-inch-wide wheels, the gearing and tire size are chosen to put the engine at peak power at just over 254 mph.

Once the Sledgehammer is assembled, Callaway wastes no time in putting it to the test. Since it is a street car, Sledgehammer is driven to TRC in Ohio from Callaway's shop in Old Lyme, Connecticut, a distance of roughly 700 miles. Along the way, a technician dials in the part-throttle fuel curve from the right seat at speed by adjusting the Zytek ECM with a lap-top computer. The trip to and from TRC nets 16-mpg fuel economy. Along the way, the Corvette is subjected to a variety of October weather conditions from heat to rain, cold, and snow, yet the Sledgehammer never flinches.

Once at TRC, the speed testing be-



Incredibly, all this power is transmitted through a Bill Hays-designed prototype single disc, 10.5-inch Centerforce pressure plate and clutch. The Sledgehammer unit features 18 weights.



Airflow, even with a turbocharged engine, is critical to maximum horsepower. Lingenfelter chooses a set of Pontiac-designed, Brodix-built, raised-runner aluminum small-block Chevy cylinder heads fitted with 2.02/1.60-inch valves and dressed with his latest porting techniques.

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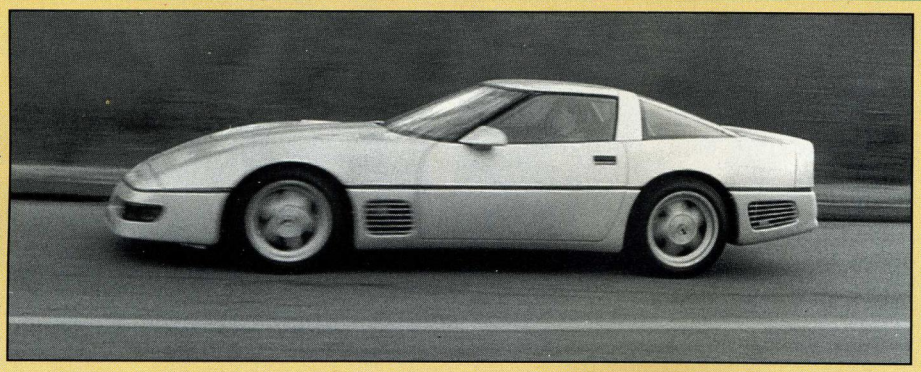


The Sledgehammer concept includes driving the Corvette from Callaway's shop in Old Lyme, Connecticut, to TRC in northwest Ohio. For the round trip, Sledgehammer generates 16 mpg on pump gas.

gins. Almost immediately, a difficult-to-find high-speed misfire plagues the engineers until two plugged fuel injectors are discovered. Still, running on six cylinders, the Sledgehammer strains to 210 mph. With the injectors repaired, Lingenfelter pushes the hyper-speed Corvette to 223 mph. Still, Good is convinced the Corvette can improve. The engine inlet air is pulled from a set of "gills" on the lower portions of the front fenders just behind the front tires. Since this is a low-pressure area at speed, Tim fashions small ⅜-inch-high scoops out of duct tape to direct air into the gills. With that simple change, Lingenfelter heads back onto the 7.5-mile TRC oval and screams the Corvette to its best 254.76 mph blast! Tim's duct tape fix is worth more than 31 mph!

In the final analysis, the Sledgehammer project illustrates the outrageous performance levels attained when you apply simple engineering concepts to tackle a problem. Here, it isn't enough just to go fast. Callaway also demands a car that exhibits the road manners of a production Corvette. Of course, being hot rodders, there's always the chance that the car can go faster. Is it already too fast? As one Callaway engineer puts it, "The only other thing you need is diplomatic immunity!" **HR**

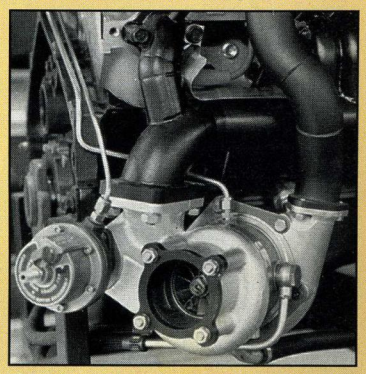
THE MEN BEHIND THE MAGIC

The following men are the motivators behind the Sledgehammer. Callaway is quick to point out that it was the cooperation of these principals, many other companies, and individuals that made this project successful.

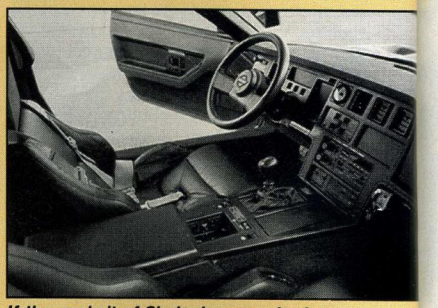
Reeves Callaway	*Mr. Motivation*
Tim Good	*Chief Engineer*
Elmer Coy	*Project Engineer*
John Lingenfelter	*Driver, Engine Builder*
Tony Cicale	*Aerodynamicist*
Paul Deutschman	*Stylist*
Carroll Smith	*Chassis*
Dave Hendricks	*Project Technician*
Talbot Hack	*Project Engineer*

"Monsieur Le Turbo"

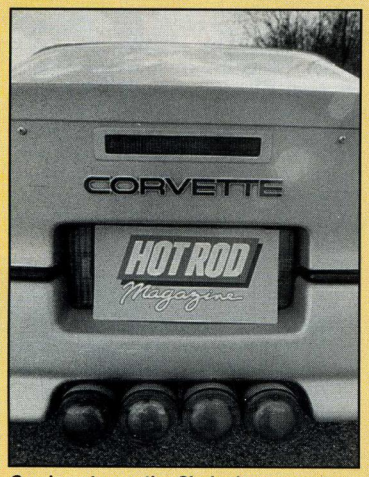
Sign on Reeves Callaway's office door



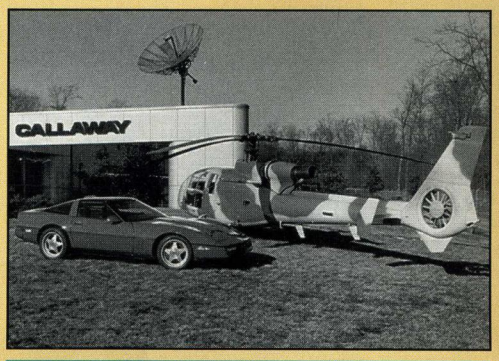
This photo shows the location of one turbocharger on a stock Callaway engine. The same location is used for the Sledgehammer, although larger, hybrid TO4B AiResearch turbos are used. Because of the low placement of the turbos, a belt-driven scavenge pump is used to pump oil from the turbos to the sump. At 6200 rpm, the pump spins at 18,300 rpm!



If the cockpit of Sledgehammer looks production, you're catching on. The only real additions are a Callaway boost gauge, five-point harness, and a roll bar. The relocated A/C evaporator and fan are placed behind the passenger's seat.



Coming at you, the Sledgehammer at speed screams with the whine of an Indy car. Then as it blasts by, the tone changes to the distinctive rumble of a NASCAR small-block. Muffling an 880-hp engine isn't easy, necessitating four SuperTrapp mufflers.



Reeves Callaway is not your typical hot rodder, so it stands to reason that he doesn't travel in conventional style. When not behind the wheel of a Callaway Corvette, Reeves makes appointments in his French-built Gazelle turbine-powered military attack helicopter. The machine guns and rocket launchers have been removed, however.