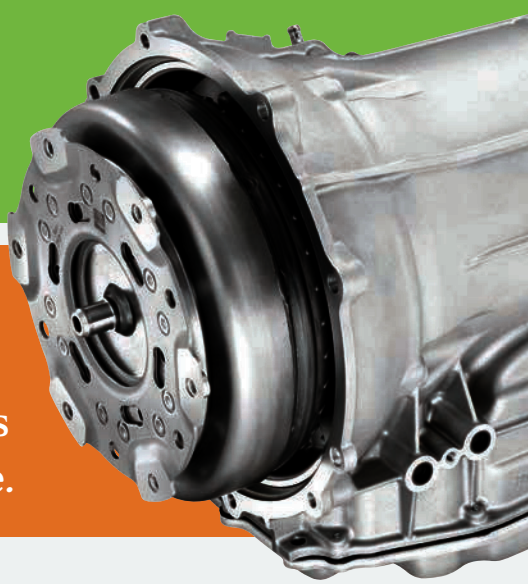
GM POWERTRAIN ENG
NEW TRANSMISSION; NEW ENGINE



Clearly, there is a whole lot of activity in the powertrain space at General Motors. These two developments are certainly impressive as to what creativity and dedication can achieve.

There two distinctively different vehicles in the Chevrolet lineup that are immensely powerful. One is the 2015 Chevrolet Silverado 1500 pickup truck. The other is the 2015 Corvette Stingray.

Product development is generally most clever when the developers overlook the obvious differences—pickup truck, sports car—and concentrate on the commonalities so that the development is something that has wider applicability.

Enter the development of the GM-engineered Hydra-Matic 8L90 eight-speed transmission.

In the Silverado*, it is mated with a 6.2-liter Ecotec3 V8 engine. The engine produces 420 hp @ 5,600 rpm and 460 lb-ft of torque @ 4,100 rpm. The engine features a cast aluminum block and heads. It has overhead valves and there's direct fuel injection with Active Fuel Management.

In the Corvette, the 8L90 is paired with the LT1 engine. This, also a 6.2-liter V8, produces 455 hp @ 6,000 rpm (or 460 hp if the optional performance exhaust system is on the car) and 460 lb-ft of torque @ 4,600 rpm (or 465 lb-ft, again with the performance exhaust). Again, cast aluminum block and heads, and direct injection.

One thing to consider vis-à-vis the transmission deployment in the two vehicles is the tremendous difference in size. A Silverado 1500 with a Crew Cab and the small box (5 ft, 8 in.) has a wheelbase of 143.5 in. and an overall length of 230 in. The Corvette, by contrast, has a 106.7-in. wheelbase and is 176.9 in. long.

All of which is to say that there is a huge packaging challenge when you're looking to use the same eight-speed transmission in these completely different applications.

Kavoos Kaveh, global chief engineer for GM eight-speed automatic transmissions: "It is a marvel of packaging efficiency and driving efficiency that has garnered more than two dozen patents for General Motors."

Realize that in the case of both the 2015 vehicles, the eight-speed transmission is going into an existing package. In the case of both vehicles, the 2014 models were equipped with six-speed automatic transmissions (although the Corvette is also available with a seven-speed manual).

The point is, they had to develop the eight-speed in such a way that it would (1) fit in both the Silverado and the

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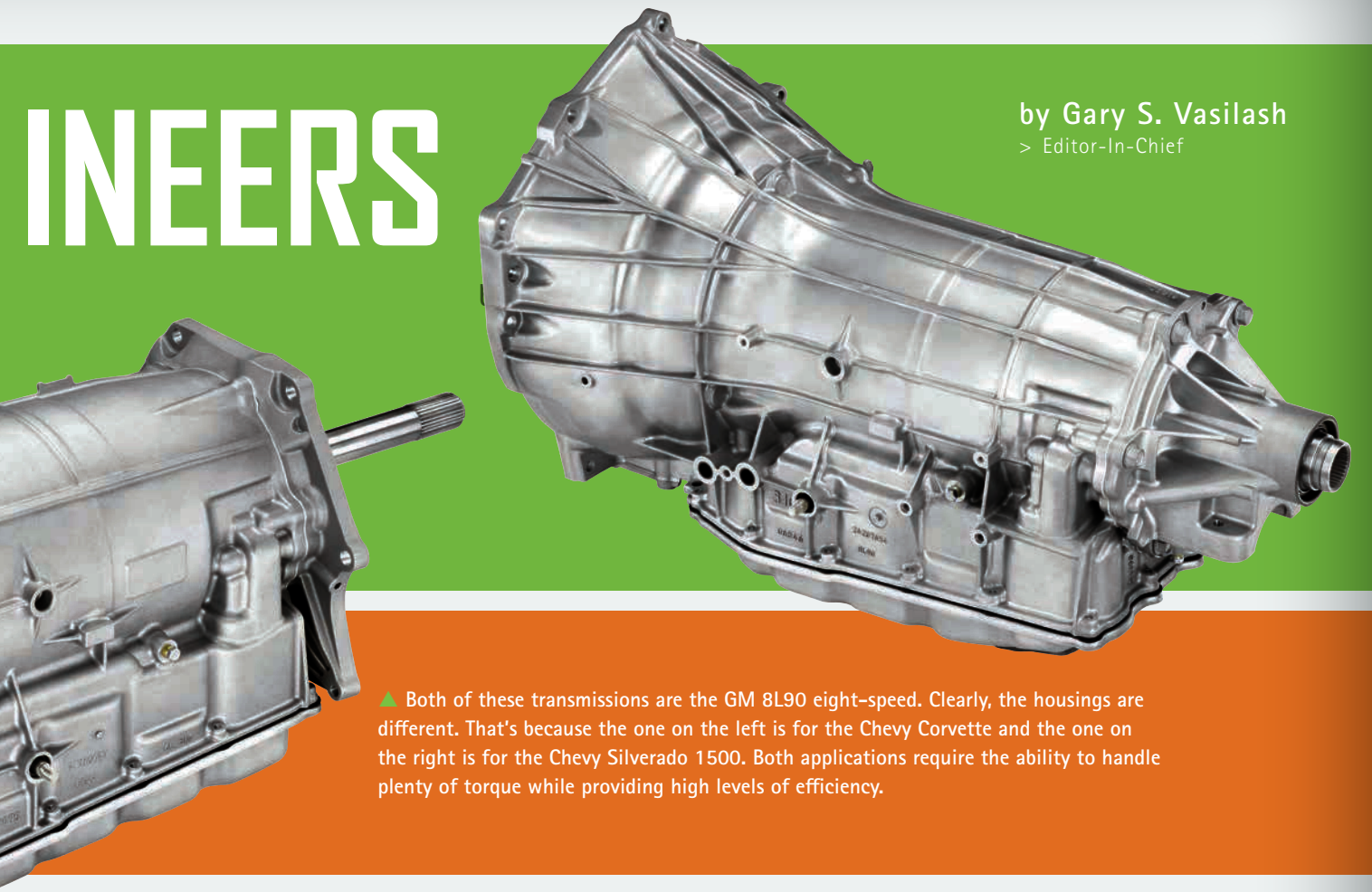


▲ Both of these transmissions are the GM 8L90 eight-speed. Clearly, the housings are different. That's because the one on the left is for the Chevy Corvette and the one on the right is for the Chevy Silverado 1500. Both applications require the ability to handle plenty of torque while providing high levels of efficiency.

Corvette and (2) fit in the space that the six-speed had been located.

According to Kaveh, a big enabler of this was a design that uses four gear sets and five clutches (two brake clutches and three rotating clutches).

One similarity between the two transmissions is the location of the grounding clutches. They are rearward of the middle of the structure, outside the gear sets. But for the new transmission, the grounding clutches are splined to the case. Consequently, the center support is eliminated and this means reduced weight.

There are smaller steps between gears in the eight-speed compared to the six-speed, which helps maximize the horsepower and torque in both vehicles, which clearly have different uses for that horsepower and torque.

In addition to which, it contributes to better fuel efficiency for both vehicles, which is of interest to drivers be they truck guys or 'Vette enthusiasts. For example, in the case of the more-aggressive first-gear ratio (4.56 vs. 4.03), it means that the Silverado is better from a start when towing a heavy load (the Silverado with the 6.2-liter and the eight-speed has a maximum available trailer rating of 12,000, while for the Corvette it means a faster time (the car with the eight-speed does a quarter mile in 11.9 seconds, which is 0.1 seconds better than the car with the six-speed).

(Speaking of quick: according to Tadge Juechter, Corvette chief engineer, the eight-speed is as quick in shifting as a first-rate dual-clutch transmission. Why not develop a dual clutch for the application? One simple reason: the packaging situation. "There was no DCT off-the-shelf that would fit in our package and meet our coming performance in the Z06." That's as in 650 lb-ft of torque from the LT4 engine. Which we'll get to in a moment.)

Here is a comparison of the gear ratios (:1) for the two transmissions:

	8L90 eight-speed	6L80 six speed
First:	4.56	4.03
Second:	2.97	2.36
Third:	2.08	1.53
Fourth:	1.69	1.15
Fifth:	1.27	0.85
Sixth:	1.00	0.67
Seventh:	0.85	N/A
Eighth:	0.65	N/A
Reverse:	3.82	3.06

The 8L90 (along with the 6L90) is manufactured in the GM Toledo Transmission Plant in Ohio.

The people working on powertrain at GM have been nothing if not busy (and we're not even talking about the new line of Ecotec engines that were announced in March 2014 and which has its first application in the China-market Chevrolet Cruze; this lineup consists of 11 engines. There are three- and four-cylinder models. The size range is from 1.0 to 1.5 liters. The horsepower range is from 75 to 165. The torque range is from 70 to 184 lb-ft. And there are normally aspirated and turbocharged variants.)

The powertrain engineers have developed an all-new engine for the 2015 Corvette Z06 that combines features found on two other engines found under the hoods of 'Vettes: the Stingray's LT1 Gen 5 Small Block and the ZR1's LS9.

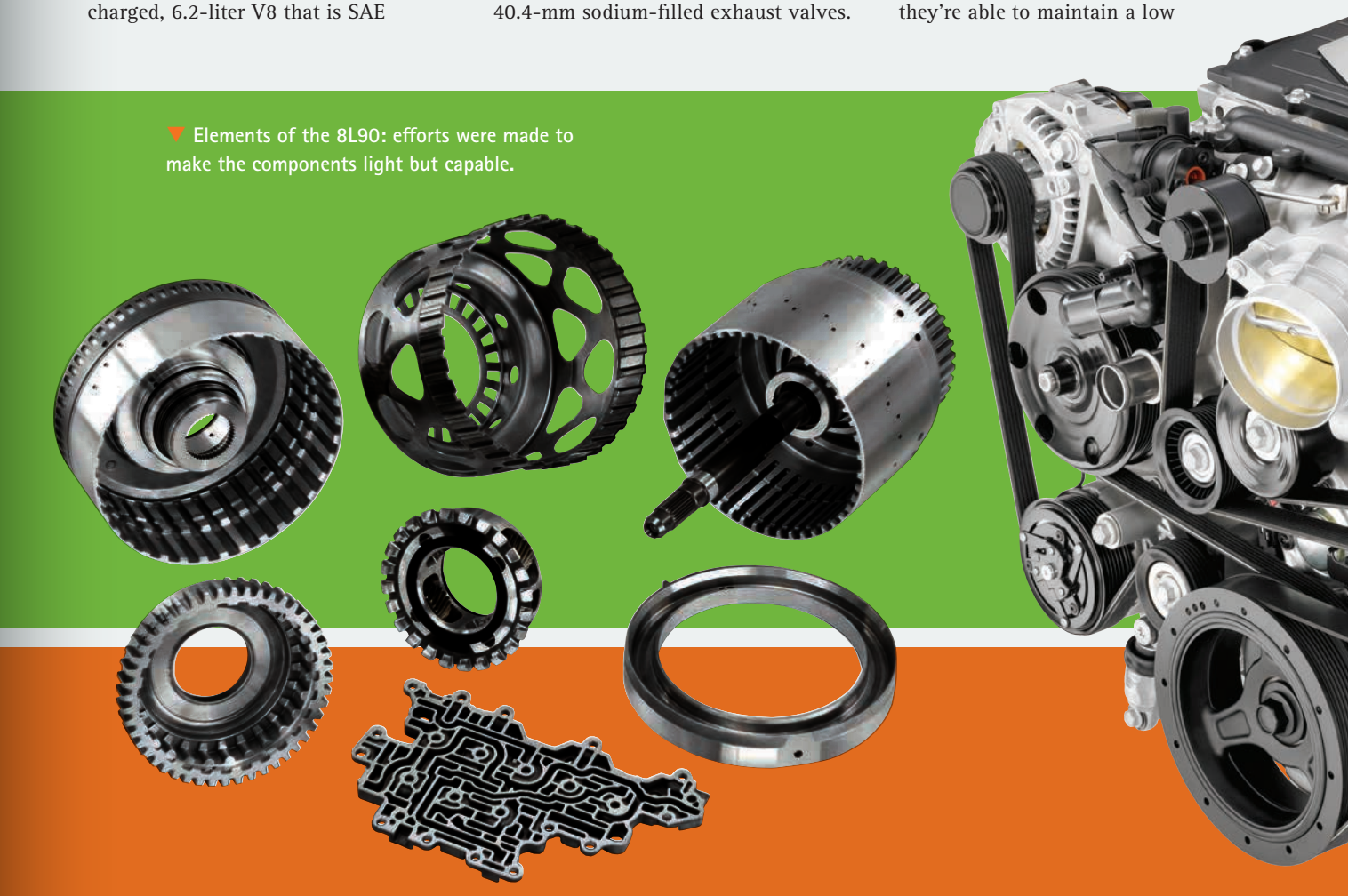
The new engine is the LT4, a supercharged, 6.2-liter V8 that is SAE certified at 650 hp @ 6,400 rpm and 650 lb-ft of torque @ 3,600 rpm.

The LT1 uses cylinder deactivation and continuously variable valve timing; so, too, does the LT4. The LS9 is supercharged; so, too, is the LT4.

While the LT4 is based on the Gen 5 small block of the LT1, there are several differences. For example, the fuel pump for the LT4 operates at 2,900 psi; it is 2,175 psi for the LT1. The fuel injectors provide 25 cc/second in the LT4; those in the LT1 20 cc/second. The design of the combustion system is similar, but the LT4 uses Rotocast A356-T6 aluminum cylinder heads. The LT4 combustion chambers are 65.47 cc; they are 59.02 cc for the LT1. The LT4 has 54-mm solid titanium intake valves; the LT1 has 54-mm hollow intake valves. Both have the same 40.4-mm sodium-filled exhaust valves.

While both the LT4 and the LS9 are supercharged, the Eaton superchargers in the engines are vastly different. Physically, the R1740 TVS 1.7-liter supercharger in the LT4 spins at 20,150 rpm. The R2300 TVS 2.3-liter supercharger in the LS9 spins at 15,180 rpm. The R1740's four-lobe rotors are shorter in length (7.9 in. vs. 8.3 in.) and smaller in diameter (3.9 in. vs. 4.4 in.), which helps account for the high rotational rate, and which help provide boost earlier in the rpm band, which helps contribute to low-end torque (the engine produces 457 lb-ft of torque just off idle and 625 lb-ft by 2,800 rpm). In addition to which, the R1740 is 20 lb. lighter.

One interesting aspect of the supercharged LT4: it is only 1 in. higher than the LT1, which means that they're able to maintain a low



▼ Elements of the 8L90: efforts were made to make the components light but capable.

hood profile for the Z06. There is another issue related to the overall package size of the LT4: the engineers had to take pedestrian protection regulations in Europe, which specify the distance between the top of the engine and the hood.

The LT4 features a cast-aluminum block. The crankshaft is 1528MV forged steel; it features tungsten balancing inserts. The damper is forged 6061 aluminum with a T6 anodized hub and iron inertia ring. The 6.125-in. connecting rod is produced with powder metal steel. The forged aluminum pistons feature a flat-top crown and internal ribs for strength. The top piston ring is PVD-coated. The floating piston wrist pins have a diamond-like coating.

"Our objective when developing this engine," Jordan Lee, chief engineer and program manager, GM Small Block Engines, "was to create ultimate horsepower and torque, to help make the most capable Corvette ever." ■

**The 8L90 is also used in the 2015 GMC Sierra, Yukon and Yukon XL and the Cadillac Escalade and Escalade ESV.*

▲ The tops of the forged aluminum pistons are comparatively flat. The compression ratio is 10:1. The fuel injectors, which operate at 25 cc/second, produce a unique spray cone that optimizes combustion under boost.

◀ The LT4 V8 for the 2015 Corvette Z06. This supercharged engine produces 650 hp @ 6,400 rpm and 650 lb-ft of torque @ 3,600 rpm. It is one of the most powerful production engines available in the U.S.